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VOL. 122, NO. 3 SEPTEMBER, 1962

Brazil, Ôba!

The Portuguese word "ôba," meaning "wow," comes naturally in this giant South American land, with its surging industry, struggling economy, and warm-hearted people

By PETER T. WHITE

Photographs by
WINFIELD PARKS
Both National Geographic Staff

NEAR THE END of my journey through the United States of Brazil, I stood in the dark atop one of the highest hills in Rio de Janeiro—on Corcovado, the Hunchback, from which rises the concrete colossus known as Christ the Redeemer.

From other hills, and from the city 2,300 feet below, drifted the barking of dogs and then the crowing of roosters, exactly what I had heard before dawn in many a Brazilian town and village. Soon Rio—the marvelous city, as her people call her—would unveil some celebrated marvels: gigantic Guanabara Bay and Sugar Loaf rock; Rodrigo de Freitas Lagoon, with an early oarsman; the white beaches; the seas of concrete-and-glass apartment towers; an airport created by pushing hills into the water; the world's biggest *futebol* stadium, with room for 153,500 soccer addicts.*

Swirling Moths Symbolize Mood of Today's Brazil

But now, at 4:30 a.m., while the tropical night was still deeply navy blue, I alone beheld an unexpected marvel right overhead. The statue of Christ, eleven stories tall and brightly illuminated, was surrounded by a mass of great moths, all silently swirling. This figure, so steadfast and tranquil seen from afar, had taken on an air of restlessness, of sustained agitation.

I found this symbolic of much of Brazil, an area roughly as large and populous as all the other nine republics of South America put together. (See the new Atlas Map, **Eastern South America,** a supplement to this issue.)

Appraised from Rio, the vast interior appeared comfortably out of focus. Few ventured far enough for a close look. Go west with me to the jungled plateau? Northwest into the Amazonian rain forest? Up to the dry Northeast? "No, thanks," my Rio friends had said, adding, "Why, these are the ends of the world!" To them travel meant a new beach resort, or the cool, alpine beauty of Petrópolis with its 7,000-foot mountains barely an hour's drive away, or Paris, or New York.

But I had visited those ends of the Brazilian world, as well as its centers, and returned under the spell of a paradox not to be found anywhere else. On one hand,

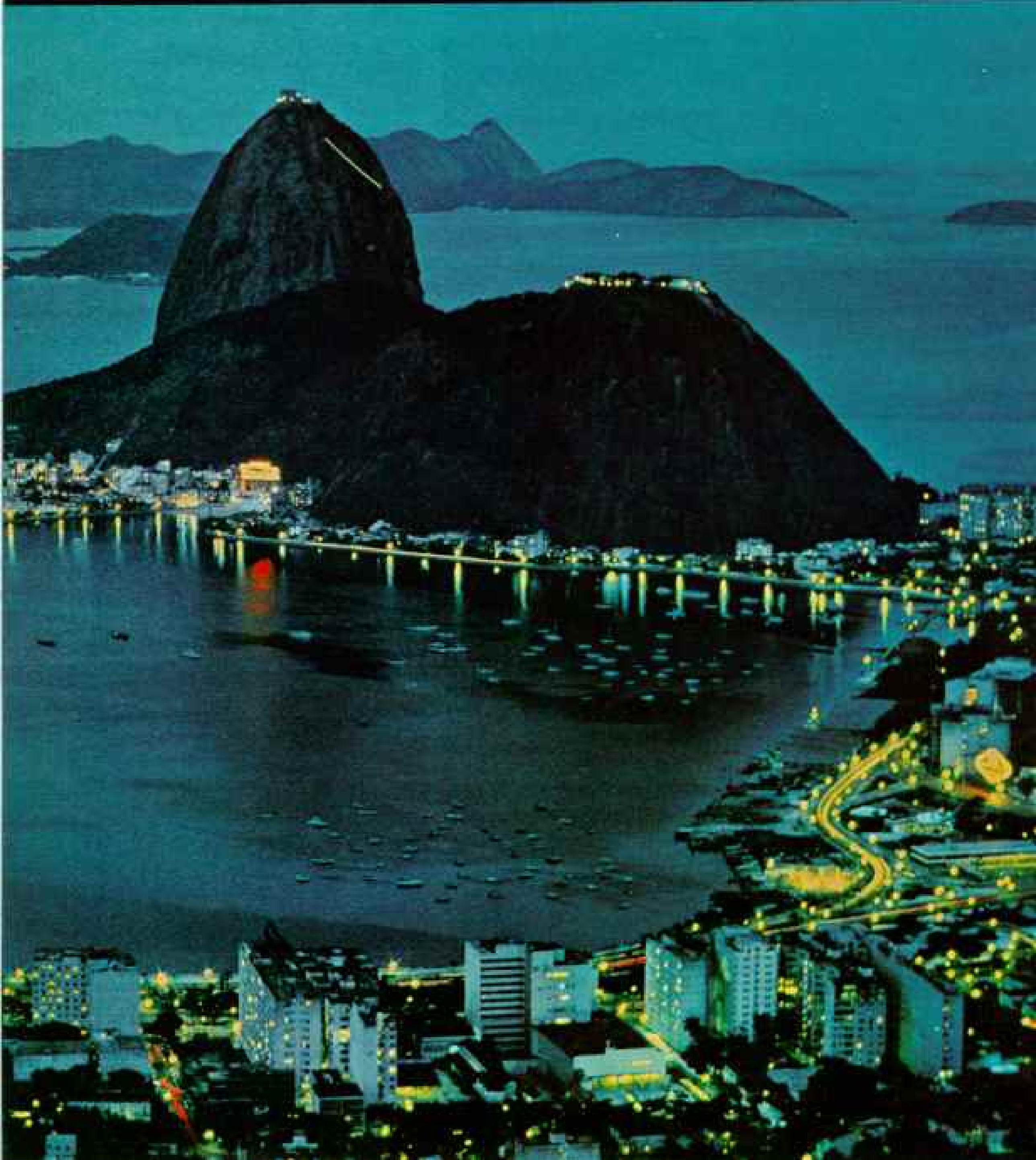
(Continued on page 302)

*Brazilian writer Hernane Tavares de Sá described the city in "Spectacular Rio de Janeiro," NATIONAL GEOGRAPHIC, March, 1955.

"MOST BEAUTIFUL CITY IN THE WORLD," *say the Cariocas, the people of Rio de Janeiro. Outlined by lights at dusk's magic moment, the Brazilian metropolis shows her loveliest face. Lamps looping Botafogo Bay seem almost to clasp together, shaping the* **colar de pérolas,** *or necklace of pearls, beloved by residents. Aerial cable car's lights streak the granite hump of Pão de Açúcar, Sugar Loaf Mountain, which guards Rio's harbor entrance.*

Arms spread in blessing, the lofty floodlit statue of Christ the Redeemer, on a peak above the city, appears to float amid moon-bathed clouds (page 309). 301

KODACHROMES © NATIONAL GEOGRAPHIC SOCIETY



stupendous energy—gigantic industries that overnight had begun turning out the gadgets and trappings of a modern economy, that not only used electronic computers but manufactured them, a triumph of free enterprise. On the other hand, inflation and, in some regions, stagnation, unrest, and stark physical misery so profound that many people spoke fearfully of a revolution.

My introduction to Brazilian energy was the Rio traffic. Sedans from Detroit, mostly taxis of incredible decrepitude, tangled with cars designed abroad but made in Brazil: German-Brazilian Volkswagens, French-Brazilian Simcas, American-French-Brazilian Aero-Willyses, expensive status symbols all. I joined a crowd without status in line for a German-Brazilian Mercedes-Benz bus.

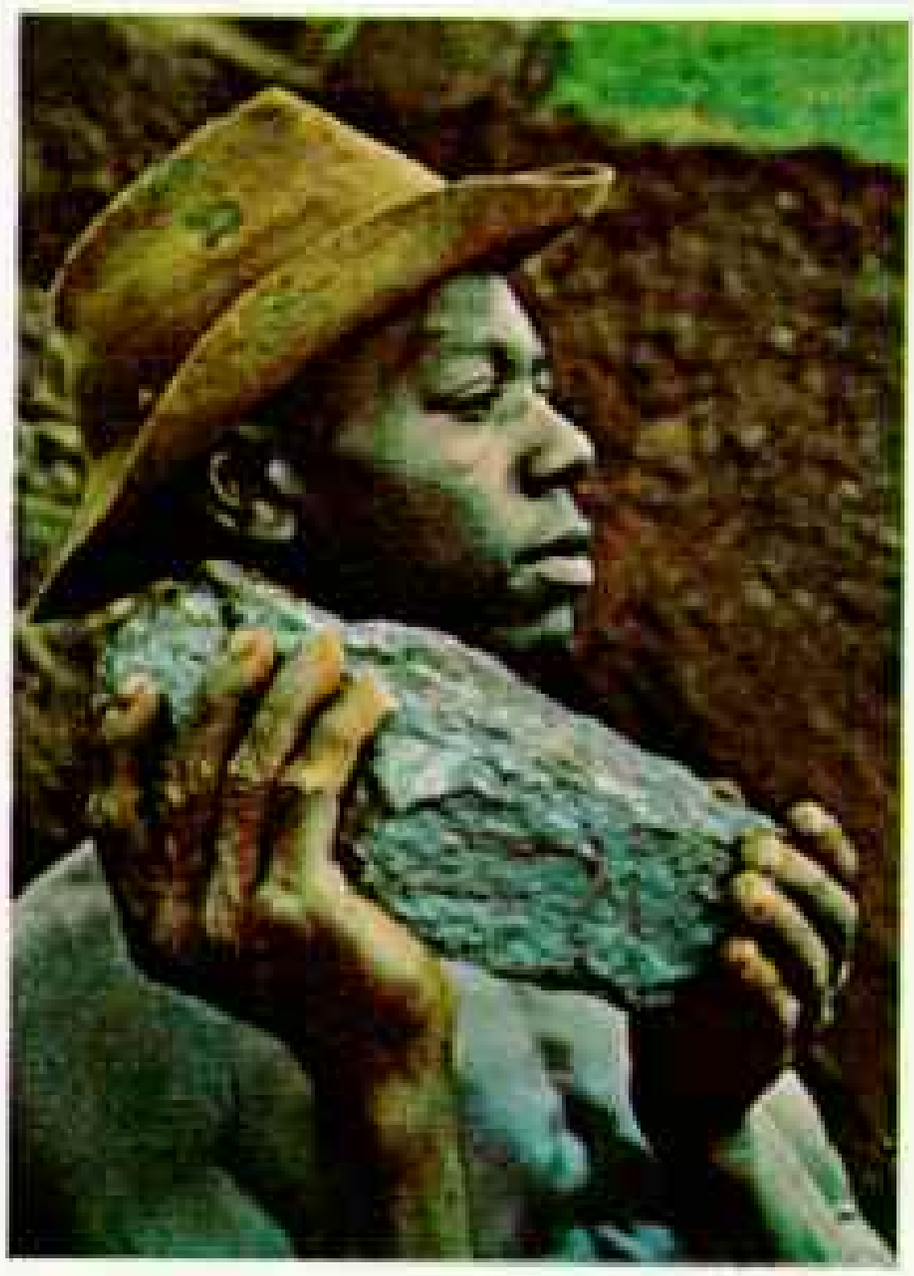
Off we went, sometimes at 60 miles an hour; often through red lights; somehow through knots of cars and people. The driver said, "If I slow down, the passengers object.

People Build the New Brazil in Laboratory, Mine, and Factory

For centuries dependence on only a few commodities—sugar, gold, rubber, and coffee—slowed the growth of South America's largest country. Today field and factory support a wide variety of pursuits. Politicians and pioneers strive to roll back the wilderness and open the rich interior to development. But most of the nation's 74,000,000 people prefer the more settled life of eastern coastal areas.

Lifesaving serums from São Paulo's Butantan Institute combat disease and snakebite. This technician seals ampules.

Kashinaua Indian from Brazil's westernmost border wears plume headdress and feathers in nostrils. Juice of the genipa fruit patterns face and body.



Mine worker loads ore scooped from a mountain near Belo Horizonte, Minas Gerais. Some chunks contain 65 percent iron.

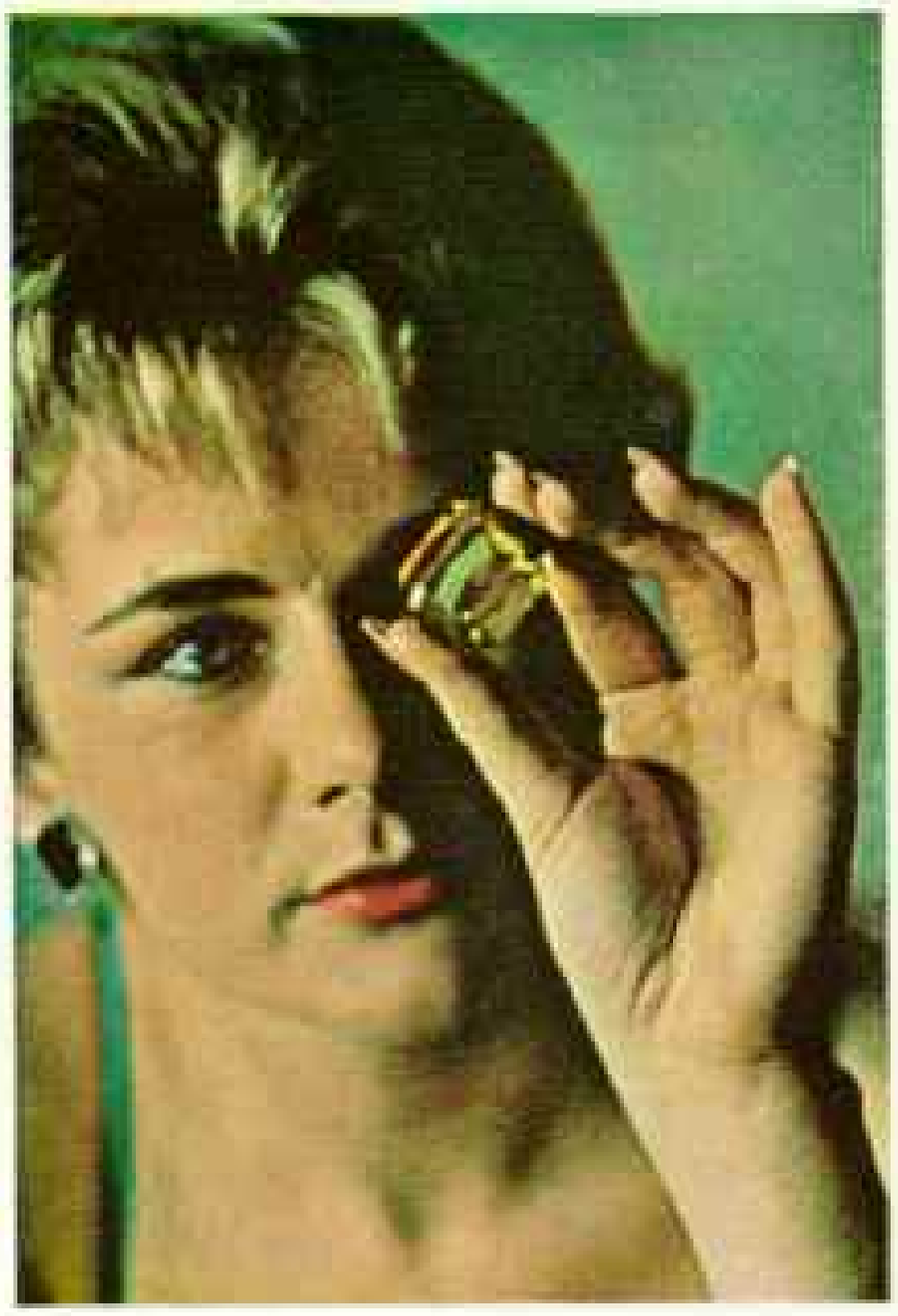
They want to get home and I want another run. I work on commission." I bought a newspaper. A bus had been unlucky: 13 passengers badly hurt, 7 dead.

Pace of Living Dooms Outdoor Cafes

Where was the famous Rio of leisure? "It survives only in old travel books," said Geraldo, a guide given to reminiscing. "Ten years ago people sat an hour with a *cafezinho*, a little coffee, at an outdoor cafe and did their little business in peace. Downtown Rio has one outdoor place left. But if you only want coffee you stand inside, and hurry."

I saw eating and big business still done calmly at the Jockey Club, the Yacht Club, and the Bankers Club, but much of Rio had progressed to quick *lanches* in *lanchonetes*.

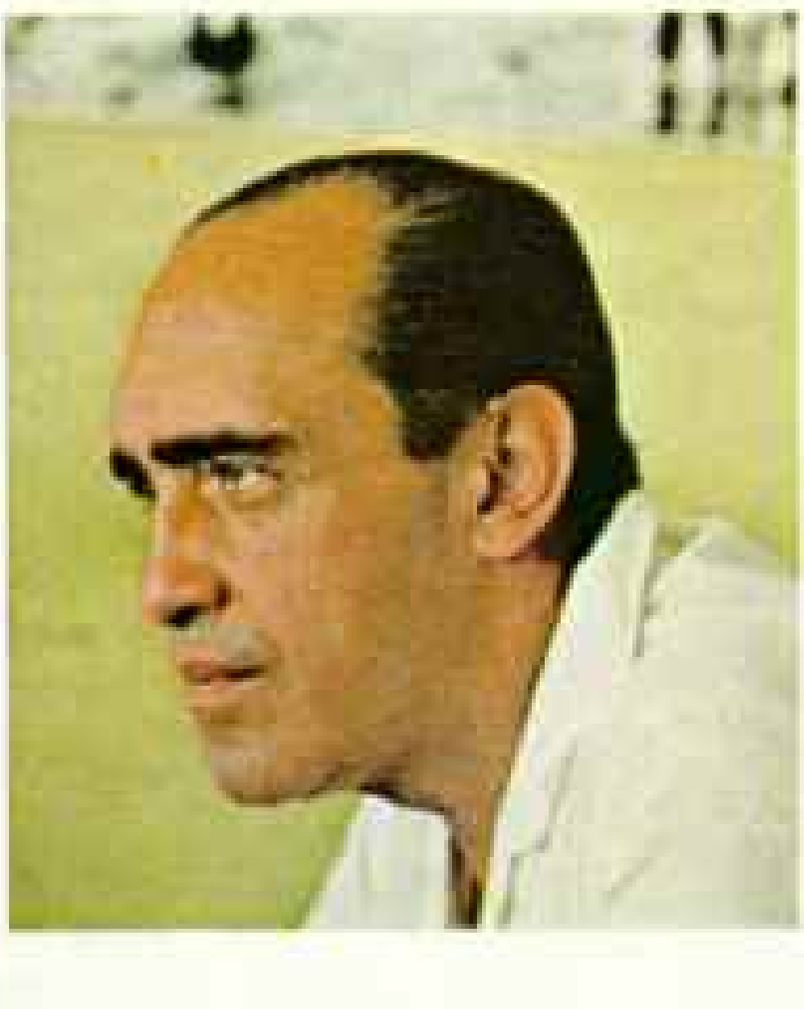
And carnival? It remains in my opinion the fiercest regularly scheduled but entirely voluntary outpouring of human and musical energy in the world. I experienced it with



Gleaming aquamarine of 145 carats enchants a São Paulo beauty. Brazil mines diamonds, emeralds, other gems.

Coffee break refreshes a laborer at a São Paulo steel plant.

Architect Oscar Niemeyer contributes bold designs to Brazil's building boom, notably in Brasilia (pages 340-1).



Beneath Gleaming Skyscrapers, Avenida Rio Branco Throbs to the Gay Din of Carnival

Gripped by Rio's pre-Lenten frenzy, a merrymaking crowd seethes under bright carnival banners. Ornate stone buildings, dwarfed by towers of steel and glass, typify an older, more leisurely Brazil. The festival's fanciest ball, attended by some 7,000 dancers, takes place in the Municipal Theater (left foreground).

Blue-faced buffoons with orange hair add a bizarre touch to one of Rio's carnival balls.

Parade watcher wears the garb of a North American Indian. Some young Brazilians copy the dress of Western hero Bat Masterson, familiar to them through the televising of U. S.-filmed programs.

shattering effect on and near the city's chief thoroughfare, Avenida Rio Branco.

As Ash Wednesday neared, this downtown area throbbed night and day with parades, floats, hundreds of costumed groups and bands, thousands of more or less costumed individuals (opposite). The music bounced at an unremitting two beats per second, until the very pavements seemed to be bouncing too.

Oba! The word means "wow," and it was repeated over and over in the refrain of a new carnival song. People danced in streets, squares, hotels, and clubs; or rather they bounced, by themselves and with one another, the ladies on chairs and tables wherever possible. Oba!

Too Busy Dancing to Feel Tired

At a block party a girl in an abbreviated Roman toga bounced on a bandstand. I waited for her to stop, but she didn't. I interrupted. How long had she been at it? "Six hours." Wasn't she tired? "No," she shouted. On she bounced, squealing "Oba!" I came by two hours later and she was still at it. So was a mature lady holding a fat black-velvet Mickey Mouse. I looked closely. It was a baby. "Only four months old," said the lady, "but he's getting the rhythm!"

At the Municipal Theater a quiet crowd assembled for the most aristocratic ball of all. The costumes dazzled me: Cleopatra, Bat Masterson, a feather-and-jewel creation called The Snows of Kilimanjaro. At 11 p.m. a whistle sounded, the band cut loose, and at once the jammed hall bounced with an exuberance few Americans reach just before midnight on New Year's Eve. Here it continued hour after hour.

I stayed up 20 hours a day. First day, fine. Second, my feet hurt. Third day, fatigue crept upward until the muscles in my back ached with

every move. My eyes burned as if changed into coals. Óba indeed.

On the fourth and last day, while tottering around on Rio Branco, I was sharply and refreshingly hit in the back of the neck with a splash of ether from a metal spray bottle. A passing duck said: "Last year a spray bottle cost 600 cruzeiros. Now, 800!"

Inflation was the steadiest source of news before and after carnival. The dollar, worth 65 cruzeiros in 1956, had gone up to 310. Federal employees demanded a 50 percent raise and the government, saying that the treasury was depleted, offered 40 percent. On a three-month-old list of bus tours the prices had already been overprinted twice. A suit rose from 2,950 cruzeiros to 6,950 in two months. Things had gone that way for four years.

How could people make ends meet? Friends help, I was told, and things arrange themselves, *mais ou menos*, more or less. Perhaps a federal government job from 11 to 5:30. Also a job in a private school, teaching English, which tens of thousands want to learn and almost as many feel qualified to teach.

Maybe a third job, like the one of the white-haired lady who knew a politician long ago. Once a month she takes the ferry across the bay to Niterói and picks up a pay check from the state government. "A nuisance," she says, "half a day wasted, and I haven't had a raise in years. But it helps." I asked several Brazilians about this sort of thing, and they said yes, there were quite a few "jobs" like that, though not as many as there used to be.

Towering São Paulo Inspires Awe

After an hour on a plane, I arrived in São Paulo, Brazil's largest city—already home to 3,700,000 and likely to surpass Buenos Aires soon as the largest city in South America (pages 315-17). I found shacks, diesel fumes, streets blocked by construction, and, at one corner after another, shops with automobile tires, seat covers, and chromed accessories. Did Paulistanos live by cars alone?

Then I walked on the Viaduto do Chá, the Tea Viaduct, named for a 19th-century tea plantation and, in a way, a reminder of the Far East trade of an even earlier day, when Brazil was a Portuguese colony. It was dusk. The broad viaduct crossed over a street 12 lanes wide. Traffic streamed quietly 40 feet below. Around me stood skyscrapers, set far back, forming a gigantic circle, imparting calm and awe. This was the very model of modern municipal grandeur, a vision of the 21st century.

Shop windows screamed *"liquidação."* Going out of business? No, the signs meant "sale," supposedly bargains, and Paulistanos gloried in installment buying, in the boom radiating from their city's factories. Transistors. Plastics. Chemicals. Tractors. To date a grand total of 452,000 cars and Jeeps and trucks.

"Fifty-six thousand factories in the São Paulo area alone," said an industrialist.

A secretary quoted from a magazine: "Our rate of economic growth is 7.2 percent a year, among the world's highest."

U. S. Buys Half of Brazil's Coffee

En route to the coast, to the port of Santos, I passed a lot of those factories and an artificial lake (see inset A on the supplement map). Then the car descended on hairpin turns. Looking back, I beheld a 2,500-foot cliff with parallel lines on its face: five black pipes to bring water down from the lake into the turbines of a power plant ("1,200,000 kilowatts, biggest in South America"); two pipes to pump oil up, from a refinery on the coastal strip. These were the veins and arteries of Brazil's new industrial might.

Santos has delightful beaches, a building boom, and four miles of docks. Coffee is its lifeblood, for Brazil, the world's chief producer and exporter of coffee, funnels more than half its export through Santos (pages 322-3). Nearly half of *that* goes to the world's chief consumer, the United States.

"We ship to all the major ports in the United States," I was told by an American whose firm handles a fortune in green coffee every week. "We buy from hundreds of brokers; so our problem is to keep our coffee tasting the same week after week. We can mix 4,000 bags at a time—about half a million pounds per mixing. But a few bags can ruin the taste of the whole batch."

I watched coffee samples being roasted, ground, brewed, poured into bowls, and placed in a circle along the edge of a revolving

Pensive Moment Overtakes a Costumed Clown Amid Carnival's Merry Roar

For weeks the holiday spirit mounts steadily in Rio, and on the Sunday before Ash Wednesday it sweeps the city like a tropical storm. From a window of the Copacabana Palace Hotel this girl views costumed merrymakers swirling through the streets.

RE ENTHRONE © NATIONAL GEOGRAPHIC SOCIETY

Christ of Corcovado, Rio's most striking landmark, looms above one of the *favelas*—shantytowns—that house a million Cariocas. Cogwheel railway lifts visitors to the 130-foot concrete statue atop Corcovado, or Hunchback, Mountain, 2,310 feet high. This helicopter view seems to make neighbors of the statue and the favelas.

Squeezed between ocean and mountains, Rio offers fantastically beautiful vistas but defies planning. Residential districts spread like tentacles around the hills, or *morros*. Tunnels link the communities.

Atlantic breakers wash Rio's Copacabana Beach, where apartment houses and luxury hotels form a solid phalanx along curving Avenida Atlântica. Fishermen unload their nets while early morning bathers splash in the shallows. Boy at right gathers clams.

table. A Brazilian tester sat down and spun the table.

As each cup passed under his nose, he dipped in a spoon, sucked a sip with a slurp, and expelled it with a whoosh, smack into a tall spittoon between his knees. Slurp, whoosh, slurp, whoosh, slurp, whoosh.

I timed him. In 19 seconds he sampled 20 bowls, banging on two with his spoon to signify rejection. Two other testers rejected the same bowls.

"The speedy testing helps spot samples that aren't right for us," said my American friend. "The methods vary, according to what you're looking for. Want to try?"

I slurped and whooshed and could spot only one reject. It seemed a bit sour. "We call it hard," said the senior tester. I asked what

coffee mixture he liked best. He said he was a good Brazilian and liked several blends, but he preferred mineral water.

At the coffee exchange I was served some hard figures: That the United States consumes about 16 pounds of coffee per person per year, Brazilians about 6 pounds. That all coffee offered for sale in Brazil must be bought—by the government if no one else bids. That of the $50 per bag the seller received at that time he turned over some $22 to the government for research and purchase of surplus coffee. That the government last year had some 373 million dollars with which to buy the surplus.

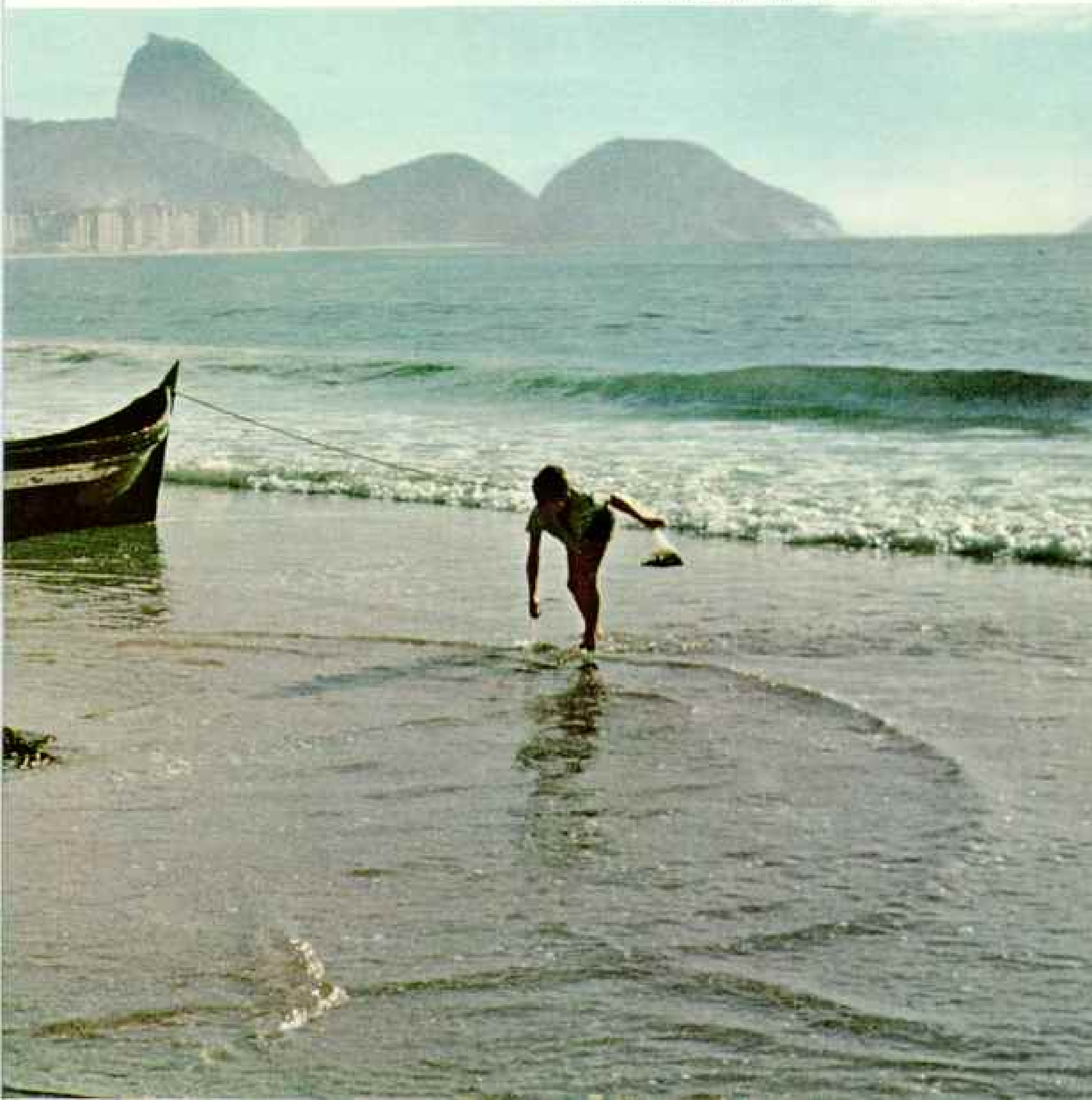
A broker said: "If only we could drink more coffee, or produce less, or export more! Then the government could use these millions. We wouldn't have to print so much money."

Another cause of inflation, some Brazilians said, was the high cost of Brasília, the city that President Juscelino Kubitschek built from scratch in the wilds of Goiás. (See supplement map with Brasília inset.)

Juscelino—Brazilians like to call popular figures by first names—passionately promoted industrialization. And road building. But especially Brasília, to draw men to the *planalto*, the 3,500-foot-high plateau where the breeze is bracing but the population thin.

This dream of a federal capital in the interior was 167 years old. Juscelino, confident that it could come true, said now or never. He spared neither the treasury nor himself. In the middle of the night he would pop up under the floodlights to spur the *candangos*, the construction workers lured from afar.

PHOTOGRAPHS BY NATIONAL GEOGRAPHIC PHOTOGRAPHER WINFIELD PARKS © N.G.S.



The red dust flew amid the scrubby trees, and the dream turned into wondrously modern buildings—congress; ministries; the supreme court; a palace for the president. On April 21, 1960, Juscelino cut the ribbons. Brasília was in business, more or less (pages 340-41).*

When I got there last spring, the Federal District was two years old. Government workers and kin numbered 20,000 among 200,000 residents, including 60,000 construction workers. More bureaucrats were moving in, reluctantly, as more apartments became available in the superblocks. Prices were high in Brasília. And who would ever leave Rio unless he absolutely had to?

Juscelino was an ex-president now, and Mayor Sette Câmara cut the ribbons. Four university buildings. A wheat mill. A new bakery. A sewage plant.

"Everything is carefully planned," said the mayor. His office had three doors, and people kept rushing in to get things signed. "Americans think we are lazy, always taking a siesta. In Rio, maybe. In Brasília, no!"

Pools Built While You Wait

I wondered how people in Brasília could sleep at all. Construction banged and clattered day and night, especially at the Hotel Nacional. The manager apologized. "On Thursday we have a fashion show at the pool, a benefit for abandoned children." Incredible. This was Tuesday, and the pool was a mess of scaffolding and cement bags.

Around the clock the candangos sang, told loud stories, and evidently wrought miracles,

*See "Brasília, Metropolis Made to Order," by Hermano Tavares de Sá, NATIONAL GEOGRAPHIC, May, 1960.

Sunday sailors from the Rio Yacht Club race swift Star boats off Copacabana Beach. Transparent panels in the sails enable skippers to see objects to leeward. Houses perched on rocky slopes of Morro do Cantagalo command a magnificent view.

São Paulo businessman Dr. Mauro Monteiro shares a quiet Sunday at home with his wife and children. Imaginative Brazilians have created an exciting new architecture for their country. Enormous windows and glistening floor of glass add sparkle to this living room.

for on Thursday afternoon, sure enough, the pool was full of water and flowers. Over it, on a runway, pranced four pretty models from Rio, to restrained applause from the charitable matrons of Brasilia.

A four-hour bus ride took me to the capital of Goiás, to Goiânia. This city was barely 30 years old, but an epic past was in the air. Since the 17th century, the Goiás wilderness had attracted the Brazilian breed of pioneers called *bandeirantes*, "bearers of the flag." They pushed west from the coast, with legendary toughness and determination, seeking Indian slaves and gold.

Some Indians fought back. A

bandeirante leader put river water into a bowl, surreptitiously added alcohol, and set the bowl aflame with a flourish. Could he turn the whole river to flame? The chastened Indians named him *anhangüera*, man of fire.

Now, on Sunday nights, young men strolled along the broad tree-lined Avenida Anhangüera to Bandeirantes Square. So did scores of girls, in pairs, their hair fluffed stylishly high in the European manner.

Goiânia also stirred vigorously by day. Busy markets. A university. A factory for submachine guns. A soccer game.

Artur! Come on, Artur! No! Thief! Turkey! Take his hide and make a saddle! Hit his face! Please, Artur! Good, Artur! No, no! Fathead! Bandit! Eater of armadillos! We'll get you at the gate!

Everybody went home quietly.

Grileiros Prey on Goiás Farmers

Goiás has deposits of nickel, chromite, cobalt, and mica, and nearly as much land as Texas. But much of the land is as yet inaccessible. Deeds are more or less confused. Clever crooks trick the farmer to get the good land near the roads.

"We call them *grileiros*," said Governor Mauro Borges Teixeira. "They are gangsters."

An aide explained how they operate. The grileiro falsifies a land title and goes to court. The judge gives notice of a hearing. But the farmer can't read; half the adult Brazilians can't. The farmer misses the hearing and his case is lost. When the grileiro comes to take over, the farmer runs to the judge. The court says: The law does not protect those who sleep. The grileiro comes with the police, takes the farm, and the embittered farmer joins a *liga camponesa*, a peasant league; perhaps friends will buy him a submachine gun.

I chartered a *teco-teco*, a small taxi plane, to visit José Porfirio, a farmer famous for resisting the grileiros. With two of the governor's aides, Clenon and Afrânio, I flew north from Goiânia—over fields of beans and rice, over an experimental farm and herds of cattle. Great green squares looked from the air like rugs of shaggy broadloom. These were coffee trees. In a yellow square, coffee was drying. Elsewhere I saw a column of blue smoke. Surplus coffee was being burned, six thousand sacks that Monday.

We saw the new red dirt road that leads all the way to Belém, 1,500 miles to the north. We passed a little town with a big church, carts pulled by six or eight oxen, swampy lakes where mosquitoes bred. At last the Serra Dourada, called the "Zone of Porfirio." We flew over his villages—first Formoso, then Trombas. The landing field was unusable and we flew on to Santa Teresa, on the Belém road, to stay overnight (see supplement map).

I kept my kerosene lamp on. Light keeps away the *barbeiro*, the crawling insect that lives in the cracked walls made of sticks and dried mud. His bite transmits Chagas's disease. The face swells and the swelling goes, but a parasite stays behind and attacks various organs, weakening the body for years until the heart is stopped. Four million Brazilians have it. No cure exists.

Tiers of traffic congest downtown São Paulo, Brazil's largest and fastest-growing city. Lacking subways, the metropolis depends on surface transport to move its millions. Trailer bus on the middle level can crowd in more than 100 passengers. Vehicles bear foreign names, but Paulistanos manufacture many of them (page 318).

REPRODUCTION © NATIONAL GEOGRAPHIC SOCIETY

Brazil shares a common border with all other South American countries except Chile and Ecuador. Only the U.S.S.R., Canada, China, and the U.S. exceed it in size. Swamps, jungles, and parched wastes cover vast areas. Population has grown more than fivefold in 75 years.

São Paulo Stretches Skyward in Ceaseless Search for Growing Room

Paulistanos completed some 22,000 buildings last year in their race to accommodate expanding in-

dustry. This flying-bridge balcony atop a recently built apartment house commands a sweeping view of São Paulo and its skyscrapers built on coffee and manufacturing fortunes.

In the morning, going on by Jeep with our pilot and the sub-prefect of Santa Teresa, we talked about guns. A .38 Smith and Wesson revolver cost 100,000 cruzeiros, about $325. A submachine gun could be had, through friends, for half as much. But a Smith and Wesson, pronounced simply "Smitch," was the very best. In fact, the word had come to mean fine, or excellent. A thing was either smitch or it wasn't.

The road became worse, the bridges shakier. We stopped, mired in mud up to the axles. An oxcart came, and I saw the value of having so many oxen per cart. They pulled out the Jeep as if it had been a matchbox.

In Trombas, Porfirio put on shoes and a shirt and told me about a gun battle in 1957. It sounded like a tale of land speculators and claim jumpers out of our own early West.

"I had 200 acres of state land," Porfirio explained. "If you stay five years it's yours. The grileiros came with a paper from the judge. I showed them the paper I had been given by the state. Then they sent the police."

Sixty-four policemen came and took away the women as a shield, Porfirio said. He, with 10 men, waited at a stream. "We killed four," Porfirio went on. "If they hadn't held the women, we would have wiped them out."

A cart passed outside. The wooden axles screamed like a siren. "The governor is having the land surveyed," said Porfirio, glancing at the cart. "He will resolve the situation."

Porfirio is a big-chested man with a little moustache and spectacles. Now he heads a peasant league with hundreds of families on more than a million acres.

Black Gravel Excites Diamond Hunters

Next, I crossed 1,300 miles of tropical forest, from Goiânia to Manaus, and on to Boa Vista, near the Venezuelan border (see map, page 314).

Most jet airliners from Rio to New York fly a similar route, but so high that the passenger sees little, only a few rivers and a lot

Supervisor in scarlet smock inspects headlights at the Volkswagen plant in São Paulo. These car bodies, as well as engines and parts, come from native metals and manpower. South America's prime automobile maker, Brazil built 145,632 vehicles last year.

Agile goalkeeper blocks a score in a Sunday soccer game between two São Paulo teams in the city's Pacaembú Stadium. Brazil's national sport, introduced by the British a century ago, pays its stars as much as $30,000 a year. Brazilian teams won the quadrennial World Soccer Cup in 1958 and again in 1962.

of distant treetops—what has been called "hundreds of miles of broccoli." I flew low and slow in a C-47 with FAB—Força Aérea Brasileira, the Brazilian Air Force, which maintains free supply services for remote areas and carries an occasional passenger.

I saw rivers by the score—some blue, some black, some a light coffee-brown, some pea-green—with islands and rapids and waterfalls. Above the cockpit loomed gray clouds. Ahead, a wide band of blue sky. Below, dark green patches where the clouds cast shadows; the rest was bright green, in brilliant sunlight.

Sudden rain hit the cockpit windshield like a shower of gravel. We couldn't see a thing. Five seconds later all was clear again. Drip. Drip. Drip. The plane leaked. "A fine plane," said the pilot, "but very old. Some of us wear plastic aprons, so we won't get so wet."

Along the way we stopped. I kept a log:

"Aragarças, Goiás, on the Araguaia River. Headquarters of Central Brazil Foundation, government-financed, aiming to open vast areas. Nearby on the river 2,000 *garimpeiros*, diamond hunters, some with diving suits and helmets. 'Where there is black gravel, there are diamonds.'

"State of Mato Grosso—Chavantina, on the River of Death. Not long ago, Indians here shot arrows at exploring planes. We unload supplies, including a piece from freshly slaughtered steer carried in passenger cabin.

"Post on the River Xingu. Sign says *atai-térekon*, an Indian word for welcome. Family of 25 Indians here, put on clothes when heard our plane. Last week two died of mumps. One has mumps now.

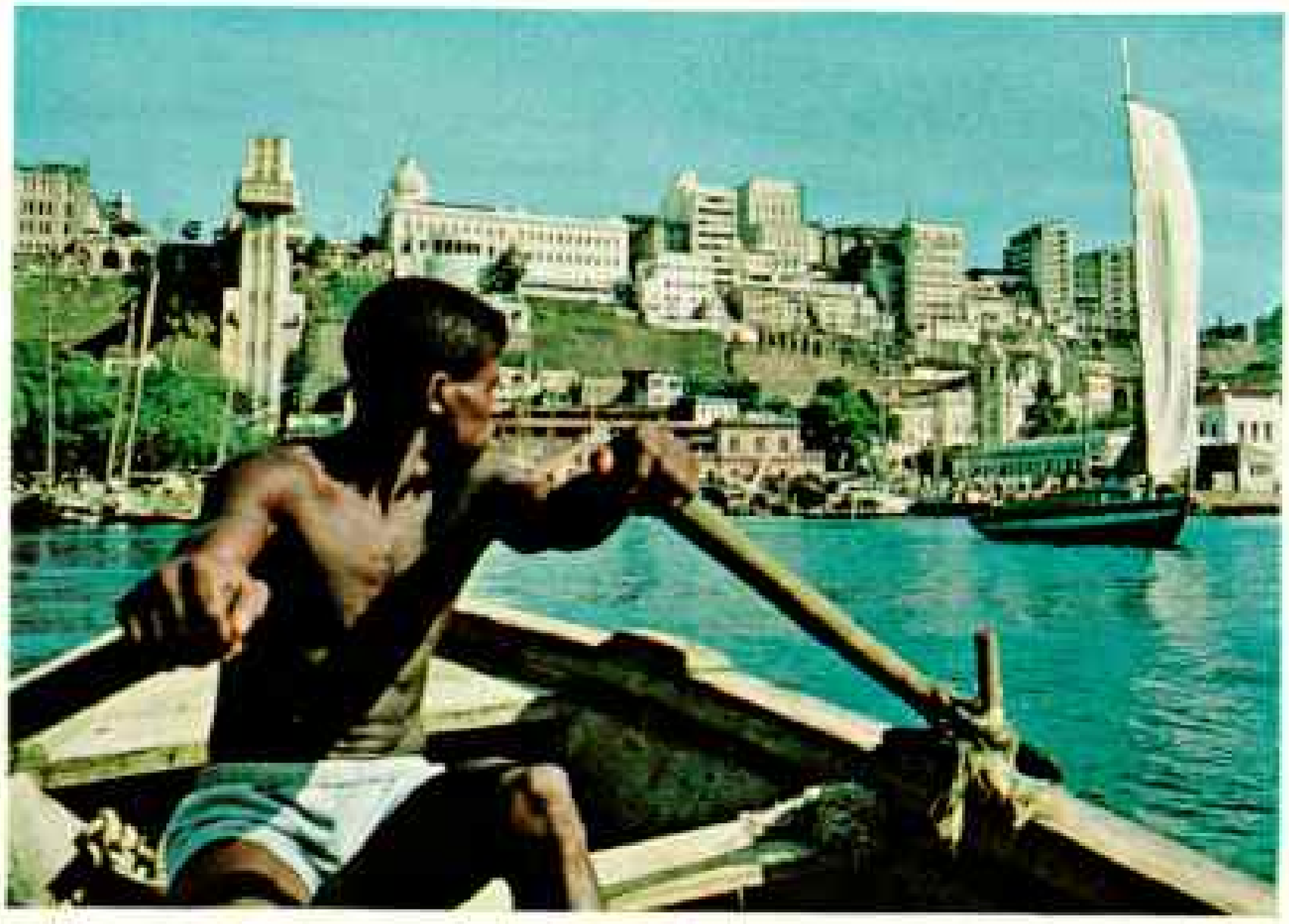
"Into the State of Pará—to Cachimbo on the Iriri. Pilot says Xingu River really 10 miles east of where shown on chart. 'This is the completely unexplored jungle.' Jungle opens temporarily to plain with patches of forest. Ground sandy; a little high, the water drains in all directions. Air Force station—29

Towering Cities Rise in Brazil's Bracing Highlands and Along Its Lush Atlantic Coast

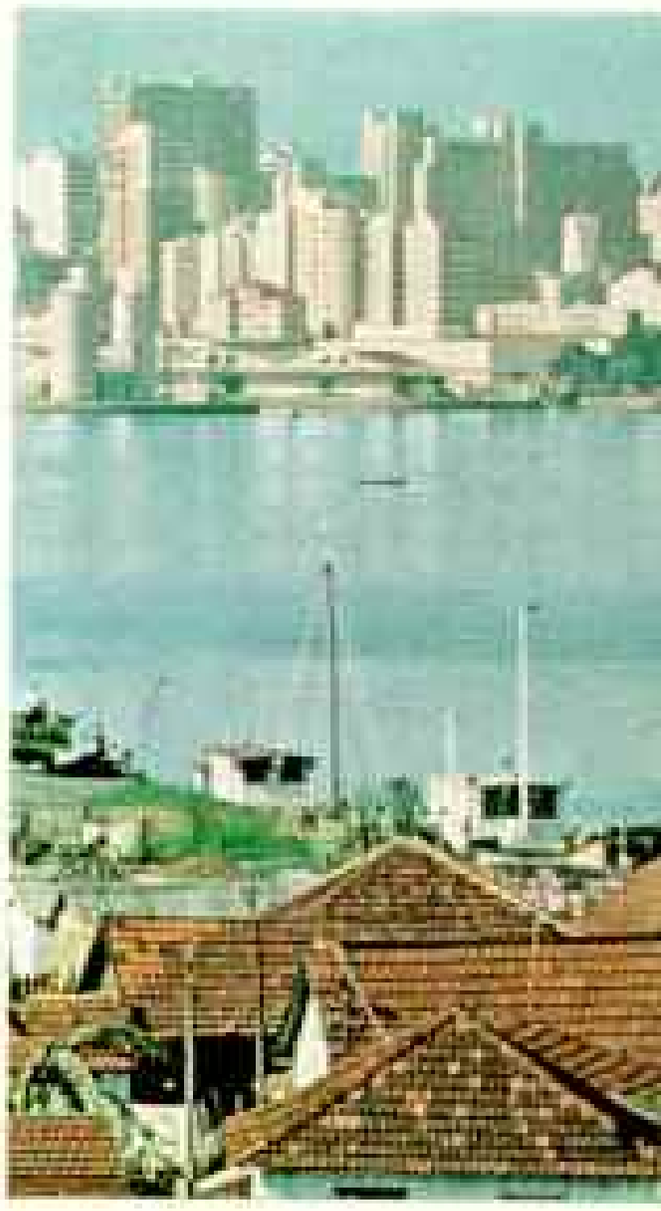
Muscles tense as a workman bends reinforcing rods into position under São Paulo's morning sun. Construction crews in the nation's industrial center often toil round the clock. Improved techniques in the use of reinforced concrete enable Brazil to build at high speed. Paced by São Paulo, lesser-known communities along the Atlantic coast stack story on story as they, too, convert into skyscraper cities.

Recife, populous port in the Northeast, brackets its several canals with towering buildings to cope with growing trade.

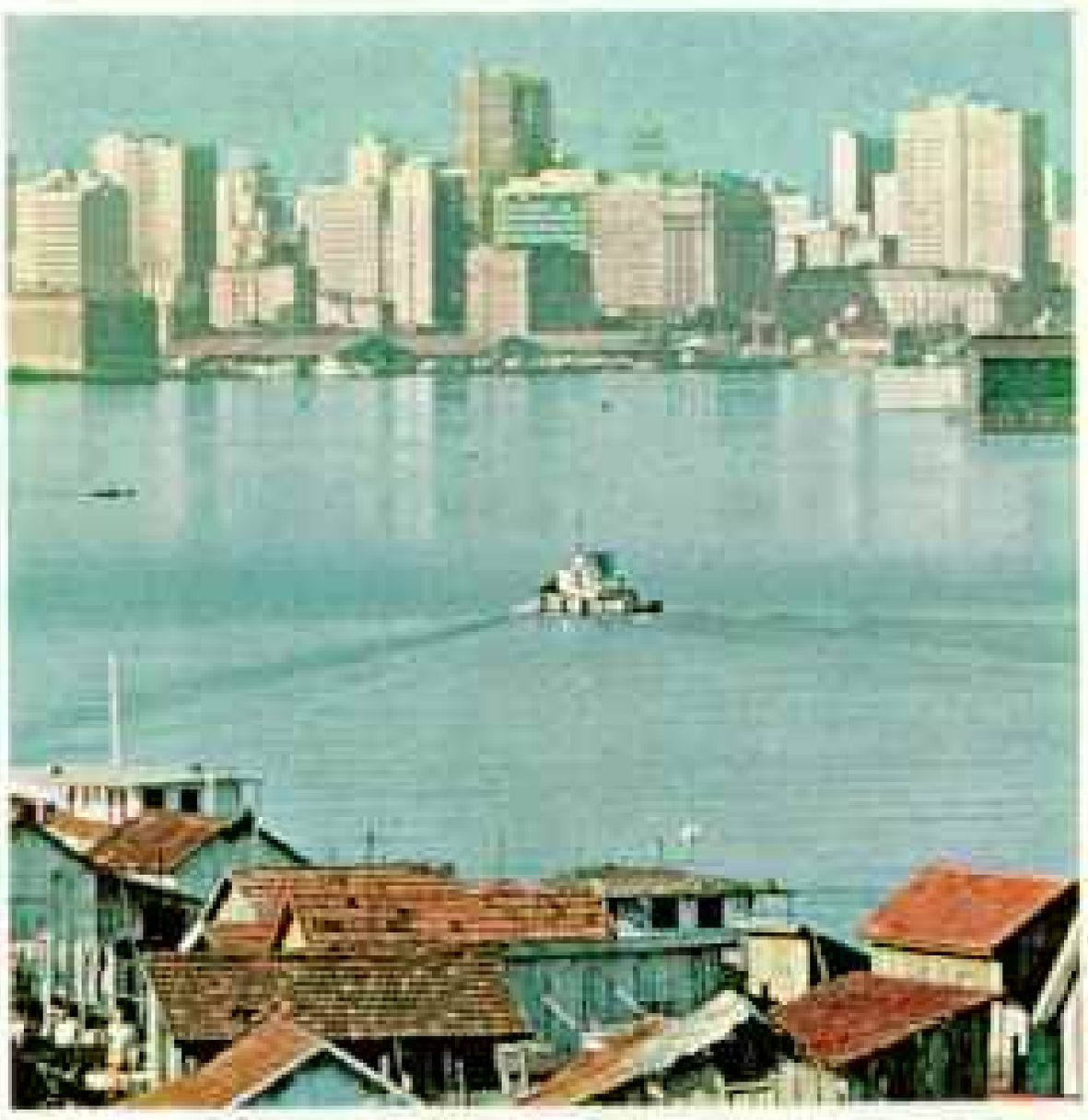
Salvador. Modern architecture rises above 16th-century fortifications in Bahia's city of contrast and Brazil's first capital. Elevator shaft at left transports pedestrians between waterfront and clifftop. Boatman rows across the harbor to market.



Pôrto Alegre casts its gleaming reflection in the waters of Rio Guaiba. The city ranks



among Brazil's leading commercial centers. To reach the sea, tugs tow barges 150 miles down Lagoa dos Patos, the Lake of the Ducks. Boats at left unload island-grown marsh grass.



Belo Horizonte caps a lofty plateau. Rich iron deposits underlie the distant Curral del Rei Mountains. Laundry-laden resident descends a steep slope toward the city.

men, 3 women, 2 children, surrounded by Indians presumed dangerous. Jet airliners depend on weather broadcasts from here.

"To Creputia, on the Cururu: Hard to find, no radio, chart useless. 'If we don't find the field soon we'll skip it, or we won't have enough fuel.' We found it. Two men, two monkeys. First plane in two months.

"To Jacareacanga, on the Tapajós: An airbase, a little town, a gold field. A resident views life: 'A lot of suffering. A lot of gold. A lot of money and spend it all fast. That's happiness.' Another said: 'You think today is humid? Yesterday I thought I was breathing water!'"

The rivers grew wider than the Hudson and the Mississippi. Occasionally there was a boat, small as a fly in a swimming pool. At last the great Amazon itself (page 330). And Manaus: after the big void, thousands of houses, hundreds of them afloat (page 329).

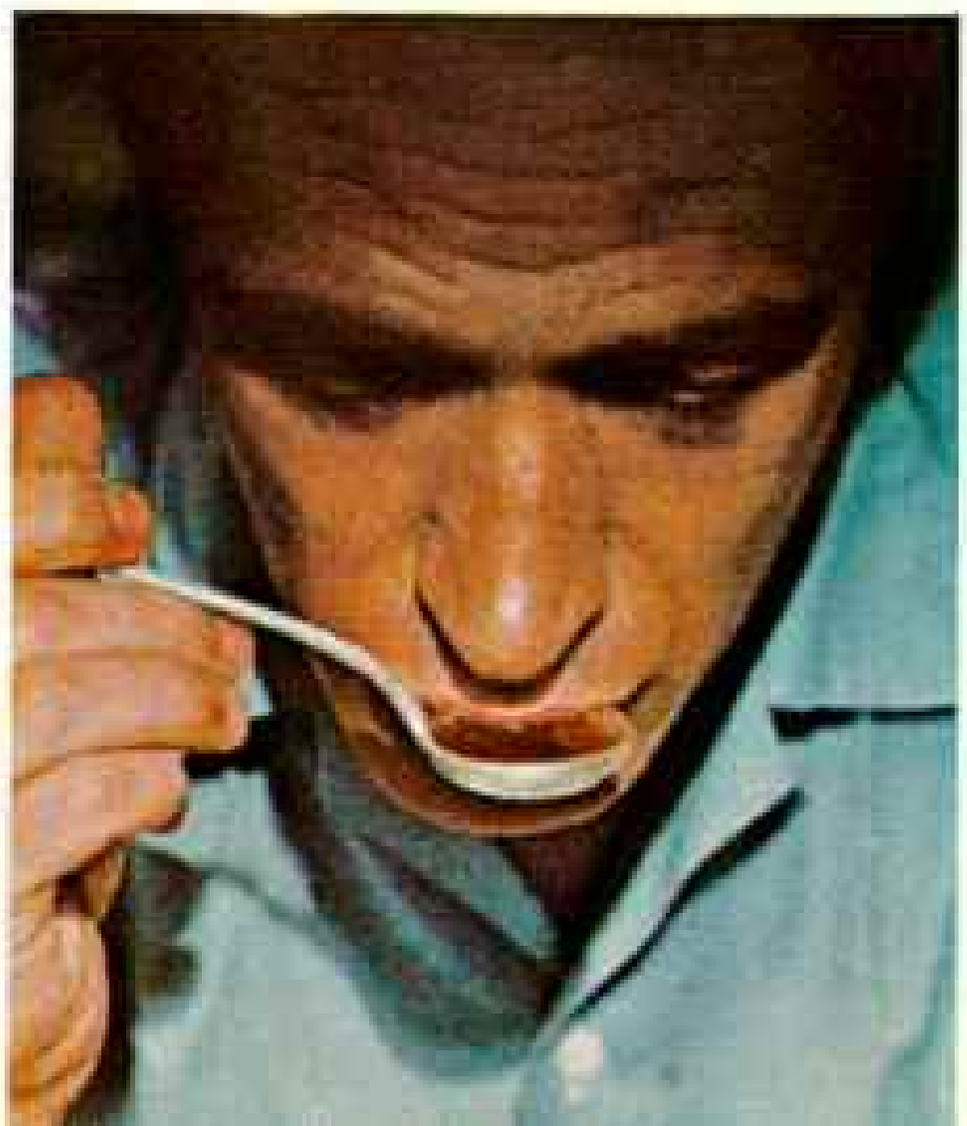
We continued north, along the Rio Branco and across the Equator. The jungle gave way to the plains. Boa Vista, capital of Rio Branco Territory, was hot but dry, like Arizona.

Back in Manaus I took a diesel launch across the Amazon into a drowned forest, changing into a canoe at a floating general store in a clearing. Soon the canoe slid quietly down a watery passage, past giant ferns and vine-encircled trees as high as 80 feet, their boughs mingling overhead.

The oblique afternoon sun lit every shape of leaf. The noise was constant and cheerful, as in the birdhouse of a zoo. Wild ducks, woodpeckers, parrots, slim birds, fat birds, dull birds, bright birds—movement every moment. Plop! I had just been missed by an apricotlike fruit, jettisoned half eaten by a *macaco-de-cheiro*, a "monkey that smells." I could smell only a magnolialike fragrance.

Behind its sleepy façade, Manaus was busy making money. Jute; Brazil nuts; rubber; dried fish; rosewood oil; hides; dozens of useful woods. In that order the commercial mu-

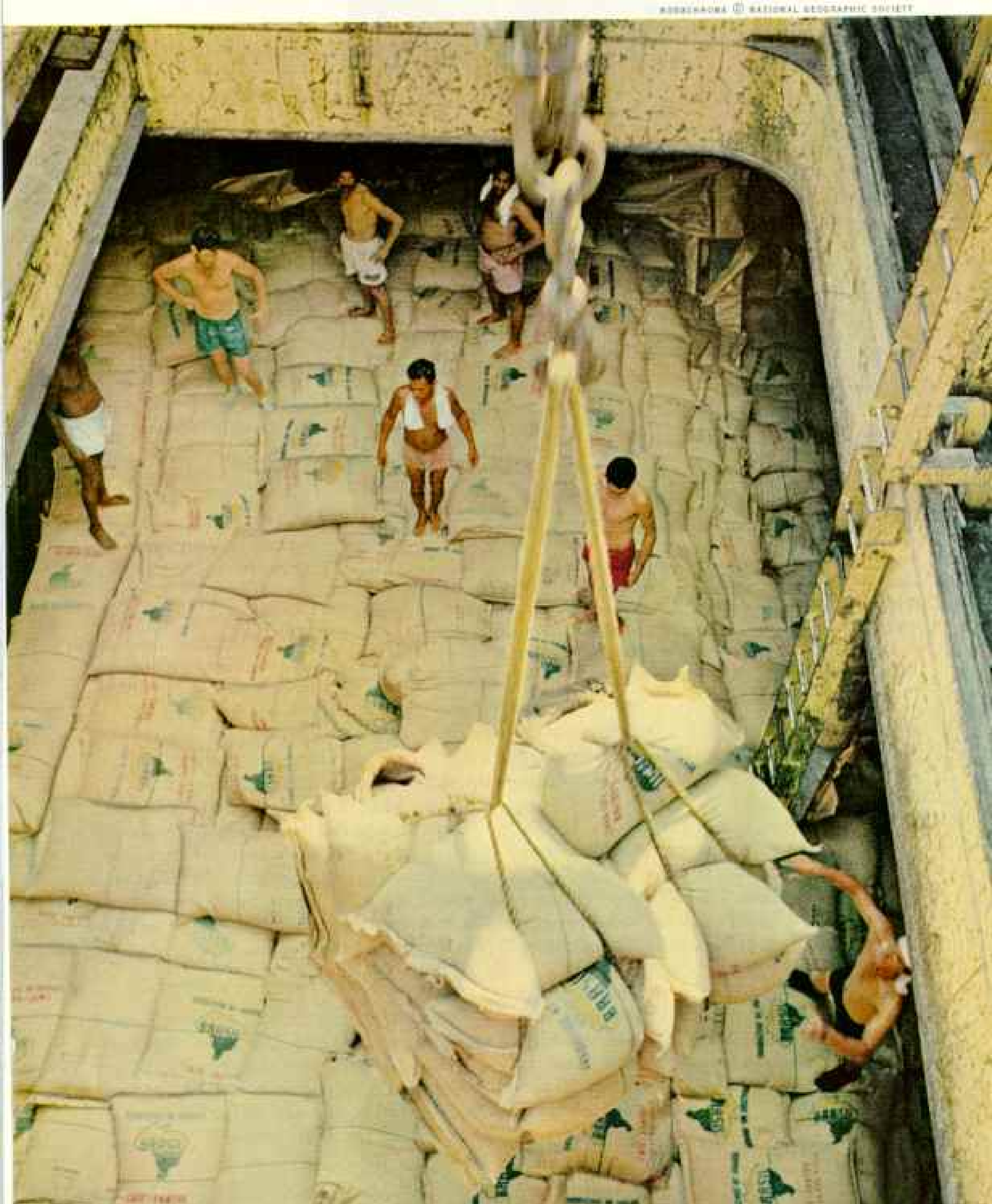
KODACHROMES © NATIONAL GEOGRAPHIC SOCIETY



Sniff and sip! Experts in Santos grade Brazil's bonanza brew for export to the United States. White-suited worker and an associate (below) test for both taste and aroma. Seated at revolving tables, they can check some two dozen cups in less than a minute. Testers never swallow samples; they rely on smell and savor.

Coffee for the world drops into a ship at Santos. Almost four billion trees yield an average pound each a year. Brazil supplies about 38 percent of all the coffee consumed in the world. Plagued by overproduction, the nation sometimes burns surplus stocks. To boost home sales, the government urges Brazilians to drink more coffee.

NGS/NGM © NATIONAL GEOGRAPHIC SOCIETY



Figures carved from wood by 18th-century sculptor Antônio Lisboa fill a room in the Inconfidência Museum of Ouro Prêto in Minas Gerais. Known as the Little Cripple because leprosy had deformed his fingers, Lisboa became Brazil's dominant artist of the colonial period.

Ouro Prêto, whose name means Black Gold, was a boom town in the 18th and early 19th centuries. Today it survives as a national monument.

seum displayed samples and statistics on wealth floating in from the entire State of Amazonas, an area more than twice the size of Texas.

The new jute spinnery turned out 500,000 coffee bags a year, the tannery 20,000 cayman skins a month. Other factories canned nuts and made plywood. The oil refinery fueled the diesels, outboard motors, and kerosene lamps for an area as big as the United States east of the Mississippi.

The old opera house, built 66 years ago during the rubber boom and then neglected, glistened with fresh paint inside and out, with new gilt and scarlet velvet (page 326). Manaus had a serious water shortage—but so did Rio and every other city I saw except Brasilia. Street lights? Only on the docks. People who could afford it bought their own generators.

To these docks, a thousand miles up the Amazon, come steamers from Liverpool and New York. Ships from river ports go on another 1,000 miles. Traders put-put off with salt, coffee, sugar, beans, machetes, and whatever else is barterable. The *caboclos*, the backwoodsmen, living on credit from the traders, pay high in the yields of the forests.

One night, on arrival of the wood-burning stern-wheeler *Campinas* of the SNAPP Line, I mingled with the starched officers and spruce passengers on the top deck. On the lower deck, next to gleaming machinery, I found people who had brought along chicken coops, pigpens, giant turtles, monkeys, birds, gentle capybaras (giant rodents, two feet long though they were still young), and leashed weasels called *iraras*, the blood-thirstiest killers in the forest.

I met much of the same wildlife again, in an old mansion turned into a warehouse by Willi Schwartz, the animal trader from Vienna. He had fish, too. "That's a discus fish," he said. "Ten dollars." I helped count a mass of cardinals, a ten-cent fish, in a big glass bowl. Difficult. They kept moving.

Wildlife kept fascinating me. Parrots whistling in the rain. Caymans in the dark, their eyes glowing pink in my flashlight beam. And a young *onça*, a jaguar, newly caught and pleased that someone came to see him, so pleased that he tried to stand on his head.

Big Snake Swallows a Deer

Aboard a canoe in the back country, I asked about piranhas. "They are here," the boatman said. "They bother you only if you have an open cut, if they sense blood. We are more afraid of electric eels and *sucuri* [anacondas]. That ripple, that was a sucuri."

I had met soldiers who had just killed one of these green-and-black river snakes. It was 17 feet long, not very big as sucuris grow, but it had an awfully big lump in the middle. What was in it? A soldier used a knife and folded back the stomach walls. They glistened smooth and bluish, like mother-of-pearl. Inside was a deer. It could have been a child.

My own worst enemies were the *maçaim*, the high-powered chiggers. As I walked through wet grass, they came up my legs, invisible, unfelt until it was too late. They dug in all over me, and the itching was monstrous and unceasing. I tried rubbing alcohol, rosewater, laundry soap, and that old remedy, the *melão-de-são-caetano* or fruit of the balsam pear, dissolved in water for a sponge bath. It didn't work. The last resort was kerosene. It burned me, not the chiggers.

Still scratching, I boarded a

Milky latex of a wild rubber tree pours from a collector's cup in the jungle near Manaus. This season's slanting scores—a gash for each day's gathering—overlie last year's cuts.

In the gloom of a Manaus warehouse, men tear and slice latex balls to judge quality. Layers of raw rubber, coagulated by smoking, form balls of 50 pounds or more.

creaky Catalina flying boat in Manaus and crossed another 500 miles of jungle, southwestward into the Territory of Rondônia, to Pôrto Velho on the Madeira River. Here in the continent's heart stood the terminus of the Madeira-Mamoré Railroad.

This isolated line was completed 50 years ago to bypass rocks blocking river traffic. The project, as challenging as the Panama Canal, was undertaken for similar reasons: to bring the rubber of Bolivia from the Mamoré River to the Madeira, and hence to the Amazon and Europe, a route 5,000 miles shorter and much safer than the sail around Cape Horn. The 228-mile stretch of rails, hundreds of miles from any other railroad and far beyond the wilds of the Mato Grosso, seemed the height of incongruity in its primeval setting (see supplement map).

Construction enterprises succumbed to disease and the jungle, to high costs and politics. Workers came from 30 countries. Many died. American engineers and doctors prevailed at last.

But the rubber bubble burst, and whatever Bolivia could sell could go more cheaply through the Panama Canal, which was just being finished. Some accounts say that every railroad tie had cost a life.

"Not true," said a railroad official. "The records show that 21,717 came to work and 1,552 died. That's one to every 354 railroad ties. We've got 549,000 of them. I know, because we replace one in ten every year. They just don't last."

Wood-burner Still Active at 53

A whistle blew, and I thought I had seen an overgrown toy train go by. It was old No. 10, a wood-burner from another age, marked "Baldwin Locomotive Works, Philadelphia, Nov. 1909," still going strong.

In the railroad-building days Pôrto Velho acquired street lights, telephones, an ice plant, a steam-driven laundry. None of these worked now, but there was still an international set. There was Father Fagan from County Meath, and Madame Jacqueline Ferry from Paris, a geologist for a Brazilian tin smelting firm. She often went into the jungle where men picked up cassiterite, the black tin ore, right on the ground. She shipped it by air to São Paulo and went looking for more.

And there was Jimmy Choate from Texas, building a 500,000-acre empire of sugar, coffee, and cattle. "They're finishing the highway from São Paulo," he said. "Imagine, 1,800 miles! Trucks will make it in ten days. Now we wait six months for goods to come by ship, sometimes a year."

One day Jimmy said about another American, "Look, he walks like a back-country Brazilian." Yes, I thought, he looks carefree, tough, manly. Jimmy said: "I mean the way his wife walks five paces behind him."

The lady had heard us and spoke right up: "I can't walk fast on these cobblestones. Besides, I feel superior to all of you. Mme. Ferry says if I come with her to the Indians they'll worship me as a goddess, because of my gray-green eyes. If you come with your dark eyes they'll eat you."

Film Starts Author on Jungle Quest

Mme. Ferry might have been joking, but that some Indians were eating human flesh was certain beyond doubt. My first inkling of this, in Rio, had given me a shock.

I watched a scientific film about a tribe of happy Indians—planting and harvesting, making boats and arrows, playing in hammocks with their plump children, and the children playing with pet parrots which had little hammocks of their own. One scene showed them cooking a deer.

And then I saw photographs of another tribe. Everyone was emaciated, sick after contact with outsiders, too sick to hunt food. A little girl was dying. After her death, parts of the body were cooked and eaten.

These Indians were Pacaás Novos. Some lived not far from Pôrto Velho. To visit them, I first took the railroad from Pôrto Velho to the other terminus, to Guajará Mirim.

We went in a diesel-powered *litorina*, a small bus on rails. It did 40 miles an hour, unfortunately, jolting us bruisingly past the neatly painted kilometer markers, through a

Painter Ponders an Empty Stage Where Opera Stars Sang for Rubber Barons

Manaus's magnificent opera house rose in 1896 on riches garnered by the river port from wild rubber passing down the Amazon. In 1912 Asian plantations, started from seed smuggled out of Brazil, broke the bubble, and the opera closed. High fees lured streams of singers and dancers while the boom lasted, despite dangers of travel and disease. This man and others have renovated the theater, mainly for the sake of visitors.

PHOTOGRAPHS BY NATIONAL GEOGRAPHIC PHOTOGRAPHER WINFIELD PARKS © N. G. S.

cross section of comparatively prosperous Amazonian hinterland.

Trees and brush rose within 200 feet of the track, more often within 30. Between stretches of varied green we glimpsed people and things related but separate, like the acts of a play. Stacks of newly cut railroad ties, stacks of firewood, thatched huts, patches of manioc. An electric blue butterfly with wings as big as saucers. A man with a shotgun, a woman in a hammock, a little girl in a swing.

We passed a couple enlarging a manioc patch in the jungle. Another couple burned a clearing before planting. Men put new green palm leaves on a house—joining to help a neighbor, and to celebrate.

At Kilometer 32 the engineer threw a can of condensed milk to a waiting woman. At Kilometer 132 he threw union leaflets to a five-house settlement. At Kilometer 175, near another settlement, we broke down.

We bought a bag of Brazil nuts and were given bananas, coconuts, and a strange sweet pineapplish fruit. I watched the engineer crack Brazil nuts on the rails. Narrow edge of the nut down on rail. Left index finger on the wide top. Then smack, right fist on top of left index finger. "It's easy," he said.

I tried, but I couldn't get myself to hit my finger hard enough. The friendly engineer, seeing me hesitate, helped with *his* fist. The nut was definitely broken. And so, I thought for a while, was my finger.

Repairing the rail car took four hours. During the last part of the trip, in the darkness, birds rose before our headlights, white and weird. Then rain came, more and more rain, until I got the idea that we were jolting and sloshing through an enormous aquarium.

Jungle Strife Taken Calmly

In the police post in Guajará Mirim I learned that in June of 1960 the police chief, en route by bicycle to a nearby farm, was killed by Indian arrows.

The new police chief showed me some records. 8/12/60: Elias Francisco de Morais, dead, Kilometer 11 on the Yata road, Indian attack. 29/4/61: Lair Ferreira Saldanha, 21-year-old woman, attacked at a rubber worker's hut, wounded, 3 children dead. 28/6/61: José Felicio, rubber worker, dead.

"Of course, there are quite a few cases we have no records for," said the police chief.

Floating city springs up on the Rio Negro off Manaus, where families have built cheap houses on log rafts. Water-borne markets, cafes, gasoline stations, warehouses, and machine shops serve the community. People move in small boats and on plank walkways thrown from house to house.

Plying his homemade oars, a trader peddles bread among the house rafts

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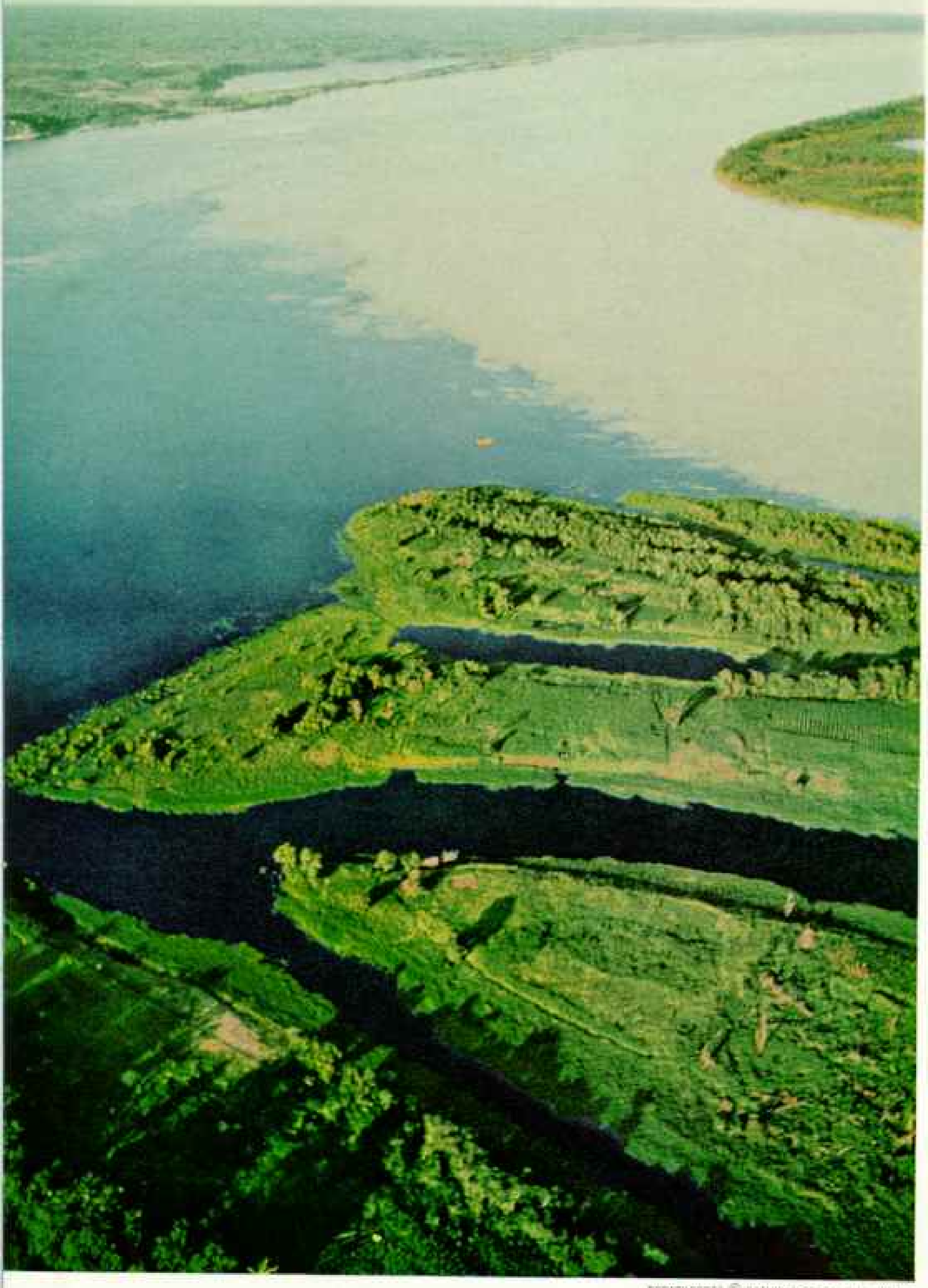
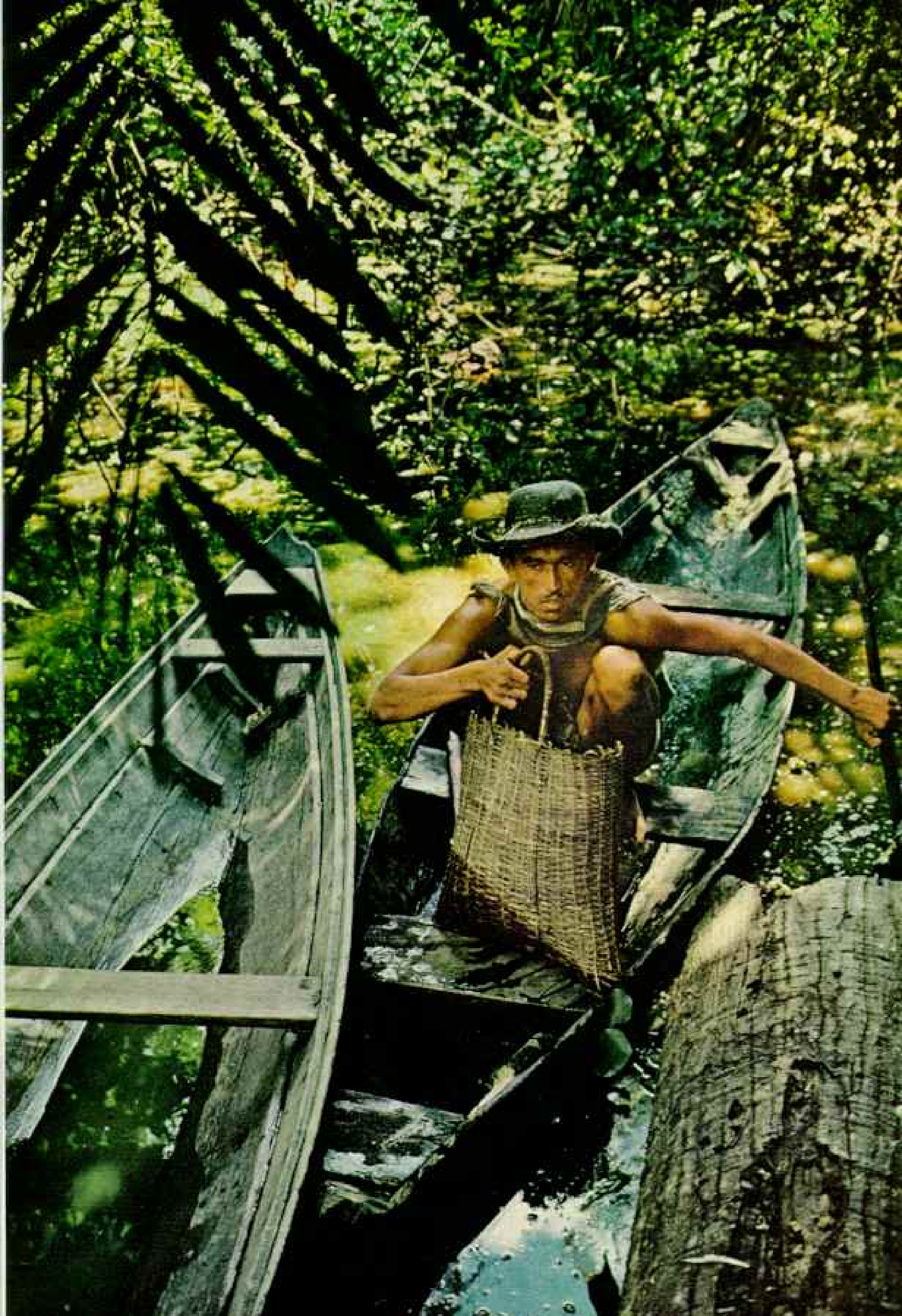


KODACHROME © NATIONAL GEOGRAPHIC SOCIETY

Clear Rio Negro joins the muddy Amazon a few miles below Manaus. For miles the two currents flow side by side with little mixing. Dark patches of Rio Negro water blot the Amazon a hundred miles downstream. Here a river steamer rounds the bend. Tongues of land between the streams bear crops of manioc, bananas, and jute.

Green glow pervades the jungle. A fisherman returns to his lonely home on the Amazon.



Ships' spars and flour sacks crowd a quay at Belém, busy port on the Baia de Marajó.

Thrashing cayman, caught lurking for cattle, churns a water hole on a Marajó Island ranch at the Amazon's mouth. The big reptiles relish dogs; one crocodilian's stomach yielded seven dog collars.

"But things are improving." He spoke matter-of-factly, the way the chamber of commerce around the corner exhibited the bloodied arrows. Such deaths seemed to be accepted here as bus crashes are accepted in Rio.

Quest for Wealth Stirs Trouble

I set out from Guajará Mirim in an 18-foot canoe with the Reverend Joe Moreno and his son Tom, both of the New Tribes Mission of Woodworth, Wisconsin.

"A mile from here my neighbor was killed by Indians," Tom said. "But remember, usually they kill only after the civilized people have killed a lot of them."

What sets off these chains of violence? I had heard reasons from many sources, some all the way back in Goiânia and Rio.

Sometimes it was a misunderstanding or accident, an Indian blundering into a gun-trap set for an animal. More often the root of the trouble was rubber, or nuts, or tin. Men sent into new forest areas to collect this wealth

clashed with the Indians already there, on their ancestral lands.

Rubber workers cannot live close together, because wild rubber trees stand far apart; each man's "rubber trail" may be five miles long. Sometimes these lonely men with shotguns felt no match for stealthy arrows and gave up. "When the Indians kill your dog," the saying was, "it's time to go."

The people who had sent the collectors were disappointed by the poor returns. They faced ruin. How could they repay their loans from the rubber bank? They sent back other men, in groups, some with submachine guns.

On the Pacaás Novos River, many Indians were slaughtered before the army came and took the submachine guns away. I heard similar stories in other parts of Amazonia. I was told that in ten or fifteen years there would be no Indians left in a whole region, that the diseases brought by outsiders killed them even more steadily than bullets.* People said it was a tragedy. But hadn't the same thing happened in the United States, more or less?

Easy to Lose Way in Watery Maze

Where the black 3,000-foot-wide Pacaás Novos River branches from the brown 6,000-foot Mamoré, our bow cut along the meeting of the colors. Brown spray flew to starboard. The portside spray was clear, for the water of the so-called black rivers is very clear indeed.

"In the flood season a ten-foot river may

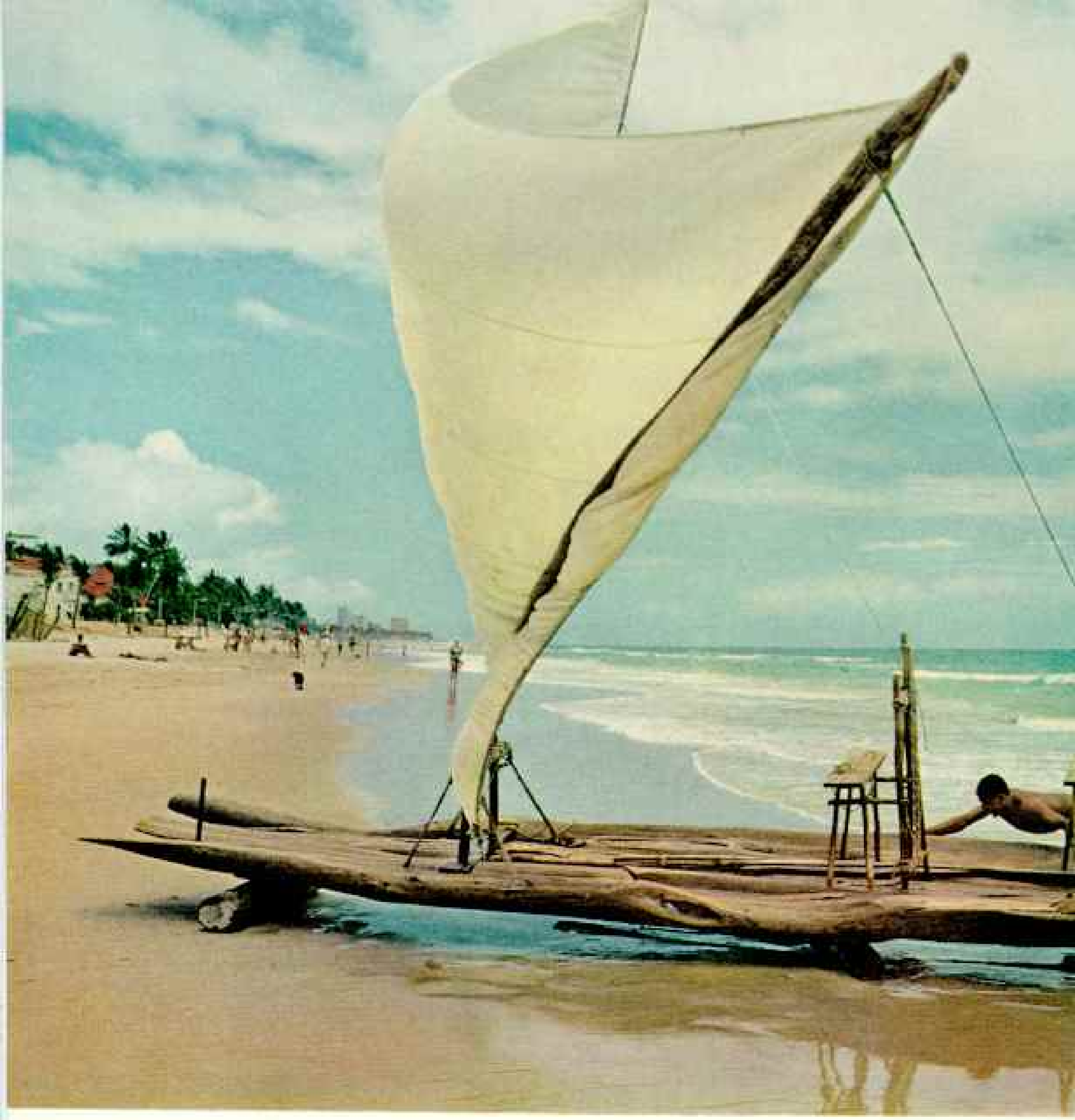
*Harald Schultz, Assistant Ethnologist of the São Paulo State Museum, has written of Brazil's Indians and their plight with insight and sympathy. See, in the NATIONAL GEOGRAPHIC: "Brazil's Big-lipped Indians," January, 1962; "Blue-eyed Indian," July, 1961; "Tukuna Maidens Come of Age," November, 1959; and "Children of the Sun and Moon," March, 1959.

KODACHROMES BY NATIONAL GEOGRAPHIC PHOTOGRAPHER WINFIELD PARKS © N.G.S.

Tandem riders tour a ranch on Marajó. Here, as elsewhere in Brazil, Caucasian, Negro, and Indian work side by side. Streams slice the equatorial island from the Brazil mainland and vein lowlands where water buffalo thrive. Hundreds of thousands of cattle range the region's broad expanses of palm-studded grassland.

Farm hand's gentle prod accelerates an eight-ox team in Bahia's sugar-cane country. Brazil's plantations reached their peak of prosperity in the 17th century, when slaves worked the fields. Sugar remains an important crop. Brazilians convert some of the sugar into alcohol to help fuel motor cars.

Traders and farmers hitch a ride behind a boat chugging up the Rio Negro out of Manaus. Having sold their cargoes of jute, Brazil nuts, rubber, dried fish, and hides, they head for their riverside homes. The city's position near the junction of the Amazon and the Rio Negro brings to it the products of a region as large as Mexico. One Manaus plant tans 20,000 cayman skins a month. Jute, a relatively new crop, now leads all other commodities in the vast, sparsely populated State of Amazonas.



expand to six miles. Then it's all water and trees, and you get lost," said the elder Moreno.

Now the floods were receding, but water still reached into the forest, past 40-foot bamboo, violet water lilies, a milky cobweb big as a man.

We passed a clearing where men hung slices of fish to dry and were toasting manioc in pans five feet square for traders to sell to rubber workers farther on. In our wake a carpet of floating grass waved gently.

Eventually we came to a tiny Pacaás Novos settlement. Bandim, the family head, was less than five feet tall, looking well-fed. Bandim knew Joe Moreno and was glad to see him. Joe is one of the few who understand a bit of the Pacaás Novos tongue.

We shook hands and stood on the riverbank for a long time, slapping ourselves, because it was dusk, when mosquitoes are hungriest.

Joe said that some of Bandim's relatives had been machine-gunned to death and that he had taken his vengeance. Bandim understood no English and smiled. He had been vaccinated by the SPI, the Service for the Protection of Indians, and he was friendly.

He seemed pleased that I smiled at the women and children in his hut, that I showed interest in his bow. He handed it to me and somehow I put a 5-foot arrow through Tom

Billowing sail and straining fishermen roll a tibourbou-wood *jangada* up the glistening beach at Recife. Wind lifts the boom and triangular sail to the full length of the restraining line. As evening sets in, bathers return to Recife, whose towers rise in the distance (page 320).

Decks awash, a jangada scuds toward open seas of the South Atlantic. Lashed and pinned together, the lightweight logs carry only one provision for comfort: crude stools on which weary fishermen occasionally sit to rest wet feet. These two catch fish on hand lines. Here one keeps a lookout for a school of fish; the other steers with a paddlelike rudder.

Eloquent of the dangers of their life, a Brazilian song runs, "The jangada went out with Chico Ferreiro Bento; the jangada came home alone."

ACHROMES © NATIONAL GEOGRAPHIC SOCIETY

Moreno's straw hat, placed as a target at 25 paces. And Bandim said yes, he had eaten people of his own tribe.

"We don't like them to go into the ground," he said. "We put them on the fire. They are good. Only the men eat. The women cry."

Joe Moreno said that nobody was sure why the Pacaás Novos did this, that probably such behavior grew from traditional beliefs, from primitive religion. In Europe, the ancient Wends

reverently killed and ate their aged parents; the old people had wanted it that way. Joe said: "Believe me, we are making progress here."

That night, at the SPI post where the Ouro Prêto and the Pacaás Novos Rivers meet, I stood before a hut in the moonlight. The mosquitoes didn't bite much any more. Cicadas chirped. The water shimmered, seeming to keep time with the insects.

Several Pacaás Novos were there. The women made a fire and roasted corn. Both women and men chewed *babaçu* nuts, to make hair oil. I said I had thought that the women did *all* the work. This set off a debate, and Joe was hard put to translate fast enough.

Men: We make arrows and hunt and fish. We clear the fields for planting.

Women: We do the planting. And we bring the wood. We grind the corn. We bake the bread. We cook.

Men: We cut down trees to get honey. We bring *açaí* fruit to make the cooling drink.

Women: We make the cooling drink. We make baskets and mats for sleeping. And we bear the children.

There was a silence. Then a man said: We kill the enemy.

The debate was over.

Life a Battle in the Northeast

I next visited the Northeast, a seven-state region as big as Venezuela. One Brazilian in four lives there. The United States, under the Alliance for Progress for Latin America, is committed to spend 131 million dollars there in the next two years alone.

First, the dry Northeast (map, page 314). When it rains, little moisture remains. You might say that 80 drops out of 100 evaporate. Sixteen run off in rivers. Only four soak into the soil. In some years it does not rain at all. Brazilians call it *sertão*, the backlands or wilderness. An American soil scientist said, "In Arizona we call it desert."

The sun is incessant, the soil sandy, the vegetation sparse and prickly. There are spiny shrubs, and cactuses like huge sausages, with 6-inch spikes.

Here rides the *vaqueiro*, the Northeastern cowboy, clad in leather from hat to spurs, his horse in leather too. As the drought deepens, he burns the needles from cactus. Cows and steers eat what's left while it still smolders.

"Some starve before they get sick," a vaqueiro said. "Some get sick before they starve to death."

(Continued on page 345)

KR EKTACHROME (ABOVE) AND KODACHROME © N.G.S.

"Break with Cuba," cries the poster on a street-side pillar in downtown Rio. "More than 1,000 executed in two years," says the caption above the firing squad. Brazil, like the rest of Latin America, finds Cuba a controversial issue.

Farmers Air Their Ills in the Northeast, Brazil's Land of Hunger and Unrest

More populous than Peru, larger than all Central America, the blighted Northeastern bulge of Brazil is depressed and underdeveloped. Many of its 15 million inhabitants live in poverty. In 1955 the first peasant league met at Galiléia to seek land-reform laws. Today the leagues claim thousands of members. The United States, working with Brazil through the Alliance for Progress, has designated the Northeast a high-priority area for development funds.

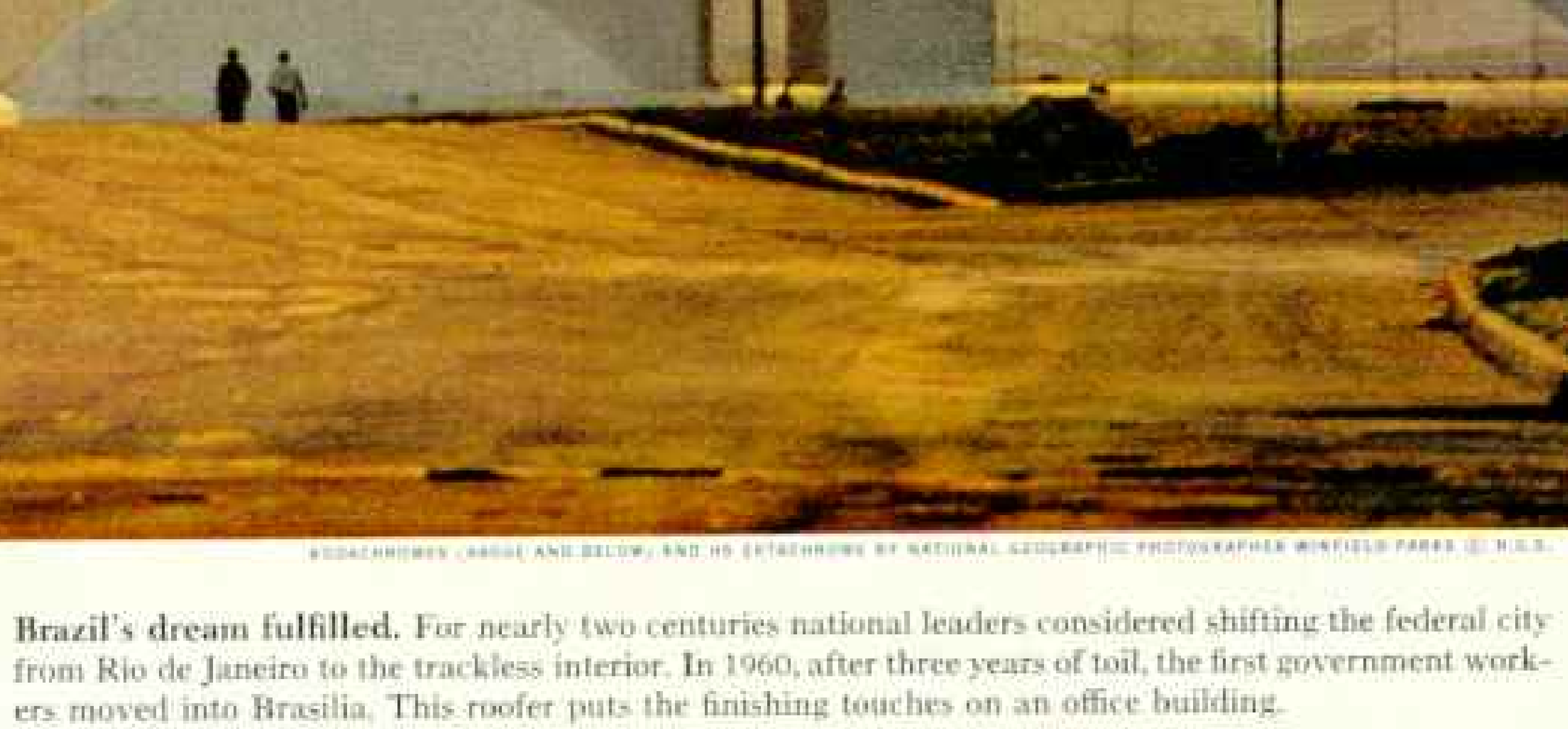
José Francisco de Souza, leader of the Galiléia League, conducts this meeting. Decorations remain from a festival.

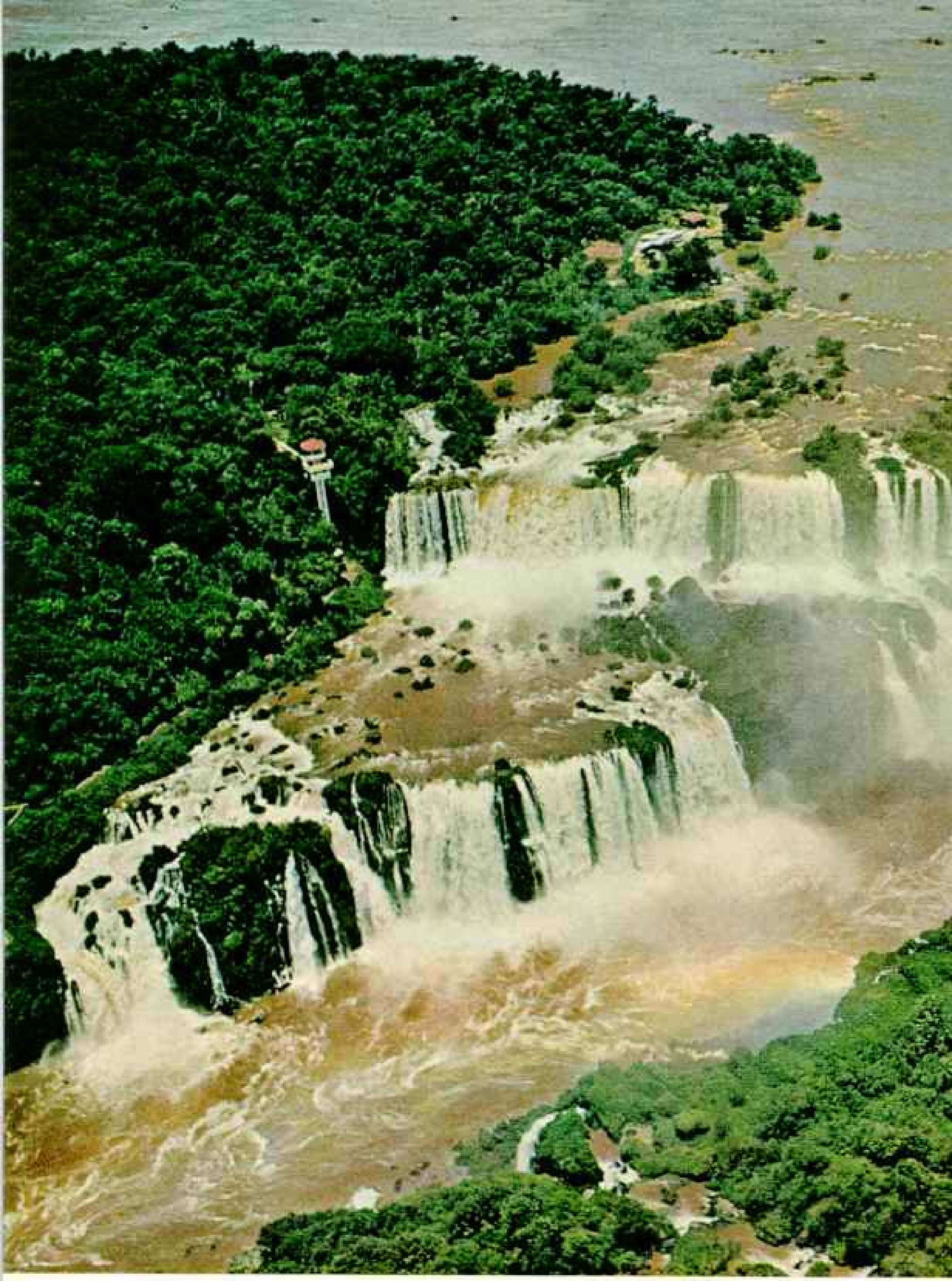
Aglow at dawn, Brasília breaks the plains 600 miles northwest of Rio. Congressional offices occupy twin towers that soar 28 stories. Senators meet beneath the dome, Deputies within the saucer-shaped structure at extreme right. Graceful lamps line the street.

Concrete crown 108 feet high forms the framework for Brasília's cathedral. Glass walls will enclose the doorless edifice; parishioners will enter through a tunnel. Workmen's construction lights glow in the unfinished business center.

KODACHROMES (ABOVE AND BELOW) AND HI EXTACHROME BY NATIONAL GEOGRAPHIC PHOTOGRAPHER WINFIELD PARKS (C) N.G.S.

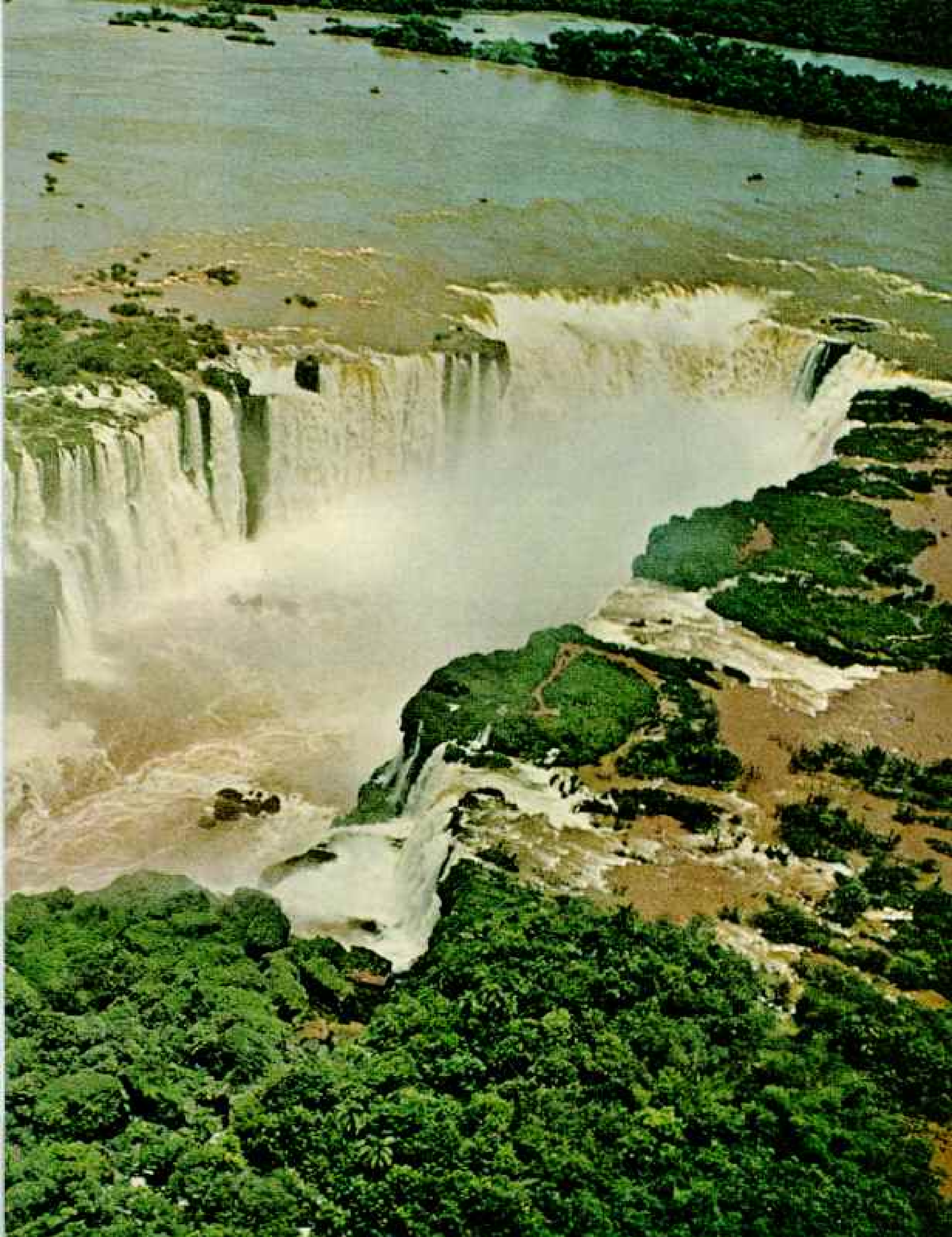
Brazil's dream fulfilled. For nearly two centuries national leaders considered shifting the federal city from Rio de Janeiro to the trackless interior. In 1960, after three years of toil, the first government workers moved into Brasilia. This roofer puts the finishing touches on an office building.





Thundering Waters of Iguazú Falls Leap 237 Feet Into Devil's Throat

One of the world's greatest cataracts shatters the Iguazú River between Argentina (near bank) and



KODACHROME © NATIONAL GEOGRAPHIC SOCIETY

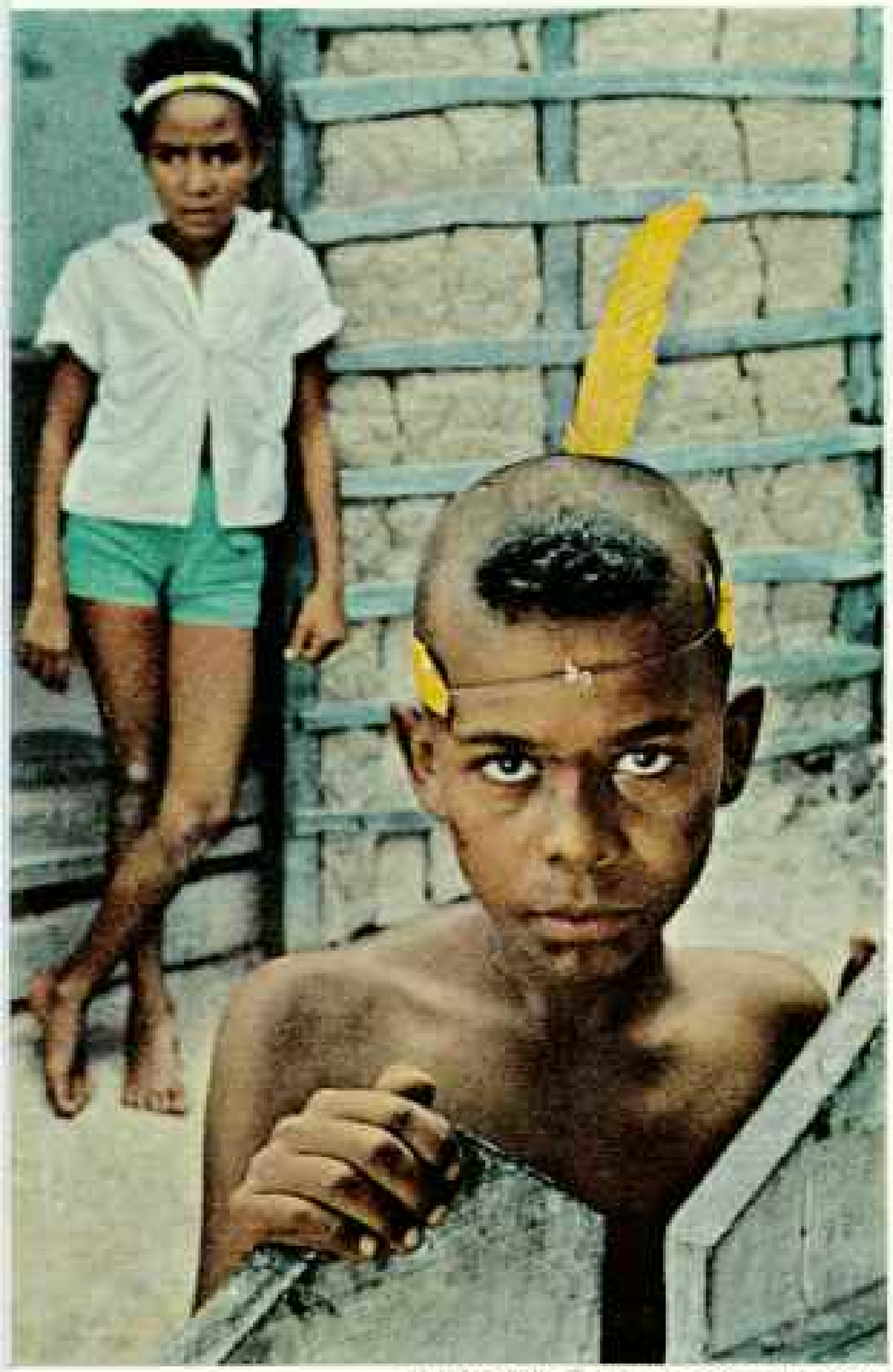
Brazil. Excursion steamers from Buenos Aires reach the falls in six days. Brazil maintains the elevator and observation tower at left. Rainbows often paint the entire gorge.

BOORCHASHEK © NATIONAL GEOGRAPHIC SOCIETY

Cook sieves rice on a Mato Grosso cattle ranch. A region of flooding plains and wide pasturelands, the Mato Grosso supports about two persons a square mile. Many Brazilian tables offer rice twice a day.

Relaxing in a hammock, a Mato Grosso ranch hand dandles his child. Saddle and saddle blankets hang on the wall; braided leather lariat coils on the floor. Hammocks swing everywhere in Brazil.

Yellow feather marks a solemn-eyed youngster's contribution to Rio's carnival gaiety. His topknot is not uncommon among Brazilian boys. Mud-and-wood walls may be seen in both city slums and the country.



KR EKTACHROME © NATIONAL GEOGRAPHIC SOCIETY

The villager works his *roça* (pronounced hrossa), a jumble of beans, manioc, corn. During drought, everything is scorched. "I planted three times," a man said. "The field is as clean as the day I started."

His wife lay on a mat, emaciated, unmoving. She had been sick for three years. "It started with a pain in the stomach. Then she got yellow, and the blood went out of her." A physician may come soon. "He goes around before the elections, every four years. This time he is running for mayor." The fetish doctor costs too much.

What is starvation? In a lonely hut, 12 people aged 3 to 70, and a blue-eyed cat with the saddest expression in the world. In the morning, a cup of coffee. At noon, a little manioc flour with a few beans. And less of the same at night.

The beans are bought at the Sunday market, on credit, meaning more debt. By Thursday they are gone, so it's only coffee and manioc, "to fool the stomach." When there is no flour left, a child may go to a neighbor with a bundle of firewood; maybe the neighbor will send back a little flour.

I left and looked back. Grandfather, mother, children—they all looked after me. Their eyes were as sad as the cat's.

Four out of ten children die here before they are a year old. But the people love this land. When they run out of food and have buried the last child, they leave, on crowded trucks, to try a new life in a faraway city. Sometimes the men go alone. The candango of Brasília, the laborer of São Paulo, the rubber gatherer in Amazonia—ask, and chances are he's from the Northeast. When he hears of rain back home, he may return.

Hunger Stalks a Fertile Coast

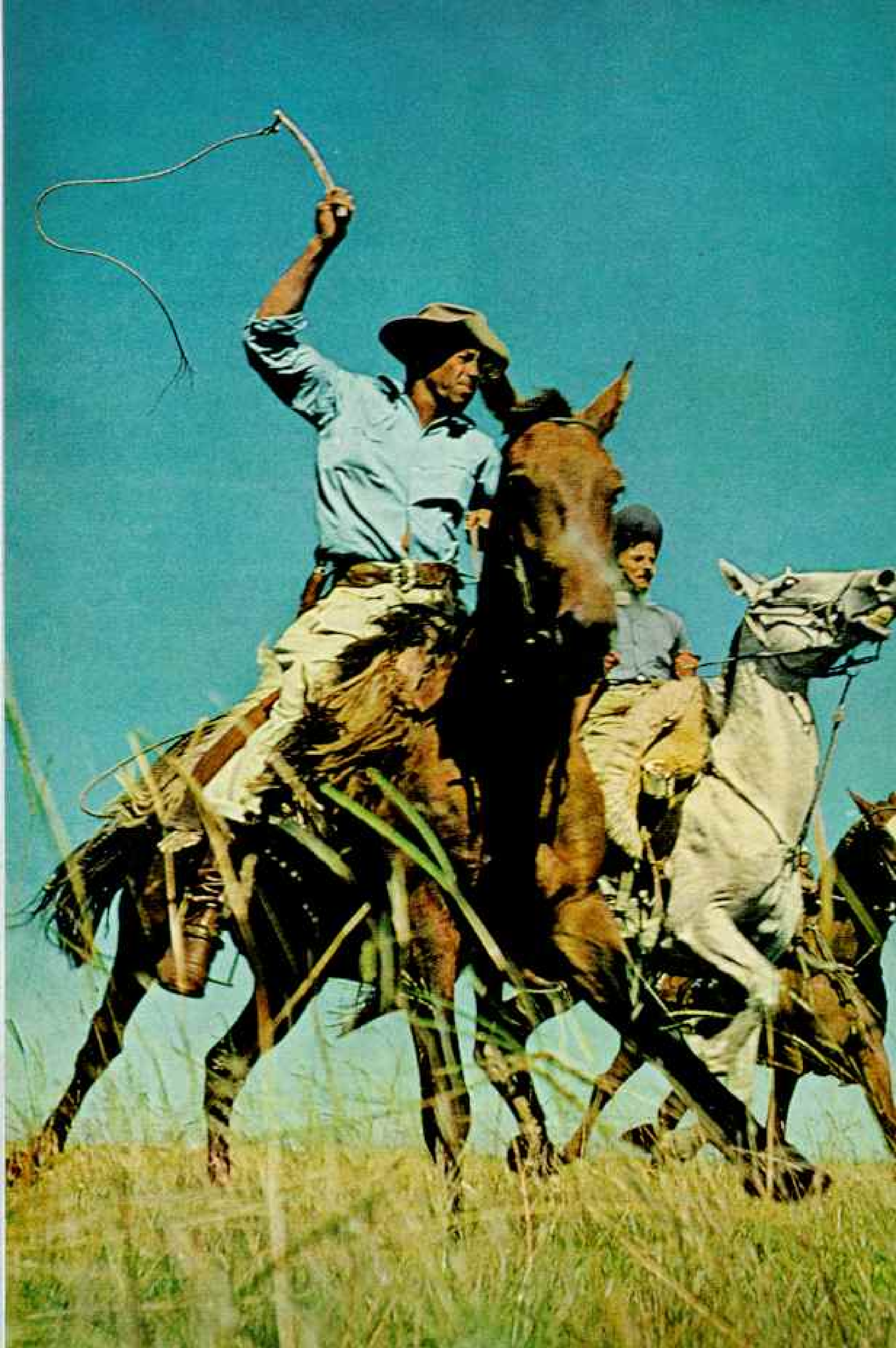
So much for the dry Northeast. The wet Northeast is a narrow strip along the coast, with the booming cities of Recife, meaning "Reef"; and Salvador, commonly called Bahia, meaning "Bay," a former capital of colonial Brazil. This humid coast is the land of sugar cane, once the basis of wealth of the aristocrats with big plantations and slaves from Africa. Slavery was peacefully abolished in 1888, but sugar remains king. Many planters, determined to devote all their land to sugar, do not allow their workers to grow food.

In a little market town I saw inflation at its worst. A cane cutter earning 100 cruzeiros a day looked at dried beef costing nearly twice that much per pound. Manioc flour cost 120 cruzeiros a pound. A year ago it was 25.

The workers on a plantation called Galiléia asked the owner for permission to grow food. He said yes. His sons changed his mind, and he told the workers and their families to leave within 15 days. Some had lived there 40 years. They went to Recife, seeking help. A young lawyer, Francisco Julião, took up their case. This was in 1955, the start of the first peasant league in Brazil.

The workers of Galiléia are still on the plantation (page 339). The land was bought for them by the State of Pernambuco. Landowners elsewhere, heavily armed, resist the pressures of peasant leagues.

In the league headquarters in Recife hung a large portrait of Julião, now a state deputy and a hero of all the peasant leagues. Beside it I noticed a small picture of Fidel Castro. League members told me there had been burning of huts, beatings, even murder. In another town, they said, a peasant league leader was shot to death in the street. Tension rose. The army received reinforcements. An American ship with 4,000 tons of corn



Quirt flying, saddles creaking, gauchos sweep out of the past and across the grasslands of southern Brazil, adjoining Argentina and Uruguay, as their grandfathers did before them. Clinging to their traditional life and dress—wide-brimmed felt hat, knife, pistol, wide belt, loose trousers, and spurred boots—Brazilian cowboys have brought such luster to the name "gaúcho" that every citizen of Rio Grande do Sul appropriates the term.

Gourd of steaming maté refreshes an off-duty gaúcho. At sundown this man sips the tea-like drink through a metal straw.

ROUGHROOMED BY NATIONAL GEOGRA

bound for Africa was ordered sent to Recife.

"Every day people see things get worse," said Celso Furtado, the head of SUDENE, the federal agency for development of all the Northeast. "We need a new attitude, an awareness that things can improve. Otherwise despair becomes unbearable, and people fall victim to irrational ideologies, to demagogues. SUDENE is our last hope."

Furtado's agency gets funds from the Brazilian treasury, the United States, and the Inter-American Development Bank—in all, some 120 million dollars a year. Experts from many countries help test soil and build roads, power lines, and factories.

"It'll be another two years before people get the benefit of what we are doing," Furtado said. "They cannot endure the present misery longer than that. We need a social revolution, a new era of hope."

It was a relief to move on to the cool, mountainous calm of Ouro Prêto, the showpiece of Minas Gerais, a state kept prosperous by its mines. In colonial days it was gold. Now it is iron and bauxite.*

On a hill high above the baroque churches of the town I met a happy man named Orlando Ribeiro. He was not rich but he had a job as a carpenter, restoring churches, and his land with its abandoned gold mines had been owned by his great-grandfather. He had 27 gold-colored birds singing in a cage, and took gold-colored snuff. His aunt, he said, had been frightened by a werewolf, and from his shelves things had crashed down alarmingly until a priest exorcised the marauding spirit. Now all was calm. "Peasant leagues?" he said. "We don't even have peasants!"

Ouro Prêto once was a cradle of rebellion against Portugal. An 18th-century dentist

*See "Brazil's Land of Minerals," by W. Robert Moore, NATIONAL GEOGRAPHIC, October, 1948.

PHOTOGRAPHER MINICIO PIRES © N.G.S.

Sand sculptor on Copacabana, Rio's most famous beach, builds a model of the Taj Mahal after completing an elaborate church. Beach-goers express their appreciation of his skill with small tips.

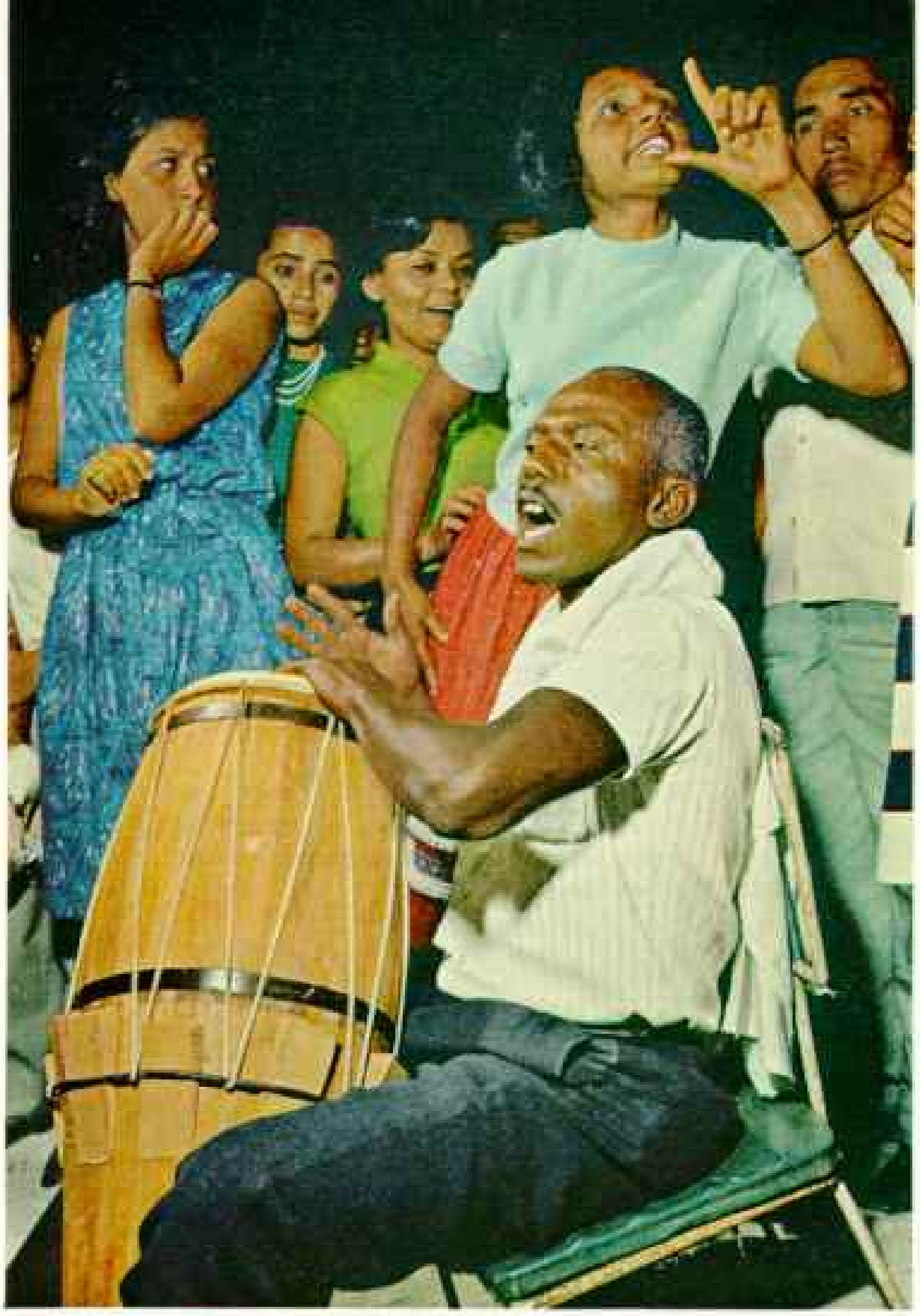
Sudden summer shower clears Copacabana's sands as sun bathers scurry for cover. With the Atlantic on their doorstep, many Cariocas make the daily dip a habit. Tropical climate permits swimming virtually the year round.

nicknamed Tiradentes, the "tooth puller," was executed for espousing ideals much like Thomas Jefferson's. Now Tiradentes is a national hero, and Ouro Prêto a most conservative town in Brazil's most conservative state.

Back in Rio I heard much talk of "basic reforms"—land reform, reform of electoral procedures, tax reform. At present the federal treasury receives more revenue from taxes on tobacco than from taxes on personal income.

President João Goulart favored basic reforms. So, for that matter, did the Communists. So did a leading Roman Catholic bishop. So did Pres-

Sunglasses take a look at a bronzed beauty. Afternoon's fierce sun will drive both the girl and her admirer into the shade.



Pulsating drum and mystic chants induce hypnotic trances during *macumba* rites in Rio on New Year's Eve. Primarily African in origin, macumba resembles the voodoo cult of Haiti. For millions of Brazilians, it supplements rather than supplants Christianity.

Sacrificial boat laden with candles, flowers, jewelry, liquor, and other gifts for Yemanjá, macumba's goddess of the waters, rests on Rio's Ipanema Beach. At the climax of the New Year's Eve ceremony, priestesses in blue skirts and white blouses will push the craft to sea.

BY ANSCHROME (BELOW) AND KODACHROME © N.G.S.

ident Kennedy, in a colorful comic book explaining the Alliance for Progress. For this vast cooperative effort of 20 American republics, the United States had promised 20 billion dollars over a period of 20 years in loans, grants, and technical assistance, provided that the other partners would add significant amounts and make reforms, to pave the way for a raising of the standard of living throughout Latin America.

When would these reforms come to Brazil? Nobody could say for sure.

I took a jet airliner for my final trip in Brazil—all the way south. En route I thought of many things that had impressed me in this huge country.

I thought of the unschooled mechanic who repaired radio transmitters with parts he made himself; of the official who studied regulations over and over to help a foreigner. That was all in the words *dar um jeito*, to find a way—to improvise, to fix things somehow.

I thought of proud men. Of the Northeastern landowner, looking elegant even in a faded sport shirt. His grown-up sons greeted him in the old-fashioned Brazilian way, kissing his hand. He had said: "No, I don't hunt and I rarely stay in my house in town. I am an old man; I read the Bible."

I remembered a scientist who said: "In my veins is Portuguese, Indian, and Negro blood —I am a good example of a Brazilian."

I admired the lady whose tax form said: "Do not write in this space; for official use only." She wrote across that space: "I am a Brazilian, I am vaccinated, and I write where I please."

Standing Steer No Test for a Gaúcho

And then I was in Rio Grande do Sul, the gaúcho state, a flat green land of beef—roasting in chunks on spits, or drying thinly sliced in the wind. I tried maté, the gaúcho's tea, burning hot, drunk from a gourd with a silver straw (page 347). And I rested on the gaúcho's bed—his saddle placed on the ground to put his head on; his poncho; and on top of that his *xerga*, the cloth that protects the back of his horse. The xerga never touches the ground, so much does the gaúcho love his horse.

A gaúcho of Spanish and Arabic parentage showed me his lasso. Its loop had little metal rings. Wouldn't those make noise, and make the cattle run? "Exactly," he said. "A gaúcho who lassoes a standing steer isn't a gaúcho."

He showed me his short eating knife and a two-foot knife for fighting. "We don't let

BRAZIL: facts and figures

One of every two South Americans lives in Brazil, whose territory covers almost half the continent. In an increasingly crowded world, Brazil is still the land of the frontier; from narrow, settled coastal strips, an untamed wilderness of rain forest, swamp, and high savanna beckons pioneers with the promise of open lands to be taken and wealth to be gained. The new capital, Brasília, in a federal district carved from the State of Goiás, stresses the nation's push into a 20th-century wild west.

The name Brazil comes from a reddish wood greatly prized by early colonists for dye; the nation's shape roughly resembles a diamond. Gems, incidentally, are among the resources that make Brazil potentially one of earth's richest nations. Minerals, timber, and waterpower in abundance exist in the vast interior. Nearly a fourth of the world's iron reserves lie in the mining State of Minas Gerais, the bulk of it awaiting the miner's pick.

Half the world's coffee grows in Brazil, and the nation is second only to the U.S.A. in production of oranges. Brazil raises beef and vast quantities of sugar cane, manioc, corn, rice, beans, potatoes, and black pepper. The varied climates and soils will grow almost any agricultural product. Yet only two percent of the land is cultivated.

History has made Brazil a melting pot of races—descendants of Portuguese colonists, of the Indians they subjugated, of slaves from Africa. Europe, Japan, and the Middle East have sent tides of immigrants. A few thousand Indians in the dimly known interior still live Stone Age lives, totally unaware of the world of the cold war and the atom.

Official name: Estados Unidos do Brasil (United States of Brazil). **Government:** Republic, made up of 21 states, five territories, and a federal district. **Area:** 3,287,198 square miles. **Population:** 74 million. **Language:** Portuguese. **Religion:** Predominantly Roman Catholic. **Economy:** 58 percent of working population in agriculture (coffee, rice, corn, cotton, black beans, and sugar cane); 13 percent in industry (textiles, chemicals, steel, and machinery). Principal resources are iron ore, manganese, and coal. **Major cities:** Brasília, the capital (pop. 200,000); Rio de Janeiro, seaport and former capital (pop. 3,200,000); São Paulo, largest city (pop. 3,700,000), industrial and financial center. **Climate:** Hot and wet in the Amazon Basin; subtropical in highlands; warm summers, mild winters; rainy season October-May in south.

Luminous sea beats against Copacabana and fort-topped Ponta do Leme. Christ of Corcovado,

quarrels rest overnight," he said. He told of a fight with knives that lasted half an hour. "Both were so tired that they became friends."

In the state capital, Pôrto Alegre, I watched the annual parade of the students with floats and brass bands—and was surprised to see how strongly some of them reflected Communist propaganda. The school of philosophy approached with a wild African beat, and I left with Hélio and Antônio, who had only recently been students themselves.

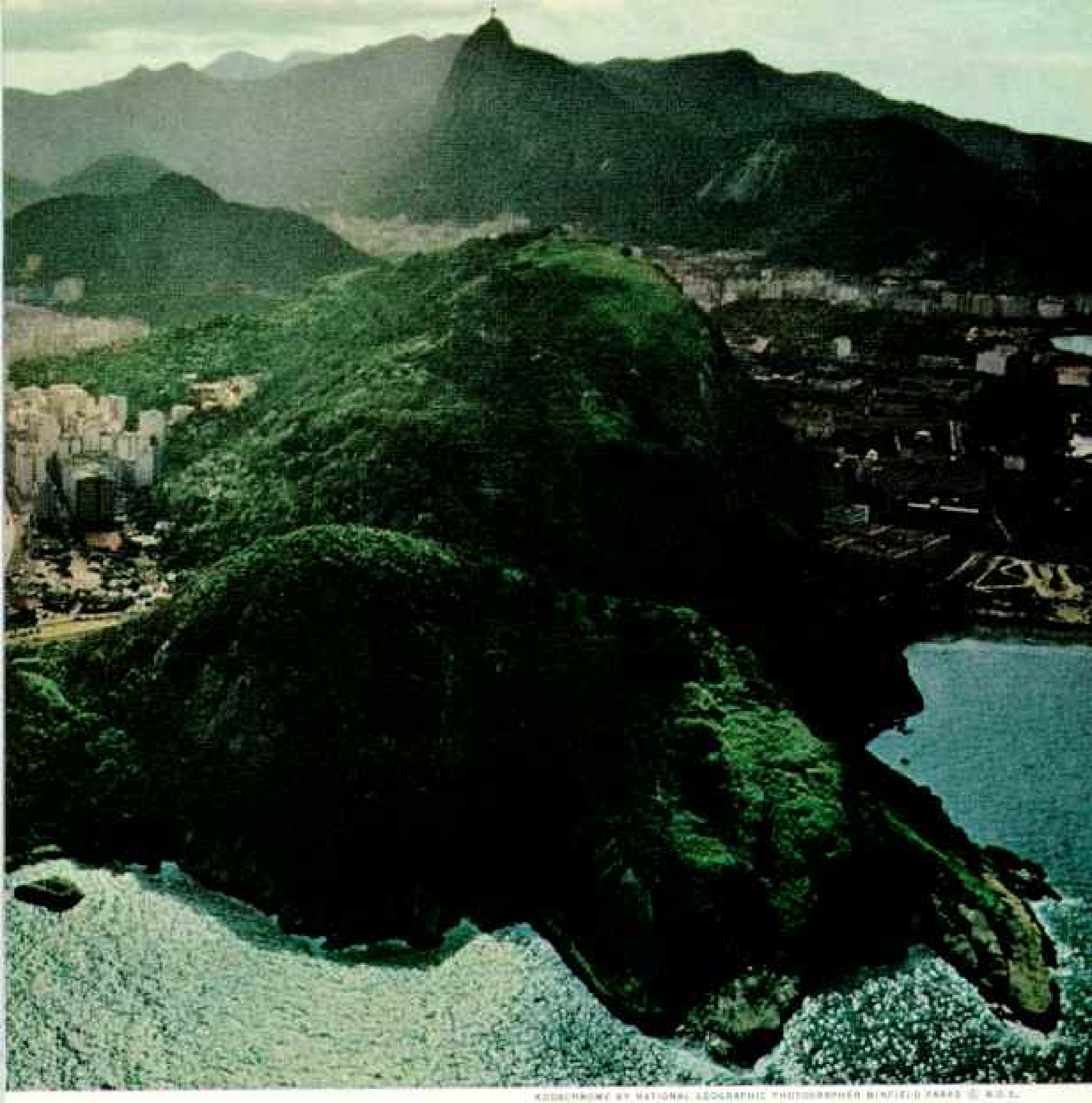
"Don't take those floats too seriously," said Antônio. "I don't.

"And don't think that we'll have a revolution here, even if we do have a lot of peasant leagues springing up all over the place."

Hélio did not agree: "The hot spot in Brazil is right here in the South. In the Northeast the people are too miserable and too backward to make a revolution. Here they are well informed and we have a tradition of revolution."

Antônio said: "What we need is evolution, intelligent planning. And for evolution we need peace."

Hélio kept silent a while. Then he said: "Brazil has twelve million children between seven and fourteen, and seven million of them don't go to school!" He added that if the new congress elected in October does not buckle



on a distant mountaintop, surveys sprawling Rio. Aerial view looks south from harbor entrance

down to real reforms, there could be trouble —perhaps a revolution.

António said: "If we have another Cuba here they will try to change my life, and I will resist. You and I will fight each other."

"Maybe," said Hélio, "but I hope not." They smiled at each other. For in Brazil, as perhaps nowhere else, political enmity is no barrier to friendship.

Nation's Hope Written on Its Flag

Flying back to Rio for the last time, I looked forward to a future when all Brazilian youngsters will go to school and know misery like today's only from history books, as American youngsters know Valley Forge and the great depression. How long would it really take for this great change to come? And could it come without widespread violence?

Yes, Celso Furtado had said, within a generation, more or less. Brazil's most distinguished social historian, Gilberto Freyre, said it might take two or three generations.

I thought of Brazil's flag and its proud motto—*Ordem e Progresso*, Order and Progress. And in the morning light I looked up once more at the concrete colossus on Corcovado. It seemed to say that Brazil would weather the trials to come. Not more or less, but surely. THE END

FRONTIERS PUSH INLAND IN EASTERN

A GREAT VEIN OF BLUE writhes across the map—the Amazon River, world's mightiest flow of fresh water. With its tributaries, it drains 2,700,000 square miles of South America, including some of the largest and richest unexplored areas on earth.

This enormous basin, green heart of a continent, covers almost half of the land shown on the National Geographic Society's new Atlas Series map, **Eastern South America,** distributed to more than 3,000,000 members with this issue of the GEOGRAPHIC.* Though mapped from the air with increasing precision, the wilderness that extends for thousands of miles on either side of the Amazon still largely defies settlement, and vast expanses can still truly be called unexplored.

Red stars now dot the river's ragged course —symbols of airfields hacked from jungle. For some towns and villages starred on the map, "scheduled air service" still means a plane every week or so—as GEOGRAPHIC staff writer Peter T. White discovered in his 10,000-mile journey through Brazil (page 299).

It is not surprising that Brazil should turn to the skies to leap the wilderness. In minutes or hours, the airplane brings civilization to areas all but inaccessible to more primitive means of travel. And prophetically, Brazil gave the world a great aviation pioneer—Alberto Santos-Dumont, born in São Paulo. Near Paris in 1906, he made Europe's first airplane flight, in a craft he built himself.

Red arteries creep inland across the new map, as South American road-builders slash jungle and dynamite hills to build a new circulatory system for their continent. Brazil, sprawled across half of South America, leads in the effort to open the interior. A paved 450-mile highway from the industrial center of

São Paulo's Congonhas Airport, busiest in Brazil, serves 32 airlines. More than 2,500 commercial

SOUTH AMERICA: A NEW ATLAS MAP

Belo Horizonte was pushed through in 30 months to Brasilia, in time to meet the new capital's inauguration date, April 21, 1960.

Another red trace marks progress of the first Atlantic-to-Pacific highway through the waist of the continent. This stupendous project compares in scope with the first spanning of the United States by railroad. The road will link Rio de Janeiro with the Pacific coast of Peru. Already it traverses the mineral-rich State of Minas Gerais ("General Mines") and crosses the Mato Grosso ("Thick Brush").

From Pôrto Velho, near the left edge of the map, a completed portion of the road winds southwestward to the northern tip of Bolivia. The inset at the lower right traces it to Sena Madureira, whence it will follow the state boundary to a tie-in with Peru's highways. Other insets enlarge the areas around São Paulo, Rio de Janeiro, and Brasilia.

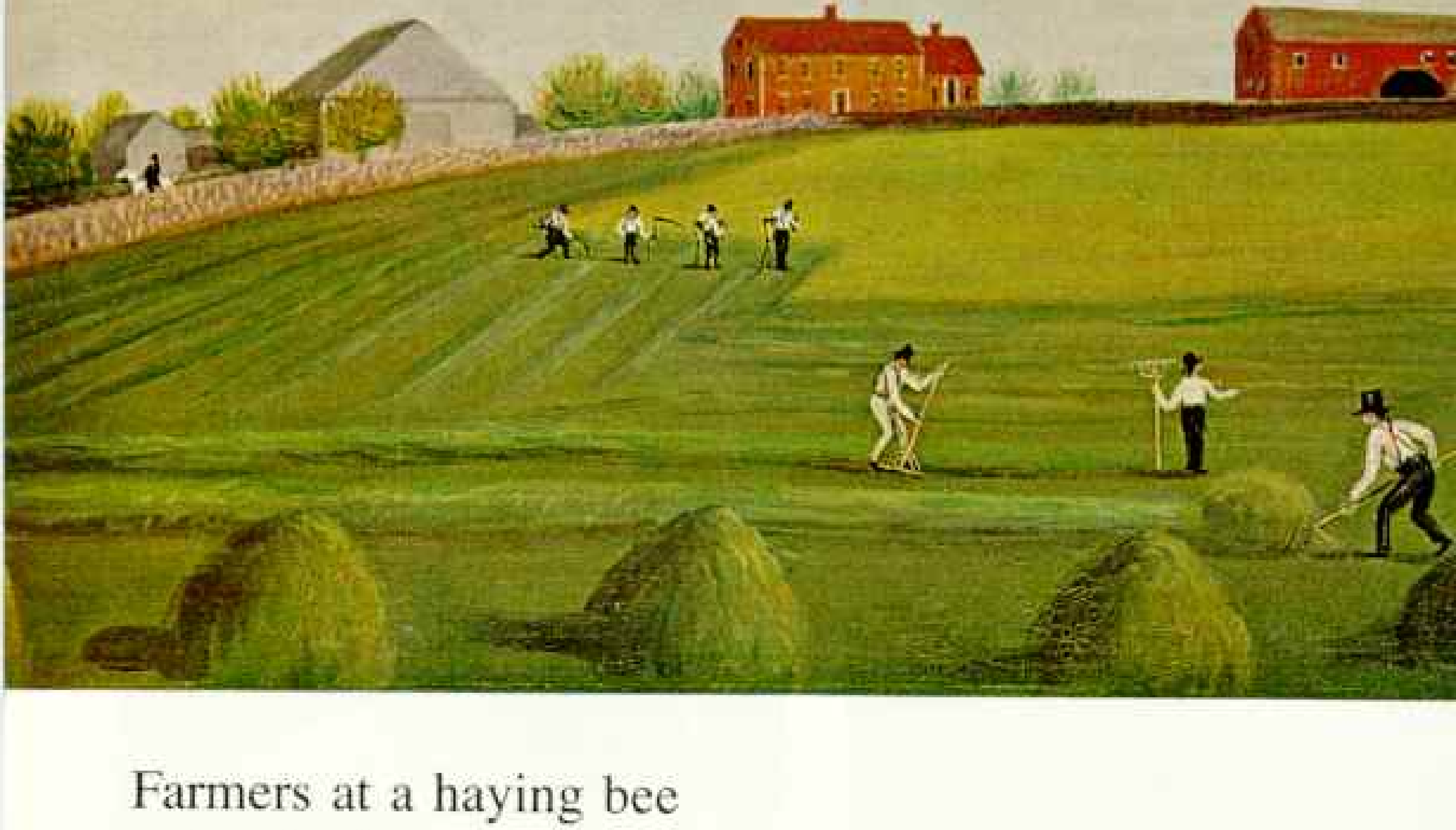
Argentinians are driving a tunnel beneath the Paraná River between Santa Fe and Paraná, giving their nation the first unbroken highway link with three transriver provinces.

Even more ambitiously, engineers are building connections to the world's largest concrete arch, over the Paraná at Foz do Iguaçu, between Brazil and Paraguay. The completed bridge, 951 feet long, will finally give Paraguay overland access to Paranaguá, its duty-free seaport in Brazil. At the top of the map, Surinam has nearly completed an east-west highway along the Atlantic shore.

*Eastern South America is the 33d uniform-sized map issued by the Society in the past five years; it becomes Plate 27 in the Atlas Series. A convenient Folio is available to bind the maps; it may be ordered from the National Geographic Society, Dept. 38, Washington 6, D. C., at $4.85. Single maps of the series are 50 cents each; a packet of the 28 maps issued from 1958 through 1961, $8.80; a combination of the 28 maps and Folio, $12.25.

flights wing in and out each month

Maku Indian baby submits to a jungle bath



Farmers at a haying bee
cut and rake a field

Early America

By HEREWARD LESTER COOKE, JR., Ph.D

BROAD ACRES of a New England farm of about 1825 appear in the painting titled "Dennison Hill, Southbridge, Massachusetts." Part of the main house, built by Capt. Ralph Wheelock in 1765, still stands.

The artist has been identified tentatively as Francis Alexander, who lived nearby. "My fame," he wrote with wry humor, "has now spread half a mile in one direction."

Alexander started as a true primitive painter, untrained in the subtleties of perspective and anatomy. He had, however, a sure eye for composition and color harmony.

Top-hatted neighbors work in relays. Picnic hamper and welcome jug remind us that harvest time was not all work.

"PROFILES TAKEN," says a notice in an 1825 issue of the Portsmouth, New Hampshire, *Journal*. "They shall be perfect if the sobriety of the person admits, or no pay for them."

Thus one of this country's early artists advertised his services—with a Yankee guarantee of satisfaction. Sobriety undoubtedly refers not to alcohol but to the customer's ability to sit still while posing.

Discussions of art tend to overlook the fact that the fledgling United States produced a style of painting of its own, a style practiced by excellent artists who owed little to customs and niceties of European art.

COLLECTION OF EDGAR WILLIAM AND BERNICE CHRYSLER GARBISCH © NATIONAL GEOGRAPHIC SOCIETY

THROUGH THE EYES OF HER Native Artists

Curator of Painting, the National Gallery of Art, Smithsonian Institution

The painters generally are called "American primitives." The term refers to their naive vision, simple technique, and lack of academic training.

Primitives Tell of Bygone Days

Luckily, many of their paintings survive. Though some still hang unrecognized in American homes, a growing number—thanks to diligent collectors—are now in museums and private galleries. They form an incomparable visual record of a bygone era.

Some of the best examples of this early American art are reproduced for this article. The 28 shown were selected from some 2,500 American primitive paintings thus far collected by Col. Edgar William and Bernice Chrysler Garbisch of New York City and Cambridge, Maryland. Twenty-three are among the works chosen from this internationally known collection for the exhibition "101 Masterpieces of American Primitive Painting," now being shown in major museums of the United States and Europe. Opening at New York City's Metropolitan Museum, the show has won acclaim wherever it has appeared.

"We saw in these native American works of art," the Garbisches have written, "those unique qualities of simplicity, forthright directness, and creative vitality in color and

PAINTING BY NATIONAL GEOGRAPHIC PHOTOGRAPHER

design, which set them apart as being indigenous to our country, so genuinely American. . . . Therefore, we felt, they merit an important place not only in the history of American art but in the history of world art as well."

This primitive style had roots in English provincial painting brought to the Colonies by limners, topographers, and "face painters." But European influence was brief. Reflecting perhaps the immigrant's unfettered spirit, American primitives soon developed new and original modes of expression.

Despite the harsh task of taming a continent, a surprising number of early Americans drew, whittled, embroidered, carved, and painted. Most taught themselves. Few ever saw an original work by even a secondary European master. Their motive usually was the same: to record a cherished scene, event, or person. If the artist's family or friends recognized the subject and were pleased with the effect, the painting was a success.

The most significant primitives, however, were by full-time professionals who wielded

P. ANTHONY STEWART © N.G.S.

Gems of Early Americana Adorn the Collectors' Home in Maryland

Bernice Chrysler Garbisch, daughter of automobile manufacturer Walter P. Chrysler, admires an 18th-century still life held by her husband, Col. Edgar William Garbisch.

Over the fireplace hang an anonymous artist's portraits of "Mr. Denison" and "Mrs. Denison," painted about 1785. "Mother and Child in White," painted about 1790 by another unknown, gaze from the wall beside a rare Philadelphia highboy. Colonel and Mrs. Garbisch continue to add to their collection of 2,500 paintings.

Mrs. Garbisch has long been a philanthropist in many fields. Colonel Garbisch, a corporation executive, won all-American football fame as center and drop-kick specialist at West Point in the 1920's.

a brush in a variety of ways. A typical newspaper advertisement of the early 19th century reads: "Bronzing, oil gilding and varnishing, enamelling on glass, painting with water colors and crayons, portraits, miniatures and military standard painting, also drawings of machinaries of every description."

Most of these artists did not sign their work and therefore have remained anonymous. Old diaries, letters, newspaper advertisements, and contracts, however, tell us how primitive painters lived and worked. Many started their careers as apprentices to coach painters, sign painters, or furniture makers.

Often they took to the road in search of work and patrons. Like the tinker and tailor, they carried their tools in portmanteau, chest, or saddlebag. As "canvas" they often used whatever material was available—bedticking, window shades, copper or zinc sheeting, wood panels, and ordinary window glass.

Advance notices heralded the painter's coming. "Those gentlemen," reads a newspaper announcement of 1760, "either in town or country, who have picture panels over the chimney pieces, or on the sides of their rooms, may now have the opportunity of getting them filled at a very moderate rate."

Patrons Demanded Stark Reality

The elite among itinerant artists were the portrait painters. They were kept busy by early Americans who were determined that their likenesses be preserved for posterity.

An enigma of primitive portraiture is that occasionally American wives in different areas appear with the same jewelry and wardrobe. One explanation is that the painter had gowns that he could drape on his subjects. Another is that he carried sample books from which patrons could select clothing and props. Or he could have prefabricated settings and bodies, leaving faces to be filled in when confronted with the sitters—though a "headless" painting has yet to be found.

Patrons allowed such license in settings and props, but when it came to faces they demanded stark reality. The hard-bitten pioneer farmer seems to have felt as did Oliver Cromwell, who sternly instructed his portraitist: "Paint my picture truly like me . . . pimples, warts, and everything as you see me. . . ."

Prices for portraits were set to suit all pocketbooks. One New England limner charged $2.92 for a portrait sketch, with glass and frame. A more finished portrait cost $25. Another, in 1825, advertised in Bath, Maine: "Miniatures on ivory from 5 to 25 dollars, side views in colors on paper for $2.00. . . ."

Primitive artists often ignored laws of perspective, anatomy, proportions, and even gravity. Their aim was not to give esthetic pleasure, but to provide information.

This suited the patrons, who demanded that a picture of a house have not only the right number of windows but the right number of panes in each window. Anatomy with strange articulations might be accepted without complaint, but every waistcoat buttonhole must be shown in precise detail.

Paintings Preserve Nuggets of the Past

Rough as it was, American primitive painting filled the needs of the community. It was the native vernacular art, and the only style understood by most Americans.

Many of the paintings contain nuggets of cultural history that might otherwise have been lost forever. What did a California wagon shop look like in gold-rush days (page 382)? Or an 1836 living room in Hartford, Connecticut (page 384)? What was war like in 1815 (page 368)? Only the eyewitness with brush or pencil could show us such scenes.

Colonel and Mrs. Garbisch, both amateur painters in their younger days, traveled thousands of miles tracking down such gems as the classic "Flax Scutching Bee" (page 372) and "Poestenkill, New York" (page 380).

In the past two decades, much of the Nation's heritage of primitive art has been channeled into museums and private collections; the achievement of Colonel and Mrs. Garbisch in assembling these works can never be duplicated. In 1953 they presented a selection to the National Gallery of Art, Washington, D. C. Now they plan bequests to other major museums throughout the United States.

"In this way," Colonel Garbisch told me, "Bernice and I hope to fulfill our original purpose in forming the collection—which was to give to the Nation a comprehensive cross section of American primitive painting, so that millions would have the opportunity to appreciate and enjoy America's indigenous art."

The author gratefully acknowledges the help of his friend and associate, Mr. William P. Campbell, assistant chief curator of the National Gallery of Art, whose knowledge of American painting contributed so much to the descriptions that follow.

"Peaceable Kingdom"

EDWARD HICKS, the dean of America's primitives, was also well known as a Quaker preacher. He entered the art field in his native Pennsylvania as a painter of signs and coach panels and later turned to illustrating Biblical themes. He did many

COLLECTION OF EDGAR WILLIAM AND BERNICE CHRYSLER GARBISCH © NATIONAL GEOGRAPHIC SOCIETY

versions of "Peaceable Kingdom," based on Isaiah's prophecy: "The wolf also shall dwell with the lamb, and the leopard shall lie down with the kid; and the calf and the young lion and the fatling together; and a little child shall lead them. . . . and the lion shall eat straw like the ox" (11:6-7). In this version of the 1830's, William Penn makes a treaty of friendship with the Indians against a backdrop of the Delaware Water Gap (left). To Hicks, this agreement appeared a model of Christian good faith.

Hicks's *Memoirs*, published shortly after his death in 1849, tell how he turned from "apple-cutting frolics, spinning frolics, raffling matches and indeed all kinds of low convivial parties" to a life of religious devotion and to painting sermons on canvas. He sold paintings of this theme for about $50; today they bring thousands of dollars.

After the Revolution, the supplying of Washington portraits developed into a thriving industry. At least 28 painters and sculptors made one or more portraits from life, and countless copies were taken from the originals. Medals, china plates, engravings, embroideries, plaster casts, plaques, and marble statues appeared. Many paintings, like this one of the general on his white charger Jack, painted about 1830, bear no signature.

Fox hunting, complete with hunting horns, was one of the many customs that Virginia settlers brought from England. This scene, painted about 1780, shows the plantation of Bartholomew Trueheart in Powhatan County, Virginia, where the picture hung in the mansion. Primitive artists generally portrayed running hounds and galloping horses with legs stretched out in front and behind. In this case the unknown artist may have had an English print to help him depict hounds and mounts.

NATIONAL GALLERY OF ART (GIFT AND BEQUEST—GIFT OF EDGAR WILLIAM AND BERNICE CHRYSLER GARBISCH) © NATIONAL GEOGRAPHIC SOCIETY

George Washington's Virginia

MOUNT VERNON, Washington's family home overlooking the Potomac, was painted in 1797, the year he retired there from the Presidency. Built about 1735, the original house was entirely hidden by additions made during his lifetime. Architectural historians, noting the changes, can date pictures of the mansion with fair accuracy.

Paintings of Mount Vernon became popular within a few years after Washington's death. Nothing is known about the artist, J. Wiess, who evidently added the weeping willow tree to improve his composition.

Little Hunting Creek Plantation, as the house was called originally, was dear to Washington's heart. On one occasion he wrote to his wife Martha: "I should enjoy more real happiness in one month with you at home than I have the most distant prospect of finding abroad, if my stay were to be seven times seven years."

Washington not only redesigned most of the mansion but planned and supervised the landscaping. From far lands he imported trees, flowers, even flagstones.

Three generations after Washington's death, Mount Vernon was falling into ruins, with rotting pillars, decaying outbuildings, and overgrowing weeds. In 1858 the Mount Vernon Ladies' Association bought building and grounds and made them a national shrine.

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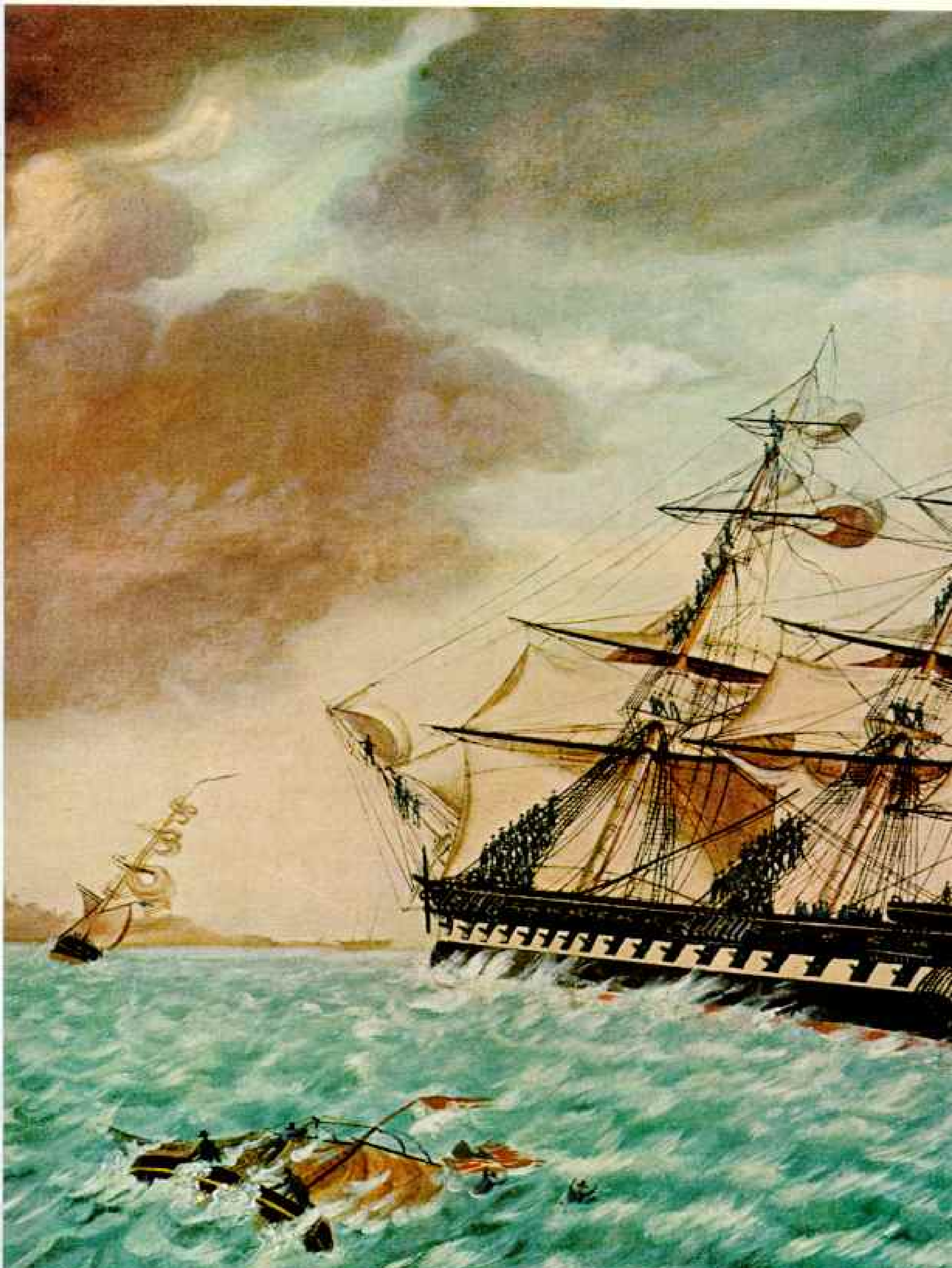

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"The White Squall" puts Navy ships to the test

SUMMER SQUALLS, often of hurricane force, were a horror to windjammer sailors.

Here a frigate, painted about 1835, has been caught unprepared, possibly in Chesapeake Bay. Crew members, following naval practices of those days, have scrambled up the ratlines on the windward side to shorten sail and help counterbalance the heeling ship until it can be brought into the wind.

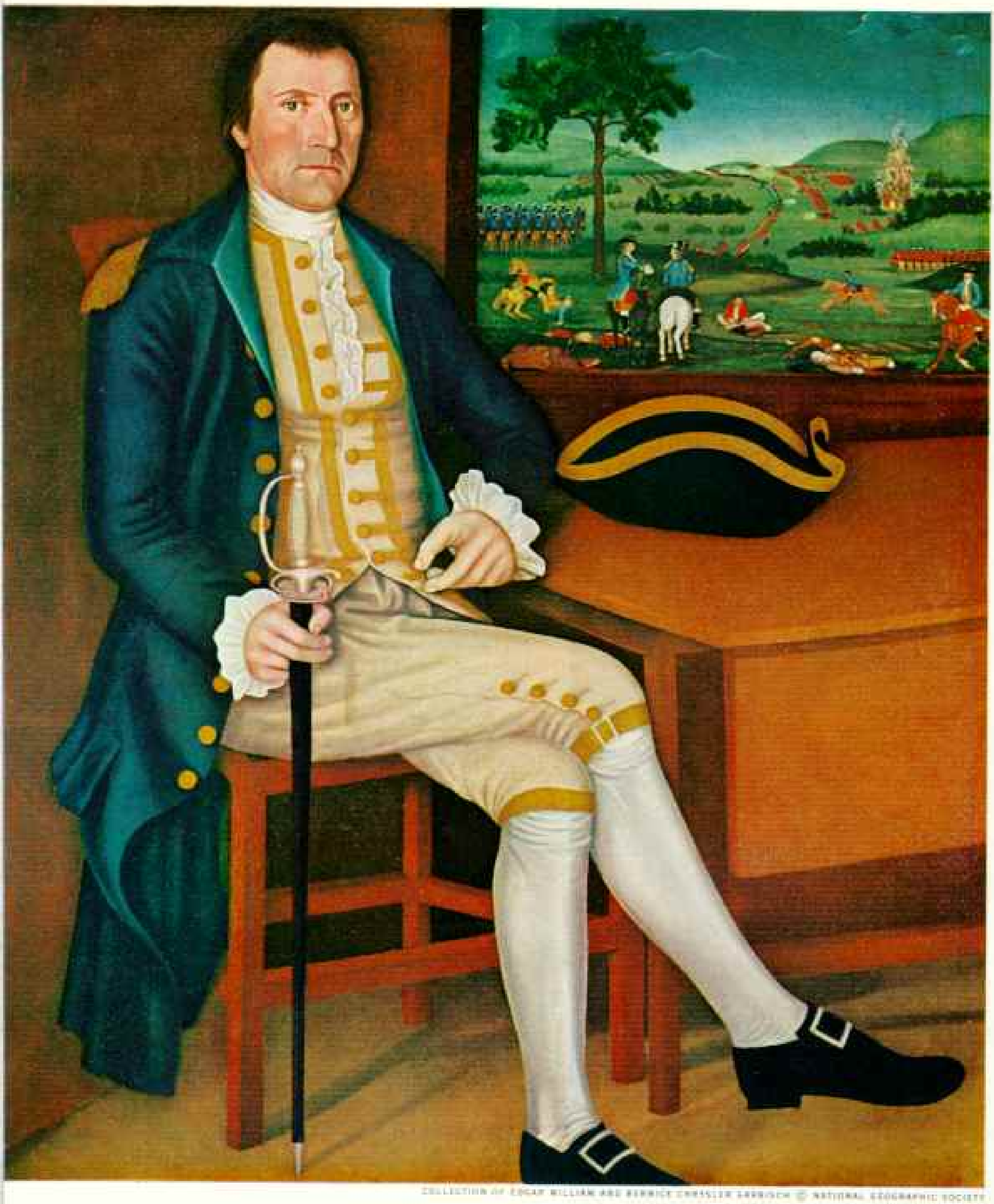
Mounting a double bank of guns, the *Raritan*-class man-of-war was one of the most powerfully armed vessels of the young United States Navy.

In the foreground, a two-masted schooner appears about to capsize. Nearby a brig, anticipating the full force of the squall, pays off before the wind. Her topsails have been hurriedly brailed up but are not yet furled. In the distance another schooner sits out the storm with bare poles.

Artist James Evans, who was active from 1827 to 1854, was well versed in the ways of the sea. Dark, scudding clouds, the way the crests of the waves have been sliced off by the gusts, and details of rigging and sail setting indicate that Evans had firsthand experience and keen observation.

Americans of the 18th and 19th centuries were justifiably proud that their shipwrights were building the world's fastest sailing vessels and that their crews and masters had a seven-seas reputation for enterprise and daring seamanship. It was natural therefore that Americans should want pictures of their swift ships. At the popular level this demand was met by print makers who, like Currier & Ives, published many sailing-ship lithographs that sold for about 25 cents each.

Owners and masters who wanted portraits of their vessels could commission ship artists; they could find one in every major port. These painters usually turned out profile views showing flags flying, brightwork gleaming, and hull freshly painted, with sails set to a fair wind above an azure sea. Only rarely did a picture or print remind the viewer that the sea could be a dangerous and relentless enemy.



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Portrait of a grim warrior

"WHEREVER the British settle . . ." a historian once observed, "they will ever carry trial by jury, horse-racing and portrait-painting."

Winthrop Chandler shows his brother, Capt. Samuel Chandler, around the year 1780, wearing the uniform in which he fought for the cause of liberty. Scene behind him depicts a Revolutionary War action in which the captain undoubtedly took part. When not in uniform, he was a tavern-keeper near Woodstock, Connecticut. His brother painted houses and sometimes portraits. Although gifted, he found limited scope for his talent.

"Sarah Ursula Rose," by Benjamin West

KNOWN as the father of American painting, Benjamin West started his career as a self-taught limner and face painter. He was the son of a Quaker innkeeper outside Philadelphia, and according to legend learned to mix paints from the Indians. Later a group of Pennsylvania businessmen raised funds to send him to Europe for study. In London he became the favorite painter of King George III and president of the Royal Academy. He turned his studio into a home-away-from-home for young American painters studying in England. Without his help, some of America's best talent might not have weathered the trials of student days. He died in 1820 and was buried among England's great in St. Paul's Cathedral. West was only 18 when Sarah Ursula Rose posed for him in 1756.

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NATIONAL GALLERY OF ART, GIFT OF EDGAR WILLIAM AND BERNICE CHRYSLER GARBISCH

Painters copied European styles

MANY early colonists wanted family portraits in the aristocratic style of Europe, but American artists professionally trained to meet the demand were seldom available. Native limners often turned to engravings made from famous European portraits and used them as models for their homespun efforts.

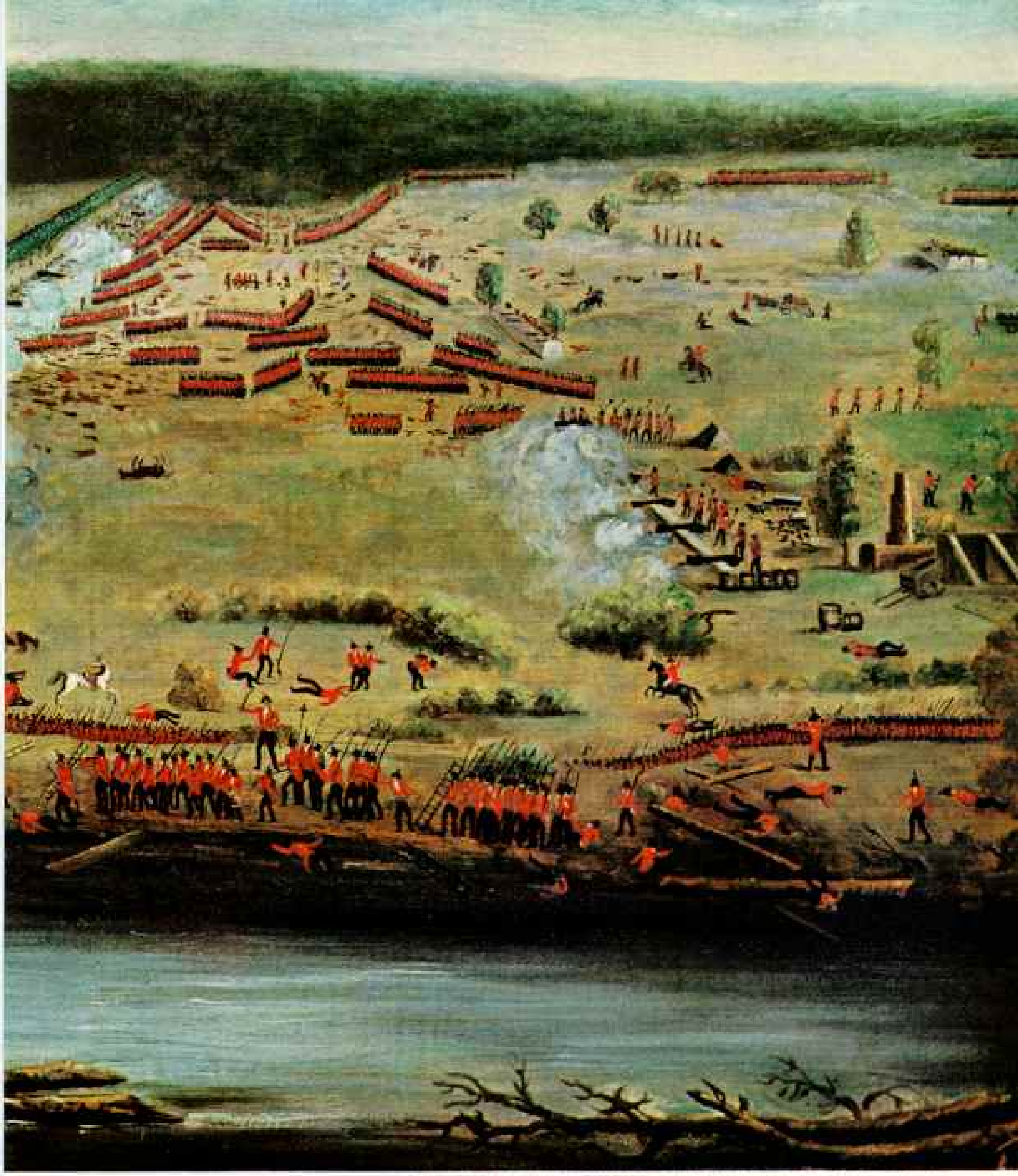
This portrait of Jonathan Benham, painted by an anonymous artist about 1710 in New York, is a throwback in pose and composition to a European style of the previous century. Frock coat, knee breeches, and powdered wig were formal dress among the wealthier classes in early New York.

Battle of New Orleans rages as "peace" prevails

So slow were transatlantic communications during the War of 1812 that some 5,000 Americans clashed with about 7,000 Britons 15 days after the signing of a treaty at Ghent, Belgium, on December 24, 1814.

Though the battle did not affect the war's outcome, it made a hero of Maj. Gen. Andrew Jackson, the American commander (in cape under flag), and started him toward the Presidency. And it proved that British regulars, advancing with drill-field precision in the standard European tactic of the day, made easy scarlet-coated targets for a motley army of entrenched sharpshooters, including Indians, Jean Lafitte's pirates, and Santo Domingo Free Men of Color.

Veiled by morning mist, the British at-



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tacked on January 8, 1815, with the Mississippi on their left and a swamp on their right. As Jackson's troops waited tensely behind a rampart along dry Rodriguez Canal (left), the fog suddenly lifted. When the redcoats reached easy range, the Americans, three men deep at each rifle post, began to fire, load, and refire in a rapid rotation that withered enemy ranks. The British 4th Regiment lost three times more men than at Waterloo six months later.

Redcoats with scaling ladders were repulsed at the rampart. Sir Edward Pakenham, British commander, fell mortally wounded, and the attack collapsed.

Before invention of the camera, the artist was the news photographer of his day. From sketches made on the battlefield, Hyacinthe Laclotte, an engineer in the Louisiana militia, did this painting, reproduced as a print. Laclotte was an architect, engraver, and drawing teacher.

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Virginia plantation reflects the good life

THIS colorful diagram, betraying an unknown artist's innocence in perspective and proportion, depicts a prosperous estate of about 1825. The river could be the Potomac, James, or Rappahannock.

Cupola and symmetry of the owner's mansion copy the fashionable Palladian style of English country houses. Winding paths connect slave quarters and overseers' houses. Twenty-four-gun sloop of war, its cannon run out, heads downriver. A mill behind the solitary fisherman at right ground the plantation's corn.

Like many primitive artists, the painter expresses a personal interpretation of relative sizes. Trees loom impossibly tall. Weeping willow often was used as a symbol of mourning, suggesting that the painter may have intended his picture as a memorial for some member of the household.

Seminary's young ladies crown an honor student

OWNERS of the Virginia plantation on the page opposite may well have sent their daughters to a nearby boarding school, or seminary. The curriculum included literature, history, and languages, often taught by college graduates preparing to enter the ministry or law practice, possibly the frock-coated young gentlemen at right.

Women faculty members taught the more feminine arts. Sewing, embroidery, music, and painting were combined with dancing, beadwork, and papyrotamia, or cutting paper designs so fashionable for valentines. From the painting classes came many examples of amateur art characterized by delicate coloring and sweet sentiment.

Richmond, Norfolk, and Williamsburg were among Virginia cities that had seminaries for young ladies by the early 1800's. Educators differed on whether women should receive schooling on a par with men. Said one: "Women are not destined to be Navigators, nor Opticians . . . nor Doctors in Medicine." But he obviously was not master of the school whose prospectus announced that its young ladies were "expected to study philosophy from the original text of the master and use no easy compendiums."

Here a dignified company gathers for a graduation exercise. The music stops, the valedictorian reads, and a lady in waiting places a wreath on the head of an honor student. High-waisted gowns reflect the neoclassic fashions of about 1810.

The unknown artist of "A Ceremonial at a Young Ladies' Seminary" probably was a student of botany and possibly a painting instructor at the school. He reveals amateur status only in inability to depict figures correctly. Composition and subtle harmonies reveal natural talent. Complex organization of space, involving the receding vistas at left and right, suggests a stage setting.

Friends toil and frolic at a flax-scutching bee

ONE of the hardest household chores in the early American home was preparing flax so that it could be woven into linen.

Here neighborly aid lightens the work of scutching, or separating fibers from woody stalks. The flax brake, or grinding machine, at left crushed the stalks. Paddles, known as swingling knives, beat the fibers over boards until they broke free.

This assembly line, painted about a hundred years ago, combines work with horseplay, rustic courting, and plenty to eat and drink.

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Buxom grandmother at left smokes her pipe.

Buildings portray two types common to the frontier. Log house at left has shingled roof, glass windows, and stone chimney. Cabin at right, made of unhewn tree trunks, exposes chinks that remain to be filled with moss and calked with clay. Its breezeway, or "dogtrot," proved a popular spot in hot weather. Crossed staves below the lean-to rasped husks off ears of corn.

Artist Linton Park, son of a Pennsylvania pioneer, was trained as a furniture maker and gained fame as the inventor of a type of Venetian blind. This painting, sold for $10, hung for years in the Houk Hotel in Indiana County, Pennsylvania.

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Polar bear eyes whalers, in an artist's imagination

CHARLES S. RALEIGH, the artist, ran away to sea at the age of 10. After more than 30 years before the mast, he settled down as a house painter and marine artist in Massachusetts, first in New Bedford and later at Bourne. His artistic output included portraits of President Cleveland and Admiral Dewey, and "Chilly Observation" (above), painted in 1889.

To portray the intricacies of rigging, Raleigh used brushes of two or three hairs. When he died in 1925 at the age of 94, he left more than 1,100 paintings. Prices for his work ranged as high as $1,500.

Although he never sailed on a whaling voyage, Raleigh painted more than 600 whaling pictures, garnering his information from retired whaling captains.

The polar bear betrays the artist's unfamiliarity with animals, but Raleigh correctly depicted the boats pursuing the whale in the background. Whaling vessels, hove-to for the launching of crews, are drawn and rigged with an expert eye. Dark object hoisted up the side of one ship is blubber being stripped from a whale.

"Skating Scene" captures fun during a cold snap

JOHN TOOLE, an Irish immigrant, studied briefly at the University of Virginia, then devoted his life to painting.

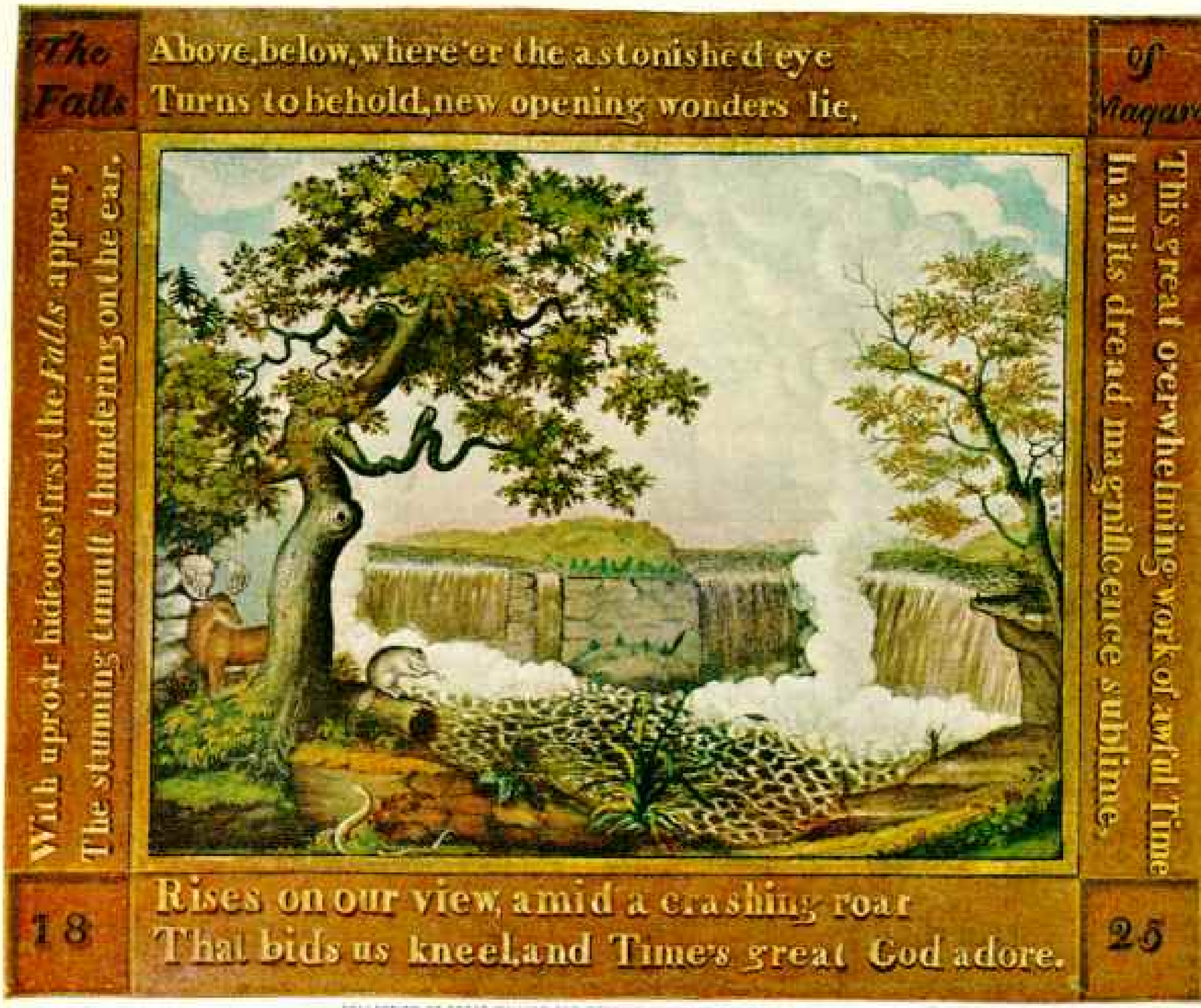
Because training was virtually unavailable, his early pictures, like this example, inevitably were in the primitive style. Later, with the help of do-it-yourself drawing books and undaunted ambition, he developed a more sophisticated manner, so that toward the end of his career he supported his family of six children solely by means of his many portrait commissions—a considerable achievement for a self-trained artist.

Toole's correspondence gives a vivid insight into the life of an itinerant painter in early America.

"I have engaged a good many portraits to do in this place," he wrote to his wife from Orange, Virginia, in the 1840's, "and many of the neighboring farmers talk of having their portraits painted. I have five portraits finished. I have done 2 miniatures at 10 dols. and one crayon likeness at 3 dols. My reason for being so particular is to show you that I am doing more than clearing my expenses. I pay 5 dols. a week for myself and horse, and the use of a room to work in, and I think it is enough.

"I will have to credit some of this work: but I first find out whether a man is responsible or not before I engage work from him on those terms. But you wish to know how I a stranger can ascertain this. I will tell you; I have found 5 good brother Masons here and if a man talks of having work done I go to one of them and inquire whether or not he is good pay. . . ."

In this scene, painted about 1840, broad-hatted boys with curved sticks play a game of shinny, named for the damage that the sticks caused to the shins. Toole's picture may be the earliest known representation of this forerunner of ice hockey in the United States.



COLLECTION OF EDGAR WILLIAM AND BERNICE CHRYSLER GARBISCH (ABOVE AND RIGHT) © NATIONAL GEOGRAPHIC SOCIETY

"Mighty Wonder of the World," Hicks described Niagara

FOR QUAKER Edward Hicks, nature's vast scale provided not only an awe-inspiring spectacle but a reminder of the lost paradise in the Garden of Eden.

Hicks saw the falls in 1819 during a 3,000-mile horseback trip in which he combined sightseeing with preaching. He painted the picture several years later.

Moose, beaver, rattlesnake, and eagle symbolize an untamed America, and the diminutive figures probably represent mankind dwarfed by nature's forces. Inscription around the border comes from Alexander Wilson's poem "The Foresters."

Sign painters double as portraitists

ARTIST-CRAFTSMEN trained in sign painters' shops were responsible for many primitive paintings. Anything that required paint—window sashes, shutters, political posters, and portraits—fell within the range of such establishments. Here a member of the firm mixes pigment with oil on a slab (left). Man at right holds a house painter's can and brush. The presumed head of the shop finishes a Washington portrait for a political placard. Found in Connecticut, the painting is undated and unsigned, but details of clothing roughly place and date it in the New England of the early 1850's.

Noble red man or howling savage?

FROM the European-American's point of view, the Indian had two distinct personalities. East coast city dwellers regarded him as a splendid creature reminding decadent civilizations of the golden age when man was free to live a simple life in harmony with unspoiled nature. To pioneers on the frontier, he loomed as a figure of terror and symbol of sudden death.

This painting, done about 1820 by an unknown primitive, seems to combine the two points of view. The statuesque figure is believed to represent the Oneida chief Shikellamy, whom the Six Nations of the Iroquois in the early 18th century sent as envoy to tribes in the Susquehanna Valley to try to stop land sales to white men.

The painting was found in Sunbury, Pennsylvania, which honors the chief with a bluff called Shikellamy's Profile.

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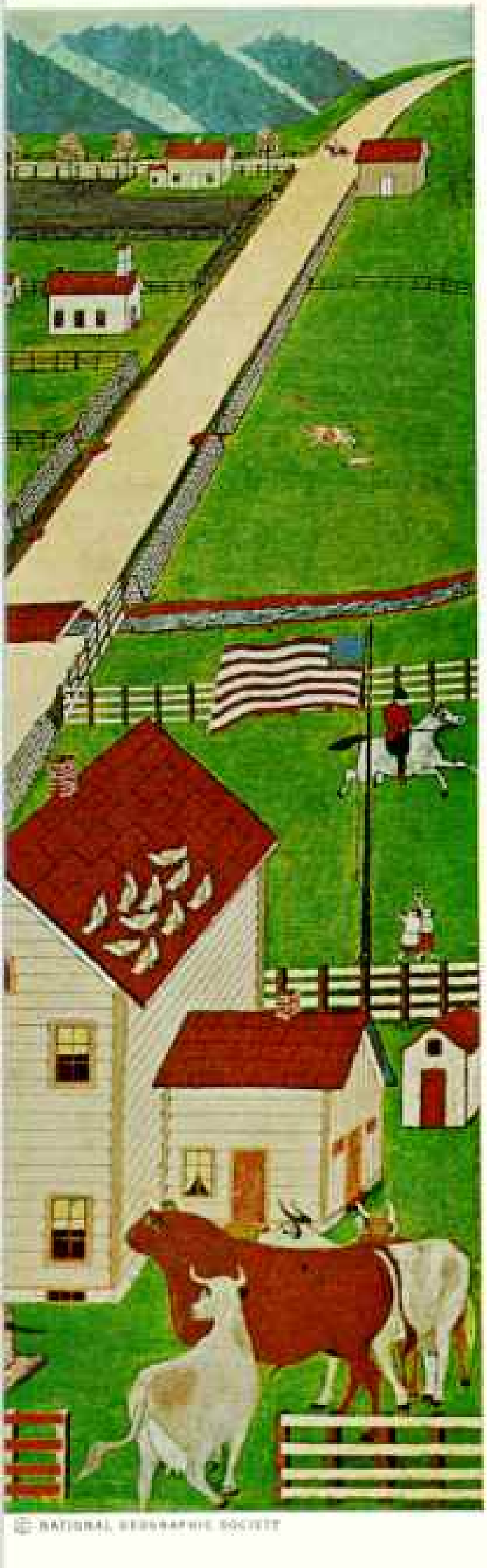
Acres, barns, and beasts: a rich farmer's inventory

MANY OF THOSE who achieved success in the New World wanted not only portraits but factual records of the tangible assets accumulated in a life of hard work.

In this painting, done about 1860, the owner of the prosperous Pennsylvania farm probably insisted that the unknown artist render a precise inventory of his worldly goods, with the stress on those that indicated his social status.

Over the house flies the Stars and Stripes, and pigeons congregate on the roof. Gun in hand and dog at foot, the farmer sets out for a hunt. His wife goes walking. A fine riding horse stands tethered to the tree in foreground. Distant hunters take aim in a copse well stocked with quail and deer.



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Crow's-eye view of old Poestenkill

NEXT PAGE

MANY primitive landscapes rank as historical documents, giving researchers information about architecture, town planning, and living conditions not available from other sources. Poestenkill, New York, presumably began as a few houses clustered around a crossroad. A home on a long, narrow lot usually started as a two-story box with a gable roof to shed snow. Stable, carriage house, and barn stood in the back yard. As the family grew and prospered, additional rooms and perhaps a front porch were added. To meet community needs, a schoolhouse, town meeting hall, and churches sprang up. Today Poestenkill retains its small-town flavor, though burgeoning Troy lies only seven miles away. Artist Joseph H. Hidley, taxidermist and cabinetmaker, was born in Poestenkill and lived there all his life. He must have known the owners of every house in the picture, which he completed about 1855. He painted five versions of the scene, which he viewed from an imaginary hill.

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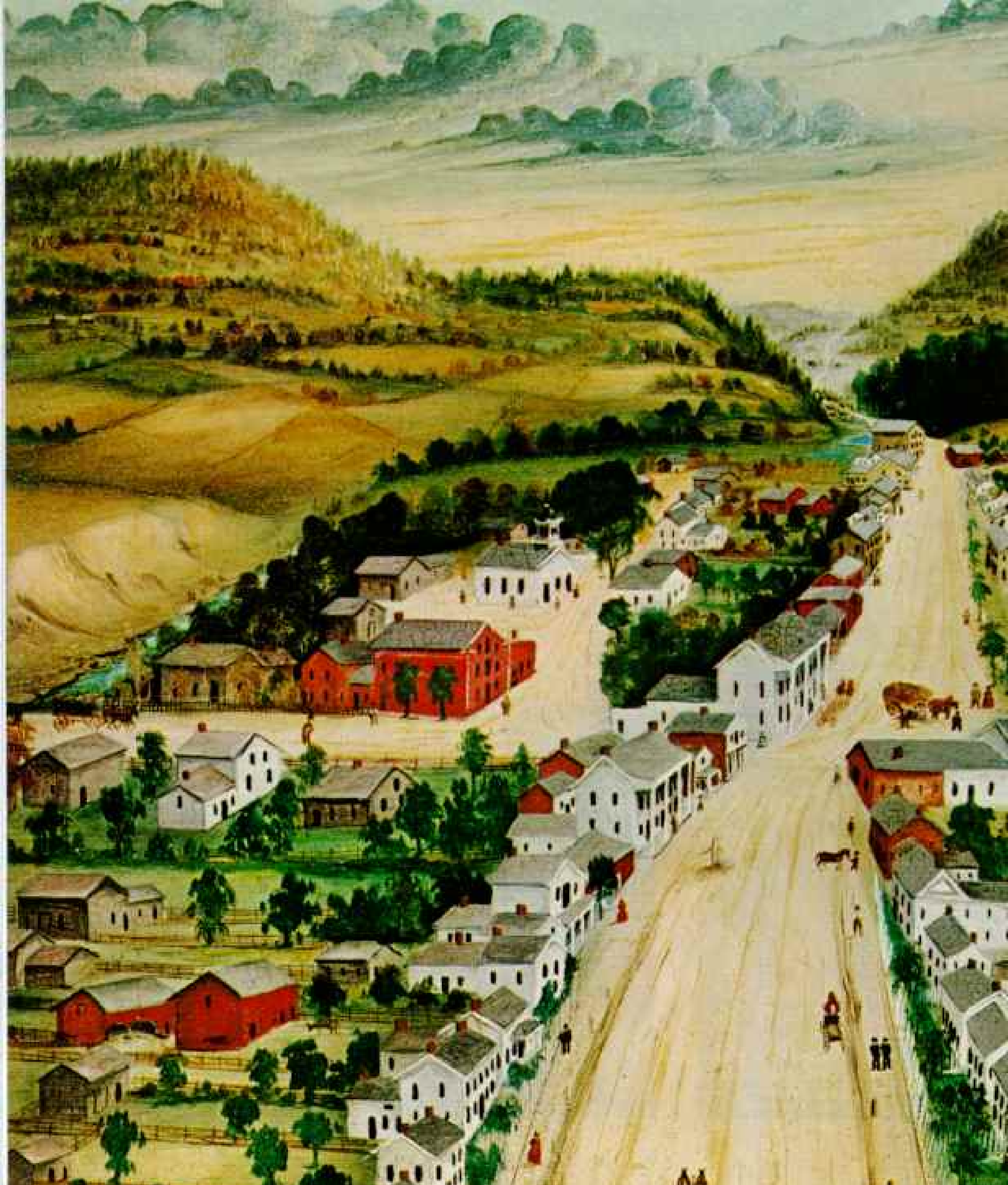
Early primitive painters, often craftsmen trained in the traditions of conscientious work, usually painted all parts of a picture with equal attention to detail. Here the leaves on the trees stand out as plainly as the human faces.

Lacking the rudimentary equipment of their trade, artists often had to make do with whatever they could find at hand. This picture was painted on a window shade converted to an artist's canvas.

Fruit and flowers make a gay still life

BRIGHT COLORS and the availability of models made still life a favorite American subject. Designs similar to this one painted by an unknown Marylander about 1835 reflect gratitude for an abundant harvest. They are found on furniture, china, embroidery, hooked rugs, and stenciled walls.



Wagonsmith Studebaker works in a California shop

IN TOP HAT, full beard, and apron, young John Mohler Studebaker stands in a smithy in the gold-rush community of Old Dry Diggings, popularly known as Hangtown, now called Placerville.

Gold fever drew Studebaker west in 1853 when he was 19. Leaving South Bend, Indiana, where his brothers made wagons, he arrived in Hangtown with only 50 cents. He made wheelbarrows for miners, acquiring the nickname "Wheelbarrow Johnny," and later repaired wagons and stagecoaches.

Five years later and $8,000 richer, he returned to South Bend and bought out one brother's share in the family wagon shop. The business thrived, became the world's largest wagonmaker, then made a successful leap into the manufacture of automobiles. Mr. Studebaker became president of the firm, a philanthropist, and a national figure before his death in 1917.

American primitive painting often reveals details of daily life not generally recorded before the wide use of photography. No verbal description could match this painting by H. M. T. Powell in showing what a wagon shop looked like in the mid-1850's.

The wagonmaker stands surrounded by tools and materials of his trade—straight bands at left, anvil, axle heating in the forge, overhead bellows, and, on the floor at right, some bolts and a dropped axle, which permitted a lower center of gravity.

Today a plaque marks the shop site. Powell's painting is probably the only authentic representation of its appearance.

Tradition says that Powell was the son of an English book and print dealer. He followed the '49 gold rush to California. An illustrated diary of his journey over the Santa Fe Trail tells of his trials and shows the disillusion of many who sought easy riches "just for the digging." In 1850 Powell made drawings of Los Angeles, San Diego, and Santa Barbara.

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Philadelphia in 1820

JUDD'S HOTEL, which stood at 27 South Third Street, won fame as a stopover for passengers of some of America's fastest mail coaches. Carriage at left took but a day to reach New York.

Cobblestone streets, brick houses, and stores with small-paned display windows were standard in many Eastern cities during the early 19th century. Sidewalk stanchions supported awnings to shade passers-by. Small plaques on walls announced that the buildings were protected by private fire companies.

Knowledge of perspective and realistic treatment of surface textures indicate that the unknown artist had acquired some professional training.

Carefree days: the family at home

A WELL-TO-DO family poses for a portrait, thereby giving us a glimpse of life in Hartford, Connecticut, during the 1830's.

Whoever commissioned the painting evidently insisted that not only faces but hobbies and pets be represented down to the last detail. Father concentrates on the

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newspaper, while mother, in ringlets and bonnet, pauses in her needlework. Eldest daughter, in lace pantalets, holds a lacquered chest. Her senior brother teases his dog, while junior does homework. To the right, a puppy considers the wisdom of disturbing a cat. Shuttlecock and battledore attest the popularity of indoor badminton. Pampas grass decorates the fireplace.

The artist painted a duplicate of his picture above the mantelpiece, and in it he shows an exact miniature of the scene.

H. Knight signed and dated his picture "1836" but left no other record of himself.

COLLECTION OF EDGAR WILLIAM

In bare-knuckle days, two teams square off

PRIZE FIGHTING without gloves was outlawed in almost all sections of the United States in the 19th century, but sub rosa duels took place in the country and even on barges to avoid police interference. Attendance, by invitation only, was restricted to small numbers of the "fancy," or sporting fraternity, who wagered heavily.

Historians confess bewilderment at the form of pugilism depicted in the scene painted by George A. Hayes about 1860. Perhaps because such fights were kept so secret, we lack written records describing teams of three men fighting in a circular ring. By analogy with modern team wrestling, one man may have taken the place of his beaten partner.

Referee, in red waistcoat, stands outside the ring on the far side. Timekeeper may be the bearded figure in a gray suit to his left. Managers and seconds stand in the ring beside the banners of their teams.

Adoption of gloves and the Marquis of Queensberry rules in 1866, shortly after Hayes painted the picture, transformed prize fighting into a legalized sport. Bare-knuckle pugilism died out, though surreptitious meetings continued until 1889.

Hayes was a true primitive in his use of flat colors, keen eye for incidental details, and his anxiety to show as much as possible, including every polka dot on the fighters' tights. Records of his artistic career are as scarce as information about the sport he depicted in his picture.

BERNICE CHRYSLER GARBISCH © NATIONAL GEOGRAPHIC SOCIETY

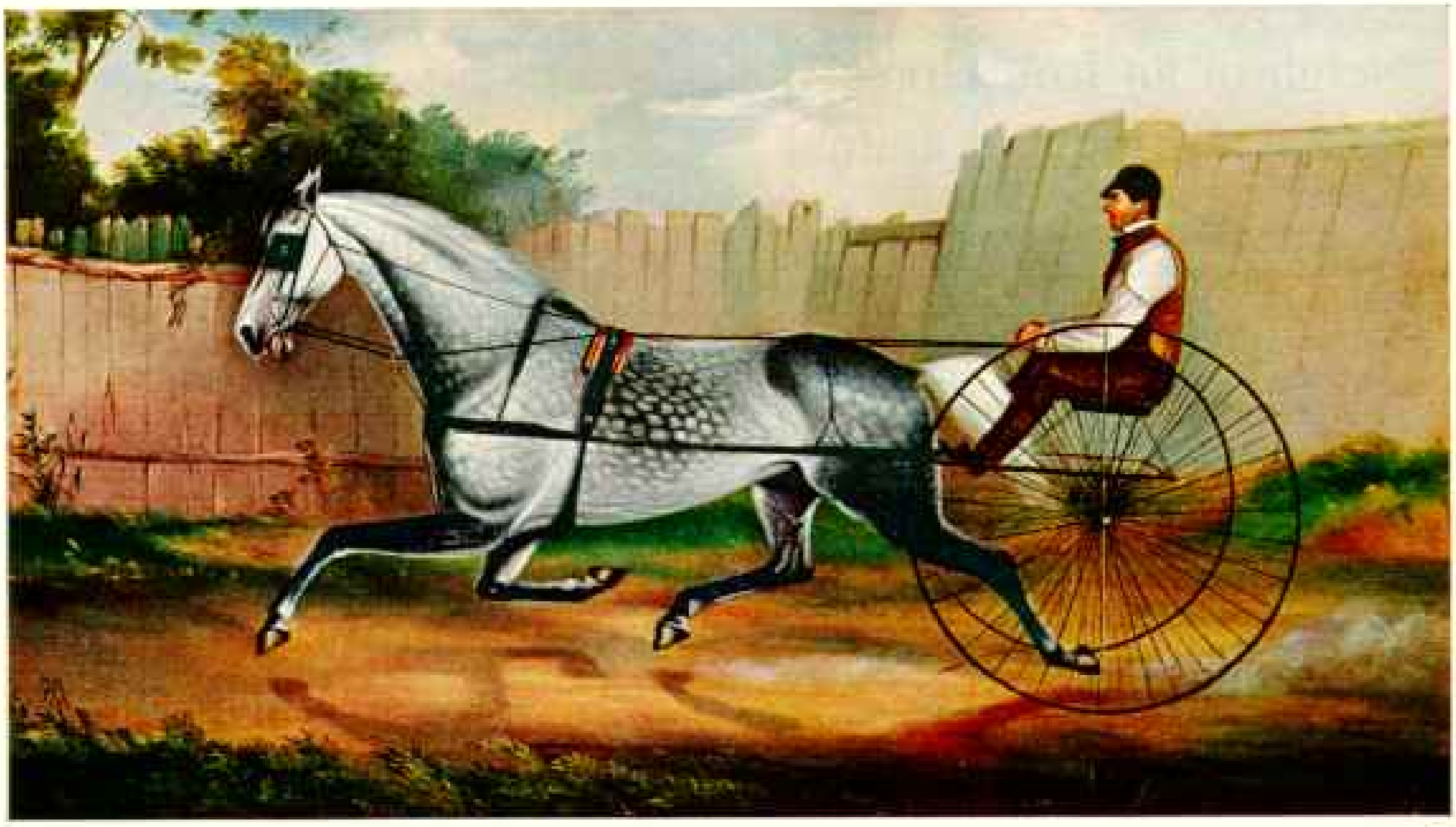
"In Full Stride" pays homage to the horse

THE horse was as important in 19th-century America as the automobile is to the 1960's, and it was natural that the Nation's artists should paint equestrian subjects in great numbers.

Currier & Ives published more than 600 different lithographs that prominently portrayed horses.

Americans developed the world's best trotters in the 19th century. Vast crowds attended races. A new speed record was an event of national importance.

Pictures of horse racing were an English specialty. This canvas, painted by an unknown probably in Pennsylvania about 1840, may have been inspired by a European horse portrait. The dappled racer appears in the trotter's characteristic full stride. High-wheeled sulky was precision-built for racing only on level roads and tracks.



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"Neigh of an Iron Horse" stampedes the real animal

A NEWFANGLED monster sends a shrill whistle across the countryside, spooking a pastured horse, which looks over its shoulder in terror. Flying mane and tail eloquently express the speed of flight and point frightened strands toward the source of imagined danger.

This 1859 painting, by A. Tapy, probably was made for the artist's own amusement as the record of a phenomenon he had observed in the countryside. Evidently he knew his subject well; he may have been a wagoner or blacksmith.

The anatomy of a horse in motion has presented problems to artists since time immemorial. Here the primitive painter, probably with little except firsthand observation to guide him, has produced an original and forceful image. He has been equally observant of the train. Students of engineering easily recognize the locomotive as an eight-wheel wood-burner of the early 1850's. The artist's scrupulous observation has not ended here; the plants could almost serve as illustrations in a botany book.

Primitive artists usually were precise about details. Occasionally, as here, they combined precision with vivid imagination and instinctive talent for design.

American collectors, beginning during the 1930's, realized that primitive paintings gave penetrating insight into the ideals, temper, history, and changing pattern of American civilization. Long overlooked by connoisseurs of fine art, the paintings now find their way into collections, where they win increasing approbation by the public.

Bird's-eye view of an Alice-in-Wonderland cat

MODERN eyes, accustomed to photographic realism, sometimes find it difficult to understand how the imagination of an untrained artist expressed itself. Except for portraiture, the primitive usually worked from sketches, notes, and remembered images. He emphasized and enlarged those features that seemed necessary to tell the story and explain the meaning of his subject. Thus he often ignored or arbitrarily altered correct relative sizes.

In this painting of about 1840, the artist's memory of a tabby cat stalking through a field was that of an enormous head, the rest of the body hidden in the tall grass. He recalled the field as a solid green mass with occasional weeds showing against the sky, and he showed trees as mere sticks to emphasize the ease with which the cat could reach top branches. The birds resemble a cardinal and two tropical American tanagers.

The unknown artist probably was a sign painter. In the United States until about 1860, virtually every store, inn, or shop displayed a placard with a picture or inscription advertising the services available within. A good sign had obvious meaning even to an illiterate passer-by.

Thus the sign painters developed a style of their own, using bold designs, bright colors, and eye-catching subjects usually portrayed in symmetrical patterns, so that the placards might be plainly visible from a distance, even on unlighted streets.

In order that the sign might endure and withstand the buffetings of weather, pigments and oils were applied in thick layers. Surfaces might crack, but materials remained tough. Similar techniques ensured survival of a considerable number of primitive paintings. THE END

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Strange Little World of the Hoatzin

Only the tangled fringes of tropical South American rivers offer survival to a raucous bird that climbs better than it flies

By J. LEAR GRIMMER
Associate Director, National Zoological Park
Smithsonian Institution

Photographs by M. WOODBRIDGE WILLIAMS

"WHAT'S A HOATZIN?" Perhaps the most intriguing answer is the description given in 1651 by a learned Spaniard, Francisco Hernández.

"The hoatzin," he wrote, "a bird uttering a curious note, sounding like its name . . . subsists upon snakes. . . . The bones of this bird relieve the pain of wounds in any part of the human body; the odor of the plumage restores hope to those who, from disease, are steadily wasting away. The ashes of the feathers when devoured relieve the gallic sickness, acting in a wonderful manner."

The trouble was that Don Francisco was not talking about the tropical South American hoatzin we know today, but was repeating folklore about a still unidentified Mexican bird, possibly a species of hawk. European naturalists, with only written notes to guide them, became confused; by chance they tied the Aztec name hoatzin (usually pronounced "wattzin") to the South American bird, and there it remains.

In 1909 the late William Beebe gave us the first detailed information about the hoatzin's curious habits. His observations in British Guiana convinced me that the truth about the bird is even more exciting than fiction. Here's a bird that has full-sized wings, yet flies clumsily. Young birds have claws on each wing and climb through vegetation like quadrupeds. Threatened, they dive into a stream and escape by swimming under water.

I first became interested in the hoatzin when I learned that the species had never been kept successfully in captivity. As a zoo man, I believe that any animal can be conditioned to captive life if its special requirements are known and provided for.

And if anyone could cajole these birds into domesticity, my wife Margaret could. One of the best foster mothers in the zoo world, Marg has successfully reared such exotic beasts as infant tigers, a snow leopard, a striped hyena, and a reindeer fawn. Why not hoatzins?

"Stinking Hannah" Puzzles Scientists

Digging into the literature, I was surprised to discover how little was really known about the hoatzin's behavior. Guianans say it has an unpleasant odor, and until recently they wouldn't eat it. They dismiss it as an unimportant bird, though they have given it a confusing variety of names: "Anna," "Hanna," "Canje Pheasant," "Governor Battenberg's Turkey," and "Stinking Hannah."

Scientists are puzzled by the hoatzin's many unique characteristics—both anatomical and behavioral. Ornithologists isolate it in a family and suborder all to itself and debate its true relationship to other birds.

Even the bird's range is in part uncertain.

Floppy wings fighting for balance, a hoatzin teeters on a *mukkamukka* stalk in British Guiana. An unlikely bird, *Opisthocomus hoazin* climbs expertly through branches but flies poorly, swims as a fledgling to escape danger, and sometimes exudes a musky odor. Author J. Lear Grimmer studied the pheasant-sized birds on three Smithsonian Institution expeditions, two of them co-sponsored by the National Geographic Society.

KODACHROME © NATIONAL GEOGRAPHIC SOCIETY

Evidently restricted to a narrow fringe of vegetation along tropical streams, *Opisthocomus hoazin* has been reported in widely separated localities in the Amazon and Orinoco watersheds (map, page 395).

The more confusing and contradictory material I uncovered, the more determined I was to study these birds in their habitat, and to bring some back to live in the National Zoological Park in Washington, D. C.

To that end, I led three expeditions to British Guiana for the Smithsonian Institution—two of which received support from the National Geographic Society. Operating from headquarters on the Abary River, 35 miles southeast of Georgetown, our party uncovered a number of hitherto unknown facts about this remarkable bird.

As it turned out, our first trip, during the drought in the spring of 1959, was mainly exploratory because the hoatzins did not nest that season. But we located nesting areas, saw many birds, and set up a base camp for future use.

Our second expedition picked up from there. Accompanied by photographer M. Woodbridge Williams, Marg and I reached Georgetown in July, 1960. Ram Singh, chief taxidermist at the British Guiana Museum, told us the hoatzins were just starting to nest.

Ram, through the kind permission of Mr. Vincent Roth, director of the museum, was able to go with us. He is an expert on birds in this part of South America, and if he said we had hit their nesting season, we undoubtedly had. I was eager to see.

Brooding hoatzin nests above an escape hatch. When threatened, youngsters unhesitatingly dive into the water and swim to a tangle of vines downstream (page 398).

© NATIONAL GEOGRAPHIC SOCIETY

Spying on hoatzin home life, the author and his wife Margaret mount a floating platform on the Abary River. Television viewers remember Mr. Grimmer as the long-time staff associate of "Zoo Parade."

Quickly loading our gear on one of the coastal trains, we headed for hoatzin country. At the junction of the railroad and the Abary River lies a 3,000-acre rice, cattle, and coconut estate called the "Letter T." Here we had set up our base camp, and now, as we got off the train, we were welcomed by Maurice Barlow, manager of the estate. Minutes later we headed upriver in our little cockleshell of a motorboat, the *Stinkin' Hannah*. There was no drought this time; the river was swollen from recent rains.

Feather Duster Flails the Air

"There's a hoatzin now!" called Marg.

All of us looked up. Perched on an overhanging branch was a bird about two feet long—roughly the size of a pheasant. Its plumage—reddish brown and olive, and streaked with black and white—was like a floppy feather duster. Long crest plumes waved in the breeze, and bright red eyes watched us warily. The bare skin around the bird's eyes was an electric blue (page 401).

As our boat came closer, the hoatzin took off like a weary helicopter. Flailing its way across the stream, it disappeared in the thick vegetation on the other side.

After chugging another few hundred yards upriver, we came to "Camp Hoatzin," two cabins built high on stilts, blissfully surrounded by coconut palms and tremendous mango trees covered with ripe orange fruit. Waving to us from the bank was a huge man, his white teeth flashing in a grin against almost coal-black skin. He was Ivan Vyfhuis, our cook and major factotum. He'd come on ahead to get the cabins ready.

After supper we discussed our plan of operations. For the first week or so, we decided, we would observe the birds and nests that Ram had already located, and find as many others as we could. After a careful study of the hoatzin's nesting habits, we would take some young birds and try to condition them to captive life.

Maurice told us of an unusual behavior pattern of the birds that he had observed while clearing land along the river for new plantings of coconut palms. About seven

KODACHROMES BY B. WOODBRIDGE WILLIAMS © NATIONAL GEOGRAPHIC SOCIETY

hoatzins were living in the trees that Maurice leveled with his bulldozer.

"As soon as we finished, those birds came back to the very same spot they had occupied before," he declared, "even though the trees were uprooted and dying."

"Wasn't there any vegetation left for them to eat?" I asked.

"No," said Maurice regretfully. "I tried to chase them off, but they wouldn't leave. They apparently starved to death, though other hoatzins were living in plenty of vegetation no more than a hundred yards away."

Here's a bird, we agreed, that is either so primitive or so specialized that it cannot adapt to any abrupt change.

It was raining the next morning, and the Abary was almost at flood level. Now the black waters were swirling close to the base of our cabin pilings.

Rain, She Use a Rolling Pin

"Today she's a woman's rain," Ivan volunteered as he cooked breakfast. "She pound you all day, she in a bad mood. A man's rain is *whoosh* . . . then it is through."

A particularly violent gust hit us. "Now she is angry," said Ivan. "She beat you with a rolling pin!"

Rain or no rain, we took out our binoculars and spotted a hoatzin from the window of our cabin. It was sitting on the nest as immobile as the Sphinx, raindrops trickling from the end of its beak.

Hoatzin habitat: waterways in the Amazon and Orinoco basins. Map at right shows the Abary River, scene of the author's studies. See also the Atlas Map, **Eastern South America,** distributed with this issue.

ANSTOMORNIS (ADULT) AND ITS FATHER/MOM © N.G.S.

Fearful hoatzins watch the approach of a deadly enemy—man. When intruders draw too close, the adults lurch into awkward flight or flounder into the foliage.

Authorities differ on pronunciation of the bird's name, though most prefer "wattzin."

Wings raised defiantly, a hoatzin called Lenore stands her ground as the author nears her nest. "I got so close she pecked me on the nose," he reports. "Only then did she retreat." Mr. Grimmer gave this bird a feminine name even though a hoatzin's sex cannot be determined without dissection.

A few minutes later, the rain ceased abruptly and the sun broke through the clouds. Ivan was proved wrong—both as a weather prophet and as the judge of a rainstorm's sex. Soon we were out in the little aluminum boat looking for hoatzins in earnest. By noon we had spotted a score or more birds and examined several nests.

During the next several weeks we were at it from dawn to dusk and often far into the night, scanning the dark foliage with lights which we wore on our heads like miners' lamps. We marked nest locations with strips of white cloth, observed the birds' activities, and took voluminous notes.

Early morning and late afternoon seemed to be the most active feeding times. As far as

Hungry fledgling thrusts its beak into a parent's gullet to dine on baby food—a mush of leaves regurgitated from the adult's crop.

Using wings as forelimbs, a day-old hoatzin chick scrambles past an unhatched egg.

we could determine, the hoatzin never eats anything but leaves, buds, or pulpy seeds. No fish. No insects. Not even any fruit. Although leaves of the pimpler thorn, monkey apple tree, and vines are taken, the favorite food by far is the big heart-shaped leaf of the *muk-kamukka,* or arum, a plant that grows in dense ten-foot-high stands along the Abary. Grasping the stalk with big clawed feet, the feathered vegetarian tears into this green salad with gusto.

As one of many peculiarities, the hoatzin has an enormous, heavily muscled crop that occupies most of the forward third of the body. Here stored food undergoes preliminary digestion.

Crash-landings Routine

Another peculiarity of the bird that intrigues the ornithologist is a flattened disk on the keel of its breastbone. This strange structure helps support the hoatzin's weight as it crouches on a branch.

The uniquely shaped keel—which anchors wing muscles and provides leverage for flight—is astonishingly small for the bird's size.

Add to this the fact that the feathers are loosely attached, and you begin to understand why the hoatzin is one of the world's most inept flyers. An average flight covers less than a hundred yards.

Launching itself with flailing wings, the hoatzin gives a protesting cry with virtually every stroke. The inefficient aviator soon runs out of energy and crash-lands in the trees. Long-toed feet grasping at every branch, the bird usually drops several feet through the foliage before stopping, upon which it gasps a final squawk. The feathers become wildly disarrayed by such exertion.

After observing hoatzins for three years, I am convinced that their breeding period is triggered by the onset of the rainy season. Two rainy seasons a year—two nesting cycles. No rainy season—none. That is why, when the rains failed during our first expedition, we observed no nesting activities.

The birds often assemble in sizable flocks during the dry months. With the first rains, these flocks begin to split up into smaller "nesting associations," or family groups—

Downy wings, each armed with two claws, enable a young hoatzin to climb through a thorn bush. When the birds molt into their first adult plumage, they lose the claws, but mature birds continue to use wings in clambering through thick foliage.

usually consisting of two to six members.

Within this nesting association, the individual birds appear to mate indiscriminately. Each contributes to the succeeding activities of the group: building the one nest that serves them all, incubating the eggs, caring for and guarding the young.

Stiff Bows Signal Changing of the Guard

The nest, crudely constructed of twigs, looks much like a heron's (page 392). From the boat we could usually count the eggs—buff-colored with a dappling of brown or bluish spots—simply by peering upward through the flimsy platform of sticks. About the size of pullet eggs, they usually numbered two or three (opposite). Occasionally we spotted as many as five.

Incubation lasts about 28 days. The birds begin to sit as soon as the first egg is laid, and the young hatch out in regular succession.

Male and female adults are indistinguishable in appearance, but apparently both sexes help incubate the eggs. The birds usually exchange brief but formal bows before they shift places. We could count on seeing this "changing of the guard" in early morning and late afternoon.

We saw other shifts during the day, and several times observed two birds on the nest at the same time. I could not discern any difference in the activities within a group to indicate that one individual was the nesting hen, another bird her true mate.

Soon, however, we discovered that hoatzins are magnificent in defense of their eggs and nestlings. Again and again the gallant adult birds set up wild outbursts of warning calls as I neared a nest, and acted as if they were about to attack. I have approached a

brooding adult so closely that she—or he—pecked me on the nose!

Man undoubtedly is one of the hoatzin's chief threats. Trigger-happy "sportsmen" sometimes kill the birds just for the fun of it. And every year land-clearing operations swallow up more of their already restricted world. Some nestlings are inevitably lost to the swift currents of the river. Other limiting factors are mouse opossums, squirrel monkeys, tree boas, and birds of prey that eat the eggs and young.

One day Woody Williams was just minutes away from seeing a hoatzin hatch. He did see the chick before it had completely dried: a scrawny, dark-gray baby huddled amid broken eggshell. The parent bird was eating the shell—something that had never before been observed, as far as we knew.

Although the appearance and actions of the adult hoatzin are strange enough, those of the baby are even more peculiar. At first the chick is almost naked. But soon it grows a reddish down, and the blue sheaths of feathers start to appear on wings and tail. Each wing has two sharp claws, one on the

Swimming to safety after a dive from its nest, a chick paddles toward a tangle of vegetation. When danger passes, adults guide the youngster back to the nest.

Windmilling wings propel a wide-eyed fledgling through the depths of an aquarium at the author's Abary River camp.

KODACHROME (UPPER) AND KODACHROMES © NATIONAL GEOGRAPHIC SOCIETY

"thumb," another attached to what corresponds to our forefinger. The chick can use these claws for climbing when it is only a few hours old. But for a few days it usually sticks close to home base.

One of the great sights we remembered was seeing a baby hoatzin entice an adult bird into feeding it. A series of infant musical pipings induced the parent bird to pump up a mush of mukkamukka or other leaves from its crop and open its beak. The fledgling then thrust its head into the adult's mouth and gulped down a meal (page 396). When it is 10 to 14 days old, the youngster begins to sample the greenery surrounding the nest.

Long before the chicks learn to fly, they venture out of the nest and start to climb about in the tangle of vines and branches surrounding their home. At this time the adults protect the unfledged chicks in an amazing way. I have seen a "family" of five mature birds spread their wings to form a continuous protective cover. Beneath this feathery umbrella, the chicks progressed along the branches, safely hidden from the eyes of eager predators.

Claws on wing and feet anchor a young captive hoatzin. Wing claws on the upper branch correspond to nails of the thumb and forefinger on the human hand. What appears to be a third wing claw is actually on the middle toe of the bird's right foot.

Fleeing Chick Goes Submarine

The youngsters use their well-developed wing hooks to good effect in moving about, as well as their beaks and the claws of their oversized feet. Sometimes one will hook its entire head over a limb and use beak and neck as climbing aids.

But most interesting of all is the escape behavior of a threatened nestling. I well remember the actions of one of the first chicks we tried to catch. It couldn't have been more than ten days old.

Crouching on the edge of the nest, the tiny bird waited warily until I was almost within reaching distance. Then, without hesitation, the nestling plummeted ten feet downward into the river—probably its first venture into the unknown.

Using its wings as paddles, the little hoatzin swam underwater a few feet downstream to the tangled growth of the riverbank. There it popped up and stared at me with bright, knowing eyes. Sheer courage. I didn't have the heart to pursue it any more, and so I retreated. I knew the youngster would climb out later. Guided by an adult, the little bird would clamber through the branches until it was safely home.

Every hoatzin nest we observed was over water, with a protective canopy of vegetation above it and a clear escape chute below, so that the youngster could dive into the water —anywhere from six to twenty feet below— if danger threatened. Invariably there was an additional safety feature, a curtain of tangled roots and vines downstream in which the nestling could take refuge before climbing back to the nest.

Hoatzins use a variety of notes to communicate with one another. We distinguished five different adult calls: a clucking noise sounded during courtship, or while changing positions on the nest; a "meow" uttered while feeding; a wheezing note of surprise or discovery; a sharp screech when captured; and a soft growling expressed while feeding the nestlings or leading them to safety.

The young have two characteristic notes besides the shrill piping when they are hungry. If danger threatens, they make a hissing sound. After diving into the water and swimming to the bankside vegetation, they give a distinct "squeeownk"—evidently a signal

to let the adult birds know where they are.

We had come to study hoatzins in captivity as well as in the wild, and so we needed to capture some of the birds. The hoatzin is easily taken at night while asleep on the roost; you just shine a bright light on the bird, then lift it gently and painlessly from its perch while the beam holds it transfixed.

Our head lamps left our hands free for the capture. If the birds nested above arm's reach, as was often the case, we used long poles with nooses on the ends.

We set forth on many a dark night to cruise the opaque waters of the Abary. As we scanned the shore for roosts, our lights often caught the eyes of tree boas, a dozen or more sets of pinpoint reflections amid the thorny growth in a single sweep of the beam.

The snakes were no hazard, but wasps were—because of the hoatzin's habit of nesting near the insects. I remember particularly one painful morning when my hands were so stung and swollen that I had dimples where the knuckles should have been.

Another hazard was being pitched into the river from our cork of a boat while handling equipment or reaching out for bird roosts. I got several wettings, but I think of one in particular. It was night, and only the faint glow of my head lamp showed my companions in the boat where I had gone under. When I finally surfaced and grasped the boat, spluttering and soggy, Woody Williams was busily adjusting his camera.

"Let's do that one more time," he said.

Special Diet Lacks Key Element

By day and by night we were uncovering all sorts of interesting facts about the life and habits of hoatzins. But keeping them in captivity was another matter. Concentrating on young birds this time, we constructed a holding pen near the river, complete with plants for them to sit in and an old sunken rowboat for a swimming pool.

Marg prepared vegetable food in a Waring Blendor, and fed the young birds with a syringe. For a while they seemed to flourish on the substitute diet. But gradually each youngster sickened and died. Apparently our mixture lacked some enzyme or catalyst vital to the digestive processes of the young and furnished only by the adult birds.

In 1961 we returned once again to British Guiana, accompanied this time by Dr. Wilhelm Marinelli, Professor of Zoology at the University of Vienna. First morphologist and anatomist to see the bird in its habitat, he gathered valuable data on its bones and muscles that are still being analyzed.

"Charlie" Establishes a Zoo Record

On this third attempt, we came closer than ever before to solving the problems of keeping a hoatzin alive in captivity. Before leaving the Abary, we air-shipped three adult hoatzins to the National Zoo in Washington. One of these birds, which we named "Charlie," lived there for nearly six months—from July 31, 1961, to January 25, 1962.

Tame as a pet chicken, Charlie seemed to thrive on a diet of fresh lettuce, kale, and spinach, which he often insisted on eating from the hand of his keeper.

In the wild we had never noticed an odor about hoatzins that would earn them the name "Stinking Hannah." But keepers twice noted a strong, musky smell when they were in Charlie's cage. In each case the bird acted in a strangely aggressive manner. When it calmed down the odor disappeared.

Just as we were making progress in determining a proper diet, Charlie developed a tumor in the beak that proved fatal. Laboratory tests show that the hoatzin's native mukkamukka is extraordinarily rich in aluminum salts; the finding will help us greatly when next we attempt to feed captives. Incidentally, we discovered after our bird's death that Charlie was a female.

We've learned a lot about hoatzins during the past three years. And Charlie was with us long enough for me to be confident that this remarkable species can be kept successfully—and even bred—in captivity.

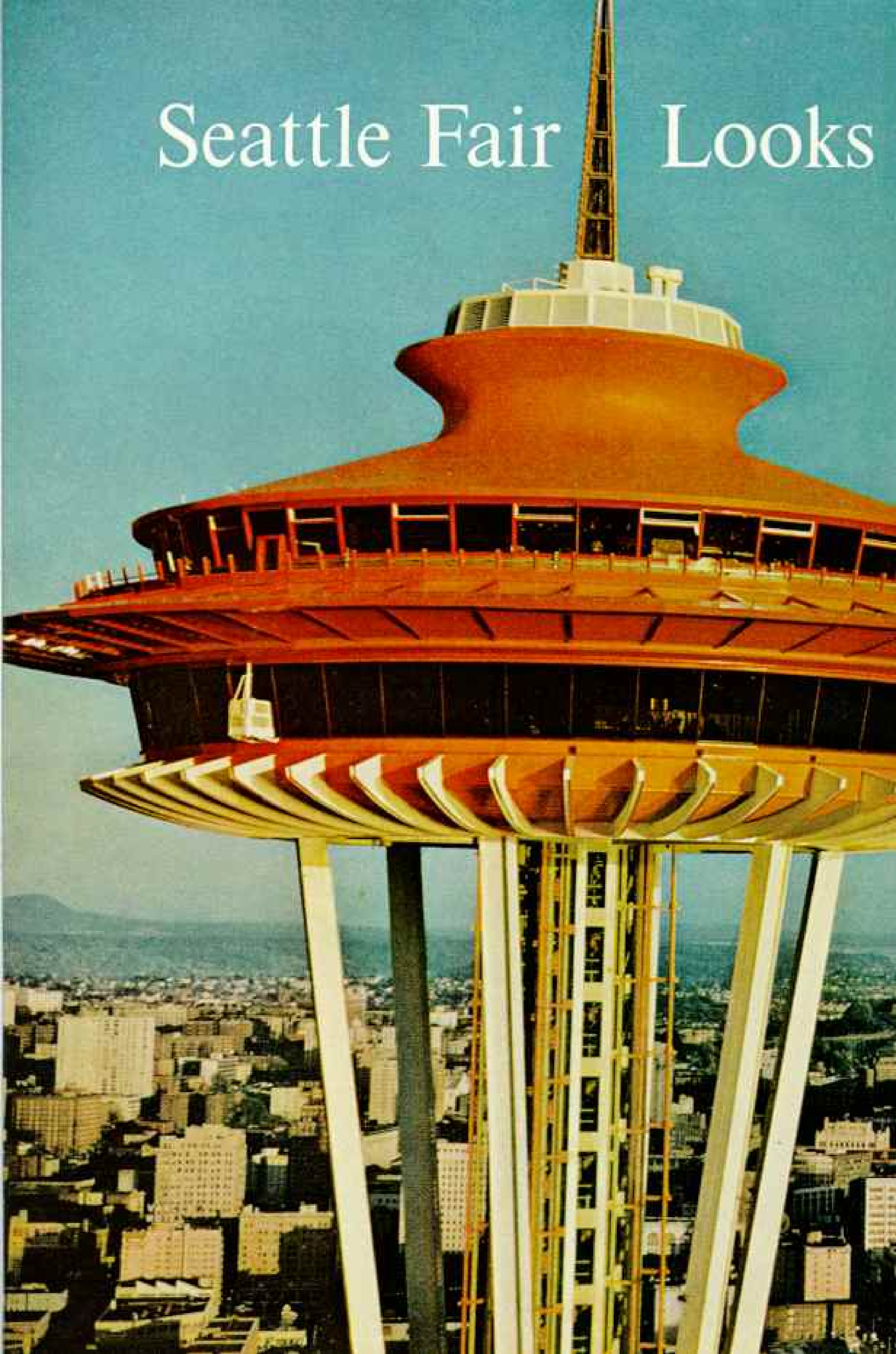
Perhaps the eventual solution will be to capture an established family group of the birds. Then the communal pattern that seems so important to their existence will not be disrupted. THE END

Plumed Crest and Beardlike Down Make the Hoatzin Appear Windblown

Eggs of bird lice dot the bare electric-blue skin around this adult's eye. Peculiar feathers resembling lashes protect the eyeball. Heavy bill allows the feathered vegetarian to chop bites from the tough leaves of the mukkamukka plant, a relative of the calla lily. Although hoatzins flourish in the wild, none lived longer than a few months in captivity.

KODACHROME © NATIONAL GEOGRAPHIC SOCIETY

Seattle Fair Looks



to the 21st Century

By CAROLYN BENNETT PATTERSON

Photographs by THOMAS NEBBIA, Both National Geographic Staff

"HOW DO I GET TO THE ROOF to catch my helicopter?" I asked the uniformed guard.

"Sounds as if you're already in the 21st century," he said. Fluttering aloft for a helicopter view of the Century 21 Exposition in Seattle, Washington, I felt I was riding a time machine that had, indeed, peeled away the less than forty years that separate this world from A.D. 2001. Two silvery monorail trains streaked a curving track between downtown Seattle and the Fair. Symbol of the Exposition, the 606-foot Space Needle rose like a gigantic sheaf of wheat, opening vistas of the city and snowy Mount Rainier (below). The United States Science

ANSCHUTZ © NATIONAL GEOGRAPHIC SOCIETY

REDACTED BY NATIONAL GEOGRAPHIC PHOTOGRAPHER THOMAS NEBBIA AND MELISSA BELL GROSSMAN (RIGHT) © N.G.

Pavilion, a vision of white with Gothic arches and crystal pools, lofted five shining towers domed in stony lace (page 412). Gleaming aluminum sheathed the sweeping roof of the Washington State Coliseum, site of the "World of Tomorrow" theme show.

On one side of the 74-acre fairgrounds ranged a group of buildings that will serve the Pacific Northwest for generations to come. Partly new, partly refurbished, the Seattle Civic Center includes a splendid Opera House, an Arena for sports, a Fine Arts Pavilion, and an 800-seat Playhouse (painting, pages 408-9).

Throughout the Fair fantasy prevailed in structures shaped like bubbles, stars, sunbursts, flowers, snowflakes, honeycombs, and rippling ribbons.

My time machine dropped down to its heliport atop the mid-Fair Armory, and I climbed out to meet the future face to face.

By Bubblelator to Tomorrow

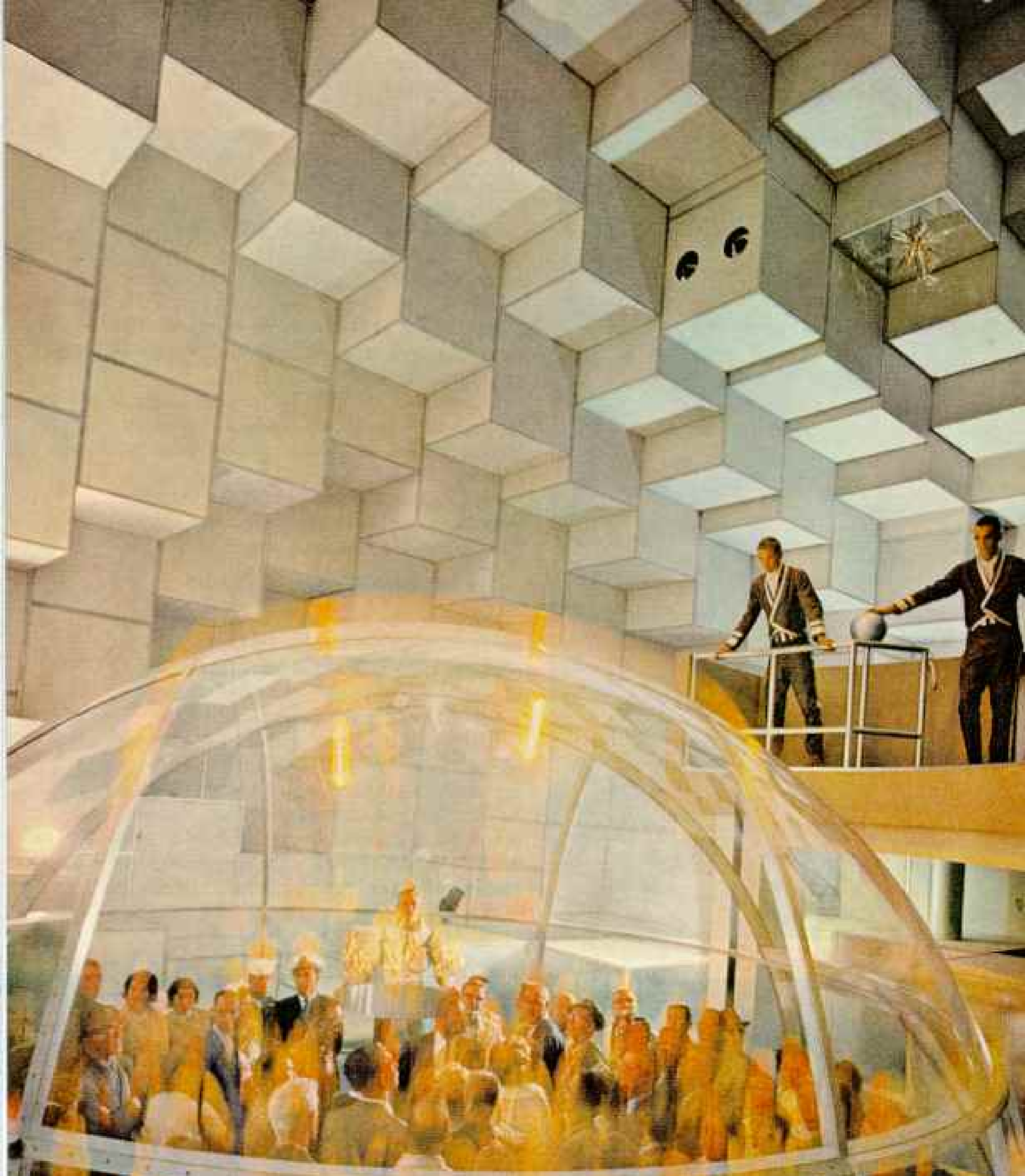
"Step to the rear of the sphere," called the operator of the Bubblelator, a ball-shaped elevator of Plexiglas that rises from the floor of the Coliseum into "floating" clusters of silver cubes near the ceiling (page 406).

I stood with my mother, Mrs. Nola Bennett of Kosciusko, Mississippi, whom I had brought to Seattle in celebration of her 80th birthday. In her lifetime my mother has witnessed man's most spectacular technological revolution, one that produced the telephone, automobile, airplane, electric power, radio, tele-

Riding a lazy susan in the sky, diners in the Eye of the Needle restaurant revel in a panoramic view. Downtown Seattle, Puget Sound, the Olympics, and Lakes Union and Washington pass in review. Snow-crested Cascades appear on the horizon at far left.

Only the dining area of the Eye moves, completing a 360° turn once each hour; windows and kitchen remain stationary. Patrons who leave purses on the window ledge find they have disappeared—to return 60 minutes later.

Space Needle cocktail, held by restaurant manager Jack Borg, comes in a Needle-shaped glass. Lake Union lies far below.



Bubblelator, a Plexiglas-covered elevator, rises into the World of Tomorrow, the Fair's theme show, sponsored by the State of Washington. Passengers step onto the platform at right and thread a walkway between aluminum cubes. Pictures and models depicting life in the 21st century flash on in succession.

Pageant of the past, lighting up screens, reminds spectators that the Sphinx, St. Peter's, Abraham Lincoln, and the Empire State Building were once part of man's future. "Tomorrow stretches out before us on a carpet of yesterdays," a guide explains—"the yesterdays we made."

HS EKTACHROME (ABOVE) AND KODACHROME BY THOMAS NEBBIA © N.G.S.

vision, and now space travel. At Century 21 Exposition she would glimpse miracles of an era she would not live to see.

The Bubblelator operator announced: "Utopia Century 21 . . . first floor, threats and thresholds, frustrations and fulfilments, challenges and opportunities." We stepped out.

Staged within some 3,700 interlocking four-foot-square aluminum cubes, the drama of the Exposition's theme show unfolds through films, special lighting effects, and three-dimensional models.

Music soared and softened, and pictures from mankind's yesterdays flashed on and off (above) as we moved along a walkway to a circle-shaped model of Seattle in the year 2001. The water-lapped miniature city features star-shaped apartment developments, each with boat docks. Greensward separates recreational facilities and business complexes. Nearby farms produce crops under climate-conditioning domes. Monorail and electronic highways link city and suburbs.

Then spotlights pick out the model of a home in the 21st century. Push buttons control partitions and color schemes, a built-in vacuum-cleaning system keeps it spotless, and a communications center brings the world's news and entertainment to the family.

How will future man labor? Pictures, lighting up the cubes, give the artists' conception of the answers: Industrial parks where machines reduce the work week to 24 hours; farm factories where weather control, minerals, and chemicals help produce three and four crops a year; business offices with audio-video communications systems.

Electronic Librarians Serve Readers

And how will our descendants learn? The artists' images show schools where television and electronic teaching machines assist human instructors; libraries whose books have been digested by computers and whose readers may order, electronically, sections from any author on a pertinent subject.

At intervals, like a harsh chord in a hymn of hope, the World of Tomorrow depicts the same faceless family living in a bomb shelter. Speaking to one another, the mannequins express yearning for the companionship of other human beings, realizing finally that "understanding is close to love."

1. Space Needle, Restaurant
2. United States Science Pavilion
3. Pavilions of Commerce and Industry
4. Food Circus in Armory
5. Heliport
6. Skyride
7. International Exhibits
8. Plaza of the States
9. NASA
10. Washington State Coliseum
11. Boulevards of the World
12. Spanish Village
13. International Fountain
14. Playhouse
15. Fine Arts Pavilion
16. Opera House
17. Arena
18. Indian Village
19. Show Street
20. Hawaii Pavilion
21. Japanese Village
22. Gayway
23. Monorail
24. Home Interiors, Fashion, and Commerce Pavilion
25. Ford Pavilion

CENTURY 21 EXPOSITION

© National Geographic Society

We exited to *Now* and settled on a bench outside the Coliseum.

"Climate control for plants! What a wonderful idea," said Mother, eying a rhododendron bush in bloom. "Seattle may not need it, but I could use some in Mississippi to protect my camellias. . . ."

Accustomed to the miracles of science, my mother was already applying a predicted advance to her daily life. But my taste of the future left me wondering what had happened in the past and what is occurring in the present that promises Utopia Century 21.

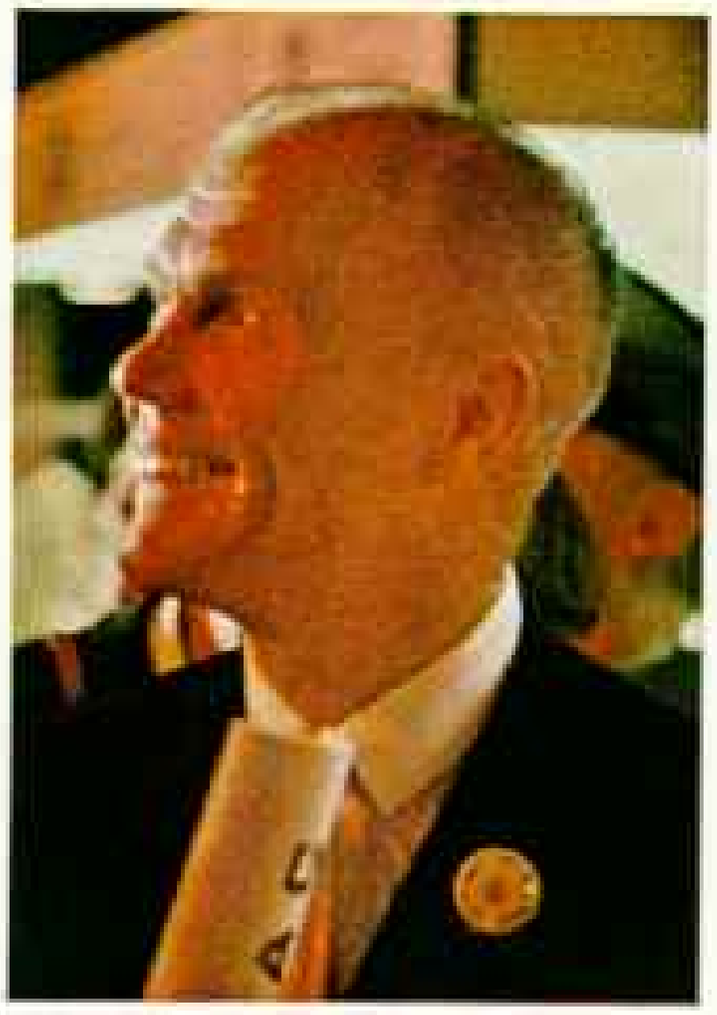
Around me spread a Fair that offered to explain. The magnificent United States Science Pavilion housed the largest exhibit devoted to a single theme ever assembled by the U. S. Government—the past, present, and future of science. Other pavilions displayed cultural treasures and technological advances of 49 foreign nations. American industries showed off their achievements in 72 exhibits.

Boulevards of the World shops stocked handicrafts from the earth's far corners. The Fine Arts Pavilion offered some of the best art in the Western Hemisphere, and the Fair's Performing Arts program scheduled

Saturn Rocket's Simulated Blast-off Lights Astronaut John Glenn's Face

America's first man in orbit, visiting the National Aeronautics and Space Administration Exhibit, inspects a full-scale model of the booster's tail section. The vehicle will carry three-man missions into space. Burning kerosene and liquid oxygen, Saturn's eight engines have a thrust of 1,500,000 pounds. Four center engines are fixed; outer ones ride gimbals to control steering.

A copy of Dr. Robert H. Goddard's first liquid-propelled rocket stands below Saturn.



Girls shield their ears against Saturn's awesome roar.

BY COURTESY OF © NATIONAL GEOGRAPHIC SOCIETY

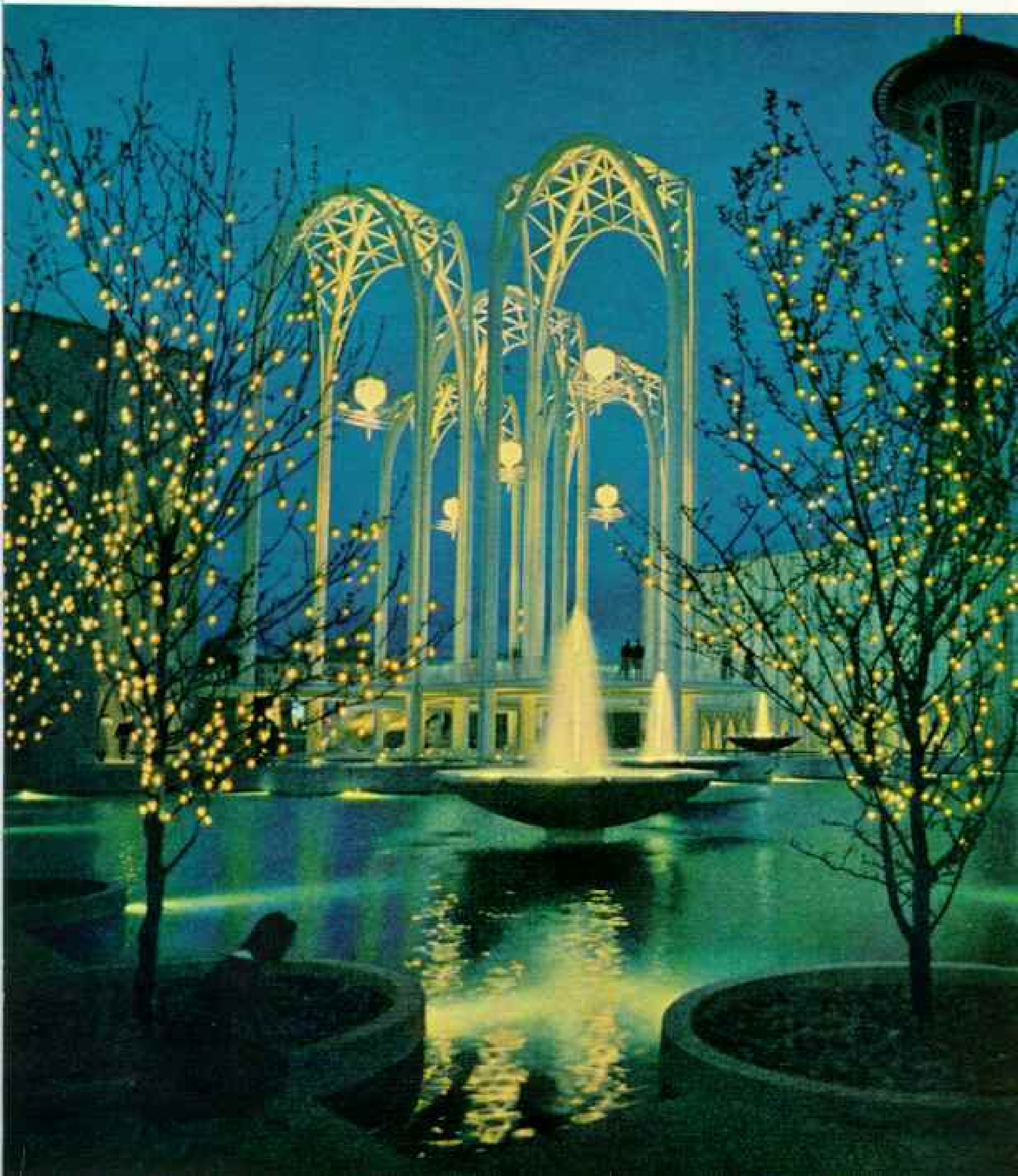
music, dancing, and drama from a dozen countries.

Called "the jewel-box Fair," Century 21 Exposition glittered with the many facets of man. To see him as a scientist, I went to the United States Science Pavilion.

In his glass-walled office Dr. Athelstan Spilhaus, Commissioner of the United States Science Exhibit, made us welcome.

"Science," he said zestfully, "is not magic but a philosophy and a tool of human needs. In our pavilion we try to tell how the tool has been used in the past, so that America can decide how it should be used in the future.

"You'll see more than 100 exhibits in our six buildings, and films in three theaters. Begin in the House of Science at the Eames Theater. You'll find the exhibits that follow are just furniture for that house."



In the theater, with its seven projectors and six screens, we sat on the carpeted floor and saw the House of Science begin in ancient Greece as a cottage of four rooms: natural philosophy, medicine, astronomy, and mathematics. An animated cartoon showed man adding rooms with the years until he had built the multistoried, sprawling palace that today holds all the branches of scientific inquiry.

We saw the faces of the famous men who now inhabit the house, and pictures of their laboratories: test-tube-filled rooms on college campuses, the ocean floor, the human body, the heavens, or just a note pad.

The narrator reminded us that the quality of the scientist is the same as that of any richly endowed human being—"his ability and his desire to reach out with mind and imagination to something outside himself."

From the theater we passed into rooms

As if lighted by fireflies, budding fruit trees glow in the United States Science Pavilion. Spotlights make gleaming torches of lily-pad fountains and illuminate the lacework arches of five Gothic towers. The pavilion's six buildings, courtyard, and pools cover nearly seven acres.

Jets of colored water dance a fantasy to music during hourly concerts at the International Fountain. At night the Space Needle lifts a flaming beacon of natural gas.

HIGHLIGHTS © NATIONAL GEOGRAPHIC SOCIETY

vivid with pictures and sounds of the natural phenomena that have long provoked man's curiosity: a volcano erupting, golden leaves in autumn, sunrise and sunset, the flight of a lonely gull.

We walked corridors of illusion showing how man's senses can betray him in evaluating what he sees, hears, and feels. A distorted horizon on a cowtown street made us feel we were walking downhill when in reality we were climbing (below). The change in pitch of a train whistle gave us the impression of a moving locomotive. We touched warm and cool pipes simultaneously and experienced the contrast as a burning sensation. Through such experiments we learned why instruments were needed and invented.

Other displays recalled for us some of the dramatic breakthroughs that opened new rooms in the House of Science: Mendeleev's arrangement of elements by atomic weight, Darwin's theory of natural selection as a factor in biological evolution, and Einstein's general theory of relativity.

Journey Into Intergalactic Space

Musing over Einstein's concept of time and space, we moved into the U. S.-Boeing Spacearium and rocketed from earth on a journey into intergalactic space that would cover two billion light years.

Through a window in our space capsule we peered out at the moon, pockmarked by its thousands of craters, and marveled at the

Topsy-turvy street of illusion makes visitors to the United States Science Pavilion feel they are walking downhill when they are actually climbing. Tilted store fronts cause the deception. Exhibit demonstrates the unreliability of man's senses.

NE EXTACHROME © NATIONAL GEOGRAPHIC SOCIETY

Thumb-sucking baby monkey clings to a cloth "mother" that is warm and soft in preference to a wire dummy (not shown) that offers milk. Experiment in the U. S. Science Pavilion provides one answer to the question: What leads to mother-child affection?

Pigeon pupils prove that rewards speed learning. Bird at left studies three peepholes on which combinations of 12 patterns appear. Its job is to peck two that match. Some birds pick winning combinations 40 or more times without error.

Having pecked a series of correct holes, the bird below hits the "jackpot." A buzzer sounds; the feedbox lights and opens.

KODACHROME (UPPER) AND ITS EKTACHROME © NATIONAL GEOGRAPHIC SOCIETY

sun's flaming geysers of hydrogen. Passing Mars, we wondered with the narrator whether "Martian flowers bloom ungathered, waiting for man one day to walk here and see their beauty."

Leaving the planets behind, our ship sailed on through the Milky Way as fast as ten trillion times the speed of light and set its course for Andromeda, a spiral galaxy, and unnamed galaxies beyond.

Finally we turned and headed for home.

"We glory in the warm splendor of earth—our shelter; our place to be born, to live, to prosper," said the narrator. "But now we know: Earth is only a single note in the vast symphony of the universe, and man is child—not only of earth—but of all the cosmos."

An imaginary journey? Yes; one possible only through the magic of film and a projector fitted with the world's largest wide-angle movie lens. But still it was a journey based on concepts developed by astronomers through the ages (opposite).

We rested on the pavilion's terrace and watched the fountains play.

"I wonder what variety of flowers might bloom on Mars?" Mother asked. Her question was about space, but her eyes were on the tulips, bright pools of red and yellow set in huge concrete bowls.

One building of the United States Science Pavilion provides an exciting progress report on 28 diverse research projects. Each exhibit poses a question.

What is the shape of the earth? We watch as technicians track Transit IV-A, a satellite put into orbit in June, 1961. Carrying the first nuclear-powered generator ever sent into space, Transit provides earthbound plotters with the most accurate measurement of our planet yet. Future Transits will provide precise fixes for ships at sea.

Where do cosmic rays come from? Cosmic rays from space shoot unfelt through our bodies and light up detectors set in the floor beneath our feet. With such devices scientists have discovered particles with energies a billion times greater than any we have yet produced on earth.

How do salmon migrate thousands of miles to their place of birth to spawn? We peer into a tank of water and see young silver salmon following signals of light, pattern, and color, clues to the factors that guide them on their wide-ranging journeys.

What leads to mother-child affection? We watch a mite of a monkey clinging to a terry-cloth dummy "mother" (page 415), giving it more time than it gives to a wire-frame "mother" that offers a nursing bottle of milk. To this near-relative of man, warmth and softness apparently are more basic to affection than is nourishment.

Praise From a Teaching Machine

Can we learn from teaching machines? We sit down before one—a projection screen and the typewriter keys of a computer. We read from the screen a paragraph of an oceanography lesson. A question on the text and four possible answers to it follow. We pick an answer and type its number on the keyboard. The machine clatters out a message: "You are right. Very good. Proceed to the next paragraph."

We feel pleased. We *have* learned from a teaching machine.

The Pavilion's Junior Laboratory of Science—itself a kind of teaching machine—gave Fair-going children, and me, a chance to learn science by doing (pages 420-21).

After waiting in line amid a sea of small faces, I took my turn at the "light ray machine," manipulating convex and concave lenses, mirrors, and prisms on a revolving wheel to bend and reflect a beam of light.

I split water into hydrogen and oxygen with an electric current and then reunited the gases with an electric spark. I shot a "rocket" from a spinning model earth toward a revolving moon, and, missing, I experienced

Cosmic wonders appear above the heads of visitors in the Spacearium. Using the world's largest cinematic projector lens and screen, the show simulates a two-billion-light-year journey through space. Here, travelers range beyond the Milky Way. The trip seems so real that spectators grasp railings for support in the darkened room.

Monster of the deep exchanges stares with a sailor in the French Exhibit. The model copies a water-jet-propelled diving saucer developed by Capt. Jacques-Yves Cousteau, with National Geographic Society support, to explore the oceans down to a thousand feet. Eyes are twin portholes through which crewmen scan the depths.

Skyride passengers see the Fair from 60 feet up. Cars for two float a quarter of a mile from foreign pavilions (beyond flags) to Gayway. Below: refreshment stands.

some of the disappointment of space scientists who are having the same kind of trouble. I observed ant colonies living out their lives behind glass; peered through a microscope at the hidden beauties of pattern in a leaf and a grain of sand; and saw a crystal grow before my eyes.

I watched a South American knife fish "navigate" and search for food by sending out electric pulses, which were translated for us into blips on an oscilloscope. When the pattern of electrical echoes changes, the fish knows it is near an object that might be edible.

The kids squealed delight and swooped in flocks from one demonstration to another. Adults, occasionally permitted to visit the Junior Laboratory—if accompanied by a child—seemed as excited as their offspring.

The interest of one father outran his patience. "Now stand aside, son," I heard him say. "Let *me* have a look."

But not everyone's gaze was on science.

"I'm just a country girl, but I've come to save the Fair from science," said Gracie Hansen, fluttering a feather boa. We sat in the Paradise International night club on Show Street where Miss Hansen is hostess. The club features Barry Ashton's song-and-dance revue, reminiscent of the Ziegfeld Follies.

Thrill Rides and a Food Circus

Gracie's place is one of a variety of Fair diversions. On the Gayway, crowds sampled the thrill rides, and, day and night, cable cars swung over the fairgrounds for a bird's-eye view of the International Fountain.

Throngs lunched at the Armory's Food Circus, where shops offered dishes from around the world: Chinese tea cakes, Mongolian steak sandwiches, Mexican enchiladas, Swedish smorgasbord, American barbecue.

For the long-at-table diners, the Spanish Village won bravos for succulent *paella*, strolling student musicians from the Uni-

versity of Madrid, and a troupe of flamenco dancers.

For us, the thrill of the Fair was dining atop the Space Needle (right). Standing at the foot of the Needle, I was reminded of the Eiffel Tower; but where the Parisian landmark dwindles to a point at top, the Space Needle spreads a broad disk, as if offering man a home in the sky. Stepping into a capsule-like elevator that rode the Needle's side, we had the feeling of shooting into space as the world fell away beyond the windows.

In the Eye of the Needle, a lazy-susan restaurant whose dining area makes a complete revolution in an hour, we ordered fresh salmon and, waiting for it to come, feasted on the view (page 404).

Across the fairgrounds lay the broad blue sheet of Puget Sound, hemmed by the Olympic snow peaks. Shortly, as we moved, the view included Lake Union, then Lake Washington, both of which are playgrounds for Seattle's huge fleet of pleasure craft. Beyond Lake Washington, the Cascades glistened. Turning, we looked across Seattle's skyscrapers to Mount Rainier, its cone a whipped-cream island in the sky.*

We came down to earth only to go aloft again in the National Aeronautics and Space Administration Exhibit. With witty understatement, NASA's Herman Oberle guided us through the history of space exploration. His words served to introduce us to NASA's exhibit of what at first seemed to be fantastic toys: silver balls made of aluminum-coated plastic one-third the tensile strength of steel, cylinders with solar-cell wings, saucers bristling with antennas. But the fantastic toys turned out to be fantastic tools.

*See "Seattle, City of Two Voices," by Anne Grosvenor Robinson, in the April, 1960, issue of NATIONAL GEOGRAPHIC.

Capsule-elevator climbs to the Space Needle's double-decked saucer. A 5,850-ton block of reinforced concrete anchors the tripod's steel legs and places the center of gravity near the ground.

We saw models of communications satellites, such as Echo and Syncom, that will shortly help to revolutionize the world's radio, telephone, and TV systems. We inspected mock-ups of Tiros satellites already at work photographing millions of square miles of the earth and sending back pictures for use in weather forecasting.*

Hovercraft Skims the Earth on Air

Impressive demonstration that men of other nations are pursuing science for the common good came during visits to the British, French, Canadian, and Japanese exhibits.

Britain features such present-day marvels of technology as the SRN 1, the amazing Hovercraft that rides on a cushion of air over land and sea. We inspected the model of a future Hovercraft, a vehicle designed to transport 300 passengers and 30 tons of freight at speeds up to 100 miles an hour.

We hefted fantastically light foods preserved by the Accelerated Freeze-Drying technique. A pound of processed peas, still unshriveled and green, weighed about an ounce and, like ordinary dried foods, required no refrigeration. They could be reconstituted and cooked in a few minutes.

Another British wonder was a model of one of the world's largest walking excavators. The original stands 16 stories from ground to tip of boom, and its bucket can remove 30 tons of earth with each bite.

Trim young hostesses in suits designed by Jacques Heim showed us around the French Exhibit, which contrasts the excesses threatening our world with the brighter future possible. A chilling, four-minute film projected wild images—street mobs and rock-'n'-roll singers, racing cars and shouting demagogues—to the accompaniment of screams, horns, sirens, and the sickening staccato of machine guns. Balancing this shocker was a dramatization of the rewards of research, using a model of Capt. Jacques-Yves Cousteau's owl-eyed diving saucer designed for undersea exploration (page 416).†

Canada's display features habitation in one of earth's most forbidding areas, the Arctic. With diorama and slides, the exhibit demonstrates how life might be in a far-north community in the 21st century. A huge transparent dome covering an entire town ensures

*See "Our Earth as a Satellite Sees It," by W. G. Stroud, NATIONAL GEOGRAPHIC, August, 1960.

†Described in "Diving Saucer Takes to the Deep," by Captain Cousteau in the April, 1960, GEOGRAPHIC.

Ants, gravity, gyroscope:

science for children only

THOMAS NEBBIA © N.G.S.

TWENTY-SEVEN exhibits in the U. S. Pavilion's Junior Laboratory of Science give youngsters between 8 and 13 an opportunity to learn the basic principles of science by playing a variety of games.

Spinning gyroscope turns a merry-go-round. When boys try to tilt the gyro, it resists and translates their exertions into a rotary motion that whirls the platform on which they stand.

Hefting grapefruit at lower left, a boy learns that an object on earth (foreground) is six times heavier than its twin on the moon. Levers produce the apparent difference in gravities.

Ant colonies, living out their busy lives under glass, intrigue young visitors. Insects in the foreground are harvesters, all offspring of a queen that started the colony in June, 1960.

Jungle-gym climb adds to the fun of ant-watching. Youngsters who enter the boxlike hideaway get another view of the colonies, which include formica and carpenter ants. Children watch the insects forage for honey, lay eggs, and bury dead.

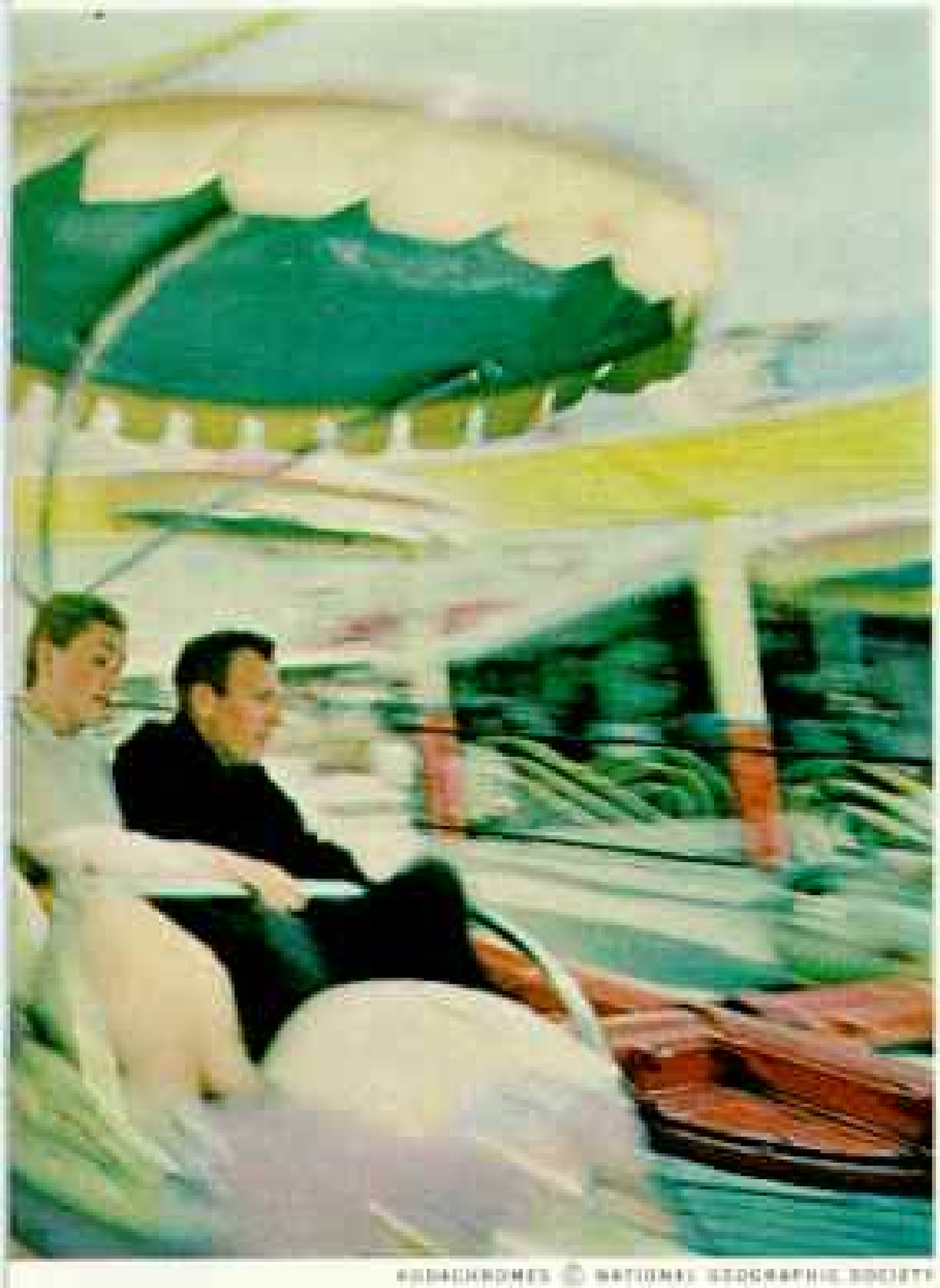
Thrill ride and art show

Space Whirl in Kodachrome captures the color and mood of a French impressionist painting: Rapidly rotating cars whip riders around and

Spray and splash fan out as water skiers circle a moat during a performance in the Stadium. The free show, given four times a day, has entertained thousands. Stadium headliners included Western stars Roy Rogers and Dale Evans.

Festival of fine arts: Small visitor stands spellbound before "The Triumph of Neptune and Amphitrite," painted by French classicist Nicolas Poussin in 1638–40. Other masterpieces on display include Winslow Homer's "Eight Bells," Rembrandt's "Portrait of a Young Man," Frans Hals's "Portrait of a Young Woman." Fine Arts Pavilion also shows works by ancient Japanese, 14th-century Chinese, northwestern Indians, and contemporary painters and sculptors.

lend variety to the Fair



KODACHROMES © NATIONAL GEOGRAPHIC SOCIETY

around while revolving in orbit. This Gayway ride and ten others were introduced to North America by the Century 21 Exposition.

KODACHROME

Oriental beauty in crisp organdy, Miss Jong Ok Kim serves a customer at Korea House, a restaurant on one of the Boulevards of the World.

Trail-blazing Indian maiden, Saline Yallup loses her bearings, and a policeman helps. Yakima child and her family dance at Indian Village.

Boy at the Bell System Exhibit dials his favorite Disney character.

KODACHROME

PHOTOGRAPHS © NATIONAL GEOGRAPHIC SOCIETY

warmth for trees and flowers and "outdoor" sports. Submarines shuttling beneath the ice carry passengers and supplies.

Japan's displays ring a serene garden of raked pebbles and islandlike rocks. We stood fascinated before a transistorized portable television receiver about the size of a desk calendar, and watched sharp pictures that originated as far as 35 miles away. The 13¼-pound set, costing $250, will operate on a battery ($30), or house current.

Also on display is the Micronic Ruby, a radio so tiny it can be worn attached to a charm bracelet.

Bell Gives Every Man a Secretary

The Bell System Exhibit showed other electronic wonders available right now: push-button dialing, direct distance dialing, and the electronic central office. The latter proved to be a supersecretary with whom the telephone user can leave messages such as: "I'll be out for the morning. Transfer my calls to Aunt Nellie on the following number. . . ."

In a free demonstration of the area-code system, I dialed 202-936-1212 and heard the Washington, D. C., weather bureau say that my home town was enjoying temperatures in the mid-80's.

Sitting down with 13 players, I picked up an extension phone and began a game called "Place the Phone," a kind of bingo with a telephone theme. I found myself the winner and entitled to make a free long-distance call anywhere in 48 states.

A smiling hostess led me to a demonstration booth and put through a call to my husband in Washington. Since it was a demonstration call, she invited four interested spectators to use extension phones to listen in on our conversation.

Somewhat unnerved, my husband and I sounded like strangers trading pleasantries—although in my absence our ten-year-old son had suffered a concussion, my husband had broken his toe, and our furnace had burned up.

Century 21 Exposition looks to the future, but it also looks over man's shoulder to his heritage. It deals not only with materials, but with memories.

In the Japanese Village, samurai and soldier figurines paraded among the exquisite minia-

Great Britain's Prince Philip, one of the Exposition's many distinguished visitors, leads a parade of officials to the British Pavilion, past trumpeters of the Household Cavalry. From left, Gordon Clinton, Seattle Mayor; Sir David Ormsby Gore, British Ambassador; Ewen C. Dingwall, Fair executive vice president and general manager, and Joseph E. Gandy, Fair president and chief organizer.

Flags of 50 states snap above the ceremonial plaza. Each state has its day at the Fair. In the right background, bell ringers entertain strollers. A helicopter whirls in for a landing atop the Armory.

tures of the Nikko shrine, 24 temples and pagodas carved from native woods and gilded like the originals. I met and congratulated Jiro Sasaki, the last living artist among the 54 who fashioned the models between 1905 and 1927.

A replica of King Tut's golden burial mask, displayed in the Egyptian exhibit, took us back toward the beginning of civilization. The 17th century was dramatized at Sweden's *Vasa* exhibit where we saw a cannon from the recently raised warship that sank in Stockholm Harbor in 1628.*

*See "Ghost From the Depths: the Warship *Vasa*," by Anders Franzén, NATIONAL GEOGRAPHIC, January, 1962.

At full-length performances, we enjoyed the stylized artistry of the Ceylon dancers; and the San Francisco Ballet renewed our appreciation of the classical dance of the Western World. We were enchanted by the sophisticated puppetry of "Les Poupées de Paris" at Le Petit Théâtre. And we gloried in Igor Stravinsky's *The Firebird*, conducted by the 80-year-old composer at the gala opening of the Seattle Opera House.

From what I saw, it seemed clear that man's greatest heritage lies in his own spirit. This concept shone in the Peace Corps exhibit, where we viewed photographs of young Americans—nurses in the West Indies, teachers in Ghana, a doctor in Tanganyika, and construction workers in Colombia—giving of themselves for the betterment of mankind.

Roger Revelle, science adviser to the Secretary of the Interior, developed this theme before a Fair conference on the peaceful uses of space.

"What men can do, they must do," he said. "Unbelievably, inconceivably, we are beginning to be able to leave the surface of the earth, on which our ancestors have crawled for countless generations, and to reach for the stars. In using our new-found ability, we are simply being human; we are rising to the challenge that lies deep within us as human beings."

Leaving the Fair, Mother and I caught the monorail downtown. The ride took only 96 seconds, just about long enough for us to settle ourselves in our seats and for Mother to say, "I wonder if I can get the name of that orange azalea bordering the fairgrounds?"

At Century 21 Exposition I had seen the wonder of man's mind. Mother had seen the wonder of God's beauty. I hoped that both would endure in the world of tomorrow.

THE END

Monorail Zips 1.2 Miles in 96 Seconds From Downtown Seattle to the Fair

Silently riding a concrete beam on rubber tires, the electric train makes a bid toward solving city traffic problems. Its T-bar supports occupy little space.

Broad windows and skylights give departing visitors a last look at the Century 21 Exposition and its sky-piercing Needle.

PHOTOGRAPHS AND ITS CATACHROME SUPPLIED, © N.G.S.

THE TIME HAD COME. I said, "Launch now!" and flicked a switch, releasing the shackles that held the X-15 beneath the wing of the huge B-52 mother plane cruising at 45,500 feet.

For a split second we fell like a bomb, my black bird and I. Then I had her under control in a fast glide toward the glaring rock and sand of the Nevada desert.

More than 1,400 feet below the B-52 we "got a light," or engine start, and the X-15's liquid rocket cut in with explosive force. Under full throttle it began a rapid build-up to the power of 548,000 raging horses, more than twice the horsepower of the biggest United States Navy carrier.

"And I'm on my way!" I said.

My radioed comment must have sounded as exultant as I felt. If all went well, I would pilot the research X-15, half plane, half missile, to its design altitude of 250,000 feet, or 47.3 miles above the earth. Our aircraft already had flown far higher than any other winged vehicle we know of, and I was shooting for a new record.

The record, however, was incidental. My main purpose: to explore speeds faster than a high-powered bullet and the problems of controlled re-entry into the atmosphere.

I wasn't looking beyond the moment, but I knew that a good flight would lead to even higher ones. The X-15's design altitude is by no means its absolute ceiling. It can hurtle far above 250,000 feet—and return safe-

Half plane, half missile, the X-15 begins its 4,093-mile-an-hour flight of November 9, 1961. At the controls: the author's fellow test pilot, Air Force Maj. Robert M. White

I FLY THE X-15

By JOSEPH A. WALKER
Chief Research Pilot, NASA Flight Research Center

Photographs by DEAN CONGER
National Geographic Staff, for NASA

ly. But our research program, a partnership of the Air Force, Navy, and National Aeronautics and Space Administration, calls for a step-by-step build-up in altitude and speed. And it was my job, last April 30, to climb 47 miles, then bring all those horses safely back to their stable at Edwards Air Force Base, California.

The long countdown check of intricate systems had been a test pilot's dream, trouble-free and no sweat. I felt just as sharp as the young fighter pilot I had once been, and overhead a cloudless sky of vivid blue awaited me.

I knew I had a good engine light without glancing at the instruments. Acceleration from that inferno in the tail pipe pinned me back in my seat with a force of 2 g's, twice the force

of gravity; hence twice my weight of 164 pounds. Pulling back on the control stick, I increased my climb angle to 38°.

Three g's . . . 4 g's . . . the force built up rapidly. I felt as though I were flat on my back and climbing vertically. My bullet would have to be slowed a bit to follow the carefully planned flight path (diagram, page 445). Right on schedule, after 40 seconds of powered flight, I popped out the speed brakes.

Ground control at Edwards began tolling a countdown for engine shutoff. We had planned on 81 seconds of engine burning time —and that meant 81 on the nose, not 83 or 84. A few extra seconds would propel me far above the intended altitude and stretch the arc of my flight. Coming back for a dead-stick landing, I might find myself beyond gliding range of the hard, dry floor of Rogers Lake at Edwards. That could be a fatal embarrassment.

Call-outs from the ground had grown weak; now they faded away. No matter. I had checked my own countdown clock with the first call-outs; it was accurate.

At 79 seconds I reached for the throttle with my left hand—and grasped nothing. Glancing down quickly, I saw my gloved fingers were a good two inches from the handle. G-forces had plastered me so far back in the seat that I couldn't reach it.

But I *had* to. Bracing against right elbow and shoulder, I lunged forward with all my strength. That did it. I got the throttle off a second late—at 81.6 seconds, to be precise.

Mind Races in Instant of Crisis

It's strange how many thoughts I compressed into those fleeting moments. The unwanted altitude flashed through my mind. I envisioned what would happen to me, decided on what to do, and did it.

All five of the present X-15 pilots have experienced similar compression of thought during critical moments. We are consistently able to recall things that occurred in split seconds as though they extended over longer periods of time. We seem to undergo a time dilation, perhaps due to the adrenalin coursing through our systems.

Engine shutdown came at 3,443 miles an hour—nearly five times the speed of sound—and an altitude of 142,800 feet. I was weightless immediately, and it felt pleasant, a welcome relief. The ends of checklist pages on my clipboard rose eerily; and a little cloud of dirt particles drifted up from the floor. Sunlight lanced through the left windshield at these motes; I could even see that they were of different sizes and shapes.

Upward the X-15 soared in coasting flight. In effect, it had become a cannon shell in space; it followed a fixed arc, just as a shell does, in response to the inexorable laws of physics. Once the X-15 is outside the atmosphere, its flight path, or arc, cannot be changed without engine power. I could not alter my course until I fell back into the air and regained aerodynamic control.

Jets Prevent Tumbling Through Space

But I could change my craft's attitude. I could dip the wings and move the nose up and down or from side to side. Yes, I could even have turned around and climbed tail first, though that would have been foolish.

For movements in space the X-15 has small jet controls, like the Mercury capsules. Hydrogen peroxide, forced over a catalyst of silver, breaks down into steam and oxygen and spurts from little openings in the nose and wings (diagram, opposite). A control stick on the left side of the cockpit operates these jets. You need them to keep the plane from twisting and tumbling and to put it into the right attitude for re-entry.

I used the jets immediately after engine cutoff. My lunge for the throttle had made the nose bob down, so I blasted it up and smoothed out other small movements. The reaction controls felt fine, and I tried a 30° left bank angle, then rolled level and pointed the nose back on the correct heading.

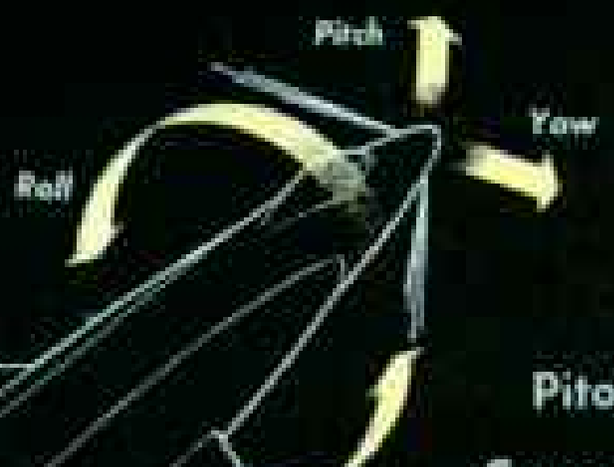
Seconds later we coasted up to the peak of our arc. My instruments showed exactly 250,000 feet. These are special instruments, part of an inertial data system. Its heart is a little platform, kept stable by gyroscopes, that always points to the earth's center. On the platform are instruments that sense changes in acceleration, hence changes in speed and direction. A computer in the airplane remembers these changes and disgorges data on course, attitude, speed, and height.

X-15 pilots complain that there isn't any

The Author: Joseph A. Walker has flown many experimental aircraft, including three rocket-powered predecessors of the X-15. For his contributions to aeronautics during 17 years as a Government test pilot, he received the 1961 Octave Chanute Award of the Institute of the Aerospace Sciences. Mr. Walker and fellow X-15 pilots were jointly presented three other coveted awards, the Harmon International Aviator's Trophy, the Robert J. Collier Trophy, and NASA's Distinguished Service Medal.

SPACE FLIGHT

Pitch, roll, and yaw, the aircraft's rotations about its three axes, are controlled by twelve jet rockets, eight in the nose and two in each wing tip



X-15 FLIES LIKE A PLANE IN THE ATMOSPHERE AND LIKE A MERCURY CAPSULE IN SPACE

Sensor (Q-Ball) indicates plane's attitude in relation to its flight path

Pitot tube measures air pressure

Cameras in "bug eyes" survey controls in tail

UHF radio antenna

Exhaust of auxiliary power unit

Eight yaw and pitch rocket jets in nose

Landing wheel

Roll jet

Upper and lower vertical stabilizers control yaw by pivoting

Speed brake

Rocket engine

Part of lower stabilizer is jettisoned for landing; parachutes ease its fall

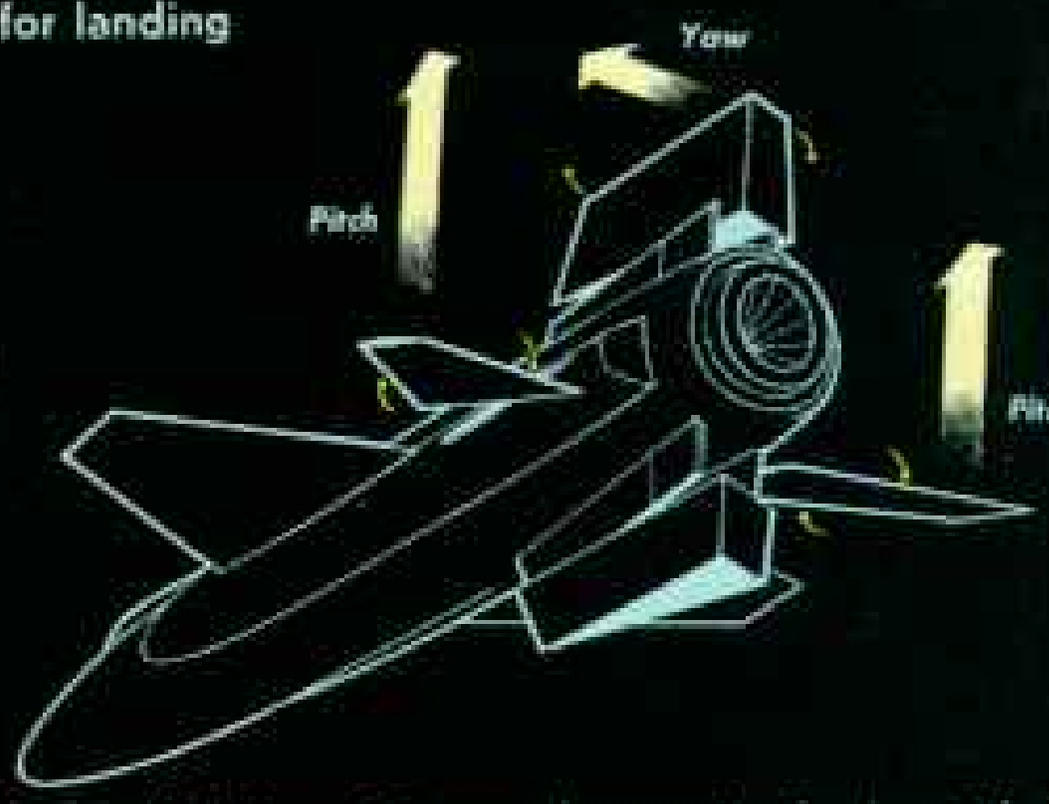
Landing skid

Both sides of "rolling tail" pivot together or in opposite directions, controlling pitch and roll

Wing

Roll jet

Landing flaps increase lift for landing



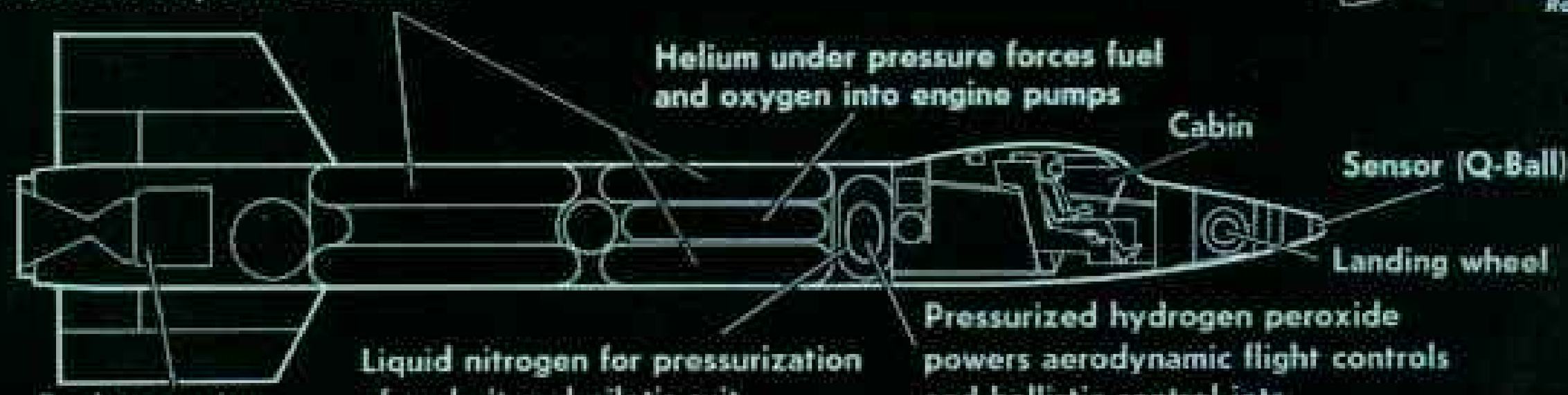
Pitch controlled by raising or depressing horizontal stabilizers. Yaw controlled by turning vertical stabilizers

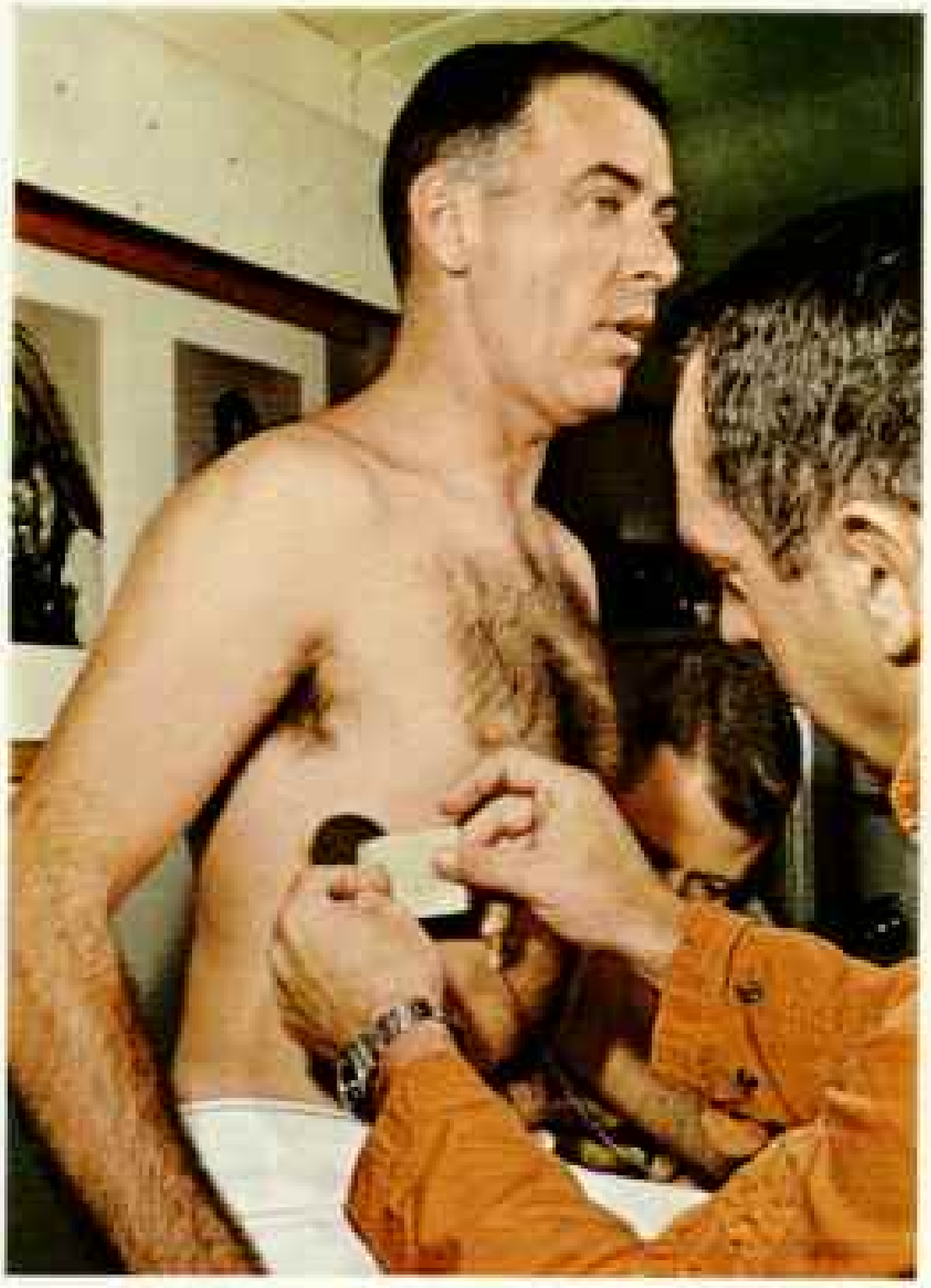
Robert W. Nicholson
National Geographic Staff
© N.G.S.

ATMOSPHERIC FLIGHT

Roll controlled by depressing one horizontal stabilizer and raising the other

5.2 tons of liquid oxygen and 4.2 tons of liquid ammonia develop up to 600,000 horsepower at burnout





US PATACHROMES FOR NASA

Sensor on chest monitors Major White's heartbeat. Under stress in flight his glands pump adrenalin, speeding the heart briefly to 150 beats a minute, not a rarity among X-15 pilots.

NASA test pilot, author Joseph A. Walker, strides toward the X-15 at Edwards Air Force Base, California. A companion carries an air conditioner plugged into the flyer's suit. Mother plane, a B-52, cradles the X-15 under its right wing, balancing the experimental plane's 17 tons with tanks of fuel in the left wing.

Walker is zipped into his inner flight suit, which will air condition him and protect against g-forces and decompression. Silver outer garment (opposite, above) will cover the orange suit.

Rocket plane's cockpit resembles a jet fighter's. Control stick stands at center beneath the ball-like attitude indicator, which gives roll, pitch, and yaw readings.

U.S. AIR FORCE

Eight engines roaring, the mother ship flies at 45,500 feet, her speedy infant tucked under a

time for sightseeing, but we always take a quick look around from the top of the hill. On my left I saw the Gulf of California and looked down the peninsula of Baja California to a cloud mass smothering its tip. On my right I glimpsed Monterey Bay. Way out in front, and as far around as I could see, the horizon curved like a scimitar.

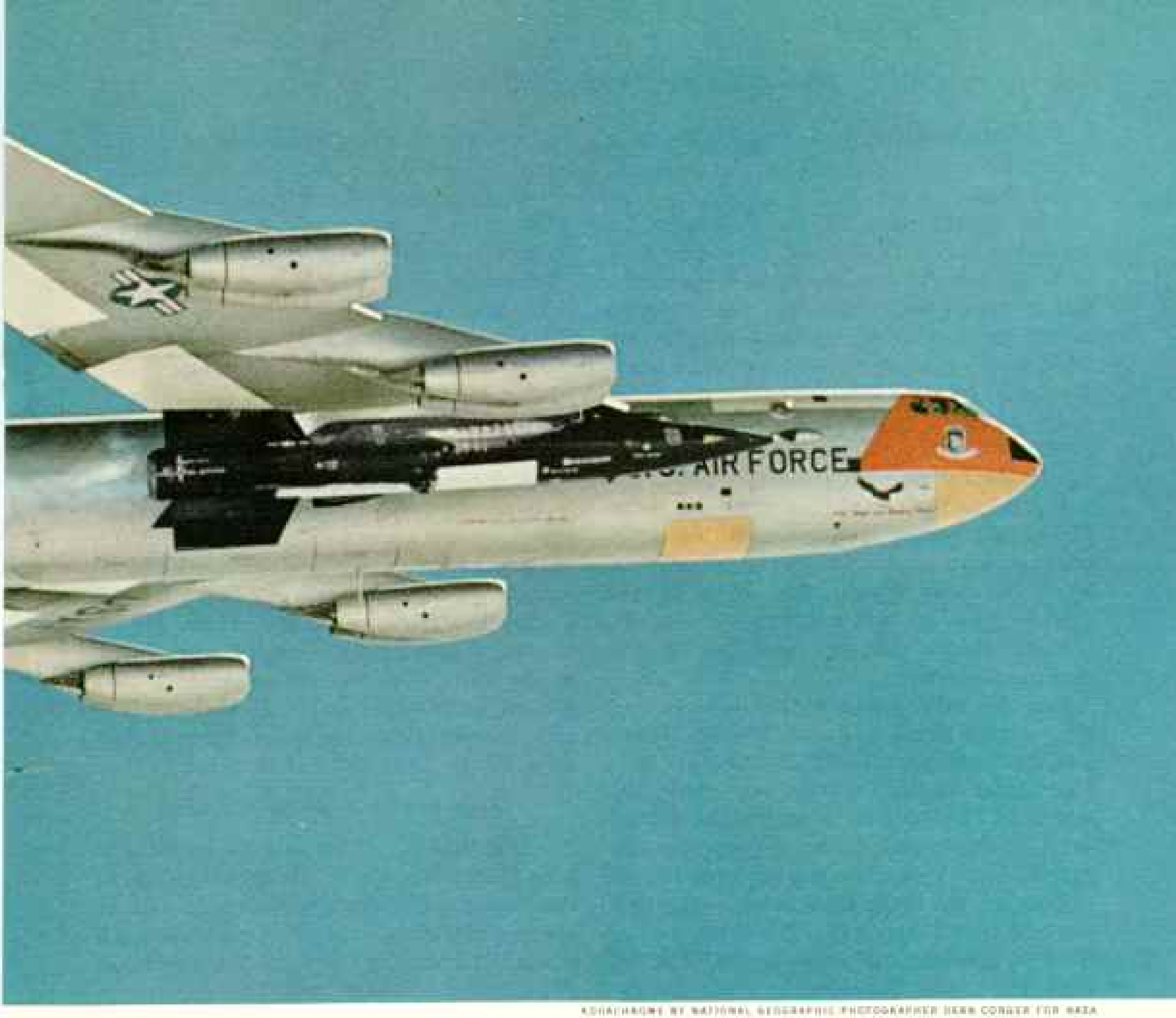
Flight Crests in a Violet Sky

A bright band of light, not as sharply defined as I had remembered it from an earlier flight, hugged the horizon. Above it the sky shaded into a magnificent deep violet. Below me the ground returned strong sunlight with brilliant sparkles.

I knew that I was nearly 200 miles from the Pacific coastline in the Los Angeles area, but so great was my height that I couldn't see it! From my heading and angle of vision, the Los Angeles coast lay somewhere under the nose. This gave me an odd feeling, as if I were over the Pacific and going into orbit.

However, as we coasted over the hump and the nose tipped down, I could see the white glare of Rogers Lake, with its 12-mile length of sunbaked clay, right where it was supposed to be. As always, I felt regret at leaving space and returning to that old cumbersome gravity.

But now I had to think about the most critical part of the flight, re-entry. You have to do this maneuver right, or buddy, you've "bought the farm," pilots' jargon for a fatal retirement. If I had slashed into the atmosphere with the nose straight down, g-forces on the pull-out would have broken up the X-15. What's more, she couldn't have survived the heat. Her skin, of Inconel "X," a nickel-chromium alloy, will withstand 1,200° Fahrenheit, but the heat load on a straight dive would have been far too great. There was



AERIAL PHOTOGRAPH BY NATIONAL GEOGRAPHIC PHOTOGRAPHER JOHN CONOVER FOR NASA

wing. F-100 chase plane keeps a sharp eye on the X-15 as it spews fuel, testing jettison valves

also a third consideration. If I had dived straight down, I wouldn't have had enough room for a safe pull-out and landing.

So, using the jet controls, I pushed the nose up to an 18° angle of attack and plunged "belly buster" into the atmosphere. In this position part of the underside of the X-15 helped brake my fall.

Heat Turns Metal Dull Red

My speed, about 3,000 miles an hour at re-entry, was so great that I could have picked up a little aerodynamic control at about 150,000 feet. But I had some pronounced side-to-side movement to worry about, and I stayed with the jets. At 100,000 feet the g-forces began mounting rapidly, soon reaching 5½ g's, and I could feel bladders in my suit puffing up to grip me tightly and dam the downward flow of the blood.

As the g's built up, so did the heat. It reached a peak of 1,000° F., recorded on the speed brakes. Leading edges of wings, nose, and tail soaked up enough heat to glow a dull red. But, from my seat in the nose, I could not see the exterior of the X-15. Through the face plate of my helmet I could feel a little radiation heat from the metal windshield frame, but the air-conditioned cabin and pressure suit kept me comfortable.

Below 100,000 feet I no longer needed the jets, and at 65,000 feet the X-15 pulled out in gliding flight. My comment to the ground: "I sure felt that one!" The dry lake lay about 35 miles away, and I had plenty of altitude to fly a lazy approach.

Soon a chase plane was on my tail. Another pilot flies just behind the X-15 during a landing. He gives advice and instrument readings in any emergency, observes jettisoning of the lower stabilizer, and confirms that your landing gear is extended.

You have to get rid of the lower half of that wedge-shaped stabilizer, or ventral fin (landing diagram, page 445). It is needed for control in high-speed flight, but it projects so far below the X-15 that you can't land with it. So you jettison it on approach. If the mechanism doesn't work—and that has happened to another X-15 pilot, Air Force Maj. Robert M. White—a backup system blows it off when the landing gear is lowered.

I was once asked what I would do if both systems failed, and I replied, "Well, I guess I'd dig the fastest furrow ever plowed."

But the fin went off O.K., and I touched the X-15's steel skids down at more than 200 miles an hour on the baked clay of the dry lake. The nose wheel came down hard—whomp!—and we slid a mile and a quarter.

"Well, there's that one for today," I said to ground control.

But the mild exuberance I always feel after a good flight was soon marred. Radar readings said my altitude instruments lied. Two radar stations placed my maximum height at 246,700 feet, or 46.7 miles, a little short of the intended goal. Apparently the engine didn't give quite the expected thrust.

Even so, the flight set a record—one that was tied June 21 when Bob White piloted the X-15 to precisely the same height, 246,700 feet! The marks coincided by sheer chance. Then, on July 17, Bob flew to 314,750 feet—almost 60 miles high. (This figure, from early data, may change slightly.)

Pioneers for Era of Space Travel

People often ask me why I fly the X-15, their tone implying that I'm akin to a high-diving circus daredevil. Well, as I said earlier, we don't fly the X-15 for records—or thrills. Reams of data from our research program will help build the airplanes and space vehicles of tomorrow.

Scores of little sensors buried in the skin of the X-15 pick up information on air flow, pressures, and heating. Electrodes on the pilot sense his heartbeat, respiration, temperature, and blood pressure (page 432). On each flight 87 radio channels relay this information, plus many other readings, to the ground. Instruments in the airplane record additional data.

Our discoveries are hard facts, not theories, and they flow out to various programs: the X-20 (Dyna-Soar), a project to build a manned recoverable glider that will be boosted into orbit atop an advanced Titan missile; the RS-70 warplane; proposed supersonic transports; Project Mercury; and Gemini and Apollo, future spacecraft.

That black beauty, the X-15, is often called "the missile with the man in it," but it was never designed to go into orbit. Instead, it is the latest in a distinguished line of "X" (for experimental) aircraft. Some, like the X-15, were rocket powered, and all have been flown at the sprawling Edwards Air Force Base in California's Mojave Desert. There NASA maintains its Flight Research Center, home of the X-15. Our agency, manager of the project, received its first X-15 early in 1960 after demonstration flights by the manufacturer, North American Aviation, Inc.*

Black Paint Aids in Heat Control

I said "first X-15" because we have three. Line them up in a row, and only their markings betray a difference to the casual eye. In shape and size they are identical triplets. All are painted black, a color that helps get rid of frictional heat through radiation.

Visitors, accustomed to the behemoths of the airlines, comment on the smallness of the X-15. It is only 50 feet long, and its thin, stubby wings span a mere 22 feet. Empty, it weighs a slim, trim 13,800 pounds, though this zooms to 17 tons when fully loaded.

Its "armor plate" of Inconel "X" posed many construction problems. No one knew much about the milling, machining, and welding of this laboratory supermetal when the program began. Also, no one had much experience in building internal aircraft structures of heat-resistant titanium and stainless steel, instead of conventional aluminum.

Scores of new manufacturing techniques

*See "Exploring Tomorrow With the Space Agency," by Allan C. Fisher, Jr., in the July, 1960, issue of the NATIONAL GEOGRAPHIC.

Wispy Condensation Trails in the Stratosphere Skywrite B-52's Signature

Carrying the X-15, the mother ship is observed by National Geographic photographer Dean Conger in a chase plane thousands of feet below. Mr. Conger, on loan to NASA, made several flights in a supersonic F-104 to get his pictures. Like all air crew members, he received training in an altitude chamber to prepare him for the hazards of the stratosphere. Silvery reflections in the picture were cast by the F-104's plastic canopy.

KODACHROME FOR NASA

had to be evolved. For example, North American successfully welded together 65 percent of the X-15's structure. In operational craft, where weight saving and superstrength are not as critical, workmen fasten the entire structure with bolts and rivets.

The specially designed XLR-99 rocket engine packaged into the slender X-15 is a marvel of compact power. Fueled by liquid ammonia and liquid oxygen, it develops 57,000 pounds of thrust, only a fourth less thrust than the towering Redstone rocket that blasted Astronauts Alan Shepard and Gus Grissom into space. But unlike Redstone, our rocket engine can be stopped and restarted in flight, and the pilot can throttle it through a range of 30 percent to full thrust.

Many missilemen thought such control could not be built into the rocket—with safety. But Thiokol Chemical Corporation's Reaction Motors Division, Denville, New Jersey, said it could be done, then did it.

Two of the X-15's have identical control systems. Besides their jets, Aircraft Nos. 1 and 2 carry a kind of autopilot that we call SAS, for "stability augmentation system." It senses motions and feeds corrections into the aerodynamic controls. It won't fly the planes without help, but it does smooth out small movements, leaving the pilot free to concentrate on

Freed of its shackles, the X-15 drops away from the modified bomber 200 miles from its home base. F-104 chase plane at left and T-38 (behind the rocket's tail) observed pilot Walker's run last April 30 to an altitude of 246,700 feet, or 46.7 miles. To get the picture, photographer Conger set up a motor-driven Nikon camera in a window of the B-52; a crewman pressed the button.

Rocket plane falls like a bomb from the B-52 at the start of Major White's speed run of last November.

Checking the tail, a "bug-eye" automatic camera took this view of the X-15's control surfaces, capturing at the same time a glimpse of the California-Nevada desert and the contrails of three other planes.

X-15 begins firing; within seconds it outdistanced the chase planes. At 4,093 miles an hour, more than twice the speed of a bullet, the front of the wing glowed red at 1,147° F.

Snug in cockpit and air-conditioned suit, the pilot feels no heat. But the loads on him are so severe—4 times the force of gravity under power, 5½ at re-entry—that he cannot use the central control stick. Instead, he employs two side-arm controllers.

major corrections. These two planes also have a backup SAS for roll and pitch in case the first one fails.

No. 3 is a unique hybrid. Its new adaptive system changes the "gain" of the controls, making the pilot's stick motions easier. At the flick of a switch, this system will also blend the jet and aerodynamic controls. The pilot needn't select which to use. An electronic brain does it for him, feeding in jets or conventional controls, or both, as needed. They respond to a single stick.

Bob White piloted the No. 3 plane when he tied my altitude record and also when he climbed to more than 300,000 feet. I flew No. 1 on April 30, the day I reached 246,700 feet.

All three planes bear an in-

genious sensor on the nose. Called Q-Ball, or "hot nose," it always points into the relative wind and gives the pilot angles of attack, roll, and yaw that must be corrected to avoid overheating. Electric components in the ball would melt like butter at a corn roast if they weren't cooled by liquid nitrogen.

You can't put together such a complex airplane without scoring some significant breakthroughs. Paul F. Bikle, Director of NASA's Flight Research Center, once said to me: "If the plane had never flown, we would still have gotten a major proportion of the benefits simply by learning how to build it."

But the X-15 does fly, and beautifully, as any of her pilots will testify. You probably have read about my flying colleagues. Scott Crossfield demonstrated the plane for North American. Maj. Robert M. White, the Air Force's principal X-15 pilot, has been trading altitude and speed records back and forth with me for more than a year. Air Force Maj. Robert A. Rushworth flies the X-15, and so do Neil A. Armstrong and John B. McKay, both NASA men. We had a crack Navy pilot, Comdr. Forrest S. Petersen, with us until his transfer to a squadron command.

Each flight requires a lot of boning up. The pilot memorizes his flight plan and practices it for many hours in simulators.

On the day of a flight, I usually have to get up before dawn to be at the base by 7 a.m. My home is in Lancaster, California, a drive of 38 miles from Edwards. I slip out of the sack quietly, trying not to wake my wife Grace, who has been up in the night with our baby daughter. I fix my own breakfast: no special diet, usually fruit juice, eggs, toast, and coffee.

As I leave the house, Grace, the baby, and our three sons are still blissfully sleeping. There is little special pressure on them from

(Continued on page 446)

Like a comet dragging a tail of gas, X-15 spews a long contrail as Walker pulls the nose up on a speed run of 3,900 miles an hour. Diffraction in the chase plane's canopy causes the sunburst and white "moon."

NOT AVAILABLE FOR SALE

Two minutes and 40 seconds after launch, the pilot reaches 246,700 feet, topping 99.996 percent of the atmosphere. He can see from Monterey Bay to the Gulf of California

Speeding at 3,000 miles an hour, Walker points X-15 into re-entry attitude. Faulty angle would cause plane to break apart

At re-entry, 150,000 feet above the earth, 1,000° F. temperatures redden the plane's wings, tail, and nose. Pilot returns to his atmospheric controls below 100,000 feet

G-stresses at leveling-off point—65,000 feet—swell Walker's 164 pounds to over 900. He slows plane and lands at more than 200 m.p.h. Total flight time: 9 minutes 46 seconds

Monterey

Cracked right windshield confronts Major White after pull-out. Speed brakes control rate of deceleration

Approaching Edwards AFB, plane begins landing maneuver at 40,000 feet. Flight time: 9 minutes 31 seconds

Los Angeles

Sierra Nevada

Rosamond Lake

Edwards Air Force Base

Rogers Lake

Dry lake beds beneath flight path provide emergency landing strips

Cuddeback Lake

Ballarat Lake

Mojave Desert

CALIFOR

Death Valley

LANDING ON DRY LAKE BED COMPLETES RECORD FLIGHTS

Air Force F-104 chase plane pilot checks X-15 visually on final approach

Altitude, 18,000; speed, 350

Chase plane talks X-15 down in case of emergency

Nose wheel down, X-15 slides one mile before stopping

Landing gear extended. Nose-up attitude cuts speed

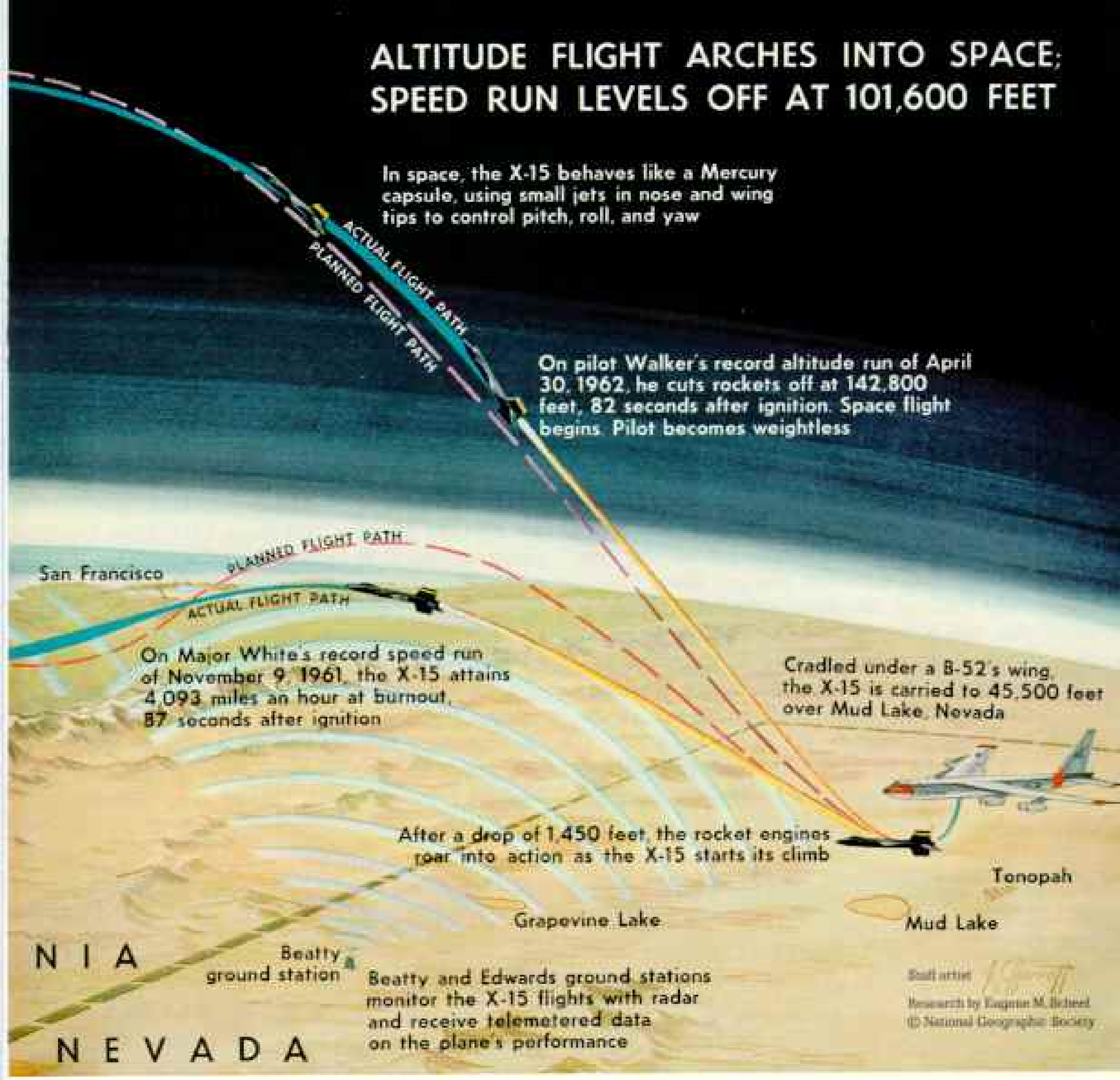
Tail-down landing puts impact on steel landing skids

Touchdown speeds vary between 195 and 255 miles an hour

Landing flaps let down

© National Geographic Society

ALTITUDE FLIGHT ARCHES INTO SPACE; SPEED RUN LEVELS OFF AT 101,600 FEET



X-15's planned course, shown by the dashed lines, is plotted as carefully as a military campaign. Engineers draw up a precise, moment-by-moment flight plan: course, speed, altitude, engine burning time, and other details. Since the pilot has no time to scan charts, he memorizes the plan and practices it in flight simulators.

Both record flights shown above have been surpassed. On June 27 the author set a speed mark of 4,105 miles an hour. Major White flew the X-15 on July 17 to 314,750 feet, or 59.6 miles.

On altitude flights, in particular, the pilot sticks closely to schedule. Once in space, he cannot change his path. Like a cannon ball, his plane traces a ballistic arc. But the flyer can, and must, use his jet controls to keep the plane stable. After coasting "over the hump," he pulls the nose up at a high angle and "belly busters" into the atmosphere. This position helps brake his fall, minimizes heat and g-forces, and saves precious altitude in the pull-out before the dead-stick landing.

Nose up, skids lowered for touchdown, the plane will slide a mile

X-15 approaches

my X-15 work; I've been a Government research pilot for 17 years. Grace knows when I'm to fly the rocket plane, but all she ever says is, "Call me when you get down."

At the base, the Boeing B-52 already snuggles the X-15 (page 433). Fueling is under way—a gingerly business. When Cape Canaveral fuels a missile, practically everyone can take shelter in a blockhouse. But our crew at Edwards must be out in the open.

I go into an air-conditioned van parked nearby, and specialists check out the electrodes plastered on my body and shoe-horn me into my pressure suit (page 432). Then I climb into the X-15 for the ground countdown, which may require half an hour or several hours, depending on the trouble we encounter. The countdown in the air before launch lasts about 40 minutes.

As in all experimental programs, we have delays. Maybe you've heard the first law of the legendary Murphy: "What can go wrong will go wrong." But we often come up against Murphy's lesser known second law, "What

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at more than 200 miles an hour

Smoke bombs on dry lake give the pilot wind direction

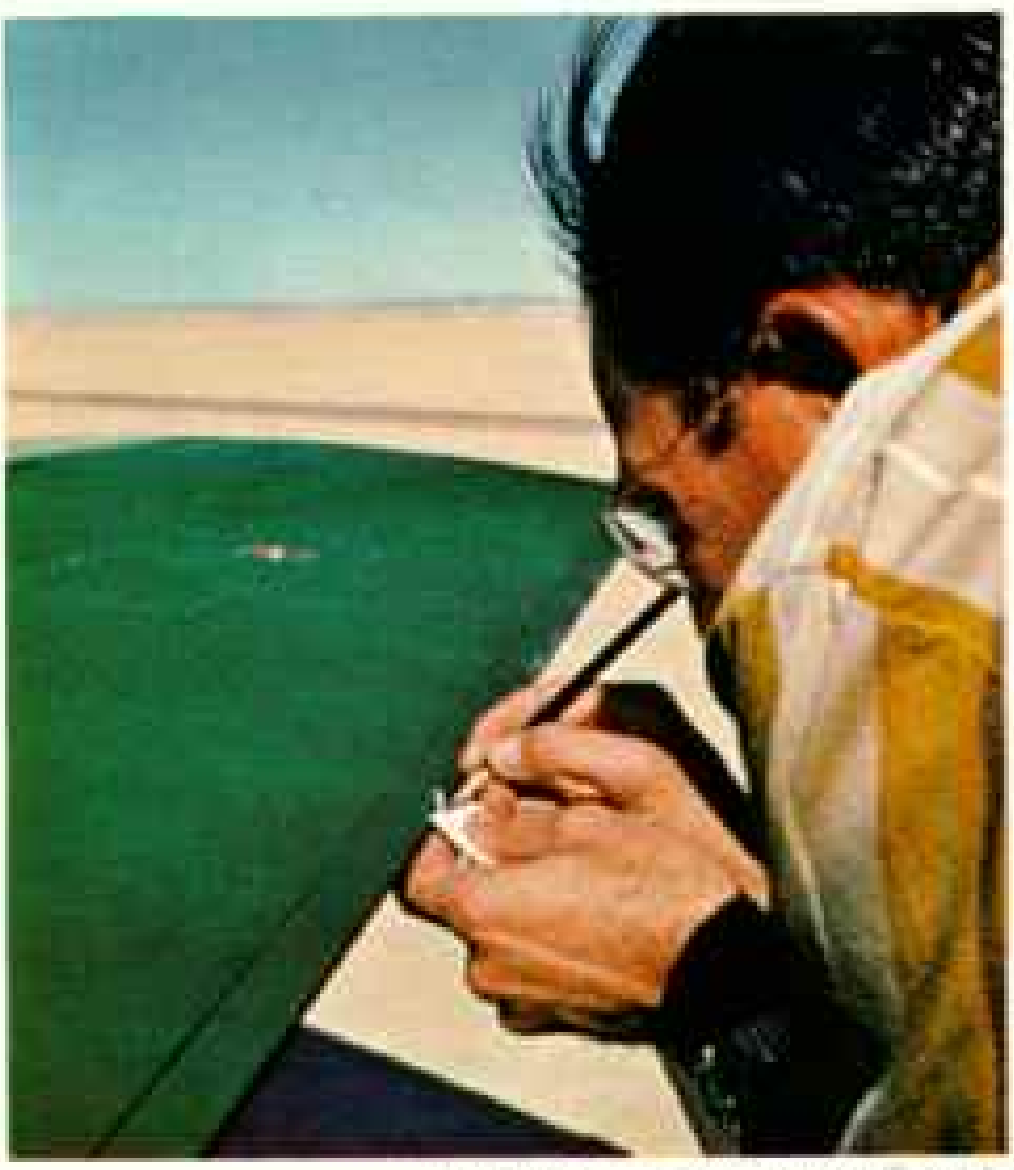
has gone wrong will get worse." Even after the B-52 is airborne, the chances are only fifty-fifty that we will launch.

The X-15 can't take off from the ground; she always needs a launch plane. We fly her in a corridor 485 miles long and 50 miles wide. Called High Range, it extends from Wendover Air Force Base, Utah, to Edwards. So far we have used about half the length of this corridor, but later, as the X-15 flies higher, we will launch farther uprange.

A program like ours can count upon an occasional mishap, and we've had our share.

An explosion wracked the No. 2 airplane during one of North American's demonstration flights, and Scott Crossfield had to make an emergency landing on dry Rosamond Lake with part of his fuel aboard. The nose wheel's shock absorber failed under the unaccustomed weight, and the impact broke the back of the plane. Luckily, Scott wasn't hurt, and the airplane has since been repaired and strengthened.

Petersen couldn't get an engine light after



Technician examines a "hot spot," a tiny white area on the wing's leading edge. There temperature-sensitive green paint, used on the wing in a test, turned white when the heat reached 1,150° F.

Observers rush out to unstrap the pilot. One carries an air conditioner that will keep the flyer's suit cool until he can shed it.

Right windshield cracked under the stress of hot metal, cutting Major White's vision in half.

a drop, but coolly jettisoned his fuel and brought the X-15 down to a perfect landing on a brick-hard emergency strip at Mud Lake.

Several of us have been saved by our pressure suits when the nitrogen atmosphere leaked from our cockpits, causing a decompression. We don't breathe nitrogen, of course. Our suits feed us oxygen, but the inert gas in the cockpit keeps our bodies pressurized against the vacuum of space. If you lose the nitrogen, your suit inflates automatically.

What to Do if Windshield Cracks

Bob White, a gifted, iron-nerved pilot, experienced a real cliff-hanger on his 4,093-mile-an-hour speed run last November 9. He had hit a velocity more than twice as fast as an Army .30-caliber rifle bullet. Then . . . but let Bob tell his own story.

"We had all the fuel we could pack into the tanks, and the engine start was good," Bob said. "The power picked up immediately. Well, we cooked merrily along and reached just about the expected velocity at 95,300 feet. But, as we slowed down, the right windshield shattered, and it happened instantaneously. The glass didn't break out, but it became full of crazed cracks, obscuring vision.

"I learned later that I said, 'Oh, good Lord! Hope this one holds!' You know what I was hoping: that the left windshield wouldn't crack. If it did, I planned to fly by instruments down to 35,000 feet, then jettison the canopy and see if the plane could be controlled in the wind blast with the canopy off. I felt I could get away with it, but if the plane proved uncontrollable, I would have no choice but to eject myself and parachute down.

"But the other side held, and I could see well enough to land by pushing my head over against the left side of the cockpit."

Severe heating on the windshield's metal frame, followed by rapid cooling, caused the accident (page 447). A similar thing had happened to Bob on an earlier flight, but that time the left windshield shattered. Since these accidents, we've installed heavy-gauge window frames of titanium. They withstand thermal stress.

My worst moments in the X-15 came during an altitude flight to 169,600 feet, about 32 miles. During re-entry the plane began shaking wildly, uncontrollably, as though I were slamming over a corduroy road. I was going one way, the plane another.

"Heavens! Sure shaking to pieces here," I told the ground.

It didn't shake my teeth loose, but I was glad I had permanent bridges on them.

Maddened quakes continued to rock the X-15 for more than 50 seconds, despite my efforts to locate the trouble and correct it. Then, at a lower altitude and speed, the vibrations stopped, and I landed normally.

Our experts found the cause. I was making large "throws," or changes, in my controls, resulting in some normal jarring of the airplane. But gyroscopes in the stability augmentation system sensed these jars as directional movement of the X-15 and began feeding corrections into the control surfaces. These needless corrections resulted in still more vibration, setting up a cycle. Every change that poor, berserk electronic brain fed into the controls made the shaking worse, not better. We solved the problem by adding a "filter" mechanism to the gyroscopes that enables them to discriminate between vibrations and actual movements of the plane. We also built in other safeguards.

On nearly every flight the X-15's skin makes loud noises. We ignore them, knowing they are caused by the alternate contraction and expansion of the Inconel "X" under cold and heat. Did you ever fire up an old wood stove and hear its metal bang and pop? That's what the X-15 sounds like.

Plane May Climb to 400,000 Feet

On June 27, I pushed the X-15's horses about as fast as they will go, 4,105 miles an hour. But we still haven't run out the string on altitude. The X-15 has enough power to climb 750,000 feet, 142 miles, but safe recovery from that height is very doubtful. We believe we can go as high as 350,000 feet, possibly 400,000, and return.

Dr. Hugh L. Dryden, Deputy Administrator of NASA and a Trustee of the National Geographic Society, has called the X-15 "the most successful research airplane ever built." In paying our team that compliment, he

Sweat Beads Walker's Face as a Ground Crewman Removes His Helmet

Each ride is a fresh adventure. On March 30, 1961, Walker experienced severe vibration during re-entry. In nearly every flight, as the plane's skin expands and contracts, he hears the X-15 making noises "like the popping and banging of an old stove."

Both Walker and White foresee a vehicle that, taking off and landing like a standard plane, will ferry men up to satellites in orbit.

ASSIGNMENT BY NATIONAL GEOGRAPHIC PHOTOGRAPHER OTIS IMBODEN © N.G.S.

announced a new job for us. Beginning this autumn, the X-15 will become a test platform for carrying out intriguing new studies in the aeronautical and space sciences.*

For example, four special cameras on the plane will take ultraviolet photographs of stars. As the X-15 nears the peak of its arc, clamshell doors atop the fuselage will expose the cameras, and the pilot will maneuver so they "see" their targets. You can't make such pictures from the ground; ozone in the atmosphere absorbs ultraviolet light. If the experiment works, the cameras will fly later in orbiting astronomical observatories. Good photographs from space will teach us more about the origin of stars.

We will also carry a scanner to analyze the light spectrum of the horizon from great height. This knowledge may lead to instruments that will sense the horizon and give improved attitude and guidance references to orbiting spacecraft. Measurements of air density and micrometeorites, tests of new structural materials and an advanced electric stick controller—these and other experiments will keep us busy over the next two years.

X-15 Helps Put Man in the Missile

But our program already has made two contributions that will prove more important than any future steps we take.

First, we showed that man could do an intricate, demanding job in space. At a time when many experts wanted to place their faith in little black boxes instead of space pilots, we put a man in the system. Our program preceded Mercury, and our success has provided much impetus for manned space flight, present and future.

To my mind, the second contribution is even more significant than the first. We demonstrated that a winged vehicle could fly into space, return through the air without breaking up or burning up, and land at a predetermined spot. I believe that most of the space vehicles of the future will have to be half plane and half missile, like the X-15, and they will take off from the ground and fly back to their home bases.

Dr. Wernher von Braun, NASA's famed rocket expert, says that in 20 years most space traffic may be ferry vehicles shuttling from earth to satellites in orbit. It makes sense that these ferries should *fly* back through the atmosphere, not fall like a meteor.

Pilots Envision Planes That Orbit

Bob White, who talks as well as he pilots, says: "We knew we had to get out into orbital space quickly, so we devised the Mercury system. But I think we all realize that we did it while accepting certain limitations, such as not being able to guide the spacecraft to a sophisticated landing.

"The Mercury capsule comes down in the ocean, and that's really the practical way to do it right now. But over the long haul, it isn't. We have to think of something as simple as taking off across country and landing at the airport of the city you intend to visit."

Scott Crossfield agrees. "To get into orbit and get back to earth—that's a job for an airplane," he says. "We are not getting rid of that atmosphere. Either you resist it, as they do in Mercury, or you put it to use."

All the X-15 pilots hold engineering degrees, and we are not underestimating the problems. Return from orbit begins at 17,500 miles an hour, far faster than the X-15 flies, and the heat and g-loads on your vehicle are far greater. But in time, new and stronger materials and structures will be developed for a ship that can fly in the air.

NASA and the Air Force now are studying proposals for a new "X" plane, one that might take off with a jet engine, build up its speed with a ramjet, then cut in a rocket that would carry it into orbit. Right now these proposals are little more than a gleam in the eyes of the experts. If such a plane is built, it will be years from now.

I'm 41, and I will be too old to fly it. But my heart will be up there with the man who does. In space he will know an inward singing joy. How I will envy him! THE END

*Dr. Dryden wrote of the development of experimental aircraft in "Fact Finding for Tomorrow's Planes," NATIONAL GEOGRAPHIC, December, 1953.

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◀ COVER: *Morning sun burns off the mists of night at Rio de Janeiro's Copacabana Beach (page 310).*

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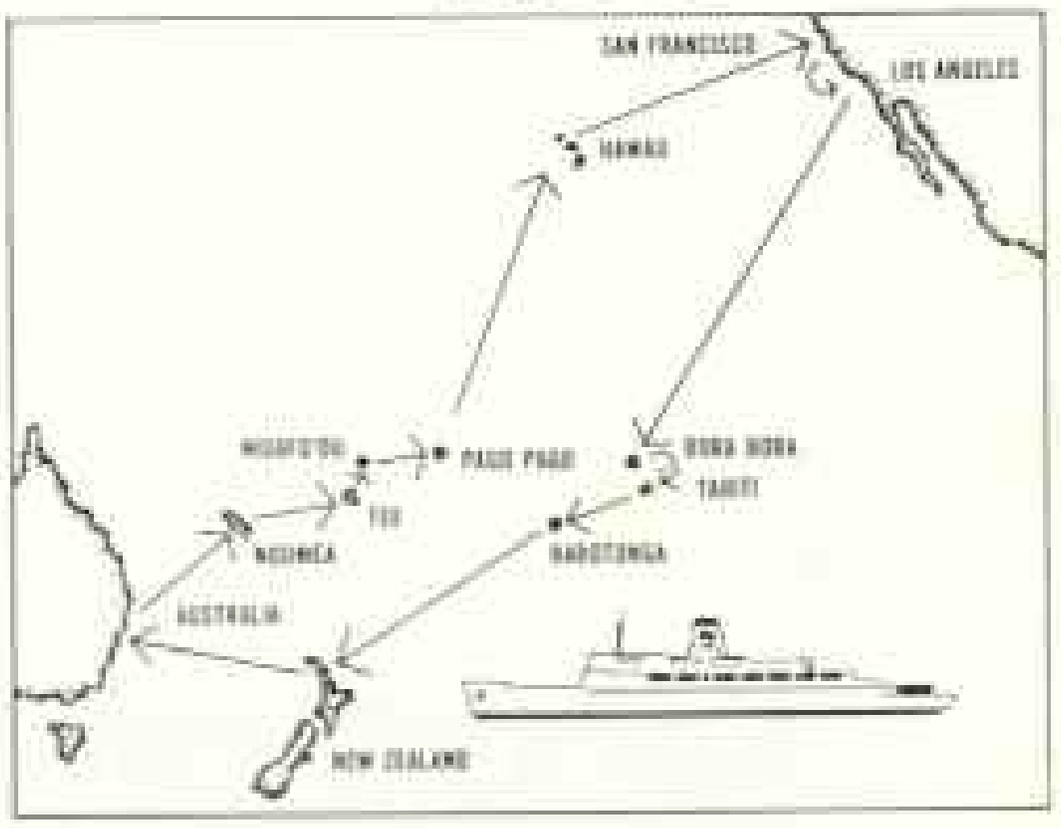

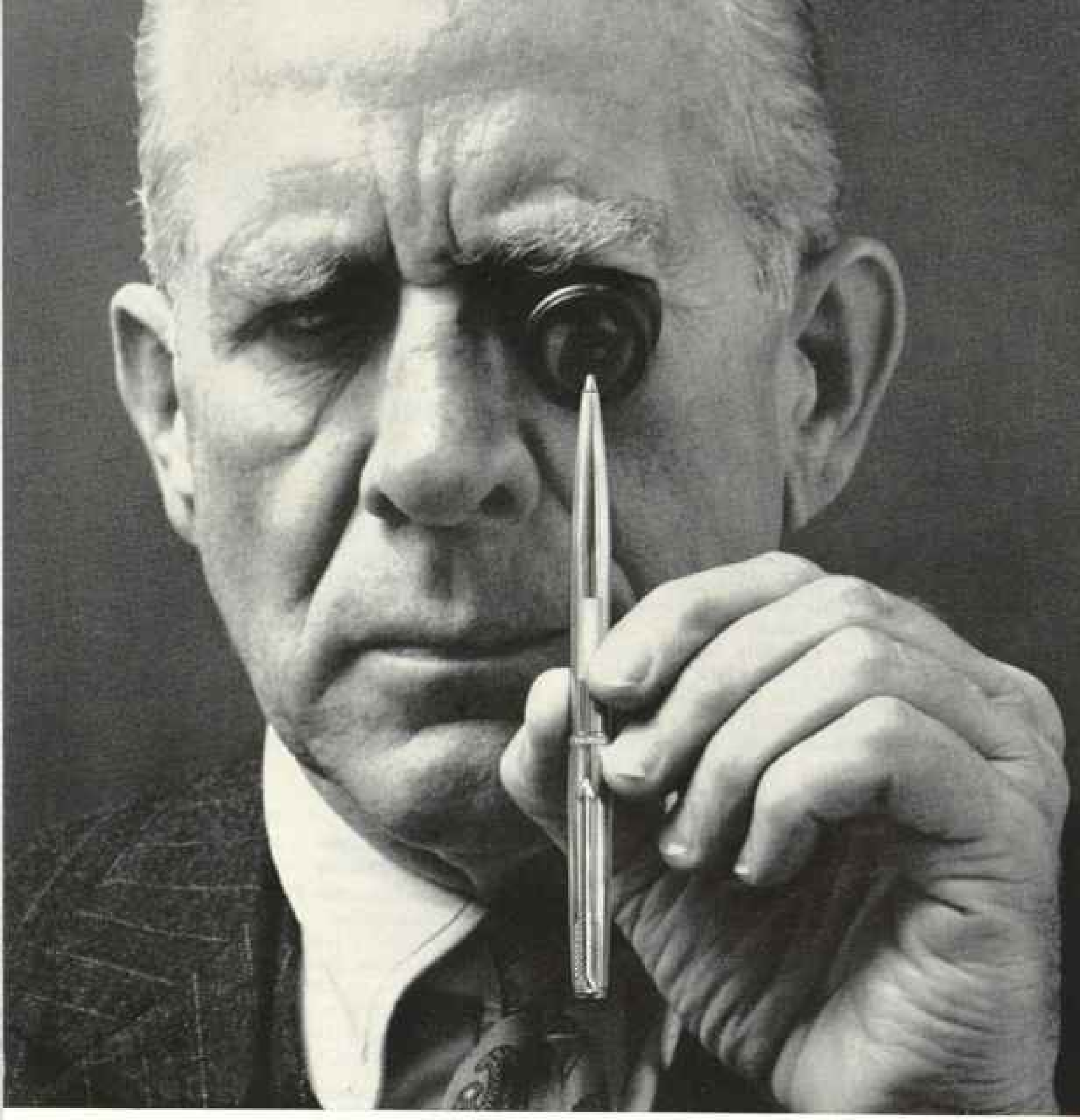

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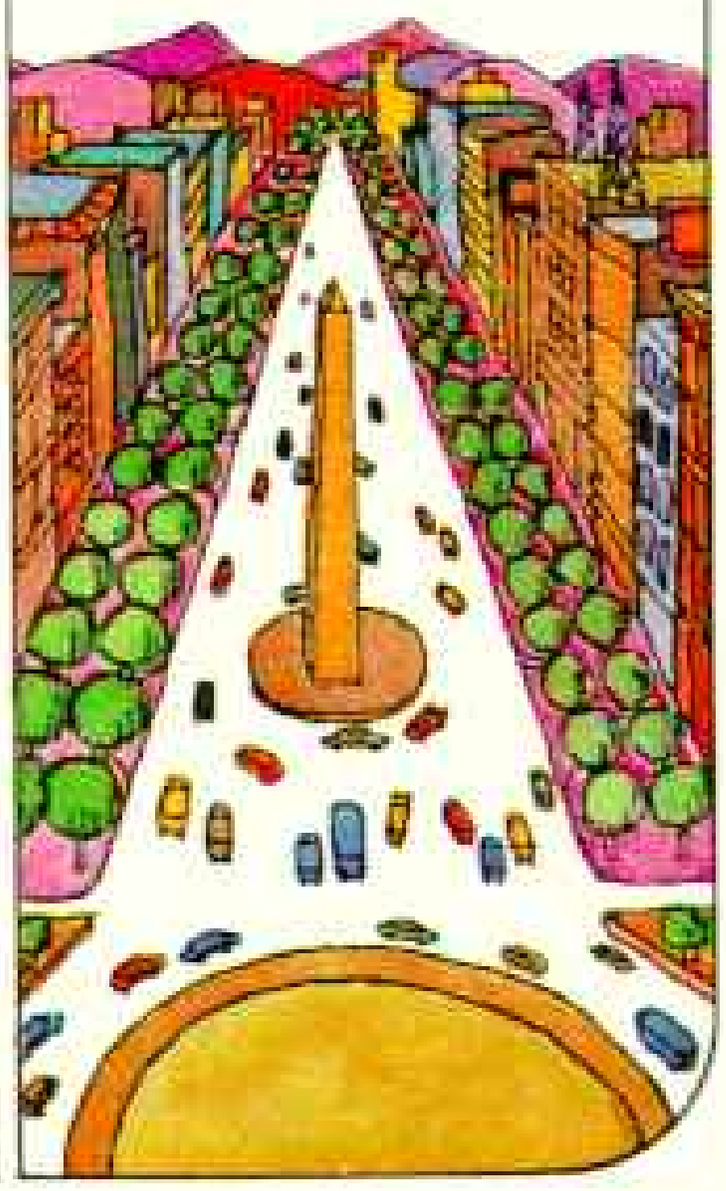

TO MARS . . . BUT WHAT ABOUT THE LAUNDRY?

Picture a Mars-bound astronaut rocketing through space at 25,000 miles per hour. All systems are functioning perfectly. The spaceship's cabin is small but comfortable. He has plenty of food and water for his 300-day journey. He has taped music and reading material to keep his mind occupied.

But how in the world does he do his laundry?

The answer, of course, is . . . he doesn't. Washing clothes in outer space would require prohibitive amounts of water and energy.

Disposable clothing is the only solution. Warm, light clothing that can be jettisoned.

And of all the fibers and fabrics known to modern man, one that is being seriously considered for the job is *paper*. Good old plentiful, inexpensive *paper*.

Until comparatively recently, paper would never have been in the running for a role like this. Paper was to write things on. And to wrap things in. And that was it.

But, today, paper has undergone a startling transformation. You can redecorate a room with wallpaper that not only pastes itself, but kills flies and repels dirt, too. You can brighten your kitchen with vinyl-coated paper flooring. Manufacturers are even experimenting with a paper bathing suit.

This paper breakthrough really began back in the early 1940's. Until that time, paper had one fatal drawback: When exposed to water, it degenerated into a soggy, useless mass of pulp. No bathing suit material, this!

Then, one day, a chemist at Cyanamid's Central Research Laboratory added a small amount of a melamine-formaldehyde resin-acid colloid to paper stock. And a practical process for making wet-strength paper was born.

Cyanamid's Industrial Chemicals Division, which supplies a broad range of products to paper manufacturers, was rushed into action. In a relatively short time, an inexpensive and commercially feasible wet-strength process was developed. Special wet-strength resins were created for the paper industry.

However, it remained for the U. S. Army to dramatize the advantages of this exciting new kind of paper.

During World War II, the army had an urgent need for paper maps that would stand up under battlefield conditions. Cyanamid turned the problem over to the new wet-strength resins. The resulting maps not only stood up under pelting downpours, they stood up under the treads of a Sherman tank!

This new map sparked the paper industry's interest in resin-treated products. Wet-strength facial tissues, rainproof grocery bags, shower scuffs and paper bathmats were just a few of the many practical uses for this new and better kind of paper.

Today, paper's progress has really just begun. Chemically-treated paper can now be woven or knitted into upholstery materials extremely resistant to weather and wear. These same fabrics have been used for fashionable accessories in milady's wardrobe: paper fabrics that can be washed, dry cleaned and re-used as many as 30 times.

Clearly, paper is ready to take its rightful place alongside the other miracle materials of our space age.

And, of course, paper possesses one special talent that spurs *all* progress on. It has the ability to be printed upon with green ink . . . and cut into delightful little rectangular sheets called *money*.

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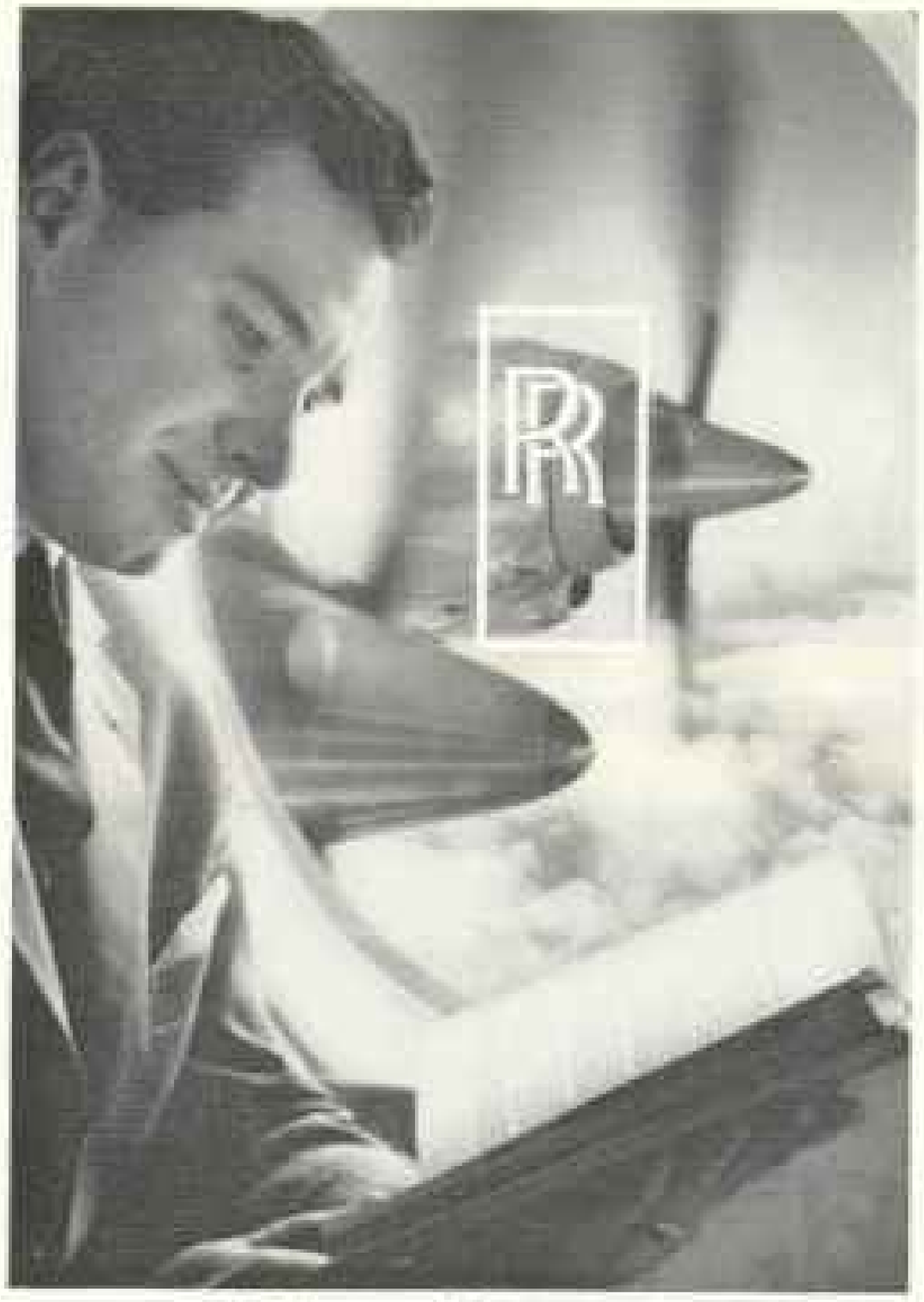

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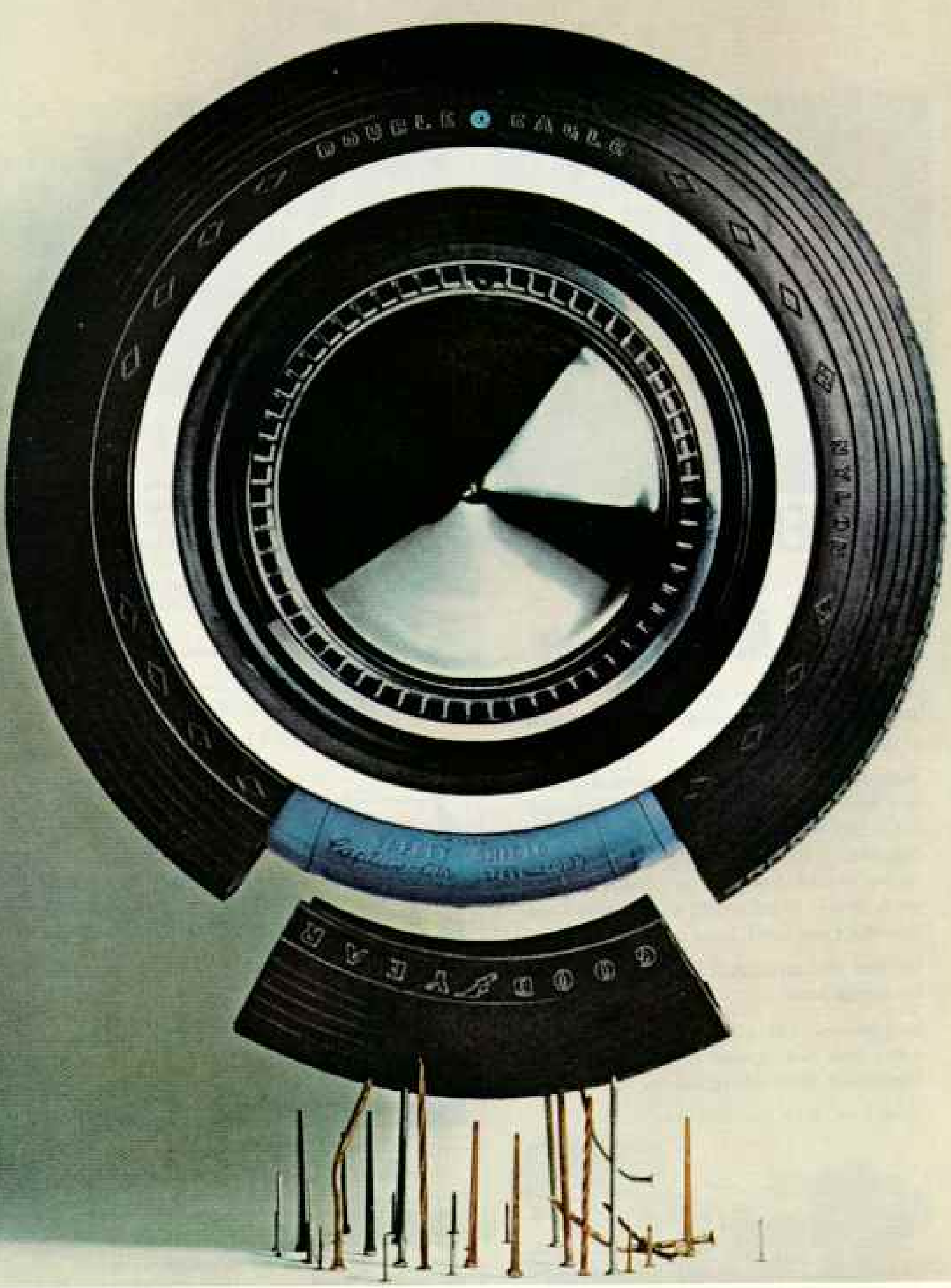

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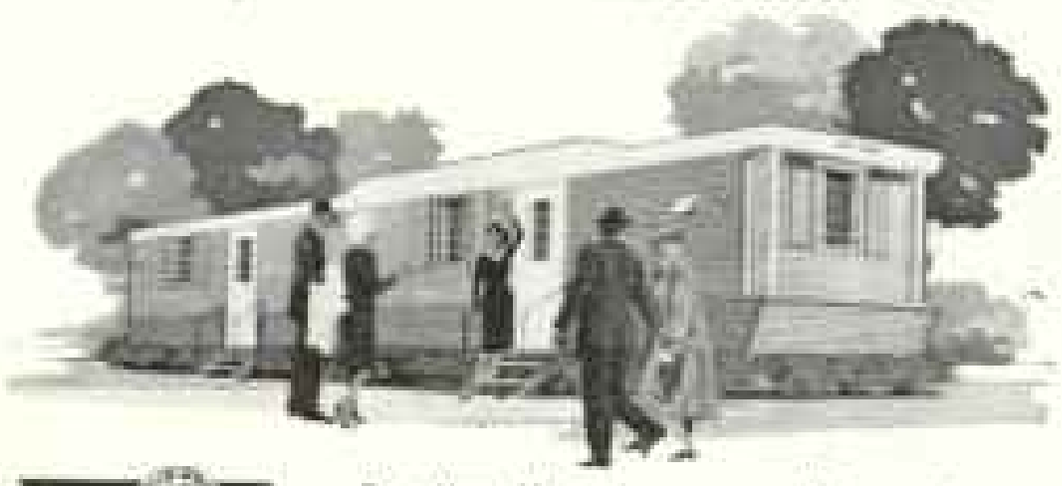

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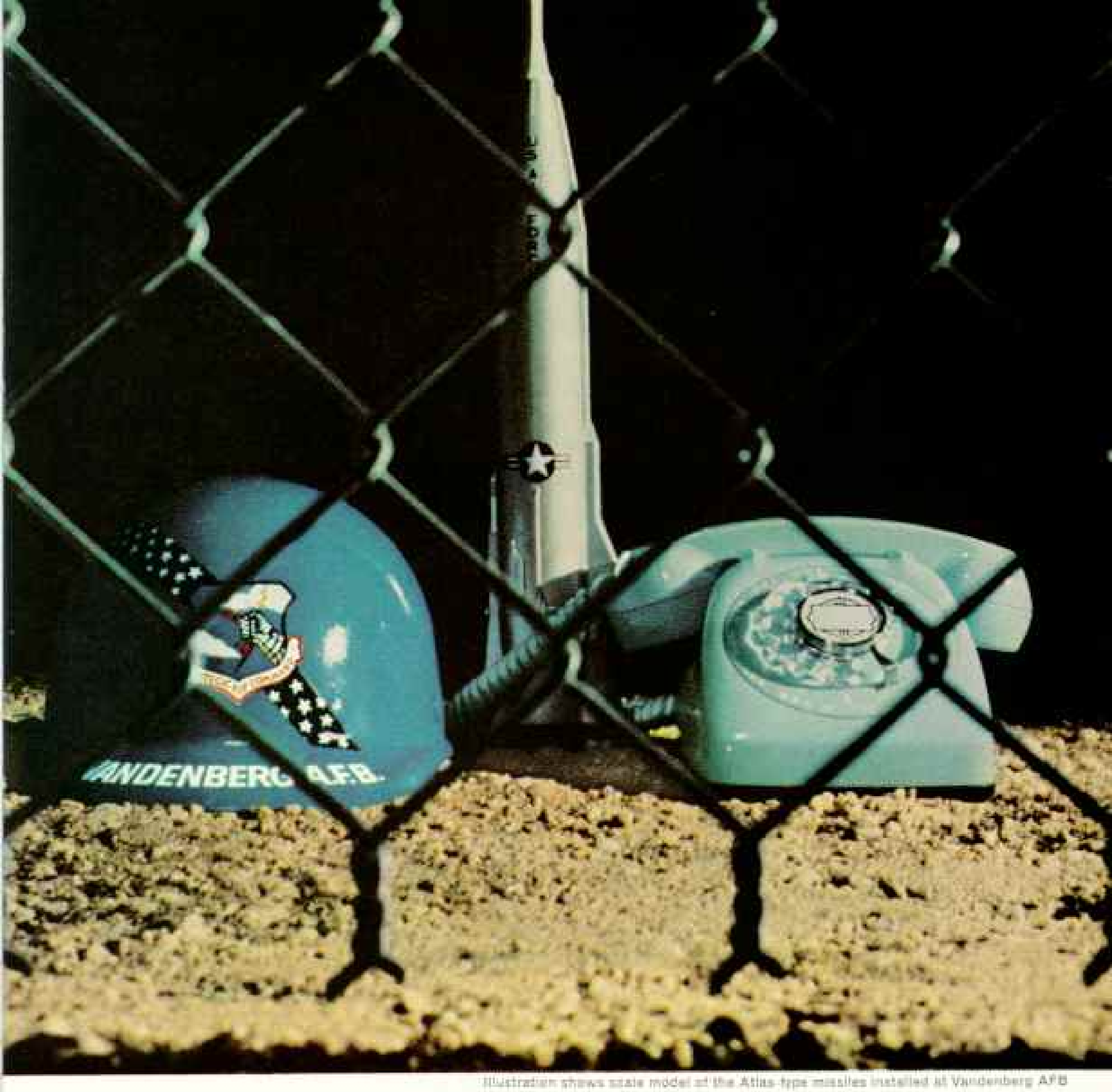

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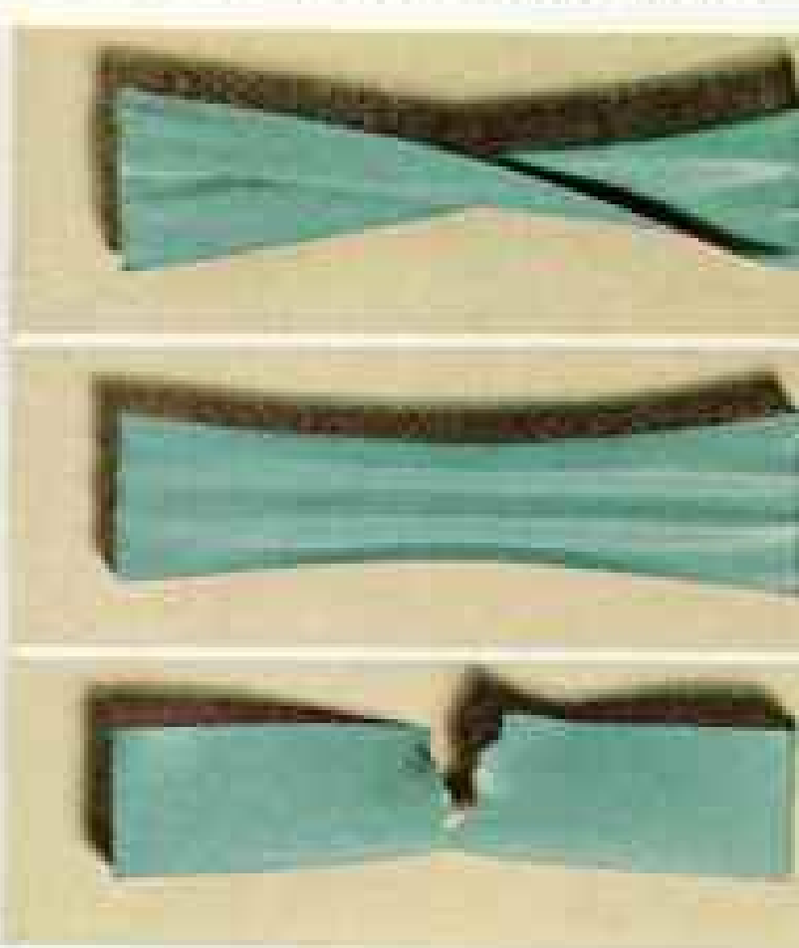

we twist it, stretch it, tear it to test its strength and durability.

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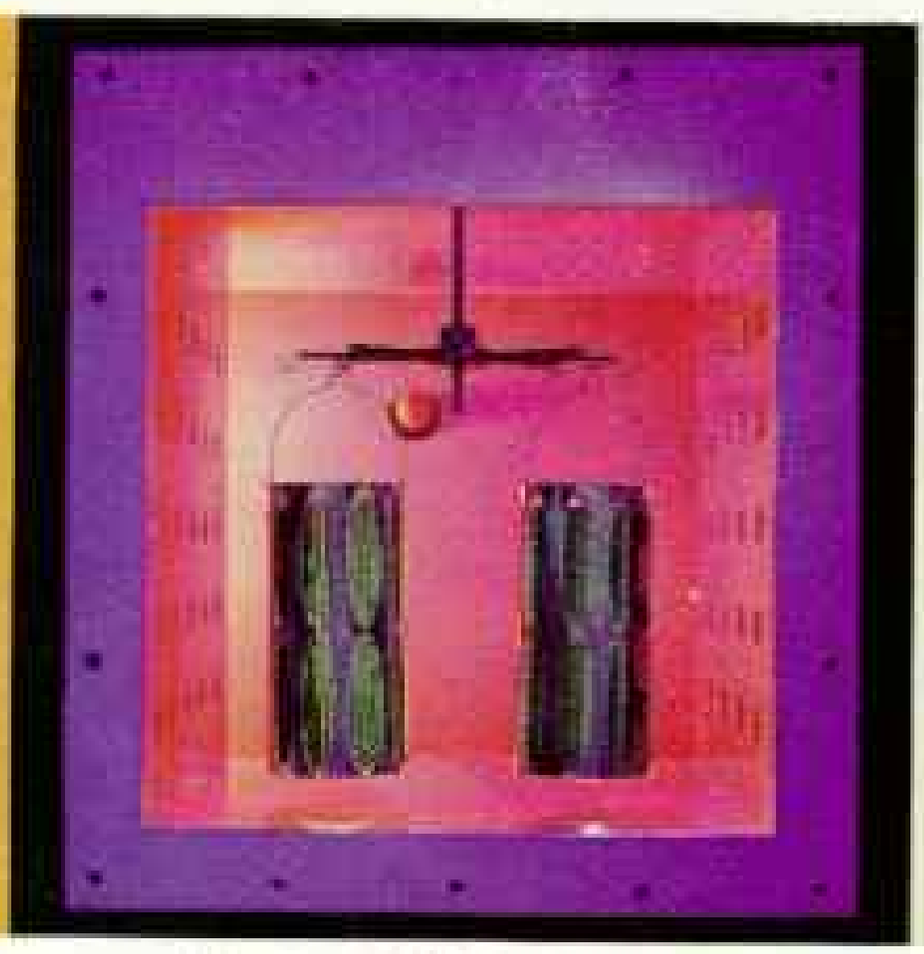

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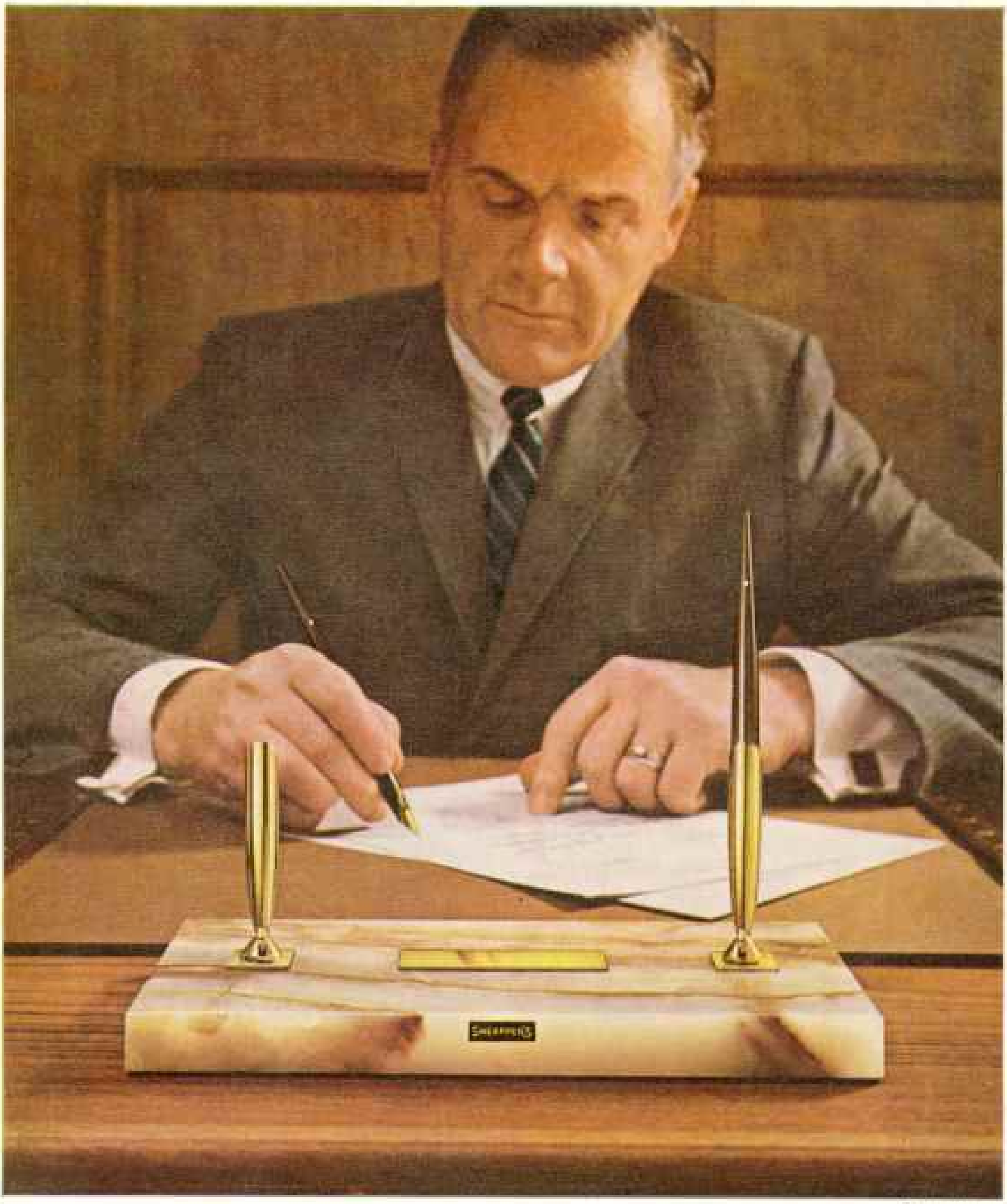

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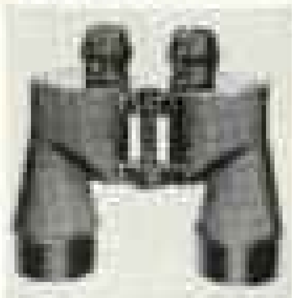

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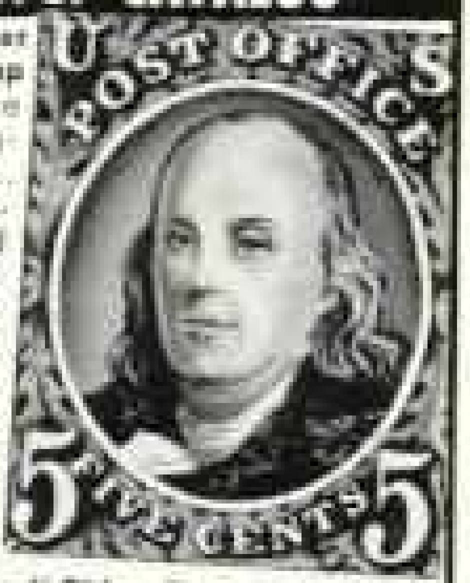

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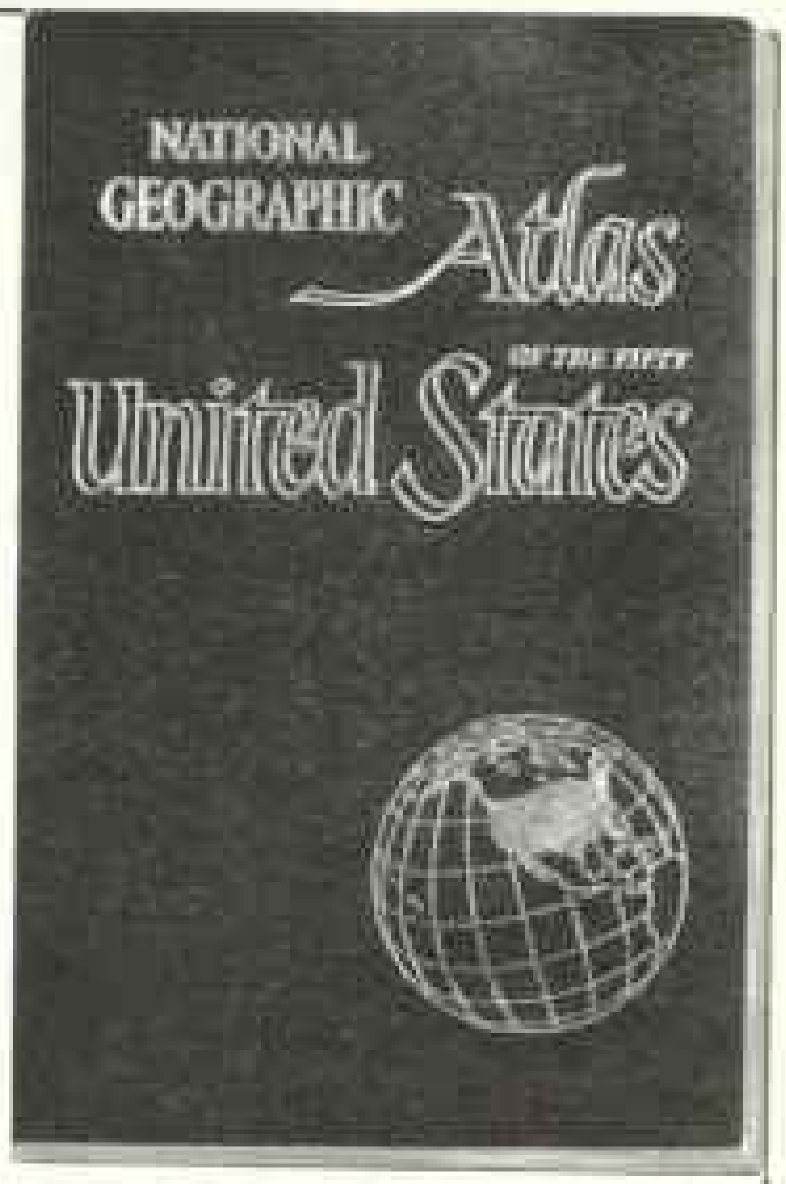

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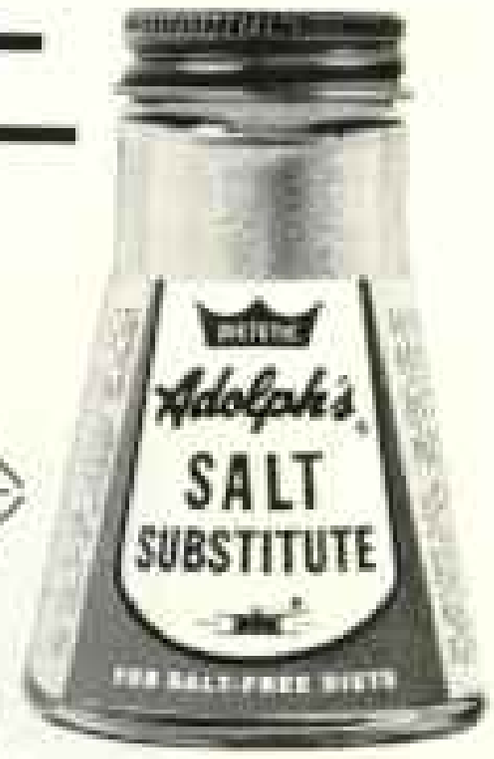

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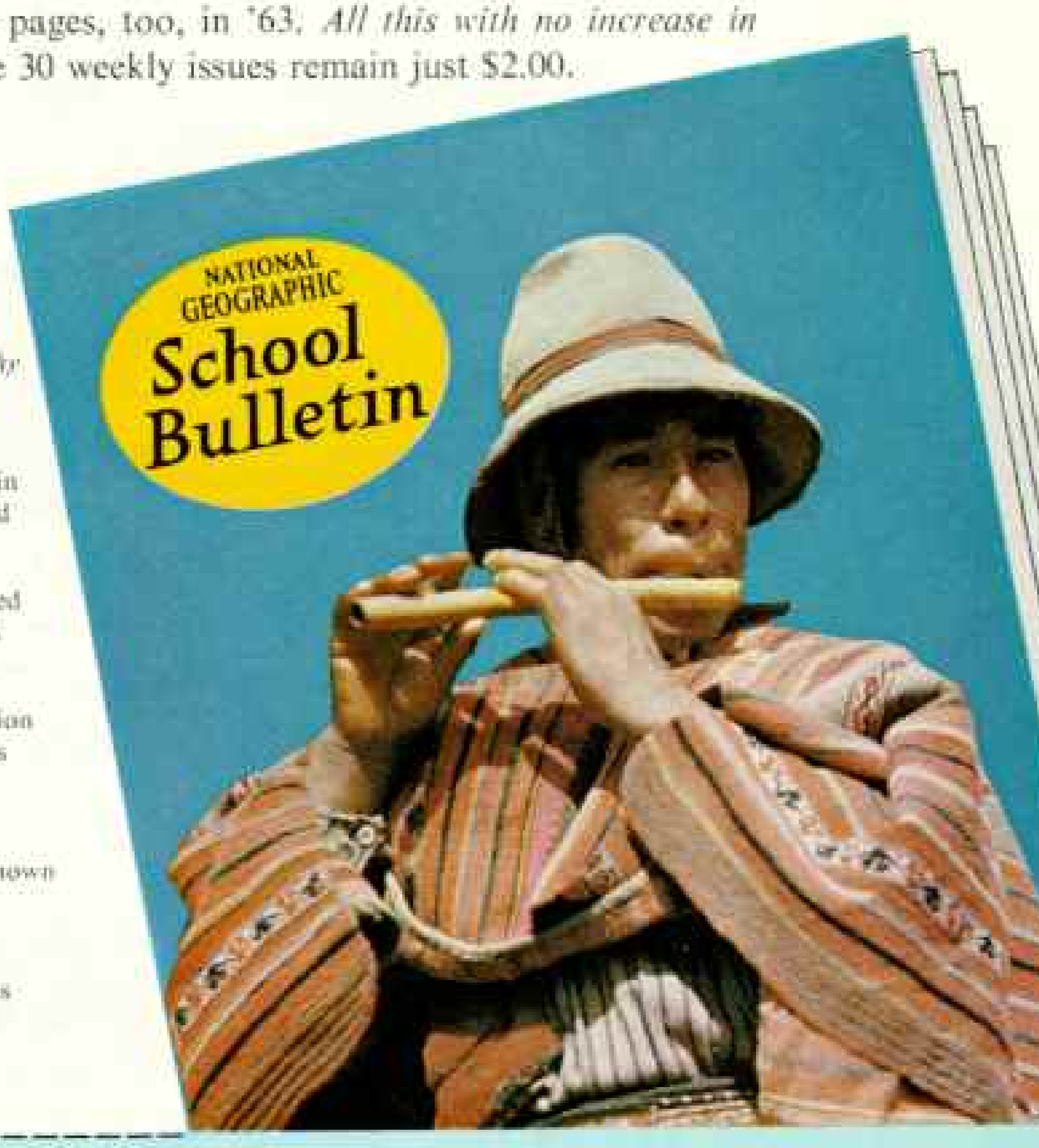

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