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Glass "Goes to Town"
With 28 Illustrations

J. R. HILDEBRAND

From Sand to Seer and Servant of Man
22 Natural Color Photographs WILLARD R. CULVER

American Bombers Attacking from Australia
With 19 Illustrations and Map HOWELL WALKER

War Finds Its Way to Gilbert Islands
With 19 Illustrations and Map SIR ARTHUR GRIMBLE

Your Dog Joins Up With 25 Illustrations

FREDERICK SIMPICH

Eastward from Gibraltar With 28 Illustrations

CYRUS FRENCH WICKER

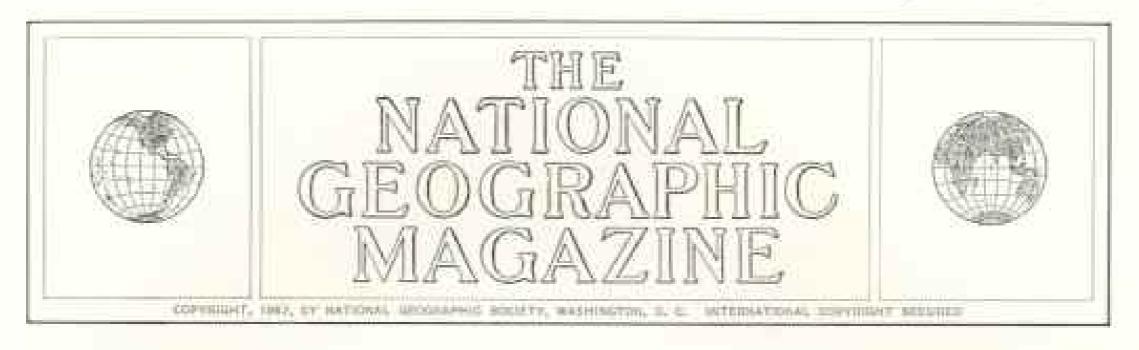
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Glass "Goes to Town"

By J. R. HILDEBRAND

With Illustrations by Staff Photographer Willard R. Culver

Tollado I sam a machina plepping

In Toledo I saw a machine plopping volleys of 24-ounce steel balls on glass for store doors—from 18 inches, from 22 inches, from 24 inches, and higher—with never a fracture of the silken surface.

Out at the zoo they coaxed an elephant up on a piece of plate glass supported by blocks under its four corners to have his picture taken. Pachyderm and plate glass came through intact.

Not only impact, but heat and cold fracture ordinary glass. Now they make glass which they lay on a piece of ice and pour molten lead on its top side without cracking it.

Formerly everybody saw "through a glass, darkly," as the Bible puts it, because the best of glass was only approximately transparent.

One New York department store put up "invisible glass" to guard its better costume jewelry. So many shoppers reached out to examine the pieces and bruised their knuckles that the store had to hang a sign, "This is glass,"

30,000 Ways to Make Glass

"What is glass?" I kept on asking.

"You wouldn't order a ton of metal. Don't speak of 'glass,' but of 'glasses.' There are more kinds of glasses than there are of all the metals and alloys combined."

One glass is lighter than aluminum; another is heavier than iron.

At the Corning Glass Works they regularly melt some 300 different glass compositions. Research men there are studying about 30,000 glass prescriptions. In huge stock piles are 110 ingredients to mix with sand in quantities ranging from tons to grams.

A new glass which transmits ultraviolet rays must be so nearly pure that one wrong grain of sand in a ton might make the product defective.

Such glass transmits two types of rays: one generates ozone from the air, the other kills germs. Hospitals use it to "blanket" contagious wards; packing plants buy it to tenderize ments.

With it banks and art galleries can detect fraudulent checks and old masters because ultraviolet rays show up different inks and paints.

Another glass which absorbs infrared rays, and therefore screens heat, is useful in operating rooms, for dentists' instruments, and in windows of trains that run through hot countries.

To control just one quality, color, the Blenko Glass Company in West Virginia has formulas for more than 300 different shades of stained glass for church windows. The mixers compound new hues as artists order them (Color Plates IV and V).

"What is glass?" I asked again.

"Truth is," replied a chemist, "the constitution of glass is about as much of a mystery as the make-up of electricity. We know what we can do with both of them, which is plenty. When we find out what glass really is we should go to town!"

Glass is "going to town" right now, as never before, to meet demands for replacement of

metals that have gone to war.

From glass now are made centrifugal pumps,



Coal-black "Honeycomb Glass" Floats Like Cork and Is Shaped with Carpenters' Tools

Here a workman saws a thick "board" of the new Foomglas into specified sizes for building insulation. Much is used in refrigerators, rafts, life belts, and on ships carrying food to our Allies. Such glass, composed of myriad tiny cells, is fireproof, waterproof, and verminproof (page 3).

fish-net floats, sole plates for electric irons, costume jewelry, furniture, thimbles, floats for toilet flush tanks, thread guides for rollers in textile mills, spiral springs, phonograph records, and kitchen stoves.

Such substitutions of glass are not so simple as they seem. For example, it took months of research to find a way to "bore" the right kind of a hole in glass before glass baskets for percolators went into production.

Enter the Glass Plumber

Glass plumbing has just been born. Soon glass plumbers will be listed in the classified section of your telephone book,

Two problems were involved which took years of research and countless dollars to solve.

One was making a glass to resist breakage and temperature changes. That development began with stormproof railway signal lanterns. When brakemen took red lanterns from heated cars out into the cold of winter nights, the chimneys would crack and rear-end collisions resulted.

Tougher glass next was used for battery jars. The wife of a laboratory worker tried the end of such a jar for cooking. From that hint scientists developed a glass to withstand the heat of cooking—stoveware through which you can see the flame beneath a frying egg-

Now they turn out glass tough enough to withstand varying temperatures of the fluids that flow through the transparent pipes, and defy the bumps and bangs inevitable in factories (Plate VI and page 5).

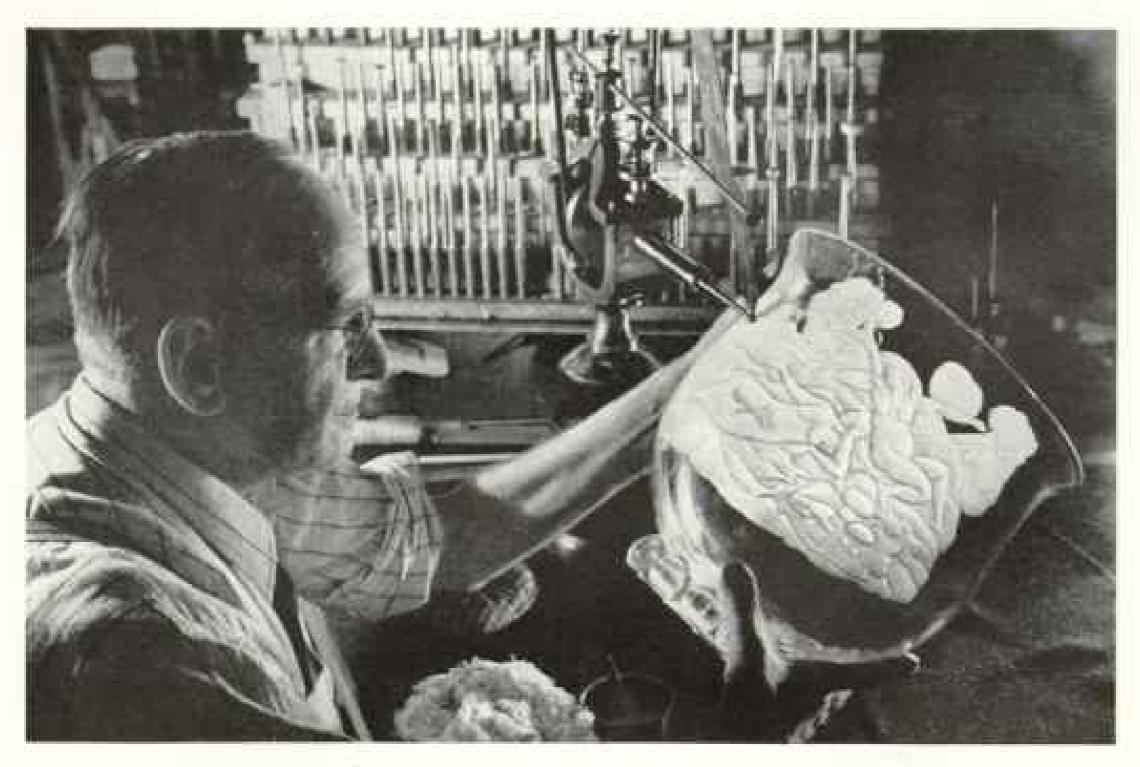
Developing sturdy glass was only part of the problem. Heretofore, glass could not be welded as metals can. Joining two pieces of glass required a cumbersome furnace to heat them and a long lehr to anneal, or slow-cool, the fused product (page 12).

The skeleton of all the piping required in a pasteurizing plant or a tomato-juice cannery could not be put together by the glassmaker and then moved into a food factory and fitted into the machinery.

Recently a revolutionary way has been found to weld and anneal standard lengths of glass piping on location.

Already in dairies, in food factories, and in beverage plants visitors see milk, ginger ale, and fruit juices pumped through pipes of glass instead of stainless steel.

Culmination of thermal shockproof glass is a quartzlike kind that shrinks in the making



Copper Wheel Engraving Requires a Skilled Artist and Crystal, Colorless Glass

A Steuben craftsman works with a small lathe, into which he fits as needed one of the scores of copper wheels in the rack to his left. Operating like a dentist's drill, the wheel is fed with an abrasive of linseed oil and emery powder. Here a design by André Derain is engraved in shallow intaglio.

and winds up being nearly pure silica. If you wish a nine-inch length of tubing you start with a piece ten and a half inches long.

It took six years of what inventor Charles F. Kettering calls the "shirt-losing stage" to perfect that kind of glass,

Stone Age Men Fashioned "Natural Glass"

The layman with even a smattering of geology here will inquire why, if pure quartz is desired, do the makers not use unadulterated sand, which is quartz, instead of mixing in other ingredients and then shrinking them out?

Nature makes glass that way. A familiar natural glass is obsidian, which originated in molten rock masses tossed out of a seething volcano and cooled too swiftly to be transformed into other minerals.

Stone Age men used obsidian for their earliest weapons, spearheads and arrow tips, and from it American Indians fashioned such tools as knife blades with razorlike edges.

However, pure silica sand has a melting point higher than any plentiful furnace material—it would have to be melted in a vacuum up to 3,500° Fahrenheit. This fact and other technical problems restrict its commercial production. One use of the new man-made silica glass is to withstand the violent temperature changes and chemical assaults of laboratory experiments.

Another new glass makes jewels, or bearings, for electrical indicating instruments that formerly required polished sapphire.

The weight of such a vital, pinpoint piece of glass is three ten-thousandths of an ounce; its diameter is only seven hundredths of an inch.

Compare that with the Mount Palomar telescope disc which weighs 20 tons, is almost 17 feet in diameter, took nearly a year to anneal, and will require years more to polish to an accuracy of a millionth of an inch—and you sense the versatility of glass products.

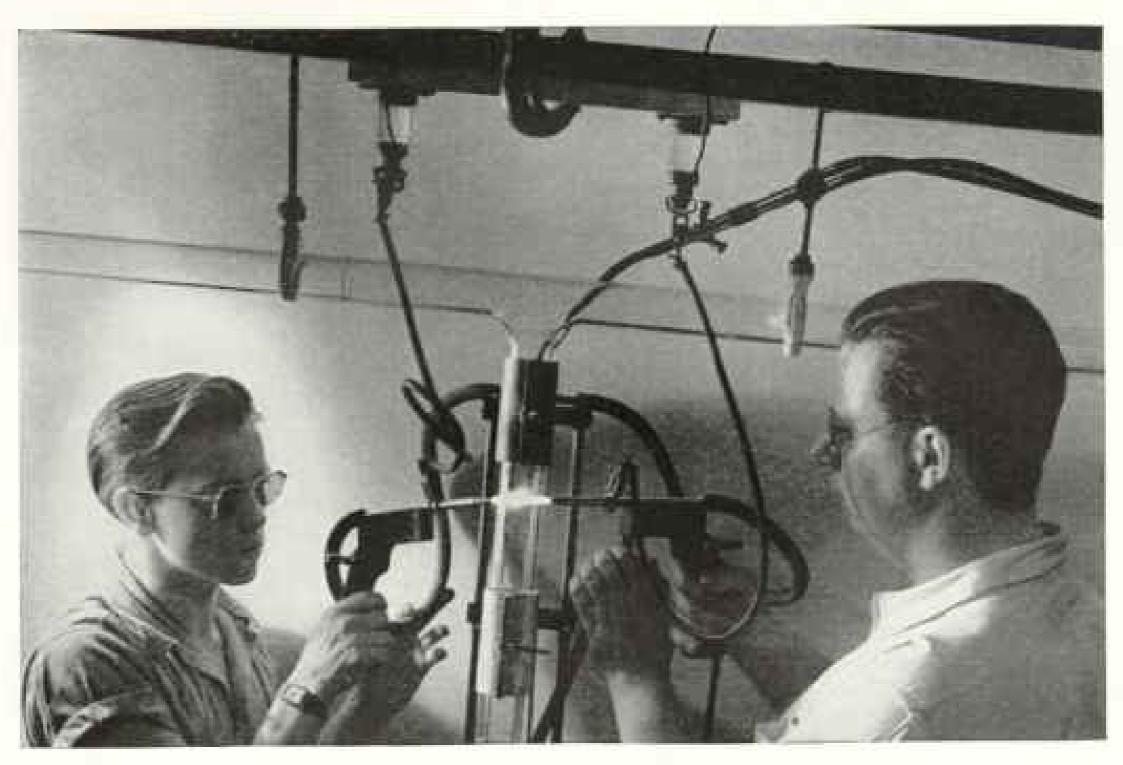
Engineers compute their glass needs by yards and tons. Laboratory workers order pieces to a tolerance of thousandths of an inch.

For some 4,000 years glassmakers have striven to get the bubbles out of glass. One laboratory has worked in recent years to put the bubbles in—a honeycomb of minute cells formed by firing ordinary glass with carbon. The carbon acts as yeast does in baking bread. Out come featherweight blocks of "carbonated



These Girls Demonstrate that Glass Is the "Perfect Elastic"

To the layman rubber is elastic because you can pull and squeeze it. But rubber will lose its shape and "give." Glass never does, this side of breaking. Stretch a piece of glass, or compress it for a thousand years, and it will bound back to its original shape. That is what the physicist means by "clasticity" of glass—no flow nor deformation. The girl at left is pulling tempered plate glass out of plane as registered by the ruler. Such glass faces bumps and weathering in doors, portholes, and searchlights. Libbey Owens-Ford Glass Co., Toledo, Ohio.



New Electric Welding Makes Glass Piping Practical

The room of a thousand curves," they call one installation where fruit and vegetable Juices flow through transparent "victory glass" which replaces stainless steel (Plate VI). Here Corning glass plumbers fuse glass pipe joints by torches of gas flame and high frequency arcs (page 2).

glass" that float like cork, and can be sawed, cut, or drilled with carpenters' tools (page 2).

A piece the size of a pound of ordinary glass weighs little more than an ounce. It is waterproof, fireproof, verminproof. Aboard ships, on trains, for houses, and in refrigerators it is used for insulation.

Making Thread from Sand

Most uncanny of all glass operations is making thread or wool from sand. The product defies all the layman's preconceptions of the way glass should behave. It can be bent like rubber, twisted like string, woven like cotton, and when a wad of it is pressed, the mass bounds back into shape like a sponge (Plates IX and XII and page 59).

Into factories roll trainloads of sand and lesser quantities of other ingredients. Therefrom pour glass wool and glass yarn for scores of products.

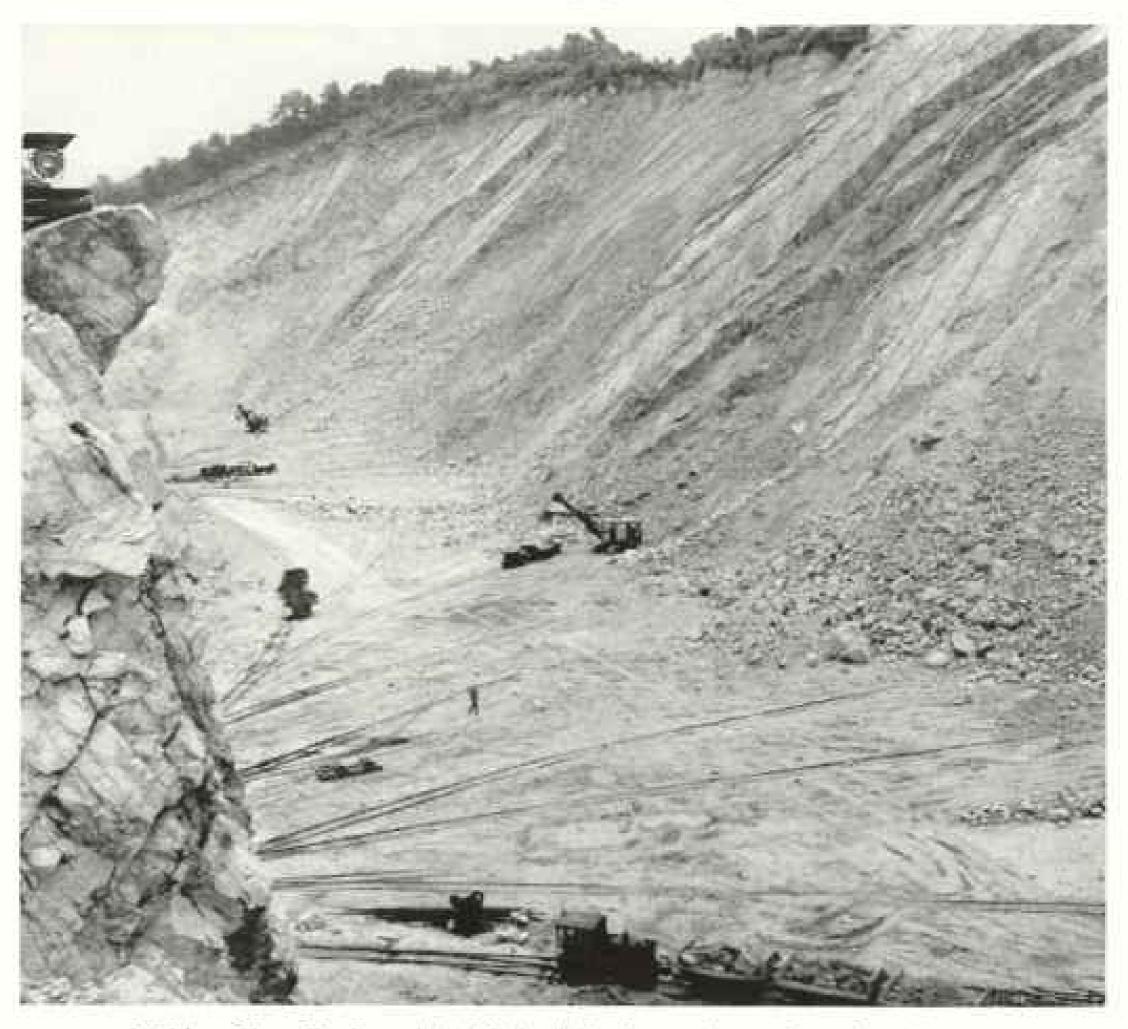
A strand of glass fiber may be 15 times finer than human hair, and have a tensile strength greater than steel. To form such strands the manufacturers first make marbles by the ton. Continuous filaments are drawn out faster than a mile a minute. A single marble yields a spiderweb filament that would reach from Washington, D. C., to Wilmington, Delaware. A pound of fiber would go around the world.

Overshadowing all the hundreds of uses of glass fibers is that of halting heat, cold, and electricity; resisting water and acids; and deadening sound and vibration. In modern industry glass is the great insulator.

Two types of glass fiber have been developed. The woolly kind is used chiefly for thermal insulation in the form of batting, blankets, and boards. The textile type makes threads and yarns which are woven into electrical insulation materials, and into a variety of versatile fabrics that defy stains of most everything, from fried eggs to nitric acid.

Wartime services of such glass range from protecting fuel and oil from subzero cold in high-flying airplanes, to sheltering batteries in submarines, shockproofing radio and control panels on battleships from the air compression that follows the firing of a heavy broadside, and cushioning batteries from the terrific jouncing of armored cars and tanks.

Bulk of the wool filters air and insulates houses, ranges, refrigerators, and water heaters. Railroads use it; so do buses, trucks, planes, and ships. Much of it goes to soundproof factory walls.



Making Glass Begins with "Mining" Sandstone in an Open-face Quarry

A vast sandstone ledge near Berkeley Springs, West Virginia, has 99.8 percent pure silica, and also a low content of iron, enemy of transparency in glass making. Stone is reduced to original quartz grains which are then mechanically "scrubbed" under water, and graded over electric vibrating screens. The Pennsylvania Glass Sand Corporation ships sand to glass plants in paper-lined boxcars.

Yarns are used principally for electrical equipment; insulation for wires, cables, motors, generators, and transformers.

Because all the raw materials for making fibrous glass are abundant within the United States, this miracle filament has entered into the war production program in numerous secret ways to replace scarce mica, asbestos, cork, and aluminum.

War has encouraged use as filters for bloodplasma kits, wicks for oil lamps, and tracer threads in surgical sponges.

If you would let your imagination run riot, think how the whole earth might be bound around with the millions of miles of twine an Olympian glassmaker could melt from the infinite sands of any big bathing beach.

Sponge glass and spun glass seem ingenious

because they are new. But glass itself would be miraculous were we to come upon it afresh.

Many inventions have contributed to man's comfort, convenience, and efficiency. None has helped him more than glass in his quest for knowledge and understanding of the world—and the universe—in which he lives.

Feats of Aladdin, Incorporated

With glass man sees stars spin and microbes squirm. He can focus a pinpoint of matter, or examine details of the valleys of the moon. Besides seeing infinitely far, and discerning incredibly small objects, he can peer through opaque walls, trap or filter out all sorts of rays, and, with the help of the glass eye of a camera, even behold things that may no longer be there (page 37).



A Glass Chef Follows His Recipe to a Fractional Ounce

There is no "pinch of this" or "dash of that" in glass "cooking." One grain of the wrong raw material in a ton may ruin some special glasses. Coming regularly dumps some 300 ingredients into such batch wagons for its various commercial glasses; uses 30,000 prescriptions in its research laboratories (page 1). To protect his lungs the miner wears an aspirator.

Windowpanes admit billions of dollars' worth of light by day, and electric bulbs give mankind all the 24 hours for work and play.

You realize how much light is worth when you note that through glass bulbs in the United States alone glow some 300 million dollars' worth of electric home lighting in a normal year. For streets, highways, offices, and factories the lighting bill is many millions bigger.

Perhaps industry's closest approach to a godlike act of creation is the glass blower who pulls from the fiery furnace a gob of molten earth stuffs and literally breathes into it a form of virtually imperishable beauty (Plate I and page 32).

In an open yard of one plant I saw massive blue-green pieces of glass for telescope mirrors that gleamed like frozen crests of ocean surf. "Seems a casual way to leave valuable glass lying about," I remarked.

"Why not?" asked my guide. "They are too big to steal. They won't weather. They will be just as good for grinding down a thousand years from now."

The little old lady who said she knew glassblowing must be very ancient because she had seen pictures of Noah's Ark with glass windows was on the right track!

Glass Diaries of Ancient Ways

The University of Chicago has a pale-green glass cylinder from Mesopotamia which may be 5,000 years old. There is ample evidence that glass was widely used 4,000 years ago.

The Toledo Museum of Art displays an amphora and a small ewer made in Egypt at

least 1,350 years before Christ. That was long before some nameless benefactor invented the blowpipe. Then semimolten glass was shaped around a cone of sand and a metal rod which later were withdrawn.

Wander through this very human museum, pride of the city that glass helped build, and its famous glass collection telescopes for you the work and worship and play of the ancients in the homely way that Samuel Pepys or Mark Sullivan might write their history.

A beaker made in Syria in the century when Christ was crucified has an inscription, "Wherefore Art Thou Come . . . Rejoice," words St. Matthew quotes from Jesus.

Another from supposedly sinful Sidon has a blown-in-mold trademark: "Neikais made it," and, on the other side, "Let the buyer remember."

From the medicine chest of a Syrian mother, who patched her children's cuts and bruises 15 centuries before the days of Mercuro-chrome and iodine, came a container for unguents, with glass spatulas for applying the ointments.

Roman ladies had for vanity cases two highly decorated glass vials, joined by handles at the top through which passed a cord to carry them. One compartment contained rouge; the other held kohl for darkening the eyelids. Flecks of color still cling to glass rods for applying the make-up.

Jewish 7-branched candlesticks and the temple door, and Christian crosses and palm leaves appear on Near East glass of ten centuries ago. Gorgeous colors still glow through enamel of Arabic lamps that hung in mosques when Columbus sailed toward America.

Glass art of the ancient world culminated in the enameled glass of the Saracens. Perfume sprinklers, beakers, lamps, flasks—all were ornamented with gold and colored enamels.

Damascus became the center of this art and among the Toledo Museum's pieces are Damascene containers with long, narrow necks. These probably were the first nonrefillable bottles (page 30).

Venetians Gunrded Glass Secrets

Venetian glass was the glory of the Middle Ages.

On the sheltered island of Murano, nestling among the proud city's lagoons, glass furnaces were fired behind barred doors patrolled by armed guards. Artisans who sought to escape and sell the secret of limpid Venetian glass were stabbed, not so mysteriously, by the medieval Gestapo of the dread Council of Ten. One blower who had been offered a fabulous bribe by the covetous court of France met death at the very gates of Paris.

First factory erected on United States soil made glass, and glass was our country's first export of manufactured goods.

Captain John Smith's colonists of 1608 included eight Polish and Dutch glassmakers who set up a crude glass furnace in the woods about a mile from the struggling settlement of "James Towne."

These pioneers made so many beads for trading with the Indians that the glass currency became inflated, and the colonists started shipping beads to England at less than ceiling prices. Old records fall to tell how long this first commercial enterprise lasted, but the pick and shovel have delivered to museums specimens of the beads and remnants of the furnace bricks and clay pots.

"Big Three" of Early American Glass

Even such hops and skips as we are making across 4,000 years of glass making—for this article is not a history of glass—cannot miss the "big three" of early American glass.

First came go-getter Caspar Wistar, German immigrant who started in Philadelphia to make brass buttons "warranted for seven years." He imported from Belgium four glass workers and set up a plant at Wistarberg, New Jersey, to make buttons and glass.

That was about 1740. More than 200 years later glass plants now are starting to make buttons again—not of brass, but of glass. And buttons are no mean field for glass; clothing manufacturers use more than 10 billion buttons a year.

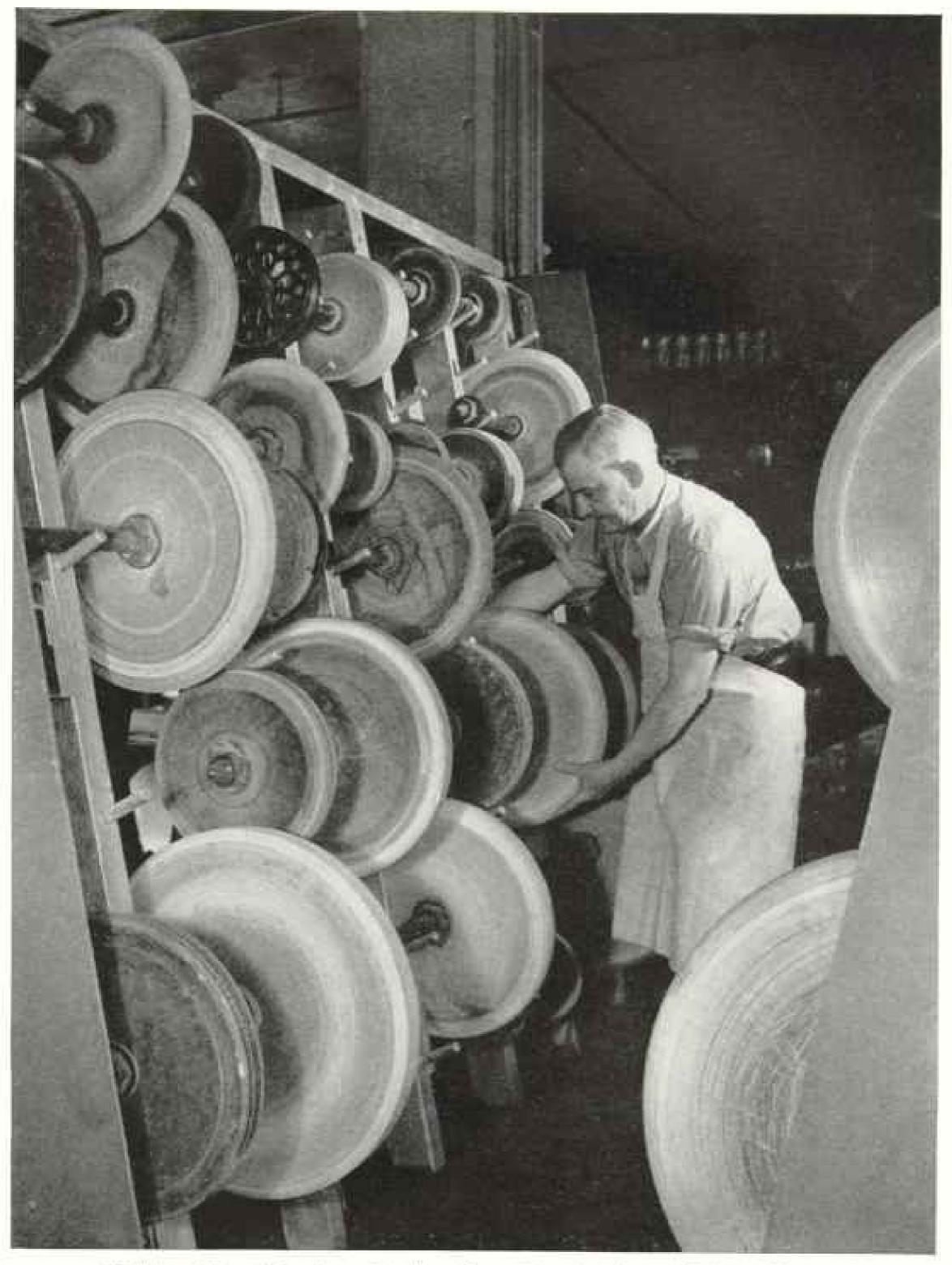
Careful collectors say there now are fewer than 30 authentic pieces of precious Wistar glass in existence; many more purport to be Wistar.

Glamor glassmaker of Colonial times was Henry William Stiegel, whose flamboyant ways and "conspicuous expenditures" amid the pre-Revolutionary simplicity of central Pennsylvania won him the nickname "Baron."

He built the feudal "spotless town" of Manheim, near today's Lancaster, with glass factory, workmen's homes, school, church and a fabulous mansion, with hand-carved woodwork, gorgeous tapestries, and a bandstand on the roof.

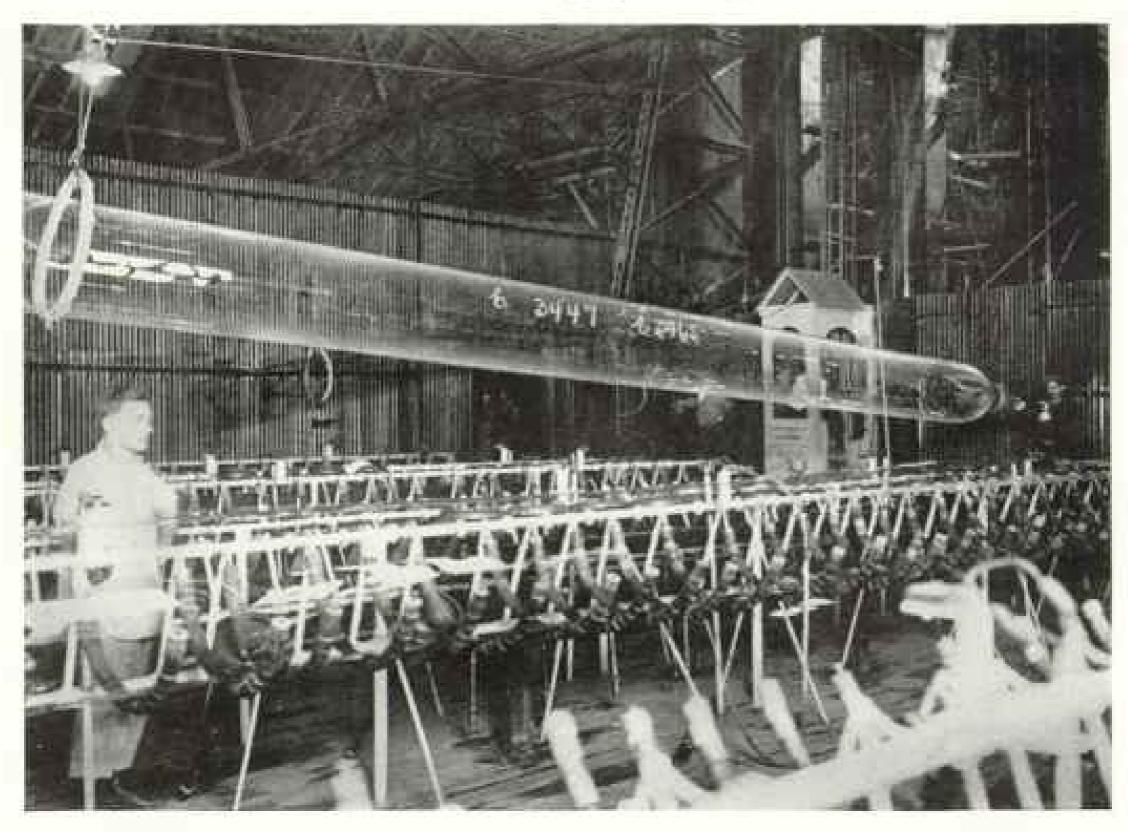
He drove about the Quaker countryside in a coach-and-four preceded by outriders, and when he approached his "castle" cannons were fired in salute.

Stiegel was no mere playboy. He was deeply religious, and he was fanatical about producing in his beloved adopted country as good glass as Europe made. He built a chapel



It Takes More Wheels to Cut Art Glass Than Brushes to Paint a Picture

Cutting and grinding wheels of carborundum or sandstone range from 3 to 18 inches in diameter. Their surfaces are rounded for hollow cuts; V-shaped for bevel cuts; and flat for panel, or flat, cuts. Then the rough white surface is ground away with felt wheels led with putty powder to restore transparency.



A Giant Test Tube? No. Embryo Panes for Scores of Windows

This historic photograph was published in the National Geographic Magazine of May, 1919. Then window glass was blown into enormous cylinders. The ends were cracked off by electric wires, the cylinder cut down the side, and then flattened out. Stained glass still is made that way (Plate V). Most modern window glass rolls off presses in continuous sheets as does the plate glass shown in Plate III.

where he often preached from an ornate pulpit, and he crossed the Atlantic to learn about foreign glass.

But the bubble burst. The "grand man" of colonial glass crashed financially. They sold his mansion, his other "towers" or "forts," even the glass of his own making—resplendent enameled pieces, and others of incomparable amber, amethyst, emerald green, and sapphire blue. Today some Stiegel items sell for more than his relentless creditors realized from his entire collection.

Two generations later Deming Jarves, the Paul Revere of New England glass, helped found a glass company at Sandwich, on Cape Cod, because thereabouts were extensive stands of virgin timber for furnace fuel.

Jarves lacked the color of promoter Wistar and baronial Stiegel, but he made glass history.

A carpenter employee suggested that instead of blowing glass in molds, the molten metal be ladled into the molds and then pressed into shape with a plunger.

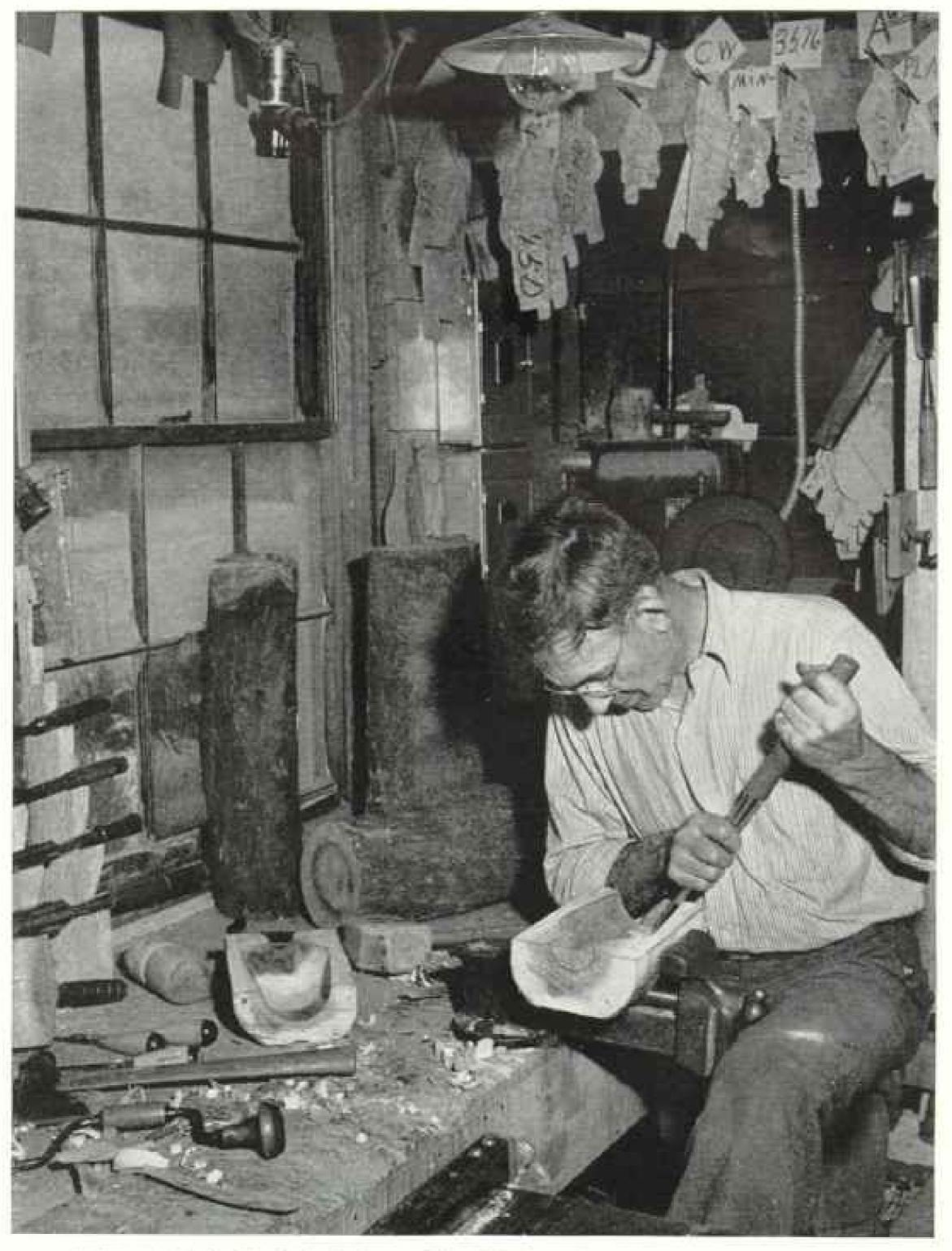
Jarves and his associates developed a pressing device. In 1827 they turned out the first pressed-glass tumbler. Thus a hundred-million-dollar industry was born!

Housewives Know the Feeling!

That cherished first tumbler was a top flight American collectors' item until 1876, when it was taken to the Philadelphia Centennial. The exhibitor tenderly lifted it from its case to show it to a group of connoisseurs, let it fall through his nervous fingers, and his tears dampened the dustpan.

The Sandwich plant operated till 1888, the year of a general strike among glassmakers. Sandwich workers were ordered out; the company said if the fires went down they would never be rekindled. The Sandwich crews none too willingly walked out, and the New England company kept its word.

Collectors seek especially the highly decorated Sandwich cup plates. Emily Posts of earlier days prescribed these for dainty ladies at parties. They rested the cups on the plates after they poured their hot tea into the deep saucers, from which they drank with their little fingers sticking straight out.



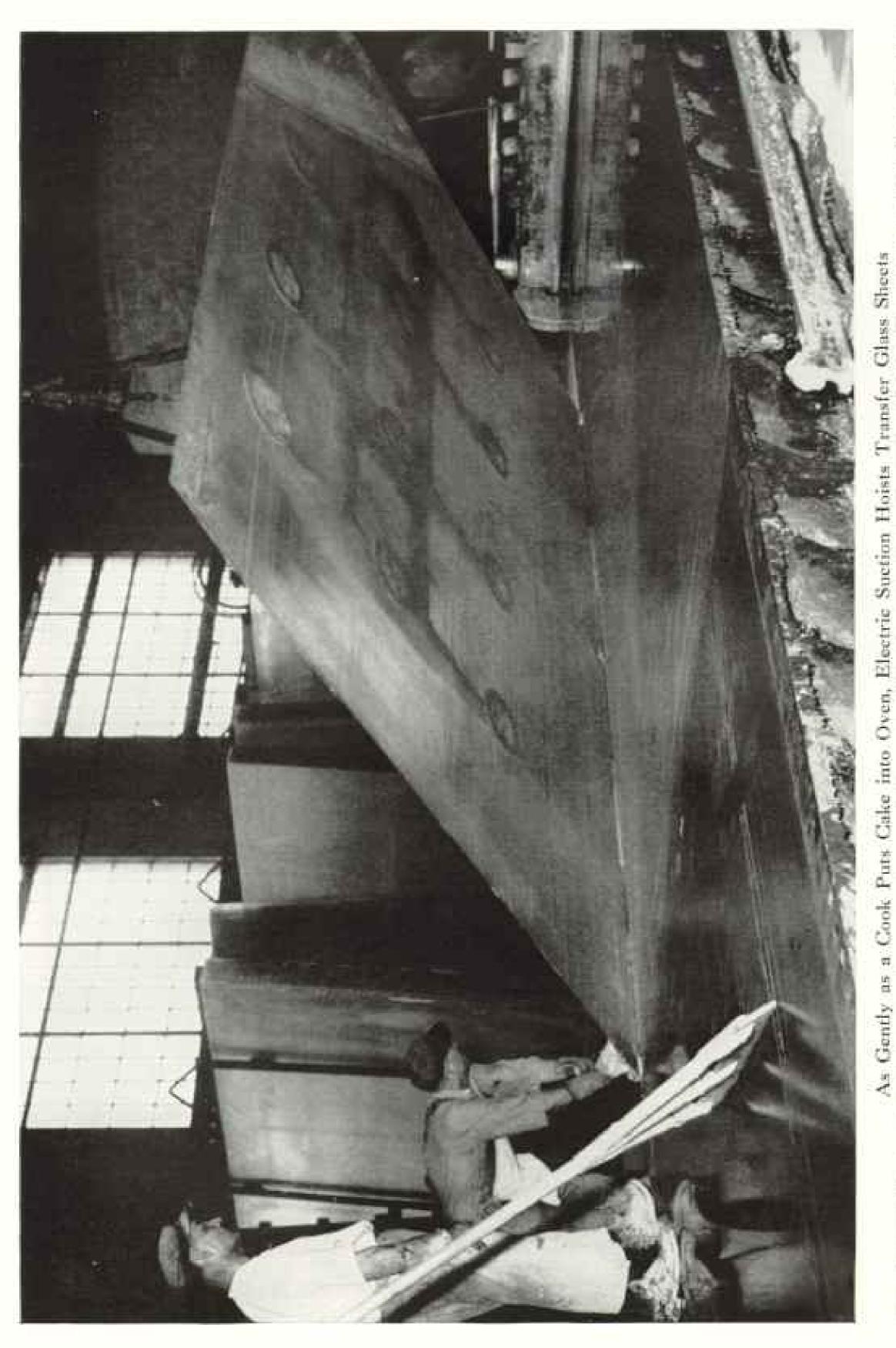
Molds of Ensily Worked Applewood Are Used to Reproduce Williamsburg Glass

First glass house in the New World was established in Virginia, near Jamestown, in 1607-3, by Captain John Smith. Today the Blenko Glass Company at Milton, West Virginia, reproduces early Virginia glass on display at Williamsburg, and also makes stained glass for church windows (Plate V). The worker carves his molds from green wood, kept water-souked for easier working. Above this veteran carver's head hang patterns for molds.



Photograph made at Fostoria Glass Company, Moundsville, West Virginia. They pass through a heated tunnel called a lehr for two to five hours to to Glass Making as Is Quick-freezing to Food Preservation cause breakage. Candlesticks, goblets, and vases come off the presses at 900 degraes, room temperature. Such annealing reduces the strains which a Slow-cooling Is as Vital

ALC: NO



Here pieces weighing from 100 to 1,000 pounds are placed on a grinding and pollabing line at the Libbey-Owens-Ford Toledo plant. This lifting device has been called the most humanitarian invention in the glass industry. Formerly many injuries resulted when such massive sheets were moved by hand.



He Seeks a Light-conditioned Nook for Lunch and the Comies

This photograph at Libbey-Owens-Ford gives a graphic idea of the size of plate glass in the making—here about 10 by 15 feet, and a quarter inch thick. The massive sheets will be ground and polished, then cut up and silvered for mirrors, or for "picture windows" looking out from homes upon exterior scenes.



Off a Rotary Press Come Glass Pie Plates Such as Grandmother Never Used An ingenious feeder automatically deposits fiery gobs of molten glass into this turntable press which has 16 molds. Out come Pyrex pie plates. Tubes over each mold are air lines for cooling the glass.

Such early American glasses often stamp indelible footprints of history in the sands of their times,

One cup plate shows Robert Fulton's squat steamboat. Log cabin ink bottles became the vogue during William Henry Harrison's campaign of 1840. A pictorial flask commemorates the opening of the Erie Canal in 1825 by Governor De Witt Clinton. Another flask has a pressed-in-glass portrait of Zachary Taylor with the slogan, "General Taylor Never Surrenders."

Kossuth bottles were made when the Hungarian exile visited the United States; on the reverse side is pictured the steam frigate. Mississippi which was to bring him over.

"Success to the railroads," reads a bottle which shows a horse-drawn car on rails. Of later date are steam-locomotive bottles. Showman P. T. Barnum promoted the Jenny Lind bottles as publicity for the Swedish singer's tour of this country.

Blowing Glass Bubbles

Such bottles—in fact, all bottles of the last century—were manufactured in substantially the same way that illuminations on medieval manuscripts show bottles were made in the Middle Ages.

One workman mixed the simple batch of silica-sand, soda ash, and lime. Another sat before the furnace and blew a bubble of molten glass into shape. A third tended a chamber wherein the product annealed by slow cooling.

You can see such units now even in the most modern factories which make special containers. There always are a gatherer, a servitor, and a gaffer. The basic tool, dating back more than 2,000 years to sandy Syria, is a hollow metal blowpipe, about five feet long, with a knob at one end to pick up a gob of molten glass.

The gatherer dips his pipe into the seething mass till he gets the right amount, pulls out the gob, and starts rolling it and shaping it on a metal table. Then, as he blows, he also swings the pipe to cool and elongate the growing bubble.

At exactly the right moment the gatherer hands the blowpipe to the servitor, who inserts the partially blown mass into a mold. The servitor guides the further shaping and passes the piece to the gaffer. The gaffer, always head man of the shop, reheats the glass and does the final blowing (Plate II).

That is the simplest type of shop. If the product has two or more pieces—such as a goblet with a stem, or a vase with handles—there may be various pit-boys, bit-gatherers, ball makers, foot-formers, crack-off boys, carry-over boys, carry-in boys, etc., to handle the added parts.

Glass Comes of Machine Age

Since 1900 glass has made more progress than in all the other 5,000-odd years of its known history,

Take bottles. Hand-blowing 450 million milk bottles, nearly 3 billion bottles for medicines and toilet preparations, and some three-fourths of a billion soft-drink bottles—not to mention millions more for beer, fruit juices, liquors, and wide-necks for foods—would make glass blowers exceedingly numerous.

Now a bottle-blowing machine is a complete

glass-making factory.

Long metal arms reach out from the mechanical octopus to the tank as the massive machine revolves. Each arm sucks up enough molten glass for one bottle. An automatic gaffer blows the bubble of glass with compressed air. A steel servitor closes the mold around it.

Machine fingers lift the bottle from the mold and set it on a conveyor which carries it through the long annealing lehr at precisely controlled speeds and temperatures. Out come the finished bottles ready for packing, unblown by human breath, untouched by human hands.

Father of mechanized glass was Michael J. Owens who, in 1905, completed his first workable bottle-making machine which was to develop into today's mechanical marvel of 10,000 parts. Owens was born in an immigrant coal miner's cabin in the West Virginia hills of Mason County. At age ten he applied for a job in a glass factory in Wheeling. The foreman told the ragged youngster that he would at least have to wear shoes to work there. The lad found a mismatched pair among the neighbors' rubbish, and showed up next morning before the plant opened. He got the job.

Glassmakers say the name of Owens, now incorporated in the titles of several leading companies, ranks in their industry with the names of Whitney and Goodyear in cotton and rubber.

Besides introducing the machine-making of containers, which now gross more than 200 million dollars a year, by far the biggest financial slice of the glass industry, he blazed the way for numerous other machine-made products, from electric-light bulbs to Christmas-tree ornaments.

"That's How Mr. Libbey Was"

In Toledo I watched an automatic machine—forty tons of machine, with 16,000 parts if you count all the screws—pounding out 900 tumblers a minute. The time it took to turn out a tumbler was 22 minutes flat, from molten gob to packing in carton, only a hundred feet away from the furnace mouth.

As tumblers cascaded out, venerable, sprightly August Kadow, godfather of this amazing mechanism, told me anecdotes of his patron, Edward Drummond Libbey, another giant of the glass industry.

"Five years I worked on that little job,"
he recalled. "Thousands of dollars it cost
Mr. Libbey; then I would ask for more thousands—and get them. 'Kadow's crazy this
time,' they said. And some whispered that
maybe Mr. Libbey was a little 'teched,' too.

"Originally the machine was to make electric-light bulbs. Temperature control, that was the trick, and it was tough going. That's why it took me so long. Mind you, working with glass a thirty-second-of-an-inch thick, with variations of not more than ten thousandths of an inch.

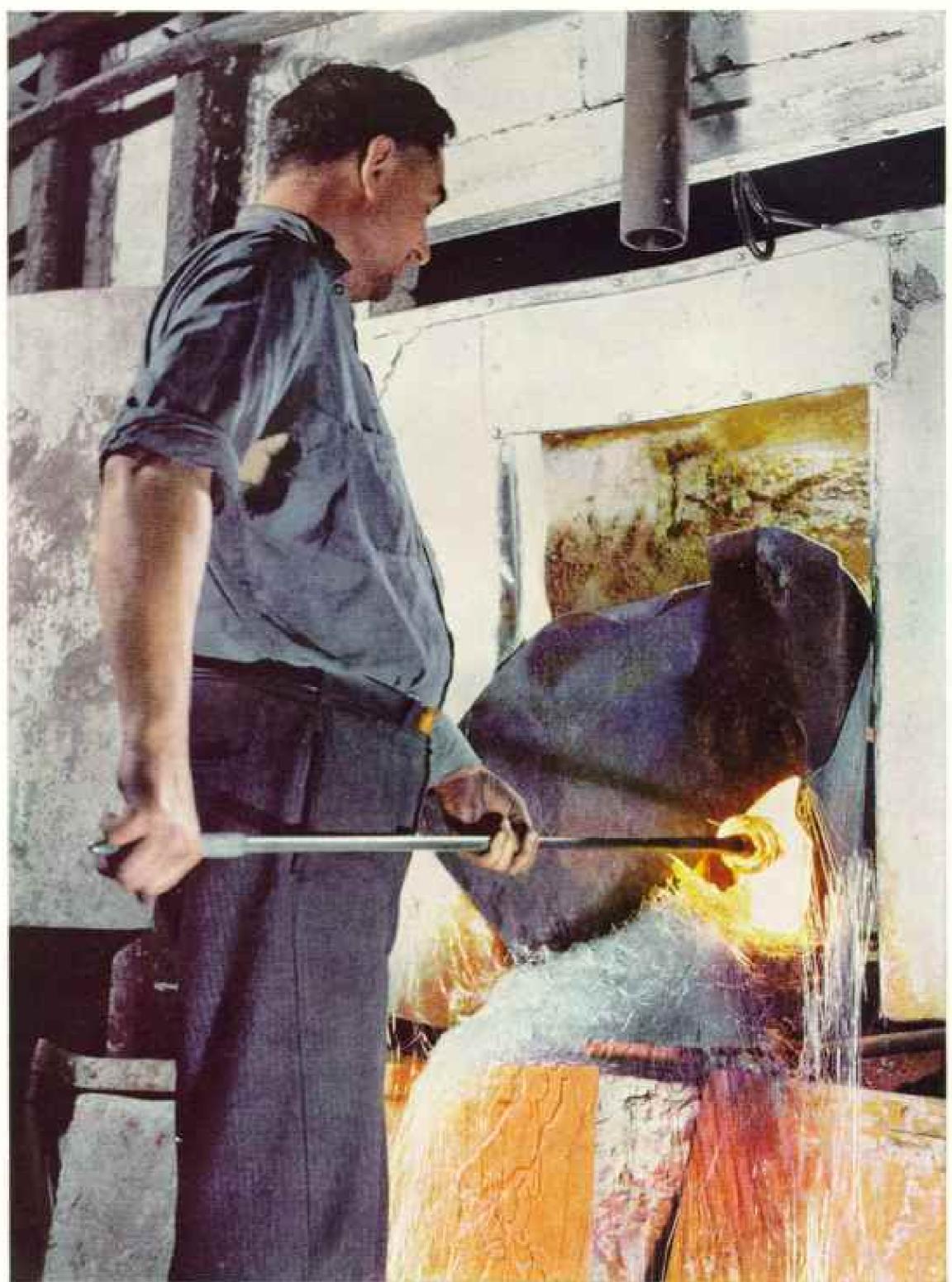
^oFinally I got going. I sent word to Mr. Libbey to come down and see it.

"I remember like it was yesterday. He just stood there and looked. And looked.

"Then, 'Kadow,' he said, 'you built that monstrosity with a quarter million of my money and five years of my time just to turn out a measly ounce-and-a-quarter light bulb!"

"I had to think fast.

"Mr. Libbey,' I said, 'if some folks I know had been alive when God poured this earth out of His furnace He would have been

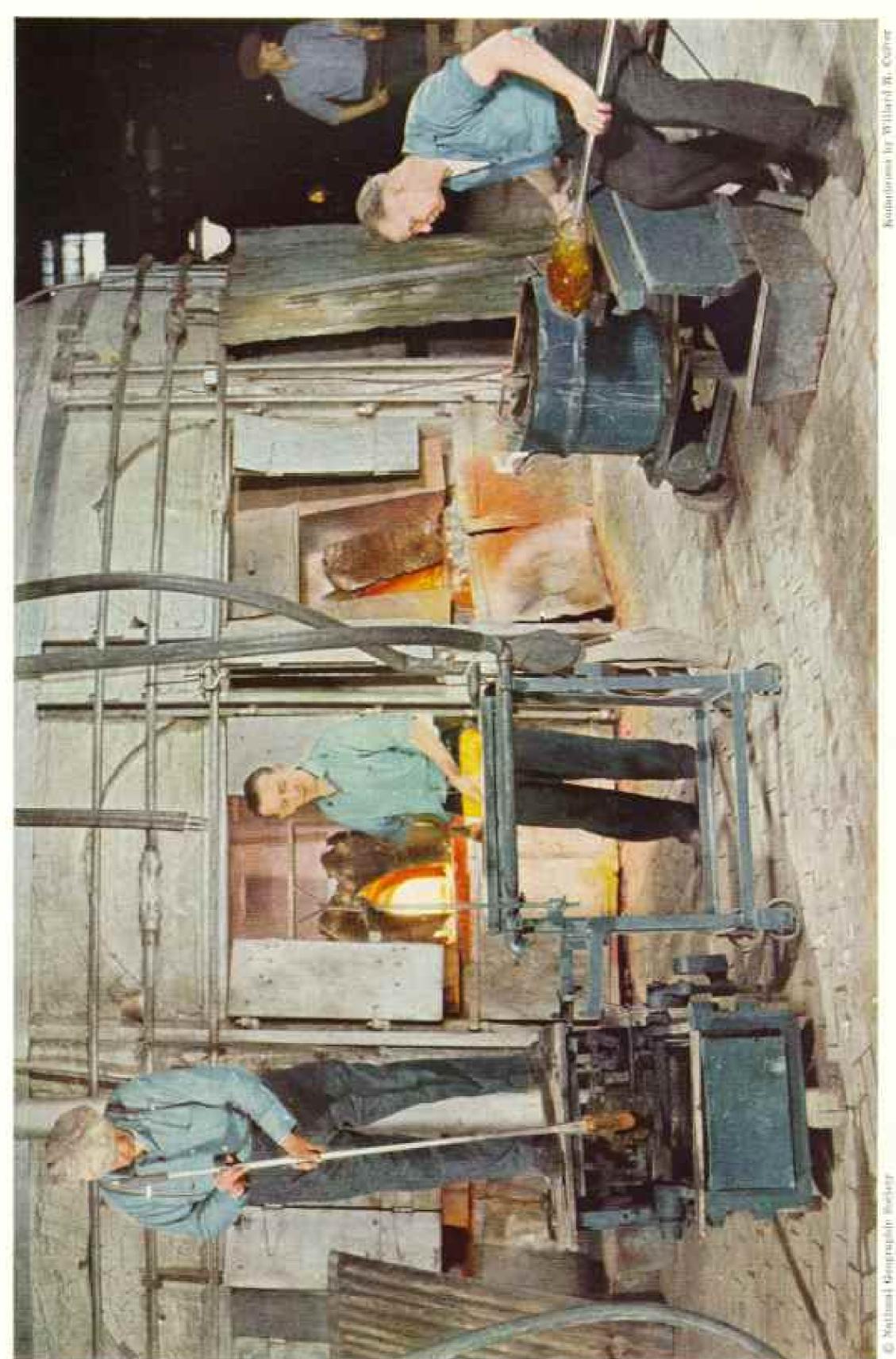


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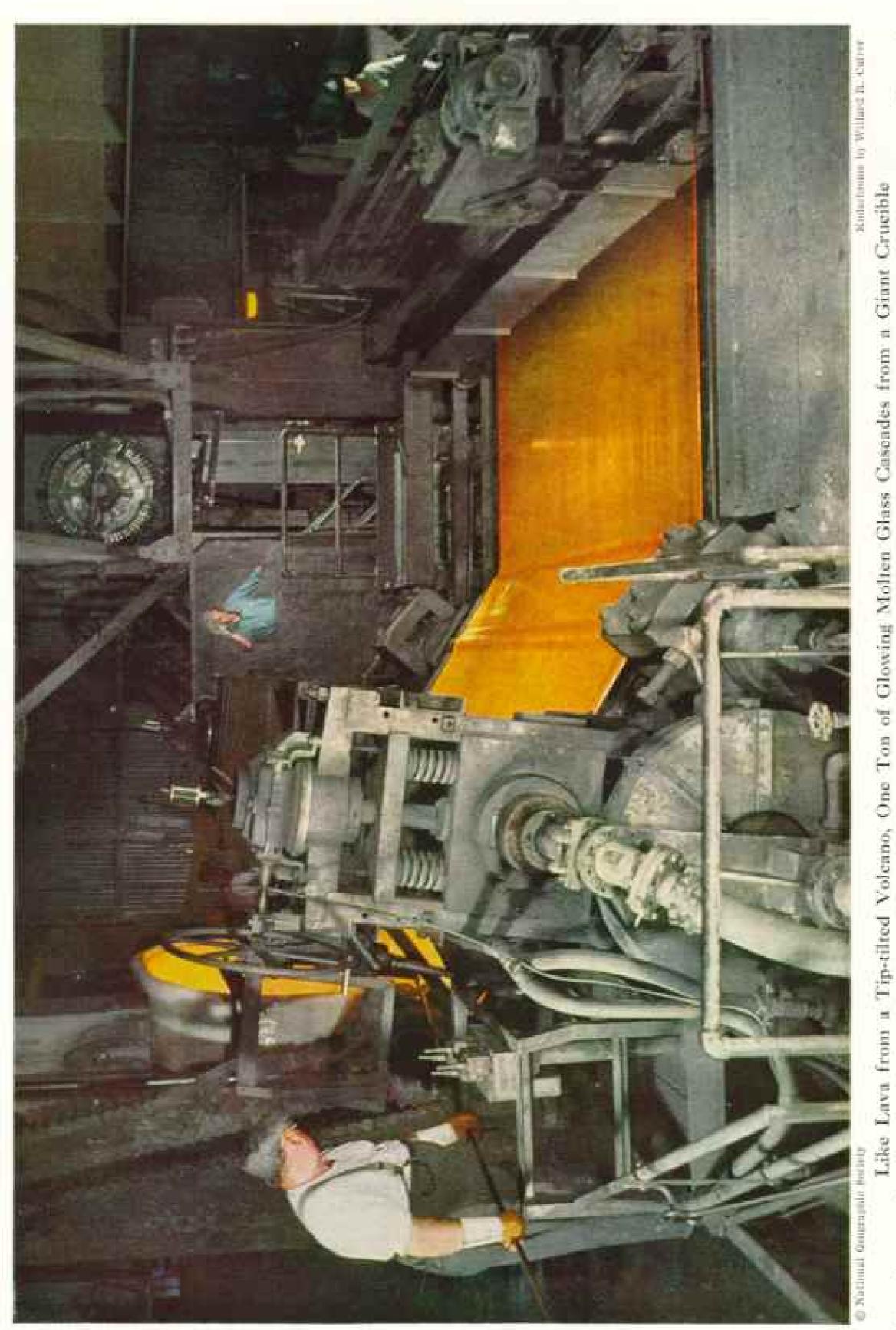
A Gatherer Twirls His Blowpipe to Collect an Embryo Gob of Molten Glass

Sand and other earthy ingredients melt and cool slowly, instead of suddenly as ice does. Therefore these opaque substances may be worked into myriad transparent objects of beauty and utility. Metal shield and air blower above protect the worker's face. Photograph made at the A. H. Helsey and Company plant, Newark, Obio.



Here, at the Libbey Glass Company, the gatherer at the right has taken a big gob for a vase from the fiery lumine. Meanwhile the marver (center) rolls a smaller gob to be blown into a gobiet by the worker at the left who stands in the "pulpit" above his mold. In Such An Offhand Shop Special Glass Pieces Now Are Made as They Were in the Middle Ages

 ${\bf 11}$



From between the rollers the glowing, glassy "syrup" flows forth into an orange curpet on the easting table. It takes 90 minutes to cool it down to a semblance of plate glass. The control man in the blue shirt stands in a cage to serven him from the intense heat.

The National Geographic Magazine



in National Geographic Society

Endactivisse by Willard B. Culter.

Two Kinds of Artists Conspire-and Perspire-to Make Stained-glass Windows

Here in the Boston studio of Charles J. Connick, sheets of glass from a West Virginia plant (Plate V) have been cut from patterns in the charcoal drawing (left). Color selection is guided by the design to the right. This "sermon in glass" will adorn St. Vincent Ferrer's Church, New York City.

From Sand to Seer and Servant of Man



He Sights Glass Sheets Sidewise So You May See Clearly through Your Eyeglasses Faintest trace of "strings" or "seeds" is cause for rejection. Colors are vegetable stains for identification.



C National Geographic Society

Endachtenes by Willard R. Colver

Symphonics of Color Glow through Such Glass As Organs Play and Millions Worship

For cathedrals building in Washington, D. C., New York, and Liverpool today, stained glass is blown in cylinders, just as it was for immortal windows of Chartres, York, and Canterbury. Closed ends are snipped off with hot wire, then the cylinders are cut down the sides, reheated, and flattened to sheet size.



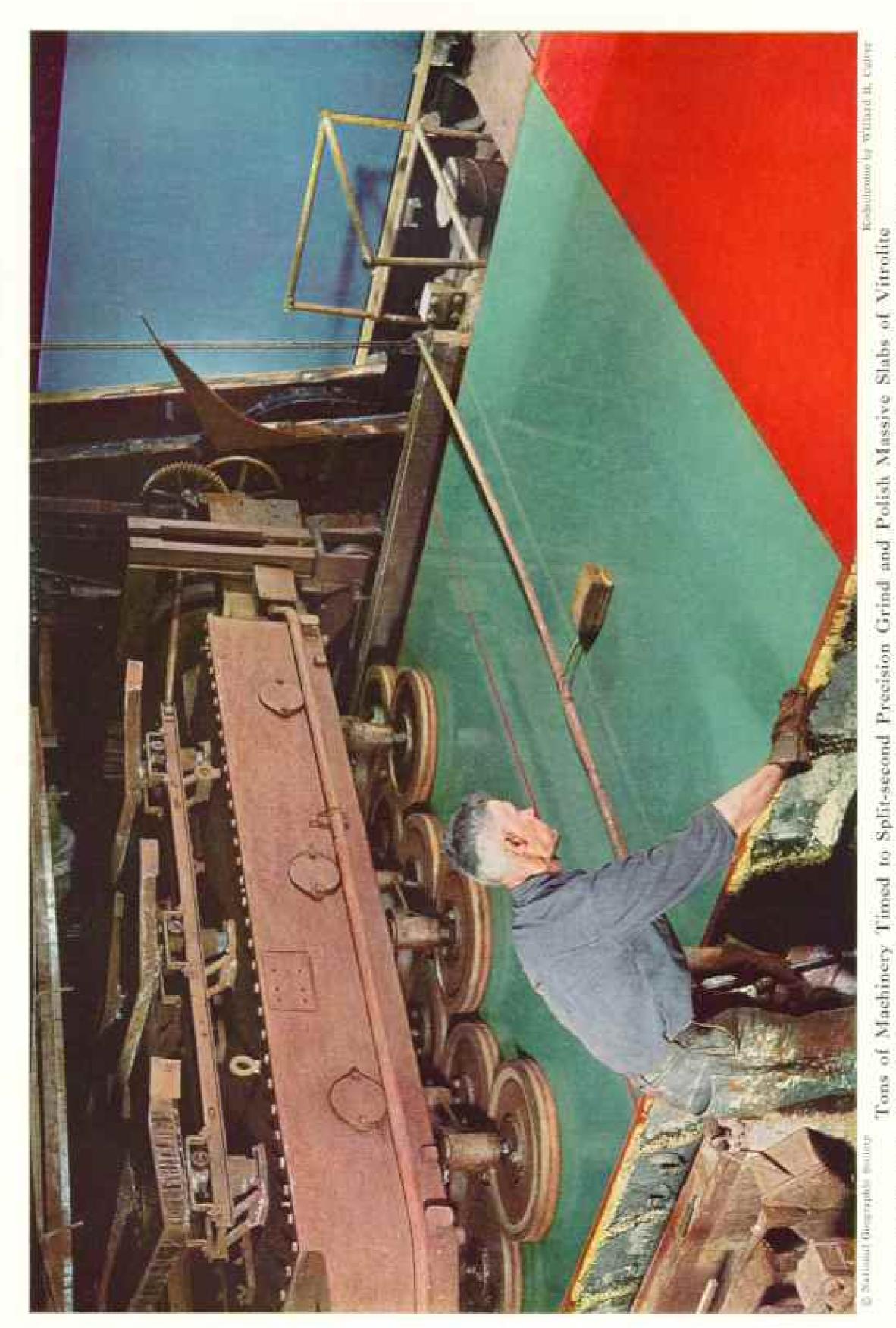
Will Bend Diamonds Cut Glass Glued on Cloth So It

Even the lightest scratch will make the strongest glass break more easily. Here this fact is utilized to cut colored glass with 42 evenly spaced diamonds—worth about \$400—to make Flexglass which will conform to curved surfaces.

Sactories Glass Replaces Metals for Piping in Food I

Company plant, Tomato Juice flows through place pipes at the P. J. Ritter New Jersey, herause ways were developed to make toughed it on location. Afrendy glass plumbing is widely used in do

C NATHORS GROUPERS RECEIPE



Batteries of rotating grinders with iron cores first abraded the surface of this coloriul flat glass. Now whirling felt-faced polishers give it luster. All the while the states of a conductor's watch.

The National Geographic Magazine



From a Bubble of Glass He Shapes a Horn of Plenty

This skilled gaffer elongated and twisted a gob, opened it at one end, and then transferred it from a hollow blowpipe to the punty rod. Seated at his beach be rolls the cornucopia on the "runner."



(5 Postional Geographic Sectory

Reductionnes to Without R. Culter

Hundreds of Ornaments a Minute Drop Off Machines to Hang On Christmas Trees

The worker attaches wire holders to the paper-thin bulbs. First stop for Santa Claus now is this Corning plant at Wellshoro, Pennsylvania. Formerly Germany, Czechoslovakia, and Japan largely supplied the United States.

severely criticized for making such a big planet for a few peewee creatures to rattle around on.

"Mr. Libbey just threw back his head and laughed, and laughed some more. 'Go ahead with it, Kadow,' be told me, and walked away. That's how he was. And I'm still here."

Bottles and Bulbs

Glass bottles and bulbs for electric lights are more closely related than the uses of the products indicate. Essentially, an incandescent lamp is a wire inside a glass bottle.

The "bottle" keeps the electric current from burning out the wire either because it encloses a vacuum wherein no oxygen is available, or inert gases which do not combine with the

tungsten wire.

Watching a machine making the bottles, or blanks, for electric-light bulbs engenders an awe akin to reading God's first utterance in Genesis, "Let there be light." Here glass helps bridge Nature's nightly blackout, and enables man to work, play, and travel any hour of the day.

Comparable with the immortal words of Bell, "Mr. Watson, come here; I want you," and of Morse, "What hath God wrought," is a laconic notation in the Corning Glass Works archives: "We blew a bubble for a man named

Edison.

What a paradox that a nation which grew up successively on wicks burned in dishes of fat, tallow candles, oil lamps, and then flickering gas jets, now finds it troublesome to dim out its cities, highways, and shoreline even briefly for defense!

Even tallow candles, now either archaic or arty, were not widely used until the century

of our country's birth.

Children of today take for granted that light will glow when they press a button. Stories of Lincoln reading by flickering pine logs, and of Calvin Coolidge taking the Presidential oath of office by an oil lamp in his father's Vermont home, seem remote.

Yet only a few years ago on a plane from Trinidad I met a kindly West Virginia glass manufacturer whose principal product was

lamp chimneys.

"Where do you sell them?" I asked.

"Some to the hill folks," he said. "But our big volume goes to the East Side tenements

of New York City."

Such cultural lags are exceptional. Now, into massive tanks pour tons of precisely measured mix, which the alchemy of fire and machinery transmutes into hundreds of electric bulb blanks every minute. Operators have to watch 25 instruments; every half

hour they must note automatic readings constantly recorded on permanent sheets.

Within 20 minutes of the time a ribbon of molten glass enters the machine, the bulb blanks are packed in trays for the racks— 2,500 bulbs to a rack.

For a few days each summer the Corning Glass Works plant at sequestered, elmshaded Wellsboro, Pennsylvania, turns to making enough Christmas-tree ornaments to supply practically the entire United States.

Off the high-speed bulb machines they pour, ten times faster than a spectator can count

(Plate VIII).

In 1937 about 90 percent of all America's tree hangings came from Germany and Czechoslovakia. In 1940 Japan sold us nearly \$117,000 worth. In Europe and Nippon these were handmade with cheap labor.

A small boy would be as thrilled to watch their machine-making as he is by the surprise

tree from which they hang.

A huge tank furnace roars as it "cooks" tens of tons of molten glass at one time. A yellow-white stream tapers out onto an endless belt—a moving ribbon three inches wide and 13,000 miles long.

Compressed air spurting through apertures in the belt converts the glass into a series of red-hot globules. Swiftly these grow longer and begin to cool. Cup-shaped molds automatically fall into position around them. A few more seconds and the glass in each mold is puffed and blown.

After passing through the lengthy lehr, like soap bubbles on a frosted stream, decorating machines take over. Suggesting myriad figures in an incredibly big ballet, they march forward in ranks, halting here and there to jump, turn, glide, and turn handsprings as they are silvered inside, emptied out, then submerged in tanks of dyes.

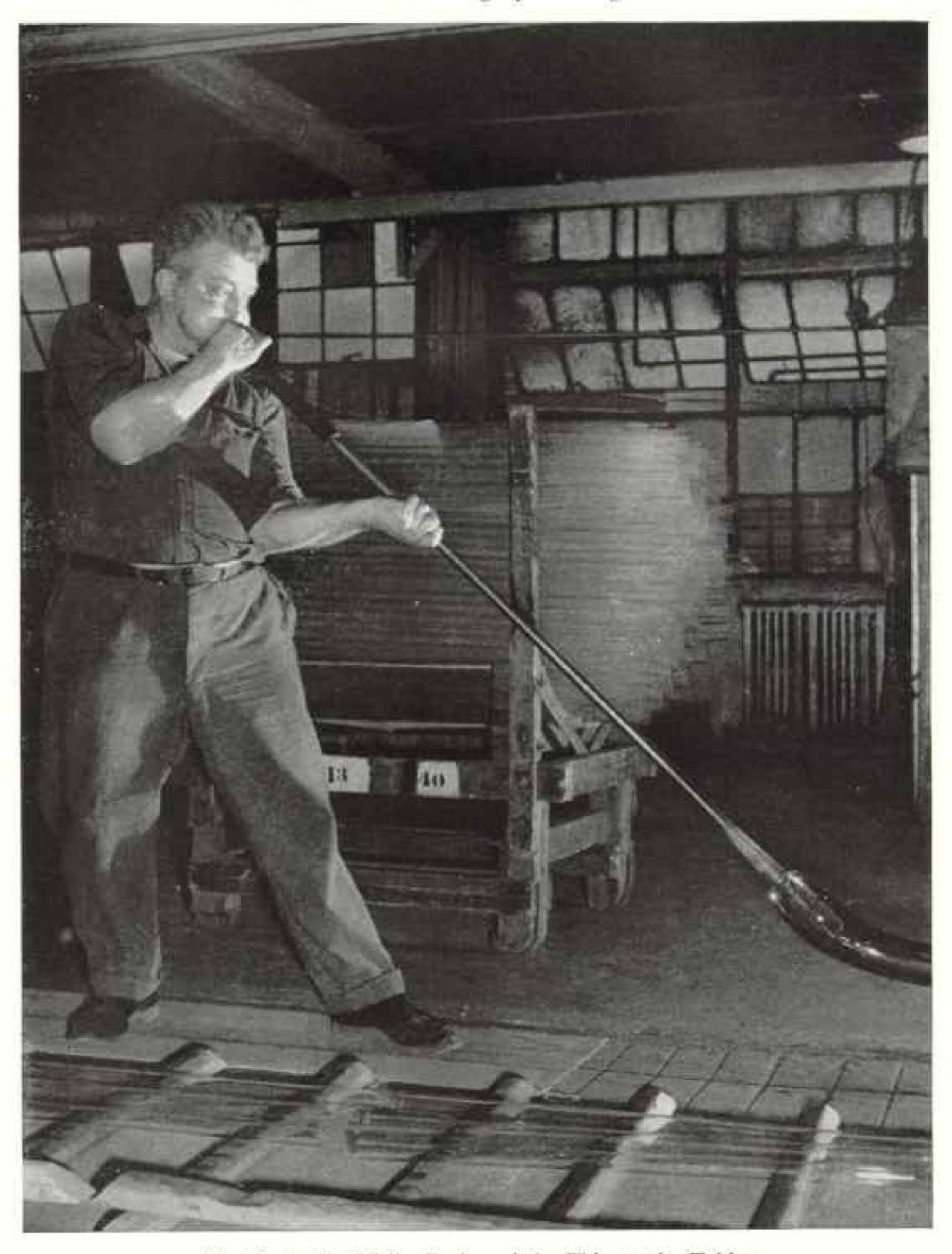
There are only a dozen or so shapes and five colors—red, blue, green, gold, and silver —but combinations of the designs and hues

give the effect of amazing variety.

Then comes the problem of storing the rainbow trinkets until Santa Claus rolls around. All over Tioga County barns and other buildings not needed for war bulge with millions of the cones, star lanterns, bells, red balls, and "diamonds."

"Why, I Never Knew That!"

Defying quantity production even by machines of such high precision is the clinical, or fever, thermometer. Making of this familiar glass product entails the most delicate and complex procedure I saw in the entire industry (Plate XV and pages 28, 29).



The Faster He Walks Backward the Thinner the Tubing

A gob of red-hot glass is attached to a pipe called a punty and held on a cradle. As the blower steps backward at a snail's pace, another worker (not in picture) tans the tube and calipers it for size. Before machinedrawing all glass tubing was hand-drawn; now only special orders are made this way. Light plays ever-changing rainbow tricks on the rack of cooled tubes.

The familiar ally of mothers and medicine, shorter than a fountain pen and no thicker than two matches, requires 105 or more intricate operations, all performed by personal trigger-timing and hairbreadth judgment.

Try asking the first twelve persons you talk with, "Why doesn't the mercury in a fever thermometer drop back until you shake it down?" I did, on a bet, and lost. Gist of all the replies was, "Why, I never thought of that."

At the Taylor Instrument Companies they have letters of complaint, mostly from young mothers, who write that their thermometers are defective because they won't recede even when they put them in the refrigerator!

Of course, if the sprightly quicksilver did drop down to room temperature again as swiftly as it does in other thermometers, a nurse could not chart a patient's fever accurately. It is kept from doing so by a "contraction," which really is a bulge in the bore a double channel when observed under the

microscope.

The mercury column remains stationary at the highest temperature to which it has been exposed after the globules squeeze through the "contraction" for reasons which have to do with the relative energy exerted by surface tension and gravity pull. This highly technical point only a physicist can explain-or understand.

But the veriest layman is thrilled by the acute skill of the workers who blow the contractions into slender tubes with bores that may be only one-twelfth the diameter of a human hair.

A fraction of a second too long over the flame, and the tiny bore closes. An instant too little, and the thermometer would be a "retreater," which means that the mercury would run back into the bulb when exposed

to lower temperature.

Fusing the bulb on the end of a tube is another operation as deft as a surgeon's touch. The tube glows yellow in the tiny point of a blue flame: with a quick, sure motion the worker fuses bulb and tube; a momentary flicker straightens the joint.

Timing Shifts from Split Seconds to Months

After these more than a hundred operations, from laundering the mercury to shakedown tests and certifying baths, the instrument is far from ready for the drugstore shelf.

Nature declines to be hurried about some things. New glass is subject to shrinkage. Especially when, as here, it has been heated and cooled down 16 times, from "cane" to blank.

The manufacturers' time charts jump from split seconds to months.

"Green glass" blanks, not yet marked, must be stored in vaults for four months or longer. There the bulb shrinks rapidly at first, then more and more slowly. Not until such seasoning can the thermometer be calibrated precisely for the final scale which indicates body temperature.

All these steps in making a clinical thermometer start with the "canes," or tubing,

which is manufactured elsewhere.

As passengers speed by the Corning Glass Works plant in New York State, they often ask trainmen about a tall structure that looks like a cathedral tower. That is where much thermometer tubing is born (pages 28, 29).

Your delicate bedside thermometer starts as a huge embryo gob of glass, gathered by hand and drawn up inside this shaft as high as 160 feet. In the composite gob already are the clear glass, the white background, the red stripe, even the bore through the center.

As the tubing is drawn vertically, the bore gets smaller and smaller, till it is scarcely visible to the naked eye. Lengths of such tubing, or canes, are packed like magnified straws in a giant soda-fountain container and shipped to the thermometer maker.

Measuring the Make-up of Air

When Torricelli concluded that air must have weight and devised his crude barometer. and his immortal master, Galileo, constructed the first thermometer by sticking a tube from which air had been expelled into a vessel of water, they could not have dreamed of the myriad applications of their inventions.

The Taylor Instrument Companies alone make some 8,000 articles having to do with measurements of temperature, air pressure,

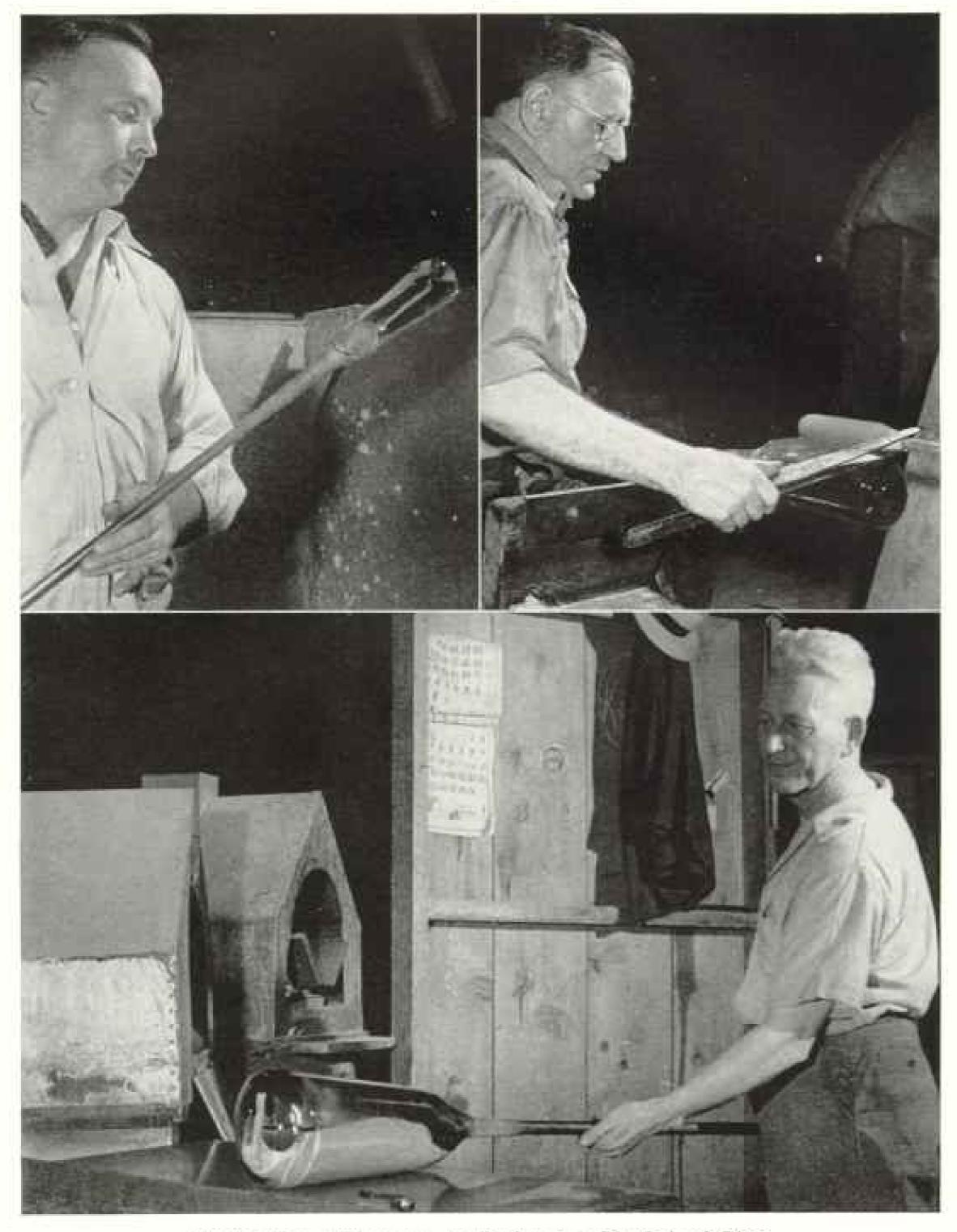
and humidity.

Suppose some super-saboteur smashed all thermometers, barometers, and other glass gauges in the United States. Then factory boilers would burst, bakeries and dairies would halt their flow of loaves and milk, industry would shut down, glass itself could not be made.

From bathing babies to melting gum, canning tomatoes, boiling oil, forecasting weather, airconditioning theaters, tempering steel, or making cakes, precise temperature measurement and control are vital.

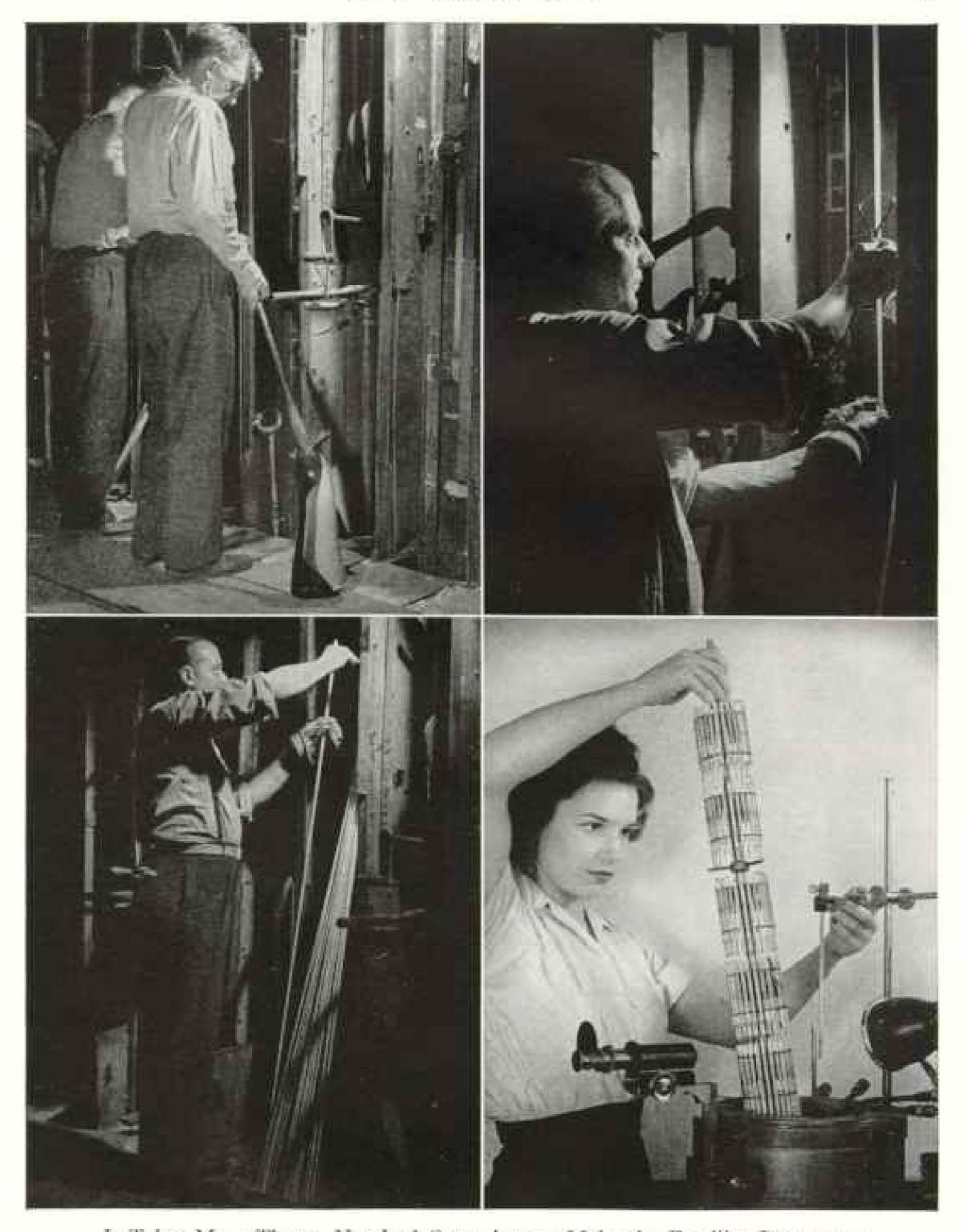
Thermometers for vats may be 12 feet long; one which hospital patients swallow is one inch long.

Recently a meat-packing plant made a count of all the instruments it used; there were more than 5,000 thermometers alone.



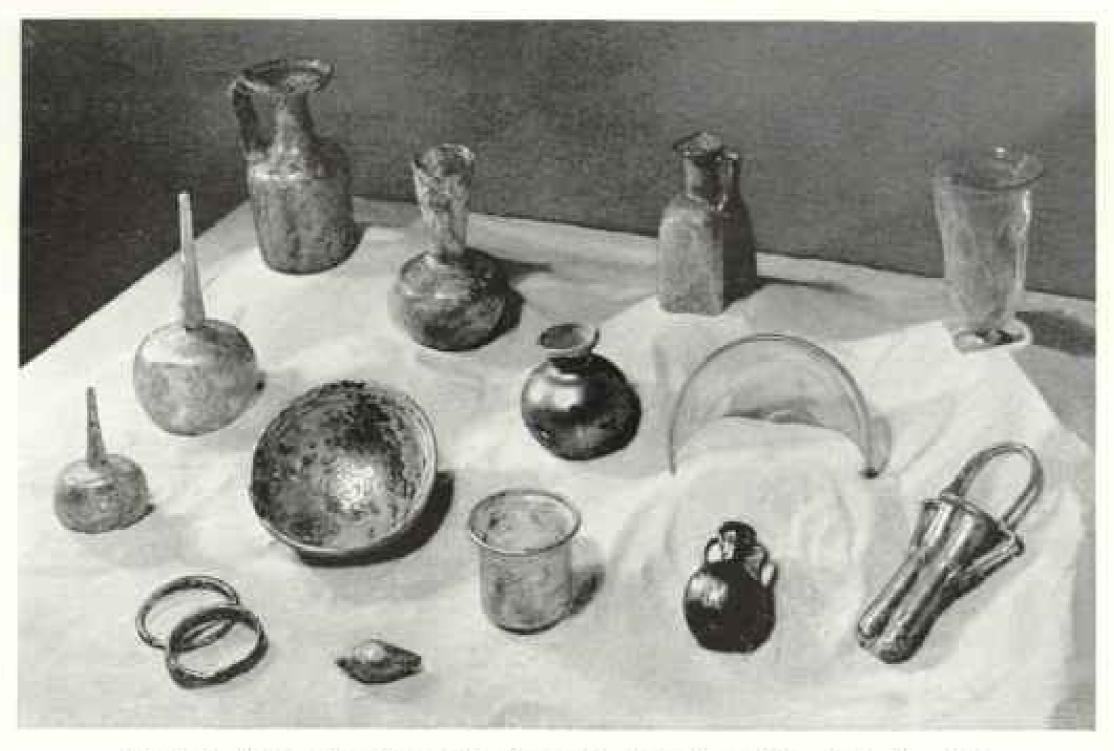
A Tiny Fever Thermometer Begins as a Big Gob of Glass

First the operator works the hot glass with metal jacks to distribute the bubble which will become a bore only a fraction as thick as a human hair (upper left). A strip of opaque white glass is applied to be the hackground for the mercury column (upper right). The glass is reheated, rolled, and then placed in a V-shaped die at workman's right, where magnifying lens is formed (lower). First six pictures in series were taken at Corning Glass Works; the seventh at the Taylor Instrument Companies plant (pages 25, 26).



It Takes More Than a Hundred Operations to Make the Familiar Instrument

The hot, taffylike gob is anchored at its thick end in a draw-up machine and the blowplpe attached to a cable. This electric draw machine pulls the glass 150 feet or more high and forms the tube for the thermometer maker (upper left). As drawing progresses the tubing is measured with calipers (upper right). Tubing is cut into six-foot lengths (lower left). Held in a circular rack, thermometers are immersed in an electrically heated both to locate position of scale before graduating (lower right).



Boudoir Accessories Show the Cosmetic Urge Was Rife Centuries Ago

Long-necked Ambic perfume sprinklers (left) are early examples of nonrefillable bottles. Remans made glass bracelets a thousand years before modern costume jewelers designed them to replace priority metals. Before the Battle of Marathon some Syrian siren used the double "unguentarium" (right) to apply red to her lips and black to her eyebrows with metal and glass rods. Bowl, ewer, goblet, stopper, jar-all show iridescence enhanced by chemical action on the impurities in this ancient glass now exhibited in the Toledo, Ohio, Museum of Art (Plate XI and page 8).

The glass industry itself affords plentiful examples of precise temperature control. At the Owens-Illinois laboratories there is an intricate machine to measure the viscosity, or fluidity, of glass, and thus determine exact blowing temperatures. Two years went into the development of this one massive instrument, in which radio tubes are used to achieve minute measurements.

Such precision is demanded in making bottles—containers as familiar as paper bags because each kind of the almost infinite varieties must be fabricated within a narrow temperature range.

The industry can afford to spend tens of thousands of dollars to perfect bottle-making, since the 450 million milk bottles the United States blows annually have an estimated value of more than 13 million dollars.

Mountains of Sand for Milk Bottles

To make that many milk bottles requires at least 400,000 tons of sand, soda ash, limestone, and other raw materials—a mountain of earth stuff that outweighs Uncle Sam's 11 biggest battleships. From now on there will be fewer kinds, but better bottles.

Already familiar are the new streamlined milk bottles. These are beralded as marking the first fundamental change in milk containers in fifty years. The new "stylish stout" is nearly one-fourth lighter than the old, an inch shorter, yet stronger.

A quarter of a century ago the average life of a milk bottle was 20 to 22 trips. Now they make from 50 to 60 trips. That longer life is equivalent to making three times as many bottles.

Examine an old-type bottle and note the heavy glass around the bottom edge. New containers—whether for milk, fruits, or coffee—curve in at the bottom where bumps and consequent breaks mostly occur.

The bottle that would be strongest and hold most for the material used in it would be a sphere. New bottles approach that form as nearly as need for bottoms and necks permits.

Reams of reports estimate capping economies of the smaller opening, durability because of the more even distribution of glass, efficiency in the filling line, space-saving in



Women Make Acres of Sandwiches-Not of Ham on Rye, But of Plastic on Glass

Such laminated glass consists of a transparent plastic sandwiched between two or more panes of plate glass. Formerly the entire output of Libbey-Owens-Ford safety glass was for automobile windshields and side windows. Now it goes into jeeps, planes, tanks, and other military vehicles. When broken, the shattered places cling to the plastic, instead of flying out and cutting the motorist. Workers must wear smocks and forego nail polish lest lint or chips contaminate the "sandwich."

storage, etc. Computations even show that a dairy route man delivering 300 quarts daily would lift 600 pounds less weight in handling the new bottles.

All through the industry you hear about the new "economy containers" worked out with the U. S. Department of Agriculture.

These are the dozen jars and half a dozen bottles which henceforth will contain such varied commodities as jellies, baby food, vinegar, vegetables, mustard, toilet water, salad oil, peanut butter, and hundreds more.

For the duration the maker of a new fruit juice or a different pickle assortment may not order specially designed bottles. This prohibition will be a loss to the glass blowers' art, but will effect enormous savings.

The food packer may identify his product by a label, but the bottle machines will roll along 24 hours a day with fewer stops for changeover, use 30 percent less glass, and save the money and metals tied up in fancy molds.

Controlling the Way Glass Will Break

Most familiar of all glass utensils, the turnbler or drinking glass, illustrates another uncanny trick of glass scientists. Glassmakers can control the way glass will break—into big pieces, little pieces, squares, lengths, or powder.

Tempered plate glass pulverizes into bits tinier than the grains of sand that helped make them. Laminated, or sandwich glass, for automobile windshields and side windows when broken adheres to an inner layer of plastic. These properties have saved countless lacerations and made closed cars immeasurably safer.

Such glass can be too tough. It should shatter before the human skull fractures. Actually, physicists have tested safety glass with "fresh skulls" from morgues to determine the impact which will break the glass and not the skull. Moreover, if one is trapped in an overturned car, the occupant should be able to smash the glass and escape.

However, one would not wish a drinking glass—or a jar, water bottle, or pitcher—to pulverize on the kitchen floor. It would be hard to clean up and the powdery glass might get into food. So containers are made to break into big pieces.

"Why can't they make tumblers so they won't break at all?" immediately asks the



A Glassmaker Blows and "Fingers" His Blowpipe with the Artistry of a Trumpet Player

"He's a blow-hard" was a compliment among old-time glass men. Such workers developed a "character face" which appears often in old prints, paintings, and etchings of glassmakers. Now the type is disappearing. The modern blower uses an airline within easy reach of his bench for blowing and cooling.

housewife who has heard of the new tougher glass.

They can, and do, but such pieces are still very expensive. What they do at one plant is to make tableware which will stand a drop of at least nine feet.

"Why nine feet?" I asked.

"Because that is about as high as the average person can reach, so shelves are usually not much higher than that."

"If you were making glasses to export to Japan, you would not have to make them quite so strong," I suggested.

"Right. And if we sold to a tribe of giants we would strengthen them."

Already glasses are being made to withstand much harder impacts than a nine-foot fall. The Army uses millions of them to replace tin cups. Hotels buy them to withstand dishwashing machines.

Here again it is not only the bumps and falls that must be taken into account, but sudden immersion into hot and cold water. You can heat one brand of borosilicate glass till it glows red, then drop it into ice water, and it won't break, In one recent year about 25% million tons of sand were used to produce more than 5 million tons of glass of all kinds (page 6).

Less than one-tenth of one percent of all that glass, by weight, went into optical instruments, including lenses for eyeglasses (which the trade knows as ophthalmic lenses).

Eyepiece of the Invisible World

Other glass products are useful to man. But it is this decimal fraction that enables him to focus on small print, on stars millions of light years away, on bacteria that strike men down in deadlier totals than all the hazards of auto traffic, train wrecks, or industrial accidents.

Optical glass is the eyepiece of man's culture. Without the microscope, pathologists say, vast areas would at times have been virtually depopulated of all humans.

Trickiest of all glass to make is optical glass, since here the manufacturer is dealing with wave lengths of light which can be measured only in millionths of an inch.

It has been said there are only a dozen men in the United States who comprehend the higher mathematics and the theory of some



Form and Color of Fragile Flowers Are "Frozen" in Glass for the Duration of Time

For nearly 50 years Leopold and Rudolph Blaschka worked in their studio near Dresden, Germany, to record flowering plants in enduring glass. Now they make up the Ware Collection at the Botanical Museum of Harvard University. Specimens illustrating 164 families not only are things of beauty, but are scientifically correct. One group of models shows the relation of insects to transference of pollen. The large white blossoms are phlox; others in this glass bouquet are mignonette, forget-me-nots, and a grass.

intricate optical instruments which industry, and now the armed forces, are using. So there is little use for the layman to try. But he can take pride in what America has accomplished.

Before the first World War, many kinds of optical glass came only from Germany. Uncle Sam now is independent of foreign optical glass, and has added some varieties of his own.

Forego discussion of refractive indices and ratios of dispersion, concavity and convexity, and the principle of optical glass, if not its bewildering applications, is simple.

Prime purpose of all optical glass is to bend light the way you want it.

When light strikes glass it travels from a lighter medium, air, through a denser medium, glass, and slows down. If light strikes glass obliquely, the light bends.

Moreover, each color ray bends at a slightly different angle, scaling down from the big bend the violet rays make to the lesser bend of the red rays at the other end of the scale. Ancients suspected the first principle; Newton proclaimed the second. Ever since, glassmakers have sought to make glass to utilize these principles effectively.

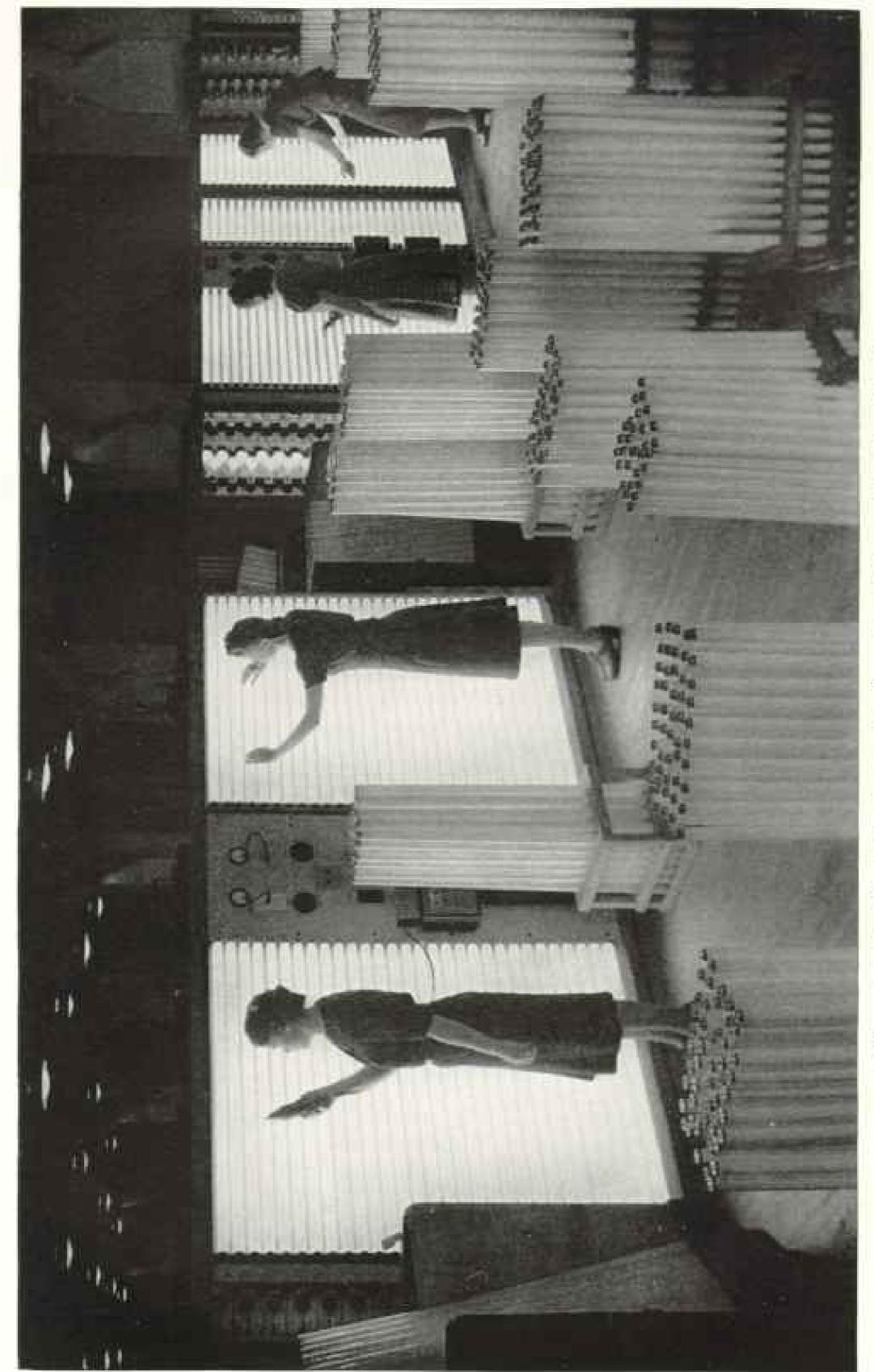
Spectrographs are G-men of the hundreds of optical instruments with strange, polysyllabic names.

Sifting Secrets of Stars, Dust, Crimes

Newton's discovery that a beam of light could be separated by means of a prism into bands of violet, indigo, blue, green, yellow, orange, and red has been applied to study the physical world from the constitution of a star to the make-up of dust particles and the detection of crime.

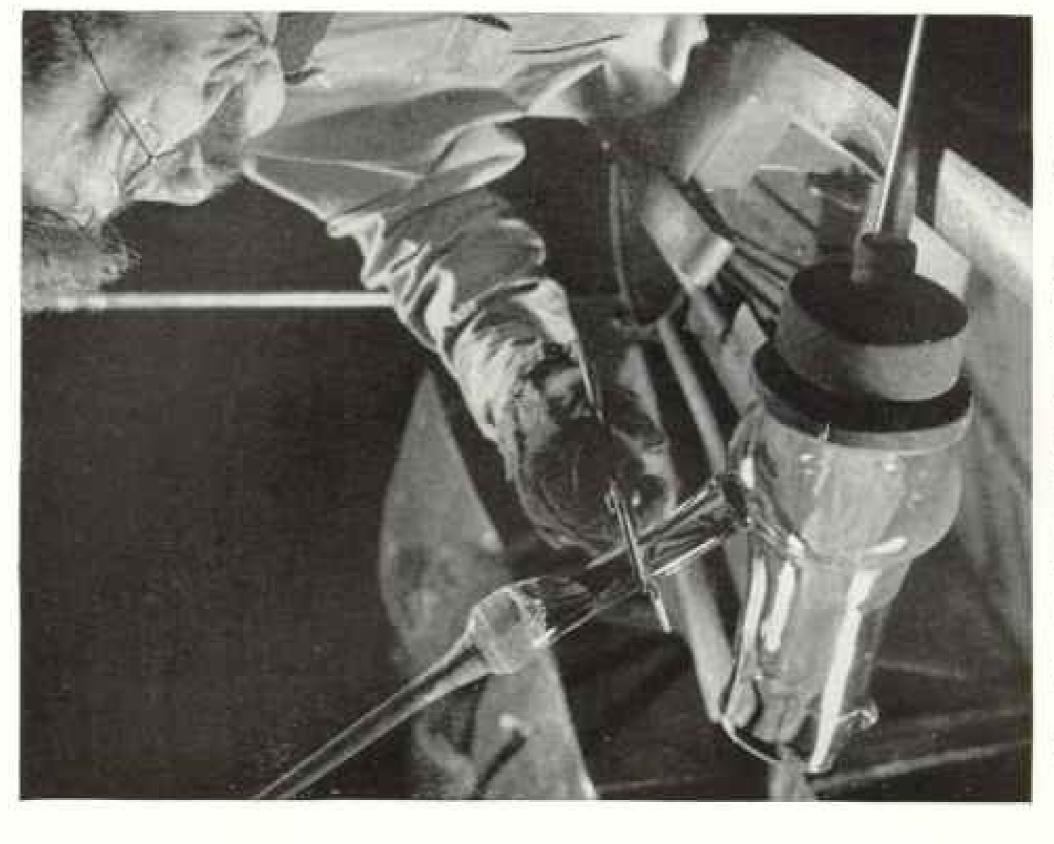
By the spectrograph men discerned elements in the stars before tangible traces of those elements were located on earth. "Spotting" helium on the sun is one example.

FBI used the instrument to prove that a pocketknife found on a burglary suspect was used at the scene of the crime to cut telephone wires. The detective spectrograph re-



Was Devised to Save Electricity and to Save the Eyes Fluorescent Lighting

Glass for the "envelopes" of General Electric's fluorescent lamps is drawn from melting furnaces in continuous tubing. Here final inspection is being made of "bulbs" cut to specified lengths, coated inside with fluorescent powder, and filled with mercury vapor. The vapor takes the place of filament wire in ordinary incandescent bulbs.

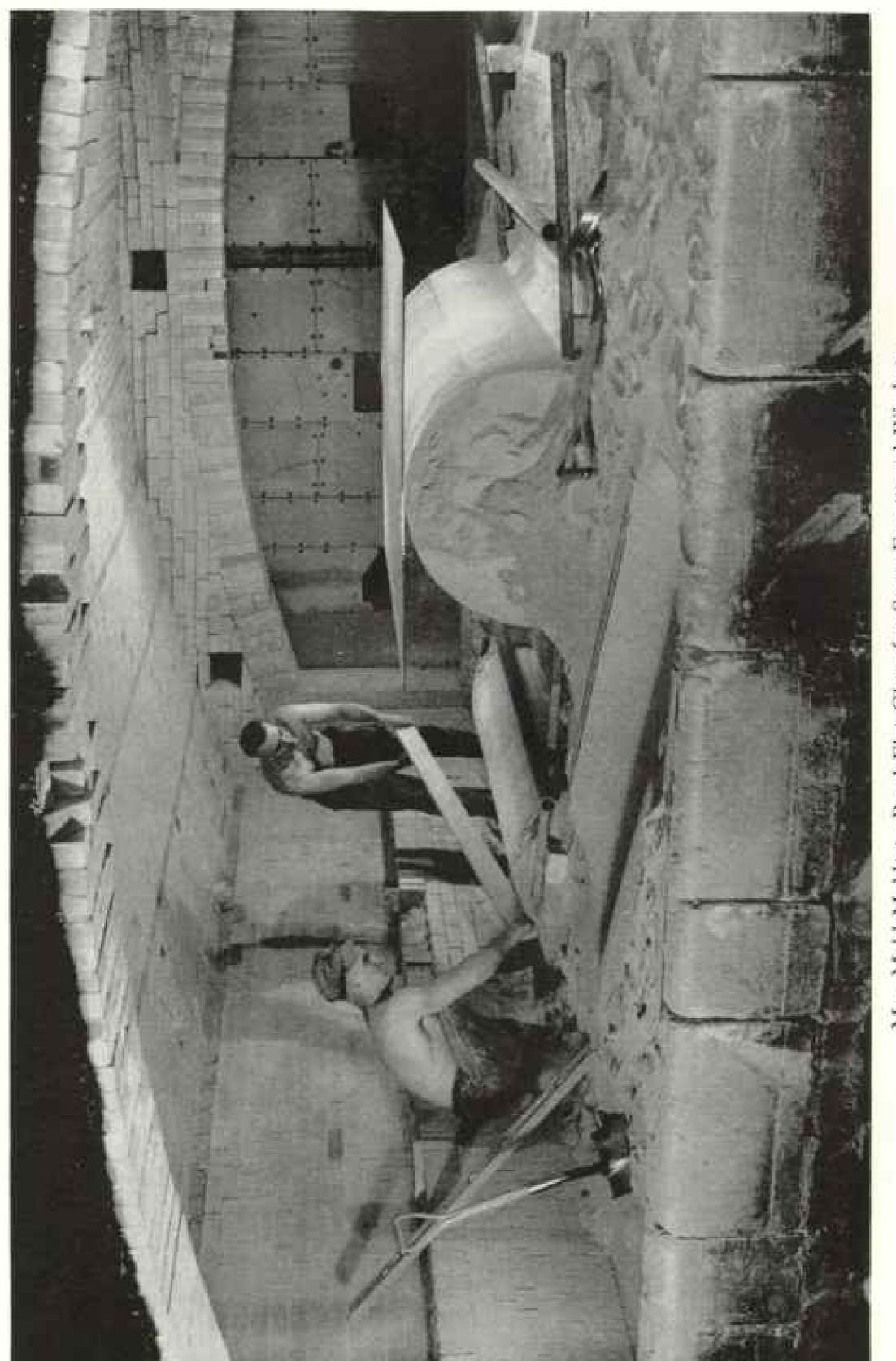


Many Mirrors Mirror the Barchand Stage in the Making of Quality Mirrors

No machine has yet doplicated the sensitive caress needed for detecting foreign particles and giving the final polish. The worker first powders his palm with flourlike purnice. The mirror maker aims at perfect reflection by backing up perfectly transparent glass with a perfectly opaque material,

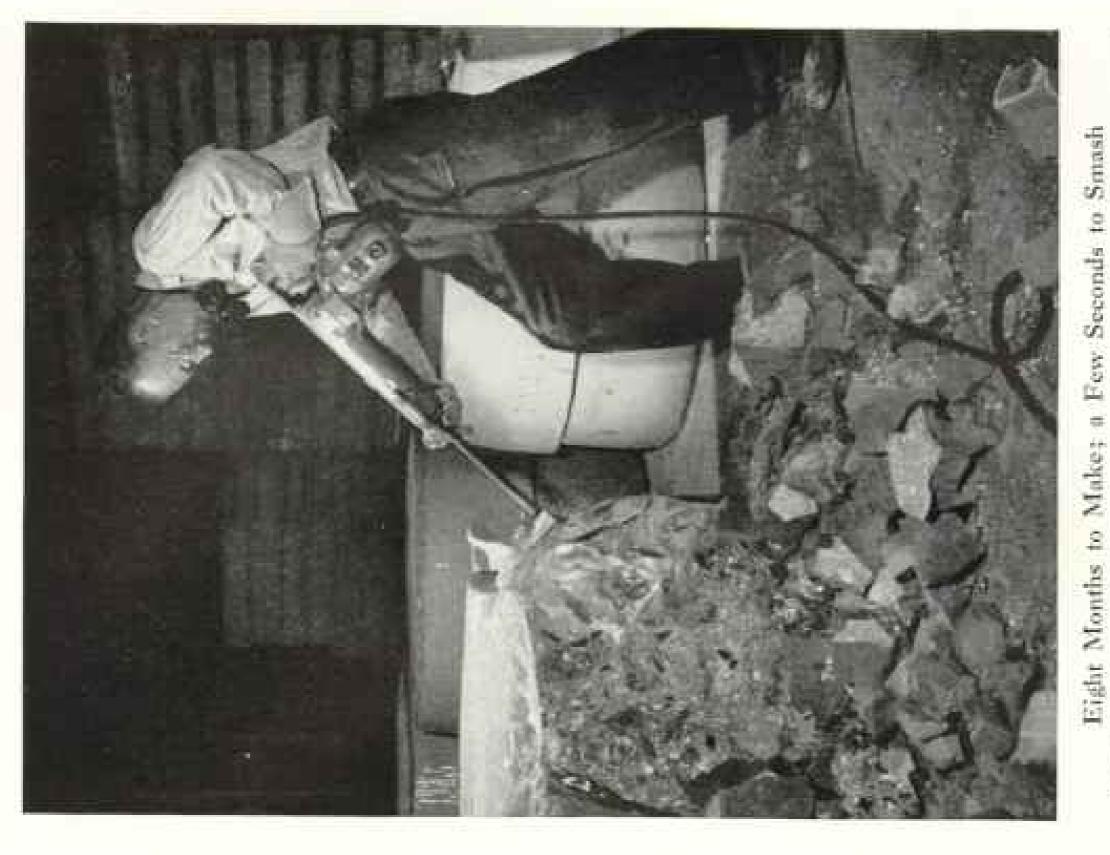
Glass Must Be in the "Taffy State"-1,200 to 1,500 Degrees Hot-To Be Cut with Scissors

A skilled finisher of A. H. Heisey and Company "rolls" a pitcher on his chair arm. At the right moment a gathorer seizes a gob from the "glory hole" (smaller furnace door) and attaches it to the side of the pitcher, The finisher shears and shapes it into a handle,



Men Mold Molds to Bend Flat Glass for Store Fronts and Windows

Special sand is used to build each kind of mold in this furnace. Glass being placed on top of the center mold will be heated to the exact temperature at which pull it downward to the curved contour. In the smaller molds the heated glass sinks from the center as it bends. Much curved glass is used for familianted aircraft safety glass, but Libbey-Owens-Ford produces such glass by a new method which makes it possible to bend many panes simultaneously.

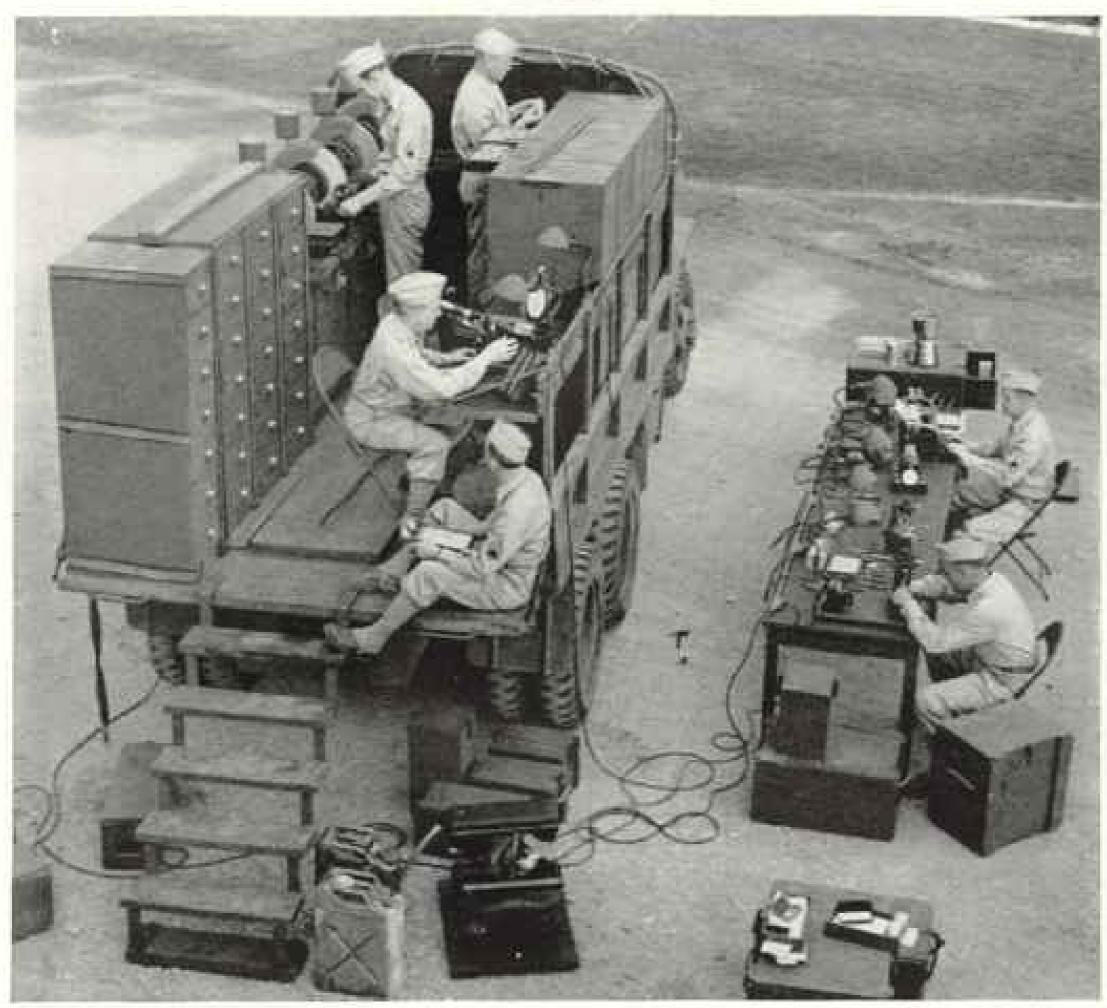


in the World Through Such Lenses Pass the Most Beautiful Girls

A Bausch and Lomb technician measures thickness and spacing of four to eight parts for completed motion picture projection lenses (left) to within two thousandths of an inch. Each part of a lens removes some distortion; some lenses are more highly corrected than the himma eye,

blanks for lenses of telescopes, microscopes, range finders, etc. (page 33).

For optical glass pots, choice clays from six different States first were ground into fine dust, then a magnetic separator extracted the iron. Clays are mixed like dough and aged before molding. The chunks of glass are made into



W. R. Amer Blanck Corpo

Spectacle Shops on Wheels Accompany American Troops Overseas

When soldiers shatter their eyeglasses in battle, they can rush back for a new pair and again identify friend and foe. An estimated 15 percent of Army personnel now wears glasses. This mobile unit carries optical machinery, 36,000 lenses, and thousands of frames and spectacle cases. It was designed by the American Optical Company to serve a field army of as many men as the entire population of Atlanta, Georgia.

vealed copper and tin on the knife blade; telephone cable also contained both.

State and city police have employed the same optical sleuth in many hit-and-run cases where traces of paint from the victim's car were found on the miscreant's fender. Recently homemade bombs have been traced to their makers by the telltale spectrograph.

Seeing a Flea as Big as an Elephant

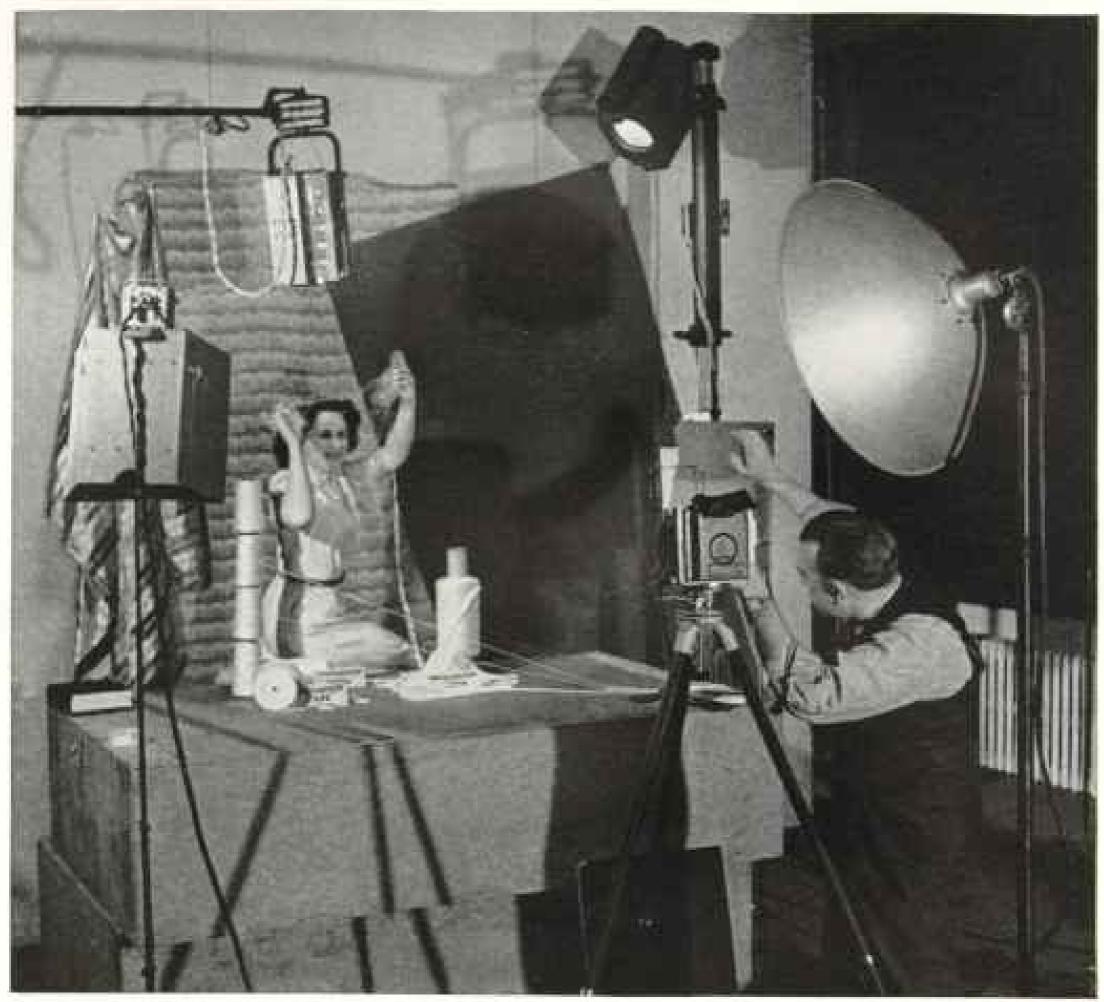
Obviously, what the optical instrument designer demands first is glass that is highly transparent, which is easier said than done. Also, the glass must be free from color, from internal strains and stresses, and from the waves, feathers, and lines which can easily be discerned in old window glass. For many purposes it must withstand exposure to weather changes, chemical deterioration, and impact.

With glass of highest obtainable transparency and even structure ("homogeneity" is the glassmakers' word for it), the next step is to curve it precisely.

Only by exact curvature can light be bent so the beholder is able to see a flea as big as an elephant, or vice versa, without distorting the objects.

Making such glass begins with making the pots to melt the ingredients. That takes from six to eight months.

Special clays for Bausch & Lomb pots come from six different States. These are used in a precisely proportioned mix of kaolin, ball clay, and burned clay—all free from such



Staff Pleitigrapher Lain Marden

Two Pictures in One Make a Geographic Color Photograph

For Color Plate IX marbles from which glass thread is drawn were photographed close up, natural size. Then, as shown here, model, spools, and fabrics were photographed on the same color film. Timing and register, or placing of the images, had to be exact.

impurities as iron and sulphur. Fine feldspar rock may be added, so that when the pot is heated to 2,600 degrees Fahrenheit, it will have a close texture to prevent corrosion by the molten glass.

There are days of air-drying under controlled humidity, testing under rising temperatures, inspections, etc., before the pot is ready for its more days of gradual heating to receive its precious batch.

After all that care the pot is used only once, For optical glass is not poured, as is other glass. The pot is cooled slowly—about 3 days for a 36-inch pot—then the expensive vessel is cracked away, leaving chunks of glass to work with (page 37).

Key man of the plant is the chemist who mixes the batch for "cooking." Purest sand is required—especially sand which is free from ubiquitous iron, bugaboo of the glassmaker. Iron gives a greenish tint which one may see by looking lengthwise through some window glass.

Highest percentage of iron in most optical glass is .0172, which is to say that 17 bad grains of sand in 100,000 is too many. It is as if a fruit grower had to throw away a carload of 100,000 oranges if 17 were spoiled.

Big Pantry Shelves for Glass "Cooking"

There are many more ingredients in optical glass than the usual sand, lime, and soda. Lead, barium, zinc, zirconium, antimony, and scores of other substances are mixed in, depending upon the peculiar properties desired.

Bausch & Lomb makes more than 50 kinds

of optical glass for use in 4,000 instruments.

More spectacular to watch, from hery furnace to nosepiece, is the making of spectacle lenses, for ophthalmic glass is poured molten white from the pot onto a metal table where it cools off to red hot, then lightens to glassy semblance as it is rolled into sheets of required thickness.

These sheets are measured, cut, inspected, and automatically weighed for the pressing room, where the pieces are reheated and given their first form.

The grinding room is the dizziest motion picture of the glass industry. One grows seasick watching row upon row of gyrating machines pitching and tossing what look like shells of a thousand turtles. The restive objects are lens blanks mounted in hot pitch on an iron block of prescribed curvature with a corresponding shell.

Rouge Makes Many Passes at Girls Who Wear Glasses

In the polishing room the annoying iron which was so painstakingly banished from the glass literally thumbs the nose of the lenses. For there a rouge, chemically like iron rust, polishes the ground lenses.

A young woman touches up her cheeks with rouge from a compact; on her eyeglasses similar rouge has been applied with a tool impregnated with wax which must be washed every time it is used.

Bifocal lenses afford one example of why glass of special qualities is required for specific uses. Fused bifocals are made of two types of glass, having different refractive indices. Yet each glass must have the same coefficient of expansion at all stages of heating and reheating, and also when completed for wearing.

One type of bifocals requires 62 different operations by 62 different persons and 26 different machines. Such refinements would have baffled even Benjamin Franklin, who is credited with first wearing bifocals.

Some spectacle frames have from 20 to 25 units, and these require upwards of 500 operations for their manufacture and assembly.

If your optician has to send away for lenses to fill an out-of-the-ordinary prescription, that is not surprising. He can scarcely carry 26,336 varieties of lenses in stock, as one big manufacturer does.

Every person's eyes are different, as are thumbprints. So even the maker of lenses often is called upon for specials for extraordinary cases,

William Caxton, the Wright brothers, and

the Industrial Revolution brought new demands on the human eye by their contributions to printing, flying, and precision machinery.

Constant eye research brings new problems for the makers of ophthalmic glass.

Take aniseikonia, new word for a recently discovered eye defect. Aniseikonia is present when images from the two eyes, as interpreted by the brain, are unequal. Airplane pilots and motorists so afflicted are a menace to themselves and others.

To detect and measure uniselkonia scientists of the American Optical Company and Dartmouth Eye Institute developed an instrument called the Eikonometer, which literally reads unequal images formed inside the brain. Then it was necessary to devise a new type of "tailor-made" lens to produce equal images in both eyes.

Mention was made of the mathematics of optics.

One investigator estimated that in a normal lifetime the average American reads 210 million words, the equivalent of some 4,200 standard-length novels.

0.000,000,000,000,000,000,075 Horsepower

A third determined that the amount of energy required to excite the retina is equivalent to that which would raise the temperature of one-fifteenth of an ounce of water to 1 degree, Fahrenhelt, if continuously expended for 60 million years.

Such tenuous calculations have no particular application; they are just the daydream doodling of men who grind lens surfaces for highly practical uses down to an accuracy of six millionths of an inch.

Eight thousand words, and the epic story of glass gone to war is yet to be written! Wisely, the censor will not let it be told now.

Glass is vital to World War II, as never before in the ageless history of wars.

Withdraw glass and all airplanes would be grounded, radios silenced, lighthouses and beacons blinded, aerial mapping stopped. Trains would grind to a standstill, cameras would cease to click, ships would drift into port if they found their way there, big guns would be aimless.

Numerous new applications of glass in wartime will be adapted in startling ways to peace pursuits when the war is won.



() Nathurd Geographic Society

Rededitions by Willand R. Cultur.

Cocoon of Silklike Glass Fiber Is a Marble Which Yields 98 Miles of Filament

Carloads of these flexible fibers are banded into retainer mats for storage batteries. Tons of yarn go into insulation for wires, cables, generators, and other electrical equipment. Weaving of glass tablecloths, neckties, draperies, and shower curtains is halted for the duration.



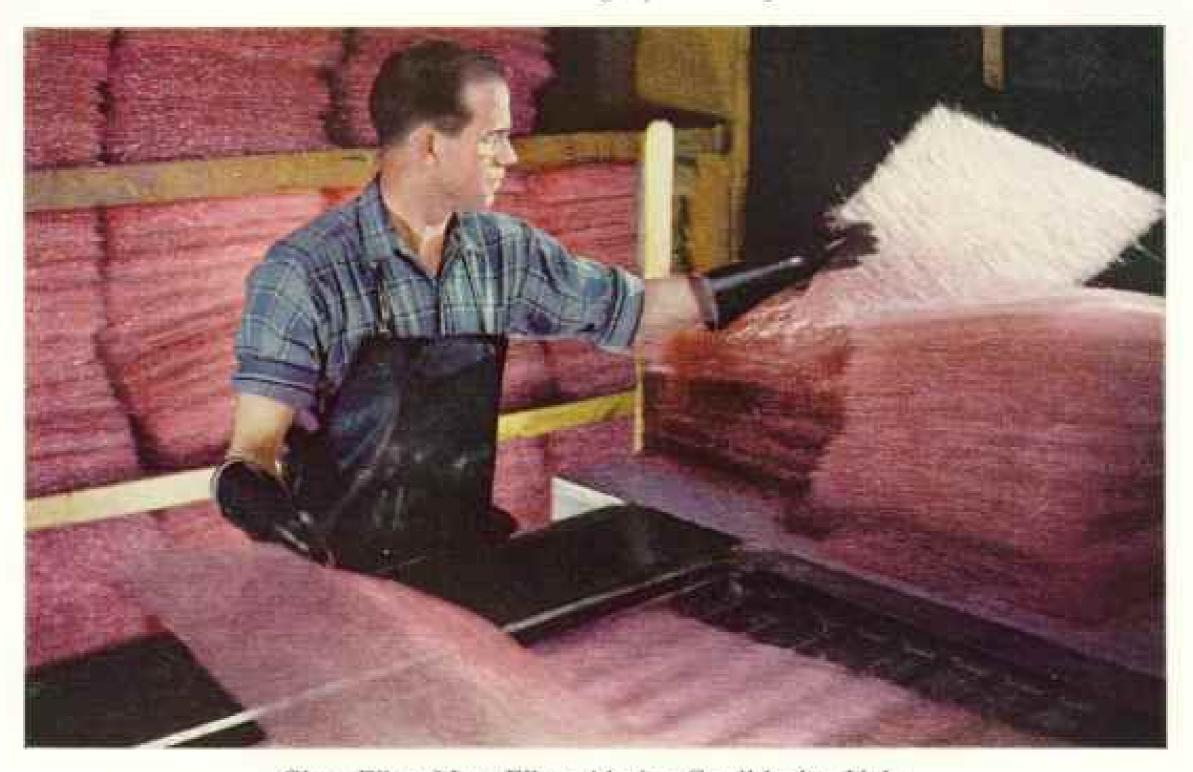
Glassmakers Designed This "Kitchen of Tomorrow" for the National Geographic Society's Photographer

Hence this combination kitchen-dining A chicken rousts in a glass oven beside a glass stove. Glass table top folds against larium or playroom, Glass blocks, plate glass, food jars, curtains, stemware—all are represented in this Many families must forego servants. Owens-Ellinois Glass Companies, Birgest space waste in homes is the dining room, used only an hour or so a dislove with glass-abelved, glass-puncled pantry between, reached from either side, the glass walls to become a mural, so the alcove may be a solarium or playroom, "dream kitchen" planned by the Libbery-Owens-Ford and the



Only time can paint the hidescence of the Syrian piece of more than 2,000 years ago. Only moderns achieved the limited transparency of the Necks, of the Necks, Stuben (left). "Etherest blue" illustrated in the Venetian was the glass glory of the Middle Ages. From the Nile to the James, from Sidon to Toledo and Corning, the Hourglass of History Records Glass Making

The National Geographic Magazine



Glass Fiber Mats Filter Air for Conditioning Units With gloves the operator takes mats from the conveyor line at Owens-Corning Fiberglus Corporation, Newark, Ohio.



(3 Nathand Grownights Berlietz

Roderheumes by Withord B. Culver

Hundreds of Filaments Form Glass Yarn for Weaving

The young woman threads an "end" into the warp of an all-glass cloth. This warp will be combined with an all-glass "fill" to make flexible fireproof cloth. Millions of yards of this fabric, woven on standard textile looms, now are destined for undisclosed military uses,

From Sand to Seer and Servant of Man-



"What's Cooking Now?" "Just Shooting 100,000 Volts through These Insulators"

Pyrex, for cooking, also insulates high-tension lines. Hence high voltage is flashed over shells in a Corning laboratory.

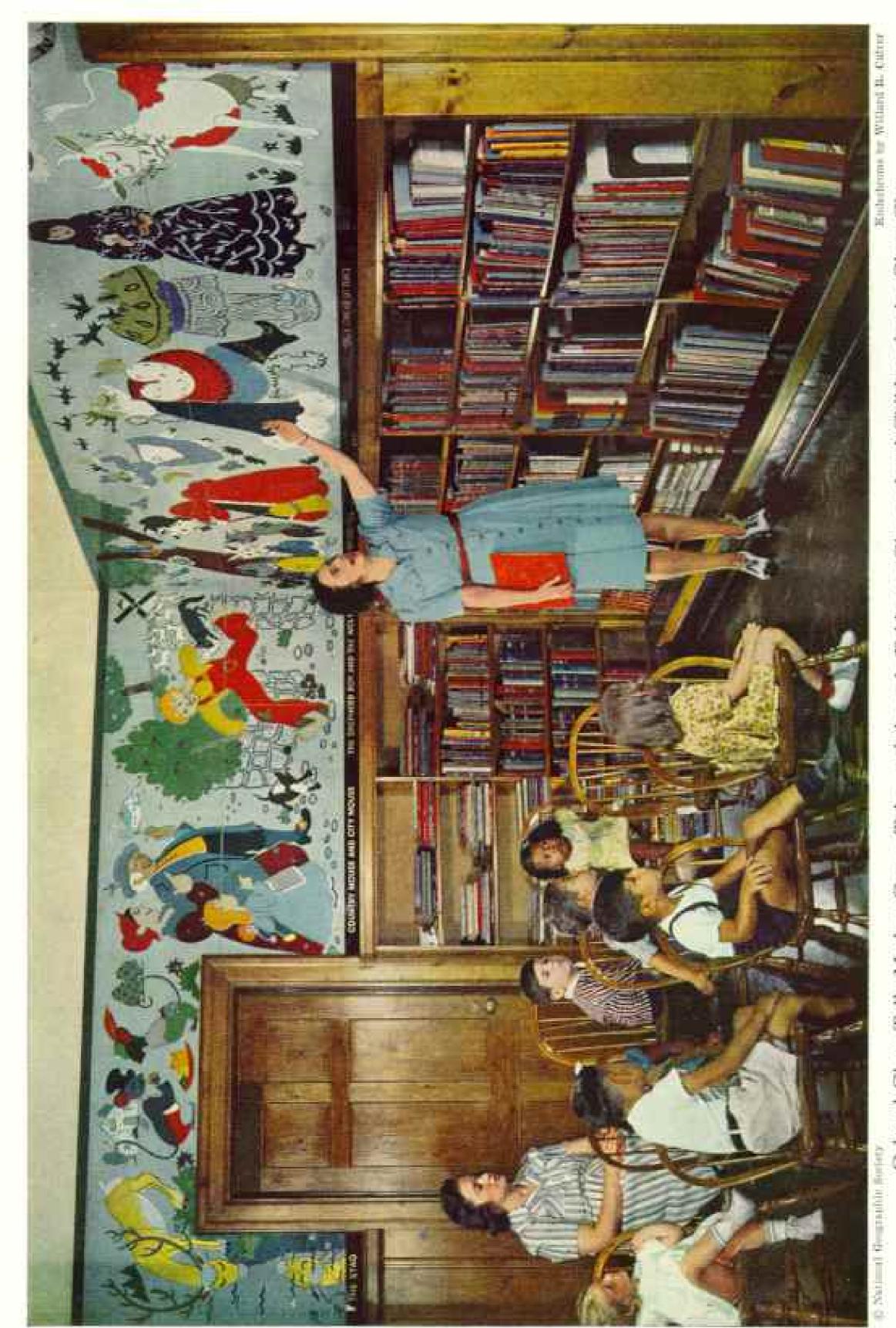


@ National Geographic Society

Reductronses by Witnerd B. Culver

Flame Is the Tool of the Artist Who Sculptures Glass

Crystal-clear rods are here beated nearly to the melting point. Without other tools or molds the worker at the Valerie Halle Crystals plant, Crestline, Ohio, shapes animals, birds, and human statuettes in the center of the concentrated cross fire.



Thousands of pieces in hundreds of shapes, sizes, and shades were inlaid in the Walls of the Tolodo, Ohio, Public Library to make murals for the children's story-hour room. Tales and Aesop's Fables to Glassmakers' Children in the Glass City Colored Glass Tells Mother Goose



A Glass Eagle Typifies a Lost and Found Art

Frederick C. Carder, founder of Steuben Glass Works, casts glass by a method similar to the "lost wax process" Benvenuto Cellini used for bronzes. Colored pieces (top shelf) were Steuben styles of decades ago.

She "Stretches" Fever Thermometers to Right Lengths

In one of a hundred operations to make a seemingly simple clinical device this worker elongates the bested tube. Chambers in which moisture, air, and excess mercury have been trapped (left) are removed and tubes scaled (right)

Sarthurf Grugzspille Berfeitz

The National Geographic Magazine



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Kodschrome by Williams R. Cutser

Newest Kinds of Glasses Blend with Old Styles in a Dining Room

Curtains are glass fabric, chairs at table ends are bent plate glass, table top is tough tempered glass which stemware and bot dishes to come won't scratch or crack. Cut-glass chandelier and black border on the mirror are older styles. B. Altman & Co., New York City.

American Bombers Attacking from Australia

BY HOWELL WALKER

With Photographs by the Author, Staff Correspondent, Naviosal Groundente Magazine

AT THE operational base of an American heavy-bombardment unit officers accepted me as one of them. I had the bed of a captain away on a mission "somewhere to the north of Australia."

In the officers' mess the long table reminded me of the dining room at college, but the atmosphere was different. These U. S. airmen seemed carefree. Not trying to fool

themselves, they were living today.

Ten months before, I had passed through this same area, thinking in terms of sheep, vast and lonely pastures, and the peace of it all. Now, instead of a town where only goats seemed awake, I saw an active war base. An Arcadian life of go-as-you-please had faded into a dashing, dangerous existence under conditions of the most modern warfare the world knows.

Topic of interest used to be how many sheep to an acre, or how many acres to a sheep. Now it was how many planes to the airfield, reckoning ground-force men and combat crews plus ordnance personnel. Weather for flying had become more important than rain for grass. Lusty voices cheered promotions, disregarded a rise in the value of wool.

Living with Crews on the Alert

As heavy bombers flew, I felt close to real war among these American wingmen. I lived with crews on the "alert"—ready to take off on a mission against the enemy at extremely short notice. In the officers' mess I sat with husky youths confidently laughing and joking like a football team at training table, though day after tomorrow they might be prisoners of war in a hot, stinking enemy camp, or at the bottom of the Pacific, or in a plane-plowed grave on a jungle island.

The commanding officer of the unit did not limit his duties to his huge job in the operational office. Like all the others, he took his

turn on missions.

Soon after I arrived at the base, he alerted his own ship and crew, including me. Five other Flying Fortresses and their crews also went on the alert (page 58).

Ordnance division immediately rushed trailer loads of bombs to the six ships. Ground crews of each plane set the fuse caps and hung up the bundles of "banzai-banisher" in the bomb bays. Mechanics thoroughly serv-

iced and tested the powerful engines. Oxygen and gasoline tanks were filled; all combat equipment, including high-flying outfits, was checked. Gunners made sure everything was in firing order, stocked ammunition. Combat crews waited only for the word to take off.

In the middle of the night someone shook me out of deep sleep. Through the mosquito netting I recognized the Intelligence officer.

"The planes will be leaving for the mission first thing in the morning. As you already know, you'll fly with Captain H. Sorry to wake you up; wanted to let you know so you could be all set."

Captain H. was the commanding officer at whose invitation I was present. He would lead the mission in his Flying Fortress, honorably christened Tojo's Physic (page 51).

Right after early breakfast, mission crews gathered in the operational office at the airdrome for roll call—first pilots responsible for presence of each member of the crews; briefing—pertinent information about target, enemy and friendly ships in area to be covered, and a second target if first inaccessible; and the weather report.

From the Intelligence officer first pilots received brief cases with orders in writing, and

emergency medical kits (page 61).

We flew to a larger operational base for further briefing during the afternoon. Afterward most of the crews went into the near-by town for the evening. Streets seethed with soldiers, sailors, and airmen of both Australian and American forces. Hotels and restaurants had to turn hungry servicemen away at mealtime.

For Tomorrow Ye May Die

With six officers from our planes I tried in vain for a square meal. We had to be satisfied with a round of milkshakes and sandwiches. In true Air Forces style we tossed coins to determine who should pay the bill, and one man had to pay 16 shillings for a few sips and nibbles.

Who cared? Tomorrow's mission, not money, counted.

Next day we flew to an advanced base. After final briefing at headquarters, the crews sat down to lunch. They had a choice of cold salmon and salad or braised chops with vegetables, tea, bread and butter, and oranges. Whether this was their last meal or



Between Forays against the Japs, the Air Forces Play a Friendly Game

Payday is payday with the A. E. F. the world over. Out in the Australian bush there is plenty of money, but little to spend it on. These men are enlisted members of a U. S. Army Air Forces bomber squarfron. The emblem on the wall behind the mosquito nets shows their bunkhouse was a Masonic hall.

not, they all acted as they would on a routine day. None made an effort to divert the conversation from what lay ahead. If they wanted to say something with a grim ring to it, they did. Most at my table ate heartily.

At the quarters where we should lodge that night—if we returned from the mission—I found many of the men stretched out on cots. A stab of before-the-race feeling pierced the pit of my stomach. I lay down,

Greater than the fear of combat within me lurked the uncertainty of whether I could take high-altitude flying under artificially supplied oxygen. I had never flown above 6,000 feet; we were to make our run over the target at an altitude of more than five miles.

The Zero Hour Approaches

Some slept while others talked quietly; but I could not keep my attention on what they said. Hundreds of thoughts whirled in my head. That I did not become outwardly excited was due to the amazing composure of the fellows around me.

Leisurely the crews walked to their planes. On the way I kicked at little white pebbles in the dry, brown dust; I wanted to remember how it felt to scuff at stones on the ground. On the ground . . . In a few hours I should be miles above the sea.

I listened to the breeze in the palm fronds, took off my cap, and felt the warmth of the sun full on my face. How delicious were deep breaths of balmy tropical air! What would an oxygen mask be like at subzero temperature nearly 30,000 feet above sea level?

The roar of engines starting up on our ship thrilled every nerve into realization of the rare opportunity ahead of me. Eagerly I climbed into the Flying Fortress.

I was excited, of course, but now in the right way. If anyone had told me just then that I could not go on the mission, I should



Tojo's Physic and Crew of Nine Americans Return from a Visit to a Jap Base

Unshaved, unwashed, and weary after hours in the freezing substratosphere, they cheerfully line up and grin for the photographer. Yes, A.E.F. morale in Australia is excellent. Off duty soon, they'll have time to think up more insults to paint on Flying Fortresses. Note that the gasoline drums are widely dispersed.

probably have fought to hold my place. Six Flying Fortresses in two flights of three, both in V formation, approached the Japanese-held base of Lae in New Guinea.

"Open your bomb bays," Captain H. ordered calmly over the interplane phone.

Through a side window I watched the bomb bay doors open on the ship off our right wing. At the same time those on the Fortress off our left opened. I could not see the three planes in B flight, for they followed directly behind us (page 54).

As we drew nearer the target area, I felt remarkably confident from the knowledge that six Fortresses in tight formation made up the attacking force. Contemplation of even one of these ships with its bomb buy wide open, all guns ready, and the four engines droning on a steady course through the frigid substratosphere is mighty comforting over enemy territory.

Anthaircraft guns began firing as we flew

in at 28,000 feet. Their shells burst below us. A few seconds before Captain H.'s bombardler released his load, the Japanese gunners fled for shelter.

Looking out of the side window, I saw bombs fall away from the Fortress off our right wing. They seemed to float through the air as in a slow-motion picture.

An Enemy Airdrome Set Affame

Interested to see what damage we had done, I nearly fell out of the plane. A tremendous fire blazed on the edge of the airdrome, and huge masses of black smoke billowed up from two other fires in the same area. Because of the straight course we followed, I had only a few seconds in which to look down on the target.

For almost ten minutes after dropping bombs we sailed on our way, unmolested by ground gunfire or enemy pursuit planes. I stood by an open window, taking in the rugged



Action

"Mr. Zero Was Swooping in Like This When"-a Flyer Tells His General

Brig. Gen. Martin F. Scanlon, second from right, gets a first-hand report from Lieut, R. W. Elliott on what happened to a Jap ship that attacked his Flying Fortress over enemy territory. In other togs the airman might easily pose as the long-armed angler measuring the lost fish,

panorama of lofty mountains with deepcreased valleys that characterize this part of New Guinea. From that altitude the jagged terrain looked like a model relief map spread on a desk.

Despite lagging by the plane on our left because of a faulty engine, formation of the two flights remained tight enough. Captain H. in the lead ship purposely retarded his motors to enable the slower Fortress to stay with us.

"A Zero at 5 o'clock!" someone suddenly called over the interplane phone.

(The clock-face system is used in aviation to locate objects. Dead ahead is 12 o'clock; dead astern, 6 o'clock. Off to the right, and at right angles to the horizontal axis of the ship is 3 o'clock; etc.)

I spotted the Jap pursuit plane almost as soon as I heard it announced. Without realizing what I was doing, I had swung the .50caliber automatic on my side through the

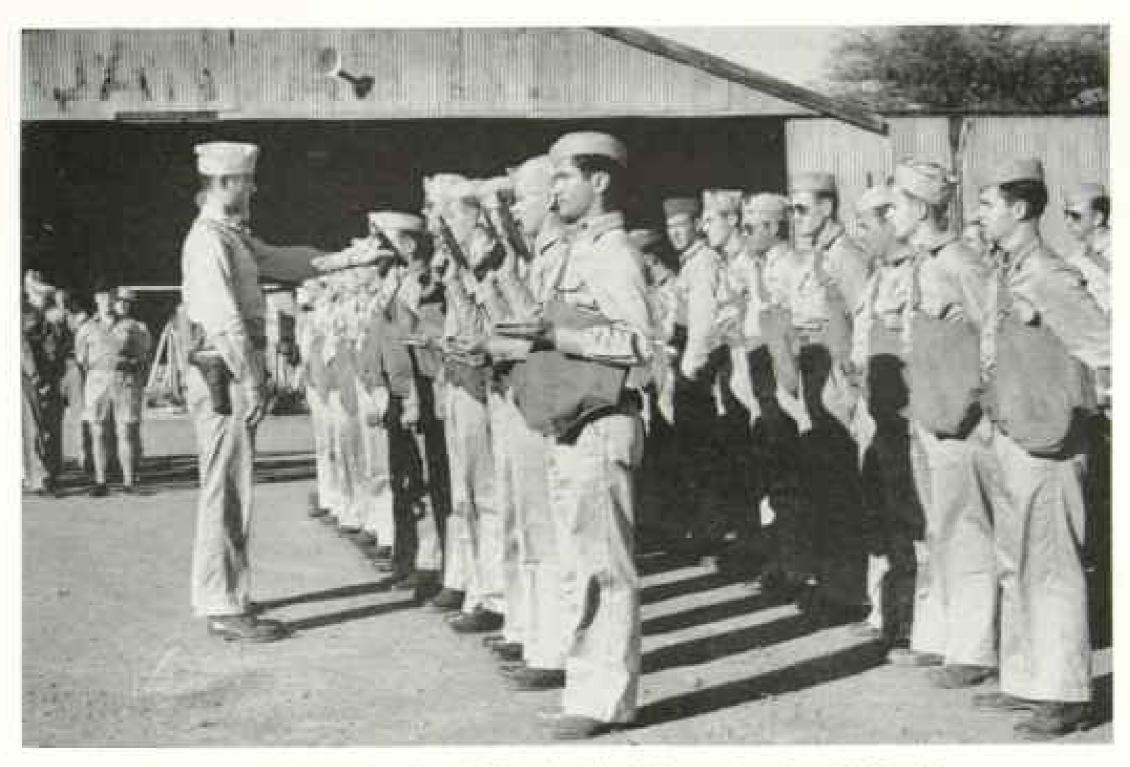
window, and held it on the Zero. The only thing that kept me from pressing the trigger was the risk of sending some bullets into the Fortress off our right.

By this time other Jap fighters had joined the combat. Their tracer shots poured past our windows like a horizontal hail of red-hot rivets:

Oxygen Vital in High Flying

Almost all the guns on the six bombers blazed back in deadly defiance. Twin .50's in the bottom turret of our plane were idle. because the oxygen system for that post failed to function properly.

The gunner had nearly passed out 30 minutes before reaching the target, and had to come up. White as dough, he panted frantically into his oxygen mask connected to another tank. Gradually he revived. Five more minutes in that bottom turret, and he would have lost consciousness, if not his life.



Ready! Point! But Don't Fire! Pistol Inspection for U. S. Airmen

Somewhere in Australia, a licutement examines .45-caliber automatics of enlisted men in a heavy-hombardment unit. Should they parachute into a Japanese-held jungle, their side arms might prove lifesavers. Gas-mask kits hang from their shoulders (page 64).



In the Antipodean Darkness, a Sentinel Stands Watch over Tojo's Jinx On the field of this north Australia air base, sentries are posted all through the night. Weapon in the American's hand is a sub-machine, or "tommy" gun, once a favorite of gangsters.



"Open Your Bomb Bays!" Calls the Squadron Leader over the Interplane Phones

All six ships are tightening the formation, for they now are close to the target. Shortly, the bombs you can see through the opened bay will come whistling down to crash on fuel dumps, airplanes, and runways at Jap-occupied Lae, New Guinea. The Flying Fortress is as destructive as she is beautiful. Forward and side guns poke wicked 50-caliber noses at Japs about to attack. Swinging in a turret, twin 30's guard the ship's belly. Bottom gunner in the photographer's plane never fired a shot. His oxygen failed, and he almost passed out (page 32).

During the first scene of the attack by Zeros, I could not catch the drift of the drama. Never before had I been in actual combat. Now that I was, it did not seem real. Mine was the attitude of a person at a motion-picture performance. Tracer bullets from enemy fighters on frontal attacks continued to streak by the side windows.

Finally I convinced myself that the Japs were shooting to kill. Toja's Physic led the flight. Those bursts of red death could not come from our guns, for they flashed at, or between, us and the bomber just off

our right wing.

How much longer before they would find their mark?

I had talked with airmen who told me how frightened they had been on their first mission. The combination of subzero temperature and fear had kept them shivering most of the time during the run over the target. Without excuse they admitted their fear frankly.

On this mission I had no particular responsibility, no specific duty to perform; nothing hinged on me. I went along simply as an observer. Perhaps I was too slow to realize what could have happened during combat with Zeros; however, I have felt worse than I did in that fighting atmosphere of the substratosphere.

Preoccupied with watching what happened without obstructing the side gunner, I experienced no personal feeling save the bite of the 20-below-zero temperature on my hands.

The Japanese Zeros, sleek, slim, and powerful, had remarkable maneuverability. Swerving, darting, dashing, and diving, they streaked the atmosphere around our big bomber like chimney swifts exercising for fun near their nesting place.

With a pair of 20-mm, cannon fixed in its wings, the Zero simply flew toward its objective, blazing lead and death almost as rapidly and automatically as the spinning of

its propeller.

Approaching a bomber from below, the fighter could fire along a nearly vertical line. Or it could dive, spitting destruction from directly overhead. Sometimes a Zero would roll over, belly toward heaven, still firing both cannon.

Captain H, told me he thought no more than six Zeros attacked on this run. According to official announcement, our bombs destroyed part of the runway at the airdrome, an oil dump, and aircraft dispersal areas.

The pursuit planes harried us for 25 minutes; yet only one of their thousands of shots bit Tajo'r Physic, and damage was negligible. Our Fortresses definitely bagged one of the Zeros, possibly two.

The Zero surely shot down could not be credited to any one bomber. Virtually every ship in the two flights had guns on this Jap. Tracers converged on the enemy craft in a beautiful show of marksmanship.

One Jap Zero Shot Down

Our side gunner poured round after round from a .50-caliber machine gun into the faltering plane. His face lit up as the Zero exploded, and, trailing thick, black smoke, started its 28,000-foot swan flight from stingy substratosphere to steaming jungle below.

Gradually the enemy began to edge farther and farther away. I watched one pursuit plane several hundred feet below us, off to the right, and pretty well out of range. It kept its distance, skirting a great white cloud into which it could dive for safety. I sensed its respect for six Flying Fortresses.

With no exception, the most unforgettable sight of my life was one of these giant bombers zooming at nearly 300 mph steadily along its course, all guns firing, all propellers synchronizing—an awe-inspiring symphony of power, confidence, efficiency, and majesty.

After the Japanese fighters had disappeared altogether, we continued on our course still at 28,000 feet above sea level. Through openings in the clouds we could see the sharply folded mountains, deep valleys, and winding rivers of southeastern New Guinea.

The sun sank behind cumulus banks between the sea and our ships; darkness slowly climbed up to us; and the last few peeks through rifts showed that we had left New Guinea and were now out over the Coral Sea, heading back to our advanced base.

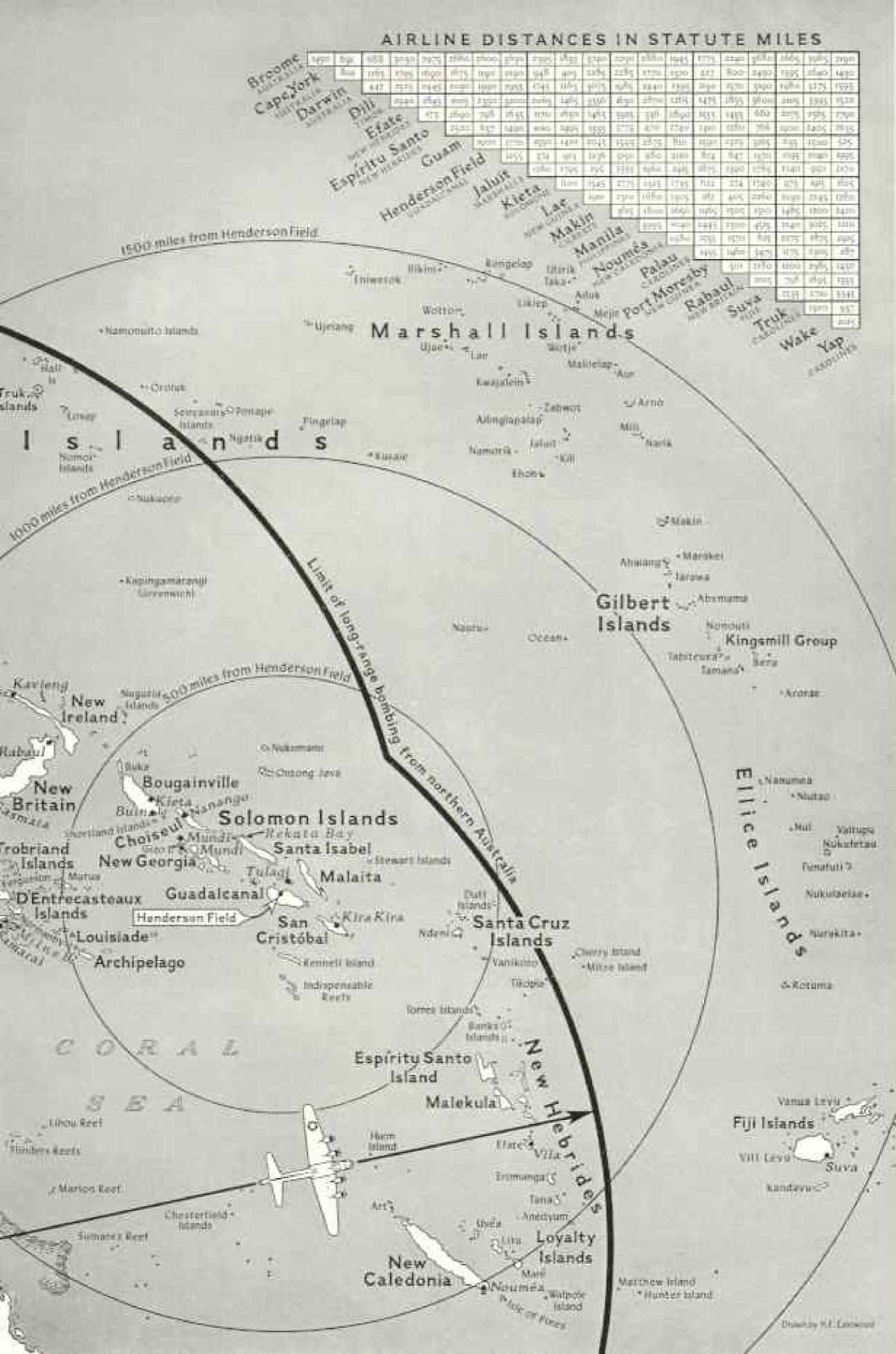
Side gunner Bostwick and I moved to the radio room, where it was possible to converse without shouting above roar of engines and wind that blustered through the side windows. He asked me what I thought of the mission. I told him it surpassed all other experiences of my life.

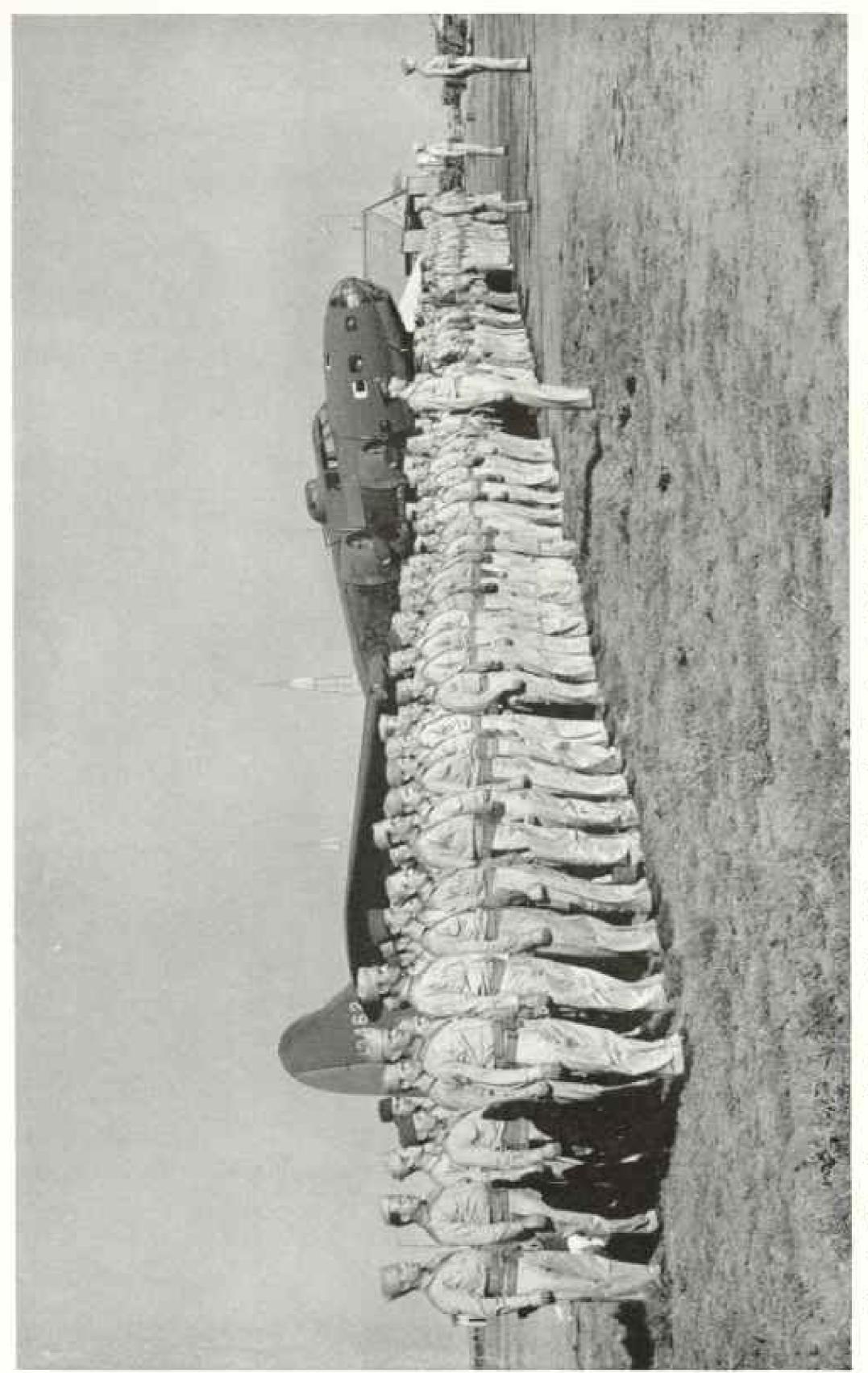
Without false modesty he said that for him it was just another routine job done. He had got a kick out of seeing the Zero burst into smoke and nose toward earth; but this mission had lacked the excitement of others he had flown.

No bullets had ripped the fuselage near him; no engines had cracked up or got shot up; no one had been obliged to bail out; all six ships had come through intact.

Bostwick had been forced to bail out 17 times in this war, and that meant from Pearl Harbor on. He had seen plenty of



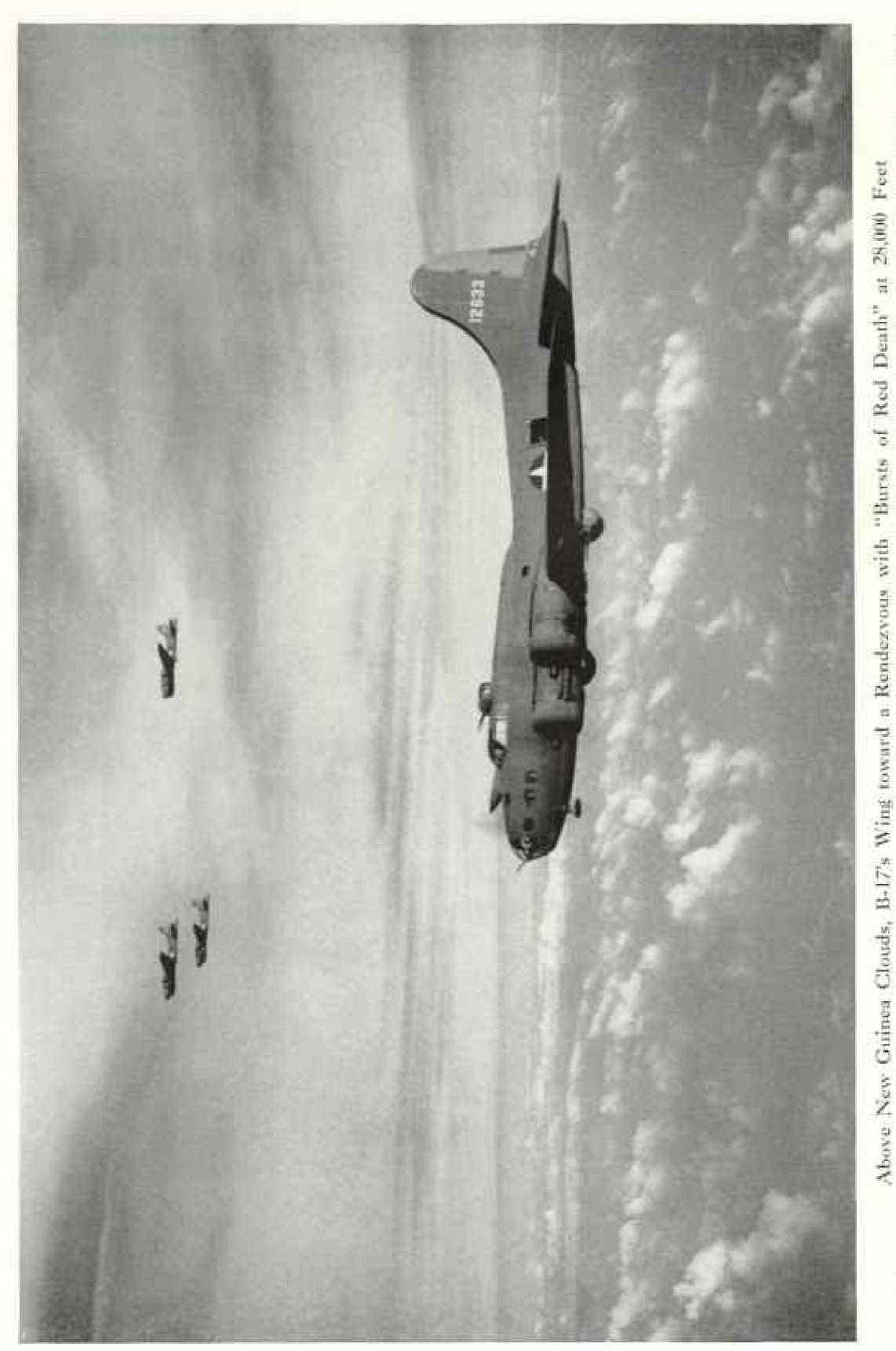




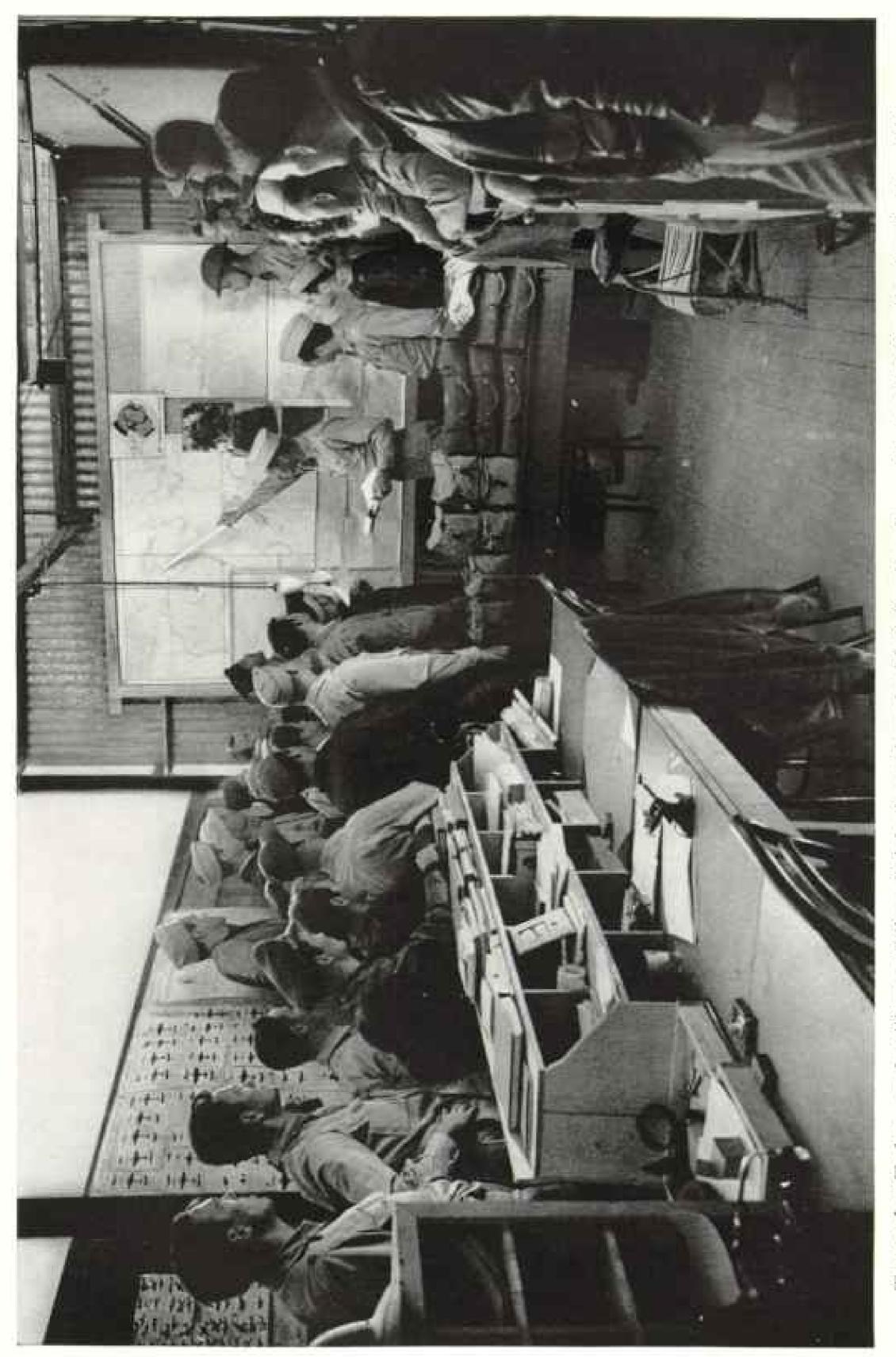
This big Bosing has been alerted; that means it is ready to take off with its crew, of nine on short notice. "Combat crews virtually lived on the alert," the author found. "Ground crews' job was tough and endless" (page 68). Both groups are represented here—complete personnel of one unit. -a Heavy-bombardment Unit Stands at Attention Beneath Wings of a Fortress Proudly They Serve the Queen of the Skies



One of six planes bound on a bombing mission to New Guinea, No. 12,635 is pictured from the leader's ship. From the astral turnet, the navigator can shoot sum, stars, or Japs. Below the pilot's cabin hangs the radio-compass bousing. This was the plane damaged on the return landing (pages 62, 64). Majesty of Air Power-a Fortress Roaring at 300 mph Shatters the Silence Five Miles Above the Coral Sea



While ripping up the Japanese airdrome at Lae, ax Fortresses met aix Zeros. The pursuit planes "streaked the atmosphere like chimney swifts exercising for fun," says Mr. Walker. He tells bow it feels to stand by a machine gun as the enemy blazes hurricanus of shells (page 55). On this mission all our planes returned; no casualties. One, possibly two, Jap fighters were shot down.



He gives the course from Australia and tells pillots when to strike and at what altitude. Before The Inclina head is the squadron insignia. Silbouettes of Jap aircraft adorn the wall, Target for Today-an Intelligence Officer Briefs Operations for U. S. Bomber Crews About to Wallop the Jups in New Guinea Ruler in hand, he points out the primary objective and a secondary, him are entergency kits and brief cases containing instructions.



Here Spare Guns and Pistols Are Kept Rendy for Instant Use

An Air Forces licutement inspects barrels of .50-caliber machine guns, which often rip Jap Zeros to bits in a single burst. An enlisted man peers into a shoulder gun. On the floor is a case of pistol holsters, Repairs are made and guns cleaned in this but in the Australian bush.

action, sticking by his .50's in Flying Fortresses all through the battles of the Philippines, Celebes, Java, and now Australia. Once he had crash-landed on a tropical isle off Java where he had stayed for a week, subsisting mainly on coconuts. Before joining the U. S. Army Air Forces, he had worked for three years with TWA commercial air lines.

No Clipping the Wings of an Eagle

The tail gunner, appropriately named Irons, joined us in the radio room. When the Second World War broke out in Europe, Jack Irons had been living with his family in England. His parents had sent him to the United States to keep him out of the R. A. F.

Two months later he had joined the U. S. Army Air Forces, and he has been flying through all the war in the Far East from the day America entered.

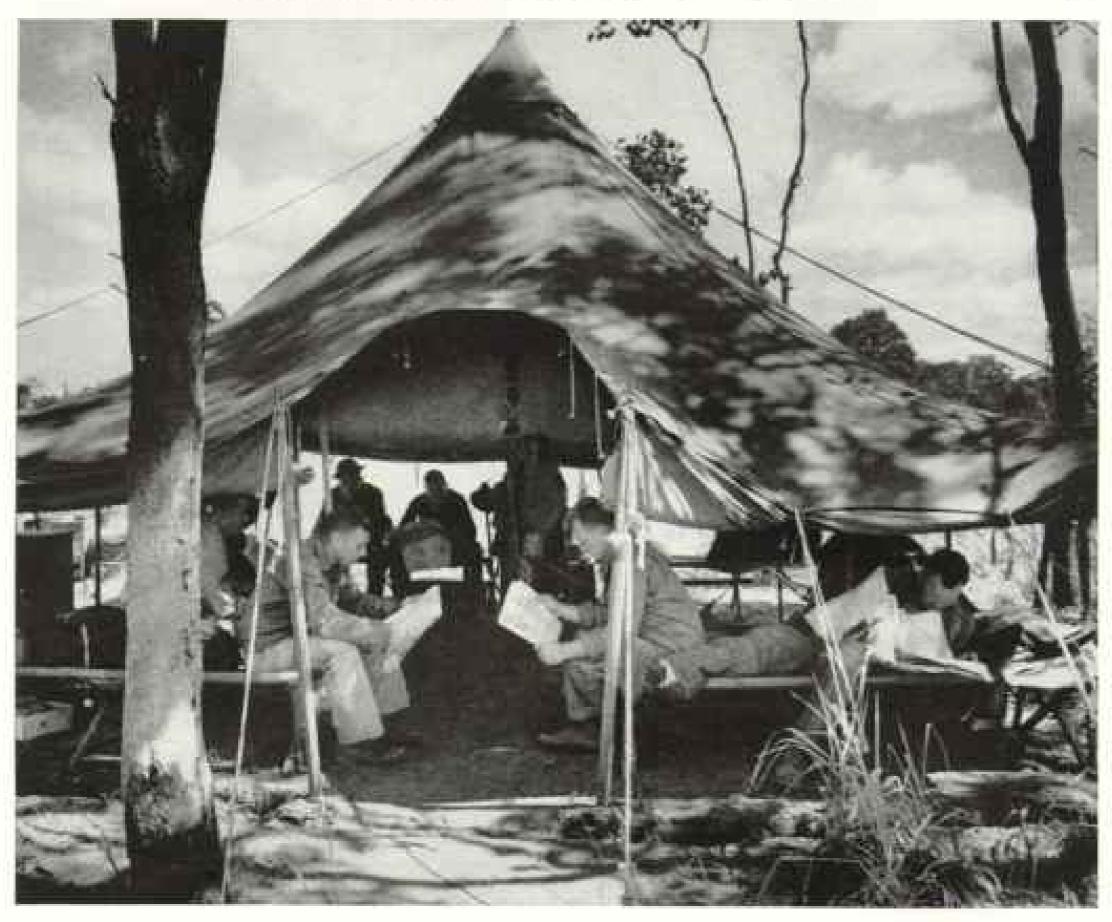
Captain H.'s alternate side gunner, Richardson, flew this mission in one of the other planes. Although a graduate of Princeton with a master's degree in languages, he was just a first-class private in this war.

Not so long ago he held a responsible position in a large aircraft factory building Flying Fortresses. He enlisted in the Air Forces to see how the stuff his company had been turning out worked under combat conditions. He got a ringside seat.

Captain H. put Tojo's Physic down in the dark at an advanced base. Before the commanding officer of the station could congratulate H. on a hundred-percent successful mission, one of our planes in landing struck a barrier on the edge of the runway.

Impact blew out the left tire, and the ship dropped with such force that the landing gear plowed up through the No. 2 engine. The plane was lost to the unit temporarily, but there were no personnel casualties (page 64).

All who had flown the mission went straight to the mess hut for a hot dinner. Only a



Better Than a Kangaroo Hunt Is a Letter, Newspaper, or Magazine from the U.S.A.

Mail has just arrived at these enlisted airmen's base in the Australian bush. Baseball scores by now
are weeks old, but who cares! Better than a thousand words, this photograph shows what a note from
home means to men in the service.

few opened bottles of beer; the men were too exhibitated to need any artificial stimulation. Everyone seemed to be talking at the same time; yet no one raised his voice unnecessarily.

With another mission to fly the next day, the crews retired right after dinner. I slept in the top bunk of a three-decker affair. Lucky to get one blanket, I spread it on the burlap slung between two-by-four timber supports.

Feeling that I should leave well enough alone, Captain H. advised me not to go on the mission the following day. I frankly agreed with him. The one experience had been enough for me to understand thoroughly the risk these airmen took each mission they flew.

When Tojo's Physic and the other four planes took off for their next attack, I sat on an empty 44-gallon gasoline tin and watched them out of sight.

Hours later while writing up my notes, I

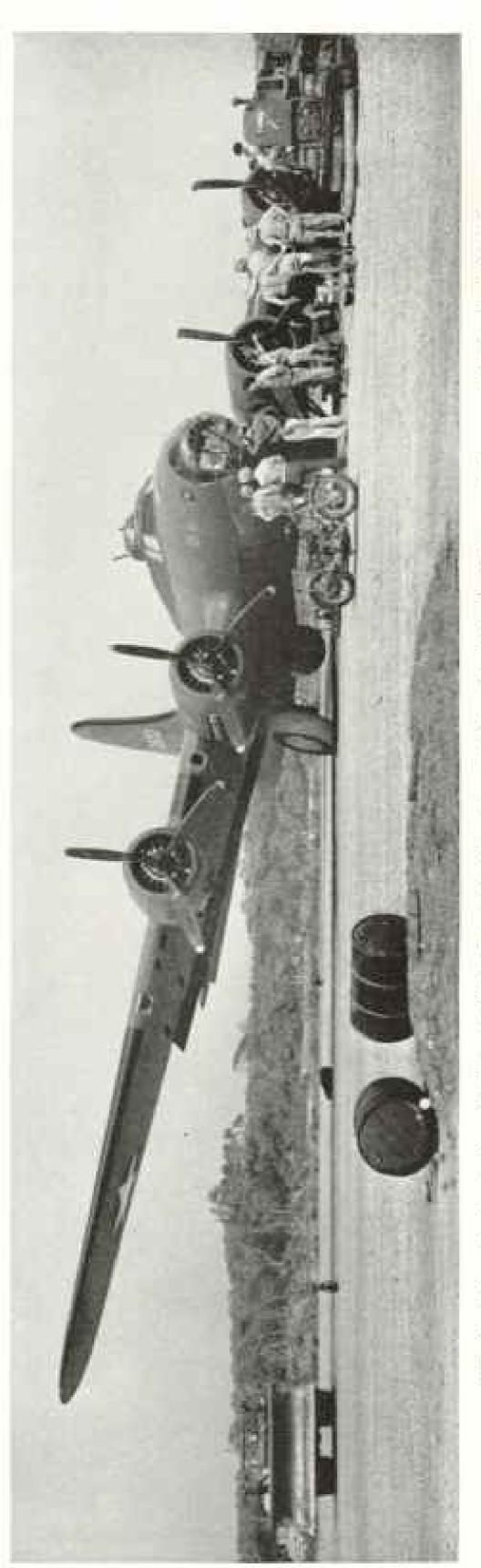
heard that familiar droning peculiar to Flying Fortresses. I rushed out to the field, counting the ships circling before landing. One, two— three— four——— five! Once again, all our bombers had returned from a mission over enemy territory.

All Abourd, All Alive

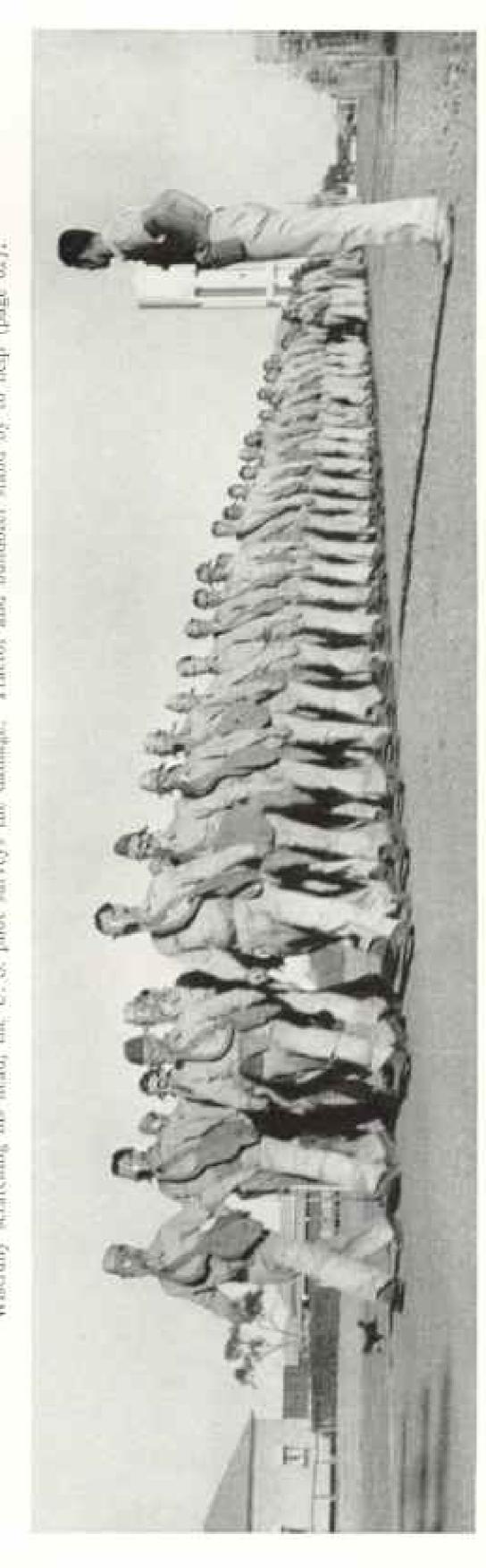
All aboard, all alive, only one plane left behind, we started back for our home operational base. A radio message reported that a Flying Fortress from another heavy-bombardment unit had had to make a forced landing somewhere in the area over which we were flying.

Endeavoring to locate the disabled craft, Tojo's Physic fairly skimmed the tops of scrubby, stunted gum trees; at other times it climbed to a higher altitude for a more comprehensive survey of the country.

Gaining height to pass over mountains, we ran into heavy clouds. For half an hour or



iis Ginnt Raider Landed in the Dark, Blew a Tire, and Crippled Itself Tructor and buildozer stand by to help (page 62). Wistfully scratching his head, the U. S. pilot surveys the damage. Having Laughed at Jap Bullets, Tl



this mask. He is on parade with a heavy-benchardment unit "down under," U. S. Combat Airmen Undergo a Stiff Drill to Inure Them to Exertion under Gas Masks No. 6 on the right has forgotten something-



Camped in tents among gum trees, authills, and sical Exam in a Forest-sheltered Tent Hospital Halfway Around the World Their heavy-bombardment squadren has just moved from a comfortable Australian town to the wilderness (page 70). Campe Their heavy-bombardment indelible red dust, officers and men continued their operations as regularly as before. Airmen Line up for Still Another Phy



Where Man and Termite Trick the Jap-"Magnetic Anthills" Hide 500-pound Bombs

Twelve-foot towers of dried mud camouflaging the bombs are called "magnetic" because their thin sides Invariably face north and south. They are built that way, according to one theory, so that their broad walls, erected by night, will be dried more quickly by the morning and afternoon sun. Acre upon acre of these weird termitaria is a dominant feature of the north Australian landscape. A few are 20 feet high. Their denizers, possessing an insatiable appetite for cellulose, destroy vast quantities of wood,

so before dusk, we saw nothing but whiteness on all sides. With darkness Tojo's Physic burst into a storm area. It was rough going. When a Flying Fortress is tossed around like a rowboat in a typhoon, a real storm is blowing.

Over the interplane phone Captain H. ordered everyone to check his parachute and stand by ready to bail out.

When we were ordered to get into parachutes, I was up in the nose of the plane with the navigator and the bombardier. I struggled aft in the pitching ship for my

chute, only to find that an additional man had already put on mine,

The fury of the storm increased. The Fortress lurched, leaped, slipped, swerved, bumped, bounced, creaked, and careened.

We could see absolutely nothing but blackness through the windows. The air began to feel colder than it should have been at an altitude of 7,000 feet. I still had no parachute; it didn't seem to matter.

Finally the engineer appeared with a chute. I could not help feeling that he was giving me his own; but he convinced me he had one for himself. Bostwick helped me into the apparatus, then said, "Well, there's nothing to do now but just sit down, hold tight, and wait."

A Wait with Death Threatening

Five of us in the rear of the ship just sat and waited—waited for Captain H.'s order to bail out. Richardson, the Princeton graduate, tried to write a letter. Tail gunner Irons busily extracted handy articles and a chocolate bar from a knapsack and stuffed them into his pockets.

The extra man, a ground officer, stared at the floor with wide eyes.

Bostwick seemed as nonchalant as if he were waiting for a streetcar. In his usual calm manner he spoke close to my ear because of noise from wind and motors: "When you bail out, remember two things: Don't put your hand on the rip cord while actually jumping from the plane—you'll find it soon enough once you're clear of the ship; and cross your legs when you think you're getting near the ground. It'll keep you from getting hung up in a tree."

We waited. No order. We waited.

Suddenly someone pointed through the window. Lights on the landing field! Safely down.

Entering the room I had occupied before the mission, I switched on the light, to find a wounded officer in the bed. Broad bandaging swathed his head like a white turban.

He nonchalantly raised himself to a sitting position and apologized for inconveniencing me in finding another place to sleep. He said the captain who usually slept here was in hospital.

Before seeking another bed, however, I heard his story. He was Second Lieut, James Hilton, co-pilot. On a recent mission the Japs had shot up the engines of his Flying Fortress, which somehow had continued to function. There had been nothing to do but try to get back to an Allied base.

Thirty miles from a friendly airfield all four engines had given up, and the pilot had crash-landed at night in the bush. When trees tore off the right wing, the bomber had dropped like a keg of gunpowder and burst into flames.

One side gunner and the tail gunner, he told me, died in the crash. For another side gunner life was a matter of a few more hours. The radio operator, still conscious, suffered from a deep gash across his abdomen. Through a rent in the battered fuselage, pilot and co-pilot crawled to safety. Navigator and bombardier miraculously extricated themselves from the tangle of burning debris; so did the engineer.

Of all the crew Lieut. Everett Davis, the bombardier, was least hurt. While the ship blazed furiously, he fought his way through the confusion of twisted white-hot girders and roaring flames to pull out the tail gunner. He went back for a side gunner, returned for the other side gunner.

Finally he even thrust himself into the center of the conflagration and struggled out with the radio operator.

Complimented for his guts by friends in the unit, Davis said simply, "There's not a fellow in the outfit who would not have done exactly the same under similar conditions."

Heroes Are Modest

For his heroic work Davis was awarded the Soldiers' Medal by General MacArthur.

I saw the citation in a newspaper, And right under it I read: "Second Lieutenant James A. Hilton of South Dakota, who was also in the plane, has been awarded a similar decoration for saving the lives of two members of the crew."

Hilton had never mentioned to me what he had done; the first I knew of it appeared in the paper.

As a result of the crash, pilot and navigator had gone into hospital at the operational base (page 70). Some of us visited regularly to try to cheer them up. Usually they cheered us up instead.

According to bedside table evidence, Captain Smith, the pilot, entertained himself with children's stories about native animals of Australia, such as Willie Wallaby, Jackie the 'Roo, Peter Platypus, and Caspar Koala, Lieutenant Hayman, the navigator, just sat up in bed, smiling and smoking a huge cigar.**

Smith and Hayman weren't the type of men to linger in a hospital. Soon they were knocking around the officers' quarters, trying to overcome their self-consciousness at being considered wounded men.

The evening Captain Smith left the hospital, he and another pilot gave a party for the rest of the officers; the two pilots had recently received promotions to major.

A number of the officers were asked to speak. Some of the talks struck a humorous note, some serious.

In everyday life, Hayman, one of the last to be called on, was capable of more mischievous pressure to the square inch than any other in the outfit. But in his speech

^{*} Hayman bolds the DFC, besides the Purple Heart.



Co-pilot Loves His Bombers-When He's Not Flying 'Em, He Paints 'Em

Upon returning from a mission, this artist records the most spectacular incidents. Here he portrays a ground crew at work. His efforts adorn an American officers' recreation room in Australia.

he pounded out the most powerful punch line of the evening.

He started by saying he didn't want to be thought of as a preacher (whereupon everyone roared); however, he did feel that in the escape from death, which he and others of his crew had had in the recent crash, some supernatural power had played a part.

He did not hedge in stating that that power was the Almighty God; and, by God, he wanted to thank God for his deliverance, and the deliverance of his friends.

God Is Real to the Airman

It struck me as the strongest, sincerest, and finest talk I had ever heard; and it taught me more than all the sermons in the world.

Of such stuff was the average man of this heavy-bombing unit. I heard some of the officers say they knew all the men in the outfit felt the way Hayman did; it just took him to come out with it.

These airmen belonged to a group trained to fight to the finish. Although officers and enlisted men of the ground forces did not actually take part in bombing raids, their job of keeping the planes ready for missions was tough and endless. Combat crews virtually lived on the alert. In fact their very existence revolved around their aerial attacks against the enemy. As I saw it, life for them, even at the rear operational base, boiled down to preparation for, and recovery from, missions.

For 24 hours after returning from a mission, fighting airmen had no responsibilities; they could do as they chose with their time. Here again it amounted to recuperation—recuperation in preparation for the next attack.

Some caught up on sleep lost during the bectic days they had just passed; others cleared out of the base altogether to aim at kangaroos instead of Japs, or to relax with the kindly folk at quiet sheep stations; still others sought relaxation on tennis courts, in the swimming pool, at the roller-skating rink, or in the movies. Two officers quietly went on with the building of model bombers.

Combat crews received assignments on the average of once every ten days or two weeks, sometimes even more frequently. Most trips lasted from two to five days, some possibly a week, the length of time depending on targets and weather conditions.

After the 24-hour grace following their return to the home base, the airmen had few definite or regular duties. Of course several officers were detailed to necessary routine jobs, but the commanding officer arranged for



Knights of the Air Get Down to Earth and Dig Trenches in a Cotton Patch

At "Camp Muscle" the writer found even officers, "stripped to the waist, energetically digging" (page 70). Slit trenches provide shelter in event of air raid. Sandbags will absorb shock of bomb blasts. Some must be Queensland, only Australian cotton State. The Dominion produces some 12,000 of its 80,000-bala requirements a year. Production has been stimulated by the war.

them to take turns at the work so that no one man got an unfair share. Generally, officers' tasks were primarily supervisory. After all, the real job of combat crews was to drop bombs on enemy targets and bring themselves and their planes back alive—if they could.

While dressing one early, bleak morning, I sang out a "good morning" to a co-pilot. Someone who overheard wanted to know what was good about that morning. The co-pilot shouted back exuberantly that it was good to be alive—a trite bit of repartee, but none-theless sincere.

Tough Fighters Like Tea Parties

Since reaching Australia, the Americans had acquired the Aussie habit of drinking lots of tea, and liking it. Their regular tea parties helped pass time while they were waiting for word to get going on their next mission.

Most of us went to the local welfare room for tea. The friendly ladies who ran the place put a price only on tea, which was pretty hard to get in wartime.

They donated all the bread for toast and sandwiches, and they made the cakes with their own hands in their own kitchens. Moreover, the women workers volunteered their services. The tearoom admitted only men in uniform; at any time between 10 in the morning and 10 at night American airmen could be found at the tables.

I could have continued living with this group of airmen indefinitely. Just being with these fellows was my best form of relaxation in 15 months away from the United States. They were the kind of boys I had grown up with—my own people.

Like most good symphonies, my visit to the unit ended on the same note with which it began—that confidence-inspiring drone of a Flying Fortress's motors. Captain H, arranged for me to fly to my destination in one of his planes.

Before leaving the heavy-bombardment unit's operational base, I learned that the whole outfit planned to move into a bush camp hundreds of miles away. Some weeks later, at the invitation of the commanding officer, I arrived at the new base,

I had already seen these airmen living under relatively civilized conditions. Now they lived in, and worked out of, the wilderness. Instead of being quartered in a hotel, municipal auditorium, and Masonic hall, officers and enlisted men camped in tents among



Five Injured Heroes of a Fortress Crash Receive Congratulations from Friends

Four with bandages and a fifth in bed are survivors of a wounded Fortress's blazing fall. The author, who
visited them, tells the story of their extraordinary courage in carrying men from the flames (page 67).

gum trees, anthills, and indelible red dust which got into and through everything (page 65).

Promotions and personnel transfers, in addition to different physical conditions, vastly altered the general setup. Captain H. was Major H. Captain P., now Major P.—leader of B flight on my first mission—had gone to another heavy-bombing unit as commanding officer. Officers I had never seen before had moved in. However, some of my best friends were still second lieutenants. Three of them reserved an extra bed in their tent for me.

The unit reached the new base only a week before I rejoined it. All the men I talked to seemed keen on life in the bush. They emphasized its healthful aspect to the point of naming it "Major H.'s Health Farm"; but they did not like too well having to get up ahead of the sun for calisthenics.

Because of the work they had to do to make the place livable, they called it "Camp Muscle," First afternoon there, I saw officers themselves outside their tents, stripped to the waist, energetically digging slit (or sweat) trenches.

Missions continued as usual. One night Don and Al, two of my tentmates, told me they would take off within the next few hours. Before falling asleep, I asked them to wake me when they got up so that I could say goodbye. At five in the morning someone came to the tent to rouse them. That voice had the rasp of an ominous summons in the cold, dark silence of the bush.

Some Go Out Never to Return

Don and Al dressed automatically and collected personal necessities for the mission in little knapsacks. I did not speak but waited for them to finish their preparations. When they left the tent, I thought it was to wash. They never came back.

I lay awake for some time, thinking of these American airmen disappearing into the darkness and cold of early morning to—to what? I thought of how casually they had got up and dressed. They had made it look as if they were setting out on a harmless practice flight. I never saw them again.

COMMUNIQUE: "Against antisircraft fire and fighter interception, Allied heavy bombers successfully struck Vunakanau airdrome [at Rabaul]. Fifteen tons of bombs hit the target area. Twenty Zero fighters engaged our formation. Seven enemy fighters were shot down in combat and others damaged. One of our planes is missing, and we sustained minor damage and some casualties in others."

War Finds Its Way to Gilbert Islands

United States Forces Dislodge Japanese from Enchanted Atolls
Which Loom Now as Stepping Stones along South
Sea Route from Australia to Hawaii

By SIR ARTHUR GRIMBLE

Formerly Senior District Officer of the Gilbert and Ellice Islands Colony, Now Governor and Communiter-in-Chief of the Sevehelles

With Illustrations from Photographs by Dr. Raymond A. Dillon

PRIOR to December 7, 1941, few people knew anything about the Gilbert Islands, and fewer still had been there. Even the cartographers had conspired to overlook them, for it was only on the most detailed maps of the Pacific that their individual names were recorded.

However, a few days after the treacherous attack on Pearl Harbor the Japanese occupied Abaiang and Makin (Butaritari) in the northern part of the group, and it was reported that they had evacuated the population of a third, Tarawa. They immediately began to turn Makin into a seaplane base from which to launch attacks on shipping between Hawaii and Australia.

In the sudden raid of January 31 the United States Navy shelled and bombed Makin, and on August 17 a task force of the United States Navy and Marines raided the island and destroyed Japanese ships, radio, and air-base installations, stores of food and gasoline, and all but two of the 350 defenders.

Thus war has brought into sudden prominence 16 inconsiderable and previously little known atolis cut by the Equator and the 175th meridian of east longitude about 4,700 miles southwest of San Francisco (map, page 74).

A Streamer of Islands 3,500 Miles Long

The Gilberts form part of that multitudinous archipelago of gemlike islets called Micronesia, which, beginning with the Palau Islands, at the gates of the Netherlands Indies, stretches eastward a full 2,000 miles above the Equator, then curves away to the southeast, crossing the Equator at the Gilbert Islands, as shown on the map on page 74.

Tiny islands—some 3,500 miles of them sparkle "like jeweled plumes at random thrown" by a Master Hand through the murmurous and sapphire solitudes of the central Pacific.

The 16 Gilbert atolls, despite their wartime prominence, do not bulk large amid so vast a concourse, and statistics seem to render them more insignificant still.

Their collective area amounts to only 160 square miles; not one of them rises as much as 15 feet above sea level, or exceeds in width three furlongs from beach to beach. They are mere ribbons of coral rock, from 10 to 50 miles long, topped with a soil so sandy that it supports no useful plant save the coconut, the pandanus palm, and an inferior taro,

Yet these islands, which have neither stream nor mountain, and lack the barbaric and colorful luxuriance of vegetation usually associated with the Tropics, have rare enchantment. Here it is form, not color, that charms the eye—the exquisite penciling of palms overleaning the lagoons, the rare gradations of light and shade, the matchless transparencies of atmosphere.

They enjoy, as Robert Louis Stevenson wrote, "a superb ocean climate, days of blinding sun and bracing wind, nights of a heavenly brightness."

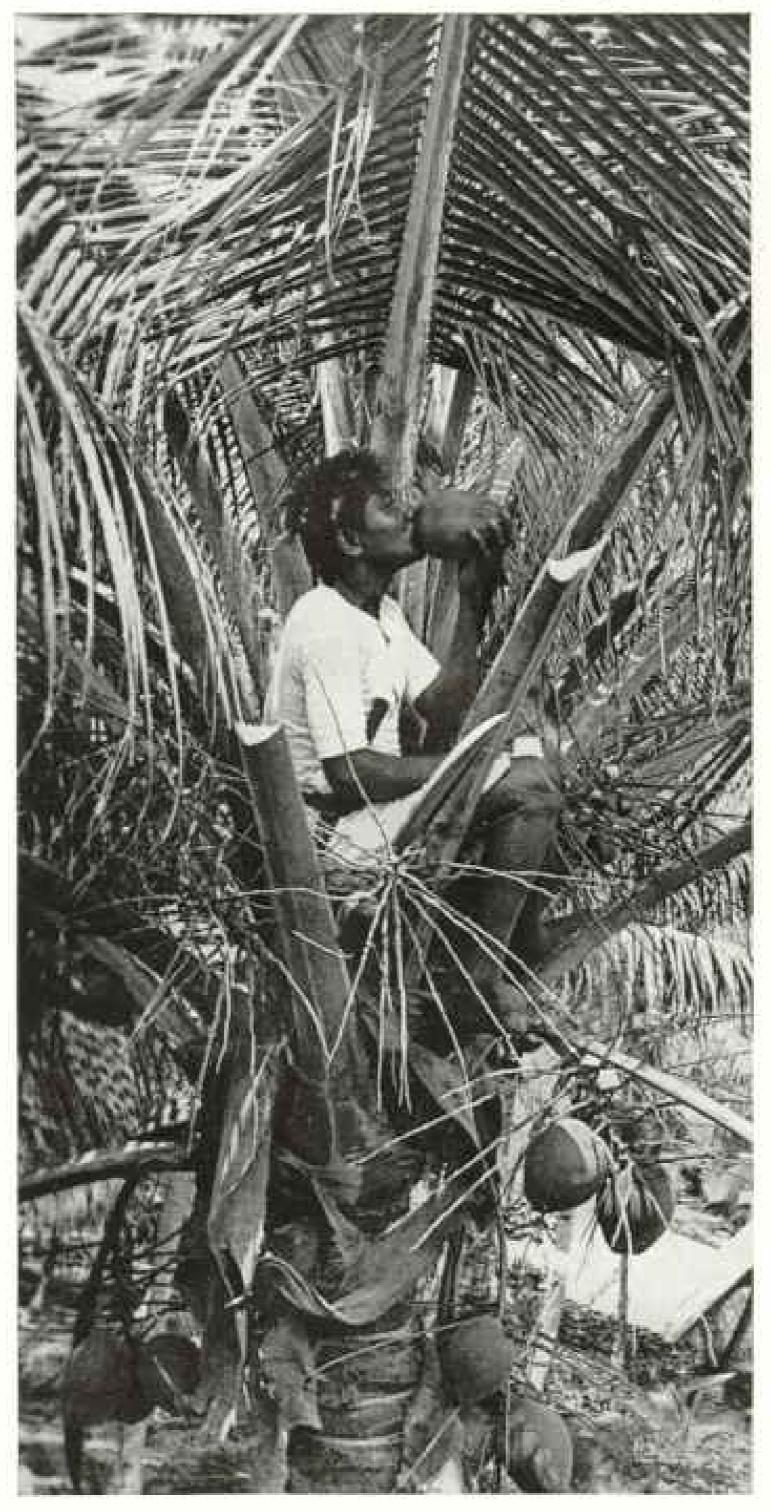
Famous Explorers Visited the Group

According to native tradition, the first white man seen in the group arrived 14 generations ago, or, say, at the end of the 15th century. He is reported to have come to the island of Beru, alone and nearly dead, "in a boat shaped like a box."

He was "tall as a giant, but very thin, like a lizard, with a head narrow like the blade of an adze," His hair was red, and he had a heard "that hung in two long points below his middle."

From this description, the stranger seems to have been of Caucasian type, and the boat "shaped like a box" suggests a craft of European construction. Possibly he was some driftaway from a Spanish ship in these waters.

*Their names are shown on the National Geographic Society map of the Pacific, February, 1942; Beginning at the north they are: Makin Meang (Little Makin), Makin (Butaritari), Marakei, Abaiang, Tarawa, Maiana, Abemama, Kuria, Aranuka, Nonouti, Tabiteuca, Beru, Nukunau, Onotoa, Tamana, Arorae.



Japanese Snipers Fired from Such Palm Trectops at the Marines

To this Gilbertese his lofty perch is merely a cool place to enjoy a drink of coconut milk, but to the Japs such cyries were ready-made ambush nests. Sharpshooters were lashed in them for several days before the August 17 raid. When asked how close the Japanese bullets came to him, Major James Roosevelt replied concerning the snipers, "We got 'em,"

Nukunau was sighted by Capt. John Byron (the poet's grandfather) of the British Navy in 1765. Most of the middle and northern islands were next discovered by Captains Gilbert and Marshall in 1788, and the rest had become known by 1828.**

In 1892 the Gilbert group, together with the Ellice Islands directly to the south, was converted into a British Protectorate, which in 1915 became a Crown Colony.

Administrative headquarters are at Ocean Island (famous with Nauru for its phosphates), which lies some 250 miles west of the central Gilberts. The Colony is under the charge of a Resident Commissioner, who is responsible to the High Commissioner for the Western Pacific resident at Suva, Fiji.

The only important product of the 16 islands is copra, the sun-dried flesh of the coconut which is made to yield its oil to the soap manufacturers of civilization, its glycerine derived from the soap process to the chemists, and its refuse to the makers of cow cake.

The copra is not grown on organized plantations, for every square foot of land is owned by natives; it is made by the brown man and sold by him to local traders, who sell it in their turn to visiting ships. In this way, about 4,000 tons a year normally are exported to Australian ports.

A twenty-mile flake of coral sand, curved like a

* In 1841 two ships of Lieut. Charles Wilkes, of the United States Exploring Expedition, visited the group and made a careful survey, upon which later charts were based.



timutat Photograph U. S. Marles Corps

With a National Geographic Society Map Lieut. Col. Evans F. Carlson and Major James Roosevelt Plan the Makin Raid

Here they are studying the map at the U. S. Marine Field Headquarters near San Diego before embarkation. On the night of August 17, these officers led a raiding force of Marines ashore through the surf of Makin Island. Remaining 40 hours, they annihilated nearly 350 Jap invaders, destroyed the scaplane base, three radio stations, and military stores. This Navy-Marine expedition, under Commander John M. Haines, U. S. N., also sunk two enemy ships and destroyed several planes.

deeply flexed bow, with horns pointing westward—that is a Gilbert atoll. This wisp is crowned with one continuous, narrow grove of coconut palms, separating gleaming beaches.

Palm Trees "Like the Lashes of an Enormous Eye"

Within the silver-and-green crescent dreams the lagoon, shut off from the ocean by its enclosing reef, which stretches like a bowstring from tip to tip of the land.

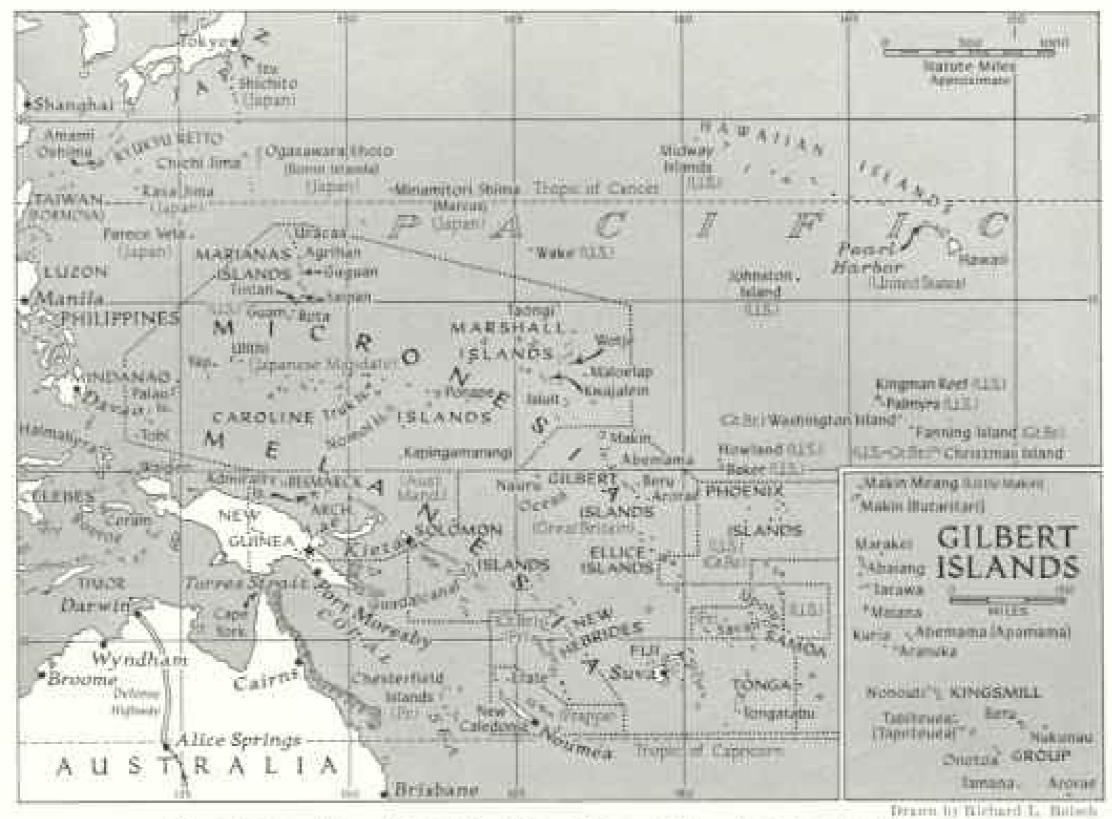
Across the lagoon from the entrance passage, the palms are seen tenuous against the skyline, like the lashes of an enormous eye.

The water under the blazing sun glows incandescent. Over the deep places burns a cobalt so vivid that it seems to be a pigment. Where reefs approach the surface there is imperial purple; by rocks awash is viridian; and where the shallows lie, there is a sheeted flame of emerald so fierce that it almost sears the sight.

Within the latticed shade of the palms that overlean the beach is an eternal cool. The gray-green of the foliage is grateful to tired eyes. Only the sound of surf, muted by trees and distance, steals through the sanctuaried stillness.

Poor in produce though the Gilbert Islands are, they are among the most densely populated groups in Oceania.

The 16 wisps of land support about 28,000 natives, more than 162 to the square mile. So serious did overpopulation become that in 1938-40 some 2,000 were transferred to the Phoenix Islands. The Gilbertese are one of the few native races of the Pacific whose yearly birth rate exceeds the death rate.



Global War Has Made the Tiny Gilbert Islands Strategic Prizes

Occupied by the Japanese immediately after the attack on Pearl Harbor, the northernmost of the 15-foothigh atolls, Makin and Abaiang, were soon being turned into lurking places for submarines and scaplanes to prey on shipping between Hawaii and Australia. The United States Navy and Marines, however, removed the threat by annihilating the enemy sea base at Makin (page 73).

The complexion of the average Gilbertese is midway between the light copper of Polynesia and the black of Melanesia; for here in the flux of race migrations black and brown have mingled to beget a hybrid folk.

Facially the native is aquiline. His brow is bold and intelligent, his nose salient though broad at the nostrils. There is decision in the thick-lipped but firmly closed mouth, pugnacity in the heavy jaw.

He carries his head high, and looks upon the world from level brown eyes in which lurks a shrewd humor. Not in this man will you find the melting languors of Polynesia. He is a lean and fighting type; his every lineament shows vigor.

Gilbertese Beauty Treatments Heroic

The women, wrote Stevenson, "cannot be compared with the Tahitian for female beauty." However, there is a frank and appealing good nature in them that has its own charm.

The ready smile of a Gilbertese girl is childish, dimpling, spontaneous; it lights up

the rather broad features and exposes teeth that bespeak cleanliness and health (pages 78, 79).

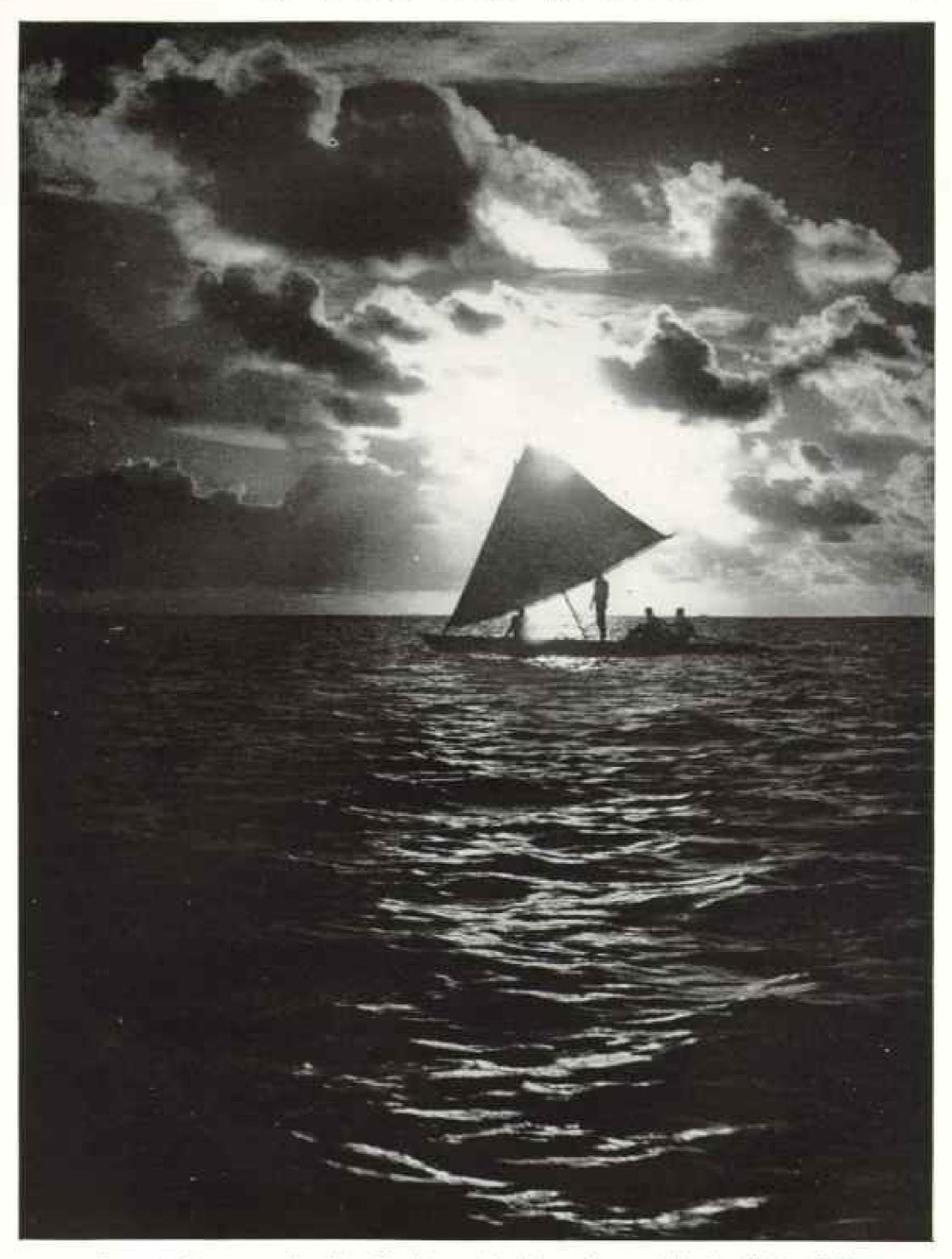
In the old days infinite pains were taken to preserve the loveliness of the tawny skin. Women and girls would shut themselves up for months in screened houses, wherein no sunlight could penetrate, for the sole purpose of improving their complexions.

Every day the whole body was massaged three times with coconut oil, washed with rain water, and then pasted over with the creamy juice expressed from coconut flesh.

After six months of such treatment a girl would emerge from seclusion, blanched almost white, with a skin, according to the native phrase, "as smooth as the garfish's."

Sex morality in the past was high. Girls went naked until marriage, and were protected by laws of extreme ferocity. To molest a maiden was to court death by slow strangulation, or by being tied to a log and floated out to sea as food for the teeming sharks.

In these days, however, morality is not so fierce. British law has abolished the death



Into the Sunset on the Vast Pacific an Outrigger Canoe Sails for Flying Fish

Distance has no terrors for Gilbertese navigators, who are taught in boyhood to steer by the stars (page 87). Among them is a tradition that one of their early adventurers reached the shores of the American Continent, more than 4,500 miles away. Not a bit of metal is used in building the craft. It is made of thin, hand-hewn planks lashed together with coconut fibers. The mainsheet of the sail is held between the skipper's toes.

penalty, robbing offence of its terror; and clothes have stimulated the lust of the eye and prurient thinking, which never before existed. Generally, the women go clad in what has been called "that aesthetic and hygienic abomination of the Pacific, the Mother Hubbard," a hideous smock of print that falls from neck to ankles (page 81).

In the more remote islands, however, especially when a dance is forward, one may still see girls wearing the old national dress, a simple kilt of grass that reaches from hip to kneecap and sets off to admiration their

comely suppleness of figure.

The old men, still clinging to the custom of their youth, are generally clothed in a mat of beautiful texture, wound about the waist and made fast with a girdle plaited of their wives' hair. The younger men use a loincloth of

trade print, worn kiltwise.

Shaded by palms just above the lagoon beach stands the native village. It consists of one long street on either side of which the houses are built at spacious intervals. The road is bordered with crinum lilies, their languid scent mingling strangely with keen sea smells from the reef and the acrid odors of native cooking.

The houses are mere thatches with eaves raised by corner posts a man's height from the ground. An elevated floor of coconutleaf midribs leaves an air space of three feet under each dwelling. There are no walls to exclude the sane winds of heaven, only leaf screens which may be let down from the eaves at night (opposite page).

Two trees supply all the material needed to build these rustic homes. The pandanus palm affords thatch, rafters, joists, and corner posts. Midribs for flooring and string for lashing the parts together are obtained from the coconut palm.

Walking down the village street between the lines of open dwellings, gives an impression

of cool spaciousness and health.

The casual stroller has no need to pry if he wishes to observe the native at home. He sees women braiding their hair, plaiting flower chains, changing garments, bathing children, weaving mats; and men taking their siesta, smoking, making nets, or sails. With interminable chatter and laughter the brown folk bandy their jokes and gossip from house to house. Nothing is secret in the village.

A Man Married a Whole Family

In these days a native is allowed only one wife, but formerly polygamy was the rule. A man married a whole household of sisters at a time; or, if his ceremonial bride had no sisters, he took with her all such first or second cousins on her father's side as might have been arranged in advance by private treaty. Furthermore, a man whose married brother died considered it his fraternal duty to take all the widows into his own household.

The primary object of such multiplication was to guarantee a husband against childlessness. If his wife were sterile, who, argued the native, could be a more fitting mother of his children than her own sister? If a husband died, who but his brother ought to save his widows from the reproach of barrenness?

"But surely," I once suggested to an old native, "in these small islands, where living is so hard, large families have always been

a great nuisance."

"Sir," he answered, "we had canoes, we had hands to fight with. And were there not many

lands around us to conquer?"

That is why infanticide, so common elsewhere throughout the Pacific, was never known in the Gilberts; and that, incidentally, is why the Gilbertese were the terror of all the surrounding islands within a thousand-mile radius.

Rigid Rules for Expectant Mothers

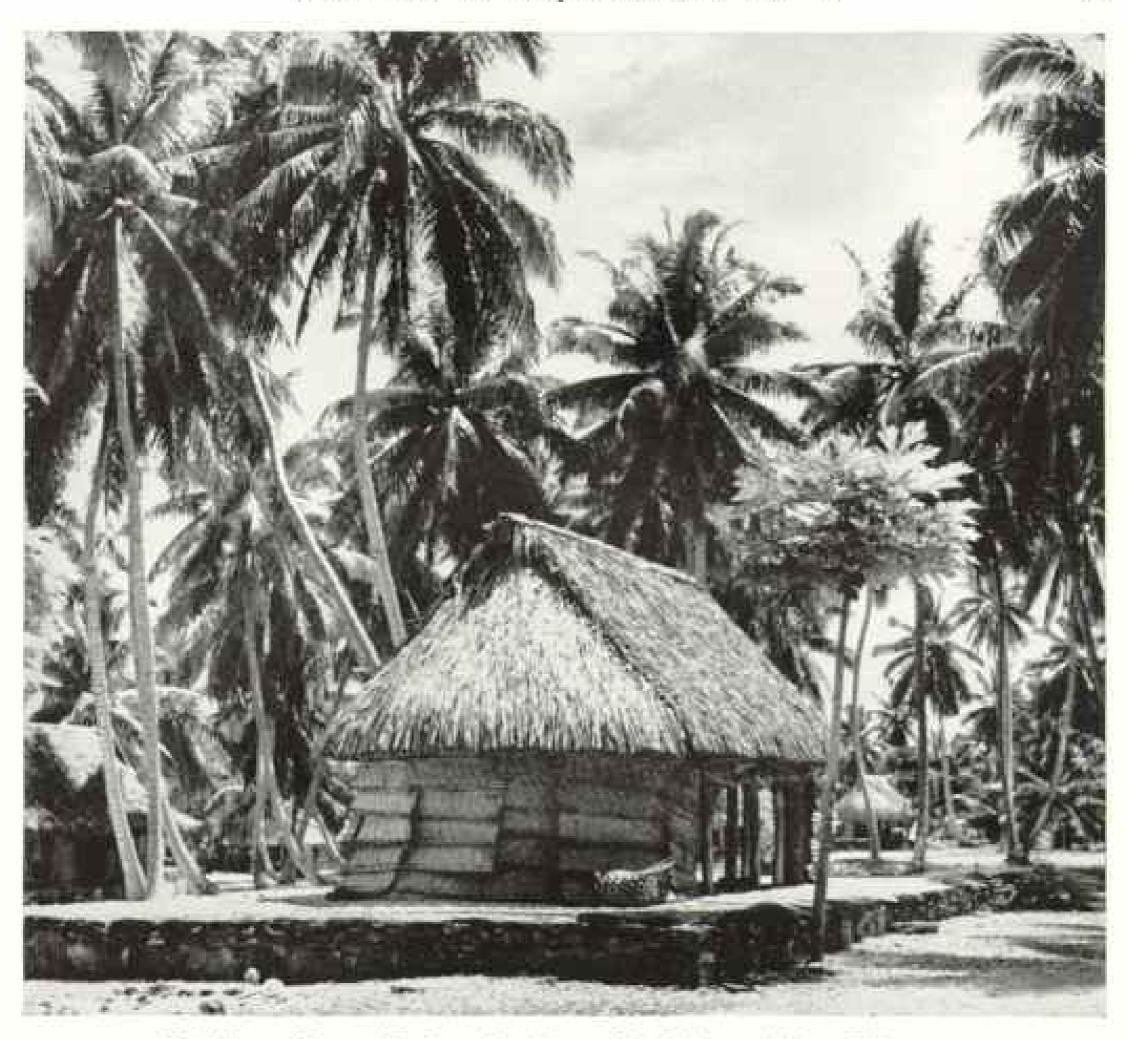
Many precautions are taken to protect an expectant mother, for she is believed to be peculiarly susceptible to the attack of sorcery. Her nail parings, hair clippings, and worn garments are carefully burned lest through these intimate things an enemy focus his magic upon her. She is festooned with amulets of leaf, porpoise tooth, and human hair; and protective charms are muttered over her at sunrise and sunset.

From her diet is excluded everything that tastes either very sweet or very bitter; she is given much coconut milk and large quantities of baked land crab, since these two foods are considered especially good for lactation.

Fish she may eat sparingly, but on no account may she touch crayfish, because it might cause her child to grow stiff bairs upon the face; flatfish, because, having both eyes on one side, it might induce a similar distortion in the unborn; turtle and eel, because they are "crawlers," and would make a cowardly toady of the child; or any slow-moving creature of the sea, for fear its sluggishness may be imparted to the infant.

On the other hand, shark and swordfish are esteemed the best possible diet; they are fighting creatures, and their courage may be conveyed to the unborn through the mouth of the mother.

In the center of the village, surrounded by a spacious square of shingle, is the Maneaba.



Well-kept Houses Reflect the Clean Healthiness of the Gilbertese

No filthy litter mars the villages, and for ventilation the houses are open to the breezes (opposite page). For building material the natives go to the sea, making walks and floors of coral gravel and foundations and pillars of lime from burned coral.

the general meeting house of the people, the hub of Gilbertese communal life. It is a thatch of colossal size, raised on monoliths of white coral. Its ridge, soaring 60 feet high, overtops the palms: its eaves descend to within three feet of the ground, so that a man must stoop to enter. Inside, it may be as much as 120 feet long by 80 broad.

Under that vast roof is a brown coolness, a solemn gloom. The place is awhisper with the voices of sea, wind, and trees, caught up and echoed as in a mighty sounding box. Between the ranks of soaring columns that support the shadowy rafters broods the quiet of a cathedral (page 85).

The Maneaba, a Community Club

This edifice is the focus of social life, the assembly hall, the dancing lodge, the news mart of the community, and the beloved resort of the aged, who, daily repairing to its peaceful shade, exchange in interminable mumbles their memories of the "days that are no more."

The Maneaba is sacred. No angry words may profane its quiet, no blows may be exchanged within its precincts; its timbers may not be insulted by careless violence; even the shingled space whereon it stands must be trodden by respectful and decorous foot.

Each native clan has its hereditary sitting place in the building, its privileged function in the ordering of ceremonial. The place of honor, where sit the so-called "Kings of the Maneaba," is by the stone pillar in the middle of the eastern side. That monolith is called "The Sun," a name also given to the clan which sits beside it.

The Sun clan is holy within the Mancaba.



In the Old Days the 10-year-old Girl Would Have Worn No Clothes

Civilization has introduced the Mother Hubbard for adult women, and insisted on at least a little covering for youngsters (page 76). This maiden flashes a ready smile, displaying clean white teeth. Her abundant hair is black and straight, and her hands are delicate.

Outside, war and the accidents of temporal life may have reduced its members to a state of serfdom; but this has not the slightest effect upon its prestige within the sacred edifice. The clan still enjoys the first share of any feast and the first and last word in all debates. It is protected by the fear of unnamable sanctions from contradiction, interruption, discourtesy, or any violence.

There can be little doubt that the Maneaba is the modern, rustic representative of an ancient sun temple, and that the Sun clan is descended from a caste of priests who officiated at an altar like the Sunstone.

When the Sunstone is erected in a new

Mancaba, the villagers chant an incantation:

O Sun, Lord, be vigorous upon thy foundation stone;

Be vigorous as thou standest above the horizon; Be vigorous as thou climbest the heaven.

O Sun, appear, show thyself above the horizon; Come to us, shine down upon us. Shine!

Health and peace! Health! Fruitfulness!

Visitors Must Know Their Genealogy

There are 27 clans scattered up and down the Gilberts and most of them have representatives on each unit. The sense of kinship between the dispersed fragments is wonderful. A native of one island may travel to another. a total stranger and without money, yet quite confident that, once he can prove membership in a given clan, friends, food, and money will be his.

He simply goes, upon landing, to the nearest village Maneaba, spreads his mat in the hereditary sitting place of his ancestors, squats there, and waits. Within ten minutes, the news that a stranger has visited the Maneaba will have reached the utmost recesses of the village.

Probably the house-to-house gossip will have supplied the newcomer with a detailed, topical, and untrue personal history.

Within twenty minutes, a small crowd containing two or three of the older men will have drifted into the Maneaba. They are all members of the clan whose seat the stranger occupies.

"Sir," says the clan spokesman, squatting before the newcomer, "thou shalt be blest."

"Thou shalt be blest," is the answering courtesy. Then there is silence, broken by the occasional sibilance of insucked breath.

"Sir," resumes the spokesman after a while,
"I would ask a question."

"My ears are thine; my tongue is thine."

"Tell me, then, whence thou comest."

"I come from the south." There ensues another long pause, ere the stranger proceeds to enlarge upon this information. "I come from that island in the south. I come from the island of Tamana."

Such is the ideal conversational style of the Gilberts.

"He comes," says
the questioner turning
to his friends (who
have already heard
every word so far
spoken), "from the island of Tamana, to
southward."

Chorus of friends:
"A-ii-a!" in tones of
infinite satisfaction;
and then, "Anaia"
(proceed).

The spokesman proceeds: "And where art thou sitting?"

"I am sitting in the sitting place of my ancestors,"

"And what is the name of that sitting place?"

"It is called Suchand-such."

"Yet, maybe, it is not the sitting place of thy ancestors."

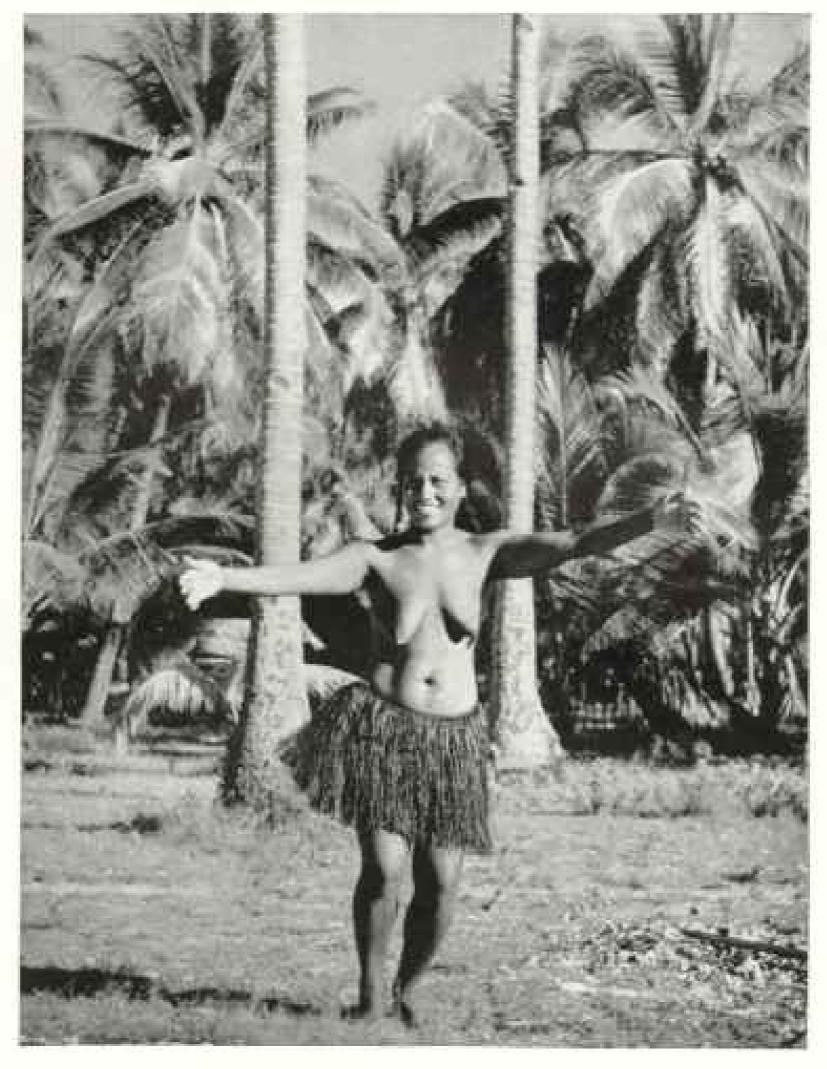
"Sir, it was the place of my father, and of his father before him, and of his father's fathers."

"Relate, then, the origin of thy father."

"So-and-so was his ancestor," answers the stranger, naming the legendary progenitor of the whole clan.

"Take up the tale," says everybody at once, and the newcomer enters upon his real examination. Under a raking cross fire of questions he must relate the ancestral traditions, down through the generations to the point when his own forebears branched off from the main stock.

The test is searching, the audience critical; but if the stranger's tale passes muster he is at once free to every house in the clan settlement.



Dancers in Remote Villages Wear Only Grass Skirts

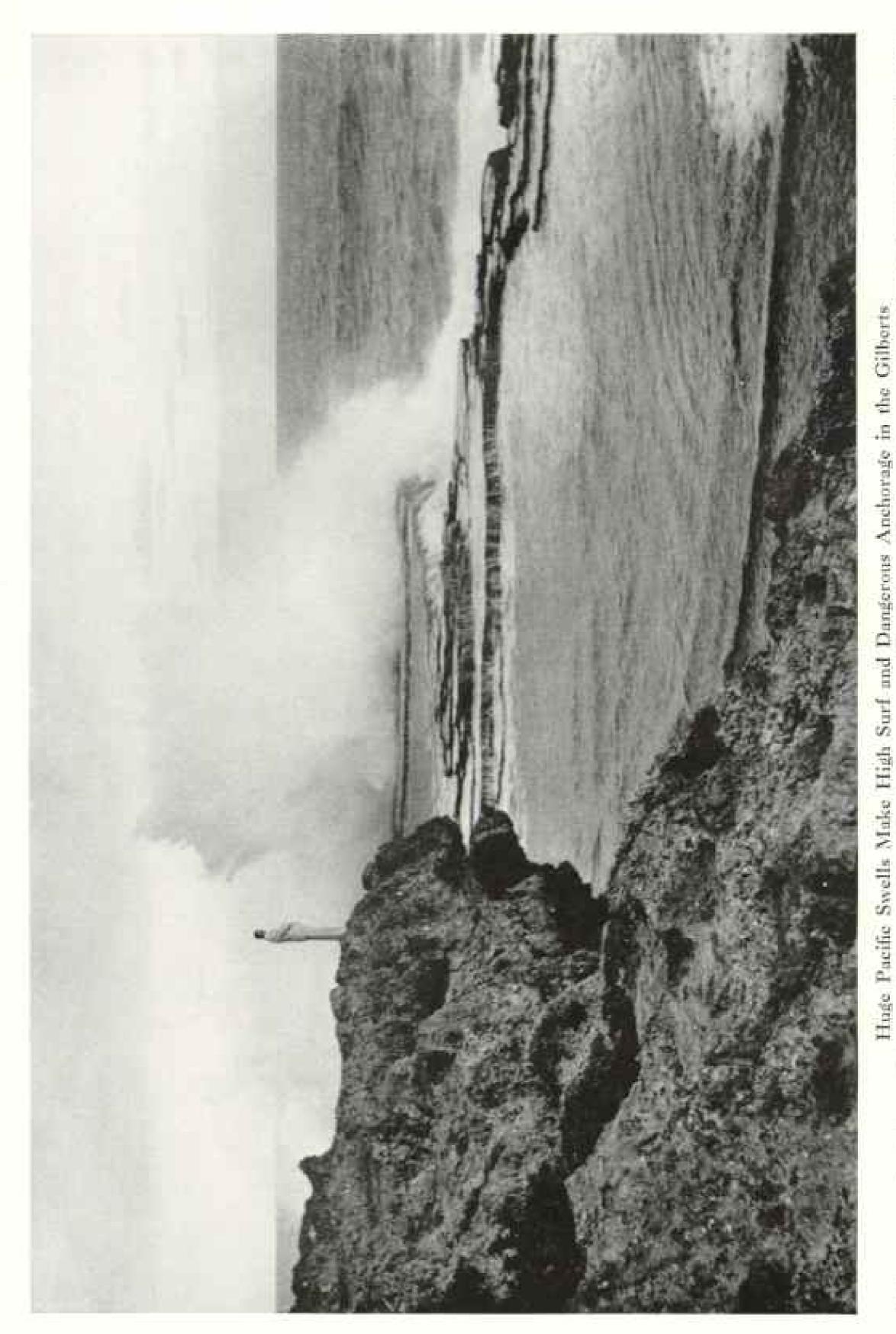
Although Gilbertese girls are not so pretty as their Samoa cousins, they are spirited and healthy. Their dances are similar to those of better known Polynesian folk.

He will receive food and clothing for as long as he cares to stay, and a handsome present of money on departure.

The Cult of the Skull

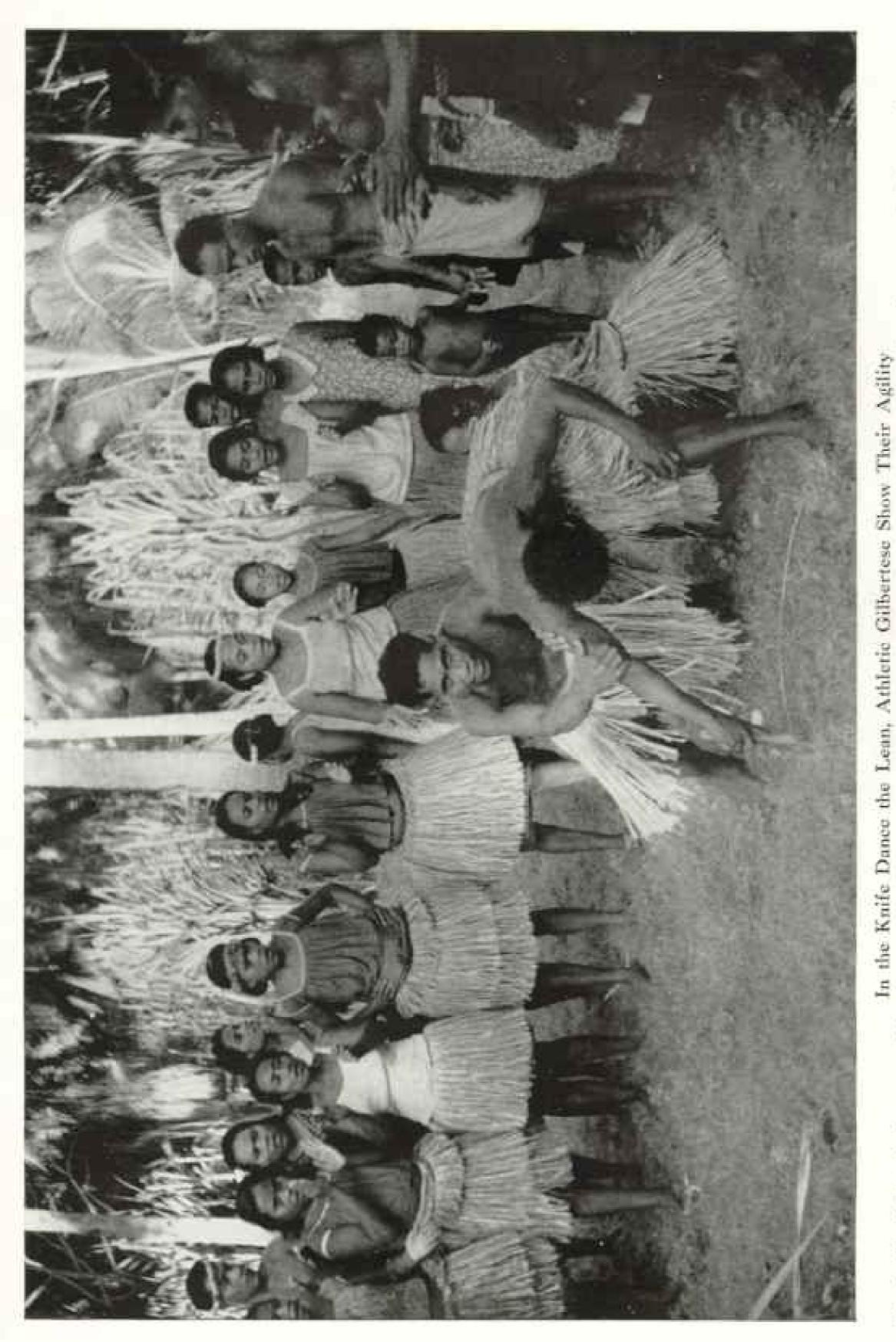
Strolling among the canoe sheds of a village one day, I came upon an odd sight. In the shadow between two canoes sat an old, old man engaged in conversation with a skull. He held the grim object at arms' length before his face, muttering endearments, and then, as I watched him, took it into the crook of his elbow to fondle it as a child.

When he had set it down on the ground before him, and remained in pensive silence, I asked, "Grandfather, what are you doing with the skull?"

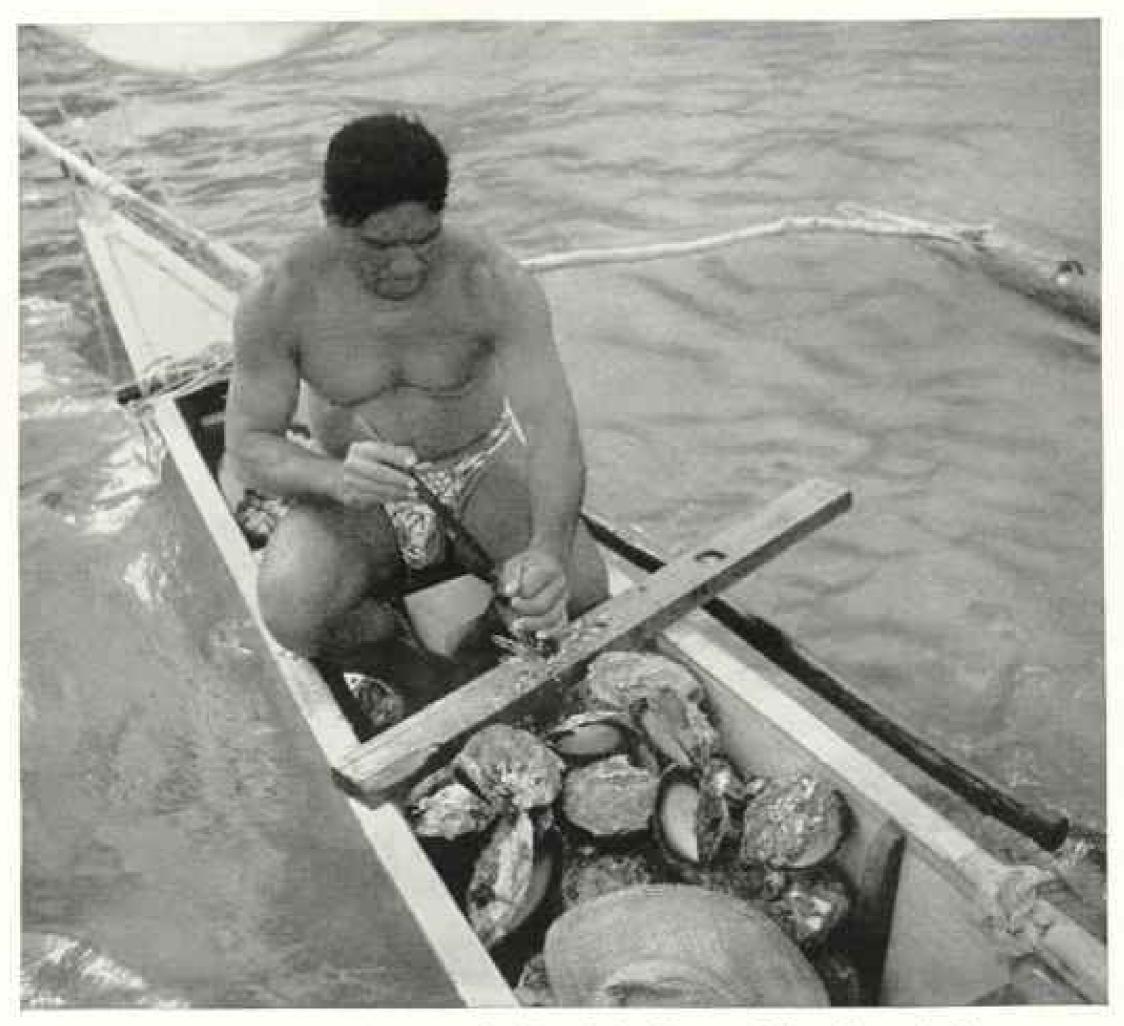


In the group are few harbors safe for vessels larger than the matives' outrigger canons. The best are at Makin and Tarawa, occupied by the Japanese in December, 1941,

By the taid of August 17, United States Navy and Marine forces nipped in the back the enemy's attempt to establish a sea base in the islands.



a native swimmer disembowels a shark. Though induced by missionaries to cover their breasts, the women, In the larger settlements the shapeless Mather Hubbard is the approved feminine apparel. The backhanded stroke demonstrated here is one with which don grass skirts for a festive occasion (page 76).



Occasionally Gilbert Fishermen Find Pearls in Oysters Taken from the Lagoons

This part of the South Pacific, however, is not notable for such treasures of the deep. Virtually the only source of revenue is copra, the dried meat of the coconut, which the natives, who own all the land, sell to traders,

With perfect simplicity he answered, "Sir, I am loving it. Is not the skull of my father's father very meet to be loved?"

I offered him my pouch. When his pipe burned well, he picked up the skull again, and began to blow rich puffs of smoke between the grinning teeth.

"Enjoy the sweet smoke, O my ancestor," he said. "Is it not good? Is it not delightful?" With affectionate chuckles and chirruping he rubbed noses with the relic and replaced it on the ground.

"Indeed, it lives," he said in answer to my query, "for within it and around it hovers forever the spirit of my ancestor. If I feed this skull, he tastes the food; if I anoint it with oil, he savors the smell; if I pray, he hears my prayer; if I love, he loves in return." "Is the ancestor, then, a god?"

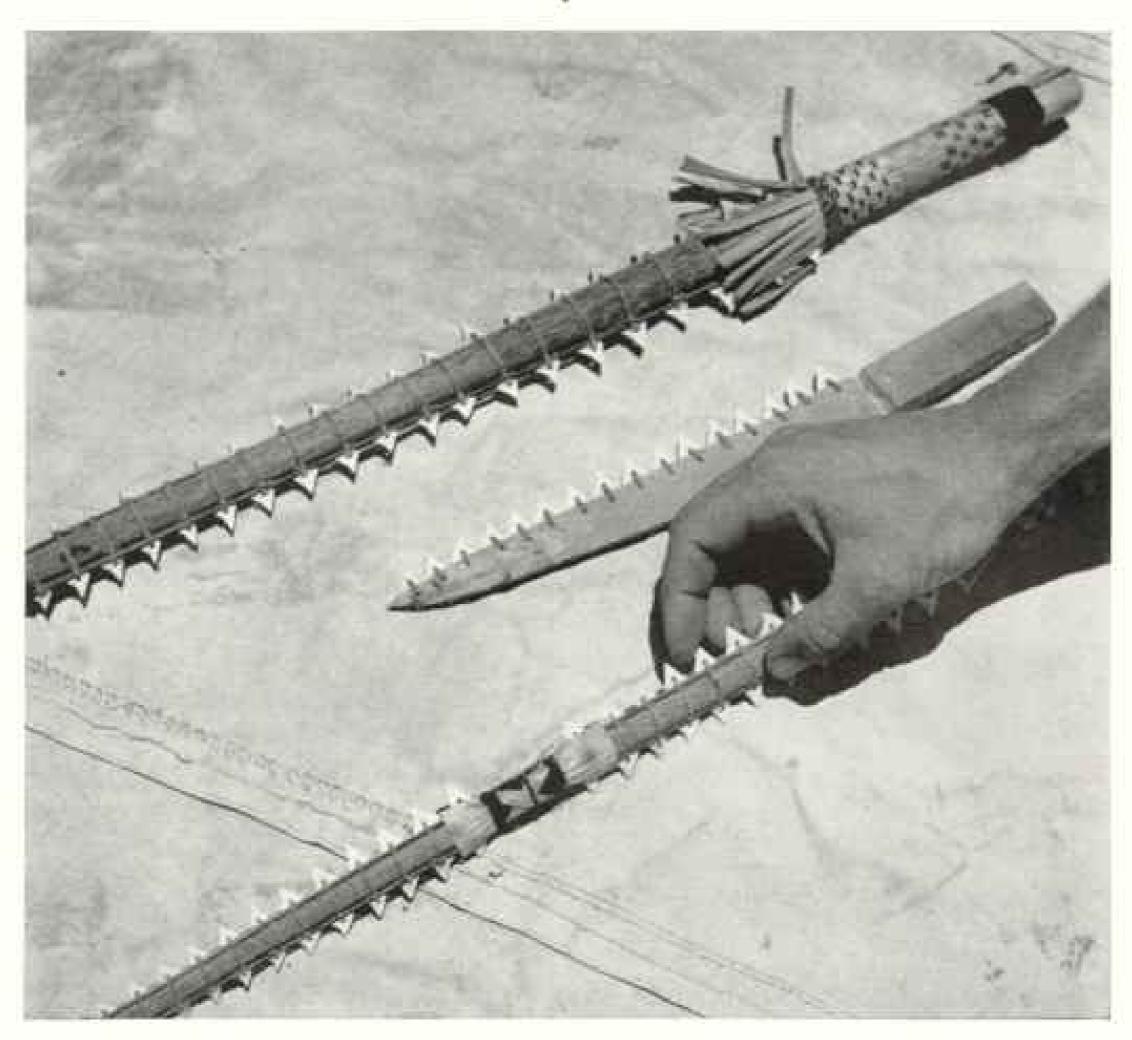
"No, not a god, but a friend of the gods of my clan, and a friend of the people of my clan."

"And what services may men expect of him?"

"He will give us abundance, and rain in season, and health; he will bring fish to our fishers; and when we die, he will await us by the sea, so that he may lend us to the Land of Spirits over to westward,"

Nowadays missionary effort has converted the majority to Christianity, and Government regulations concerning the burial of the dead have made the cult of the skull impossible. Only a few aged men and women who have managed to keep ancestral bones intact still practice the ancient faith.

The Gilberts are now 72 percent literate,



Sticks Edged with Sharks' Teeth Serve as Weapons for the Gilbertese

With such crude knives—they have no metal or suitable stone for axes, blades, and arrowheads—the daring natives attack and kill tiger sharks and even the deadly "gray ghost." These people were formidable in battle, too, and for generations were the terror of the islands within a thousand-mile radius (page 76),

though probably fewer than 100 white people live on the 16 islands. At the time of the Japanese invasion a group of 25 Catholic sisters were working in the northern islands. Their fate is unknown.

Sorcery Slow to Die

Magic and sorcery have not died so easily; the practice and fear of these may, in fact, even now be said to dominate the native life. There is magic for eating and magic for drinking, for breathing, dreaming, fishing, climbing, and talking—for every human activity conceivable to an islander.

If a man has a son for whom he desires social success, he probably will pray for the boy in a perfectly Christian manner. He will not, however, disregard the extra chance of good fortune that magic offers him.

Just before surrise he will take his son to the eastern beach, seat him upon a stone facing the dawn, crown him with a fillet of coconut leaf, anoint him with oil, and, at the moment of sunrise, mutter three times over him:

By this crowning with a fillet, by this anointing with

Thou art beautiful, thou art the first of thy generation. Thou overturnest the hearts of the old men, of the warriots:

They shall gaze upon thee and eagerly speak thy name. Thou art become the child of the Sun:

Thy feet shall trend high places;

Thy heart shall burn, thy body shall shine;

Thy face shall be lovely and terrible;

Thy word shall be a judgment that is judged;

And only thy name shall be in the mouth of all people, Thine, thine!

The Sun is risen!



Among the Gilbertese Kite Flying Is a Favorite Sport

These 25-foot toys, flown without talls, depend for equilibrium on perfect proportion. An expert can manipulate one so that it travels up wind and soars directly over his head or does battle with another in the clouds.



At High Tide on the Ocean Beach Fishermen Boldly Launch Their Flimsy Canoes
No lagoon angling for them; they brave the open sea without thought of danger.



Meeting Place, Club House, and Sanctuary Is the Maneaba

Standing in the center of a spacious square, this cathedral-like thatch—perhaps 120 feet long by 80 feet wide—is the bub of Gilbertese communal life. Its ridge soars 60 feet and its sides come close to the ground so those entering must stoop. Inside, traditional places are reserved for each clan (page 77).

There are other spells of a more sinister kind, chief among which is the dreaded Water, or death magic. One of the many methods of "wishing to death" in the Gilberts is to curse the fire on which an enemy has cooked a meal. The sorcerer secretly approaches the smoldering embers, and, stirring them with a piece of green wood, intones:

Spirits of sickness, spirits of fear, spirits of rottenness! Stab him, pierce him! So! (he stabs the fire)

Strike him! Rend him apart! His bowels heave: the pain begins,

His vitals are overturned, they are torn apart, they die. Shame him! Confuse him! Torture him! Strangle

him! It is finished; he is dead; He is dead, dead, dead.

He is rotten

Could anything be more utterly impregnated with malignance? And it is a malignance that too often through the power of suggestion achieves its aim—the death of the victim.

The Government has been obliged to prohibit the practice of sorcery under pain of imprisonment, but it has not yet banned the sort of charm that the children use to put a star to bed at night:

Mr. Star, thou, the little one, Wink once, wink twice. Thee I have chosen; thou art sleepy!
Thou sleepest, Mr. Star, thou, the little one,
In a little cloud.
O-o-o-a-a-a! Sleep!

Does not this compare well with our own "Twinkle, twinkle"?

The Origin of the Gilbertese

To understand who the Gilbertese are and how they came to populate these 16 small land flakes so far from any mainland, one must piece together their centuries-old traditions.

First dwellers in the islands were a small, black-skinned, large-eared, flat-nosed race, much addicted to sorcery, whose deities were the spider and the turtle. Though acquainted with fire, they probably reserved it as an object of worship, and ate only uncooked food. In very early times the spider folk were overrun by immigrants from the west.

The newcomers were utterly different from the autochthons. They were of great stature, light brown in color, and had no knowledge whatever of magic or sorcery. They practiced the cult of the ancestor. That they were essentially a maritime race may be gathered from their traditional names—"Children of the Sea," "Fierce Fish of the West," and "Fighting Sea Birds." They came from



The Yankee, Nearly a Year in the Vast South Pacific, Sighted Only One Steamer

Blacked out, this vessel was carrying phosphate from Ocean Island to Australia. German raiders soon afterward sank most of such cargo ships, including that on which the American voyagers were sending home mail and curios (see "Westward Bound in the Yaukee," National Geographic Macazine, January, 1942).

Boeroe, Halmahera (sometimes known as Gilolo), Ceram, Waigeo, south Celebes, and other islands in this area.

This swarm of mighty men would have destroyed the puny Spider folk root and branch had it not been for one thing—the need of wives. They had left their women at home; they had to marry into the black race. Thus, their descendants were a hybrid stock, in which black and brown were equally commingled.

The tale carries us now 1,200 miles southeastward to Samoa. Only a fraction of the big men from the west settled in the Gilberts: the rest, a great multitude, turned southward down the chain of islands, through the Ellice group, and so on to Savaii and Upolu of Samoa. There they remained for perhaps as long as seven centuries, only to be driven out in the end. By Savea, a great national chieftain of the Samoans, they were scattered over the face of the Pacific during the 15th century of our era.

Learning Navigation and the Stars

Some fied as far as New Zealand, some to the Cook Islands. A third horde came back northward, along the old migration track, to fight for a foothold in the Gilberts, where their ancestral kin had settled on the southward course so many centuries before. They overwhelmed the whole group by sheer force of numbers. The people of today reckon their descent from these warriors, outcasts from Samoa, who yet were able after such a rout to win new homes in the Gilbert Islands.

This is a race of seamen. There are still graybeards in the group who have made voyages of more than a thousand miles in canoes sewn together with string. Until 30 years ago interisland trips of 250 miles and more were regularly made in these frail craft for the purpose of exchanging dances!

Only the night sky gives the brown man his sense of direction in the huge emptinesses of the Pacific. He navigates as we do, by the stars. He has a general knowledge of the heavens that many of our own skilled navigators might well be proud to possess.

My old friend Biria of Makin (Butaritari) has told me how, 60 years ago, as a boy of about 14, he was instructed in astronomy. His lessons did not begin under the stars of

heaven, but in the village Maneaba.

He was made to sit at the base of the central pillar that supported the ridgepole, facing the eastern slope of the roof. The eaves represented the eastern horizon, the upward slope of thatch the eastern sky, and the ridgepole the meridian. The summit of the central post by which he sat represented the star Rigel, and from that central point in the heavens began the boy's instruction.

Just as the roof was divided by lines of rafters, so the heavens were plotted out for him in lines of principal stars. Every constellation of the Gilbertese chart was allotted its imaginary place in the thatch, according to what we would call its angular distance from Rigel, and its declination north or south

of that star,

The Gilbertese Knows His Stars

Line by line he learned them: first the middle rank with its leader Rigel; then a line to the north, led by the Pleiades (Seven Sisters); and after that, a southern rank led by Antares and so on.

Before the pupil was allowed to identify a single star in beaven, he had to name wordperfectly a list of no fewer than 178 stars, constellations, and nebulae; to indicate their relative positions with precision in the rafters; and to say at what height above the caves (i. c., the horizon) any one of them might be observed at surrise or sunset during any given season of the year.

When these elements were firmly fixed in his mind, he was made to memorize separate and individual lists of stars by which courses might be steered to the lands included in his tutor's geography. He learned, for example, how to navigate to and from Samoa, 1,200 miles to southeast; and Truk in the Carolines, more than 1,400 miles to northwest. There was talk of other lands, too, the existence of which was less well authenticated. For instance, there was Naba-naba to westward, the Island of Breathing Bones, inhabitants of which were animated skeletons.

Farther still to westward was Onouna, surrounded by whirlpools, and by caves that were the gullets of man-eating hags. To southwest lay Kabintongo, the Island by the World's Edge, where ocean plunged down in one vast cataract into unfathomable abveses.

cataract into unfathomable abysses.

Of all these lands of tradition, Maiawa should be the most interesting to Americans. It is described in travel stories as the "Wall at the side of the world, four moons' sail to eastward." It was discovered by one Raakau, the greatest of all Gilbertese navigators, who lived in the dim ages before the coming from Samoa.

Did Gilbert Canoes Reach America?

He reported it as a land that stretched along the "eastern edge of the ocean, to northward without end, and to southward without end." "Beyond the farthest eastward islands it lies," he said, "a wall of mountains up against the place where the sun rises, standing over plains full of fertility."

There is only one littoral in the Pacific that can be said to fit this description, and that is the western coast of the American

Continent.

Nowhere else in the world may travelers find a sport finer than the canoe racing in these lagoons of the central Pacific. The craft used for racing is the veriest knife-blade of a vessel, some 30 feet long and under 30 inches in beam amidships, built up of planks lashed edge to edge with string of coconut fiber, and stabilized by an outrigger. Not a nail or a piece of metal is used in its construction (pages 75, 82, 84, 89).

Under the pressure of its enormous triangular sail, such a vessel, on a calm day with a smart breeze, will attain a speed of 18 miles an hour. She reaches her maximum with the outrigger float poised a couple of

feet clear of the water.

It is the object of the man at the sheet to keep his sail just so full of wind as to heel his craft over to leeward, heave the float above the lagoon's surface, and keep it swaying there for miles at a stretch.

Helping him is a special outrigger expert, whose sole duty it is to watch that float. When it rises dangerously high, out he flings himself upon the outrigger, so that his weight, acting as a lever against the sail's pull, depresses it again toward the water and thus saves the canoe from capsizing.



For a Special Feast the Natives Cut up a Roast Pig

Pork is a rare treat, for feed is scarce in the islands, and few swine are raised. The regular diet consists of coconuts, an inferior sort of tare, and fish—particularly the recking flesh of sharks.

Before the float swings low enough to foul the wave crests and so reduce speed, back like a flash he springs to deck, leaving the wind to "pick her up" again.

A dozen canoes racing neck to neck with lifted outriggers, poising, swaying, swooping like immense dragonflies in the vivid sunlight across the emerald and turquoise face of the lagoon make an unforgettable picture. To be in one of these craft as she hurls her lean hull aquiver through the crisp waves is thrilling.

Shark Flesh a Favorite Food

A staple article of the islander's diet is, of course, fish; but his taste is hardly our own. Though the lagoons teem with delicious flatfish and crustacea, he much prefers the reeking red flesh of the shark. Probably this esteem for shark flesh is generated less by its actual flavor than by the difficulty of getting it. To the islander, the more dangerous the species the more succulent its flesh. Good as the almost harmless bluenose is, the tiger shark is better, and best of all is that bloodthirsty pirate, the gray nurse.

The hook whereon the native fisherman takes his ferocious quarry is an enormous wooden affair, not less than 14 inches long. For the sake of strength, it is grown to shape on the living tree. A young branch is bent to the required curve, lashed in position, and then left to "set" for a year, after which it is cut and trimmed to hook form,

The rest of the tackle consists of a 30fathom line of plaited rope (sennit) as thick as the middle finger. This, hitched around



Gilbertese in Canoes Swarm about a Visiting Schooner

When not in use, the woven mat sails are rolled neatly on the outriggers, for there is no room for them in the siender hulls.

some projecting part of the canoe, will resist the furious struggles of the biggest shark.

The heavy-barreled tiger requires a 30yard circle for doubling. For this reason a brown swimmer provided with a knife will face without fear the attack of a tiger shark. I have seen a native neatly avoid the rush of one of these brutes, and as it flashed by, rip its belly open for seven feet.

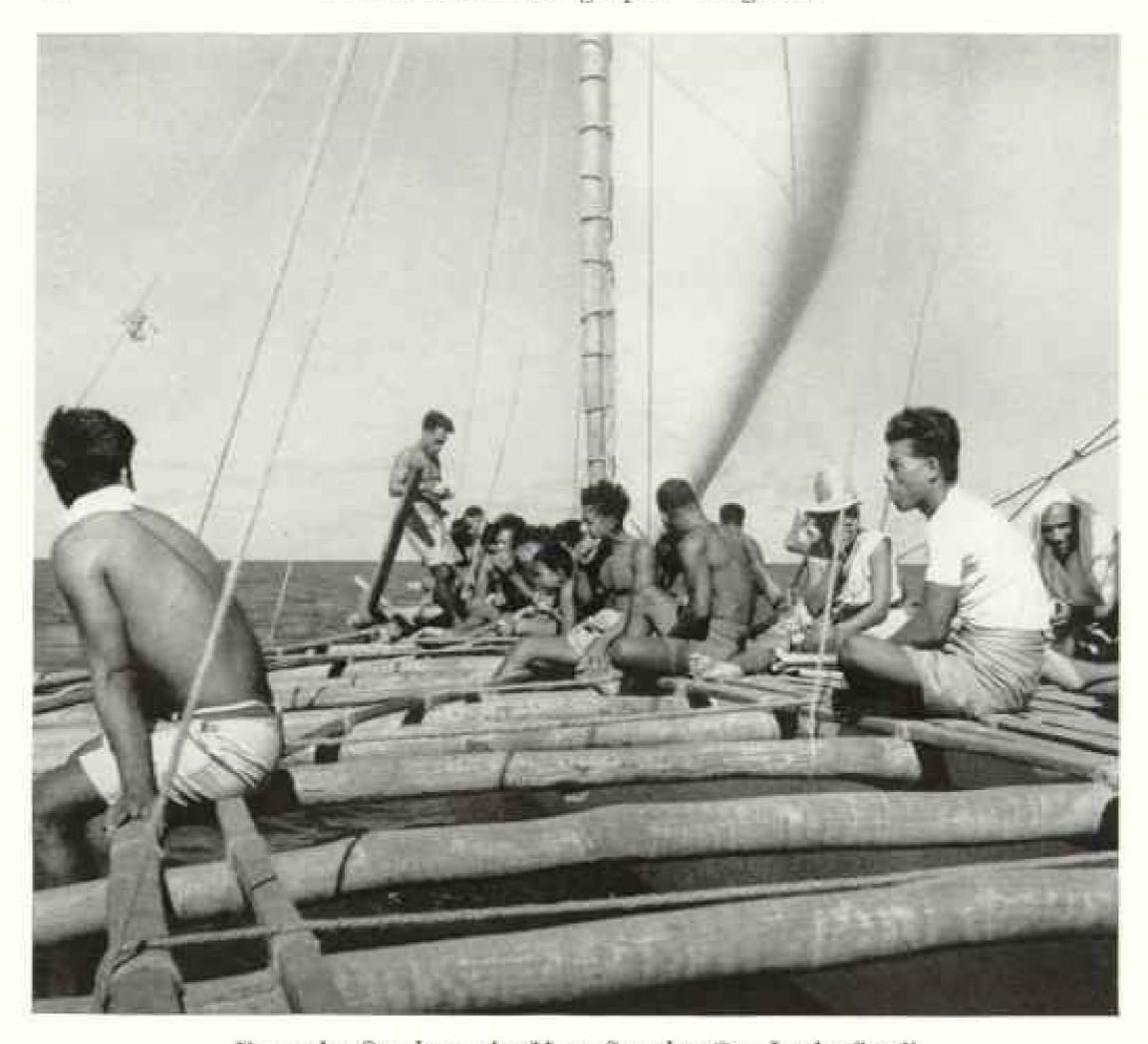
A Gilbertese of my acquaintance stood one day fishing with his brother, waist-deep on a sandbank half a mile offshore. Suddenly screaming, "A shark, a shark!" this brother disappeared in a welter of blood and foam.

The survivor returned home and brooded for a day on his loss, then arose and, taking a spear of ironwood, waded out to the fatal sandbank. He knew well that a shark always returns to a lucky feeding ground. Presently the enemy launched its tremendous attack, but the man was prepared. Side-stepping as it passed, he gave it the spearpoint in its belly. When it circled and came back, he did even better; straight for the gaping jaws he aimed his thrust.

The spear passed down the shark's gullet and a fathom deep into its entrails. The man was hurled aside unburt; the shark, impaled, raged a while and died.

The Road to Paradise

Hauled ashore, the brute was slit open, and entombed within it, still half digested, were found the remains of the man it had devoured the day before. These were carefully collected and given decent burial. Thus was a brother's death avenged and his path made easy to the Land of Shades.



From the Outrigger the Huge Steering Oar Looks Small

For the lads who clamber out on the framework to keep the speeding craft on an even keel clear vision of the steersman is vital. An unexpected puff or flaw might fling them overboard.

Two things assist a departing soul along the road to Paradise: the manner in which the body has been buried, and the tattooing which it bears.

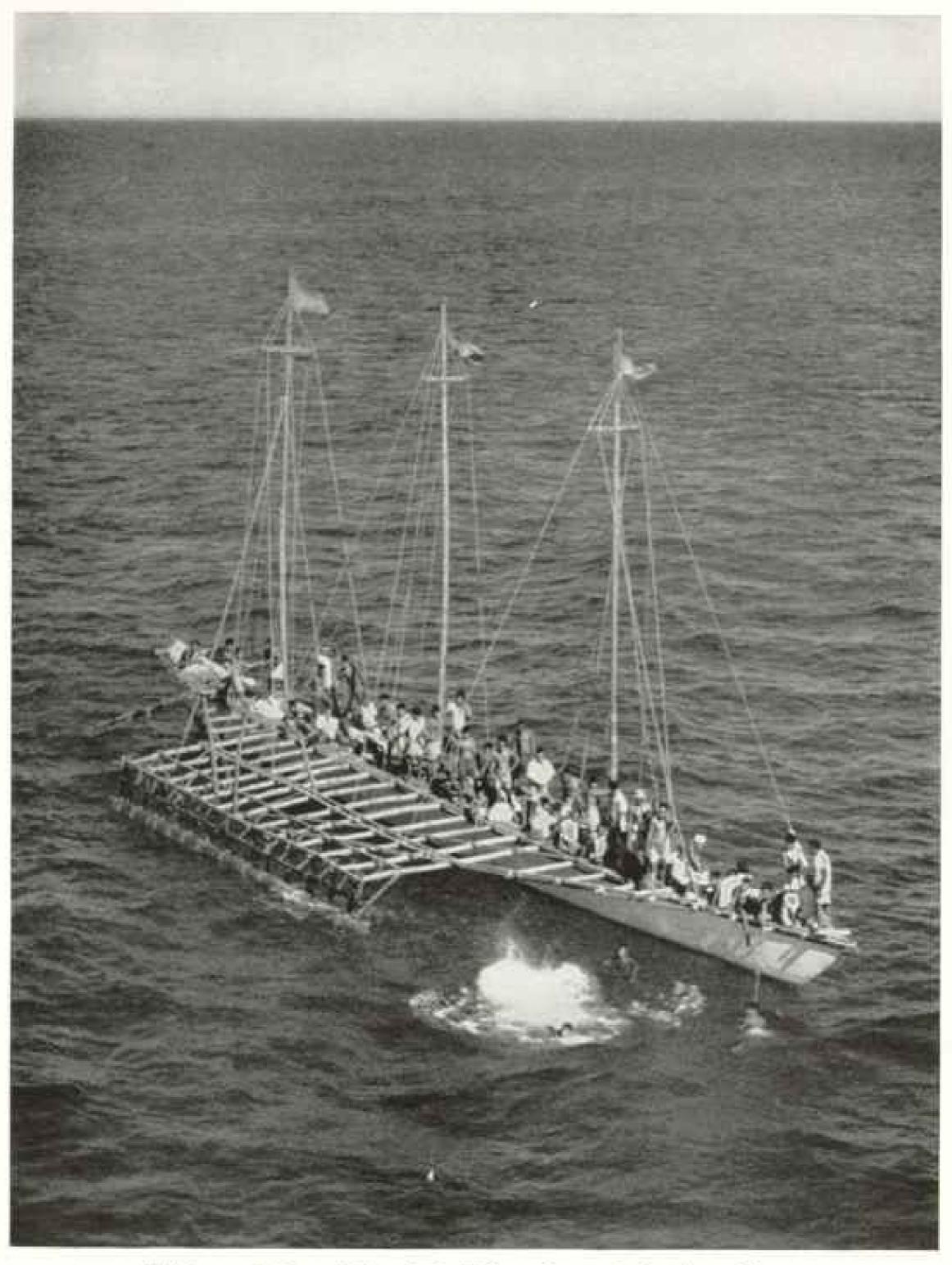
The dead must be buried with feet to westward, so that when the soul stands up out of the grave, it may walk straight forward to the western horizon. There the ancestral shades wait to welcome and guide it to the Happy Land beyond the world's western edge.

But even these companions cannot help the soul to pass the Bird-headed Woman who awaits it in midocean; only the tattoo marks on its skin can avail it in her presence, for these are her food and its passport.

With her long beak she picks the blue stains from the flesh and, satisfied, sends the soul forward on its way. But if she find no trace of the needle upon it, she plucks forth its eyes instead, so that it is doomed to wander blind forever, a lost soul, deserted of companions, over the empty spaces of ocean.

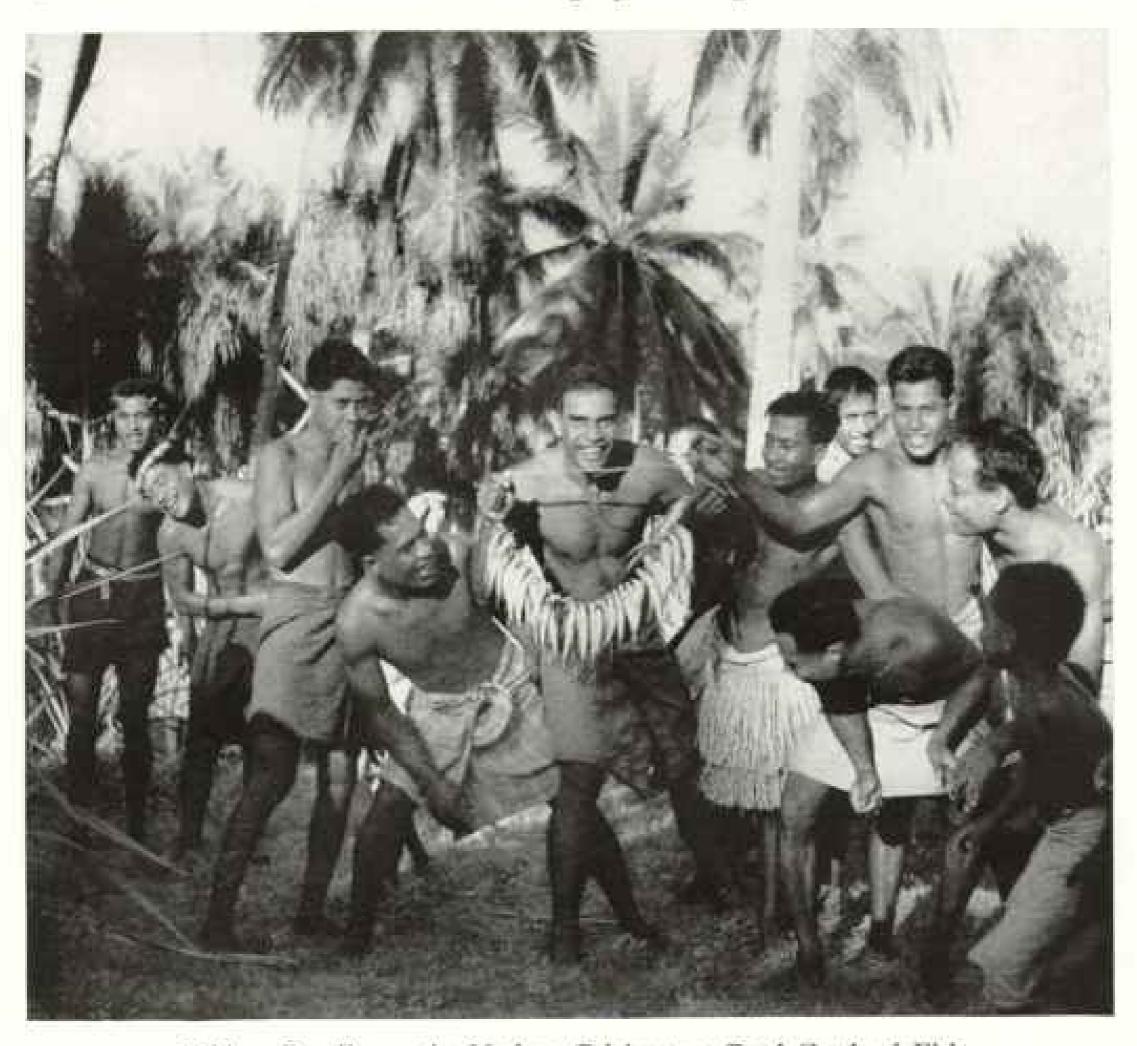
If a soul comes safely past the Bird-headed Woman, it is led without further obstacle to the very gates of Paradise. But there an even more terrible being awaits it—the Watcher with the Net. Caught up in the net of the Watcher, the trembling shade must endure the scrutiny of his all-searching eyes.

If during life the soul has been guilty of incest or of treachery to its clan, the Watcher will see its guilt and fling it into a dreary pit where, impaled on a wooden stake, it will writhe forever in torment. But if it be clean of offense, the stern guardian of the gate will release it from the net, smile, and say, "Pass on into the place called Bouro, where is neither war nor want. Eternal peace, eternal health!"



Tabitenea Natives Sail a Swift 96-foot, 3-masted Outrigger Canoe

Its width is 5% feet, freeboard 5 feet, and draft 3 feet. The outrigger is a single log about 49 feet long and 2 feet in diameter lashed to the hull amidships by thirteen 20-foot pieces forming a scaffold. The masts are 40 feet high. Since the deck is only half covered, it is possible to "go below" at any point. A red flag floats from each masthead. Like the smaller craft, it is constructed without metal, all parts being tied together with encount fiber.



With a Gay Dance the Natives Celebrate a Good Catch of Fish

They care little for the delicious but unexciting flatfish which abound in the lagoons but enjoy gamler kinds such as flying fish captured on barardous canoe trips and sharks killed by daredevil swimmers (page 58).

Most of us picture the brown man as a savage, pleasant-mannered enough to visit in an idle hour, but still a savage. As a poet whose work might bear comparison with that of our Western singers we simply do not think of him. Yet his songs are literature, though they have never been written.

Translation is the ultimate test of poetry. Hear how a lover sings of his mistress:

How deep are my thoughts as I sit on the point of the land

Thinking of ber tonight.

Her feet are luminous over dark ways,

Even as the moon stepping between clouds;

Her shoulders shine like Kaama (the Southern Cross);

Her hands in the dance

Trouble my eyes as the flicker of stars; And at the lifting of her eyes to mine I am abashed— I, who have stared undaunted into the sun. The brown singer knows full well that there is no subject however humble that cannot be turned to song.

Even in a little thing

(A leaf, a child's hand, a star's glimmer)

I shall find a song worth singing

It my eyes are wide, and sleep not.

Even in a laughable thing

(Oh, hark! The children are laughing!)

There is that which fills the heart to overflowing,

And makes dreams wistful, Small is the life of a man

(Not too sad, not too happy).

I shall find my songs in a man's small life; behold them soaring!

Very low on earth are the frigate birds hatched, Yet they fly as high as the sun

Here is a voice lifted in the sea-fast solitudes of the Pacific to celebrate the beauty that is in little things.

Your Dog Joins Up

By FREDERICK SIMPICH

With Illustrations by Staff Photographer J. Baylor Roberts

HIS is the story of how Uncle Sam is training big dogs both to help kill our enemies and to save the lives of Amercan soldiers.

In long, eventful years of world-wide reporting, I've never met up with a tale more bizarre, more unusual. Parts of it, in fact, seem so unreal—so incredible—that were the facts not proved by photography, and supported by official records in the War Department, I should not dare set them down,

Here we are at this minute, cameraman Joe Roberts and I, knee-deep in dogs at a "K-9" reception and training center far out in the Blue Ridge Mountains of Virginia.

Already a veritable army of dogs is here, and each day more and more recruits pour in. No sooner out of their crates than they're inspected, weighed, groomed, "manicured," and put to work.

Climb up on top this high hill in vast, busy, barking Dogtown, and look around.

From this vantage point you see and feel the size and growing power of this strange new army, and begin to realize how dogs can help win this war. You can't see it all at once, because too many things are happening (pages 96, 99).

Here comes one company of soldiers, each man with his dog on leash "at heel"; as men and dogs keep step, the soldiers sing, "Tramp, tramp, tramp, the dogs are marching..."

Down there in that flat some men hold dogs while others fire off guns to teach dog soldiers not to fear the roar of battle.

Two dignified Newfoundlands walk sedately up a hill, carrying packs—packs which in battle may include ammunition, machine-gun parts, telephone sets, or even food and water.

Dogs Carry Maps and Messages

Across a distant field messenger dogs are racing. To each dog's collar a waterproof metal capsule is attached. It may hold maps, secret codes, important orders, or frantic calls for more ammunition or reinforcements (page 106).

Up from a copse at the edge of a meadow comes a Red Cross crew. Its rescue dog has searched the "battlefield" and located a "wounded" man; then, returning to its trainer, the dog has "reported" its discovery and led the stretcher-bearers to the injured man, who is carried to the ambulance (109). Down on that other parade ground Coast Guardsmen put a pack of police dogs through their paces to help patrol the ocean beaches.

"One problem," they say, "is that our dogs cut their feet on broken sea shells, so we order little boots for them—not 'pairs' but 'sets' of four—hundreds of them." At one internment camp out west, says an officer, guard dogs have to wear leather boots because of cactus thorns.

Marines are here, too, for they use patrol, guard, and scout dogs in some kinds of landing operations.

Show Dogs Are in the Army Now.

"Previous condition of servitude" is no bar to canine military service. Before the colonel's office you see a troop of vandeville dogs putting on their act. They skip a rope, climb ladders, play sick or dead, put on and take off their own collars, steal a man's hat and run to hide it, raise a trunk lid and crawl in and then shut the lid, walk on their hind legs, and smoke pipes.

"They're smart, but they'll have to unlearn all that show stuff," you hear their trainer say. "That big Doberman Pinscher has played theaters from Maine to California, and an English circus once offered \$10,000 for him. But he's in the Army now—just another buck private who used to be a movie star."

Trainers walk in from the fields leading their dogs. They tie them up, each dog to his own one-room pine shack of a kennel. Some are bedded with cedar shavings against fleas; most have only straw. Stretching over the hills, rows of these kennels, facing toy streets, form a veritable Dogtown.

At 4 p. m. each day up and down these streets moves the dog-feed wagon. It unloads a tin plate of food at each kennel. Some dogs jump the length of their leashes, barking furiously, trying to grab the plate. Others, in hungry dignity, sit atop their houses, waiting their turn.

Here the dog ration of manufactured food costs Uncle Sam about 30 cents a day. When this is spiked with boiled horsemeat the dogs like it better.

Horses thus butchered are usually old ones from a near-by cavalry remount station.

Because Europe was breeding and training dogs long before the United States, many of



She Proudly Watches as Her Dog Joins the Coast Guard

Horse barns and race track on the Widener estate near Philadelphia are now used as a dog-training station by the 4th District, U.S. Coast Guard. Only German Shepherds are accepted for sentry duty by the Coast Guard. During bad weather, dogs are trained in an indoor riding hall.

the best trainers now on duty at our wartime dog schools are naturalized U.S. citizens who were dog specialists in European armies in the first World War. There are also some good American-born trainers, including well-to-do dog fanciers who long followed this interesting work for the sheer love of it.

The manual on dog training now used in our Army is based on the work and experience of foreign armies, and on reports from our military attachés stationed in foreign lands

where war dogs are used.

This is the first time the American Army has trained dogs for use in war. In World War I, it borrowed some from the French and British.

History Is Packed with Dogfights

Except in the United States, there's nothing new about using dogs in war.

Long before powder and guns were invented, when men fought hand to hand with clubs and swords, dogs often fought beside their masters. Some dogs were coats of mail in those days.

One early Turkish traveler mentions dogs "the size of asses." When bid to do so, they would grab a man and drag him off his borse! On old Assyrian temple walls in Iraq I saw bas-reliefs of great dogs straining at their leashes. Attila always used dogs to guard his camps, and Pliny says the Colophonians had whole squadrons of dogs which fought in ranks with the Ionians.

Long before we read about the wicked dogs that chased poor Eliza across the ice in *Uncle Tom's Cabin*, the English were using "slough hounds" to trail and catch fugitives.

Quesada, fighting in Colombia, had with him a large dog, and Nikolaus Federmann, a later companion, dressed his dogs in armor of quilted cotton to save them from Indian arrows. Natives feared the dogs more than they did the Conquistadores.

In 1795, 100 savage dogs were taken from Habana to Jamaica for use in the Maroon War. In more recent years, fighting the Riffs in Morocco, the Spaniards found the Moslems

using war dogs.

One trick was to dress a dog up in a turban and burnoose and let him run across in front of the Spanish lines. He looked like a skulking man. This fooled the Spaniards into firing, thus revealing their outposts' locations and making it easy for the Riffs to plug a sentry. You can browse for days in any big library and never find the end of good dog stories. In the Bible and in other early Jewish annals, you find little about dogs that is complimentary. When I lived in Baghdad, I saw that to both Jews and Araba the dog was unclean. Moslems, particularly, avoided even touching a dog, and then only with the left hand; yet for him they had a definite respect.

In Baghdad streets every pariah dog had his own beat, which he'd fight to hold. When not hunting food, these tramp dogs congregated in certain streets and slept in big piles. Once as I drove to call on the Wali Pasha, my carriage driver came to such a pile of dogs and carefully drove around it, to avoid disturbing the sleepers!

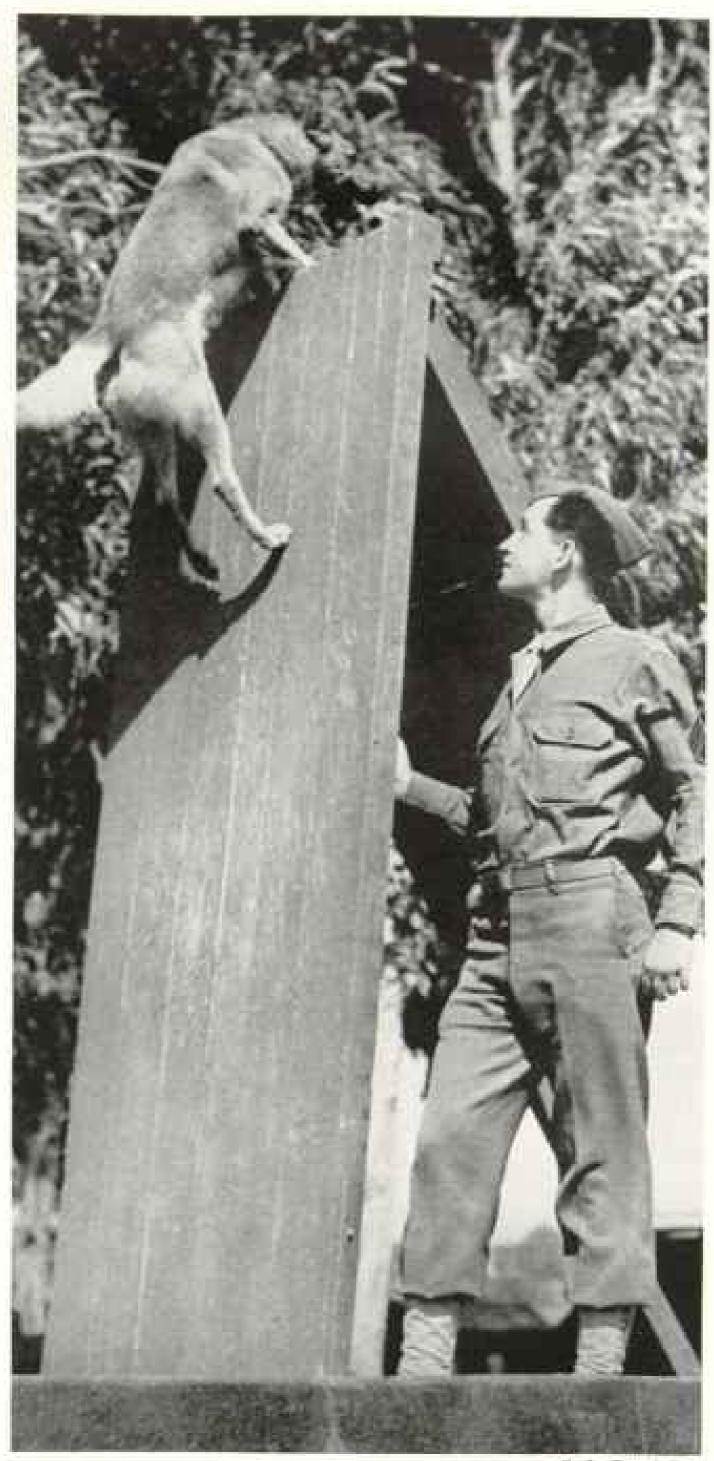
A dog would rather associate with a man than with another dog. Dogs have been closer to man, and were probably tamed by him long before be domesticated any other animal. Hence, through the centuries, odd beliefs about dogs have grown up.

Best hunting and racing dogs ever known are those developed in England.

Belgium uses many draft dogs in civilian life. These were made to haul machine guns when war broke.

After World War I, when I was living in Germany, I saw vast numbers of Dobermans and German Shepherds being trained, especially around Berlin and Hannover. Ostensibly these were for police work, though everybody tacitly understood they would eventually wind up in the Army.

Widest publicity had long been given to dog training in Germany, Crowds always stood about the grounds watching dogs being taught to attack, jump hurdles, trail, and carry packs. In France, too, the public was kept fully informed on war dogs and the Army's urgent need for more of them.



Cr La Tour & Son

Up and Over a Smooth Eight-foot Wall He Climbs!

He uses his front feet to pull himself over the top. No obstacle meer outshines the swift, sure, highly trained messenger dog. He swims rivers, scales walls, finds his way through dense underbrush, through barbed-wire entanglements, and the heaviest traffic of city streets. He is taught never to pause to fight, chase cats, play with children, or accept food from strangers lest he be poisoned. Nothing must interfere with his errand.



Main Street in Dogtown as Army Trainers Bring Canine Rookies Back from the Drill Ground

Airedales, Shepherds, Dalmatians, Dobermans, Boxers, Afghans—these and more are here. Each dog has his own kennel. Dogs by thousands are trained now, at various canine schools from coast to coast. Many graduates have already gone on duty with troops. Pitted against them, somewhere, sometime, may be the canine hordes of Germany and Japan, believed to number more than 150,000 dogs.

This encouraged people to breed dogs to sell to the Army.

England long had trouble getting enough dogs for war use, because at first she shrouded all dog training for war in utter secrecy. This policy had to be changed—to get enough dogs.

Today's War Dog Does More Than Fight

"War dog" now means far more than in Roman times, when these animals were taught to attack armed men on the battlefield.

Today's war dog does little fighting at all, except in some phases of sentry work in which he may attack and hold prowlers and fugitives.

Most useful to the Army now are dogs trained to seek wounded men, to carry messages and burdens, to walk patrol with sentries, and to guard property.

Some dogs are also used in the Medical Corps to carry supplies. Chief difficulty with pack dogs, however, is that their saddles so often get caught on brush and wire fences.

Most humane task of the war dog is his night work on battlefields, seeking wounded men.

One tactical class at war dog school specializes in telephone work. At this task the dogs drag telephone wires off a drum or reel and out across the ground to the front lines, or elsewhere. This is to save soldiers of the Signal Corps from dangerous trips under fire.

Such wire dogs may also wear pack saddles, or blankets with pockets to carry tools, telephone instruments, batteries, etc.

Army doesn't say, now, just where in the United States it's using guard and patrol dogs. But try to approach certain Quartermaster depots after dark, or venture near a pier, a powder mill, or a strategic airport, and the chances are the war dogs used there will



Just Like a Two-legged Recruit, Every Rookie Dog Must Pass His Physical

"We want big dogs, sound and sane, anywhere from one to four years old," says the doctor. So far most dogs have been recruited through Dogs for Defense, Inc., New York City, a patriotic civilian group of dog lovers who volunteered their services. Through this body dogs by thousands are being enlisted.

hear or see you before the human sentries do, and begin to bark and growl.

Theirs is purely night work. By day they're kept locked behind high board fences.

Though hundreds are used around factories, bridges, and other places named, and though Coast Guard sentries leading watchdogs walk the beaches every night from Maine clear around to Oregon and Washington, few people passing by day even suspect this vast activity (pages 102, 105). In the same way, packs of sharp-nosed, keen-eared watchdogs help the military police patrol outside barbed-wire barriers about certain unpublicized internment camps.

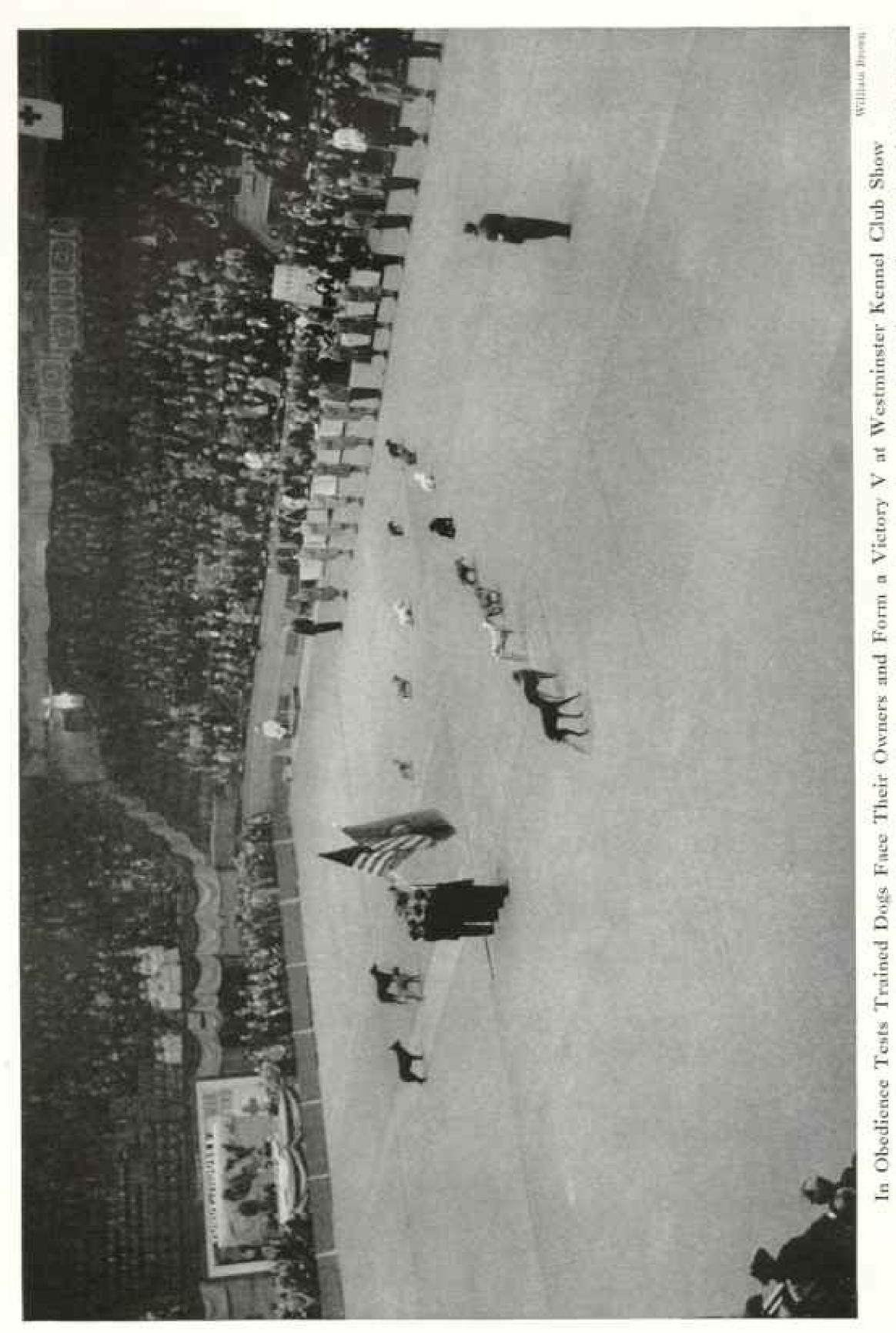
Tail-waggers Turn Tough on Night Patrol

In some forms of advanced training the sentry dog is liberated and allowed to plunge into adjacent brush or other cover to investigate for himself, or to attack any prowler he may overtake. One aspect of this nocturnal dog work astonished me. By day a certain dog was just a smiling, friendly tail-wagger. But when he was put on a leash after dark, and an armed man started leading him along a lonely beat, this dog completely changed. He was transformed into another animal—a grim, suspicious, watchful beast.

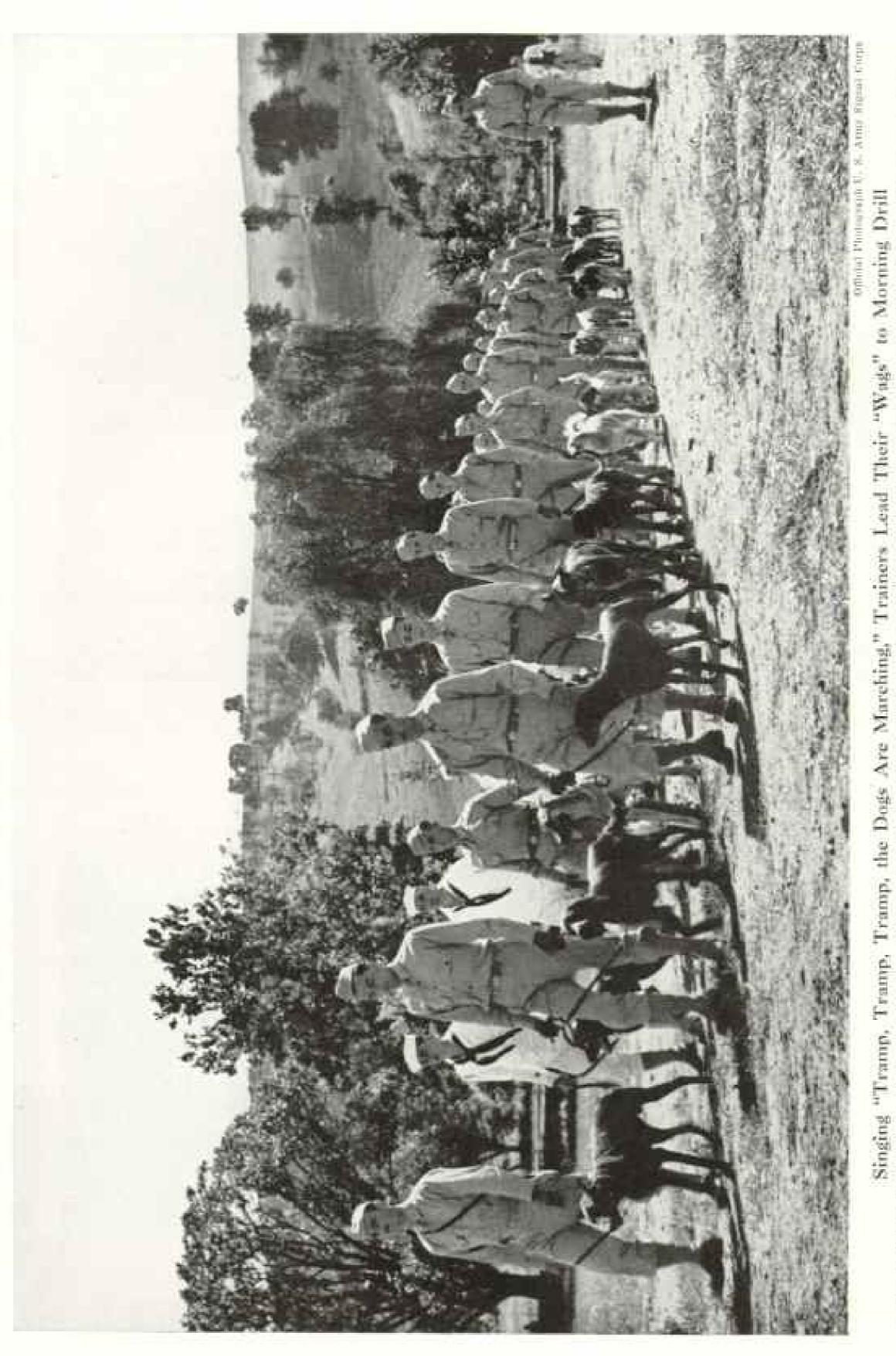
Dogs hear sounds beyond the range of human cars. Dog fanciers all know the "silent whistle." You can't hear it at all. But to a dog its blast must be intolerably shrill, for it sets him into frenzy.

"I use a silent whistle," said one commanding officer, "so as not to disturb my neighbors, I can't even hear it myself, but my Doberman hears it more than 200 yards away!"

In some phases of Army work, dogs must be trained to trail. Teachers use various methods. Some walk with their shoes on; some walk barefooted, at least during primary lessons. Some use a canister, from which



Held every February in Madhon Square Garden, New York City, this is the world's largest indoor dog show. Attendance often reaches 50,000, and 2,000 or more canine champions from all over the United States are entered. Proceeds in wartime are donated to the American Red Cross.



At the Cavalry Remount Station in Front Royal, Virginia, the Arney mobilized its first dog recruits. Professional tealners were called in from all over the United States to train the dogs and teach soldlers how to handle their canine charges,



"Hold Still, Till I Brush the Burrs Out of Your Hair!"

Nails are pedicured. Hair is washed in "Shampooch," If dogs get wet in rainy weather, they're carefully subbed dry at bedtime. If necessary, temperatures are taken. Among canine recruits are many which, in private life, have sold for upwards of \$500 each.



"Look in His Ear and See If He's an Army Dog"

Army horses and mules are branded on hip or shoulder. A dog is tattooed inside one car with his official serial number. Veterinarians do this with an electric needle, which works like a fountain pen (page 108).

chemical fluids with smells that appeal to dogs are allowed to drip out and thus "lay a trail," just as in Missouri we used to drag a polecat skin behind our pony when training hounds to "track," Early writers say the Roman watchdog's nose was so keen that he could, by smell, tell a Turk from a Christian!

Messenger dogs are often shown the route they are to use by putting them on the fresh track of a human who has run the course, or on the trail of the chemical fluid dropped for their guidance.

Pack and Sled Dogs Also Go to School

We saw powerful Newfoundlands and Great Danes carrying loads on their backs which would have taxed a small burro. In emergencies, especially in hot fights, or over rough, trackless terrain, soldiers often use big dogs to transport ammunition, pigeon cases, medical supplies, dry socks, food, water, telephone sets, and even machine-gun parts.

The American Indians' travois dogs, Eskimo dogs, and those used to haul sleds on many polar expe-

readers. The dog teams of explorer Elisha Kent Kane, it is written, hauled sleds over ice for days at the rate of 57 miles a day.

Army is training dog teams now in New Hampshire and in certain Rocky Mountain States, and shipping them with harness and sleds and dog drivers to Iceland, Alaska, and elsewhere.

Japanese Army agents, who for years bought dogs here, sought white ones for snow work and black ones for night duty.

Judging by official reports, including those from American military observers with foreign armies, the messenger dog is the most useful of all in active war work. He runs many times faster than a soldier on foot, and is so much smaller and lower than the human courier that he's perhaps ten times less liable to be hit than a man.

Each messenger dog wears a leather collar, to which is attached a small hollow aluminum tube or capsule for carrying the rolled-up map, letter, or other document.

ENROLLMENT APPLICATION U. S. COAST GUARD DOG PATROL

PHILADELPHIA DISTRICT

Date Sentember 15, 1942

To the Commandant of the Coast Guard:

I hereby apply for enrollment for active service in the Coast Guard Renerve.

Period of Enlistment Duration Duties Dog Patrol

I hereby agree to perform active service, without pay or allowance. other from submistance.

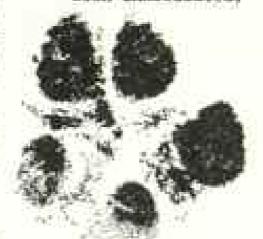
I cms (Breed SERMAN SHEPHIND Shoulder Height 25" Age 2 Yours PROMUTER Call Name Sex Male

your number? Have you lived in a kennel or a house? HOUSE How long have you lived in your present place? 2 YEARS Are you nervous? NO Do you run away? NO Have you been

fire or loud noisee?_____ What is your attitude toward strangers? BUSPICIOUS Have you been a good watch

dog? YES Have you had any obedience training? NO With this application you must furnish us a picture.

General Remarks (Give the general outline of your disposition, training, bookground, or any special habital. I am loyal to my master, alert, and love to jump. I have never had distanger, and I have not been innoculated.



Yest Coruga St., Philadelphia, Pa. Owner's Address.

(Prepare in triplicate)

Watch a trainer teach a messenger dogditions are all well known to Geographic. You see him begin by sending his canine pupil on short trips of only a few yards, from one trainer to another. These trips are gradually lengthened until the dog's course may cover miles.

> The whole secret lies in the fact that a faithful dog, attached to his chief trainer. naturally wants to get back quickly to the man who feeds and pets and shelters him, whether this spot be at headquarters, on a far outpost, or where not.

> Stop not to fight cats, to sniff other dogs, to take food from strangers, or to pick up any food seen on the ground—these are stiff lessons every messenger dog must learn. One trainer I know locks his messenger dog pupil in a pen with cats, chickens, and rabbits, so he'll get to know them and not chase them when on duty.

> At one K-9 school I watched them teach dogs not to fear battle noises. Guns were fired about them, closer and closer; firecrackers were thrown in their faces. Grenades were tossed out, and bombs exploded, blowing rock



This Snarling Coast Guard Sentry Dog Gives Warning of a Nocturnal Prowler

Because of his amazing sense of smell and hearing, a dog may detect the presence of any intruder long before the human sentry discovers him. On night patrol work, dogs are particularly useful where sentries must walk beats that lead past lonely woods, dark lanes, or deserted buildings.

and earth beside the path the dogs were running over.

One trainer I watched was sending his dogs through village streets, past heavy truck traific, under bridges, and through streams, so they might learn never to get confused.

Because these important dogs may carry orders, calls for reinforcements or more ammunition, or secret reports on enemy movements, it is highly important that absolutely nobody except their actual bosses shall even speak to messenger dogs, or notice them in any way. To offer one food or to try to play with him and thus even innocently divert him from his vital errand is strictly against Army orders.

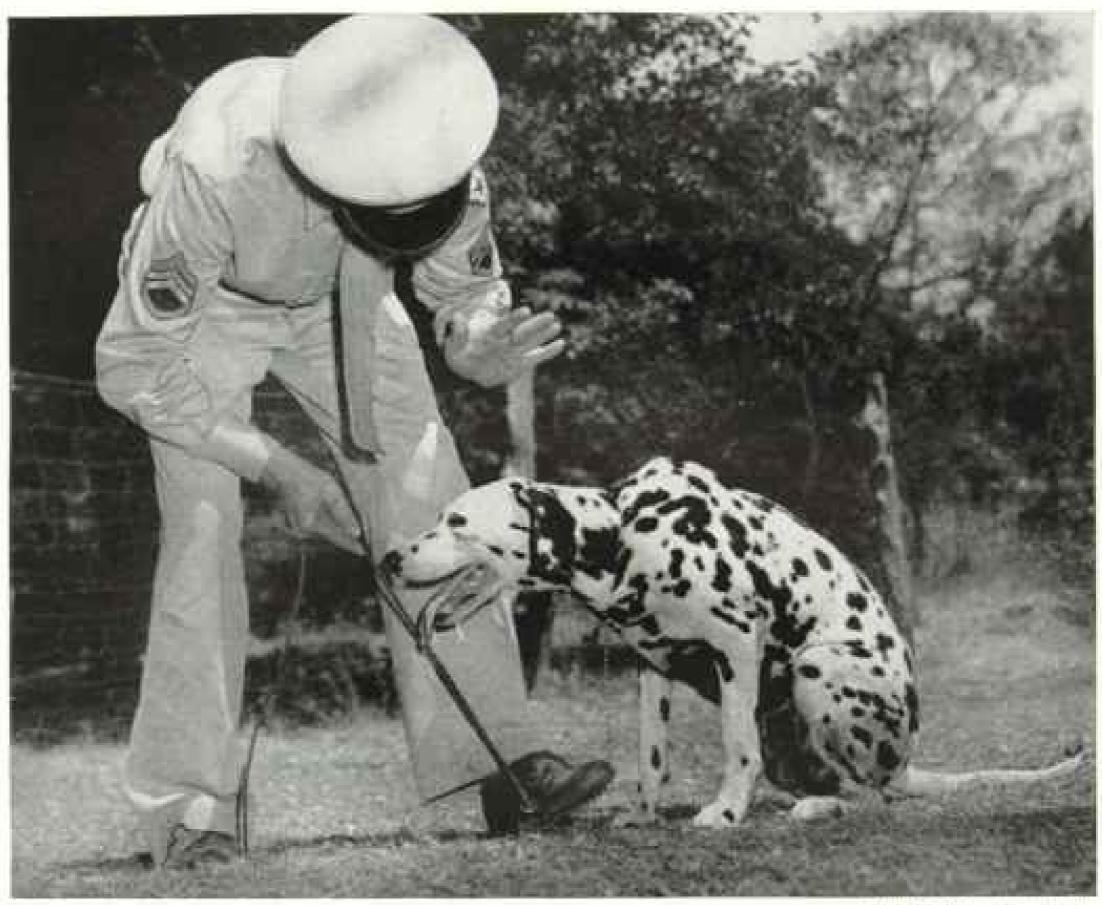
Punishment to Fit the Crime of Little Use in Dogdom

One basic principle of dog training, I noticed, was this: Army men never punish a dog after he has sinned. They punish him in the act, or not at all. "It's useless, when your dog has disobeyed," they say, "to call him over and then whip him. It's too late then—he doesn't know what you're punishing him for."

Good messenger dogs, when taken up to the firing line and then sent back to headquarters with dispatches, will run through shell and rifle fire, jump trenches and fences, scale walls, and swim creeks at full speed, just to get back to their masters.

Lieut. Col. E. H. Richardson, long Commandant of the British War Dog School, for years studied war dog work in Morocco, France, Germany, Russia, and elsewhere. His book, British War Dogs, is now a favorite with American Army officers detailed to duty at K-9 schools. In his book the author gives many fascinating examples of heroic feats by dogs under fire. One official report reads:

"Headquarters released my dog Tweed, with the message, Send up reinforcements and



While World from Peess Ass'n.

"Down, Lady! Down!" Orders the Sergeant, Teaching Obedience to a Dalmatian

Kindergarten work for canine recruits begins with learning how to "sit," "heel," "come," "down," etc. About this Dahnatian's neck is a training chain. To teach her to lie down promptly, the trainer pulls her head down by stepping on the chain. At the same time he gives her a light tap on the head and demands in a firm tone, "Down, Lady! Down!"

small round ammunition.' He came through a Boche barrage—3 kilometers in 10 minutes."

Says another report:

"The Batt, had to go in and support the 3rd Canadian Division. The O.C. wished dry socks for his men. There was no way to get a message back in daytime, so he released Tweed with a message, 'Moving forward tonight. Send socks for men and some S.O.S. lights.'"

Again we read:

"My dogs carried Sealed Code, Maps, and other messages from raiding troops. . . . Paddy, one of my dogs, carried a message about artillery when all other means failed."

Here is a good one:

"All lines of communication were cut and a battalion of the Inniskilling Fusiliers was cut off. This battalion released a dog, which returned and thus gave news of the plight of this battalion. The dog thus was the means of getting reinforcements sent up to the relief of the Inniskillings and that gallant body was saved from being wiped out. . . .

"A black retriever called Dick had a wonderful record, worthy of the V.C. While carrying a message . . . he was wounded severely, in the back and shoulder. The dog completed his run in good spirit"—but later died of his wounds.

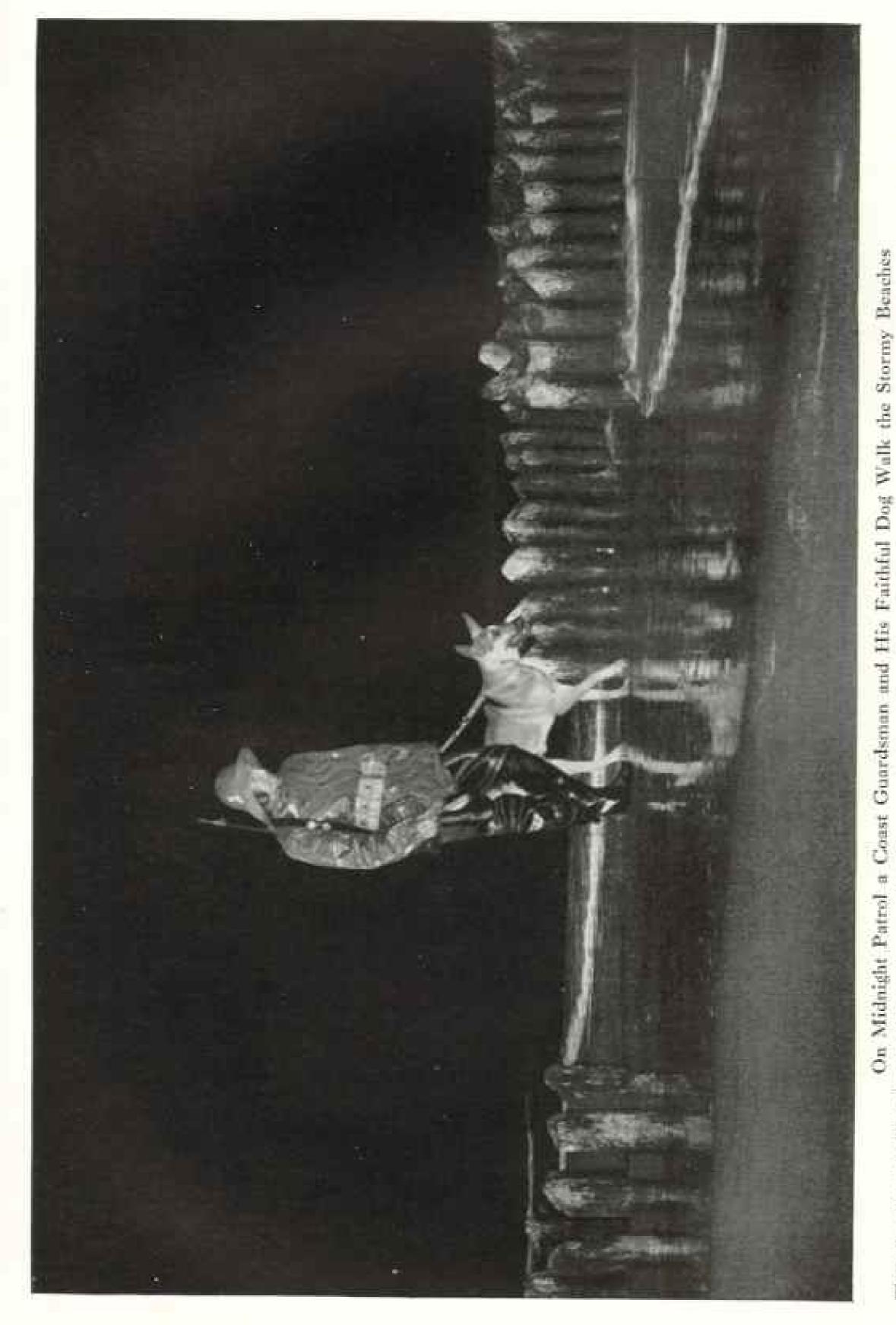
"My bitch Rab was hit by a piece of shell on her second journey. She managed to stagger in with her message . . . but she died the next day."

Seen and Heard at Dog School

After one rainy afternoon's drill we watched the soldiers rubbing their dogs dry before putting them to bed. If needed, they get baths, too, in fluid a soldier called "Shampooch."



From Maine down to Florida, arotind the Gulf of Mexico, and along our Pacific coast, dogs are need for beach patrol. Each Coast Guard station has its bigh-boarded dog pen which nobody may approach except regular handlers. Up His Ears; Then into the Fields They Go for Daily Training Attention! Every Dog Pricks

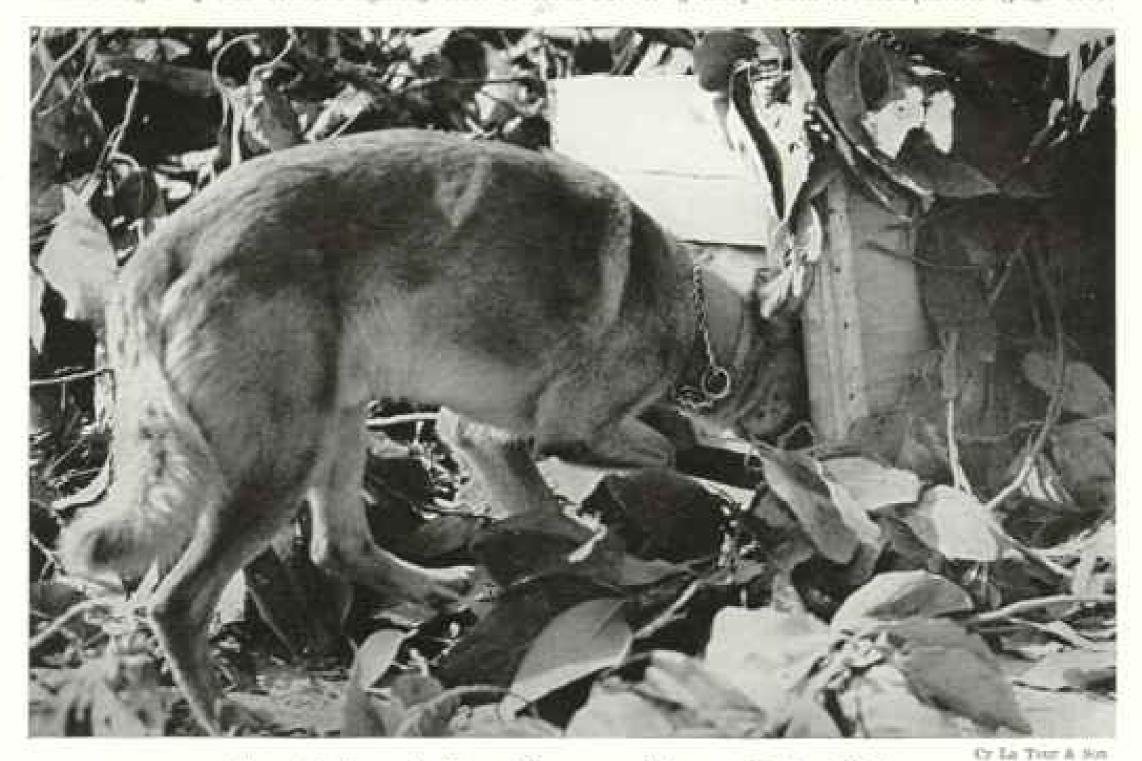


There are some 12 million dogs in this country, most of which are unfit for military duty. So far, however, enough good dogs have been given to the Army; eventually have to buy dogs, or even breed them, to get enough. This happened in England, Germany, and France.



"Now Take This Note, and Run-Don't Stop to Chase Cats!"

Attached to the messenger dog's collar is a light, waterproof capsule, which holds the map, letter, or orders. Errand dogs may run between fighting units or from advancing troops back to headquarters (page 101).



Scented Kennels Trap Messenger Dogs at End of Trips

These crates, carrying a pungent chemical smell so that dogs may locate them, are set in sheltered spots where the Army wants to receive its secret messages. A self-locking device prevents the dog from getting out.



"Yes, Dog, It Does Smell Good—But It Isn't to Eat"

This soldier holds a canister from which scent is dripped to lay a trail, just as a fex or polecut skin may be dragged to lay a trail for training bounds to bunt (page 97).



Cr. Le Tour à don

Sneaking through Barbed-wire Entanglements Is Part of War Dog Work

Being trained at Fort MacArthur, California, this dog has just Jumped a three-foot hurdle, climbed an eight-foot ladder, squeezed through a hole, and scaled a wall. Now he must tackle this sharp-pointed obstacle.



This Boy Wears Hockey Gloves to Protect His Hands While Training an Attack Dog

Enlisted men volunteer to take lessons in dog training from Army officers, many of whom in civil life were professional dog handlers. When graduated, the new trainers are sent to other camps, there to teach still more men how to train dog soldiers. Others, fully trained, return to active duty with troops, there to handle sentry, attack, messenger, hospital corps, or pack dogs.

Smartest animal in one Dogtown residential street was a mongrel bitch, known to the men as "The Quiz Kid of the Dog World."

As Army horses are branded, so Army dogs are also marked—but not on the body. Each dog has a number tattooed in his ear. I watched the veterinarian and his two nurses grab a big collie, tie his mouth shut, hobble him, and lift him up on a table to be tattooed (page 100).

Coming out of the isolation ward, a green rookie trainer complained to the "vet": "Sir, I can't make the Boxer hold this thermometer under his tongue."

"You'll learn," grinned the vet.

All dog training is based on memory. "And dog memories are good," observed the white-smocked vet. "That Russian psychologist, Ivan Petrovich Pavlov, worked for years studying dogs' conditioned reflexes. He used bells, lights, metronomes, drugs, and even

geometrical figures in his research. He learned much about dogs' moods and memories by observing their saliva flow under different tests.

"One good canine memory test involved the case of a dog that was given a hypodermic injection, from which he promptly vomited.

"Next day that was repeated, with the same result. The third day, however, the doctor had barely entered the room, and was merely taking his syringe from its case. The dog got one glimpse of it and promptly 'put his lunch'!"

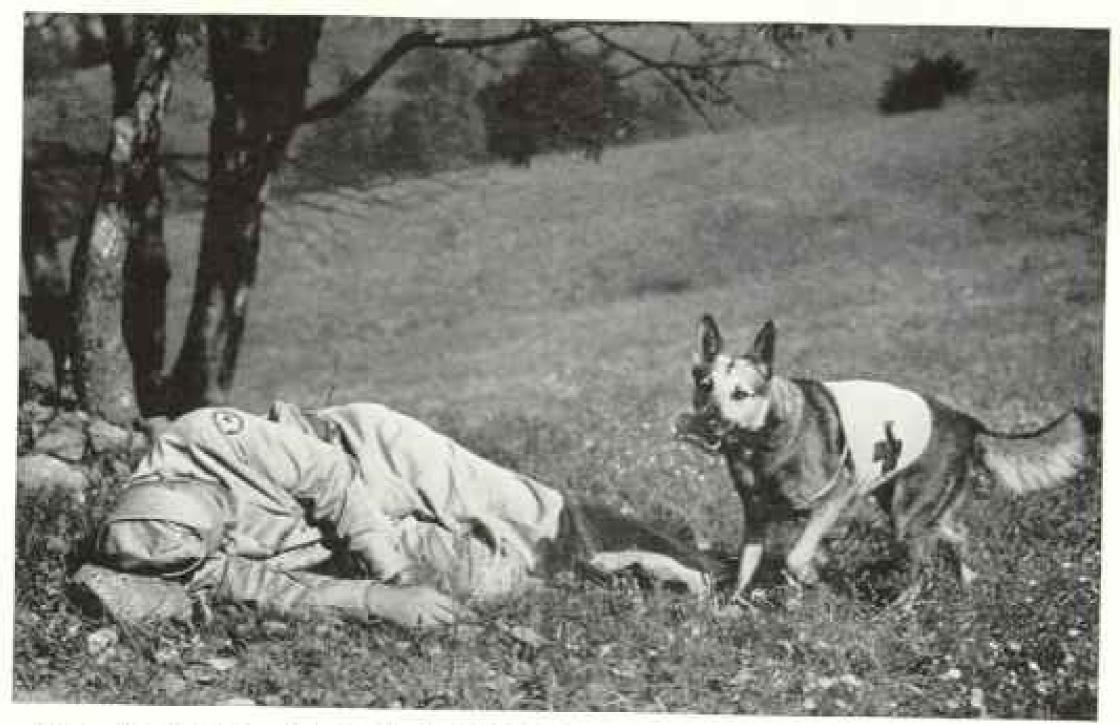
I heard of a similar dog memory case. This dog had been operated on by a veterinarian in a white smock. Going home, he met a street-cleaning "whitewing," whereupon he howled and raced away!

Trainers judge a dog's mood by the position of his tail. Some obey only when it's down.



The Colonel's Doberman Pinscher Threatens a Prowling Stranger

Dogs are easily taught to protect their master's house, automobile, or other property, and to attack any one, even an old friend, who dares menuce the master himself. Here Liest, Col. Lambert B. Cain is defended by his trained Doberman.



When the Dog, Searching a Battlefield, Finds a Wounded Man, He Signals That Fact by Picking Up and Bringing Back His "Brinsell"

This brinsell is a short stick hung from the dog's collar. His work with it is an advanced form of retrieving. Going back to his master with the brinsell in his mouth shows the dog has located a wounded man. Then he leads stretcher-bearers to the rescue (page 63).



It's Not a Cold Winter He Fears, but Dogs' Long, Sharp Teeth!

He puts that white, heavily padded suit on over his uniform. On top of it he dons yet another suit of heavy canvas coveralls. Despite all this protection, the trainer often gets hurt. At various war-dog schools the author observed men who had been bitten-mostly on the hands and about the knees.

When others curl it up tight, as in a mutual dog-sniffing party, the trainer knows their minds are not on the lesson.

A Hollywood trainer who coached many famous canine characters for motion-picture work and trained valuable dogs for Clark Gable, Loretta Young, Joe Penner, and others, says memory, obedience, and aggressiveness are the most important traits a dog must have to make a good soldier.

Teaching a Dog to Obey in Chinese

Memory, especially. This trainer was once asked by a Chinese diplomat in Washington to train a Collie which was to be sent to China.

Here an odd memory feat was involved. The trainer knew no Chinese; yet the Collie was going to China, where he'd have to take orders in that language.

At the trainer's suggestion, the diplomat first taught the American trainer how to say "Heel," "Sit," "Come," "Down," "Speak," etc., in the Chinese language, and then the trainer taught the dog!

"After all," he says, "the dog's own name is the most useful word in training. And, when you want him to heel. you may say any word that sounds like 'heel' —for example, reel, meal, or peal, and he'll heel just the same. It's tone of voice, too, that makes him obey."

I saw that in the use of the word "shame," as hissed to correct a wrong act. Good trainers fairly hiss it out after the dog's name, as, "Spot! S-s-s-h-a-m-e!"

Good-natured horseplay among the men keeps these workers usually in merry mood, At the dog trainers' mess one day I saw Private Jones take two doughnuts at once. Corporal Smith, also

seeing this breach of good manners, pointed his index finger at Private Jones's nose and said in his best dog-training voice, "Jones! S-s-s-h-a-m-e!"

Down went comedian Jones's hands, like paws, on the edge of the table, his chin resting on his wrists, and up he looked with an expression of mock mortification, just like a sensitive dog that has been scolded. "Good boy, nice work!" approved Corporal Smith, patting Jones on the head, still in the best dogtrainer's manner-for they always praise a dog instantly after any punishment.

Hunters of centuries ago, says Arrian, the Greek historian, were advised always to pat their greyhound's head after he had caught

a hare and to praise him by saying, "Well done, Cirrus!"

To his students I heard one trainer say: "When your dog obeys, praise him. Pat him on the head and say 'Good boy." Praise him as you would your wife, when she makes a good pie."

"That part's O.K.," said a soldier. "But how about telling your wife to 'heel,' or throwing a chain at her when she starts fighting!"

Into one freshman class I saw them bring a quarrelsome Doberman Pinscher, Almost at once, snarling like a lion with a face full of fangs, be sprang forward and badly bit a Shepherd that marched ahead of him. Punishment, by being rapped smartly on the nose with the loose end of the leash, was dealt out; but in a moment the Doberman Pinscher tried to bite yet another dog-and another. Again they warmed him up, this time with a whip. It was the only use of the whip I ever saw, in many trips to dog achools.

"We may have to discard him," said a trainer, "He was born to fight. I'd like to turn him loose, and 500 more like him, on some of those jungle islands that swarm with Japs. He'd work over those sneaking swamp angels!"

The dog that was bitten was sent straight to the hospital, where the vet patched him up. Dogs used to lick their own wounds, or eat grass to cure tummy fuss; here high-powered dog doctors keep them fit.

It's interesting at all these classes to see how hard a dog tries to understand what his trainer wishes him to do. But some make funny blunders. One day, when dogs were being trained to jump, a Great Dane made a ridiculous mistake. Not catching on at once



Cy La Zour & s-

To Avoid Injury, Trainers Dress Like Knights in Armor

To save his throat and protect his eyes the man wears a wire netting over his face. Splints and bandages, then heavy gloves, guard his hands from snapping teeth. Some dogs' jaws are so strong they can exert a pressure of 500 pounds on a man's wrist.

> to what was wanted but wishing to please, when he got to the wooden hurdle, instead of jumping over, he picked it up in his teeth and brought it back to the trainer!

If you send your dog to a DFD (Dogs for Defense) reception center, be sure you send along his name. Army says that's most important. A dog responds to his own name, and he should keep the one whose sound is familiar to him (page 101).

Repetition of words, whose sounds thus become familiar to the dog, are the secret of successful training. That's why, far and wide, all training orders are phrased exactly alike; then a dog, working for one master after another, always associates the spoken



Cr. La Tour A. Fon-

A Commando Dog Trainer Is Helped into His Clumsy Suit

Here two assistants "cinch up" the last heavy covering worn by a soldier trainer of the dreaded Commando dogs. So vicious is the attack of these animals that even the trainers must be defended against their 42 snapping teeth. Padded sheet metal shields the man's throat. The apponlike flap buttons between his legs.

command with the act he must perform. Unusual talk may confuse him.

With my small son I was riding one Sunday morning through Berlin's wooded Tiergarten. At a bend in the bridle path we came upon a German boy, whose Dachshund was furiously throwing up dirt, trying to dig out some rodent. Dismounting to watch, I said to the dog, "Catch him, Däckel!"

At once the Dachshund quit digging to snarl at us and growl.

"What's wrong?" I asked the German.

"He's astounded—he never heard English before," he answered.

Four abreast, 100 dog trainers marched across a field, all dogs dutifully "at heel."

Instead of "Tramp, tramp," etc., these men were singing, "When Irish Eyes Are Smiling." It was impressive—I thought of the Roman dogs going to battle, or of the canine phalanx fighting with the Colophonians.

I said to the colonel:
"But look! Marines
on the march sing of
'The Halls of Montezuma'; Artillery has its
'Caissons Go Rolling
Along.' Why not a
marching song for the
Dog Corps?"

"Who'll write it?"

"Advertise!"

"Where?"

"Well, in that new Army weekly—the Yank." Offer a cash prize to any man in uniform."

"That might work," said the officer, "Already we're planning a newspaper for dog trainers."

From Army camps and Coast Guard stations all over the country ever-increasing streams of enlisted men flow now to K-9 schools to learn this form of animal training.

When professionals have taught a class of soldiers, Marines, or

Coast Guardsmen, they in turn scatter to other dog schools, there to teach still more men to do this work.

Also, dogs learn from each other. I watched green dogs taking their first lessons. They would look up and down the line on the training field to see what the dog students with more advanced knowledge were doing, and then try to imitate them.

Trained dogs and dog trainers multiply day by day.

When this war ends, think what an amazing outfit this canine corps will have grown to be. Already, Uncle Sam's Quartermaster Corps runs the biggest trained-dog show ever seen in America.



Cy La Tour & S-

Racing 80-pound Dog Hits Man Terrific Torpedo Blow

Most dreaded of all modern implements of war, say some officers, is the recently trained Commando dog. His powerful, steel-trap jaws and sharp fangs are more frightening than shot and shell,



By La Tour & Sun

"Enemy's" Pistol Flies through the Air as a Dog Disarms Him

Striking at terrific speed, the dog knocks the man down and holds him till human sentries run up and take over. In this attack work, dogs are trained to grab a man by the hand that holds the weapon.



From A. Perrie

White City of Apartments and Palm-shaded Boulevards Is Tunis-Goal of Allied Armies

The Avenue Jules Ferry cuts a wide swathe through the heart of the modern quarter (page 139). This Tunisian "Broadway" continues off the top edge as a dike for electric trains north to Hannihal's Carthage. Between dikes, a 98-foot channel leads across the shallow Lake of Tunis (El Bahira, or "Little Sea") to the small harbor where liners from France and Sicily docked (upper right). Porte de France, lower end of the boulevard, is the gateway between two worlds. European department store and native soule (bankar).

Eastward from Gibraltar

Overland Route Across North Africa to Tunisia and Libia

BY CYRUS FRENCH WICKER

Formerly American Charge d'Affaires at Tangier, Morocco

Africa, unless he came by air, had his first glimpse of Morocco from the deck of the paddle-wheeled steamer Gibel Mouse that plied between Gibraltar and Tangier.

The Spanish hills to the north of the strait are a tawny lion color, scored with deep ravines and stony gullies, treeless and without habitation except for a few solitary, earth-tinted cottages.

On the southern shore the Moroccan mountains are pale blue, and recede through seemingly infinite distances to the ridges of the Beni Hasan.

A few ruined castles still cluster around the foot of lofty Djebel Mousa, the African Pillar of Hercules, which rears its bare and rounded head opposite lionlike Djebel-al-Tarik, now Gibraltar, on the Spanish side.

Here the strait is less than nine miles across, although opposite Tangier it broadens out to nearly twelve and beyond that into the wide Atlantic, where Capes Trafalgar and Spartel signal to passing ships the last messages of land.

Lovely Algerians with its gardens of jasmine and bougainvilles is left behind, and Morocco holds one in its grip.

Gateway City of the Mediterranean

Morocco is at once the sentinel at the ocean gates of the Mediterranean and the corner doorway to all North Africa.

People have come away from Tangier with no more lasting memories than of a beach and a dancing girl, or perhaps of a prearranged quarrel in a dimly lighted Moorish café out of which they are rescued from certain death by the faithful guide—a tale which is so often repeated that I have come to believe that it is written somewhere in a book.

I stood on the deck of the Gibel Mousa, newly appointed Chargé d'Affaires of the American Legation, accredited to His Imperial Majesty the Emperor of Morocco, Prince of True Believers, Vice Regent of God on Earth, religious as well as civil head of a country whose interior is less known to Americans than the fastnesses of Tibet.

Then and there I vowed that I would try to become an understanding envoy to western Barbary. Crossing the strait is not merely a transition from Europe to Africa; it is a reversal of time, of ages even, from one civilization to another and from conceptions fundamental as life itself to others totally different. Similar changes are met with elsewhere only after thousands of miles of travel.

Inland from the city of Tangier are the same yellow mountains, the same treeless hillsides, the same absence of life as on the Spanish shore.

But suddenly, where there was nothing but hillside and blue sky and white glare, is a white-and-blue metropolis, with domes and slender minarets, a battlemented castle, and terrace upon terrace of gray-pink crumbling walls, emerging as by magic from the desert hills.

The great white city lies on a curving blue bay, with a beach 200 feet wide encircling it as far as to the watchtower on Malabata Point, below the hills of Andjera.

My first glimpse was a panorama of irregular whiteness, pierced by slender mosque towers glittering with multicolored tiles and enlivened by the flags of a dozen nations interested in the future of this gateway city of the Mediterranean. Among them was the American flag.

The pier was crowded with picturesquely garbed Moors, and at the shore end, as might be expected in Barbary, a riding horse, not an automobile, was waiting for me to mount.

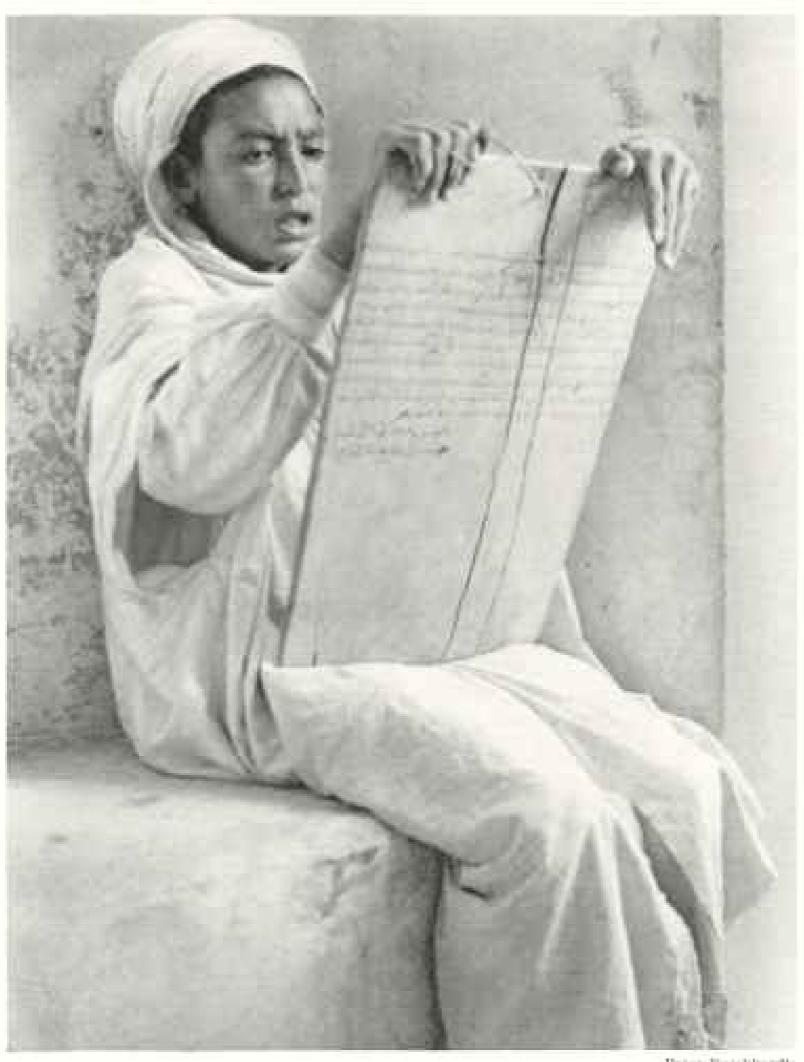
By the horse's head stood a Legation soldier, robed in a flowing garment of midnight blue edged with gold embroidery, belted with a broad red girdle, and exhibiting a spotless white sleeveless garment known as a sulham above his bare legs and yellow slippers. On his head was the customary white turban, red fez, and blue tassel.

His countenance was that of a wise and benevolent baby. He spoke the necessary English with a cheering smile, said his name was Mohammed, and led me to the Legation.

The Ancient Law of Sacrifice

Tiny shops lined each side of the narrow way. The owners squatted cross-legged in the center, seemingly unperturbed by the passage of possible buyers. As I passed through the market place, a Moor rushed from between two or three companions and, stooping, kissed my boot. At the same time he held up both hands in supplication.

Now, I had but lately left Oxford, where



Pater Bushkhardt.

His Blackboard Is White, His Slate Pencil a Quill Pen

Religious verses, written with ink that can be washed away, are committed to memory. Lips move in oral accompaniment to thought. Koranic verses, learned in the shadow of the mosque, are everyday fare in Moslem schools.

I had completed courses the month before in the law of nations, the philosophy of jurisprudence, and Ancient and Roman Law.

Thirty minutes after my arrival, Ali, the head soldier, informed me that a Moor had just sacrificed a sheep on the Legation doorstep, calling on Allah and me for justice before the Kadi (local judge)!

This was contact with a law more ancient still, with which I was to become better acquainted—the law of sacrifice. Gifts could be sent back, but a blood sacrifice, whereby some living thing, however innocent, had lost its life, could not be ignored.

On the advice of Ali I sent the suppliant to the Kasba, where was the Governor's residence and the court of native justice, accompanied by a soldier to say that the Legation was "interested that justice be done."

Of course nothing more could be done for him, as he was not a "protected" subject; but the request procured for him a hearing before the judge which, being a poor man, he could not otherwise have obtained.

From the roof of the Legation we could see out over the flat-topped Moorish town, with its latticed windows behind which the beauties of Tangier are hidden by day, to come out only under cover of darkness.

Northward I could look across the Strait of Gibraltar to the little town of Tarifa, where, 1,200 years ago, the Moslem leaders Tarik and Musa had landed on their way to conquer Spain and carry the banner of the Star and Crescent to the walls of Tours, A little to the left lay Cape Trafalgar, off which the empire of great Napoleon tasted hitter defeat.

To the east, Gibraltar, Tarik's own mountain, gave evidence of Britain's supremacy on the broad and narrow seas; but behind me, on the African side, lowering Djebel Mousa was even then believed, behind the cloak of Spanish sovereignty, to hold in its hollowed chambers German-built guns that one day were to threaten Gibraltar across the narrow strait.

Contrast of Morocco and Tunisia

Official duties were soon to take me eastward, across Spanish and French Morocco, Algeria, and Tunisia, passing by degrees to higher levels of civilization; but, starting with Morocco, the shock was stimulating. Tunisia is as well behaved as Egypt; but Americans landing in Morocco are plunged headlong into a country but little removed from barbarism. In general, only the coast towns are known to Europeans. In the interior, Knids (tribal heads) of the High Atlas rule with feudal despotism and the magnificence of kings.

To go eastward through North Africa, however, I had first to go south, along the Atlantic coast and inland to Fez (Fes), through a shimmering land of sun and sand, but also of wheat and barley, of sheep and goats and horses. This exceedingly rich and fertile region has supplied, from ancient times down to the war-torn present, food for continental Europe's industrialized nations.

The newly built railroad from Tangier to Fez is operated by a joint Spanish and French company, since it has to run through both the Spanish and French protected zones.

It is a standardgauge road, at first

paralleling the coast, then turning inland to Alcazarquivir to join the main east and-west French trunk line at Petitjean.

From this junction one branch of the French railroad runs southeastward through Meknes to Fez, and beyond to Oujda near the Algerian frontier. The other tracks westward to Rabat on the Atlantic, whence it turns south to follow the Atlantic coast to Casablanca and inland to Marrakech.

This system, with first- and second-class coaches, sleeping, and even restaurant cars, provides an efficient artery running all the way across French North Africa, from the Atlantic semports of Casablanca and Rabat to Taza and Oujda in eastern Morocco,



25 Balon Tachiry Lacks Doll European

Doughboy Beware! These Casablanea Eyes Have It

To avoid misunderstandings, American soldiers landing in Africa carried booklets warning them not to speak to Moslem women. "Your conduct may decide the fate of this campaign."

There it connects with Oran, Algiers, and Constantine in Algeria, and continues on to Bizerte and Tunis.

Thence a Tunisian railroad carries onward to Gabès on the Gulf of Gabès.

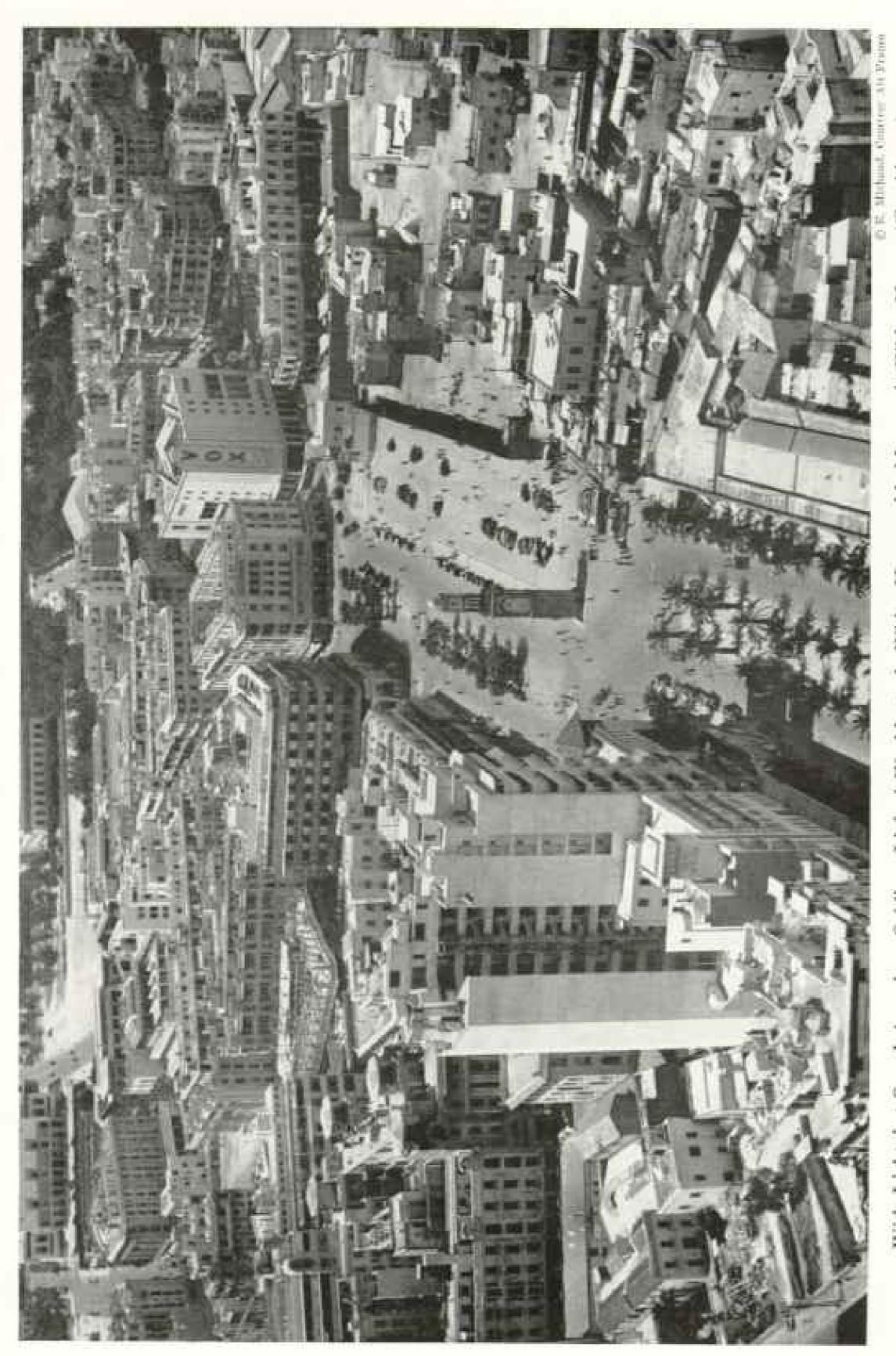
Food Stores for Warring Europe

This railroad is all the way paralleled by superb highways built by French engineers. It connects the principal towns with the ports and reaches far into the country districts.

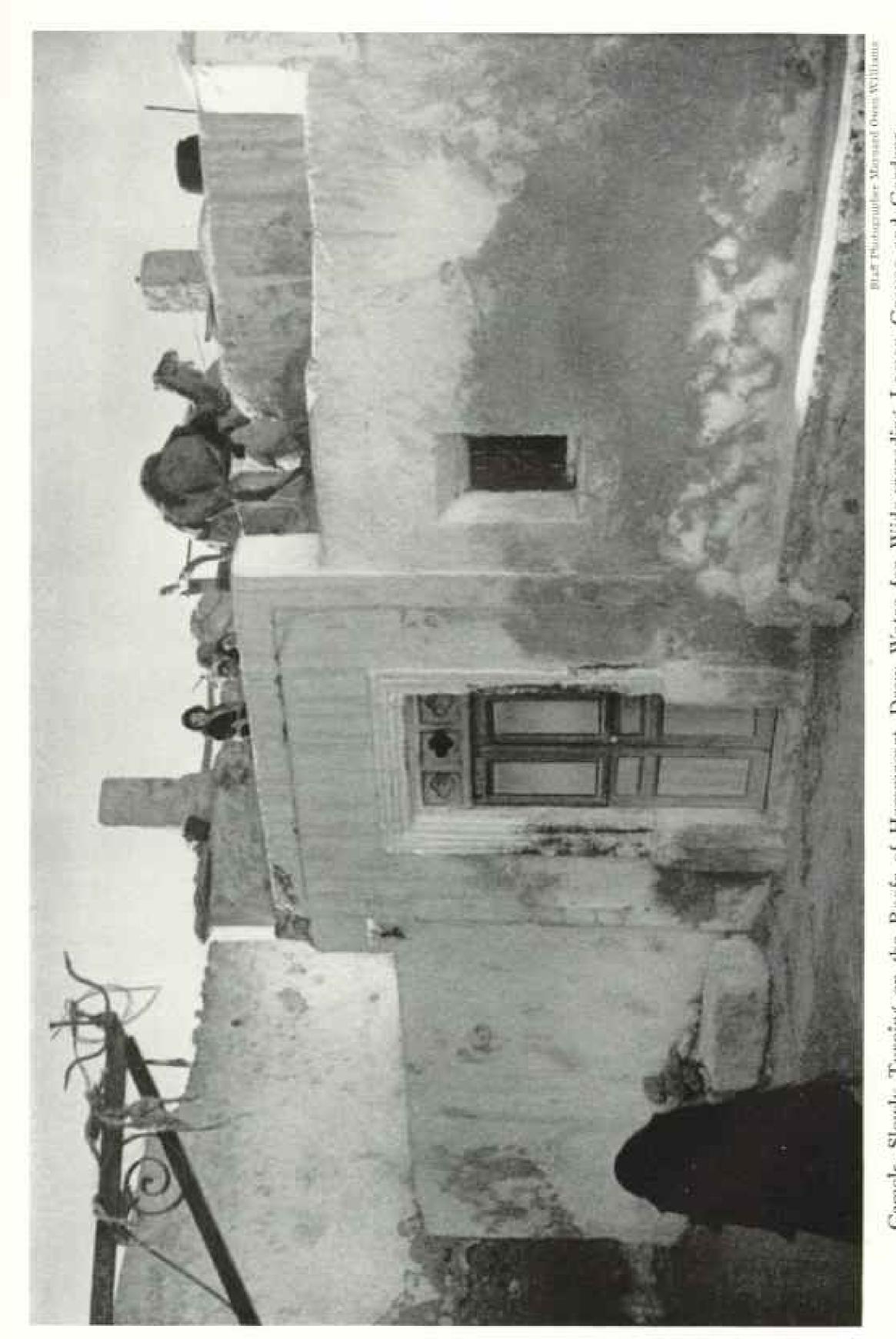
Over these lines and through these ports have been passing products of the entire French North African empire—the cereals, the meats, the fruits, and the wines—to feed the famished populations of Europe.



sternational Zone of Tangier. This 223-square-mile area, administered by British, Funch, and Spanish on June 14, 1940, Khalifan troops of Spanish Morocco marched into the zone "to guarantee its neutrality." Across the narrow Strait of Gibraltar from Spain lies the In-authorities, is surrounded by Spanish Morocco and the sea. C



Now a city of parks and palaces with an Linked Washington's White House with Morocco's White House (Casablanea Until Marshal Lyautey built a new "Cara," the clock tower in the Place de France rose above a pestiliential marsh. > improved port, Casablanca rivals Algiers in population and importance (page 135). With Lightning Speed American Soldiers

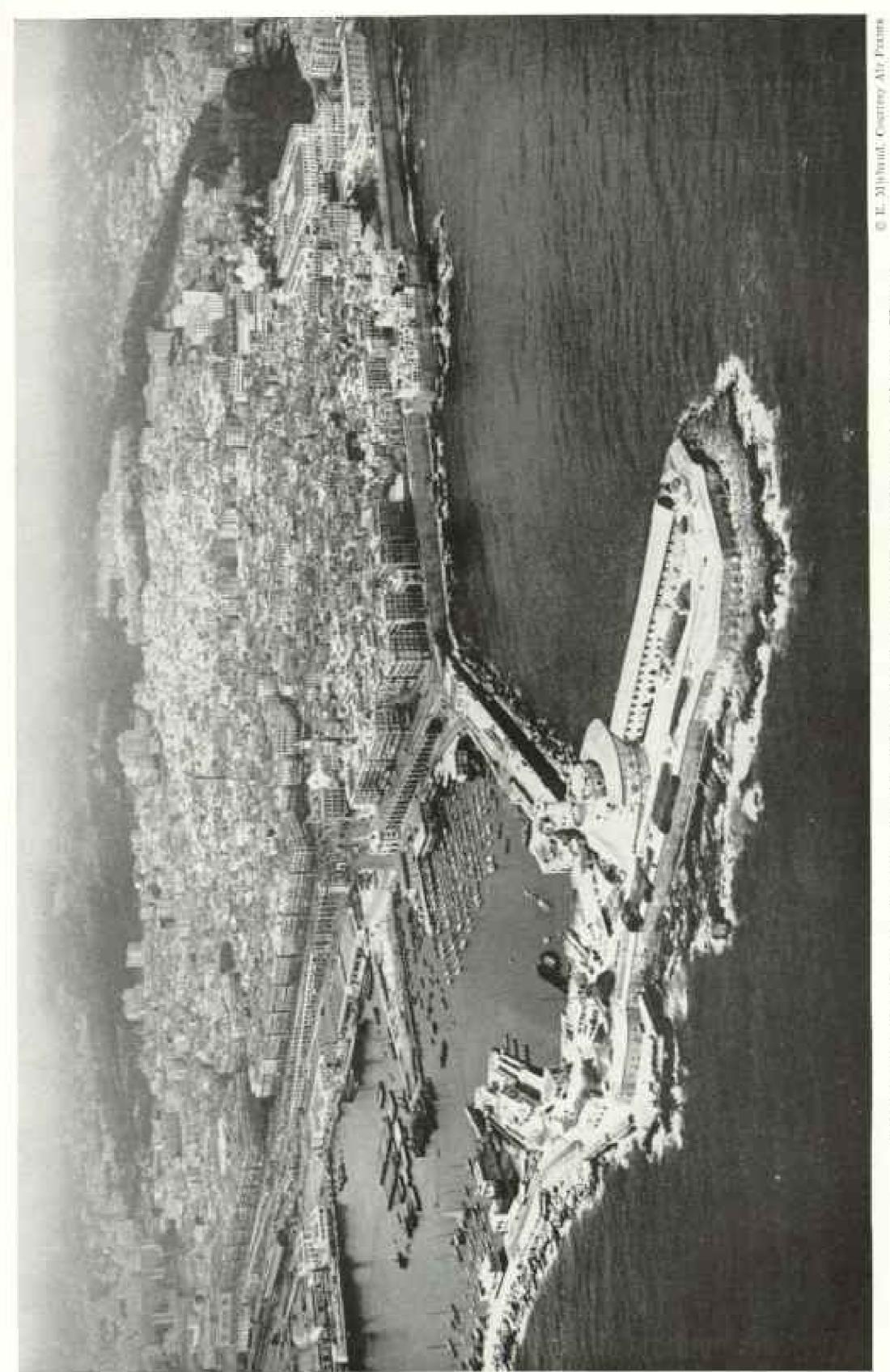


and railway across the base of Tunisla's rocky penimsula, whose tip is only 90 miles from Sielly. Hummamet, Draw Water for Wide-spreading Lemon Groves and Gardens Camels, Slowly Turning on the Roofs of This idyllic old town, on a curving beach, controls road



Up and Down Rabat Streets, a Blind Dervish Beats His Drum

In peacetime, Morocco was the western gateway to the lands of the Arabian Nights. On November 8, eleven months after Pearl Harbor, it was an Atlantic base for the Allied thunderholt against North Africa (page 128). The Mediterranean coast is often wet, cold, and bleak in winter,



Algiers, Richest Port of French North Africa, Fell to American Forces in Sixteen Hours

, and olive oil flowed across the Mediterranean to Nazi-controlled France and Germany 1916ff. On June of Algiers in this pirate den, ending American payments of tribute or ransom and wiping out the scourge From here, until the Allied occupation, vital grain, wine 78-30, 1815. Commodore Stephen Decatur bearded the Dey of Burbary corsairs based on Algiers, Tunis, and Tripoli (pag

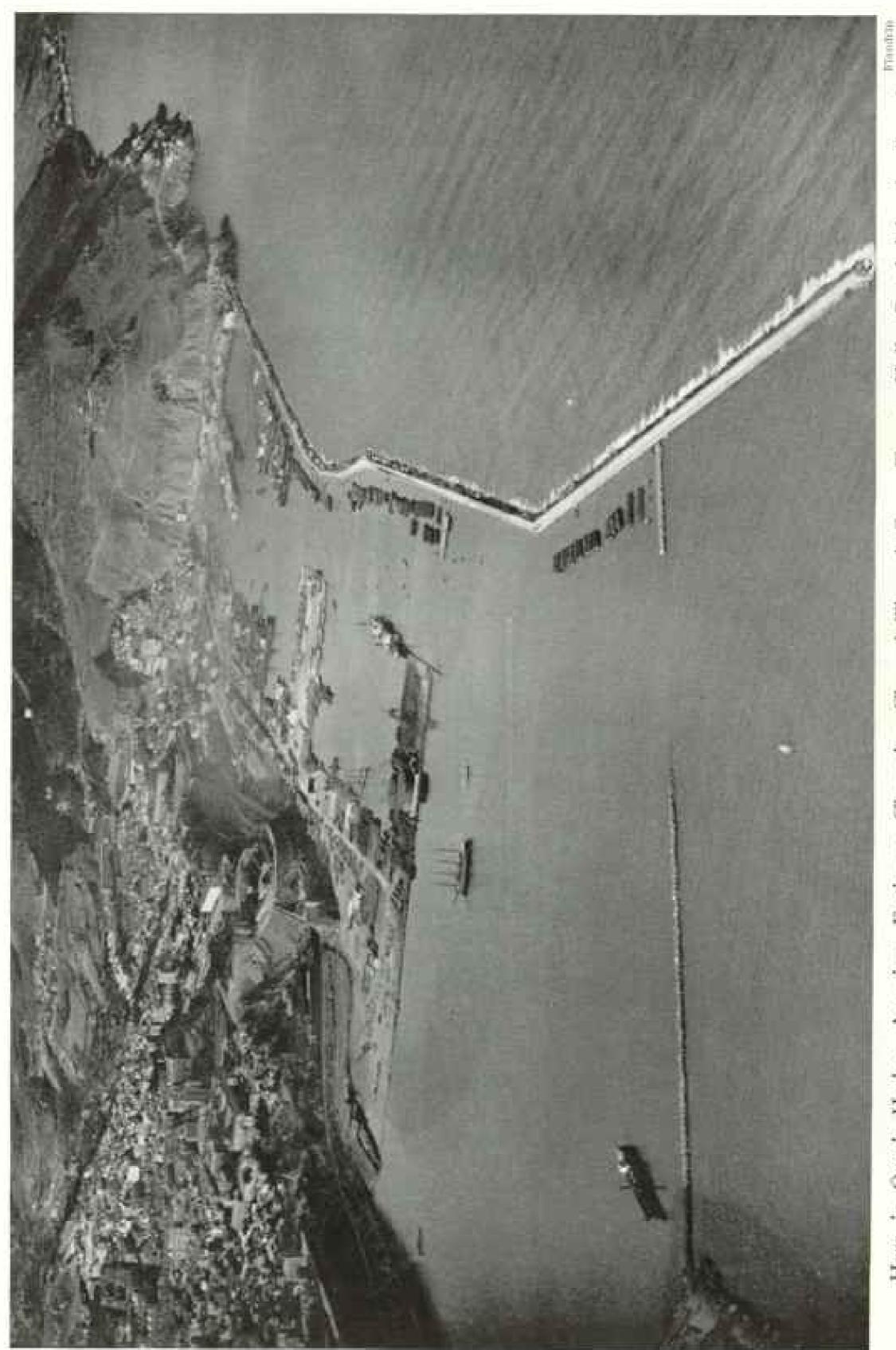


With Their High Turbans Carefully Wrupped With Dark-brown Camel's-hair Cords. Algerian Gentlemen Woo the Sun and Chat at a Grand Cafe

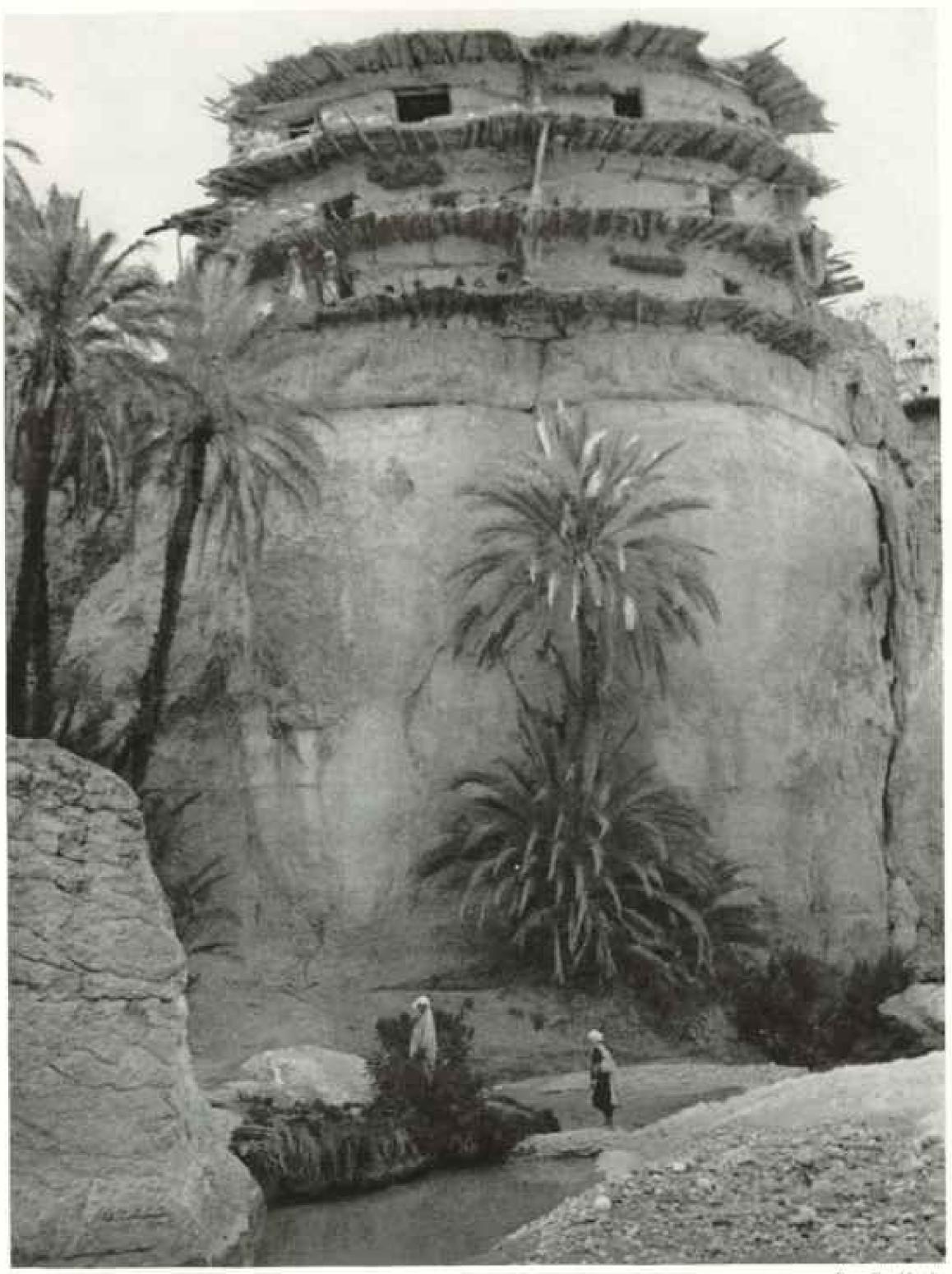


Modest of Face, Coquettish of Foot, Are Algiers' Veiled Women, Swathed in White

in 1830, colonies of Spanish, Italians, Prusslans, Swiss, and Irish settled in Algeria, Normally nearly 50 percent of the Europeans in Algeria are French. In North Thus two worlds, shafing streetcars and motion-picture theaters, evolved a com-Before the American Forces landed, Arabs, Moors, with French administrators, English sun-hunters, and American travelers. Soon after the French conquest a part of Algiers, costumes and races are mixed. men life that made the North African tour popular and scattered modern hotels in the desert itself. African cities European quarters have developed close to the original native towns. Kabyles, Sudanese, and Jews worked and played able by side In a typical crowd awaiting the streetcar in Mustapha,

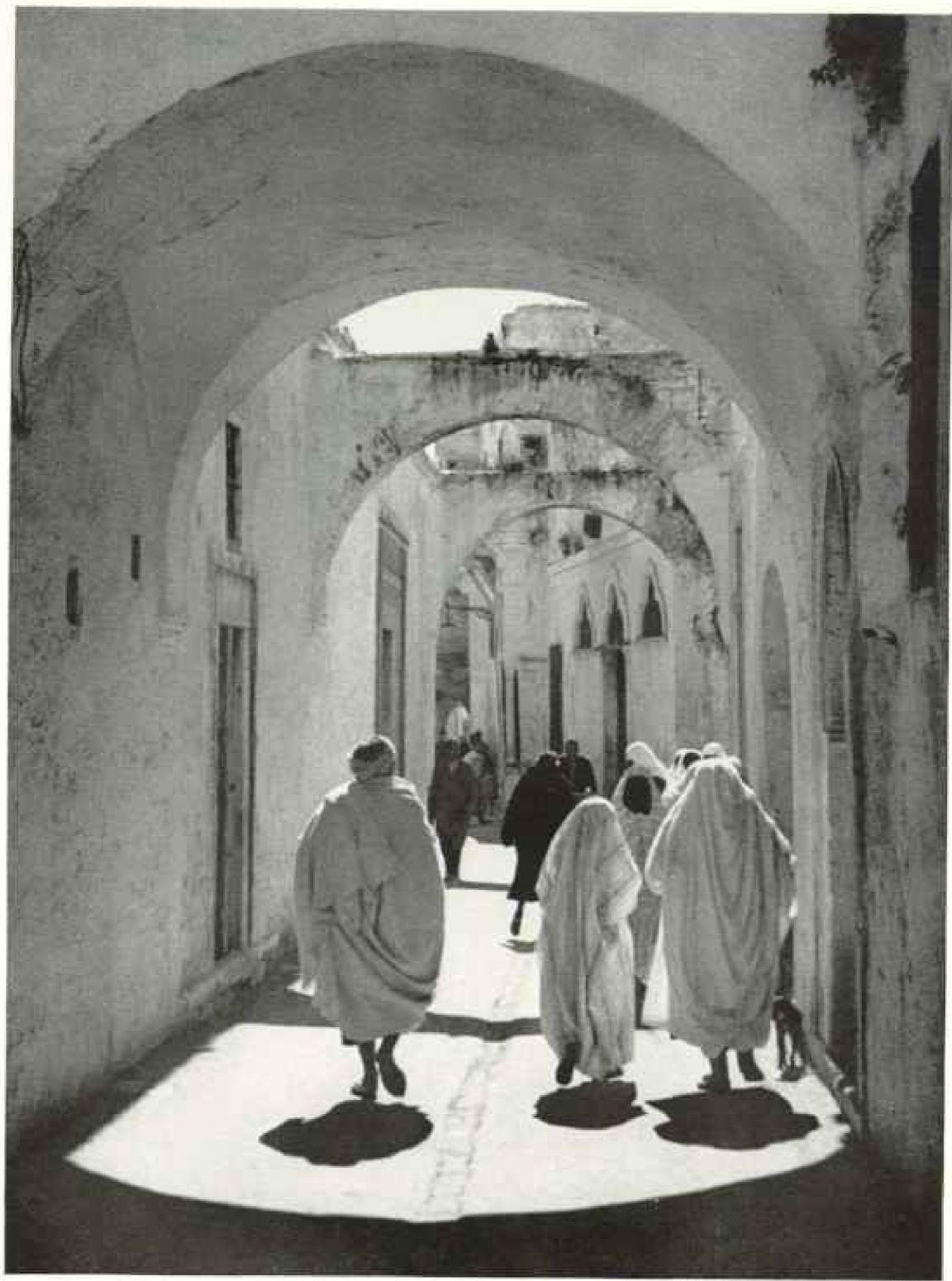


Before Admiral Darlan gave the order to "crase fire," the French attempted to block the harbor by sinking ships in the bottleneck entrance, Soon thereafter British and American salvage experts were working together to clear this port, a spearhead of Allied occupation of North Africa (page 138), Here in Oran's Harbor, American Engineers Cleared a Channel Through Some Twenty Hulks Scuttled by the French



Pener Burckbarch

Defense Post and Grain Elevator Is This Mud Tower of Mehouncehe, near the Garden of Allah South of the Aures Mountains, the Abiod River has cut a deep trough, its bottom tufted with date palms. Above the high bank rise adobe towers where grain could be stored and defended. Under the French, these strongholds, no longer of defense value, became attractions for visitors.



Shall Photographer Marnerd Oven Williams

Under Flower-tufted Arches of Tunis, Light and Shade Compose a Pattern of Shrouded Grace

The half-Moslem city of Tunis has more Italian civilians than it has French. In the covered barrans, or rouks, each commodity has its own arched lane. The Street of Perfumes is world-famous, but the streets of goldsmiths, wool, books, and tasseled fexces (chéchias) serve local needs.



Branon De On from Enting Gallering

An Algiers Streetear "Holds It" for the Photographer

Bound for the northern suburb of Bab el Oued (River Gate), this line runs to the Hospital of the Dey. Formerly a suburban home for the Turkish governors, with soft tiles and cool gardens, it is now a military hospital, ten minutes from Government Square and City Hall.

Even when commerce through one of these ports was interrupted by submarine activity, the many remaining, connected by the inland railroad and highways, assured deliveries of food in quantity from the entire area.

Only by following the line from Petitjean to Rabat and Casablanca could the traveler obtain a correct knowledge of the Atlantic entrances to French North Africa, of its vast food supplies, and of their important bearing today on the conduct of the war.

Modern Buses Pass Camel Caravans

Leaving Tangier, I took by preference the bus the better to observe the country. It is a luxurious trip, normally made in comfort over an excellent paved highway, with signposts surely the highest and most informative in the world.

Huge walls of concrete ten feet high bear the names of towns, and the distances and the minor hazards of the road are marked in black characters in French and Arabic.

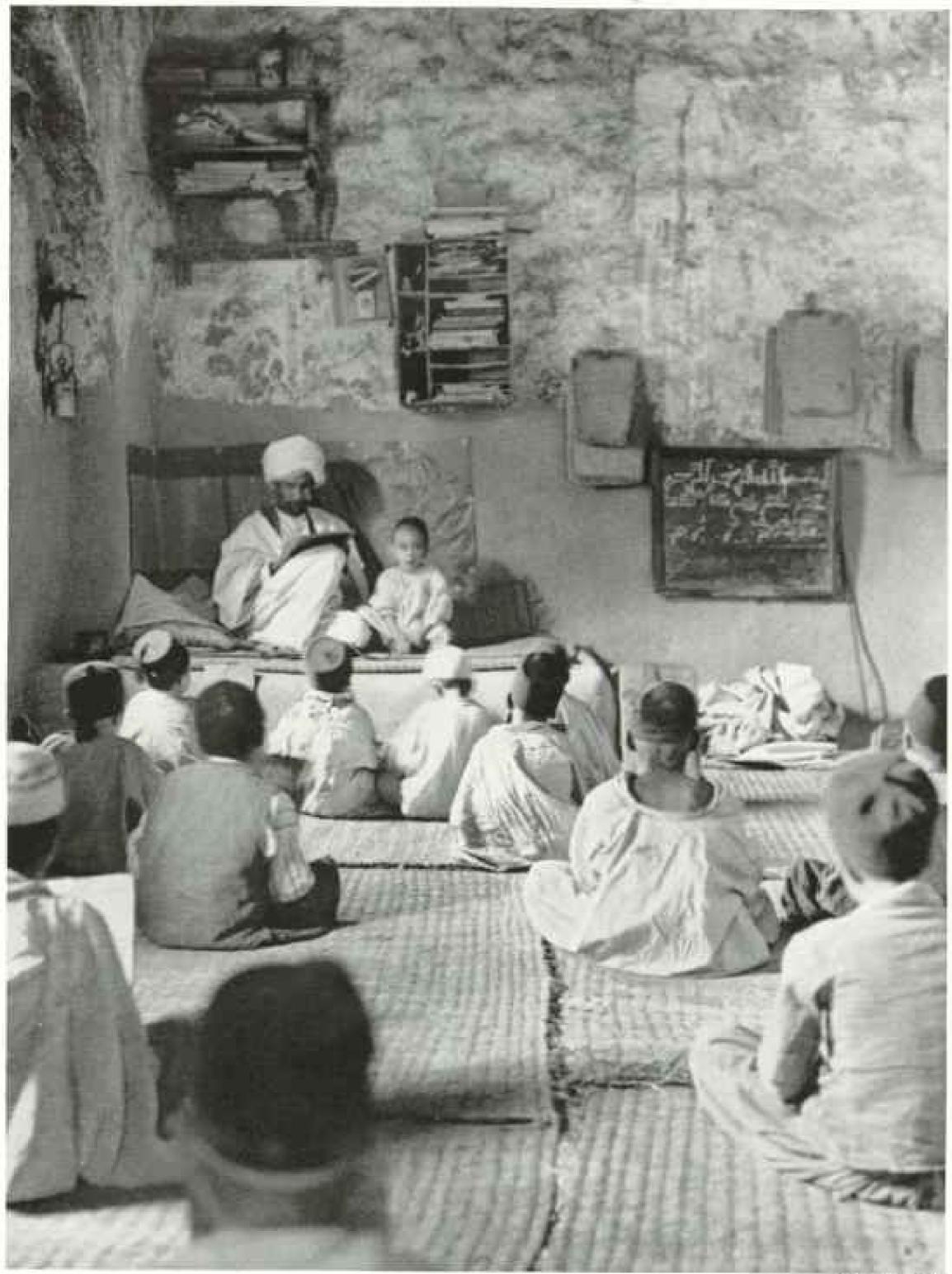
Swiftly we pass long trains of camels and plodding donkeys heavily burdened with sacks of barley, wheat, and millet, and droves of sheep and goats led (not driven) by slender shepherd lads. In the distance tiny villages perch on hilltops or hide in valleys where pastoral life reigns. Crops are sown and harvested in the primitive simplicity of Biblical times. The oxen still tread out the grain beside hardworn threshing floors.

In these villages are sometimes celebrated rites more ancient than the Law of the Prophet. There a doll, the descendant of Astarte of the Phoenicians, is in springtime carried around the fields to bless and fertilize the crops.

The coast is reached at Mehdia, at the mouth of the Sebou River, and presently Rabat appears (page 121). The lofty tower of Hassan, built in the late 12th century by Yakub el Mansur, becomes visible from afar.

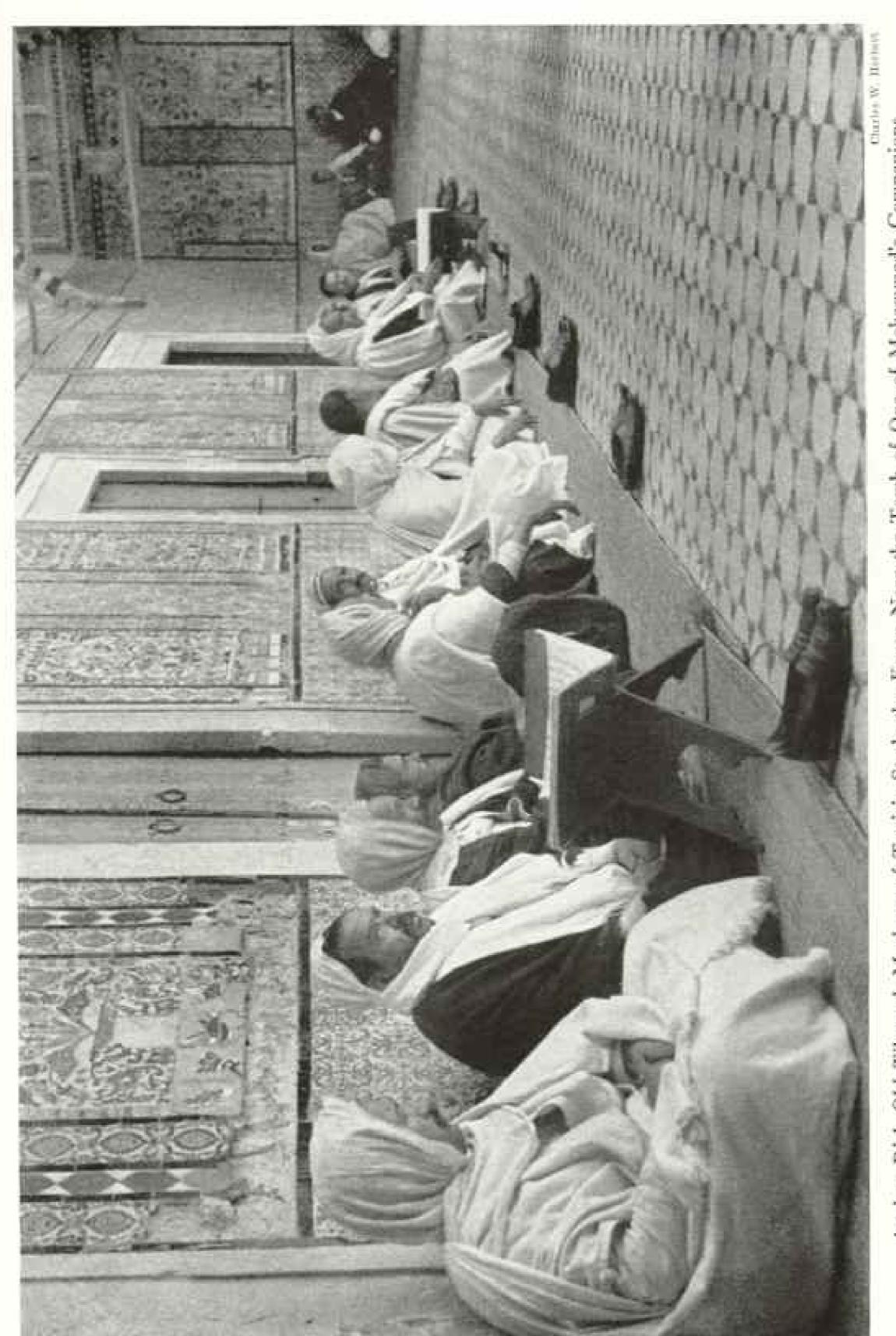
Rahat is an excellent scaport, in the latitude of Cape Hatteras—with only an Atlantic Ocean in between. One of the four capitals of Morocco—the others being Fez, Marrakech, and holy Meknès—it is the usual residence of Morocco's Sultan, Sidi Mohammed. It is also the seat of the French Resident General, the real power in the Protectorate.

The city is correspondingly divided into two parts—one the old Moorish quarter, the other the modern French city. There French



Petty Buyrkhaidt

In Moslem Schools Teacher and Pupils Recite Koran Verses While Ears Help Eyes to Read Beside the instructor in this Algerian school sits a two-year-old who makes no pretense of bolding a book. Such youngsters often can recite the lessons older pupils are reading. Students learn the language of the Koran as they rock back and forth to the rhythm of Mohammed's teachings.



Outside the walls of the holy city of Kaironan is the Zaouia of Sidi Sahab. Here, with their shoes neatly ranged before them, Moslammas of Sidi Sahab. Prayers are said five times a day, after ablutions (pages 131, 134, 135, 136). unisin Study the Koran Near the Tomb of One of Mohammed's Companions Against Rich Old Tilework Moslems of T



Second only to Mecta in the esteem of North African Moslems is Kalrouan, former capital of Tunisia. When French troops occupied the city in 1881, Christian solitiers followed the Moslems into their mosques, thus "defiling" them so that European visitors could enter without wearing special slippers (opposite page). Juring Knirouan's Annual Rog Fair and Cavalende of Desert Tribosmen Shop Fronts Are Hung with Carpets I



Blast Photographer Maymed Owen Williams

On This Ferry, Bus and Cart Cross the Entrance to Today's Headline Harbor-Bizerte

Around a wide take near the northeast corner of Tunisia spread the fortifications, flying field, workshops, and graving dock of the world-tamous naval fort. The Bizerte base lies close to the narrows between Africa and Sicily. This (erry crosses the bottleneck where, if sunk, it might close traffic in and out of the buge harbor (page 142).

engineers and architects during a whole generation, under the wise direction of General Lyautey, destroyed much that was ugly and unsanitary, but retained even in modern governmental constructions what was beautiful and in the traditional spirit of Moslem art.

While the modern city around the Residency is new, in the native quarters a Moorish atmosphere persists. Here the streets are filled, especially on market days, with countless crowds from all races and tribes of western Barbary.

The Moors, descendants of the Arab and

Berber stocks, dress in long white burnooses like nightgowns with monks' hoods.

Native Berbers wear garments of sacking and sheepskin, their heads shaved except for the long black lock which lies wildly over the shoulder and by which the Angel will lift their souls from earth to Mahound's paradise.

Scribes pass by on slowly pacing mules, their stout forms clad in voluminous folds of soft muslin, their mien recalling those of old who "enlarged the borders of their garments and loved greetings in the market place."

In the throng are grave members of the Umena, learned men, attended by black slaves



Biof Photographer Maximal Dress Williams

Movie Posters on Tunisian Walls Mark the Surge of Two Tides in North Africa

During the century after Mohammed's death, his followers swept across North Africa from Mecca, boly city of Islam, to Tours, then a holy city of Gaul. In 732 Charles Martel, the Hammer, turned back the Moslem waves. Reversing the tide, the French extended their sway into Africa from the Atlantic to Libia. These arches are those of the Bah el Khaifra, or Green Gate, of Tunis.

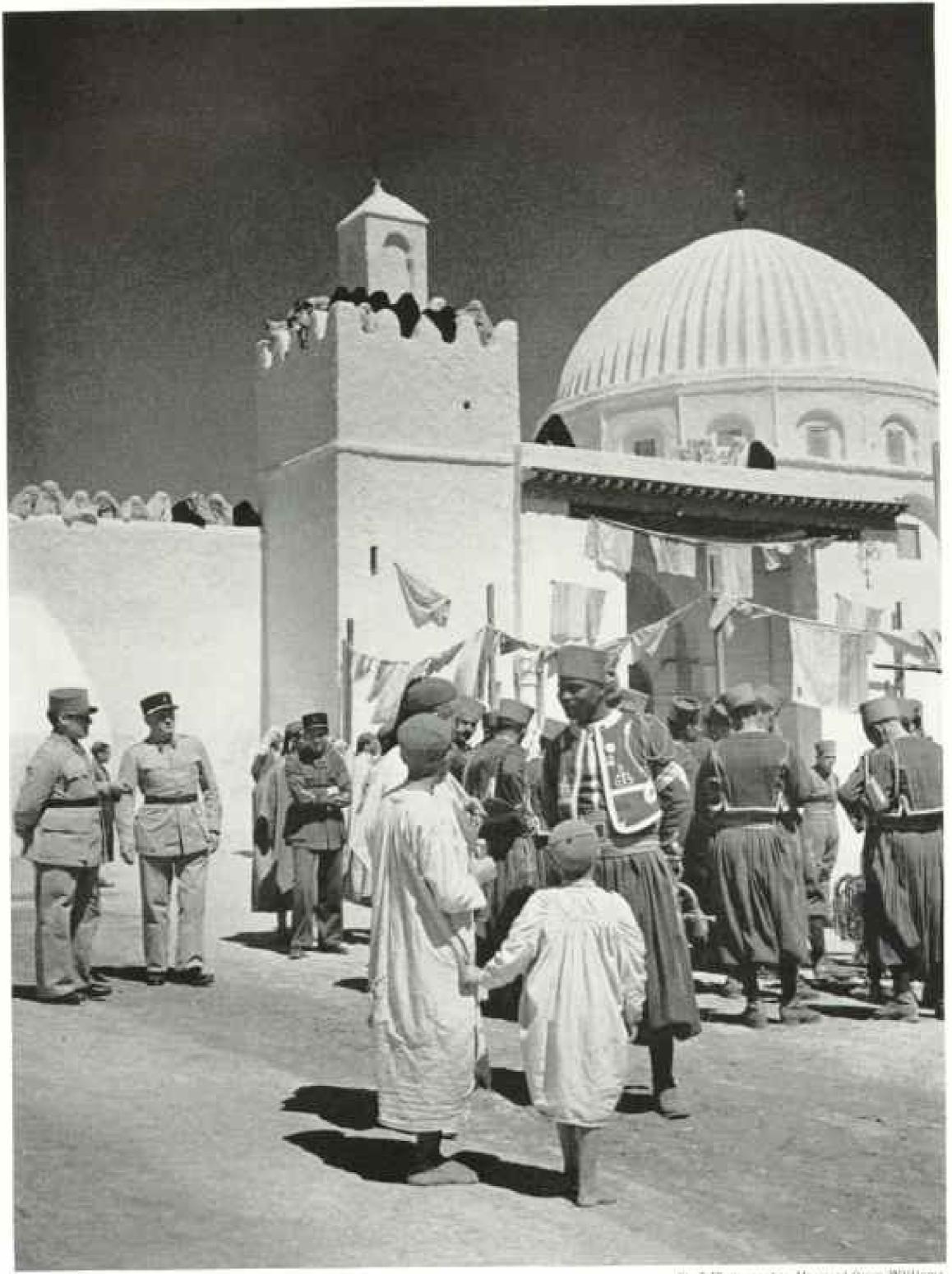
in white robes and red fezzes, Arabs distinguished by their spirited horses, holy men from the hills, clad in rag carpets, and groups of veiled women, guarded from the hot sun as well as from strange eyes in fold on fold of heavy woolen blankets.

Some hold one corner of the haik in their teeth; their bodies often are bent nearly double under heavy loads of charcoal, straw, or firewood.

Ever and again appears the black gaberdine of the Jew, once the slave even of slaves in Morocco, for which somber clothing, compulsory by Moslem law, his womenfolk make up by appearing in brilliantly dyed scarfs that vie with Joseph's coat in many-colored splender.

Everywhere are black slaves from the Sous, carriers of water jingling their brass cups, sweetmeat sellers, jugglers and beggars, while naked children, burros, and ubiquitous, fleainfested dogs circulate among the crowd.

Just across the often-turbulent Bou Regreg River, which here debouches into the Atlantic over a treacherous bar, is the sister city of Salé, once the dread stronghold of the pirates whose swift galleys terrorized the narrow seas and carried plunder and rapine along Christian Mediterranean shores.



Braff Philipprapher Married Owen Williams

Veiled Women Add a Living Cornice to Kairouan's White Walls

French officers in khaki and the Bey's handsmen in braided jackets and balloon trousers await the Resident General. The dome is not that of a mosque but of a zaowia-meeting place for a Moslem brotherhood. In its halls is held an annual rug fair. A genuine Kairouan rug bore a seal which allowed free entry into France.



Blaff Plenngrapher Marrisol Owns Williams

"Shoo, Fly, Don't Bother Me" Is a Gesture, Not a Song, in Kaironan

Far from being an arid land of sterile dunes, French North Africa is a vast granary. With a population equal to that of Washington State, Oregon, California, and Texas combined, the region produced about 90 percent as much wheat as the three Pacific States—62,000,000 bushels a year. Bread is the mainstay of the native diet and mutton the common meat.

Unnumbered thousands of captives labored and died in the building of Sale's harbor and forts, mosques and palaces, or entered the detestable harens of corsair captains.

Even now, in secret places and from furtive hands, may be purchased bracelets and necklaces and earrings plundered hundreds of years ago from noble ladies who disappeared within the blood-red walls.

Casablanea the Chicago of North Africa

Casablanca, White House in Spanish, Dar-(house) el-Baida (white) of the Moors, lies some 60 miles southwest of Rabat.

It is another white city, with a better port, much stronger fortifications, and is French Morocco's largest city (page 119). It is commercial, possessing the best Atlantic port north of Dakar, and is the terminus of the trunk railroad and highways across North Africa—north, south, and east. Through its

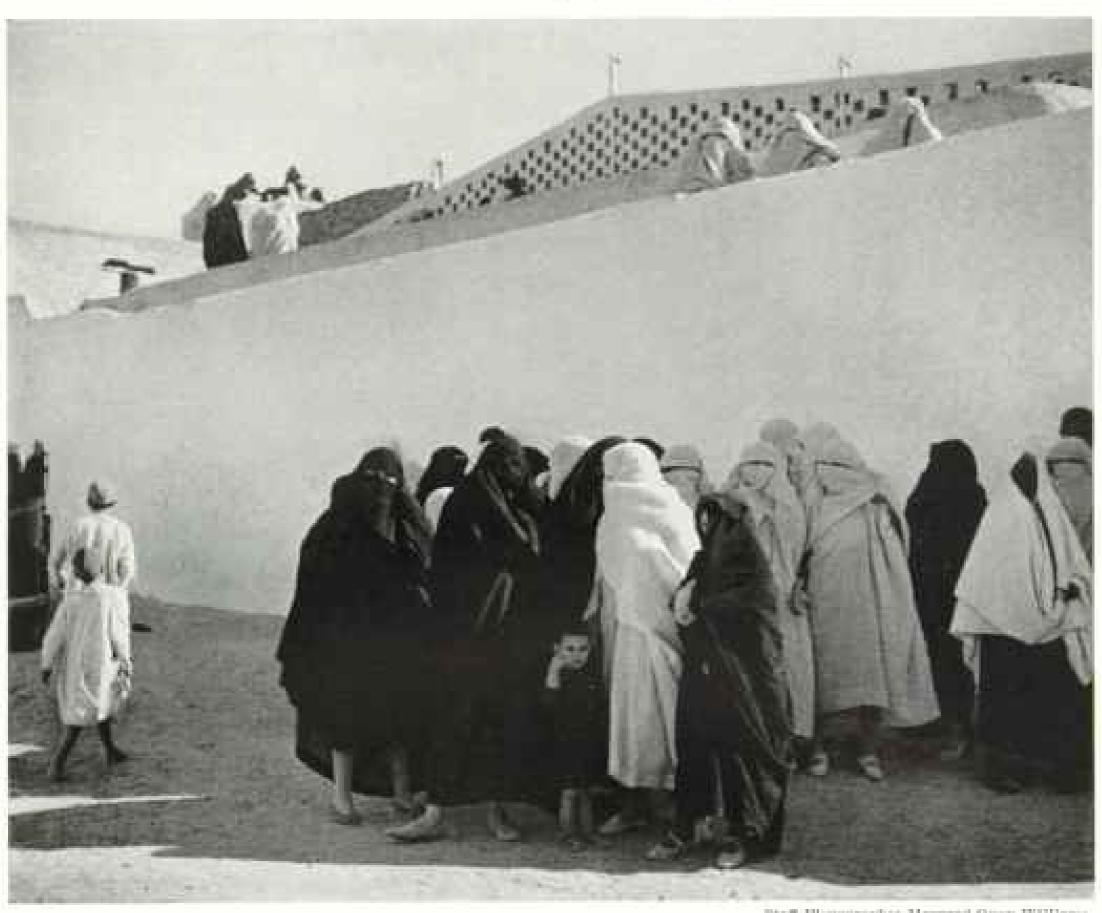
port passes most of the agricultural produce of Morocco.

Casablanca's capacious harbor is filled with ships, a matter of exceeding interest to Americans.

Though Morocco is not the granary that is Algeria, still, if the Mediterranean ports are closed, the produce of all northwest Africa could be brought by rail and highway to this port of the open Atlantic; or the traffic might be reversed the other way to supply the interior from the west.

The congested, noisy, and unsanitary quarters of the native population contrast sharply with the open, wholesome residence districts of the European. Though all else change, one thing will yet remain; the unifying influence of religious faith.

A few days after my arrival, on a clear evening toward the end of the Mohammedan month of Ramadan, a sign in the heavens



Staff Plenographer Mayoned Owen Williams.

Moslem Women Huddle in an Isolated Group to See the French Resident General Arrive At Kairounn's annual rug fair, woman's place is apart, but she sees what's going on. Most of the gowns, unlike the white robes and black year of Tunis, are dark.

recurred after centuries of oppression and deterred hone.

The phenomenon stirred the minds of millions of Berbers, restless under their Arab rulers, set prophets prophesying, purged men's hearts of fear, and uplifted them in exaltation.

A Sign in the Heavens

The new moon, ending the month-long fast during which, in daylight hours, no Moor may eat or drink or smoke, was looked for in the west.

For two evenings the wise men of the council had kept their watch, beginning before sundown, to mark the first appearance of the crescent.

Twice they had been disappointed: only the evening star was out, and the weary fast continued.

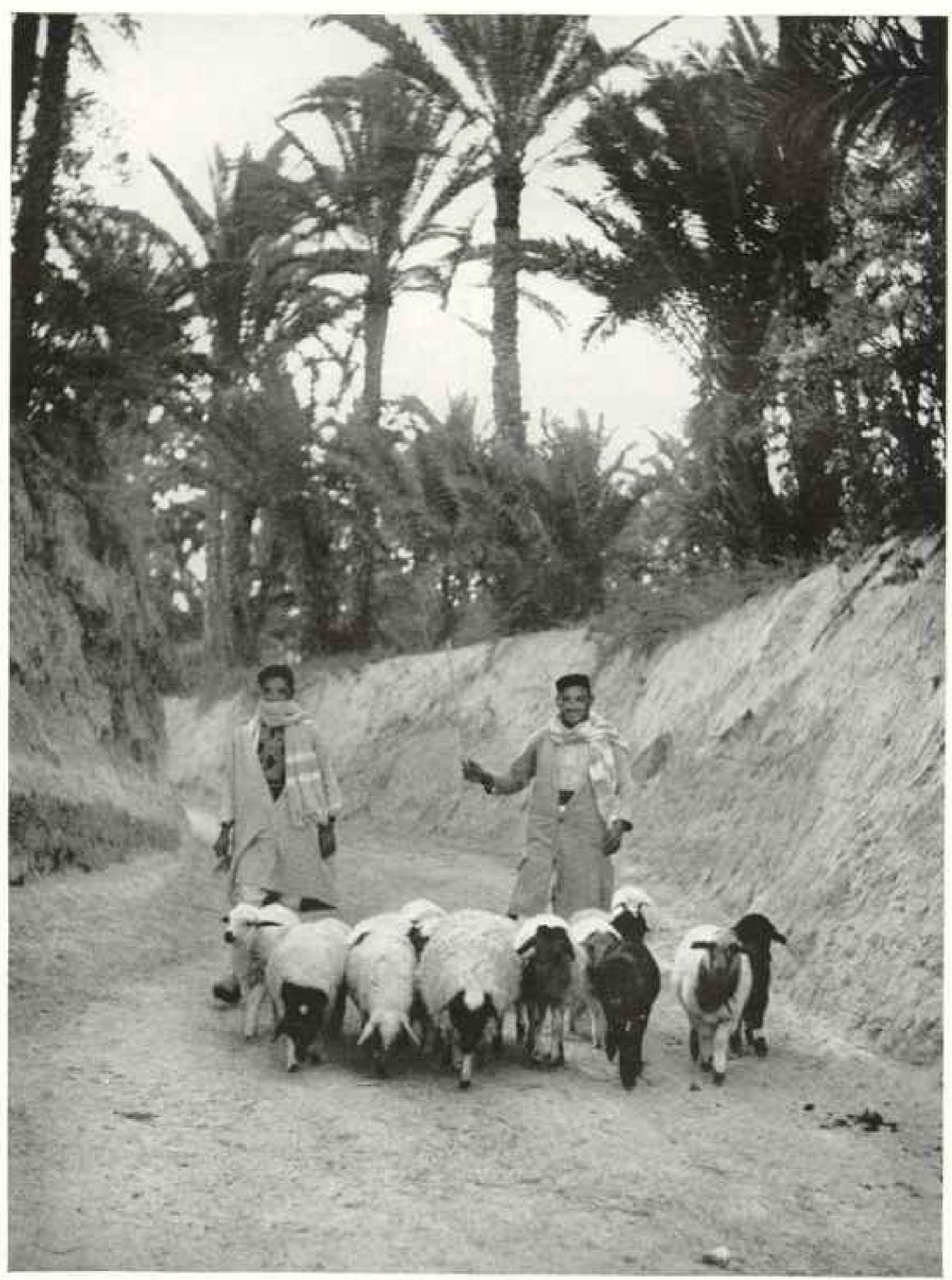
Then a miracle happened. The new moon was seen, pale at first as a ribbon of silver, and poised on its very tip, like a gem balanced on a saber of steel, hung the evening star, the symbol of Islam's undying hope and faith.

A single cannon spoke from the Kasba to announce the end of the fast; but this was instantly followed by crashes of artillery fired by gunners rendered hysterical by religious emotion.

With the speed of summer lightning the news was flashed among the Moors. Old and young, rich and poor, crowded the housetops, stood transfixed in the fields and open spaces, shouted, prayed, prophesied.

All prisoners were released. The sacred but forbidden green banners of the Faith, some of them hidden in secret places for generations, were paraded through the streets.

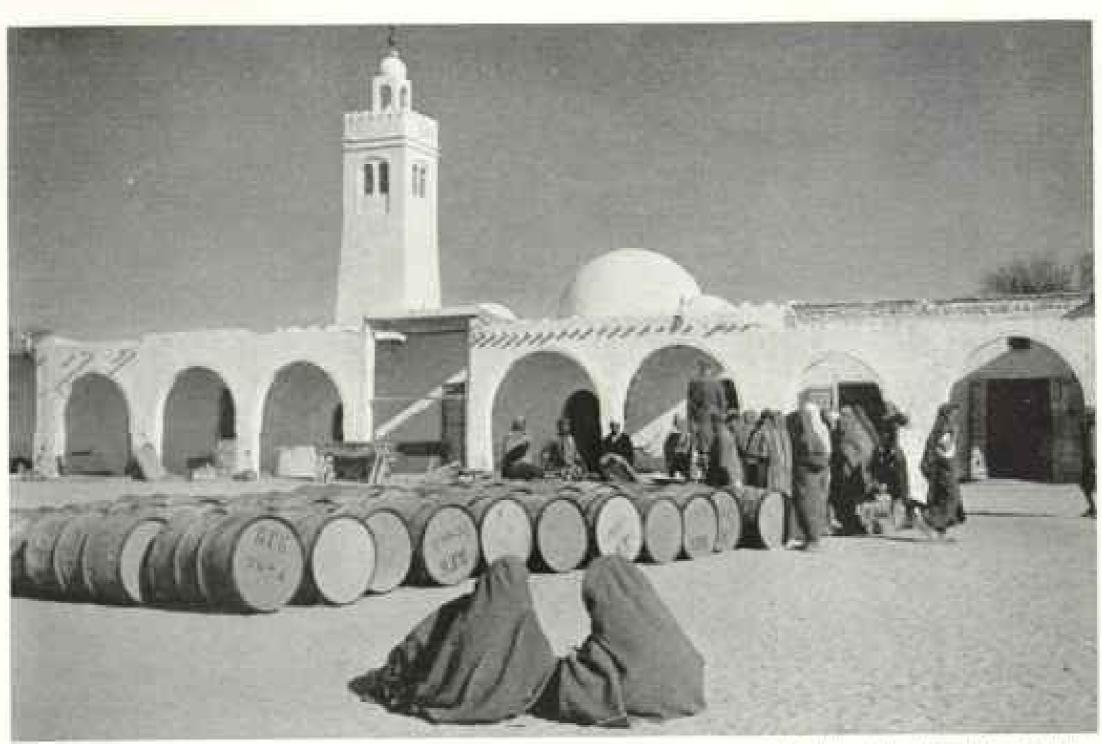
A prophecy was chanted that the Archangel Ithuriel, holding the scroll of judgment and the sword of power, would wing his way from the west, to aid the Berbers in throwing off the yoke of their oppressors, and give to the Moroccans wisdom and self-government and prosperity forevermore.



Nish Phetographer Magnard Once Williams

Palm Fronds Muffle the Sound of Gunfire at Gabès, Where Railway Meets Caravan

Beyond this seaside oasis one entered the world of barbed wire and tank trap, gun emplacement, and walled market places facing the Libian frontier. South from Gabes, Tunisian railhead, a line of hills stretching into the desert forms a natural frontier, well inside the political boundary with Italy's African colony.



Stat Planegrapher Mayured Owen Williams

American Military Supplies Soon May Crowd This Frontier Post Near the Libian Frontier
At Ben Gardane drums of olive oil were transferred from noisy trucks to silent-footed camels bound for
secret desert destinations.

Perhaps this prophecy is even now being fulfilled, and a leader from the west may yet stand beside the ancient gateways to the Mediterranean looking east and south into Africa, and beyond to the great bulge which, like a clenched fist, stretches out almost to touch the coast of South America.

Along the High Atlas

To unroll the map of French North Africa eastward we take the train or bus along the sole passable route to Algeria and Tunisia. It follows the depression that runs between the steep cliffs that overlook the Mediterranean and the higher plateaus and towering peaks to the south.

On our right the High Atlas and the Grande Kabylie of Algeria preclude any breakthrough, and beyond them is the desert.

To the north are the yet unexplored mountains of the Riffs, who forcibly resist the advent of foreigners and have confined the Spaniards, whose country it nominally is, to a narrow strip of Mediterranean shore no wider than the range of a gunboat's cannon.

Taza and Ouida on the Moroccan side, and Tlemcen and Sidi-bel-Abbès on the Algerian, are military towns. Here were laid out the barracks and vast parade grounds of France's North African army. Here, too, it always seemed at first glance as if the population was wholly military, so crowded were the streets with soldiers in uniforms of surpassing variety and color.

Gorgeous are the scarlet cloaks and flowing trousers of the Spahi cavalry; notable the visored képis and immaculate white uniforms of the Foreign Legion, their waists encircled with blue sashes and with a scarlet fourragère on the left shoulder; intriguing the tirailleurs in road-dusty khaki.

They also wear a thirsty look which seems never quenched however numerous the wine shops or tiny tables set out invitingly upon the payement.

Mingled with them are Turces and Zouaves, Algerian and Moroccan colonial infantry, dark Senegalese, and chasseurs d'Afrique, infantry and cavalry on foot, mounted or motorized.

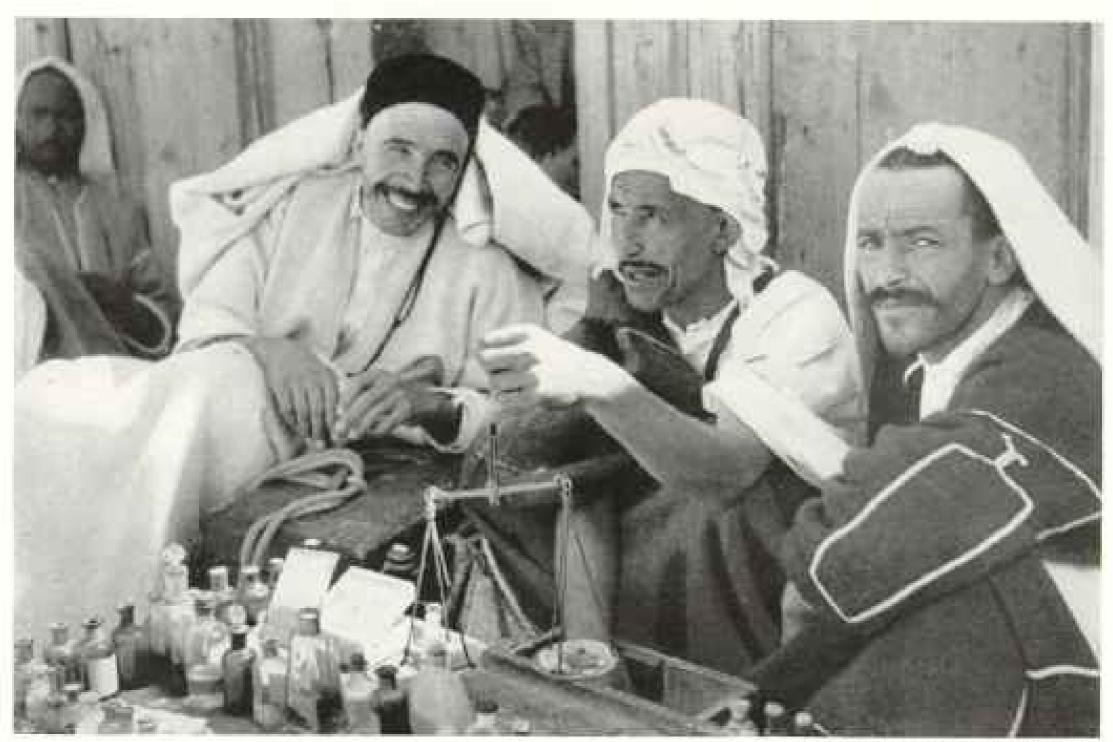
Oran a Fortified Boom Town

The most spectacular part of the trip is left behind at Oujda. Ahead are the much visited cities of Oran and Algiers, where romance dies on the accurately dry pages of Baedeker and Cook.

Oran is a heavily fortified boom town. Not but that it, too, is old in its way, for it



Red-fezzed Farmers Share a Bench on Avenue Jules Ferry, Broadway of Tunis



Rhaff Plonugrapher Maximed Oven Williams

Perfumes Persist in Djerba, Island of the Lotus-eaters

In the open-air market at Midoun, a dealer weighs out the sweet-smelling essence. This island where Odysseus encountered the lotus-enters lies off the Tunisian shore, east of Gabès. About 4,000 descendants of Jews who fled from Palestine nearly 1,900 years ago now live on the Island (page 142).



Buff Protographer Marneyd Owen Williams

Hand-hammered Copper Rings to the Mallet Beside the Battlemented Walls of Sfax

Refore this wide bowl is used for food, the inside will be "tinned" with a solderlike alloy to prevent poisoning. Fuel shortage makes such quick-heating copper vessels popular. Stax, Tunixia's second largest city, is the shipping port for phosphate mines near Methagui.

dates from the tenth century. But the modern has so swallowed up the old that its life and atmosphere closely resemble those of a thriving metropolis of the American Middle West (page 125).

Mosques, old town and new town, native markets, and sun-lit public squares replete with palms and fountains exist, and mighty wharves to take care of Algerian commerce across the Mediterranean.

Spearhead of Mediterranean Control

But its chief distinctions are the modern airfield of Oran-La Sénia, largest in all North Africa, including those of Algiers, the ouarran, or ravine, that lends its name to the town and is made into a double fortress, and the magnificently fortified naval base of Mers-el-Kebir, four miles northwest of the city.

Here on July 3, 1940, British and French naval power met in a struggle involving the immediate control of the Mediterranean. Some 40 miles from Algiers, at Khor-er-Rumia, "the grave of the Roman [i.e., foreign] lady," is the tomb of Cleopatra Selene, daughter of Mark Antony and Cleopatra, Queen of Egypt.

According to the half-forgotten story, Juba II, descendant of certain kings of Numidia who once aided Rome against Carthage, petitioned Emperor Augustus for the hand of the maiden.

The emperor, glad to be rid of a possible rival in whose veins ran the blood of the Ptolemies, approved the marriage.

Juba and matrimony, he thought, might dull any aspirations that would have led Selene and her followers again to contest Rome for mastery of the world.

In this he was correct; the beautiful Selene "became more settled in her mind" and with Juba devoted herself to love and art and philosophy, holding a miniature court in a splendid palace above the blue Mediterranean



Blaff Photographer Maynard Owen Williams

Male Wedding Guests Attend One Party; the Women Another

To the lower courtyard of a bome in Sousse have come friends of the groom to talk, smoke, drink, and watch a male dancer in female dress wave his hips about while holding a jar of water on his head. Christian catacombs are found near this Tunisian port, where Roman monuments rise above olive orchards.

Sea. They were buried in the tomb that stands near by.

It is a huge, circular structure with a pyramid roof supported by 60 Ionic columns. Unfortunately it has been rifled and the ashes of the royal couple scattered to the winds.

Legend further relates that the vandals twice were driven off by swarms of wasps emerging in legions from the violated tomb. Guidebooks prosaically say "mosquitoes," but I feel sure that Cleopatra's daughter's corpse could have had nothing less royal and vengeful than wasps.

Haunt of the Barbary Corsairs

The commanding city of Algiers is capital of Algeria, haunt of the Barbary corsairs, tourist haven, mistress of Mediterranean shipping. The harbor normally is filled with ships, the shops and boulevards may rival those of the Continent, and the passing people are as many-tongued as Babel (page 122).

Yet the importance of Algiers lies more in the fertile land behind it, once the granary of Rome, today still noted for its productive soil.

Fully two-thirds of the population engage in agriculture.

In the highlands are grazing lands for cattle and horses, sheep and goats; on the slopes are vineyards and orchards, and in the level plains, rich with alluvial soil, are waving fields of grain; all of which may be carried in ships across the Mediterranean to hungry Europe.

Algeria exports wheat, wine, barley, oats, corn, and tobacco, and an amazing variety of fruits, including oranges, apricots, peaches, plums, and dates. Production and refining of olive oil are of prime importance, and the soil of Algeria is particularly adapted to the cultivation of the vine.

Not all parts of the country are equally rich in produce or the inhabitants equally industrious. Productiveness has been enormously increased by the sinking of artesian wells and by the introduction of scientific methods of farming, especially by the European settlers.

Most natives still regard such innovations with a mixture of apathy, curiosity, or open hostility. Nevertheless, the intelligent direction and stimulation of agricultural pursuits have increased enormously the yield of fruits and meats and cereals.

Bizerre Guarded from Sea and Air

Easterly again, powerful Bizerte and warmly colorful Tunis exhibit the influence of Italy and the near presence of the Sicilian isle.

Because of its strategic position, defended from the sea and supported by air from the two fields of Bizerte-Karouba and Bizerte-Sidi Ahmed, Bizerte has been called "a pistol pointed at the heart of Italy" (page 132). Rather, it seems aimed at the Achilles heel, Sicily, which here is less than 150 miles away.

Over this narrow strait the naval powers of France, Italy, and Great Britain, from her staunch island fortress of Malta, have kept

icalous watch.

The desolate site of near-by Carthage, now a bare heap of ruins where once was the proudest maritime capital of the world, helps keep alive the thought that empire in Africa must ever be defended.

The city of Tunis near by, though it is the capital of Tunisia and the residence of the Bey, fails strikingly to live up to the glory and splendor of past ages (pages 114, 127, 133, 139).

It was, until recently, hardly a seaport at all, being seven miles inland on the shores of a salt lagoon called El Bahira, the "Little Sea," and connected with the Mediterranean only by a canal dredged and kept open by French engineers.

The jeweled palace of the Bey is a thing of beauty, with its façades and fountains glittering with Tunisian faïence tiles. Politically, it is unimportant except as the seat of French authority, and the fortifications are negligible

as compared with Bizerte.

Here the standard-gauge railway a

Here the standard-gauge railway ends and travelers must change to the narrow-gauge Tunisian railway to continue the journey to Sousse, Kairouan, Sfax, Gabès, a rail journey of 14 hours from Tunis.

The route is along the sen, through a nar-

row strip of fertile land lying between it and the desert. This last is but a bleak, monotonous stretch of land which it is impossible to associate with the grain and date country of the African Roman Empire. From there, chroniclers relate, caravans of a thousand camels, loaded with dates, once left weekly for the northern ports.

Now travelers view ruins of temples, arches, and amphitheaters, and even more informative aqueducts. In other ages this shore was densely populated and highly productive, coveted and fought over by invaders and kings going far back behind the veil of history.

Island of Lotus-enters

Off the island of Djerba divers have found statues and capitals of columns from sunken cities the names of which are only conjectured. The island itself was the reputed home of Homer's lotus-eaters and the ancients' "Never-never land" (page 139).

On the Moktah River, the fortified line between Tunisia and Libia, a French North

Africa journey comes to an end.

From the Atlantic to the Gulf of Gabès the pilgrim has trod the soil of Berber and Arab, Carthaginian and Roman, Turk and French.

Today the treads of tanks and the rubber wheels of motorized artillery are added to the trains of warlike transport that have crossed this frontier.**

* For other North Africa articles in the Navional. Geographic Magazine, see: "Mediterranean Checkerhoard," by Frederick Simpich, April, 1942; "Fez, Heart of Morocco," by Gordon Casserly, June, 1935; "Beyond the Grand Atlas," by V. C. Scott O'Connor, March, 1932; "Across French and Spanish Morocco, by Hasriet Chalmers Adams, March, 1925; "White City of Algiers," by Gordon Casserly, February, 1928; "Trans-Africa Satari," by Lawrence Copley Thaw and Margaret Stout Thaw, September, 1938; "Old-New Battle Grounds of Egypt and Libia," by W. Robert Moore, December, 1940; "Circuaica, Eastern Wing of Italian Libia," by Harriet Chalmers Adams, June, 1930; "Crossing the Untraversed Libyan Desert," by A. M. Hassanein, September, 1924; "Tripolitania, Where Rome Resumes Sway," by Gordon Casserly, August, 1975; "Ancient Carthage in the Light of Modern Excavation," April, 1924; "Time's Footprints in Tunisian Sands," by Maynard Owen Williams, March, 1937; "War Meets Peace in Egypt," by Grant Parr and G. E. Janesen, April, 1942; "By Felucca Down the Nile," by Willard Price, April, 1940; "Land of Egypt," by Alfred Pearce Dennis, March, 1926. For further references see "Cumulative Index to the NATIONAL GEOGRAPHIC MANAGERE."

Notice of change of address of your National Geographic Society by the first of the month to affect the following month's issue. For instance, if you desire the address changed for your March number, The Society should be notified of your new address not later than February first.

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To entry out the purposes for which it was founded fifty-five years ago, the National Geographic Society publishes this Magazine menthly. All receipts are invested in The Magazine itself or expended directly to promote geographic knowledge.

Articles and photographs are desired. For material The Magazine uses, generous remaneration is made.

In addition to the editorial and photographic surveys constantly being made. The Society has sponsored more than 100 scientific expeditions, some of which required years of field work to achieve their objectives.

The Society's notable expeditions have pushed back the historic horizons of the southwestern United States to a period nearly eight centuries before Columbus emised the Atlantic. By dating the ruins of the vist committed dwellings in that region, The Society's researches solved secrets that had puzzled historians for three hundred years.

In Mexico, The Society and the Smithsonian Institution, January 16, 1939; discovered the object work of man in the American for which we have a date. This slab of stone is engraved in Mayan characters with a date which means November 4, 291 a. c. (Soinden Correlation). It America, and reveals a great center of early American culture, previously unknown,

On November 11, 1935, in a flight spomored jointly by the National Geographic Society and the U. S. Army Air Corps, the world's largest ballson, Explorer II, ascended to the world altitude record of 72,395 feet. Capt. Albert W. Stevens and Capt. Orvil A. Anderson took aloft in the gondola nearly a ton of scientific instruments, and obtained results of entraordinary value.

The National Geographic Society-U. S. Navy Expedition cumped on desert Canton Island in mid-Pacific and successfully photographed and observed the solar eclipse of 1937. The Society has taken part in many projects to increase knowledge of the sun.

The Society cooperated with Dr. William Beebe in deep-sea explorations off Hermoda, during which a world record depth of 3,028 feet was attained.

The Society granted \$25,000, and in addition \$75,000 was given by individual members, to the Government when the congressional appropriation for the purpose was insufficient, and the finest of the giant sequota trees in the Giant Forest of Sequota National Park of California were thereby saved for the American people.

One of the world's largest forfields and glacial systems outside the polar regions was discovered in Alaska and Vakon by Bradford Washburn while exploring for The Society and the Harvard Institute of Exploration, 1938.



artur Rodzinski

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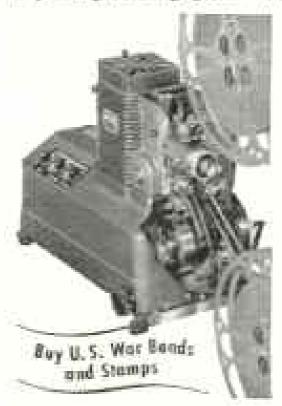
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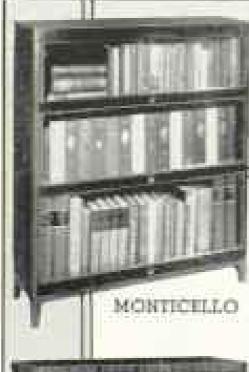
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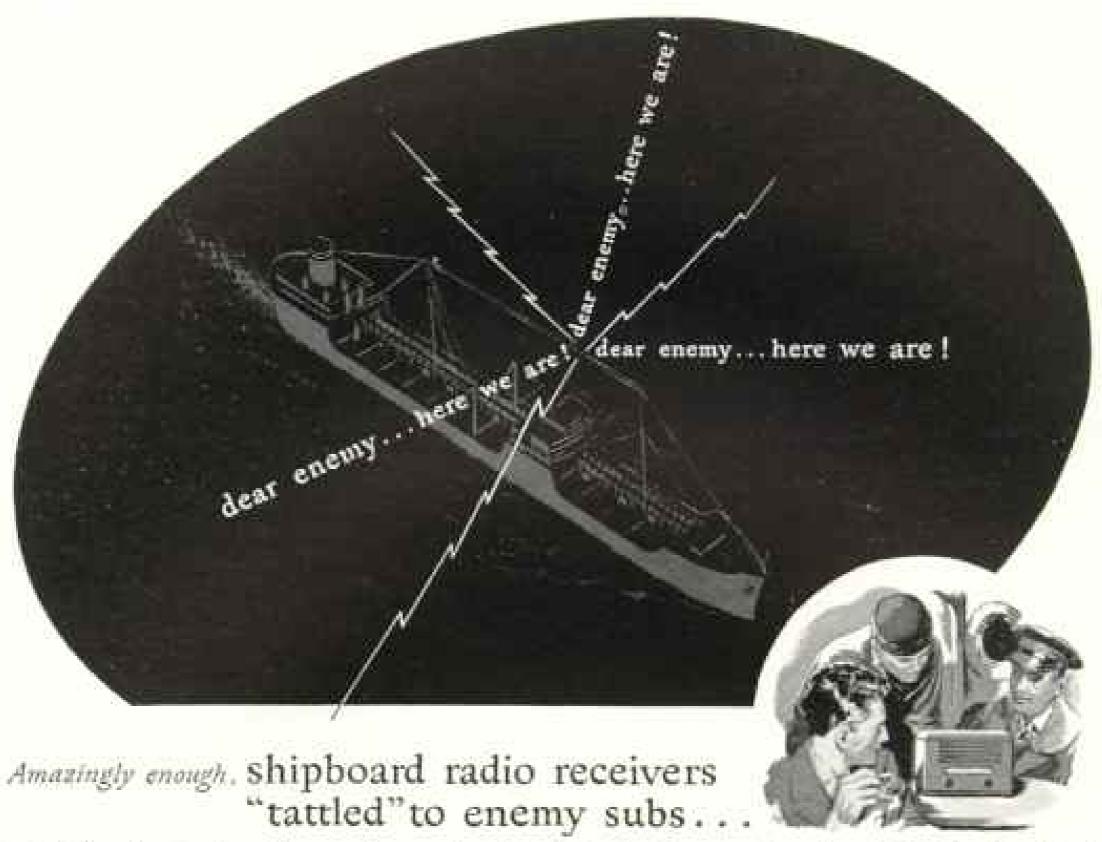
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SCOTT Marine Model

> The Scott Marine Model is for marine use exclusively and is available for shipboard installations under priority ratings.

Do you know why the Federal Communications Commission banned all shipboard entertainment radios? Because, the instant they were turned on for listening they divulged the ship's position . . . much farther than the 10 or 15 miles most officers and men believed possible. Actually a receiving set rebroadcasts a signal detectable as much as 100 miles away by sensitive enemy direction-finders.

To eliminate this hazard, the Federal Communications Commission urged radio manufacturers to develop a safe radio for use at sea. In less than a month Scott engineers invented a special Marine Model that can't be detected 25 feet away—fully approved by the Federal Communications Commission!

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Three sensible ways to avoid Pneumonia



 Keep fit! Most adults require eight hours of sleep daily, children considerably more. Regular exercise, outdoors whenever possible, is important and so is relaxing recreation. Above all, a well-balanced diet, including plenty of vegetables, fruits and milk, will help you.



3. Wotch that cold! Respiratory infections often pave the way for pneumonia. It is best to take seriously even a common cold. Early signs of pneumonia are coughing, accompanied by pain in the side or chest...thick, rust-colored sputum... rapid breathing. If a cold is very severe or lingers on, be particularly careful. The wisest precautions are: Go to bed...call the doctor!



2. Avoid chilling! Dress warmly during the "pneumonia months," early winter to late spring. Lower home temperatures this winter may require warmer dress indoors. Chilling is especially risky when you are over-tired. Change wet clothing and shoes as soon as possible. A chill followed by fever is one of the early signs of pneumonia.

THE AMAZING REDUCTION in the death rate from pneumonia in the last few years is due largely to the use of the new sulfa compounds.

The greatest service you can perform for one who develops signs of pneumonia is to call the doctor immediately. The doctor (and no one but the doctor) should be given the earliest opportunity of using the powerful sulfa drugs. In most types of pneumonia his chances are excellent of both hastening recovery and of preventing serious, perhaps fatal, consequences.

Metropolitan will send you upon request a free pamphlet, 13-N, "Respiratory Discases," containing valuable information about pneumonia.

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This fellow can bite his way into trouble

WITH HIS STRONG, cutting teeth, the beaver can fell a tree eight of ten inches in diameter. He is also adept at trimming off branches, and he can quickly cut a fallen tree into near, easily handled logs;

But, when a beaver cuts down a tree with his big, chisel-like teeth, he quite frequently bites his way into trouble. You see, beavers, like men, get careless. And naturalists report instances of these flat-tailed lumbermen being killed or injured by falling trees.

But the beaver's industrial safety record probably beats man's. Last year alone, industrial accidents in this country caused 18,000 deaths among workers, permanently disabled over 70,000, and resulted in the loss of 42,000,000 man-days.

At any time, this would be a sorry record. But now, when success or failure in this war depends so much upon production, it represents a real danger to this country. Fortunately, however, there is a proven way to reduce these industrial accidents.

Many contractors and manufacturers do it by enlisting the aid of Travelers Safety Engineers. These men are trained trouble shooters. Years of which lead to accidents form a definite pattern. They have learned, too, that 9 accidents out of 10 are due to man's own careless working practices, and they know what these practices are:

This knowledge enables Travelers Safety Engineers to spot the kind of carelessness liable to cause accidents, long before an accident takes place. It is the big reason why they have had almost unbelievable success in reducing industrial accidents and thus speeding up war production.

Hundreds of stories can be told about what these experts have done for others. You can learn what a Travelers Safety Engineer can do for you by calling the nearest Travelers office. It is likely he will be able to reduce the accidents in any factory or industrial operation, or hold them to a minimum on any construction project. His work frequently results in lower insurance costs.

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designed to furnish the motive power for one of the Union Pacific fleet of Limited trains providing comfortable passenger transportation between Chicago and the West Coast. Today, he and many like him are performing an important war-time task. Uncle Sam has called on the railroads,

This husky fellow was not only to move vast quantities of war materials, but also to transport thousands of men in service. Thus, we are not always able to provide preferred accommodations for civilians who find it necessary to travel. To these patrons, Union Pacific wishes to express its appreciation for their

patience and cooperation.



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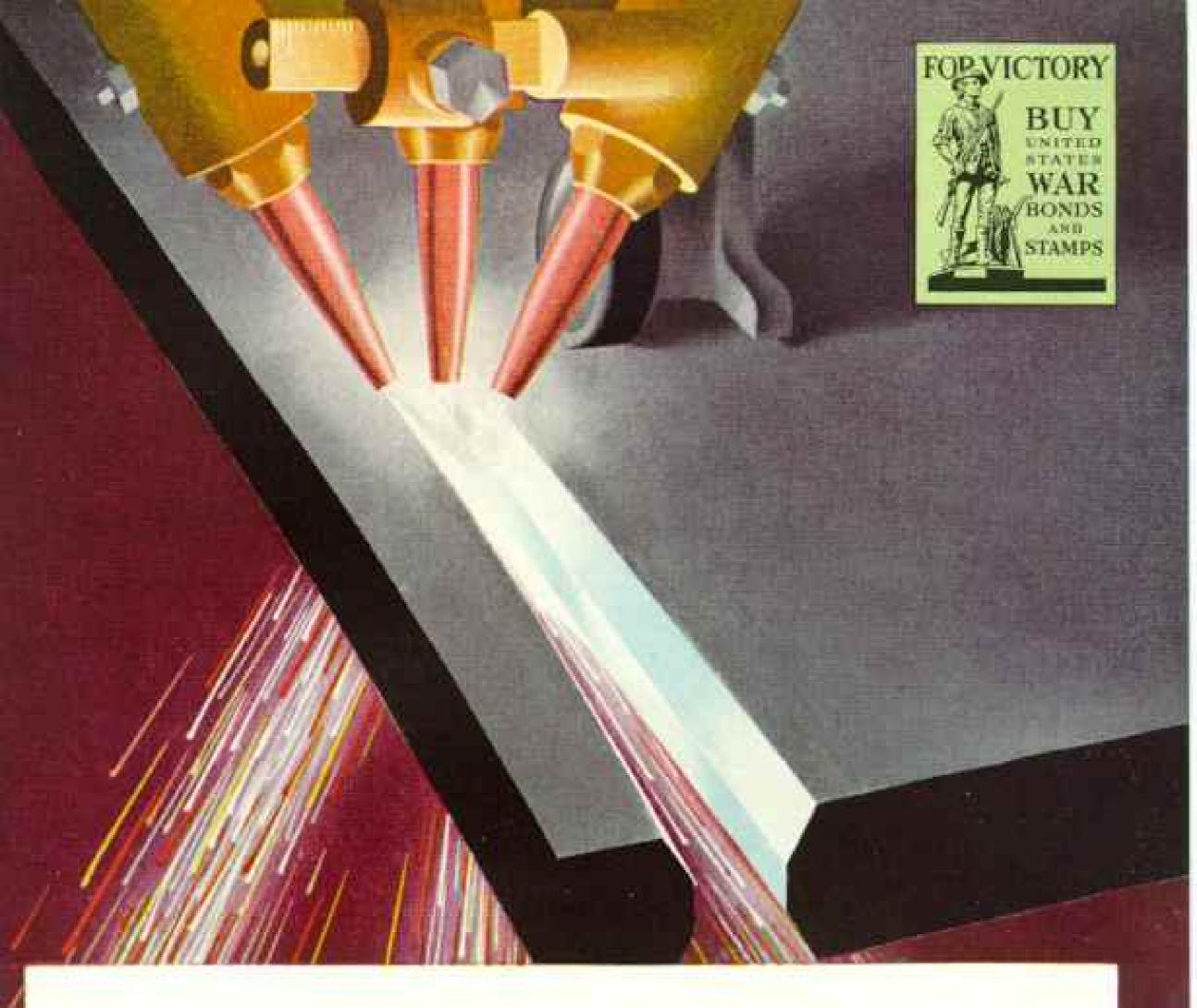
"Then I could give the public all the service it wants and take care of the war on top of that.

"But I can't get bigger now because materials are needed for shooting. So I'm asking your help to make the most of what we have.

"Please don't make Long Distance calls to centers of war activity unless they are vital. Leave the wires clear for war traffic."

BELL TELEPHONE SYSTEM





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But before welding can take place, steel plates have to have their edges beyeled and squared-up so that, when butted together, they look like this:

In the past, preparing plates in this manner was done by heavy machine tools. Cutting was slow and costly. Each plate had to be handled many times. Plate cutting on this basis could hardly keep pace with welding today.

Now, expacetylene flames...cutting in different planes simultaneously...prepare the edges of steel plates of any commercial thickness at one pass...in a fraction of the time required by mechanical methods!

This Linde flame-planing method is as simple as ABC. It is economical... and easy to use, It cuts plates so smoothly and accurately that no machining is necessary! And it uses materials which can be produced in abundance.

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