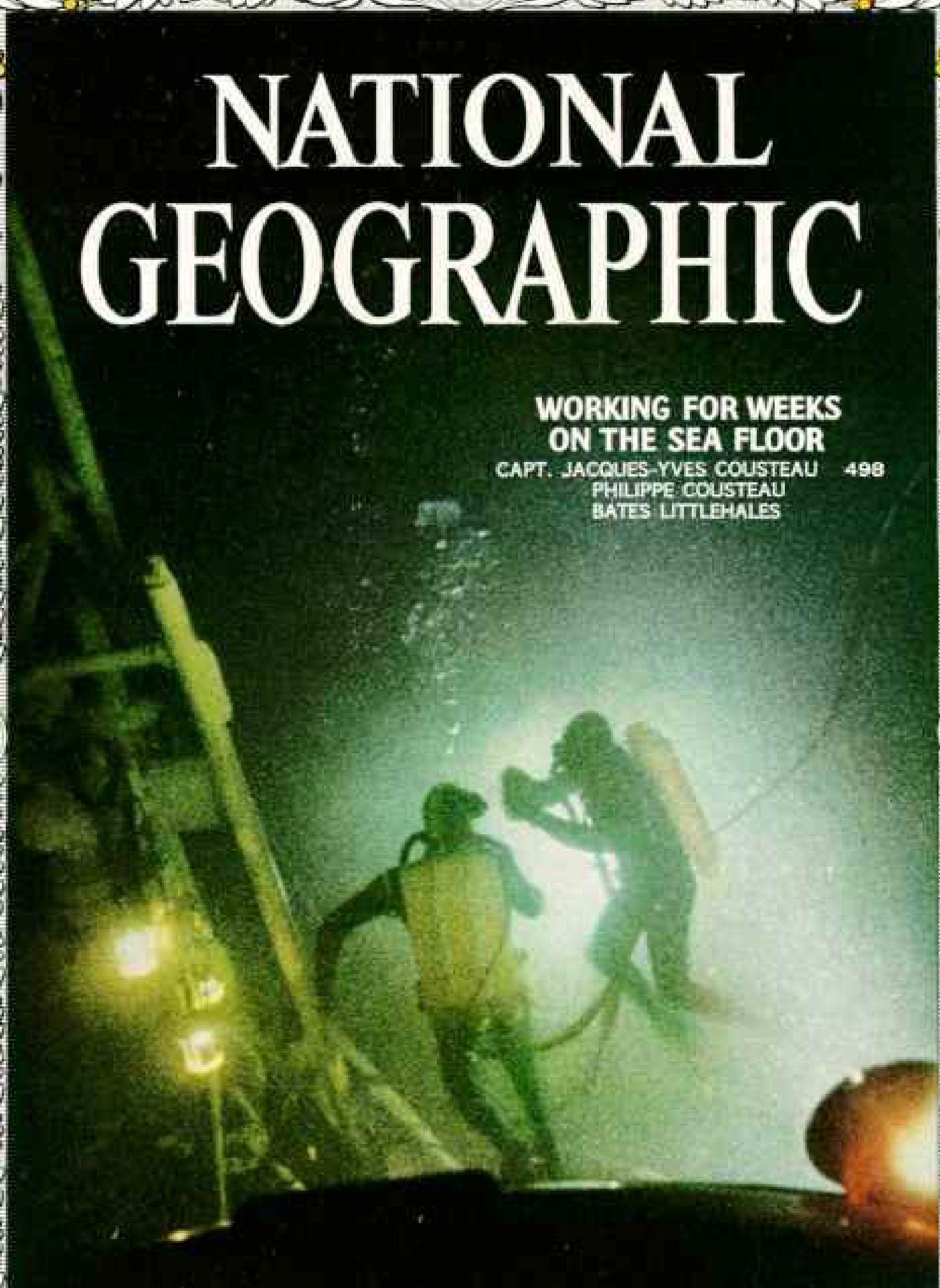
VOL. 129, NO. 4 APRIL, 1966

NATIONAL GEOGRAPHIC



SEE "WORLD OF COUSTEAU" THURSDAY, APRIL 28, ON CBS TV (page 529A)

THE JOURNAL OF THE NATIONAL GEOGRAPHIC SOCIETY WASHINGTON, D. C.

NATIONAL GEOGRAPHIC SOCIETY

WASHINGTON, D. C.

Organized "for the increase and diffusion of geographic knowledge"

The National Geographic Society is chartered in Washington, D. C., in accordance with the laws of the United States, as a nonprofit scientific and educational organization for increasing and diffusing geographic knowledge and promoting research and exploration.

Since 1890 the Society has supported more than 385 explorations and research projects, adding immeasurably to man's knowledge of earth, sea, and sky. It diffuses this knowledge through its monthly journal, NATIONAL GEOGRAPHIC; more than 28 million maps distributed each year; its books, globes, and atlases; 30 School Bulletins a year in color; information services to press, radio, and television; technical monographs; timely exhibits from around the world in Explorers Hall; and now a nationwide series of programs on television.

Articles and photographs of travel, natural history, and expeditions to far places are desired. For material used, generous remuneration is made.

COVER: Pioneer diver= labor on an oil rig 370 feet deep in the Mediterranean (page 522).

NATIONAL GEOGRAPHIC MAGAZINE

Step
OUT FRONT
IN '66 ... in a Rocket Action Olds!

Ho-hum driving is out . . . Toronado's in!

Sleek projectile shape is in. Warmed-over style is out. Road-hugging front wheel drive, definitely in. Flat floors, full-view side windows, concealed headlamps, draft-free ventilation system, full-size room for six are all in. 425-cube Toronado Rocket V-8 is way out—front! Fact is, every good thing we could think of is in. With one exception . . . You! LOOK TO OLDS FOR THE NEW!

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We're 116,000 strong and dedicated to Total Communications.

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GENERAL TELEPHONE & ELECTRONICS

THE OCEANAUTS' HOME: a crowded, pressurized sphere of steel 328 feet down in the Mediterranean. Outside, the darkness is ominous; the cold, numbing. The divers' breathing atmosphere of helium and oxygen—"heliox"—distorts their voices into squeaks. Lack of sun bleaches them white; exhaustion lines their faces. Ignoring the hardships, the men swim out to work on an oil-well head at the unprecedented depth of 370 feet—and do the job more quickly than riggers on land.

Thus for three weeks lived Philippe Cousteau (right) and five other daring oceanauts. They made their epic descent last year off Cap Ferrat, France, in the sea workshop known as Conshelf Three.

A "fish man" since boyhood, Philippe donned a miniature Aqua-Lung at the age of four. In the 20 years since, he has swum at his father's side as the world-famous explorer Jacques-Yves Cousteau extended man's conquest of the depths.

For Conshelf's historic dive, sponsored in part by the National Geographic Society, Philippe won the role of cameraman in the near-blackness of the deep. He brought back unique photographs; you see some of them in Captain Cousteau's article (page 498), as well as one on the cover. On April 28, the Society's fourth color television program will show his dramatic motion pictures of Conshelf's pioneering achievements.

Your support makes possible such vital explorations of land, sky, and sea. Why not invite others to join in these adventures, and to read about them in NATIONAL GEOGRAPHIC? Nominate your friends for Society membership on the form below.

Young man and the sea

Lincoln Continental
distinguishes your way of life.

Shown above, the Continental coupé, broadening your invitation to ownership. Also available, the sedan and America's only four-door convertible. For 1966, a new 462 cu. in. engine and a completely new transmission. New luxury options include automatic temperature control system, stereo tape/AM radio, and many others.

Lincoln Continental distinguishes you among fine car owners. It is the luxury motorcar that stands apart from all other cars. As an expression of individuality, good taste, accomplishment. As the reflection of a way of life. Come take a closer look: drive it, experience it, and discover for yourself how close you may be to owning a Continental.

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Watch surfers swoop in on a wave!

Sample our easy-going way of life

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Movie people are often seen here

One of our many "fun land" attractions

Lawns here are often solid flowers

All this at hometown prices

Southern California's famous weather actually helps hold vacation costs down. How? High rates generally reflect a short season. Ours is the longest: 12 months. With a steady year-around flow of visitors, your money does go further. Most prices aren't seasonally inflated: they run about the same as at home. Remember, too, you'll see the U.S.A. on the way! Mail coupon now.

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Sure, we're the people who build cars — from Mustangs to Lincoln Continentals.

And the same people who come up with some of the newest ideas in cars—like 2-way tailgates, Stereo-Sonic Tape Systems.

But that doesn't mean when we build a Philco refrigerator, we put a dashboard in it.

We've never limited our thinking to automobiles.

As far back as forty years ago we were making trucks, tractor plows and airplanes.

Today one of our "assembly lines" is less than one inch long. Making Philco micro-circuits for the Apollo Block II guidance computer.

Others are producing air conditioners...color TV ...communication systems...Autolite spark plugs.

We designed NASA's huge Mission Control Center in Houston. (Try putting that in your garage.)

The point is — next time you see our familiar Ford trademark, please make room in your mind for more than cars.

Make room for a new idea of Ford. Where the new ideas are coming from.

HONG KONG?

Don't be surprised if one of these Chinese beauties speaks to you in flawless English. For you're on Mott Street in Manhattan's Chinatown, surrounded by all the exotic sights, sounds and fragrances of the Far East. Browse from store to store for everything from pressed duck to Oriental ceramics. Unusual? Not in New York State, where you'll see the United States Military Academy at West Point . . . the Baseball Hall of Fame at Cooperstown . . . and right off the New York Thruway in the Mohawk Valley, you can visit the North American Martyrs' Shrine at Auriesville. All over New York the roads are great . . . places to stay plentiful and reasonably priced.

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How to keep a forest from becoming a neon jungle

America's wild and beautiful lands are going fast. Each newly born baby has one-quarter acre less of such land to enjoy than the baby born a moment before.

Near you there is probably a leafy and lovely forest, or a quiet pond, or a blissfully untouched piece of seashore. And you've often thought of protecting this rare area, but assumed that nothing could be done about it. The fact is that plenty can be done, and *you* can help do it—even though you are not a conservation specialist.

You start by getting a group to work on the problem of keeping a favorite natural wild area as God made it. This group might consist of you, a lawyer, a town official, a clergyman, a Boy Scout leader, a businessman, and your local PTA.

Throughout the country, other Americans, just like yourself, have done the job in their localities. For full information and a complete program, write to Foundation of America, 814 H Street, N.W., Washington, D.C. 20001. Ask for the Sinclair "Serve America" booklet.

For more than ten years, we at Sinclair have led in support of wise conservation of the natural beauty and resources of America.

Sinclair

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Have a travel agent? Please write his name below.

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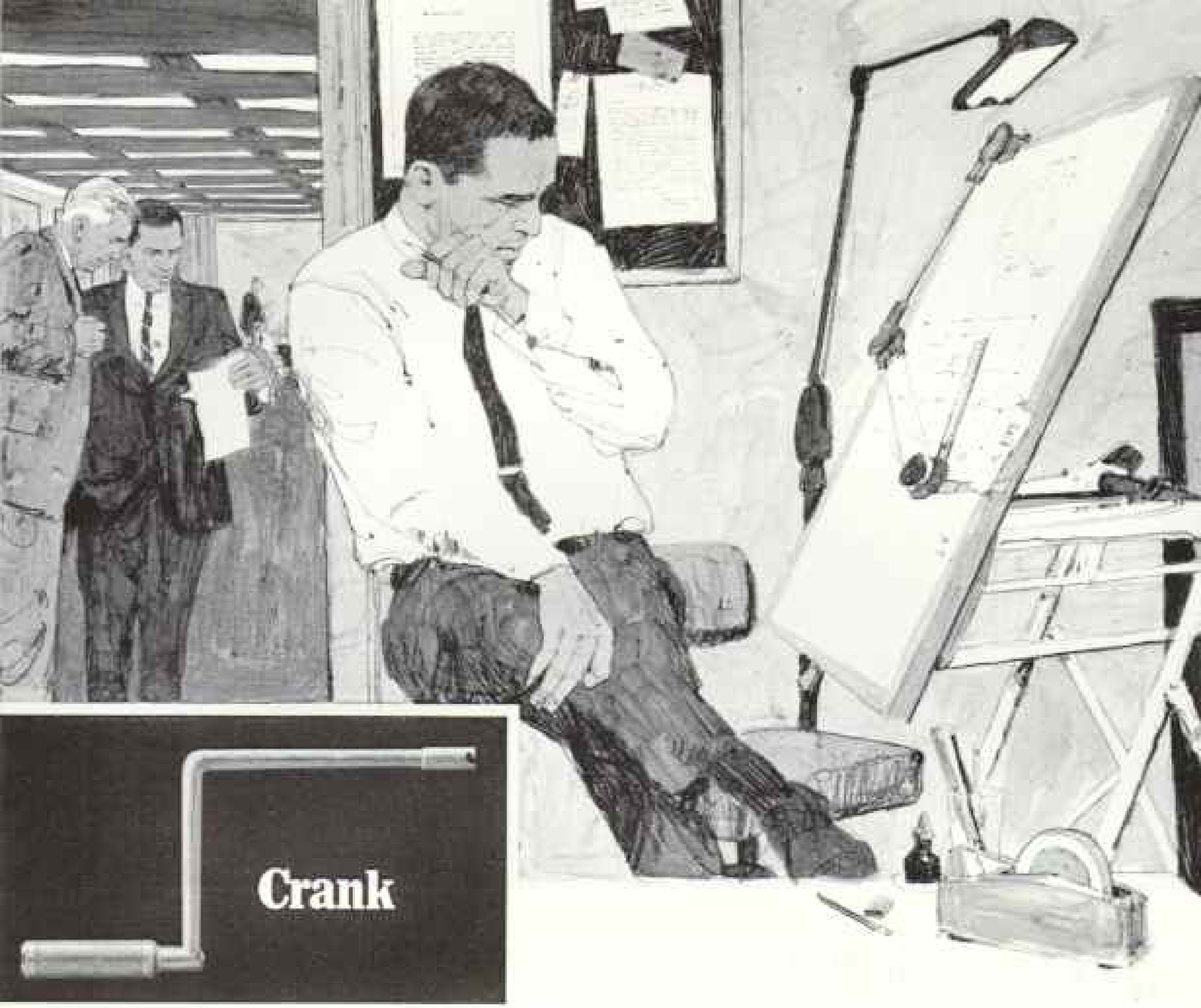

Self-Starter

It took a human self-starter to eliminate the crank. General Motors engineers have been inspired by that example ever since. They have kept to the trail laid down by a genius named Charles F. Kettering.

Back in 1910, the experts told Mr. Kettering that a practical electric starter for automobile engines was an impossibility. It took him six months to develop one. His self-starter eventually eliminated the dangerous hand-crank, revolutionizing motoring and putting women in the driver's seat. His record of scientific achievement in the decades that followed is without parallel.

And like this remarkable man's most famous invention, today's GM engineer is a self-starter—one who doesn't wait to be asked, who seeks out the tough problems and sets out to solve them.

They're a vital group, these men of science who follow the Kettering flame—restless, curious and devoted to the idea that nothing is so good it can't be improved. Their collective contribution to GM's progress over the years is beyond measure.

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free: Just mail the coupon and you'll receive more than 130 pages of helpful travel information, 200 pictures, 4 maps to help you plan a happy "cruise".

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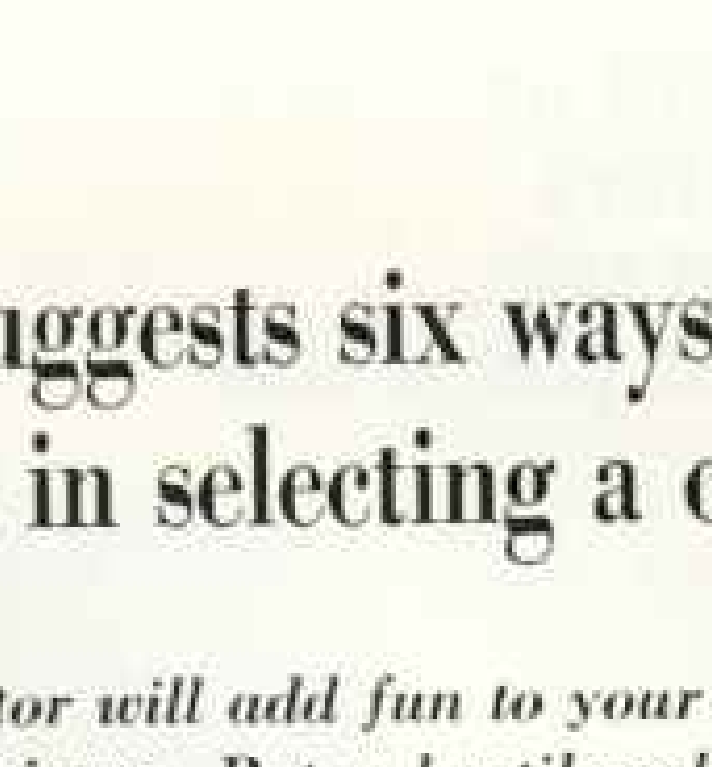
Bolens suggests six ways to avoid disappointment in selecting a compact tractor

A compact tractor will add fun to your yard-work and hours to your leisure. But a hastily-selected make can lead to regret. Here are six tips for the wary buyer:

1 Compare how attachments are driven. The powered attachments on most compact tractors are driven by belts. On a Bolens Husky, attachments are driven by a drive shaft. With a Husky, you can raise or lower attachments while under full power (as, for example, when you lower the mower for a closer cut). Raising or lowering belt driven attachments can lead to belt misalignment and wear, and eventually loss of power.

2 Learn how much time and effort are required to hitch-up a powered attachment. Hitching up a powered attachment on most compact tractors means lining up a belt, then pulling and straining to stretch it over a pulley or sheave. Belts add time to your work and subtract skin from your fingers. Hitching up a Bolens powered attachment is simply a matter of sliding the attachment's own drive shaft into the Bolens Power-lock and securing the attachment to the tractor with a few hitch pins. It's that easy!

3 Be sure the tractor offers a wide range of ground speeds to match various working conditions. On certain yard-care jobs, you'll want high speed;



A Bolens Husky powers over 25 different lawn and garden attachments

on others, low speed. A Bolens Husky has two speed ranges for twice as many geared working speeds as most other compact tractors. You select — from 6 forward and 2 reverse speeds (¾ to 6 mph) — the *one most efficient* ground speed to match working conditions. With a Bolens Husky, you'll never feel limited to a speed too fast or too slow for the job.

4 Find out whether the tractor delivers extra traction for slippery or tough going. Many tractors make no provision at all for extra traction. When your wheels begin to spin, you have a problem. With a Bolens Husky, you have a solution. Just reach over and turn the differential control knob for the extra traction you need to keep you going. With a Husky, you'll get out of tough, slippery spots other tractors stay in.

5 Buy from a manufacturer who specializes in compact tractors for lawn and garden use. For many manufacturers, compact tractors account for only a small part of their business. They could stop production tomorrow and hardly notice it. If Bolens stopped, we'd be out of business. Compact tractors are our bread and butter. So all our efforts, ideas and engineering talents go into our tractors. And to this we add 47 years of experience.

6 Be sure you know exactly what the price includes. Many manufacturers charge extra for essential equipment. With a Bolens Husky, one price covers one completely-equipped tractor, and includes extras you don't pay extra to get. Before you buy, look around. Compare carefully. If you can find a tractor that's better than a Bolens, buy it!

Bolens Husky tractors — 3 models, 6 to 10 h.p.

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FIRST IN POWERED EQUIPMENT SINCE 1918

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(1) model(s)

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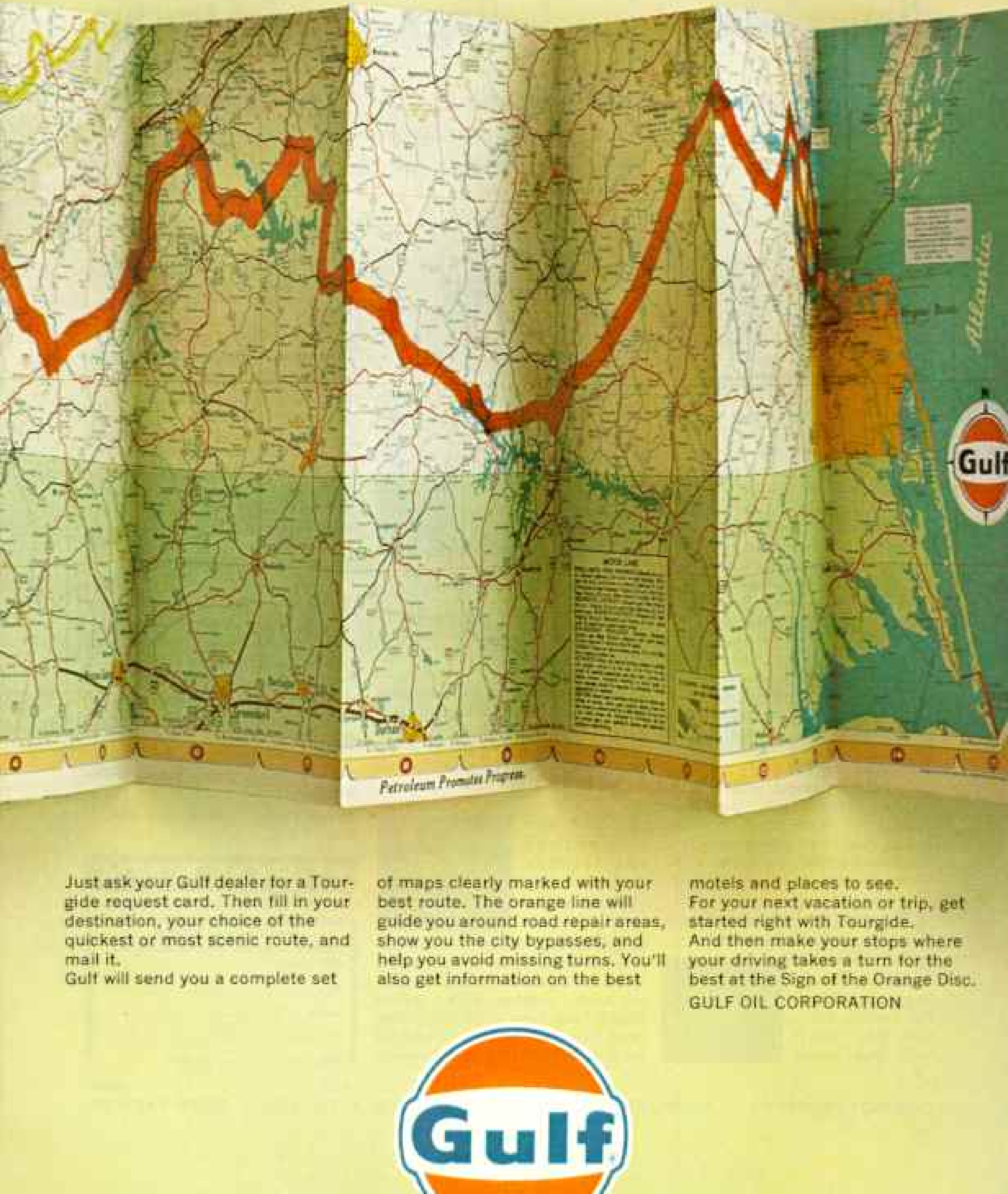
If you send us a line before your next trip, we'll send you a line.



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Gulf will send you a complete set of maps clearly marked with your best route. The orange line will guide you around road repair areas, show you the city bypasses, and help you avoid missing turns. You'll also get information on the best motels and places to see.

For your next vacation or trip, get started right with Tourgide.

And then make your stops where your driving takes a turn for the best at the Sign of the Orange Disc.

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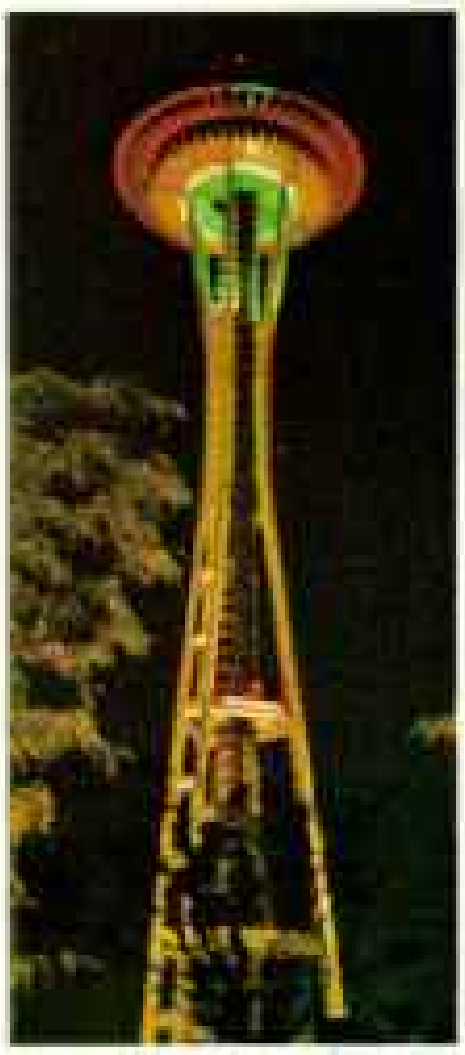
Gulf



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Explore vast ocean beaches

Travel there on the Vista-Dome North Coast Limited
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Northern Pacific Railway has free folders to help you plan your vacation. Use the coupon to send for your copies.

You'll also get "Your Northwest Adventure," a 20-page folder picturing travel on NP's Vista-Dome North Coast Limited. It tells about accommodations available on the train, the Stewardess-Nurse, the dining car, Slumbercoaches, the Traveller's Rest car and the exciting Vista-Dome cars.

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ONTARIO Canada

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GM

Cadillac Motor Car Division

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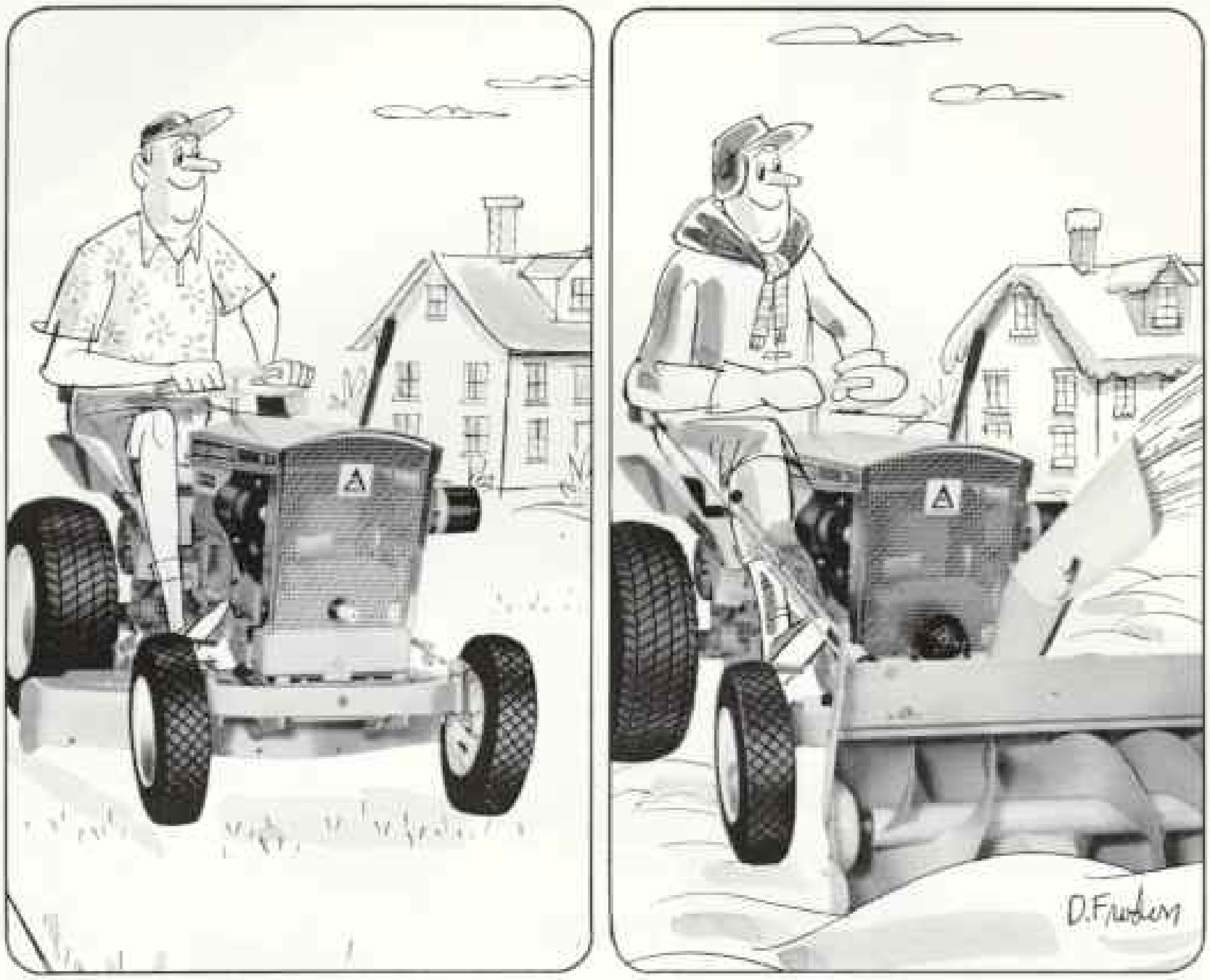
Now the most automatic of cameras does even more for you.

This camera makes it so much easier for you to take the indoor pictures you've always wanted. The new instant-loading KODAK INSTAMATIC 804 Camera does practically everything for you automatically. It even gives you automatic flash advance with the new rotating flashcube! It automatically adjusts for film speed . . . automatically advances the film for you after each shot . . . automatically adjusts the fast f2.8 lens for correct daylight exposure . . . automatically warns you when you need to use flash . . . automatically switches to flash speed when you pop on a flashcube . . . automatically sets itself for correct flash exposure as you focus . . . automatically indicates by rangefinder when focus is correct . . . and more, much more! Yet this most helpful of precision cameras costs less than $125.

Price subject to change without notice.

KODAK INSTAMATIC 804 Camera



There's nothing like a home with hot and cold running BIG-TEN

Probably the greatest household convenience since running water. Summers, your Allis-Chalmers BIG-TEN tractor can mow the lawn, weed the garden, till the soil, smooth the gravel, or haul a whole ½ ton.

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fashionable cities, so near and yet so foreign.
There's more to do in Mexico.

The temperatures are in the 80's in Mexico now. That's beach weather. Perfect for relaxing on the white sands at Acapulco or splashing in the sun-warmed waters off the coast of the Yucatan peninsula. Perfect for sightseeing in cosmopolitan Mexico City with its outstanding new museums or in colonial Guanajuato. For visiting the temples and pyramids of Teotihuacan. Whatever vacation pleasure you're looking for, now is the time to find it in Mexico.

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Home of the 1968 Olympic Games
Site of the 6th World Golf Championship, 1966
World Soccer-Football Cup, 1970
Mexican National Tourist Council
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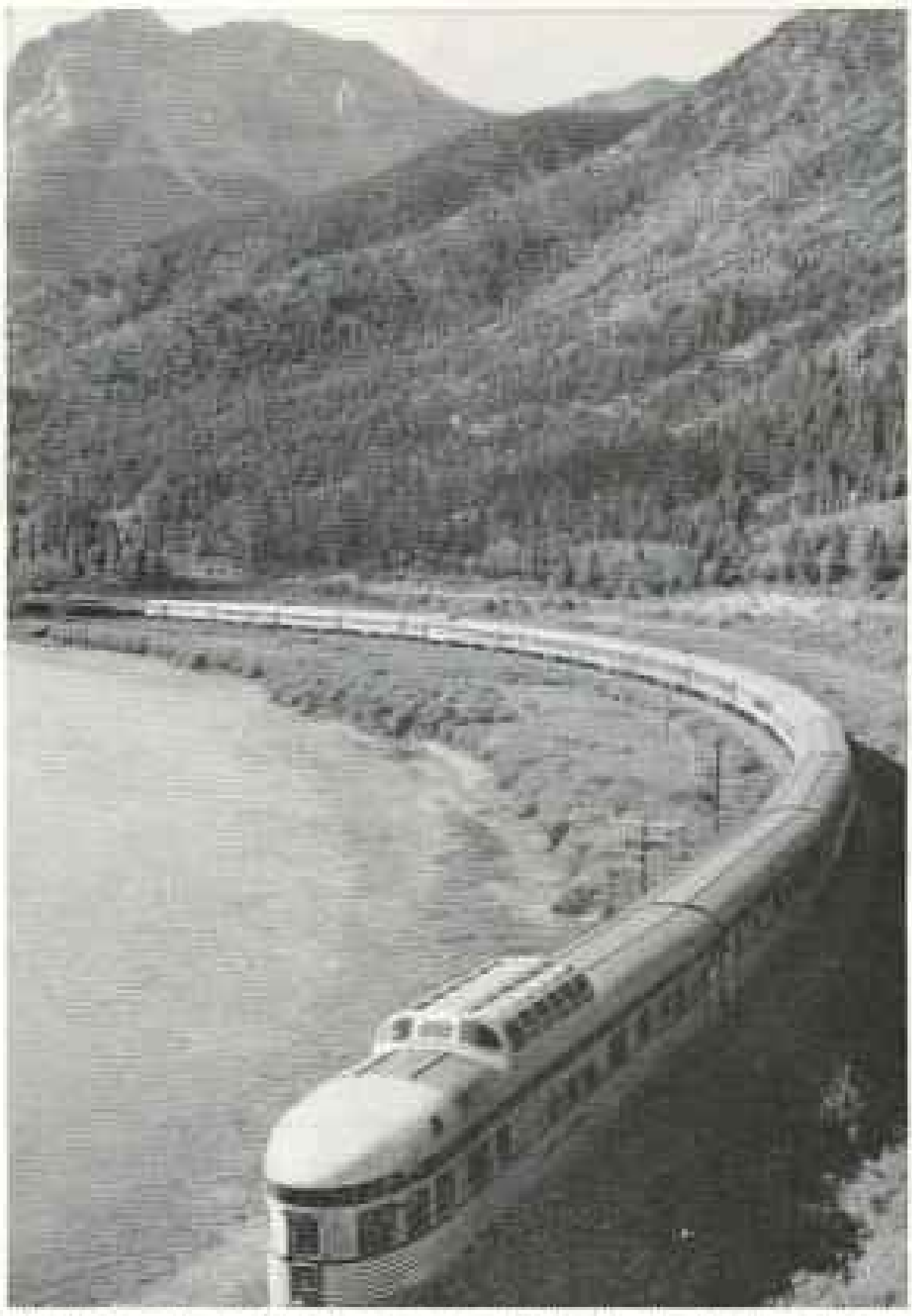
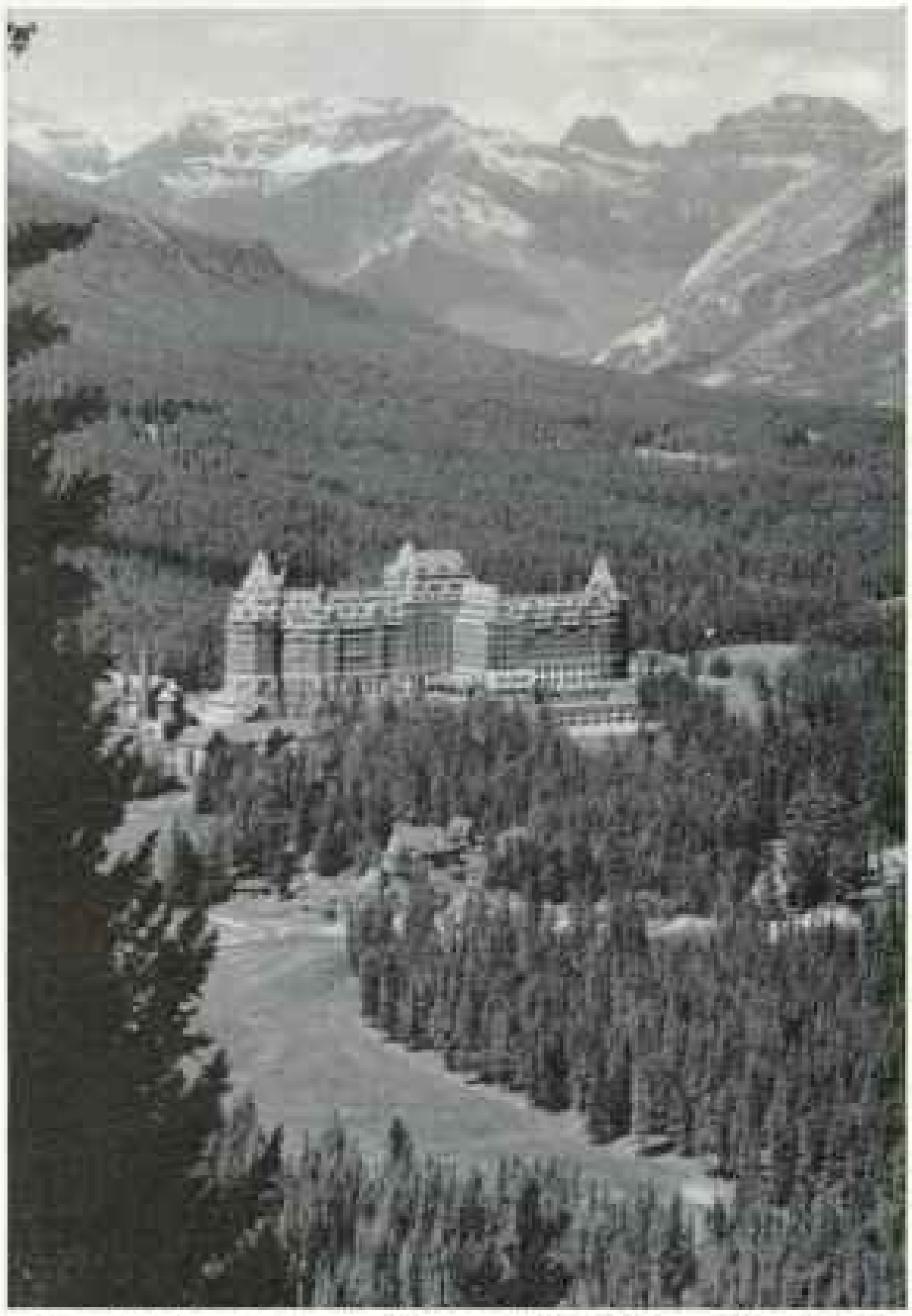
We'll give  your holiday a foreign flavor all the way (just north of the border)! Rail away with us through the Canadian Rockies to enjoy spectacular scenery in spectacular comfort. Then play mile-high  at Banff Springs Hotel, North America's fabulous mountain resort: entertainment nightly, outdoor activities, service in European style.



Ride the scenic Banff-Lake Louise route through the Canadian Rockies aboard "The Canadian." You'll see 2,881 miles of spectacular scenery from the comfort of a scenic-dome streamliner as you travel between Montreal, Toronto, and Vancouver. You'll enjoy gourmet dining, tasty budget meals, snacks. All accommodations, from coach, tourist, to first class, are reserved.



Relax mile-high in the Canadian Rockies at Banff Springs Hotel. This internationally famous resort offers golf, tennis, swimming, fishing, boating, riding, climbing, dancing—you name it. And there's nearby Lake Louise, Victoria Glacier, and Emerald Lake to visit. With its continental cuisine and gracious service, Banff Springs is an unforgettable holiday. May 29-Sept. 15.

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the case for the folding motor

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Stows like a traveling case.

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Or get an Evinrude folding motor.

The 3 hp Lightwin is a problem solver. It fits into a clean, compact traveling case.

It's easy to carry and handy to stow in car trunk, closet, or camp trailer.

The way people stop on the dock to stare when you unfold it, you'd think it was the biggest thing that ever happened to fishing.

Maybe it is.

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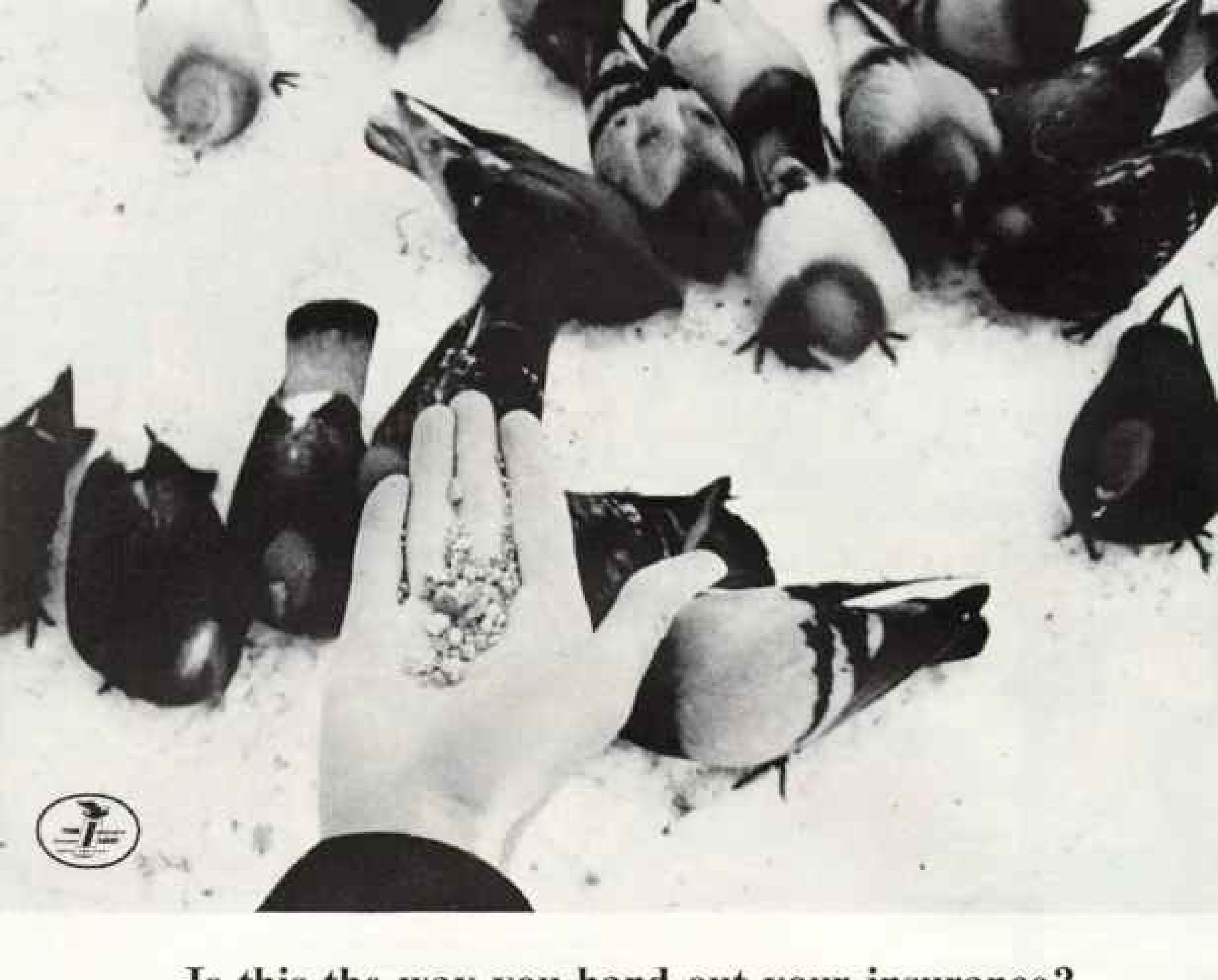

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NG

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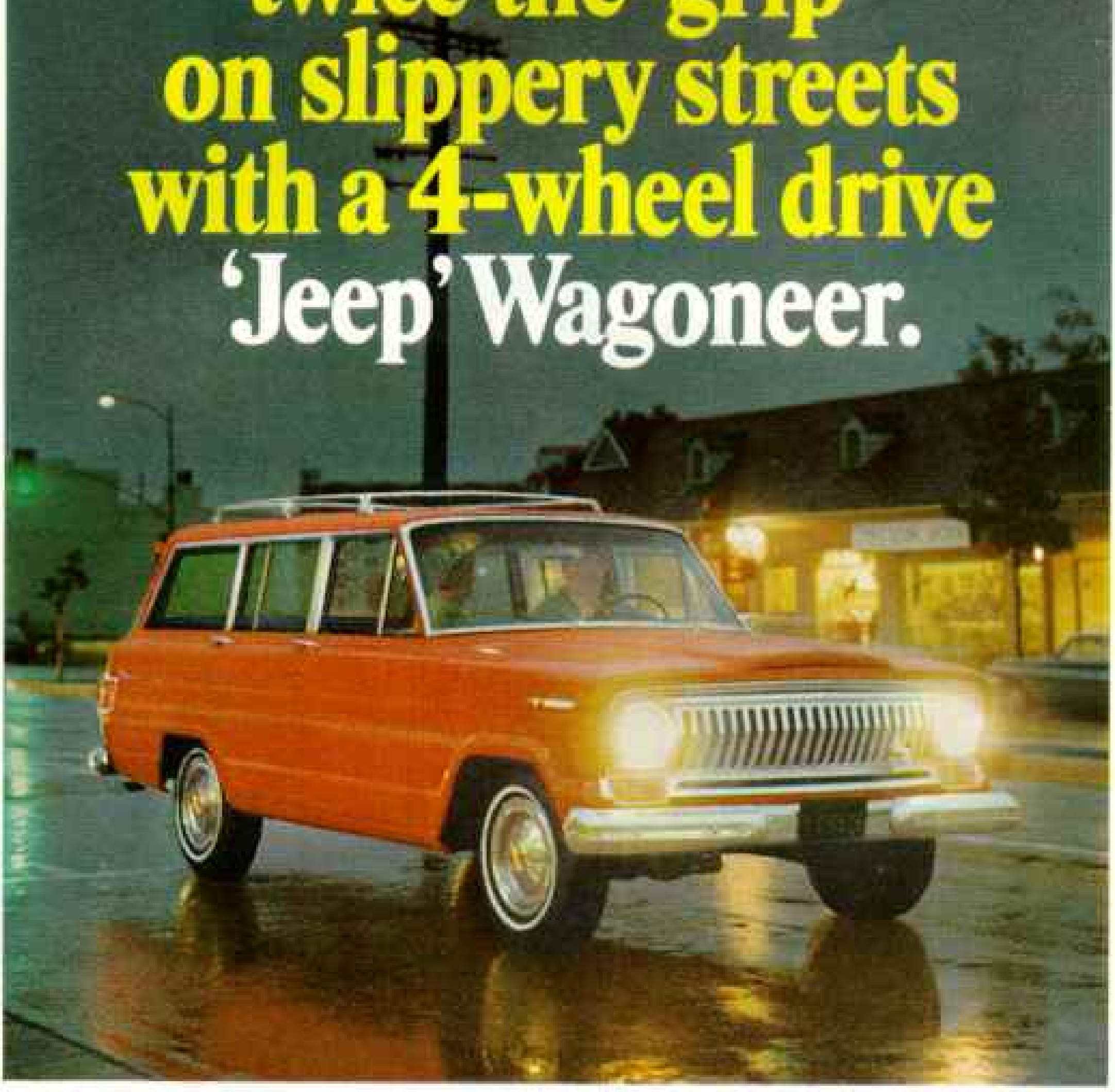

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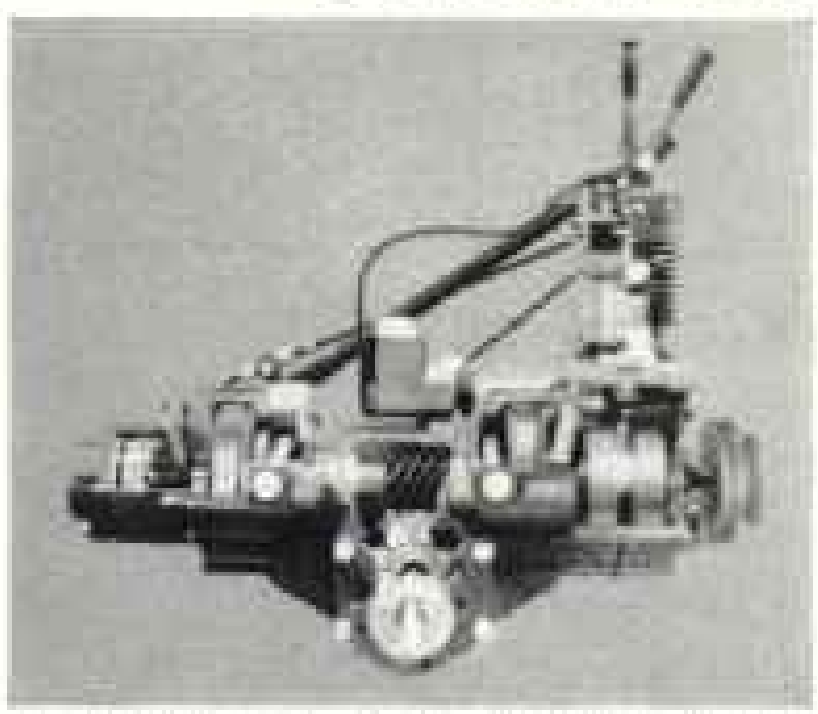

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40" Rotary, one of five mowing attachments.

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WIDE-TRACK PONTIAC/'66 GM

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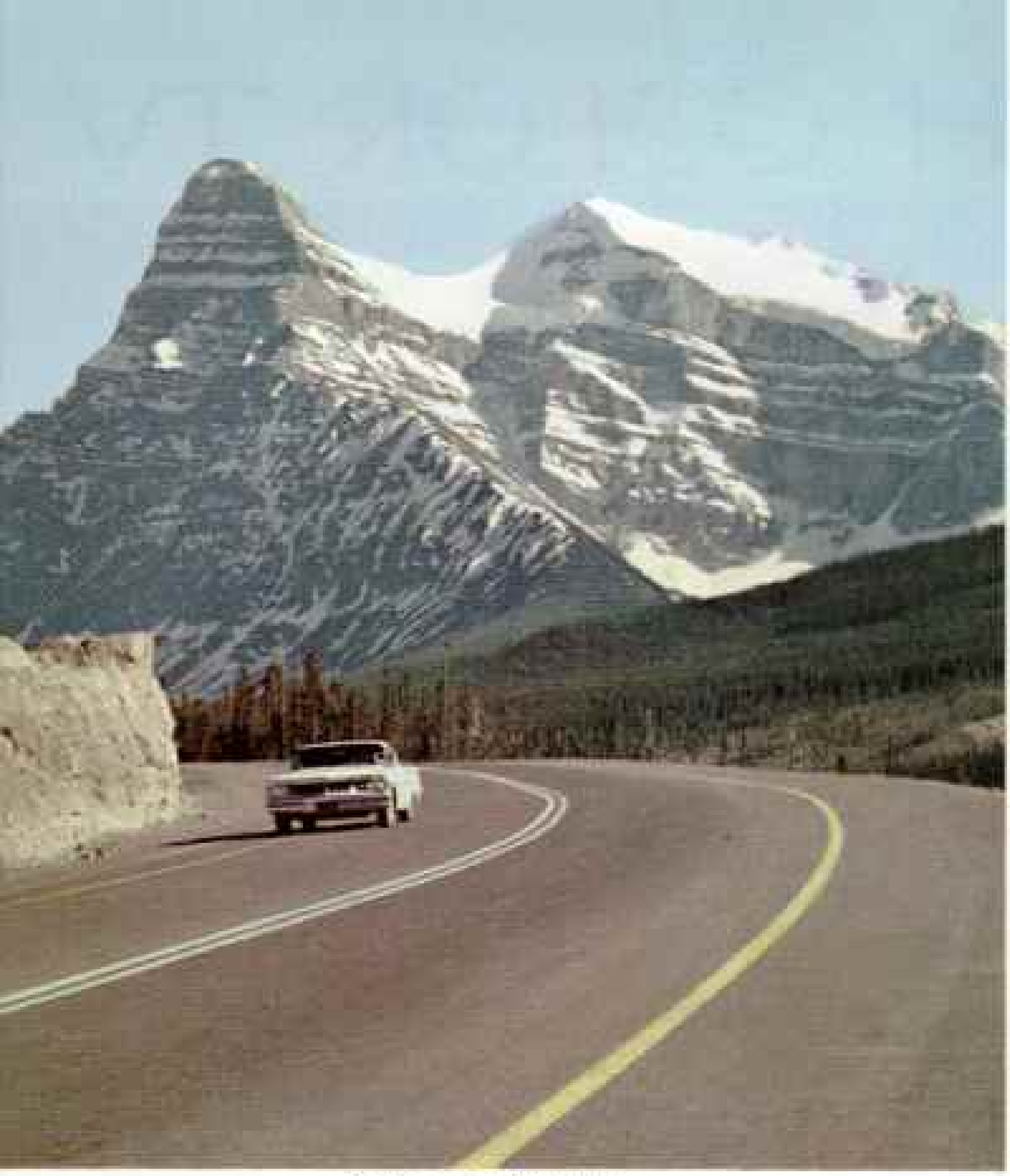

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For information on travel and accommodation, contact your nearest Canadian Government Travel Bureau office, Canadian National Railways, Canadian Pacific Railways, Air Canada, Greyhound Bus Lines or your travel agent. Or, clip the handy coupon.

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we build into every
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Zenith's new 25"* Rectangular Color TV with a giant Color picture shaped like a movie screen.

Skilled craftsmen work with extra care to create things of lasting value. That is how we build Zenith Handcrafted Color TV—with extra care.

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*Overall diag. meas., 295 sq. in. rect. picture area

ZENITH

BUILT BETTER
BECAUSE IT'S HANDCRAFTED

April
1966

NATIONAL GEOGRAPHIC

Ceylon

Article and photographs by
DONNA K. and
GILBERT M. GROSVENOR
Senior Assistant Editor

A CANNON BOOMS, breaking the still of evening under the August full moon. Echoes, scampering across the hills, knock on every door, summoning all to the celebration. From the Chalet Guest House, my wife Donna and I watch as the beautiful city of Kandy, couched in the mountains of Ceylon, dresses in light for the annual procession climaxing Perahera, the city's age-old Buddhist festival.

Below us the Temple of the Tooth flares suddenly in the dusk as white lights blaze along its crenelated outlines. Fountains in the nearby lake play in pastel patterns, and the surrounding hillsides twinkle with twisting ribbons of gaily lit bungalows. Even the fireflies seem to bear brighter torches.

Kandy's storied temple enshrines a relic venerated for centuries as an eyetooth of the Buddha. Though the precious tooth itself never leaves the temple, tonight a symbolic golden casket will be borne through the streets. And tonight Ceylonese from all reaches of the island nation will relive the pomp and pageantry of their ancient royalty.

Within minutes of leaving the Chalet, our car is entrapped in a mesh of humanity. We

Bright as a butterfly, a woman in a flowing skirt flutters across a terraced rice field in Ceylon's highlands, balancing on a dike as if on a tightrope.

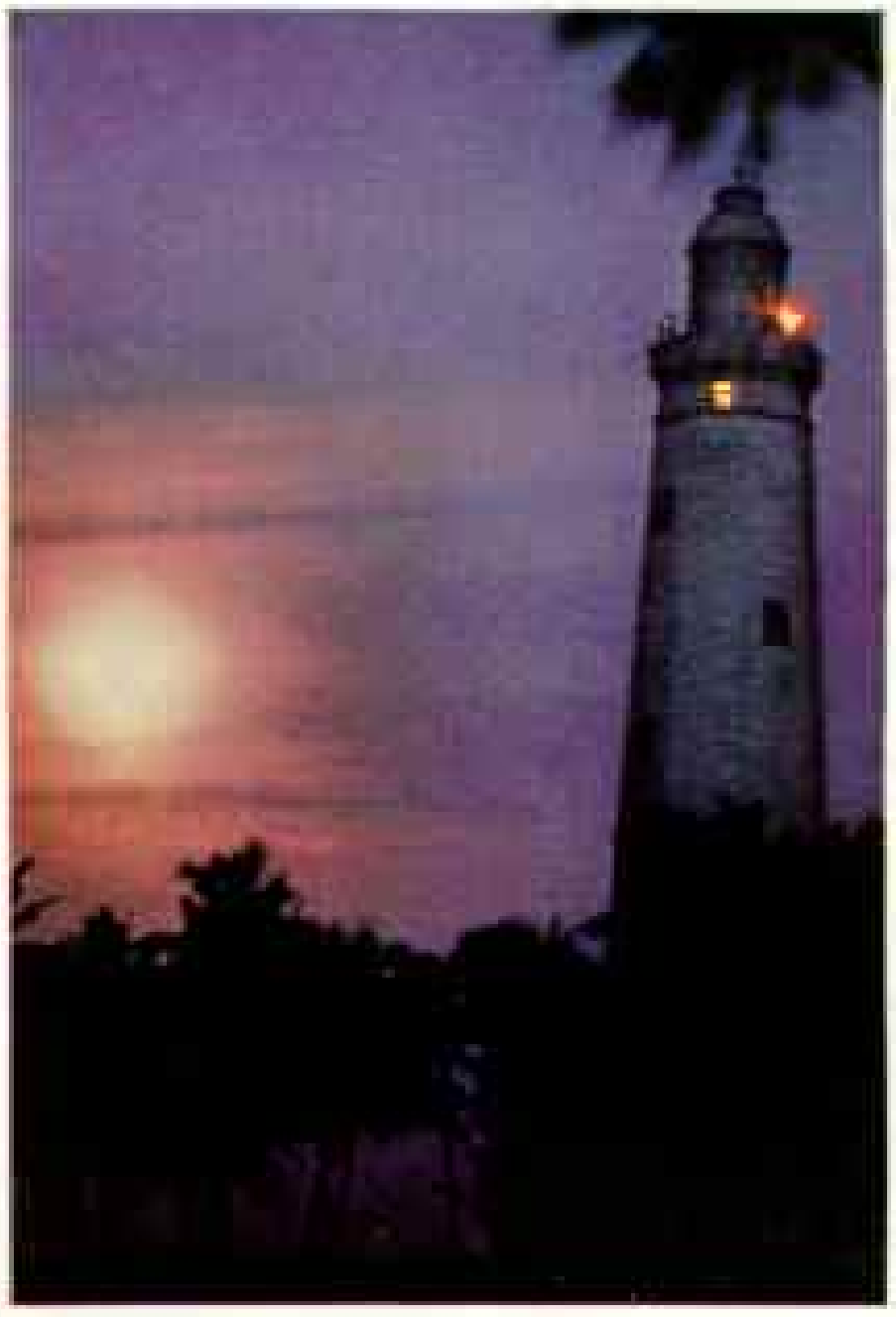
ROADCHANGE © N.G.S.

Festival lights

WHEN MIDSUMMER's full moon silvers Ceylon's skies, peaceful Kandy turns into a fantasy of light and sound for the celebration of Perahera. From the moated Temple of the Tooth (left) emerges a golden casket, copy of one that holds a relic vener-

flare in Kandy

ated as a tooth of the Buddha. While the relic stays behind in the temple, the casket goes on parade, riding atop Rajah, an elephant with gold-sheathed tusks. He leads scores of others, three abreast, down Kandy's streets. Clothed in shining satin, the pachyderms twinkle with portable electric lamps. Drummers, musicians, acrobats, and dancers join the exuberant procession. For ten days, Kandy becomes a fairy-tale town out of the far-distant past.



EXTACHROMES BY GILBERT M. GROSVENOR © N. G. S.

Man and nature combine to turn night into day during the Perahera. The moon, electricity, and torchbearers with braziers of flaming copra light the glittering observance. Major events in the life of the Buddha occurred at the time of the full moon, and believers schedule religious festivals like the Perahera to coincide with it.

abandon it and wriggle our way along on foot. As we reach the temple, a final cannon shot signals the beginning of the procession.

Rolling drums pound cadence, and crackling whips welt the air. Torchlit waves of dancers tinkling with silver ornaments leap and whirl to the stirring rhythms of martial music. Elephants—an incredible, orderly herd of close to a hundred—lumber three abreast, their gray hulks spangled with satin emblazoned with myriad lights.

"Madam, there's Rajah!" Dan Dias, our driver-guide, points to a huge elephant draped in shimmering brocade, its tusks bound with gold (preceding pages). "For many years Rajah has carried the eyetooth casket of our Lord Buddha. He knows that all eyes watch him. See how carefully he steps upon the carpet of white linen unrolled before him?"

Behind Rajah parades a stately figure: the Diyawadene Nilame, lay guardian of the temple, swathed in bulging layers of magnificently jeweled ceremonial robes and wearing brocaded slippers.

Ceylon Turns to the West

The last elephant passes, crowds flow into the streets, and Kandy reverts to the 20th century. But the explosion of light and color and sound, with its admixture of carnival atmosphere and reverent mysticism, has given Donna and me a glimpse into Ceylon's legendary past. Even today that kaleidoscopic past is everywhere evident.

We had arrived at a crucial time in the little nation's affairs. After drifting perilously close to bankruptcy and Communism, the island voted its leftist government out of office in March, 1965, and installed a democratic regime friendly to the West.

Now Ceylon, custodian of a culture 2,500 years old, struggled valiantly to establish a 20th-century identity. Its new government sought to broaden the economy, largely dependent on tea, rubber, and coconut products, and to instill a sense of unity and purpose among a diverse population of 11 million.

For seven weeks Donna and I crisscrossed the island, finding it surprisingly varied in terrain and climate for such a relatively small area. Under a fiery sun we explored the northern plains, parched with drought from June to October but often inundated by northeast monsoon rains during the winter months. We climbed tortuous roads into Ceylon's south-central highlands, an area where nature rations rain and sunshine in delicate proportions to nurture tea bushes blanketing the contoured hills. And we followed the crescent of the southern plains, like the north a farming region subject to the capricious extremes of the monsoon cycle (map, page 454).

Between forays around the island, we savored Colombo—sprawling seaport capital, a city where bullock carts plod along in the shadow of modern skyscrapers. Not a section of Ceylon's largest city escaped our fascinated inspection. But, like most visitors, we always returned to the Pettah, or marketplace, whose narrow clogged streets resound in a raucous symphony of blaring horns from vintage cars and battered buses, of rumbling carts and chattering humanity (page 457).

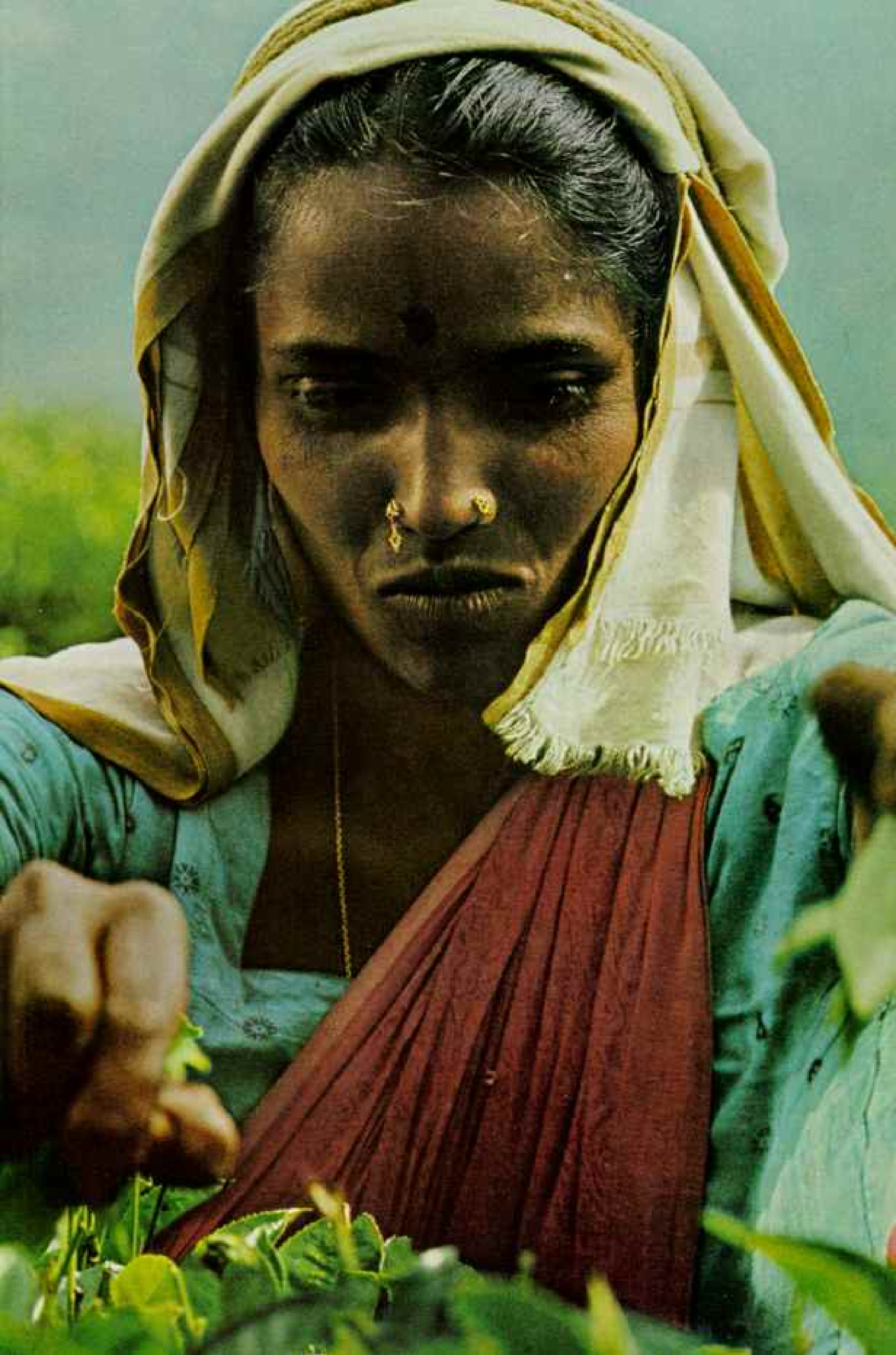
A sweating porter, bent beneath bulging bags of rice, nudges me against a wall of tin kettles. Bounding out of his stall, a bearded Moor seizes upon my embarrassment at his tumbled wares to barter for a quick sale. I veto 10-gallon pails, but buy a Thermos jug.

In one cluttered shop, permeated with the pungence of fish and curries, I stop to finger the grocer's latest selection of large dried fish: they swing like stiff cardboard from a hook above baskets of Bombay onions, little red chilies, and black peppers.

Everywhere we hear betel vendors hawking a five-cent chew. Donna edges close to a vendor and watches. His customer selects a few choice chunks of areca nut, places them on a fresh betel leaf, then dips a dirty finger into a white paste of powdered limestone. He spreads the sticky lime on the nut and leaf—like mustard on a hot dog—then rolls up the concoction and pops it into his mouth. When the vendor offers Donna a sample, she flees.

The Pettah abruptly yields to Colombo's administrative and commercial center, the Fort, once the site of a Portuguese and later

Dark skin and golden nose "trills" identify this tea picker as an Indian Tamil. Her people have been brought from southern India since the 1830's to work on coffee, tea, and rubber plantations. Now more than a million strong, many still have close ties with India. Unlike them, a million Ceylon Tamils, whose forebears came centuries earlier, are citizens and may vote. Both groups are Hindu, set apart by religion and language from the Sinhalese, the island's Buddhist majority.



of a Dutch stronghold. Stark modern skyscrapers dwarf rows of government buildings (above), boutiques and jewelry shops, and the century-old Clock Tower. Money-changers hustle rupees, street traders peddle National Lottery tickets, and cycling salesmen push Elephant House brand ice-cream wagons.

"Industrialize!"—Though Funds Are Scant

On the fringe of town Donna and I see another facet of Colombo's personality. Ducking down a sleepy side street, we walk into the roar of a new can factory. Huge hydraulic presses slam in vibrating staccato, spitting out thousands of tin cans. Above the din of rending metal, away from the searing heat of soldering machines, Mr. Basil Amerasinghe, one of the owners, proudly tells us:

"Our factory marks one of Ceylon's first efforts toward medium-scale manufacturing. When we built it in 1963, we committed ourselves to mass production with expensive machinery. Financing proved difficult, as few European countries would risk new capital

here. Also, we had to train every technician—none could be found in Ceylon. But with enough capital and increased tin imports, I could employ more men, run at greater capacity, and meet all Ceylon's needs for cans."

Although Mr. Amerasinghe is succeeding, tremendous financial obstacles discourage many others from risking investments.

"The West strives to inspire the capitalist system, but won't support private industry," echoed another manufacturer. "Loans are negotiated only on a government-to-government

"A great island . . . resort of ships," wrote the sixth-century Greek trader Sopater of the land known today as Ceylon. The description holds. From the ends of earth ships still come, dropping anchor in the protected harbor of Colombo to take on tea, rubber, and coconut products. And a democratic government, now looking to the West, builds toward a return to onetime greatness. In the House of Representatives and the Secretariat, right foreground, government officials strive to keep faith with the island's original name—Lanka, the Resplendent.

Ceylon

Kankesanturai
Point Pedro
Palk Strait
Jaffna
Mullaittivu
Adam's Bridge
Mannar
Gulf of Mannar
Vavuniya
Trincomalee
Mutur
Anuradhapura
Kurunegala
Putzalam
Sigiriya
Polonnaruwa
Dambulla
Eravur
Batticaloa
Chilaw
Matale
Kalmunai
Negombo
Kegalla
Gal Oya Dam
Akkaraipattu
Colombo
Nuwara Eliya
Badulla
Pottuvil
Moratuwa
Panadura
Hapitale
U V A
Ratnapura
Balangoda
Kalutara
Beruwala
Rakwana
Ambalangoda
Hikkaduwa
Kalutara
Galle
Weligama
Matara
Dondra Head
Hambantota
TEA
RICE
RUBBER
COCONUTS

CEYLON

PEARL pendant off the tip of India, the 270-mile-long land of the Lion People, the Sinhalese, is justly famed for gems and tea. This parliamentary state became an independent British Commonwealth member in 1948. Traditionally tolerant, Ceylon gives voice to four world faiths: Buddhism, Hinduism, Islam, and Christianity.

AREA: 25,332 sq. mi.; slightly bigger than West Virginia. **POPULATION:** 11,000,000; 70 percent Sinhalese, 22 percent Tamil. **LANGUAGE:** Predominantly Sinhalese; Tamil and English also spoken. **ECONOMY:** Agricultural; second (to India) in world tea output, fourth in rubber. **MAJOR CITIES:** Colombo (510,947), capital and port; Trincomalee, port; Kandy, center of Buddhist culture and pageantry.

basis. Ceylon pleads to businessmen, 'Industrialize!' But when we respond, our national banks cry, 'Sorry, no credit available!' "

Near Colombo, at Ekala, the government has built an industrial complex to stimulate small manufacturing. It offers inexpensive factory facilities, electricity, water, and abundant labor. But limited foreign exchange has forced cutbacks of imported raw materials.

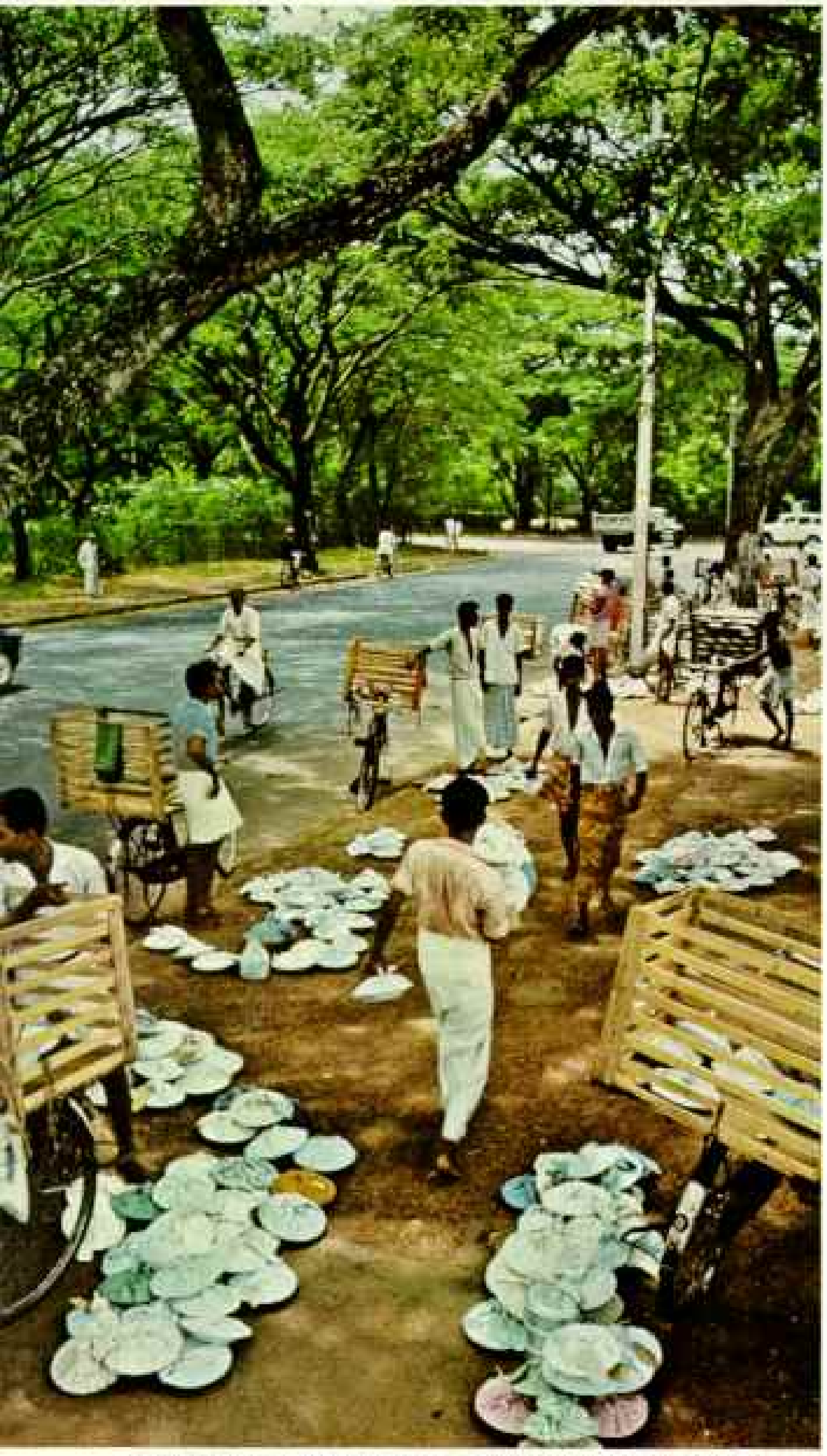
An owner who invested in the project lamented: "I have the finest German machinery for making carbon paper. My papers and ribbons equal any European imports into India or Southeast Asia. I know I can undersell those imports, if only Ceylon would lift its meager import quota for carbon black. Without carbon black, I'm finished. How can I pay for idle machines?"

Bare Treasury Confronted New Prime Minister

The destiny of Ceylon's fledgling industries—indeed of the entire nation—rests in the hands of Prime Minister Dudley Senanayake (below). Elected in March, 1965, he inherited a treasury so bare that funds had to be borrowed to meet payrolls for civil employees.

Earlier Ceylon writhed in economic chaos and political discontent. A leftist government, headed by the modern world's first woman prime minister, Mrs. S. W. R. D. Bandaranaike, threatened to suppress a critical free press. Rumors had it that she would

Prime Minister Dudley Senanayake heads a neutral coalition government struggling to stabilize and modernize Ceylon with help from the West. At the Royal Colombo Golf Club he plays with Dr. Bede Muller, a Burgher, as descendants of early European settlers are called. Declining to stoop, the caddy retrieves a golf ball with his toes.



EXTACHROMES (ABOVE AND BELOW) AND KODACHROME BY GILBERT M. GROSVENOR © N.G.S.

nationalize the large tea estates, which provide 65 percent of Ceylon's foreign exchange. As the government gravitated toward the Communist bloc, Western nations lost confidence in Ceylon.

"Our country was fighting for its life in perhaps its last free election," a brilliant Ceylonese lawyer told me. "All of us—professional men, intellectuals, and businessmen alike—laid aside our jobs, fanned out across the country, and vigorously campaigned against Mrs. Bandaranaike.

"For forty days I ran from speech to speech—sometimes ten a day. I'd leave home at dawn with three shirts and a flask of tea. The issues were fundamental, rising above caste, community, religion, or party.

"When Dudley Senanayake carried the vote, our country turned the corner. We chose not to be just cogs in the wheel of state, not to belong to the state, but rather to have it belong to us," the lawyer concluded.

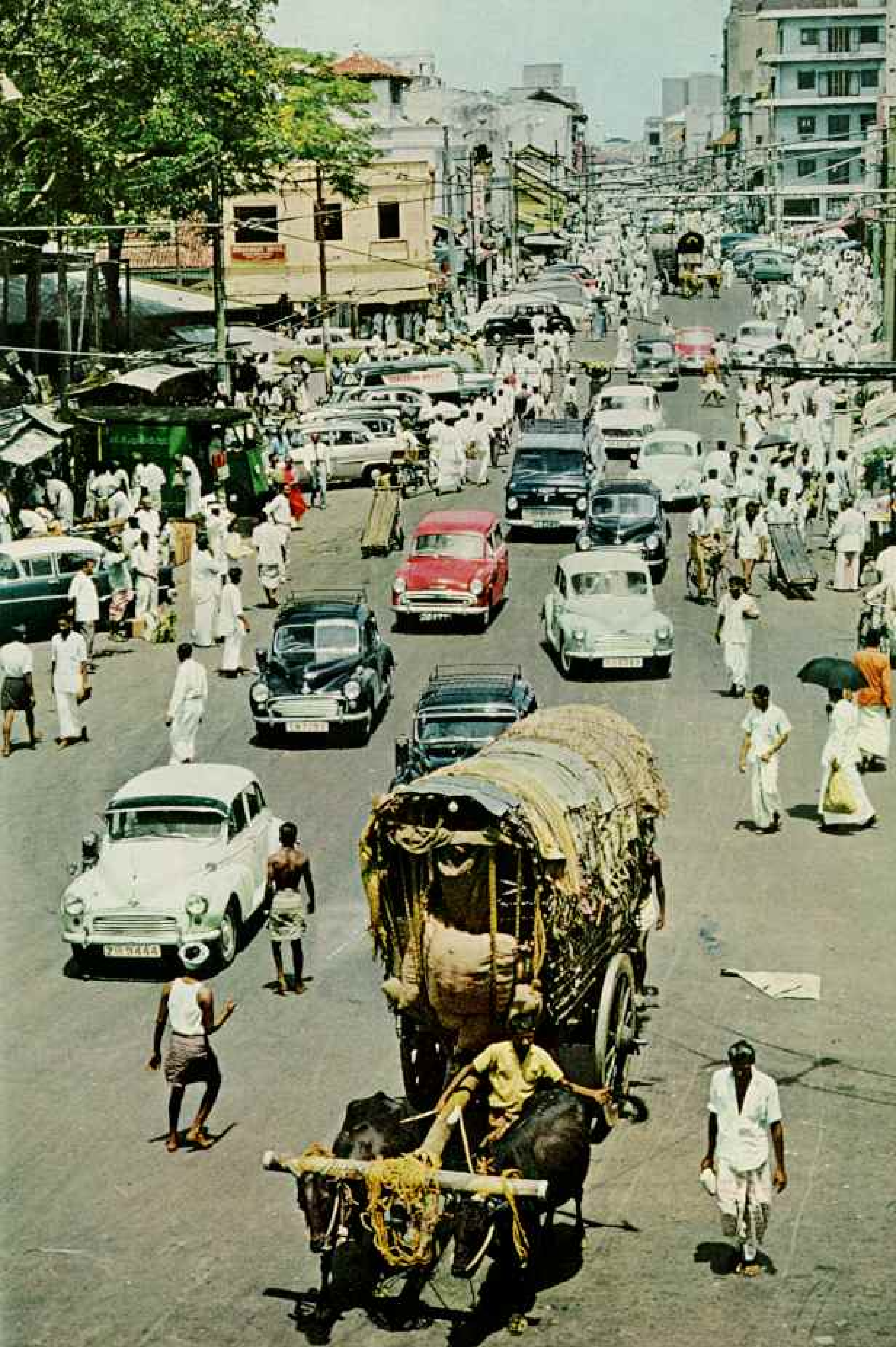
Donna and I called upon the prime minister several times. A kind, modest, soft-spoken man, he discussed candidly the difficult problems confronting his country.

"First we must stabilize the economy," said Mr. Senanayake. "Our United National Party controls almost 100 of the 157 parliamentary seats, enough to ratify our programs.

"Like many small developing nations, we need foreign exchange to bolster our critical imports of food and raw materials, machinery and

Freshly cooked curries in covered platters await delivery by bicycle to businessmen in Colombo. Each morning boys collect the lunches from customers' homes and gather here in Cinnamon Gardens to sort them according to office buildings. After serving, they wait for the plates, sort them again by neighborhood, and return the empties—all for about five rupees ($1) a month.

Bullock carts rumble down the street. Autos honk through crowds. Sidewalk salesmen hawk eggs, fruits, brassware, and betel chews. Chickens squawk in portable cages (left). The time: any daylight hour at the Pettah, Colombo's market.



With trunk and toes, an elephant hoists a log at a lumbermill near Kitulgala. His mahout directs the work by shouted commands and pressure behind the ears. Bulldozer of Ceylon, the animal can haul 1,000-pound loads through trackless forests, yet it needs no spare parts, yearly tune-ups, or imported fuel.

Ceylon's elephants once roamed the island freely, property of kings. But shrinking jungle domain and elephant roundups cut numbers from 10,000 a century ago to fewer than 1,200 today. The government no longer grants licenses for capturing wild elephants for training.

Kneeling for a daily bath, the lumberjacks have hides scrubbed by their mahouts. At the command *"Dheri udheri"*—"Rinse, please"—they raise trunks like fire hoses and shoot water over spots freshly cleaned.

consumer goods. To earn additional foreign currency, we must increase our exports; tea, rubber, and coconut products are not enough."

The prime minister sighed. "But without raw materials, the task is difficult. For the next two or three years, aid is essential."

"Do you plan new industries?" I asked.

"We wish to encourage small industries to manufacture products that we now import or do without," he replied. "To support these industries, my government has recently lifted the ban on many essential imports, especially spare parts for lorries and machinery. Also, Western capital is again beginning to flow into Ceylon."

Economic Problems in a Land of Plenty

Later, strolling Colombo's crowded ocean front, I wondered if many Ceylonese shared Prime Minister Senanayake's deep concern over the nation's economic problems. I recalled the words of a Ceylonese friend: "In my land, where starvation is unknown, life touches our people lightly. Just thrust a stick into the ground, and it will bear fruit. Crack open a fallen coconut, and you will find nourishment."

We lingered with the throng of carefree Ceylonese families gathered on Colombo's mile-long ocean-front stretch of emerald turf known as the Galle Face Green. When the scorching sun lies spent on the horizon and cooling breezes blow across the green, a medley of faces, fair and dark, mingle here in a profusion of vivid saris and white sarongs, gay print dresses and European business suits.

Few small nations can claim a more plural society than Ceylon. The eight million Sinhalese Buddhists mix with two and a half million darker-skinned Hindu Tamils, plus a sprinkling of fairer Christian Burghers, who descend from early European settlers. Europeans and Ceylonese Moors add to the cultural montage.

More than 2,000 years ago, when much of Europe was still inhabited by barbarians, Ceylon boasted magnificent kingdoms built by Sinhalese upon the foundation of a great religion, Buddhism. The Sinhalese, a people from northern India, came by sail in the fifth or sixth century B.C. to settle on this island off the toe of India. They constructed huge artificial lakes and dug intricate irrigation canals. Appropriately, they called the land Lanka, meaning "resplendent."*

Buddhist Lanka prevailed for 1,800 years, despite repeated invasions by fierce Hindu warriors from southern India, the Tamils. For centuries the Sinhalese and Tamils fought, until finally all the dams and canals were destroyed and the land ravaged. What war had started, malaria finished, and by the early 16th century both the Buddhist and Hindu kingdoms had withered.

Ceylon, divided and exhausted, endured occupation by the Portuguese, and later by the Dutch and British. The island did not regain its independence until 1948.

Choice of Language Leads to Riots

Despite centuries of coexistence, Ceylon's diverse groups have maintained, in general, their own ethnic identities, even languages. Although the British endowed the island with an international tongue, in 1956 a fervid nationalistic government proclaimed Sinhalese the official language. This decision, rekindling ancient Tamil-Sinhalese feuds, led to bloodletting riots in 1958 and serious unrest as recently as early 1966.

Seeking a solution, the predominantly Sinhalese parliament has decreed that districts

*See "Ceylon, Island of the 'Lion People,'" by Helen Trybulowski Gilles, NATIONAL GEOGRAPHIC, July, 1948.

with Tamil majorities could use Tamil in their schools and local governments. However, since the central government and many businesses are conducted in Sinhalese, Tamils suffer a handicap when they compete with Sinhalese.

As one Ceylonese friend put it, "When we rejected English as our national language, we went from the solution to the problem."

But such concerns seem remote on Galle Face Green. The band plays "oom-pa-pa" melodies, children trot by on ponies, and 20-foot cobra kites dance overhead.

By late dusk the crowds melt away. Even the audacious crows, Ceylon's omnipresent pests, scavenge their last morsel and fly off, leaving the crashing breakers playing to an empty house. Piercing the solitude, a lighthouse beacon sweeps its watchful eye over the vital port, illuminating ships under all the flags of the globe waiting to exchange rice, flour, and dried fish for tea.

We, too, drift home to Cinnamon Gardens, where flaming sentries of flamboyant trees, flanked by walls of bougainvillea, guard the city's most fashionable residential suburb. Once it was a Dutch plantation, but its spice bushes have long since yielded to spacious, elegant houses, among them the home of our friends Cynthia and Vere de Mel.

"String-hoppers" Cool Fiery Curries

When we first arrived in Colombo, Cynthia had said: "You can't capture Ceylon from hotel rooms! You must come live with us."

The De Mels typify modern Ceylon. Although both are Sinhalese, Cynthia was reared as a Christian and English-educated. She married of her own choice, while girlhood friends still expected parentally arranged matches. Bright, beautiful, and effervescent, Cynthia skillfully manages her own travel agency. Vere, devoutly Buddhist and a former transportation official, owns Colombo's taxi service, Quickshaws.

Through Cynthia and Vere, we touched the pulsebeat of Ceylon, its gentle people. We ate torrid curries, always careful to take plenty of "string-hoppers"—spaghetti-like patties—as fire extinguishers for the more flammable dishes. Cynthia taught Donna to drape a sari, to bargain for fruits and vegetables in the market, and to prepare many Ceylonese delicacies.

We came to understand the old saying, "The Ceylonese are happiest with a stranger in their streets or a visitor on their doorstep."

Every day at the De Mels' was rewarding. But I vividly recall one evening in particular. Cynthia informed us: "The cook isn't well. He has been told an evil eye is cast upon him. Only a lime ceremony will drive away evil spirits, he feels."

"A lime ceremony?" I asked.

"A part of bali, devil worship," she said.

Bali, whose roots trace back to northern India, mysteriously blends astrology, demonism, and ancestor worship, forces that inexorably govern the lives of many Ceylonese. Vestiges of primitive popular religions, animism and witchcraft, are intricately and often subtly woven into contemporary religious behavior. Devotees calculate propitious moments for every act by the planets—the controlling spirits. Magic rites exorcise evil spirits and curry favor with benevolent ones.

"Go, Go You Devils"

At 9 p.m.—the auspicious time—the ceremony begins. Areca palm fronds and seven species of flowers adorn the altar—a porch chair. "There must be flesh from sea and land—see the dried fish and strip of leather?" Cynthia whispers. "The seven limes mean purification; the coins appease the gods."

The cook sits on a straw mat, hands folded in prayer on the altar. A bearded man in white sarong and open shirt begins chanting and throws incense into a smoldering pot.

"He's the *kapurala*, or doctor of magic lore," murmurs Cynthia. "First he invokes all the gods—Yama, Lakshmi, be present!—and names all the devils who must leave."

Squeezing a lime over the cook's head, the kapurala chants: "...all gods in heaven and earth stand witness.... Go, go you devils from the joints, and from the head let evil go away...." After touching each limb with split limes, he drops the limes into a bowl of water.

"He talks to the devils in a scolding manner, slipping from Sinhalese into Tamil," Cynthia explains. "Now he'll watch to see if an odd number of limes float face up to the surface—a very good sign."

Suddenly, a huge insect lights on Donna's arm. She swings viciously but misses. "Don't worry, he's a friendly spirit," Vere chuckles.

After 30 minutes of unbroken recitation, the kapurala ties a string around the patient's arm. A sprinkle with lime twigs, an anointment

Hanging onto a short tusk, a mahout brushes his elephant's teeth with a coconut husk. Light splotches are natural markings, not the result of wear and tear on hide.

"Second Eden!" Thus early Islamic traders called Ceylon, believing that Allah sent Adam and Eve here to console them for the loss of Paradise. And beauty yet abides—

PHOTOGRAPHED BY GILBERT M. GROSVENOR © NATIONAL GEOGRAPHIC SOCIETY

in exquisitely terraced and contoured hillsides, in watery mirrors being readied for rice seedlings . . . and in rolling, distant highland slopes, green with gardens of tea.

with hot oil, and the ceremony ends. If the doctor mispronounces even one word, the ceremony is unsuccessful.

"How long before the cure works?" I ask.

"When the aches and pains are gone, it has worked. The therapeutic effect isn't unlike a psychiatrist's couch," says Cynthia.

Next morning the cook looks happier, if not healthier. But several days later, when we leave the De Mels' for a journey into Ceylon's upcountry, I notice he still clings to the security of his string.

As always, we depart from Colombo at dawn, the city's most glorious hour. Not a soul stirs; only the screeching *koha* birds pierce the quiet of first light. Ocean breezes rustle the rain trees, and they unfold their leaves, splashing Colombo's pavements with cupfuls of moisture collected during the night. Nearby, smoke curls skyward from the waning embers of a funeral pyre.

Ceylonese Scarecrows Wear Sarongs

In scattered villages, as we pass, shadowy forms of children squat beside thatch-roofed houses and slosh themselves clean with jugs of water.

Foliage crowds the road with a wild luxuriance of palms and fruit-bearing trees: mango, breadfruit, jak, banana, pawpaw. Clusters of villages, tucked into the folds of hills, lie amid a woven pattern of paddy fields fringed with dark-green coconut palms. Croaking frogs and humming cicadas serenade sarong-draped scarecrows policing the fields of this pastoral paradise.

Rice knows no season here. Some fields near harvest as others are prepared for planting. Teams of buffalo heave powerful shoulders against wooden plows that sink deep into the rich ooze of watered fields. Lean sinewy men, naked to the waist and caked in mud, scold their protesting beasts. When the turf is turned, men paddle the mud into smooth sheets, now ready for flooding and planting.

Along the road slender barefoot women bear 60-pound bundles of wood atop their heads with a grace befitting royalty. When we stop to watch, inquisitive children swarm out of nowhere, surrounding us like bees around buttercups. Dark faces press so tightly about the car that windows fog.

Our driver Dan, perhaps embarrassed by their enthusiasm, explains, "Madam, they're as curious about you as you may be about them. Few Europeans stop to talk to the villagers."

We had not driven far when we saw him: an elephant, ponderous and gray, with his trunk twisted around a mass of palm fronds. We slowed our car as he swayed across the road. Perched on his back, like a flea on a moving mountain, a tiny mahout shouted commands and prodded with a spiked pole.

Just beyond, at a lumbermill near Kitulgala, these Ceylonese bulldozers neatly rolled huge logs

Sacred pinnacle hallowed throughout history, Adam's Peak (below) stands alone against the sky, 7,360 feet above the sea. Its crown cradles a three-foot-long depression shaped like a human footprint. Who stepped there? Followers of the Buddha believe he left the mark on one of his three

trips to Ceylon. Hindus see it as that of the god Siva. Certain early Christians gave St. Thomas credit for making the print. And Moslems hold that Adam himself stood on the peak.

Pilgrims join by night to climb the four-mile trail. At the holy summit (opposite), they pay homage to the footprint and greet dawn with prayer. Beyond these worshipers another wonder appears: The shadow cast at sunrise by the sacred mountain rises high against the clouds.

with their foreheads and feet. Then, hoisting the logs with their trunks, they flung them like twigs onto a pile.

In Ceylon's jungles, machines cannot compete with elephants. No mass of metal, bolts, and gears could daily tramp along rivers, weave through miles of tangled, swampy undergrowth, gather up a felled tree, and drag it back to the mill.

Elephants offer 50-year warranties—no parts, no overhauls, just a few hundred fronds and a daily wash (pages 458-9 and 461). Ceylon's elephant, an Indian breed, frequently tuskless, is considered more easily tamed than the larger African elephant.

"Owning an elephant brings great prestige," Dan remarked. "Depending upon training, age, and ability to work, they cost from 10,000 to 20,000 rupees [$2,000 to $4,000]."

Adam's Peak Bears Hallowed Footprint

We continued ascending into the clouds as the road coiled around sheer mountain walls. Dizzily they spilled away into a panorama of misty waterfalls tumbling down a verdant backdrop of undulating hills. Among the hills the cone of Adam's Peak rose like a natural cathedral (pages 464-5). A shallow depression at its peak is hallowed by three great religions.

Predictably, Dan knew well the mountain's legends. "We Buddhists believe that Adam's Peak bears the holy footprint of Lord Buddha.

EKTACHROMES BY GILBERT M. GROSVENOR © N.G.S.

Plucking tea "flushes"—the tender buds and adjoining two leaves—workers at Norton Bridge toss them into baskets without a backward glance. After withering, rolling, fermenting, and drying, teas go to tasters. At the Brooke Bond tea plant in Colombo, Mr. Michael Tissera spits out a sample, one of perhaps 200 he will taste in a day. Judging taste, color, and aroma, he decides how much his company will offer the grower.

Hindus deem it their god Siva's mountain. Moslems say that Adam, hurled from Paradise, stood here a thousand years atoning for his sin. Finally he was reunited with Eve, and they lived in Lanka for many centuries, propagating humankind."

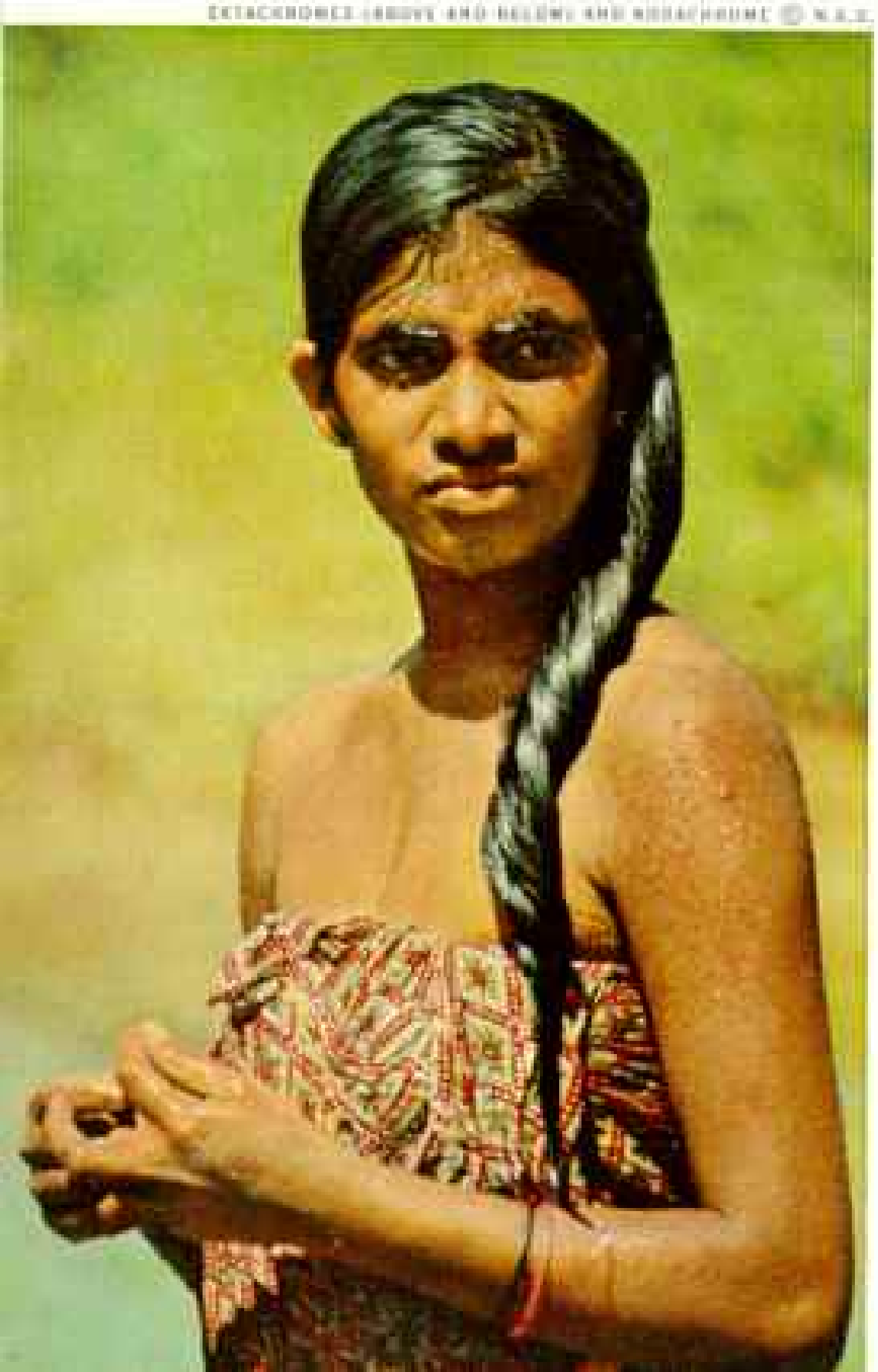
Generations of pilgrims have toiled by torchlight up the perilous cliffs to await sunrise and the mysterious shadow cast by the sacred mountain. Today sturdy stairs and protective rails ascend the cliff face, replacing notched stone steps and huge chains anchored into the solid rock by unknown hands centuries ago.

"Many times I've climbed to the summit with pilgrims when the weather was favorable," Dan told us. "But in times past, climbing Adam's Peak was very dangerous. I've heard that high winds used to sweep pilgrims from the cliff face and hurl them into the valley below. But still the aged, the ill, and the crippled hobbled painfully up the final precipice, driven by faith and hope."

We could not follow the time-worn trail trod by the ranks of pilgrims. It was the time of the southwest monsoon, when the climb was most treacherous. Paths lighted at other times were dark; resthouses along the way were shuttered tight; and leopards and other threatening animals prowled the slopes.

Reaching the mountains of mile-high Nuwara Eliya, Ceylon's picturesque resort area

EKTACHROMES (ABOVE AND BELOW) AND KODAFHOME © K.O.D.



about 100 miles east of Colombo, we looked out on a patchwork quilt of cultivation. Serried ranks of tea bushes stretched across the horizon, contoured to peak and valley like a tailored knit dress. The delicately manicured plants had been "tipped," or trimmed, waist-high, bushy and flat-topped. Tea bushes (*Camellia sinensis*) would tower 40 feet high unless severely pruned every one to five years. Many produce for 50 years.

Tamils Tend Ceylon's Tea Crop

More than 400,000 Indian Tamils, workers and offspring of workers imported during the past century from southern India, tend the 590,000 acres under cultivation. Unlike Ceylon Tamils, whose ancestors came much earlier, many of these Indian Tamils still have close ties with India.

Throughout the upcountry, in tea-growing altitudes between 2,000 and 7,000 feet, large estates offer Tamil families free housing, schools, and hospital care. Although individuals are paid very little, households frequently include four or five wage earners. Women tend tea slopes, men operate heavy machinery, and children often work between classes, or full time after elementary schooling.

Since independence, successive Ceylonese governments, struggling with chronic unemployment, have debated deporting these unfranchised Indian Tamils back to the continent to create jobs for the Sinhalese. I asked an estate manager about this problem.

"Tea production would cease without Indian Tamil labor," he said. "Most Sinhalese refuse to till the soil for these wages. 'They'd rather eat jak fruit,' as the saying goes. Without tea exports, everyone, including the government, would be unemployed."

While we talked, a rainbow trail of brightly

Like green-carpeted stairs, rice fields climb a hill near Kandy; a fringe of palms breaks the symmetry. Though some farms harvest two crops a year, Ceylon must still import $60,000,000 worth of rice annually, half the amount eaten by her people.

Golden chaff rains from the basket of a worker winnowing rice near Demodara.

Love of water sends this Sinhalese beauty to the village stream for a daily bath. Love of company holds her there, chattering with friends as she pours potfuls of water over her head—so many for luck, so many for health, so many for coolness.

Skimming the waves at close to 15 knots, its single sail ballooning, a fishing outrigger off Negombo heads for home. In these slender, seaworthy craft, Ceylonese sailors venture 65 miles from home ports. Such primitive methods, however, make the industry

clad Tamil women (page 451) wound past us. The women bore loaded wicker baskets cinched high on their backs by straps over their foreheads. Earlier, I had watched these nimble-fingered women pluck the new, tender "flush"—two leaves and a bud. Now they headed for the processing factory.

We followed them to the top floor, where green leaves were thinly spread over nylon "tats," or shelves, for withering.

"Hold your skirt!" the teamaker warned Donna as we walked over grill-covered ducts. "Our huge blowers circulate hot air through the withering lofts, evaporating moisture from the leaf and leaving it soft and pliable."

He led us down steep wooden stairs to a floor crowded with monstrous machinery. Puzzled, I asked, "Do you really need such heavy equipment to crush a tiny tea leaf?"

"These rollers must daily twist and curl thousands of pounds of leaves," said the teamaker. "The machines crush cells to liberate aromatic juices—the essence of tea. They must work quickly, yet delicately.

"Then we put the leaves in a cool, moist room to accelerate oxidation, during which green tea turns bright copper. The tricky part is deciding when to choke off oxidation, at precisely the proper time, by 'firing,' or heating. The copper leaf turns black, as carefully

inefficient, and Ceylon must continue to import fish until modern vessels replace the outrigger fleets.

Toddy tapper inches across a taut ropeway between coconut palms to gather sap in the treetops. Liquid collected in the pot yields potent Ceylonese drinks.

controlled driers reduce water content to 3 percent. Finally, we sort the 'made tea' into commercial grades, ready for shipment."

Taste of Tea Reveals Weather in Uva

Competition in the sale of tea is keen. Samples are whisked daily by jets from Ceylon to world markets. We visited the Brooke Bond tea company, where Mr. T. Jayalingam, sales director of the Colombo office, predictably invited, "Join me for tea?"

"Hmm, not bad," he brightened, taking a sip. "Weather's still clear at Uva."

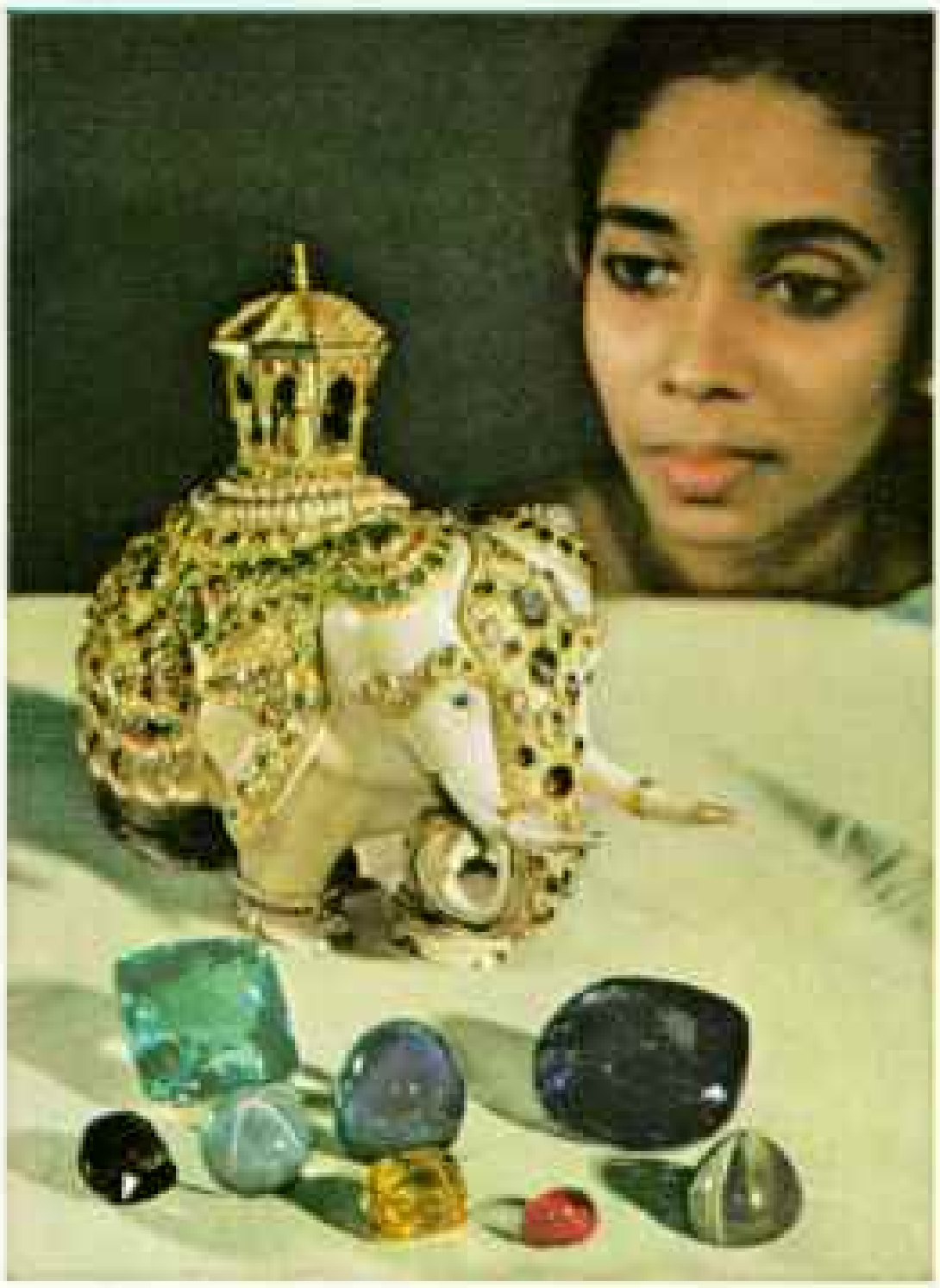
"Yes, we've just returned from there. But how did you know?" I asked naively.

"This new tea sample from an Uva estate is top quality, with good body. Only dry days and cool nights produce such quality," he explained. "Tea contains tannin, an astringent; caffeine, a stimulant; water; and an essential oil for flavor. The oil remains mysterious, but we know that flavor varies with an estate's altitude, rain, sun, soil, plucking, processing, blending, and other factors."

"Blending?" I questioned.

"Naturally. Americans prefer 'pointy,' light-flavored, high-grown teas from Dimbula or Nuwara Eliya; the English like 'thick' teas, with more body, from Uva," he explained.

"Pointy? Thick?" This was another tongue.



Ceylon's fabulous gems, to early Chinese, were the crystallized tears of the first man. Arab traders, too, marveled at the precious stones; in *The Arabian Nights*, Sindbad visited the King of Ceylon "on the battlements of whose palace are a thousand jewels."

A Colombo jewelry firm, Macan Markar, treasures this collection, including a 485-carat sapphire at upper right. Others are a chrysoberyl cat's-eye, lower right, star ruby, yellow sapphire, two star sapphires, square-cut aquamarine, and alexandrite at lower left. Rare stones also garb the ivory elephant.

Pit sunk in mud at Ratnapura yields gem-bearing gravel. Miners pan and sort their hauls in the clear water of a nearby stream.

Like cranes standing on one leg, fishermen perch on stilts to cast for spotted herring in shallow waters near Matara.

"Tasters classify teas with specific terms," said the patient Mr. Jayalingam. "Pungent, pointy, meaty, body, bakey, thick—those terms describe taste. Coppery, dull, bright—those define infusion, or the moist tea leaf. We're tasting now. Have a look."

White-robed technicians whispered in a room so quiet you could hear a tea leaf drop. Then I detected a curious "shush," like sand sifting into a tin pan, followed by a "slurp," and finally the sound of spittle finding a spittoon.

A crisp voice announced, "Alpha, little flaky, thick, bright, rupees 2.20."

"He's rated another lot of medium-grown tea," Mr. Jayalingam whispered.

Light Must Be Right for Tasting

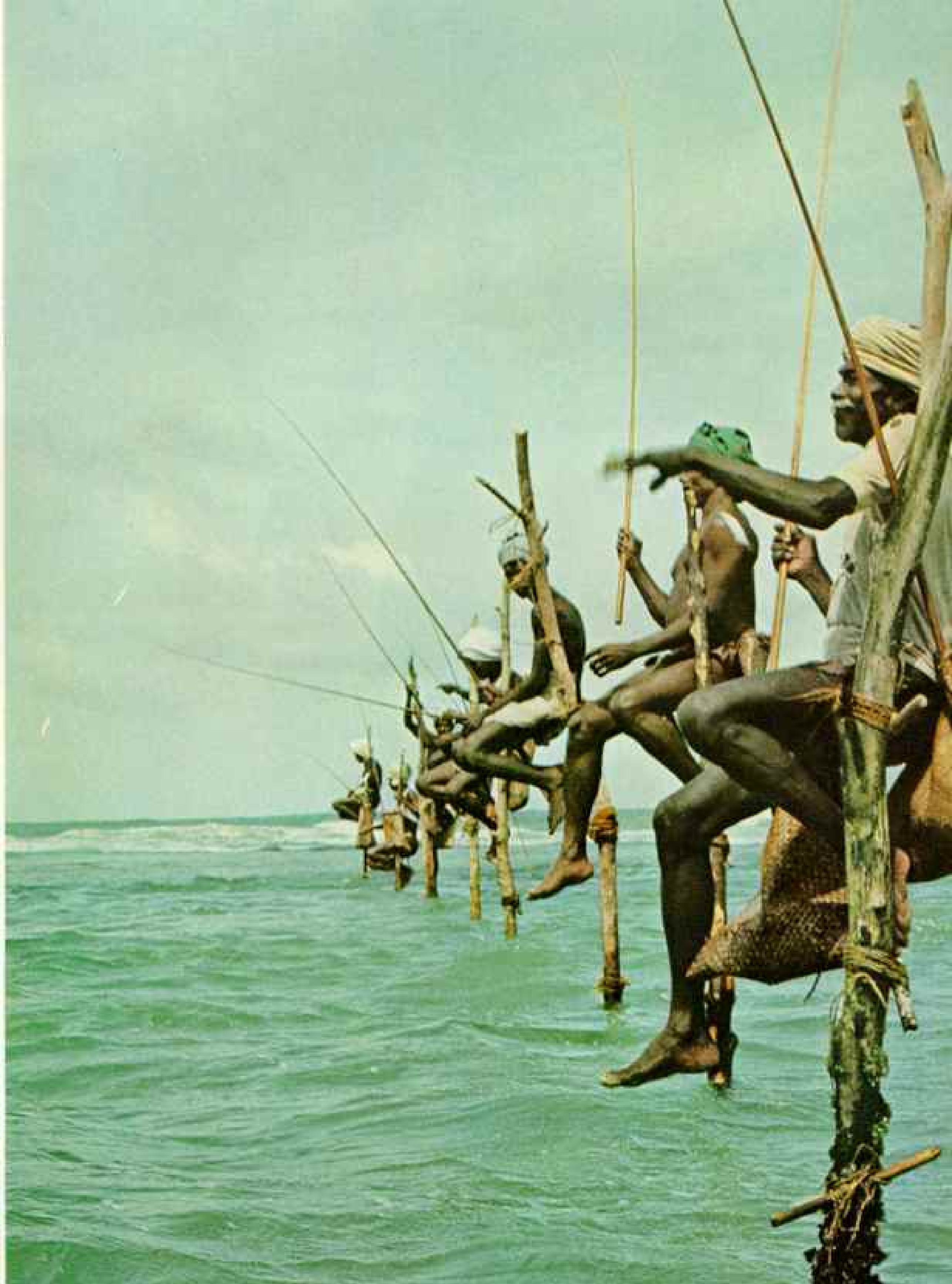
Tiptoeing past a long table lined with bowls of tea, each beside a tin of tea, I unwittingly paused beside a window.

"Please move," the taster requested.

"He tastes only against north light," Mr. Jayalingam explained (page 467). "Color of the infusion and of the liquor are vital in judging tea, and change with light. We taste under precise conditions to match established standards."

I felt like a bull among tea cups.

"We prescribe 6.5 grams of tea per bowl, steeped exactly six minutes with freshly boiled filtered water, plus two teaspoons of fresh, TB-tested milk. No sugar. When the tea cools, we taste," said Mr. Jayalingam.



"You try it," he insisted. "First sift dried tea through your fingers into the tin tray to determine texture. Slurp up a sample of tea—it's polite in tea-tasting society—in fact a necessity, to fully savor the flavor; now, swish the tea around your palate; then, spit. Never swallow!"

Slurping was trained out of me at an early age, and I found it difficult to emulate the taster. But I must admit to getting the range of the spittoon after only one dribble on my tie and a squirt on the taster's shoes.

I soon distinguished subtleties between estate teas, but invariably judged the top quality to be inferior. Just when I thought I had learned the art, I spat out a thick tea, declaring it unfit to drink. Mr. Jayalingam winced. I had defamed his finest Uva sample.

He sighed. "Time for a break."

Back in his office, Mr. Jayalingam excitedly read an overseas cable. "Oh, no! They're fluorinating their water. I must alter the blend. Let's see, add pungence and. . . ."

"Tea Party" Colors China Bay

We left our friend to his problems and headed toward Trincomalee, Ceylon's northeast port, whence much tea is shipped overseas. From his dockside office, Mr. Lionel Keess, manager of the Trincomalee Tea Administration, surveyed the fleet of freighters anchored in the China Bay harbor.

"We've just loaded one million pounds of tea. That gray freighter's bound for England, via Aden and Suez; the one moored close aboard heads to Australia; that black one getting up steam sails for Boston, New York, Philadelphia, Baltimore, Jacksonville, and Galveston. An average day," Mr. Keess mused.

Below us, laborers, their backs lumped black with calluses, muscled 125-pound tea chests aboard lighters that ferried the cargo to the ships. Booms angled out from the freighters like tentacles of an octopus, holding nets to haul aboard the precious cargo.

"Ceylon exported 455 million pounds of tea in 1963, and again in 1964," Mr. Keess said. "Trincomalee handled 315 million of those pounds in 1963, while Colombo and Galle shared the balance. With the cyclone, Trincomalee's 1964 volume shrank to 265 million."

"The cyclone?" Donna inquired.

"It hit December 22, 1964—I'll never forget it!" Mr. Keess said. "A howling northwest gale blew up and forgot to stop. Winds gusted to 150 miles per hour. All 36 lighters sank, and 8,000 chests of tea, almost a million pounds, floated in the harbor—our Trincomalee tea party," the Englishman joked.

Later, driving toward the beach in search of Trincomalee's fishing fleet, Donna groaned and commented, "It's sure a long way from plucking 'two leaves and a bud' to dunking a 'Flo-thru' tea bag."

Fishermen Race Home Under Sail

We found the long sandy beach bare of boats. The fleet had taken to sea the previous night, but it was expected back soon from fishing grounds five to ten miles offshore.

How curious, I thought, that Ceylon should be so dependent upon an agrarian economy when it floats in an ocean teeming with a limitless wealth of fish. Why does Ceylon yearly import 50 million rupees' worth of dried or tinned fish? I would soon find out.

At first only white specks dot the distant blue waters. As I watch, the specks blossom into canvas; then long slender hulls and outriggers pop above the horizon (page 470). They race at a fantastic pace, driven by a fresh quartering breeze and following sea, planing at top speed of perhaps 15 knots.

Smartly, each helmsman spills the wind and slides off the waves, killing momentum just as his outrigger grounds. I join eager lads on shore, lending a hand to beach the craft.

The skipper calls cadence in rhythm with the breaking surf. Together we push the vessel far up the shore, well above the tide line.

"Any luck?" I ask.

"Not much for a night's work—a few seer-fish, some mackerel, and a couple of tuna," answers a tired, discouraged fisherman.

After dark, I squeeze aboard a small outrigger. I help my fishing mate, Paddy Singho, paddle. In his small boat, we dare not venture out of sight of Trincomalee's lights.

Breeze-whipped cloud of cotton cloth, destined for saris, dries at a fabric-printing factory at Ekala, 15 miles north of Colombo. Although part of an industrial complex built by the government, the factory wrestles with a problem common to other new Ceylonese enterprises. Capable of producing a thousand saris a day, the factory turns out only 480 because of the scarcity of cotton cloth, which must be imported from India. Thus the lack of materials and limited foreign exchange hamper Ceylon's industrial growth.

Bellying in the breeze, outrigger sails dry in the late-afternoon sun at Trincomalee, Ceylon's magnificent port on the Bay of Bengal. Slender coconut palms bend their

Three miles off the shore Paddy lowers a square-framed net about five feet down; then, to attract fish, he lights a bright kerosene lamp lashed amidships. Carefully, we rehearse the routine: When a fish surfaces below the light, Paddy will jerk the net upward, trapping the catch. With a smaller hooplike net, I will scoop the fish aboard.

A dark sky broods on the horizon. Thunderbolts clash and lightning sparks the night, but directly overhead the stars shine. Like a reflection of these stars, two hundred kerosene lights twinkle in the undulating seas.

For hours we thrash about in the growing swell. No fish. More hours pass.

The thunder growls. Lightning stabs closer, but we hold to the sea. No fish.

First a sprinkle, then the wet sound of the approaching downpour. Now I see the curtain of rain closing across the bay. Still no fish.

We blow out the light and paddle for the beach. On shore, we are not the only ones heading for home—away from the fish market. Until a modern deepwater fleet replaces outriggers, fishermen will reap scant harvests, and Ceylon must import dried fish.

Government Recognizes Fishermen's Needs

When Paddy Singho and I parted company, I was filled with pity for this frustrated, lonely man, whose family lived far away in Kaluwella village, along Ceylon's southwest coast. He could afford neither the bus fare nor the time to visit them. Not until the southwest

EXTACHROMES © NATIONAL GEOGRAPHIC SOCIETY

tufted heads to the murmuring voice of the sea—without which, say the islanders, they cannot live.

Calling cadence with the waves that slap the shore, fishermen strain to beach their craft. Footprints mark their progress with each breaker.

monsoon passed would Paddy dare sail his outrigger home to Kaluwella.

As Donna and I drove south, my thoughts drifted back to Prime Minister Senanayake. He knew the plight of Ceylon's fishermen.

"When the Bandaranaike government subsidized the fishing industry, funds evaporated into fishermen's villages for housing, food, and other needs," said the prime minister. "But we're investing our rupees in a more efficient fleet: ocean-going ships, hydraulic winches, nylon nets, electronic gear. Our vessels will range far out into the Indian Ocean, where vast quantities of fish are caught."

Perhaps someday Paddy Singho will not return to port empty-handed.

Beyond Haputale, as we continued south, the crisp, clear air and tropical lushness of the hill country abruptly wilted away to low scrub jungle. Here a sparse populace scratched parched soil for a meager subsistence. Salt flats stretched across the land's blanched face near the village of Hambantota. At Ruhunu National Park, elephants, deer, and bears wandered its vast expanse, desperately seeking some undiscovered pool (map, page 454).

But at Dondra Head, Ceylon's southernmost tip, the monsoon breezes were bracing. A lonely lighthouse guarded the headlands, as if to cover scars incised when the great temple of Dondra was desecrated by the Portuguese in the 16th century. Those were ruthless days.

When Portuguese caravels probed for rich

Oriental markets, they first touched Ceylon at Galle. As trade routes to the Far East developed, the Portuguese took cinnamon, gems, and elephants from Ceylon to Europe, spreading the island's fame afar.

The Portuguese brought the Cross to Ceylon. Dr. Richard Spittel, an elderly surgeon and anthropologist, bluntly expressed Ceylonese feelings when he commented to us, "The Portuguese forced their faith with fire and sword on 'heathens' whose traditions and religion predated Christianity."

Near Matara, as we followed the coast from Dondra Head, we spotted near-naked fishermen seated precariously atop slender vertical poles in the frothy surf (page 473). Sunlight reflected a glint of wriggling silver as one man jerked rod and line upward and deftly unhooked a tiny fish, which he stowed in a straw basket belted about his waist.

"They are after *korrumburua*, a small fish we use in our hottest curries," Dan told us. "Because the fish frighten easily, the men must sit very quietly on their stilts. Only during the southwest monsoon, when seas are too high for boats to sail offshore, do they fish here. On a good day a man may catch 300 little herring, worth about 15 rupees."

On the beach a wiry, weathered old man, with long silver hair knotted behind in a tortoise-shell comb, broke open a young coconut, offering us a drink of its sweet, clear water.

"*Bohoma stuthi*," Donna replied. His face-splitting grin beamed approval of her Sinhalese "thank you."

Late-afternoon shadows were creeping across Galle when we stopped for the night at the charming Hotel Closenberg, overlooking the town's churches and red-tiled Dutch rooftops. Quiet ramparts of the old Dutch fort still stand, facing the sea on three sides.

After the Dutch wrested control of the island from the Portuguese in 1658, they developed inland trade and ruled with a gentler hand. When Napoleon overran the Netherlands, Great Britain seized the opportunity to take control of Ceylon.

As dawn broke we continued our journey, hugging tiny silver bays and sanded expanses of beach carved into the southwest coast. At Hikkaduwa resort, a miniature Great Barrier Reef sparkled under sapphire seas

Leaves of plantain for their plates, the floor for their table, the Kandasamy family dines on rice and tortoise in a one-room home on China Bay. Mr. Kandasamy pilots a lighter shuttling tea crates from docks to ships in Trincomalee's harbor.

in a kingdom of coral gardens, a skin-diver's paradise.

A few miles farther, at Ambalangoda, Dan told us, "We are in the heart of bali country. We should visit one of the fine devil dancers and mask carvers who live here."

Chips were flying from a partially chiseled grotesque mask when we interrupted Mr. Ariyapala Wijesooriya, a sun-bronzed man with silver hair and piercing eyes. Laying down his mallet, he spoke proudly of his heritage.

"My family has danced and carved masks for a hundred years. My father taught me; his father taught him. To my eldest son I will pass on the secret bali charms and a knowledge of astrology, enabling him to read a sick person's horoscope and prescribe the healing charms."

Whirling into a trance, dancers transform a courtyard into a festival ground at Kolonnawa, a Colombo suburb. To honor two Hindu gods, Vishnu and the God of Kataragama, they twirl ecstatically, lifting arched wooden frames called *kavadis*. Buddhists, also recognizing the Hindu deities, fly their bright flags. Suddenly, drummers pound faster. Villagers push closer. And those who will fulfill religious vows by self-mortification step forward.

We handled several of his beautifully carved enameled masks—Nagaraksha, the cobra god; Gurularaksha, the bird god with hawk eyes and parrot beak. In devil dancing, particular masks for specific illnesses must be worn to drive away the evil spirits.

The old man noticed Donna scrutinizing a gold chain and amulet adorning his neck.

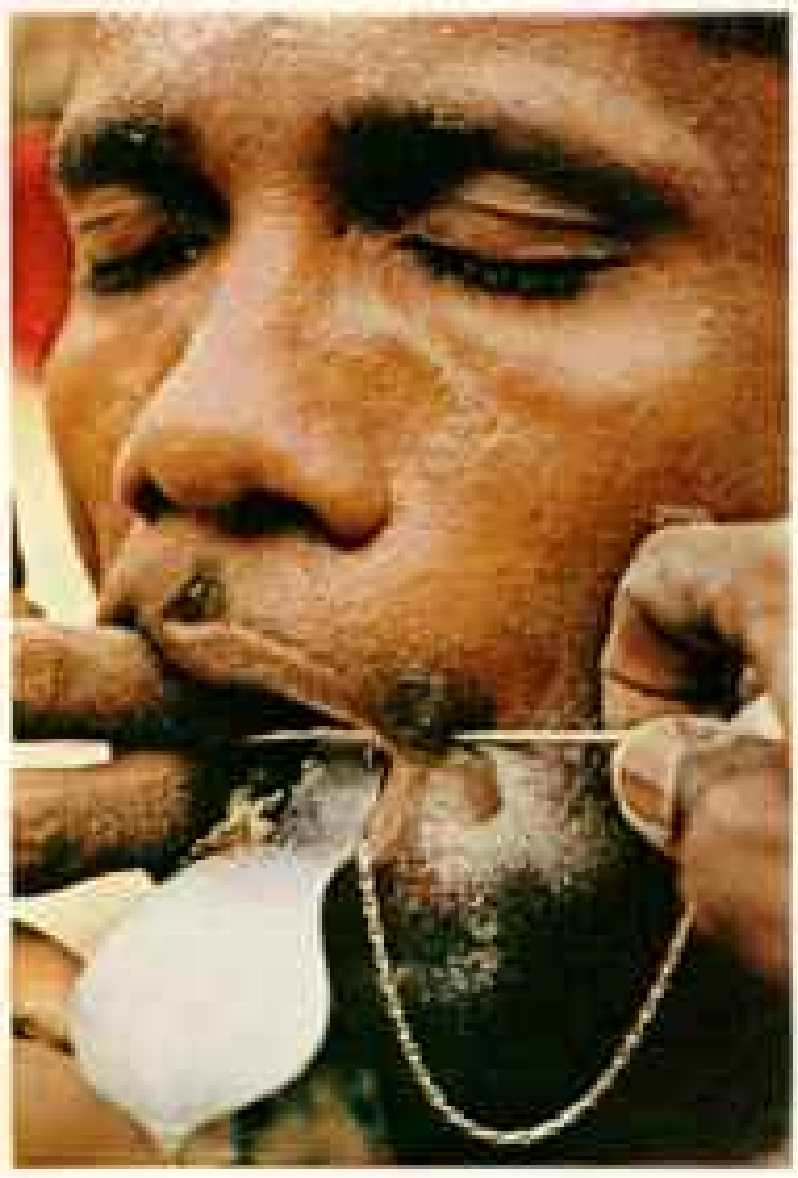
"The rulership of the planet Saturn threatens ill omens for me. I wear this astrological sign, which I charmed 100,000 times, to ward off any evil effects. Saturn will rule 19 years, six of which have already passed."

"What form would this evil take?" I asked.

"Perhaps sickness, or loss of favor with friends or in my work," said Mr. Wijesooriya.

Astrology touches every stratum of society in Ceylon. A person's horoscope is predicted by reading mathematical charts pinpointing the planets' positions at the time of birth. Movement of these planets during a person's lifetime determines his fortune, chronicled on *ola* leaves (talipot palm) by an astrologer using a metal stylus and black powder.

Horoscopes oftentimes influence the selection of a profession, or even a marriage partner. Each day newspapers carry advertisements such as this: "Goigama Buddhist family seek suitable husband for attractive 25-year-old daughter with stenographer skills.



EKTACHROME ⓒ K.O.D.

Dowry 10,000 rupees. Bring horoscope. Apply at. . . ."

We tested astrology for ourselves when Mr. P. A. Ediriweera, Dan's employer at Ceylon Tours, surprised us by having our horoscopes cast by his astrologer. With astonishment we read accurate accounts of significant, and even minute, incidents from our pasts: A back injury of mine, almost to the day; an important decision by my wife was detailed (thank goodness she answered "Yes!"). However, there seemed to be one slight anomaly. While we both are to be proud parents of a daughter, I somehow am to be blessed with additional dividends—two sons. If the astrologer found this difficult to explain, I find it downright impossible!

Leaving Hikkaduwa and driving along the coast, we headed inland 40 miles to Ratnapura, City of Gems. I needed no astrologer to remind me that Donna auspiciously timed our arrival to coincide with her birthday.

Hooks pierce, lances stab, but no expression reveals pain in age-old rites shocking to Western eyes. Fulfilling vows, ten men stop frenzied dancing to endure the ceremony of flesh-piercing. Prime participant, Mohotty first rubs their skin with sacred ash. Then, grimacing, he forces lances into the flesh of a stoic worshiper, and drives a skewer through the cheeks of another, shown with a tongue depressor. Not a drop of blood flows. Mohotty promised one of his gods to endure an ordeal each year if a murder charge against his father was dropped. With hooks sunk into his back (above), he drags a heavy cart (right) while wearing spiked sandals.

Enthusiastically, she hinted that the Queen of Sheba's jewels were found near Ratnapura, and that Ceylon's famous gems sparkle in the world's finest collections.

Some enchantment faded as we watched men toiling in slimy pits and semidarkness 60 feet beneath a paddy field. Basketfuls of *illam*, or gem gravel, were hoisted to the surface, then swished round and round in a nearby river until all the mud washed away. Amid the residue of colored pebbles, perhaps a priceless treasure would appear.

But, as Mr. Bhadra Marapana, a friend and gem collector, told us: "More fortunes are squandered in the search than are made by hitting the jackpot. If you wish stones from Ceylon, purchase a sapphire or a cat's eye. Colombo has many fine gem stores."

Suddenly Donna was anxious to return to the capital, a two-hour drive from Ratnapura.

In Colombo, Dan steered us to Macan Markar's, a jewelry shop specializing in unique stones. Deep in its vault, Donna gingerly fingered in one hand a 485-carat blue sapphire valued at $250,000 (page 472); in the other she held a 105-carat cat's eye, worth $150,000.

"Ceylon has the finest cat's eyes in the world," a director told us. Noting Donna's covetous sparkle, he added, "But this one is not for sale. It's been the family mascot for a hundred years, bringing good luck to all three generations of sons in the firm."

I found it vastly flattering to be thought a prospective buyer of a $150,000 stone.

A Vow to Walk the Fiery Path

We had just reached the De Mel home when Dan telephoned. He told me, excitedly, "I have learned of a fire-walking ceremony in Kolonnawa village, near Colombo. Before the

ceremony, a man named Mohotty will pierce his body with needles and pull a cart roped to hooks in his back."

Now it was my turn to be excited, if a bit skeptical. Hurriedly I gathered up my camera gear, and we piled into Dan's car for the short drive. From the main road we heard lively flutes and drums resounding from the small courtyard of a village house. Fronds of margosa, the tree of purity, decorated doorways; coconut flowers, alms to the Hindu God of Kataragama, adorned the doorstep of the house; and Buddhist flags of brilliant blue, yellow, red, white, and orange flew from ropes strung around a small shrine laden with fruit and incense (page 479).

"Why do they fly Buddhist flags at a Hindu ceremony?" asked Donna.

"Madam, many Buddhists take part in Hindu ceremonies of piercing and fire walking," explained Dan. "The Hindu deities for these rites, Vishnu and the God of Kataragama, are recognized by Buddhists, and Hindus in turn pay homage to the Buddha."

A tall, fragile-looking man with soft, calm eyes appeared and introduced himself as Mohotty. Anticipating our questions, he explained: "I walked the coals in devotion many times as a young man, but when my father was falsely accused of murder, I vowed that if he was found innocent, I would reconfirm my faith each year by walking the fiery path and enduring the needles. This I have done ever since he was freed 16 years ago."

Fire-walker possessed by belief dances across coals measured at 1,328° F.—hot enough to melt aluminum—yet he shows no sign of pain. Other men, women, and children follow, not once but two and three times, believing that the longer they stay on the coals, the more merit they gain. Afterward, the feet of Mohotty (left) bear traces of ash on the instep and dirt from the ground around the fire, but not a blister. Skeptics offer explanations: Villagers harden their soles by years of walking barefoot; ash on the coals serves as insulation; perspiration protects the feet. But to the few who consider the fire the only way to fulfill religious pledges, the answer lies in steadfast conviction.

Stream of the faithful, their raised hands cupping lotus blossoms, flows humbly before the huge figure of the Buddha, reclining in the attitude of entering nirvana, the state of eternal happiness. The standing figure may be that of the living Buddha or his disciple Ananda, his grief forever etched in stone. The shrine survives amid the ruins of Polonnaruwa, majestic

Mohotty's words sent my eyes searching his face and body for puncture scars. Not a mark could I find.

Suddenly, drums pound a faster rhythm, and the villagers crowd closer as ten dancers, thrashing their heads violently from side to side, whirl around the courtyard.

The dancers kneel, and Mohotty rubs their cheeks, arms, and chests with sacred ash. They stare with glazed, half-closed eyes, bodies motionless, as Mohotty forces skewers through each man's cheeks. Not a drop of blood seeps from the wounds, nor is there any expression of pain.

Mohotty Submits to Steel and Fire

Then steel pierces Mohotty's own cheeks; needles drive into his arms from shoulder to wrist; tiny arrowheads sink into his chest and stomach; spiked clogs are lashed to his feet.

AUTOCHROME BY BRIAN BRAKE © NATIONAL GEOGRAPHIC SOCIETY

capital of medieval Ceylon. In the 12th century King Parakrama Bahu the Great had the reclining Buddha carved and the city adorned with parks and palaces, baths and temples; he wanted to make all Lanka "a festive island . . . like unto a wishing tree." But Parakrama's wishing tree withered, and his capital fell to the jungle. Excavation began early this century.

Straining, three men drive fearsome hooks into Mohotty's lower back, but only once does he sway, as if faint. He seems coherent, but lost in utter supplication to his gods.

Ropes attached to the cart and tied to hooks in Mohotty's back pull taut against stretching flesh. Slowly, he draws the creaking cart around the courtyard. We gasp. Children, wide-eyed, reach for their mothers' hands. Only Mohotty remains expressionless.

"What is your secret?" I question him later.

"My secret?" he repeats. "Faith, total faith in my gods. Now, if you'll excuse me, I will enter my little shrine to pray."

A great fire smolders until long after midnight, when chanting dancers, gleaming with perspiration, circle the red-hot embers. One man collapses; others drag him away.

At 4 a.m. my friend Ed Lark, an American movie photographer and lecturer, measures

the temperature of the coals with an optical pyrometer from the Ceylon Institute of Scientific and Industrial Research. The pyrometer registers 1,328° F. Since Ed is also a trained engineer familiar with this precise instrument, I trust his measurement.

Crowds perching on banks fall still as a young man dances across the 20-foot carpet of coals, twisting his body and feet as he moves (page 483). Then another man follows, scooping up handfuls of embers and throwing them over his shoulders. Nearly twenty men, women, boys, and girls fire-walk, not once, but two and three times.

Mohotty crosses the fire four times, twice with his young son on his shoulders.

The crowds chant, "*Haro-hara.*"

When it is over, we rush to thank Mohotty for letting us photograph the ceremony. Smiling, as if reading our minds, he sits and lifts his feet. They bear no trace of burns or blisters.

Well after dawn we fall into bed, but sleep evades us. Our minds cannot digest the incredible sights we have witnessed, nor can we explain them by hypnosis or drugs, tricks or gimmicks. What we saw was real, as real as the faith upon which these believers base their immunity from pain of steel or flame.

Religious faith has always shaped Ceylon. This was especially true in ancient days when faith, inspired by the Buddha, brought about the rise of the Sinhalese Kingdom.

Seeking the remnants of that splendid ancient civilization, we journeyed northward across the scorched, wasted plains, beyond the cities of today, to where the buried citadels of Ceylon's golden age sleep.

At Anuradhapura, oldest, most glorious Sinhalese capital, we paused in quiet meditation beneath the sacred bo tree, planted 2,250 years ago, according to Buddhist belief, as a branch from the parent tree under which Buddha attained enlightenment.

Before us, huge domed dagobas (opposite), impenetrable structures of brick enshrining the holy relics of the Buddha, brooded over the crumbling bones of great palaces, pavilions, and shrines, outlined by weathered walls and ruined promenades. Wooded parks and sparkling man-made lakes suggested the ordered splendor of the past. We explored silent paths once trod by 10,000 saffron-robed Buddhist monks. At the grassy basement of the Brazen Palace, we imagined its fantastic nine stories, its rooms festooned with gold and silver, the ivory throne of its great hall.

Enriched by 90 kings, Anuradhapura stood from the fifth century B.C. until treasure-seeking Tamils finally destroyed it in the 11th century.

We, too, retreated from the heat of Anuradhapura, guided by bands of chattering black-faced langur monkeys in the trees lining the road that weaves 65 miles to Polonnaruwa, second great capital of the Sinhalese.

An oasis set in north-central Ceylon, Polonnaruwa is a monument to King Parakrama Bahu the Great, who in the 12th century carved vast statues and built shrines that still exist (pages 484-5). But the water system he left marks perhaps his greatest achievement.

"The tank [derived from the Portuguese word *tanque*, meaning "reservoir"] is still one of our largest," Dan told us. "The ancient

ATTACHMENT BY GILBERT M. GROSVENOR © N.G.S.

Saffron-robed youngsters, carrying begging bowls and parasols, study to be monks at a Buddhist school in Colombo. Mrs. Grosvenor asked one why he wished to be a monk. "To make my journey to nirvana shorter," he told her.

Ceylon's most famous dagoba (opposite), Ruanweli preserves relics of the Buddha at Anuradhapura, the island's capital even before Polonnaruwa. Built of brick, the shrine has at its top a crystal, the gift of Burma, that refracts sunlight into all colors of the rainbow.

bund damming the valley stretches eight and a half miles. At capacity, the man-made lake covers 18,000 acres.

"A few years ago, engineers reconstructed the tank," Dan recalled. "It had lain in ruins ever since invading Tamils destroyed it 800 years ago. The engineers unearthed the king's original sluices and spillways—precisely where the new ones were to be placed."

Citadel of a Remorseful King

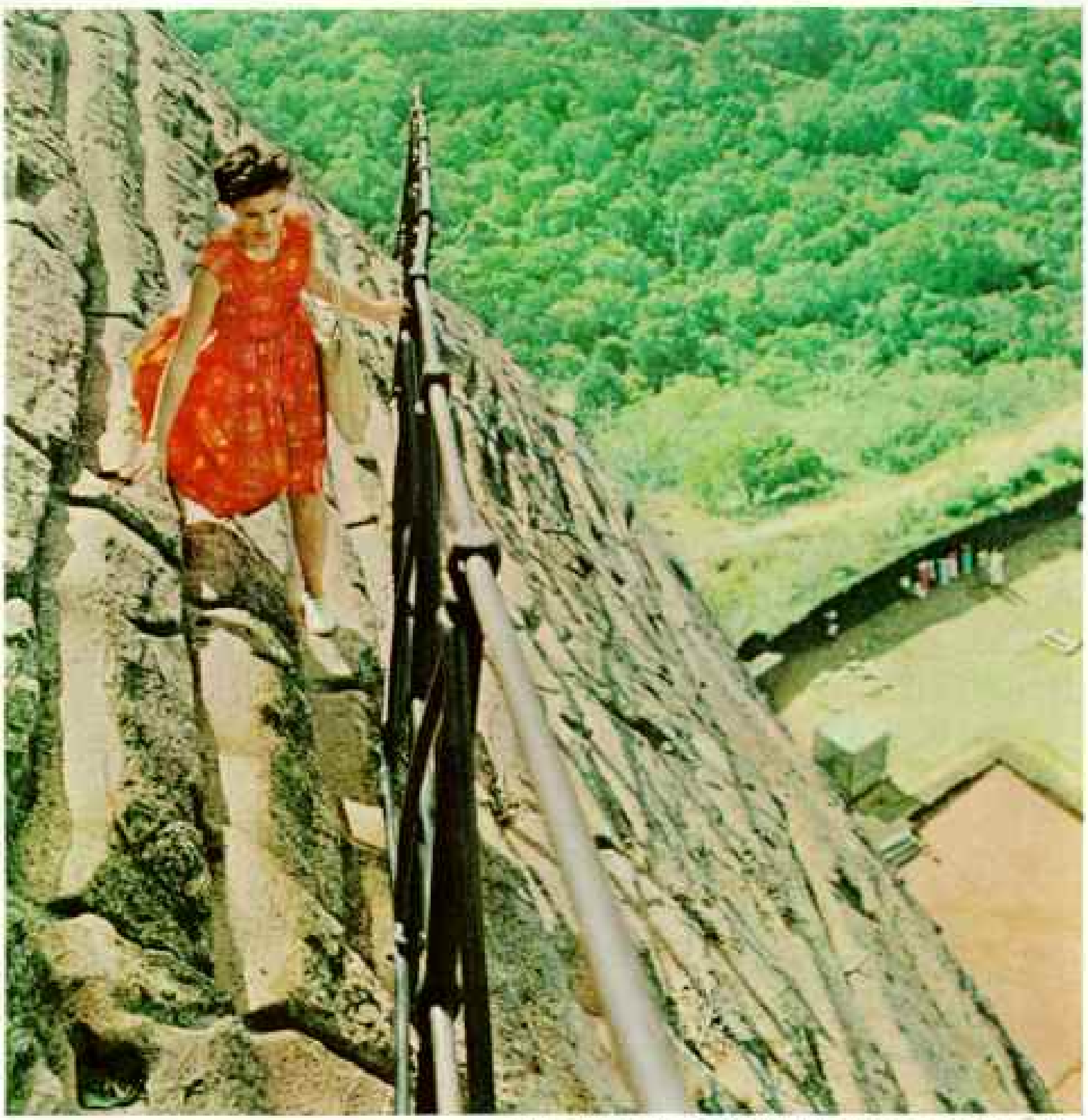
Forty miles from Polonnaruwa, we explored a huge russet-and-black mound of granite that looms like a great sulking beast 600 feet above the plains. There, at Sigiriya, the spirit of once-upon-a-time still broods (opposite).

In the fifth century A.D., in Anuradhapura, lived King Dhatu Sena with his two sons—one wicked, the other good. The wicked son, Kasyapa, murdered his father and seized the throne. The good son, Moggallana, fled, escaping assassins sent by his usurper brother.

Haunted by remorse for his deed, fearing his exiled brother and the quiet condemnation of his subjects, Kasyapa abandoned Anuradhapura for Sigiriya, the great rock rising sheer and lonely out of the wilderness.*

Around the base he cleared 50 acres for a city and encircled it with a mighty moated wall. On the very summit Kasyapa built an

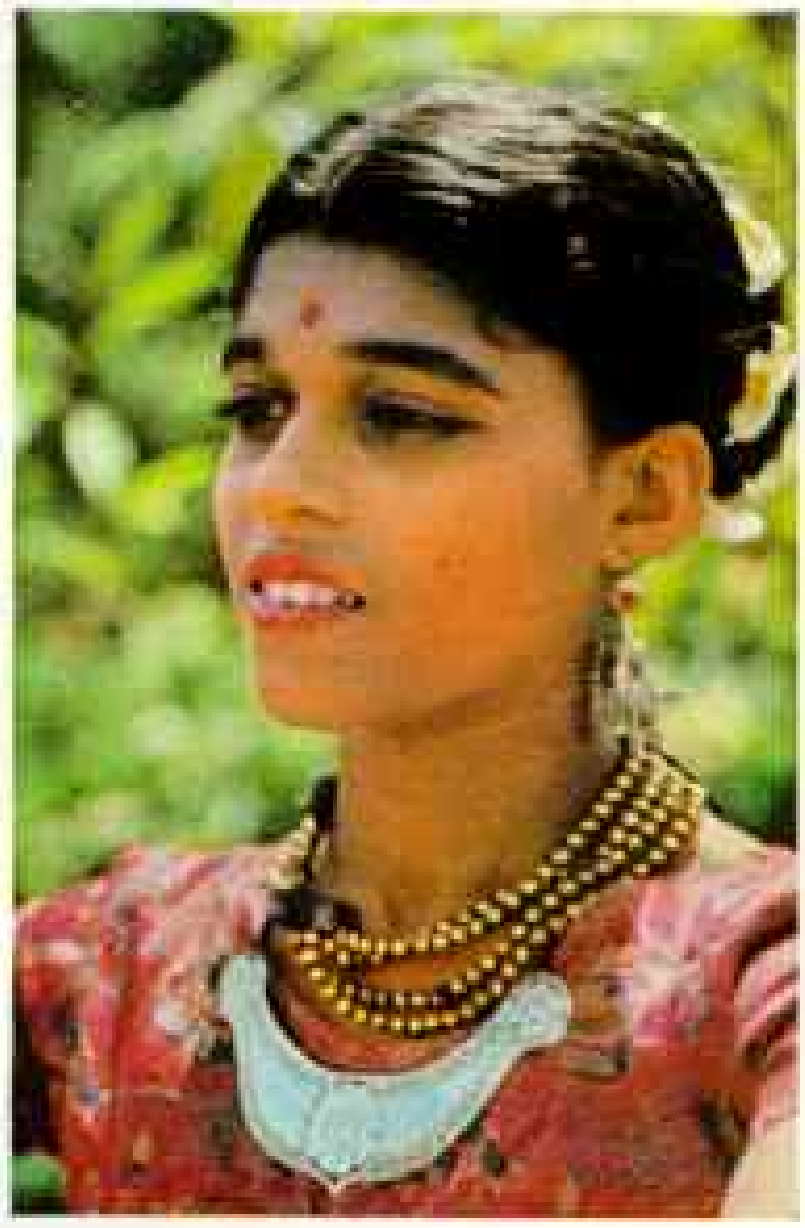
*See "Sigiriya, a Fortress in the Sky," by Wilson K. Norton, NATIONAL GEOGRAPHIC, November, 1946.



PAINTED HERE (ABOVE) AND REDRAWN BY GILBERT A. GROSVENOR © N.G.S.

Fortress built in fear: A terrified king who had murdered his father lived atop Sigiriya, or Lion Rock, a 600-foot-high granite monolith. Kasyapa moved his capital here from Anuradhapura to escape his brother's vengeance. A gallery, starting between gigantic lion's paws, leads up the sheer cliff to the three-acre top. Only ruins remain of Kasyapa's majestic palace. Donna Grosvenor, climbing the slippery face, braves whipping winds and the hordes of wasps that are the only inhabitants of Sigiriya.

Goddesses or court ladies? No one knows. But these voluptuous damsels glow with a life of their own—a tribute to unknown Sinhalese artists of 1,500 years ago.



Classic features of a Kandyan dancer echo the golden beauty of the Sigiriya frescoes. Of 500 figures that once graced the ascent to Kasyapa's lofty palace, only 21 remain, protected by a granite overhang. The ladies stand half-hidden by clouds, and though seemingly barebreasted, they actually wear gossamer blouses. Charmed visitors scratched verses of praise on a polished wall nearby—among the earliest examples of Sinhalese poetry.

RESEARCHING (TOP LEFT) AND RETOUCHING © N.G.S.

CATALHOYUK © NATIONAL GEOGRAPHIC SOCIETY

Exquisite climbing lily, *Gloriosa superba* lives up to its name, but its yamlike root contains a deadly poison.

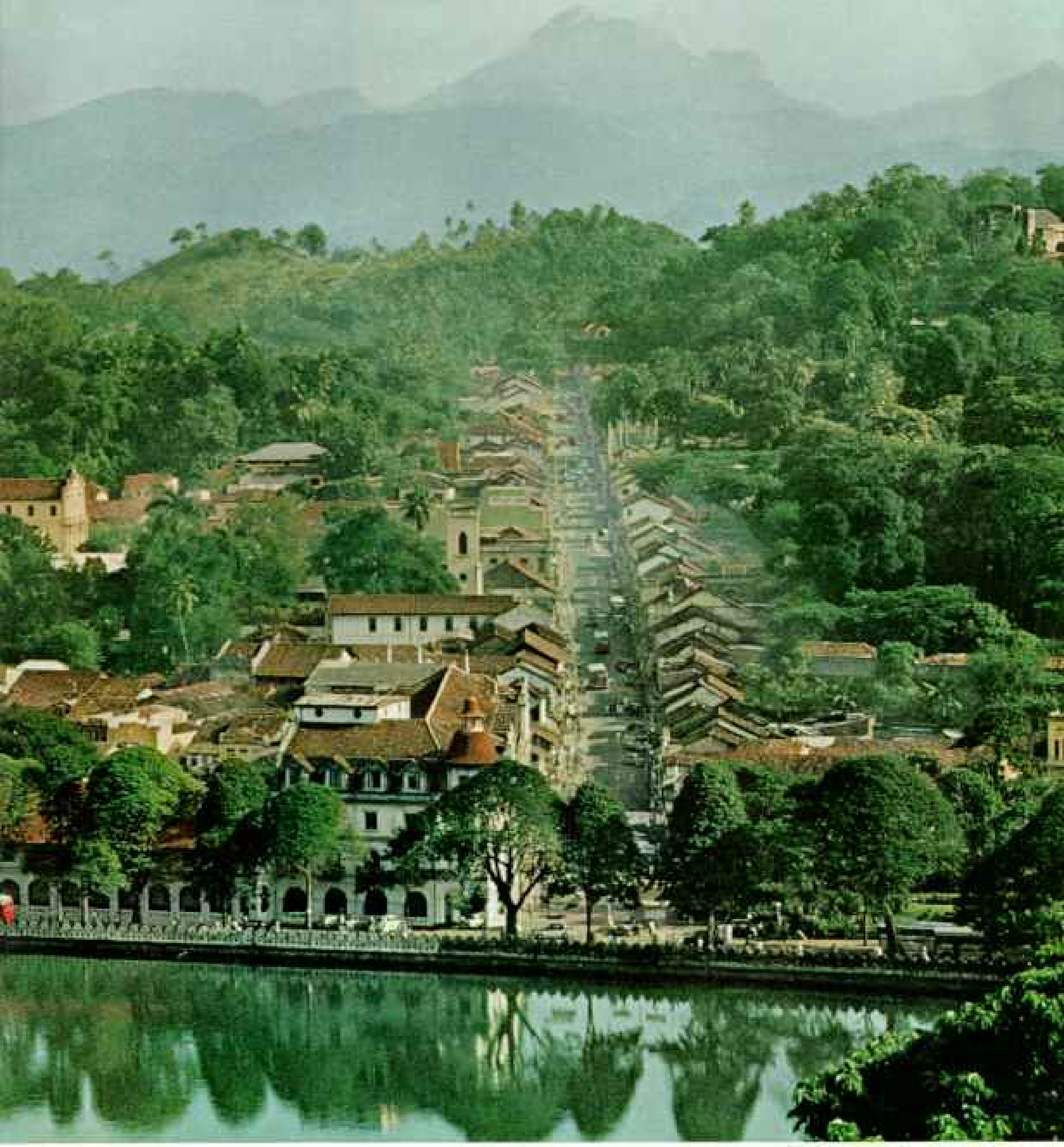
Vedda boy, descendant of Ceylon's nomadic aborigines, roams the jungle in search of food. He carries a bow and arrow and an ax. Veddas cling to traditional customs, but their numbers dwindle under pressure of advancing civilization and intermixture with other races.

Highland capital of the last Ceylonese kings, flower-scented Kandy borders a limpid lake. During the full moon of midsummer, the sleepy city throbs with animation as visitors come to witness Perahera (pages 448-9).

impregnable fortress in the sky, from which he ruled his kingdom for 18 years.

To reach the summit fortress, we hiked up endless terraced stairs, then walked halfway around the rock along a narrow corridor cut into the cliff and flanked by a 9-foot-high parapet. En route we stopped to admire Kasyapa's art gallery—the exquisite frescoes of the renowned and sensuous "Ladies of Sigiriya," who forever hide their identity behind taunting smiles (preceding pages).

Emerging on a broad, flat balcony between two huge brick paws of the Lion Rock, we began the hazardous zigzag ascent



KODACHROME (OPPOSITE, LOWER) AND KODACHROMES © NATIONAL GEOGRAPHIC SOCIETY

to the final high plateau. We clung like acrobats to the near-perpendicular walls and clutched a metal railing to sustain us against the lashing winds. Leg and arm muscles ached from crouching and straining for a foothold as we inched up the cliff's slippery, notched face (page 489).

Fearful King Dies by His Own Sword

We dared not speak for fear of arousing the menacing hordes of wasps that now alone inhabit the three acres of the once-great palace, the pink throne room, baths, and galleries of the king's domain.

At the summit, still breathless, we gazed out upon a panorama of jungle, lakes, and mountains. From this same spot Kasyapa's sentries, watching day and night for any approaching enemy, finally reported Moggallana's army gathering on the plains below.

Perhaps because even the safety of his wondrous palace in the sky could not protect the sorrowing Kasyapa from his own bitter conscience, he descended to battle his brother.

In the midst of the fray, the king's elephant came to a marsh. When he turned the beast to find surer footing, his armies, thinking that he was fleeing, faltered and scattered.

"**Rainy Day**" and "White Horses" show the brilliant colors and rhythms of child artist Senaka Senanayake.

Gods dance, elephants parade, and lotus blossoms unfold on panels of batik cloth at the Colombo home of Mrs. Osmund de Silva. She supervises girls using hot wax and dye to decorate fabrics with Ceylonese designs.

Famous at 13, Senaka Senanayake —nephew of Ceylon's prime minister—began his career at 6, painting on brown poster paper. Since then he has sent 42 one-man shows to cities around the world, exhibiting twice in Washington, D.C. A mural he painted hangs in United Nations headquarters in New York. Yet, happy and natural, he remains interested in sports and stamp collecting. "I really want to be a doctor," he told the authors. An accomplished sculptor, he sits beside "Father and Son," one of his recent works.

EKTACHROMES (ABOVE AND OPPOSITE, LOWER) AND KODACHROME © NATIONAL GEOGRAPHIC SOCIETY

Without dismounting, Kasyapa unsheathed the royal dagger and slit his own throat.

Whatever infamy surrounds Kasyapa the king, it cannot tarnish the glorious creation of Kasyapa the architect, the artist, the engineer. Sigiriya stands as final testament to the monumental efforts of Kasyapa the man to claim salvation for Kasyapa the king.

From the searing plains of the buried cities, we retreated to the cool of Kandy's hills. The tinsel of Perahera had gone; quiet hung along the city's winding drives (pages 492-3).

Suddenly, without warning, rain descended upon us. First came the dull thump of heavy raindrops on an elephant-ear plant, then the clean smell of breezes driven before a torrent. Finally a steady sheet of water streamed from the skies with such determination that one might have wished for the security of a Noah's Ark and two reserved spaces aboard her.

Moments later, just as suddenly, the scowling clouds broke open, flooding the sky with color. Only rivulets running off rooftops, the squishing of bare feet on muddy paths, and the reflection of passing vehicles in the shiny streets proved the rains had come at all.

The deluge over, we probed the Peradeniya Royal Botanic Gardens near Kandy, 150 acres of flora from many tropical lands. Dan guided us through a scented spice reserve, where we sniffed nutmeg, cinnamon, clove, cardamom, and pepper. We found avenues lined with palms, a fairy glen of ferns, pools of lotus lilies, and greenhouses and laboratories where orchids are delicately nurtured.

River Jaunt Atop an Elephant

As we left the gardens, Dan had only to mention elephants bathing, and we headed for the river at Katugastota, near Kandy.

"Madam, you've wanted to ride an elephant. I know the mahouts; we'll find the best one for you," Dan promised.

Momentarily, Donna regretted ever having

mentioned the subject. Dan scurried off, returning with a mahout leading an elephant.

"Madam, meet Lechchimi. She's gentle."

"What should I do?" Donna asked.

"Madam, just stand there; Lechchimi will do the work," Dan instructed.

Blowing hot air in my direction, a great bewhiskered trunk reached out, hoisted my wife aloft, and gently set her down on the beast's broad forehead. The mahout shouted, "Head higher!" Lechchimi obeyed with an upward jerk of her head, and Donna slipped. Instantly the great trunk folded securely about her waist, holding her fast.

Now confident, Donna climbed astride Lechchimi's back for a stroll in the river. Only a few tasty slices of cocoa fruit from Donna, plus a sharp prod in the posterior from the mahout, persuaded Lechchimi to meander ashore.

"How was it?" I asked.

"Great, but she could do with a shave," Donna replied candidly.

At the Chalet Guest House in Kandy, Donna retreated to shower off essence of elephant, while I took time to relax and to scan the latest edition of the *Ceylon Observer*. Little had changed during the seven weeks Donna and I had traveled through this beautiful land. The world's spotlight was still cast on the troubled Asia around us. India and Pakistan battled for the Vale of Kashmir; blood flowed in the Red River Valley and Mekong Delta of Viet Nam; the Federation of Malaysia faltered; Indonesia seethed with discontent.

But here in the tranquil hills of Kandy the sounds of distant war and political turmoil echoed only faintly. One could still hear, clear and unchanging, the timeless voice of Lanka —the voice we had heard in the giggle of an upcountry girl, the trumpeting of a wild elephant crashing through primeval jungle, the roar of surf spending its fury against sandy shores, the rhythmic pounding of barefoot Kandyan dancers, and the shrill wind that sends dust eddying across the hallowed ruins of Buddhism's buried cities. THE END

Cooling off under a golden shower, a worker ends his day at Anuradhapura, with the massive brick dome and spire of the Ruanweli Dagoba rising in the distance. The lake, part of an ancient system of irrigation reservoirs and canals, is named for King Tissa, Sinhalese monarch of the third century B.C. who first embraced Buddhism.

Walking with natural grace, women carry water jugs to a village near Anuradhapura.

(TRANSPARENCIES (ABOVE) BY GILBERT M. GROSVENOR, HIGHLIGHTED BY BRIAN BRAKE © N.G.S.)

Working for

Weeks on the Sea Floor

By CAPT. JACQUES-YVES COUSTEAU

Photographs by PHILIPPE COUSTEAU and BATES LITTLEHALES

THE OCTOBER SUN gleamed on the white stone lighthouse at Cap Ferrat and reflected from a jetliner beginning its climb from Nice-Côte d'Azur airport on France's south coast. Off the cape a statuesque water-skier crossed the sparkling sea. Oblivious to the vivid scene, a dozen of us sat closeted in the lighthouse watching closed-circuit telecasts of a historic event taking place 370 feet below the skier's foaming wake. We were witnessing one of the first steps in man's economic occupation of the ocean floor.

I had wagered a $700,000 project, involving 150 technicians and a dozen vessels, on the skill and dedication of a few young men shivering in the cold darkness of that lonely and forbidding realm. It was an expensive gamble on a tough and tricky task. But if they proved me right, millions

EERIE OUTPOST IN THE WILDERNESS OF SEA, *a spherical house-workshop known as Conshelf (Continental Shelf) Three crouches on the Mediterranean floor. The station's "street lamps" and the ghostly glimmer of day outline the author's famous diving saucer, above, probing the chill depths like a shark. Working out of the sea house for three weeks, six "oceanauts" boldly advanced man's exploitation of the ocean bed.*

EXTACHROME BY ANDRÉ LABAN © N.G.S.

First to test the oceanauts' breathing apparatus, Captain Cousteau hooks up, watched by his deputy, Jean Alinat. To survive at depths below 300 feet, the Conshelf crew breathed "helios"—a mixture of about 98% helium and 2% oxygen.

of square miles of offshore territory would be added to the regions exploitable by man.

On our screen a passing fish lent the only movement to a picture of a strange knobby totem pole picked out of the dark by haloed lights (painting, page 518). Slowly into the scene came an apparition, a big globular body with wide astonished eyes. In the pupil of each eye there was a man's face. This monster that swallowed men cast a glaring light on the scene.

"It's the diving saucer," said my wife Simone, as if to reassure our guest viewers. "You can see the crewmen at the portholes."

A Halloween skeleton drifted into the picture. "Raymond Coll," someone said. Only the light-colored tapes on the seams of Coll's black rubber trousers and sleeves showed in the darkness. Another skeleton appeared. A watcher identified him: "Christian Bonnici." The image shifted as an invisible diver, who could only have been my son Philippe, the cameraman, picked up the undersea TV camera and approached the totem pole.

"Christmas Tree" Simulates Submarine Oil Well

That singular structure was now recognizable as a production-type oil-well head, a vertical stack of pipes and valves known to oilmen as a "Christmas tree." Although it did not stand atop an actual oil well, the Christmas tree had been fitted with a tank of compressed air to create the internal pressure of a working wellhead.

Oil wells, whether on land or offshore, are controlled by Christmas trees, whose valves are adjusted to produce

Shaved pate bristling with electrodes, expedition chief André Laban turns human guinea pig. As red light flickers in the hand-held panel during a test ashore before the dive, sensors record his brain waves. Later, on the bottom, another electroencephalogram will show any effects of pressure and helium atmosphere. This, together with other mental and physiological records taken under water, revealed an amazing ability by the oceanauts to withstand the fatigue of their long ordeal. "The most modern machines often failed in the depths, but the men, never," says Captain Cousteau.

an even flow. Sometimes they choke up or run wild. On land, trucks with cranes lift tools and men for maintenance and repair.

On the bottom of the sea, in place of a crane, one of our practical underwater engineers, Albert Falco, had tethered over the wellhead an air-filled steel globe with a half-ton upward pull. From it hung a chain hoist, with which the oceanauts could raise and lower heavy tools. A diver seeking to mount the rig simply flipped his fins and soared.

Oceanauts Tackle "Impossible" Job

Our six divers, or "oceanauts" as we call the new breed of sea-floor technicians, had been working on the bottom for two weeks without surfacing. Each day they ventured from a spherical undersea house 150 feet away to carry out their assigned tasks. Now came the crucial test: The success of Continental Shelf Station (Conshelf) Three, the most advanced outpost yet established by man in the offshore wilderness, would be judged by the way these men managed the work they were about to begin.

With me were several skeptical oil engineers from the French Government's Bureau de Recherches de Pétrole, which helped to sponsor our third undersea settlement. They had their stop watches ready to time the oceanauts on the difficult operation. Several colleagues from the National Geographic Society, also a sponsor, had joined us.

We watched Bonnici attempt a key aspect of a wellhead repair job which oil technicians considered almost impossible under water. This consisted of threading a stiff wire through a thick pack of pressure-proof seals. Coll lent stability by sitting on his shoulders.

Bonnici trembled from head to foot with

"**You first!**" grins Cousteau as chief biologist Raymond Vaissière, project dietician, samples one of his own menus. Dr. Charles Aquadro, an American member of the staff, helped test Conshelf's breathing mixture.

Oceanauts ate frozen dinners like those served by airlines. Told that sauce for lobster thermidor would be banned because it might be difficult to digest, the gourmet divers said "*non*" to the lobster, too.

Trial dive in Monaco harbor seals six men in Conshelf Three. When the research vessel *Expadon* raised her gangplank, the unique sea station pumped water into ballast tanks for an 85-foot descent to the harbor bottom. Two Galeazzi decompression chambers, underwater "lifeboats," rode down with the sphere. Each of these cylinders could lift three men to the surface if pressure failed in the sea house or some other disaster occurred in the depths.

cold and concentration. He retreated several times to the house for infrared warm-ups, but he persisted—and he prevailed. When the oilmen saw him ease the wire through the last seal, they stood up and cheered.

After seven hours in the water, Bonnici dragged himself into the house and learned that his coordination test that night would consist of threading needles!

Conshelf One: 33 Feet for 7 Days

Oceanauts had made much progress since our first manned undersea base was established in September, 1962. In Continental Shelf Station One—Conshelf One, as we called it—Albert Falco and Claude Wesly remained submerged for a week at a depth of 33 feet off Marseille. Using Aqua-Lungs, they labored outside as long as five hours a day at depths as great as 85 feet. They were supported—or rather oversupported—by a clutter of vessels and men; as other divers and just plain well-wishers dropped in, they sometimes felt as if they were living in a bus station.

Conshelf One proved that divers could live and work efficiently for a significant period while continuously submerged. The key word here is work. The reason for putting manned stations on the bottom is to multiply divers' work capability by hours and fathoms.

For Continental Shelf Station Two, we set a larger challenge, that of making a precursor of underwater society. We wanted to see what would happen to a group of average men during a month-long sojourn.

Conshelf Two, the first human colony on the sea floor, was set up in the Red Sea off

Port Sudan during the summer of 1963. The main settlement, 36 feet down, housed five men for a full month. There was also a deeper camp in which two men lived and out of which they worked for a week in a regimen of half helium, half air, pushing the work range of oceanauts to 165 feet.*

Our first continental-shelf structures were combinations of cylinders and domes. For Conshelf Three our engineering team, headed by Commandant Jean Alinat, went to the most logical form: the sphere. Our new undersea station, 18 feet in diameter, had two stories, the lower for diving, sleeping, and sanitation, the upper for dining, communications, and data gathering (painting, page 519).

The oceanauts swam out to work through a bottom hatch that was open to the sea during their whole time below. Pressure inside the house equaled pressure outside, so that water could not rise above the hatch. The steel globe rested on a 48-by-28-foot chassis that held 77 tons of ballast (half of it in iron pellets), water ballast tanks, and reservoirs of helium, oxygen, and compressed air.

On the open deck of the chassis were nine tons of wash water in a big neoprene bag, and a bin of canned table water and fruit juices. Here also were the "lifeboats"—two three-man Galeazzi decompression chambers, whose bottom hatches were kept open while the station was on the sea floor. In a life-or-death situation the men could enter the chambers, close the bottom hatches, and soar to the surface, there to undergo controlled decompression in big medical pressure chambers.

Fewer Ties Link Men With Surface

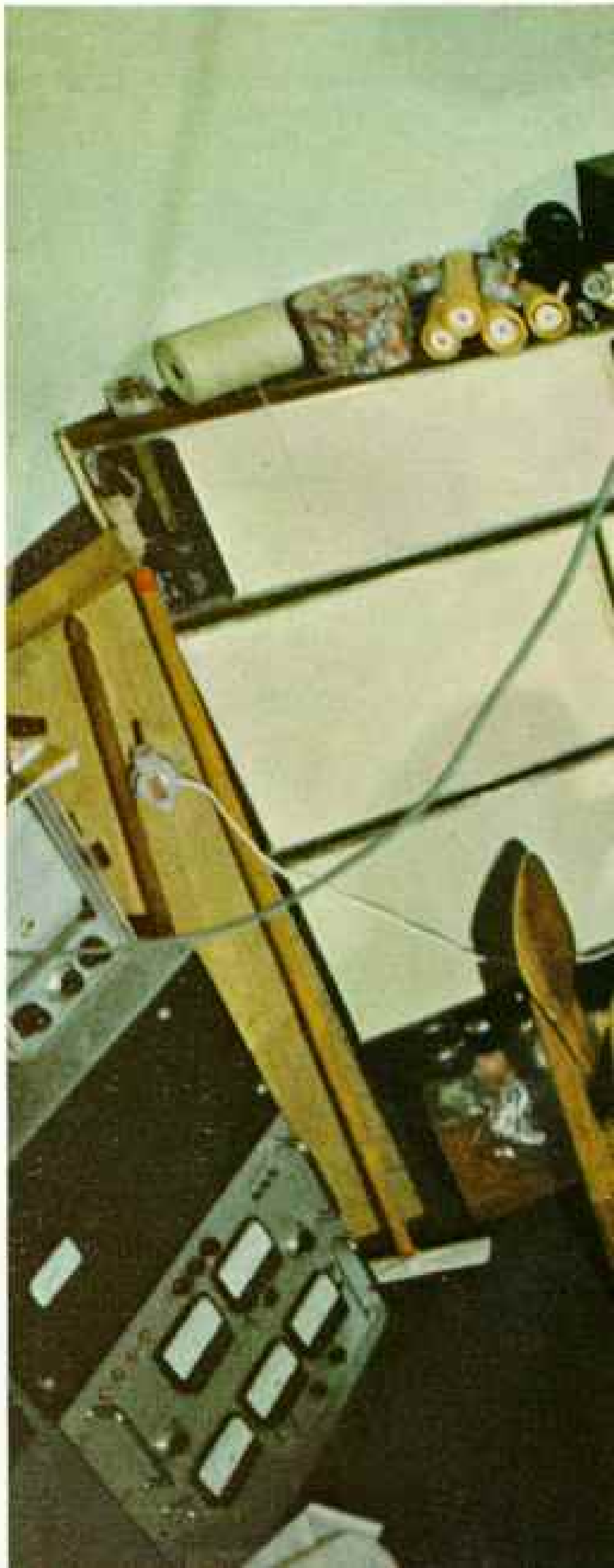
Before Conshelf Three reached the planning stage, I had come to the conclusion that it was wrong, expensive, and dangerous to bind the underwater people to a welter of ships, machinery, and specialists on the surface. I wanted to deliver them from total dependence on vulnerable cables, pipes, tackle, processions of support divers, and people who wanted to hit their knees with rubber mallets.

Our early oceanauts had lived in endless calm down below, but were at the mercy of surface storm damage to their communications and supplies. It was ridiculous. I set out to lessen Conshelf Three's reliance on the surface, even though the new station was to be nine times deeper than earlier ones.

The oceanauts would not be able to breathe air, because its nitrogen content would be lethal at 11 atmospheres; they would need an atmosphere of helium and oxygen, "heliox" for short. They would be in darkness; at 100 meters, 328 feet, daylight is weak and dull. They would be alone; compressed-air divers from the sunlit world could not safely venture so deep. Only the diving saucer could visit them, and the only hand it could lend was its cold steel claw.

As oceanauts, we selected from our underwater research group skilled men in superior physical and mental states, who had performed well in difficult situations. If a man had personal reasons for declining, all he had

*See "At Home in the Sea," by Capt. Jacques-Yves Cousteau, NATIONAL GEOGRAPHIC, April, 1964.



Farewell to sunshine: Raymond Coll and Christian Bonnici queue up in the water off Monaco to board their undersea home. André Laban, beside the sphere, breathes oxygen to purge his lungs of nitrogen before ducking through the bottom hatch.

At home in the sphere, though still afloat in the harbor, oceanauts undergoing pressurization top off a roast-beef lunch with fruit. Laban pinches his nose and blows to equalize the pressure on his eardrums.

EXTACHROMES BY PHILIPPE COUSTEAU (BELOW) AND JAMES STILLMAN © N.G.S.

Human cargo inside, the sea house eases past Monaco's north harbor light on its way to the diving site seven miles away. Directing the move from the deck of *Espadon*, Cousteau sets a course that at no time crosses depths greater than 165 feet, so that if the sphere should accidentally sink, conventional divers could come to the rescue. Yellow fin and a pair of buoys steady the wobbly sea house. Lights of the Casino of Monte Carlo blaze from the hillside.

Trouble waited at the diving site. When Conshelf Three prepared to descend, mounting seas tore away power cables and forced a return to base. For two days divers made hurried repairs while the oceanauts, still under pressure, waited in the sphere. Then, once more, the flotilla said farewell to Monaco.

to do was tell me. We were not making an underwater home for heroes, but pitting capable working men against tough tasks.

Of fifty candidates, we initially took three men in whom we had firm confidence (page 520). We started them in five months' training as oil-well technicians. Christian Bonnici at 29 was an intense, driving worker, a good mechanic and self-reliant diver with no time for comedy. Raymond Coll, 27, had joined our group at 16. He was one of the coolest, most resourceful, and likable people in our outfit. Yves Omer, 24, was the youngest of the lot, a diligent worker with a flair for underwater rigging and learning new jobs.

We named a total of 12 oceanauts to undergo full training, dividing them into "A" and "B" teams, the latter as standbys for members of "A" team who might be disqualified for medical reasons. Heading "A" team and slated as *chef de mission* of Conshelf Three was André Laban, 37, an engineer with 14 years in our undersea group (pages 516-17). Laban is a slim, taciturn, easy-smiling individual with a shaven head and talent as a musician, painter, and cameraman.

As scientific chief of the undersea station we picked Jacques Rollet, a 28-year-old physicist from the laboratories of the Oceanographic Museum (pages 514-15). The demanding job of producing the film and photo record of the deep colony went to my younger son, Philippe, 24, recently schooled as a professional cinematographer (see nominations page at

ILLUSTRATIONS BY BATES LITTLEHALES © NATIONAL GEOGRAPHIC SOCIETY

beginning of magazine). He has been diving for 20 years. I put a miniature Aqua-Lung on Philippe when he was four.

A year of training, testing, and construction went into Conshelf Three. The oceanauts helped build their house and furnish it.

Doctors Test High-pressure Heliox

In Marseille, our physicians put goats and sheep through prolonged heliox exposures in pressure chambers, simulating a depth of 660 feet. Only then did we make the first human trials. Dr. Charles F. Aquadro (page 503), an American member of my staff, and Dr. Jacques Chouteau spent three days in a tank of heliox at 13 atmospheres of pressure, the equivalent of 400 feet down in the sea.

We stinted nothing to make the underwater base efficient and safe. Time after time, I put off the launching date in order to improve the self-contained heliox breathing center. When you are pitting a new, unproven life-support system against the pressures of the deep, you cannot allow a schedule to interfere.

To place working men so deep for so long, we had to surround them with unfamiliar and exotic appliances. The heliox breathing center, our most radical departure, was a large installation called a cryogenerator, named after cryogenics, the study of extreme cold. The cryogenerator circulated the gases the oceanauts breathed, froze out carbon dioxide and other noxious gases, and dehumidified the house. It also served as a deep-freeze locker

and refrigerator for three weeks' food stocks.

To keep a close watch on their breathing mixtures, the oceanauts had gas analyzers whose findings could be read simultaneously in the house beneath the sea and by electrical transmission in the lighthouse above. This equipment was backed by a miniaturized mass spectrograph that continuously recorded the presence of every gaseous element in the oceanauts' environment. To rid the sphere of nitrogen, we created a vacuum inside it that wrung all gas out of its porous materials; then we filled it with heliox.

At last the top hatch was sealed and the lower hatch opened to welcome aboard the adventurers of Conshelf Three. The oceanauts entered it at noon on September 17, 1965 (page 505). They closed the bottom hatch, laid on heliox pressure, and reached 11 atmospheres in six hours. Still on the surface, they now lived under the equivalent pressure of 328 feet of water.

Heliox Changes Bass to Soprano

As soon as the men breathed heliox, their voices reverted to babyhood. Helium is so light that it does not slow the vibrations of the vocal cords, and a basso profundo turns to a mezzo-soprano. Days would pass before the oceanauts could understand each other.

They had to learn to speak slowly and succinctly, and to avoid high-pitched sounds. Omer described it: "Sooner or later, you were bound to get excited, and when you saw the genuine puzzlement on the other fellow's face, your hot emotion turned into a big laugh."

As we readied our 140-ton undersea house for its seaward journey, the panorama on the south jetty at Monaco was one of splendid chaos. Four vessels, several launches, and a hundred line-handlers crowded the quay. It was crammed with helium and oxygen tanks, a road crane, miles of spooled cable, camera crews, communications huts, hundreds of spectators, and the inevitable small child standing under the heaviest weight that was being transferred. Watching were naval observers from the United States, Britain, Italy, Sweden, West Germany, and France.

Half-hidden in the work party, giving no orders but keenly scanning the tumultuous scene, stood a pioneer among oceanauts, the safety chief of our complicated operation. Albert Falco's veteran eye and undersea wisdom perceived every aspect of the three-dimensional operation. He did not need symbols of authority. Our people knew he was there.

As our smaller research vessel, *Espadon*, slogged through the darkening sea with the sphere in tow (pages 506-7), a reporter on board said to Simone, "Madame Cousteau, you must be concerned about your son in there." She replied, "Monsieur, I have six sons in there, and I am thinking of all of them."

We reached the station site in the morning, and the weather turned hostile. One of the big marker buoys got out of control and tore up three of the power and communication cables that ran out from the Cap Ferrat lighthouse to the dive site. We could not submerge the house without its cables, nor leave it afloat in a rising storm, so we hauled it ignominiously back to Monaco. The oceanauts remained sealed up on the surface of the harbor for two days, while our electricians repaired the multiconductor cables in the water. All was ready again on the morning of September 21.

We anticipated that there would be two great critical periods for Conshelf Three: the descent and precise landing on the bottom, and the return to the surface under the control of the oceanauts themselves.

A considerable flotilla was engaged in preparing Conshelf Three to slide down a tight guide wire to its destined site on the floor. Five seagoing vessels, our diving saucer, and half a dozen launches and rubber boats were involved. Most of them had walkie-talkies, whose messages could be transmitted via headquarters on Cap Ferrat to the diving saucer and the deep-sea station itself. Under the surface, 15 divers made the sea house ready to descend.

Husky Bernard Delemotte's job was to plug in 14 multiconductor cables beneath the house. With compressed air he blew water out of the 3-by-5-foot entry tube and squeezed into it with cable ends, tools, and a three-tank Aqua-Lung. He dried himself and his gear, removed waterproof compound from the connections, and joined them with many turns of protective tape. Three hours of this unseen agonizing work gave the oceanauts warmth, telephone, and TV transmission.

The currents began changing. Ships and divers eased restraining lines or made them taut to keep the undersea house in position. The sea put kinks in the cables hanging on yellow drums between shore and sphere. Launches tugged at the writhing power lines to keep them in order (page 511).

The sun set. A lot of work remained. I

listened as privately as possible to French Navy weather reports. They predicted imminent gales. A storm would put us in a terrible mess.

I kept quiet and stood on the foredeck of *Espadon* as if I had no cares. My role was to concentrate on problems we had not foreseen.

It was nearly midnight before we could release the sea house from its support buoys. From its position under the surface, it started down unseen. The string of yellow floats diminished as they were hauled under, one by one.

The oceanauts had no sensation of sinking. They felt the legs of the house touch softly. From the saucer, Falco saw it land within one foot of the place he had picked (next page). It was 15 minutes after midnight, September 22, 1965.

Thus began a test of human ingenuity and adaptability, of dogged courage and kindling spirit that I am convinced will lead mankind to greater rewards than the space race.

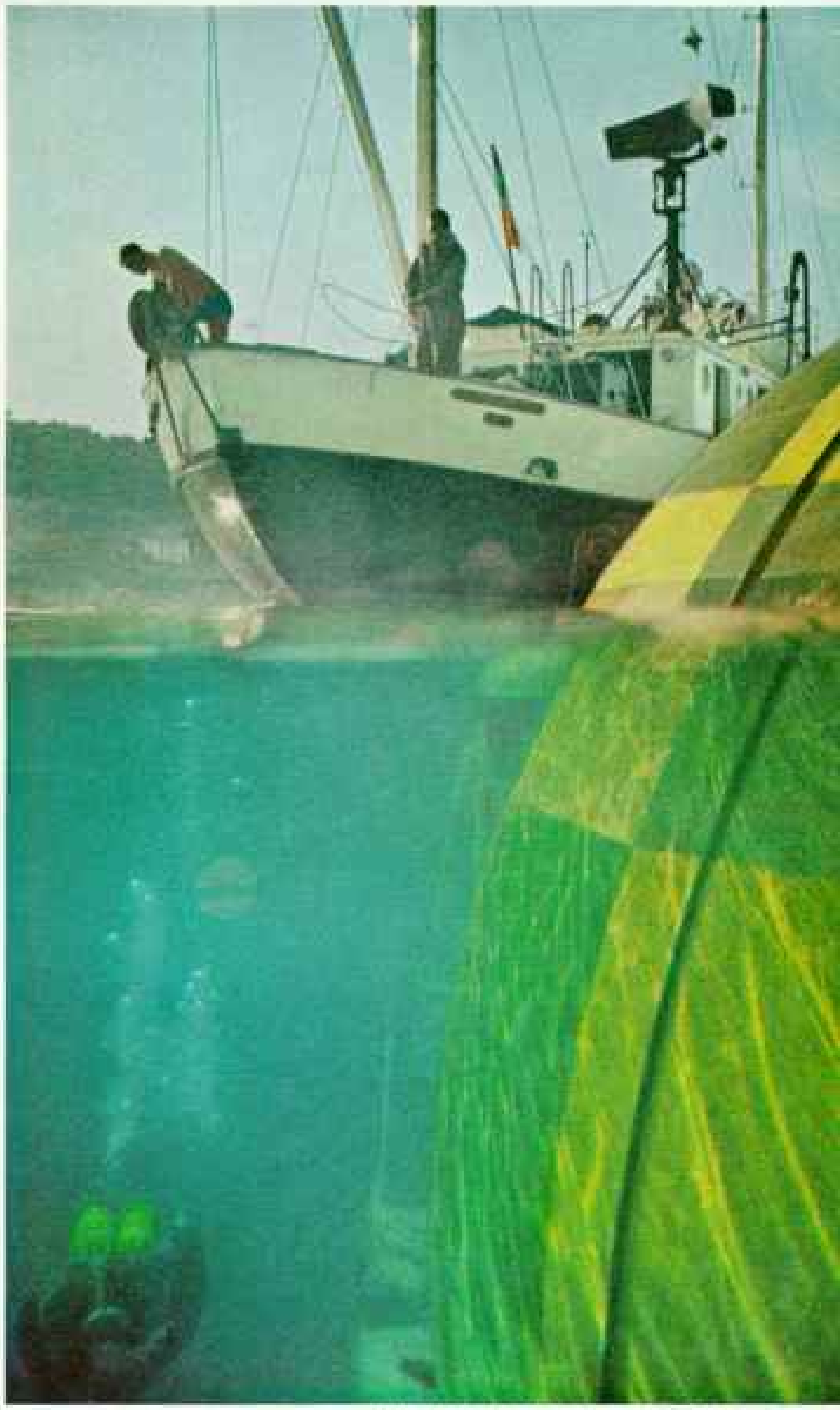
Hatch Opens to Darkness

The oceanauts unbolted the bottom hatch to expose the liquid door through which they would pass to their labors on the ocean floor outside. The water was naked, clear, and black. The diving well looked like a barrel of tar. The oceanauts swallowed secretly. They were sunk in perpetual night.

The first chore was to bring in the ends of the 200-foot breathing hoses, strapped outside on the chassis, and expel water from them. Philippe put on a three-bottle Aqua-Lung filled with heliox and slipped into the cold, concealing water.

"As soon as I venture away from the *maison sous-marine*," said he, "I am struck by one overwhelming fact—we have lost the surface. It is far above us, out of sight, buried in treacherous night. The surface means death. Here on the bottom is safety—life itself. I reach down and touch the ground, our friend, our salvation."

Philippe passed the heavy hoses up to his companions. Taped together were each man's yellow inhalation pipe and a black hose to



PHOTOGRAPHS BY BATES LITTLEHALES © N.G.S.

Wake of bubbles traces a diver's path beside the sphere. Here in protected Villefranche Bay, a mile from the point of descent, Aqua-Lungers working off the ship *Winnaretta Singer* adjust Conshelf's metal legs and check external fittings. The station traveled the last mile to the diving site submerged beneath pounding surface waves.

Name of the support ship honors the daughter of sewing-machine manufacturer Isaac M. Singer. A foundation she established donated the vessel to Monaco's Oceanographic Museum, which Cousteau heads.

CAP FERRAT LIGHTHOUSE

VILLEFRANCHE

Power and communication cables from Cap Ferrat lighthouse hang from steel-drum buoys.

ESPADON

LABOR

PHYSALIE

Buoy exerts 3 1/2-ton upward thrust to keep guide cable taut

CONSHELF THREE dangles safely beneath surface waves during preparation for descent

Telephone line speeds orders from diving saucer, undersea eyes of the operation

LABOR lowers sea house. Nylon guy from PHYSALIE steadies CONSHELF THREE on guide cable

GUIDE CABLE

Bobbing column of buoys descends with the station. Sea pressure forces water into the drums' air pockets and reduces their buoyancy, gently lowering the power and communication cables

CONSHELF THREE reaches final position 20 minutes after descent began

DIVING SAUCER

ANCHOR

OIL WELL HEAD

carry his exhalations back into the house. The oceanauts were forced to recover their helium, purify it, and replace expended oxygen. They could not, like compressed-air divers, blow bubbles into the sea. Three of them would have drained the house of gases and flooded it in a matter of hours.

A compressor forced heliox through the yellow pipe, and a "depressor," or reversed compressor, pulled the gas back through the black pipe. The oceanaut at the end of this giant respiratory system wore two heavy foam-rubber wet suits; on his chest was our new two-way regulator for high-pressure heliox; and on his back he carried a conventional Aqua-Lung filled with heliox. Like a provident parachutist, he had a reserve pack.

Between wet suits the oceanaut wore an incompressible vest, the armor with which we hoped to overcome the ocean's main threat to deep fish men—sheer cold, exaggerated by pressure and the heat-stealing effect of helium.

Insulating Vests Resist Flattening

Near the surface, foam rubber will adequately insulate a man at 55° F., but 11 atmospheres of pressure will compress its air bubbles and destroy their insulating quality. To permit oceanauts to work in deep water, we had to have incompressible foam rubber.

The patent consists of enclosing microbubbles of gases in tiny ebonite spheres, no bigger than motes of dust, and filling a rubber blanket with millions of them. There wasn't time to make enough yardage for complete suits. We settled for vests to preserve the heat of

Half-mile arc of buoys, holding up power and communication lines, links the diving site with Cousteau's headquarters in the Cap Ferrat lighthouse. Line to left helps the research boat *Physalie* fight the current as her crew awaits Conshelf Three's descent.

Vertical voyage to a new world: Intricate maneuver of ships and men drops Conshelf Three 328 feet to a tiny patch of level bottom. As Cousteau watches from aboard *Espadon*, divers couple the sphere to a vertical guide wire. Then *Labor* slowly lowers away. Later, at a depth of 370 feet, Conshelf technicians erect an oil-well head, or "Christmas tree."

GROPING IN RELENTLESS GLOOM *that man-made lighting never quite dispels, André Laban inspects every inch of his command for rust, loosened cables, or any other defect. Emergency heliox tanks supplement standard breathing hoses trailing tail-like behind him. Glaring eyes of the diving saucer shine down to guide his rounds.*

EKTACHROME BY PHILIPPE COUSTEAU © NATIONAL GEOGRAPHIC SOCIETY

the central organs of the body. Legs and arms can become numb and recover, but life is in danger if heart and lungs get too cold.

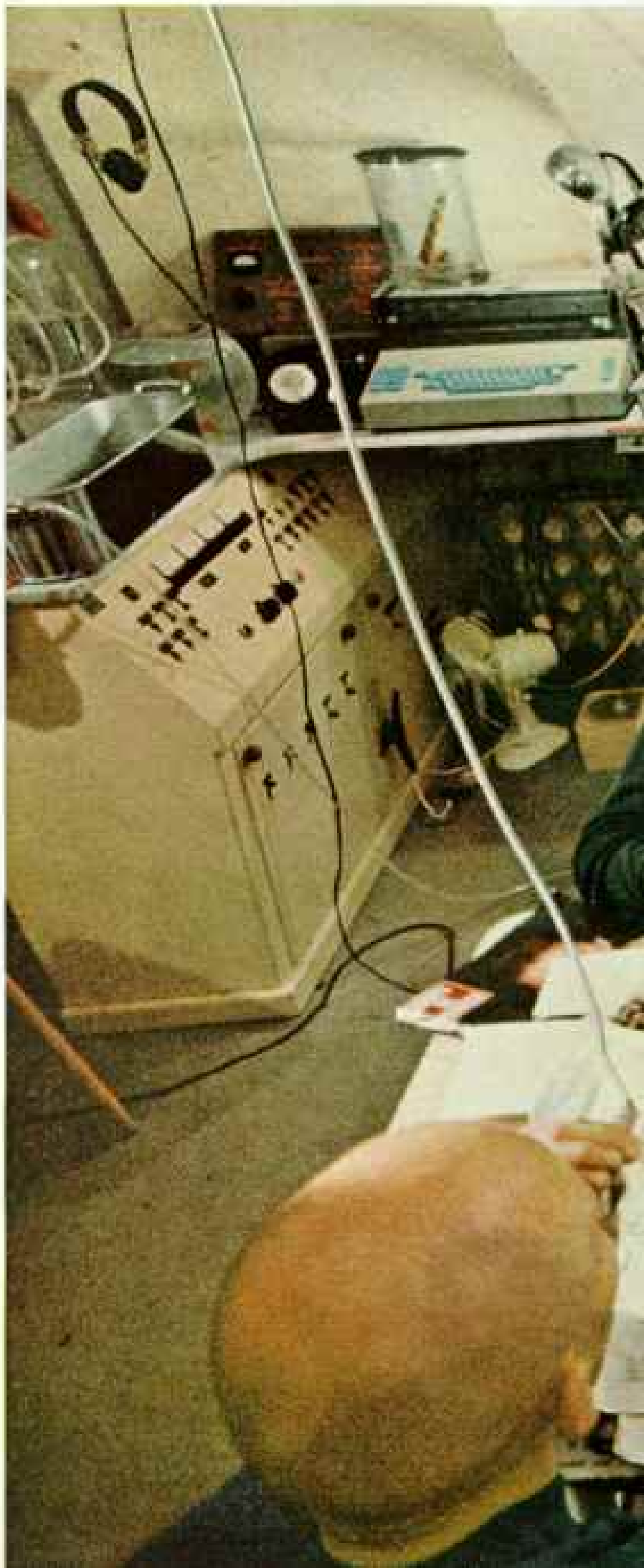
Conshelf Three itself soon got very cold, because of the heat conductivity of helium under great pressure. Here body warmth was lost 77 times faster than in normal atmosphere. The oceanauts turned on extra heaters to reach the ideal 90° F. temperature.

I did not forbid them to smoke. I did not need to. When you light a match in high-pressure heliox, the phosphorous tip fizzles out and the stem will not catch fire. If you put a glowing electric lighter to a cigarette, the tobacco and paper will not stay lit. Organic substances do not retain enough heat to burn.

Helium's heat diffusion also played tricks with food preparation. Although the deep-freeze meals needed only warming, the oceanauts had to heat water for tea and coffee. The water never boiled, although it reached temperatures half again as high as the sea-level boiling point.

Helium is a mischievous, merry element.

Old-fashioned apparatus of flasks and tubes stands by to analyze the breathing mixture should modern electronic testers fail. Chief scientist Jacques Rallet's laboratory doubles as Conshelf's dart-throwing range.



Reporting to the surface by means of a television camera on the ceiling, Rollet posts a measurement of the breathing mixture—oxygen: 2.5 percent. An increase to 5 percent could cause anemia in the divers; a drop below 1 percent, blackout. Written messages prove better than speech because the helium atmosphere distorts voices into high-pitched squeaks. In off-duty moments, oceanauts crack nuts and assemble model planes. Red wool *togues* have been worn proudly by generations of divers. Rollet and Yves Omer go shirtless in the sphere's 90° F. temperature, kept high to offset rapid loss of body heat in helium.

While it treats underwater man well, it gives his inventions and artifices a very bad time. The machines and electronic systems in Conshelf Three had passed short pressure tests in helium, but during days below, high-pressure helium infiltrated everything.

Artificial Atmosphere Disables Machines

The cryogenerator, the oceanauts' fountain of life, fell victim to helium's tricks. Air in the cells of the insulating material had been replaced by the insidious gas, robbing the unit of cold retention. The oceanauts had to help the sick machine with our emergency chemical atmosphere purifier.

Television tubes, too, suffered in the helium environment. There were two waterproof television cameras for outside work, plus two fixed units in the upper and lower stories of the station, on which we watched the men 24 hours a day. Continuous monitoring was vital to the security and documentation of the operation. We also used the interior cameras as videophones: If we could not understand

E.E.G. Prise A

N°	Electrodes clavigueur	Electrodes à coller Beckman
1	•	●
2	• •	○ — A
3	• • •	●
4	• • • •	●
5	●	● — B
6	● •	○
7	● • •	●
8	● • • •	○ — C
9	● ●	●

Laver les électrodes après usage

Equipage

the oceanaut's falsetto, we could watch his lip movements, gestures, and scribbles held up to the lens (page 515).

But two or three days after Conshelf Three reached 11 atmospheres, its crewmen's images faded out on television. They replaced the "defective" vidicon tubes, and the replacements failed. A container sent from the surface brought fresh tubes and carried back the dead ones. The new tubes clouded over after three days. Tests showed the mischievous gas had infiltrated them. It cost $250 a day to keep Conshelf Three in TV tubes.

Sea-floor "Desert" Crawls With Life

The divers explored the sea-floor scenery. "The desert around us is no desert," Philippe found. "It crawls with life." Spiny lobsters with long antennae surrounded the house. There was a large octopus in residence atop a neighboring rock. Scorpionfish loitered on the bottom, confident of their camouflage. The oceanautic acres were littered with civilization's leavings, from pre-Christian amphorae to contemporary beer cans.

Myriad tiny creatures came to the lighted diving hatch; small frantic fish and prancing shrimp jammed into the glowing arena and made the water sizzle with their jerky celebrations of light. In his hand Laban dipped up the wriggling little things and downed them as the freshest of sea-food cocktails.

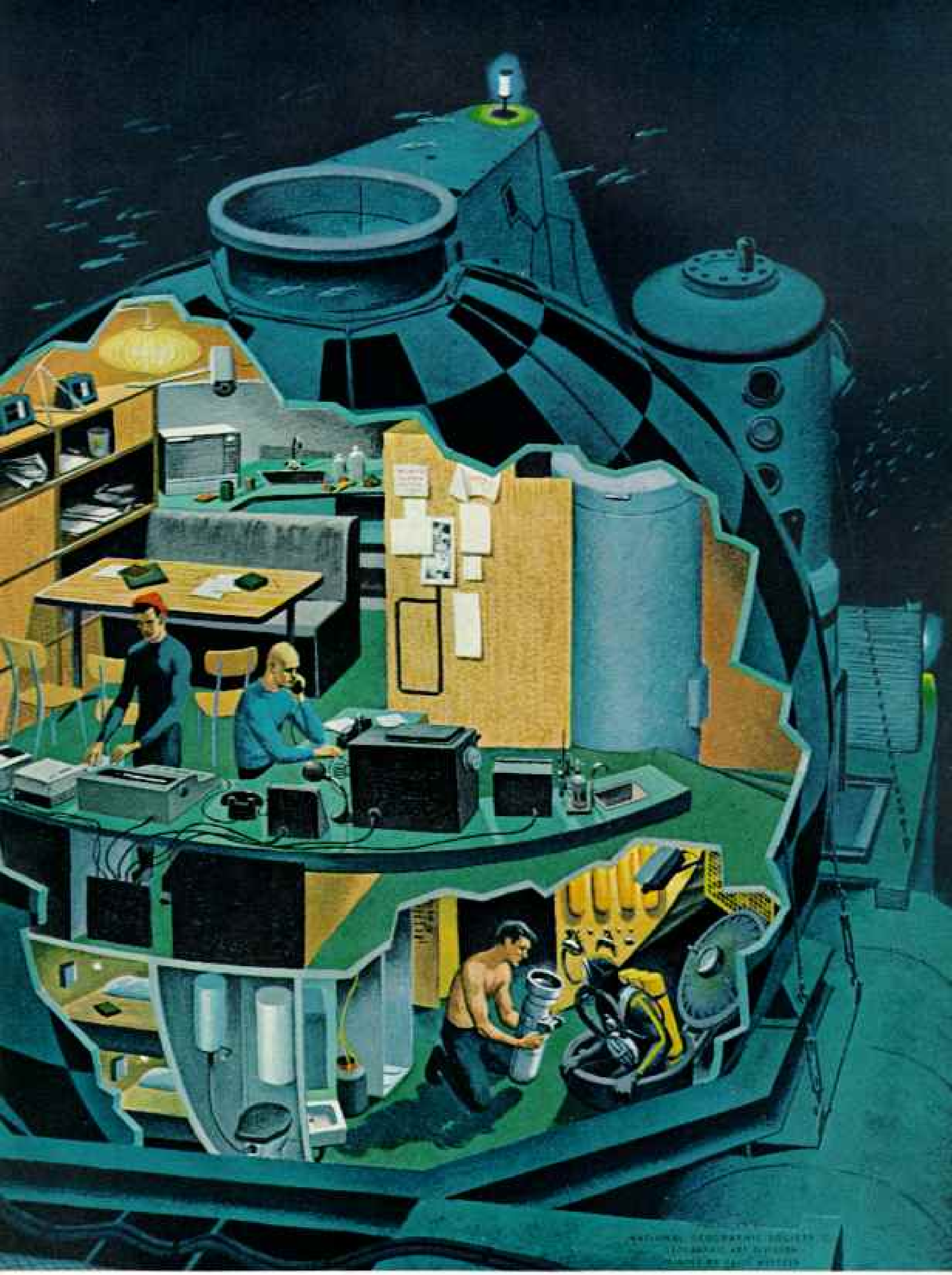
By the third night the chief's animated appetizers were gone. Big fish had discovered the little ones jigging against the station lights, and were robbing Laban from below.

We had confidence in Conshelf Three; so we invited the public to watch the experiment unfold. Scores of thousands of visitors to the

Impulses from electrodes stuck to Laban's scalp record brain waves during the exhausting weeks below. Readings flowing to a computer ashore, for comparison with an earlier surface test (page 501), showed no ill effects. The diagram tells Laban where to place the multicolored detectors. With all of them properly affixed, he telephones instructions to "tune me in."

Fatigue contorts Laban's face after a dive; weary hands unfasten the regulator. The station chief not only bore the burden of making all final decisions; as the team's top electrician he had to repair failure-prone machines. Eldest oceanaut at 37, he was sustained by strength of will, huge meals, and a steady stream of vitamin pills.

Every inch serves a purpose in the 18-foot-wide Conshelf sphere, seen here in cutaway. While station chief Laban telephones ashore, his mates operate an IBM teleprinter, ready a motion-picture camera at the diving hatch, and labor outside at the oil-well head in the glow of the diving saucer's



headlights. Kitchen, dining room, and data-gathering equipment crowd the upper level. Spiral stairs beside the cylindrical deep-freeze lead down to hatch, shower, lavatory, and bunkroom. An outside chassis holds ballast tanks, a mesh pantry box, and net-covered bag with nine tons of wash water.

Oceanographic Museum saw the computer center, where data recorded in the sphere were analyzed and direct telecasts were received from the sea bottom (page 534). Indeed, people were looking into the diving room when an oceanaut stepped into a hot shower without realizing he had crossed in front of the camera.

While everyone could see the oceanauts, they could see none of us. They only heard voices from the surface, mostly that of the duty television monitor, whom they irreverently called "God."

After watching them for a while, Simone said: "Look at Dédé [Laban]. Up here you can't get him to say an extra word. Down there he is a chatterbox. *Regardez* Rollet! A serious face. He never laughs. Now look at him. All smiles and jokes." Then of her younger son: "And Philippe! The biggest playboy in town has become a man who is not satisfied with working less than twenty hours a day."

Living in high-pressure heliox affected the tactile senses. "I feel a kind of perspiration all over my body," reported Laban. "But when I wipe my forehead, it is dry. Another modification of our senses is the almost complete disappearance of smells. Most of us complain we can't taste the food."

Luckily for us, the bad weather predicted for the descent operation held off until Day Four. The oceanauts and their sea-stead were then safely beyond range of surface disturbance. Yet, when the storm broke overhead, the turbulence echoed minutely even in their refuge. The water in the diving well rose and fell two inches.

We were scheduled to lower the oil-well head on Day Four, but the weather held us off. The storm mounted on Day Five. Torrential rains lashed the coast. Rockslides rumbled behind us on the coastal corniches.

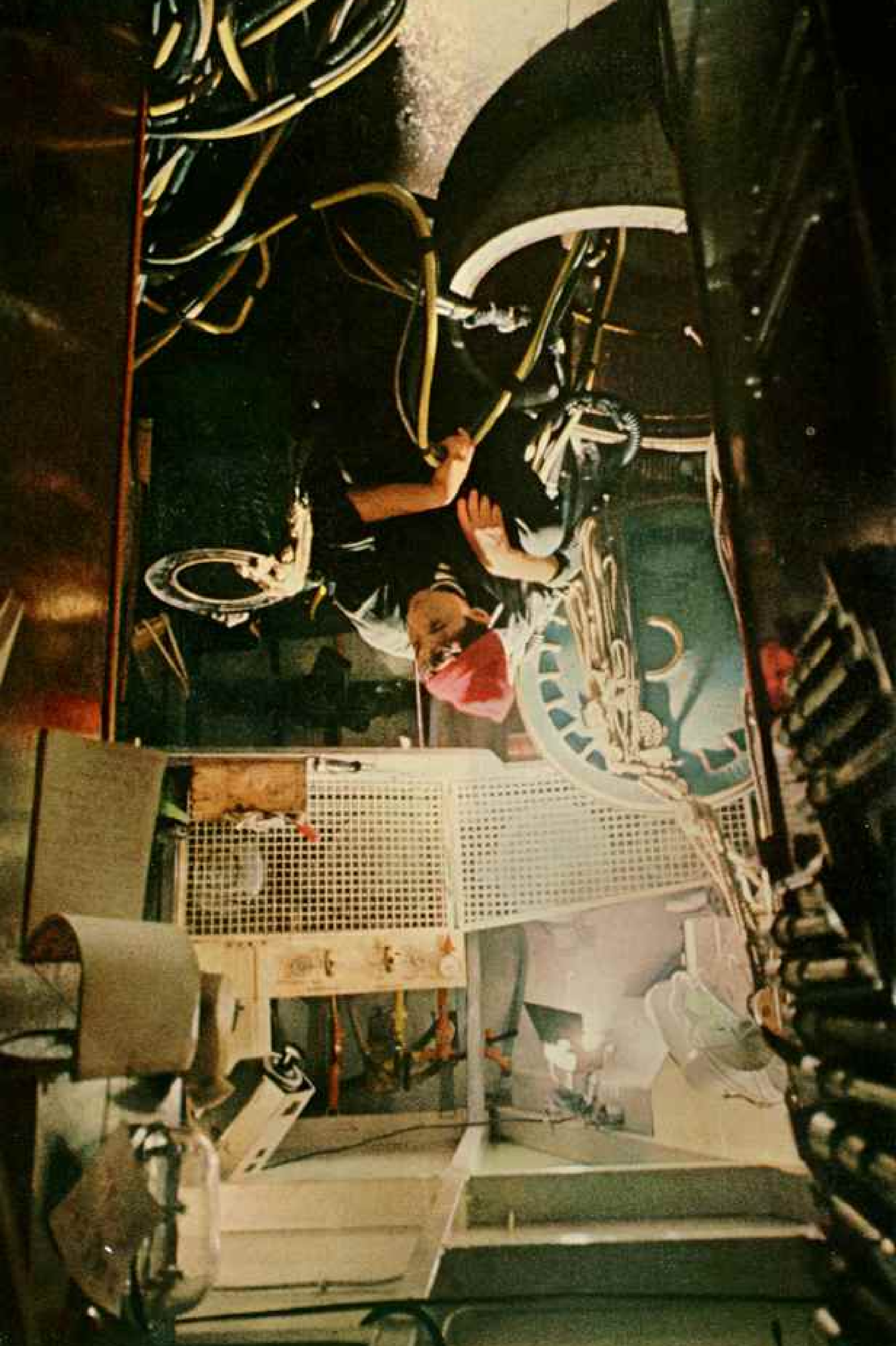
I stood on the lighthouse terrace, watching the most vulnerable aspect of Conshelf Three, the point where the power and communication cables passed into the raging water. To minimize exposure of the cables to wave action, we had planted a stable A-frame out from the rocks and passed the heavily cushioned cables over rollers on top of it. The sea threatened to chafe away the cables on the

EXTACHROMES BY PHILIPPE COUSTEAU © N. G. S.

Lonely sentinel at the door of the sea house (right), Bonnici tends the hoses of two oceanauts. He cocks an ear to the throb of compressors behind the grid. They pump heliox through the yellow hose and retrieve exhalations through the black line.

"Crossroads of the world," divers called the cluttered hatch area. Laban (above) hands up canned food from the outside pantry. Water pushes up at 160 pounds per square inch through the open hatch, but equal pressure of heliox inside the sphere holds the black flood at bay.

Bonnici, Coll, and Omer discuss tools needed for work on the sea-floor oil rig.



rocks. One of the lightkeepers told me helpfully, "We are getting the heaviest swells we've known here since 1947."

Nobody left our lighthouse headquarters for lunch. Simone appeared with a basket of bread, cheese, ham, and pizzas, which we ate gloomily on the terrace, sheltered from the rain in jeeps and TV vans, while looking down at the waves rising around the arteries and central nervous system of Conshelf Three.

Storm Tears at Conshelf's Lifelines

Foaming waves battered the A-frame, carried away its plank deck, and snapped one of its mainstays. I hurriedly conferred with my engineering chief, Alinat. We put the oceanauts on emergency standby to surface. If the A-frame were destroyed, the cables would part; we could not continue to transmit power to the station. In that case Laban was to button up the sphere, break out his two-week supply of atmosphere-regenerating chemicals, and jettison ballast to ascend.

Once free from the bottom, the oceanauts were to get into bed in down sleeping bags and cover themselves with blankets and outer clothing, for without their electric heaters they could well freeze to death in a few hours in helium. They had iron rations to chew while hibernating. The sphere could ride out any storm, provided we could maintain lines on it to hold it off the lighthouse rocks.

After noon another stay parted. Falco and Raymond Kientzy climbed the A-frame and strung new stays that saved Conshelf Three.

By morning it seemed that we had withstood the worst of the storm. For miles out, the Mediterranean looked like potato soup, and the oceanauts were at the bottom of the tureen. Apparently all unattached grains of sediment on the southern slope of the Maritime Alps had been flushed into the sea. It was bad news for our photo and TV coverage.

We lowered the five-ton oil-well head to its chosen place 150 feet downslope from the undersea house. This Christmas tree was going to an unprecedented depth. An oil well

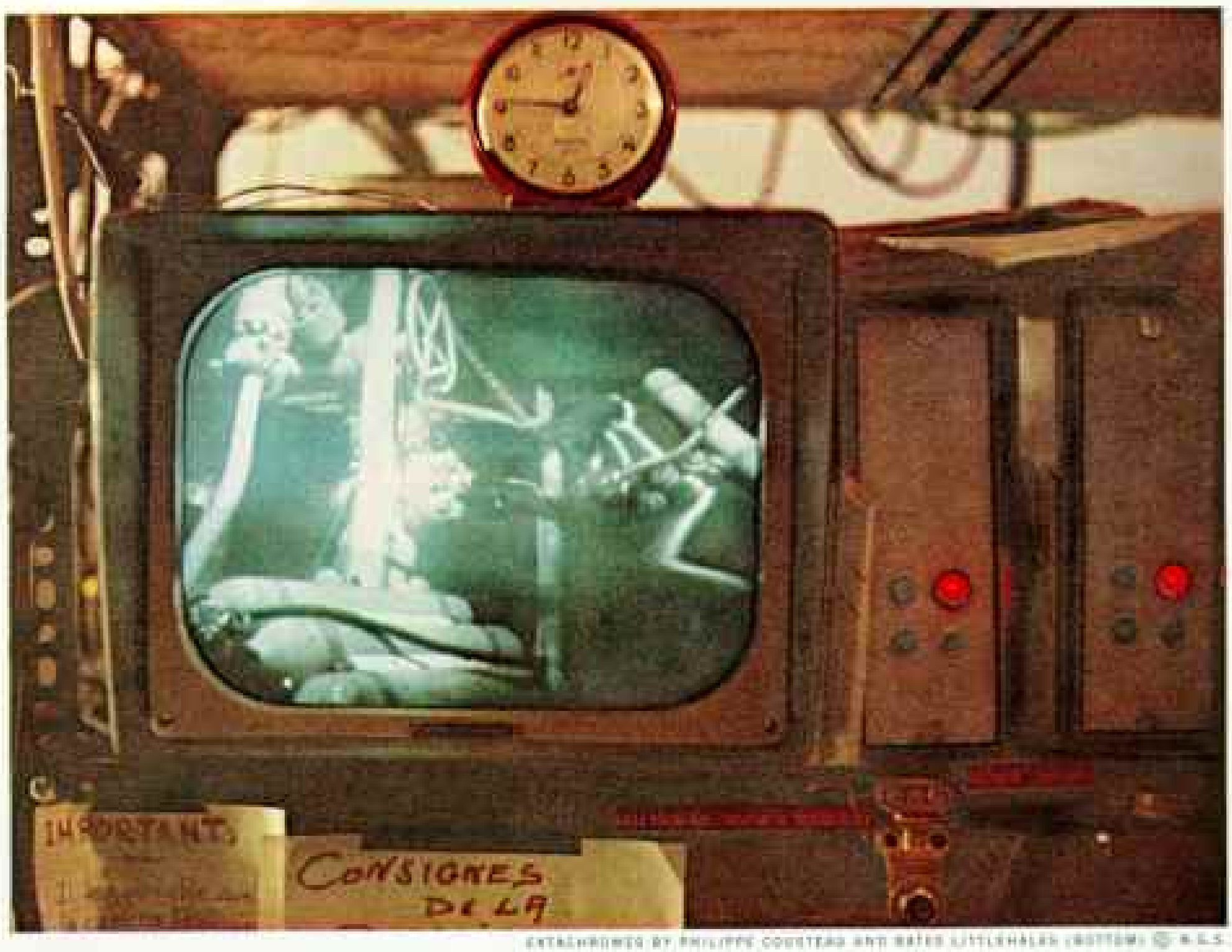
(Continued on page 527)

Human phantoms, in a beam from the diving saucer, labor on the Christmas tree. Bubbles escape a diver as his lips shiver uncontrollably on the mouthpiece. Umbilical cords carrying heliox vanish in the darkness.

"We were buried in treacherous night," recalls the author's oceanaut son, Philippe, who as the crew's photographer brought back extraordinary still and motion pictures.

EXTACHROME BY PHILIPPE COUSTEAU © N.G.S.

Toll of a day's work in numbing cold and forbidding darkness shows in the eyes of Coll and the "dishpan" hands of Laban. Outside chores lasting more than an hour caused mounting discomfort in the 50° to 55° water, but the sphere's infrared heating warmed the men in 15 minutes. Threading a repair assembly into the Christmas tree, Bonnici labored in the sea for seven aching hours—a working day unparalleled at such depths.



ILLUSTRATIONS BY PHILIPPE COUSTEAU AND BATES LITTLEHALES (BOTTOM) © N.G.S.

Toiling oceanauts attach the 400-pound repair assembly to the wellhead as television flashes the drama to oil engineers ashore. The divers performed the feat more quickly than land crews, proving that men can operate heavy equipment at twice the depth heretofore possible.

Like a fiddler with his bow, Rollet manipulates a pellet tube for a test of bottom turbulence. When he places it in a metal frame (opposite), it drops plastic balls that settle slowly, wafted by the subtlest currents. Grid on the sea floor measures their deflection.

Locked in battle with the cold, divers wore two wet suits with a special vest between. At these depths, pressure crushes air pockets of conventional foam rubber, making it useless as insulation. Bright yellow stripes of tape on the suits help the divers keep track of one another.

Flooding a "greenhouse" with light, Rollet tries to cause photosynthesis in the sunless deep. The experiment tests whether the depths harbor enough spores to build life under artificial illumination.

"Increasing the productivity of the great dark oceans," declares the author, "could help save half of humanity from malnutrition."

EXCHANGE (ABOVE) AND PORTRAIT COLOR BY JACQUES-YVES COUSTEAU © N.G.S.

PAINTING BY PHILIPPE COUSTEAU © NATIONAL GEOGRAPHIC SOCIETY

150 feet or more down cannot be efficiently maintained by surface-based divers, so that test drillers who hit oil in such depths customarily cap the well to await new methods of deepwater maintenance. We hoped to demonstrate that wells could produce profitably at more than twice the present depth.

If the oceanauts could man a wellhead at 370 feet, workers living in undersea stations could handle many other jobs, such as mining, submarine stock farming, and hydroarcheology. The marine sciences could be revolutionized by investigators residing in laboratories far below present-day diving access.

Wellhead Comes Down Like a Yo-yo

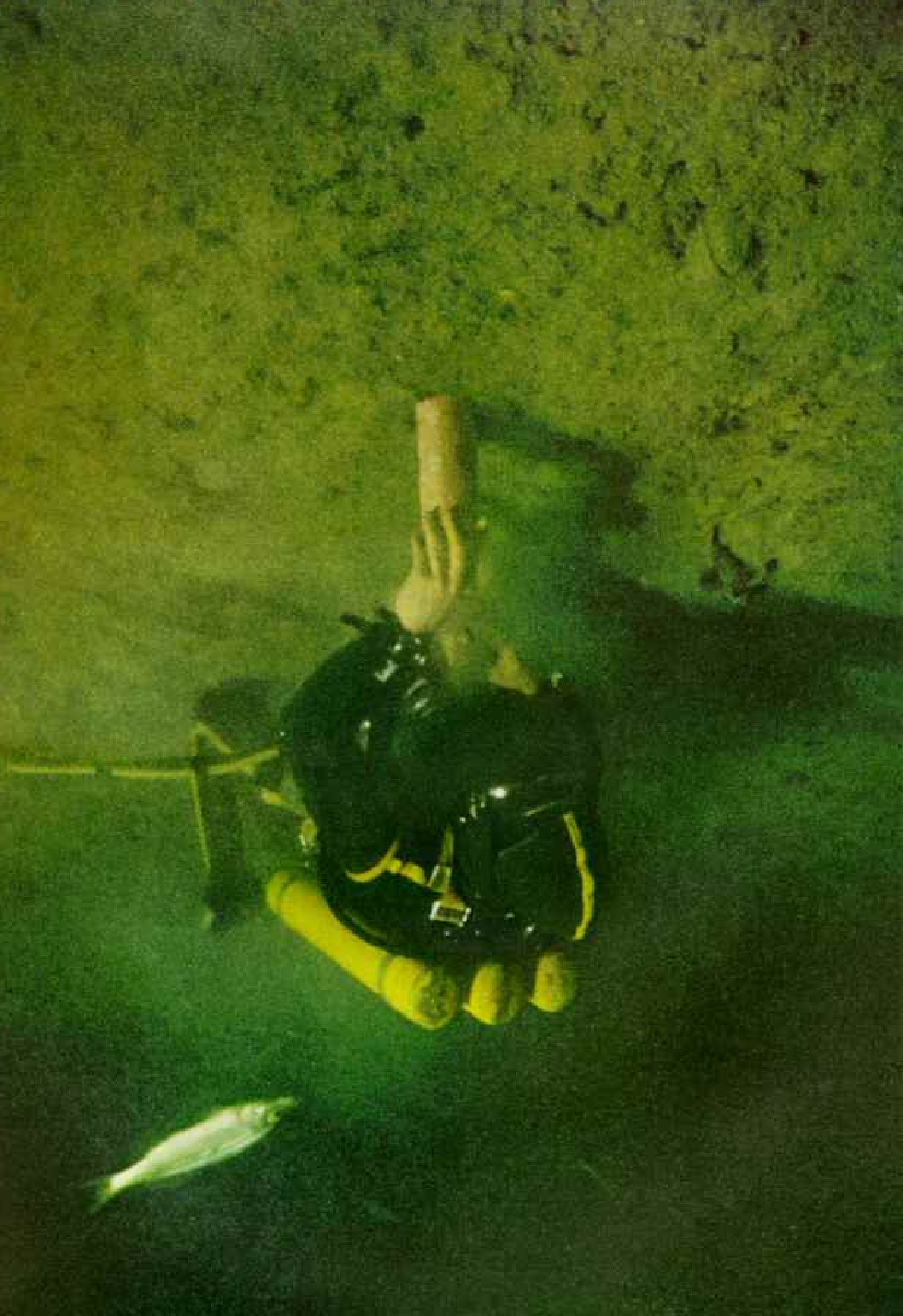
The lowering of the wellhead went poorly. The floating crane was rocked by eight-foot storm swells. As the wellhead sank into the oceanauts' lights, it bounced up and down like a five-ton Yo-yo; it trampled the bottom, exploded a pall of sediment, came plowing out, and jerked up out of sight in the dark.

The oceanauts felt fragile; they got back into the house. Falco, supervising the operation from the diving saucer, was equally cautious. If the berserk Christmas tree came down on his submarine, the result would be similar to that of a one-pound hammer smiting a half-pound crab.

It took an hour to plant the monster and let go the hook. The oceanauts gave Falco a sign by thumb and forefinger. He returned it and floated through the black ceiling.

The oceanauts made their biggest impression on the peeping oil engineers by replacing the 400-pound McEvoy valve, the main component of the wellhead, while it was under pressure of 2,500 pounds per square inch. Because tools are lighter in water and the men didn't have to fight their own weight, they did the job in 45 minutes, quicker than the engineers had ever heard of its being done on land.

Storm sediments continued to hamper work below as we approached Day Fifteen, provisionally the final day of Conshelf Three. We had considered two weeks as a term sufficient to show results, but bad weather had robbed us of eight days' work. Photography was at a standstill, and the scientific experiments were not even begun. I felt justified in asking the oceanauts if they would stay on and complete as much of the plan as possible.



The Electrowriter in the lighthouse dashed off a message in Rollet's handwriting: "To the Surface People: Have mercy on us, poor little oceanauts in the womb of the Immense Sea. Bring us back up . . . as late as possible."

Such was the spirit of their decision to go on. It was their choice alone. From the start, it was they who decided how they would work and how long. I kept watch on them, ready to bring them up if they showed signs of heavy strain. I went sleepless for days on end.

I began an intensive motion-picture campaign with Falco in the diving saucer. Each day we went down for five- or six-hour dives. I logged 40 hours below in the next week.

I continued to marvel at Falco's mastery of the diving saucer. He used it as a camera boom, practically framing my shots with his maneuvers. He shone our big light on Philippe's subjects. When the oceanauts went in for lunch, Falco simply parked the submarine under the house and turned everything off to save power for the afternoon's work. We lay on our backs and chatted in the dark.

To Falco the saucer was more than a photographic platform. Omer wrote in his diary: "I was laboring uphill with some heavy cables in my arms. Falco brought the saucer gently up behind and pushed me up the slope."

Sea Team Solves Its Own Problems

On the evening of Day Eighteen, the pump that brought back the exhaled breath from divers outside the sphere broke down. The depressor had given us trouble before. Now it simply exploded. It was pretty spectacular. Pieces of the machine rattled off the walls of the diving room.

It took two days to get a new depressor to the station, but the work outside did not stop completely. Since the wellhead sat 42 feet lower than the house, the oceanauts found their exhalations would travel up the black hose without mechanical inducement.

The Conshelf team, bottom and top, met and solved more unexpected engineering problems in three weeks than we had in all our undersea operations since 1950. To me the achievement was especially bright because the team did the job without referring more than two or three decisions to me.

Despite all the safeguards we had devised, lives were at stake. Yet the men—aided by women, who stood long watches in the computer center—brought it off with smart and imaginative seamanship, or perhaps it should be called under-seamanship.

By Day Twenty-one, the sea-floor workers had been away from the known world for six extra days. Although they did not grumble, they could not conceal fatigue. It was telling particularly on Laban, the eldest and the one with the most responsibilities.

After Three Weeks—"Prepare to Surface"

The men of the sea bottom were willing to spend their last physical reserves to carry out the few remaining scientific experiments, which would take several days more. I decided to cancel them. "Let's start the surfacing procedure," I said to Alinat.

Every foreseeable aspect of the ascent was listed in detail. More depended on the oceanauts now than had on the descent. They completely controlled the return to the surface.

The next day would be the most dangerous of our continental-shelf campaign. The greatest risk—and an awful one—was a leak in the bottom hatch. If, on the trip up, helium escaped as outside pressures diminished, the pressure within the house would rapidly fall from 11 atmospheres to one, killing the oceanauts by massive decompression.

Day Twenty-two, the last day of Conshelf Three, opened bright and sweet. The sea was mirror-flat under lambent autumn sunshine. We needed every second of daylight. A night surfacing would be hazardous.

The arithmetic of surfacing began to click. The oceanauts were outside early, casting off cables, until they had only power and videophone left. Our research fleet rallied. In the museum, the data-processing machines stuttered out, engorged with their last ream of information on how oceanauts lived.

Around the ships the water was furrowed with the wakes of launches and inflatables. Walkie-talkies honked. I stood among the

Water can serving as cookie cutter, Rollet carefully collects cores of undisturbed sediment under the gaze of a sardinelike *mendonle*. Traces of radioactive fallout sifting down after nuclear-bomb tests may show up in such sea-floor samples. A ceaseless mild rain of debris builds sediment that roils like explosions when divers walk or drag equipment across the bottom.

TEAR OUT THE ATTACHED PAGE, fold, and keep as a reminder of a memorable evening to come, when you may enter, by way of television, the undersea "World of Jacques-Yves Cousteau."

hundreds of onlookers on the lighthouse terrace, with a walkie-talkie turned low and a devout wish that nobody would pay any attention to me all day. That would mean all was going smoothly.

Ballast Drops but Station Stands Fast

The oceanauts returned from the final outside chores at 11 a.m. and closed the bottom hatch and turned the bolts. Through a porthole they looked at the outside depth gauge that would register their upward movement.

Everything stopped for two hours, while the oceanauts increased internal pressure to test the sphere for leaks. There were none.

Laban turned a crank to release the iron-pellet ballast; in the saucer, Falco saw an immense metallic hailstorm pounding the bottom and sending up mud clouds that hid the station. He hovered in mid-water, waiting to see the house come up. Nothing rose. The station held fast.

EKTACHROME BY PHILIPPE COUSTEAU © N.G.S.

Pressure-dimpled cans of juice and water fill the outside pantry bin. Sea salts penetrated a few tins of water, perhaps through tiny cracks in the soldered seams.

Inspecting intruders in its domain, an ocean sunfish glides by. The *Mola mola*, a young 2½-footer, may grow into a two-ton leviathan on its diet of jellyfish. Small sea animals swarmed unafraid about the fish men, but larger ones usually shied away.

At the lighthouse I glanced at my watch. Less than two hours of daylight remained. I phoned Laban, suggesting that he blow a very small amount of compressed air into the water-ballast tanks, just enough to loosen the station. Too much buoyancy could send it rushing aloft to leap from the sea and wallow about, perhaps injuring those inside.

Laban squirted compressed air for two seconds. The oceanaut at the pressure gauge reported, "She's not moving."

I said to the station chief, "Give it another gentle injection, Dédé."

Laban needled two more seconds of compressed air. Still there was no result.

Conshelf Breaks Free at Last

Day Twenty-two was fading in a lyrical peace that contrasted grimly with the dilemma of the oceanauts, down in the icy dark.

Laban said, "Here goes a bit more," and twisted the aircock.

"Tiens!" exclaimed Coll. "We're shifting."

The deck trembled. The sea dwellers grinned at each other. Inches at a time, the station departed from its foundations. I heard Alinat cry, "She's coming!"

The oceanauts traveled back to their natural habitat much more quickly than they had gone to their adopted one. The trip took only three minutes. The water boiled, and the big checkered globe miraculously appeared on the surface. The red sun vanished over Nice.

Saucer Jets Hail Returning Oceanauts

The vessels gathered protectively around the steel globe. Divers rolled out of rubber boats to make lines fast. The diving saucer surfaced nearby, and Falco turned up his water jets like a New York fireboat hailing a new ocean liner.

In the dark the riggers, navigators, talkers, and divers went to work to undo what had been done the day before the oceanauts went down. Bernard Delemotte plunged under the house and disconnected the remaining power and TV cables from the lighthouse. In two hours he replaced them with lines to a generator and TV room aboard our research vessel, *Calypso*. On the screen we saw the oceanauts turning on the infrared heaters to prepare dinner. I said to Alinat, "These men are great." *Calypso* took up the tow in a mild sea.

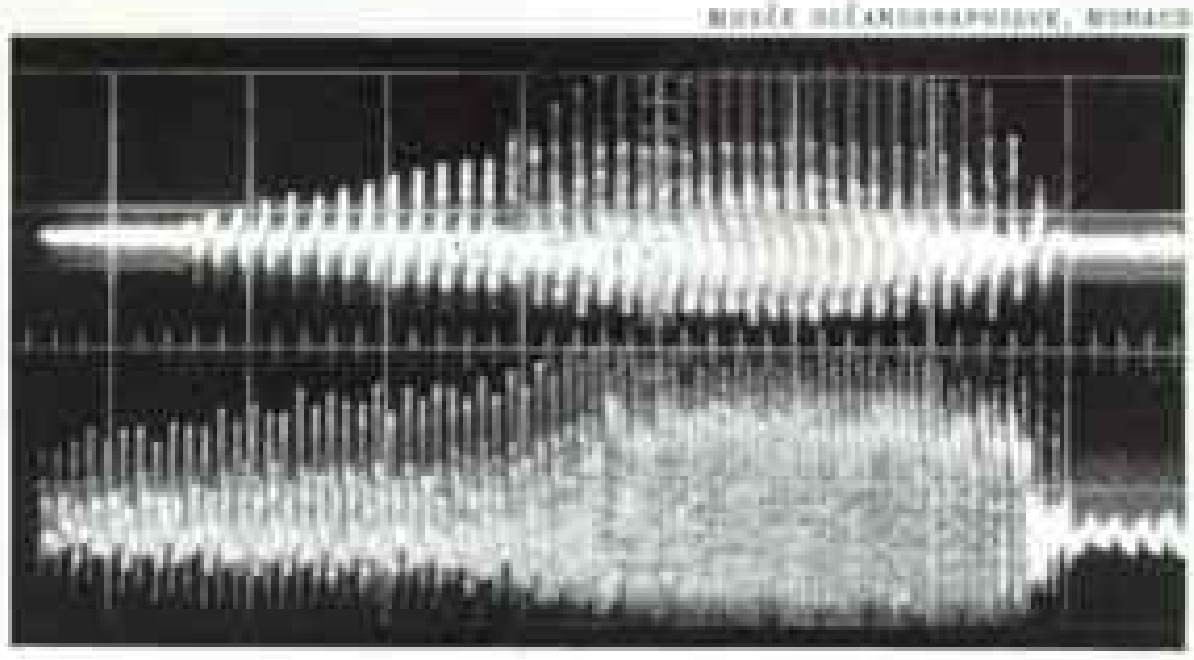
At the time the station unstuck itself, the oceanauts had been working and living continuously on the bottom in pressures 11 times normal for 21 days, 17 hours, and 16 minutes. There was nothing in the computer-processed data, self-administered daily medical check-ups, or biological samples they had sent to the surface to indicate that their submarine stay had harmed them in any way.

Calypso dragged the undersea house behind the Monaco harbor jetty whence it had started (pages 536-7). Clinging to the sphere were white sea anemones, which had taken up squatters' rights on the house. Inside, the oceanauts began their carefully computed period of decompression. Its duration: 84 hours.

High above us in the stony peaks, the first light touched a colossal Roman monument, the Trophée des Alpes, built in 6 B.C. to honor

"**Conshelf calling Sealab.**" Two undersea settlements make a historic first contact as Laban talks by telephone to aquanauts of Sealab II, the United States Navy's undersea experiment conducted in 205-foot depths off La Jolla, California. With Coll eavesdropping, Laban speaks first in English, then shifts to French in talking to a bilingual scientist in Sealab 0,000 miles away. Giant neon lung feeds "neox"—neon and oxygen—to help rid Laban's voice of helium squeaks.

MUSÉE OCÉANOGRAPHIQUE, MONACO



Squiggles of oscillograms contrast Laban's baritone on the surface, upper graph, with his rasping heliox falsetto on the sea floor. Oceanauts soon learned to avoid high-pitched sounds that garbled words. Voices raised in anger produced comical squeals—a deterrent to any argument. The croaks of two frogs sent down with the divers changed to canarylike chirps.

In their undersea Pullman, all six oceanauts could sleep at one time—though the watch-stander's bunk always remained empty. The exhausted men "slept as if dead," said Philippe Cousteau.

Caesar Augustus for his conquest of the Alpine tribes of Gaul. The oceanauts, too, had subdued a hostile territory. Theirs was larger than all Transalpine Gaul. They had helped to double the habitable and exploitable region of the world's continental shelf.

In the falling pressure, the men swallowed and blew their noses to clear their ears. Treble speech reverted to baritone. They did not recognize each other's voices in the masculine register. Somebody phoned the prisoners, "The sun is bright and clear." They groaned. They had not seen the sun for 27 days.

We asked the public what it wanted to know

about the oceanauts, and passed the questions in to them by teletypewriter.

An elderly woman asked, "Could you have tolerated a longer stay?" Four oceanauts said, "Yes, but not much longer," while two were ready to stay two weeks more. All six replied "No" to a small boy who asked if they'd had nightmares.

Watches Explode As Pressure Drops

A young lady wanted to know if they thought life downstairs would be more agreeable with feminine company. "No," said four oceanauts. One said women would be "agreeable but impossible," while another declared bravely, "One must try."

Many of the questioners asked what was the first thing the oceanauts wanted to do when they emerged. Two of the adventurers were going to see their parents first. One wanted to rest "far from everything;" another preferred "a walk in the country." Still another said he wished to "see other people and let them pamper me."

During decompression, Laban heard a small muffled explosion. In his sea chest, where it had lain unworn since Day Two, was his impressive new deep-sea wristwatch with a shattered crystal. The timepiece had withstood water and exceptional pressure, but had been infiltrated by helium. When the house pressure fell, the helium expanded and smashed its way out. As Laban looked at his broken timepiece, he heard his comrades' watches exploding one by one.

On the evening the oceanauts came out, crowds covered the mole and threatened to capsize our vessels at their berths. Movie lights bathed the sphere as Western Europe watched on television.

As numbers flash in a memory test sent from shore, Yves Omer tries to type them on a boxlike transmitter that feeds into a computer. Coll awaits his turn. In some instances the men did better below than ashore, perhaps because concentrating was easier in the sphere. A series of tests revealed no deterioration of the oceanauts' reflexes, coordination, or physical well-being. Except for weariness and paleness from lack of sun, they came up exactly as they went down.

"There no longer exists any physiological or psychological obstacle to the occupancy of the entire continental shelf," asserts Captain Cousteau.

Rampart of clicking computers and communicators, arrayed in the main hall of the Oceanographic Museum at Monaco, serves as the expedition's intelligence center. Manned 24 hours a day, it processes torrents of data emanating from underwater men and machines. Guy Levi-Soussan transmits a memory test to Conshelf Three. TV monitors flash round-the-clock coverage from the sphere and wellhead. Thousands of visitors, watching on sets ringing the center, saw the most candid scenes. Once a naked oceanaut strolled unknowingly before a camera on his way to a shower. Monaco's "Savant Prince," Albert the First, stands watch on a marble flying bridge in the museum he founded 56 years ago.

Up at last! Coll breathes deeply of oxygen during decompression.

Homeward come heroes as their sea house, towed by the research vessel *Calypso*, floats safe in Monaco harbor. Before they step ashore, the oceanauts must decompress for 3½ days inside the sphere.

Jubilant captain greets exultant divers. Total time in the sphere: 30 days, 10 hours, 52 minutes. Television audiences in 17 countries watched the moment over Eurovision.

From the top hatch, a red diver's cap and the blanched visage of André Laban appeared. He carried a full briefcase. Dédé had brought his homework back from the office. Grinning, blinking, and greeting friends, up came the other pale hostages to our dream. Six red caps went bobbing through the crowd (left).

A reporter asked Philippe, "*Etes-vous fatigué?*" The cameraman of Conshelf Three said: "Of course; I have never been so tired in my life. But we lived wonderful days. We have the rest of our lives to recover."

Conshelf Three was an epic of triumphant men and failing machines. In this day of automatamania, or worship of gadgets, the oceanauts served up a healthy reminder of how vastly superior to mechanisms old *Homo sapiens* remains.

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

Of course the equipment was first-class on land, but manufacturers have little experience with machines that must operate in exotic gases under heavy pressure. The oceanauts were forced to battle continually against the equipment in order to maintain their foothold on the bottom.

Vital Steps Toward Conquering the Sea

In addition to the oceanauts' fine accomplishments on the oil-well head, I think Conshelf Three contributed significant gains to the art of occupying the deep-sea bottom:

—We proved our high-pressure breathing system on its first application.

—By using incompressible vests, we showed that full suits of microbead material will lessen hardship for future oceanauts.

—By reducing the ties to the world above, we enabled the station to survive weather that would have forced earlier undersea installations to close down.

We have heeded our own discoveries and learned the lessons they present. The greatest of these is that if man is to make an undersea creature of himself, he must do it wholeheartedly and without a backward glance. As with a newborn infant, the umbilical cord must be severed.

We are now planning Conshelf Four. Our principal effort is to further reduce dependence on the surface. We are confident that within a few years we will entirely eliminate ties to the world above. Then, for the first time, oceanauts will have true freedom of the deep.

THE END

Chase in space nears its triumphant end as Gemini 6 homes in on a moonlike Gemini 7 for the world's first spacecraft rendezvous. Distance between them: 273 feet.

Flying at five miles a second, the two-man American spaceships perform a stately dance (left). Gemini 6 looks straight down at its twin, 90 feet away, and beyond to the cloud-dappled Pacific Ocean, 185 miles below.

Space Rendezvous

MILESTONE ON THE WAY TO THE MOON

By KENNETH F. WEAVER
National Geographic Senior Staff

"IT WAS NIGHTTIME, just becoming light. We were face down, and coming out of the murky blackness below was this little pinpoint of light. The sun was just coming up and was not illuminating the ground yet, but on the adapter of Gemini 6 we could see sunlight glinting, and as it came closer and closer, just like it was on rails, it became a half-moon. At about half a mile we could see the thrusters firing, like water from a hose. And just in front of us it stopped. Fantastic!"

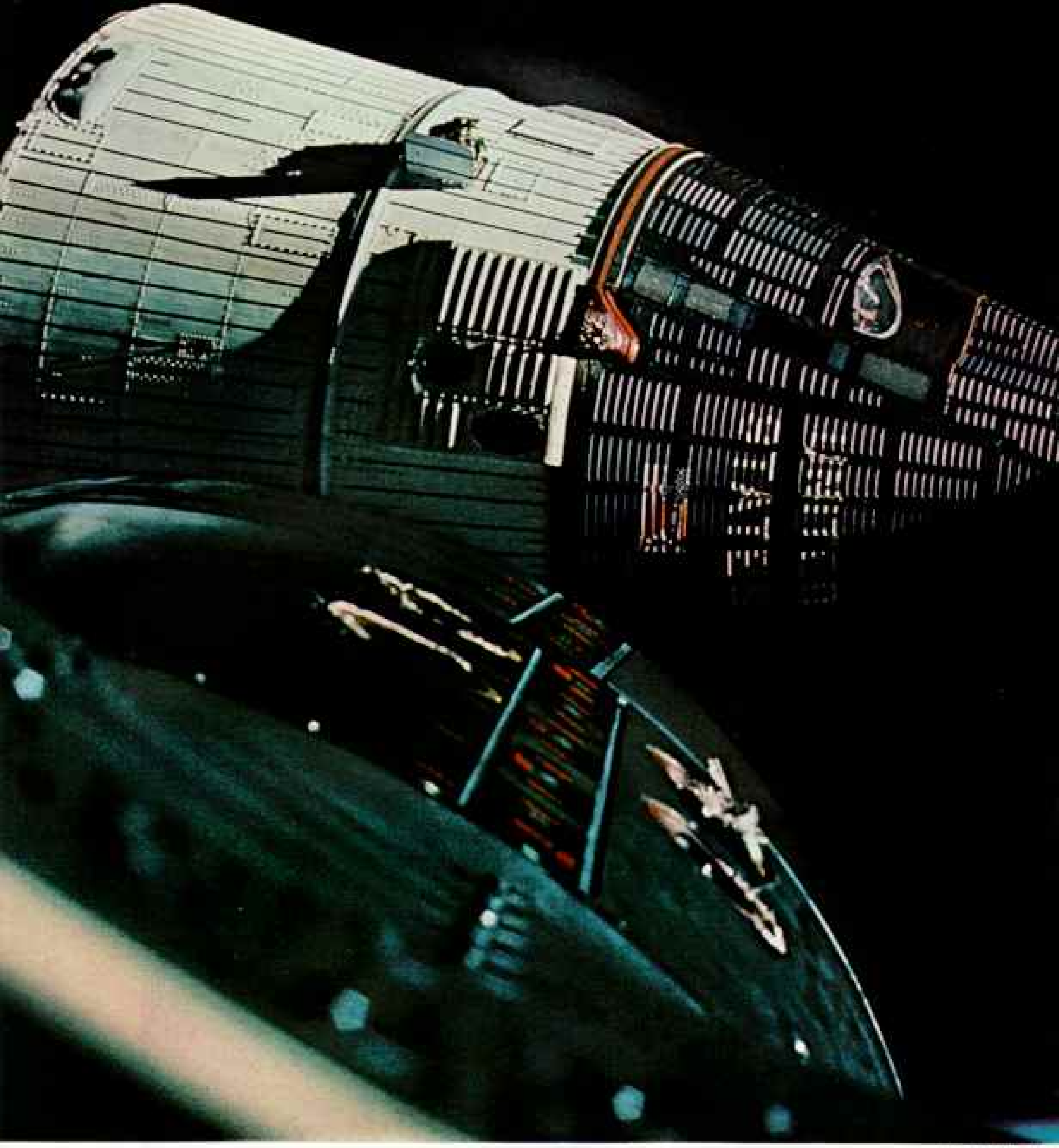
Astronaut James A. Lovell, Jr., thus recalls how he and Frank Borman, command pilot of Gemini 7, saw the historic rendezvous with spacecraft Gemini 6, piloted by Walter M. Schirra, Jr., and Thomas P. Stafford.

Fantastic it was, indeed. For on that December day last year, a day that will live in the annals of exploration of the universe, man cleared away one of the major obstacles on the hard road to the moon. He proved that he could find and reach his fellow man in the vastness of space.

When these American astronauts brought their spaceships

Rocketing off in pursuit of Gemini 7, G-6 trails a snowy wake as it streaks into space. Winds aloft twist the plume like a pretzel. Camera-bearing Air Force chase planes sweeping up beside the Titan rocket stripe the sky with smaller contrails.

Huge Kennedy Space Center, from 135 miles up, shows as a small bulge on Florida's Atlantic coast as G-7 Astronauts Frank Borman and James A. Lovell, Jr., soar over the peninsula. At this moment, down on Pad 19, technicians labor feverishly to ready G-6 for launch. Command pilot Walter M. Schirra, Jr. (below, foreground), and pilot Thomas P. Stafford check controls in the cabin. After two thwarted attempts, they roared heavenward on December 15, 1965, to rendezvous with G-7.



NASA ESTACHROME

almost within touching distance 185 miles above the Pacific on December 15, 1965, they pioneered a technique that must be mastered before men can make a round-trip flight to the moon. After exploring its surface, they can return only by making successful rendezvous with their mother ship (pages 552-3).

For that reason the remaining Gemini flights, all scheduled for 1966, are designed primarily to practice rendezvous maneuvers. Indeed, by the time you read this article, Astronauts Neil A. Armstrong and David R. Scott may already have gone into orbit aboard Gemini 8, seeking to hook up with an Agena spacecraft—an unmanned rocket specially fitted with a docking collar.

What do men say to each other on such an unprecedented occasion as the first meeting in space? When 200 feet still separated G-6 and G-7, Schirra greeted his fellow astronauts with a laconic, "Having fun?"

The words, garbled perhaps, were not heard on the ground, nor was G-7's response:

"Hello, there!"

And then, his eyes aching from the intense glare of the rising sun on the other spacecraft,

THOMAS P. STAFFORD (ABOVE), JAMES A. LOVELL, JR. (LOWER RIGHT), AND FRANK BORMAN

Splash of sunlight marks lines of strain in the bearded face of Navy Commander, now Captain, Lovell during G-7's 14-day, 220-orbit flight.

With the cool skill of a seasoned pilot, Navy Captain Schirra nudges within 14 feet of G-7. Later he closed the gap to a single foot. Smoke from jettisoned staging rockets thinly clouded the windows, but the crews could see each other.

Friendly taunt, carried to space by Schirra and his fellow Annapolis graduate, Air Force Major, now Lt. Col., Stafford, urges football victory over West Point, the alma mater of Air Force Lt. Col., now Colonel, Borman. White shield covers a radar unit used to track G-7.

Schirra said, "Hey, Frank, I see your hatch is on fire!"

A little later, Schirra told ground controllers in Hawaii:

"There seems to be a lot of traffic up here!"

To which Borman shot back, "Call a policeman!"

But the astronauts, for all their joshing, knew better than anyone else the meaning—and the difficulty—of their accomplishment. Their rendezvous came as the climax of an extraordinary chase through space—100,000 miles at speeds of more than 17,300 miles an

hour before Gemini 6 closed in on its target (diagrams, pages 546-7). It took nearly six hours of complicated maneuvering, using radar, a global tracking network, and one of the world's largest assemblages of computers, as well as that more primitive instrument known to astronauts as the "Mark I Human Eyeball."

And yet, ironically, it all seemed so simple to the earth-bound audience when Schirra and Stafford eased their four-ton vehicle to within a single foot of Gemini 7, to look through the windows and marvel at Jim Lovell's 11-day-old beard. Or when they slowly circled in a stately minuet, then settled down to fly nose to nose for hundreds of miles.

Schirra himself noted this irony while flying from Bermuda to Cape Kennedy the day after the Atlantic splashdown. Frowning as he read a sheaf of glowing press reports on the rendezvous, he remarked: "I'm real sorry

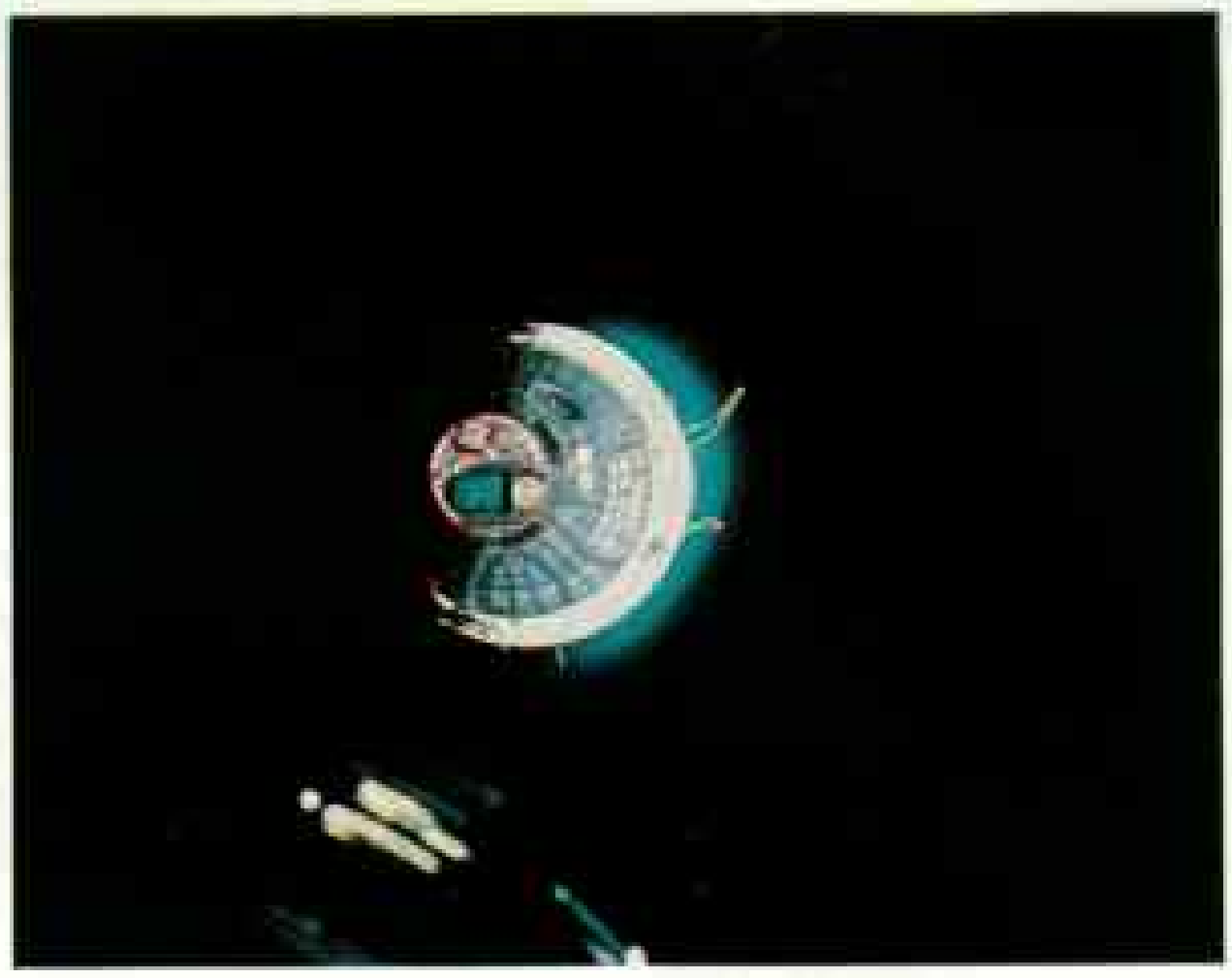
they made the rendezvous sound so easy. It may have looked easy, but it was only because we had practiced so much."

Tom Stafford agreed: "I figure we must have worked out at least 80 times in the simulators, an hour and a half each time."

Wally Schirra reacted also to suggestions that if two spacecraft come within three or four miles of each other—as the Russians' Vostok 3 and 4 did momentarily in 1962—then a true rendezvous has been accomplished.

"That's when the job really starts," said Schirra. "I don't think rendezvous is over until you are completely stopped, with no relative motion between the two vehicles, at a range of approximately 120 feet. From there on it's station keeping. That's when you can play the game of driving a car, or driving an airplane; it's about that simple."

Other astronauts agree. "It's easier to fly in



Spaceships part company (above) when Schirra fires his thrusters and moves away from a radiant G-7; both craft orbited the earth at 17,300 miles an hour.

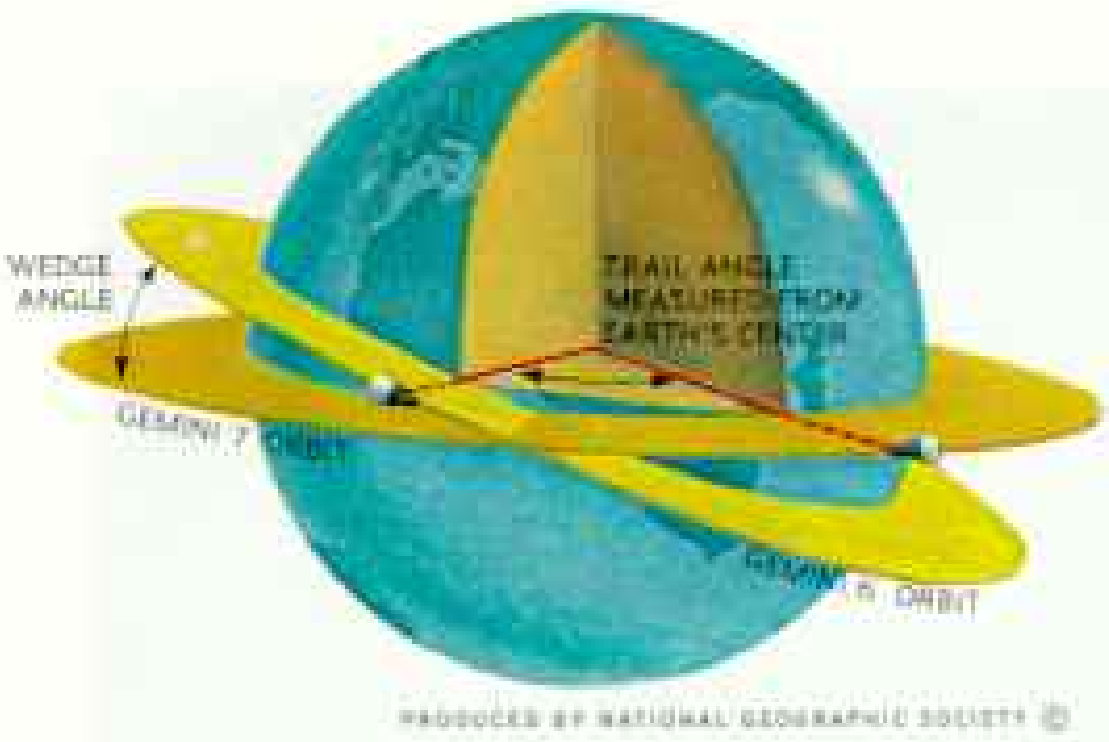
Lovell, watching G-6 recede, photographs it from a quarter mile away (below). Nose of G-7 partially hides a horizon aglow with bands of color at sunset.

NASA EXTRAVEHICULAR BY THOMAS P. STAFFORD AND JAMES A. LOVELL, JR. (LOWER RIGHT)

"Brightest thing I've ever seen in my life," Schirra described the sunlight blazing on G-7's white skirt (left). Nose to nose, the vehicles glide through the void in a game of near-tag, and later of celestial ring-around-a-rosy.

How Gemini 6 caught its twin in a 6-hour, 100,000-mile chase

LIKE A RACE HORSE on the rail, with less ground to cover than an outside horse, G-6 circled the earth faster than higher-flying G-7. This helped G-6 catch up with G-7. But G-6 also had to climb into G-7's orbit (diagram above). The rules of motion in space helped G-6 rise. Each burn of its thrusters automatically raised its altitude. As G-6 moved farther from earth, Schirra needed less speed to offset the pull of gravity. Thus, G-6 went slower in the higher orbit. Schirra began the chase at 25,414 feet per second. Burns of his thrusters totaled 208.6 feet per second, but by raising his orbits, they slowed him finally to G-7's speed of 25,366 feet per second at rendezvous.



Whirling in different planes, G-6 and 7 could not have rendezvoused without delicate maneuvers. G-6 went into orbit 1,200 miles behind G-7 (trail angle). To catch up, Schirra kept his craft in a lower and faster orbit. While still 439 miles behind, he jockeyed into G-7's plane by turning at a right angle to his line of flight and firing aft thrusters for 40 seconds. This erased the fraction-of-a-degree difference in their orbital planes (wedge angle). The execution of such intricate tactics marks the rendezvous as a masterful feat of flying. The angles in the diagram are exaggerated for clarity.

space than to pilot an aircraft, once you've mastered the controls," says Frank Borman. And Neil Armstrong adds: "Docking is like putting a car in the garage."

Gemini 6 and 7 did not touch, leaving still unanswered the question of whether a spark of static electricity will jump between two docking spacecraft. As a safeguard, the Agena's collar wears metal "whiskers," like a lightning rod, to bleed off any charge.

When Gemini 6 went into orbit, it trailed more than 1,200 miles behind Gemini 7. Its orbit was lower and was tilted slightly to the orbital plane of the other craft.

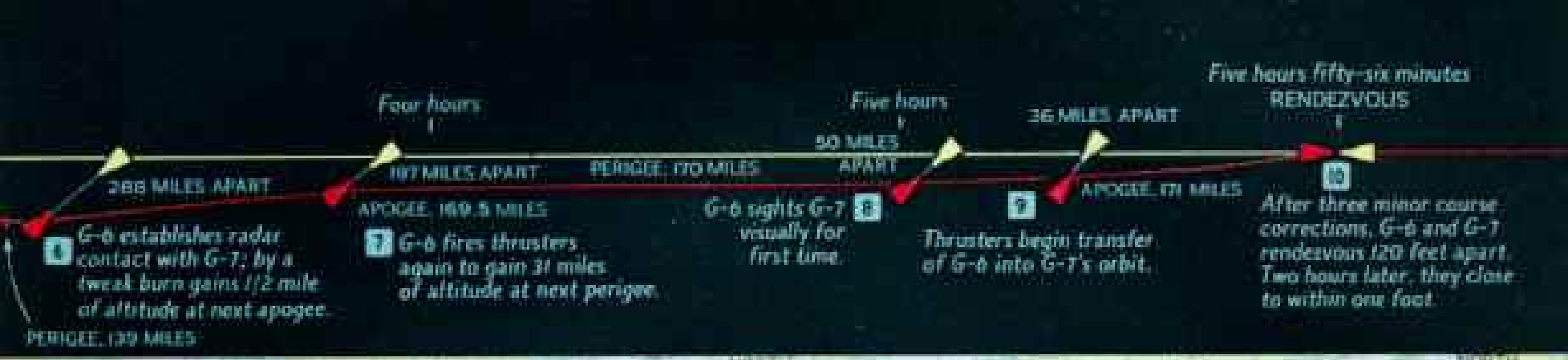
To correct these differences, Wally Schirra fired his thrusters in a series of skillfully controlled "burns," timing them according to instructions from the ground and computations made by Tom Stafford with the spacecraft's own computer. Stafford, incidentally, was so busy with his navigation duties that he was able to look out of the window no more than 15 minutes during the first six hours of flight.

Schirra, who had more opportunity to observe outside the spacecraft, said later of the cloud-banked earth: "If we four had come from another planet, I'm sure we would have said, 'That's not inhabitable. Let's leave!'"

In the wave of excitement over the successful rendezvous, it is easy to lose sight of the importance of the equally successful 14-day flight of Gemini 7. Dr. George E. Mueller, the National Aeronautics and Space Administration's Associate Administrator for Manned Space Flight, says:

"It's true that we could not go to the moon until we learned to rendezvous. The first astronauts who set foot on the moon will have to rendezvous with the mother ship orbiting 92 miles above them, or they will have no possible way to return to earth.

"But neither could we go to the moon until we learned whether man could function successfully in space for days at a time, and then



adjust easily to gravity on earth after a long period of weightlessness."

The experience of the Gemini 7 pilots with weightlessness is reassuring. They did react to retrofire, the reverse blast of rockets that slows a spacecraft and starts its fiery plunge to earth. But they said they had no real problems after returning to the ground.

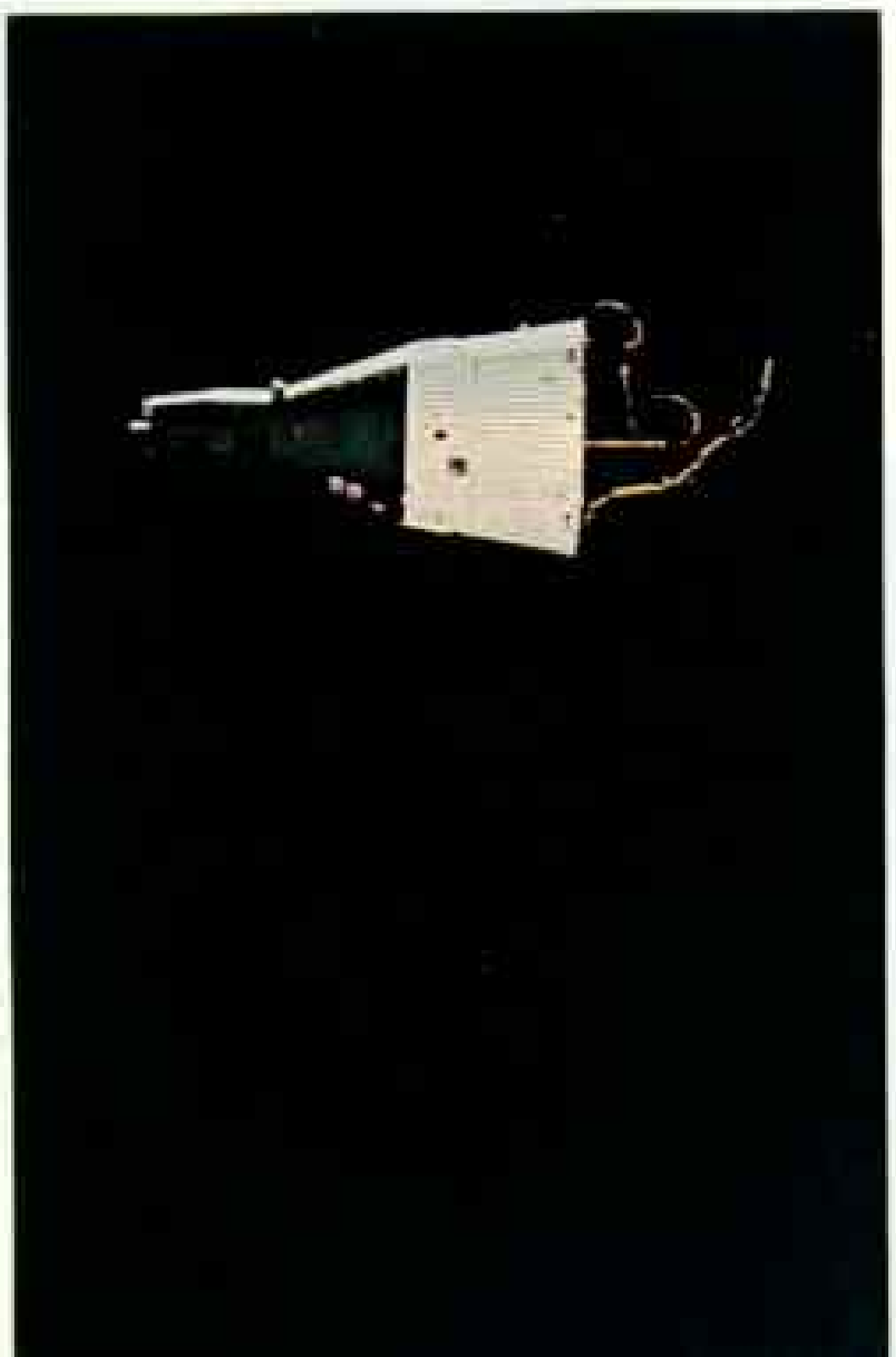
"After being desensitized to G's [weightless] for 14 days," reported Borman, "we felt we were going backward when the retrorockets fired—I think John Glenn said back to Hawaii—I felt we were going back to Japan. But when we got back on the carrier, if we had any deterioration at all, it was that our legs were heavy because they hadn't been used. We were able to run a mile the day we got back to the Cape. In my opinion, with proper crew-comfort provisions, people will have no difficulty going a month, two months, or as long as they want to in space."

Both men stressed the necessity of comfort, noting that they functioned much better when they took off their bulky pressure suits.

"One of our biggest problems," says Jim Lovell, "was the same thing that everybody faces here on earth—eating, sleeping, and housekeeping. We were worried that we'd sort of get pushed out of the spacecraft with all the debris that would accumulate. So we spent many hours prior to the flight finding little spots and crevices in the spacecraft

Tail feathers of tape, part of the insulating material used to minimize blast damage at separation, float behind G-7. They flapped on 7's roof during its third orbit, mystifying Lovell and Borman until G-6 reported sighting the cords.

NASA ATTACHMENTS BY THOMAS P. STAFFORD



Eye test occupies Borman in this motion-picture sequence taken by cabinmate Lovell. He holds a biteboard that, clamped between his teeth, maintains the proper distance from his face to a binocular device used for testing ability to see detail. Borman has shed his space suit and wears only underwear, as did Lovell during much of the flight.

"You guys are really a shaggy-looking group with all those wires hanging out," G-6 radios to G-7 as both pass over the Pacific, 600 miles west of Chile. G-7 to G-6: "You have some too." Gold curtain guards the instrument package from solar radiation.

"Constellation Urion," Astronaut Schirra jokingly labeled this photograph at the postflight press conference. Droplets of urine, vented from G-7 at twilight and instantly frozen in space, follow as miniature satellites. They eventually sublimate and vanish, like dry ice.

MAIN EXTRAVEHICULAR BY THOMAS P. STAFFORD (ABOVE) AND JAMES A. LOVELL, JR.

where we could pack things. We would eat three meals a day, and Frank would very nicely pack the containers in a small bag, and at the end of the day he would throw it behind the seat. We managed to get nine days' debris behind those seats."

The spacecraft returned surprisingly clean.

"Other Gemini crews," says Lovell, "have reported that they became increasingly tired due to the fact that one person would be on watch and the other sleeping, and communication between the ground and the spacecraft would wake the sleeping person. So we decided to sleep simultaneously.

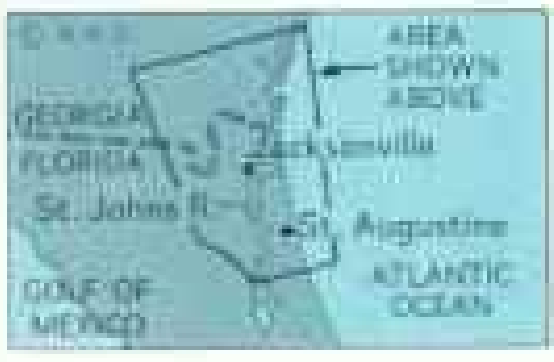
"We worked on a Houston day. Our watches were set on Houston time. We had a regular work day, had three meals a day, and then at night we went to bed. We put up light filters in the windows and didn't look out, and to us it was nighttime.

"We had absolutely no sensation of movement. Our world was inside the spacecraft. We even had some books along. Frank had one which was quite apropos. It was called *Roughing It*, by Mark Twain!"

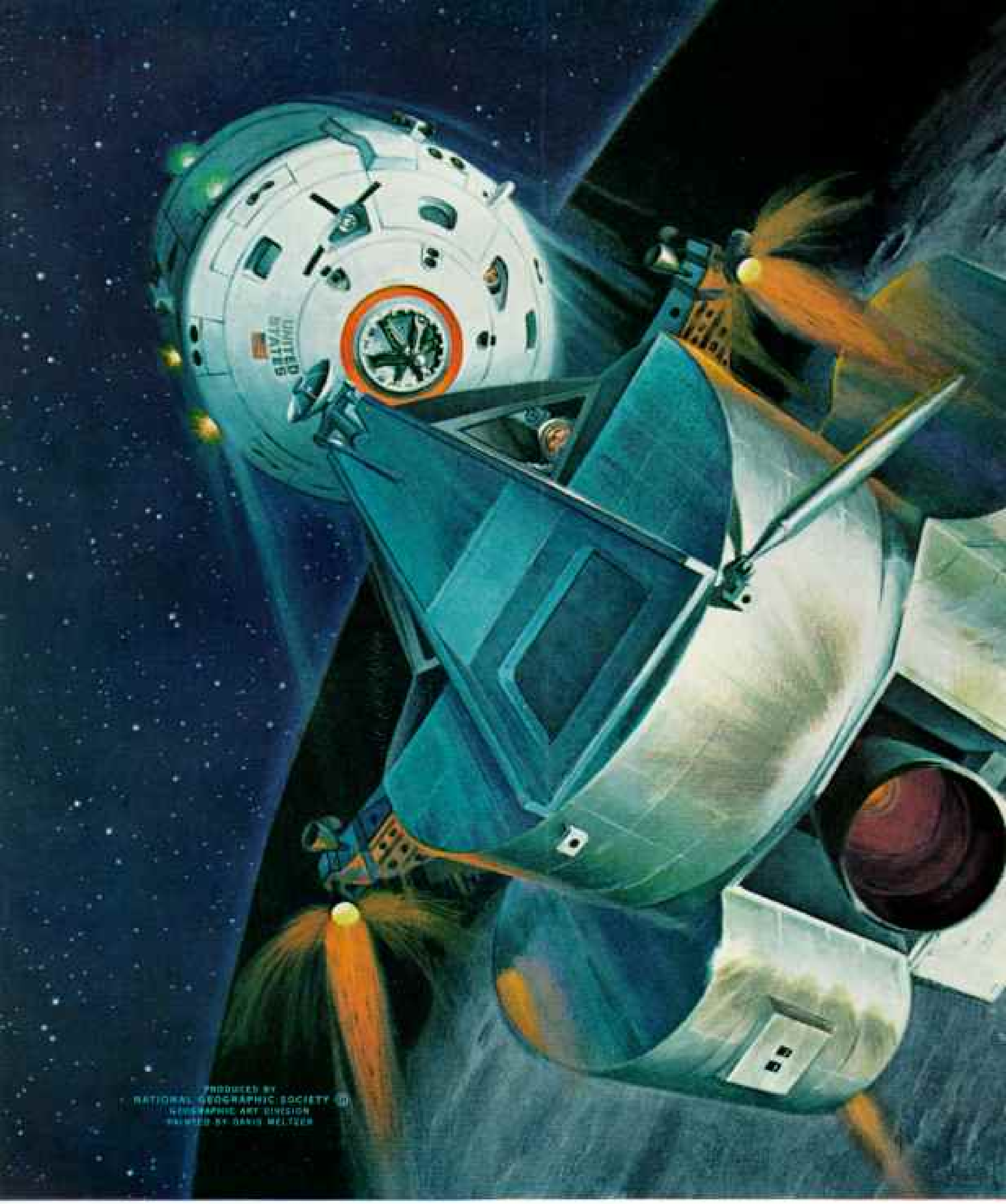
These December flights climaxed a year in which five Gemini teams orbited the earth for a total of 650 hours, covering more than

"**We spent many hours** just observing the beautiful tones and colors," Lovell said of North Africa. With hand-held Hasselblad camera, Borman captured the thousand-foot-high Tifernine sand dunes in Algeria from 150 miles up. His 250mm lens looked south as the setting sun burnished the tops of the dunes against a desert darkened by dusk. Filtering effect of the atmosphere tints the earth blue. As Heinz Haber wrote in the GEOGRAPHIC ten years ago—even before the first satellite—ours is "the most beautiful planet of the solar system. It is Earth, the blue planet, the home of man."

Island of Socotra, source of myrrh, frankincense, and dragon's blood—resin of the dragon tree—covers 1,400 square miles, about the size of Rhode Island. This view from G-7, 185 miles high, looks southwest. Islands at top center, The Brothers, lie between Socotra and the African coast. For this and most of their earth photographs, Borman and Lovell used an 80mm lens and a basic exposure of 1/250 at f11.



St. Johns River forms a broad path in the low-lying region of northern Florida before narrowing at Jacksonville. Southward, the inlet at St. Augustine appears as a tiny notch in the coast. Gemini pictures are the clearest yet made from space.



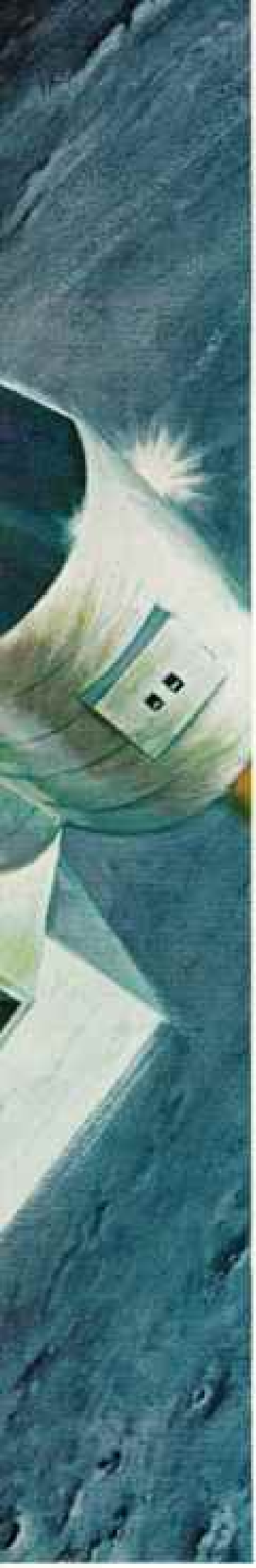
11,000,000 miles—nearly fifty times the distance from here to the moon.

What lies ahead now on the road to the moon? Dr. Mueller forecasts a wind-up of the Gemini program this year, with five two-man flights of from one to three days' length.

"On each flight," he says, "the astronauts will practice rendezvous and actual link-up with an Agena or a similar target. Then they may use the fuel supply of the Agena to propel both vehicles into new orbits and maneuvers. On each flight an astronaut may leave the Gemini vehicle to 'walk around the earth.' * And once the Gemini and Agena have docked as a unit, they may seek out and rendezvous with a second Agena to be left in orbit from a previous Gemini flight."

As Gemini comes to an end, the real moon

*"America's 6,000-Mile Walk in Space," in the September, 1965, GEOGRAPHIC, described this feat.



NASA PAINTING BY JAMES A. COVELL, JR.

Beckoning destination of America's space program, the pearl-like moon rides high over the Pacific. NASA's Apollo astronauts hope to reach it by 1970.

Homeward bound from the moon, a LEM (lunar excursion module) fires its guidance rockets to dock with its orbiting mother ship. The Apollo pilot uses an overhead cross-hair sight to line up with the craft that will return the crew to earth. Artist Meltzer's look at the future incorporates the knowledge and advice of NASA experts, astronomers, and the Apollo contractors, Grumman Aircraft and North American Aviation. Dated June 24, 1969, 12 noon, Greenwich mean time, the painting shows the stars in their true positions for that date.

program, Apollo, gets under way. With the success of G-6 and 7, it is now conceivable that the first manned Apollo vehicle, boosted by the huge Saturn 1B rocket, will carry three astronauts into orbit before the end of 1966. To NASA officials, the goal of Americans on the moon by 1970 now seems within grasp.*

Far beyond Apollo, scientists visualize space crews rendezvousing above the earth to assemble orbiting laboratories, or eventually to put together space ports from which travelers will set out for Mars and even more distant points. And they regard as certain the day when these techniques will permit rescue of astronauts stranded in space and examination of potentially hostile satellites.

Rendezvous—our newest space achievement—makes all this possible. THE END

*See "Footprints on the Moon," by Hugh L. Dryden, NATIONAL GEOGRAPHIC, March, 1964.

WYOMING
High, Wide, and Windy

By DAVID S. BOYER
National Geographic Staff

FOR A MAN who narrowly escaped hanging ninety times a year, Mr. Clover Sturlin seemed remarkably cheerful. He was not the least bit bothered about the grisly fate that threatened him every summer evening in Jackson, Wyoming.

"It's a living," he said, stroking a desperado-type mustache.

A few minutes earlier, with hundreds of other visitors, I had seen "Clover the Killer" get his daily dose of frontier justice. Along about sundown we had heard a distant clatter of hoofs. Looking eastward, we saw a rider on a galloping black horse, pursued by a dozen others.

Near Jackson's main intersection, the posse caught Mr. Sturlin.

TRIGGERED BY EARTH'S INNER FIRES, *geysers steam above a wintry Yellowstone National Park. Old Faithful puffs a cloud that weather researchers have seeded with silver iodide. Gleaming ice crystals fall as man-made snow. Measuring the amounts caused by various chemicals, scientists hope to learn more about weather control.*

All four feet off the ground, a flying bronco tries to unseat a Wyoming cowhand at the Frontier Days rodeo in Cheyenne, bringing to life the symbol on the state's license plates. A high, often dry land straddling the Continental Divide, Wyoming pastures three times as many cattle—more than a million head—as it has people. In recent years, petroleum has displaced agriculture (livestock and farming) as the leading industry. Stark mountains, blue lakes, and sweeping plains draw millions of visitors each year; entertaining them ranks third among Wyoming's industries.

PHOTOGRAPHED BY JAMES L. AMOS (ABOVE) AND ROBERT W. MADDEN © N.G.S.

Still mounted but with his hands tied behind him, he was led to the town square, where a noosed rope was thrown over an arch of elk antlers. But at the last moment, Mr. Sturlin was granted a chance to shoot it out with the sheriff. There was a popping of blanks, and both men fell "wounded." The tourists loved it.

"It's just like television!" I heard a small spectator exclaim.

As the make-believe ended, Mr. Sturlin made his exit draped across the saddle of his horse. For another 24 hours he would be back in real life—a peace-loving retired cowboy who has never committed any crime more heinous than overtime parking.

With this and other Old West touches, Jackson amuses visitors while housing them in neon-bright motels with swimming pools. Wooden sidewalks boom hollowly under the high-heeled boots of genuine cowpokes and Eastern dudes. In a cocktail lounge, customers marvel at a bar inlaid with 2,231 silver dollars. At the Pink Garter Theater, where college students perform in gaslight-era melodrama, the audience roundly hisses the villain.

Jackson, an authentic Western town despite its modern trappings, serves as a rousing introduction to Wyoming. And a hearty, outgoing expanse of America it is, this second highest state of the Union (after neighboring Colorado). A resort and ranching center close to the Idaho border, Jackson Hole is a fair sample: green valley rimmed by the majestic Teton and Gros Ventre Ranges . . . high country abounding with elk, antelope, and bighorn sheep . . . moose standing tall in swampy willow brakes . . . rushing streams and placid lakes alive with giant trout . . . and always an unbelievably blue sky over craggy peaks rising from an infinity of grassy rangeland.*

A vast upland more than a mile high, Wyoming owns half a dozen mountain ranges outright, and goes partners with neighbor states on a few more. It straddles the Continental Divide, sending its melting snows to both oceans (map, pages 578-9).

In Laramie, the Nation's highest university town, Wyomingites smile at lowland football teams. The visitors bring bottled oxygen to help them battle the husky Cowboys of Wyoming U. on their 7,200-foot-high field.

Yellowstone: First National Park

Besides being one of the highest states, Wyoming is one of the most spectacular. It is also one of the wildest, windiest, and coldest—and, in places, one of the drabbest, saddest, and loneliest. Only a salt-shakering of people live here, a mere 340,000 sprinkled across nearly 100,000 square miles—an area twelve times the size of Massachusetts. Twice as many people live in Boston alone. Of all the states, only Alaska has fewer.

At least two chunks of Wyoming—Yellowstone and Grand Teton National Parks—are household words.

Trapper John Colter discovered the scenic wonders of Yellowstone in 1807; it became the world's first national park, in 1872.†

The Tetons became a park in 1929, and the story of how Jackson Hole came to be added to this public preserve is best told by Horace M. Albright. Mr. Albright, now in retirement in Los Angeles, was Superintendent of Yellowstone back in the 1920's; later he served as Director of the National Park Service.

"In 1924," Mr. Albright told me recently, "Yellowstone had a very important visitor—Mr. John D. Rockefeller, Jr.—with his three older sons. I showed him around and urged him to visit the Jackson Hole country; but did

*Lynda Bird Johnson describes her visit here in "I See America First," GEOGRAPHIC, December, 1965.

†Conrad L. Wirth tells of the start of the Nation's Park System in "Heritage of Beauty and History," NATIONAL GEOGRAPHIC, May, 1958.

Oil-boom city, Casper presents a shining, prosperous face in this time exposure of Center Street. Automobile lights streak and squiggle; street lamps shine like stars. The town boasts 40 millionaires—one for every 1,100 people.

Just 35 miles north lies Teapot Dome, a rich oil field made notorious in the 1920's when the Secretary of the Interior illegally leased Government oil reserves to private companies. Supreme Court action returned them.

Town hat hung like a six-gun on his hip, an off-duty cowboy takes the measure of Cheyenne's 17th Street on a Saturday night.

PHOTOGRAPHS BY DAVID S. BOYER (ABOVE) AND TED SPIEGEL, © NATIONAL GEOGRAPHIC SOCIETY

not mention our hope of adding it to the park.

"Two years later the Rockefellers returned to Yellowstone. I took them to see the Tetons, and the mountains, lakes, and forests made a profound impression upon them. The spectacular beauty of this land, they thought, surpassed anything they had ever beheld.

"I called Mr. Rockefeller's attention to the growing disfigurement along the roadsides—hot-dog stands, dance halls, filling stations, ramshackle buildings, and the like. All I had in mind was showing him the Jackson Hole country and then telling him of our program for getting national-park status for the region.

"Mr. Rockefeller, however, at once saw the possibility of preserving for all time the scenery and the wildlife for the benefit and enjoyment of the public. He asked me to compile a map showing the private properties and to estimate the cost of acquiring them.

"It was an immensely complicated business, of course, and it took years. But the final result was that Mr. Rockefeller purchased more than 33,000 acres of Jackson Hole, for about $1,500,000, and presented them to the people as part of Grand Teton National Park."

Today one of the donor's sons, Laurance S. Rockefeller, who visited Yellowstone with him that summer, continues this pursuit of conservation for public use as the President of Jackson Hole Preserve, Inc.

Visitors Find New Hotel a Boon

Rambling Jackson Lake Lodge (following pages) and the camping and recreational area at Colter Bay command breathtaking panoramas of the Tetons. Laurance Rockefeller, a Trustee of the National Geographic Society, told me one afternoon how the hotel and the campsite were born.

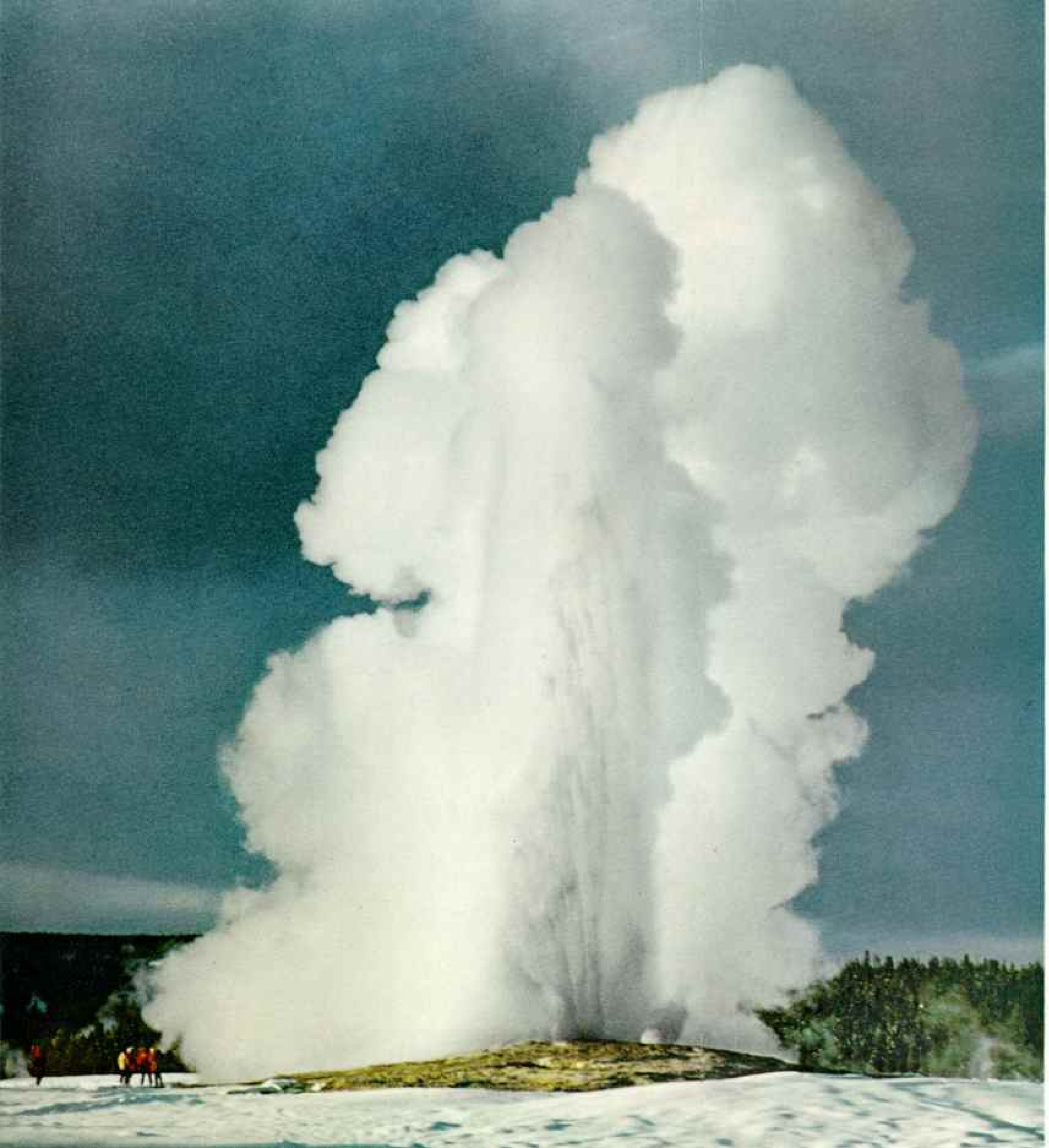
"On one of our trips to Jackson Hole, about 1951," he said, "my father heard that so many people were visiting the park they

(Continued on page 564)

MONARCHS IN RAIMENT OF SNOW, *the Tetons dwarf Jackson Lake, its lodge and cottages. Immense picture windows of Jackson Lake Lodge frame fantastic views of the peaks. The buildings, accommodating 1,100 guests, lie low on the land—in harmony with the setting.*

560 VIGNETTE BY WILLIAM ALBERT ALLARD © N.G.S.

OPPOSITE PAGE FOLDS OUT



couldn't find accommodation. Many were sleeping in their cars. It was then that he thought of building a hotel so that others could enjoy the beauty of the Tetons, as we had on many trips over nearly thirty years.

"With park officials, we chose the site—Lunch Tree Hill, where we had often picnicked. The Park Service supplied land, utilities, landscaping. Jackson Hole Preserve, Inc., built the hotel. All profits go to conservation."

Like millions of others, I have marveled at the Tetons, framed in the big picture windows of Jackson Lake Lodge. I like the scene even better through the trees from Colter Bay. Here the Rockefellers made a home for those who take their parks a bit more basically.

Colter Bay: Haven for Kitless Campers

For the family that has never camped, that doesn't own a tent, a sleeping bag, or even a frying pan, Colter Bay has the answer—log-shelter campsites and camping gear for rent, by the night or by the week (page 590). Even an especially designed trailer camp is provided, where people who take their homes with them can tie on to electric power, sewer, and other connections, and find a cafeteria, laundry machines, showers, and grocery store within walking distance.

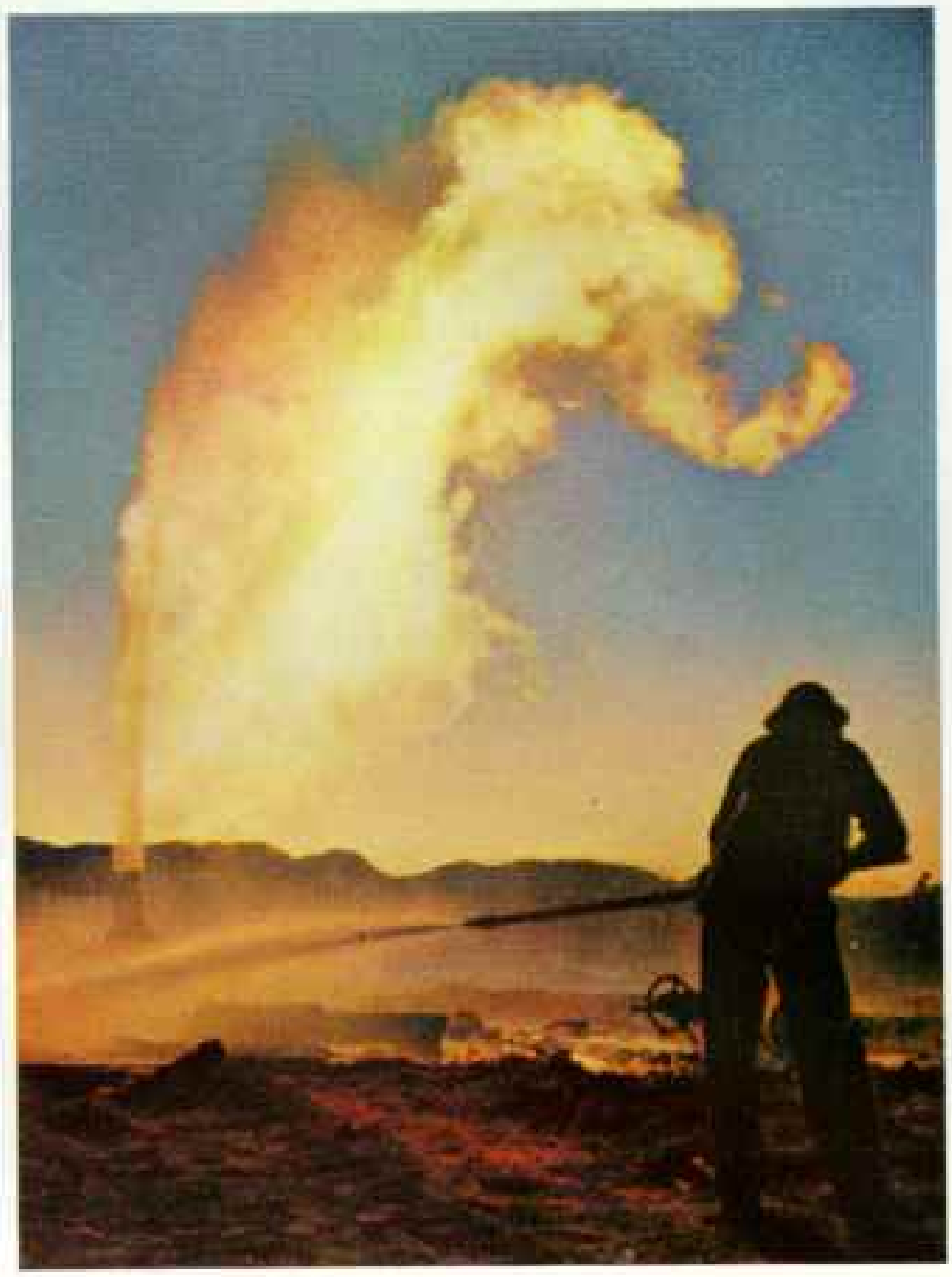
Fittingly, between them Yellowstone and Grand Teton National Parks attract more than two million visitors a year to Wyoming—seven times the state's own population. But countless others use Interstate Highway 80 across the southern part of the state as a sort of transcontinental racetrack, scarcely stopping for hamburgers or gasoline.

Wyomingites consider this dash across their land a sorrow. A few think it should be made a misdemeanor. After seeing the rest of Wyoming, I'm inclined to agree.

My travels took me to Cheyenne, the lively capital; to oil-rich Casper, the "other city," whose population almost equals Cheyenne's 52,000; and to dozens of towns. I remember most fondly the little places with the poetry of a rugged young country in their names.

The Indians named Ten Sleep, because they reckoned the site was ten days' travel from Fort Laramie or from the Yellowstone hunting grounds. Chugwater Creek is named for an Indian legend that a tribe once drove buffalo over a bluff to slaughter them, and the beasts landed with a chugging sound.

The most graceful name of all belongs to a pleasant town in the Bear Lodge Mountains of northeastern Wyoming, not far from Devils Tower National Monument (page 588). It is



Plume of vapor towers 150 feet (opposite) as Old Faithful erupts in Yellowstone. Though it performs every 67 minutes on the average, the geyser is hardly faithful enough to set a watch by; it has waited as long as 96 minutes and as little as 33. Ten to twelve thousand gallons shoot out during each four-minute burst.

Fighting fiery gas, a workman sprays water on a well near Cody. Reaching for oil, the drillers hit instead a pocket of natural gas; a spark in the drill rig ignited it. Twelve million cubic feet burned in four days and nights before firemen put it out.

Fifth among states in oil production, Wyoming harbors reserves estimated at a billion and a half barrels. Twenty-seven million acres, though leased, remain to be explored.

Gnarled fingers of lightning stab sand dunes at Rock Springs. Interstate 80 appears as a luminous band, painted by automobile headlights. "The thunder here is not like the tame thunder of the Atlantic coast," wrote 19th-century historian Francis Parkman of a summer storm. "Bursting with a terrific crash directly above our heads, it roared over the boundless waste . . . seeming to roll around the whole circle of the firmament with a peculiar and awful reverberation. The lightning flashed all night . . . revealing the vast expanse . . . and then leaving us shut in as if by a palpable wall of darkness."

EXTACHROME BY JACK S. RICHARD (UPPER) AND KODACHROME BY CORNELL C. BORGER © N.G.S.

Ball game, Indian style: Feathered braves and booted squaws, linked wrist to wrist by handkerchiefs, run after the ball during the All American Indian Days in Sheridan. Each summer 2,000 Indians from some 40 tribes across the continent gather here to stage the three-day festival, climaxed by a beauty contest to select Miss (Indian) America.

Oil-drum horse, towed by a vintage roadster, bucks through Cheyenne as members of "Forty-and-Eight," a veterans' organization formed after World War I, help celebrate Frontier Days. Loosely mounted tail wheel adds eccentric motion to the steed. A week-long carnival in rawhide, Frontier Days will erupt for the 70th consecutive year this July.

Sundance, so called for the festivals once common to all Plains Indian tribes.

I also saw places called Goose Egg and Greybull, Mule Creek Junction and Lightning Flat, Little America and Pitchfork, Lost Cabin and Recluse, Wolf and Moose. Others hint at Wyoming's frontier past: Crazy Woman Creek, Powder River, Whiskey Gap, Rattlesnake Range, Baby Wagon Creek, and Hell's Half Acre. Most amount to little more than a building or two at a wide place in the road; they serve as trade centers and post offices for cattle and sheep ranchers who live miles away on far-flung spreads.

Wyoming Hoards Scenic Treasures

My most indelible experience was an October pack trip into the Bighorn Mountains. For hours we rode through deep snow, with only the blowing of horses and creak of leather breaking the silence. Night overtook us, and moonlight through the evergreens cast picket-fence shadows across the trail.

Our horses whinnied up a sudden conversation, nickering back and forth. We straightened up in our saddles. There it was: Mistymoon Lake, treating us to glassy, inverted images of Cloud Peak and Bomber Mountain. Deep down in the cold, dark mirror flickered the stars, half a million diamonds set in the lake floor, washed and sparkling. The Wyoming heavens were winking upward.

Edward Schunk, a young rancher from Sheridan, reined in, tilted back his ten-gallon hat, and took a long look. So did the rest of us: Dr. William F. Schunk, who moved to Wyoming from North Dakota before his son Ed was born, businessman John Ferries and his son Greg, who had just moved to Wyoming weeks before; and I.

Will and Ed had ridden to this Cloud Peak Primitive Area dozens of times. For me, it was a first pack trip in the snow; for John and Greg, a first into high country at all. Now we sat still in our saddles, transfixed, near the top of a very high world.

Dr. Will rested a gloved hand on the rump of his patient old mountain horse, Socks, and waved out toward Mistymoon.

"You see," said Doc, "you've got to move off the highway and get up into the hills to see the real Wyoming!"

We pushed across a snowy pass above the Christmas-card lake. Before the moon set we had built a fire, broiled a steak, and unrolled sleeping bags in a white silence beside another lake, called Solitude.

Next to wife and kids, Will Schunk loves Solitude best. A physician in Sheridan, Doc has devoted half a lifetime to protecting wilderness areas. There are eight in Wyoming—some of the most extensive and spectacular reaches of unspoiled land in the Nation.

The Wilderness Society, of which Doc is a member, scotched plans to slash a road in to Solitude and lower its waters for irrigation. Now there was no road, and we were very much alone in these high mountains.

"Someone once called Wyoming 'the land of high altitudes and low multitudes,'" said Doc, as we crawled into our sleeping bags. "The only thing we're sure of today is the first part. High multitudes may be on their way."

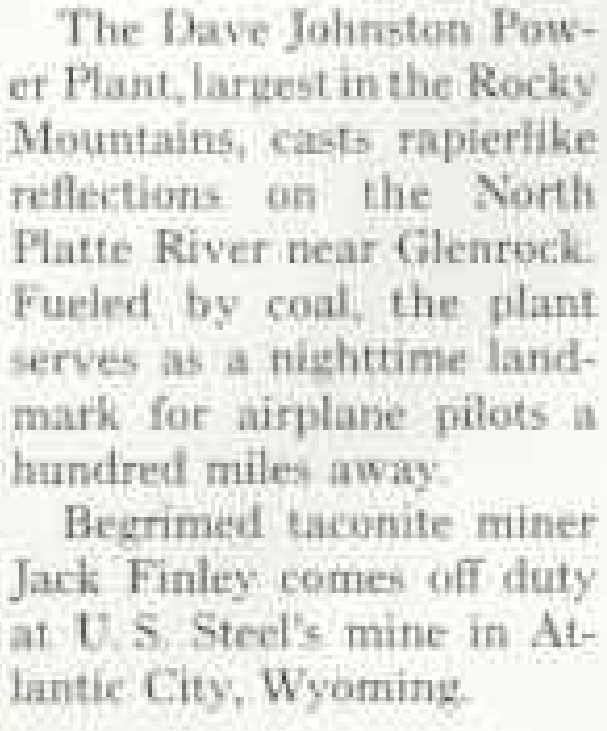
I knew what he meant. Bumper-to-bumper traffic in Yellowstone-Teton suggests that tourists may become a stampede. The whole tempo of Wyoming life is accelerating.

A hundred years ago, Wyoming was a land of trails: the Oregon Trail (pages 572-3), the California Emigrant Trail, the Mormon Trail, and others—wagon ruts across the plains and through the Rockies, the highroads of the Old West. For the pioneers, this was a region of cruel mountains, battering rivers, and hostile

Man-made Grand Canyon: To bare rich veins of uranium ore, miners gouged 30 million tons of barren rock from this pit near Jeffrey City.

The Dave Johnston Power Plant, largest in the Rocky Mountains, casts rapierlike reflections on the North Platte River near Glenrock. Fueled by coal, the plant serves as a nighttime landmark for airplane pilots a hundred miles away.

Begrimed taconite miner Jack Finley comes off duty at U. S. Steel's mine in Atlantic City, Wyoming.



KODACHROMES BY DAVID S. BOYER (ABOVE AND OPPOSITE) AND LOWELL J. GEORGIA © N. G. S.

Indians—obstacles and miseries overcome at oxen pace.

Early travelers left their names here on trailside rocks, their dead in shallow graves, and sagas of hardship in the history books. Some liked the looks of the land and stayed.

Wyoming Territory came into being in 1868 because of the Union Pacific Railroad. The U. P. had picked the flattest possible right of way through 440 miles of dreary sagebrush hills from what is now Nebraska to Utah. It spawned five brawling Wild West children along its way—Cheyenne, Laramie, Rawlins, Rock Springs, and Evanston. As five county seats, the towns governed great slices of wilderness country during territorial days. But by 1890, when Wyoming achieved statehood, the number of counties had grown to 12.

Ever since covered-wagon days, travelers have drifted by and dropped off. Most Wyomingites still seem to come from somewhere else. They find here an echo of early Western comradeship. Wyoming is where a stranger gets a cheery "Good morning!" even if it isn't. And where no man stays a stranger.

Partly for these reasons, Wyoming has been rediscovered. A new wave of pioneers is pressing in, many to develop the state's dormant natural resources. Having located untold mineral wealth in Wyoming, they see a snowballing economy, cities building, an era of manufacturing, people rolling in by millions.

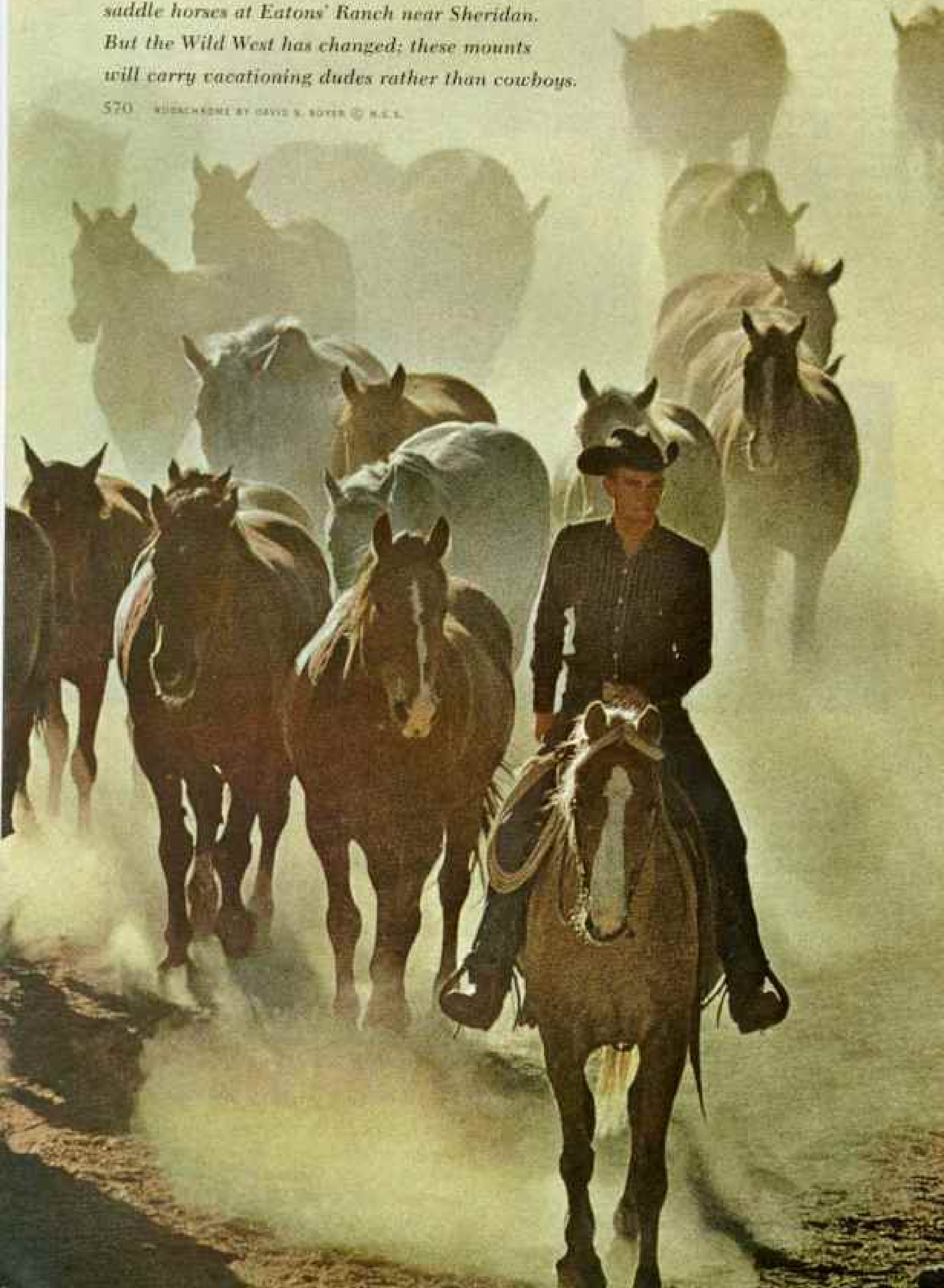
"The good Lord," a newcomer said, "made a lot of Wyoming into desert. But He made up for it with what He left underground."

No Coal Worries for 300 Years

Somehow I had never thought of Wyoming as an important state in oil production. But it ranks fifth in the Nation. More than anything else it has coal, God's plenty of it. Its reserves could supply the entire United States for 300

IN THE GOLDEN DUST, *a vision of the past.*
Early-morning roundup brings in a string of
saddle horses at Eatons' Ranch near Sheridan.
But the Wild West has changed: these mounts
will carry vacationing dudes rather than cowboys.

570 WATERCHROME BY DAVID S. BOYER © N.G.S.



PAINTING COURTESY UTAH STATE HISTORICAL SOCIETY; DETAILS(?) AND BORDERS(?) BY LOWELL J. GEORGIA © N.G.S.

Oregon or bust! Hundreds of prairie schooners buck "this cursed wilderness." In the picture by William H. Jackson, pioneers trudge across the Continental Divide at South Pass. Francis Parkman, who followed the Oregon Trail in 1846, reported "abundant and melancholy traces of their progress. . . . Sometimes we passed the grave of one who had sickened and died on the way. The earth was usually torn up, and covered thickly with wolf-tracks. . . . One morning, a piece of plank . . . attracted our notice, and riding up to it, we found the following words very roughly traced upon it, apparently with a red-hot piece of iron: *Mary Ellis, Died May 7th, 1845, Aged two months.* Such tokens were of common occurrence."

Ruts of prairie schooners, cut more than a century ago, still scar the limestone plain near Guernsey.

Arrowhead in a bison skull—a Plains Indian nearly hit the bull's-eye. The relic at Farson survives from an age when buffalo provided every need for the red man: food, clothing, shelter, beds, ropes, saddles, fuel, boats, and skins for trading.

years. Uranium ore, too, bulks large; the state bows only to New Mexico in annual production. Wyoming also mines most of the Nation's bentonite, a versatile clay used principally in steelmaking and to condition oil-well drilling muds; and virtually all its trona, a mineral used in manufacturing glass, soap, textile dyes, and paper.

Sheep and cattle outnumber people in Wyoming better than ten to one—except possibly during the tourist season, when a stampede of free-spending visitors makes cash registers jingle to the tune of ninety million dollars a year.

Nearly a billion dollars of new investment has been pumped into Wyoming industry in a decade. Many of the millions went into huge new plants to exploit low-grade iron ore, high-grade gypsum, and coal for electric power. Economists foresee an even faster growth in industry. And, of course, in people.

Not all Wyomingites view such a future with enthusiasm. One old-timer told me:

"Sure, new year-round industry would help us in the winter, when the tourists are gone and there's some unemployment. But how many people can come in and settle before our towns start growing into cities and the whole state starts to change? The way things are, we've got God's country pretty much to ourselves. And that's the way I like it."

Rangeland Bristles With Minutemen

Cheyenne, once a roistering railroad and cowboy town whose streets frequently resembled shooting galleries, now has a major industry a hundred million times more lethal than the wildest of the Wild West. The men with fingers on today's triggers are a new breed, absolutely sober and clean.

I met a pair of them deep underground. Air Force Maj. James M. Donohue and Capt. Gerald W. Buchman wore spotless white coveralls, punctuated by black pistols on their hips. They showed me the "triggers"—actually two keyholes, so far apart that no one man could reach both—which could send ten Minuteman missiles screaming over the roof of the world, carrying awesome nuclear power.

Around Cheyenne clusters the free world's greatest concentration of combat intercontinental ballistic missiles. Here, a rifleshot away from Wyoming's Capitol, lies Francis E. Warren Air Force Base, headquarters of one of the Nation's newest missile sites.

The 90th Strategic Missile Wing controls 200 of the Nation's more than 800 Minuteman missiles. The wing's installations lie scattered

KODACHROME BY LOWELL J. GEORGIA © N. G. S.

Fishing in rock. Dr. Paul O. McGrew lands sunfish, herring, and *Notogoneus* (foreground) that swam 50 million years ago, when southwestern Wyoming was covered by a lake. The University of Wyoming professor studies fossils from the Green River shale near Kemmerer.

Like a bullet in a cocked pistol, a Minuteman missile stands as a deterrent against enemy attack. The solid-fuel rocket can deliver a nuclear warhead 6,300 miles from its silo in the prairie. Maintenance crew slides open the four-foot-thick protective lid.

across 8,300 square miles of rangeland extending into Colorado and Nebraska. Miles apart, the missiles present an almost inconceivably difficult target to any enemy, for they are buried in underground silos, invulnerable except to a direct hit.

Twice a week, for a 24-hour day, Major Donohue and Captain Buchman control ten missiles. These Minutemen could be fired in less than a minute after receiving a verified "fast-reaction" Presidential order.

We were deep down inside a "launch-control facility." This steel-and-concrete underground fortress has an electronic core, a two-man heart.

"If we ever do get the word, we'll *know* it has come from the President!" Jim Donohue assured me. "If people could only know how elaborate and absolutely foolproof the system is—the system to prevent the arrival of a false message—they would never worry. But, of course, the details are secret.

"Also, there isn't much we can say about how we rule out the possibility of an unauthorized firing, but there are many safeguards against its happening," Major Donohue continued. "In order to launch a Minuteman, for example, more than one crew must authenticate firing orders and throw switches before any missile can get off the ground."

These "hardened" underground missile sites bespeak U. S. policy of striking back, or waging war only in retaliation. The system is built to ride out an atomic attack; then, with men and missiles still intact, to destroy an enemy with a counterblow.

"Obviously," Jerry Buchman said, "an enemy will try to knock our missiles out, but we feel perfectly safe down here."

Jim Donohue had a parting word.

"We even feel safe about Cheyenne, where our wives and kids live," he said. "You see, we really believe that it is our being here, ready to retaliate, that protects them, and everybody else. It's more than just a clever slogan when we say 'Peace Is Our Profession.'"

Cheyenne Relives Its "Frontier Days"

It seemed a long jump backward into Wyoming's past, from a nuclear-missile silo to Cheyenne in the frenzy of Frontier Days. For a week in July the city bulged and throbbed with people (page 566).

A sort of Mardi Gras in rawhide, Frontier Days has been held annually since 1897. Crowds up to 45,000 watched each performance of this granddaddy of rodeos. Riders risked their necks in feats of calf roping,

bulldogging, broncobusting (page 556), and wild-horse racing. Afterward there was dancing in the streets and action in the bars.

"Hell on Wheels," they had once called Cheyenne, back in the late 1860's, the years of the town's tumultuous birth as a division point on the westward-pushing Union Pacific Railroad. The U. P.'s arrival set more than the stage for a state. It launched one of the most ripsnorting booms in American history. With the railroad builders came swarms of gamblers, land speculators, claim jumpers, and other bellicose types who looked for trouble and usually found it.

Now, the people who had crowded with me into Cheyenne were simply looking for fun—and finding it.

Northwest from Cheyenne, nearly the breadth of the state away, lies the little ranching center of Pinedale. There I looked further back into Wyoming's beginnings.

Mountain Men Ride Again

Wyoming, some say, got its first reputation because of a hat. In the early 19th century beaver hats were the rage in New York, London, Paris, and Vienna. And in Wyoming trappers and traders penetrated some of the West's best beaver country (and some of its worst Indian country) to furnish the pelts.

Autumnal gold floods a valley as hayfields yield their abundance beneath peaks already heavy with snow. Hay covers half of Wyoming's cropland; sugar beets, wheat, oats, barley, and corn grow on the remainder.

Several of their annual rendezvous took place in the valley of the Green River.

Names of these mountain men became legends—Gen. William H. Ashley, Jim Bridger, Kit Carson, Thomas Fitzpatrick, Joe Meek, Robert Campbell, Andrew Drips, Lucien Fontenelle, Jedediah Smith, David E. Jackson, William Sublette, and many more.

Now, in Sublette County, just outside Pinedale, the mountain men ride again each July. It is the Green River Rendezvous—held where the stream flows down from the cloud-piercing Wind River Range—a wild, swirling re-enactment of the annual gathering.

To the original rendezvous flocked the Indians, with beaver pelts to trade for guns and powder, knives and traps, blankets, tobacco, and liquor. While here, they tested their prowess against the white men in wrestling, horsemanship, and drinking.

"There are thousands of people watching here today," said Jim Harrower, Pinedale's mayor, "more than have come together for any event in Sublette County in 125 years. But there were more here for some of those original rendezvous. Of course, 95 percent of them were Indians then."

But things didn't look much different at this rendezvous. The cowboys, wives, and kids of Sublette County had ridden into Pinedale in "tribes," wearing Indian costume. With a few buckskinned cowboys and ranchers playing the roles of the mountain men, they brought Wyoming history alive.

They plan to immortalize it further. Late this spring they hope to break ground for a Museum of the Mountain Men.

Indians Lived Here in 11,000 B.C.

Leapfrog a few mountain ranges northward to the town of Cody, and you stand in a museum where the Old West already lives in elegance. Paintings and sculpture by cowboy artist Charles Russell and his contemporary, Frederic Remington, enhance a gallery of art and artifacts.

I talked with Western author Harold McCracken, Director of the Whitney Gallery of Western Art.

"It is the Wyoming cowboy who has captured the world's fancy, you know," said Dr. McCracken. "Our Crows, our Blackfeet, our Sioux, and our Shoshoni are the Indians that are best known across the world, as well."

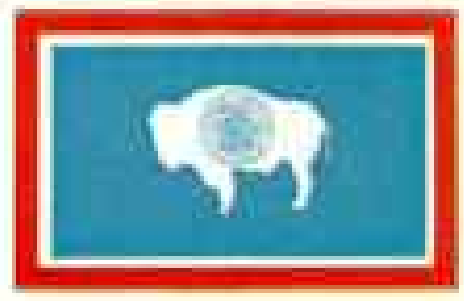
Moreover, Dr. McCracken is making known to the world some of the Indians who inhabited Wyoming as early as 6000 B.C. He directs excavations, supported by the National Geographic Society, at Mummy Cave near Cody.

Across the state, at Hell Gap in eastern Wyoming, another expedition, sponsored by our Society and Harvard University's Peabody Museum of Archaeology and Ethnology, has discovered traces of the oldest houses yet known in the Americas. Circles of postholes mark the sites of two round huts built some 10,000 years ago. Prof. J. O. Brew, Peabody


MONTANA
WYOMING
IDAHO
UTAH
COLORADO
110°
108°
Nye
Emigrant
Roberts
Edgar
Pryor
Fromberg
Bridger
Red Lodge
Lodge Grass
Wyola
Warren
Frannie
Cowley
Lovell
Byron
Kane
Garland
Powell
Ralston
Cody
Emblem
Greybull
Shell
Burlington
Otto
Basin
Manderson
Hyattville
Meeteetse
Worland
Ten Sleep
Parkman
Dayton
Acme
Sheridan
Wolf
Big Horn
Buffalo
Kaycee
Bighorn
Shoshone
Gardiner
Mammoth Hot Springs
Mt. Washburn
Canyon Village
Fishing Bridge
Lake
Old Faithful
West Thumb
YELLOWSTONE
NATIONAL
PARK
Yellowstone Lake
Heart L.
SHOSHONE
NATIONAL
PARK
BIG HORN
SHERIDAN
JOHNSON
WASHAKIE
HOT SPRINGS
FREMONT
NATRONA
SUBLETTE
LINCOLN
SWEETWATER
UINTA
CARBON
TETON
GRAND TETON NAT. PARK
TETON NATIONAL FOREST
BRIDGER NATIONAL FOREST
BIGHORN NATIONAL FOREST
MEDICINE BOW NATIONAL FOREST
Marysville
Tetonia
Driggs
Victor
Jackson
Alpine
Etna
Thayne
Bedford
Afton
Smoot
Cokeville
Montpelier
Randolph
Woodruff
Evanston
Kemmerer
Diamondville
Frontier
Opal
Granger
Fort Bridger
Lyman
Mountain View
Robertson
Lonetree
McKinnon
Manila
Dutch John
Green River
Rock Springs
Little America
Farson
Eden
Point of Rocks
Wamsutter
Creston
Rawlins
Saratoga
Baggs
Dixon
Savery
Slater
Bondurant
Merna
Daniel
Pinedale
Boulder
Big Piney
Marbleton
La Barge
Fontenelle Reservoir
Dubois
Crowheart
Kinnear
Pavillion
Shoshoni
Riverton
Lander
Fort Washakie
Hudson
Atlantic City
South Pass City
South Pass
Thermopolis
East Thermopolis
Kirby
Lucerne
Winchester
Grass Creek
Hamilton Dome
Bonneville
Lysite
Lost Cabin
Arminto
Moneta
Hiland
Waltman
Powder River
Hell's Half Acre
Independence Rock
Muddy Gap
Lamont
Bairoil
Seminoe Dam
Seminoe Reservoir
Owl Creek Mts.
WIND RIVER INDIAN RES.
Boysen Res.
Ocean L.
Gas Hills Uranium Mining Dist.
Rattlesnake Range
Granite Range
Green Mountains
Whiskey Gap
Hay Res.
Lost Creek Lake
Red Lake
Steamboat Mountain
Superior
Table Rock
Bitter Creek
Black Buttes
Pine Butte
Bridger Pass
Wind River Pk.
Gannett Pk.
Fremont Pk.
Downs Mt.
Bull L.
Franks Pk.
Wyoming Peak
Hoback Pk.
Circle Ranch
Flaming Gorge Reservoir
FLAMING GORGE NAT. RECREATION AREA
Elizabeth Mt.
Uinta Mountains
Kings Pk.
Whiterocks
Tridell
Maeser
Vernal
Greystone
Sunbeam
Maybell
Lay
Craig
Hayden
Milner
Steamboat Springs
Columbine
Hahns Peak
Elkhead Mts.
Bear Lake
PRODUCED BY NATIONAL GEOGRAPHIC SOCIETY CARTOGRAPHIC DIVISION

WYOMING

With its jagged peaks, green valleys, and sagebrush plains, Wyoming bears the indelible stamp of the Old West. Cowboys still ride the range, though they sometimes drive jeeps or helicopters. The population totals only half that of Boston, Massachusetts. Across the open rangeland lie scores of missile launching sites, their weapons in underground concrete silos. Minerals lead the economy; Wyoming ranks fifth in petroleum production, ninth in natural gas. Deposits of soft coal could supply the entire United States for centuries. The state's tallest mountain, Gannett Peak in the Wind River Range, rises to 13,785 feet. South of matchless Yellowstone, 13,766-foot Grand Teton mirrors itself in the cool blue lakes of Grand Teton National Park.



Equality State, so called because of its early adoption of woman suffrage. **AREA:** 97,914 sq. mi., ranks 9th. **POPULATION:** 340,000, ranks 49th. **ECONOMY:** minerals (oil, natural gas, iron, uranium); ranching (2d in U. S. in wool), farming, tourism. **CLIMATE:** Summer temperatures, though ranging above 100° F. in desert areas, are generally temperate. An average elevation of 6,700 feet results in prolonged winters. **MAJOR CITIES:** Cheyenne, pop. 52,000, capital (State Capitol shown below); Casper, 45,000; Laramie, 20,000. **ADMISSION:** 1890 as 44th state.

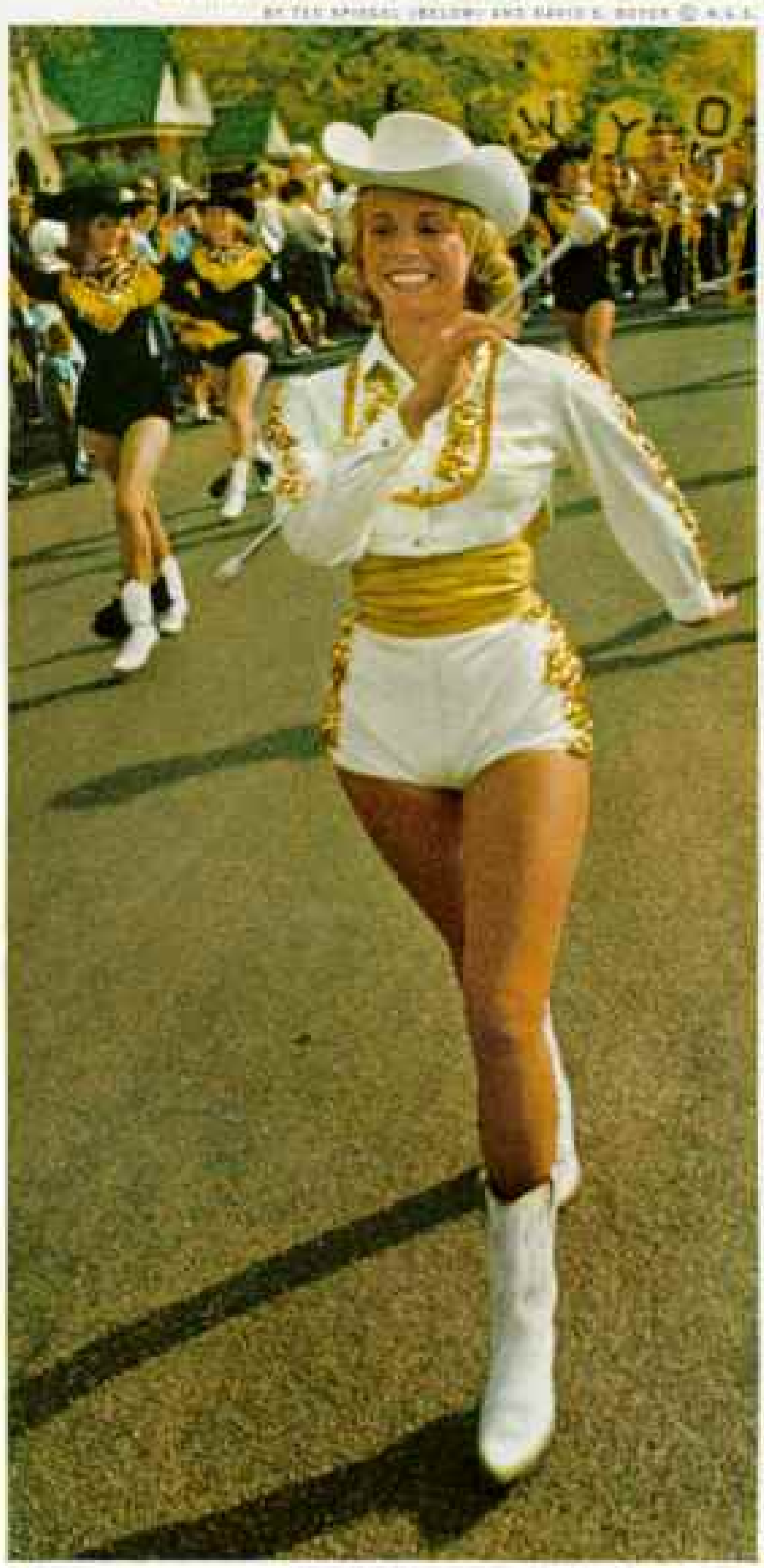
ENGRAVING BY LOWELL J. HESSER © N.G.S.

Fighter for the vote, Esther Hobart Morris helped inspire the act that gave Wyoming its nickname: Equality State. The territorial government in 1869 became first in the world to grant women the vote. The statue, standing before the State Capitol in Cheyenne, contrasts with the drum majorette leading the University of Wyoming band at Laramie.

Annie Oakley, "Peerless Lady Wingshot," appeared with Buffalo Bill Cody's Wild West show. Her name became a synonym for free tickets, which usually bore perforations resembling the bullet holes she shot in playing cards during her act.

PHOTO COURTESY BUFFALO BILL MUSEUM, CODY, WYOMING; ASSACHUSETTS

BY TED SPIEGEL (BELOW) AND DAVID S. BOYER © N.G.S.



director, and field leaders Cynthia Irwin-Williams, Henry Irwin, and George Agogino have uncovered a continual sequence of cultures here from 11,000 B.C. to the present. They have also found some of the finest flint artifacts of North America.

Outside Cody's Whitney Gallery, with Winchester rifle raised high, a familiar figure rides a bronze horse—the man for whom the town was named, Col. William Frederick "Buffalo Bill" Cody, among the most colorful heroes the West has known.

Iowa-born Cody moved to Kansas with his parents and while still a boy became a Pony Express rider. Later, as a professional buffalo hunter, he supplied tons of meat to railroad construction crews.

He won his nickname fairly, no doubt, but one story still told pokes a little fun. A buffalo gored his horse and chased him across the prairie. A colleague, hearing of the incident, roared with laughter: "That's our Bill, our Buffalo Bill!"

By 1872 Cody had become a widely known figure, picturesque in fringed buckskin and with flowing yellow locks and whiskers. Encouraged by admirers, he organized a Wild West show. For years the troupe thrilled crowds all over the United States and Europe with its daredevil cowboys, howling redskins, clattering stagecoaches, and the astounding feats of Annie Oakley, "Little Sure-shot."

Cody also served as an Army scout, helping

BUFFALO BILL'S WILD WEST.

CONGRESS, ROUGH RIDERS OF THE WORLD.

MISS ANNIE OAKLEY,

THE PEERLESS LADY WING-SHOT.

Gen. Philip H. Sheridan quell Indian uprisings. Soldiers with Colonel Cody told how he killed Cheyenne Chief Yellow Hand, taking his war bonnet and claiming "the first scalp for Custer."

Buffalo Bill became a rancher in his final years, though his main interest continued to be his Wild West show. At Cody, his Irma Hotel, named for his daughter, still does a brisk summer business, with guests rocking in a long row of chairs on the porch. He died in 1917 and was buried on Lookout Mountain, just west of Denver, Colorado.

Next door to Cody's TE Ranch was the Bobcat Ranch, today the prized possession of Wyoming's junior Senator and former Governor, Milward L. Simpson.

"Buffalo Bill used to be a great hit with us kids," Senator Simpson told me. "Sometimes we'd see him out in front of the Irma. I remember he'd have someone toss up a silver dollar, and he'd blast it out of the air with a .22 rifle. I used to have a dented souvenir dollar myself. It seems like only yesterday."

The past is never far away in Wyoming. At Senator Simpson's urging, I drove to Laramie to visit a stimulating scholar who has traced that past back as far as it can be read—Professor Samuel H. Knight, retired head of the University of Wyoming's Department of Geology and Mineralogy.

Oil Helps Build a University

"The rocks exposed in Wyoming cover much of the scope of geologic time," the professor told me. "The state is a tremendous workshop for us, with an amazing diversity of earth structures. Several other universities maintain summer geology camps in Wyoming; with our summer weather we hardly ever lose a day in the field."

Professor Knight, who still teaches part-time, pointed out the warm pink limestone of the university's handsome buildings. "Quarried near the campus," he said. And he told me of the curious relationship between these buildings and the geologists he has trained over the past fifty years.

Wyoming's Legislature, he explained, long ago earmarked part of the state's royalties from oil and gas wells to be used for construction at the university. Meanwhile, geology graduates, finding jobs with Wyoming oil companies, helped discover the oil that further financed their alma mater's growth.

Capital city of the state's leading industry is Casper (pages 558-9), where petroleum money has sprouted plush new homes, colorful office buildings, sophisticated shops, and an ultramodern bank with a domed roof that suggests an astronomical observatory. The city claims a millionaire for every 1,100 persons—some 40 of them. It also admits to a fairly frequent rangeland wind that howls into town and down Center Street.

Landmark Recalls a National Scandal

Twenty-six miles north of Casper stands Teapot Rock, an outcrop big enough to brew a nationwide tempest back in the 1920's. Teapot Dome, an oil structure underlying the land to the north, became a blot on President Warren G. Harding's Administration.

After almost a decade of investigations and trials, Albert B. Fall, Harding's Secretary of the Interior, went to prison. A Supreme Court decision took Teapot Dome out of private hands and restored it to Government control.

The area still contains vast oil reserves. In the adjacent Salt Creek oil field, the wells began producing in 1890, and in 1923

PHOTOGRAPH BY JAMES A. SIMON © N.G.S.

Early snowstorm surprises hare and people. The white-tailed jack, crouching in its Yellowstone igloo, will turn a camouflage white later in the season.

Campers, caught in the park's first storm of the season, huddle beneath a tarpaulin. Snow closes Yellowstone each year from November 1 to April 30, but during the summer months two million persons come to visit. Set aside for public enjoyment in 1872, Yellowstone became the first national park in the world and remains the largest in the United States, with 3,472 square miles.

poured forth a fantastic 97,000 barrels a day. Then the wells slowed. But today, thanks to water-injection techniques, they flow again at 34,000 barrels a day, with a quarter of a century at that rate still ahead of them.

I drove 26 miles east out of Casper one night to photograph a monument to Wyoming's second mineral industry—coal. On an improbable superhighway beyond Glenrock, crossing black and virtually uninhabited rangeland, I rounded a lonely hill and met it face to face.

The largest power plant in the Rocky Mountains advertises its own product, electricity. If you stumbled on Chicago's Wrigley Building spotlighted there you could not be more startled. The Dave Johnston Power Plant is a tower of light that airline pilots say they can see a hundred miles away (page 569).

Dave Johnston himself got out of the car with me, and we stood there on the old Oregon Trail, watching his plant burning Wyoming coal and churning out nearly half a million kilowatts of power.

"I came out here in the 1920's from Wisconsin," he said. "This is still young people's country today. The fishing hooked me on Wyoming 45 years ago. The fishing, the great outdoors, and the people still keep me here."

Dave had launched the Natrona Power Company, which later became Mountain States Power, at Casper. Now, Pacific Power & Light Company, Wyoming's biggest investor, had merged with Mountain States and built the Glenrock plant. They named it after Johnston—a well-merited tribute to a man who had pioneered in building an industry and a community.

Rusting Locomotives Stir Nostalgia

North of Glenrock is Gillette, another coal town, and between them lie vast coal beds nearly 100 miles long. Estimated to contain 47 billion tons, they could supply the Dave Johnston plant for 20,000 years.

The southwestern towns of Evanston, Green River, and Rock Springs have long looked sad to cross-country travelers racing the length of Wyoming (map, pages 578-9). Union Pacific steam locomotives stood rusting

on pedestals, sorry souvenirs of the demise of steam, reminders that this depressed area once supplied coal to the railroad.

But there has been a revival, in nearby Kemmerer.

"During the next five years," President Glenn E. Sorensen of the Kemmerer Coal Company told me, "we'll mine twice as much coal a year as we ever did for the U. P. By 1970, we'll mine two million tons a year. Utah Power & Light Company's new plant here will take more than half of it."

A few miles west of Green River—and a third of a mile beneath the Wyoming plains—several companies are tapping another vast mineral deposit, buried in the bed of an ancient lake. The miners are honeycombing a 15-foot-thick deposit of trona, the yellowish-white mineral that yields soda ash, a chemical widely used by United States industry.

The lake bed yields a million tons of trona annually, yet the deposit is so extensive that Wyoming can continue to mine it for a century or more.

Recent cutbacks in the Federal Government's requirements have dulled the luster of one of Wyoming's most glamorous minerals, uranium. But in Rawlins I met a millionaire miner who refuses to accept the idea of a depression in his business. He was among the first to dig the radioactive ore for atomic weapons during Wyoming's uranium boom, and expects he'll still be digging it when peaceful atomic power creates a second boom.

Robert W. Adams was not long out of a German prisoner-of-war camp when he came to Rawlins to open a restaurant and night club. Then came a uranium strike in the nearby Gas Hills. Mr. Adams mortgaged his holdings, borrowed from friends, and in 1955 set up the Lost Creek Oil and Uranium Company, with offices in Rawlins.

The company later changed its name to Western Nuclear, Inc., and for its 200 employees it built a town, Jeffrey City, in country where the deer and the antelope still play. (The old town here had been called Home on the Range.)

Until recently Western Nuclear had been mining by the open-pit method—digging ore close to the surface (page 568). Now it goes underground in search of higher grade ore. Twelve hundred tons of high-grade ore are already coming daily out of an 860-foot shaft on the company's Golden Goose reserves, 11 miles from Jeffrey City. In a state that has been selling nearly 30 million dollars' worth of uranium annually, the golden eggs are not yet all laid.

Sheep Ranchers Face Varied Woes

Rawlins is the seat of Carbon County, where more sheep are raised than anywhere else in the United States, except two counties in Texas. Carbon County woolgrowers, however, have Texas-size troubles.

I listened to a few over a predawn breakfast at a Rawlins restaurant. Curtis Rochelle, Bus Rendle, Charles Vivion, and Elmer Peterson are early risers and hardy hangers-on in a traditional Wyoming industry hard hit by sagging lamb prices, foreign wool competition, synthetic fibers, periodic drought, and troubles with fences. They have troubles, that is, with conservationists and hunters, who say fences—thousands of miles of them across leased Federal land—restrict the movement of deer and antelope.

"One reason we put our sheep behind fences," Curt Rochelle was saying, "is that we can't get enough good sheepherders any more.

"We'll have to come to some kind of compromise with the hunters, I guess," Curt continued. "The Wyoming Game Commission recommends a fence low enough for a deer to jump, and high enough for an antelope to crawl under. This may satisfy the conservationists too.

"As far as conservation is concerned, sheep *should* be fenced and not herded around. Herding ruins a lot of forage, and leaves sheep trails that encourage erosion.

"Sheep themselves are just like human beings," he

Sheep command the right of way as they move to winter range, stalling a motorist near Powell. Basque shepherds once herded vast flocks on open range; today more and more sheep grow up behind fences. Second only to Texas in wool production, Wyoming supports some two million sheep.

HELICOPTER HERDERS *drive elk toward corrals in the annual thinning of the Northern Yellowstone Herd. The elk increased to about 7,000 during the calving season, more than the range could feed, and were cut back to 5,000 last winter to prevent starvation. Park rangers ship surplus animals as far away as Michigan and Texas.*

586 KODACHROME BY JACK E. RICHARD © NATIONAL GEOGRAPHIC SOCIETY

ACROCHROMES BY DEAN CUNNER (ABOVE) AND DAVID S. BOYER © N.G.S.

Gigantic stone stump, Devils Tower rises 1,280 feet above the Belle Fourche River in northeastern Wyoming. It took shape millions of years ago when molten rock, forced up from below, cooled near the surface. Water has since eroded away the softer stone around it.

Near-vertical columns of Devils Tower National Monument provide a challenging rock climb, as these members of the Iowa Mountaineers discover. Legend ascribes the cracks to the claws of bears, when the animals tried to catch Indian maidens; the girls jumped onto a low rock that saved them by soaring skyward.

went on. "They do better when they aren't pushed around. Some want to eat salt sage, and some want grass. Some want to go for water often, and some don't. Especially at lambing season, we're better off with fences. Ewes tend to lose their lambs in all the confusion of being herded."

Curt's final reason for defending fenced prairie was, to me, absolutely unassailable. He has 360 miles of fences flung across Wyoming—at $1,000 a mile.

"We used to raise sheep for money and cattle for respectability, behind the same fences," Charlie Vivion said. "Now you can't get either one out of either one."

"That's right," Bus Rendle said. "I'm operating with one man and myself, and I'm thinking of firing me."

Then Bus took off in his private plane to sell some sheep over on the Idaho border.

Back in the old days, raising sheep and cattle together would have been unthinkable. For years, Wyoming cattlemen, first on the scene, accused sheepmen of denuding the range and draining water holes with their hungry, thirsty flocks. There was a vicious war and much bloodletting.

"I remember talk about sheep wagons on fire in the hills when I was a kid," said cattleman Danny Budd. His great-grandfather, a cattle rancher, started the town named Big Piney in the 1880's.

Danny introduced me to Everett Curtis of Big Piney. Everett remembered back to the days before fences, almost to the era of bad blood among cattlemen, in the 1890's, when cowboys died in range wars because they'd put their brand on another man's calves.

Winter Begins at 40 Below

"My dad came to Wyoming in a wagon train bound for California," Everett told me. "He dropped out because he liked the looks of the land. I was the first white baby born in Big Piney. My folks laid me out on a table, and everybody filed by to get a good look."

We were riding out to a cattle branding on the Circle Ranch of James F. Michelson, a spread of about 60,000 acres. Everett punched cows here for 25 years, and now owns a small herd of Herefords himself.

"Big Piney's temperatures are always being talked about on the radio," I mentioned. "Is it pretty bad here in the winter?"

"You know," he said, "we never noticed it till the radio picked it up. We don't even get into our long johns until it hits about 40 below. Of course, that happens pretty often."

All across Wyoming cattle country, I had vaguely wondered about the kindergartens of calves clustered in the sagebrush around a single cow.

"Cows are smarter animals than you'd think," Everett told me. "They'll leave one or two old cows to baby-sit all day with 20 calves, while the mothers go off to find grass and water and salt.

"I don't know how they decide who does the calf-sitting. But I do know that if you roped one of those ornery little critters and dropped him off from a truck miles away, he'd be back in the same patch of sagebrush with his baby-sitter almost before you could get back yourself."

False Teeth Save Pampered Cattle

I picked up another odd bit of range lore that afternoon.

"What did you say about false teeth?" I asked a rancher who was at the branding.

"That's right," he said. "Several years ago quite a few cattle wore 'em. Particularly registered purebreds. A few still do, especially in areas where there is a lot of grit."

Grazing animals, he explained, often pick up dirt, bits of stone, and other abrasive materials together with grass. With steers, there's no problem, since they go to market pretty young. But over the years the teeth of valuable breeding stock wear down. Some of the animals are worth thousands of dollars apiece. Unable to chew a full ration, they might eventually starve.

"In the old days, we just slaughtered stock that had reached that point," the rancher said. "Then a dentist came along and invented stainless-steel crowns that fit right over the lower incisors, adding years to their lives."

The original cattle of Wyoming were the buffalo. They fed and clothed the Indian for centuries, then became nearly extinct at the hands of the paleface. A few years ago a meat packer from San Francisco thought buffalo might be made to feed and clothe modern Americans, and started one of Wyoming's strangest enterprises.

It was in the town of Buffalo that I heard about the 66,000-acre B-Bar-B Buffalo Ranch of D. C. (Bud) Basolo, Jr. The route to the ranch goes east to Gillette, then south. I followed a four-lane highway for 70 miles without seeing a filling station. Livestock herds

EKTACHROME (ABOVE) BY JAMES W. ELDER, KODACHROME BY WILLIAM ALBERT ALLARD © N.G.S.

In the lee of the Tetons, Colter Bay pioneers a partnership between the National Park Service and a nonprofit foundation, Jackson Hole Preserve, Inc. Hundreds of sportsmen from across the Nation launch boats from the Jackson Lake marina for fishing, boating, and skiing. Spray flies from the ski of Mrs. Peter Mead, daughter of Wyoming Governor Clifford P. Hansen.

Colter Bay's economical facilities range from campsites, trailer park, and tent village to actual homestead cabins, moved to this site and newly equipped with hot and cold running water. General store, restaurant, laundromat, and tackle shop serve campers. No one need bring even a sleeping bag; all gear may be rented on the spot.

use underpasses to avoid the infrequent but very fast traffic.

Basolo started with 125 bison bought from a ranch in Texas. Now he grazes thousands and ships the frozen meat all over the U. S.

"We herd these fellows with jeeps," he said. "They're pretty docile for the most part. You can walk among them or lead a horse. But don't *ride* a horse into a herd. Chances are you'd wind up gored or trampled or both. You'd almost think they have a lingering, hereditary memory of men on horseback hunting them down. Buffalo Bill Cody, you know, personally killed about 4,000 head when he was supplying meat to the railroads."

A chance discovery by Mr. Basolo's wife Georgia has opened up new possibilities for buffalo-ranching. Seated one night on an old buffalo robe, she ran a hand through the hair, admired its texture, and wondered aloud, "Why can't a buffalo hide be sheared and used as a fur?" Her husband echoed, "Why not?" and sent several sample hides to a furrier.

The result: Handsome, durable buffalo coats, jackets, hats, and after-ski boots, designed by Mrs. Basolo, have gone on the market. But the B-Bar-B turns out an even stranger by-product—bleached buffalo skulls.

"Interior decorators are snapping them up," said Mrs. Basolo.

Bighorn Mountains Challenge Motorists

In my rear-view mirror, the shaggy brown bison dwindled into the prairie landscape. My car was aimed at Wyoming's far west. Now, in late September, the standing-room-only signs were coming down in Yellowstone and Grand Teton National Parks.

The least traveled route over the Bighorn Mountains is U. S. Alternate 14. I took it.

Driving down the breathtaking switchbacks into the Bighorn Basin, you see vast reaches of flaming desert color, rivaling that of Arizona. Half a dozen mountain ranges march away like a deep stage with many banks of sets. The Absarokas—Yellowstone's eastern wall—pinprick a horizon 100 miles away through the clear Wyoming air—whenever you dare take your eyes off the next curve to look at them. At places on Alternate 14, it's better to park before viewing the scenery.

In the town of Lovell I stopped for coffee to settle my nerves. "There's no other road like it in the world," I was told. "Only a few tourists take Alternate 14. Some come down as if from seventh heaven. Others reach here petrified. Their fingers have been embedded in the steering wheel, their eyes locked on the

middle of the road, and their foot mashed against the brake pedal for an hour."

I flexed my toes inside my right shoe and said nothing. Cal Taggart, who was talking, seemed a nonchalant sort of mayor to me.

Scenic Grandeur in Town's Back Yard

An hour later, in a high wind, Cal had me up in his private plane, showing me the town of Lovell, and a miniature edition of the Grand Canyon of the Colorado River—the magnificent Bighorn Canyon. Across the line in Montana, the Department of the Interior has built the Yellowtail Dam on the Bighorn River. Soon vacationers will enjoy boating and fishing and water-skiing on the upper end of the reservoir, right in Lovell's back yard.

Also aboard the plane was Joe Rumburg of the National Park Service, Superintendent of the new Bighorn Canyon Recreation Area.

"Down in Utah there's practically a twin for this recreation area, Flaming Gorge, with water backed up the Green River into Wyoming, just like this," Joe told me. "In the first eight months of last year, more than half a million people came to use it.

"If we get a highway over the Bighorns that isn't quite so terrifying, we may get half a million here, too."

There had been two million tourists at Yellowstone during the season. When I pulled in at Old Faithful Inn, only a handful remained,

warming themselves before a fire crackling in one of the eight hearths beneath the lobby's 85-foot stone chimney.

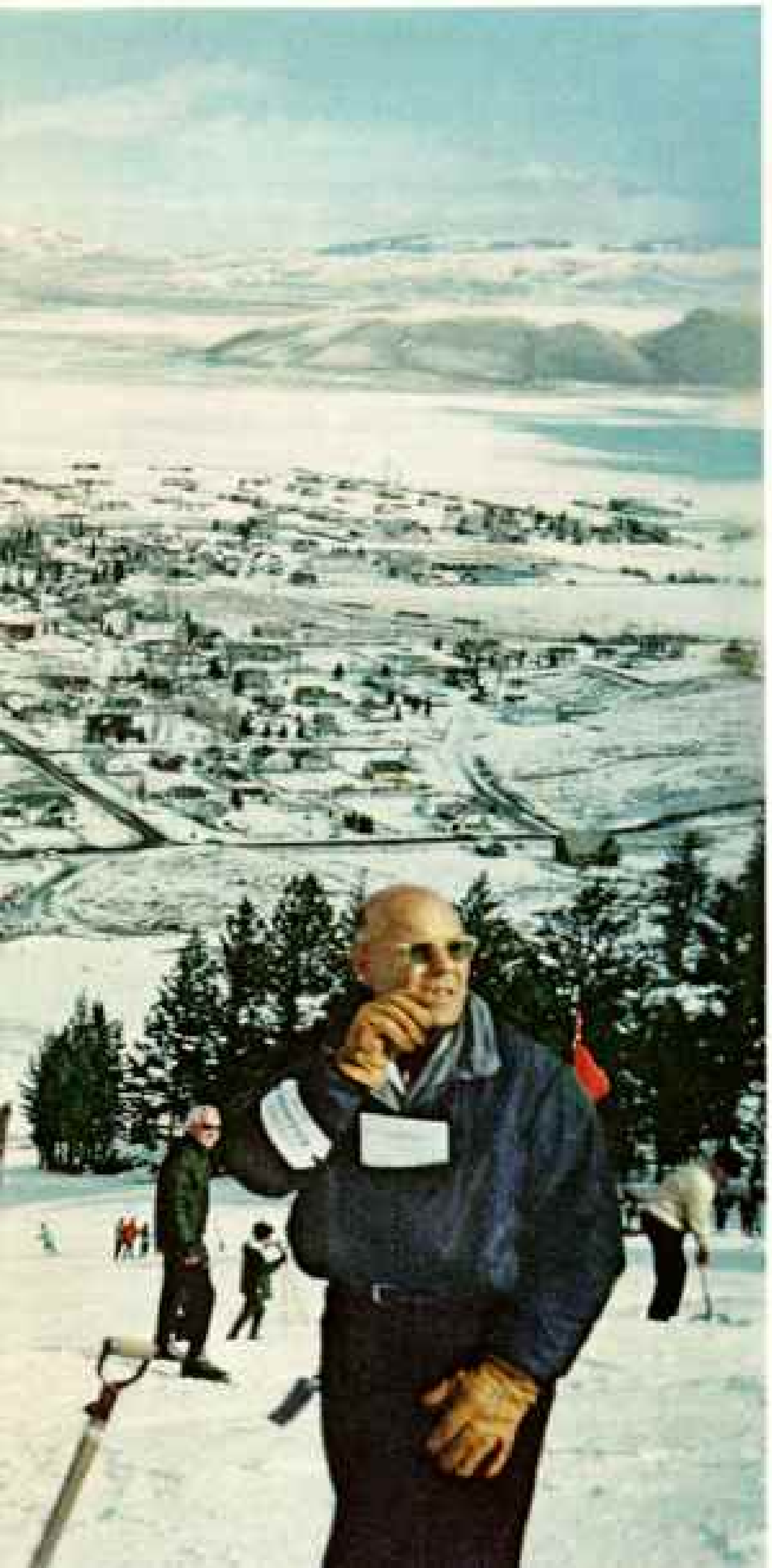
I related a rumor I'd heard that they were going to demolish Old Faithful Inn, a vast, rambling masterpiece of weathered pine logs, and replace it with a modern building.

"Tear this old log cabin down? No! Why Yellowstone would never be the same." *

The reaction came from George D. Marler, veteran park geologist and geyser expert.

"I have heard, though," he said, "that

*For earlier GEOGRAPHIC accounts of the park, see: "Springtime Comes to Yellowstone National Park," by Paul A. Zahl, December, 1956; and "Fabulous Yellowstone," by Frederick G. Vosburgh, June, 1940.



CATACHROME (ABOVE) BY JAMES M. SIMON.
KODACHROME BY JAMES M. SIMON © N.G.S.

Leaping skier trails snow from a small cliff at the Jackson Hole Ski Area, newest of Wyoming's dozen developed slopes. Skiers can descend 4,135 feet—greatest drop in elevation of any ski resort in the country. Developers anticipate that within five years as many as 15,000 skiers a day will use the area's facilities. Already, slopes like Snow King (left) lure hundreds of winter visitors, turning Wyoming's tourist season into an all-year affair. This home of the schuss and sitzmark overlooks the town of Jackson.

they're thinking of moving other accommodations out of the park, or at least away from Old Faithful Inn. The pressure of visitors around here in the summer is terrific. It's like Times Square."

I mentioned that a nice lady in Sheridan had told me to be sure to watch Old Faithful erupt under the colored lights at night.

George smiled resignedly.

"There are no colored lights," he said. "Never have been. But lots of people seem to remember them. And you'd be surprised how many recall when we had Old Faithful on the other side of the highway. 'When did you move it?' they want to know."

I decided to play straight man for him once more.

"There's a bill before Congress to give the Secretary of the Interior authority to lease public domain for the development of geothermal energy. Have you heard any talk about tapping the Yellowstone geyser basins?"

"No, and I hope I don't," George Marler said. "I know they get commercial power from underground steam in Italy and New Zealand, and I think Iceland, too. And there's a geothermal power plant in California.

"They drilled some test holes here years ago, and I think they calculated that Yellowstone's underground heat could melt six tons of ice a second. But of course, if they tapped into our hot springs, even miles away from Old Faithful, for example, it might be the end. It could upset the thermal balance of all that interconnected underground plumbing."

Quake Changes Flow of Springs

The slightest alteration of temperature or pressure can suddenly change a spring's way of life. In August, 1959, a severe earthquake, centered at nearby Hebgen Lake in Montana, gave Yellowstone a memorable jolt.* The underground convulsions, Marler said, had altered many springs and geysers. Some beautiful geysers became dormant; others, previously insignificant, sprang to furious and photogenic activity.

"What we need," George said, "is not more power, but more respect for these wonders of nature. It's a crime what people will do to them. One morning we drew water out of Morning Glory Pool and made it erupt. It reswallowed most of what it had regurgitated. But around its chin we picked up 75 towels and bath mats, any number of sticks and marbles, two wristwatches, a wedding ring, and $115 in coins."

I drove southward through the rest of Yellowstone. It was quiet. The park bears, hold-up artists of the highways, weren't bothering the lonely likes of me. They would hibernate till spring, when bumper-to-bumper tourists would make the begging worthwhile again.

Wyoming's Future: Higher Multitudes

Grand Teton National Park, like Yellowstone, had survived another summer's tourist onslaught. Some Wyomingites regard this fact with wonder at the end of every season. How many more visitors, they ask, can these areas take before the parks come unraveled from the heavy wear?

Staring out at the splendid crags from Jackson Lake Lodge, I pondered what Laurance Rockefeller had told me in Washington, D. C.

"Open space isn't the problem," he said, "but how we use it. For example, about 95 percent of Yellowstone—one of our most heavily traveled parks—is still unused. Visitors concentrate at a few well-known landmarks in the remaining 5 percent.

"I think eventually we'll have to turn to a zoning concept—keeping the wilderness hearts of our parks intact, surrounding them with buffer zones of trails and footpaths, then, around that, developing areas for high-density recreational use. This seems a practical compromise between a sort of 'deep-freeze' philosophy and wide-open development of the parks."

Still in the shadow of the Tetons, I watched a onetime little cow town sigh and try to settle down for the winter. Jackson had been trying to act like Las Vegas all summer, providing food and games and souvenirs for an invasion two million strong. Now Jackson was tired.

But it wouldn't be allowed to sleep this winter. Developers were spending nearly thirty-five million dollars to turn a mountainside near Jackson into one of the highest, most dramatic ski resorts west of Switzerland. In five years, they told me, they'd have a dozen lifts and tramways, and 10 to 15 thousand skiers a day on their slopes.

More multitudes on their way. This time mostly by plane. From both coasts. In the wintertime.

Doc Schunk was right. Maybe only the high altitudes would last.

*See "The Night the Mountains Moved," by Samuel W. Matthews, NATIONAL GEOGRAPHIC, March, 1960.

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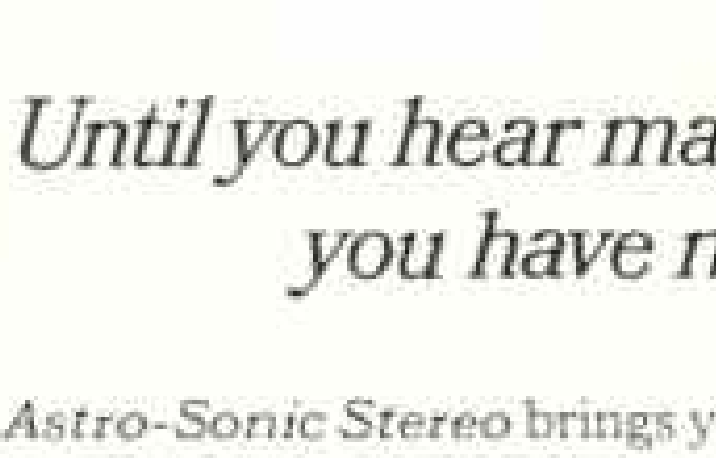

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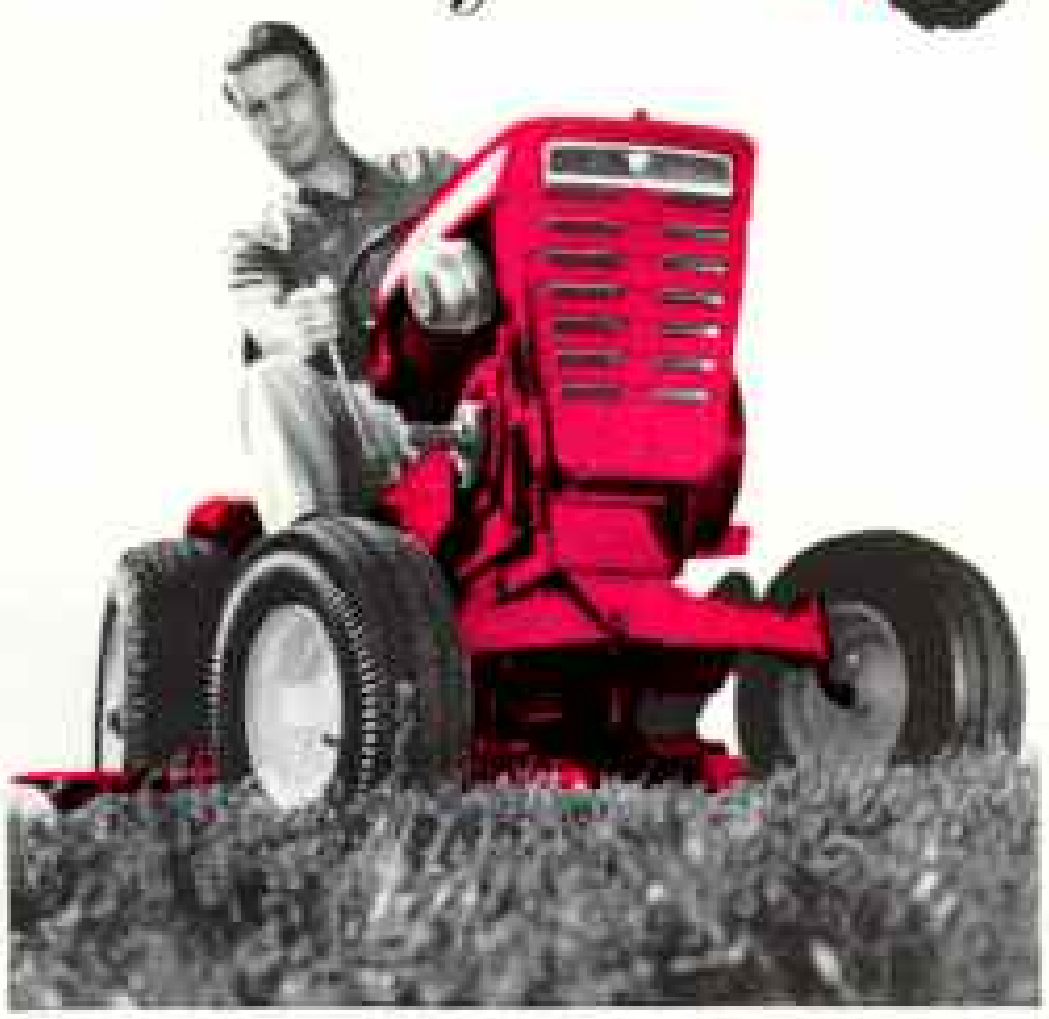

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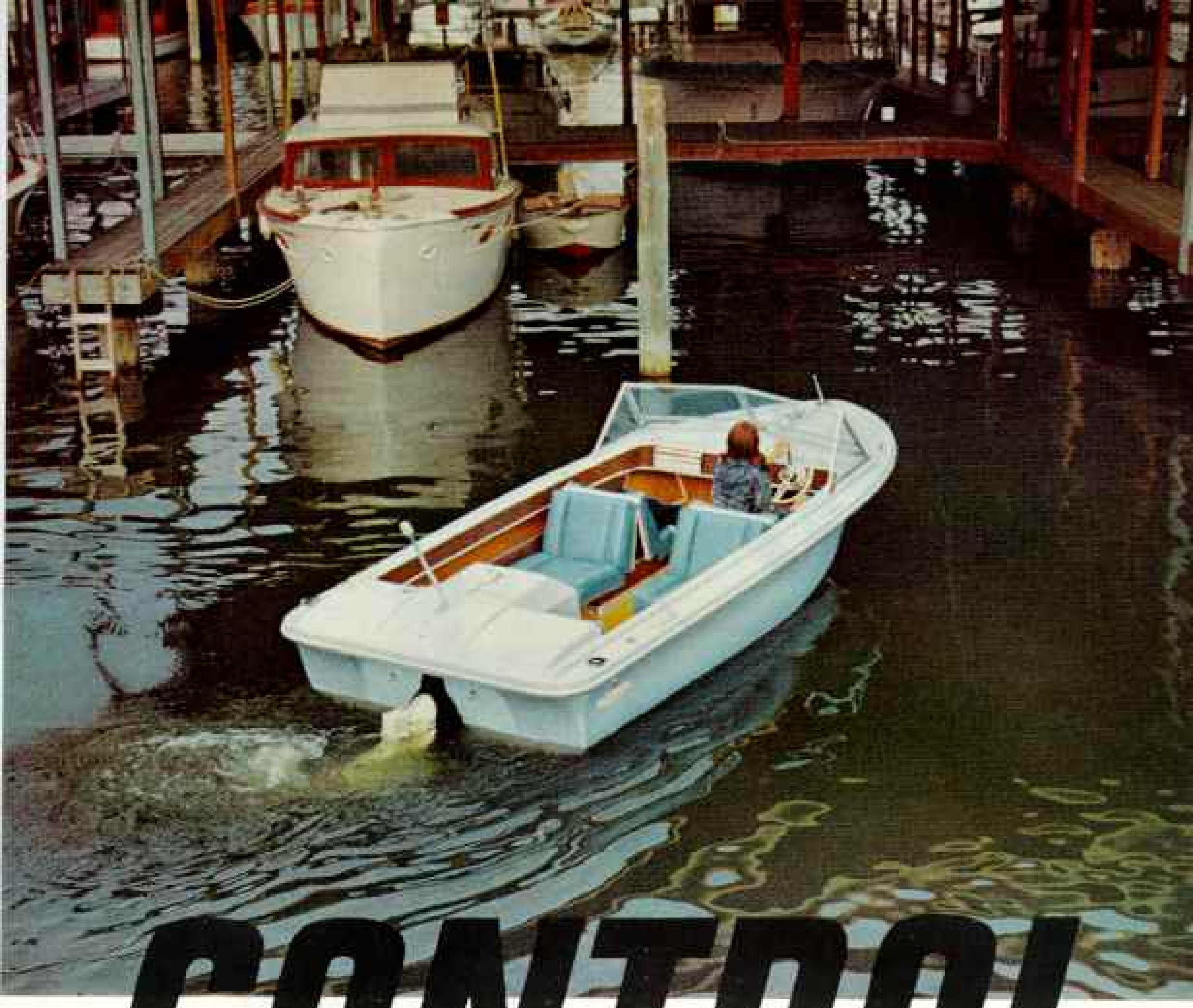

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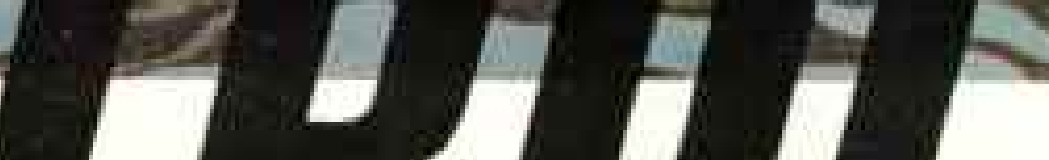

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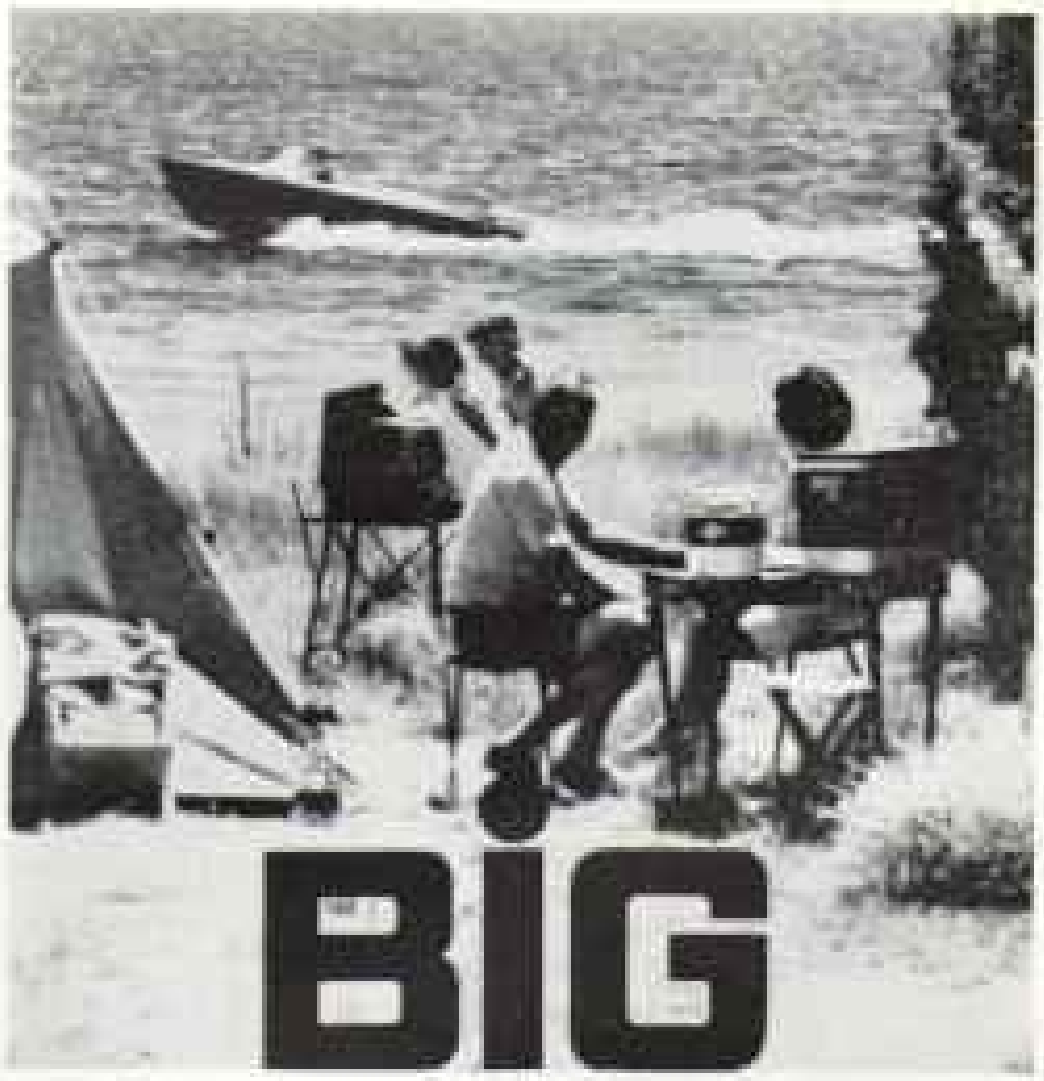

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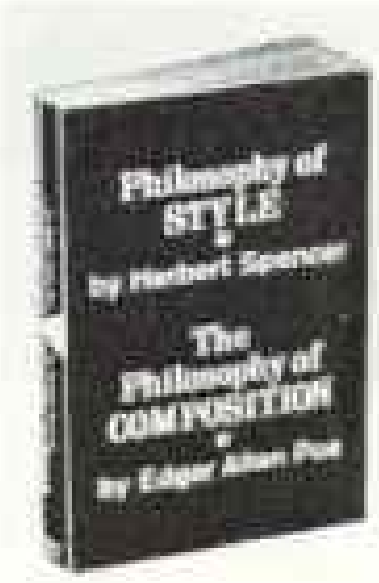

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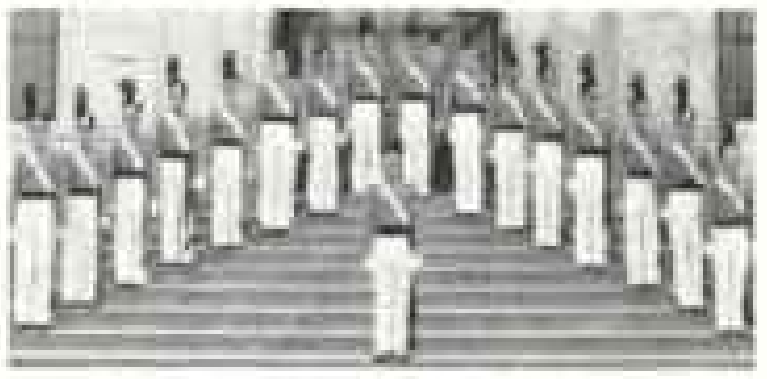

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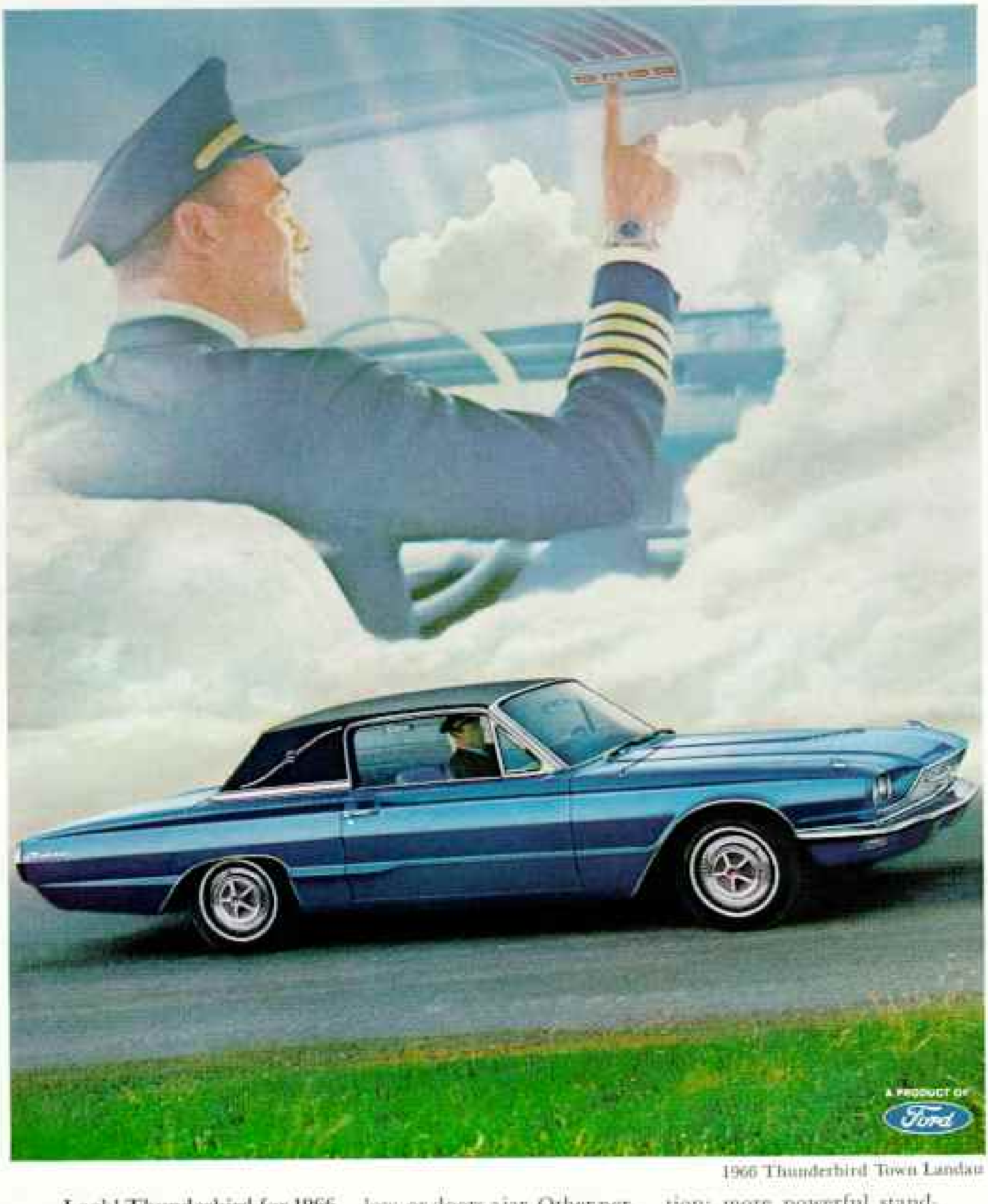
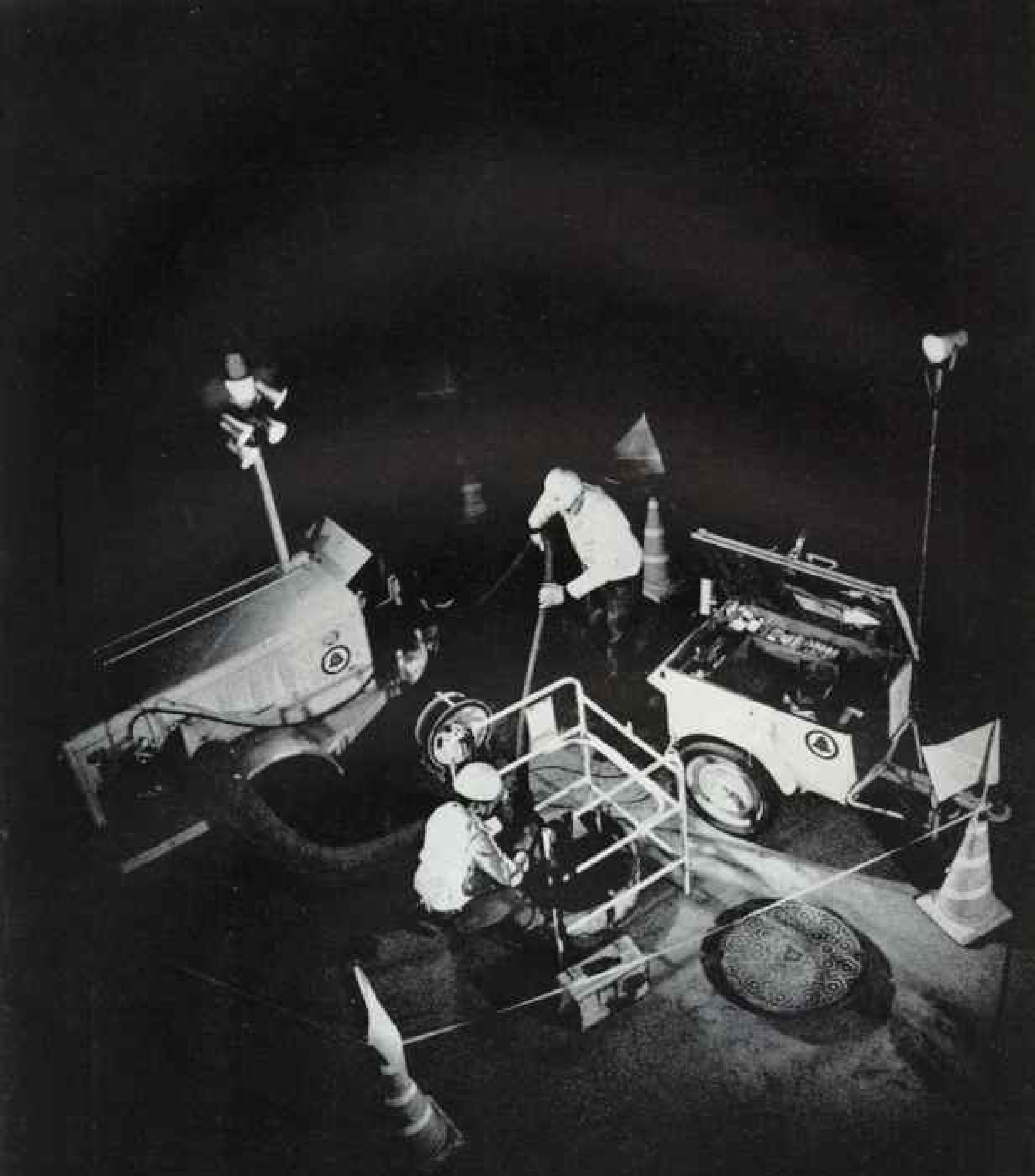


1966 Thunderbird Town Landau

Look! Thunderbird for 1966 has a unique Safety-Convenience Panel, mounted overhead on Town models. Tap a switch and the Emergency Flasher System sets four exterior lights blinking. Other lights remind you to fasten seat belts, tell when fuel is low, or doors a jar. Other personal Thunderbird touches for 1966 include the optional AM Radio/Stereo-sonic Tape system to give you over 70 minutes of music on easy-to-load tape cartridge. New, too, are: an automatic Highway Pilot speed control option; more powerful standard V-8—plus a 428 cu. in. optional V-8. And all the craftsmanship that has made this car a classic in its own time.

Thunderbird



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Start by telling her about the transistorized shutter that lets you shoot black and white pictures *without flash* in a dimly lit room and get perfect time exposures automatically. (You could go into the kids' room at night, for instance, and get pictures of them asleep, with only the night-light on.)

Tell her you'll be able to take beautiful close-ups, too, maybe even win a prize or something, because you can use the close-up and portrait attachments with this camera.

Tell her sure, the economy model will give you color prints in 60 seconds. But *this* camera has a triplet lens. Two exposure ranges for color, two for black and white. A superimposed-image, coupled rangefinder. That should get her. Especially if you say it very fast.

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