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◀ COVER: Tethered astronaut ventures out of a Gemini spacecraft: an artist's conception (pages 368-9).



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High-spirited bronc battles a determined rider at the annual Frontier Days rodeo in Prescott, Arizona.

## Wheels spin, hoofs fly: GEOGRAPHIC tours U. S. 89

WHEN STAFF MEN go on assignment, they are likely to end up riding anything on wheels or feet. To roam the West and see its phantasmagoria of wonders old and new, writer Ralph Gray toured Route 89 with his family and Ginger the dog in *Roadrunner*. The windshield framed many a vista of cowboy country as the caravan motored northward along the route often called the national parks highway because it links six parks in the United States—including Grand

Canyon, Yellowstone, and Glacier—and three others in Canada.

In next month's issue Mr. Gray will log *Roadrunner's* trail "From Sun-clad Sea to Shining Mountains," and perhaps spark ideas for your family's summer trip.

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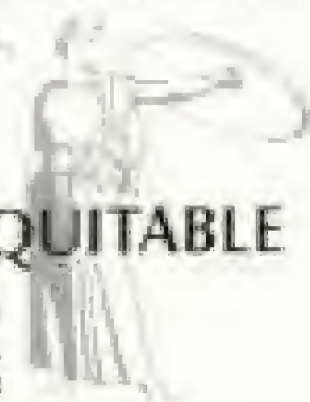
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WELCOME



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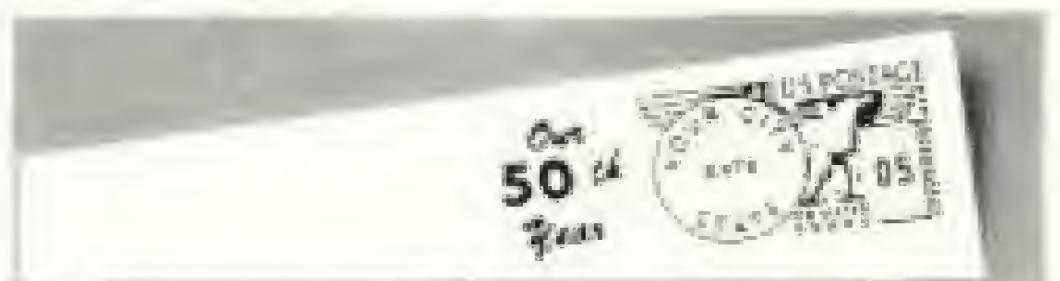
"Mail is incidental in a business such as ours. And that's why we put in this little Pitney-Bowes postage meter. It frees us from the bother of buying and protecting and sticking stamps, or stocking inefficient pre-stamped envelopes. I was skeptical about a postage meter at first, but the longer we have it, the more we like it."

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Catalog free. Write Evinrude Motors, 4246 N. 27th Street, Milwaukee, Wisconsin 53216.

# STARFLITE 90-S by EVINRUDE



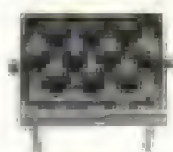
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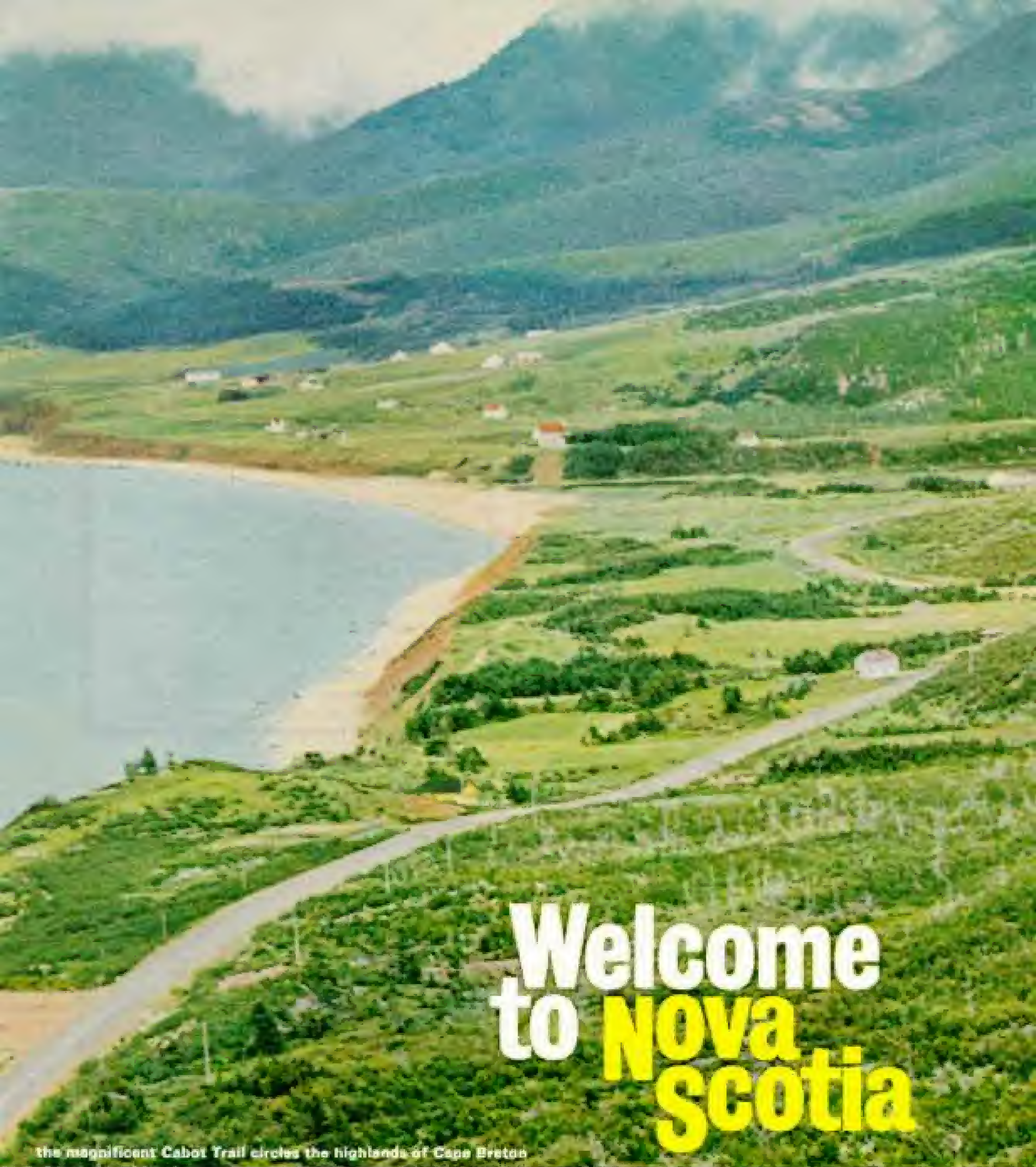
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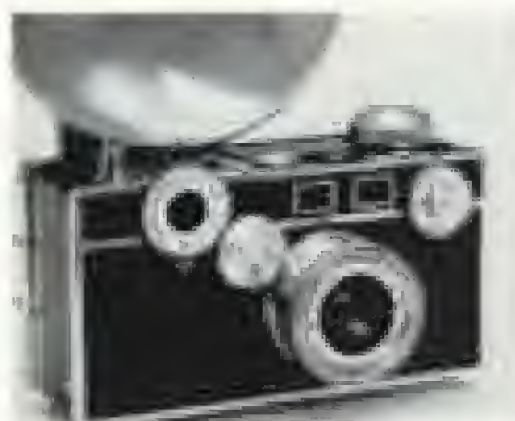
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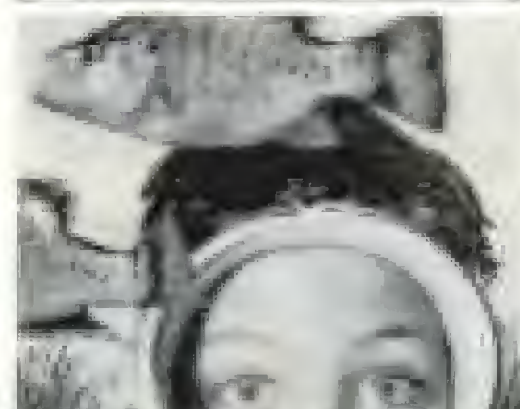
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*... come see!*

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# COME SEE THE CHANGING MIDDLE SOUTH

(Arkansas • Louisiana • Mississippi)



National Military Park, Vicksburg, Mississippi



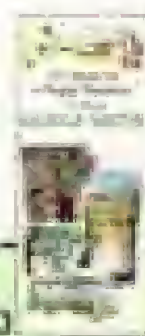
Saturn rocket booster plant, New Orleans, Louisiana

The battlefield of Vicksburg, amid beautiful hills, inspires thousands of visitors with its mementos of courage and daring. The contrast of century-old weapons with rocket boosters being built at the NASA-Michoud plant symbolizes the Changing Middle South. Most important, here men and women are quick to learn needed skills, are dedicated to doing the job right. In the Middle South, people support industry's right to profit.

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# Love Letters to Rambler



Mr. Bernard Myers

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**"36,000 miles of heavy traffic—  
\$5.10 in expenditures to date"**

"The Rambler, in my opinion, is one of the most reliable, economical and pleasantest driving automobiles on the road today.

"That 36,000 miles represent hard miles of heavy traffic, in all kinds of weather, including mountains and broken-up roads.

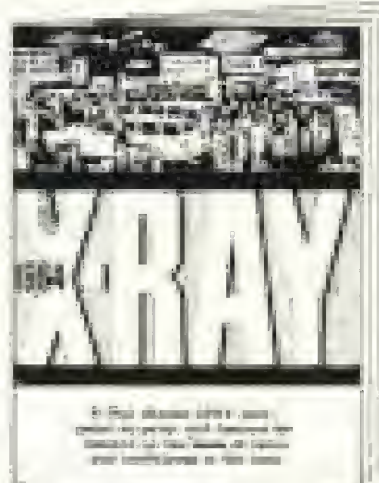
"In expenditures to date, the car has cost me \$5.10 (excluding normal maintenance). And it still runs as good as the day it was delivered. If anyone can beat that for economy, he's not riding.

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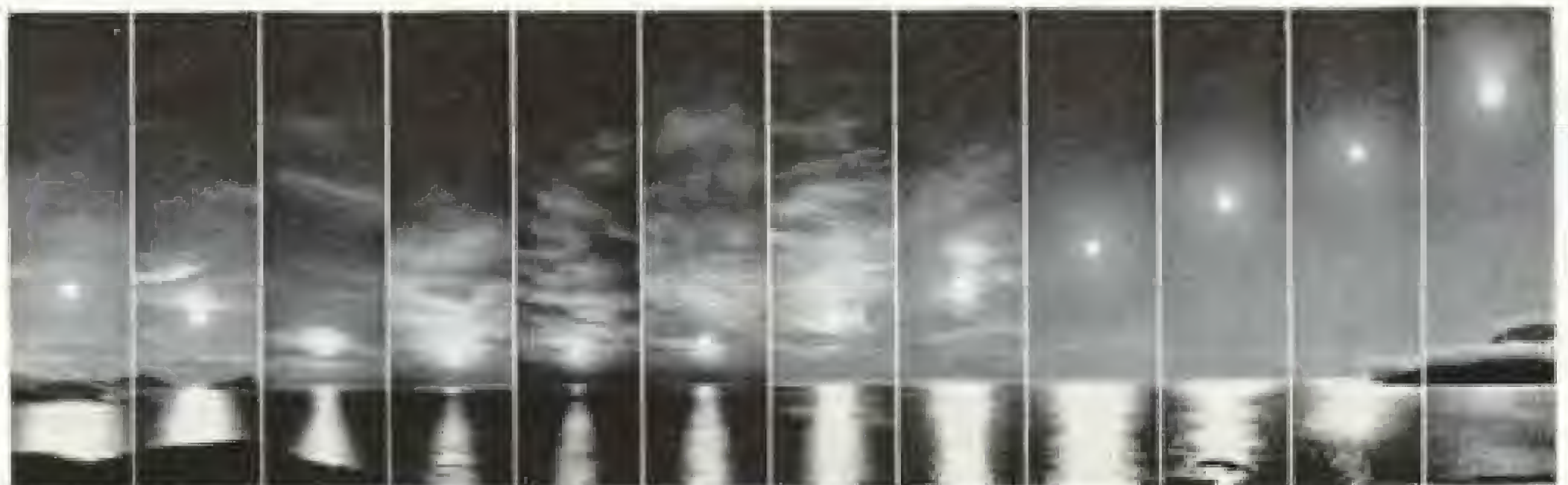
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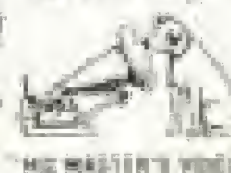
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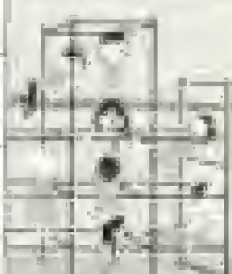
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March, 1964

# NATIONAL GEOGRAPHIC

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## The Last Full Measure

THE WORLD PAYS TRIBUTE TO PRESIDENT KENNEDY

By MELVILLE BELL GROSVENOR  
President and Editor,  
and the Staff of the National Geographic Society

**H**IS LIFE WAS SUCH—the radiance he shed—that if we live to be a hundred, we will remember how he graced this earth, and how he left it.

Only the future can assign to John Fitzgerald Kennedy his true place in history. But this I know: When men now boys are old, in distant time beyond the year 2000, they will say, "I remember. I remember when they brought him home, the murdered President, from Dallas..."

Again and again the story will be told—just as I recall my Grandfather Grosvenor, at 92, telling me graphically of how, as a young student at Amherst College in Massachusetts, he traveled by horse and train to the bier of the martyred Lincoln.

It was at Amherst, as it happens, that President Kennedy received his last honorary degree, four weeks before his death. Said poet Archibald MacLeish at the time:

"The people of this countryside may forget



JOHN FITZGERALD KENNEDY  
PRESIDENT OF THE UNITED STATES  
JANUARY 20, 1961—NOVEMBER 22, 1963

**P**RESIDENT KENNEDY expressed a particular liking for this photograph when it was shown him by a White House photographer several months ago. "Let's save it for a special occasion," he said.

Mrs. Kennedy was unaware of the remark at the time she selected the likeness for the prayer card distributed at the President's funeral. The reverse side carries a simple prayer written by Mrs. Kennedy:

"Dear God, Please take care of your servant John Fitzgerald Kennedy."





in ordinary human course what anyone says on this occasion, but they will remember for many, many years that a young and gallant President of the United States, with the weight of history heavy upon his shoulders, somehow found time to come to our small corner of the world to talk of books and men and learning."

#### Sense of Mission Toned Mind and Body

And after he was gone forever, his host, Amherst President Calvin H. Plimpton, spoke to students during a memorial service on the impression he had made there:

"Four weeks ago he was here. We saw him, we heard him, and we knew him. He was one of us, for he was our most recent alumnus.

"Now he is gone. But I think we bear with pride our sorrow so sharpened by this very intimacy.

"I suppose I saw more of him than the rest of you. He came to our house twice. The first time he took off his coat, and we talked in our shirtsleeves. We talked about Adenauer, McNamara, Eisenhower, the atom bomb. . . . It was high level, and it was good to hear.

"What was the impression he made upon me? He had said that Robert Frost had toughness, but this was also the impression that Mr. Kennedy gave: not tough in the sense of ruthlessness or boorishness; rather tough in the sense of purpose, of mission, and of meaning business. Tough like a machine that had all the frills removed and is honed down hard for action—action in mind, in thought; action in body.

"He had a certain leanness which I admire. He was born rich, but he worked harder than the poor. There was no softness about him. Becoming President and then being President is not a sweet indulgence of one's ego. He was ambitious, but his concern was not himself.

"He was physically lean, no extra flab or paunch around his middle. He was lean with words. His speech was no windy diatribe. And he was lean in personality. He was not a

charmer, not smooth, no soft soap, no affectations, no 'side,' no effort to seem important—rather a strong sense of purpose, with no time to ask himself if he was happy.

"He believed he could do the job better than anyone else, so he moved briskly. What's the question? What's the response? His thoughts were clear, going immediately to the heart of the problem. It was a tough, yet supple mind. . . .

"As we shed our tears, let us remember his toughness, let us trim our paunches, curtail our self-indulgences, our petty searches for little concerns, our laziness.

"As Robert Frost said of tennis courts: We are not on them to see if the lines are straight, but to play tennis. Let us study to live, not merely to prepare to live. We are here to sharpen our wits, and strengthen our bodies. Let us remember to advantage our late great President's toughness in mind, body, and soul. Let us stand a moment in silence to honor him; then let us go and do the work he couldn't complete."

#### Courage Triumphs on Longest Weekend

After the funeral, Dr. Plimpton spoke too of the President's courageous wife:

"We have talked of one we knew. Now let us talk of one we didn't know. For on this, the longest weekend, there was another figure, another star. She had a role to play for which there was no time to rehearse, no opportunity to learn her lines. . . .

"Her preparation was all literary and artistic. She redecorates the White House and brings music to it. She is lovely. She rides, she water-skis. And she did arise from the death of her son.

"And then the longest weekend. One moment laughing gaily, and then the next cradling her husband in her arms as his life's blood flowed upon her.

"Then she was placing a ring in her dead husband's hand. Then standing beside President Lyndon Johnson as he took the oath of office. We see her riding with the coffin, sitting

This young and vibrant family stood together in Palm Beach, Florida, last Easter: Jacqueline, John, Jr., John F., and Caroline Kennedy.

Bidding her husband goodbye in Dallas, Mrs. Kennedy kissed his lips, then slipped her wedding ring into his lifeless hand. The moment was so heart-shattering that Senate Majority Leader Mike Mansfield made it the theme of his eulogy before the President's bier in the Capitol Rotunda: "There was a sound of laughter, in a moment it was no more. . . . There was a father with a little boy, a little girl, and a joy of each in the other. In a moment, it was no more. . . . A piece of each of us died at that moment."





in a vigil, and then going to the Capitol with Caroline and John-John.

"Again yesterday she decided what her role was and she played it. She saw her duty and she lived up to it.

"Not one of us would have blamed her if she had hidden at home—not one of us would have blamed her if she had worn dark glasses, or if she had left the children behind. Yet she went from triumph to triumph, all showing that something within us, for which, when it is revealed, we can all be proud."

Like Lincoln's passing, the loss of President Kennedy moved men to poetry as well as tears. England's 85-year-old poet laureate, John Masefield, penned a tribute which appeared in *The Times* of London on the day of the funeral:

*All generous hearts lament the leader killed,  
The young chief with the smile, the radiant face,  
The winning way that turned a wondrous race  
Into sublimer pathways, leading on.*

*Grant to us Life that though the man be gone  
The promise of his spirit be fulfilled.*

And in a program of the British Broadcasting Corporation so movingly sincere that it was made a part of the *Congressional Record*, heartsick young actors who normally devote their talents to satire quoted Longfellow's grand old words inspired by the death of the Civil War President:

*Sail on, O Ship of State!  
Sail on, O Union, strong and great!  
Humanity with all its fears,  
With all the hopes of future years,  
Is hanging breathless on thy fate!*

"When Kennedy was elected three years ago, it was as if we'd all been given some gigantic, miraculous present," said one young man in the special November 23 broadcast of B.B.C.'s "That Was the Week That Was."

"Suddenly over there in Washington was

Home for the last time, John F. Kennedy enters the White House at 4:25 a.m., Saturday, November 23. Jacqueline Kennedy, still in the pink suit selected for a triumphal ride through Dallas, Texas, follows the flag-draped casket, her husband's brother, Attorney General Robert F. Kennedy, walks at her side. Sisters-in-law Eunice Shriver and Ethel Kennedy, with Peace Corps Director Sargent Shriver, follow them. Servicemen present arms as their slain Commander in Chief moves past.

this amazing man who seemed so utterly right for the job in every way that we took him completely for granted. Whenever we thought about the world, we had that warm image at the back of our minds of a man who would keep everything on the rails. Now suddenly that present has been taken away. . . ."

"When the news came through shortly before eight o'clock last Friday night," said another, "more than a thousand people all over London caught buses or tube trains, took taxis, drove or walked to the American Embassy in Grosvenor Square. They had to do something. In Berlin, Mayor Willy Brandt asked people to put lighted candles in their darkened windows. Within minutes they were flickering all over the city. In Moscow at five past eight the radio broke into its programs to announce the news. . . ."

Later on this British telecast, a woman sang the saddest of songs, like an old English ballad of blood and woe:

*A young man rode with his head held high,  
under the Texas sun.*

*And no one guessed that a man so blessed  
would perish by the gun.*

*Lord, would perish by the gun.*

*A shot rang out like a sudden shout, and  
heaven held its breath,*

*For the dreams of a multitude of men rode  
with him to his death.*

*Lord, rode with him to his death.*

*Yes, the heart of the world weighs heavy with  
the helplessness of tears,*

*For the man cut down in a Texas town in the  
summer of his years.*

*And we who stay must not ever lose the  
victories that he won,*

*For wherever men look to freedom, then his  
soul goes riding on.*

*Lord, his soul goes riding on.*

In this country, television and radio networks canceled all commercials. Setting a new high standard for their professions, they gave the Nation an inspired and inspiring view of those unforgettable days.

By far the largest television audience in history—an estimated 93 percent of all sets and 175,000,000 transfixed viewers in the United States alone—watched the historic events unfold. The U. S. communications satellite Relay, orbiting the globe, enabled people in 23 countries to view portions of the lying in state, the funeral attended by the great of this earth, and the final scenes at Arlington National Cemetery.

The television industry also gave a heartening and illuminating lesson in civics to the American people as it showed in detail the smooth transfer of power to Vice President Lyndon B. Johnson. None who watched will soon forget his grief-stricken words as President to a Joint Session of Congress:

"All I have I would have given gladly not to be standing here. . . . I need your help. I cannot bear this burden alone. . . ."

#### **We Shall Remember Him, Smiling**

In the press, some of the most moving photographs and paragraphs ever produced to meet an urgent deadline resulted from the dedicated efforts of talented men and women to express the inexpressible.

Many writers recalled the young President's wit, for like Lincoln he had a keen sense of humor that lightened the Presidential load.

"He brought gaiety, glamor, and grace to the American political scene in a measure never known before," said an editorial by Mary McGrory in the *Washington Evening Star*. "That lightsome tread, that debonair touch, that shock of chestnut hair, that beguiling grin, that shattering understatement—these are what we shall remember.

"He walked like a prince and he talked like a scholar. His humor brightened the life of the Republic. . . . Shown his latest nephew in August, he commented, 'He looks like a fine baby—we'll know more later. . . .'

"When the ugliness of yesterday has been forgotten, we shall remember him, smiling."

In the shocked reactions that poured into

#### **J.F.K.'s Chair Stands Empty, but the Presidency Is Not**

Vice President Lyndon B. Johnson automatically became President at the moment John F. Kennedy died, and the United States system of government continued unbroken. Transition was swift; even before the funeral, Mr. Kennedy's office furnishings, including the rocking chair he favored, were moved from the White House to make way for the new President. Mrs. Kennedy plans to re-create the Kennedy office in a library at Harvard University, her husband's alma mater.







PHOTO BY AP/WIDEWORLD FOR LIFE; PHOTO BY AP/WIDEWORLD FOR LIFE



Chief Justice and Mrs. Earl Warren speak a word of sympathy to Mr. Shriver on the White House steps.

Lying in repose in the crape-hung East Room, the President drew homage from the Nation's leaders, who walked past his bier throughout the dark, rain-shrouded hours of November 23. Guard of Honor from the Navy, Coast Guard, Army, Marines, and Air Force stands at parade rest; priests kneel in prayer.

The Nation's parlor has seen both gaiety and gloom. Here rested the bodies of Presidents William Henry Harrison, Taylor, Lincoln, McKinley, Harding, and Franklin D. Roosevelt. Here in betrothal stood daughters of Presidents Grant, Theodore Roosevelt, and Wilson. Here actors, musicians, and dancers performed in fetes given by the Kennedys. Now the laughter is gone, and the shuffle of mourners marks the hours.

our headquarters from all over the world, his name was often linked with Lincoln's.

New Zealand author Maurice Shadbolt wrote us: "I doubt if there has been a President since Lincoln, Franklin D. Roosevelt included, who has commanded such respect beyond the U.S.A. Perhaps only a man as young as Kennedy could have given hope back to the world. . . ."

From Israel, GEOGRAPHIC Assistant Editor Kenneth MacLeish reported: "Acting President Kadish Luz told the Knesset [Parliament], 'Here we rightly see him as the successor of Lincoln.'"

The news had reached MacLeish at a hotel in Tiberias, by the Sea of Galilee. It came at

### Mourners Surge Toward the Capitol Like a River Flowing to the Sea

Some 300,000 lined the cortege route (below) on the wind-cold, sun-bright Sunday of November 24. Most stood wordless, eyes burning and throats dry, in a grief-disciplined silence almost unknown among crowds. Men lifted children not their own to their shoulders; photographers made way for rivals, and young policemen, their faces strangely bare of sternness, quietly asked for cooperation of the throngs.

After the procession had passed, crowds moved toward the Capitol, where the President's body would lie in state for 24 hours. This view of the west façade shows a congregation that pushed around to the east door and merged with a line that eventually stretched 40 city blocks (page 324). Thus did an estimated quarter of a million people wait to pay their respects before the bier.

PETER LINCOLN (RIGHT) © 1964



Funeral cortege moves down historic Pennsylvania Avenue toward the distant Capitol. Six gray horses pull the flag-draped casket, mounted on the same caisson that bore Franklin D. Roosevelt. Less than three years before, President-elect Kennedy traveled this route to his inauguration.









Flag at half-mast flies above the caisson on its arrival at the Capitol. High-spirited black horse, with saddle empty and boots turned backward in silver stirrups, symbolizes a warrior who will never ride again.

With labored step, pallbearers lift the mahogany casket up the 37 steps of the Capitol; the Presidential flag follows. Servicemen present arms; widow and children wait.

almost the moment when the first star appeared on that Friday night, ushering in the Jewish Sabbath, and Israelis were greeting each other with the ancient phrase "*Shabbath Shalom*"—"Sabbath Peace."

"Sudden jarring silence and frozen postures signaled tragedy," MacLeish recorded, "though the radio's Hebrew words were meaningless to me. Instantly, solicitously, people turned to translate: 'Your President shot!' As men with bowed heads waited further word, there was no sound but the sea's lapping waves. In this silence a man beside me whispered, in bitter irony, 'Shabbiath Shalom!'"

In Copenhagen a Danish student, fighting for control of her voice, told our Everest climber, Barry Bishop, "This was the first time in my life I ever saw my father cry."

And so, around the world, people in synagogue and sanctuary, pagoda and public square, mourned the lost leader as their own.

Thirty thousand gathered in St. Peter's

REUTERS. WORLD PHOTO © N.S.A.



Square in Rome to hear Pope Paul VI lament "how great a capacity for hate and evil" still lies in the hearts of men.

More than 10,000 lined up eight abreast to sign the condolence book at the United States Embassy in Warsaw, Poland.

Londoners heard a national memorial service announced by the half-muffled peal of all twelve bells in St. Paul's Cathedral.

Radio Moscow broadcast an unprecedented dirge of organ music. A solemn Premier Khrushchev called at Spaso House, the U. S. Ambassador's residence, and silently signed the book of condolences. His wife, who also called, signed the book with tears in her eyes.

Japanese fishing vessels in Tokyo Bay, their flags lowered to half-mast, drifted alongside U. S. warships in silent tribute.

In Kenya, weeping Kipsigis warriors in their ceremonial feathers and paint heard a leader extol the murdered President.

And in lonely Antarctica, parka-clad Navy men and scientists prayed for him at the Chapel of the Snows.

#### Four Indelible November Days

But the world's grief came to final focus on a flag-draped casket in Washington.

Each of those four November days left an impress all its own: the black Friday of the nightmare news; that awful Saturday of steady rain when the President lay for the last time in the White House and those who knew him called to bow before his bier in the silent East Room; the sunny Sunday of the muffled-drum procession to the Capitol; the cold, bright Monday of the funeral when emperor and queen, presidents and prime ministers walked with grooms and gardeners to the cathedral.

And what will each of us tell our grand-

*(Continued on page 324)*







Before the bier of husband and father in the Capitol Rotunda, Mrs. Kennedy and 5-year-old Caroline kneel and pray. Card on the wreath of carnations reads: "From President Johnson and the Nation."

To make this enduring record, NATIONAL GEOGRAPHIC photographer Mobley climbed to the Rotunda balcony and focused on the catafalque some 80 feet below.

#### Mr. Kennedy Rests on the Catafalque That Bore the Body of Lincoln

Beneath the Capitol's great dome, leaders of Congress, Supreme Court Justices, members and friends of the Kennedy family, and representatives of press, radio, and television form a circle of tribute.

In his eulogy here, Chief Justice Warren drew a lesson from the tragedy. "If we really love this country . . . if we fervently want to make this Nation better for those who are to follow us, we can at least abjure the hatred that consumes people, the false accusations that divide us, and the bitterness that begets violence."



Through television's eye (left), some 175 million Americans saw the rites and almost



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felt they had a role in them. In the Rotunda, widow and daughter approach the bier.



NATIONAL GEOGRAPHIC PHOTOGRAPHY CENTER © 2009

Dawn gilds the dome as a patient throng still waits at the Capitol's East Front. Entire families, some with babies in arms, stood through the bitter night, six and eight hours at a stretch, for the privilege of a few seconds beside the President's bier. When Capitol doors closed at 9 o'clock Monday morning, some 12,000 were still in line. Only a few went home; most stepped behind roped lines and waited until the casket moved down the steps two hours later.

Guard of Honor changes amid encircling citizens. A woman comes on crutches, men wipe away tears. At 9 p.m. Sunday Mrs. Kennedy returned to pray.



children? Volkmar Wentzel of our Foreign Staff remembers best the arrival from Dallas, the landing of the Presidential plane with the President's body—and a new President:

"When I went to Andrews Air Force Base on that fateful Friday, the story was written on people's faces. They were stunned with horror and disbelief. A newspaper reporter next to me kept saying, 'I can't believe it.' But the organization and the quick improvisation made me think of December 7, 1941, the day Pearl Harbor was bombed.

"Shortly after 6 p.m. the plane taxied into place almost directly ahead of me. A yellow hydraulic platform was rolled up to the rear door. Clusters of important people converged on the ramp—mem-



bers of the Cabinet, Congress, the Supreme Court, the diplomatic corps. Everyone was silent—and shaken.

"Almost before I was ready with my camera, the casket appeared on the lift and was slowly lowered. It was flanked by several men, one of whom was the President's brother, Attorney General Robert Kennedy. A gray efficient-looking ambulance backed up toward the hydraulic platform. Quickly the coffin was placed inside the ambulance, and Mrs. Kennedy descended on the lift.

"For a moment the ambulance stood alone, shut up and ready to drive off. It seemed so final—until Mrs. Kennedy stepped forward, her face pale and grief-stricken. She was still wearing the suit she had on at the time of the assassination. It still bore the tragic stains.

"With a quick stride she walked to a door

of the ambulance and, opening it herself, she disappeared inside where her dead husband lay. Then Robert Kennedy followed.

"This moment I shall never forget. Mrs. Kennedy seemed so utterly alone. The bright suit she had put on that morning in Texas was so incongruous in this sad scene.

#### Burden Shifts to Broad Texas Shoulders

"After the ambulance drove off, steps were wheeled to the plane door, and in the opening appeared President Johnson and Mrs. Johnson. This was a familiar sight to me, for only a few weeks earlier I had accompanied the then Vice President and his wife and elder daughter on their Scandinavian tour.

"But there was a difference: This time they were not smiling. On this man's broad Texas shoulders now rested the weight of the world.



Resolute in her grief, black-veiled Jacqueline Kennedy, with brothers-in-law Robert and Edward Kennedy beside her, follows her husband's body from the White House to St. Matthew's Cathedral, an eight-block march. On this sad pilgrimage she led the most powerful congress of national and international leaders ever assembled in the Capital. Members of the White House staff, at Mrs. Kennedy's invitation, line the drive, flags of the 50 states and of Puerto Rico, the Virgin Islands, Samoa, and Guam flutter above them.

Leaving the White House for the last time, the caisson's burden rolls ahead of the Presidential flag, riderless horse, and walking mourners. The clop of hoofs, the grating of wheels on pavement, the slow throb of muffled drums, the shuffle of many feet, and the tolling of the bell from nearby St. John's Protestant Episcopal Church—these are the sounds that will be remembered by the hushed multitudes who lined the streets.







President and Mrs. Lyndon B. Johnson walk behind the Kennedys to the cathedral. Urged by the Secret Service to forgo this exposure and ride to the funeral, the President replied, "I'd rather give my life than be afraid to give it."

Two former United States Presidents, Harry S. Truman and Dwight D. Eisenhower, stand in tribute on the steps of the cathedral. Mrs. Eisenhower holds Mr. Truman's arm.

WIDE WORLD BY NATIONAL GEOGRAPHIC SOCIETY



"Even through the universal grief, I felt a surge of pride in our country—'this old but youthful Union,' as John F. Kennedy had called it. There had been no panic, no uncertainty. Smoothly, as our founding fathers ordained, Vice President Johnson became President Johnson—sworn in at once aboard this very plane in Dallas, with Mrs. Kennedy and Mrs. Johnson beside him.

"The American Government, I felt, is immortal. No wonder that, in succeeding days, France and other countries gave thought to improving their own systems of succession."

#### New President Asks Nation's Help

The tall new President moved from the plane to a waiting bank of microphones and read a statement written in his own firm hand:

"This is a sad time for all people. We have suffered a loss that cannot be weighed. For me it is a deep personal tragedy.

"I know that the world shares the sorrow that Mrs. Kennedy and her family bear. I will do my best. That is all I can do. I ask for your help—and God's."

A waiting helicopter carried the Johnson party toward the White House and its never-finished work. In Lafayette Square across the street, a crowd watched as the 'copter landed on the White House grounds.

"Near Caroline's tree house," someone said.

At the National Naval Medical Center in Bethesda, while the President's body was prepared for burial, Jacqueline Kennedy waited, sleepless, in the 17th-floor Presidential suite. There was her husband's funeral to plan, and she would not shrink from the smallest detail.

Time and darkness flowed on without the punctuation of sleep. From the hospital a telephone call was made to the Kennedys' friend William Walton. Mrs. Kennedy remembered

Men of the New Frontier follow their fallen leader in the march to St. Matthew's. Front row, right to left: Stewart L. Udall, Secretary of the Interior; Robert S. McNamara, Secretary of Defense; C. Douglas Dillon, Secretary of the Treasury; Adlai E. Stevenson, Ambassador to the United Nations, and Dean Rusk, Secretary of State. Second row, right to left: Orville L. Freeman, Secretary of Agriculture; John A. Gronouski, Postmaster General, and Luther H. Hodges, Secretary of Commerce. Paul H. Nitze, Secretary of the Navy (right), and Cyrus Vance, Secretary of the Army, walk in the last line.

AP/WIDE WORLD





Britain's Prince Philip (left) and Prime Minister Sir Alec Douglas-Home represent Queen Elizabeth II and her people. Of the President's death, Sir Alec said, "There are times in life when the mind and heart stand still, and one such is now."

Plaintive moan of bagpipes, played by nine pipers from the Royal Highland Black Watch Regiment, adds to the solemn pageantry. Only 12 days earlier President and Mrs. Kennedy heard the bandsmen perform for some 1,700 children on the White House lawn. On tour in the United States, the Black Watch sent these pipers back to Washington at Mrs. Kennedy's request.

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a book in the White House library; in it were drawings and photographs made when Lincoln's body lay in state in the East Room. Could Mr. Walton find the book and prepare the East Room in the same way?

#### His Last Day in the White House

In Lafayette Square the silent crowd still waited. A teen-age Finnish student said, "I just had to see him to the last." And a girl with red hair collapsed and was taken away in a police car.

Photographer James Blair remembers:

"At 4:23 the quiet of the night was broken by the sound of motorcars

"Tension!"

"The honor guard presented arms. The President's flag-draped casket was borne between the tall white columns and through the front door. Mrs. Kennedy walked beside it, still wearing the pink suit."

Many hours later on that dismal day, Mrs. Grosvenor and I made our own pilgrimage to the darkened East Room. Around the catafalque was posted a Guard of Honor, and at the head of the casket stood a Navy lieutenant—the rank John F. Kennedy had held during his heroic years in World War II.

In this same room the handsome young couple had presided at their famous White House affairs. Only weeks before, we had come to dinner at the President's invitation and had watched the dynamic young Chief Executive greet his guests. The quickness of him, the laugh, the twinkling Irish eyes, the



keenness of his attention—these are the memories that will not die.

As we paused sadly before the bier, I recalled the graciousness of this wonderful man in encouraging our National Geographic Society's work. Memories came unbidden . . . of occasions in the Rose Garden when President Kennedy presented the Society's Hubbard Medals to Capt. Jacques-Yves Cousteau and to the American Mount Everest climbers. And his gracious words when he accepted from me the first copy of his wife's White House guidebook, which our Society produced under her guidance.

We, like everyone else, have lost a staunch and loyal friend.

### Final Ride to Capitol Hill

All that day, in the rain, the dignitaries came.

When the sun rose at 7 a.m. on Sunday, people had already begun to gather again in Lafayette Square, still soggy from yesterday's rain. Some had slept there all night.

By late morning the crowd numbered thousands, and tens of thousands more lined Pennsylvania Avenue to the Capitol.

People talked quietly. Transistor radios softly recounted the day's events. Then suddenly came the electrifying announcement: "Oswald has been shot!" The man charged with shooting the President had been killed by a night club owner in the Dallas city jail. The word spread swiftly.

Then a hush fell over the crowd across from the White House. A black-shrouded caisson drawn by six gray horses pulled up at the North Portico. That same caisson had borne the body of President Roosevelt in 1945, and one of the Unknowns in 1958. Now it received the casket of John F. Kennedy.

At 1:10 p.m. the cortege stepped off. First came an honor guard of District of Columbia police. Next, the escort commander and the chiefs of the Nation's military services—Army, Navy, Air Force, Marine Corps, and Coast Guard. They were followed by a phalanx of drummers.

A company of men in Navy blue—the uniform the President had worn as a wartime PT-boat commander—led the Stars and Stripes. With them marched three representatives of the Nation's clergy.

Then came the caisson, flanked by a 24-man guard drawn from honor units of Army, Navy, Marines, Air Force, Coast Guard, and the guerrilla-war-trained Special Forces. Behind the caisson marched the bearers, and a

lone sailor who carried the Presidential flag.

Last in line came a riderless horse, a gelding caparisoned in black and chosen for spirit in memory of the life taken away. A black-handled sword in a silver scabbard hung from the saddle. Polished black boots with silver spurs were thrust in the stirrups—reversed. Here was the age-old symbol of a departed leader. A woman in the crowd burst into tears, turned, and fled.

A file of limousines slid through the White House gates to join the cortege. Mrs. Kennedy rode in the first, accompanied by the President's brother Robert. With them were her children, Caroline, only three days from her sixth birthday, and John, a day short of three. Mrs. Kennedy had asked President and Mrs. Johnson to ride with them. "Poor Lyndon," the President's widow said as they rode, "that you should have to come in this way. . . ."

Along the avenue came the drummers, their instruments shrouded in black bunting, with drumheads loosened to muffle the sound. A hundred to the minute they beat their unrelenting threnody—a cadence that pounded and clutched and grieved. And a chill wind cut the warmth of the sun.

Sadness lined the avenue. There were tears and tight throats—and silence.

Across from the Department of Justice Building, six-year-old Susie Bodrogi stepped from the curb, a dozen red roses in her arms. She walked to the middle of the street as the cortege moved toward her. Before the crowd, the police, the soldiers with their fixed bayonets, she knelt and placed the roses on the pavement one by one. She did it, she said, "'cause I love him and I'm very sorry he died."

Hardened reporters of the White House press corps asked permission to march to the Capitol behind the limousines. And there were tears among them as they walked.

### "Hail to the Chief" Sounds; Cannon Roar

When the slow cortege arrived at the Capitol, the Navy Band played ruffles and flourishes, then struck up "Hail to the Chief." Cannon boomed the Presidential 21-gun salute.

A Negro man raised a three-year-old white boy to his shoulder so the child could see.

Echoes from the cannonade rumbled over the throng packing the slopes of Capitol Hill as bearers lifted the casket from the caisson. Tenderly they carried the 900-pound load up the East Front steps—steps that not quite three years before had seen a youthful President fire imaginations with his Inaugural

*(Continued on page 338)*







SAVINGS AND LOAN

REROUTED  
TEMPORARILY

*President and premier, prince and emperor march bareheaded to the funeral (key to names, pages 338-9).*

AP/WIDE WORLD

*To the beat of muffled drums, the march moves down the Avenue of Heroes.*



*Army's Old Guard Fife and Drum Corps stands at attention.*

THE MALL, THE WASHINGTON POST





**Key to the notables on pages 332-3-4:**

- 1 Chung Hee Park, President of South Korea
- 2 Rashid Pharron, Saudi Arabian envoy
- 3 Diosdado Macapagal, Philippines President
- 4 Haile Selassie I, Emperor of Ethiopia
- 5 Baudouin, King of the Belgians
- 6 Frederika, Queen of the Hellenes
- 7 Charles de Gaulle, President of France
- 8 J. Rudolph Grimes, Secretary of State, Liberia
- 9 Ludwig Erhard, Chancellor of Germany
- 10 Luis A. Somoto D., ex-President of Nicaragua
- 11 Heinrich Lübke, President of West Germany
- 12 Mrs. Peter Lawford, Mr. Kennedy's sister
- 13 Amier Biddle Duke, U. S. Chief of Protocol

- 14 Princess Radziwill, Mrs. Kennedy's sister
- 15 Hayato Ikeda, Prime Minister of Japan
- 16 Petar Stambolić, Council President, Yugoslavia
- 17 Mrs. Sargent Shriver, Mr. Kennedy's sister
- 18 John Karefa-Smart, Foreign Min., Sierra Leone
- 19 Einar Gerhardsen, Prime Minister of Norway
- 20 Éamon de Valéra, son of Ireland's President
- 21 Prince Georg of Denmark
- 22 Prince Jean, Grand Duke of Luxembourg
- 23 Peter Lawford, Mr. Kennedy's brother-in-law
- 24 Frank Aiken, Foreign Minister, Ireland
- 25 Shahpur Gholam Reza Pahlavi of Iran
- 26 Crown Prince Harald of Norway
- 27 Prince Philip, Duke of Edinburgh
- 28 Alberto Lleras Camargo, ex-President, Colombia

Address. And the band played the solemn Navy hymn:

*Eternal Father, strong to save  
Whose arm hath bound the restless wave . . .*

No flowers banked the great Rotunda under the Capitol dome; no black draped its curving walls. On the wide stone floor in shafts of sunlight stood a waiting catafalque.

This wooden bier had been built to support the coffin of a murdered Lincoln almost a hundred years before. Since then it had borne the remains of 15 other honored dead who had lain in state in the Rotunda.

Now the bearers placed on the catafalque the mahogany casket of the President who had served here for 14 years as Representative and Senator. Around the vast room an imposing array of dignitaries had gathered. And statues of the martyred Lincoln and Garfield looked down from their pedestals.

Countless millions saw and heard the eloquent eulogies given by Senate Majority Leader Mansfield, Chief Justice Warren, and Speaker McCormack.

Then a tall man stepped forward, the burden of the past two days written in his eyes. He placed a wreath of red and white carnations before the casket, with a card "From President Johnson and the Nation."

The Rotunda ceremonies were over—except that a stately young woman in widow's weeds led her daughter to the bier, a daughter in red shoes, white socks, and blue coat.

Tired little John Kennedy, Jr., like any restless three-year-old, had been taken to the office of Speaker McCormack, where a display of tiny flags on a mantel caught the little boy's eye. Given one to play with, he asked for a second for his sister Caroline "and one for my daddy, too."

**Thousands Wait All Night in the Cold**

Now the great bronze doors of the Rotunda opened to the public. With Mrs. Grosvenor and our children, I passed by the bier and watched as the endless line filed by. "The Silent Americans," someone said.

Whole families came; there were many



- 29 Eamon de Valera, President of Ireland
- 30 Prince Moulay Abdallah of Morocco
- 31 Alec Douglas-Home, British Prime Minister
- 32 Prince Bernhard of the Netherlands
- 33 Ahmed Guedira, Foreign Minister, Morocco
- 34 Piotr Jaroszewicz of the Polish Cabinet
- 35 Merriman Smith, White House correspondent
- 36 Friedrich T. Wahlen, Swiss Foreign Minister
- 37 Crown Princess Beatrix of the Netherlands
- 38 Mahmoud Fawzi, Foreign Minister, U.A.R.
- 39 Alfons Gorbach, Chancellor of Austria
- 40 J.M.A.H. Lams, Foreign Minister, Netherlands
- 41 Lester B. Pearson, Prime Minister of Canada
- 42 M. Malita, Deputy Foreign Minister, Romania
- 43 Zulfikar Ali Bhutto, Foreign Minister, Pakistan

- 44 Agustin Muñoz Grandes, Vice President, Spain
- 45 Luis Supico Pinto, Chief of Portuguese Chamber
- 46 Bahi Ladgham, Secretary of State for Tunisia
- 47 Sukich Nimmanheminda, Thai Ambassador
- 48 Alexander Bustamante, Prime Min., Jamaica

Also marching, but obscured, were Prime Minister Ismet Inönü of Turkey, President Shneur Zalman Shazar of Israel, Soviet First Deputy Premier Anastas I. Mikoyan, Prime Minister Tage Erlander of Sweden, Senate President Cesare Merzagora of Italy, Assembly President Hadj Ben Alla of Algeria, and Senate President Auro de Moura Andrade of Brazil.

children. People came in furs, in Sunday best, in soiled working clothes directly from farms. A blind man on the arm of a friend. A youth on crutches. A woman in a wheel chair.

They came dry-eyed—and they came in tears. When one Negro woman entered the Rotunda crying, the white woman in front of her looked back reprovingly. But as they reached the casket the white woman, too, broke out in sobs. Then she turned, put her arm around the colored woman, and the two walked out together.

Night fell, and still the patient throng inched through. Outside, the line of mourners lengthened—until at one time it stretched for 40 blocks.

Some had blankets, others, coatless, shivered. Breaths frusted in near-freezing cold.

Doors were to close at 8:30 a.m. By midnight it was plain that thousands would fail to reach their goal. But still they stood, shuffled forward, and waited.

A youth turned to the girl at his side.

"Look, honey, this is crazy," he said. "We

can't possibly make it to the Rotunda—even if we wait all night."

"I don't care, I want to stay in line anyway," she replied. "It's the least we can do."

Forty Yale students hired a bus and came, they never made it to the doors. A Cleveland family was 20 feet from the entrance when guards had to say, "No more allowed."

Behind them, near the head of a line that still numbered 12,000, a woman told her children: "We can pray right here. God and the President will hear us just as well as inside."

The Rotunda had been kept open an extra half hour, and in 21 hours nearly a quarter of a million people had passed by the catafalque.

Soon people by scores of thousands were filling the sidewalks of Pennsylvania Avenue and other downtown streets, for this was the day John F. Kennedy would be laid to rest.

Mrs. Kennedy and her husband's brothers, Robert and Edward, came and knelt again by the catafalque. Then with infinite care the eight bearers bore their burden down to the waiting caisson. Again the drums throbbed:

Measured tread of young men from the Nation's service academies breaks the silence of the funeral procession. The Marine Band, called "the President's Own," leads units from the Military Academy, Naval Academy, Air Force Academy, and Coast Guard Academy. Telephoto lens pulls the 89-man companies into close-order formation.

Overcome by grief, a spectator shuts her eyes to the passage of pomp and pageantry.

SEE PAGE 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841, 842, 843, 844, 845, 846, 847, 848, 849, 850, 851, 852, 853, 854, 855, 856, 857, 858, 859, 860, 861, 862, 863, 864, 865, 866, 867, 868, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912, 913, 914, 915, 916, 917, 918, 919, 920, 921, 922, 923, 924, 925, 926, 927, 928, 929, 930, 931, 932, 933, 934, 935, 936, 937, 938, 939, 940, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 951, 952, 953, 954, 955, 956, 957, 958, 959, 960, 961, 962, 963, 964, 965, 966, 967, 968, 969, 970, 971, 972, 973, 974, 975, 976, 977, 978, 979, 980, 981, 982, 983, 984, 985, 986, 987, 988, 989, 990, 991, 992, 993, 994, 995, 996, 997, 998, 999, 1000



again the gray horses leaned into their harness. And so John F. Kennedy began the long journey that would end in Arlington.

#### From Distant Lands the Great Descend

All through the night the muted thunder of planes had told of the coming of the great from afar. Doughty little Emperor Haile Selassie flew in from Ethiopia. Premier Khrushchev sent his deputy, Mikoyan. There were lovely Queen Frederika of Greece, King Baudouin of Belgium, Prince Philip and Prime Minister Home of Great Britain, President De Gaulle of France, and other wielders of power. Observers could recall no such concentration of world leaders since the funeral of King Edward VII in London in 1910.

Former Presidents Truman and Eisenhower had come, and governors of most states—even the southern governors who had fought President Kennedy hardest. John B. Connally III represented his father, the Governor of Texas, who had been badly wounded by

*(Continued on page 346)*











At the altar of St. Matthew's Cathedral, Richard Cardinal Cushing of Boston celebrates the pontifical low Requiem Mass for the repose of the soul of the President. "May the angels, dear Jack, lead you into Paradise," he prayed. The Kennedy family sat in front pews.

A eulogy by Washington's Auxiliary Bishop, Philip M. Hannan, consisted of excerpts from Mr. Kennedy's speeches, including these final words from his Inaugural Address: "With a good conscience our only sure reward, with history the final judge of our deeds, let us go forth to lead the land we love, asking His blessing and His help, but knowing that here on earth God's work must truly be our own."

#### NEXT PAGES ▶

Clergy file out of the cathedral; the Army Band plays a hymn; riderless horse tugs at the bit, and the caisson awaits the ride to Arlington. John, Jr., at left in light-blue coat, stands at salute.

Wiping away tears, Cardinal Cushing watches the casket of his President leave the cathedral.



THE WASHINGTON POST (LEFT); THE WASHINGTON POST (RIGHT); AND AP/WIDE WORLD (THIS PAGE)





one of the assassin's three shots at the Presidential motorcar in Dallas.

The President's mother, a brave Fitzgerald of Boston, had come to join her sorrowing sons and daughters. She had stayed to console her ailing husband, Joseph P. Kennedy, as long as possible. Now, in Hyannis Port, Massachusetts, he mourned his son alone. Three children gone: World War II pilot Joe, Jr., killed in action, Kathleen in a plane crash, and now Jack. . . .

#### Chiefs of State Follow Casket on Foot

In all, eight heads of state were in Washington, ten prime ministers, and much of the royalty left in the world. There were more than 200 men and women representing more than 100 countries, the United Nations and four other international organizations, and the Roman Catholic Church.

At the White House they gathered—simple mourners from distant lands, who would walk bareheaded, without thought of protocol, in a formless group.

Escorted once more by her brothers-in-law, Jacqueline Kennedy stood near the caisson, behind the Navy enlisted man carrying the Presidential standard. Softly a United States Naval Academy choir sang hymns. Across packed Lafayette Square, the bell of St. John's Protestant Episcopal Church—the "Church of the Presidents"—was tolling.

Then bagpipes wailed. Pipers from the band of the Royal Highland Black Watch Regiment had come to the funeral at Mrs. Kennedy's request, interrupting a U. S. concert tour.

Only twelve days before, these famous pipers had played on the White House lawn for the Kennedy children and their guests, among them my own children. The President put aside his duties to view the performance. (One boy I know will never forget how President Kennedy reminded him with a look that the first notes of "The Star-Spangled Banner" had sounded and it was time to stop drinking cocoa and stand at attention.)

Now, at the sound of the pipes, Mrs. Kennedy came close to tears. But as the drums began to roll she lifted her head high. The

wind stirred her long black veil as the caisson moved down the White House drive.

President and Mrs. Johnson walked behind the three Kennedys, ahead of the mourners from other lands. The Secret Service had urged the new President to ride in a car behind bulletproof glass. He refused.

Jacqueline Kennedy walked with a poise and grace that words cannot convey—as regal as any emperor, queen, or prince who followed her.

"Grace under pressure." That had been Ernest Hemingway's definition of courage, and John Kennedy had quoted it in his Pulitzer Prize-winning book, *Profiles in Courage*.

As I watched from a fourth-story window opposite the cathedral, I felt an admiration shared by all who saw her. A London newspaper was to express it this way: "Jacqueline Kennedy has given the American people from this day on the one thing they have always lacked—majesty."

At St. Matthew's Cathedral, Richard Cardinal Cushing came out to meet the family. He had married John and Jacqueline Kennedy, he had christened their daughter, and last August he had buried their infant son.

Cardinal Cushing bent to the two children, who had been brought to the church by car. He kissed Caroline, patted John's head, then placed a comforting arm around Mrs. Kennedy's shoulder.

As the casket reached the cathedral portico, he sprinkled it with holy water. Bearers carried it inside for the hour-long Requiem Mass, a ritual in which the Roman Catholic Church for centuries has besought God's mercy for the souls of the dead.

#### World Stops at Moment of Funeral

For the next few minutes, whatever the hour in other lands, countless millions of the earth's people paused to honor the dead President. Many entered their houses of worship.

Across our Nation trains stopped. Jets halted on airport runways. The Panama Canal suspended operations. Motorists paused in New York's Times Square. Evening traffic halted in Athens, Greece. Around the world, flags stood at half-mast.

**John, Jr., salutes** the father who adored him. Thus on his third birthday he says farewell, just before the caisson leaves the cathedral. Caroline, squeezing her mother's hand, holds a church booklet given to her brother during the service. Jacqueline Kennedy, said one observer, bore her grief "like a brave flag."



*"I could stay up here forever," President Kennedy had said of this knoll in Arlington National Cemetery, which commands a view across the Potomac to the Lincoln Memorial and the Capital City beyond. Now the head and hand of a saluting soldier frame the President's grave as cannon boom a 21-gun farewell. A moment later riflemen fired three volleys, and a bugler sounded the aching lament of taps. It was all over. The grieving family walked down the hill as the world's mighty passed by the grave in silent respect.*

*Eternal flame, ignited by Mrs. Kennedy, burns before the unlowered casket.*

NATURAL GEOGRAPHIC PHOTOGRAPHER THOMAS REEB © R. G. L.





At the end of the cathedral service, the Most Reverend Philip M. Hannan, Auxiliary Bishop of Washington, read a eulogy consisting of excerpts from Mr. Kennedy's addresses, including favorite Biblical quotations. Two were from the speech he made in Houston, Texas, the day before he died in Dallas:

"Your old men shall dream dreams, your young men shall see visions" (Joel 2:28) and "Where there is no vision, the people perish" (Proverbs 29:18).

President Kennedy's last journey through the streets of Washington began at 1:30. This was the saddest one of all, for now the numbness of initial shock had gone.

Crowds jammed Connecticut Avenue. They formed a living wreath of mourning around the Lincoln Memorial and a lane of honor along the Avenue of Heroes that stretches beyond Memorial Bridge.

By shortly after two o'clock the caisson was across the Potomac. Tiring now, the six grays breathed heavily as they moved up the winding lanes of Arlington National Cemetery. They climbed the height on which a contemplative President Kennedy had relaxed from the cares of the White House on a soft Sabbath morning the previous spring.

"I could stay up here forever," he had remarked then.

Now he was returning.

Fifty jet planes of the Air Force and Navy, one for each state, roared low overhead as the caisson halted beside the grave. The apex of the last V formation was empty, symbolizing a fallen leader. The President's personal jet plane, Air Force One, trailed the formation and dipped its wings in salute.

#### Gaelic Farewell by Irish Cadets

The bearers placed the casket above the grave. Then an honor guard of Irish officer cadets, following commands in Gaelic, executed a manual of arms traditional at Irish military funerals; Mr. Kennedy had once seen and admired this ceremony. The U. S. Marine Band played "Garry Owen."

Cardinal Cushing read the brief graveside services and led the mourners in the Lord's Prayer and the Hail Mary. Three 76-millimeter cannon boomed the 21-gun salute. Riflemen fired the three volleys for a fallen hero. A bugler sounded the brave sadness of taps, and men in uniform, from Charles de Gaulle and Haile Selassie to buck privates, held a last long salute.

Some 200 miles away, in Lower New York Bay, the aircraft carrier *Franklin D. Roosevelt* was putting to sea; the crew dropped a wreath over the side.

With deft precision, servicemen folded the flag that had covered the coffin for four days. Mrs. Kennedy tucked it beneath her arm. First she, then the Kennedy brothers, touched a torch to a jet of gas, lighting an eternal flame.

One further official duty awaited her, and it was a duty of her own choosing. She would receive the foreign dignitaries in the White House.

"It would be most ungracious of me," she said, "not to have all those people in our house." For each she managed a wan smile and words of thanks.

Her husband had once said of her:

"My wife is a shy, quiet girl, but when things get rough, she can handle herself pretty well."

There was still something she wanted to do. Junior Village is Washington's home for homeless children. When the shocking news had reached them on Friday, many had cried, for they knew the Kennedys well. Mrs. Kennedy had visited the home the previous

*(Continued on page 355)*



PHOTOGRAPH BY PHOTOFEST FOR THE NATIONAL GEOGRAPHIC SOCIETY





Rifles reversed, Irish cadets at the graveside execute a manual of arms for death, a tradition at Ireland's military funerals. On a trip to his ancestors' home in June, 1963, Mr. Kennedy saw this ceremony at a Dublin memorial observance for Irish revolutionary heroes. Mrs. Kennedy remembered his interest and invited the honor guard.

Military pallbearers fold the casket flag before the sorrowing eyes of President Lübke (left), President De Gaulle, Chancellor Erhard, and Emperor Haile Selassie. These and other rulers represented shocked millions in their homelands. As one American wrote from abroad, "The whole world stopped to cry with us."





QUEEN FEDERIKA OF GREECE AND MRS. KENNEDY. (AP/WIDE WORLD)



Outpouring of sympathy from world leaders goes to Mrs. Kennedy and Senator Kennedy, who receive them in the White House Red Room following the funeral. At left, Anastas I. Mikoyan, First Deputy Premier of the Soviet Union, expresses the condolences of the Russian people, who, in the words of Premier Khrushchev, "share the deep grief of the American people." For the first time Russians were permitted to watch live television from abroad, viewing the funeral via Relay satellite.

Queen Frederika of Greece (upper) expresses her sorrow; both hands go out to the young widow.

Germany's Chancellor Erhard (above) hears Mrs. Kennedy say, "Thank you for coming... goodbye."

And so she said goodbye, too, to the glittering years she graced the White House.



Christmas-time and had invited the children to three parties at the White House. Now their chief concern was for the widow. "Will Mrs. Kennedy be able to get a job?" they asked, knowing well the harsh realities that had wrecked their own home lives.

They had sent Mrs. Kennedy a telegram: "We loved him as we do you."

Now Mrs. Kennedy sent the children some of the flowers from the funeral.

#### Flame to Light the World

Thousands stood through the rest of the night awaiting their turn to pass before the flickering flame in Arlington. Jacqueline Kennedy came again that night and placed a spray of lilies-of-the-valley on her husband's grave. Returning to the White House, she crossed the Potomac into Washington just as the clocks of the Capital struck midnight.

So ended that heart-aching weekend. Those days and nights had brought to the American

people a Gethsemane of the spirit which time has assuaged but not erased.

Our youngest President is gone. In Lincoln's phrase at Gettysburg 100 years ago that very month, he gave "the last full measure of devotion." But the deeds, the words, the example of the man remain—and there will always be the flame to remind us.

What more appropriate than a flame? John F. Kennedy, in his Inaugural Address, had spoken of fire:

"In the long history of the world, only a few generations have been granted the role of defending freedom in its hour of maximum danger. I do not shrink from this responsibility; I welcome it. I do not believe that any of us would exchange places with any other people or any other generation. The energy, the faith, the devotion which we bring to this endeavor will light our country and all who serve it, and the glow from that fire can truly light the world."

Thousands climb to the grave in Arlington National Cemetery, their line winding among the stones of a silent host. Mourners pass below the Custis-Lee Mansion, onetime home of Confederate General Robert E. Lee.

In the month following President Kennedy's death, an estimated 700,000 people visited his tomb.


President's seal in chrysanthemums stands behind the eternal flame. An unidentified visitor hung a rosary on the wreath. Boys pass by with grave faces. William Attwood, who served under President Kennedy as Ambassador to Guinea, wrote of a similarly affected youngster—his 11-year-old daughter. "She was crying that terrible weekend because her friend was dead. . . . I think a lot of Americans, like my daughter, feel they have lost a friend. They have."

Reprints of this tribute to President Kennedy in a color cover are available to members of the Society at 50 cents each. Address: Dept. 166, National Geographic Society, Washington, D. C. 20036.

PHOTO BY NICK HORNBY FOR NATIONAL GEOGRAPHIC SOCIETY







*America mobilizes her resources for mankind's greatest adventure—a landing on the moon before 1970*

# Footprints on the MOON

By HUGH L. DRYDEN, Ph.D.

*Deputy Administrator, National Aeronautics and Space Administration*

**B**EFORE THE END of this decade man will launch his greatest voyage of discovery, a journey whose magnitude and implications for the human race dwarf any high adventure of the past. For the first time he will leave his home planet and set foot upon another world, the luminous satellite of earth we call the moon.

Although Premier Khrushchev has said the Soviets have no target date for a flight by cosmonauts to the moon, our own national objective—an American on the moon prior to 1970—remains unchanged.

At this time no one can say whether the first man to make that epochal voyage will be a citizen of the United States or of the Soviet Union. But the perils will be successfully navigated; there will be footprints in the lunar dust.

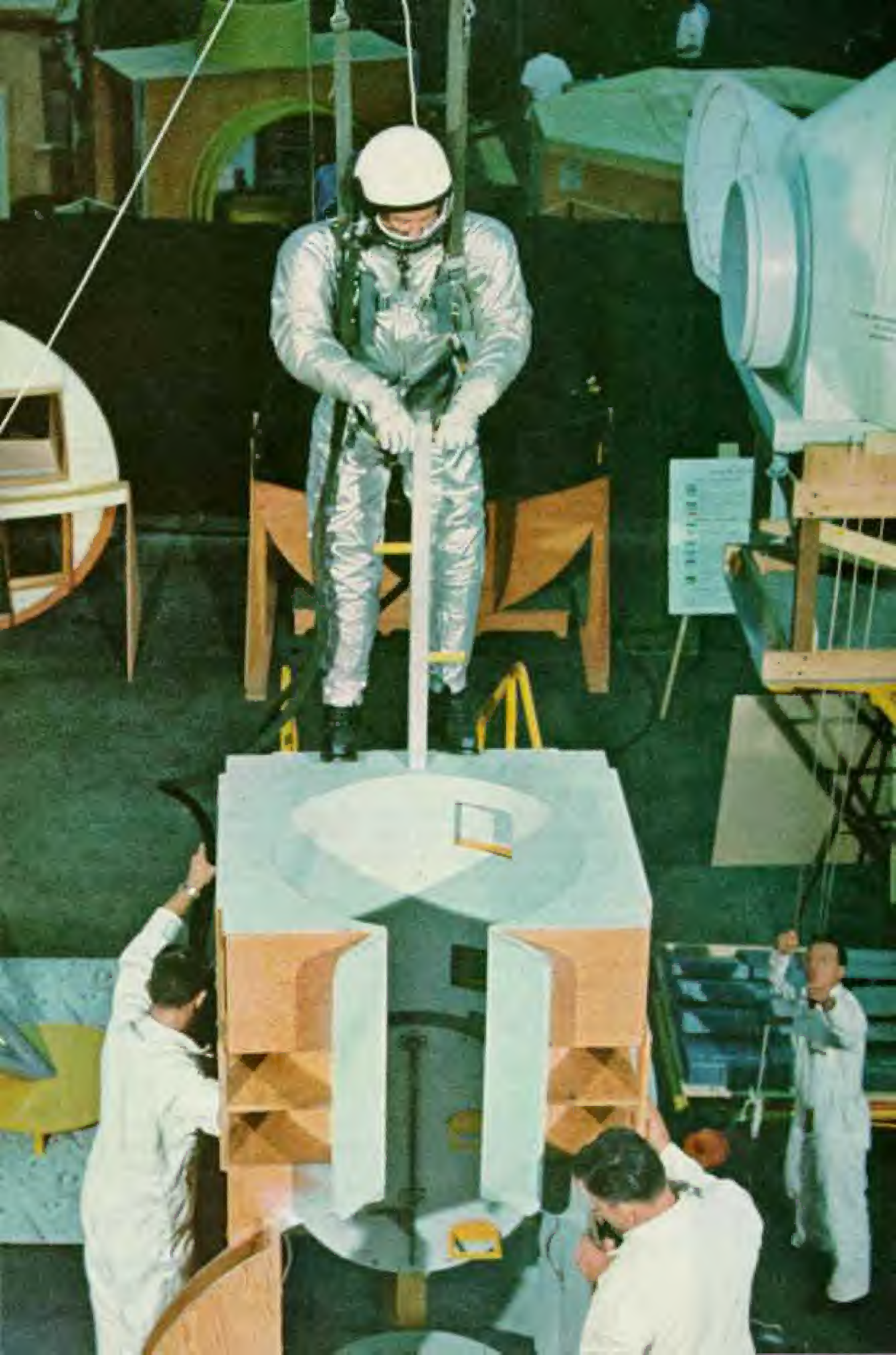
By the end of this century the conquest of the moon may seem only a modest first step along the spaceways to still other worlds. However, our natural satellite, the moon, circling earth at an average distance of 238,857 miles, is a formidable target for the sixties. More than 5,000 of the Nation's industrial firms are directly involved in United States efforts to place men on the moon. The National Aeronautics and Space Administration estimates that 20,000 companies and 300,000 people eventually will participate. In addition, all of NASA's 10 major centers and most of its 30,000 employees now contribute to the effort.

The task this Nation has set for itself will be expensive, costing an estimated 20 billion dollars. But the goal of a man on the moon is well

## FIRST MAN ON THE MOON LEAVES FOOTPRINTS ON ITS DUSTY, POCKMARKED FACE

**Q**UITTING HIS SPACECRAFT, an astronaut walks cautiously across the meteorite-battered surface of a dead, atmosphereless globe. Earthshine—far brighter than the glow of moonlight on our home planet—lights his way. LEM, the spider-legged lunar excursion module in which he landed, seems a fantasy borrowed from science fiction. Blast of LEM's descent-stage rocket has hollowed out the small crater directly beneath the vehicle.

Until man lands vehicles on the moon, he can only guess what the surface is like; this painting represents the thinking of the author and many other scientists.





within our national capability, and it can be accomplished on schedule if the necessary funds are appropriated.

NASA, the agency I serve as Deputy Administrator, is entrusted with the peaceful exploration of space. Though only 5½ years old, it has wrested many secrets from the space environment with a galaxy of unmanned satellites, 52 by recent count. Yet, understandably, it is in the field of manned space flight, where astronauts' lives are at stake, that we feel a special responsibility.

NASA was only seven days old when it set up a unit to plan Project Mercury, which ended May 16, 1963, with the safe return from 22 orbits of L. Gordon Cooper, Jr. The Mercury score: six manned flights and six dramatic successes.

How do we propose to accomplish the much more demanding task of lunar flight?

NASA attacks the problem through Project Apollo, now well under way. Apollo's command module, the term we apply to the

moon spacecraft's living quarters, will house three astronauts during the trip to and from the moon. When in orbit above the moon's pocked face, two of the astronauts will enter a special vehicle, attached caboose-like to their command module, and descend to the lunar surface. Hours later, after taking photographs and making scientific studies, they will blast off and rendezvous above the moon with the third man, re-entering the command module for the trip home. Their special vehicle, called the lunar excursion module, or LEM, will be left behind in moon orbit.

Most of the necessary components for this epochal voyage—booster rockets, myriad subsystems, command module, LEM—are under development. NASA has set for itself and its contractors a very high but realizable standard of performance: The mission must have a 99.9 percent probability for safety for the astronauts and a 90 percent chance of success.

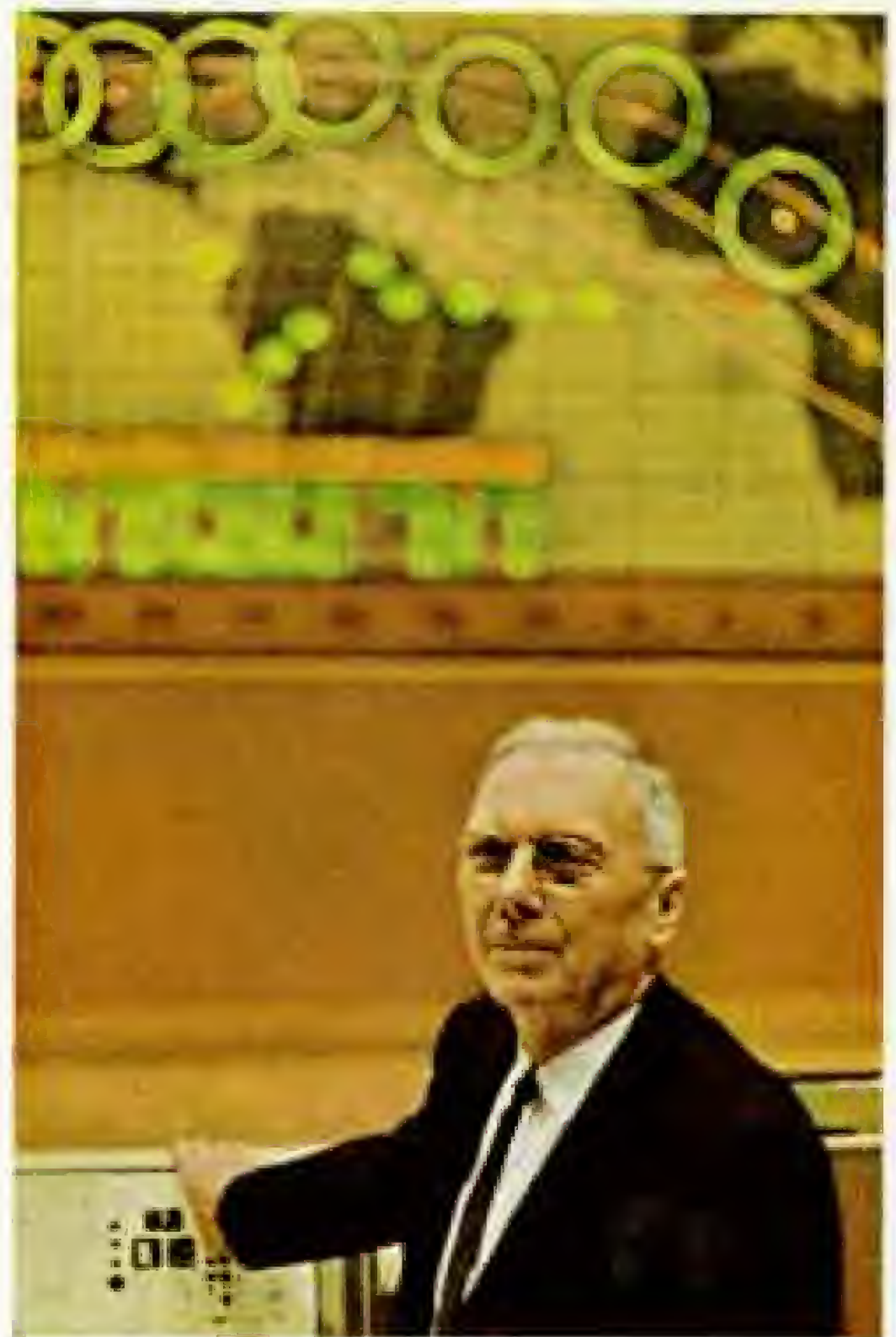
Shakespeare's self-confident man of action, Hotspur, declares in *King Henry IV*, "By

**THE AUTHOR:** In 1910, when only 12 years old, Hugh Dryden wrote his first paper on aeronautics after seeing an Antoinette monoplane flying over Baltimore, Maryland. Eight years later, as a youthful scientist with the National Bureau of Standards, he began a distinguished career that has won international recognition for important contributions to supersonic flight.

For the past 16½ years Dr. Dryden has served as chief scientist for the United States Government's research efforts in aviation and space. In 1947 he was named Director of the National Advisory Committee for Aeronautics, predecessor of the space agency. When NASA was born in 1958, he became its Deputy Administrator. Here he watches operations in Mercury Control Center during the John Glenn space flight in February, 1962.

Dr. Dryden, a Trustee of the National Geographic Society since 1951, contributed "Fact Finding for Tomorrow's Planes" to the December, 1953, magazine, which commemorated the 50th anniversary of powered flight. With prophetic insight, he predicted supersonic transport aircraft and man-made satellites of the earth.

Regarding lunar flights, he wrote: "I am reasonably sure that travel to the moon will not occur during my lifetime, but I am sure that the technical problems are solvable with a large but finite amount of manpower and money."



**TEETERING AT THE END OF A "PETER PAN RIG,"** Astronaut Frank Borman practices entry and egress in the small hatch of an early LEM mock-up at the Grumman Aircraft Engineering Corporation, Bethpage, New York. Counterbalanced back harness simulates gravity on the moon, where a 180-pound man would weigh only 30 pounds.





**S**PACE-SUITED engineer-test pilots "fly" a mock-up of the two-man Gemini spacecraft. Command astronaut sits in the left seat, facing forward in the pressurized cabin of the re-entry module. The dummy craft, made by McDonnell Aircraft Corporation of St. Louis, Missouri, is continually updated to reflect the latest engineering and hardware changes.

THE "EIGHT-BALL"—a glowing red circle on the instrument panel of a Gemini simulator—allows a McDonnell engineer-pilot to determine yaw, pitch, and roll of his craft. Tracer light attached to a glove reveals movements needed to reach flight instruments. Future Gemini astronauts will reap the benefits of such ground testing when they maneuver in space.

heaven, methinks it were an easy leap to pluck bright honour from the pale-fac'd moon. . . " I have yet to meet an astronaut who would agree with him.

To date the flight time in space compiled by United States astronauts totals only 53 hours, 56 minutes, and 8 seconds. Some 2,000 hours, all in earth orbit, must be accumulated before we are ready to vault to the moon. This experience and mastery of rendezvous, the joining together of two vehicles while they hurtle around the earth at 17,500 miles an hour, will be vital to success.

So our next man-in-space program is not Apollo but Project Gemini, aptly named after the third constellation of the zodiac, featuring the twin stars Castor and Pollux.

The Latin *geminii* means twins, and this second generation spacecraft will hold two astronauts seated side by side. Gemini will have the rocket power to change its orbit and maneuver, whereas the Mercury capsule, equipped with jets to control roll, pitch, and yaw, could change only its attitude.

#### Gemini and Agena Rendezvous in Space

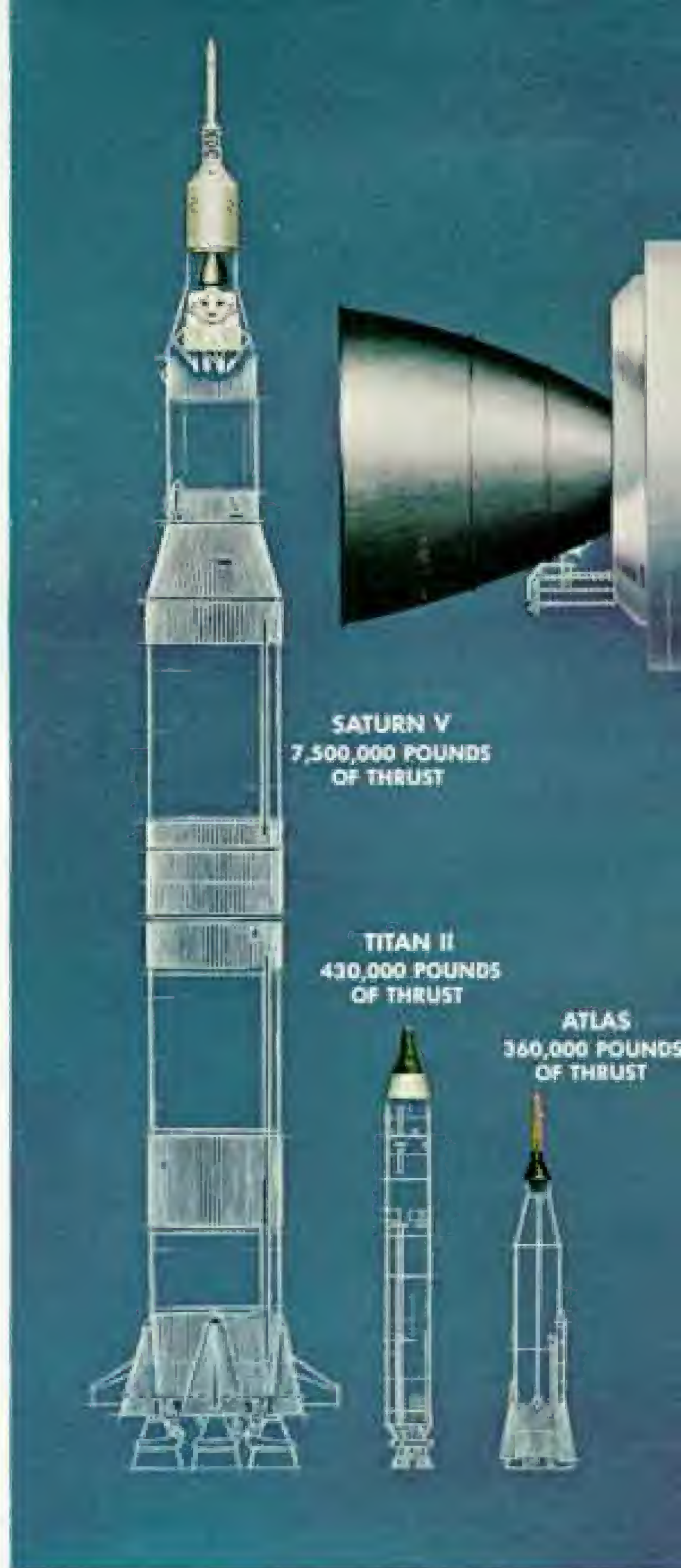
Once it attains orbit, Gemini will overtake and attach itself to an unmanned Agena vehicle previously sent aloft. When joined to this fueled stage, the spacecraft can blast itself into a flight path that will take it farther from earth. Its oxygen system will support the men for periods as long as two weeks.

A kinship between Mercury and Gemini capsules is apparent in their outward appearances, but the Gemini crew compartment is 50 percent larger in volume than Mercury's (opposite). Moreover, Gemini introduces many advances in technology.

Take, for example, ease of maintenance. When a component in the old Mercury capsule became balky, technicians frequently had to remove perfectly good equipment, instruments, or wiring to get at the part needing replacement. In Gemini most components are grouped in prefabricated assemblies around the sides of the spacecraft. Access is through exterior service hatches; if a part goes bad, repairmen remove an entire package and quickly install a new one.

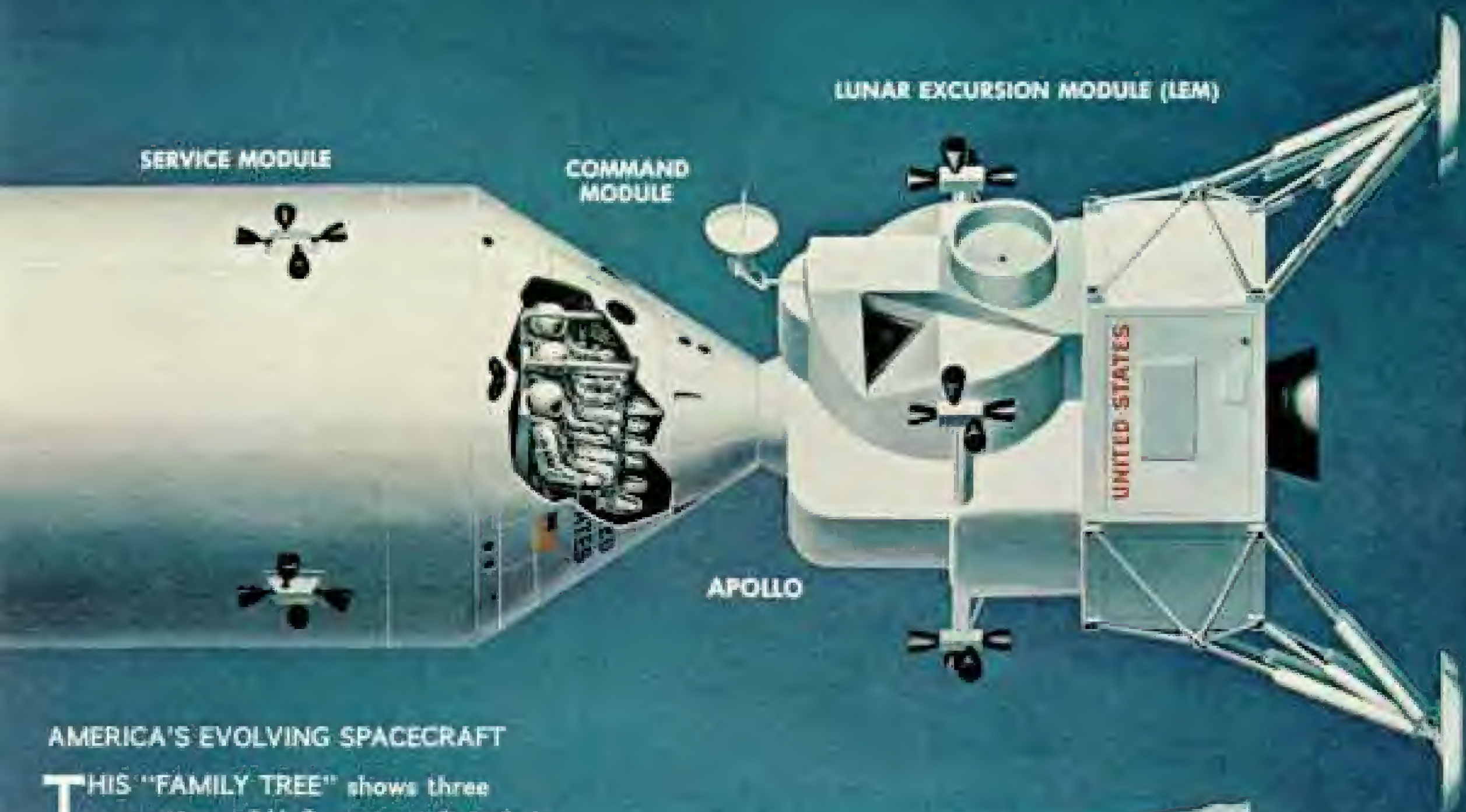
You may never have heard of fuel cells, devices for producing electricity, but Gemini will use them instead of batteries for most of its power needs. Moreover, these ingenious cells will yield an important bonus: drinking water for the astronauts.

Fuel cells of the type planned for Gemini use hydrogen and oxygen and convert the



chemical energy from their reaction into useful electricity. They reverse the process of electrolysis. Instead of breaking water down into its components by passing an electric current through it, they form water in a controlled reaction that liberates electrons.

Such cells are not new, but their development is just now coming of age. Those in Gemini, with their fuel, will weigh about 550 pounds, half the weight of batteries of comparable power and life. They will supply enough water so that only an emergency



### AMERICA'S EVOLVING SPACECRAFT

**T**HIS "FAMILY TREE" shows three generations of U. S. spacecraft and the ever-growing rockets that will propel U. S. astronauts into the unknown.

Flying solo, orbital Mercury spacemen rode a craft 10 feet long and 6 feet in diameter, hurled aloft by an Atlas launch vehicle.

Gemini's two-man team will soar aloft in a capsule with 50 percent more cabin space than Mercury's. A 90-foot Titan II will boost them into a 185-mile-high orbit.

Apollo astronauts will race to the moon in a command module, as their spacecraft will be called, twice the size of Gemini's capsule. Two of the three men aboard will descend to the satellite's surface in the lunar excursion module (LEM), a 12½-ton craft. A third section of the Apollo vehicle, the service module, contains vital flight equipment. Powerful 362-foot-tall Saturn V will boost the Apollo team into orbit.



*D. Maltby*

ILLUSTRATION BY DAVID MALTBY © NATIONAL GEOGRAPHIC SOCIETY

drinking supply need be put aboard for the crew. Apollo, too, will use fuel cells.

In the words of a Gemini engineer: "What a system! It's like carrying your own well with you on a long desert journey."

The fuel cells, plus such equipment as 16 small rocket thrusters needed for maneuvering in space and retrorockets that bring the craft out of orbit, are housed in two sections attached behind the capsule's heat shield. Crewmen jettison these sections and turn the capsule around before its re-entry through

the atmosphere, blunt end first as in Mercury.

The Atlas rocket, with 360,000 pounds of thrust, hurled Mercury capsules into orbit, but the Old Faithful of those pioneering flights lacks the power for Gemini. It will require the Titan II, a booster with two rocket stages. The first develops a thrust of 430,000 pounds, equivalent at burnout velocity to more than six million horsepower, or the combined power of 32,000 medium-size American automobiles. When this stage drops, the second cuts in with 100,000 pounds of thrust.



PHOTOGRAPHS BY NATIONAL GEOGRAPHIC PHOTOGRAPHER JAMES F. BLISS (2)

**I**N THE CLEAN ROOM, so named because air filters trap 95 percent of microscopic dust, the cabin section of an early Gemini spacecraft comes off the McDonnell assembly line. One crew installs metal shingles; another in the interior completes the electronic systems. This particular craft will be mated to a Titan II launch vehicle (opposite) when NASA astronauts attempt the first Gemini two-man flight into space.

cury escape, or jump when well within the atmosphere.

Ejection seats, though a tried-and-true escape technique, could not be used with Mercury. Atlas engines burn kerosene and liquid oxygen, and an extensive blast and fireball are characteristic of these propellants if the booster explodes. Had any done so in the Mercury program, the men would have needed the protection of their capsules. Titan II, on the other hand, burns one of the "exotic" fuels, a combination of hydrazine and unsymmetrical dimethyl hydrazine, with nitrogen tetroxide as the oxidizer. Their blast effect and flame would be confined to a lesser area.

One of the most critical periods from the standpoint of astronaut safety begins with launch and continues until the rocket is out of the atmosphere. Should a malfunction occur in the booster, the crew must be whisked away from it, and almost instantaneously, because it may explode.

Mercury met this problem with a rocket-powered escape tower capable of pulling the capsule free for a parachute descent. In Gemini the technique is quite different. The astronauts can jettison the hatches and blow themselves and their seats out of the capsule, as they would from a jet aircraft, and descend by individual parachutes. They would do this only if an emergency occurred below 70,000 feet. Above that altitude they would free Gemini from the second-stage booster, fire Gemini's rockets to pull away, then ride the capsule down to the ground, as in a Mer-

Thanks largely to these new propellants, the countdown for a Titan II launch is much shorter than for an Atlas. Fuel and oxidizer burn instantly on contact. This eliminates need for an ignition system. Moreover, they may be kept in the rocket without deterioration, ready for instant use. In contrast, the Atlas's liquid oxygen vaporizes and must be replenished periodically.

A shortened count, increased simplicity, reliability... these will be mandatory for Gemini. Lift-off must be on schedule. Rendezvous requires accurate celestial marksmanship, precise timing is all important.

The mission begins when an Atlas blasts off from the Kennedy Space Center and thrusts a 32-foot-long Agena target vehicle into a nearly circular orbit 185 miles above the earth. About 24 hours later Agena again will approach the point east of the space center where it entered orbit.

**S**IX-MILLION-HORSEPOWER chariot, a 90-foot, two-stage Titan II rocket undergoes checkout in a 14-story-high test cell at a Martin Company plant in Baltimore, Maryland. Men at top remove a cover on the second stage's oxidizer tank, where Gemini will be attached. Tanks of the launch vehicle were welded in Denver, Colorado, and airlifted to Baltimore. Then the entire vehicle was flown to the Florida space center.

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Now it is time for Gemini to begin pursuit. Its optimum "launch window," the interval when it can take off and catch up with the least expenditure of fuel, lasts 20 minutes. So Titan II flames from its launch pad and hurls Gemini into an elliptical orbit with an apogee, or highest point, of 185 miles and a perigee, or lowest point, of 100 miles.

Much hinges on the inter-relationship of these orbits. To understand why, picture the two vehicles as runners on an oval track. Agena has a head start, but he sticks to the outside lane and takes longer to go around than Gemini, who swings from outside to inside and travels a lesser distance. So Gemini gradually catches up; his orbital period, or time for one revolution, is less.

The same thing will happen in space. Our astronauts could leave their rocket throttles untouched and gain as much as five degrees on each orbit.

Also, don't forget that the two orbits touch at their high point. On one of its outward swings Gemini will come close enough to its quarry to close in.

Actually it isn't quite that simple. Ground stations or the astronauts themselves can command Agena to change its orbit and speed, and Gemini too can make such changes. So various rendezvous techniques are possible, including some



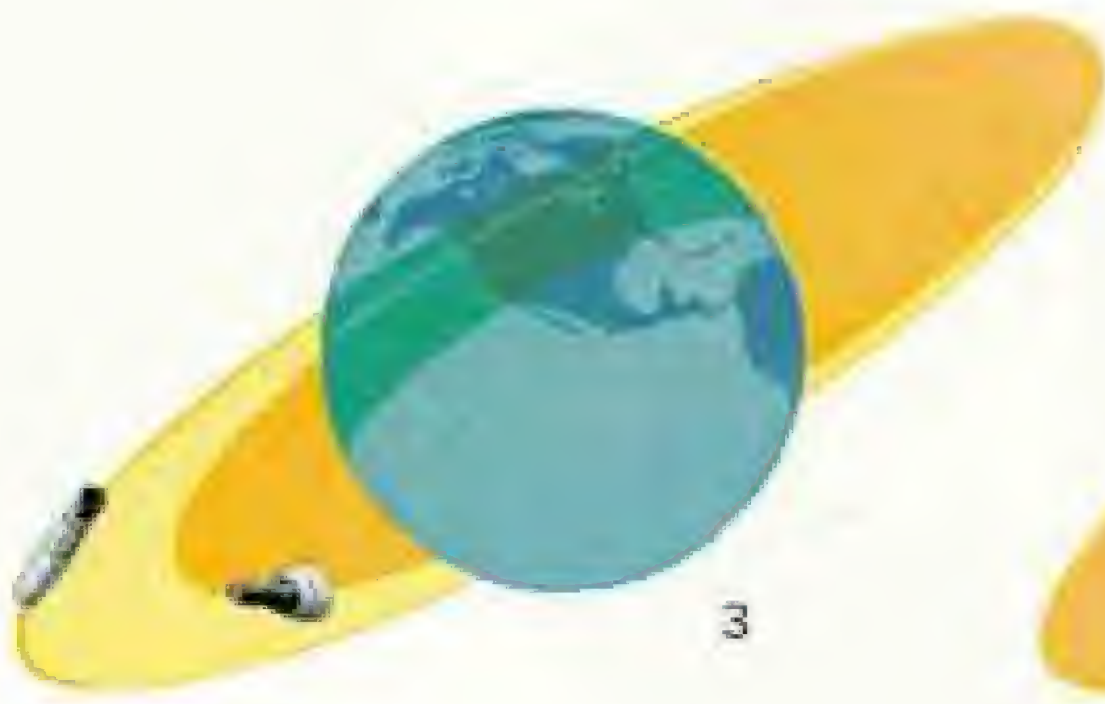


**P**OWER PLANT IN SPACE, an unmanned Agena-D satellite will provide fuel for extended maneuvers by Gemini astronauts. Sequence shows how Gemini's two-man crew will bring the target vehicle into docking range. 1 Agena rocket, loaded with fuel, is launched from Florida. Yellow line traces its climb to a 185-mile-high orbit. Because the earth rotates on its polar axis, engineers must wait 24 hours until the launch site is once again directly below Agena's orbital plane (yellow shading)

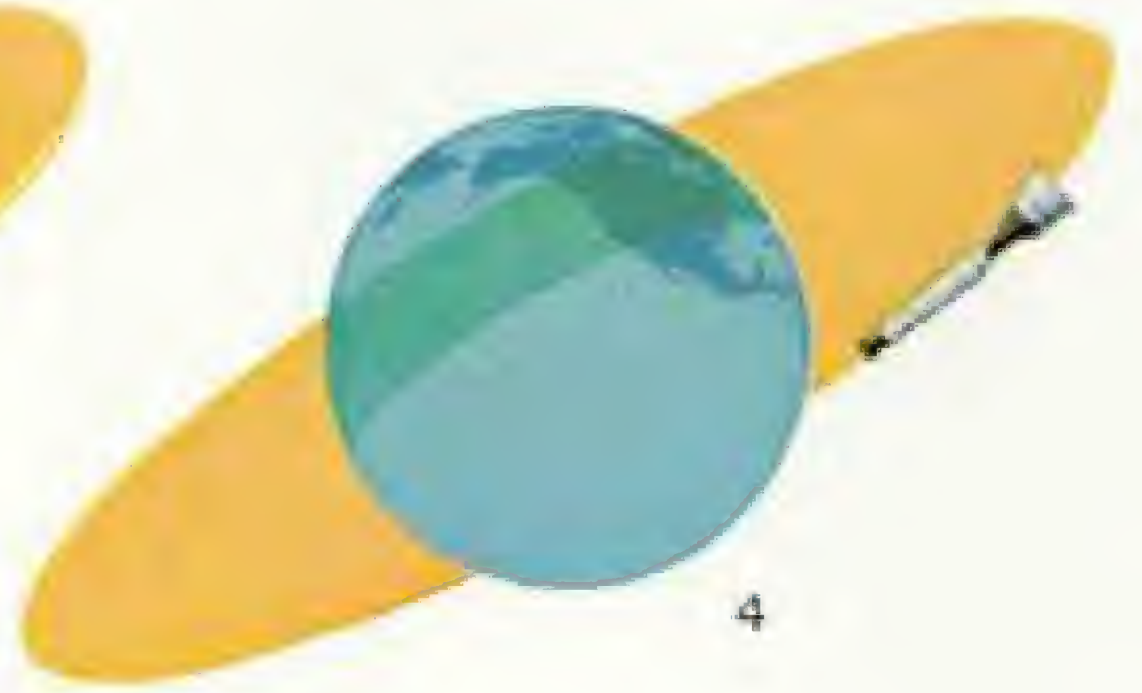
**S**CANNING THE DARK SKY, Gemini's radar locates Agena at a distance of 350 miles and holds the quarry in view (far left). Gemini's computer determines the approach speed and point at which the two craft will meet. An 8-foot boom antenna on the target craft receives radio signals from the astronauts, who order Agena to assume a stabilized position. Guided by flashing beacons, the astronauts speed up their vehicle and maneuver it toward Agena's cone-shaped docking collar. Though







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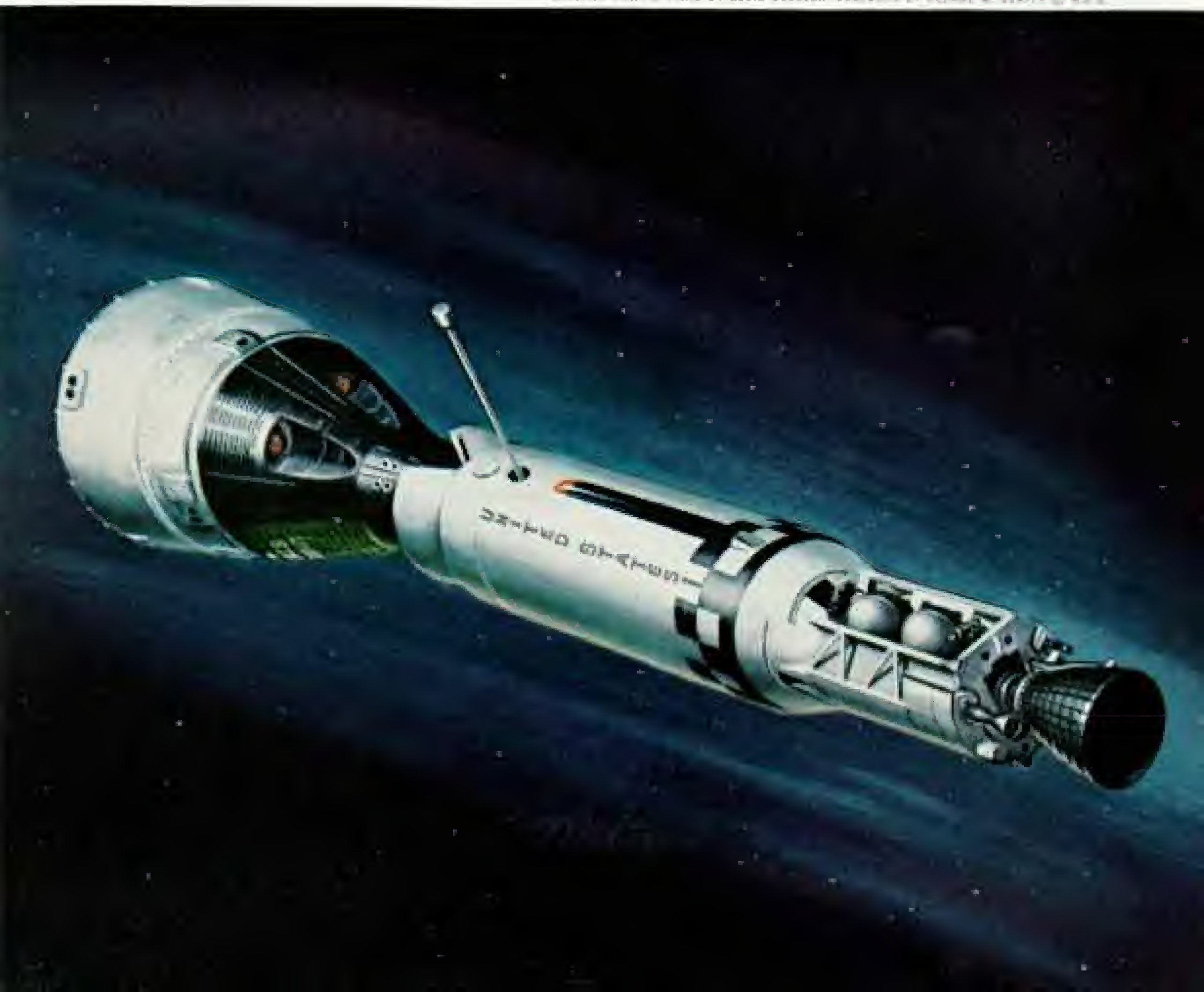
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before launching Gemini. 2 Two astronauts blast off in Gemini just before Agena passes overhead. Apogee, or high point, of Gemini's elliptical orbit is 185 miles, the perigee, or low point, 100 miles. 3 Pilot fires maneuvering rockets and changes Gemini's orbital plane (orange shading) so that it coincides with Agena's. The orbits meet at the 185-mile-high point. 4 Gemini's pilot ignites rockets, catches up with Agena, and brings pursuer and target together.

the two craft travel 17,500 miles an hour, their difference in speed is only a little more than one mile an hour at final closure. Crewmen maneuver Gemini's nose into a V-slot in Agena's collar; then mechanical latching fingers snap the craft together. The space-mated couple turn around, placing Agena's restartable engine in position to propel the vehicle into a new orbital path so that the astronauts can probe deeper into space. They will detach Agena before re-entering earth's atmosphere.

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ILLUSTRATION AND PHOTOGRAPH BY DAVID BOLLEIGH. PHOTOGRAPH BY GEORGE W. BEARDS © NASA







that lengthen the launch window from minutes to hours. But let's not venture too far into the maze of orbital mechanics. Essentially the mission begins as I have described it.

There is one other vital factor involved: plane error, or the difference in the planes of the two orbits. This error must be corrected. But diagrams tell that story best, and I refer you to the excellent illustrations on pages 366-7. There you can see the problem and its solution.

Now let's assume that the hunter is nearing the hunted. Ground stations have been tracking both, and the information needed for precise maneuvering has been passed to Gemini. When the craft are about 250 miles apart, Gemini's radar picks up Agena. Computers tell the astronauts how far they are from the target and what course corrections to make. They fire rockets, moving up, down, or laterally, at times increasing or decreasing their speed. If a large correction is required, they may flash a signal to Agena, and it will maneuver obediently.

Part of the chase may occur on the night side of earth. Then stroboscopic beacons flash on Agena; the astronauts see them as intermittent lights moving among the stars. They take sightings on the beacons and keep changing the direction of their flight until the winking lights seem to be stationary in relation to the stars. That means they have drawn a direct bead on the target, now dead ahead.

#### Spacecraft Join While Traveling 17,500 Miles an Hour

So Gemini closes in. Crewmen see their quarry clearly when two to 20 miles away, depending upon the time of day. Should it be night, floodlights illuminate Agena's docking collar. Flick-firing his maneuvering engines, powered by propellants similar to those used in Titan II, the Gemini commander eases his craft's nose into the collar. Latches trip and hold the vehicles firmly together, a bond that will not be broken until the astronauts trigger a release mechanism. Now, if the men wish, they can rotate the Agena-Gemini combination and fire Agena's engines to venture farther out into space.

Joining two vehicles together while both travel 17,500 miles an hour may seem difficult in the extreme, but it is only the relative speed between the two that is of concern. Have you ever seen two speeding automobiles play a game of "bumper tag?" One inches up on the rear of the other and playfully nudges it. This is a popular game among some teen-age drivers, and I deplore it, but it is not difficult. Similarly, when Gemini scores its tag, it will be moving only  $1\frac{1}{2}$  feet per second faster than Agena, a difference of little more than one mile an hour.

Visibility for the docking maneuver does not seem to be a problem, even though in space there is no air to scatter, diffuse, and soften light. All four Mercury astronauts placed in orbit saw the Atlas clearly after it separated from the capsule. Observing the booster for some time as it drifted away, they felt their judgment of its distance from them was

#### DARING GEMINI ASTRONAUT FLOATS WEIGHTLESS, A THISTLEDOWN IN THE VASTNESS OF SPACE

**O**PENING THE HATCH of his spacecraft, the tethered explorer ventures out alone into the deadly void. Pack on his thigh contains enough oxygen for a 20-minute sortie. Design of the pressure suit ensures that it will not balloon out in the vacuum of space, lest it impair the man's mobility. To determine the problems repairmen might face in servicing manned space stations, Gemini pilots may eventually go outside their ship, as this astronaut is doing, and perform experimental tasks. The astronaut himself becomes a satellite traveling 17,500 miles an hour. But, without air resistance, he has no sensation of speed. Small round jets on the nose of the Gemini capsule stabilize the craft during re-entry. Maneuver-control jets on the fore section of the white retro-module control Gemini's attitude in orbit.



UNIQUE PARAGLIDER THAT WILL LAND GEMINI ASTRONAUTS LOOKS LIKE A KITE BUT FLIES LIKE A PLANE

LIKE MERCURY ASTRONAUTS, the first Gemini teams will touch down by parachute in the ocean. Later manned Gemini flights, however, may be able to glide to a preselected site on land with the new paraglider technique now under development. Here is how it will work:

- 1 Astronauts jettison their equipment module.
- 2 They fire retro-rockets, which slow Gemini to re-entry speed, and jettison the retro-module.
- 3 Craft blazes into the earth's atmosphere like a meteor.
- 4 At 60,000 feet the astronauts deploy their drogue parachute, which pulls off the paraglider's canister at 50,000 feet.
- 5, 6 & 7 Paraglider automatically takes shape as gas inflates the 32-by-37-foot fabric structure.
- 8 Manipulating controls that pay out or reel in cables attached to the frame, the pilot can bank or change his rate of descent. The bizarre craft will glide up to 20 miles in any direction.
- 9 & 10 Astronauts employ a nose-high flare maneuver with the paraglider at 200 feet to slow the craft to a landing speed of 50 miles-an-hour. They sever cables at the instant of touch down. Dust flies as Gemini skids 200 feet.

PAINTING BY DAVID MOLTZER © NATIONAL GEOGRAPHIC SOCIETY

D. Moltzer

not impaired by the starkness of the sunlight.

Gordon Cooper conducted an experiment directly related to Gemini when, on his third orbit, he deployed from his capsule's heat shield a 5¾-inch, 10-pound sphere containing two xenon stroboscopic lights. They flashed on for approximately one ten-thousandth of each second and were about the same magnitude, when viewed from seven to nine miles away, as the star Polaris. The beacon traveled in front of Cooper's flight path. His job: to evaluate it as an aid to rendezvous in future space flights.

#### Astronaut Reports on Flashing Beacon

Cooper did not see the light during his third orbit, but he found it during his fourth. Here is his own description of how the beacon appeared to a man in space:

"On the nightside on the fourth orbit, I once again turned to the 180° heading in yaw so that I was looking forward along the orbital path. This time, as the sun was setting behind me, I saw a small light coming up toward me from below, very, very, slowly. As I watched it, it moved higher in my line of sight to the earth. Rather than flashing, however, it was a solid light.

"My first thought was that it looked just like some of the missiles I had seen launched at night from our Florida space center when I had been flying at high altitudes. . . . I must have seen the setting sun shining off the sphere, and this must have been brighter than the flashing of the xenon light. It continued to move higher, and when it reached a point about 15° or so above my line of sight, it suddenly began to flash. Perhaps by this time the sun had set.

"The flashing light was easily visible and appeared to be approximately 10 miles away [actually it was 3 to 4 miles distant] and about the brightness of a second-magnitude star. I

deliberately maneuvered the spacecraft away from the target so that I could no longer see it and then eased back into the 180° yaw position and easily picked up the flashing light once more. It appeared to be around 12 to 14 miles away [actually it was about 8] and still quite easily visible.

"On the third nightside pass after deploying the light, I had not anticipated seeing it at all, but there it was, blinking away! At this time it was very faint and appeared at a distance of about 16 to 17 miles [actually about 9]. I would say that it was approximately the brightness of a fifth-magnitude star."

Bracketed material has been inserted in Cooper's statement to contrast true distances with his estimates. Apparently even a highly trained observer has difficulty judging how far off a beacon is in space. This human fallibility, however, should not affect plans for Gemini. Radar will accurately determine the astronaut's distance to target. The important thing is that Cooper could find a small flashing light in the immensity of space and observe its movements.

"We should be able to detect it fairly easily at distances where it will appear as bright as a second- or third-magnitude star," Cooper says. "However, it will be important to know the approximate area in which to search for it."

Cooper adds that he would prefer the beacon to be twice as bright and flash every two seconds, not every second. He also recommends two beacons on the Agena target.

#### Long Weightlessness Worries Doctors

Agena has the power to push Gemini to an apogee of 2,000 miles, far above any manned flight to date. With an improved Agena the distance would be much greater. However, you pay a price for such forays in increased speed and heat rate upon re-entry into the atmosphere. To withstand the fiery passage, the capsule would have to be toughened and its heat shield thickened.

Initially, we have less ambitious plans for Gemini. We must practice to perfect rendezvous, and we must find out how well astronauts can tolerate stays of many days, not hours, in space.

For example, we do not know the effects of prolonged weightlessness. Mere bed rest over long periods leads to cardiovascular disturbances, evidenced by the weakness and dizziness a convalescent feels when he gets to his feet. Many medical men believe zero

**T**O ILLUSTRATE Dr. Dryden's authoritative account of the Gemini and Apollo projects, NATIONAL GEOGRAPHIC staff artist Robert C. Magis interviewed NASA's space experts and those of its contractors across the Nation. Under Magis's direction, Pierre Mion and Davis Meltzer executed these paintings as a forecast of science's most spectacular achievement. Their conceptions of the epochal voyages take orbiting Geographic members far beyond the reach of photography.

## GEMINI "ARABS" TEST NEVADA'S HOSTILE DESERT

**R**ATTLESNAKES and scorpions, a sand blizzard, and 120° F. temperatures beset ten astronauts as they trained last August for a possible landing in the desert. They fashioned burnouses from discarded parachute nylon as protection from the blazing sun. Left to right: Neil A. Armstrong, Frank Borman, Charles Conrad, Jr., James A. Lovell, Jr., James A. McDivitt, Elliot M. See, Jr., Thomas P. Stafford, Edward H. White II, John W. Young, and Donald K. Slayton.

**JUNGLE LANDINGS** pose hazards, too. Here water from a vine quenches the thirst of Maj. L. Gordon Cooper, Jr., in the Panama bush. Sixteen astronauts participated in a rugged four-day survival course last June, learning how to kill and eat lizards and wild pigs should their spaceship land in the tropics.



gravity may have the same effect. You may recall that Gordon Cooper felt momentarily dizzy when he emerged from his capsule after a helicopter had hoisted it from the sea to the deck of a carrier. Also, astronauts have experienced a mild but mystifying postflight reduction in blood pressure and pulse pressure.

Some experts feel that weightlessness, like bed rest, may lead to a loss of calcium from the body. This occurs in bedfast patients when the skeletal structure softens because of prolonged inactivity. As yet it has not been detected in our astronauts.

Probably it will be necessary to set up exercise programs for flight crews. They can't jump about and do calisthenics while weightless, nor would there be much room in Gemini for moving around. But they can easily exercise what medical men call the antagonistic muscle groups, such as the extensors and flexors. For example, an astronaut may tightly interlock his fingers while trying to pull them apart. Or he may grasp the arms of his seat and hold himself firmly down while at the same time trying to push himself up with his legs. He may even be trained to tense his muscles at will and then relax them, as a yogi would.



PHOTOGRAPH BY GUY WILSON FOR NATIONAL GEOGRAPHIC PHOTOGRAPHY COURTESY OF NASA. © 2004. GUY WILSON

Perhaps we may find that special exercise equipment, such as tension devices that can be pulled or pushed, will be needed.

Certainly the men must be kept in good shape for the rigorous deceleration forces that mount quickly when their capsule smashes into the atmosphere during re-entry. Moments later they must be fit enough to steer their craft toward an airplanelike landing at a predetermined spot. They will do this by deploying a paraglider, 37 feet broad from wingtip to wingtip and 32 feet long, which they can readily maneuver (page 370).

However, Gemini will land by parachute, as did Mercury, during its first manned flights. The paraglider is under intensive development, but time will be needed to perfect it.

Mercury's builder, McDonnell Aircraft Corporation, also holds the prime contract for Gemini. It fabricates the capsule's pressure vessel, or interior wall, from heat-resistant titanium, a difficult metal to work and weld. Shingles of beryllium and the alloy René 41, capable of withstanding high temperatures, cover the exterior wall. Though

the capsules are far from mass-produced items, and the equipment in each varies according to its mission, McDonnell now has a production line for them. At this stage some are what we call "boiler-plate versions," intended only for ground tests; others will be flight-tested without passengers.

Yet now on the line is a capsule that will be "man rated," meaning it will carry the first two Gemini astronauts into space. If all goes well, that flight will occur sometime in the fall of 1964.

"I have never been associated with a project in which the men became so engrossed," a production line supervisor told one of my colleagues. "A seven-day work week for them, and not a single gripe! They're building with the heart, not just head and hands."

Mercury and Gemini share a significant limitation: They were built to operate in earth orbit. Putting men on the moon is not only more complex; it requires a brute force in rocketry far exceeding any booster flown to date by the United States or Soviet Union.

We estimate the thrust of rockets used in



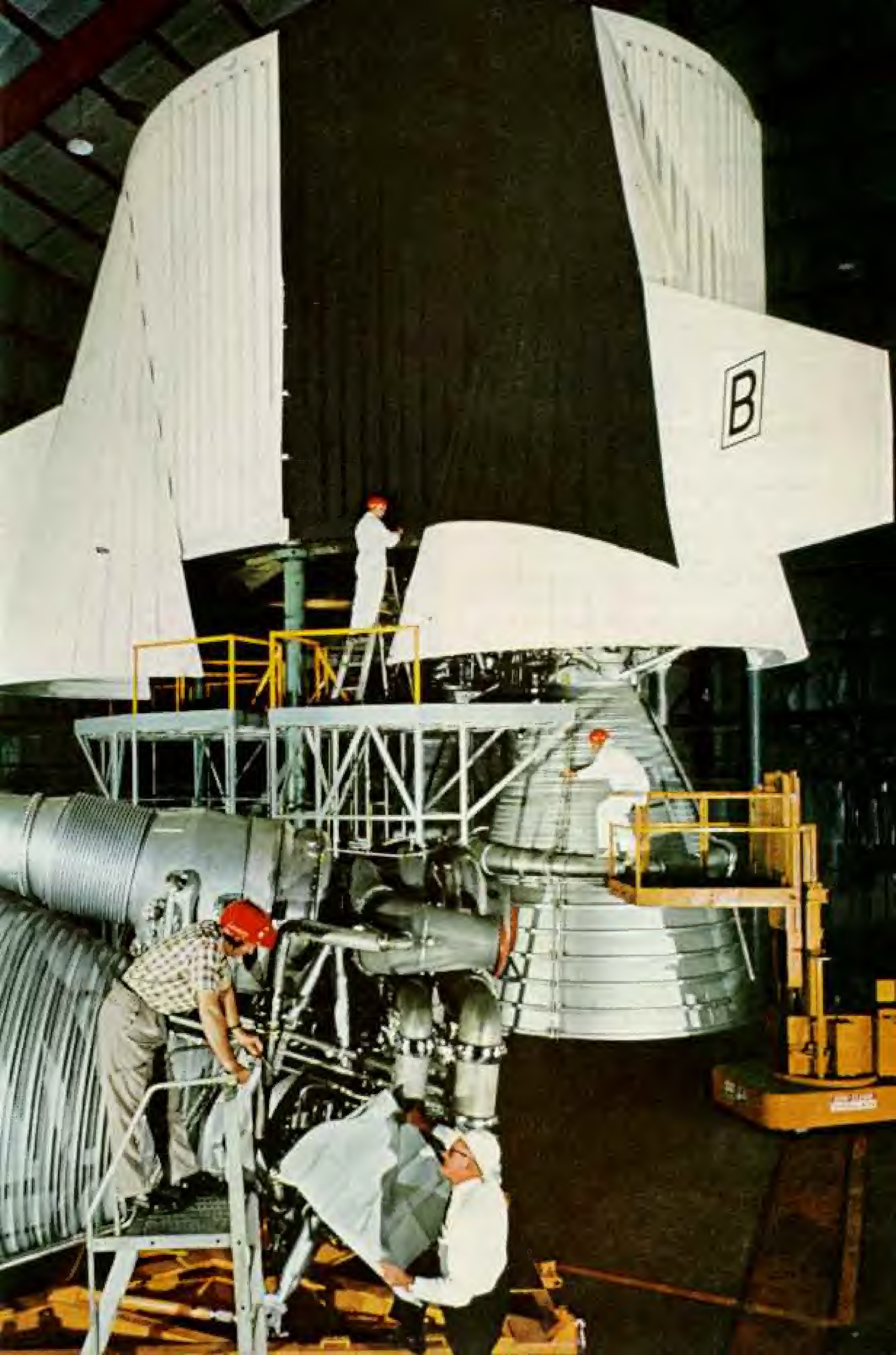
PHOTOGRAPH BY BOB LINDSEY AND IZ ESTADORE BY JAMES F. SMITH © 1969

**RAGING HORSEPOWER** spews from Apollo's mighty F-1 rocket engine in a test firing by its builder, Rocketdyne, at Edwards Air Force Base, California.

**GIANT MOCK-UP** of the tail section of Saturn V, Apollo's launch vehicle, dwarfs workmen at the Marshall Space Flight Center in Huntsville, Alabama. Five F-1 engines will produce 7,500,000 pounds of thrust.







**L**IKE TOYS IN A BATHTUB, tugs bob fore and aft of a Saturn I booster on Florida's sun-bronzed Intracoastal Waterway. Too large to travel by air, rail, or truck, metal-encased Saturns ride by barge from Huntsville to the space center via the Tennessee and Mississippi Rivers, the Gulf of Mexico, and the waterway.

Soviet cosmonaut flights at about 800,000 pounds, more than twice that of an Atlas. With this power the Soviets could put up a manned space station. They might even send one man around the moon and back, though it would be a marginal venture. But they cannot land men on the moon and bring them home without building a much larger booster. We believe the United States and Soviet Union began that task on fairly even terms.

#### Monstrous Boosters Will Hurl Apollo Aloft

So the lunar trip involves a weight-lifting contest, and there are three basic ways to approach the problem.

One we call EOR, for earth orbital rendezvous. Using two big first-stage boosters, you put up a tanker rocket and later your spacecraft, join them, then fly to the lunar surface. In the second, or direct method, you build rockets so monstrously huge that you can blast off to the moon without rendezvous. The third technique, LOR, for lunar orbital rendezvous, represents a choice between extremes. With multistage boosters you fly close to the moon, descend to the surface in a special vehicle, and rendezvous later with a mother ship in lunar orbit.

We chose the third method for many complex technical reasons. In essence, however, it seemed safer, less complicated, and represented an important saving in payload weight.

A comparison of Gemini with Apollo illustrates the power required. With the Gemini system we will be putting several tons into earth orbit at 17,500 miles an hour. With Apollo we must send 45 tons into *lunar* orbit, which means all that massive tonnage must be accelerated to about 24,200 miles an hour, the speed necessary to escape earth and enter the gravitational field of the moon.

**P**ELICANS FLAP SKYWARD from a sand bar in the Banana River. Lofty gantry looms from the space center's launching area. Displaying little fear of blasting rockets, birds of many species feed and nest here.







In Mercury and Gemini, NASA has depended upon boosters built for the Air Force. Without these rockets, as well as Air Force contractors and personnel, many of the space agency's achievements in unmanned as well as manned flight would have been impossible. But NASA's future programs, particularly Apollo, demand boosters with a thrust beyond present Air Force needs, and the space agency is developing these superrockets.

We have had a number of successful unmanned test flights with the Saturn I, whose first stage is capable of 1½ million pounds of thrust, more than quadruple the power of the Atlas. With a larger upper stage, this rocket will become the even more powerful Saturn I-B and will be used to send three-man Apollo crews into earth orbit for practice flights.

But even these behemoths will be too puny for the lunar mission. That epochal voyage will require the Saturn V, a three-stage rocket towering 362 feet, nearly two-thirds the height of the Washington Monument in our Nation's Capital. Assembled and fueled on its launch pad, it will weigh 3,000 tons, about the weight of the nuclear submarine *Nautilus*.

We haven't built this giant yet, although all components are under development by industrial contractors. To test its massive stages and engines, NASA is building a huge facility in southwestern Mississippi, only 35 miles from the manufacturing complex at Michoud, Louisiana, where the Saturn V will be assembled. Barges will carry the moon rocket to its final checkout and launching site, a new area adjacent to the famed pads of the Florida space center (pages 392-4).

Contractors have logged hundreds of successful test firings of Saturn V's ultrapower-

#### FIRST SATURN BLASTS OFF, AND A CASCADE OF FLAME ENVELOPS PAD 34

**B**EFORE HUMAN PASSENGERS climb aboard, NASA rockets must prove themselves with dummy cargoes. Carrying two mock upper stages atop the live booster, the 165-foot, eight-engine projectile leaped 90 miles high in October, 1961, and then splashed down 225 miles away in the Atlantic.

ELEVEN FEET TALLER than the Statue of Liberty and twice as heavy, the second Saturn I receives a final checkout on the pad. Later, in a flawless flight, it generated 1,300,000 pounds of thrust. Although four times more powerful than Atlas, it is far less powerful than Saturn V (page 375).



מיל-20  
101-100

מיל-20



PHOTOGRAPH BY WALTER J. BURROUGHS © N.S.A.

**A**STRONAUT'S TOOL KIT includes new devices for making repairs in the weightless environment of space—spammer (space hammer), plench (pliers and wrench), and zert (zero reaction tool). In this multiple exposure, a test engineer, unable to brace himself, spins around at left in reaction to the force he exerts attempting to tighten a bolt with a conventional wrench. At right, a special wrench called nab (short for nut and bolt) allows him to apply twisting force to the bolt without moving his body.

ful F-1 and J-2 engines (page 374). Five of the F-1's, clustered in the first stage, will yield  $7\frac{1}{2}$  million pounds of thrust. In terms of electric power at stage-one burnout, this thrust is equivalent to more than 67 times the generating capacity of the Potomac Electric Power Company, serving all of Washington, D. C., and its Maryland suburbs.

The F-1 burns liquid oxygen and kerosene—three tons every second. J-2 engines in the upper stages, however, devour liquid hydrogen and liquid oxygen. Hydrogen is lighter than kerosene and gives a higher specific impulse, a measure of thrust effectiveness, but it has the disadvantage of requiring a greater volume of tankage space. If we used it in the first stage, we would have to build a bigger booster, and the efficiency of the hydrogen would be offset by increased drag in the lower atmosphere.

Apollo's command module, like the Gemini capsule, is in limited production, but these

are very early test versions by its builder, North American Aviation, Inc. In final form the cone-shaped five-ton spacecraft will have a double hull, one layer consisting of two sheets of stainless steel with a honeycomb between them, and the second having two sheets of aluminum alloy, also separated by a honeycomb.

Inside these stout walls the three crewmen will recline in a row on contour couches during the first phase of the journey. Later the middle couch will be stowed beneath the left-hand one and will be used as the bed for an off-duty astronaut (page 391).

In Gemini, after working out the position of instruments and equipment, we could allow only 35 cubic feet of space per man, less than in the cockpit of a T-33 jet aircraft. By comparison, the Apollo command module will be rather roomy, with 75 cubic feet per man.

Crewmen will be able to move about even though their home in space will be packed

with intricate gear, including a computer that will give them guidance information. Most of their support equipment, however, and the rocket power to put them into lunar orbit and bring them home, will be housed in another Apollo section, the service module.

As our plans for the LEM evolved, the vehicle looked increasingly like some nightmarish insect, so we nicknamed it "the bug" (page 356). It has a round face (crew quarters), two eyes (viewing ports), a mouth (the hatch for egress to the moon), and long spindly-looking legs (landing gear).

This bizarre craft weighs 12½ tons and can move in any direction, even hover like a helicopter. Since it was especially designed for lunar landing and take-off, it is more versatile than the single all-purpose roundtrip

vehicle we originally planned. Indeed the LEM represents a new line of thinking, so it is not as far along in development as the command module. Grumman Aircraft Engineering Corporation will build it.

All the various Apollo sections will be tested in a circumlunar flight and return to earth, as well as in earth orbit, before an actual landing on the moon.

Many problems and hazards exist for a lunar mission that are not encountered while orbiting the earth. Before I describe a voyage to the moon, as we now plan it, let's look at some of these possible pitfalls.

The Van Allen radiation belt, named for its discoverer, Dr. James A. Van Allen, must be traversed. It consists of charged particles expelled from the sun and trapped above

**L**QUID FUEL SPLASHING VIOLENTLY in a rocket during launch or landing can affect the spacecraft's stability or even destroy it. Plexiglas sphere at NASA's Lewis Research Center in Cleveland, Ohio, contains a fluid much like the fuel. A machine churns the liquid to simulate launch and landing vibrations, while an engineer studies its behavior to help him design rocket tanks.

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PHOTOGRAPH BY NATHAN L. SCHLESING FOR PHOTOGRAPHY SERVICES, INC., WASHINGTON, D. C.



the earth by our own planet's magnetic field.

Basically there is only one belt, but it includes two dissimilar regions. One consists of high-energy protons caught in a layer that arches some 2,000 miles above earth at the magnetic equator. The other, containing high-energy electrons, girdles the magnetic equator about 10,000 miles from earth. In schematic drawings these regions curve around the globe like horns or crescent moons. The second, in particular, is quite deep, extending outward some 20,000 miles.

Manned space flights to date have been too low to get into this radiation, but Apollo crewmen will have to slash through it going out and coming back. Fortunately they will be exposed for a total of only a few hours, and the estimated 20 roentgens of radiation they will absorb will not be serious from a health standpoint. Their spacecraft, of course, gives only limited protection; it cannot be sheathed in thick lead.

#### Solar Flares a Threat to Astronauts

Beyond the Van Allen belt lies another radiation hazard from intermittent solar eruptions, or flares. Actually the sun is never really quiet, since it ejects about 400,000 tons of matter a second in all directions. But these sub-atomic particles, called the solar wind, are very sparse in the vastness of space and limited in velocity. They would not pierce a sheet of tissue paper. Flares, however, produce concentrated streams of far more energetic proton particles, some traveling at nearly the speed of light.

Fortunately an outburst of radio noise coincides with these eruptions, and they can also be viewed by astronomers as they occur. Apollo crewmen will have at least four hours' warning before the major part of the proton stream reaches them. They may have to shield themselves with special garments and goggles, but their equipment and double-hulled spacecraft are designed to keep the radiation dosage safe during one large flare. In the event of a second flare during the outward journey, they might have to scurry home.

Actually the prospects are not as serious as they seem. We know the kinds of solar activity—particularly sunspots—that tend to forecast eruptions, and a safe period can be predicted with a reasonable degree of accuracy. Even when danger indicators are present on the sun, large flares do not occur in most cases. If one should happen, the chances are favorable that it will be minor or be directed away from the earth-moon system.

NASA is pushing a determined program to improve the reliability of flare forecasts and to find ways for making long-range predictions. Such knowledge will be particularly important during periods when the 11-year sunspot cycle reaches a peak, as it will in late 1968 and early 1969.

Space contains a lot of rubbish—the meteors we often see streaking down the night sky—but most of this celestial debris is extremely minute and no danger to Apollo. Pieces as large as a sand grain are believed rare.

Statistics indicate only one chance in 10,000 that Apollo would encounter a meteor big enough to pierce the hull, yet we have planned for that possibility. If a half-inch hole were blasted, permitting the spacecraft's atmosphere to escape, the life-support system would automatically gush out enough oxygen to sustain the men for five minutes. In that period they could get back into their space suits and plug the hole.

However, Apollo may have to avoid meteor streams that intersect the orbits of earth and moon. Astronomers count about 30 of these periodic streams or showers, but only four are considered of major importance: the Quadrantids in January, the Perseids in August, the Geminids in October, and the Leonids in November.

#### Extremes of Heat and Cold Grip Moon

Perhaps the greatest hazards will be found on the moon itself. For example, we know little about the composition of the lunar surface. Some authorities believe it may be covered by a dust layer from four inches to three feet in depth. Others think the dust in some areas may be far deeper, enough to engulf any spaceship. A third group holds to the theory that porous rock covers much of the surface.

Obviously we cannot risk landing men until these uncertainties are resolved by unmanned lunar probes, such as our forthcoming Rangers and Surveyors.\* Their intelligence will determine the final design of LEM's landing gear.

On the airless moon, a man's best friend will be his pressure suit. If it fails, or if he should fall and tear it open on some jagged rock, the vacuum would claim him. We have good experience in building tough, dependable pressure suits, but the Apollo garment must be a super one, able to withstand micrometeorites, easily flexible at the body joints,

\*See "NASA's Robots to the Moon," by Frank Sartwell, NATIONAL GEOGRAPHIC, October, 1962.





**S**PACE WATER GUN restores moisture to dehydrated carrots and peas.

**F**ORCING FOOD through a mouthpiece, a researcher taste-tests an experimental dish that spacemen will eat in flight. Plastic containers on the table equal the conventional meal in foreground.

**D**UCKWEED FRONDS may provide both food and fresh air for future astronauts on long interplanetary flights. The plant, which feeds on carbon dioxide and emits life-giving oxygen, is being tested at the School of Aerospace Medicine in Texas.



ILLUSTRATIONS BY JOHN JENNINGS (LEFT); BOB LAMER; P. 24-25: K.C. L.





UNDERCLOTH BY NELORE; EDOGRAPHIC PHOTOGRAPHY JAMES F. BLAIR © N.Y.S.

**S**TYLISH ATTIRE FOR LUNAR EXPLORERS. prototype pressure suit has pleated sections at neck, shoulder, elbow, thigh, and knee for freedom of movement. Close-fitting hard helmet carries earphones, microphones, and sun-filtering visors. Engineer-pilot Paul Couluris models one version of the suit before a LEM mock-up at the Grumman plant.

and equipped with a highly efficient temperature-control system.

This latter requirement may be the most difficult. Temperatures on the moon fluctuate savagely. Lunar daylight brings a maximum as high as 241° F., 29 degrees above the boiling-point of water. In the lunar night the temperature plummets to as low as minus 271° F., or 92 degrees below the freezing point of ethyl alcohol.

It is easier to heat a suit than cool it, and our astronauts may land in an area of the

moon not punished by the powerful rays of the sun but gently illuminated by earthshine, the reflected sunlight of our own planet.

We will learn more about these hazards in the next few years, and they will yield to man's ingenuity. So, one day before the end of this decade, NASA will declare a "go" condition for a huge Saturn V poised on its launch pad at Merritt Island, Florida, just north of the older launching sites.

An elevator hoists three men in gleaming silver space suits to the level of the command

module, 33 stories high, and they climb in. The long countdown goes smoothly, and at T-minus-0, the moment of launch, F-1 engines blast them from earth with the roar of a thousand Niagaras.

At 206,000 feet the first stage drops like a discarded garment, and the second stage ignites. Moments later the escape tower, similar to the one used with Mercury, is cast off, and the moonship, now much lighter, accelerates rapidly. Soon stage three cuts in, burns just long enough to thrust Apollo into earth orbit, then shuts itself off.

The first phase of the mission, "parking" Apollo in space, is successful. Now, at the Manned Spacecraft Center in Houston, Texas, computers calculate trajectory and orbit and determine the precise moment when stage three must again be fired to put the explorers on an accurate course—not to where the moon is at the moment but to where it will be 70 hours later.

This complex problem must take into account the speed of the earth at 67,000 miles an hour relative to the sun, the speed of the moon at 2,500 miles an hour relative to the earth, and the average speed of the craft, about 3,300 miles an hour en route to the target.

But the necessary information soon flashes up to the crew. They trigger stage three, and it pushes Apollo to escape velocity.

#### Critical Moment: Linking With LEM

Now another intricate maneuver must be executed. With the skill of long practice, the astronauts detach their command and service modules from the third stage, turn them around, then link them with the LEM. This frees the service module's engine for use and joins the LEM's access hatch to the crew quarters. The useless third stage is blasted loose, and the men settle down to a routine (pages 395-7).

Probably they alternate four hours of work with four hours of rest and plan their schedule so that two men stay at duty stations at all times. They talk to earth and continually monitor equipment, particularly their computer. Linked to an inertial guidance system, it constantly tells them their course and speed.

At intervals one man takes star sightings with a specially designed sextant and feeds this information to the computer. Six times, perhaps oftener, the astronauts reorient Apollo and fire its engines briefly to make necessary course corrections.

Long practice in earth orbit has taught them how to move about while weightless,

and light harness, fixed in strategic spots, gives them handholds or anchors them as needed. Cumbersome space suits are placed aside most of the time, though one man is always "suited up" in case of emergency.

When hungry, the men drift over to their tiny galley and prepare a hot meal: meat and potatoes, sea food, fruit, vegetables. Each item comes dehydrated in a plastic bag (page 383). The astronaut adds hot water, kneads the bag, and squeezes the food into his mouth. (I have tried it. Though not *haute cuisine*, it is surprisingly tasty.)

#### Apollo Tops a Crest and Falls

Like an automobile coasting uphill, Apollo has been losing speed. Now, 220,000 miles from home, it reaches a point where the moon's gravity wins the tug-of-war with earth's. Once past that invisible crest, the spaceship speeds up and falls toward the moon. To brake the plunge, Apollo uses its engine like a retrorocket and enters a circular orbit 90 miles above the lunar surface.

It is time for the climactic phase, the descent to the moon. Two crewmen wriggle feet first through a hatch into the LEM, release it from its mate, and fire its engine to put themselves into an elliptical orbit.

Now LEM circles the moon in a race with the command module; every two hours they pass each other as their orbits cross. If anything goes amiss at this stage, they will rendezvous and return home.

But LEM checks out perfectly. As it approaches the low point of its orbit, 50,000 feet from the surface, the expedition commander again fires his descent engine and brings the bug down toward a preselected landing site near the moon's equator.

While the craft hovers, the men stare intently from their viewing ports, scanning the surface. They know their fuel supply permits them only two minutes to decide on a landing or a return to the mother ship.

But the terrain looks safe, and they descend in a torrent of flame and dust (page 397). Their landing gear sinks for a heart-stopping moment, then hits rock. The bug stands steady, its engine cut.

When the commander, burdened with cameras, scientific equipment, and a life-support backpack for his suit, steps down from the bug and treads the lunar dust, he will forget for a time his assigned tasks and stand in awed immobility. Myriad stars, nearly double the 2,500 visible from earth at any one time and place, sequin the heavens. Overhead



ILLUSTRATION: JEROME W. LINDEN

hangs a huge luminous globe predominantly blue in color but wearing a veil of brilliant white over vast areas. It is the time of "full earth" as seen from the moon, and our planet, though not quite four times the diameter of its neighbor world, glows with a much greater brilliance than that of the loveliest full moon ever observed by man. So a strong, eerie twilight bathes the ancient rocks and craters of the desolate lunar plain.

For perhaps as many as four hours, the commander explores this new world. He makes photographs, takes notes, collects rock samples, and places instruments that will relay information home after he leaves. He moves easily in the gravitational field of the moon, only one-sixth that of earth. The sensation is one of buoyancy, like that of a man standing chest deep in calm water. All too soon his allotted time ends. He returns to LEM and gives his partner a chance to explore.

Later, their tasks completed, they begin a countdown for rendezvous with the command module. At just the right moment for intercept, they blast themselves back into the alien sky, leaving behind the LEM's descent

stage and landing gear (page 398). They overtake their target, dock, and crawl back into the mother ship for a jubilant reunion with their comrade.

The 70-hour journey home proceeds much as did the outward trip. Again the men make course corrections, probably more frequently and even more painstakingly than before. Their lives depend on hitting a corridor in the earth's atmosphere only 300 miles wide and 40 miles deep (page 400). If their angle of descent is too shallow, Apollo will skip out of the atmosphere and hurtle on into space. If their angle is too steep, abrupt deceleration in the thickening air will crush them like ants under a boot.

Indeed the accuracy requirement seems fantastic, equivalent to shooting the nap off a tennis ball—but not hitting the ball—from a distance of 100 yards.

But the guidance system does its job. Apollo obediently executes its last course correction, the service module is jettisoned, and the command module scores a bull's-eye on the narrow corridor. Flame envelops the blunt heat shield as its surface vaporizes at 6,000° F.,



PHOTO COURTESY OF JAMES P. QUINN & SONS

ATOMIC-AGE RUBE GOLDBERG WHIRLS AN ASTRONAUT, AND HE EXPERIENCES THE STRESSES OF SPACE

**S**TREAKS OF LIGHT in a time exposure trace a pilot's ride as his cab simultaneously rolls (red), pitches (yellow), yaws (blue), and moves horizontally (green). The cab can also swing up and down. This motion device at Ames Research Center, California, enables scientists to study the physiological effects of space flights on astronauts.

IN A TWO-MAN LEM MOCK-UP, Martin Company engineers simulate the critical rendezvous and docking portion of the Apollo lunar mission. Command module (top) reacts to flight controls in the LEM, movable on three axes. Suspended from a crane, the module moves back and forth in this multiple exposure. In actual flight it will be passive and LEM will be moving. For the final docking maneuver, the pilot (right) will turn his chair around to see Apollo's command module through one of LEM's ports.

twice the temperature of the Mercury shield (page 401).

Apollo's shape and an offset center of gravity give the spacecraft some lift in the atmosphere, and throughout this fireball descent the commander has been maneuvering by using his roll jets. His skill brings Apollo near its landing site, probably in the southwestern part of the United States. Three parachutes billow from the top of the cone and lower the men to earth.

Tired, shaky, but well, the astronauts step out. Within moments the entire United States and much of the world goes quite mad. A week of unbelievable tension ends in scenes of tumultuous rejoicing.

Will this triumph of man's mind, hand, and heart be worth the cost? Are there good reasons for going to a dead, hostile world?

To scientists trying to fathom the origin of the earth and other bodies of the solar system, the moon is vitally important and its lack of an atmos-





APOLLO ESCAPE ROCKET LAUNCHES AT WHITE SANDS MISSILE RANGE, NEW MEXICO

**F**OUR-NOZZLED ESCAPE ROCKET hurls aloft an unmanned test version of the Apollo capsule at the White Sands Missile Range in New Mexico. Last November's flight test evaluated the system that would free the three-man lunar team from their Saturn booster should an emergency arise during countdown or lift-off.



**B**LAST JETTISONS the escape tower from the capsule at 5,100 feet. The capsule tumbles earthward until a drogue parachute (not shown) slows and stabilizes it. Black dots and red square on the capsule help photographers track it in flight.

**M**AIN CHUTES, blossoming from the nose section of the capsule, slow the craft to a 16-mile-an-hour impact speed. NASA officials termed the test highly successful. "The vehicle did exactly the things we expected," they declared.

phere a decided asset. Here on earth our vast oceans and the wind and rain have obliterated surface features that could tell us much about the way the world was formed. But the surface of the moon preserves a record that may go back 4½ billion years. There the primordial rocks remember their history and will reveal it upon scientific analysis. Similarly the moon's interior holds secrets that we may one day discover by deep drilling.

Robots fired to the moon will give us only limited information. We cannot build into them the versatility and powers of decision of a man. We cannot make them as dependable as a man. Only humans can give us answers to the most important questions.

However, if finding out more about the origin of the solar system were the trip's sole purpose, we would not be attempting it. Other national purposes are involved.

A Soviet sputnik, not a U.S. satellite,

ushered in the Space Age on October 4, 1957. That first venture into space could have been ours. As a nation we had the ability to do it but not the foresight or the will.

In the intervening years we have accomplished much, and most of us now realize that we cannot remain a great nation if we do not pursue the conquest of space wholeheartedly, using whatever resources are required. It is not merely a matter of national prestige; it also involves national strength and security. The assault on space will change our lives and our prospects in ways yet undreamed of, and we must acquire the knowledge, the resources, and the trained personnel to be first in man's greatest endeavor.

Today the military advantages of space supremacy may not be apparent, but they probably exist. No nation achieves such advantages by paper studies, nor can a threat be countered by some overnight crash pro-

APOLLO CAPSULE BY LOREN F. GARDNER FOR LIFE



**M**INUTES AFTER Apollo's landing, technicians clamber over the capsule amid the sand and sagebrush of the impact area. They found the craft undamaged inside and out.



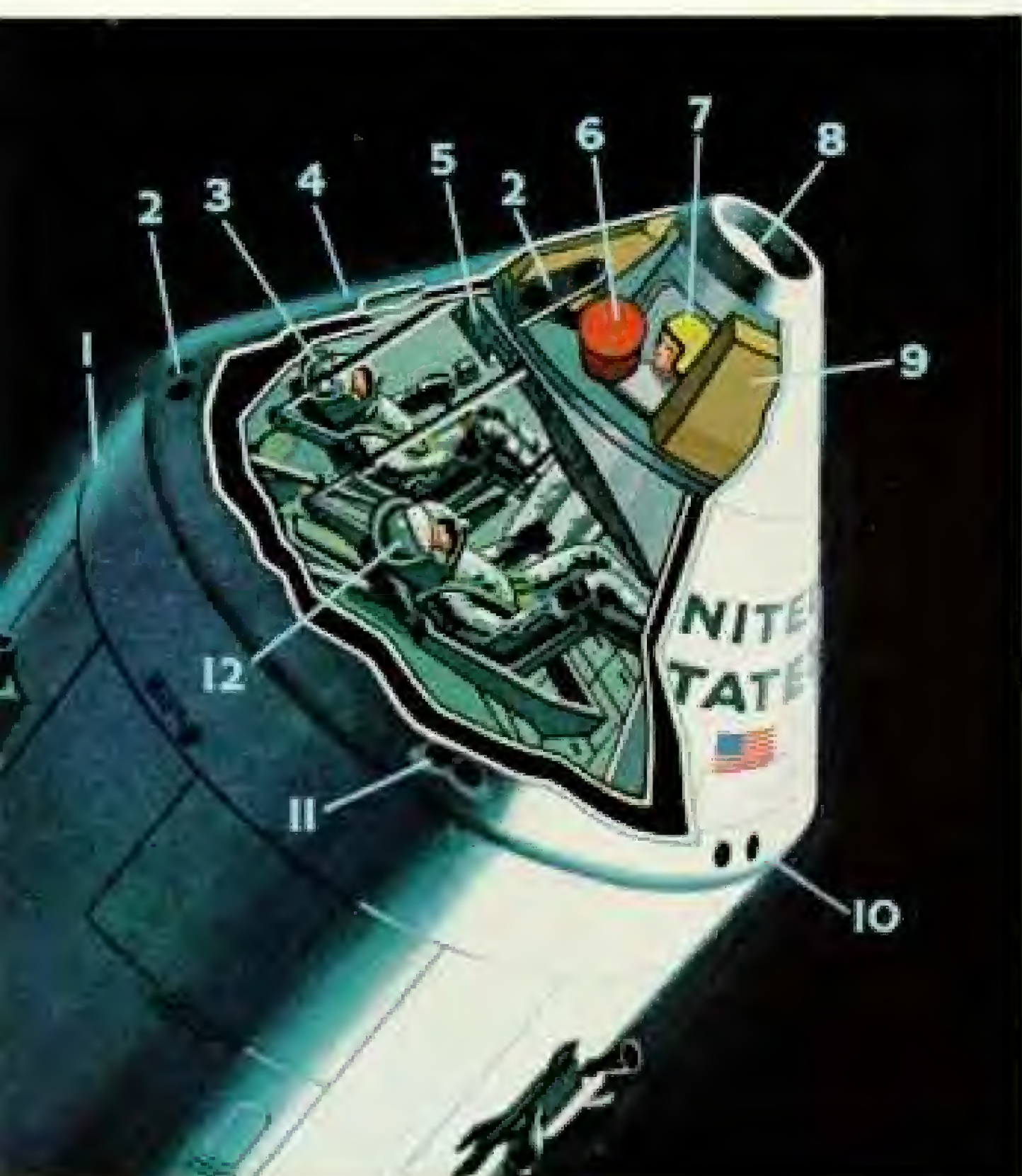
gram. To be safe, and to insure the safety of its friends, our Nation must build the launching sites, the huge rockets and engines, and vast assembly plants needed to get into space with heavy loads. It must develop new techniques. It must enlarge men's knowledge in a score of scientific fields.

All these things the Nation is now doing through NASA. True, the space agency has no military mission. Space and Antarctica are the only regions today where men do not bear arms, and we all pray they will remain that way. Nevertheless, NASA's work is vital to the national security.

Apollo represents a unifying goal, an incentive, and a goad for much of this work. Indeed a trip to the moon makes an ideal goal. It is difficult enough to require the building of a new and vital technology, but not so difficult that it cannot be done.

History teaches us that the creation of a new technology in one field invariably affects others. The automobile industry was largely responsible for development of efficient internal combustion engines, alloy steels, synthetic rubber, new fuels, and many other products. The aircraft industry created a wide market for aluminum alloys, which now have countless industrial uses.

Similarly, the exciting advance of our space industry has a tremendous implication for all of us who will never leave the earth. Such projects as Echo, Telstar, Relay, and Syncom, the communica-



**W**ITH SECONDS TO GO, Apollo crewmen lie tensely on their backs as they await lift-off for the moon. Three North American research engineers enact the historic moment in this mock-up. Each man must wear his pressure suit during his turn as command astronaut, in the seat at far left. Others may take off the burdensome garment. Once in orbit, the astronaut in the middle rises and pushes his seat under the command astronaut for use as a bed by the off-duty spaceman.

CUTAWAY DIAGRAM OF APOLLO shows position of 1 service module, 2 pitch controls, 3 command astronaut, 4 command module, 5 control panel, 6 drogue parachute mortar, 7 systems engineer, 8 docking hatch, 9 parachutes, 10 yaw control, 11 roll control, and 12 engineer-pilot.





REARVIEW BY NATIONAL AERONAUTICS PHOTOGRAPHIC SERVICE, WASHINGTON, D. C.

tions satellites; Tiros, the weather "eye in the sky"; and Transit, the earth-measuring satellite, are of obvious practical benefit.

Less apparent, but of growing importance, is the space industry's "spin-off," the term we apply to developments that can be adapted to consumer use. For example, many heart patients live today because of tiny electrical devices, called cardiac pacers, that stimulate heart action. These devices, often implanted in the patients, were made possible by the aerospace industry's success in miniaturizing electronic components.

Pacers now in the planning stage may dispense with batteries and operate on the fuel cell principle, as in the electrical systems of Gemini and Apollo. Tiny cells would convert oxygen and glucose in the patient's bloodstream to electricity. Water produced as the

by-product would be insignificant in amount and no threat to the patient's well-being.

Many other examples of spin-off could be cited. They range from high-temperature ceramic cooking utensils to better and faster computers, from improved industrial planning techniques to the concentrated dried foods, requiring no refrigeration or cooking and occupying far less storage room than conventional foods, that have been developed for astronauts.

In my opinion the most valuable bonus from our space activities has been the impetus given education. Colleges and schools throughout the land have changed outmoded curricula and taken up the space sciences as a new and inevitable challenge.

The Space Age is only six years old. Who  
*(Continued on page 400)*



## TRIP TO THE MOON I – The Take-off

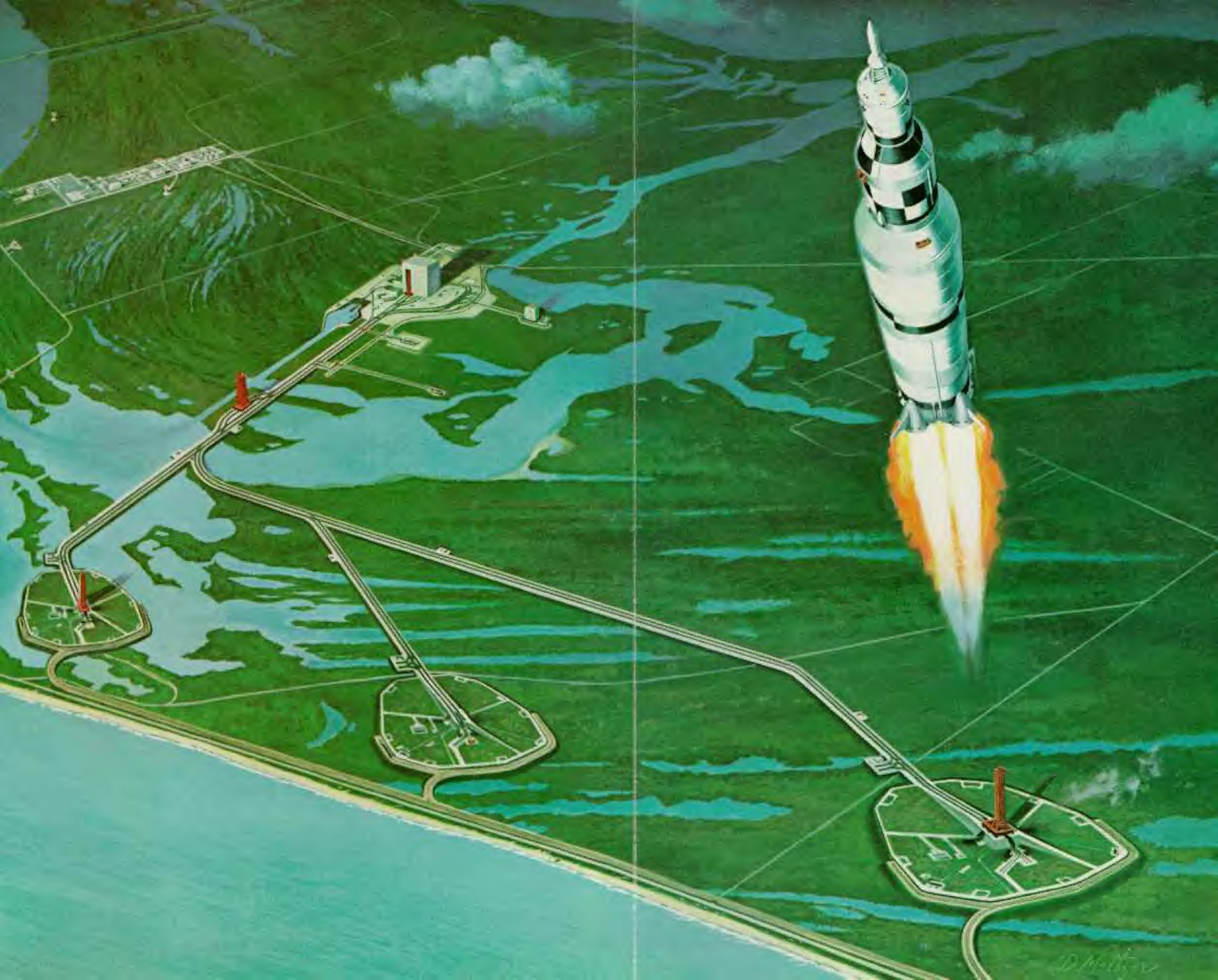
**I**T IS A DAY in the late 1960's. Gleaming in the early morning sun, a moon-bound rocket blasts from its pad at the Kennedy Space Center. Forty seconds after launch, Apollo astronauts roar skyward 8,900 feet above the Atlantic as they head toward their target, some 239,000 miles and 70 hours away. Gaining speed rapidly, they will proceed to a prescribed earth orbit and a speed of 17,500 miles an hour; then, after computers on the ground discharge course instructions, the men will blast themselves into a lunar trajectory.

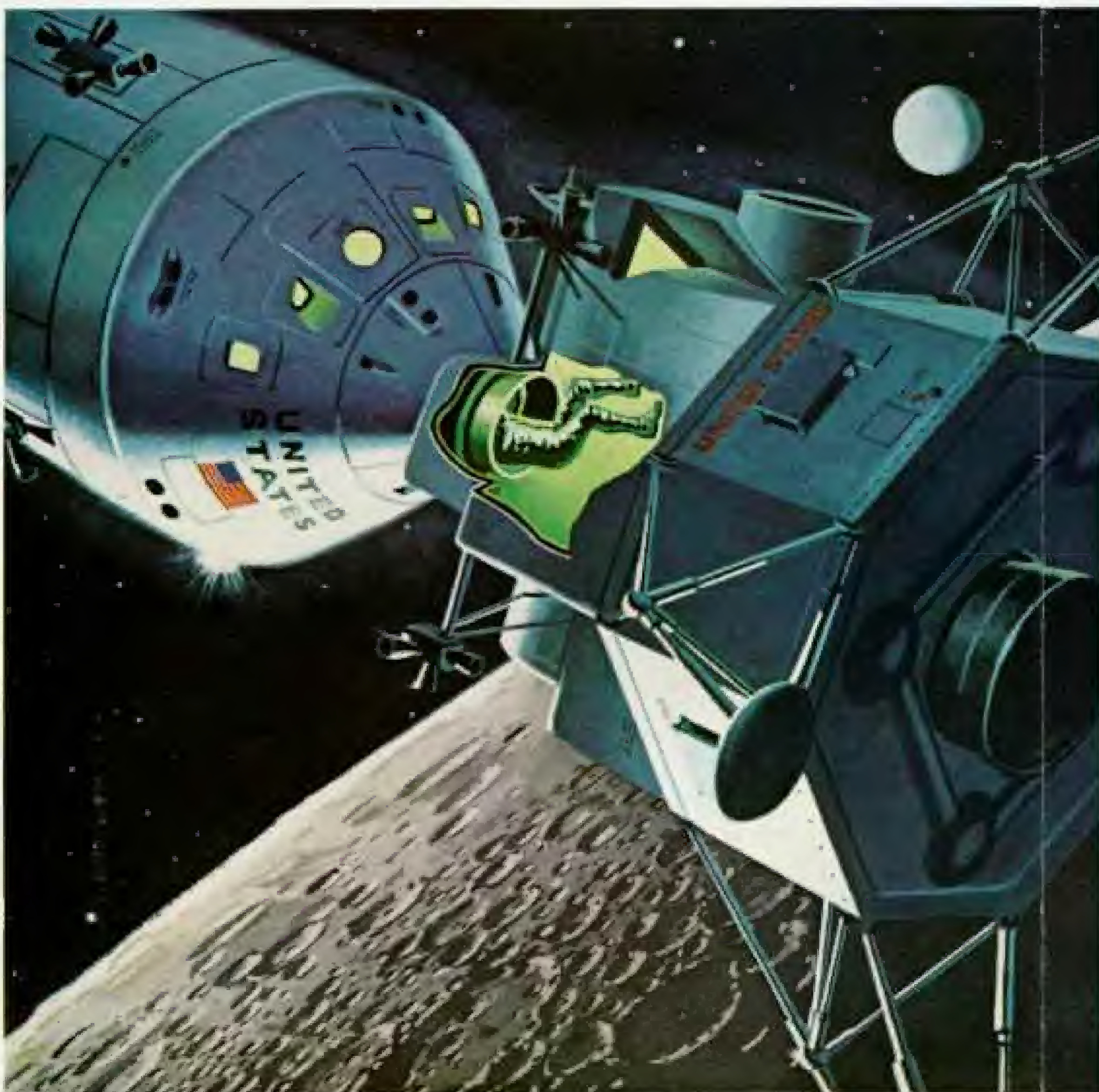
The artist's view reveals the immensity of America's spaceport. Three enormous launch pads for Saturn V stand 8,700 feet apart. Graded causeway links each to the new NASA complex on Merritt Island. Just beyond the intersection of the causeways stands the arming tower, a service area for the vehicles. Behind the tower rises the world's largest building, a 48-story concrete monster that can house four erect Saturn V's.

Fifteen miles separate Apollo's pad at right from the tip of the cape (left, above). Earlier and smaller launch sites line the coast. Helicopters hover nearby in case of trouble.

ILLUSTRATION BY PHILIP HALL FOR LIFE IS NATIONAL GEOGRAPHIC SOCIETY

NEXT PAGE FOLDS OUT ►





## II - The Flight and Approach

**M**AN'S FIRST LUNAR MISSION involves fantastically intricate maneuvers. Diagram at top depicts the first hours of the Apollo astronauts' flight. 1 & 2 Burned-out booster rockets strew Apollo's wake. Saturn V's first stage blasts the mooncraft to 200,000 feet. Stage two drops at 600,000 feet, after the escape tower and attached nose cover are jettisoned. In a sequence not shown, Apollo's third stage fires briefly; the craft enters an earth orbit and astronauts await instructions from the ground on a course to the moon. 3 Third stage's restartable engine fires again, placing craft on a lunar trajectory. 4 Course established, Apollo astronauts separate the command and service modules from Saturn's third stage and perform a turnaround maneuver, thus freeing the service module's engine for use. Simultaneously, the crew jettisons the adapter of the third stage; it breaks into pieces, exposing the lunar excursion module (LEM) in the forward section. 5 Apollo astronauts link with LEM and 6 discard Saturn's third stage. LEM's legs automatically pop open as Apollo streaks toward its target.

**TWO CREWMEN SQUEEZE** feet-first into LEM (cutaway view at extreme left) as the mooncraft follows a circular orbit 90 miles above the satellite's equator.

**PREPARING TO LAND,** Apollo astronauts separate LEM from the mother ship (left, above). Firing the descent engine, they thrust LEM down toward the moon and place their craft in an elliptical orbit with a low point only 50,000 feet from the surface. If observation proves the site acceptable, astronauts may land on the next pass. Site chosen, moon men turn LEM around (below) and fire its engine as a retrorocket to slow for a landing.

**HOVERING ABOVE MOON** (right), astronauts seek a level landing spot for LEM. In the vacuum of space, gases from the retrorocket assume a balloonlike shape.



RENDERING BY PETER MITCHELL, COURTESY OF NASA'S JSC ARTS & MEDIA







### III - Landing and Return

**M**OOON'S BLEAK, HOSTILE FACE grows in the viewing ports as the astronauts gaze from LEM. This view, taken by the 120-inch telescope at Lick Observatory, California, focuses on wide Copernicus Crater. A level area near smaller Landsberg Crater at lower left is under consideration as a landing site because it lies on our satellite's equator. For a successful reunion with the command module, the two moon explorers must land LEM within five degrees of the equator.

**MOON MISSION COMPLETED**, astronauts blast off in LEM (painting) to rendezvous with the mother ship. Four-legged descent segment, having served as a launch pad, is abandoned.

**DIAGRAM ABOVE** illustrates how the moon men will lift off. **1** Astronauts soar up in LEM as command module passes overhead. **2** LEM's elliptical orbit brings it into mate's path; then the two spacemen in LEM accelerate the craft slightly to assume a circular orbit. **3** Spaceships dock; astronauts transfer from LEM to the command module. **4** Crewmen separate LEM from the mother ship. **5** Abandoned vehicle continues in lunar orbit. **6** Firing the service module's engine, astronauts put their ship on a course to earth.

PAINTING AND DIAGRAM BY PIERRE HON.  
PHOTOGRAPH BY LICK OBSERVATORY © N.S.S.



**F**OR A SUCCESSFUL RE-ENTRY, Apollo astronauts must guide their craft into a relatively tiny corridor in the immensity of the earth's atmosphere. If they aim too high, the ship will hurtle past earth and career into space. Too low, and gravity loads up to 350 g's will crush them.

can say at this stage what prizes await the bold and the resolute? But we do know that our world is undergoing an explosion in science and engineering. Ninety percent of all the scientists who ever lived are living today. The majority of the drugs being prescribed today by physicians were not even used ten years ago. In that kind of world we must not limit our horizons. A ceiling on our flights into space would be a ceiling on our spirit and our growth.

To date the total space program, not just Project Apollo, has cost us about 20 cents a week per capita. We spend far more on cigarettes and alcohol than we do on space. We can afford the price of the moon and the price of the high adventures to follow.

As yet, NASA has no firm programs for manned space flight beyond Gemini and Apollo, but proposals are being weighed and analyzed under study contracts with industry.

#### Space Stations May Be Next Step

Perhaps we will want to explore the moon with a number of expeditions and even build lunar bases. Some scientists have proposed an observatory there; others think the moon may become a supply depot and waystop for expeditions probing deeper into the solar system. However, my personal feeling is that such development will not proceed rapidly unless something of economic value is found, possibly rock that can be processed into water and fuel for spaceships.

I think it more likely that a higher priority



will be given manned laboratories in earth orbit. The Air Force already has announced the first such project. In 1967-68 it will fly a Gemini capsule with an attached cylindrical "caboose." Such a craft would hold several men. Later NASA might design space stations for ten or more men, so large they would have to be assembled in orbit.

In such laboratories crewmen would test over many months the equipment and components needed for voyages to Mars and Venus. Periodically their celestial home would be resupplied by spacecraft from earth.

Project Apollo, complex as it is, will seem a modest step compared to the magnitude





ILLUSTRATION AND DESIGN BY DAVID MALTZER © NATIONAL GEOGRAPHIC SOCIETY

of getting to other planets. A round trip to Venus would require nearly a year and to Mars 1½ years. For such long journeys we would need nuclear-powered upper stages or electrically powered engines that would spew a plasma of atomic particles from their exhaust nozzles to give thrust.

It is very likely that men will reach Mars and Venus within the next 25 years. Before the year 2,000 unmanned probes will have scouted all the planets of the solar system.

We have embarked upon a long, long road from which there can be no turning back. The stars beckon us, and a brilliant new era in man's progress unfolds. THE END

#### RIDING A FIERY METEOR, TIRED LUNARNAUTS PLUMMET BACK TO THEIR HOME PLANET

**A**S THE APOLLO SPACECRAFT slams into earth's atmosphere, the three astronauts in this cutaway painting look out viewing ports and see glowing ablation vapors in the wake of their ship. Flaming pieces of the specially designed heat shield melt and stream away. Converging gases form a golden trail. Between the capsule's heat shield and the shock wave, immediately ahead of the craft, temperatures reach a maximum of 100,000° F., nearly ten times the temperature of the sun's surface.





*Wracked by civil war, an ancient Arabian land  
struggles to find its place in the world of the 20th century*

# Behind the Veil of Troubled YEMEN

By THOMAS J. ABERCROMBIE

National Geographic Foreign Staff

*Photographs by the author*

**W**ITH SUBMACHINE GUNS at the ready, the three soldiers moved cautiously ahead of me through the dim, labyrinthine streets of Ma'rib.

The desert town, once the thriving capital of ancient Sheba, had already written its share of history. Now, as a no man's land in the Yemen civil war, it was suffering another bitter chapter.

"Keep your eyes and ears open," cautioned the lieutenant in charge. "A Yemeni rifleman rarely misses—and we had trouble with a pair of stragglers here day before yesterday." Two fresh graves we passed on the way into town proclaimed their fate.

We were on patrol. My companion was young Lt. Morsi Farouk Hassabou, an Egyptian infantry officer from the garrison on the site of an old Turkish fort within rifle shot of the town.

Modern Egyptian armies, supporting the newborn Yemen Arab Republic, had already captured the cities and the plains. But royalist troops commanded by the deposed Imam, Mohammed al-Badr, had dug into Yemen's rugged mountain ranges. Supplied with Saudi

Brandishing his curved *jambiyah*, a Bedouin dances at Ma'rib to celebrate his tribe's joining the Republican Army in Yemen's grim civil war. His belt holds his wages—"bread and bullets." Egyptian soldiers at right support the rebels, who deposed the Imam, Mohammed al-Badr. The Imam's forces, backed by Saudi Arabia, withdrew to the mountains. The author visited only territory occupied by the Republican Government, which was recognized by the United States in 1962.

Arabian arms and ammunition, the royalists were holding their own, forcing a costly and uneasy stalemate.

The new Yemen Arab Republic was born in September, 1962. Mohammed al-Badr had just succeeded his father, Imam Ahmad, who had died on the 19th. A week later a group of army officers led by chief of staff Brigadier

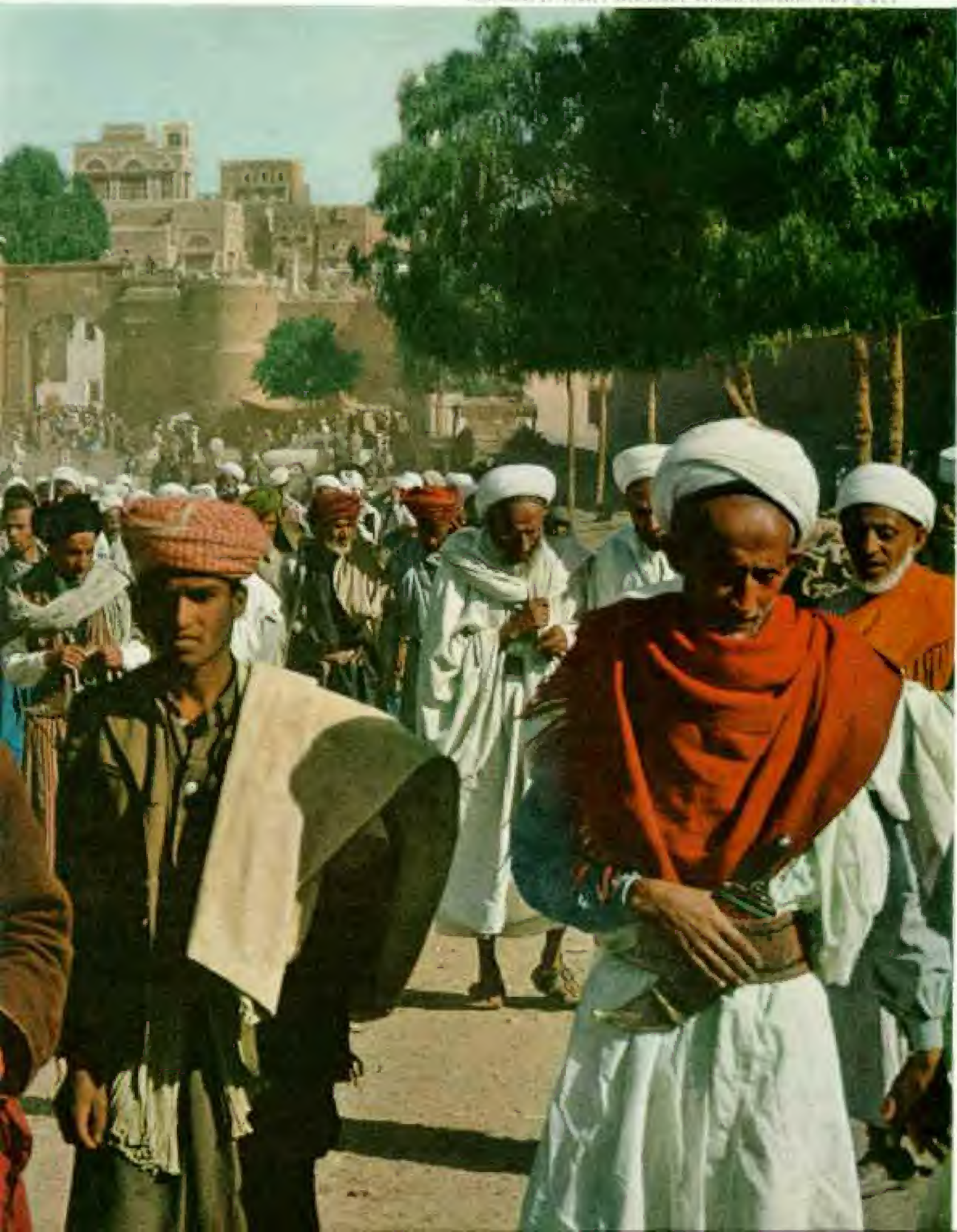
Abdulla al-Sallal commandeered tanks and shelled the royal palace from outside the walls of Ṣarā'. In disguise—some say behind a woman's veil—the young Imam fled to the mountains and Sallal became president.

I saw no signs of danger around Ma'rib's abandoned marketplace. Dark windows stared vacantly from towering mud-brick



*In Their Friday Best, Ṣan'ā' Citizens Pour Out of Yemen's Arabian Nights Capital*

A crowd mills through the Bab al-Yemen, main gate to the city. Five- and six-story houses of the well-to-do, embellished with whitewash and bas-relief, loom above the walls. Bright scarves and turbans ward off the fierce midday sun as well as the chill night air of a city 7,200 feet above sea level. Ṣan'ā' men, who often stroll hand in hand, dress more colorfully than their veiled women. This funeral procession shoulders a body to a cemetery outside the walls.





Only the vaguest frontiers separate the unsurveyed hinterland of Yemen from Saudi Arabia and the British Protectorate of South Arabia, the former Aden Protectorate.

houses, some of them five stories high. Still, snipers could be lurking anywhere.

Here in happier days, prosperously robed merchants bickered in guttural earnest, blacksmiths hammered out ringing sparks, camels bawled, women traded gossip through dark veils, the muezzin chanted from the minaret, and dogs scavenged noisily. Now the entire town reflected only grim silence.

#### Strife Splits Yemeni Loyalties

Suddenly we heard voices. Farouk's safety catch clicked off as we eased forward.

Around the corner we burst face to face upon six Yemeni tribesmen. The dust of recent battles had cushioned our footsteps; they were as startled as we.

"Don't shoot, in the name of Allah and the republic!" shouted their leader.

He wore typical Yemeni garb, a long dress-like caftan with puffed sleeves. A richly deco-

rated dagger was thrust into his wide embroidered belt. Cartridge belts crossed his shoulders. In one hand he carried a pair of sandals; in the other, a .303 Enfield rifle.

"We have walked all the way from Bari Zabyan," said the tribesman, "to help count the days of the Imam."

His dark eyes smoldered under lids blackened with antimony. Long black curls and sparse charcoal beard framed a desert face, lined by a life between sun and sand.

The lieutenant passed around a pack of Egyptian cigarettes. Somewhat relaxed, the tribesman continued:

"For six years my oldest son was held hostage in prison in Ta'izz," he said as we started back to the fort. "That is how the old Imam inspired loyalty from his tribes. But now my son has been freed—and I fight proudly for the new republic!"

Not everyone in Yemen holds this view. In

the hills not far from Ma'rib, tribesmen were willing to die for the royalist cause. And in my tour of the country, more than once I heard the same doubt guardedly expressed: "The Imam is not merely a king; he is our spiritual leader. When we revolt against him, do we not also revolt against Allah?"

I traveled through this new republic last March and April—or rather through a major part of it. Although I was unable to penetrate the hills held by royalist tribesmen backed by Saudi Arabia, my journey took me across boulder-strewn passes, green fields, and drifting deserts. I visited cities like *San'ā'*, Yemen's capital, some 7,200 feet above sea level; dusty Mocha, the port that gave a coffee its name; and Ma'rib, whose ruined temples attest the glory of ancient Sheba.\*

#### Border Fades Into Empty Quarter

A sizable piece—and the greenest one—in Arabia's jigsaw puzzle, Yemen faces the Red Sea on the southwest coast of the peninsula. Its eastern border fades gradually and undefined into *Ar Rab' al Khālī*, Arabia's vast lifeless Empty Quarter. Most of the country's five million people live in the cool mountains and high plateaus; few dwell along the *Tihāmah*—the sweltering narrow coastal plain (map, opposite).

Yemen's geographical ancestor, the land of Sheba, straddled the profitable incense roads that stretched from the Hadhramaut, on Arabia's south coast, to ports on the Mediterranean. Three thousand years ago Bedouin tribes, growing rich on caravan plunder, crystallized into a powerful state and grew richer still from tolls. The kingdom of Saba, the Biblical Sheba, was born.

About 650 B.C. the Sabaeans built a giant dam and irrigation system across the *Wādī Adhanah*, and lush gardens blossomed around Ma'rib. A hundred years before Christ, the Himyarites succeeded the Sabaeans as the power in southern Arabia.

Later, the caravan routes declined in competition with Roman sea lanes. A flood during the time of Ethiopian rule in the sixth century broke the neglected dam; today, only a few ruins of Sheba survive the drifting sands.

"But you can't leave Sheba without seeing the Temple of *Iluṃqūh*," insisted Lieutenant Hassabou.

So next day, after morning prayer, we piled

Bugler wears massive curved dagger, Enfield rifle, and embellished cartridge belt. Formerly a royal soldier, he now serves the republic.

PHOTOGRAPH BY NATIONAL GEOGRAPHIC SOCIETY



\* See "Yemen—Southern Arabia's Mountain Wonderland," by Harlan B. Clarke, *NATIONAL GEOGRAPHIC*, November, 1947.





Rising sun silhouettes the Sabaean moon-god temple of Bar'ān. The ruins stand near Ma'rib, capital of ancient Sheba, the traditional realm of the queen who visited Solomon in Jerusalem. An Egyptian soldier patrols the area.

Twenty-century-old inscription in the temple of the moon-god Ilumqub asks the deity to protect a man's sons and to grant them the favor of their king.



RECALCULATED BY TACMAS J. BERENSON/ALIA © 2011



Alabaster bust graces a private collection at Ṣan'ā'.

knapsacks and cameras into his Russian-built armored car and scrambled aboard. With us came two armed soldiers and Sheik Abdul Hamid Salem, a Moslem chaplain from Cairo attached to the Egyptian garrison.

As our wheels whined through the Ramlat as Sab'atayn, the sands of Sheba, I wondered about this ancient kingdom, so famous yet so little explored.

Tradition names Bilqis, most famous ruler of this rich land, as the queen who visited Solomon (I Kings 10) with "... a very great train, with camels that bare... very much gold, and precious stones... there came no more such abundance of spices as these which the queen of Sheba gave to king Solomon."

#### Ancient Gardens Bear Bitter Fruit

Only once did archeologists probe the mysteries of Ma'rib. The party of American scholars who began digging at the Ilumqub Temple in 1951 were guarded constantly by soldiers of the Imam. They found statues in bronze and alabaster and inscriptions that indicated the temple wall was built around 650 B.C. But the soldiers became increasingly suspicious—finally hostile. After only four months' work the group was forced to abandon its equipment and flee across the desert to Beihan in friendly territory.

We found the temple banked with dunes. I clambered up the high wall that formed its main outline. It was kidney-shaped, about 300 feet across, and filled with sand.

With Sheik Abdul Hamid I walked down dust-scoured steps through a stately line of square stone pillars into the partially excavated entrance hall. It was beautifully finished with limestone blocks laid without mortar, precisely fitted. Rows of false windows, finely cut to resemble wooden lattices, lined the walls. Blocks incised with Sabaean script lay everywhere.

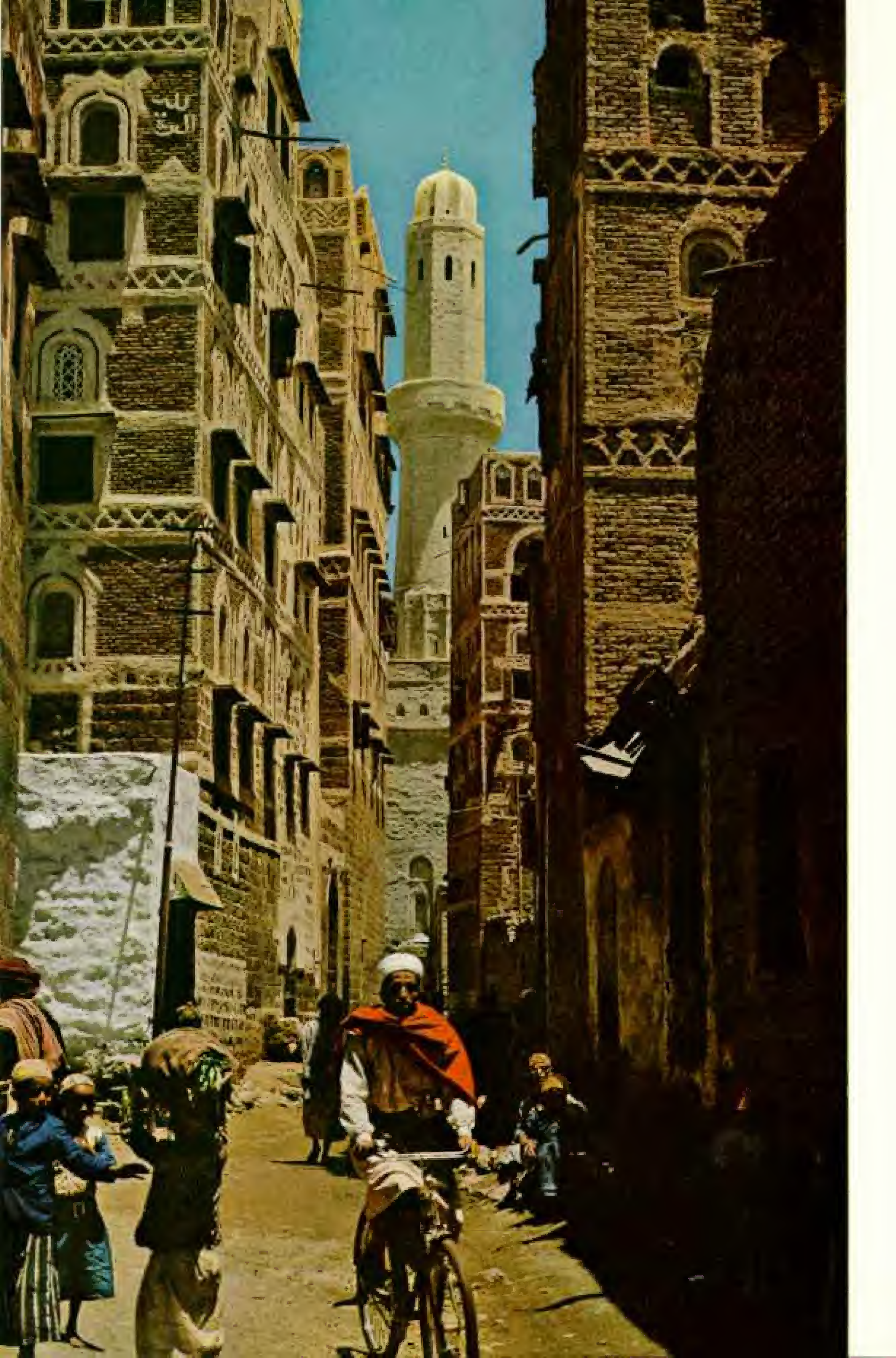
"The Koran tells us of Sheba," said the sheik, and quoted from Sura (chapter) XXXIV: "'Two gardens on the right hand and the left... A fair land and an indulgent Lord.'" A mile north of the temple I could see the dry ravine that once split the famous gardens of the Sabaeans.

"'But they were froward, so We sent on them the flood of 'Iram, and in exchange for their two gardens gave them two gardens bearing bitter fruit, the tamarisk and here and there a lote-tree.'"

We rumbled back to the fort past the bitter fruit of today's Sheba: charred royalist trucks and a bullet-pocked helicopter.

In the distance I could make out the ruins of Ma'rib dam, cornerstone of Sheba's realm. It once stood 46 feet high and stretched half a mile across the wadi, doling out precious rainwater for irrigation. But it was out of our reach. It lay too close to the royalist-held mountains; as Lieutenant Hassabou put it, "too close to trouble."

Later, from the Egyptian Air Force helicopter whisking me from Ma'rib to Ṣan'ā', I



Six-story houses of stone and mud brick frame the whitewashed minaret of Al-Ab-har Mosque in Şan'ā'. Stables and store-rooms often occupy ground floors; servants use second stories and families live above. Inscription high on the building at left proclaims the might of Allah.

White robe, turban, and imported bicycle mark the man in foreground as a wealthy resident of Yemen's capital.

Japanese-made radio brings a Yemeni news and music from his capital city. Radio Şan'ā' helps to unify a land short of paved roads, newspapers, and mail service. Listeners can also hear Cairo, 1,300 miles away.



APRIL 1962 / NATIONAL GEOGRAPHIC MAGAZINE

spotted the dam again. It was barely visible; of the magnificent gardens the Koran described I saw not a trace—only a river of gravel flowing into a sea of land.

Almost everywhere I went in republican territory I found enthusiasm for the new regime. "*Jumhuriyyah! Jumhuriyyah!*" sang truckloads of army recruits in Ta'izz. "Republic! Republic!" In Ibb, a stonemason chanted "Long live Sallal and the Arabs!" as he mended a wall. In Şan'ā' taxi drivers echoed with jeep horns the four beats of "*Aish as-Sallal!*"—"Long live Sallal!" Pictures of Sallal and Egypt's Gamal Abdel Nasser decorated tea-houses, barber shops, even key chains and boxes of crackers.

### Through Şan'ā' Gate to Antiquity

I had first arrived in Şan'ā' one day in March. Just before sunup I pulled my Land-Rover off the road near the Bab al-Yemen, main gate to the walled city. The crowd gathering around the great wooden doors showed that the nightly curfew would soon end.

I recall now the distant cannon declaring the dawn; behind the gate I hear keys jingle and steel clank.

Beside me a dusty camel driver yawns as he prods his grumbling beast to its feet. I follow him into the thickening throng. Trains of trotting donkeys piled high with sorghum stalks, red-veiled women deftly balancing pottery jugs on their heads, small ragged boys with sticks whacking a handful of sheep into tighter formation, an ox-drawn cart loaded with black bread—all funnel into the giant gate now swinging wide on thick hinges of creaking iron.

"*Tariiq! Tariiq!*" shouts the old man bent double under a heavy chest he carries on his back. "Make way! Make way!" Through the

gates I drift, forward with the human current—but backward through time.

Outside the walled city, tanks and artillery of modern armies rumble night and day, but once inside the walls I am plunged into tenth-century Yemen.

Stone-and-mud-brick houses rise five and six stories—sometimes seven—above narrow noisy streets. Many are topped with richly carpeted penthouse parlors where men meet in the afternoon to smoke water pipes. The better houses gleam with whitewash; from many protrude elegantly carved wooden balconies where women of the harem, respectfully hidden, watch the parade of life below.

In Şan'ā' the suq, or market place, assails every sense at once: the reedy wail of a troubadour's flute and the shouting of hawkers, the aromas of cinnamon, saffron, and rose at-tar mingling with stable smells; the taste of a sesame-and-honey-flavored tidbit bought from the sweets seller who brushes away squadrons of flies with a black oxtail; the squeeze of the crowd watching a glassy-eyed zealot who stands on a stone shouting Koranic scriptures with wild gestures; the tug of a blind beggar at my coat sleeve—and my conscience. I drop a small five-sided coin into his hand and move away.

Sounds of steel on steel lead me into the Suq al-Haddadin, the Street of the Blacksmiths. I peer into one of the dim cubicles filled with flying sparks.

There under the hammer a cherry-colored lump of iron quickly takes the form of a mattock head. The ragged smith quenches the finished piece in a hollow stone filled with water and settles back for a few puffs on his hubble-bubble pipe.

I shift to make room for a thin, barefoot farmer wearing a pin-striped caftan and a



n'clock until dawn. Domed Al-Baqiliyah Mosque reflects the influence of Turks, who ruled Yemen

in the 16th century. The camera looks south toward the somber, towering Jabal Nuqum.



generous orange turban. As he examines one piece after another, I strain my Berlitz School Arabic to follow the bargaining.

"A fine mattock and surely worth the eight buqshah."

"The price is fifteen buqshah."

"It's well made, true, but iron is iron."

"Fifteen, not one buqshah less."

"I want it to break soil, not mine gold!"

"I'm a busy man. Give me twelve and let me get back to my furnace."

"Nine, good smithy, nine."

"In the name of Allah..."

It may be an hour before the mattock changes hands for ten pieces of copper. I move on. Commerce is complicated in Yemen.

The country has no official currency. Maria Theresa thalers, locally called riyals and worth about a dollar, are used instead. Originally an Austrian coin of the late 1700's, the thaler is still minted in Vienna—and dated 1780—for use in Yemen and southern Arabia.

Bigger than our silver-dollars, the 30 or 40 I carried for gasoline and supplies made a heavy, jingling pocketful. I pulled one out to pay for an ear of roasted corn. Like many, the coin had a small silver loop soldered onto it, for it had once hung as jewelry. Bedouin women often wear the family savings around their necks.

A riyal is 40 Yemeni buqshah. The busy

vendor grudgingly counted out my change, mostly in half-buqshah coins, piling my free hand full of copper. Now both trouser pockets bulged uncomfortably.

The tempo of the busy suq reaches a climax around midday when the Yemeni comes to buy his daily supply of kat, the "poor man's happiness."

The leaves of the kat bush (*Catha edulis*), when chewed, act as a stimulant and offer a mild kick without intoxicating. From the nearby mountains, where the bushes thrive, a steady supply flows down to the city on the backs of camels and donkeys.

Near me a contented merchant, already sold out, had unwrapped the one remaining bundle for himself.

"You see," he explained through teeth stained green, "a man can go a long time without food and water—but not one day without his kat."

#### Yemenis "Drink" Strong Tobacco

But if the habit stimulates the individual, it leads the country as a whole to languor. By midafternoon all Yemen slows to a crawl—even armies stop fighting—for the hour of kat.

A few days later I was invited by a Yemen nobleman, Sultan Fadhī Bin Ali Bin Ahmad, to spend an afternoon with him "at the kat." I came to see him at the former Imam's palace,



Puffing a hubble-bubble and chewing kat leaves, two sultans pass an afternoon in a Ṣan'ā' rooftop parlor. Man at right plucks leaves from a tender shoot; discarded foliage litters the floor. Tobacco smolders under charcoal in the top of a tall water pipe, whose 20-foot hose cools the smoke. Habit-forming kat competes with coffee as Yemen's leading cash crop. Every afternoon the average Yemeni whiles away hours "at the kat."

Wad of leaves swells the unshaven cheek of a kat addict. He will gnaw his plug all afternoon, swallowing the bitterish juices and spitting out the residue. Yemenis spend as much as three-fourths of their earnings on daily bundles of the leaves. Sampling kat, the author compared its effect to 10 cups of coffee.



then under repair and due to become the first modern hotel in Ṣan'ā'. He was staying there with seven other sultans, waiting for an appointment with President Sallal.

I left my shoes outside the sultan's quarters and sat cross-legged on one of the divans that lined the newly whitewashed walls. I took care not to point the soles of my feet toward any of my companions. In Yemen it would be a breach of manners. The floor was littered with kat twigs and grass wrappings.

"The small red leaves on the top of the shoot are the tastiest," said the sultan, passing me a bundle. He cleaned a leaf with thumb and forefinger and popped it onto his tongue.

I found the sprouts slightly bitter, but not unpalatable. Quickly I mastered the technique of packing them into one cheek and gnawing slowly at the wad. The trick is to swallow only the juices.

"Take plenty of water," my host advised, offering me his pottery jug. "And then drink

Yemen's President Abdulla al-Sallal, who led the revolt against the Imam, salutes troops at a Ṣan'ā' review. Field Marshal Abdel Hakim Amr, a Vice President of the United Arab Republic, sits beside him. Robed advisers and guards flank the pair.

Waving a portrait of President Sallal, a wild-eyed Yemeni cries, "*Jumhuriyyah! Jumhuriyyah!*—Republic! Republic!"





this." To my surprise he offered me the tube that led to his giant hubble-bubble pipe 15 feet away. Drink? Yemeni Arabic, I remembered, lacks the verb "to smoke"; one "drinks" even cigarettes.

For the first hour little was spoken. I heard only the gurgling of the water pipes, refueled regularly with charcoal and strong tobacco by attendants (page 415). I pondered the strange setting.

The sultans' rifles stood stacked in the

corner. Across the room, facing the pear trees and poinsettias of the garden, a row of tall windows topped with intricate patterns of stained glass lit the scene.

Sultan Fadhl's starched turban was tied in a regal way: One end formed a crest and the other trailed down his back. He wore a Western-style sport shirt and a saronglike *footah* gathered by an ornate belt which also held his *jambiyah*, the curved dagger Yemeni men carry. A man's dagger belt is a

ILLUSTRATION BY THOMAS J. BEECHER/ARTIST. NATIONAL GEOGRAPHIC SOCIETY © 1983



Harsh Foothills of Arabia's Highest Peaks  
Glower Above a Verdant, Stream-fed Valley

Pleasant climate and green fields that characterize this corner of the Arabian Peninsula prompted classical writers to name it Arabia Felix. Happy

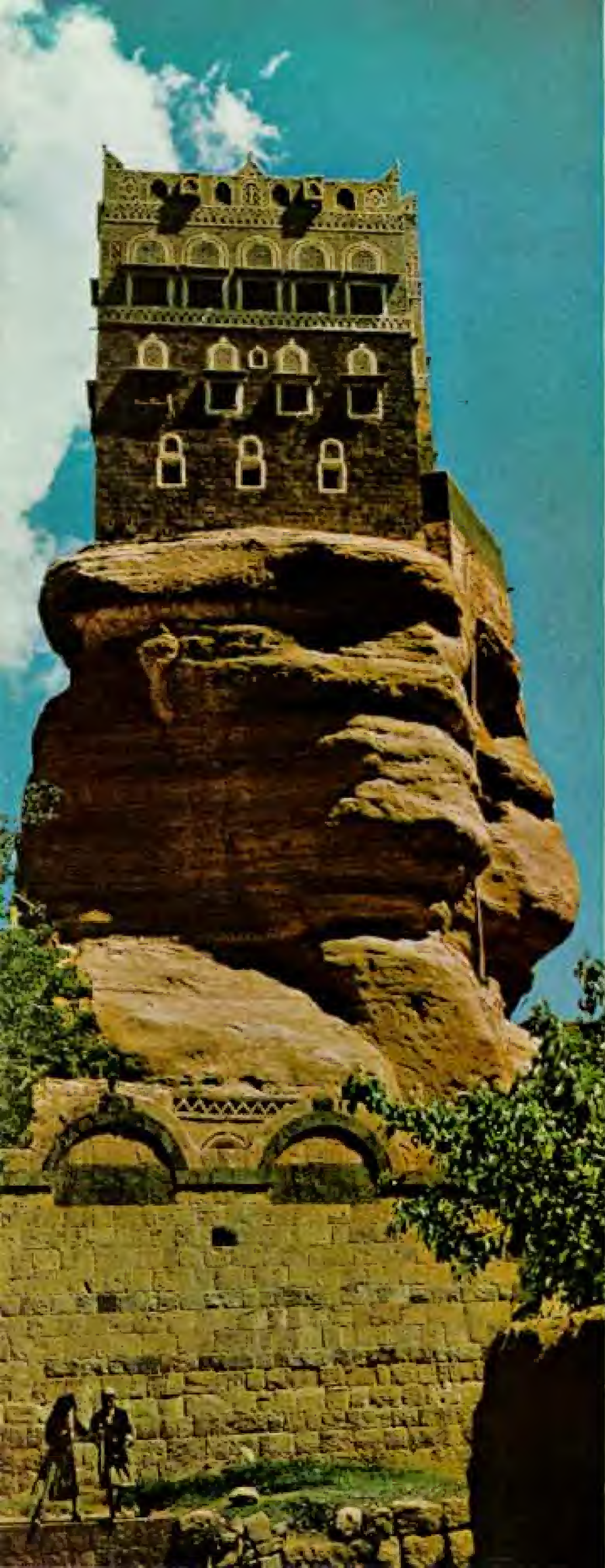


Arabia. In winding valleys and on rain-blessed terraces, farmers sometimes harvest three crops a year. Here at Wāfi Dahr, 10 miles northwest of

Şamā', sorghum, coffee, apricots, grapes, and sweet lemons thrive in walled gardens. Turks built the round watchtowers to spot raiding Bedouin.

WORLDWIDE BY NATIONAL GEOGRAPHIC SOCIETY





status symbol. Sultan Fadhī's belt, I noted, served him as a cosmetic kit, lunch box, hip pocket, and briefcase as well.

Strapped to the scabbard was his wristwatch. Tucked behind it I saw a table knife, tweezers, a chunk of cheese, several tiny foolscap documents rolled up like cigarettes, an American fountain pen, and a six-inch iron key. From the belt hung a snuffbox and a silver bottle of eye shadow. With the long, narrow stopper he lined his eyelids with a touch of powdered antimony.

The sultan drew his dagger for me to examine. Gold coins and filigree work trimmed its ivory handle. The gleaming steel blade curved to a needle-sharp point. But like all other jambiyyahs I had seen, it had edges no sharper than a butter knife. I told him I thought the daggers must really be only for show.

"No," he replied quickly, "for killing." The others, sensing my discomfort, laughed, and we switched to lighter topics.

I took my leave just before afternoon prayers. Standing up, I felt somewhat light and detached—yet not intoxicated. The room seemed smaller and warmer, adrift in a

**Royal palace** commands a sandstone perch above Wādī Ḍahr. Himyarites, who succeeded the Sabaeans, built a fortress here 1,500 years ago. Invading Ethiopians, Persians, and Turks occupied the site in turn. A well bored through the rock supplied the palace during sieges. Imam Yahya, grandfather of the deposed king, built the present chateau. Protruding top-floor balconies allowed his harem to watch life in the street a hundred feet below. Author Abercrombie made the view on pages 418-19 from the palace roof.

ILLUSTRATION © W. W. R.

**Leg irons clank** on a ragged felon. In Yemen, convicts are often shackled and turned loose in the streets. Cloth strips keep heavy links from battering ankles.

mist of colors. Was it the magic of the kat, I wondered, or only the sun and stained-glass painting rainbows in the curling smoke?

A few days later I prepared for an important appointment. But keeping track of time in Yemen can be complicated. My interview with President Sallal was set for 7 o'clock in the afternoon—that would be right before lunch, I calculated, on the 5th of Zu'lkadah, 1382.

Yemenis count the hours beginning at sunset, which makes midnight and noon 6 o'clock, give or take a few minutes depending on the season. The Moslem lunar calendar, based on Mohammed's flight from Mecca in 622, placed us in the 14th century. By some miracle I arrived a few minutes early.

A wail of sirens announced the arrival of President Sallal at the Qasr al-Jumhuuriyyah, the House of the Republic. Stepping out of a green Dodge carry-all, the President was surrounded by a crowd of favor-seekers, shouting and waving small scraps of foolscap. One enterprising tribesman held his tiny petition aloft on a forked stick.

For five minutes the President heard them out, reading as many of their pleas as he could, and signing a few. Later in his richly carpeted office upstairs, he explained the frantic ceremony.

"The Imam was an absolute monarch. If you wanted to settle a land dispute, or import a truckload of soap from Aden, his personal signature was necessary.

"We are trying to decentralize, but most people still refuse to obey even the smallest order unless I sign it personally."

The President still wore the olive-drab uniform of an army officer. His deep-set, jet-black eyes watched me with fierce attention, but they betrayed a mind occupied with the problems that nag most revolutionists.

"First we must drive the despot from our land," he said. "Next we must liberate occupied Yemen." By this he meant the British-backed Aden Protectorate, now called the Protectorate of South Arabia. "In Aden the Yemeni are in the majority; historically and geographically we are one people."

And what about roads, schools, public health? Busy with its struggle for survival, the new government had done little in these directions, I had noticed.

"Must we make a hundred-year leap overnight? First we must learn to breathe free—all of our country—then we can build. But we will need help."

#### Doors Opened to Foreign Experts

Yemen's appeal is bringing aid from many countries. For centuries, under rule of the Imams, Yemen kept her doors closed to the world.\* The few foreigners penetrating the little-known mountain kingdom carried a visa from the Imam himself. But today, as a battleground between Arab socialists and

\*See "Yemen Opens the Door to Progress," by Harry Hoogstraal, NATIONAL GEOGRAPHIC, February, 1952.



STYLING: JANE BROWN. PHOTOGRAPHY: HARRY HOOGSTRAAL

## YEMEN

**OFFICIAL NAME:** Yemen Arab Republic. **GOVERNMENT:** Republic, but royalist forces of the deposed Imam still hold mountains in north and east. **AREA:** An estimated 73,000 square miles.



**POPULATION:** About 5,000,000 (1962). **LANGUAGE:** Arabic. **RELIGION:** Moslem. Zaidis, a sect of the Shi'a branch, predominate in the highlands; desert coastal dwellers are Sunni Moslems. **ECONOMY:** Ninety percent agriculture and grazing.

**EXPORTS:** Coffee, hides, and kat, a mildly narcotic leaf. **MAJOR CITIES:** Sana'a, capital (pop. 80,000); Hodeida, principal port; Ta'izz, trade gateway to Aden. **CLIMATE:** Hot and humid along Red Sea (above 130° F.), but inland highlands average a high of 71° F. in June.



Cryptic marks of powdered antimony beautify a sultry street singer in Dhamār.

Arab monarchists, Yemen is no longer isolated.

I encountered efficient American road builders pushing a highway through the mountains; ruddy-faced Russian engineers finishing a new port at Hodeida; taciturn Chinese Communists; a French woman doctor; an Italian businessman; an Egyptian economist.

Just outside Ṣan'ā' I visited a new agricultural experiment station built by West Germany and run by an easy-going Bavarian, Wilhelm Heckenstaller. I followed him through tentative patches of lettuce, onions, and carrots, and past budding apple, apricot, and sweet-lemon trees.

Stretching northward as far as I could see, the beautiful Sha'ūb plain was green with waving grains. The air smelled of corn and clover.

"In Yemen nine out of ten people are farmers," said Heckenstaller, "and they're the luckiest farmers in Arabia. Here in the high plateau they get more than 15 inches of rainfall a year.

"Little arable land is wasted," he said, "but we



can help by teaching techniques—things like better seed selection and crop rotation.”

Whenever Heckenstaller started up his small gasoline tractor, he always drew a crowd. An old, sinewy farmer plowing in the next field tied his oxen to a salt cedar tree and joined me.

“Some day, *inshallah* [Allah willing], I will have one of these machines,” he said. “We have spent all our lives working for the soil; soon it will work for us.”

Much farming in this rugged country is done on tiers of steep terraces that contour whole mountainsides, or along narrow wadis, or watercourses, where winter rain can be trapped and channeled.

One such wadi lies 10 miles northwest of Ṣan‘ā’: Wādī Ḍahr, an emerald oasis in the shadow of 12,336-foot Ḥaḍūr Shu‘ayb, the Arabian Peninsula’s highest mountain (pages 418-19). Guarded by tall, round watchtowers,

the valley twists a sheltered course down through the red sandstone foothills.

I eased the Land-Rover down the rocky slopes along the dry river bed that was the valley’s main street. It led to the village—and the strangest building I have ever seen.

Perched dizzily atop a towering boulder, a brick chateau soared upward for five stories (page 420). Formerly one of the royal summer palaces, it now serves as the provincial governor’s office.

“*Ahlan w-sahlan*—welcome,” said Mohammed Ali Daar, the governor’s secretary, who greeted me in front of the amazing building.

“The Himyarites, who succeeded the Sabaeans, built a fort here first,” he said as we climbed the stone steps. “In the 16th century the Turks rebuilt it. Imam Yahya, grandfather of the present Imam, added this new building about 30 years ago.”

I observed that it stood well protected for



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Floating clock rations a stream’s precious flow. Water in the kettle slowly fills the smaller copper bowl through a hole in the bottom. In five minutes it sinks—a signal to the irrigator that he must divert the flow into another field.

Camel and donkeys draw up cowskin buckets from a well near Dhamaḥ. The driver’s lash and chanting urge the beasts to the ends of the ropes, and the buckets automatically spill their contents.

any siege—except for the problem of water.

"The Himyarites thought of that too," he answered, leading me to a small hole. He dropped in a pebble; after a few seconds it splashed faintly, far below. A well ran down through the solid rock!

From the citadel roof, still puffing from the climb, I surveyed the whole wadi and its complex of walled gardens where grapes, pomegranates, limes, pears, apricots, and sweet lem-

ons ripened between rows of tall tamarisks.

"Here we are graced by the bounty of Allah," said Mohammed Ali, pointing to a small spring that bubbled far below us, "from the ground as well as the sky."

But how could this mere trickle make such a broad valley green? The next day I would see for myself.

I awoke at sunrise to the clanking of chains. Prisoners were being escorted to the mosque





for morning prayers. Dangerous criminals are confined to the crowded prisons. Minor offenders—some of them children—are locked in heavy leg irons and left to roam the streets. In every town I saw them clanking through the suqs, hauling water or hawking vegetables in spite of their chains (page 421).

Corporal punishment is still the rule in Yemen. Convicted of stealing, a man can lose his right hand; of treason or murder, his head

### Mountain Fortress of Al-Qahira Towers Above the Morning Mists of Ta'izz

Sons of sheiks lived as hostages in this grim eyrie to ensure their fathers' loyalty to the Imams. Gateway to Aden, Ta'izz is still host to most embassies and foreign missions in Yemen; some eighty U. S. Government employees and their families make their homes here. Twin minarets cap Al-Ashrafiyah Mosque, a Ta'izz landmark. Farm villages dot the slopes of 9,859-foot Jabal Şabir.

425

PHOTOGRAPH BY THOMAS J. ROSS/SHOOTER, NATIONAL GEOGRAPHIC © 2011



—in a grisly public ceremony. As we walked out through the prison courtyard after breakfast, I asked Mohammed Ali if the new government might abolish this cruel code.

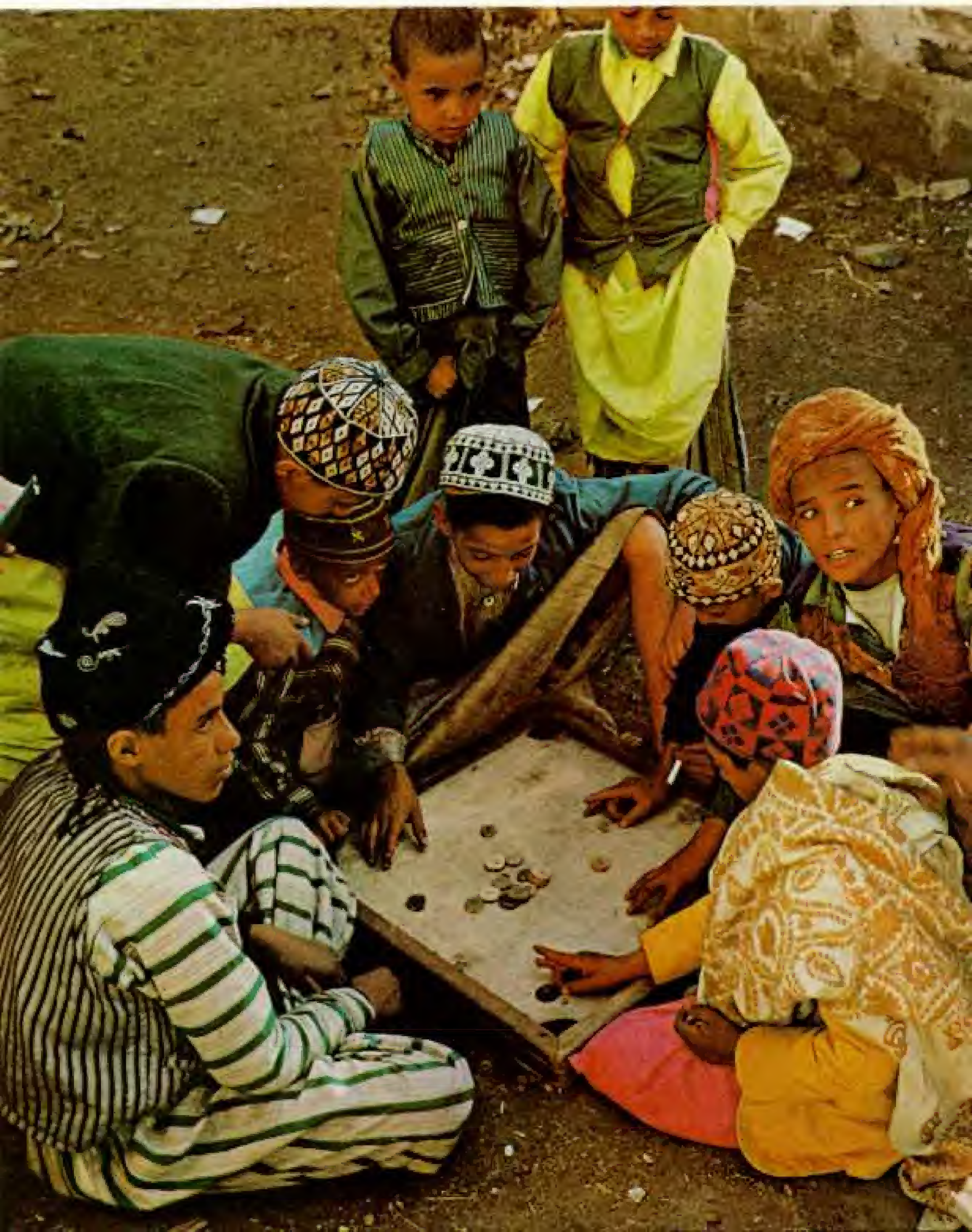
426 "It is the law of the Koran," he said. "But of course, you understand, we must interpret

the old wisdom with modern perspective."

I had heard of a man losing his hand in Dhamār the Friday before. What of him?

"Ah, yes," Mohammed said, "but did you not hear also that first they gave him novocain?"

Mohammed Ali introduced me to Muhsin



Ataya, an important man in town who looked the part. He was tall and large-boned, but his delicate hands had not known the harsh toil of a farmer. A beard, dyed bright red with henna, blazed under his chin.

Muhsin Ataya was the *muqassim ad-dayr*,

the divider of the water, for the gardens of Wādi Qahr.

"We have water but it is precious," he explained to me. "My job is to see that not a drop is wasted and that it is fairly shared."

Muhsin and I walked a mile or so downstream, stopping finally at one of many wooden gates in the long mud wall that lined the river bed. A few yards above the gate a dam of dirt was diverting the stream under the wall and into a farmer's vineyard.

Inside the garden Muhsin introduced me to his apprentice, who presided over a strange device: a water clock for timing the farmer's share of the stream's flow. It was simply a copper bowl, about the size of a large coffee cup, that floated in a water-filled copper kettle (page 423).

As I watched, I saw that the smaller bowl actually was filling with water through a tiny



Spattered smile of a Ta'izz whitewasher brightens the scene as much as his paint.

Nimble fingers snapping disks into corner pockets, a knot of *Ṣaḥī'* boys gathers around a caroms board. The game, popular throughout Yemen, resembles billiards. Young kibilizer at the right wears a pair of toy spectacles.

Few Yemeni males ever go bareheaded. Most boys favor bright skullcaps; their fathers usually add bulky turbans.

hole in the bottom. In a few minutes it sank.

"*Khalas!*" shouted Muhsin. "Finished!" Two men dug feverishly with mattock and spade, opening the earth dam that blocked the stream bed. The water gushed along until another temporary dam turned it into the next garden.

"We let the bowl sink once for each 100 *lubnah* [about two-thirds of an acre] the farmer owns," explained Muhsin. "Day after tomorrow we'll reach the lower end of the valley. Then we'll start over again at the top."

It was midday when we reached Muhsin's

own garden, and the sun was heavy on us. In the cool shade of his orchard we lunched on almonds and fruit beside the busy brook.

"*Tamaam,*" I ventured, popping a juicy slice of sweet lemon into my mouth. "Fine."

"*Tamaam wa-nuas!*" Muhsin replied, smiling, with an often-heard Yemen phrase—"Fine and a half!"

To classical writers, Yemen lay in Arabia Felix, Happy Arabia. Seldom, I thought, did it live up to the name. But in Muhsin's garden, when the wind rustled the tamarisks and the bulbuls began their song, it came close.

Gestures and haggling settle the price of a mess of sardines in a Ta'izz bazaar. If patient, the turbaned customer will walk off with five pounds for less than 20 *buqshah*, about 50 cents. Vendor wears her savings in silver on fingers and forearms.

PHOTOGRAPH BY NATIONAL GEOGRAPHIC SOCIETY



Driving south from Ṣan'ā', I kept my eyes open for trouble. Two weeks earlier on this same road, a correspondent from the *Irish Times* was ambushed by royalist tribesmen who took him for an Egyptian officer. They held him near the town of Ma'bar for two days, debating whether to kill him or not. Finally they let him go—minus his passport, money, cameras, baggage, and jeep.

Most of Yemen's roads are excellent for pedestrians, fine for donkeys, not bad for camels, but nothing less than a cruel challenge for anything with wheels. Coming down from steep Sumara Pass in the southerly province of Ibb, the road led out onto a giant boulder—then disappeared, seemingly into the air. I stopped short and went ahead on foot. To my surprise I found neither a washout nor a landslide ahead. The road simply led down the steep far side of the boulder.

Locked in four-wheel-drive, low gear, I skidded down the bare rock, picking up the road again a hundred feet below.

#### Kisses Form Part of Yemeni Greeting

Soon after, I found myself rumbling along on cobblestones. I stopped at a roadside *sa-ggaayah*, a small domed well, then walked a short way to where the ancient highway steepened for its climb to the walls of Ibb.

Past me plodded knots of barefoot porters carrying clumsy clusters of pottery jugs, long crooked logs, or backbreaking bundles of onions and carrots. Next came a long train of sullen camels slung with newly cut building blocks of limestone.

Perched sidesaddle under a white umbrella aboard his donkey, a well-groomed sayid, one of the noble class who claim descent from the Prophet, jolted proudly past followed by his trotting barefoot servant boy.

The well-polished stones now formed steps as I hiked upward through Ibb's main gate, set deep between two round guard towers.

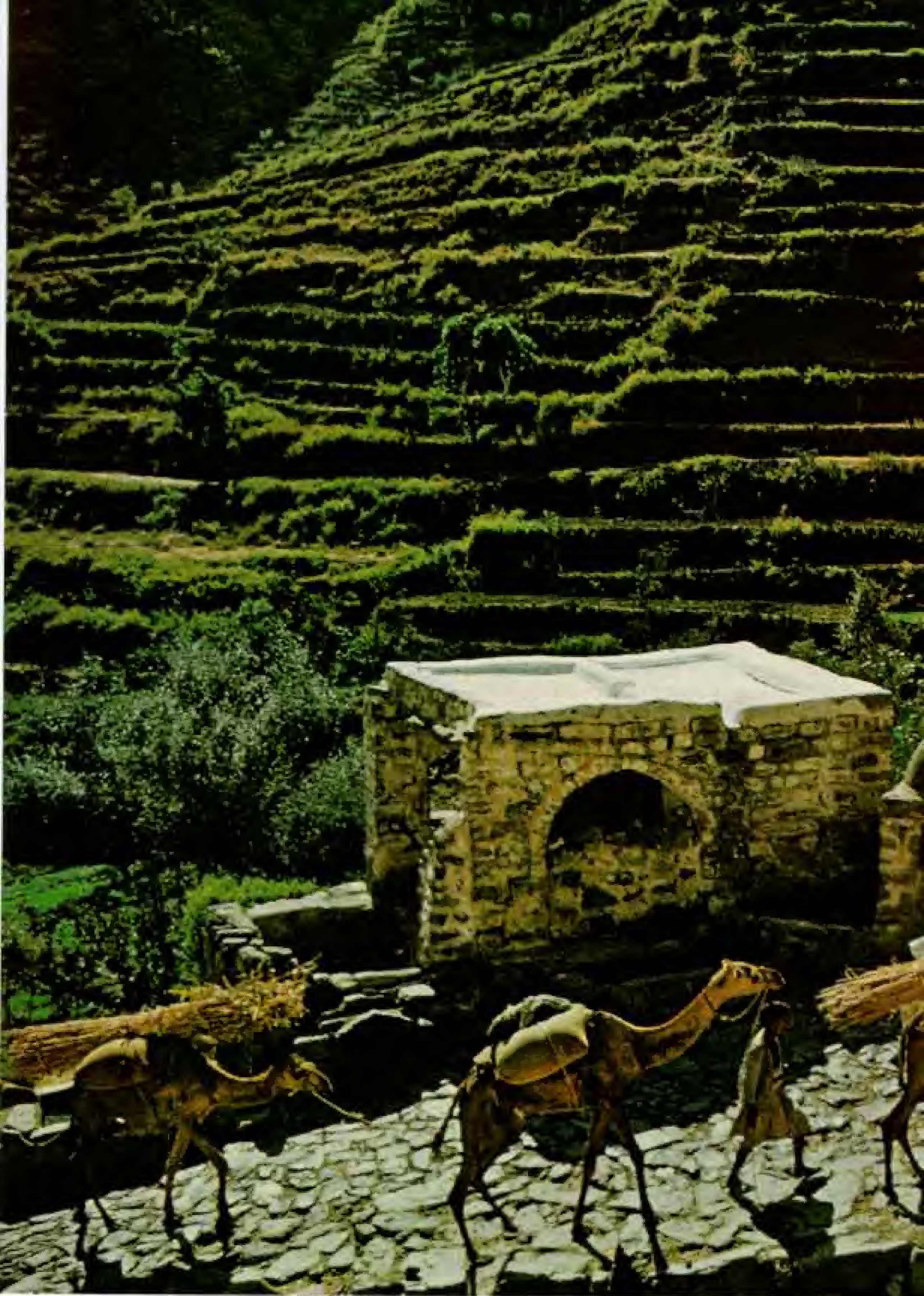
I watched two barefoot soldiers in indigo raftans and turbans strolling, as Yemeni men often do, hand in hand. They stop to greet another, in white dress and colorfully striped scarf. Blue, acknowledging white's higher status, deftly kisses his hand, his elbow—then his cheek. White, in symbolic salute, kisses his own hand.

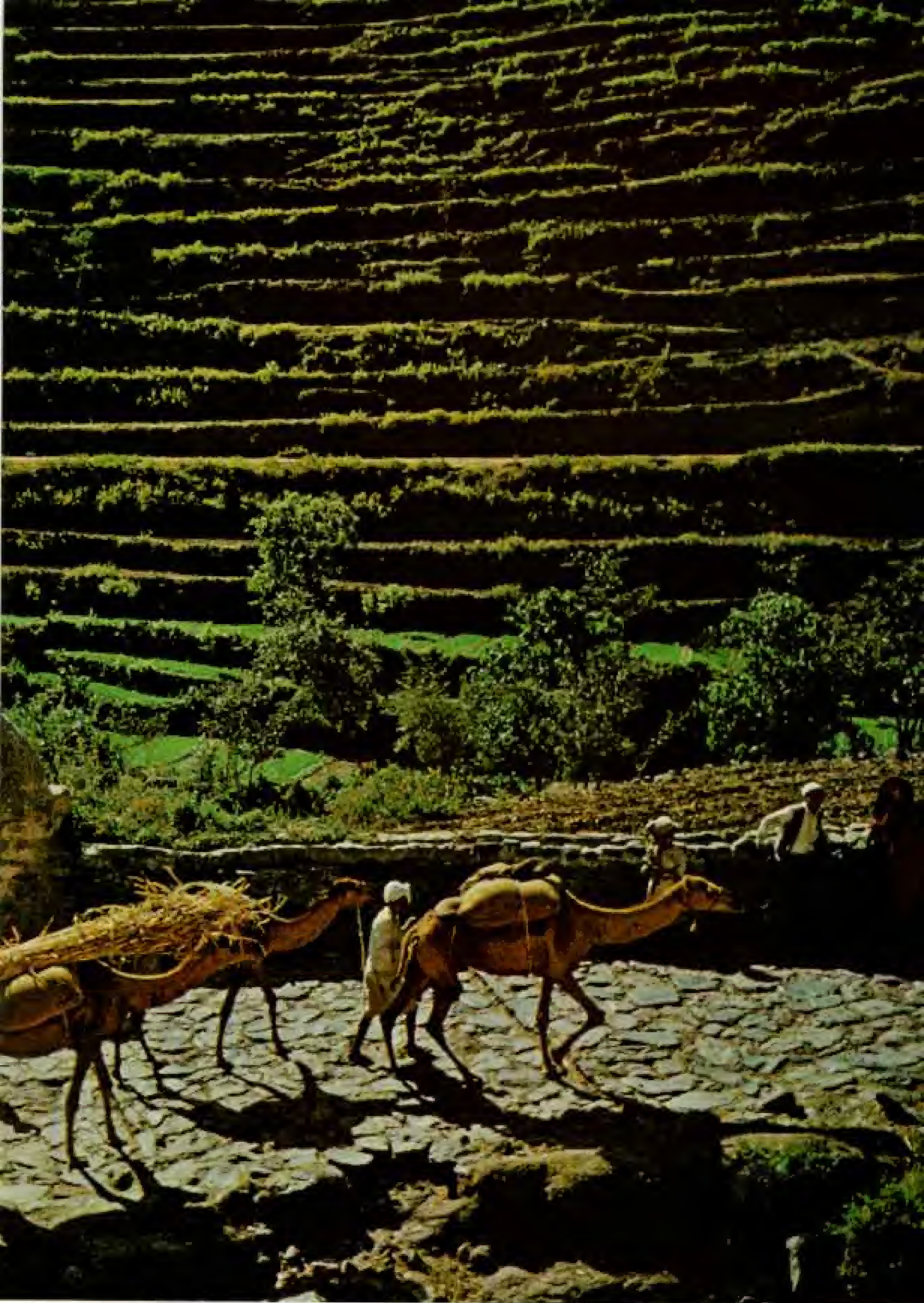
Children were miniature copies of their elders, complete to the toy wooden jambiyahs in their belts. They spotted my strange garb and blue eyes.



RECORDED BY NATIONAL GEOGRAPHIC SOCIETY

Beard dyed with henna, a jovial highlander plots the road to Yarim, a five-day walk from Ṣan'ā'. Offered a ride by the author, the traveler accepted—then changed his mind. "What would I do with the other four days?" he asked. Square-toed sandals are cut from discarded tires; "worry" beads hang from silver scabbard. Four-foot pipe with silver cap dangles from his hand.





of fertile terraces. Bundles of fodder and sacks of grain ride to market in Ibb.



EDUCATION © NATIONAL GEOGRAPHIC SOCIETY

Mocha coffee beans are sorted in a warehouse in Hodeida. Venetian traders brought Yemen-grown coffee to the Occident's attention; Venice boasted coffee houses as early as 1615. Today strong-flavored Mocha is used mostly for blending with other varieties.

"*Nusrani!*" they shouted. "Christian!" I was quickly surrounded by a mob of the curious. A police officer shouted, pelting the children with clods. To my dismay he finally dispersed them with his rifle butt.

After dark, Ibb—a city of 10,000—glowed like a page from *The Arabian Nights*. Tall houses, blue-white in the moonlight, reached high above the walls of the fortress city. Others, newer, dotted the hillside below. Their stained-glass windows twinkled a thousand colors in intricate patterns—no two alike. The cool air carried the lonely strain of a distant goatherd's flute.

That evening I called on the most powerful sheik of the area, Amir Mata Daraj. Age had thinned his beard and his teeth, but not

his spirit. Over tea and sweets we talked about Yemen's past and its future.

"The waters of change are flowing in Yemen," he said, "and we are thirsty for them. What we need first are the channels.

"In ancient times Yemen had good roads. The old road you saw outside the city was part of the frankincense highway laid out by the Himyarites almost 2,000 years ago. Our Queen Sayida binta Ahmad paved it 10 centuries later."

Now Ibb has a new highway. The United States Agency for International Development (USAID) is pushing a road all the way from Mocha through Ta'izz to Ṣan'ā'.

On the way to Ta'izz, 40 miles south of Ibb, I heard dynamite echo from terraced hills and met husky power shovels and bulldozers cutting a slash around the mountain. Most of the drivers, I noticed, were Yemeni—like young Mohammed Arsi. We talked while two Yemen mechanics greased his D-7 bulldozer.

"For half a century my father tilled the terraces in this same valley," he said proudly. "Now, I move as much earth in a day as he did in a lifetime."

#### Kat Replaced by Coffee Break

Ta'izz was Yemen's provisional capital under Imam Ahmad from 1948 until the revolution. There I met the director of USAID in Yemen, a hearty, no-nonsense Wisconsinite named James Megellas.

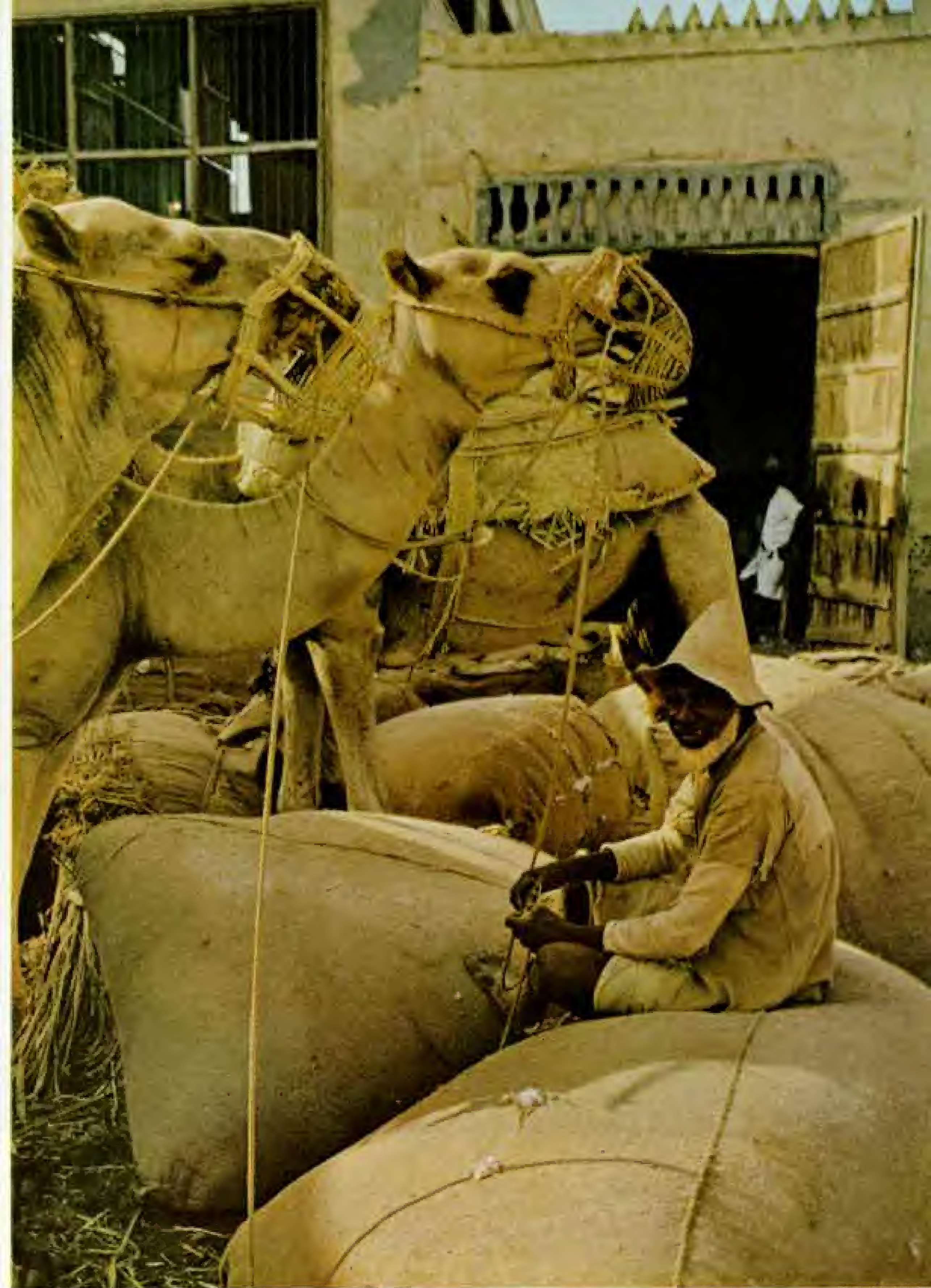
"Before starting our training program, most of these workers had never dreamed there was anything more complicated than a well pulley," he said. "Now we have more than 1,600 Yemeni working for us—many of them operating trucks, bulldozers, graders, compressors, and air hammers."

Jim's house overlooked the city dominated by the graceful twin minarets of Al-Ashrafiyah Mosque (pages 424-5). The walls of Ta'izz that for centuries had kept its enemies at bay could no longer contain its friends. Smart modern suburbs had spread to the surrounding hills.

"The Communist Chinese built a road from Hodeida, on the Red Sea, to Ṣan'ā', but their technique was entirely different," Megellas continued. "They brought in 2,000 coolies and lived in tents. They left a blacktop road behind and a measure of good will.

"We're working closely with the Yemeni people, and we've brought a little of the U.S.A. along with us for them to sample. We're building more than a road. We're training Yemenis to build their own roads."





PHOTOGRAPH BY THOMAS F. WELCH/ARND BRONKHORST PHOTOGRAPHY

Bags of cotton surround a weary camel driver outside a Hodeida gin, the country's only industrial plant. Yemen grows an estimated five thousand tons of the fiber a year on the hot desert plain along the Red Sea coast between Hodeida and Zabid.



Most of the foreign missions and embassies remain in Ta'izz and the 20th century is being felt—especially along “Broadway.”

On Al-Ariida, literally “the broad,” the paved road that skirts the city’s walls, jeep taxis and embassy cars already outnumber camels. Crowded new stores tempt workers, now enjoying the highest wages in Yemen’s

history, with Japanese radios, American toys, French cologne, and Swiss watches. Young men in Western dress pass up *kat* for the afternoon coffee break.

Still, the Ta'izz suq retained its ancient charm. There, with a Yemeni friend, young Aden-educated Mohammed Abdul Wahad Mardas, I sipped a morning cup of *qishr*, a



PHOTOGRAPH BY WILLIAM G. SCHERER FOR NATIONAL GEOGRAPHIC

sweet coffee popular in Yemen, made with the hulls instead of the beans.

At the next table, locked in serious combat, two men slammed down large marble dominoes. Outside in the street, country women noisily hawked baskets of bread made from durra. They were dressed in bright-red gowns but wore no veils. Their faces were

### Lone Fisherman in Melancholy Mocha Mends His Nets Beside a Decaying Fleet

Once-thriving Mocha grew rich exporting coffee, cultivated in the mountains nearby, and its name became synonymous with the drink. Decline set in when 18th-century planters successfully grew the bean in Java and the New World. Today blowing sand dusts the town and silts its harbor.



dyed a ghastly yellow-green with turmeric.

To Mohammed I lamented that of all the trappings of civilization, I missed most my morning paper. Under the Imam's rule journalism had languished in Yemen.

"Here comes our morning paper now," said Mohammed with a sly smile. Into the noisy teahouse strode a young man, tattered and barefoot, carrying a tambourine.

He struck up a somber tempo and chanted:

"Last week the armies of  
King Saud attacked,  
We buried them at the border.  
Sallal met them with can-  
nons like thunder,  
In an hour the enemy was  
unconscious."

He went on with current events and local gossip which, I gathered from the chuckles of the crowd, he colored liberally.

The "feature page" drew even greater response. I found myself applauding, too, after the light tempo of:

"My sweetheart, tender as  
a young branch  
The sound of your steps,  
Your olive eyes, lips of honey;  
I am your slave. Lock me  
in your heart,  
Or set me free."

Then, his tambourine jingling with bak-sheesh, Yemen's answer to tabloids and television disappeared into the crowd.

Like most Yemeni, Mohammed was drinking tea. It is ironic, I thought, that tea is the national drink in the very country where coffee was born.

Around A.D. 850, according to one legend, a goatherd named Kaldi, driving his flock through the mountains, was astonished by the dancing and cavorting of his goats after they had nibbled the red berries of a certain ever-green bush.

The curious Kaldi picked some of the berries and concocted a brew for himself. Delighted with its refreshing and stimulating qualities, he ran off to proclaim his discovery to all Arabia.

By 1600 the aroma of coffee had wafted to Europe. Yemen prospered, with a virtual

**Green field of millet, a major Yemen crop, takes water from a ditch near Ibb. Farmer breaks an earth dam, flooding a fresh row.**

AP/WIDEWORLD © NATIONAL GEOGRAPHIC SOCIETY

monopoly until about 1700, when bushes were planted in Java and the New World. One of Yemen's small Red Sea ports—Mocha—became synonymous with the beverage.

Caravans from the mountains bringing coffee to Mocha took two days to cross the sweltering Tihāmah. Now, over the new American road, I crossed the same desert in less than an hour. It was a trip from paradise to purgatory.

From ten miles away I spotted Mocha's minarets. In mirage they floated and flickered above the hazy shoreline. Strangely, the closer I came, the less I saw until finally, driving down the main street through the city, I could see nothing at all.

Sand was blowing a rage all around me. It gritted against the side of the car, driving in through even the smallest cracks. Near the remains of a long-neglected mosque, I parked and stepped out into the fury.

#### Mocha Dreams of a Prosperous Past

The hot, screaming sand stung like buckshot and the choking dust reddened my eyes. A muezzin atop the crumbling minaret nearby was calling the faithful, but his voice was lost in the howl of the storm.

I plodded through the sand-drifted streets toward the waterfront, past buried thatched huts and brick ruins. A woman struggled by, head down and long robes flapping in the wind, not even noticing me. A man, scarf wrapped tightly around his face, plowed the dunes away from his door with a wooden scraper drawn by two half-blinded oxen.

Along the shore the wind was just as strong, but, coming off the sea, was free of the stinging sand. Clustered around the small silted harbor huddled most of Mocha's living remains: a few whitewashed houses, two mosques, and an old Turkish watchtower.

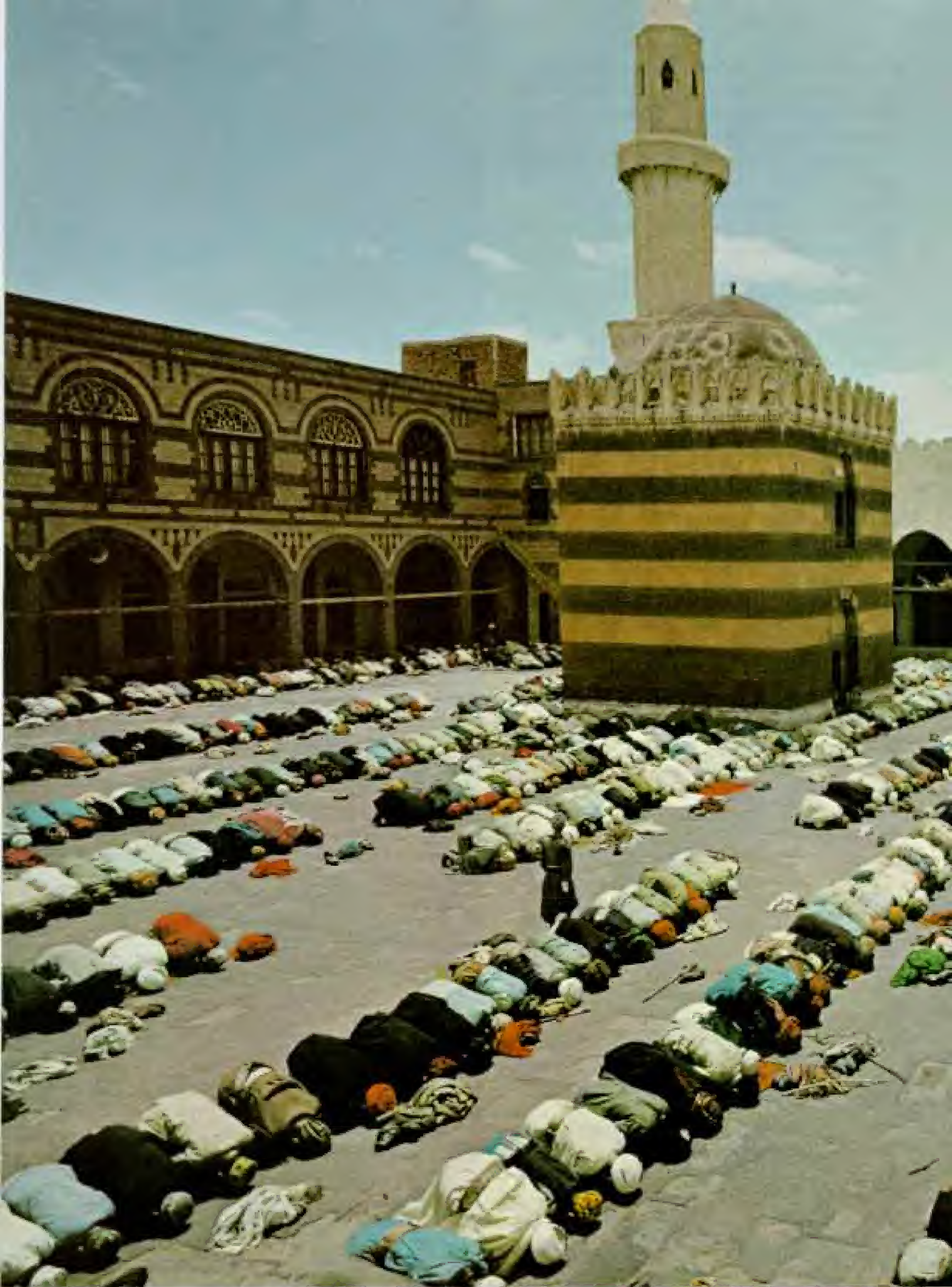
A road led out onto the long curved sand spit that enclosed the greater harbor. A fleet of dhows tacked back and forth lightering soap, matches, and tins of gasoline from a Russian freighter in the channel.

The skeleton of an abandoned fishing dhow lay bleaching in the sun. On its lee side, I found an old fisherman replacing conch-shell weights on his nets. He had spent all his 99 years in Mocha, Ahmad Abdu told me.

Red field of veils colors a street under the hot sun of Hodeida. Pigment extracted from madder provides the dye.

Illustration by Richard W. Wright





*"Allahu akbar!"* The Muezzin Calls, and a Thousand Turbans Dip Toward Mecca

Foreheads pressed to the ground, Sana'a Moslems kneel for Friday morning prayer at Al-Kabir Mosque, Yemen's holiest and one of the oldest



and most venerated in the entire Muslim world. The stone Kaaba in the courtyard once rivaled Mecca's shrine as a pilgrim center. The muezzin's

melodic cry of *Allahu Akbar*, which means "God is Greatest," echoes across the land five times each twenty-four hours beginning at sunset.

and he remembered happier, brighter days.

"For twelve summers I was captain of my own dhow. We hauled coffee to Aden and sometimes to Assab in Ethiopia," he said as we retreated toward a nearby teahouse.

It was hardly more than a shelter, built of crooked *rabb* logs and skimpily thatched with twigs and desert grass. On couches around the walls lounged half a dozen other fishermen puffing on clay water pipes.

"When I was a boy, the harbor was crowded with dhows. Caravans came from as far away as *Ṣan'ā'* with coffee and strange tales of the cities beyond the mountains. From the suqs and blending houses came the fine aroma of the beans.

"In those days our city was beautiful," Ahmad reminisced. "More than 600 houses and 20 minarets. And it was green with date groves and durra and patches of sweet melons."

#### Thermometer Climbs off Its Scale

The proprietor stood over us with his steaming teakettle, but Ahmad continued:

"Then, about 30 years ago, the sky forgot us for three long seasons. Trees died, the dust of our fields choked us, and our wells turned salty. Then came a great flood that washed half the city into the harbor."

He was silent for a minute—remembering—then he motioned for the tea.

Perhaps, I suggested, I should try some of the famous Mocha coffee instead.

My friend and the proprietor traded looks of embarrassment, then Ahmad apologized:

"Coffee? But no one in Mocha drinks coffee."

In order to find my Mocha coffee I would have to drive northward 150 miles through the desert fringing the Red Sea to Hodeida, Yemen's chief port. On the way, my Land-Rover bogged down in the rippled dunes near the village of Ash Shubbah.

I had made a wrong turn, easy to do here; the track of crisscrossing ruts is often half a mile wide. My four wheels whined in the sand. An old villager and three boys came over with bundles of desert grass to throw under the tires and a goatskin of water to cool my steaming radiator.

When we got the Rover on solid ground again it was nearly noon. My pocket ther-

mometer, hanging from the rear-view mirror, had climbed above 130° F. and off the scale.

"Stay with us past the heat of the sun," the old man, Manusar Mahadi, offered. We hiked into his village.

As is typical in the region, Manusar wore only a cotton loincloth and a pointed palm-straw hat. His skin was dark brown; his fine features were somewhat Somali.

It was cool under the thatched roof of his round mud-walled house. The dirt floor was covered with clean palm mats. He motioned me to a crude rattan couch and seated himself on a wooden well pulley.

From the outdoor kitchen that served all the nearby huts, a dark boy wearing a silver headband brought steaming loaves of coarse, sour bread and bitter camel cheese.

"I'll send young Abdul to Bayt al Faqih for some kat and . . ."

No, I insisted; it was too far and too expensive. Besides, I would much prefer a tour of the village with my cameras.

By late afternoon we ended up at Ash Shubbah's noisy social center, the village well. Long ropes, pulled across the sand by women hauling up the goatskin bucket, measured its depth—more than 150 feet.

Chattering women, waiting their turn, carried their own jugs and pulleys. A young boy carved a basin in the ground with his heel to water his camel and goats. Another trilled a battered brass flute while naked children danced around him.

#### Manusar Receives a Gift of Stars

Before leaving I thanked Manusar and asked how I could repay his hospitality. He was acutely nearsighted; could the American *tabīb*, or doctor, help him?

I promised I would try. Many of Yemen's first visitors from the Western World were doctors, and wherever I went people thought I must be a healer, too, and they came to me for treatment.

It was a month before I passed through Ash Shubbah again, and I wondered if Manusar had forgotten my promise. I arrived in early evening; but it was already dark.

Manusar was as eager as a boy at a birthday cake. In the darkness I fumbled for the

Gaunt oxen, drawing a creaking wooden scraper, clear a Mocha street heaped with drifted sand. Drought and neglect have stifled the city's gardens of date palms, millet, and melons, and dunes relentlessly choke the soaring Shadhili Mosque.





glasses I had bought in the suq in Hodeida. He couldn't wait to try them on.

"*An-nujum! An-nujum!*" he shouted, his face upturned to the clear, black, moonless sky. "The stars! You have given me the stars again!"

In Hodeida I found an old friend, Michel Harriz, an American of Lebanese descent, whom I had first met at the old Roman ruins in Baalbek. He was in Yemen representing a Houston, Texas, oil operator.

"We're a thousand miles from Arabia's rich Persian Gulf deposits," he said, "but we

have a pretty good chance here. We've already sunk five test wells; so far no oil, but there are some hopeful signs."

We walked together through the covered suqs, across a parking lot jammed with dozing caravan camels, and out into a street bright red with freshly dyed cloth (page 437). These *magramahs*, women's veils, were destined for mountain markets; few of the dark-skinned women along Yemen's seacoast cover their faces.

"*Moya! Baarid!*" cried the husky-throated water peddler. "Water! Cold!" Creaking two-



wheeled camel carts were Hodeida's water mains. The houses that fronted the hot, pastel waterfront—with their wooden balconies, palm-mat awnings, and carved trim—reminded me of the architecture of old Delhi in India.

Michel led me into the crowded office of coffee exporter Mohammed Ali Idris Daffa. Business seemed good. The floor was covered with colorful pokes of bean samples attended by three mountain merchants.

Mohammed Ali was a tall black man with heavy features and a hospitable smile. He wore, Hodeida-fashion, a spotless white caftan and a lightly embroidered skull-cap, and he wore them with dignity and aplomb.

He bargained quietly, choosing half a dozen of the



YEMEN/ARABIA © NATIONAL GEOGRAPHIC SOCIETY

Heavy silver bracelets ornament the elbows of an unveiled desert beauty. Palm-straw hat shades her from the intense heat of this coastal region, where temperatures soar above 130° F.

Thatched huts of dry mud dot the Tihama, a 50-mile-wide desert plain lining Yemen's Red Sea coast. Villagers from Ash Shubbah graze goats and sheep and coax scant crops of cotton and grain. Cattle, donkeys, and camels share acacia-shaded corrals fenced with barbed camel's thorn.



blends in less than five minutes at a price that left everyone smiling. His nephew counted out 350 riyals for 1,500 pounds, and the merchants went outside to unload their camels.

"Each year they bring less coffee," Mohammed Ali complained. "Today, Yemen is exporting less than half the coffee it did in my father's time.

"It's the kat," he continued. "Some planters can pick three coffee crops a year, but kat is more profitable. Still, one thing Yemen coffee hasn't lost is quality. Come—I'll show you."

I followed him upstairs. The many interconnected rooms, the balconies, stairways—even the covered roof—were filled with dark-skinned women cleaning and grading the beans by shaking them in large flat baskets (page 432). Some of them nursed children while they worked; others gossiped and giggled, accompanied by the hissing thrash of the beans. It sounded like hail on a tin roof, a handful at a time.

Mohammed Ali led me into a huge storage bin. Wading knee-deep into a mountain of coffee, he scooped up a double handful.

"This is real Yemen coffee—from Manākhah," he said, sniffing the beans. His eyes reflected the aroma. "There is none finer in the world."

Before I left, my host proved his point: he served me a small steaming cupful brewed with the same beans. I had tasted this robust Arabic-style coffee all over the Near East, and had learned to prefer it to our Western recipes. One sip convinced me—Mohammed Ali was right.

#### Tools of War Pour Through Hodeida

Around Hodeida one feels the presence of the Communist bloc. The highway from Ṣan'ā', built by the Communist Chinese, led past the airport lined with MIG jets of the Egyptian Air Force to the Russian-built seaport at Ra's al Kathib nearby.

From the port streamed Russian jeeps and Egyptian-built Ramses trucks loaded with red drums of gasoline, soldiers with burp guns, and spare wings for fighter planes at Ṣan'ā'. I shuddered, thinking of all this modern fighting equipment going off to war against barefoot tribesmen in the hills.

What would be the final outcome, I wondered. The new government seemed secure behind the walls of the major cities—certainly as long as Egypt kept her 20,000 to 30,000 troops and modern war machinery in Yemen. But how long could Egypt spend a quarter of a million dollars a day maintaining its forces there? Could the Egyptians train an effective army for the young republic before pulling out?

Meanwhile, the Imam and his followers still held a sizable piece of Yemen's mountain country, where tanks and planes had proved ineffectual.

Not until after my departure would an encouraging break in the stalemate occur, when Saudi Arabia agreed to stop supplying the royalists and Egypt promised to withdraw its troops from Yemen. But a 200-man United Nations observation mission reported violations of the agreement.

Peace still lay somewhere over the desert horizon.

#### Transistor Radio: Portent of Future?

On my last day in Ṣan'ā', tentative drops of April rain kicked up puffs of dust, then quickly turned the streets into a quagmire. I scurried to the shelter of a crowded archway. Beside me a young Yemeni soldier, barefoot and drenched, tuned a small Japanese-made transistor radio, twisting the dial from Ṣan'ā' to Aden to Ethiopia.

Until the revolution few radios were seen in Yemen. The Imam's was the only voice that counted. Now, wherever I went everyone seemed to be carrying *al-Marconi*.

The rain stopped. The soldier settled the dial on Cairo, hung the radio on his jambiyah, and scooted off toward the kat market for his traditional afternoon chew.

That, I thought, was Yemen: the 20th century versus the Middle Ages. Not only on the battlefield, but in the high villages, behind centuries-old city walls, in shallow harbors and along green terraces, today was at war with yesterday.

Could either emerge the clear and permanent victor? I left Yemen pondering that question. The answer awaited tomorrow.

THE END

"Hast Thou Not Seen That . . . Allah Hath Created the Heavens and the Earth. . . ."

Bathed in rays of soft morning sunlight, a bespectacled and bearded sheik chants a passage from his hand-lettered Koran during an open-air service in Ṣan'ā'.

# JAMBO — First gorilla raised by its mother in captivity

By ERNST M. LANG

*Photographs by PAUL STEINEMANN*

**G**REAT APES are man's nearest relatives in the animal kingdom, and their natural history has long stimulated his interest. Yet until a short time ago little was known about these dwellers of the dense forests, particularly the gorilla. Thus it was a great event in the zoo world when on April 17, 1961, Achilla, one of our female lowland gorillas, gave birth to Jambo, whose name means "good morning" in Swahili.

This happened in the Zoological Gardens in Basel, Switzerland, of which I am the director. Jambo was not the first gorilla baby born in a zoo; he was the third. But he was to prove an even more significant first in many ways. The important facts to be learned from such a captive birth come *after* the event: close-up observation of the relationship between adult and offspring, the rearing and training of the young by the mother. In both earlier cases, this was impossible.

Colo, the first gorilla baby born in captivity, arrived in Columbus, Ohio, December 24, 1956. The mother left her lying on the cage floor. A keeper found her near death, revived her with artificial respiration, and she was reared by the zoo staff. Today she weighs a robust 130 pounds.

The second gorilla infant was born to Achilla in our own zoo on September 23, 1959. Her name was Goma, and stories about her appeared in many publications. Achilla, then 12 years old, actually held her carefully in her arms—but the wrong way round, with her back to her breast, so the young ape could not feed. We decided therefore, on the second

Three-hour-old Jambo, who weighed four pounds at birth, lies cradled in the arms of his mother Achilla at the Basel, Switzerland, Zoological Gardens. She caresses his lips with hers, as if kissing him. Previously, no gorilla born in captivity had been raised by its mother—not even Jambo's older sister Goma (page 453).

Year-old Jambo presses against his mother and begs for a cherry; she cannot resist. After two years, the zoo separated the mother and fully weaned son.





day, to remove the infant and bring her up like a human baby.\*

So when Achilla gave birth again we all held our breath, wondering how she would behave on this occasion.

This was the first time a gorilla birth had been at least partly observed. An assistant keeper entering Achilla's cage at 7 a.m. noted her sitting as usual in the automobile tire that served as both toy and nest. Half an hour later he came back. Rising, Achilla greeted him with a grunt, placed her hand beneath her body, and held out an infant in her hand.

She curled up with it in the tire. At first the tiny newcomer lay in her arm, turned away from her breast, just as Goma had done 19 months before. But during the day the picture changed. Achilla appeared more relaxed and moved her infant from one position to another.

The young gorilla was completely helpless, in the same state as a human baby at birth. He weighed only about four pounds. His ability to grip was scarcely developed, as compared to that of chimpanzees and orangutans which cling tightly to the mother's fur from the moment of birth. For the most part the baby stretched out his arms with hands limp, clenching his fists only when abrupt changes in position were made.

The proud mother now made it her business to present the newborn infant to her circle of acquaintances. First on the list came the chimpanzees, who had heralded the birth

with shrill cries. Soon one of Achilla's human friends came to see her, and the baby was held to the wire netting to be duly admired. When my wife—for whom Achilla shows a marked affection—arrived, the mother gorilla, in her enthusiasm, tried to push the baby out to her through the netting. Achilla herself often studied the infant's tiny hands and feet and licked them carefully.

The second day after the birth we saw the baby nursing for the first time. The mother lay in her tire holding the baby breast to breast. Suddenly the youngster started an intensive search in the area of the armpit and finally found the teat. He fed to his heart's content, and Achilla seemed to enjoy it, too. From then on the baby suckled whenever he was hungry.

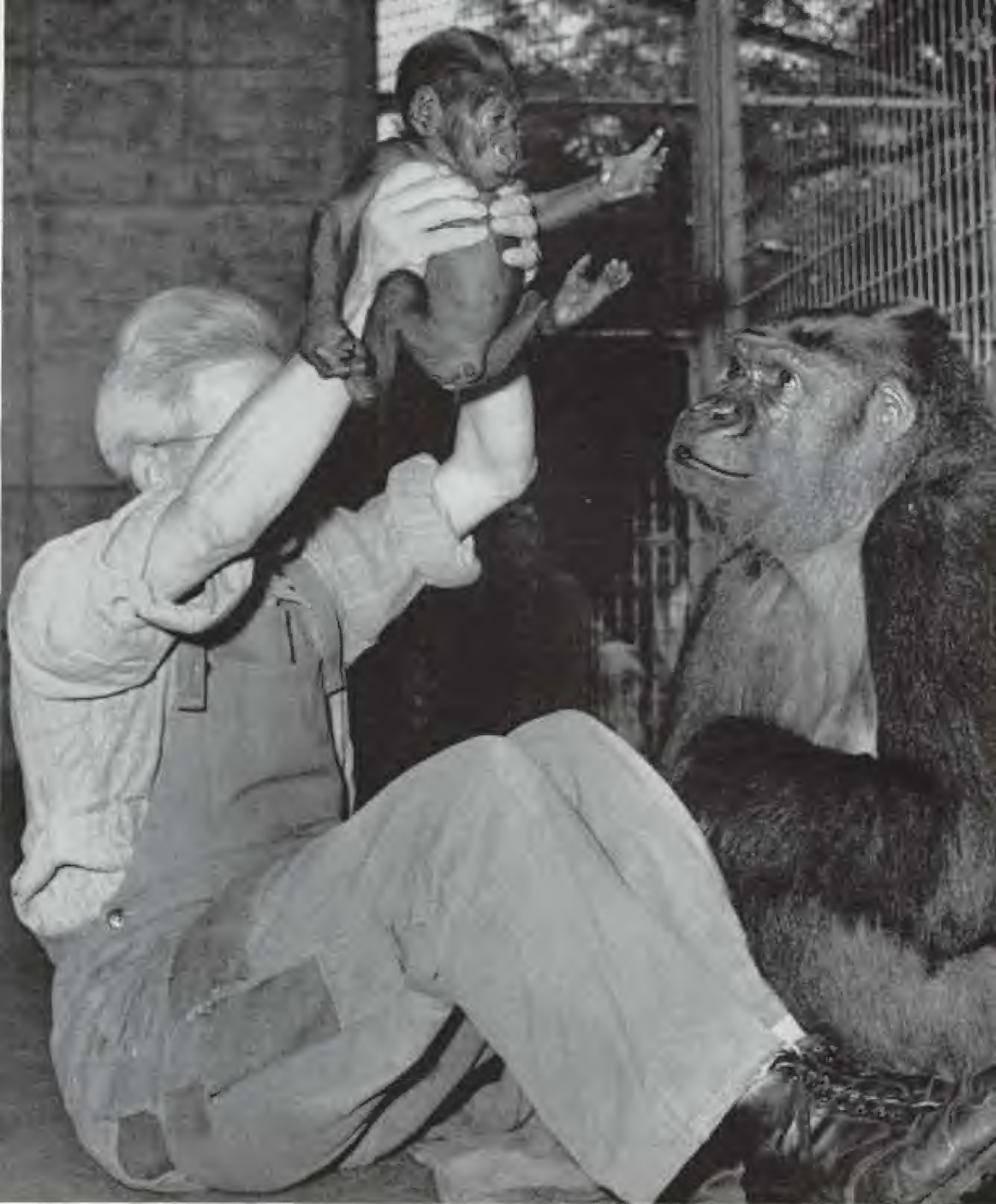
Later on, Achilla tried to feed Jambo soup with the spoon she herself had mastered. The results were more comical than nourishing: Once she did manage to poke the loaded spoon at his mouth, but the next time she tried it he turned his head and got an earful.

Achilla carried Jambo in many different positions. Sometimes she held him in her hand or in the crook of her arm. Once she wedged him between her head and shoulder,

\*Since Jambo, a fourth gorilla has been born in a zoo. He is Tomoka, who arrived on September 9, 1961, at the National Zoological Park, Washington, D. C. However, like Colo and Goma, Tomoka had to be taken from his parents to assure his survival.







**Jambo's muff-armed father,** 14-year-old, 400-pound Stefi (extreme left), was captured as a juvenile in Africa, suffering from gunshot wounds. He was traded to Basel by the Columbus, Ohio, zoo.

**Tiny hitchhiker rides Achilla piggyback** as he would in the jungle. Parents use trees as nests. Gorillas usually stand on all fours, resting on knuckles; museum specimens often rear on hind legs.

Trust shines from Achilla's face as head keeper Carl Stemmler holds her son aloft. Here, at seven weeks, Jambo cannot yet crawl. He grabs his own toes but lacks the tenacious grip with which babies of tree-swinging apes constantly cling to their mothers' hair. Unlike a chimpanzee, Achilla can put down her son and take a rest. Small for a gorilla, she weighs but 165 pounds. Sometimes she sits affectionately on Mr. Stemmler's lap.



catching him adroitly when he fell. At other times she carried him breast to breast.

On the fifth day Achilla laid her son on the floor for the first time. He did not appreciate it at all and loudly expressed his resentment. Immediately his mother cradled him in her arms. But she persisted in putting him down, and soon the baby became used to it.

No other anthropoid species is known to put down its young. Experience in zoological gardens has taught us that very small chim-

panzees or orangutans simply cannot be put down because the grip habit is so marked. In order to separate a little orang from its mother for weighing, for example, two people are needed to disengage the extremities. Probably, since gorillas live on the ground, the ability to grip has not such a vital importance as for the tree-dwelling chimpanzees and orangs.

Two months after the birth Achilla made a weighty decision and handed Jambo over to head keeper Carl Stemmler for the first time.



### Achilla Dandles Jambo by His Arms and Pretends to Nibble His Feet

At first the three-month-old gorilla did not like the game, but before long he grunted with pleasure. Glass beyond the wire netting protects the gorillas from viruses that may be carried by visitors. Four-inch hairs clothe Achilla's arms, and massive eyebrows shadow her face.

Mother's sheltering arms mean security to Jambo, who here flees a stranger venturing too close. Achilla's look of ferocity actually reflects only momentary alarm.

Illustration by Paul G. Schaller, © 1963



He was allowed to hold the infant under the close supervision of the mother—who took it back at the first whimper.

Hitherto we had not heard of any case where an anthropoid mother entrusted a human being with her baby. On the other hand it is known from the observations of the American anthropologist George Schaller that mother gorillas in the wild often allow their small babies to be cared for by older brothers and sisters.\*

Gorillas develop twice as fast as human babies. Jambo learned, as human infants do, by imitation and trial and error. When proud of some feat, showered with attention, or happy from a full stomach, he showed his pleasure by a deep-throated grunting, equivalent to the chuckling of a human infant.

Jambo was almost three months old when

\**The Mountain Gorilla, Ecology and Behavior*, by George B. Schaller, the University of Chicago Press, Chicago, 1963.



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Drinking milk, Jambo needs help from keeper Stenmuler, but Achilla handles her mug expertly. Fruit, vegetables, meat, and cereal round out their diet. Achilla's arms are six inches longer than her legs.

Jambo teases mother by tugging at an arm and disturbing her rest. Achilla patiently endured her son's antic assaults and mad attempts to climb the cage's wire netting. A hairy arm always hauled him back to safety.



Achilla put him down on the floor in front of her, then moved backward each time the baby crept toward her. This was one of the few instances of the mother's teaching that we were able to observe.

At four and a half months, Jambo gingerly propped himself on his hands and made his first faltering attempts to walk in real gorilla fashion. At five months, he was much steadier. By then he weighed about eight pounds.

As Jambo became more and more agile at navigating by himself, he and his mother would often play together. On the whole, Achilla was strict in her behavior toward Jambo, but only when he tried to steal foods from her did she reprove him with a cuff or a bite.

By the age of 18 months Jambo rarely nursed at his mother's breast, and the intervals between feedings became increasingly long. His interest in fruit and monkey cake, a scientifically prepared food, had been aroused with the onset of teething at about two months. He also learned to drink milk from a mug held for him by his keeper (opposite). The weaning process took place very gradually and there were no perceptible reactions. At the age of two years the baby was no longer being breast-fed, and we separated him from his mother.

Jambo had already got to know a little female gorilla, Cathy, through the wire netting, and the liking of the two for each other was evident. Cathy had come to us from Africa and is about a year older than Jambo.

One day we opened the door between their cages. Jambo slipped through and instantly the two little gorillas fell into each other's arms. For the next two days Cathy carried Jambo about on her back until she decided he was too heavy for her—not surprisingly, for by this time he weighed 31 pounds.

Jambo has never appeared to be homesick for his mother. He has gained weight steadily, developed strong arms, and shows a distinctive personality in our group of adolescent gorillas. Human beings are always welcome with Jambo; he is very tame and loves to be picked up and carried around.

After Jambo's removal Achilla was put back with her mate, Stefi, so she had no time to grieve after her son. The pair had several compatibility problems to overcome at the beginning, but at the end of about a fortnight they settled down together again. If we are fortunate enough to have another baby born, we intend to leave all three gorillas together, so we can observe the life of a whole family.

THE END

#### Young Gorillas Mind Their Manners at a Tea Party for Four

Keeper Gerd Morgen teaches Jambo to use a spoon as Cathy and Pèpè (center) and older sister Goma are doing. These apes will grow up together as a family. Goma, first gorilla born in Europe, was raised at home by the author and his wife when Achilla failed to nurse her. The snack is a mush of rolled oats, grated raw fruit, and yogurt.

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ILLUSTRATION © NATIONAL GEOGRAPHIC SOCIETY



# First Flight Across the

By REAR ADM. JAMES R. REEDY, USN,

“THIS IS THE LAST great long-distance flight left to be made on this earth connecting two continents,” said Lowell Thomas as we waited in Cape Town to board the planes.

Ours would be the first flight in history between Africa and Australasia by the direct route across Antarctica—thousands of miles shorter and many hours faster than any other way. Two United States Navy C-130's would take us 4,700 miles from the tip of Africa over the South Pole to the U. S. Antarctic station at McMurdo, then 2,400 miles on to Christchurch, in New Zealand.

The idea had been born during Operation Deep Freeze 1963 when I mentioned it to some of the officers of our operations planning staff in Antarctica.

“You’re talking about unknown quantities,” replied one. “No one has ever flown to the Pole directly from the mainland of either South America or Africa.”

“Plenty of flights have crossed distances just as great,” said another, “but not over 4,700 miles of icy nothing. You’ll be flying above sea and ice areas more inaccessible than any other spot on earth.”

“But can we do it?” I asked our Air Squadron leader, Comdr. George R. Kelly.

“Yes, sir, we can do it.” The answer came quickly. I think his Irish dander was up at the hint there might be a job in the Antarctic that his veteran flying sailors couldn’t handle. Thus, within a few weeks, the idea began to grow from a dream to an excitingly real possibility. Two new



*Illustrations by National Geographic photographer OTIS IMBODEN*

# Bottom of the World

Commander, U. S. Naval Support Force, Antarctica

*PALE ANTARCTIC MOON glows above two U. S. Navy C-130 Hercules turboprop transports on a pioneer transpolar journey from South Africa to New Zealand. Heavy clouds obscure the rim of the frozen continent some 30,000 feet below. Radarscopes, revealing a mountain range, wrung from crew members the exultant shout, "We've made it to the coast!"*



*GLACIERS fasten  
a frozen grip  
on a peak in the  
Admiralty Range;  
a view from  
the leading plane.*



*UNDER AFRICAN SUN, crew-  
men stow gear for the flight.*

*IN ICY MCURDO, Lt. (jg)  
Alan F. Blanchard presents  
a bag of African flowers to  
Chaplain David L. Windle.*

*AT FLIGHT'S END, Rear  
Admiral Beedy and news-  
caster Lowell Thomas  
hold a press conference  
at Christchurch.*





circumstances brought the plan even closer to reality.

First, I learned that the 1963 meeting of SCAR—the international Scientific Committee for Antarctic Research—was scheduled for late September in Cape Town, South Africa. It seemed impossible that I could participate and still get to Antarctica in time to open the 1964 Deep Freeze season at McMurdo on October 1—unless I flew there direct.

Second, a new capability was developing for our Lockheed C-130 Hercules ski-plane. To deliver bulk fuel to inland stations on the polar continent, a new tank had been developed—an enormous metal cylinder capable of carrying 3,600 gallons of fuel in the hold of the huge transport.

As we soon proved, it could also be used to stretch the flying range. With the new tank we would have an emergency reserve of at least two hours' flying time to take care of head winds or to get us to an alternate landing area in case of bad weather.

By September 19, 1963, when we left Andrews Air Force Base near Washington, D. C., for a series of hops to Cape Town, we already had the jump on our worst enemy—Antarctic weather. Masses of data had been put through a computer for analysis. The prediction: favorable winds for three days before and five days following our intended take-off date of September 30.

A week ahead of time, the South African Navy sent its frigate *Trans-*



**RISING MIDNIGHT SUN** *bursts above the polar plateau. Frost edges windshield posts. During the flight, outside temperatures fell as low as  $-72^{\circ}$  F.*

EDDACHROME © NATIONAL GEOGRAPHIC SOCIETY

*vaal* far out into Antarctic waters, into the "furious fifties," to act as weather observation post and as a search and rescue vessel if we should need it. The South African Air Force flew weather probes for last-minute information.

Monday, September 30, dawned clear and brisk. Weather information promised tail winds most of the way.

We prepared for take-off with a gross weight of 145,000 pounds for each of our two planes. That is some 10,000 pounds more than the recommended operating weight of the C-130, but at sea level with a long run our aircraft-performance graphs promised adequate room for smooth take-off. Each plane carried 62,000 pounds—nearly 9,600 gallons—of JP-4, a gaso-

line-base jet fuel. It would give us 17 hours of flying time.

On board the lead plane with us were Lowell Thomas, internationally known news commentator; Prof. L. C. King, geologist from the University of Natal, representing the South African Government; and Otis Imboden, roving staff photographer for NATIONAL GEOGRAPHIC. Allyn Baum, photographer-reporter of the *New York Times*, rode in the second plane. All told we numbered 29.

As we lumbered out onto the runway, our squat and ungainly C-130's resembled penguins, altogether too fat to fly. Our wings drooped from the weight of fuel, and the special fuel tanks in the holds pressed us close to the ski-shrouded wheels.



am not the only one aboard who is wondering at this moment whether by the next day we'll be called heroes or just plain fools.

1500. On course—due south. Our flight path is planned to take us straight down the 18°30' meridian.

"Ready to take her up to 22?" Commander Dickerson asks Marine Staff Sergeant Arthur L. Kring, the navigator on duty. A check of the fuel chart. Answer: Thumbs-up.

At the new altitude of 22,000 feet, our plane will perform at top efficiency. When our fuel load is lighter, air speed will increase accordingly and we can fly still higher. This step-climbing procedure helps get the last extra mile out of the fuel.

1530. Message relayed from McMurdo: "Due to worsening weather do not intend to launch C-130's over Pole Station." We will have to do without the airborne communications relay we had hoped to use at the Pole.

1600. Weatherman reports tail winds blowing from 300° at 50 knots. This is a good boost for us. Outside temperature down to -24. Ground speed estimated at 300 knots. This should help put us ahead of schedule. Things are going so smoothly we can almost dare to breathe easily.

1630. Our sun is starting to set. Bright bands are streaking the horizon over the whole southwest segment of our sky.

1700. It's nearly dark outside. I've relieved Commander Dickerson at the controls. We're on autopilot at 25,000 feet. The red glow of our instrument panel almost matches the last scarlet rays of sunset. We're nearing our friends in the South African ship. Have them now as a small bright blip on our radar.

1715. We pass over the *Transvaal*. Can't see her for the cloud cover. Must be a lonely sea down there. Comdr. W. D. Hogg sends a message of "best regards" from Commodore M. R. Terry-Lloyd of the South African Navy, and adds his and the *Transvaal* crew's wishes of "Godspeed." We relay our gratitude to them and to all the South Africans who contributed so much to our flight.

1800. Communications growing spotty with the *Transvaal*. We lose contact with the Ysterplaat Air Force Station on the mainland at about the same time we pass over the ship. Our outside temperature gauge continues to drop. We are beginning to feel Antarctica's icy breath.

1900. Members of the crew start to get into their cold-weather gear. We'll lower the cabin temperature to remain comfortable. Heavy thermal boots and long-handle underwear may be awkward aboard the plane, but if we

have an emergency we don't want everyone scrambling at the last moment to get shoelaces tied. We also turn on the electric heater blankets on the plane's skis, to keep our hydraulic system from freezing.

1930. We've passed latitude 60° south. Must be nearing the pack ice, but our radar has no definite reflection yet. I'm going back to get into my long johns. We're starting to climb again. This should bring us to 27,000 feet. The moon is up and nearly full. Tops of the clouds below us look innocently silver. Haze still ahead.

2000. We're nearing our PSR—"Point of Safe Return." They used to call this the "Point of No Return"—more poetic, but I suppose the Navy prefers the note of optimism in "Point of Safe Return." Our "go or no go" point is 2,347 statute miles out from Cape Town. This brings us almost to the coast of the white continent.

Navigators Kring and Lt. (jg) Donald E. Miller have their heads together over calculations for celestial lines of position. Miller is using the sextant, still the navigator's best friend in this desolate world where all those wonderful electronic black boxes don't come to much. Our only guideposts here are the first magnitude stars Canopus, Altair, Antares, and the bright planet Saturn.

Our lovely tail wind continues. It occurred to me to thank God for that help, because if a wind of such velocity had been on our nose or even a bit ahead of our beam, we probably could not have made it.

2030. We're out of communications range with the ship. Our last position report had to be sent out "blind," uncertain whether anyone could read us. Now we can hear the Russian station at Mirnyy transmitting weather data in Morse code.

2045. Over the PSR! Past our point of crucial decision in flying style! Two solid celestial fixes put us 15 minutes ahead of flight plan. The "Howgozit" chart shows we're slightly high on fuel consumption. We're climbing to 30,000 feet. Outside air temperature reads -50°. Frost is forming on the inside of our windshield.

2120. We've made it to the coast! Radar shows mountain ranges just inland. Celestial lines and radar agree that we're right on course—running straight down the notch between the Sor Rondane Mountains on our left and the Wohlthat Mountains on our right. We've also picked up our communications again and talked to the Pole. Feel as if we're on the way home!

2130. McMurdo Station booming in on

voice radio. Relays message from Russian station leader M. Tyabin—"Congratulations and best wishes. Facilities available at Mirnyy station if you wish to land." We return our thanks, explaining that we're going over the Pole to McMurdo, but hope to return to accept the invitation another time.

2200. Now we're hearing all the stations on the ice. Chief of Staff Capt. Roy G. Shults talks to us from McMurdo. He says weather there shows signs of going bad.

2230. Strong radar echoes appear over an area of polar plateau shown blank on charts. We're supposed to be well inland of all charted mountain peaks. Want to return later to see what's under that heavy cloud cover.

2300. Pole Station reports weather deteriorating. Visibility decreasing to one-quarter mile in blowing snow. Temperature  $-28^{\circ}$ . "Typical day at the Pole," remarks Dickerson, "Hot and dusty."

0030. 1 October. Beautiful Antarctic dawn beginning in a glow of color. Sight brings

#### WHEEL-AND-SKI-SHOE TRANSPORT

*slides toward a parking apron at McMurdo Sound. Her sister craft (right) touched the skiway only a minute off schedule after crossing 4,700 miles of sea and ice from Cape Town. Ground controllers, wintering at the base, talked the plane down through overcast and blowing snow.*

Imboden out of a short sleep to get pictures. This is truly the midnight sun.

0115. Latitude  $90^{\circ}$  south. Over the Pole. We can see the Amundsen-Scott Station landing strip off under our right wing. The radioman at the Pole reports he can see our contrails. I radio a message to Dr. Colonel Bessinger (really a Navy medical lieutenant, whose first name is Colonel), leader of the wintering-over party of 22 men at Pole Station. We send greetings to all and assure them that we will be in to take them out as early as possible.

Plane 320 comes up on our port side. She makes a beautiful sight, her aluminum and red fuselage glinting in the morning sun.

0140. Now that we've passed the Pole we've turned slightly to the left, following the usual route to McMurdo. Blowing snow obscures most of the polar plateau, but we get glimpses of endless snow dunes casting long shadows in the low, slanting sun.

0230. Two hours to go. The sun is well up over the horizon now and very bright. We're all in dark glasses. McMurdo reports the weather is getting more questionable, and we get a little more fidgety. Do we press on, or decide to go to Hallett Station, or land at Byrd Station, or go back to the Pole?

Our fuel is marginal for reaching any of these alternate ski-landing strips; we might be forced to come down blind on the sea ice near McMurdo with the aid of our ground controllers, hoping that through the overcast



we had picked a spot relatively free of sus-  
trugi, the ice-hard ridges of wind-blown snow.  
Such an emergency landing had been made  
before, so we press on to McMurdo.

0330. Occasional glimpses of the Queen  
Elizabeth and Queen Maud Ranges. Dr. King,  
the South African geologist, is on the flight  
deck and very absorbed by this bird's-eye  
view of Antarctic land forms.

0400. The undercast is getting thicker.  
We're on the VHF (Very High Frequency)  
homer beacon from McMurdo. We expect to  
see the base on our radar within a few minutes.

0418. GCA (our Ground Controlled Ap-  
proach radar unit) reports it has us on its

scope and steers us onto a new heading for a  
landing approach. The ground controllers  
will talk us down to within a hundred feet of  
the ground or a quarter mile from the end of  
the skiway. Blowing snow still keeps us from  
seeing our goal.

0425. Ground Control has us on the glide  
slope. Our own radar shows we're lined up  
between the rows of gasoline drums which  
mark the skiway approach.

"We've got the barrels," Copilot Kelly calls  
out as he spies the marker drums.

"We've got the threshold," Kelly can see  
the end of the runway.

Within seconds our heavy skis rumble on  
hard-packed snow. We've made it!

I congratulate the crew: "All right, boys,  
you're all a bunch of ruddy heroes!"





### Hooded Bear Admiral Gets an Icy Welcome at McMurdo: $-35^{\circ}$ F.

Antarctic duty began for author James R. Reedy in 1963, when he succeeded Rear Adm. David M. Tyree as commander of the U. S. Naval Support Force on the southern continent. During the layover at McMurdo, Admiral Reedy formally opened Operation Deep Freeze '64 (so designated for the fiscal year July 1, 1963-June 30, 1964).

Lt. Col. Ronald A. Tinker (left), 1963 leader of New Zealand's Scott Station close by, offers congratulations on the polar flight. He drew from the author this quiet reply: "Ron, I'm happier than usual to see you today."

0431. Bundled-up ground crewmen wave us into the aircraft parking area. As they lead us in and our engines are shut down, I note the time—exactly one minute off the flight plan we figured out in Washington, 9,200 statute miles away. We have been just 14 hours and 31 minutes from Cape Town. Plane 320 slides to a stop only minutes behind us. Williams Field at McMurdo is a gray but happy scene. More than a hundred of the men who have spent the long winter on the continent have come down to greet us.

And what have we accomplished? By present-day standards, our 4,700 miles was not a great distance. It couldn't compare to Tom Davies' 1946 nonstop flight of more than 10,000 miles from Perth, Australia, to Columbus, Ohio, in the *Truculent Turtle*, or to many of today's long-range Air Force flights.

But we had been first (and there is no feeling like it) to fly by the back door into our main logistics station on the continent. We had proved that our communications could satisfy requirements for regular flying into or over Antarctica from Africa.

After a short layover at McMurdo, we took off for an uneventful flight to New Zealand. We knew now that, with reasonable range built into planes, Antarctica could be a logical stop for air traffic between South Africa and Australia or New Zealand.

I must admit that there is little prospect of commercial flights passing through Ant-

arctica very soon. The U. S. Navy's primary task on the ice is the support of the U. S. Antarctic Research Program of the National Science Foundation. And by the time air traffic from South Africa to Australia or New Zealand is heavy, supersonic jet transports will make the distance easily, but Antarctica will serve as an emergency way station.

I have no doubt that the day will come when planes will fly this route across the South Pole, just as today transports routinely fly great circle routes across the top of the world. As one of my distinguished predecessors, Rear Adm. George J. Dufek, wrote in the October, 1959, *GEOGRAPHIC*:

"The demand for such shortened routes will come with growth of population, development of resources, and expansion of industries in the Southern Hemisphere."

Some say that exploration is dead, a glory of the past. I believe that there is still much to be learned in Antarctica. Our ventures there are overshadowed by the great ones for which others are preparing, ventures which will take them far beyond the confines of our planet. But I'm certain that the lessons learned in Antarctica about men and the stresses of a hostile environment will prove of value as we move into the vast arena of space.

And as we look back on this "last great long-distance flight," it is gratifying to think that it, too, may add its bit to man's knowledge of his earth and universe.

### SIX-MONTH INDEX AVAILABLE

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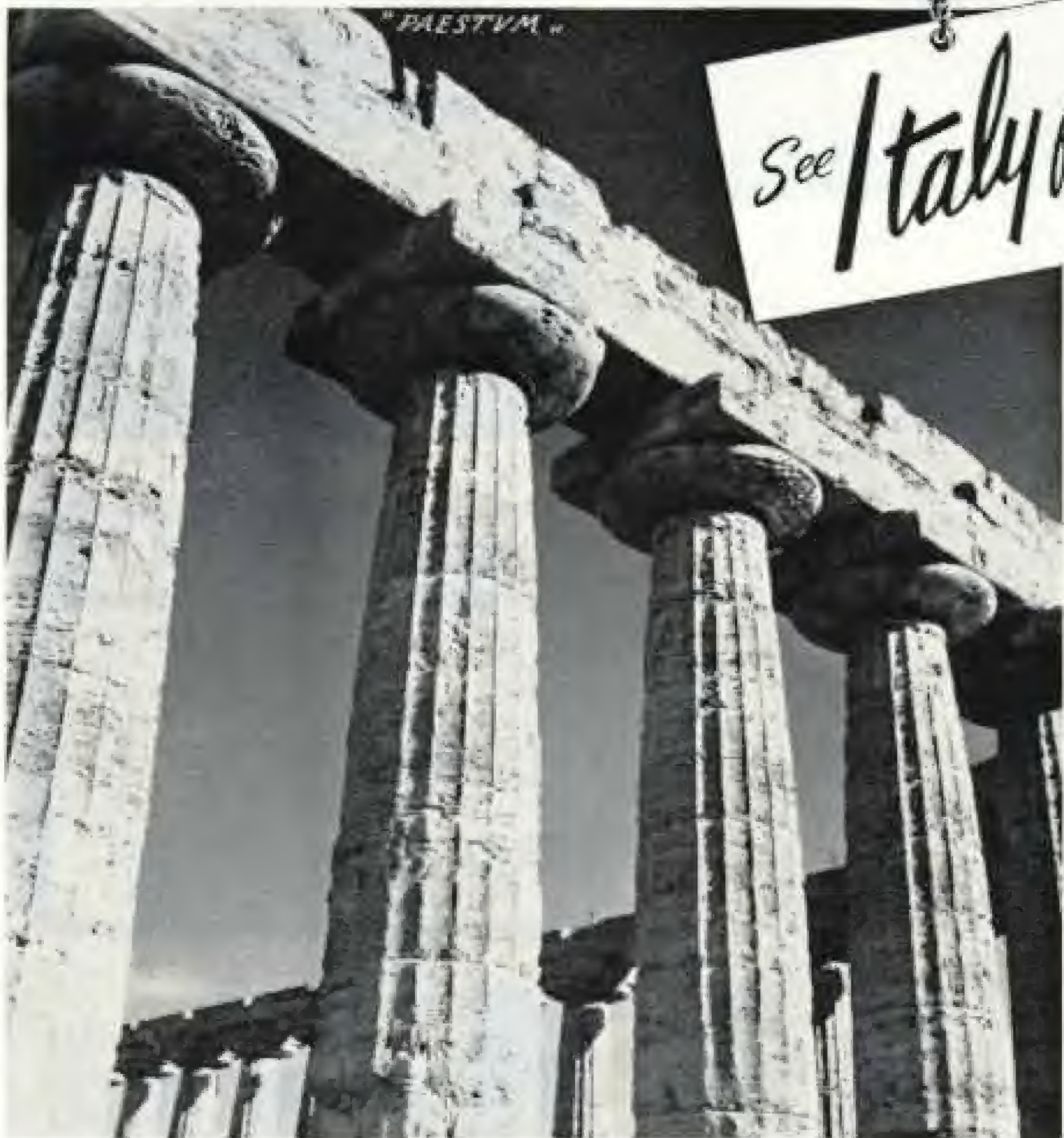
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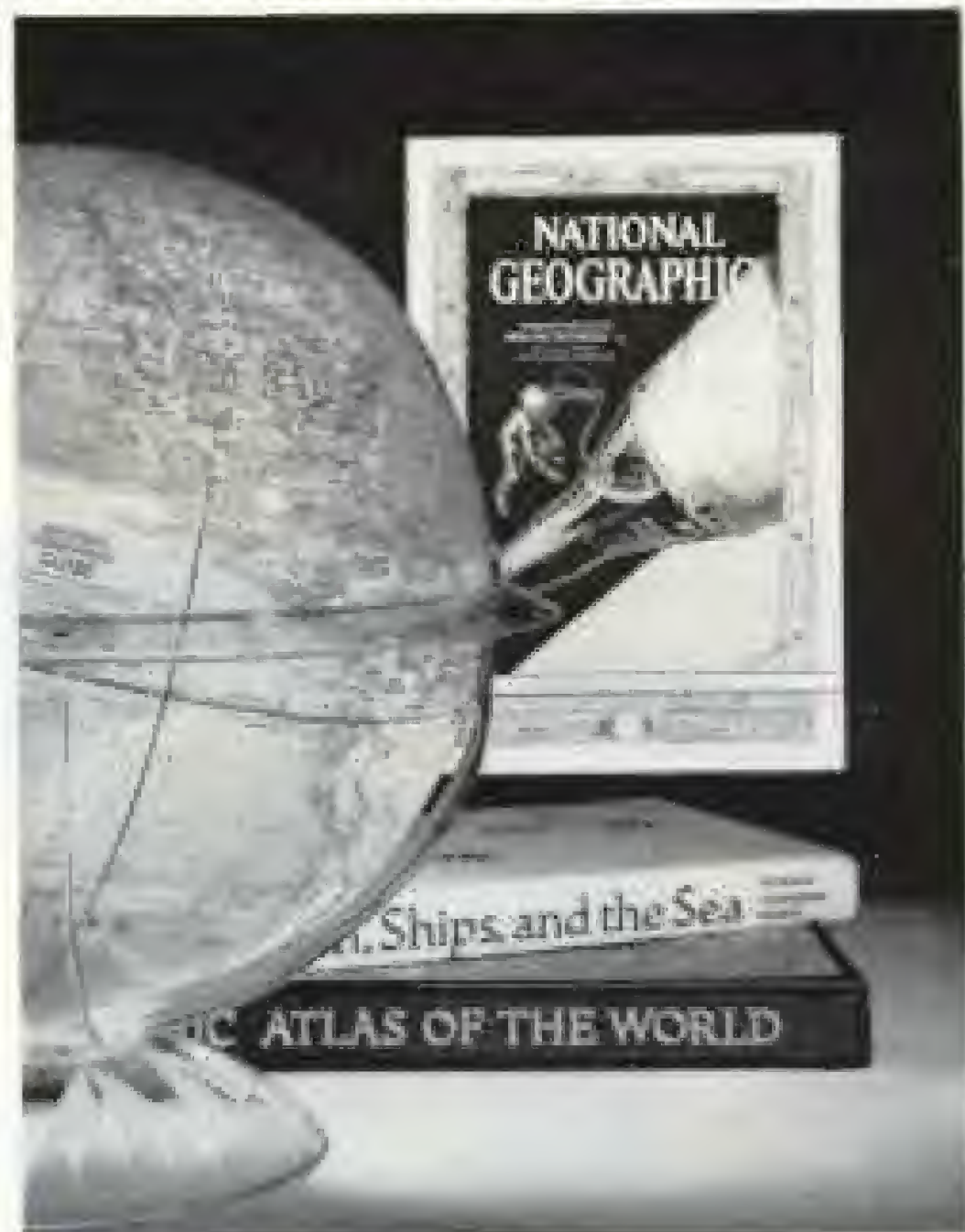
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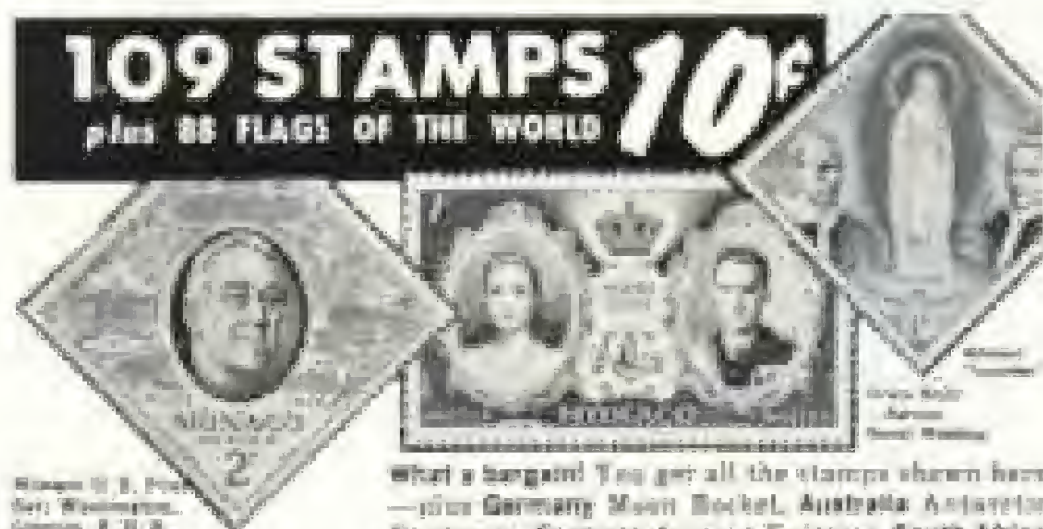
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