

VOL. 165, NO. 3



MARCH 1984

NATIONAL GEOGRAPHIC



A laser-sculpted image shows the magic of a hologram.

The Laser "A SPLENDID LIGHT"
FOR MAN'S USE 335

THE WONDER OF HOLOGRAPHY 364

PEOPLES OF CHINA'S FAR PROVINCES 283

CALGARY: CANADA'S NOT-SO-WILD WEST 378

THEY'RE KILLING OFF THE RHINO 404

SEE "RETURN TO EVEREST" WEDNESDAY, MARCH 7, ON PBS TV

NATIONAL GEOGRAPHIC

March 1984

PERCHING proudly on our cover this month in its three-dimensional glory is the first hologram to be printed by a major magazine. Kissing cousin to photographs, holograms use film but no lens and are exposed only to the light of a laser.

Striking as he is, our little eagle offers more than graphic novelty—he gives us a peek into an onrushing technological storm based on the marriage of computer sciences and the laser beam. Like the quiet before an Asian monsoon storm, the early sprinkling of concepts and products that have reached us gives only a hint of the flood to come.

In this issue our team of writers, photographers, and artists brings us an update on this exciting field—including an explanation of how the cover was made (page 372), and how the same techniques will someday bring us three-dimensional color television.

Though the rest of the magazine lacks the eagle's high-tech look, its consistent high-quality printing is just as dependent on laser and electronic developments. Even the hologram's blue frame was designed without pen touching paper, by a machine normally used in designing and drawing our wall maps utilizing lasers.

This column was written on a paperless typewriter—a four-pound portable computer that transmitted these words via my home telephone in seconds to an electronic typesetting system, which fit them to this page. With a bit of help, it will even correct my misspellings.

All the words and photographs for each issue's articles are electronically scanned and engraved onto printing cylinders with an accuracy of one thousandth of an inch. On press, 13,500 miles of six-foot-wide paper flies over these cylinders at 30 feet a second with near-perfect register of the five to seven colors, thanks to electronic controls. Without these tools your GEOGRAPHIC would cost at least twice as much and not be as well done. More important, the same technology that made our cover a reality is already being applied to everything from supermarkets to surgery to make possible a better and longer life for all of us.

Wilbur E. Garrett

EDITOR

China's Remote Peoples 283

They are the other Chinese—nomads, farmers, monks, mountain tribesmen—almost 70 million people in a nation exceeding a billion. Journalist Wong How-Man travels 11,000 miles to visit China's little-known "national minorities."

The Laser: "A Splendid Light" 335

Dazzling in its uses, the laser taps the awesome power of light for technologies from medicine to the military. Allen A. Boraiho and Charles O'Rear illuminate its bright promise.

The Wonder of Holography 364

Interacting streams of laser light create three-dimensional images that intrigue artists, foil counterfeiters, and pinpoint industrial flaws. Dr. H. John Caulfield reports, with photographs by Charles O'Rear.

Canada's Not-So-Wild West 378

Once a tough little cow town, Calgary is now the flamboyant oil capital of Canada. David Boyer and photographer Ottmar Bierwagen chronicle its rough-and-tumble ride on fortune's wheel.

They're Killing Off the Rhino 404

From Africa to the Far East, this powerful but vulnerable behemoth is rapidly disappearing. Conservationist Esmond Bradley Martin and photographer Jim Brandenburg track the rhino from its shrinking habitat to far-flung marketplaces that spur its demise.

COVER: A miniature model of a bald eagle appears in three dimensions in a hologram produced by the American Bank Note Company. The image is best viewed under a single light source.

THE NATIONAL GEOGRAPHIC MAGAZINE
IS THE JOURNAL OF
THE NATIONAL GEOGRAPHIC SOCIETY
FOUNDED 1888



Peoples of China's Far Provinces

ARTICLE AND PHOTOGRAPHS BY
WONG HOW-MAN

IN THE END I never needed the louse shampoo, though it was reassuring to have it along. The dealer in Hong Kong had insisted it was made especially for Asian lice, and at the time it seemed a good investment.

No one, in fact, knew much about the area I planned to explore. The remote region of central China is still largely closed to foreigners. Perhaps partly because of my Chinese ancestry, the government had made an exception—or so I thought. Now, in my hotel room in the southern city of Kunming, I surveyed the mountain of food and equipment I had brought along for my expedition and wondered if I would get to use it after all.

I had been in Kunming a week, waiting for the jeep and two drivers I had been promised. I had laid out my itinerary carefully, including six provinces and two autonomous regions, the homelands of ten ethnic minorities in whom I was especially interested. If the expedition should fall through now at the last minute, it would mean the end of many years' study and preparation.



Priceless heirlooms of silver, batik, and needlework adorn a woman of the Ge people (facing page), classed as a subgroup of the Miao (above), who also treasure silver jewelry.

The author, a Hong Kong-born journalist, tackled formidable terrain as he sought out some of China's most isolated and least known minorities.

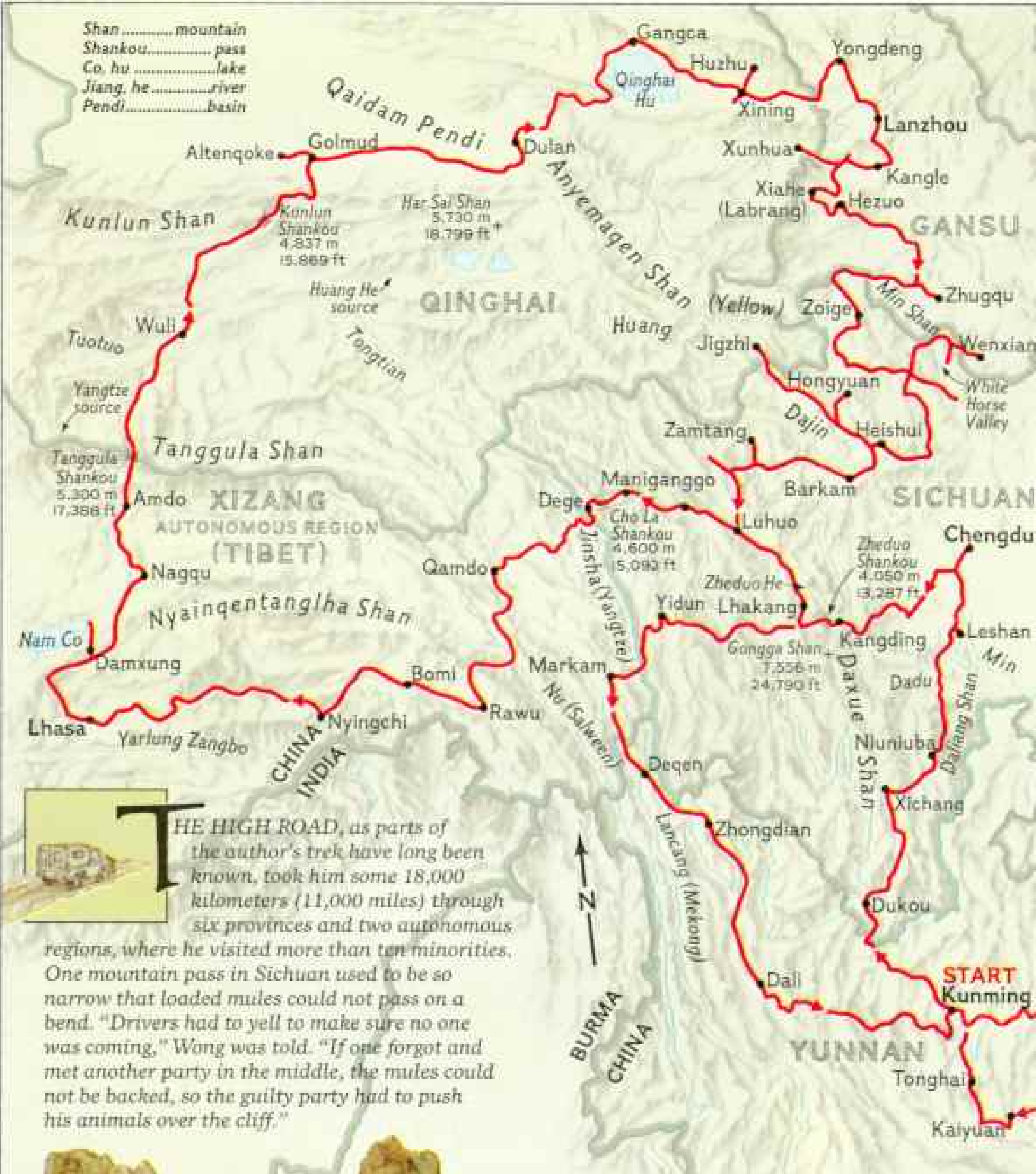


Sheer drops test the nerves of lumber-truck drivers in the Min Shan range between Sichuan and Gansu Provinces. The mountains were the final hurdle for the Red Army in

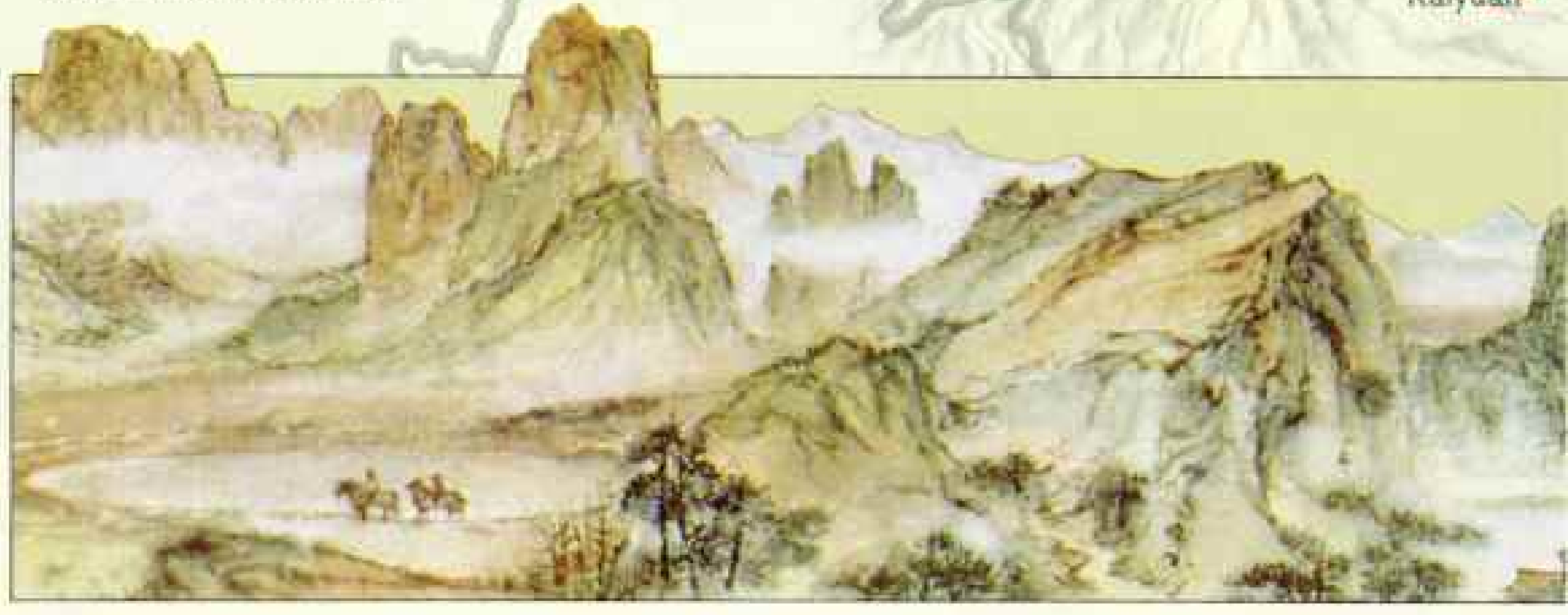


1935 on its famous Long March. Skirting Nationalist areas, the Communists met peoples who sometimes joined them, sometimes fought them, but always had to be reckoned with.

Shan mountain
 Shankou pass
 Co, hu lake
 Jiang, he river
 Pendi basin



THE HIGH ROAD, as parts of the author's trek have long been known, took him some 18,000 kilometers (11,000 miles) through six provinces and two autonomous regions, where he visited more than ten minorities. One mountain pass in Sichuan used to be so narrow that loaded mules could not pass on a bend. "Drivers had to yell to make sure no one was coming," Wong was told. "If one forgot and met another party in the middle, the mules could not be backed, so the guilty party had to push his animals over the cliff."





RUGGED JOURNEY TO CHINA'S OUTLANDS



PAINTING BY HUIJIN-MIN FANG

IN THE PEOPLE'S REPUBLIC of China I am what is known as an overseas Chinese—one of Chinese origin who lives outside the mainland borders. I was born and raised in Hong Kong, graduated with a degree in journalism from the University of Wisconsin at River Falls, and make my home today in Los Angeles.

During the 1970s I lived with my parents in Hong Kong and worked as a journalist. In 1974 I had my first opportunity to visit China with a group of other overseas Chinese journalists. At that time the People's Republic was still in the grip of the Cultural Revolution, and our movements were strictly limited. Later, when the Cultural Revolution had passed, I made a number of trips to more widely traveled areas of the country.

I was aware that the Chinese authorities always saw what I published, but they continued to allow me into the country. From that I learned a valuable lesson: The government of the People's Republic of China will tolerate honest criticism, but not what it regards as prejudice.

In 1982 I determined to pursue my primary interest, the study of national minorities within China. The trip would be a difficult one, by four-wheel-drive vehicle over rough terrain, but the government gave me permission. Now in Kunming, I began to wonder about that permission—had it been canceled, postponed, or just what?

A knock on the hotel-room door interrupted my thoughts. I opened it and found two young Chinese who smiled politely.

"Wong *Laoshi* [Teacher Wong]," one addressed me in respectful tones, "we are your two drivers, Zhang Changjiu and Luo Wengui. The jeep is outside the hotel with spare gasoline cans. What are your wishes?"

My wishes were that we load up and get started. Within an hour we were packed and on the road in our Chinese-built jeep. The date was June 10, 1982, and a long journey lay ahead of us. In all we were to drive some 18,000 kilometers (11,000 miles) through Yunnan, Sichuan, Xizang (Tibet), Qinghai, Gansu, Guizhou, Hunan, and Guangxi. We would visit more than the ten ethnic minorities originally counted on and I would experience some of the rarest moments of my life.

Of China's population of more than one billion, 93 percent is Han Chinese. The Han



Once defamed as the "barbarians of four directions" surrounding ancient China, some 67 million minority members now possess a degree of autonomy from the Han majority.

After Mao Zedong's forces triumphed in 1949, the new government asked ethnic groups to register for official listing as "national minorities." More than 400 did so, to the consternation of ethnographers, who continue their study for possible additions to the 55 minorities now recognized.

Apotheosis of ethnic complexity, some five million Miao encompass scores of subgroups. Bearing a spinning wheel, her hair wrapped around a frame and then covered with yarn, a woman in Guizhou Province can be identified by her vivid costume as a Flowery Miao (left). In southern Guizhou, embroidery and layers of blouses embellish a Hei (Black) Miao (below, far right). While this group refers to itself as Miao, those driven into Southeast Asia by conflict with the Han call themselves the Hmong.

Likewise, Tibetans spill far beyond the borders of their autonomous region. In Sichuan a woman displays the woven dress (above right) of a subgroup sometimes called White Horse Tibetans, who say they are the Di and number about 10,000. In Qinghai a woman wears the partial veil (below right) of the 70,000 Salars, Muslims who trace their origins to Samarkand. In Guizhou a girl of the Dong minority (above, far right), who number some 1.4 million, attends a Spring Club festival to greet the kitchen god.



emerged as the rulers of China's fledgling empire by establishing a dynasty of that name in the third century B.C. along the Yellow River. Though invaded by the Mongols and ruled by their khans between A.D. 1260 and 1368, the Han Empire gradually expanded. Neighboring peoples, the forerunners of today's "national minorities," were peacefully assimilated, were conquered, or withdrew to remote areas to retain their independence.

WHEN the Communist Chinese came to power in 1949, they promised the national minorities a measure of autonomy and assistance in maintaining their languages and cultural identities.

Today China's 55 national minorities total some 67 million people. The purpose of my trip was to see how some of these minorities had fared over the past three decades—how they live, how they are treated, and what the future holds for them.

We began with the people known as Yi, some of whom live in the Daliang Shan, or "great cool mountain" region, three days' journey north of Kunming. Here in 1908 John Weston Brooke, a former British cavalry officer and a fellow of the Royal Geographical Society, was killed by the local inhabitants. These people number about 750,000 and belong to the larger group of

five million Yi scattered over a wider area.

Brooke's remains were ransomed only with the help of native intermediaries—others of his expedition dared not try to penetrate the Yi's mountain fastness. Even during the early years of the People's Republic, anyone entering these regions did so at his peril, though the Yi now admit outsiders.

At Niuniuba, in the heart of the Daliang Shan area, I came across a man in his mid-60s named Halakuka, returning home from the Sunday market. Halakuka invited me to visit his house, a rare opportunity I quickly accepted. After hiking for half an hour through some cultivated fields of corn and potatoes, we arrived at Halakuka's home among the hills.

Squatting outside the thatch-roofed house, we began to chat. Until as recently as the late 1950s, I learned, the Yi maintained a rigid hierarchical slave society. The society was divided into four distinct levels. At the top were the Nuo-nuo—sometimes called Black Bones—who were the nobles. Next came the Qunuo, or commoners, and next the Ajia, or so-called tributary slaves, who lived outside the nobles' households. Finally, at the bottom, were the Yaxi, or house slaves, who were forced to live with their noble masters.

"I was lucky," Halakuka explained. "I was a tributary slave and could live separately. My biggest aspiration was not to



Four for the road pitch camp at 3,250 meters (10,670 feet) in southeast Tibet: the author, second from left; to his right, assistant Chen Yuenkai; and to his left, his government-assigned drivers, Zhang Changjiu and Luo Wengui. "They had to be mechanics as well," says Wong, "because breakdowns of our Chinese four-wheel-drive jeep started the first day out of Kunming. We carried spare parts that even included a clutch—which we eventually needed."

be free—that was out of the question—but to own a few slaves of my own. Such were the wishes of most people in my class.”

In 1955 the first *ganbu*, or Communist cadres from Beijing, appeared in the Daliang Shan. “In the beginning,” Halakuka said, “everyone was skeptical and refused to believe the *ganbu*'s promises to end slavery. But then a few who dared to run away from their masters were protected by the *ganbu* and allowed to start new lives. Word got around, and eventually we all became free.”

The development brought Halakuka not only freedom but also new responsibility. Today at 65 he is in charge of his community's grain storage bins.

FROM the Daliang Shan, we made our way north to Chengdu, the provincial capital of Sichuan. The city lay under a canopy of hot, humid air and was surrounded by a golden fringe of rice fields. Everywhere the markets were crowded with people and produce, the latter raised in local farmers' private plots during spare time outside their required work for their communes. Such open-air free markets give farmers additional income beyond their share of proceeds from their communes. Under the more relaxed economic policy for the countryside, rural Chinese are in many ways better off than their city counterparts.

Some 200 kilometers southwest of Chengdu lies Kangding, whose name in the old days was Ta-t sien-lu—literally “arrow-tempering furnace.” The term is popularly believed to have originated in the third century A.D., when the celebrated military strategist Zhuge Liang of the Eastern Han Dynasty ordered that his army's iron arrowheads be forged here.

In the past, Kangding was considered the gateway from China into Tibet. Most trade between the Han Chinese and the Tibetans was transacted here. The Chinese merchants bought silver, herbs, musk, or furs from Tibetan traders, who purchased tea and small items such as needles and pins.

Standing 4,115 meters (13,500 feet) above sea level, Kangding is ringed by snow-clad mountains in a valley where the Zheduo River thunders through. As one of many methods of disposing of the dead, townspeople often dump corpses into the Zheduo.

This is called “water burial.” Another method is known as “sky burial.” This involves cutting up the body and feeding the pieces to the vultures. Tibetans believe that as the vultures finish feeding and take flight, they carry the spirit of the deceased heavenward.

Cremation, or “fire burial,” is restricted to the wealthy. Simple interment, or “earth burial,” is favored by Han Chinese and Tibetans who have assimilated Chinese culture. Finally, there is the technique of embalming and mummifying the body, a practice reserved for Buddhist saints.

At Kangding I heard the first of many explanations of why Tibetans refrain from eating fish. When bodies are dumped into rivers, they are usually eaten by fish. The fish are thus contaminated and unfit to eat. Later, on the northern Tibetan Plateau, I heard another explanation: Fish live in water and do not compete with people, so one should not kill them. Still another version in Qinghai holds that the taboo is a merciful act of Lamaism toward fish, which carry so many eggs inside their bodies. The most bizarre explanation of all came from southern Gansu, where I was told that since a fish has no tongue, it cannot gossip. Because Tibetans consider gossiping a cardinal sin, they thus reward the fish for its virtue.

SINCE I was about to enter an area inhabited by Tibetan nomads, the manager of my hotel in Kangding gave me a short course in Tibetan etiquette.

“The nomads,” he began, “are most hospitable. They will offer any passerby food and drink. Refusal implies that the offering is not good enough. So when you are given food, whether it is palatable or not, make sure you eat a full portion.

“Tibetan gestures are different from ours,” the manager continued. “When addressing you for the first time, a Tibetan may stick out his tongue at you and show his open palms at waist level. This is an ancient and very courteous form of Tibetan greeting. The outstretched hands show that no weapon is hidden, and thus no harm is intended. The display of the tongue dates back to an old superstition that one who poisons others has a black tongue.”

Driving northwest from Kangding, we climbed steeply among breathtaking



snow-clad mountains that seemed to continue forever. Laboring in low gear, the jeep crawled ever higher through a series of switchbacks and hairpin turns. We set out amid pines and birches, which gradually gave way to junipers and rhododendrons. Beyond 4,000 meters (13,000 feet) above sea level the trees ended and there were only low shrubs, grasses, and a profusion of blue and yellow poppies. The latter were to become our instant altimeter: Whenever we were climbing and came upon the poppies, we knew we had reached the 4,000-meter level.

NEAR THE TOWN of Luhuo we stayed for two days with five Tibetan yak herders from a local commune. Among the five was a 23-year-old named Bobolanga, who always wore a smile. Bobolanga had spent three years in the Chinese People's Liberation Army and spoke Putonghua, or Mandarin Chinese, which is understood by many Han and minority groups alike.

I spent long hours with Bobolanga and his companions, drinking tea in their tent. Tea is indispensable to Tibetans. They are so addicted to it that both the Chinese and British once thought that by controlling the tea trade in Tibet they could subdue the Tibetans. They were wrong, but tea is nonetheless an integral part of Tibetan life.

Entering a Tibetan tent puts one's senses to a most severe test. Smoke from the furnace fueled by yak dung saturates the entire living space and brings tears to unseasoned eyes. Yak butter, with its pungent odor, is sliced and then mixed with salt and boiling tea in a wooden cylinder. The mixture is poured into wooden bowls and offered to the visitor, serving after serving.

Besides consuming buttered tea and spending long hours talking, my new friends and I developed a keen mutual interest in one another's objects of daily use. Much to the Tibetans' astonishment, our tents went up within minutes, while theirs took a good half day to pitch. Bobolanga showed great curiosity in my mountain stove, which burned a variety of fuels from gasoline and diesel to kerosene or oil. Accustomed to the yak-hide bellows he used to fan his fire, he always wondered where I hid my bellows.

In the evening our Tibetan friends

rounded up their 200 yaks and drove them to camp with much hissing and occasional rock throwing. The calves were separated from their mothers, and Bobolanga and his colleagues began milking the cows. Streams of rich, yellowish fluid spurted into wooden buckets, with yak hairs mixed in as unintentional ingredients. Bobolanga and his friends milked the cows so enthusiastically that I was afraid little would be left for the calves. Bobolanga put my mind at ease. "There are four teats to each cow," he said. "We milk only three and leave the fourth for the calves. They never complain."

AFTER two days we left the nomads and headed west toward Lhasa. The usual run between Chengdu and the Tibetan capital takes a fortnight for a truck driver. Chinese Army outposts offering heated rooms and hot suppers are stationed at 70-kilometer intervals, and we took full advantage of the service.

At Maniganggo the road divides. The northern route leads to Qinghai Province and the other to eastern Tibet. By the time we made it up the pass, 4,600-meter-high Cho La, our jeep had overheated four times, and each time we had to stop and pour in glacial water from streams along the road. During one of these refillings of the radiator, the boiling water spouted out and some drops hit my face. Instead of being scalded, I found the water temperature to be surprisingly low. I recalled then that at such great height water boils at a much lower temperature. From then on, whenever we heard the radiator fizzing, we took our time refilling it.

Two weeks after leaving Chengdu, Zhang and Luo and I arrived in Lhasa. For



Planting on a slant, modern Yi farmers (facing page) in Sichuan have abandoned slash-and-burn methods—along with slavery. Unmarried girls still favor a headdress of rolled fabric (above).

centuries this was the legendary goal of Western explorers. It is only within the past few years that the city has become accessible to Western tourists.* Even at that, the price is high: Western visitors to this sacred city are automatically booked into the best guesthouse, which is located on the outskirts of Lhasa and costs 290 yuan (\$145 U. S.) per person per day. The *next* best—Number One Hostel in the heart of town—costs just three yuan, or \$1.50, a day. My drivers, Zhang and Luo, and I opted for the less luxurious accommodations.

At Number One Hostel tickets for meals and showers are sold daily at fixed hours. The showers, boasting solar heating, were set in another building, painted a romantic pink—unusual indeed for China.

For four days I tried in vain to take a shower within the prescribed two hours of

the afternoon. Each time, however, I was told that the water was not hot enough. That seemed odd since, as it happens, Lhasa is known as “sun city,” because the sun shines there 3,000 hours a year—an average of more than eight hours a day. The last day I was in Lhasa I finally succeeded in cornering the manager as he walked into the bathroom. It was the appointed time for showers and I refused to be denied. Towel and soap in hand, I strode into the building behind the manager and found many of the hotel staff soaking in tubs or leisurely taking showers. The water was deliciously hot.

Every day I spent hours walking the streets of Lhasa, watching the Tibetans living under the shadow of the fortress-like palace known as the Potala. In the evening

*See “In Long-Forbidden Tibet,” by Fred Ward, in the February 1980 NATIONAL GEOGRAPHIC.



Getting there, or not: Trucks bog down in a horrendous quagmire on a detour from a stretch of road being paved between Lhasa, Tibet's capital, and Golmud in Qinghai Province (right). Here at some 4,500 meters (15,000 feet), permafrost blocks drainage. The author was told of 1,800 mired vehicles in this sea of mud and another nearby.

“Ambition as high as the clouds,” reads the banner of Shi Zhao-ming, 25, on a bike trip to all 26 mainland capitals within a year. That young people have time and approval for such adventures is a sign of a changing China.



hundreds upon hundreds of Tibetans walked around the great Jokhang Temple in a clockwise direction, spinning prayer wheels or humming the sacred words, "Om Mani Padme Hum—Hail to the Jewel in the Lotus."

Historically the people of Tibet enjoyed not only cultural and religious freedom but political autonomy as well. Following the collapse of Nationalist Chinese power on the mainland in 1949, the Communists moved into Tibet and reasserted China's age-old claim to the territory. Representatives of the 15-year-old Dalai Lama, leader of the people of Tibet, signed an agreement with the Communist Chinese providing for self-government but allowing Beijing jurisdiction over all military and foreign affairs. Whatever the merits of the agreement, it failed to solve China's and Tibet's ancient

differences. The Dalai Lama himself fled Tibet in 1959 and has never returned to his homeland.

FROM LHASA, Zhang and Luo and I planned to drive north to Golmud in the province of Qinghai, a trip of some 1,200 kilometers (750 miles) that normally takes a week. But torrential rains had drenched unpaved sections of the highway, bringing commercial traffic to a halt and miring hundreds of trucks in oceans of mud. Since our jeep had four-wheel drive and was relatively light, we decided to take a chance.

We were lucky indeed. Throughout the entire trip we were stuck only four times.

On July 6, near Nam Co, Zhang came down with mountain sickness, a malady whose symptoms are severe headache, dizziness, and

(Continued on page 300)





Efficiency born of life on the move speeds a band of Kazaks and their herds to new grazing grounds. Felt walls of a domelike yurt are stripped to the wooden lattice framework (right), itself collapsed and tied with family possessions onto four camels (above) in just 45 minutes. Assembled, the yurts are cozy shelters permeated by the aroma of rancid butter tea (left).

Most of China's 900,000 Kazaks inhabit Xinjiang Autonomous Region. But this group tells of fleeing a warlord in 1936 and moving south into Qinghai. Beset there by Mongol nomads, the Kazaks moved farther south in 1939, only to be caught and massacred by a local warlord. Of 10,000 Kazaks, they say, all but 700 perished. Today they have recovered to become a commune of about 2,000 semi-nomads, who raise sheep, horses, cattle, and camels and live in houses near Golmud in winter.

National Geographic, March 1984





Joining together under a wide-open sky, a Kazak bride and groom bow their heads as a peer reads their rights and responsibilities (right). Although the Kazaks are Muslims, this couple was married with a civil service.

Ceremony complete, the day's nonstop feasting was tempered with dancing, wrestling, and a favorite exercise—horse races in which women pursue men.

After a 20-day honeymoon the groom, an elementary-school teacher, and his bride, a factory worker, moved into housing her company provided.

No wedding is needed for a Kazak tot to show off her finery in Golmud (above).





nausea. Luo took over the wheel, and we rushed Zhang to the nearest hospital, at the town of Nagqu, 100 kilometers away.

There we learned from a Tibetan doctor that mountain sickness, caused by insufficient oxygen, is common among drivers along the Lhasa-Golmud road. When their trucks are stuck at such high elevation, the drivers strain themselves in freeing the vehicles, at the same time suffering from hostile weather. That can aggravate mountain sickness or cause pneumonia, or both. Unfortunately Zhang had contracted both ailments, and the doctor was not hopeful.

BUT MIRACULOUSLY Zhang began to recover, and within days he was well enough to travel. Zhang's fellow patients at the hospital wondered to just which god he prayed!

On the road once more we continued

north, climbing higher and higher until we arrived at Tanggula Pass—at 5,300 meters (17,388 feet) the highest point we were to reach during our expedition. Nearby, amid these spectacular mountains, lies the source of the Yangtze, which flows 6,380 kilometers (3,960 miles) to the sea, third longest river in the world. From here we had 600 kilometers to go before we reached Golmud, only 3,200 meters above sea level. Slowly, then, we descended from the roof of the world to what were merely the eaves.

Over the next day or two we saw many antelopes, a few wolves, and a lot of emptiness. There were practically no settlements along this stretch of road save occasional highway maintenance and military stations.

In our eagerness to reach Golmud, we stupidly continued driving after dark one night, went off the road, and got stuck in an ocean of mud. We were forced to give up



Eager traditionalists, members of the 160,000 Tu minority perform an impromptu dance in Qinghai. Former nomads related to the Mongols, the Tu won partial autonomy as frontier guards for imperial China. They have jettisoned some customs, such as girls' losing their chance for traditional marriage if not betrothed by age 15.

and sleep in the vehicle without supper.

Next morning I walked to the nearest road construction station, four kilometers away. There the supervisor dispatched a huge tractor that easily towed us out.

During my ride on the tractor I talked with the driver, a soldier in the People's Liberation Army, which is improving and paving the road. "Outsiders spend one winter here," he told me, "and they find even that too much to bear. But we on the road crew spend *two* winters each year." I looked puzzled and he explained.

"During winter months all road construction stops, and we descend to Golmud. Even at that elevation, the winter is brutal. Then during summer we come back up here. Working out in the open at nearly 5,000 meters, we are exposed to a second, equally severe 'winter.'"

ON JULY 12 we drove our mud-stained jeep at last into Golmud, Qinghai Province's second largest city, after Xining, the capital. Here, on the southern edge of the Qaidam Basin, stands a modern oasis and a transportation center commanding traffic into Tibet from the north. The railroad from China proper ends here, but one day it may be extended to Lhasa. Looking at the string of military and civilian truck convoys being readied for the strenuous journey south toward Lhasa, I reflected that Golmud owes its very existence to Tibet. The south side of the city seems one vast motor pool. Gasoline tanker trucks form their own convoys, for approximately one out of every seven trucks on this road carries fuel for the other six.

From Golmud we drove east through the Qaidam Basin toward Xining. After the snows of high Tibet, the desert was a welcome change.

On the way to Xining we stopped briefly at Qinghai Hu, the largest lake in China. In the middle of the lake lies a tiny island once occupied by a Tibetan monastery. Songs of the children of Xining used to recount how in winter the lamas walked across the frozen surface of the lake to town to sell their handmade goods and buy daily necessities.

As spring approached, the lamas sighed in grief as the city merchants, who were mostly

Muslims, raised the prices on their merchandise. They knew that the lamas, who were too frugal to purchase boats, had to stock up for summer and rush back to their island before the ice thawed.

Although Muslim peoples migrated centuries ago from Central Asia to Tibet, religious differences between them and the Buddhist Tibetans sometimes led to distrust. No area was forbidden to Muslims in Tibet, but none of them would ever enter a lamasery. By the same token, no Tibetan would enter a mosque, for Tibetans believed that the Muslims deliberately buried Tibetan holy books under the thresholds of their mosques so that visiting Tibetans would inadvertently sin by treading there.

Pausing briefly in Xining, we continued toward Huzhu, 45 kilometers northeast. Here stands the seat of government of an ethnic minority known as the Tu.

A local government jeep was waiting for us on the road between Xining and Huzhu. I was invited to ride in the official vehicle while Luo followed in our jeep. After a short drive we reached the village of Dazhang. As we neared the outskirts, I could see that the entire village had turned out. People in bright costumes lined both sides of the road, swarming around us as the jeep stopped. As I stepped down, I was offered "wine"—a barley liquor—by two village elders and was obliged to drink three glassfuls in succession. As it turned out, this feat was to be repeated many times before the day was over.

At noon we were invited to a private home for lunch and were seated on a bed beside a low central table. To the accompaniment of many songs we were served several dishes, including a ceremonial one, a wooden bowl of tsamba, or parched barley, on top of which was a pat of butter sculptured in a three-legged symbol representing earth, sun, and moon. This was a reminder to the Tu that they had once led the life of nomads, roaming the earth under the sun and moon and eating tsamba.

From a Tu official, Li Yandai, I learned that there are only 160,000 Tu in all China—47,000 of them in the Dazhang area. I wondered if one reason for the small population figure might have been the Tu practice of *daitiantou*. Under this custom, if a girl was not betrothed by the age of 15, her parents



would "marry her to heaven," declaring her no longer eligible for traditional marriage. But I discovered that these "heaven-bound" daughters often raised families outside marriage, apparently with social approval.

I was much moved by the charm and hospitality of the Tu people. As I took my leave, I was careful to observe their custom of offering three servings of wine to my gracious hosts. Though it was their own wine I was offering, they seemed nonetheless appreciative. Men, women, and children all gathered to see us off. As our jeep left the village, a farewell song followed us down the road.

SOME 600 KILOMETERS beyond Dazhang on our route stood the majestic lamasery of Labrang in southern Gansu Province (page 307). Operated both as a religious center and as an institute of higher learning, Labrang boasted an average of 3,000 faculty and students from the monastery's founding in 1709 until the coming of Communism in 1949.

Labrang has six colleges—the College of Esoteric or Metaphysical Teaching of Buddhism, the Lower and Higher Colleges of Theology, the College of the Wheel of Time, the College of Medicine, and the College of Astronomy. The College of Esoteric Teaching, largest of the six, once enrolled 2,500 monks. Completion of all its courses can easily take as long as 15 years. The college confers the Tibetan equivalents of bachelor's, master's, and doctoral degrees.

The interiors of Labrang's major temples were both luxurious and well preserved, contradicting reports that everything had been destroyed during the Cultural Revolution. I was fascinated by the lamasery's two master kitchens, where meals for more than 3,000 monks were once turned out. Five gigantic woks, each measuring some three meters across, were built into each of these kitchens—or rather, the kitchens were built around the woks.

Wooden buckets for serving the monks were neatly lined on shelf after shelf along the walls. It was said that in the past these buckets served a second, more formidable purpose: Every student monk who failed his tests in recitation was forced to wear such a bucket filled with water around his neck, and to wear it until he could recite properly.

Since the government relaxed its restrictions on religious practices following the Cultural Revolution, there has been a stampede of Tibetans to the celibate life at Labrang. Though this should contribute to China's population-control program, the government has limited enrollment at Labrang to no more than 500 monks.

During our expedition I wanted to visit a few of the sites through which the



Mirrors of past and future reflect from southern Gansu. A tiled solar reflector focuses the sun's rays on a teapot (facing page) at a wheat-growing commune of the Hui, a Muslim minority. The innovation boils water in 20 minutes and burns no precious wood in the bargain. A timeless street scene in Kangle finds a curbside dentist with a foot-powered drill advertising painless tooth removal under a canopy propped by a tree trunk.

Communist Red Army had passed on its historic, 10,000-kilometer Long March in 1934 and 1935. From Labrang, therefore, Zhang and Luo and I drove south toward the mountain range known as the Min Shan, the last great obstacle facing the Red Army before it reached Yan'an, its refuge in northern Shaanxi Province.

AT HEZUO, on the way to the Min Shan, I stopped briefly at a Tibetan burial site where bodies of the dead are ceremoniously sliced up and fed to the vultures. I was welcomed by a lone lama in his 60s who lived in a small chapel and

disposed of the bodies when they were brought to him. Perhaps too flippantly, I asked how business was.

"This is not a 'business' but a charitable work," the lama corrected me. "When someone passes away and his family wishes the body disposed of in this meritorious fashion, I am here to be of service."

I asked if the government or anyone else interfered with his charitable work.

"I have problems," the lama answered, "but not with the government. For a while the vultures would not cooperate—they were simply nowhere in sight." He shook his head. "Some lamas know how to call the



"Look at the mushrooming roads and bridges," mourns Luo Jungui, one of the last of the Muslim builders of inflatable sheepskin rafts on the Yellow River at Lanzhou, Gansu's capital. His people, the Hui, with seven million members, are the largest of China's ten Muslim groups and differ little from the Han except in religion.

vultures, but unhappily I do not. So I hired an assistant who knows the trick. His calls are always answered, and now we have successful burials once more."

As we approached the Min Shan range on the northern border of Sichuan Province, I was struck by the way Tibetans there carry their personal weapons—rifles, pistols, swords, and knives—wherever they go. By contrast, the Han people walk about unarmed. I was told that the Tibetans living farther south had been largely disarmed by the government as a result of unrest there in the late 1950s. Tibetans living to the north, having caused the government no headaches, are allowed to retain their weapons, which they do with great pride.

DEEP INSIDE THE MIN SHAN, home of the giant panda, we visited a little-known tribe sometimes referred to by outsiders as the White Horse Tibetans (page 289). The name derives from the White Horse Valley, one of the areas they inhabit.

The tribe calls itself the Di people—a name that appears in ancient Chinese histories. Yet all written records of the Di end around the year A.D. 420, more than 15 centuries ago.

Though the Di have no written language, they enjoy a colorful oral history. Chen Yuanguang, a Chinese authority on the Di, told me a delightful legend purporting to explain the people's habitual singing.

In ancient times, runs the legend, heaven bestowed on humans an abundance of rice covering the entire earth like snow. But a woman accidentally stepped on some grains of rice, thereby offending God. God sent the ox to earth to announce His punishment for mankind: Each person was to comb his or her hair three times a day and eat but one meal a day.

By mistake the ox ordered combing of the hair once a day and eating of three meals a day. God was much angered and banished the ox to earth to toil and repent. The ox begged for mercy. First, he claimed he would be ill-treated on earth. God therefore gave the ox horns to defend himself. Second, the ox worried about insect bites. God gave him a tail to drive the insects away. Third, the ox was afraid of being punished if he was

to oversleep. So God asked the people to sing to the ox to keep him awake. To this day, the Di always sing whenever they plow the fields with their oxen.

FROM WHITE HORSE VALLEY we traveled south, following the river called Min Jiang. Along the way every ox we came across seemed somehow a bit special.

On its upper reaches the Min Jiang is spanned by suspension bridges, cantilever bridges, and bridges consisting of nothing more than a pair of slender steel cables. At one point we stopped to admire the skill of a man crossing the river by means of such a "bridge." He was shuttling goods back and forth between the two banks, oblivious of the foaming torrent below. After much coaxing by some of the local residents, I agreed to cross over the Min Jiang hanging on to this master acrobat.

There was a cable for each direction, and each was slanted down so that gravity did most of the work. Starting from the high end of our cable, we pushed off with me clutching my companion as we sat on a rope sling suspended from a trolley running along the top of the cable. As we slid downward, the cable gave off an eerie whistling sound.

Near the far bank our forward momentum ceased, and we were suspended in mid-air at a dip in the cable caused by our own weight. Relinquishing the pulley handle, my partner grasped the cable and pulled us hand over hand up the last few meters to the bank. As my feet touched the earth, I wiped my sweating forehead. Had there been any other way to make the return crossing, I would gladly have accepted it.

Our next stop was the homeland of a small ethnic minority of some 100,000 people known as the Qiang, who live north of Chengdu in Sichuan Province. The villages of the Qiang resemble fortifications, with slender watchtowers that rise as high as 13 stories, or roughly 30 meters. From a distance the towers look like factory smokestacks. They are usually located at the most strategic places, on cliffs or precipices with the farthest view. The abundance of these towers, which today are used mostly for grain storage, attests to a darker period in Qiang history.

Their faith entrenched in a niche of southern Gansu, Tibetans beat a path to Labrang Lamasery, exponent of the form of Buddhism called Lamaism. Borrowing heavy wooden-bound Buddhist prayer books from the lamasery, pilgrims carry them around the entire compound on the day of Buddha's birth to earn merit (facing page). A penitent's faith may also give her pet a chance at reincarnation in a higher form (right).

At a Tibetan festival on the nearby Songke grasslands, a living Buddha, the Gong Tung Sang, accepts gifts of white silk scarves called khatas (below). Living Buddhas are said to undergo continual reincarnation to guide other souls. Highest among them is the Dalai Lama, still in India after he and 90,000 Tibetans fled Chinese troops that crushed a rebellion in Tibet in 1959.



DURING my research I had read that very early marriage was once prevalent among the Qiang. A lady I met in one of the villages confirmed the fact. "It is true we used to marry early," she told me. "Some were betrothed even before birth. It was not unusual for a boy to marry between the ages of seven and ten. Women married older, between 12 and 18, so the wife was often much older than her husband."

"What about your husband," I asked, "how old is he?"

"I am still a maiden," she answered, smiling, "though this year I am 26." I gathered both from the reply and the smile that the custom of early marriage has been abolished among the Qiang.

She went on to recite the words of a song that was once popular among her people. The song went like this: "It is the sixth moon,



and the wheat flowers are blooming in the field; my husband is still an infant drinking milk. How long will it be before he grows up? The leaves shall fall and the flowers wilt."

The lady invited Zhang and Luo and me to her house for lunch. Among other things, she served us tortilla-like bread, a staple among the Qiang, called *sanchuisanda*. The term literally means "three blows, three

hits." The bread is made of wheat flour and is baked in hot ashes, at the side of a fire. After 20 minutes out comes a delicious loaf. But since the loaf is covered with ashes, one needs to blow on it two or three times and pat it as well. Hence the unusual name.

We had been on the road nearly three months when we crossed the Yangtze River for the last time and approached Yunnan Province, where our expedition had started.

Soon we saw our first truck with Yunnan license plates, and Zhang brought our jeep to a sudden halt. He and Luo rushed over to the truck driver to ask for the latest news from home. On August 31—82 days and some 13,000 kilometers (8,000 miles) after we had left Kunming—we entered the city once more. Zhang and Luo were home, and I too needed a break, to see my family and to plan the rest of my travels in remote areas of China. On the first of September I said good-bye to Zhang and Luo, then flew to Hong Kong for a few days to see my parents and continued to my home in Los Angeles.

THE FOLLOWING MARCH I was back in Kunming, making arrangements for the final leg of my journey. Having visited five provinces on the previous trip, I had three more I wanted to see—Guizhou, Hunan, and Guangxi. For family reasons Luo could not join us, so I set out with Zhang and a new member of the expedition, Jin Xuezhong, whose family name means “gold.”

Guizhou Province is noted for being one of the poorest regions in China. Mention Guizhou to almost any Chinese, and he will inevitably quote the ancient description of the province: “There are not three days of clear sky, the land has not three li [$1\frac{1}{2}$ kilometers] of flat area, and the people have not three taels of silver.”

The description is unkind, though accurate in one respect: Guizhou is an up-and-down land. The endless mountains and canyons that divide the province have doubtless contributed to its human makeup of distinctive ethnic groups. Of these the people known as Miao have become almost symbolic of Guizhou Province.

There are an estimated 5,000,000 Miao in China, more than half of them in Guizhou. The Miao, in fact, extend far beyond China's borders, into Laos, Vietnam, and Thailand, where they were driven centuries ago by the Han Chinese. In these areas they refer to themselves as Hmong, though they are all related to the Miao of China. Some anthropologists claim there are close to a hundred distinctive subgroups of Miao in China alone, each speaking a slightly different dialect and maintaining its own traditions and customs.



A secret passes between lamas in a courtyard of Labrang Lamasery. A theological center of learning since 1709, its six colleges once taught a



student body of 3,000 monks, now limited by the government to 500. In the first half of this century one out of four Tibetan men lived in celibacy in such lamaseries, one factor that reduced the population of Tibet to 1,270,000 by 1957. Since the 1960s a decline in the number of lamas has contributed to steady population growth.



In a nostalgic return to their roaming days, onetime nomads camp on the Songke grasslands at the annual Langshan summer festival. Under tents families display their proudest possessions, such as a black-and-white television (left), switched on and awaiting a signal from a hilltop relay station. Power was graciously shared by a living Buddha, who brought a portable generator.

Entertainment includes traditional Tibetan drama (right), with some plays dating from the 15th century. Teams from different Tibetan counties show their colors in a tug-of-war (below).

Although a few true nomads attend Langshan, the majority have homes near Xiahe (Labrang) and its lamasery, which fostered stability by creating a livelihood for those willing to settle and serve the lamas.





*Spirited gunfire and blowing of conch horns resound in a joyous Tibetan ritual called *Planting of the Arrow*, performed each summer to invoke protection of the mountain god. At dawn each family brings a long decorated staff, its "arrow." The staffs are sanctified (above right) with smoke from a fire burning offerings of yak butter and tsamba, or parched barley. On signal, men implant the staffs inside a corral (above), to remain until the following year.*

The author spent two frantic predawn hours looking for the site. He found it "at the end of a road as rough as a riverbed and as wide as a wheelbarrow."

The Miao can be divided into five main groups: the Black, Red, White, Blue, and Flowery Miao—all designations based on traditional costume.

AT ANLONG, in southwestern Guizhou, Zhang and Jin and I put up at a hostel. Early next morning loudspeakers along the streets blared the martial tones of the revolutionary march "The East Is Red." In the days of the Cultural Revolution this was the standard overture and finale to each workday throughout China. The custom ended for the most part in the late 1970s, save in remote areas of the nation where change comes slowly, if at all.

In other ways, too, Guizhou lags behind



the rest of China. When we stopped at a local gas station, we saw a tank truck draining gasoline into a large metal tub, weighed before and after filling to determine how much gas had been delivered. Each tubful was then piped into the main container above ground. The process was repeated many times over before the truck was emptied.

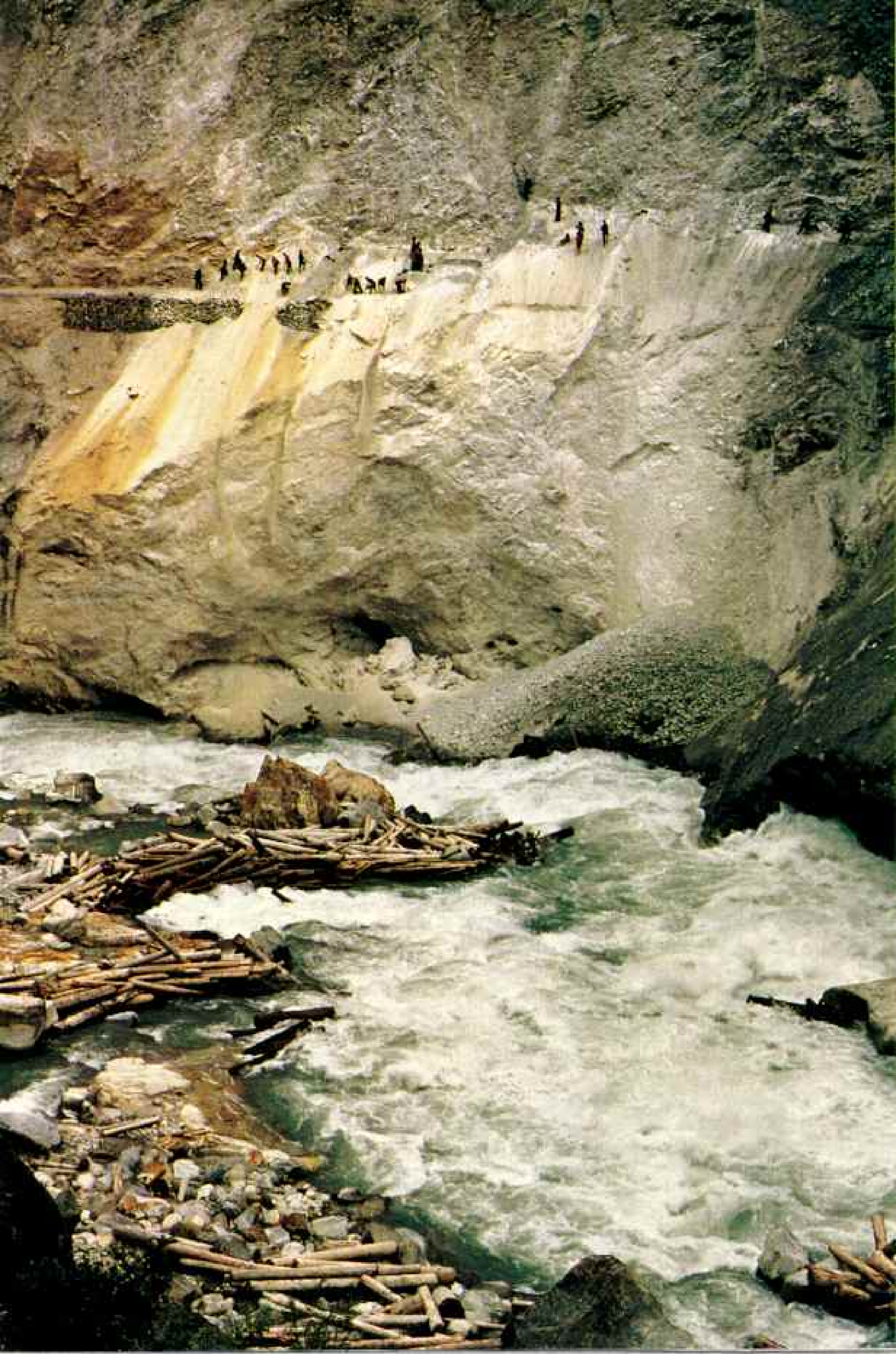
Though the city of Anlong is made up largely of Han Chinese, the surrounding countryside is inhabited mainly by Black, or Hei, Miao. Among these, one subgroup calls itself Mpeo, a term meaning "embroidery," probably a reference to the elaborate needlework these people create.

The Mpeo I saw were all quite well dressed. The men had more or less adopted

standard Han Chinese dress, with the loose-fitting Mao jacket and trousers to match. The women's costumes were predominantly black, with purple, brown, and blue embroidery—hence the name Black Miao.

I stopped to talk to one Mpeo lady who was walking with her teenage daughter. The daughter wore a number of heavy, finely engraved silver bands around her neck.

"Where does all the silver come from?" I asked the mother, uncertain whether she could understand my dialect. But she replied in excellent Putonghua, "The necklaces were handed down in the family. When my daughter marries, she will take them with her, and in turn she will pass them down to her own daughters."



I remarked that one did not expect to see so much jewelry in a poor province like Guizhou, and the mother seemed surprised.

"We do not think of such things as wealth," she said, "for we would never consider selling them. We Miao would rather starve than part with such possessions."

I asked if new jewelry was ever made, and the lady replied: "A little. If you can prove you are a member of a minority group, you can buy a small amount of precious metal such as silver from the government for 18 yuan [50 U. S.] per tael. With that we occasionally make new jewelry."

OFTEN IN OUR TRAVELS through Guizhou we would ask how far it was to a particular point or to the next village. People would reply in terms of money, such as *sankuaiyimao*, which means three yuan and ten fen—roughly \$1.55. We finally realized that the figures referred to the bus fare to such places. At China's bus rates, three yuan can represent half a day's journey.

In eastern Guizhou lies the town of Chonganjiang, named after the river that flows through it. We had not planned on stopping there until Zhang noticed two strikingly dressed figures down a side alley in the town. By now both Zhang and Jin were well aware of my great interest in minority peoples, and they were always on the lookout for anything unusual.

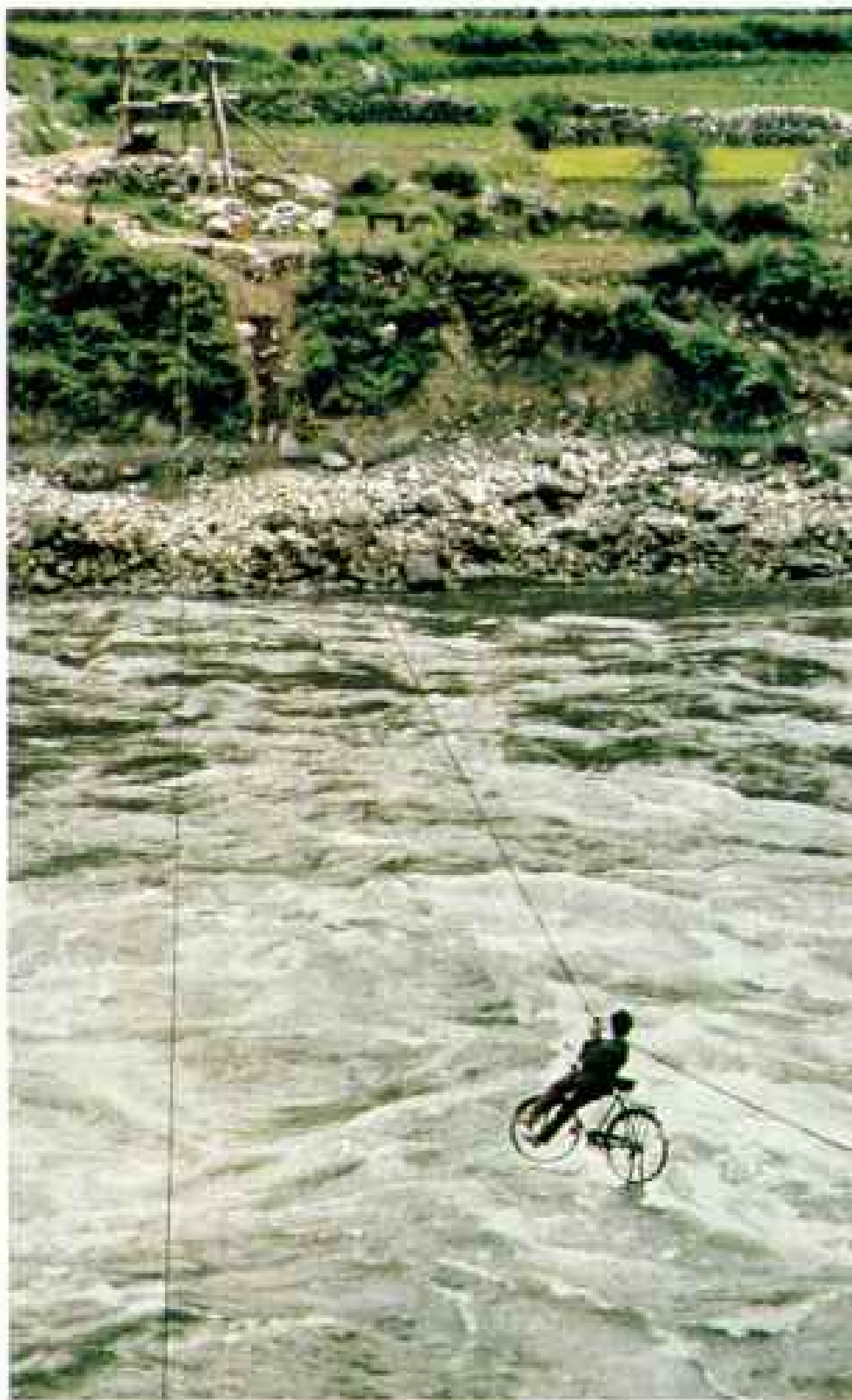
What Zhang had seen was a pair of teenage girls buying vegetables at a street stand. Each wore colorful and attractive headgear: a batik scarf of blue-and-white design, with a carved silver headband around it. Each headdress was crowned with a red topknot, and the entire unit was secured by a single carved silver skewer. The girls also wore blue apronlike dresses with elaborate embroidery.

In Putonghua, I asked the girls their nationality. They answered politely that they belonged to the Ge people. Until that moment I had never even heard of a Ge people among China's minorities, and I was frankly excited.

My excitement was short-lived, however, for after telling me they lived in the mountain village of Fengxiang, which means "maple fragrance," the girls declined to

let me accompany them on the seven-kilometer trip home. No, they explained, it was too far away inside the mountains. I felt desperate, for here were two members of a minority group that was entirely new to me, and moreover their appearance was striking.

Finally one of the girls agreed they would ride in our jeep if we would pick up their father along the way. I instantly accepted.



High-wire act without a net takes a cyclist over the Dadu River on a cable bridge in Sichuan Province. He hangs from a traveling pulley's handle, to which he has also tied his bike. At the low point, he will pull himself up the remaining distance with one arm.

Above Sichuan's Min Jiang a group of the Qiang minority hews a road out of solid rock (facing page).



"I can beat anyone," say the grins of southeast Tibetans preparing to ride to an annual horse race near Markam. But the saddles and fine rugs are only for show; after arriving in style, the men will race bareback. And winning's not as important as the camaraderie of Tibetans, their blood up, riding together.



A proverb defines the code of these proud riders: "A horse that will not carry a man uphill is no horse, and a man who rides his horse downhill is no man."

Following a narrow dirt road up a mountainside in our jeep, we stopped at an old school, where it turned out the girls' father was headmaster. His name was Liao Ruqi, and he spoke fluent Putonghua, thanks to a year and a half as a student in Beijing and seven years' duty with the People's Liberation Army in other provinces. He seemed genuinely pleased by our visit.

"It is of great importance that people from outside should know about us," Liao said. "In the past the Ge people were so little known that we were not recognized as a separate minority. Instead, we have been classified as a subgroup of the Miao, but they are an entirely different people."

I asked how many Ge there are, and Liao answered, "About 70,000, nearly all of them in Guizhou Province and half that number in this area. Our farm commune has about 11,000 members and more than 7,000 of them are Ge. If you want to find out about us, you have come to the right place. Our village, Fengxiang, with more than 400 households, is the largest Ge community anywhere."

IN A NARROW VALLEY at the end of the road we finally came to Fengxiang, a village of well-ordered, mostly thatch-roofed houses. Kids from all over the village crowded around our jeep and then followed us as Liao led the way through a labyrinth of paths to his home. We soon learned it was not sufficient to address our new friend simply as "Mr. Liao," for just about the entire village had the same family name.

Liao and his wife were extremely hospitable and insisted that I stay the night at their house. I gladly accepted, and a room was prepared for me. During the evening many villagers came to visit. Some had round red chop marks painted on their faces. They had evidently been drinking at a friend's house, and the more chops the more evidence that their host had been generous.

Since Fengxiang has no electricity yet, we used flashlights and torches as we listened to young girls singing, accompanied by two old men playing mouth organs fashioned of hollow bamboo pipes.

The next morning at 6:30 I was awakened by the sound of a gong and someone shouting from across the valley. I rushed out of the



Gathering of the clans for the Markam races covers the fields with enormous tents (left), each big enough for 50 Tibetans to socialize in; most sleep under the stars in fair weather. The group shares a feast of yak or beef stew (below), then it's off to the races. Women dress their best and sit together on a hillside as the men compete.

These semi-nomads, who speak a Tibetan dialect, move their livestock up the slopes in warm weather and down into the valleys as winter approaches. The rugged landscape of this region—

the Kham—plunges from the eastern foothills of the Himalayas down into three awesome river gorges.

As formidable as the country, Tibetans here once regarded themselves undressed without a rifle, a sword, or at least a dagger, and their relations with the Han rarely have been better than civil. In the wake of the late-1950s uprising, southern Tibetans are still discouraged from carrying weapons, whereas those in the north, who did not join the fighting, are allowed to wear theirs and do so with pride.



house to find out what was wrong. The haze was so dense I couldn't see beyond a few meters. Liao followed me out of the house, laughing at my confusion.

"Don't worry," he said. "It's merely the man in charge of environmental-protection propaganda. Until recently too many trees were being felled in our area, and we all got very concerned. The villagers met to find some way of making everyone aware of the need for conservation. We decided to put someone in charge of announcing the new tree-protection policy in a way that everyone would notice. Morning is the most peaceful time in the village, and this way we can be sure all will pay attention to the message."

From the way the message woke me up, I feel sure it's getting across.

After a day at Fengxiang we said goodbye to Mr. Liao and the villagers, expressing a hope that when we next returned, the Ge people would be officially recognized as an ethnic minority group on their own. With government recognition and assistance, they would have a far better chance of preserving some of their cherished traditions.

THE CENTRAL and southern parts of Guizhou are inhabited by the Hei Miao, who are by far the largest group of Miao in the province. According to legend, the first Miao came from Jiangxi Province to the east. Another legend explains why the Miao do not have a written language.

Long, long ago, runs the legend, the Miao lived in the same area as the Han Chinese. But the Han were too cunning for the Miao, so the latter decided to move away. They traveled a great distance and finally came to a broad stretch of water that, as they had no boats, they were unable to cross.

At that time, according to the legend, the Miao knew at least some written characters. As they stood beside the water pondering what to do, they noticed water spiders walking about on the surface. They said to themselves, "If these little things can walk on the water, why can't we?"

So the Miao tried, with the result that they nearly drowned. In struggling to regain the bank they swallowed a lot of water, and along with the water they swallowed all the written characters they knew. Since that



Laughter breaks the pall of a trip to a funeral for three Hei Miao; an older woman carries a chicken along. Here in



southwestern Guizhou Province, the Hei Miao are further subdivided into the River Hei Miao—this group—and their counterparts, the Mountain Hei Miao. Long lacking a written language, the Miao have a rich oral history.



day the Miao have been without any written language.

Along the roads of central Guizhou, one cannot fail to notice a great variety of Hei Miao. Every 50 kilometers or so we found that the women's dress and appearance varied. There were those with long skirts, those with short skirts, hair done in a knot, hair done in more elaborate coiffure, fabrics of chocolate brown, others of dark purple. In this same area there are Hei Miao who live in the mountains and those who live along the rivers. At the town of Shibing we saw both groups, beginning with the River Hei Miao.

Shibing is the seat of government of Shibing County, and I was warmly entertained by the county officials. The county chief, Luo Guobin, is a Miao, as is his deputy, Li Xinyi. The county secretary, Luo Hongxiang, and the security chief, Luo Guochao, are also Miao. During my stay at Shibing it became obvious that the Miao had a virtual monopoly on high office.

Two rivers, the Qingshui and the Wuyang, flow through the county. In these two rivers are giant salamanders that weigh as much as 30 kilograms, or 66 pounds, each. The Chinese and the Miao call these huge salamanders *wawayu*, literally "baby fish." The term derives not from the creature's size but its appearance, which supposedly reminds one of an infant. In addition, the salamander has a cry like that of a baby.

The River Hei Miao know a number of recipes for turning *wawayu* into delicacies. While taking a cruise along the Wuyang River, we purchased three salamanders, each costing five yuan (\$2.50) and weighing approximately two kilograms. I was told that in Guangzhou (Canton), where any exotic food finds a ready buyer, a salamander of such size can bring 25 yuan.

At Pingzhai Commune, a mountain settlement near Shibing, we were welcomed with a formal reception. Young women came in their finest embroidered costumes. Unmarried girls wore especially lavish ensembles of silver jewelry, adorning them from head to waist. Each collection of ornaments must have weighed more than five kilograms.

Huge pans of sticky rice were served to the guests. This ceremonial dish is called

National treasure, one of China's largest waterfalls (facing page) cascades 67 meters (220 feet). Named Huangguoshu, "yellow fruit tree," for the oranges of Guizhou Province, it is a major tourist attraction. A high school in an adjacent village of the Bouyei, a 2.1 million minority whose fashionable matrons partially shave their heads (below), now mars the best view. Mindful of Bouyei influence, officials dare not move the structure.



zimeifan—"sisters rice"—signifying the closeness of two sisters sticking together. Part of the rice was dyed yellow, the other part was natural color. The yellow dye was said to keep the "little demons," or mischievous gods, from recognizing that it was rice and whisking it away to satisfy their hunger.

THE MIAO are an exceptionally musical people. In the evening I went to the main square of the commune, where young men and women meet after dark to sing songs of courtship to one another. Miao songs are distinguished by their simplicity of tone and their changeable lyrics. The melodies are few in number, and the words are composed extemporaneously to suit any occasion. The directness of expression and sincerity of thought make most of the songs beautiful in their innocence.

Traditionally the Miao have been exceedingly superstitious, with strong beliefs in both spirits and demons. The former they



Years in the making, costumes of fabulous intricacy have been donned in the author's honor by two young women of the 70,000-member Ge people. Believing a girl's prime asset to be her needlework, mothers start their daughters at about



age eight on an ensemble that may take until their mid-twenties to complete. These girls are walking to a market of the Hei Miao. Though relations are better today, the Ge have been dominated both by the Hei Miao and by the Han.

thought of as benevolent, while the latter were considered mischievous. One had to be continuously on guard against demons lest they do harm not only to men but to beasts and crops as well.

The Miao feared and disliked the demons, and they systematically lied to them. During an offering of food to the demons the Miao might present a piece of a pig's leg but call it a whole pig in their prayers. A glass of proffered wine would be inflated to a whole jar or kettle.

Few aspects of life could be detached from one or another superstitious ritual. For example, before a marriage could be approved, a chicken had to be killed in front of

the parties concerned. After the chicken was cooked whole, the size of both its eyes was examined. If the eyes were identical, it symbolized a happy union. But if they were of different size, it was considered a bad omen and the wedding plans automatically were canceled. The weight of the chicken was also of importance: Any party that broke an engagement after the formal announcement had to pay the other party an amount of silver equivalent to the weight of the chicken.

A Miao wedding is not only a family affair but also a social gathering of the entire community. Unlike Han marriages a proper wedding among the Miao is less a physical union than a social one. On the auspicious



Eggs in straw sleeves, packaged in tens, are sold at the market by Ge women who lack red caps on their headdresses, showing they are married. Morning smoke curls from the Ge village of Fengxiang, "maple fragrance." In this part of Guizhou, day begins with exhortations to spare the trees.



day the happy couple may not even converse publicly, let alone cohabit. The bride comes to the groom's house as a guest and sleeps either with the groom's sister or alone. After a few days she returns to her parents' home. Only occasionally—usually during harvest-time—does the groom send for his bride to help with the housework as well as the harvest. She gladly complies, for only then does their real married relationship begin. But even these visits are of short duration. After a few days the bride returns once more to her parents' home. This back-and-forth relationship lasts until the first birth occurs. After that the wife takes up permanent residence in her husband's home and counts

herself as a regular member of the family.

ONE OF THE MOST spectacular events observed by the Hei Miao is the Dragon Boat Festival (following pages). It takes place every year along the Qingshui River on the 24th of the fifth moon, which falls in June or July. Historically the festival symbolized the Miao's prayers for rain, with which the mythical serpent is associated. Dragon-prowed boats, each dug out of three great tree trunks and each representing a village on the Qingshui, are rowed downriver by costumed oarsmen on a ceremonial voyage. Each dragon head is beautifully carved; streamers



of red cloth hang from the dragon's horns, and offerings for the crew of live ducks and geese are suspended from its neck at each village where the boat stops.

As a gesture of great courtesy, part of the Dragon Boat Festival was staged out of season for me. The event drew more than a thousand spectators along both banks of the Qingshui. Jin and Zhang and I left Shibing with a sense of debt and profound gratitude to the Miao for such memorable hospitality.

IN THE SOUTHEASTERN CORNER of Guizhou Province lives another colorful ethnic minority known as the Dong. The Dong number roughly 1.4 million and are famous for their expert carpentry. Their "wind-and-rain bridges" and "drum towers" (following pages) put the best efforts of the Han Chinese to shame.

Before returning to Kunming, we stopped briefly at the town of Longe near the provincial border between Guizhou and Guangxi. Here each year the Dong women celebrate dual festivals they call Chunshe and Qiushe, meaning respectively Spring Club and Autumn Club. Spring Club is held to welcome the kitchen god and Autumn Club to bid him farewell. People come from villages within a hundred-kilometer radius of Longe for the two festivals. Dressed in their best costumes, the crowds assemble at a historic wind-and-rain bridge, so called because it is built to shelter users from the elements. The guests spend their entire day eating and shopping at temporary stalls set up near the bridge. Men carry with them locally made matchlock guns with long barrels and short handles resembling oversize pistols.

Spring and Autumn Clubs date back some 2,000 years among the Dong people. The festivals are supposed to ensure both a good harvest and a safe year.

As with many such festivals a colorful

In silversmith masterworks, River Hei Miao hold a "sisters-rice" ceremony (above), with two colors of sticky rice symbolizing friends who stick together like sisters. The Dragon Boat Festival (right), a traditional prayer for rain normally held in June or July, was staged earlier for the author.







Mending the excesses of the Cultural Revolution, members of the Dong minority replace one of five "drum towers" (above) destroyed a decade ago. Behind rice fields two completed towers rise above their village of Zhaoxing in Guizhou (right). Not a single nail reinforces the structures of joined timbers.

Traditionally, each clan built a tower manned by a sentry who beat a drum when danger threatened, alerting villagers to gather below for safety. Nowadays such shelters are popular socializing spots.







Most exquisite way to reach the other side, a "wind-and-rain bridge," completed at Sanjiang in Guangxi Autonomous Region in 1916, occupied Dong carpenters for

legend goes with Chunshe and Qiushe. In ancient times, say the Dong, there was a man by the name of Muadianlong. He and his good friend were chefs for the king.

During one of the birthday banquets given by the king, the two chefs prepared an exquisite menu for the guests. After lunch the king asked everyone which dish had tasted the best. When Muadianlong was asked, he replied that salt tasted the best.

The king grew angry and ordered Muadianlong beheaded. Muadianlong's fellow chef felt very sad, and from then on he put no salt in any of the food. As a result, guests at the palace found the food quite tasteless,

and the king again was upset. The remaining chef then explained that since Muadianlong was executed, he dared not add any salt to the food.

The king realized then that he had misjudged Muadianlong. In his memory the king ordered a day to be set aside for festivals in spring and autumn. Before eating a meal on those days, people have to drink some salt water; and, since a sword was used for Muadianlong's execution, no knives may be used at table. Nowadays the festivals have become special times for feasting and courtship among young people.

After many months of exposure to the



ten years. Eagerly awaited power lines march toward a Dong village. Can China's minorities, like the old bridge, bear the heavier traffic of modern times?

high level of culture and artistic excellence among China's varied minorities, I can only say that the historic notion of the Han Chinese that these people were barbarians was totally unfounded. On the return trip to Kunming we left Guizhou Province behind and entered Guangxi. At the scenic area of Guilin I again reentered the familiar Han culture, aware that I had barely scratched the surface of those equally ancient, and equally proud, cultures of China's great family of minorities.

Beyond Guilin, at Luocheng, we passed briefly through the area of the minority people known as the Mulam. The Mulam have

been so assimilated into the mainstream of Han culture that they actually resemble the Han Chinese in appearance. Very little is left of their own culture save their language.

Granted that the Chinese government seems genuinely concerned over the future of its minority peoples, the preservation of such cultures is still no simple matter in this age of rapid change. Among some of these peoples, like the Mulam, the changes are already irreversible. How much separate cultural identity should be compromised for the sake of modernization?

To me this will always be the unanswerable question. □



"A SPLENDID LIGHT"

LASERS

By ALLEN A. BORAİKO
SENIOR EDITORIAL STAFF

Photographs by CHARLES O'REAR
WEST LIGHT

EACH MORNING, in the soft, coral flush of daybreak, a laser dawns on Mars. Forty miles above frigid deserts of red stone and dust, it flares in an atmosphere of carbon dioxide. Infrared sunlight kindles in this gas a self-intensifying radiance that continuously generates as much energy as a thousand nuclear reactors. Our eyes are blind to it, but from sunrise to sunset Mars bathes in dazzling lasershine.

The red planet may have lased in the sun for eons before astronomers identified its sky-high natural laser in 1980. The wonder is that its existence was unknown for so long.

In 1898, in *The War of the Worlds*, H. G. Wells scoured earth with Martian invaders and a laserlike death ray. Pitiless, this "ghost of a beam of light" blasted brick, fired trees, and pierced iron as if it were paper.

In 1917 Albert Einstein speculated that under certain conditions atoms or molecules could absorb light or other radiation and then be stimulated to shed their borrowed energy. In the 1950s Soviet and American physicists independently theorized how this borrowed energy could be multiplied and repaid with prodigious interest. In 1960 Theodore H. Maiman invested the glare of a flash lamp in a rod of synthetic ruby; from that first laser on earth he extorted a burst of crimson light so brilliant it outshone the sun.

More than light bolted from Maiman's

ruby. It inspired new lasers, and their designs and powers quickly diverged like a sunbeam transiting a prism.

Today the spectrum of laser types extends from those as large as football fields to others tinier than a pinhead. Their light ranges from invisible—ultraviolet and infrared—through all colors of the rainbow. A few fire in pulses lasting but quadrillionths of a second; many could beam steadily for decades. Like Wells's ray, some lasers can focus light to a fine point bright enough to vaporize iron or any other earthly material, concentrating energy on it a million times faster and more intensely than a nuclear blast. Others do not emit enough energy to coddle an egg.

From the first, likely uses for the laser have flashed into people's heads at a large fraction of the speed of light. Hundreds of ideas have proved better directed than an early one—the laser eraser.

Newspapers and the GEOGRAPHIC use lasers to transfer photographs and maps to printing plates. FBI lasers disclose, even 40 years after, the otherwise undetectable print left by a fugitive fingertip. Lasers weld car parts, husk peanuts, and cut teeth in saws. They also drill holes in baby-bottle nipples.

Often lasers are the preferred tools of surgeons in the operating room. Holograms—laser-light patterns recorded somewhat like photographs (pages 364-77)—create images in three dimensions. Underground, glass

A gathering force of precision and power, lasers are unlocking a technological treasure chest for human benefit. To dramatize their multifaceted nature, a technician uses mirrors and a prismslike optical device to split the beams of krypton and argon lasers into a rainbow spectrum.

fibers carry laser beams that each transmit hundreds of phone calls. Overhead, lasers have tracked volcanic gases, gauged winds surrounding Midwest storms . . . and confirmed the natural laser above Mars.

That last service of the laser reveals it to be something more fundamental than a simple invention. Thus it promises remarkable insights and technologies. Fresh in hand or foreseeable by the laser's bright light are:

- Action views of viruses, enzymes, and DNA molecules, encoders of the genetic messages that determine hereditary traits.
- All but unlimited energy from the forced fusion of hydrogen isotopes, in imitation of nuclear reactions fueling the sun.
- Ways to quell cancer and open blocked arteries without distressing the body.
- Means to trace one molecule among trillions, probe its fastest motions, or coax it to tailor-make catalysts and drugs.
- Faster computers built of smaller circuits, including microscopic light switches.
- And—fear weds hope—arms to war in space and blunt nuclear attack on earth.

"Don't undervalue the laser," says John Asmus, chief laser scientist at Maxwell Laboratories in San Diego, California. "It harnesses light, a basic form of energy. We harnessed energy in another way once, and started the industrial revolution."

ASMUS CITED THIS in his laboratory some months ago, to me and to John the Baptist. In blessing and as if in the flesh, the martyr was hovering with raised right hand just in front of a laser-illuminated photographic plate. Haloed by laser light in the darkened laboratory, this vision re-created by a hologram was a three-dimensional revelation.

Asmus had recorded the image in 1972 in Italy, holographing a 15th-century carving while consulting on an art-preservation project. Now resurrected, the benedictory Baptist seemed to sanction Asmus's gospel:

"People think of the laser as a mere device, but that's a narrow perspective. We're

learning the potential of light from a profoundly powerful technology."

What makes it so—and lends the laser its name—is "light amplification by stimulated emission of radiation." By this means the laser marshals light so compellingly that when Einstein penetrated the heart of the matter he rejoiced to a friend, "A splendid light has dawned on me. . . ."

The physics Einstein found so illuminating operates daily in the supermarket product code scanner. If you could view this automated checkout's laser, you would see a glass tube filled with helium and neon. Its ends are sealed by flat, parallel mirrors, one partially transparent and one fully reflective. Centered inside this tube is another; pencil slim, it extends into a metal sleeve—a cathode that radiates electrons when energized by electricity. The helium-neon laser—the kind in widest use—might almost be part of a neon "No Vacancy" sign.

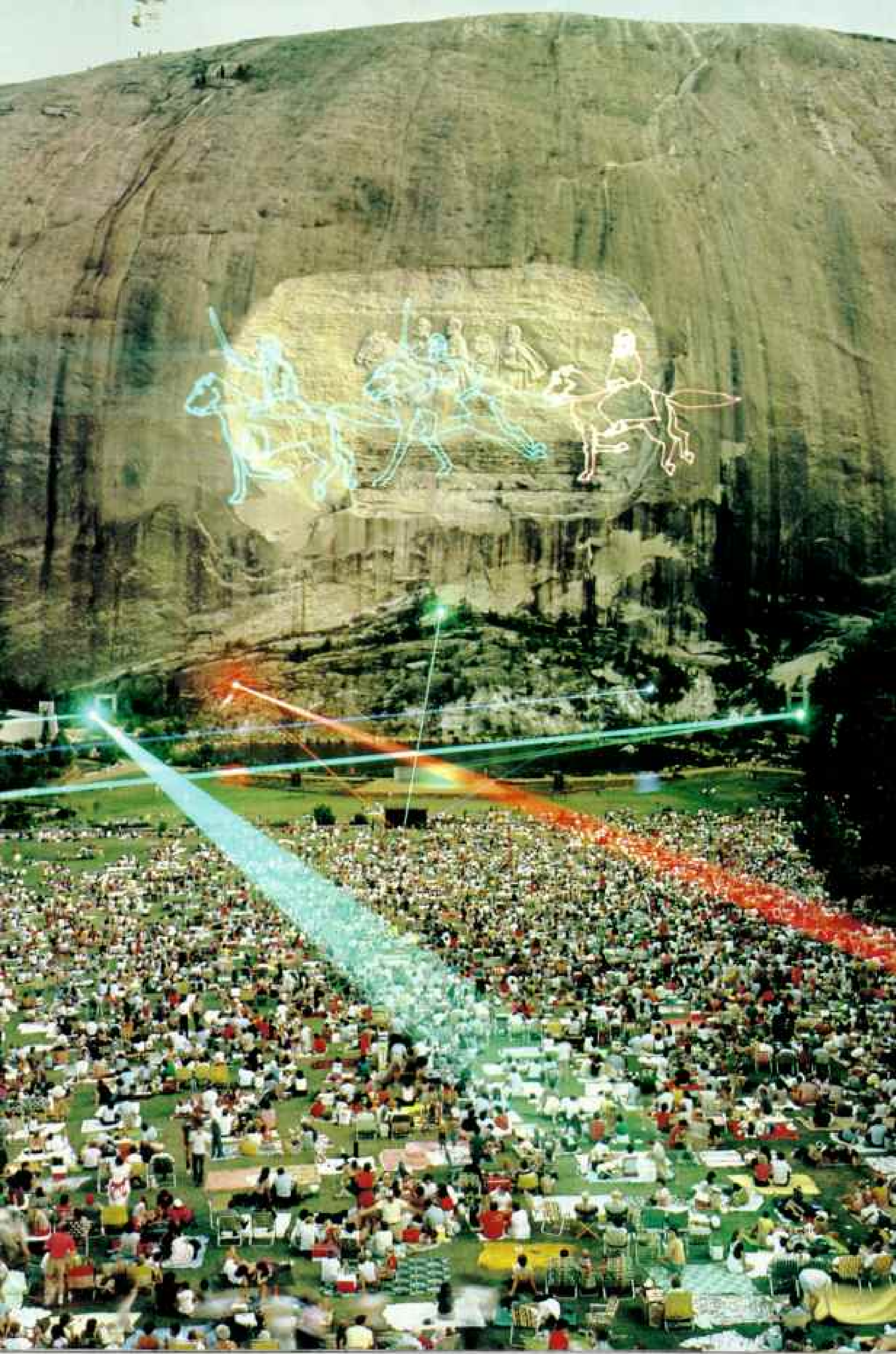
But "No Vacancy" is no laser, and any remote likeness pales when an electric current triggers the cathode. After a pause as brief as lightning, it steadily showers electrons into the gas-filled tube. These so excite the helium atoms sealed within that they smash into their neon neighbors, whose own orbiting electrons then jump into arrays more complex and energetic than usual.

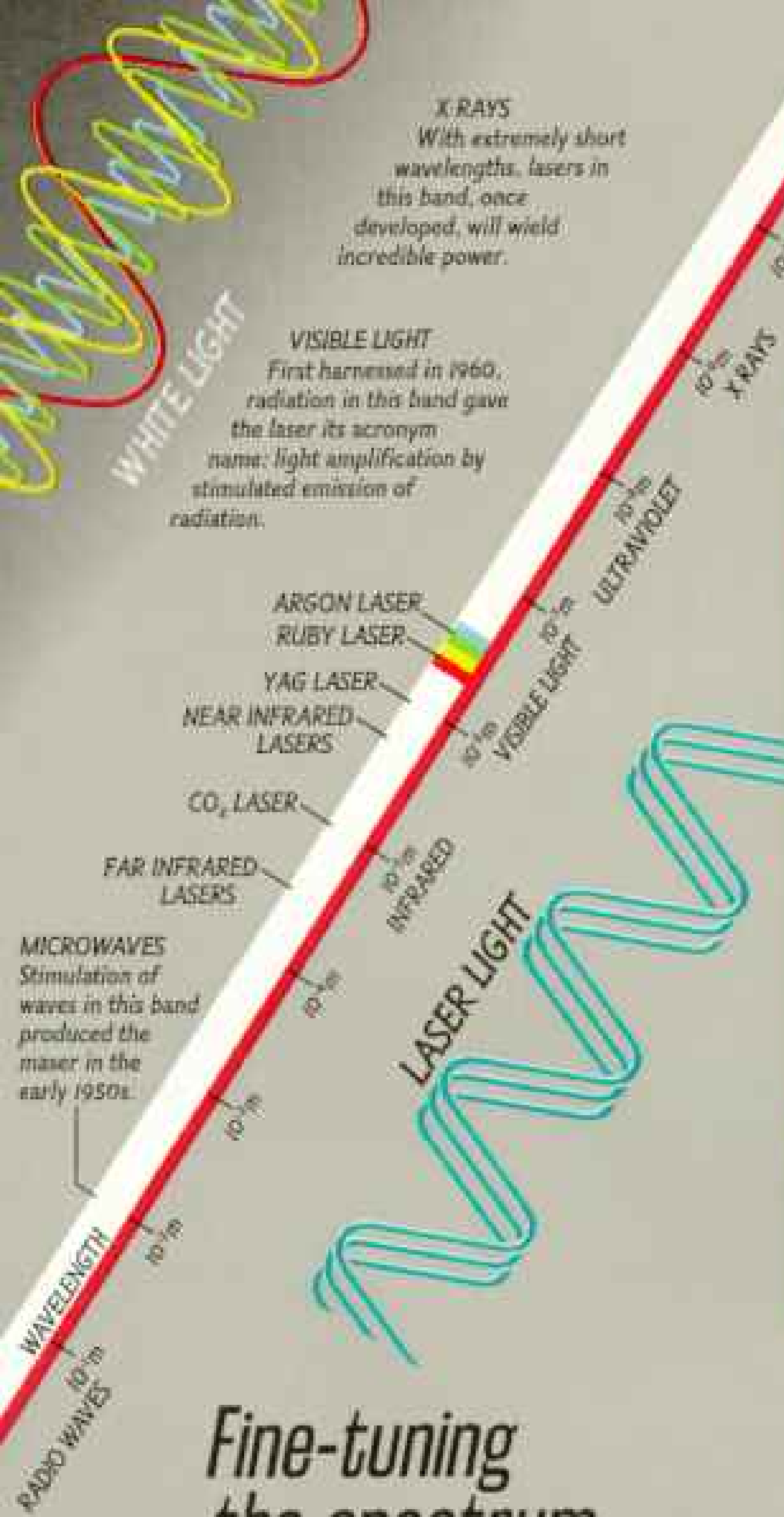
The agitated electrons remain rearranged only an instant. They begin almost at once to fall back into their old, less energetic order, and from each retreating electron there escapes a tiny burst of surplus energy—a photon, the basic unit of light.

With no mass but behaving like particles, photons tan us in the sun, toast bread, and—flooding aimlessly and spontaneously from fluorescent signs—put the rude red glow in "No Vacancy." But many of the laser's photons are trapped between its mirrors, and lasing begins as they bounce back and forth along the laser's center tube, striking still more neon atoms.

Each of these collisions releases another burst of light energy, equal to and in step

Charge of the "light" brigade, Robert E. Lee, Stonewall Jackson, and Jefferson Davis gallop across Stone Mountain, near Atlanta, Georgia, through the magic of laser animation. Laser beams streak above the audience in a light show like those that have pleased crowds since soon after the invention of lasers in 1960.





X RAYS
With extremely short wavelengths, lasers in this band, once developed, will wield incredible power.

VISIBLE LIGHT
First harnessed in 1960, radiation in this band gave the laser its acronym name: light amplification by stimulated emission of radiation.

- ARGON LASER
- RUBY LASER
- YAG LASER
- NEAR INFRARED LASERS
- CO₂ LASER
- FAR INFRARED LASERS

MICROWAVES
Stimulation of waves in this band produced the maser in the early 1950s.

Fine-tuning the spectrum

TO KNOW LASERS, one must first know the electromagnetic spectrum, which ranges from long radio waves to short, powerful gamma rays.

The narrow band of the spectrum we know as visible, or white, light is made up of red, orange, yellow, green, blue, and violet light. These frequencies, as well as all radiation waves, are jumbled or diffused (top left), much as noise is a collection of overlapping, interfering sounds. Laser light (the mechanics are explained on the following pages) is organized and concentrated, like a single, clear musical note.

In lasers, nature's disorder is given

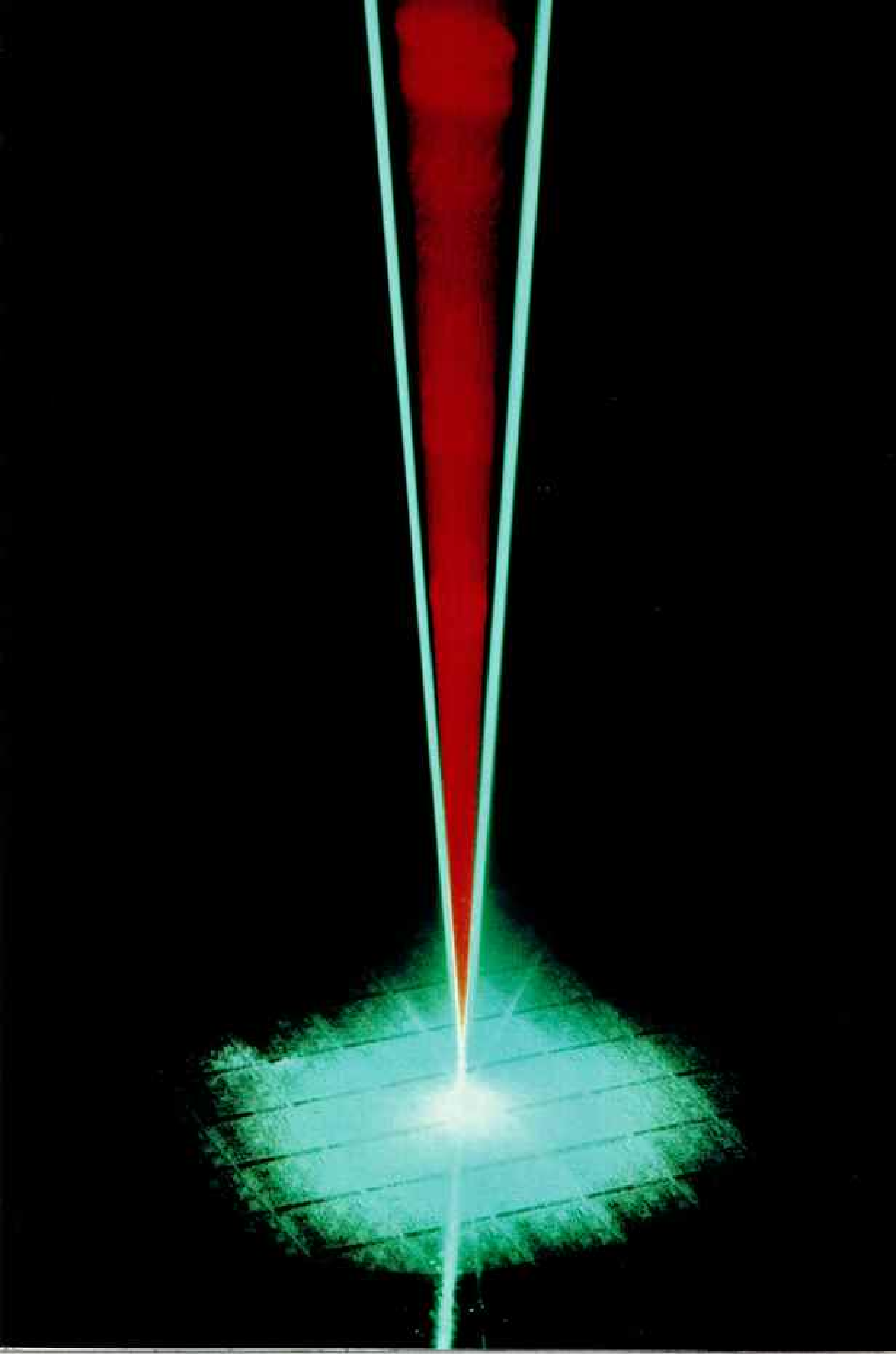
DIAGRAM BY NATIONAL GEOGRAPHIC CARTOGRAPHIC DIVISION

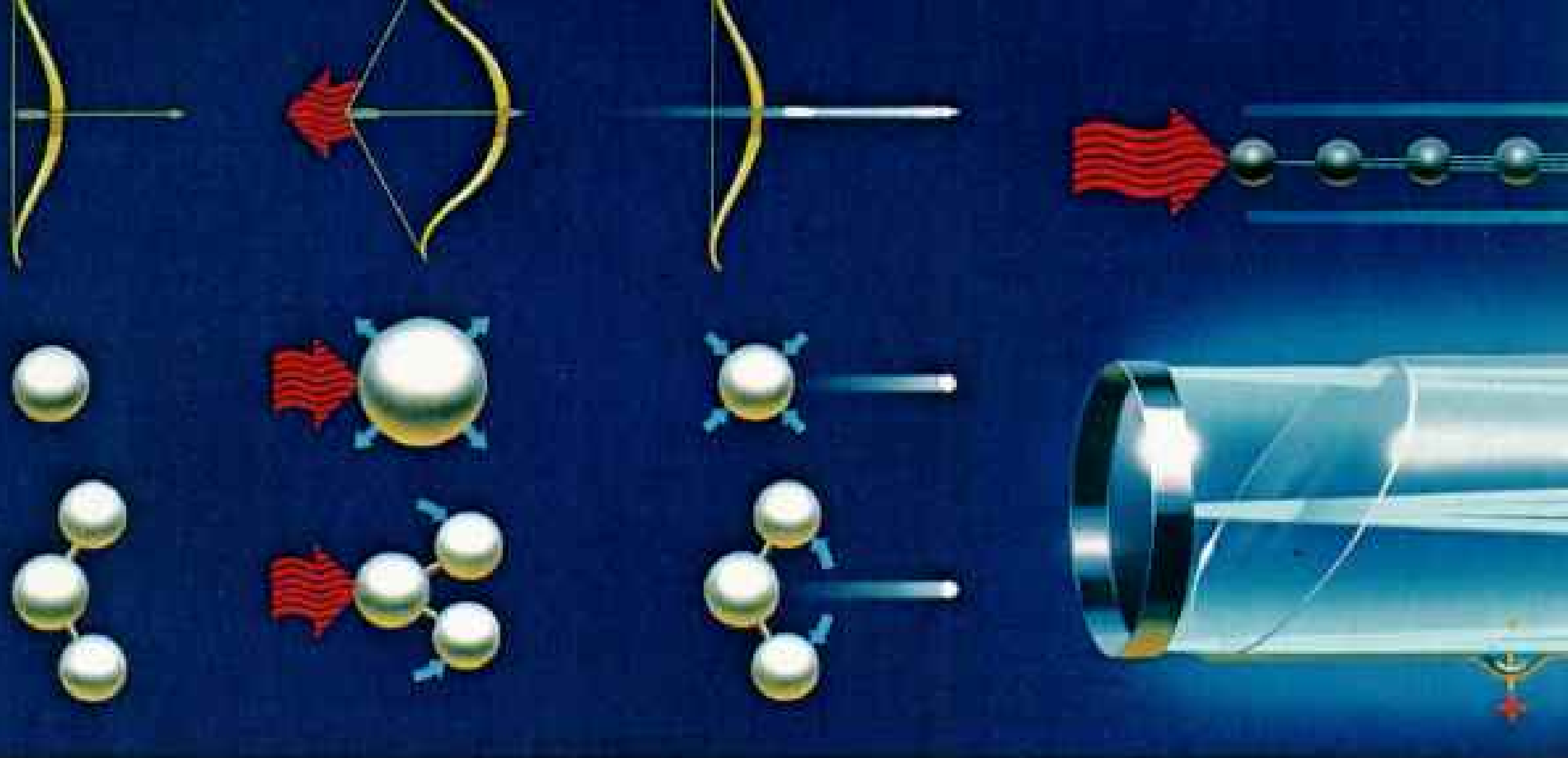


coherence, and photons—the basic units of all radiation—are sent out in regular ranks of one frequency. Because the waves coincide, the photons enhance one another, increasing their power to pass on energy and information.

The first devices to emit concentrated radiation operated in the low-energy microwave frequencies. Today laser technology is extending beyond ultraviolet toward the high-energy realm of X rays. Each wavelength boasts its own capacities as a tool for man.

A laser's beam can be modulated into an infinite number of wavelengths using fluorescent dyes (above) like those produced at Exciton Chemical Company in Ohio. At Hughes Research Laboratories in California, a blue-green laser (right) reflected at an acute angle anneals silicon microchips, while a low-energy red laser monitors the process.





Harnessing light

AS A BOW stores energy and releases it to drive an arrow (above, top series), so lasers store energy in atoms and molecules, concentrate it, and release it in powerful waves.

When an atom (center series) expands the orbits of

its electrons, they instantly snap back, shedding energy in the form of a photon. When a molecule (lower series) vibrates or changes its geometry, it also snaps back to emit a photon.

In most lasers a medium of crystal, gas, or liquid is



with the photon that liberated it. First a few, then millions, and finally countless photons thus synchronize themselves, until an avalanche of light streaks between the mirrors. Intense beyond restraint after dozens of round trips, the cascading photons burst through the laser's partially transparent mirror as a needle of red radiation.

In millionths of a second, the unbridled energy from the cathode has been intensified and harnessed into a beam of the purest, most concentrated light ever seen.

Laser light differs from ordinary light much as music does from noise. Like sound, all light travels in waves, similar to ripples wrinkling a pond. The number of waves that pass a set point in one second decrees the frequency of light. Its color is dictated by its frequency and wavelength, the distance from the peak of one wave to the next.

Common light—from a fire, a light bulb, or the sun—is incoherent: a medley of wavelengths radiating in all directions. A prism shows this as it sorts a sunbeam's disordered white light into individual colors.

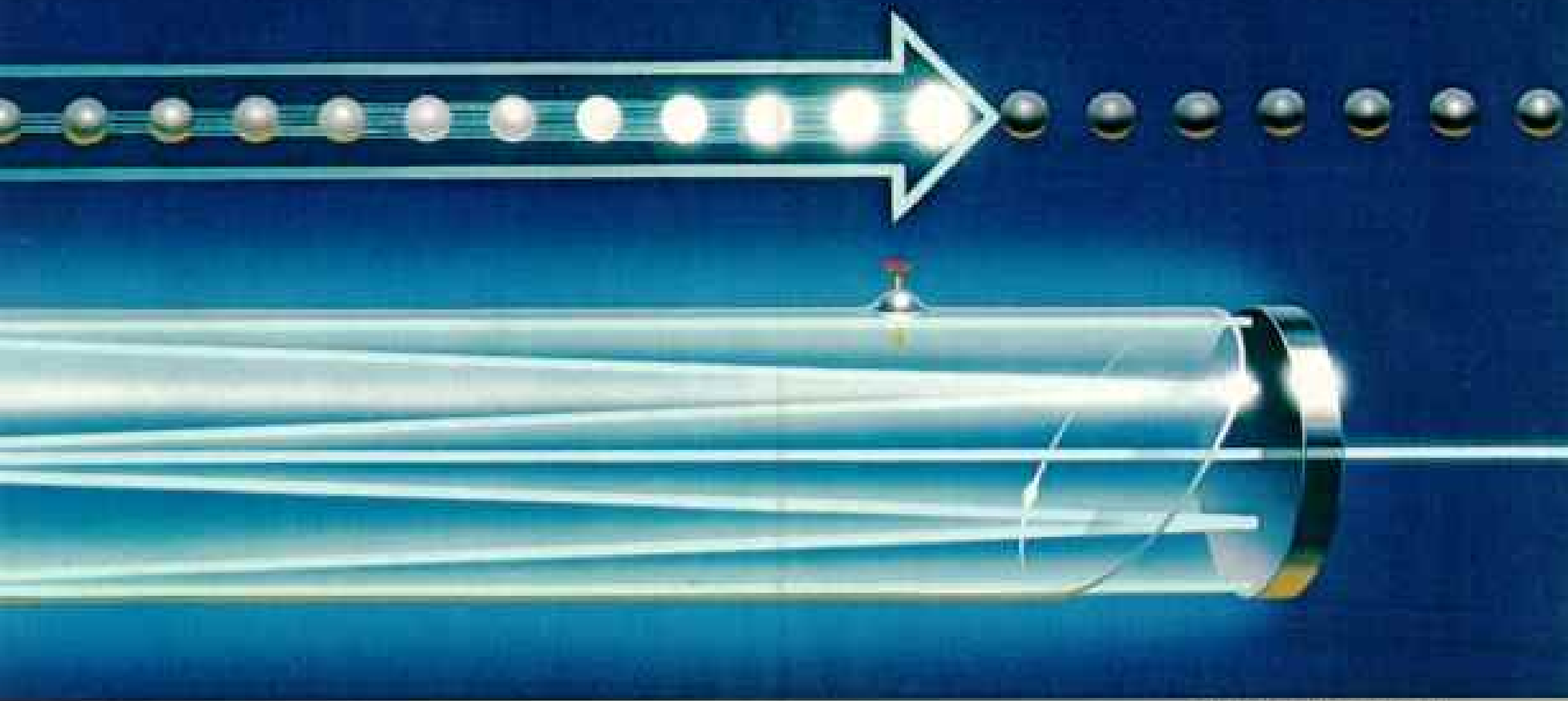


DIAGRAM BY DALE SUSTAFSON

energized by high-intensity light, an electric discharge, or even nuclear radiation. When a photon reaches an atom, the energy exchange stimulates the emission of another photon in the same wavelength and direction, and so on, until a cascade

of growing energy sweeps through the medium.

The photons travel the length of the laser and bounce off mirrors—one a full mirror, one partially silvered—at either end. Photons, reflected back and forth, finally gain

so much energy that they exit the partially silvered end, emerging as a powerful beam.

In some gas lasers transparent disks called Brewster windows (*lower left*), slanted at a precise angle, polarize the lasers' light.

Laser light, in contrast, is coherent—almost exclusively of one wavelength or color, and with all its waves traveling in one direction. Waves of laser light are so uniform, in fact, that if they could be heard like sound waves, a laser beam would resonate with the crystalline purity of a single musical tone.

Moreover, a laser's parallel light waves move in unison, reinforcing each other like voices in a choir. In concert, so to speak, they can carry to the moon in a narrow pulse that remains compact enough to "echo" measurably back to earth or, at close range in a tiny area, heat a substance at the rate of one trillion degrees per second.

Most lasers work in principle just like the helium-neon laser at the supermarket. Yet scientists orchestrate laser light to scores of distinct pitches and purposes by extracting it from materials as varied as emeralds and the dyes in color film, or—with heroic effort—even the food coloring in Jell-O.

In dye lasers, for example, a vial of fluorescent liquid such as detergent whitener is used. Tunable by a prism, from blue

through tones of yellow and orange to red, their visible light can match a ruby laser's in both shade and sharpness.

Not only electric current "pumps," or excites, lasers. So can chemical reactions, radio waves, and even the radiation from nuclear explosions. A flash lamp can excite atoms of neodymium, a rare earth, in a rod of YAG—yttrium-aluminum-garnet. YAG itself is a water-white imitation diamond—you may be wearing it—but as a laser it becomes a surgeon's light knife.

LASER LIGHT is so intense, directional, and pure that it long ago enlightened many scientists and engineers who first mocked the laser as "a solution in search of a problem."

Of laser light's premier qualities, its enormous intensity, or brightness, appeals especially to industry. A laser's power is rated in watts, like that of a light bulb. Point to the sun at noon on a clear summer day, and about one-tenth of a watt of solar power falls on your fingertip. Upon a piece of steel no

bigger, an industrial laser can easily concentrate ten billion watts.

Lasers of such power produce immense heat for hundreds of manufacturing tasks, such as plating easily corroded metals. And with no bits to wear or blades to break, ardent laser beams irresistibly and precisely cut fabric for suits, weld refrigerator doors, and drill eyes in surgical needles.

At the General Motors Electro-Motive



Peerless cleaners, lasers can apply the precise amount of energy exactly where needed to vaporize microscopic amounts of material—a function with promise for art restorers. In Ottawa, chemist David Rayner experiments with excimer lasers for the National Research Council of Canada.

Division in La Grange, Illinois, I watched lasers heat-treat to extreme hardness liners that shield engine cylinders against the pumping pistons of diesel locomotives.

The brawling work halls of the locomotive plant seemed the toiling industrial biceps of nearby Chicago, Carl Sandburg's "Player with Railroads and . . . City of the Big Shoulders." Cranes four stories overhead hefted crankcases as big as cars, drills whined, and air hoses hissed as if to shush the wail of vexed steel. Welding torches flashed like lightning in the cabs of locomotives, some enameled black and yellow for the Chessie System; one dark green, with a blade to plow the sands of Morocco.

Invisible in this tumult were the infrared beams of four carbon dioxide lasers, aimed by mirrors at the finger-thick inner walls of piston-chamber liners. These cast-iron cylinders would have been bored through had turntables not steadily spiraled their interiors through the beams.

Where swaths of laser light "painted" circling iron, it inflamed to above 1500°F in hundredths of a second, then began to cool, its skin hardening into unyielding armor. Robots plucked finished liners from their purgatory, and one still hot as sin seared my curious fingertip.

THE LASER'S TOUCH is golden as well as torrid, annually creating in the United States more than two billion dollars' worth of industrial goods. Robots use laser tools and sensors, and, in future factories, heat, pressure, and other stresses that alter laser light's passage in glass fibers will be exploited for remote monitoring of materials and operations too dangerous for workers, human or robot.

To monitor the shifting earth, geophysicists bounce uniquely directional laser light off reflector-bearing satellites. Timing light's round trip from a laser tracker to a satellite of known orbit fixes the distance between them with extreme accuracy. Regular surveys of the ranges to one satellite from lasers worldwide reveal shifts in their relative positions—an aid in tracking drifting continents and predicting earthquakes.

"Laser ranging clarifies how the earth rotates on its axis and changes form and shape," says Andrew Adelman of the

Crustal Dynamics Project at NASA's Goddard Space Flight Center not far from Washington, D. C. This in turn documents continental drift.

Continents raft across earth's hot, plastic interior on stiff plates of planetary crust. Where these collide, the earth may quake, islands emerge, or volcanoes erupt. Mountains may bulge as one plate dives beneath another, to be melted and reappear eons hence as new crust, flooring for a rising ridge deep in mid-ocean.

How rapidly does earth spread at its mid-ocean seams? What propels the continents and subtly deforms them? Where, precisely, do the crustal plates abut?

"Measuring such things exactly is vital," says Adelman. "Minute motions in the earth portend vast ones—earthquakes—and major energy and mineral resources lie along the boundaries between earth's plates."

The lasers at Goddard's Optical Research Facility ride the American plate. With them on a moonless autumn night I kept an eye out for the Laser Geodynamics Satellite.

LAGEOS orbits more than 3,600 miles high, and with 422 recessed reflectors it resembles a silvery, dimpled beach ball. Far beyond my view from inside a portable observatory, LAGEOS was in the Little Dipper when intercepted by the first pulses of the observatory's neodymium-YAG laser.

The laser's usual infrared radiation had been shifted, for less atmospheric absorption, to visible green light. Focused and fired at ten pulses per second through a telescope, it flickered hypnotically inside the observatory dome, but shot starward in an illusory solid beam, an emerald pointer aimed so true that no eye could be blind to its peremptory guidance: "Look, *there!*"

Each pulse was triggered and timed by an atomic clock, synchronized with others at laser trackers in Germany, Japan, Australia. . . . Round the world that night, lasers waited to wink at LAGEOS.

Little of their light returns to telescope receivers from the satellite. After filters screen out starlight and the sunlight reflected by LAGEOS, the echo of a laser-ranging pulse may be only a solitary photon.

The U. S. Geological Survey and other federal agencies have more light to work with, ranging to closer targets in tests of

airborne lasers. These profile terrain too rugged for ground surveys and chart coastal waters more cheaply than ships.

SOMETIMES remote sensing by laser more resembles chemistry than cartography. The purity of laser light enables it to seek and sense, from miles away, airborne atoms and molecules of pesticides, nerve gases, power-plant pollutants, and leaking natural gas.

Each substance adrift in our atmosphere (and oceans) uniquely identifies itself by absorbing or reflecting light of a distinct wavelength. The purer the searching light, the surer its discovery of a suspect substance, be it dust or water vapor, ozone or oxygen.

Directed at oxygen molecules, such light detection and ranging, or LIDAR, reveals atmospheric pressure and temperature. Thus the laser promises routine and precise meteorological readings in parts of the globe and the atmosphere—the oceans and the jet stream—where weather brews and moves beyond easy and constant watch. A future space shuttle will survey atmospheric pressure at cloud tops by laser, and ultimately lasers on satellites may make even 30-day weather forecasts accurate and detailed.

Looking ahead to other advances, scientists foresee a trio of lasers with great promise—for chemical production, military applications, and biological research.

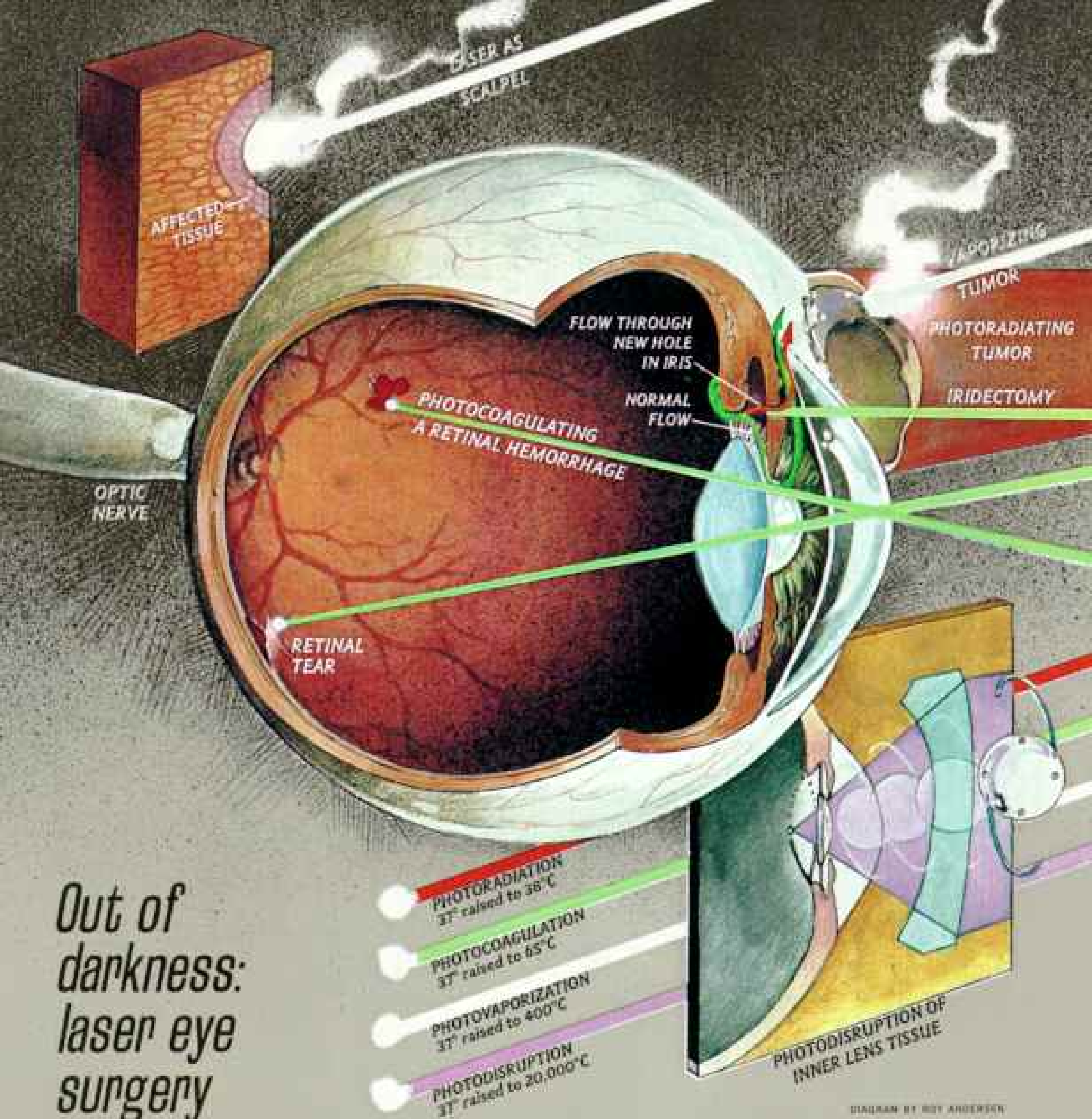
University of Illinois physicist Keith Boyer attends to "free-electron" lasers. They draw their energy from high-speed streams of electrons not bound to the atoms or molecules of a lasing dye, gas, or crystal.

Generating free electrons for such lasers takes costly, complex equipment. Outweighing this, however, is the prospect that free-electron lasers will be tunable over the broadest range of radiation yet—from microwaves to the far ultraviolet, a million-fold difference in wavelength from longest to shortest. Future versions may be tuned, like radios, by spinning a dial.

"This flexible laser opens fundamentally new ways to do things," Boyer told me. "It moves chemistry, for instance, beyond the technology of fire and heat."

In the laboratory laser light already produces some catalysts—chemical additives that speed up a (Continued on page 348)





Out of darkness: laser eye surgery

SIGHT-SAVING shafts of light able to enter the eye without injuring it, lasers are revolutionizing eye surgery.

Using techniques of New York ophthalmologist Francis L'Esperance, eye surgeons employ four levels of laser energy. Exposure times range from 30 minutes for low-energy photoradiation to several billionths of a second for photodisruption.

With microscopic focus, beams weld breaks in the retina or seal leaking blood vessels by

photocoagulation. A painless 20-minute operation called an iridectomy relieves the excess fluid buildup of glaucoma.

When an artificial lens is placed behind the iris, the supportive membrane often grows milky. A laser beam is pinpointed on the taut tissue in a series of minute explosions. This photodisruption causes the tissue to unzip and part like a curtain.

To destroy an eye tumor, a surgeon at Children's Hospital

in Los Angeles (left) guides a liquid dye laser beam transmitted by an optical fiber. He uses an experimental drug called HPD, which is retained by cancerous cells and laser-activated to photoradiate the tumor. In photovaporization, laser light of another wavelength destroys malignant tumors.

Bloodless scalpels, lasers can make extremely delicate incisions, cauterize blood vessels, and leave tissue unaffected only a few cell widths away.

DIAGRAM BY ROY ANDERSON

Beams that heal

SURGICAL TRAUMA, the jarring aftermath of the surgeon's knife, may one day be consigned to the annals of primitive medicine—thanks to a procedure called “least invasive surgery” by its growing number of practitioners. Using an endoscope (right), surgeons can view the interior of the body and operate with the least amount of damage.

An end view of the flexible tube, bottom, shows a large optical fiber (at nine o'clock) to light the way. Smaller openings (three o'clock) facilitate fluid suction and gas dispersal. A forceps, controlled by a cable near the microscope viewing lens, extracts tissue for analysis. A laser, controlled by dials to the left of the eyepiece, streams from another tube, ready to perform wherever the doctor directs it. Twisting and probing with the end of the scope, he can identify and coagulate a bleeding ulcer in the stomach or blast tumors in the esophagus (inset). The beam is fed through the scope by an optical fiber from a laser machine, background, that might cost the hospital from \$20,000 to \$150,000.

At USC Medical Center in Los Angeles, Dr. Daniel Doiron examines small laser fibers (top right) before a lung-cancer operation. Though no cure for cancer, laser therapy can clear obstructions and prolong life. Tumors in the brain and

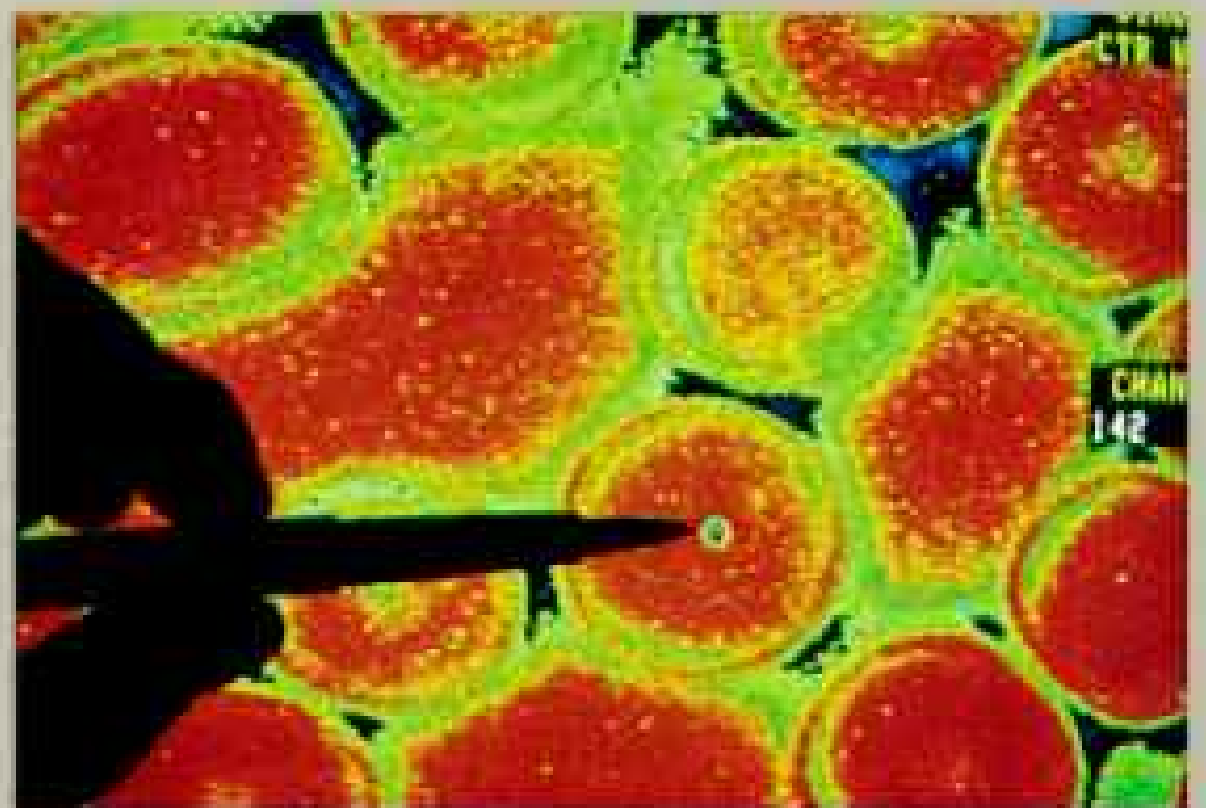
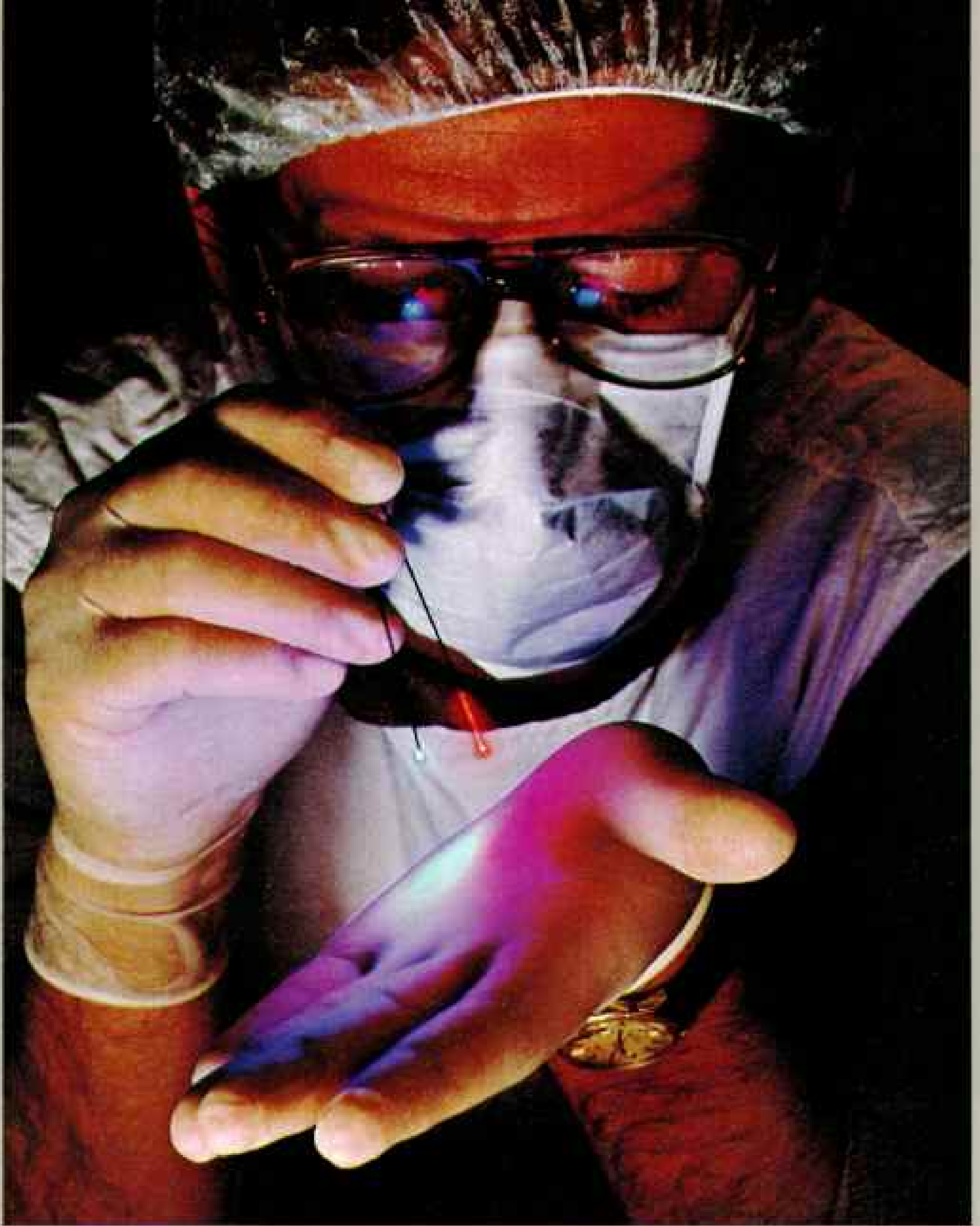
spinal cord, many of which were previously inoperable, are proving particularly receptive to the laser's delicate and healing touch. At the University of California at Irvine, Dr. Michael Berns uses the laser's fine-focusing ability in experimental genetic surgery. A laser borehole in a red blood cell (far right) is only half a

micron wide. A human hair, by comparison, is about 80 microns wide.

Lasers are also valuable diagnostic tools. At Seattle's Harbor View Medical Center vascular specialist Dr. Allen Holloway (right) uses a laser blood-flow meter to identify areas of critically poor circulation in the leg of a patient.



DIAGRAM BY ROY ANDERSEN





Perfection's apprentice, the laser has come a long way from its early dismissal as "a solution in search of a problem." In the automobile industry, where efficient design is now close to an obsession, the laser is becoming ubiquitous. At General Motors in Warren, Michigan, a technician beams lasers through a portal in a running engine (above) to monitor performance. In West Germany a designer for Daimler-Benz (top right) obtains microscopically precise measurements with a laser scanner to improve the aerodynamics of new models.



reaction and link molecules into raw material for fibers and fertilizers, pesticides and plastics. Someday the light of free-electron lasers may be tuned to selectively break and reforge chemical bonds on an industrial scale. This could reduce the hazardous wastes of chemical production and tailor-make beneficial plant genes, vaccines, and anticancer drugs.

On a different wavelength, so to speak, is the excimer laser. It takes its name from excited dimers, or diatomic gas molecules, that lase to generate ultraviolet light pulses.

Converted to blue-green light, excimer laser radiation easily penetrates seawater to submarines patrolling at their deepest depth. That exceeds the reach of all but the



lowest frequency radio signals, and to receive messages a sub must now cruise slowly and shallowly, towing a telltale antenna. It risks betrayal as well by its heat, magnetism, noisy machinery, and the bubbles that pop in its wake.

Here the excimer laser may soon help by pulsing coded one-way messages through the ocean from satellites. Its light, scanned rapidly over hundreds of square miles and to depths of several thousand feet, would not pinpoint receptive submarines. Tests from high-flying planes to subs have proved the technique already, even through clouds.

"An excimer laser could be in orbit by decade's end," ventures R. Norris Keeler, former U. S. Navy director of technology.

"Under all conditions, a President could instantly command or recall strategic bombers or missile-launching subs. And we could defend our ports, or pen an enemy in his, with mines controlled from space."

How the Navy enlists lasers interests many researchers less than another trend: toward shorter wavelengths and ultimately an X-ray laser.

"X-ray lasers rivet the attention of scientists," notes Lowell Wood of Lawrence Livermore National Laboratory in California. Wood himself strives at one of the nation's premier nuclear weapons labs to devise the laser he classifies as the "Holy Grail." As far as its design bears on weaponry, government censors classify it "secret."



Industry's new precision tool

BEST YARDSTICK yet, lasers found an early and eager reception in the construction industry as a surveyor's tool. Tunnels drilled by laser-guided machines, for example, are straight to within a centimeter or two, compared with several inches of misalignment in older tunnels—like those serving the nation's railroads. But even there lasers can help. Using a truck-mounted helium-neon laser (right), Union Pacific is obtaining precise clearance measurements of all its tunnels, with the aim of accommodating higher, wider loads. Likewise, at Seaboard Lumber Company in Seattle (top left), laser-assisted saws assure maximum yield from each log.

Of major value to industry is the great intensity of high-power lasers. Able to deliver extremely high energy to the surface of a workpiece, their use is proliferating in jobs such as welding, drilling, and heat treating. Carbon dioxide lasers are able to cut through the toughest metal with unrivaled speed and precision. At Spectra-Physics in San Jose, California (left), a laser cuts out a steel saw blade in two minutes.





UNION
PACIFIC

TUNNEL 5
MP 442.01
578' LONG

CRANE

166473

The X-ray laser is attractive for the energy of the pulse it would fire. At peak energy, this pulse would shatter a missile with utmost violence. Contemplating it, physicists speak lamely of "explosive disassembly," their tongues tied not by jargon but by government secrecy.

Equally important, the short wavelength of X rays—down to the scale of the smallest atom—permits them to scatter tellingly from many things of such scale or larger. Moderated X-ray laser pulses would behave as do the ripples lapping a beach, which reveal by how they spread out—or diffract—the size and shape of seashells they wash against.

Whether for destruction or detection, an X-ray laser would need pumping by an energy source of extremely high intensity. To little avail so far, Lowell Wood uses 20-trillion-watt Novette, a laser whose heart is a stack of glass disks impregnated with neodymium. But nuclear blasts have reportedly succeeded in underground laser weapon tests conceived at Livermore. Or, an excimer laser might pump the X-ray version, jolting it with one trillion watts of power delivered in one-trillionth of a second.

At suitable intensities an X-ray laser's swift pulses would be a boon to biologists. Typical X-ray diffraction studies are so slow that they capture only relatively static biological details. But the X-ray laser could catch a DNA molecule, enzyme, or virus in action, or "snapshot" a living cell. As well, the coherent radiation of an X-ray laser could record holograms, to render dynamic views in three dimensions.

X-ray lasers could revolutionize our view of the world. To be able to see the dynamics of life in finest detail and in three dimensions would be like removing a blindfold. New theories of disease might result, or life-saving drugs.

DOCTORS REACHED EARLY for the laser and have not let go of it since. Indeed, their grip has so tightened that today the laser treats patients from head to toe.

"The number of things medical lasers can do is past imagining," says Terry Fuller, head of the nation's largest laser-surgery research lab at Sinai Hospital of Detroit.

There alone last year, surgeons performed 5,000 operations using lasers.

In a laser-surgery course in San Francisco, Dr. Michael Edwards of the University of California sat me at a binocular microscope to practice neurosurgery on anesthetized rats. The light of the argon laser I pulsed at them through the microscope injured the animals much less than if I had wielded a scalpel.

"The laser's precision outstrips our ability to exploit it," Edwards said as I aimed blue-green light pulses with the microscope's joystick. Laser light excels at surgery because it can be matched for specific effect to body tissues of varying sensitivity.

The intense light I fired, using a foot pedal, severed and cauterized blood vessels but sacrificed no other tissues, because only red blood cells absorbed it. To vaporize tumors or to melt and rebond torn nerves or blood vessels, surgeons guided by red helium-neon aiming beams use the unseen radiation of carbon dioxide lasers. Tissue vanishes beneath it in tiny wisps of smoke.

In blocked arteries, buildups of calcium and fatty fiber called plaque yield to laser light much as do red blood cells. Plaque can so narrow an artery that blood flow halts, resulting in a stroke or heart attack. But a laser-beam catheter threaded into an artery can truly ream it open, blasting at plaque so precisely that the first man to receive this experimental treatment—for a blocked leg artery last year at Stanford University—went home the next day, with only aspirin.

Doubts remain, however, about such arterial laser surgery. Further experiments must determine laser power levels that least risk puncturing an artery or coagulating blood into a clot.

Thousands of women have no such reservations about gynecological surgery by laser. Because of it, they are mothers. I met the pioneer of laser gynecological surgery, Dr. Joseph Bellina, at his Laser Research Foundation in New Orleans.

"Until a few years ago," Bellina told me, "an infected pelvis or perpetual menstrual bleeding usually prompted a hysterectomy—sterilization. Laser treatment now gives people a chance to have children, by preserving internal organs."

Or by reconstructing them, as I saw Belina rebuild the pinhead-size tips of a young woman's damaged and blocked Fallopian tubes. Using a carbon dioxide laser, he sculpted blunted and scarred stumps into florettes of pink flesh, delicate "fingers" to caress the ovaries in search of eggs no bigger than the smallest grains of sand. Microsurgery that might have lasted seven hours took but one, and the woman conceived six months later.

To screen women for cancer of the cervix, Dr. Leon Wheelless and colleagues at the University of Rochester Medical Center in New York stain cells with a fluorescent dye and analyze them with a unique laser scanner. Cells whose nuclei fluoresce abnormally may indicate cancer; they absorb more dye and glow brighter in the laser light. This scanner also recognizes when a sample may contain too few cells to reveal cancer reliably—critical because, if detected early, cervical cancer is nearly always curable.

Experimental therapy for cancer patients lies in another laser-sensitive dye—hematoporphyrin derivative, or HPD. Prepared from cow's blood, HPD injected into the body is absorbed and excreted by all cells, healthy and cancerous. HPD remains longer in malignant cells, however, and where

laser light can reach and activate it—as in the lung by glass fiber, or just under the skin—cell membranes dissolve. Dozens of cancers wilt under such attack, without the painful and sometimes disfiguring side effects of chemotherapy and X rays.

PHOTOCHEMISTRY—any chemical change driven by light—is a commonplace of nature. Think of sun-tanning, or of the photosynthesis by which plants convert sunlight to food, or of the chemistry of vision enabling you to read this page. Small wonder that scientists use the laser and its light to study or control these and other chemical reactions.

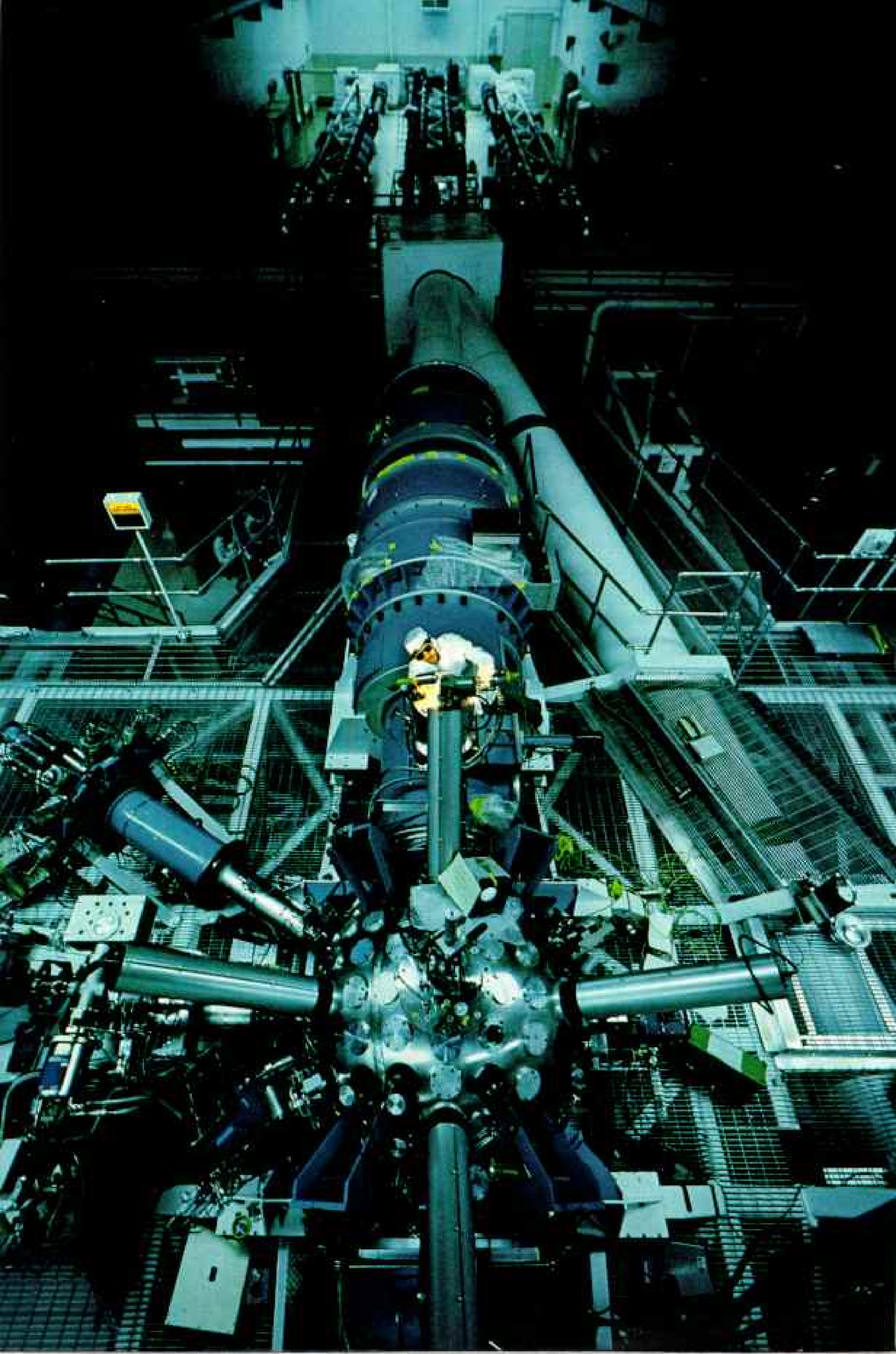
"Lasers have become ubiquitous in experimental chemistry," I was told by Richard Zare, a preeminent laser chemist at Stanford University. "The very way we do research has been changed by the laser. It's a new searchlight revealing things we could never before see, make, or measure."

Zare conceived laser-induced fluorescence, or LIF, an ultrasensitive method of detecting chemicals in gases and liquids. Tuned to the correct wavelength, laser light beamed into a solution so deftly elicits the "light signature" of an odd molecule that it stands out among a quadrillion others.

Incriminating light, the argon laser is adding muscle to police labs. In Orange County, Florida, a representative of Laser Ionics, Inc., shows Sheriff Lawson Lamar how his new system can detect fingerprints on a Styrofoam cup. The laser makes the print fluoresce, and a TV camera displays it on a screen.

An improvement on powder-dusting techniques, the laser is also able to detect prints on previously print-proof materials, such as Formica and leather—even human skin. Dangerous if viewed directly, most lasers require the use of protective glasses.





Fusion: the hope in binding energy



SEVEN FLEMING LEFT/IL. DIAGRAM BY JAM. HOLLER



GROWING MORE POWERFUL every year, high-energy lasers are bringing the world ever closer to the energy source of the stars—nuclear fusion. Laser pulses delivering trillions of watts are aimed at minuscule pellets of hydrogen fuel, such as that suspended on a spiderweb at the University of Rochester's fusion laboratory (top). The fusion laser at California's Lawrence Livermore National Laboratory (left) is aiming for break-even energy, where power output equals input. In the fusion chamber, foreground, the fuel pellet's outer shell shatters under laser impact (above). The resulting implosion fuses the hydrogen isotopes, creating a tiny thermonuclear explosion—the harnessed energy of the sun.

"I believe lasers will play a key role in future medical analysis," Zare said, "to detect insulin in human serum, for example. With LIF we could probe blood, sweat, and tears—like checking a car's exhaust to learn its running condition—and determine a person's health in time to give him a minor tune-up, before he needs a major overhaul."

At the General Motors Research Laboratories in Warren, Michigan, I found chemists overhauling theories of combustion, a review prompted by laser study of fuels and flames. Putting these in the right light may cut GM's cost of auto-pollution control—more than four billion dollars since 1974—and upgrade the efficiency of car engines.

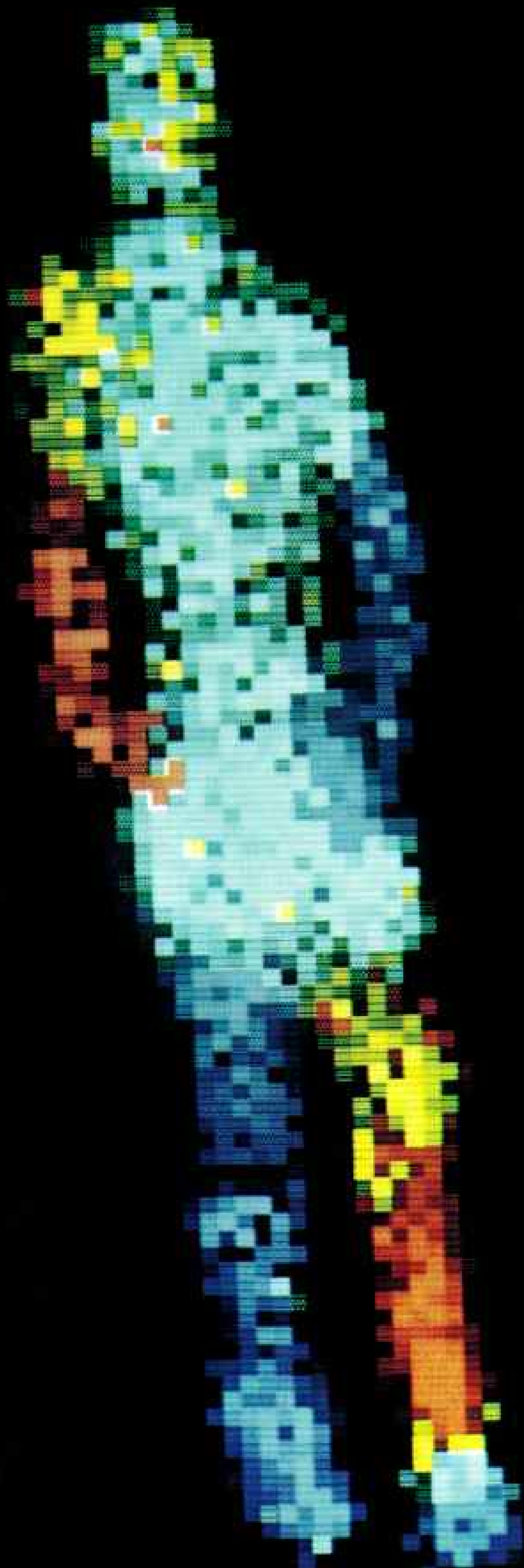
In one GM lab I watched an argon laser sense the size and number of soot particles forming in a cone of yellow flame. Only lasers can probe the chemistry of a flame without altering it. GM researchers have also used laser holograms to record flames at the moment of extinction, an investigation that might lead to better engine designs.

In addition, lasers can reveal moment to moment how molecules vibrate, bend, twist, and rotate. Such information can improve the efficiency of chemical reactions, or simply clarify them. Many elementary steps in chemical reactions, physical processes, and living cells occur in picoseconds—trillionths of a second. With ultrashort bursts of laser light, these events can be clocked for study.

At AT&T Bell Laboratories in Holmdel, New Jersey, physicist Charles Shank has fired from a dye laser sharp spikes of light lasting but 30 millionths of a billionth of a second. In so brief an instant even a supersonic jet travels only the minutest fraction of the diameter of one of its atoms. Virtually nothing happens too fast to be timed by the laser stopwatch.

"It's like having a microscope able to peer into a world of fast events rather than small things," Shank told me. One event that he clocks is electron movement in gallium arsenide crystal, a competitor of silicon as the basic material in microelectronic circuits. By this study, Bell Labs hopes for smaller and faster microcircuits and computers.

This drive for more computing power has pushed laser photochemistry from labs into



Laser eyes for tomorrow's robots are on the drawing boards, thanks to the science of light-wave detection and ranging, otherwise known as LIDAR, or laser radar. At the Lincoln Laboratory



of the Massachusetts Institute of Technology, scientists are developing a transportable imaging laser radar (above) with a remarkable ability to identify the speed of objects and their moving parts. A computer-processed image of a jogger (left), with reds and yellows indicating the faster speed of the forward leg, dramatizes the technique. Like traditional microwave radar, LIDAR works by bouncing radiant pulses off distant targets and analyzing their return. But with much shorter wavelengths, lasers are capable of detecting microscopic particles, such as pollutants in a smokestack plume or even oxygen molecules in global winds.

industry. In furnaces where wafers of silicon crystal are processed into microcircuits, laser light beamed into special gases provokes chemical reactions that etch silicon with intricate circuit patterns, or lace it with "wires" far too fine to see with the naked eye.

IN ANOTHER FIELD lasers already perform alchemy, the ancient dream of transmuting common substances into precious ones. By separating different atomic forms—or isotopes—of the same element, lasers can enrich ordinary uranium, turning it into valuable fuel for nuclear-power reactors.

Natural uranium contains chiefly the isotope U 238 and a scant amount of U 235, whose concentration must be raised in uranium meant for nuclear fuel. Chemically, U 238 and U 235 atoms all but match, so only a tiny weight difference allows their separation by conventional enrichment methods that require huge amounts of electricity or costly mammoth facilities.

Far cheaper in energy and money are lasers that separate isotopes by ionizing U 235 atoms in vaporized uranium metal for electromagnetic collection. A pilot laser isotope-separation plant to purify plutonium opens in 1984, and others to enrich uranium may follow in the 1990s.

Scientists worldwide hope before then to show the feasibility of laser fusion—the production of nuclear energy by heating, crushing, and fusing hydrogen isotopes with laser light. A reactor that could fuse atoms rather than split them for their energy offers much: no risk of explosion, less radioactive waste, and the prodigious energy of an abundant fuel isotope—deuterium—found in the hydrogen of seawater.

"Burning a fuel pellet little larger than a grain of sugar frees almost as much energy as a ton of explosives," said Robert McCrory, Jr., director of the Laboratory for Laser Energetics at the University of Rochester. With him I wandered a football-field-size building: a tight fit for Omega, a neodymium-glass laser of 12 trillion watts power.

Later I watched mirrors split a pulse of Omega's light into 24 beams that entered portholes in a spherical steel target chamber. In billionths of a second, they vaporized the outer
(Continued on page 362)

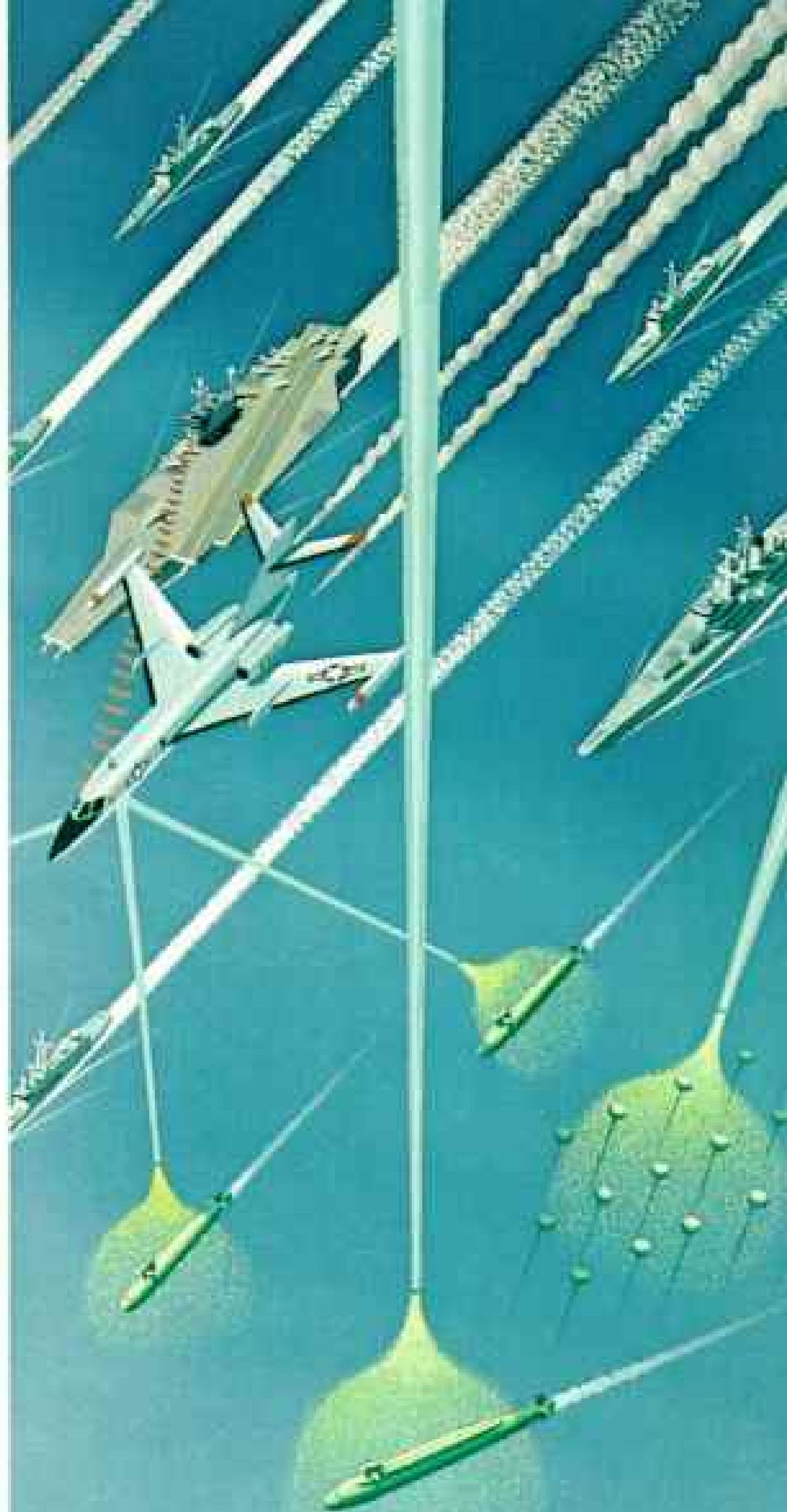


ILLUSTRATION BY PIERRE WIDON

Talking to the depths

PENETRATING ocean water thousands of feet deep, lasers in blue-green wavelengths now under development will communicate with submarines and fields of "smart" mines. Currently subs must tow a detectable antenna.

In future a flagship will radio its orders to a carrier-based air-cover jet, which will relay them via laser to escort subs. Lasers beamed from satellites will program minefields and communicate with missile submarines without revealing their positions.



The dark side of the force

AGGRESSOR TANKS sweep in from the east, and laser beams dart across the plain to meet them. In this war-game strategy the laser helps even the odds. "We cannot hope to build and ship enough tanks to meet the Eastern bloc threat," says an official of the U. S. Department of Defense. "But we can use technology to reduce the effectiveness of the tank."

Small lasers can guide weapons with unprecedented

accuracy, beaming across long distances to pinpoint targets or even the most vulnerable parts of targets.

The simplest way to designate a target is with a portable unit operated by ground troops, lower right. An AH-64 Apache attack helicopter, upper left, designates the target from a nose-turret laser, as its Hellfire missile homes in on backscatter—laser radiation reflected from the tank. The M-1 tank, lower left, uses precise laser ranging to aim

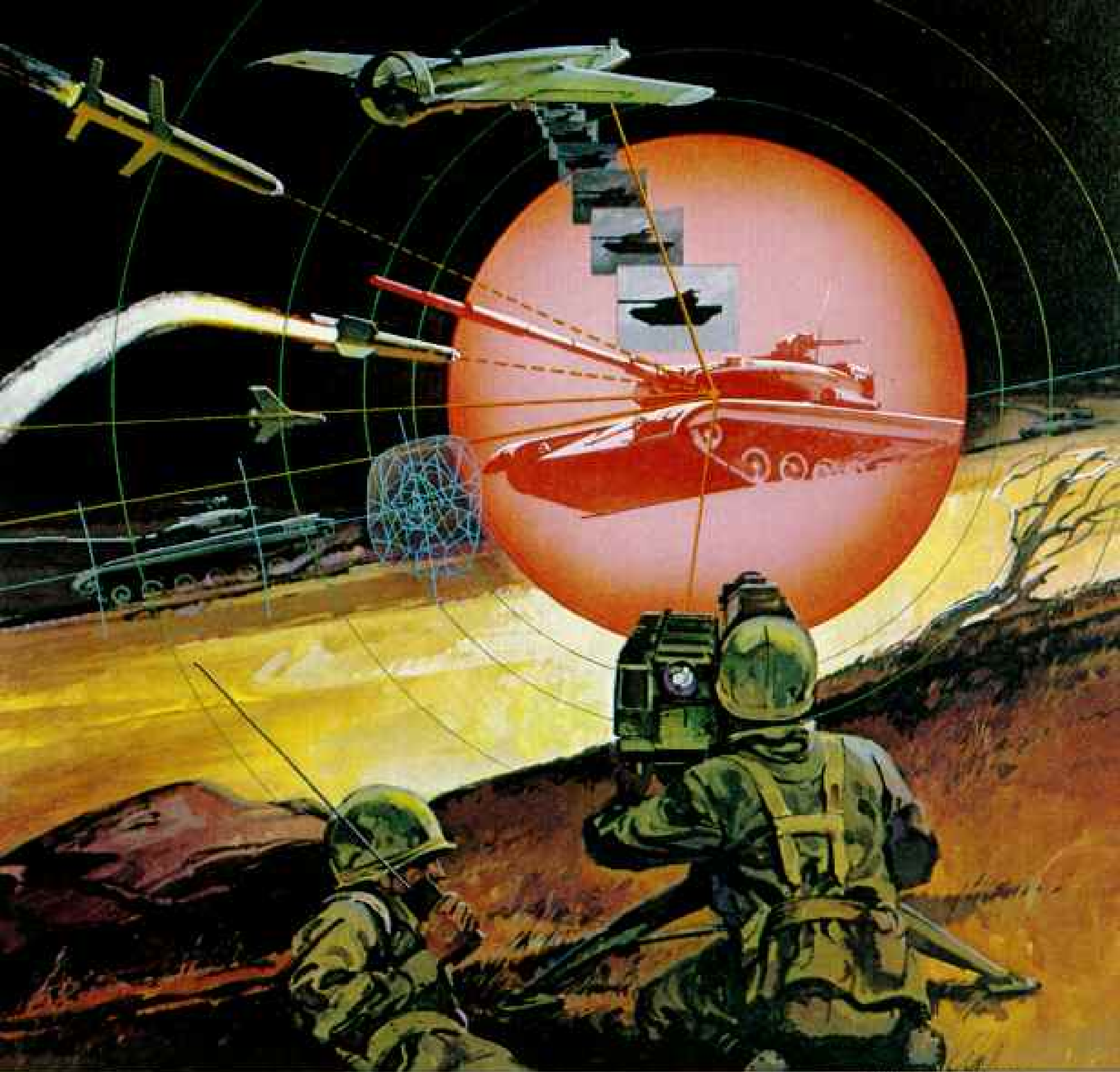


ILLUSTRATION BY BOB BULLOCK

its armor-piercing rounds. It, in turn, is vulnerable, since for every technology there is a deterrent. The race is on to develop field-dependable portable lasers powerful enough to disable the optic lenses, middle right, of an opponent's gunsights, range finders, viewing ports—and lasers.

Above the field flies a darting and deadly flock of remotely piloted vehicles (RPVs) called Aquilas—Latin for "eagles." From miles behind the lines, pilots man

the controls of consoles to guide the small, propeller-driven drones through maneuvers that would disorient or incapacitate an on-board pilot. The RPVs send back a television view of the battlefield, generate electronic countermeasures to confuse the aggressor, and designate targets by laser.

The ground support A-10 aircraft, above the helicopter, makes a run across the field after loitering in low-level flight beyond the horizon. At a signal it can fire a homing

missile guided by an Aquila, then resume its lurking.

The Aquilas can also guide Copperheads, center top—extraordinary artillery shells. As a Copperhead leaves the gun, winglets flick out. Optics in its clear nose cone search for backscatter, a microcomputer locks on, and the shell "flies" as much as falls to its target. Critics cite the weapon's high cost (\$54,000) but agree that if each can destroy a million-dollar tank, a one-round kill is cheap.





KERRY SMITH (LEFT), PAUL ELY

Space-war scenarios, as depicted in a studio simulation (left), envision orbiting laser "death rays," able to wipe out enemy satellites and intercontinental missiles alike. In tests lasers have already graduated from missile guiders to missile killers. Actual deployment, in space or on the ground, is raising a storm of controversy. Proponents of a "high frontier" defense believe that lasers, firing unerringly over vast distances, would render nuclear missiles obsolete. Opponents say the defense system would drain national resources and prove vulnerable to countermeasures.

On a peaceable mission, Hawaii's Haleakala laser-ranging station (above) tests a beam that can reach a satellite 6,000 kilometers aloft, enabling scientists to calculate continental drift of a few centimeters a year.

layer of a glass-and-gold pellet filled with deuterium and tritium. As its hull exploded, the pellet "blasted off" in rocketlike reaction—inward, not outward—fusing atoms of fuel at the pressures and temperatures of a star, which it became in miniature. The pellet had absorbed power 20 times greater than the output of all the nation's power plants combined.

Even mightier than Omega are Novette at Livermore and the carbon dioxide laser Antares at Los Alamos National Laboratory in

New Mexico, other centers of laser-fusion research. Ignition—a self-sustaining fusion reaction—will likely not be seen before 1987, perhaps first at Livermore.

Beyond lie severe engineering challenges. "Laser fusion probably won't be commercialized before the year 2020," McCrory told me, "so, few U. S. firms are investing. We may lose out to the Japanese."

NOT JAPAN but the Soviet Union looms as the greatest threat in the field of laser weapons. For research on speed-of-light defense against missiles, bombers, jet fighters, and ground forces, the U. S. last year spent some 450 million dollars, the Soviet Union perhaps three times that amount.

"What the Soviets get for their money is hard to say," Robert Cooper told me in his Pentagon office, where he heads the Defense Advanced Research Projects Agency. Much of this country's research funding for space laser weapons comes from DARPA.

"The Soviets seem highly interested in lasers for ground warfare," Cooper continued. "And we suspect they have two lasers able to damage low-orbiting satellites from the earth. It would be no surprise if they put a laser weapon in space this decade, but it would probably be of little utility."

In tests an Air Force carbon dioxide laser has downed air-to-air missiles, and the Pentagon is researching a ballistic-missile defense system including lasers that might cost 27 billion dollars by 1989. Yet open questions and contrasting claims mark the debate about laser weapons. They deliver inescapable destruction but must track and stay on target over hundreds or thousands of miles. Can they? Can lasers be coordinated with other weapons in defenses of unprecedented complexity? Might lasers slow the arms race, or speed it in new directions? Will we amend or abrogate arms treaties?

Across the Potomac from the Pentagon, on Capitol Hill, I found Senator Malcolm Wallop of Wyoming favoring a constellation of laser battle stations in space. They might blunt a nuclear attack, he points out.

"The laser offers to protect people and reduce nuclear terror," says the congressional backer of greater spending on space defense. "Such a shield would preserve much of our



The sound and image of future home-entertainment-and-education systems may lie in the laser-recorded disc. At a 3M plant in Menomonie, Wisconsin, dust-free clean rooms protect billions of data pits in a light-refracting videodisc. With an affinity for the infinitesimal, the laser promises to play a major role in the onrushing information age.

nation and its retaliatory power. By making attack less likely to succeed, it would lower the risk of war and give us incentive to reduce nuclear arms."

Edward Teller, key creator of the hydrogen bomb and prime advocate of a laser ballistic-missile defense, agrees with Wallop's motives but not his means.

"Nuclear deterrence is unstable," he told me, "and our one hope to avoid war is defense. But lasers stationed in space won't fill the bill—they must be deployed in great numbers at terrible cost and could be destroyed in advance of an attack." Colleagues say Teller prefers earth-based lasers teamed with other weapons, and X-ray lasers ready to be rocketed into space at the first alarm.

Richard Garwin, physicist, collaborator with Teller on development of the H-bomb, and frequent Pentagon consultant and critic, sees the matter quite differently.

"Earth-based lasers require large space-based mirrors, which are vulnerable to attack," he said. "And lasers sent into orbit only as enemy missiles lifted off would arrive in orbit too late to intercept them at their most vulnerable point. Instead, they would face a swarm of smaller, more numerous warheads." Proposes Garwin, "We should consider a ban on all high-power laser work by the Soviet Union and the U. S., except that done jointly."

How and whether to employ the laser for national defense is perplexing, but there's no doubt of its promise for communication and computers. Advances in these areas include:

- *Semiconductor lasers.* As small as grains of salt, 400 of these light sources can be diced from a sheet of semiconducting crystal the size of a telephone push button. These cheap and rugged lasers—some with projected working lives of 100 years—pulse messages through the glass fibers of light-wave telephone links. Beginning in 1988 they will transmit calls underseas between the U. S. and Europe. New ones can send the full text of the *Encyclopaedia Britannica* in less than two minutes.

- *Integrated optoelectronic circuits.* Combining optics and electronics on a semiconductor chip, these consist not only of transistors and related devices, but also of tiny lasers, lenses, prisms, light switches, and shutters. IOCs could one day switch

and steer light signals in an optical computer much faster than an electronic computer.

- *Laser videodiscs.* Below its plastic surface, one of these grooveless platters hides billions of pits so tiny that 100 of them could fit in the diameter of an eyelash. Encoded by the indentations on each side of the platter may be music, the text of thousands of books, or 54,000 color TV images, decipherable by the laser beam in a videodisc player.

AT THE CALIFORNIA Institute of Technology in Pasadena, astrophysicists showed me a laser gravity-wave detector. No use of laser light so well caps a survey of its significance.

In 1916 Einstein drew on his theory of relativity to predict that movement of mass anywhere in the universe can launch gravity waves. They sweep at the speed of light across space, rippling it and jiggling anything they meet. But they are so weak that only the most violent events set off bursts of gravity waves we can now hope to detect.

"If we detect a gravity wave," said Stanley Whitcomb, "it will likely be set off in our own galaxy, by a supernova—the swift collapse of the core of a massive star." That will also blow off the star's shell in a dense cloud of gas, and just as astrophysicists most want to study it, the core of the supernova will be screened from their telescopes.

But perhaps not from a laser detector. Caltech researchers led by Ronald Drever have hung weights as free to move as possible at the ends and elbow of an L shape. I watched the green beam of an argon laser split and dart simultaneously to the ends of the detector, where it bounced off mirrors on two weights, to rejoin in a bright spot on the mirror of the third weight, at the elbow. A gravity wave jiggling these weights would put the returning beams out of step, and the bright spot would dim or disappear.

This jiggle—a motion less than the width of an atom's nucleus—would be momentous. Laser detectors worldwide would trace the gravity wave to its source and spy like a huge new telescope on the final awesome moments of a star. Einstein's insight would be proved again, and something of the firmament reflected in the laser's light will dawn on us like the "splendid light" that dawned on him so long ago. □

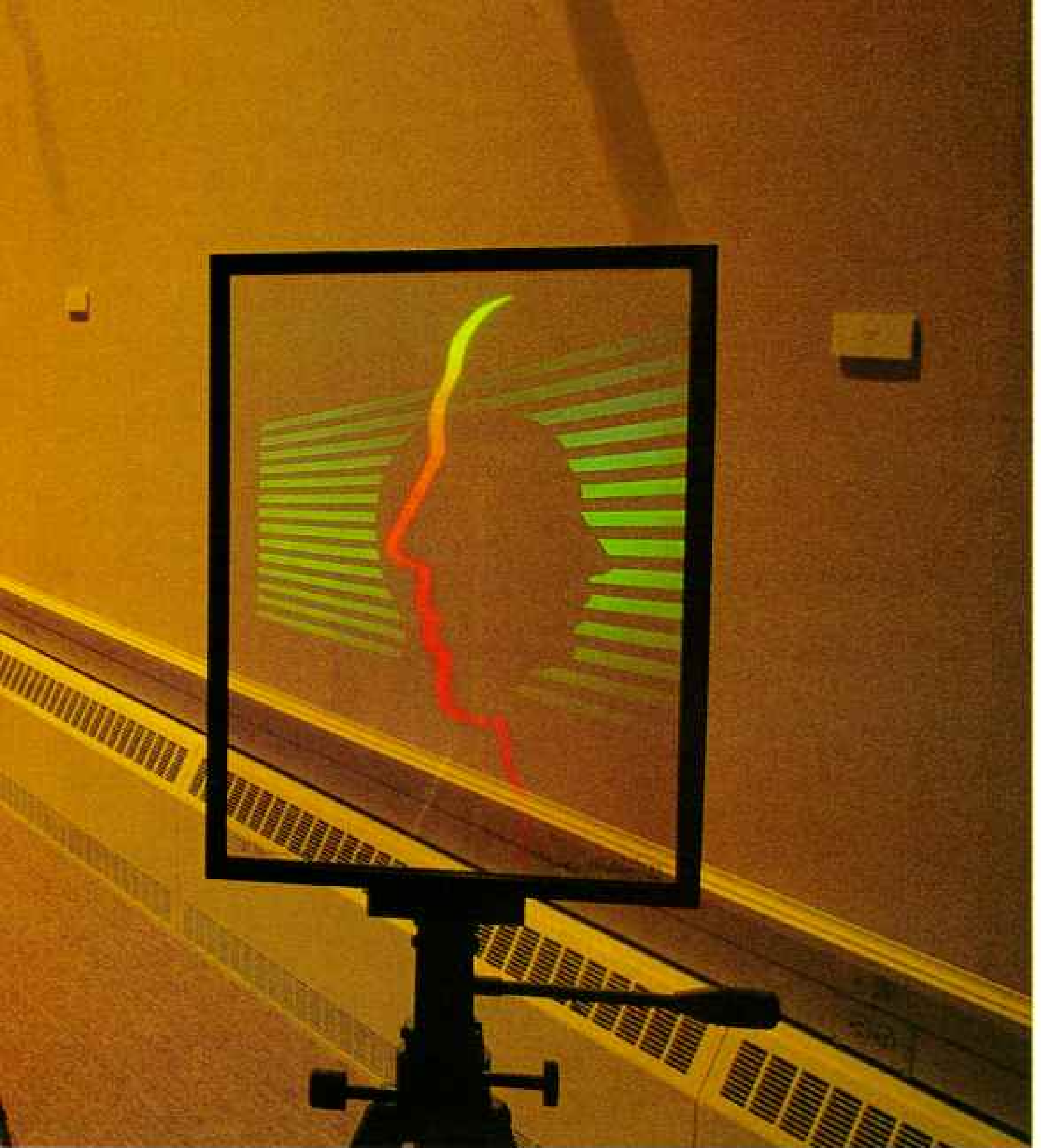


THE WONDER OF
HOLOGRAPHY

By H. JOHN CAULFIELD

Photographs by CHARLES O'REAR

WEST LIGHT



Like sculpture floating magically in space, three-dimensional images emerge from the glass plate of a hologram—a record of laser-light patterns—created by New York artist Rudie Berkhout. As viewers change position, they see different perspectives and colors. An artist's medium soon after its invention two decades ago, laser holography is used increasingly in commerce and industry.

IT WAS A MISTAKE easy to make, and several people made it. Walking the halls of the CBS Laboratories in Stamford, Connecticut, you would glance into an office and see Hungarian Nobel laureate Dennis Gabor smiling at you from behind his desk. You'd smile back and say hello. But embarrassment soon followed as you realized the joke: You had greeted not Dr. Gabor but a perfect three-dimensional image, floating in space, formed by a hologram!

By what magic can holography re-create today its impish scientist-inventor, who died in 1979? How does it perform such marvelous services as inspecting car and airplane parts, scanning grocery product codes at supermarkets, and aiding pilots? Will it lead to three-dimensional movies and television? As one of many scientists pursuing these questions worldwide, I believe we are on the threshold of even more remarkable advances in this fourth decade of holography.

Gabor developed holography in 1947 to improve the electron microscope, which views and photographs objects with a probing beam of electrons. The lenses needed to focus such a beam were then so poor that Gabor set out to create a way to take pictures without lenses.

Holography works with any waves—electron, sound, or light. To appreciate holography with light, recall how a camera works. Suppose your picture is being taken. The camera film records the intensity pattern of light scattered from your face. But if there is no lens, that pattern of scattered light is uniform and without details. By contrast, the proper lens set at the proper distance between you and the film casts a sharp image of your face onto the

film. Thus a lens focuses light patterns to match the shape of the objects that scatter them.

Gabor's problem was with accuracy of focus of his lenses. Blurred information seemed to be lost completely, but if the direction as well as intensity of the light could be recorded, re-sharpening might be possible. "Why not," he reasoned, "take a bad electron picture, but one which contains the *whole* of the information, and correct it by optical means?"

The complete light pattern represented by this combined information about direction and intensity is called a wave front. When such a wave front strikes a glass photographic plate or film without an intervening lens, it creates no picture. But intersect it at the plate or film with a second set of light rays—a reference beam—and the wave front can be recorded and later reconstructed by the proper illumination. Viewing it from the correct angle, we can use the restored wave front to form—with no lens beyond that in our eye—an image in its original depth and detail, exactly as if a real wave front from a real object, scene, or person were just then reaching our eyes.

Little wonder that Gabor coined the name for his uncanny photographic technique from *holos* and *gramma*, Greek for "the whole message."

Gabor's holography techniques were rather crude, and his experiments went largely ignored for some 15 years. But the construction in 1960 of the laser gave hologram-recording methods a significant boost. In the United States, Emmett

Dr. H. John Caulfield, principal research scientist at Aerodyne Research, Inc., is also guest curator for the exhibition "Holography Works," now at the Museum of Holography in New York City.

Leith and Juris Upatnieks illuminated a subject with a laser beam, which then reflected to a photographic plate. From the first beam they split off a second, which bounced from a mirror to the plate. Where the two beams met on the plate, they created interference fringes, or patterns, that appeared to the eye as nothing but gray smudges. But from those indistinct smudges a holographic image could be reconstructed. Nearly all scientific and industrial holograms are made today in this way.

Independently, in the Soviet Union, Yuri Denisyuk pioneered a technique that now records many display holograms, such as those Professor Denisyuk has made of art in the great museums of Leningrad and Moscow. By means of holography, such art treasures have toured the Soviet hinterland, to be seen and enjoyed by far more people than could crowd into a few major museums.

Some holograms bend light but do not re-create an image; these are called holographic optical elements. Cheap, easily shaped, and lighter than conventional glass lenses and mirrors, they can:

- Combine laser light of varied wavelengths for simultaneous transmission of telephone calls on one optical fiber.
- Split starlight into a spectrum, or rainbow of separate colors, to analyze the chemical elements in a distant sun.
- Serve as a helmet visor to block out the blinding radiation of laser weapons.

Curiously, a hologram allows us to view a recorded scene or object from different directions. It is like viewing a three-dimensional scene through a window: By moving to different parts of the window, we see the same scene from new angles. So

even small fragments of a shattered hologram may let us see the entire scene that it records, though only from one vantage point.

Rather than breaking up holograms, however, it is easier to mass-produce them from a master hologram. Indeed, the hologram on the front of this magazine is one of almost 11

million copies. Each gleams as brightly as the master.

More holograms—the logos of credit-card companies—are beginning to appear on tens of millions of charge plates, lending an extra margin of protection against counterfeiters. As a further safeguard, the credit-card numbers cannot be altered without defacing the ultra-thin

hologram. Other holographic deterrents to fraud are under review for use on U. S. currency.

Mass-produced, embossed holographic novelty stickers for children are widely available, sometimes packaged with candy and toys. Soon, possibly this year, you will be able to give and receive holographic greeting cards. Already here—holographic pornography.

Two new holography uses are interrelated: forming holograms of things that do not exist or perhaps *cannot* exist.

I am familiar with such synthetic holograms through my own research. By calculating the hologram of an ideal standard and then drawing it with a computer-run "hologram writer," we obtain a perfect reference against which to compare human productions such as giant, carefully shaped mirrors for infrared sensors.

It's also possible to computer-generate in a few seconds a three-dimensional hologram of an engineering, architectural, or even medical situation. The ability to plot, or draw, such images should lead eventually to three-dimensional television.

For all the progress in holography today, its future looks brighter still. Holograms for massive information storage will revolutionize computing. X-ray holograms will offer us undreamed-of detail about objects as small as viruses and DNA molecules. A screen for large holographic films has been invented, and Professor Denisyuk, still active in Soviet holography, has just created lovely natural-color holograms; perhaps by the year 2000 we will enjoy three-dimensional movies and television.

These are just a few virtual certainties. There is one more: We haven't yet seen the whole message of holography! * * *



PHOTOGRAPHED AT MUSEUM OF HOLOGRAPHY, NEW YORK CITY

Rare full-color hologram of chessmen is a triple exposure made with red, green, and blue lasers (above). Polaroid Corporation's Dr. Stephen Benton (below), who created the chess hologram, invented the rainbow technique used in his "Crystal Beginning." Its colors change from blue to red as a viewer moves up and down.



CARY WOLINSKY, STOCK, BRITISH

Finding the flaws: industrial applications

A SHERLOCK HOLMES of high tech, holography ferrets out ordinarily invisible deficiencies in such products as computer disk drives, aircraft and automobile parts, tires, pipes, pressure vessels, and even tennis-racket handles.

Newport Corporation in Fountain Valley, California, a major manufacturer of holographic equipment, has developed a portable, push-button rig weighing only 70 pounds (*facing page*) that can be set up in laboratory, field, or factory.

Here with its protective cover removed, the setup detects a flaw in the bonding of a plastic pipe assembly, like those in automatic lawn-sprinkler systems. First a beam from a helium-neon laser mounted under the perforated board is split, and part is directed by mirrors to strike the assembly and reflect on an electrically charged holographic glass plate under the metal piece in the foreground. On the glass plate interacting waves of light form an interference pattern that is recorded and developed electronically in ten seconds, creating the hologram. That image is then superimposed over the pipe assembly for a stress test.

Air fills the assembly, exerting pressure at several pounds per square inch, causing minute bulging. This action creates patterns called interference fringes that account for the contour map appearance (*inset, above*). Each band represents a displacement of only six millionths of an inch. The bull's-eye at each elbow indicates normal stress, but the bull's-eye where the pipe enters the lower

joint spotlights an improper bond, the result of faulty workmanship. This imperfection would cause failure in operation. On an aircraft tire, such a flaw could lead to a blowout.

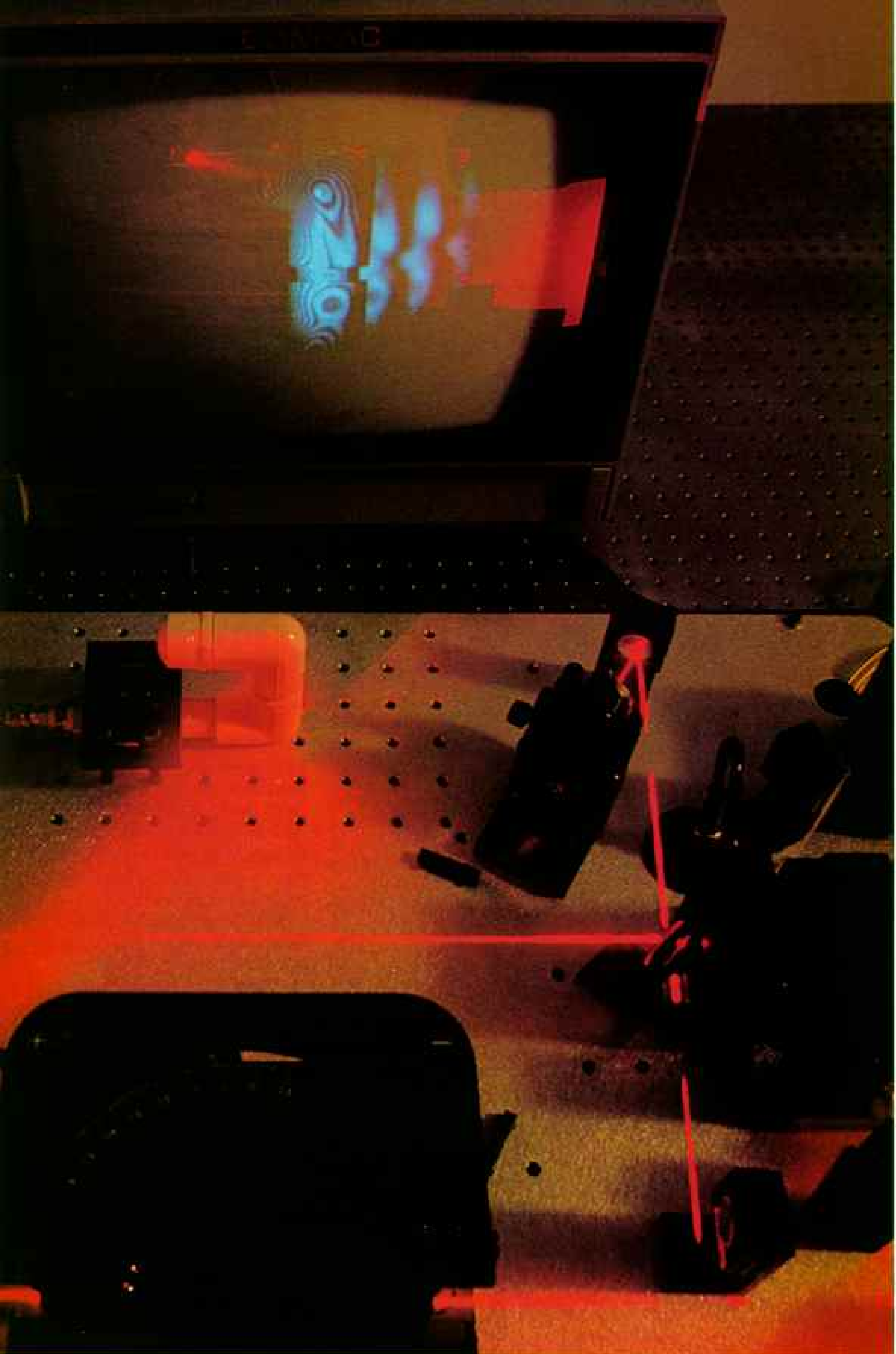
Newport's Holocamera is here tied to a companion video-system to magnify the experiment and pinpoint problems on



the spot. To detect such small changes, equipment must be free of vibration—a problem solved by placing the table on inner-tube air cushions.

Called holographic interferometry, the technique can also observe minute changes due to heat and vibration. It can even visualize deformation in a concrete slab caused by the weight of a dime. Never before has industry had such a sensitive, all-inclusive measuring tool.





A three-dimensional look into the future

WHAT GOOD is a 3-D image? As Benjamin Franklin chided scoffers at the time of the first manned-balloon flight, "What good is a newborn baby?" Though still in infancy, the art and science of holography promise significant advances in the technology of peace and war. Following are some possibilities:

X-ray holography will, for the first time, enable researchers to record a three-dimensional view of human cells. This advance may become a tremendous tool in the diagnosis of human disease, perhaps as early as the next decade.

Computer graphics, married with holographic techniques, can create three-dimensional models from two-dimensional information programmed into a computer.

Thus a hologram of an industrial part, a building, or a DNA molecule could save time for engineers and architects and enhance a medical student's education.

Data storage, holographic style, could in theory record all the material in the Library of Congress on a medium about the size of a sugar cube. This is because holograms, being essentially light waves, can reduce information to incredibly tiny dimensions

approximating the wavelength of light used.

Holographic storage may someday outstrip all existing methods in quantities of data; its speed of access offers the greatest immediate payoff. Progress is held up by constraints in materials technology.

Pattern recognition: Carrying a memory bank of holograms of enemy tanks and aircraft as seen from hundreds of angles, a launched missile would electronically examine potential targets. An image of a tank, when illuminated by a laser, would be instantly compared with the holographic tanks in the memory. Thus the missile would autonomously seek, recognize, and destroy enemy targets.

The technology also has a peaceful application in the field of industrial robotics. Stationed by a conveyor belt, robots with holographic memories could identify and select desired parts.

Gunsight: A holographically produced line with cross hairs at the end of it appears to be projected into space, as seen through the holographic gunsight. The gunner swings the line and cross hairs to the target and fires.

A working model of the sight has been prepared for the U. S. Army.

A HOLOGRAM is created by the intersecting beams of a laser. Light emanating from a laser (**right, top**) is split to create an object beam and a reference beam. Spread by lenses, the object beam is reflected by a mirror to the model of the eagle that appears on our cover. Light waves from the eagle are reflected toward photographic film.

Simultaneously, the reference beam is also spread and proceeds directly toward the film without striking the eagle. Like waves converging on a beach, the two beams interfere with each other to create new wave patterns. Where the troughs and crests of the two waves reinforce each other, a stronger wave is created—constructive interference. Where the troughs and crests are out of phase, they tend to cancel each other out—destructive interference.

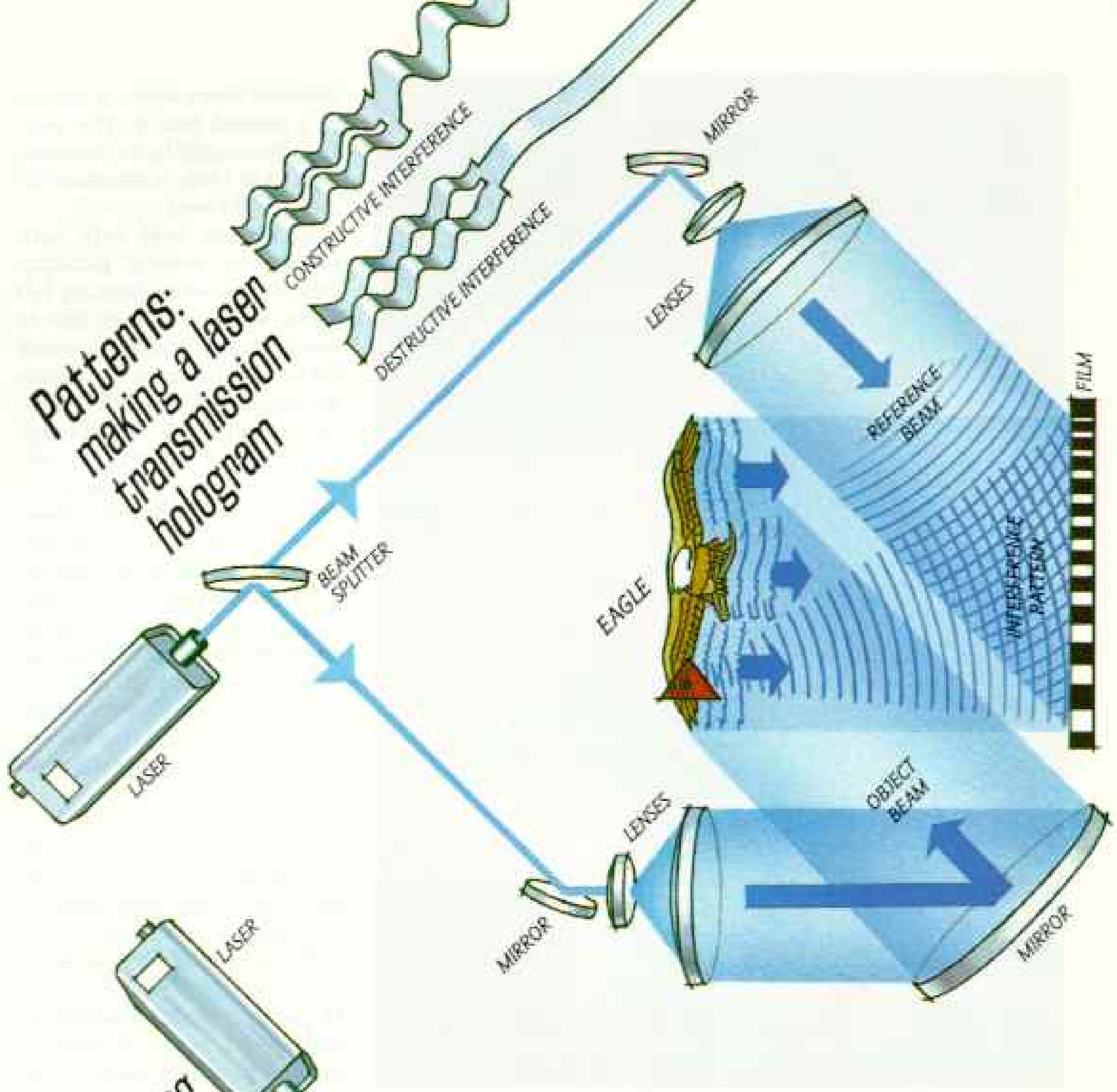
The resulting waves, or interference patterns, striking the film plate expose the photographic emulsion. Light waves from every spot on the eagle, such as its wingtip, indicated by a triangle, interact with the reference beam and are recorded everywhere on the film.

Hence, when the film is developed, the interference pattern—now a hologram—becomes a permanent, three-dimensional record of the infinitely complex light waves that reflected from the eagle.

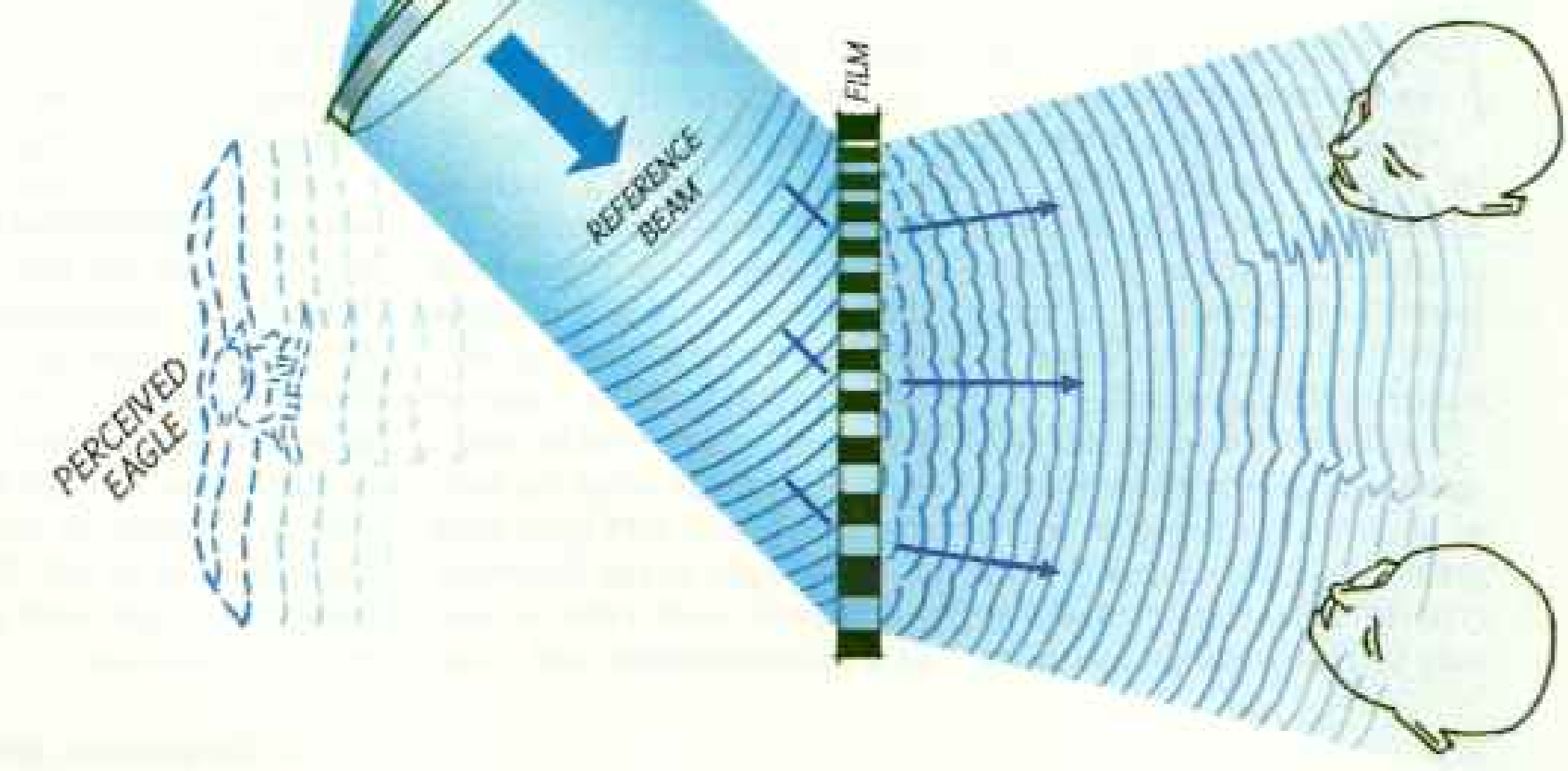
Illuminated by laser light (**right, bottom**), the hologram diffracts, or bends, the light to re-create the original waves. As the light waves spread out, viewers in different locations perceive the waves exactly as they came from the eagle and see it in three dimensions. The eagle appears to be suspended in space in its original location.

PAINTING BY PIERRE NIOM

Patterns: making a laser transmission hologram



Viewing





FACING PAGE: PAINTING BY PIERRE MIGNON

How our cover was made

THE BALD EAGLE you see on our cover began as a tiny sculpture (*above*), produced by Eidetic Images, Inc., in Elmsford, New York. Eidetic, a subsidiary of the American Bank Note Company of New York City, used the eagle to construct the hologram.

The first step in a typical production sequence is the making of a laser transmission hologram (preceding pages). This type of hologram is viewable only by laser light and requires

further refinement for viewing by ordinary, or white, light.

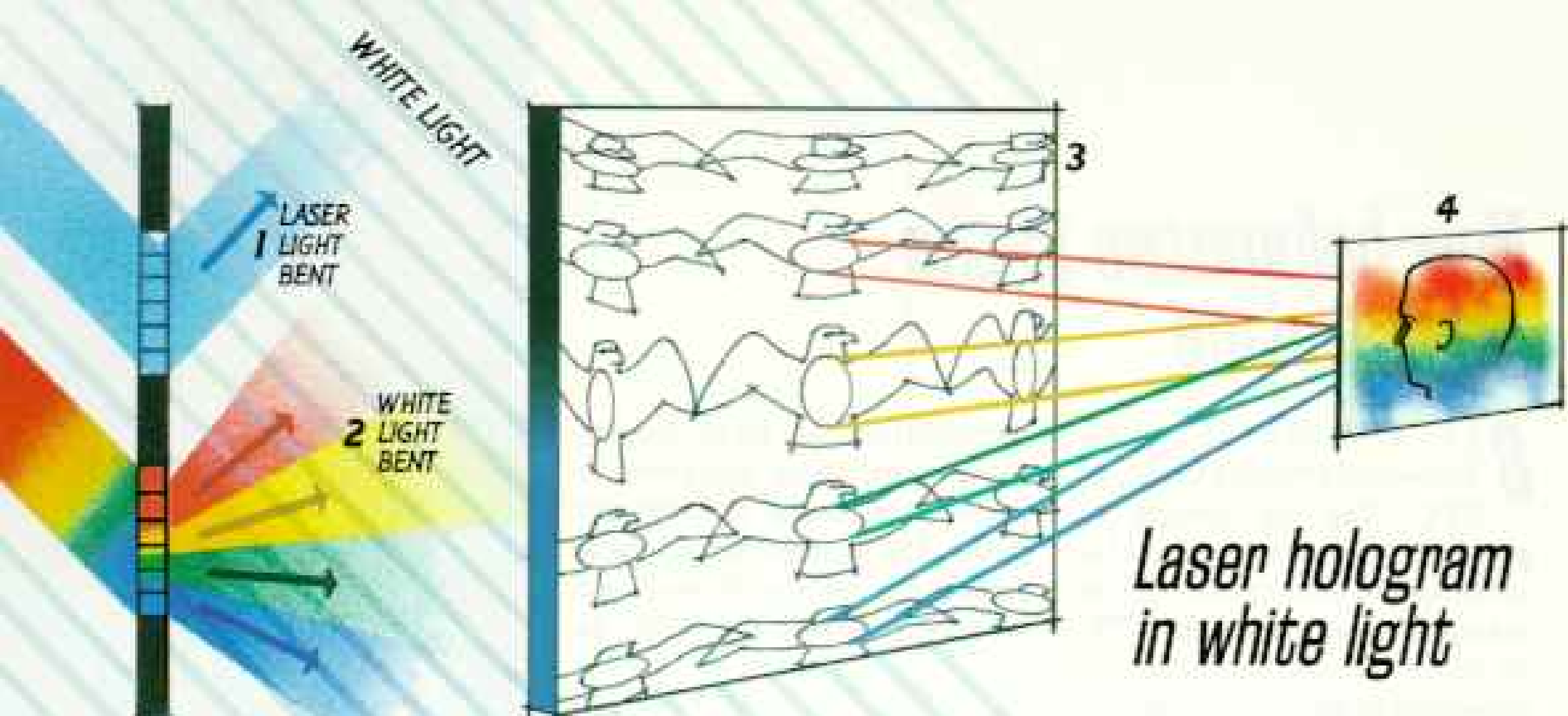
Passing through a hologram, laser light bends in a single direction **1** because it consists of a single wavelength. White light, made up of many wavelengths, bends at many angles **2**. A hologram contains many views of the eagle **3**, each visible from a particular angle when the hologram is viewed with laser light. If white light is the illuminating source, each color is bent at a different angle, and many

different views arrive at the eye as a colored blur **4**. The solution, discovered by Dr. Stephen Benton in 1968, is to reduce the number of views.

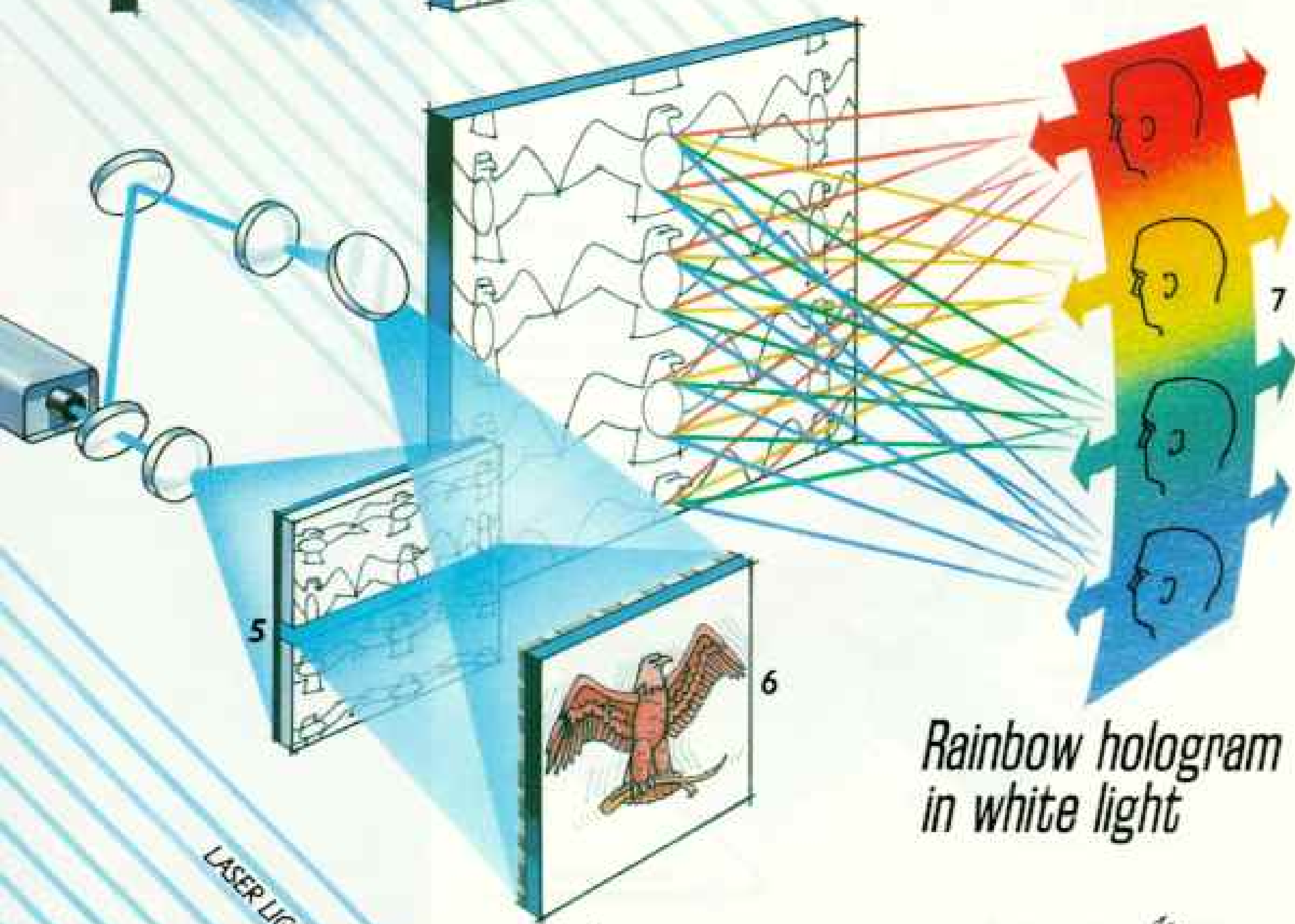
Holograms have both horizontal and vertical parallax. That is, they offer changing 3-D views when seen from side to side or up and down. To reduce the vertical information, the eagle hologram is masked **5**, leaving a horizontal slit through which a laser constructs a second, or rainbow, hologram in the image plane **6**. This allows viewing with a variety of light sources. The slit deletes the angles providing vertical information. The rainbow hologram therefore has only horizontal parallax, permitting 3-D views from side to side and a many-colored spectrum of clear identical images as a viewer's head moves up and down **7**.

To mass-produce rainbow holograms after exposure by the laser **8**, the hologram's special emulsion, called photoresist, is developed **9**, rendering the interference pattern as a series of ultrafine ridges. By electrolysis **10**, particles of nickel are deposited on the ridges to make a mold. The nickel mold **11** impresses the interference pattern into plastic, and a thin aluminum coating is applied **12**. Functioning like a mirror, the coating reflects white-light waves through the interference pattern to create the changing image of the bald eagle model.

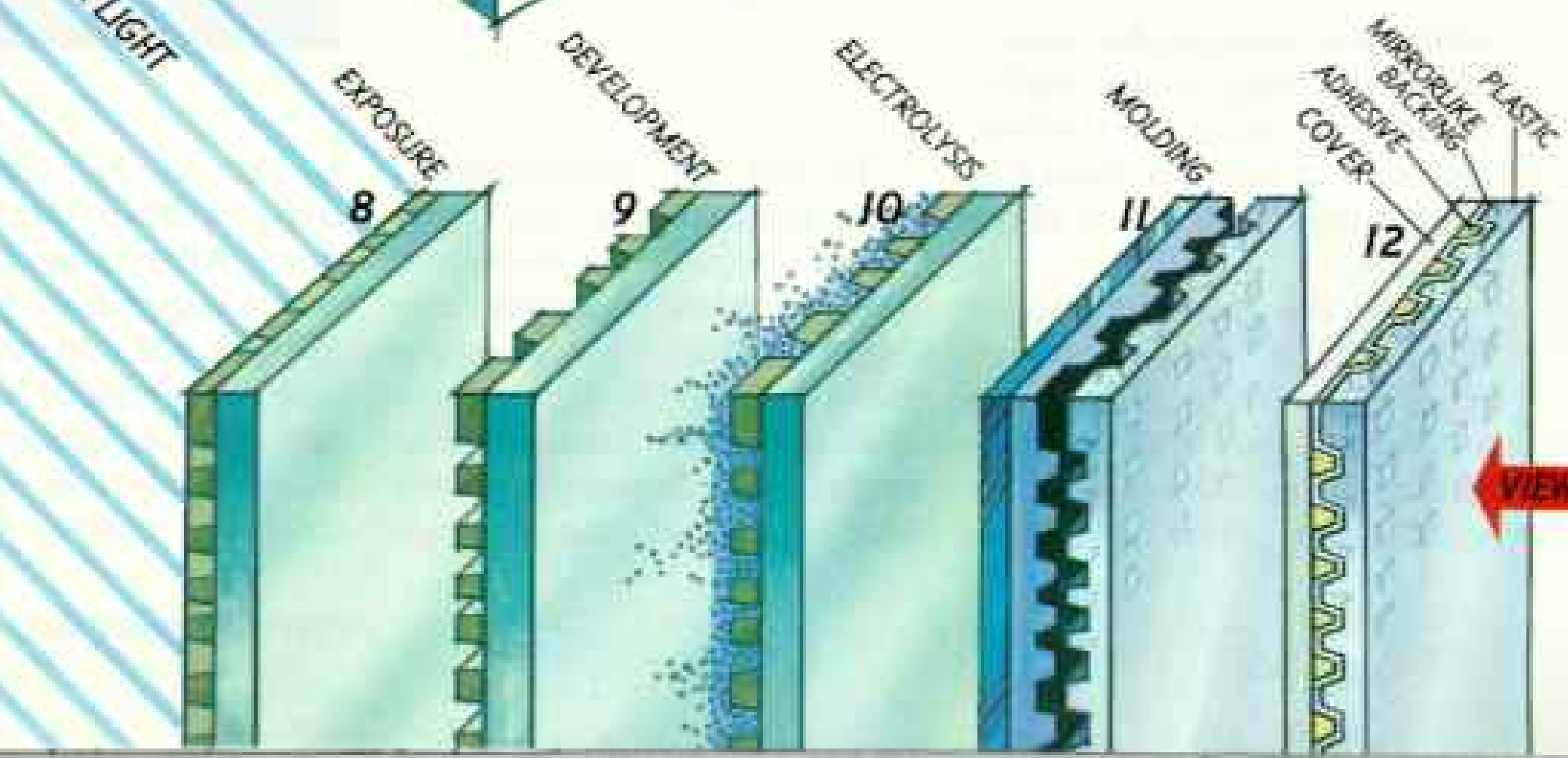
Such a process was repeated almost 11 million times to create the hologram on this issue of NATIONAL GEOGRAPHIC, the first major magazine to reproduce a hologram on its cover. It is best viewed in direct sunlight or light from a single artificial source. Though the sculptured eagle looks to its left, the cover hologram image faces right for heraldic tradition.



Laser hologram in white light



Rainbow hologram in white light

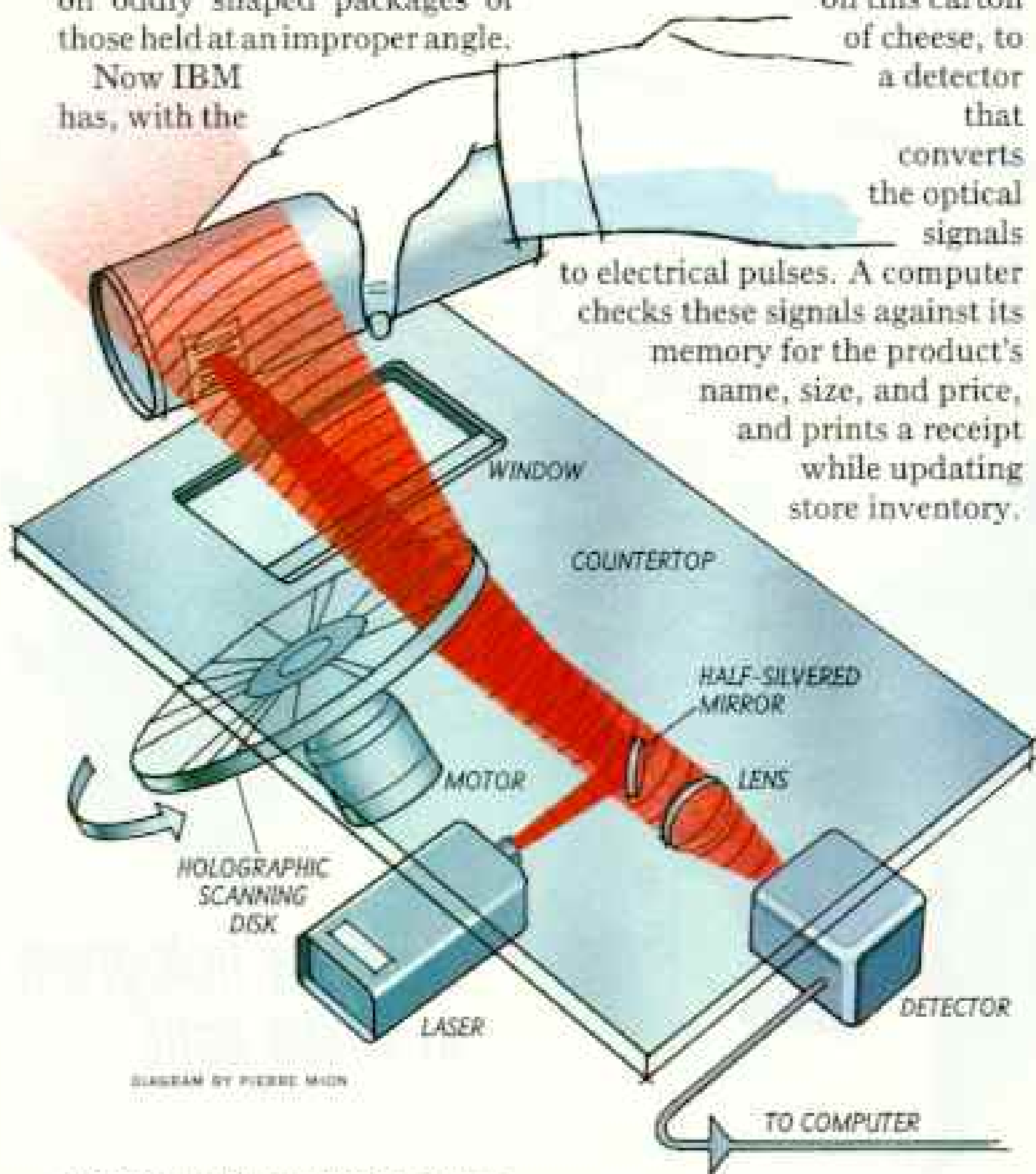


New helpmates in the marketplace

BARS AND STRIPES of the Universal Product Code, or UPC, flag the identity of groceries when scanned by a laser linked to a computer. Early scanners often missed the UPC on oddly shaped packages or those held at an improper angle.

Now IBM has, with the

combination of focal length, skew angle, and elevation to deflect the beam in different paths. On at least one of these sweeps the beam will reach and be reflected from the UPC, as on this carton of cheese, to a detector that converts the optical signals to electrical pulses. A computer checks these signals against its memory for the product's name, size, and price, and prints a receipt while updating store inventory.



addition of holographic lenses, invented a wrap-around reader capable of seeing the bottom and sides of any item passed at most angles over the scanner window.

Inside the checkout counter (*diagram*), a low-power laser beam bounces from a mirror to a rotating disk with 21 pie-shaped facets. Each facet bears a hologram with a unique

To help foil counterfeiters, Visa International has redesigned its cards to include a hologram of its trademark dove (*right*). The photographer made this triple exposure to show the dove from different angles. The hologram covers four digits of the account

number so they cannot be altered without damaging the dove. After losses to counterfeiters leaped from \$740,000 in 1981 to \$11,000,000 the next year, Visa added the hologram and other safeguards. Participating banks will reissue more than 100 million Visa cards





during the next three years. Holograms also lend security to MasterCard and one foreign passport and are being tested for traveler's checks, U. S. currency, and identification cards. In New York City, the Museum of Holography displays such applications of holography.





A pilot's window on the world

FOUL-WEATHER friend for pilots during a landing approach, a transparent holographic combiner mounted in front of a pilot's eyes (*left*) displays in one handy spot vital flight-path information normally found on a variety of instruments. A cathode-ray tube above the pilot's head in a Boeing 727 at Everett, Washington, beams the information

Other symbols give the pilot information regarding the aircraft's course to the runway, its relationship to the earth's horizon, and thrust requirements.

The device, manufactured by Flight Dynamics, Inc., of Hillsboro, Oregon, is called a head-up display because it enables a pilot to fly the entire approach head up, looking through the combiner to the real



onto the combiner.

By means of its holographic optical element, the combiner acts as both a mirror reflecting the green light from the TV tube and as a window to the world outside. Thus a pilot, approaching Everett's Paine Field on a clear day, sees the runway and his aircraft's flight-path information at the same time (*above*).

Here the aircraft is at an altitude of 960 feet, with an air-speed of 122 knots and a rate of descent of 650 feet per minute.

world outside the aircraft's windscreen. Normally a pilot flies an approach to a fog-shrouded runway by monitoring his instruments—head down—and switches to the real-world scene in the latter seconds of the approach to land the airplane.

After certification by the Federal Aviation Administration, Flight Dynamics' head-up display will be approved for foul-weather landing operations where the visibility is as little as 700 feet. □



Unbridled spirits still range in Calgary, whose towering skyline

Calgary: Canada's

By DAVID S. BOYER NATIONAL GEOGRAPHIC SENIOR WRITER

HE DIDN'T LOOK like a cop—not my mental image of a onetime Canadian Mountie, now chief of police for the most macho big city in the Canadian West. He was slender and soft-spoken, tailored in a three-piece pin-striped suit, and innocent of that bristling Anglo-Saxon policeman's badge, the toothbrush mustache. He wore a clean-shaven smile, and wasn't talking drugs or guns or trouble.

Brian Sawyer was telling me about a frontier town that grew up in the foothills of the Rockies, a tough little cow town that won its first set of spurs for a Wild West show still famous as the Calgary Stampede—a dirt-ring rendezvous for men who wrestle steers, ride bareback broncos, and risk death in the chuck-wagon races (pages 398-9).

Long before the Stampede, though, the North-West Mounted Police had staked out



reflects its dizzying transformation from cow town to prairie metropolis.

Not-So-Wild West

Photographs by OTTMAR BIERWAGEN

a post in an unruly wilderness, on a bend of the Bow River. Mountie Col. James Macleod called it Calgary—"bay farm"—a name from his Scottish homeland. The Mounties and the log fort constructed in 1875 were warnings against invading Americans, unscrupulous fur traders plying Canadian Indians with whiskey.

To back up the Mounties came the Canadian Pacific Railway, a thin line of steel

reaching to cross the continent in the 1880s. It was a lonely line, laid by sheer national determination to save the West from the grasp of the Yankees and *their* national determination called Manifest Destiny.

To help lay the rails came Chinese, recruited for the railroad but despised as "coolies" and paid half wages. To settle the land came recruited peasants from Europe. Unpronounceable names still pepper Calgary's



Flaunting the wealth of energy that fueled its growth, downtown Calgary glows long after quitting time. With new high rises linked by elevated covered walkways, office



workers can fend off bone-chilling winter winds. The city issued 6.1 billion dollars' worth of building permits from 1978-1981, when oil-boom euphoria reached a peak.

phone book, mixed with bland names from Britain and, only recently, exotic new names from India and Pakistan, Vietnam, and the Caribbean.

I would listen one day to a Calgarian named Wing Wong, grandson of an exploited coolie laborer. Canada discouraged further Chinese immigration, so Wing and his mother had to wait in China for 20 years—until the Chinese Immigration Act was repealed in 1947—to join the family.

I would talk also with Mary Dover, tall and regal, age 78, granddaughter of Mountie Macleod himself (page 397). By the time she was born here, a new Hudson's Bay Company store was selling ropes and saddles, gingham dresses and groceries from a handsome building on Eighth Avenue.

But right now, police chief Sawyer was going ahead with his story: About a cattlemen's town reinvented in the 1940s and '50s by oilmen, many swaggering in with a Texas twang, developing a bonanza of gas and oil up and down the province of Alberta, some of it within Calgary's city limits. About a conservative, free-enterprise city that, during the oil boom of the seventies, parlayed rising prices and tides of newcomers into an explosion of wealth and an extravagance of gleaming glass skyscrapers, shimmering across the prairie like a mirage. The oil executives and bankers in their galaxy of office towers and penthouse suites have taken Calgary on a wonderful, precarious ride, at times uncontrollable and, more recently, traumatic.

Thus, the capital city of the Canadian Oil Patch. (Pronounce it *CAE*-gree, please.) It's the heart of the newly rich Canadian West, its most startling symbol, its fondest hope.

THE WEST, for a century dirt-farm poor and ignored by the more industrialized eastern provinces of Ontario and Quebec that control Canada, has lately begun to sway the nation's entire economic structure. And that has drawn the earnest attention of lots of eastern Canadians, who voice pride and concern.

Calgary's new high-rise banks and oil-company skyscrapers, sandwiching the towers of investment and insurance companies, are home base for a flamboyant collection of Canadian millionaires and big

consortia and astronomical contracts, all representing incalculable consequences for Canada's political future. The West has recently been hard hit by recession, but its continuing sense of power, centered in Calgary, stands in ongoing confrontation with the federal government at Ottawa, over taxes and prices and freight rates and socialistic policies. For a century there has been alienation, and even talk of secession, though separatist sentiment has now receded.

The western dynamo shoots out sparks from Calgary, by plane and phone and computer and satellite, to every corner of the nation and, indeed, the world. And now Brian Sawyer was telling me how he perceives this hustling delirium of 620,000 people, and more than half as many cars, and their new houses and condos grazing out in all directions like the undisciplined herds of buffalo that once roamed these hills and prairies.

Out the window over Brian's shoulder, as a stage backdrop for this whole improbable scene, rose the serrated wall of the Rockies, etched in snow and ice, jagged as a giant bread knife along the western horizon.

"Nobody can claim credit or take the blame," the chief was saying. "This city just exploded. We didn't know what hit us.

"Yes, crime did go up faster even than the population—crime and drinking and divorce and suicide. For ten years we averaged 58 new Calgarians a day—an inundation of money-hungry people from everywhere. What can you expect when strangers pile in on each other like that? You can see for yourself what we had here. Uncontrolled growth.

"It has all cooled down now—including, I'm happy to say, the crime. Our timetable has been stretched out, but we could still be the prototype 21st-century city of the planet. The slowdown, meanwhile, is making the place more manageable and more livable."

Brian gestured out at the old sandstone City Hall. Rising next door was its fairy-tale replacement—all glass, stair-stepped, and a block square. Cloistered in the old building, however, Mayor Ralph Klein and his aldermen had painfully cut nearly 150 million dollars from the city's 1983 budget.

"The recession and the oil slump," Brian said, "have been very tough. But this city, the whole West, will rise again. We've got

nothing out here but oil and gas and coal, uranium and silver and gold, beef and grain and timber, brains and experience and expertise, money and optimism and guts. All things that Canada needs. The world needs. There's nowhere to go but up!"

IN EARLIER DAYS Calgary was run by men who had made their fortunes in ranching. Gentlemen, for the most part. They invented their own aristocracy; their Calgary meeting place: the Ranchmen's Club.

Later came the big oilmen, mainly from across the line, men with Texas accents, technologies, and New York banking connections. Some 20,000 Americans occupied the city at one time, *their* aristocracy welcomed into the Calgary Petroleum Club and the Canadian Petroleum Association (CPA). And, just to lower their profiles a bit, Canadianized.

At a meeting of the CPA board of directors, so a story goes, a member surveyed his colleagues, nearly all of them from the United States, and in a deep drawl said: "Well, boys, y'all know that a lot of us Southerners have become Canadians. M'self now, I'm carryin' a Canadian passport. An' I believe that y'all may be too." He asked for a show of hands from all Americans. One hand, only, went up. "Y'see? Ain't hardly nobody here but us Canadians!"

Calgary today has become a melting pot, and tomorrow's leaders could be anybody—oil-field roughnecks, blue-collar workers, ethnics from anywhere, eastern moneymen from Toronto and Montreal, high-tech mathematicians, petroleum geophysicists. Oil aristocrats notwithstanding, democracy works in this city.

Ralph Klein is an example. Offspring of a farm-immigrant family from Germany, he started out at City Hall as a TV reporter, began to sense the swing of things, made friends, got himself elected mayor. "His Worship," at age 38, a man of the people—a new mayor who, at first, was spoken to only by the kitchen help at the Petroleum and Ranchmen's Clubs.

"From boom to recession. Like riding a crazy horse, this job," Ralph Klein said to me, two locks of hair falling crossways over



DRAMA BY RANCOY MURRAY, COMPILED BY JIHA S. TREIBER
NATIONAL GEOGRAPHIC CARTOGRAPHIC DIVISION

FOUNDED as a North-West Mounted Police outpost and linked to the East by rail in 1883, Calgary flourishes from proximity to the vast deposits in Canada's Oil Patch.





Bending the ear of Mayor Ralph Klein (left) is as easy as dialing the phone. During his Saturday morning radio show, Klein often listens to routine complaints about traffic hazards and junked autos. One resident, upset over stray cats, suggested that they be licensed. When told that an English law enacted by King Henry II prohibiting the licensing of cats was still on the books, the caller had a simple solution: Since horses are licensed, merely pass a bylaw stating that, in Calgary, cats are horses.

While traffic rushes through the glittering canyons of the new downtown, Calgary encourages an unhurried appreciation of the old. The city created a pedestrian mall along a three-block stretch of Stephen Avenue, formerly Eighth Avenue, the original shopping district. In front of the 1929 Hudson's Bay Company store (below left) benches invite people-watching as a statue entitled "Conversation" depicts the perpetual Calgary pursuit of talking business.

For ten days each summer, Calgarians put away their business suits in favor of jeans and ten-gallon hats during the Stampede, billed as the world's largest rodeo. After a free chuck-wagon breakfast of flapjacks and bacon, square dancers whoop it up downtown.



his forehead. He still looks more like a TV reporter than a His Worship.

From the mayor's modest suburban bungalow to City Hall, we were riding the trolley—Calgary's unfinished Light Rail Transit (LRT). He hopes that it will become the 750-million-dollar solution to the bumper-to-bumper traffic. Downtown the LRT is free, to get you to leave your car home; elsewhere, a 90-cent fare on the honor system.

"This city," Mayor Klein said, "intends to be world class."

Eventually the downtown core will be indoors and upstairs. Nearly half its buildings are already linked by Plus-15s—skyways 15 feet over the traffic. If downtown doubles in size and if Plus-15s quadruple, as envisioned, a February lunch hour of the future will be rivers of office workers in shirt

sleeves and dresses, flowing for miles through channels of second-story shops and restaurants and theaters, banks, apartments, and condos.

"The oilmen decreed it that way," the mayor confided, "so that they could meet their bankers for lunch without taking coats or hats."

We had left the trolley and walked to Stephen Avenue. "We did preserve a little of our heritage here," the mayor said.

Well, a little. Stephen is the only avenue that is partly protected from the advance of the sterile skyscrapers. Here on warm spring days the Plus-15 promenade pours out-of-doors, flowing past old-time two-story buildings and street-level shops. No cars, only pedestrians. And a mile-long mall that will tunnel right through the giant new city



hall. Benches and tables and wandering musicians among the trees.

A civilized avenue.

The others are mostly one-way rivers of traffic, roaring through canyons of glass.

In a taxi navigating me down the rapids of Fourth Avenue, a young cabbie from Manitoba offered a vote for Calgary's weather. "Mind you," he said, "it does get cold. Maybe even 30 below, like Winnipeg. But dry. And not much snow. Falls in the mountains before it gets here, eh? So you don't get ice-covered streets. Even if you do, it'll start chinooking and melt 'em all off, eh?"

"Eh?" is a Canadian ending for any sentence; the chinook is a warm wind from the Pacific. Rushing down across these foothills, it can sometimes shoot the mercury from minus 22°C to 3° above in two hours

Early dusting of snow brings a taste of winter to Calgary, which sits at the foot of the Rockies. First burgeoning as a cattle center, the city now boasts a sleek skyline dominated by the 52-story Petro-Canada tower. Railcars of sulfur, a by-product of natural gas, head for docks in Vancouver. Across the tracks, beyond the bubble-topped Lindsay Park Sports Centre, stands the Olympic Saddledome, site of the 1988 winter games.

Among Calgary's sizable community of transplanted Americans, Smiley and Bernice Raborn (below) were lured from Oklahoma by a post-World War II oil boom. Raborn became chairman of CanDel Oil Ltd., and helped create TransCanada PipeLines Limited.





Bringing continental flair to Calgary's artistic community, Hungarian-born Arpád Joo (above) coaxes the best from prodigy Helen Kim at Mount Royal College. Joo works with gifted young students between engagements as principal guest conductor of the Calgary Philharmonic Orchestra, which will move into the 75-million-dollar Calgary Centre for Performing Arts next year.

Stern but graceful taskmaster, Madame Regina Cheremeteff (right) coaches her young charges at the Calgary Russian Ballet School. A native of Germany, Madame Cheremeteff began dancing professionally at age nine. At 18 she married a Russian count and performed with him in a Cossack trick-horse-riding troupe until his death in 1943. After moving to Canada in 1955, she set up shop in Calgary and now instructs some 150 students.





before lunch. Instant springtime, eh?

"A few years ago," my taxi-driving refugee from Winnipeg said, "I was picking 'em up with their golf bags and tennis rackets on Boxing Day. It was like June, eh?"

Boxing Day is December 26, a Canadian holiday that observes the old English tradition of boxing up food and clothing and unwanted Christmas gifts. "T' t'yke 'round t' th' tradesmen, y' know," an old ethnic from England explained.

BUT ETHNIC is no longer the word for British or Americans. Most of them long ago blended with Calgary's other immigrants. Only the Canadian Indians and the Chinese, in one of Canada's largest Chinatowns, have remained visible. Until, that is, the newcomers from Asia of the 1960s and '70s: Indians and Pakistanis, who became the city's taxi drivers, and Southeast Asians, the new cooks and waiters and maids in the hotels.

One quiet night when crime seemed on holiday, I rode in a squad car with Constables Dennis Teters and Norman Manyfingers. Manyfingers, of the Blood tribe, is Calgary's only Indian policeman. In almost deserted downtown streets, Chinatown's restaurant district was still animated.

At dark Calgarians retreat to their suburbs.

"But sometime we hope to open the Plus-15s at night," Dennis said, "to bring the city alive again. Then, we'll be patrolling indoors, on foot."

"Most of us have to spend the weekdays in town because we need jobs and money," Norman said. "But nights and weekends many go back to the reserves."

I knew. I'd met Alex Scalplock, a Blackfoot and a guard at the Glenbow Museum. The Glenbow has a superb Indian collection, though Eric Harvie, the oil millionaire who gave Calgary one of the finest museums in western Canada, managed to collect everything from medieval armor to World War I machine guns.

"I like the job," Scalplock had told me. "But the city has no freedom. On the reserve I can play my drum and sing a beautiful song under the moon, and nobody calls the cops."

Of the several Indian reserves near Calgary, the Sargee is closest; in fact, the two share the city's southwest boundary. "It's a mixed blessing," Chief Clifford Big Plume told me at the tribe's new rodeo arena. "We've leased some land as high as \$50,000 per building lot. But our kids are too exposed to the liquor and drugs of the city. We're trying to get them back into ranching and rodeoing."



It isn't only Indian cattlemen whose lives have been affected. Hundreds of white ranchers have sold out superb cattle range to the housing developers.

"This was our town," cattleman George Anderson told me, "till the oilmen took over. Now they run the Ranchmen's Club and even the Calgary Stampede."

George's voice was plaintive: "The Stampede grounds aren't what they used to be. They have so many trade fairs and auto shows now, and it's all just for tourists."

George is also a cattle auctioneer, and he was heading for a flight to auction cattle in the United States.

RECSSION DIVERTED Calgarians' minds from skyscrapers and expansion. There is new emphasis on the quality of life. A 75-million-dollar Calgary Centre for Performing Arts is going up, with three theaters and a new home for the Calgary Philharmonic.

In a rehearsal hall at the University of Calgary I met the city's best recognized ethnic of all: Árpád Joo (pronounced Yoe), an immigrant from Hungary (page 388).

I watched him playing the piano while conducting the orchestra with his head and eyes. Slight and slender and calm, when he

takes baton in hand he becomes a willow in a wind of sound. Árpád is international: He carries an American passport, lives in Calgary, and has been a guest conductor in London, Amsterdam, Budapest, and several cities in the United States.

He invited me to Calgary's Mount Royal College, where he teaches master classes for gifted young musicians. His assistant for the occasion: Kálmán Berkes, first clarinetist of the Budapest Philharmonic.

"Kálmán flew in from Hungary Friday," Árpád said. "It's his third day in North America, ever. Forgive his English."

On piano and clarinet the two performed a mini-concert, then took turns critiquing the students' solos, Árpád translating Kálmán's Hungarian. Having played her flute and heard Kálmán's critique, a girl with blond hair and knee-length wool socks returned to the audience and sat by me.

"What did he tell you?" I asked this 14-year-old. Her name was Rhian Kenny.

"To demonstrate more happiness in my harmonic changes," she replied, "and to make my staccatos more staccato."

Did she know anything about her critic, I wondered, impressed by her aplomb. "Well, two things. He's 31 years old, and he's the best clarinetist in the world. Árpád himself

Feelings of self-worth rise at Crowfoot Sunrise Residence (left), an alcoholic treatment center for those of Indian heritage. Counselor John Little Light asked members to imagine themselves on an airplane that will crash unless some jump out to reduce the weight. "The ones who volunteered often had a low self-image," he said. "We found out who was hurting the most and why." By watching videotapes of sessions, clients study how they appear to others.

At Calgary University's Foothills Hospital an anesthetist checks the display screen of a hemodynamic tracking system during surgery (right). Manufactured by Global O. A. Systems Inc., the micro-computer monitors blood pressure, cardiac output, temperature, and other vital signs.



Dressing up an old neighborhood, owners of a row of turn-of-the-century Edwardian homes being converted to apartments (below) chose boldly unconventional color schemes. The initial reaction was decidedly mixed, recalls property manager Tom Squires. "As I began painting the first one, someone called the police and said I was vandalizing the property." Now affectionately called the "painted ladies," the houses have inspired similar paint jobs in nearby areas.

For "purely sentimental reasons" Sam Mahood (right) is restoring his boyhood home, an 1890 log house, now covered with siding, just west of town.

Nine Mahood children grew up there, on the farm bought by their parents after emigrating from Ireland in 1912. Despite nearby suburban growth, Mahood and his sisters, Kathleen and Harriet, refuse to sell their 135-acre dairy operation. Developers have made lucrative offers, Mahood said, so "there must be a stubborn streak in us."

Pushing toward a seemingly limitless expanse, Calgary's suburbs grew to accommodate an influx that took the city from 243,000 in 1960 to 620,000 today. With the oil market slumping and construction down, the city looks for an economic boost when Calgary hosts the XV Olympic Winter Games in 1988.





will be one of the best conductors in the world too. He's only 35."

When last I saw the two Hungarians, they were off to teach at the Banff Centre of Fine Arts. To Banff, 75 miles west of Calgary, from many countries come hundreds of students and faculty artists—instrumentalists, vocalists, composers, conductors, painters, dancers, actors. Secluded on a mountain overlooking Canada's second ranking tourist town (after Niagara Falls), they pursue their arts and sometimes take their performances to Calgary.

Whether for culture or climbing or skiing or just looking, millions of people crowd through Banff every year, and en route most of them pass through Calgary.

Árpád and Kálmán each owe something to a compatriot. Joseph Sefel, a Hungarian refugee in 1956, is now a Calgarian millionaire. After several ventures here, he made his fortune in geophysics and business. His private jet brought Kálmán from Budapest. Sefel Records is only one enterprise of this remarkable new Canadian. Six of its best-selling stereo discs are of Árpád conducting world-renowned orchestras.

"I'm more interested in music than money," Joe told me. "I love to help talented people contribute to culture in my new country. Canada, you know, is a wonderful place. Except for Ottawa."

He sat behind a mammoth desk—elegant in pin-striped blue suit, diamond rings, massive coiffure of jet black hair, explosive gray

sideburns—enormous and powerful, yet his voice was soft and quiet. He seemed a strange giant from some children's book.

He was one of hundreds of free-wheeling Calgarians with little good to say for Ottawa. "We're fighting socialism in Canada, you know. The eastern Liberal government of Pierre Trudeau. I can admit only that it beats fighting Communism in Hungary."

SOCIALISM?

In the conservative West you hear the word often. In Calgary, particularly, it refers to taxes and price controls and royalties and regulations on the oil industry. And the restricting of foreign companies, buying of others: Canadianization takeovers. Oilmen believe Ottawa has alienated foreign investors and crippled some Canadians in the Oil Patch as well.

Carl O. Nickle, president of Conventures Limited, an all-Canadian company, is Calgary's oil patriarch.

"Canada probably has more latent energy than OPEC," he told me. "But our bickering over whether or when or how to try to become a world power in energy has been a farce. Trudeau's National Energy Policy was bureaucratic, antiwestern, and ill-advised. The feds spent billions buying out foreign companies, at terrible prices. Federal taxes and provincial royalties were raised unconscionably.

"Even before the oil glut," he continued, "it was a disaster. We may have to go



Keeping tabs on the competition, oil companies have no qualms about using scouts, the industry's term for spies—a legal but sometimes dangerous profession. With only his dog Sam for company, free-lance scout Doug Abell lives in his camper for weeks on end as he haunts the oil fields of Alberta, British Columbia, and Saskatchewan. A spotting scope helps Abell count the joints of pipe as they are pulled from a well to determine the depth of drilling.

through another oil crisis before we wake up. We've got to get some of our big, long-term energy projects going again."

Several multibillion-dollar oil megaprojects have collapsed in the Canadian West over the past few years. Not far out of Calgary, however, on a screeching, pounding drill rig, among a bunch of mud-covered, long-haired roughnecks in cold-weather gear and hard hats, I learned that there were still some solid winners. Here I met a blond man with a childlike smile and a Dutch accent. His clothes were clean. He couldn't be one of the crew.

"I'm the geologist," he admitted. "And the engineer. In fact, I own the well."

Ed Koetsier also admitted he slept in his car, engine running and heater on, between tests and calculations to see whether the \$200,000 he was putting into the well would pay off. It did. He's one of Calgary's surviving millionaire independents. Some were swept away by taxes or takeovers or high interest rates or falling prices. A few went under in the surge of speculation. Expanding too rapidly, borrowing too deeply, overreaching on takeover attempts.

WHAT'S HAPPENED to U. S. companies, and the Americans who built so much of Calgary? Well, they've been Canadianized. Some American companies have pulled out or sold out, some American executives replaced by Canadians. The trend to dispossess foreigners hasn't made them happy, but they saw it coming.

Canadianization. It's today's password in a country long owned largely by outsiders. Foreigners, mostly Americans, once controlled 90 percent of Canadian oil and almost as much in automotive manufacturing and other industries. Today Petro-Canada is a cornerstone of Canadianization. This new federal energy corporation, now one of the nation's largest, has two new skyscrapers in Calgary. Socialized oil.

NOVA, once only a pipeline company but now the second ranking gas-and-oil conglomerate in the private sector, reflects the same trend. It was built by Bob Blair.

When Blair's short-cropped white head is lowered, it looks rather like a buffalo's: formidable. The gleam in his eye is reasonable

though, and his Scottish burr is reassuring.

He gestured out the windows of his presidential suite atop NOVA's new 36-story tower: "Those skyscrapers out there—mostly U. S. and foreign owned in the beginning. Your oil industry and banks helped us years ago when our own investment institutions wouldn't or couldn't. But today I'm in favor of Canadians' recovering some control over our own nation's economy. Even if that's somehow considered anti-American."

If more Calgarians are joining the chauvinistic struggle to control Canada for themselves, in the process there may also be a softening of their image as male chauvinists. Equal rights for women haven't yet penetrated the Petroleum Club, but when they do, Dianne Hall, senior vice president for NOVA, probably will be the first lady allowed in for lunch. She is the most elevated businesswoman in town.

Dianne is the daughter of a Saskatchewan truck driver. She went to work at age 16, and reached a top-floor office in 25 years.

"We've had some nice changes in town lately," she told me over coffee in her white-carpeted office. "Calgary has begun to accept NOVA and Canadianization, even to some extent Petro-Canada. Also, the recession cleaned out some of the operators who came because of the boom. The city is back in the hands of professionals. We're doing business again with a handshake or a phone call, in the tradition of the Canadian West."

SOME DEMOCRATIC NOTIONS do come out of the Petroleum Club. That's where I talked with Harley Hotchkiss, geologist and oil independent, also self-made. (A friend told me that Harley went through all the grades of a one-room country school without owning a pair of shoes.)

Harley and some business associates bought the Calgary Flames ice-hockey team from an owner who had to sell because of the falling real estate market.

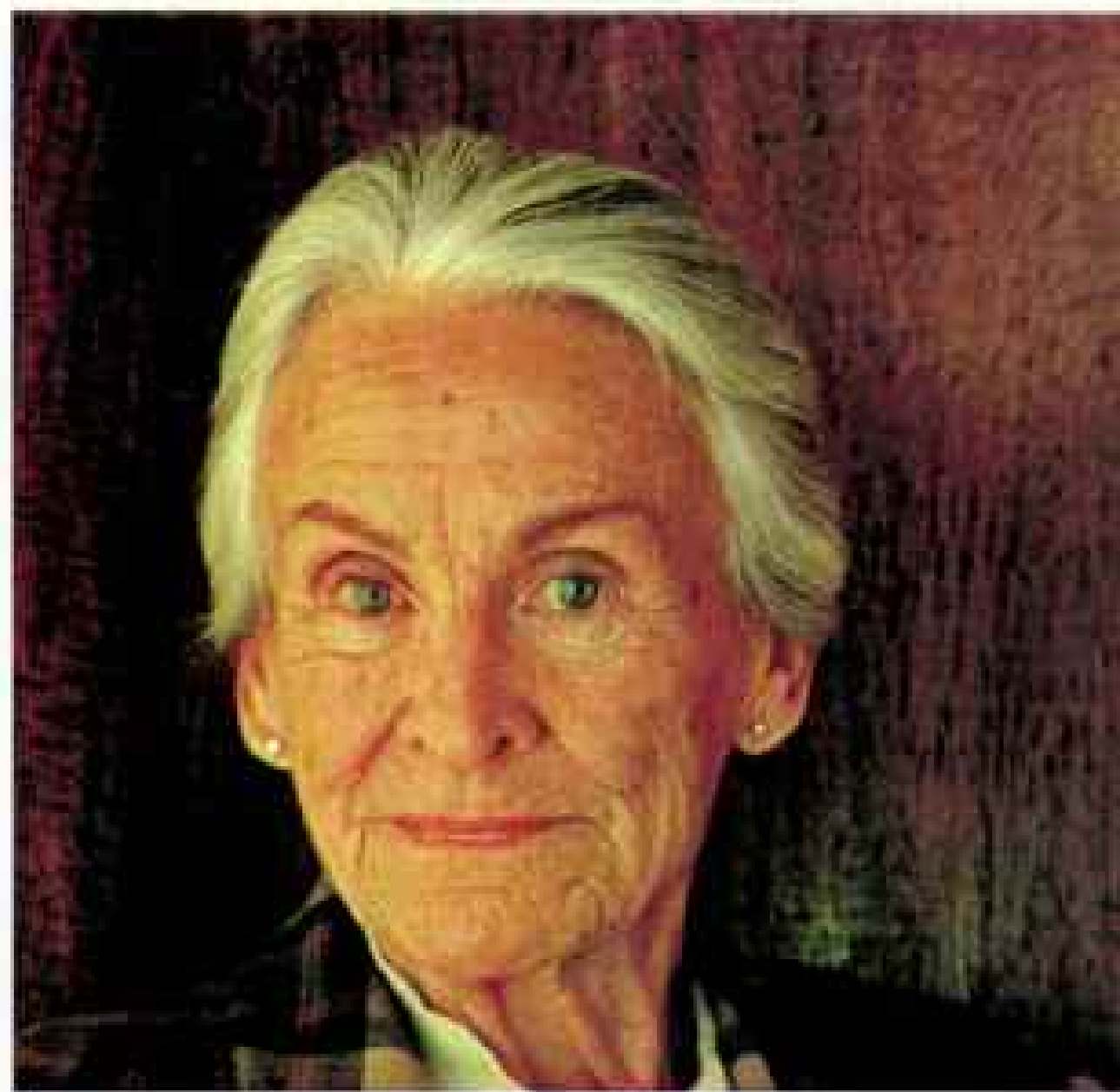
"For a year or more we had to struggle," he confided. "But all of us loved hockey, and we wanted to keep a National Hockey League team in Calgary. Now that the team is in the new Olympic Saddledome, they're inspired. We'll put the profits into scholarships and Olympic hockey. Calgary's been



Small armada of private craft (left), including a Boeing 727, keeps Calgary business officials in close touch with their far-flung interests. Most planes hangared at Executive Flight Centre, Ltd., belong to oil firms but bear no company name to avoid tipping off competitors about exactly where those interests lie. "There's a certain amount of stealth involved," says Executive Flight president Ken Lett, "a tendency to play everything close to the vest. Pilots will often say, 'Don't ask me where I'm going because I can't tell you.' " The

number of planes sitting idle in the hangar is an indication, says Lett, that Calgary's boom days are easing into "a more conservative period."

Few Calgarians have seen more of the city's ups and downs than Mary Dover (below). Granddaughter of Col. James Macleod, who named the city, Mrs. Dover was born in July 1905, two months before Alberta became a province. Mrs. Dover has served four two-year terms on the Calgary City Council and remains active in cultural organizations.



Elegance went west when stockbroker Philip L. Heimbecker and his wife, Gayadelle (left), moved from Winnipeg to Calgary—and took their home with them. Built on Winnipeg's exclusive Wellington Crescent by Heimbecker's grandfather, grain magnate Norman Heimbecker, the house was completed in 1906 and appointed with European antiques by his grandmother. Philip Heimbecker offered to sell it at a fraction of its worth to the Manitoba government for use as an official residence but was turned down. He then had the house—including its 11 fireplaces—dismantled brick by brick and reconstructed on a hillside west of Calgary, a process that took five years.



Hell-bent for victory, drivers jockey for position as they thunder around the bend in a chuck-wagon race held during the Stampede. The competition



originated, according to one legend, when the last crew to reach town was stuck with buying drinks. Entrants now vie for nearly \$200,000 in prize money.

good to us, and we want to return the favor."

Hockey teams and figure skaters from around the world will meet in the Saddledome, the city's new 17,000-seat ice palace, in 1988, when Calgary is host to the XV Olympic Winter Games. Even the luge and bobsled runs and the ski-jumping hill will be within the city limits.

Money to expand facilities at the University of Calgary for the Olympic Village, where the participants will live, comes from the deep pockets of the Alberta government at Edmonton—pockets that help many causes. Alberta is the most solvent province in Canada, with 13 billion dollars in a Heritage Savings Trust Fund. Derived from the heritage of oil and gas, it is dedicated to improvements for the future.

Nearby, the fund is helping a giant new high-technology research and development park. At the university itself, nearly 15 million dollars a year polishes the city's image as a mecca for medical research.

"We can pay to hire top people from across Canada, the U. S., and Europe," Doctor Veale said.

Doctors W. L. Veale and K. E. Cooper offered me a cold Canadian beer in the faculty restaurant, looking out across a campus of superb modern buildings. These two researchers, past and present heads of the physiology department, have found a substance in the brain that may help control brain damage caused by fevers and convulsions—without the side effects of some drugs used today. Their work on hypothermia, too, may help save the lives of skiers, climbers, and outdoor workers across a cold country.

GEOPHYSICISTS are the big high-tech professionals of Calgary. A thousand of them are headquartered in glass-walled beehives downtown: scientists whose electronic data, from seismic explosions in the field, reveal the earth's stratigraphy; their computers and their analysts can detect locations for oil and gas that would otherwise never be suspected.

"You're not allowed to photograph these synthetic sonic logs," the dean of geophysicists, Roy Lindseth, told me. "They're confidential. They belong to oil companies in Norway or Indonesia. Here's

one, though, that has been released."

Across an entire wall was a computerized color picture of 15,000 vertical feet of Brazilian geology. His finger traced the profile of an ancient riverbed. "Filled with sediment a hundred million years ago, it was once as deep as the Grand Canyon."

Roy is president of Teknica Resource Development Ltd. and past president of the international Society of Exploration Geophysicists. He showed me one computer that fires 1.4 million jets of ink onto a whirling drum every second.

"We feed it seismic data from this other computer," Roy said. Swiftly it pictured a layer-cake slice of the earth, so readable that even I could see possible oil or gas pockets.

"This opens a new era in locating energy reserves around the world." Next morning Roy would carry a suitcase full of his color logs to Australia, Indonesia, and Africa, then on to the Middle East and North Sea.

WHILE MANY CALGARIANS like Roy keep in close touch with the rest of the world, many visitors from the United States seem oddly ill-informed about Calgary—or Canada, for that matter. There are stories about Americans who arrive in July with skis, snow tires, parkas, and gloves. Most Canadians are too polite to want to be quoted. But one uninhibited young waiter, Craig Ihme, sat himself down at the table in his quiet neighborhood restaurant and couldn't stop talking, except to get us more coffee:

"You think we're just like you Americans, eh? Well, in some ways maybe we are. We've got your U. S. channels on our TV. Most of our magazines come from across the line. We travel in the U. S. for our vacations. We are Americanized. But we're still Canadians, eh? With our own history and culture. And strong national goals.

"You don't know about our climate or about how most of us feel about the East and Pierre Trudeau. You don't realize how upset we are. From the entire West, he holds only one Liberal Party seat in parliament."

Alberta's premier, native Calgarian Peter Lougheed, epitomizes western sentiment. A nationwide poll in late 1982 ranked him the most popular political figure in Canada.

In his high-rise Calgary apartment the

premier decreed that I call him Peter and showed me his view of his hometown's skyline. Then he talked of the Canadian West:

"After what we've accomplished in ten years here, Canada will never again be the same. We've acquired some significant influence in national policies. The governments in the East are going to have to become reconciled to a new kind of nation—a Canada in which the western provinces play their proper role. A Canada in which the West is recognized for its contributions.

"For too long we've had too little to say about the country's directions. But now

we're determined about the future. There'll be a big change in the next national election. Meanwhile, we have to get Calgary and Alberta and the West ready for it."

Canada is watching Calgary and Alberta closely, and the entire West. And Peter Loughheed too. He could have run for the national leadership against Trudeau. He elected to stay with Alberta, "through the bad times as well as the good." He may still figure in the future fireworks of his country. He's only 55.

My last day in town I had lunch with my favorite Calgarian, queenlike Mary Dover,



Glamour on wheels: Donald Michalkow, owner of a beauty salon, the Box Office, puts the final touches on a new hairdo for Karen Murray. After moving from Edmonton in 1980, Michalkow lacked garage space for his prized Harley Davidson. "It was a shame to see snow pile up on it," he said, so he wintered it at work, where it attracts the avant-garde elements of his clientele.



Saturday morning saunter takes Helene and Camile Savard and friends through a new subdivision. The Savards rent a nearby farm to stable their horses. Whether the land will soon sprout condominiums may hinge on the ability of Calgary's oil-dependent economy to avoid a prolonged stall and pick up where it left off.

Her grandfather on one side was Mountie Macleod, who named Calgary. On the other side, her father, cattleman A. E. Cross, helped found the Calgary Stampede. She herself has taken constant part, for years as a member of the city council, for all her life as a lady who gives herself to her city at the Glenbow Museum and on radio and TV.

A man with long braids and Indian jewelry came to our table to pay his respects to



Mary Dover. He was George Calliou, a Cree, Petro-Canada's Coordinator for Native Affairs. He is a good friend, for the many causes she has championed include a strong concern for the welfare of Alberta's native inhabitants.

Mary Dover is a Calgary elder statesman. (She prefers that to stateswoman.) Now she gave me her assessment of the future:

"This recession has hurt a lot of us. The

unemployment, bankruptcies, scaling back of our long-range hopes and plans. But today we are sensing this city's texture, its quality, not just its dollars. We have a tradition of education and culture, and concern for people, newcomers as well as Indians, children as well as oil executives.

"Calgary is going to be more than just the city that leads the West. It's going to be a better place to live." □

They're Killing Off

SOMETIME in the late 1970s half the white rhinoceros population of Uganda suddenly disappeared—a single rhino, probably shot by a gang of poachers. At the time, nobody realized that it was one of only two left in the country.

For almost eight years Uganda had been in chaos. Idi Amin was struggling to stay in power, tens of thousands of citizens had been murdered at his command, and the ordinary people of Uganda were frightened and hungry. To shoot any animal for food or

needed cash was perhaps understandable.

Today, as one would expect five years after the overthrow of Amin's regime, Uganda's wildlife is in less critical condition. But even with reduced poaching, there is no hope for white rhinos here with only one left, and now even the black rhinoceros, smaller cousin of the white, may be on the final lap toward extinction in Uganda.

Always more numerous than the whites, black rhinos were also thought to be considerably less vulnerable to poaching



the Rhino

By ESMOND BRADLEY MARTIN

Photographs by
JIM BRANDENBURG

because of their greater wariness and their tendency to keep to thick bush. Nevertheless, according to Iain Douglas-Hamilton, who was employed as an adviser to Ugandan antipoaching operations in the early 1980s, there *may* still be six or so black rhinos in Uganda. No more than that.

"Because of the war of liberation in Uganda," Iain told me, "thousands of cheap automatic weapons became available. Almost anyone who wanted one could get one—and they're ideal for anyone who wants to poach.

Symbol of extinction, this black rhinoceros died just inside Tanzania's Lake Manyara National Park, brought down by a Masai spear in its liver. The poacher fled without the coveted horn. Heavily depleted by white hunters in the 1800s, African rhinos in the past 15 years have decreased by 75 percent as prices for rhino horn skyrocketed and agriculture transformed their habitat.

405

BARON HUIJUN LARICA



Under the circumstances, poaching is now quite a profitable livelihood for unscrupulous people.

"These guys mean business," he continued. "And since they are often better armed than the rangers who guard the parks and reserves, they've had a free rein. Usually they're going after elephants for the ivory, but if they find a rhino they'll shoot it as well. They only want the horn—they leave the rest to rot."

Iain is an internationally acclaimed elephant expert, and largely because of his work many people know about the decline of those animals in Africa.* But the fate of the rhino has received far less attention. Even many conservationists are unaware that while there may be more than a million elephants on the African Continent today, the number of African rhinos has plummeted to fewer than 20,000 and continues to dwindle.

THE UGANDAN EXPERIENCE is not unique. In Chad, Ethiopia, Somalia, Zaire, and Angola, raging civil wars over the past decade have also taken a heavy toll in rhino lives.

Even in relatively stable, conservation-conscious Kenya, where I live, the number of rhinos has dropped from 18,000 in 1969 to about 1,100 now. Similarly, in northern Tanzania poachers have wiped out 90 percent of the rhinos in the past ten years.

Rarer still are the three species of Asian rhinos—all quite distinct from the African types. The population of Indian, or greater one-horned, rhinoceroses left in India and Nepal has shrunk to about 1,700. The Sumatran rhino (also called the hairy rhino) today numbers only about 500, widely dispersed in the forests of Burma, Indonesia, Thailand, Malaysia, and, possibly, Kampuchea, Laos, and Vietnam. And with fewer than 70 animals the Javan rhino, restricted to the western tip of the island from which it takes its name, is considered one of the world's rarest beasts.

Years ago, when I first saw rhinos in the wild, I developed an immediate admiration for them. Second in size among land animals only to elephants, they are endlessly

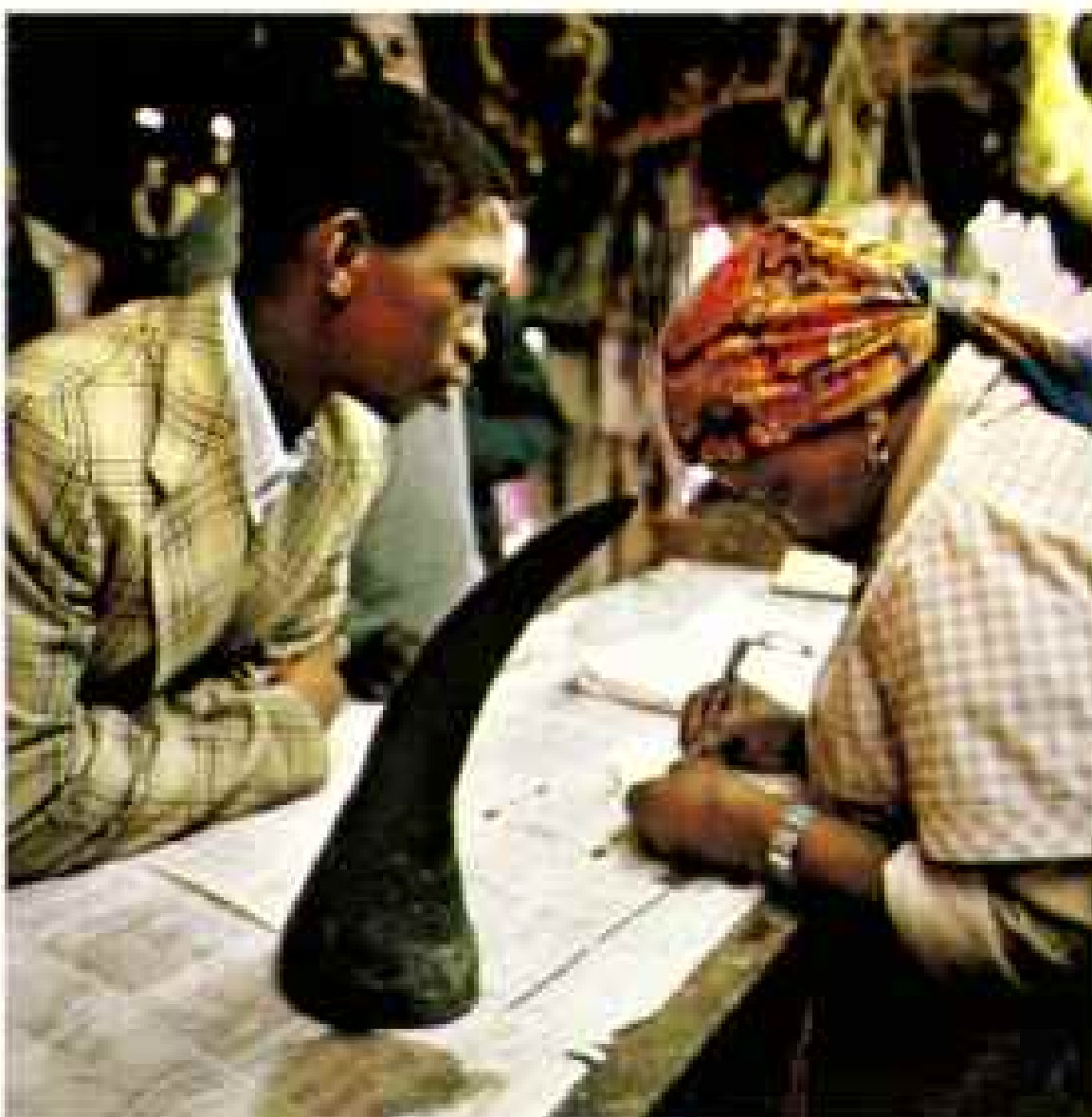
*Oria and Iain Douglas-Hamilton reported on Africa's elephants in the November 1980 *GEOGRAPHIC*.



Poachers' grisly handiwork, the carcass of a rhino felled by a rifle festers in South Luangwa National Park in Zambia, one of the last refuges of a large population of the endangered black rhino. Its killers sawed off the horns to earn about \$350 from smugglers, who attempt to satisfy international demand. A solitary creature, the black rhino leaves three-toed prints on regular routes, making it easy to track. Even with a crack antipoaching team and mandatory jail terms for those caught, Zambia finds it difficult to halt the carnage in a park three times the size of Rhode Island.



RED ST. JOHN



Over-the-counter cure-all, rhino horn is popular in a Zulu muti, or medicine, shop in Johannesburg, South Africa. The six-pound horn could bring as much as \$1,400 wholesale; shavings will sell for \$30 an ounce. Rhino-horn trade is illegal in South Africa, but some shops continue to sell their old stocks.

Natal Province, home of most South African rhinos, has dealt strictly with poachers and smugglers, including officials caught in the trade. As a result, the number of white rhinos here has recovered from dangerously low levels.

fascinating because of the great variation of behavior among the different species.

With camera in hand I stalked white rhinos in Murchison Falls National Park in Uganda—before the troubles there—and was amazed at how unaggressive they were. I could pull my Land-Rover within several feet of them, and on foot get nearly as close. I remember creeping up downwind of a male that must have weighed more than 5,000 pounds to take a series of photographs showing the square lips that are so well adapted to plucking a few blades of grass at a time (in fact, grass is the chief food of these enormous beasts).

When he finally realized I was nearby, I was lying prone in front of him, completely vulnerable. But he simply ambled a little farther away. This docile nature of the white rhino is what makes it such easy prey for poachers.

CONVERSELY, I have been charged by aggressive black rhinos—which have also been known to charge at trains passing through their territory. A black's bulky yet compact form (sustained by massive amounts of shrubs, herbs, and fruits, but hardly any grass) is no hindrance to speed. The animal can sprint at 35 miles an hour, and its extraordinary muscle structure gives it the ability to turn and change directions incredibly fast.

When one of these creatures comes galloping toward you at top speed, its head swaying back and forth menacingly, making a thunderous noise each time its feet hit the ground and snorting loudly, your only thought is how to escape. Usually that means climbing a tree, but many of us are around to tell about charges simply because a black rhino became distracted from the attack by something else at the last moment, or because it had intended only an intimidating mock charge in the first place.

But one can never assume with a black rhino. In the early days of Kenya's parks, visitors were warned, "Find your rhino before it finds you!" Totally unpredictable, these animals have been reported to enter campsites at night, scatter smoldering logs of a fire, then peacefully walk away.

They are inclined to curiosity, which leads some people to believe that what sometimes may appear to be a charge is actually only an attempt to investigate. Rhinos don't have very good eyesight for distance, and I think this is what causes them to behave erratically when disturbed.

It is not always easy to find a black rhino before it finds you, however. The animal is elusive in heavy bush, and the oxpeckers that accompany it serve it as an effective early-warning system. Yellow- or red-billed birds about the size of starlings, they pry ticks, flies, and other insects from the rhino's hide. They also sound a shrill alarm when an intruder approaches—which doubtless has saved more than a few rhinos from the arrows or bullets of poachers. The poachers, however, obviously have not missed all their opportunities.

APPALLED by the ever increasing number of rhino carcasses being found, many of them with gaping holes where their horns had been removed, I set out to learn what the market for rhino products was, why the market apparently had grown larger, and what kind of prices were being paid for rhino parts. That investigation took me throughout Africa, into the

Dr. Esmond Bradley Martin is vice-chairman of the African Elephant and Rhino Specialist Group, International Union for Conservation of Nature. Jim Brandenburg, winner of the Magazine Photographer of the Year award in 1981 and 1983, has been under contract to National Geographic since 1979.

Dilemma of the horns: Employees of the Natal Parks Board near Durban ponder what to do with a fortune in confiscated rhino horns, each worth thousands of dollars to Asian dealers, some of whom stockpile the commodity against future price increases. South Africa's provincial governments formerly sold the horn to raise money for wildlife conservation but now abide by international agreements banning the trade. The distinctive spike on the rhino's head is composed not of bone but of matted hair and other fibrous keratin.





"Rub on the eyebrows to attract women," says Petros Rabahela (left), who recommends a rhino elixir in Johannesburg. The author, in tracking the worldwide trade in rhino horn, discovered that such traditional Zulu medicine represents an infinitesimal percentage of the market.

In Sanaa, North Yemen, where royalty once sported daggers with rare rhino-horn handles, young men cash-rich with Saudi oil-field earnings purchase the status symbols new for \$400 to \$1,000 each (lower left). This outlet, the author reckons, today accounts for half of world demand. North Yemen outlawed horn imports in 1982, but dealers last summer were still



buying horn from agents in Khartoum, Sudan, for \$700 a kilo, selling to Sanaa carvers for \$850, and then buying back the shavings to resell to pharmaceutical companies in the Far East, the major market.

In China, where for a thousand years medical literature has prescribed horn for fever, companies box pills and prepare strips of hide for treating skin afflictions (above). The bottled tonic comes from Malaysia. Only in India did the author see a powder reputed to be an aphrodisiac.



NATIONAL GEOGRAPHIC PHOTOGRAPHER STEVE RAYMER

Mideast, and later—in cooperation with the World Wildlife Fund, the International Union for Conservation of Nature and Natural Resources, and the African Wildlife Foundation—to India, Southeast Asia, Korea, Taiwan, and Japan. I got my answers, and a couple of surprises.

In Africa the only place where there is real demand for rhino products turned out to be South Africa, especially in the *muti* shops of Johannesburg and Pretoria. Muti is the Zulu word for medicine, and in these shops an array of herbal and animal products—including rhino—is sold.

Dr. K. M. Naidoo, a retired practitioner of homeopathic medicine and the proprietor of one of the largest muti shops in Johannesburg, told me that Zulus would buy a little powdered rhino horn to mix with dried lice, which they swallowed to treat jaundice.

"But I actually sell more rhino hide than rhino horn," he said.

"Whatever for?" I asked.

"Zulus have a multitude of uses for it," he replied, "both medicinal and, well, kind of magical. For instance, they'll sometimes burn a piece of it inside their homes, believing that its vapors will chase away evil spirits. They also eat a bit of rhino hide to stop a nosebleed or prevent ill effects from snakebite. I can sell a piece just an inch square for five dollars. . . . If you're really interested in the sale of hide, though, you ought to go to Natal."

I TOOK HIS ADVICE. Most of the available rhino hide comes from ranches there, where surplus old male white rhinos from the parks are stocked for sportsmen from abroad to shoot. Most of the trophy seekers don't want the hide.

The manager of one of the game ranches in Natal told me he used to sell a lot of rhino hide before the government banned its export.

Export? "I thought it wasn't sent out of the country—that it was used by Zulus instead," I said.

"Just a small fraction," he responded. "Wholesale, I could get a lot more by selling it to a Chinese merchant who sent it to Hong Kong. He used to pay me \$30 a kilogram [2.2 pounds], and since the average white male rhino yields about 120 kilos,

that meant one hide was worth \$3,600!"

That was all very interesting, but it didn't explain why rhinos had been slaughtered elsewhere in Africa in the 1970s—little or no hide had been taken from them.

WHY WERE PEOPLE somewhere suddenly wanting a lot of rhino horn? The middlemen who encouraged hunters to supply the horn on a scale hitherto unknown would not disclose any information, but it was widely rumored that plane loads of rhino horn were leaving international airports clandestinely and that dhows, the old wooden sailing ships that have plied the Indian Ocean for centuries, were also carrying the horn, stashed under their legitimate cargoes.

It was said that the Chinese used rhino horn as an aphrodisiac, and that they had been buying it since ancient times. I had no firsthand information to confirm that supposition, and, frankly, it seemed rather fanciful that a demand for love potions could escalate so greatly.

Nevertheless, I was willing to accept the idea that it could well be a traditional use for rhino horn that had recently been spurred.

"Look for some traditionally oriented people who have suddenly become rich," I told myself.

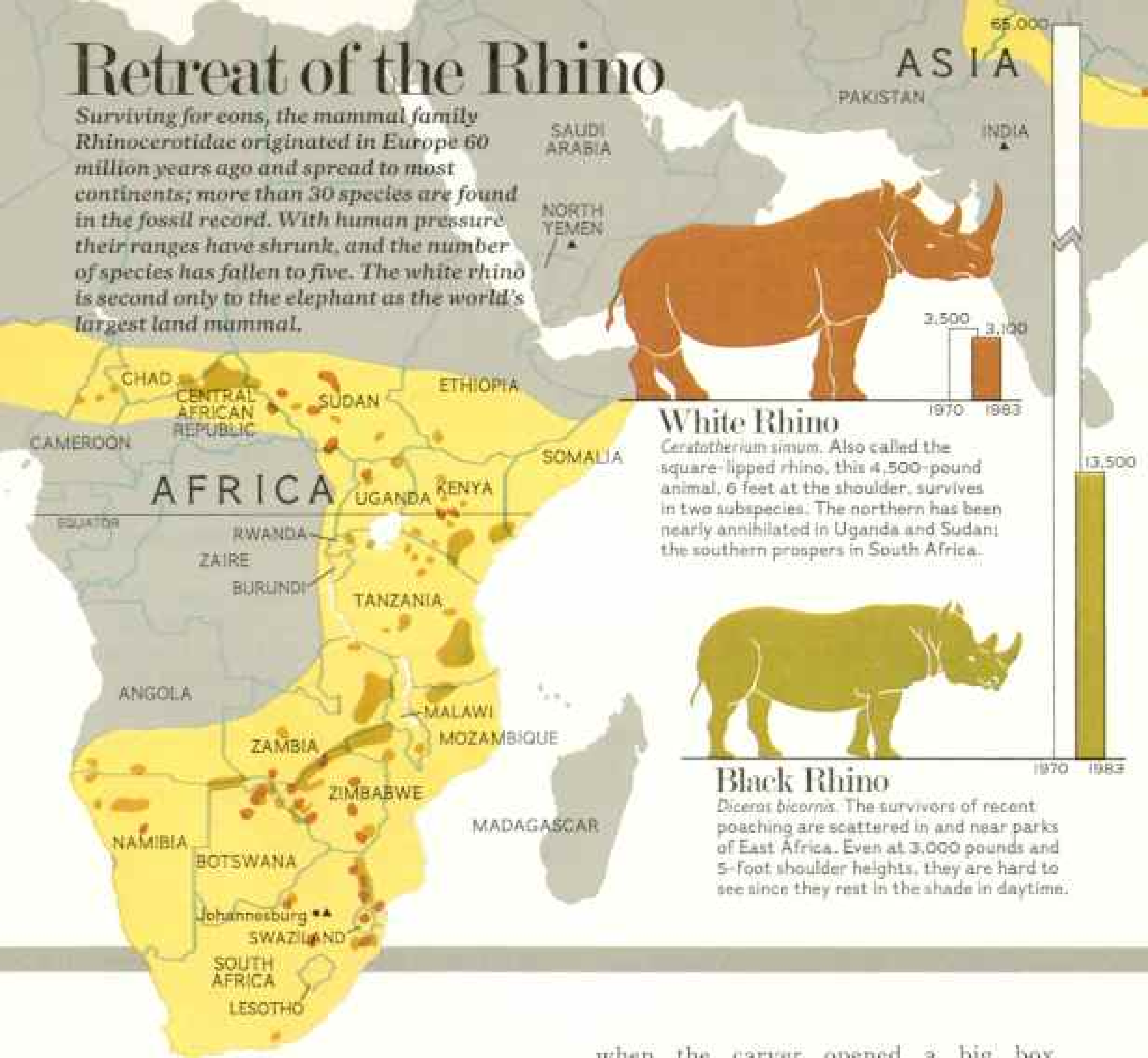
So I went through the rhino-horn statistics from the days when such trade had been legal. I was searching for a place on the Indian Ocean that used to buy rhino horn in some quantity and that had found new wealth, perhaps from the discovery of oil.

The old export records showed that Aden once bought rhino horn. That was no help! Whatever prosperity Aden once enjoyed has gone by the wayside. I began to feel that I must be on the wrong track. Then I thought of a country that had been closely associated with Aden—North Yemen. It doesn't have oil, but Saudi Arabia right next door does, and North Yemen in the 1970s had just opened up to the outside world.

A few weeks later I flew to Sanaa, the capital of North Yemen. Just how I was going to find out whether rhino horn was in demand here, I didn't quite know. However, I thought a good place to look for it would be in the suq, one of the most colorful marketplaces in all Arabia.

Retreat of the Rhino

Surviving for eons, the mammal family *Rhinocerotidae* originated in Europe 60 million years ago and spread to most continents; more than 30 species are found in the fossil record. With human pressure their ranges have shrunk, and the number of species has fallen to five. The white rhino is second only to the elephant as the world's largest land mammal.



I was looking for the quarter where jewelry is sold when I found myself amid an array of stalls in which craftsmen were busily making different parts of daggers.

More than 80 percent of Yemeni men wear daggers, called *jambiyya*, and they are loath to part with them for any reason.

In the suq dagger making was a major activity. There were scores of people sharpening blades, sewing belts, and carving handles. I noticed among the carvers one who was carefully collecting the shavings from the floor of his stall.

"What are you going to do with them?" I asked.

"There's someone who has offered me a good sum for them," came the reply.

I picked up some of the shavings and was sifting them between my hands

when the carver opened a big box.

"You see," he said, "they're special—not like ordinary dagger handles, which are made of water-buffalo or cow horn."

Curious, I peered over his shoulder into the box and saw a dozen rhino horns!

"This is what we use for making the best *jambiyya* handles," he explained.

I must have stood there gaping for several seconds—my hunch had been right!

NORTH YEMEN used to be one of the poorest countries in the world. An eight-year civil war that ended only in 1970 succeeded in overthrowing the autocratic imams who had wielded the sole political power in the country. Prior to that time few Yemenis traveled abroad, but afterward many began seeking jobs in Saudi Arabia, where they helped on construction



projects and earned very high salaries. Their money flowed back into North Yemen at the rate of about three million dollars a day in 1978. As a result, Yemeni men could then afford daggers with rhino-horn handles; formerly such adornment was the prerogative of a very small elite.

It was mostly the Yemeni demand for rhino horn that caused the wholesale price to go up from \$35 a kilogram in 1974 to \$500 in 1979. This 15-fold increase in the value of rhino horn in just six years led illegal hunters in Africa from the Sudan all the way south to Namibia to go after rhinos. An average of eight tons of rhino horn a year was sold between 1972 and 1979—at a cost, overall, of some 22,000 rhinos' lives.

Even though the North Yemenis were buying more rhino horn than any other people in the world, I discovered that their

market accounted for less than half the total. That's when I decided I must go to eastern Asia. Not only could the journey help me determine if, in fact, rhino horn was used as an aphrodisiac, but it also could lead me to an explanation of what had happened to the Asian rhino populations.

IN THE TRADITIONAL medicine shops in Singapore, my first stop, I began to doubt the stories of rhino horn as an aphrodisiac. I saw a lot of other animal products being sold as sexual stimulants—dried lizards, monkey brains, sparrow tongues, deer tails, rabbit hair, and tiger penises—but no rhino horn. For other purposes, yes, as I would notice again in larger pharmacies in Hong Kong, Macao, Taiwan, Thailand, Japan, South Korea, Indonesia, Malaysia, the Philippines, Brunei,



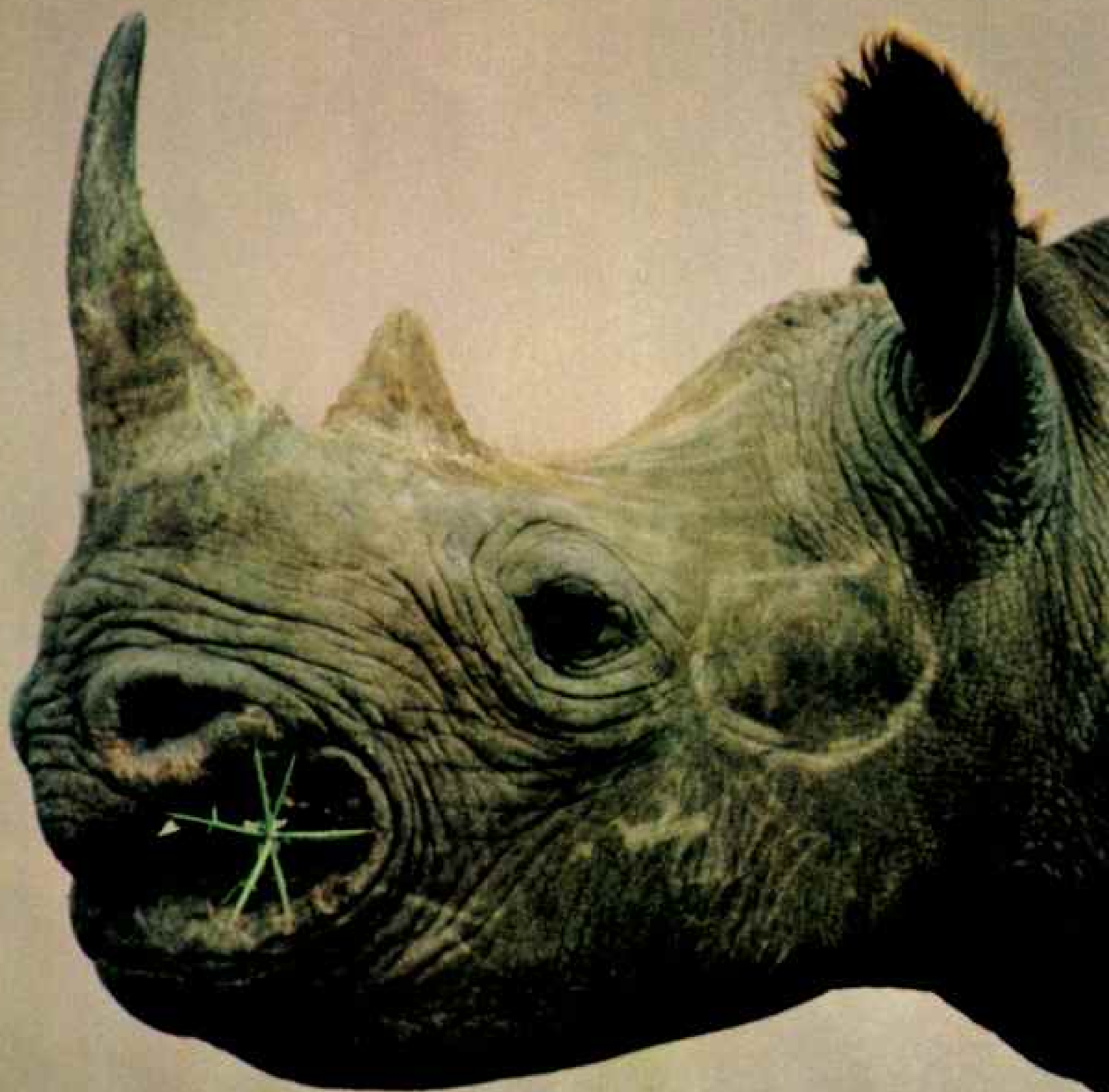
Ever alert for poachers, an armed guard watches over white rhinos transferred to Kenya's Meru National Park from Natal, where the species has increased beyond the capacity of its parks. Since the 1960s Natal has exported 3,000 rhinos to other preserves in South Africa and beyond.

Another recipient, the private Solio Wildlife Sanctuary southwest of Mount Kenya, guards breeding populations of both black and white rhinos (right) behind steel fences in the heart of an immense cattle spread. Black rhinos living unfenced on nearby ranches have been hit by poachers in recent months. Few individuals or developing nations can afford enough guards or fences to protect endangered animals, but they can encourage education. This poster (left), commissioned by international wildlife associations, has been distributed throughout Kenya, where schools are sponsoring increasingly popular wildlife clubs. But as long as demand remains high, little will deter armed poachers.



ROBERT CAPITO





It's a tough job for a tender mouth. A black rhino bull gently folds an acacia thorn, a favorite food, with his prehensile lip until, flattened, it can be chewed with huge molars. Where browse contains sufficient moisture, he can survive for weeks without water. Saucerlike ears rotate constantly, picking up sounds like the hissing of the red-billed oxpecker that harvests ticks, blood-sucking flies, and scabs from the inch-



thick hide. The rhino bathes by wallowing for hours in dust or mud. The habit of stomping in its own dung permits it to leave odor trails across the savanna, easily followed by its own kind.

They're Killing Off the Rhino.

and Burma. But in interviews with more than 400 practitioners of folk medicine, as well as rhino-horn importers, wholesalers, and consumers, I came across rhino horn as a love potion or a cure for impotence only in parts of western India. My conclusion is that the belief that peoples of the Far East use rhino horn for sexual purposes is wrong.

I also noticed that wherever rhino horn was used as a medicine, the Javan, Indian, and Sumatran species were preferred. But because of those species' growing scarcity, customers are turning more and more to the African horn.

The retail price for African rhino horn in Manila or Singapore is the equivalent of \$11,000 a kilogram. Asian rhino horn is considerably more; in Mandalay it retails for a staggering \$20,000 a kilo. Customers, of course, buy only a minute quantity at a time, never more than a few grams (far less than an ounce). Still, the cost is greater than it would be for almost any other drug.

IT WAS when I went to Burma that I found the oddest medicinal use of a rhino product. Zookeepers in Rangoon collected the urine of a baby rhino to be drunk for the cure of sore throats and to ward off asthma attacks.

"We give it to anyone who asks for it, but I think elsewhere it's actually sold, and in much larger quantities," one keeper said.

He was correct. The Calcutta zoo earned \$750 in just one year from the sale of an old rhino's urine. Strange, perhaps, but at least the animals don't have to be killed for it.

In Nepal I learned that the death of a rhino can have religious significance, for in Nepalese Hindu mythology the rhino is a special sacrificial animal, whose horn was given to it by Lord Vishnu.

In a rite called the Blood Tarpan, which every Nepalese king is required to perform upon his accession, rhino-blood libations are offered to the Hindu gods.

In Kathmandu I met Gen. Kiran Shumshere Rana. Though not a king, this distinguished gentleman was the retired commander in chief of the Nepalese Army and the son of a former prime minister—and he performed the Blood Tarpan at age 19.

He told me how he had gone to Chitawan Valley, where the country's only rhinos lived



and which had become the private preserve of the Ranas, to hunt a suitable animal. These Indian rhinos are a ferocious species, and their thick, folded skin, covered with tubercles resembling iron rivets, gives the impression of metal armor. But from atop an elephant, the young man brought a large male down with a single shot.

"Then," he said, "a team of helpers dragged the rhino to a nearby riverbank, where, using special knives, they disemboweled him. I climbed into the abdominal cavity they had made in the rhino and sat in its blood up to my waist for a few minutes while the Hindu priest officiating at the ceremony offered prayers. When I was directed to do so, I stood up, my hands cupped with

rhino blood, and held them outward to the gods in memory of my mother.

"Later I ate the meat between the hoof and ankle of one of the rhino's legs; the rest of the meat I gave to the villagers."

In January 1981 the same rite was repeated by Nepalese King Birendra, just outside what has become Chitawan Park, in honor of his late father, King Mahendra.

Although the rite requires the death of a rhino, it is so important that it guarantees the survival of the greater one-horned rhino in Nepal. No fewer than 500 armed soldiers guard the Chitawan rhinos. As a result, their numbers have risen from 160 in 1966 to 375 today—and there has been no rhino poaching inside the park since 1976.



BARON HUGO VAN LAWICK

Uncommon combatants, a black rhino cow with tail raised in fright confronts an aged Cape buffalo bull in Tanzania's Ngorongoro Crater. Charging, she stopped inches from his nose. The buffalo posed no threat, but the female may have feared for her calf.

With less bluff and more blood, rhinos often battle each other. This old bull (right) was gored by a young male seeking a female in estrus. During the mating ritual females attack too, and bulls may even charge calves. Aggression can cost the rhino its horn, but it grows back, three inches a year.



BECAUSE of the present demand for rhino horn and hide—and the high prices being paid for them—I fear that present conservation methods are not adequate to ensure a future for rhinos outside zoos or a few isolated reserves. The international community is only beginning to accept the necessity of attacking the problem by abolishing the demand.

At the moment, though, I don't think we have to worry about the Indian rhino species. Not only in Chitawan Park but also in Kaziranga Park in Assam, India, their numbers are increasing—from 970 in 1975 to 1,600 today, with another hundred or so outside the two parks. In fact, Kaziranga may have to relocate some of its rhinos to other Indian parks in the near future.

The other two Asian species—the Javan

and the Sumatran—present special difficulties. There is not a single one of either of these in any zoo in the world today, let alone a breeding pair.

Despite money and expertise provided by the World Wildlife Fund for Ujung Kulon Nature Reserve, there are probably only about 65 Javan rhinos alive today. Any let-up in their protection, or an outbreak of disease, could bring their extinction. I feel strongly that a small breeding group should be transferred to some place where modern scientific facilities could help them breed more successfully.

Although there are more Sumatran rhinos—some 500—are they too widely separated to survive? Among the few scientists to have attempted a detailed study of this species, Markus Borner recently spent three



years in Gunung Leuser, one of the two areas where they are said to be most plentiful.

"Yet in all that time," he told me, "I actually saw only one—when it charged through my camp quite unexpectedly—and that was just for a matter of seconds."

IN TOTAL NUMBERS, however, it is tropical Africa that is losing the most rhinoceroses. And it is too much to expect that countries destabilized by revolutions and civil wars will have much room on their agendas for the plight of the rhinos.

Wildlife expert Ian Parker sees another side of the problem. "Conservation is attempted today through the barrel of a gun," he told me.

"We rely on paramilitary forces equipped with the gadgetry of modern warfare

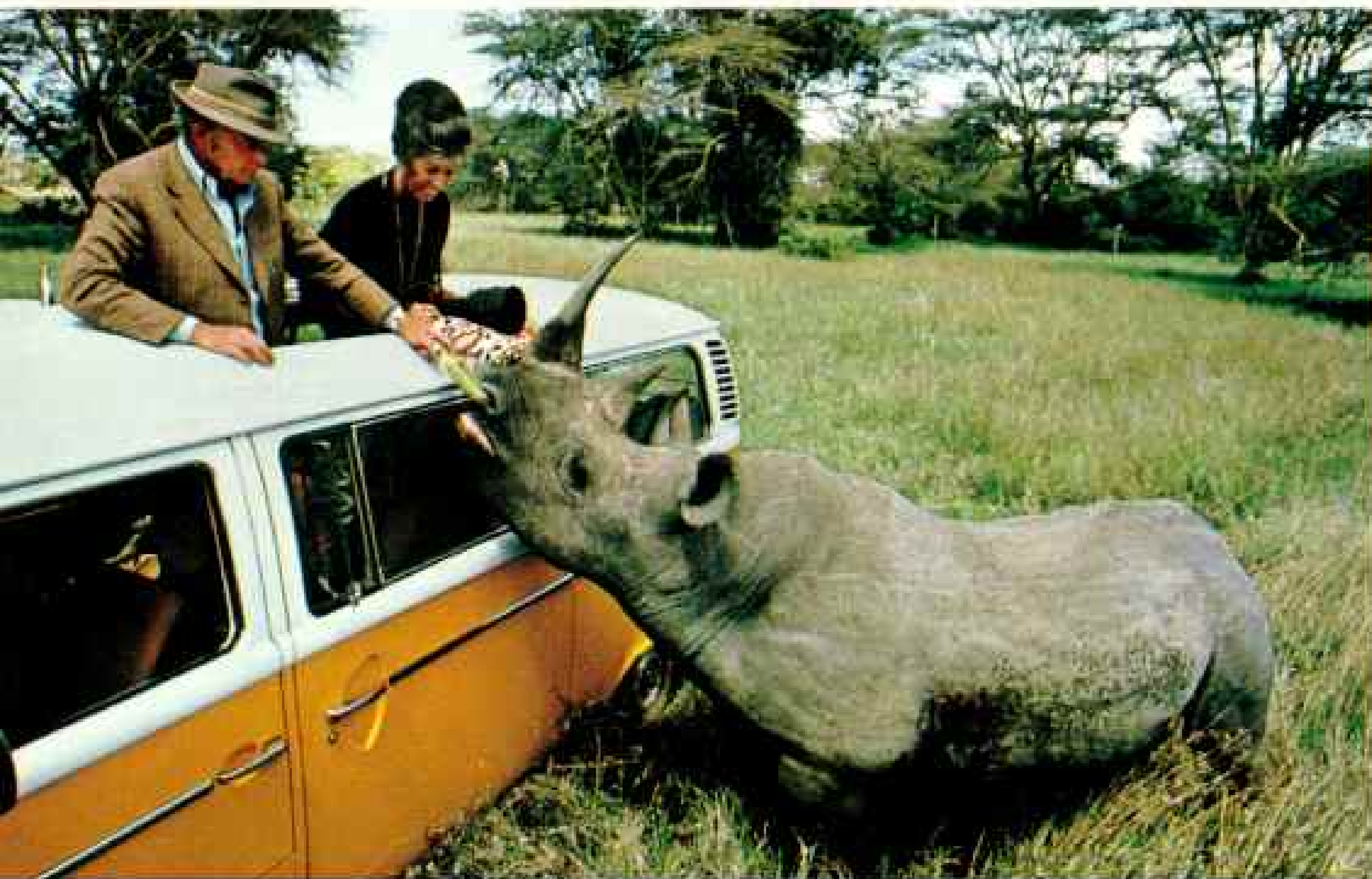
As if clad in armor, an Indian rhino and her calf trot through the riverine forest of Nepal's Royal Chitawan National Park. Deep skin folds give the plated effect. Here the king's soldiers patrol against poachers, and calves, born about three years apart, are only occasionally threatened by rhino bulls and tigers. As the rhino population rose, the two-ton animals ravaged cultivated fields on park borders, killing several villagers. Now farmers guard against nocturnal raids with lighted torches.

Some 2,500 years ago, carved rhino-horn cups were used in Persian courts to detect poison, a power later attributed to the horn of the legendary unicorn, with which the rhino has been confused.

421

ANDREW LAURIE





Gentled by attention, a ten-year-old black rhino named Hoshim takes sugarcane from Courtland and Claude Parfet, owners of Solio Wildlife Sanctuary in Kenya. Here in the refuge, black rhinos, though breeding only once every five years on the average, have multiplied. The Parfets hope this year to fulfill their dream of reintroducing to a secure national park a breeding herd of the animal that Kenya President Daniel Arap Moi has declared a national treasure.

because conservation does not receive popular support. It is, instead, a source of tension, a matter of ethics and priorities at odds. That issue will have to be solved first if many wildlife species are to survive."

South Africa has shown that where the citizens support conservation, it can succeed—aided by an enlightened park management with adequate manpower and skilled administrators, all of them highly trained, motivated, and disciplined. Consequently, the country's black rhino population is increasing by more than 5 percent a year, and the number of white rhinos is growing at such a rate that culling will probably be necessary within 20 years.

It would be preferable, of course, if the surplus animals of South Africa's reserves and other African private game farms could be used to restock areas where the rhinos are going or are already gone. That is impossible, however, until the animals can be

protected—and until consumers stop their demand for rhino horn, that seems very unlikely.

I HAVE JUST RETURNED from another trip to Asia, where I tried to get wholesalers and retailers to substitute water-buffalo hide for rhino hide (they are used for the same medicinal purposes) and saiga antelope horn for rhino horn. And I would urge anthropologists to go to North Yemen to take on a study of how to convince the Yemenis to use another material for their dagger handles.

But more important than any of those things might be to get, for the first time, the full mutual cooperation of conservationists, wildlife administrators, traders, and law-enforcement officers.

Those hornless carcasses rotting in the sun are a blight not only on the landscape but also on the conscience of mankind. □

NATIONAL GEOGRAPHIC SOCIETY

WASHINGTON, D. C.

Organized "for the increase and diffusion of geographic knowledge"

GILBERT HOVEY GROSVENOR
Editor, 1899-1954; President, 1920-1954
Chairman of the Board, 1954-1966

THE NATIONAL GEOGRAPHIC SOCIETY is chartered in Washington, D. C., in accordance with the laws of the United States, as a nonprofit scientific and educational organization. Since 1890 the Society has supported more than 2,400 expeditions and research projects, adding immeasurably to man's knowledge of earth, sea, and sky. It diffuses this knowledge through its monthly journal, **NATIONAL GEOGRAPHIC**; its books, globes, atlases, filmstrips, and educational films; *National Geographic*; **WORLD**, a magazine for children age 8 and older; information services; technical reports; exhibits in Explorers Hall; and television.

GILBERT M. GROSVENOR, President
OWEN R. ANDERSON, Executive Vice President
ALFRED J. HAYRE, Vice President and Treasurer
WILLIAM T. BELL, **FREDERICK C. GALE**, **LEONARD J. GRANT**,
JOSEPH B. HOGAN, **ADRIAN L. LOFTIN, JR.**, **LEWIS F. LOWE**,
RAYMOND T. McELKIGOTT, JR., Vice Presidents
EDWIN W. SNIDER, Secretary and Corporate Counsel

BOARD OF TRUSTEES

MELVIN M. PAYNE, Chairman of the Board
ROBERT E. DOYLE, Vice Chairman
LLOYD H. ELLIOTT, Vice Chairman
President, George Washington University
THOMAS W. McKNEW, Advisory Chairman

OWEN R. ANDERSON
THOMAS E. BOLGER
Chairman of the Board, Bell Atlantic
FRANK BORMAN, Chairman of the Board and President, Eastern Airlines
J. CARTER BROWN, Director, National Gallery of Art
WARREN E. BURGER
Chief Justice of the United States
MICHAEL COLLINS
Vice President, Vought Corporation
GEORGE M. ELSEY, President Emeritus, American Red Cross
WILBUR E. GARRETT
GILBERT M. GROSVENOR
ARTHUR B. HANSON, Attorney
CARYL P. HASKINS, Former President, Carnegie Institution of Washington
A. LEON HIGGINBOTHAM, JR.
Judge, U. S. Court of Appeals for the Third Circuit
JEROME H. HOLLAND
Former U. S. Ambassador to Sweden

CARLISLE H. HUMELSLINE
Chairman of the Board,
The Colonial Williamsburg Foundation

MRS. LYNDON B. JOHNSON

CURTIS E. LEMAY, Former Chief of Staff, U. S. Air Force

LAURANCE S. ROCKEFELLER
Chairman, Memorial Sloan-Kettering Cancer Center

ROBERT C. SEAMANS, JR.
Henry R. Luce Professor of Environment and Public Policy, Massachusetts Institute of Technology

JAMES H. WAKELIN, JR., Former Assistant Secretary of Commerce for Science and Technology

CONRAD L. WIRTH, Former Director, National Park Service

Trustees Emeriti

CRAWFORD H. GREENEWALT

WM. McCHESNEY MARTIN, JR.

FREDERICK G. VOSBURGH

JAMES E. WEBB

LOUIS B. WRIGHT

COMMITTEE FOR RESEARCH AND EXPLORATION

MELVIN M. PAYNE, Chairman
F. DALE STEWART, Vice Chairman
EDWIN W. SNIDER, Secretary

BARRY C. BISHOP, **HARM J. DE BLIJ**, Professor of Geography, University of Miami; **GILBERT M. GROSVENOR**; **CARYL P. HASKINS**; **THOMAS W. McKNEW**; **BETTY J. MEGGERS**, Research Associate-Anthropology, Smithsonian Institution; **PETER H. RAVEN**, Director, Missouri Botanical Garden; **CHARLES H. SOUTHWICK**, Professor of Biology, University of Colorado; **GEORGE E. STUART**; **JAMES H. WAKELIN, JR.**; **GEORGE E. WATSON**, Curator of Birds, Smithsonian Institution; **FRANK C. WHITMORE, JR.**, Research Geologist, U. S. Geological Survey; **CONRAD L. WIRTH**, and **PAUL A. ZAHL**.

ASSISTANT VICE PRESIDENTS: James P. Kelly, Ward S. Phelps, Clotis Hyde.
ASST. TREASURER: H. Gregory Platts. **ASST. SECRETARY:** Earl Corlies, Jr. **ASSTS. TO THE PRESIDENT:** Joyce W. Graves, Thomas E. Kalikonky, Richard E. Pearson

ADMINISTRATIVE STAFF: Accounting: Dorothy L. Damerna, Jay H. Graves, Laura L. Leight, William G. McGhee, George E. Newstedt, David H. Peters. Administration: D. Evelyn Carnahan, Robert V. Koenig, Zbigniew Jan Lutyk, Marta M. Marschalka, Myra A. McLellan, Jennifer Moseley, Ross L. Mulford, Shirley Nell, Jimmie D. Pridemore, Joyce S. Sanford, Janet C. Super, Frank M. Twigg. Computer: James G. Schmeizer, William L. Chewing, Ronald C. Kline, Richard A. Michler, Harold E. Smith. Educational Services: Wendy G. Rogers, Dean R. Gage, Carl W. Harmon, Jr. Employer Benefits: Howard R. Hudson. Membership Services: Margaret L. Bassford, Robert C. Dove, William T. McDonnell, Paul B. Tylor, Dorothy M. Wagner, Marguerite M. Wise, Peter F. Woods. Personnel: Thomas L. Hartman, M.D., Robert E. Howell, Glenn G. Pepperman, Shirley N. Wilson. Printing: Joe M. Barlett, Frank S. Oliverio, Margaret A. Silber, Hans H. Wegner. Promotion: Robert J. Wazfel, Joseph S. Fowler, Joan Anderson, Eileen W. Bowering, James R. Dimond, Jr., Robert L. Feige, Thomas M. Keen, Charles T. Kneeland, F. William Rath. Purchasing: Robert G. Corey, Thomas L. Fletcher, Sheila H. Inonel

ADVERTISING: Director: George E. Moffat, 1251 Avenue of the Americas, New York 10020. *Asst. to Dir.:* Eileen K. Avvaxian. *U. S. Advertising Manager:* William K. Hughes. *Office Mgr. — New York:* William M. Donohoe. *Dir.:* O. W. Jones, Jr. Los Angeles: Robert D. Johnson. San Francisco: James D. Shepherd. Europe: Michel A. Boutin, 90 Ave. des Champs Elysees, Paris. *Marketing/Research:* Alex MacRae. *Promotion:* Pandora Browne. *Administration:* Blanche Coffey. *Business:* Paul A. Delaney. *Production:* G. Sarita Lapham, Washington, D.C.

COPYRIGHT © 1984 National Geographic Society, 17th and M Sts., N.W., Washington, D. C. 20036. Second-class postage paid at Washington, D. C., and elsewhere. **NATIONAL GEOGRAPHIC** and **Yellow Border**: Registered Trademarks © Marcus Registradas. \$15.00 a year, \$1.90 a copy. **POSTMASTER:** Send address changes to National Geographic (ISSN 0027-9381), P. O. Box 2174, Washington, D. C. 20013.



MELVIN M. PAYNE *Chairman of the Board*
NATIONAL GEOGRAPHIC MAGAZINE
GILBERT M. GROSVENOR *President*
WILBUR E. GARRETT *Editor*
JOSEPH JUDGE *Associate Editor*

SENIOR ASSISTANT EDITORS

John B. Garvey, Jr., Cartography; Robert E. Gilka, Photography; William Griggs, Expeditions; Robert P. Jordan, Special Projects; H. Edward Kim, Layout; Edward J. Linahan, Manuscripts; Samuel W. Matthews, Production; O. Louis Macdonald, Control Center; Charles McCarty, Contract Writers; Howard E. Prime, Art; Carolyn Bennett Patterson, Legends; Thomas R. Smith, Illustrations; Mary G. Smith, Research Grant Projects; Kenneth F. Weaver, Science; Ann K. Wood, Research

TEXT

ASSISTANT EDITORS: Kent Britt, Thomas Y. Canby, Rowe Findley, B. McDowell, Elizabeth A. Moize, Merle Severy

SENIOR WRITERS: Thomas J. Abernethy, David S. Bayar, Mike Edwards, William S. Ellis, Rick Lane, Noel Grove, John J. Pitman, Peter J. White

SENIOR EDITORIAL STAFF: Harvey Arden, Robert Booth, Allen A. Bomakis, John L. Ebot, Boyd Gibbons, Alice J. Hall, Brynn Hodgson, David Jeffery, Michael E. Long, Pitt J. Vestilind, Gordon Young. *Production:* John L. McIntosh

EDITORIAL STAFF: Judith Brown, Larry Kohl, Douglas Lee, Louise E. Levathes, Peter Miller, Cathy Newman, Cliff Tapp, June Vessels

RESEARCH: Lesley B. Rogers (Assoc. Dir.), Michaeline A. Swenney (Asst. Dir.), Research Editor; Susan L. Anderson, Researchers: Carolyn H. Anderson, Rebecca Bull, John G. Gruber, Ann B. Henry, Jan Holderness, Patricia H. Kellogg, Kathy B. Maher, Barbara W. McConnell, Jean H. McConville, Margaret S. Nottingham, Jeanne E. Peters, Frances W. Shaffer. *Geography:* Bettie Joan Guss. *Legends:* Victoria C. Duchonauas, Abigail A. Tipton. *Planning Council:* Gauthier G. Kyan, Mary McPeak

ILLUSTRATIONS

PHOTOGRAPHERS: Dean Conger, Joseph J. Scherschel (Assistant Directors); James L. Amos, Joseph H. Bailey, James P. Blair, Victor R. Boxwell, Jr., Tad Cobb, Bruce Dile, David Alan Harvey, Olin Imboden, Emory Kristof, Joseph D. Lavenburg, Bianca Lavis, Bates Littlehales, Robert W. Madden, George F. Mobley, Robert S. Oakes, Steve Raymond, Robert F. Sisson (Nat. Sciences); James L. Stanfield. Administration: Claude E. Petrone, Susan A. Smith

ILLUSTRATIONS EDITORS: W. Allan Royce (Assistant Director); David J. Arnold, Taylor Grigg, Bruce A. McElfresh, Charlene Murphy, Robert S. Putton, Elie S. Rogers, Jon Schneberger, Susan Welchman

LAYOUT: Constance H. Phelps, William T. Dwyer

ART: Jan Adams, J. Robert Terzino (Assoc. Directors); Artists: William H. Bond, Ned M. Seidler. Design: Charles C. Uhl (Asst. Dir.); Betty Claxman

ENGRAVING AND PRINTING: William W. Smith (Director); James R. Whitney (Assoc. Dir.); Bill M. Aldridge, John T. Dunn, Judy L. Garvey, John W. Gergel

CARTOGRAPHY

Richard J. Darley (Senior Assoc. Director); John F. Stupe (Assoc. Director); Wilbur O. Crowe, John F. Dorr, Harold A. Hanson, Harry D. Kaibane, Richard K. Rogers, Elin Sahban (Asst. Dir.); *Map Editors:* Thomas A. Walsh (Supv.); John F. Blozis, Russel G. Fritz, Charles W. Gotthardt, Jr., Thomas L. Gray, Mary Anne McAlver, Gus Plans. Artists: Lisa Biganzoli, John W. Lothens, Nancy Schweickart, Sally Saunton-Summerall, Tibor G. Toth. *Archaeologist:* George E. Stuart. *Geographer-Tad Dauchtera, Researchers:* Timothy J. Carter, Ross M. Emerson, Marguerite B. Hunaker, Mary C. Latham, Dorothy A. Nicholson, Douglas A. Strobel, Susan Young. *Map Artists:* Roland R. Nichols, Leo B. Zeburth (Supvs.); Iskandar Baday, Alfred L. Zeburth. *Specialists:* Charles F. Case, Martin J. Golden, Thomas A. Wall, Scholonia; Charles L. Miller, Henri A. Delange. *Map Library:* Margery K. Barkdull (Supv.); Karen F. Carrick. Administration: Catherine M. Hart, Patricia M. Oakes

EDITORIAL SERVICES

ADMINISTRATION: M. Janet Yile (Asst. to the Editor), Elaine Rice Ames, Marie L. Barnes, G. Merrill Cih, Neva M. Collins, Lilia Davidson, Virginia H. Finnegan, Eleanor W. Hafner, Mary F. Kleinman, Ellen E. Kohlberg, Lisa Maurer, Lucille L. McMurry, Carol D. Rhoads. *Papers Requests:* Barbara A. Shattuck. *Correspondents:* Carolyn F. Clewell, Gwendolyn C. Blackman, Joseph M. Blanton, Jr., Andrew Jobert, M. Blozis, Travel: Virginia A. Bachant

LIBRARIES: Publications: Susan Filer Corby (Director); Patricia Murphy Smith, Carolyn Lucke, Louise A. Robinson, Marta Strada. *Records & Illustrations:* Lorie Northrop (Director); L. Fern Dams, Mary Anne McMillan, M. Scott Borden, Carolyn J. Harrison, Marguerite S. Northwood, Mamen M. Smith. *Photo Archivist:* Velkamar Wintzell. *Film:* Betty G. Katcher

NEWS SERVICE: Paul Sampson (Director); Joy Aschenbach, Kenneth C. Danforth, Donald J. Frederick, Rebecca R. Kirtland, Barbara S. Moffat, William J. O'Neill. *Radio:* Robert C. Radcliffe

PHOTOGRAPHIC LABORATORIES AND TYPESETTING: Carl M. Strader (Director); Milton A. Ford (Associate Director); Lawrence F. Ludwig (Asst. Director); Herbert Altamus, Jr., Billy R. Barnett, Richard A. Bredeck, David H. Chisman, Ellwood M. Kahler, Jr., Geoffrey T. McConnell, William S. Petroni, Bernard G. Quarick, Joan S. Simms, James H. Trott, Alfred M. Yee

RELATED EDUCATIONAL SERVICES OF THE SOCIETY

ROBERT L. BREEDEN *Vice President*

SENIOR ASSISTANT EDITORS: Donald J. Crump, *Special Publications and School Services*, Charles O. Hyman, *Book Service*

BOOK SERVICE: Gusta Arnold, Ross Bennett, Mary Dickinson, Karen F. Edwards, Suzanne Kane, Anne D. Kober, J. Edward Lanolette, Carol B. Lutyk, Linda B. Meyerzicka, Elizabeth Newhouse, David F. Robinson, Shirley Scott, David M. Senger, Margaret Sedeen, Susan Sidman, Penelope Timbers, Jonathan Tuattalio, Arne Withers

SPECIAL PUBLICATIONS AND SCHOOL SERVICES: Philip B. Silcott (Assoc. Dir.); William L. Allen, William K. Gray (Asst. Dir.); John G. Agnone, Jody Boh, Jane H. Burton, Marilyn W. Clement, Margery G. Dunn, Tom Eugene, Seymour L. Fishbein, Ron Fisher, Patricia F. Frakes, Barbara Grazzini, Sallie M. Greenwood, Mary Ann Harrell, Suzanne J. Jacobson, Bonnie S. Lawrence, Christine E. Lee, Jane R. McCauley, Tom Melham, Robert Messer, H. Robert Morrison, Thomas O'Neill, Thomas B. Powell III, Cynthia Ramsey, Jennifer C. Urquhart, George V. White, Merrill Windsor. *National Geographic WORLD:* Ralph Gray (Editor); Pat Robbins (Mgr. Ed.); Jacqueline Geschickter, Pat Holland, Joan Hart, Tee Lofin, Margaret McKeelway, Veronica Morrison, Judith Risard, Eleanor Shannahan, Urmla Vossler. *Educational Media:* George Peterson (Editor); Jimmie Abernethy, David F. Bencom, James B. Caffrey

PUBLICATIONS ART: John D. Gast, Jr. (Director); Virginia L. Hull (Asst. Dir.); Map Artists: Isaac Ortiz, Peter J. Baich

TELEVISION AND FILMS: Dennis B. Kane (Director); Sidney Platt (Director, Educational Films); Donald M. Cooper, Anne B. K. Krumhauer, Yorgos N. Lampothakis, Karen S. Marsh, Louise C. Millikan, Marjorie M. Moomery, Nola L. Shrewsbury, Kathleen F. Teter, Carl E. Zaeb

AUDIOVISUAL: Joanne M. Hess (Director); Jon H. Larmure (Tech. Director); Ronald S. Altamus, Robert G. Floregal, Paul Gorski, Gerald L. Wiley

YOU'VE
NEVER SEEN
ANYTHING
LIKE IT
BECAUSE
THERE'S NEVER
BEEN ANYTHING
LIKE IT.





Dodge Caravan. A truly revolutionary vehicle. It can handle two adults plus 125 cubic feet of cargo. Or five adults. Even seven with the available rear seat. Yet it's shorter than a full-size station wagon, so it's easier to maneuver and park. And since Caravan stands a mere 5'5," it's easy for you to get in and out of. And it's easy to get Caravan in and out of your garage.



Caravan's 2.2-liter engine rates an est. hwy. of 37 and EPA est. mpg of [24]*—impressive mileage for a vehicle of this sort. Caravan also has front-wheel drive to handle slippery surfaces outside and give you more room inside. Yet for all of this, Caravan is remarkably low-priced and even backed by Dodge's 5 year/50,000 mile Protection Plan on engine, powertrain and outer body rust-through.**

The totally new Dodge Caravan. You've got to see it, sit in it, and drive it to believe it. All of which can happen

at your Dodge dealer—where you can buy or lease*** your very own transportation revolution. Order one now.

The New Chrysler Technology. Quality backed by 5/50 Protection.

*Use EPA est. mpg for comparison. Your mileage may vary depending on speed, distance and weather. Actual hwy. mpg and CA est. lower. **5 years or 50,000 miles, whichever



INTRODUCING DODGE CARAVAN. A TRANSPORTATION REVOLUTION.

**NOT AS LONG AS A FULL-SIZE STATION WAGON,
YET IT HOLDS 40% MORE CARGO. AND IT'S ABOUT THE
SAME HEIGHT AS THE AVERAGE AMERICAN WOMAN.
IT HAS FRONT-WHEEL DRIVE, GETS INCREDIBLE MILEAGE,
AND IS BACKED BY 5/50 PROTECTION.**

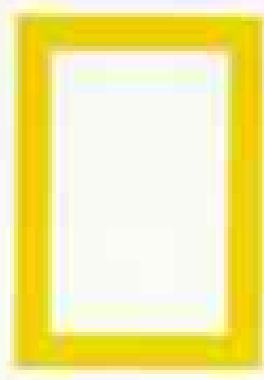


FULL-SIZE VAN



DODGE CARAVAN

**WE ARE
DODGE.  AN
AMERICAN
REVOLUTION.**



The truth about the North Pole

AS PRODUCERS of award-winning TV specials for 18 years, we at the National Geographic Society appreciate the value of the spice of entertainment in documentary programs—but sometimes the price of the spice is too high. This is true of ITT's docudrama "Cook and Peary: The Race to the Pole," aired last December 13 by CBS. We were asked to believe by author I. C. Rapoport that Dr. Frederick A. Cook reached the North Pole in 1908, and that his legitimate claim was denied him by a vicious and paranoid Robert E. Peary, whose own claim to the Pole in 1909 was cast in doubt.

This is blatant distortion of the historical record, vilifying an honest hero and exonerating a man whose life was characterized by grand frauds. In fact, there has never been anything to substantiate Cook's claim, other than his word. As the University of Copenhagen reported when it studied his claim and failed to find any proof, he brought back not a single astronomical observation.

How good was his word? Of the important biographical events the film failed to mention were Cook's attempt to publish a Yahgan Indian dictionary, another man's lifework, under his own name, and his colossal fraud at Mount McKinley in Alaska. Two years before he claimed to have stood at the North Pole, Cook claimed to have stood upon the summit of McKinley, North America's highest peak, then unclimbed. He came home in triumph, to many honors.

His claim was a fraud, based upon a doctored photograph and fictitious entries in a diary. An Explorers Club-American Geographical Society expedition in 1910 located and photographed Cook's fake "summit" some 19.5 miles from the mountain and 15,000 feet lower than the true crest. Dr. Bradford Washburn of the Boston Museum

of Science and Adams Carter of the *American Alpine Journal* used photogrammetry in 1955-57 to demonstrate beyond doubt that Cook lied about climbing McKinley. It was for this, incidentally, that he was expelled from the Explorers Club and the American Alpine Club—not for his polar claim.

The only witness to Cook's claimed climb of McKinley signed an affidavit that he never attempted it. The only witnesses to his journey to the Pole, his Eskimo companions, told Peary and later Donald B. MacMillan that he never attempted it.

In 1910 Rear Adm. John E. Pillsbury, USN, concluded that Cook did not have enough food to get to the Pole and back, and that his photographs could not have been taken at the times and latitudes claimed.

Perhaps the largest falsehood of the program was the implication that Cook was hounded into jail because of his polar claim. In fact, he was convicted in 1923, along

with other officers of the "Petroleum Producers Association," of using the U. S. mails to defraud—an oil-stock swindle that landed him in Leavenworth Penitentiary, where he served five years of a 14-year-9-month sentence. This alone is enough to destroy the credibility of "Race to the Pole."

Peary's claim is backed by astronomical observations made by others as well as himself, by soundings taken through the ice, and by the testimony of his companions, including Eskimos. Even his severest critics cannot deny he came close to his goal, and his supporters have no doubt he made it. It is small wonder he felt that his life's achievement had been stolen by a con man.

I have stood at the North Pole, with one of Peary's flags in my pack. I was proud to take it back there, a pride based both on sentiment and a sense of justice.



U. S. FLAG PEARY TOOK TO THE NORTH POLE

Silbert H. Brown

PRESIDENT, NATIONAL GEOGRAPHIC SOCIETY

A chocolatier's tribute to almond lovers everywhere.

Whole toasted almonds
crowded into thick milk chocolate.



quinta-feira, 27 de maio de 2015

avaliar meus novos trabalhos em

**You don't
have to give
up service
to save on
long
distance.**

Save 40% & 60% with AT&T's Special Discounts.



You don't have to choose between service and savings with AT&T. Our Evening Special saves you 40% from 5-11 p.m.

Sunday through Friday. Our Weekend Special saves you 60% all day Saturday and Sunday till 5 p.m. and every night after 11. Just dial it yourself anywhere state-to-state.

(Different discounts apply to Alaska and Hawaii.) And with AT&T, you can expect more than just savings. You can count on our service, too.

Call from anywhere to anywhere.

Only AT&T gives a town of fifty the same nationwide long distance service as a city of five million. And no matter how far away you call, your voice will sound as close as you feel.



Call any time. There are never any restrictions on calling hours with AT&T. You can call any time of day or night.



Collect and Person-to-Person Calls.

When you need important services like person-to-person and collect calling, it's nice to know you can count on AT&T.

Operator Assistance.

Only AT&T gives you long distance operator service 24 hours a day. So if you have a problem or question, there's always someone ready to help.

For over a century, AT&T has worked to bring you the best long distance service in the world.

And that service comes with savings when you have time to enjoy them. Calling anywhere, any time, operator service, and calls that sound as close as next door. That's AT&T. **The more you hear the better we sound.**



AT&T

Reach out and touch someone.™



It also has
a new, more
powerful engine.
But what
would you rather
look at?



Any way you look at it, the Accord Hatchback is new. New engine. New tighter suspension. New lower hoodline. New sporty black trim. New contoured bucket seats. We could go on. But the best way to look at this new Honda isn't in a picture. It's out on the road. **HONDA** The Accord Hatchback

 ©1987 American Honda Motor Co., Inc.

Members Forum

Peary and Cook

On Tuesday, December 13, I watched with riveted attention the CBS movie "Cook and Peary: The Race to the Pole." Since this presentation casts genuine doubt on polar-exploration history as it has been accepted for more than 70 years, placing the National Geographic Society at the core of the controversy, some sort of explanation by the Society should be formulated.

C. Darrell Lane, M.D.
Bowmansville, Pennsylvania

In the Cook-Peary program, the Society was presented in an unfavorable manner. The biased nature of the presentation was an insult to a viewer.

My own readings revealed that the polar experts involved in the University of Copenhagen study came to the conclusion (in spite of disagreement by Amundsen) that Peary's claims were valid while those of Dr. Cook were a hoax.

William C. Caccamise, M.D.
Rochester, New York

The National Geographic Society was alleged to have perpetrated a fraud upon the American public. As members of the Society and as Americans, we would like to see a full and accurate disclosure of the events.

R. C. Lentzner, M.D.
L. S. Lentzner
Carmichael, California

I was personally appalled at the way Cook was depicted, as well as the Society. I do not believe Cook did get to the Pole. His track record speaks for itself, a series of lifelong lies. I am ashamed that an American broadcasting station can produce such a program and get away with it. Admiral Peary was undoubtedly there; he had proof.

Daryll Antoszyk
West Newton, Pennsylvania

Did the National Geographic Society and Admiral Peary put one over on me and Dr. Cook?

Michael L. Steiner, M.D.
Rocky Mount, North Carolina

Actually, ITT and CBS put one over on the viewing public, neglecting critical biographical facts about Dr. Cook, such as his conviction for mail fraud and his fraudulent claim to have been first to climb Mount McKinley, a parenthesis of historical events that surround his claim to the Pole. See the accompanying President's Page.

Escape . . . With Folbot

Folding from \$149
Rigid from \$509
Ribs from \$329

Sailing rigs available
for all models.

- Explore streams, rivers, lakes or sea coasts.
- Quiet, comfortable, easy paddling.
- Quality construction for years of trouble-free use.
- Much more stable than a canoe or kayak.
- Perfect for cruising, fishing, and family fun.



Affordable Quality —
Factory Direct Price
Since 1955

Send \$2.00 for new
1984 color catalog
(mailed First Class)

Folbot, Inc.
PO Box 20877, Dept. 384
Charlotte, NC 28040-0877

When you have a foreign student live with you for a year, the world becomes more than the evening news.

For more information write to: AFS
International/Intercultural Programs,
313 E. 43rd St., N.Y., N.Y. 10017

Or call toll free (800) 526-7443.
In New Jersey (800) 522-4503.

AFS International Exchanges for high school students.

We provide the students. You provide the love.

CALVERT SCHOOL

EST. 1897

Kindergarten through 8th grade.

Educate your child at home with approved home study courses, or use as enrichment. Home is the classroom, you are the teacher with the help of step-by-step instructions. Start anytime, transfer to other schools. Used by over 300,000 students. Non-profit. Write for catalog.

Phone: 301-243-6000 or Write: Calvert School
Box 94-3, Tuscany Road, Baltimore, MD 21210

ARIZONA'S VILLA-OASIS SCHOOL



Co-ed Boarding or 7-12 Prep & Gen'l Curric. Prog. for the Under-motivated; Dev. Reading, Computers, Art, Marine Biol., Photog., Horses, Pool, Fencing, Sailing, Travel, Wheel activities. Int'l Student Body. Warm dry climate. Fully accredited. Catalog: John Steinbeck, Ph.D., Ed. Box 1218, Casa Grande, AZ 85222 602-466-9726

CARSON LONG MILITARY SCHOOL

Box 983
New Bloomfield, PA 17068

Accredited. Educates the whole boy - physically, mentally, spiritually. How to learn, how to relax, how to live. Happy environment. Prepares him for college and life. Grades 6-12. 14th year of character building. Devol charges \$4,500.

FREE - PARENTS GUIDE

Vincent/Curtis, Inc. 27
244 Clarendon St., Boston, MA 02116

Over 400 private boarding schools, camps and summer programs in U.S. and abroad, serving children 6-18. Must visited by publisher. For guide and free referrals give child's age, grade, interests, geographical preference and admission date. Est. 1960.

TMI ACADEMY

Box 107, Sweetwater, TN 37888
615-339-6633

Boys' Boarding, Coed Day Grades 5-12 & PG College Prep. Fully accredited. Small classes. Excellent Faculty. Friendly atmosphere stimulates self-motivation, self-discipline, maximum academic potential. 11000 year. Non-Military. Catalog. Certified Grey Pass.

JUDSON SCHOOL-ARIZONA BOARDING • COLLEGE PREP • CO-ED



Est. 1928. Prep & Gen'l Curric. Gr. 5-12. Small classes, 100 staff. Healthful life. Sports: Travel, Fencing, Soccer, Ski/Swim, Golf, Tennis, ESI, Dev. reading, Adv. math. Daily extra help. Computers. CATALOG: Henry N. Wick, Yale D.A., Dir. Box 1568, Scottsdale, AZ 85252. TELEX 669440

602-948-7731

Byzantine Empire

Like Byzantium, your December 1983 issue was splendid. But it helped perpetuate an unfair myth: "While Charlemagne could barely scrawl his name and only clerics had clerical skills, many Byzantine emperors were scholars." Charlemagne might have had difficulty with what we call running hand, but it is certain he could write. Lambecius, secretary of Christina of Sweden, speaks of a manuscript of St. Paul's Epistle to the Romans "corrected by the Emperor's own hand." Charlemagne spoke Latin fluently and elegantly and was familiar with Greek.

Frank Morriss
Wheat Ridge, Colorado

That Charlemagne was a scholar is one of many myths that surround the great leader. Though he possessed a keen intelligence and brought learned men to his court, most historians say he was only semiliterate and did not speak Latin well.

Our small California monastery is a dependency of a large monastic community in Fili (Athens), Greece. Our attempt to keep alive in America the traditions that we Orthodox Christians have maintained from the early church has earned us, at times, ridicule and abuse. The West has a disturbing tendency to forget it owes to Byzantium a debt for its own religious, social, political, and

DISCOVER A DIFFERENT WORLD



Dine on fine French cuisine in Old Montréal tonight and relax in the Laurentian Mountains tomorrow. Come on up.

legal traditions. Your article on the Byzantines goes a long way in refreshing the memory of your readers regarding their lost ancestors.

The Very Reverend Archimandrite
Chrysostomos, Abbot,
St. Gregory Palamas Monastery
Etna, California

On pages 752-3 you picture a Byzantine icon. The caption says: "Christ surrounded by angels, prophets, and saints." The icon depicts archangel Michael, conqueror of Lucifer, surrounded by angels, saints, and Christ (upper left).

Orestes Pitsionis
Philadelphia, Pennsylvania

We should have pointed out that the photograph shows only a part of the Pala d'Oro. Christ is at the center of the whole, and it is one of the angels surrounding him that appears in the picture.

Mount Athos

As a follower of the Serbian Eastern Orthodox faith, the photos of Mount Athos (December 1983) had special meaning for me, as I am sure they did for many other Orthodox readers (especially the women, who will not be able to see the Holy Mountain any other way). It was unfortunate that you did not include photos of the many Serbian monasteries like Studenica, Ravanica, Sopoćani, and Gračanica. In fact, we so revere



JUST DOWN THE RIVER

AMERICA BORDERS ON THE MAGNIFICENT
Canada 

For more information about vacations in Canada, write Canadian Tourism, Box 1159 AZ, Glenview, Illinois, 60025.

these holy places of our past that an exact copy of Gračanica is being built in Third Lake, Illinois, to serve as the see of the Free Serbian Orthodox Church in the U.S.A. and Canada.

Alex Stosich
Hamilton, Ontario

If, as described on page 740, "the remains of a former abbot rest in a special box," he must have been a very interesting character. From what is shown in the box, it looks as if he had two heads!

R. A. Dunbar
Redding, California

We prefer to think that the box holds the remains of two former abbots.

Europe Map

The map "History of Europe" (December 1983) is most informative. However, may I draw your attention to an error in depicting Kaiser Wilhelm II wearing a beard. Not during any period of his life did he have a beard (mustache only). Perhaps the artist has confused his likeness with that of his father, Friedrich Wilhelm, who wore a beard.

D. H. Wilson
Toronto, Ontario

Our illustration of Wilhelm II was based on a photograph made after his abdication and exile in Holland. As kaiser, he wore only a mustache.

Your otherwise instructive and beautiful map

should have given at least honorable mention to the Croats, who stood between the Ottoman Empire and Western Europe (1453-1900). Surely the culture of the West would have been far different (had it survived at all) if it had not been for generations of my ancestors who repulsed the Turks for more than four centuries.

Tom Ballen
Portland, Oregon

Decoys

It was a source of great pride for me to see my grandfather Ira Hudson mentioned in your recent article on decoys (November 1983).

One sad footnote to his story is that grandfather carved three dozen decoys a week, sold them for 25 cents each, and relied on this income to support 11 children. After his death there were no decoys left in the family to pass on to his offspring. Your pictures were the first glimpse I have ever had of his work.

Earl Hudson Hegar
Broomfield, Colorado

I'm surprised that NATIONAL GEOGRAPHIC would publish this story. Decoys may be works of art and considered masterpieces; still the main thrust of the article is akin to hunting and killing of waterfowl, and that is appalling.

Chester L. Smith
Hanover, Pennsylvania

PONTIAC GIVES YOU THE LUXURY OF CHOICE

At Pontiac, we believe the selection of a fine automobile should involve a choice, not merely of color and equipment, but of size and style as well.

That's why we offer you two luxurious 1984 Pontiacs.

BONNEVILLE From its understated elegance to the sheer comfort you'll find inside, Bonneville Brougham offers thoughtful refinements. Like passenger assist straps. Courtesy lamps. Even a soft chime that gently reminds you to buckle up. Bonneville Brougham. It's Pontiac luxury at its contemporary best.



BONNEVILLE

Hawaii

In the article on King Kamehameha (November 1983), the author's conclusion that settling 200 native Hawaiians each year constitutes "much-needed reform" in the Hawaiian Homes Commission does not take into account the fact it will take 40 years at that rate to settle all present applicants. A federal-state task force has proposed a five-year accelerated effort to place all the nearly 8,000 native applicants on homestead lands. The Secretary of the Interior and the Governor of Hawaii have not yet agreed to accept the proposal, but progress finally seems at hand.

Joseph D. Gebhardt
Washington, D. C.

While perusing the map with your article on Hawaii, I was surprised to see an "interstate" highway. Can you tell me what states a traveler of this road might expect to pass through?

George A. Dillon
Boston, Massachusetts

A state of surprise, if one tries to reach California. "Interstate" is short for the National System of Interstate and Defense Highways.

Pitcairn and Norfolk

I was in the library today and noticed the collection of NATIONAL GEOGRAPHICS dating back to

1908. In the December 1957 issue was an article about Pitcairn Island entitled "I Found the Bones of the *Bounty*," by Luis Marden. According to this article, the mutineers "grudgingly granted them some bread and water, a little pork," and Captain Bligh and crew "fought starvation, thirst" for 41 days. This is quite a contrast to the "most gentle" mutiny recorded by Ed Howard in the October 1983 issue, which states that Mr. Christian not only gave Bligh his own good sextant but enough provisions to have "11 days' rations remaining when they landed."

Greg Stanko
Roseburg, Oregon

Our 1957 article relied on Bligh's published account of the mutiny, which was understandably bitter. Christian's descendants on Pitcairn, on the other hand, would rather emphasize that no lives were lost. Food given to Bligh and crew made for small portions because of Bligh's decision to sail for Timor—a 3,600-mile voyage.

.....
Letters should be addressed to Members Forum, National Geographic Magazine, Box 37448, Washington, D. C. 20013, and should include sender's address and telephone number. Not all letters can be used. Those that are will often be edited and excerpted.

PARISIENNE Our stylish full-size Parisienne Brougham is designed for comfort. The fully reclining front passenger seat makes long trips a pleasure. And the outstanding riding qualities of full coil suspension help you arrive refreshed. Parisienne Brougham. It's Pontiac luxury at its traditional best.



PARISIENNE

PONTIAC 
WE BUILD EXCITEMENT



BEFORE WE PUT THIS DIAL ON OUR RANGE IT HAD TO PASS AN EYE TEST.

At Frigidaire, good design and good sense go hand in hand.

For example, take this life-size dial. It isn't just beautiful. It's *readable*. In fact, if you place this ad 12 feet away, you can still read it.

If you also consider how this dial is infinitely adjustable (many range knobs aren't), easy to grasp and pulls right

off (so you can clean behind it, instead of cleaning *around* it), you'll notice one more thing.

An uncommon display of common sense.

You see, no matter where you look on a new Frigidaire electric range, you're bound to find a logical idea.

Look at the cooktop. Not only does it lift



up, it *props up* for easy cleaning. Its continuous "upsweep" design is seamless, so no dirt and grease can get caught in illogical cracks.

If you want a range with a self-cleaning oven, ours is so energy-efficient it only costs about 36¢* per cleaning. (And what's more logical than saving money?)

Now look at a Frigidaire range's cooking capabilities.

Like Dual-Radiant Baking. What makes this so logical is how it uses both top and bottom cooking elements, simultaneously, to efficiently bake and brown what you're cooking.

Then consider our broiling element. It's extra wide, so you can cook with even heat radiating across the oven.

There's even a Pre-Heat setting on our new ranges that cuts the normal warm-up time almost in half.

But our most logical idea is the Frigidaire Quality Test Track, where every range goes

through a lot more than an eye test before it can leave the factory. It's the kind of quality control that gives all our appliances a reputation for being so reliable.

So if you're looking for a new range, look at one of ours. Once it passes *your* eye test, we think you'll make the logical choice.

Frigidaire

Logical ideas that last.



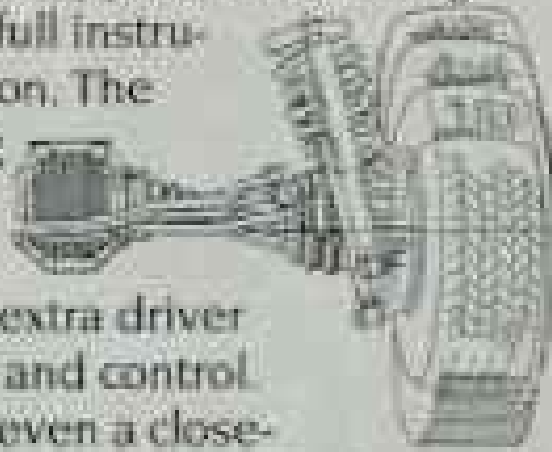
Take an open mountain road. Coiled and unforgiving. Add a sleek, slippery Celica GTS, bunting with muscle, agility and command performance. Fasten your seat belts, strap on your gloves. And look out. You're about to conquer the curves and tame the turns as it's never been done before.

For '84, Celica has even more inspired performance and obedient handling than ever before. Refinements to the front end, like fully retractable headlights and an enlarged front air dam, give Celica a drag coefficient of a mere .34 and sharp looks as it cuts through the wind. But that's not all. There are



MacPherson struts, variable assist power rack-and-pinion steering, independent rear suspension, and 4-wheel disc brakes. Plus extra wide steel belted radials on 14" x 7" aluminum alloy wheels. All this powered by an Electronically Fuel Injected 24 liter single overhead cam engine. It all adds up to a car that grabs attention as easily as it grabs the road.

Inside, Celica GTS gives a no-nonsense approach to driving. There's full instrumentation. The steering wheel is padded for extra driver comfort and control. There's even a close-ratio 5-speed overdrive transmission, and a 5-speaker AM/FM/MPX



OH WHAT A FEELING! TOYOTA

stereo with automatic power antenna. And for hip-hugging thigh-bolstering comfort there's the famous 8-way adjustable driver's Sport Seat that *Car and Driver* rated as the best in the business.*

A breathtakingly exciting machine. Watch it turn you on as it takes its turns.



**Car and Driver*, January 1983

BUCKLE UP—IT'S A GOOD FEELING!

THE 1984 CELICA GTS.
WITH PERFORMANCE LIKE THIS,
ONE GOOD TURN DESERVES ANOTHER.



AGILE!

Just once in a lifetime.

The World's Fair and New Orleans. It's a magical combination that can only happen once. So come on down the river. Join America and other great nations in a celebration the likes of which the world has never seen. Walk from the French Quarter into a part of China's mysterious past. Stroll through an Italian village. Tip a stein at a German beer garden. Sense firsthand the wonders of Egypt, Japan, Mexico— 22 different countries in all. See every kind of show—from a nonstop jazz

and gospel tent to a lavish Broadway-style aquacade. See every kind of entertainer from Bob Hope to The Oak Ridge Boys. Taste every kind of food in over 70 restaurants from around the world. See the space shuttle Enterprise.

But first you have to get there. We have 25,000 hotel rooms waiting. Just tell your travel agent or tour operator that you want to go to Louisiana—to the biggest celebration ever—the "Great Celebration." For more information call (504) 525-FAIR.

The World's Fair in New Orleans.
May 12-Nov 11



The Great Celebration!

On Assignment

HE HARDLY LOOKS THE AGE to be an old China hand, but a decade has passed since *Wong How-Man* first journeyed to the People's Republic. The difference now? "You can sense the increase in relaxation with the first steps you take in the country," he says.

The Hong Kong native earned a journalism degree in 1973 from the University of Wisconsin at River Falls. After returning home and making brief trips into China, whetting his appetite for the country, he married a Chinese-American and moved to Los Angeles.

But his interest in China, and particularly in her ethnic minorities, persisted. In 1982 Mr. Wong and two Chinese drivers set out in a four-wheel-drive vehicle to challenge remote, precipitous country better suited to yaks' hooves than tires. In six months of travel—despite an overheating radiator, dead batteries, and occasionally getting stuck in the mud—Wong visited numerous ethnic groups like the Tu (*right*) of eastern Qinghai Province. They fed him sumptuously, but his camp meals suffered from the lack of a pressure cooker. "At high altitudes I could only heat water to about 80°C [176°F], so my rice was only half-cooked," he explains.

In the chilly hills of Guizhou Province, Wong photographs a woman of the Ge people dressing formally in his honor (*below*). Like



WONG HOW-MAN (LEFT); ZHANG CHANGLIU

many peoples, the Ge are classed by the Chinese government as a subgroup of another minority, the Miao, although the Ge hope for full minority status someday.

The touchiest issue, Wong found, concerns China's international border areas. "Where a people overlap a border, they will feel much closer to each other culturally than to faraway governments," he notes. "But I believe the authorities are earnestly trying to allow these peoples autonomy. China may be backward in some ways, but not in minority policy."



DEAL OF THE CENTURIES.

TWA GETAWAY. EUROPE AT PRICES YOU THOUGHT WERE A THING OF THE PAST.

Historically, TWA Getaway® Vacations have been known for their value. And this year is no exception.

What's more, they're easy to plan. TWA Getaway takes care of all the details. We reserve your flights. Book your hotel rooms. Even map out your daily itinerary. To top it off, this year we've made it even easier to go by expanding our entire vacation program. So you can take more tours to more destinations. In fact, the hardest thing about TWA Getaway Vacations is choosing one.

Take *The Georgian*, a princely 2-week jaunt through England, Scotland and Wales. It's pomp and pageantry. But it won't cost you a king's ransom.

ANCIENT GREECE. CLASSIC DEAL. ONLY \$698-\$798*.

The Argonaut is equally alluring. It's a classic combination of the spectacular Greek mainland with a cruise to the poetic Aegean islands. You'll go for another attraction on this 10-day repose. The low price.

Now that you're tempted, you should know about the *Iberian Explorer*, a Super Saver

GREAT BRITAIN'S EVEN GREATER. ONLY \$689-\$768*.

SPAIN AND PORTUGAL SHINE. ONLY \$398-\$469*.



Vacation featuring 2 weeks of sunshine and sangria in Spain and Portugal. Even more tempting is how little it costs.

And there are 110 more vacations where these came from. For your free brochures, see your travel agent, call TWA at 1-800-G-E-T-A-W-A-Y, or send in the coupon.

TWA Getaway and Super Saver Europe. They're deals that'll go down in history.

*Per person, double occupancy, excluding airfare.

Free TWA Getaway® Europe and Super Saver Europe Brochures.

I wouldn't miss the deal of the centuries. Please send my brochures right away. Mail to: Trans World Airlines, P.O. Box 2690, Smithtown, NY 11787

NAME _____

ADDRESS _____

CITY _____

STATE _____



TWA GETAWAY VACATIONS
EASILY THE TIME OF YOUR LIFE

When John Deere builds an economy rider, only the price is stripped down.



5-speed shift-on-the-go gear transmission for smooth operation and durability.

Optional 6½-bushel bagging system for efficient collection of grass and leaves. (Other attachments include a 38-inch front blade, a 500-pound capacity dump-cart and a 15-bushel lawn sweeper.)

8-hp Briggs and Stratton engine with solid state ignition for plenty of reliable power.

Sector and pinion steering for easy turning and positive control. Tight 27-inch turning radius.

Hinged mower chute for quick installation of bagging attachment.

Separate clutch and brake pedals for easy-to-use automotive-type operation and smooth starting on hills.

Band-on-axle brake for quick, reliable stops and secure parking.

Full-length 54-inch solid-steel frame for strength and durability.

Four-point mower suspension for stability and level cutting at any mowing height.

Deep-contoured 30-inch mower with adjustable cutting heights of 1½ to 3½ inches and a 12-inch opening for clean bagging or uniform discharge.

Two-position footrests for comfortable operation.

Introducing the new R-Series Riding Mowers.

Until now, if you wanted to buy an economy rider, you had to settle for economy features. But this year, John Deere introduces the R 70 and the electric-start R 72, two solid economy riders that are built with traditional John Deere quality.

Each comes with several features you won't find on competitive riders.

And each is built with an attention to detail that'll keep them running for years, and your lawn looking well groomed.

So if you want to save on a riding mower, but you don't want to sacrifice comfort, convenience, performance or reliability, take a look at the new R-Series riders at your nearby John Deere dealer. Because if you can afford a riding mower, you can now afford the best.

For more information or the name of the dealer nearest you, call 800-447-9126 toll free (Illinois, call 1-800-322-6796). Or write John Deere, Dept. 59, Moline, Illinois 61265.



Nothing Runs Like a Deere®

Ford LTD

Comfort when you want it...

Ford LTD. It's a beautiful balance of the two most important things a car needs to be. LTD's design is smart, crisp and understated. Inside, it is a comfortable, functional place to be. The seats are designed for driving comfort. They provide good lower back and under-thigh support. Side bolsters are generous to provide support while cornering. Both front seats are fully reclinable and feature fold-down armrests. LTD's interior is designed to let you drive, and drive well, in comfort and style.



Capability when you need it.

Beneath all the comfort, there's solid capability. LTD's suspension with its front stabilizer bar and gas-filled shocks and struts coupled with rack and pinion steering makes up a ride and handling system that can handle almost any driving situation.


LTD. It's from Ford. And a recent survey concluded Ford makes the best-built American cars. The survey measured owner-reported problems during the first three months of ownership of 1983 cars designed and built in the U.S.

Ford LTD. Comfort when you want it. Capability when you need it.

Get it together—
Buckle up.

Have you driven a Ford...
lately?





They led Hillary to the top of Mount Everest. He led them out of its shadow.

In 1953, Sir Edmund Hillary became the first man to conquer Everest. But the Sherpa people who guided him had a far greater mountain to conquer.

They had no schools. No hospitals. No way to learn about the world beyond the mountains.

Discover the story of the man who spent 20 years of his life leading the Sherpas out of the shadow of illiteracy and disease.

Watch *Return to Everest*, a new National Geographic Special on PBS.

It's television that breaks new ground. The kind of television Gulf believes in.

Produced by the National Geographic Society and WQED/Pittsburgh.

Underwritten for the ninth consecutive year by Gulf Oil Corporation.

Watch *Return to Everest*, March 7 at 8 p.m. EST on PBS. Check local listings.



Gulf

Gulf Oil Corporation • National Geographic Society • Public Television • Partners In Discovery

Closed Captioned for the hearing-impaired. © 1984, Gulf Oil Corporation



Photographed by Merlin D. Tuttle with a Canon F-1 **Kitti's Hog-Nosed Bat:** Genus: *Craseomycotis*
Species: *ibonglongrat* Adult size: About the size of a large bumblebee; wingspan up to 17cm
Adult weight: Approx. 2 grams Habitat: Caves in one small area in western Thailand
Surviving numbers: Fewer than 200 are known to exist



Wildlife as Canon sees it: A photographic heritage for all generations.

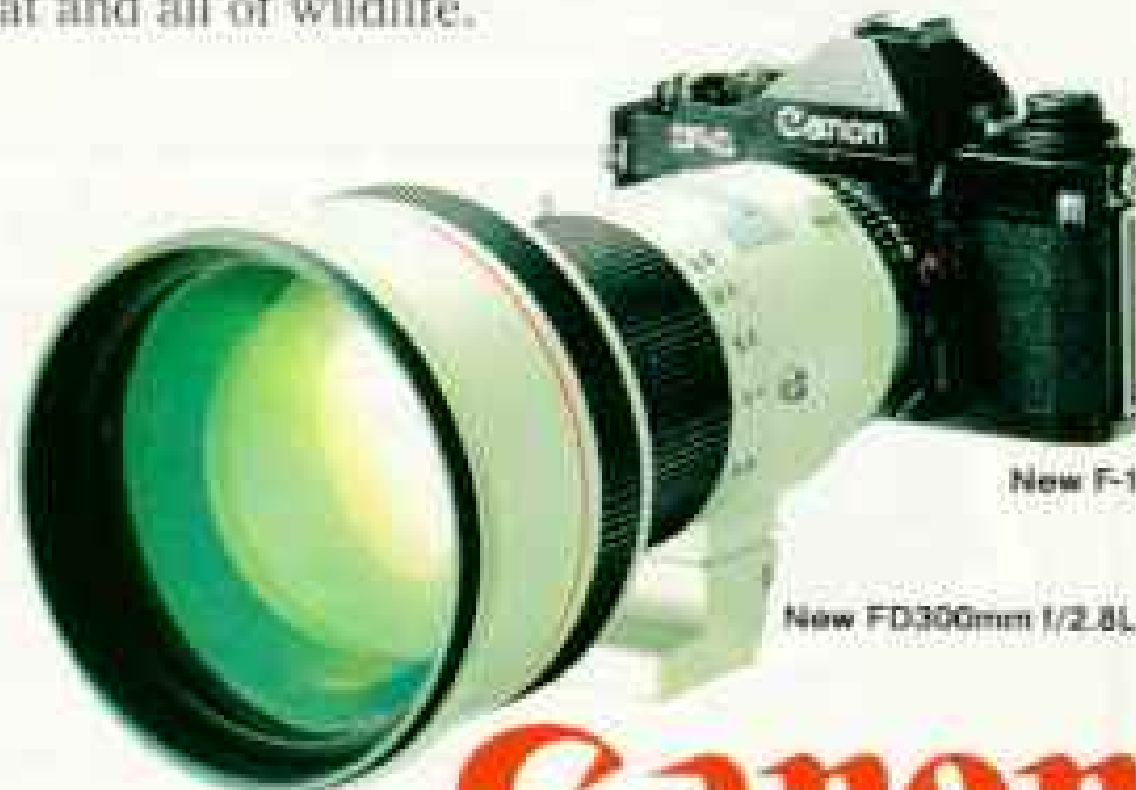
The Kitti's hog-nosed bat has the distinction of being the world's smallest mammal. It weighs only 2 grams and is the size of a large bumblebee. Discovered in 1973 inhabiting caves at a national park in western Thailand, this unusual bat is the only member of its genus and family. Since its discovery, it has captured the curiosity of visitors to the caves and has become much sought after by specimen collectors. Today, it is found in only three caves.

The Kitti's hog-nosed bat could never be brought back should it vanish completely. And while photography can record it for posterity, more importantly photography can help save it and the rest of wildlife.

In addition to being an invaluable research tool for scientists, photography can help enlighten the public about the Kitti's hog-nosed bat. It can call people's attention to the urgency to protect the Kitti's hog-nosed bat from further human distur-

bance, while enhancing their understanding of this unique mammal.

And understanding is perhaps the single most important factor in saving the Kitti's hog-nosed bat and all of wildlife.



New F-1

New FD300mm 1/2.8L

Canon
Images for all time

The Symbol That Takes the Guesswork Out of Buying Carpet.



Tough Testing is the Reason Why.

After you select the color and style of a carpet, how can you be sure the carpet will really last? Just look for carpet that carries the Monsanto Wear-Dated® label.

Wear-Dated carpet is the most thoroughly tested carpet you can buy. Every grade of Wear-Dated carpet must pass a series of rigorous tests before it can earn our famous label. This tough testing is your assurance the carpet you buy will give you many years of luxurious service.

As a Wear-Dated carpet customer, you can call a toll-free number, 24 hours a day, and get personal carpet cleaning and service advice — absolutely free.

Wear-Dated® carpet is warranted by Monsanto for five full years normal wear from date of original installation; carpet installed on stairs or put to non-residential use excluded. For repair or replacement of identical or equivalent carpet, forward your sales slip to Monsanto.



Soil and Stain Resistance.

Special fibers protect against stains and soil. Vacuuming is more effective.



Pile Resilience.

All Wear-Dated carpet is made of 100% Ultron® nylon and is specially designed to resist crushing and matting.



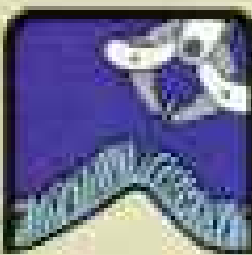
Static Control.

Wear-Dated carpet fibers are made with mini conductive elements which virtually eliminate static electricity.



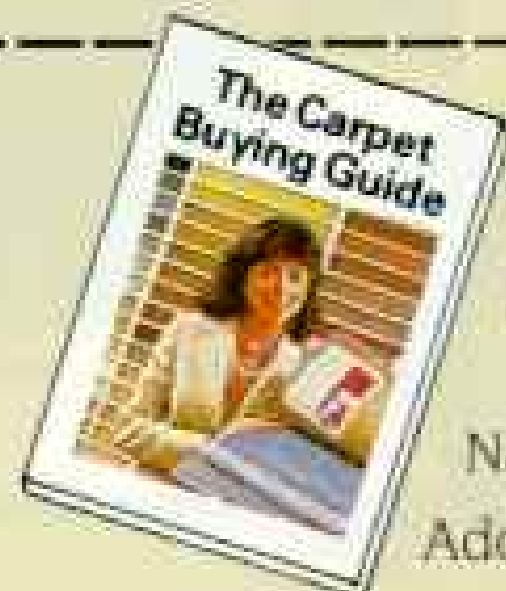
Resistance to Fading.

Your carpet stays beautiful longer because Wear-Dated carpet has been rigidly tested for colorfastness.



Durability.

Carpet with the Wear-Dated label has been tested and approved for maximum resistance to snagging and pulling.



Send Now for your FREE Carpet Buying Guide.

It's everything you need to know about carpet. Choose with confidence.

Mail to: Monsanto Textiles Company, Dept. 1000
P.O. Box 646, St. Louis, MO 63188

Name (Please Print) _____

Address _____

City _____ State _____ Zip _____

WHEN YOU PUT MONEY INTO WHOLE LIFE INSURANCE, THIS IS WHAT YOU'RE REALLY INVESTING IN.



The people you care most about. Your family. An investment in their future is probably the most important one you could ever make.

Metropolitan understands your concerns for them. For their happiness and security both now and in the future.

That's why we offer Whole Life *Plus*. It's permanent insurance that you can keep for as

long as you wish. Protection that will be there when you need it.

And Whole Life *Plus* does more than provide security for your family's future. It builds cash value providing you with an increasing reserve of cash to draw on, should you need it.

Metropolitan's Whole Life *Plus* is one of the best buys in permanent insurance protec-

tion. And its premiums are guaranteed never to rise.

Call your Metropolitan representative, a trained professional who can give you more information on solid protection for your family's future.



Metropolitan
Insurance Companies

METROPOLITAN REALLY STANDS BY YOU.

Life/Health/Auto/Home/Retirement