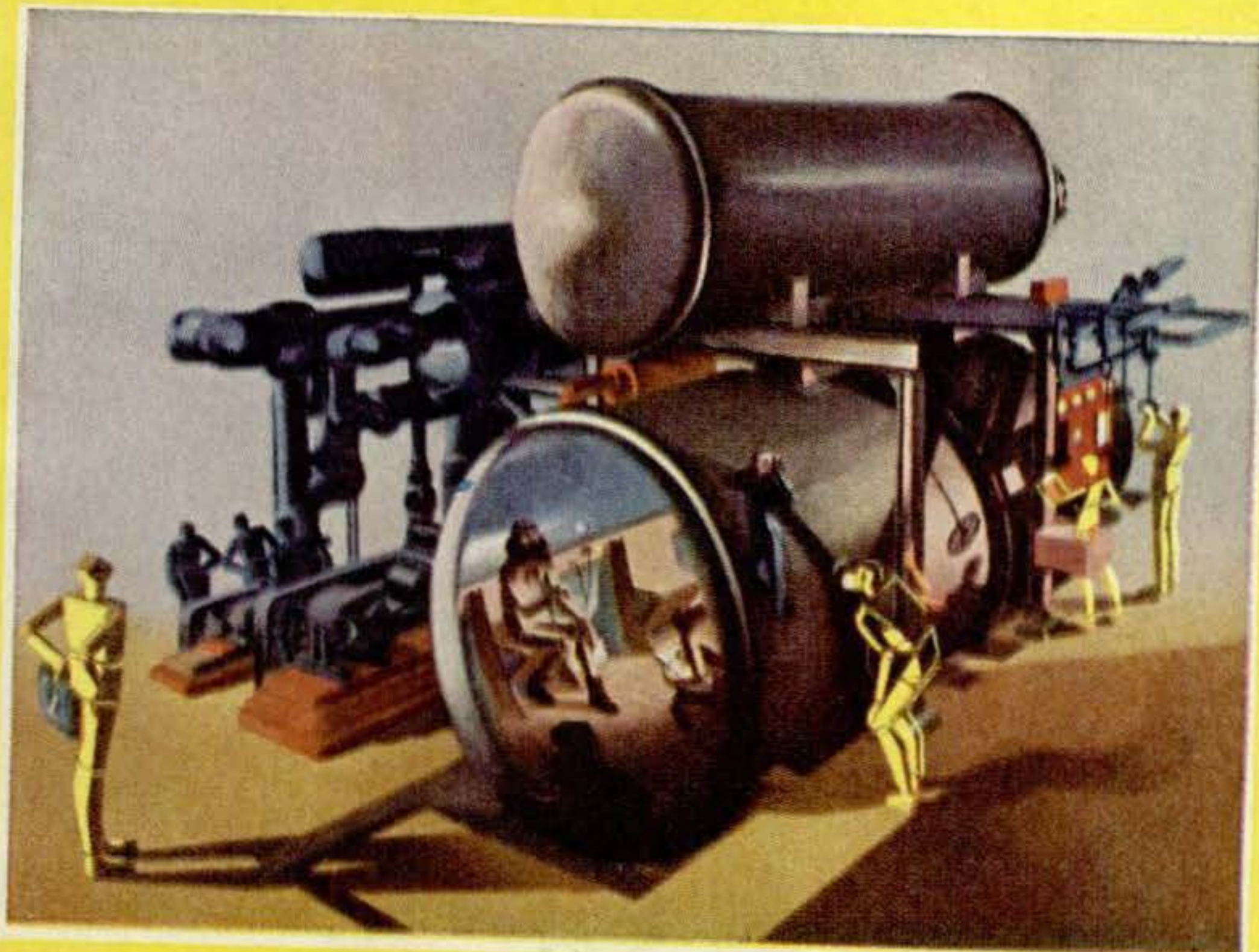


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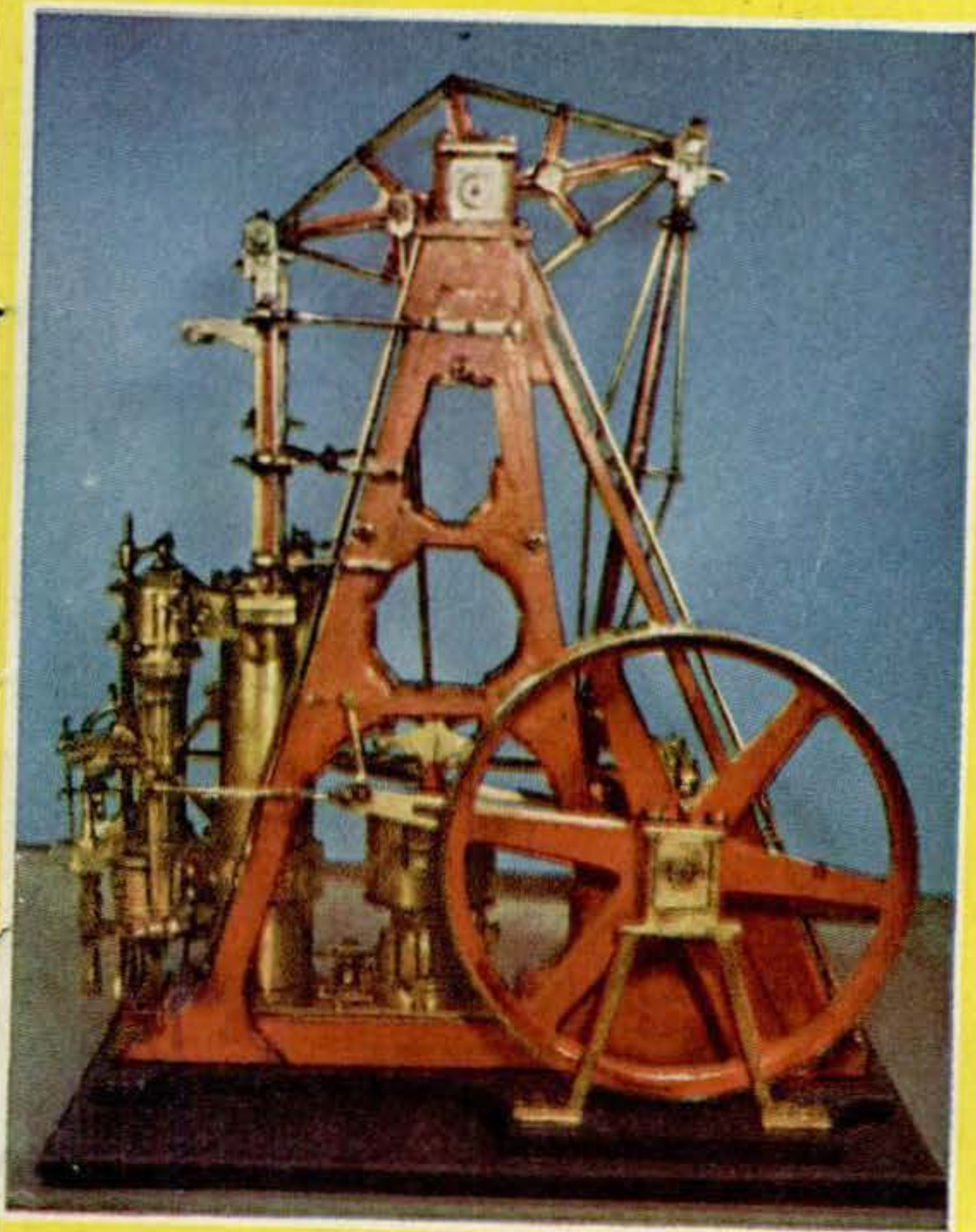
MECHANICAL MARVELS as seen by a mural painter. Page 80.



ATOMIC INSIGNIA worn by officers and enlisted men who worked on the war-ending bomb.

SCALE-MODEL ENGINES THAT WORK.
Kodachromes of miniature machines. Pg. 115.

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New brilliance for this year's lighting. Page 120.



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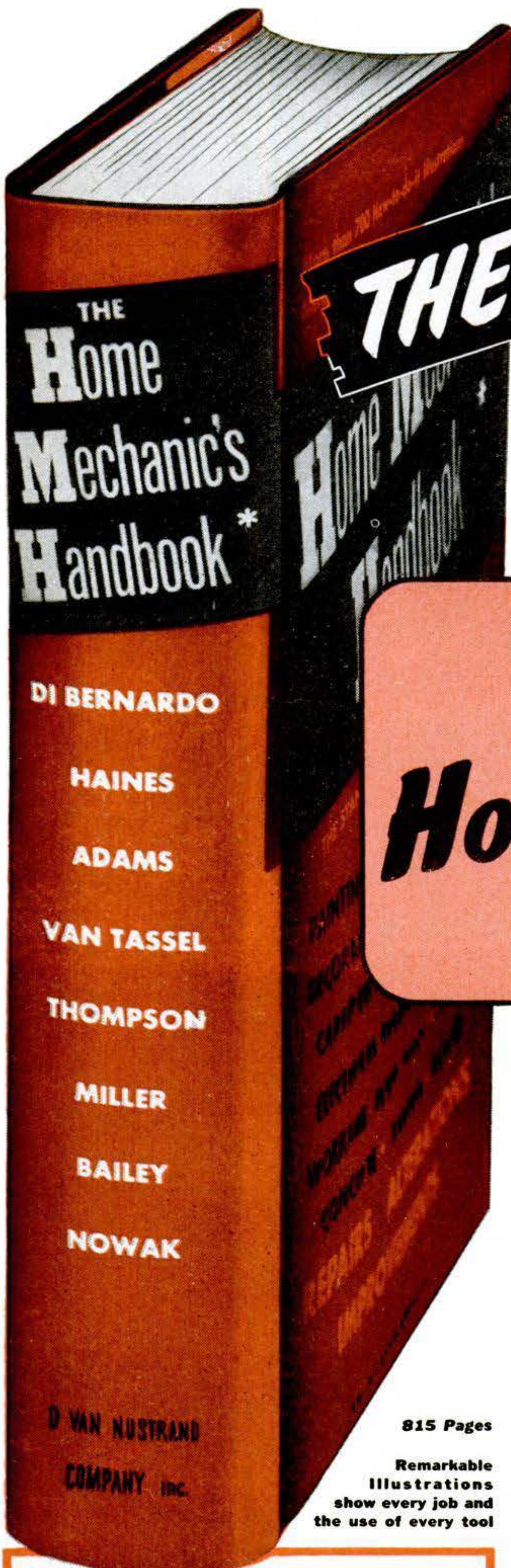
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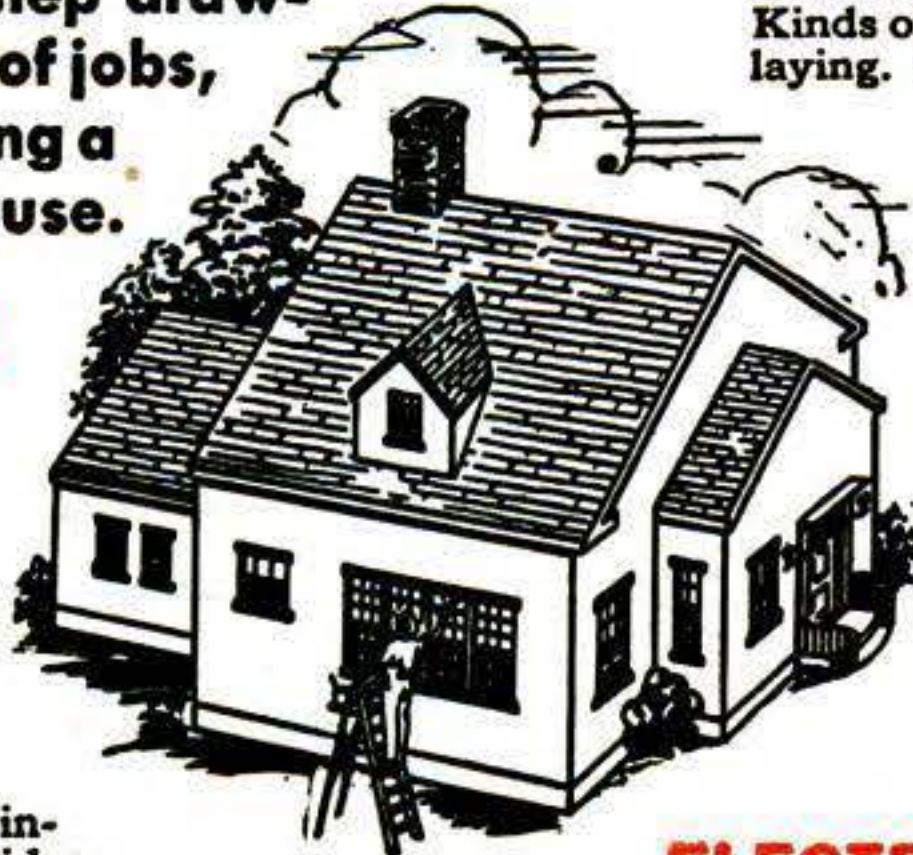
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The various kinds of pipe, pipe fittings, valves, and fixtures. All the common plumbing tools—types, sizes, functions, and how to use them. How to cut, ream, thread, and assemble iron and brass pipe. How to connect copper tubing and make lead joints. The technique of pipe fitting, and the proper sequence of steps in assembling a piping system. Household plumbing projects—installing a hot-water heater, radiator, and various other units. How to drain a plumbing system when closing the house for the winter. How to fix leaks in faucets and valves, repair a faulty section of pipe. The cleaning, and maintenance of each part of the plumbing system.

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A TECHNICAL JOURNAL OF SCIENCE AND INDUSTRY

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DR. W. L. DAVIDSON, Jr. (page 65) has been working with atoms since 1936, when he entered Yale University for graduate work in nuclear physics. He is co-author of the book "Applied Nuclear Physics" (John Wiley & Sons), a leading text on the subject. As head of the physical research section of the B. F. Goodrich Co. laboratories, he worked on self-sealing fuel tanks for war use.

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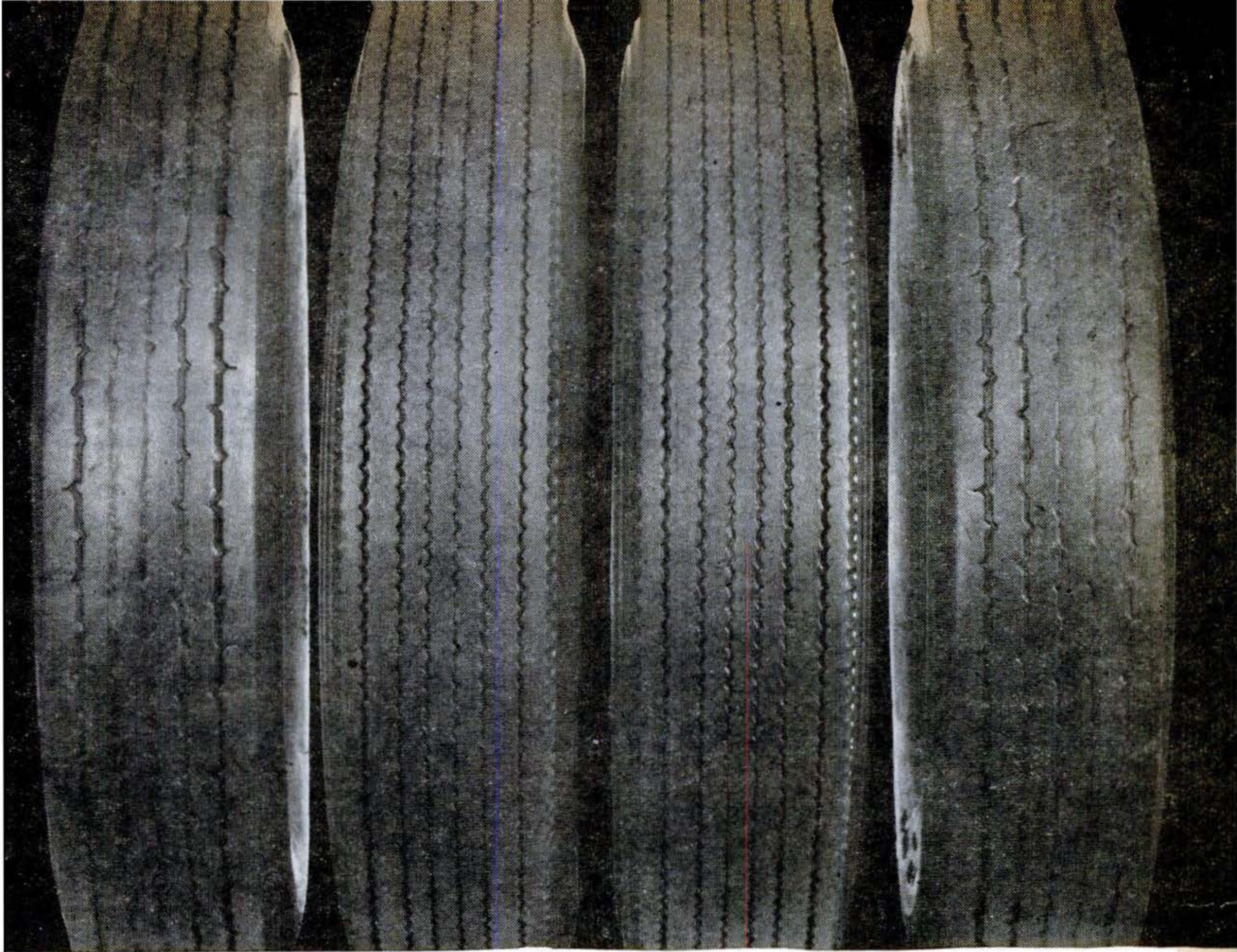
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New synthetic tire will **OUTWEAR PREWAR TIRES**

B. F. Goodrich passenger car tire coming soon

BEFORE these tires had their pictures taken, they went thousands of miles on a test car. They were carefully rotated so all got equal wear. The unretouched picture shows exactly how they looked after the test.

The two outside tires were made of natural rubber with prewar treads—equal in every way to new prewar tires. Note that they were run until nearly smooth. Then observe the still effective tread on the middle tires . . . the new B. F. Goodrich synthetic-rubber Silver-towns. This was one of many tests that have proved the new tires give

better-than-prewar mileage.

These tires are newly designed for passenger cars. B. F. Goodrich builds them of a new, better synthetic rubber—different from the ordinary synthetic in general use by the tire industry. This rubber was also a B. F. Goodrich development. The tire body is stronger too, with a new, stronger kind of cord reinforcement. The tread is slightly wider and flatter.

The tires have had more than 2,000 tests and nearly 17,000,000 miles of all-weather, all-road driving by taxicab fleets, state police departments, and the B. F. Good-

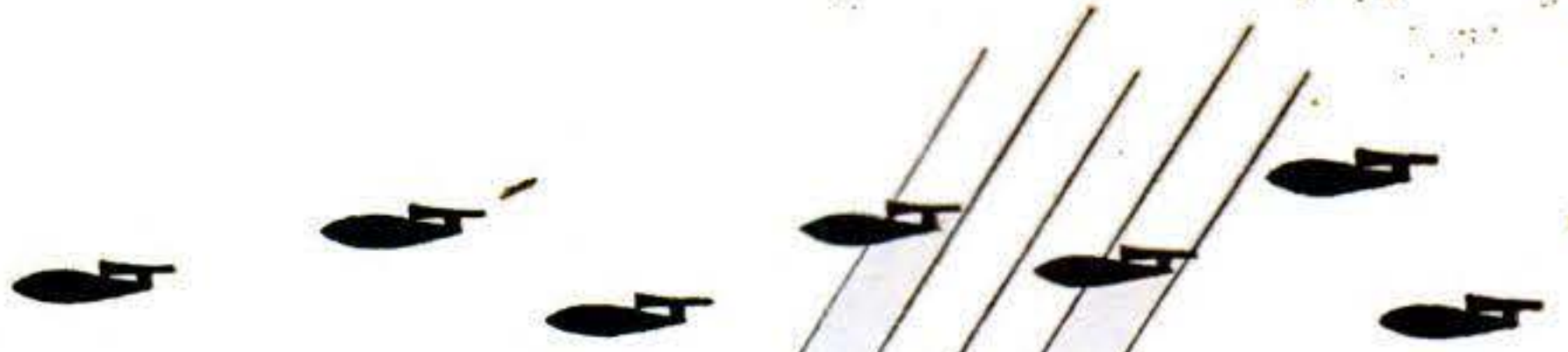
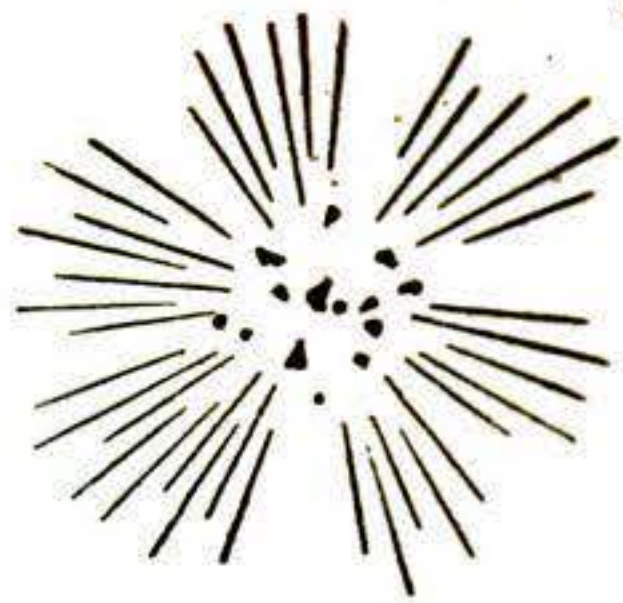
rich test fleet.

When can you get them? We *hope* to have them in the hands of nearly all dealers and ration-free by the end of the year. If you make your present tires last as long as possible, you may be able to get these new better tires by the time you have to buy. *The B. F. Goodrich Company, Akron, Ohio.*

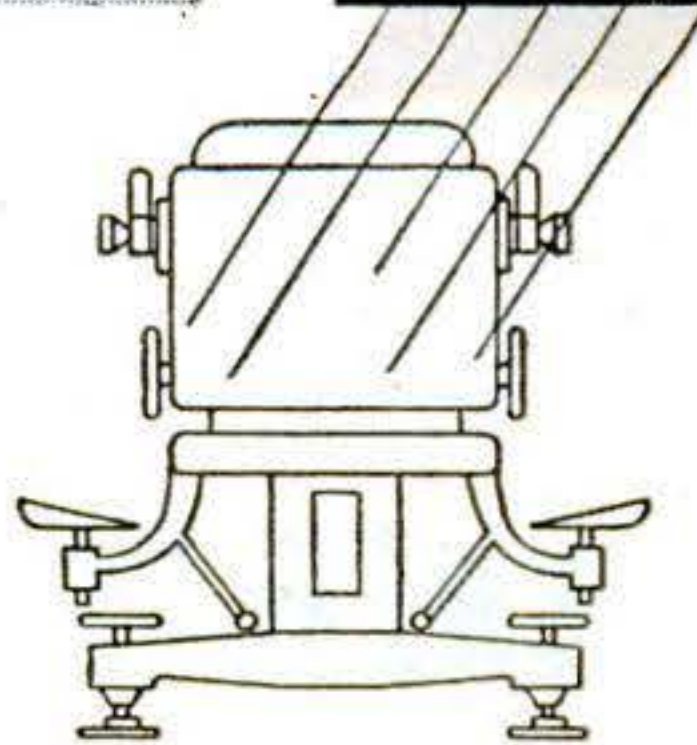
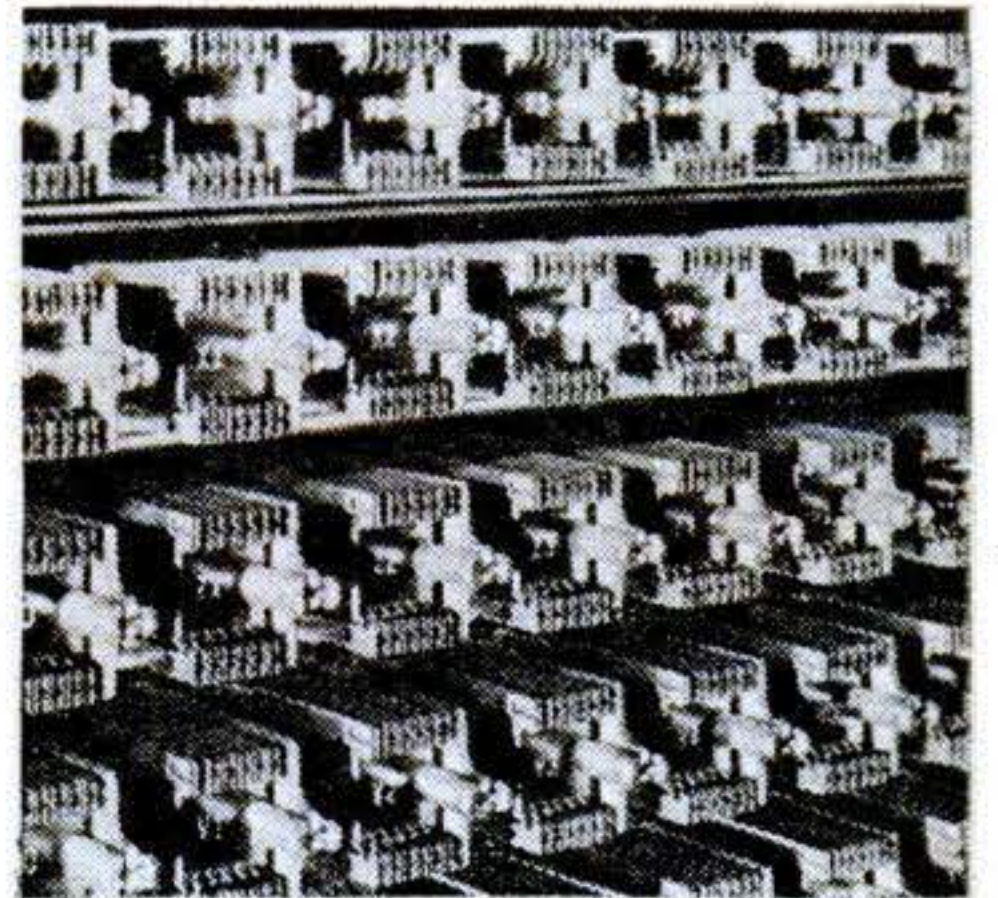
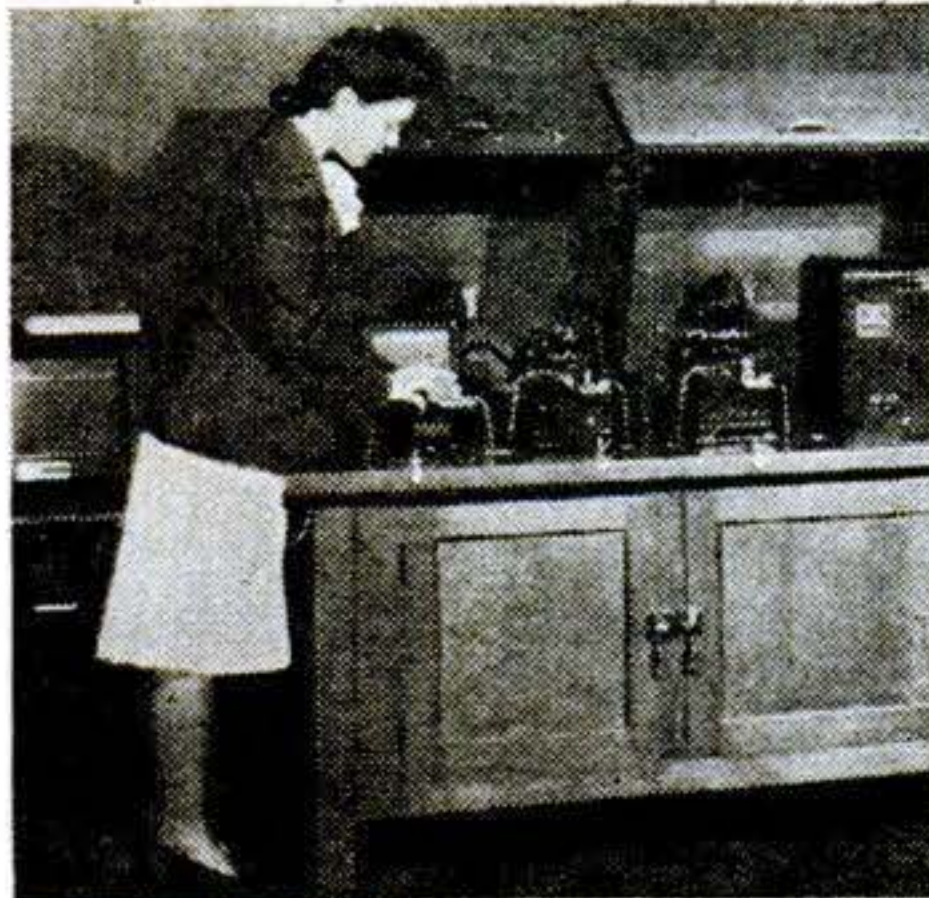
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(Left to right) The operator punches the problem data on tape, which is fed into the computer. The solution emerges in the teletype receiver. Relays which figure out the problem look like your dial telephone system.

In designing the gun-control systems which shot down enemy planes, Army ballistic experts were faced by long hours of mathematical calculations.

So Bell Laboratories developed an electrical relay computer. It solved complicated problems more accurately and swiftly than 40 calculators working in shifts around the clock.

Resembling your dial telephone system, which seeks out and calls a telephone number, this brain-like machine selects and energizes electric circuits to correspond with the numbers fed in. Then it juggles the circuits through scores of combinations. It will even solve triangles and consult mathematical tables. The operator hands

it a series of problems with the tips of her fingers—next morning the correct answers are neatly typed. Ballistic experts used this calculator to compute the performance of experimental gun directors.

In battle action, Electrical Gun Directors are instantaneous. Such a director helped to make Antwerp available to our advancing troops by directing the guns which shot down more than 90% of the thousands of buzz bombs.

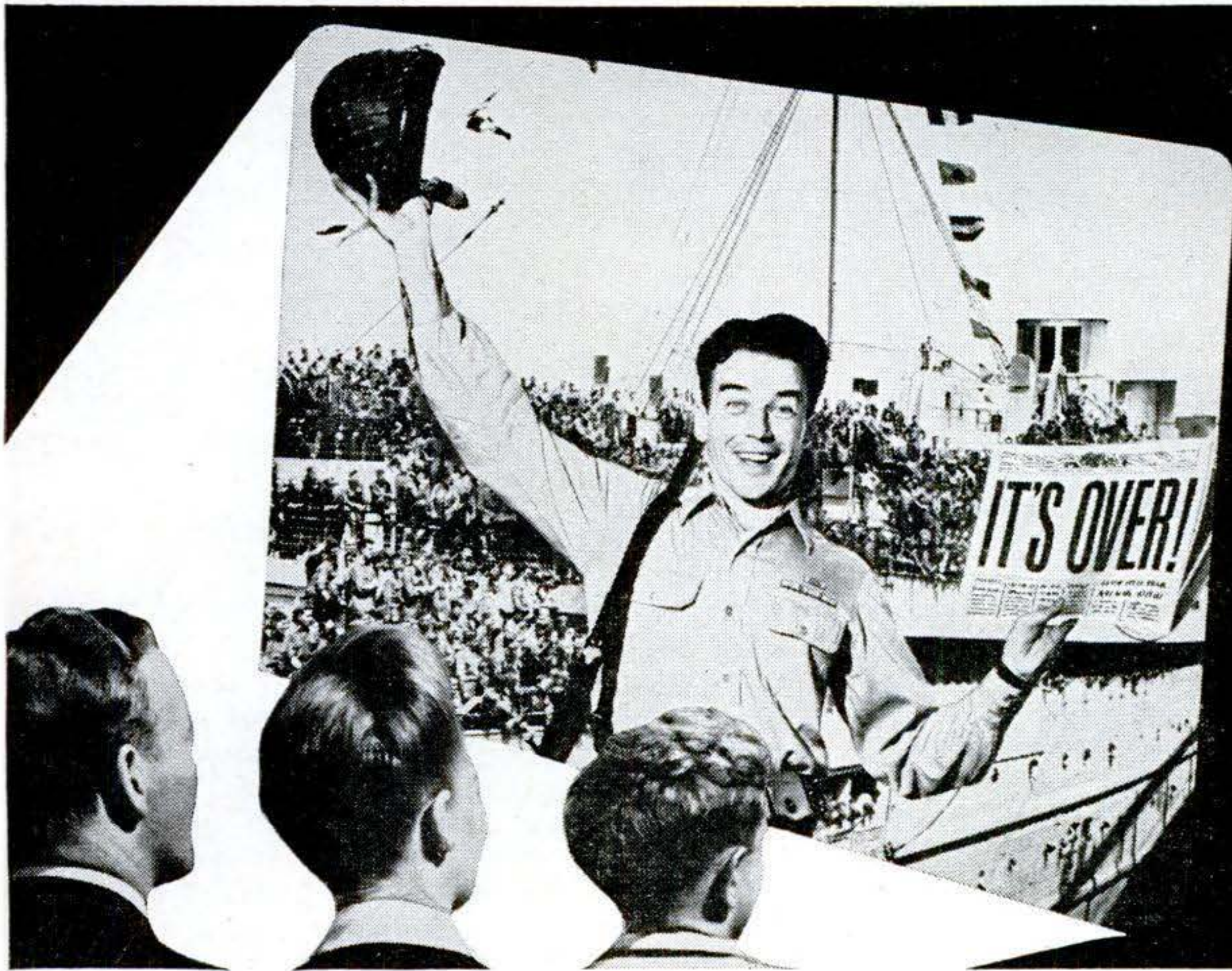
Every day, your Bell System telephone calls are speeded by calculators which use electric currents to do sums. Lessons learned are being applied to the extension of dialing-over toll lines.



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TEN MILLION PASSENGERS A DAY are said to travel on elevators in New York City alone. The accident rate for the whole country is almost unbelievably low. Good news—but why? This illuminating article gives the answers and tells a whale of an interesting story of the elevator's development during the last 20 centuries. The story and pictures will give a lift to your respect for the usually taken-for-granted elevator.

SCRUBWOMEN OF THE FLEET is what they call the minesweepers that are cleaning up the dangerous dirt that still menaces ships at sea. The over-all job may take two or even three years—a scientific but dangerous task that is being adequately handled. You may read how it's done—excitingly pictured.

THOMAS JEFFERSON, INVENTOR. The third president of the United States, author of the Declaration of Independence, could also have qualified for the editorship of POPULAR SCIENCE MONTHLY. He was alert to what was going on in scientific development. He was even better than that: he invented a lot of things that are still used in our everyday life. Read about them in Gold Sanders' revealing article, and see them pictured in glowing colors.

TOO MANY COLLISIONS were occurring between Naval and Merchant Marine vessels. There were nearly 13,000 of them during World War II. But a young lieutenant commander named Davis Newton Lott devised a system of training for officers that came pretty close to eliminating the evil. It was a combination of science and common sense. Through the text and pictures, you can read and see how it worked.

A HOME-BUILT ICEBOAT FOR BOYS is fully described, diagramed, and pictured in an article that will send many a young man rushing to his workbench. The craft has speed enough to satisfy the youngsters of this swift-moving age, and is easily handled by even very young boys. The designer's six-year-old son sailed the boat successfully all one winter.

THRILLING, TERRIFIC EFFECTS can be obtained from the cigar-box Tesla coil you can make with a few familiar radio parts. This spectacularly illustrated article tells how to make and demonstrate the apparatus for stepping up an ordinary alternating current to almost fantastic high-frequency voltages. The effects, as pictured, are astounding.

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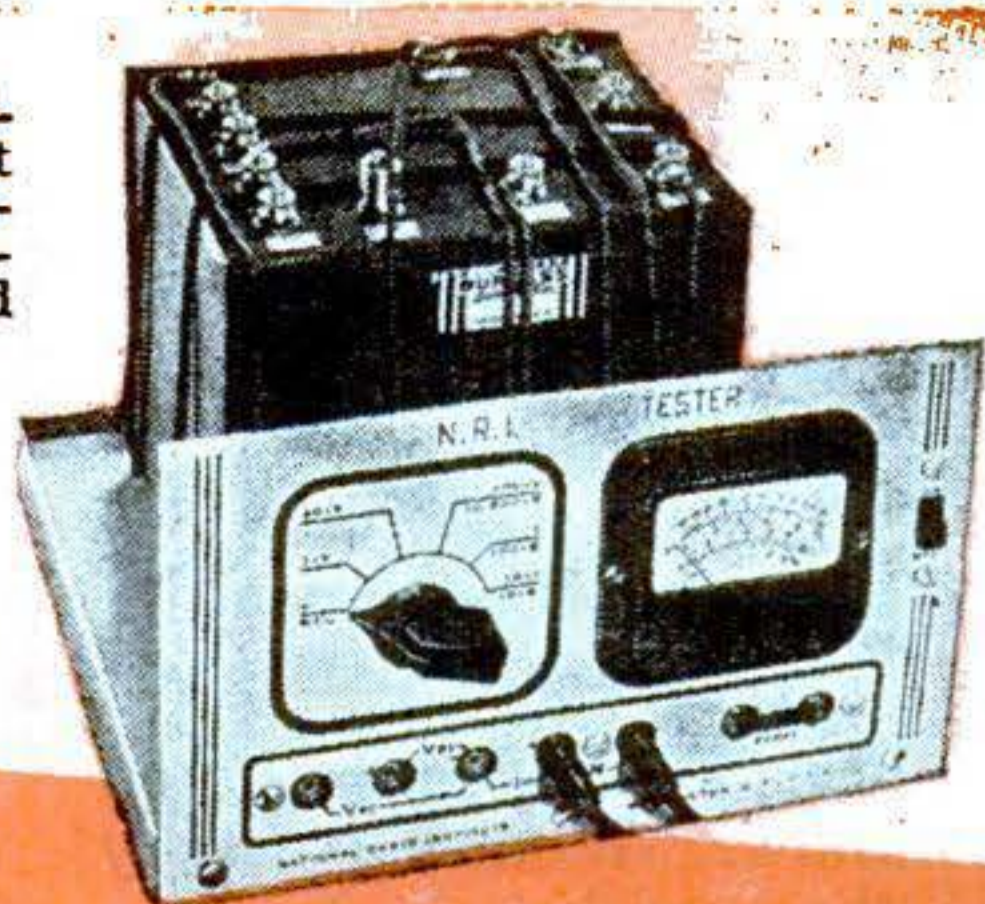
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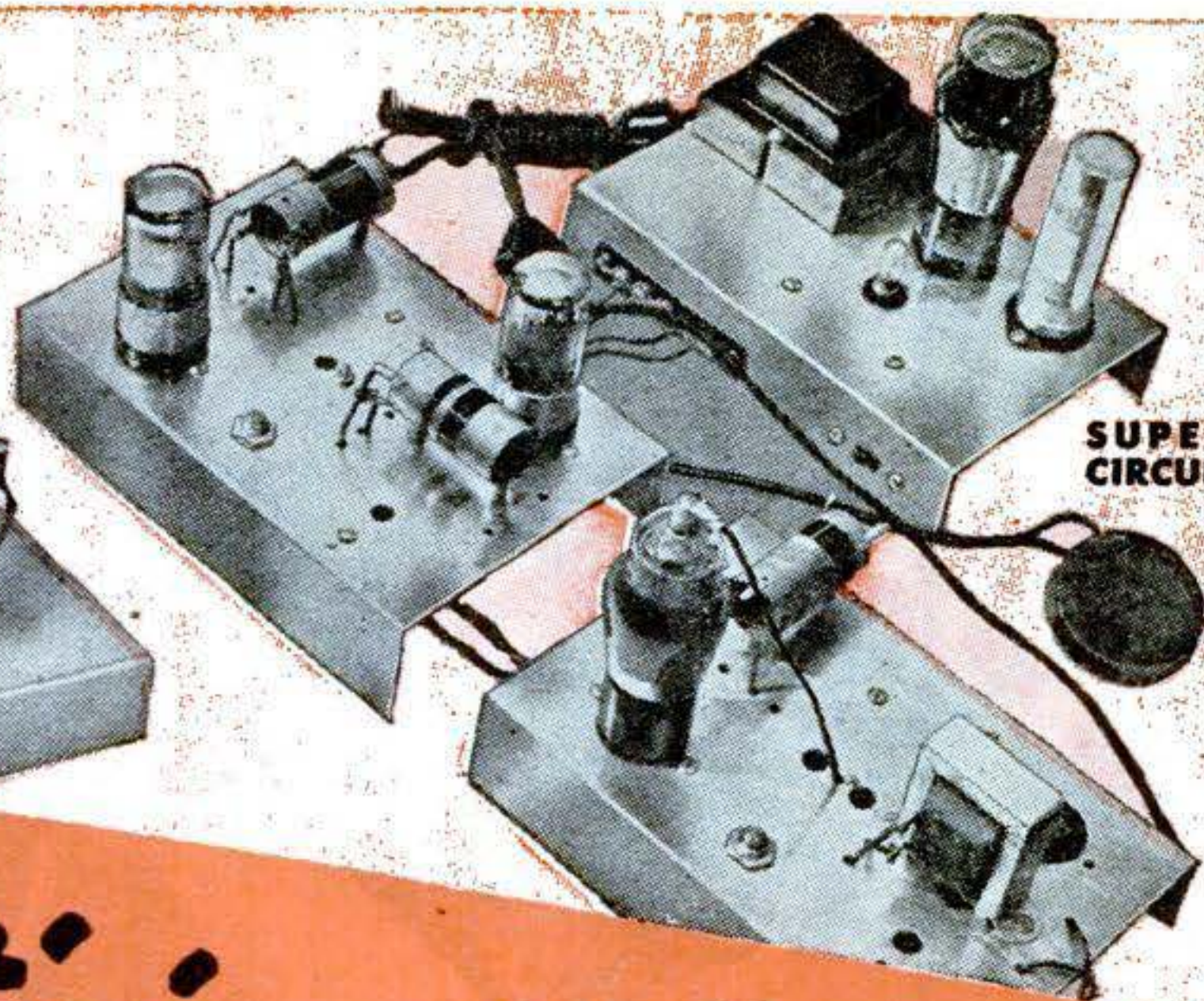
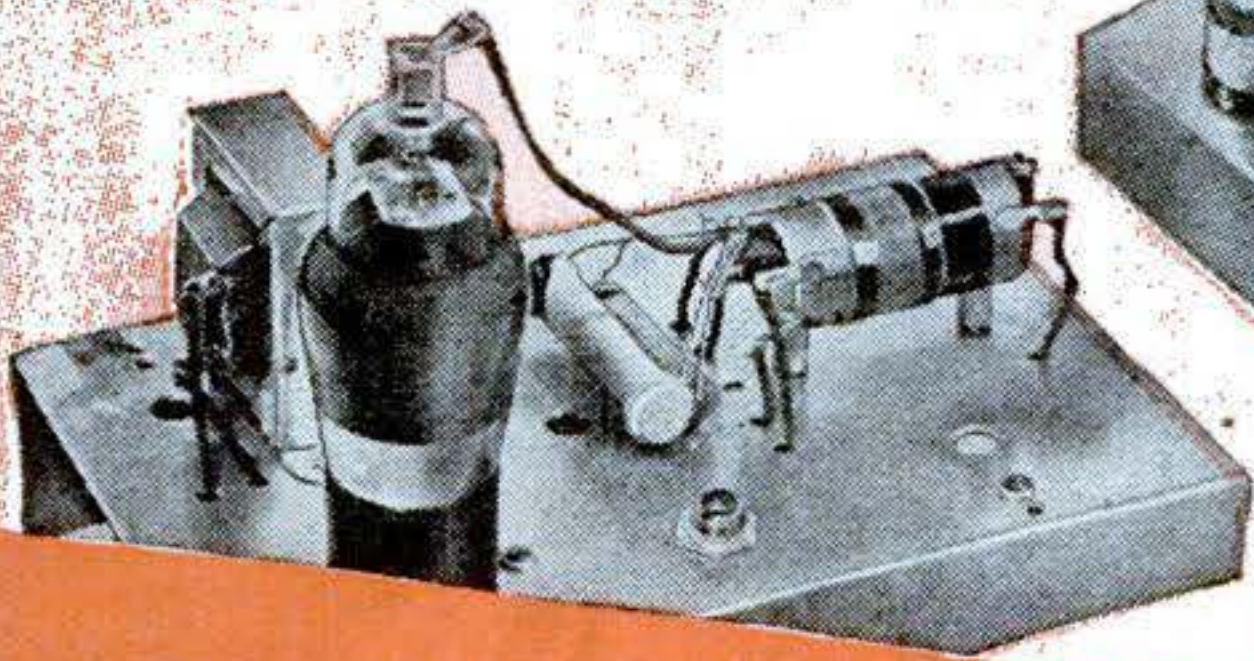
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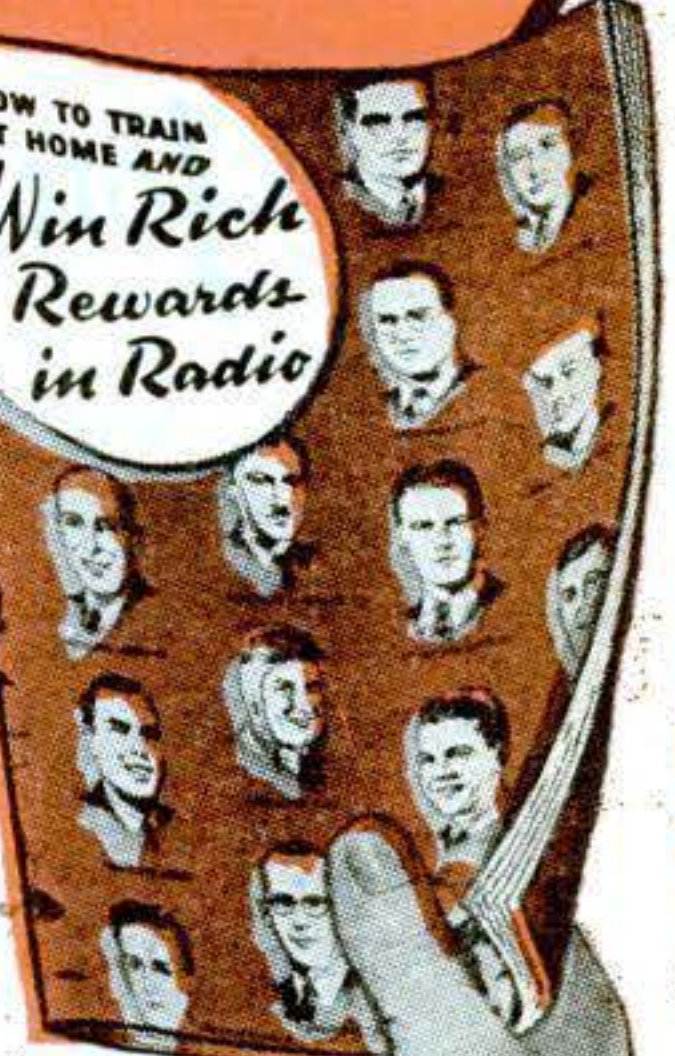
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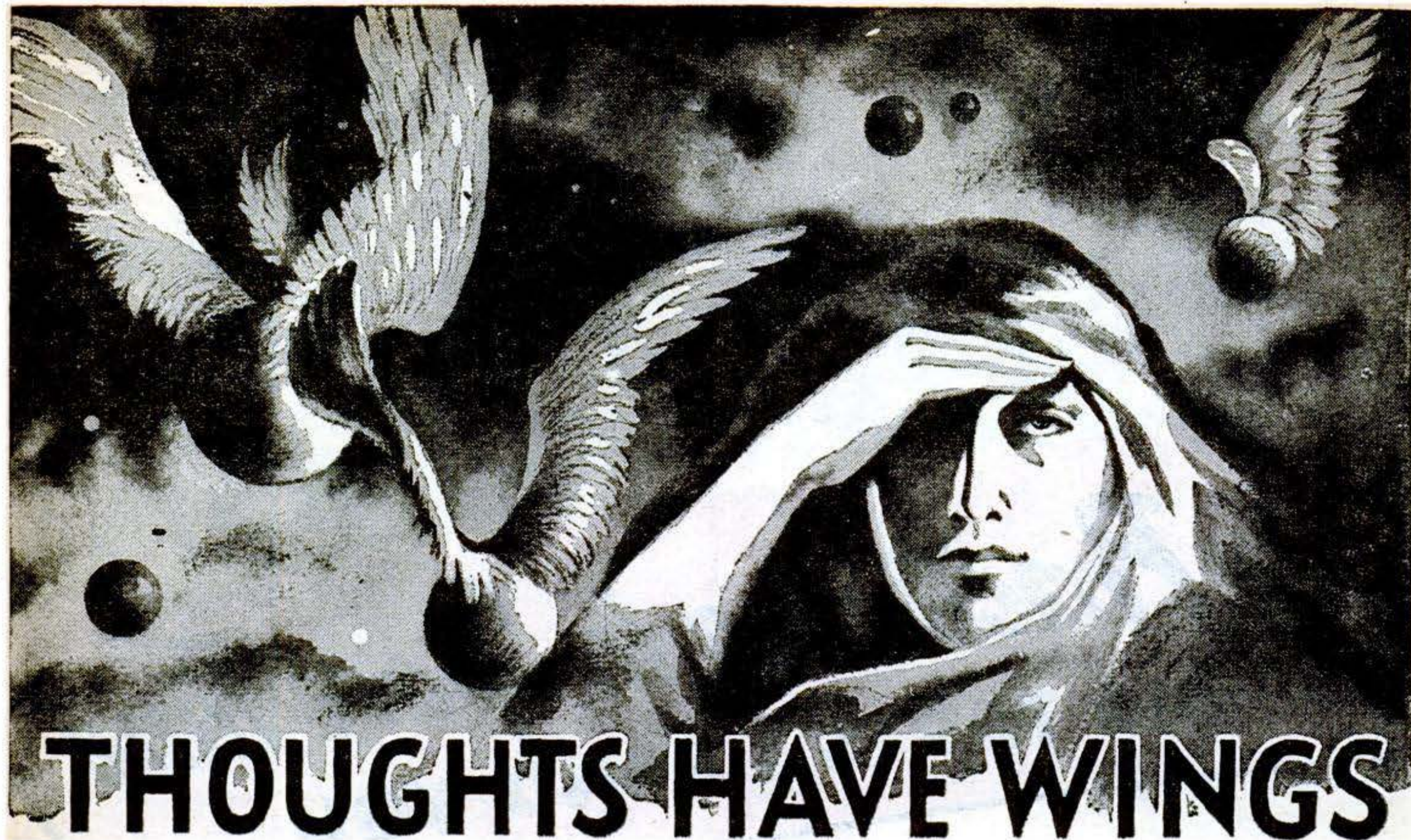
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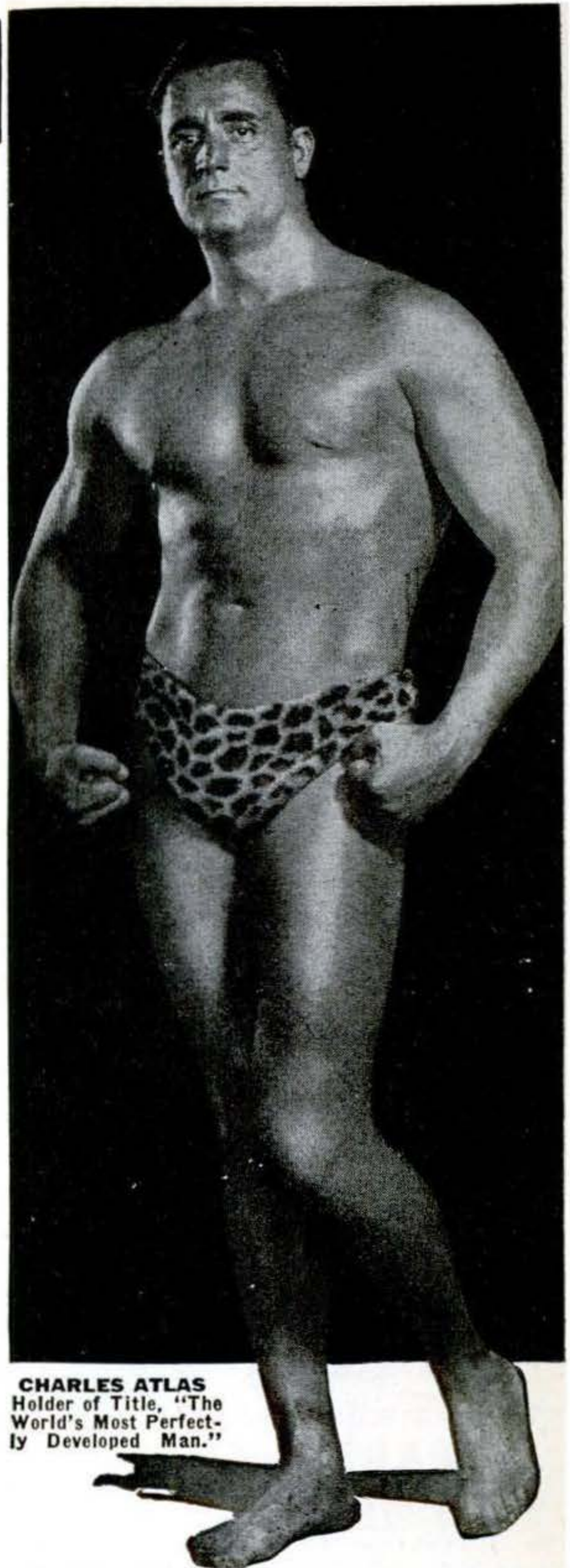
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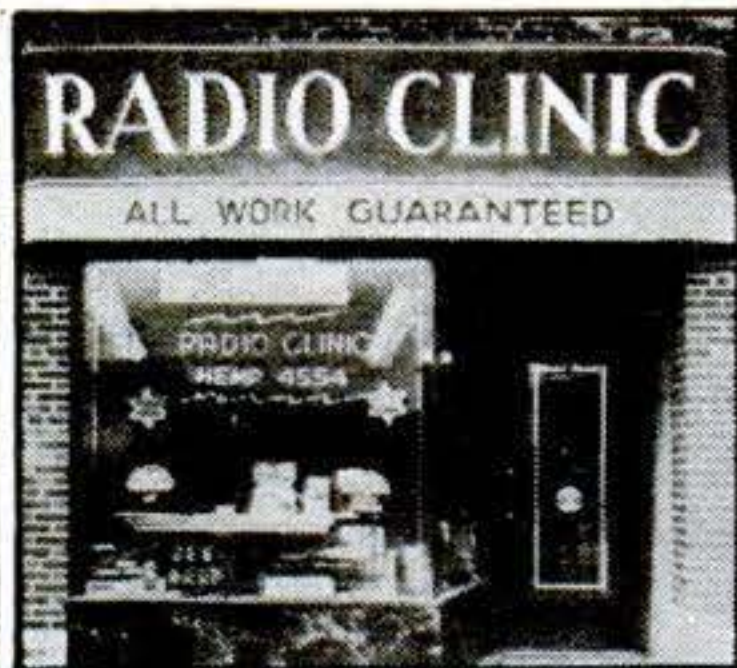
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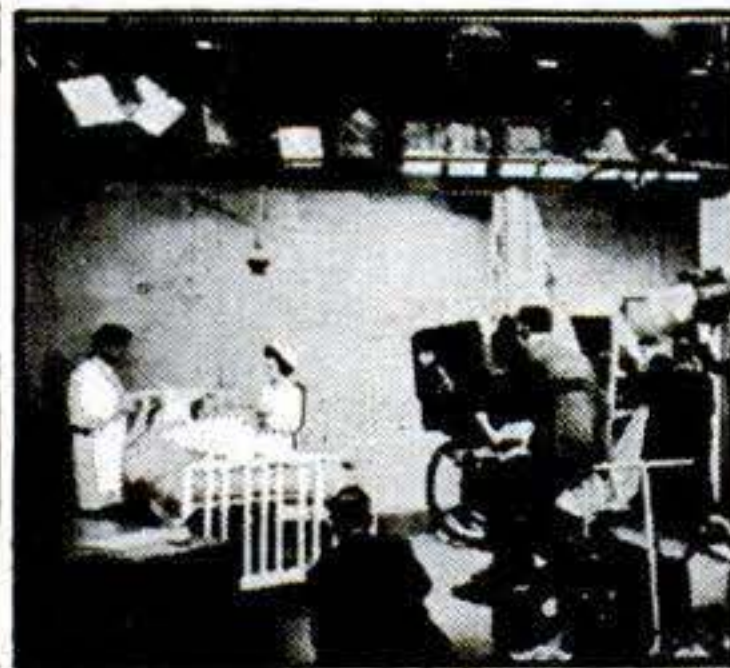
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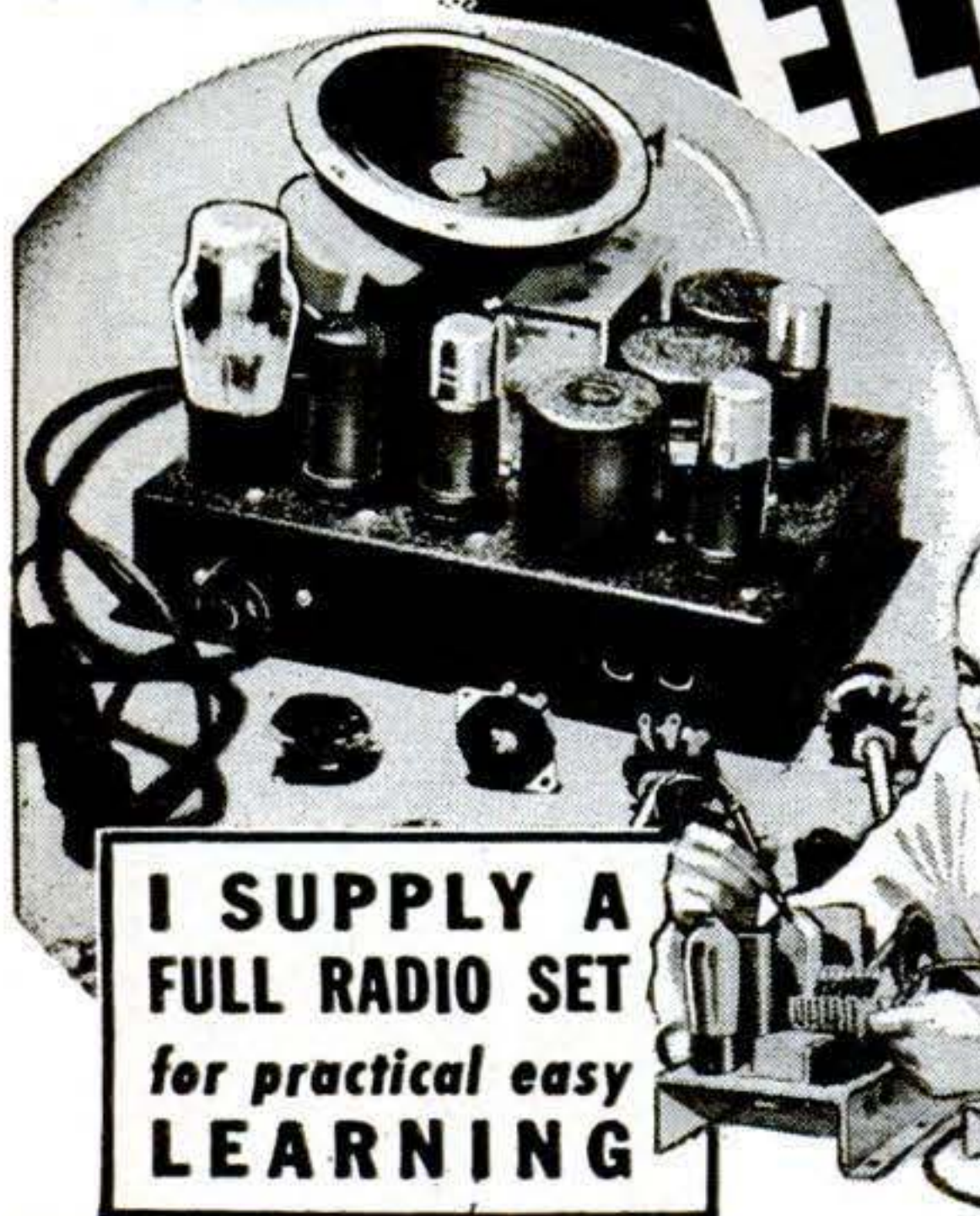


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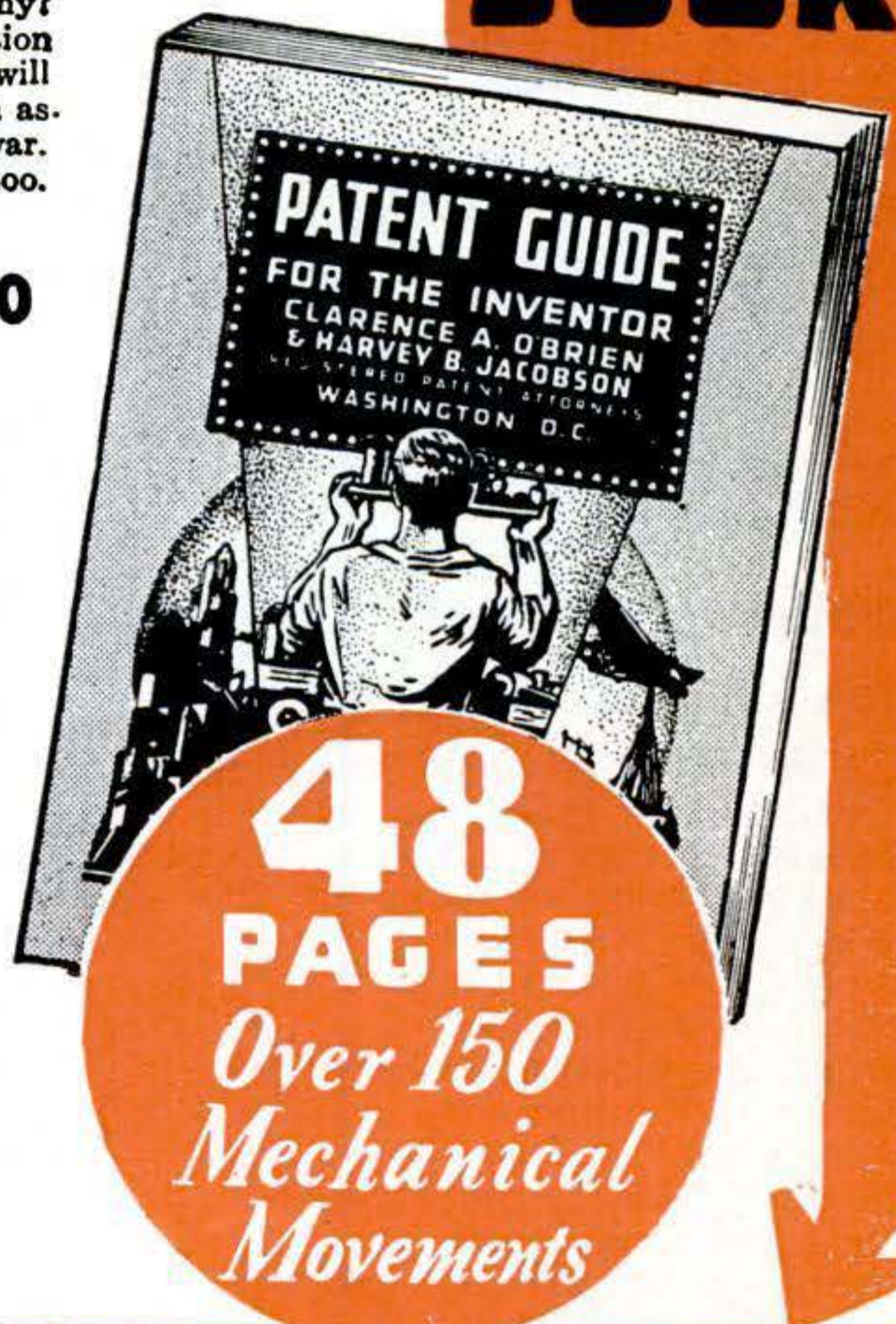
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That Helicopter Book Is Still Hovering

MORE than a year ago you ran a story on helicopters by Devon Francis. The statement was made that Mr. Francis had written a book on the subject. Please tell me if the book has been published, and where I can get it.—E. B. B., Austin, Tex.

Staff writer Francis tells us that, owing to the recent paper shortage, he has had to deal off the bottom of the deck on the helicopter book. It is now scheduled for publication next spring by Coward-McCann, Inc., New York. Meanwhile Francis has just had another book published—"Aviation: What Everyone Should Know." It is issued by Bobbs-Merrill. Most bookstores have it.—Ed.

Jitterbug Mice Are Now Admitted to Scientific Consideration

HOW MANY readers know that the word "jittery" has made its debut in the stratosphere of scientific and technical language? Looking over my copy of *The Journal of Heredity* (Special Jax-Mouse Issue) for September 1945, my startled eye fell upon the title "Linkage of Jittery and Waltzing in the Mouse." From the opening paragraph of the article, I learned that: "Jittery is a new recessive juvenile lethal mutation in the mouse characterized by muscular inco-ordination and tetany." The article also warns me against confusing jittery mice with pirouetting mice and with waltzing mice. There's no danger; I keep a cat.—P. S. T., Bloomfield, N. J.



How to Save Face (and Hands) in Soldering Gasoline Tanks

YOUR article about a gas-stove steamer in a recent issue brings to mind a trick of welding or soldering tanks that have held inflammable liquids. You fill the tank with water and, while it is full, stick a candle on

something that will float, put it in the opening, and light the candle. Then drain the tank, leaving the candle burning. When the water is all out, go ahead with the welding or soldering without fear of losing life or limb.—E. E. S., Tinian, Marianas Islands.

Here Are Some Uses for Milk-Bottle Wire

I HAVE been saving the pliable wire that fastens the outer paper caps on our milk bottles and find that it's good for hanging pictures and Christmas-tree ornaments, mending torn places in screens, and fastening beanpoles to the supporting wire. You can also use it for stringing and grading buttons according to size, type, and color. A fisherman can find his hooks quickly and easily if they are strung on this wire according to size, and hung over the edge of the tackle box. It is good for stringing washers and taps for hanging on a nail above the workbench. Then you can take a wire coat hanger, bend it in whatever shape you wish, pad it with newspaper, and cover with green tissue or florists' paper as a base for fastening on flowers with these short wires. I have no doubt that many other uses abound.—F. B. L., Knoxville, Tenn.



Gap in Red Line Means Lost or Borrowed Copy

HERE is my subscription to *Popular Science* for another two years. I note with interest the improvements made from time to time in the make-up—such as the red line on the back.—R. H. F., Montclair, N. J.

The reason for that $\frac{1}{4}$ -inch red stripe that slants across the spine of the magazine may not be apparent to new readers. When back numbers are arranged in proper sequence on a shelf, the stripes form an unbroken diagonal line. Any breaks will show where copies are missing.—Ed.

"Horsepower" Defender Kicks Back at Critic

IN ONE of your recent issues, W. B. R. stated his opinion that "horsepower" should be abandoned for a modern term because the age of the horse is past. The term was devised by the scientist James Watt to indicate the rate at which work is done when 550 pounds are raised one foot; this was considered approximately the work a horse could do. Just what would be the point in abandoning this term, with its definition, for a new one that couldn't possibly be any simpler?—J. D. McT., Noel, Mo.

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YOUR fine article "How You Can Use Surplus War Material" in a recent issue of your magazine leaves but one question in the mind of this foot-weary and mentally exhausted house hunter. Where can Quonset huts be bought? Perhaps some data on converting one of them

to family use to relieve the critical housing shortage would be worthy of some space in P.S.M.—T. E. M., Canton, N. Y.

How Can You Ease a Young Boy into Mechanical Problems?

I HAVE a son eight years old. He seems to have a mechanical bent, and I want to encourage it in every possible way. But the dickens of it is that I don't know enough to do anything for him except discourage such ambitious projects as making an automobile by fitting an old motorcycle engine to his express wagon. What I would like is suggestions for training this kid along mechanical lines. I'd like something that is even simple enough for me. Then together we can make a contrivance that actually works, thereby accentuating the positive and eliminating the negative.—F. X. J., Los Angeles, Calif.

Fluorescent Tubes May Be Down but They're Never Out

BURNED-OUT fluorescent tubes can still be used. You can take a neon-sign transformer and connect it to several of these tubes in series. The tubes will light, but not quite to their full brilliance.—J. C., Euclid, Ohio.

FLUORESCENT light tubes that are burned out make very attractive and substantial towel racks. You simply use metal brackets at the ends. These have holes to fit the pins at the ends of the tube, and they are screwed to the wall.—R. W., Pearsall, Texas.

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Idea for Speeding Service at Soda Fountains

I HAVE been in many soda fountains and other places that serve ice cream. I have observed that when you order an ice-cream cone or sundae, the clerk almost always has to lift two or three lids on the fountain freezer before locating the right compartment. Why don't manufacturers make these freezers with the lids of heavy transparent plastic and have a cold light inside the freezer so that the time wasted looking for the right flavor could be eliminated by merely glancing through the top?—W. G. E., Charlevoix, Mich.

Might Be Used for Loading Pugilists' BX-ing Gloves

I AM an apprentice electrician, and I'd like to know what can be done with those knock-out slugs from electrical boxes besides selling them for scrap or shoring up wobbly furniture.—W. H. R., Los Angeles, Calif.

She Advises Feminine Touch in Table of Contents

MAY I suggest a more detailed table of contents for your magazine? It would be helpful if the following features were grouped under the heading "Of Interest to Women": New Ideas from the Inventors, What's New in Modern Living, For Home Owners, and the Shipshape Home.—L. L., Salem, Ohio.

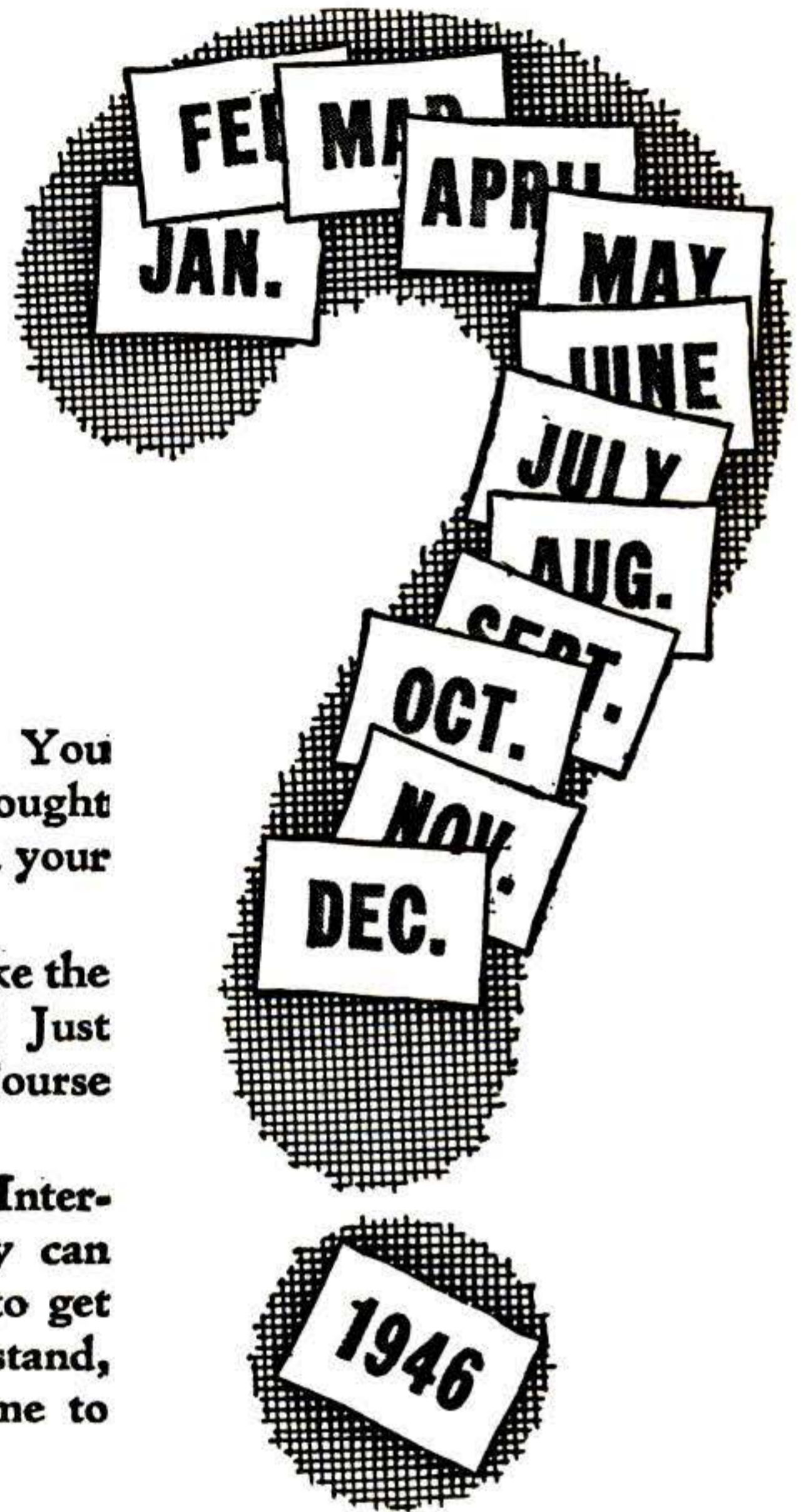
How to Signal Mail for Special Attention

MAY I suggest an idea that would be useful to everybody? When you receive a black-bordered letter, you know at first sight it is bad news. Why not have red-bordered envelopes and use the same principle for urgent letters?—R. L. S., Jadotville, Belgian Congo.

The only reason we can think of is that the bill collectors would grab the idea as sure as shooting.—Ed.



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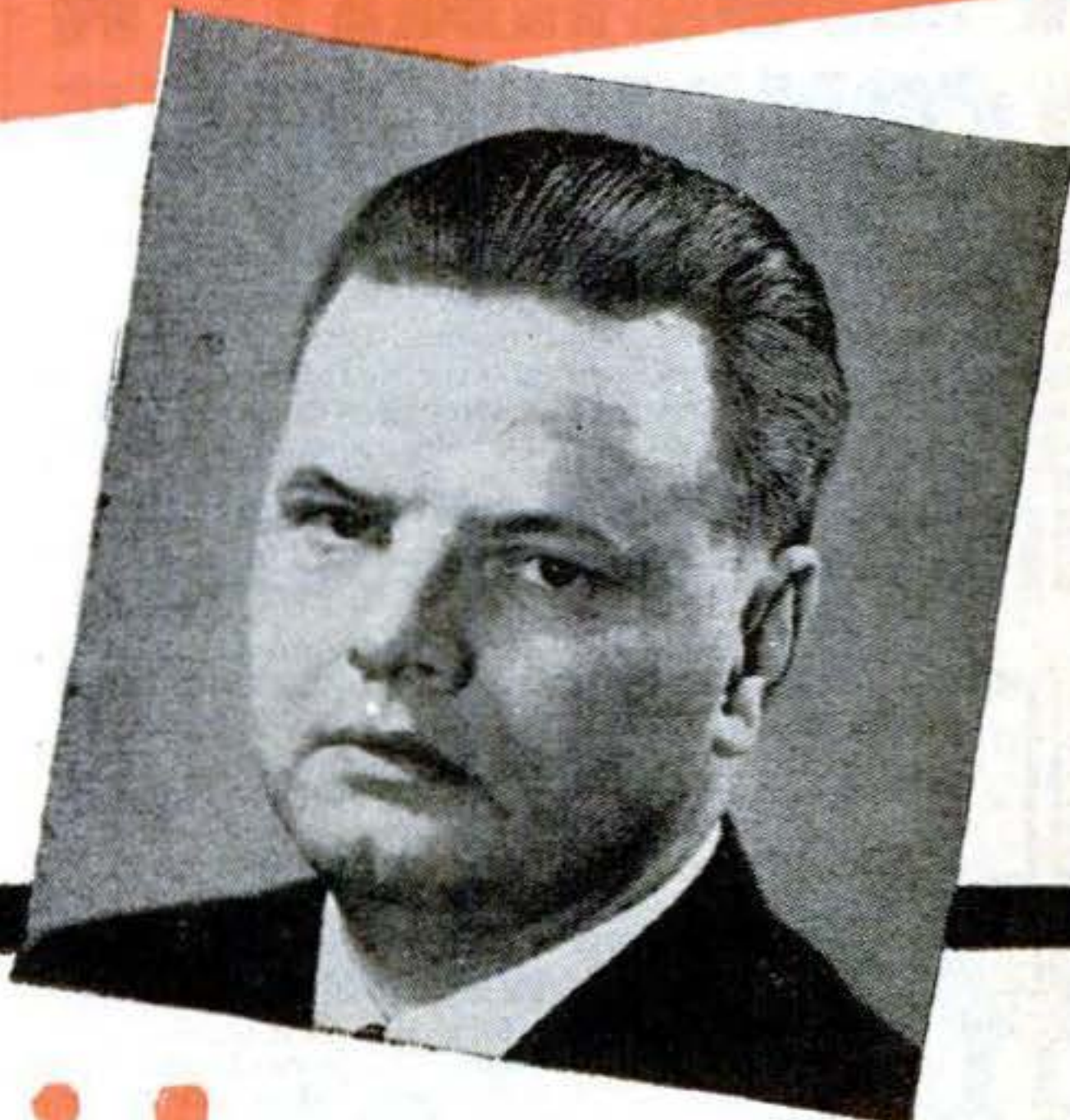


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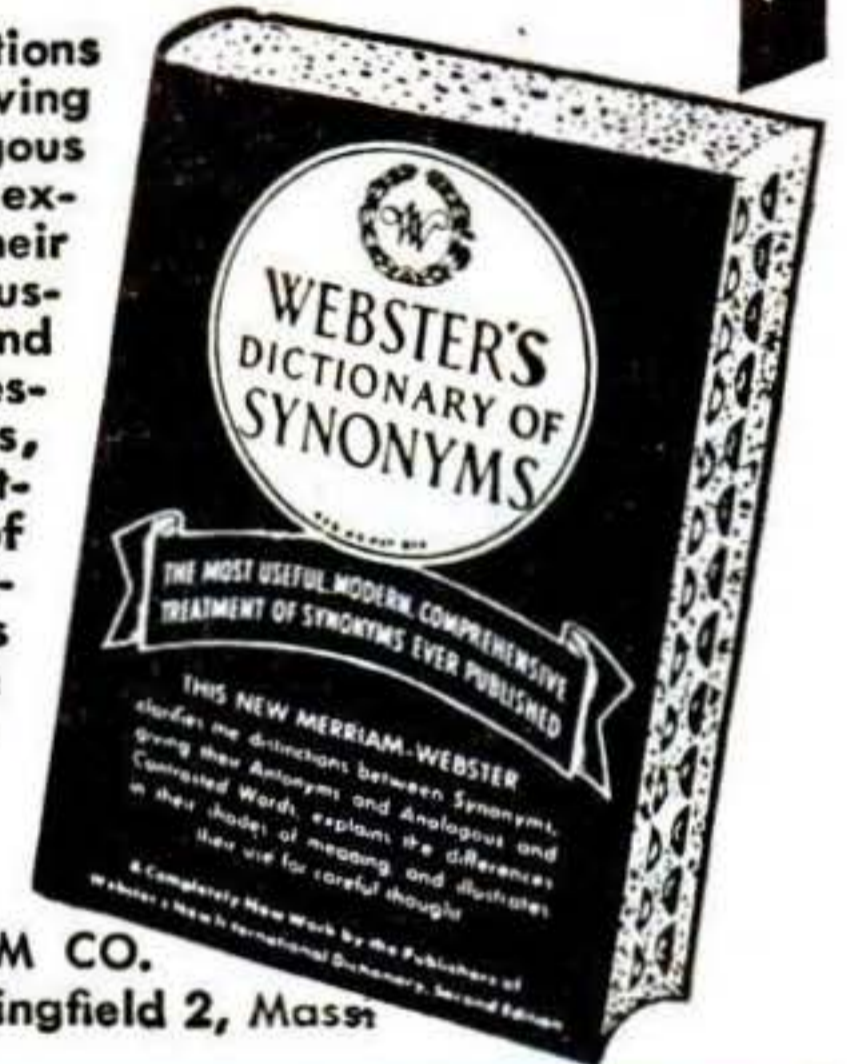
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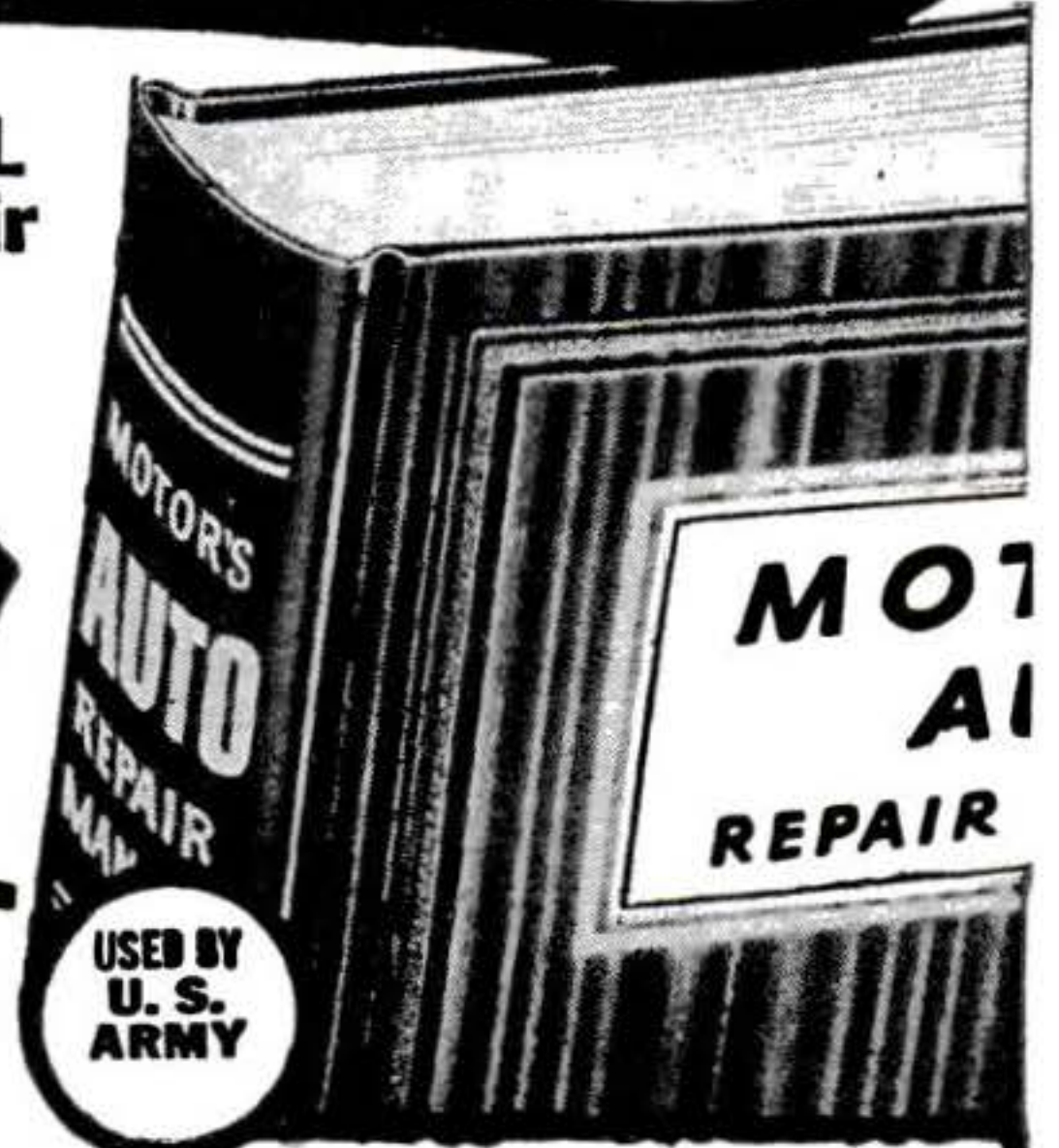
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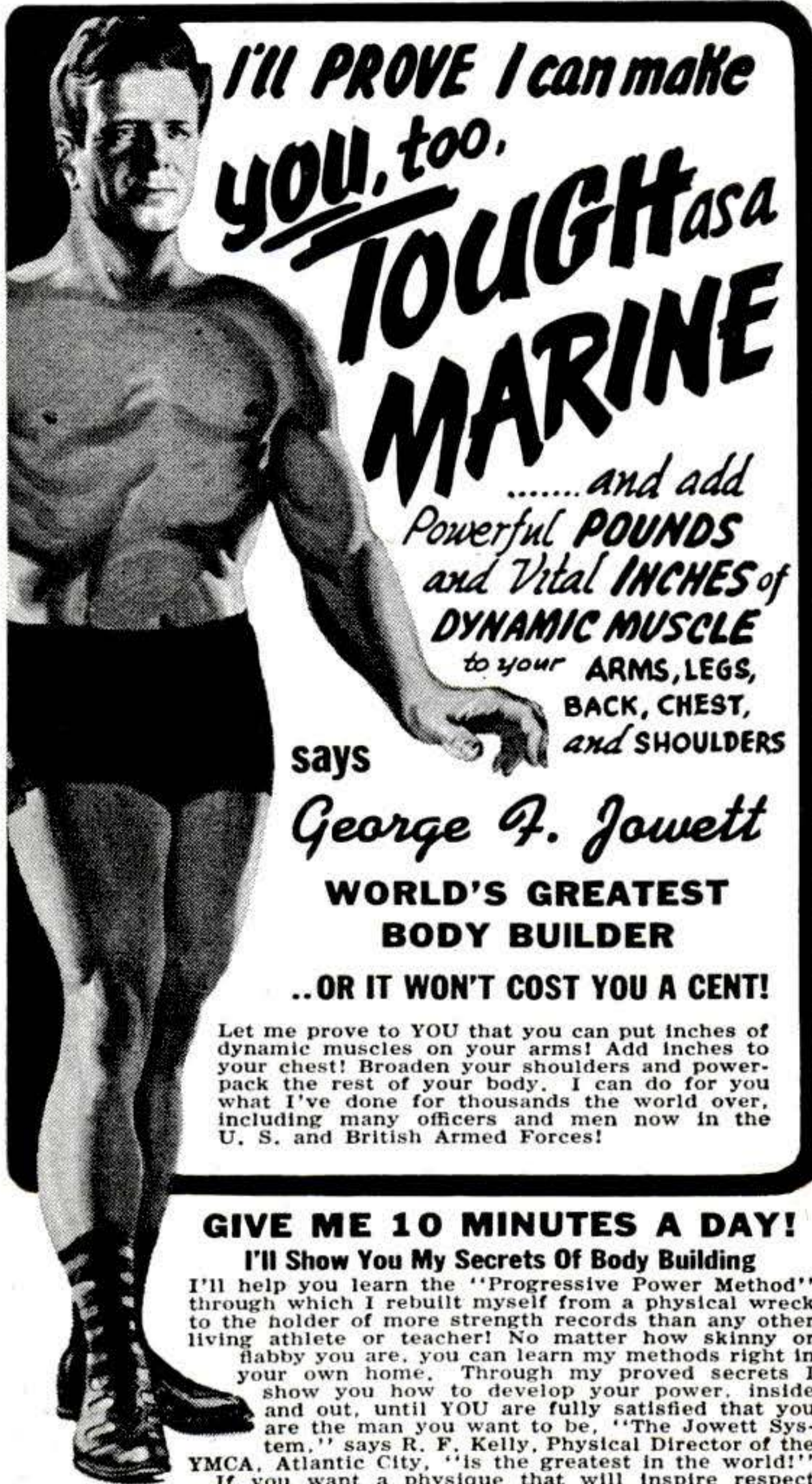
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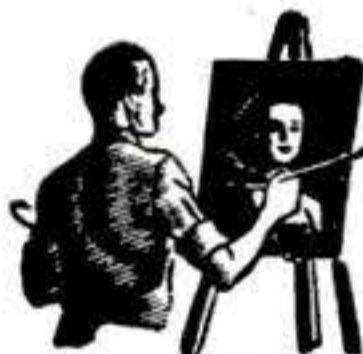
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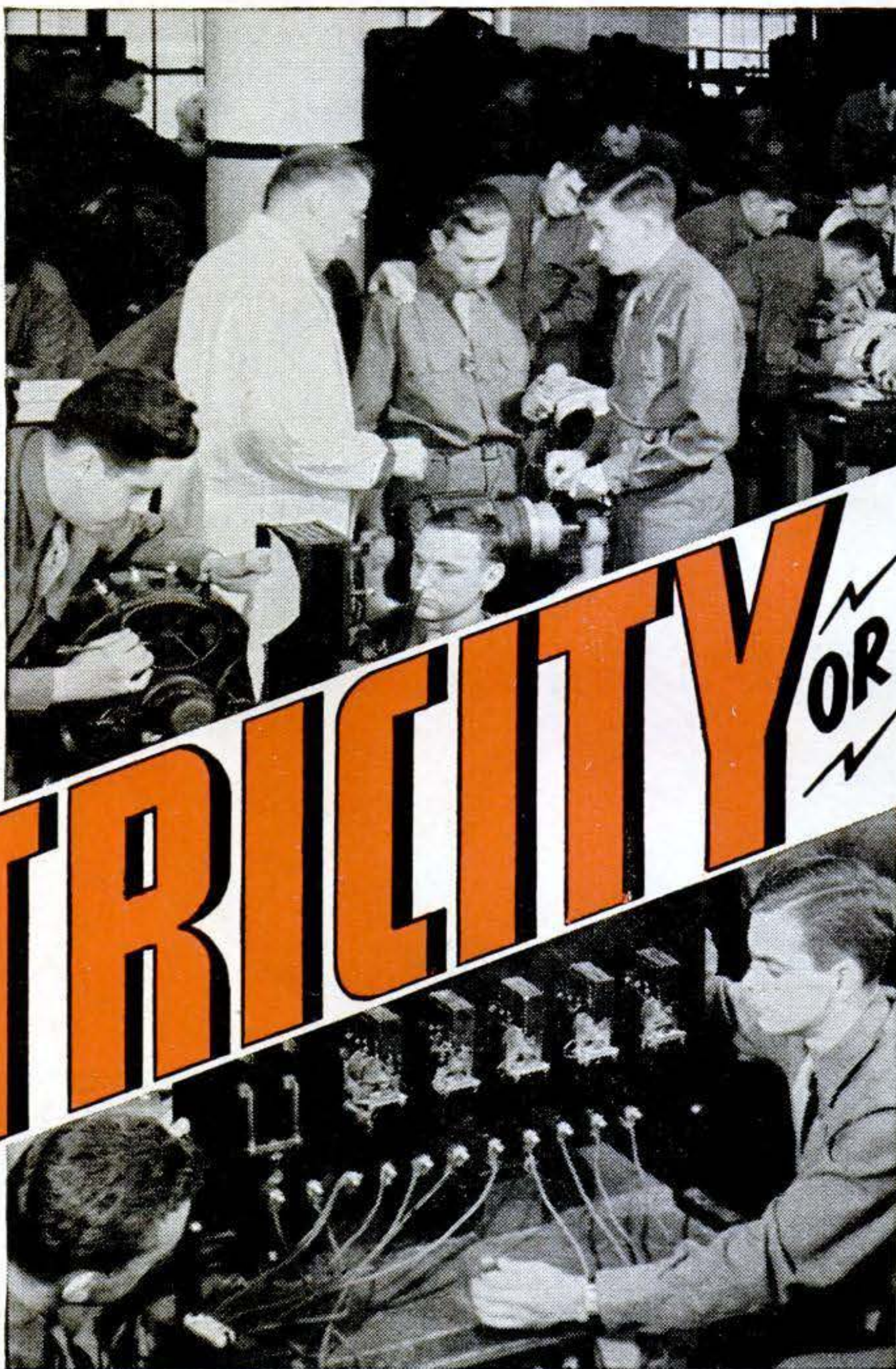


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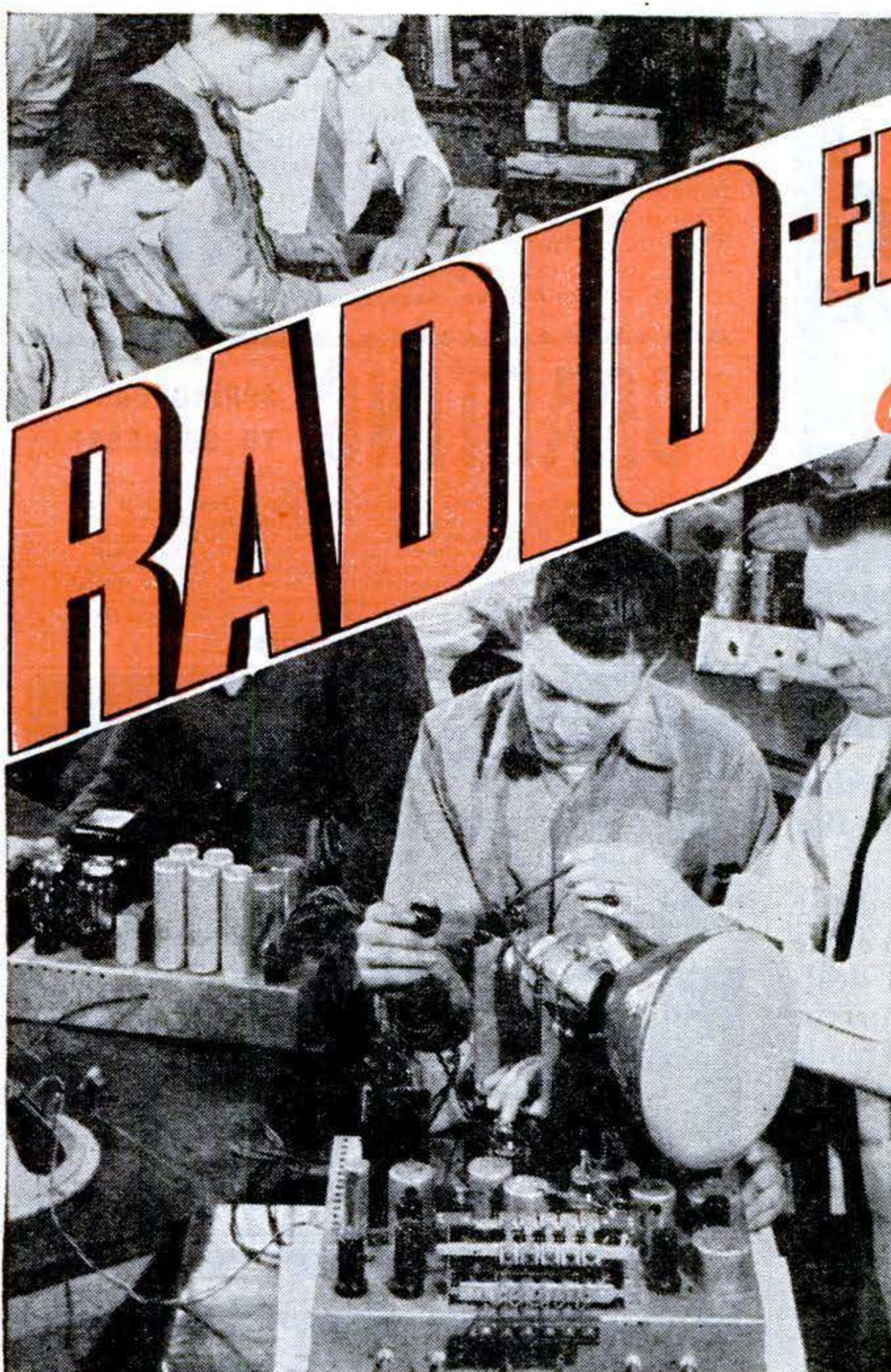
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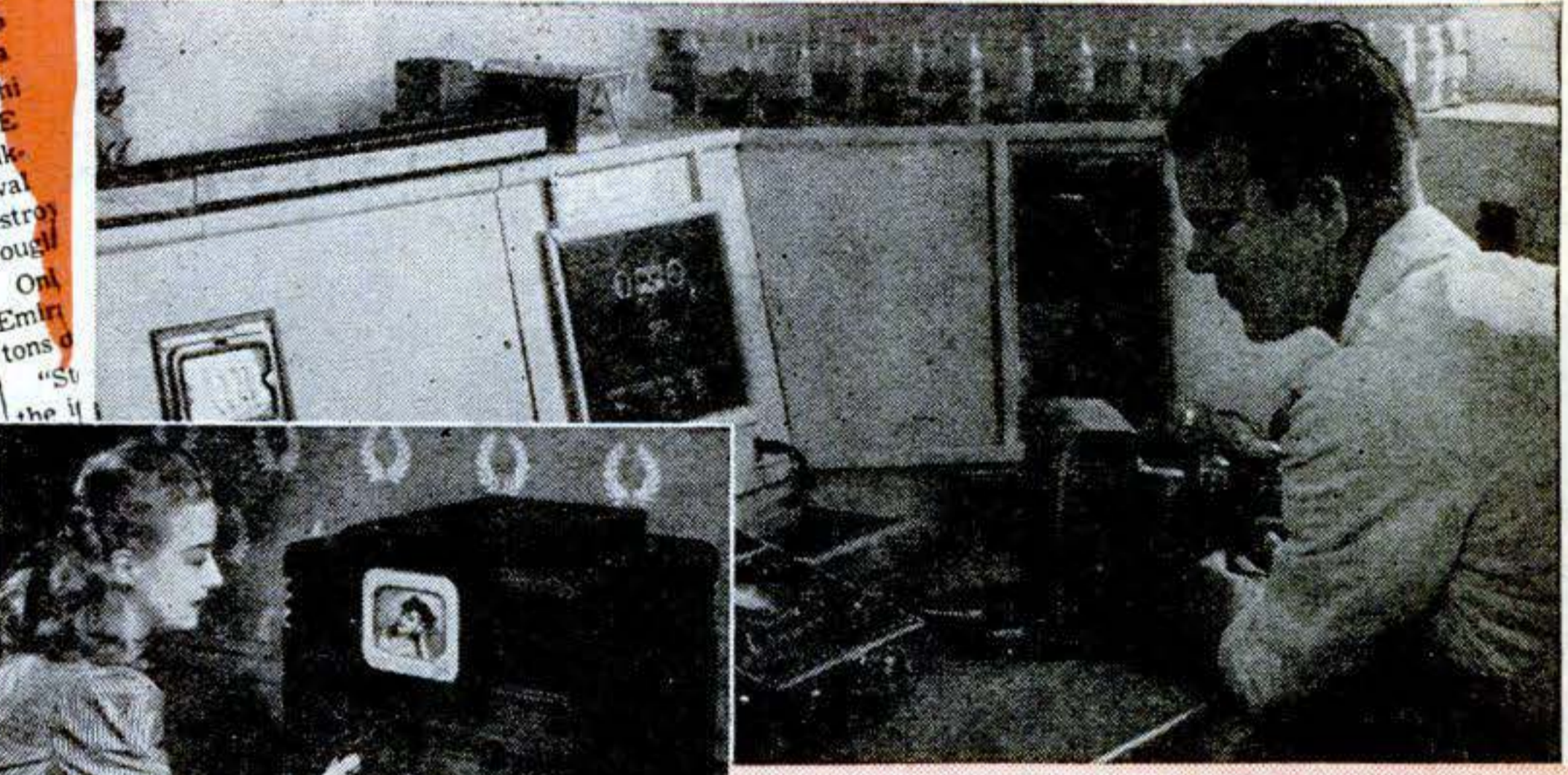
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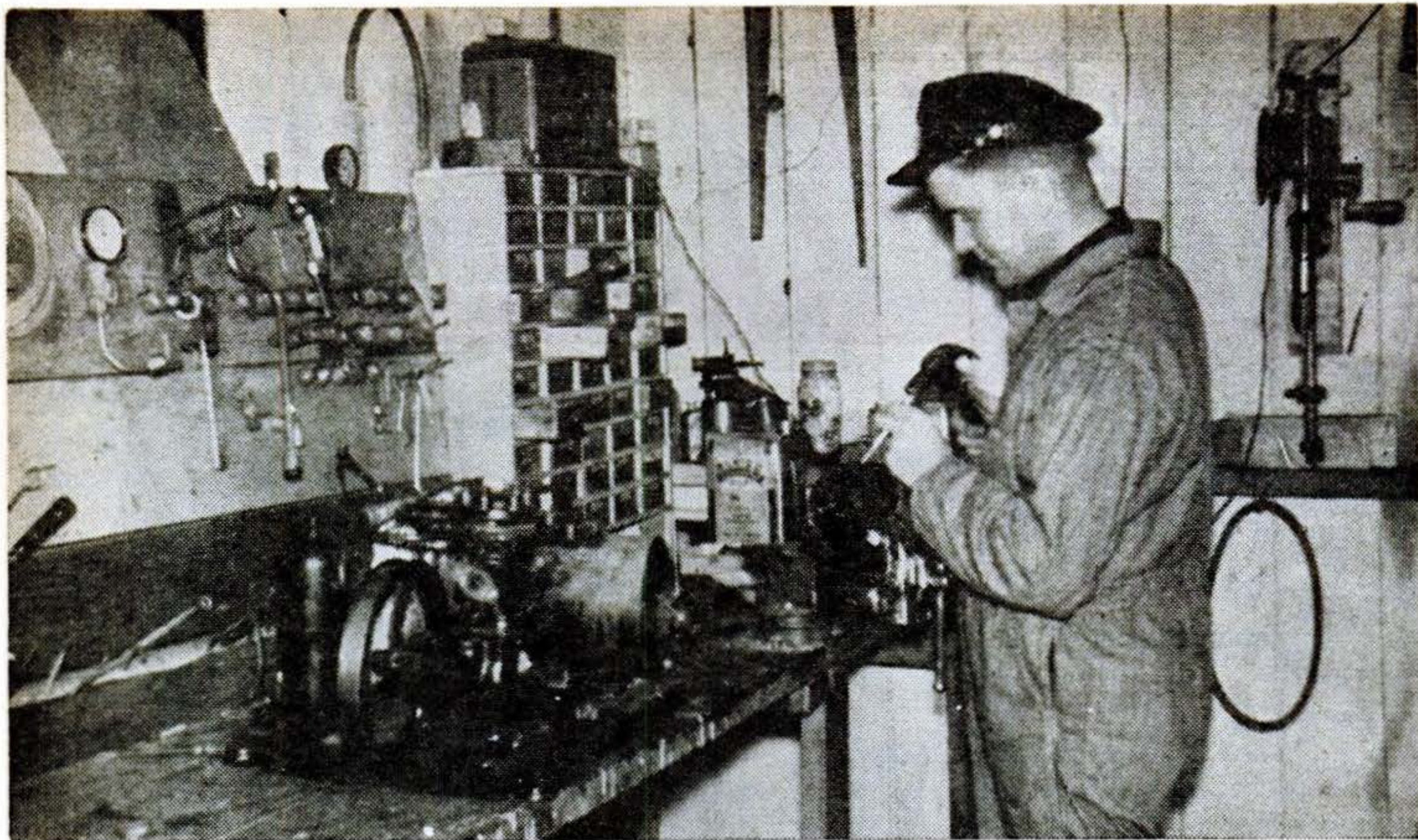
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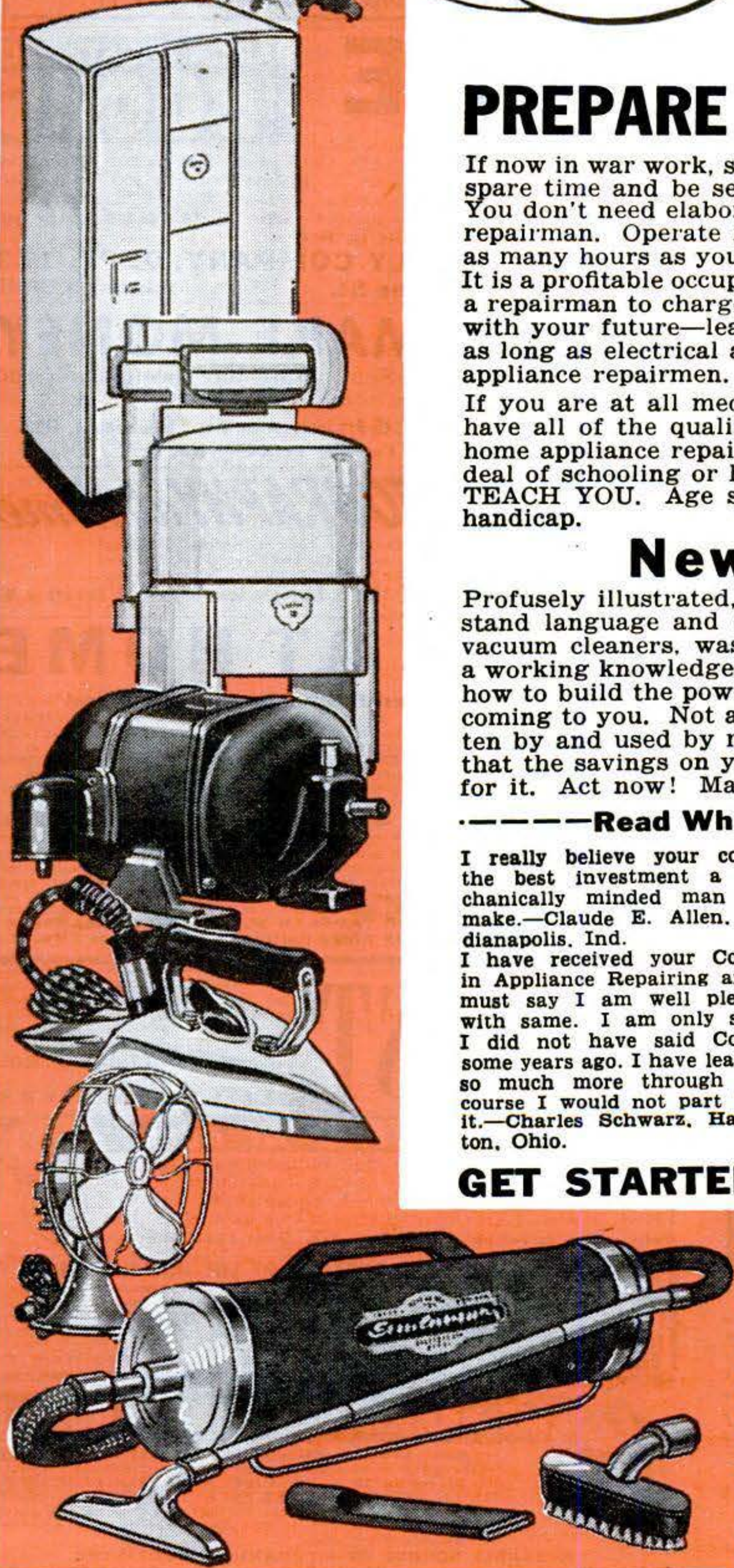
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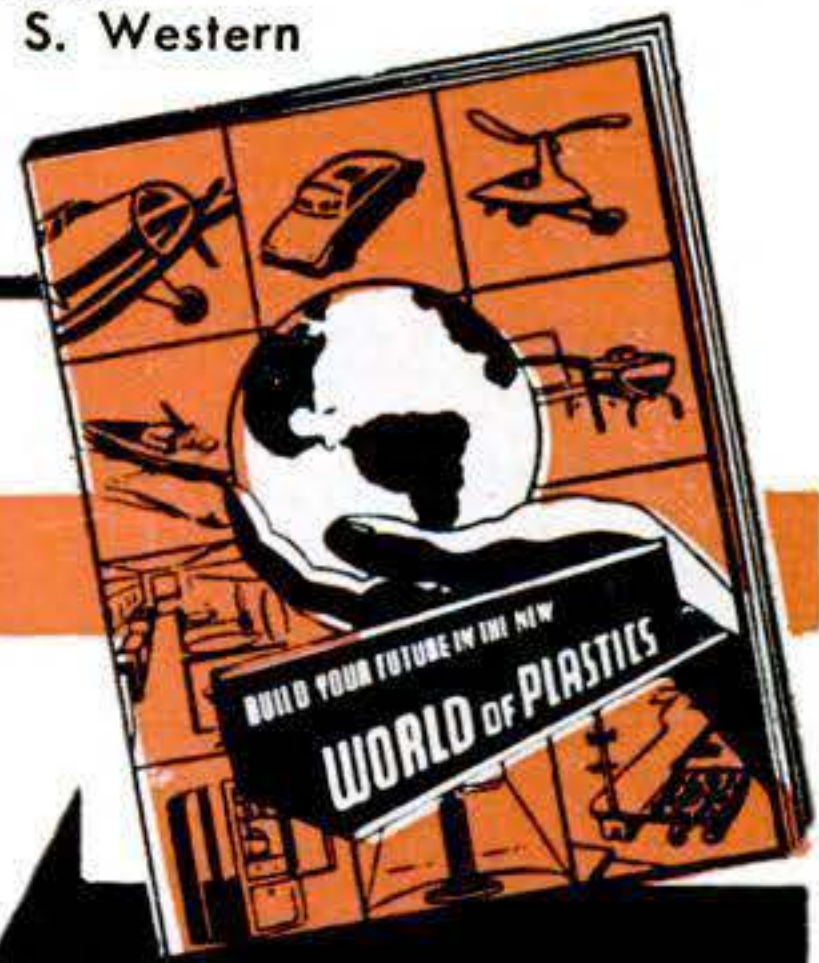
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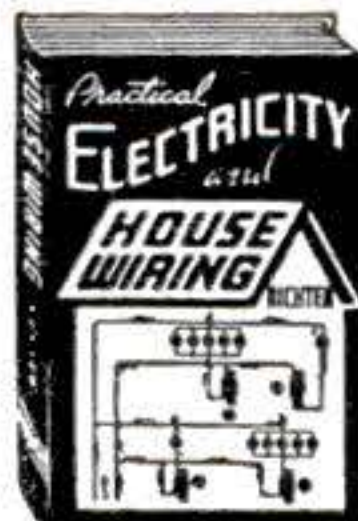
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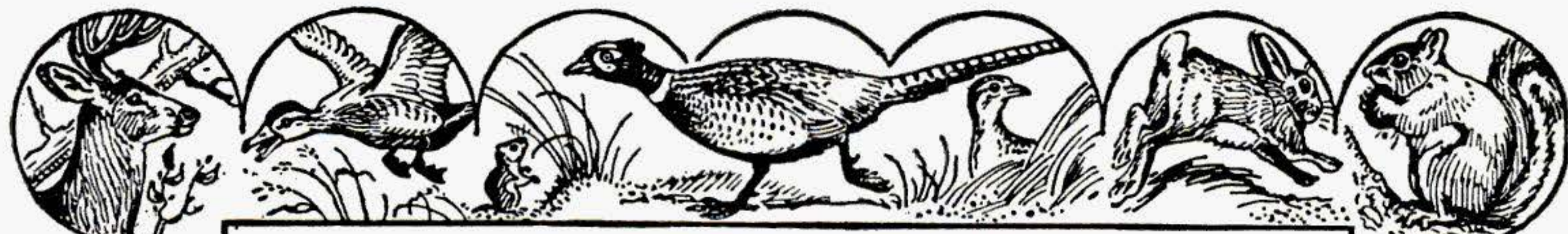


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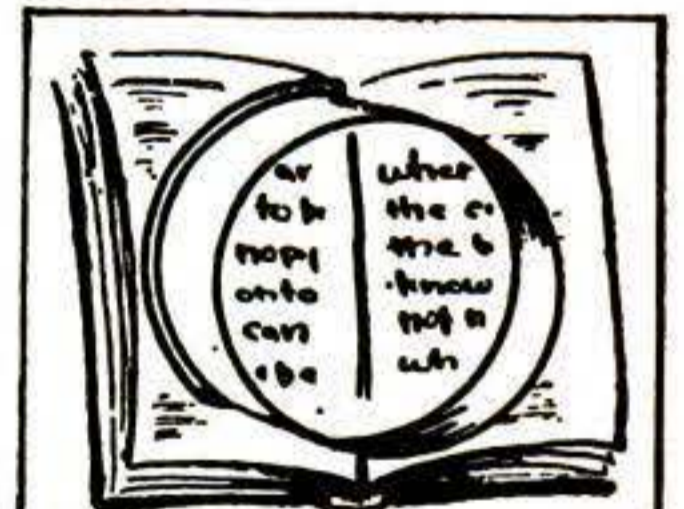
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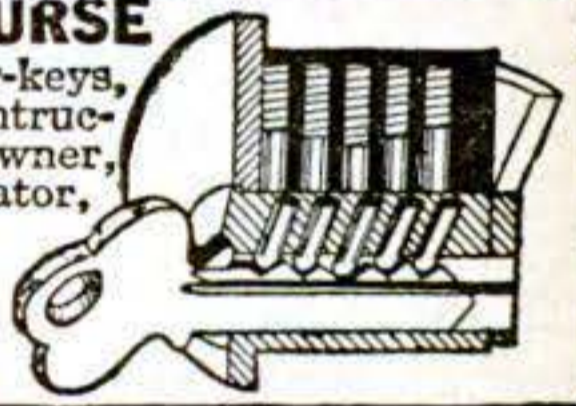
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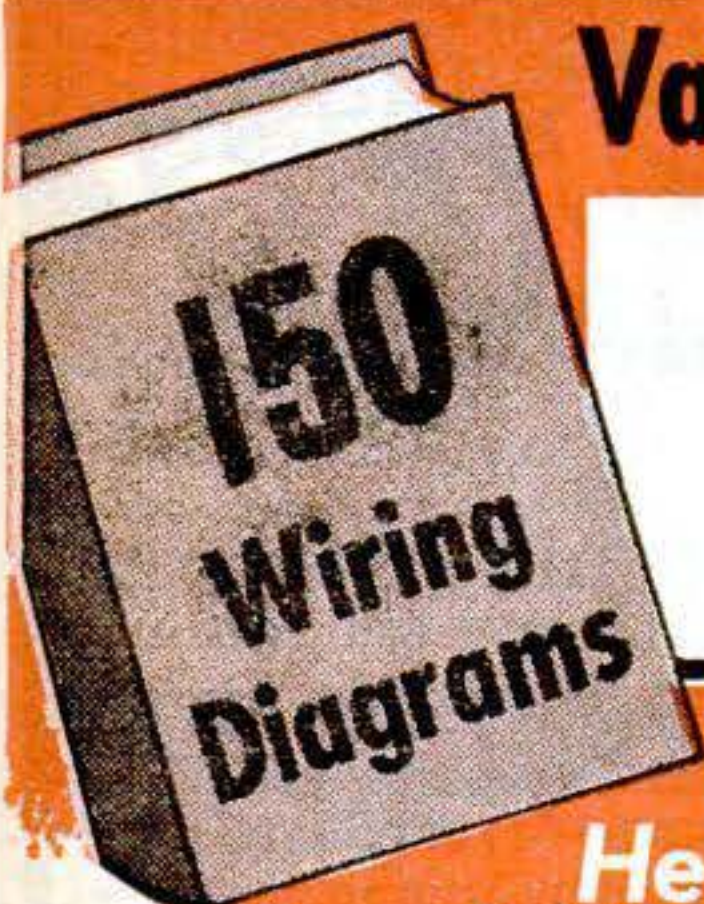
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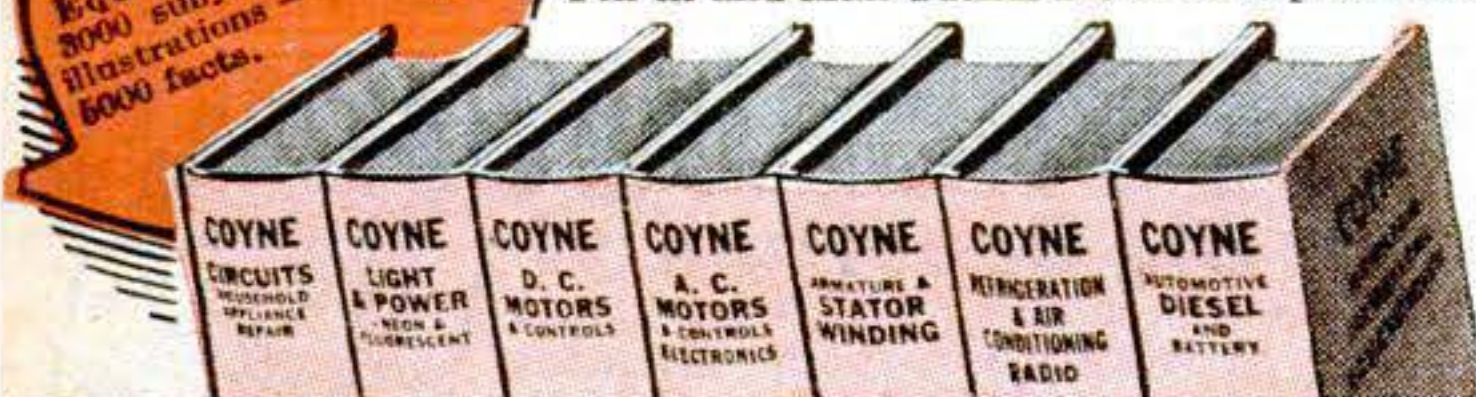
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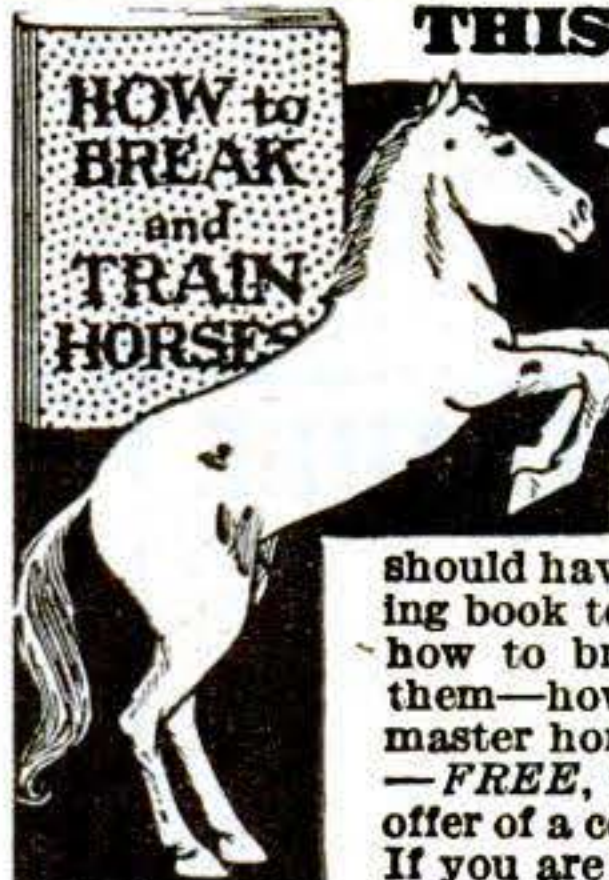
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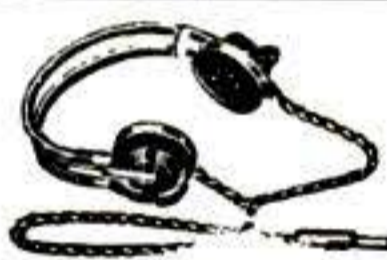
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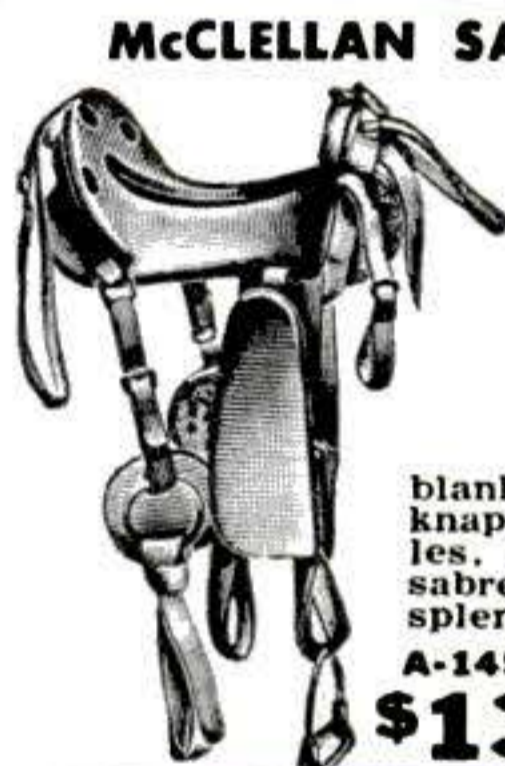


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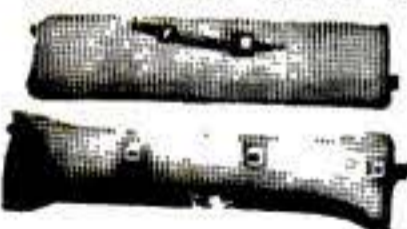
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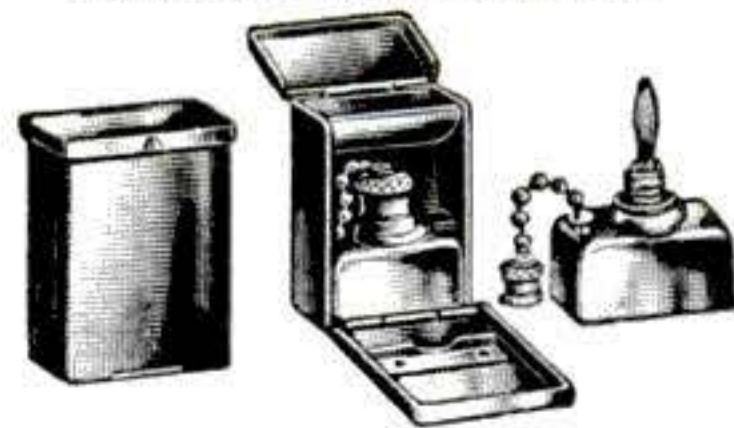
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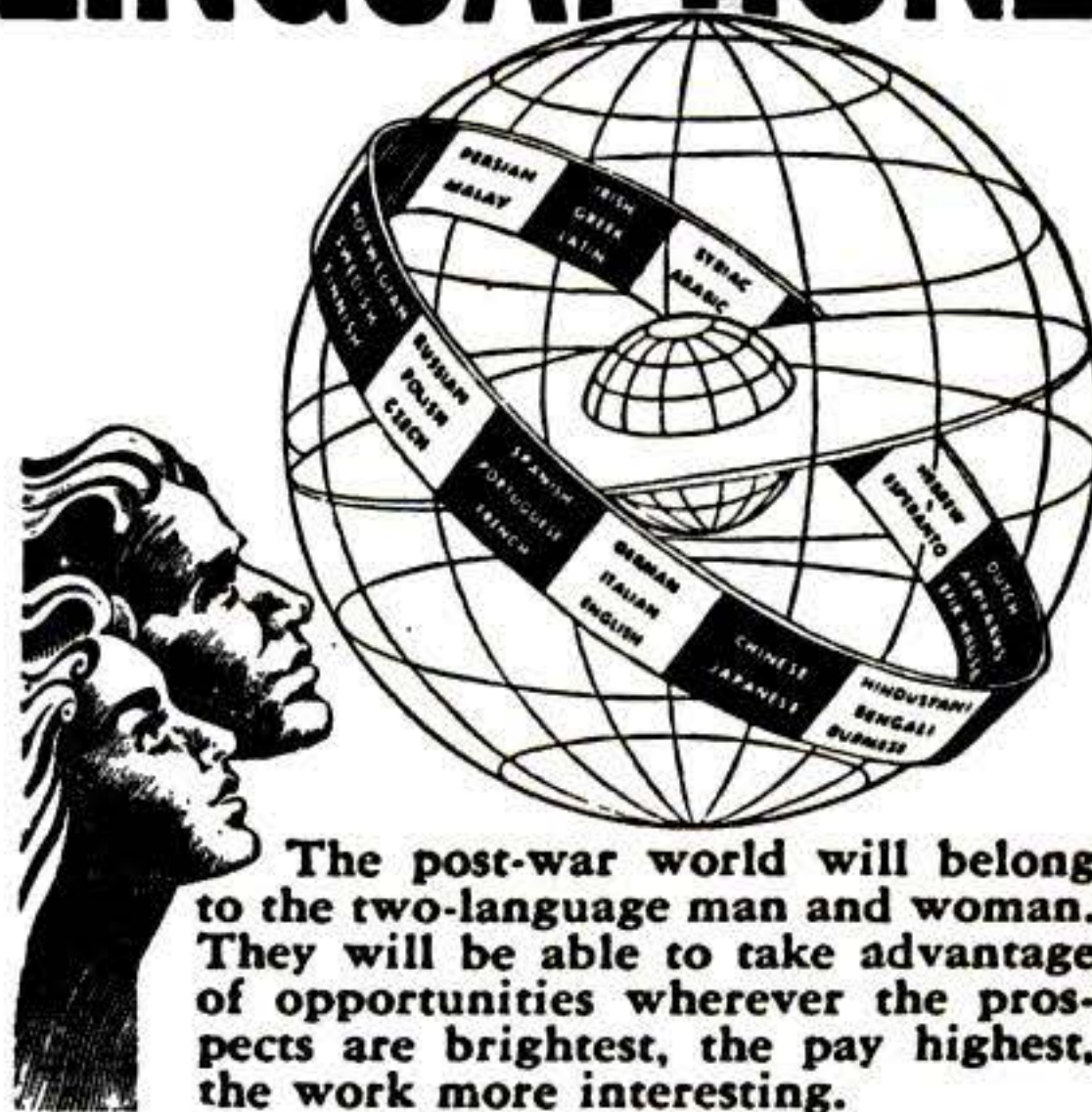
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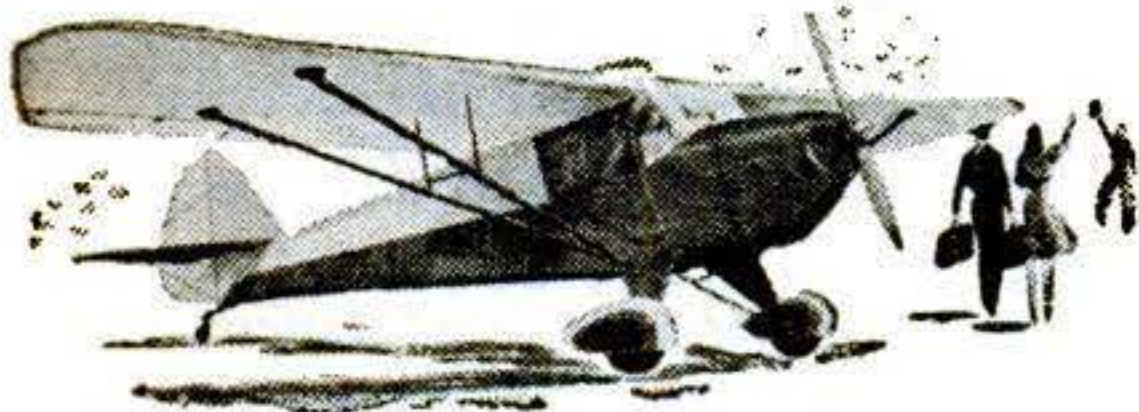
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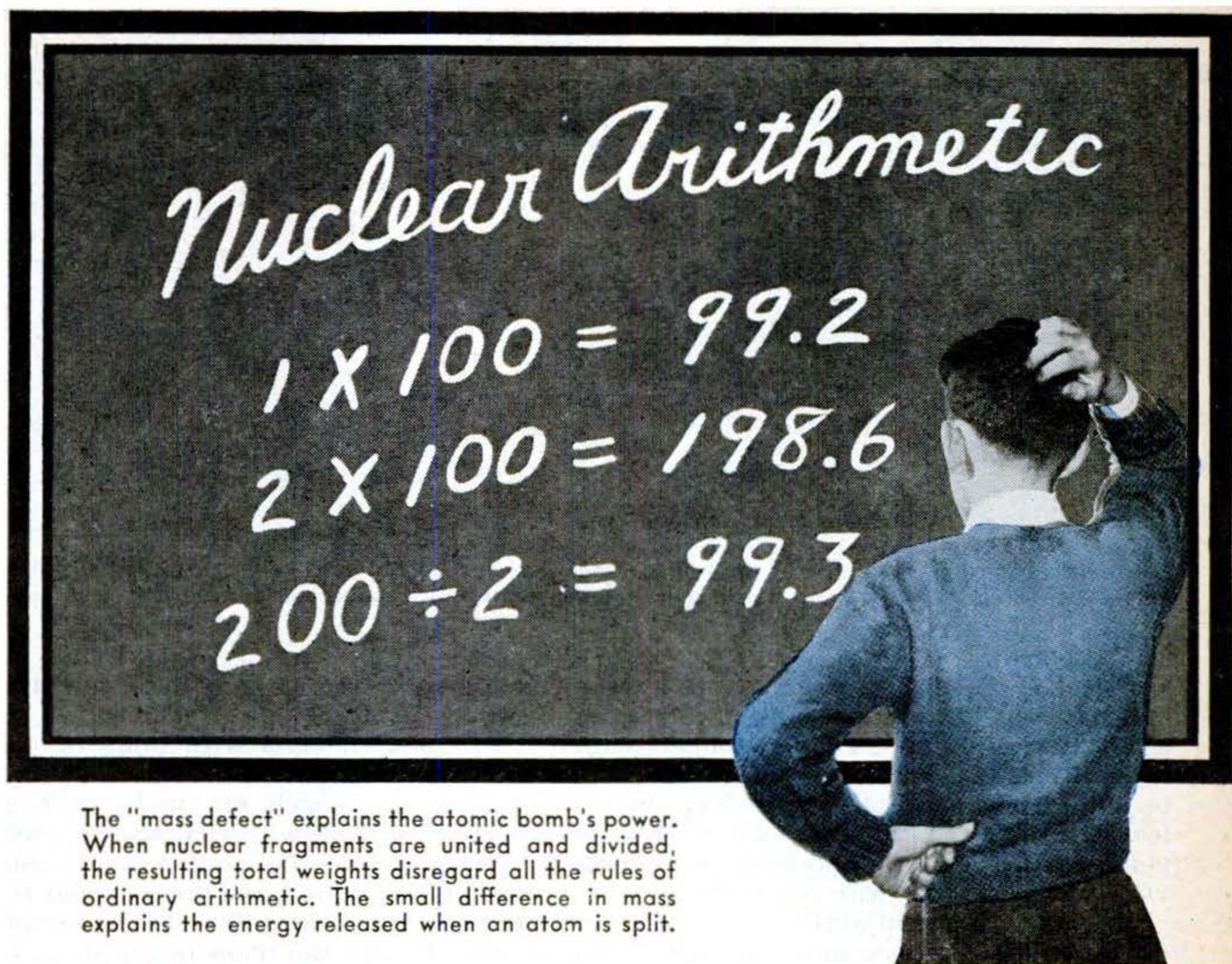
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The "mass defect" explains the atomic bomb's power. When nuclear fragments are united and divided, the resulting total weights disregard all the rules of ordinary arithmetic. The small difference in mass explains the energy released when an atom is split.

WE CAN HARNESS THE ATOM

You will soon see mobile engines running on U-235, and cities heated by steam from stationary graphite piles.

By DR. W. L. DAVIDSON, JR.

Drawings by RENÉ BRAS

THE consensus among experts now is that engines to harness the same kind of atomic power that was used against Japan can be developed within 10 years. Whether such engines will replace those we already have is another matter; too many "ifs" stand in the way of intelligent forecasting. For uses where the weight of fuel is a deciding factor, however, engines utilizing atomic energy almost certainly can and will be produced.

Hundreds of nuclear reactions, dozens of which release relatively large amounts of energy per atom, have already been discovered. Ingenious experiments

have enabled scientists to describe the interior of an atom almost as accurately as they might describe their own homes. The only secret now is just how tremendous nuclear energy is freed at the precise times and places chosen by the possessors of the secret.

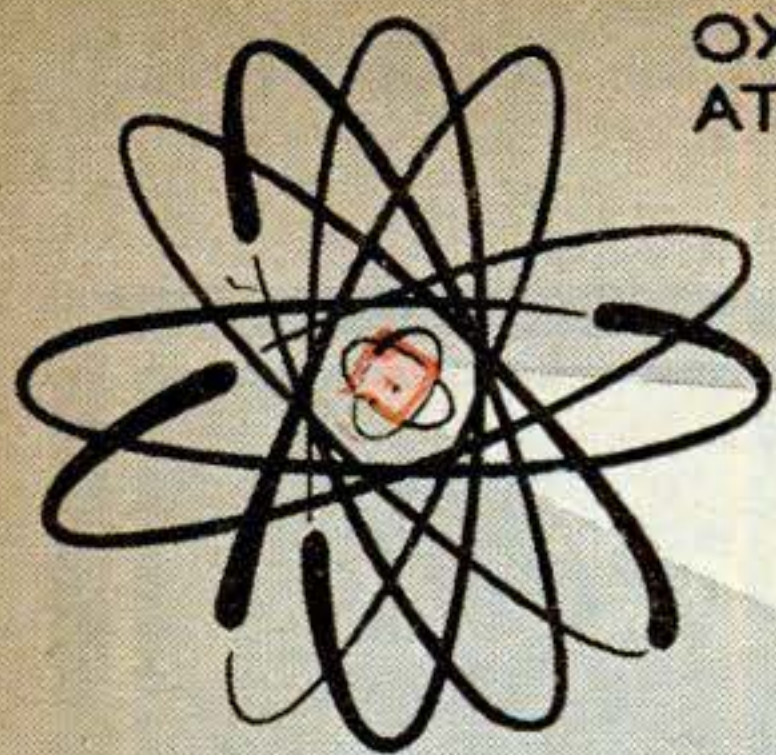
Nuclear engines would have been developed long ago if nuclear physicists had not been such notoriously poor marksmen. They had to fire roughly a million projectiles to smash a single atom; they rarely hit the nucleus of an atom because matter is mostly emptiness. It seems continuous to us only because powerful electrical forces hold atoms together.

Despite the vast empty spaces in matter, the developers of the



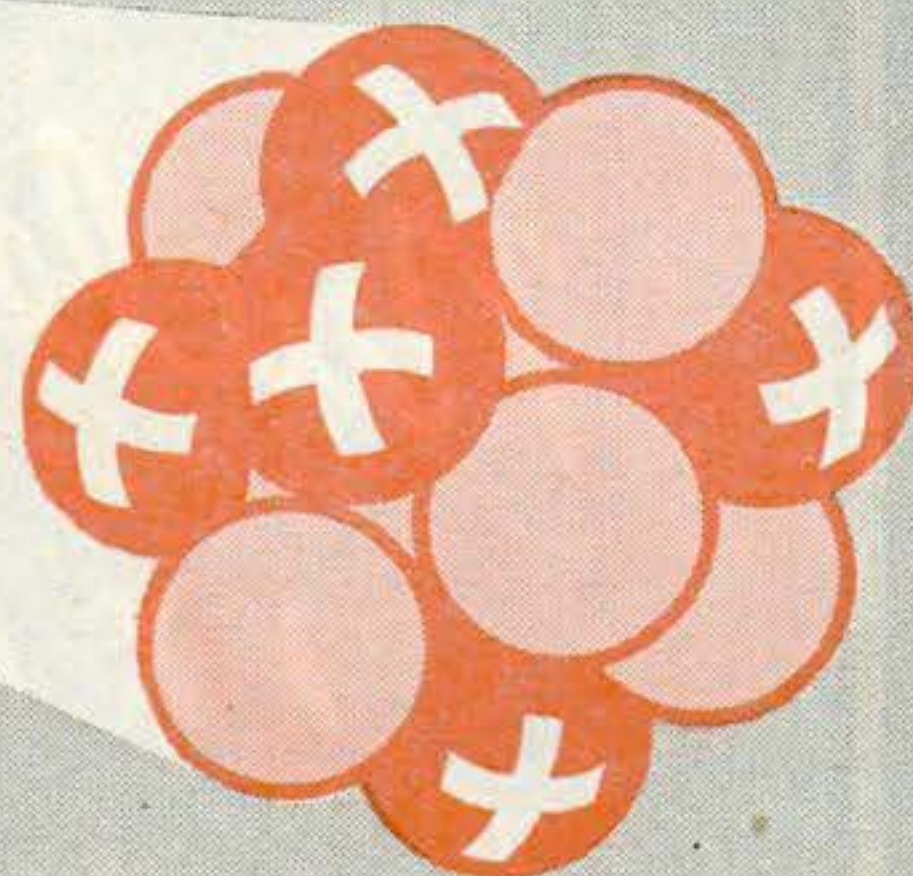
Insignia of the Army's "Manhattan Project."

OXYGEN ATOM



ELECTRONS 8

⊕ PROTONS 8
○ NEUTRONS 8



OXYGEN NUCLEUS

A physicist's idea of the inside of an oxygen atom. The nucleus occupies only one trillionth of the total volume. If the nucleus were the size of a golf ball, the nearest electron would be a quarter of a mile away.

atomic bomb found a way to make every bullet used in atom-smashing not only score a hit but also produce two new bullets with which the hearts of two more atoms could be hit. They succeeded, moreover, in releasing from 10 to 100 times as much energy per atom as had been obtained in any previous man-made nuclear reaction.

To grasp the potentialities of atomic power, you must first become acquainted with atoms. They consist of:

Neutrons, which may be thought of as mass without any electrical charge;

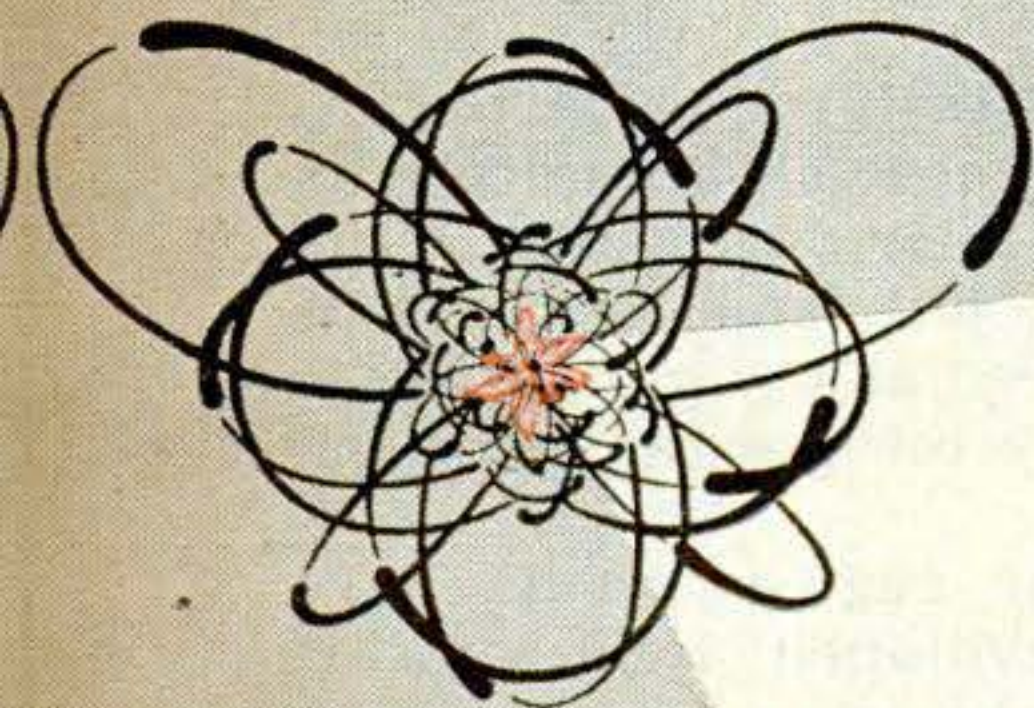
Protons, or mass with units of positive electrical charge, and

Electrons, which are units of negative electrical charge with virtually no mass.

The neutrons and protons constitute the nucleus of an atom, and the electrons revolve around this nucleus like planets around the sun. Most of the mass of an atom, consequently, is in its nucleus. No atom's nucleus

Uranium-atom nucleus is more complex. Electrostatic repulsion among protons gives it a dumbbell shape. Only a small amount of energy need be applied to this nucleus to make it break apart into two fragments.

URANIUM 235 ATOM



ELECTRONS 92

⊕ PROTONS 92
○ NEUTRONS 143



URANIUM 235 NUCLEUS

is satisfied until it becomes electrically neutral by gathering around itself as many electrons as it has protons. Changes in the arrangements of these electrons are responsible for the energy released in chemical reactions. Hence, burning coal or gasoline releases "atomic" energy, but not "nuclear" energy. Much more energy is released by changes deep in the heart of atoms.

Atoms of the same element do not always have the same mass, because the number of neutrons in their nuclei may vary. This is true of uranium, the raw material of the atomic bomb. Every atom of uranium has 92 protons, but the number of neutrons varies. A uranium atom having 142 neutrons is called U-234 (92 plus 142 equals 234), one having 143 neutrons is called U-235, and one with 146 neutrons is called U-238.

The most common kind of uranium is U-238. Atoms of U-234 are found so seldom that they can be disregarded. But U-235 atoms are highly important, because ways to separate them from U-238 have been discovered, and the energy provided by adding one slow neutron to this kind of atom's nucleus will shatter that nucleus. This is not true of the nucleus of an atom of U-238.

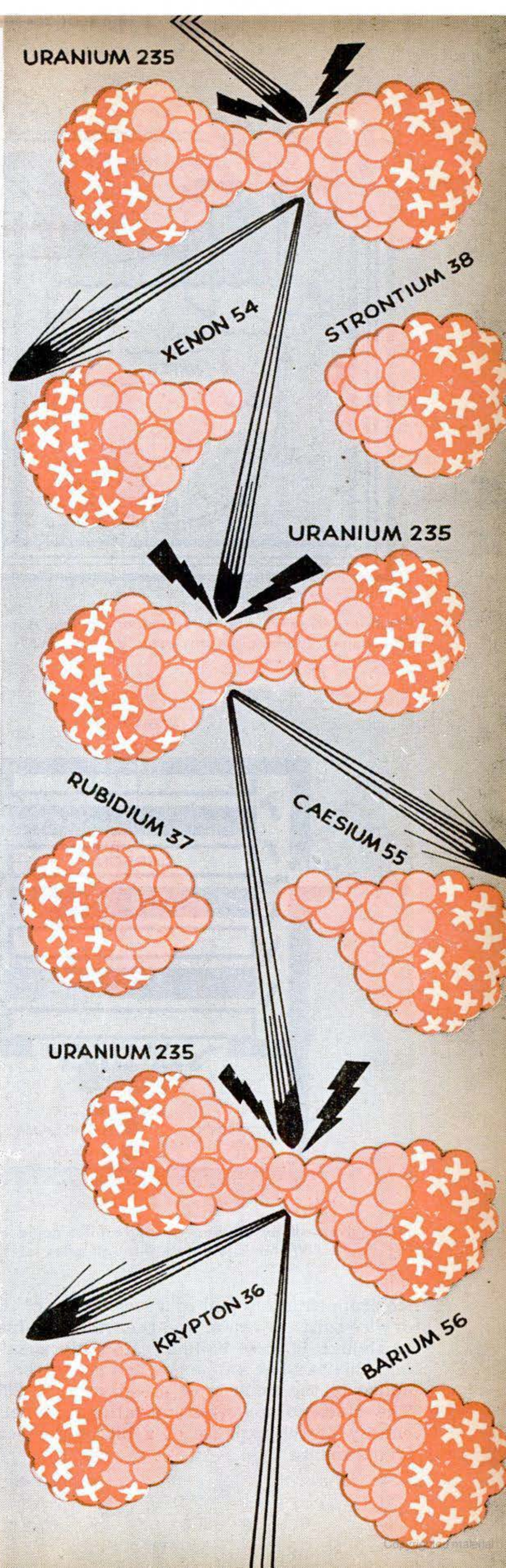
The diagrams on page 66 show why an atom of U-235 is more vulnerable than most atoms. You will note that the nucleus of an oxygen atom is depicted as a sphere, whereas the uranium nucleus looks like a distorted dumbbell. What accounts for this difference?

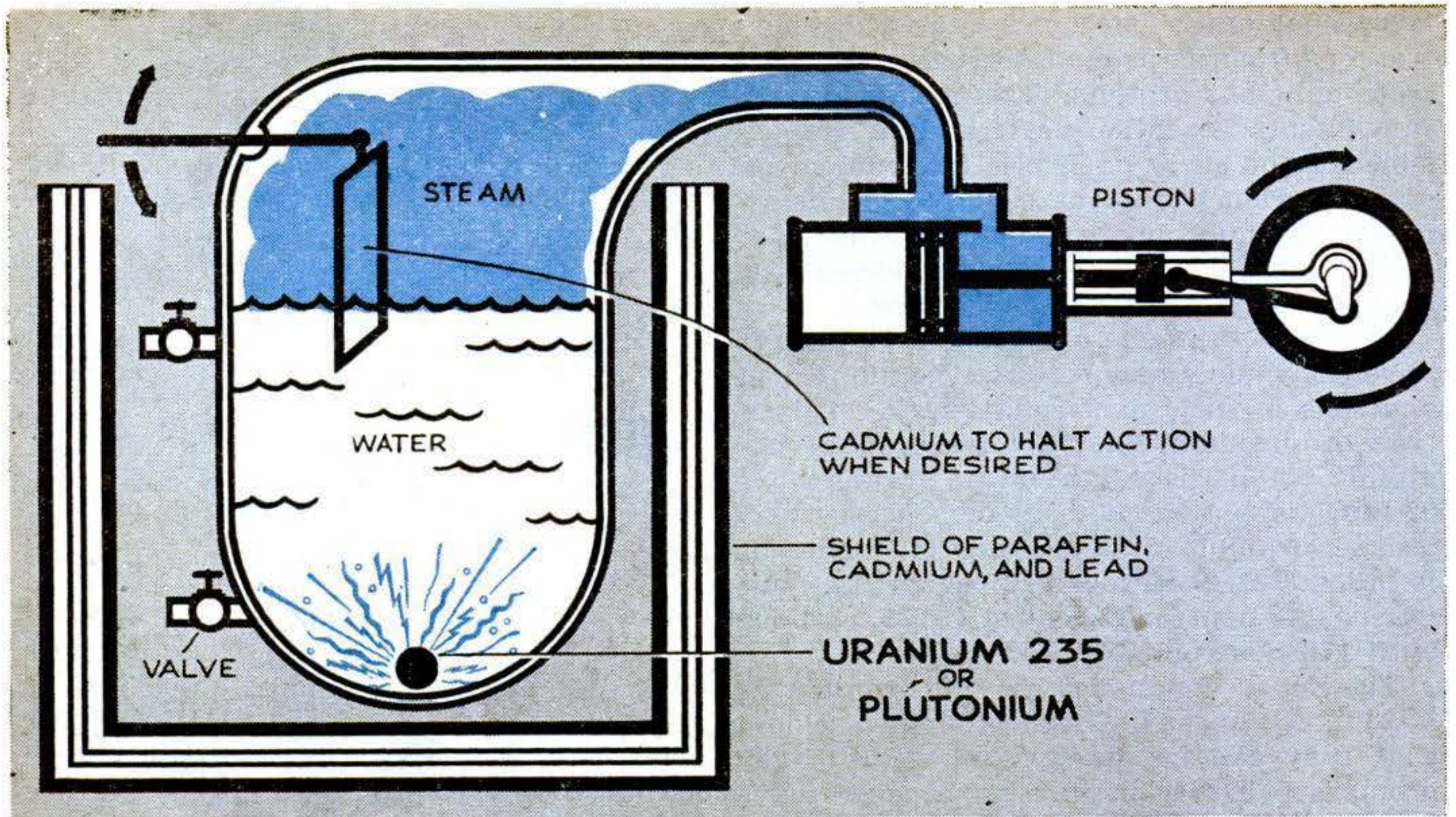
Two forces affect nuclear particles. The first of these is an electrostatic, repulsive force pushing the protons apart. If it were the only force present, the nucleus of an atom would fly apart automatically. But it is opposed by an attractive force that operates among all nuclear particles, whether they possess electrical charges or not, when they are brought into close proximity.

In a light nucleus, such as that of the oxygen atom, the attractive force far surpasses the repulsive force, so the nucleus tends to be a compact sphere. In a heavy nucleus, such as that of the uranium atom, the repulsive force is relatively greater. When it is great enough, a slight perturbation divides the protons into roughly equal groups, pitted against each other in a kind of tug of war. A single, additional neutron entering the nucleus may then make the nuclear drop fly apart into two smaller droplets.

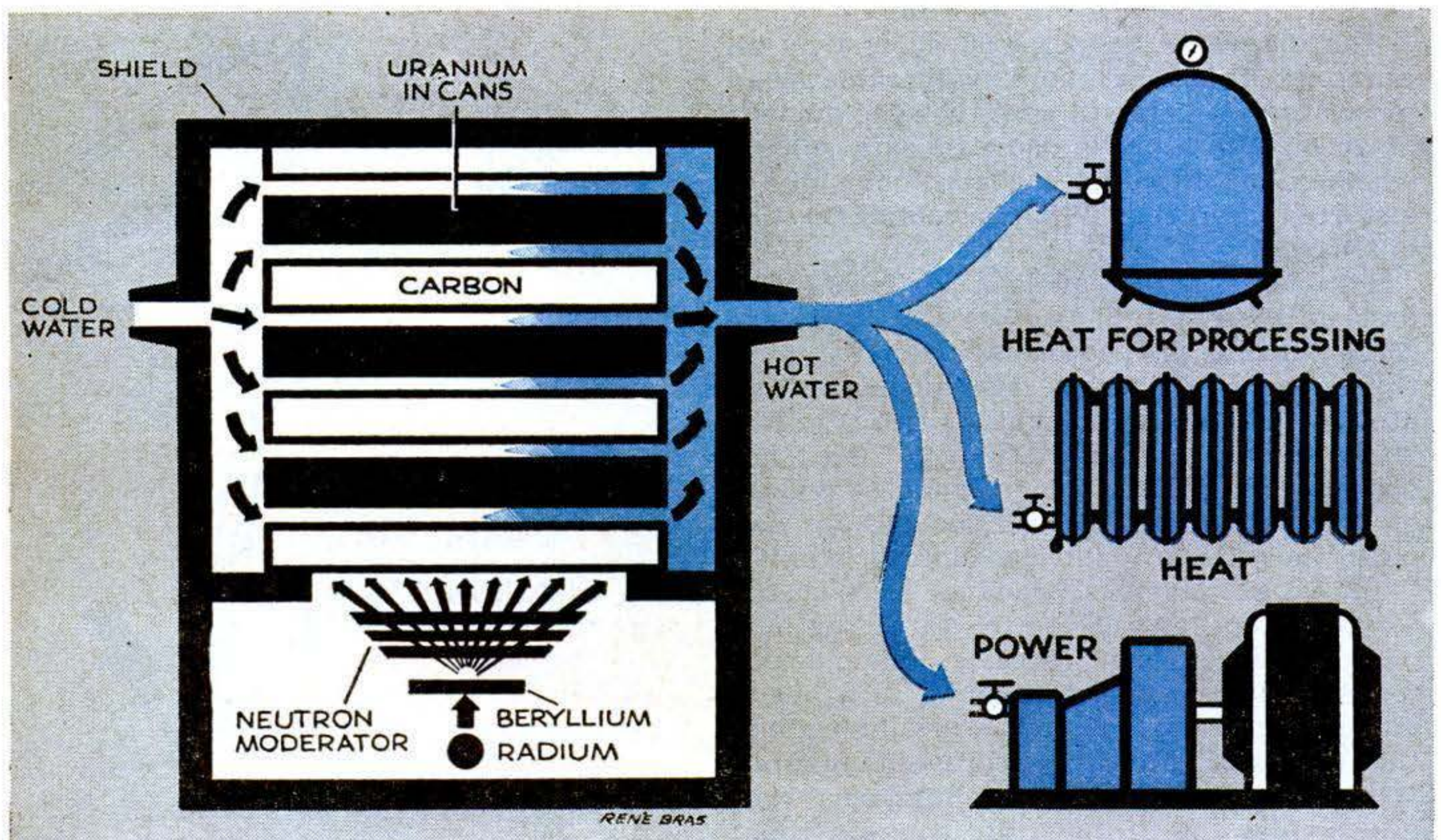
You probably have seen a chunk of dry

When a neutron splits a uranium atom, more neutrons are released. Nearly all the elements from selenium (atomic no. 34) to lanthanum (57) have been found among fragments of shattered U-235 atoms.





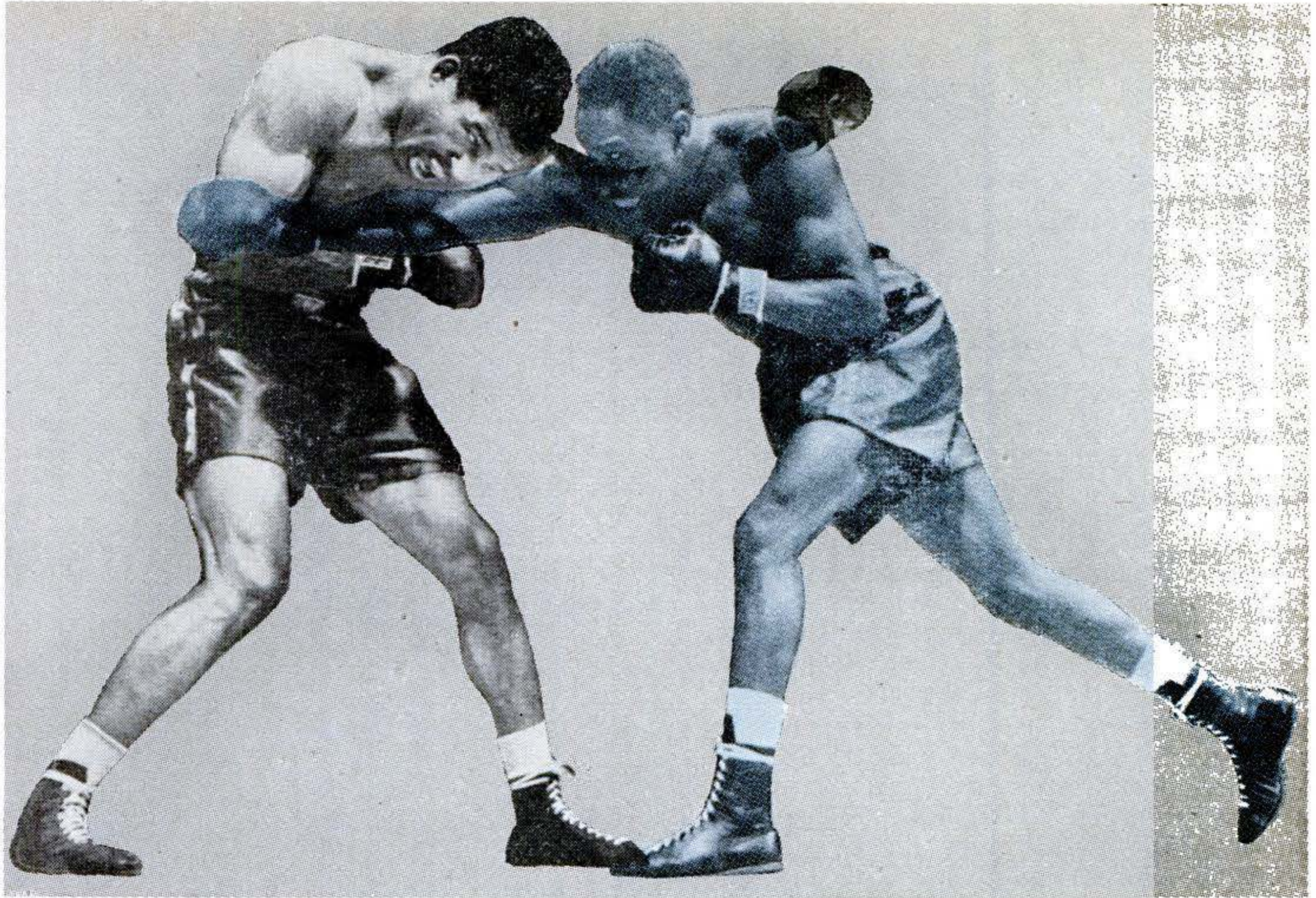
Possible design of a mobile nuclear engine. A chain reaction started by a cosmic ray in a small piece of uranium 235 would turn water into steam. A cadmium rod might help retard the release of energy.



Heat given off by uranium-graphite piles could heat cities or drive stationary engines using low-boiling liquids. Water circulated through piles at the Hanford, Wash., plant would supply a fair-sized city.

ice dropped into a pail of water. Part of the dry ice turns to vapor, and the water bubbles as though it were boiling. Roughly speaking, this is what happens when a neutron is added to the nucleus of an atom of U-235. The nucleus acquires vibrational kinetic energy at the expense of a bit of the neutron's mass.

The energy results from what is known as the "mass defect." Suppose, for a moment, that you had 100 ordinary marbles, each weighing one pound. Lumped together, they would weigh 100 pounds. But, if those marbles behaved like the protons and neutrons in the nucleus of an atom, the total weight would be only 99.2 pounds.



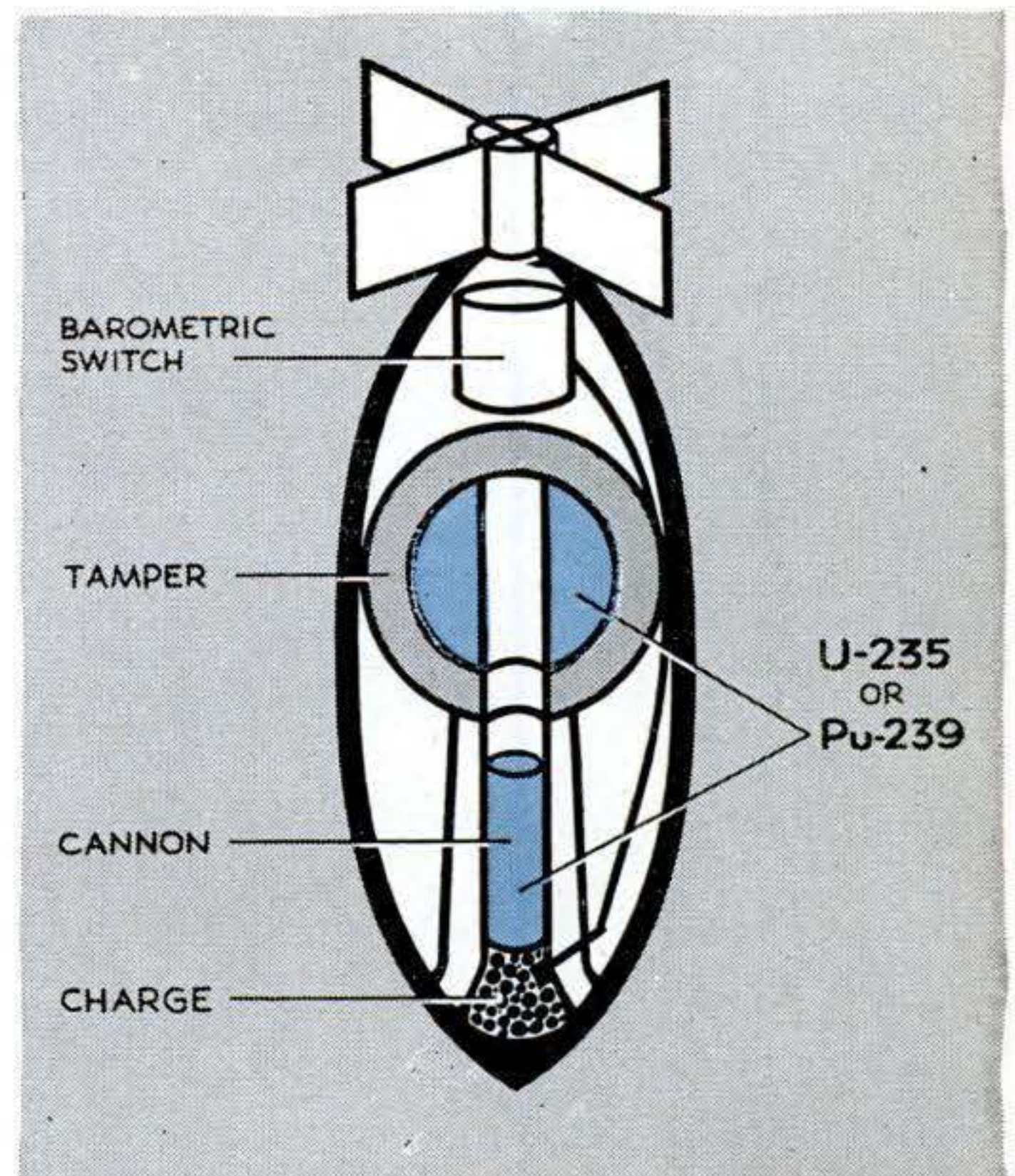
Matter is mostly emptiness. If the electrical "glue" between the atoms composing two heavyweight fighters were removed for an instant, the men might pass right through each other like a couple of ghosts.

In other words, the marbles would weigh less in a heap than separately.

Now suppose that you had 200 such extraordinary marbles. If they all behaved like nuclear particles, you would naturally expect them to weigh two times 99.2, or 198.4 pounds, when brought together. But they would actually weigh 198.6 pounds. And if you divided a group of 200 such marbles into halves, each group of 100 would weigh 99.3 pounds or a tenth of a pound more than your original pile of 100 marbles.

This peculiarity of protons and neutrons has been found to be true experimentally. The loss in weight when they are united in nuclei is the mass defect, and the change in weight when a group of 200 such particles is divided into two groups of 100 is exactly analogous to what happens when a U-235 nucleus is broken apart. The resulting fragments are about .1 percent heavier than ordinary atoms having the same number of particles. These overweight fragments, as if unhappy because of their obesity, immediately shake loose their excess mass in the form of kinetic energy. This is the energy that powers an atomic bomb.

But how are enough neutrons obtained and put into the nuclei to break up tremendous number of [\(Continued on page 218\)](#)



An explosion occurs when sufficient amounts of uranium 235 or plutonium are brought together. In an atomic bomb, this may be done by shooting one piece of explosive material into another piece from a tiny cannon fired by a barometric switch.

JUDGES IN CONTEST

Popular Science announces \$3,300 Servicemen's Handicraft Contest—All men and women now in service AND veterans eligible—Details on page 150—Judges from wide fields.

HERE are the judges of Popular Science's Servicemen's Handicraft Contest. These five men and two women have made outstanding contributions to America's successful war effort, and particularly to the welfare of the fighting forces. Two of them have directed fine service publications which meant so much to the servicemen and women, especially overseas. Two others have devoted their full energies to vocational and cultural rehabilitation of those returning from the fighting fronts. Another was one of the most popular entertainers at every front she visited—and she got to most of them. Of the other two, one played an important role in providing the weapons of war to the fighting men, and the other in bringing the story of the war to the people.

SGT. MERLE D. MILLER founded and edited the Pacific Edition of *YANK*, the Army Weekly, in 1942. In Paris, in August 1944, he established *YANK's* Continental Edition. Miller covered two Pacific invasions and the Battle of the Bulge.



BRIG. GEN. GEORGES F. DORIOT, ASF, is Director of Military Planning for the Quartermaster General. French-born and World War I veteran, he has been a Harvard professor and industrial executive. He became a U.S. citizen in 1940.

MRS. CASS CANFIELD, noted sculptress, directs the Arts and Skills Corps of the American Red Cross, which provides constructive and creative occupation for sick and disabled servicemen during their recuperation in military and naval hospitals.



FOR GI'S AND VETS

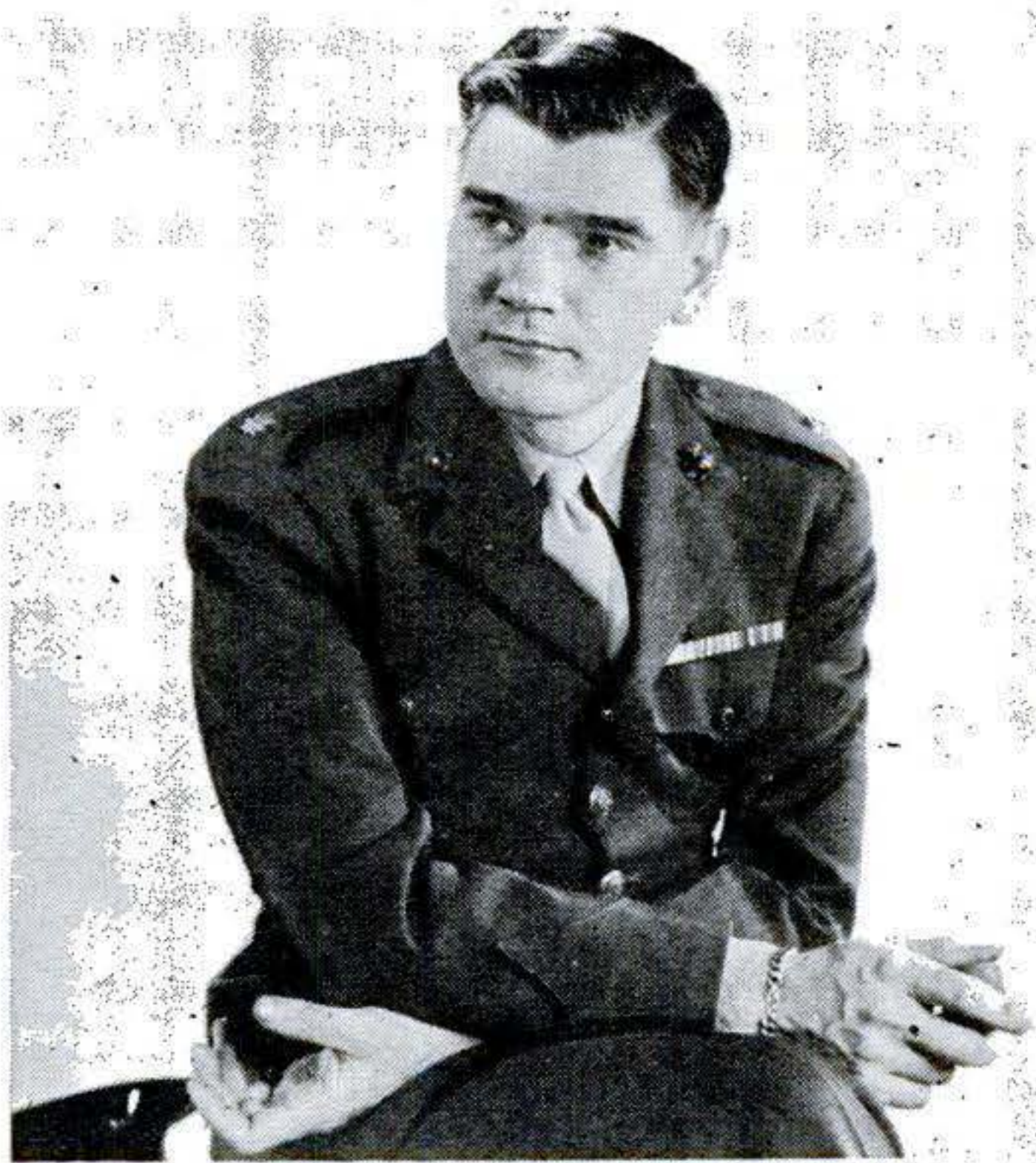


MAJ. NATHANIEL SALTONSTALL, as Chief of the Handicraft Branch of Army Service Forces, supplies handicraft kits and workshops to overseas theaters and troop transports. The program, for able-bodied soldiers only, is extremely popular.

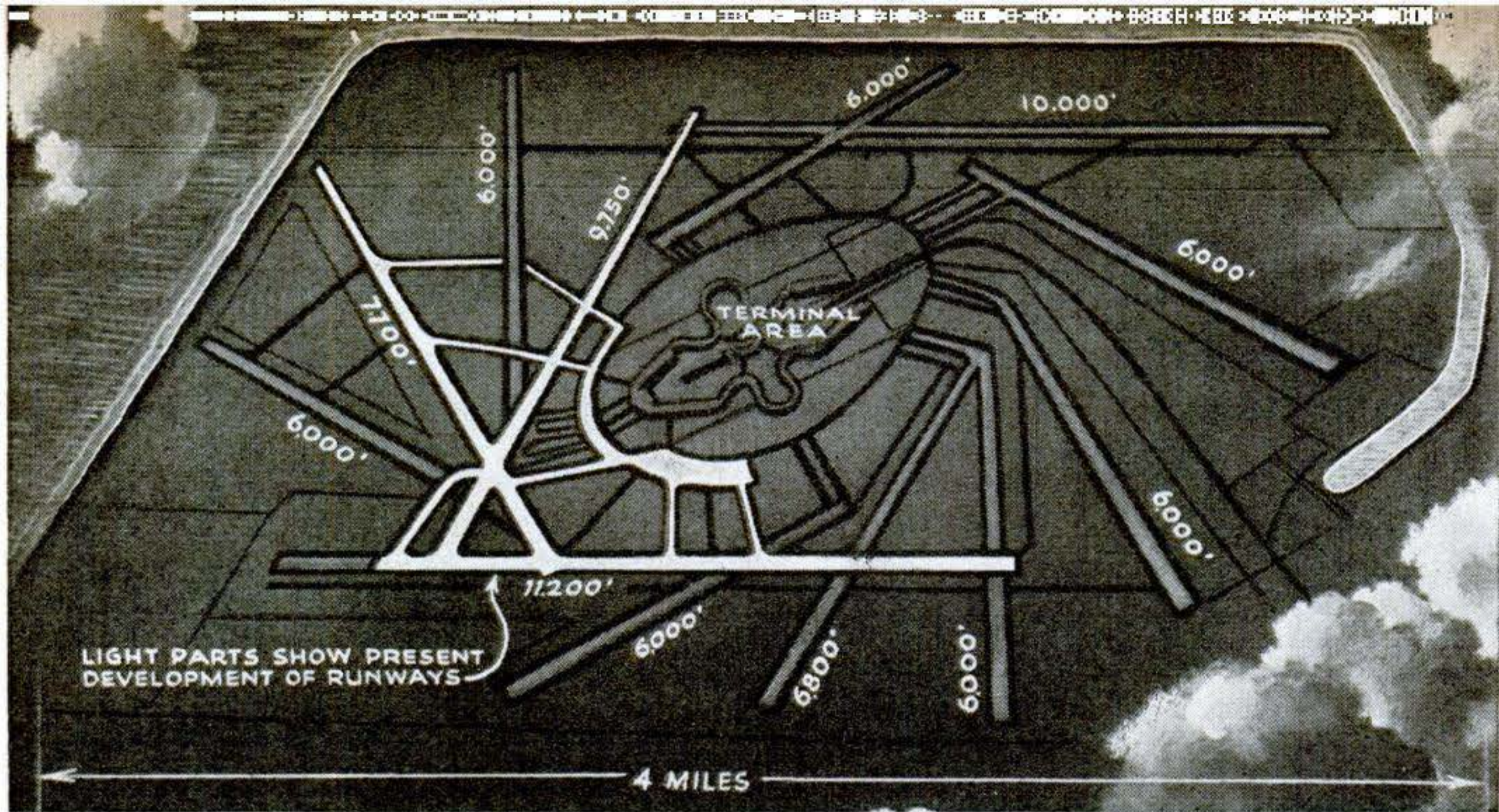


FRANCES LANGFORD, movie, stage, and radio star, has been a globe-trotter entertaining millions of service personnel. Tropic heat, lashing sandstorms, Nazi shells, Jap snipers couldn't stop her, and she says war-end is not job-end for her.

REAR ADM. HAROLD B. MILLER, at 42 the Navy's youngest admiral, is that service's Director of Public Information. He has done more than any other one person to bring to the public the full story of the Navy's part in World War II.



MAJ. WALTER W. HITESMAN, JR., has been editor of the Marine Corps magazine, *THE LEATHERNECK*, since January 1942. A graduate of Louisiana State, he was a newspaperman in Baton Rouge before joining the Marines in October 1940.



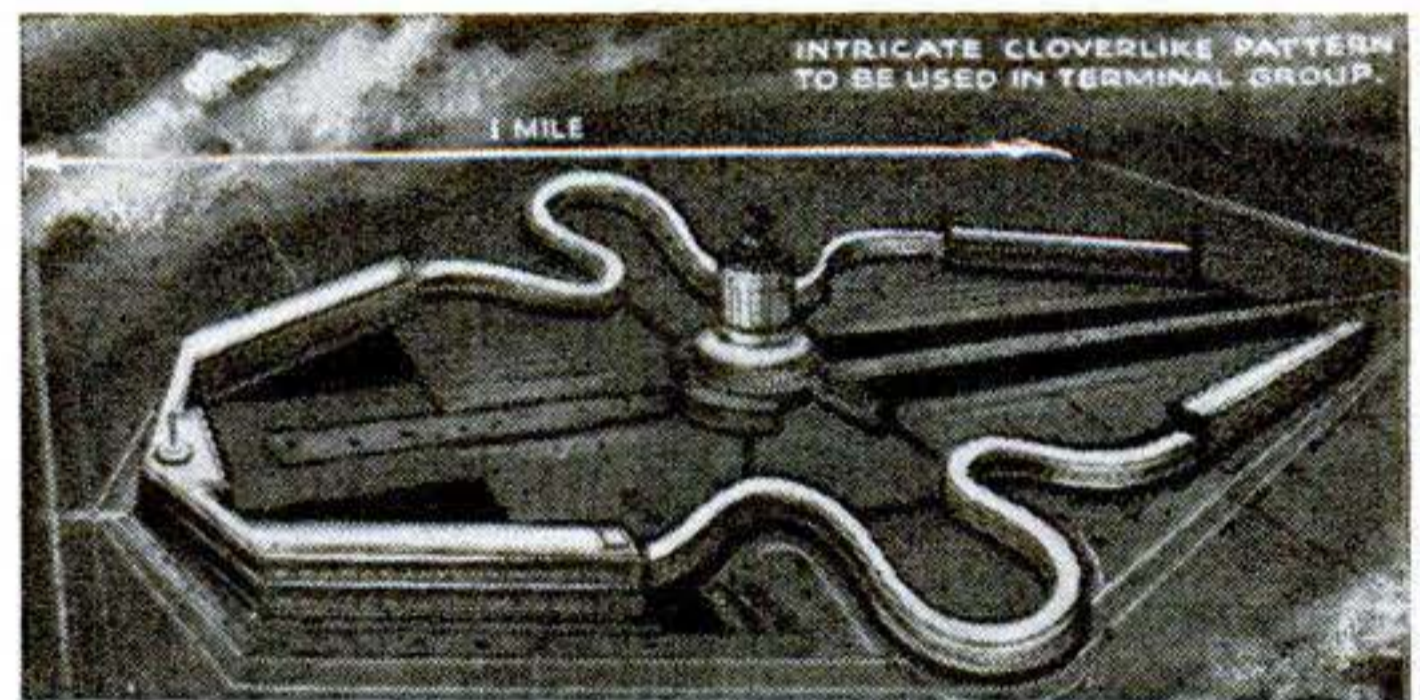
Idlewild's landing strips will be able to accommodate three of the largest types of planes taking off and three landing at the same time. The longest runway will be over two miles. In all, there will be 12 landing strips with a total length of over 16 miles. A 15,000-foot seaway on Jamaica Bay will serve seaplanes.

IMMENSE IDLEWILD

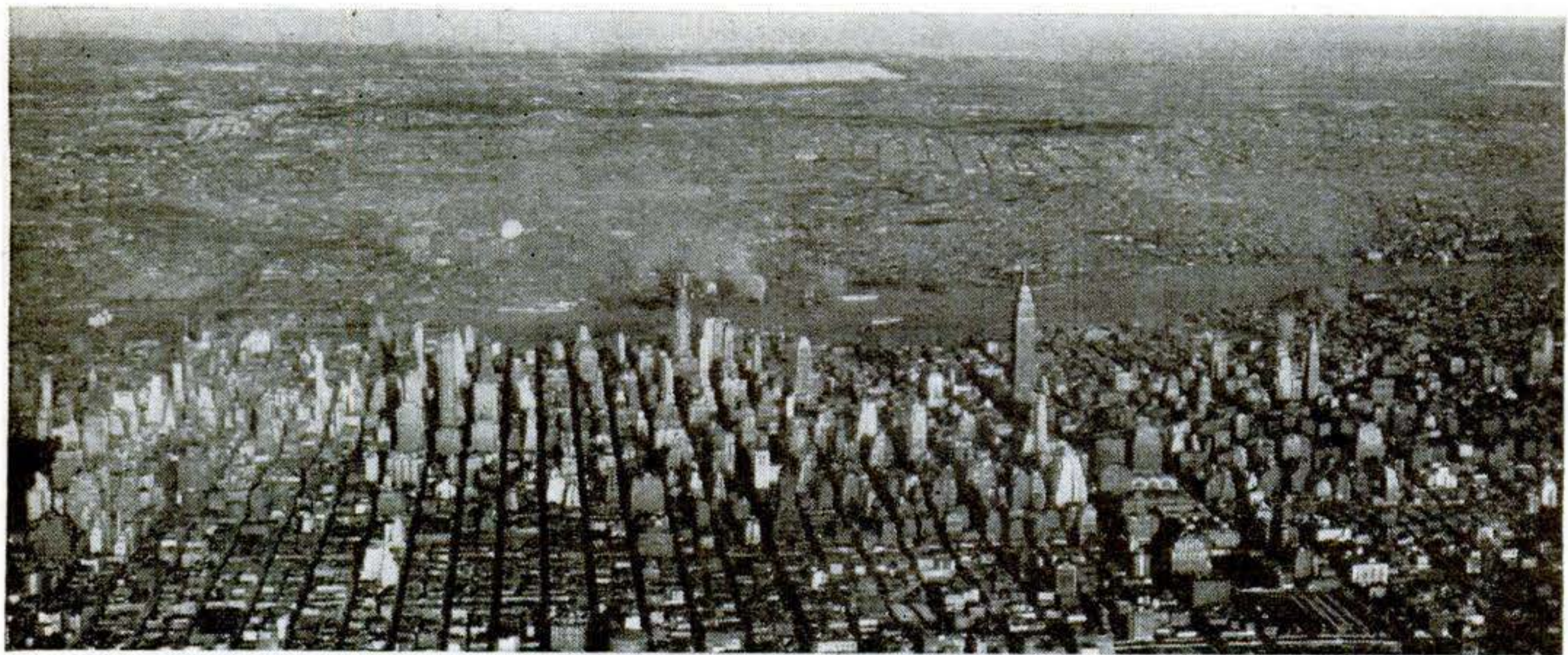
New York's \$200,000,000 airport will be equipped to handle 600,000 landings and take-offs per year.

NEW YORK CITY is taking an enormous gamble on the future of intercontinental airplane travel—a hundred-million-dollar gamble. It is sinking that sizable sum in the swamplands of Jamaica Bay, building what is confidently expected to be the world's greatest airport. The total cost eventually will be near \$200,000,000.

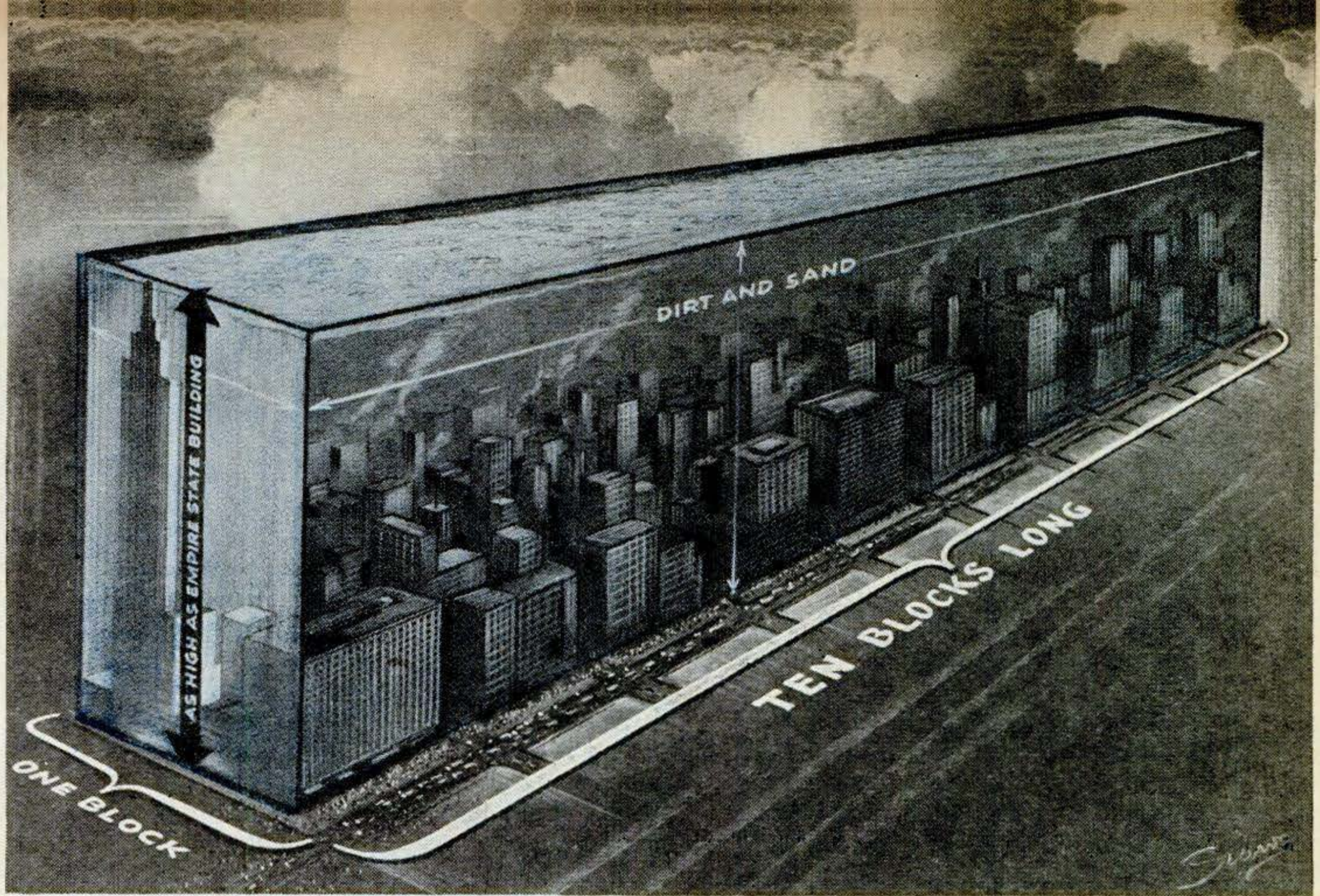
Millions add up mighty fast when you go out and buy 4,600 acres of land 13 miles from the heart of New York, and with it the 1,100 buildings that stand on it. For the site alone, the city paid over \$10,000,000,



Putting the terminal buildings and loading arcade in the center of the field will speed up the heavy traffic expected when air travel hits its stride.



Looking toward the west over New York City's concentration of skyscrapers, one sees Idlewild as a dim white area in the background, 13 miles from the heart of the city. The new field takes in an area of more than 4,600 acres; its cost will reach \$200,000,000. Thirteen air lines have already contracted for space.



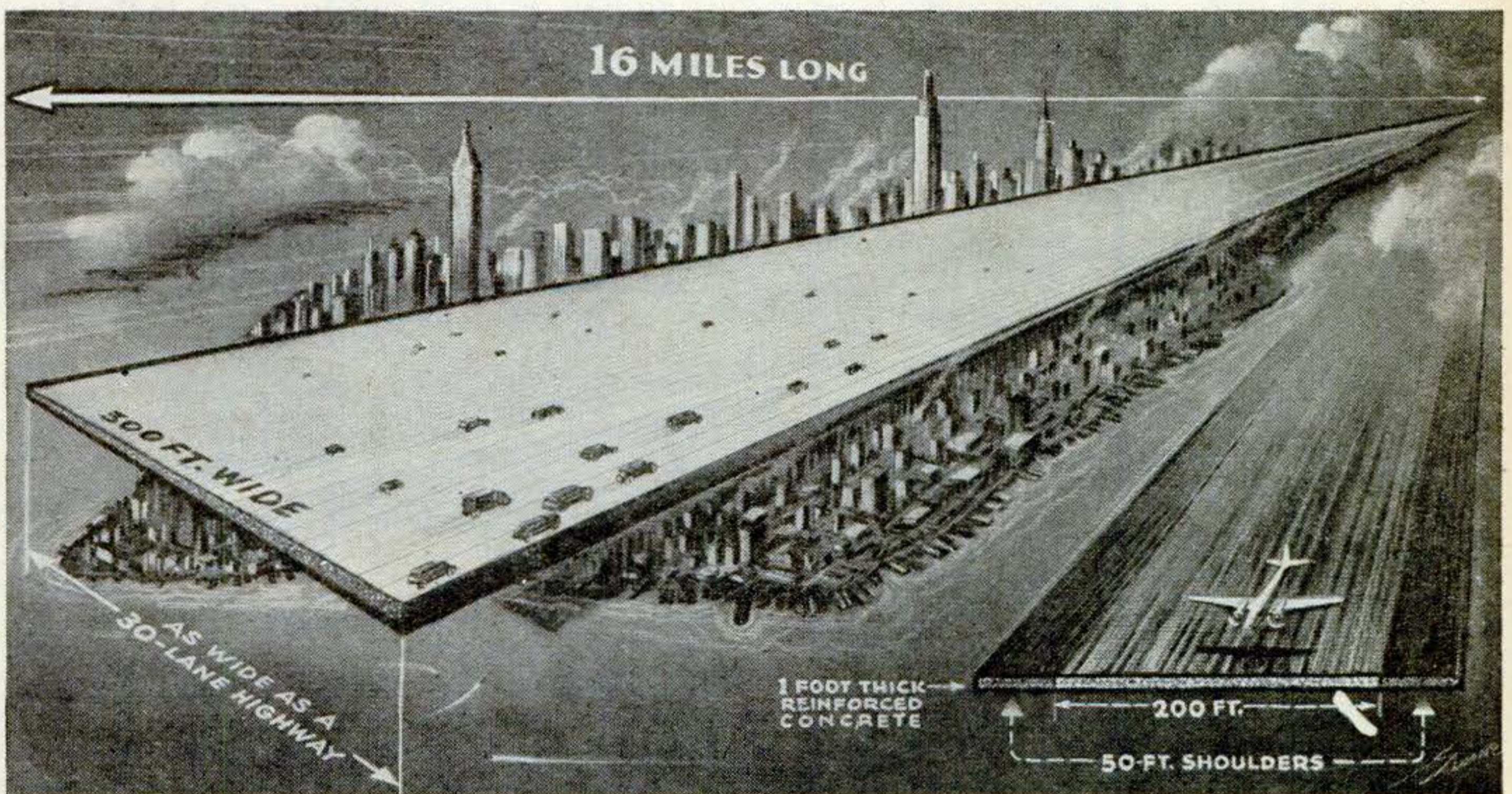
More than 40,000,000 cubic yards of earth were pumped onto the swampy meadowland from the adjacent waters of Jamaica Bay to bring the site of the airfield up to 12 feet above sea level. This tremendous load would fill an area 3,000 feet (10 city blocks) long and 300 feet wide to a height of more than 1,200 feet.

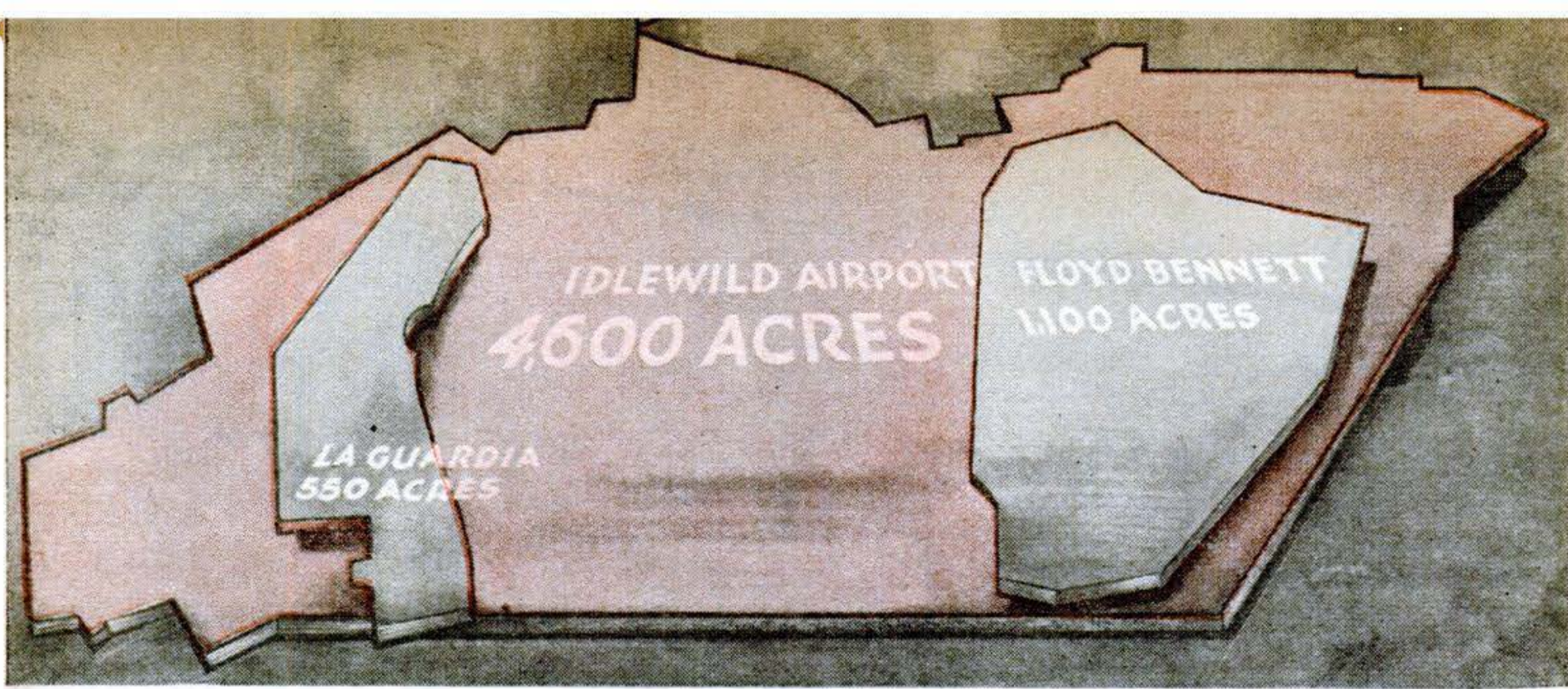
and this was just a starter, with more to go.

Idlewild is not just another airport of immense size. It is unique in design, from runways to the huge loading and administration area in its center. They call the runway system "tangential," because none of the landing strips runs directly into the central area.

While the City of New York took the original gamble in starting an airport on such a grand scale, the major air lines have come in and eagerly taken on their share of the ante. Thirteen lines have signed contracts for use of the field at fixed fees calculated to amortize the city's investment and pay for the whole operation. Though

Idlewild's runways will be the world's finest, with a combined length greater than New York City's Manhattan Island. Their intricate pattern will make it possible to handle 600,000 landings and take-offs per year, more than one every minute, day and night. This is far in excess of LaGuardia Field's 90,000 capacity.





Idlewild's 4,600 acres dwarf New York City's famous LaGuardia and Floyd Bennett airfields. A 20-mile network of roads, with its own bus line, will thread the layout. A parking area will hold 30,000 cars.

they were being charged in proportion to the space used, there was such a scramble for it that city officials had to haggle some of them downward on their demands in order to squeeze them all in.

Idlewild is New York's bid for the airplane trade of the world, passenger and freight. It is to be used for international traffic and the longer trips within this country. LaGuardia Field will eventually handle only the shorter hauls.

Space for hangars and shops has been contracted for by the air lines to the extent of 685 acres. The total cost of these buildings is estimated at \$60,000,000. The city will build them and charge the lines rental in proportion to cost. Each line may design its own buildings, but the city will have the veto on exterior appearance.

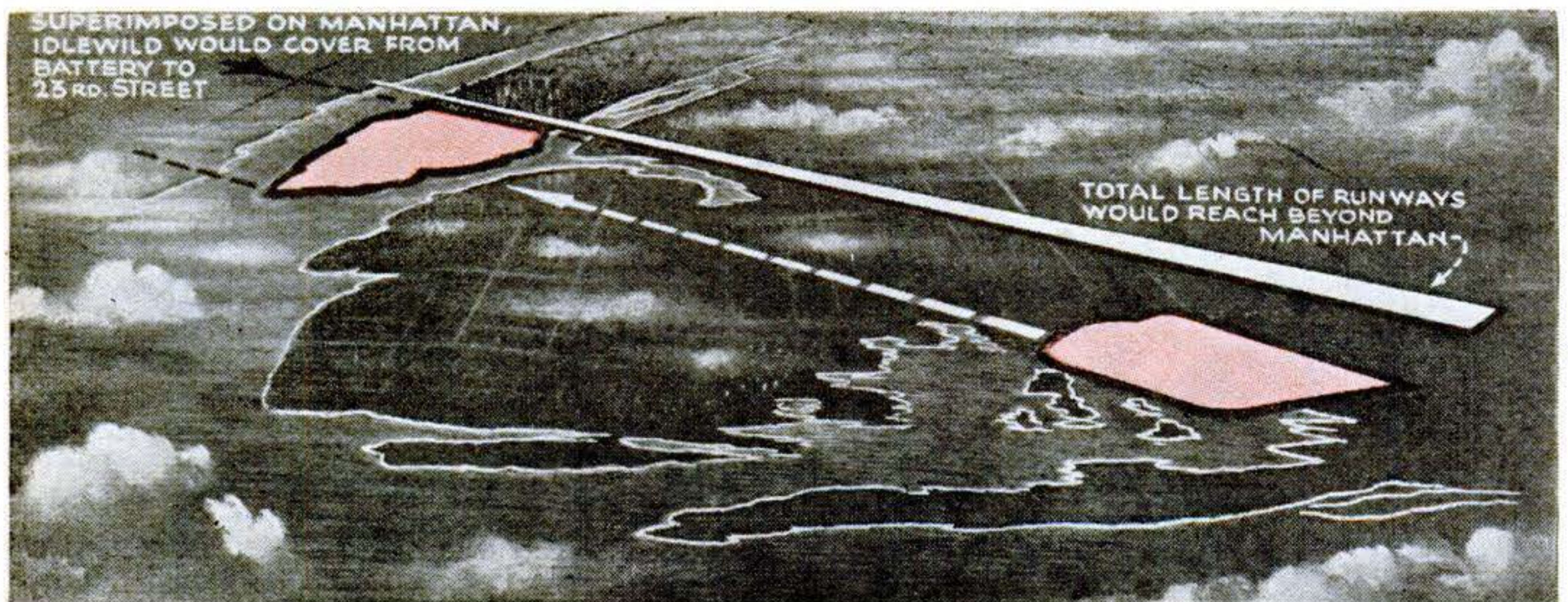
Construction of Idlewild has been planned in three stages, the first one of which is now finished. Besides the first three runways, there is a temporary administration building of concrete blocks and sufficient apron

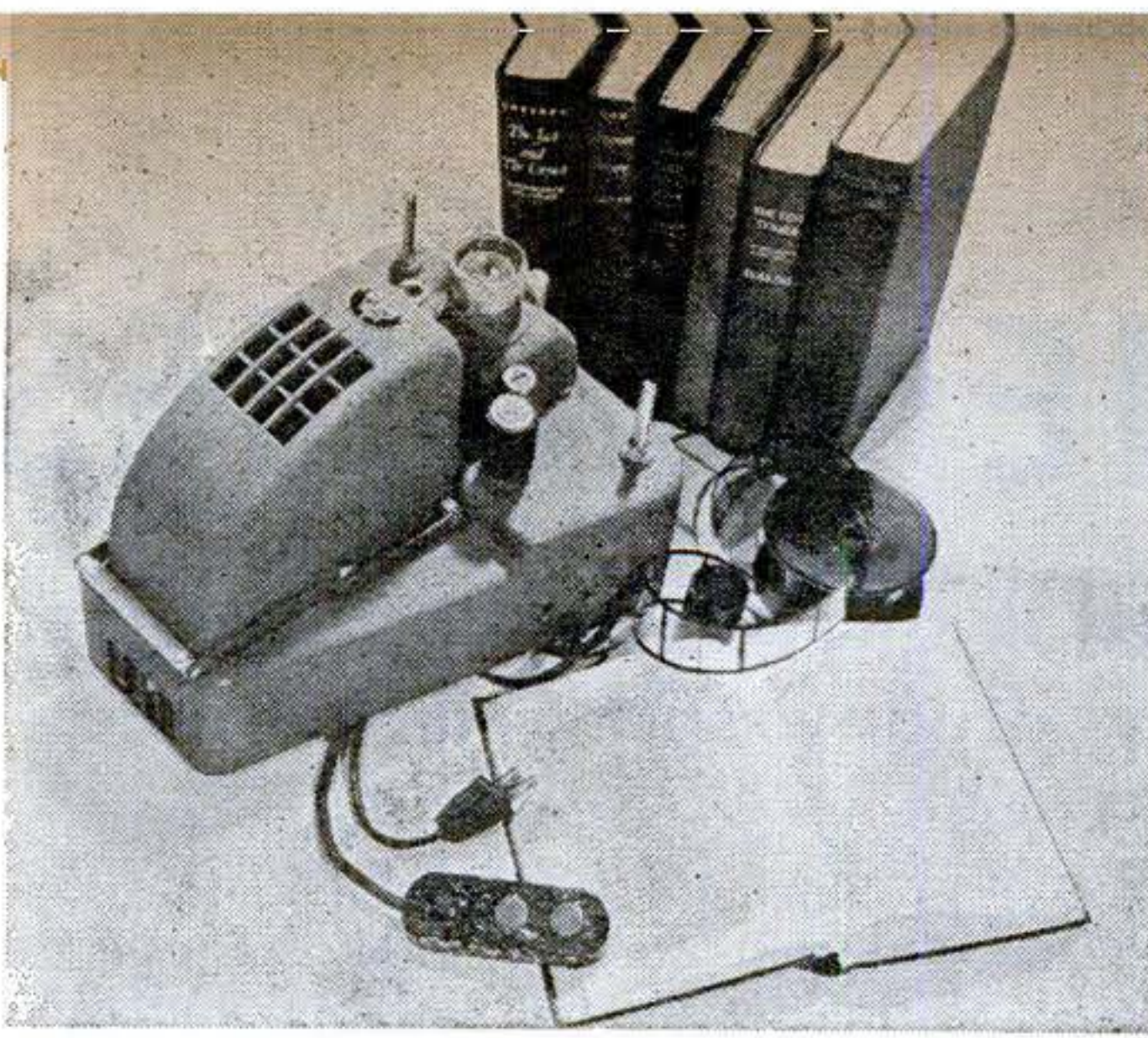
for the time-being use of these few runways.

The second stage calls for six complete runways, a four-story administration building to cost \$12,000,000, and more apron space. The date set for completing this stage is 1947. By that time, too, there will be many hangars and shops as well as a tank farm for storage of fuel. Oil companies have been clamoring for privileges at the airport but no contracts have been signed as yet. The present plan is to permit all companies to participate. There will be a complete pipe-line system through which oil and gasoline can be pumped from the tanks to any part of the field.

Just when Idlewild will reach its third and final stage of completion, with its 12 runways finished, is not certain. The date will probably be after 1950 and will depend upon the growth of long-distance plane traffic. Already, the original ambitious plans for the field have been modified many times in the light of developments and indications of future demands.

The enormity of the new field is emphasized in the drawing below. The central area alone, including the administration building, arcade, and aprons, will be more than 300 acres, bigger than most major airports.

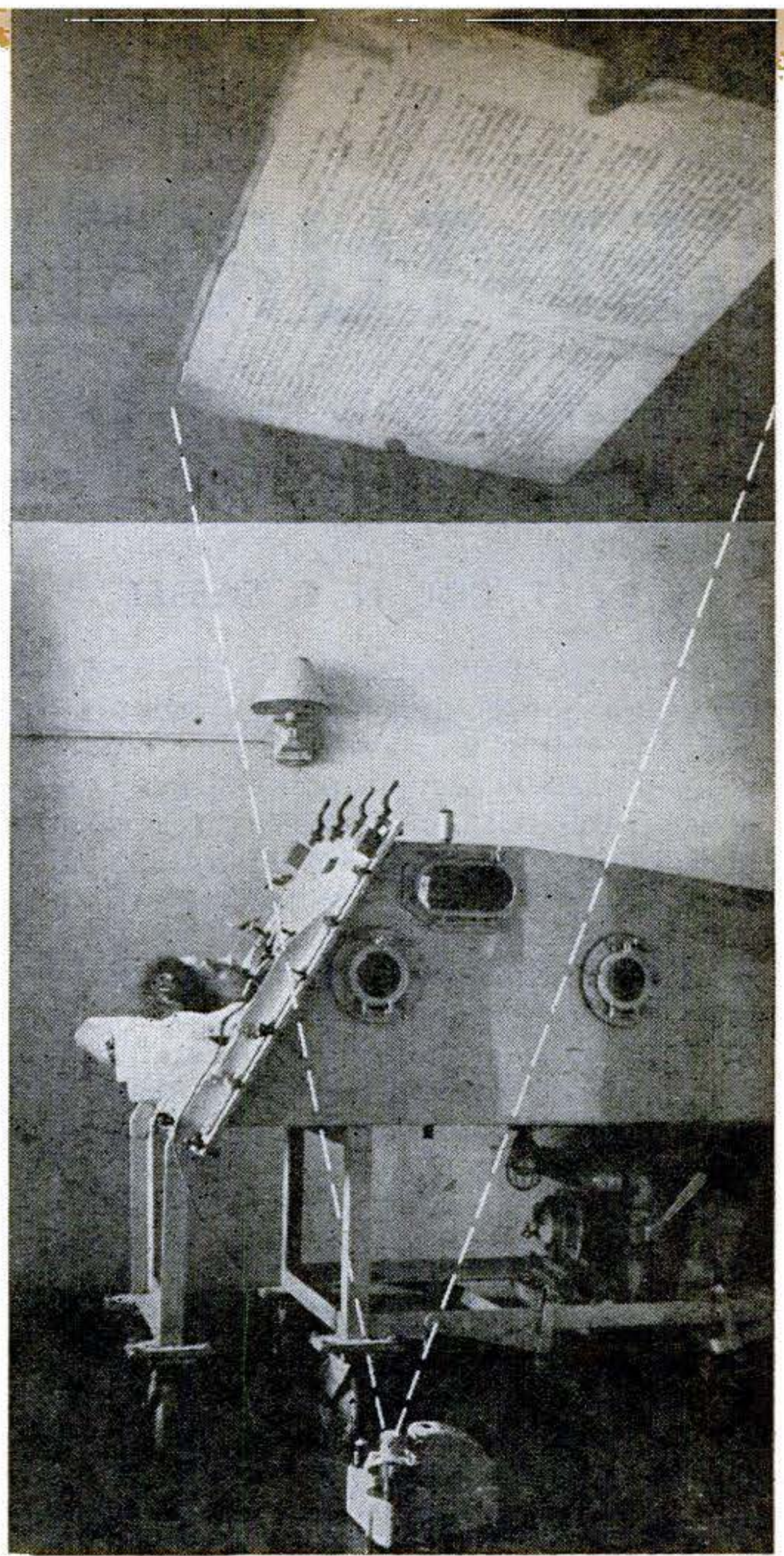




Bedridden People Can Read Books Flashed on Ceiling

THE microfilm that sped V-mail to servicemen overseas is now being used for the entertainment of hospitalized veterans and other bedridden patients. Books, magazines, and comics are recorded on it. The roll is placed in a projector, and the patient reads from the ceiling, as shown at right.

The patient needs only to operate three buttons on a panel placed at his hand. The first flashes a square of light on the ceiling, the second brings the pages of a book into view progressively, and the third turns the film backward so that any page may be reread. A patient in an iron lung moves the head to either side to turn the pages forward or backward. The projector was developed by Eugene B. Power and Robert D. Howse of Ann Arbor, Mich.



Built-in Stand Makes Firm Support for Book

A STAND that is part of the front and back covers of a book forms a sturdy support, holding the volume or notebook in an upright position for reading and ready reference. Two triangular-shaped segments fold down from the covers and are locked together with a long pin, making the book appear as if it were resting on a lectern.

Invented by Hugh Pearce Botts, a New York City artist and etcher, the standing book cover will facilitate reading for convalescents, students, businessmen, and typists who are required to copy excerpts. It is also expected to find wide use on books specially bound for libraries.

JET-TURBINE PLANES

Something new has been added to the jet engine: propeller drive that gives top efficiency at any speed or altitude.

By LT. COL. N. F. SILSBEE

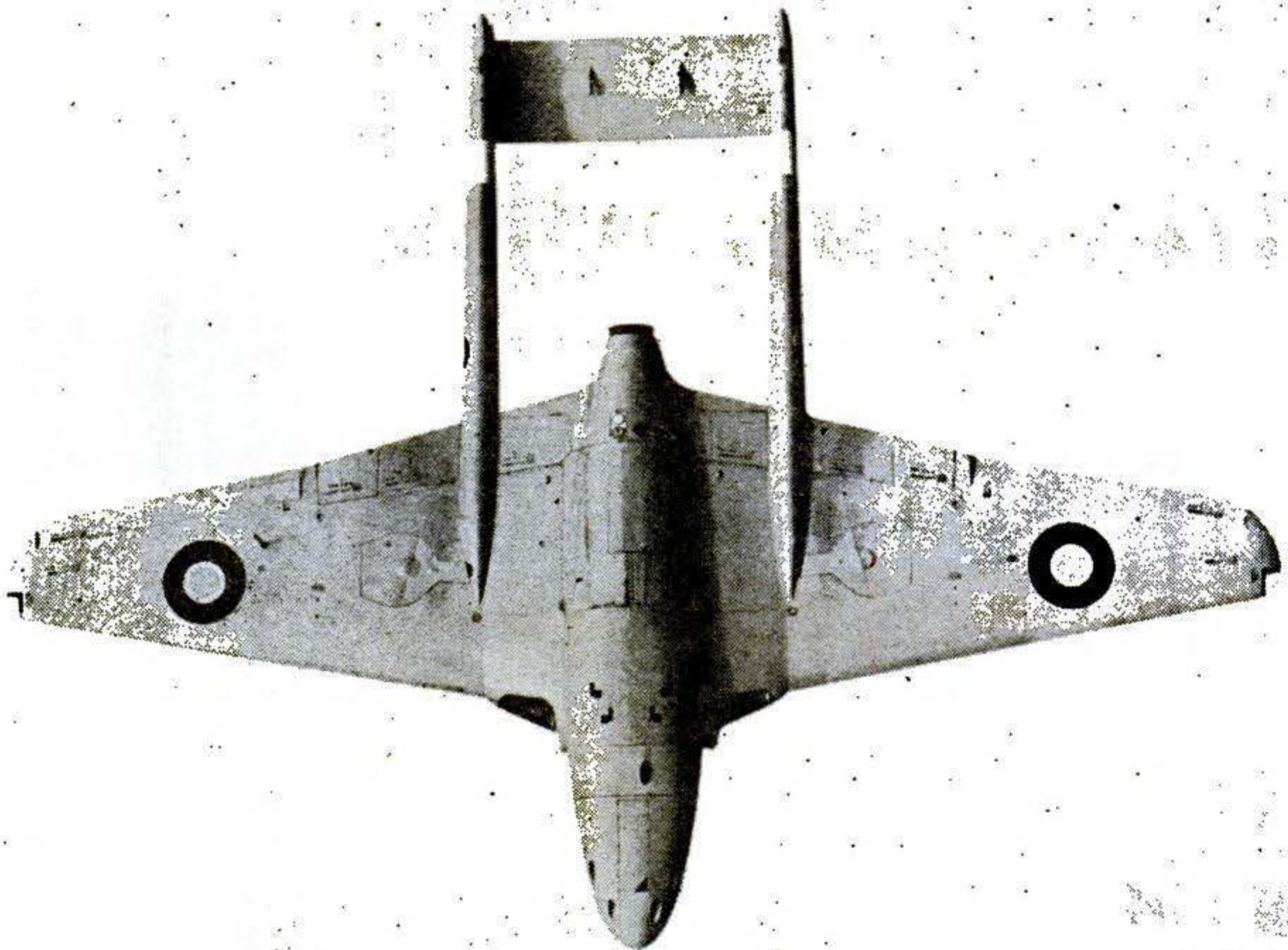
ENGINES that deliver both jet and propeller power have been developed behind the veil of wartime secrecy. While the atom smashers were tapping a new source of heat, the aviation engineers were seeking new, more efficient means of using heat to fly airplanes—and their discoveries can be used immediately.

Already, the new-type engine's performance is being evaluated in an experimental AAF plane soon to be test-flown. This airplane differs from all others in that a gas turbine both pulls and pushes it through the air. The P-80 Shooting Star and the British Vampire are merely jet planes. The Ryan FR-1 Fireball has a conventional engine in its nose and a jet engine in its tail. The new fighter has a gas turbine that twirls a prop in the nose and a turbo-jet engine that emits a jet in its tail.

Jet propulsion is such a momentous development that May 14, 1941, the date the first British jet fighter flew, already ranks second in importance in aviation history only to December 17, 1903, the date of the Wright brothers' first flight. That fighter had a W-1 turbo-jet, designed by Frank Whittle, and was built by Power Jets, Ltd. It proved that, at long last, airplane speeds were high enough, heat-resistant alloys were good enough, and the installed weight of power units plus fuel was low enough to permit the gas turbine's use in aircraft.

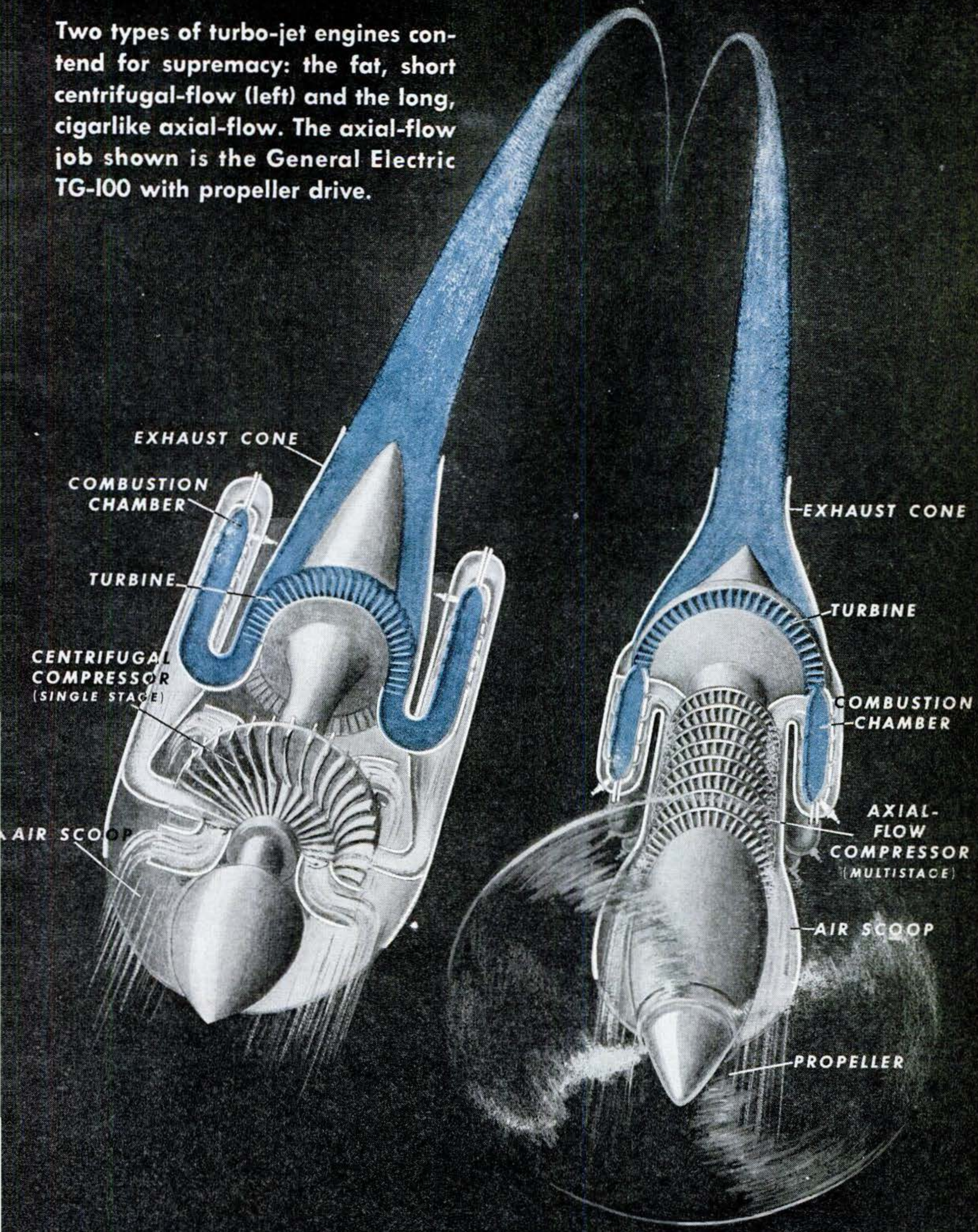
The turbo-jet engine, as is now well known, operates by pulling in air, compressing it, and adding heat at high pressure. Some of the energy resulting from the expansion of the combustion products turns the turbine that drives the compressor; the rest can be ejected through a nozzle at high velocities. The reaction to this high-power discharge of *(Continued on page 78)*

THE VAMPIRE, British jet fighter, has a normal top speed of 540 m.p.h. with full military load. It is powered by a De Havilland Goblin turbo-jet engine with a single-sided impeller and "straight-through" combustion, rated at 3,000 pounds' thrust. Top speed can be maintained from 10,000 to 25,000 feet.

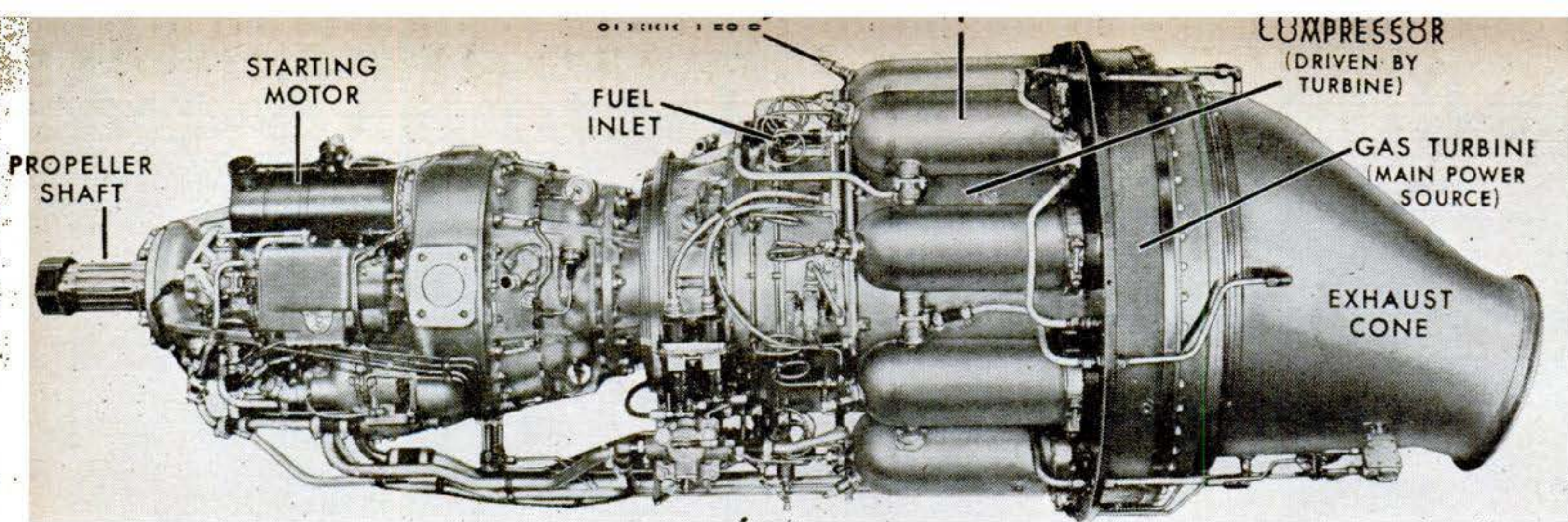


THE RACE OF THE TURBO-JETS

Two types of turbo-jet engines contend for supremacy: the fat, short centrifugal-flow (left) and the long, cigarlike axial-flow. The axial-flow job shown is the General Electric TG-100 with propeller drive.



Stanley Bate



PROPELLER AND JET drive are combined in General Electric's TG-100, soon to be flight-tested in an experimental AAF fighter, which also has a regular jet engine in the tail. Combination of jet and propeller drive in the same plane is expected to give efficient operation at all speeds and altitudes. Engines of this type may be widely used to power the huge transport planes of the future.

such a jet will thrust an airplane forward.

Such turbo-jets differ from rocket engines (P.S.M., May '45, p. 70) in that they rely on the atmosphere rather than their fuel supply for oxygen. They are most efficient at very high speeds and altitudes. At low speeds and altitudes, too much of their thrust power is needed to turn the turbine which pulls in and compresses the air. By using two gas turbines, however, one to emit a jet and the other to turn a propeller, aircraft can be operated efficiently at either high or low speeds and altitudes. "The gas turbine," says Dr. Jerome S. Hunsaker, head of the department of aeronautical and mechanical engineering at Massachusetts Institute of Technology and chairman of the National Advisory Committee for Aeronautics, "gives evidence of being the next step in the evolution of power plants, comparable in its effect on technology to that of the steam turbine at the turn of the century."

There are two important types of turbo-jet engines, operating on the same fundamental principles but differing in the arrangement of the essential parts. One type is the *centrifugal-flow* turbo-jet, and the other is the *axial-flow* turbo-jet. The difference is somewhat analogous to that between conventional radial and in-line re-

ciprocating engines. A centrifugal-flow turbo-jet is likely to be short and fat like a drum, whereas an axial-flow engine may be long and thin like a cigar.

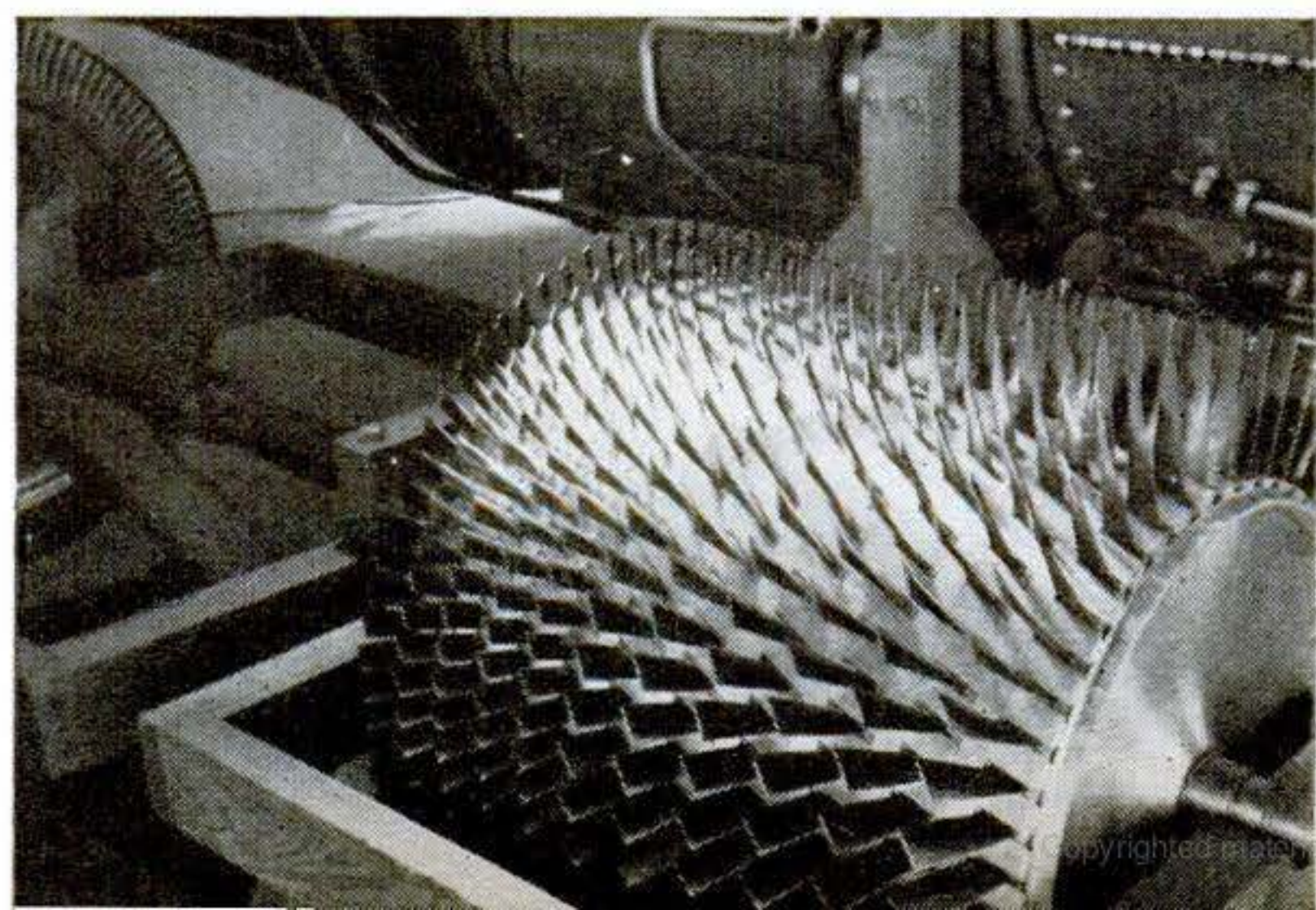
Centrifugal-flow engines, based on Captain Whittle's original conception, pull the air in near the center and whirl it out toward the ends of the compressor blades. The rear casing of the air compressor may have seven, ten or more symmetrical channels radiating outward, depending on the number of combustion chambers. These channels distribute the air to the chambers where it is mixed with the fuel.

In the axial-flow engines, on the other hand, the air flows straight through the five essential parts of a turbo-jet: (1) intake duct, (2) compressor, (3) combustion chamber, (4) turbine, and (5) exhaust nozzle. These parts are arranged in a straight line in axial-flow engines, and compression is obtained by the action of several sets of blades rather than by the single-stage action usually found with centrifugal flow.

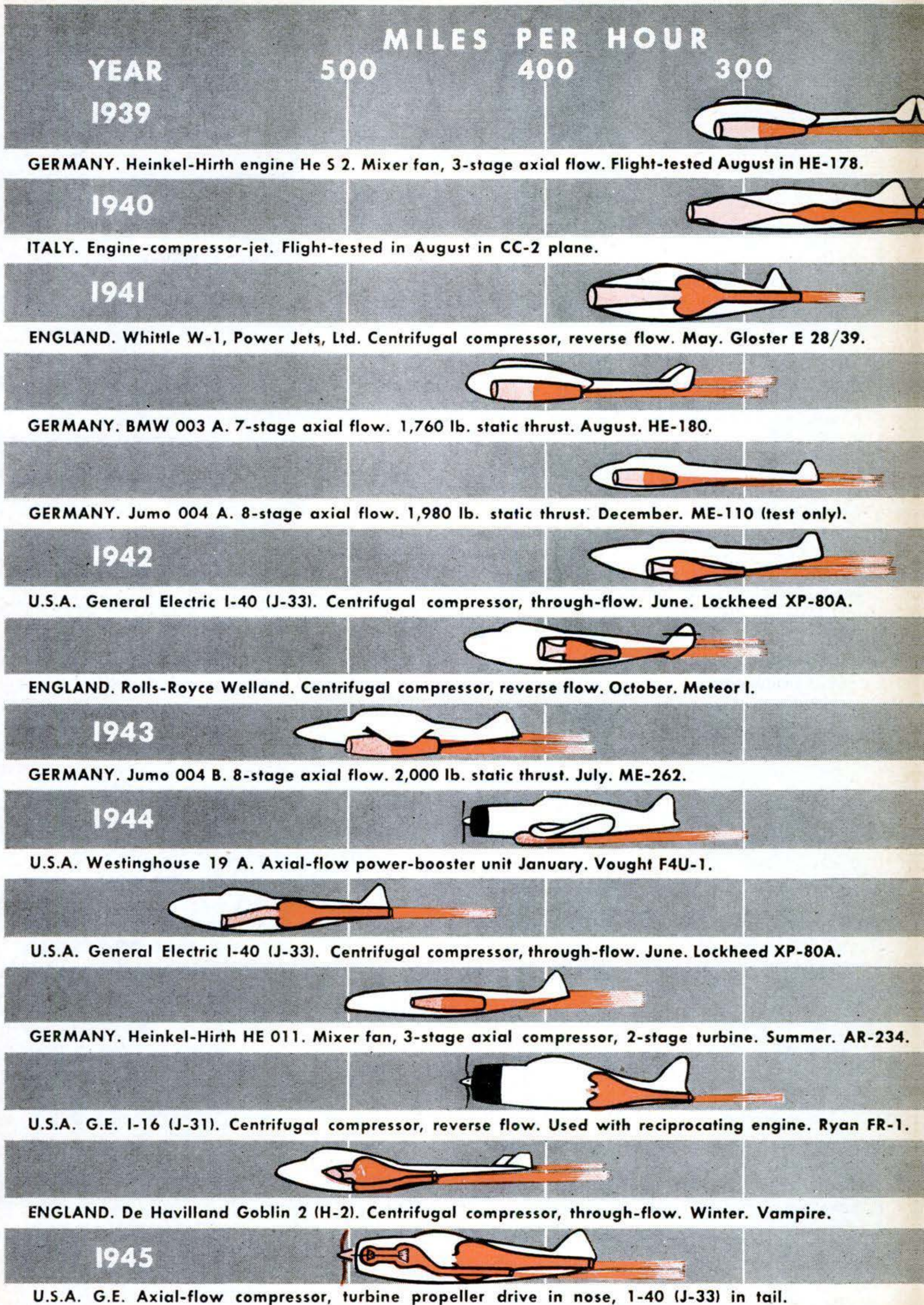
Advocates of centrifugal-flow engines rightly contend that greater power per pound of the engine weight has been obtained thus far from engines of this type than from axial-flow engines. The latter, however, being smaller in diameter, are cleaner aerody- *(Continued on page 234)*

Rear view of the General Electric I-40 (J-33) centrifugal-flow turbo-jet that drives the P-80 Shooting Star. Note the cylindrical combustion chambers.

This is the multistage axial-flow compressor of the General Electric TG-180, the projected power plant of several experimental fighters and bombers.



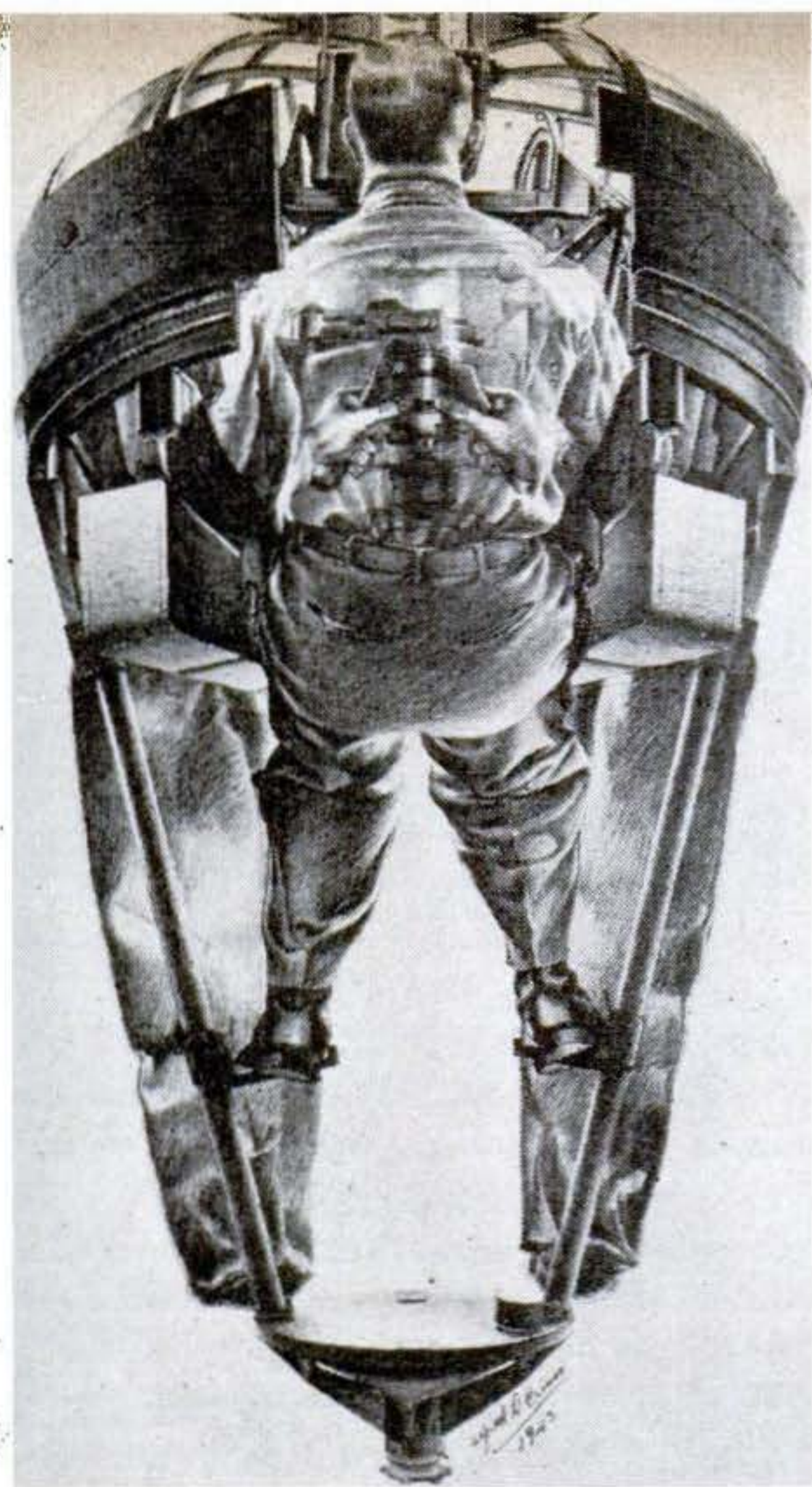
DEVELOPMENT OF TURBO-JET ENGINES



ARTIST RECORDS HOME-FRONT WAR

GUNSIGHTS, gyrocompasses, and other intricate instruments of war, together with the people at the Sperry Gyroscope Company who developed them and who helped to assemble them, are the subjects of a group of drawings and paintings by Alfred D. Crimi. Six selected specimens of his work are reproduced here. Widely known in the art world as a mural painter, Mr. Crimi imparts an individualistic technique that is particularly effective in industrial drawings because he is able to show intricate detail and more general impressions at the same time.

The artist has captured the deep concentration of operators, working with microscopes, fitting into place the tiny parts of mechanisms that were vital to victory. In other drawings he depicts massive gyrocompasses undergoing tests that compare with the actual conditions under which they are to be used. His entire series of pictures reflects the keen application of skilled hands on the home front striving continually to send the best and latest weapons to the men on the fighting fronts.



TURRET GUNNER sits in a sling, hands (seen through body) on levers, thumbs on range dial.

HIGH-ALTITUDE LABORATORY at Sperry's simulated conditions 60,000 feet up and 90 degrees below zero. Crimi depicts a typical scene in the main test chamber during a "flight into the stratosphere."





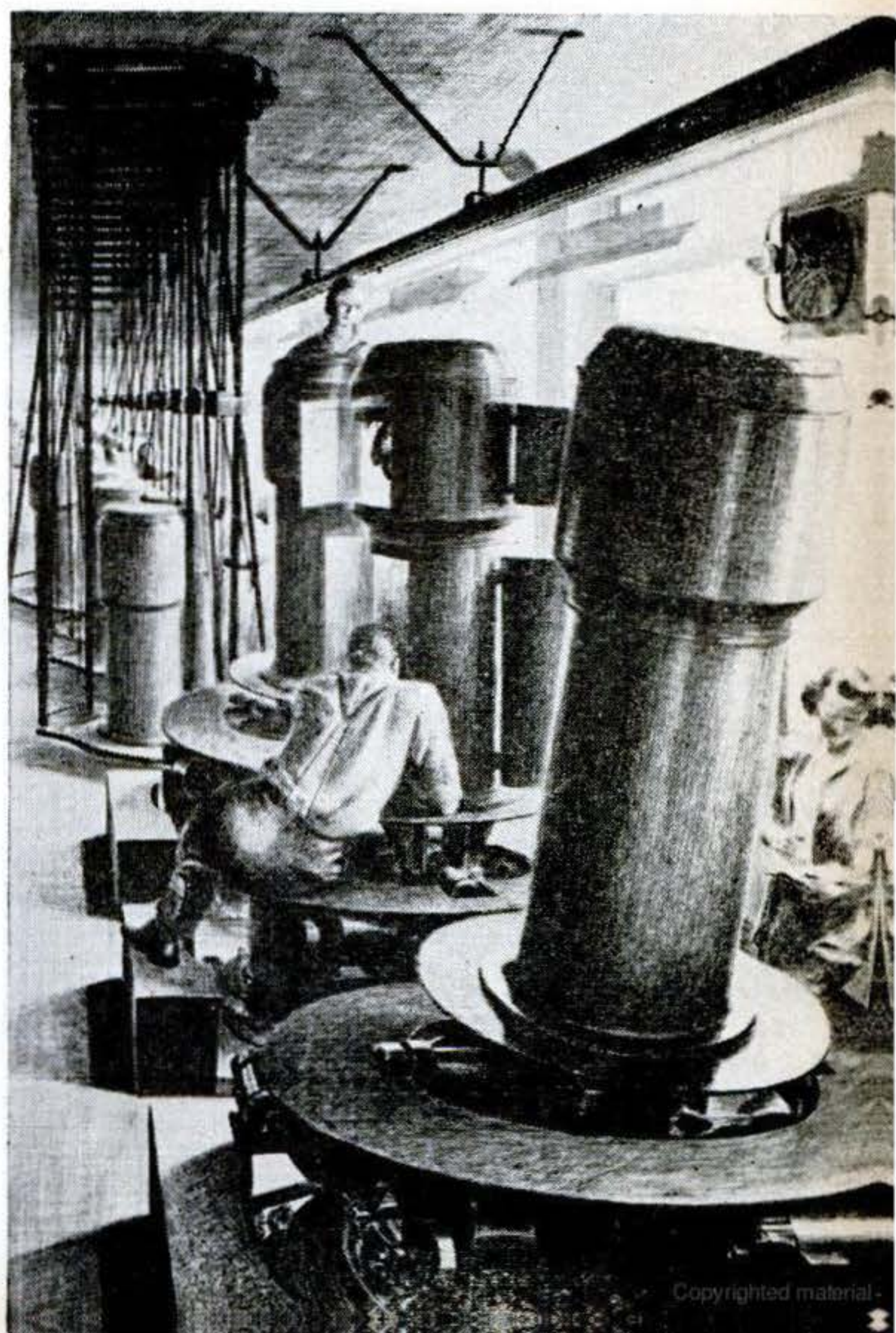
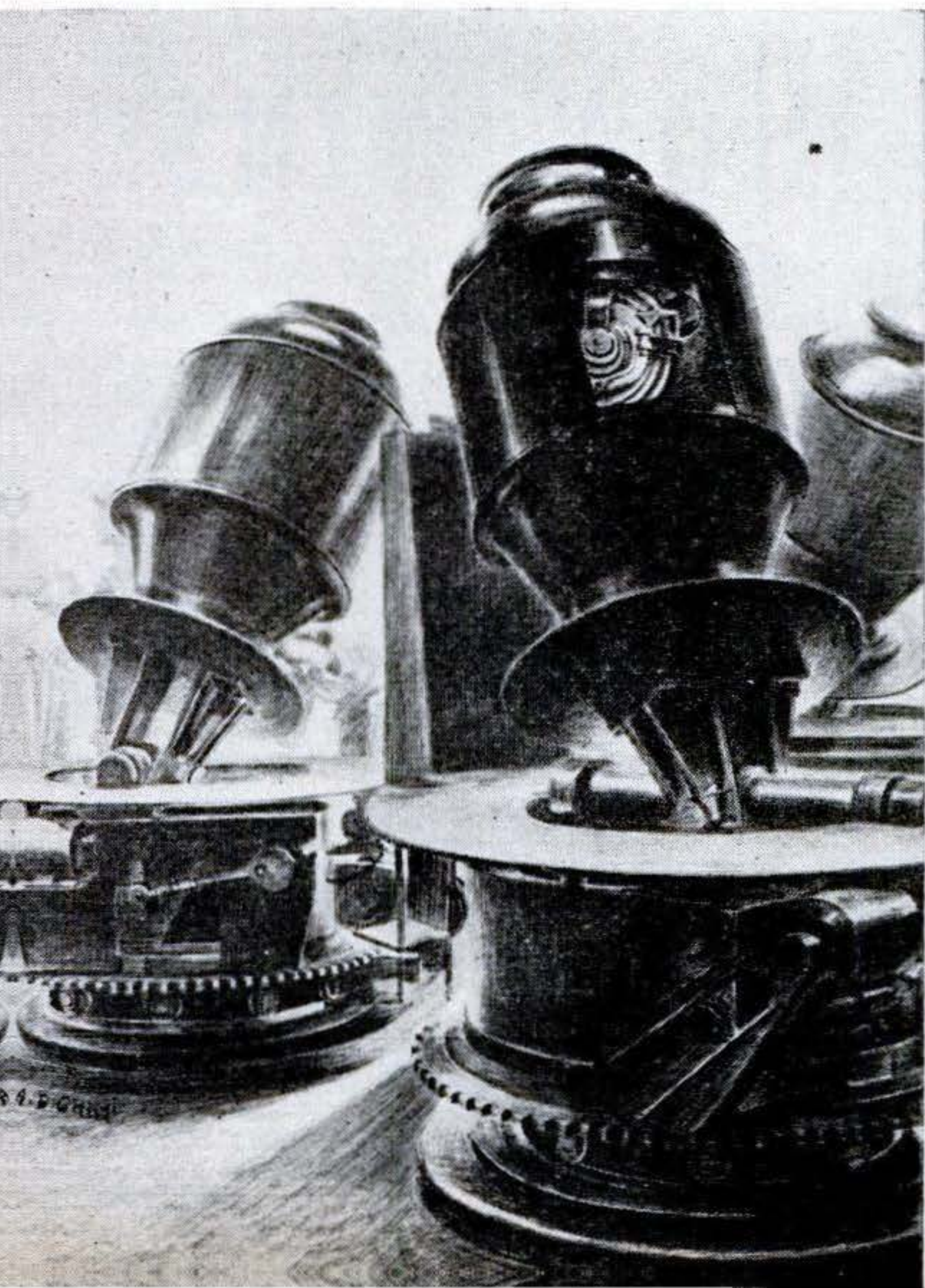
ASSEMBLY LINE of a Navy gunsight, where rigid adjustment is made on the sight's optical alignment.

GIANT GYROCOMPASSES getting the Scorsby test, which simulates roll, pitch, and yaw of ship at sea.



RANGE SPRINGS for the sight are set under a microscope. A study in patience and concentration.

"INVASION" COMPASSES for landing craft get the Scorsby and, in the background, swing test.





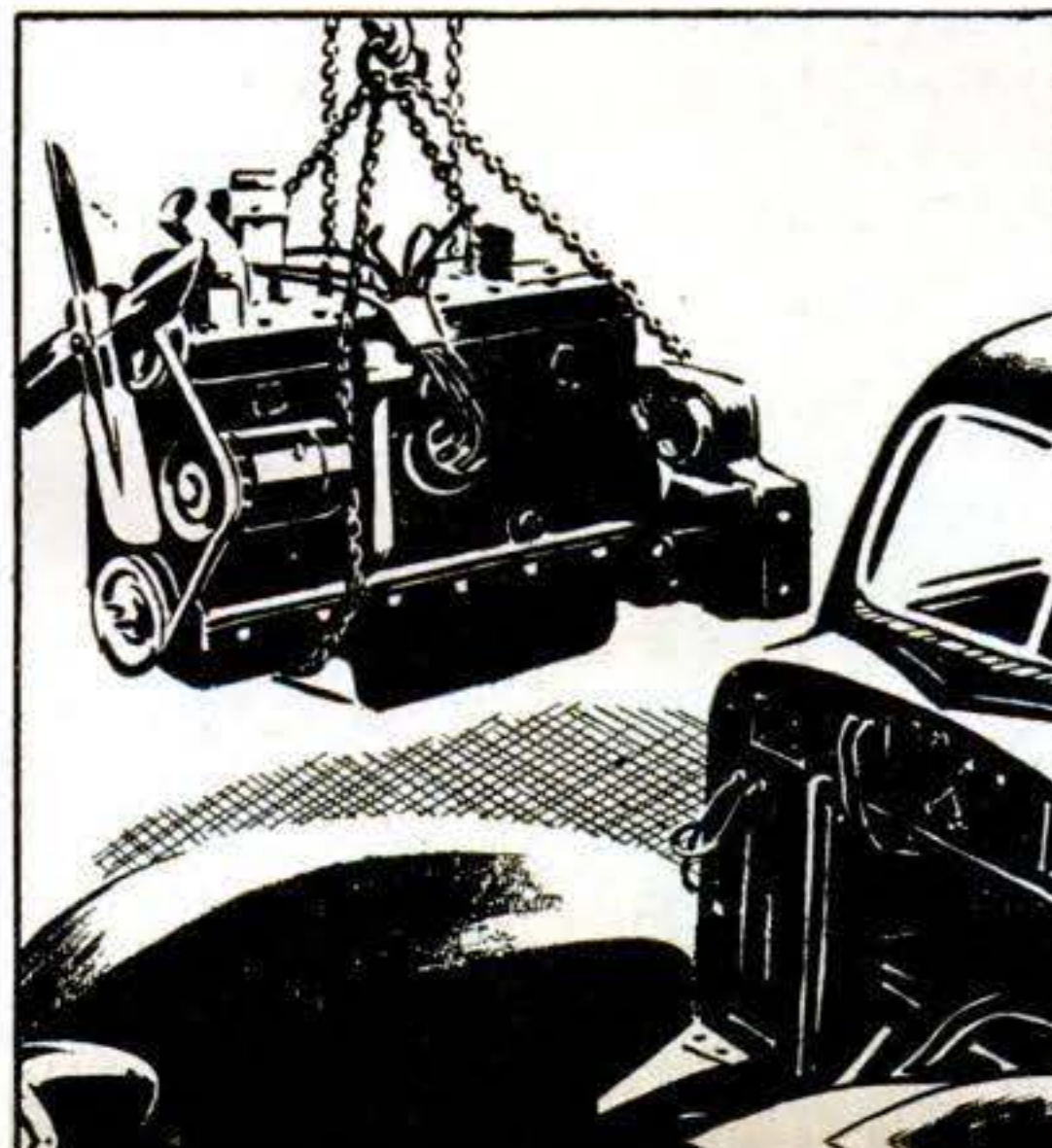
Former Lt. Burl D. Harrison (left) and ex-Maj. Edgar D. Yule, founders of Yule Industries, Inc., were both wounded in battle. The African campaign cost Harrison a leg; Yule wears a metal cap where a bullet shattered his skull.

ARMY KNOW-HOW WINS

Combining grit and git-up with some tricks they learned in the service, these disabled veterans started a successful motor-maintenance business.

CUSTOMARY METHOD LAYS UP TRUCK DURING MOTOR REPAIRS . . .

In the conventional way of major motor overhaul a heavy-duty freight truck is left standing idle while garage mechanics make the necessary repairs. This method is costly to owners of fleets of trucks because it not only ties up the vehicle in the shop, but often necessitates sending another truck and transferring the freight load.





IN THE OFFICE. Yule, whose left side is still paralyzed as a result of his war injury, directs the company's activities. He was formerly sales manager of a truck firm.



IN THE SHOP. Harrison checks a cylinder block that has been reground. Despite his artificial leg, he is able to oversee and help with the shop's work.

By **ROBERT K. LEAVITT**

Photographs by **WILLIAM W. MORRIS**

ONE year ago a couple of cracked-up veterans in the Army's Percy Jones General Hospital spent much time projecting the kind of business *they* would start, when, as, and if they ever got to be operational again. Today that business is running, brisk as you please, in Quincy, Mass.

The story of how these two bunged-up men started a business concern while they were still so shaky they had to hold each other up, how they did it on very limited capital, how they surmounted difficulties that would have stumped an able-bodied

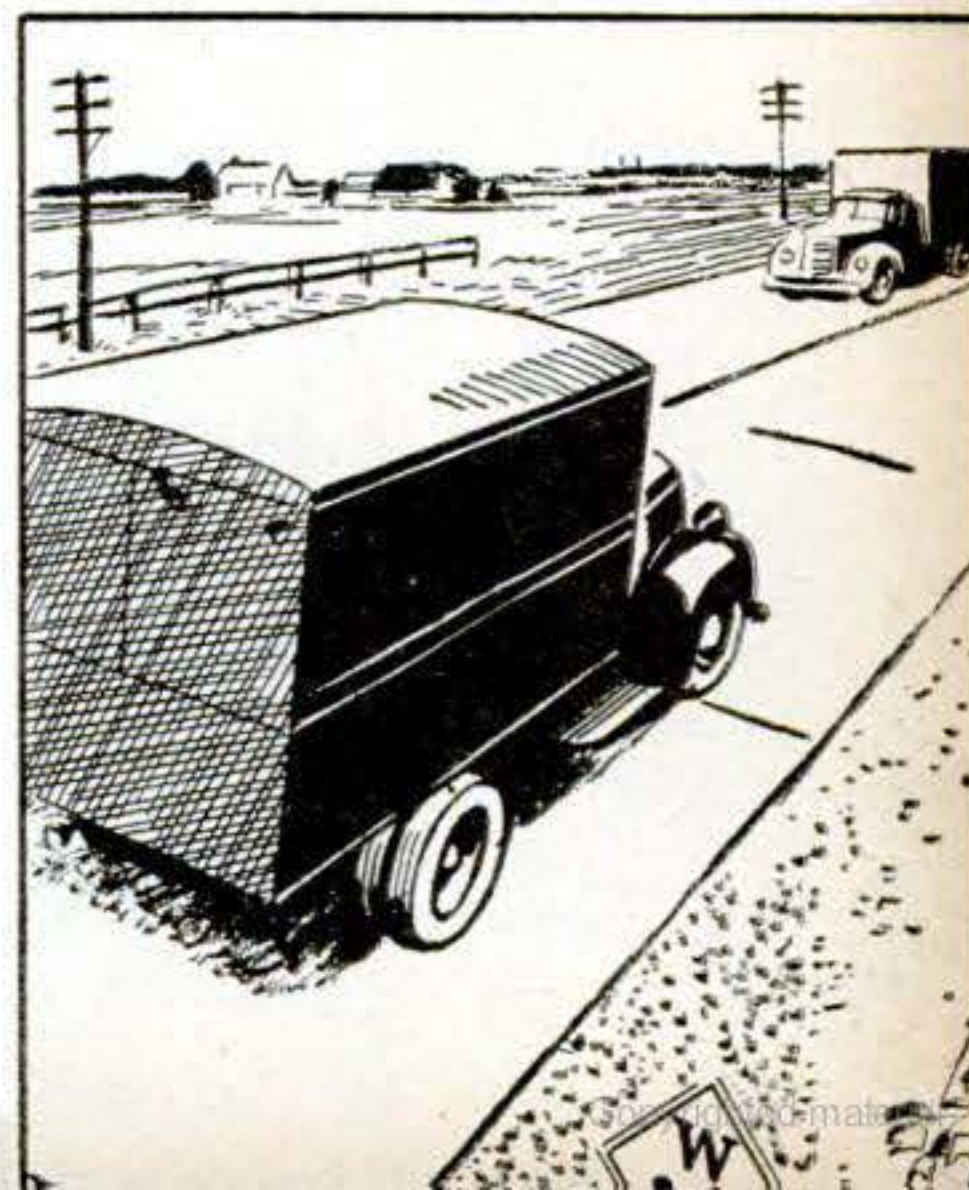
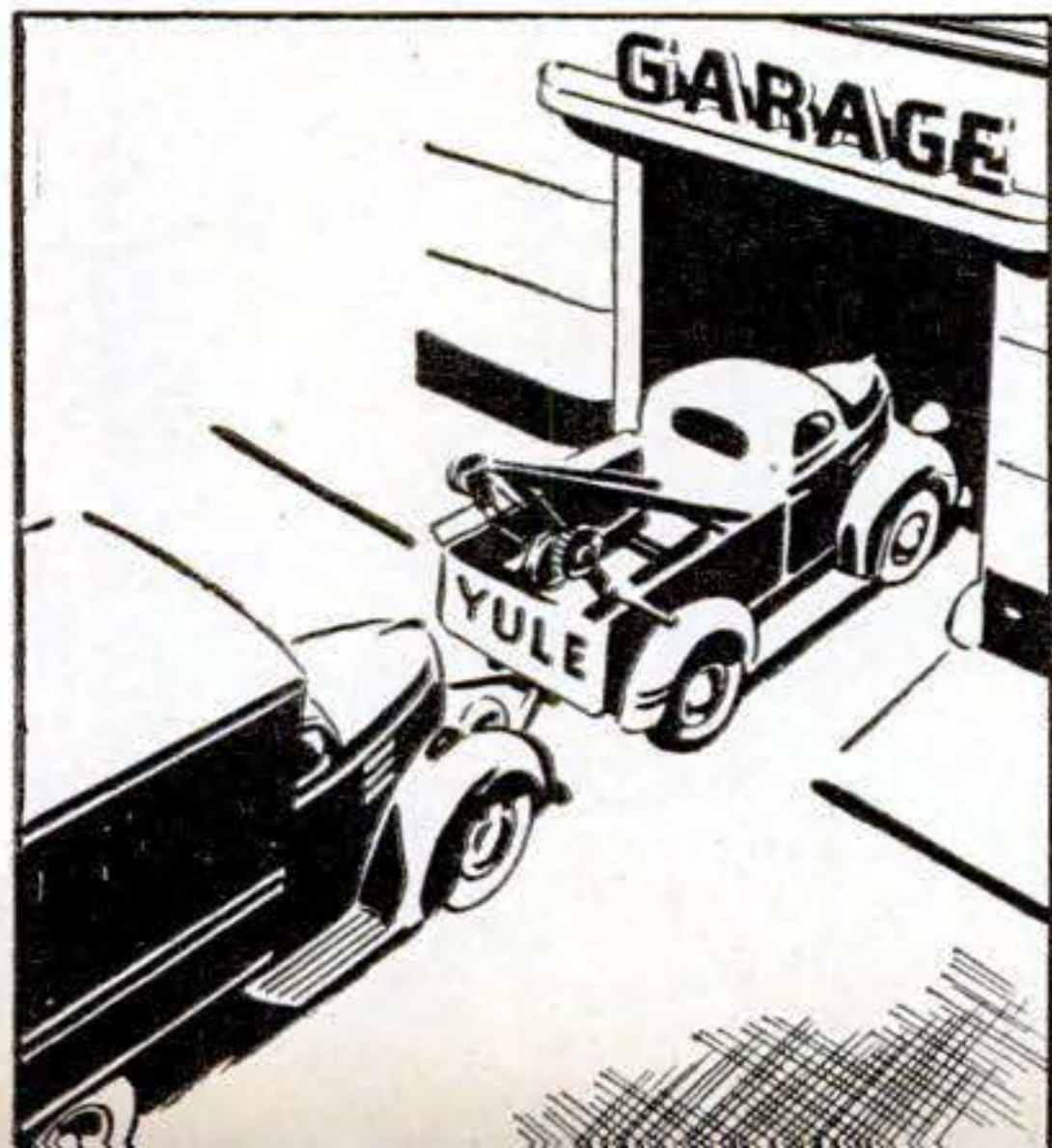
citizen, and how they have now turned the corner is one of grit, git-up, and know-how. And by no means the least is know-how. These two boys are smart apples.

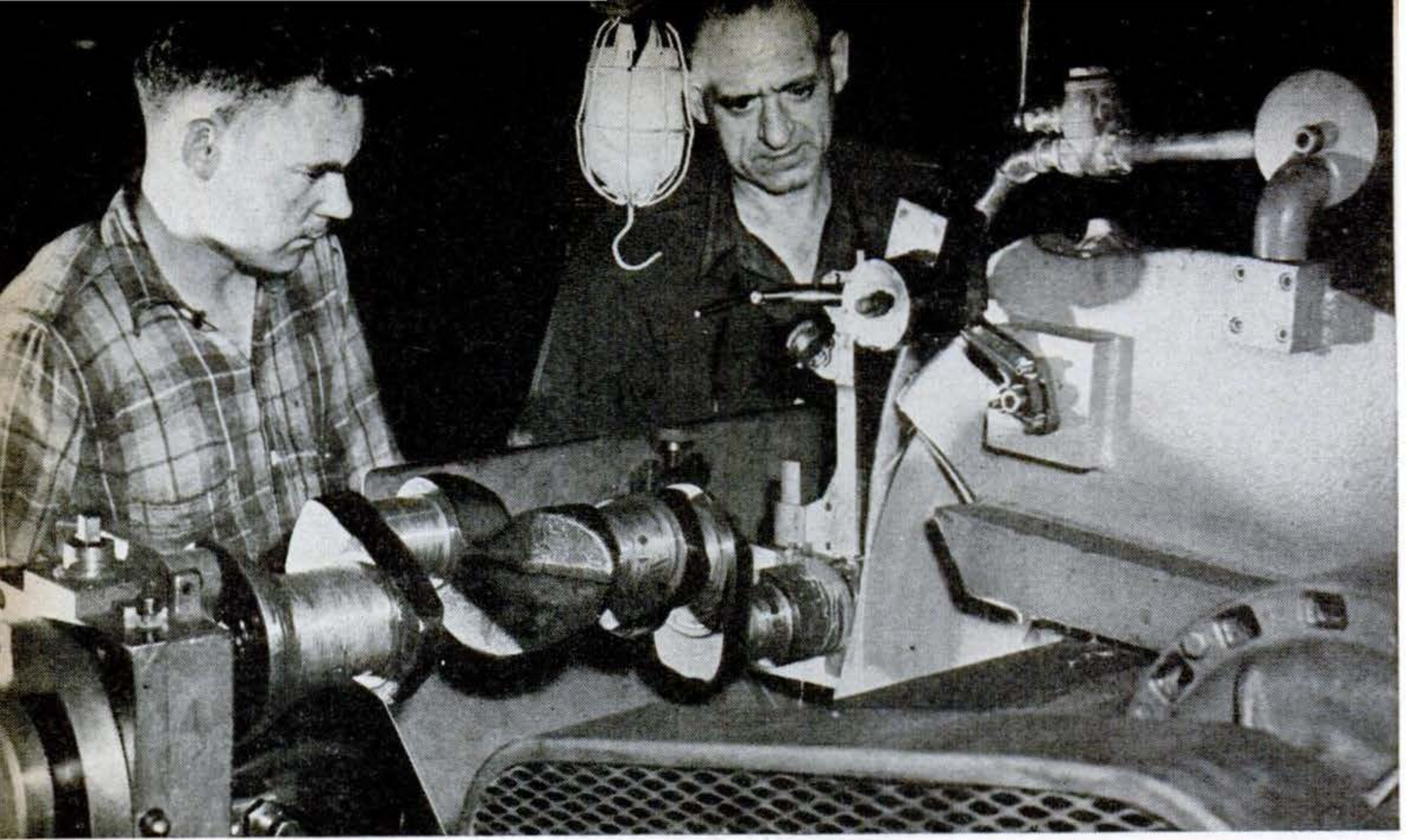
Step up and meet them:

Edgar D. Yule has a brainpan that is mostly metal—put in by surgeons to replace bone shattered in a line-of-duty accident. He walks with a cane, and his left side is still partly paralyzed. During the war he was Major Yule, running a top-efficiency ordnance motor-maintenance shop that "kept 'em rolling" for outfits in the Sixth Service Command. Before that, he had been a successful sales and service executive in the truck end of the busy automotive business around metropolitan Boston. He's still

YULE SYSTEM KEEPS TRUCK ON ROAD WITH MOTOR REPLACEMENT

Under the Yule system, the pattern of Army Ordnance Maintenance is followed. A broken-down truck is towed into the garage, where its engine is disconnected and lifted out intact. A rebuilt engine is immediately installed, and the truck goes right back on the road. The damaged motor is rebuilt and held for the next emergency.





Skilled mechanic (right) instructs J. F. McKeever, an ex-GI, in crankshaft grinding at Yule Industries, Inc.

a success in this highly competitive line.

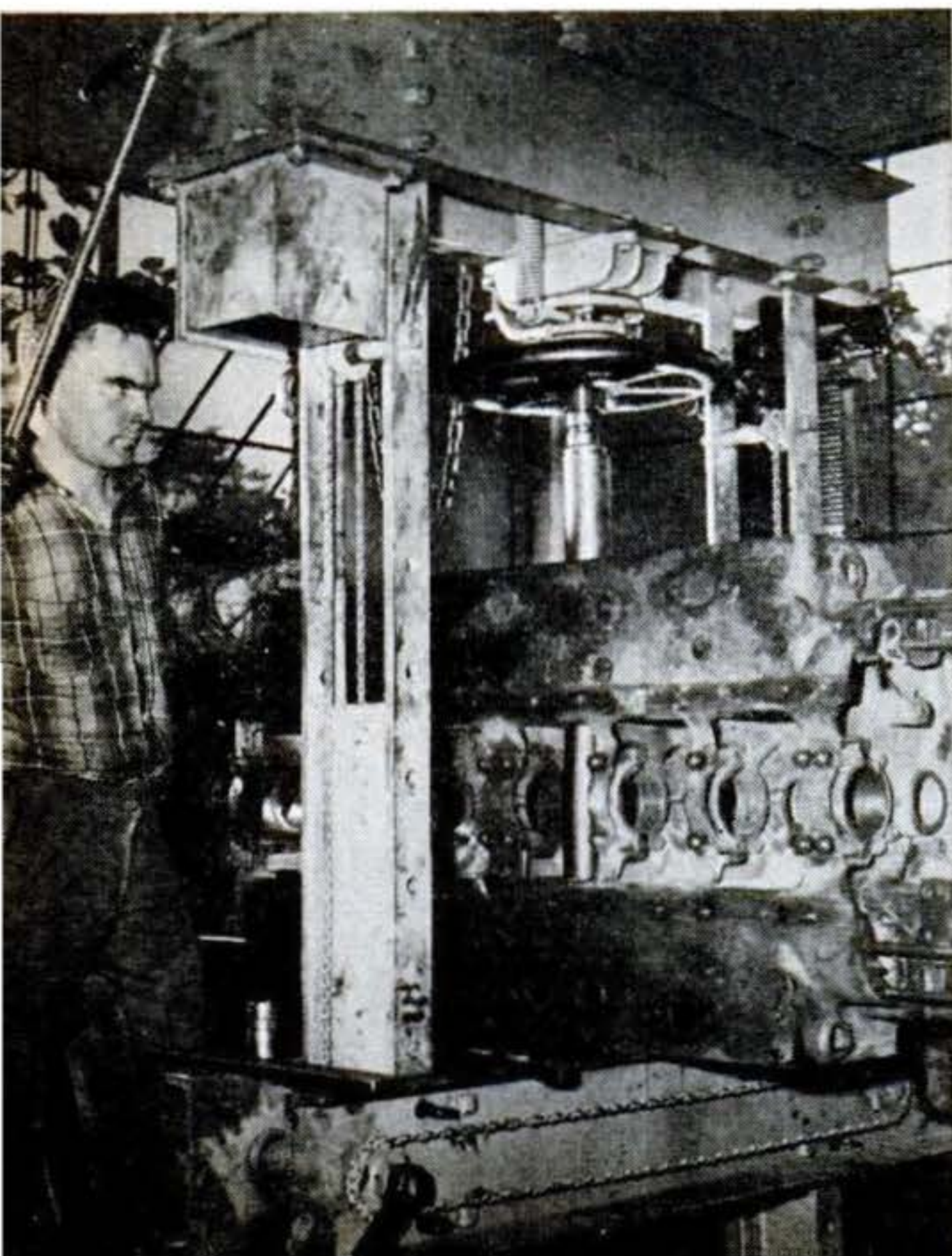
Burl D. Harrison is minus a leg. The Krauts shot part of it off in North Africa and amputated some more when they took the wounded Lieutenant Harrison prisoner. He had been commander of a mechanized-cavalry reconnaissance unit. Before the war he was a chemical engineer, mechanical engineer, and metallurgist.

The war taught these two—as it taught millions of other Yanks—that there's no such

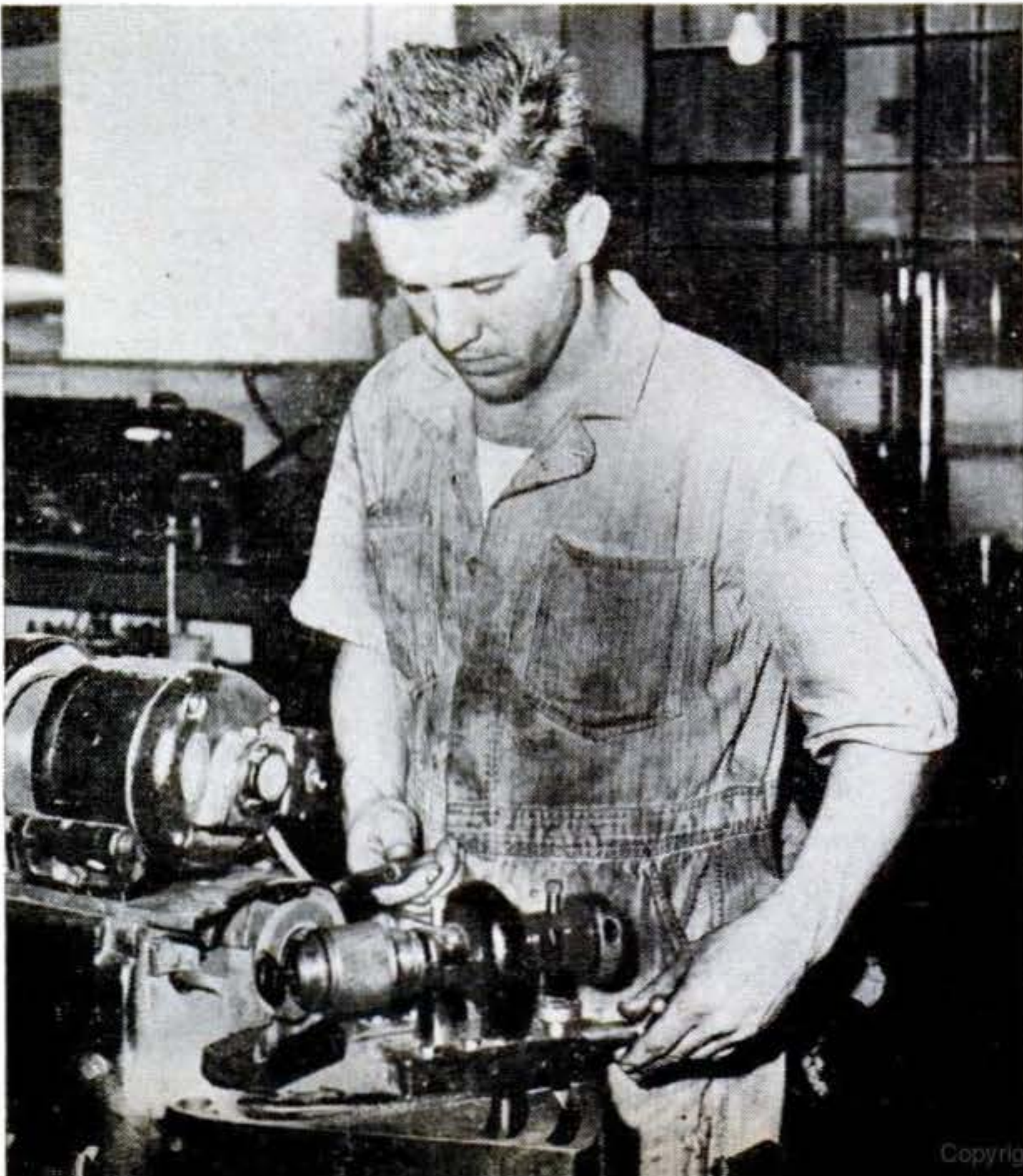
thing as being licked. It taught them the science of organization and the art of leadership. Further, it gave them both firsthand experience with one of the really big accomplishments of the Army: motor maintenance. Harrison depended on ordnance outfits that kept his vehicles moving. Yule ran the kind of outfit that did this job.

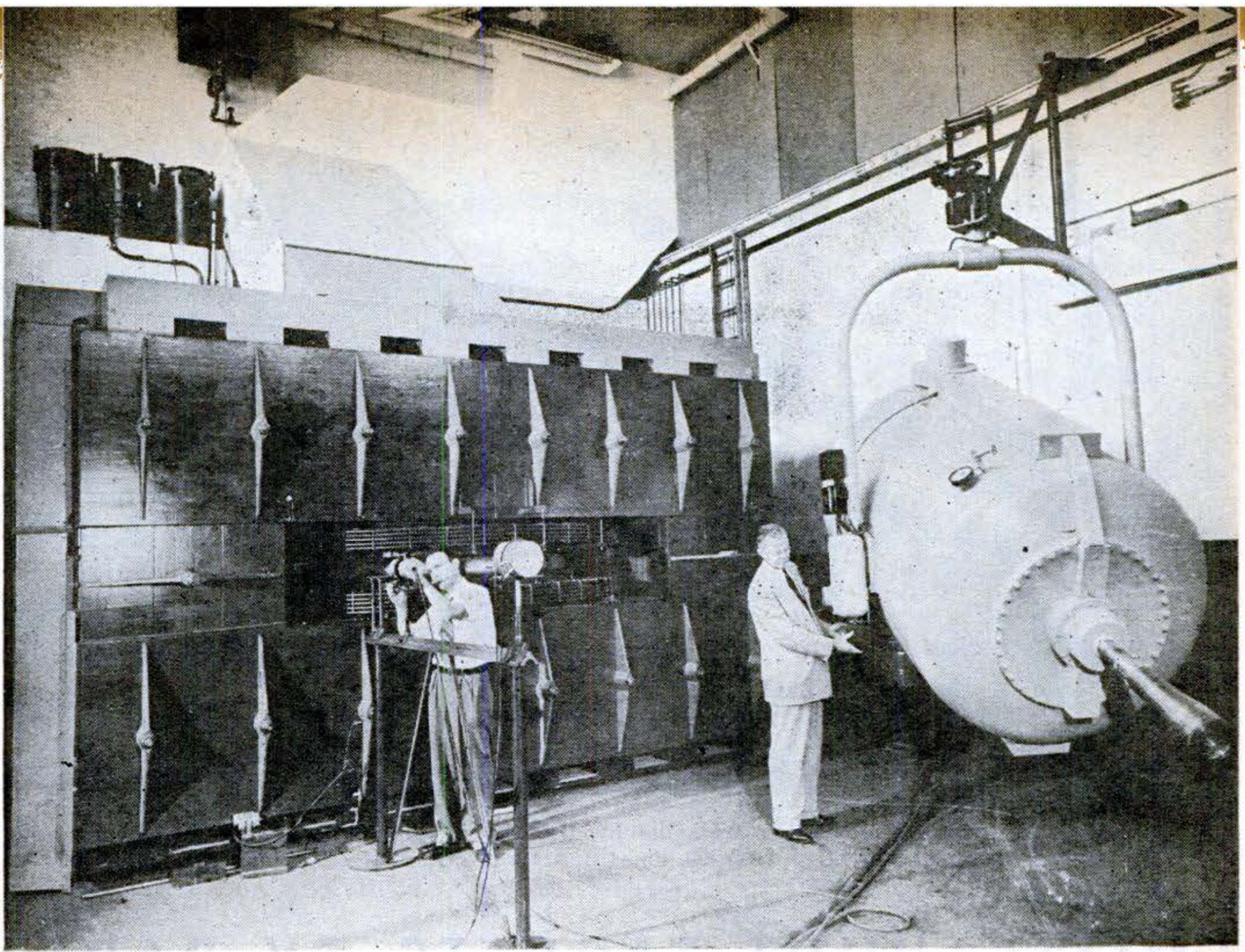
Now, the essence of Army Ordnance Maintenance is to keep vehicles moving by a process that *(Continued on page 210)*

Here McKeever is pressing sleeves out of a cylinder block of a motor. This is ordinarily a factory job.



Aldo DeGrasse, former Navy seaman, starts as apprentice valve grinder. Yule men are schooled in the shop.





Super X-Ray Machine Develops 100,000,000 Volts

ELECTRONS will be speeded to energies of 100,000,000 volts, producing X rays of the same power, in a machine developed by General Electric scientists and engineers at Schenectady, N. Y. Fifteen feet long, nine

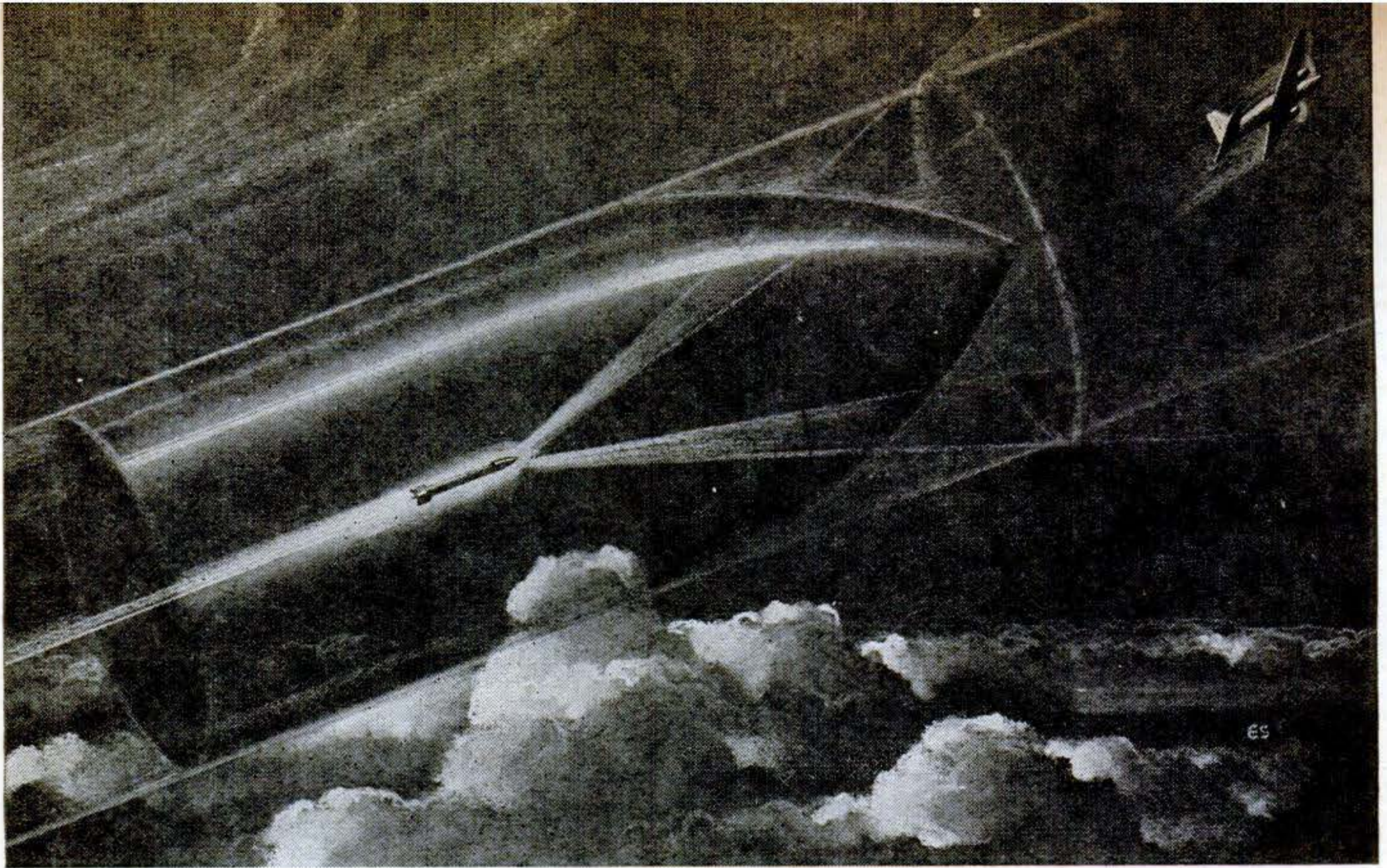
feet high, and six feet thick, the super X-ray machine contains a huge electromagnet, between whose poles there is a doughnut-shaped glass vacuum tube in which the electrons are whirled.



Navy Bearcat Fighter Has Range of 1,500 Miles

ANOTHER cat of the famous Grumman litter of Navy fighter planes, the light, high-powered F8F Bearcat, can do more than 400

miles an hour at sea level and climb over 5,000 feet a minute. A bubble canopy gives the pilot 360-degree visibility.



Sending out invisible radio "feelers," a projectile fitted with the VT fuse will burst if it comes within 60 or 70 feet of its target. This gives it 50 times the target area of a projectile with impact fuse.

SHELLS HUNT TARGETS BY RADIO

By DEVON FRANCIS

EARLY last December, every man on a certain sector facing the Von Rundstedt "bulge" in the Ardennes suddenly was thrust into combat. Cooks, waiters, and truck drivers were called on to participate in a counterattack. The Germans had speared into the American lines, and in doing so had overrun an ammunition dump containing thousands of shells.

The counterattack succeeded. The dump was recovered intact. And the Germans, all unknowingly, sacrificed a chance to filch from the United States the secret of one of the three great scientific developments of World War II. If, in retreating, they had carted along with them just one of those thousands of shells, they would have known about the VT or "proximity" fuse, as closely guarded against enemy intelligence as the atomic bomb and radar.

So cautious had the Army and Navy been about using the VT fuse, which explodes a shell or a bomb merely by "looking at" a target, that for almost two years after its development the device had not been committed to battle use under any circumstances where the enemy could recover duds. When the "Battle of the Bulge" developed, it was decided to risk the fuse for the first time under such conditions.

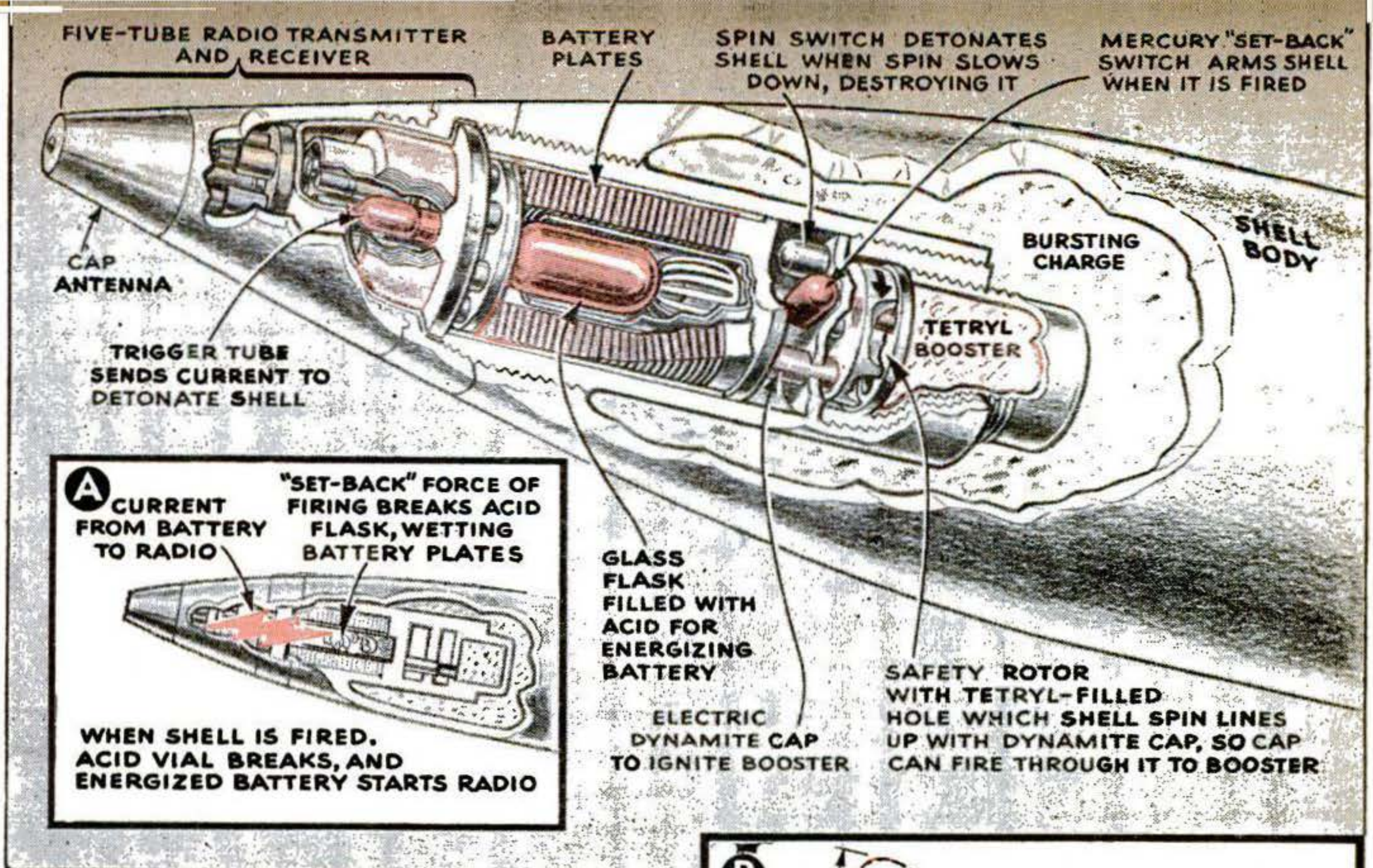
The VT (variable time) fuse is what

artillerymen the world over have wished for ever since the explosive shell was invented. When it passes within damaging distance of a target, it explodes the projectile that carries it.

Until a sultry August day in 1940, when the first handful of what was to become a home army of 80,000 persons began working on VT's, only two ways of exploding a bomb or a shell were known. It could be set off either with a fuse that started a train of detonation when it actually hit a target, or with a fuse that was timed to start working a given number of seconds or fractions of seconds after launching.

But time and impact fuses could not be relied on to give a blanket of air bursts over an enemy position at long or even medium range. An enemy soldier hidden in a trench or foxhole, or even lying flat on the ground, had a fair chance of escaping an artillery barrage unhurt. An impact-fused shell did some damage, but when it hit it shattered upward in an inverted cone. In antiaircraft fire a direct hit on a plane at long range was pure accident, so impact (or contact) fuses could not be used. Time fuses caused a great dispersion of bursts around a plane, but only a small percentage of them were close enough to do any damage.

All armies recognized the problem. Navies recognized it even more. It had begun to look as though the airplane, as a weapon



Drawings by STEWART ROUSE

Construction of proximity fuse for a rotated shell and how it operates (A) in firing, (B) in flight, (C) on receiving radio wave reflected from target, and (D) on bursting. VT fuses for rockets and bombs use three-tube instead of five-tube radio sets and get their current from windmill-driven generators.

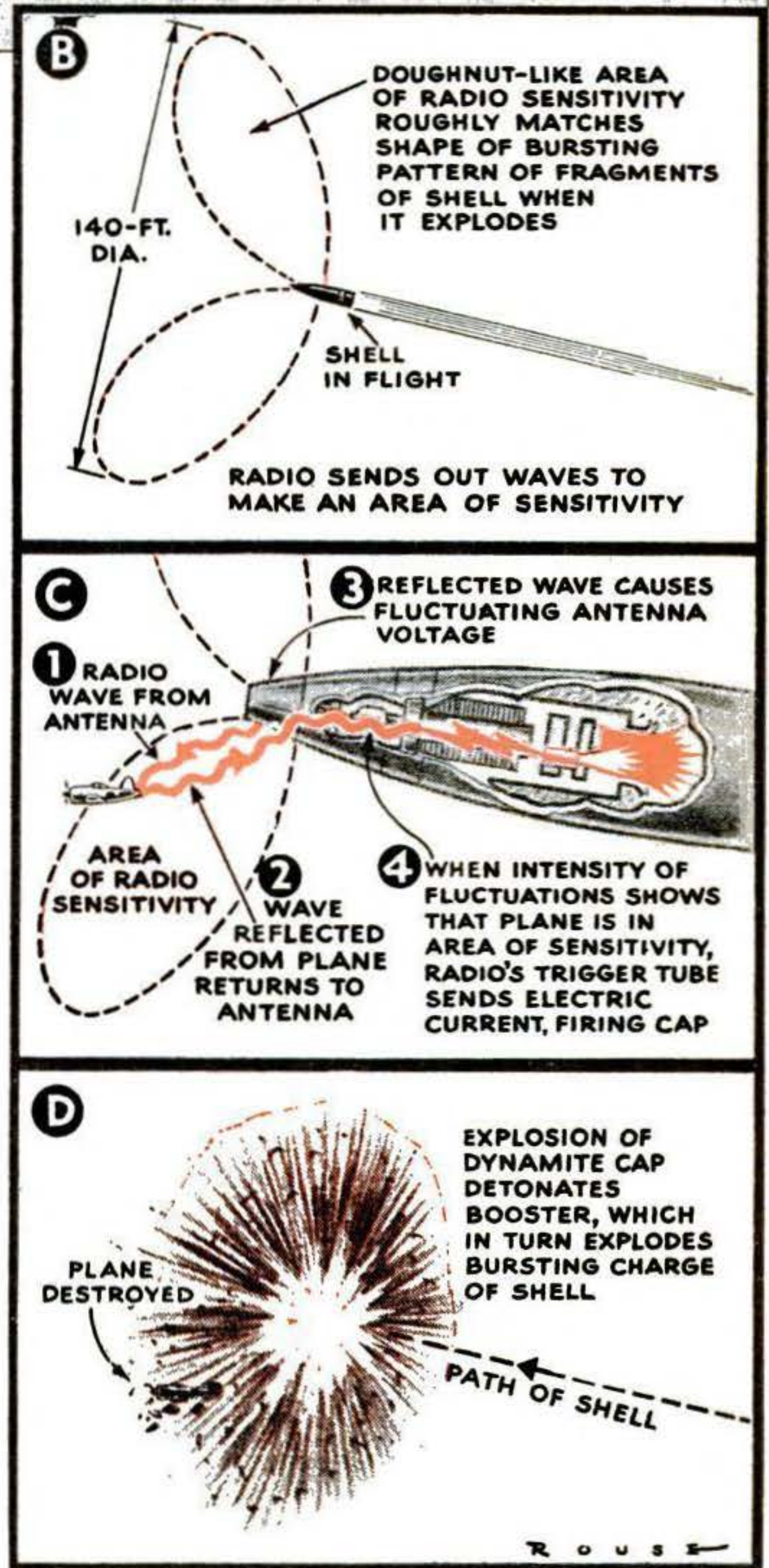
against ships, might never be coped with. Despite our firepower, could we ever bring our Navy to within effective distance of the inner core of Jap resistance without losing a prohibitive number of ships? If the Navy found a weapon to solve its problem, it would be a two-edged sword—our air forces could use it against the ground fire that plagued their operations.

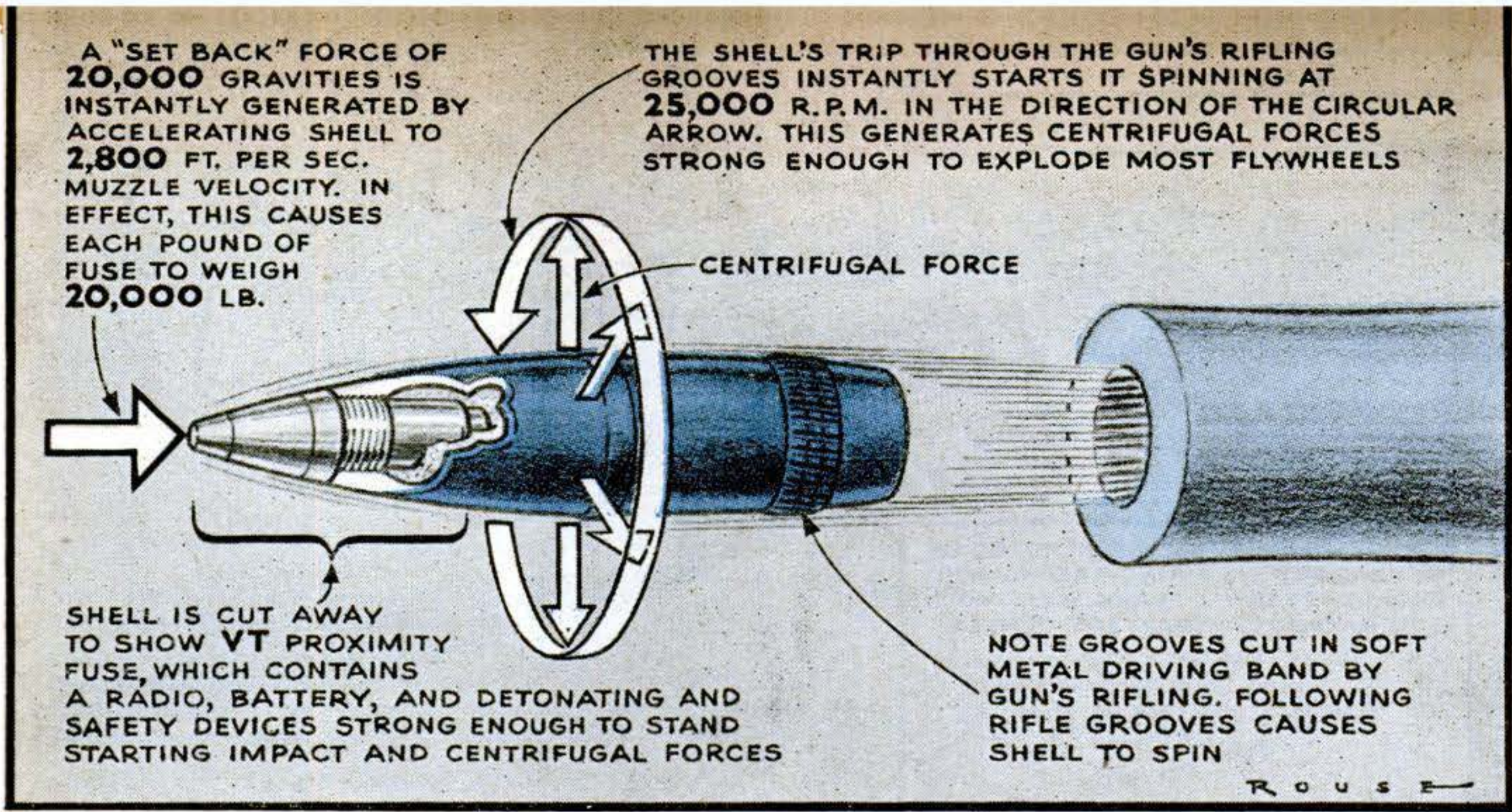
Every resource of research was applied to the problem. The detonation of an explosive container by a change in air pressure or by changes in light intensity was considered. Then someone thought of the possibility of detonation by radio wave. A radio wave travels at the speed of electricity and light, or at the rate of about $7\frac{1}{2}$ circuits of the earth in one second. That would provide sensitivity. Someone in Germany had thought of it, too. Captured German documents showed that Nazi scientists had worked on the radio-wave problem for at least 10 years and had given it up.

American and British scientists didn't give up. Less than three years from that day in 1940, radio fuses were in production. And this is their record in combat:

In the Battle of the Bulge, German prisoners trudged dejectedly rearward muttering that this new and terrible weapon of the Americans ought to be outlawed.

In the famous 80 days of V-1 bomb attacks on London, the VT fuse became so





Making tubes and other parts able to withstand the shock and centrifugal force was one of the greatest problems in developing VT fuses for rotated shells. Mortar-shell fuses were difficult because of size.

effective that defensive airplane attacks on the robots were almost abandoned in favor of straight anti-aircraft fire. In the final week of the buzz bombs, four out of every five of the missiles shot at from the ground were destroyed. No small measure of the VT fuse's success in anti-aircraft operations was due to its companion piece, the American electronic predictor (P.S.M., Sept. '44, p. 115).

In ground operations, the VT swept Rhine bridges clear of enemy troops like a broom, yet left the bridges themselves intact. It

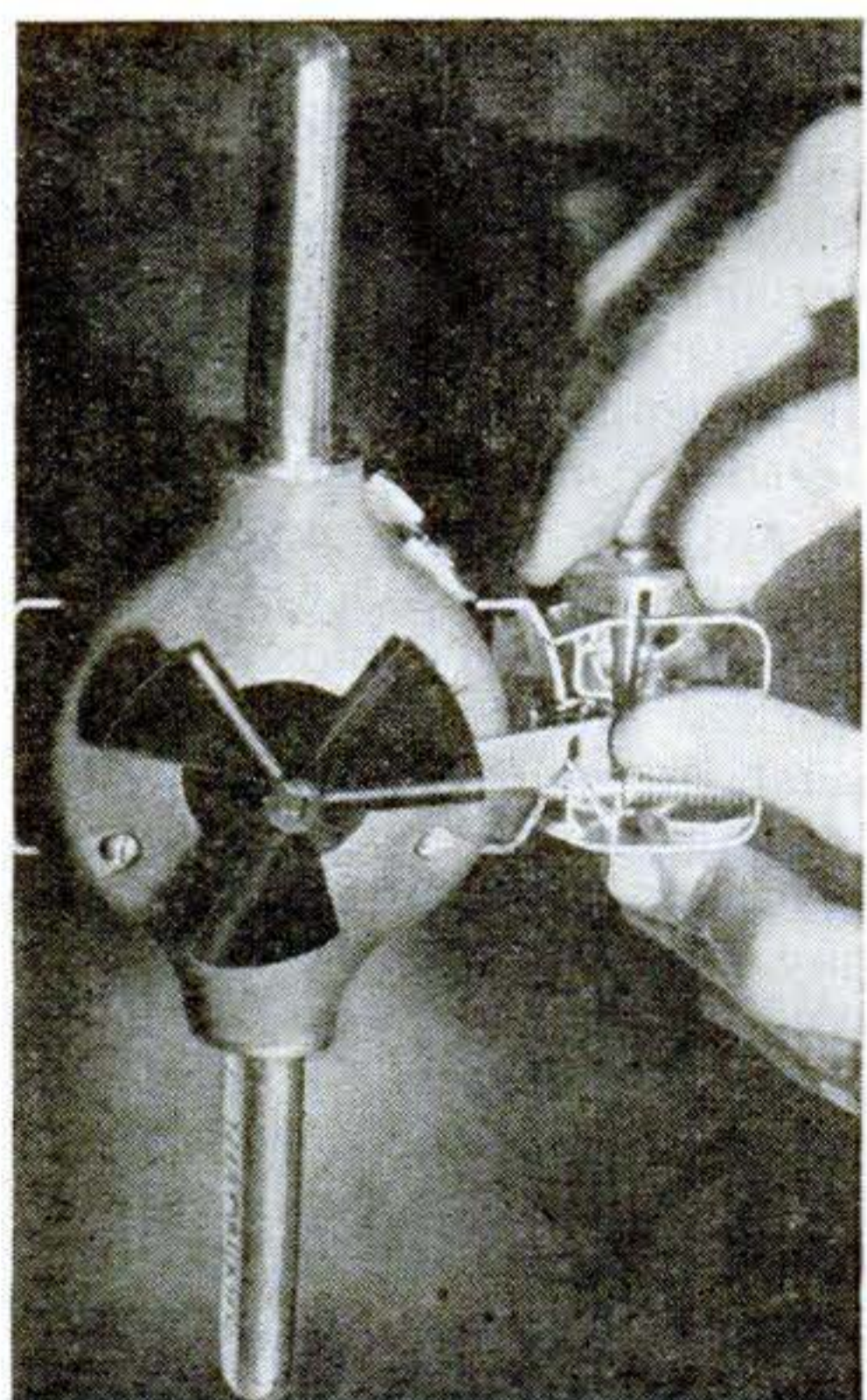
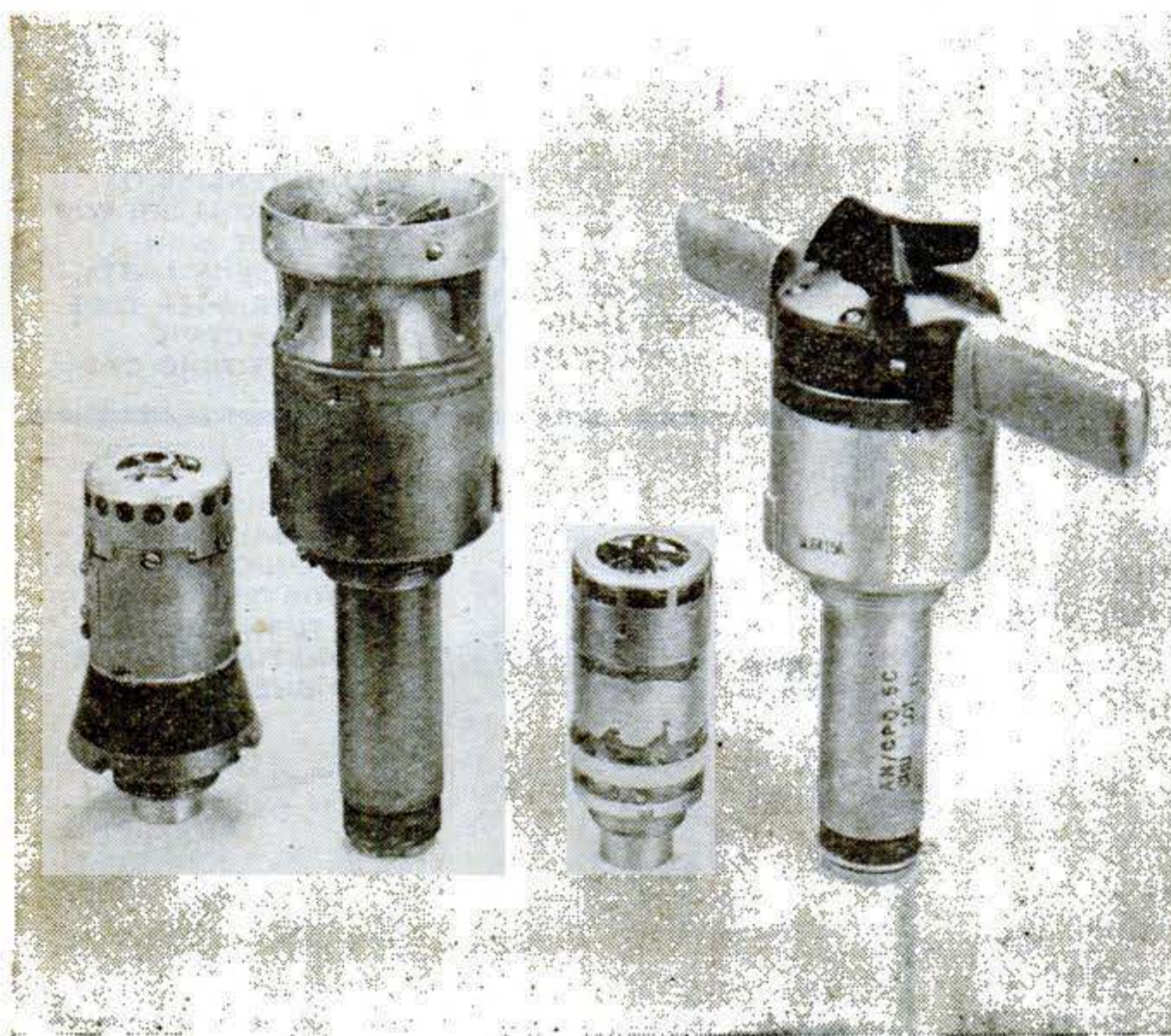
snapped Jap and German telephone communications and opened paths through barbed-wire entanglements as easily as Moses parted the waters of the Red Sea.

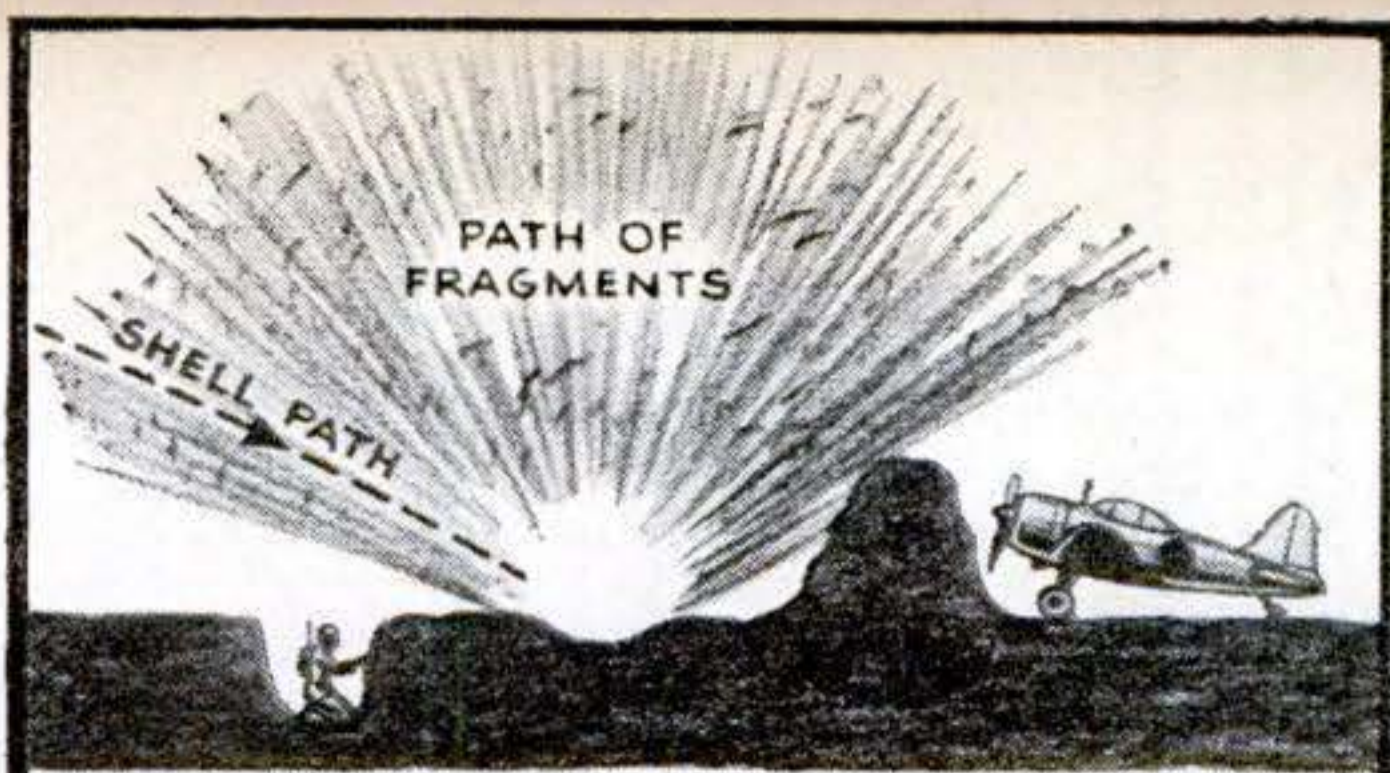
In one instance, 60 howitzer shells, catching the enemy in the midst of a sneak attack by rubber boat across a river, killed 702 men.

Allied fighter planes firing VT-fused rockets averaged two hits out of every three shots against enemy planes.

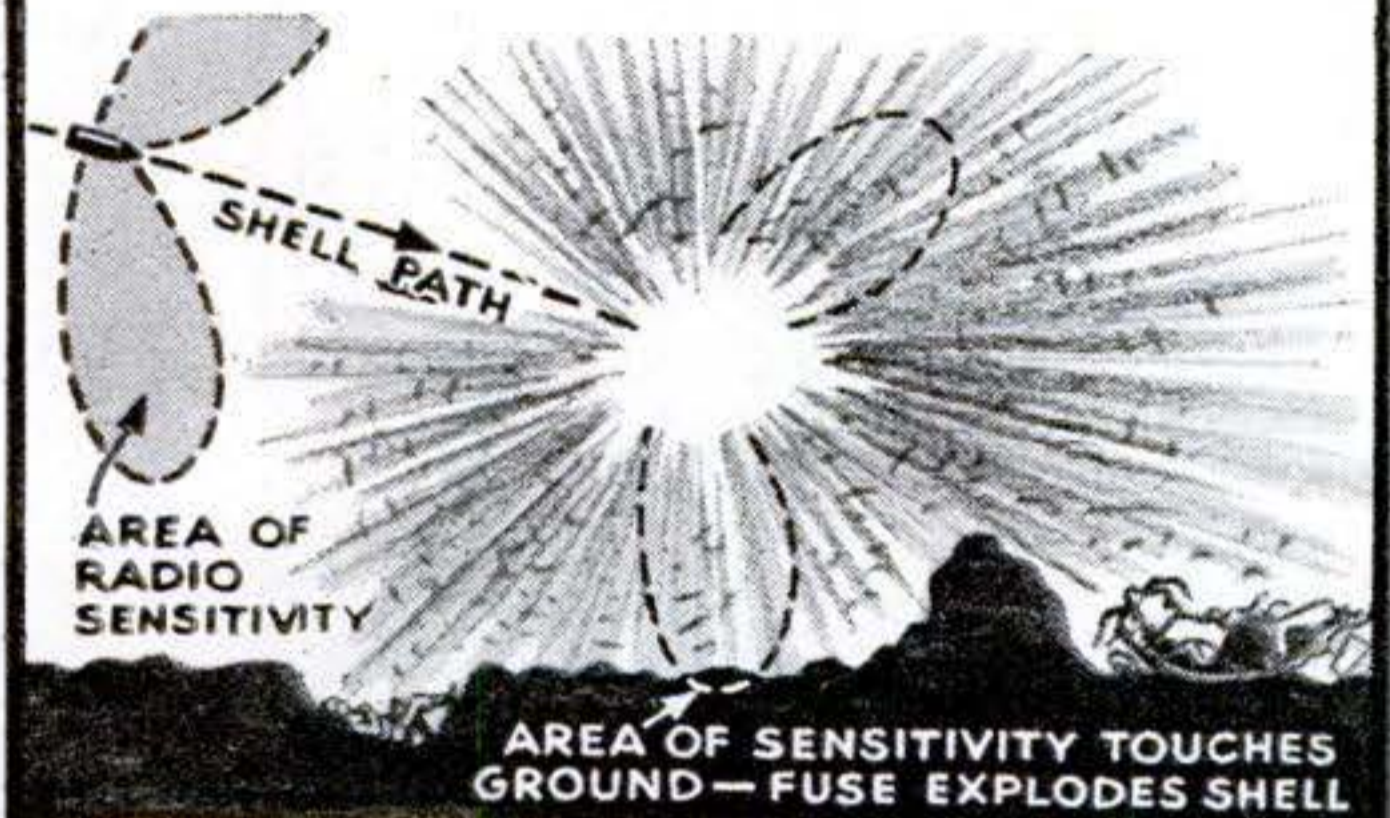
In one year, the Navy's statistics showed that 51 percent of all enemy aircraft shot down by anti-aircraft five-inch guns had to

Below, left to right, are proximity fuses for a rocket, for either rocket or bomb, for a mortar, and for a bomb. The projections on the bomb fuse are antennae for "transverse excitation." In the photograph at extreme right is a clockwork mechanism that keeps the wind-driven generator on a bomb fuse from working until the bomb has had time to pass through formations of friendly aircraft beneath the bomber.

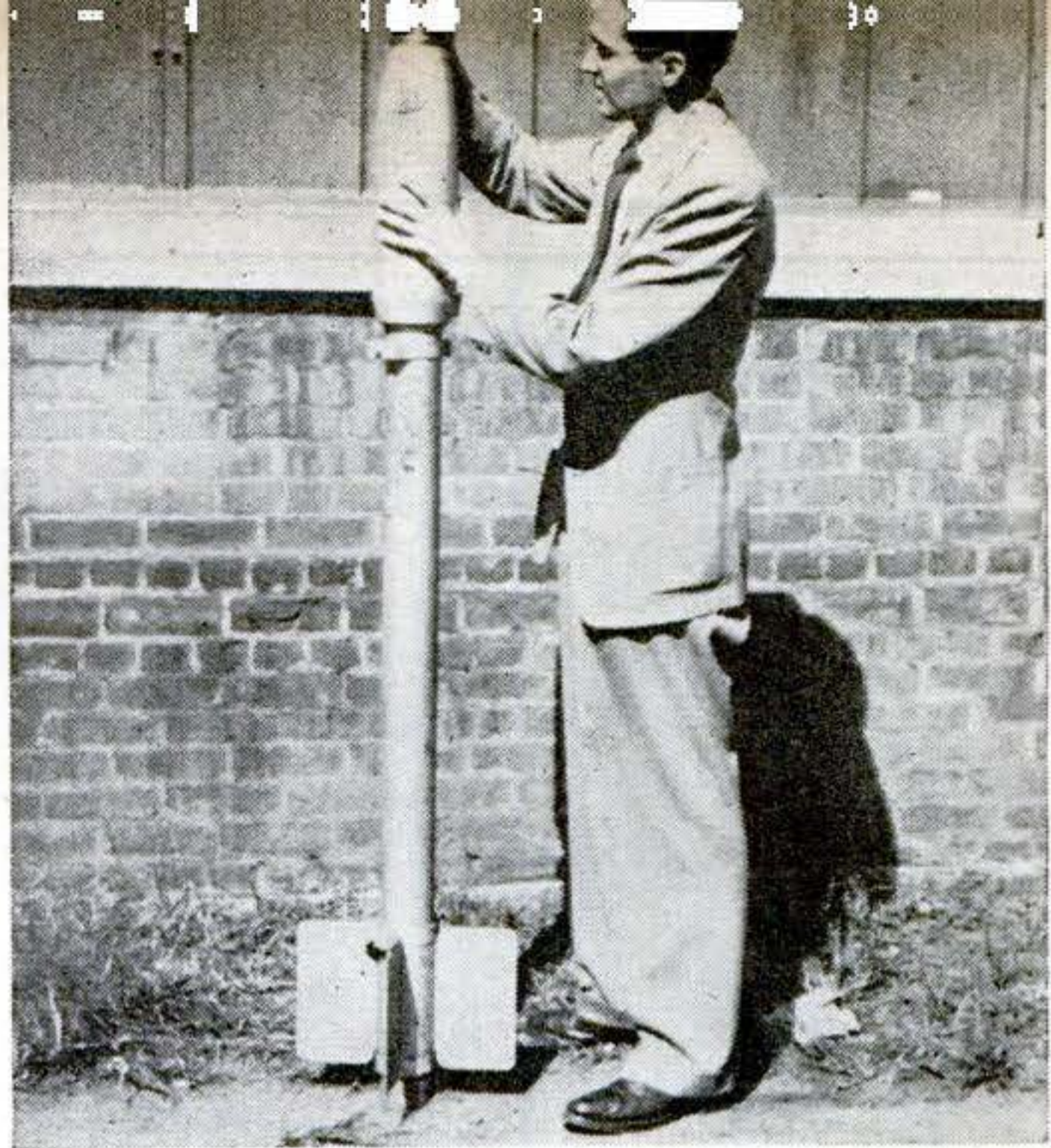




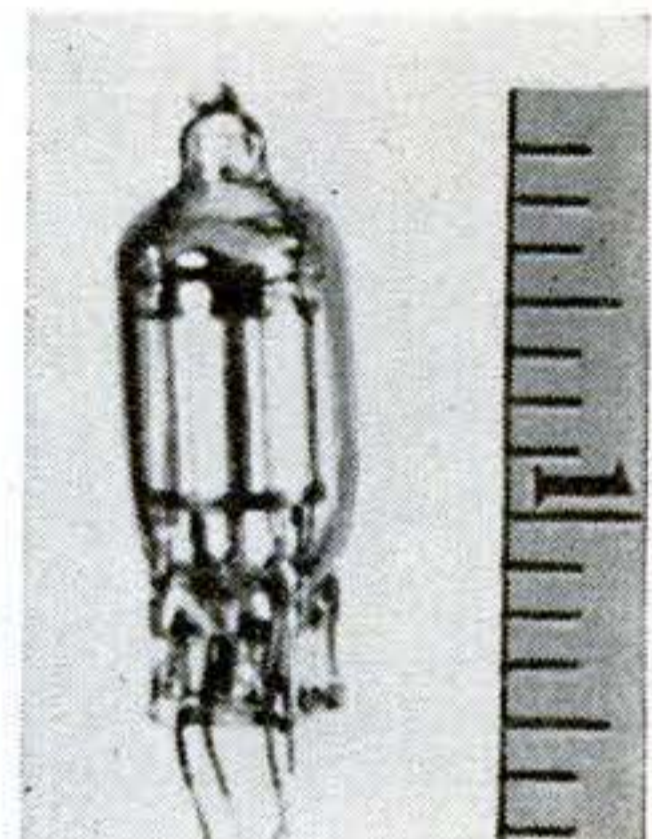
CONTACT FUSE on artillery shell causes fragments to be thrown upward in a cone. Airplanes can be protected by revetments, and soldiers by trenches or foxholes.



VT FUSE explodes shell before it hits the ground. Fragments are showered across revetment walls and into hideouts. Blast effect for destruction of buildings also is enhanced by exploding shells in air.



General Electric engineer S. D. Epstein looks at a proximity fuse used on a rocket projectile.



Radio tubes for VT fuses are tiny. Experience in making them shockproof will bring us sturdier bulbs for Christmas trees.

be credited to VT fuses. The remainder were shot down by time fuses—but three times as many time-fused as VT-fused shells were used.

VT fuses gave the American First Army a bag of 471 enemy planes in a single two-week period. In the Pacific, trouble from Jap anti-aircraft fire was stopped regularly with an antidote attack by aircraft carrying VT-fused rockets and bombs.

The gun firing VT-fused shells was, generally speaking, from 300 to 400 percent more effective than one using time fuses.

Perhaps the most brilliant characteristic of the proximity fuse used in bombs and artillery shells is that it causes bursts to conform to the terrain. An explosive charge detonates as readily at a given distance above a 2,000-foot mountain as it does above a river valley.

"I think," wrote a four-star general from the European theater to Maj. Gen. T. H. Campbell, Jr., of the Ordnance Department, Washington, D. C., "that when all armies get this shell, we will have to devise some new method of warfare."

The success of the VT fuse rests on a well-known scientific principle known as the "Doppler effect." Happily enough, the minds engaged in working on detonation by radio wave knew it would function from a change

in the *intensity* of the reflected signal. In other words, they knew a shell could be fired on a horizontal path five feet off the ground and that it wouldn't go off until the signal rose in crescendo by increasing proximity to the target.

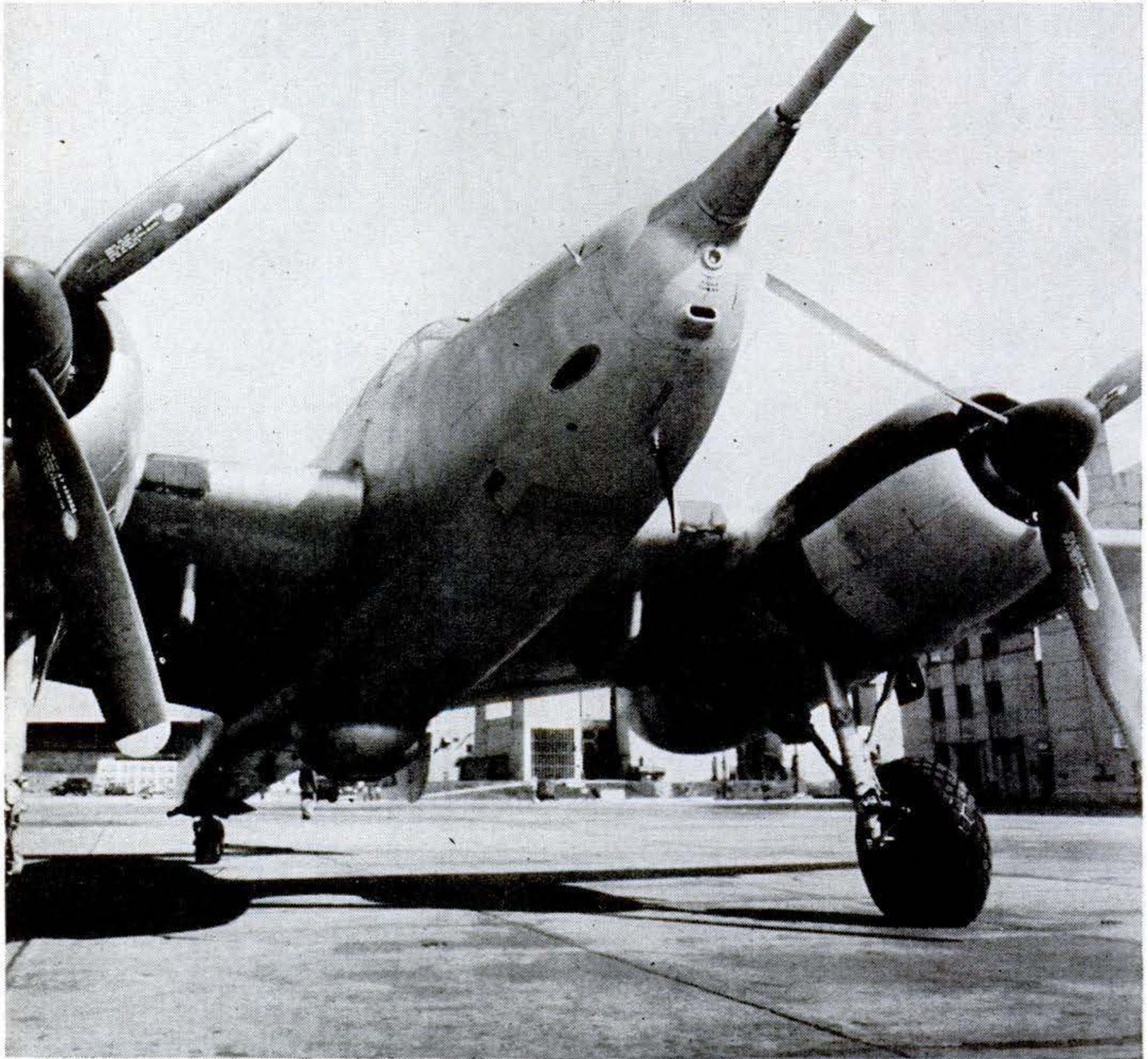
You get "Doppler effect" when an airplane or a train roars by you. Astronomers get it when planets approach and retreat from the earth. The pitch of sound in the train or the airplane rises as it approaches you. The pitch drops as it goes by you. Stars change color as they come toward the earth, change again as they move away. All this is due to the fact that a moving body, overtaking the waves that it creates, piles up those waves into shorter segments. Their "pitch" rises.

The radio signal from the VT fuse builds up "pitch" on the rebound, and the explosive goes off. And to show how sensitive the VT is, as compared with other devices proposed, it will measure a distance of 70 feet accurately, even though the waves energizing it travel at more than 186,000 miles a second.

The VT fuse in the United States started as an idea in 1940 at the Department of Terrestrial Magnetism, Carnegie Institution, in Washington. The Navy sponsored the research on VT fuses for high-rotation projectiles such as *(Continued on page 230)*

WRIGHT FIELD SHOWS ITS SECRETS TO THE PUBLIC

THE inside story of how America won mastery of the skies was recently revealed by the Army Air Forces at Wright Field, Dayton, Ohio, the \$150,000,000 laboratory of aeronautical science. On these three pages POPULAR SCIENCE shows some of the newer developments.



XA-38 Wallops Like a Bomber, Flies Like a Fighter

DESIGNED around the hard-hitting 75-millimeter cannon, which makes it look like a flying swordfish, the Beech XA-38 attack plane strikes with the powerful blows of a bomber while boasting the speed and maneuverability of a fighter. A gunner, who rides in an armored cockpit well back on the fuselage, mans a four-gun top turret and a two-gun bottom turret by means of remote control while aiming through a two-ended periscope sight. The pilot fires the cannon and, in an emergency, can take over both turrets for straight-ahead firing or strafing.

The XA-38 has no bomb bay, but provision is made for carrying externally in

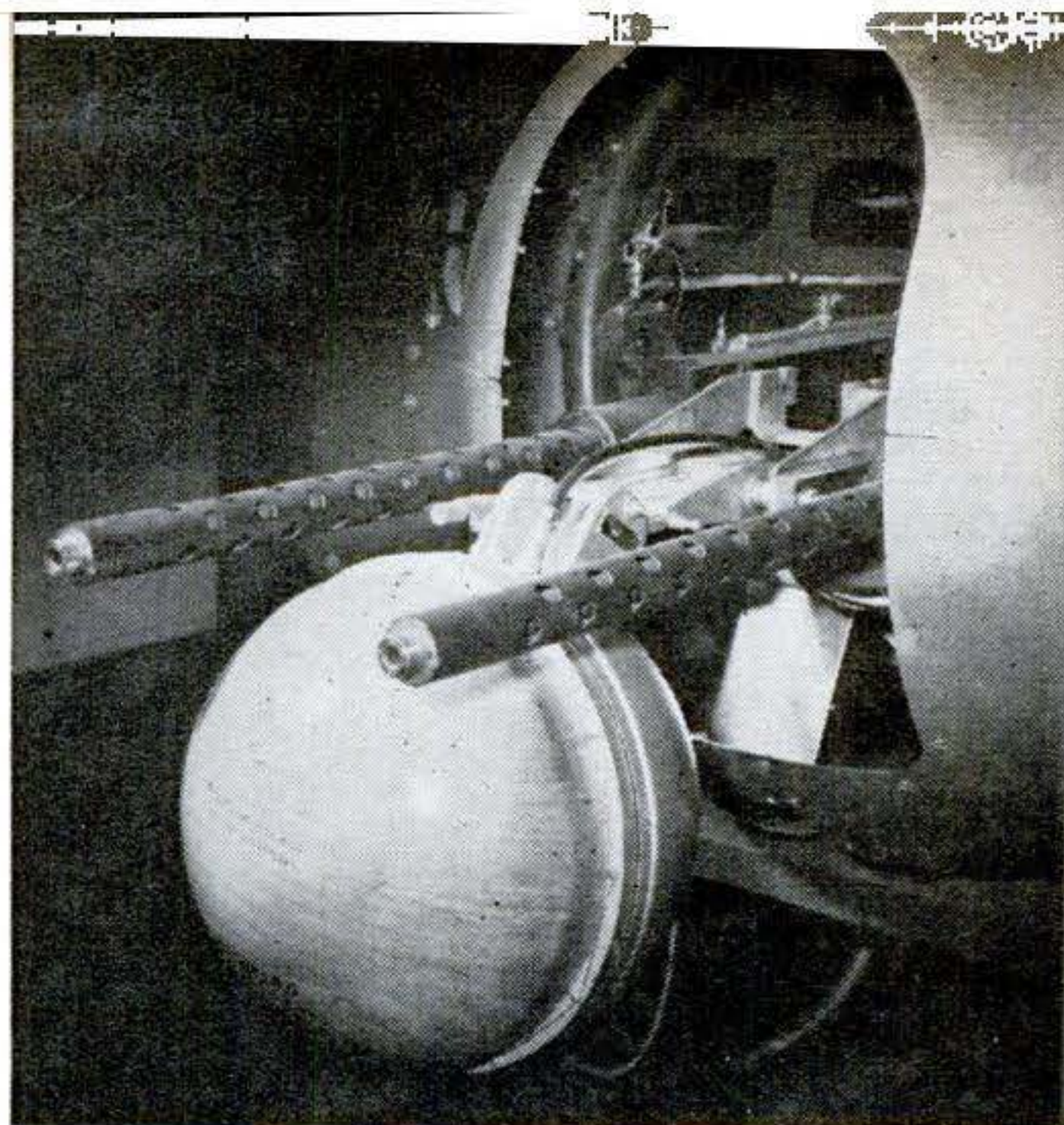
wing racks either four 1,000-pounders or a combination of smaller bombs. Four tree-type rocket launchers, which permit firing a salvo over a wide area, can also be carried on these wing racks.

Powered by two 2,200-horsepower Wright Cyclone engines and equipped with three-bladed, full-feathering propellers, this 14½-ton attacker can make a speed approaching the 400-mile-an-hour mark. From the forward end of its cannon to the tip of its tail and from wing tip to wing tip, the XA-38 is a model of streamlining which gives it the speed and maneuverability of a fighter when it needs to defend itself.



Ejector Seat Saves Jet Pilots

THIS new catapult seat, soon to become standard equipment in the Army Air Forces' speedy jet planes, throws the pilot clear of his ship when serious trouble develops. An explosive charge swings the seat upward and backward, hurling him out of the cockpit and over the plane's tail.

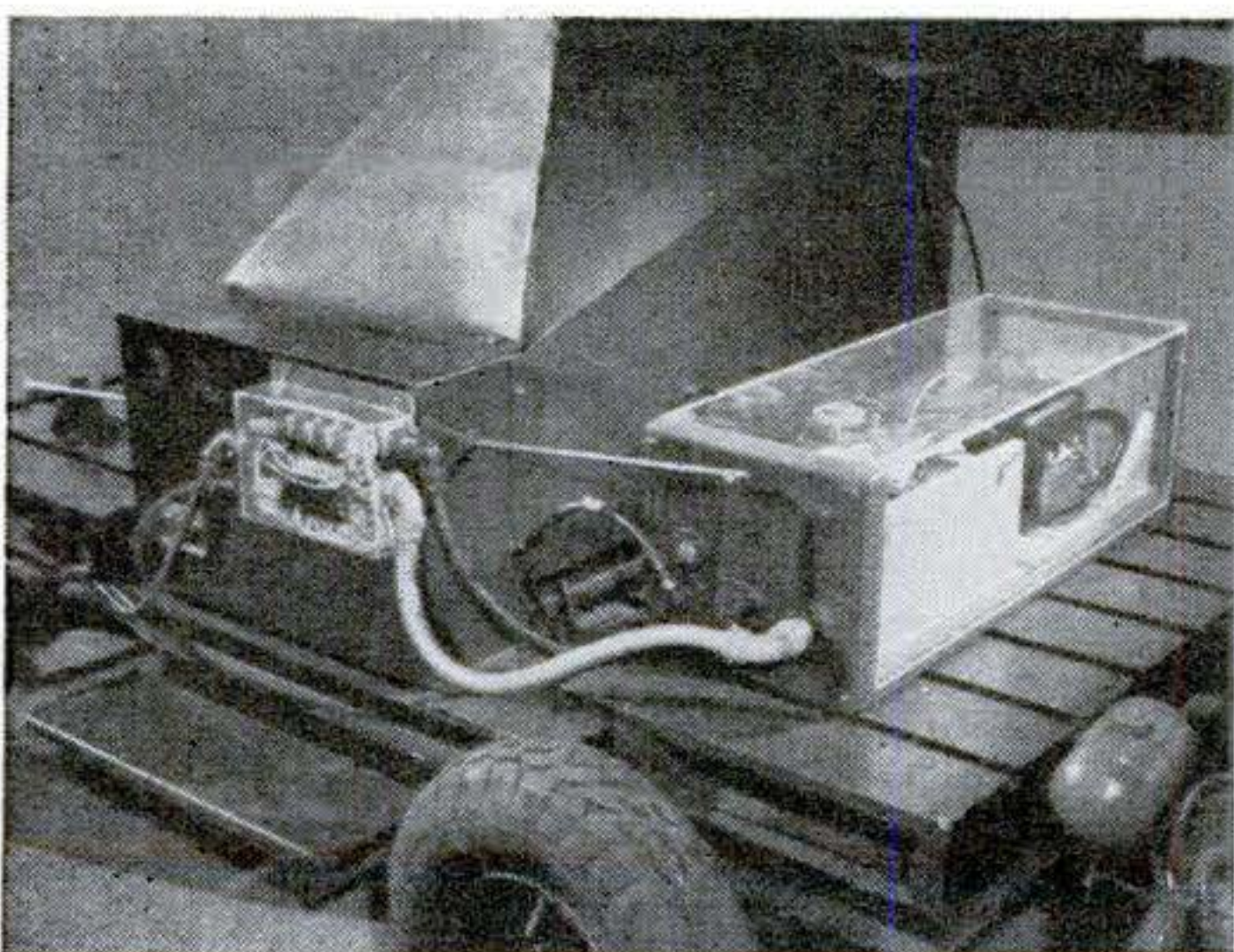
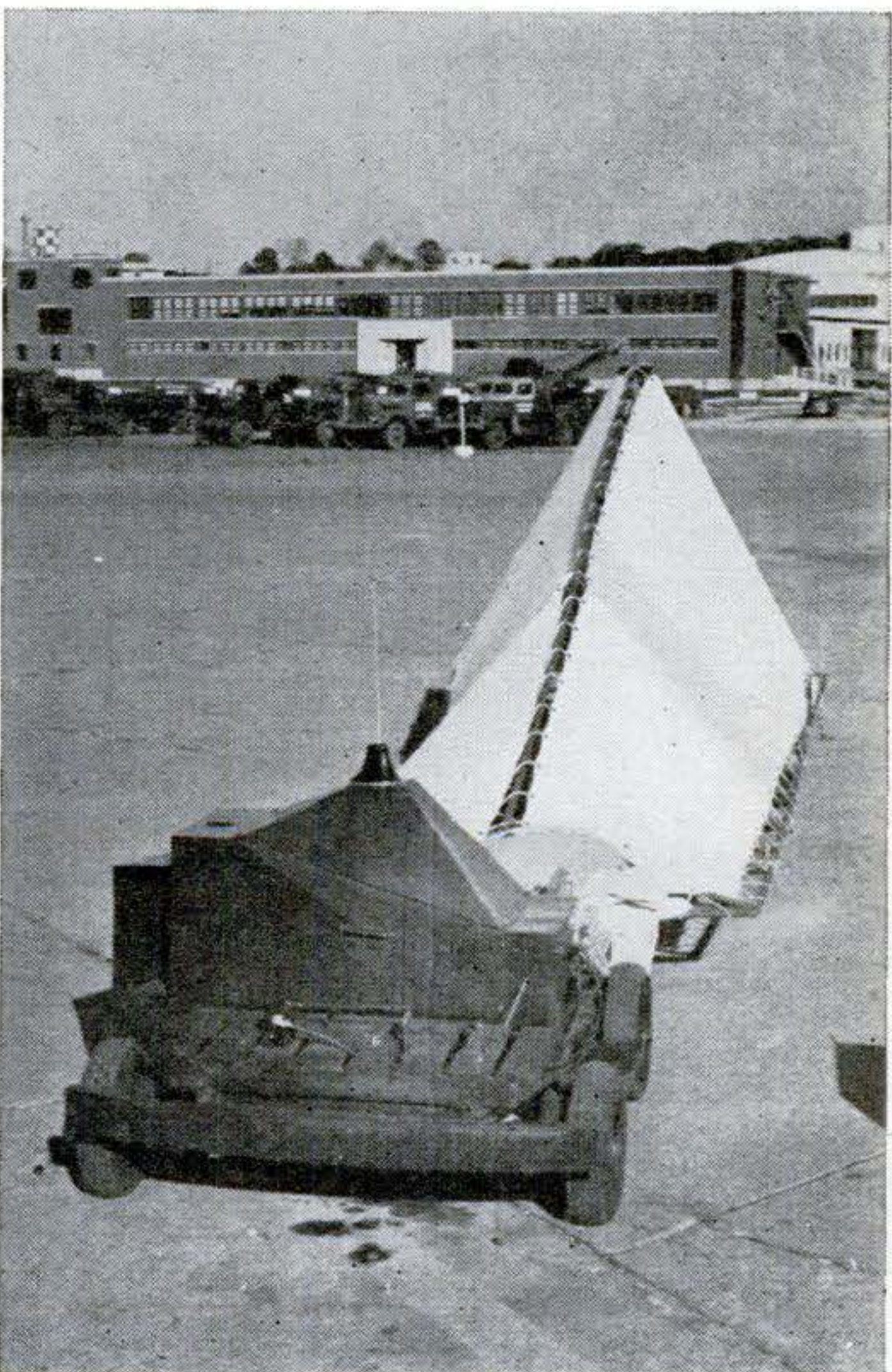


Radar Ball Spies Enemy Planes

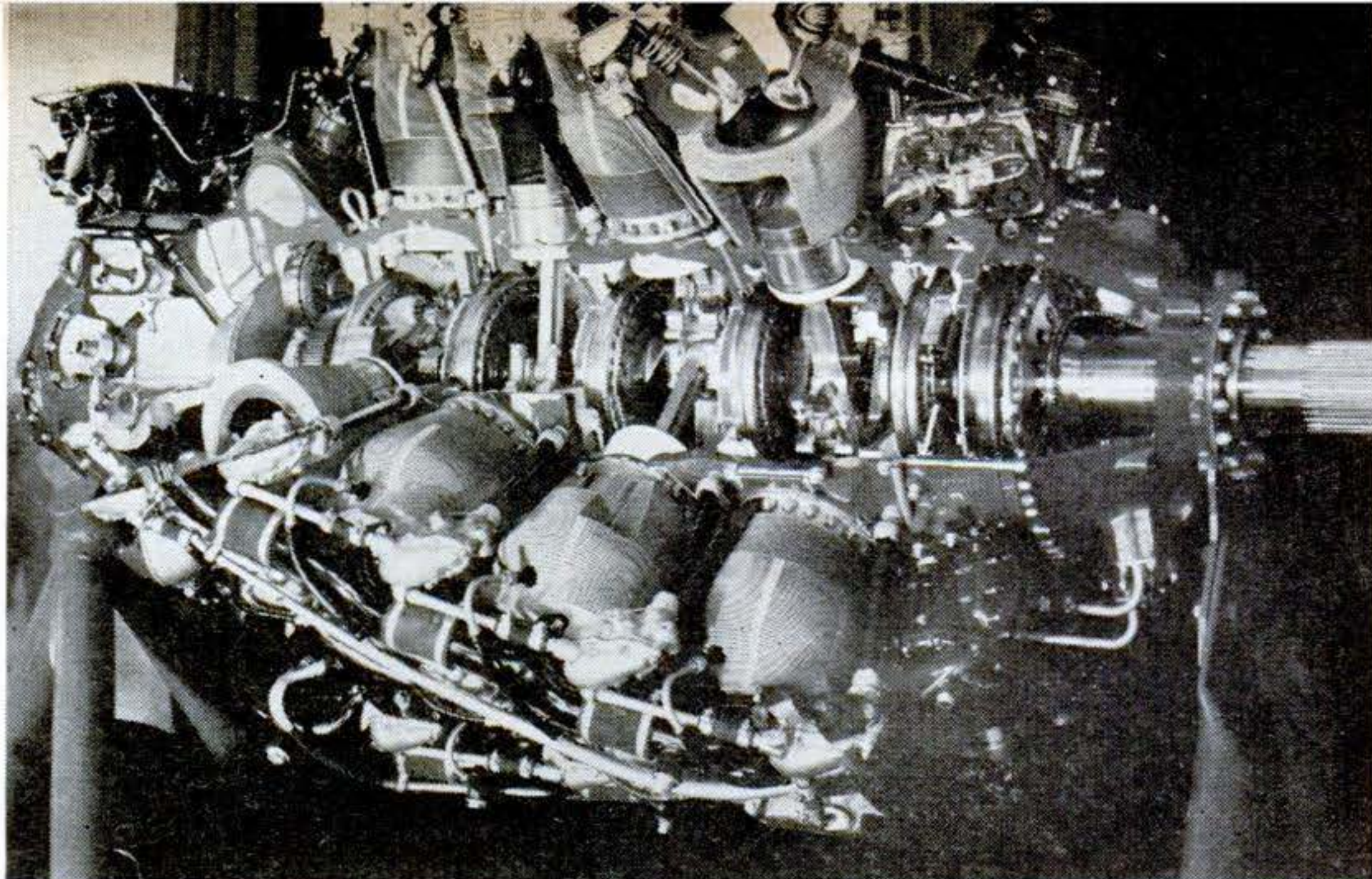
RADAR beams from the antenna of a plastic ball fitted on tail turrets of B-29's and B-32's put the finger on invisible enemy planes. A distant ship shows up as a spot on the gunner's radar scope. When this spot comes between two "goal posts," the gunner knows the enemy is within range.

Mobile Radio Land Target Tests Bomber Marksmanship

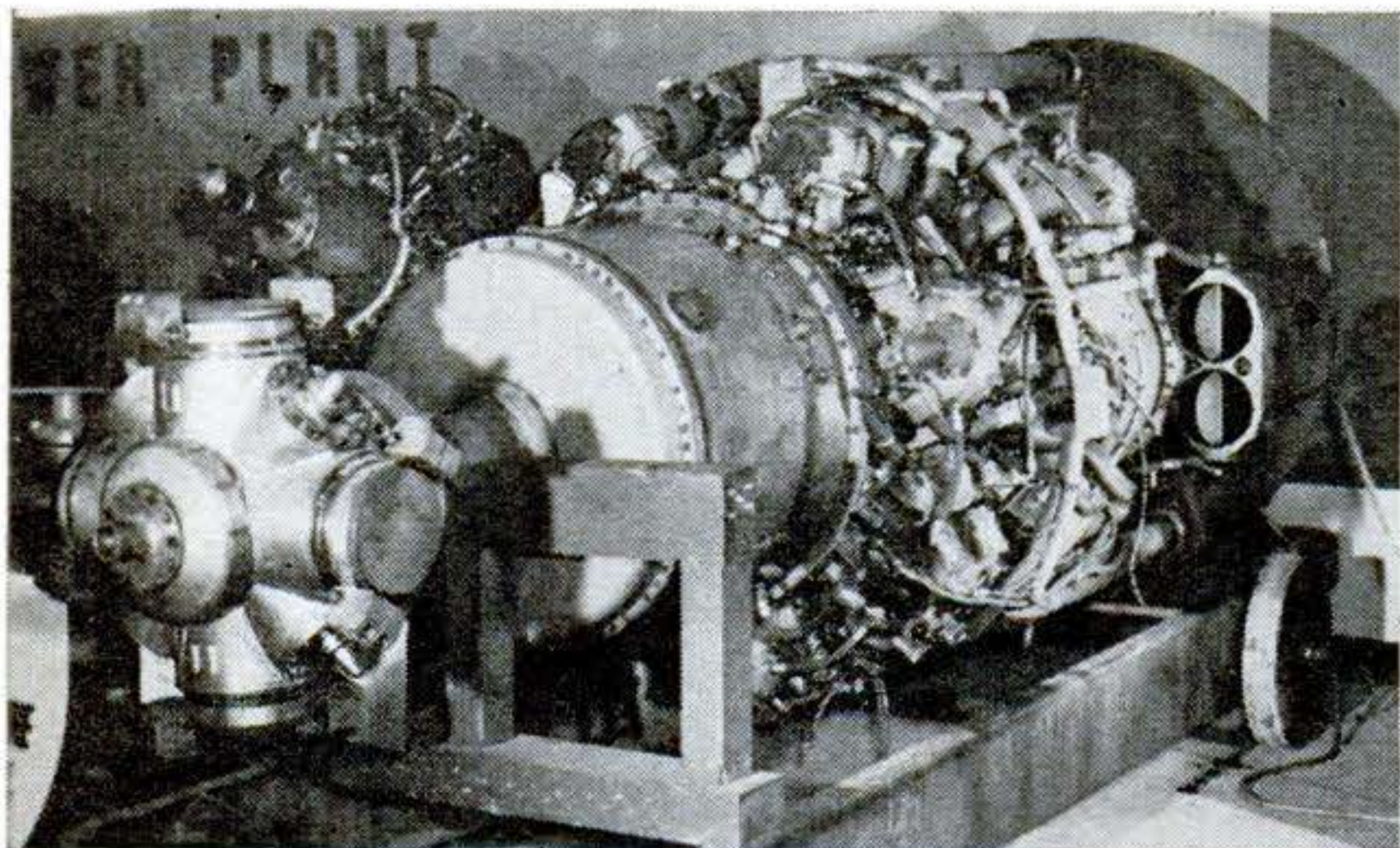
DESIGNATED the A-6 landborne target, the radio-controlled device at the right is used to train Army Air Forces and Navy bombardiers. Improvised from motorized trucks being made for railroad section gangs, the A-6 was fitted with rubber-tired wheels and a radio robot to permit maneuvering under remote control (see picture below). It is powered by a 63-horsepower gasoline engine and has a speed of 35 miles an hour. An A-5 model is made with wheels to run on railroad tracks laid on some bombing ranges. The target itself is a pipe frame covered with canvas, shaped for easy visibility.



Clean-looking and compact, the Pratt & Whitney 4-row radial powerhouse develops 3,000 horsepower at normal rating and up to 3,500 horsepower with water injection.



The German BMW 803 appears to be two 14-cylinder radials joined back to back. Its normal horsepower rating is 3,350, but nitrous oxide boosts it to 4,000.

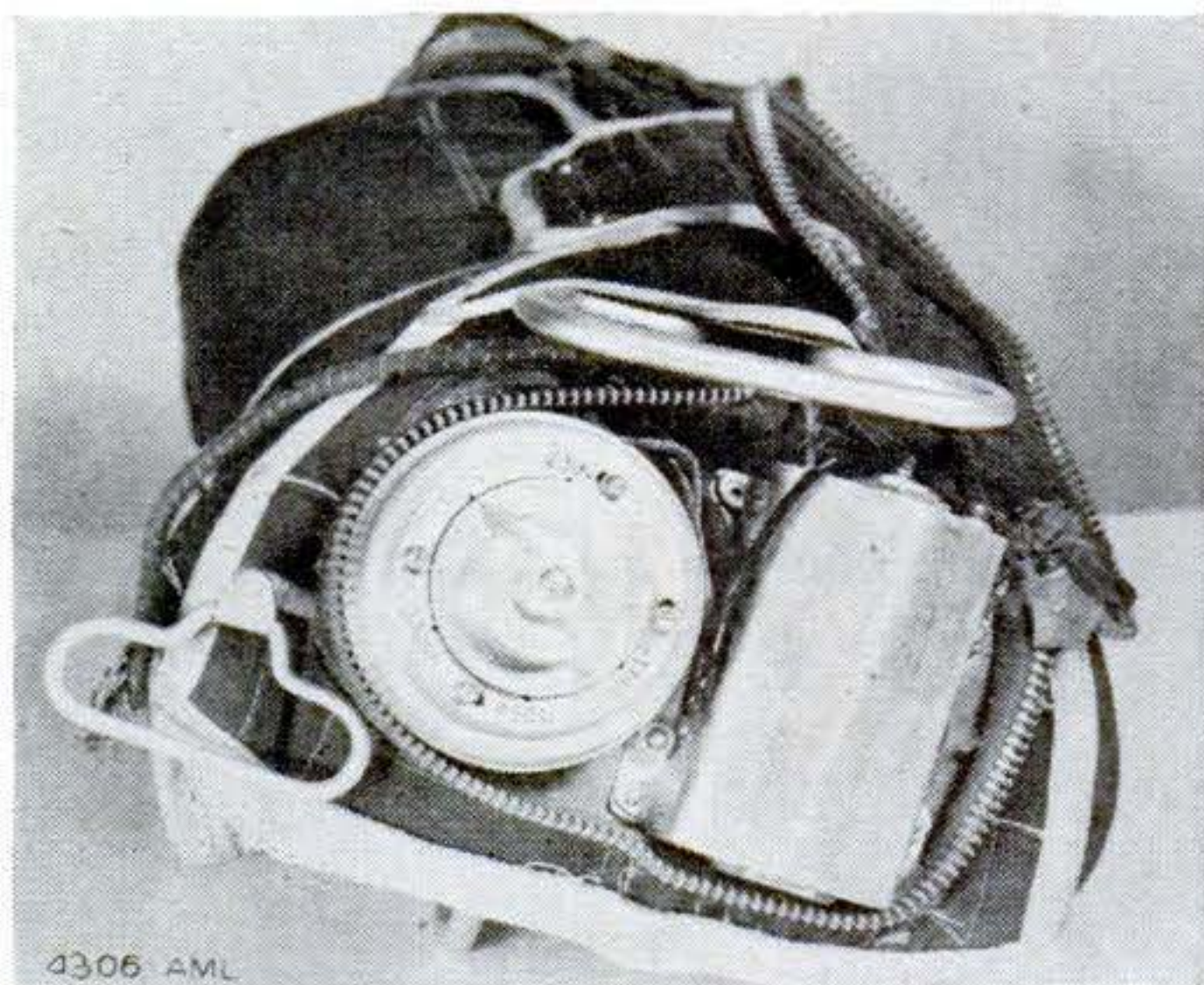
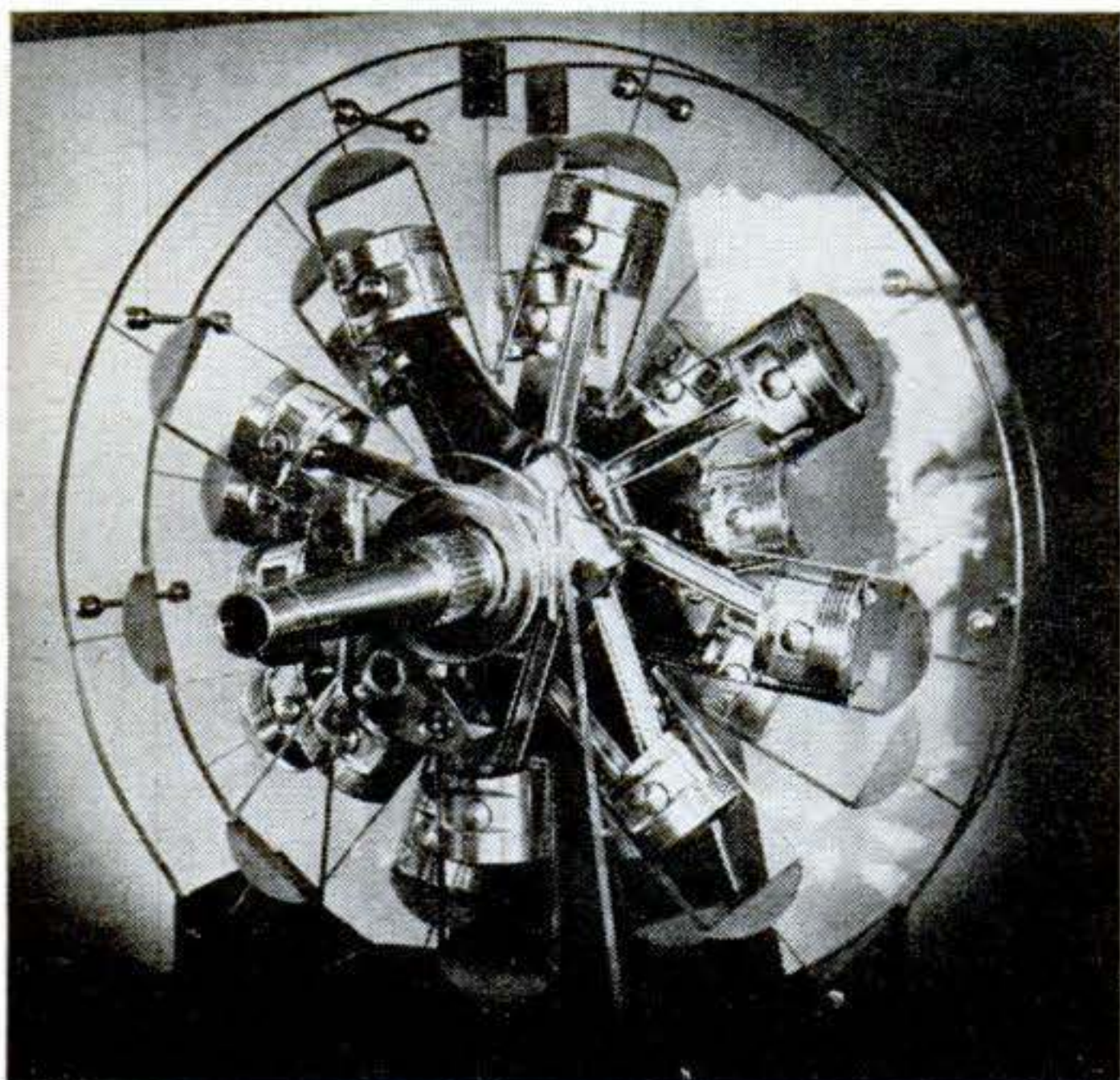


Multi-Row Radials Pack Power of Steam Engines

CONCENTRATED power is locked up in these two compact aircraft engines, the Pratt & Whitney air-cooled Wasp Major (above) and the German BMW 803 (left). The Wasp Major drives the F2G-1 Corsair fighter, and is being installed in a number of super airliners. The BMW 803 was the Luftwaffe's most powerful air-cooled job, but was never used in actual combat.

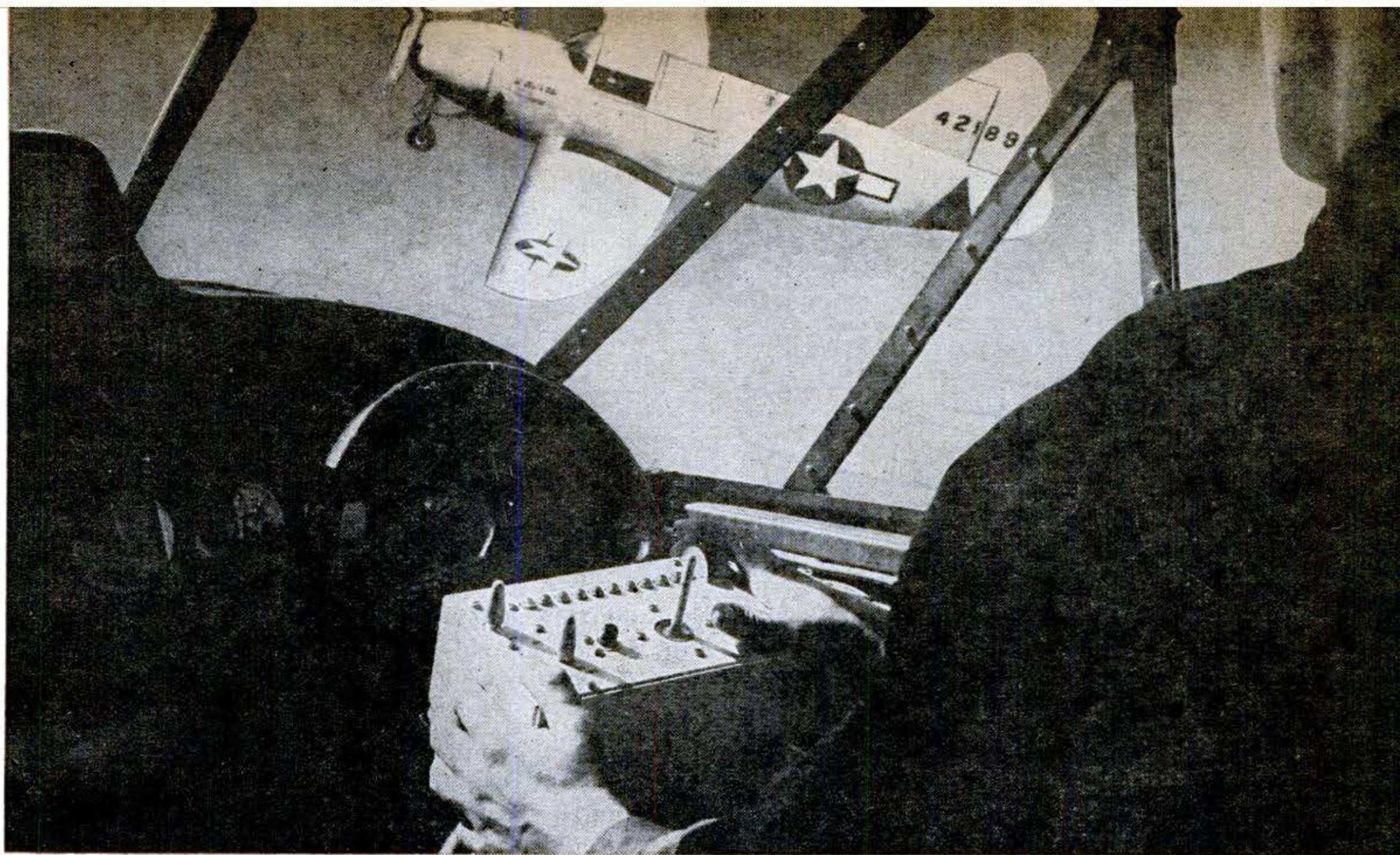
"X Ray" Shows Cyclone Insides

CRANKSHAFT, articulating rods, and pistons of the Wright R-3350 Cyclone engine are revealed in the unusual Lucite mockup below. R-3350 Cyclones powered B-29's and other hard-hitting USAAF craft.



'Chute Blossoms Automatically

WOUNDED airmen need only to jump clear of their ships in emergencies; an automatic parachute will float them down safely even if they lose consciousness. At a given altitude a barometric altimeter device makes an electrical contact that fires a cartridge, releasing the pilot 'chute. This, in turn, drags out the large canopy.



WITHOUT A PILOT, a Culver PQ-14 radio-controlled plane flies in close formation with a CQ-3 "mother plane," from which an operator maneuvers it with a little "stick box." The robot at the controls handles the radio plane as deftly as a human pilot, and collision is not so imminent as it may seem.

WHO IS YEHUDI?

He's a robot pilot that flies a plane like a veteran, under radio orders from the ground or a mother craft.

By **JAMES L. H. PECK**

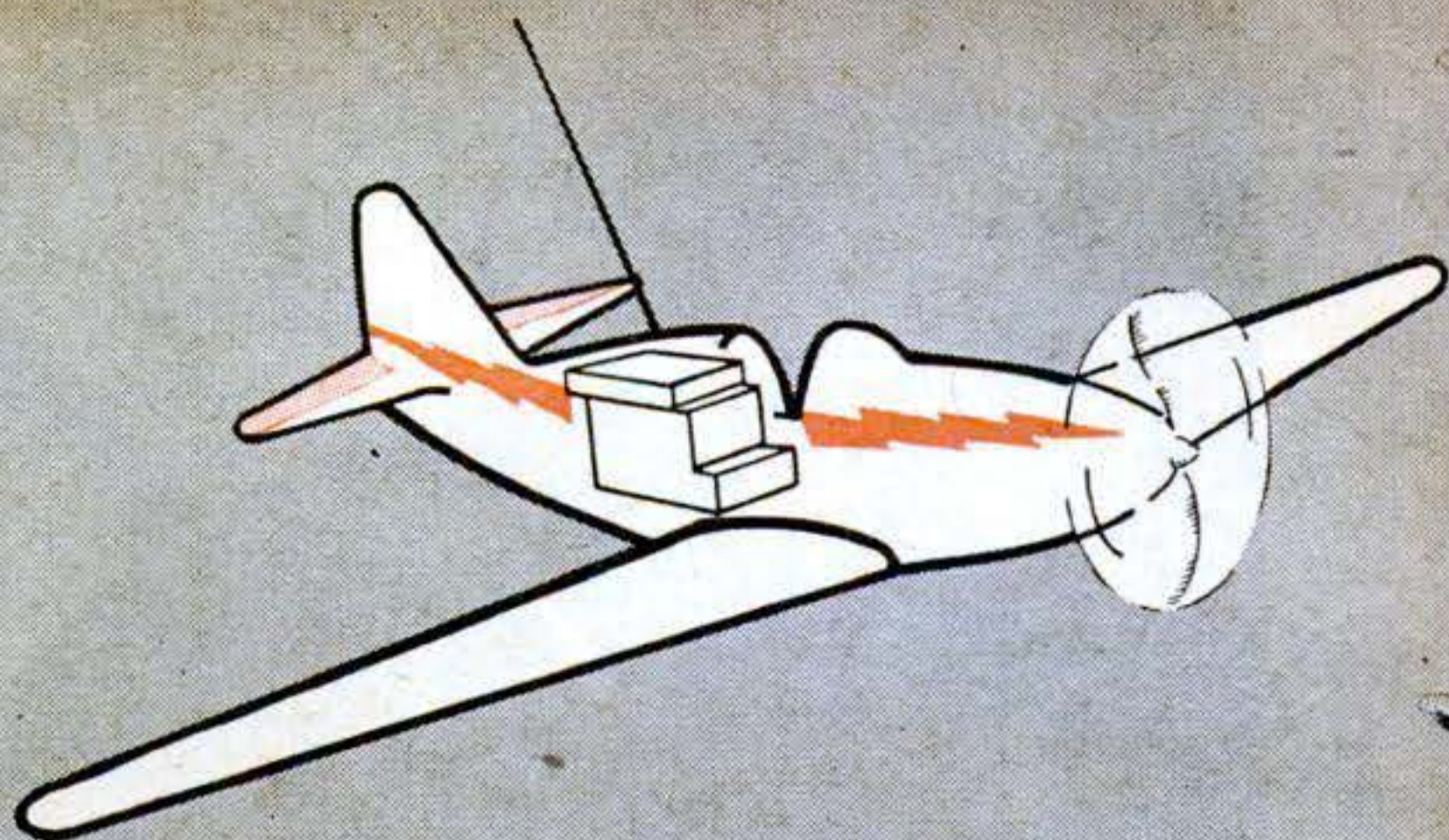
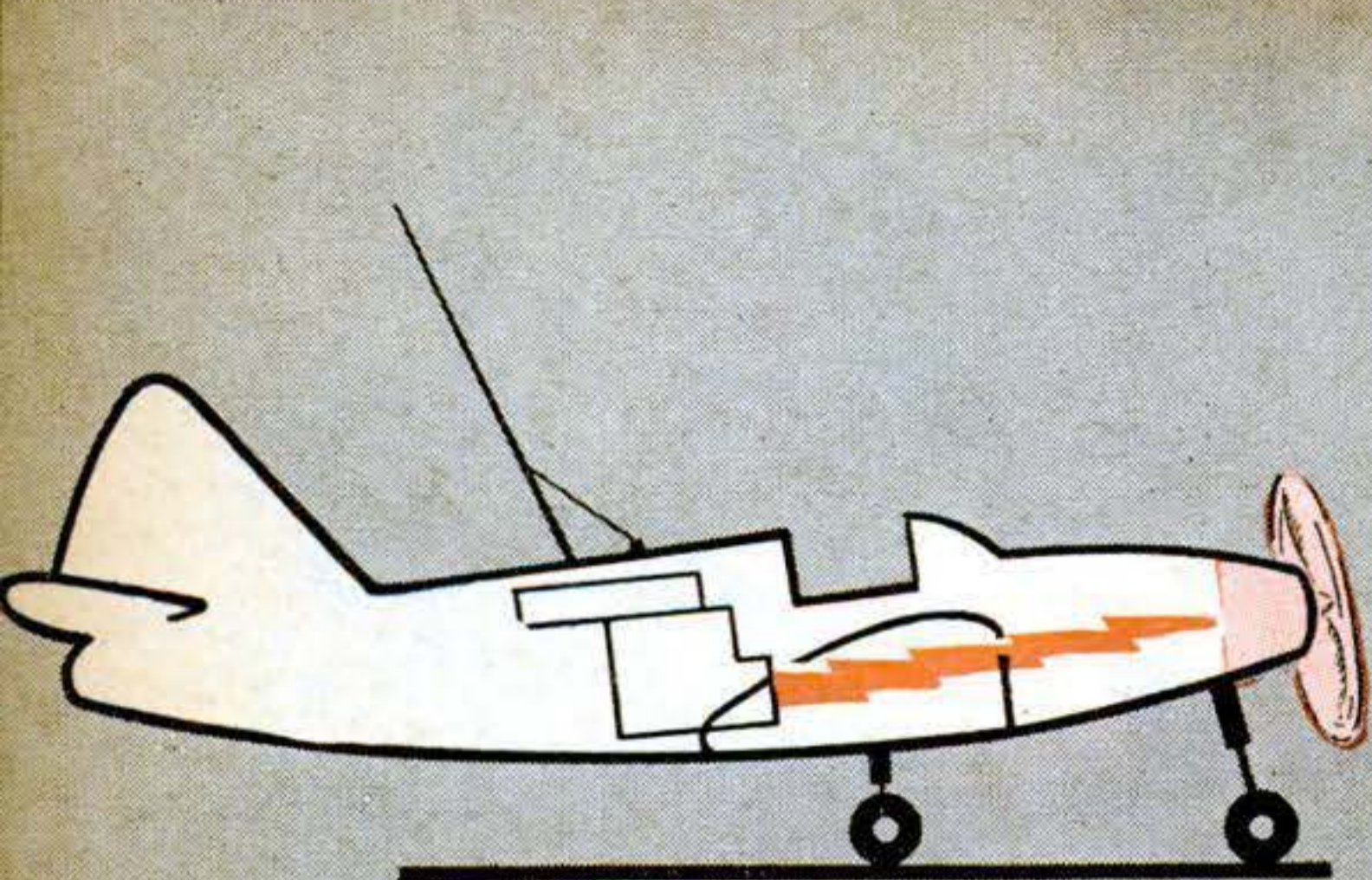
A WAR-WEARY Flying Fortress staggered off an Eighth Air Force airdrome with the heaviest war load ever lifted by this type of bomber. It carried only enough fuel for a one-way trip, a pilot, a copilot, and a device they called "Yehudi." This was the take-off of the top-secret, joint Army-Navy "Anvil Project," and the beginning of one of the war's weirdest air missions.

After the climb to its cruising altitude, the explosive-filled Fortress was abandoned by the two pilots, who parachuted safely to British soil, leaving the bomber in the hands of "Yehudi"—the little man who isn't there. Guided by his invisible hands, the B-17 flew in perfect formation with the accompanying Fortresses and escort fighters out over the North Sea for nearly three hours.

Flak became heavy as they approached the vital German naval base on Helgoland. The Forts and fighters climbed several thousand feet higher and took evasive action. None was more evasive than that

lone B-17 with the empty cockpit away below. Suddenly it stopped its weaving in flight, made several turns in a steep, gliding spiral. Then it dived straight toward the submarine installations on Helgoland. The German gunners never got it on the way down. And they never got that sub yard back into operation. Concussion waves from the explosion bounced the escorting planes at their 30,000-foot altitude.

The push-button warfare continued from early in 1944 until the very end of World War II, as war-wearies were crammed with TNT and a new explosive, which is still secret, and sent plunging, by remote control, into a number of German and Japanese high-priority targets. On each mission an officer on special duty from the Air Technical Service Command's Equipment Laboratory—one of the AAF's most secret installations at Wright Field—rode in the copilot's seat of one of the accompanying bombers. He carried in his lap a small aluminum box with which he sent radio commands to "Yehudi," a combination radio



ENGINE STARTS at a radio command. The PQ taxis onto the field and lines up with the runway. It can take off with a 30-m.p.h. cross wind.

IN THE AIR, landing gear is retracted, rudder locked, and engine throttled to cruising speed. Automatic pilot flies plane if radio is cut off.

receiver and automatic pilot in the controlled plane.

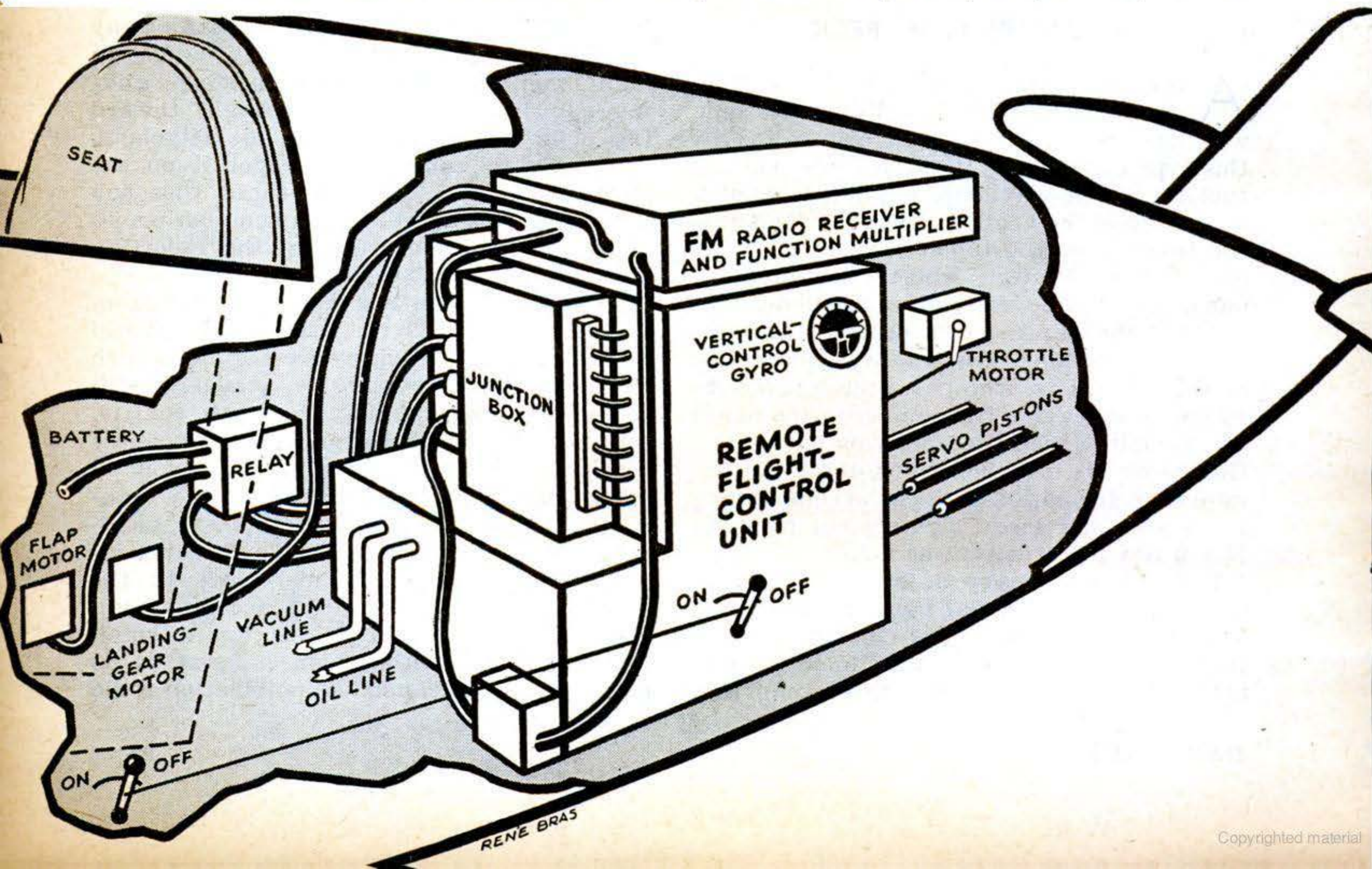
Smaller pilotless craft have been used as ground and aerial gunnery targets for more than three years. And the art of radio piloting has progressed to the point where "Yehudi" can now replace the pilots of jet planes and carrier-based Hellcat fighters, or the test pilots who normally fly untried, experimental craft.

This miracle of radio piloting is accomplished through the use of an aluminum "stick box" which is fitted with a miniature control stick, switches, and indicating lights.

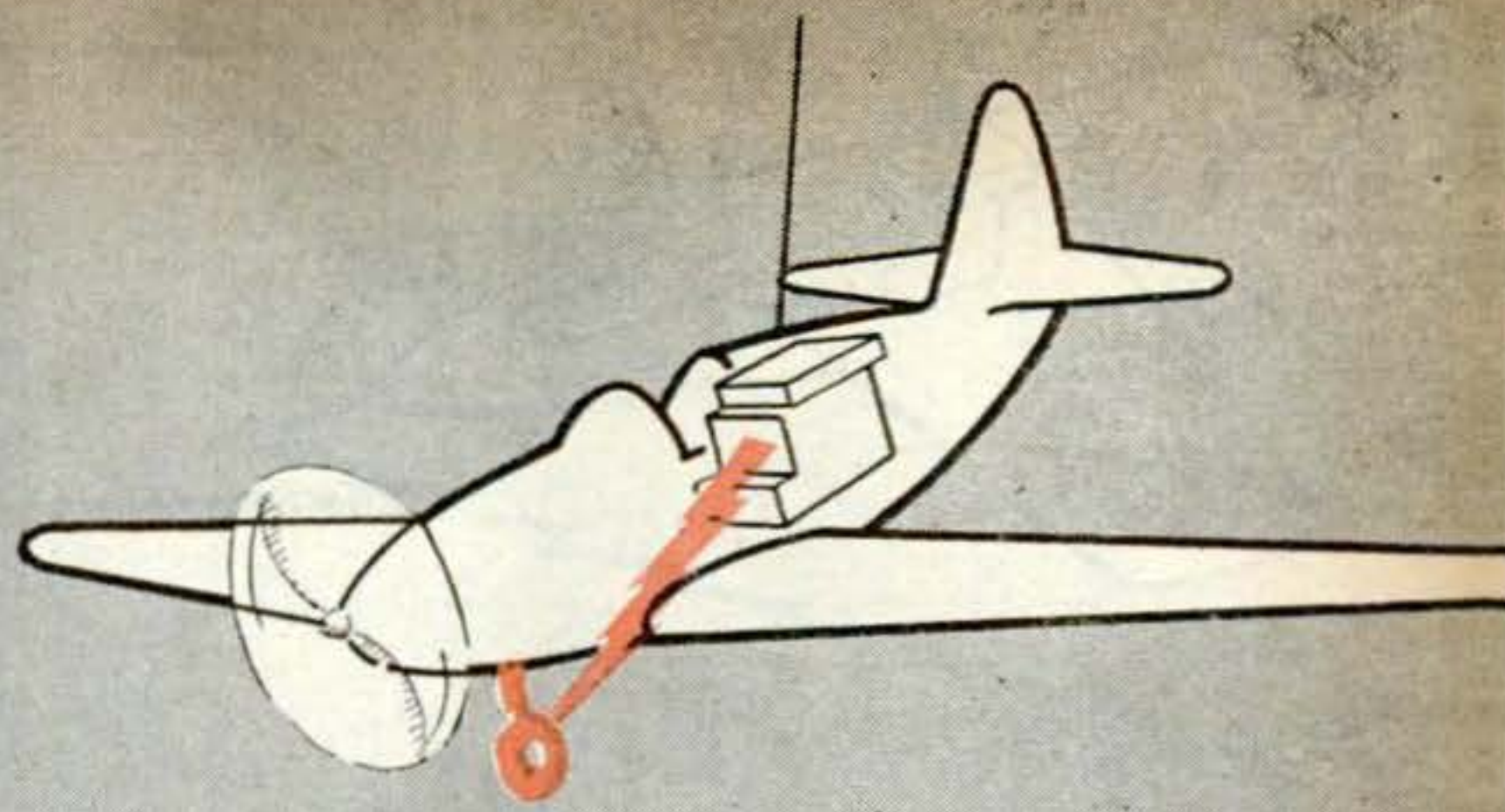
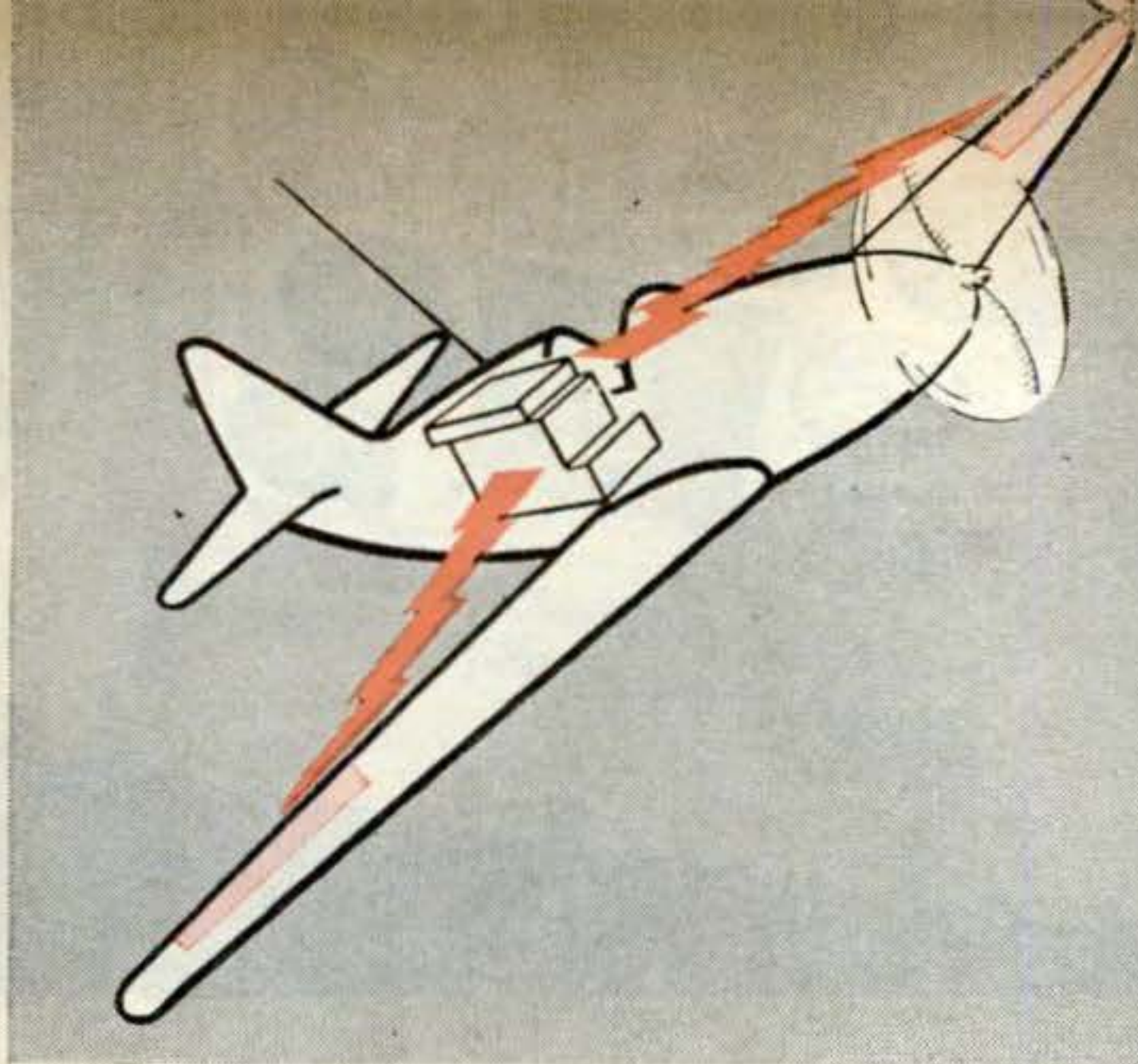
A cable connects this with the FM radio transmitter and its five-foot, half-wave-length whip antenna that sends the commands to the 10-channel FM receiver in the controlled plane. The radio impulses then go through a "function multiplier" box where they are "decoded" and passed on to the remote flight control unit (RFCU). Here they are translated into motion for the working of the plane's controls by means of hydraulic pistons.

You don't have to be a musician to be a good radio-plane pilot, but it helps. There is a balanced modulator in the transmitter

"YEHUDI," the Remote Flight Control Unit, rides just behind the pilot's seat in the radio-controlled plane. Stabilized by three gyroscopes, it works controls through hydraulic pistons and electric "trim motors." This is the most human robot pilot. It doesn't just help a flyer; it replaces him.



RENE BRAS



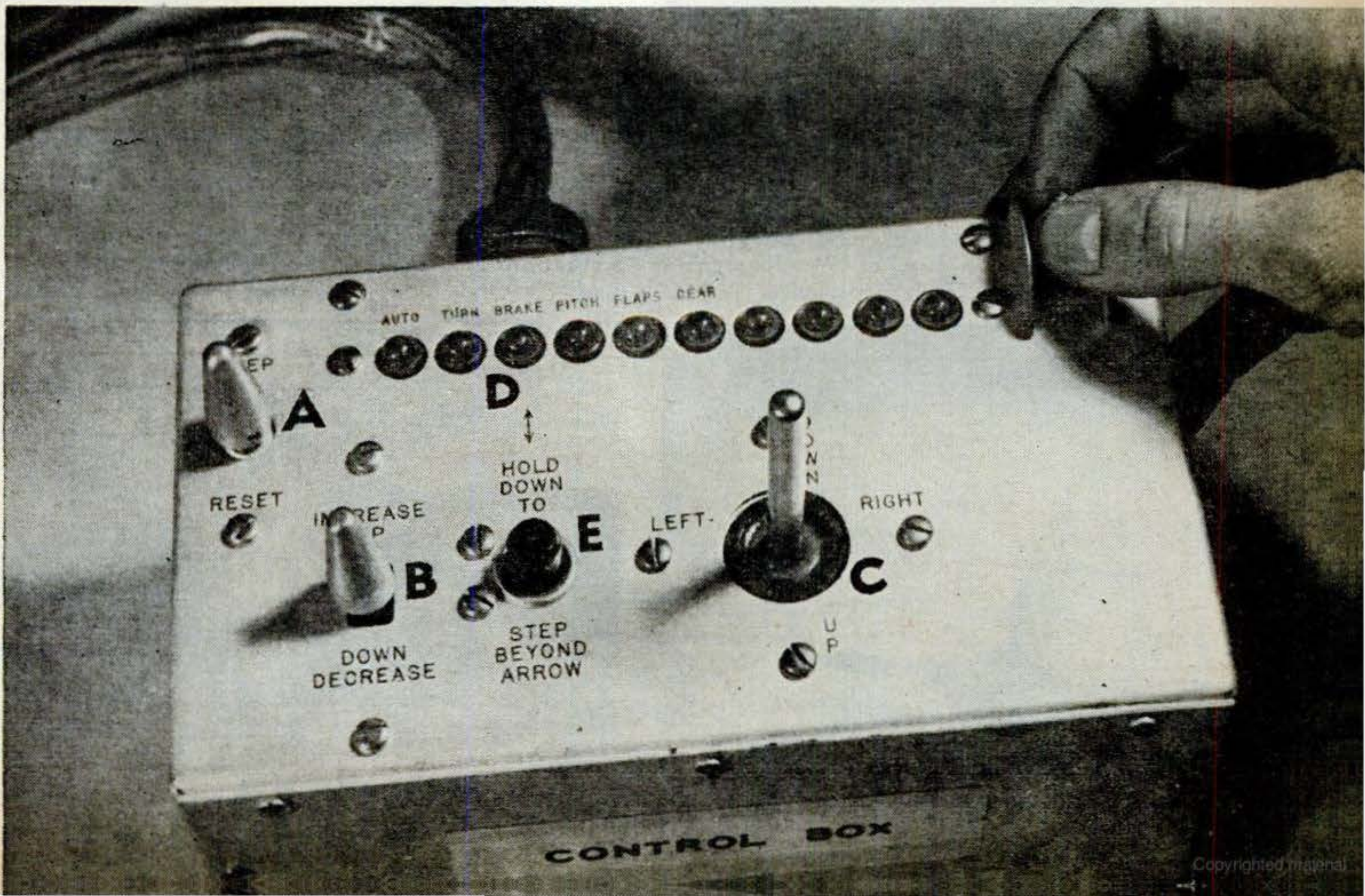
TURNS are made by banking with ailerons, rudder being used only in take-offs and landings. Gyros with pneumatic solenoid governors control banking.

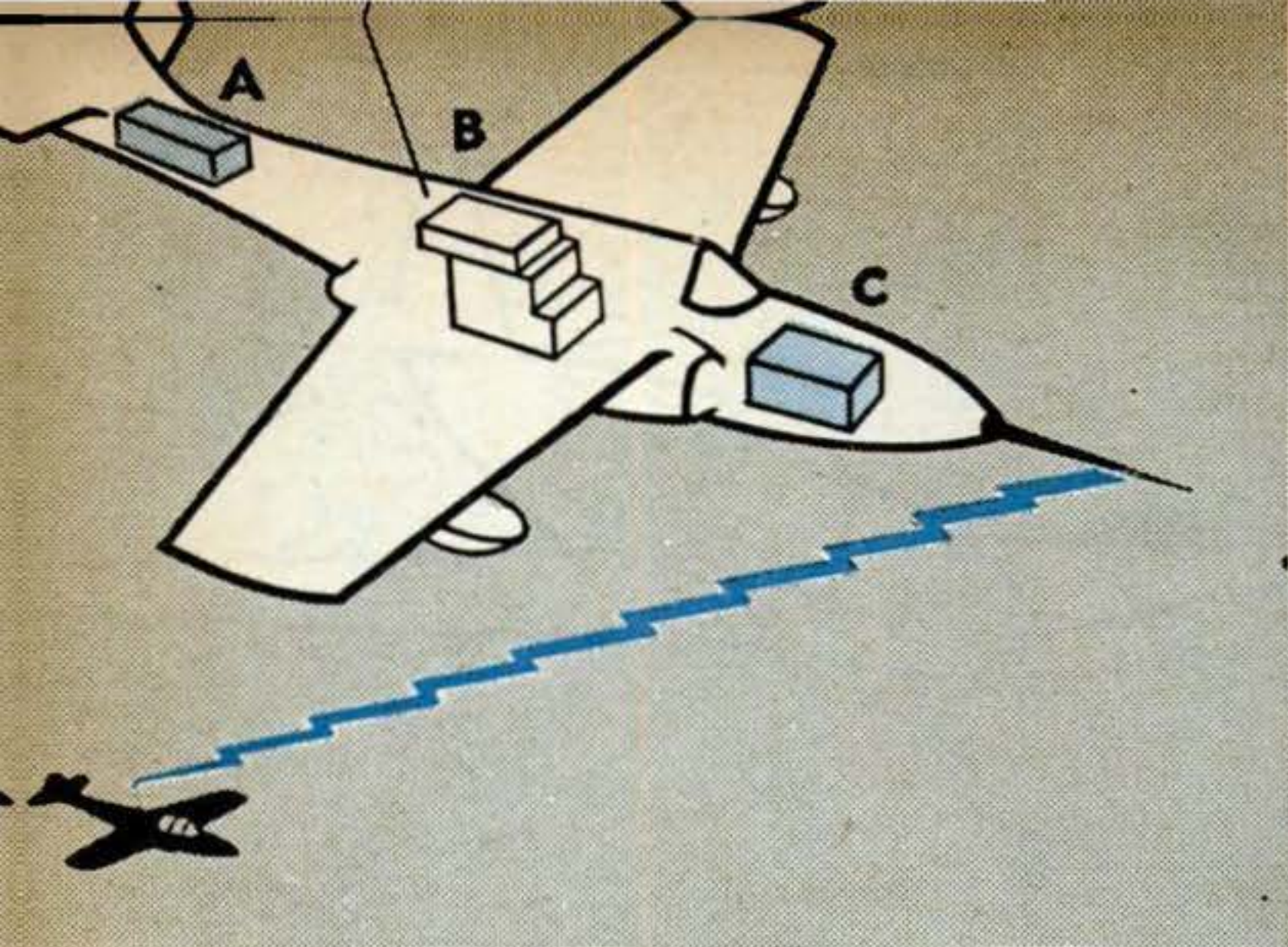
FOR LANDING, wing flaps and landing gear are lowered and engine is throttled. Brakes are applied; plane taxis off field; engine shuts off.

hookup that produces eight musical tones which can be heard through headphones worn by the operator. Each of these denotes some movement of the plane's controls. Each of the eight amber lights on the stick box also glows to the tune of some control function, but the lights are seen before the tones are heard. When the "turn" light glows, for example, this indicates that the circuit is clear for turning action. The operator hears no tone until he moves the little stick and the plane begins to turn. The order is given with the light, and the "execute" command with the musical tone.

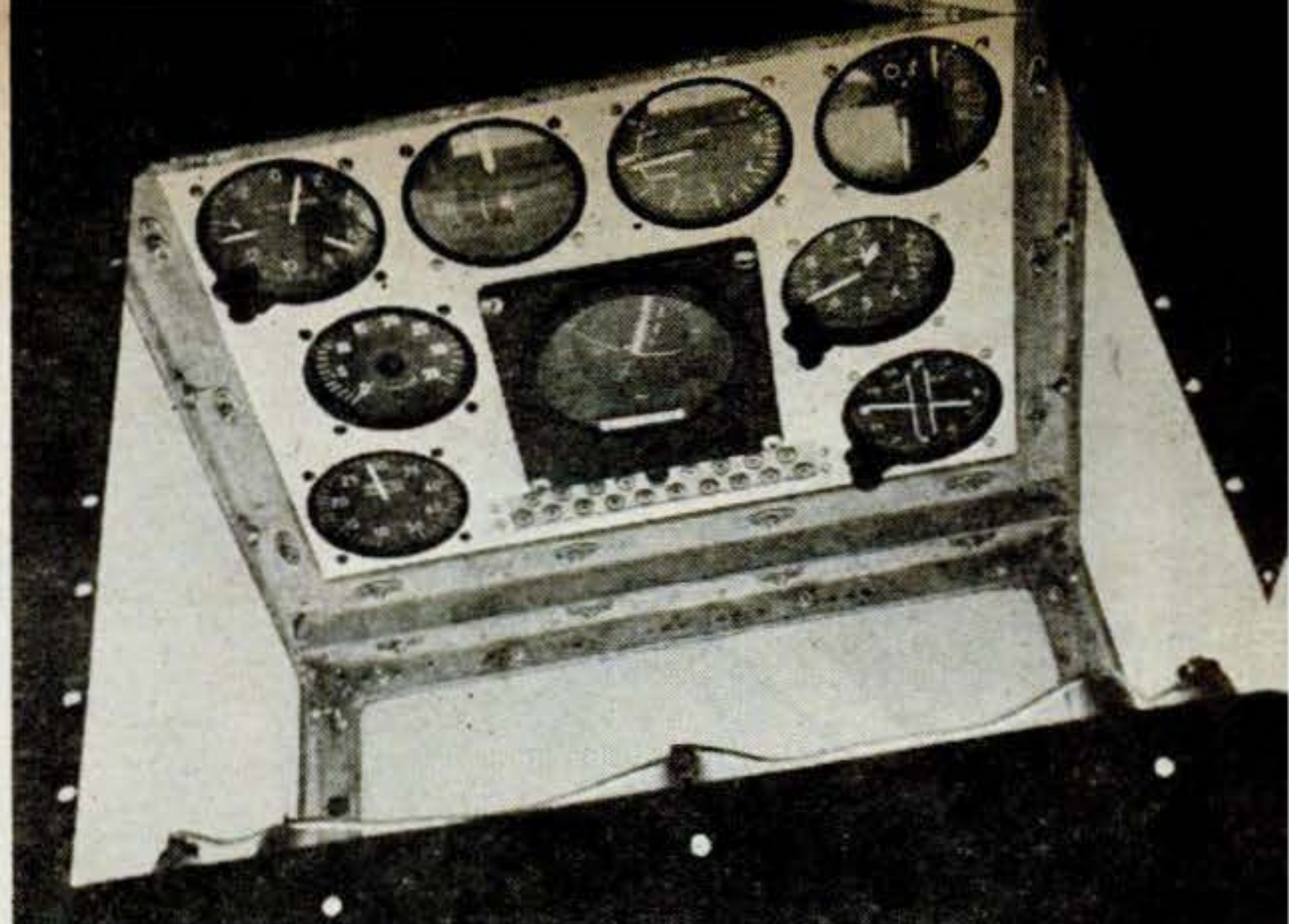
Expert radio-plane pilots rarely wear the headphones while the plane is within sight. Really "hot" operators do not even watch the lights, but concentrate on the controlled plane itself. Only rated AAF or Navy flyers are recruited for this musical flying duty, and it takes an experienced airman about 50 hours to learn how to be a "beep pilot." There is no "feel" to radio flying; it is strictly a matter of air judgment and finger facility. A safety pilot rides in the controlled plane to correct the student's mistakes, and an automatic power valve enables him to (Continued on page 224)

"STICK BOX." Selector switch (A) sets and resets circuits for action. Actuator switch (B) operates the throttle, landing gear, flaps, brakes, etc. Control stick (C) noses PQ up or down, banks, and turns. Indicator lights (D) show actions selected. Button (E) prevents accidental raising of gear.

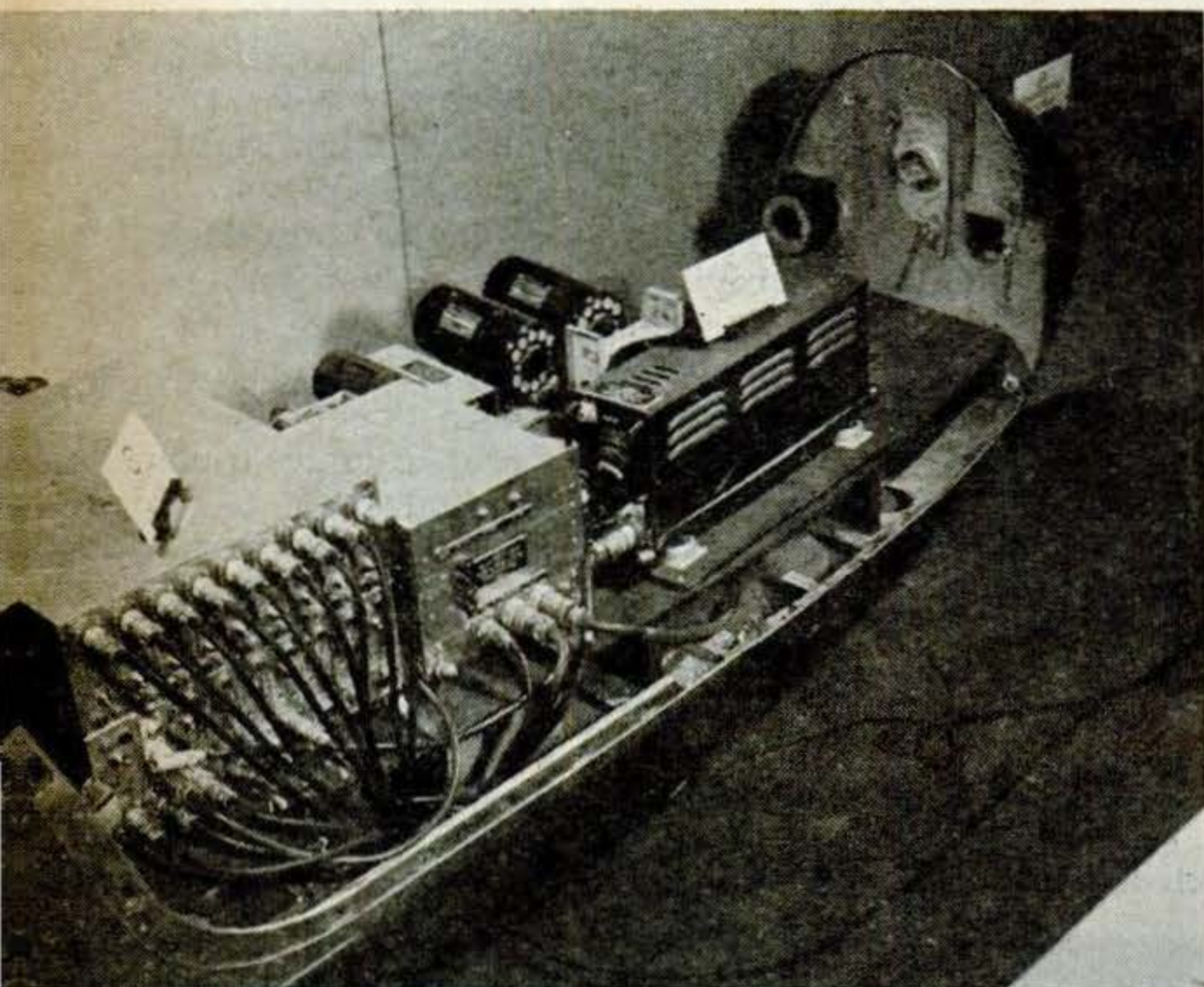




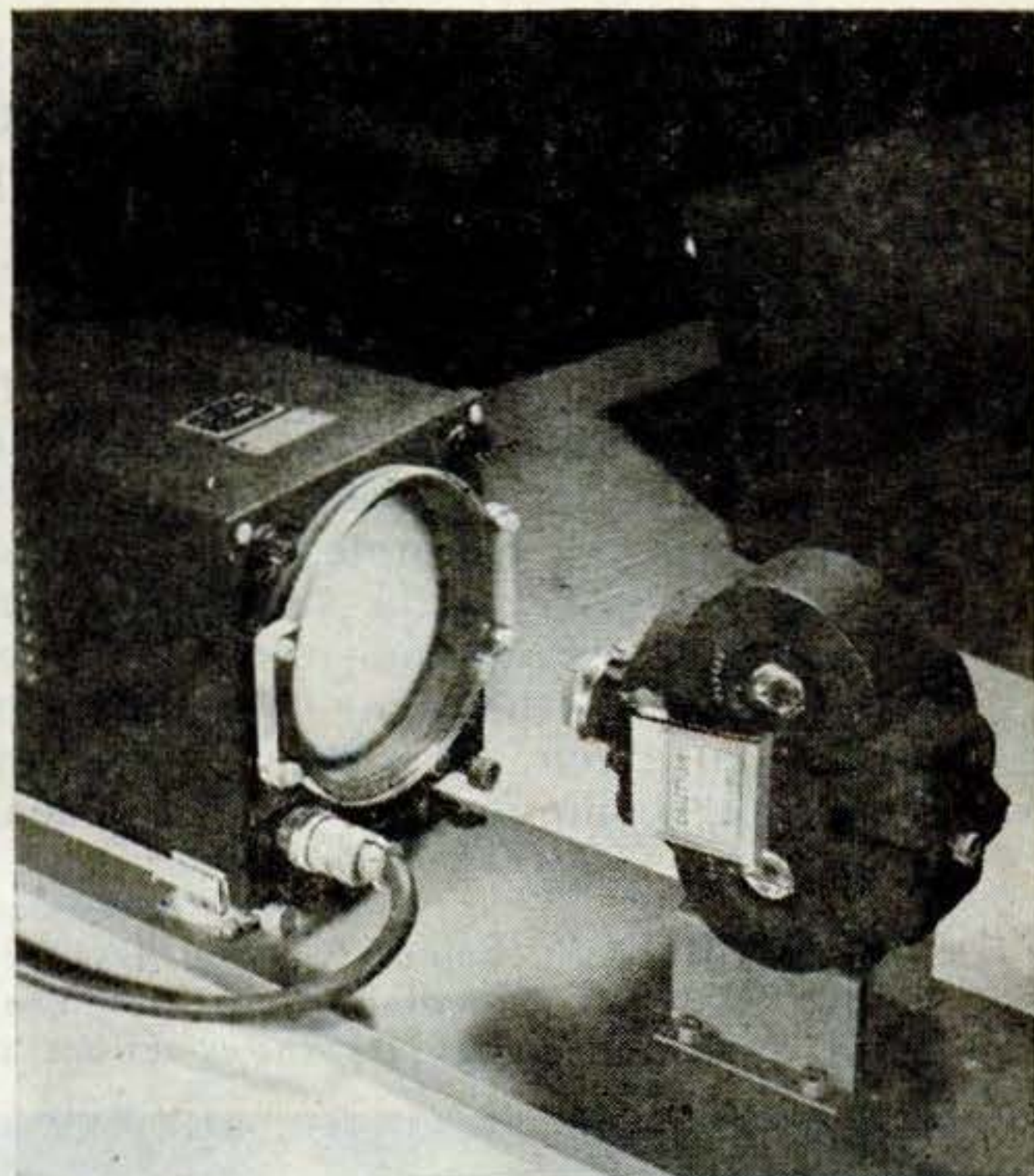
"RELUCTANT ROBOT"—first radio-controlled jet. (A) Television camera and instruments. (B) Special RFCU. (C) Television transmitter (below).



TELESERVER is combination camera and illuminated instrument panel in rear of fuselage of Bell YP-59B jet fighter for "telemetry" tests.



TRANSMITTER of television unit in nose of a test plane. With the camera pointed downward, same equipment could transmit views of terrain below for reconnaissance.



RECEIVER SCREEN in mother plane or on ground shows instrument reading in test plane. Camera makes permanent record.

CULVER XPQ-15 is newest radio plane. First U. S. type was Kettering's "bug" of 1941. Then came Culver PQ-8, Fletcher PQ-11, and Culver PQ-14.



"MYSTIC MISTRESS" is mother plane for "Reluctant Robot." Extra cockpit is for observer. Radio controls are on pilot's throttle and stick.

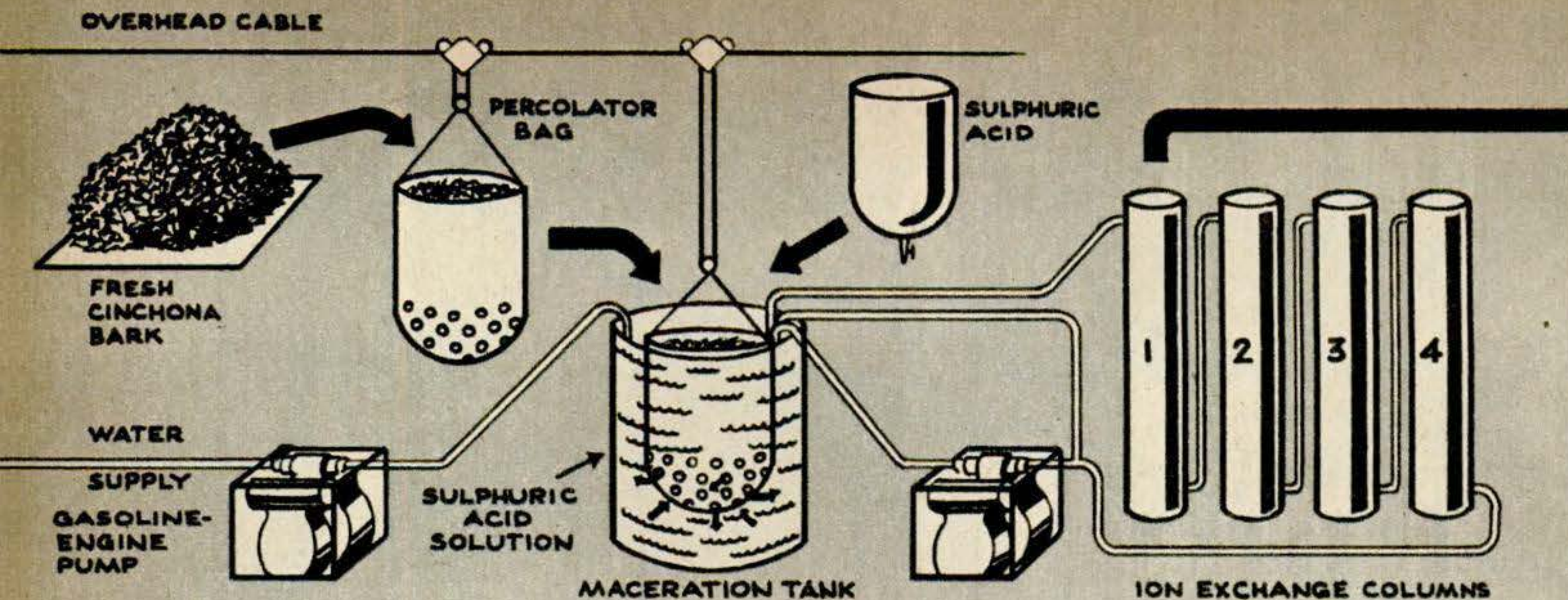




JOHN T. MCCOY, JR.

Your Pin-Up

CONVAIR B-32 BOMBER. With a wing span only about six feet less than that of the Boeing B-29 Superfortress and a fuselage only 15 feet shorter, Consolidated Vultee's "super" bomber has a gross weight of 100,000 pounds with capacity load and normal crew of eight men. Four 2,200-horsepower, 18-cylinder Wright Cyclone engines, equipped with two exhaust-driven superchargers apiece, turn the 16 $\frac{2}{3}$ -foot Curtiss electric reversible-pitch propellers.



HOW THE ARMY'S MOBILE PLANT EXTRACTS ANTIMALARIA

QUININE DIRECT FROM JUNGLE TREES

A MOBILE unit for extracting quinine and other drugs from the bark of fresh, green cinchona trees right where they grow in the dense forests of Latin America is the newest weapon in the fight against malaria. Although the military requirements for antimalarials have been met satisfactorily by other means, the new process has important peacetime possibilities for providing low-cost drugs for the 300,000,000 malaria sufferers in the world each year.

Three types of field extraction plants—whose product is totaquine, a medicine containing quinine and other related alkaloids—have been developed under the direction of Maj. Robert L. Kaye, chief of the Cinchona Research Unit of the Engineer Board, U. S. Army.

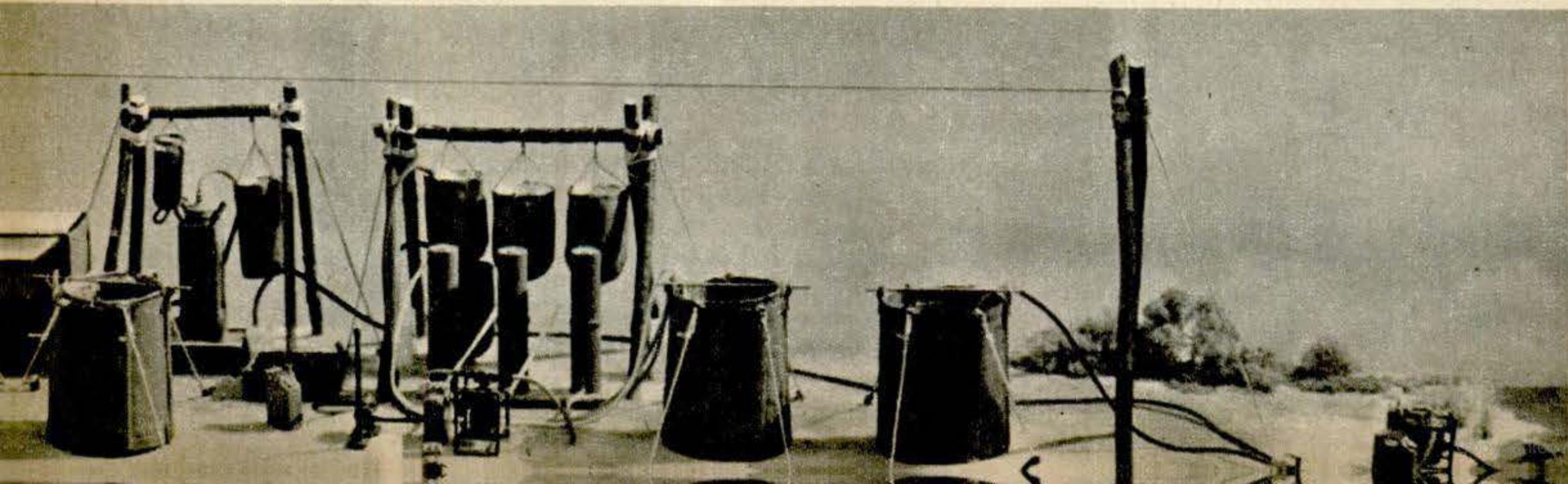
Totaquine has long been called "the poor man's quinine." Its cost today, when made from dried bark shipped to this country, is \$16 per 1,000 doses, or about one and one half cents per dose. Even at that price, most of the millions of malaria victims cannot afford proper treatment. Quinine, at

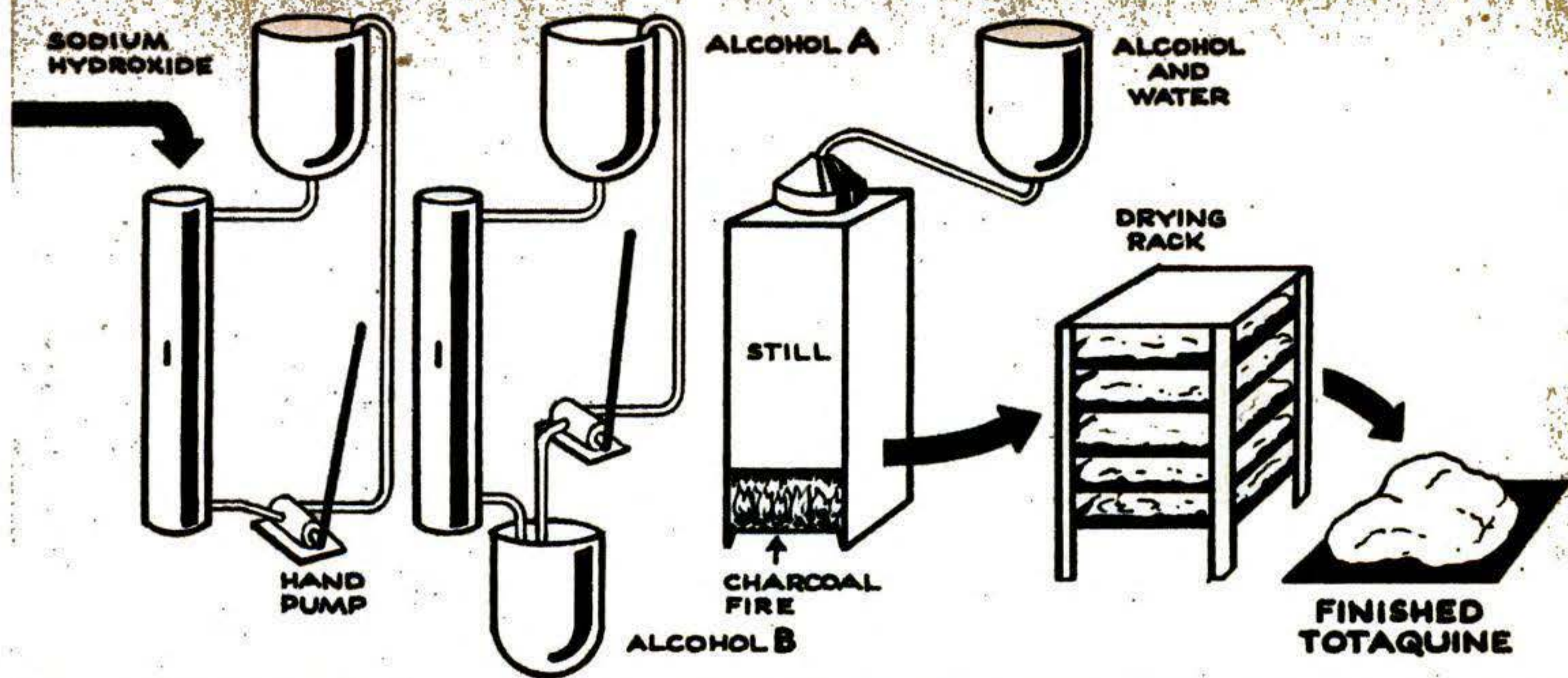
the time the Government last bought it, sold at \$90 per 1,000 doses, and atabrine, the synthetic compound, cost \$4 per 1,000 doses when bought in large quantities. The cost of these drugs is far out of the reach of the poor inhabitants of malarial regions who are in most need of such medicine.

Totaquine can be produced from fresh bark by the new method at a cost of \$3.80 per 1,000 doses, or about one third of a cent per dose. This figure is based on labor costs in this country when the gasoline-engine, ion-exchange process is used. When a simplified method is used and native labor employed, the production cost is cut drastically.

One type of mobile plant is an engine-pumped outfit using the ion-exchange principle (separation of the quinine and other related alkaloids from the cinchona bark by an acid solution), the operation of which is shown in the flow chart above. This plant weighs 1,500 pounds and the necessary chemicals for one month's operation weigh another 1,000 pounds. However, it can be

The engine-pumped plant is here set up and ready for operation in the field to extract malaria drugs from fresh cinchona bark. Each of the three percolator bags on the rack holds 500 pounds of bark chips.





DRUGS DEEP IN LATIN AMERICA'S CINCHONA FORESTS

broken down into small units and carried by pack mules over mountain trails. The plant can process 13,000 pounds of fresh bark a month, producing 120,000 ten-grain doses of totaquine at a cost of \$182 for labor and \$68.78 for chemicals.

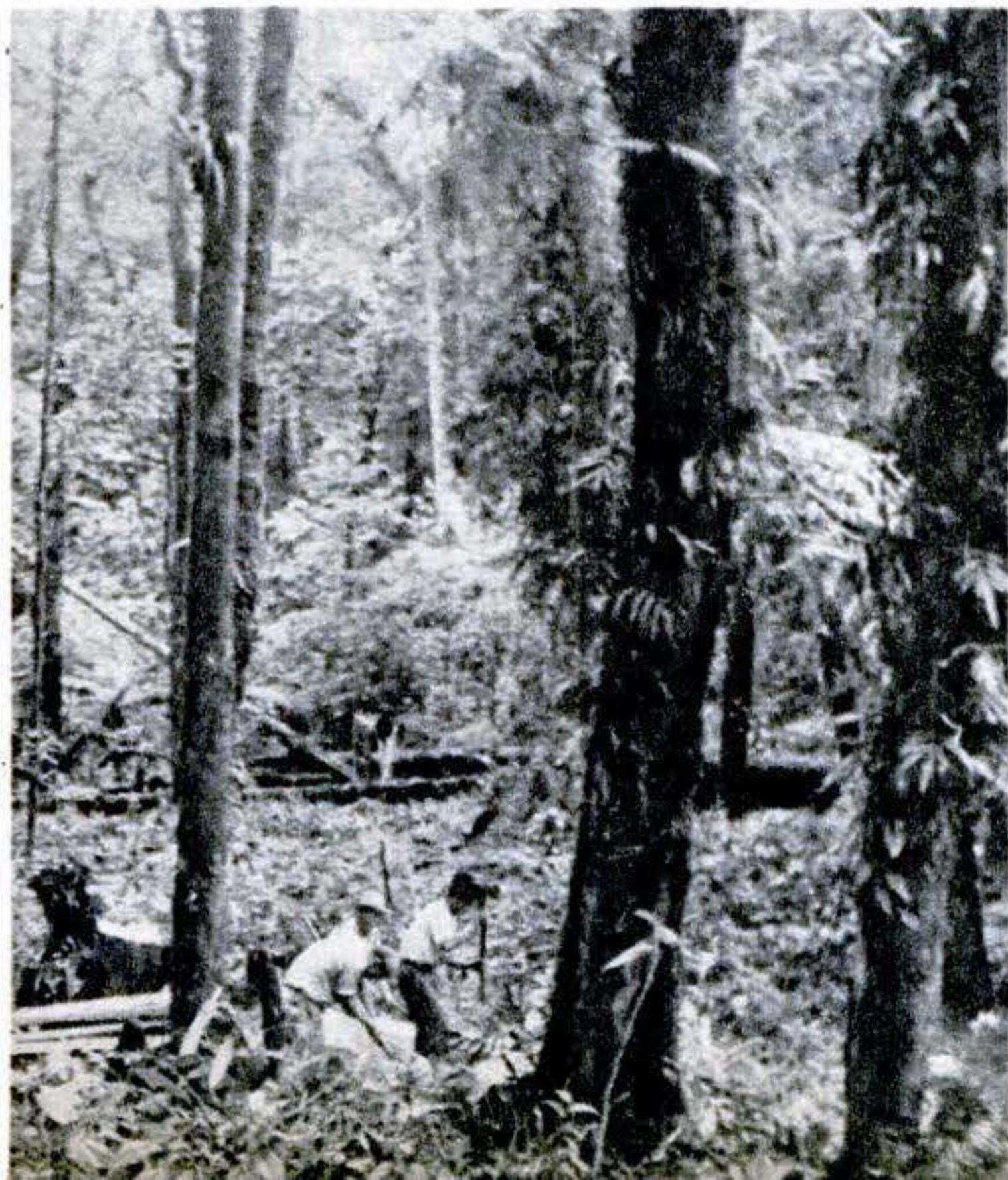
Another unit is a hand-pumped, gravity-flow plant that also uses the ion-exchange principle. It operates in the same manner as the engine-pumped plant, except that the circulation of the acid solution through the ion-exchange columns is accomplished by gravity flow and that the agitation of the bark mass in the maceration tanks is by means of a manually operated paddle or similar device. The capacity is about one half that of the engine-pumped plant.

Quinine-extraction field units will get the malaria drug from these trees in the rugged Andean region.

The third type is a simplified plant that does not use the ion-exchange method. Alkaloids are precipitated from an acid solution by the addition of a strong alkali. This plant is not nearly so efficient as the other two, but it is well adapted to small-scale production to meet local needs. Equipment may be improvised from barrels or pottery jars. A minimum of technical knowledge is necessary, and vinegar may be used for the acid solution.

The totaquine produced by any of these plants is an immediately usable anti-malarial that conforms to United States Pharmacopoeia standards. The quinine content of the alkaloid depends on the quality of the bark used.

Seedlings flown out of the Philippines started this American-operated cinchona planting in Costa Rica.





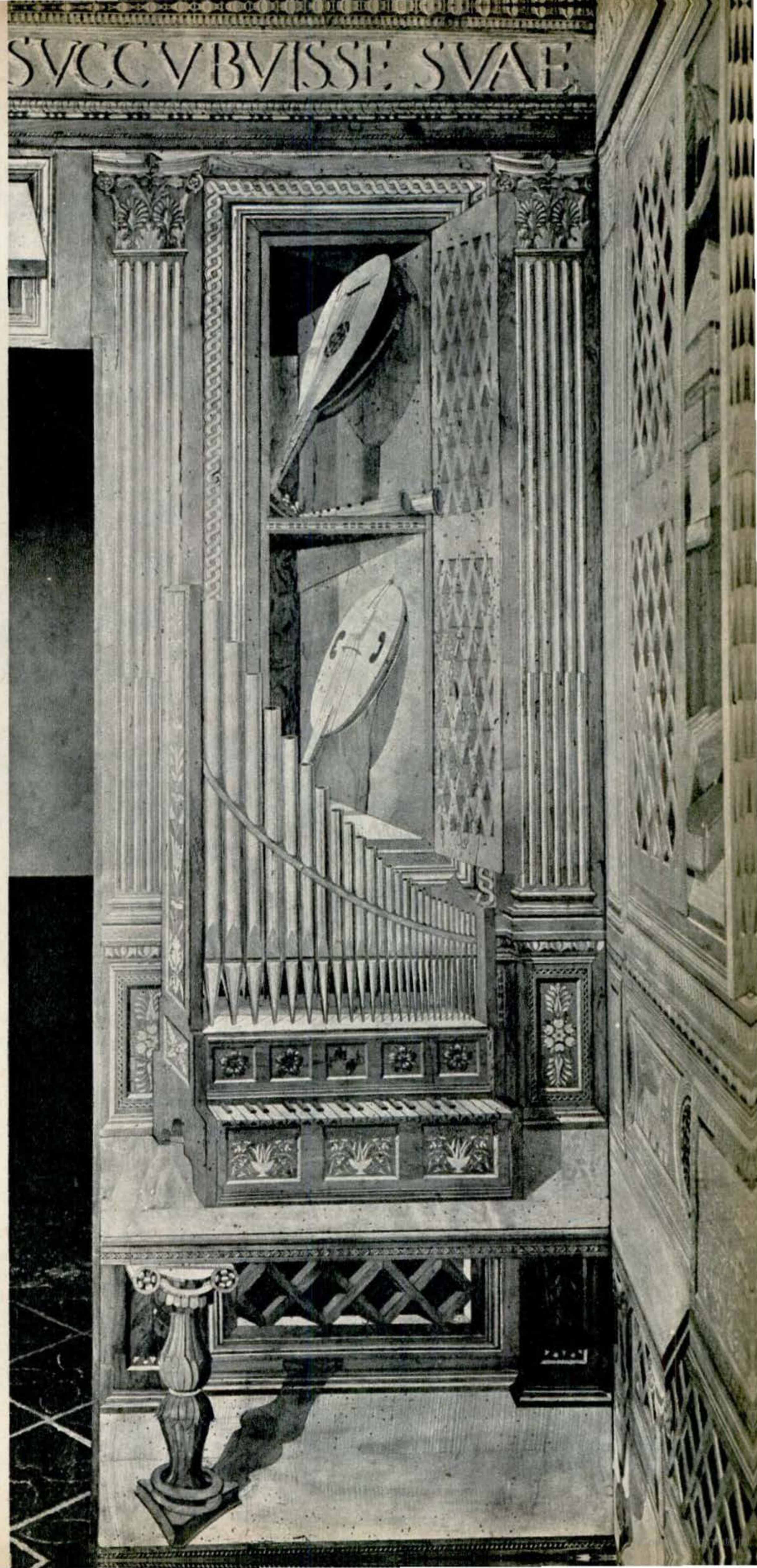
The Room of a Million Pieces

COUNTLESS tiny pieces of differently colored wood, inlaid in patterns to give the illusion of perspective and shadow, create the definite impression of a wide variety of furnishings in a small, bare room now on display at The Metropolitan Museum of Art in New York City. It is the private study of Federigo da Montefeltro, Duke of Urbino, transplanted from a palace at Gubbio, Italy.

The wainscoting was executed 500 years ago in intarsia (wood inlaid in wood) by Renaissance artists under the supervision of the Florentine woodworker Baccio Pontelli. It makes the room realistically ap-

pear to be lined with hinged benches and latticed cupboards containing articles symbolic of the Duke's many interests and accomplishments. The partly open cupboard doors reveal books, writing materials, musical instruments, and other contemporary objects, including a very businesslike dagger.

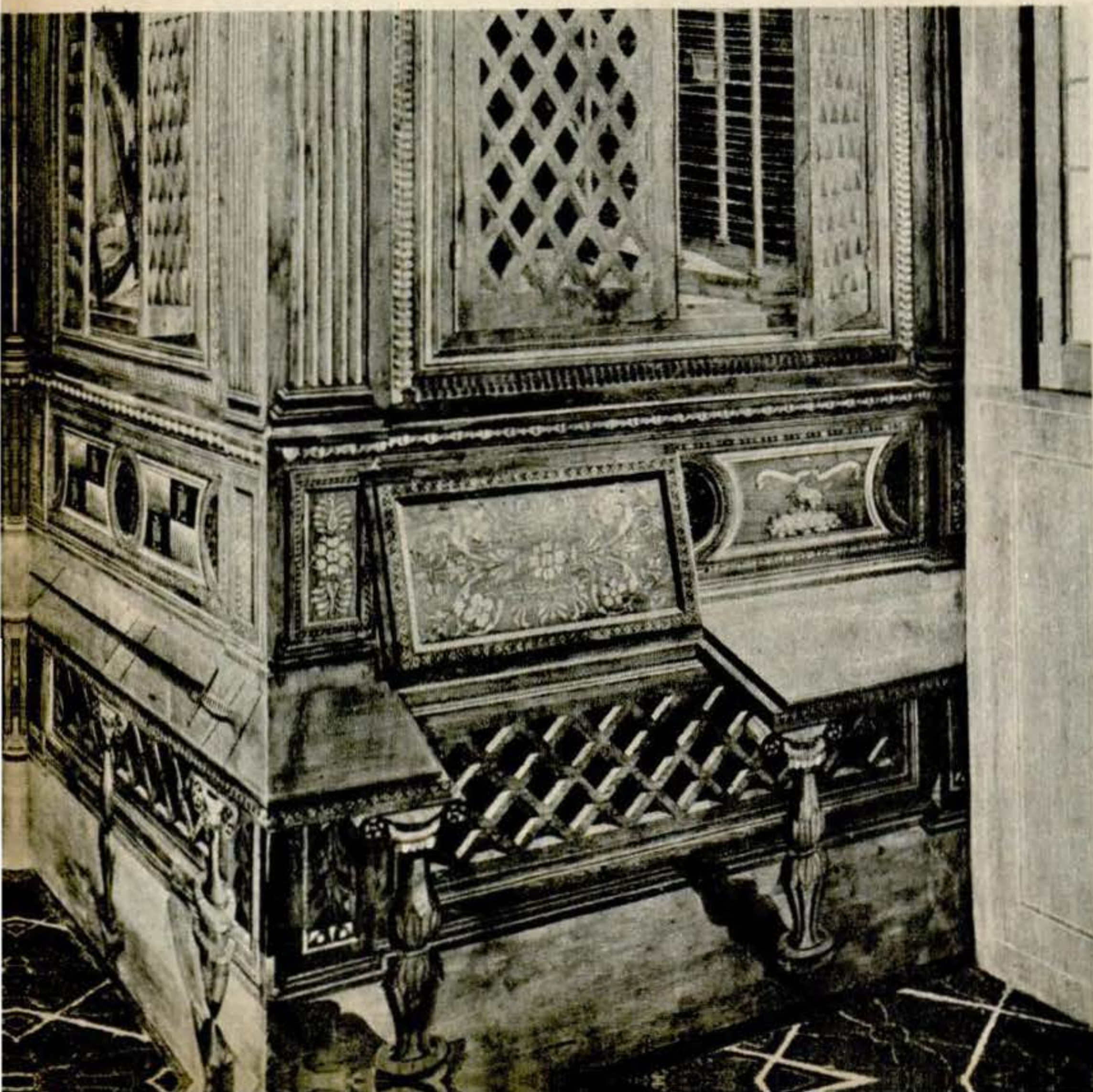
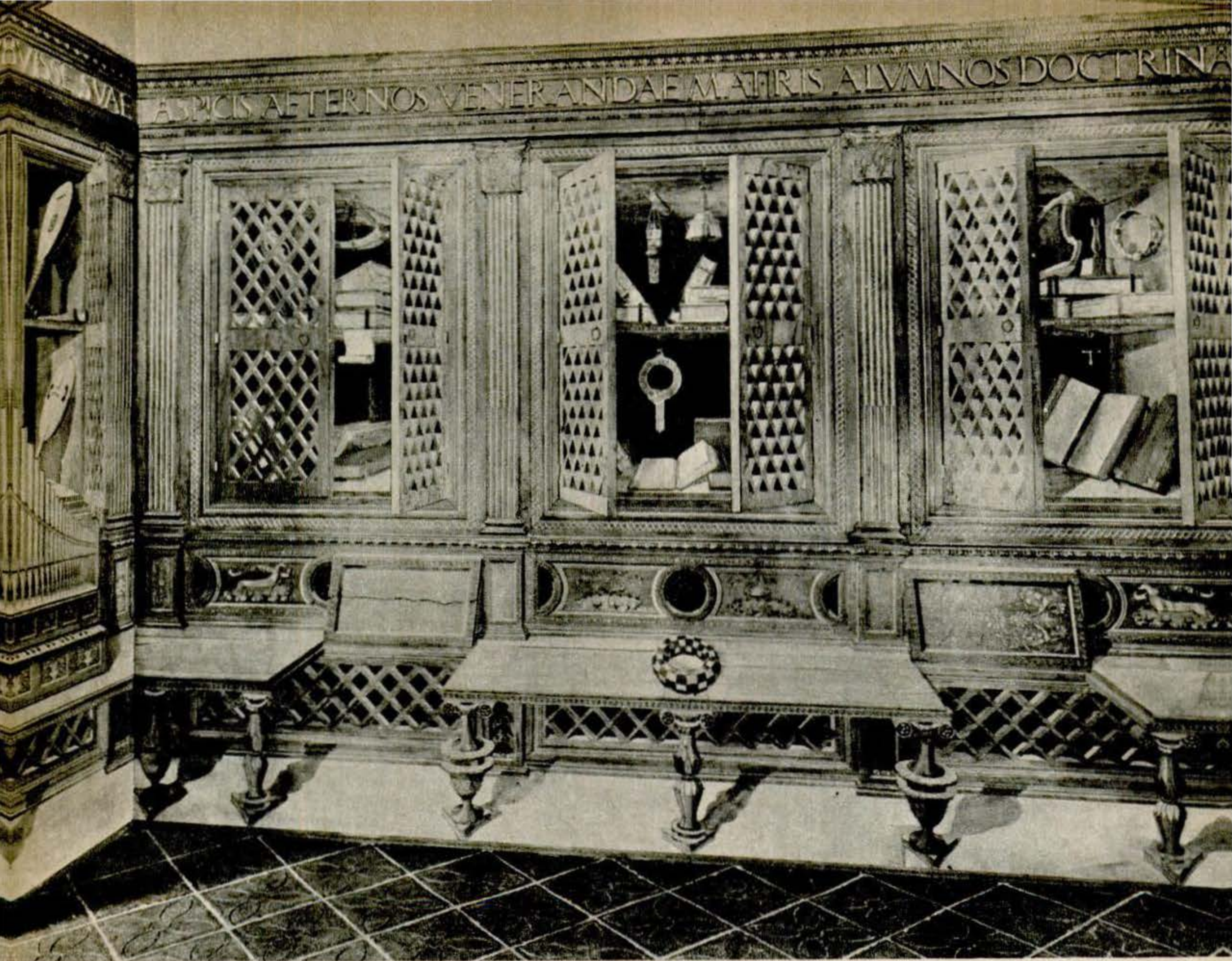
Electric lighting outside the frosted window is arranged so that sunshine appears to throw the shadows indicated by the dark inlaid wood. Visitors are allowed to enter a restricted portion of the room to study its detail and the three-dimensional effect of its decorations.



The lady in the period costume stands in a 500-year-old room at The Metropolitan Museum of Art. None of the furniture shown is real. The illusion is produced by the skillful inlay of wood on the flat wall.

A musical corner in the study of the fifteenth-century Duke of Urbino. It represents a portable organ resting on a wall bench. Behind the organ is an open cupboard containing a lute and cornettos (top shelf) and a rebec upside down.

Photos courtesy of The Metropolitan Museum of Art



Flat walls, inlaid to lend lifelike perspective, are made to give the impression of a fully furnished room. The hinged bench is represented so realistically that people have tried to sit on it. Undulating edges of the books' pages on the shelves look as though they were ready for thumbing by the ducal reader.

A section of the bench is shown lifted to display an arabesque on the underside. This inward-jutting corner of the room gives an opportunity to study the effective use made of perspective in creating the realistic sense of depth.

IT'D LIKE TO SEE THEM MAKE...

Everybody has his own pet idea of some gadget he would like to see in general use. What is YOURS? Popular Science Monthly will pay five dollars for every such suggestion published.

NONCLOGGING SALT SHAKER. The dry-rice treatment offers temporary relief, but there must be some way to "make it pour" always—especially when you're sitting behind a luscious steak and don't want to have your digestive system upset by a balky salt shaker before tackling the meat.



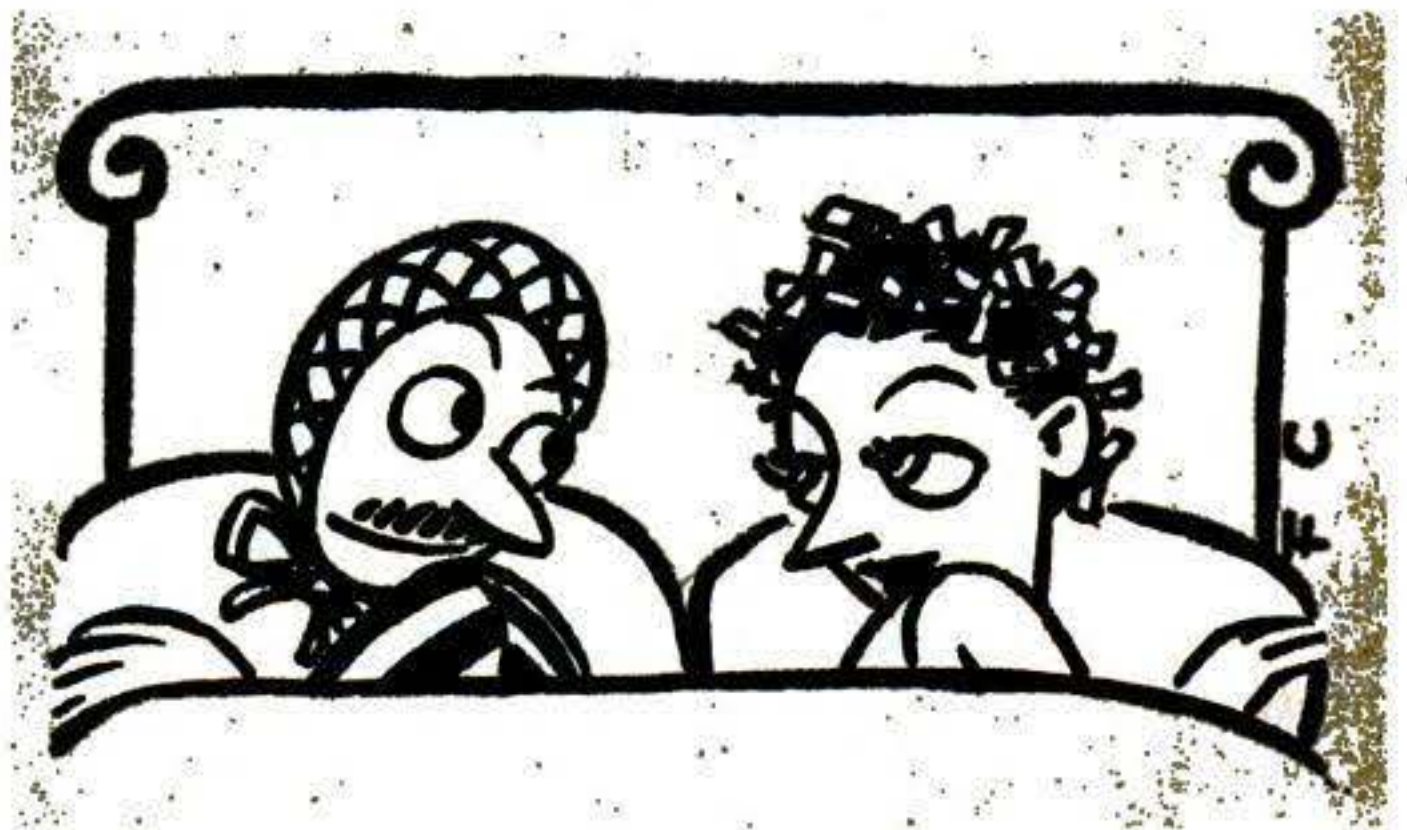
THEFTPROOF BILLFOLD that could be fastened securely to the trousers pocket. Such a tie would readily warn the wallet's owner when some light-fingered thief attempted to lift it. A further improvement would be a warning with sound effects, but that can come later.

LUMINOUS KEYHOLES would be a boon at all times. And, for high-spirited people who are lucky even to find the house, it would be like hitting pay dirt to have the keyhole stand out in the dark.



TELEPHONE SIGNAL to tell a person to call the "message operator." This would be a telephone-company service to get messages through should the phone be unattended when the original call is made.

A KNITTED ELASTIC CAP for us fellows who "can't do a thing" with our hair (what there is of it) after a shampoo. Of course, we could use a football helmet, but a knitted cap would let the air dry the hair and at the same time help train it. It just seems to be one of those quirks of nature that makes some men's hair, after a washing, look as if it should adorn the head of a wild man of Borneo, while the Missus, her locks in crimpers, tries valiantly to make hers look alive.



A DETECTIVE STORY: AMERICA'S FIRST INDUSTRY RECENTLY REDISCOVERED

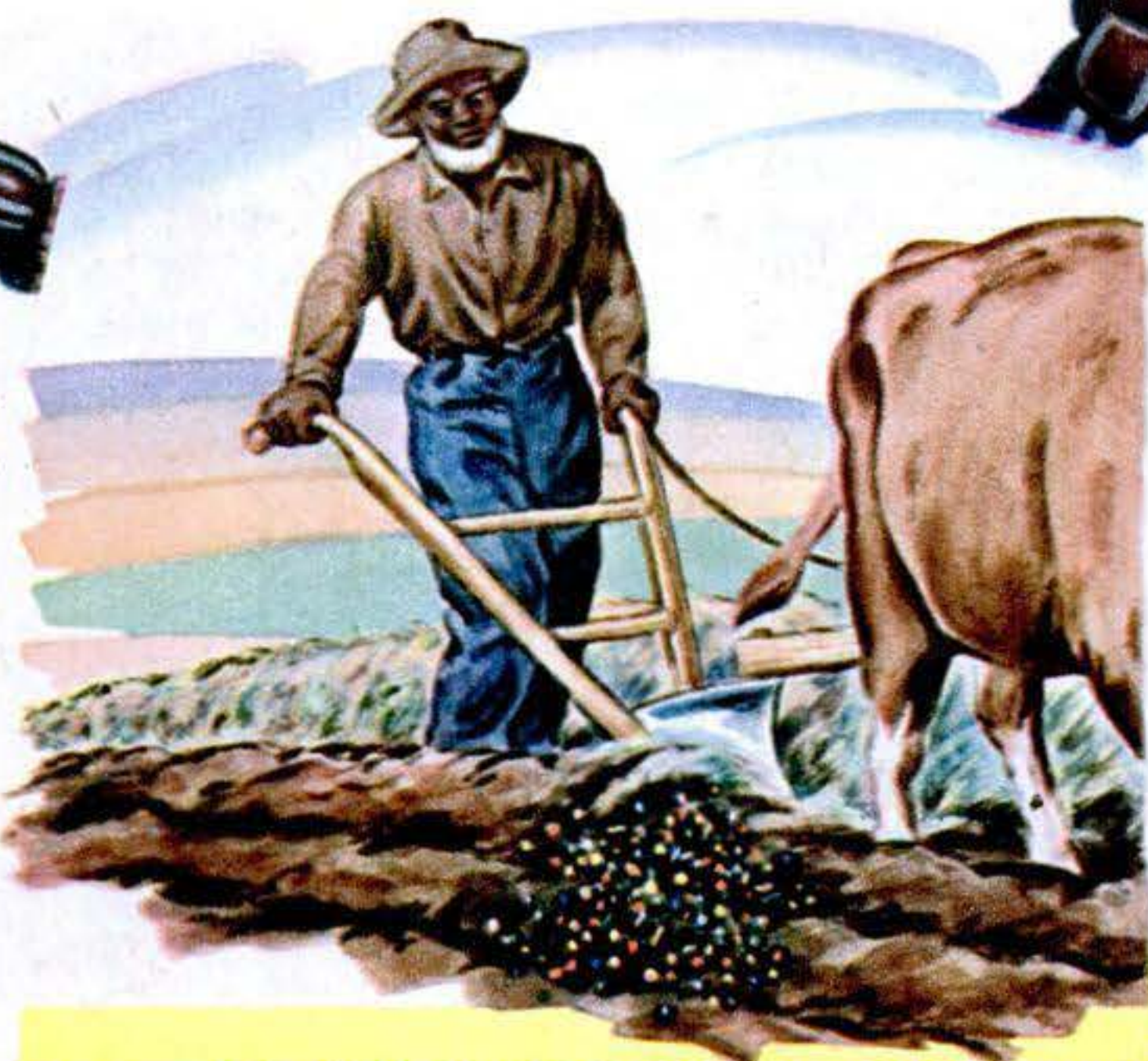
By WALTER J. SPARKS

ONE DAY in 1933, Jesse Dimmick, a Virginia farmer, while tramping through a densely wooded portion of his land a little more than a mile from Jamestown, stumbled upon an ancient glass furnace. It proved to be the furnace in which the first glass made in North America was produced. Captain John Smith had it built in 1608 for use by some Polish artisans who made bottles and windowpanes for the first permanent English settlement in America.

The discovery was like one of those lucky breaks that sometimes happen in detective stories. It led to the reopening of an investigation that had been started in 1930 by the Governor of Virginia with the purpose of finding the fabulous "King's Treasure" of Powhatan, the Indian sachem who was the father of Pocahontas. Many obscure clues have been followed up, and today we know the whole extraordinary story.

It turned out that Dimmick had found not only the spot where American industry was born, but also what was really the first mint of the New World. A few years after it was built, this furnace had been converted to the making of glass beads for use in trading with the Indians. The beads were handled exactly like money; each one, even if defective, had to be accounted for as if it were a coin. Great care was taken to safeguard the process and restrict the output of the Italian glassmakers who operated the furnace. This was to prevent what would now be called inflation. Today the beads are very rare; the few illustrated on these pages are insured for \$1,000.

The story of these skilled Italian artisans is in itself romantic. They had journeyed to London in quest of fortune. But when one Captain Norton, a man no less adventurous than they were, discovered them, they were living in want in a London slum. Norton got an idea. Across the seas, in



EDITOR'S NOTE:

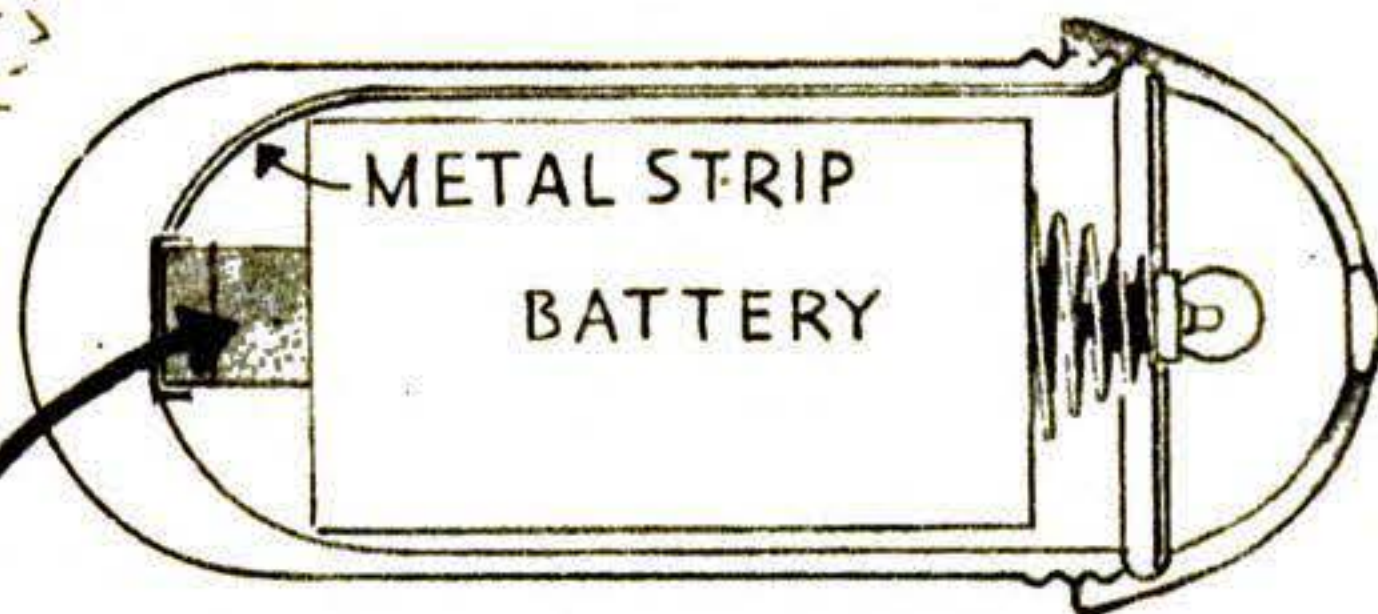
The cleverest detective work is sometimes done to solve a crimeless mystery. This story tells, for the first time in their entirety, the results of a 15-year-long investigation that finally uncovered the truth about the "King's Treasure" buried by Powhatan, father of the Indian maiden Pocahontas, more than 300 years ago. We know now what the treasure was—you can see some of it in the accompanying illustrations—where it was made, how it was made, who made it, and why.

Virginia, glass beads were in great demand for trading with the Indians. They were money.

So Captain Norton went to his friend, the poet George Sandys, "a gentleman of ample means and noble birth," and together they formed a joint-stock company with Sandys as treasurer and Norton as manager of the glass works. A contract was signed with the six Italians, who, with their wives and families and their two forward-looking employers, set sail (*Continued on page 208*)



NEW IDEAS FROM



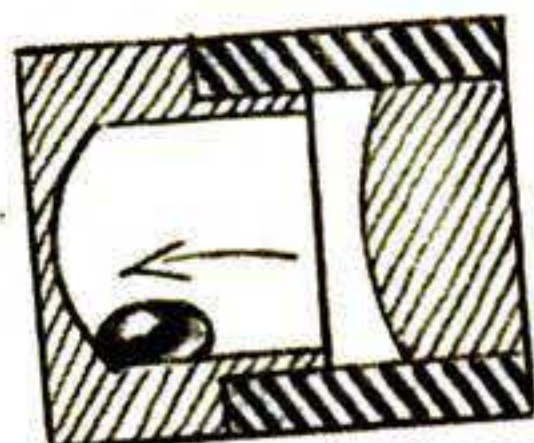
MERCURY SWITCH

QUICKSILVER FLASHLIGHT SWITCH controls the beam according to the position in which the lamp is held. It lights up when you point it down or hold it horizontally. In the end opposite the bulb is a drop of mercury, which rolls to make the contact closing the circuit. The flashlight was invented by Gwilym F. Prideaux, Cleveland Heights, Ohio.

DROP OF MERCURY

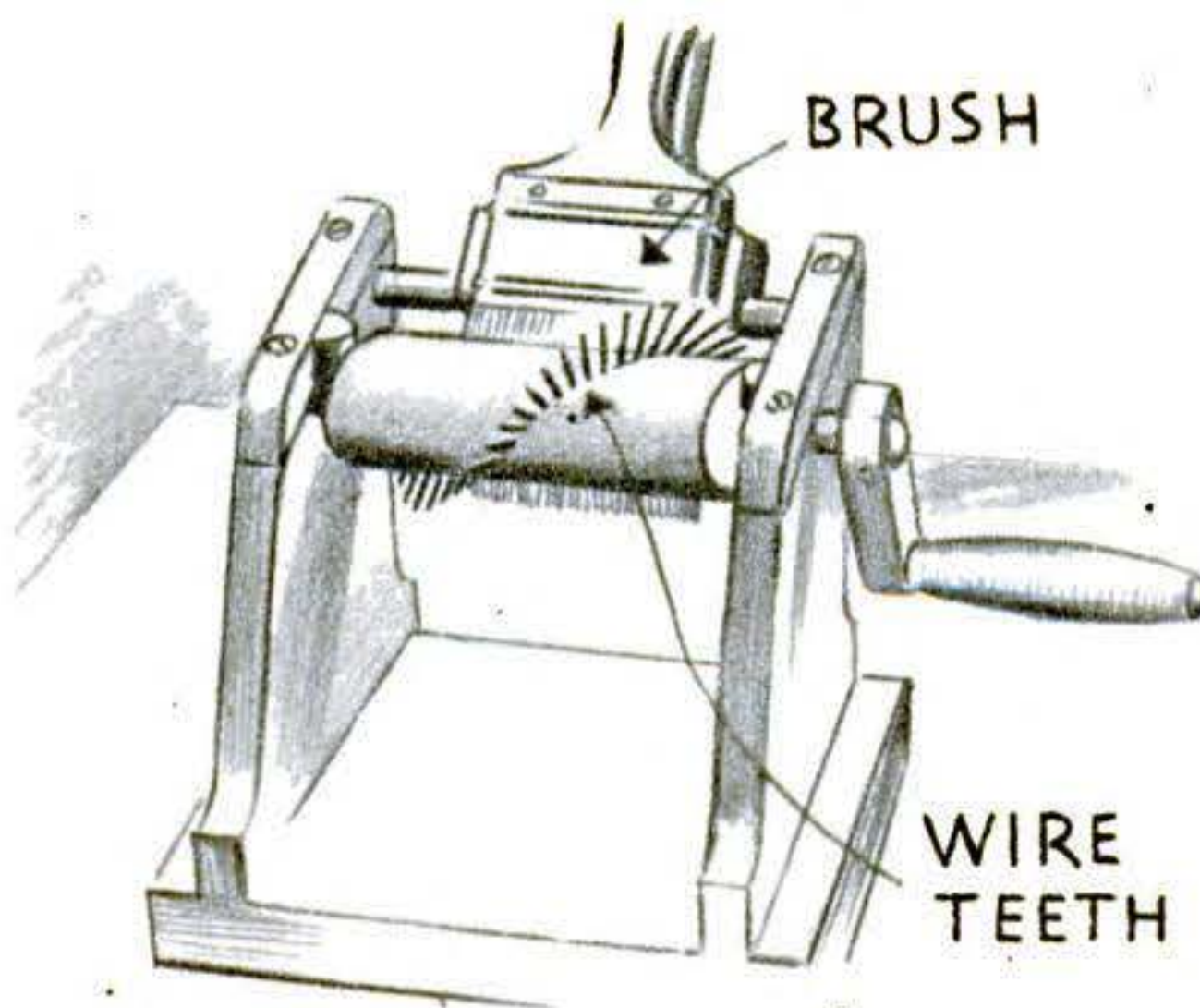


CONTACT MADE



CONTACT BROKEN

PAINTBRUSH CLEANER has teeth in it to comb out dirt and hardened paint. Embedded in a cylinder of wood or plastic material are wire teeth set at an incline toward the direction in which the cylinder revolves. The brush is fastened on a support so that the spirally arranged teeth will travel across it with a back-and-forth motion when the cylinder is turned by the handle. For a brush that has become hard with caked paint, a cleaning solution is first used to partially soften it. The machine embodies the ideas of Carl Jay Wiksten, St. Joseph, Mo.



CHEATING THE OUTDOORS of the heat that would merely go to waste up the chimney is accomplished by the device originated by Wilbur R. Brooks, West Hartford, Conn. Since the largest proportion of the heat generated by an open fire goes up and out, even with a well-designed fireplace, the inventor conceived the idea of returning part of this heat to the room by means of a fan intake that pipes the chilly air through the flames of the fire. Lengths of pipe are joined and arranged continuously at the back of the fireplace in the direct rays of the heat going up the flue. Low-temperature air from the room is sucked through the conduit, heated, and ejected back where it will do the most good. The contrivance also helps in the ventilation of the room. It is portable, easily set up, and can be fitted to any fireplace with a few simple tools. The end of the pipe through which the heat is discharged can be extended to the part of the room where additional heat is most needed.

HOT AIR OUTLET

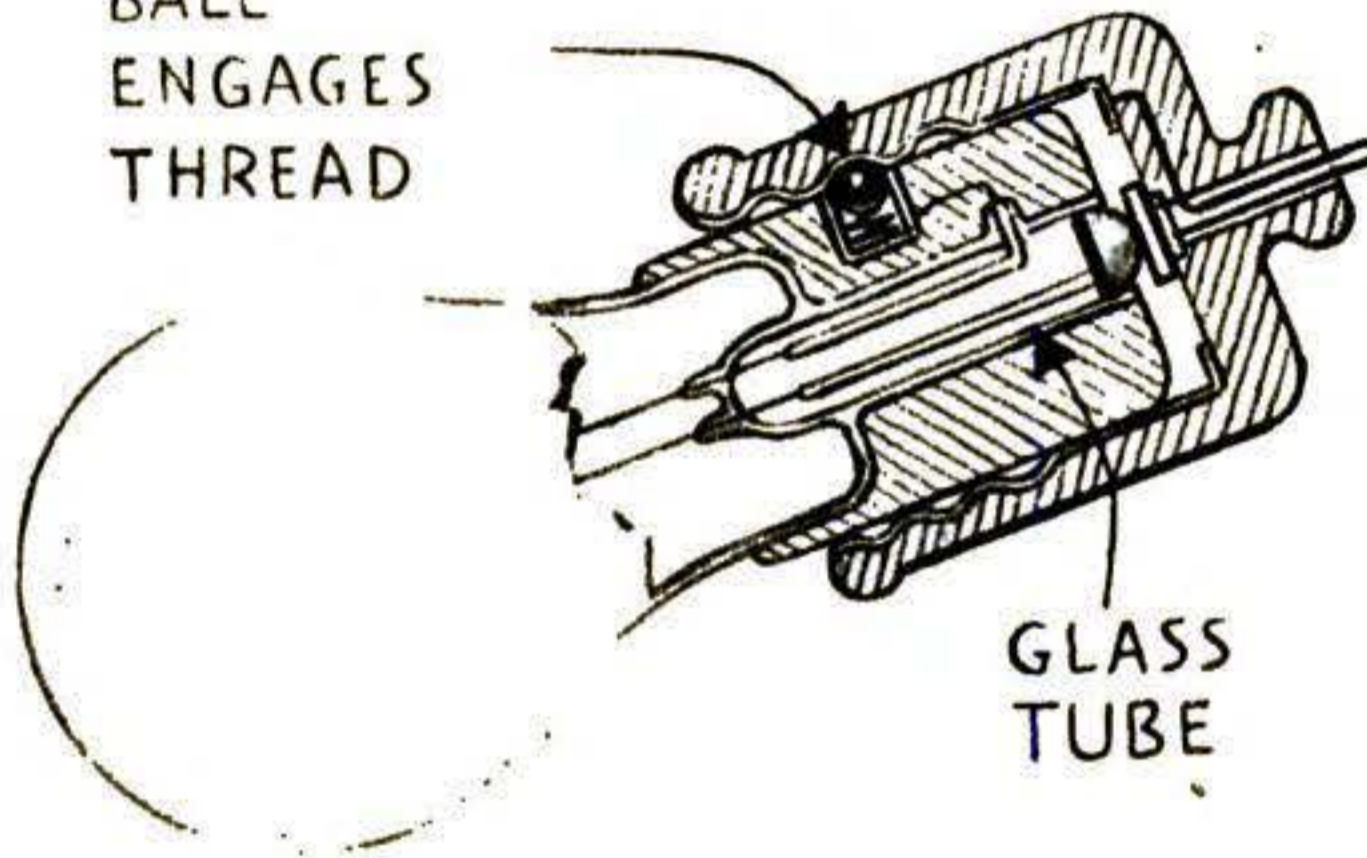
COLD AIR INTAKE AND FAN

THE INVENTORS

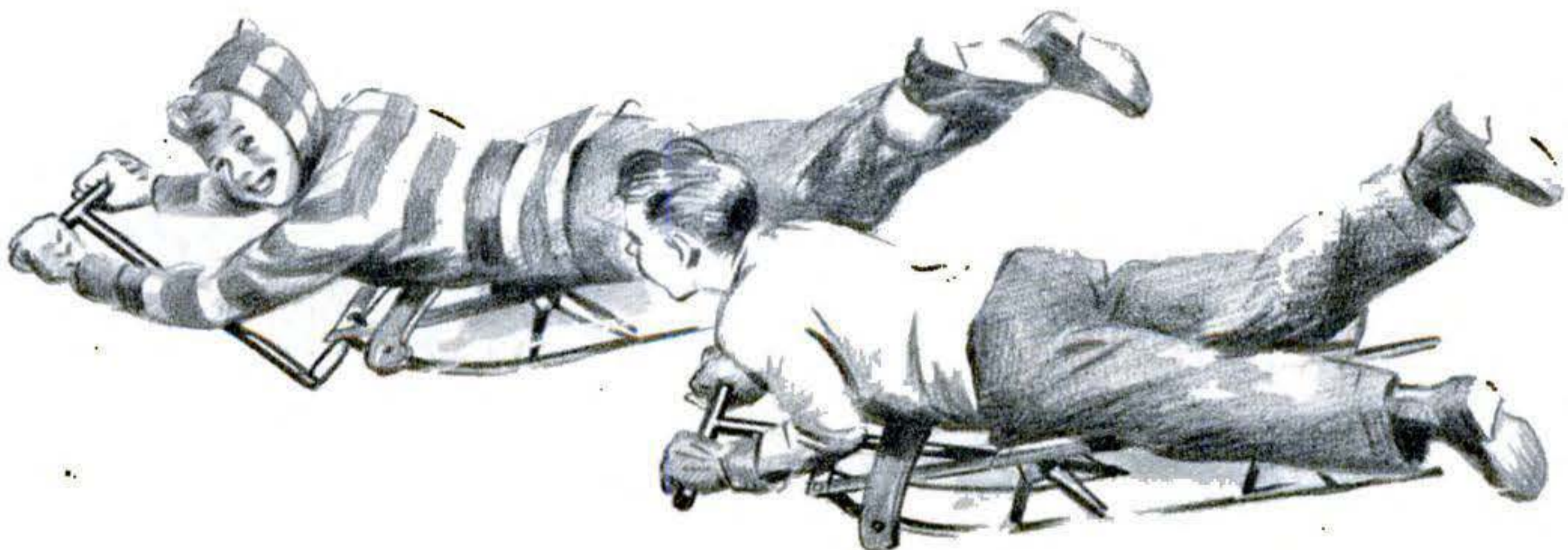
IT'S EASY TO READ IN BED if you have one of the new attachments designed by Courtland D. Burton, Indianapolis, Ind. You can lie flat on your back and, except for the slight exertion involved in turning the pages, do nothing but enjoy the latest "whodunit" or the current issue of **POPULAR SCIENCE MONTHLY**. A suitably slanted easel is held at a comfortable distance in the reader's line of vision by an adjustable rod that is secured by a thumbscrew to the headboard of the bed. Suspended on this rod is an electric spotlight focused to illuminate the reading matter. The book or magazine is attached to the easel by spring clamps on either side, and is kept from sliding down by a rest at the bottom edge. The apparatus can be easily removed, taken apart, and packed for storage or shipping.



BALL
ENGAGES
THREAD



ELECTRIC BULB SNAPS INTO IT. No more twisting of a bulb in its socket if the invention of Louis Frank, Fellows, Calif., is generally used. Bulb ends are molded of plastic, in which, instead of threads, are from one to three friction catches, or steel balls on spring cushions. The bulb is shoved into an ordinary socket, where the friction catches establish connection with one pole of the circuit. The other pole connects in the usual way with a wire extending through the lamp to the base of the plastic plug.



BELLYWHOPPERS DE LUXE are possible to girls and boys who own the sled improvement invented by Emerick Hodaly, Detroit, Mich. Not even a hill is required. A pole with a handlebar crosspiece at one end and a pointed piece of steel at the other is fixed by ropes fastened to the sides of the forward end of the sled. Holding onto

this attachment, the sledder can propel himself over level snow or ice, or he can use the device for steering when coasting downhill. The ropes that attach the pole to the sled control the length of stroke and thereby prevent bruised hands from too hearty a push. Stretched ahead, the contrivance can be used for pulling the sled.



COMPOSE YOUR COLOR PHOTOS AS HOLLYWOOD DOES

HOW THE GLAMOUR CAPITAL TAKES LESSONS FROM NATURE

By **ROMAN FREULICH**

Portrait Photographer, Republic Pictures, Inc.

WHENEVER I am asked why I prefer color to black-and-white photography, I invariably reply: "Not until you copy a painting with your camera can you understand."

In taking color pictures, you paint on film

with light. You copy the visible colors of the spectrum in their many combinations and variations as reflected by the objects within range of the camera lens.

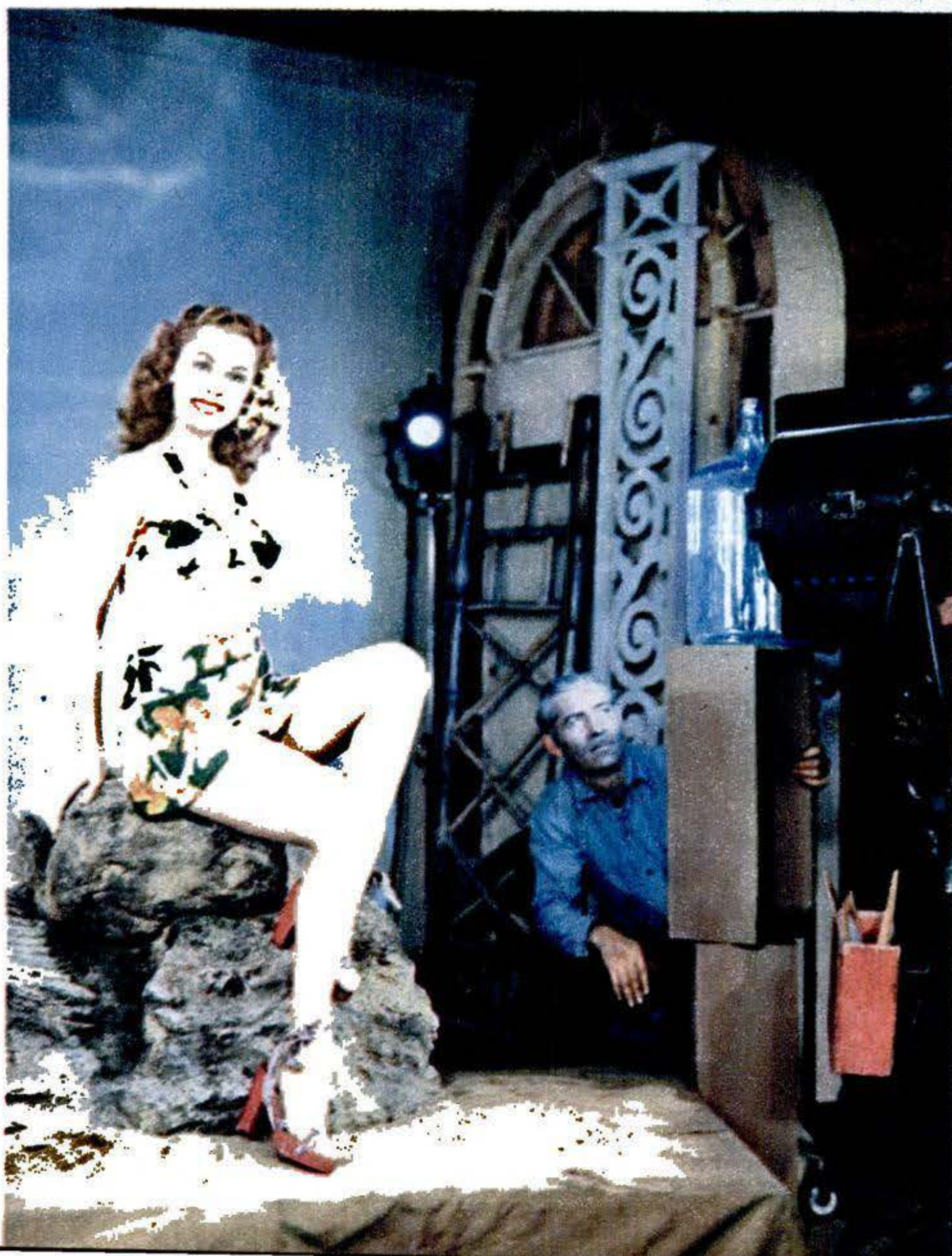
Although the amateur must be aware of important differences between black-and-white and color photography, there is no reason for him to hesitate to explore the beauties of color, for he can take good color

pictures with the equipment that he probably has at hand. Besides the film, he needs only his camera, tripod, sunshade, two flood lamps and a reflector, and perhaps a light meter.

I make many color portraits of Hollywood stars, some of which are reproduced on these pages. But at home I get just as pleasing results with amateur equipment. When taking outdoor snaps of my two children, I boost light into the shadows with a homemade reflector. It is the approach rather than the equipment that counts.

Amateurs know that in black-and-white photography they can put the shadows to work, balancing them against the lighter areas to render a more pleasing composition. You achieve much the same effect in color if you play complementary colors against each other. Try to wash out the shadows and permit

Yellow and red provide contrast for Janet Martin's brunette hair, while her gown is set off effectively. Below, red-headed Linda Sterling taken against a synthetic ocean, and at left, against a green tray.



color to give separation, for deep shadows blacken color.

You cannot correct mistakes on the transparency, as you can by intensifying or reducing a black-and-white negative. The shutter snaps on color with finality.

Put complementary colors to work! That is the basic rule in a nutshell. You need only explore the fields—or your flower garden—to find many examples of colors working harmoniously together as nature intended. Red roses are complemented by green leaves and branches. We call the colors complementary because in combina-

tion the red appears redder and the green actually greener. Both stand out more brilliantly because of the relationship. But pluck a red rose and place it against a wall of dull-red brick, and it loses much of its brilliance.

As in arranging complementary colors in painting, compose your photographic subjects with the same eye for colors. Here are six color combinations that will be easy to remember and of immeasurable value in color photography because the 12 colors in them occur frequently:

Crimson	Green
Scarlet	Blue-Green
Orange	Blue
Yellow	Blue-Violet
Green-Yellow	Red-Violet
Yellow-Green	Magenta

In portraiture, including even informal outdoor snaps, clothing colors and the background should harmonize as do these examples. Colors should be subordinate to the subject. Contrary to black-and-white practice, light backgrounds need not be provided for dark subjects and dark backgrounds for light subjects because the colors

will create contrast. Harsh and brilliant colors, as well as very dark ones including black, should be avoided because they obscure important detail and may be otherwise unpleasing. Children dressed in light colors photograph well against pastel shades. Men in blue may be placed against a background of maroon. Try pastel green for women in lavender, or jade green for women in pink.

Faces, tending toward yellow-orange, usually photograph well against blue sky, but many portraits, particularly close-ups, can be improved greatly by make-up. In general, application of make-up offers no difficult problem—provided you can get any males in the picture to stand for the stuff.

Make-up obscures blemishes such as slight scars and splotchy freckles. Persons, particularly girls and children, who enjoy a fair and clear skin require scarcely more than a touch of lip rouge.

Several types of make-up are generally available in drug stores. I prefer a grease base of a tint to suit the individual. Simply daub it on the forehead and cheeks with a finger and smooth it down. Shade the surface with powder. Apply a natural red lip

PLANNED LIGHTING IS THE SOLUTION TO YOUR

ONE of the most important factors in the production of a good portrait is the photographer's ability to see high lights and shadows. Every light that is used has a specific purpose and does a certain job in creating an effect in the portrait.

What the four lights most often used by professionals will do for a portrait is shown dramatically in the five photos below. The diagram at the far right is keyed to indicate just which lights were used in making the photos. Thus, the key light was used for Figs. 1, 2, 4, and 5, but not for Fig. 3.

Just as in nature, where the sun is the main source of light, good portraiture ordi-

narily involves the use of a single key light. This key, which alone was used in Fig. 1, should be placed before any other light. Without complementary lighting, it will leave sharp shadows. Either a spotlight or diffused floodlight can be used; a spot gives sharp-cutting, crisp details, while diffused light is often more desirable for photographing children or elderly people. A spot is ideal, nevertheless, when a dramatic character study is being made of an old man or old woman—it brings into sharp contrast every whisker, wrinkle, and pore in the face. In general, a floodlight is more flattering.

A "fill" light is used to throw an over-all



rouge, smoothing the contours with a soft brush. Men usually require a rouge of brownish cast to match their naturally ruddy complexion.

You cannot always find exact color combinations for your photography, especially outdoors where you usually must take what nature provides. A change of suit or dress, if you are at home, may simplify the problem. Since the light in early morning and late afternoon carries a reddish tinge, it is a good idea to take your pictures between nine and three. Place your subjects in the sunlight away from both shadows and shade. Include such dark backgrounds as trees and hedges only when they are lighted by the sun. It is a good idea, too, to photograph people from a low angle in order to include blue sky or clouds. To avoid unsightly squinting, have your subjects turn slightly away from the sun. Use a reflector to fill in shadow and provide some side lighting.

There is little you can do about the light for landscapes and scenics except to select an appropriate time. Choose a bright, sunny day if possible. Include a tree or doorway or a friend in the foreground.

Once you are satisfied with outdoor color pictures, you will be ready to move indoors. This means artificial light, either flash or flood, and you will discover the most important difference between black-and-white and color photography.

Contrary to what you have learned in making black and whites, you will find flat lighting best, except for certain effects in which shadows are needed to dramatize a scene. The flat technique succeeds because the contrasting colors themselves provide separation and give a feeling of depth.

To produce flat lighting, two No. 2 flood lamps in reflectors are adequate for full-length figures and room corners. Place one on each side about 18" from the camera, one at camera level, the other 18" higher.

Start with close-ups of persons or a still life of objects grouped on a table. I always try to include at least four colors, for the more you include the richer the result will be.

If possible, back up the principal interest with a colored screen or dyed bed sheet, or place your subject near a colored wall to take advantage of reflected back light. Select a background of some variant of red,

PORTRAIT PROBLEM

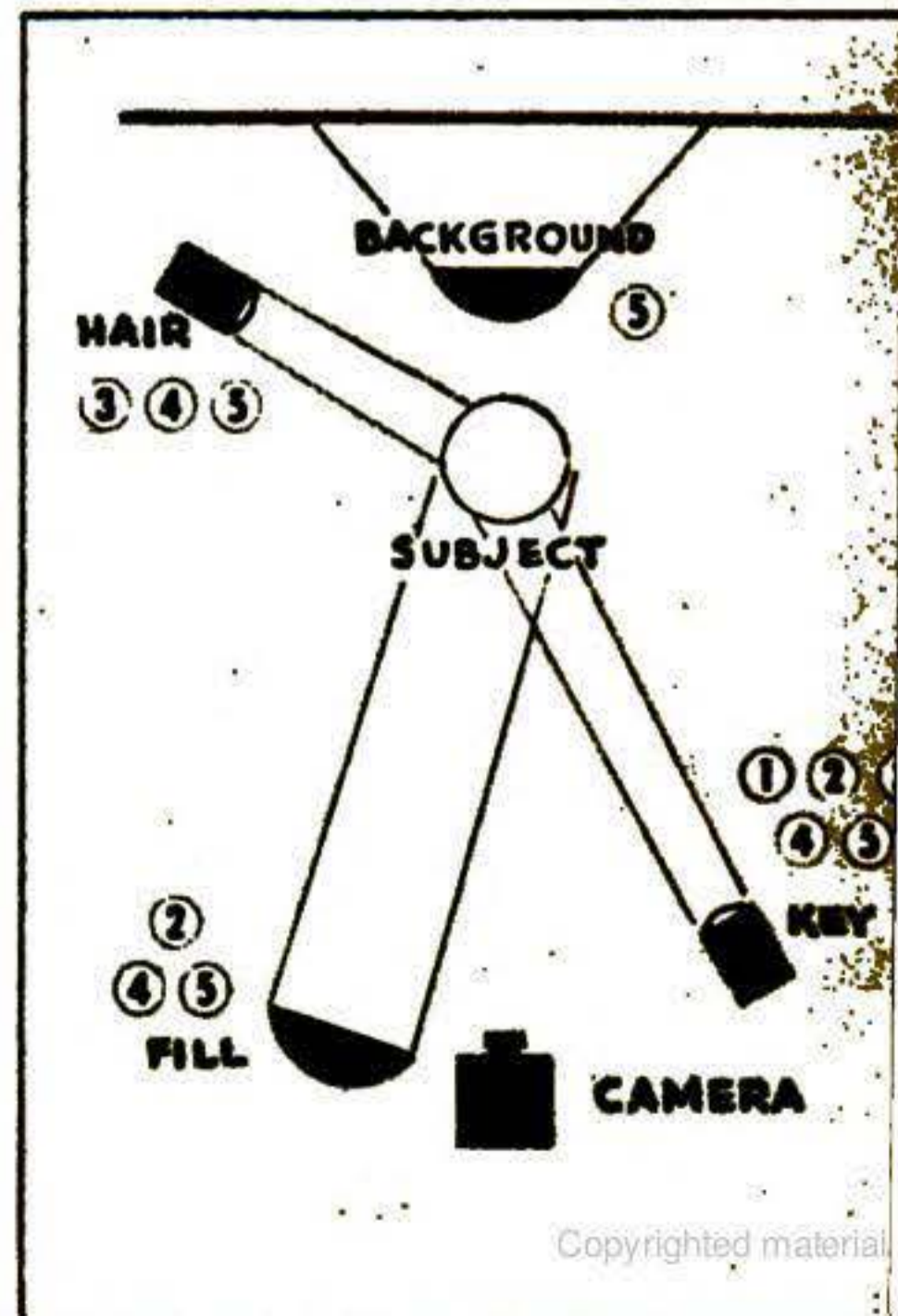
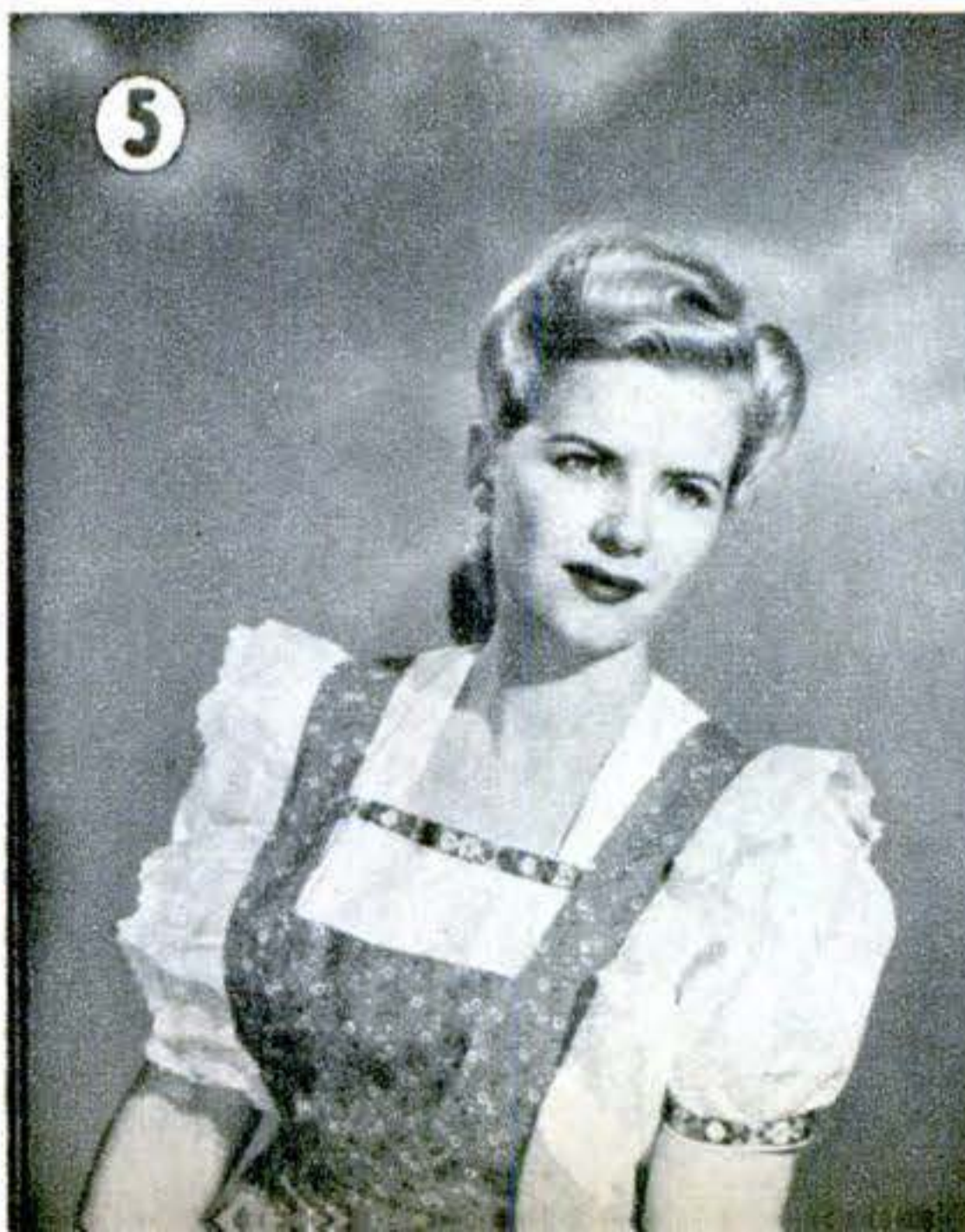
By EMERSON HALL

illumination on the subject and serves to soften the shadows created by the key light, as indicated in Fig. 2, which was taken with both the key and fill in place. The fill should be as close in line with the camera as possible and at about the same level to direct light full on the subject from the viewpoint of the camera lens. Its intensity should be less than that of the key. The closer it is to the subject, the more the softening effect on the shadows. But take care not to wash out shadows completely.

A "hair" light, while not a necessity, adds greatly to a portrait. Figure 3 was taken with no other lighting, and it shows vividly

just where the hair light falls. A small spot is best for the purpose, though a diffused light will serve fairly well. Place it behind the subject and 12" to 24" higher on the side opposite the key. Take care that its rays do not hit the lens, and don't let its light strike the subject's nose. What effect the hair light has when used with the key and fill is shown in Fig. 4.

The final light is that for the background. It is focused on the background itself, not on the subject, and is used to build up the light value of the background in relation to the picture, as in Fig. 5, where all four lights were used in making the portrait.





Both sky and water are captured with the camera at a low angle, and their color adds beauty to this diving-board study of actress Lynne Roberts.



Even a background of straw lends interest to this view of blonde Vera Hruba Ralston. One flash bulb was used. The straw reflected light on her hair.

blue, yellow, or green. Leave dark colors and white alone. A pattern sometimes adds eye appeal. I created the synthetic ocean background in one of the accompanying photos by projecting hard blue-white light through an empty 5-gal. bottle. Colored cellulose acetate sheets over a spot or flood give similar results.

Brilliant pottery, gourds, china flowers, paintings lighted from the side to avoid reflections, figured sweaters, brilliant neckties, and ribbons or flowers in the hair—all

these add effectiveness to color composition.

If the colors you select harmonize, then the picture is good and you are pleased. But if they clash, the picture looks odd even to an untrained eye.

One final word: Avoid an extreme brightness range, that is, do not include very dark and very light areas. Outdoors this may be done by having the sun somewhere behind the camera. Indoors, careful selection of your colors and careful placement of your lights will do the trick.

MAKE-UP IS IMPORTANT. First, a grease base of a tint to suit the skin is dabbed on and smoothed with a finger, and then shaded with powder. Natural red lip rouge is next applied and blended to the contours with a soft brush. The make-up items shown at right can be obtained at most drug stores.





LITTLE time remains to complete that gift list. Shown on this page are four of the many projects designed especially for this postwar Christmas by POPULAR SCIENCE contributors. To make them, see the listed Home and Workshop pages.

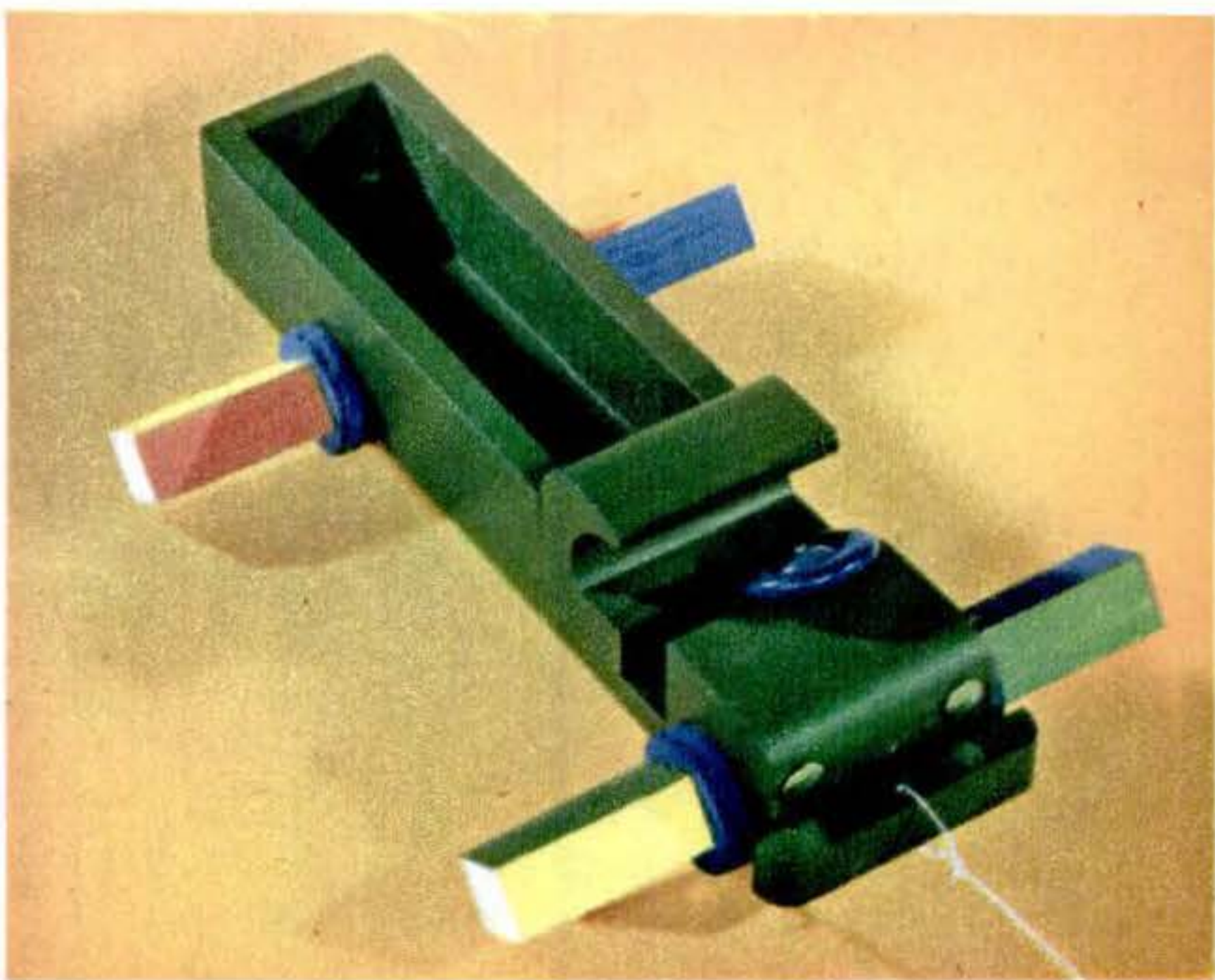


A JEEP FOR AN ACTIVE BOY. Junior will go for this all-wood pedal model, but you may make him one of metal if you prefer. Turn to pages 162 to 166.

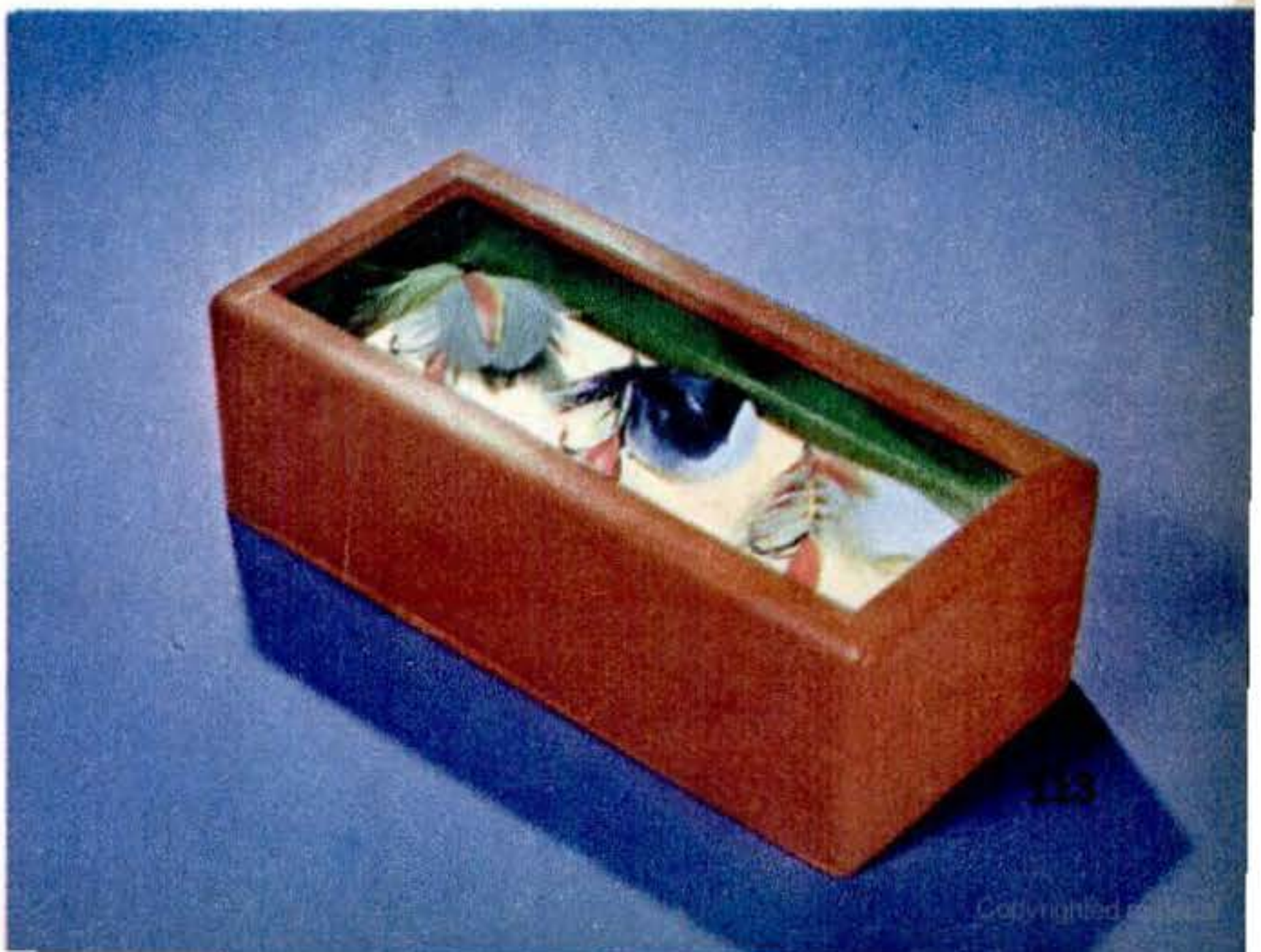


WHEN BIG BROTHER comes home from the wars he will go in for colorful ties, and what could be more appropriate than an equally colorful tie rack? This one, with alligator and palm trees for its tropical allure, is described on page 161.

DAD OR A FISHERMAN PAL will delight in the cigarette box shown at the right. In its glassed-in top is space for a display of favorite flies. It holds an ample supply of smokes. See page 148.



FOR THE YOUNGER CHILD. The pull toy shown above flashes the colors of the rainbow from the blocks extending from its wheels. They turn along with the wheels for a variegated color show. See page 155.





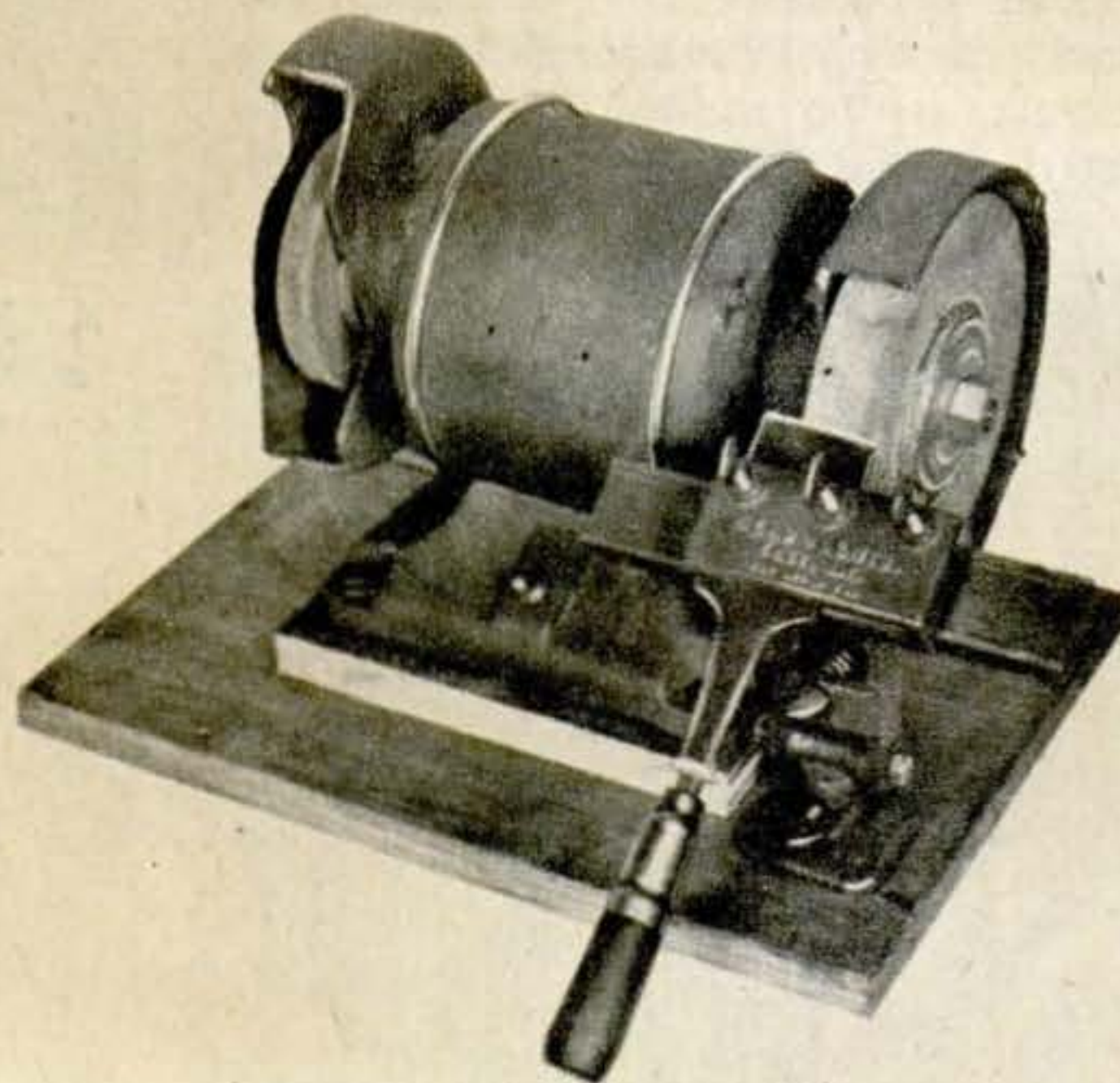
PLASTIC LOUPE with precision-ground lenses giving a magnification of 2.5 times is put out by the American Optical Company, Southbridge, Mass. The lightweight plastic frame is held securely and comfortably before the eyes by an adjustable elastic headband. Also adjustable for different facial contours and widths between eyes, the loupe is well ventilated and will fit any type of face. It can also be worn over eyeglasses easily. Artists, inspectors, and others will find it conserves eyesight and improves efficiency.

FAST AND SMOOTH wood cutting is obtained with the new expansive bit below. It features a wedge-lock groove that is formed when the replaceable center lip is locked tight with a machine screw and which holds the cutter blade at the diameter set. The bit comes in two models, each with two blades with easy-to-read scales, and cuts holes from $\frac{3}{4}$ of an inch to $3\frac{1}{2}$ inches. Manufacturer is Bruno Tools, Beverly Hills, Calif.



NEW Tools

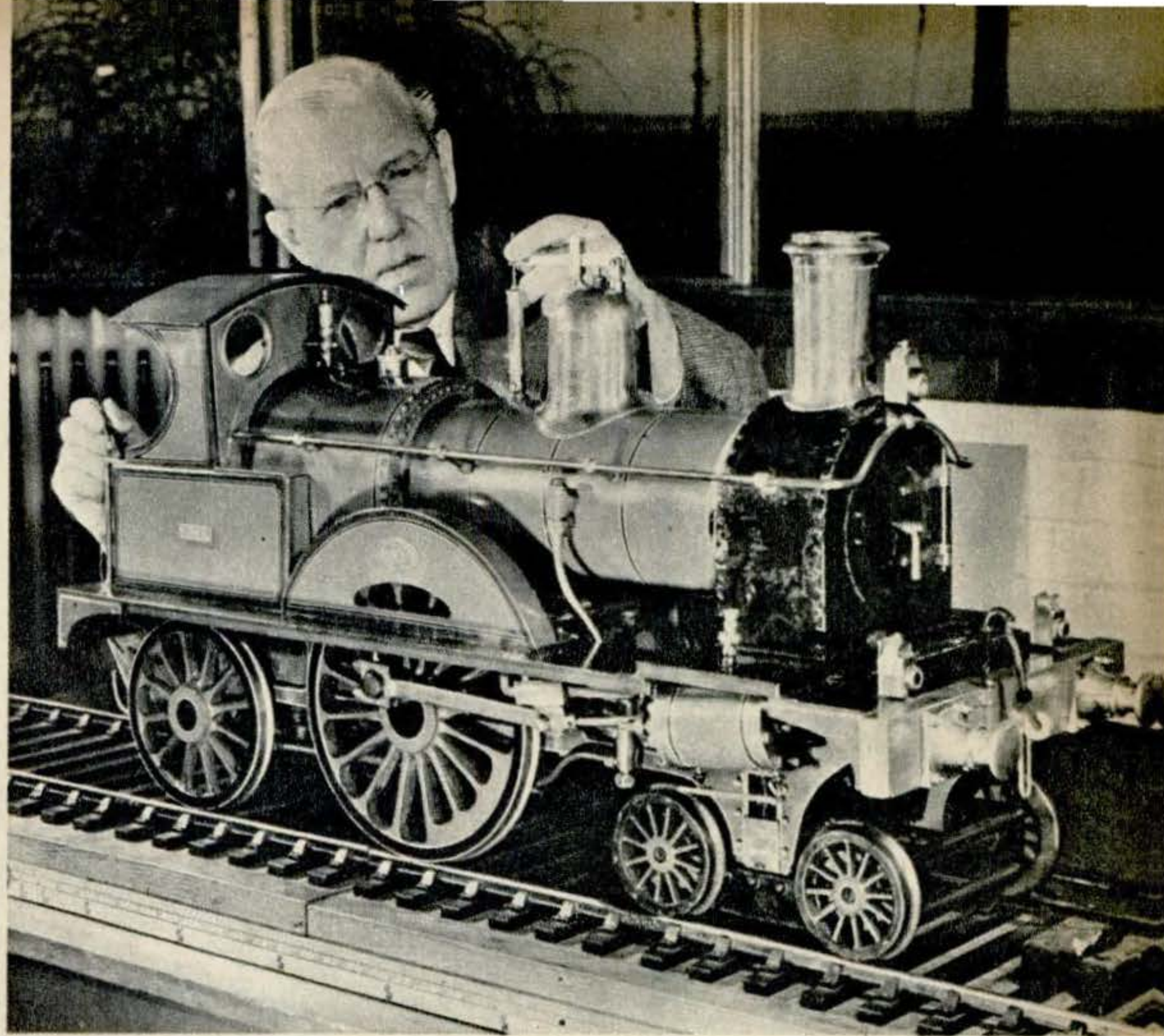
PLANE IRONS AND CHISELS can be kept sharp as new with this adjustable grinding attachment. It can be used with grinding wheels of any size or shape and will take plane blades and chisels up to $3\frac{3}{8}$ inches wide and $\frac{3}{8}$ inch thick, holding them firmly at the critical sharpening angle. Read-Lewis Machine Co. makes it.



MAGNETIC STRAIGHTEDGE that exerts an 18-pound pull and adheres to any metal surface is used to guide flame-cutting tools in making uniform cuts. Made of aluminum by the B. & W. Company, Los Angeles, Calif., it is available in three models from 18 to 36 inches long.



Here's Collector Charles B. King examining one of his important group of working models, a British locomotive that is shown complete with tender on the next page. The collection includes models of practically every form of power installation for industry.



Engine Models That Work

PIONEER AUTO ENGINEER OWNS RARE COLLECTION

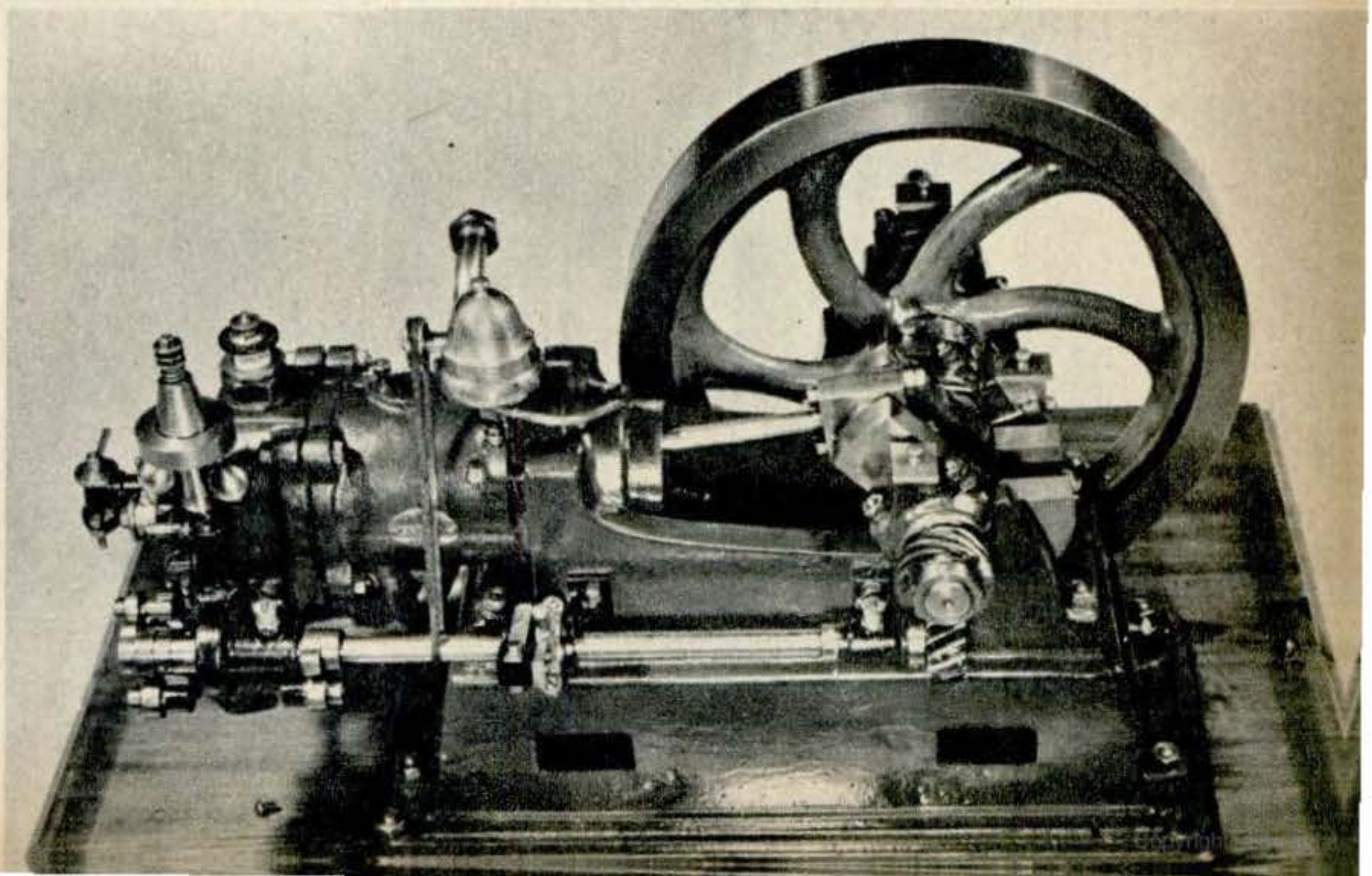
Photographs by ROBERT F. SMITH

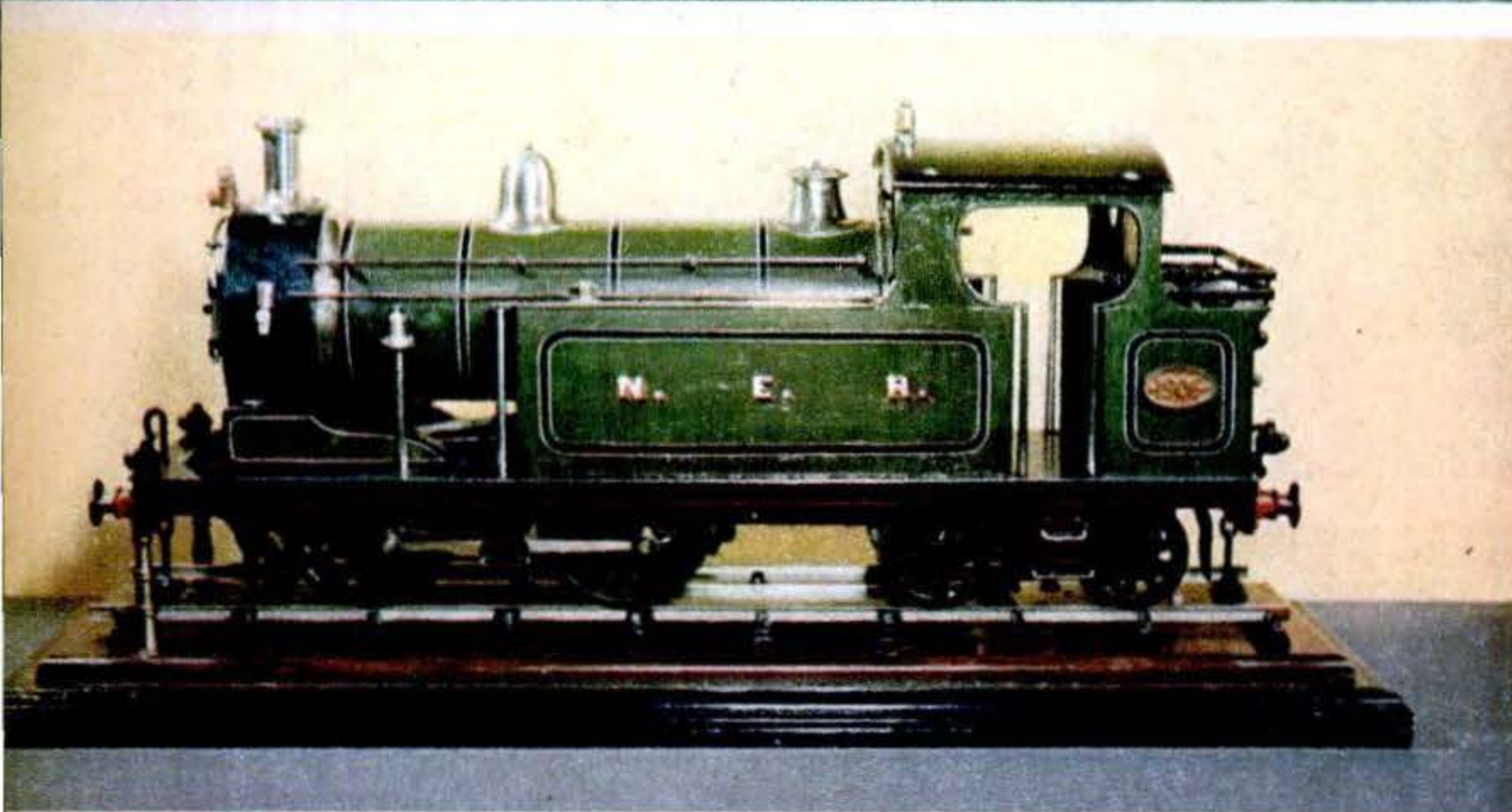
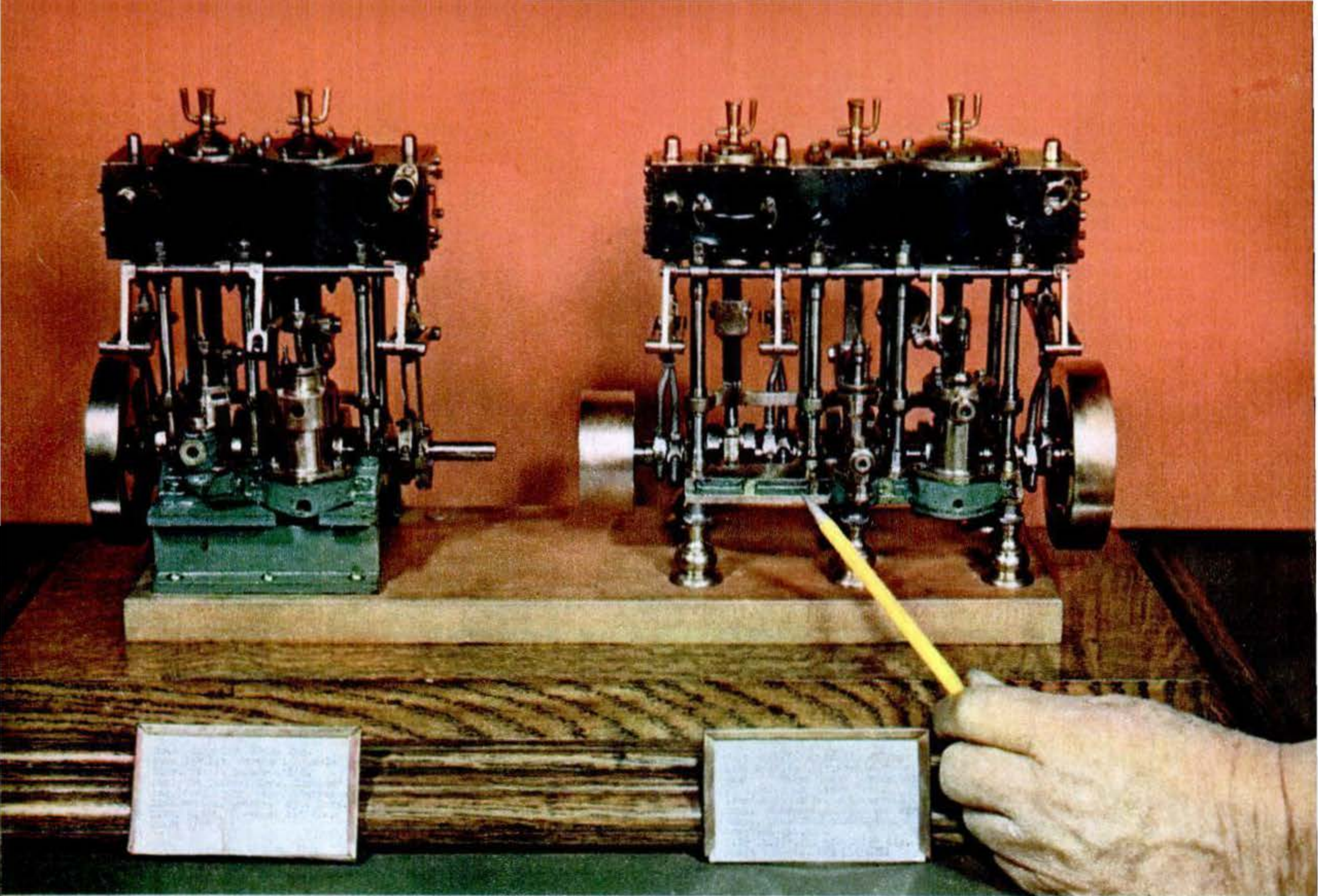
THIRTY-SIX working scale-model engines, made with the precision of fine jewelry and representing practically every form of power installation used in industry, make up one of the finest collections of its kind in the world. The models, some of which are shown on these pages, are owned by Charles B. King, and are on display in his home at Larchmont, N. Y. The machines in miniature include electric-light plants, steam-operated mill machinery, ferryboat and steamboat engines, locomotives, automobile and airplane engines, steam hammers, locomotive air pumps, and power-generating plants.

Engine models comprise only a small part

Scale model of a 100-hp. National gasoline engine built by A. C. Curzons of Leeds, England, about 1910. The bore of the model is $1\frac{1}{2}$ inches, with a two-inch stroke. The shaft diameter is $\frac{5}{8}$ of an inch, and the flywheel nine inches.

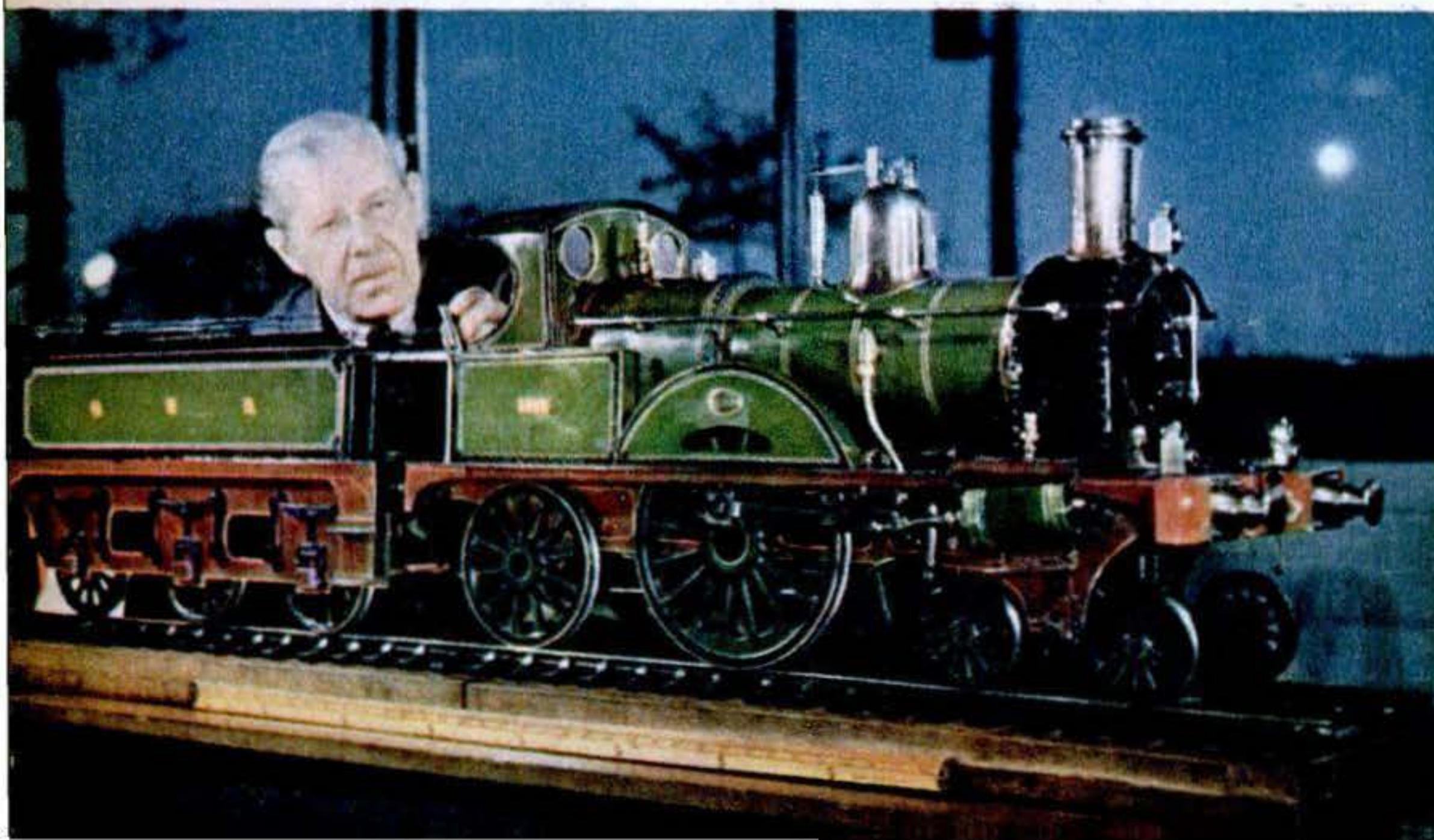
DECEMBER, 1945



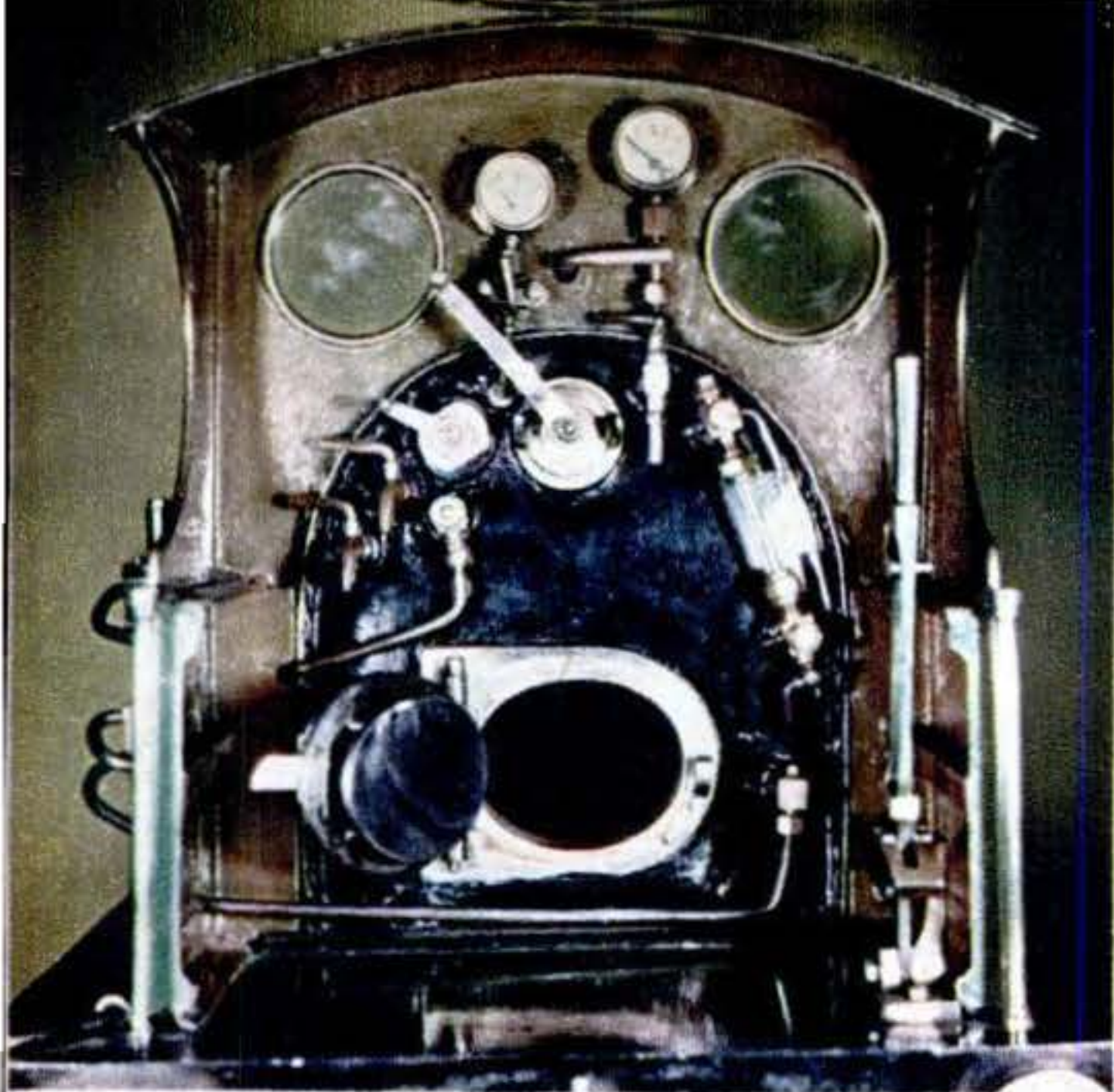


Two marine-engine models. At the left is a compound engine with bores of $1\frac{1}{4}$ and $1\frac{3}{4}$ inches, having a one-inch stroke. At right is a triple-expansion job that is equipped with feed and air pumps, and overhead lubrication.

This North Eastern Railway passenger tank locomotive model was built in England about 40 years ago. It has a copper boiler, firebox, inside cylinders, and Joy valve gear.



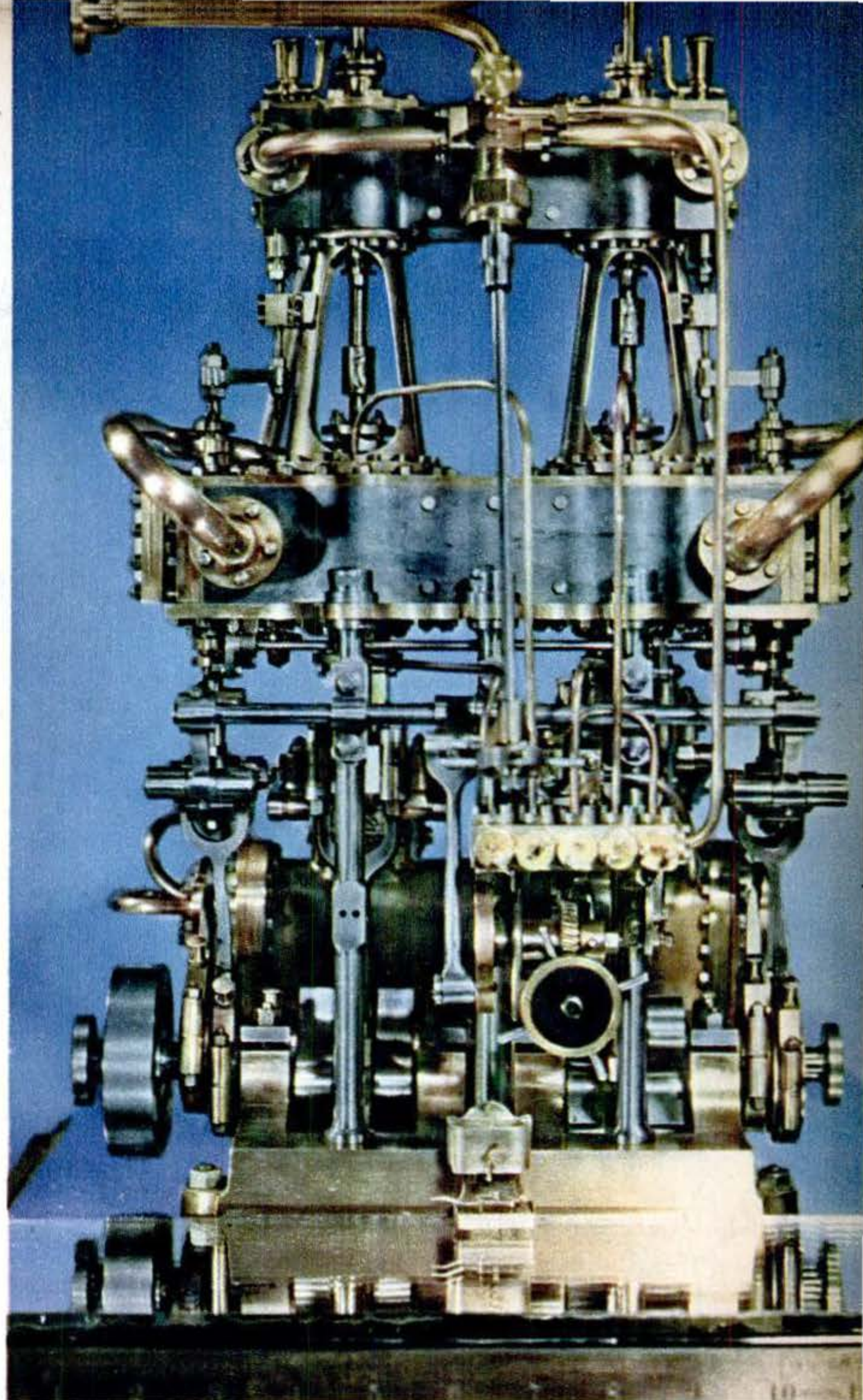
Fired with cannel coal, this model is believed capable of developing approximately one horsepower. It is 64 inches in length, and the height to top of stack is 18 inches.



Looking into the cab of the Great Northern model. Controls and gauges are all made to scale, and are in working order.

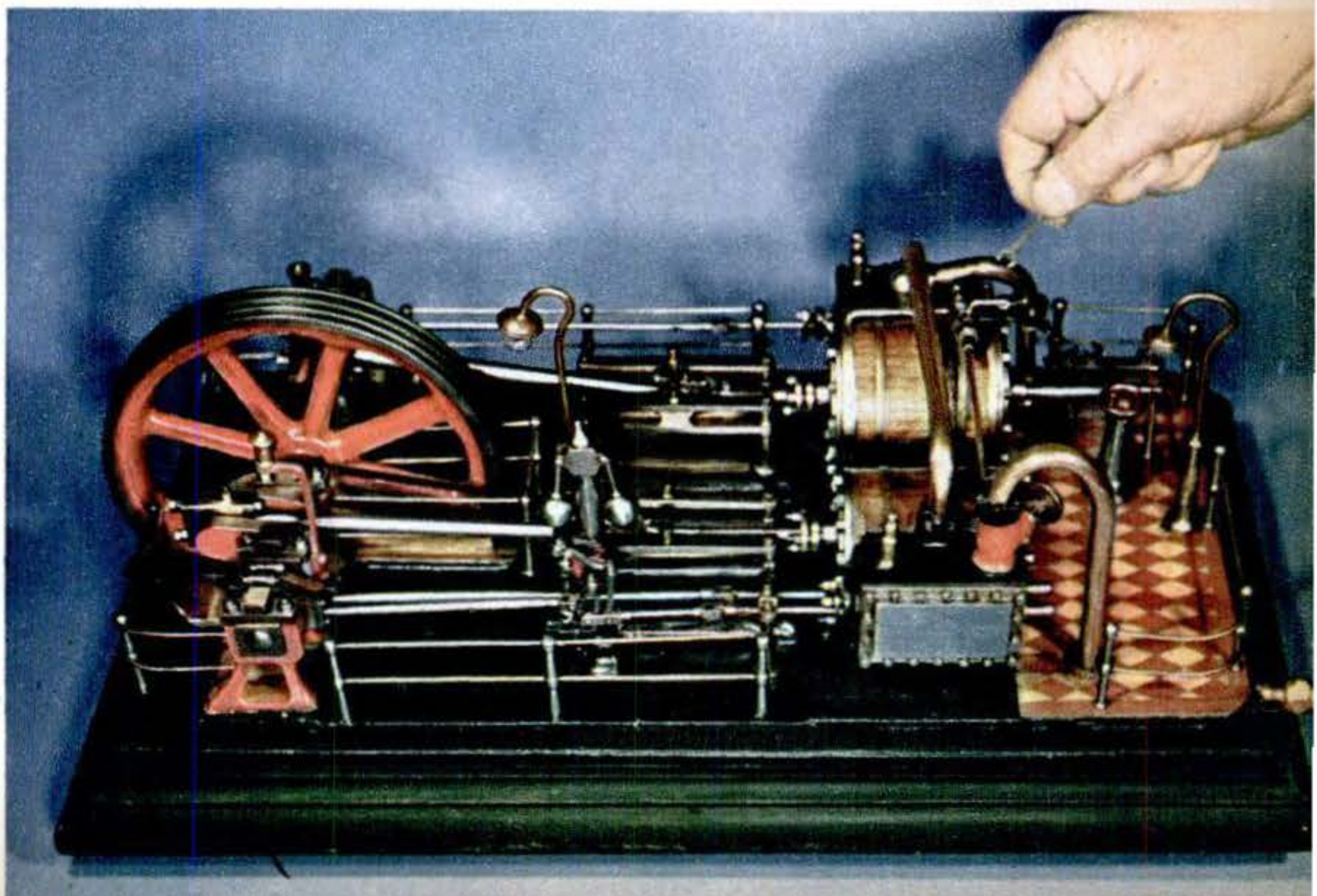
of King's complete group, which includes small-scale copies of ships, guns and cannon, and antique locks. His ancient eight-inch howitzer model was described and pictured in the November issue of P.S.M. (pages 116-117).

Mr. King, who has spent several years in gathering his collection from all parts of the world, was a pioneer in the automobile industry. Back in 1895, he was a driver in America's first automobile race, held in Chicago on Thanksgiving Day over a 54-mile course. He finished second. He helped Henry Ford build his first car by giving him some parts and suggestions, and, in 1896, rode with Ford in the first test run. In the following years he designed automobile, marine, and aeronautical engines.



Tandem compound marine condensing engine, fitted with steam reverse gear and air and circulating pumps, is 18 inches high and has 896 bolts and screws. The model was built in England.

On a base $9\frac{1}{4}$ by $17\frac{1}{4}$ inches is mounted a model engine-room layout. It includes a horizontal compound mill engine, and the miniature tools upon rack are correctly scaled.





There are approximately 1,800 tiny screws in that thimble, all individually made on automatic machines that turn out 600 an hour. Used in fine instruments, they cost about \$100 an ounce (more than 4,200 screws).

\$100-AN-OUNCE SCREWS MAKE GOLD LOOK CHEAP

A MERE spoonful of little screws as a day's work for a man and a complicated machine would seem to be a poor output, but when the tiny screws are worth more than their weight in gold it's a different story. Though they are made of brass or steel, these little screws cost around \$100 an ounce. Gold is worth \$35 an ounce.

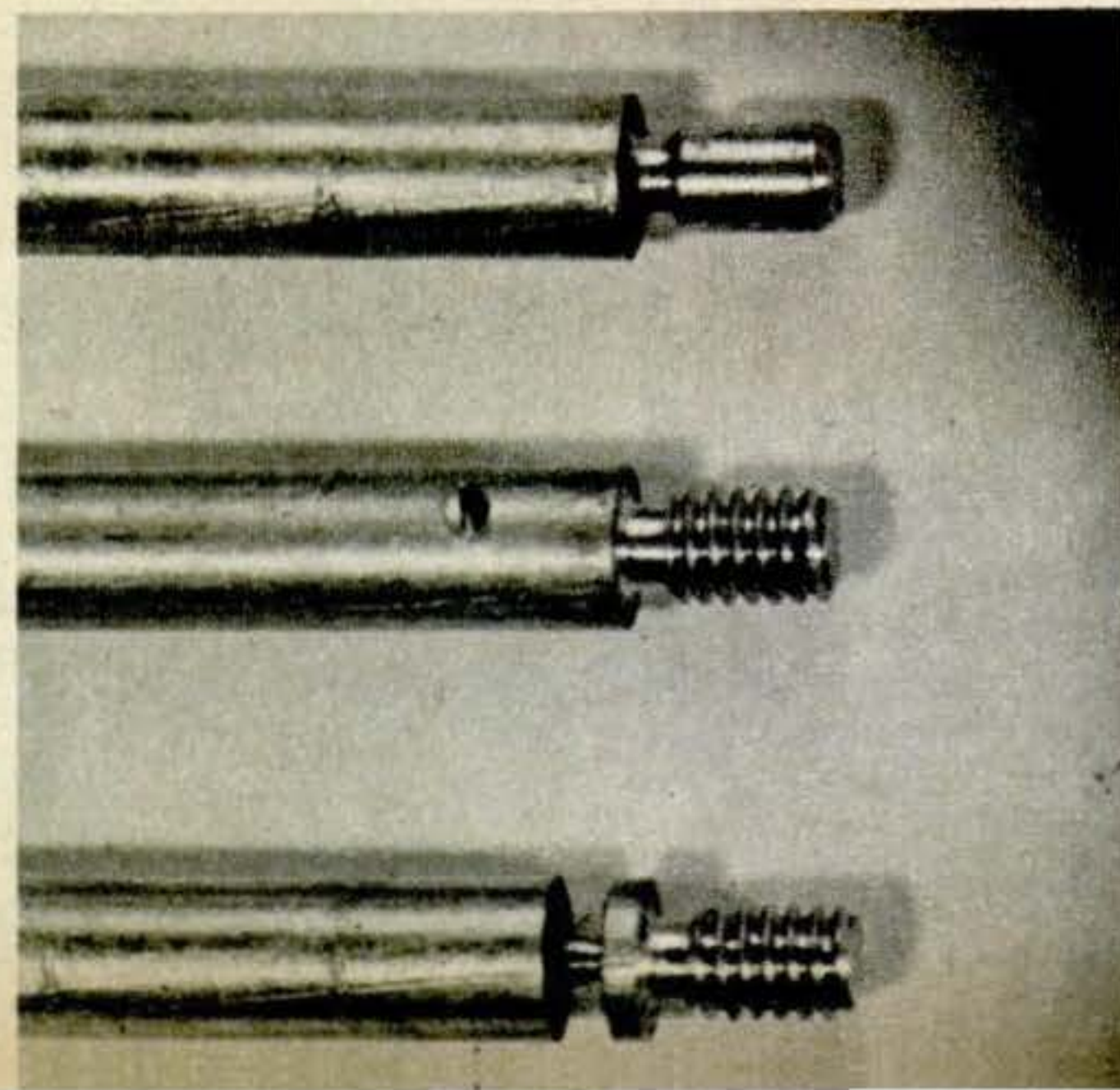
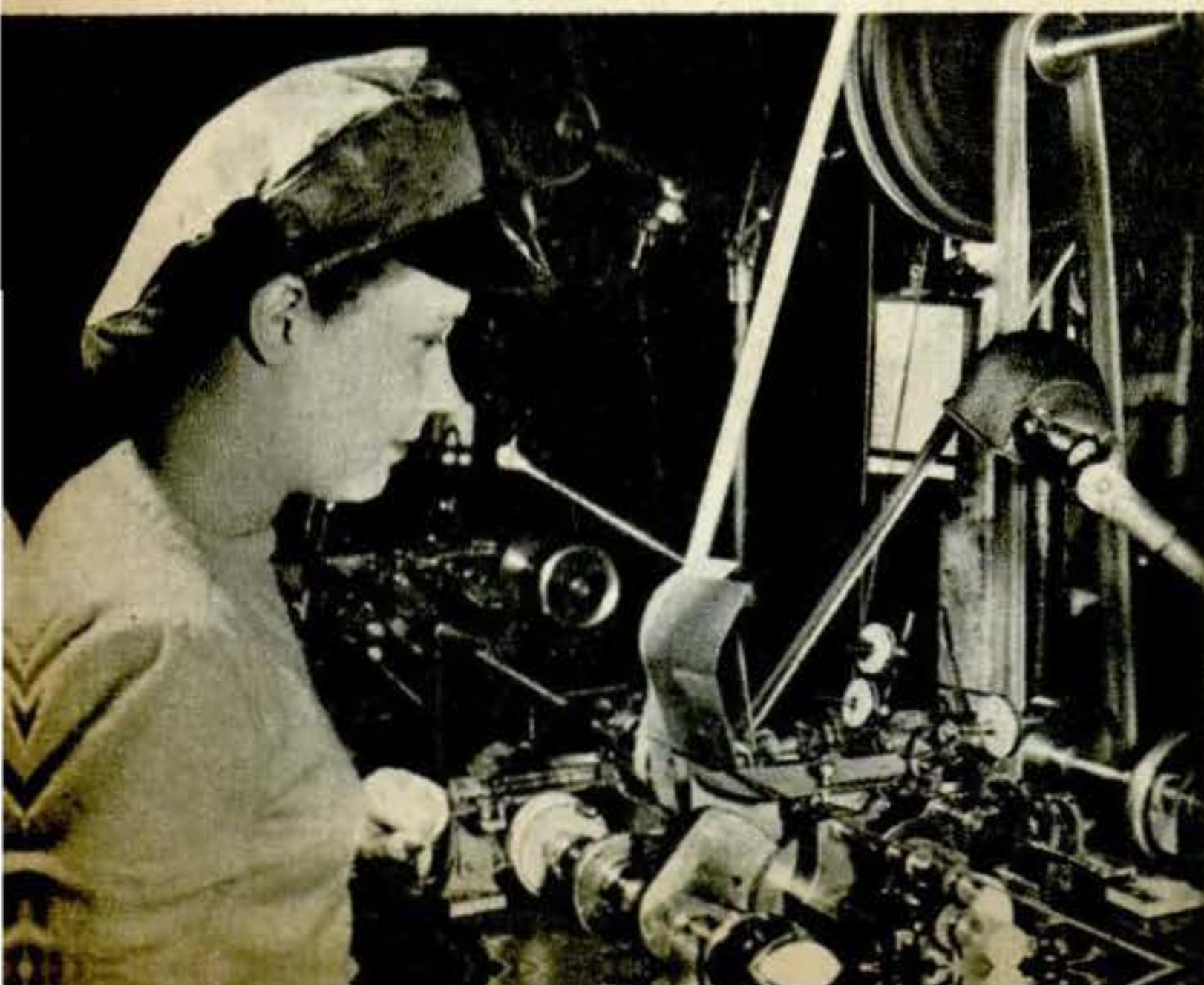
Automatic screw machines do what the ancient alchemists could not—they take base metal and turn it into something more precious than gold.

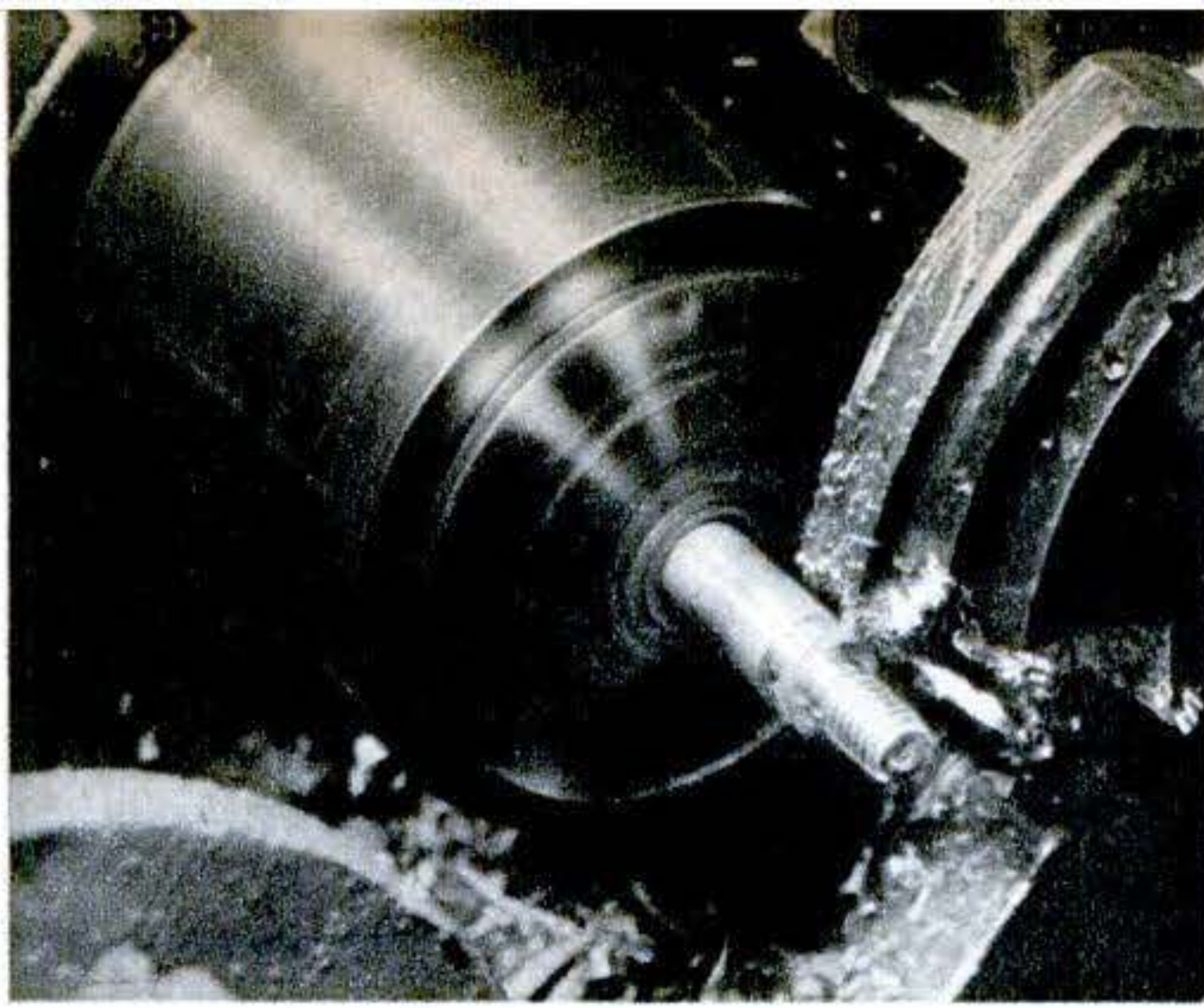
An operator checks a machine that forms, threads, and slots the heads of screws by successive automatic steps from 12-foot lengths of wire stock.

These miniature screws for watches and instruments are all made individually. To turn out one of them is just as much labor for man and machine as to make the largest machine screw. And, of course, they are as important as the big ones, for without them we would not have many fine instruments that are essential to the machine age of today.

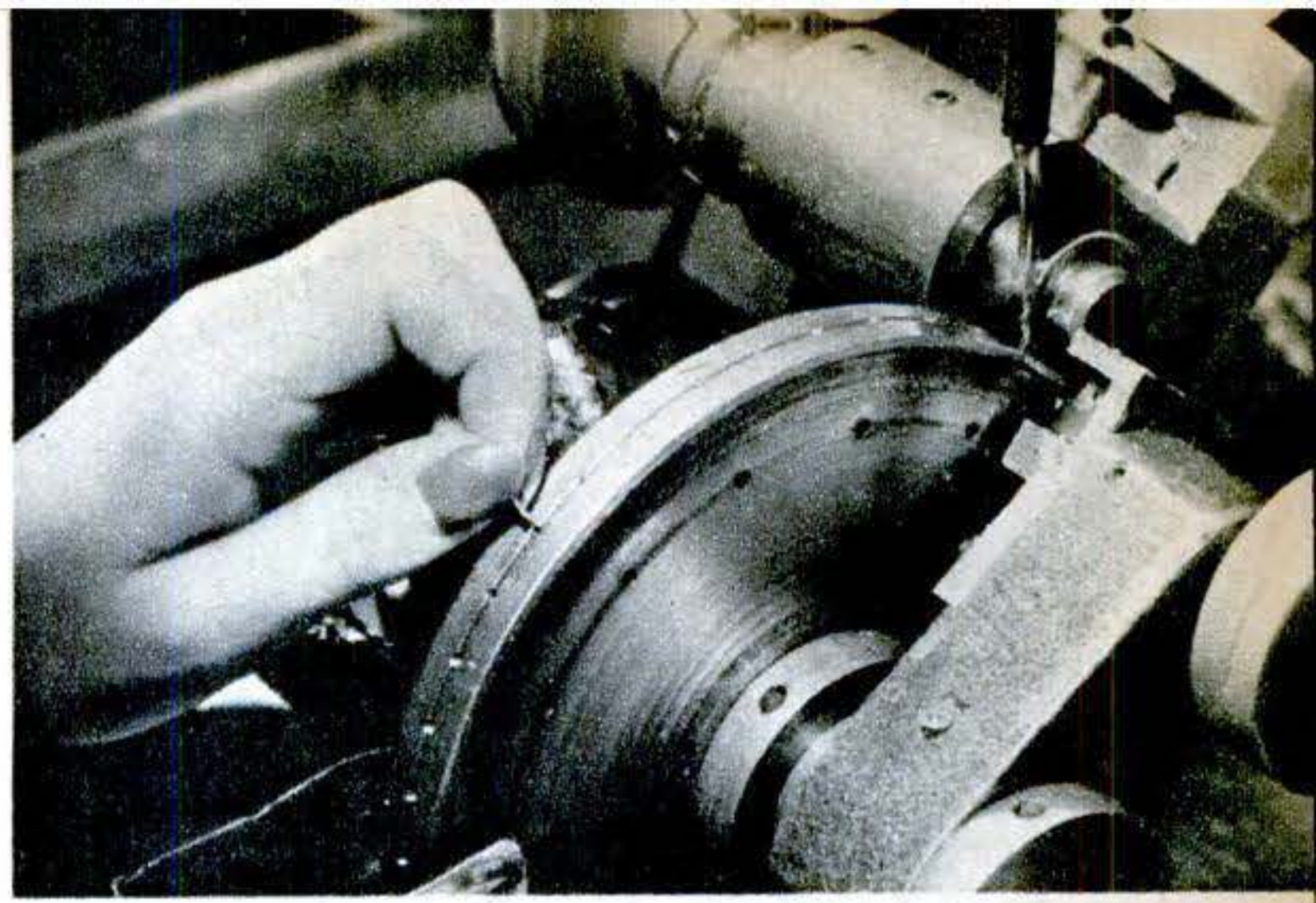
A firm that takes pride in the smallness of its products, having specialized for three generations in the finest machine screws,

In making a screw, the end of wire stock (greatly magnified) is tapered to size and threads are cut. A knife cuts the head and forms base of next screw.





Here is the shaping knife cutting the head of a screw and making the taper of the screw to follow.



Screws not slotted on the automatic machine are set one by one into rim of this wheel and cut by a circular saw.

Photographs by WILLIAM W. MORRIS

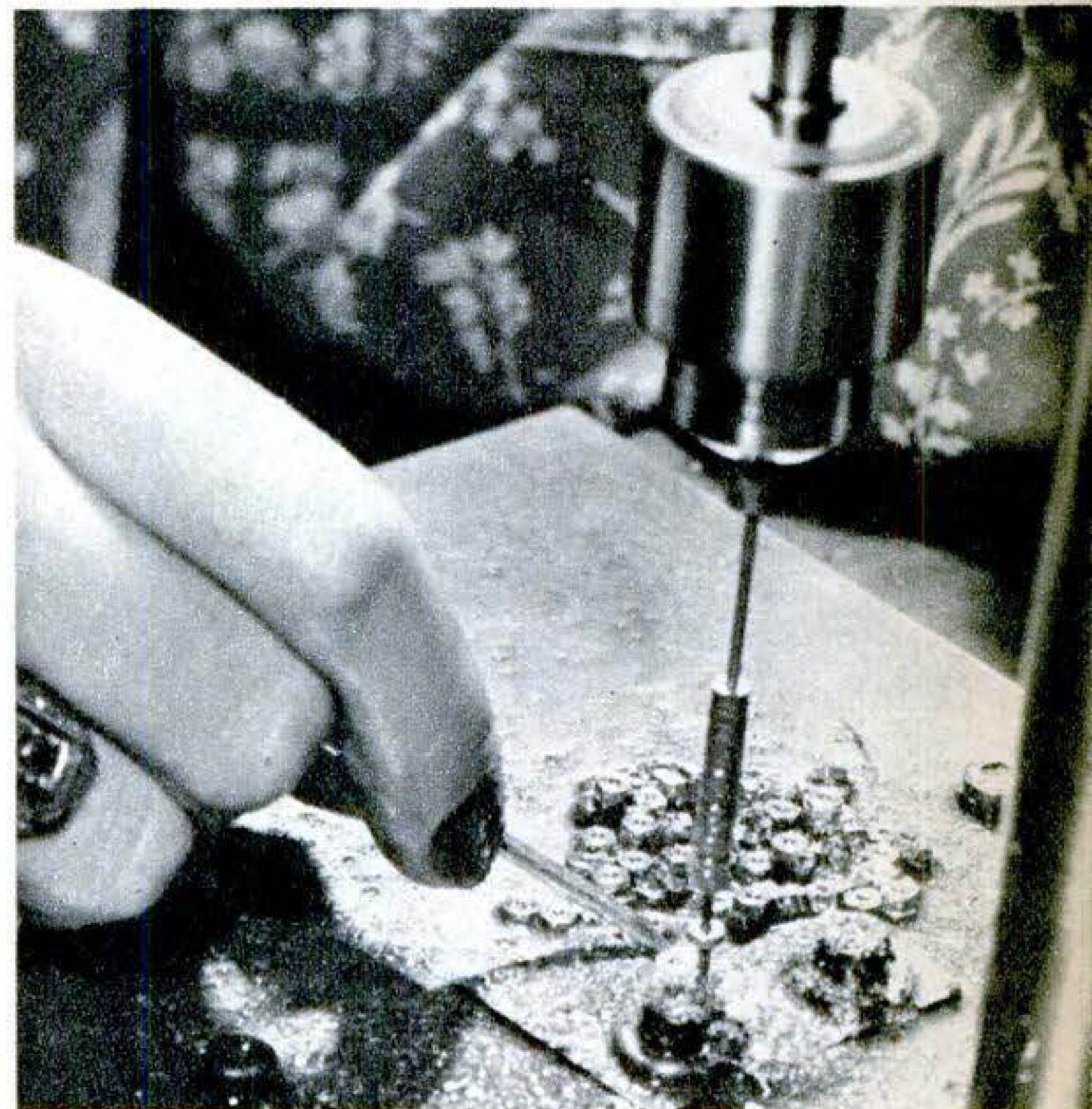
is the Waltham Screw Company at Waltham, Mass. There the writer saw how these tiny machine parts are turned out. The workers go around with watchmakers' eyeglasses hinged to their regular glasses or on headbands. You can watch one of the screw-making machines in operation without seeing what it is doing unless you look very closely and have good eyesight. When threads are as fine as 100 to the inch they are almost invisible. And this factory turns out screws with 240 threads to the inch.

Automatic machines developed in this plant helped to make the dollar watch possible by bringing down the cost of the screws that went into it. In wartime this factory's products were as important as the guns, tanks, and planes in which they were used by the million.

Tolerances on these fine screws are on the order of half a thousandth. It is not merely a matter of cutting so many threads to the inch, but the shape of these microscopic threads must be correct. They are just so high and so wide, and have an exact angle of "pitch," usually 60 degrees, which is the American standard for machine screws.

The master tap from which the cutting die is made to turn out screws with 240 threads to the inch is smaller than a pin. yet close examination with a glass will show that the threads are there. These taps are produced on a miniature lathe, then hardened and tempered. They are used to thread the dies used on the automatic machines. A die may make as many as 100,000 screws before it wears out. That is, when it is used on brass or ordinary steel; stainless steel wears out the die about five times as fast.

Automatic screw machines in the Waltham plant occupy only about a square yard of space each, but they do everything to turn out a finished screw from wire stock, once they are tooled and adjusted.
—GOLD V. SANDERS.



Tiny hexagonal nuts also get individual handling. Two drills countersink the hole on both sides to avoid burrs.

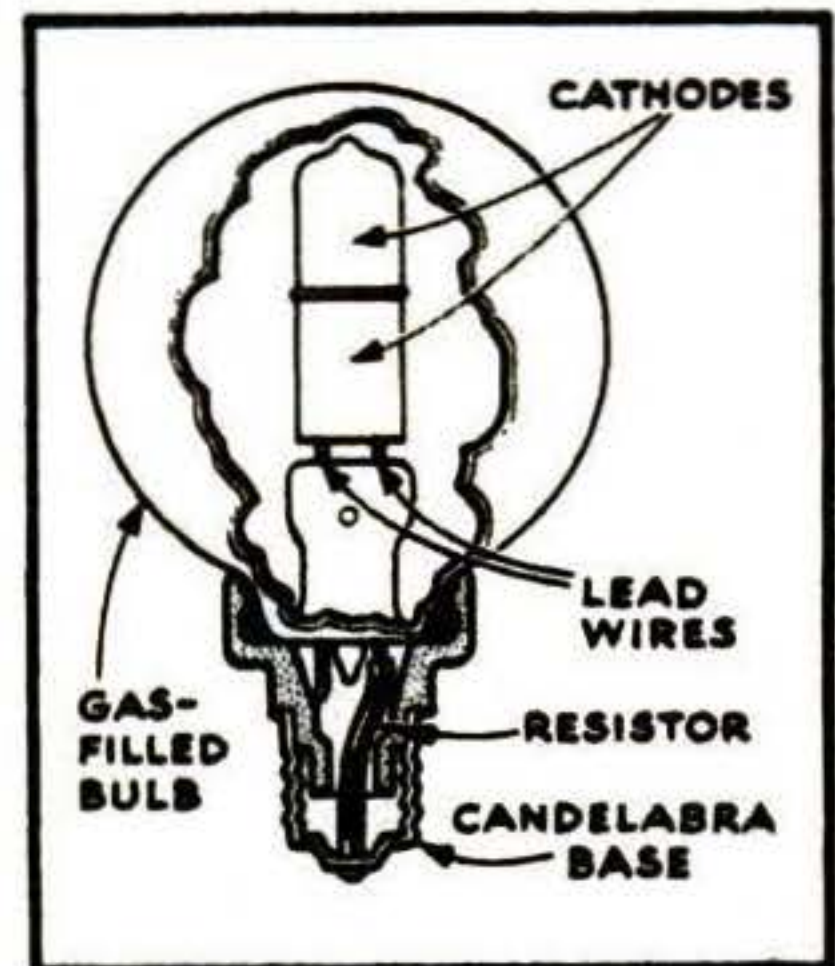


A shank threaded only about a half inch from the end taps the nuts and they build up until the shank is full.



Christmas Trees Are Now Lighted by Fluorescent Bulbs

FLUORESCENT lamps have been adapted for Christmas-tree lighting by Sylvania Electric Products, Inc. Being free from mercury, which tends to return to its normal liquid state when there is a low bulb temperature, these new bulbs can be used outdoors in winter as well as indoors. No starting device is necessary since the careful selection of gases helps to keep the glow discharge voltage below the 120-volt standard. Lamps are marked for AC, but can be used on DC without any particular harm.



Conning Tower for Railroad Cars Will Give Panoramic View

PASSENGERS on railroad trains will have an opportunity to see all the landscape there is through the windows of the Vista Dome car recently put in service on the Burlington system. This penthouse addition to the

standard car is built into the roof, and its top and sides are laminated heat- and ray-resisting glass. Air conditioning adds to the comfort of the 24 passengers who can be accommodated at one time.



**NOW IT CAN
BE TOLD**



FROG MEN

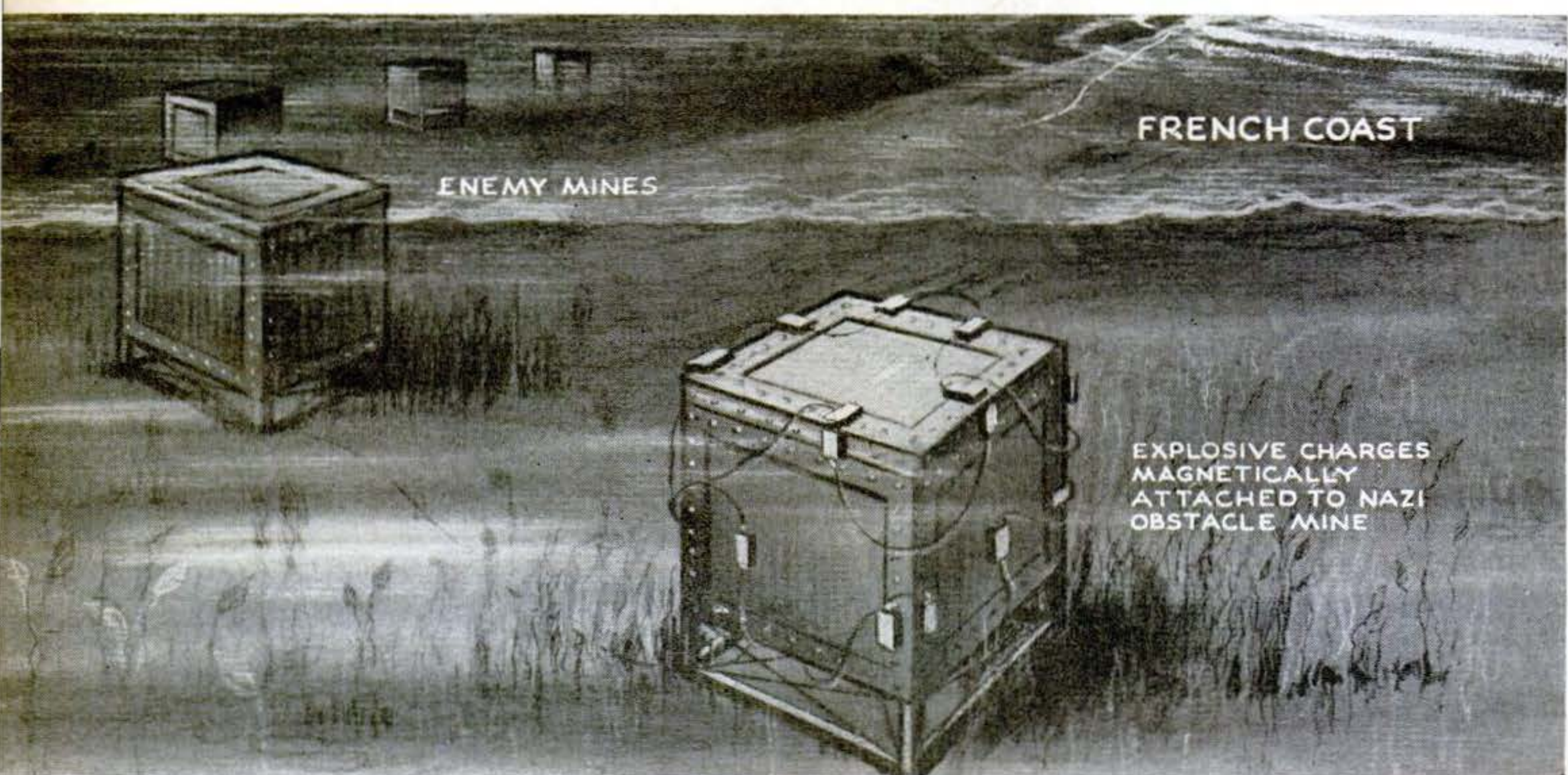
IN RUBBERIZED diving suits fitted with helmets and breathing apparatus, Britain's web-footed "frog men" performed one of the most hazardous operations of the war. Shortly after dawn on D Day, they slipped unobserved from rubber dinghies and swam like fish to neutralize underwater mines and booby traps. Also, they flattened massive obstructions the Germans had erected in the shallows off the coast of Normandy and

opened a path to the beaches for the flat-bottomed landing craft.

In the Pacific, from the Marshalls to Balikpapan, the U. S. Navy had its "warriors in swim trunks." Unarmed, and garbed only in shorts and webfoot galoshes, these mermen of the Underwater Demolition Units braved sharks and enemy fire to blast natural and man-made obstacles, clearing the way for our assault troops. ➔

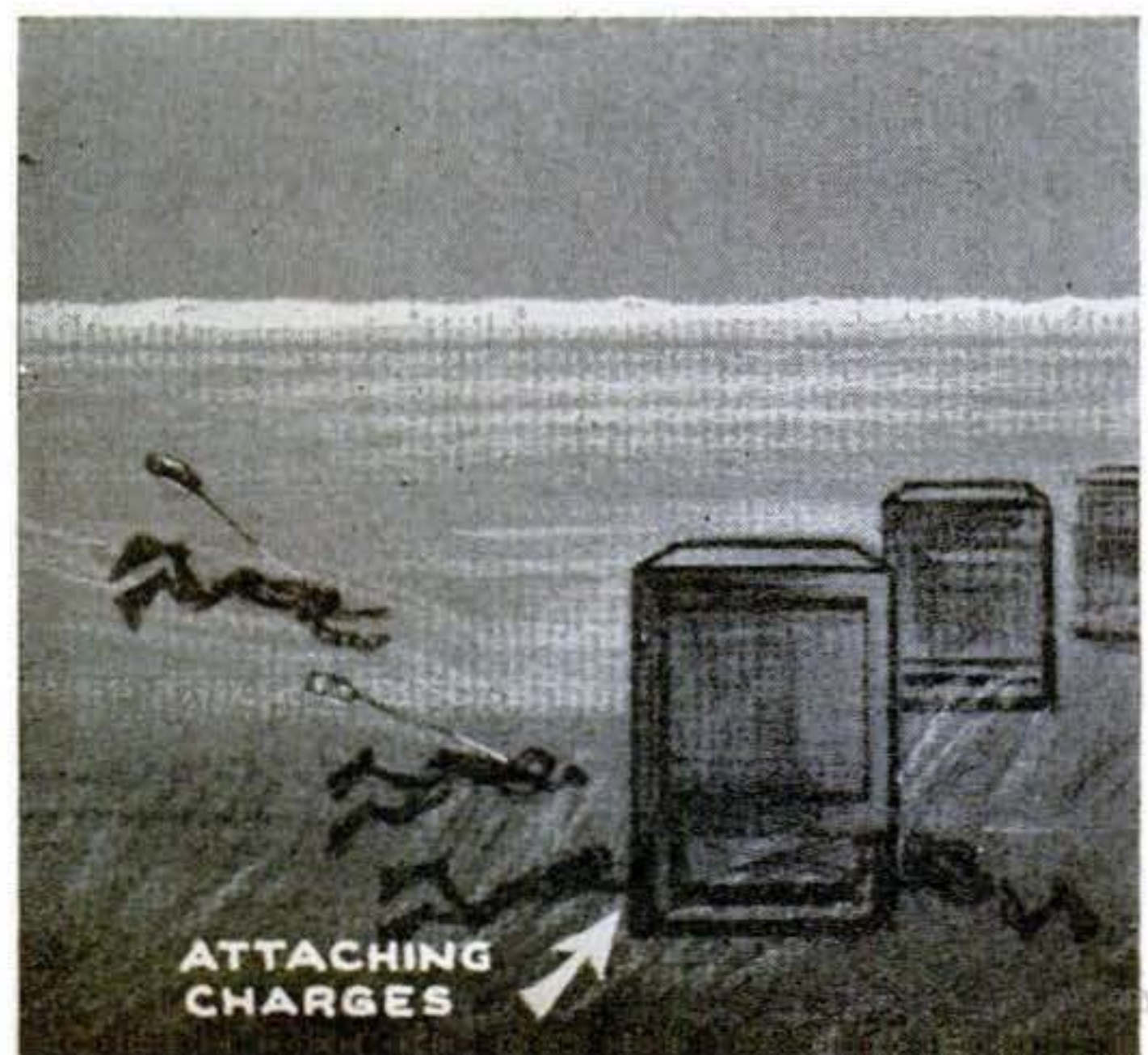
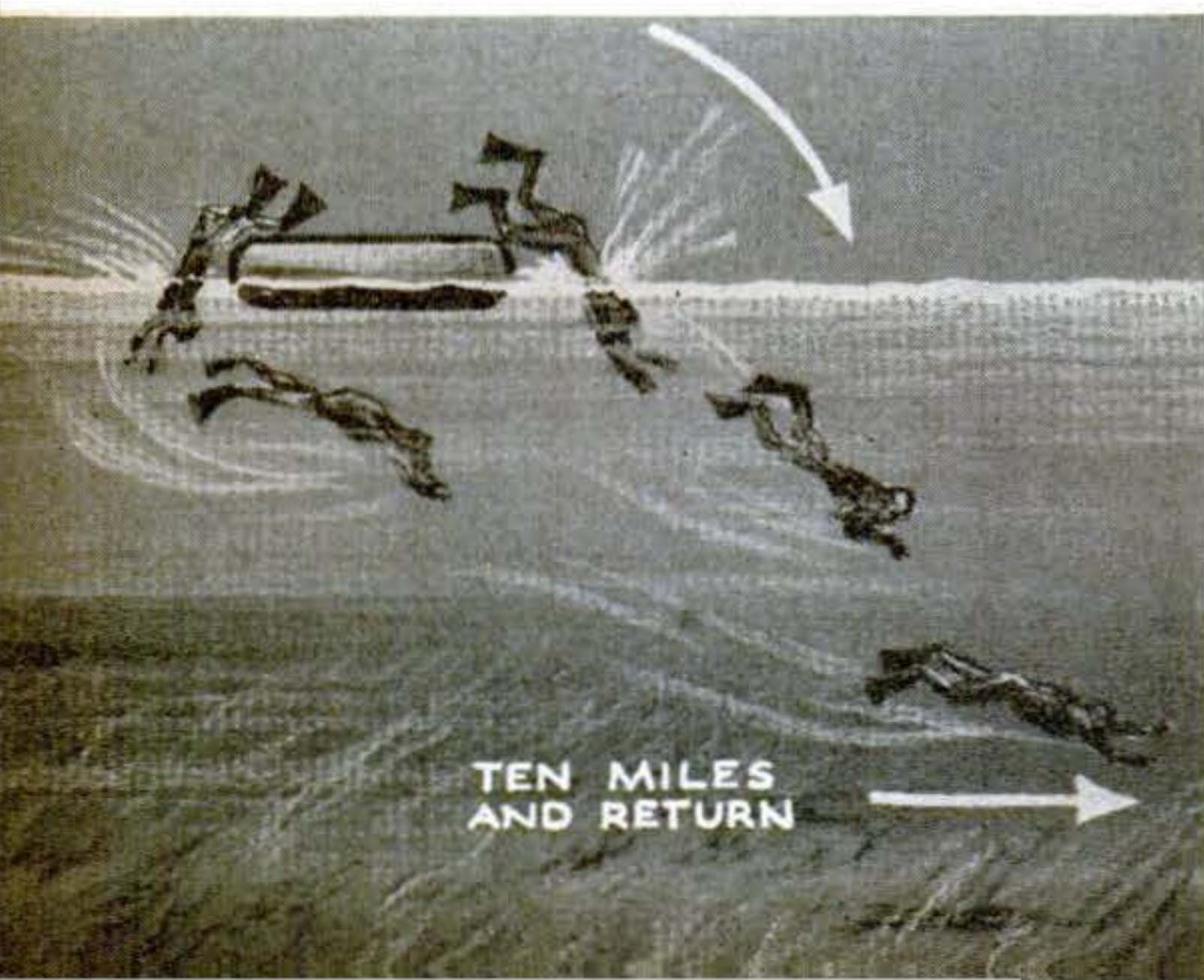


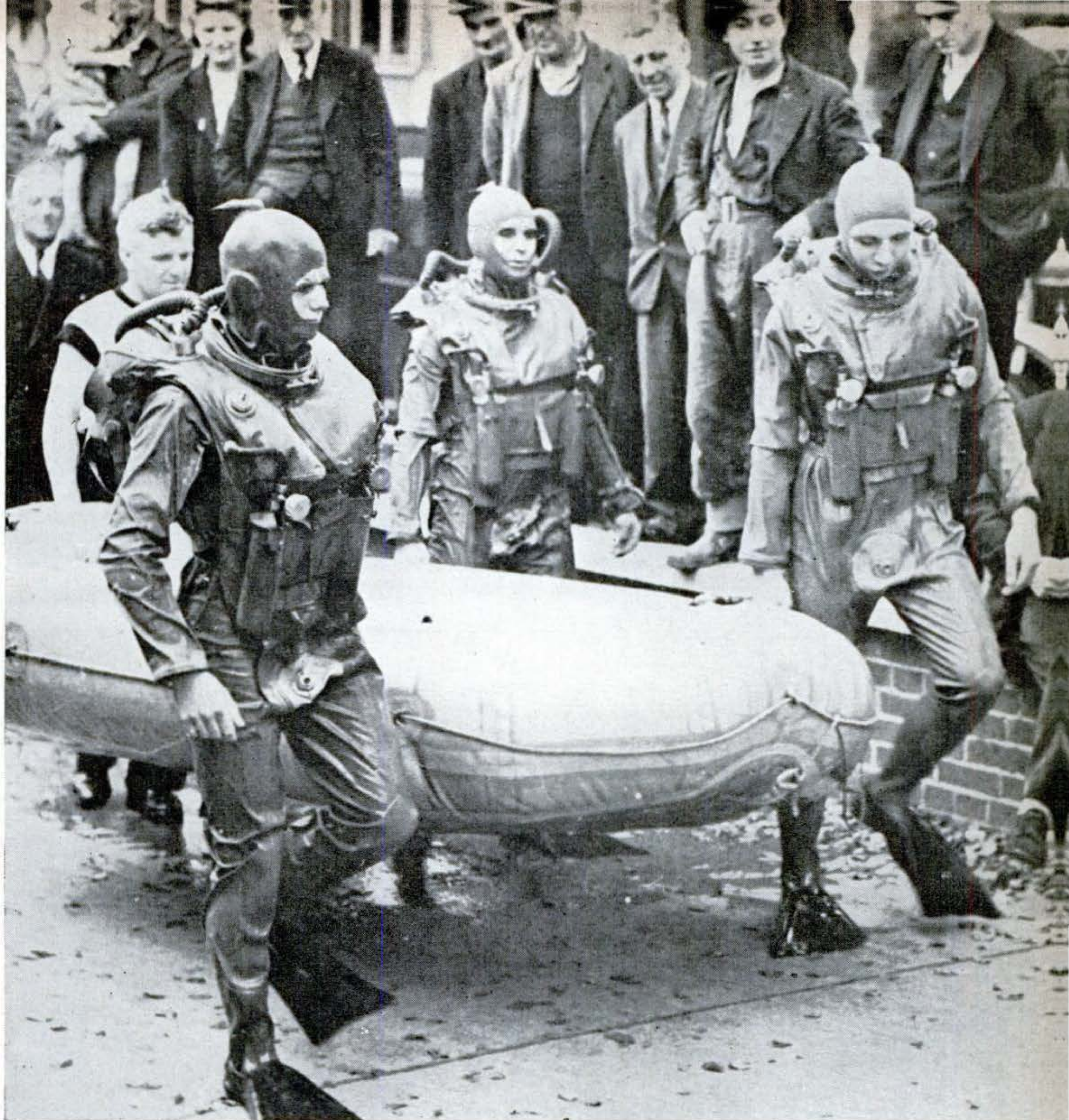
Britain's underwater specialists could remain submerged for nine hours while swimming on missions covering more than 10 miles. Unhampered by their equipment, they moved about freely without betraying their presence.



Unseen by surface watchers, the frog men swam close to the Normandy beaches to fix magnetic charges to thousands of German mines (above) and underwater steel barricades, blasting a path for our invasion craft.

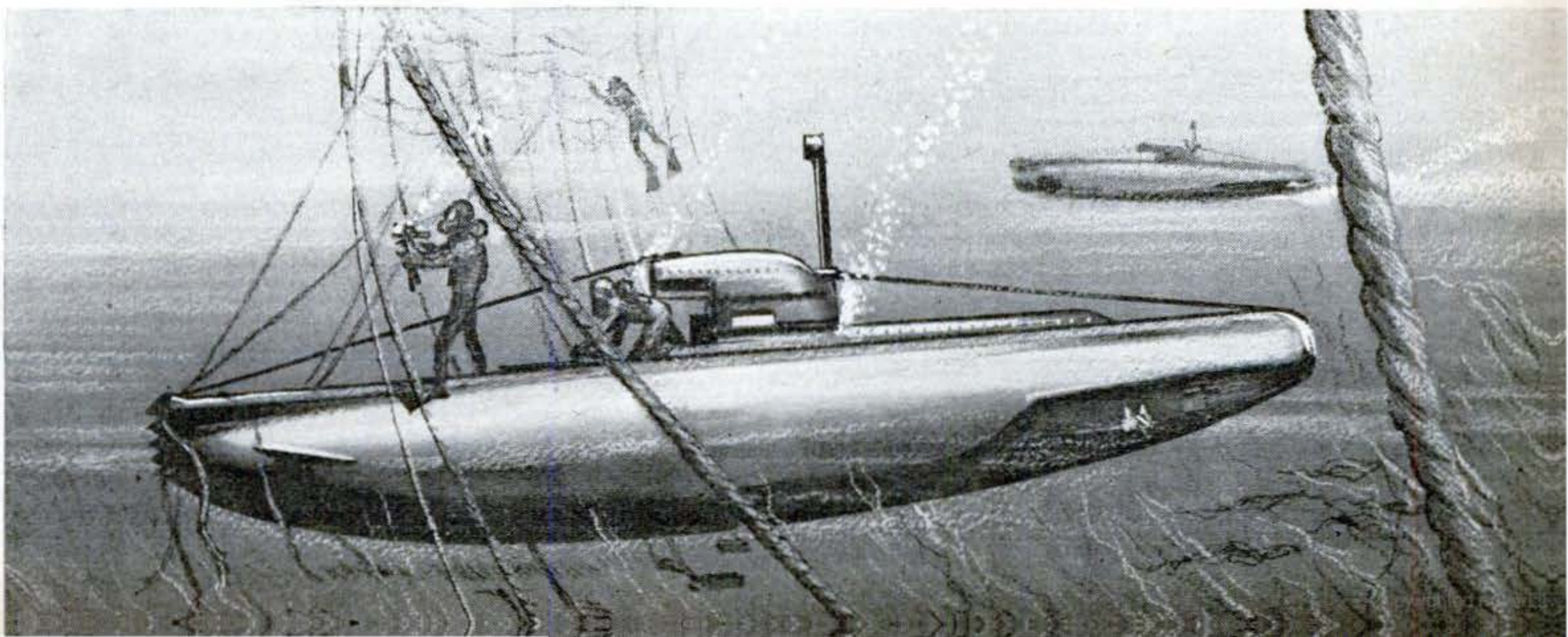
Overboard! Carried by rubber dinghy as near as possible to their target, the men spill out and . . . slither noiselessly to their objective, towing explosive charges. They better two miles in an hour.





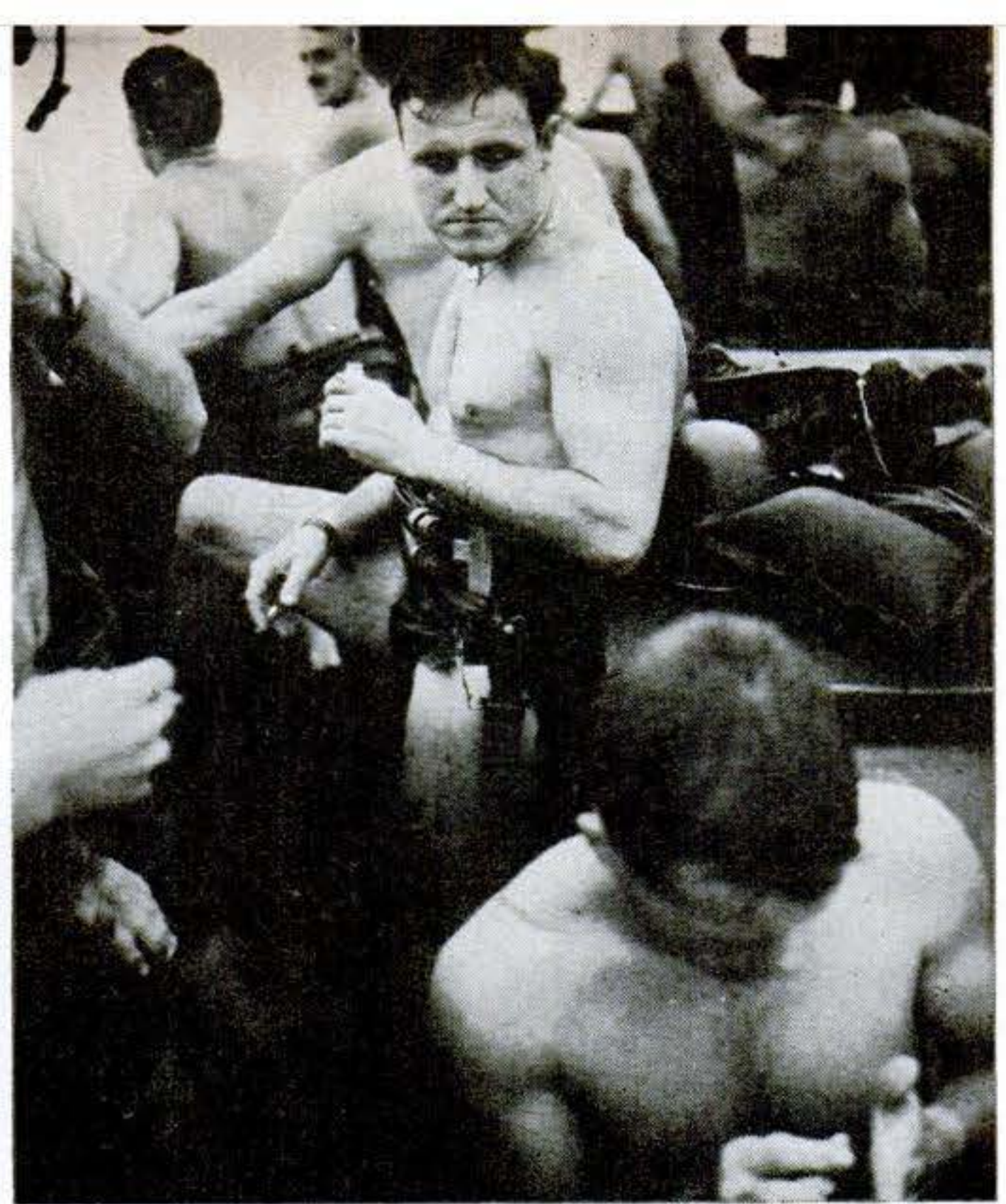
The human mine sweepers carry their boat to a beach to head out into the Channel. Under their rubberized suits they wear inch-thick kapok jerkins for protection against the shock of underwater explosions.

Frog men also worked out of midget submarines. Armed with cutters, they severed the strands of antisubmarine nets, allowing the subs to slip through. In enemy waters they fixed delayed-action charges to harbor craft.





In the Pacific, U. S. Navy underwater scouts hit at the Japs. Sergei Aalto, of Portland, Ore., exudes delight at the prospect of smashing Guam defenses.



A smoke and a drink make just the right bracer for Shipfitter I/C John Regan, of Boston, aboard the pickup boat after he had set charges at Balikpapan.

No zero-hour nerves here. Members of a Navy Underwater Demolition Unit watch in fascination as B-25's strafe Balikpapan's beaches to drive the Japs inland. After the bombers winged away, warships took up the shelling to provide protection for these heroes, soon to dive in and plant explosives around underwater obstacles.



THE "SPIRAL MUSEUM"

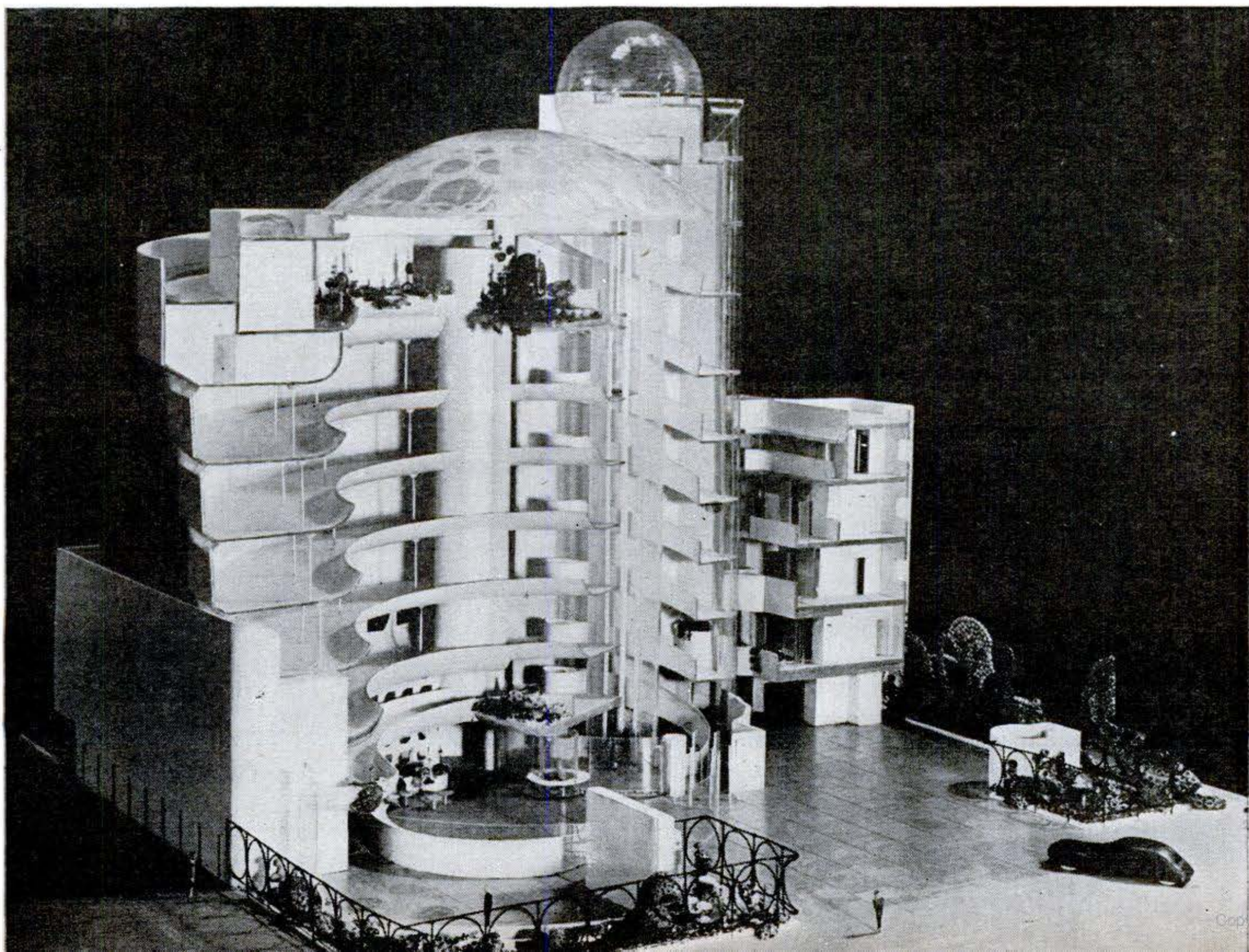
LOOKING like a coil spring set on its small end, a strange building will be added next year to New York City's skyline. Frank Lloyd Wright, "modern" Wisconsin architect, designed it to house the Solomon R. Guggenheim collection of "non-objective" painting.

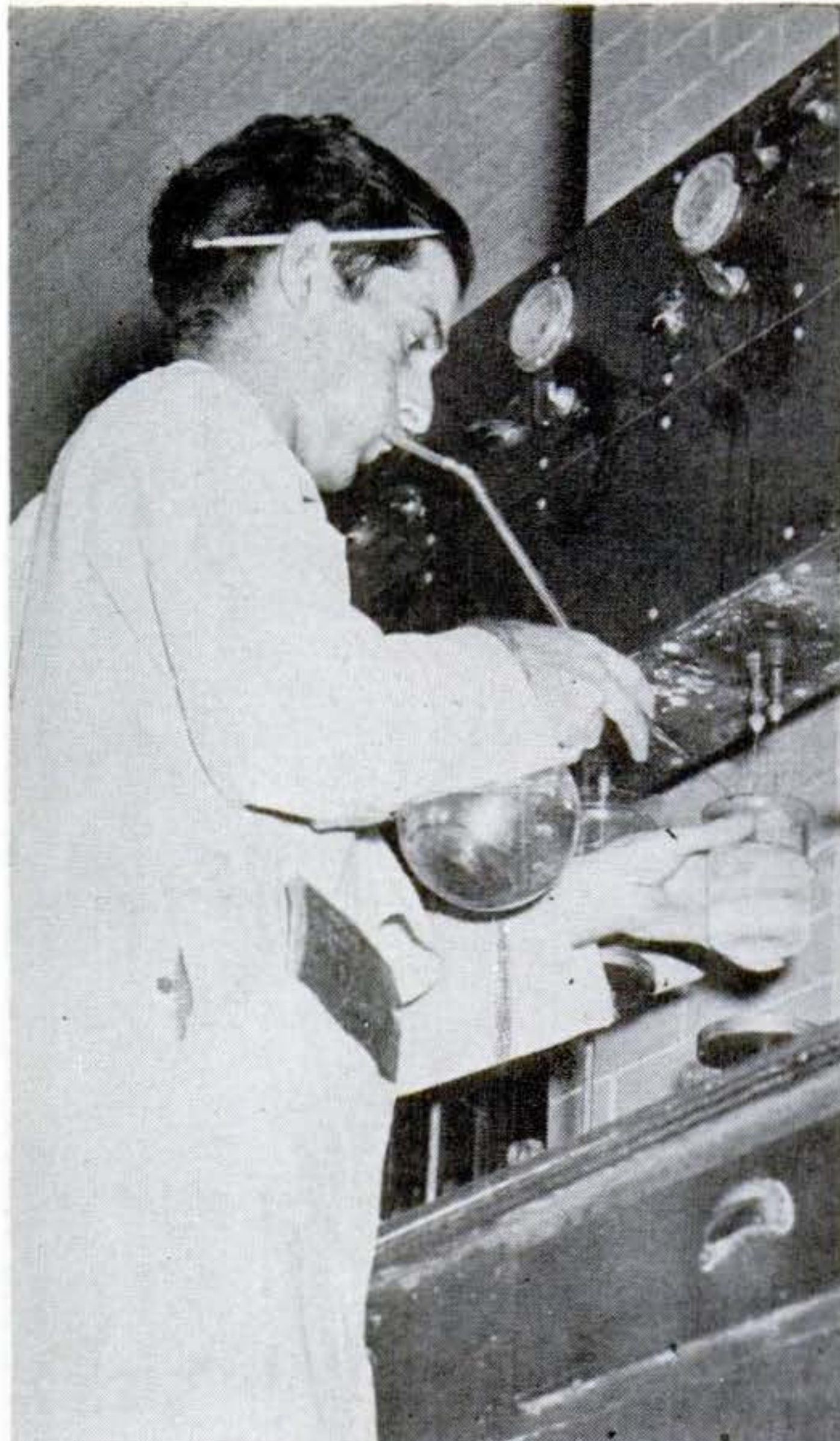
Although the building will be 12 stories high, it will have no floor levels. Instead, a spiral ramp, increasing in diameter from bottom to top, will wind around a central light shaft topped by a glass dome. Paintings will be displayed on the outside walls. As visitors pass over a grill at the entrance, a vacuum system will draw dust off their clothing and shoes. This, with air conditioning, will make it unnecessary to cover pictures with glass. Floors, ceilings, and walls will be covered with cork for heat and sound insulation.



Model of the unique museum building designed by Frank Lloyd Wright for construction in New York next year. Its "gallery" is a continuous ramp spiraling outward as it circles a light shaft. The overhang of successive turns will provide a continuous window—the only opening in the outside wall. Rectangular sections at base will house the administrative offices.

Cross-section view shows the odd interior arrangements of what will be Manhattan's most bizarre building. The tower at the right, topped by a glass-bubble astronomical observatory, contains "fast" ramps that will enable visitors to go from one level to another without making the circuit of the main gallery ramp.





IT IS FUEL FOR THE HOUSEWIFE . . . RAW MATERIAL FOR THE CHEMIST
 Since 1859 natural gas has been used for cooking in America, but it was not until the 1920's that chemists discovered that the hydrocarbons of the gas were reactive, opening up a vast, new field of research.

NATURAL GAS

By J. D. RATCLIFF

Drawings by Stanley Bate

RESEARCHERS HAVE BARELY ENTERED THE CHEMICAL WONDERLAND THAT HOLDS A STORE OF NEW PRODUCTS

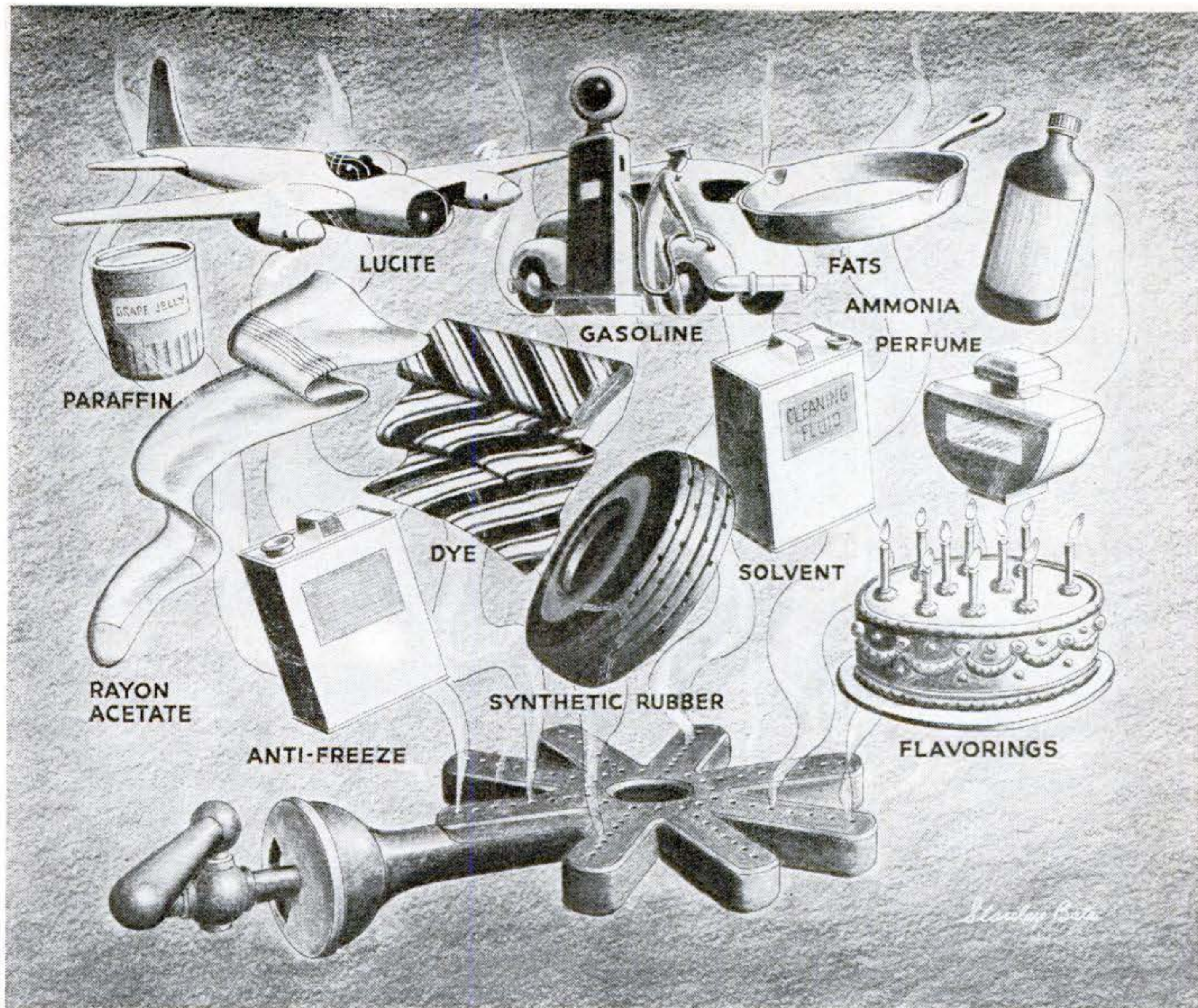
MENTION natural gas and people think of the flame in the cookstove. They never think of the chemist. But to the chemist natural gas is a fabulous raw material with dazzling possibilities. It is a source of desirable atoms that can be re-strung to make molecules worth millions.

"If one starts with natural gas," says Dr. Gustav Egloff of Universal Oil Products, "all the known synthetic products that man has developed in organic chemistry can be derived—and there are over 500,000 of them!"

Potentially, natural gas is the basis for a new industry which can dwarf the coal-tar

industry we built a generation ago. The gas that issues from the ground in 37 of the 48 states can be converted into an incredible array of products: potable alcohol, plastics, rayons, perfumes, drugs, solvents, explosives, insecticides, flavorings.

Practicing the wizardry of his trade, the chemist has done all these things. And he believes that he barely has his foot in the door. Yet some chemical texts still state that natural gas is completely unreactive, completely inert! These texts even offer proof that the molecules in natural gas can never be ripped apart and retailored into



PRODUCTS FROM NATURAL GAS may be seen almost everywhere, and chemists have only begun to explore its possibilities. They call it "the most desirable chemical raw material the world has yet seen." During the war, natural-gas chemistry produced tens of millions of gallons of toluene—for TNT—when the building of thousands of coke ovens to supply such an amount was out of the question.

new patterns! This idea was accepted by everyone until one day in the early 1920's when a momentous accident happened in the laboratory of an oil company. A group of chemists were studying the problem of corrosion in natural-gas pipe lines. They correctly guessed that corrosion was due to the action of gas plus air that had leaked into the pipes.

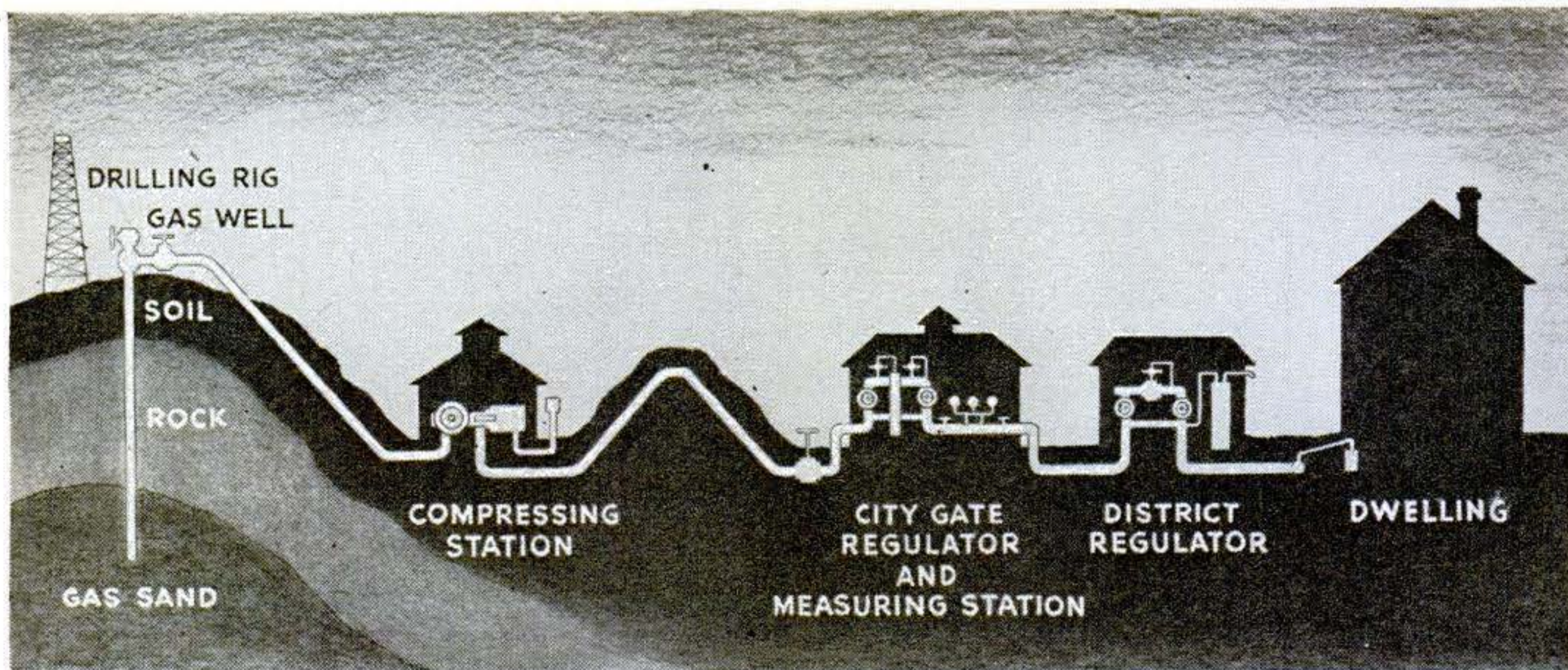
To reproduce conditions artificially, and to hasten any reactions, they put natural gas and air in a steel chamber under pressure. When they opened the chamber they found droplets of wood alcohol, formaldehyde, and formic acid! This was one of the golden moments of chemical research, and the investigators had the wit to realize it. It was easy enough to see what had happened. One atom of oxygen from the air had combined with a molecule of methane to make wood alcohol, two atoms of oxygen to make formaldehyde, and three to make formic acid.

Despite what chemical texts said, the hydrocarbons of natural gas *were* reactive. Once this was realized, the lid was off. Natural gas represented a chemical raw material cheaper and easier to handle than any other raw material previously known.

Rough calculations brought out striking facts. Potentially, 1,000 cubic feet of natural gas—which cost five cents at the well—could be converted into eight gallons of ethyl alcohol, four gallons of methyl alcohol, one gallon of acetic acid, and other valuable products. Weight for weight, natural gas costs only one fifth as much as crude oil.

Natural gas is a mixture of four gases: methane, or marsh gas, ethane, propane, and butane. Of the four, methane is the lightest and most plentiful. It constitutes 90 percent of all natural gas. Besides these things, natural gas contains smaller amounts of pentane, hexane, heptane, and helium.

In most cases, industry takes out the component wanted, then uses the remaining



FROM WELL TO DWELLING. Compressing stations located near gas fields extract rich gasoline vapors and such gases as propane, butane, and helium before the natural gas is piped to the consumer area. Transmission mains as long as 1,000 miles then carry it to the smaller distribution pipes.

gas as fuel. Carbide and Carbon Chemicals Corporation uses this procedure in its vast plant at South Charleston, W. Va. It extracts ethane from natural gas, and pumps the remaining gas into city fuel lines.

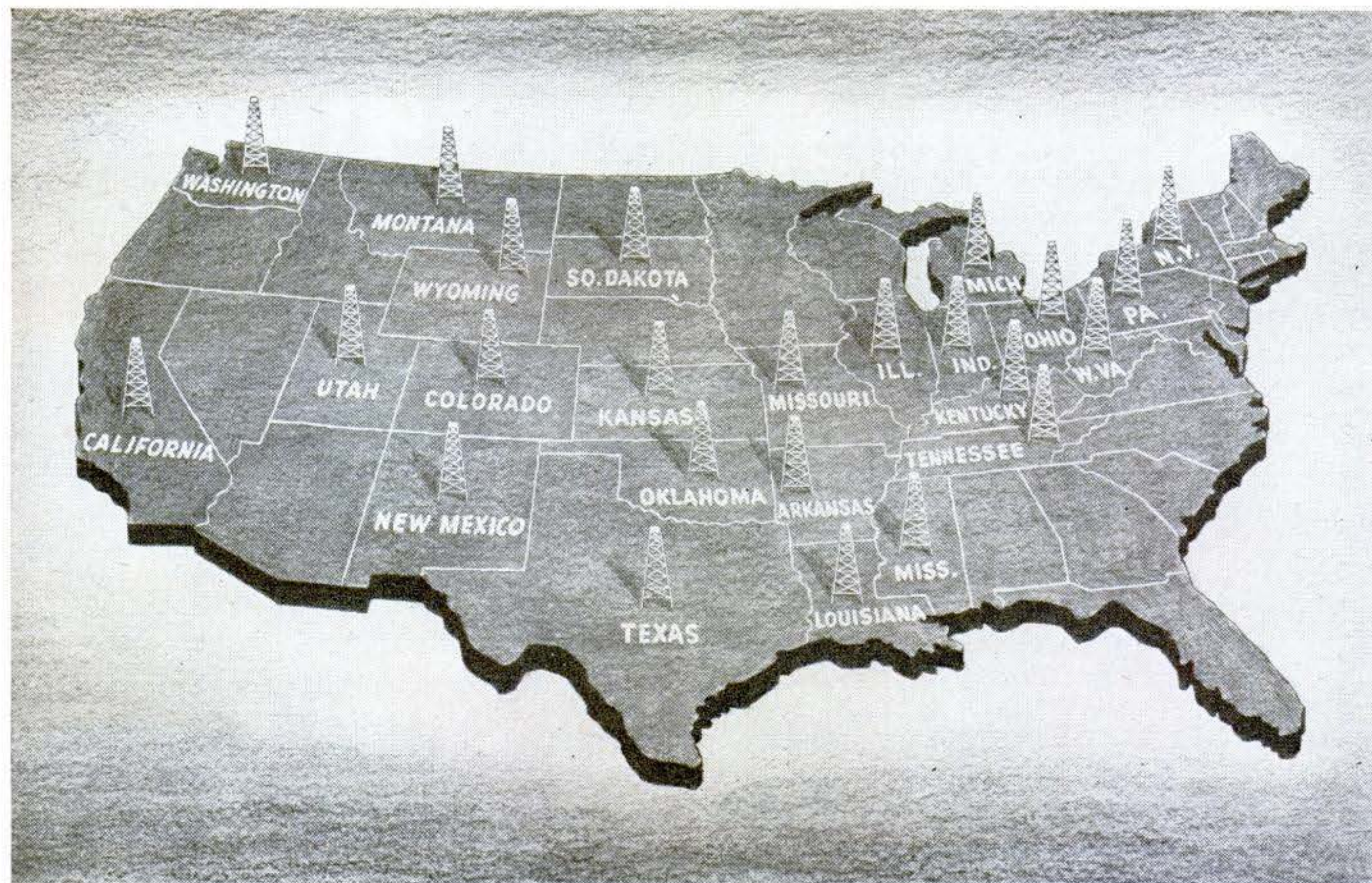
The chemist has four general lines of attack in ripping apart the molecules in natural gas:

OXIDATION: Oxygen is added to various components of natural gas under heat and

pressure—and sometimes in the presence of a catalyst—to produce a giant array of chemicals. Example: ethane and methane are oxidized to produce formaldehyde. In turn, formaldehyde is used to make resins of the bakelite type. Ethane and propane can be oxidized to produce ethyl alcohol and acetic acid—used in making acetate rayons.

The magical oxygen atom interacts with natural gas to make dyes, solvents, photo

37 OF THE 48 STATES have natural-gas deposits, but only 24 (indicated on the map) are now marketing the gas in commercial quantities. Pipe lines from Amarillo Field in Texas extend as far north as Minneapolis, Chicago, and Detroit, and plans are under way to liquefy the gas and ship it by barge.



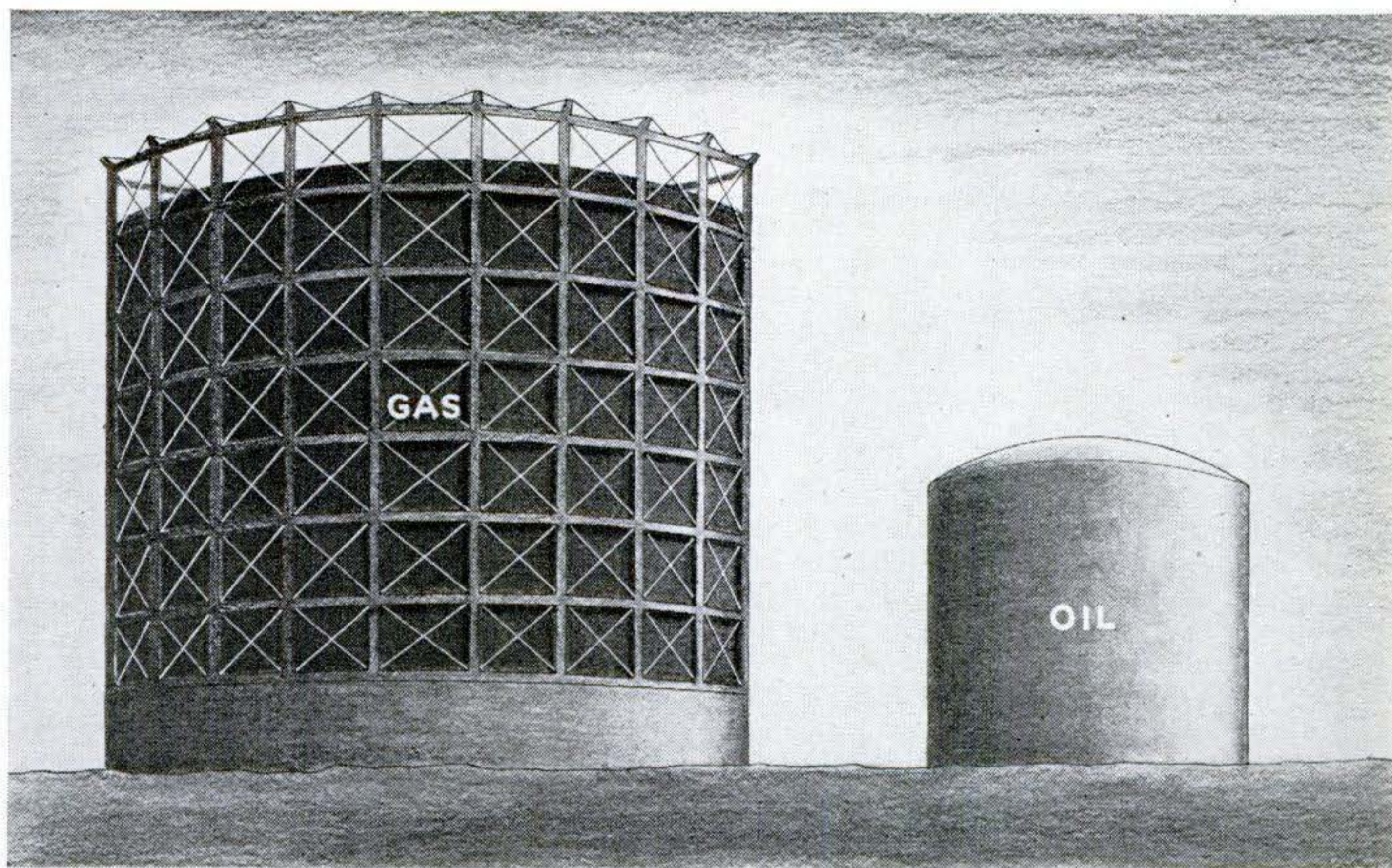
film, paraffin, antifreeze compounds, and a thousand other substances.

DECOMPOSITION: Chemists can chip off an atom of hydrogen here, an atom of carbon there, to convert natural gas into a variety of new products. Or, the molecules can be split completely apart to leave free hydrogen and carbon. The hydrogen may be used to hydrogenate cottonseed and other vegetable oils into edible fats. Or, the hydrogen may be combined with atmospheric nitrogen to make ammonia for fertilizer and explosives. The carbon left in this process goes into automobile tires and printing inks.

solvent, carbon tetrachloride, is another.

NITRATION: Adding a nitrogen atom to natural gases opened the way to a host of new explosives, some of them almost incredibly violent. Several years ago a teaspoonful of one of these explosives went off in a Swiss laboratory. It wrecked the laboratory, killed 10 people, and injured 20 others.

All this new knowledge, which was being put to work just as war started, was invaluable. It would have been virtually impossible for the United States to wage war on such a tremendous scale without the help of natural-gas chemistry. Products of



THE NATURAL-GAS RESERVE in the U. S. is 200 trillion cubic feet, or enough to last over 60 years, as compared with a petroleum reserve of 20 million barrels, a 15-year supply at the present rate of consumption. The average domestic consumer of natural gas uses approximately 62,300 cubic feet a year.

Retailoring the hydrocarbon molecules in natural gas is an infinitely fruitful field. Either the ethane (CH_3CH_3) or methane (CH_4) molecule can be converted into acetylene ($\text{HC}=\text{CH}$). Then the acetylene is used to make nylon and a synthetic rubber, neoprene.

Ethylene (C_2H_4) is derived from ethane, propane, or butane. This gas is used to ripen oranges and other fruits. It is also used to make antifreeze, ethyl alcohol, and blending stocks for high-octane gasoline.

HALOGENATION: By combining the halogens—chlorine, bromine, iodine, fluorine—with natural gas another set of chemicals results. Chloroform is one of them, and the

this new industry are everywhere: in the Lucite nose of a bomber, in the rayon fabric of the bomber's tires, in the plastics on the instrument panel, to name only a few.

Natural-gas chemistry broke one of the most dangerous bottlenecks that faced the country. We needed toluene—for TNT—in unprecedented quantities. Coke-oven gases supplied the 25 million gallons of this vital stuff we used in World War I. This time we needed more than ten times this piddling production—and building coke ovens to supply it was out of the question. Gas chemists came to the rescue—producing tens of millions of gallons of toluene at unheard-of low prices. *(Continued on page 206)*

LENSES AND PRISMS "GROWN" FROM SALT

Chemists produce synthetic crystals that are larger and purer than those found in nature.

By **HARRY WALTON**

THROUGH a new kind of gunsight, a Navy gunner sees projected in space a series of concentric rings like a bull's-eye in the sky. It moves wherever the gun is aimed, an optical finger of death pointing out the spot where the shell will strike. Its heart is a thin, transparent optical element—a chemical crystal that could be "grown" in a kitchen oven.

In a plant making synthetic rubber, butadiene passes before the inanimate but alert eye of a spectrophotometer. This is a critical stage in the process; if impurities pass, they may spoil material already further processed. Suddenly electric relays click. An automatic valve snaps to a new position, and impure butadiene is by-passed and returned for processing. Infrared light passed through the chemical is continuously and instantaneously analyzed by the instrument. A change in the characteristics of the spectrum signals, "Impurities." This activates electronic controls without halting production for an instant. The prisms and windows of the spectrophotometer are not glass, but chemical compounds synthetically "grown" in crystalline form.

Optical crystals, ground into prisms and

lenses, can spot enemy camouflage undetectable by the eye, photograph objectives by night or in fog, analyze the smoke of factory chimneys to reveal the product of the furnaces beneath, monitor the quality of aviation fuel, and serve the cause of victory—and peace—in myriad other ways that may not yet be revealed.

Optically considered, the finest glass has limitations at both ends of the visible spectrum as well as within it. Common glass only imperfectly transmits ultraviolet and infrared radiation. Certain natural crystals not only are more transparent to these wave lengths, but are more effective in spreading incoming light into wave bands analogous to the color bands in an ordinary sunlight spectrum. Many are capable of double refraction—they break up a single unpolarized beam of light into two beams polarized at right angles to each other.

Natural crystals such as calcite (Iceland spar), rock salt, sylvine, fluorite, tourmaline, and others, have long been used in laboratory instruments, but proved altogether inadequate to meet wartime needs for more and better military and analytical instruments. Natural calcite and fluorite crystals of optical quality are scarce; only a fraction of those found are suitable for

Lens, prism, and window blanks cut from a synthetic crystal grown from common table salt are ready for polishing. Made by The Harshaw Chemical Company, of Cleveland, the crystals are used in gunsights and in instruments for infra-red and ultraviolet spectroscopy, infra-red photography, and polarizing optics.



HOW OPTICAL CRYSTALS ARE "GROWN" FROM SALT



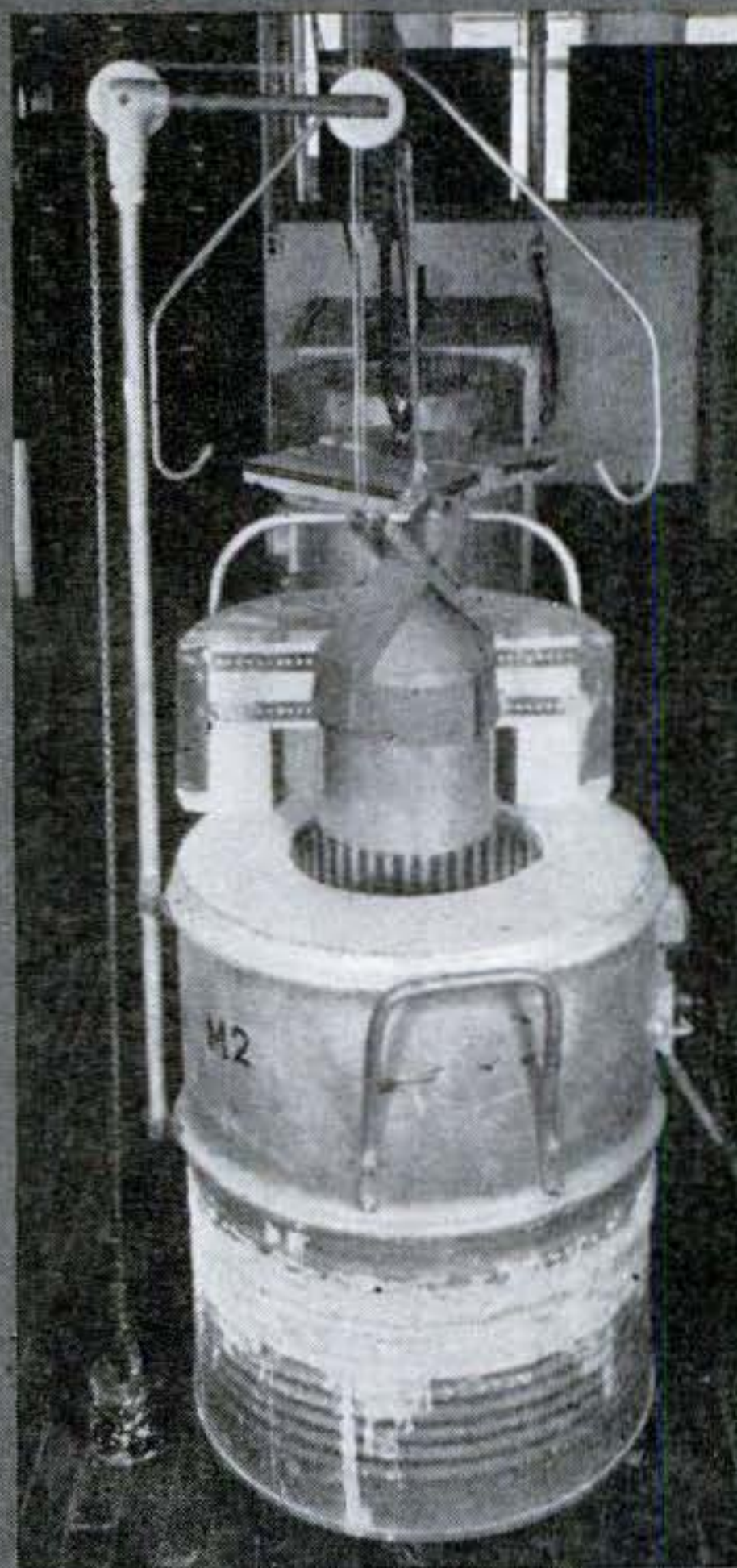
1 Sodium chloride (pure table salt) is loaded into a platinum crucible, then lowered into a four-place crystallizing furnace. Large, single crystals of sodium chloride, potassium bromide, and lithium fluoride, weighing up to 33 pounds each, are grown in these special ovens.



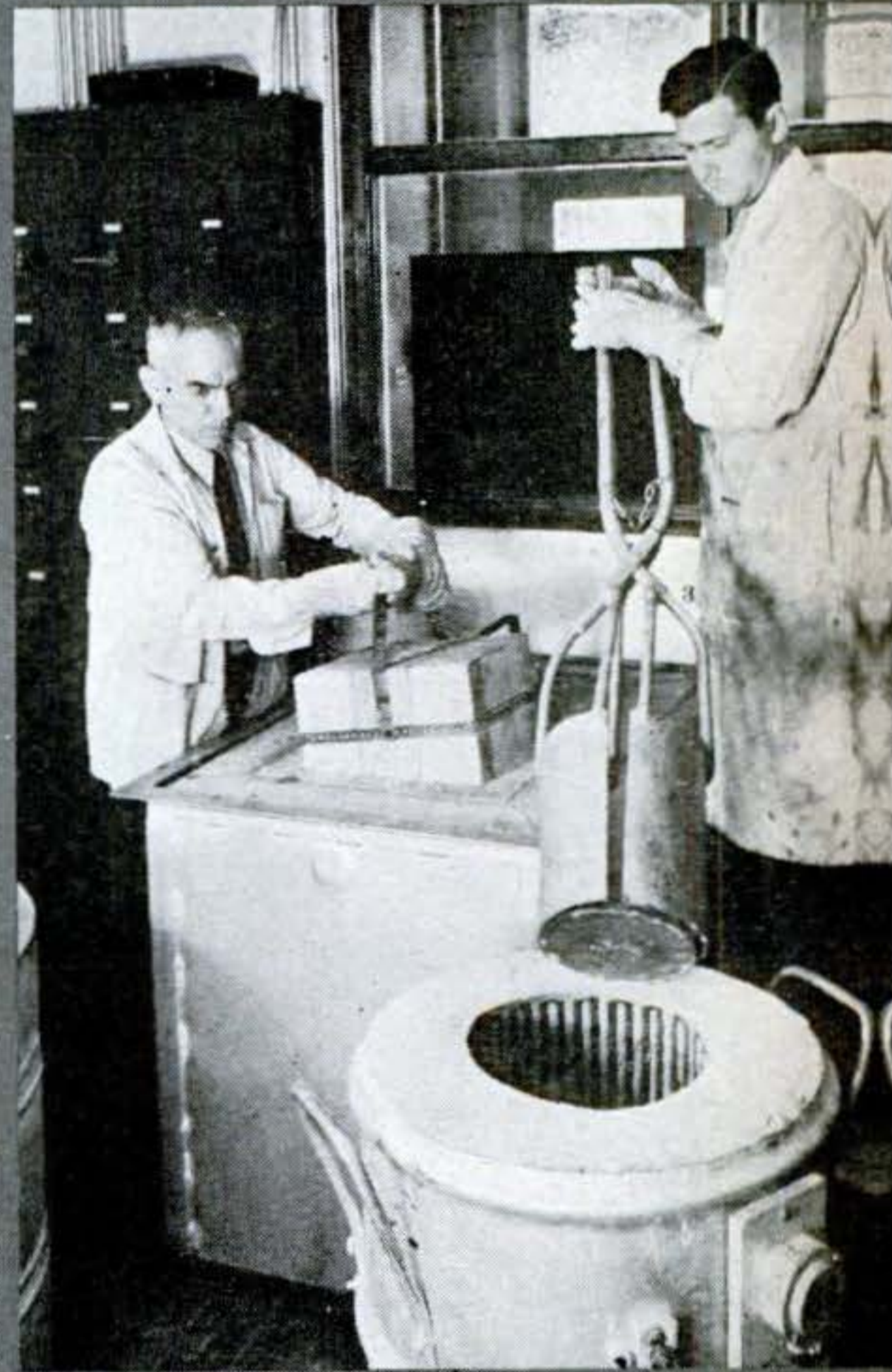
2 The grown crystal, still red-hot, is transferred to the melting-out furnace. This transformation of salt into a large crystal is a continuous process; both the temperature and the mechanical lowering of crystals during growth are under complete control.



3 Placing the red-hot crystal in the melting-out furnace. Platinum crucibles are used because of the metal's ability to withstand the high temperature of the molten salts.



4 In the melting-out process the outside of the crucible is heated, freeing the crystal. The crucible is removed, and the crystal remains at the bottom of furnace.



5 Then the still red-hot crystal is quickly lifted out and transferred to the annealing furnace where it is allowed to cool slowly for one week. Result: a larger and better crystal than nature can produce.



A platinum crucible comes out of the furnaces battered and scarred. This one has just been reshaped on the steel mandrel, or mold, and repolished both inside and out. It is now ready to be used again.

use. The supply of rock-salt crystals from Russia was cut off for several years. Prisms or lenses were always limited by the size of the natural crystals from which they were made, and large crystals were rare. Furthermore, some natural crystals could be judged as to quality only after laborious grinding

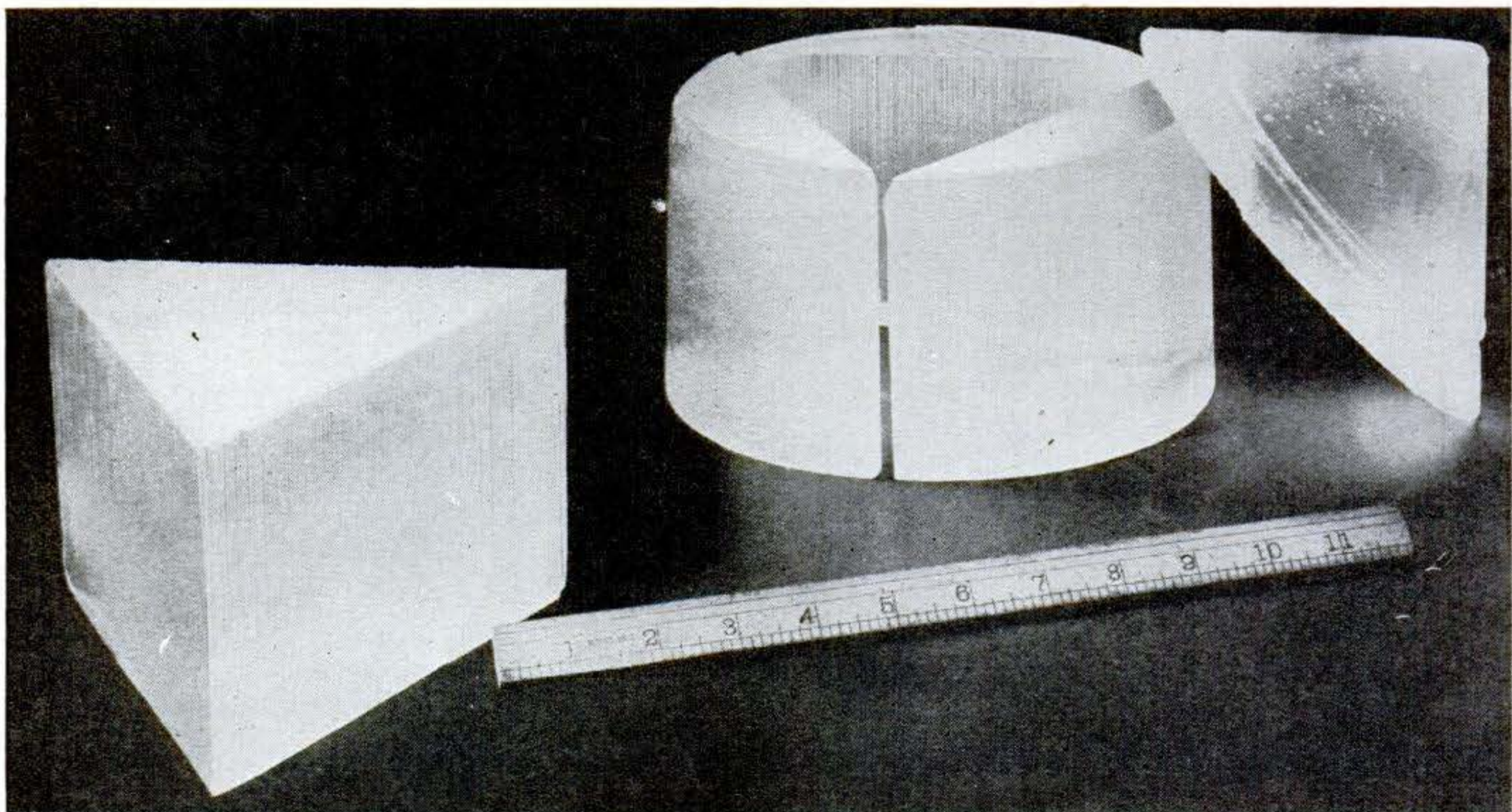
and polishing, with resultant waste and high cost.

Naturally these disadvantages stimulated efforts to produce synthetic crystals with the same optical properties. It was known that certain chemical salts could be melted by heat and would, under favorable conditions, solidify into crystalline form. But more often they merely hardened into a mass consisting of thousands of separate crystals. Such a mass is partially opaque and useless for optical purposes. Its atoms lie in random planes, whereas those in any single crystal are oriented along definite lines. The difference is roughly similar to that between frozen winter slush and a clear block of ice.

The problem was to orient the atoms of the molten mass during the critical cooling period. A means for doing so was developed at Harvard University and Massachusetts Institute of Technology. Since 1937 The Harshaw Chemical Company, of Cleveland, Ohio, under the direction of Dr. H. C. Kremers, senior chemist, has been producing by this method crystals much larger and more nearly perfect optically than those found in nature.

In outline the procedure is simple. The raw material—purified common salt, for example—is poured into a cylindrical platinum crucible with a cone-shaped bottom and lowered into a crystallizing furnace. By carefully controlled heat, the mass is melted and then allowed to cool enough to “grow” into a single crystal. The crucible with the completely grown crystal, still red-hot, is then transferred to a melting-out furnace, where the outside of the crucible is

The largest rock-salt prism blank ever made (left), and the 25-pound single crystal from which it was cut.



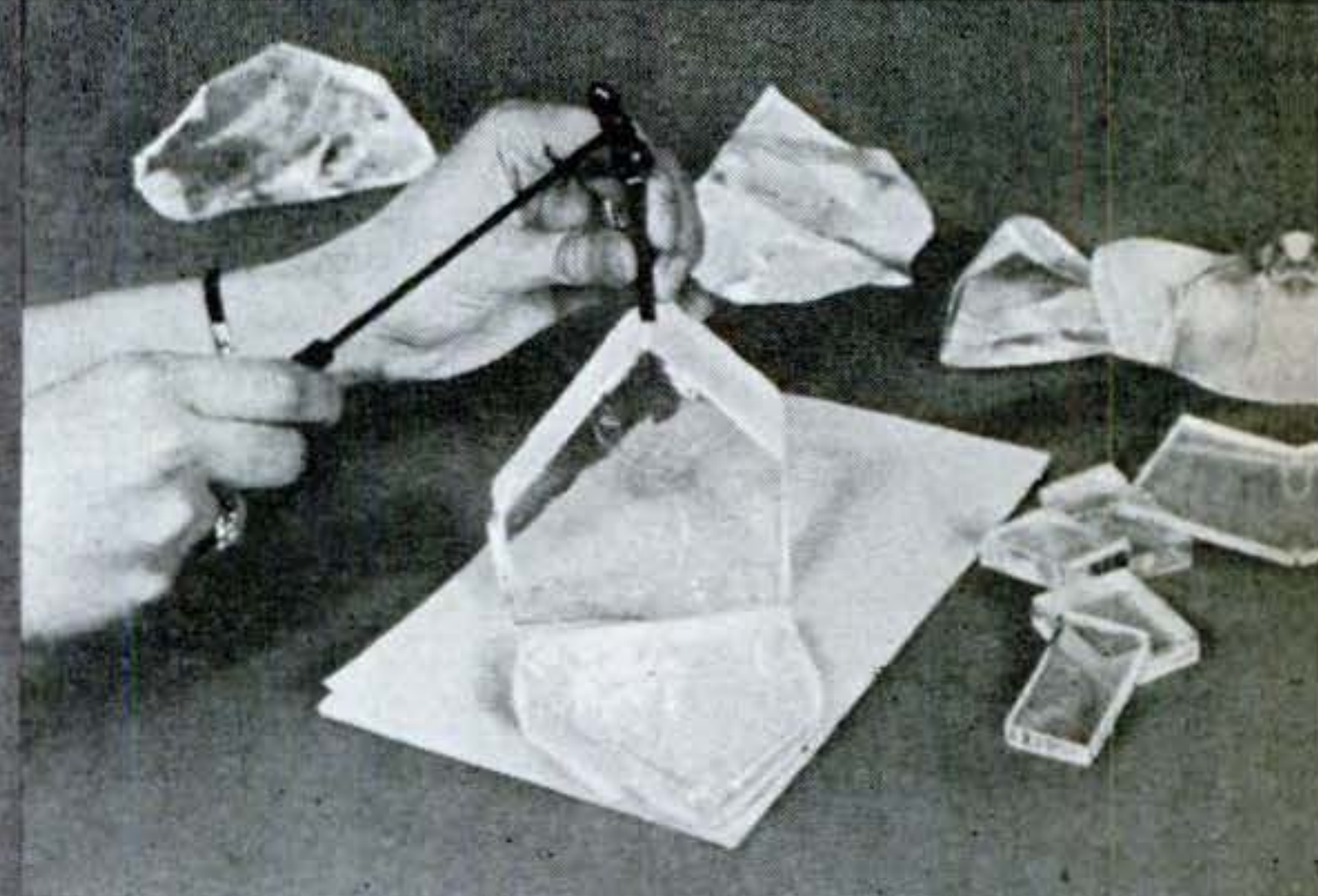
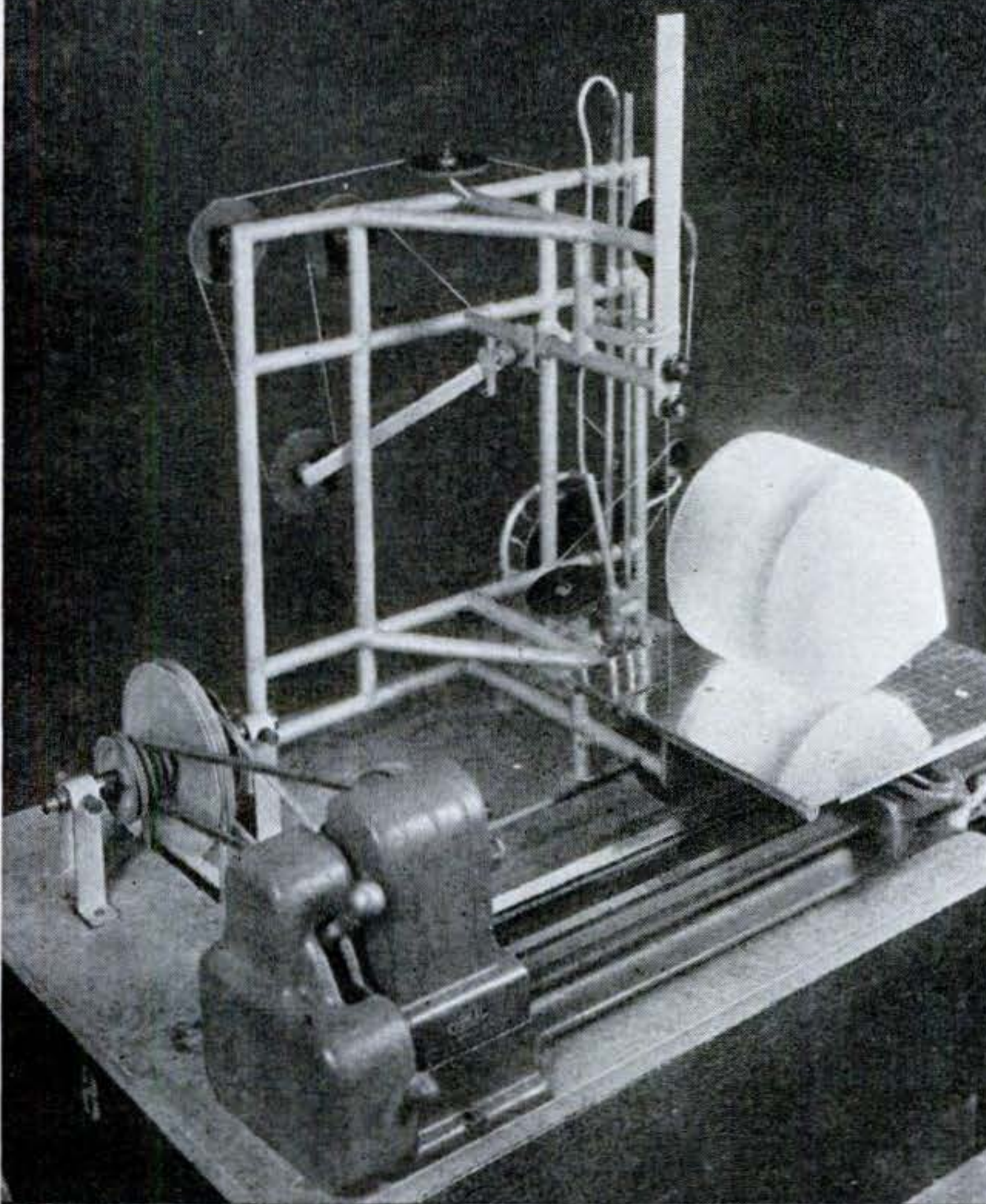
heated sufficiently to let the crystal drop free, like ice cubes from a tray over which warm water is run.

The red-hot crystal is then quickly transferred to an annealing furnace and allowed to cool slowly over a period of one week. The key to proper growth of the crystal is careful control of temperatures at all stages within a tolerance of one half a degree centigrade.

Platinum crucibles are used not only to withstand the high temperature of the molten salts, but to prevent contamination. After a crystal has been grown in it, the crucible is re-formed on a steel mandrel, patched if damaged, and repolished both inside and out.

The single crystals as grown are 250 millimeters (about 10 inches) high and 190 millimeters in diameter, and weigh between

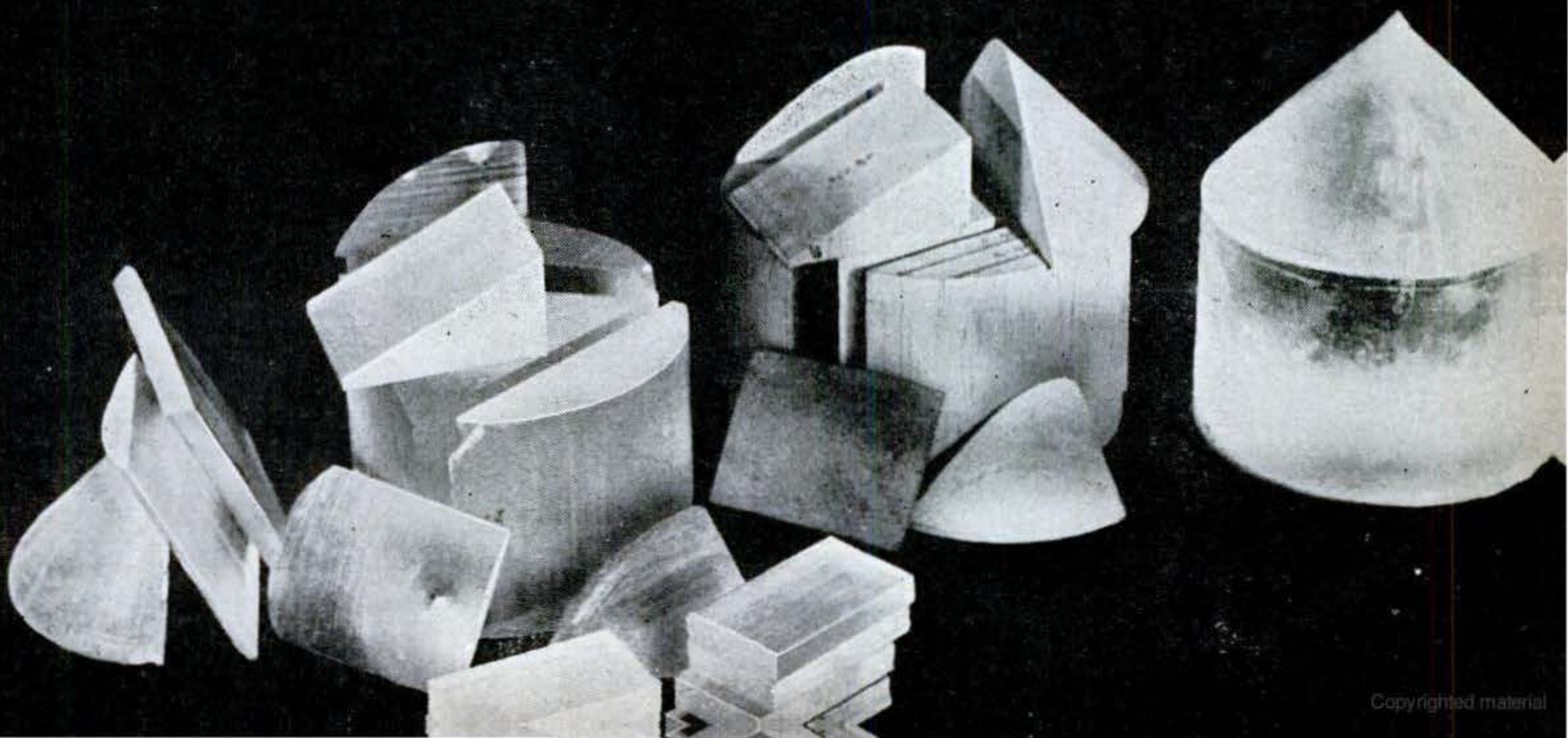
HOW SALT CRYSTAL IS CUT INTO PRISM AND LENS BLANKS



Cleaving window blanks from a chunk of synthetic rock-salt crystal. The blanks are first cut roughly to size, then ground and polished for exactness.

Wet-string saw (left) for cutting water-soluble crystals. The headstock supplies power to a jack shaft and an arrangement of pulleys over which the string runs. The crystal rests on a table affixed to the lathe carriage and moves against the string.

There is very little waste in cutting up a perfect synthetic crystal. At right, below, an uncut crystal stands beside a wooden dimensional model showing how it may be cut. On the left are the prisms and windows cut to the specifications of the model.



A SHEET OF MICA IS THE MATRIX USED IN GROWING



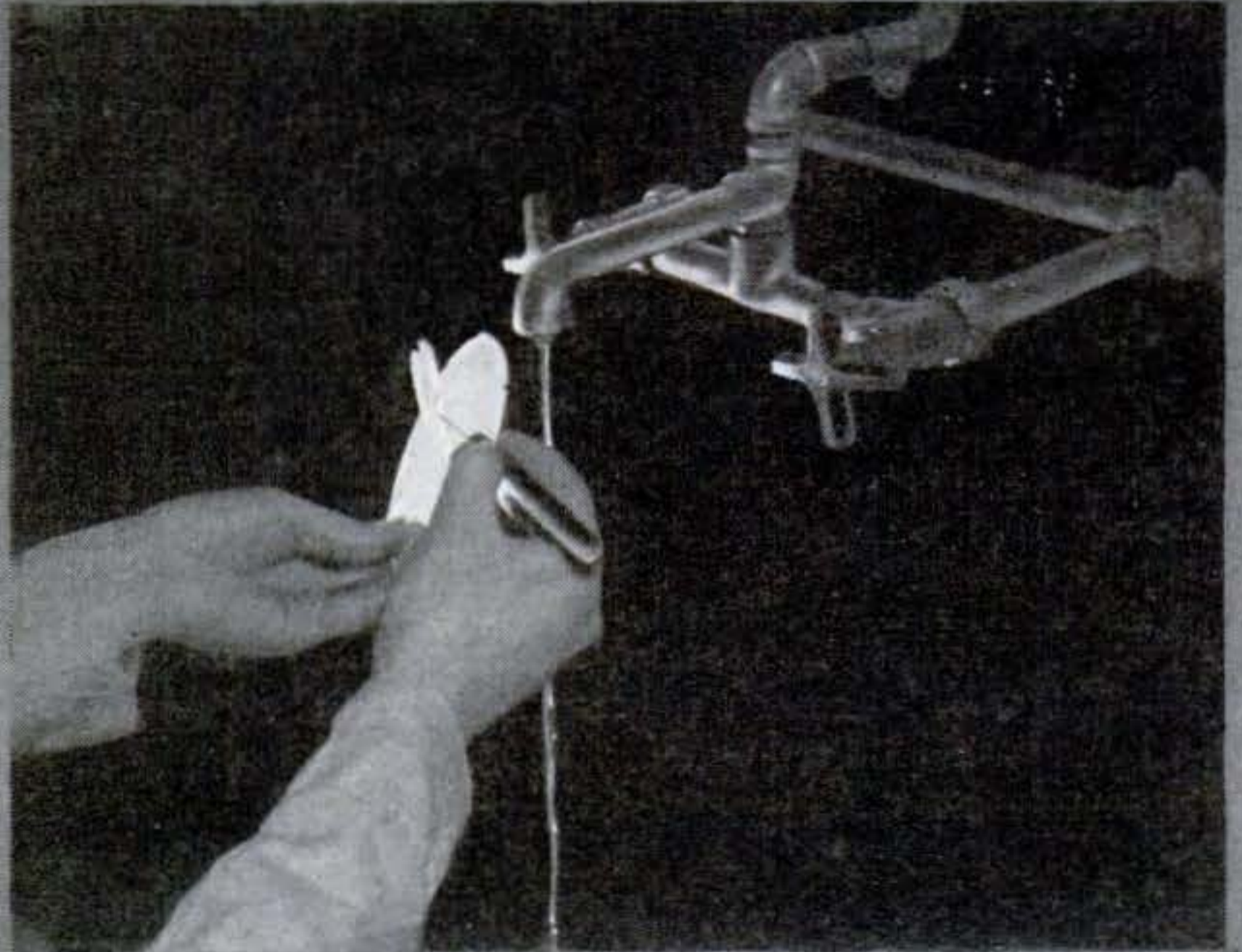
1 Synthetic crystal, which has effectively replaced calcite, can be made in 20 minutes. Aluminum foil is shaped on a glass form to make dish, as on right.



2 Aluminum-foil dish is then placed inside asbestos insulating mold, which permits molten crystal later to cool from top first. Sodium-nitrate crystals are added.



4 During the hardening process each atomic layer is correctly oriented, making the crystal optically useful. Cooled, crystal's foil is torn off.



5 The mica is then separated from the crystal with a needle or sharp-pointed knife. If care is taken to remove mica, the same piece can be used again in making crystals.

30 to 35 pounds each. They are sawed or split by cleavage into prism blanks or lens blanks of various sizes, as shown in some of the accompanying photographs. The largest salt prism made by the Perkin-Elmer Corporation, of Glenbrook, Conn., from a Harshaw-grown crystal, has faces four by six inches—a size many times larger than the biggest natural-salt crystal ever found would afford. The synthetic sodium-chloride crystal is further superior because it is free from defects caused by imperfections and impurities in natural rock salt.

Sodium chloride (common salt), potassium bromide, and lithium fluoride crystals

are used in infrared spectroscopy, the latter in the region between one and five microns, sodium chloride up to 14 microns, and potassium bromide up to 25 microns. Lithium fluoride is used in ultraviolet spectroscopy.

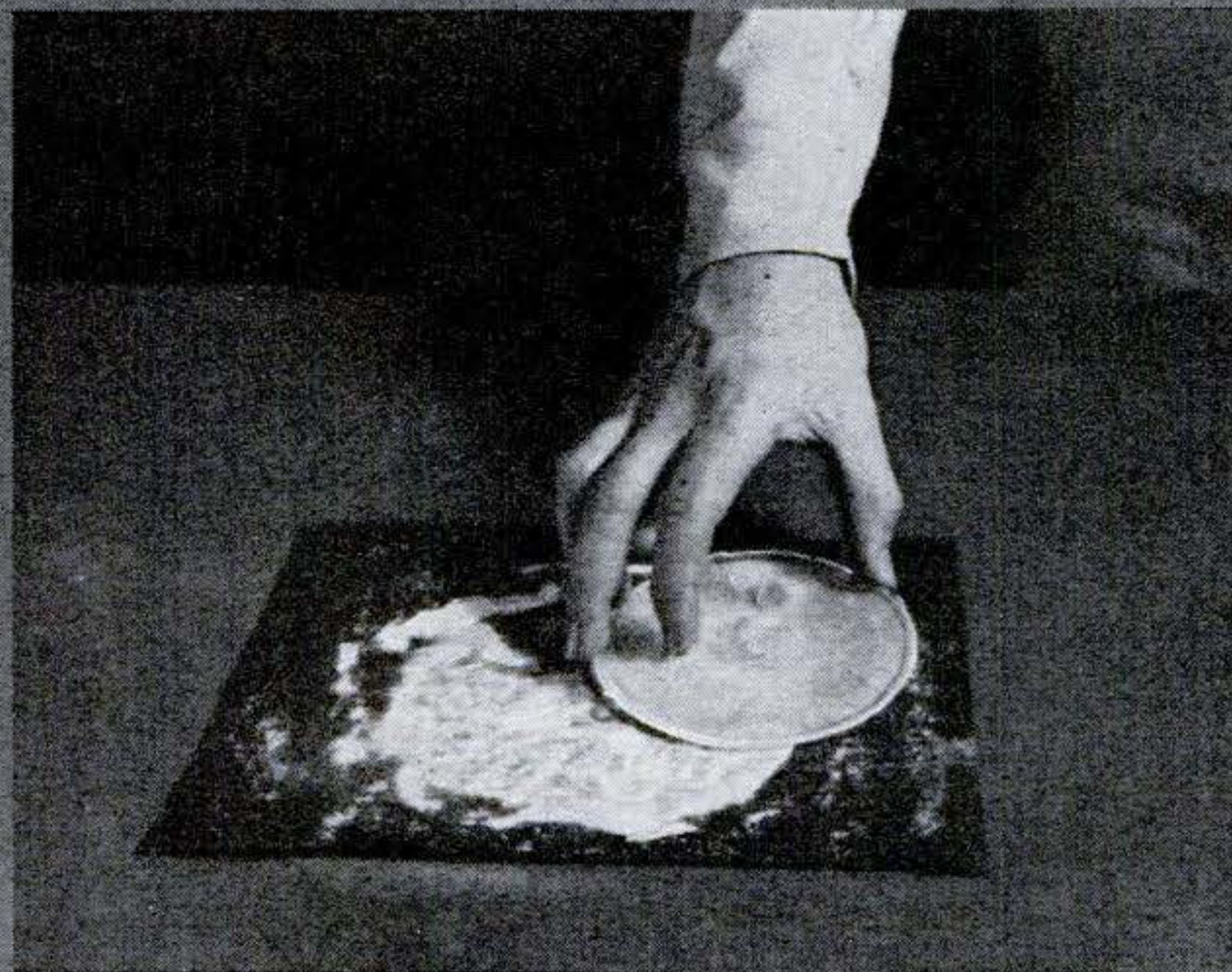
A comparative newcomer is the sodium-nitrate crystal, which replaces natural calcite. It has been the most difficult to grow, and for a long time could be produced only in small sizes. But a new technique developed by Dr. Cutler D. West and Frederick J. Binda of Polaroid Corporation, Cambridge, Mass., makes it possible to produce good-sized crystals readily even in a kitchen oven!

The problem was to make the first atomic

LARGE OPTICAL CRYSTALS FROM SODIUM NITRATE



3 Molten crystal is withdrawn from the oven, and the mica floated on it. This piece of mica controls the arrangement of the atoms in the molten mass as it hardens.



6 The synthetic crystal, optically superior and much larger than calcite produced by nature, is ground on a piece of sandpaper to eliminate minute surface bubbles.

Dr. Cutler D. West and Frederick J. Binda of the Polaroid Corporation, inventors of the new method for growing large lens blanks for polarizing optics, measure a giant sodium-nitrate crystal. Dr. West reports he has grown crystals three quarters of an inch thick and $7\frac{1}{2}$ by 15 inches in area that have optical qualities superior to those of calcite. The disks in the foreground are aluminum pans for round lenses.

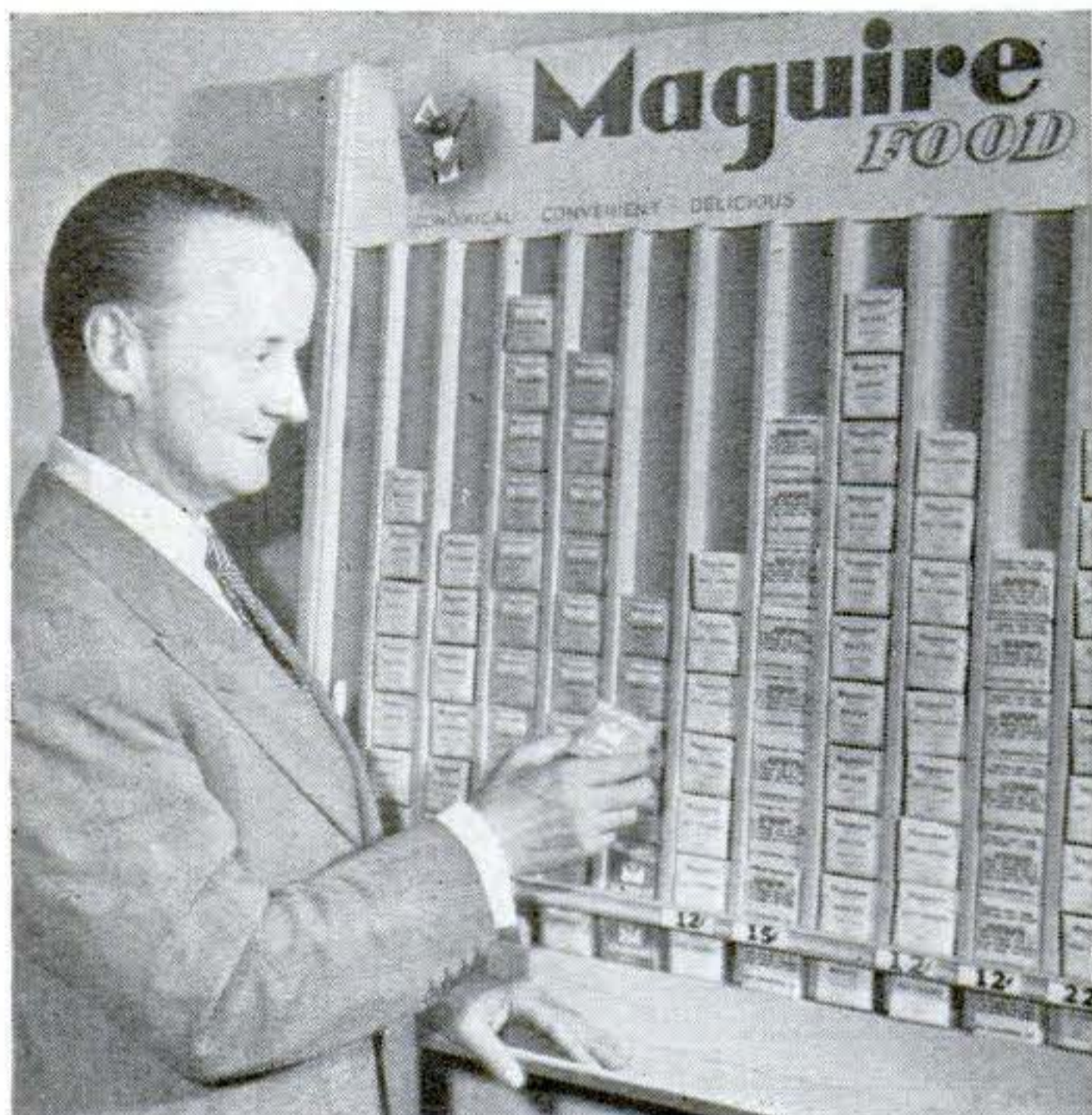


layer of the molten salt harden in correct orientation. If this could be done, subsequent layers would all orient themselves after the first. The West-Binda method is amazing in its simplicity. It is to place in contact with the molten surface a substance having the same atomic arrangement as that required in the melt. Mica, which is available in sheets up to three feet in diameter, is the natural matrix so used. The potassium atoms on its surface have a pattern like those of the sodium atoms in the molten sodium nitrate and thus form an atomic mold for the latter. Once the contact layer has hardened in correct orientation,

succeeding layers follow the same basic pattern and the crystal grows downward.

In practice, sodium nitrate is melted in an aluminum dish. A sheet of mica is then carefully lowered into the molten surface and the melt is returned to the oven. Temperature is gradually reduced until the crystal has solidified, at which point the mica is stripped off with the aid of water. The whole process can take as little as 20 minutes. The crystals have high resistance to thermal shock. In tests they did not crack even when taken from an oven at 300 degrees centigrade and quenched in oil at room temperature.

What's New in Modern Living

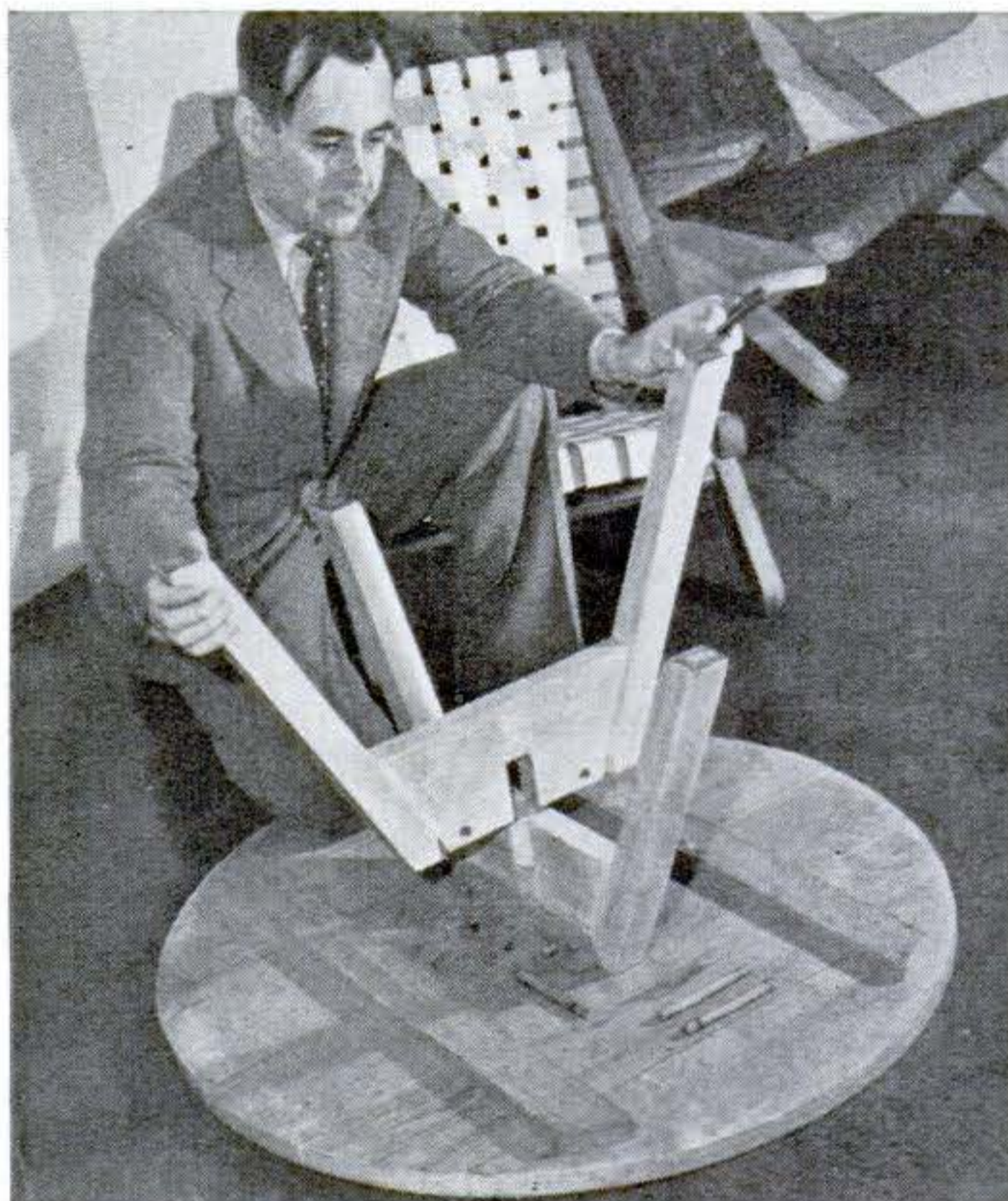


COMPRESSED FOODS of the type used by the armed forces will be presented to civilians by self-service stores. Foods will be sold from dispensers that flash a light and ring a bell when a package is removed. It is the idea of Maguire Industries, Inc., N. Y.

CLOTHES ARE SPUN DRY in heated air in this automatic drier, a Westinghouse re-conversion product. And when they are dry, the machine shuts off of its own accord. It can be stopped manually for removal of damp pieces for ironing.



KNOCKDOWN FURNITURE that can be assembled with wood pegs in the home is now being made. Available besides tables like the one shown below are beds, chairs, and cabinets in both wood and plastic models. Ferdinand Kramer, a New York architect, is the designer. He says a saving in shipping space and in the cost of assembly results in reduced prices.



TYPING OUT TUNES is possible with this little musical instrument having a typewriter keyboard and a $2\frac{1}{2}$ -octave scale. Music provided with it permits an untrained person to play tunes by striking the right letters. Made by the Electronic Corporation of America, the "Typatune" also helps teach touch typing.



CRAFTSMEN RIDE THEIR HOBBIES

CALLED A "DOODLE BUG," this tiny car that "rides like a baby carriage" was built by Sgt. Arthur P. Joslin, of Washington, R. I., during spare time while he was stationed at Peninsular Base Headquarters at Leghorn, Italy. It is made entirely of salvaged materials that were available there.

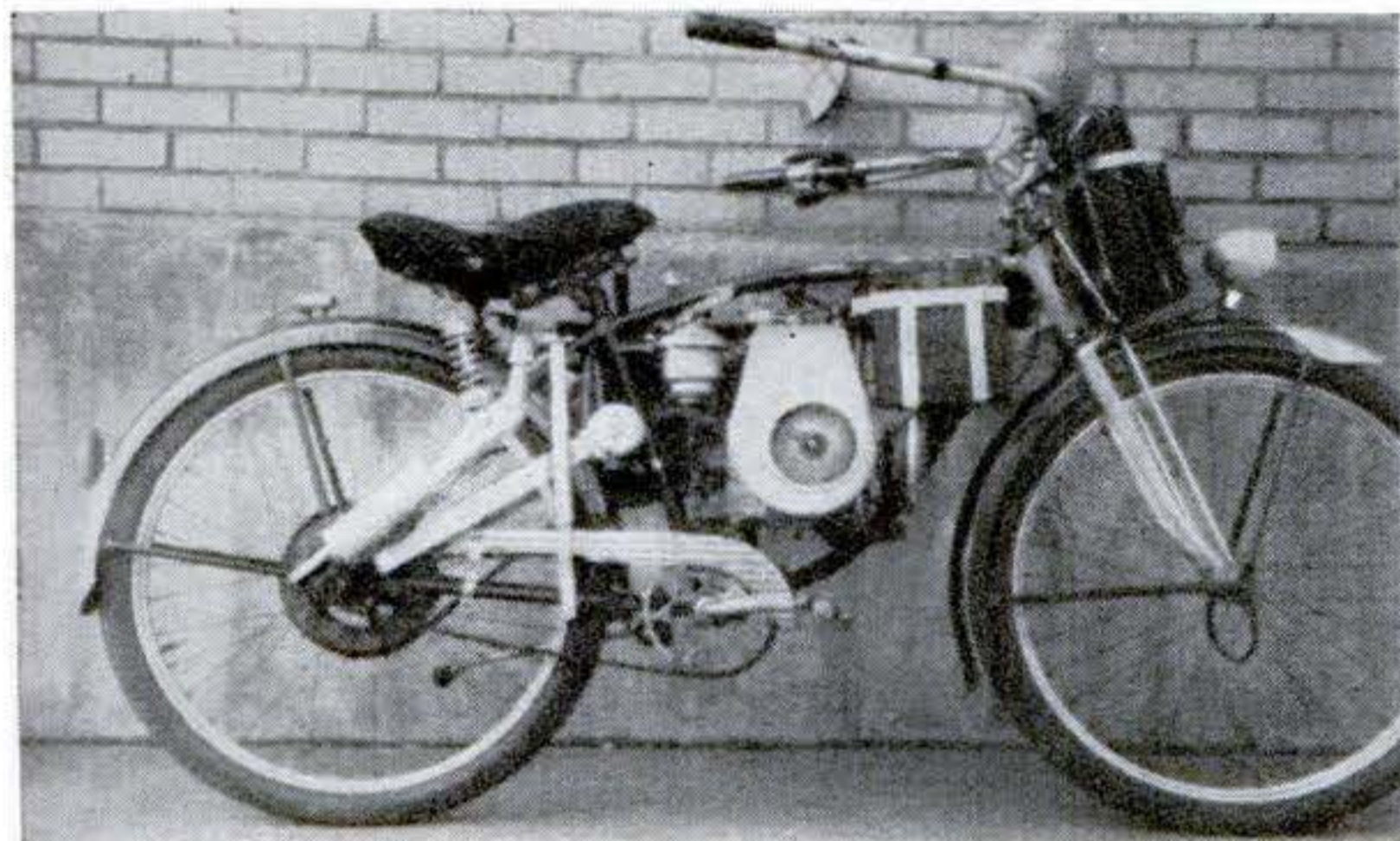
Sergeant Joslin took the motor from an Italian Fiat 500 and the wheels from British Spitfires. The body is a spare gas tank from an American P-38, and the windshield is part of a plastic nose from a bomber. There is only one headlight.

Spring construction is the sergeant's own idea. The rear spring is a cantilever type,



but it is made from a semielliptic model, and it contributes to riding smoothness.

With four speeds forward, the "Doodle Bug" is said to get up to a top speed of 70 miles an hour. It averages more than 50 miles on a gallon of gasoline.



MOTORIZING A BIKE was accomplished by C. Hill Hutchins, of Spartanburg, S. C., by installation of a 1½-hp. engine and a homemade transmission and clutch. A standard 52-tooth sprocket was put on the rear wheel, being turned and bushed for a tight fit on the coaster-brake hub.

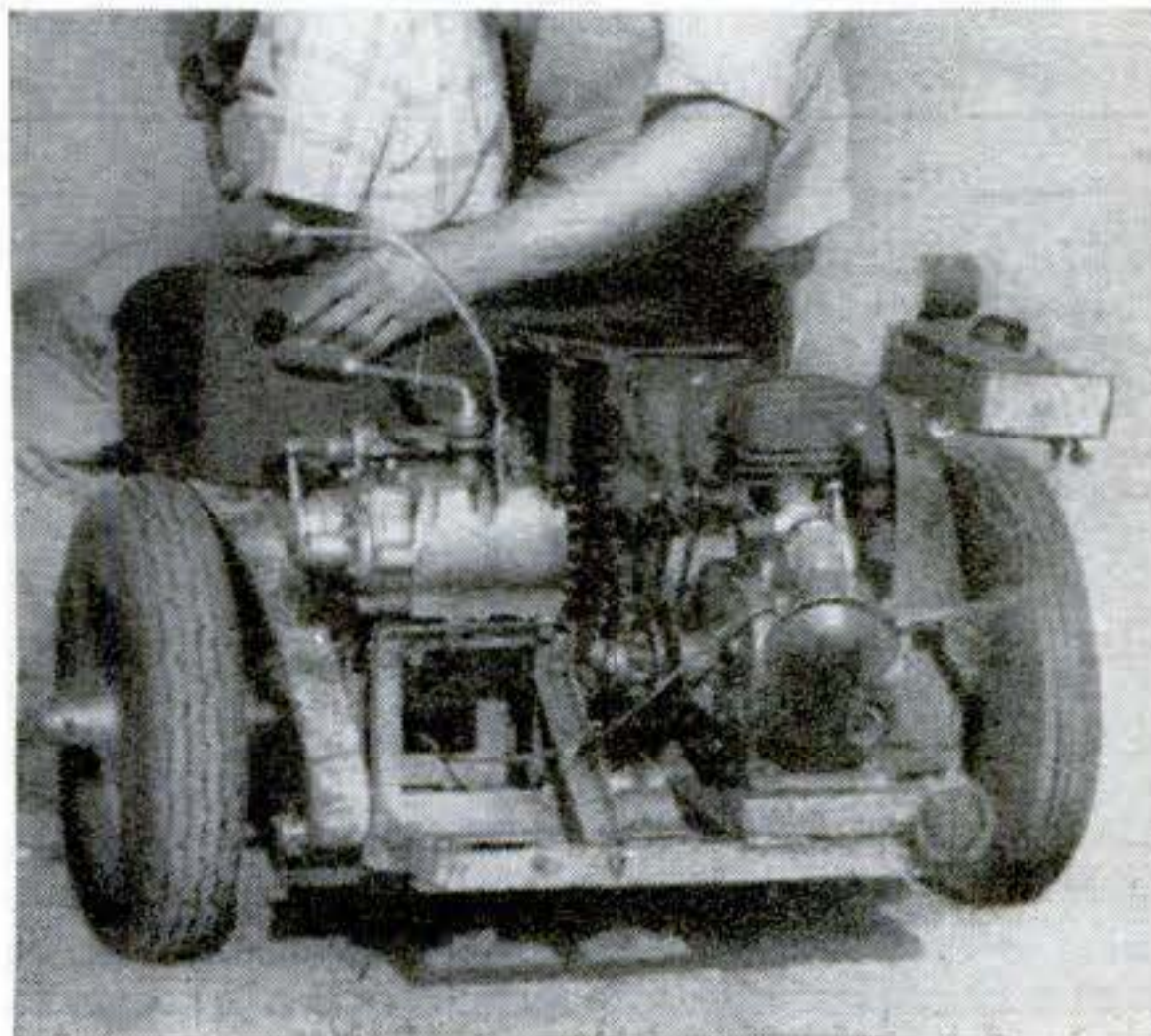
There are two driving speeds from a double-grooved pulley on the motor. One ratio of 11½ to 1 gives a speed up to 30 m.p.h., and the other, at 9½ to 1, has a maximum of 40.

The bike has gone 10,000 miles.

WITH WHEELBARROW WHEELS, a three-speed motorcycle transmission, and a tiny ¾-hp. gas engine, Louis M. Goodman, of Detroit, built the little underslung car shown below. He can get 30 m.p.h. on a level surface.

The little car weighs only 230 lb. and is chain driven, eliminating problems of belt

slippage. Goodman asserts that the motorcycle transmission is the secret of good performance, for without it the tiny motor would hardly drive a scooter. The motorcycle clutch is connected by chain to the transmission. After a 10' start in low speed, it is possible to skip second and go immediately into high.



CHRISTMAS EVE AT



For 20 years he'd run a newsstand in front of the Park House.

By **MARTIN BUNN**

WITH a wide grin, Gus Wilson reached up to the wall calendar that hangs over his workbench. He tore off a leaf and indicated the big red "25" he had disclosed.

"Knock off, kid," he told Stan Hicks, the Model Garage's grease monkey and slowly developing mechanic. "It's close to five o'clock of another Christmas Eve and time to celebrate . . . Now, what's this?"

The shop door had opened, letting in a wintry blast, and closed again. Inside stood a pint-size figure in olive drab. Gus was surprised to see that it was a girl—the smallest Wac he'd ever come across. When she opened her overcoat to flap off the wet snow, he noticed an ETO service ribbon over one pocket of her blouse and an honorable-discharge insigne over the other.

"Yes, miss," Gus said. "Is there something we can do for you?"

She was unsmiling. "You don't recognize me, Mr. Wilson," she said. "I used to sell you newspapers at Pop's stand. Ann Perkins—Charley Perkins's kid."

Gus remembered her then. Charley Perkins is a gaunt, silent man with a bad limp who has run a sidewalk newsstand

outside the Park House for the last 20 years. Old-timers say he got his game leg, with a double lungful of poison gas thrown in, in the Argonne back in 1918, but Charley never talks about it—or about anything else, for that matter. Until a few years ago his motherless daughter—a skinny, shabby kid with a nice smile—helped him at the stand sometimes. Then we began to miss Ann, and people who asked about her got no more than a grunt from Charley.

"Oh, sure," Gus told her. "But you look so different in uniform, and your father never told us you had enlisted."

"He wouldn't," Ann said briefly. "I suppose everyone in town thought I'd walked out on him. Well, I hadn't. He wanted me to go—not having a son to send."

Gus thought of several things to say, but he couldn't put them into words.

"Well," he said lamely at last, "I'm glad to see you back. We'll have to put your name on the Honor Roll outside Town Hall. We're mighty proud of you kids."

"Skip it, Mr. Wilson," Ann cut in. "I didn't come to get a bouquet—I came because I'm out of luck about something that means a lot to me and because you're the only person I know who might help. But I guess even you can't."

"I can try, anyway," Gus told her. "What is it that you're out of luck about?"

"It's a car I bought for pop—for his Christmas," Ann said. "He needs one so badly—his bum leg's worse, and it's pretty tough for him to have to walk to the Park House and back every day. I was going to have it waiting for him in front of the house tomorrow morning. But I guess that's washed out now. I'm told I've bought a lemon with a good paint job."

Ann dabbed at her eyes with a large khaki G.I. handkerchief.

"Cheer up," Gus said. "Maybe it isn't so bad. Anyhow, I've taken the sourness out of many a lemon in my time. Where did you buy it, and what's the matter?"

"Excuse me," Ann said, "I didn't mean to stage a baby act. I bought it from a used-car place in the city. It had to be cheap, because I didn't have much money. The

THE MODEL GARAGE

bus is 10 years old but looks real nice. They let me try it, and it ran fine, but the boss told me I'd have to take it 'as is'—no guarantee. I knew I was taking a chance—but I wanted a car for Pop's Christmas, and I thought it would turn out all right.

"Well, I drove it home and left it in a neighbor's garage so Pop wouldn't see it. Next day I drove it down to the city where I'm trying to find a job. When I got there I stopped for gas, and the oil was low. I thought that was queer, but I had a quart put in. The next time I got gas the oil was two quarts low. I started watching it then and found I was only getting 25 miles to the quart."

"That," Gus said unexcitedly, "does seem sort of unreasonable."

"I don't know much about automobiles,"

Ann went on, "but that's what I thought, too. It made me afraid that something really serious was the matter, so I took the car to a big repair shop in the city. The manager told me the only way to avoid bad trouble would be to have the cylinders rebored and new pistons put in. They wanted a lot more for the job than I could pay, so I took the car back to the place where I bought it. The boss there just laughed, told me it was my headache now, and asked why I thought they had sold it so cheap.

"That was this afternoon. I came home feeling sunk and made up my mind that there wasn't anything I could do about Christmas but just sweat it out—that I wasn't going to stick Pop with a present that wouldn't be anything but a disappoint-



"It was my headache, they told me, and asked why I thought they had sold the bus so cheap."

ment and an expense. Then I remembered how people used to say that if anyone could make an automobile run right, you could. So I brought the car over. I don't much hope you can do anything, but if you'd just look at it—"

"Drive it in," Gus said. "That's easy."

Stan opened the big shop doors, and Ann drove a black sedan into the shop. Gus's ears told him the engine would be better for an overhaul, but it sounded no rougher than plenty that are on the roads every day.

"Leave the engine running, please," Gus said. He raised the hood, and stood watching for half a minute. "Switch her off," he told Ann. "Your engine could stand having some work done on it, but there's nothing seriously wrong. There's just an oil leak somewhere. It probably won't be hard to fix, but it may take a while to find. Leave the car here and come back for it this evening—say about 10 o'clock."

Ann's face crinkled into her nice smile.

"Why," she cried, "that's wonderful! Tomorrow I'll be able to—but isn't it past your quitting time, Mr. Wilson?"

Gus gave Stan a surreptitious wink. "We always stay open Christmas Eve," he said.

After Ann had gone, he grinned at Stan and asked: "What are you planning to do this evening, kid?"

"Same thing you are, boss," the grease monkey replied gravely. "Without getting paid for it, you understand. What are you going to do to the gal's car?"

"The first thing," Gus said, "is to find and fix that oil leak. That ought to be easy enough. Then we can do a few little jobs that'll make the old bus run better—but we needn't tell her we've done them. She's the kind of kid that deserves a break—especially on Christmas Eve."

"You said it," Stan agreed. "While you're getting your dinner at the Park House, I'll look for the leak. Soon as I find it I'll go over to the diner. Then when you get back, we can get on the job."

When Gus got back, he found Stan munching a sandwich and looking gloomy. "There's something screwy about this car," the grease monkey confessed. "I've checked everything two or three times, but I can't

find an oil leak. There's an awful lot of oil around the pan and the bottom of the crankcase, but I can't find where it comes from."

Gus grunted and went over to the car. He filled and lit his pipe. Then he leaned over, removed the oil-filler cap, glanced inside it, and handed it to Stan.

"I guess you've never seen a filler cap just like this one," he said. "They were before your time."

"What's this stuff inside?" Stan asked.

"It's a metal-wool filter—same as there is in an air filter over a carburetor," Gus explained. "On some of these old cars the oil-filler cap also serves as a breather."

"So what, boss?" Stan wanted to know. "How does that help find the leak?"

"We don't have to look now," Gus said. "There isn't any leak. This cap caused the trouble. As you see, the filter in the breather is clogged. Since there's always some blow-by past the pistons, the clogged breather lets this build up pressure in the crankcase. This forces oil past the rear main bearing, and also past the rings

into the firing chambers. Clean out the filter, and the pressure will be released."

They replaced the clogged filter with new metal wool. Then they really went to work. At half past nine Gus took the car out for a test, and came back grinning.

"Good for another five years!" he gloated.

Stan went into the office and switched on Joe Clark's radio. When Ann came in a few minutes before 10 she found the two listening to Christmas carols.

"Did you get the leak fixed?" she asked.

"It's all right now," Gus assured her. "You haven't a thing to worry about. It didn't take Stan 15 minutes . . . Where's your time slip, Stan?" He took a slip and did some figuring on the back. "Thirty-five cents—and I'm overcharging."

"That seems very little," Ann said, and put the money on the bench. "I won't even try to thank you—I'll just wish you as nice a Christmas as Pop and I are going to have." She got into the car and stepped on the starter. "Why, what's happened?" she cried. "The motor is smooth!"

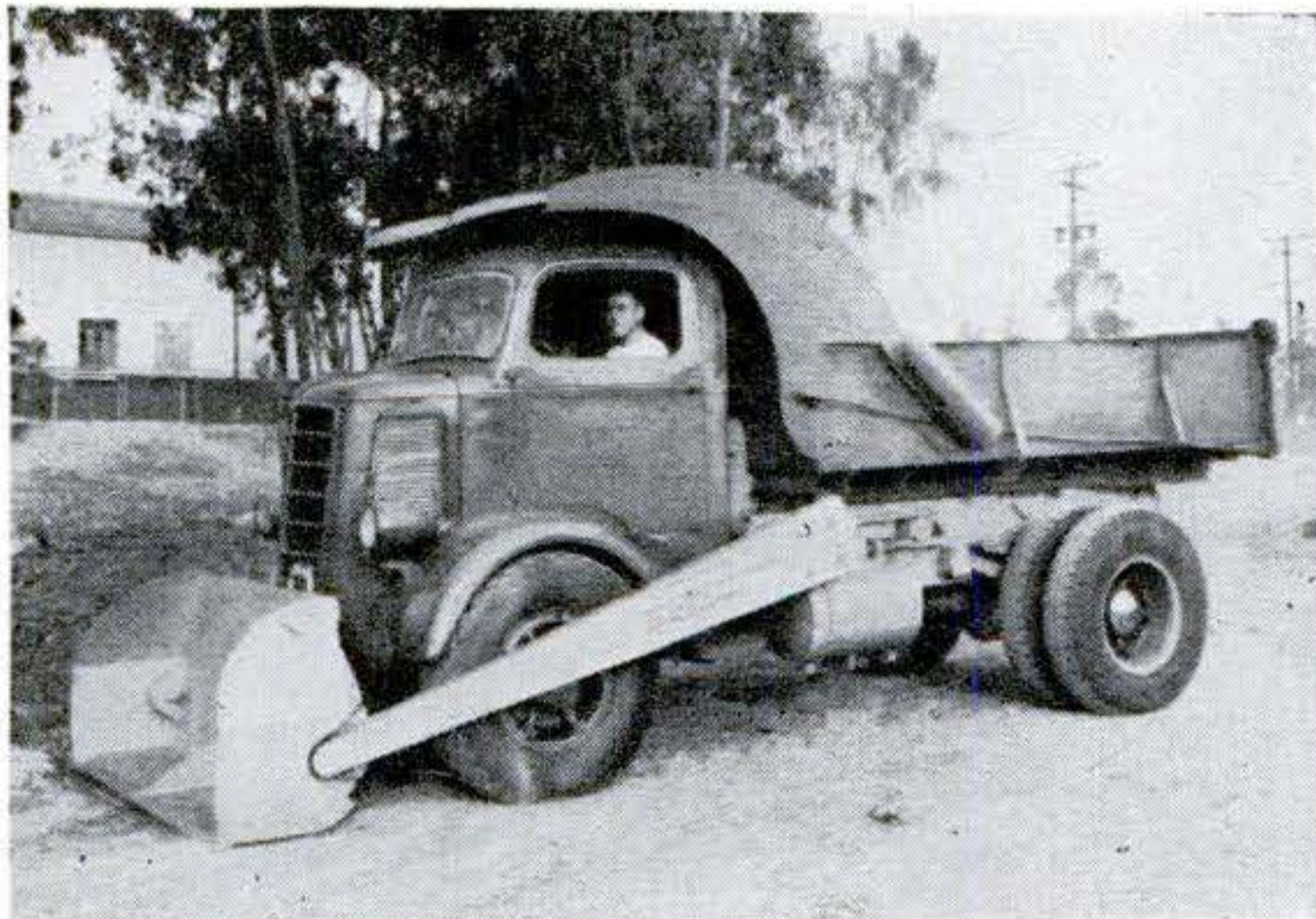
"Oh, that's because the oil isn't leaking," Gus said vaguely. "Merry Christmas!"



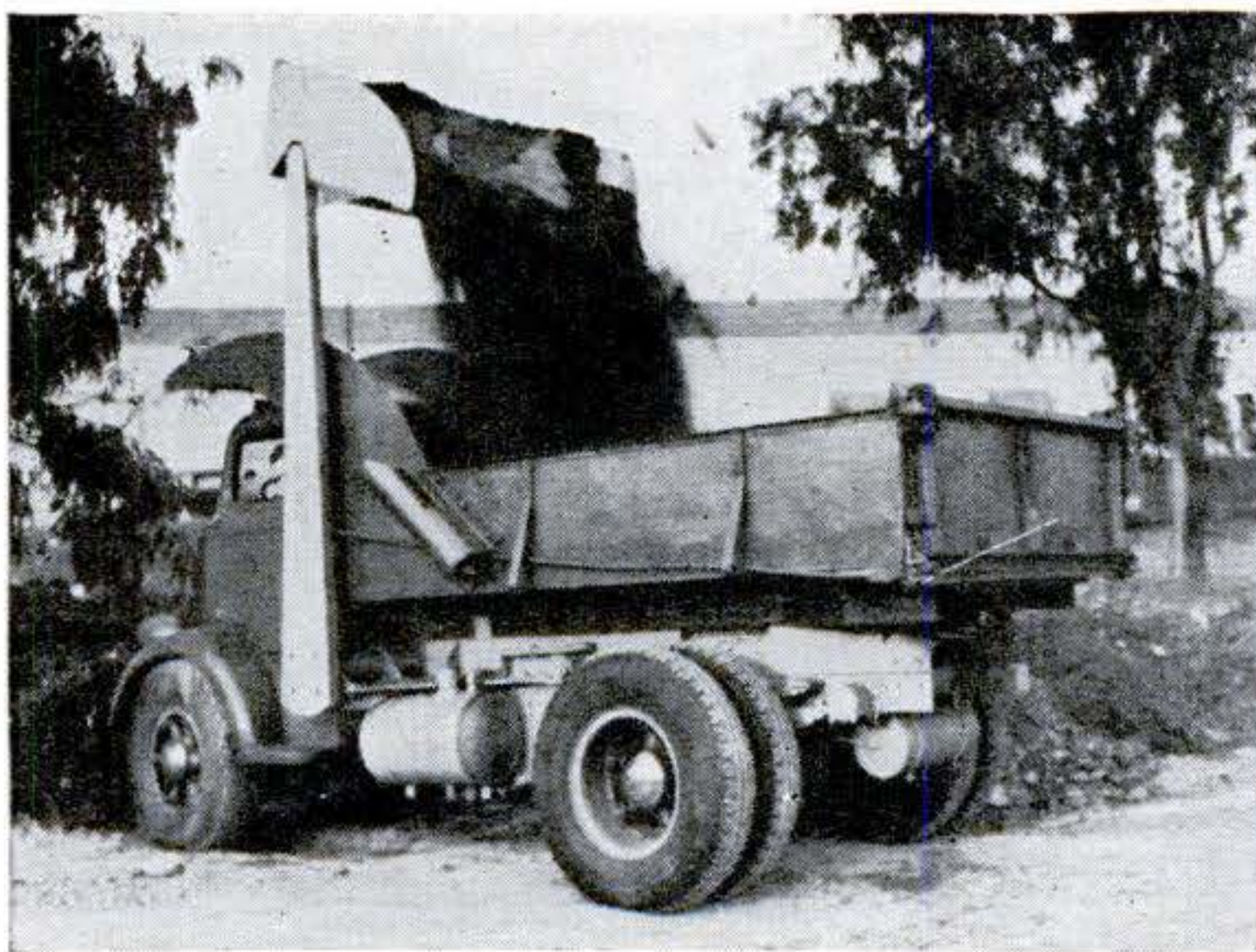
She had been planning to have the car outside the house to surprise him when he came downstairs Christmas morning.

AUTO IDEAS

LOADING A TRUCK equipped with the automatic hydraulic unit below requires only a few minutes, and the driver can accomplish the job alone without leaving his seat. The shovel, which has a one-yard capacity, will handle earth, gravel, sand, fertilizer, snow, and other loose material. Locked in position in front of the truck, the shovel also can be used as a modified bulldozer. The unit is manufactured by the Western Industrial Engineering Co., of Los Angeles.



With shovel lowered, the truck above moves forward to scoop up a load of earth. Then, swinging the load up and back, the driver dumps it, below, into the truck.

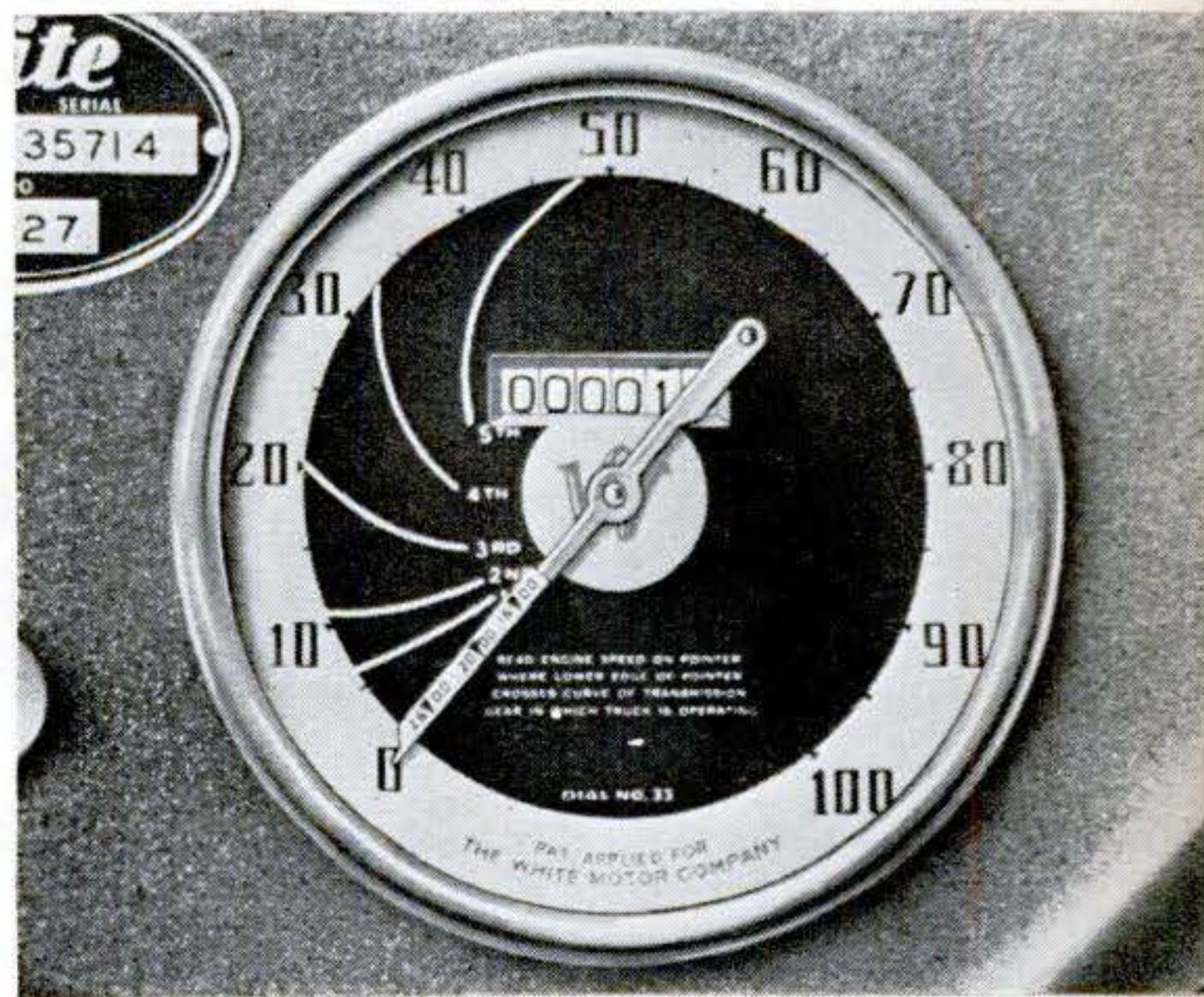


WHEN TO SHIFT GEARS for efficient engine operation is shown at a glance by a combination speedometer and tachometer produced by the White Motor Company. Curved white lines on the dial are provided for each transmission ratio. To read engine speed, the driver notes where a scale marked on the pointer intersects the curve of the transmission speed in use. A white area in the middle of the pointer indicates the ideal operating range—from 1,700 to 2,400 r.p.m. At either end is a red area indicating that the engine is outside that range.

DECEMBER, 1945



TEST TIRES like the one above have been installed on a number of Shell Oil Company cars and trucks. The purpose is to determine the wearing qualities of Dutrex, a petroleum product developed by Shell for use as a plasticizer and extender for synthetic GR-S rubber in place of the more expensive Buna-S. With the co-operation of the General Tire and Rubber Company, 212 test tires were produced, half of each tire being made of ordinary synthetic rubber and half of synthetic rubber with Dutrex added. Weekly records of tread wear on each half are being kept. Tests already have shown that the new plasticizer speeds up the production of tires manufactured from synthetic rubber.



Auto Transmissions That

THE TREND IS TOWARD AUTOMATIC OPERATION. HERE'S

By MORGAN C. KENT

TIME was when an autoist's dexterity with a gearshift lever was a tip-off on his driving skill. The duffer produced harsh gnashings of teeth, while the fellow who could deftly doubleshift from high to second at 25 m.p.h. proclaimed himself a hot shot. For a decade or more, however, designers have been steadily making it more difficult to separate the sheep from the goats by the transmission test. First came ingenious little synchronizers that matched the speeds of meshing gears; then came steering-column shift levers; and just before the war, transmissions that could shift for themselves. Still brainier gearboxes are scheduled to put in an appearance soon.

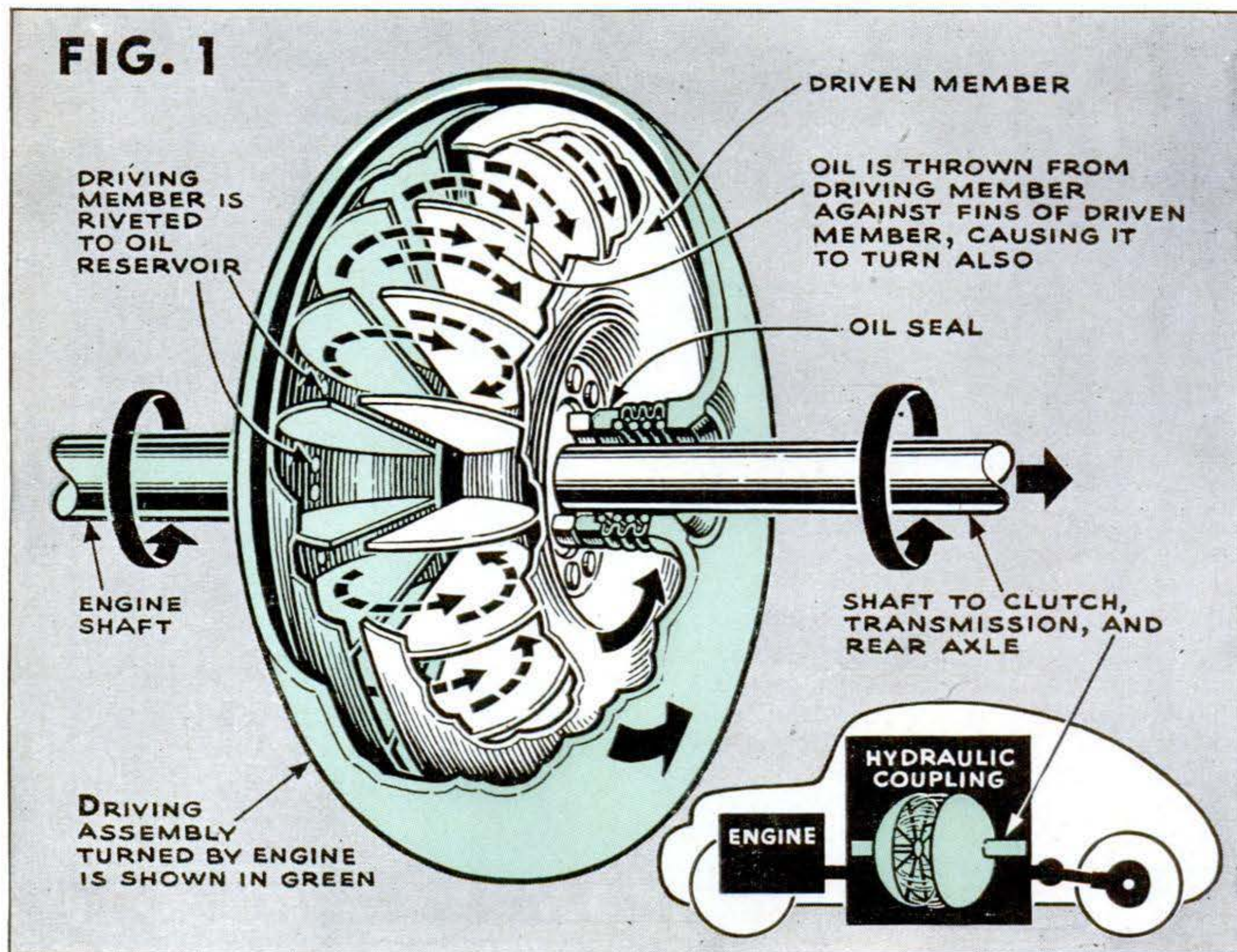
The only reason why a transmission is needed at all is because of an inherent limitation of the gasoline engine. It cannot develop sufficient torque (twisting force) at

low speeds. Transmissions weren't needed in the old steamers or electrics, because their power plants developed high starting torque. There were no gears to shift and no clutch to operate. Only three controls were used to drive the car: the throttle, brake, and steering wheel.

Engineers have long been searching for a commercially practicable automatic transmission that will duplicate steam-car simplicity. Transmission designers have posed two requirements for this ideal gearbox; it must be stepless or infinitely variable, and it must be of the "positive-displacement" or nonslipping type. No transmission to date has fulfilled all requirements.

The automatic transmissions in prewar cars are, nevertheless, a close approach to the ideal. The considerable variation in their methods of operation reflects a difference of opinion as to what the motoring public wants. The battles between the hydraulic

Introduced in America in the late thirties, the hydraulic coupling is now found in many different drives.



Shift for Themselves

AN EXPLANATION OF HOW THE NEWER GEARBOXES WORK

and the mechanical transmissions, and between semiautomatic and automatic ones, have just fairly begun.

A semiautomatic transmission is one requiring the direction of the driver, however slight, as when he releases the accelerator to shift gears. In a fully automatic one, on the other hand, the driver is relieved of all gear-shifting responsibility. Here is a quick picture of the main transmission devices now in use or under development:

Automatic Clutch. Here the job of throwing the clutch in or out is taken over by a vacuum-operated piston. To throw out your clutch in the low-speed range, release the accelerator; to engage it, step on the accelerator. Solenoid-powered valves, connected to the throttle linkage, control the piston. In the high-speed range, a centrifugal governor keeps the clutch always engaged and thus prevents free-wheeling.

Overdrive. Introduced more than a decade

ago, this device adds a fourth speed, allowing the engine to turn over about 25 percent slower in the high-speed range. To go into overdrive, the driver releases the accelerator for an instant when traveling above a set "cut-in" speed. Later, as the car drops below this critical speed, the transmission drops back to third speed automatically. If he needs a burst of speed to pass another car when in overdrive, he can push the accelerator down hard and be back in third in a jiffy. A free-wheeling unit is commonly provided that operates only below the "cut-in" speed.

Current overdrives consist of a planetary-gear combination that produces the needed increase in ratio, an overrunning clutch, and suitable controls linked to a centrifugal governor and to the accelerator.

Hydraulic coupling. In this device (Fig. 1), the two rotating members resemble two halves of a grapefruit after the edible parts

The torque converter, essentially a pump and turbine, performs hydraulically what gears do mechanically.

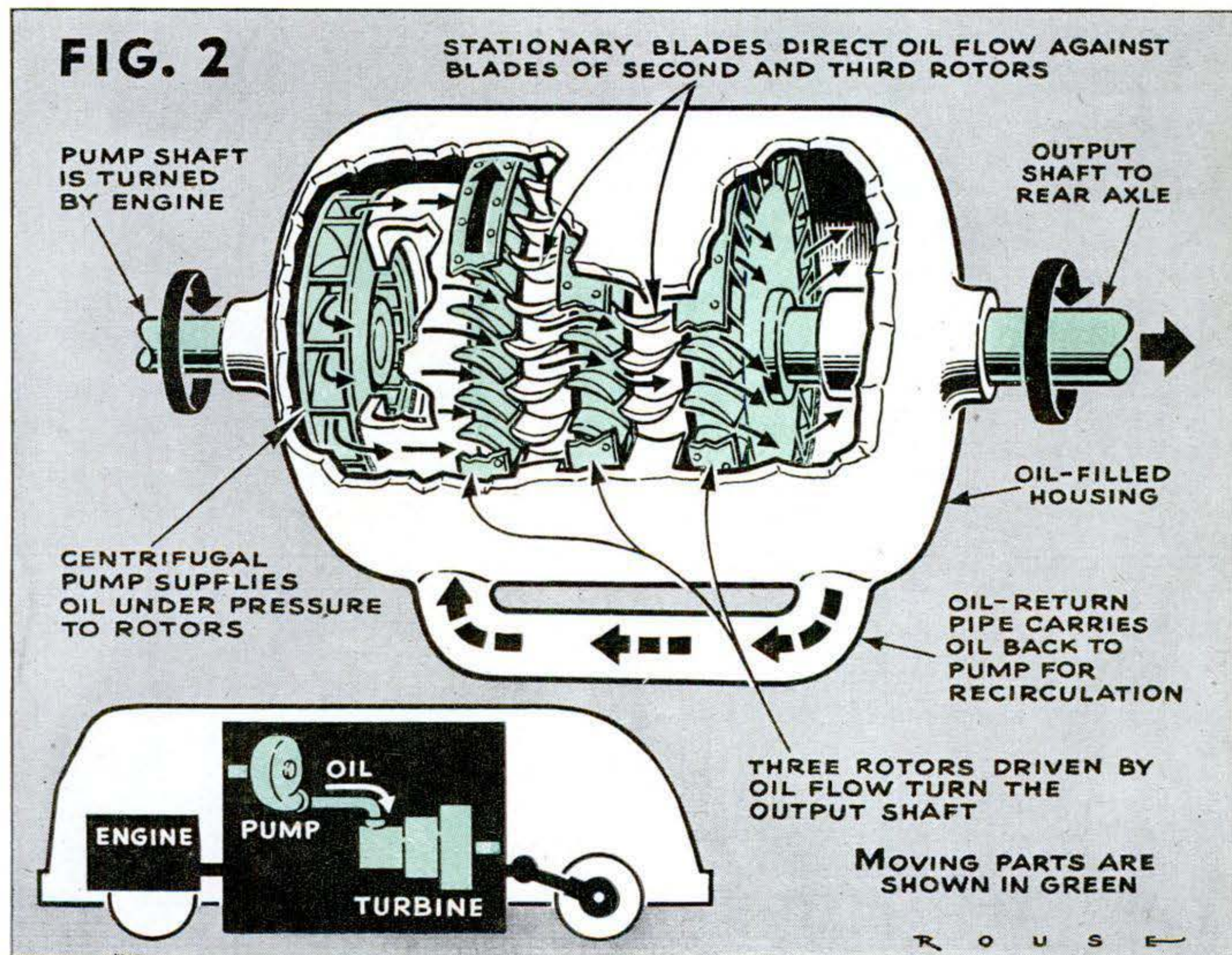
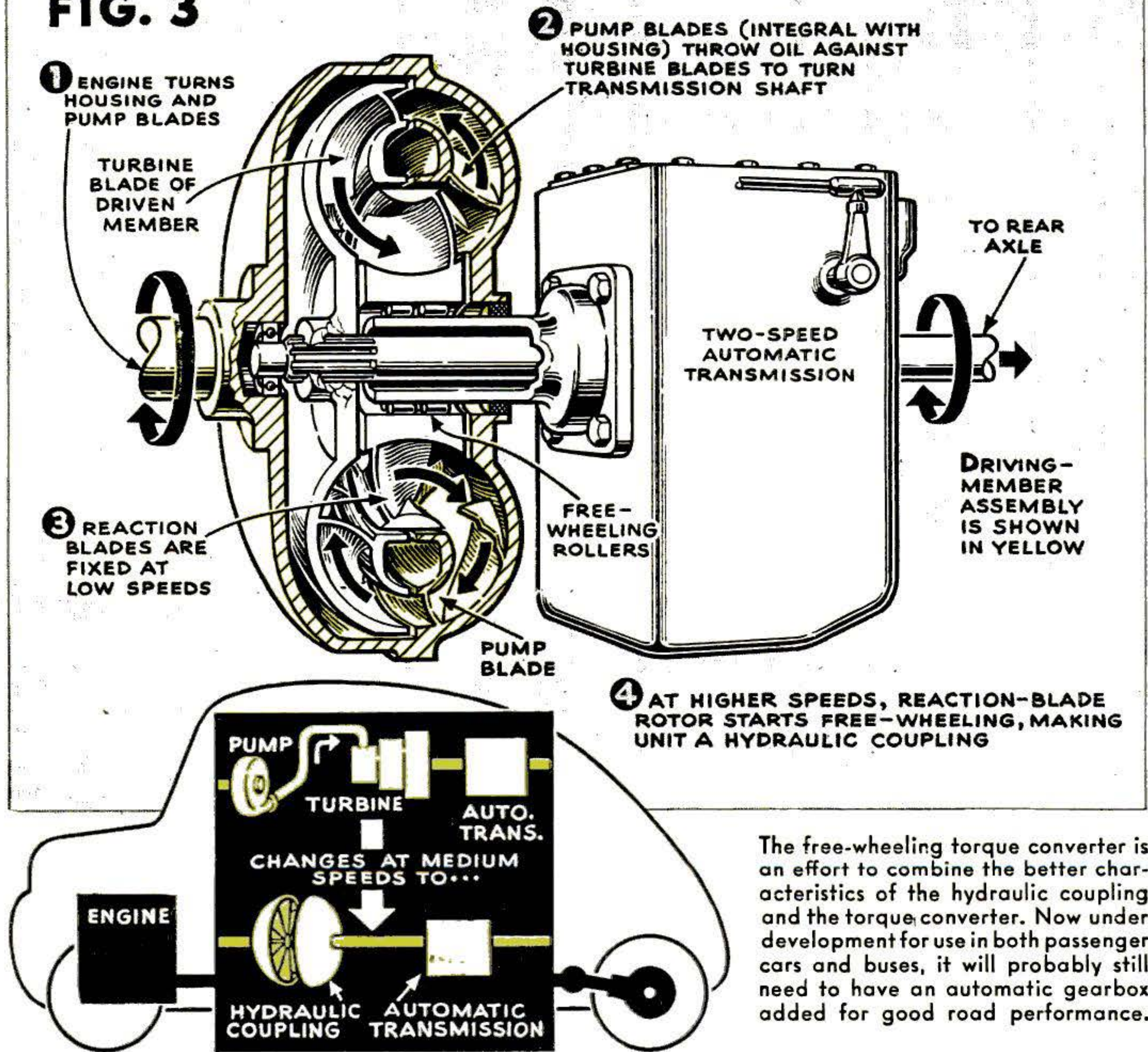


FIG. 3

The free-wheeling torque converter is an effort to combine the better characteristics of the hydraulic coupling and the torque converter. Now under development for use in both passenger cars and buses, it will probably still need to have an automatic gearbox added for good road performance.

have been removed. The driving member acts as a simple centrifugal pump that throws oil outward and against the driven member. Oil alone transmits the power. The driven member can never revolve as fast as the other because of power lost in circulating and heating the oil. Slip is of course 100 percent when the engine is idling and the car is stationary, but at high speed it is said to be less than 1 percent.

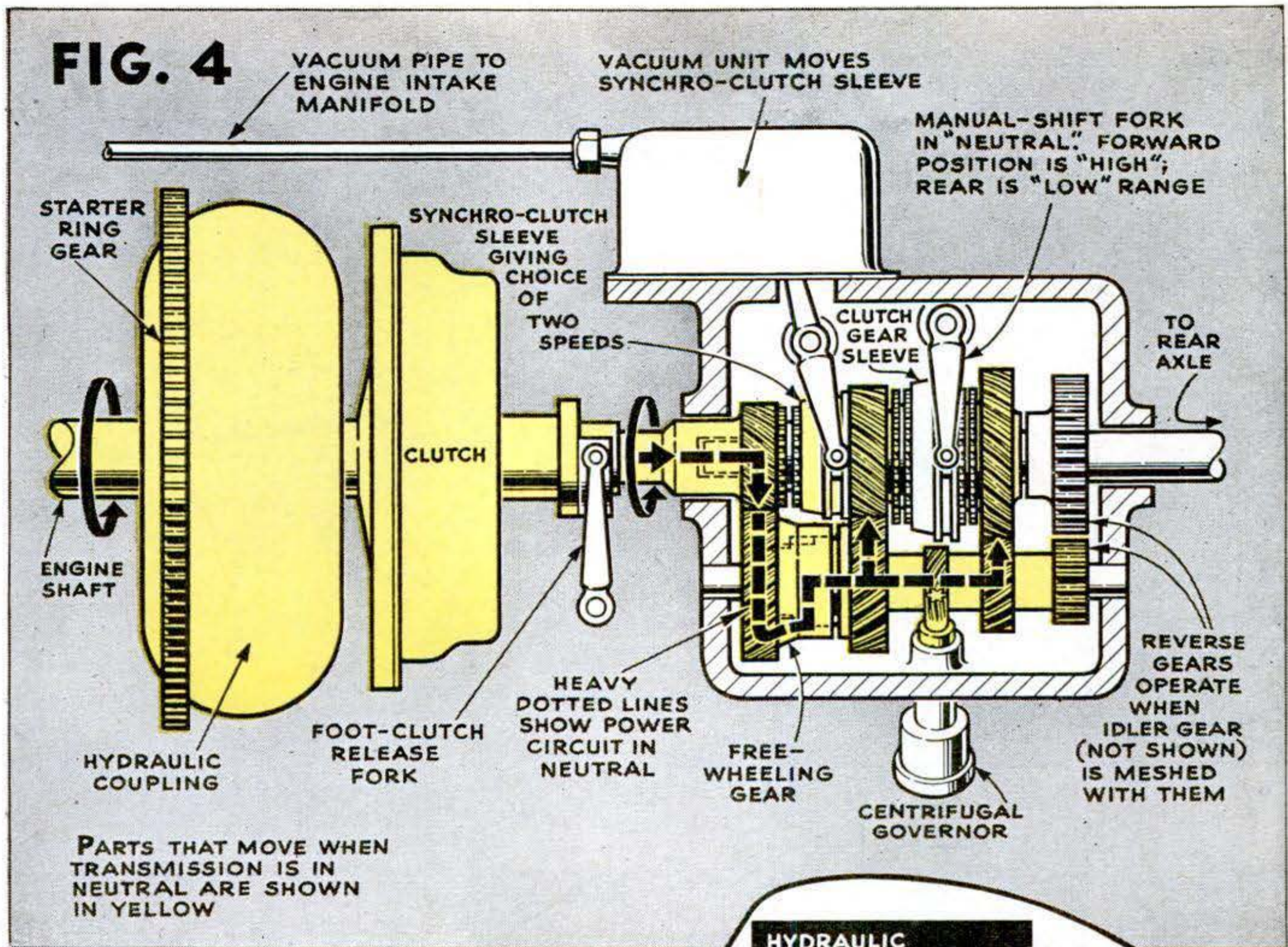
In its present form, the hydraulic coupling cannot transmit a torque greater than that of the engine, and a transmission must therefore be used. A friction clutch is needed to allow gear shifting, which the drag of the coupling otherwise prevents. Another weakness is slip; so far it has not proved practicable to "lock up" the coupling.

Torque converter. The ability to multiply engine torque is the outstanding feature of this drive, shown schematically in Fig. 2. The engine drives a centrifugal pump that forces oil against three sets of revolving

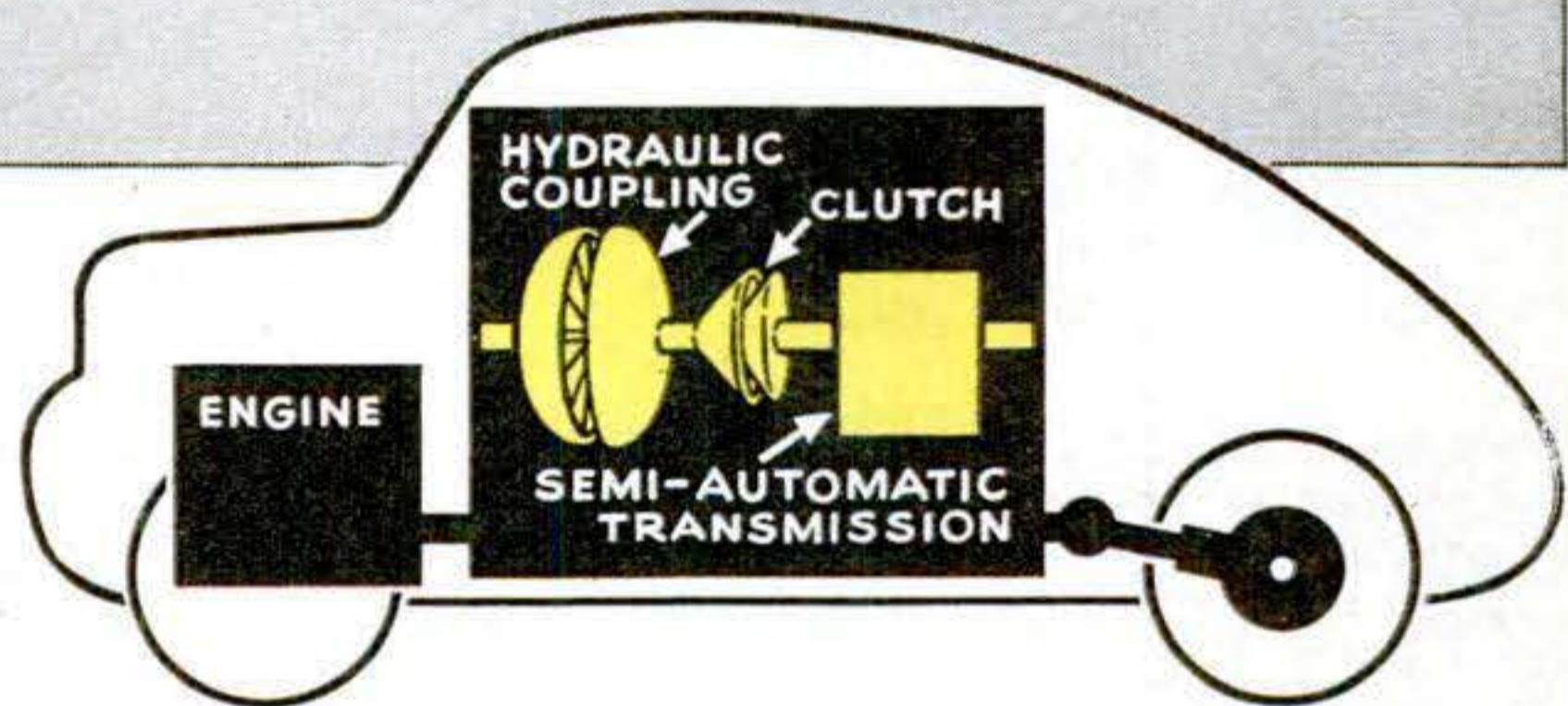
blades and two sets of stationary blades. The secret of the ability to increase torque lies in the three turbine stages, which increase force at the cost of distance (revolutions), much as does a hydraulic press. Installed in a bus, a converter of this type delivers a starting torque five times greater than that provided by the engine.

In its present form, the torque converter is relatively complicated and costly to build. Unlike the simple hydraulic coupling, which gains efficiency with speed, it loses efficiency sharply above a fixed speed. For this reason it is often used only for starting and acceleration, through the lower speeds, after which the converter is "short-circuited" and the vehicle moved by direct drive. Fuel consumption is apt to be higher than with conventional drives. So far, torque converters are used chiefly in trucks and buses.

Free-Wheeling Torque Converter. This device, shown in Fig. 3, is an ingenious attempt to combine the hydraulic coupling and



The semiautomatic transmission shifts between first and second or third and fourth according to throttle position and car speed. A steering-column lever allows the driver to select either of the two ranges. The foot clutch is not used except in changing from one range to the other, or for reversing.



the torque converter. It has one set of reaction blades that are fixed at low speeds, providing torque increase for starting. At the point where the efficiency of the converter starts to fall off, the reaction blades are automatically "free-wheeled" or allowed to rotate. Thus the unit operates as a hydraulic coupling at higher speeds, where such a coupling is most efficient and where torque multiplication isn't needed. One penalty of this compromise is that the single-stage converter cannot increase torque as much as a three-stage one, and a two-speed automatic transmission is therefore needed.

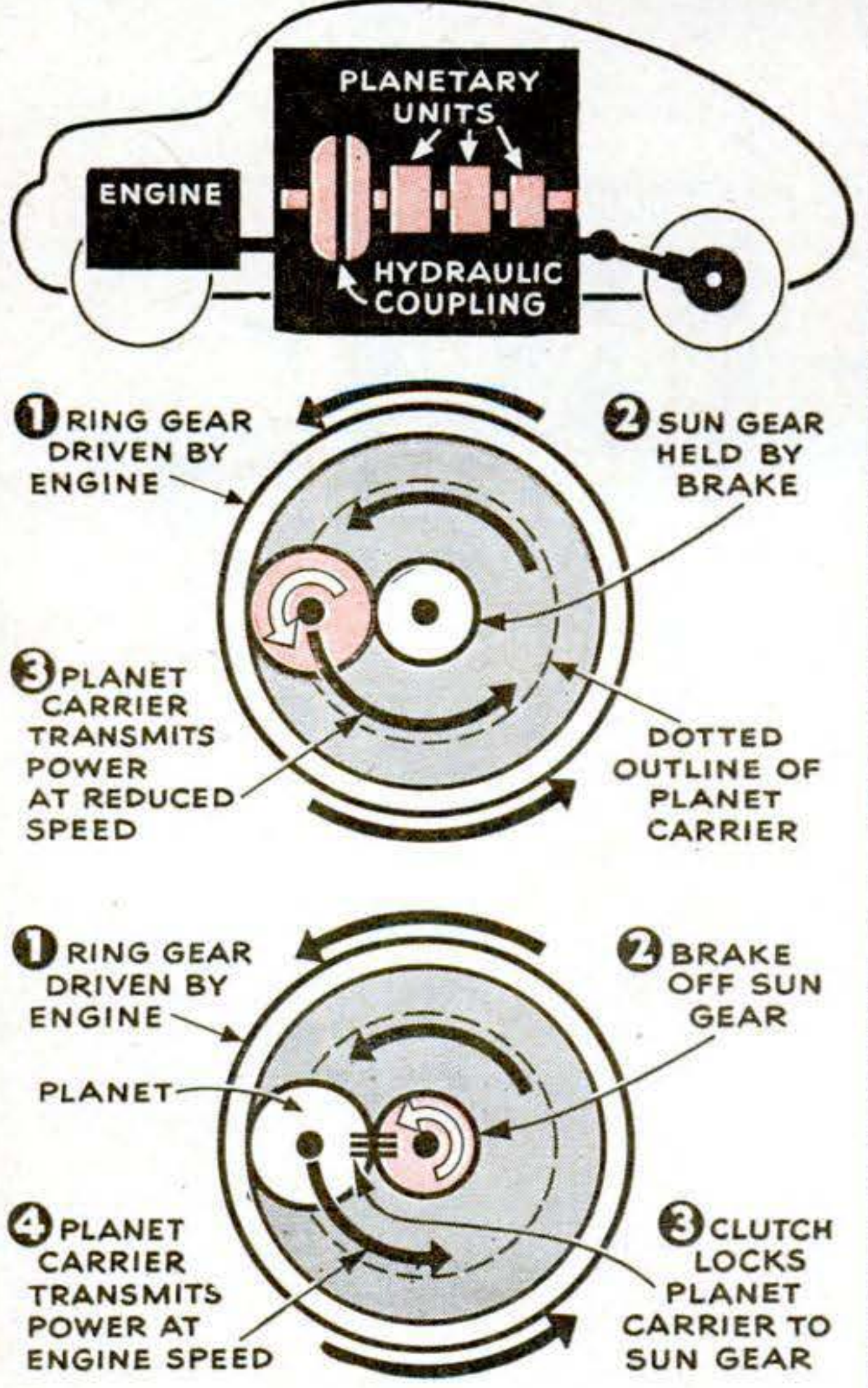
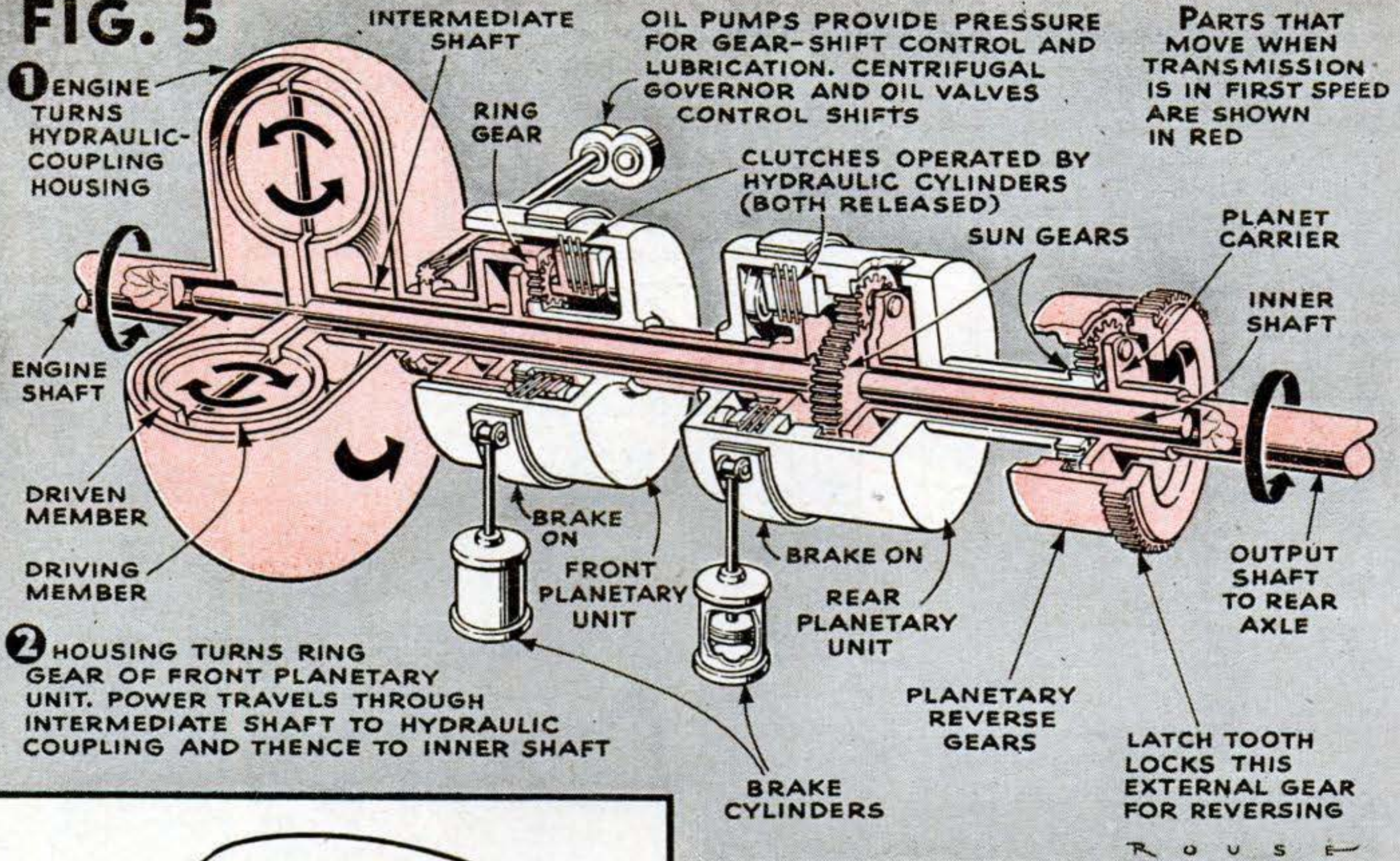
Semiautomatic Transmissions. Four designs of semiautomatic transmissions were available in the last pre-Pearl Harbor cars. The operation of one can be considered as typical (Fig. 4). It combines a hydraulic coupling, a conventional clutch, and a gear-box affording four speeds forward plus reverse. The gearshift lever has but three positions—high, low, and reverse. In the

high position the transmission is semiautomatically shifted back and forth between third and fourth gear by a vacuum unit and centrifugal governor. As in an overdrive, the upward shift is initiated by a momentary release of the accelerator, and the down shift is governed automatically by speed.

The low position of the shift lever, recommended for steep hills and rough going, causes the transmission to shift semiautomatically between first and second. The conventional clutch is used only when the lever position is changed. A "kickdown" linkage permits the driver to use the low speed of either range at will.

Fully Automatic Transmission. In a car equipped with this almost magical mechanism, all driving is done with the steering wheel, accelerator, and brake, though there is a control lever that can be set for high (normal driving), low (difficult going), neutral, and reverse. Once placed in the desired position, the lever can be forgotten.

FIG. 5



How a brake and clutch can change gear ratio in a planetary system is shown above. In both diagrams the ring gear is driven by the engine and the planet carrier (spider) acts as the output shaft. If the sun gear is braked, the carrier rotates at a reduced speed; but if the brake is released and the sun gear is locked to the planet carrier, power is then transmitted at engine speed.

The only fully automatic transmission to appear on American passenger cars so far, this device selects the right gear ratio for each car speed and accelerator position, without assistance from the driver.

It is not even necessary to ease up on the accelerator to change gears. As you roll along, gears are automatically shifted up and down through four different ratios.

As shown in simplified form in Fig. 5, the drive combines a hydraulic coupling and three sets of constantly meshed planetary gears. The planetary units are placed in series so that power may be transmitted through either or both of the two forward sets to produce four forward speeds, or through the rear unit to produce reverse. Since only a portion of the engine torque is transmitted through the coupling in third and fourth gears, slippage is minimized.

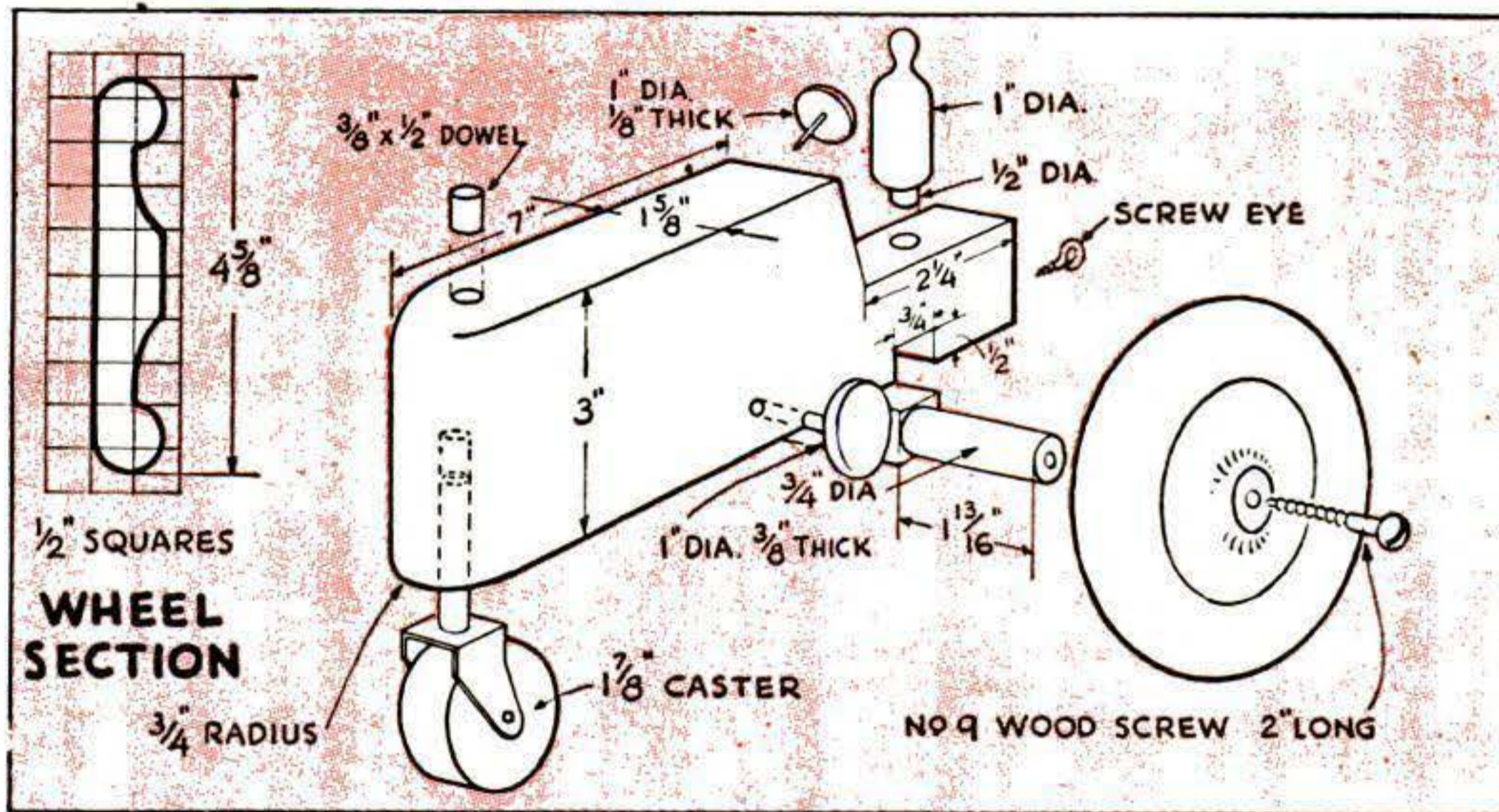
A centrifugal governor selects the proper ratio for each car speed and throttle position. When quick acceleration is needed in fourth speed, the car can be "kicked down" to third at will by the accelerator. The actual shifts themselves are accomplished by oil-actuated pistons that control brakes on the planetary units and clutches within them.

Like all transmissions, fully automatic drives have their disadvantages. They do not quite attain the stepless and positive-displacement goals. They are more complicated than semiautomatic transmissions, cost more, and are harder to service. Although development will undoubtedly produce simplification, these penalties may always be present in some degree.

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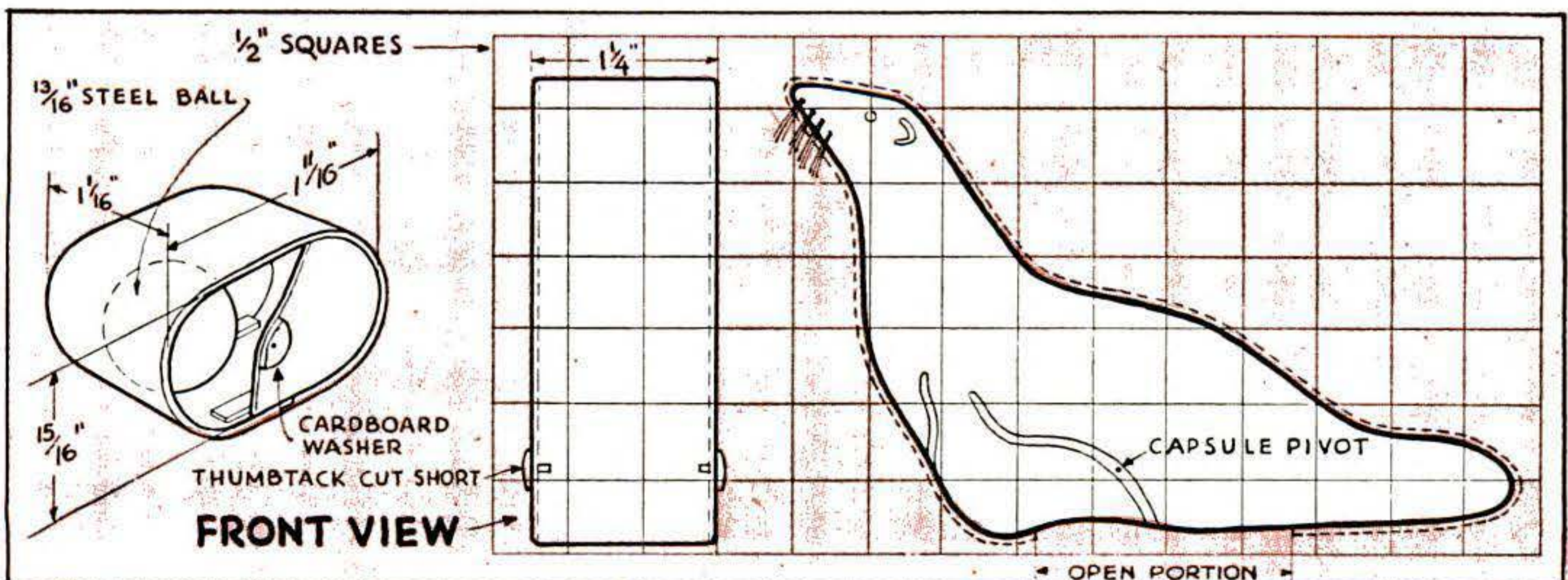
CASTER SERVES AS FRONT WHEEL OF TOY TRACTOR

PULL toys as a rule are a favorite of the younger child. With a stout cord attached, this tractor will go places and do things. The body is cut from a piece of pine two-by-four about 10" long, while the axle, which is 5 1/4" long, and the rear wheels are turned from 3/4" oak or maple. A groove is cut into the lower edge of the body for a depth of 1/2", and the 3/4" by 3/4" middle section of the axle is fastened into this with a 1 1/4" wood screw. The wheels revolve on the screws that hold them to the axle.—LESTER DEWITT.



AMUSING SEAL JOGS DOWNHILL BY ITSELF

IF THIS toy is started down an inclined plane, it will jog along to the bottom in a delightfully seal-like manner. A carefully balanced capsule containing a heavy metal ball or marble animates the toy. This capsule, as well as the seal itself, is cut from 14-ply showcard board. The parts may be held together with rubber bands while the glue hardens. Insert the ball before assembling the capsule. Two thumbtacks serve as pivots. A small weight, such as a piece of putty, placed in the tail will balance the seal. Bristles from a brush provide a mustache.—FRANK SHORE.





Sportsman's Cigarette Box

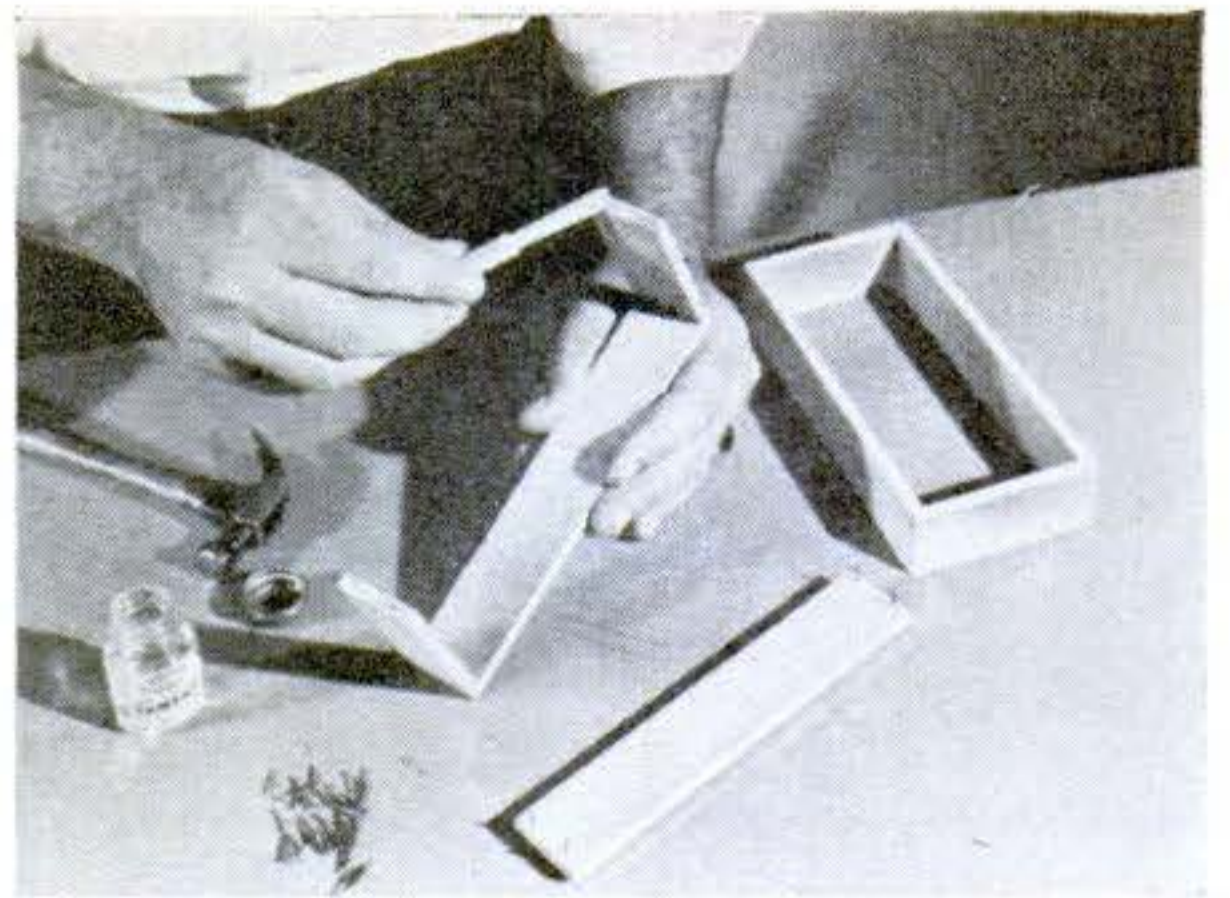
By FRANK HEGEMEYER

COLORFUL and practical, this cigarette box displays a fisherman-smoker's favorite flies. It has a glass-topped lid that houses a shallow tray in which the flies are attached with bits of cellulose tape holding the hooks at the eye and point. The tray is readily removed for changing the display.

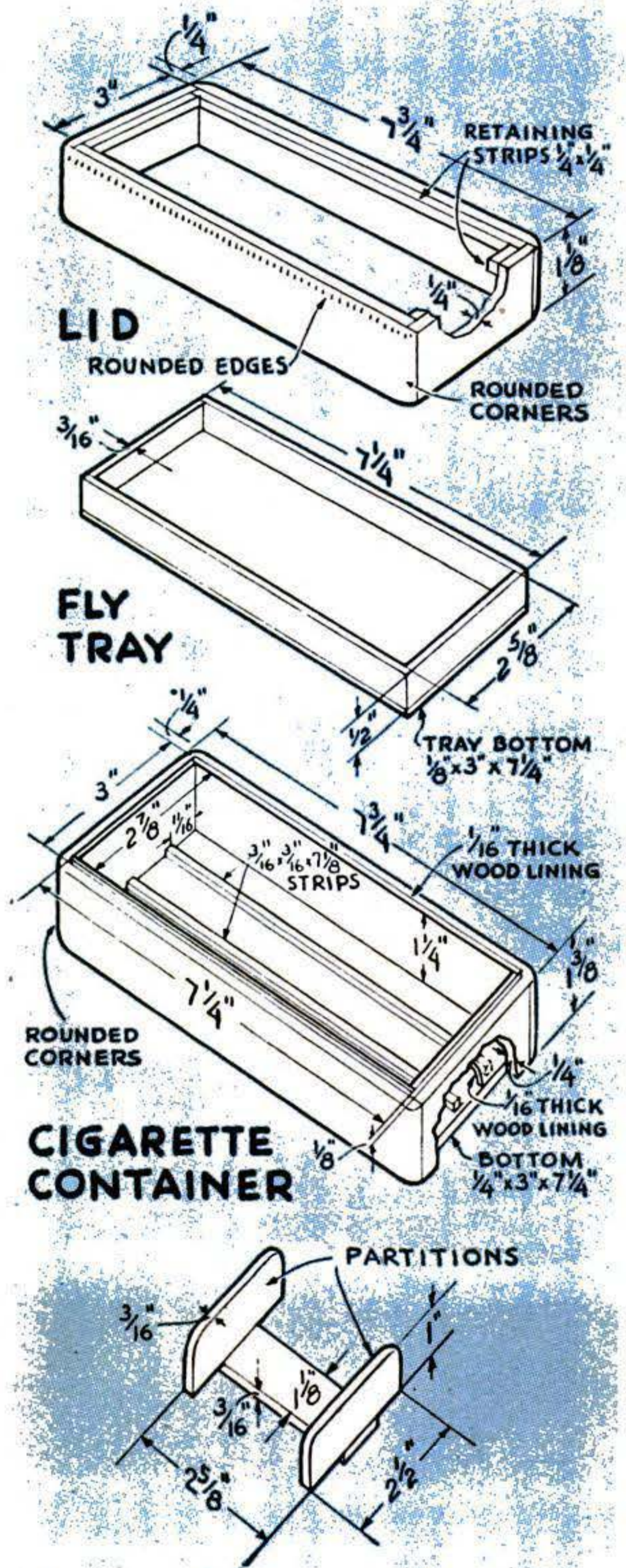
The box is dimensioned so as to hold three full packs or 60 cigarettes of standard size. Resting on two strips on the bottom, the cigarettes are easy to pick up even when few are left in the box. Removable partitions separate brands if three different kinds are used. Details of construction are given in the drawing at right, and the step-by-step process of putting the box together is shown in the photos above and on the facing page.

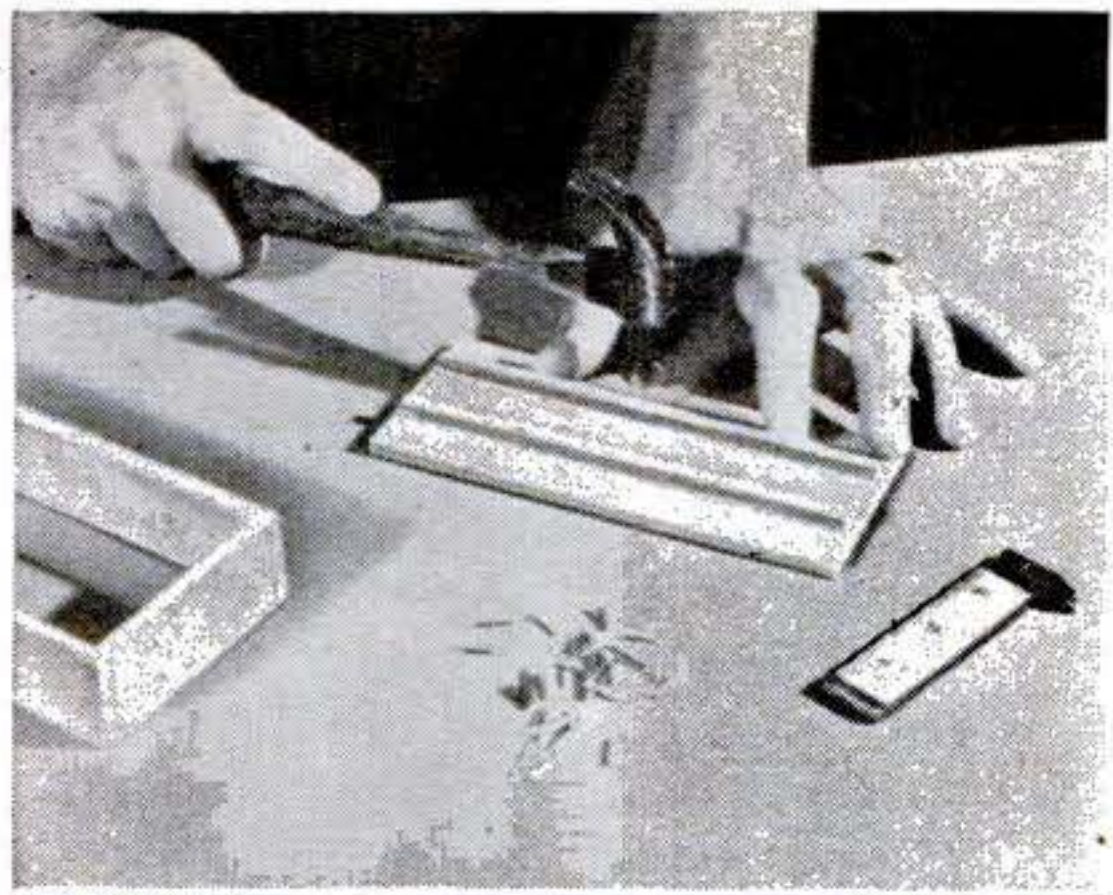
A full-color photo of the box finished in red, green, and gold is shown on page 113. Equally effective color combinations might be a bright yellow outside with a light blue interior including the inside tray walls, a blue-green exterior and light purple interior, or a medium blue exterior and bright orange interior.

Use lacquer on the outside and rub it to a high polish. Model-plane dope in colors is a good interior finish. Bronzing powder sprinkled on tacky varnish and brushed off when dry is a brilliant background to show off the flies.

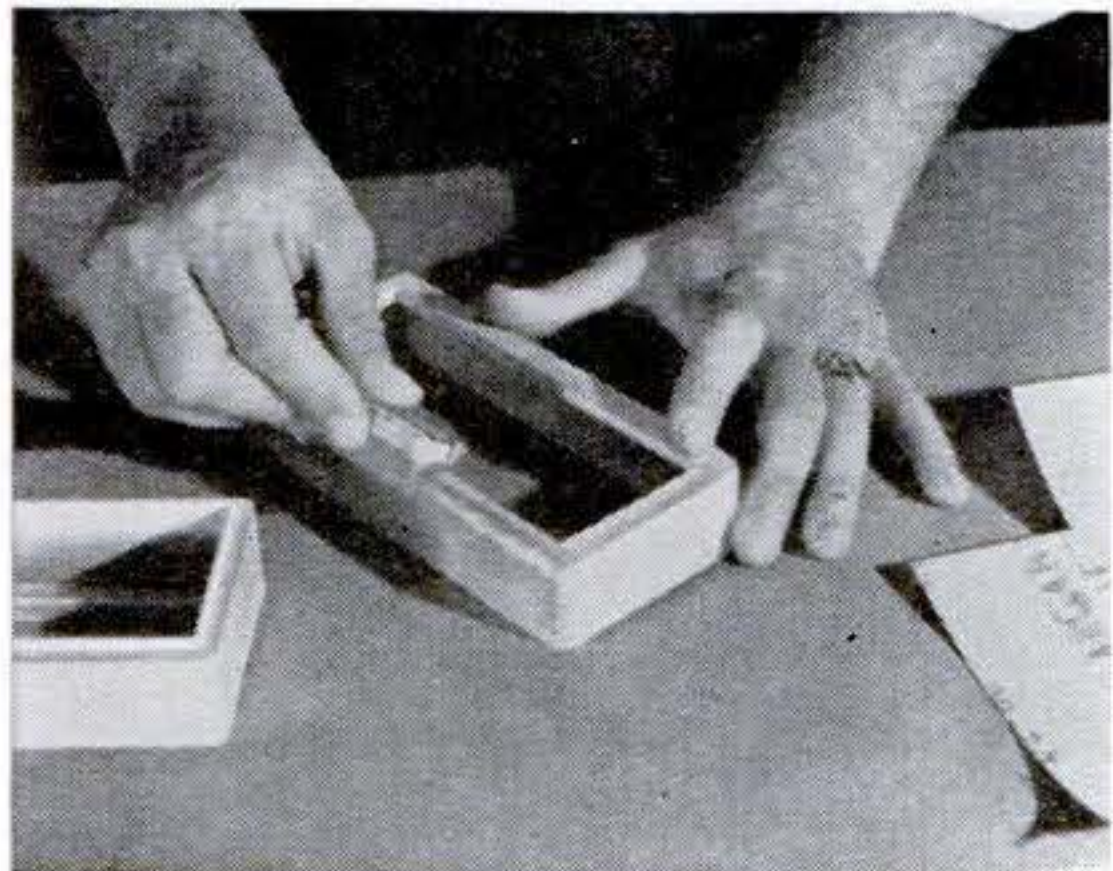


Glue and two brads hold each joint of both the top and bottom. Drive brads part way in a trial assembly; then take the frames apart, apply glue, and drive the brads back.

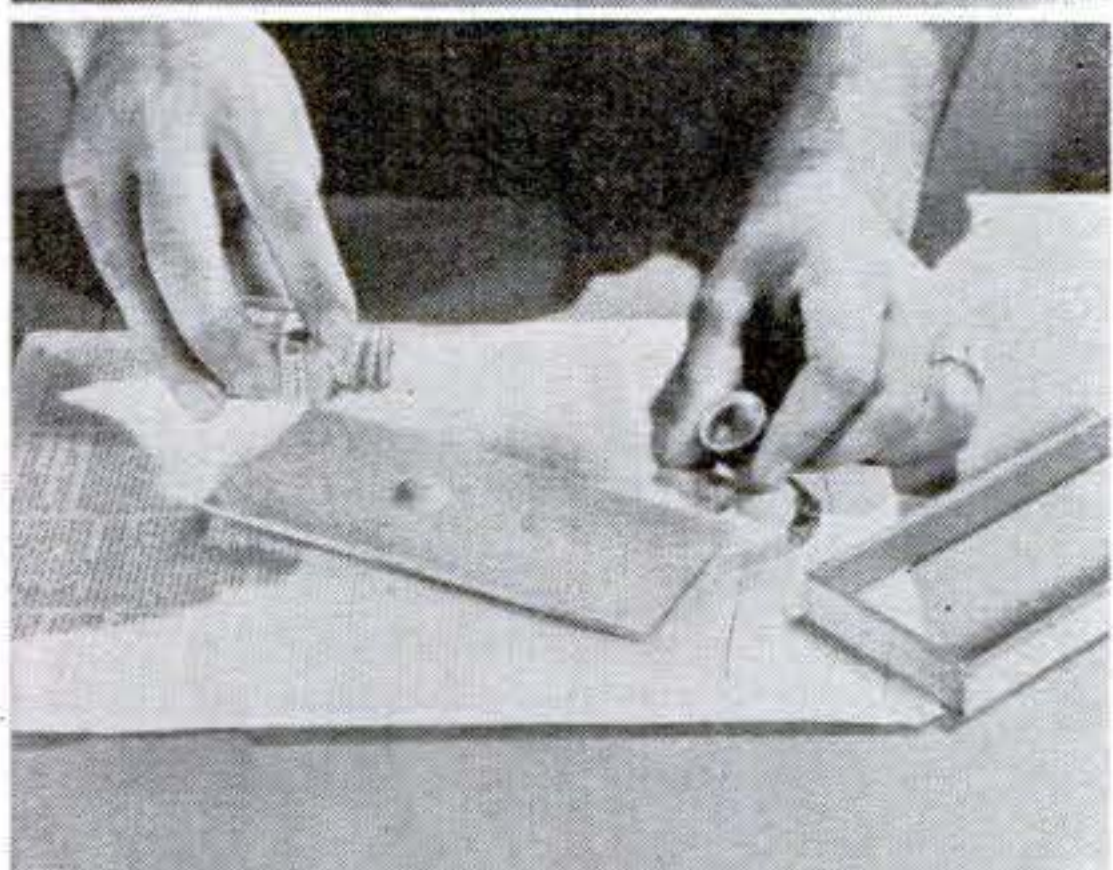




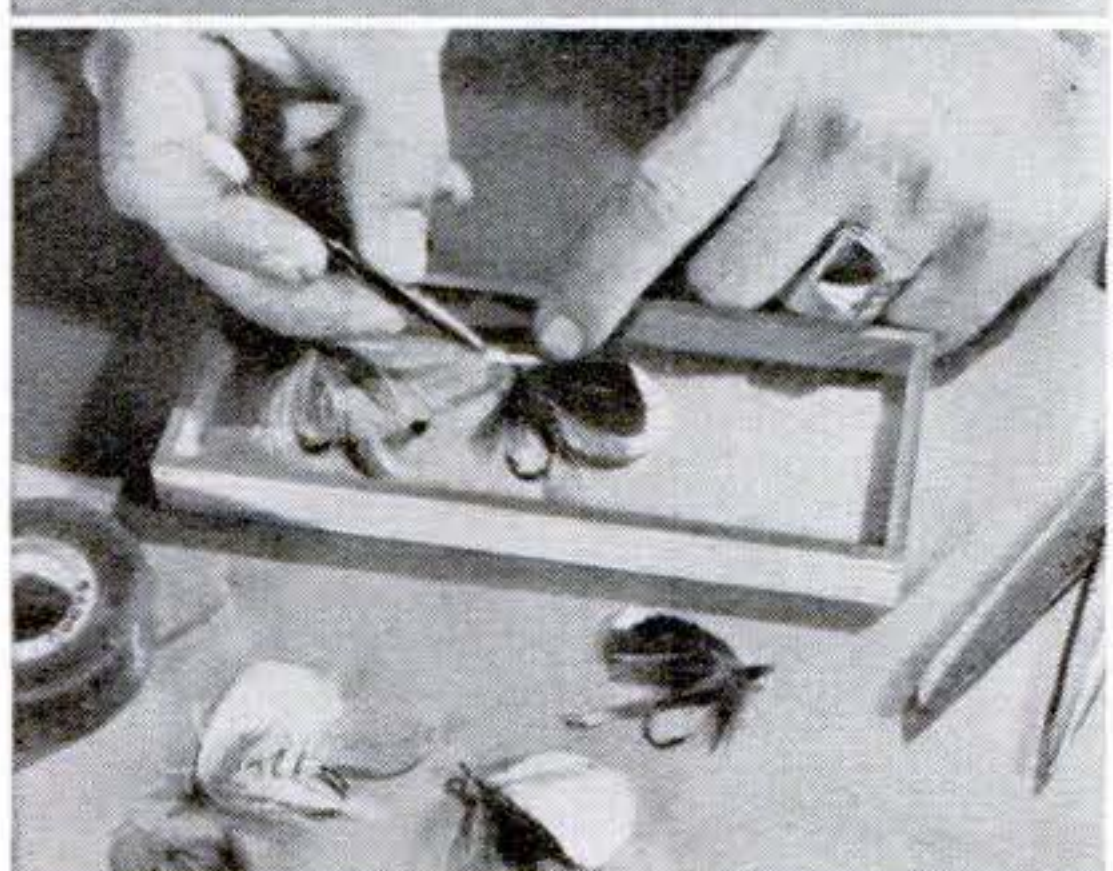
Cigarettes lie on two strips bradded to the bottom and are easy to lift out. The bottom is glued and nailed on the assembled sides.



Edges and corners are rounded with a concave sanding block—using coarse and then fine grit. The entire box is next sanded smooth.



Airplane dope, which comes in a variety of colors, gives a good inside finish, but it dries quickly and must be applied with care.



Bronzing powder makes a rich background for the flies. Sprinkle it generously on varnish that is slightly tacky. Brush off the surplus.



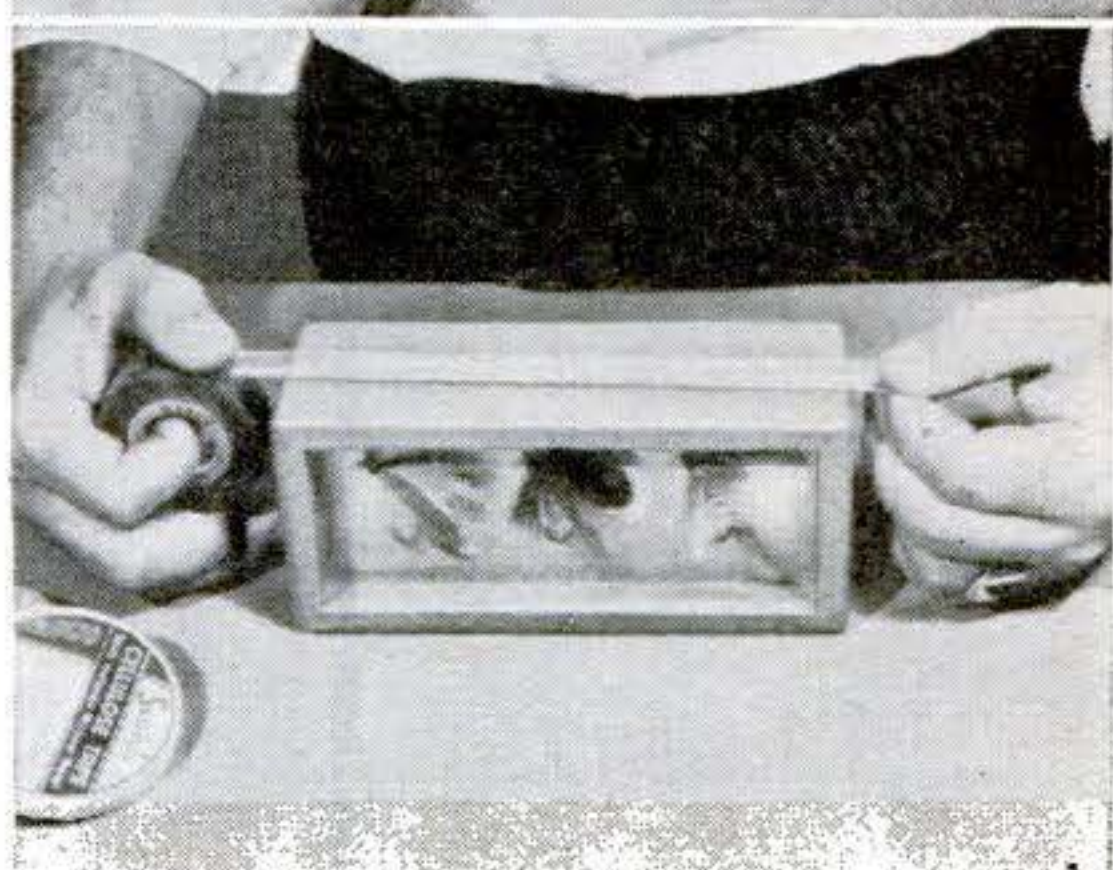
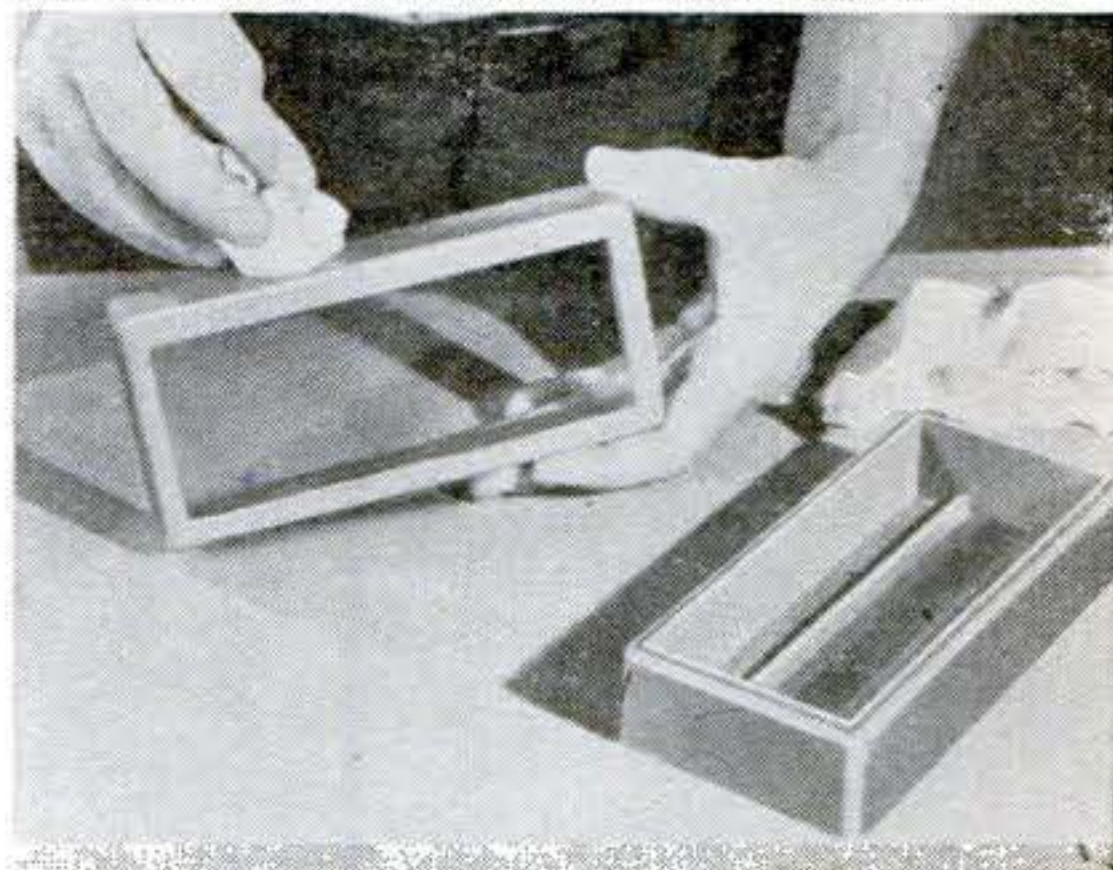
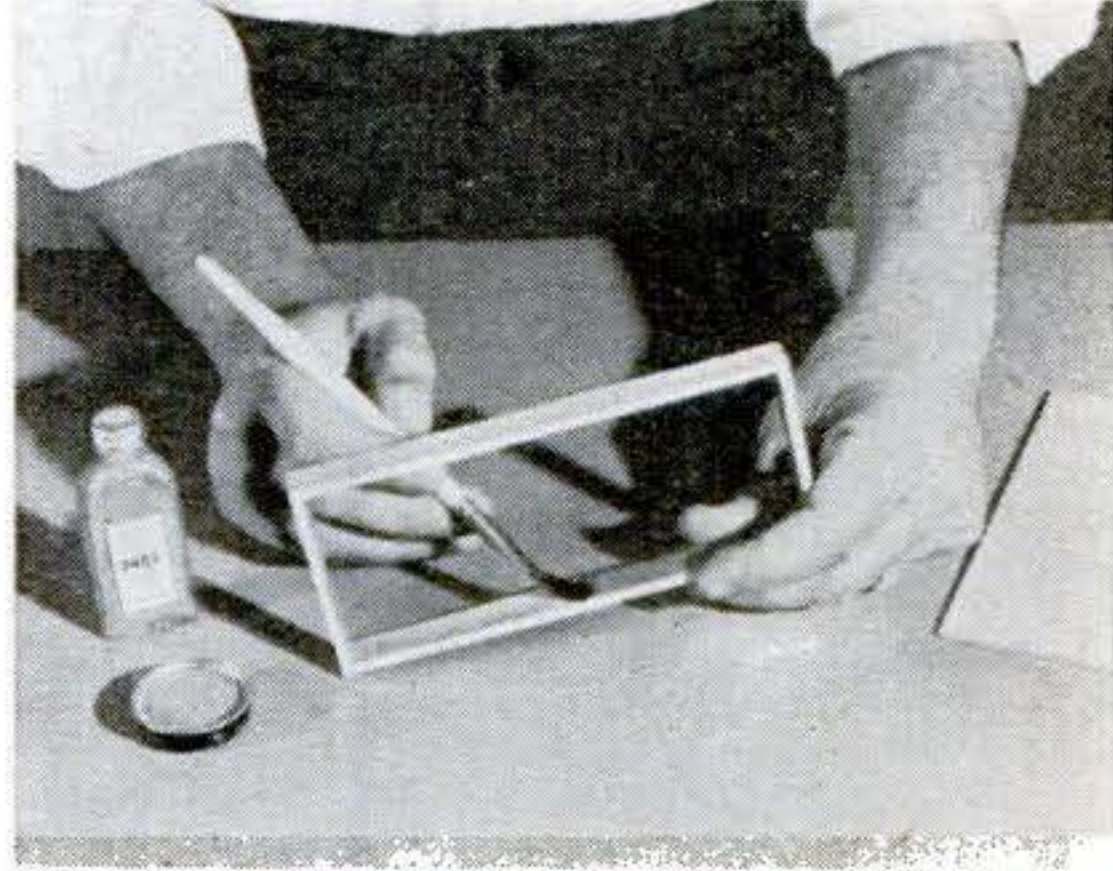
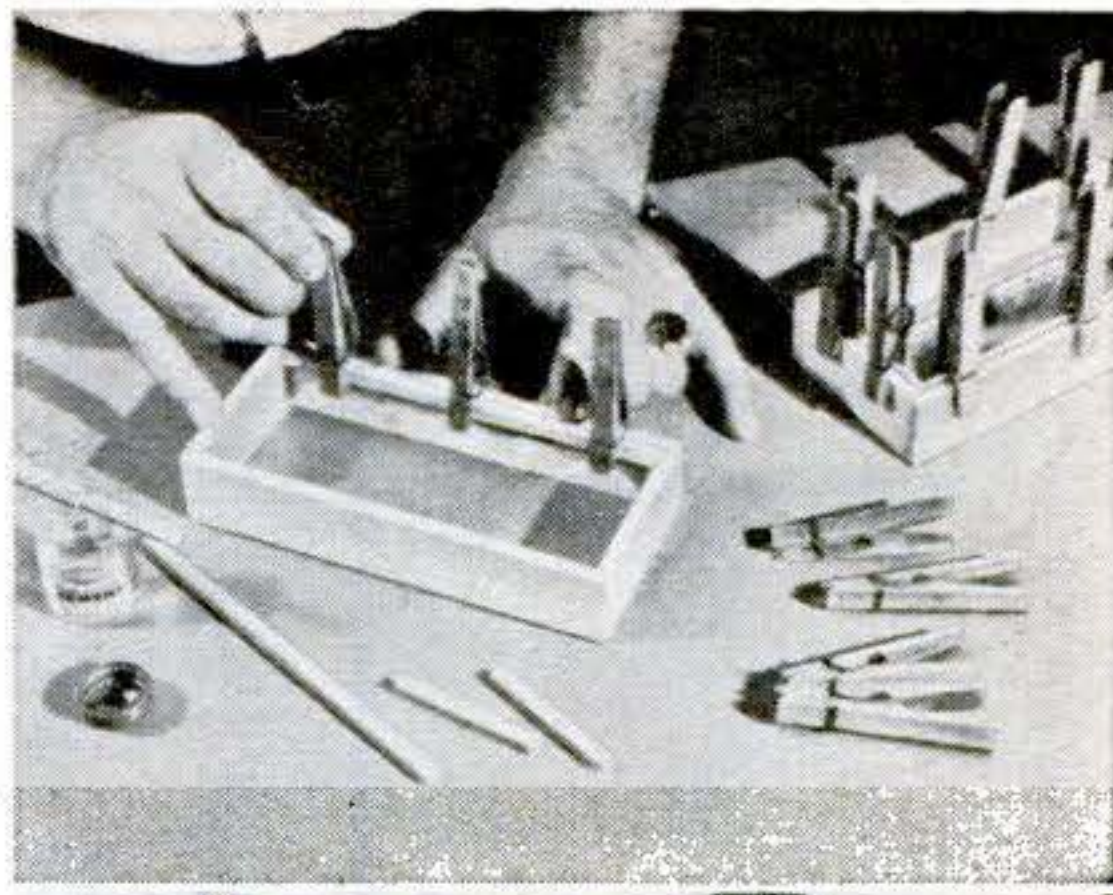
Lacquer the outside of the box and rub it to a high polish. Rubbing compounds are handled by paint stores. They are applied sparingly.

After the bronzed tray bottom has thoroughly dried, brad it onto the frame. Attach the flies with bits of cellulose tape holding the hooks.

Picture-framing glass cut to size is placed on the retainer strips to protect the flies. Glazier's points secure the glass and the tray.

Felt attached to the bottom with linoleum cement keeps furniture from being scratched. Wipe off excess cement at once and trim later.

If small hinges aren't available, $\frac{3}{4}$ " cellulose tape makes a temporary substitute. Attach it along the full length of the box, as shown.



ENTER OUR

SPECIAL SERVICE officers are urged to write at once to **POPULAR SCIENCE MONTHLY** for copies of this bulletin-board poster. It lists the rules, awards, and other contest details.



POPULAR SCIENCE MONTHLY
Offers...
\$3,300
IN CASH!
For **CRAFTWORK**
MADE BY
SERVICEMEN AND
WOMEN AND VETERANS

1 ST PRIZE	-----	\$1,000.
2 ND "	-----	500.
3 RD "	-----	200.
4 TH "	-----	125.
5 TH "	-----	100.
6 TH "	-----	75.
7 TH "	-----	50.

AND 50 OTHER AWARDS OF \$25. EA

Entry SCIENCE APRIL 1st 1946 NEW YORK 10

RULES OF THE CONTEST

1. The contest is open to (1) men and women now serving in any branch of the armed forces of the United States, (2) men and women who have been honorably discharged from any of these services since December 7, 1941, and (3) men who served in the United States merchant marine *during the wartime months*. Veterans and merchant seamen, however, must have completed their handicraft entries during the period of their service. Employees of **POPULAR SCIENCE MONTHLY** or their families are not eligible.

2. Each article entered in this contest must have been made personally by the serviceman or woman in whose name it is entered. Entries may represent any type of craftsmanship or handicraft except paintings, drawings, prints, renderings, or photography. Contestants may enter as many articles as they desire, but no one shall be eligible for more than one prize.

3. Prizes will be awarded for those articles of craftsmanship which, in the opinion of the judges, rank highest in craft technique, use of unusual or discarded materials, original design, and utilitarian or decorative value. In the case of ties, duplicate prizes will be awarded.

4. A friend or relative may enter an article in the name of a serviceman, provided the entry is accompanied by a signed statement from the serviceman giving his permission and attesting that the object was made by him under the conditions stipulated in these rules.

5. All entries must be accompanied by a statement giving the name, rank, and permanent home address of the contestant; the materials and tools used; the approximate date when the object was completed; if a veteran, the date of discharge; and if a merchant seaman, the beginning and closing dates (approximate) of his service at sea.

SERVICEMEN'S CRAFTWORK CONTEST

Veterans Also Can Win Share
of \$3,300 in Cash Prizes

LIST OF PRIZES

First	\$1,000.
Second	500.
Third	200.
Fourth	125.
Fifth	100.
Sixth	75.
Seventh	50.
And 50 other awards of \$25 each.	

WHEN Americans went off to World War II they carried into all parts of the world an inherent ability to improvise, an adeptness at making something out of nothing.

Waste scraps of metal, plastics, and other materials were put to good use. Native materials, free for the taking or obtainable by barter, were turned into various articles of beauty and utility.

Cigarette lighters were made from empty shell cases. Discarded ammunition containers became mail boxes. Strips of tin cut from old cans were woven into cigarette boxes. Sea shells turned up by bulldozers on South Sea beaches were made into necklaces and bracelets for girl friends back



Seaman Edward M. Wood shows his model of a Coast Guard cutter to Wave Ensign Florence Chamberlin.

home. The variety of such mementos had virtually no end.

POPULAR SCIENCE MONTHLY is conducting this contest to bring into the limelight some of the thousands of craftwork articles so produced by servicemen, servicewomen, veterans, and merchant seamen, and to give

6. The articles of craftsmanship themselves (not photographs) must be forwarded direct to Servicemen's Handicraft Contest Editor, POPULAR SCIENCE MONTHLY, 353 Fourth Avenue, New York 10, N. Y., in a package carefully tagged with the name and address of the sender. An envelope containing the information requested in Rule 5 should be attached securely to the package.

7. When packed for shipment, entries must not exceed 50 lb. in weight.

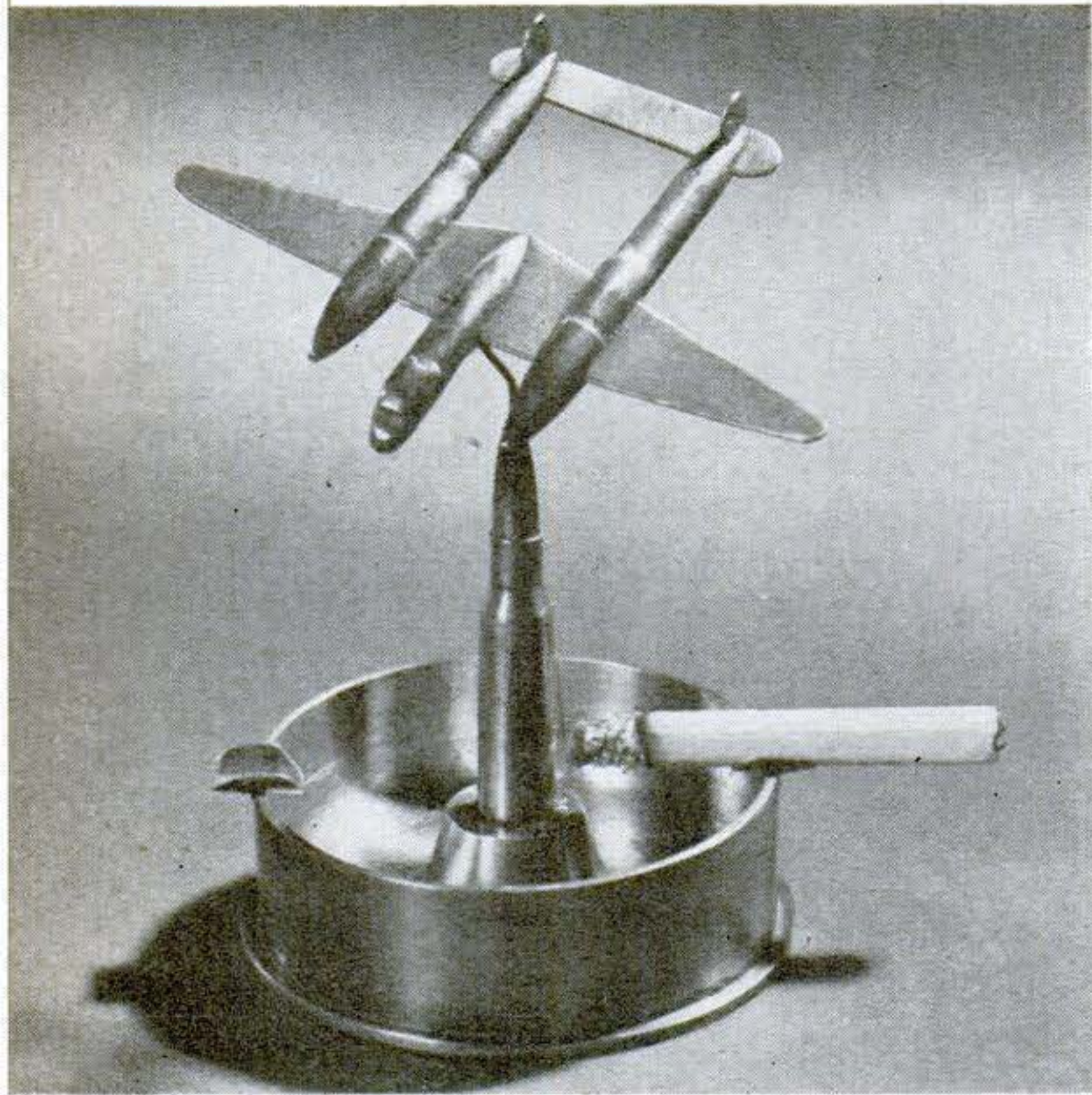
8. Entries must bear a postmark not later than 6 p.m., Monday, April 1, 1946, or must have been shipped not later than that time; provided, however, that no entries will be accepted if received later than 6 p.m., Tuesday, April 30, 1946. Winners will be announced in POPULAR SCIENCE MONTHLY as soon as practicable after the closing date.

9. Prize-winning entries will become the property of POPULAR SCIENCE MONTHLY. POPULAR SCIENCE MONTHLY will make every effort to return non-winning entries which are accompanied by adequate postage but assumes no responsibility therefor. Contestants desiring return of items must attach thereto an envelope containing postage and a self-addressed sticker or tag.

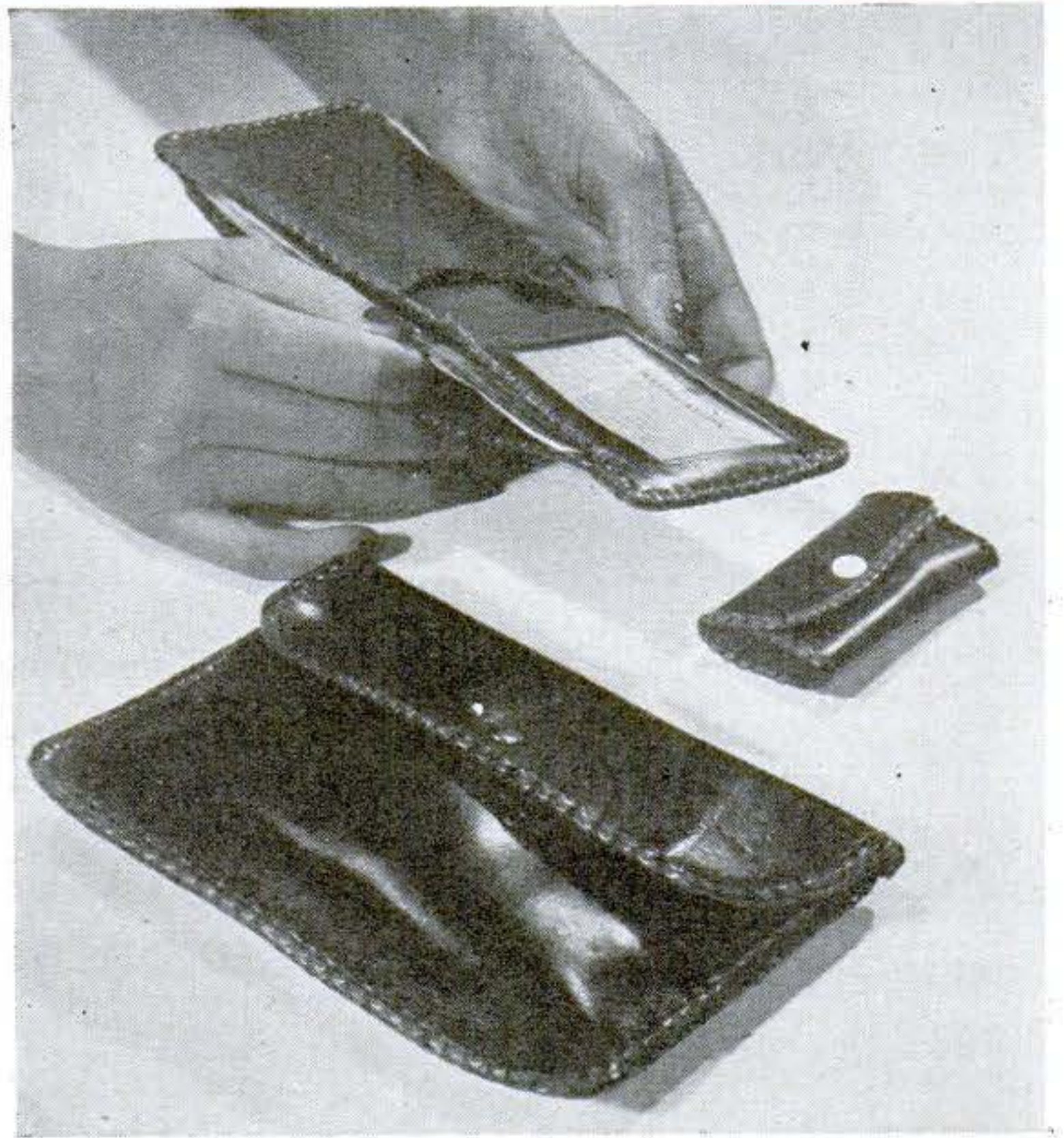
10. Judges will include representatives of the United States armed services, the editors of POPULAR SCIENCE MONTHLY, and others. The decisions of the judges will be final.

For names and biographical details of the contest judges [please turn to page 70.](#)

ENTER OUR SERVICEMEN'S CRAFTWORK CONTEST



Booms and fuselage of this P-38 ash tray are Jap bullets, soldered end to end. A mortar shell was cut off to form the tray, and the waste used for wings and a tail. A cartridge supports the plane.



Leatherwork was a common hobby in all branches of the service throughout the war. Here are examples of such handicraft—a billfold, a key ring, and a make-up case—produced in one recreation center.

special recognition, through cash awards, to those whose work is adjudged the best.

Work done overseas, work done in barracks in this country, aboard ships, in hospitals, in rest camps, prison camps, redeployment centers—anywhere in the world, in fact—can be entered. Friends and relatives who have received choice examples of a serviceman's handiwork may submit them for him, if his permission is sent along.

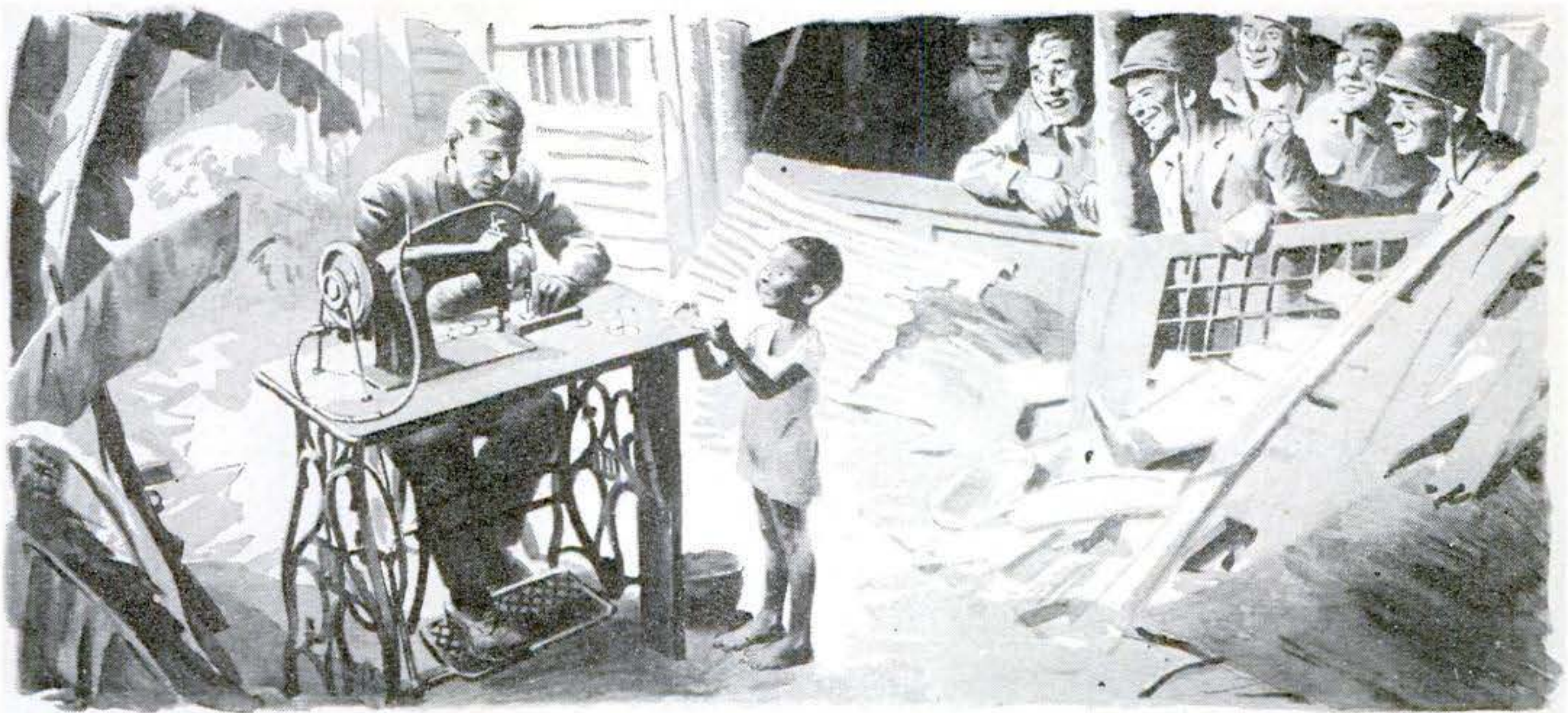
Sea shells gleaned from a beach in the Pacific were wired together to make this necklace and bracelet.



But before dispatching your craftwork to POPULAR SCIENCE MONTHLY, check all the contest rules carefully. Make certain particularly that you are embraced in one of the classifications given in Rule 1 and, if you are a veteran or a merchant seaman, that your entry was completed within the prescribed time limits. If you still are in the service it is important that you give your permanent (Continued on page 154)

Scraps of stainless steel obtained on Kwajalein were the raw materials for this wrist-watch band.





WHEN THE MARINES USED A SEWING MACHINE

By LARRY McMANUS

Former Correspondent for *Yank* in the Pacific

AMID the ruins left by war the rhythmic whir seemed strangely out of place in that Saipan village. It was a familiar sound, one somehow remindful of home, and the strolling soldiers and marines, now shaved and clean after days of fighting, shrugged their carbines to new positions and turned aside from the debris-littered street.

Hopping over abandoned foxholes and climbing piles of rubble, they emerged in the back yard of a battered Japanese house. There they joined a dozen others already watching a lone marine. Sitting on a three-legged stool, his helmet on the ground beside him and his carbine resting against a banana tree, he was working intently over a sewing machine, pedaling it as furiously as an old-maid dressmaker finishing a wedding gown.

But no cloth slid across the top of the machine, nor was there any thread on the dancing spools. The old Singer was in use strictly as a power plant, and its belt, instead of agitating a threaded needle, was rotating a dentist's drill with which the marine was boring holes in a pile of Japanese coins on the makeshift table before him.

After drilling four holes in each of the coins, the marine joined them by two strands of small chain, formed a crude clasp of chrome wire, then tried on the bracelet for size, eyeing it with obvious pleasure.

Earlier that day he hadn't looked so happy. That was why we'd noticed him. He was sitting glumly by himself, while

other survivors of his platoon frolicked and splashed around a cistern of brackish water. These men had every reason to be jubilant. They had just been pulled out of the line, they were washing for the first time in more than three weeks, and, most important, the struggle for Saipan was over and they were alive.

The glum marine profanely told us his troubles.

"Here I am out on this fouled-up island," he said, "my wife's birthday coming up in a couple of weeks and what in the hell can I get her for a present!"

Frowning, he idly patted his pockets, finally pulling out a grenade and tossing it into the air.

"Should I maybe send her a hand grenade?" he asked rhetorically. "Or maybe she might like a nice box of K-rations—"

We agreed that he was indeed in a spot.

Next time we saw him he was at the sewing machine—and his troubles were over. His wife was to have a bracelet with a history, a gift not to be found on the counters of any store in the United States, an example of GI handicraft from an island which had been secured only the day before.

There was a minor scuffle as the marine left the machine. His place on the three-legged stool was won by a soldier carrying small strips of aluminum. A red arc curved across each strip, a sign that the metal had been cut from the "meatball" section of a Japanese plane. The newcomer said he planned to make a wrist-watch band.

While this Rube (*Continued on page 205*)

ENTER OUR SERVICEMEN'S CRAFTWORK CONTEST



While recuperating at a naval hospital, these sailors made decorative articles from scraps of plastic.

(Continued from page 152)

home address, for you may have been discharged before the contest ends.

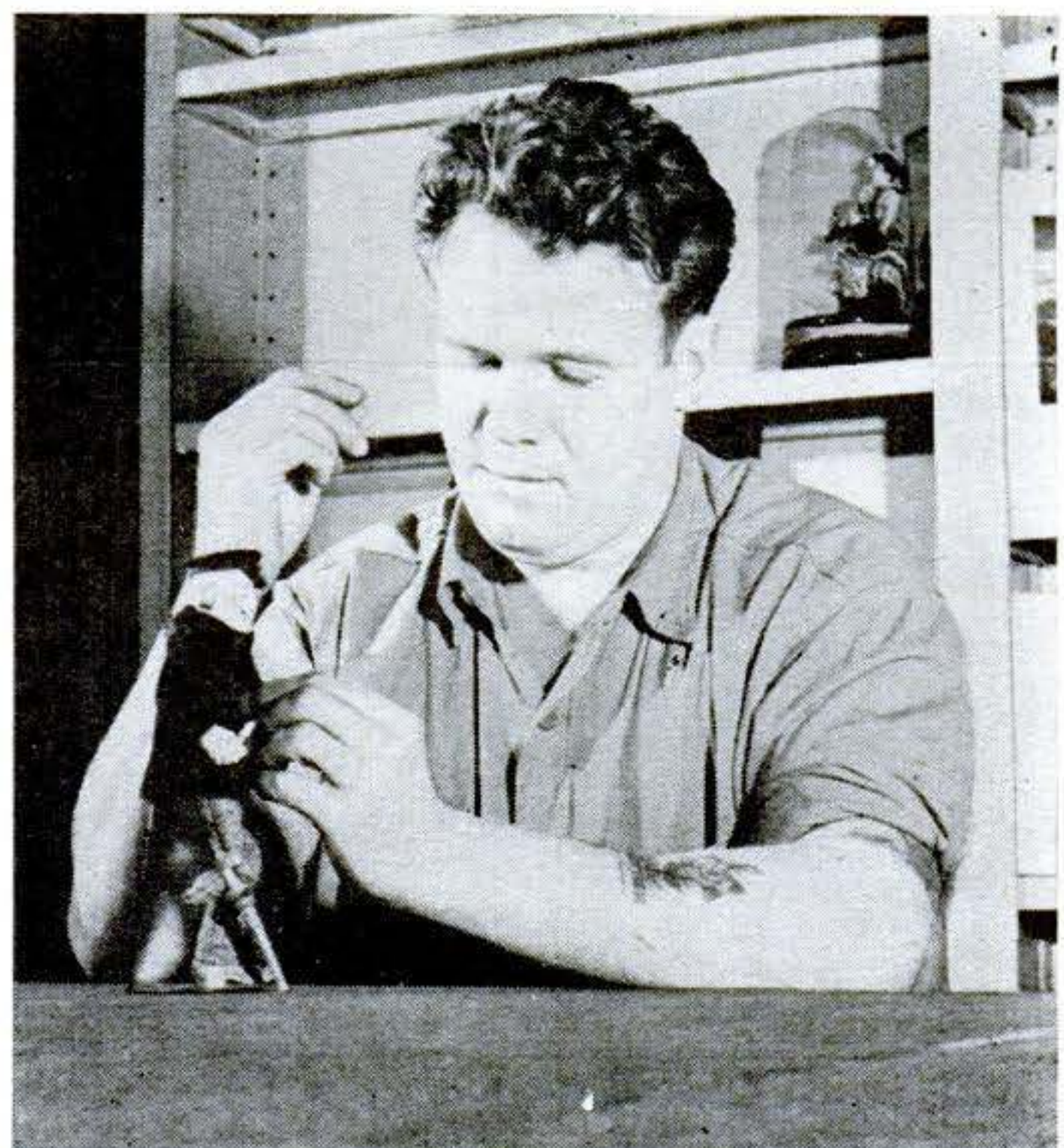
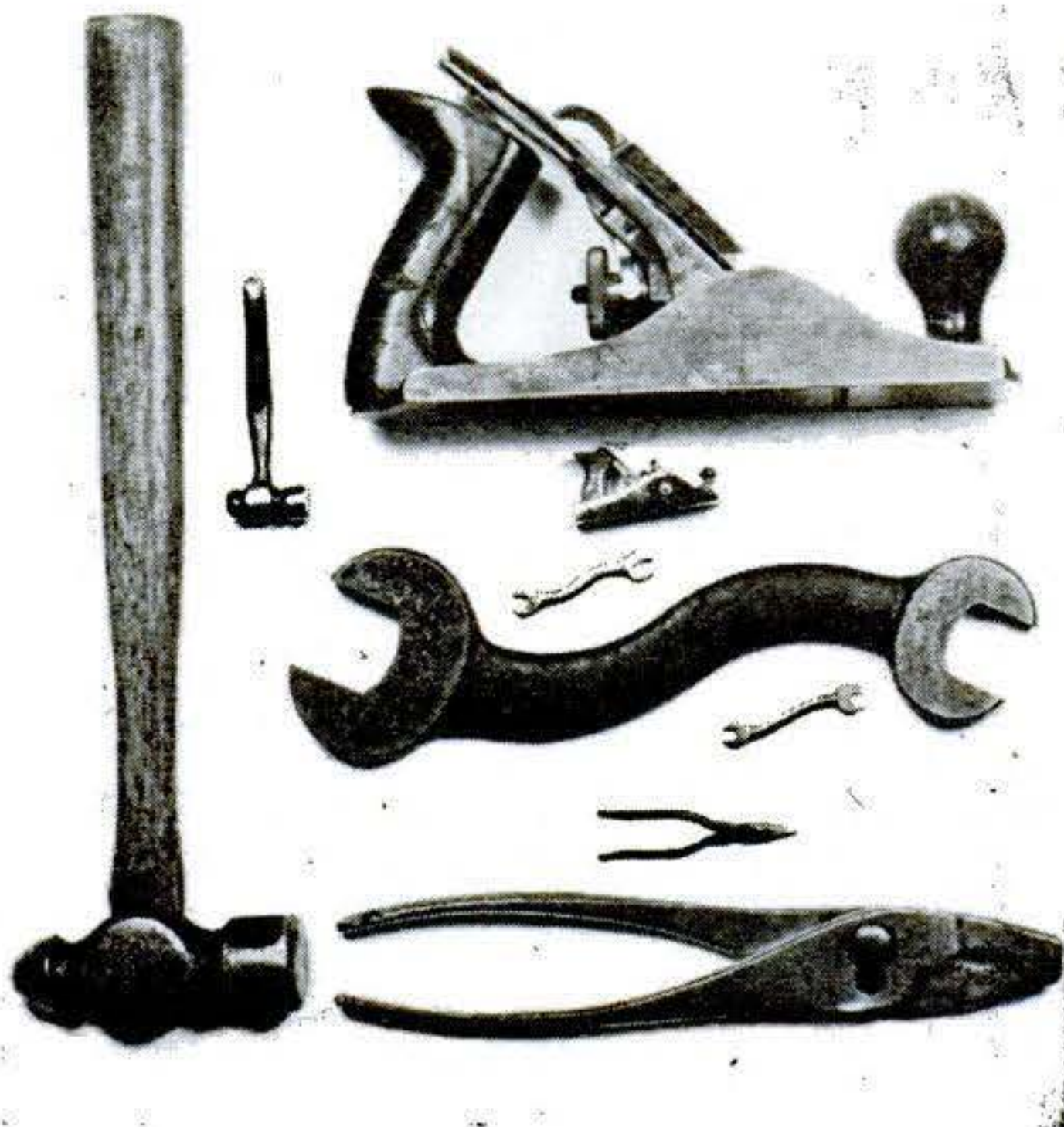
A maximum weight limit of 50 lb. has been set for entries in order to rule out any office-filling, king-sized projects such as the windmill washing machines or belly-tank boats which were common in the Pacific.

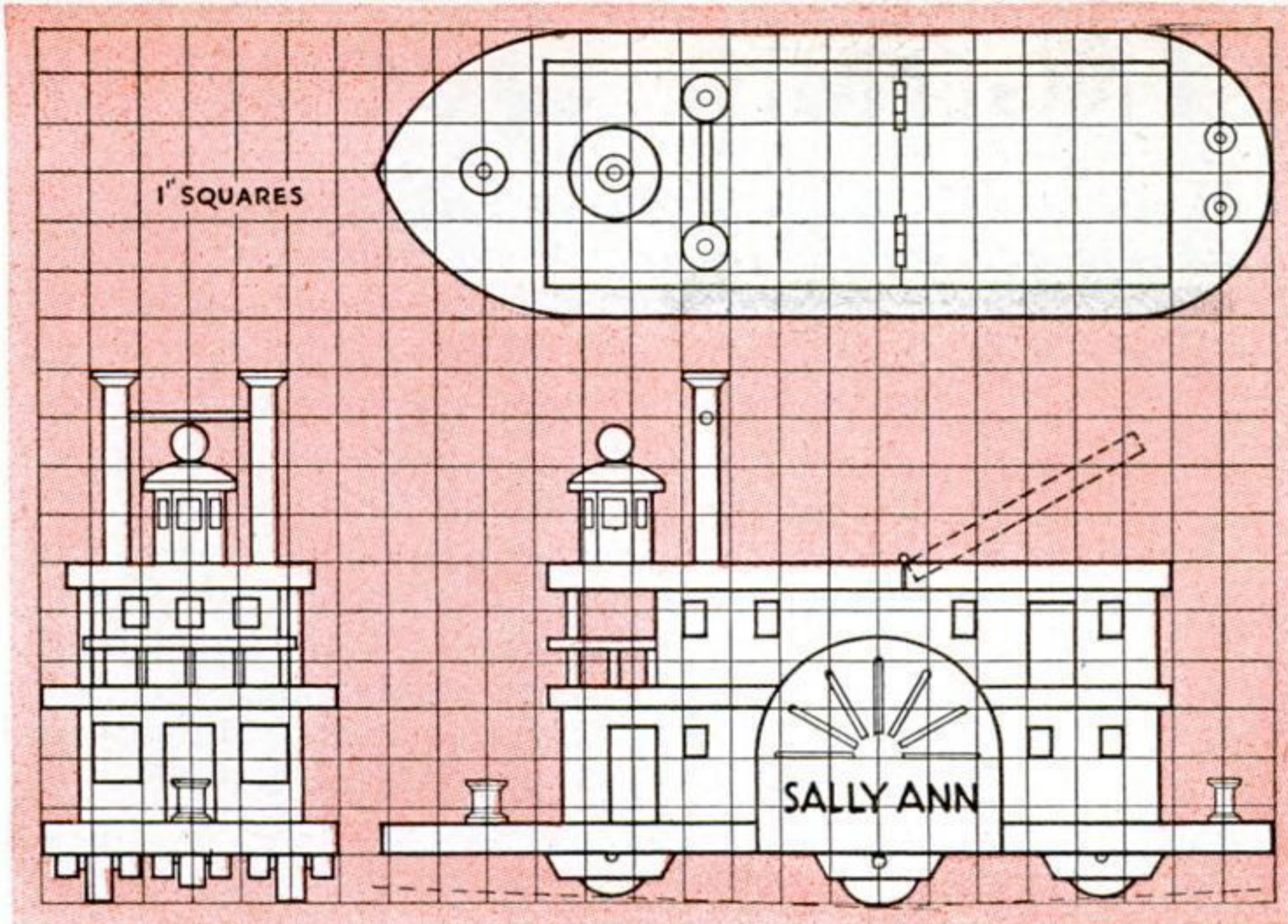
Your entry may be sent either by parcel

post or express. Make certain that the article is carefully packaged and, if you place a high value on your work, it would be well to insure it. If you want your entry returned, do not forget to attach directly to the article itself an envelope containing postage and a self-addressed sticker or tag. In any case, attach your name and address securely to the article itself.

Tiny tools, shown here beside their normal-sized counterparts, were produced by Cpl. Paul L. McFall.

John Hoermle stitches a coat on a wooden figure carved by one of his pals in the Merchant Marine.

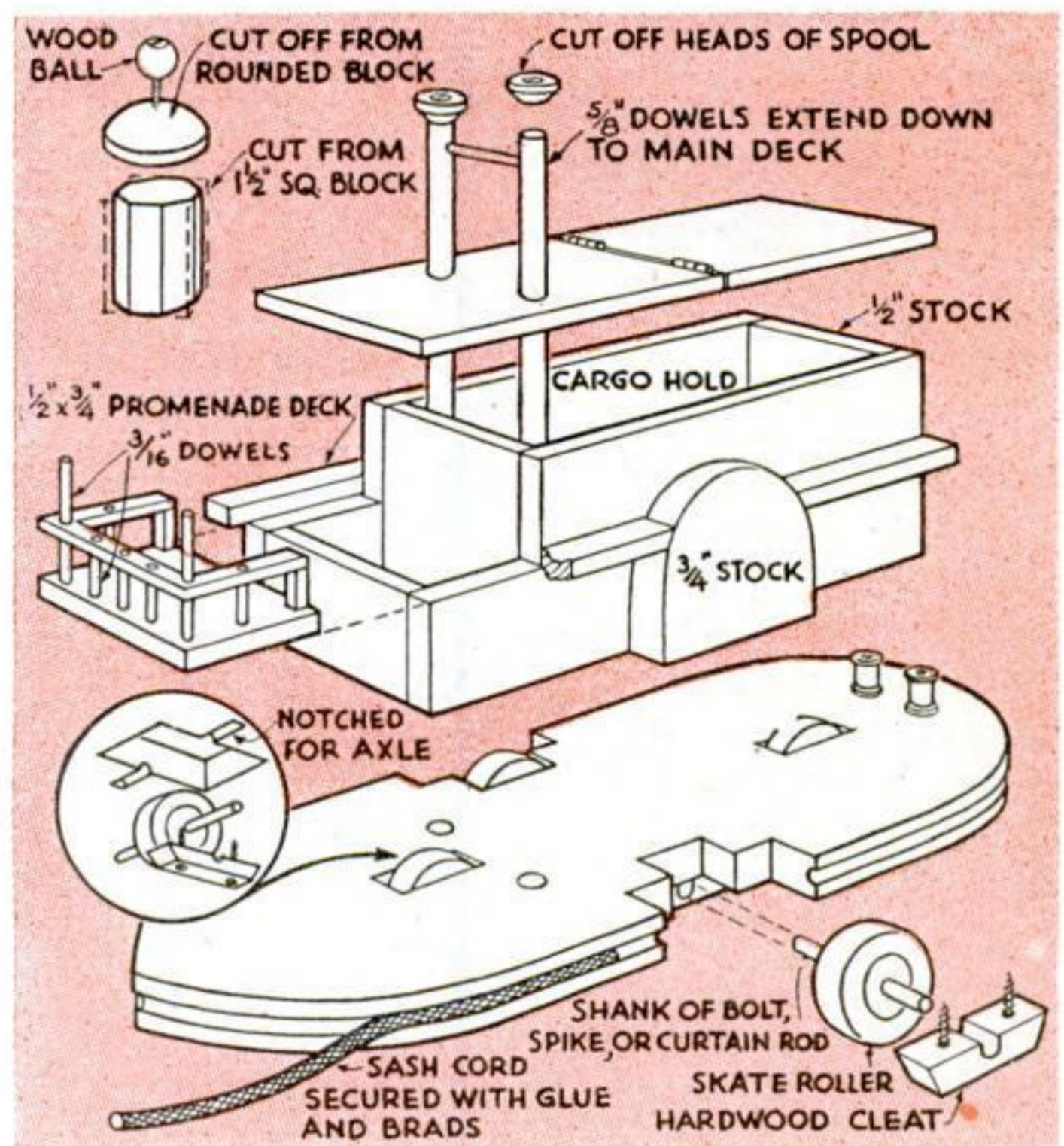




PARLOR PACKET CARRIES YOUNG SKIPPER AND TOY CARGO

THIS easy-running parlor steamboat will provide plenty of amusement for toddlers. The child not only can load the hold with cargo, but can climb aboard and navigate the craft himself. Four ball-bearing skate rollers enable it to sail over the floor as he provides "steam" by pushing with his feet.

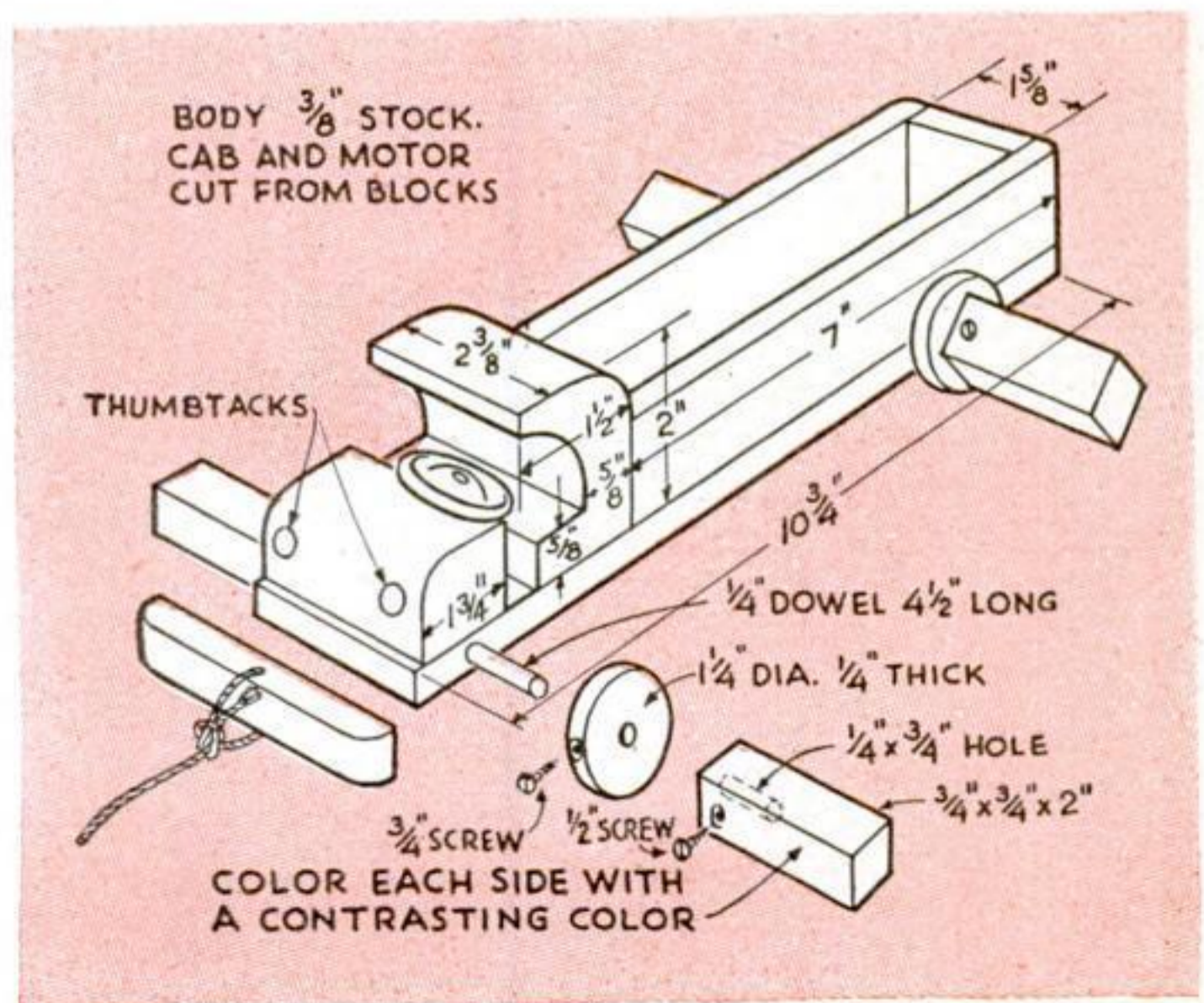
Cut the parts to size by scaling them off the drawing on a grid of 1" squares. Assemble as shown at the right. The amidships axles are recessed in blocks just below the hull, while those fore and aft are recessed partly in the bottom of the hull and partly in the supporting blocks. This construction never lets more than three wheels touch the floor at the same time, and makes the craft maneuverable. Large radiator or similar hose cemented to the rollers will deaden the sound.—HI SIBLEY.



RAINBOW-WHEELED PULL TRUCK DISPLAYS SPINNING COLORS

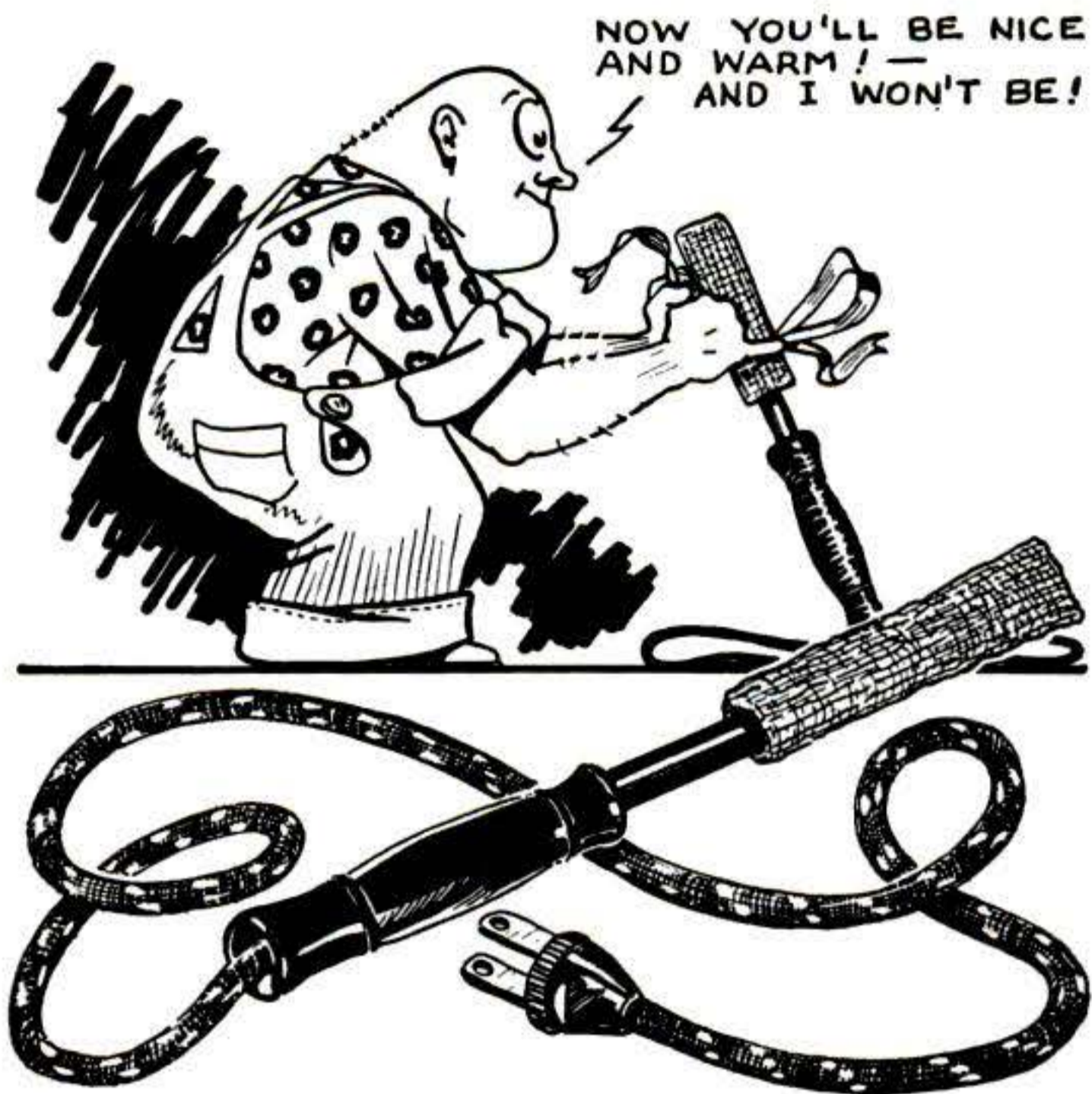
ALL young children delight in colors and in toys they can pull. Here is a little truck that combines both features. Besides being a pull toy, it has exaggerated hubs in the form of blocks painted with a contrasting color on each face. When the truck is pulled along the floor, the spinning blocks create a rainbowlike display. The toy is shown in full color on page 113.

Make the truck as shown at the right. Drill $\frac{1}{4}$ " holes in the blocks to receive the elongated axles, which turn in holes in the floor of the truck. Drill wheels and blocks for countersunk wood screws to fasten them to the axles. If you prefer, similar colored blocks can be put on an old toy by lengthening the axles.—MYRON FLEISHMAN.



WHAT'S YOUR **INGENUITY** QUOTIENT?

Have you pulled off a smart one lately? We will pay for each contribution accepted for this page showing ingenious solutions of problems in the home, shop, garage, or camp. It doesn't matter if it's wacky—if it works.



ANYTHING TASTES GOOD when you're stranded in the wilds of Burma with a busted fuel pump, but I would have been glad to pass up the gasoline à la rubber hose I had to swallow to get my jeep rolling again. With an extra fuel can tied to the windshield, I started siphoning the gas through a rubber tube, and then let the liquid flow directly to the carburetor intake.—MAJ. BRUCE E. REY.

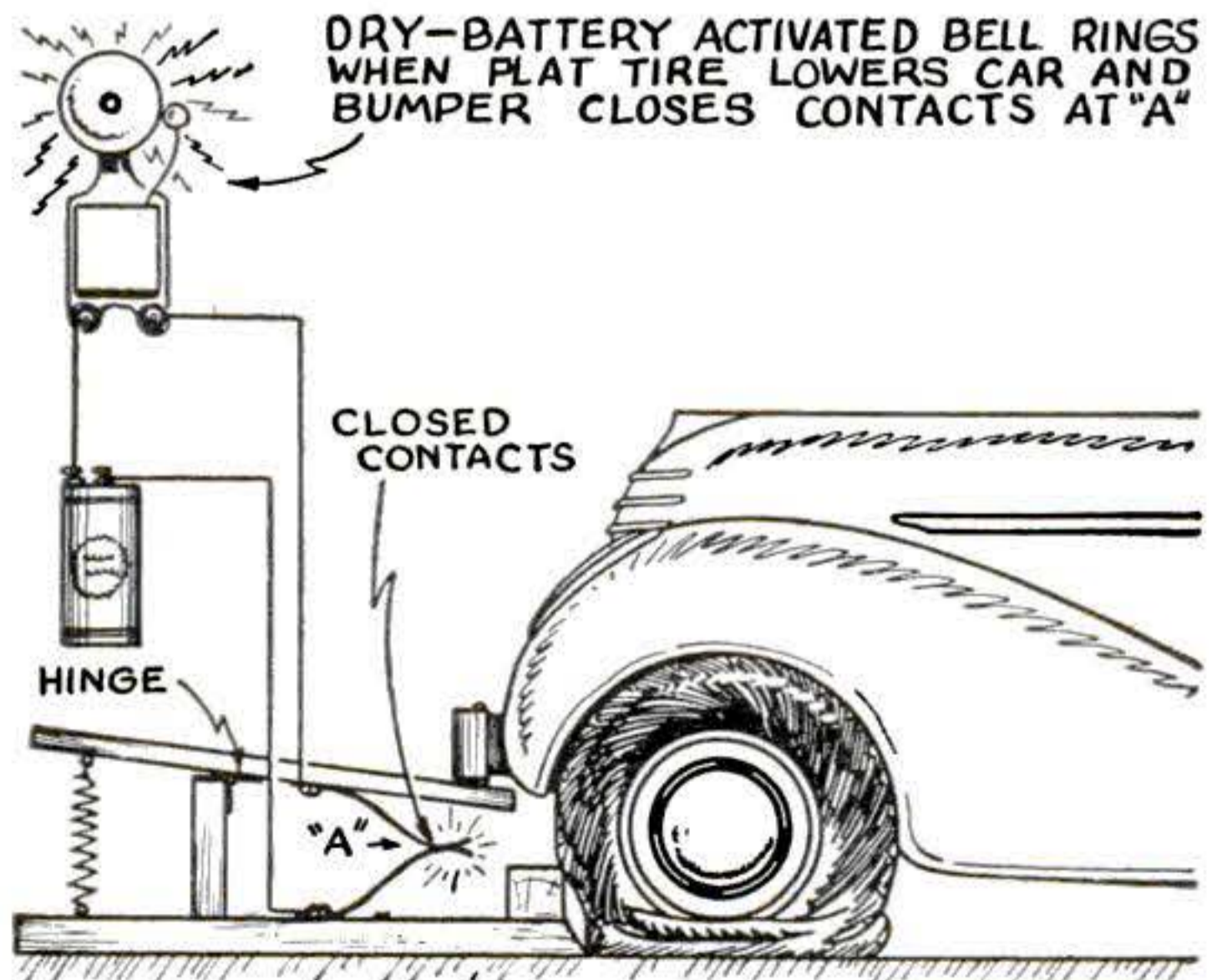
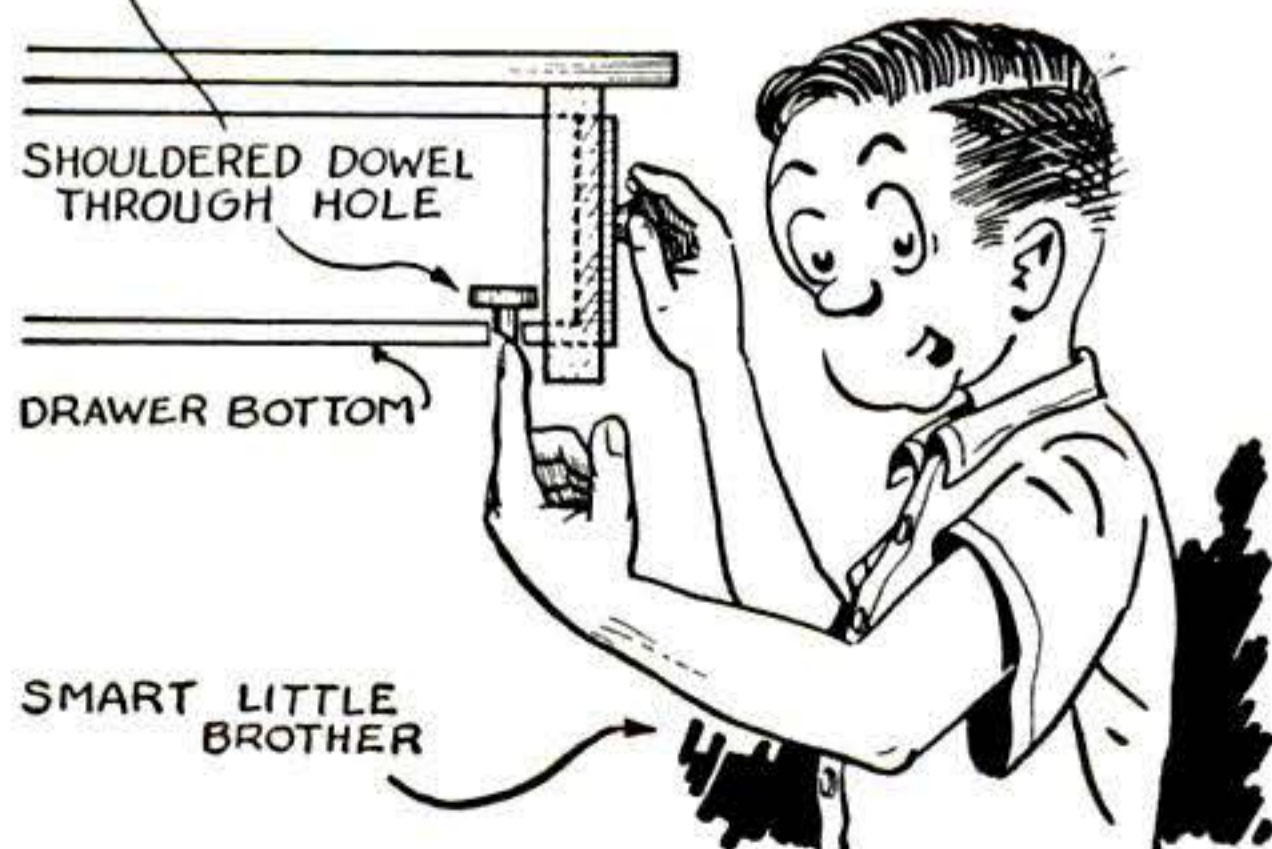


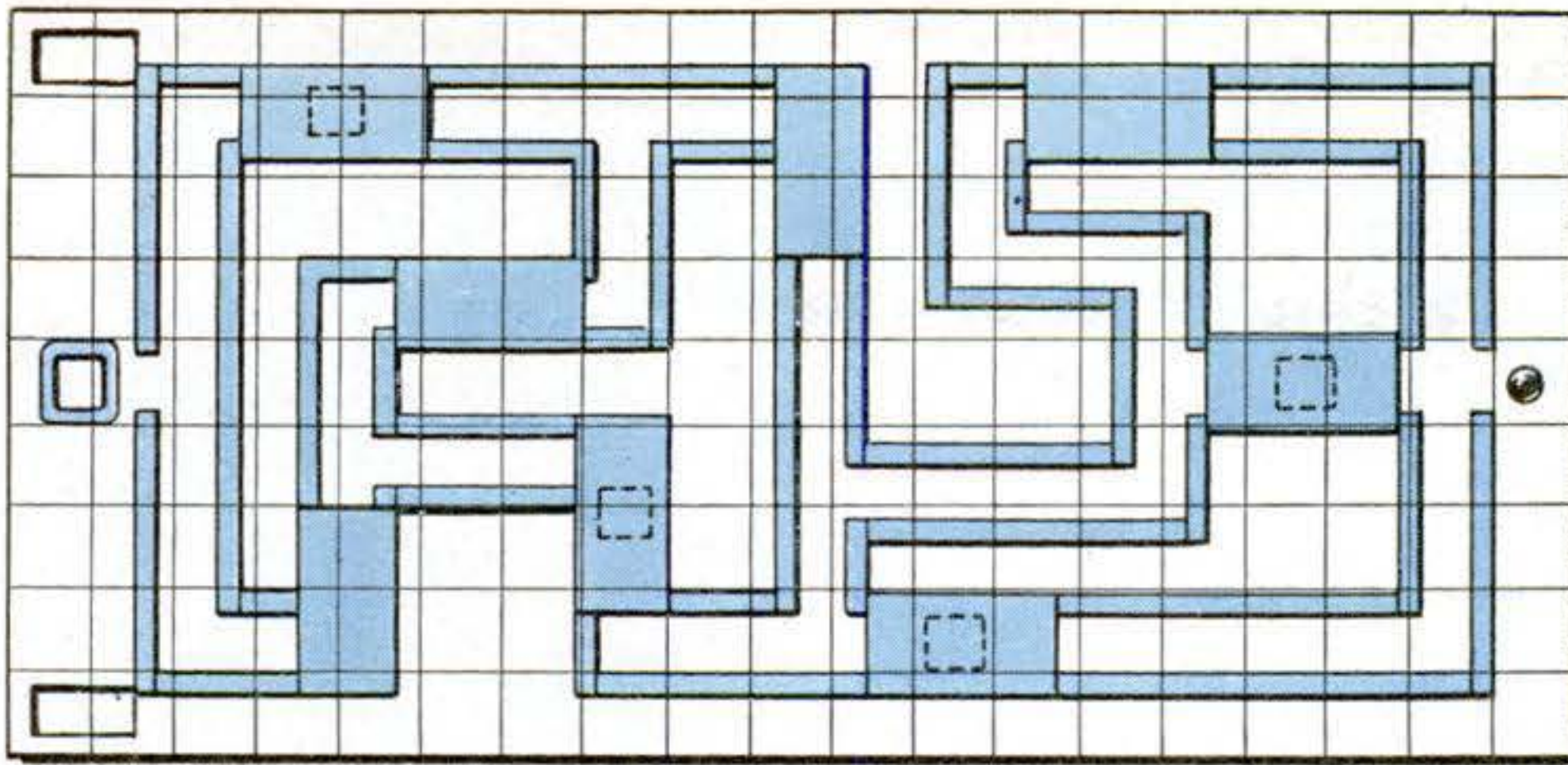
HOT STUFF in the form of a soldering iron in a radio man's tool kit is no help when he wants to pack up to go to the next job. To keep from scorching my tool bag, I made a heatproof jacket out of glass cloth stuffed with glass wool. Stitching can be done with asbestos cord or fine-gauge copper wire. On busy days I find that the iron is still fairly warm at my next stop.—RUFUS P. TURNER.

CARS DON'T CRY, as I discovered to my sorrow when, rushing out to the garage for a late start, I found the old girl sitting dolefully on all that was left of a slow leak. Not wanting to have it happen again, I dreamed up an alarm system that never hesitates to break the bad news.

Two pivoted contacts in front and two hinged to the garage door keep all four wheels under inspection. As the tire goes down it closes a bell circuit. You may not believe this, but I've discovered that flat tires can be fun.—T. M. RUTHERFORD.

PRIVATE DRAWERS are the right of any man, but my kid brother didn't think so. To keep his prying mitts out of my possessions, I drilled a hole in the bottom of the drawer and inserted a shouldered dowel as a drop lock. It works!—PAUL HALLIDY.

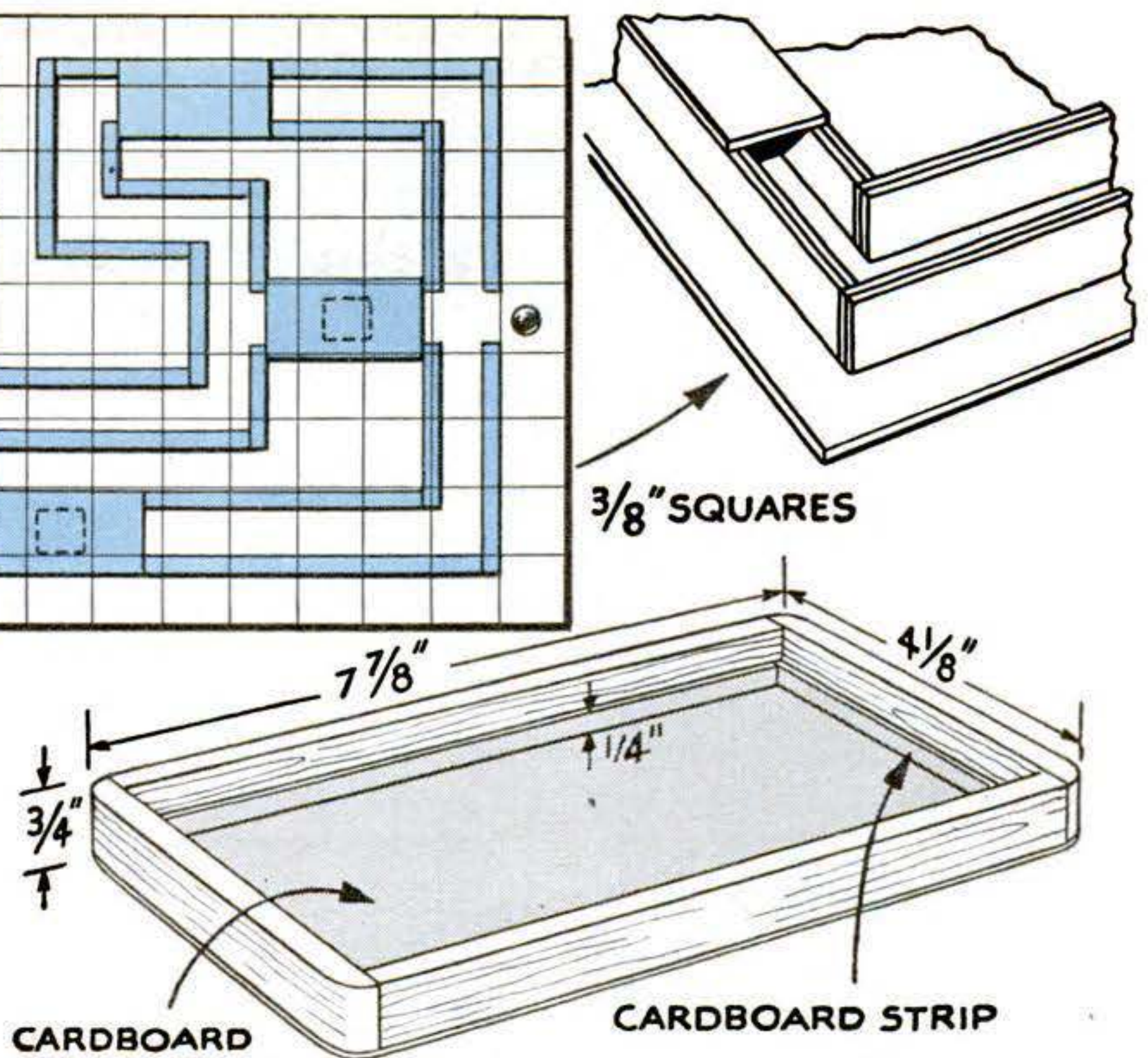




LABYRINTH PUZZLE IS A MAZE OF CARDBOARD

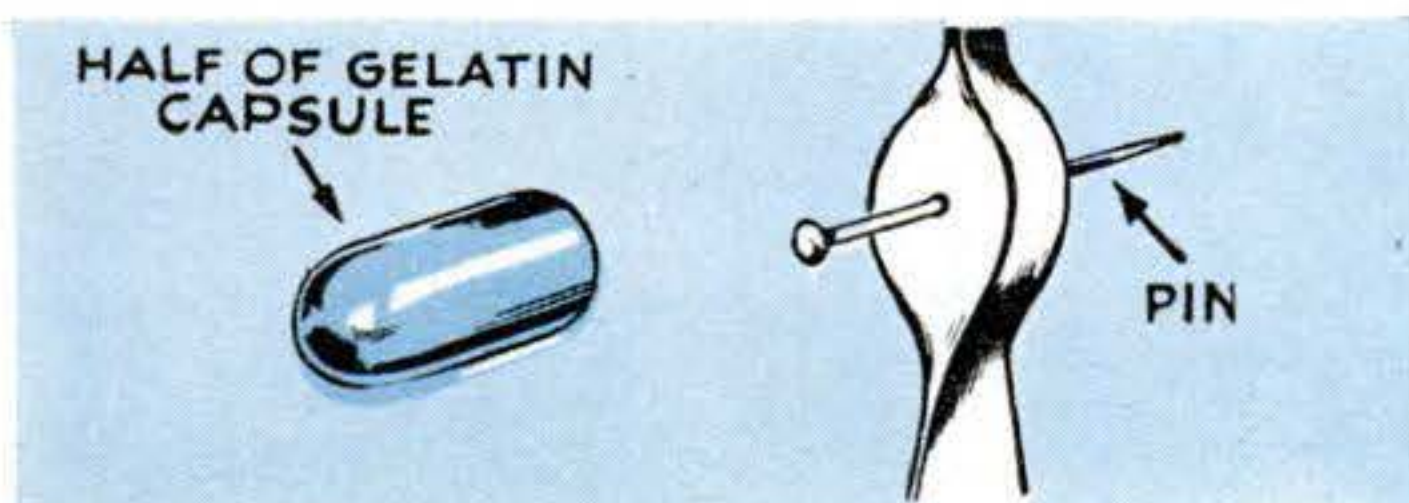
FOUR of the eight bridges that span the cardboard alleys of this labyrinth conceal open traps designed to catch the $\frac{3}{16}$ " ball before it reaches the goal.

The game is made of showcard board and a few strips of $\frac{3}{8}$ " by $\frac{3}{4}$ " wood. Cut and glue the wood to form a frame. Make the labyrinth walls out of two layers of showcard board glued together and trimmed to a height of $\frac{1}{4}$ ". For the traps and the goal, cut holes $\frac{1}{4}$ " square;



elongated holes at each end of the goal line will prevent the ball from sneaking in the back way. Paste a cardboard patch underneath the goal opening. Sandpaper all edges and finish with several coats of liquid floor wax.—FRANK SHORE.

SPINNERS FOR MODEL AIRPLANES FROM GELATIN CAPSULES

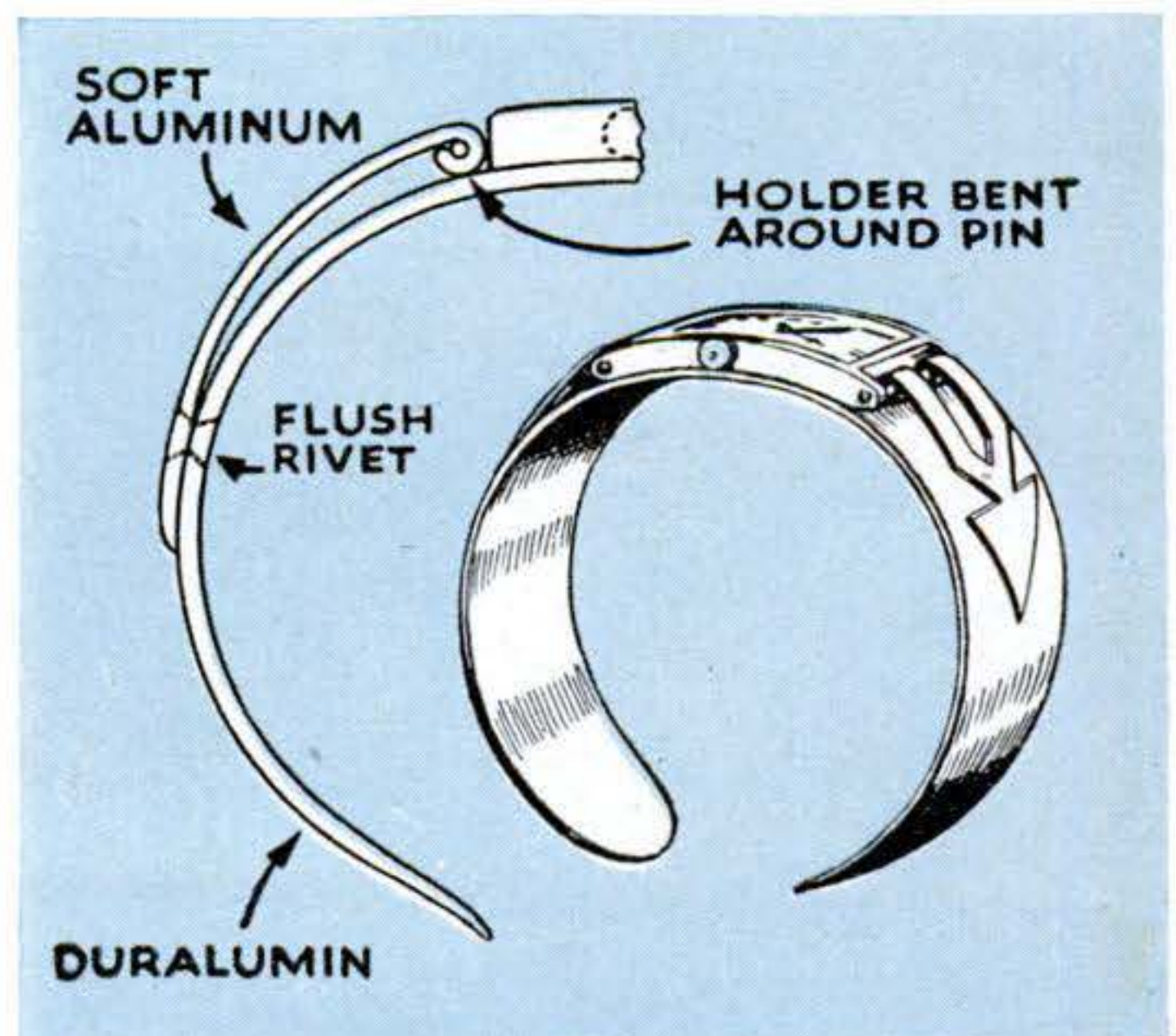


If you can forget your dislike for those tonsil nudgers your doctor sometimes prescribes, you will find that gelatin shells, available in small and large sizes at any drug store, make good prop spinners. Only half a capsule is used, of course. Cement it in place over the pin.—F. M

WRISTWATCH BAND OF SCRAP ALUMINUM WEATHERS PACIFIC DAMPNESS

DOWN in the South Pacific, where men had to battle humidity and heat as well as Japs, leather and cloth wristwatch bands deteriorated rapidly. That's one reason why this all-metal strap became one of the most popular items of G.I. jewelry. Another reason was that the band could be fashioned easily and was as individual as its maker.

The body of the band is made of hardened aircraft aluminum; use fairly thin stock so that it can be shaped to the wrist and still remain flexible. For the holders, select any aluminum soft enough to be bent around the pins. Fasten each holder to the band with one $\frac{3}{32}$ " soft aluminum flush-type rivet. Countersink and file the rivet head flush on both sides. The holder or the entire band can be worked as desired.—W. OTTO.



CABINET KEEPS TOYS IN ORDER

HABITS of orderliness taught in childhood, we are told, help to build character. They also pay a quicker dividend by freeing parents from the chore of following behind a child to pick up toys. The cabinet shown here helps give a little one a sense of order. It has roomy shelves on which he can keep his toys fairly well sorted and, because there is no lid to slam down, it will help to prevent breakage.

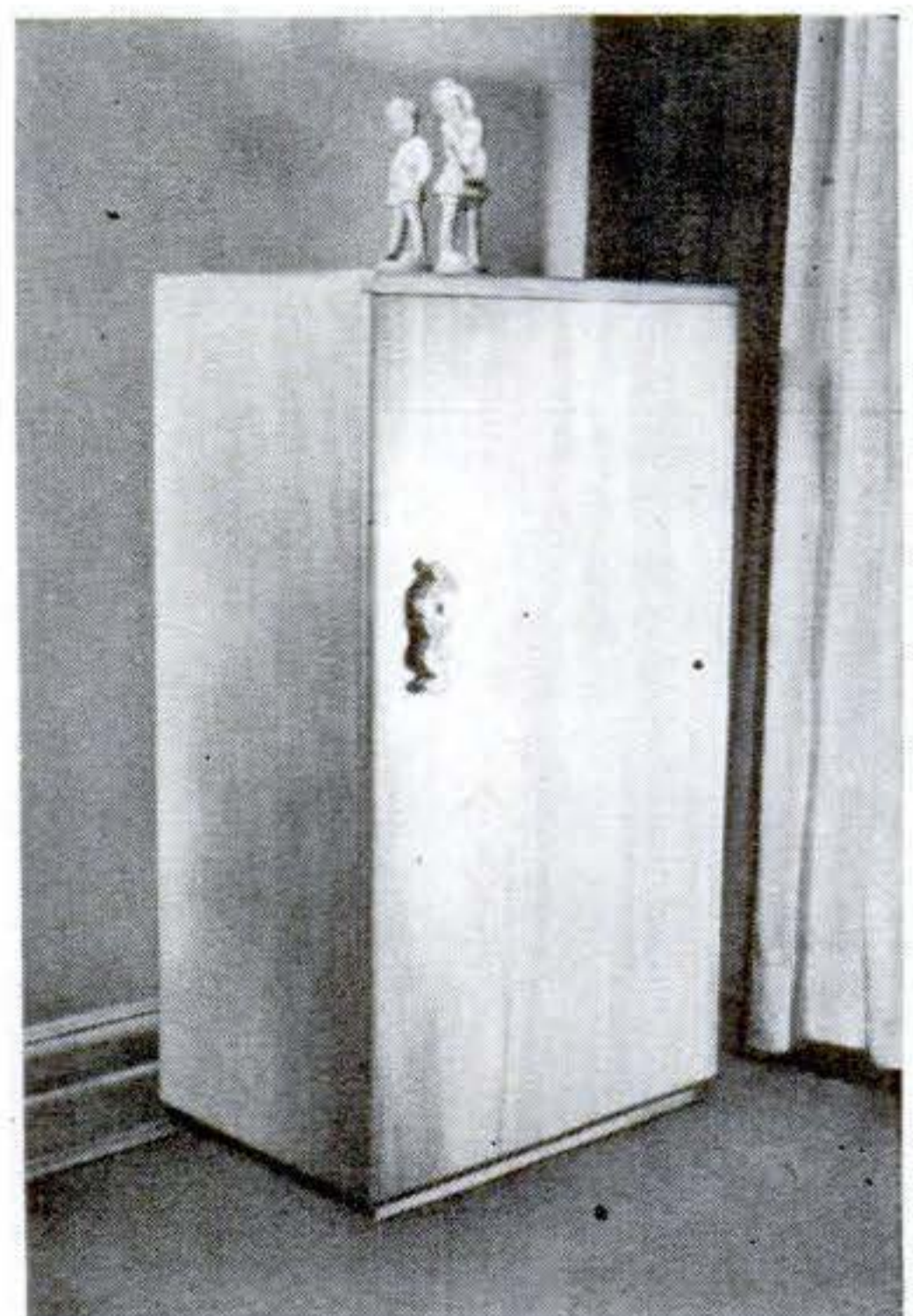
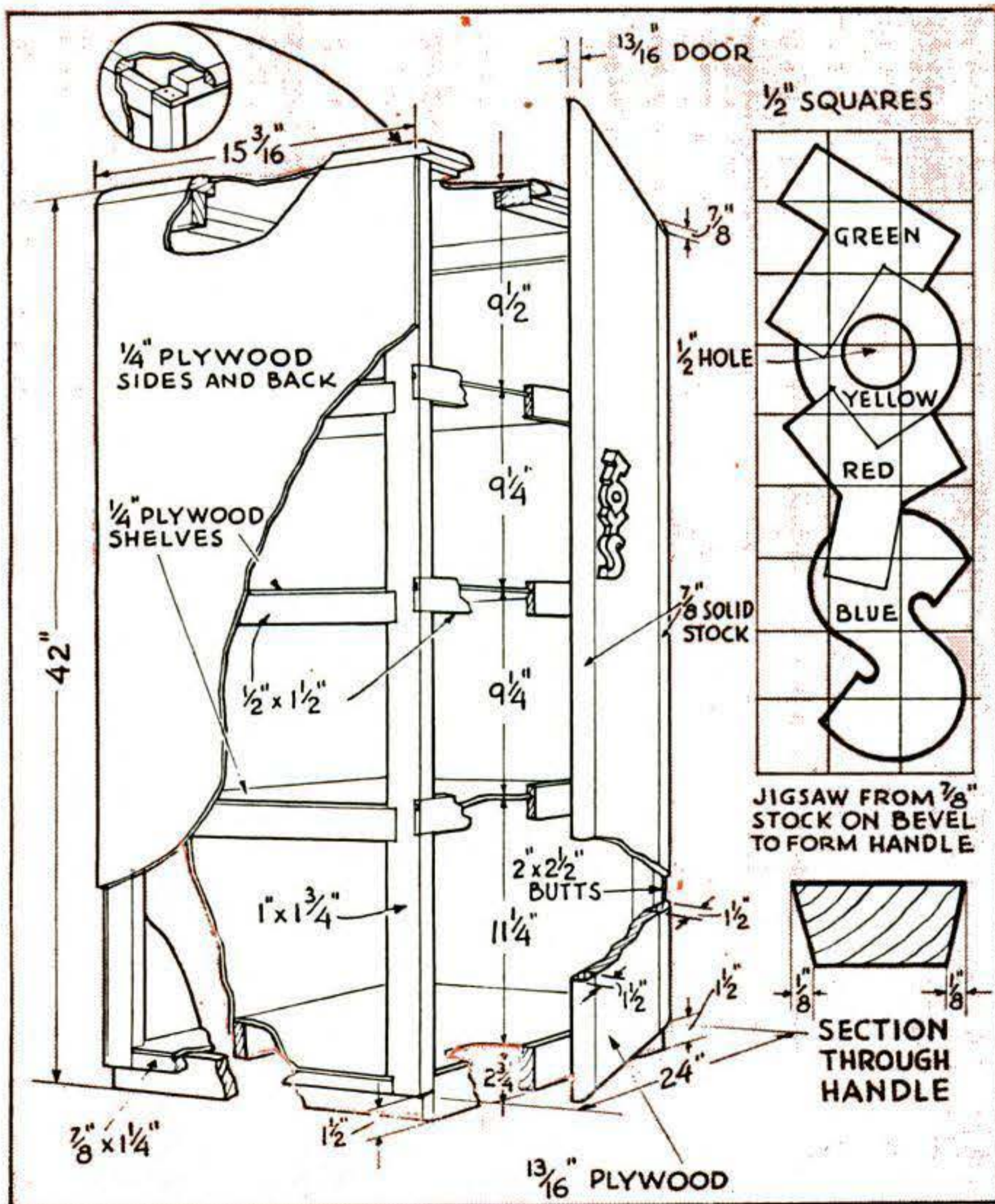
Cut corner posts and notch them for the shelf supports, as indicated in the drawing. Assemble the two sides separately with glue and nails or screws, and then assemble them on the base and add front and rear cross members at the top. These pieces are end-rabbeted in the form of a half-lap joint to receive the side moldings. Notch the shelves around the corner posts, glue and nail them in place, and add the grooved front strips. Then dress the shelf edges at the sides and back and put on the plywood panels. Finishing nails well set and puttied



over are sufficient if the piece is to be painted, but gluing in clamps will be necessary if a natural finish is desired.

Solid vertical strips are glued to the edges of the plywood door and dressed quarter round. The handle is jigsawed and painted, as indicated, and a friction catch for the door is added.—HARRISON NEUSTADT.

Clean-cut, simple lines harmonize with any nursery plan. The jigsawed handle is beveled to afford a grip.



YACHT-RACE GAME

CAN you pick the winner of this race between three yachts? You'll be lucky if you can, for it's largely a game of chance, and the hidden behavior of the steel balls that drive them forward can rarely be predicted.

The board is built on the familiar bagatelle principle with the balls driven by a plunger, as shown in the drawing below. Nail heads protruding slightly above the bottom board cause the balls to bounce about, but a solid hit on a block under a boat drives it forward.

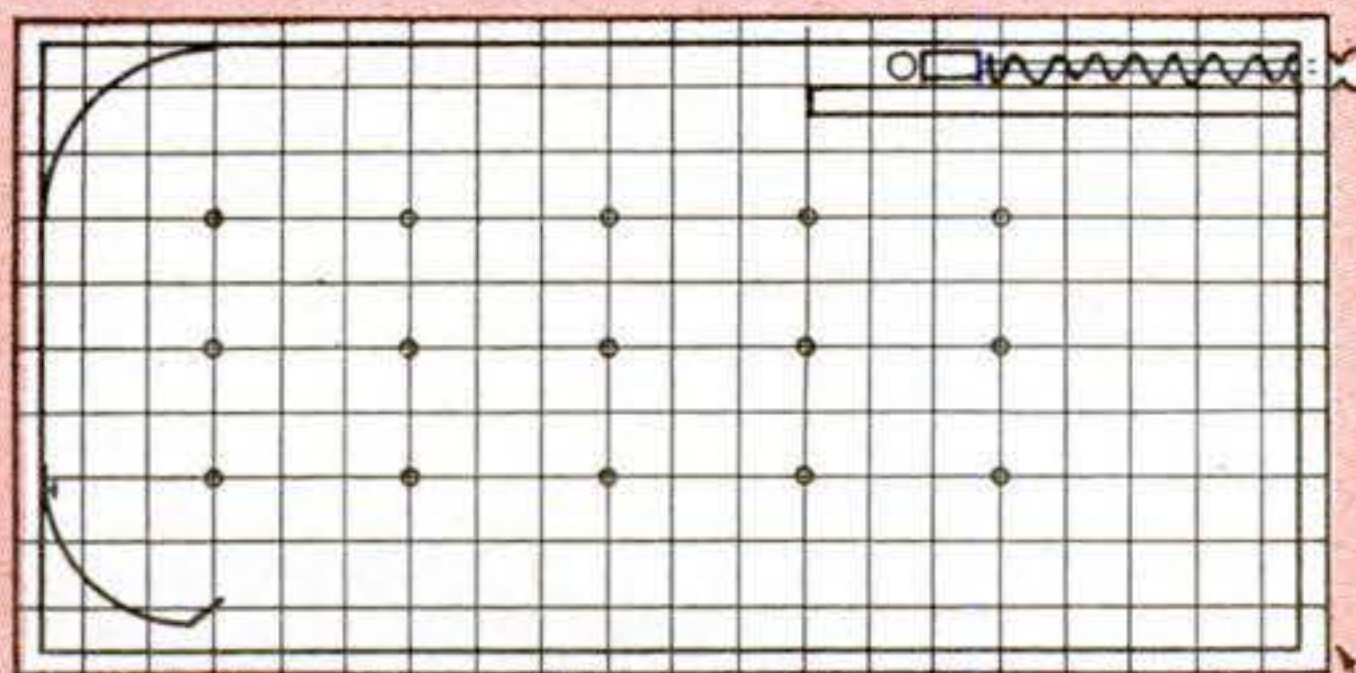
Rabbit the frame at top and bottom to receive the hard composition-board panels and attach two 1" legs to slope it toward the plunger. The bottom panel is glued and nailed, but the top is left free to lift out if adjustments are necessary. Three slots in the top provide courses for the boats.

Cut out the boats as indicated and sand

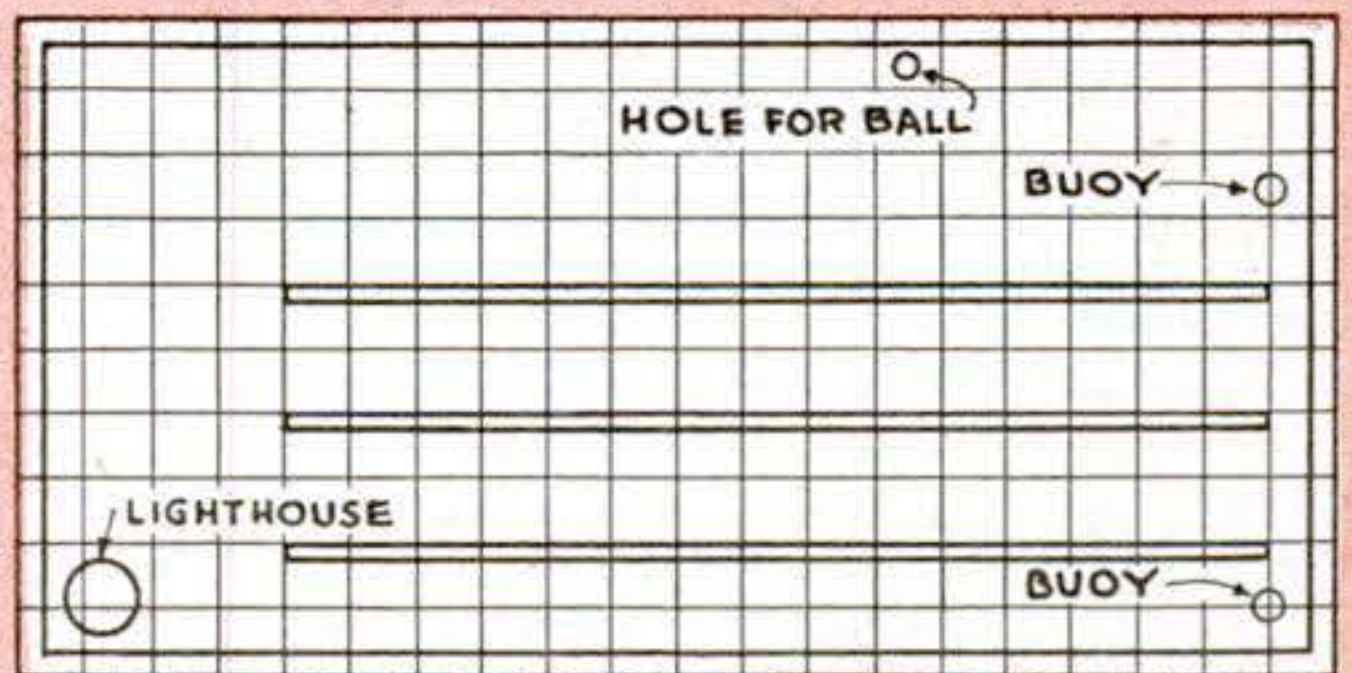


them and the base blocks so they will slide easily. The lighthouse and the base of the buoy, which serve as handles to lift off the upper panel, may be turned or whittled.

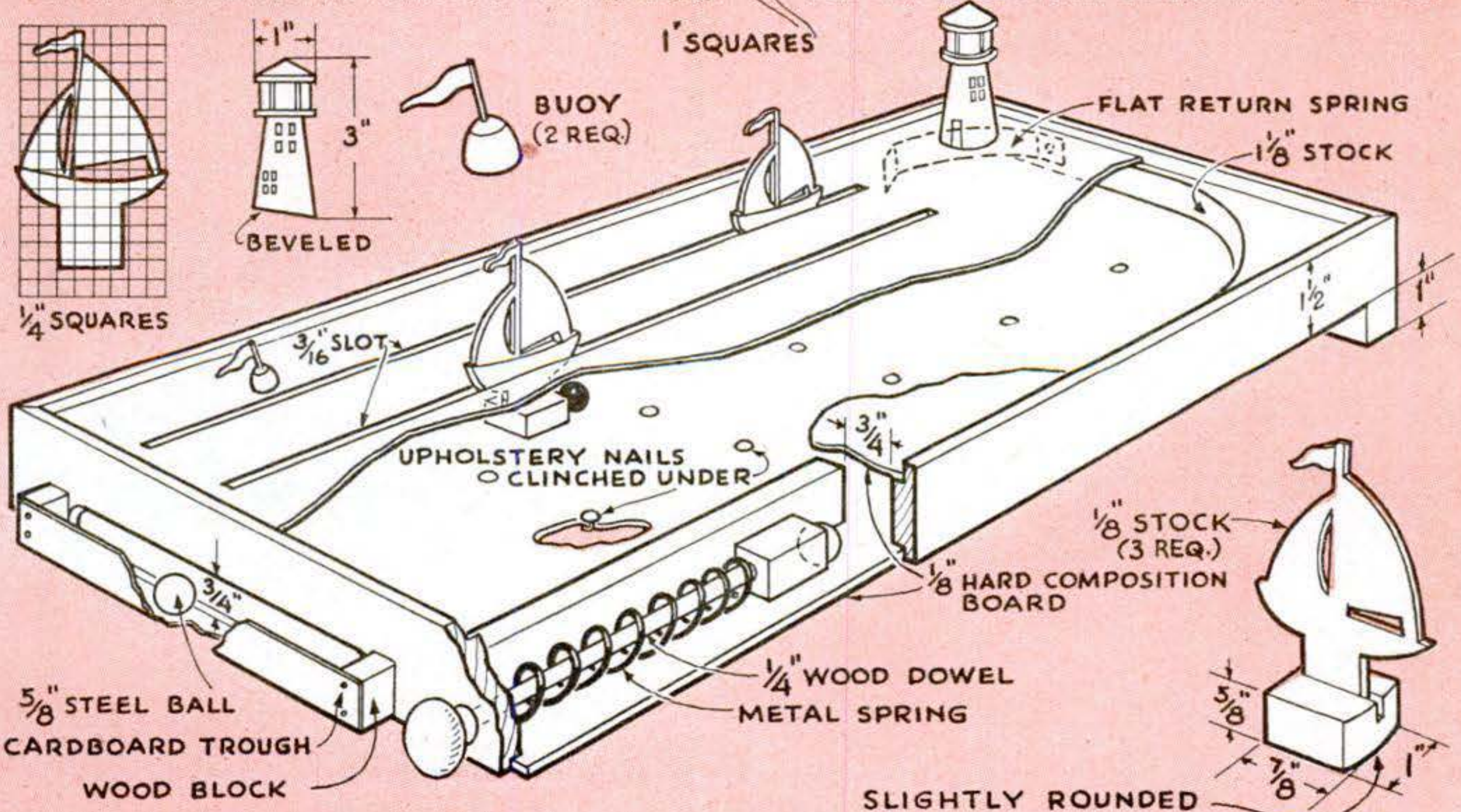
Paint the sides red and the top green except for a brown area around the lighthouse. The lighthouse may be gray or white, and the numbered boats painted in various colors for contrast.—HI SIBLEY.




TOP OFF SHOWING LOCATION OF NAIL HEADS



TOP ON SHOWING LOCATION OF SLOTS

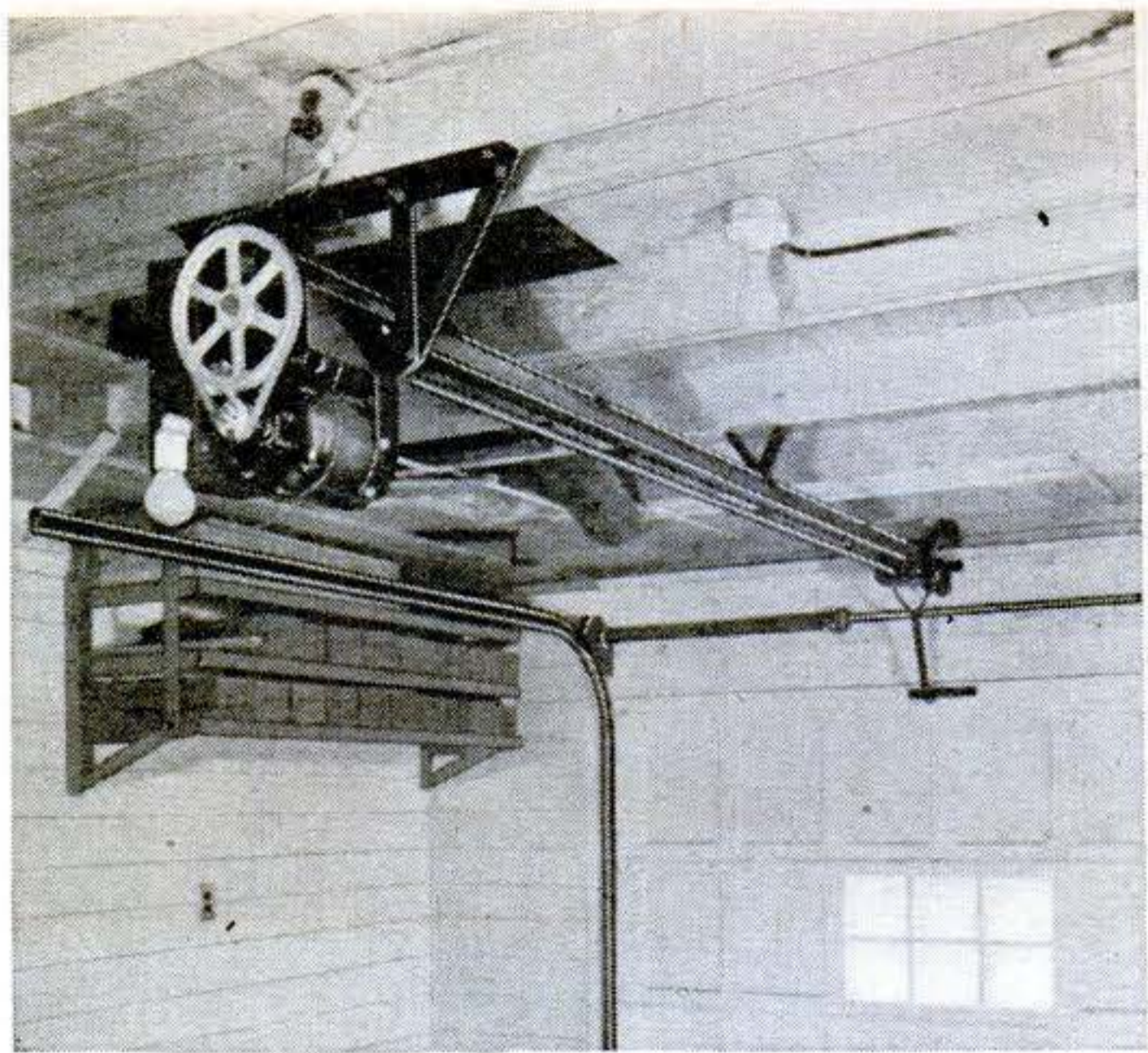


OF INTEREST TO



HOME OWNERS

WHAT SIZE HEATER a building needs can be determined with a cardboard indicator developed by the Evanair Division of the Evans Products Company, Detroit, Mich. When the length, width, and ceiling height of a space are known, the dial indicator yields the B.T.U. requirements. A heater or furnace giving this heat is then chosen.



GARAGE DOORS are opened by the mechanism shown above at the touch of a dashboard button as your car enters the driveway. Pressing the button sends current from the battery through a coil mounted underneath the car near the ground. The magnetic field of the coil trips a sealed all-weather mercury switch buried in the drive, and the latter switch closes a relay, setting the mechanism in operation. Likewise, while you are leaving the drive the doors can be closed from the driver's seat. Other control-button switches are located in the house and garage. The Horton division of The Aviation Corp., Detroit, makes the system.



PROCESSED COAL put on the market in Philadelphia by the Blaw-Knox Company as "White Glove Packaged Fuel" simplifies furnace tending. Both anthracite and bituminous coal are used. After dust and moisture are removed, the two types of coal are crushed separately, and then placed in a mixing chamber where a hot asphaltic binder is added. Presses squeeze the mixture into 3" cubes, six of which are wrapped in each package. The fuel is used without opening the wrapper.



DECORATIVE and easily applied, ready-pasted cutouts put on the market by Trimz Co., Inc., are intended for use on accessories around the house as well as on painted walls and furniture. The objects at the left show how the cutouts can be used to advantage by the decorator. These cutouts are available in a variety of designs.

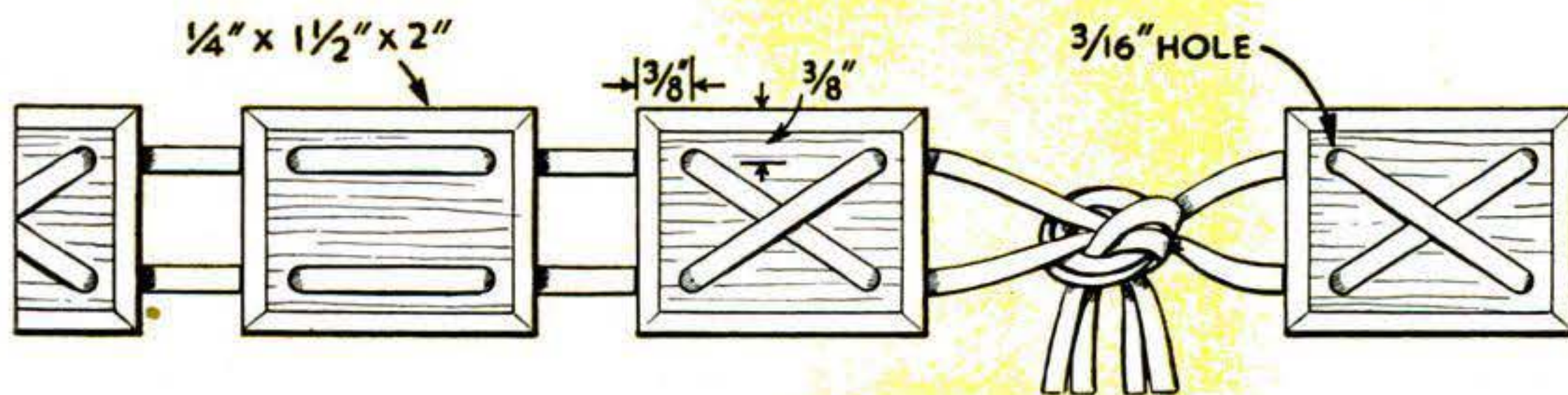


WALNUT BLOCKS LACED TO FORM GIRL'S NOVELTY BELT

Two rawhide laces and 11 walnut blocks make a pleasing belt to wear with feminine sport ensembles. Drill each block in the four corners, and sand both faces smooth with coarse and then fine sandpaper. The edges may be rounded or chamfered.

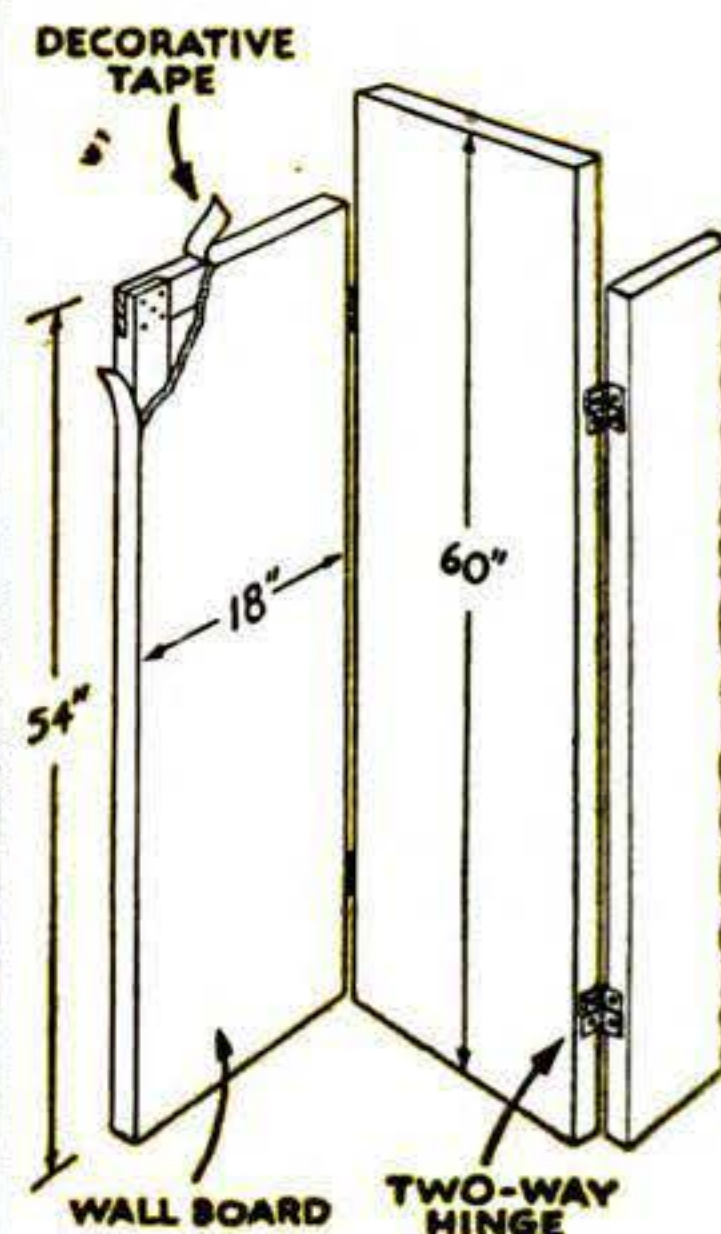
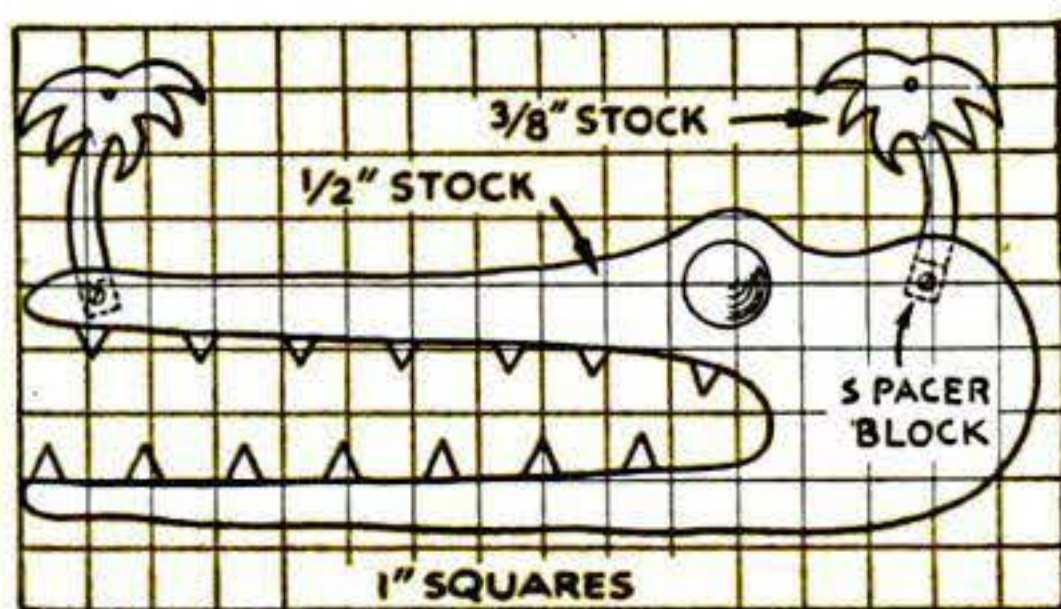
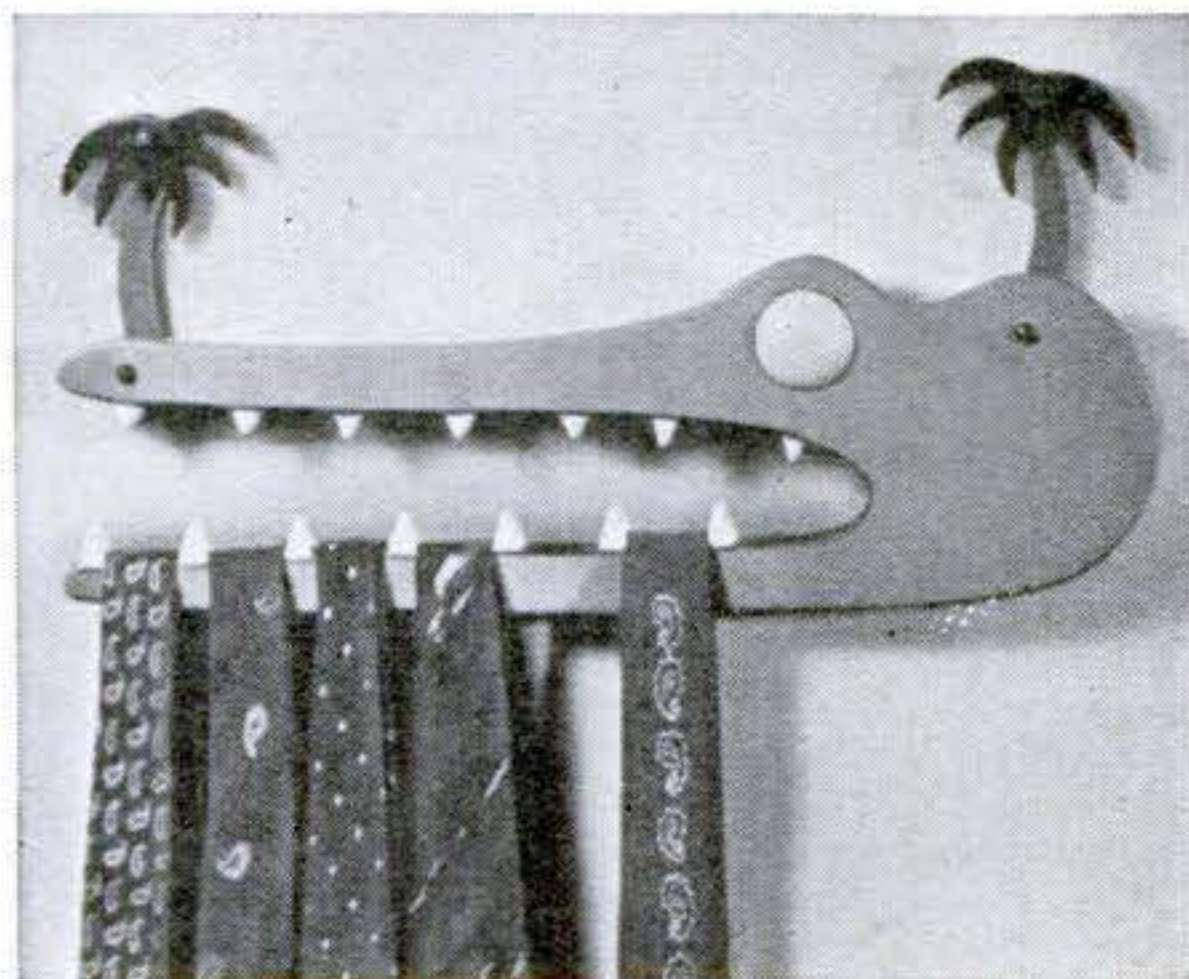
Rawhide laces 54" to 60" long of the type used in men's high boots are ideal for joining the blocks, but 48" lengths may be sufficient. They cross on alternate blocks, as shown below.

For a satin-smooth finish, rub the blocks with a half-and-half mixture of turpentine and linseed oil, repeating daily for a few days, and then wax.—RALPH S. WILKES.



TROPICAL TIE RACK HOLDS YOUR SPORTIEST NUMBERS

IF YOU can't go to Florida this winter, you can at least create a bit of its atmosphere with this tie rack, also shown in color on page 113. Draw the outline on $\frac{1}{2}$ " stock by tracing it on a grid of 1" squares, and jigsaw to shape. Use a big wooden button or disk for the eye. Cut the palm trees out separately, attaching them with spacer blocks so that the body is held off the wall.—MYRON FLEISHMAN.



WALLBOARD-AND-WALLPAPER SCREEN IS DECORATIVE HOME PROJECT

EITHER as a gift for a friend or for your own home, a screen like that shown above is sure to be useful. It consists of three frames of $1\frac{1}{2}$ " or 2" stock covered on both sides with wallboard and wallpaper and assembled with two-way hinges. If desired, paper of one design can be used on one side and another design on the other.

Lap joints make firm corners, but be sure they are square. Brad the wallboard to the frames, paste on wallpaper, and bind the edges with passepartout. When dry, brush with hot gelatin mixed 1 tablespoonful to 1 cup boiling water, and when dry again, apply three coats of shellac, the first diluted with half alcohol. Sand lightly between coats and finish with wax.—N. E.

A JEEP FOR YOUR YOUNG GI

EITHER of the two pedal-powered jeeps described in this article would make some boy or girl the envy of every other child in the neighborhood. Of the two, that shown in the photograph at the right is the simpler, although it has two features that the other does not—a windshield that pivots forward on the hood, and coil springs under the kingpins to provide a degree of “knee action.” The other, the “Bizerte Gerte” jeep pictured on page 164, is a more ambitious project. It has a metal body, headlights that work, a more elaborate steering mechanism, and an adjustable seat. If the dimensions were increased somewhat, it could be powered with a gasoline washing-machine engine.

Herbert R. Pfister, of New York City, designed and built the first; H. A. Machlan, of El Campo, Tex., the second. Some builders may want to use some features of each.

Construction details for the first are given on this and the next page. For the hood, four pieces of stock are glued and screwed together to form a tapered box 15" wide in front and 17" in back. The body sides are one piece from the hood to the rear panel. Bevel the front edges of the sides and the matching edges of the hood cowling so that they will butt evenly against each other.

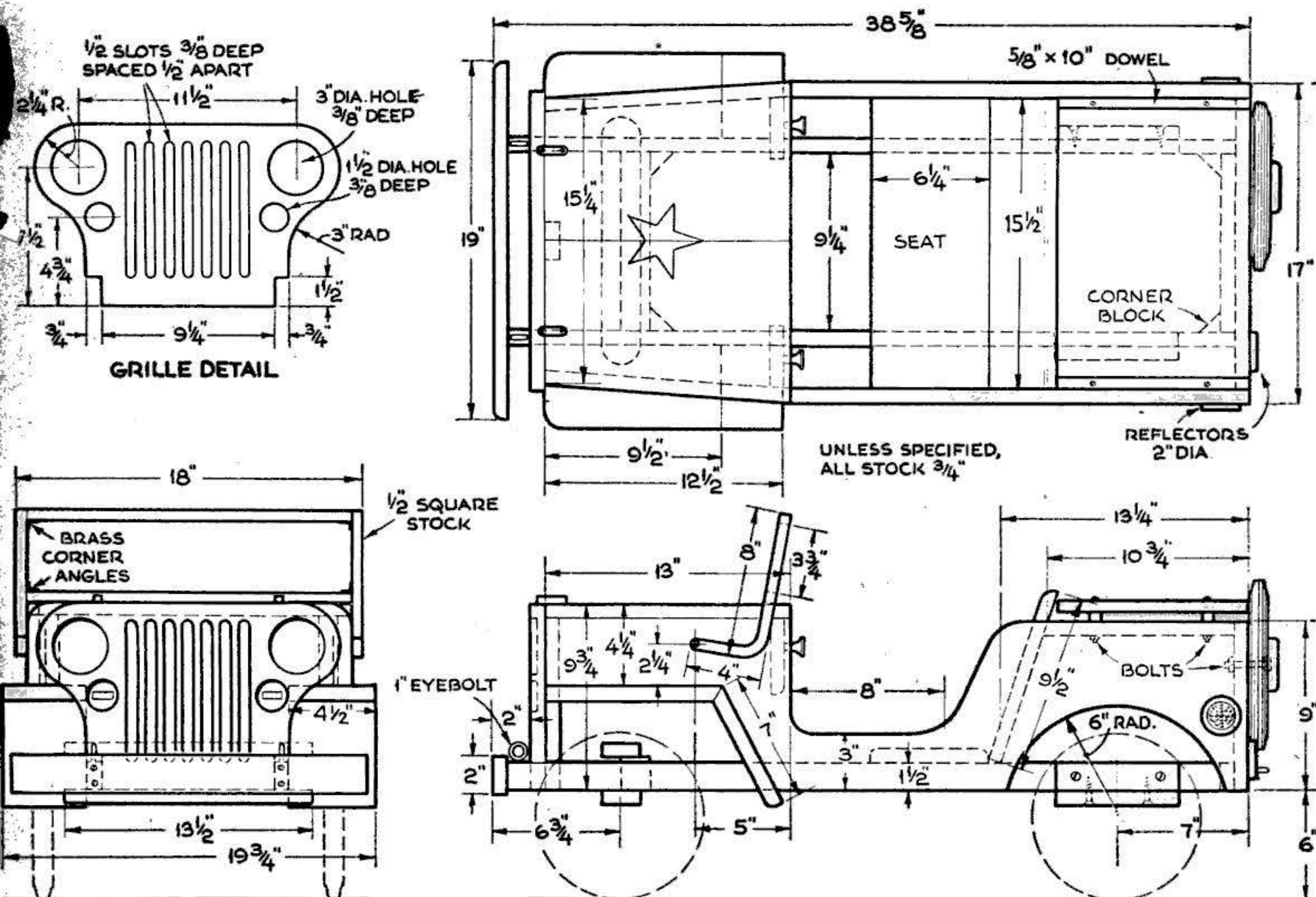
After assembly, round off the joints and the upper edges of the hood.

Cut from $\frac{1}{2}$ " plywood to the shape shown in the side elevation, the sides of the windshield frame are bolted to the hood so that the frame pivots forward, with the top edge coming to rest on two rubber toilet-seat bumpers near the front of the hood.

After bending the rear axle, thread $1\frac{1}{2}$ " of each end with a $\frac{3}{8}$ "-20 die. Pillow blocks support the axle on the frame and attach it to the wooden pedal rods.

Note in detail A that kingpins are turned in one piece with a circular head $\frac{3}{4}$ " in diameter. A $\frac{3}{8}$ " hole is drilled in this head for the axle. Experiment with several springs under the kingpins until you find a set that gives a soft knee action, yet supports the jeep and child. The axle consists of four pieces of $\frac{3}{8}$ " rod—the two L-shaped end pieces bent from 8" lengths, and a two-part tie rod with a threaded connection (shown in detail C) for adjustment. The L-shaped pieces are each threaded for $1\frac{1}{2}$ " on one end while the other is filed flat to fit in a slot (detail B) in the tie rod.

Detail D shows how the tie rod is connected with the steering arm by cutting a slot 1" deep down the middle of a $\frac{3}{4}$ " rod 2" long. The steering arm, filed flat, fits



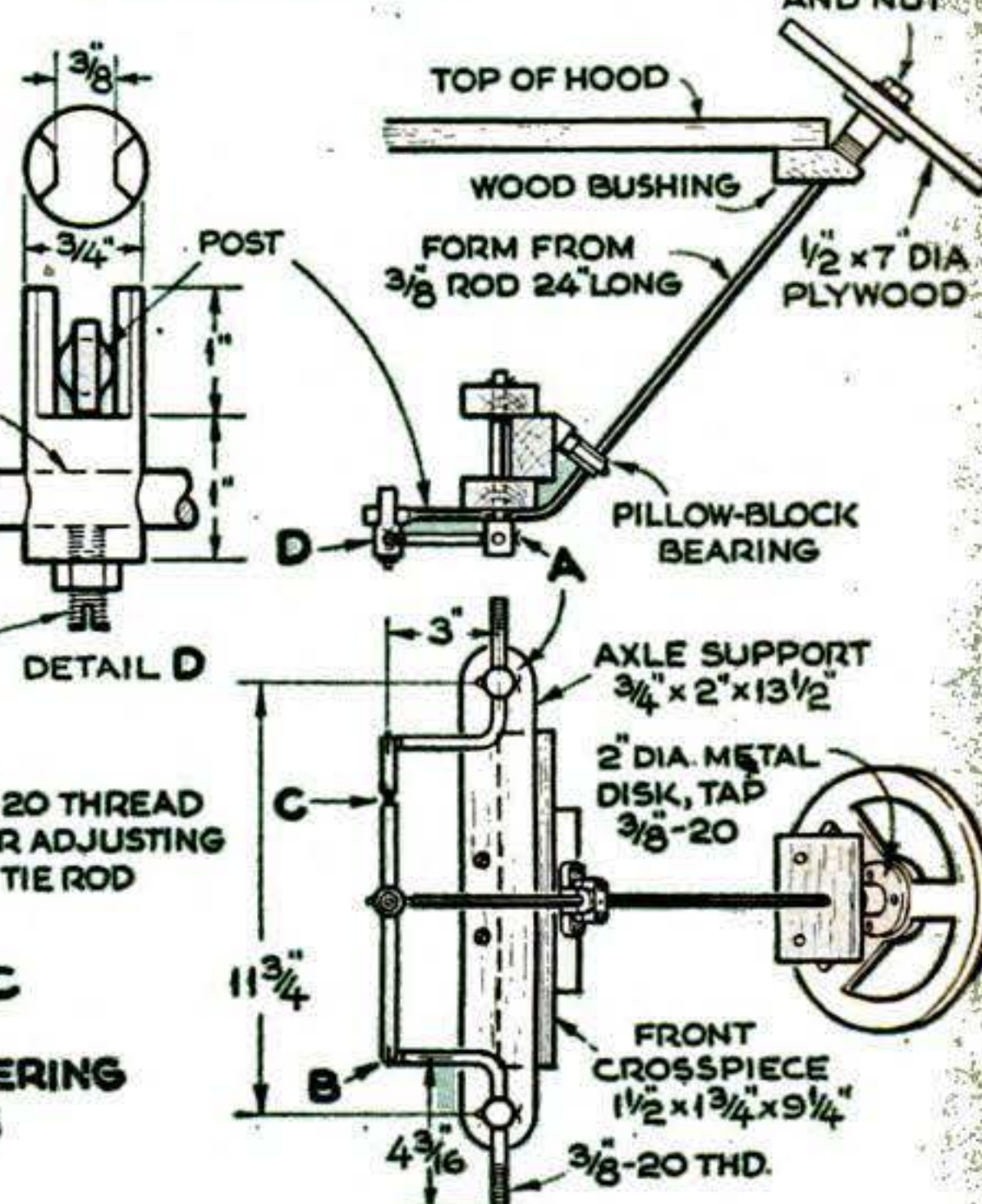
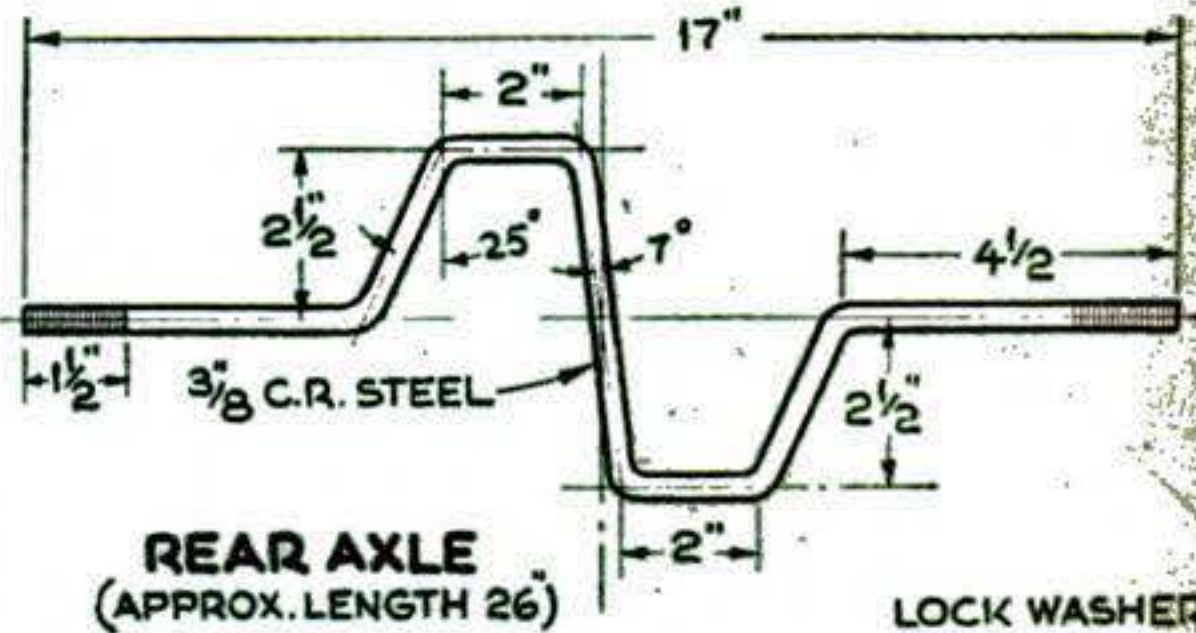
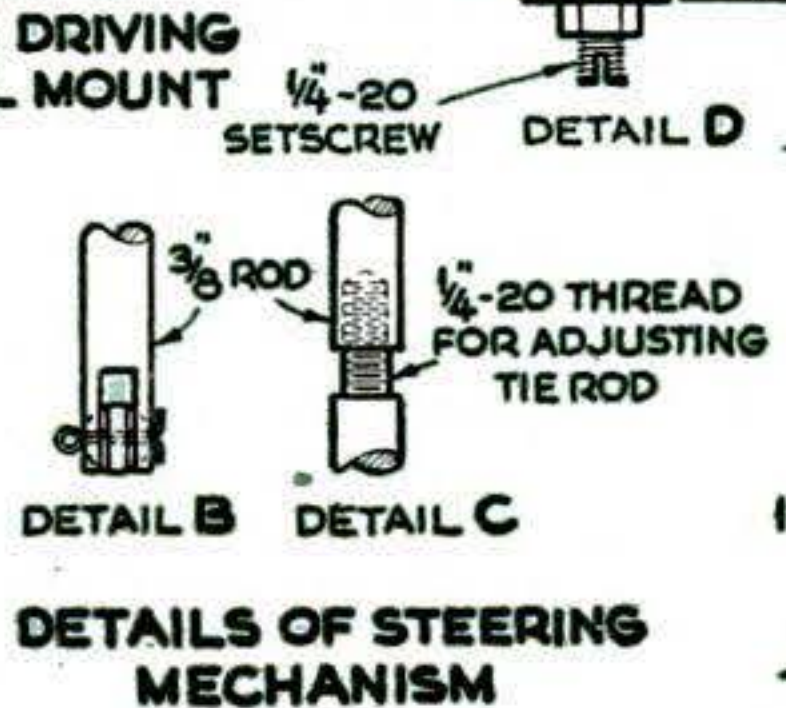
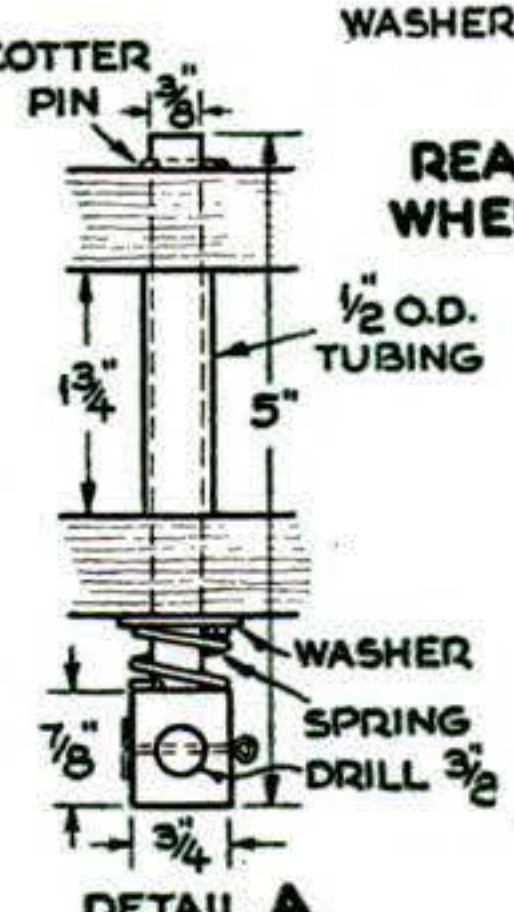
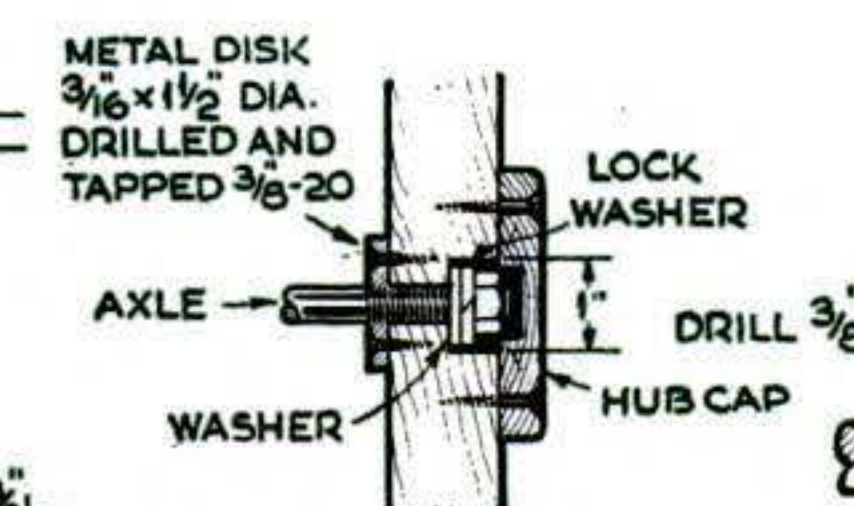
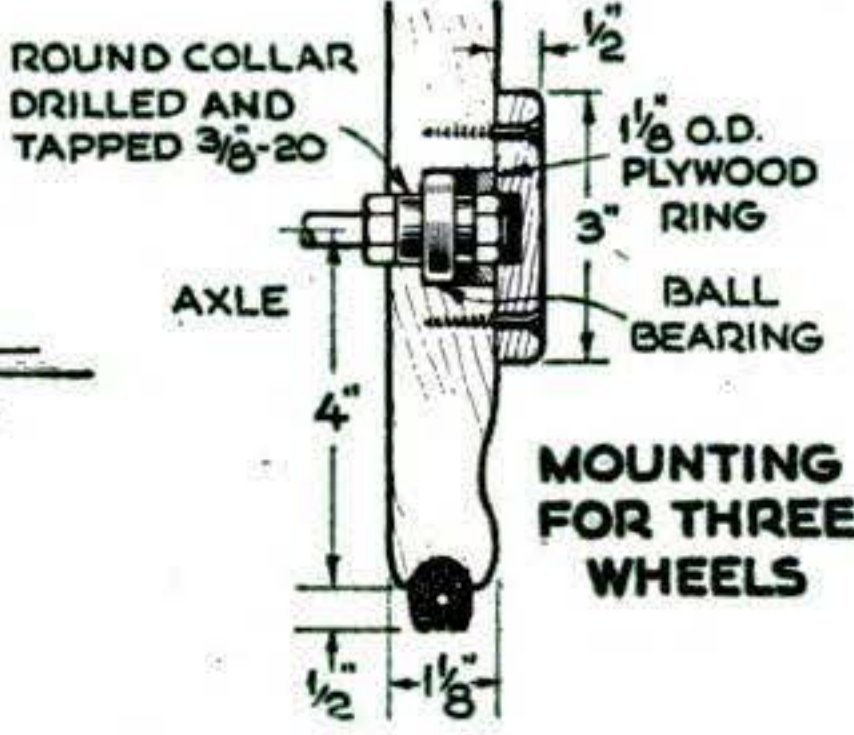
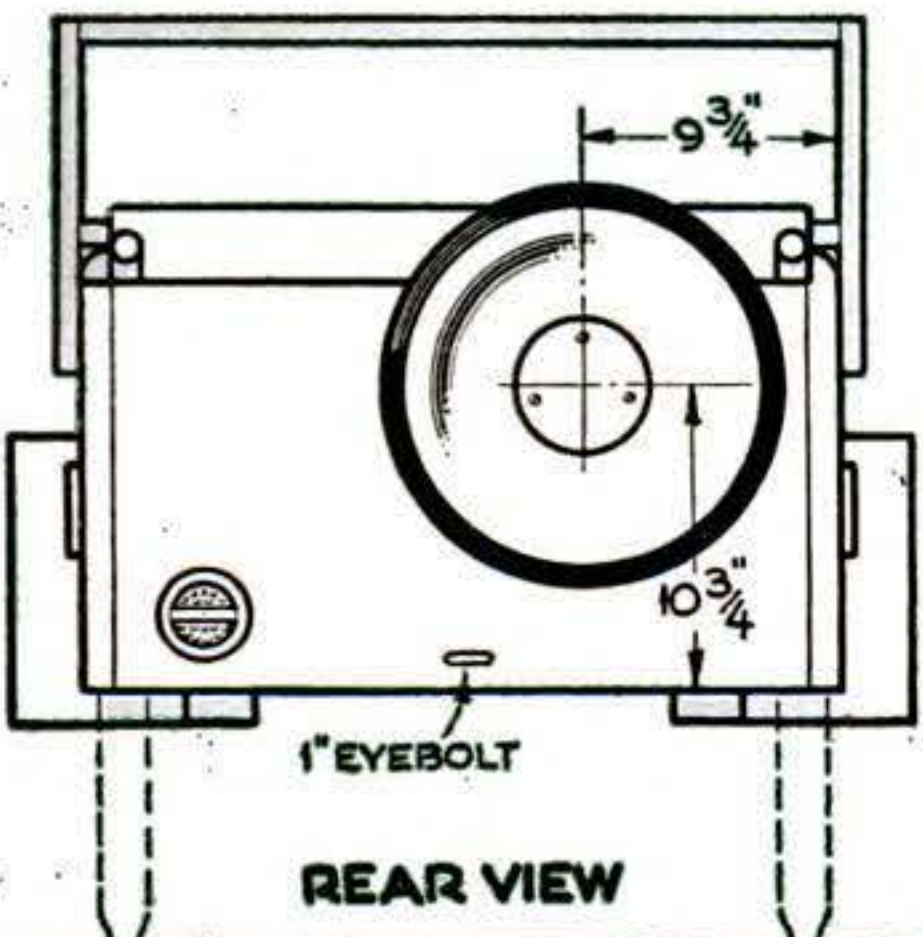
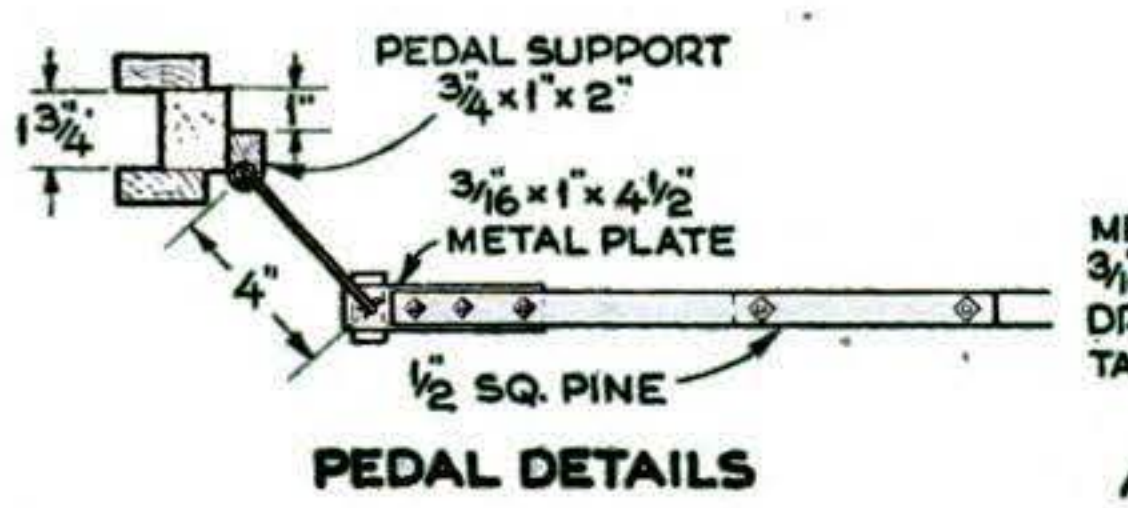
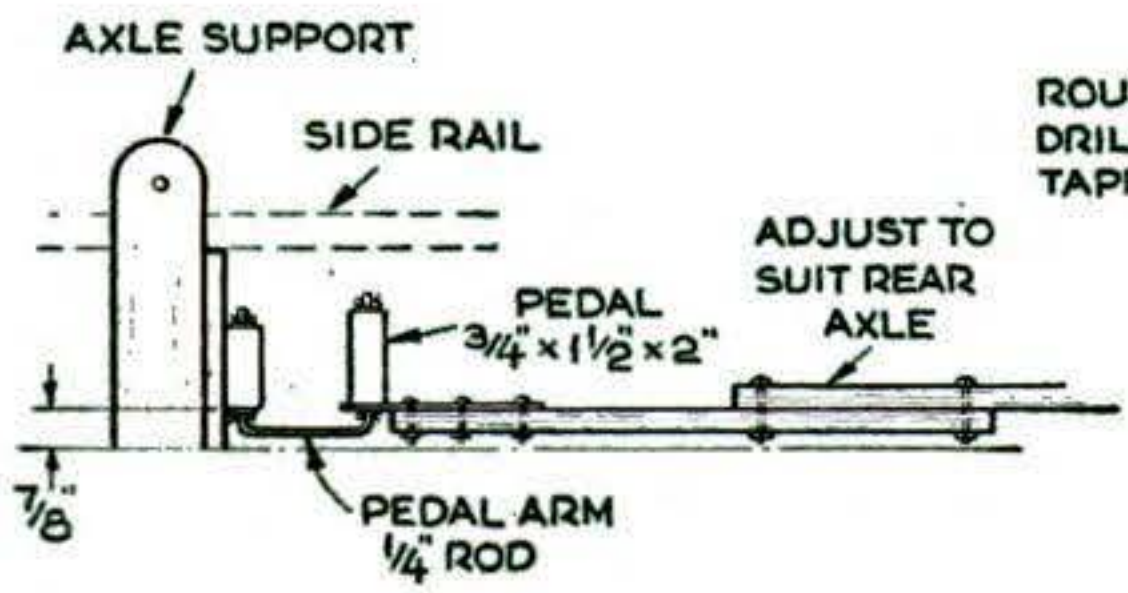
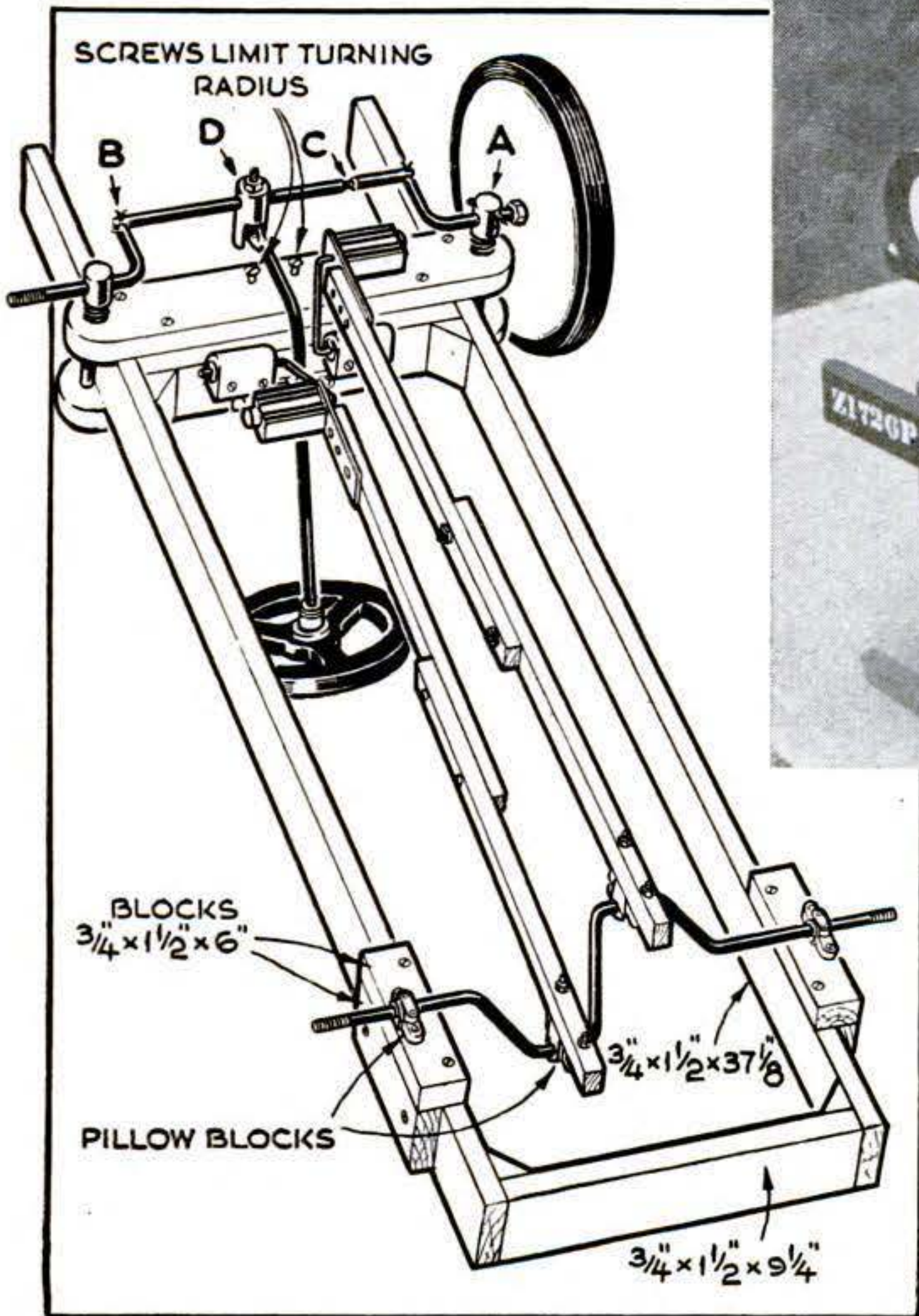
MAKE IT NOW FOR
Christmas



How Herbert R. Pfister built the pedal jeep above is shown in plans on this and the preceding page.

loosely in the slot. The 7" steering wheel is jigsawed from a piece of 1/2" plywood.

After turning the five wheels, fit them with regular toy-wheel or garden-hose tires. For the latter, grooves 3/4" deep should be cut in the edge of each wheel. Bend the hose around this and cut it off so the ends meet snugly. Then form a 4" piece of metal rod to the radius of the wheel and drill nail





Designed by H. A. Machlan, this jeep boasts a metal body and adequate room for little sister in back.

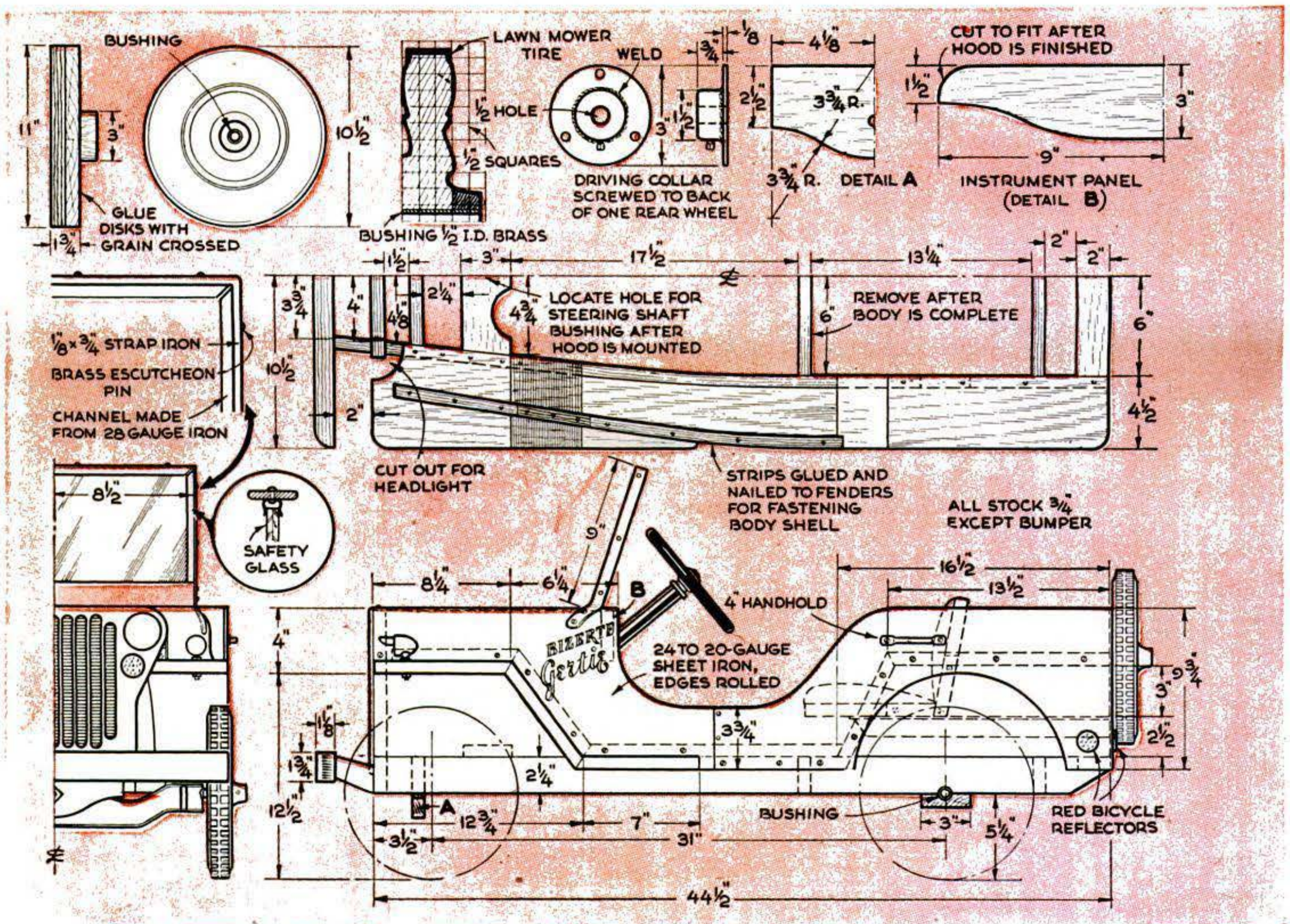
holes in each end. The ends of the hose are shoved over this rod and the whole nailed into place.

Three of the wheels are equipped with ball bearings. Experiment on scrap wood

with an expansion bit until you have it adjusted to bore a hole just large enough so that the bearing is a press fit. With the bit so adjusted, drill a hole in the center of the wheel deep enough so that when the bearing is in place it will be about in the center of the thickness of the wheel. Then drill a $\frac{5}{8}$ " hole the rest of the way through. Tap a $\frac{3}{8}$ "-20 thread in a collar that is a press fit inside the bearing. Finally, cut plywood rings of the same outside diameter as the bearing and thick enough to come flush with the face of the wheel when set in on the collar.

Assemble on the axles in this order: a nut screwed all the way up to the end of the thread, the collar turned on tight against the nut, the wheel with the bearing pressed in place, a lock washer and nut turned up against the collar, the plywood rings against the bearing, and the hub cap, which is screwed into place. A $\frac{1}{2}$ " hole drilled half-way through the hub cap allows the end of the axle plenty of room.

The other two wheels are drilled $\frac{3}{8}$ " and counterbored 1" half through to allow room for a flat washer, a lock washer, and a nut. One is bolted to the back as a spare, and the other is the driving wheel. A $1\frac{1}{2}$ " metal disk at least $\frac{1}{8}$ " thick is used to attach the latter. Drill and tap the disk in the center $\frac{3}{8}$ "-20. Also drill it for three



wood screws. Turn the disk up as far as it will go and solder or braze it to the axle. Then slide on the wheel, screw it to the disk, and put on a washer, lock washer, nut, and the hub cap.

Two wooden blocks with $\frac{1}{4}$ " holes drilled in them are screwed to the front cross brace to support the pedal arms. The latter are formed of $\frac{1}{4}$ " rod bent in the shape of a U, each end being drilled for a cotter pin. Wooden pedals are fitted over the lower ends of the arms, each arm operating in a metal plate bolted to one of the connecting rods.

After attaching the connecting rods to the pedal arms, set one pedal to the back limit of its movement and the other to the forward limit, place the rear axle so the crankshaft throws are parallel to the floor, and screw on each rod the pillow blocks that have been placed on the axle. This should give the proper action.

HARDWOOD, preferably oak, ash, or hickory, is used for the chassis of the "Bizerte Gertie" jeep, and pine for the fenders and body structure. Dimensions for these parts are given on this and the preceding page.

Forming the body shell of sheet iron is not as difficult as it might appear, for all the lines are straight, with no compound curves. By rolling a wire into the edges you

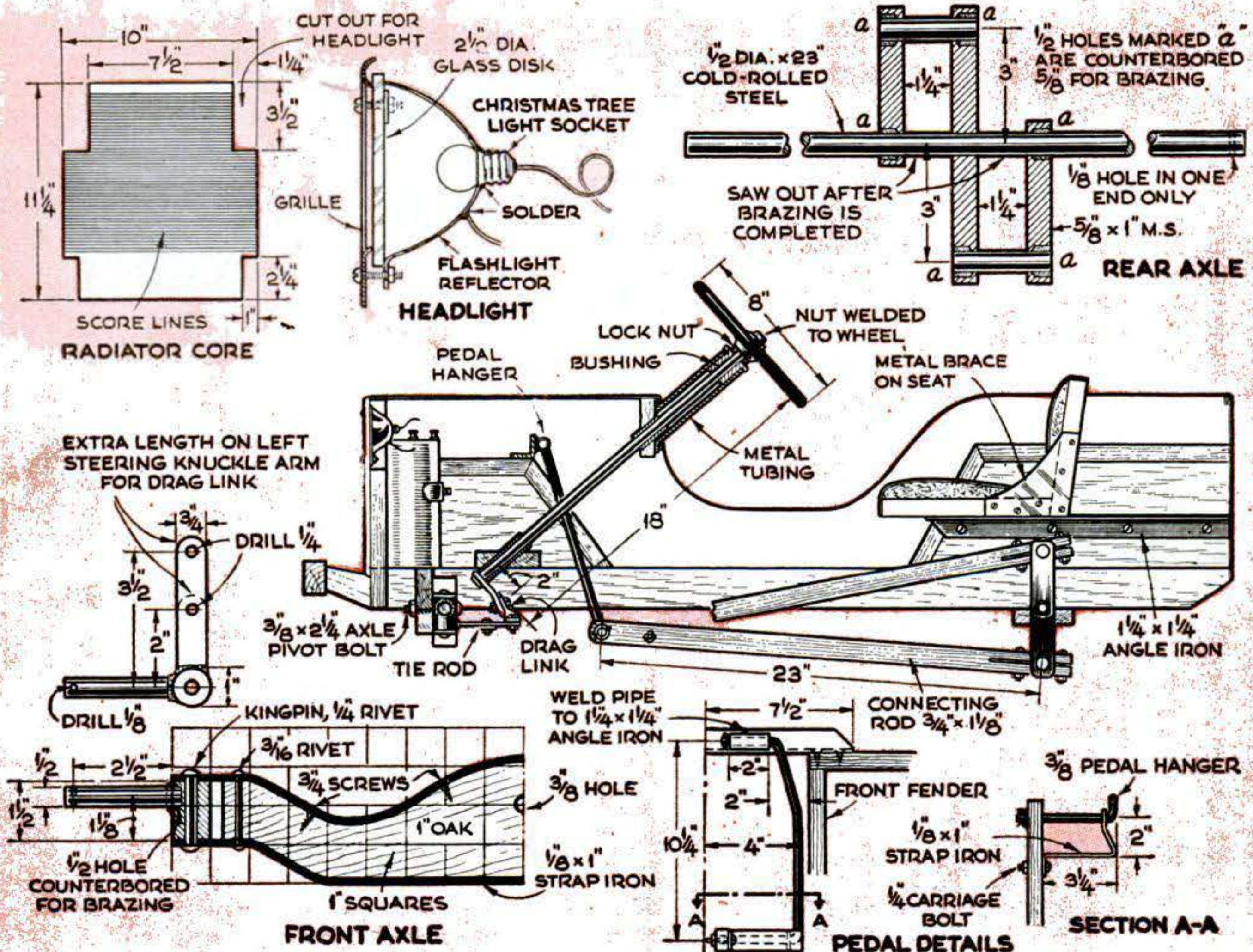
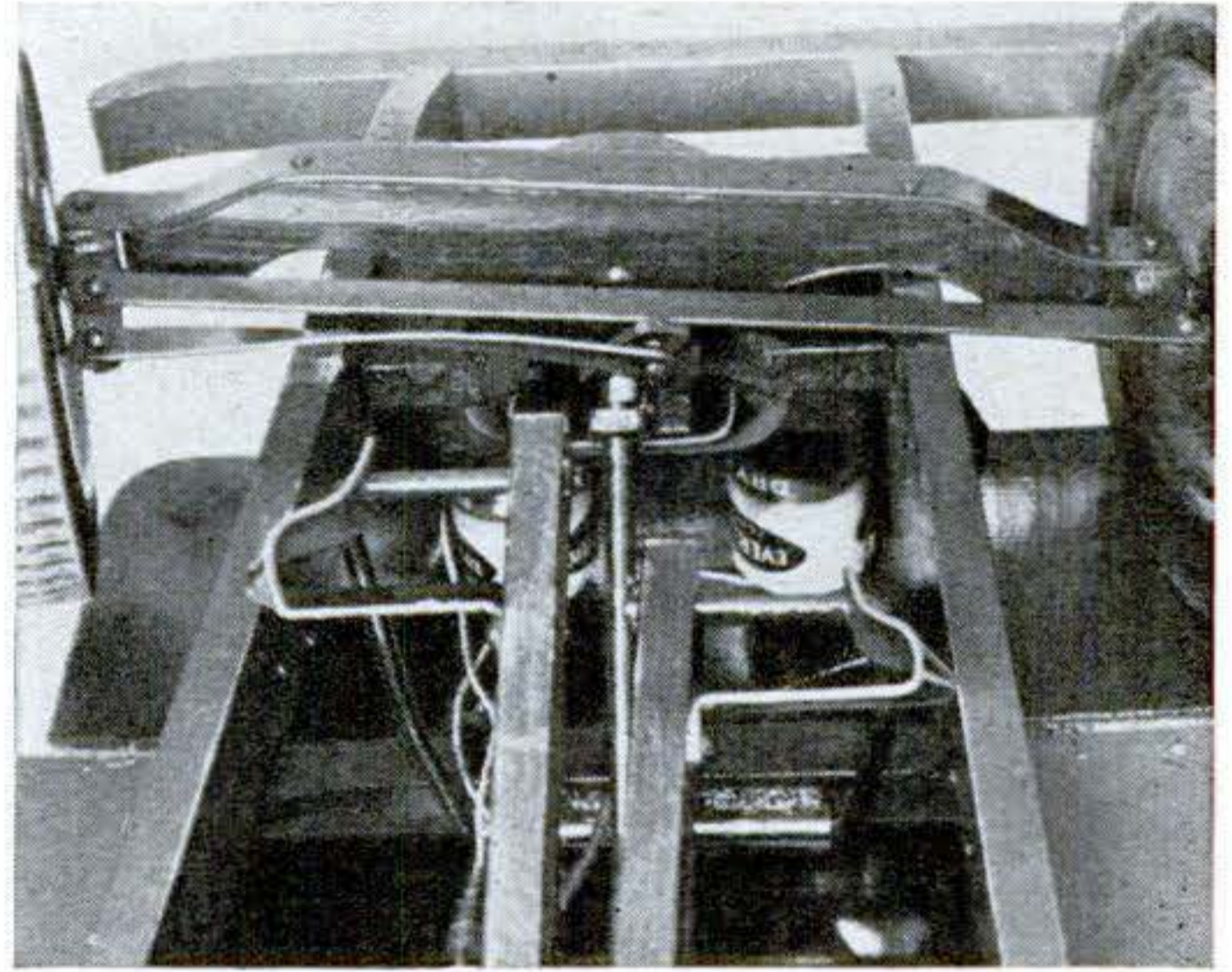
will have a more professional-looking job. Note that although only half of the hood pattern is given on page 166, the entire hood is to be cut in one piece.

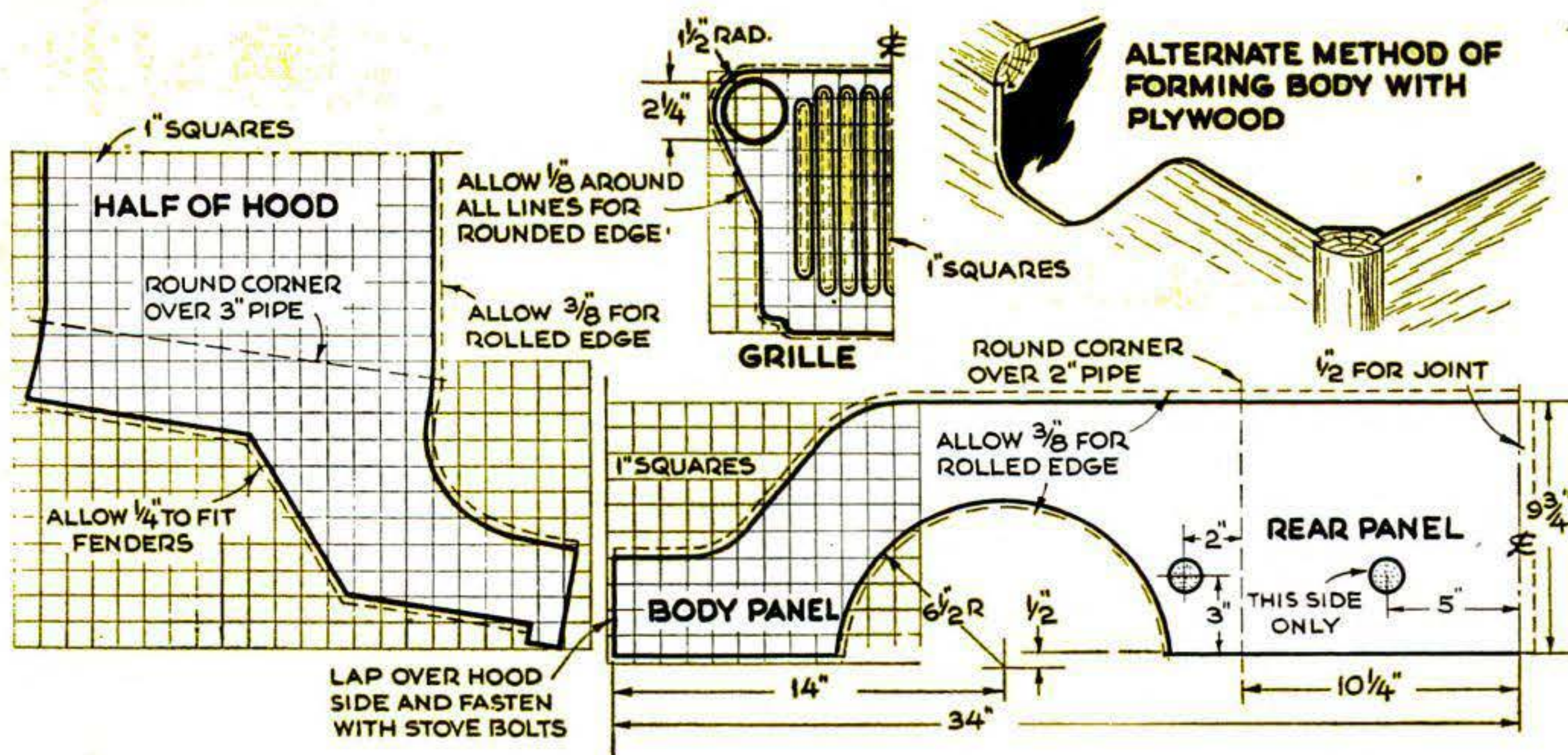
The windshield frame is a single piece of $\frac{1}{8}$ " by $\frac{3}{4}$ " strap iron. Safety glass is fitted into a groove in the narrow strip of wood across the bottom of the windshield.

Turned from three layers of hardwood, the finished wheels are $10\frac{1}{2}$ " in diameter with tires attached. Ap-



Here is the steering assembly of the metal jeep. Note the slight twist in the drag link so it can join the steering-column arm to the knuckle.



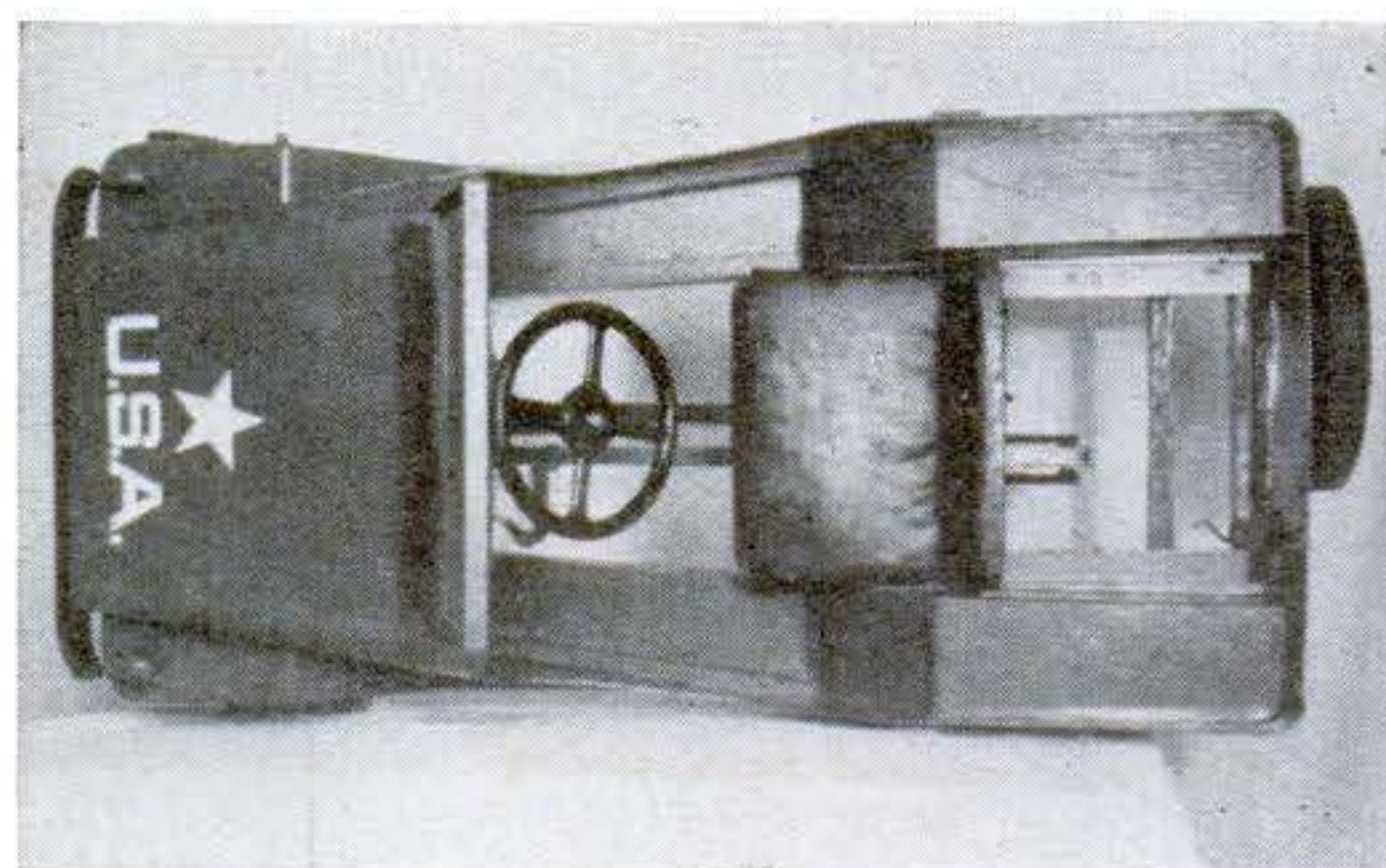


ply a coat of shellac to all five wheels. In three of them, fit bushings of $\frac{1}{2}$ " i.d. brass tubing. Two of these are to be used in the front and the other in the rear. Drill $\frac{1}{2}$ " holes in the remaining two wheels, and to one of these attach a $\frac{1}{2}$ " collar, welded to a 3" metal disk, for locking the driving wheel to the axle. Cotter pins hold on the other wheels. Bushings or bearings with a $\frac{1}{2}$ " i.d. are attached to the frame, as indicated in the side elevation, to support the rear axle. Form this axle from cold-rolled steel brazed together as shown.

Possibly the most troublesome parts of the entire jeep may be the front axle assembly and steering gear, but these should give no difficulty if the plan is followed carefully. Note that the spindles are made as a pair, one right and one left, with extra length on the left steering knuckle arm for the drag link.

For the upright body of the spindle assembly a $1\frac{1}{2}$ " length of 1" shafting was used, but 1" square stock would be easier to handle. A $\frac{1}{2}$ " hole for the spindle is bored transversely most of the way through, and is then counterbored for part of its depth to give brazing space. Saw a slot in the body to receive the steering-knuckle arm, made from $\frac{1}{8}$ " by $\frac{3}{4}$ " strap iron. After brazing in the spindle and arm, drill the $\frac{1}{4}$ " longitudinal hole for the kingpin.

Locate the holes in the tie rod by aligning the spindles after this part of the assembly is completed and measuring the distance between the holes in the steering-knuckle arms. At the same time measure the distance from the hole in the outer end of the extended arm to the center line of the axle. Use this measurement to lay out the drag link. A slight twist in the drag link is necessary so that it can be connected to the steering arm at the bottom of the shaft.



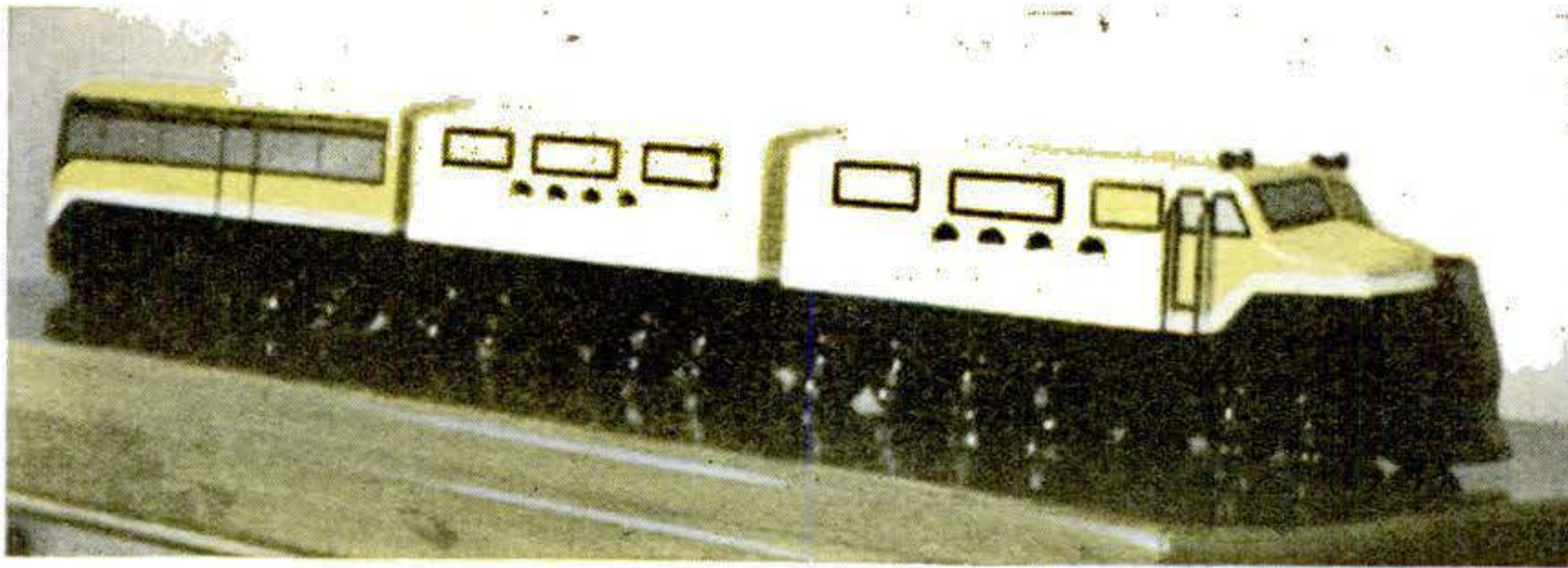
Two angle irons serve as rails on which the seat can be adjusted back and forth to suit the child.

Metal bushings are placed diagonally in the dashboard and the second cross member of the frame as bearings for the $\frac{1}{2}$ " steel steering shaft. The steering arm, made of $\frac{1}{4}$ " steel, is riveted or welded to the lower end of the shaft, and a $\frac{1}{4}$ " hole drilled in it for the drag link. An 8" valve wheel, obtained from a junk yard, served as a steering wheel in the jeep shown.

Connecting rods are cut from oak or ash and have no bushings. If lubricated occasionally, they will wear very little. Bore the hole for the rear bearing before sawing the slot that is provided for adjustments. Pedal hangers are bent as indicated from $\frac{3}{8}$ " mild steel rod, the upper ends being supported in a $\frac{3}{8}$ " i.d. pipe welded to a piece of angle iron placed across the fenders.

Headlights are made and installed as shown, and are operated by a switch on the instrument panel. Small cleats screwed to the bottom keep the seat at any desired location on the angle-iron rails. Upholster the two seat pieces before assembling.

Both jeeps need a good coat of olive-drab paint. The white star on the hood will do a lot to make them more realistic.



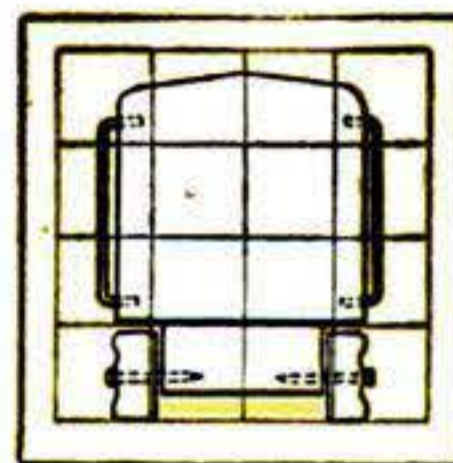
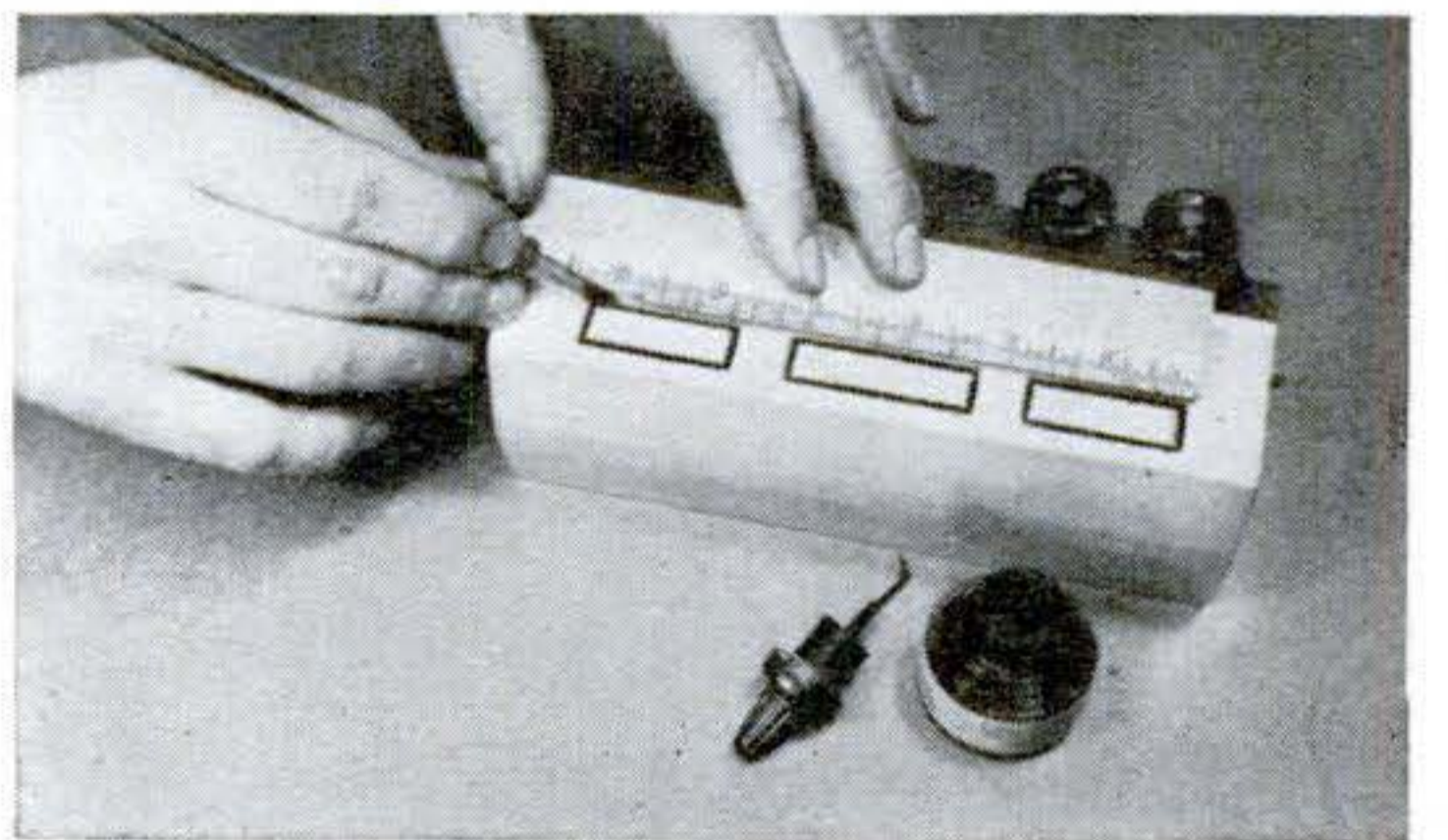
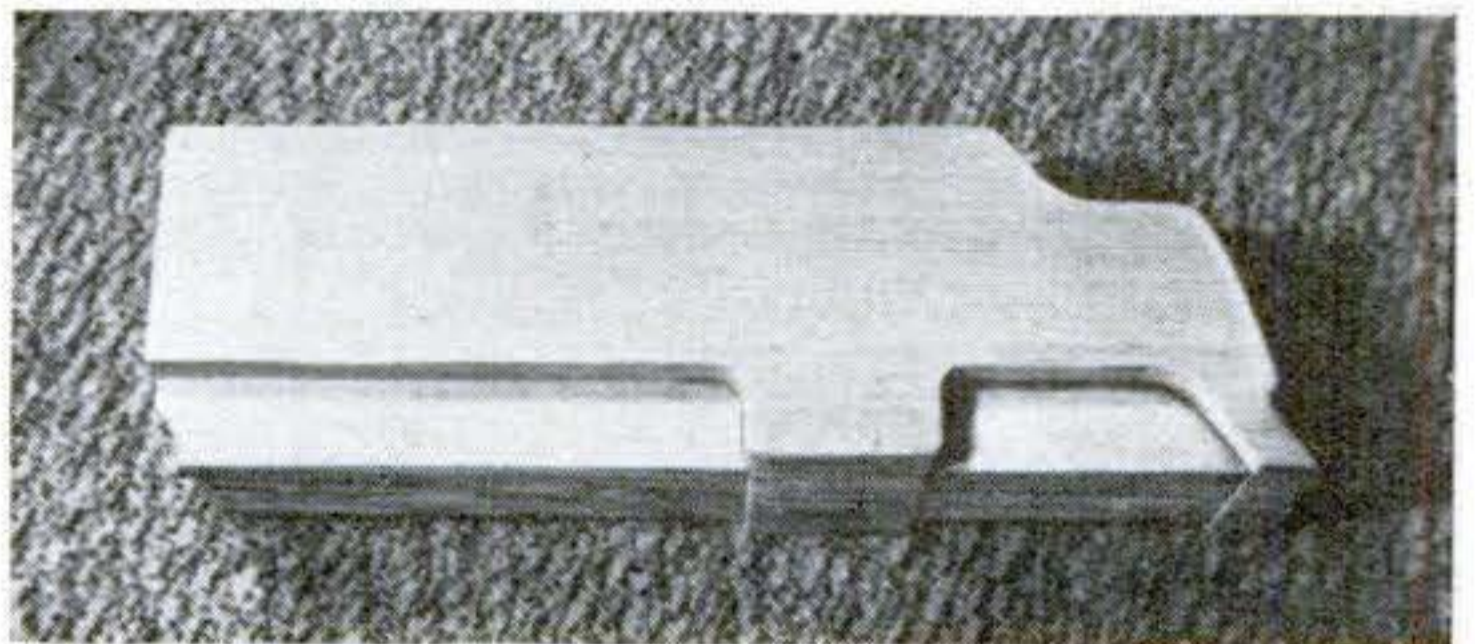
TOY STREAMLINER

A One-Evening Project

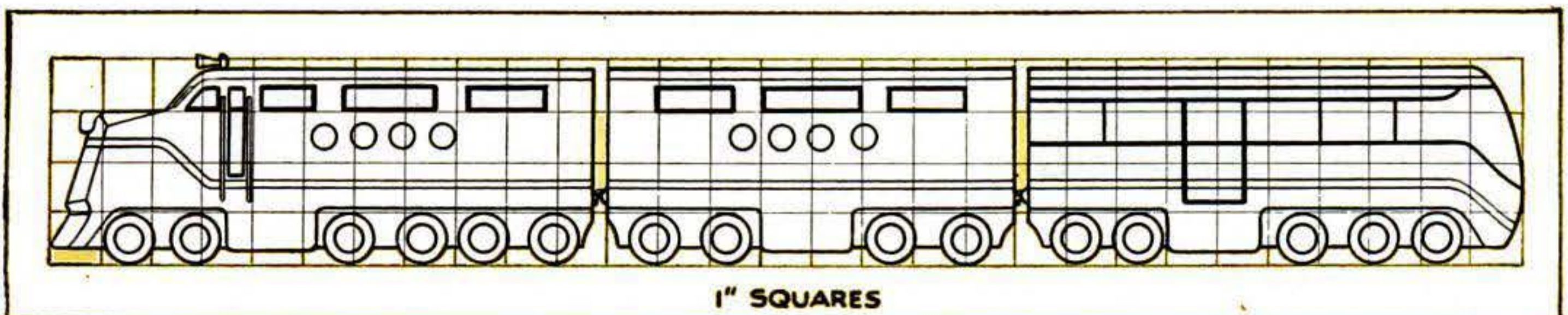
WITH youngsters in the family, you'll certainly want to give this streamliner a high priority on your Christmas schedule, so that it can roll in "on time" bright and early Christmas morning. All three units, including the 30 wheels, were actually completed in two hours with the use of machine tools, and the painting was finished the second evening.

The whole train may be laid out on a 30" length of $2\frac{3}{4}$ " by $3\frac{1}{2}$ " pine or redwood, the top beveled on the table saw, and the profile bandsawed to cut off the undercarriage. A 1" strip is then ripped from these undercarriage blocks, and they are replaced under the locomotive and cars with glue and finishing nails to leave a $\frac{1}{2}$ " recess on each side. The hood, windshield, sloping front, and guard of the locomotive are beveled by tilting the bandsaw or jigsaw table 10 deg. and cutting around a line drawn $\frac{1}{4}$ " from the edges. Portholes are made with a $\frac{1}{2}$ " drill stopped when the full diameter just enters the wood.

Wheels are $\frac{1}{2}$ " thicknesses sawed from 1" dowel or curtain rod. They may be faced in the lathe, if desired. Holes in the central wheels of each car somewhat larger than those in the end pairs provide "knee action" on bumps. The horns are turned or whittled and attached with finishing nails through drilled holes. Couplings are screw hooks and eyes. Rubber-covered tacks on the front of each car serve as bumpers. The handrails on the locomotive doors are of coat-hanger wire.—LECIL J. SLABACK.



India ink, a $\frac{1}{8}$ " drawing pen, and a ruler are used above to form window outlines. Glass is simulated by a single coating of thin silver paint. Overall colors are dark green, bright yellow, and white trim stripe.



1" SQUARES

JUNIOR DESK-CHAIR

HAS FOLDING LEAF

ANY youngster of early school age will welcome this desk-and-chair combination. The drop leaf on the arm serves as a desk when it is pulled up and is fine for coloring or writing letters to grandmother. Two drawers of different depth hold crayons, pencils, coloring books, and tablets.

Use $\frac{3}{4}$ " stock for the legs, arms, leaf, hinged leaf support, seat, drawer guides and pulls, and for the side panel at the rear of the drawers. For the front and back panels, the slat between the back posts, and the drawer members, $\frac{1}{4}$ " stock is heavy enough. Plywood can be used for the drawer bottoms if desired.

Note that the back posts are grooved for a distance of 4" from the top to receive the back slat, which is glued in place after the chair has been assembled. Attach $\frac{3}{4}$ " by $\frac{3}{4}$ " by 12" drawer guides to the inside of the front and back panels before assembly, taking care to lay them out accurately so the drawers will not bind. A single rail under the front of the lower drawer joins the front and back legs.

Dimensions of the drawer backs and bottoms are not given. The bottoms might be

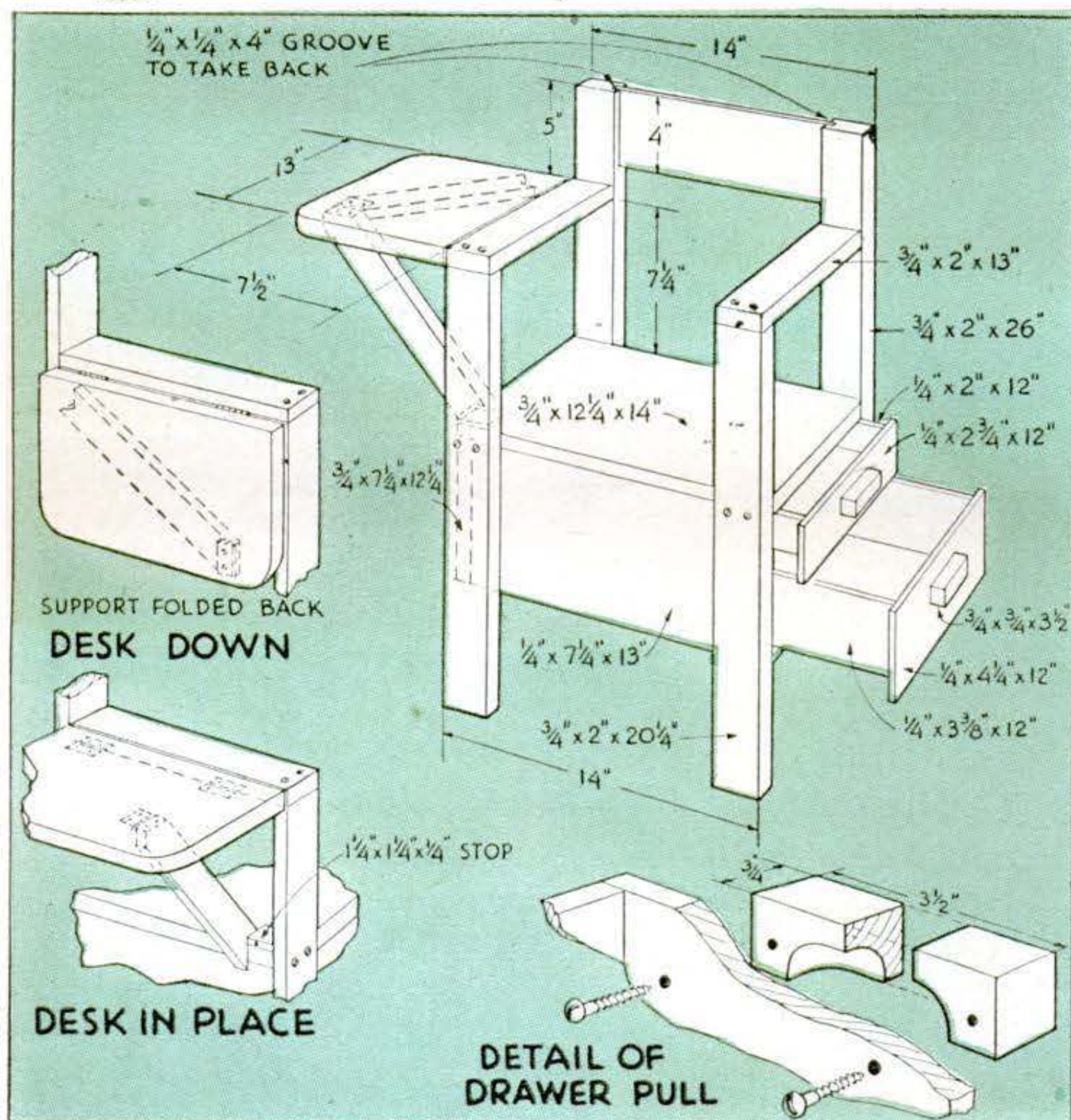


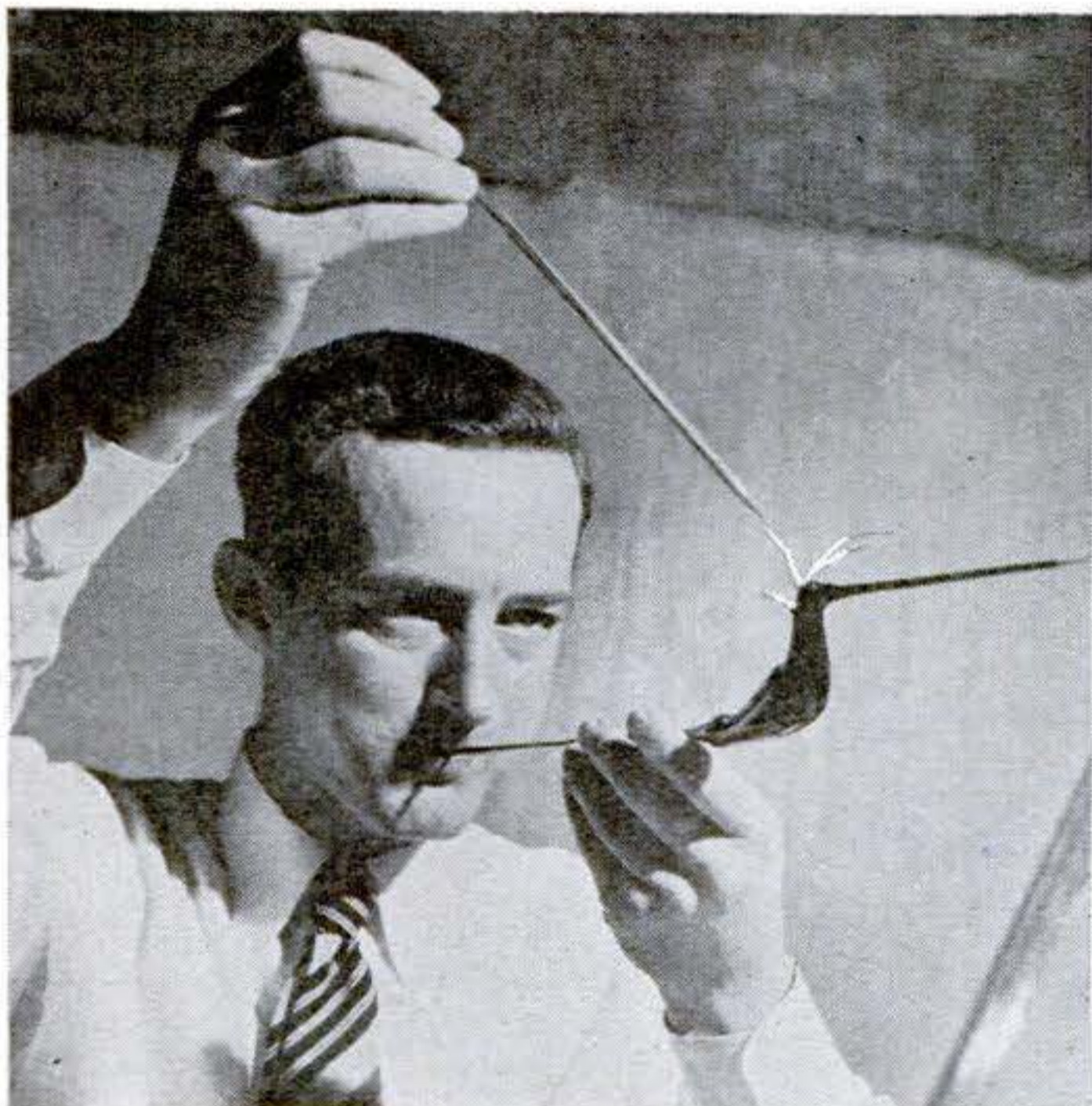
assembled between the sides, and the backs and fronts then butted with glued corner blocks for reinforcement. This isn't standard construction, but it is simple. Make the drawers $\frac{3}{4}$ " shorter than the space allowed for them to insure closing.

In hinging the drop leaf, turn the chair upside down and rest the arms on a flat surface. Then lay the leaf in place and screw on the hinges. The leaf support is notched for the seat and is hinged on the bottom of the leaf. It folds back for dropping the leaf down.

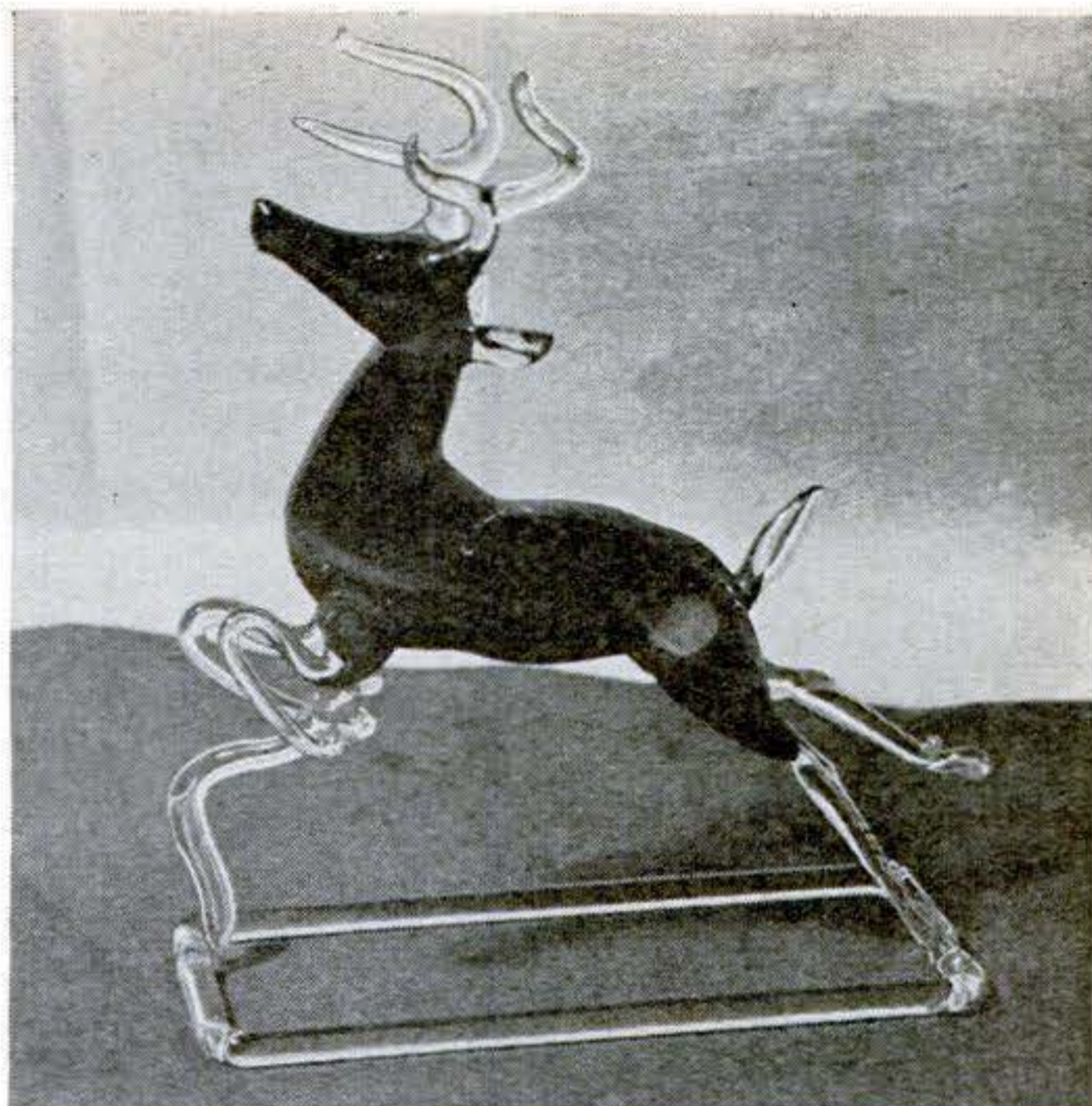
Apply varnish, rubbing well and waxing, for a natural finish. Or, if preferred, the piece can be stained first to match other furniture or finished with lacquer or enamel in colors.—E. W.

With the desk height only 8" above the seat, the chair is suitable for children up to six or seven years. Assembly is chiefly with nails, but screws at several key joints assure sturdy construction.



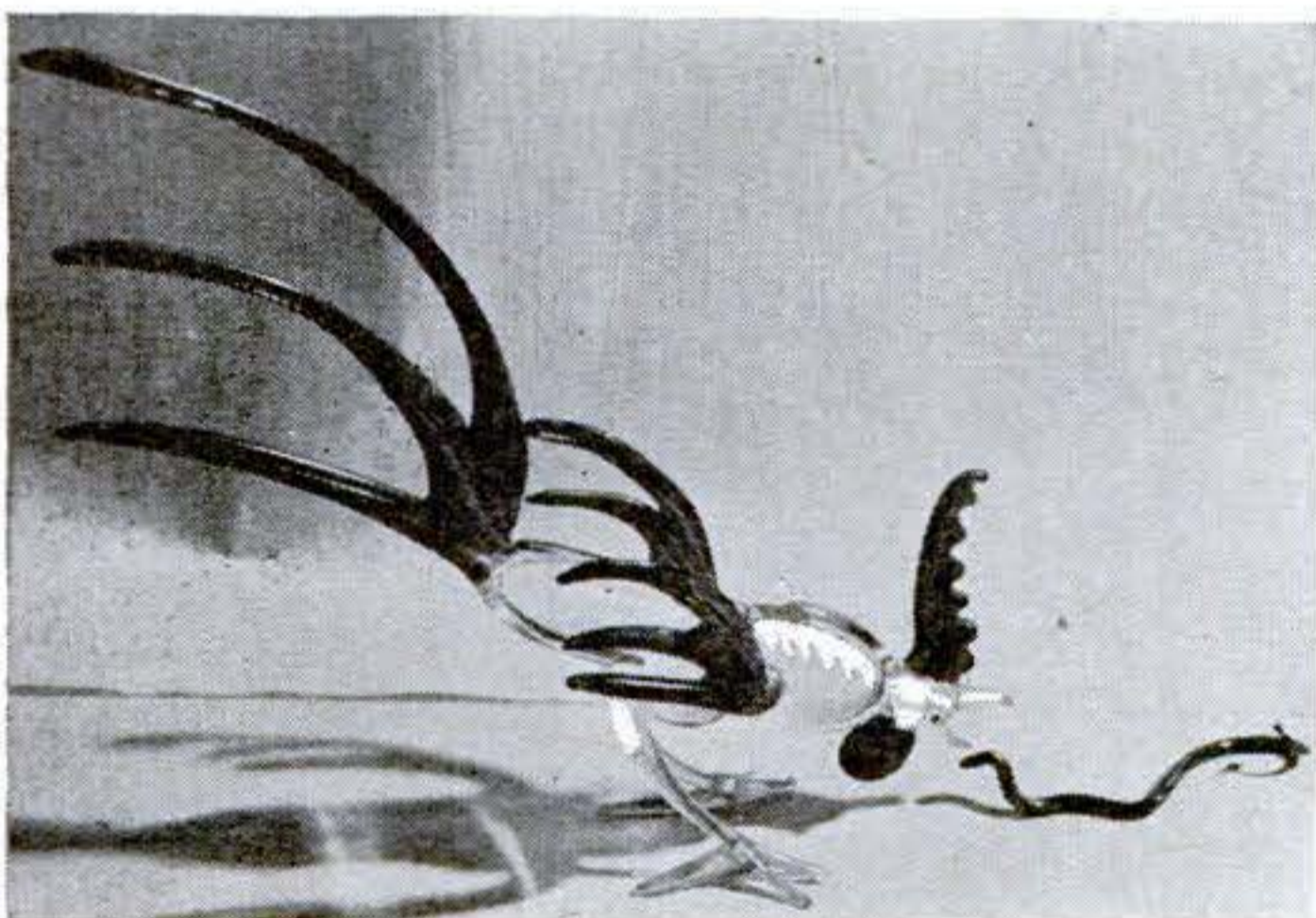


At the American Glass Blowers plant, descendants of Herman Hammesfahr have for four generations carried on the art he brought to this country in 1854. Above, antlers are put on the head of a deer.



And here is the completed deer, one of a number of decorative objects turned out by the Brooklyn glass-blowing family. Besides ornaments, they make glass ties, belts, lamp shades, and hatpins.

Glass with the Breath of Life

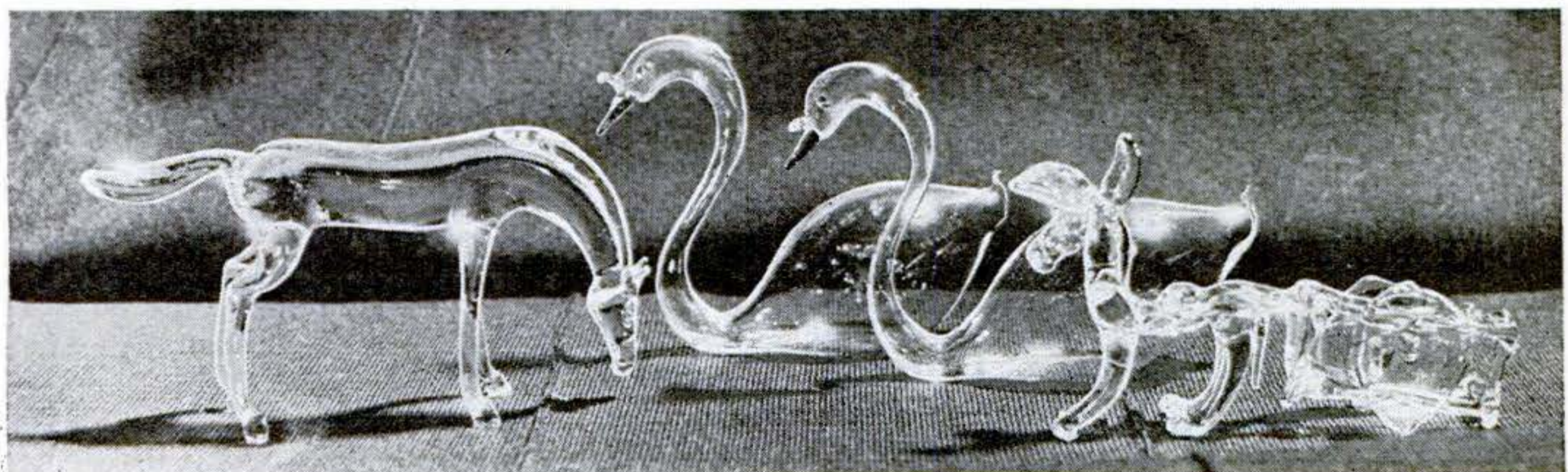


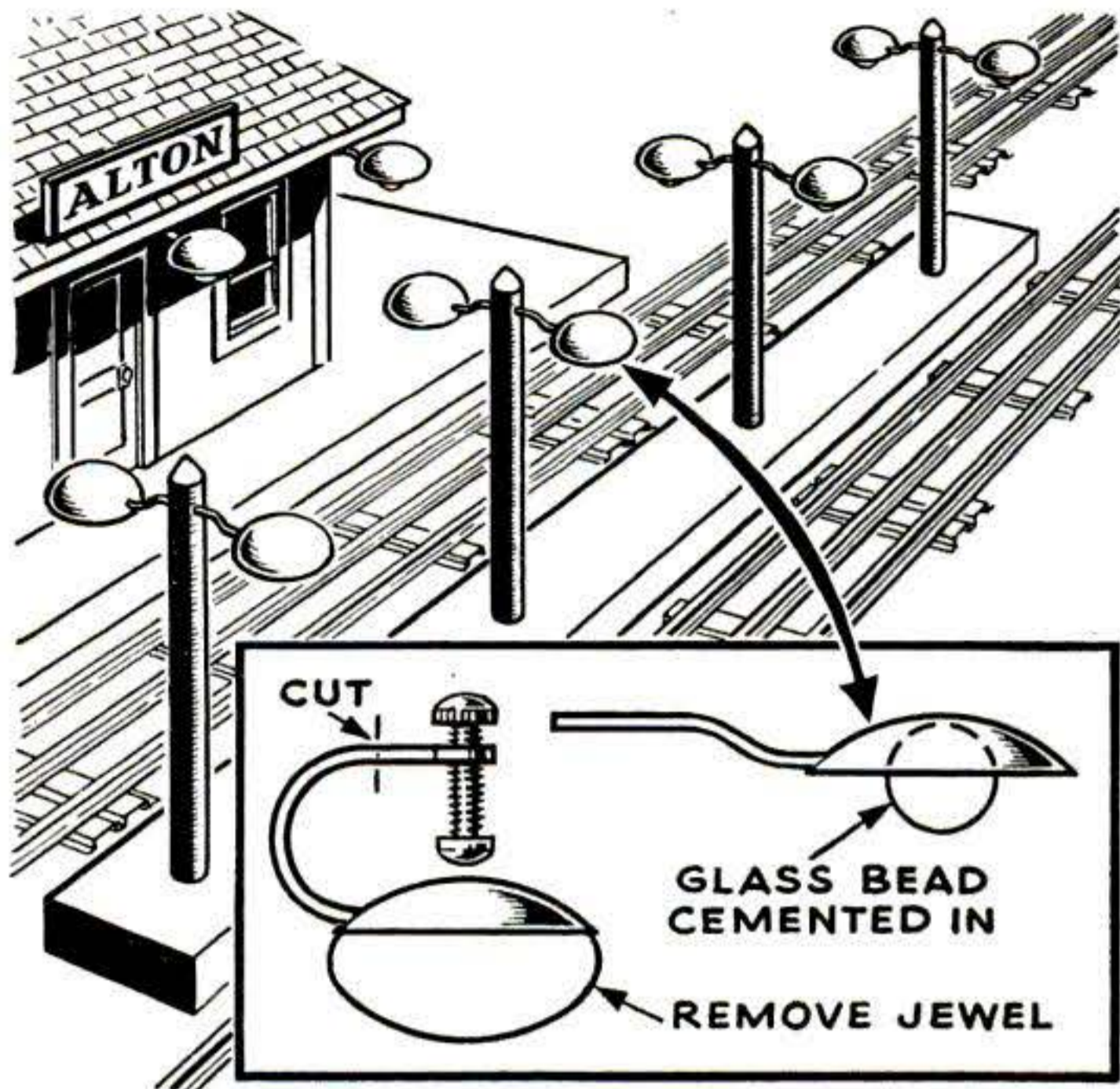
Come to papa. This long-combed and long-tailed rooster of colored and clear glass bends down to breakfast on a glass worm he never gets—just one of many amusing displays created by the Hammesfahrs.



Jam session of the perky penguins, glass fantasy reminiscent of a familiar circus and vaudeville act. The figures are hollow glass, the limbs and instruments solid, and the piano and drum network.

Two graceful blown-glass swans here serenely float past a grazing glass horse and a sly-looking glass donkey tugging at a glass cart. The Hammesfahr talent is also applied to making industrial objects.





SALVAGED EARRINGS TRANSFORMED INTO MODEL RAILROAD LAMPS

EXTRA realism is given your model-railroad layout by adding dummy street, station, and platform lamps made of discarded earrings or ones bought for the purpose.

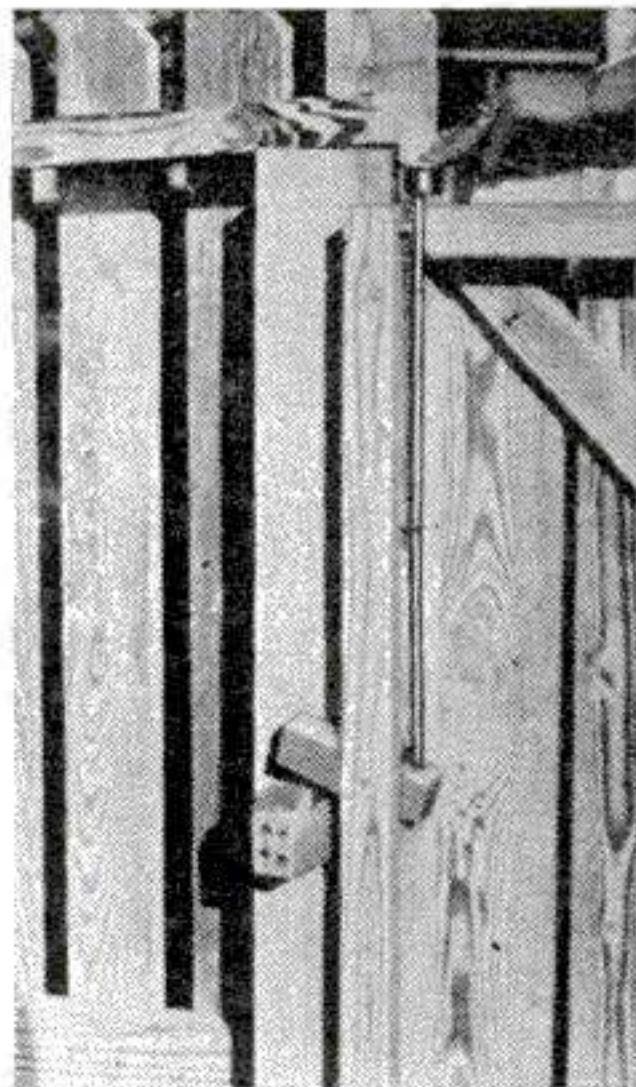
Remove the ornament and cement in its place a glass bead. Then cut off the end of the loop and bend the rest as required. Either push it into an undersized hole drilled where you wish to mount the lamp, or solder a brad to it and drive the brad in at the desired point.—RICHARD SALZER.

PRACTICAL GATE LATCH REQUIRES ONLY WASTE BITS OF STOCK

NEEDING a gate latch and being unable to find one in nearby stores, I made one from odds and ends that has been in use over a year.

A two-by-four is set on edge along the latch side of the fence. In this I cut a square hole in which the latch is pivoted well off center. A 20" length of $\frac{1}{4}$ " dowel sliding in two staples rests on the light end of the latch and has half a spool on top.

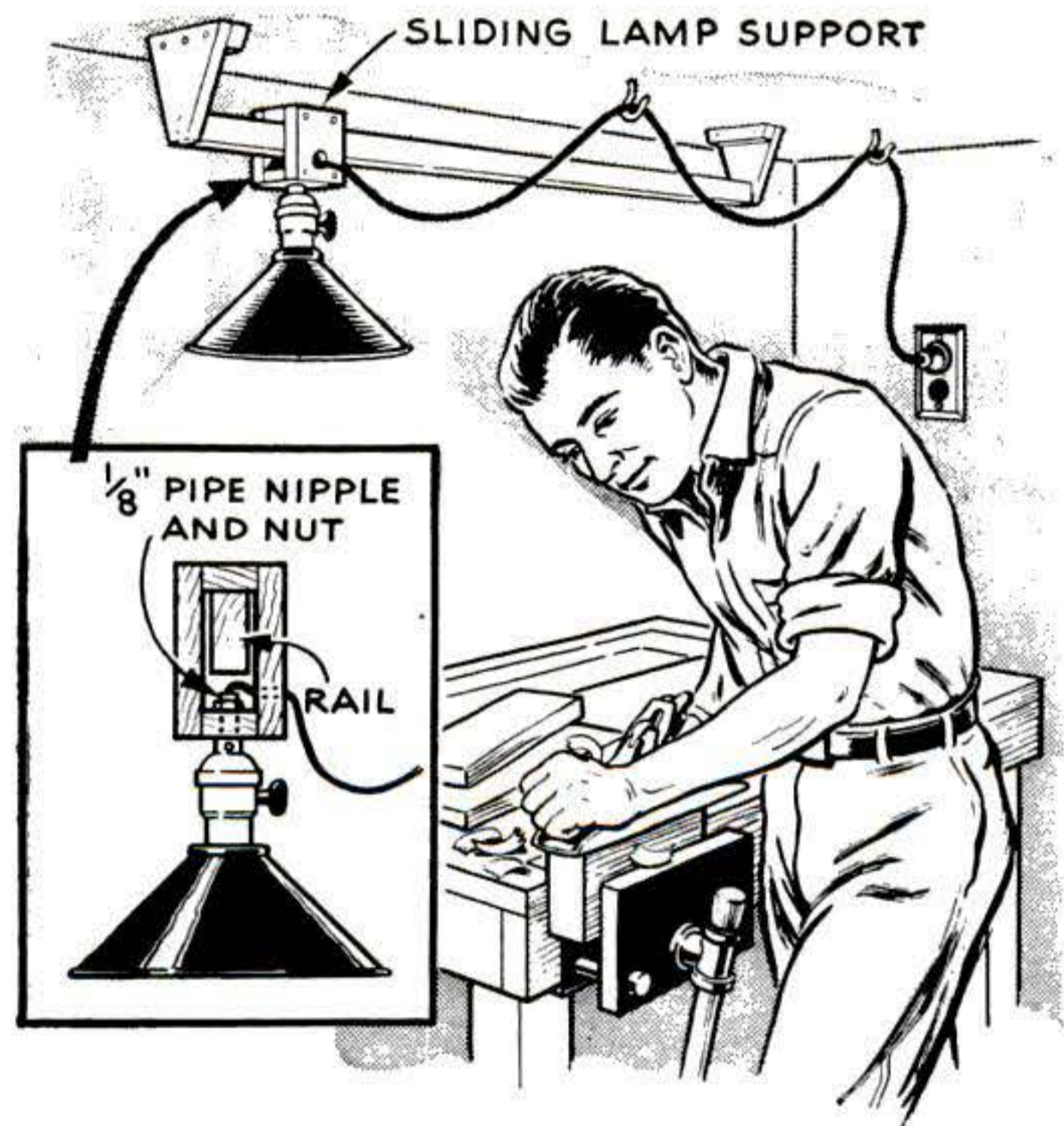
The latch should be drilled to work freely on its pivot nail, and must be overbalanced enough to lift the dowel and spool. Cut the hole in which it pivots small enough to keep its heavy end from falling below the strike when the gate is open.—E. R. S.



ADJUSTABLE WORKBENCH LAMP GIVES SHADOWFREE LIGHTING

YOU can't get in your own light when working at your bench if it's equipped with an overhead fixture like that shown below. Because the lamp can be slid the full length of the workbench, light can always be thrown on the work from the best angle.

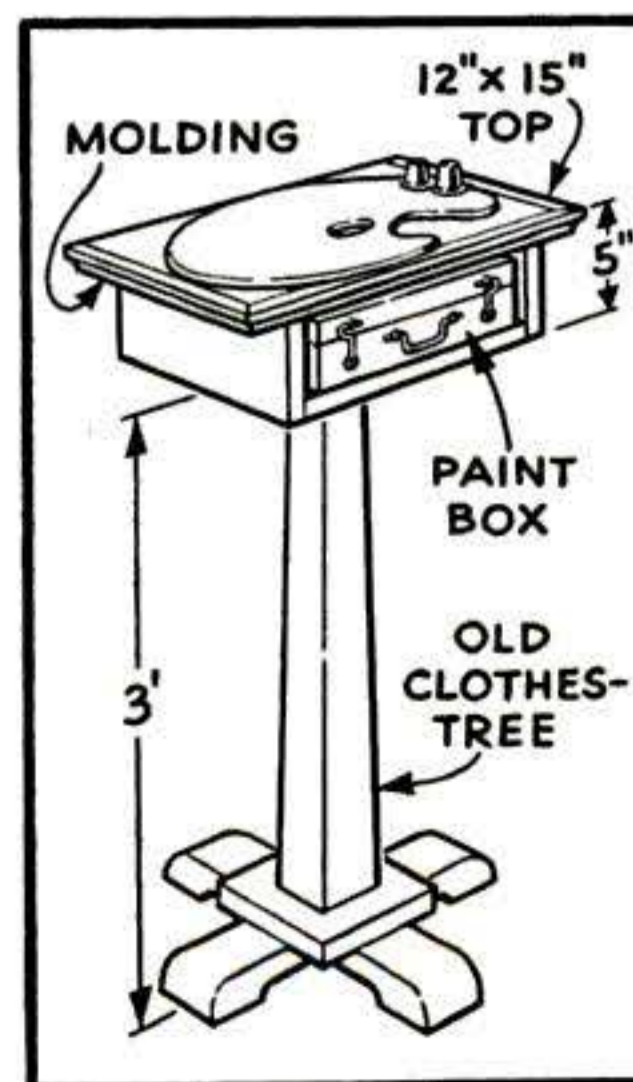
For my own fixture, I used 1" pine throughout. The length of the beam and of the end hangers will depend on your own workbench and the height of the ceiling. Bring the cord out through the front of the sliding support and loop it over cup hooks to keep it out of the way.—T. M. RUOTSALA.



OLD CLOTHES TREE FORMS STANDARD FOR ARTIST'S UTILITY TABLE

A CONVENIENT stand for an artist's paint box and palette was made by cutting a 3' long base section off a discarded clothes tree and building a three-sided case atop it. The size of this case was determined by the dimensions of the paint box, some extra space being allowed for clearance so that the box could readily be taken out and replaced through the open front.

A $\frac{3}{4}$ " decorative molding was mitered around the top of the case to afford a finished and more professional appearance to the job.—J. H. RICH.





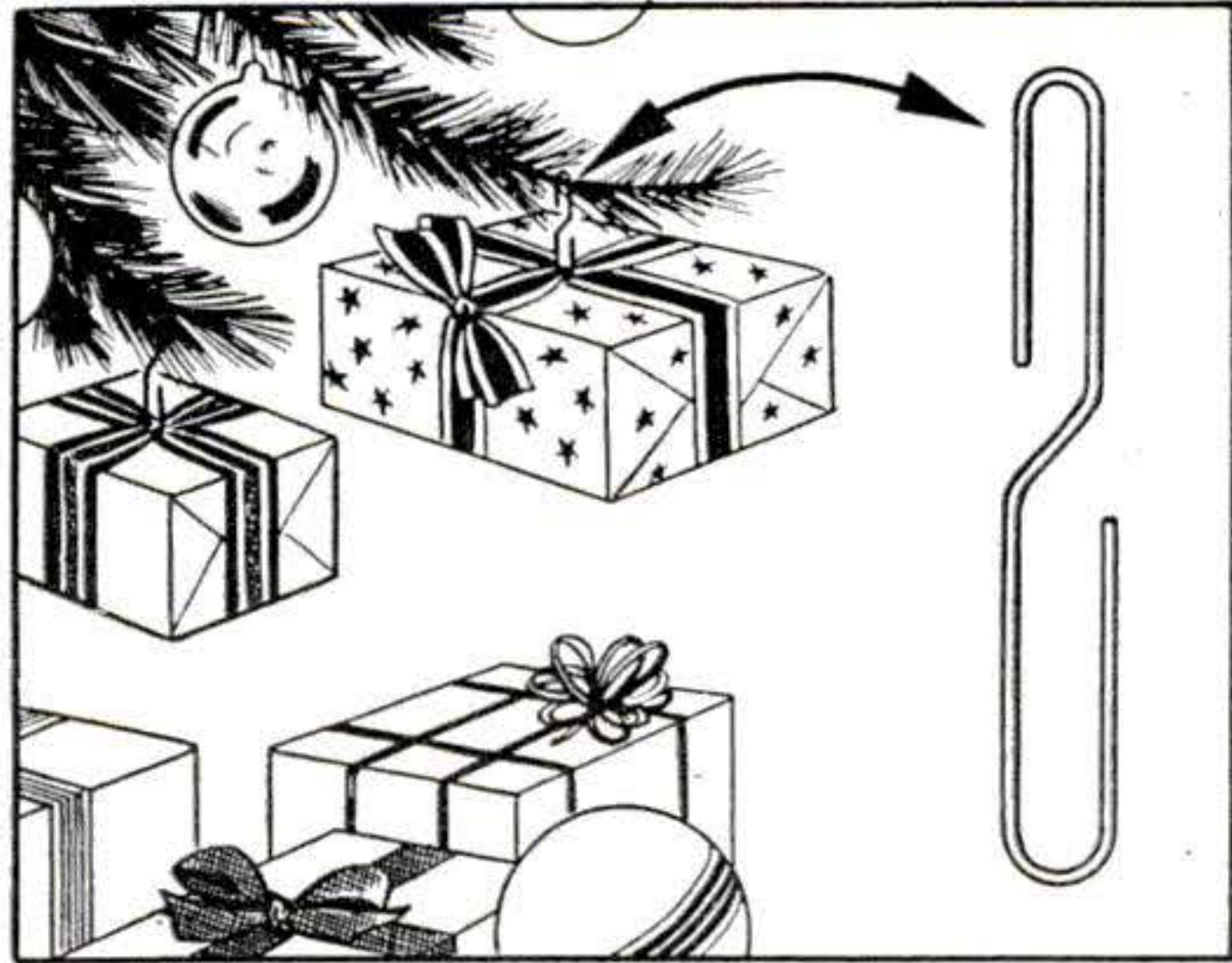
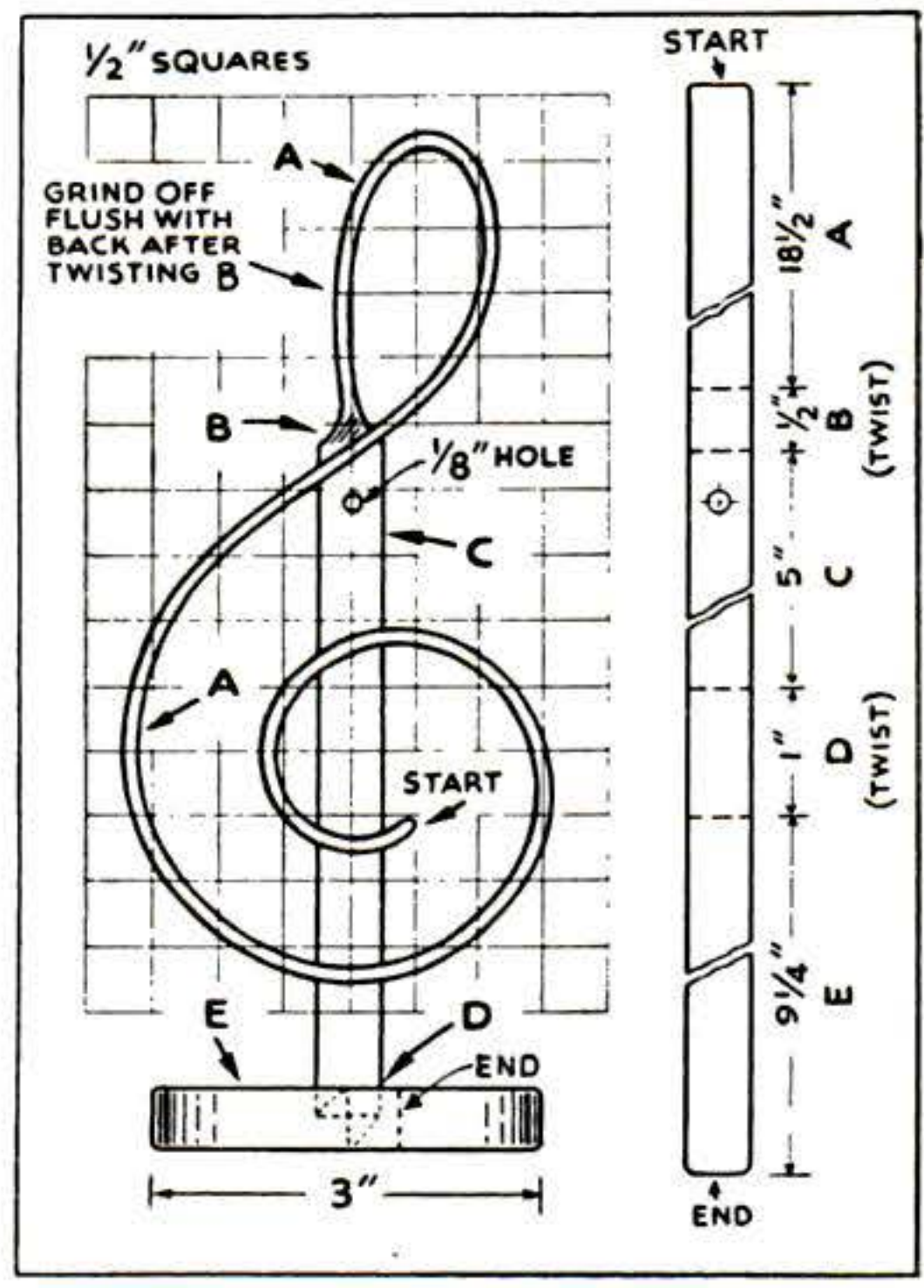
WALL PLANTS HARMONIZE WITH MUSICAL BRACKET

KEYED to any bright room where flowers and music are equally appreciated is this flowerpot wall bracket patterned after the musical G-clef.

For convenience, the drawing at the right has been marked off into lettered sections corresponding to the dimensions shown on the $\frac{1}{2}$ " by $3\frac{1}{4}$ " strip of light band iron.

Scribe the metal and bend part A to form the outline of the musical key. Next, form the 3" diameter flowerpot ring by curving

part E. Holding the strip in a vise, use a wrench to form the two quarter-turns at B and D. Where C and D meet, bend a right angle so that the ring will be horizontal when attached to the wall. After these operations are completed, grind the back flush, drill a mounting hole, and paint the bracket to harmonize with the colors of the room.—GLENN A. WAGNER.



BENT PAPER CLIPS HOLD GIFTS ON CHRISTMAS TREE

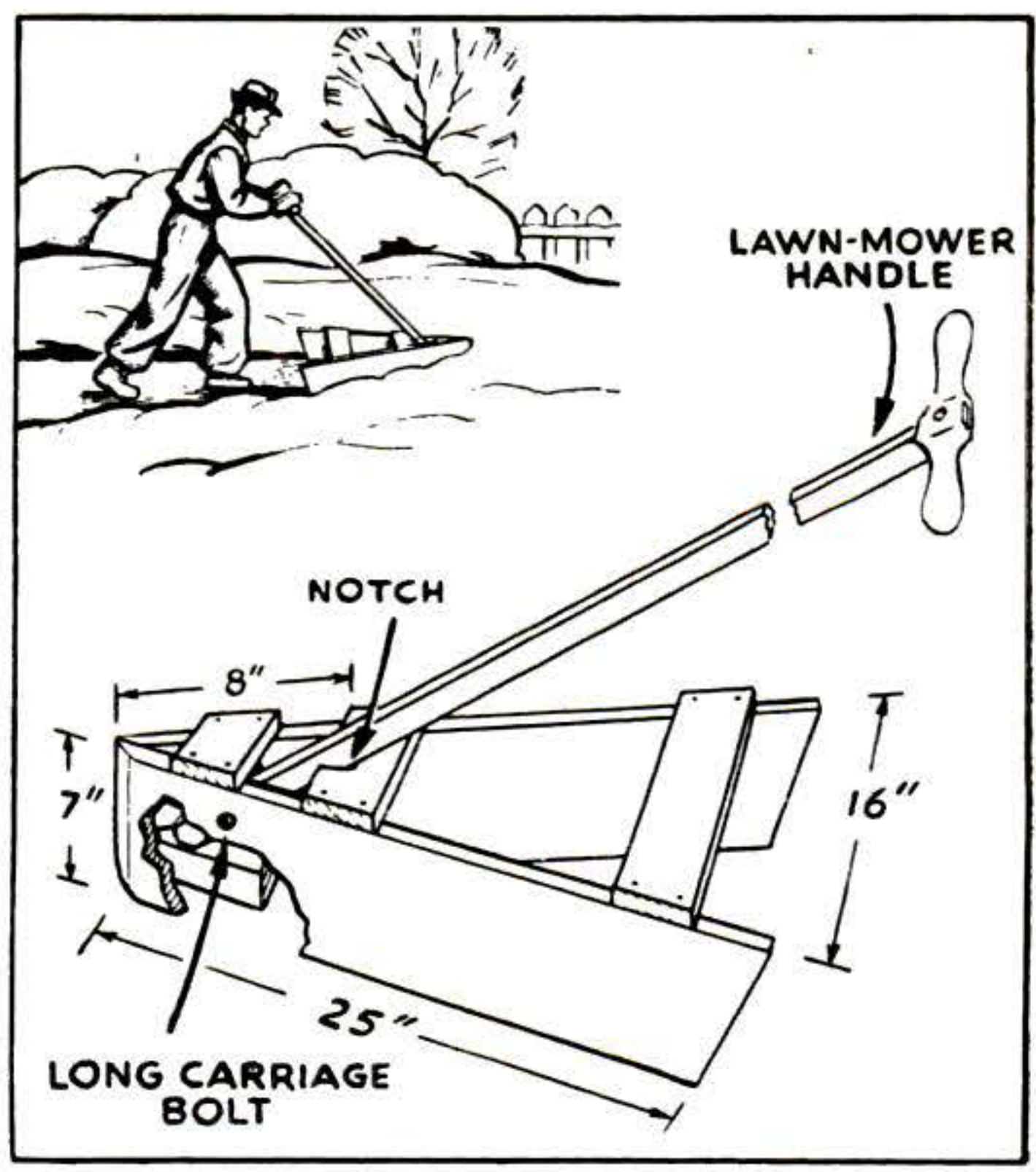
PAPER clips bent to an S-shape are handy hooks for attaching gifts to a Christmas tree. Hook the larger section over a branch and slip the smaller through the ribbon or tape on the package. Small-size clips similarly bent will secure a string of lights to the tree. The clips can be coated red with fingernail polish.—KEN MURRAY.

BOILING WILL ADD THICKNESS TO THIN PLASTIC PIECES

THIN plexiglas and similar clear plastic can be thickened by boiling in water. The finish is not affected, but allowance must be made for loss in width to compensate for gain in thickness.—FRANCIS E. HOLMES.

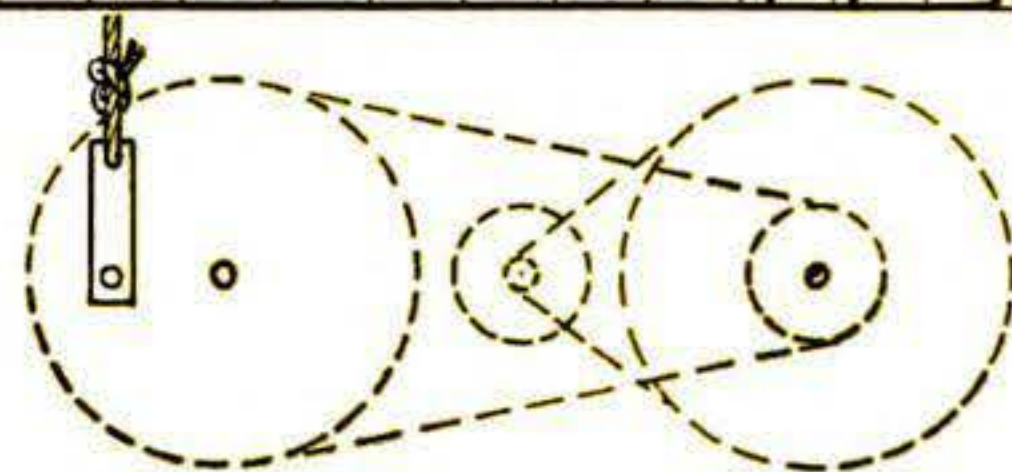
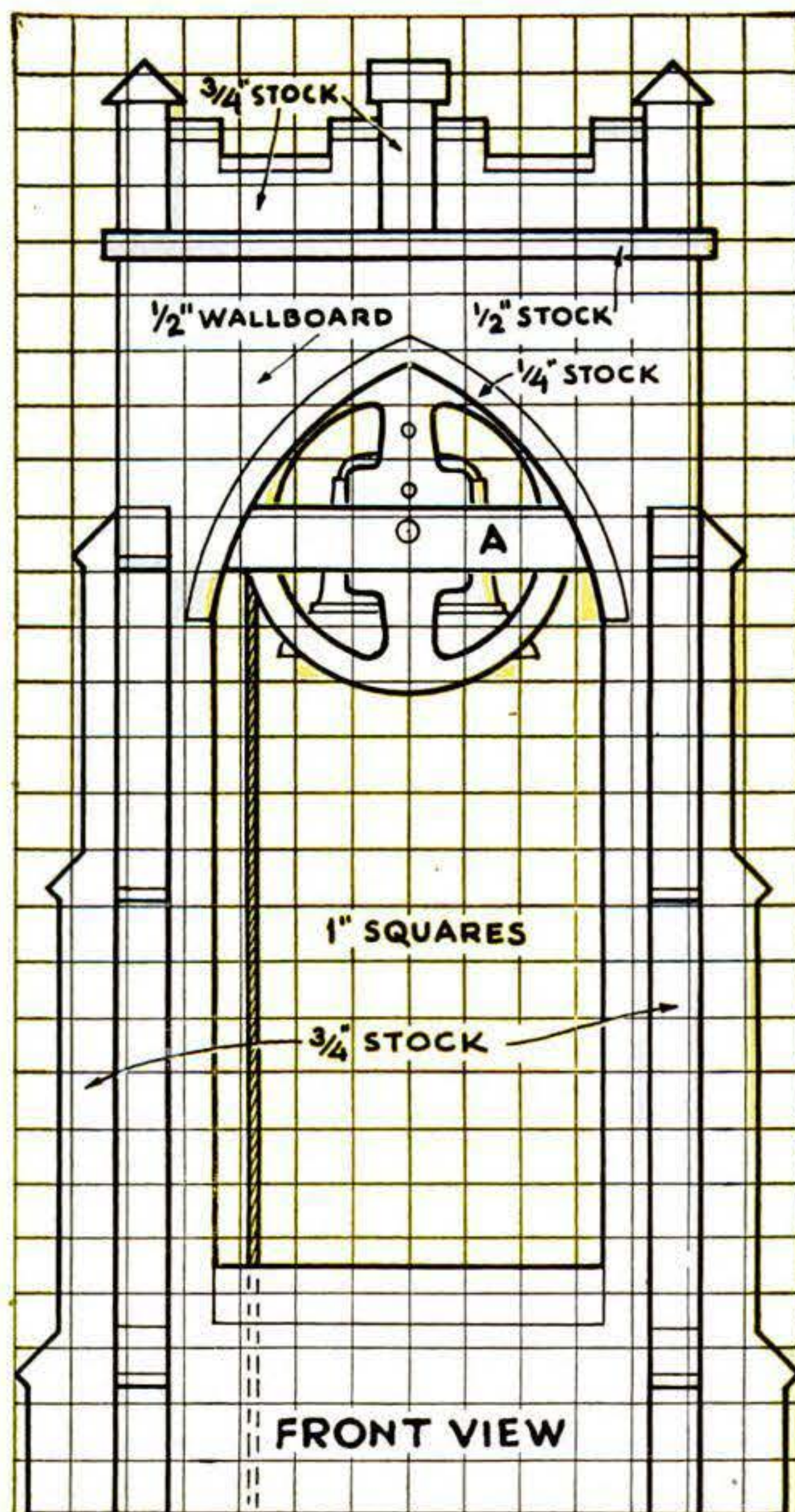
WEDGE-SHAPED SNOWPLOW EASES WINTER PATHMAKING

SHOVELING snow off your doorstep becomes a sizable chore when the "doorstep" between house and barn is a hundred yards or even a lot less. A few pieces of sturdy lumber of the approximate dimensions shown below will cut the job from hours to minutes. Assemble the sides around a 2" by 4" by 8" wedge, and use cross braces to hold the pieces firmly. Any strong stick will do for a handle; since your lawn mower isn't doing much good at this time of year, you might use its handle.—T. MCDONALD.





Bell Ringer in



By
EDWARD J. THATCHER

YOU can ring out the joyful tidings in true Yuletide style with this animated display, which is sure to delight young hearts on Christmas morning. A bell ringer in colorful garb, standing in a Gothic bell tower, tugs lustily away to the chiming of a bell.

Any small electric motor, such as might be taken from an old fan, will operate the display. A bell with a clapper is required. The one shown is a Swiss cowbell of heavy bronze, shaped like a church bell and possessing an excellent tone.

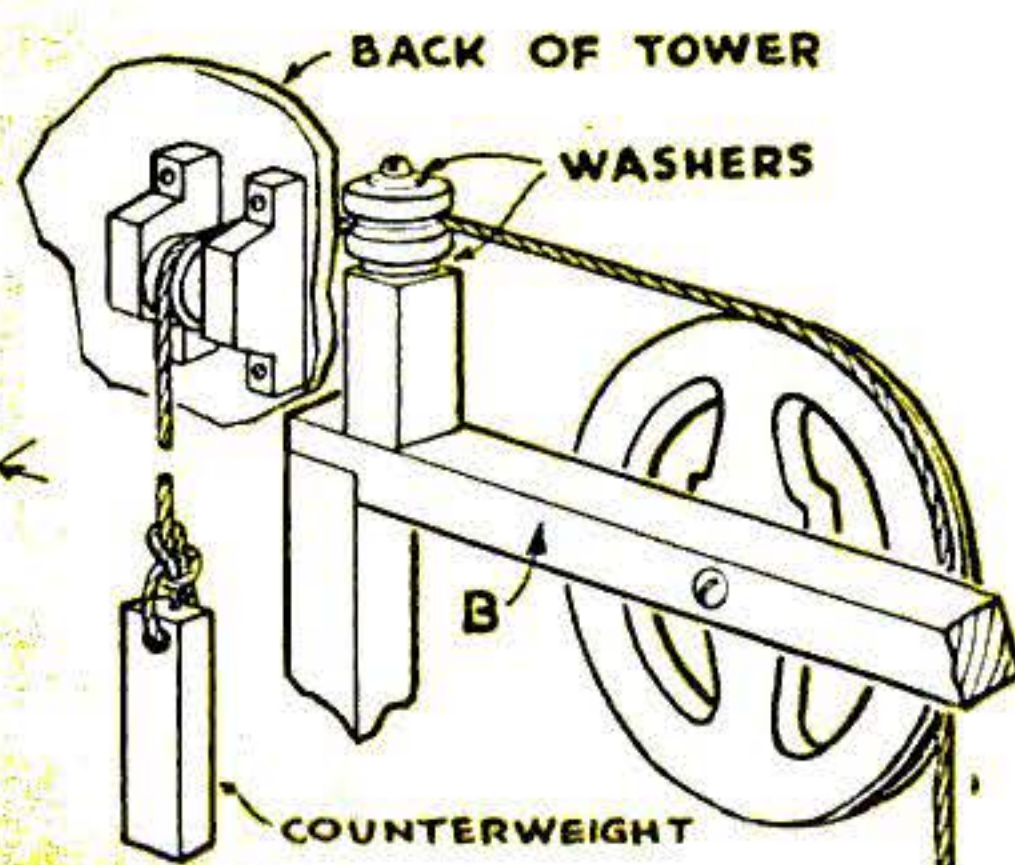
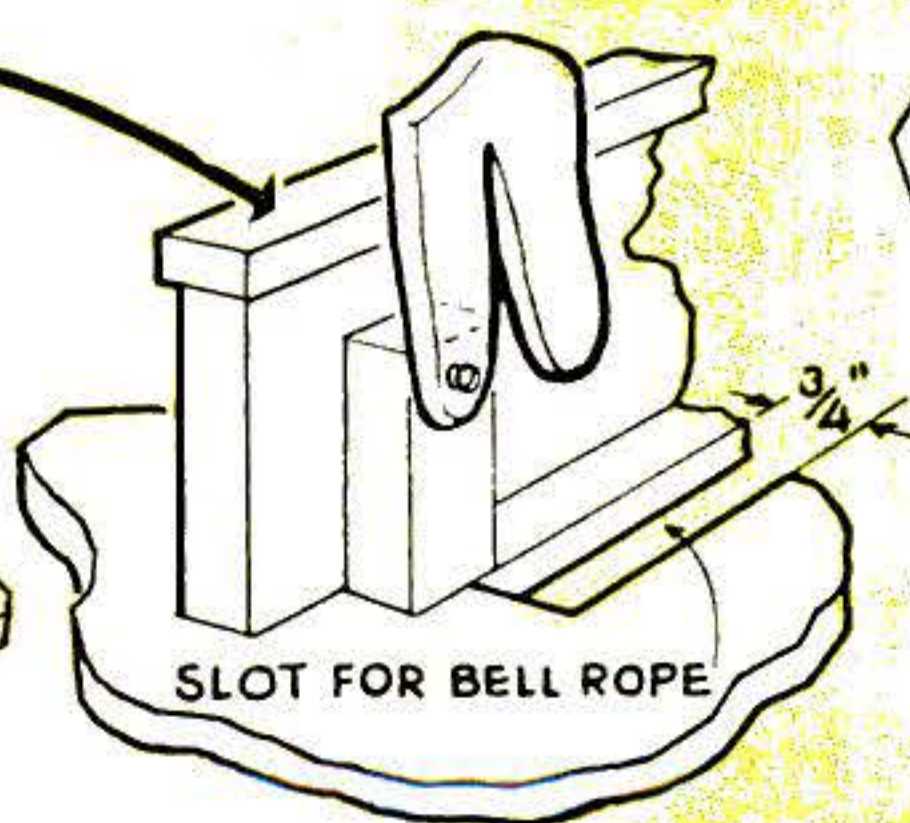
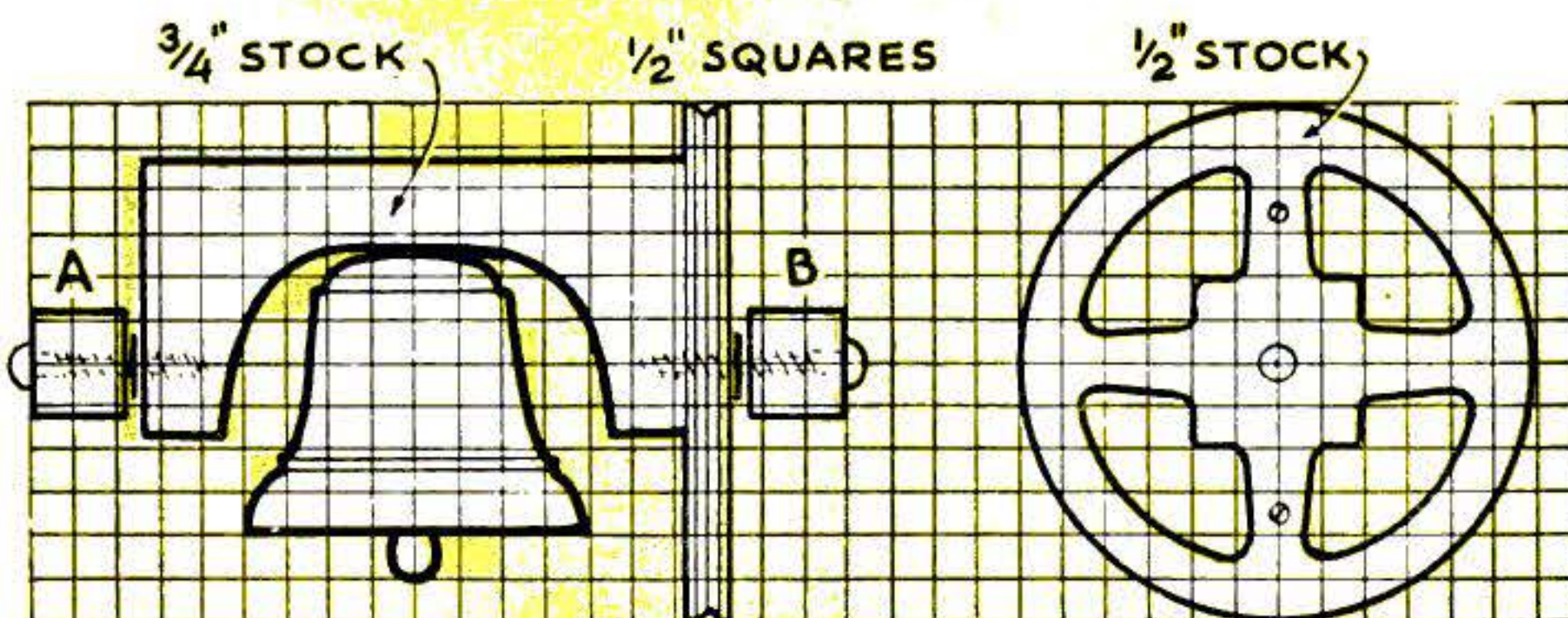
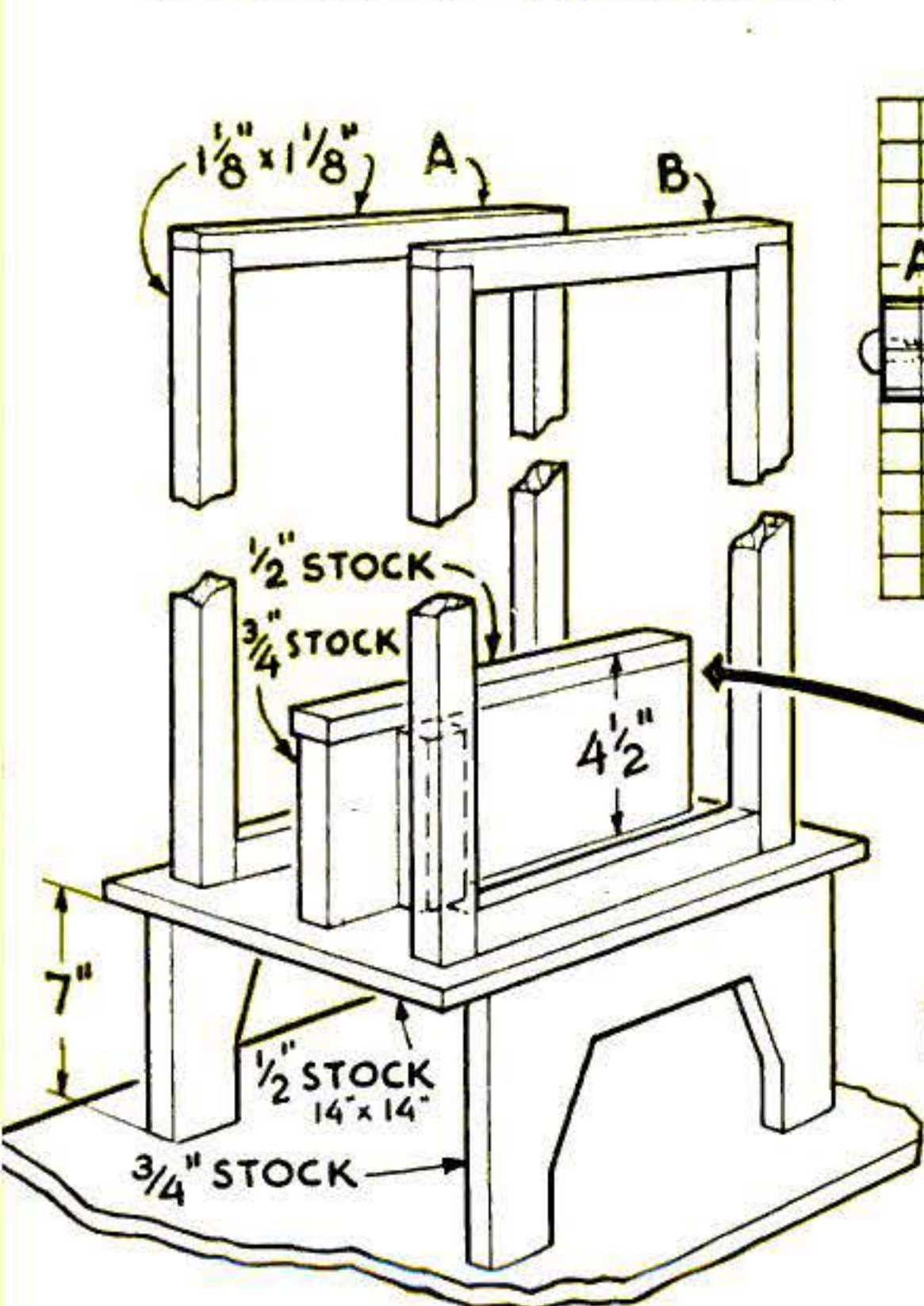
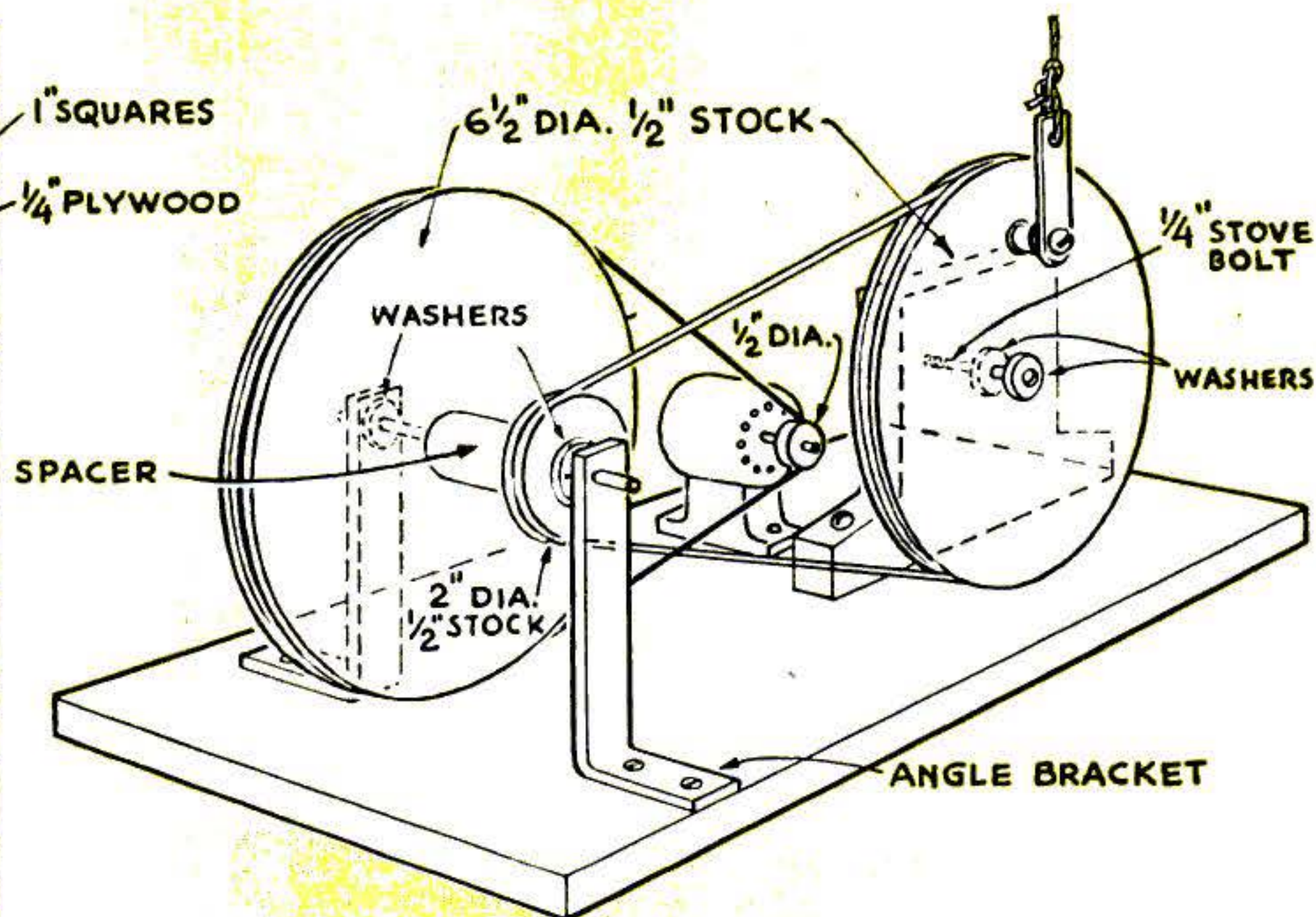
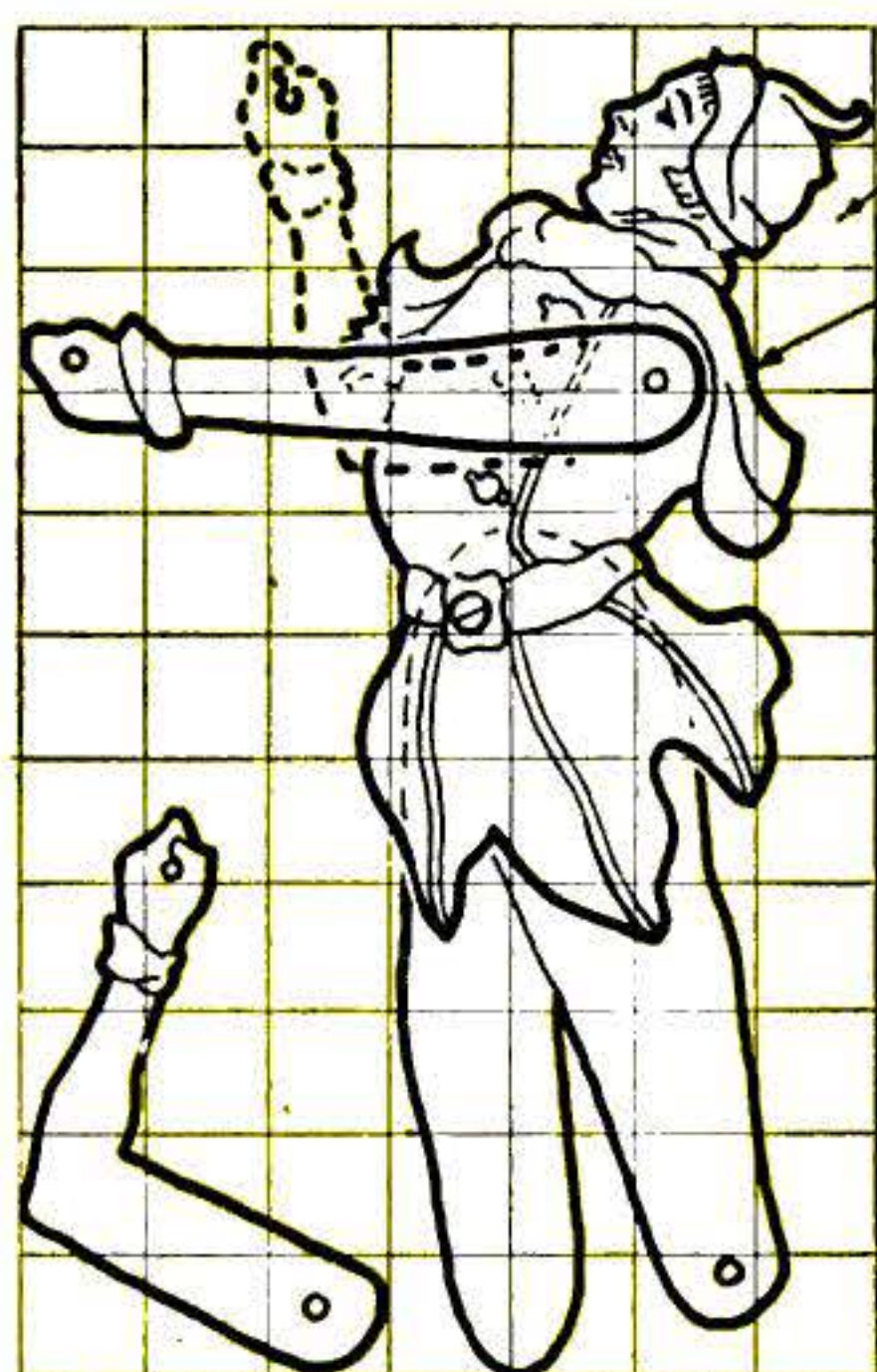
The tower, 14" by 14" by 26 $\frac{1}{4}$ ", is built around a firmly constructed frame in which the motor, pulleys, bell ringer, bell, and bell yoke are mounted. A height of 7" between the base and platform gives ample room for the motor and pulleys, and brings the overall height to 33 $\frac{1}{4}$ ". Slot the platform for a length at least equal to the diameter of the bell-rope pulley and just above it so the rope will have enough space to work in. The bell wheel is glued and screwed to

the yoke, and the assembly is pivoted by two screws on parts A and B of the frame, as shown.

Grooves in the pulleys and bell wheel may be turned, if a lathe is available; filed painstakingly by hand; formed on a spindle shaper or drill press with a suitable cutter; or made by assembling the part from three disks, the middle one being smaller than the outer ones.

Make the bell ringer from $\frac{1}{4}$ " plywood in four parts, pivoting the two arms on the

Tower Sounds Yuletide Chimes

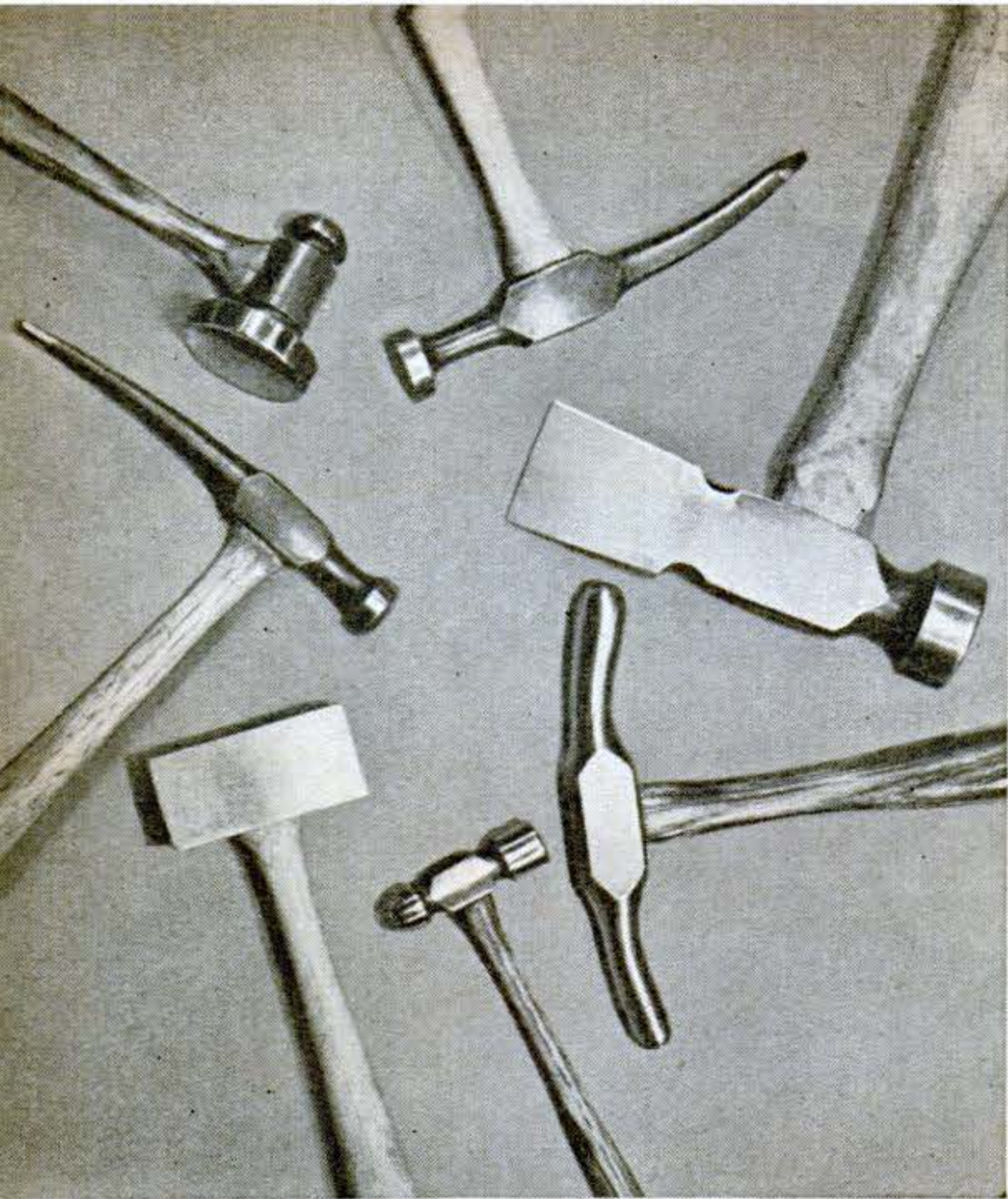


body. Pivot the body to the legs at the waist so the arms move and the body bends as the bell rings. The lower end of the back leg is pivoted on a block attached to the 4 1/2" high upright along the center of the platform. Run the bell rope up through tight holes in the hands, over the grooved bell wheel, and over a pair of pulleys at the back of the tower, as shown at the lower right of the drawing. The counterweight should be heavy enough to pull the bell back with sufficient force for the

clapper to strike when the link at the pulley end is at top dead center of its travel.

Jigsaw the sides of the tower from wall-board and glue and nail them to the frame; then glue and nail on the buttresses at the corners. Attach a flat roof of 1/2" stock and add the pinnacles and parapets, as indicated, beveling the latter toward the outside.

Evergreen twigs hide the motor and pulleys when the bell ringer and tower are set on a table at the window. Arrange lights to show the assembly to best advantage.



Try This Anvil Chorus HAMMERS AS

physical properties. The method is simple enough if you have a furnace and an anvil. Heat the piece to redness and hammer it to shape, reheating as often as necessary. Most of the hammers shown here, however, were turned in the lathe and then filed or ground.

To make the square hammer shown in Fig. 1, you have only to square up the steel and form the hole for the handle. One face is flat with the sharpness of the corners and edges removed by abrasive cloth, and the other is slightly crowned. The design is primarily for driving brads in close quarters such as the inside corners of a box, and is useful also for driving nails into picture frames. If the hammer is hardened all over, it can be used as a small anvil for jewelry and model work. Holes or small depressions in the sides will adapt it as an anvil for small-scale dapping or punching jobs.

A simple way to form the oval eye in a hammer is to drill two holes that almost touch and then cut away the unwanted metal with a round (rattail) file until the oval is smooth. Or a neat eye can be produced with an end mill. Usually the eye is slightly smaller at the handle end so the wood will grip securely when the handle is spread by a wedge, but for extremely small hammers that are never swung with much force, the eye may have straight sides.

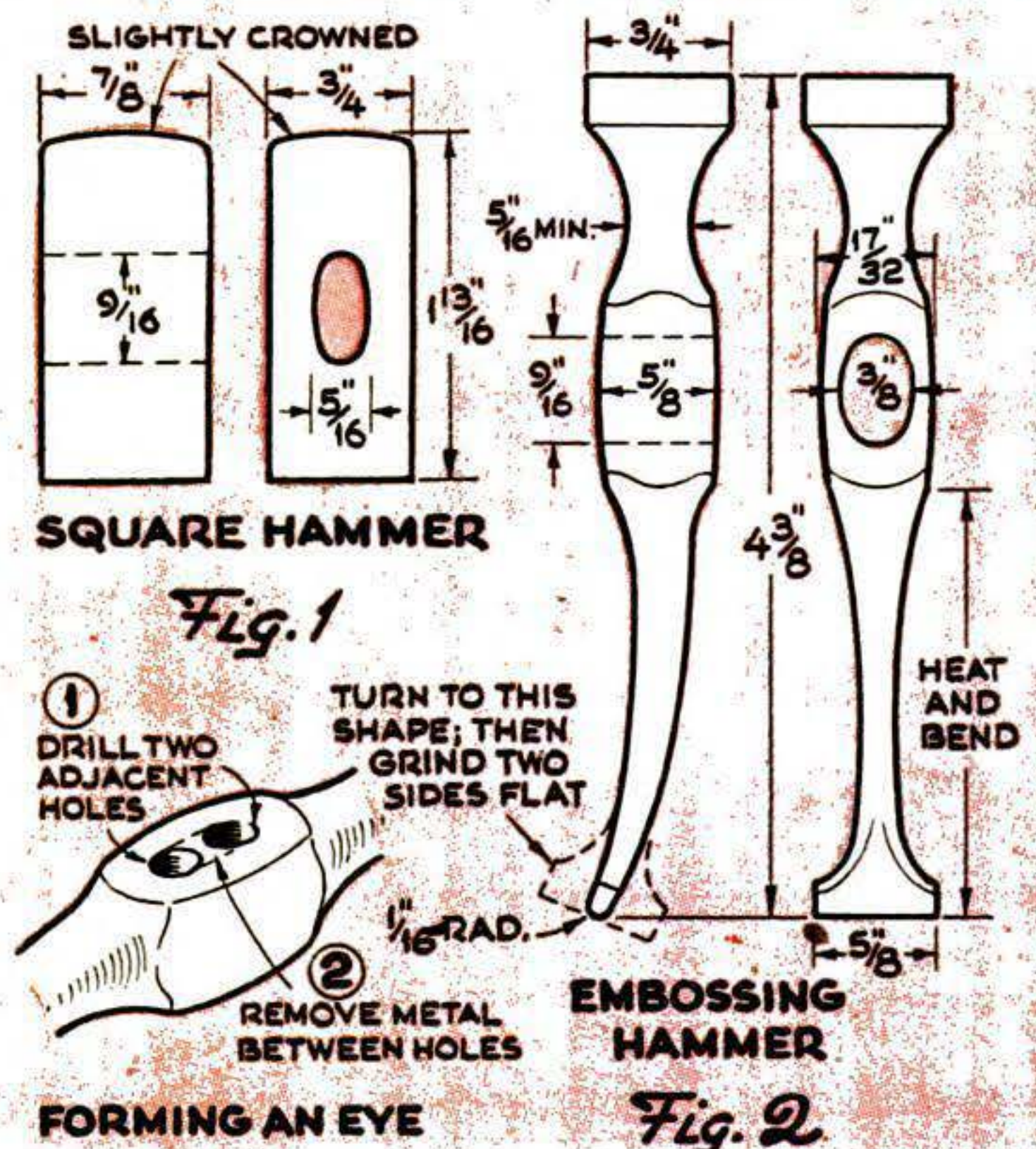
By Walter E. Burton
and W. A. Conway

COMMON carpenter's and machinist's hammers can usually be purchased at the nearest hardware store. But what if your hobby is making silver bowls or building elaborate scale-model locomotives, fashioning jewelry or turning out hand-carved furniture, tooling leather or tinkering with gasoline engines? Have you ever tried to buy a machinist's 1-oz. ball-peen hammer or any of the many other specialized forms from the average dealer?

Every craftsman has his own ideas about hammers for special purposes, and often the only way he can acquire a tool that pleases him in every respect is to make it. This in itself is a fascinating hobby. From old cold chisels, scraps of drill rod or other tool steel, or alloy steels obtained specifically for the purpose, you can fashion an endless variety of hammers. And from broken ax handles and similar sources, you can obtain the hickory for making handles.

The illustrations on this and the following pages show only a few possible forms—some conventional, some highly specialized. Your own requirements should dictate the ultimate size, shape, and material. Those described here are all made of steel, but for use on delicate work that might be easily marred, you may prefer brass, lead, plastic, wood, or fiber.

Forging, especially for large hammers, is sometimes the method preferred by craftsmen. In addition to shaping the piece, it compacts the steel and often improves its



on Your Lathe . . . YOU LIKE THEM

The embossing hammer shown in Fig. 2 has a flat head that may be used for planishing and for driving small chasing tools or punches. Its cross peen has a number of uses, among them the smoothing of the bottom of a narrow groove in sheet metal. The peen is turned to a diameter equal to its width and then flattened with a file or on a grinding wheel. To curve the slender nose, heat the metal to redness, clamp it in a vise, and hammer or otherwise force the nose to the desired contour. If you use a torch, you can exert considerable control over the bending by applying more heat at certain spots.

Most of the shaping of the bird-nose hammer shown in Fig. 3 can also be done in the lathe, and its nose is similarly curved by heating and bending. It is useful for planishing, producing faceted textures, and working in deep depressions.

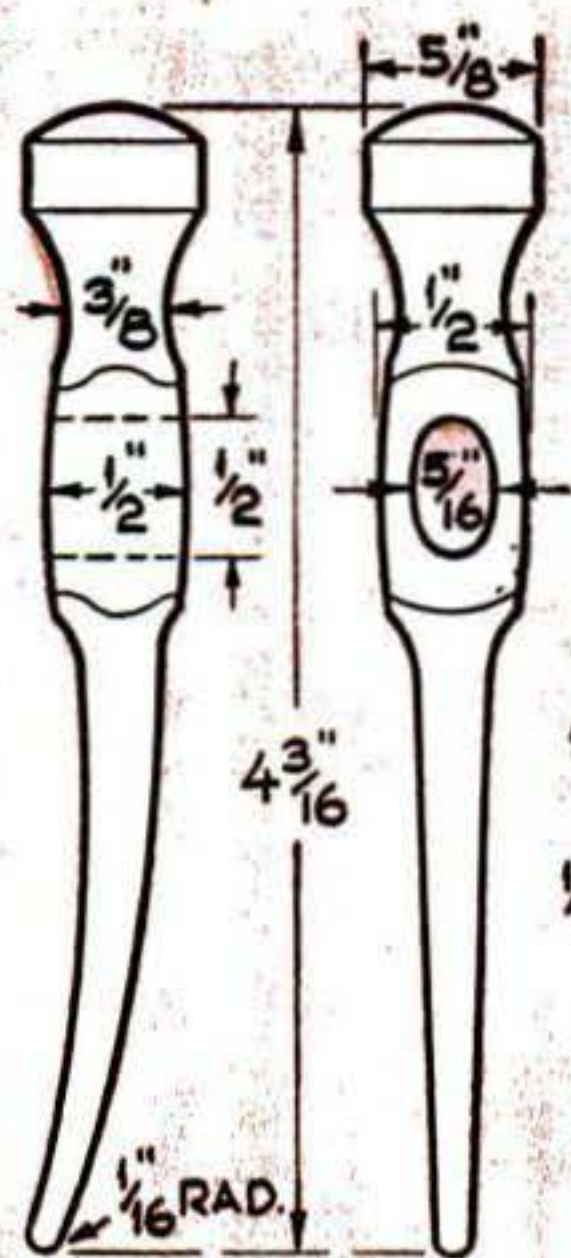
Whether or not a hammer should be curved depends partly on whether it is to be swung from the wrist or elbow. Planishing hammers, used in working silver and doing other sheet-metal craftwork, are usually straight and are swung through small arcs by wrist action. The so-called silversmith's and shaping hammers are generally swung through wide arcs by elbow action and are curved. This sounds a bit



Using the machined shingling hammer. The hatchet edge splits bad shingles to make removal easier.

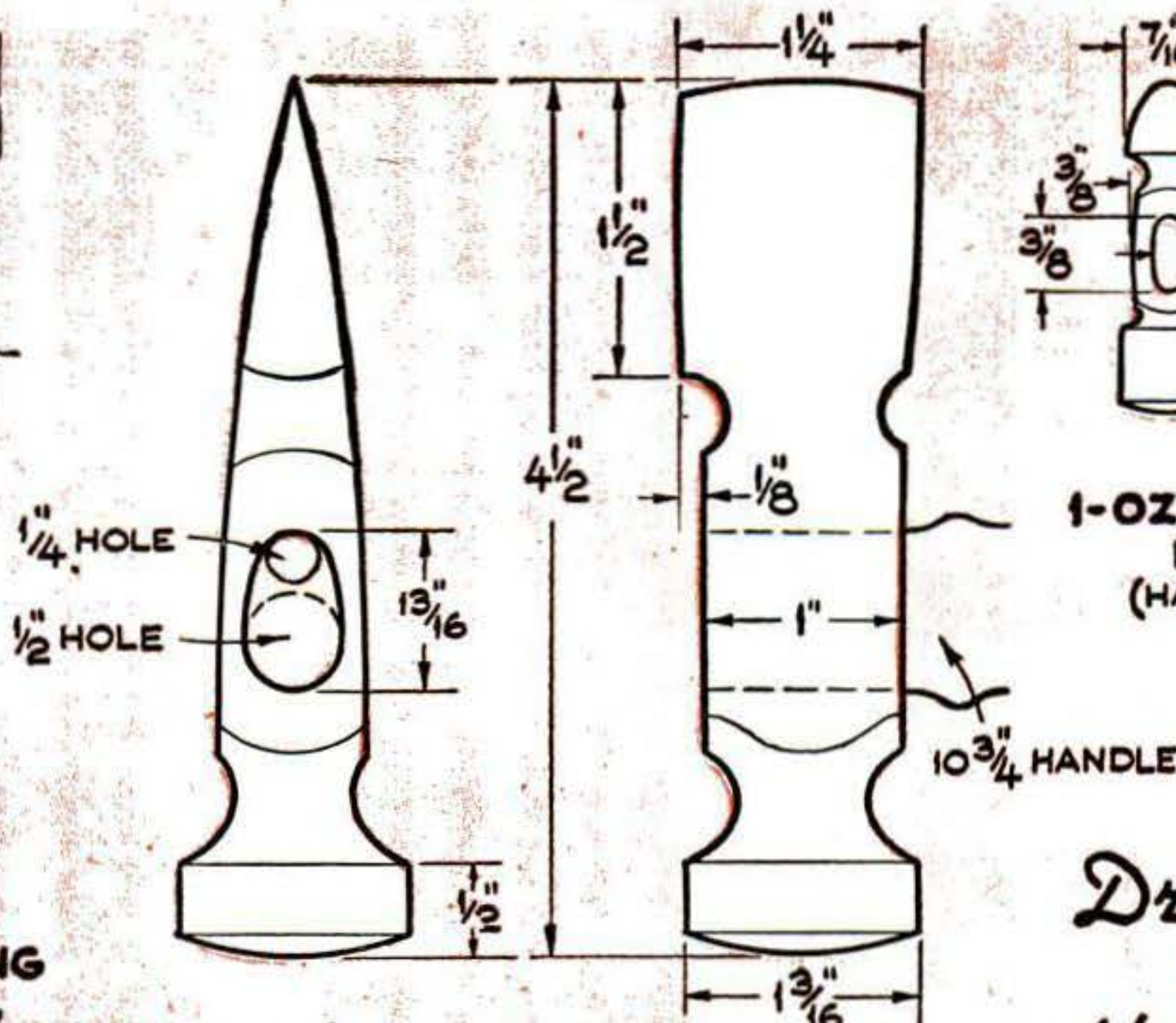
reversed because the arc described by a hammer in wrist action is more curved than that in elbow action. The best way, no doubt, is to shape the hammer so it has the best feel and is most easily controlled. After you use a few different hammers, you can determine which form is best in each case.

Figure 4 shows a small shingling hammer turned from tool steel and then cut to a wedgelike shape on a metal-cutting band-



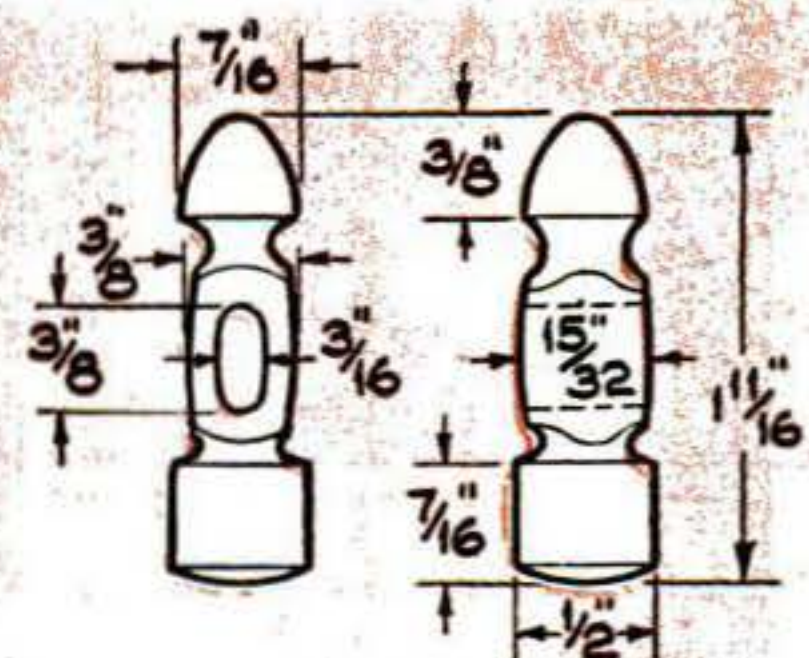
**SPECIAL RAISING
OR EMBOSsing
HAMMER**

Fig. 3



SHINGLING HAMMER

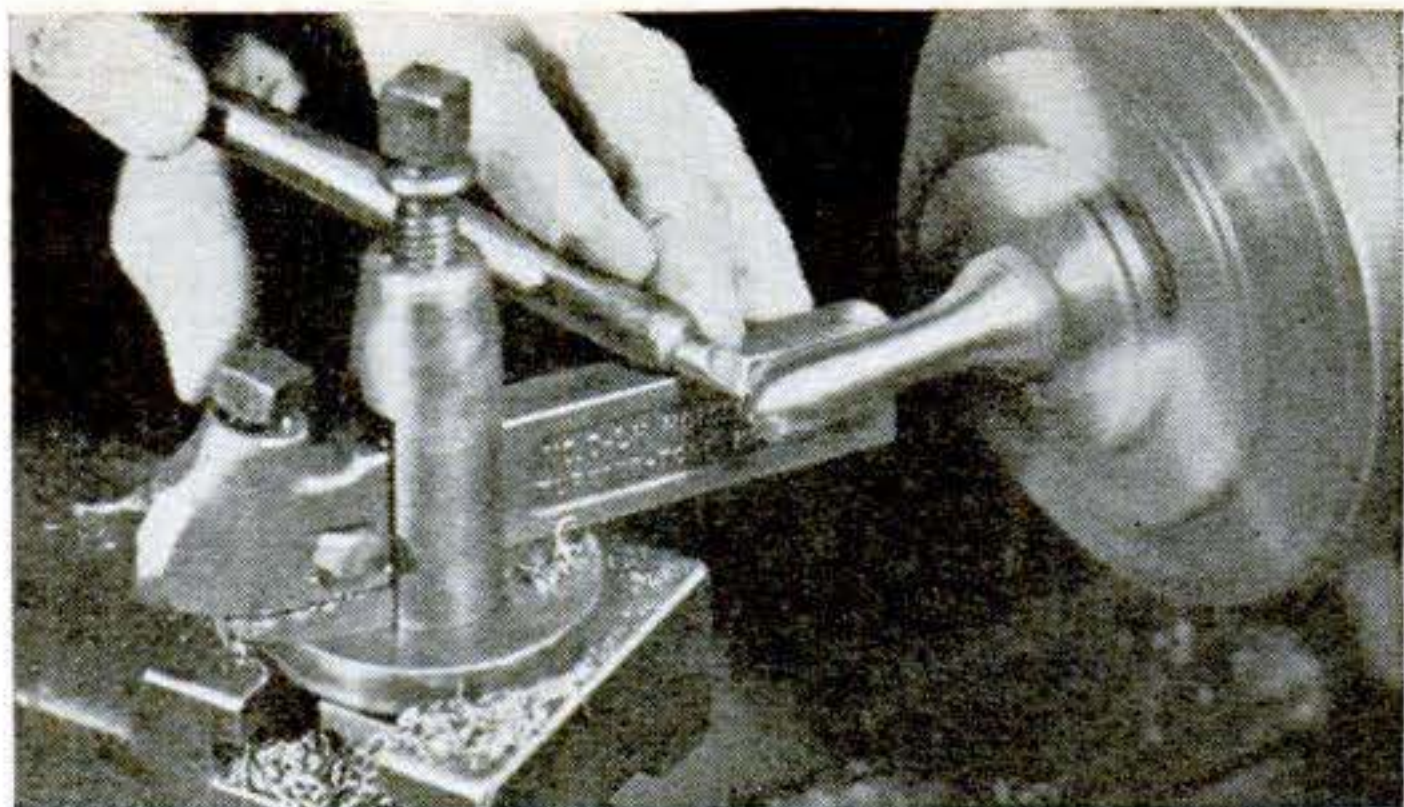
Fig. 4



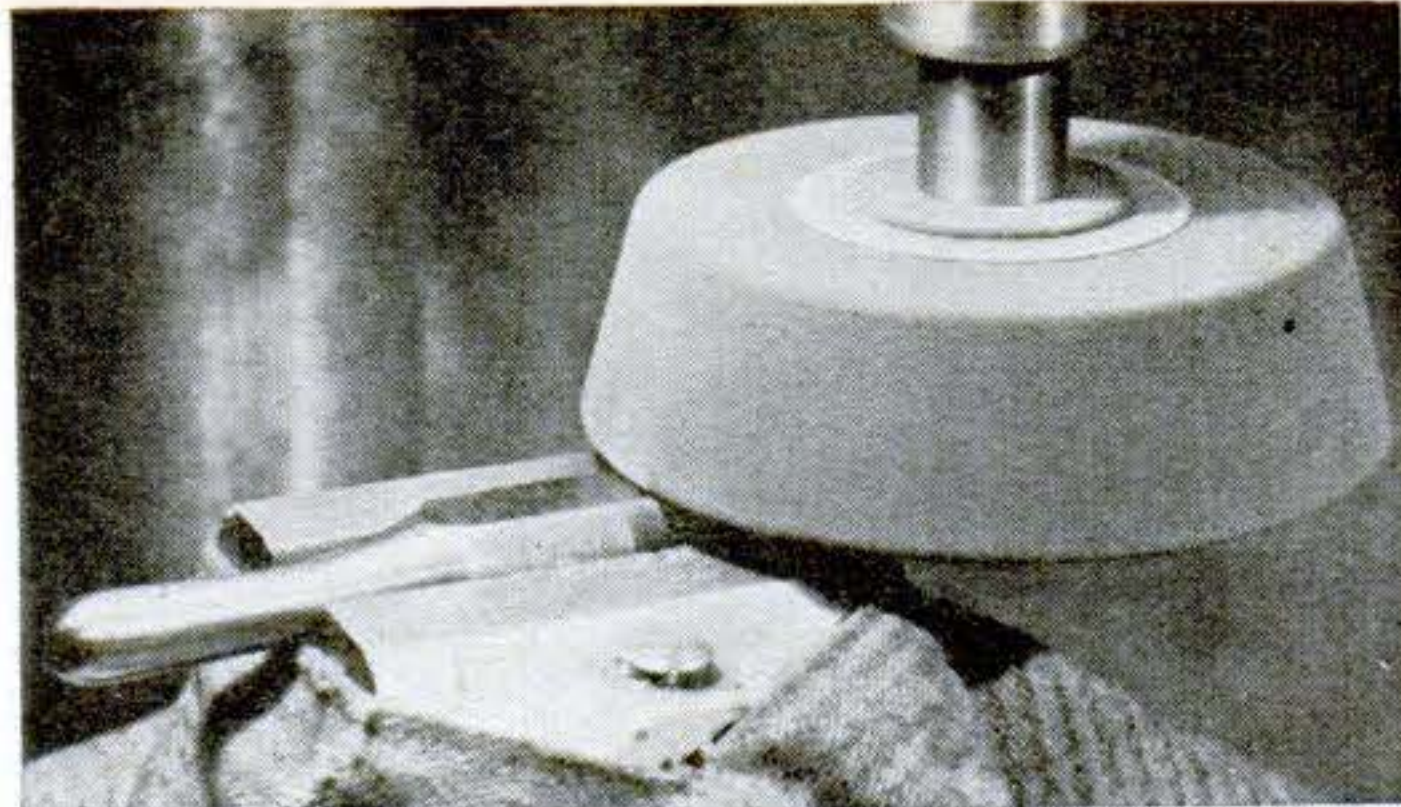
**1-OZ. MACHINIST'S
HAMMER
(HANDLE 8" LONG)**

Fig. 5

*Drawings
Are
Half Size*



Slender, rounded ends of a silversmith's hammer are turned with a high-speed tool having a skew edge. The lathe tool holder is used as a rest.

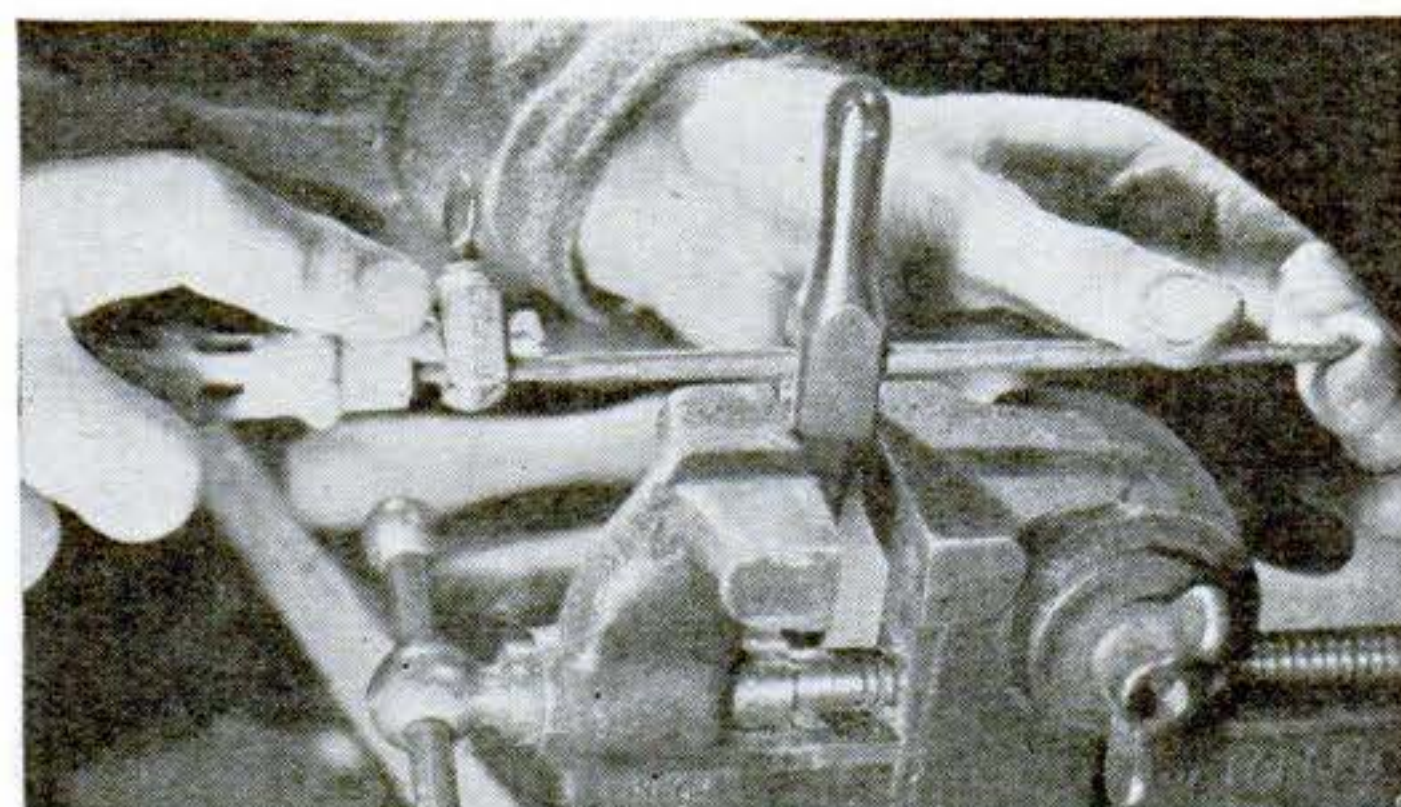


Flats are ground on the central portion here with a cup wheel mounted in the drill press. A cloth over the milling table protects it from grit.



Filing brings the ends to oval shape. Note that two holes are laid out on the flat for the eye.

Heating and bending curves the noses; and then the ends are heated and quenched for hardening.



These holes are drilled through and the metal is cut out and further shaped with a rattail file.

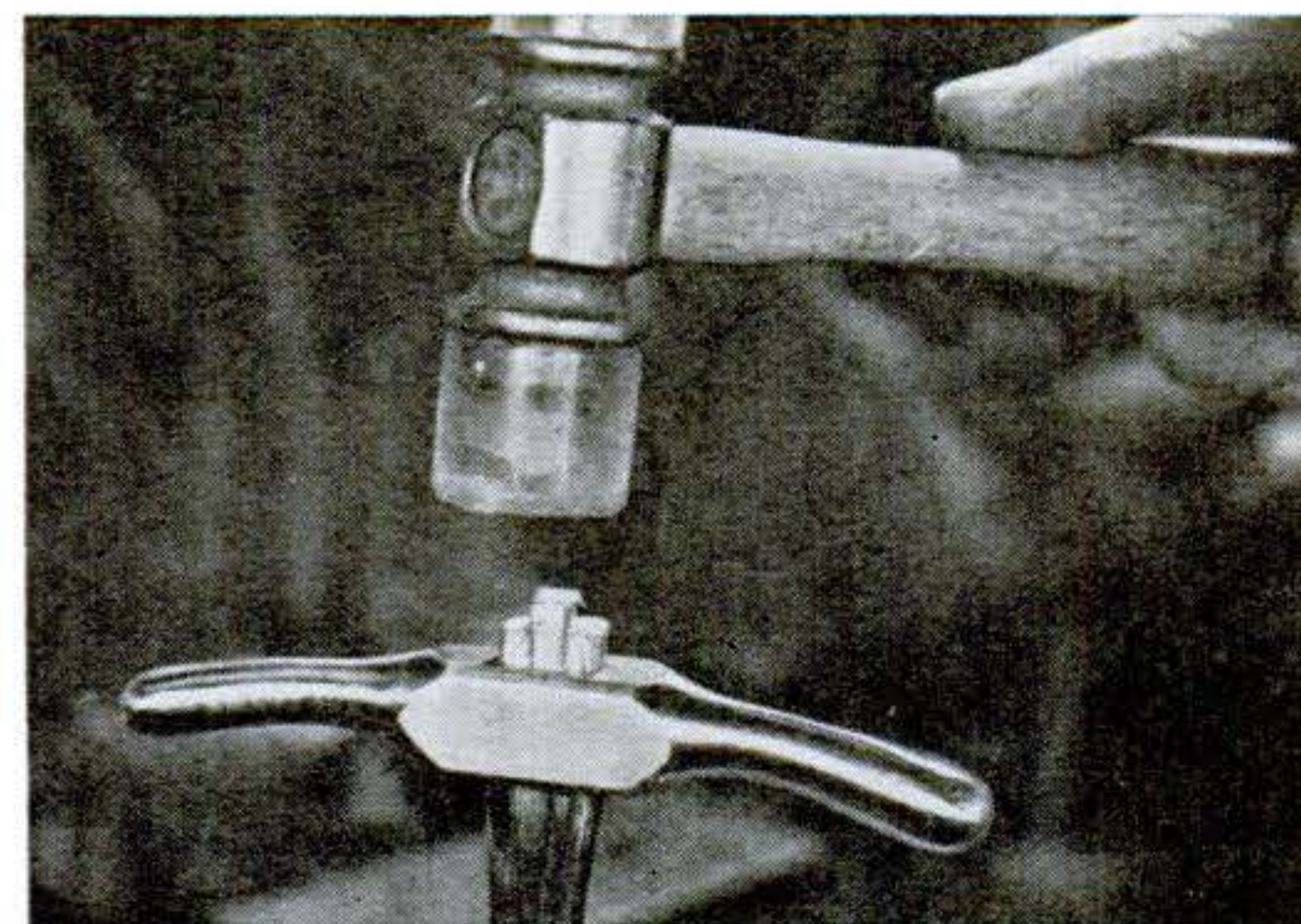
Finally the handle is shaped and fitted in the eye. A wedge driven in the end holds it fast.



saw. The egg-shaped eye was started by drilling two holes of different sizes. Including the handle, the hammer weighs less than 1 lb.

Ball-peen hammers shaped as in Fig. 5 are among the handiest in use, but it is not always easy to obtain them in small sizes for delicate work. The dimensions given in the drawing are for a hammer weighing about 1 oz. Chuck a piece of drill rod, machine the ends, finish the central portion with a file, and make the eye.

A modification of the ball-peen hammer, generally called a French chasing hammer, is shown in Fig. 6. The broad, flat face is



ideal for striking chasing tools, punches, nail sets, and the like. All machining on it is done in the lathe, for the central portion is round. Hammer and handle weigh 5 oz.

For shaping bowls of silver, copper, or other sheet metal on a sandbag or in a wooden mold, for embossing sheet metal embedded in pitch, and for much other craftwork, a silversmith's hammer with a curved and rounded end is essential. A small hammer of this type is shown in Fig. 7. Made of tool steel, it is chucked in the lathe for machining one end and reversed for machining the other. File the ends and polish with abrasive cloth while

the piece is still in the lathe; then grind, mill, or file the central portion to a rectangular cross section and put the eye through the wider dimension. The ends are curved with the help of heat.

Although the tips may be left spherical, it is customary to flatten them slightly, as shown, and smooth them up to form an oval tip. If you make several hammers of this type, include at least one with a tip one and a half to two times as wide as it is thick, as shown in Fig. 8. A full set of silversmith's hammers would contain sizes up to 7½" long with the largest weighing nearly 3 lb.

Variations are almost endless. Besides silversmith's, you can make tack hammers and upholsterer's long, slender, curved hammers; square hammers shaped something like that in Fig. 1 but longer and with one end brought to a transverse chisel edge; and hammers for riveting and many other purposes. A useful hammer is one shaped exactly like a cold chisel with a handle that makes it easy to hold for delicate cutting.

It is not always easy to get a smooth ball peen or spherical face in the lathe by manipulating the compound rest. In such a case, shape the end roughly with the aid of the compound, and then finish with a hand tool, such as a lathe bit of high-speed steel sharpened to a skew point and mounted in a holder like a wood-turning chisel. By holding it so the edge makes a shearing cut, you can shape the steel with surprising ease and produce a finish that needs little more than a bit of abrasive-cloth work. The tool post may be turned so the regular tool holder is parallel to the lathe axis to form a tool rest.

Drill rod can usually be obtained in diameters up to 1¼", and most craftsmen have no difficulty in obtaining tool steel suitable for making hammers. When the steel can be selected specifically for hammer making, a carbon percentage of around .60 is preferable for heavy-duty hammers and sledges, while drill rod and similar steels running as high as 1.10 or 1.20 percent in carbon are suitable for light work.

If you use special alloy steel, follow the

manufacturer's directions when possible for hardening and tempering. For other steels, heat the hammer until it is cherry red all over—if it is not too large—and quench it in water or a quenching oil. Water produces greater hardness, and there is no reason for preferring oil, since hammer shapes are relatively simple and their dimensions are not critical. Quench drill rod in water.

When a hammer is fairly large, or you do not want to harden it all over, direct a torch against one end at a time until it is cherry red, and then quench it. This works only when the heating of the second end does not soften the one already hardened.

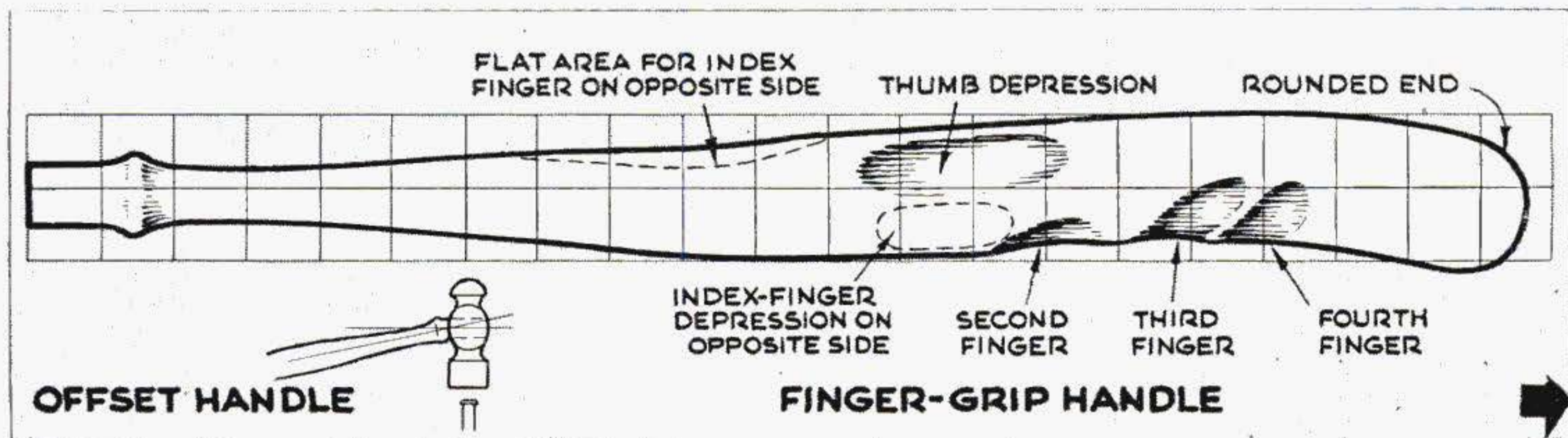
A hammer should possess toughness and enough hardness to keep it from deforming rapidly or becoming rough on the face. For carbon tool steel such as drill rod, the temper should be drawn to a dark straw color or, if the work is done in a furnace, heat for about nine minutes at 550 deg. F.

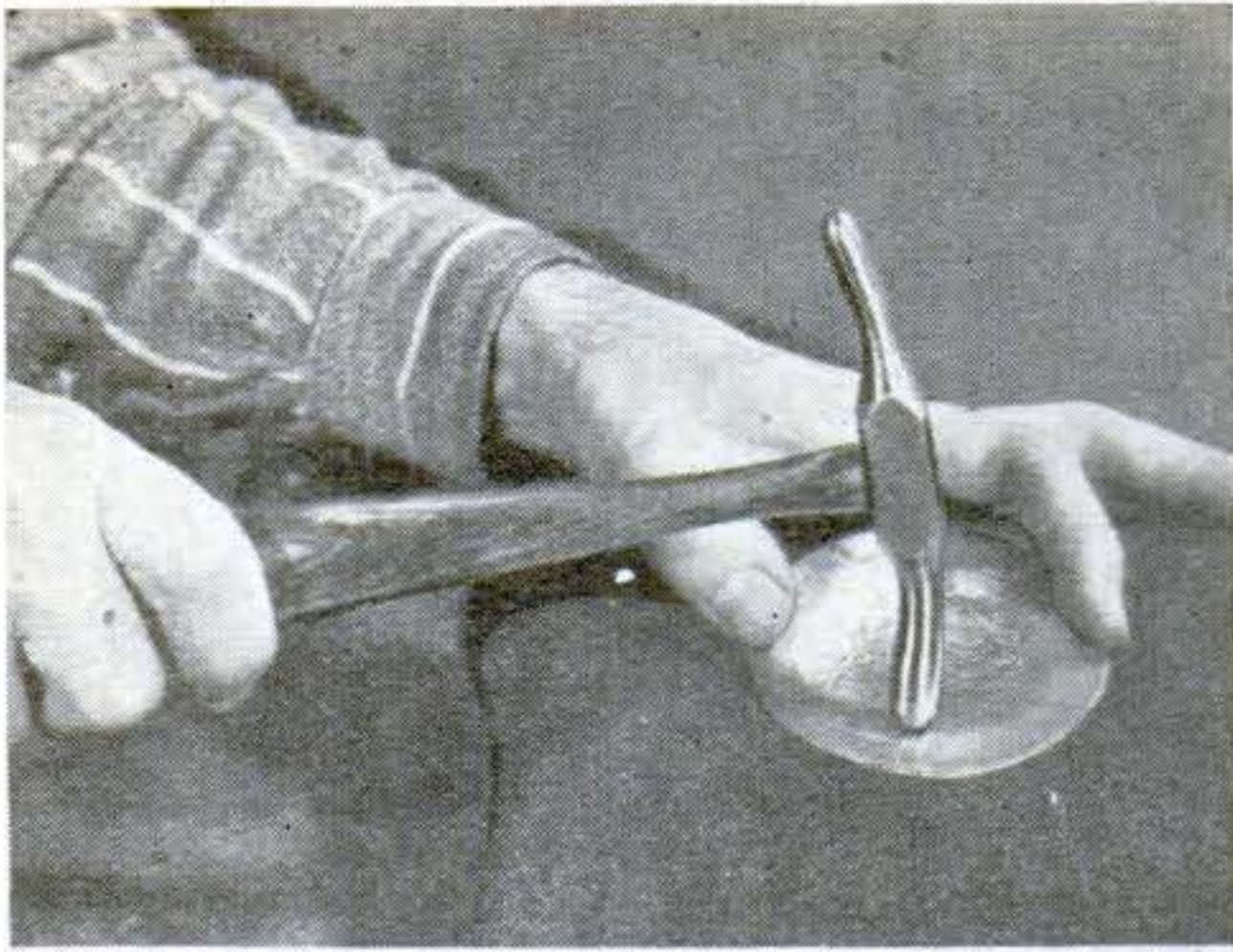
After hardening and tempering, polish the ends or faces until they are bright and smooth. Fine abrasive cloth is probably best for this.

Sometimes you can find in a hardware or salvage store a handle that will be just right for a special hammer, but more often it will be necessary to make a handle by splitting and shaping hickory from an old handle or by cutting down a new hammer handle. By splitting a large handle, you do away with cross grain. Actual shaping may be done with a rasp, a belt or drum sander, a sandpaper block, or a wood scraper or pieces of window glass.

The conventional handle is straight and often uncomfortable. For maximum ease and accuracy, you will find a form fit like that shown in the drawing below much superior. This drawing shows some features of a handle designed for one-way swinging, as with a chasing hammer.

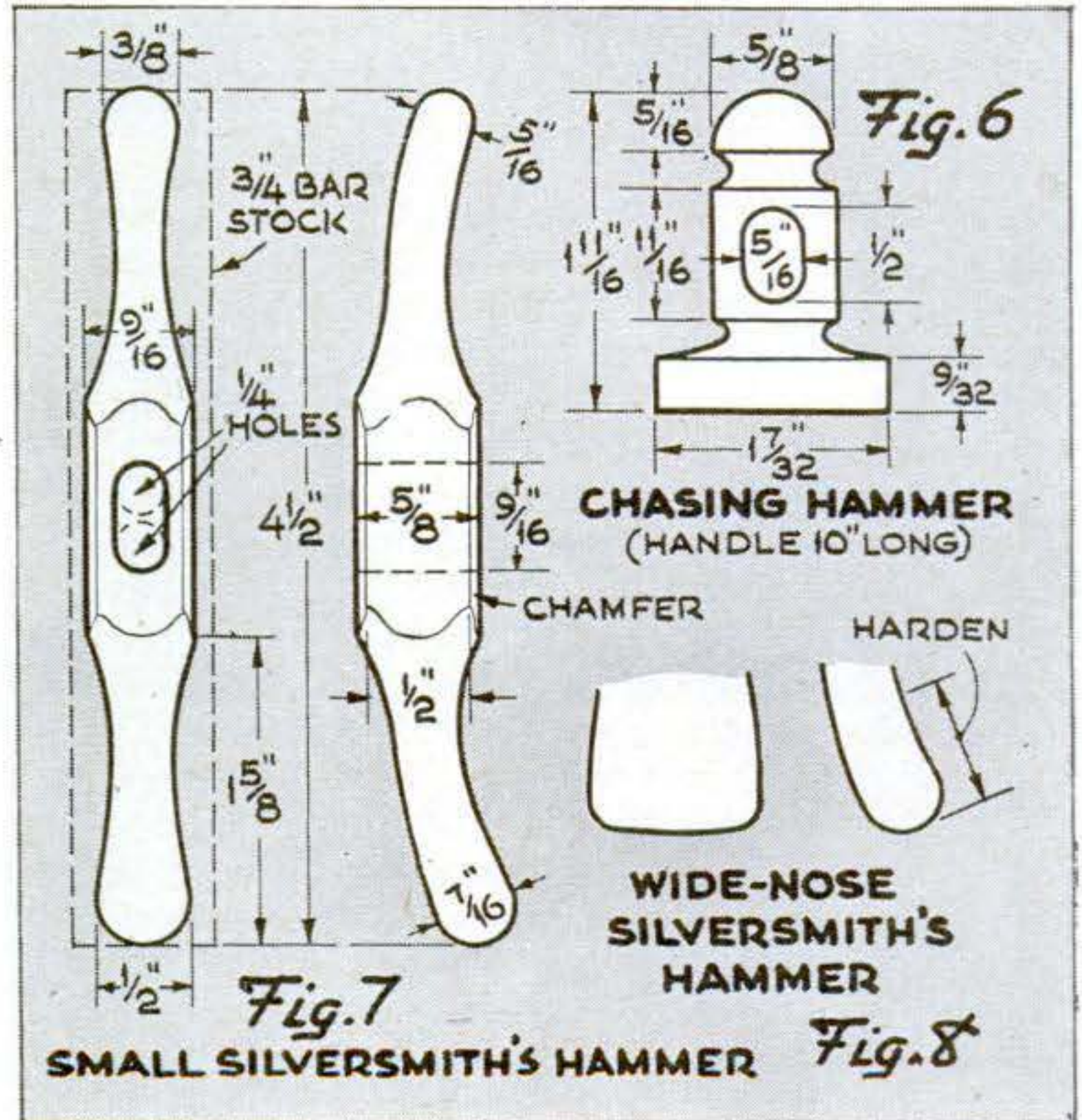
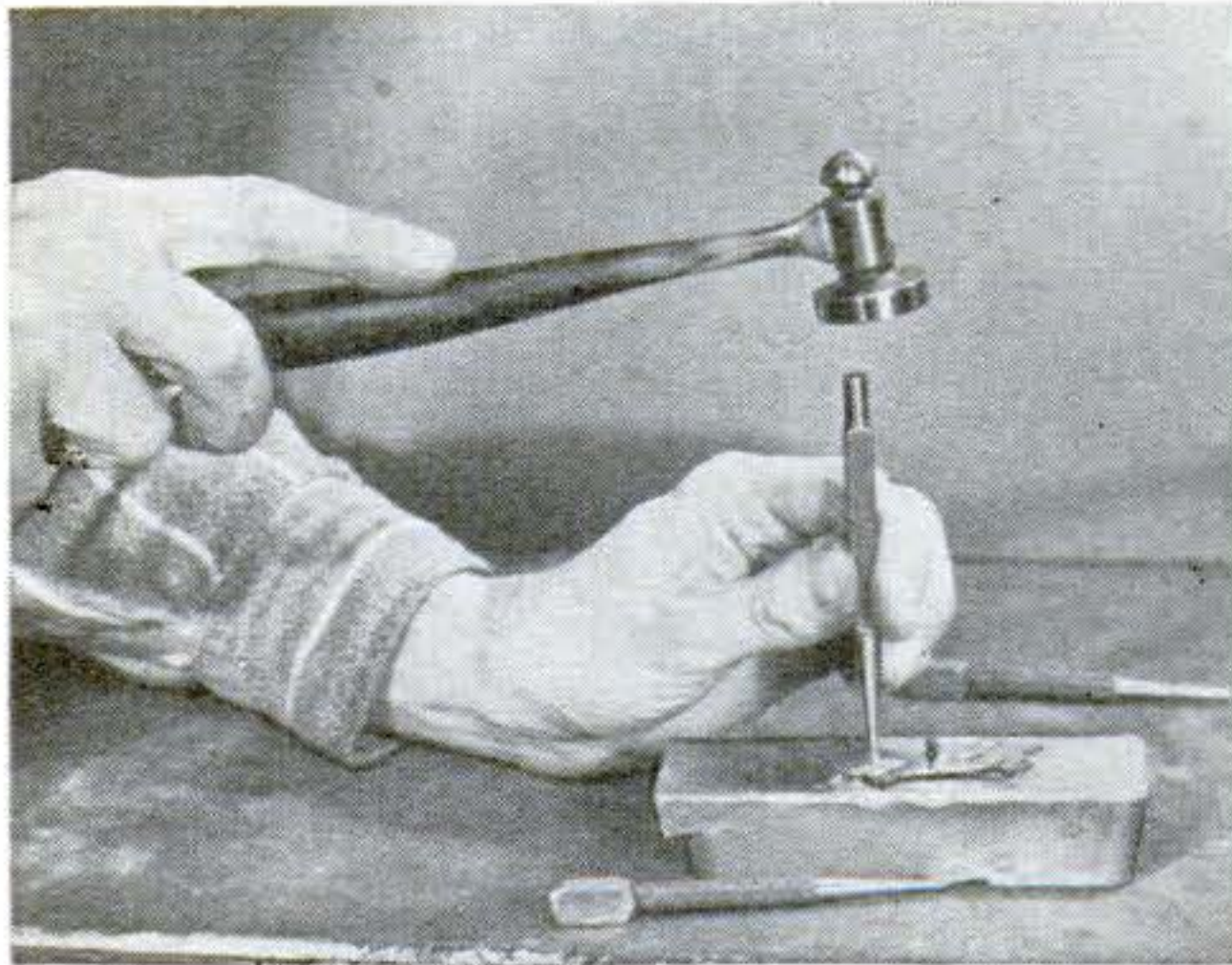
First grasp the partially shaped handle in the usual manner and note where your thumb rests. Then make a depressed spot with a rasp, testing and filing until the depression feels comfortable and firm to your thumb. Next make a similar depression for your index finger, or rather, two





Silversmith's hammers are useful for shaping sheet-metal craftwork on sandbags or in molds.

Below, a French chasing hammer like that shown in Fig. 6. It is ideal for striking punches.



depressions—one where the finger rests in ordinary hammering and the other where it is extended for gentle tapping.

Sometimes the thumb and index-finger depressions are enough, but you can carry the process further by making shallow grooves or notches for the fingers.

In the same drawing is shown a method of mounting a hammer at an angle on the handle so it is more effective when used for striking punches and chisels.

Avoid making handles too stiff. You might be surprised at the extremely thin handles some craftsmen use for relatively heavy hammering. They shave the wood down along the 3" or 4" just behind the hammer head until it looks scarcely strong enough to hold itself together. Such a handle is not suitable for prying, but when properly manipulated it produces a resiliency that permits hammering all day without fatigue.

After shaping the handle, wet it thoroughly with water and toast it gently in a gas flame to raise the grain. Sand until smooth again and repeat the wetting and drying. The result is that if the handle

is later wet accidentally it won't roughen.

Next, file and sand the end to the contour of the eye. Don't force the handle if the eye turns up a shaving. If the fit isn't tight, cut a wedge-shaped notch in the end, make a hardwood wedge to match, drive the handle again into the eye, put glue in the notch, and drive the wedge in to spread the tip. Cut off excess wood and smooth it even with the metal. Use metal wedges for large hammers and carpet tacks with the heads cut off for extremely small ones.

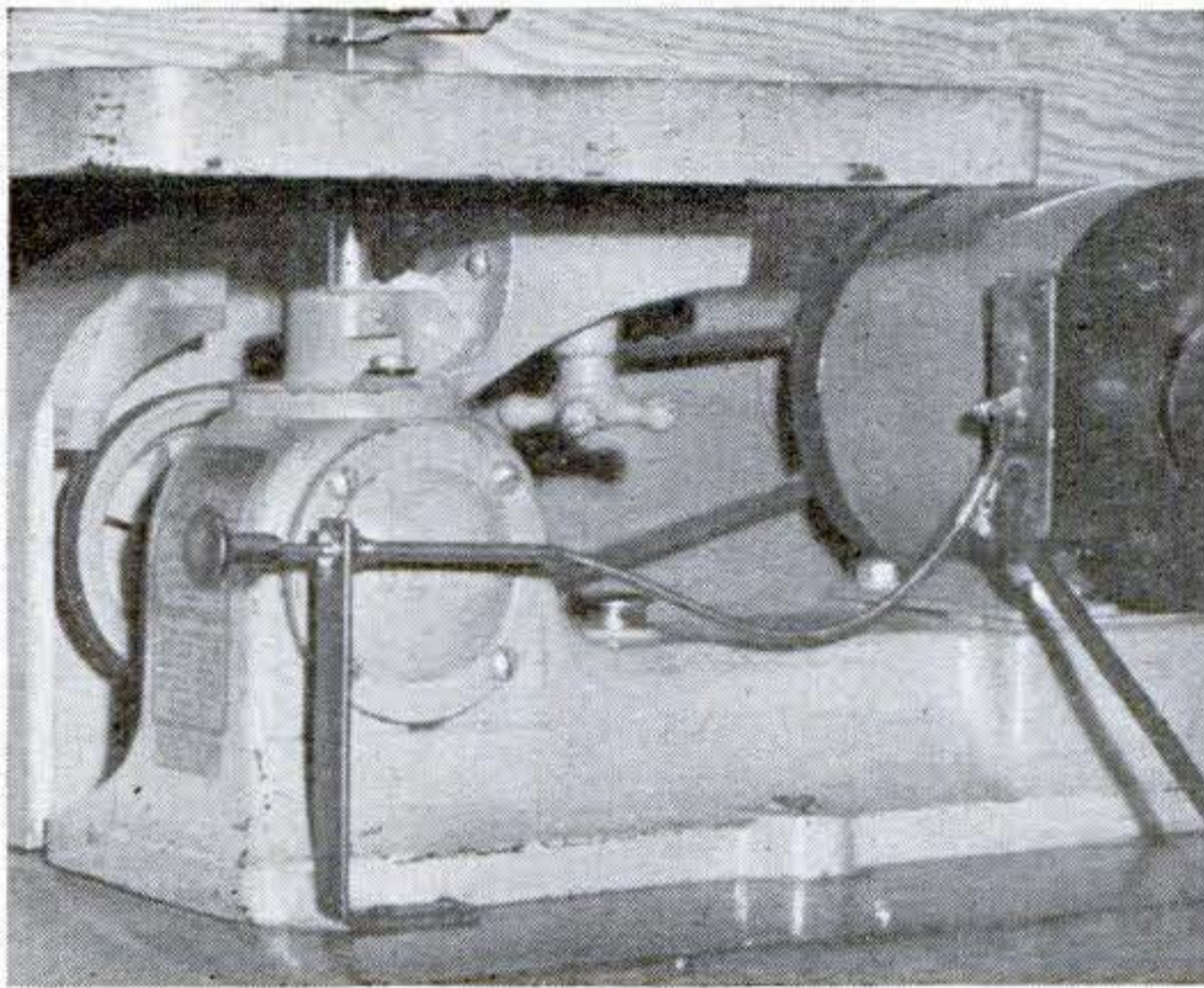
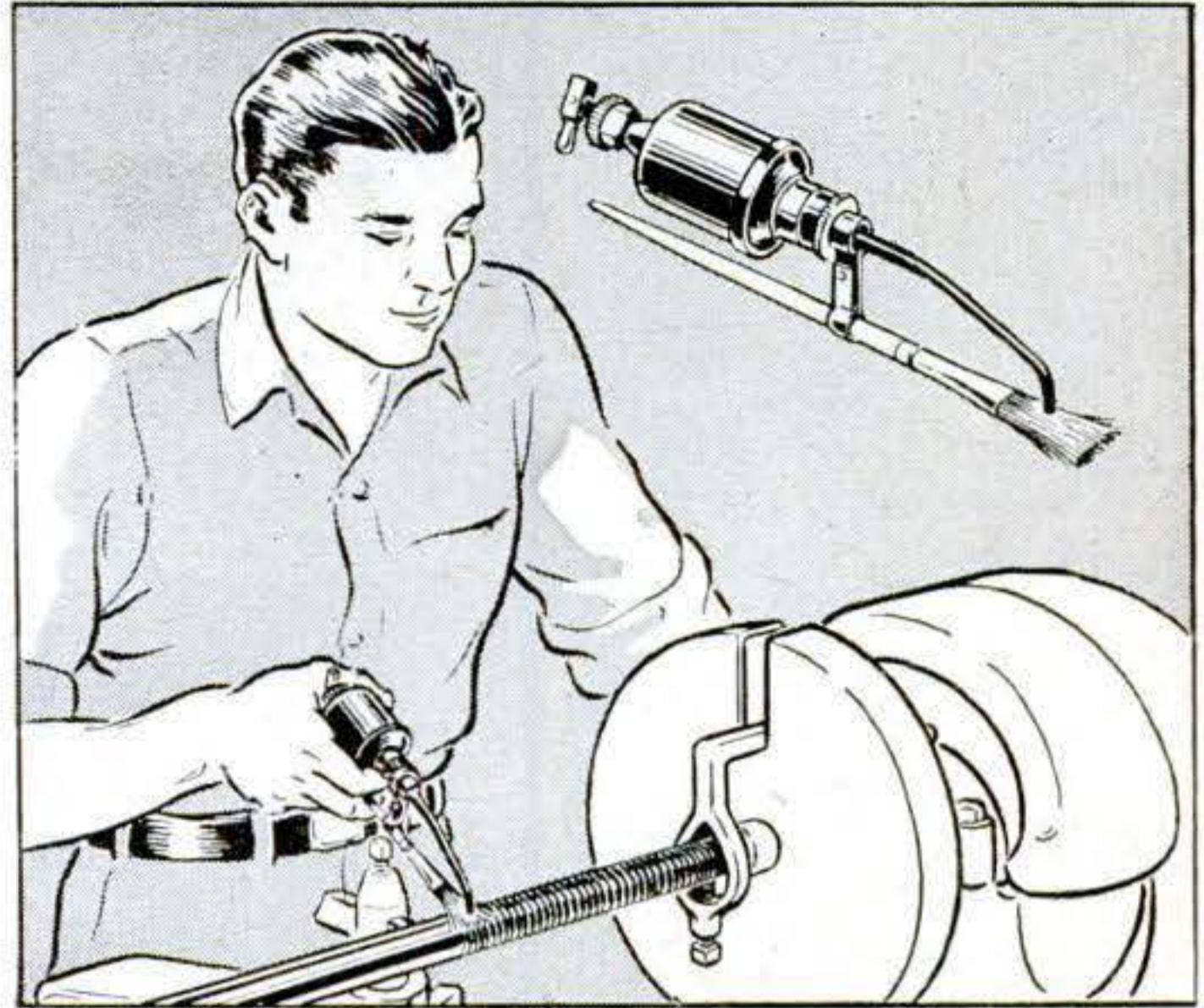
A good handle finish is one or two coats of linseed oil. Some craftsmen use auto or furniture wax. Clear lacquer or shellac is good when sanded smooth.

One attractive finish consists of charring the handle unevenly with a torch, sanding lightly, and then applying linseed oil, lacquer, or a French polish of shellac and linseed oil. Apply French polish with a pad and rub to a high polish; then let it dry overnight. This finish is one of the best for occasionally used hammers. For much-used handles and those used around lacquer thinner and other solvents, linseed oil or no finish at all will often prove best.

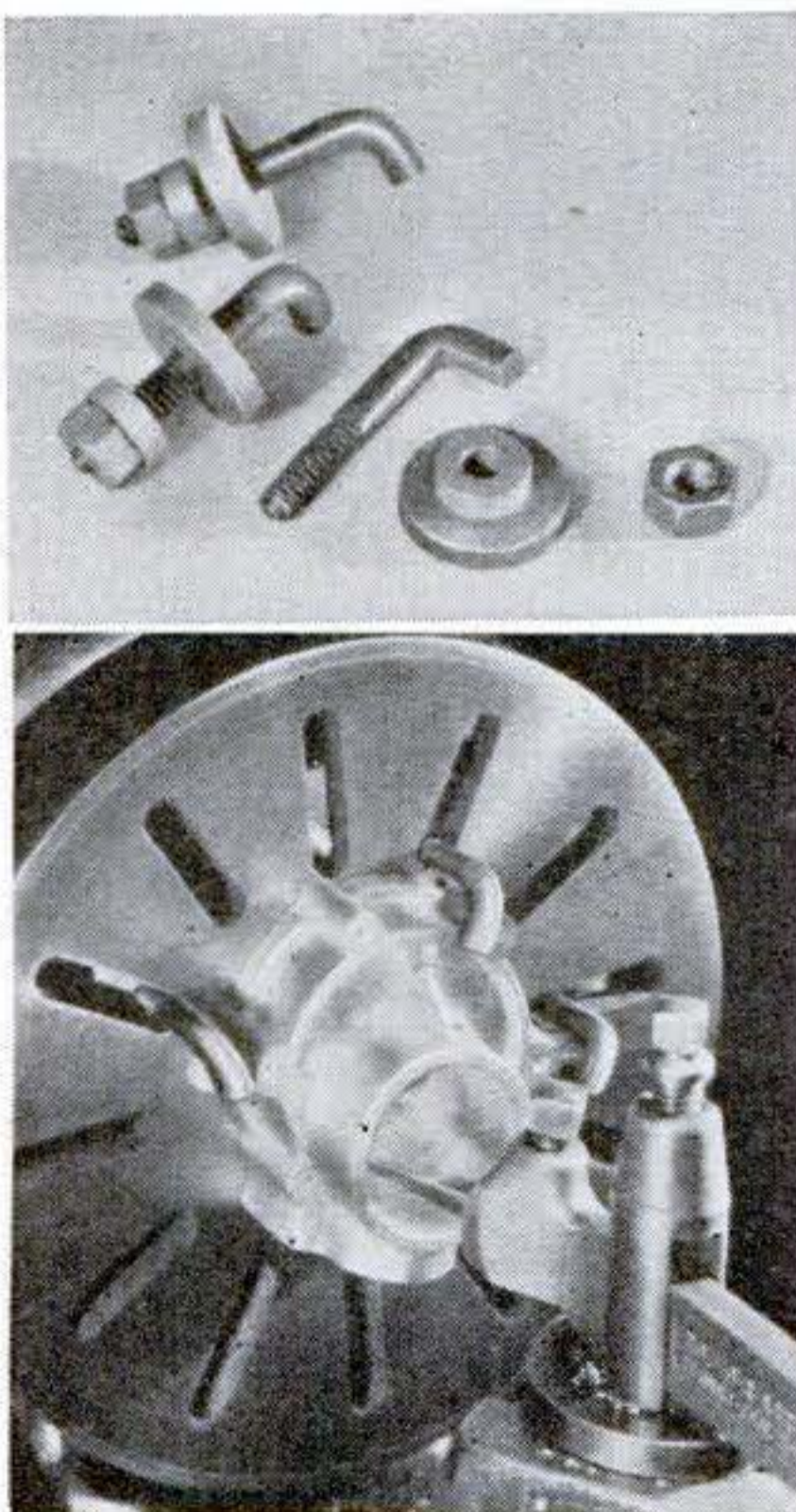
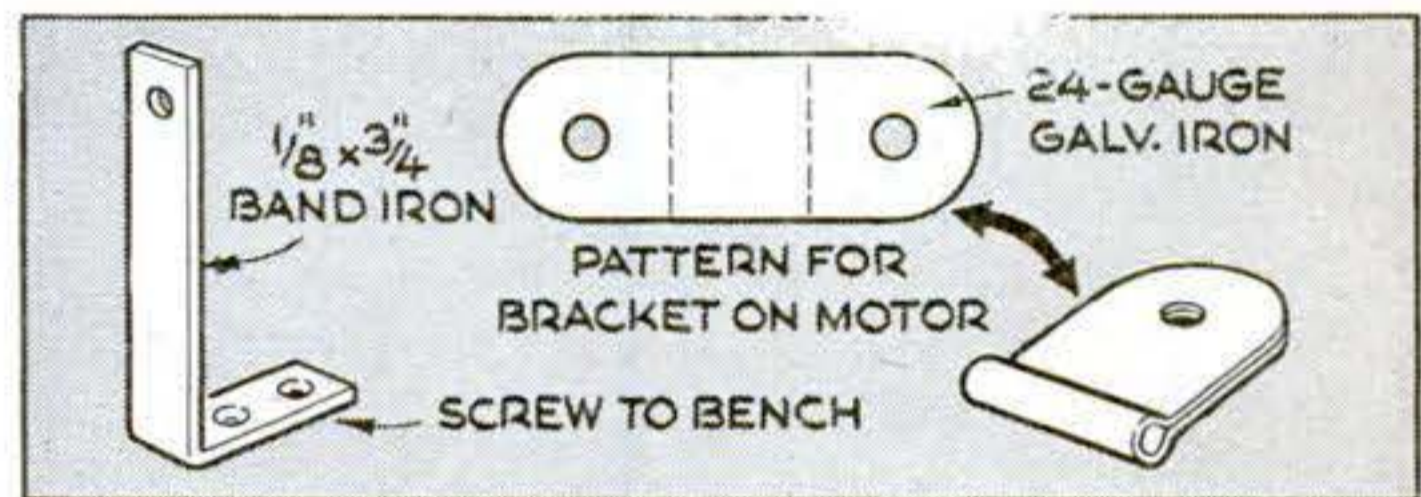
NEW SHOP IDEAS

SMOOTHER FINISH results when a cutting fluid is applied in heavy turning or thread cutting in the lathe. The oil can commonly used often supplies too much fluid at one point on the work and too little at another. The applicator shown at the right, made of a sight drip oiler and a cheap paint brush, supplies just the amount of fluid you want evenly all along the work, besides clearing away chips from previous cuts.

Solder a short length of $\frac{1}{4}$ " copper tubing to the bottom of the oiler and make a clamp as shown. Secured by a screw and nut, this clamps the brush to the oiler. Hold the brush against the work and adjust the oiler to the amount of flow best suited to the particular job.—AUGUST DOBERT.

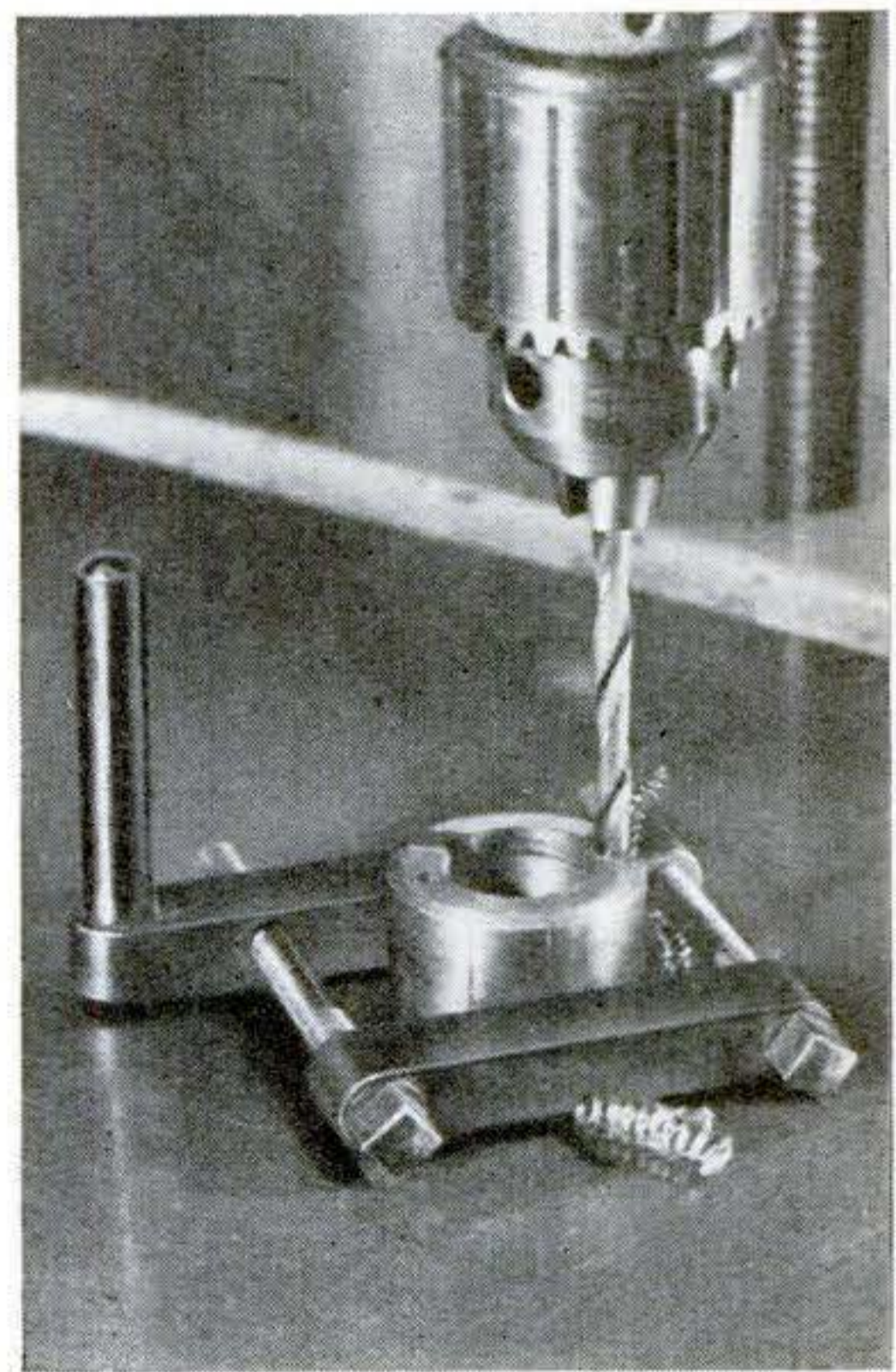


OUT-OF-THE-WAY SWITCHES can be brought close to hand with an automobile choke cable. The photo at left shows such a switch extension on a jigsaw. Make a bracket and cable clamp as shown in the drawing. Fasten the latter under a bolt on the switch housing and mount the bracket within easy reach. Cut the cable to length and mount it.—HORACE GAMBELL.



CLAMP DOGS such as are used for driving work mounted between lathe centers can, in an emergency, be used as drill-press vises. They permit the work to lie squarely on the drill-press table and afford a measure of safety over holding work by hand.—C. W. W.

FACEPLATE CLAMPS can be improvised in a hurry from ordinary bolts. Cut the heads off; then clamp the bolts in a heavy vise and hammer over the unthreaded ends at 90 deg. to the shanks. Use nuts and washers behind the faceplate.—C. W. W.



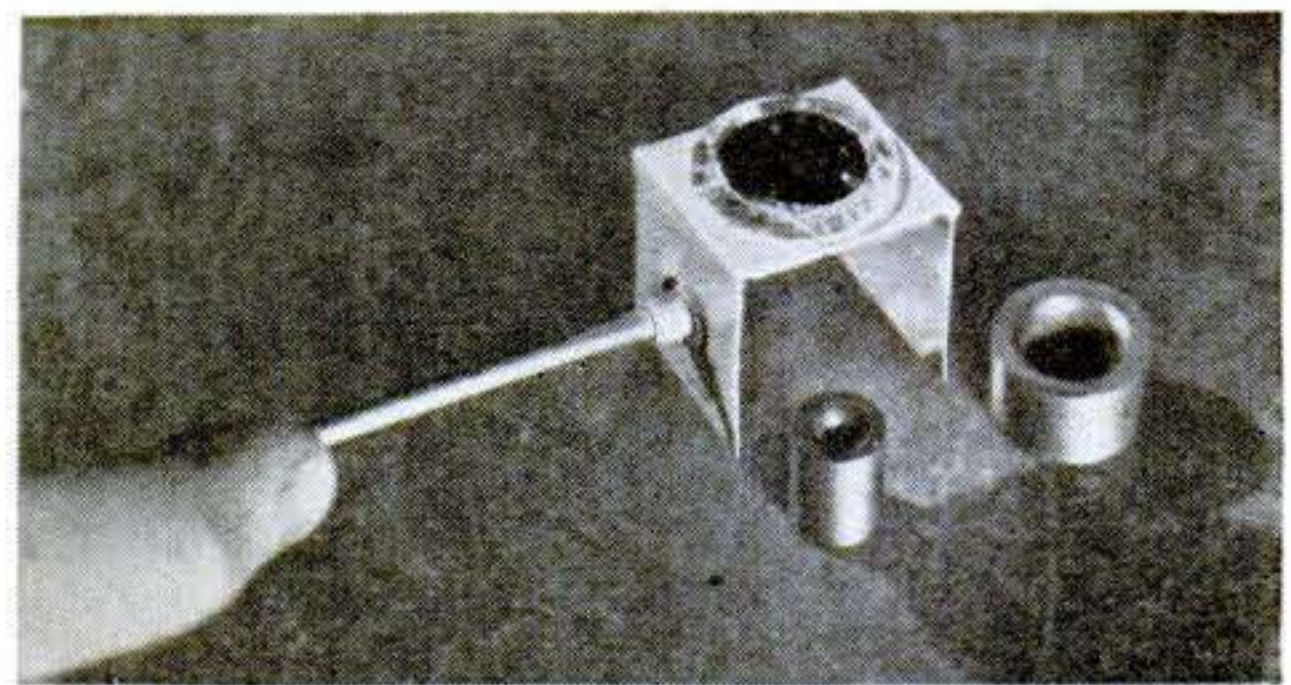


FLASHLIGHT MAGNIFIER PUTS LIGHT WHERE YOU NEED IT

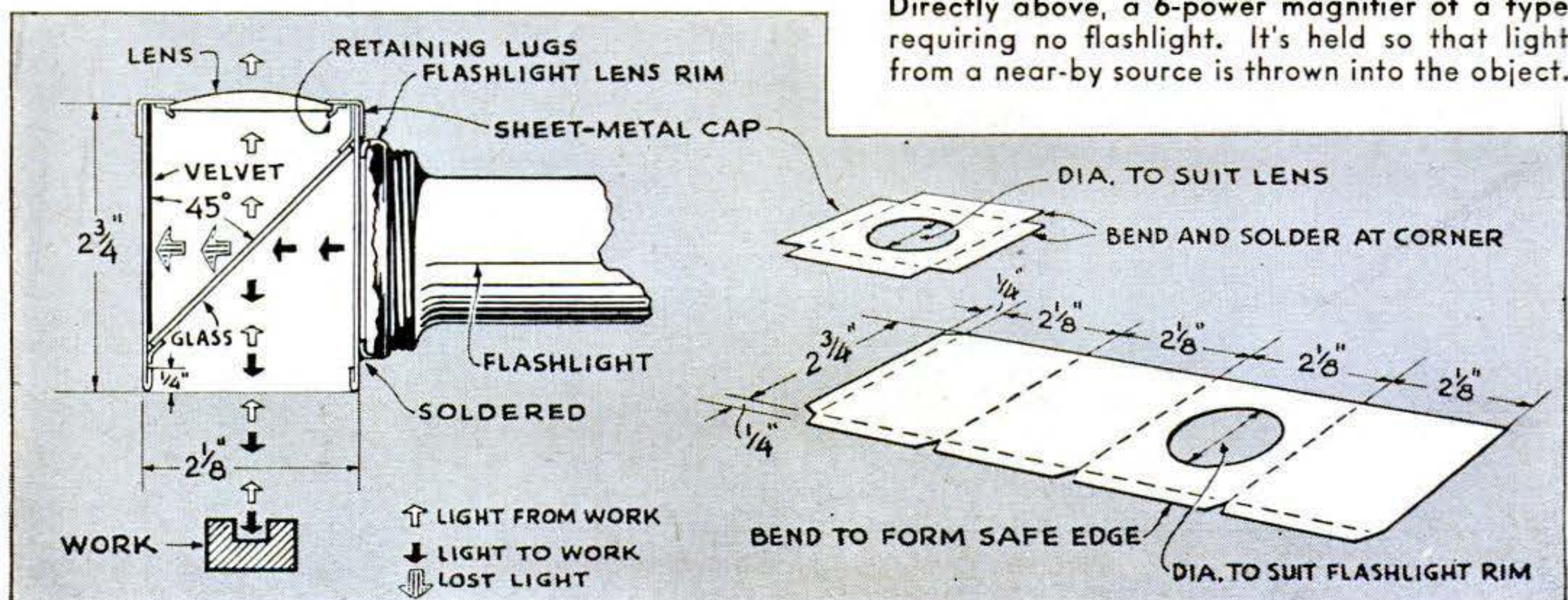
BY COMBINING a lens and a flat piece of glass you can make an illuminating magnifier that will enable you to inspect the bottom of a pistol barrel, internal threads, deep bores, and similar cavities hard to illuminate and look into at the same time. Illumination is afforded by a piece of plain glass mounted at an angle of 45 deg. below the magnifying lens. Light from one side is partially reflected down into the work and back from it to your eye.

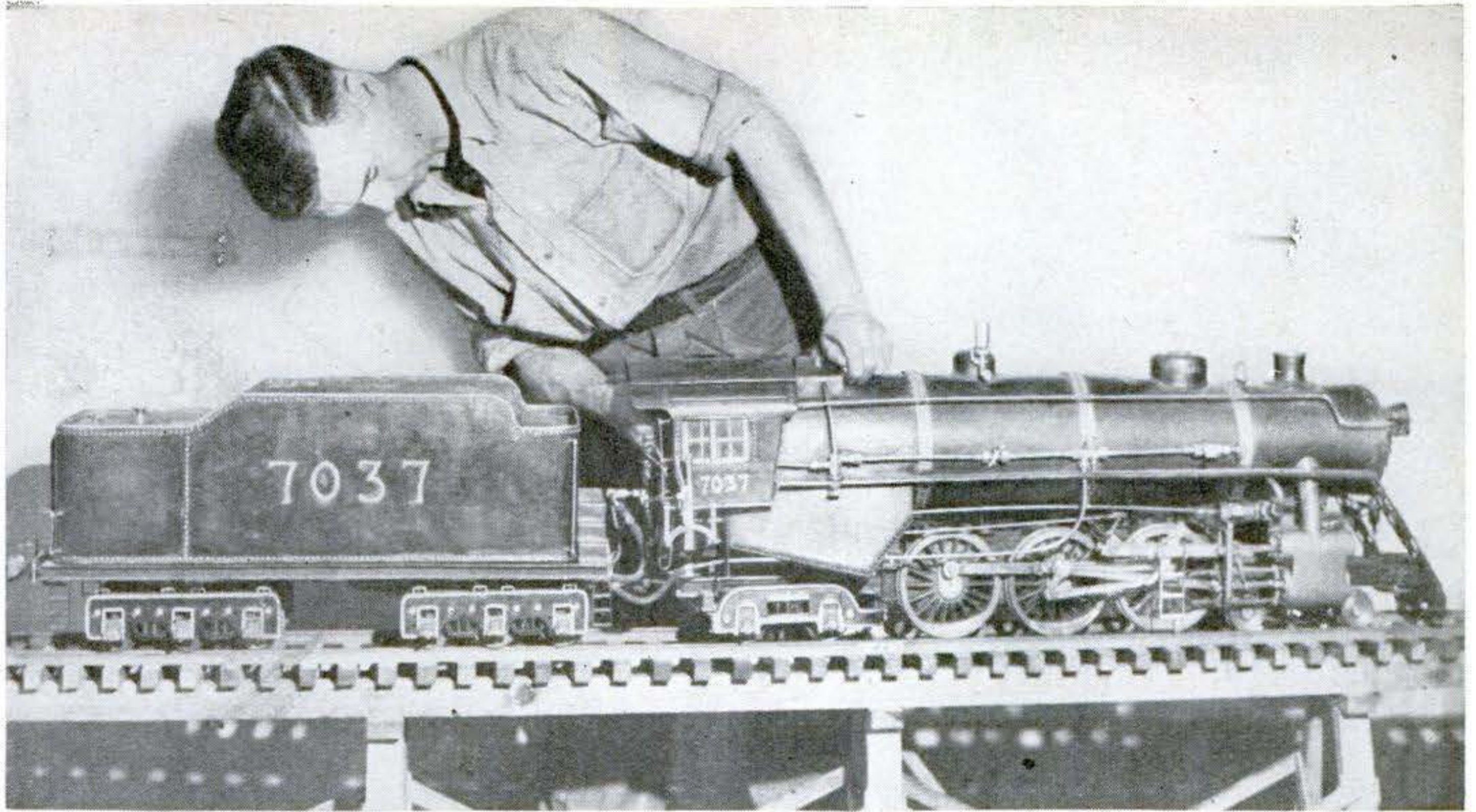
Make a square sheet-metal box, open at both ends, to suit the lens. Dimensions given are for a 45-mm. diameter lens of 136-mm. focal length. The box should be shorter than the best working distance between lens and object. In one side cut a hole the same size as the lens ring of a flashlight (Fig. 1) and solder the ring to it.

Flat, flawless glass from an old photo plate or lantern slide is mounted with metal clips soldered into the box. Paint all the inside flat black (Fig. 2) or glue a bit of black velvet opposite the flashlight. Make a lid for the box and mount the lens by means of small lugs, as in Fig. 3, over a hole in it.—M. C. WALLING.



Directly above, a 6-power magnifier of a type requiring no flashlight. It's held so that light from a near-by source is thrown into the object.





Running on aluminum tracks, this all-metal model locomotive is operated by steam generated by fuel oil.

CRAFTSMEN AT WORK

STEAM RAILROADING in miniature, exemplified by the live-steam locomotive above, is a hobby of Daniel Boone VII, of Burnsville, N. C. He started this engine in 1937, intending to exhibit it at the 1939 World's Fair, but it wasn't completed until 1943. It weighs 200 lb. and pulls a 1,500-lb. load with its builder-engineer perched on top of the tender.

HOLDS ALL, HIDES ALL just about sums up the function of the handsome sewing cabinet shown below, designed and built for his family by R. M. Utterback, of Newark, Ohio. Although full of thread, there are certainly no strings attached to this job.

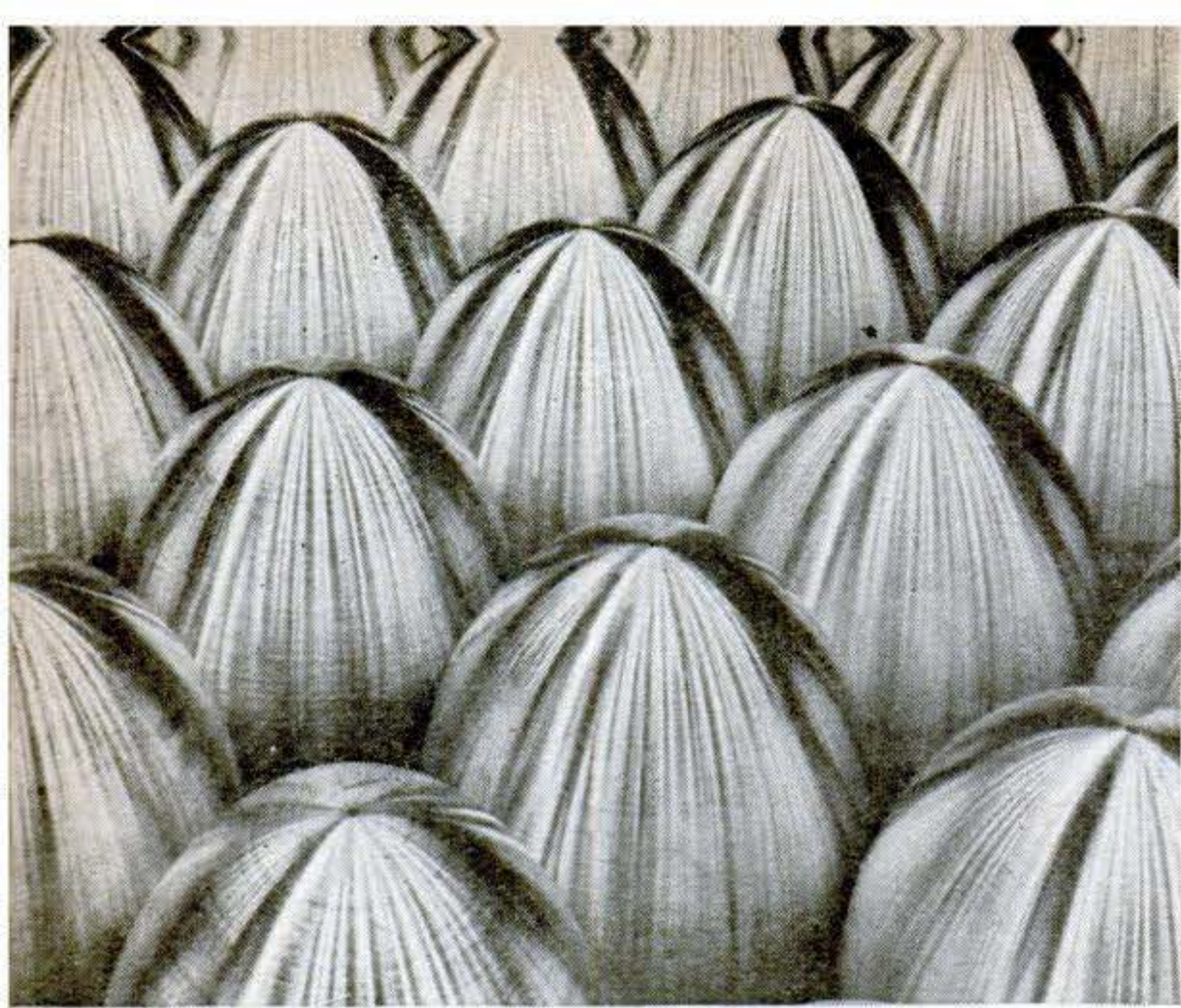
It is built of solid oak and is 13" by 22" by 32". The drawers are set in to allow room for spool racks, fitted with metal pins, when the doors are closed. Shelves at top and bottom are for storing unfinished work.



WOODCARVING is only one of several hobbies of Chester E. Lawton, of Whitewater, Wis., but it is the one in which he can best express his historical interests. Mr. Lawton uses only a jackknife and a few assorted chisels, and specializes in reliefs carved in pine planks.

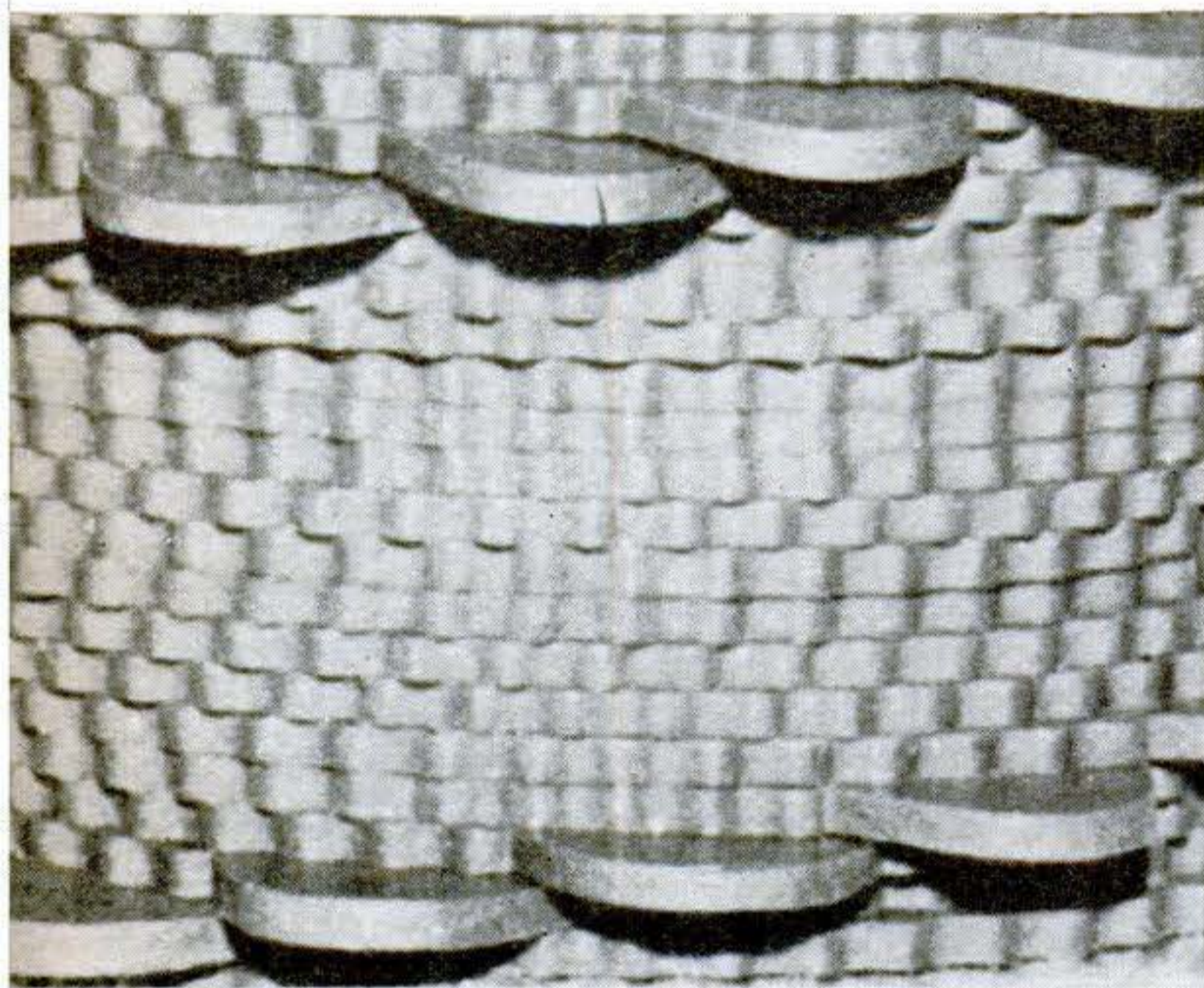
In the photo above, he is seen holding a plaque called "The Alamo" which he completed in 40 hours. Among his varied subjects are a ballet dancer, a prehistoric man, an American eagle, local buildings, and a castle. He also carves lapel pins.





NEITHER BEEHIVES NOR IGLOOS these, but the nose sections of housings in which aircraft machine guns are mounted. The photo was taken at a Douglas Aircraft plant.

GEARS IN AN ADDING MACHINE? No, the photo below is a cropped one of ordinary rubber jar rings stacked with the tabs stepped. It is the work of Stella M. Ludlow, of Penn Yan, N. Y.



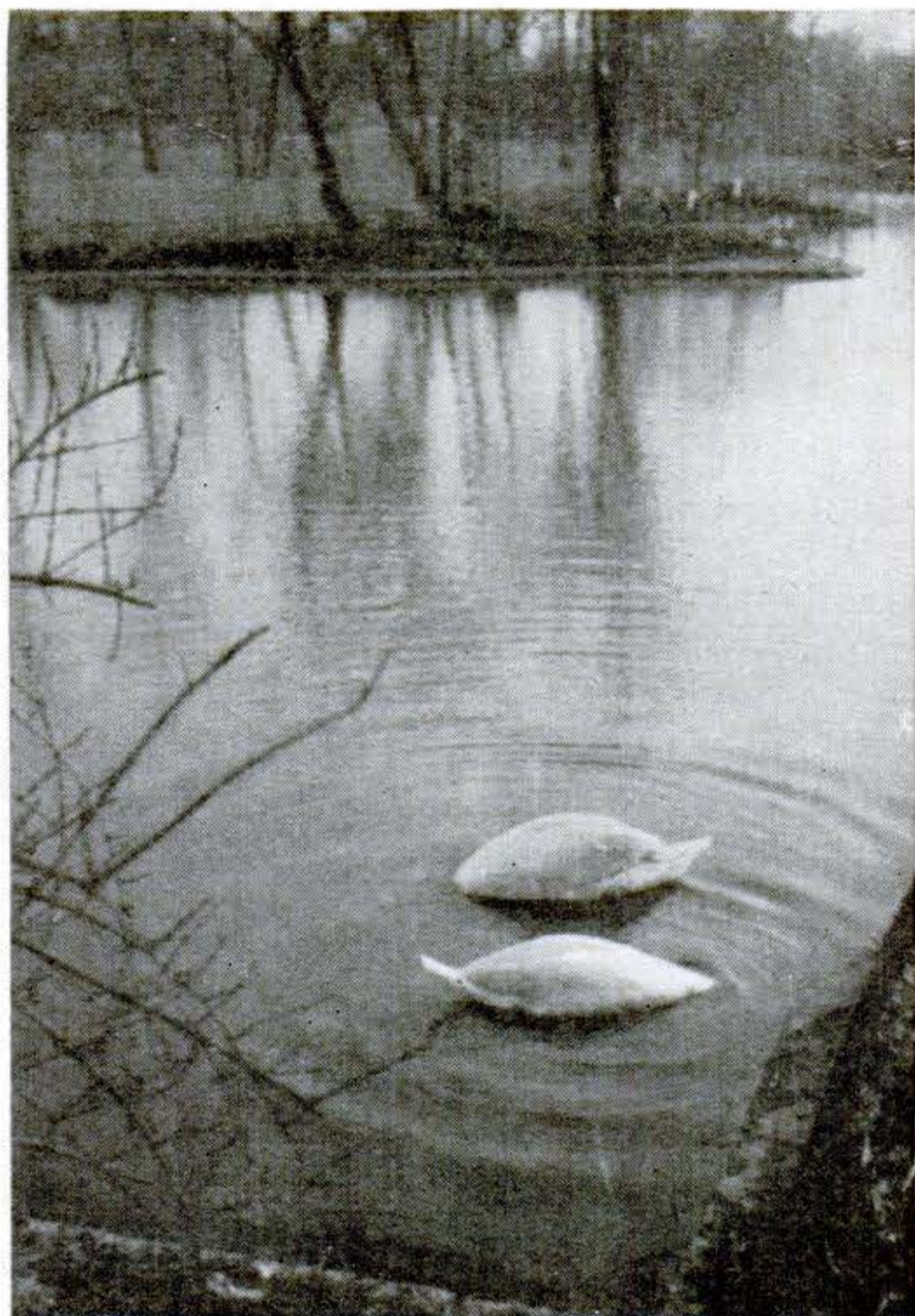
WOULD A CAR ROLL up or down on this optical downgrade on the Blue Ridge Parkway in North Carolina? You guessed it. The car shown would coast backward, apparently uphill, for the road actually slopes down toward the camera. Optical illusions are frequent in mountains, where there are few horizontal bases.



CAN YOU BEAT THESE PICTURES?

We will pay \$5 for any photo used on this page. Write your name and address on each print. Enclose a stamped, self-addressed envelope and the negative, if it is available, and send your contribution to the Curious Photos Editor.

WHAT DOES THE CAMERA SEE over a wall that's too high for you? E. W. Schade, of Fair Haven, Mich., tried it at the St. Louis Zoo and got two ducking swans.



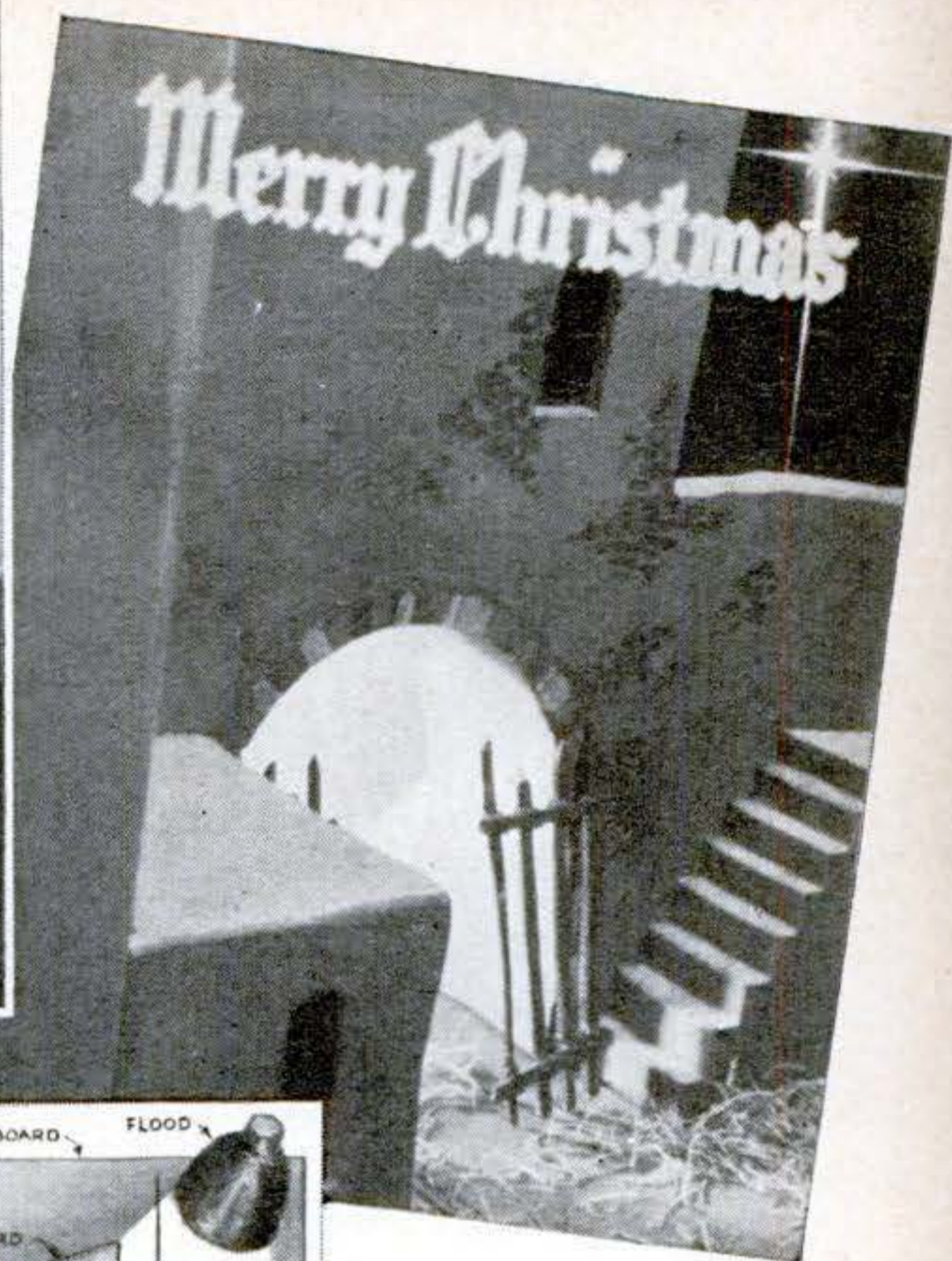


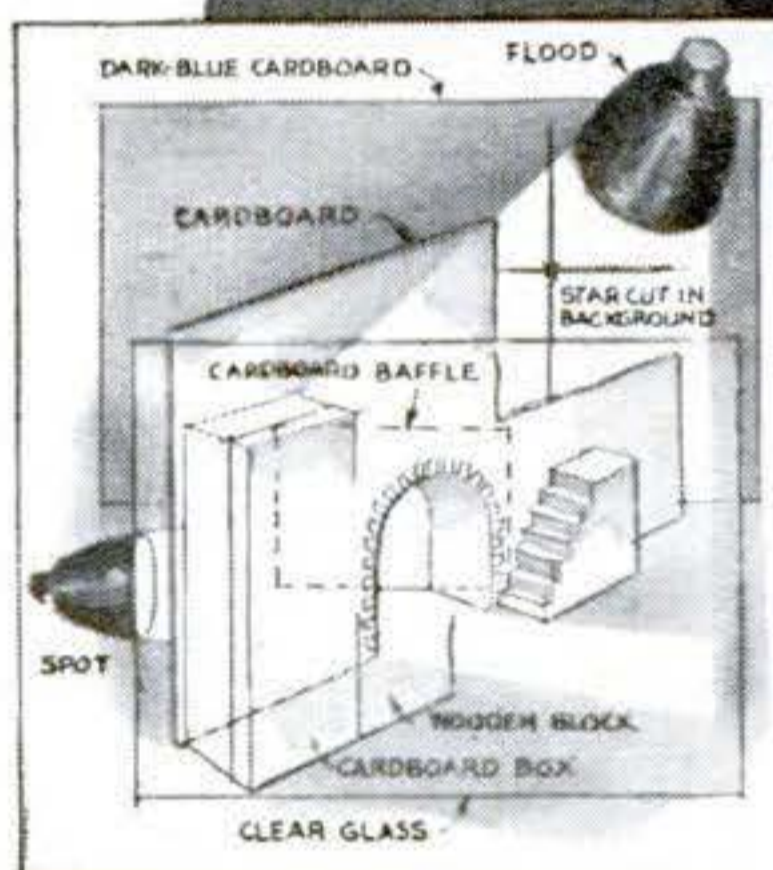
Photo Christmas Cards Are Personalized Greetings

STEREOTYPED holiday greetings may be avoided if you use the photographic method to make your own individualized cards. The three shown on this page suggest how large is the scope for your imagination.

For the skating card, the angels were built up with wooden bodies, wire legs, tinplate skates, and costumes snipped from gift wrapping paper. Base of the scene was a sheet of glass, over which melted paraffin was flowed to simulate ice. The lettering was scratched into the paraffin and the grooves filled with table salt. For the jagged edge, the paraffin was cut away with a knife and a piece of black cardboard placed under the glass at that point. Lighting was arranged to pick up the lettering.

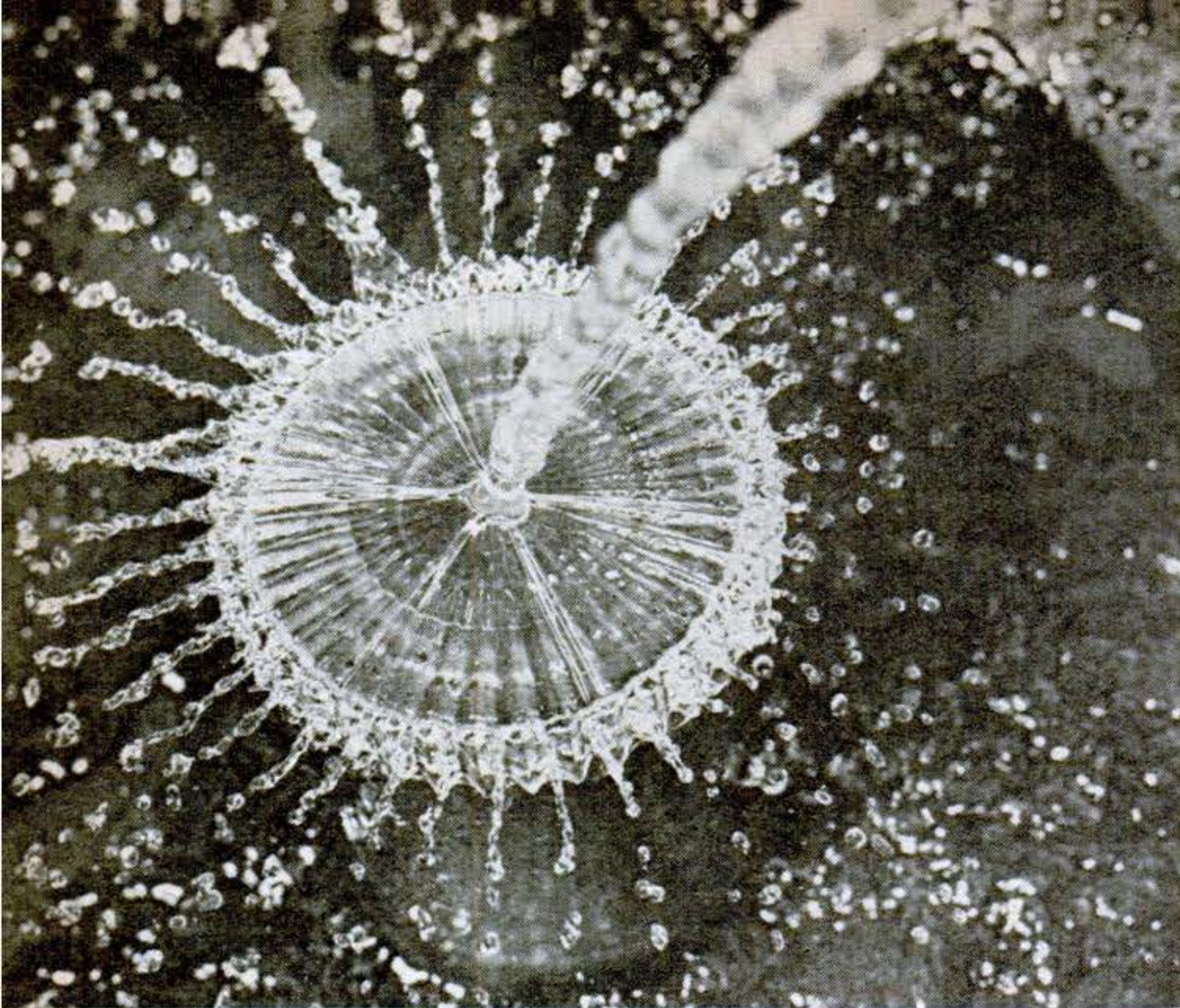
In the manger courtyard, the stable gates were thin strips of wood bound with cord, the stairs were cut from a block of wood, and dried grass served as hay. The lettering was painted on a sheet of clear glass with white poster paint and the scene photographed through the glass.

A triple exposure was needed for the Christmas-tree card. Lettering was punched with an ice pick through the back-lighted cardboard background, in front of which an evergreen sprig was mounted. Soap flakes and water, mixed to paste consistency, served as snow. The outlines of the balls were carefully traced on the ground glass of the camera as a guide for making the portrait exposures, which were then successively taken on the same film. It was necessary, of course, not to throw light on the exposed portions.—CARL W. BERTSCH.



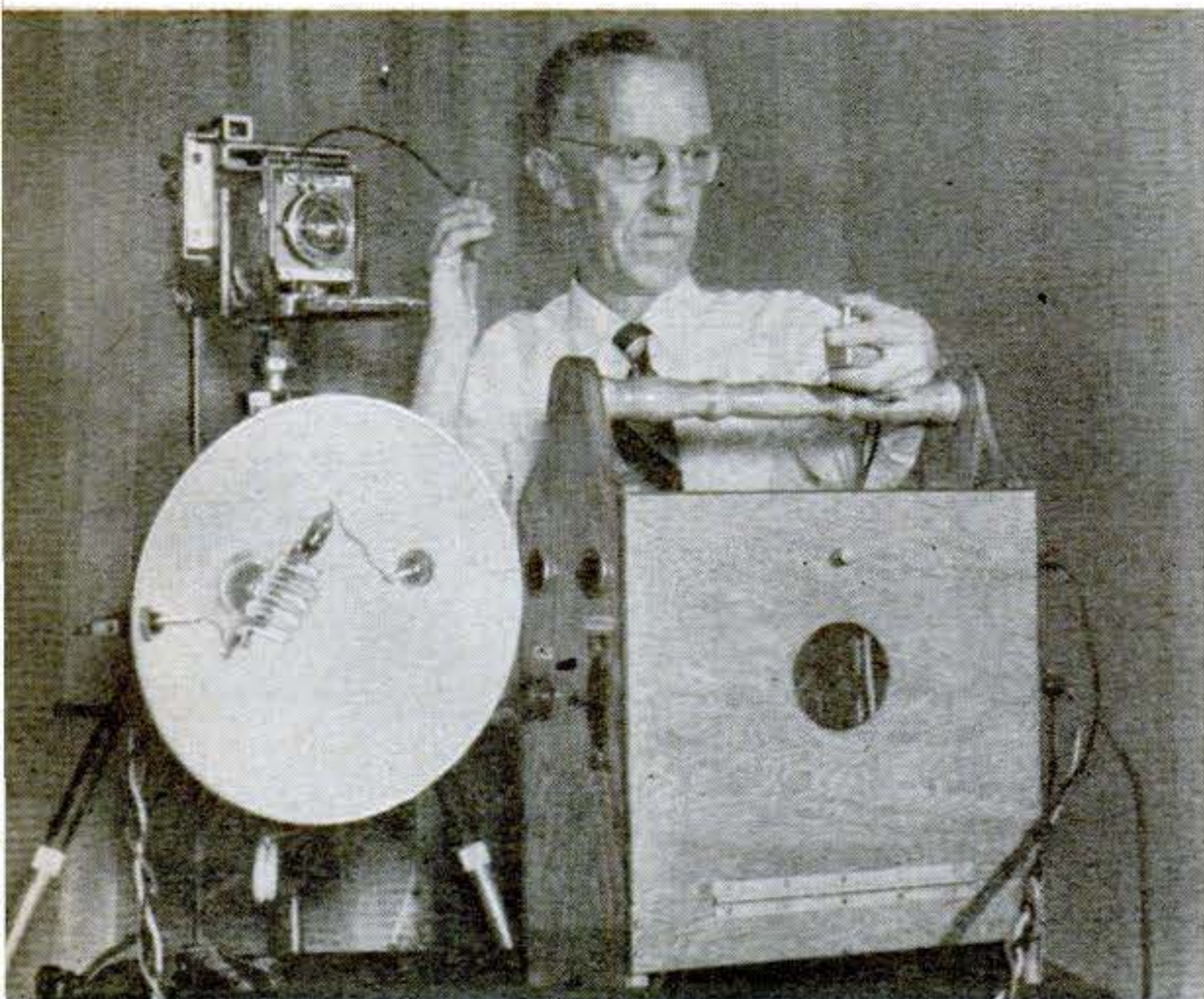
The effective manger scene above, a tabletop shot, was set up as shown at the left. The star was made by cutting some slits in the background and using a light behind.





Drops of water splashing from a glass coaster under a wide-open faucet are caught in a 1/10,000-second photo flash. Right, water bounces out of a tumbler rebounding from felt on which it has been dropped.

HOMEMADE SPEED FLASH STOPS FAST ACTION



A high-speed flash comes from the gas-filled tube, left. The electronic control for it is in the box.

USING home-assembled equipment, Arthur Palme, of Pittsfield, Mass., catches on photographic film action that is too quick to be seen by the eye. Motion arrested with the aid of his speed-flash outfit is much faster than any that could be stopped by the best mechanical shutter.

The essential parts of the equipment are a high-voltage transformer, a rectifier tube, a battery of condensers charged with 2,000 volts D.C., a spark coil, and a krypton-gas, coiled flash tube. By means of a specially devised electric-trigger circuit, intense flashes as short as 1/10,000 second are released at the exact instant of desired action. With the camera shutter left open in semi-darkness, the film records only what is visible during the brief flash.

Examples of action that can be stopped are the photos above of a violent stream of water splashing on a glass coaster and of water bouncing out of a dropped tumbler.

SHOEHORN HELPS MEASURE OUT DRY PHOTO CHEMICALS

GETTING the scales to balance exactly with those last few grains of chemical is often an exasperating task. Try using a metal or plastic shoehorn, and you will be surprised at how it speeds up the job.

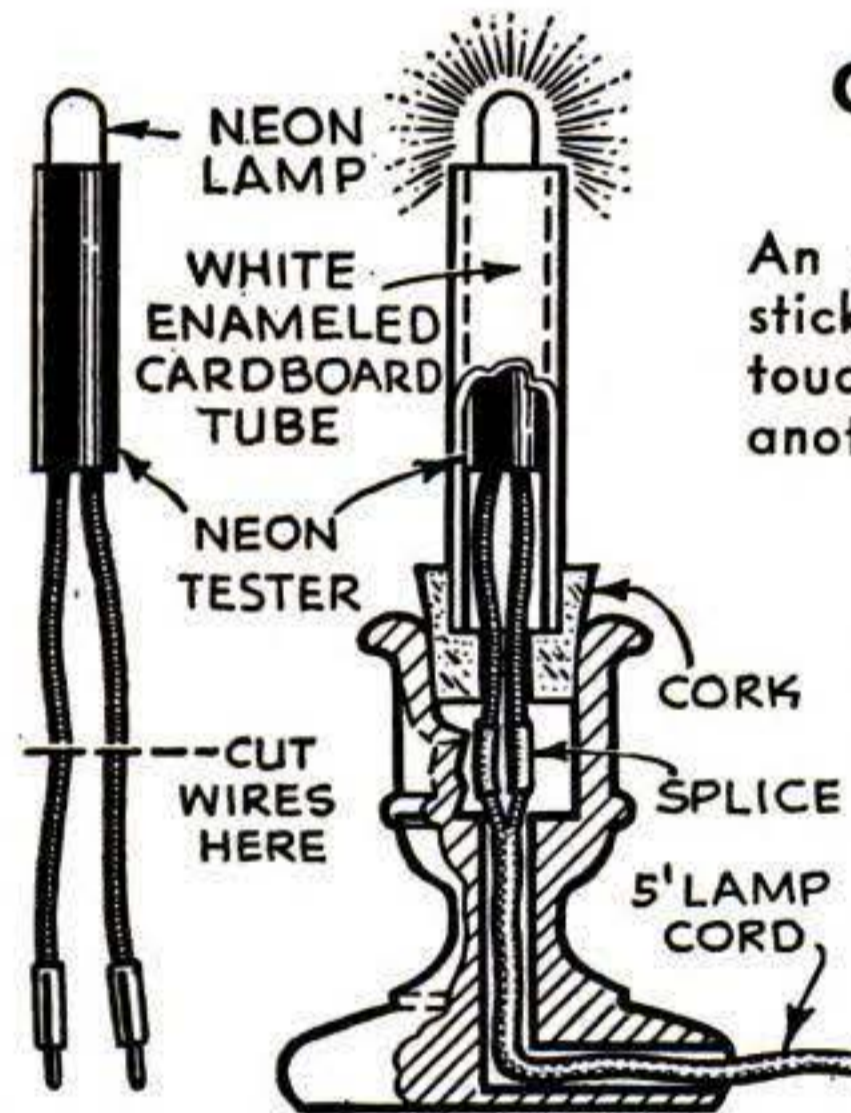
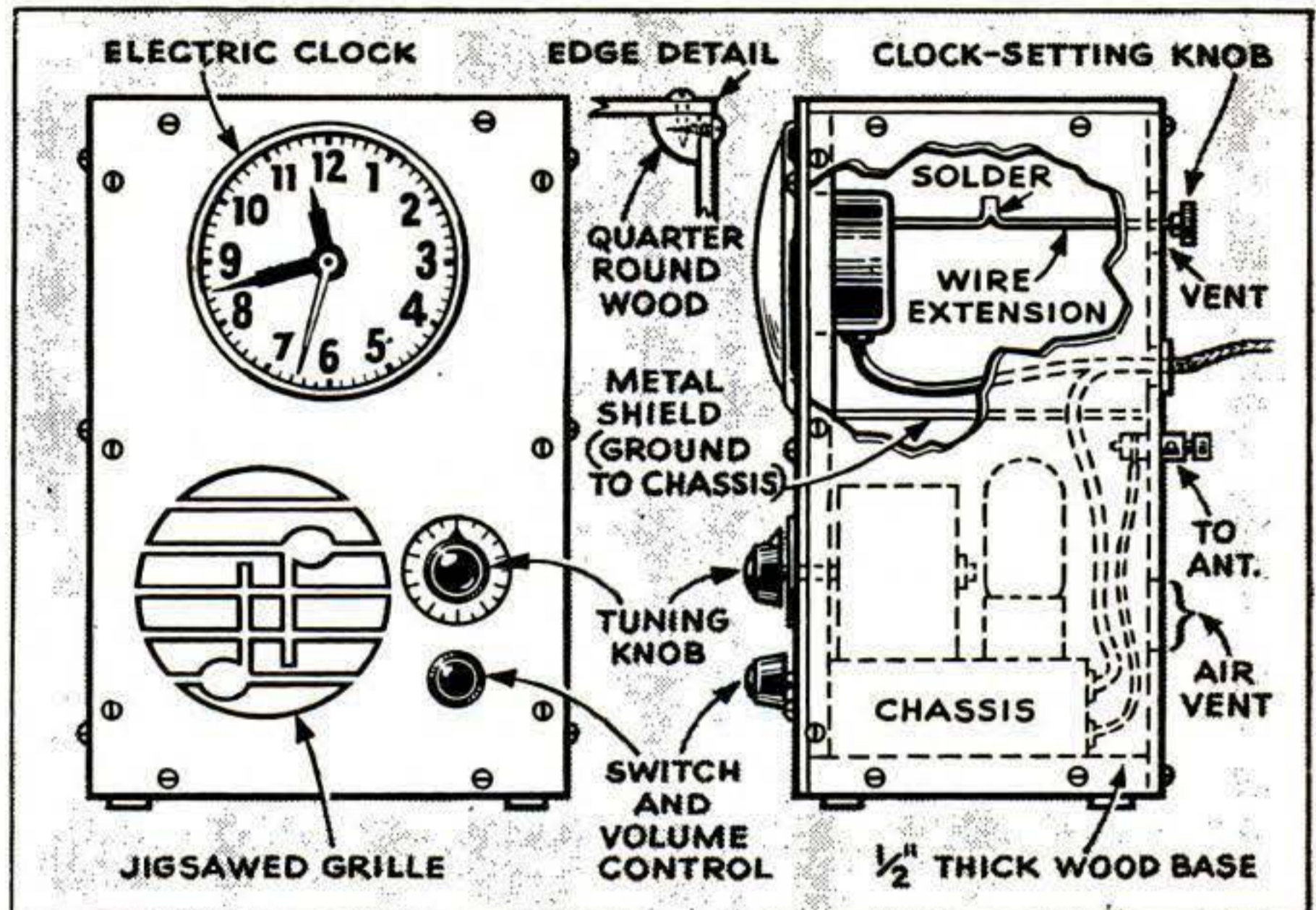
A shoehorn is more efficient than a spoon, for its smoothly rounded end permits shaking off small amounts of powder or crystals to get an exact balance. It removes excess chemical just as well.—WILL THOMAS.



COMBINATION CABINET HOUSES BOTH A RADIO CHASSIS AND CLOCK

HAVING a good but unhoused radio chassis and an electric clock with a badly damaged case, I constructed a combination cabinet for both units along the lines shown here.

Clock, speaker, and shaft positions were first marked off on a composition panel, which was then drilled and jigsawed. A square of cloth is glued behind the loudspeaker grille. To extend the clock-setting knob, I soldered to it a stiff wire extension, and between the clock and radio I placed a metal shield grounded to the radio chassis.—JOHN E. RASK.

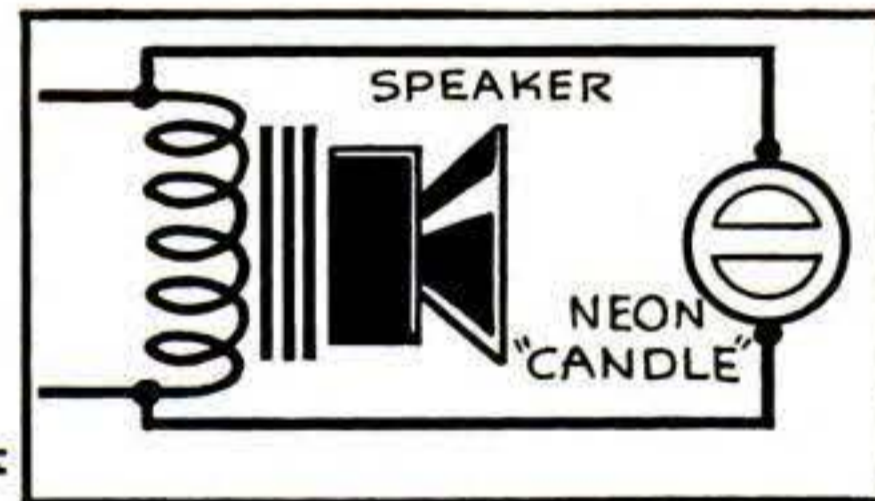


GLOW OF RADIO "CANDLE" KEEPS TIME TO MUSIC

An old wooden candlestick adds a realistic touch to the lamp, but another base would do.

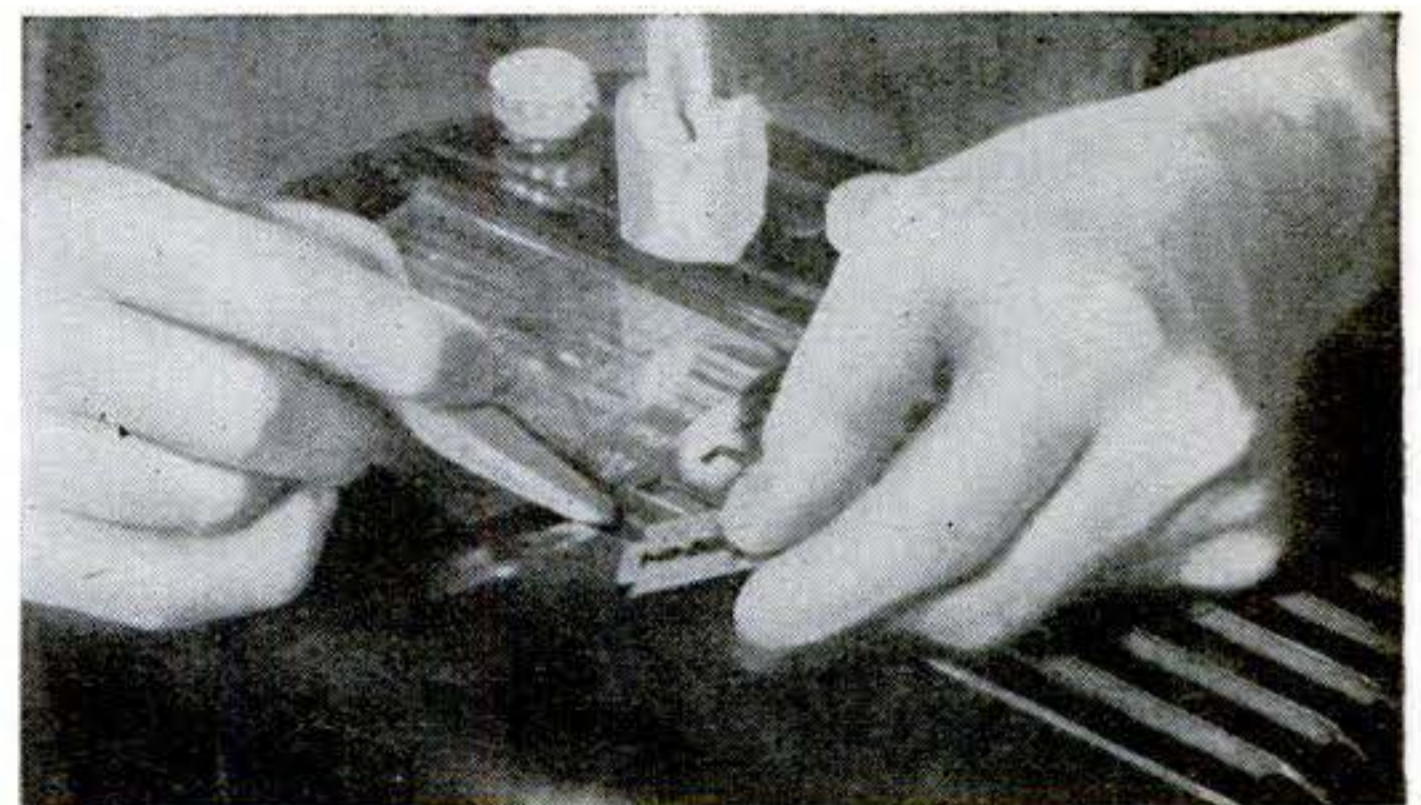
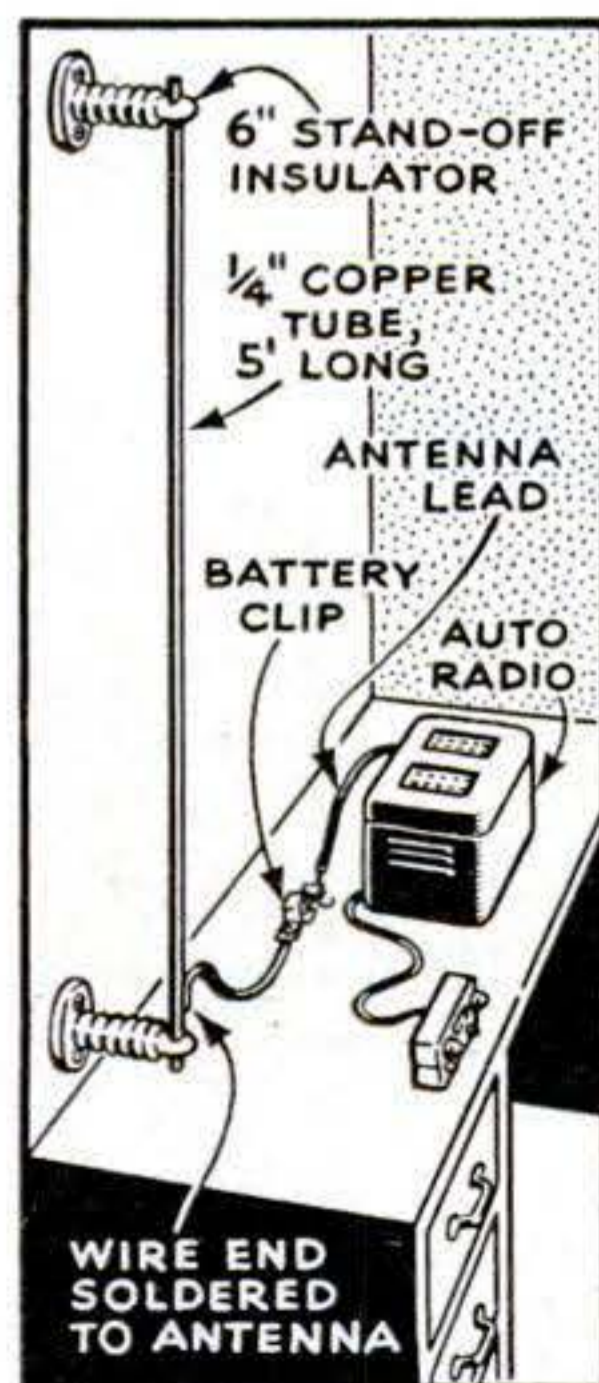
A LITTLE light that seems to flicker and flare in time with the voice or music reproduced by your radio can be made of a neon tester of the kind used to check circuits.

Substitute a 5' length of lamp cord for the test leads and enclose the shaft in a 4" tube of white enameled cardboard to simulate a candle. Mount the tester in a wood or cork base and connect the wires across the primary of the output transformer of your radio.—E. E. YOUNGKIN.



SHOP ANTENNA FOR AUTO RADIOS MADE OF COPPER TUBING

TESTING auto radios in a shop sometimes fails to give an accurate picture of performance because the long outside antenna tends to overload the set under test. Auto radios are designed for high - sensitivity reception since they are expected to operate with short aerials. If you often have occasion to service these sets, use a copper tube about 5' long, installed above your workbench by means of stand-off insulators, as shown at the right.—W. MOODY.



SEALING WAX FILLS SCRATCHES IN PLASTIC CABINETS

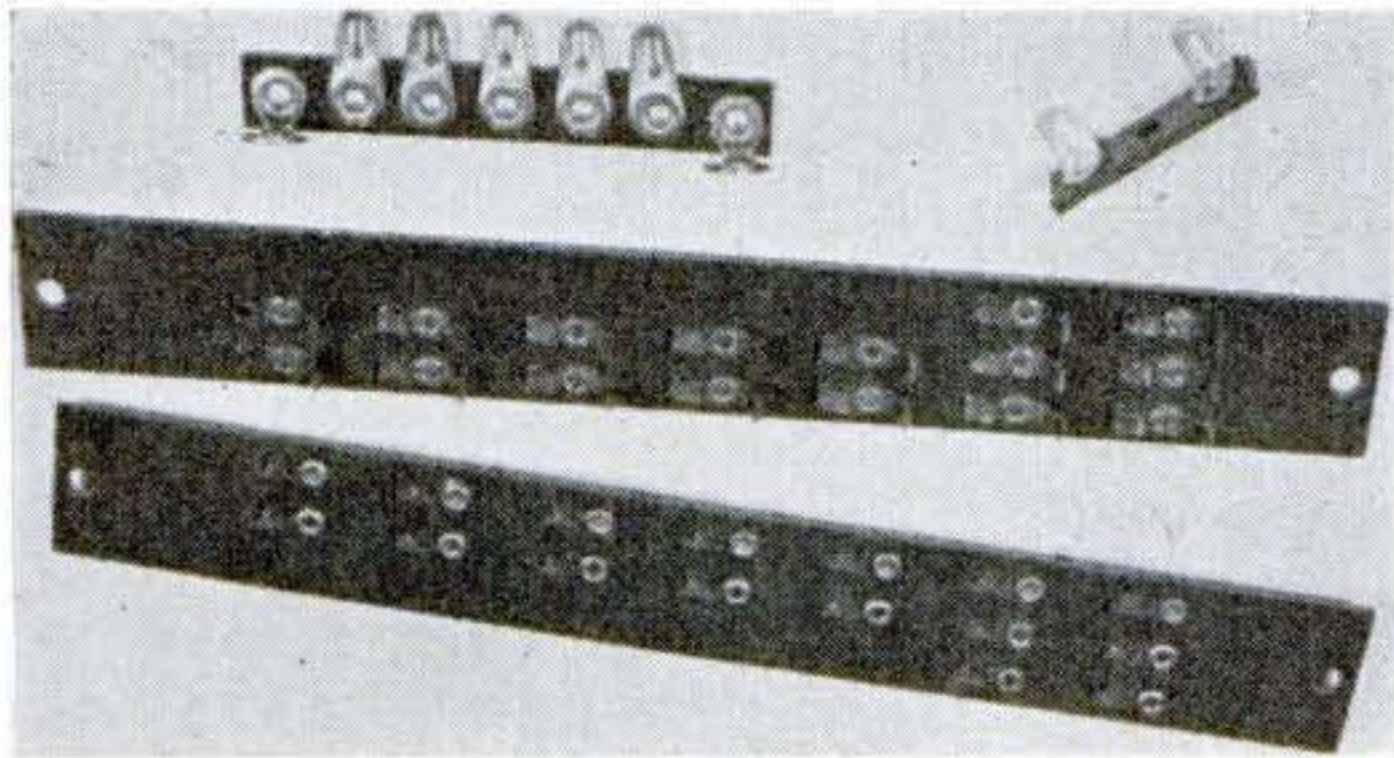
SMALL nicks and scratches on plastic radio cabinets can be neatly repaired with ordinary sealing wax. To prevent the sealing wax from hardening too quickly while it is being worked, warm the cabinet by removing the chassis and replacing it with a large lamp bulb.

Drop a tiny blob of wax where needed and smooth with a razor blade.—H. KLEIN.

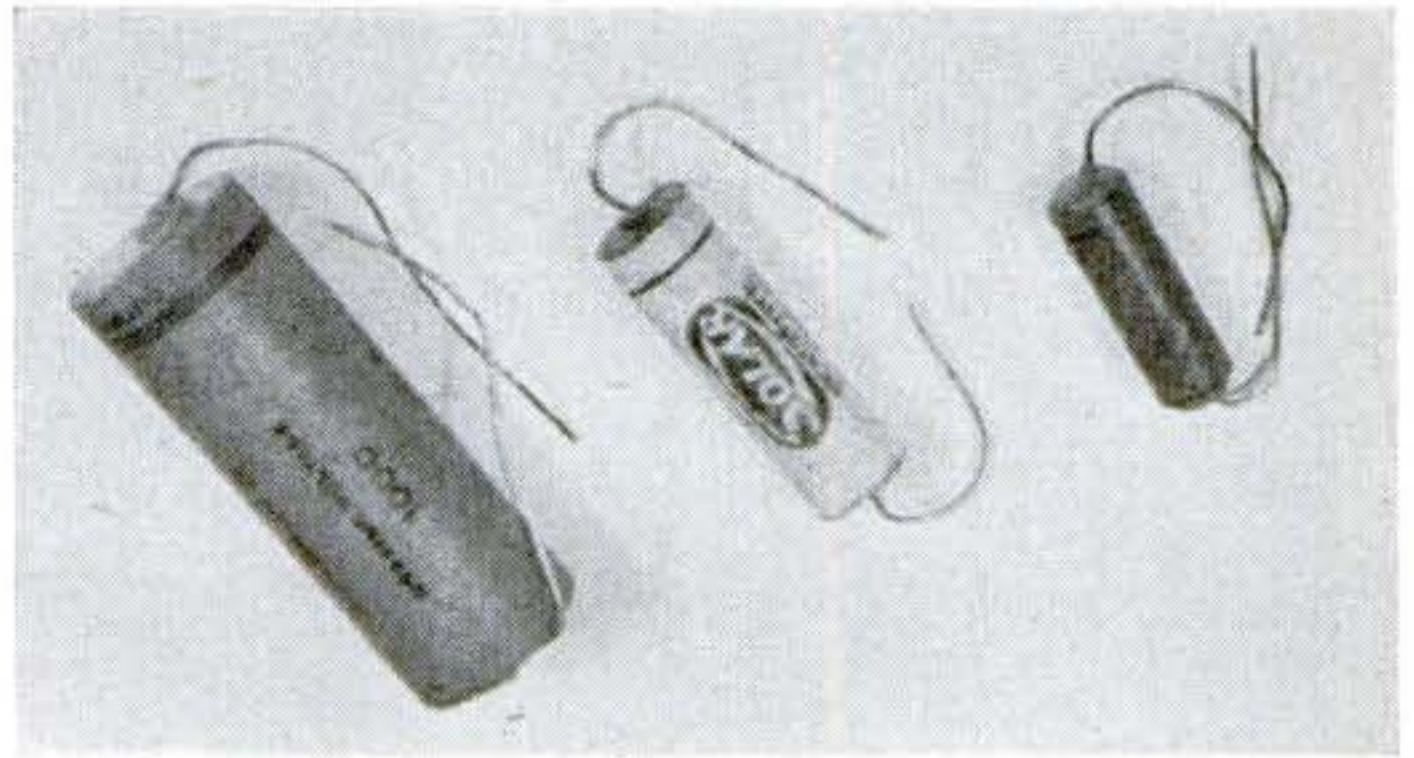
ANSWERS

- 1. Universal output transformers.
- 2. C bias cell, a "perpetual" battery that maintains a 1½-volt potential for an indefinite time.
- 3. Intermediate-frequency (456 kc.) transformer.

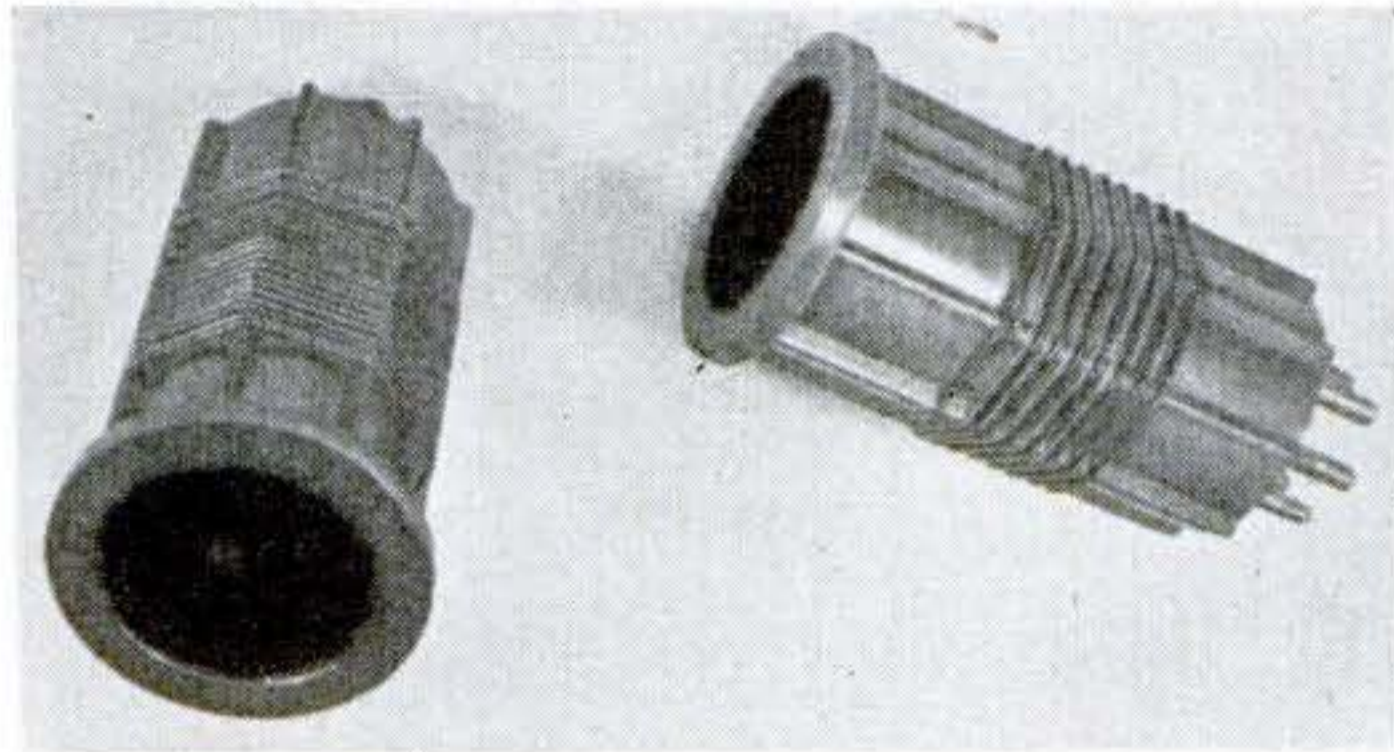
- 4. Radio-frequency chokes.
- 5. Straight-line frequency short-wave tuning condenser.
- 6. Short-wave receiver plug-in coils.
- 7. Paper bypass condensers.
- 8. Mounting or terminal strips.



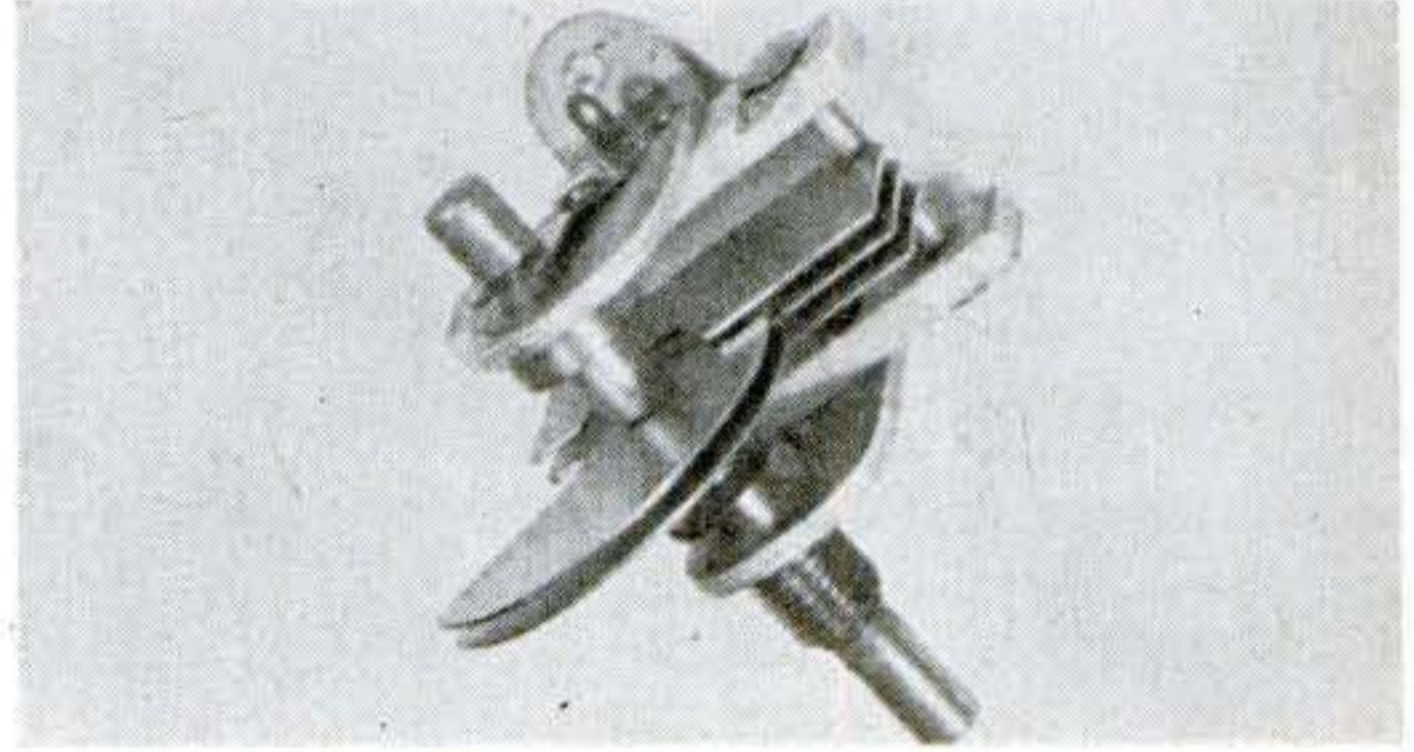
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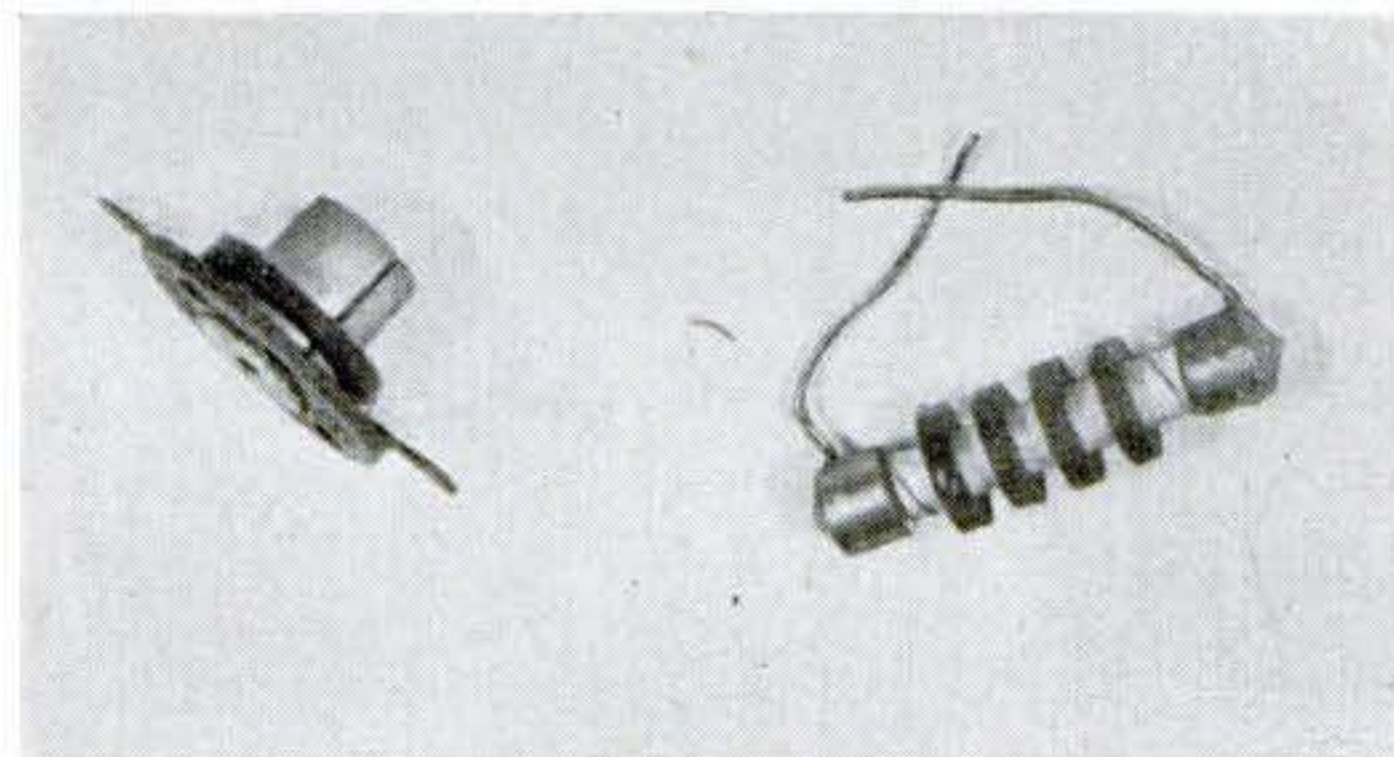
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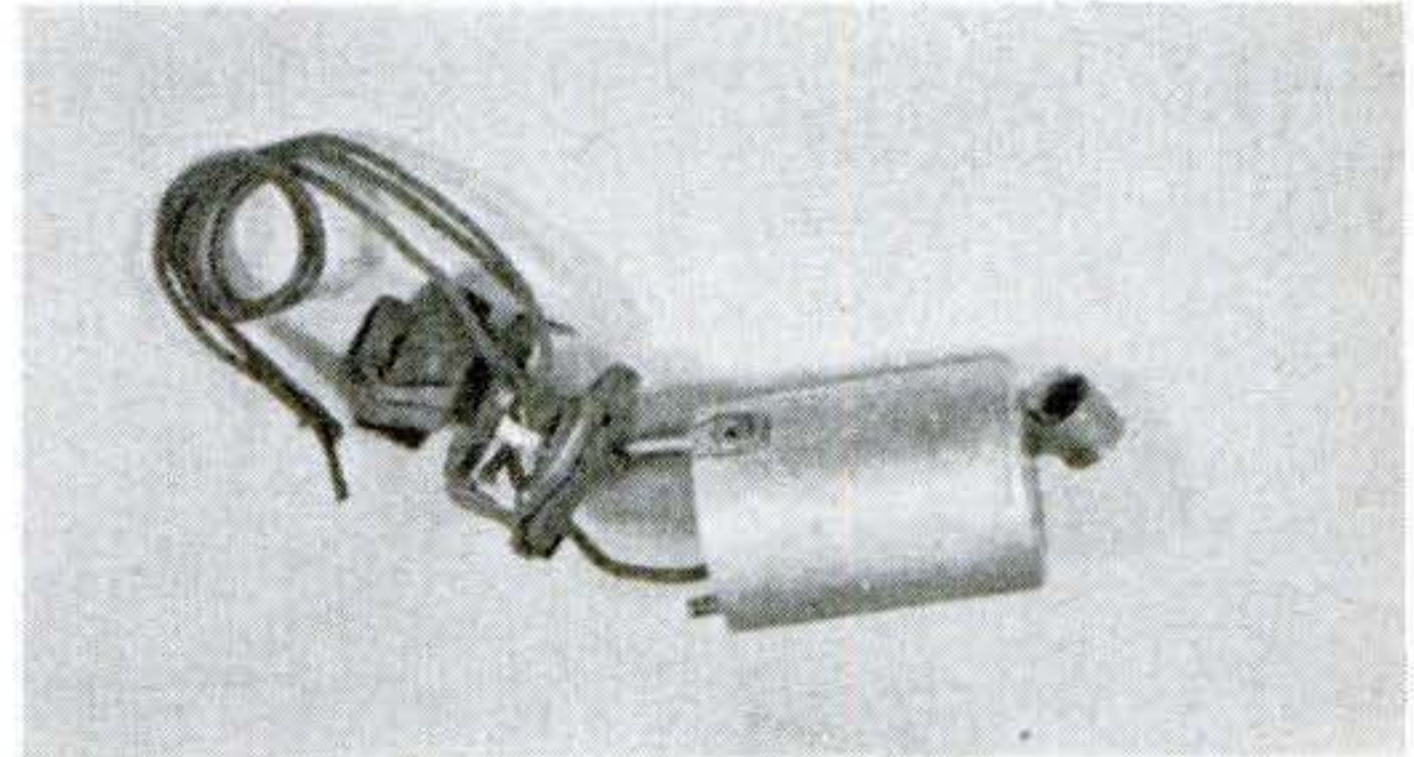
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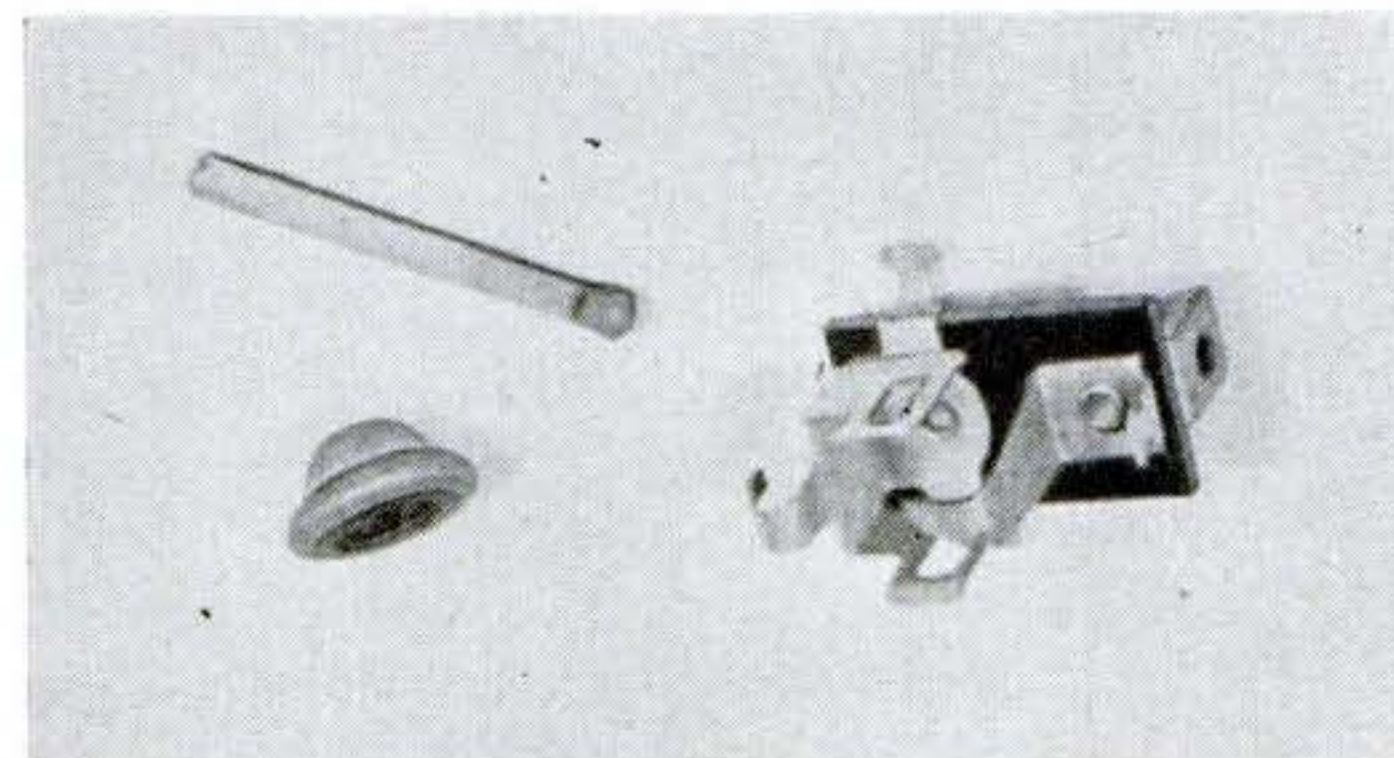
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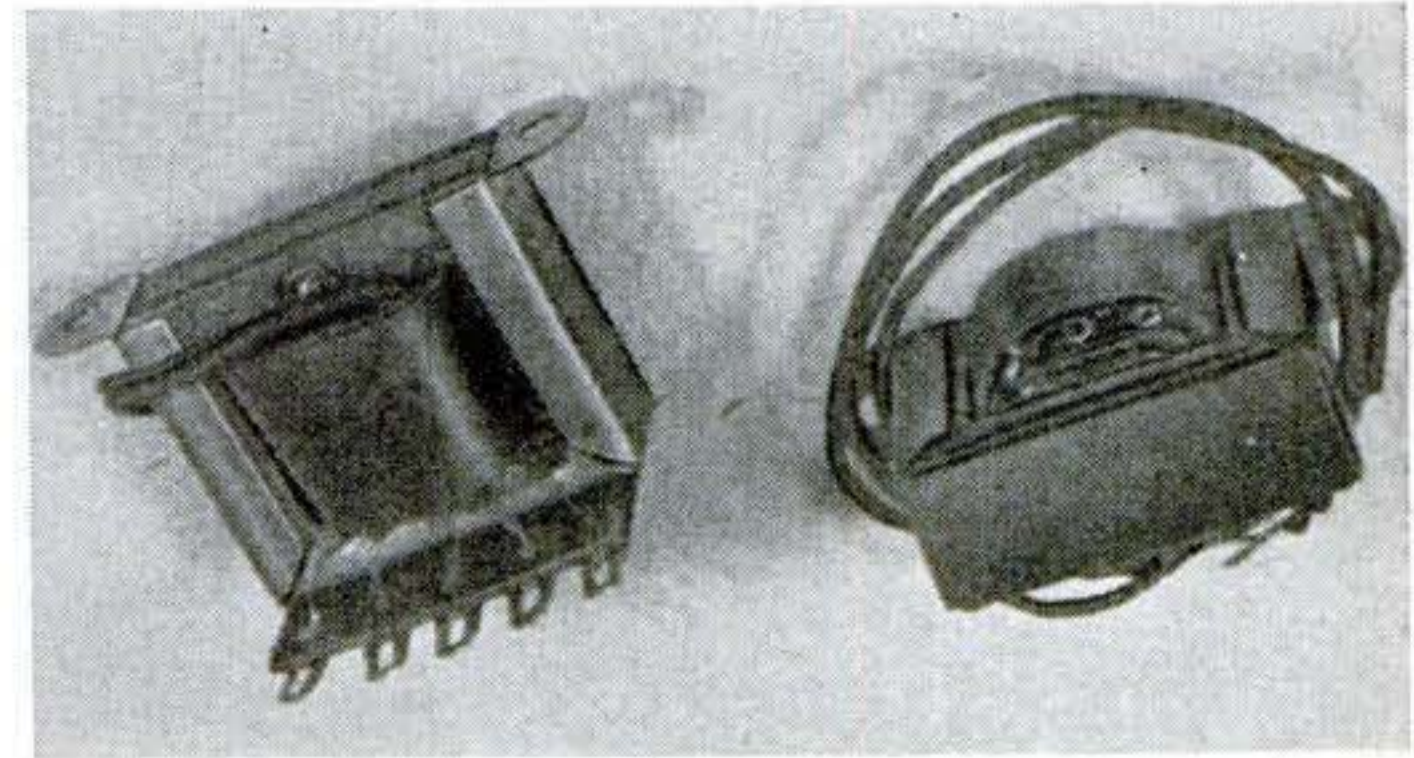
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3



2



1

CAN YOU IDENTIFY THESE RADIO PARTS?

Question Bee

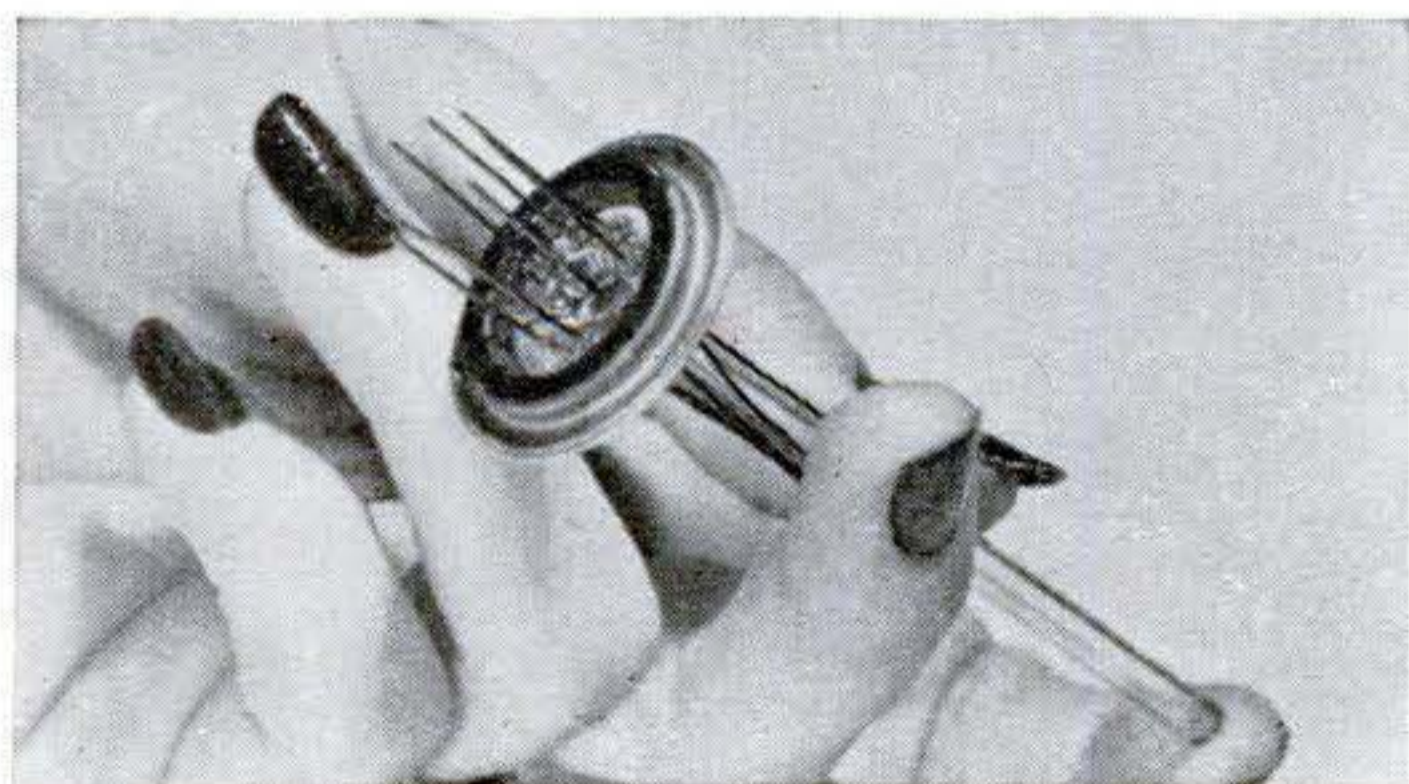
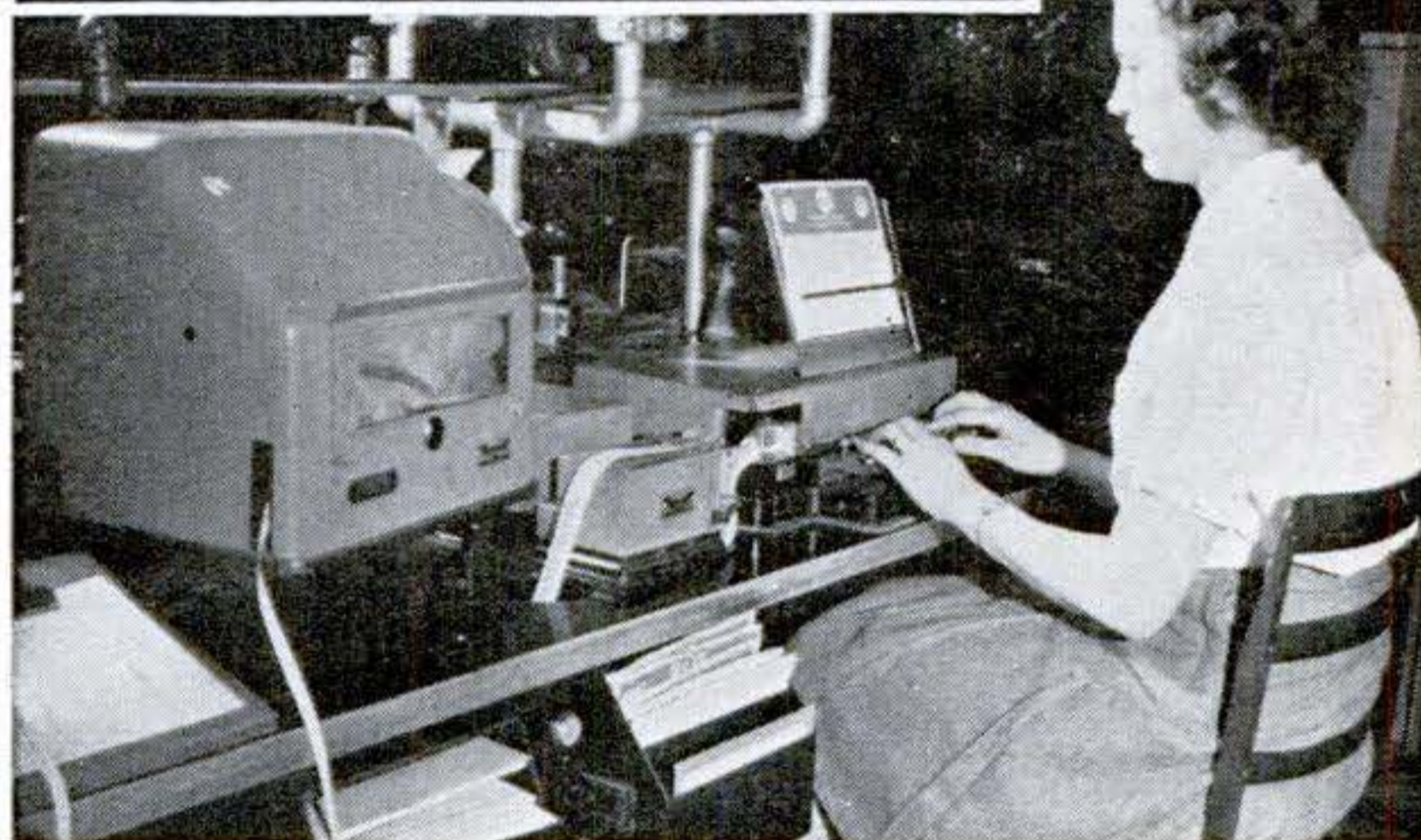
RADIO IDEAS



CLOCKS APPEAR where television performers can't miss seeing them with the arrangement shown at the left. General Electric's WRGB in Schenectady accomplishes split-second program timing by having a large clock installed below the front of each camera. Then, when cameras are moved from one position to another, at least one is bound to be within all performers' sight, and lines may be speeded or slowed as necessary in order to bring the program to an end exactly "on the nose."

ERROR-PROOFED radio-telegraph transmission has been developed by RCA Communications, Inc., for its eight-channel, single-transmitter system between London and San Francisco. The printing mechanism, capable of handling 488 words per minute in either direction, sounds a warning bell if any letter is garbled by static. At the same time a Maltese cross appears on the tape in place of the error to facilitate correction. The printers receive each letter in seven impulses, three with a signal and four for spacing. Each arriving impulse is counted automatically, and if it varies from the proper number the error-proofer goes into action and prints the cross on the tape.

I I S N L O N D O N S A N F R A N Y C H A N # D L E
 I I S N L O N D O N S A N F R A N Y C H A N I D L E
 I I S N L O N D O N S A N F R A N Y C H A N I D L E

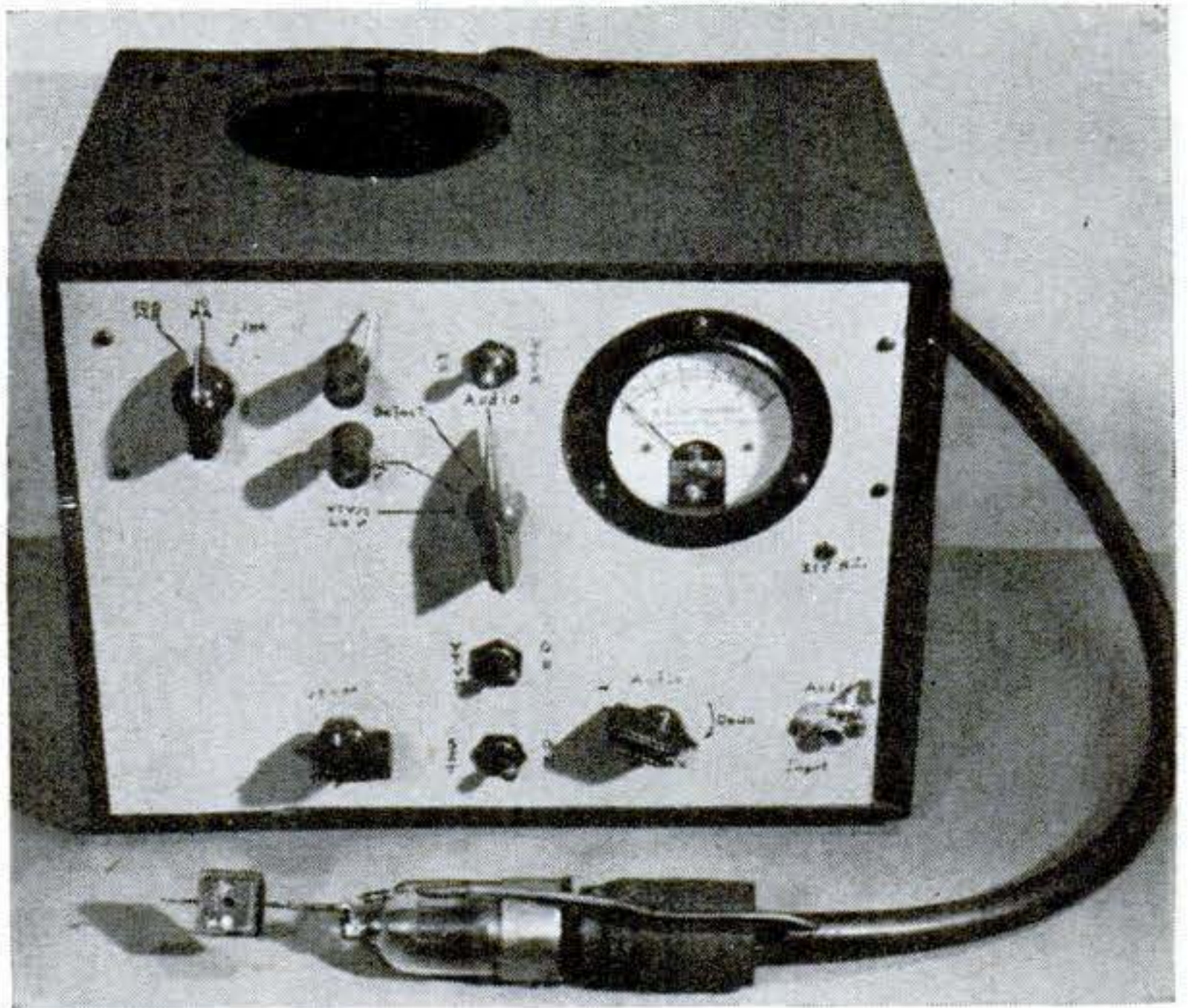
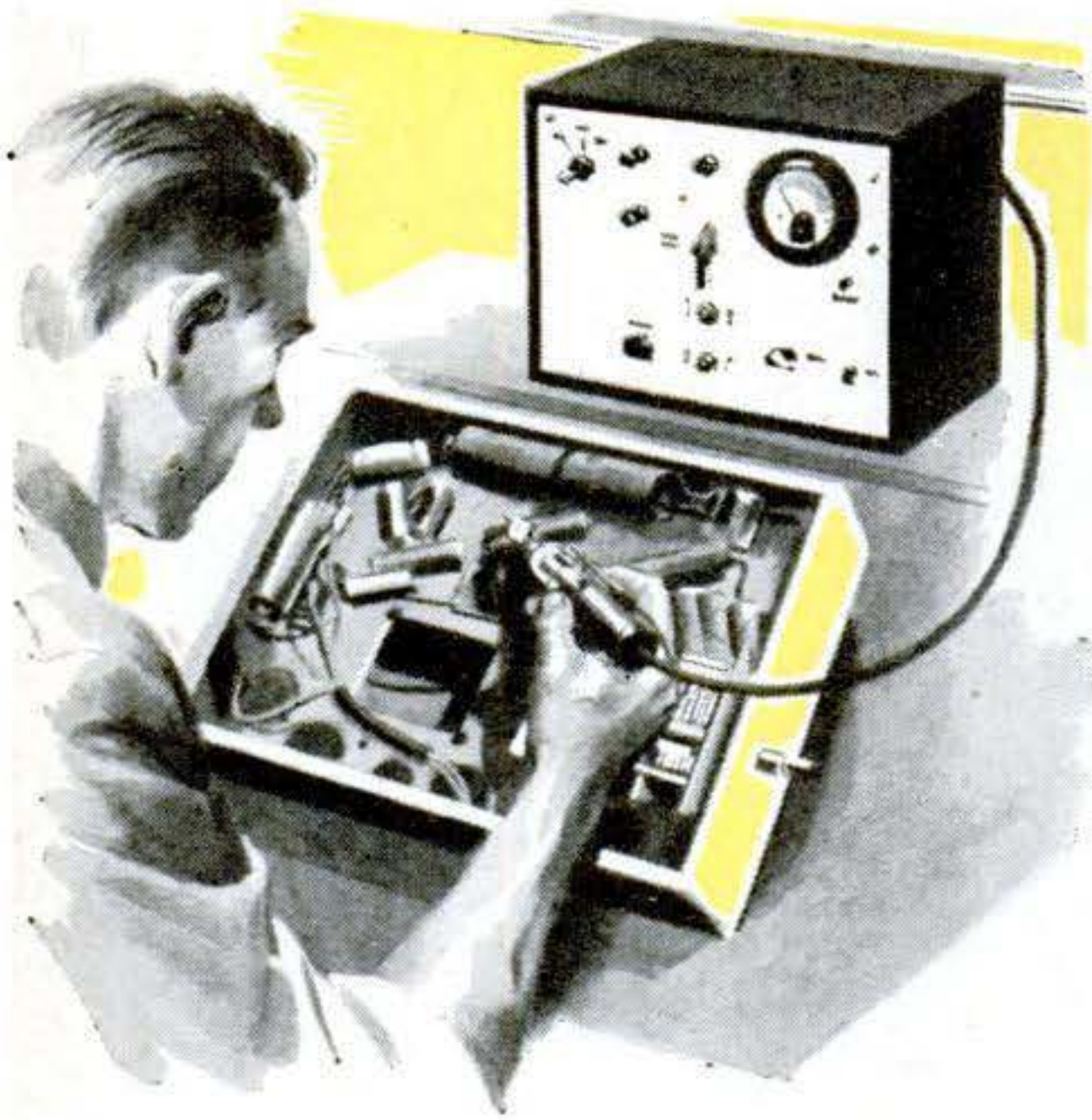


FUSING STEEL AND GLASS by a new method developed by the Radio Corporation of America, Camden, N. J., made it possible to use steel instead of a more costly alloy for the header insert of this tube stem. The insert is the band of metal encircling the glass through which wires enter the tube.

EXTENSION SPEAKERS known as "Hushatones" now are in wide use in Government hospitals, enabling patients to hear a radio program without disturbing others. Produced by the Brush Development Company, Cleveland, Ohio, the flat, disk-shaped speaker is designed for use under the patient's pillow. Adaptable for any sound system or bedside radio, the Hushatone is declared to have a tone quality comparable to large speakers. A lightweight crystal element insures good response and sensitivity.



MULTIPURPOSE TEST INSTRUMENT



By John W. Campbell, Jr.

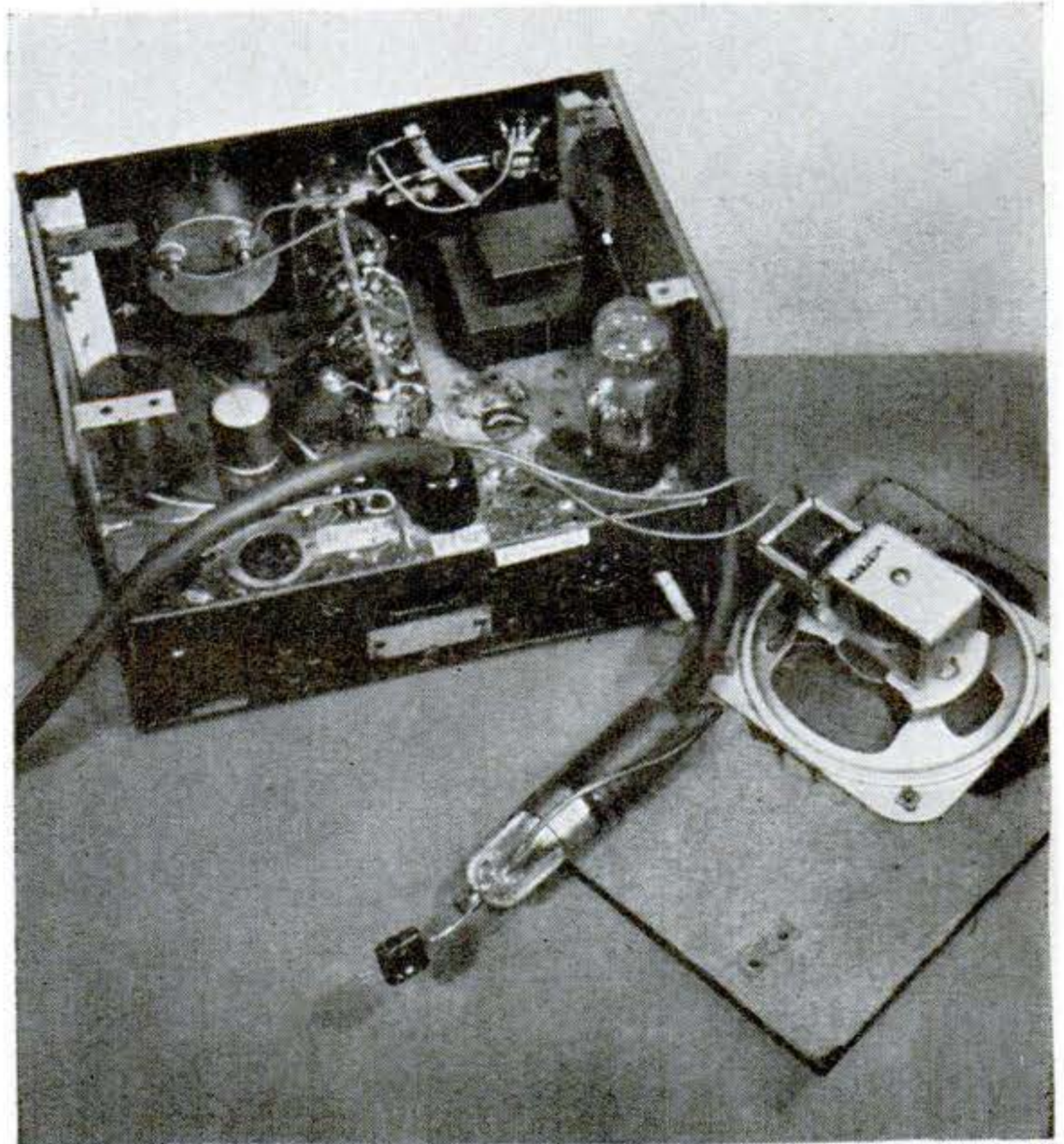
TRACING receiver troubles is a routine job with this multipurpose tester, for it has the "know how" to pick out even carefully hidden sore spots in most sets. Turning the selector switch converts the gadget from a cathode-follower type vacuum-tube voltmeter with two voltage ranges to a very tricky and equally useful sort of detector-and-audio system; another flick and it becomes a simple audio amplifier with speaker.

Touch the grid-cap lead of the 6F5 tube to any point of any circuit carrying amplitude modulation at audio frequencies, and the speaker will tell whether that modulation is clear or distorted. Acting as an infinite-impedance detector, the 6F5 adds very little capacitance and almost no load to the circuit being tested.

Do you want to trace the I.F. signal? The infinite-impedance detector can pick it up anywhere down the line. It is also quite capable of isolating audio distortion no matter at what stage it originates, from the output right back to the antenna.

The fact that the tester can pick out modulation at the antenna stage itself permits you to determine the frequency to which the antenna stage is tuned independently of the oscillator tuning.

Switching from an infinite-impedance detector to a cathode-follower vacuum-tube voltmeter, you have an extremely sensitive instrument that can be used as an output meter at power levels where the loading



imposed by a standard meter would be ruinous. When no signal is applied to the vacuum-tube voltmeter circuit, the cathode tends to bias itself upward to near cutoff, due to plate-current flow through the cathode resistor. If a positive signal is applied to the grid of the 6F5, the tube is no longer biased to cutoff, but the increase in plate-current flow tends to cause a larger drop across the cathode resistor, till the cathode is again biased up to nearly match the grid voltage. Since the cathode will always remain slightly negative with respect to the grid, grid current never flows.

DOUBLES AS AUDIO AMPLIFIER

The filter arrangements R_1 - C_4 and R_2 - C_5 hold the cathode at the highest voltage attained during any voltage wave cycle, so the instrument becomes a peak-reading voltmeter. To obtain a root-mean-square voltage, you will have to adjust the reading. For a sine wave, r.m.s. voltage equals 0.707 times peak voltage.

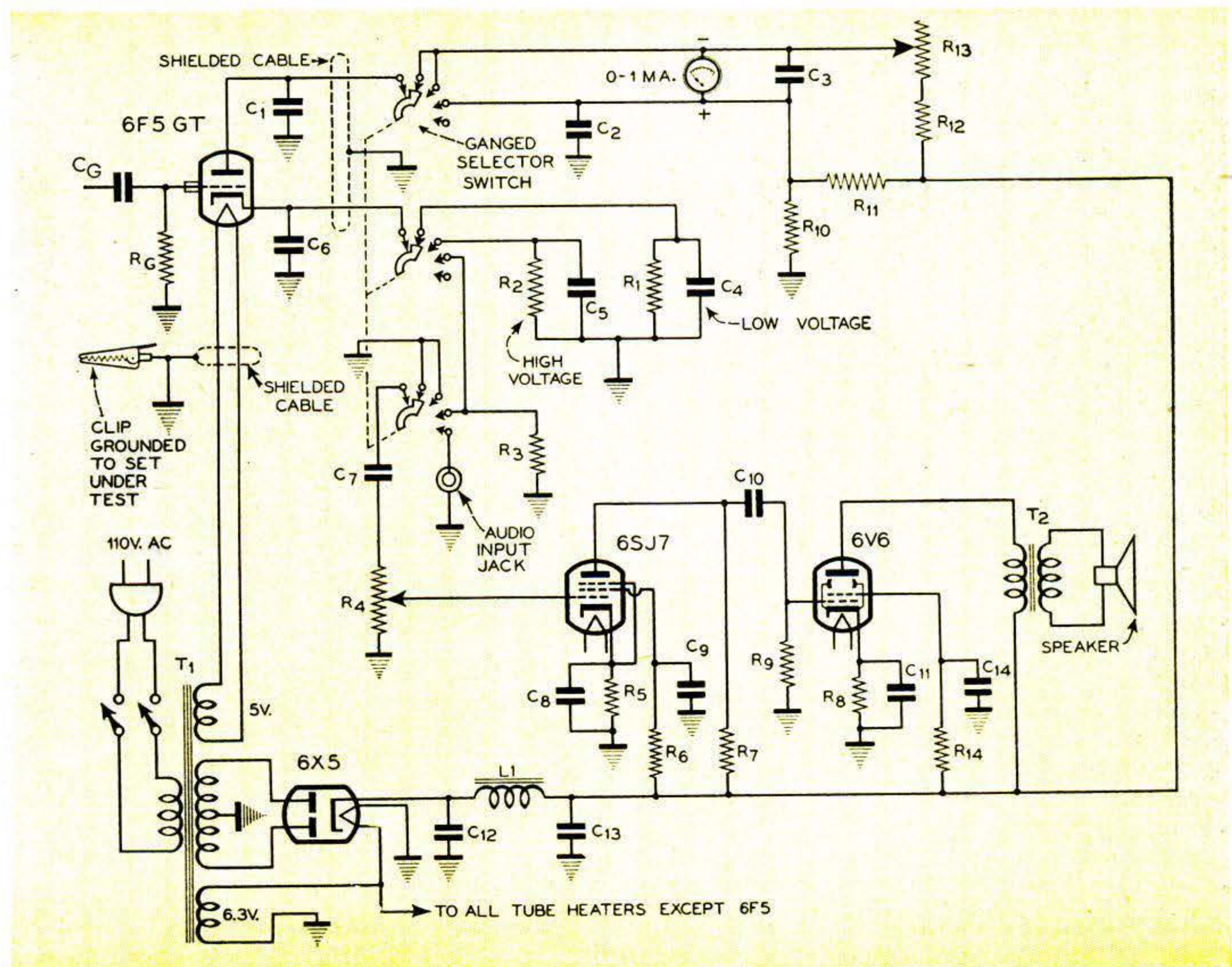
Shunting the grid condenser of the 6F5 will cause the instrument to record D.C. volts, the grid lead becoming positive.

Potentiometer R_{13} is used to adjust the millimeter to zero so that the initial plate current that must flow to bias the cathode can be balanced out of the meter.

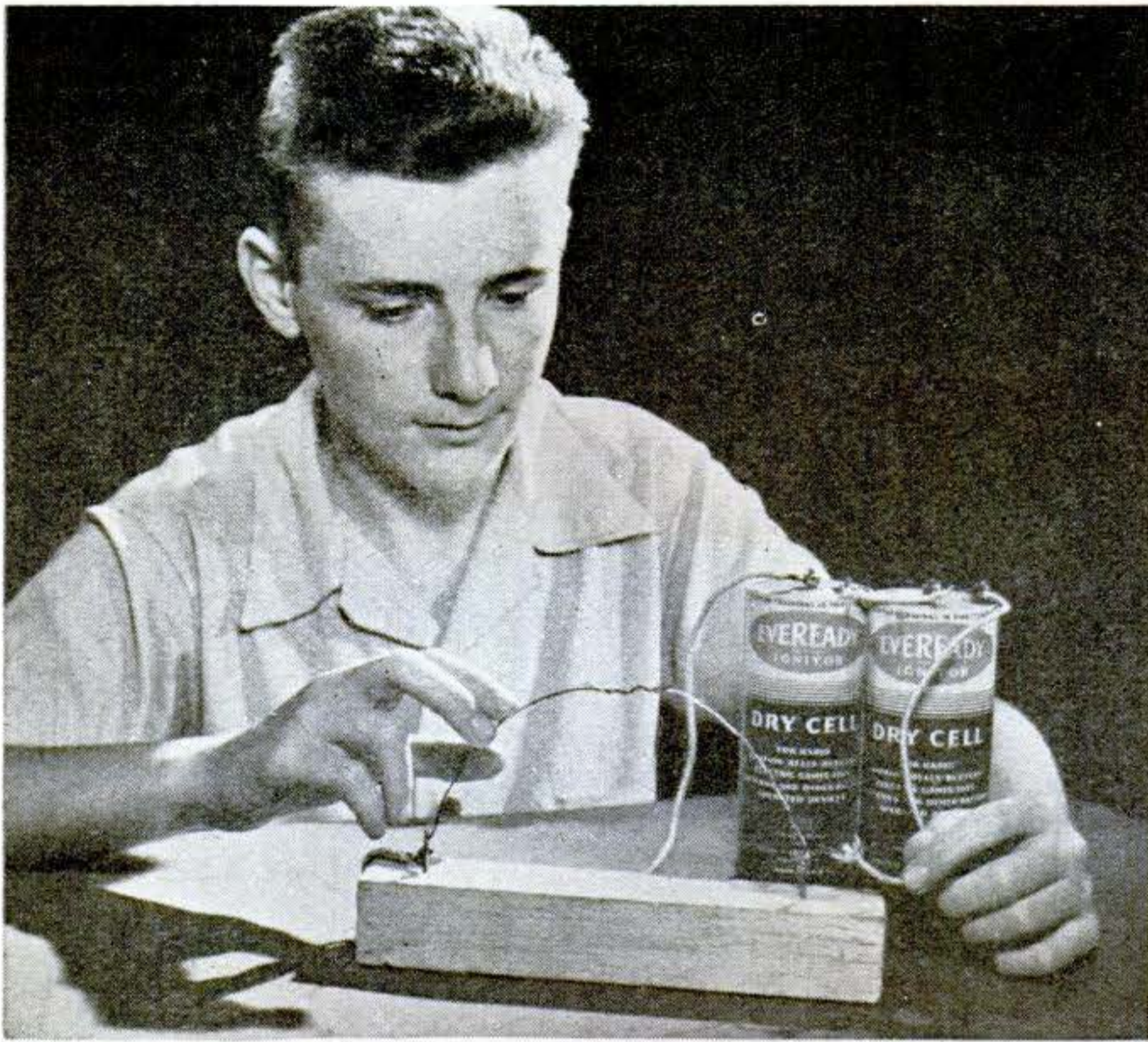
To minimize grid emission in the 6F5, the heaters are operated at less-than-rated voltage via the 5-volt filament winding, and a 6X5 rectifier is employed in place of the usual rectifier circuit. If a 6X5 is not available, but you happen to have a 5Y3 or similar tube, the 5-volt transformer winding can be diverted to its use. In this case, insert a 5-ohm resistor in series with the 6.3-volt tap and the 6F5 filament.

KEY TO MULTITESTER PARTS

- C_1 : 1,000 mmfd. mica
- C_2 : 8 mfd. electrolytic, 400 v.
- C_3, C_4 : 25 mfd. electrolytic, 25 v.
- C_5 : 8 mfd. electrolytic, 200 v.
- C_6 : 500 mmfd. mica
- C_7 : .01 mfd.
- C_8, C_{11} : 10 mfd. 25 v.
- C_9, C_{14} : .1 mfd.
- C_{10} : .01 mfd.
- C_{12}, C_{13} : 8 mfd. 450 v.
- C_G : .01 mfd. mica
- R_1 : 10,000 ohms
- R_2, R_3 : 200,000 ohms
- R_4 : 1-megohm pot.
- R_5 : 1,400 ohms
- R_6 : 2.2 meg.
- R_7 : 0.5 meg.
- R_8 : 350 ohms
- R_9 : 1 meg.
- R_{10} : 30,000 ohms, 10 watt
- R_{11} : 5,000 ohms, 2 watt
- R_{12} : 25,000 ohms
- R_{13} : 25,000-ohm pot.
- R_{14} : 25,000 ohms, 3 watt
- R_G : 20 to 50 meg.
- T_1 : 350-volt, 50-ma. power trans.
- T_2 : 8,500-ohm output trans.
- L_1 : 10-henry filter choke



ELECTRICAL EFFECTS SHOWN

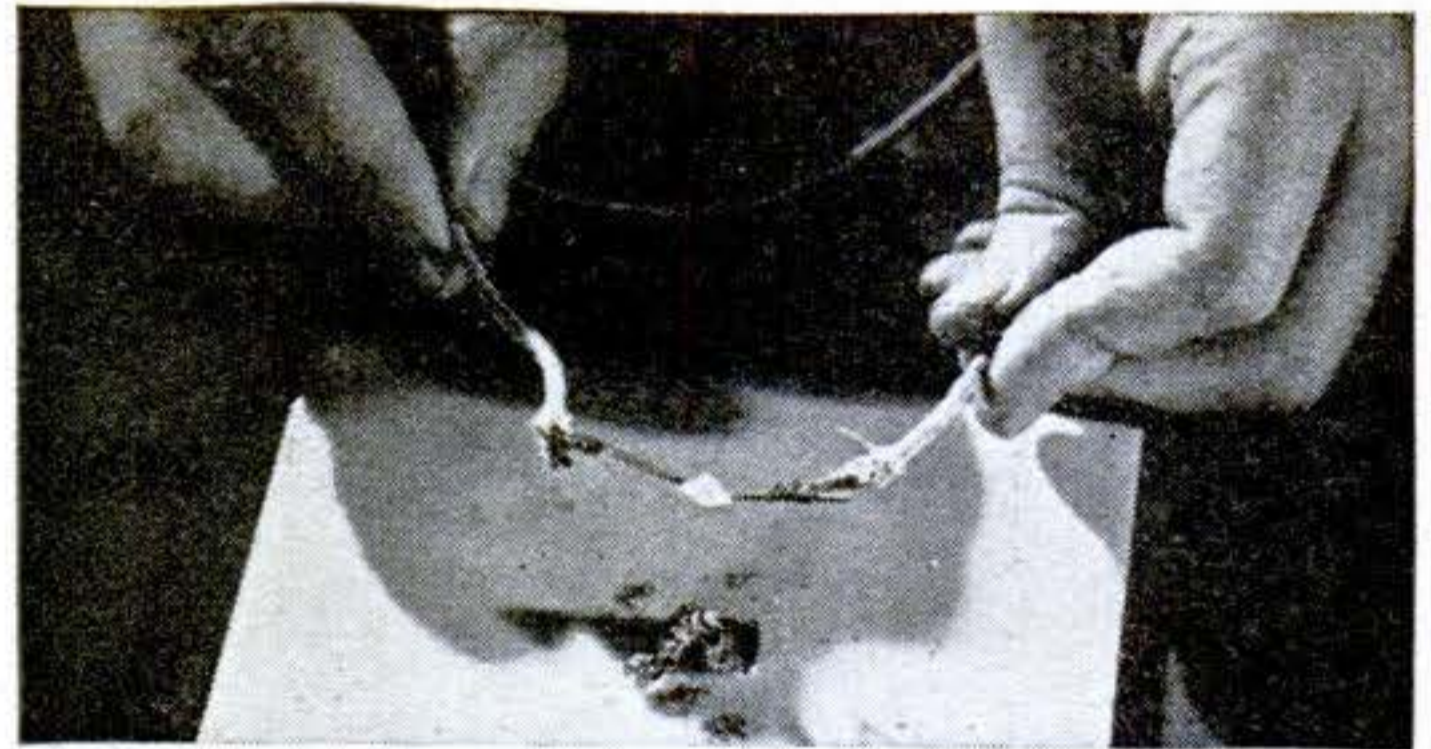


ELECTRICITY HEATS stoves, irons, light bulbs, and heaters in proportion to the resistance of the conducting material to the current passing through. Substances of high resistivity become hotter than those of low because their molecules put up a stiffer fight against the flow of electrons.

You can demonstrate this with two dry cells and a short length each of *thin* copper and iron wire of the same diameter. Twist ends of the wires together and wrap the opposite ends around nails in a block, as at left. Connect the nails to the dry cells for a few seconds and cautiously touch the two wires. The iron one, with greater resistance, will be the hotter one.

HOW CURRENT WORKS in arc lights, arc furnaces, and arc welding may be shown with short iron wires as electrodes on the ends of two stout copper wires. Use a 6-volt storage battery or four dry cells in series.

The iron wires become red and then white hot when brought together; an arc jumps the gap when they are pulled slightly apart. It will melt foil and solder. Don't keep the flow up long if you use dry cells.

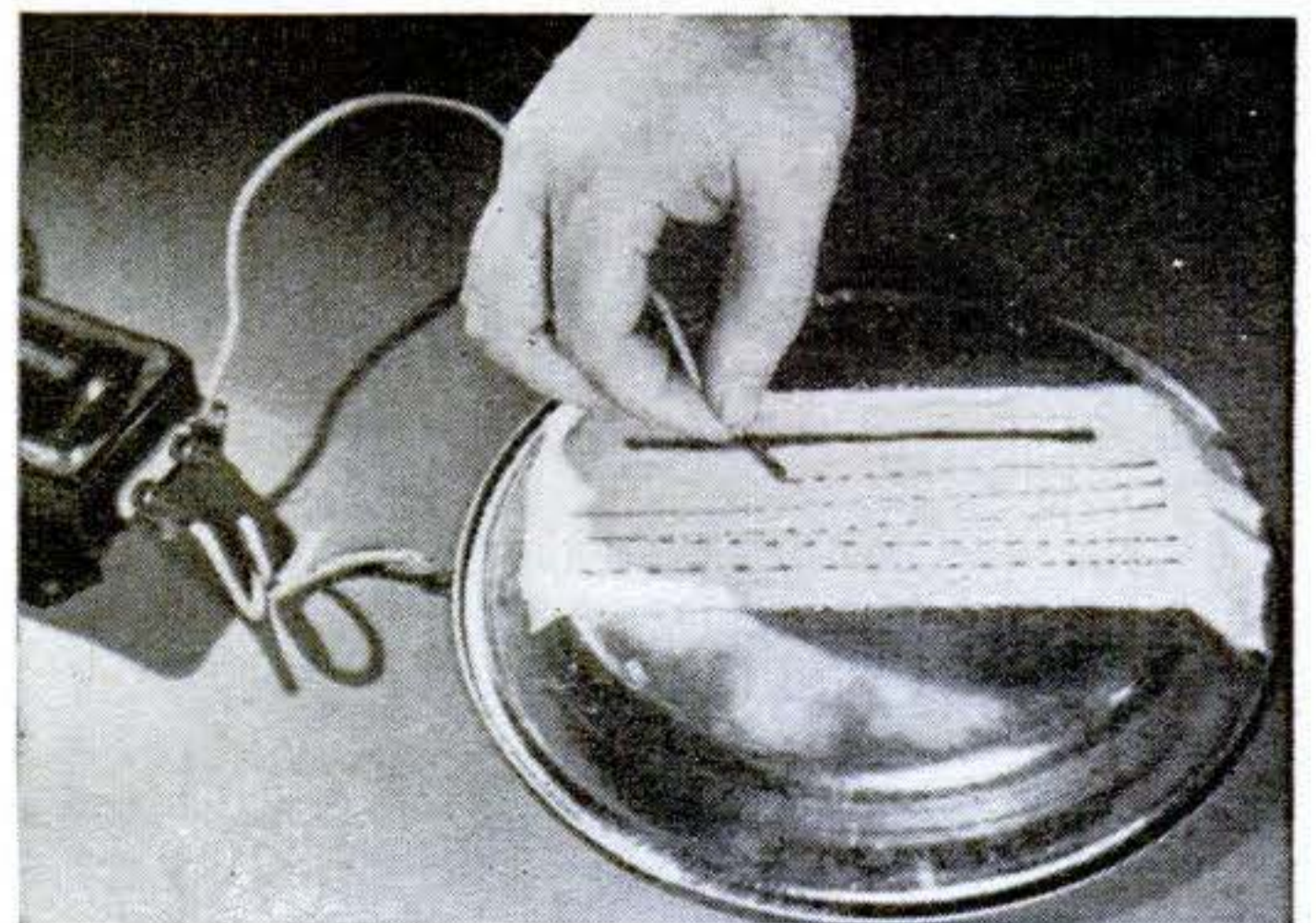
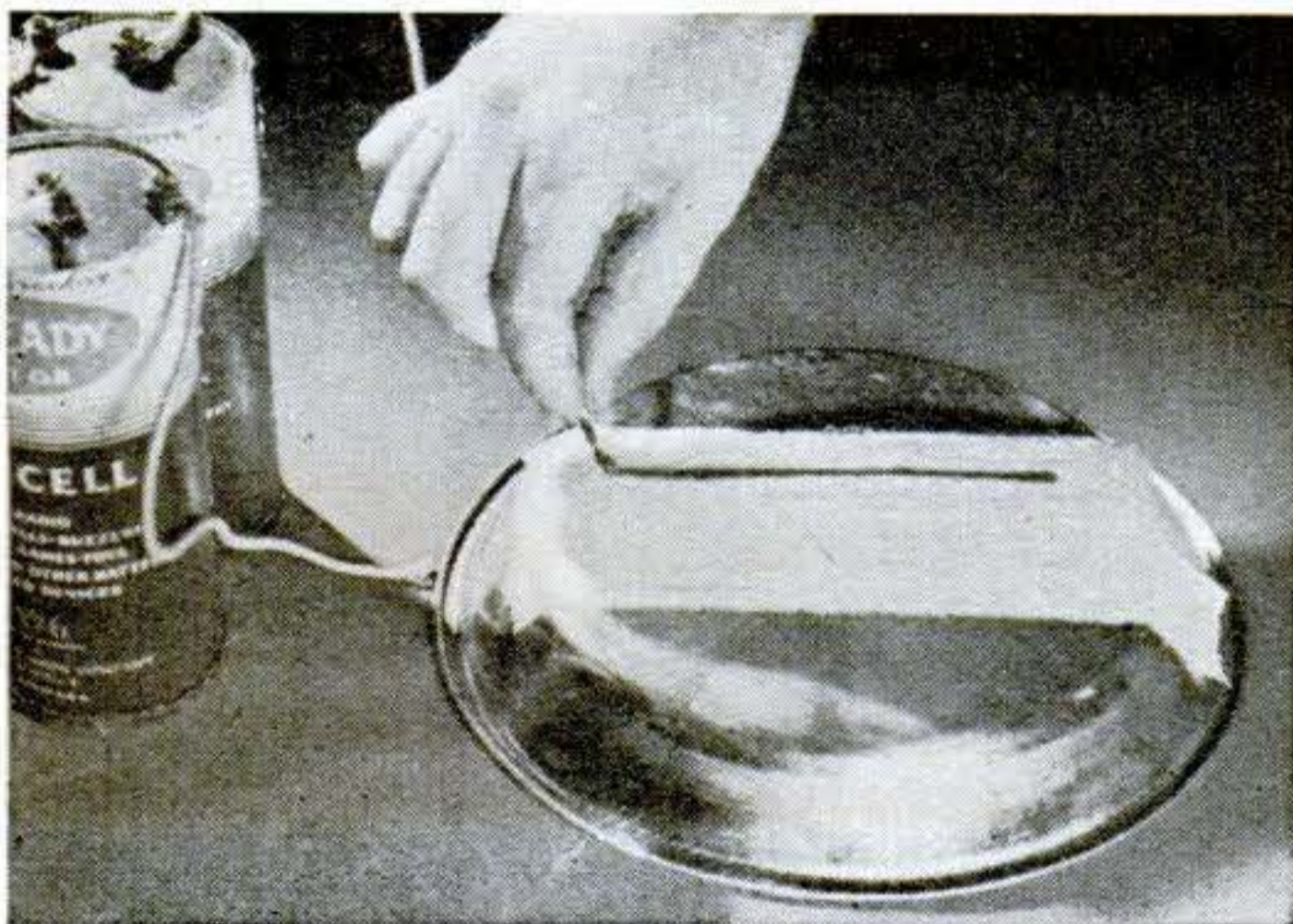


VISIBLE DIFFERENCES between direct and alternating current are shown in a fascinating experiment. Wet a cloth in water containing a little starch and potassium iodide, wring out the excess, and smooth it over an upturned pie tin.

For direct current use a hookup of several dry cells and connect the negative (out-

side) terminal to the plate. Then draw the bare end of a wire from the positive terminal across the cloth. A solid line will be left as the current releases free iodine and it reacts with the starch.

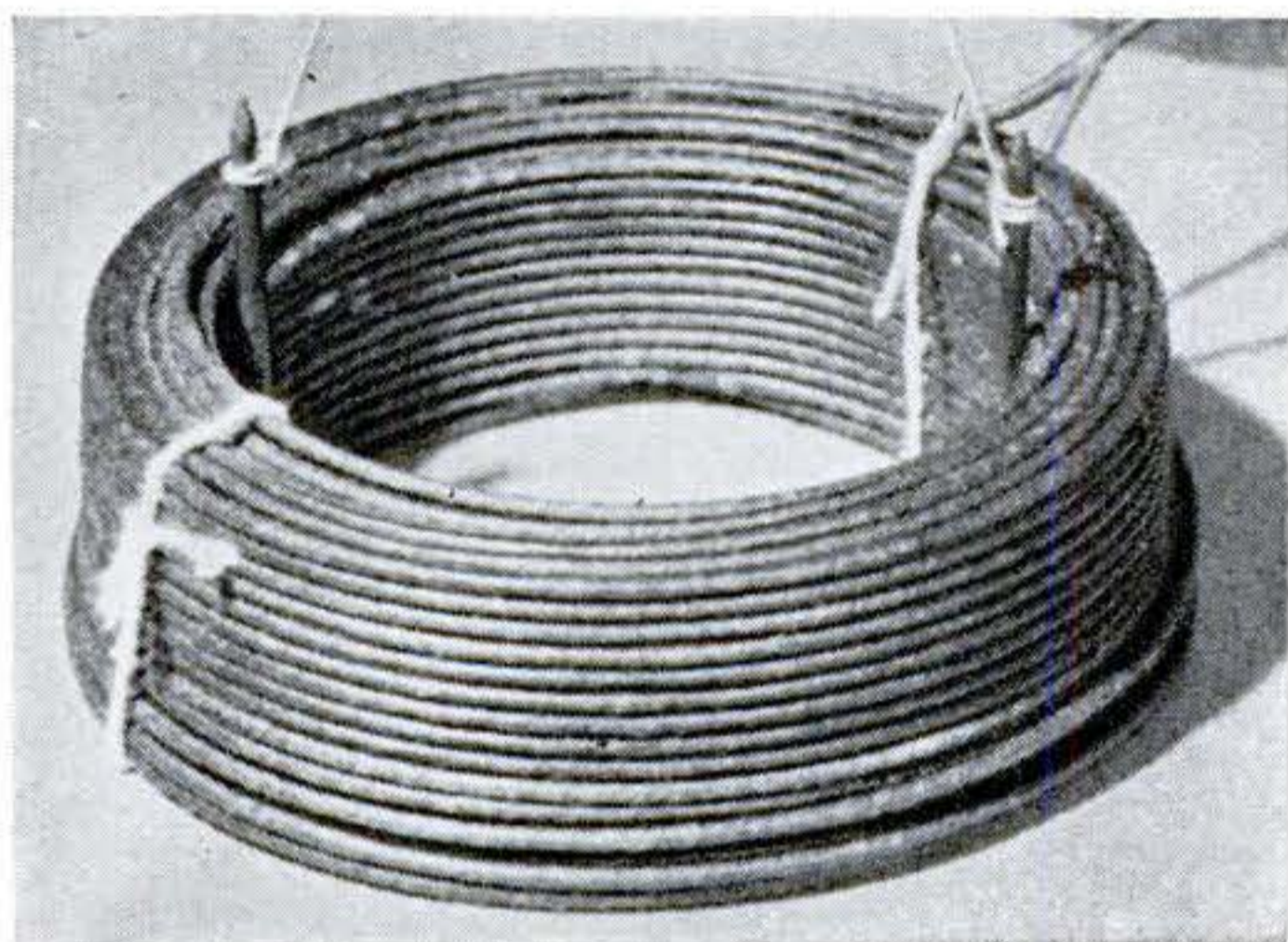
Use a bell or toy transformer for A.C. and repeat the experiment. There will be a dotted line with uncolored spaces.



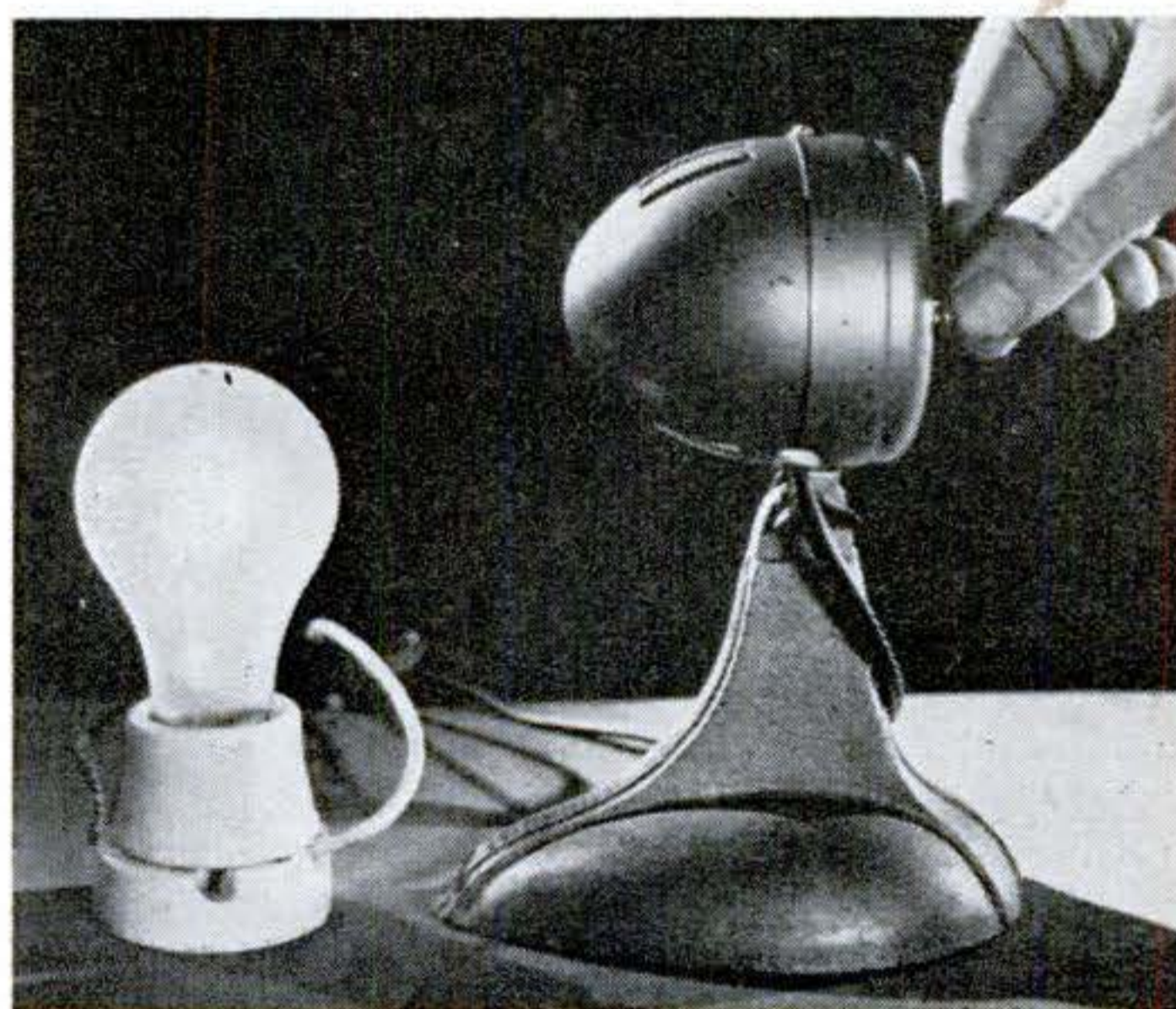
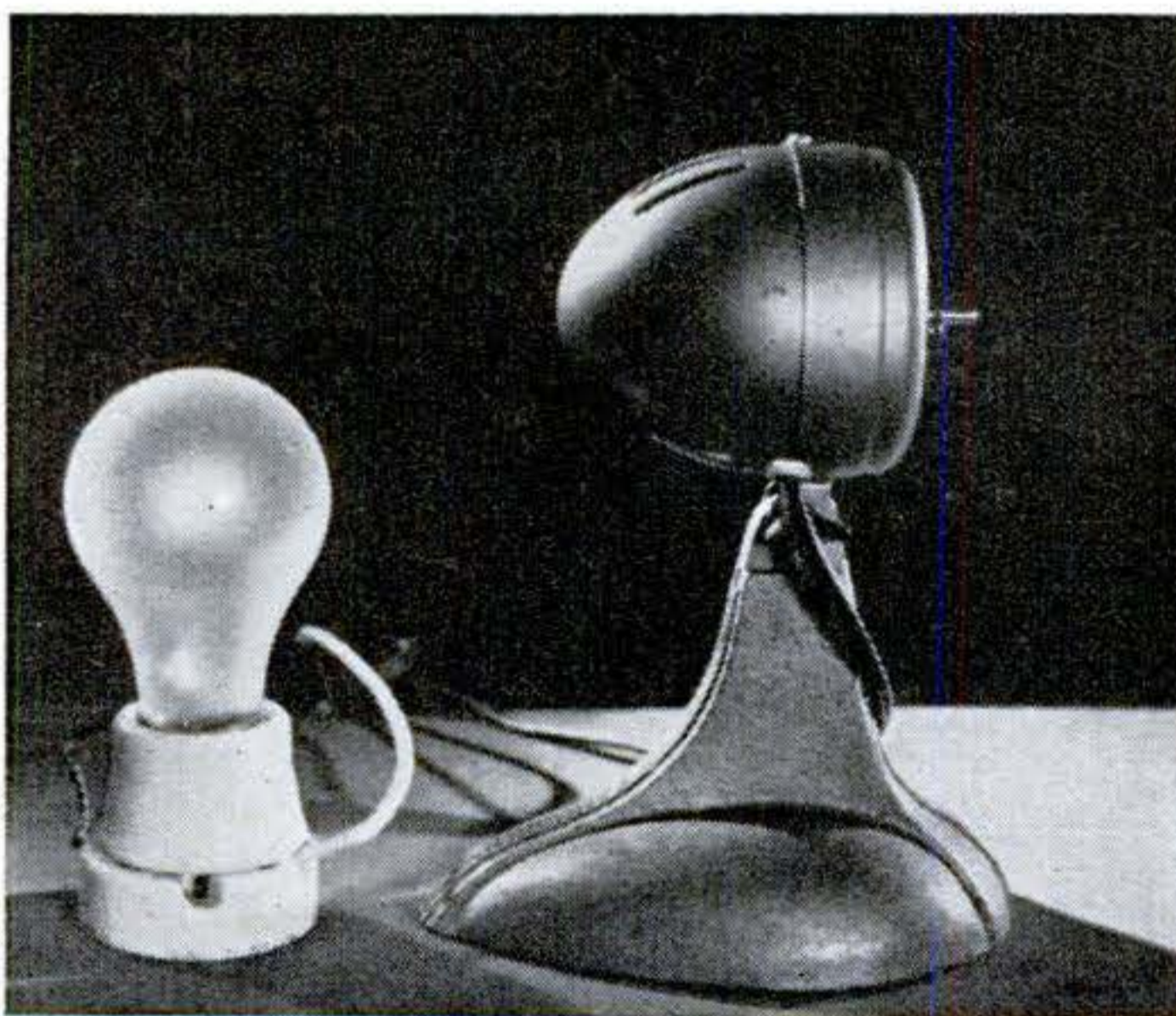
BY HOME EXPERIMENTS

MAGNETIC REPULSION illustrates the principle of A.C.-D.C. current-measuring instruments. Anneal two nails by heating to redness and letting them cool slowly; then hang them side by side on threads in the center of a $\frac{1}{2}$ - to 1-lb. coil of bell wire.

Connect the ends of the coil in turn to several dry cells and then to your toy transformer. In both instances the nails, acquiring similar poles, will fly apart, for though A.C. direction changes constantly, the poles change with it. Some ammeters and voltmeters depend on this mutual repulsion.



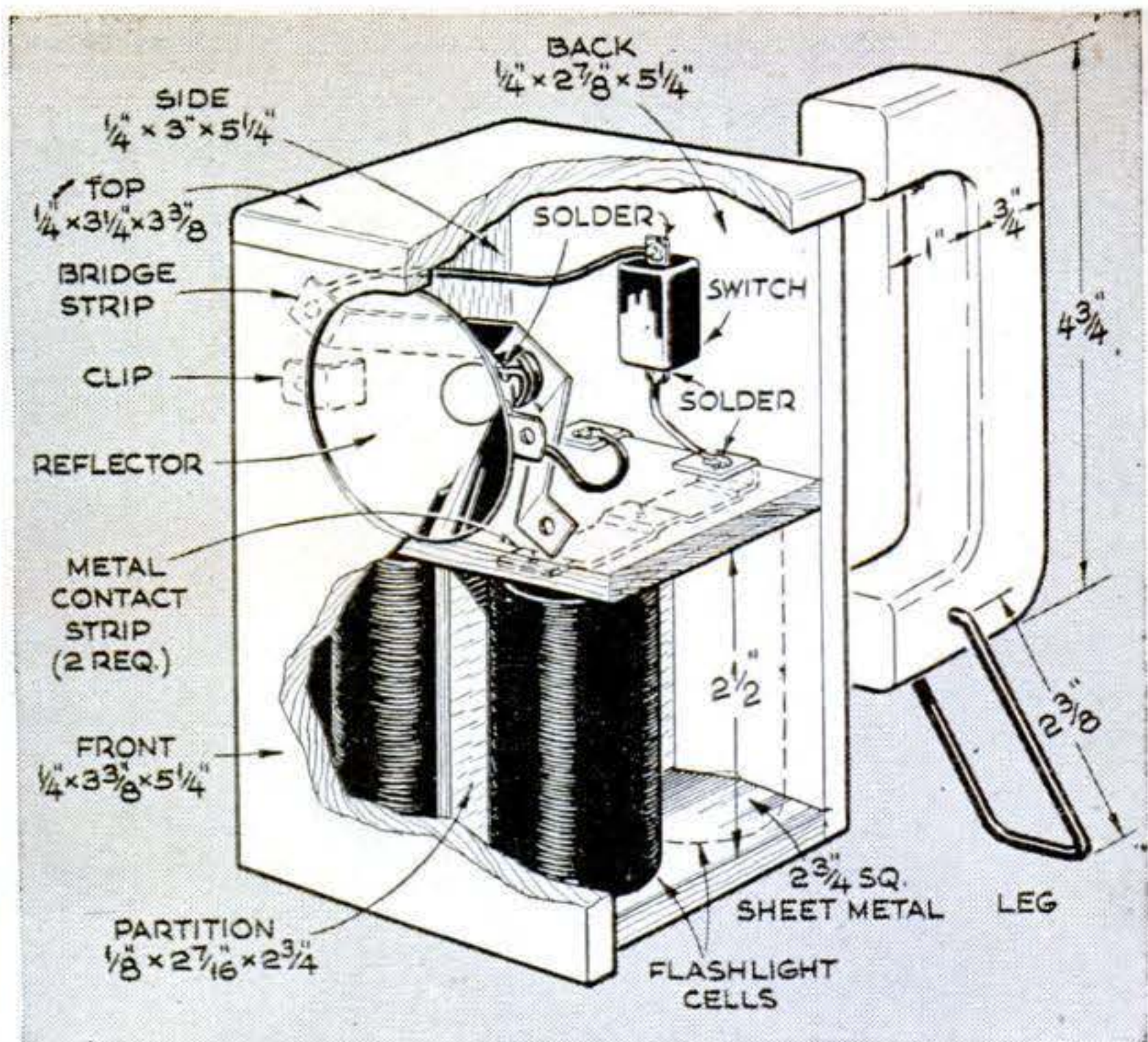
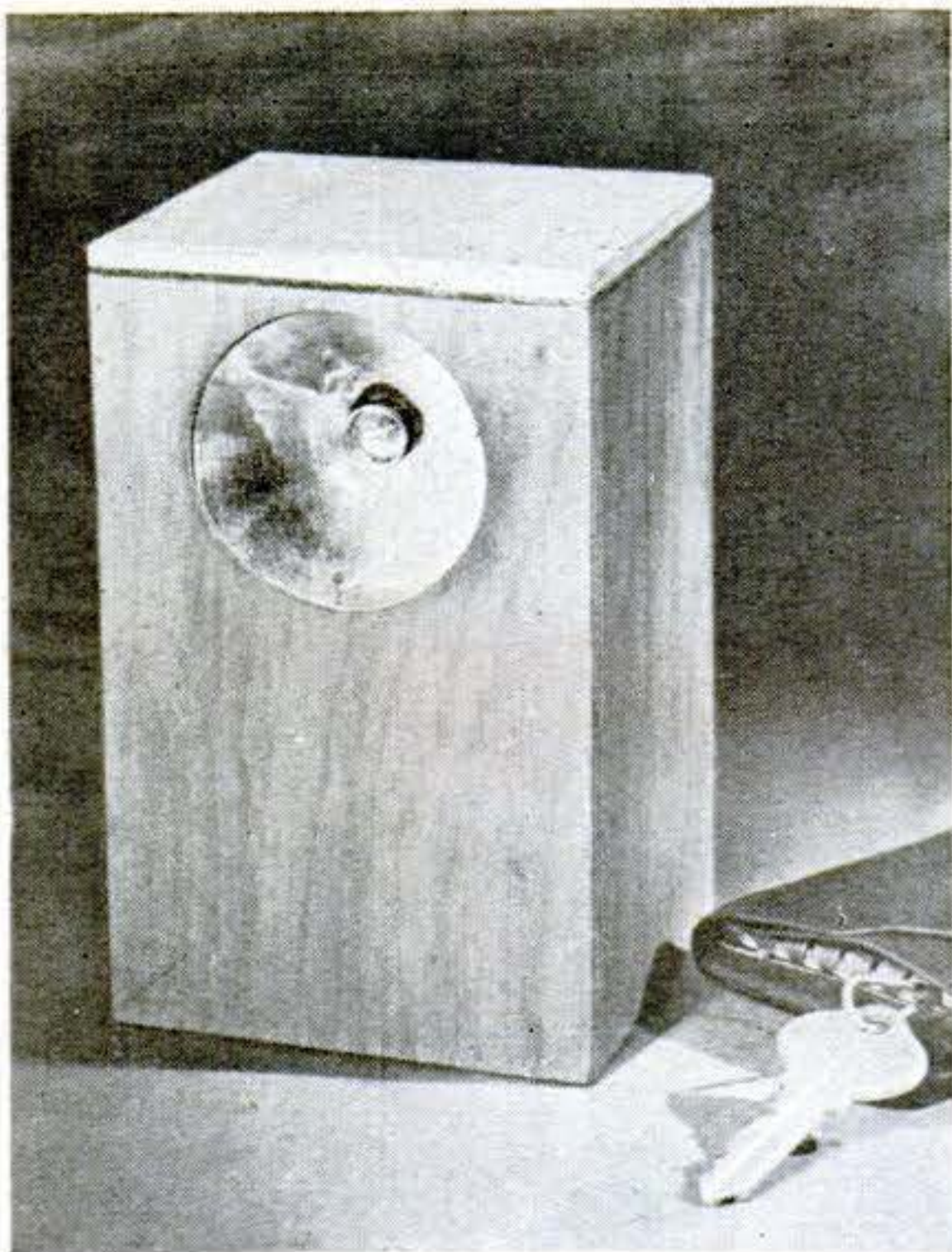
Two nails hang side by side when no current flows in the coil, but when a magnetic field is set up, they acquire like poles and fly apart as at left.



THAT LESS CURRENT FLOWS in a speeding motor than in one running slowly under load is shown by connecting a bulb in series with a small motor. As the motor starts, the bulb shines brightly, but it grows dimmer as speed picks up, becoming dimmest when top speed is reached, as at left above. Grasp the shaft to slow the motor, as at right, and the lamp again becomes bright, indicating a greater current flow.

What causes this variation, making a motor draw more current when hard at

work? It is because an armature spinning in a magnetic field acts secondarily as a generator, creating a voltage in its windings that is always opposite in direction to the electromotive force impressed upon the motor. It is generally called the *back e.m.f.*, and it is this back e.m.f. that reduces the current flowing through when the motor is running at high speed. At the instant of starting, back e.m.f. is zero. Large motors require such high starting current that a variable resistance is needed in the circuit to limit it.



Midget Lantern Uses Four-Cell Battery

By ERVIN WALTERS

ELECTRIC lanterns aren't usually appreciated until a flashlight peters out at an awkward time. Before that happens to you, convert a few pieces of plywood and metal scrap into one of these durable lanterns that, with its series-parallel circuit, will give long service on a set of cells.

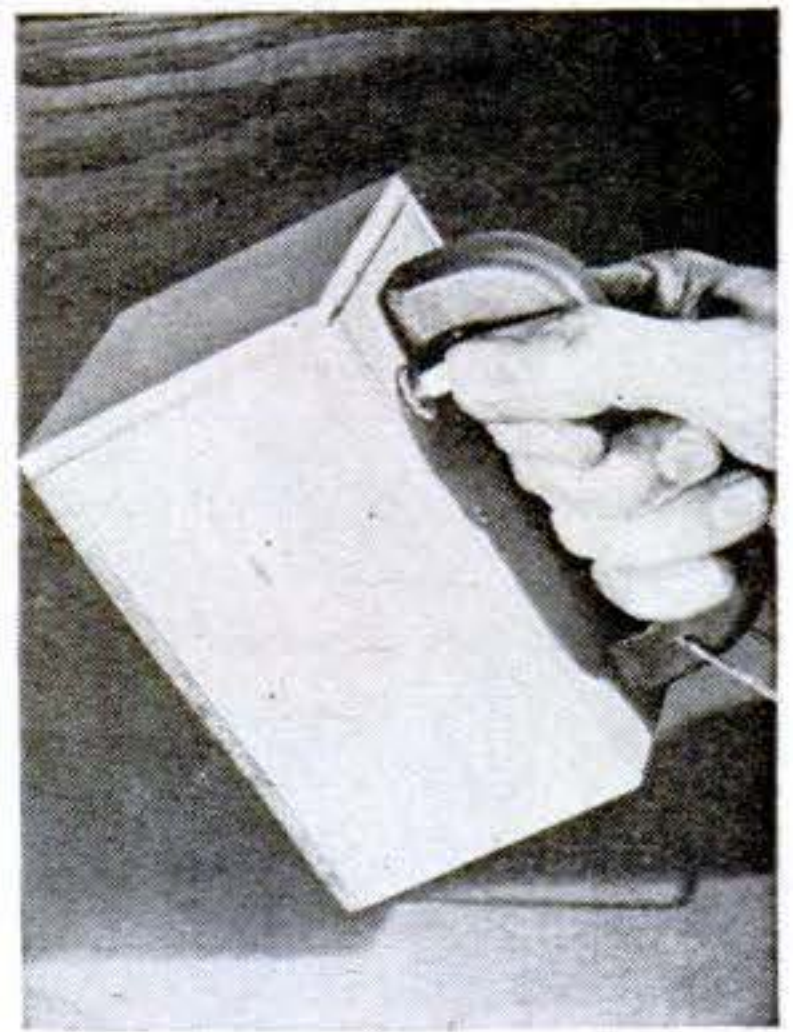
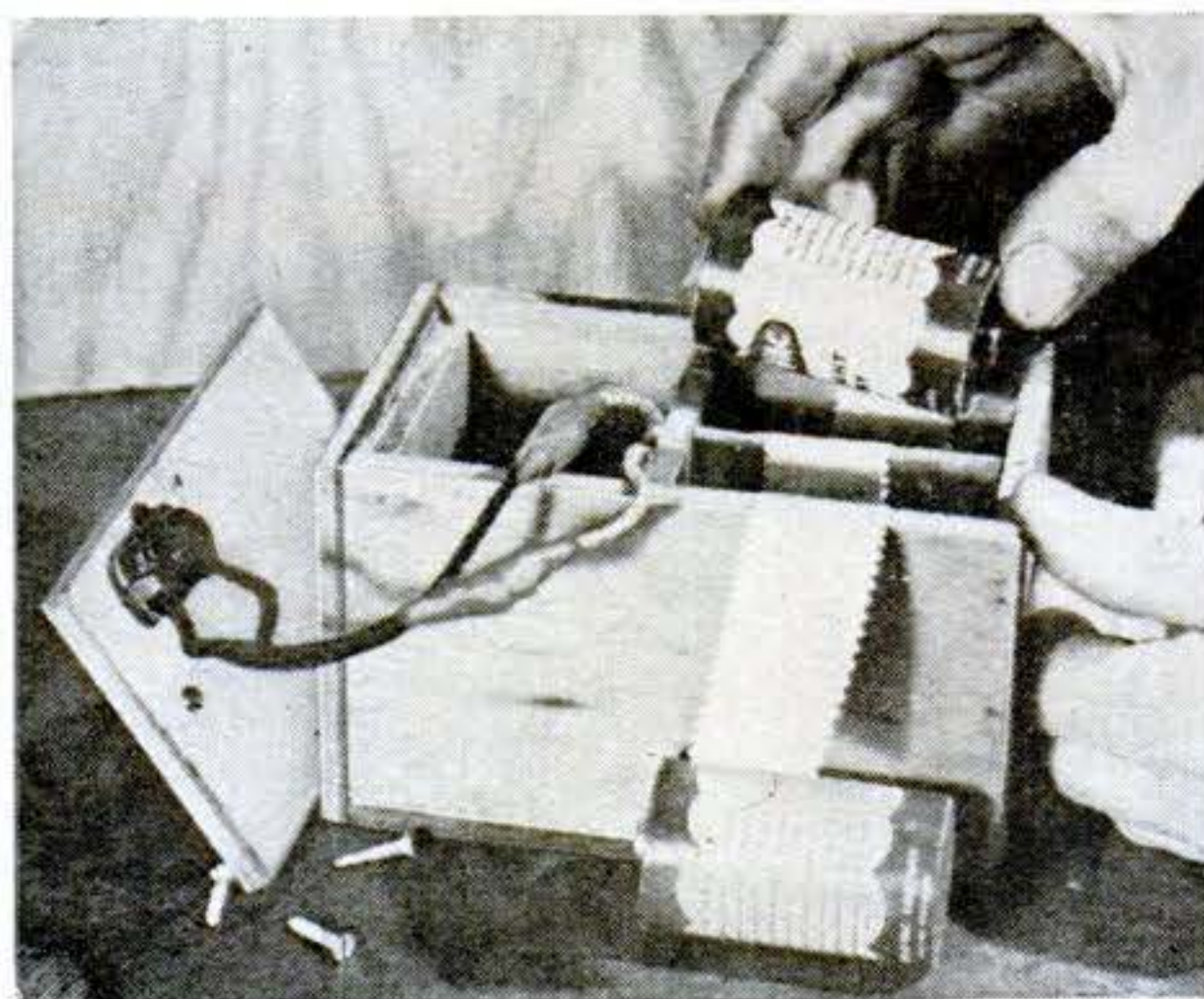
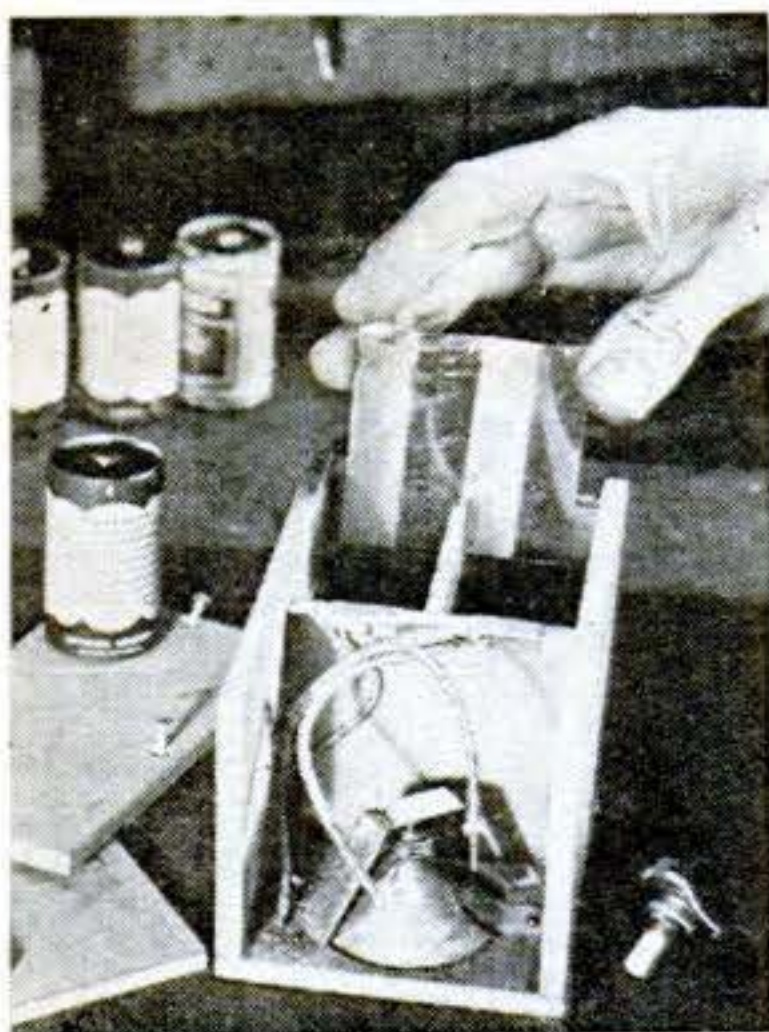
Near the top of the front piece, cut a hole 2" in diameter. From a piece of bright-surfaced metal, snip a disk of about 3" diameter and make a 1/2" hole in the middle. A straight line cut from this hole to the disk edge will enable you to bend the metal into a smooth reflector.

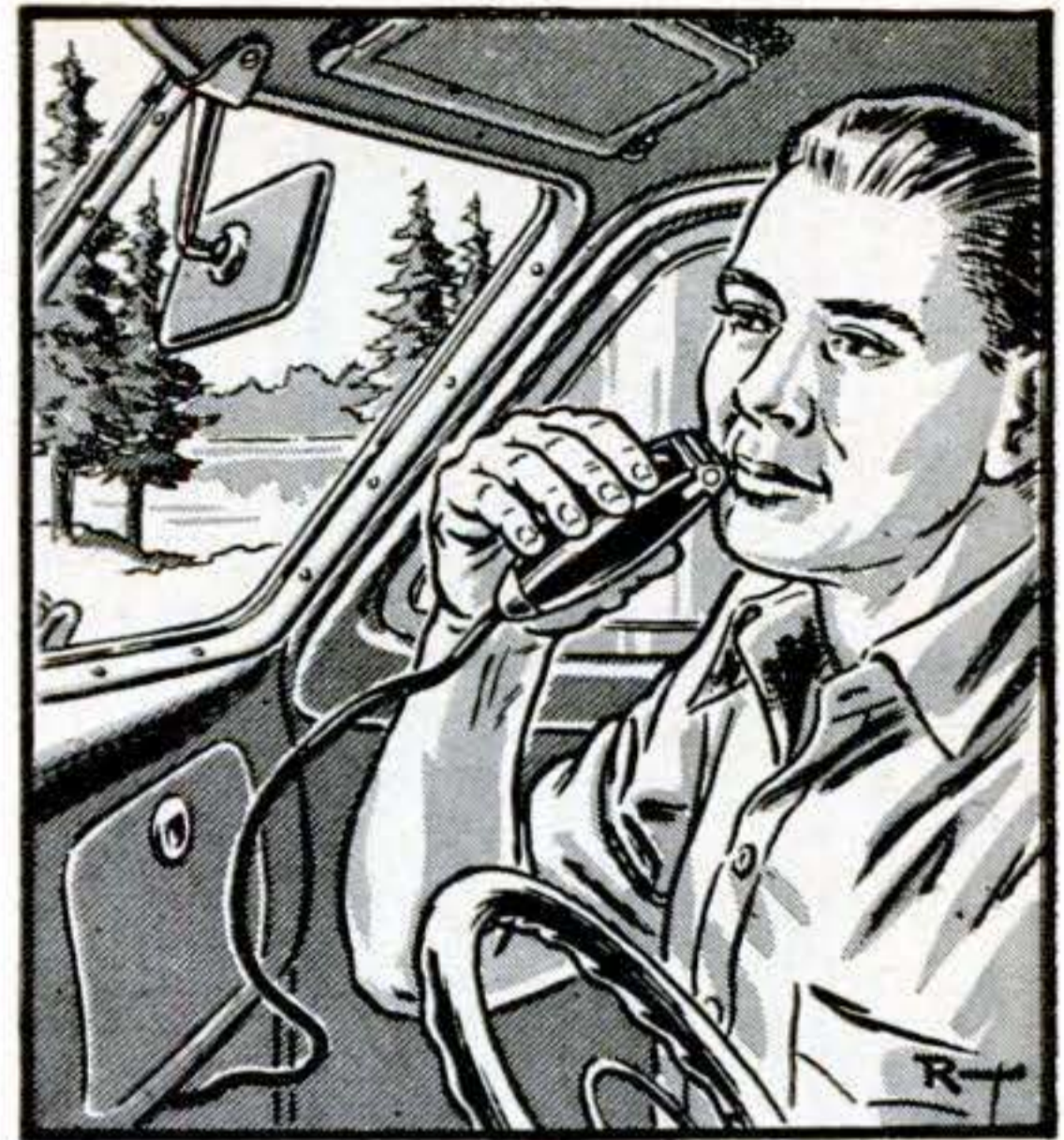
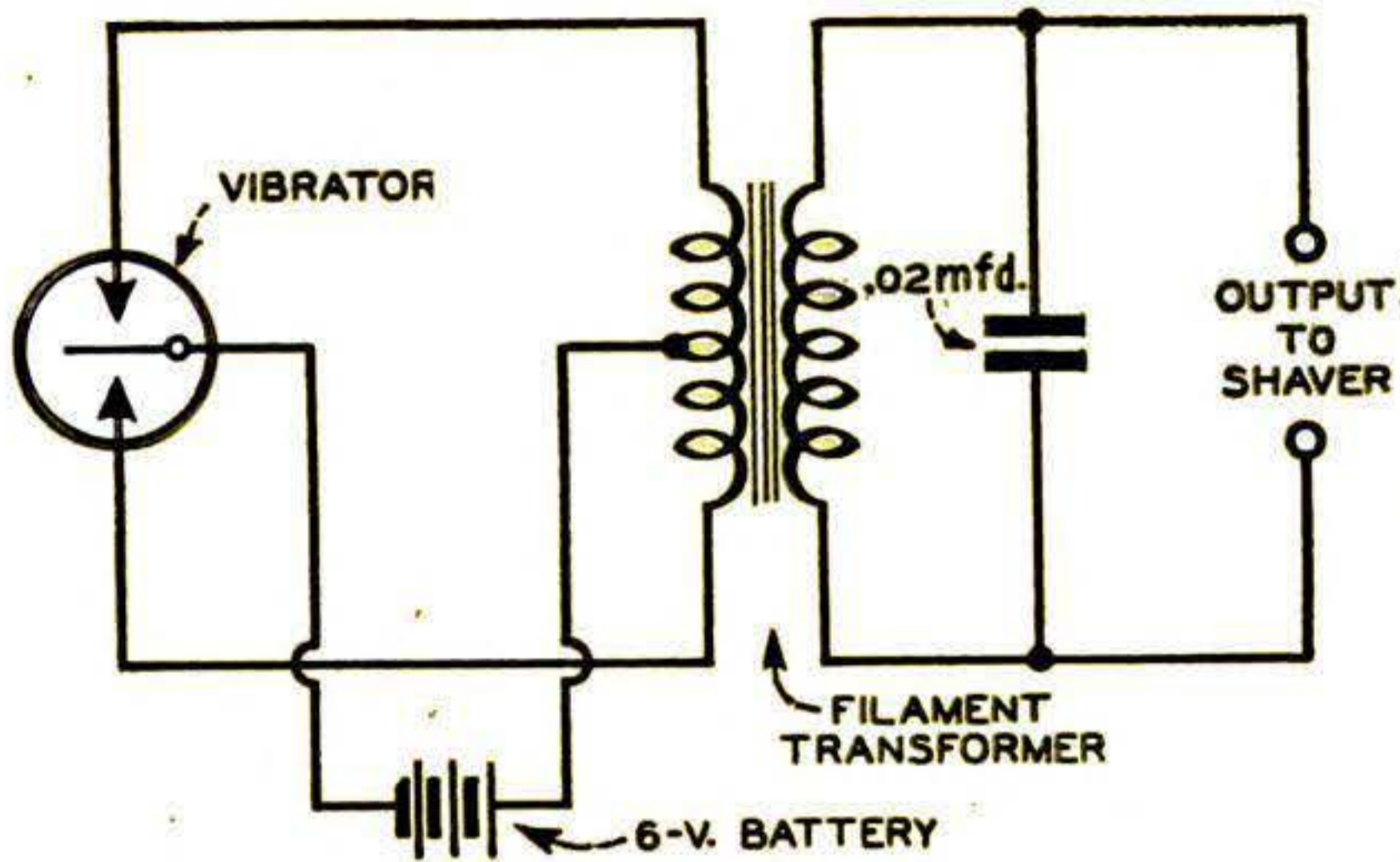
Two angle lugs soldered to the back of the cone and screwed to the wood will hold the reflector securely in place. Insert a two-

cell flashlight bulb through the hole, and wrap two or three turns of soft copper wire around the threads to form a socket. Solder one end to the cone, then bridge a 1/2" strip of brass over the cone so that it touches the center contact of the bulb but doesn't touch the reflector.

Bend two battery-cell contact strips out of sheet brass 3/4" wide, and clip them over the horizontal partition as shown in the drawing. Connect one contact strip to the bridge strip, and the other to one side of the switch. If a toggle switch is used, attach it in the center as indicated in the drawing; if you can get a push-type canopy switch, place it to one side as shown in the photograph below. Insert the cells so that the pair in one compartment faces up while the other pair faces down.

Bend the 2 3/4" metal square to the shape of a flattened "M" before wedging it beneath the partition. Wrap cloth tape around the cells for easier removal, screw on the back piece, and the lantern is ready for use.

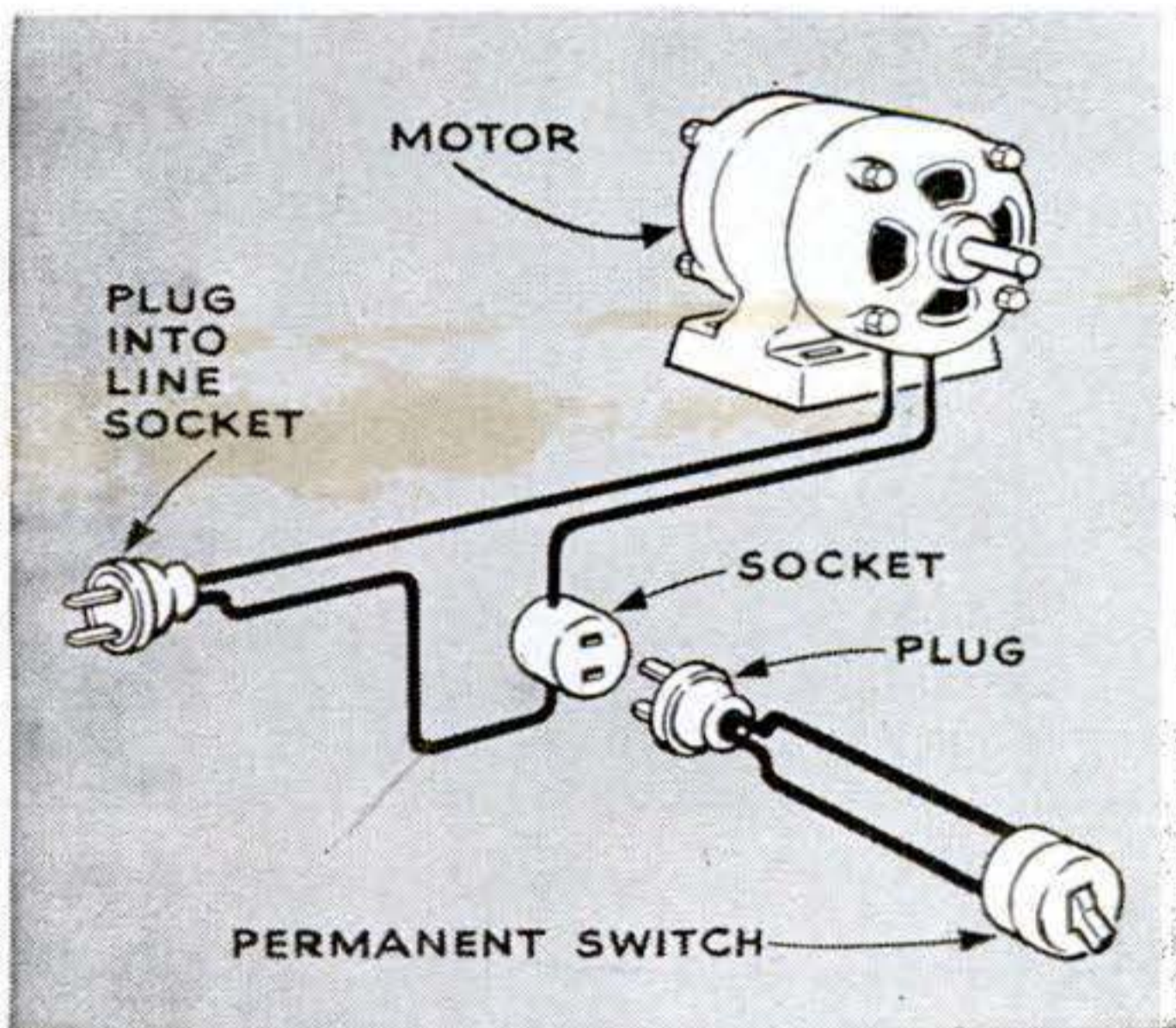




PORTABLE POWER SUPPLY FOR 110-VOLT ELECTRIC SHAVERS

ANYONE who uses an electric shaver regularly knows the inconvenience of being away from a suitable source of power. With this converter you can turn your car into a private barber shop. To operate shavers with contactor-type motors, connect an automobile-radio vibrator, a center-tapped 7.5-

volt transformer, and a .02-mfd. condenser as shown above, using the high side of the transformer for the output. The condenser reduces the vibrator's tendency to arc. For shavers with commutator-type motors, place a .5-mfd. condenser in series with the output.—J. A. BENNETT.



FIXED SWITCH ON POWER TOOLS MAKES BORROWED MOTOR SAFER

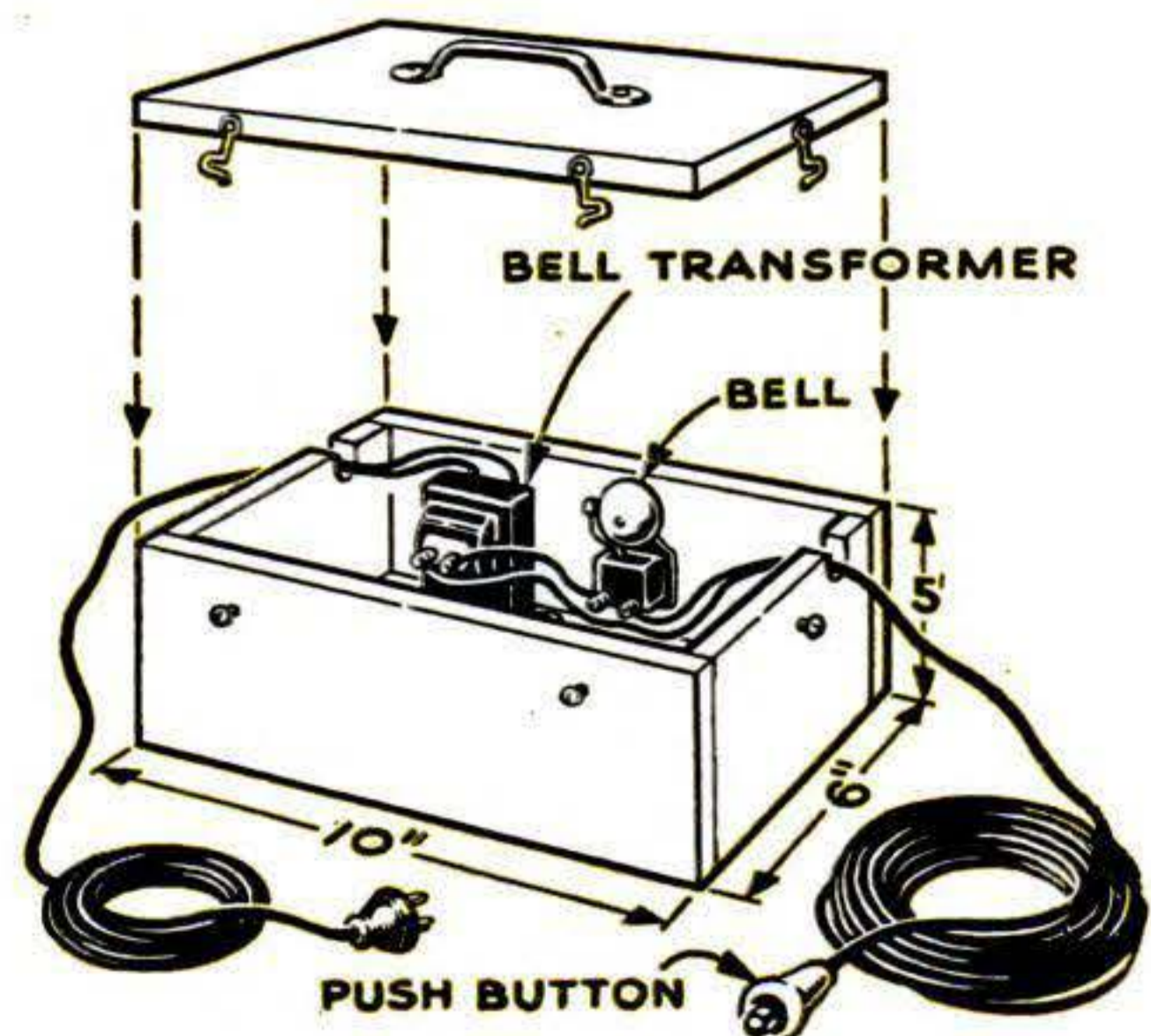
EVEN when motors were plentiful, it was often convenient to use a single motor interchangeably on several power tools. For added safety in using and moving such a motor, mount a permanent switch on each tool, wire it to a plug, and connect it in series with the motor as shown.

To use the motor on a job where no switch is available, insert a shorted plug (one with a jumper between the prongs) to complete the circuit.—CURTISS M. PEASLEY.

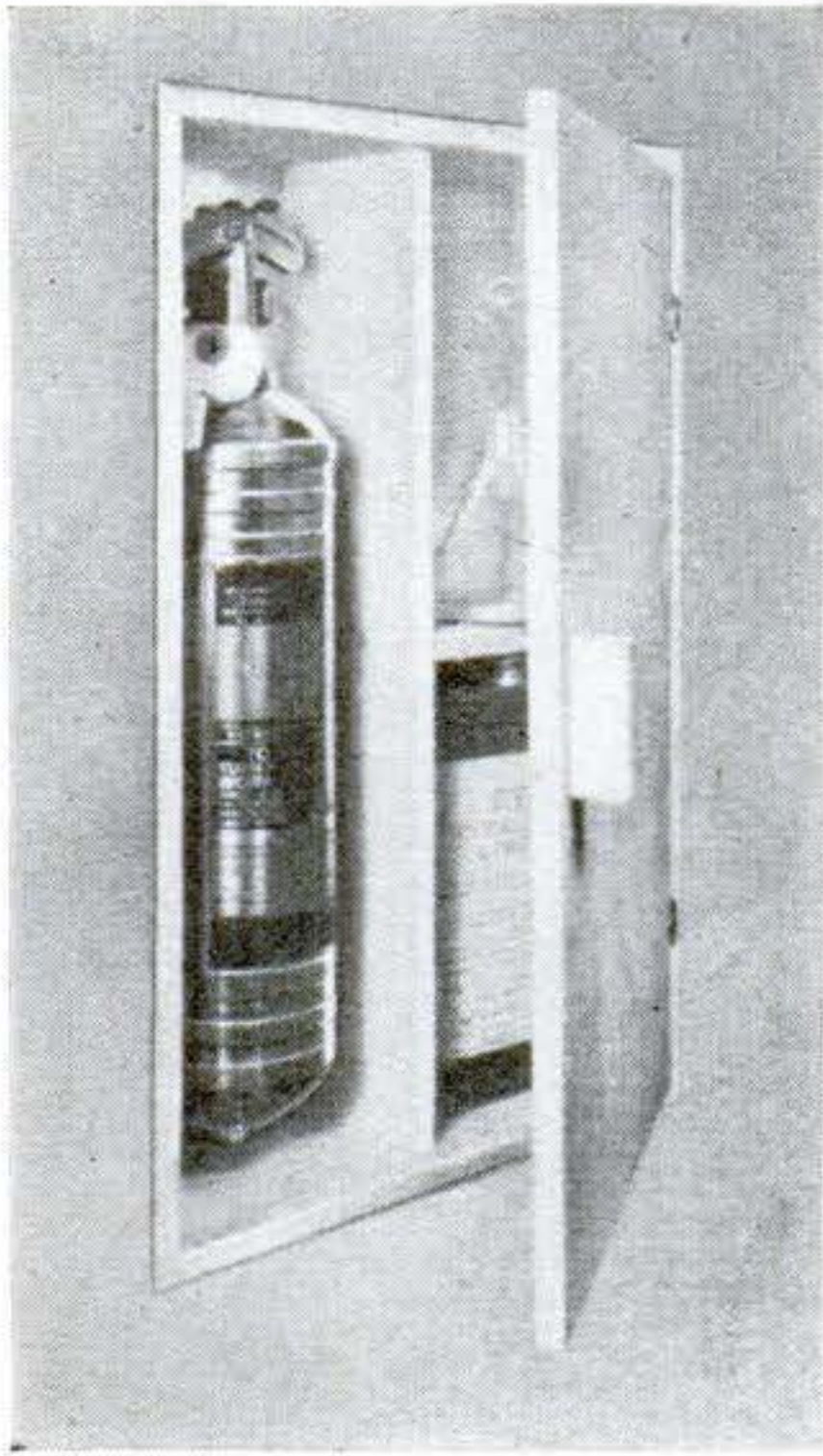
COMPACT SICK-ROOM CALL BELL SUMMONS HELP TO BEDSIDE

SICKNESS IS confining not only for the patient, but also for the others in the family who are afraid to leave the sick one out of earshot. This easily storable call bell can be contained in a box of the size shown, for it consists only of a bell, a transformer, and two lengths of wire.

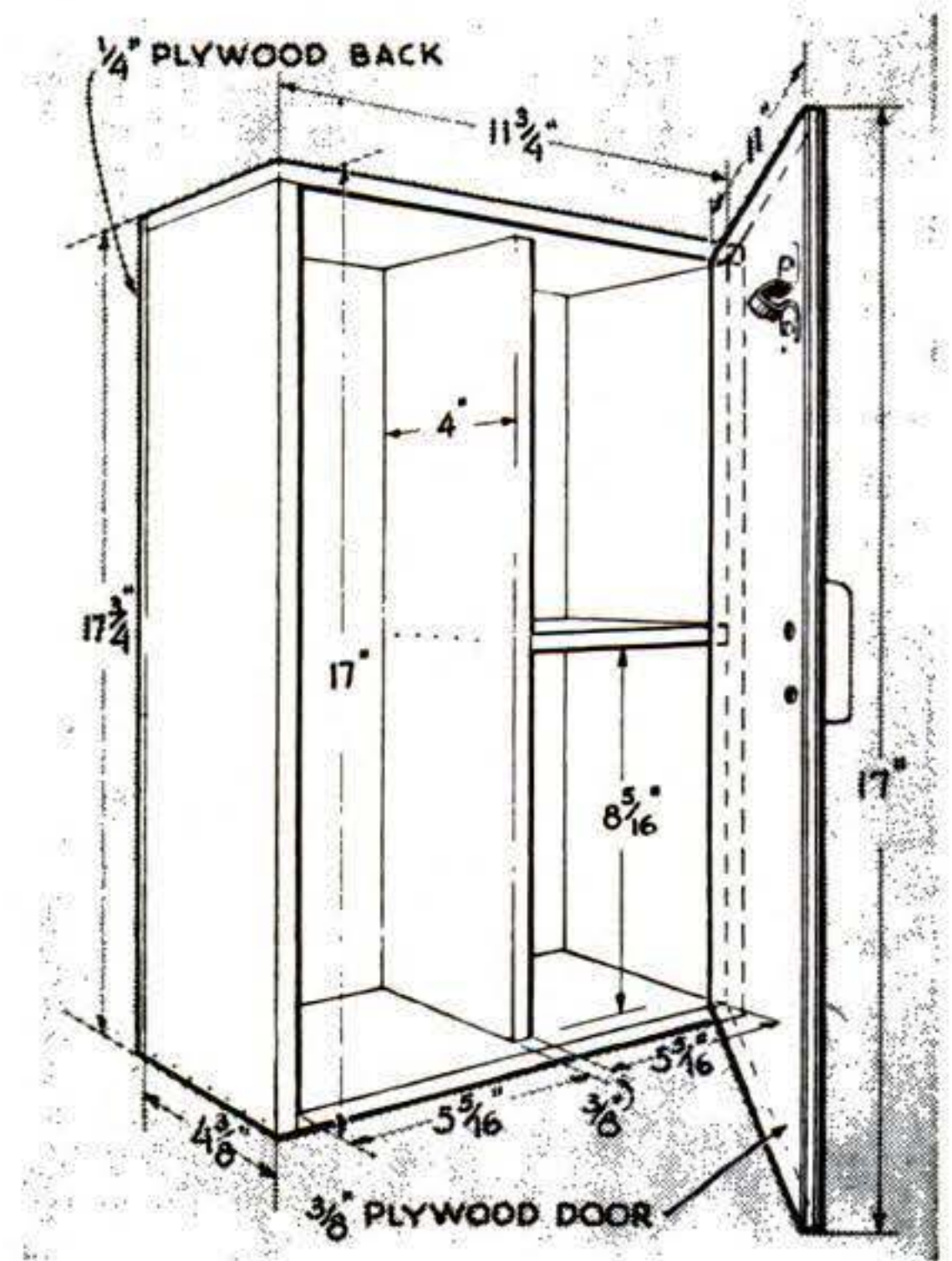
Plug the unit into an A.C. outlet and place the box at some central point. The wire ending in a pushbutton can then be led along to the bedroom, terminating at the patient's bedside.—THOMAS S. SMITH.



CABINET IN WALL WILL KEEP FIRE EXTINGUISHER OUT OF THE WAY

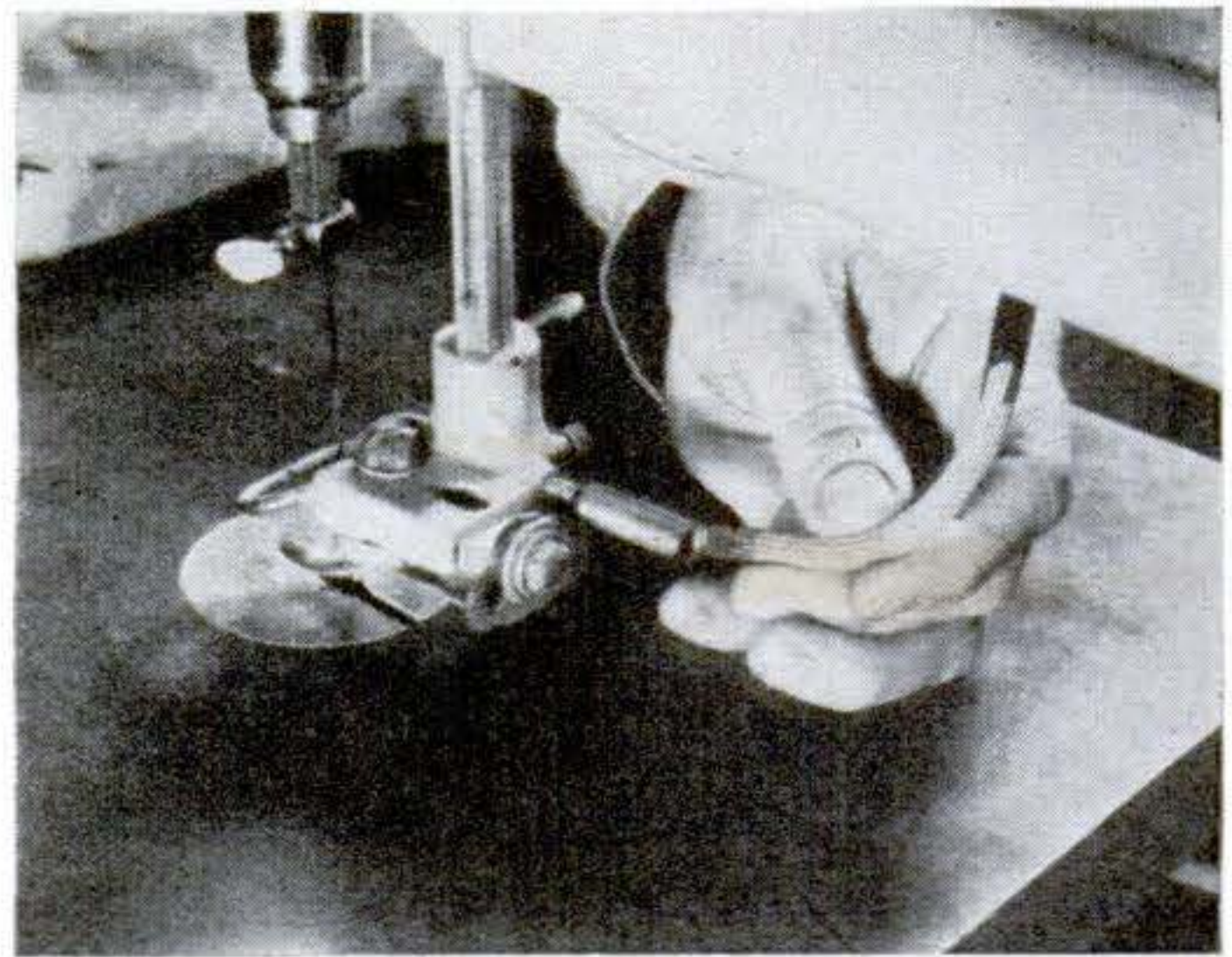


FEW homes include architectural provision for storing fire extinguishers without obstructing hallways or detracting from the decorative scheme. A cabinet recessed so that its face is flush with the wall will serve this purpose. The accompanying drawing shows construction details of a cabinet with adequate space not only for the extinguisher but for a can of extinguisher liquid and a small funnel. Except for the back, it is built entirely of $\frac{3}{8}$ " plywood. It is a good rule to locate extinguishers so as to be accessible from two directions.

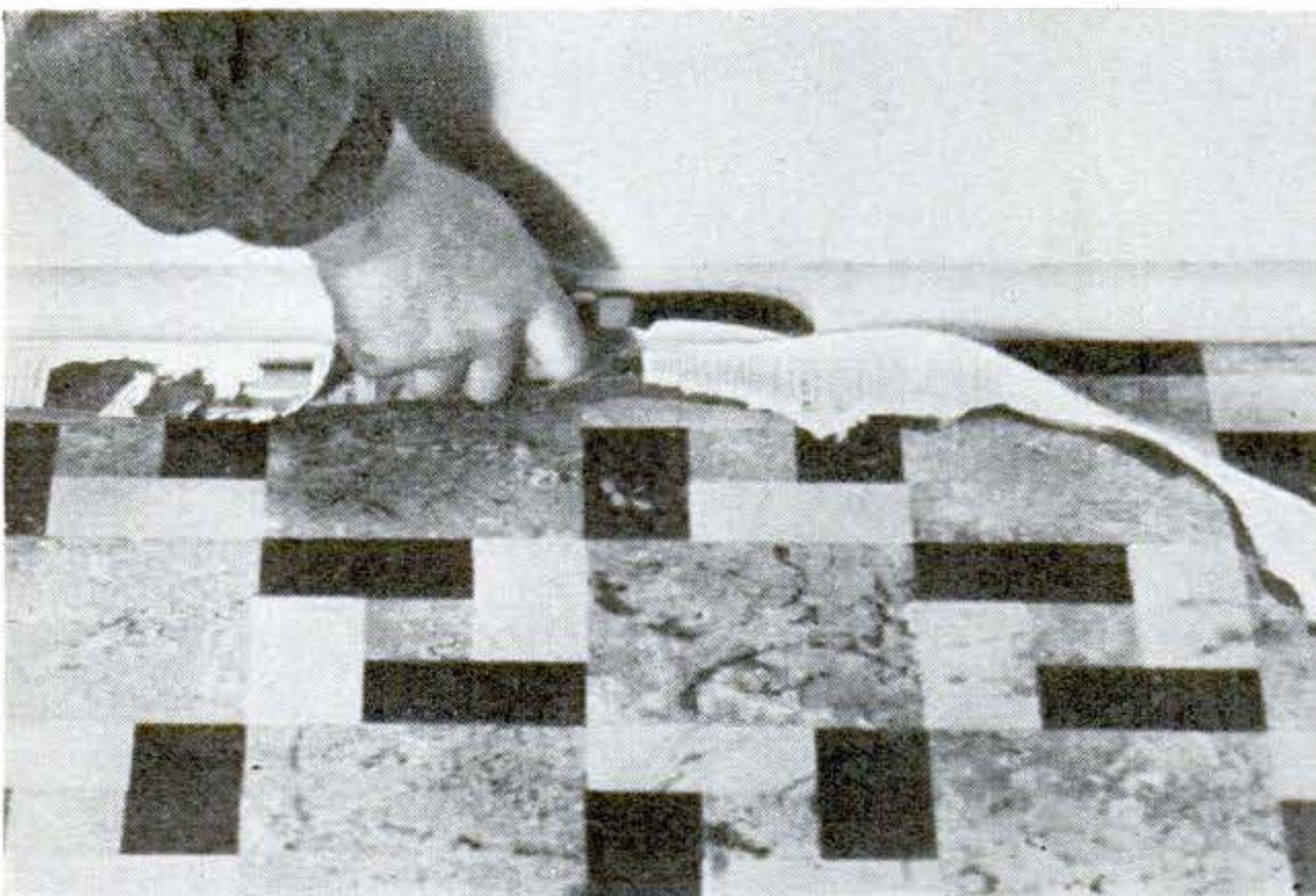


REDUCER CUT FROM RAZOR HANDLE SAVES SCROLL-SAW HOSE FROM WEAR

FORCED over the outlet tube, the blower hose on a scroll saw frequently begins to leak and fall off because the rubber end is stretched, causing it to deteriorate rapidly. A neat reducing fixture that does not interfere with the saw and makes this stretching unnecessary can be formed from the hollow handle of a safety razor. Cut off about $1\frac{1}{2}$ " of the handle and ream out the threaded section to fit the outlet tube. After cutting off the hose to fresh rubber, sand a taper if necessary so that it can be pushed inside the large end of the reducer. Since the rubber then is in a normal state or even compressed, it will last indefinitely.—E. M. L.



TEMPORARY PAPER GUARD GIVES PERFECT PAINT JOB ON NEW MOLDING



WHEN new quarter-round or other molding is being installed at the base of a wall, you can get a perfect paint job by inserting 3" strips of newspaper under the molding before nailing it down. Dust off both the molding and the paper before applying each coat of paint. After the last coat has dried thoroughly, hold a sharp-pointed knife at an angle of about 60 deg. away from the wall and neatly cut the paper strip away from the molding. The resultant job will be clean as a whistle and no signs of the paper will show between molding and floor.—N. E.

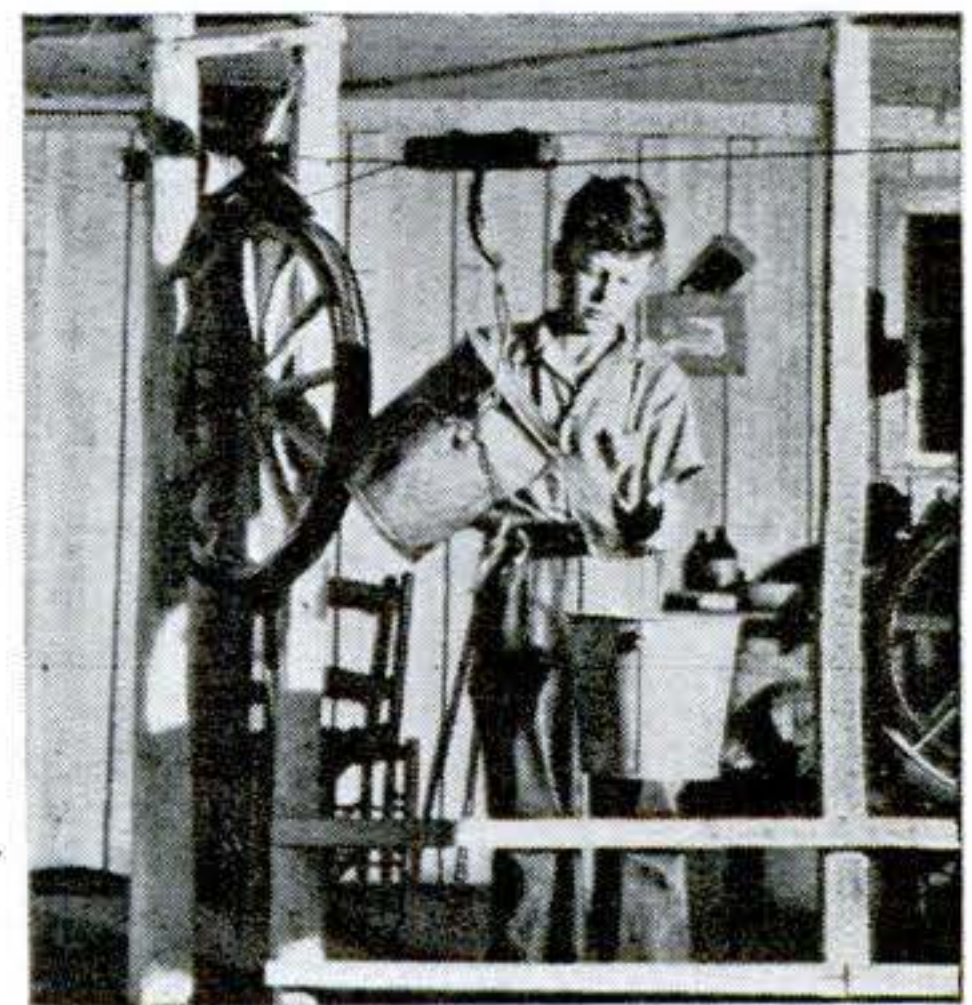
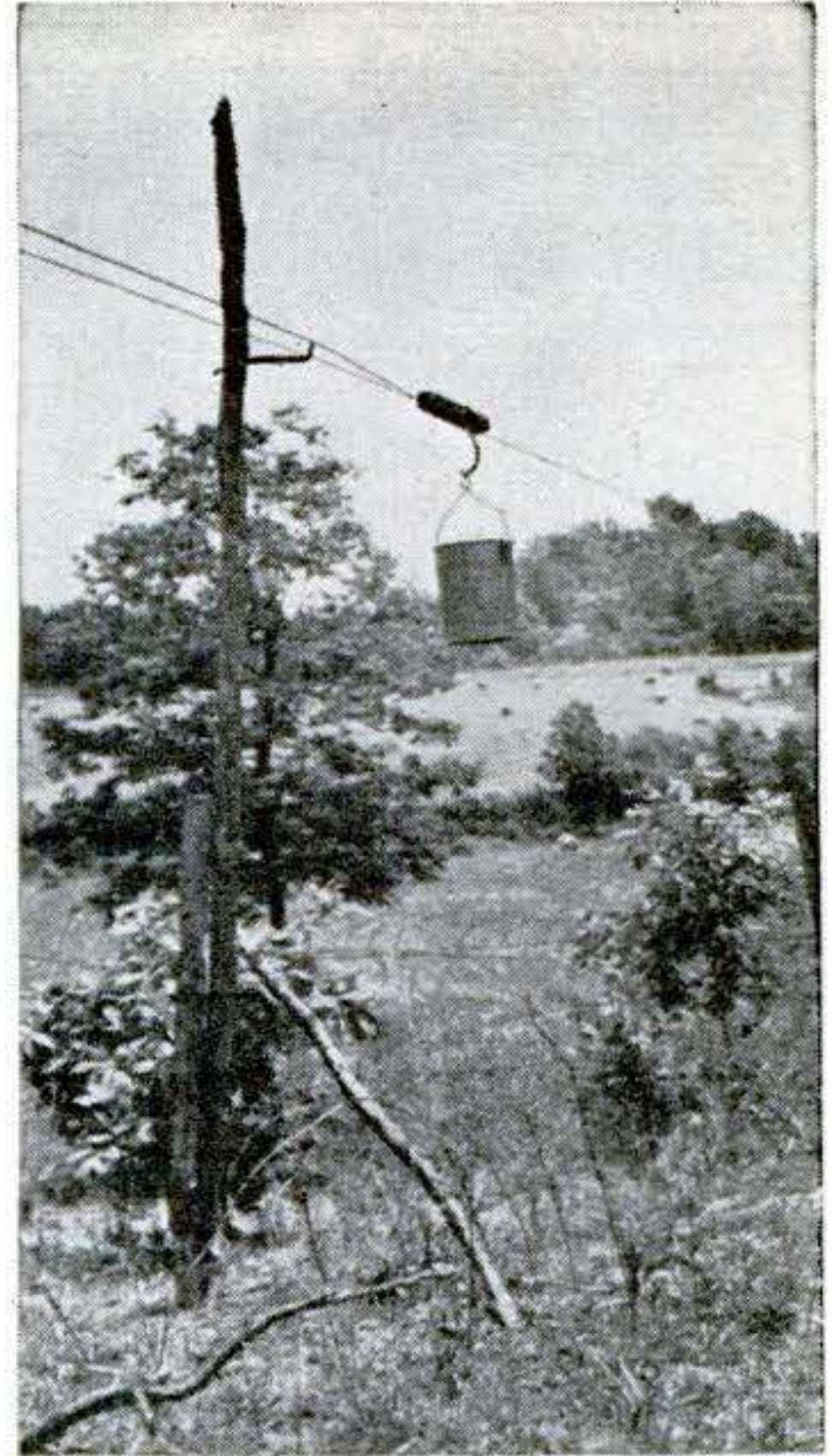


Supported on a cable reaching from the farmhouse porch, the bucket above splashes into the spring and fills with water. On the porch far up the hill, the farmer's son then turns a crank, and away goes the bucket on its journey to the house. It saves a lot of walking.

ELEVATED CABLE TRANSPORTS SPRING WATER UP TO A FARMHOUSE ON A HILLSIDE

ON ONE hillside farm in the mountains of North Carolina the farmer's son no longer has to trudge down the hill and carry up water from a spring several hundred yards away. Standing comfortably on the farmhouse porch, he can now hook a bucket on a cable that reaches to the spring—and pull up the water.

Impelled by gravity, the empty bucket rides down the cable, through the garden and high over a field. When it reaches the spring, metal weights wired to the lip cause it to tilt over and fill with water from the leaf-shaded supply. Then, on the porch, the boy, who used to have to make several fatiguing trips to the spring each day, begins turning a crank attached to an old auto wheel mounted on a post. As the cable is moved by the wheel, the bucket of water comes up the hill to the porch with comparative ease. Several neighbors also have installed similar systems.



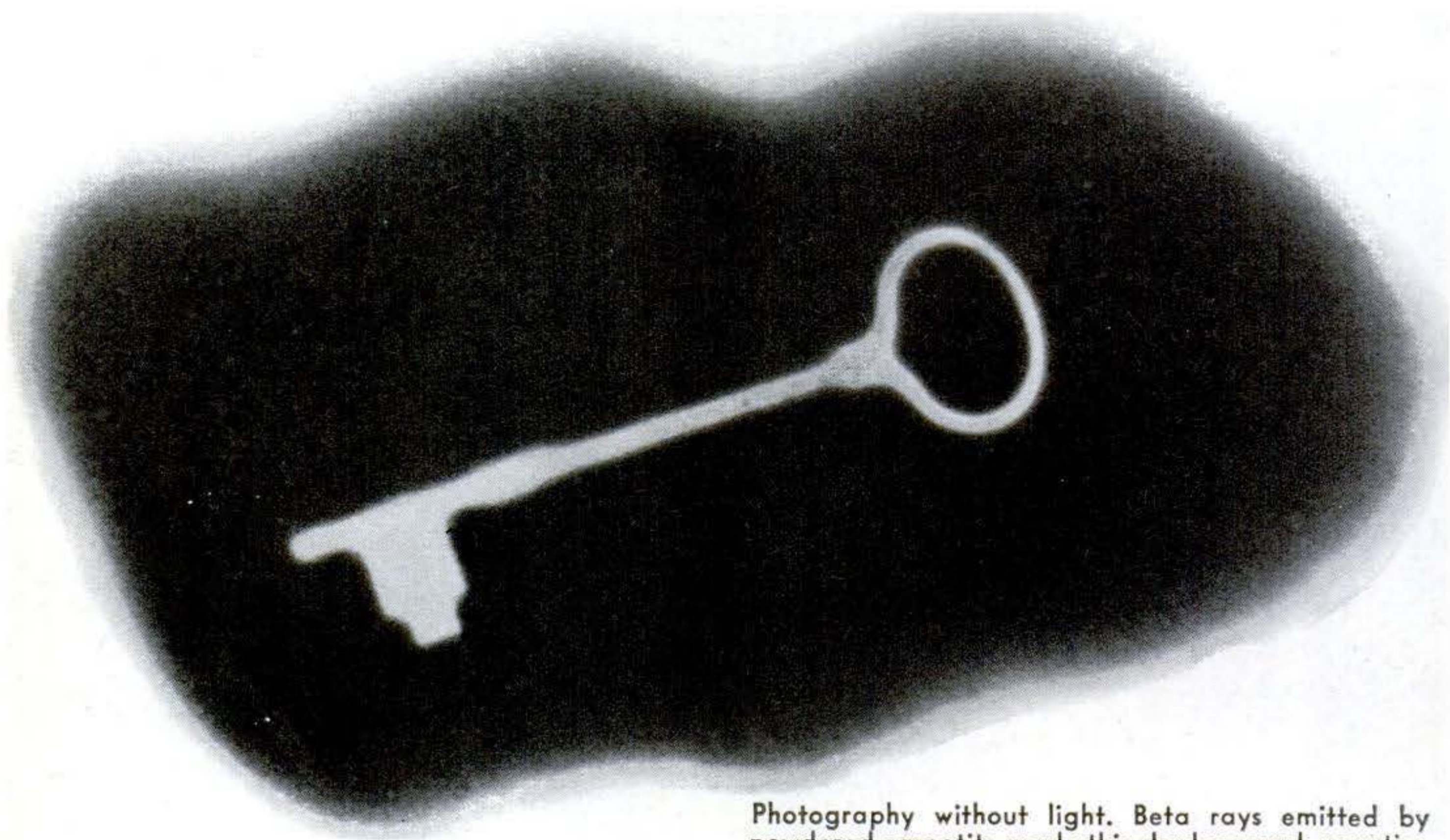
MOBILE SERVICE UNIT SAVES TIME IN CARING FOR FARM EQUIPMENT

DESIGNED especially for farm use, a portable unit produced by the Alemitte Division of the Stewart-Warner Corporation brings the facilities of a service station directly to equipment in the field. It supplies pressure lubrication, inflates tires, dispenses gear lubricant or motor oil, and has a spray gun for application of rust preventive or paint. Mounted on a tubular base which serves as an air tank or reservoir, the unit weighs 246 lb., measures 29½" by 31⅛", and can be easily pulled behind a car, truck, or tractor. It has its own air compressor, driven by a gasoline engine, which maintains constant pressure of 130 lb. in the air storage tank. The engine is started when the unit arrives on the spot.



RADIOACTIVITY...

EXPERIMENTS IN YOUR HOME LAB DETECT RADIANT ENERGY



Photography without light. Beta rays emitted by powdered carnotite made this shadowgraph negative of a key resting on the slide of a cut-film holder.

By TRACY DIERS

WHEN two atomic bombs hastened the end of our greatest war, the world suddenly became uranium conscious. And much of the discussion, when the first awe had subsided, was over the possible effect of radioactivity set loose by the splitting of uranium or plutonium atoms.

As a matter of fact, many substances around us are radioactive. You can make simple tests that will detect their strange emanations and identify them as well. Practically all the chemicals and materials needed for the experiments can be obtained from large chemical-supply houses at a cost of no more than two or three dollars. Most of the apparatus is homemade.

First, you will need a leaf electroscope of the kind used in high-school physics classes. One shown on the facing page is made of thin plywood and measures about $3\frac{1}{4}$ " by $3\frac{1}{4}$ " by $6\frac{1}{2}$ ". It has a glass-covered opening in front about $4\frac{1}{4}$ " high. A specimen holder is attached by means of a bolt and a spacer, which may be a large spool, through a slot in the back. Its wing nut permits adjustment for height. The conducting rod may be copper, brass, or other metal and is topped with a metal ball through which it

is charged. A thin piece of aluminum $\frac{3}{8}$ " by $1\frac{3}{4}$ ", a $\frac{5}{16}$ " by $1\frac{3}{4}$ " leaf of extremely thin aluminum foil, and a cardboard scale are bolted to the end of the rod, as shown.

Before assembling the box, bore a $\frac{3}{4}$ " hole in the center of the top; then lay the piece on a sheet of cold metal and fill the hole with molten sulphur, a nonconductor. Drill a smaller hole through the sulphur when it has solidified and press the rod through, sealing it with more molten sulphur.

The electroscope can be charged by touching the metal ball with a stick of sealing wax that has been rubbed on flannel or wool. If the weather is not too humid, the conducting rod carries a charge of the same polarity to both the aluminum plate and foil at the end, they repel each other, and the leaf swings up on the scale, gradually falling back as the charge leaks off.

But place some radioactive substance such as pitchblende or carnotite in the specimen tray, and the leak is much more rapid. This is because emanations from the radioactive substance ionize the surrounding air and make it a better conductor.

The emanations that this test detects are known as alpha rays, which are identical with helium atoms. They are easily stopped by paper or aluminum foil. To show they

Storehouse of Atomic Power

THROWN OFF BY ELEMENTS AS THEIR ATOMS DISINTEGRATE

can be stopped, lay a sheet of writing paper over the specimen, recharge the electroscope, and time the falling leaf. You will find the drop considerably slowed.

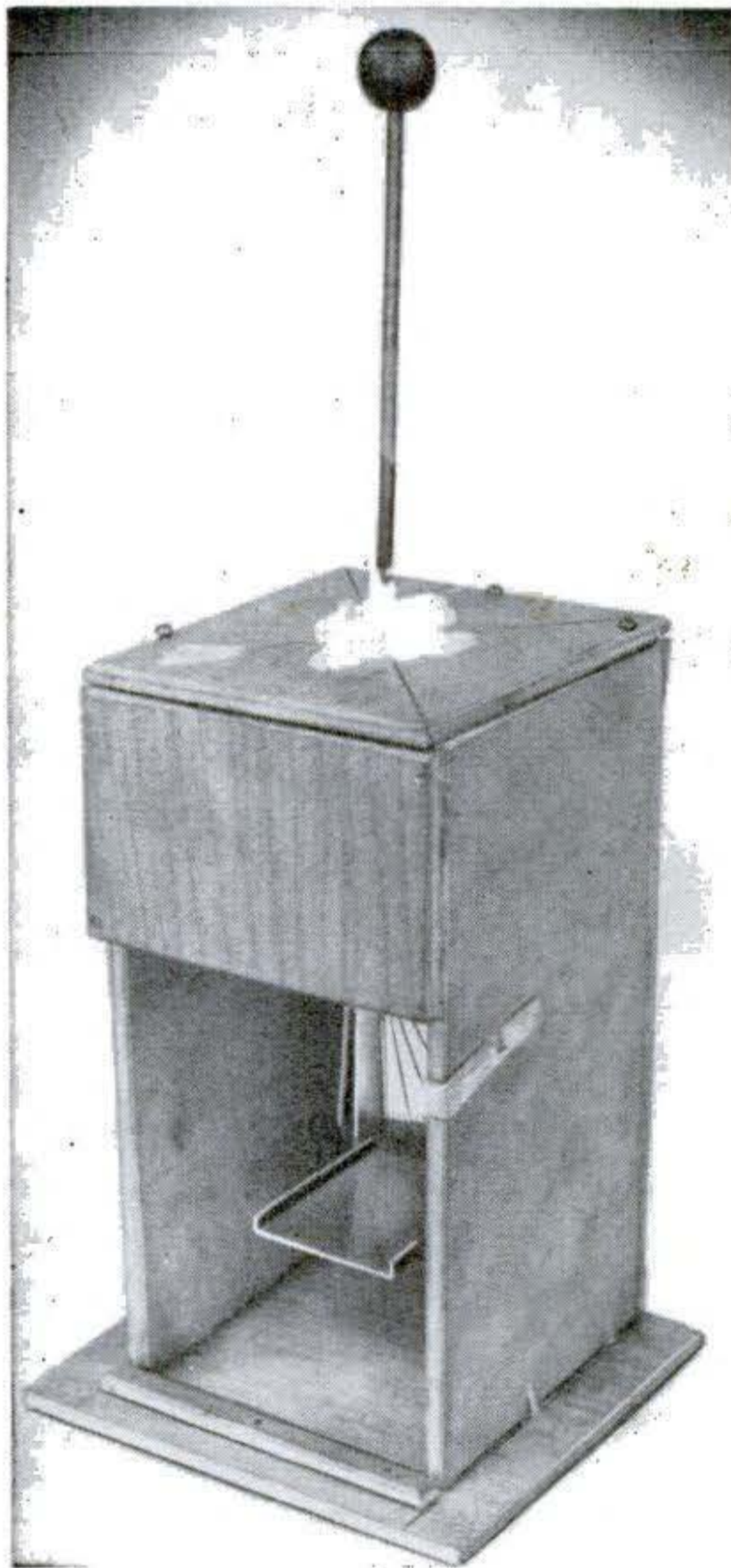
Besides pitchblende and carnotite, you will want to test other radioactive substances for alpha rays. Some of these may be such minerals as autunite, orangite, thorite, euxenite, samarskite, broggerite, and chalcocite, as well as uranium salts.

Another test for alpha rays, and a rather spectacular one, is based on fluorescence. It is carried out in a dark room, and the alpha

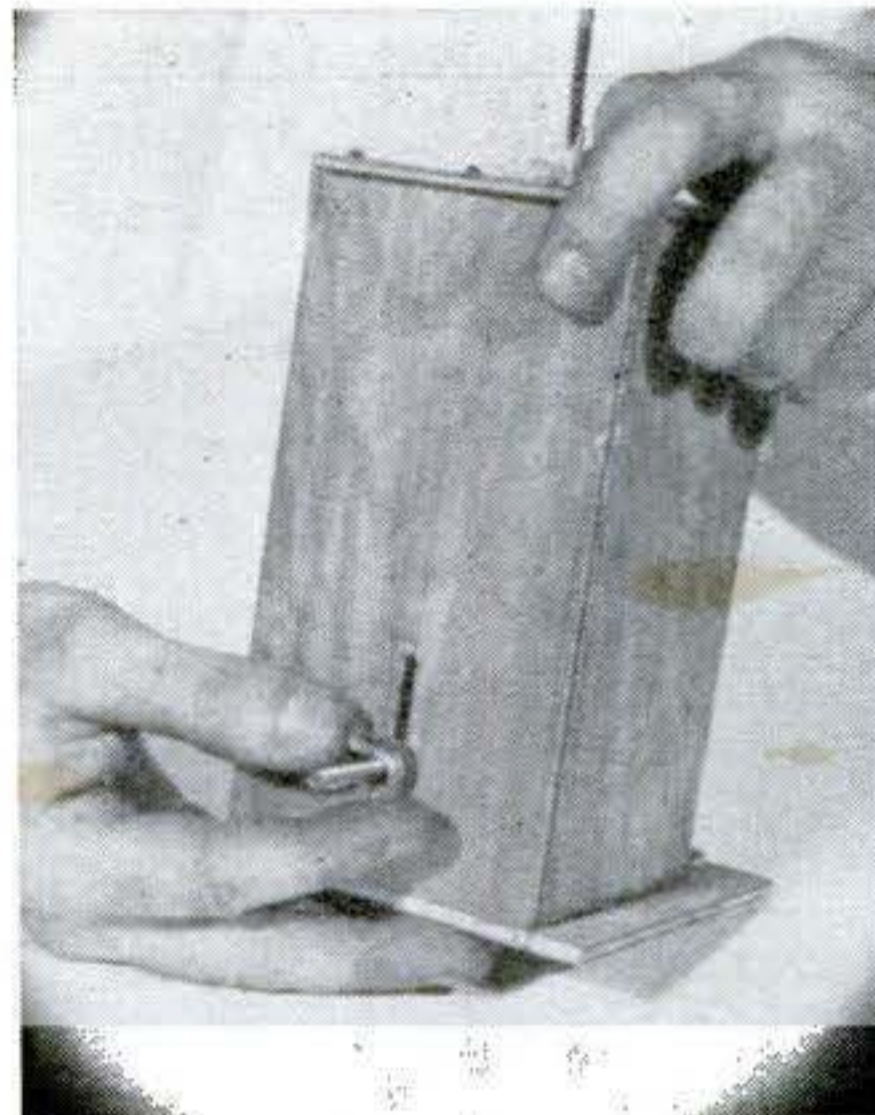
rays bombarding grains of a fluorescent substance produce intermittent flashes as they strike. Pour a thin pool of a weak solution of gum arabic on a clear lantern slide; then stretch cheesecloth over the neck of a zinc sulphide bottle and gently tap the powder onto the gum arabic. When the gum has dried, you will have a radioscope or fluorescent screen for your experiment.

Half fill a pint bottle with water and grind and add some of the radioactive substance to be tested. Shake the mixture thoroughly; then uncork it and lay the screen over the

HOW TO MAKE AN ELECTROSCOPE TO TEST FOR RADIATION

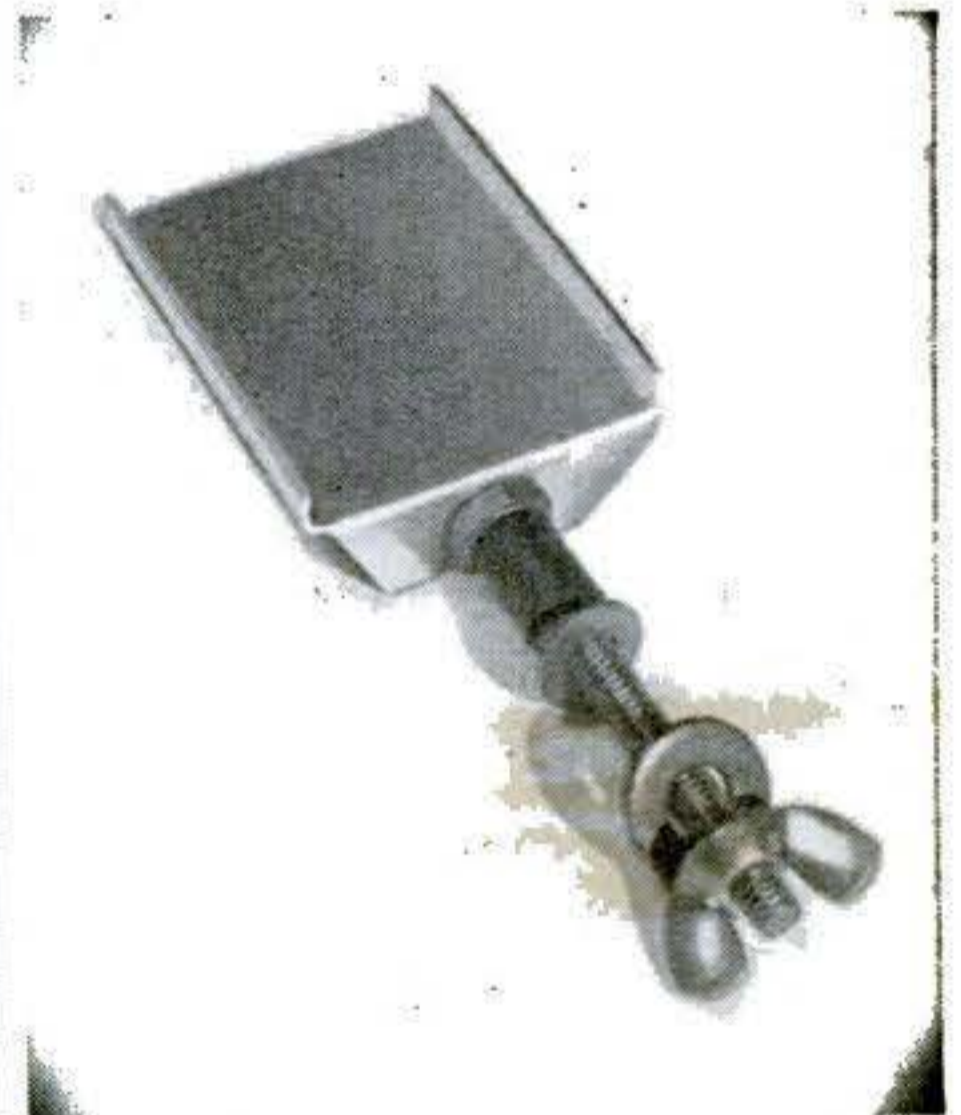


This is the completed device for testing a radioactive substance, which is put in the tray under the foil leaf and scale. A sheet of glass then covers the opening.



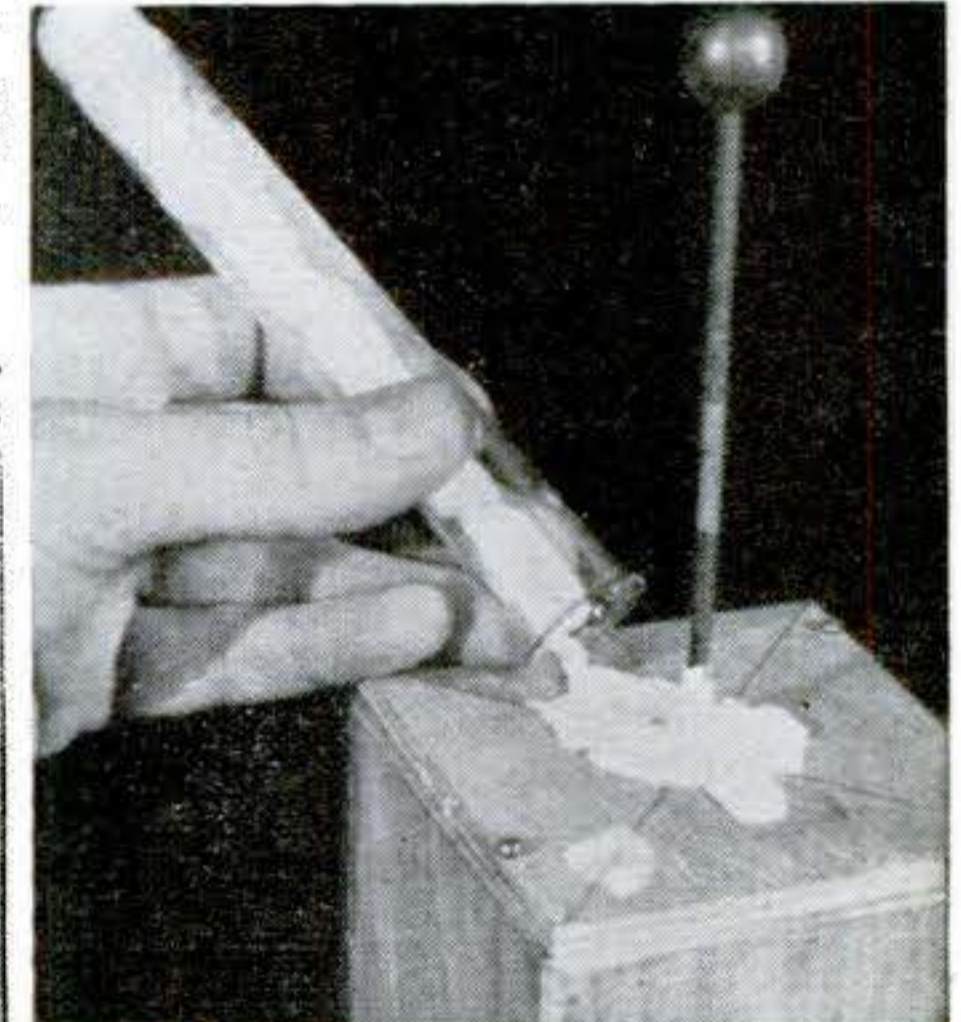
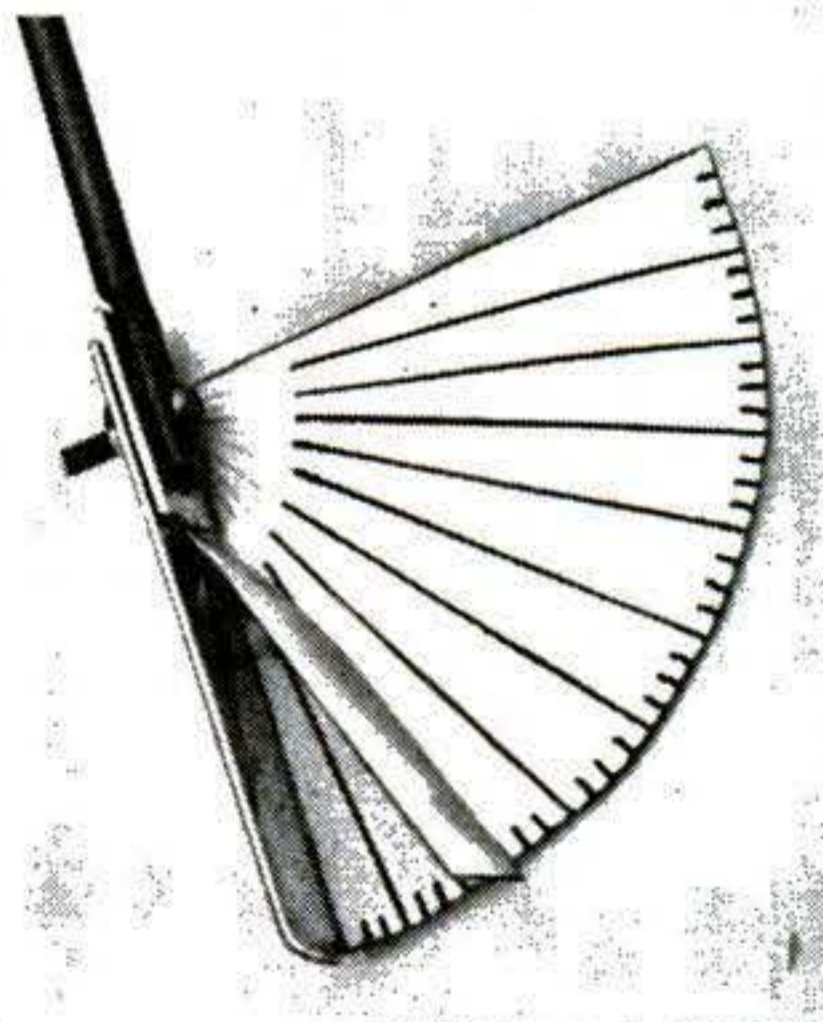
Height adjustments to regulate distance between the tray and charged leaf are made by a wing nut holding the tray.

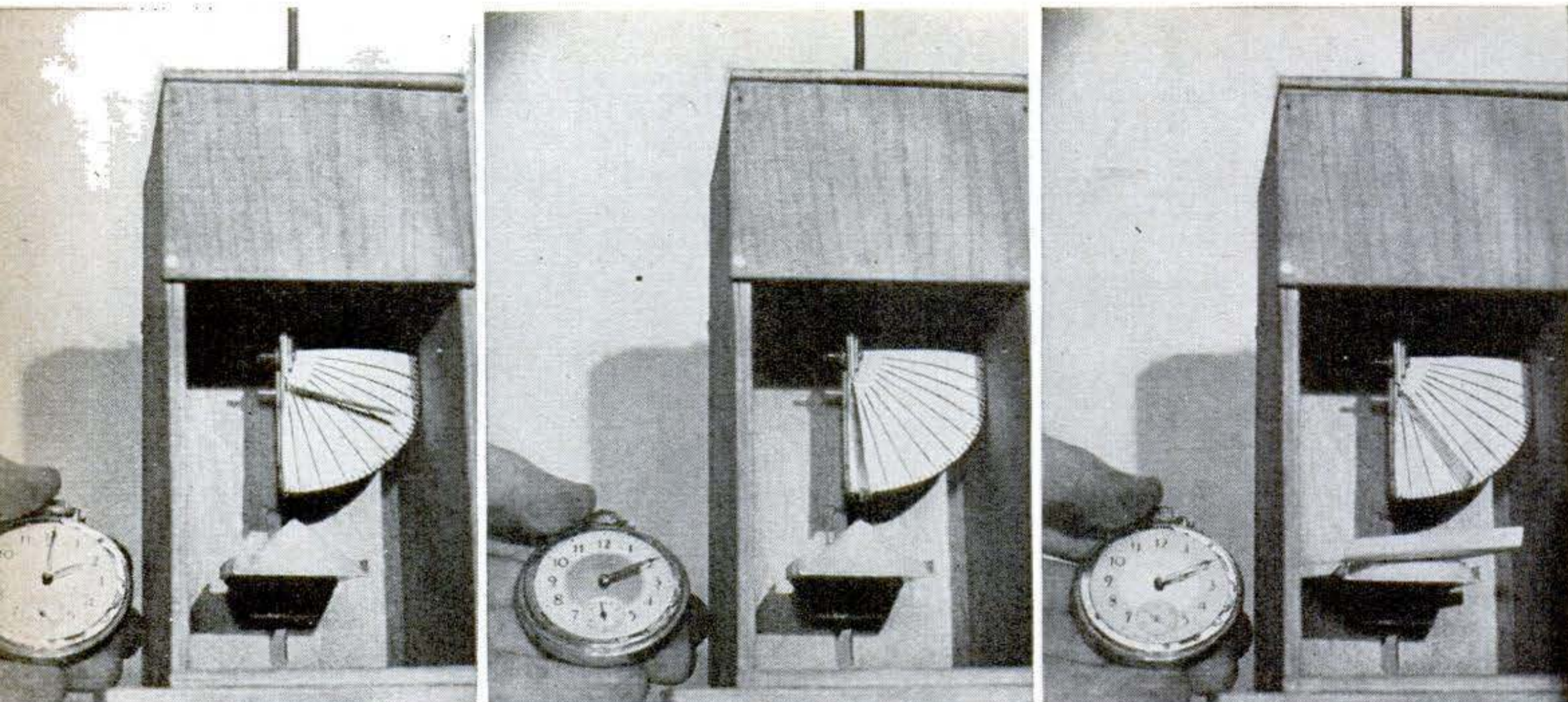
Taking like charges, the two parts repel each other, and the foil travels up the scale.



The specimen tray shown above is made of aluminum. A spacer sleeve on the bolt will hold it directly under the charged leaf.

Molten sulphur seals the hole around the conducting rod and prevents leakage to the case.





DETECTING THE ALPHA RAYS. These emanations from radioactive substances ionize the air and make it a better conductor than it would otherwise be. The charge leaks rapidly and the foil collapses, as shown at center. But a piece of paper placed over the substance, as at right, stops the alpha rays, the surrounding air is less ionized, leakage is less rapid, and the leaf falls more slowly.

top of the bottle with the sulphide side down. Look for the flashes with a magnifying glass. Your success may depend on how well your eyes have been "dark-adapted," which may mean spending about a half hour in complete darkness.

The luminous paint on watch dials is made of an active alpha bombarder such as mesothorium mixed with zinc sulphide or some other fluorescent substance. In this mixture the zinc sulphide is under continuous bombardment for many years.

In addition to alpha rays, radioactive substances also emit beta and gamma rays. Beta rays are electrons with greater penetrating power than alpha rays, but they can be stopped by 1 cm. of aluminum. Gamma rays are similar to X-rays except that they have a shorter wave length. They are extremely penetrating.

Prof. Henri Becquerel discovered in 1896 that beta rays emitted by uranium salts would expose a photographic plate in the dark even with a sheet of black paper between the salt and the plate. As a result of his work in radioactivity, all three of the rays are called Becquerel rays. You can test for beta rays in the electroscope and also duplicate the original Becquerel experiment.

Place your specimen in the electroscope and cover it with aluminum foil to stop the alpha rays. You'll find that it will take considerably longer for the electroscope leaf to collapse than if the alpha rays were not stopped. But because the beta rays also ionize the air to some extent, the fall will come in a shorter time than it would if no specimen at all were present.

For the photographic test, place a piece of cut film in a holder, lay a key on top of the slide, and sprinkle powdered carnotite, pitchblende, or uranium nitrate crystals over the key. Develop the film 48 hours later, and you will get a perfect shadowgraph of the key, like that shown on page 196. The emanations expose the film, turning it black except for the part covered by the key, which stops them.

Even with a substance rich in alpha, it can be shown that beta rays, and to a lesser extent gamma rays, are the ones that darken the film. Flow gum arabic over a glass plate, sprinkle it with black uranium oxide, and lay the plate oxide side up when dry in a lighttight box. Cover half the plate with a sheet of 1/32" aluminum and place a photographic film on top with the emulsion side down, as shown on the facing page. A wedge of paper at the edge will keep the film and oxide from touching.

Cover the box and let it remain three days before developing the film. You will discover that the alpha, beta, and gamma rays that have bombarded half the film have made it but slightly darker than the half from which the aluminum kept the alpha rays. With your homemade equipment it is not possible to separate gamma rays from beta, but this does not affect the experiment.

Return to your electroscope for an experiment to show that it is the surface area of the radioactive substance rather than the mass that emits the greater amount of alpha rays. Sprinkle about 80 grains of black uranium oxide on a 2½" square of card-

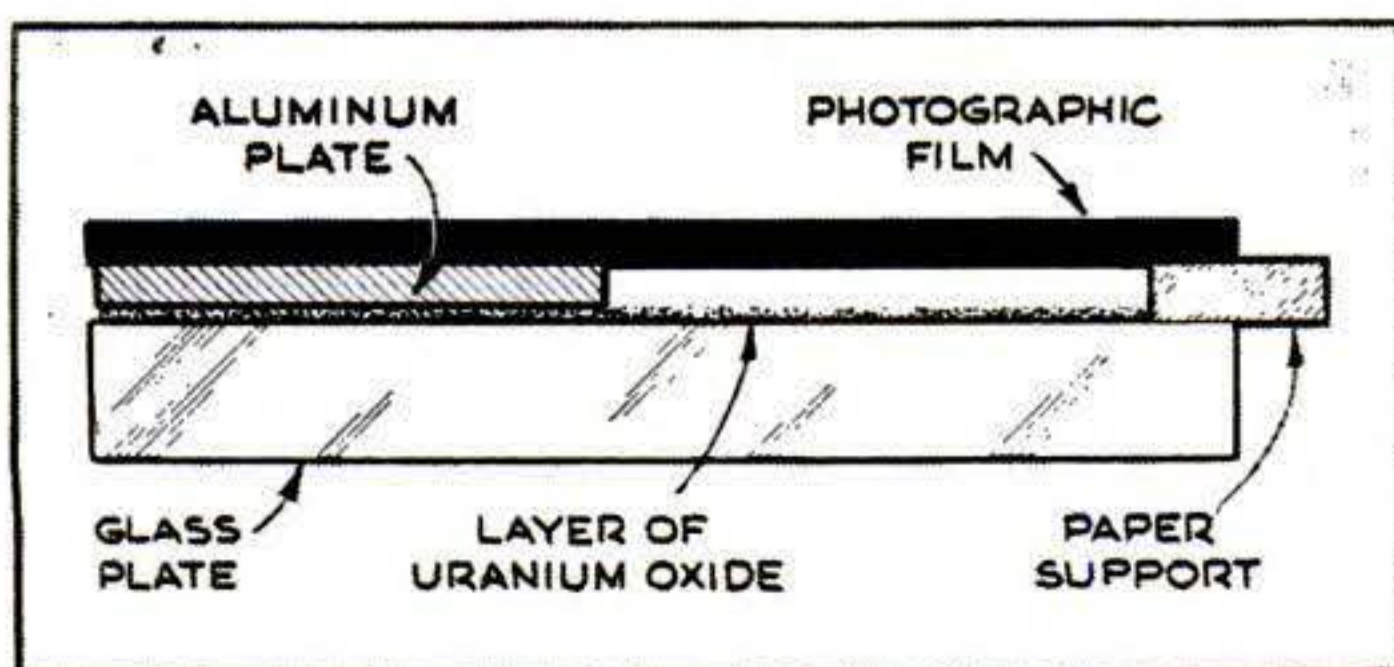
board, and time a given leaf fall. Then fill a tiny paper box $\frac{1}{2}$ " by $\frac{1}{2}$ " square by 2" deep with about 300 grains of the same uranium oxide, and time the same fall. The first test, with a smaller mass but a larger area, will discharge your electroscopes faster than the larger mass. The reason is because alpha rays near the bottom of the pile cannot penetrate the upper layers.

This is not true with beta and gamma rays, as can be shown by placing a film holder loaded with fast film over two piles of carnotite, one about $\frac{1}{8}$ " high and the other 1" high. When the film is developed a day later, the smaller pile will be shown to have made only a faint image while the large pile has produced a dense black area. This is because beta and gamma rays can penetrate the upper layers.

What happens to your radioactive substances as they emit these rays? They lose electrons and atoms of helium and change into other substances—a process known as transmutation of elements. In nature some of these changes take billions of years, others only a few minutes when a radioactive element passes through an unstable stage to another more stable one. In the atomic bomb and in other types of atomic fission, this process can be speeded up by artificial means, that is, by firing the nuclei of some atoms against the atoms of some other elements.

You won't be able to make an atomic bomb in your home lab or build a cyclotron in which to hasten nature's transmutation process, but you can perform experiments to show that changes in elements *do* occur.

Beta rays penetrate thin aluminum and darken the entire film in a setup like that below, showing that alpha, which are stopped, have little effect.



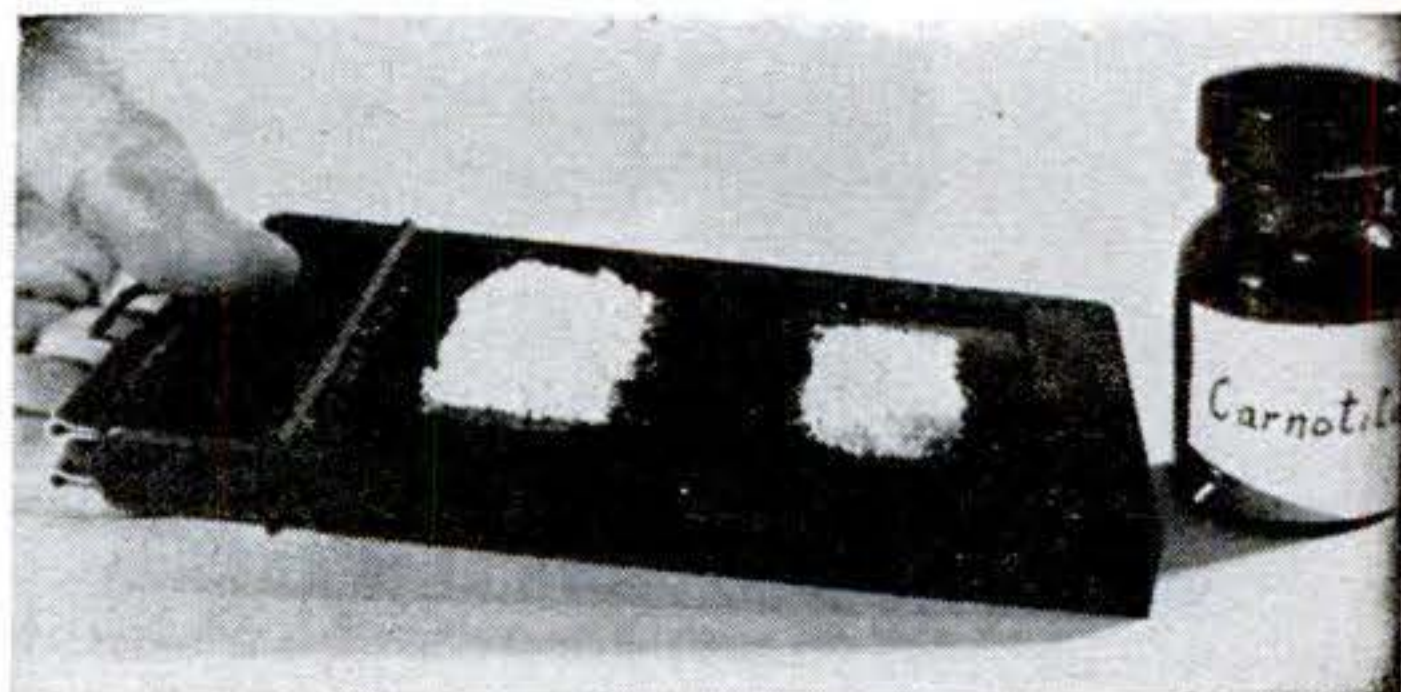
Tiny fluorescent flashes are given off when alpha rays bombard zinc sulphide in a darkened room. It is the same principle as that employed in treating watch dials with luminous paint.

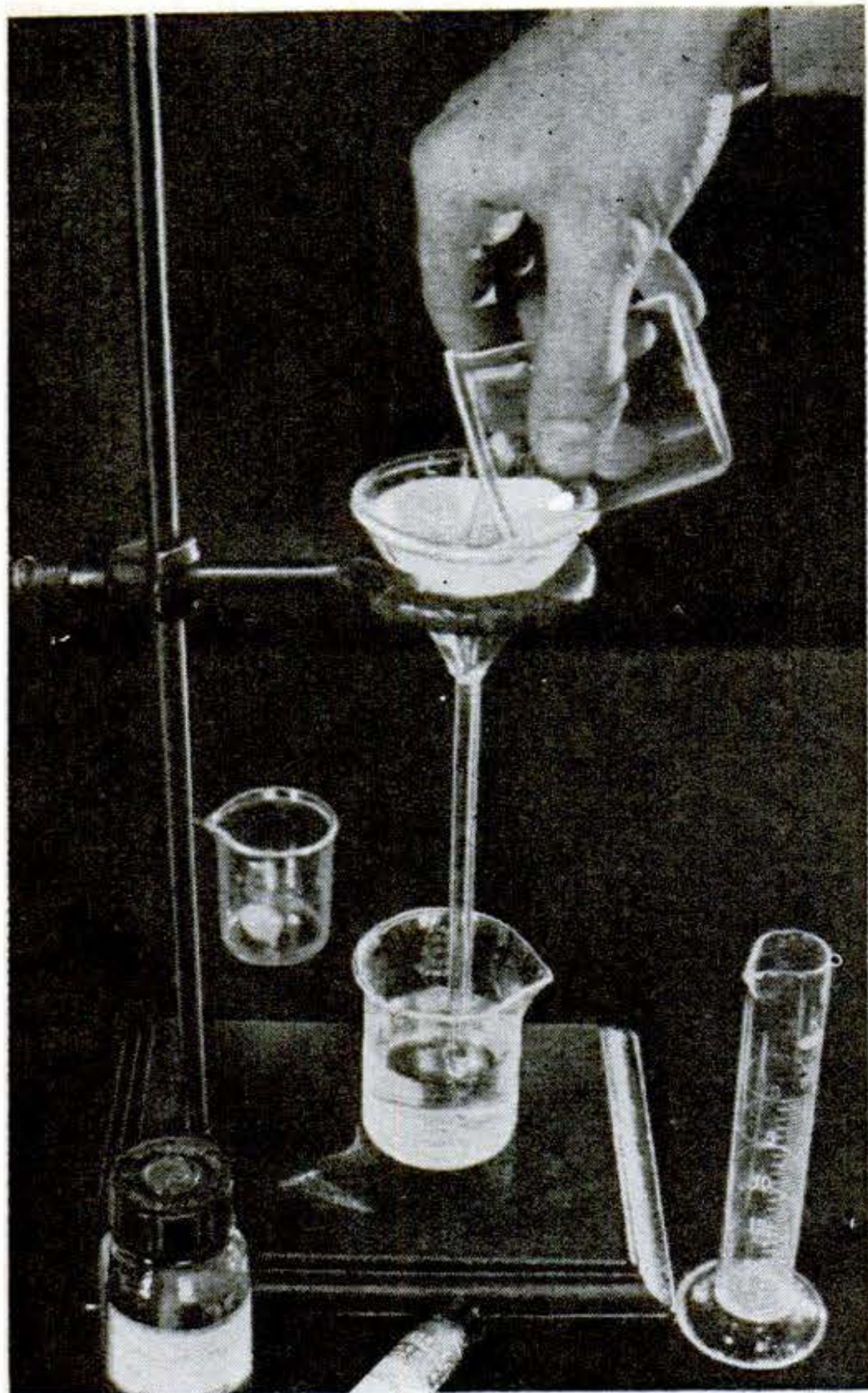
Physicists, for convenience, employ the term "half life" in connection with the disintegration of radioactive elements. It is known that only a fixed proportion of any given amount of radioactive substance changes in a given time and that the fraction remains constant. Therefore less and less of the total of the specimen changes in each succeeding unit of time, and an infinite time is required for the entire amount to disintegrate. As a result, the "half life" of an element becomes a useful measurement in calculations. It means the time required for half the amount of the element to disintegrate.

Among the half-life figures arrived at for uranium are 4,500,000,000 years for the parent element and only 24.5 days for the next stage, known as uranium X.

You can make a test with $\frac{3}{4}$ oz. of uranium nitrate, showing that the parent uranium emits alpha rays and that uranium X₁ emits beta rays. Uranium X₁ in reality

That beta rays come from inside as well as from the surface of radioactive substances is shown by testing two unequal piles of carnotite on film.



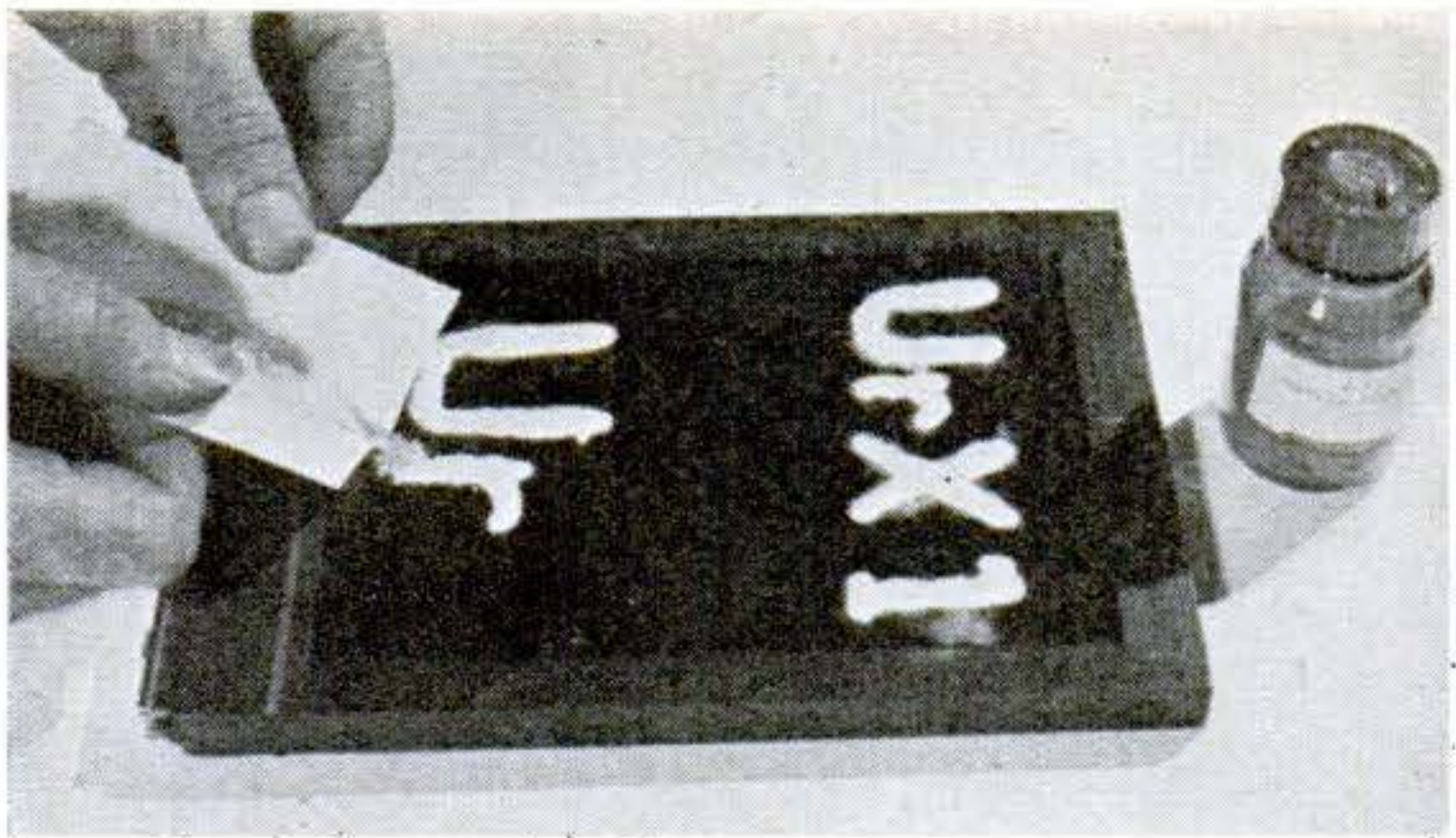


Uranium X_1 can be separated by chemical means from uranium in uranium nitrate. It combines with iron perchloride to form a sludge when ammonium carbonate is added to a solution of the two salts, and can be easily filtered.

emits both beta and gamma, but you cannot separate them with your equipment. Two of the tests should be made at 24-day intervals—the half-life period of uranium X_1 .

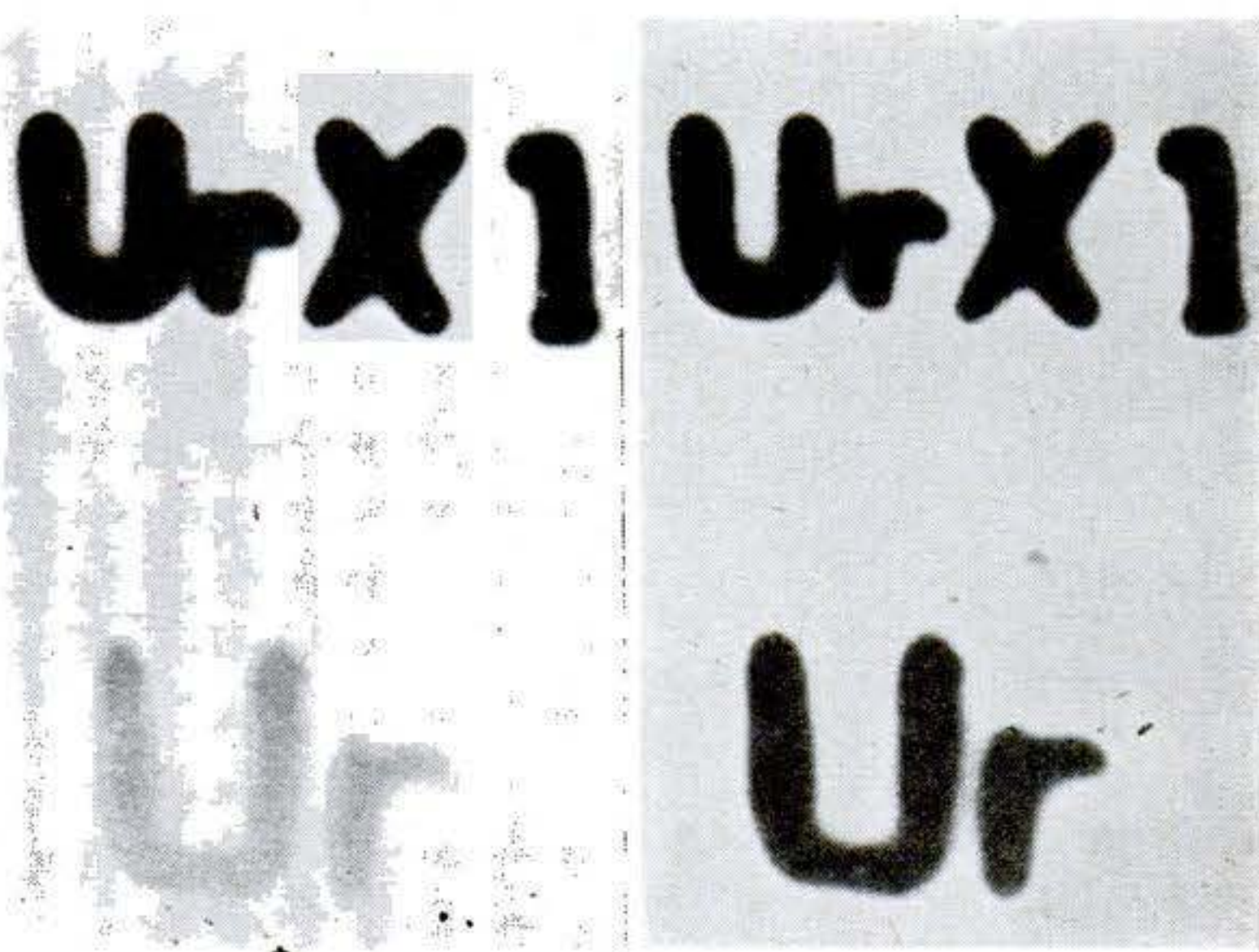
Test the uranium nitrate in the electroscope for alpha rays and record the time it take the leaf to fall through a fairly large fixed division on the scale. Cover the specimen with aluminum foil to stop alpha rays, recharge the electroscope, and make the beta-ray test, recording the time of collapse through the same scale division. Then place the crystals on top of a plate holder for 10 hours, develop the negative, and put it aside.

In addition to uranium, the nitrate contains a trace of uranium X_1 , which can be precipitated chemically and filtered out in combination with iron perchloride. Dissolve the uranium nitrate in 2 oz. of water, add one or two drops of a concentrated solution of iron perchloride, and next pour slowly into the mixture a concentrated solution of ammonium carbonate until a yellow precipitate forms and then just dissolves. There



Here's how to compare beta radiation of uranium X_1 and of uranium from which the X_1 has been removed by chemical means. The film is exposed for 10 hours.

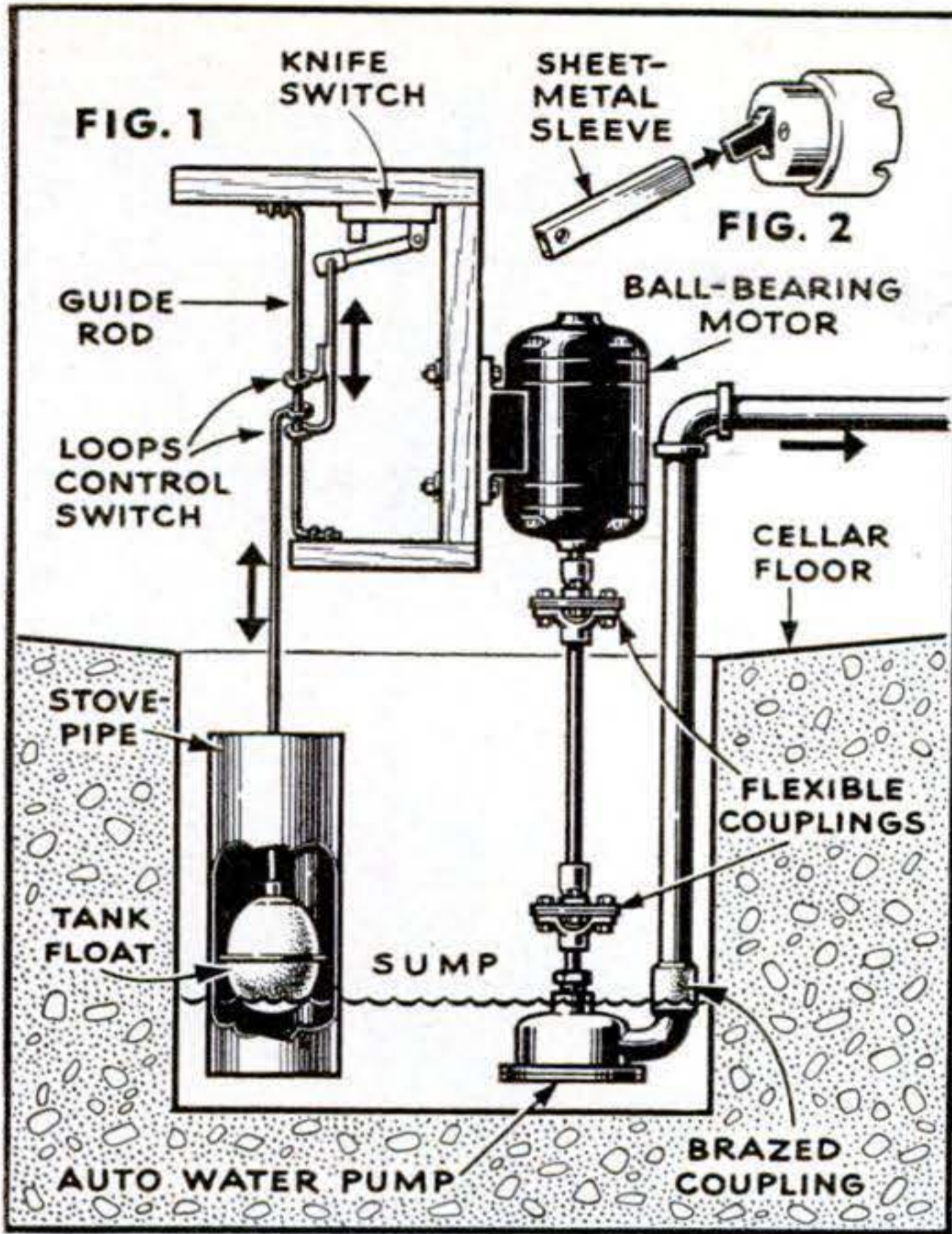
At left below, the purer uranium has darkened the film but slightly, while right, 24 days later, it shows disintegration and produces a dark exposure.



will be some traces of an orange-brown sludge in the bottom. This contains your uranium X_1 and should be filtered out; the solution that ran through the filter paper contains uranium nitrate stripped of its uranium X_1 . Heat the latter gently until it no longer gives off a smell of ammonia, and then dry the precipitate.

Test both samples in the electroscope without delay, and you will find the uranium X_1 emits no alpha rays and the uranium little or no beta. Next try the two specimens on film, one at one end and one at the other, letting them expose it for 10 hours. Finally, 24 days later, test them again for 10 hours on another piece of film.

The results are shown in the photos above. On the negative made at the start of the test, beta rays make a dark exposure. Only the uranium X_1 shows a dark beta exposure on the second of the three negatives. Then on the final negative, both samples show beta rays, the uranium having again disintegrated sufficiently to form more uranium X_1 .



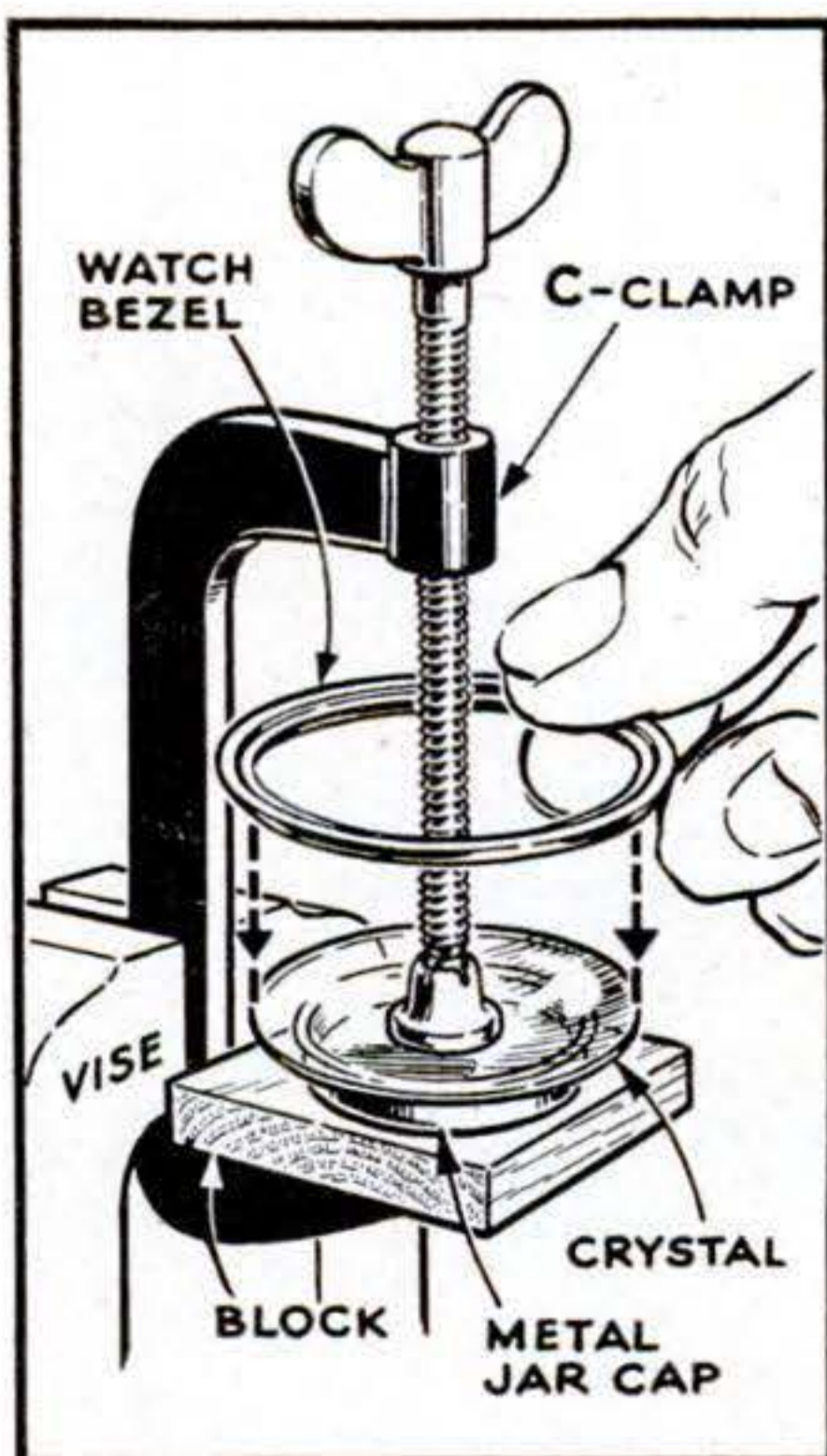
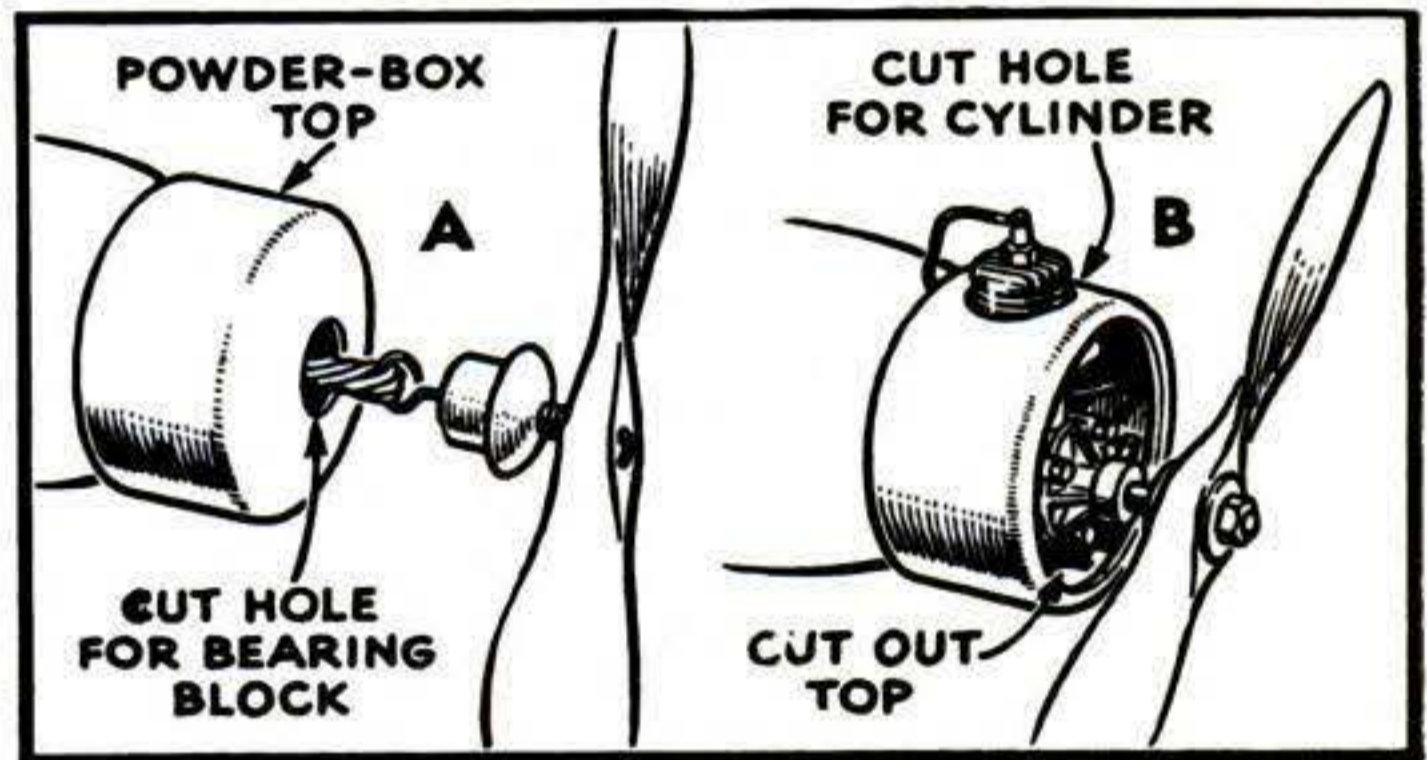
CELLAR DRAINAGE SYSTEM USES OLD AUTO WATER PUMP

AN AUTOMATIC sump pump that will keep a leaky basement dry can be built around a discarded automobile water pump. The intake opening of the pump should be screened, and a standard pipe coupling brazed or welded to the outlet. Though the pump might be supported by the discharge pipe, better assurance of shaft alignment can be obtained if it is held securely in place by other means. The $\frac{1}{4}$ -hp. motor, which must be a ball-bearing type capable of vertical mounting, is connected to the pump by an extension shaft and two flexible couplings.

The toilet-tank float that controls the device is guided by a short length of stove-pipe. Its rod is looped around a fixed guide rod and travels between two other loops that are linked to a knife-switch handle, as in Fig. 1. If the switch tends to bind on the break of the circuit, pry the prongs slightly apart. Figure 2 shows how a toggle switch might also be employed to provide the necessary action.—FRANK ZIEHR.

COWLINGS FOR MODEL PLANES MADE OF POWDER-BOX LIDS

TOPS of suitable size taken from powder boxes are strong and light enough for use as engine cowlings on model planes. As shown at right, a small hole is cut for the nose plug of a rubber-type model. The entire end is cut out for a gas plane, and it also may be necessary to cut a hole for the cylinder.—FREDDY MITCHELL.

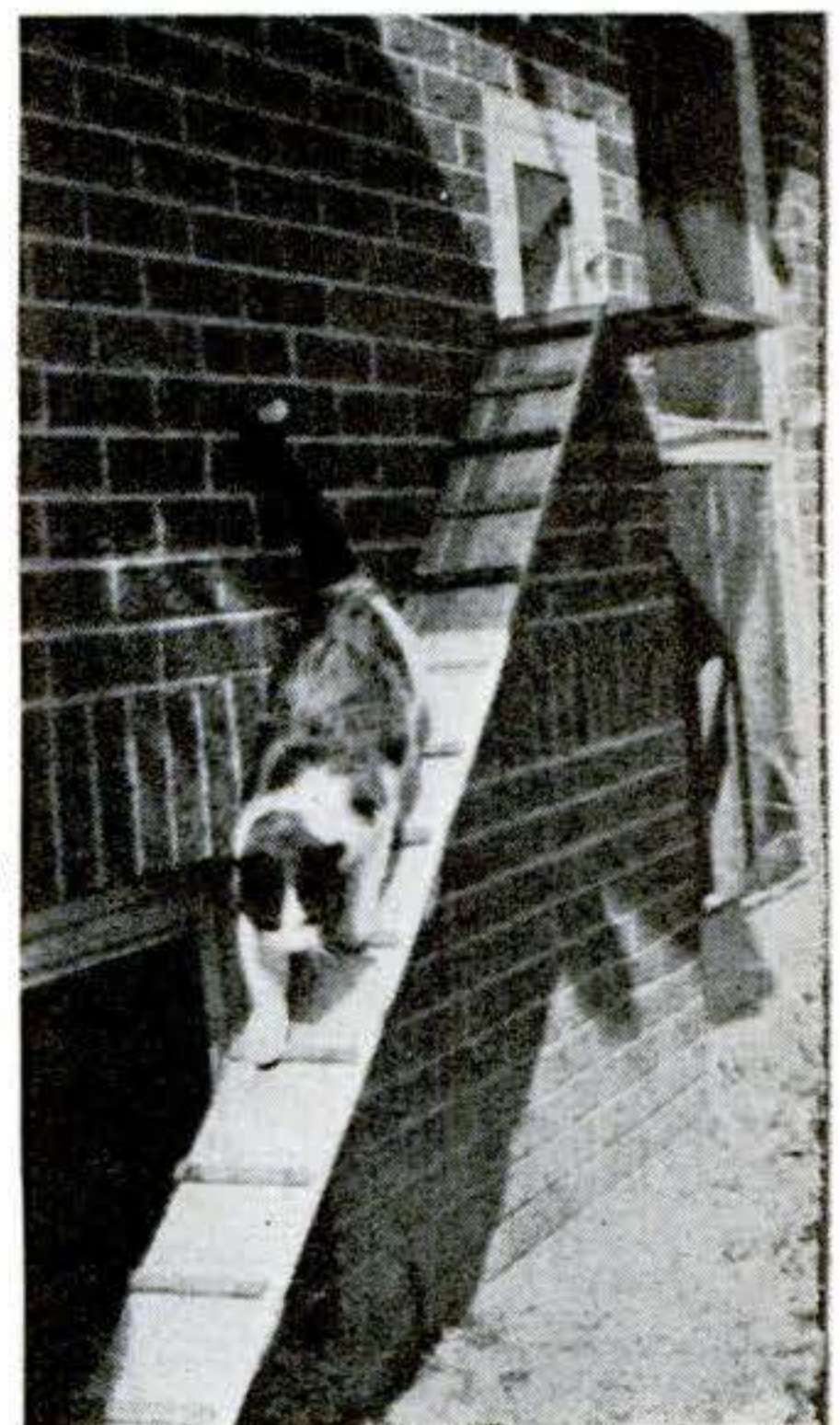


C-CLAMP PUTS CRYSTAL IN WATCH

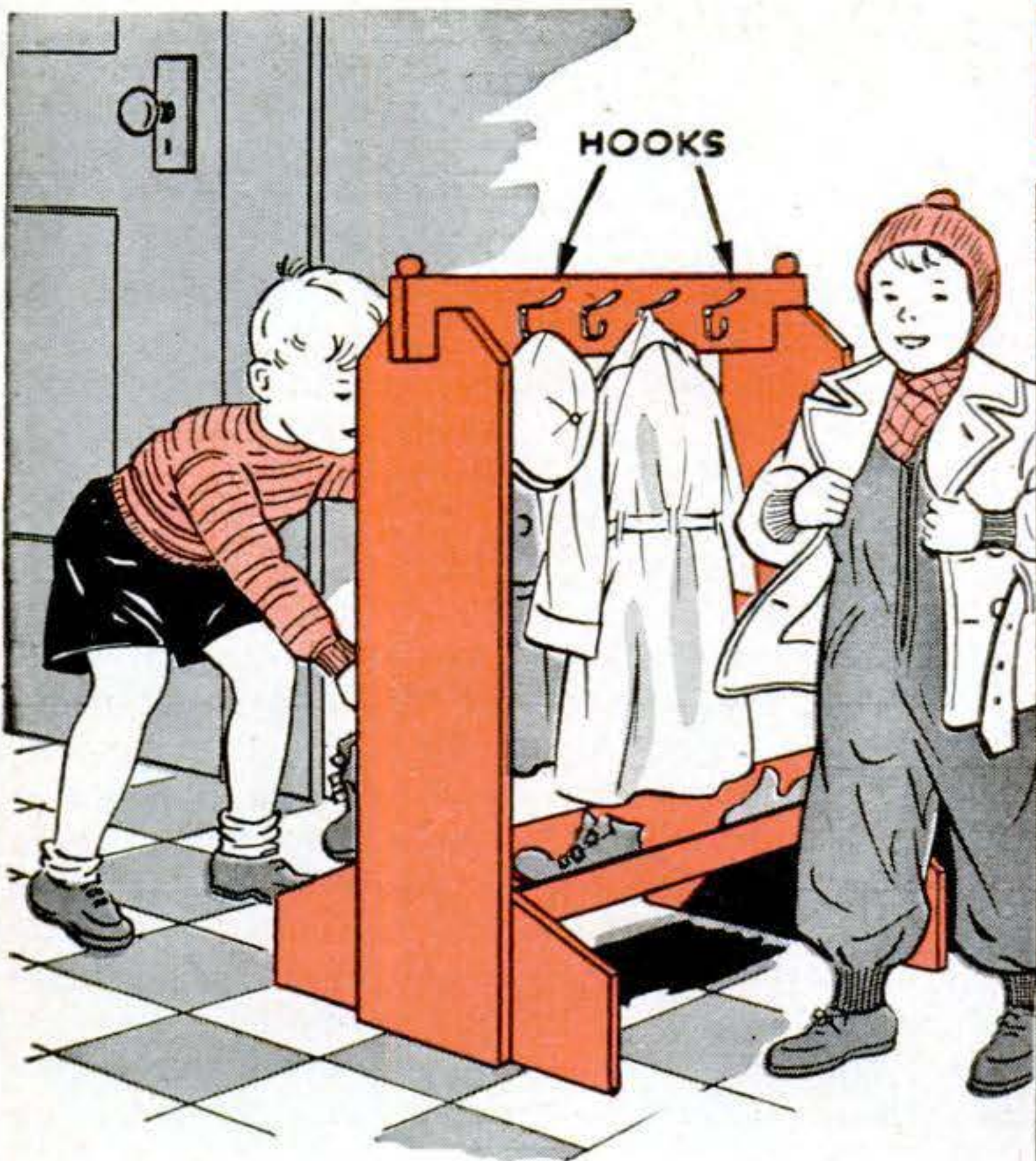
LIGHT pressure, applied as at left, will cup an unbreakable watch crystal so it can be slipped into the bezel. Protect both surfaces from scratching by several thicknesses of cleansing tissue or paper.—S. E. MICHAELS.

CATWALK GIVES KITTY A SAFE HAVEN

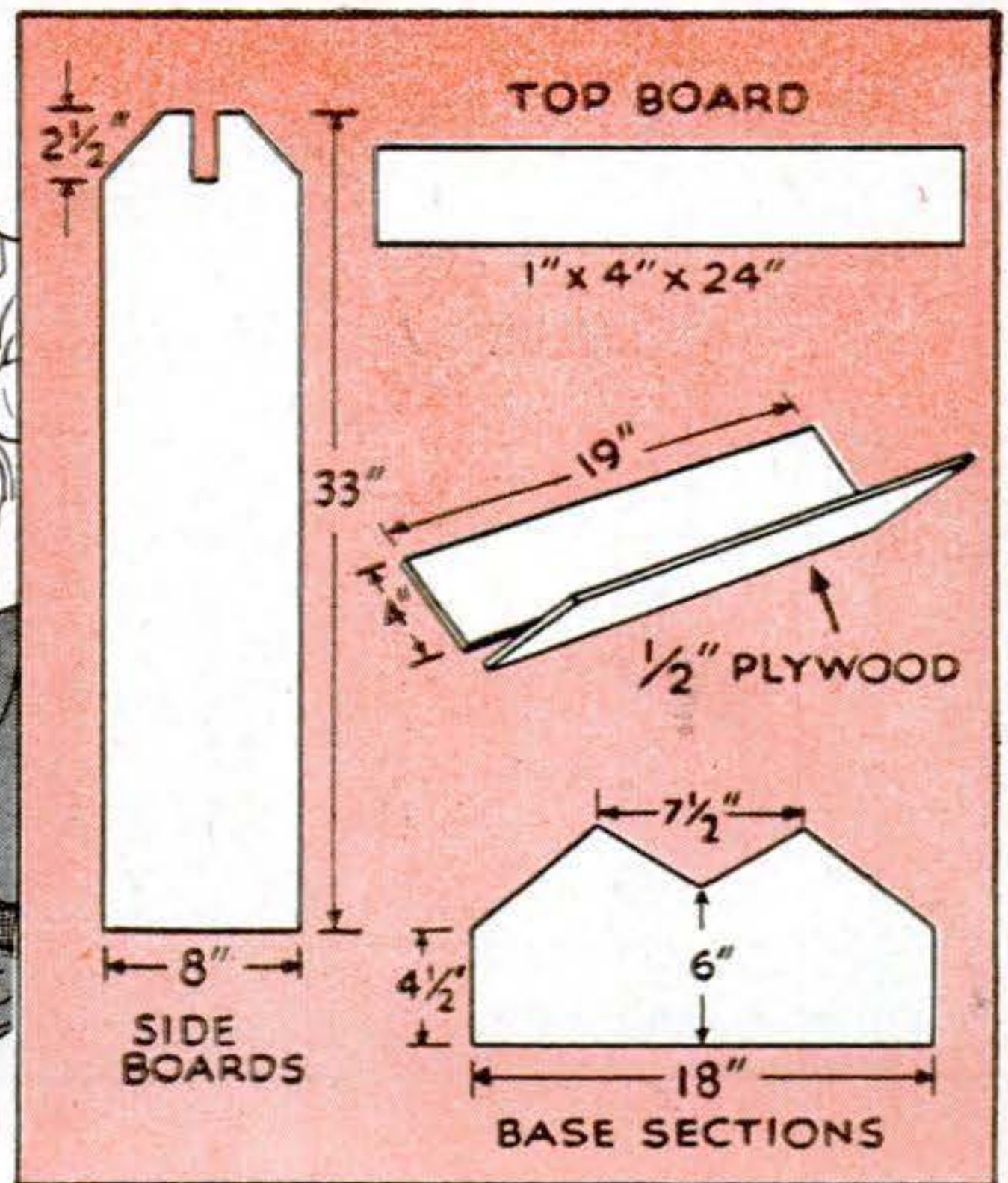
A RUNWAY leading to a window or balcony will provide your cat with a safe retreat from dogs. At the right, the cat has ingress through a package door covered with a mat that is tacked only at the top.—ALICE SPENCER COOK.



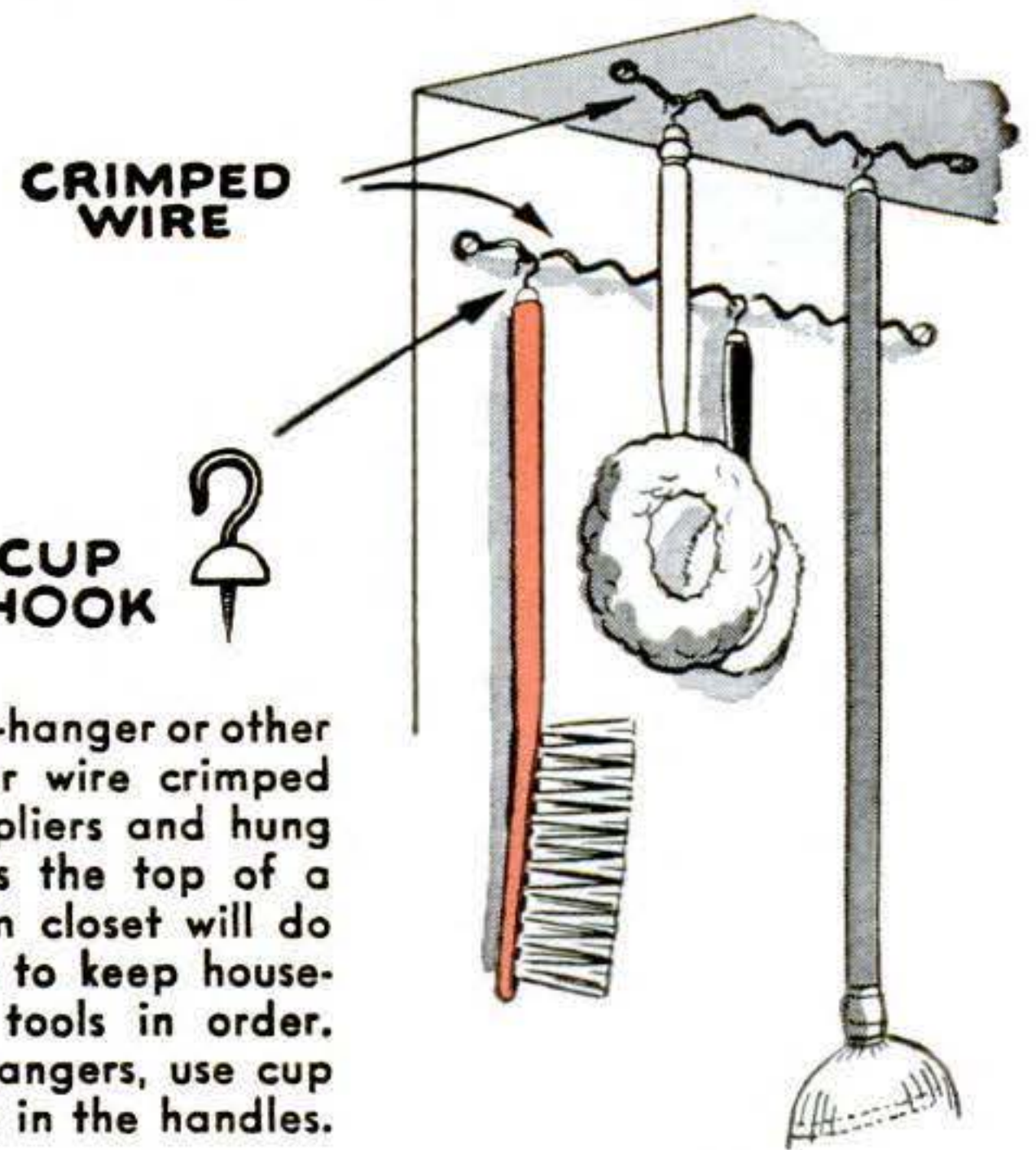
KEEPING



When neatness is easy, children will co-operate by not leaving coats, snow suits, and overshoes on the floor and chairs. Use 1" lumber for a strong top rack and sides and for adequate nailing surface on the V-notch of the base. A plywood trough will hold the overshoes.



Covered with wallpaper, ordinary shipping cartons can be made into handsome matching storage boxes. A single roll will cover several. Use a prepared wallpaper paste, and spread it on smoothly.

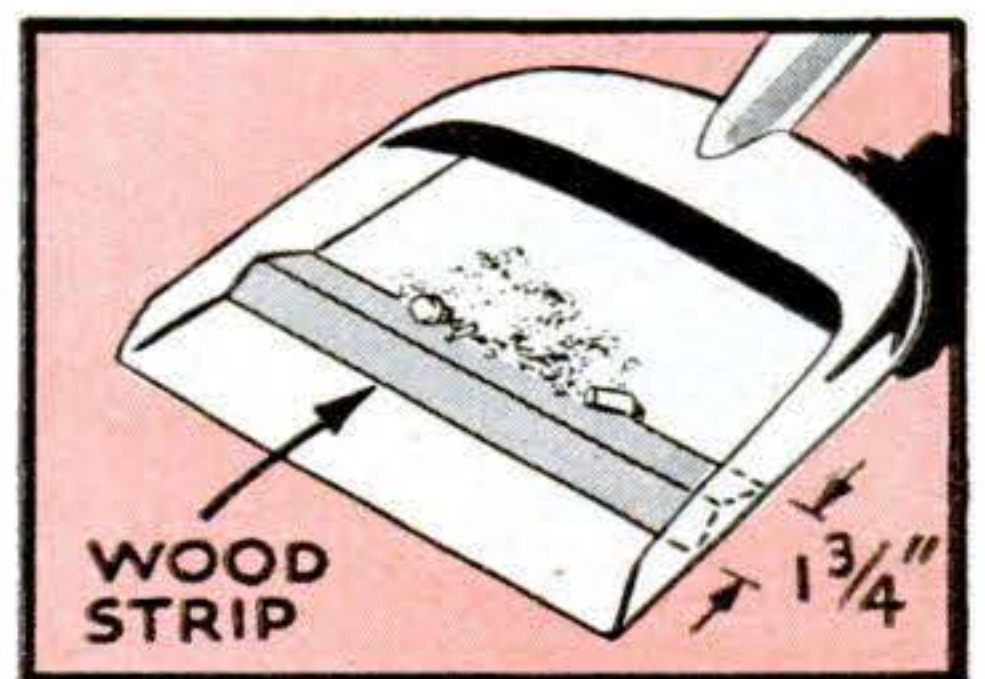
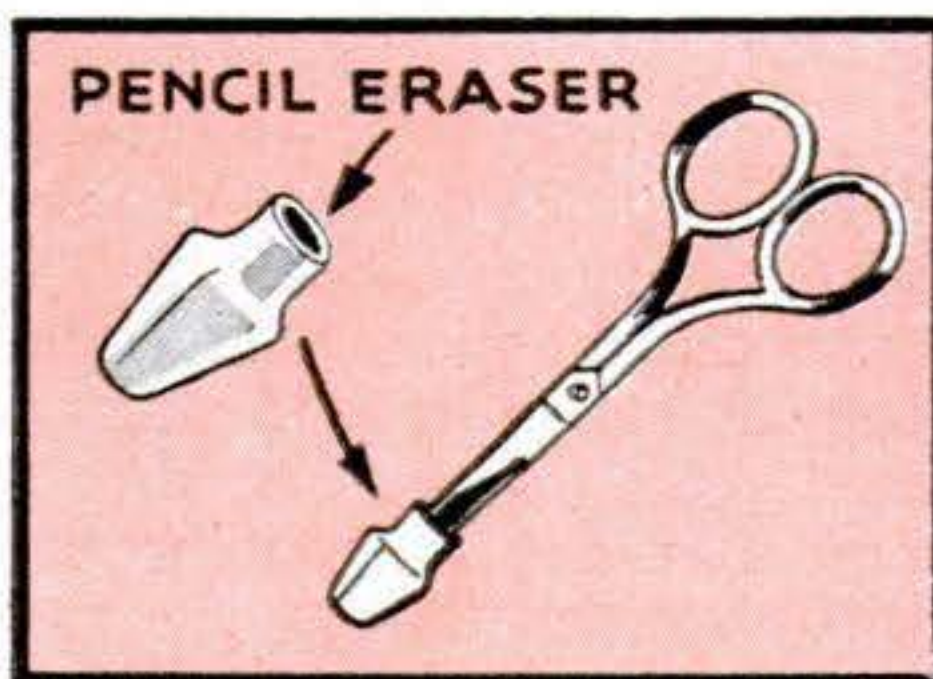


Coat-hanger or other similar wire crimped with pliers and hung across the top of a broom closet will do much to keep household tools in order. For hangers, use cup hooks in the handles.

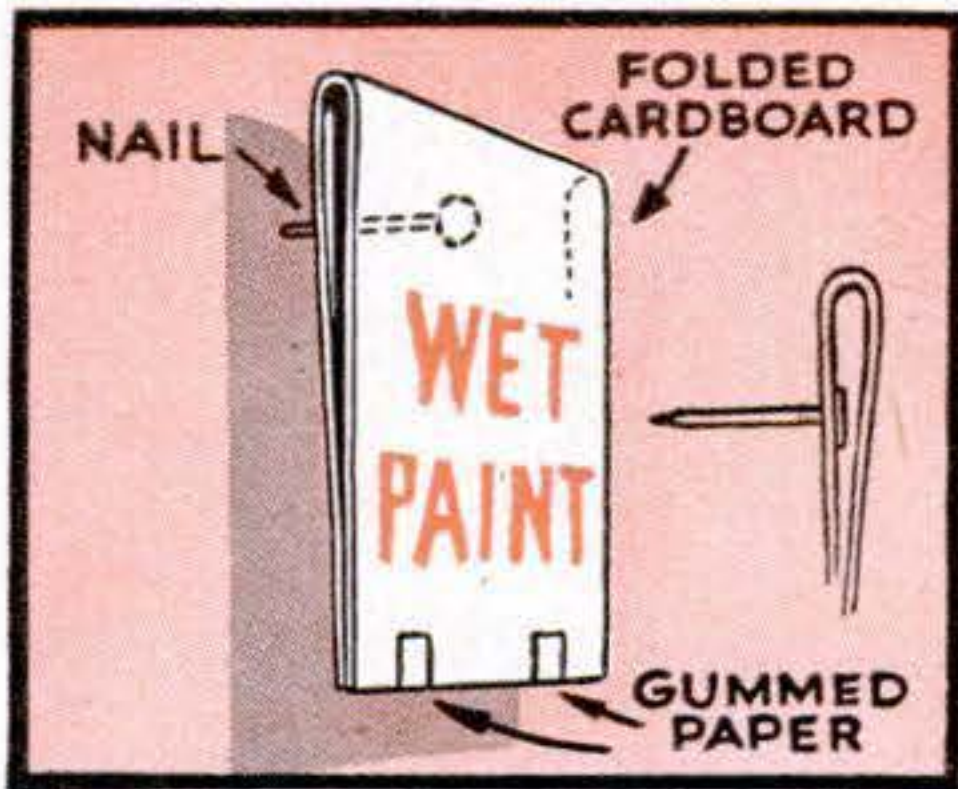
Sawed in half lengthwise and held in a spool, a small clear-plastic bar becomes a handy magnifier. It can be kept in the sewing basket.

For protective caps on the points of manicure and other scissors in a purse, traveling bag, or sewing kit, slip on large pencil erasers.

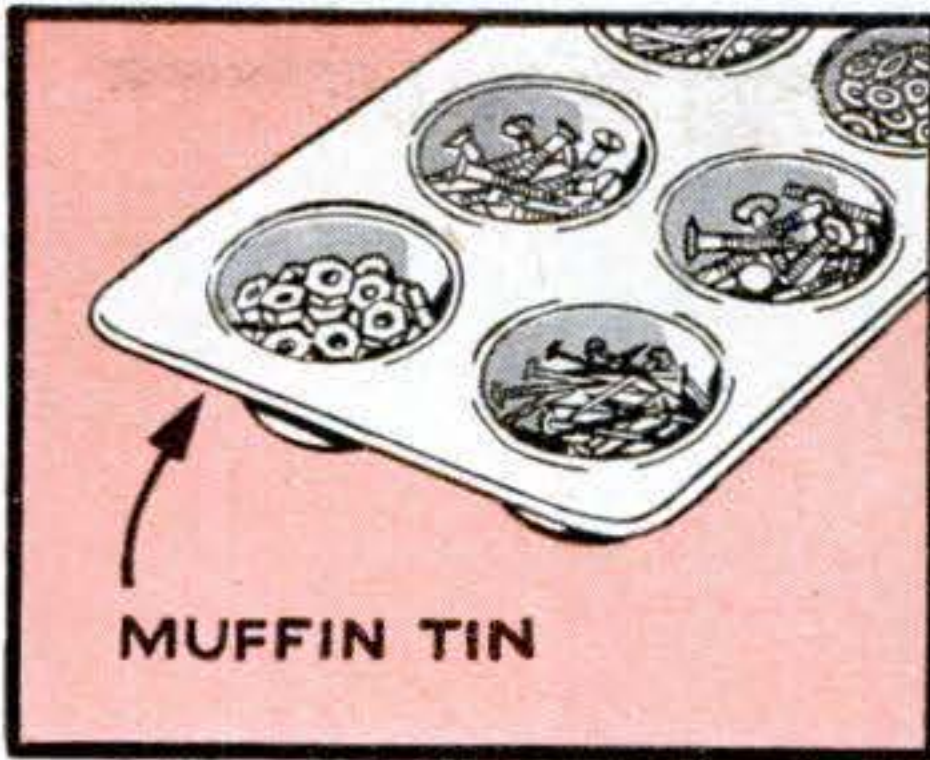
Sweepings will not fall out of a dustpan fitted with a triangular wood strip like that shown below. Screw or nail it from the bottom.



THE HOME SHIPSHAPE



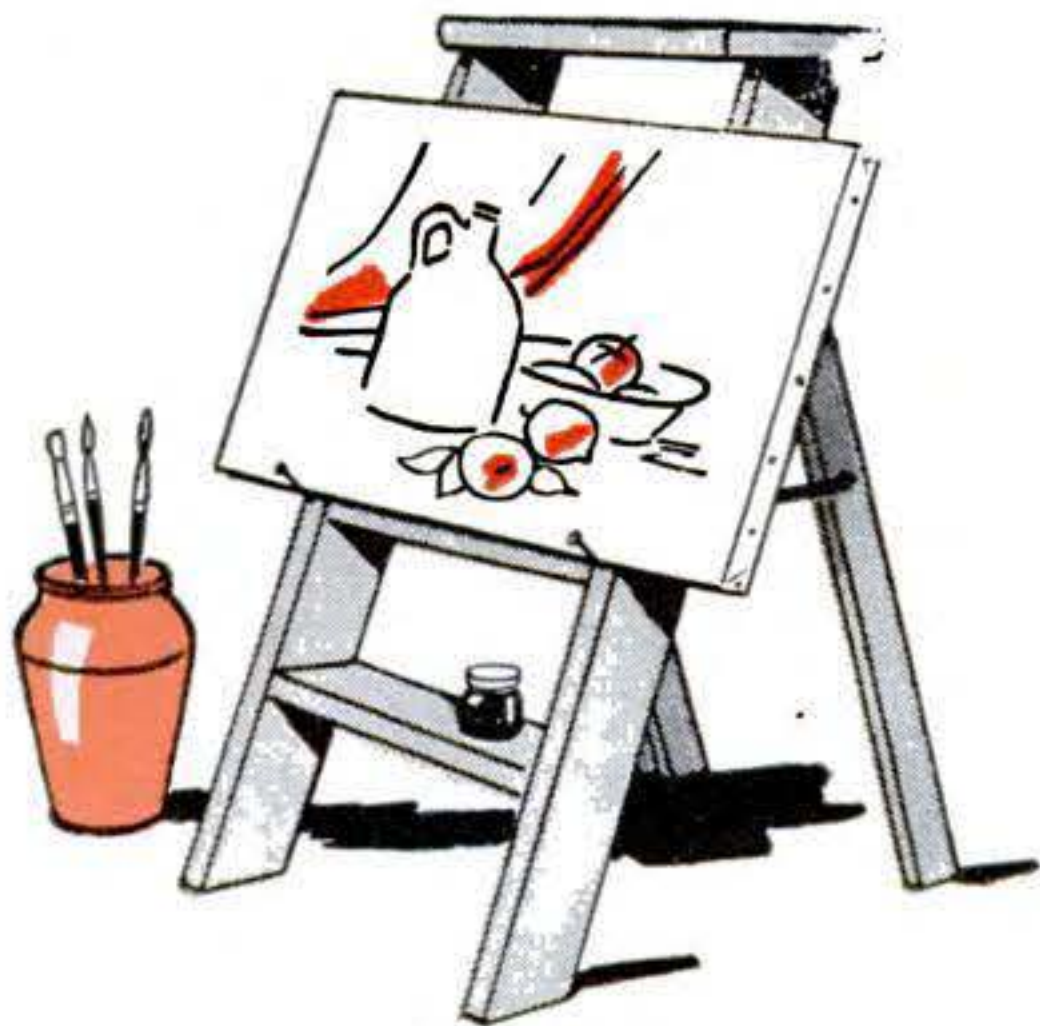
To prevent a freshly painted wall from being marred by "wet paint" signs, try this trick. If a nail itself would mark the wall, thumbtacks having long shanks would do.



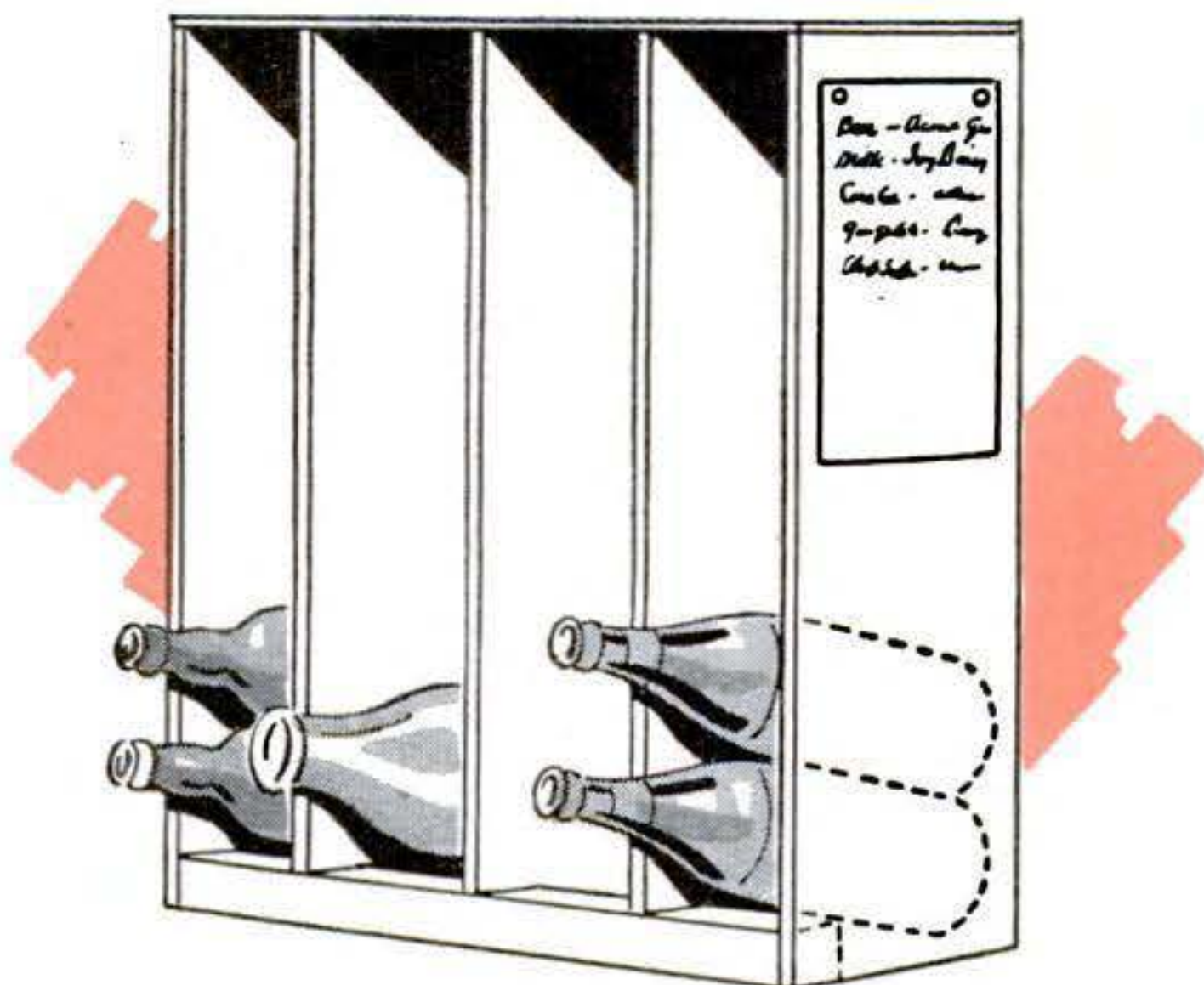
When several sizes of screws, nails, bolts, and the like are needed on a job, time is saved by having them sorted at hand in the small cups of a muffin tin.



Locking a hose tap by removing the handle is common. If you lose or mislay it, don't mar the shaft with pliers or a pipe wrench. Try a doorknob, which will often fit.



Canvases or signs to be painted can be held on a stepladder just as on an easel. Two nails driven in the ladder at the proper height will support the work. The steps can hold paints and brushes.



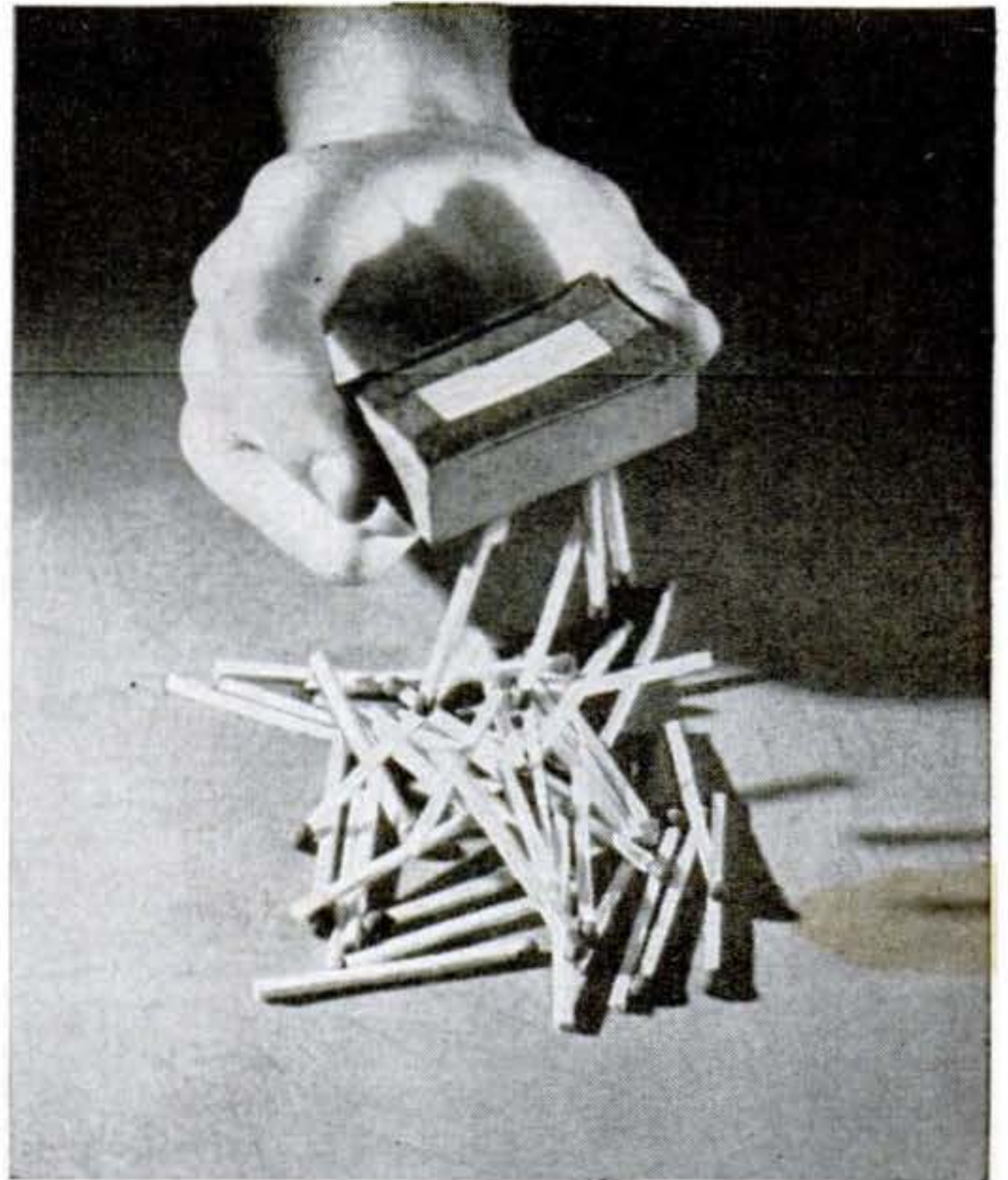
Empty returnable bottles that clutter the kitchen floor can be stacked neatly in a simple wooden rack until it is convenient to return them. A memo on the side lists the types and the stores.

Two coats of automobile wax applied to both sides of a snow shovel and rubbed to a shine require an ounce of effort that will save pounds of energy next time it snows. If the shovel is rusty, rub it down with steel wool and enamel-it before waxing.



Table Tricks

MATCHES DEFY GRAVITY if given a little help. Pull the drawer of a penny match box part way out to show it is full. Then turn the box upside down and pull the drawer completely out. The matches stay in! But with a magic word, and pressure on the ends of the box, they all fall—including part of one that was wedged crosswise in the drawer to hold them in!

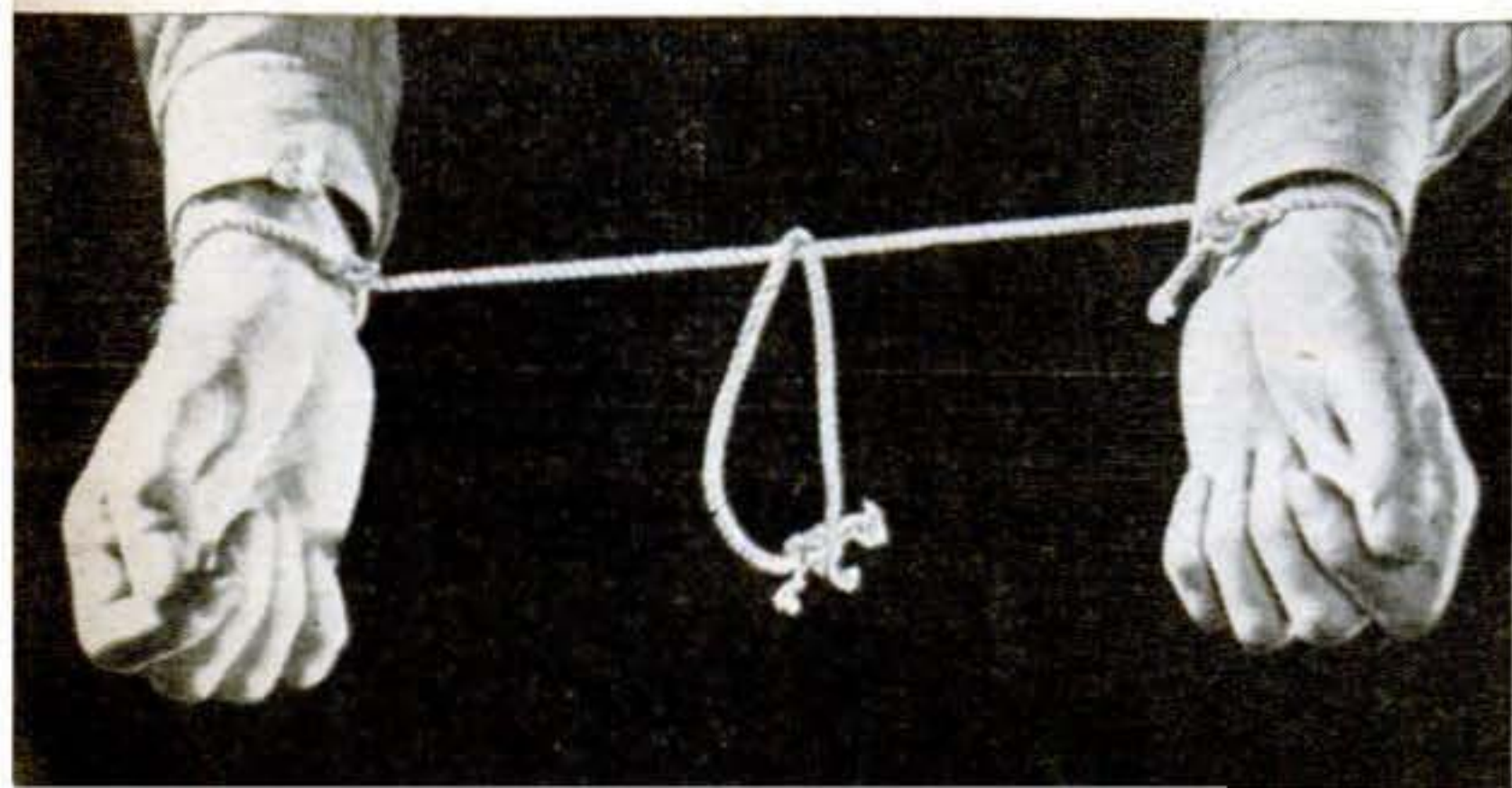


THIS TRICK LAYS AN EGG, but not in one sense. You take the egg and more like it from the mouth of an assistant! Pat his head with your right hand and remove the egg with your left. Walk to his other side, pat with the left hand, and remove a second egg with the right. Repeat four or five times, alternating between sides.

Your stooge already has one egg in his mouth, preferably hard-boiled, and you palm the others from a pocket. He exposes his egg as you pat and put your hand to his mouth, and then draws it back as you produce the palmed egg. The last egg is, of course, the one he really had in his mouth.

MAGIC WITH A ROPE RING can be performed with or without anything up your sleeve. Have a cord tied firmly around your wrists and another tied in a loop that you propose to work into the position shown below. Pull the loop up over your wrist through the encircling cord, and then pull it down over your hand outside the cord. With a duplicate ring up your sleeve, you can work the trick faster.

NAMING THE CARDS with a dinner knife thrust at random in the deck is a real puzzler, but it is an extremely simple stunt. You can never miss telling the card immediately above the knife if the blade is bright and you pull it over to the index corner of the card, which is always the left-hand corner toward you when the deck is face down. Be sure to tilt the handle of the knife slightly downward so you can catch a reflection of the index corner in the bright blade of the knife.



Craftsmen at War

(Continued from page 153)

Goldbergian drilling contraption was, without question, a high point in handicraft, every serviceman at almost any time between induction and demobilization was likely to see one of his buddies busy on a spare-time hobby.

On the first day at training camp in California our drill corporal spent the 10-minute breaks carving an intricate pattern on the 40" rod he carried to measure the distance between rookies as they stumbled through close-order drill. On our last day at the Fort Dix separation center, the lanky private who led us through processing for discharge laced away at a leather billfold while marching us from one building to another. He was still lacing when our group left the post as civilians.

During the four years that elapsed between the California baton and the Fort Dix billfold we saw hundreds of servicemen scattered over islands in the Pacific whittling, pounding, grinding, fabricating, or decorating gadgets of one sort or another. Indirectly, we know that similar projects by the tens of thousands were under way in other theaters of war where Americans were stationed.

On the Pacific islands, where, at best, the civilian population is composed of a handful of natives, hobbies were a necessity to prevent the men from becoming completely "rock happy."

Then, too, there was quite a little money to be made. Sea-shell salesmen on the Central Pacific atolls weren't quite as numerous as shoeshine boys in the centers of civilization, but they were every bit as persistent. Their stock in trade consisted of necklaces, brooches, and bracelets made of colorful shells gathered from the reef which rimmed the atoll, their place of business was the eye-searing white coral airstrip, and their customers were the transient men and officers whose planes landed to refuel.

Shellwork was common to all the Pacific islands. Other types of handicraft to be found generally were determined by the topography and war history of the island.

For example, on islands where we met no land-based opposition the Americans were forced to fall back on the ever-present shells, woodworking, or on military equipment. (We hope Quartermaster and Supply never discover how much!)

But if the island originally was a Japanese air base and our invading troops and late-landing garrison forces found an airstrip littered with wrecked Zekes and Betties, it was a sure thing that within a

few weeks one half of the wrists on the island, GI and native alike, would be adorned with a watch band or bracelet of aluminum.

An indication of the speed with which Japanese planes were converted into souvenirs came from Admiral William F. (Bull) Halsey, who was on the bridge of his carrier flagship when a Kamikaze pilot joined his ancestors on the flight deck. The admiral remarked plaintively that before he could make his way from the bridge to the wreckage on the deck, half of the enemy plane already was in the process of being drilled, cut, or polished into trinkets by souvenir-hungry sailors.

In the Pacific there was little use in learning weaving, for the natives already had something of a monopoly on grass mats, rugs, skirts, and fans. During the early days of an occupation a cigarette or two would be sufficient barter for a finely woven sleeping mat. A week later the standard native price would be a T-shirt or a towel, and after a month—by then the natives owned all the towels and most of the underclothes on the island—the rate was "fi' dollah."

Intricate work of many varieties was produced in the rear areas, such as the Hawaiian Islands, where the USO, Red Cross, and similar outfits operated shops with equipment comparable to that found on large military posts on the mainland. And sailors aboard the larger ships, Seabees, and Army engineers were able to take occasional advantage of the excellent tools and equipment available to them. But the men "out forward," the garrison and station complements on islands with weird names, were forced to stave off "Section Eights" by their own efforts.

Everywhere, the American servicemen adapted themselves admirably to their surroundings. That no longer amazes us, for not so long ago we met a T/5 who had been on most of the Pacific islands and still hadn't missed shaving with his precious electric razor. He reported that a half-million dollar radar or searchlight power plant always could be pulled down to 110 volts.

Now that the atomic bomb—with the help of several million servicemen of the Allied nations—has ended the war, we expect on our next Pacific trip to find some ingenious soldier or sailor who has carved the Lord's Prayer on the head of an atom. And probably a plug for his home state on the other side of the little rascal, too!

How we faced disaster for lack of rubber is now an old story. But not too many people know the part played by gas chemists. They found how to chip four atoms of hydrogen off butane (C_4H_{10}) to make butadiene (C_4H_6), source of most of our synthetic rubber.

Aviation would never have reached its present high level of achievement without the aid of natural gas. High-octane gasolines have revolutionized design of aircraft engines—permitting greater power and added range. But these high-octane fuels would not have been possible without “natural gasoline”—the blending stock squeezed from natural gas.

Natural gas has provided dozens of short cuts for industry, which has meant higher production schedules. For example: in heat-treating metals, oxygen in the air always leaves a scale which must be laboriously cleaned away. Then an engineer had a bright idea. Why not he reasoned, heat-treat in a “tailored” atmosphere—an atmosphere containing no oxygen? Then there would be no scale formation. Metals would come from heat-treating furnaces bright and shiny. Natural gas furnished the desired “tailored” atmosphere. This procedure is invaluable in making razor blades, bed-springs, and other metal items.

Natural gas is a source of ether in tank-car lots—ether used chiefly as a commercial solvent. It is also the source of that brilliantly promising new anesthetic, cyclopropane. This gas has all of ether's virtues and few of its drawbacks. It is almost odorless, and produces no nausea. Patients emerge from cyclopropane anesthesia in a few minutes with no bad aftereffects.

Natural gas as a source of motor fuel holds brilliant promise. We have more natural gas left than we have petroleum. When our petroleum is gone, chemists feel that we shall turn to natural gas, rather than to coal, as a source of gasoline. Cost enters here—gasoline from natural gas costing about half what it would cost if made from coal. The best estimates indicate that gasoline from natural gas would cost as little as nine cents a gallon. Even today, liquefied natural gases are used as fuel in 25,000 U. S. trucks, tractors, and busses.

Research men now feel that we are barely entering the chemical wonderland of natural gas. Its cheapness and ease of handling prompt one talented engineer to regard it as “the most desirable chemical raw material the world has yet seen.”

Enormous new industries will be built around natural gas. It isn't necessary that all this activity be centralized in gas-producing areas. Plans are under way to liquefy natural gas and haul it by barge to various points in the country. Gas, for example, might be liquefied in Texas and hauled along the Gulf Coast and up the Mississippi to St. Louis. It wouldn't be necessary to keep this gas under pressure. A certain amount would boil off—just about enough to provide fuel for the tug pulling the barges.

One proponent of this idea has a secondary idea with engaging possibilities. He proposes to utilize the cold generated when liquid gas passes into vapor. He would use this to liquefy air! He would sell steel bottles of liquid air to homes and restaurants for air conditioning! A nozzle fitted to the bottle would permit the liquid air to pass into vapor and escape in a room—providing a cooling stream of fresh air.

By good fortune, the U. S. is blessed with an almost inexhaustible supply of natural gas. There is a visible reserve of 100 trillion cubic feet and a likely reserve equally as large. Since we are currently using gas at the rate of three trillion cubic feet a year, this gives us a supply which will last more than 60 years. There is little chance that a new chemical industry, no matter how large, could make more than a slight dent in this giant reserve. A single gusher well would produce enough methane to make all the wood alcohol we need—and this is one of the most vital and widely used of all solvents.

Further tightening of conservation laws should stretch our gas reserve even further. As late as 1936 we were wasting more gas than we were using. After gas forced petroleum to the surface, drillers simply burned it at the well head. Flares burning on a thousand wells made a tragic and memorable sight for anyone who flew over Texas or Oklahoma at night.

Other waste resulted in plants which extracted natural gasoline from natural gas. They simply squeezed out the wanted gasoline and liberated billions of cubic feet of dry gas into the air.

This almost criminal waste now has been largely stopped. Belatedly, we have awakened to the tremendous wealth locked up in the hydrocarbon molecule. The chemist has prodded us into realizing what we have here: a limitless source of new industry, new jobs, and new products which can revolutionize everyday life.

DDT in Paint May Protect Ships from Barnacles

A NEW use for the insecticide DDT is suggested by experiments conducted at Oregon State College. Wooden panels coated with a paint containing DDT remained free from barnacles after six months' submersion in sea water, while panels treated with ordinary antifouling paint were heavily covered after only three months of exposure.

Since DDT is not soluble in water, it is believed that paint containing the insecticide may retain its barnacle-resisting properties for long periods of time. Such a paint would be valuable not only for protecting the bottoms of ships but also for guarding marine structures. Studies are being continued to determine the efficiency of DDT as an antifouling agent for marine animal forms other than barnacles, and as a control for wood-boring marine mollusks.

That Push-Button Convertible Top

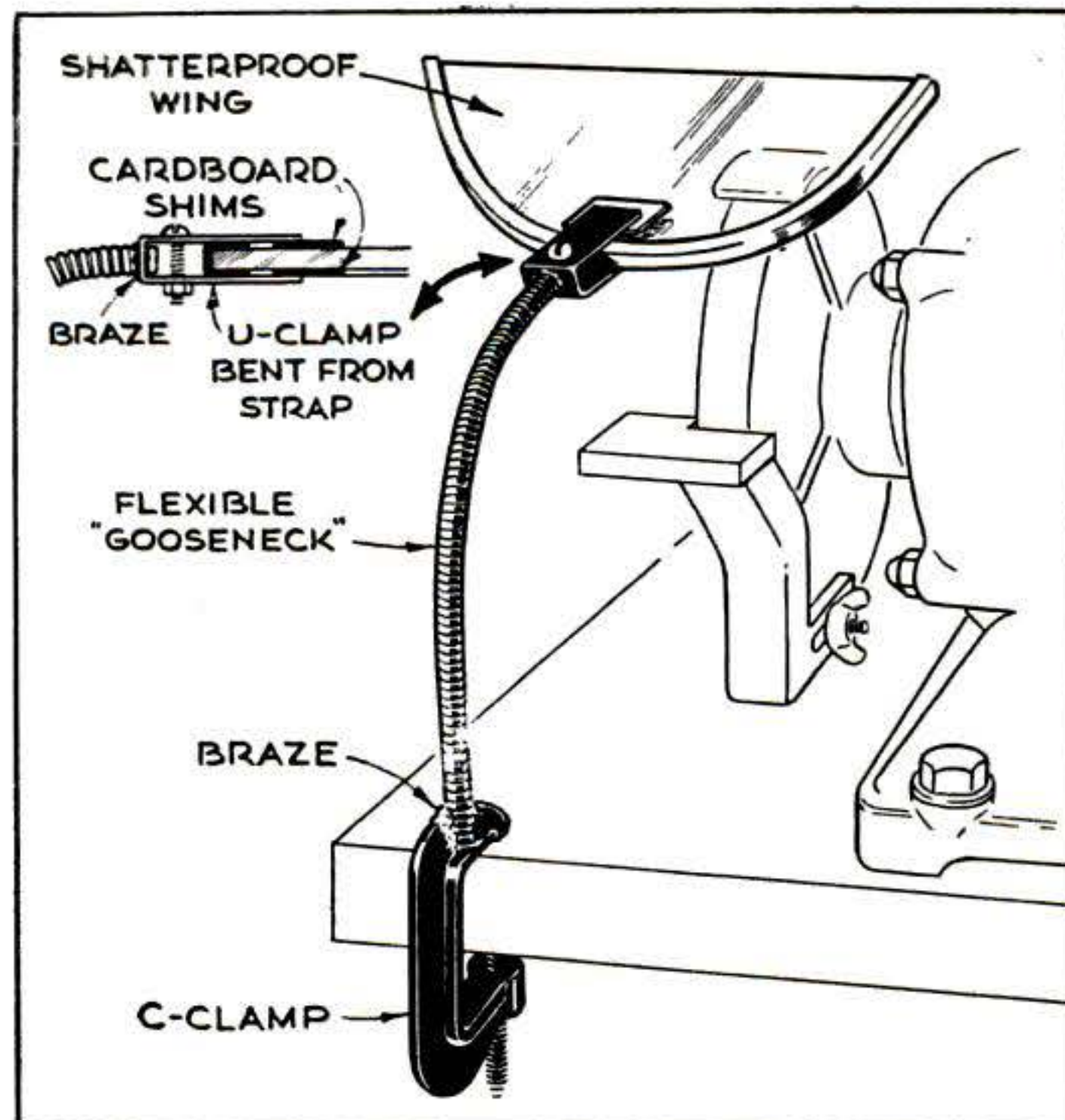
OUR apologies to Motor State Products Company, of Ypsilanti and Detroit, Mich., for omitting to credit them with the development and designs of the push-button convertible automobile top illustrated on page 144 of the September issue.

Statement of Ownership, Management, Circulation, etc., required by the Act of Congress of March 3, 1933, of Popular Science Monthly, published monthly at New York, N. Y., for October 1, 1945, State of New York, County of New York, ss. Before me, a notary public in and for the State and county aforesaid, personally appeared Godfrey Hammond, who, having been duly sworn according to law, deposes and says that he is the Business Manager of Popular Science Monthly and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of March 3, 1933, embodied in Section 537, Postal Laws and Regulations, printed on the reverse of this form to wit:

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(Signed) Godfrey Hammond, Business Manager.

Sworn to and subscribed before me this 20th day of September, 1945, Esther Eyl, Notary Public, Kings County, Kings Co. Clerk's No. 60, Registry No. 70-E-6, New York County Clerk's No. 108, Registry No. 62-E-6. (Seal) My Commission expires March 30, 1946.

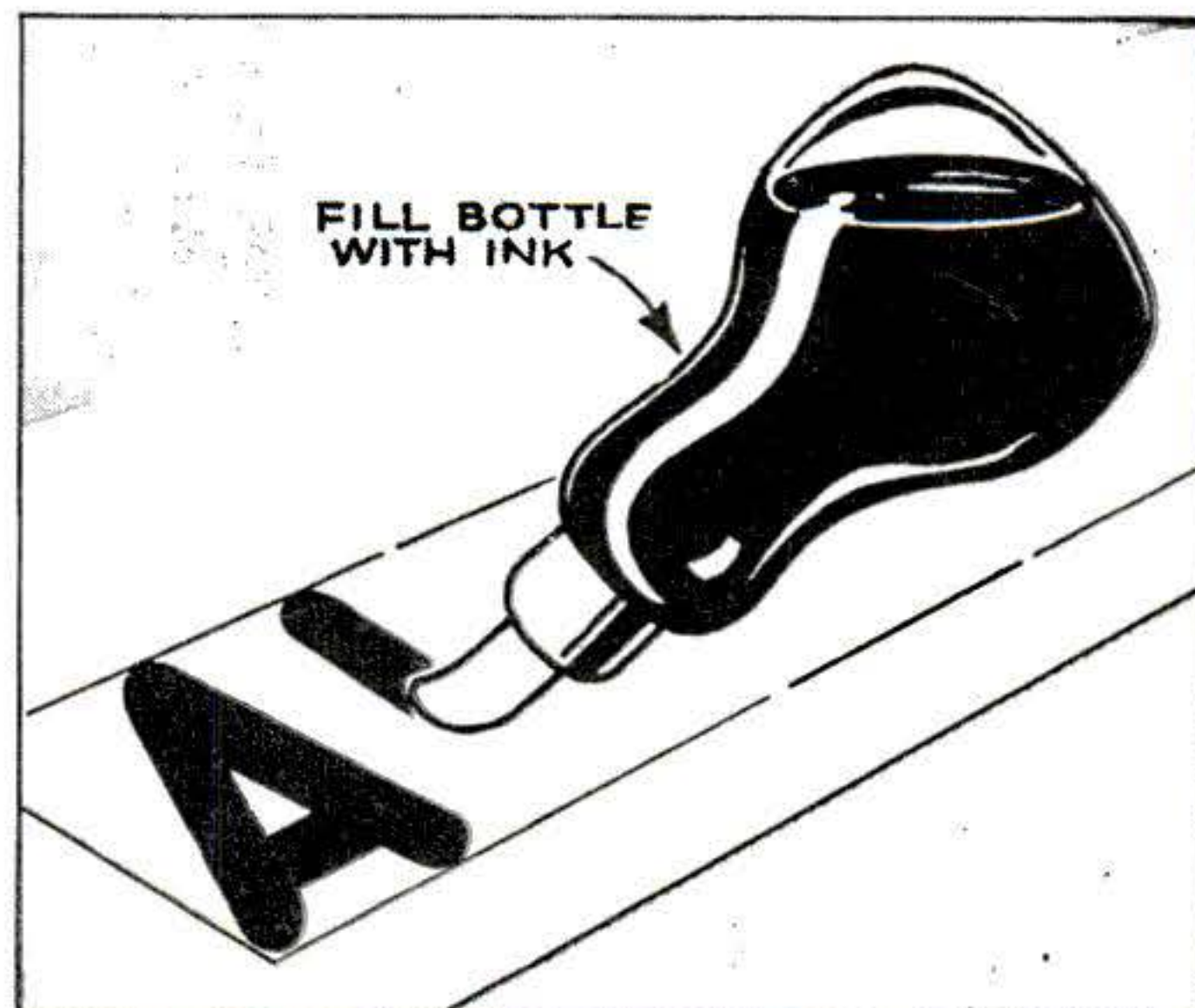


Bench Shield Made of Safety Glass

AUTOMOBILE ventilator panes of safety glass, obtainable at car wrecking yards, will increase the safety factor in grinding and polishing operations in the shop. If possible, obtain one with a chromium or other metal frame and mount it as shown above. Moved about on its flexible support, the shield can be placed between the operator and a grinding wheel or similar tool to protect the face from flying sparks.—CARROLL MOON.

Mucilage Dispenser Used as Marker

FOR marking packages or lettering signs, fill a mucilage dispenser with ink and apply as you would the mucilage. Pressing too heavily on the tip may cause the ink to flow too fast. If lighter pressure doesn't help, add one part of mucilage to four parts of ink. This will thicken the mixture and cause it to flow slowly.—FRANK SHORE.



America's First Industry

(Continued from page 104)

on the same ship that was bringing Sir Francis Wyatt to Virginia as Governor.

Their plan was to build a glass furnace suitable to the needs of the Italians on their arrival at Jamestown. But a deadly plague was raging in Virginia. Norton came down with it and died. George Sandys carried on. But although he was a man of great energy, it was not until 1622, two years after they sailed from England, that the Italians began to manufacture their glass, and then not in a new furnace. They started with the furnace that John Smith had built in 1608, the furnace Jesse Dimmick was to find three centuries later.

The glass beads were similar to, but should not be confused with, wampum, or *roenoke*, as the cockleshell beads of the Virginia Indian tribes were called. In New York State, this form of money, made of periwinkle shells, was used almost exclusively at the time. There it was called *seawan* or *zeewand* by the Dutch settlers, who soon discovered that good imitations could be made of bone and proceeded to fleece the Indians with spurious beads. Thus, to residents of New Amsterdam falls the distinction of being the first counterfeiters in North America.

There is plenty of proof that the oval (Normandy type) furnace discovered by Dimmick was that used by John Smith's Poles and later by the Italians. In uncovering the heating chamber, Dimmick dug up a piece of bottle glass in which were numerous brown specks of iron. The local sand contained iron that would not melt at the relatively low temperature needed for making bottle glass. While this sand was adapted to bottle making, it was not at all suitable for the high-quality products of the Italians. For the most part, their sand came from Cape Henry and was entirely free of the offending iron content. With it they made beads of seven gemlike colors.

In a pile of dirt close to the furnace, part of a drinking glass was uncovered. Crystal clear, it is as thin as paper. None but the skilled Italians could have made an object of such fragile beauty, still lustrous after 300 years' burial. Also near the furnace was discovered a mound of scintillating glass particles matching the beads in color.

The fact that no beads have been found near the site is accounted for by the fact that, according to the Italians' contract, all the beads, whether perfect or imperfect, were to be turned over to the company. They were money, and their output was

definitely limited to prevent depreciation of their value. George Sandys enforced this rule to the letter. Moreover, the beads were not only money but jewelry, and highly prized by the Indians. It is a matter of history that many of the most beautiful found their way into the collection of King Powhatan, known as "the King's Treasure."

They are of such archaeological value that when, in 1930, rumor persisted that, in a village 60 miles from Jamestown, the residents had found a "vast treasure of ancient beads made by the Italians," Governor John G. Pollard ordered an investigation. The investigators returned with a string of about 50 beads belonging to an early period, but no information about their source. The Governor consulted an Indian chief who was a descendant of Powhatan and well versed in early American history and Indian lore. From him it was learned that the Indians who originally owned the land had left the site of the village in 1660, and that, eight years later, white people had settled there. It was the chief's opinion that the beads had been made by the Italians and had possibly been part of the "King's Treasure" that might have been buried for safekeeping. But they couldn't find the source of the beads, and the Governor presented the string to the Indian chief. Then the incident was forgotten.

In 1940, seven years after Dimmick discovered the furnace, a friend of the chief, now dead, visited his widow, and she showed him the necklace. She could tell him nothing about the King's Treasure or where the beads had been found, but she willingly sold him the necklace. From two clues—the technique used in making the beads and the date the Indians had left the region where they were found—the visitor located the village and learned the story of the beads.

In 1668, when the white people laid out the village, they graded the steep river bank, spreading the excavated earth over an adjoining field. Thus they distributed part of the King's Treasure over a considerable area. Centuries later, a Negro farmer's plowshare turned up a shower of small objects whose color and brilliance made him gasp. He had uncovered the long-forgotten burial place of the King's Treasure.

Today the treasure is being reassembled. Local residents are co-operating to get it steered into a museum where the public can see how beautiful American money could be three centuries ago.

Helping you sleep better

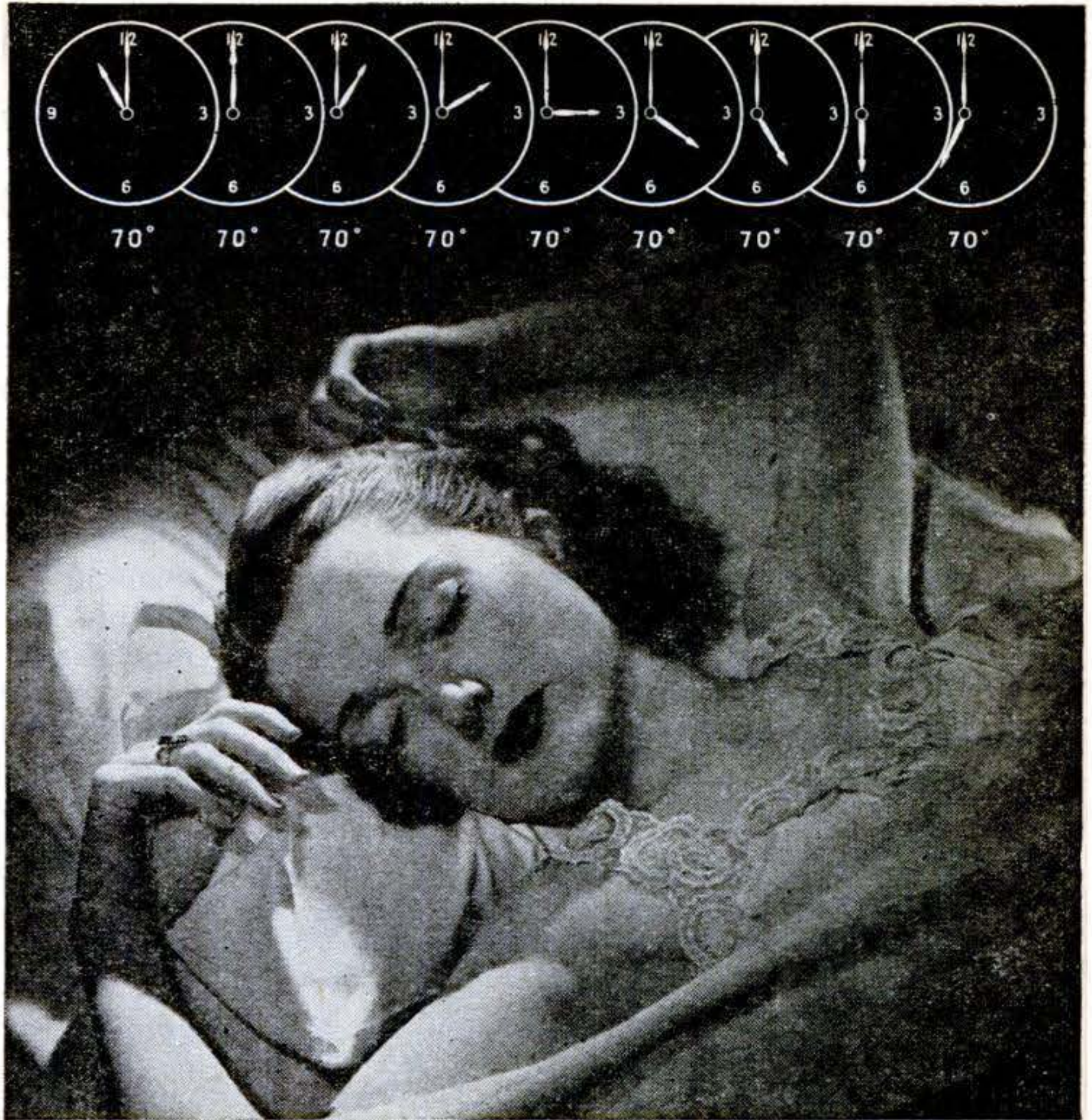


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...that an electrical manufacturing company serving so many needs of a wide-awake, workaday world should be interested in helping you sleep. But with General Electric it's a fact.

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FILES FOR EVERY PURPOSE



Army Know-How Wins

(Continued from page 84)

goes like this: A reconnaissance car, for example, limps in with a badly worn crankshaft. Instead of laying up the car while you take out and regrind the shaft, you snatch out the entire engine, replace it with another, and send the car right back to fight. Then you rebuild the engine in an efficient, production-line shop with a crew of expertly trained men and have it ready for the next ailing "recon" car, which may come in with a cracked block.

Yule reasoned with Harrison that any business in civil life that could do for fleet operators what Ordnance did for combat troops would earn itself real money by saving vehicle time (which runs into big money) for its customers. They projected the kind of concern that could do this.


While they were still in hospital they started putting their idea down on paper: what they'd need in equipment, spare parts, and personnel; what their expenses would be; where and how they would find their customers; where they could obtain their parts and supplies. Even on the closest figuring they needed something like \$20,000.

They wrote and rewrote their plan, and prepared it as a prospectus. The minute they got out of hospital they started the ball rolling. Physically they were just barely able to get up, but mentally and spiritually they had unlimited "git-up-an'-git." "We were so wobbly," says Major Yule, "that half the time I was holding Harrison up and half the time he was supporting me."

Fortunately, they knew their business so well, and their prospectus showed this clearly, that some of the people they talked to about orders and parts got interested and put up a portion of the money. In this way

(Continued on page 214)

Model Builders Attention!



	V	V-2	V-3
Hex	1/2"	3/8"	5/16"
Thread	3/8"-24	1/4"-32	1/4"-32
Thread Length	7/32	7/32	5/32
Weight, Grams	8	3 1/2	2 1/2

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demonstrated the fundamental superiorities inherent in all Champion Spark Plugs by the outstanding manner in which they proved their ability to insure maximum performance and dependability in every engine, on land, sea and in the air.

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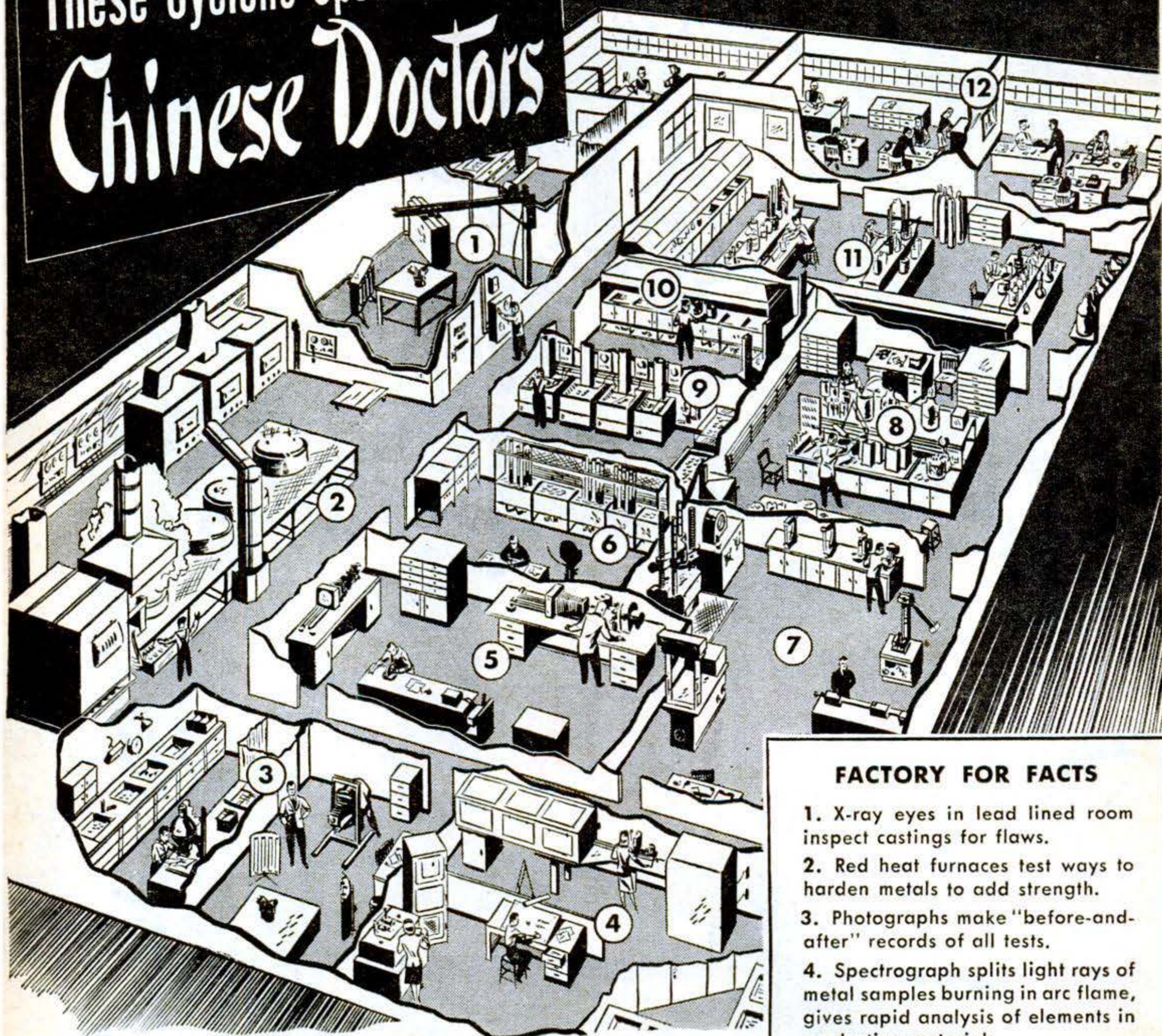
DECEMBER, 1945



They Finished Their Job—
Let's Finish Ours

211

These Cyclone Specialists are Chinese Doctors



Chinese doctors, so legend says, are paid to keep patients healthy, not just to cure them when sick. In this Materials Laboratory at Wright Aeronautical, scientists follow much the same idea — to make powerful Wright Cyclone aircraft engines even more powerful, more economical.

Heat, cold, salt, acids, light rays, endurance runs and utter destruction are used for one end: more power. Year after year, war or peace, research goes on. It's one more reason why Wright Cyclone engines continue to lead the parade of power.

FACTORY FOR FACTS

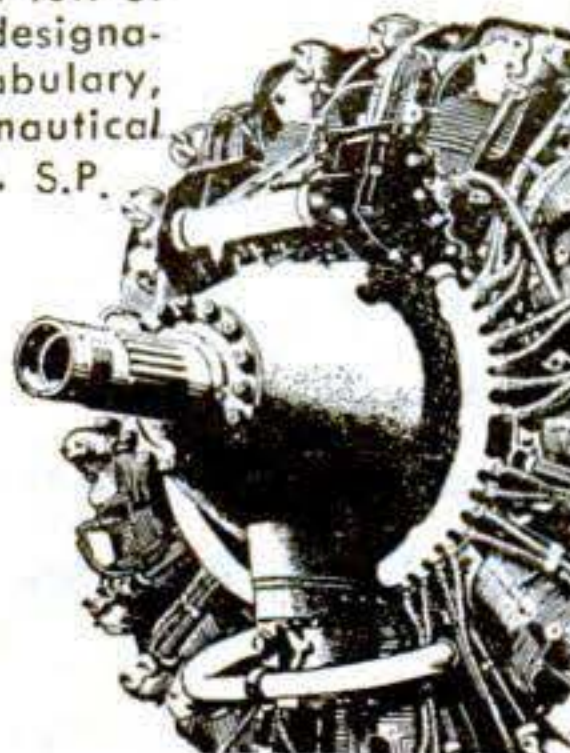
1. X-ray eyes in lead lined room inspect castings for flaws.
2. Red heat furnaces test ways to harden metals to add strength.
3. Photographs make "before-and-after" records of all tests.
4. Spectrograph splits light rays of metal samples burning in arc flame, gives rapid analysis of elements in production materials.
5. Metallographers enlarge specimens 4,000 times for metallurgical study of grain structures.
6. Research projects on plastics, rubber, non-metallic materials.
7. Physical test section measures fatigue, impact, breaking point and hardness of engine materials.
8. Oil and gasoline scientists guarantee fuels of specified power.
9. Electro chemists develop and check plating methods.
10. Acids etch cross-sections of metals for grain flow study.
11. Chemists analyse alloys, study corrosion-resistance tests.
12. Scientific trouble-shooters aid production, foundries, shops, test cells. Research groups map out new development work.

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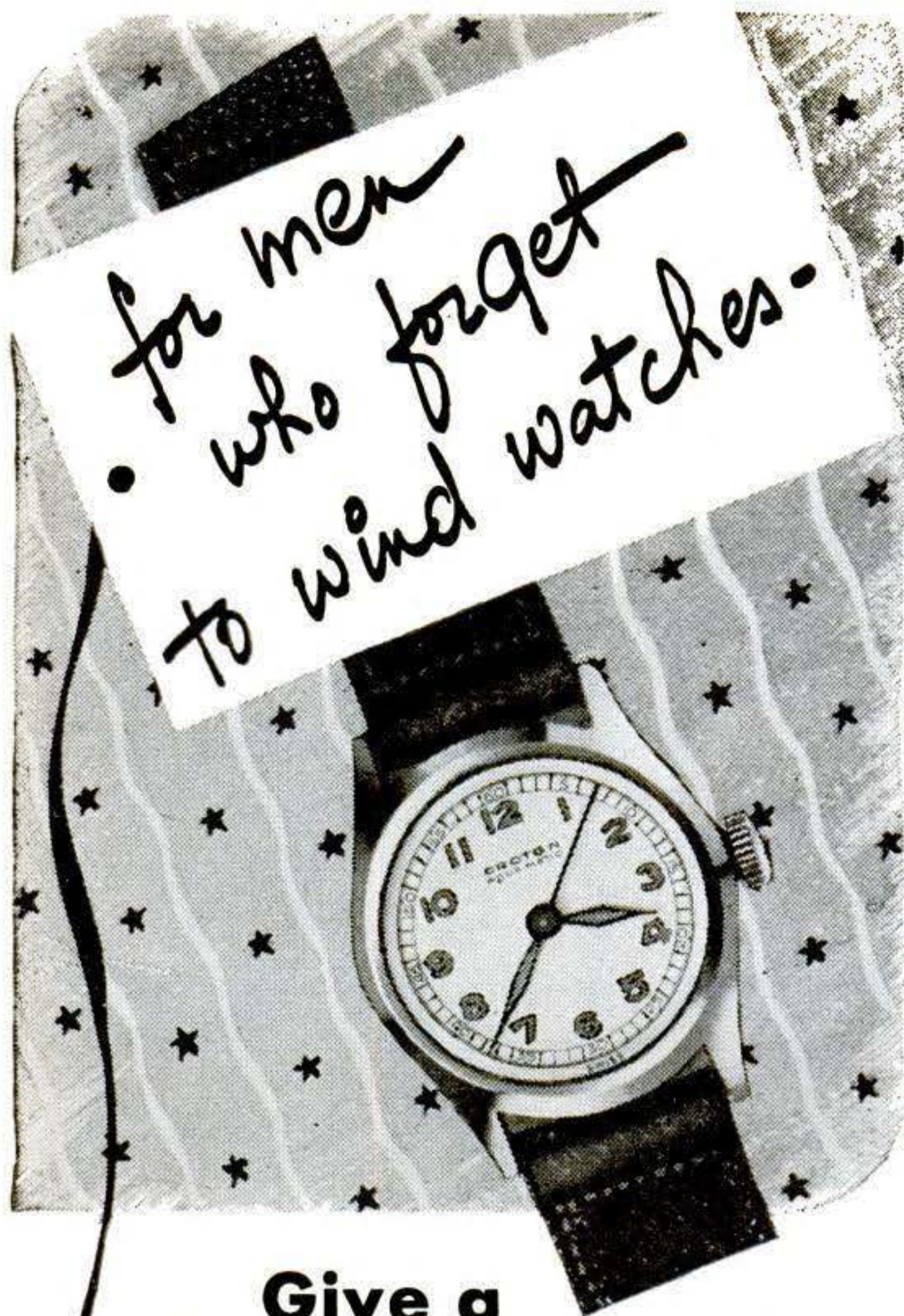
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When you install new piston rings,
it will pay you to get Hastings rings.
They *stop* oil-pumping, *check* cylinder
wear, *restore* engine performance. Ask
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No man's memory is infallible—but the Croton Aquamatic *is!* It keeps on running day and night, *without winding!* It actually winds itself, by natural motions of the wrist. It's *more accurate*, too. In a 30-day wearing test, 3 Aquamatics proved to be *13.5% more accurate* than the average of 9 other famous hand-wound watches.

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Croton 

WATERPROOF AQUAMATIC

Army Know-How Wins

(Continued from page 210)

they acquired approximately half their capital, plus two associates who knew the spare-parts business from valve caps up.

The remaining half of their capital still had to be obtained. To the Smaller War Plants Corporation they brought their prospectus, buttressed with statements from the OPA, the ODT, the WMC, and several of their prospective customers. And they got the money.

With it they promptly set up Yule Industries, Inc., Automotive Engineers. Last June they took space in what had been a garage, laid in machinery, ordered spare parts, tools, furniture, and equipment, started hiring, and went out for orders.

A drive-yourself car company, seeing the profit in fast maintenance, gave the boys their first orders. Others quickly followed from Boston's traction company, the "El;" from a big interurban bus corporation, and from the operator of a large fleet of trucks.

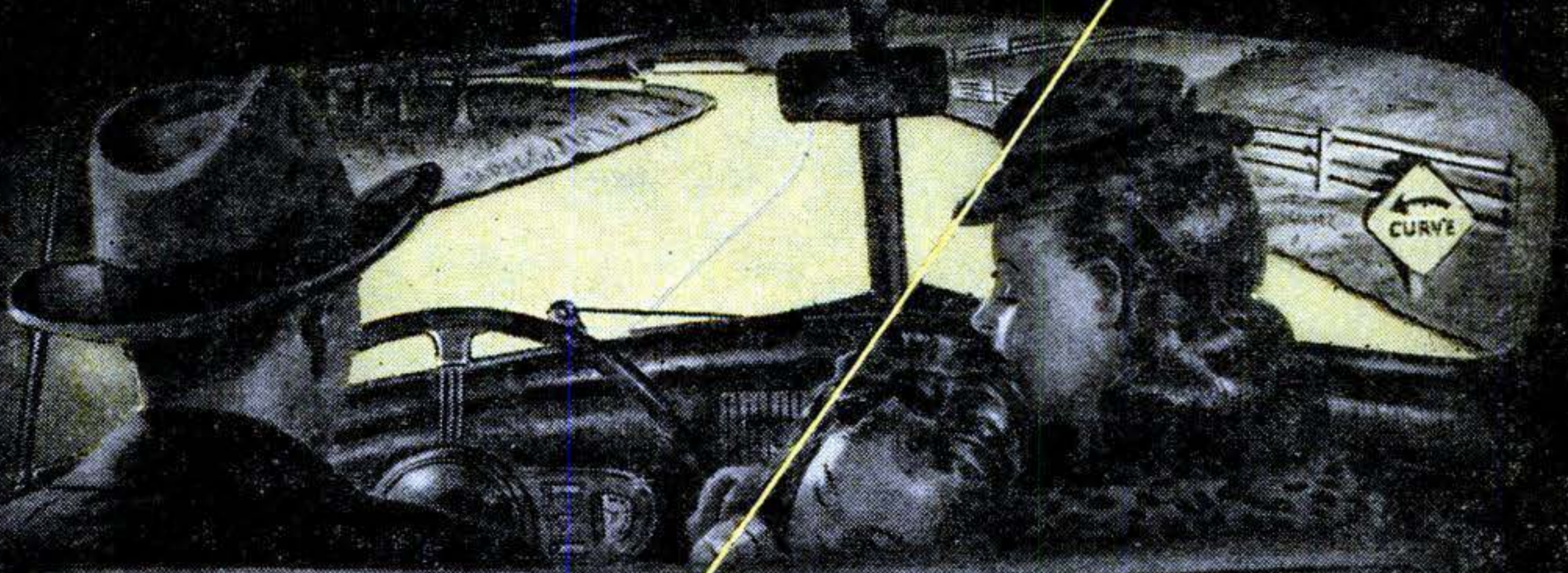
Orders were a cinch on the basis of their idea, but parts and materials were extremely hard to get. Indeed, if it had not been for the experience and connections of the firm's principals in this field, they might have come to grief here, as so many hopeful but inexperienced firms have.

And personnel was even more of a problem. Originally, the Yule-Harrison idea was to staff their outfit with ex-servicemen—preferably damaged ones like themselves, but, at any rate, men experienced in the Army brand of swift maintenance. These proved hard to get and harder still to keep on the kind of work the company is geared to do, for a great many people are looking for service-trained mechanics and maintenance men.

So the Yule outfit has gone back to another basic Army principle: the trainer-trainee system. Its experienced operatives—mostly older men—have been trained in the exchange-and-rebuild techniques. New men, regardless of previous experience, start as trainees. When they have mastered the Yule techniques they step up in grade, responsibility, and pay. Results already show that, given time, this system will produce a rapidly operating, efficient shop—and a money-making one.

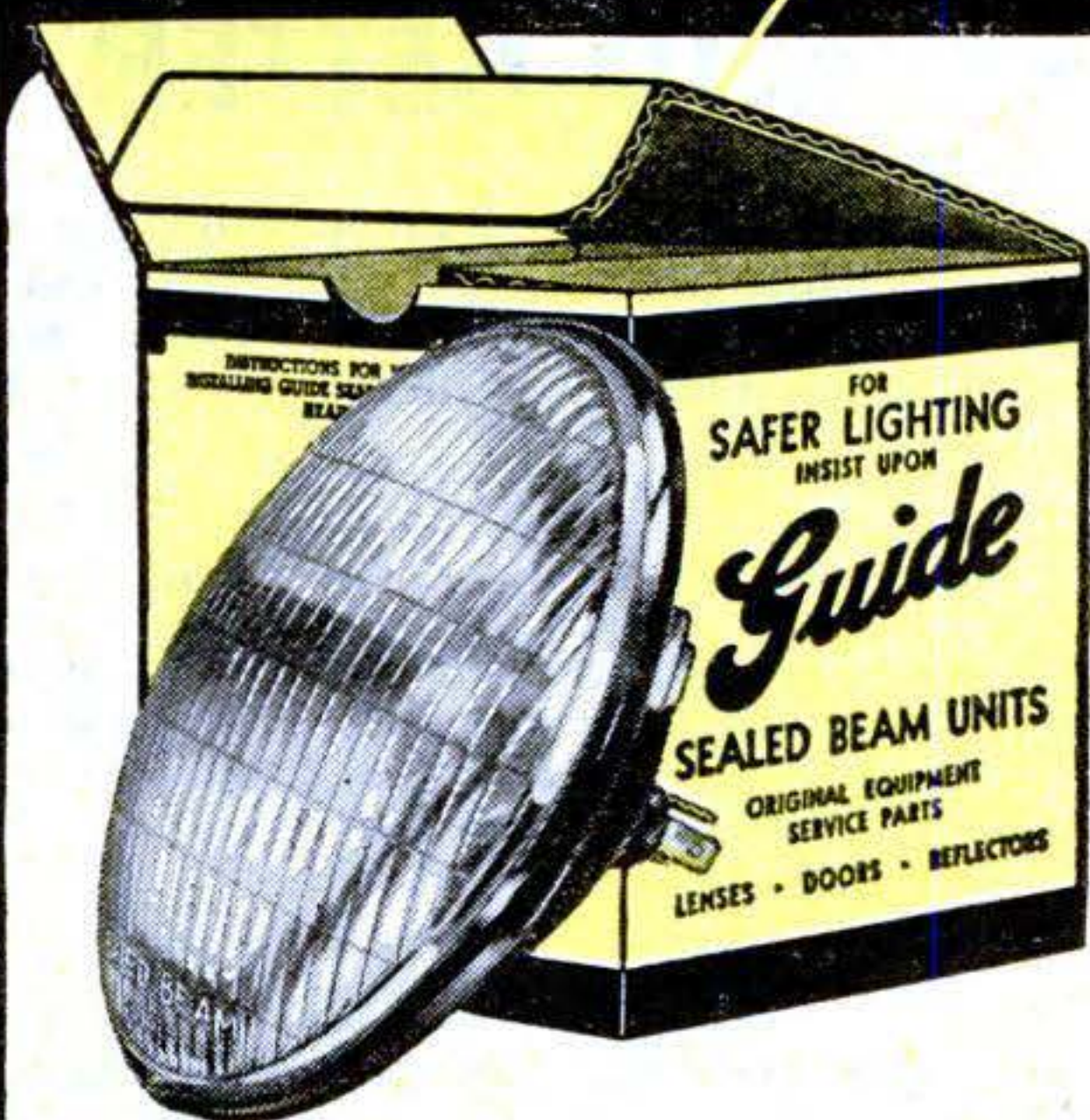
In many respects the company has had to depart from its original ideas. But, here again, Army training tells. One basic requirement of successful soldiering is adaptability or flexibility—the ability to master a situation *whichever* way it changes. These men have it.

Let safety share the ride...
 Drive with Guide Sealed Beam Units



BUY VICTORY BONDS

LET SAFETY SHARE THE RIDE—
 REPLACE WITH GUIDE



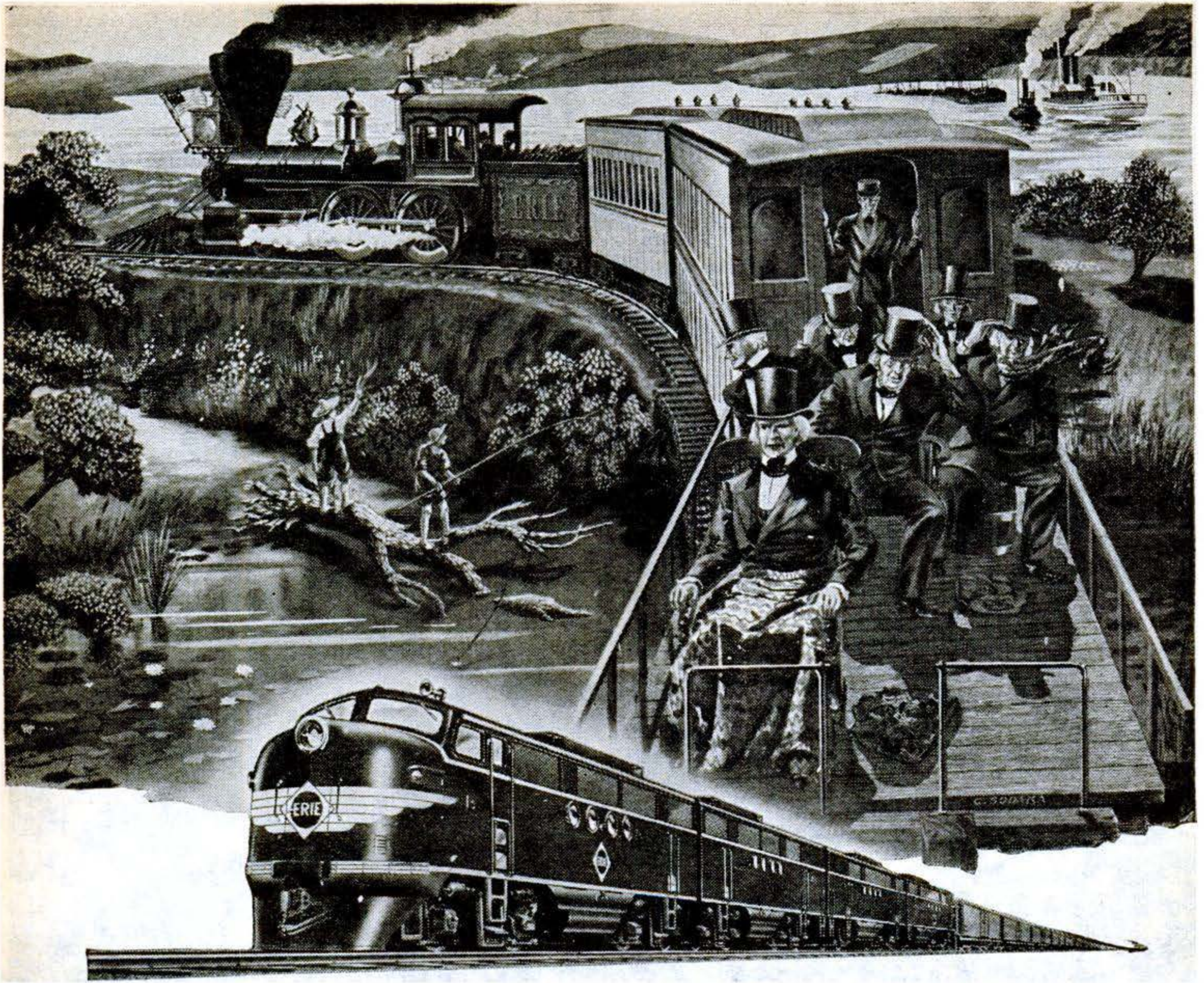
All the safety that can now be built into automotive lighting is yours when you have Guide Sealed Beam units. They give you an even, easy-on-the-eyes pattern of light for all your driving needs: an upper beam, bright and far-reaching for country roads—a lower beam, glare-free and ample for city streets and meeting other cars. They also give you the important Guide safety feature of *double protection*—no dim-out for the life of the unit, no black-out if a stone or blow should crack the lens. For Sealed Beam lighting at its best, ask for Guide units.

NO DIM-OUT—Your Guide Sealed Beam unit is sealed against dirt, dust and traffic film. It stays bright for the life of the unit—does not lose its efficiency, as earlier-type headlamps do.

NO BLACK-OUT—Your Guide Sealed Beam unit will not fail in case of an accident to the lens. The bulb within the sealed unit continues to burn with full intensity—lights the way safely until the damaged unit can be replaced.

GUIDE LAMP DIVISION OF GENERAL MOTORS CORPORATION

SAFE HEADLAMPS ARE "CORRECTLY AIMED" HEADLAMPS—HAVE YOURS CHECKED TODAY



To celebrate the opening of the then longest rail line in America, the Erie Railroad arranged a now famous junket for May 14, 1851. Included among the guests who made the 427-mile trip were President Millard Fillmore, several members of his cabinet and Daniel Webster, who is pictured here as he elected to travel.

SAMPLE OF THE NEW AND BETTER

In his hair was the snow of 69 active years—but in the heart and mind of Daniel Webster was ever-youthful eagerness to sample new and better things.

So when the Erie Railroad celebrated the opening of the first "long" rail line, he prescribed his own accommodations. Other distinguished guests could ride in coaches if they preferred—Mr. Webster would take a rocking chair on an open flatcar, so as not to miss anything new and exciting.

Were he with us today, Daniel Webster would still find new and better things along the lines of the Erie. Heavy grades that "bottlenecked" freight movements

for a long time, have bowed down before General Motors Diesel locomotives—and long strings of freight cars now move with dependable on-time regularity without split-up between Chicago and Jersey City.

Here, as in the service of 83 other major lines and heavy industries, this modern motive power is dramatically heralding new and better things to come.

For their great power, their speed, their unmatched smoothness make one thing clear: *When whole lines become completely GM Dieselized, schedules can be clipped, costs still more reduced—and all your travels blessed with fresh new comfort and ease.*

ADD SECURITY
TO VICTORY
BUY MORE
VICTORY BONDS



LOCOMOTIVES **ELECTRO-MOTIVE DIVISION, La Grange, Ill.**

SINGLE ENGINES ... Up to 200 H.P.)
MULTIPLE UNITS ... Up to 800 H.P.) **DETROIT DIESEL ENGINE DIVISION, Detroit 23, Mich.**

ENGINES ... 150 to 2000 H.P. **CLEVELAND DIESEL ENGINE DIVISION, Cleveland II, Ohio**



Back at last!

No doubt you've read our ads before
And sighed at our excuses
That Texcel Tape was not around
Because of its war uses.

Well, here's good news! It's back at last!
The tape you've waited for!
Though there's not much in stock just yet
Say "Texcel" at your store.



For Texcel wraps, protects and seals,
It holds with just a "stick."
At home and work, in stores and plants
It always does the trick.

And Texcel is an improved tape
Whose "stickum's" bonded on.
It won't come off, it won't dry out,
Before the judgment dawn.

So ask for Texcel at your store
And if there's none today,
Be patient, please, and bear in mind
That more is on the way.



CELLOPHANE TAPE -
STICKS WITH A TOUCH

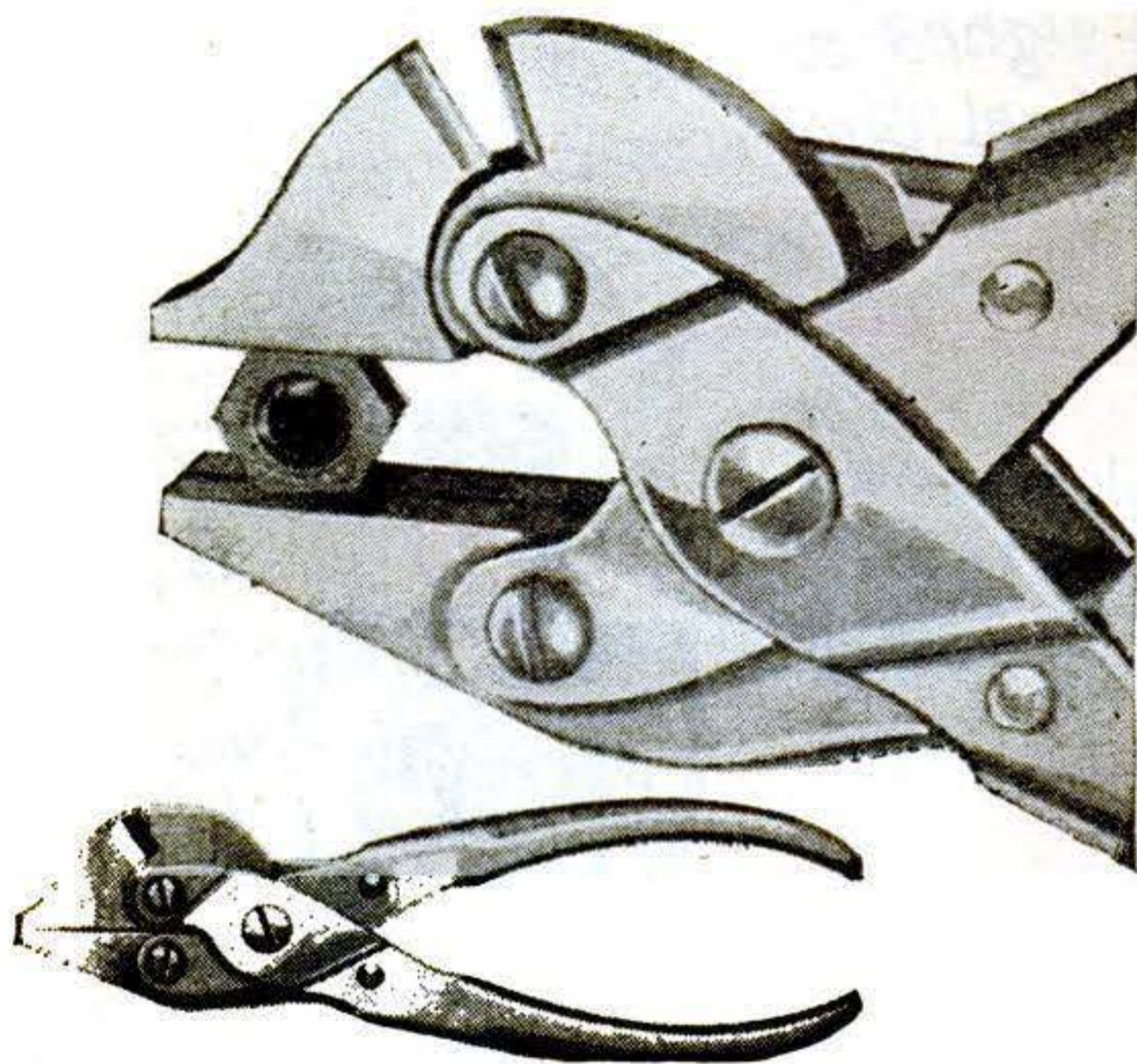
Texcel Tape

INDUSTRIAL TAPE CORPORATION • NEW BRUNSWICK, N. J.

DECEMBER, 1945

A WONDERFUL HEAD ON ITS SHOULDERS

Yes, sir, this is the plier with the 3-purpose head (plier, cutter, wrench)—and the compound action that gives over twice the power. It's the BERNARD—and there is no other plier like it.



Jaws always parallel. Close like a vise. Hold FAST. Don't slip. Won't mar the nut.

Cutter on outside of head, convenient to use. 6" size cuts 8-penny nail easily.

Open throat—just the thing for handling wire. Note how jaws fit snug against wire.

Your local hardware store has BERNARD parallel-action pliers and other BERNARD tools. They are ideal gifts for Christmas.

For an interesting, illustrated catalogue of BERNARD pliers, nippers, cutters, pruners, etc., please use the coupon below.

BERNARD

TRADE MARK REGISTERED

Wm. Schollhorn Co., New Haven 9, Conn.

"Quality Tools Since 1870"

Wm. Schollhorn Company
7012 Chapel Street, New Haven 9, Conn.

Sirs: Please send me your free, illustrated catalogue of BERNARD hand tools.

NAME _____

STREET _____

PLACE _____ STATE _____

(Zone No.)

We CAN Harness the Atom

(Continued from page 69)

atoms? The method found and used in atomic bombs is remarkably simple.

When a raindrop divides, several fine droplets often appear at the point of division. Likewise, when a uranium nucleus divides, an average of two such droplets (neutrons) is set free. These neutrons start a cumulative chain reaction. The two neutrons freed when the first nucleus is hit can hit two additional atoms, releasing four neutrons to hit four more, which free eight neutrons to hit eight more, and so on and on.

Ordinary uranium, containing four times as many U-238 atoms as U-235 atoms, does not explode because atoms have certain human traits. Like baseball players who have trouble grabbing hot grounders, uranium atoms do not catch many of the neutrons, which start out at terrific speed (several thousand miles per second), until they are slowed down. Most of them are then caught by U-238 atoms, which can withstand the addition of a single, slow neutron. Hence, the chain reaction is immediately squelched.

Five years ago, scientists estimated that if enough pure U-235 could be assembled, a single neutron would set off the greatest explosion ever seen. There are always a few free neutrons everywhere, produced by cosmic rays, so the problem was to get enough pure U-235 together suddenly at the right time and place. That has been done in atomic bombs.

For any peacetime applications of nuclear energy, some scheme to slow down the reaction must be found. This can be done.

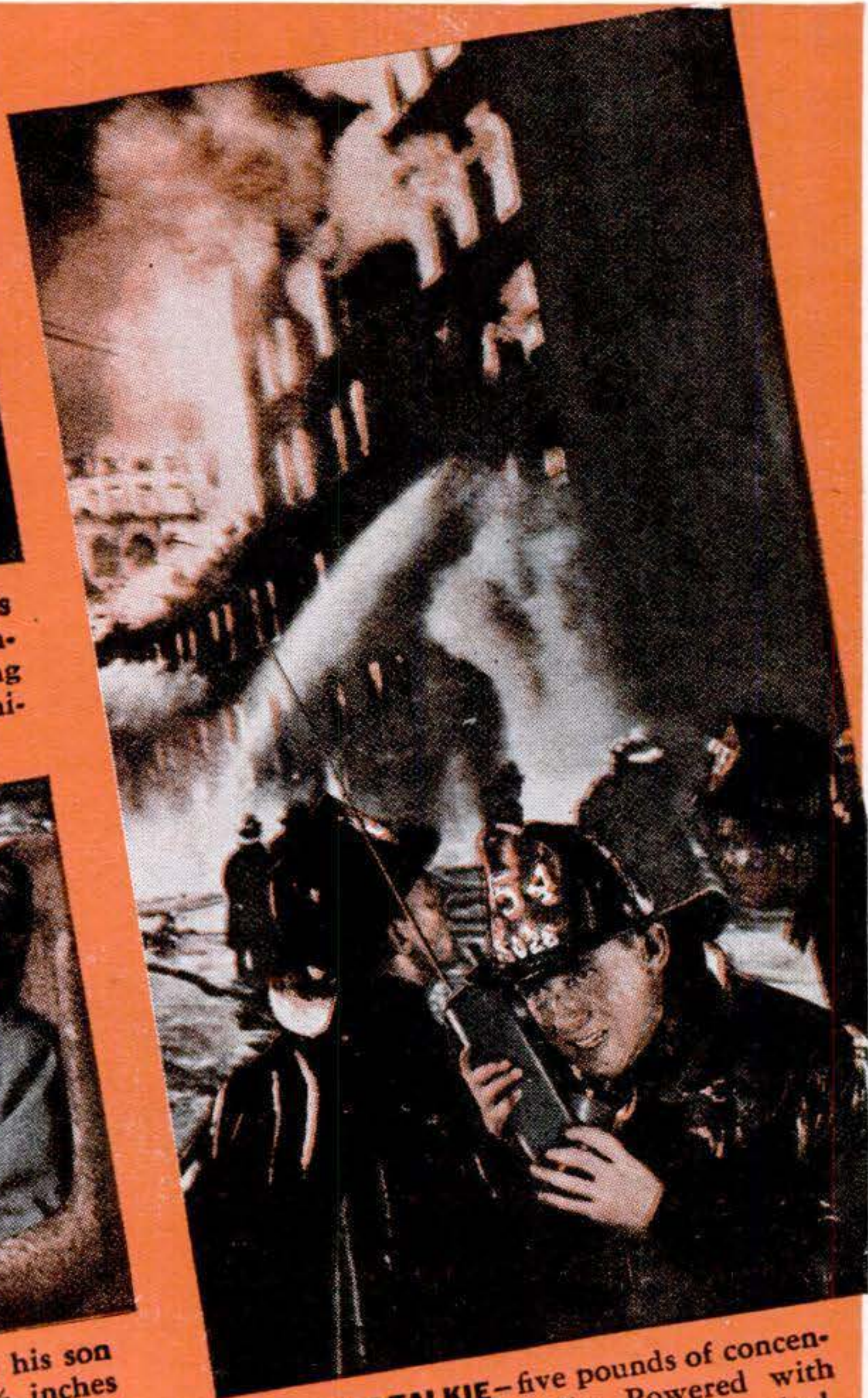
There is a way to release energy from very small pieces (ounces) of U-235 at a controlled rate. A small chunk of U-235 is surrounded by water which, as you know, contains hydrogen. Neutrons are slowed down efficiently by hydrogen. In operation, this nuclear-energy "engine" would be started by a cosmic ray entering the uranium. These would pass into the water, where collisions with hydrogen atoms would slow them down. Eventually, they would bounce back into the uranium, and the process would be repeated.

Since the neutrons would be moving comparatively slowly, each cycle would require several millionths of a second. This would give the energy released by each broken atom time to be conducted away from the uranium to the surrounding water. After a few neutron cycles, the water would become steam. There are far fewer hydrogen atoms per unit volume in steam than in

(Continued on page 222)



SIZED LIKE A CIGARETTE CASE, this radio is easily carried. Personal earphone permits listening without bothering others. Strong, day-long reception, thanks to the tiny, powerful "Mini-Max" battery, now available.



HANDIE-TALKIE—five pounds of concentrated two-way radio. Powered with "Mini-Max" batteries, it will be ideal, when available, for fire fighting, outdoor jobs, exploring, auto racing.



BREAST-POCKET HEARING AID—lets Dad hear his son play those first tunes. It measures $4\frac{3}{4}$ by $2\frac{1}{2}$ inches and weighs a mere 6 ounces. Yet, its "Mini-Max" "B" Battery—available now—has phenomenally long life.

"VEST POCKET" POWER

Wartime battery research packs giant power into midget space

An "Eveready" "Mini-Max" Battery, with an "Eveready" Flashlight Battery, in the palm of a hand. Insist on "Eveready" batteries. They're dated to assure freshness. Fresh batteries last longer!



EVEREADY
TRADE-MARK

ELECTRONIC experts have lately outdone themselves in giving us "vest pocket" reception. They have made possible hearing aids easily concealed in the palm of the hand. They have designed radios the size of a cigarette case. And now they give us a postwar edition of the amazing Handie-Talkie—famed GI sending and receiving set. A key to these accomplishments is "Eveready" batteries. One of these storerooms of power, the "Eveready" "Mini-Max" battery, weighs only $1\frac{1}{2}$ ounces. Yet, size for size, it is the most powerful "B" battery ever made.

Registered trade-marks "Eveready" "Mini-Max" distinguish products of National Carbon Company, Inc.

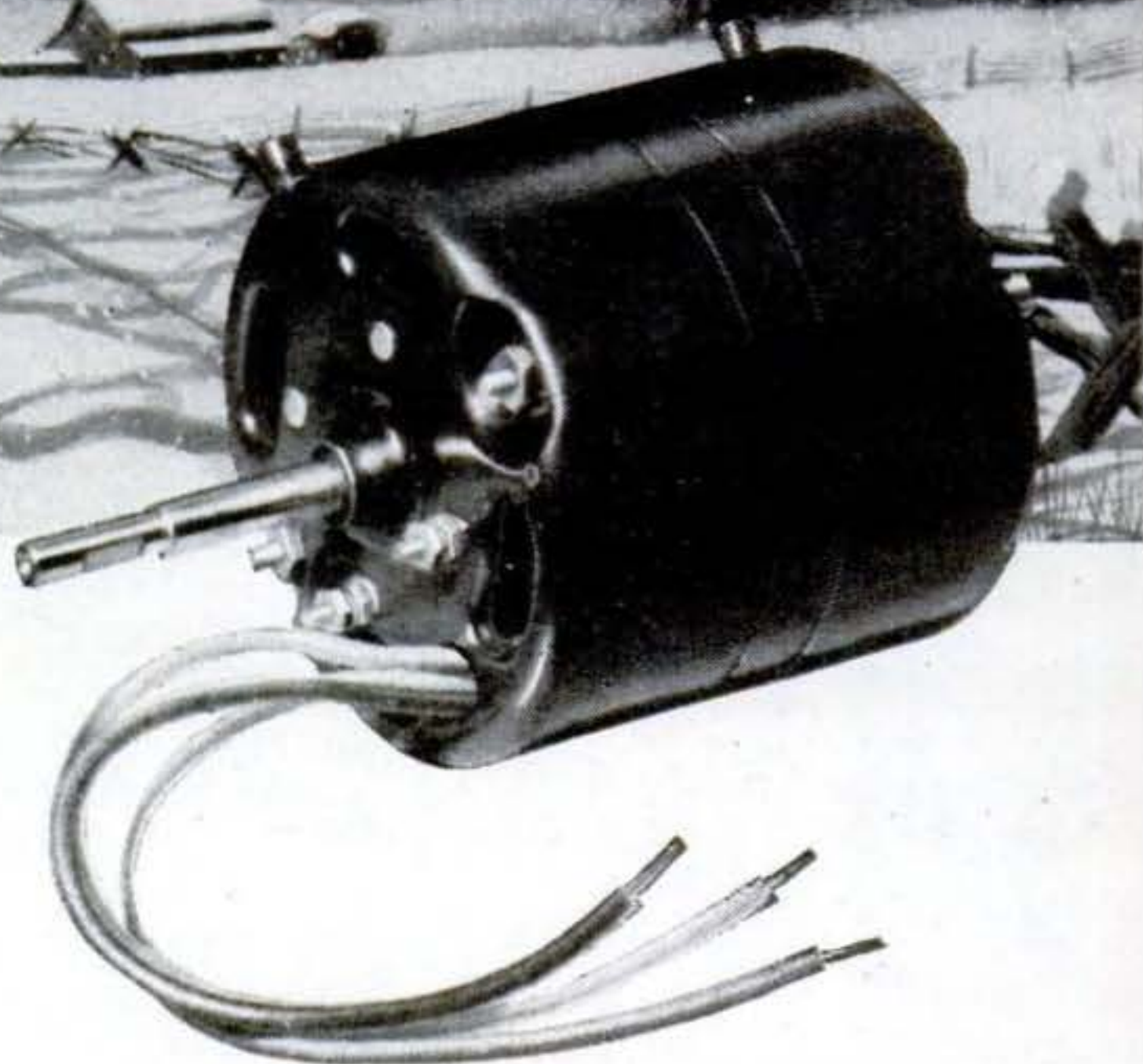


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SINGLE VALUE
CAPACITOR MOTOR**

This miniature powerhouse heads the parade of Ballentine Motors now rolling off the production lines and available for prompt delivery.

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adherence to close tolerances. It is especially suitable for built-in applications, as it has no switches—no brushes. Ideal for projectors, fans, and similar applications where high heat losses are not desirable.

Other QUIET Ballentine Motors from 1/1000 to 1/8 H.P. will soon be available.

SPECIFICATIONS

Single value capacitor motor. Diameter 3½", Length 3½". Double or single shaft extension. 2 pole—1/20 h.p. 3400 RPM, 4 pole—1/25 h.p. 1700 RPM. Strap type mounting. Cool running, 50% efficiency. Motor parts—rotor and stator available for built-in applications.

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A world of almost limitless opportunities for pleasure and profit opens up for you when you own an Atlas lathe.

Hundreds of useful things of metal, wood, or plastic can be made for your home—and home equipment repaired. Valuable tools can be made to add to your shop facilities. And if you have the time and interest you can make special tools—as does S. G. Williams, above—for profitable sale.

Whatever project you undertake, an Atlas will help you make the most of

your mechanical skill. It gives you the precision needed for delicate operations—the strength required for heavy cuts. It gives you a wide selection of speeds and feeds—and complete versatility in all the fundamental lathe machining operations. Yet it will come to you—at an exceptionally low price.

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Atlas 4 TOOL TEAM



LATHES



MILLING MACHINES



SHAPERS



DRILL PRESSES

HOW TO GET THE MOST OUT OF BETTER FUEL

Don't expect to fill your tank with the new, higher-octane gas and get top-grade performance from spark plugs you may have switched to during the war. Now that you're getting far better fuel—and have returned to normal driving, you need to consult your service station about changing to AC plugs that run *cooler* than those you may have used with wartime fuels.

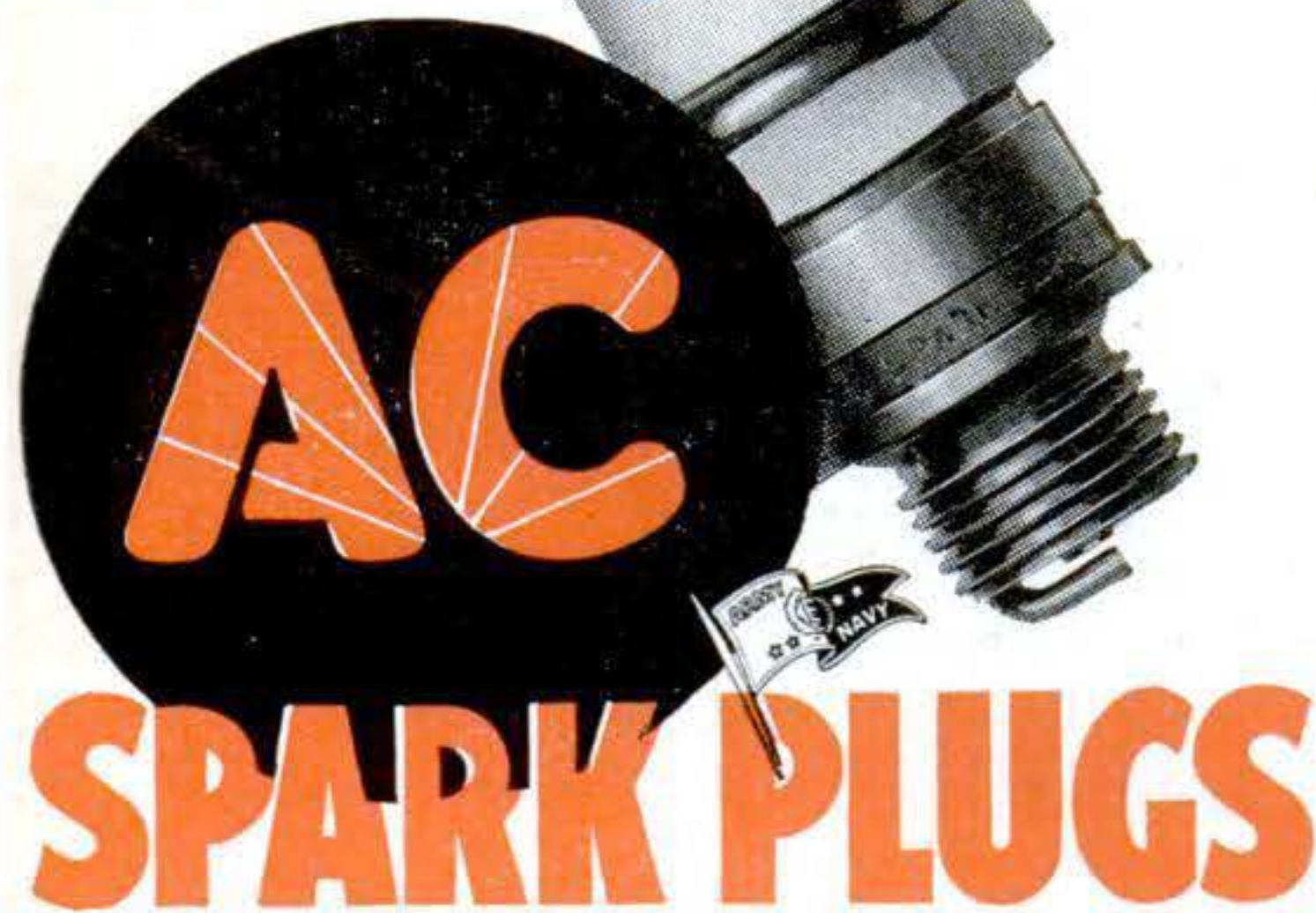
The correct type of plug is *necessary* to avoid hard starting—loss of power—waste of gas—cracked insulators—rapid electrode wear—excessive oxide coating—misfiring under heavy loads.

The AC Heat Range, and today's wider heat range per plug, enable you to fit spark plugs exactly to engine operating conditions. That's why AC's were standard equipment on 2 of every 4 new cars and trucks—why your AC service station can help you to get the *utmost reliability* in spark plug performance. Have your plugs checked today. Be sure you have the type that will give you the best in performance.

AC SPARK PLUG DIVISION • GENERAL MOTORS CORPORATION



CLEAN PLUGS SAVE
UP TO ONE GALLON
OF GAS IN TEN



LET'S FINISH THE JOB — BUY VICTORY BONDS

We CAN Harness the Atom

(Continued from page 218)

water, so at this stage the slowing-down process would become less efficient. Hence, the neutrons would escape and the reaction would die down until more water was added. Such an arrangement would give us a self-regulating source of energy from U-235, which is exactly what we need to utilize nuclear power productively.

U-235 has been produced in two different ways at Oak Ridge, Tenn., but the rate of production is probably not great, and a new element, plutonium, has been synthesized from U-238 for the bombs. Plutonium has been produced in reasonable amounts at the Hanford Engineering Works, near Pasco, Wash., by using some of the neutrons released from chain-reacting U-235 atoms in rods of pure uranium metal. The massive assembly for doing this is called a uranium-graphite pile. The graphite slows down the neutrons escaping from the U-235 in the rods. Some of the neutrons then combine with U-238 atoms to create atoms of plutonium, while other neutrons hit nuclei of U-235 atoms to continue the process.

Water enough to supply a fair-sized city circulates through the piles at Hanford to cool them, and the heat carried off from such piles could undoubtedly be used to heat cities or drive engines. These piles emit deadly radiations in large quantities, however, so means of shielding human beings from them must be supplied. A sandwich of lead, paraffin, and cadmium surrounding the pile should do this trick. Radioactive gases produced in the piles must also be disposed of.

No utility can economically replace its coal furnaces by nuclear piles, even if these hazards are overcome, however, until two further developments have taken place. A cheap method of increasing the concentration of U-235 in the uranium rods that go into the pile is needed, and a cheap and easy way must be found for removing the fragments of broken atoms from the rods.

Unless some method is found to bring about controlled chain reactions in some abundant common element, we are likely to remain dependent on atoms of very heavy elements for nuclear power. If lighter atoms can be used, nuclear energy will indeed become the Aladdin's lamp for all humanity. The world's uranium resources are estimated to be about as great as its supply of copper. Mobile engines, running on pure U-235 or plutonium, and stationary piles, functioning with enriched uranium, may not become commonplace tomorrow or the day after—but who can tell?



*Smoother than ever
- it's a new ride!*



This new Ford car—so big and smartly styled—offers more new developments than most pre-war yearly models . . . New multi-leaf springs give you a ride that's smooth and level . . . Brakes, too, offer major new advancements. They're oversize, self-centering hydraulics for quick, quiet stops . . . There's stepped-up power—and new thrift in gas and oil . . . Inside, new luxury awaits you. Colorful fabrics and trim in pleasing two-tone combinations . . . Choose from two great engines. The V-8, now increased from 90 to 100 horsepower; the 90 horsepower Six . . . Ask your Dealer about the smartest Ford cars ever built.

FORD MOTOR COMPANY

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THERE'S A

Ford IN

YOUR FUTURE

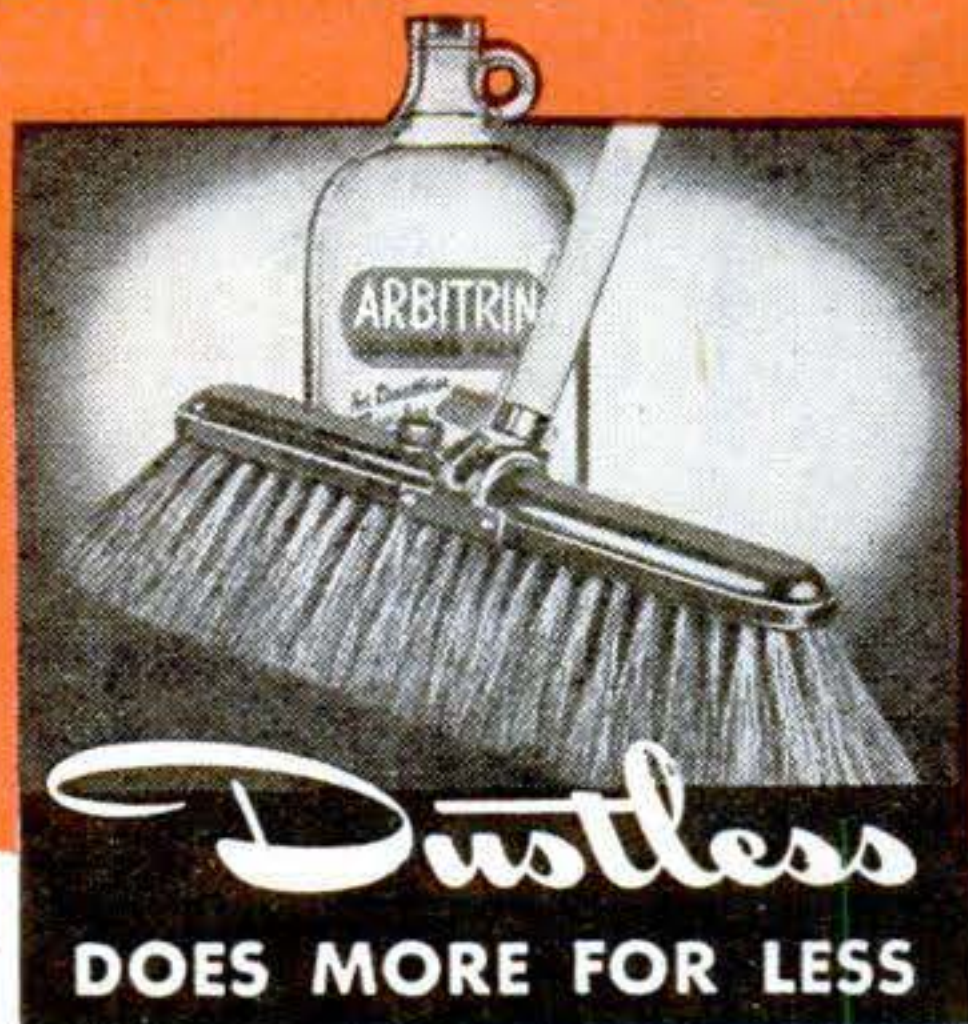


NOW! DUSTLESS SWEEPING



The Dustless brush is the only brush

ever perfected for "Dustless" sweeping. This brush has a reservoir in its back for Arbitrin sweeping fluid. In the process of sweeping, Arbitrin filters through the brush and makes the best kind of sweeping compound out of every particle of dust it contacts. Besides reducing dust 97%, the Dustless brush also eliminates sweeping compound, saves labor and outlasts ordinary brushes 3 to 1. Get complete facts about this better method of sweeping. Write today.



- Dustless
- Speed Sweep
- Speed Wash brushes

MILWAUKEE DUSTLESS BRUSH COMPANY

528 N. 22nd Street • Milwaukee 3, Wisconsin

Who Is Yehudi?

(Continued from page 95)

override the RFCU control action at any time. Trainees begin their radio flying from ground stations and fly from a mother plane during the advanced stage.

The flight-testing of new experimental airplanes is one of the newer and more imaginative applications of radio piloting. Particularly dangerous maneuvers such as power spins and terminal-velocity dives, from which a plane might not recover, can now be carried out under radio control from a mother plane or ground station.

The reason for putting a new plane through these maneuvers is to find out how it responds, or doesn't respond, and why. The instrument readings of a plane under test usually furnish most of this information. Pilots and technicians of the Air Technical Service Command, Bell Aircraft, and other commercial firms collaborated a few months ago in the development of the YP-59B Airacomet jet fighter. The test jet is called the "Reluctant Robot."

A specially equipped mother plane, another Airacomet called the "Mystic Mistress," is used as a mother plane, and is probably the only two-seater jet fighter in America. It can be distinguished from any other YP-59B jet by the long, swordlike antenna protruding from the nose and by the extra cockpit in the cowling ahead of the regular pilot's cabin. A flight engineer or observer rides in this extra seat. Instead of the conventional stick box holding all the necessary controls, the "Mistress" has the miniature control stick set into the handle of the regular pilot's control stick. The function switches and their indicating lights are installed in an extra-large handle on the jet plane's throttle.

Thus, in putting the "Reluctant Robot" through its paces, the mother-plane pilot flies both his ship and the "Robot." The instrument readings are televised, passed on to the transmitter in the test plane's nose and sent down to the ground or to the mother plane. Here, the observers can read the test plane's instruments on a television screen as well as if they were flying in the "Reluctant Robot" itself.

Wright Field pilots say that radio-controlled aircraft can now be used for any purpose piloted planes can fulfill. Although passengers can hardly be expected to be intrigued by the idea of flying in pilotless airliners, there are many other uses to which "Yehudi" can be put. In war and peace, he has proved himself a pretty intelligent robot.

NORTHROP AIRCRAFT, INC.

Announces the Establishment of THE NORTHROP AERONAUTICAL INSTITUTE

*dedicated to the training and
advancement of men for careers in aviation*



The entire aviation industry recognizes the critical shortage of aeronautical engineers, airline maintenance specialists, and expert master mechanics. For these important positions you must be trained to handle *all types* of civilian aircraft. Limited training in specialized subjects isn't enough. To handle a responsible, well-paid job for civilian air lines, air bases, maintenance depots, and manufacturers, you must have comprehensive, up-to-the-minute training.

To meet this need, NORTHROP AERONAUTICAL INSTITUTE has been founded.



Here, in a completely new school located in the midst of the big Northrop plant, you

will learn the aviation of *today*— and *tomorrow*. You will be surrounded by history-making, intensely interesting research and development work—jet propulsion, gas-turbine aircraft engines, radar, and advanced airplane designs pioneered by Northrop. You'll be right on the mile-long Northrop air field, next to the Northrop wind tunnel, the Northrop experimental laboratories, and the plant where the famous P-61 Black Widow night fighter was designed and built.



The Northrop Aeronautical Institute brings to aviation training completely new standards. Through the courses offered, you can now obtain specialized education for positions in postwar aviation. Every detail of every course is fitted to the new aviation requirements. Yet the

Northrop training programs are already proved by the education of many thousands of Northrop employees and Air Forces personnel.



Each Northrop student gets the benefit of completely modern technical information and advanced educational methods as well as extensive equipment for practical shop experience. Even the specially designed school buildings are new.

In this short space, it is impossible to tell half of the advantages of this great new school in the heart of one of the world's great aircraft-engineering plants. To get all the details, just send in the coupon. We will be glad to mail you an interesting booklet with complete information and pictures describing the school and the courses available.

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Please send me your free, illustrated booklet and information, including starting dates and tuition rates, on the training courses checked.

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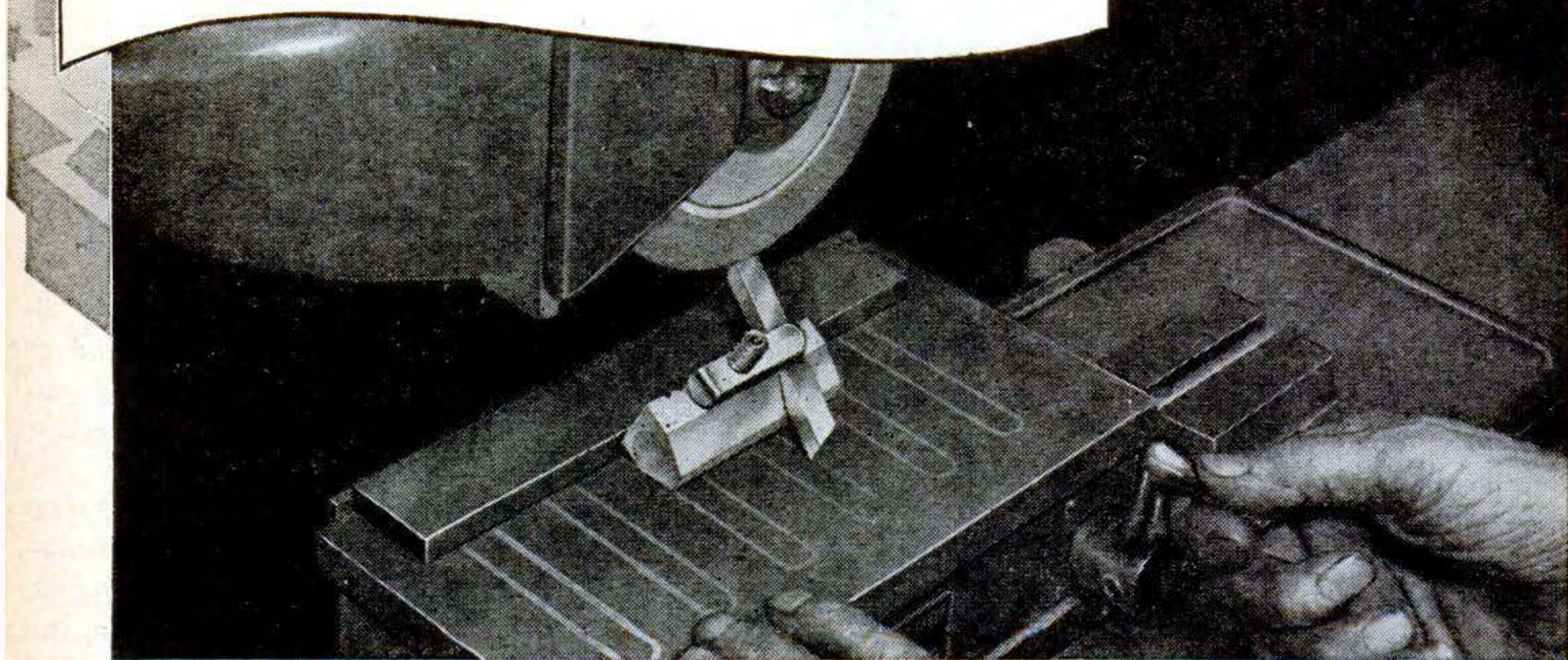
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Check one: Veteran In Service Civilian PS-1

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To Help You with Your Reconversion
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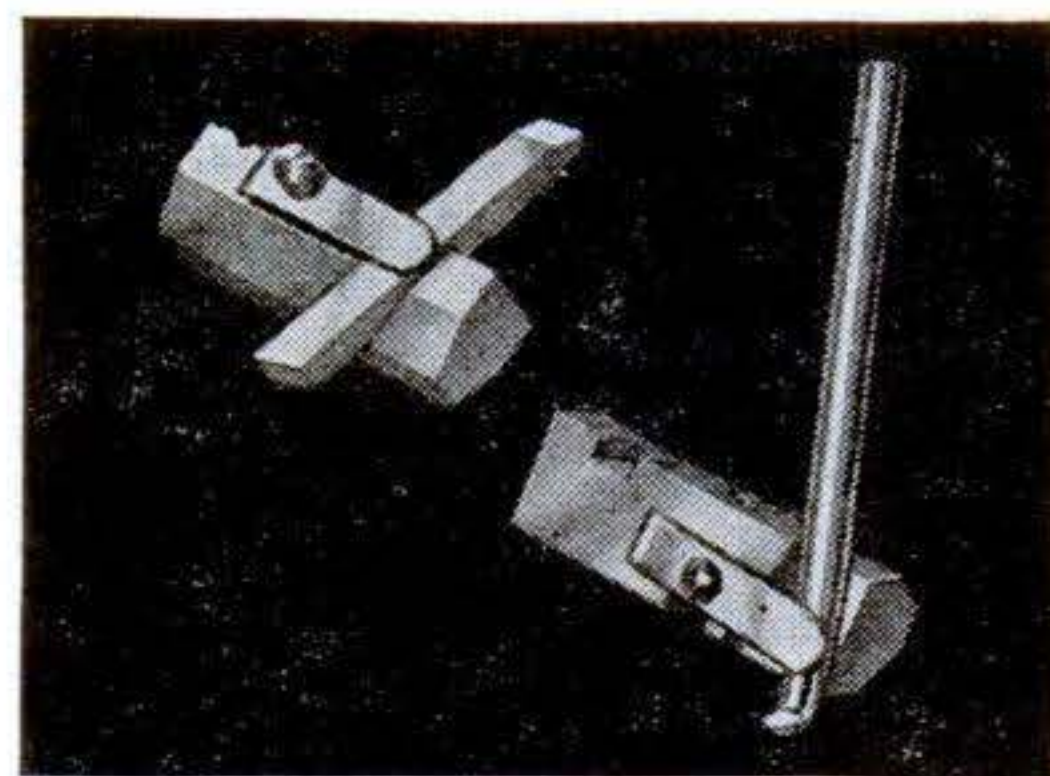
Now Anyone Can Grind Threading Tools!—with Master Grinding Gauge!

Until the advent of the Acro Master Grinding Gauge, only a skilled mechanic could grind thread-cutting tools to the required degree of accuracy. Now anyone can do it—in less time, with less waste, with even greater precision!

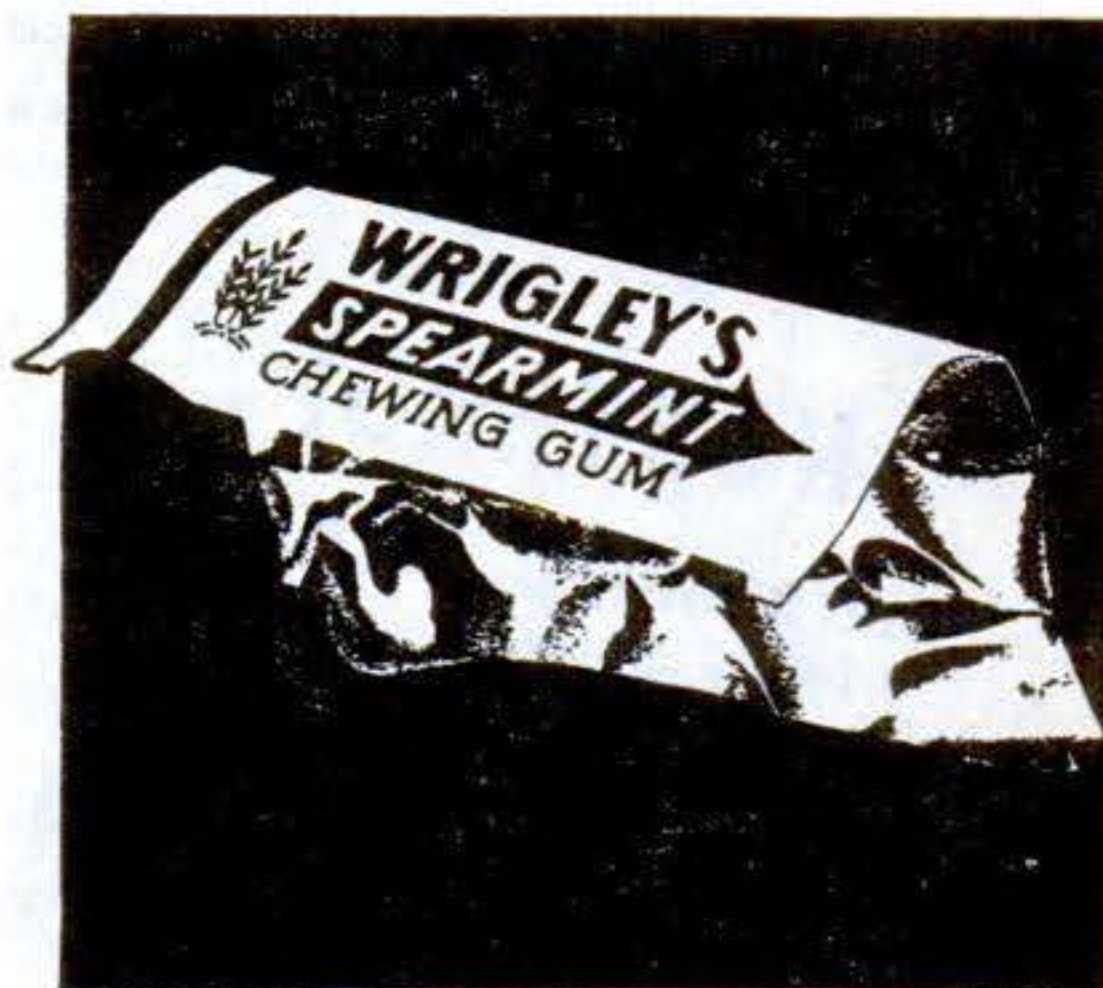
The cutting tool is simply placed in slot of the Master Grinding Gauge, and thumb screws hold it tightly in place, at the proper angle, while being ground on any type of surface grinder! The Gauge is made of hardened tool steel. There are no delicate or moving parts to get out of order. Milled slots at top and bottom provide correct grinding angles. A small set screw at end, eliminates any lateral motion. There is nothing special to learn—anyone can use it!

Anyone can be "helped on the job" by Wrigley's Spearmint Gum, too, once this quality product again becomes available. Just now, no Wrigley's Spearmint Gum is being made, and until conditions permit its manufacture in quality and quantity for everyone, we again urge you, please, to "Remember the Wrigley's Spearmint wrapper." It is our pledge to you, of the finest quality and flavor in chewing gum—that *will* be back!

You can get complete information from:
Acro Tool and Die Works, 4554 Broadway, Chicago 40, Ill.

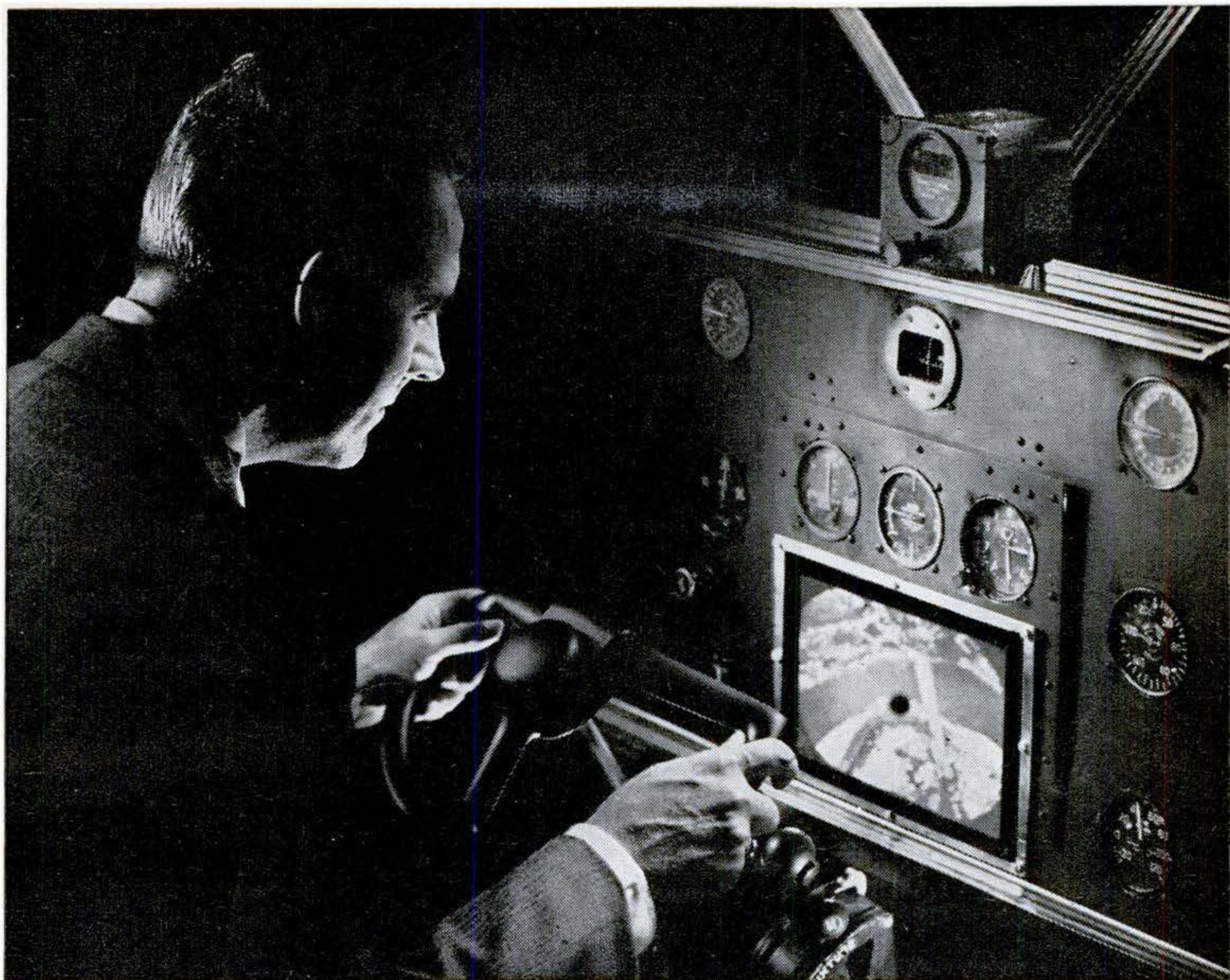


Acro Master Grinding Gauge



Remember this wrapper

Z-93



One of the many ways radar can serve aviation is by enabling the pilot to "see" through fog and darkness.

Radar—a "Moving Roadmap" for Flying

Pilots can now have an accurate radar "roadmap" of the earth below—showing landmarks and major details of terrain. Radar will make it a whole lot safer to fly at night or in stormy weather—as well as in broad daylight.

This is only one of the many possible uses for radar. For example, radar will "see" icebergs or islands many miles away—day or night—and will thus enable ships to avoid them. It will provide men with an amazing new "sixth sense"—and will be used in a great many ways yet to be discovered.

RCA research and engineering played a leading role in developing radar . . . the same research that goes into *all* RCA products.

And when you buy an RCA Victor radio or television set or Victrola, made exclusively by RCA Victor, you enjoy a unique pride of ownership. For you know, if it's an RCA it is one of the finest instruments of its kind that science has achieved.

Radio Corporation of America, Radio City, New York 20. Listen to *The RCA Show*, Sundays, at 4:30 P.M., E.T., over the NBC Network.

HOW RADAR WAS BORN

During RCA experiments at Sandy Hook in the early 1930's, a radio beam was shot out to sea. Men listening with earphones discovered that this beam produced a tone upon hitting a ship that was coming into the New York harbor.

Later on the question arose, "If radar could 'hear' couldn't it be made to 'see'?" So the viewing screen—or scope—was incorporated into radar. This scope is an outgrowth of all-electronic television that was invented and perfected at RCA Laboratories.



RADIO CORPORATION of AMERICA

Blatz



Beer

A Tradition ...

Good Taste



Since 1851, Blatz has been celebrated for Good Taste. That's why it has become a traditional favorite with those who appreciate the finer things. On a holiday, or any day, it's always Good Taste to serve Blatz.

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Fast Becoming America's Favorite




WHEN IT'S AN EXIDE

... YOU START

A good dealer is known by the fine products he sells and the dependable service he renders. Generally both will be found in the establishment of the man who sells brands of KNOWN high quality.

THE ELECTRIC STORAGE BATTERY COMPANY
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BUY TO LAST

Depend on the Exide dealer for good products, good service.

They're easier to reach with

"SUPERRENCHES"



● Awkward, hard-to-reach adjustments present no problem for these slim, taper-jawed "Superrenches". Forged from alloy steel, they are thin enough to operate half nuts yet their strength is equal to that of the strongest wrenches made.

Williams "Superrenches" are available in a wide range of patterns, with openings from 3/16" to 3-1/8". Write Department S-12 for free Tool Data Sheets.

J. H. WILLIAMS & CO.
BUFFALO 7, NEW YORK



DROP FORGINGS AND DROP-FORGED TOOLS

Shells Hunt Targets

(Continued from page 89)

the shells used by big rifles. The Army sponsored that on nonrotated and low-rotated projectiles such as bombs, rockets, and mortar shells.

The National Defense Research Committee, within the framework of the Office of Scientific Research and Development, took over the actual supervisory task. Special scientific groups were set up at the Applied Physics Laboratory of Johns Hopkins University at Silver Spring, Md., just outside of Washington, and at the National Bureau of Standards. In addition, scores of industrial and educational institutions were given pieces of the project to work on. Every hour of the day and night, liaison was maintained with the Office of the Chief of Ordnance and the Office of the Chief Signal Officer of the Army, and the Bureau of Ordnance of the Navy.

Three percent of all the physicists in the United States were employed on the project, in addition to scores of British physicists.

On January 5, 1943, VT's were used in battle action for the first time. The cruiser *Helena* opening up on a Jap pilot, who thought he was out of effective AA range and was dallying along on a straight course, brought him down in flames.

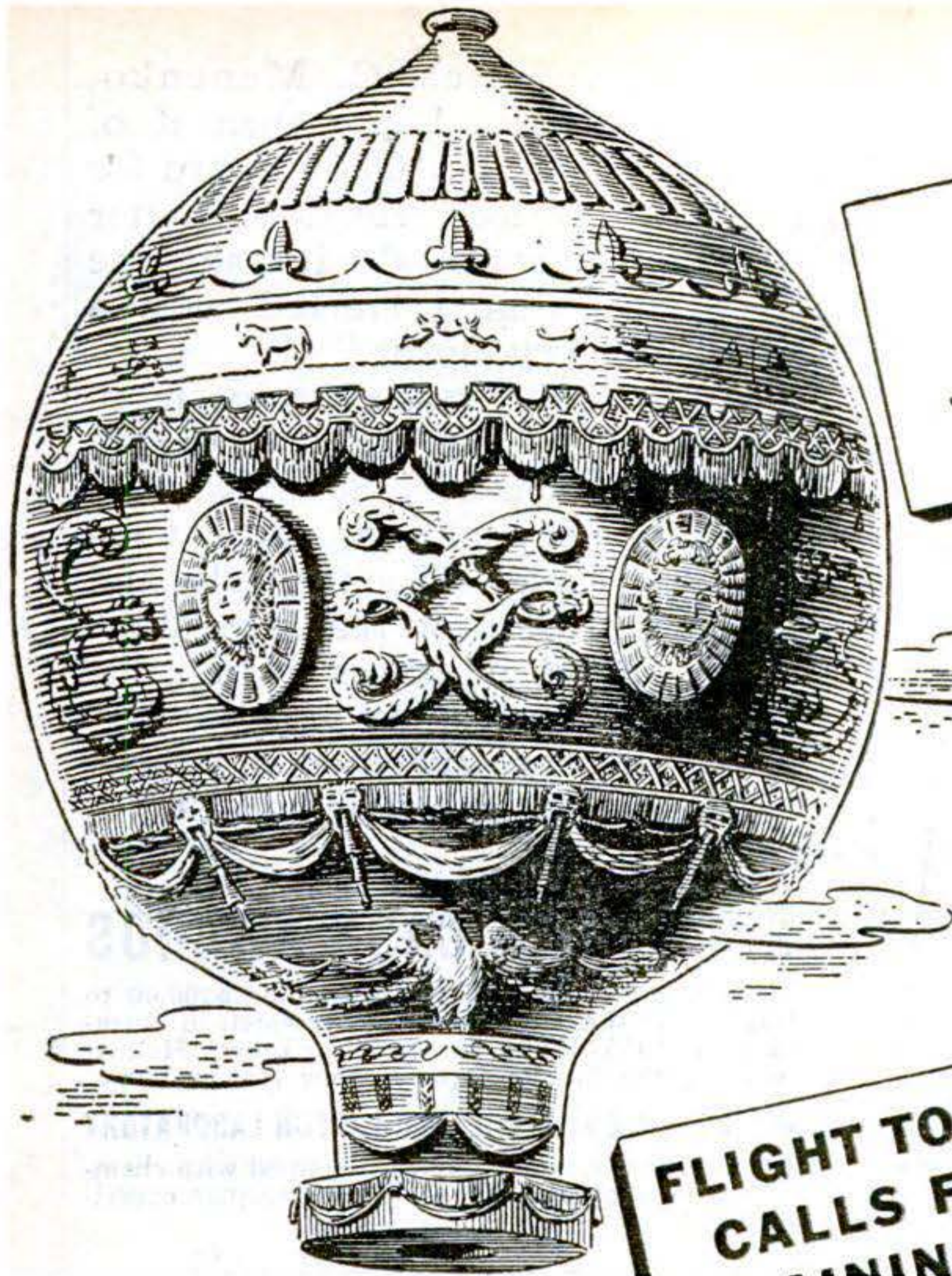
Just how American scientists managed to make radio sending and receiving sets that could be shot from guns and mortars remains a top-drawer secret. Only hints leak out in official accounts of the development of the fuse.

It is known that the glass tubes in the shell fuse were mounted in rubber cups and then embedded in a heavy compound to provide mechanical support. In fact, all the electrical components were firmly mounted. In the bomb, mortar, and rocket fuses the amplifier and thyratron circuits were completely embedded in polymerized tung oil.

POPULAR SCIENCE MONTHLY asked one of the men involved in the development of the fuse what the knowledge and techniques gained would be good for in peacetime.

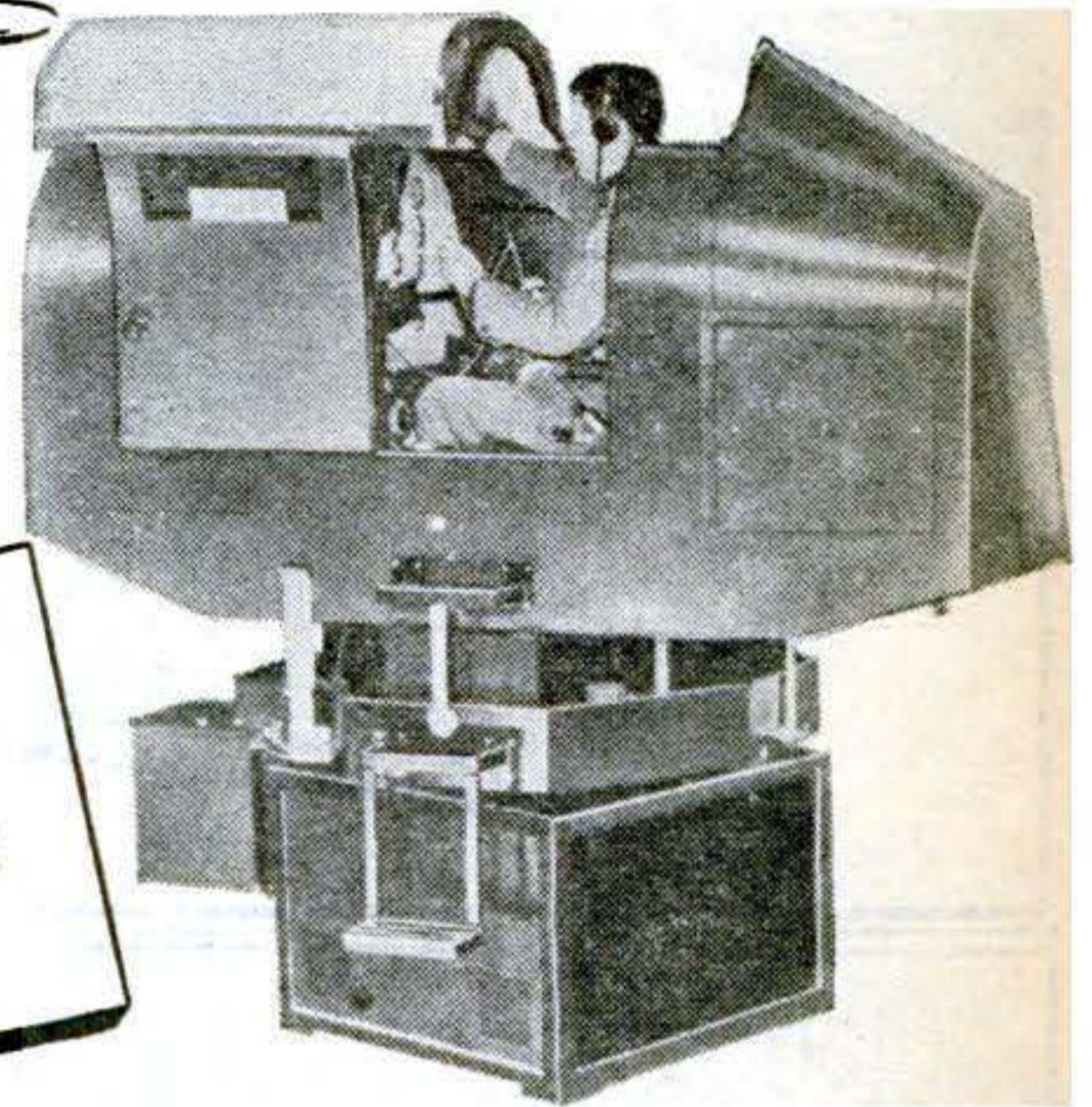
"How would you like to own," he replied, "a vest-pocket radio to tune in the news on your way to work in the morning?"

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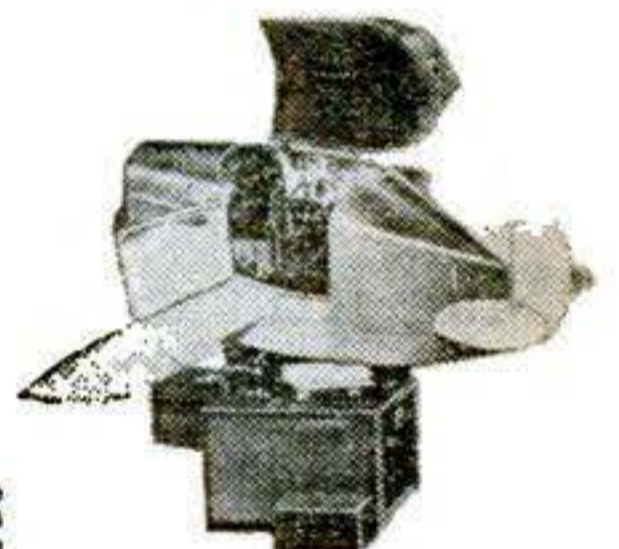
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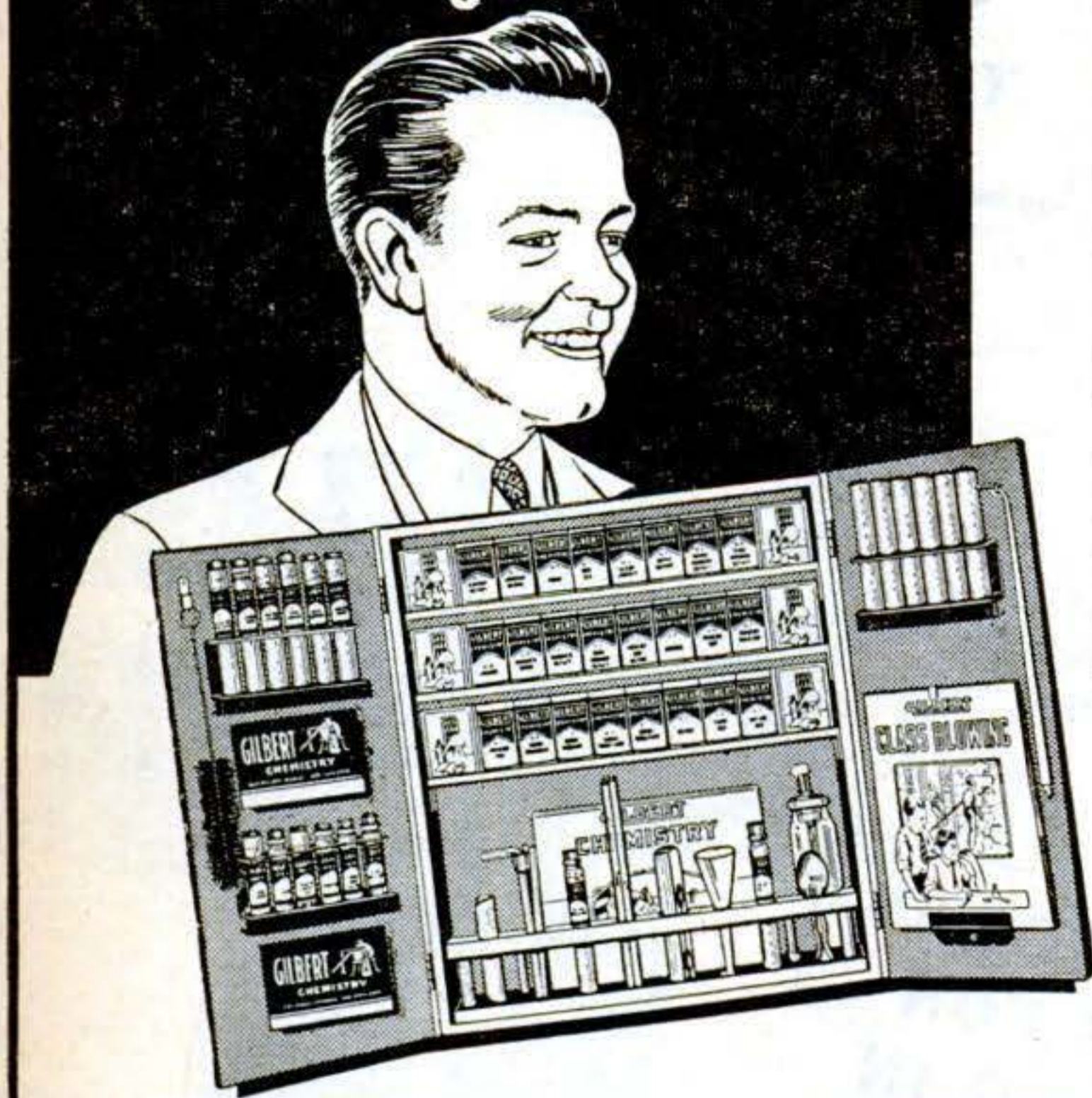
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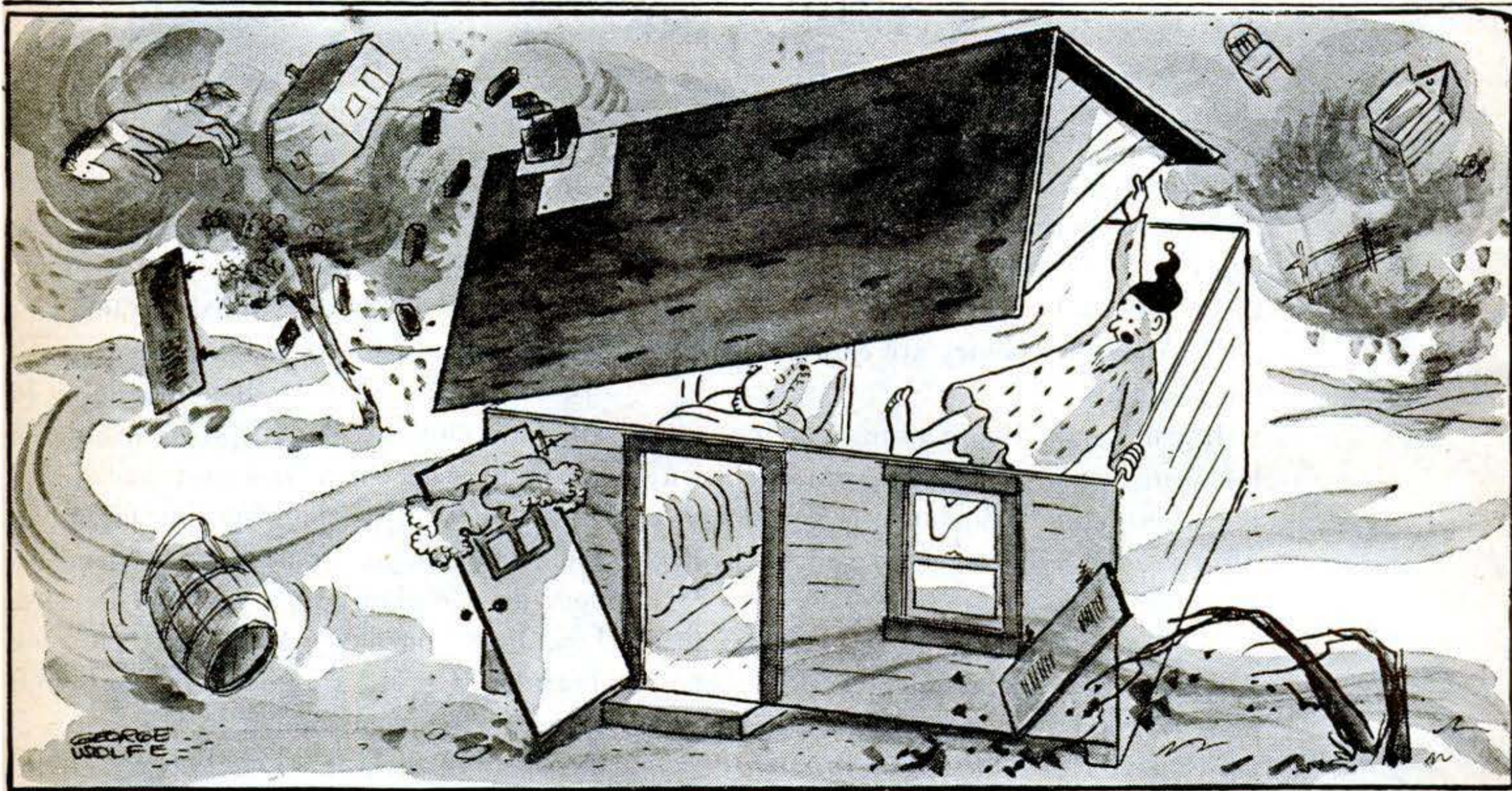
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Jet Turbines

(Continued from page 78)

namically and better suited for installation in high-speed aircraft.

The Germans concentrated almost wholly on development of axial-flow engines—and came dangerously close to winning the behind-the-scenes battle of the aeronautical engineers. Ernst Heinkel, one of their most versatile engineers, and his firm became interested in jet propulsion in the late 1920's; research work began at the Bavarian Motor Works near Munich in 1934, and at the huge Junkers works at Dessau in 1937. Test flights were made with jet planes in Germany before Whittle's motor was tried in the British Gloster, although his original unit was run earlier on test stands.

German plans called for the development of huge aircraft of the flying-wing type, powered by turbo-jets. Supersonic aircraft with ram jets, and accurately controlled, long-range, guided missiles, were also projected. Basic research for these machines was largely completed by the summer of 1945, when Allied technical experts poured into Germany. Their findings give point to the Nazis' boast in 1940 that their military-aircraft program was well in hand for six or even eight years to come. They had the men, the money, and the research facilities, and came disturbingly close to success.

British engineers at the Royal Aircraft Establishment had also begun work on axial compressors and gas turbines in the 1930's, but it was Whittle's centrifugal-flow type that really sparked the production program in England. While the test flights were being made in 1941, a more advanced Whittle unit, the W/1A, was being run on test stands—and this engine became the basis of the first American operational units.

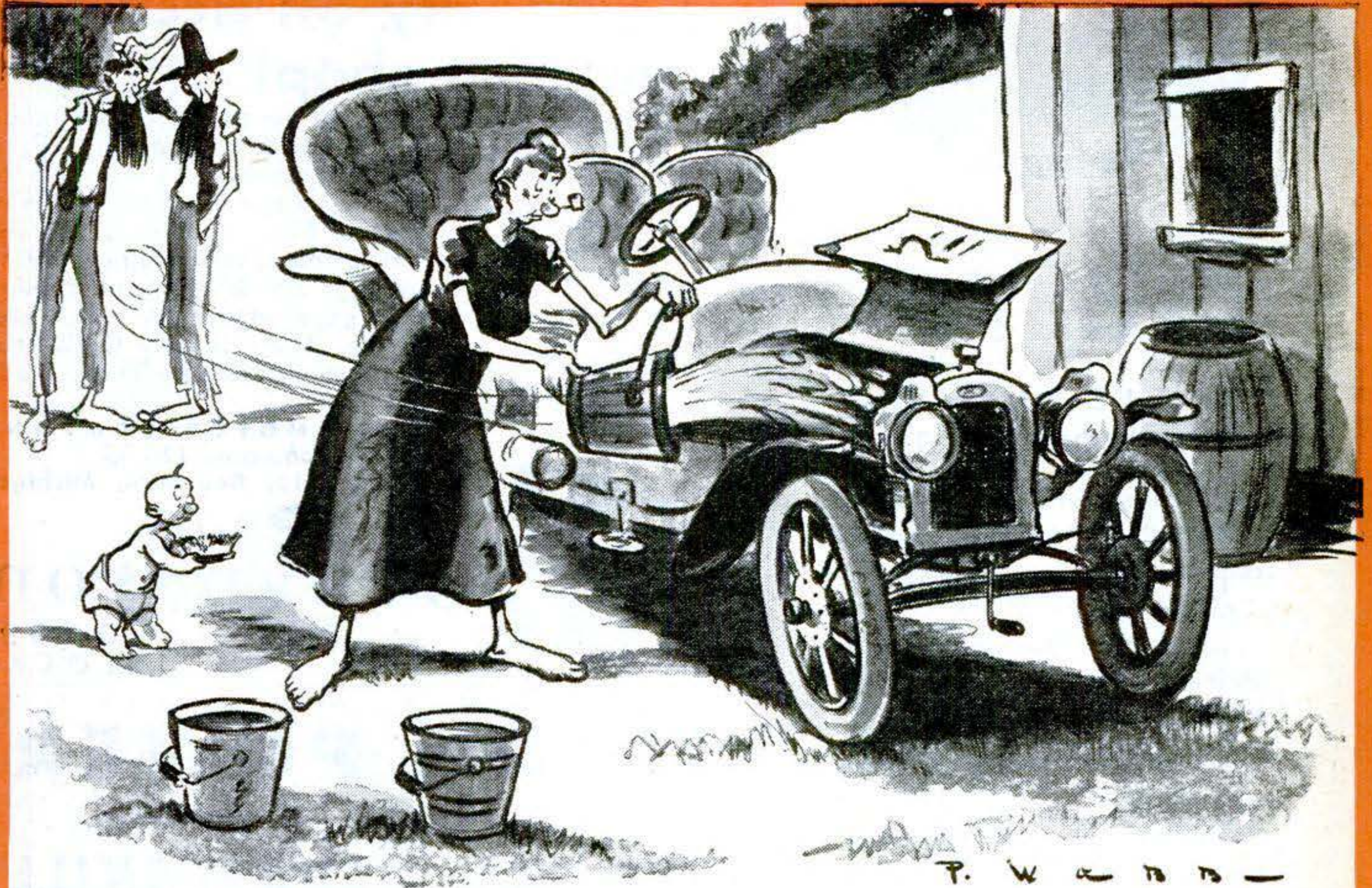
A Whittle engine, built by Rolls-Royce and called the Welland, powered the British Gloster Meteor, the twin-jet fighter that was used successfully to combat the V-1 flying bombs in the summer of 1944. Meanwhile, Major F. B. Halford, chief designer of De Havilland's aero-motor division, designed a more powerful turbo-jet which became the power plant of the De Havilland Vampire, Britain's speediest jet fighter, with a top speed of 540 miles per hour.

Colonel Donald J. Keirn of Wright Field went to England in the summer of 1941 and returned with one of the first Whittle W/1A units. General Electric then produced the 1-A turbo-jet and greatly improved it as the I-16. Its top speed of 414 miles per hour in the Bell jet fighter was less than that of

(Continued on page 238)

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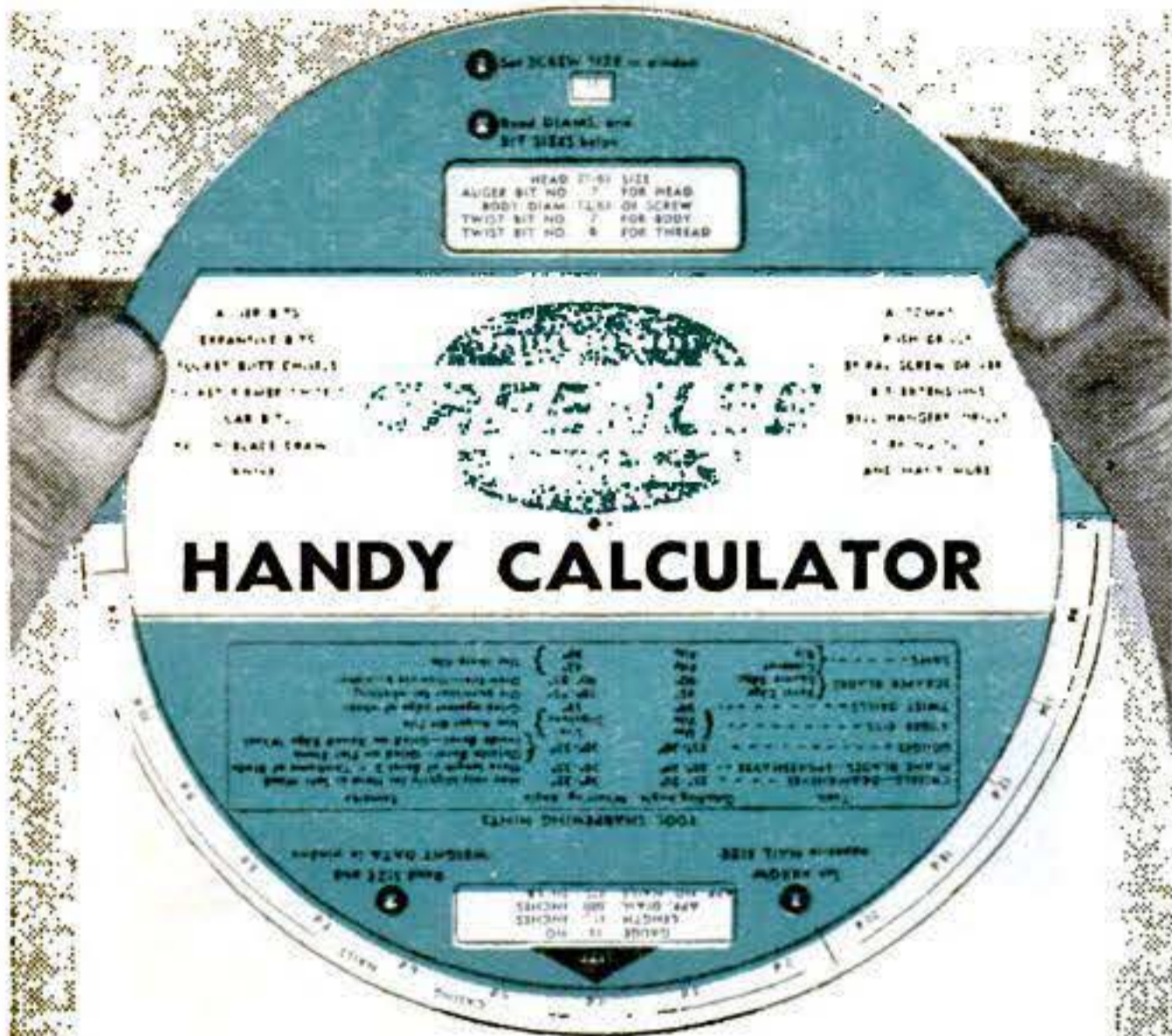
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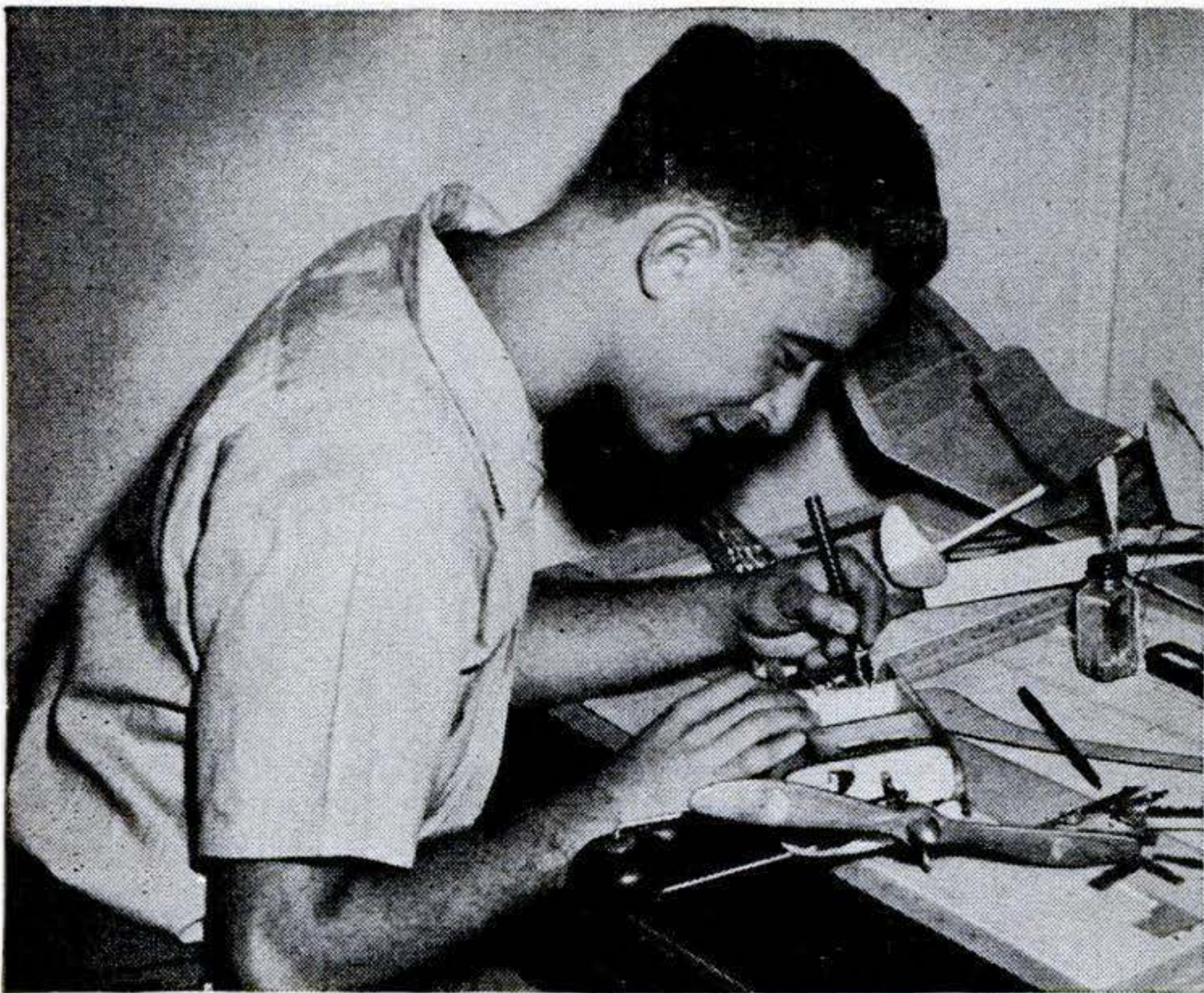
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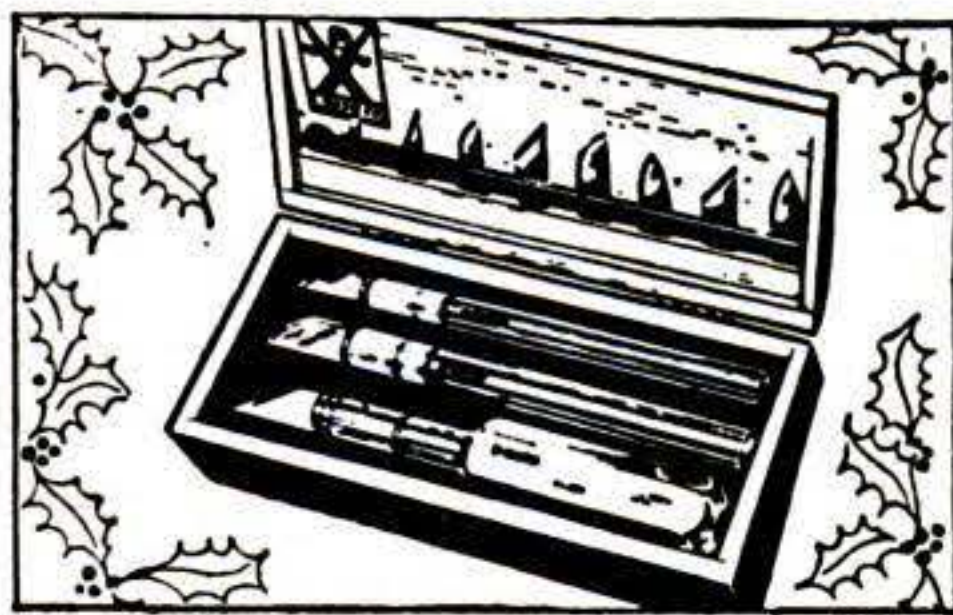
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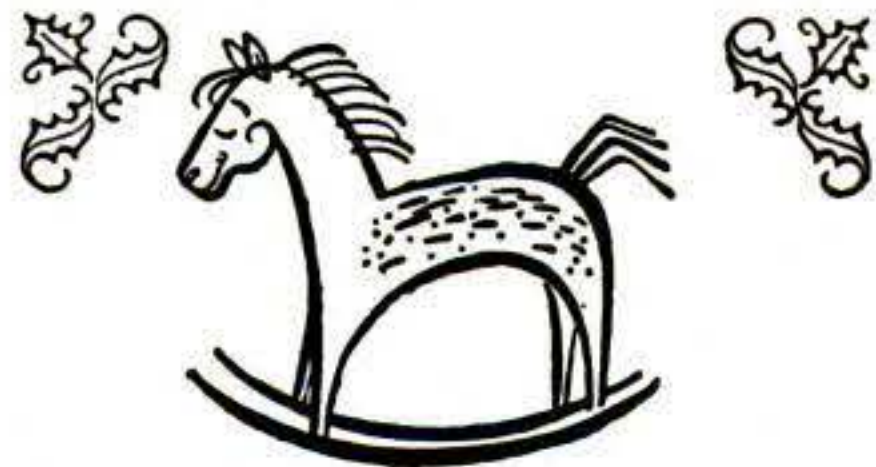
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Jet Turbines

(Continued from page 234)

the P-47 and P-51 with boosted reciprocating engines. It was essential that the Allies have a fighter with a jet speed 100 miles per hour higher than that. So Wright Field asked General Electric to produce a larger and more powerful turbo-jet based on the Whittle design. At the same time Lockheed was asked to design a suitable airframe to take a more powerful unit.

As a result of this high-pressure development, the XP-80A with GE I-40 turbo-jet was test-flown in June 1944. This was the Shooting Star, still the fastest plane in the air.

The I-40 turbo-jet is the most powerful aircraft engine in production. With its magnesium compressor housing, it weighs 1,850 pounds, compared with 828 pounds for the I-16, and has 14 radially arranged combustion chambers instead of 10. The I-40 embodies the "through-flow" rather than "reverse-flow" feature of the I-16, Welland, and early Whittle designs, and this permits a diameter only seven inches greater than that of the I-16. Sea-level static thrust is 2 1/2 times greater than that of the smaller engine.

In addition to these developments of centrifugal-compressor-type turbo-jets, a group of engineers has been working for several years on the design and development of axial-flow gas turbines for jet propulsion and for propeller drive. The first project to be completed was the unit for propeller drive, which underwent its first test-stand run in the spring of 1943. In June 1945, the first unit was installed in the experimental fighter mentioned at the beginning of this article. This is an all-gas-turbine job, with a propeller turbine in the nose (TG-100, newly designated XT-8) and a turbo-jet (I-40, or J-33) in the tail for fast take-off, accelerated climb, and combat booster power.

The General Electric axial-flow turbo-jet unit (TG-180) was developed in 1943, and was first run on the test stand in April 1944. It is the projected power plant of several experimental fighters and bombers that are well distributed throughout the American aircraft industry. Both this unit and the gas turbine for propeller drive should also be suitable for use in long-range transport aircraft.

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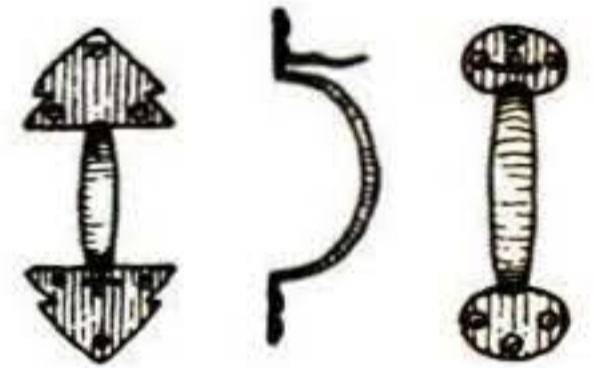
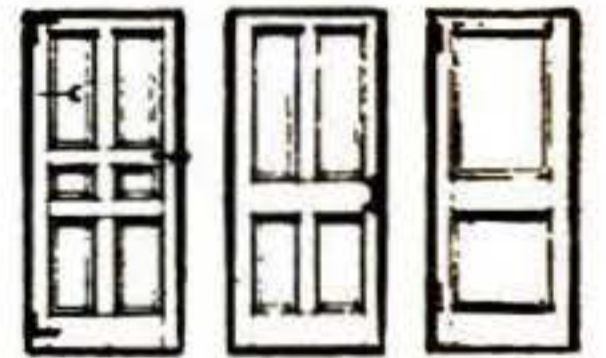
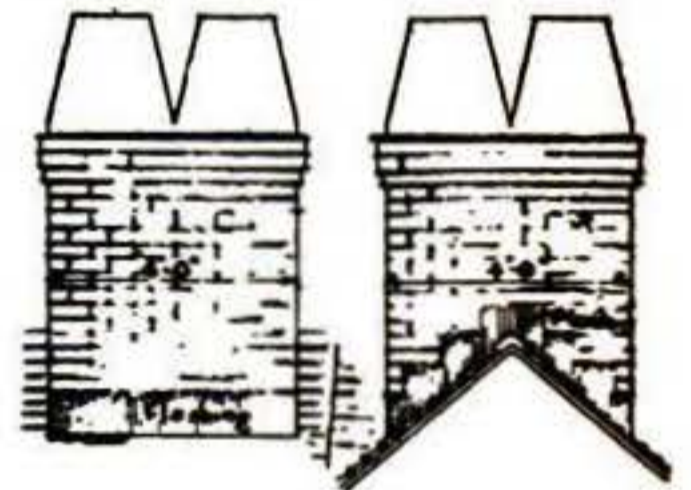
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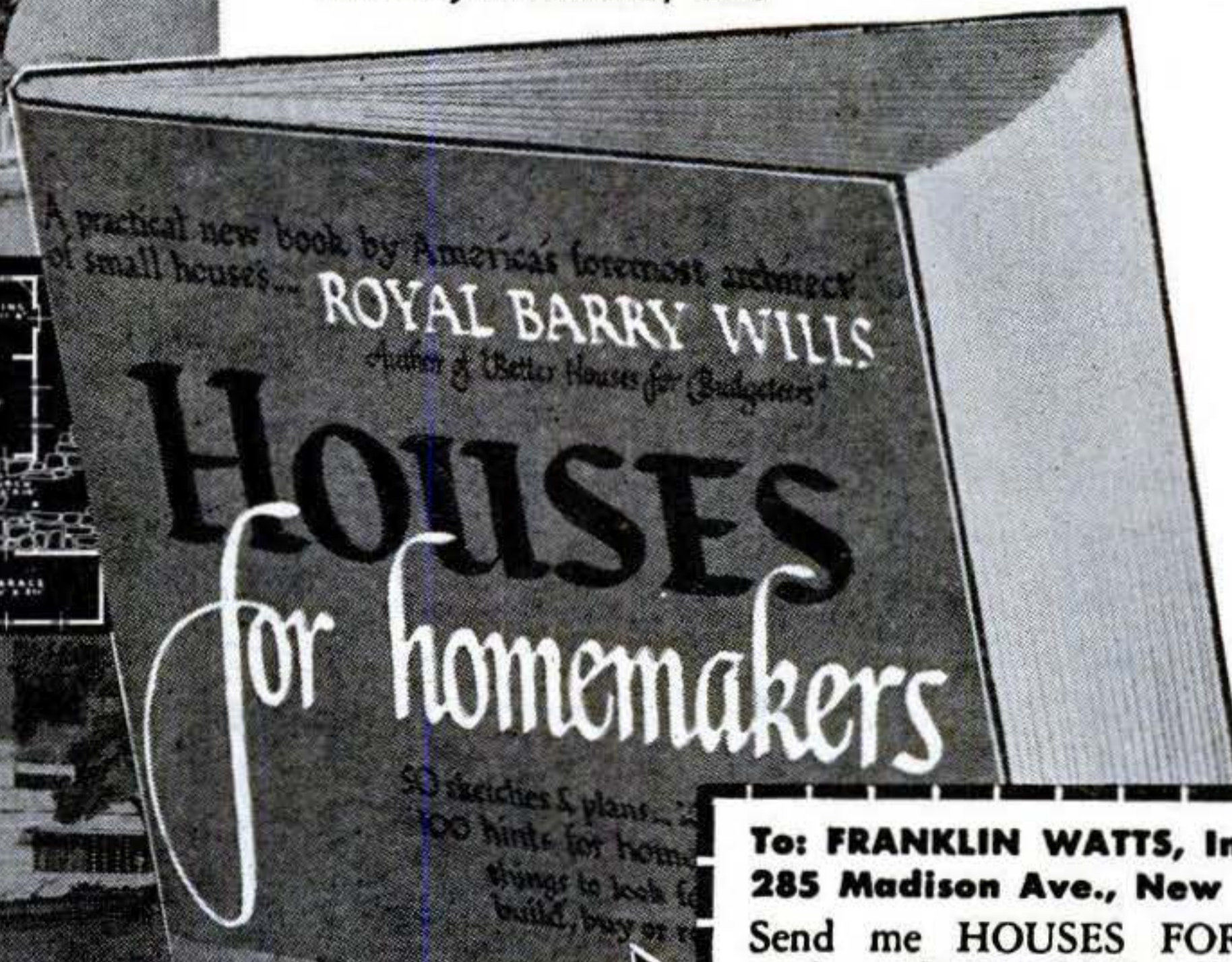
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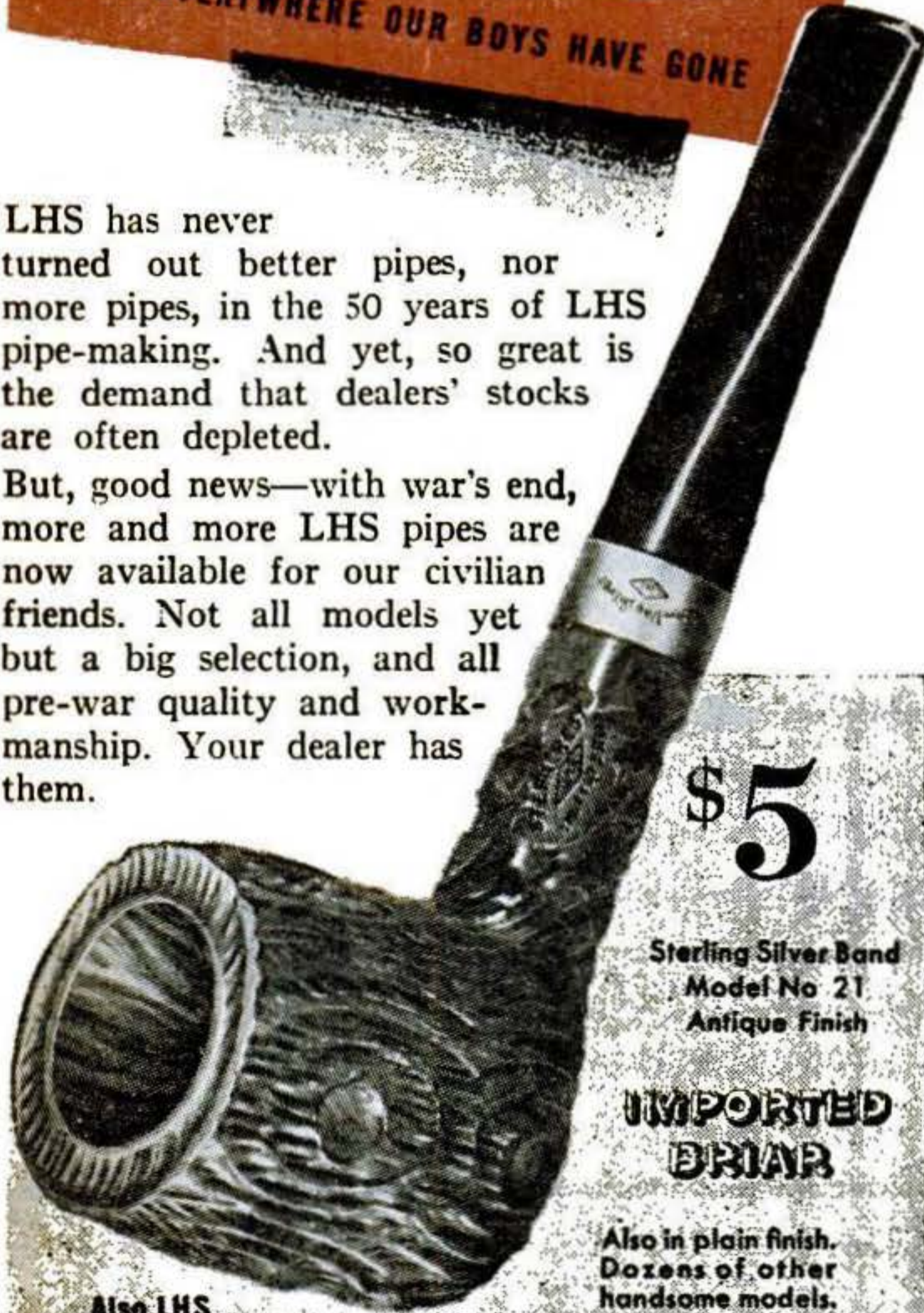


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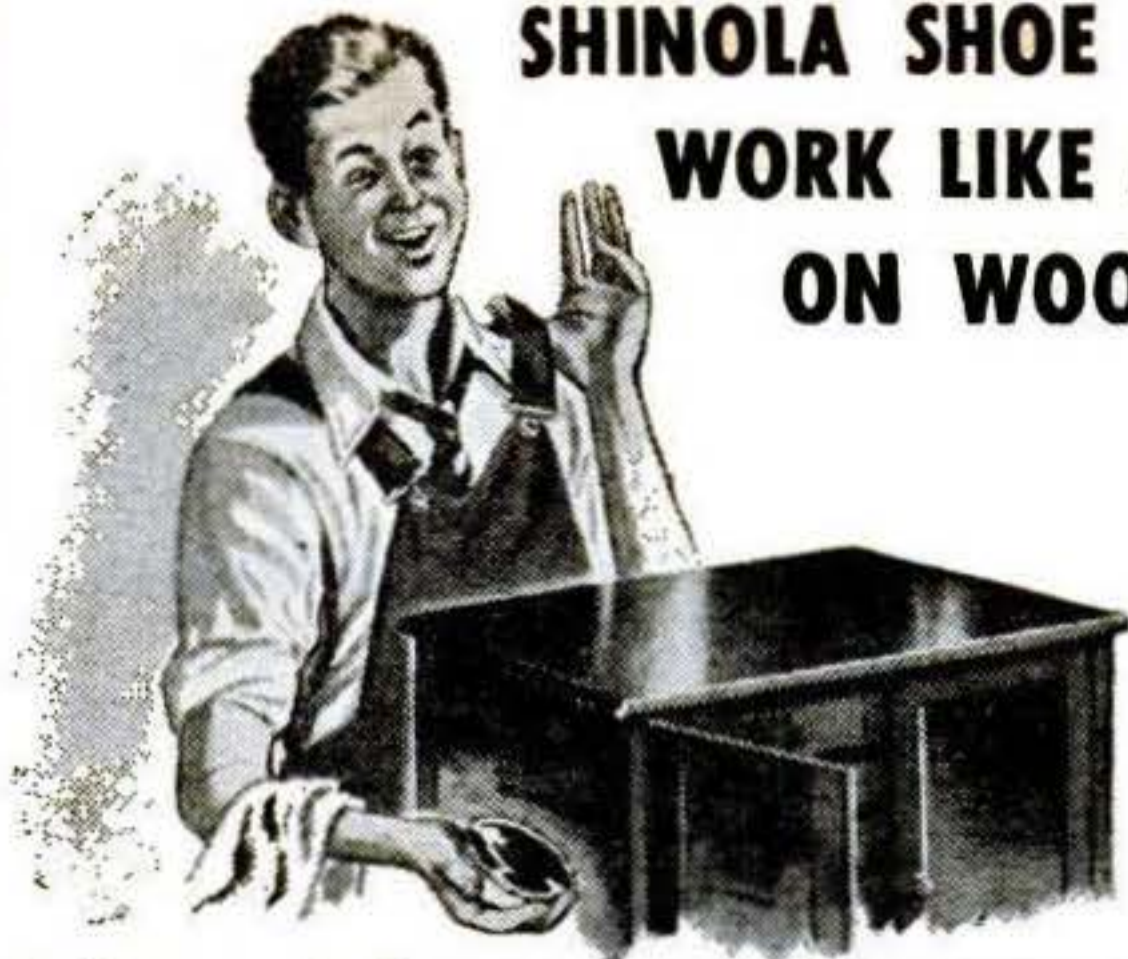


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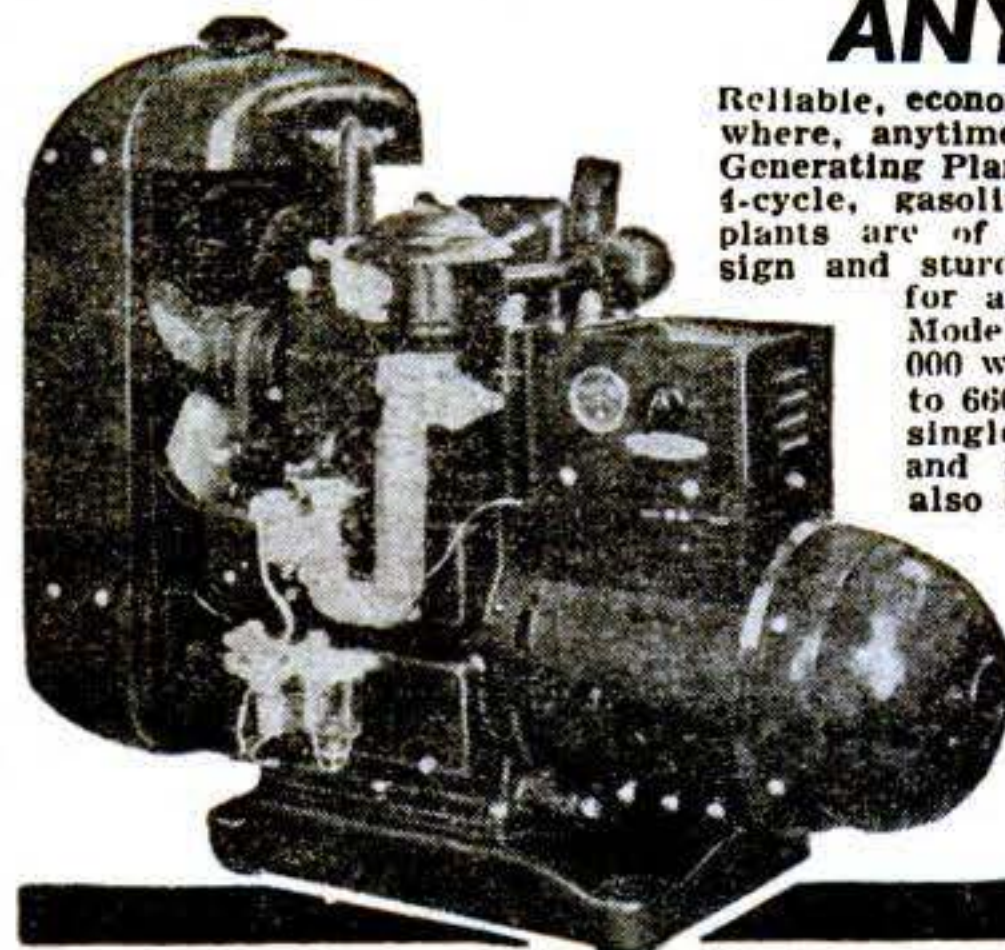
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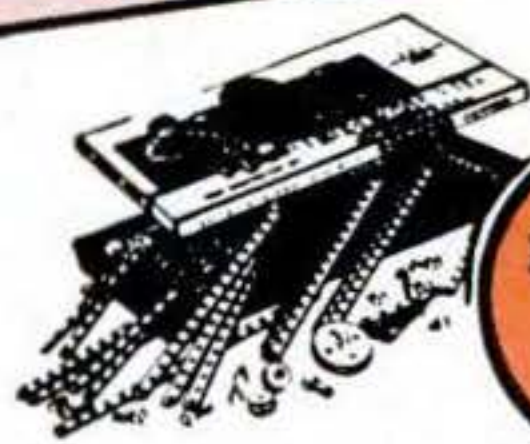
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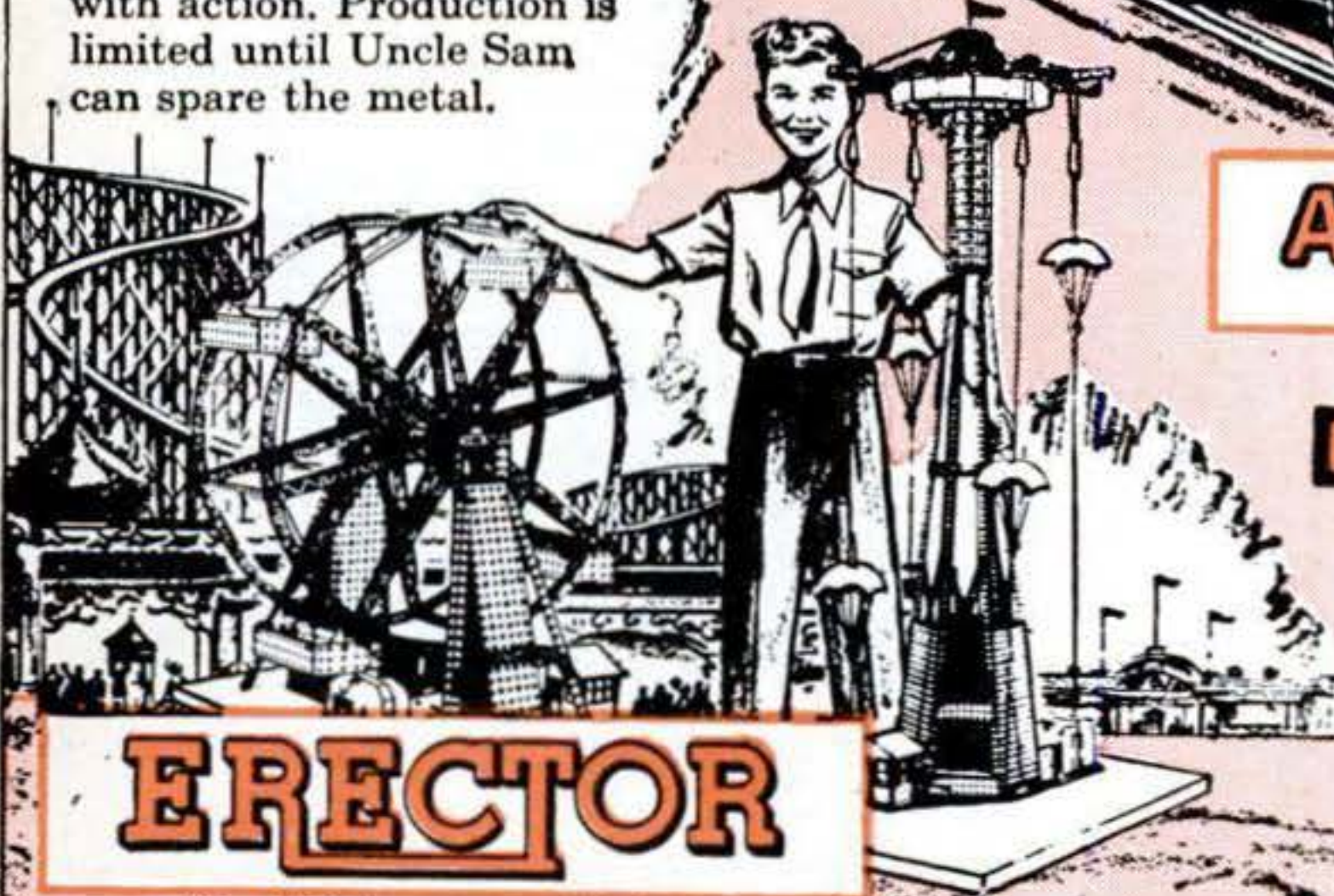
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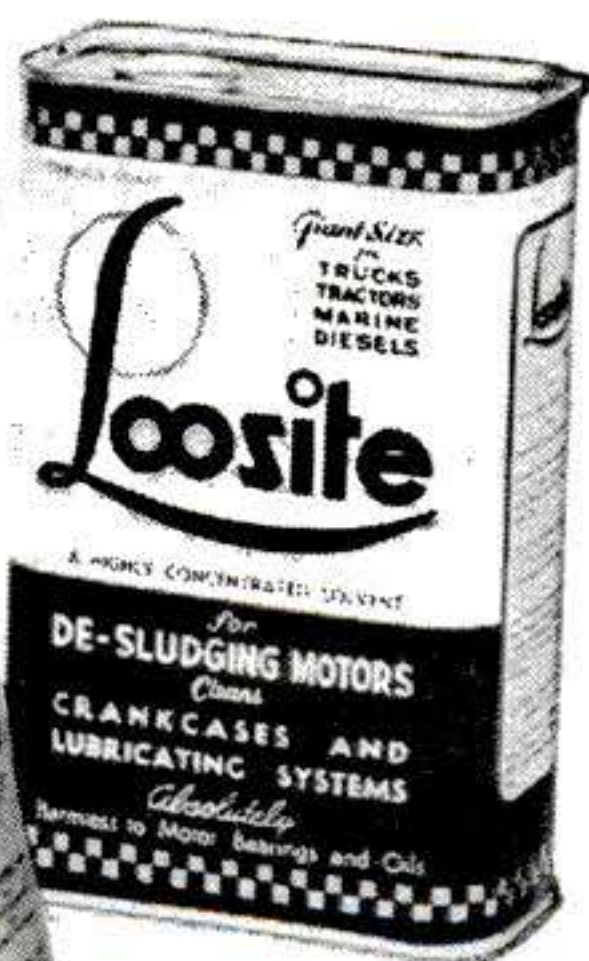
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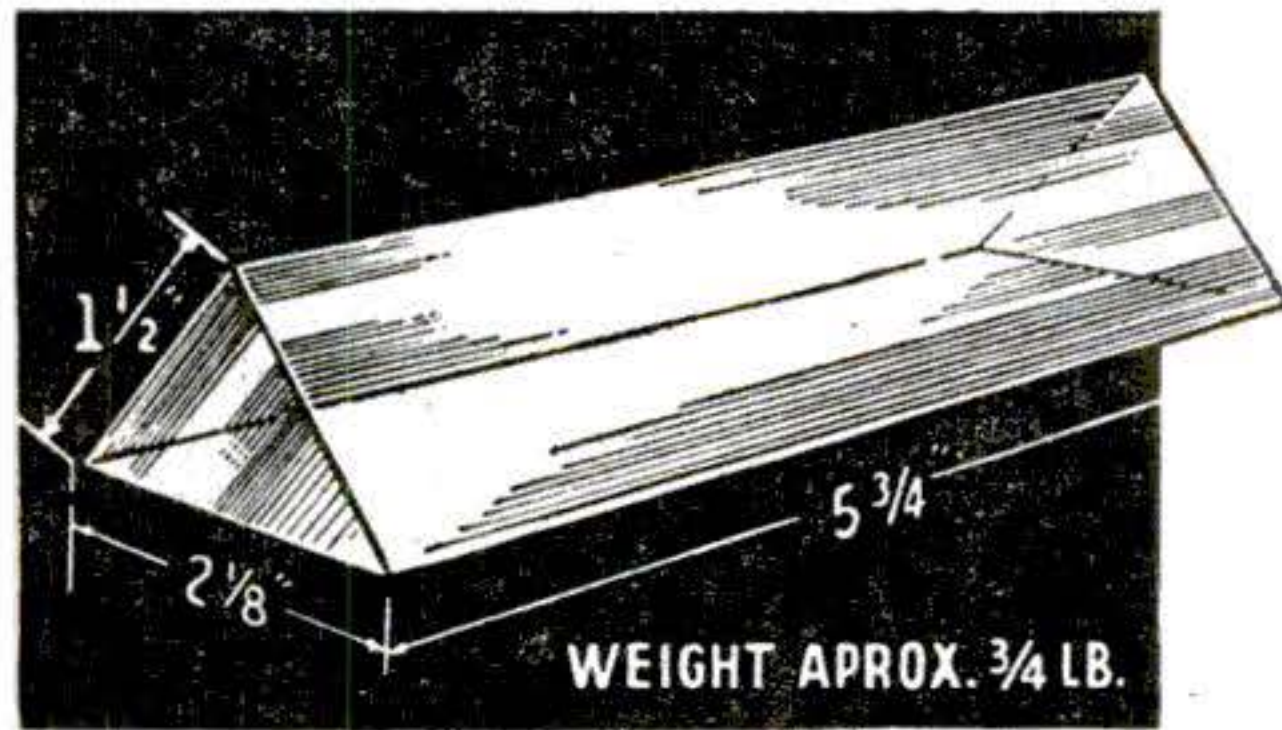
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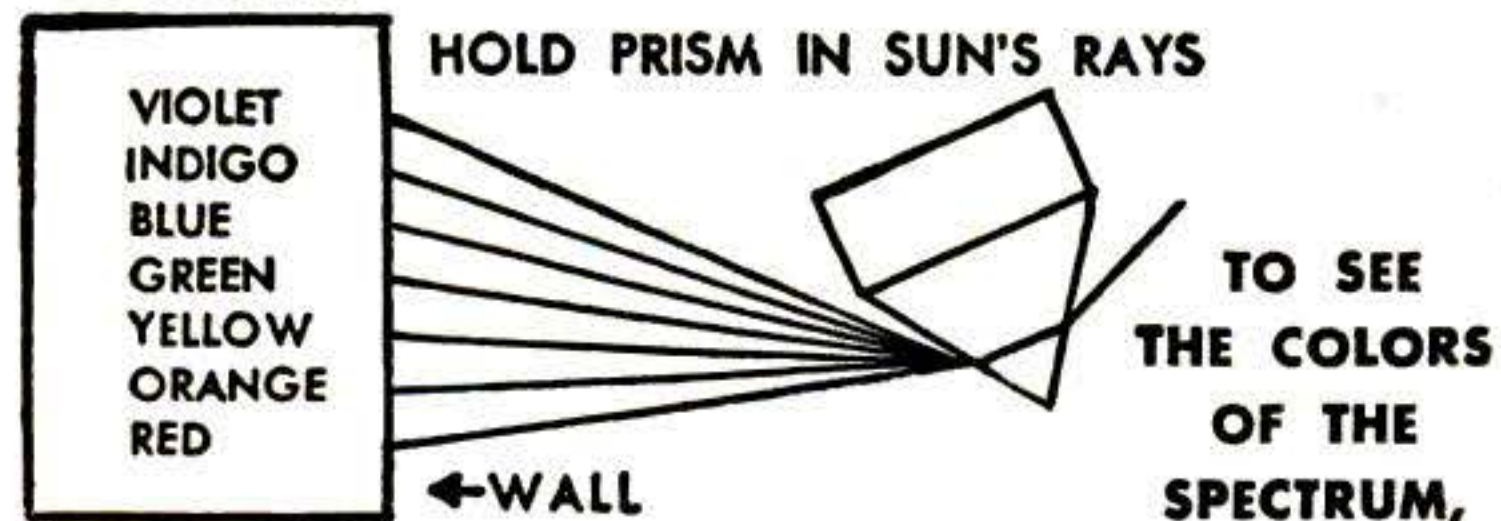
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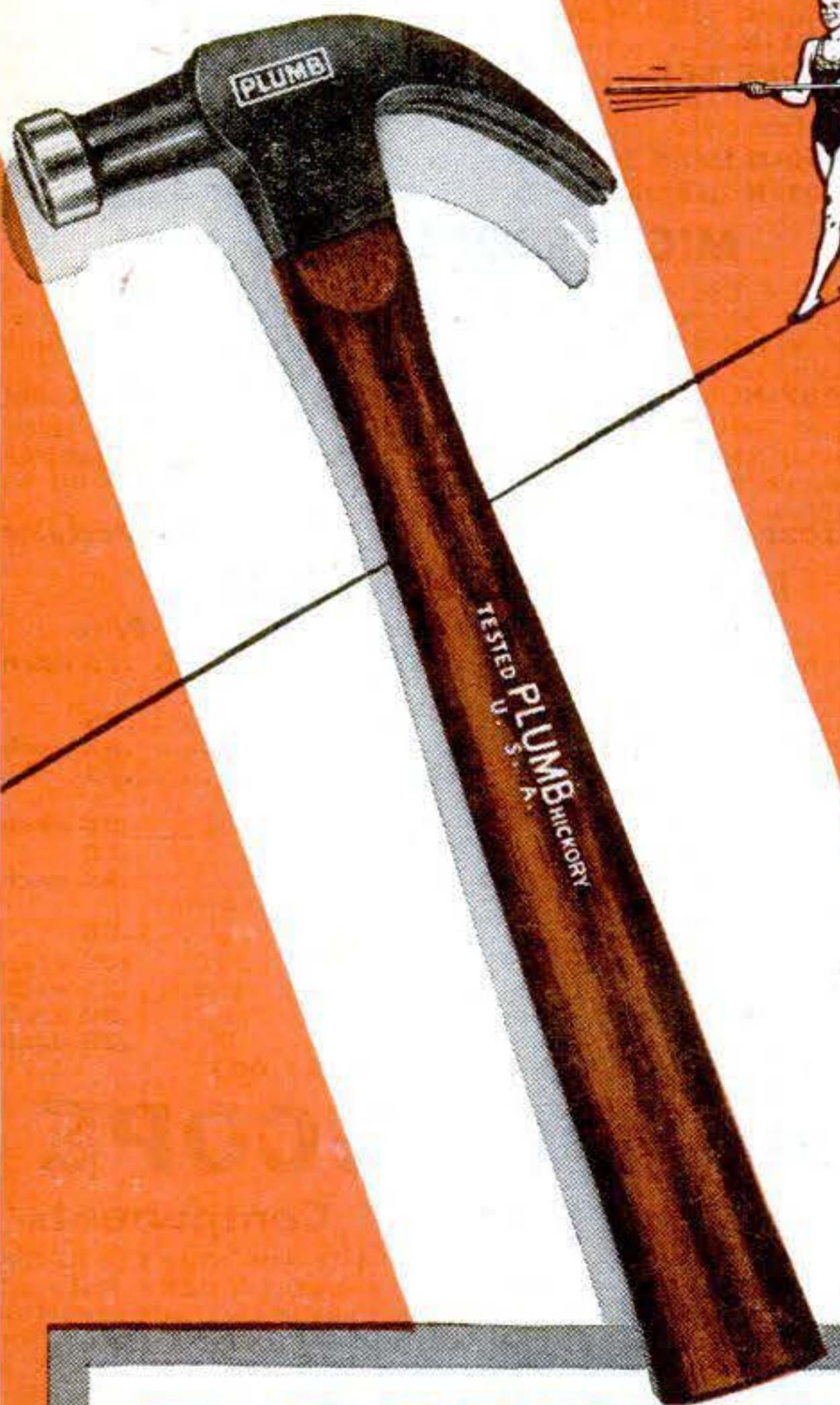
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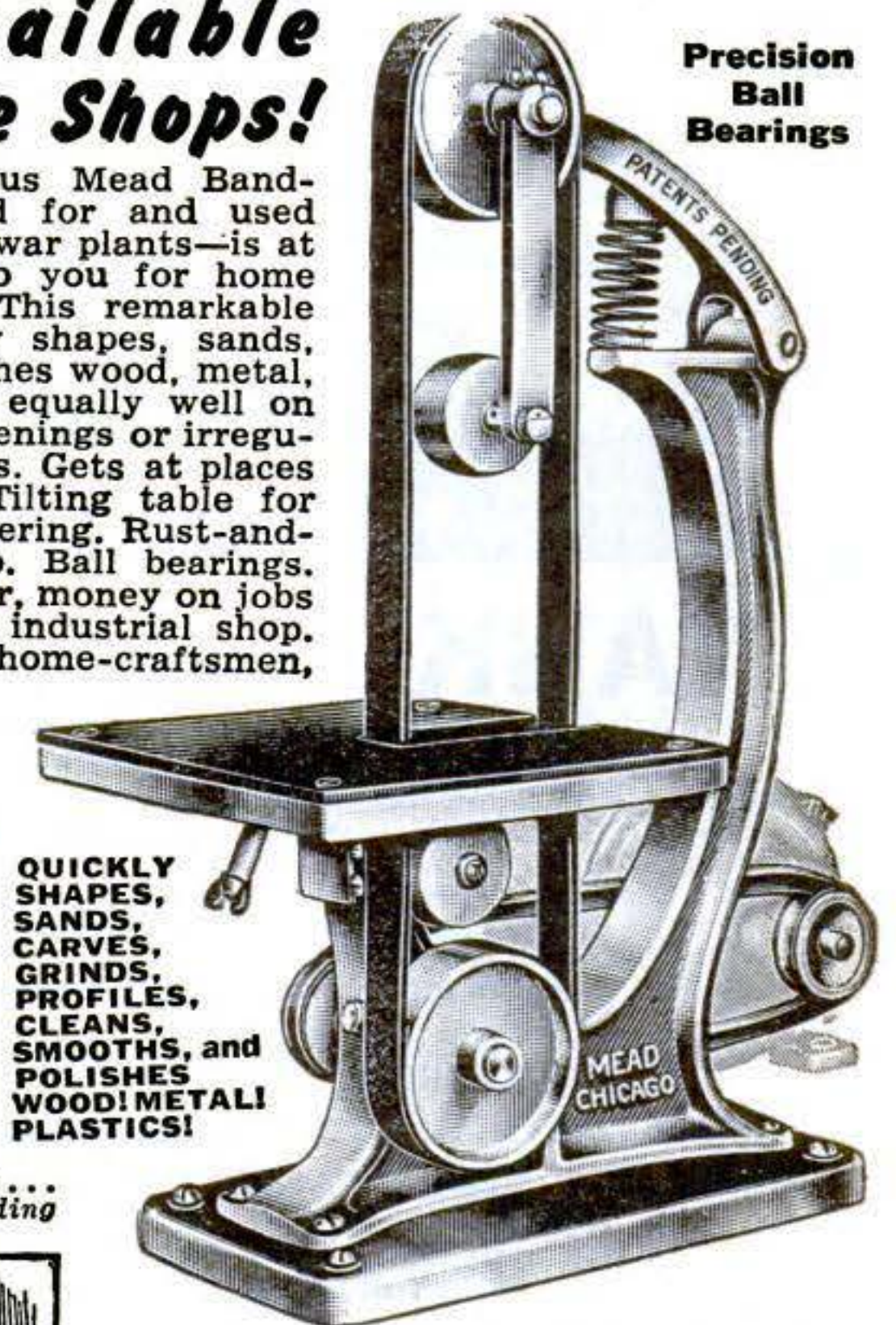


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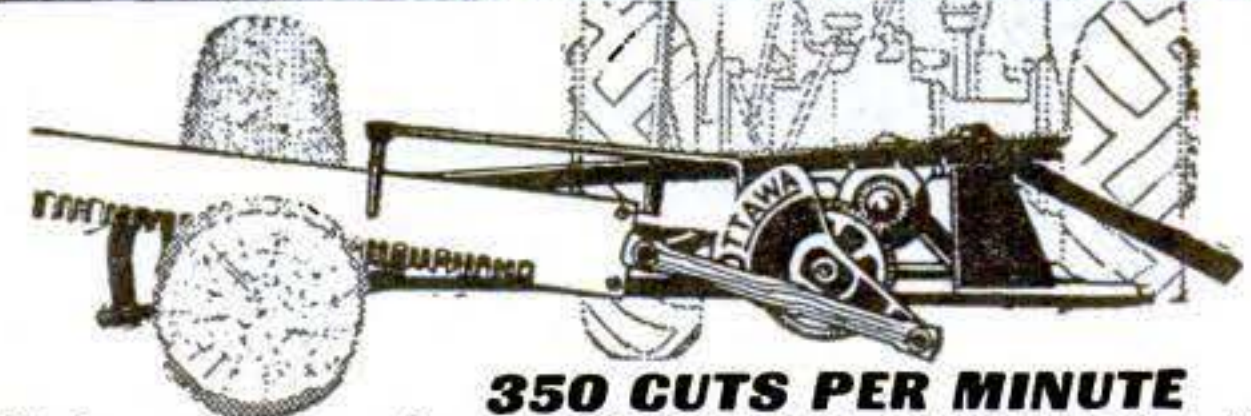


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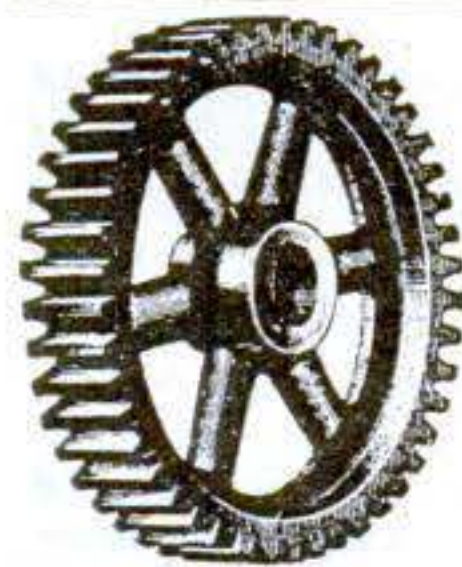
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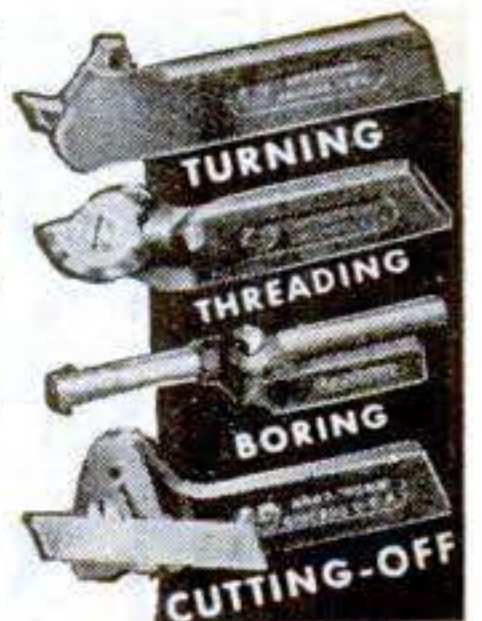
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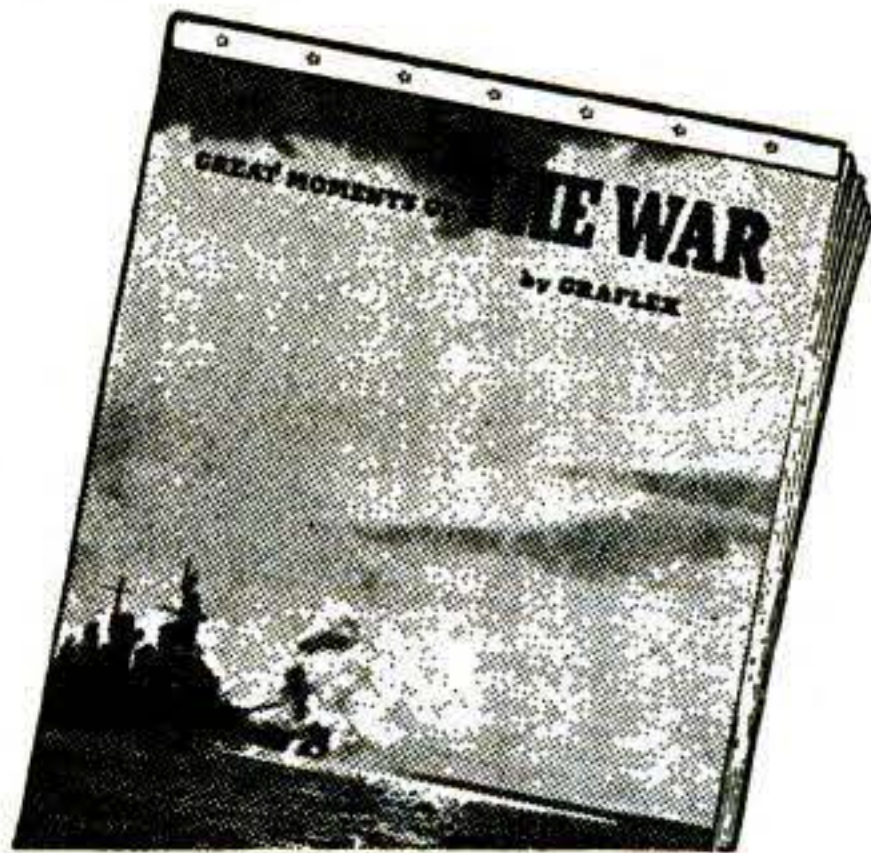
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**THE TRUTH
THE WHOLE TRUTH and
NOTHING BUT THE TRUTH**



*about the condition
of your oil*

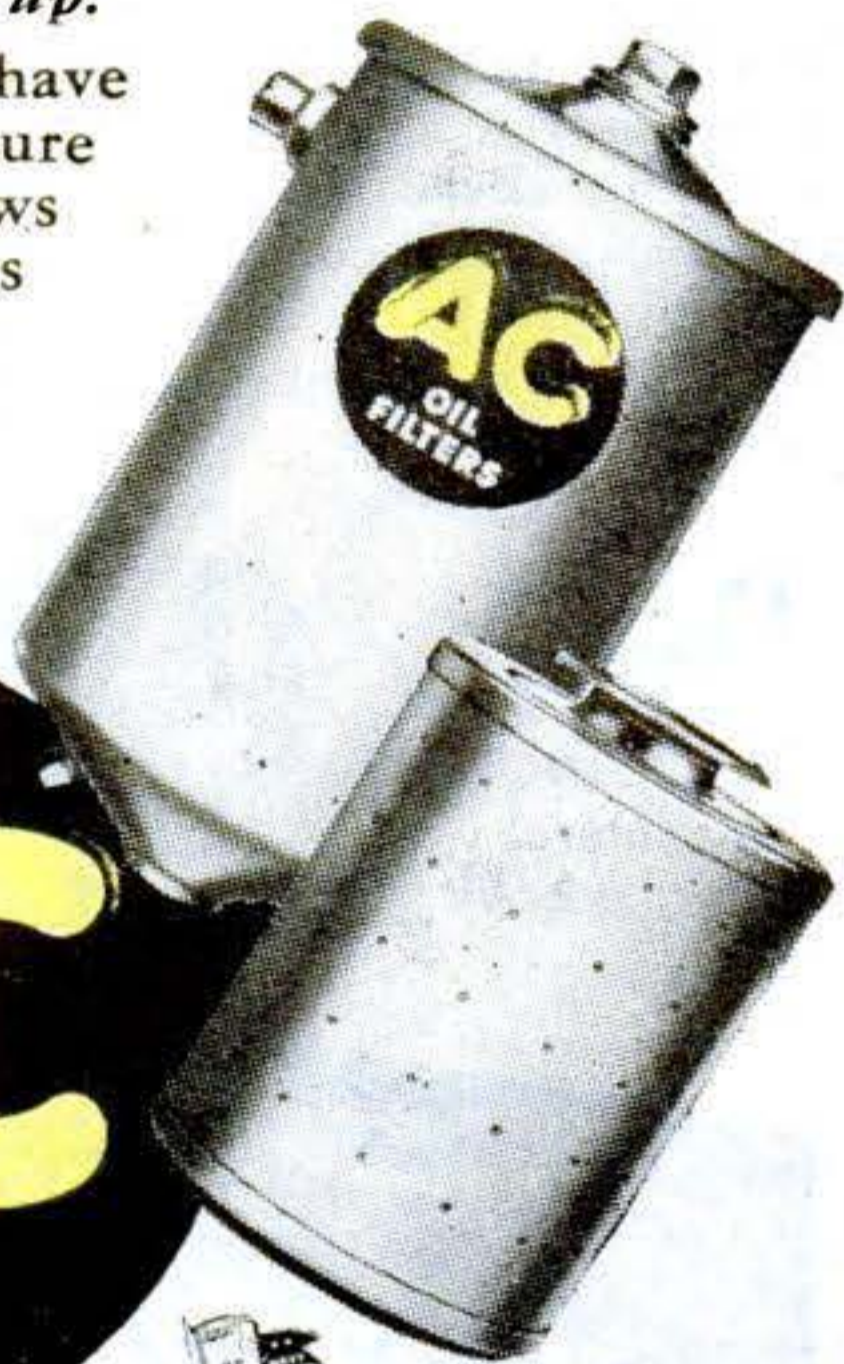
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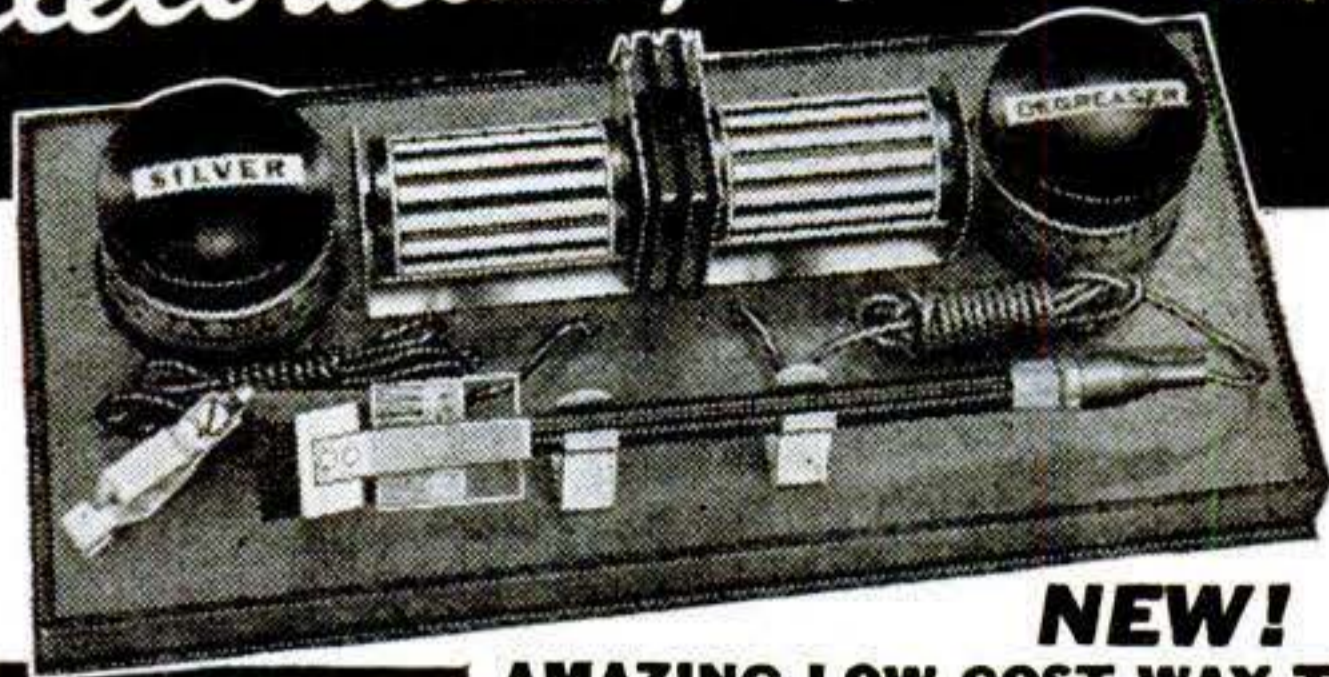


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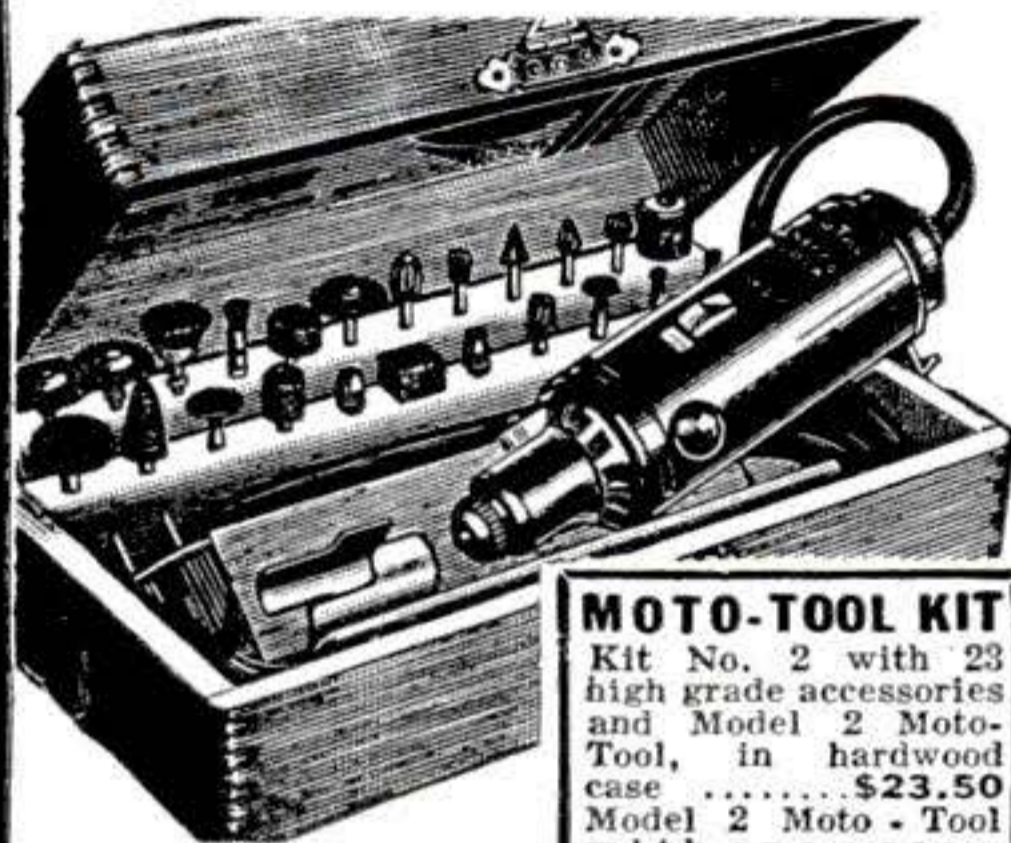


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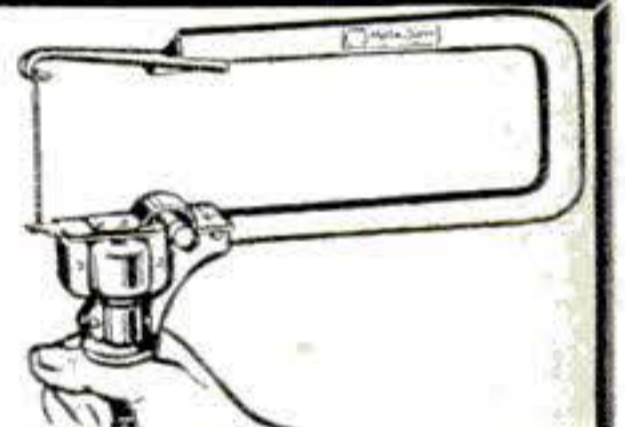
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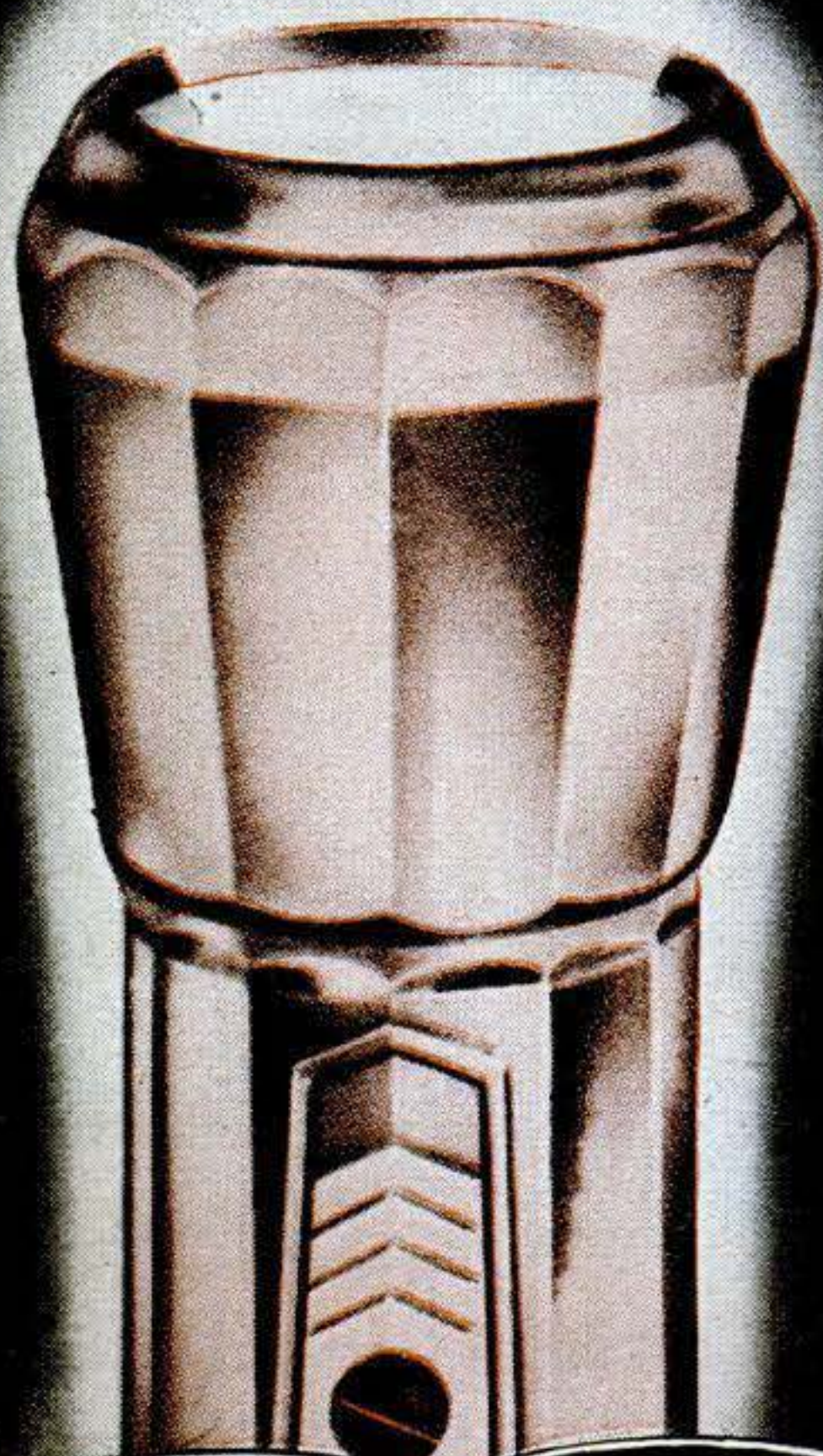
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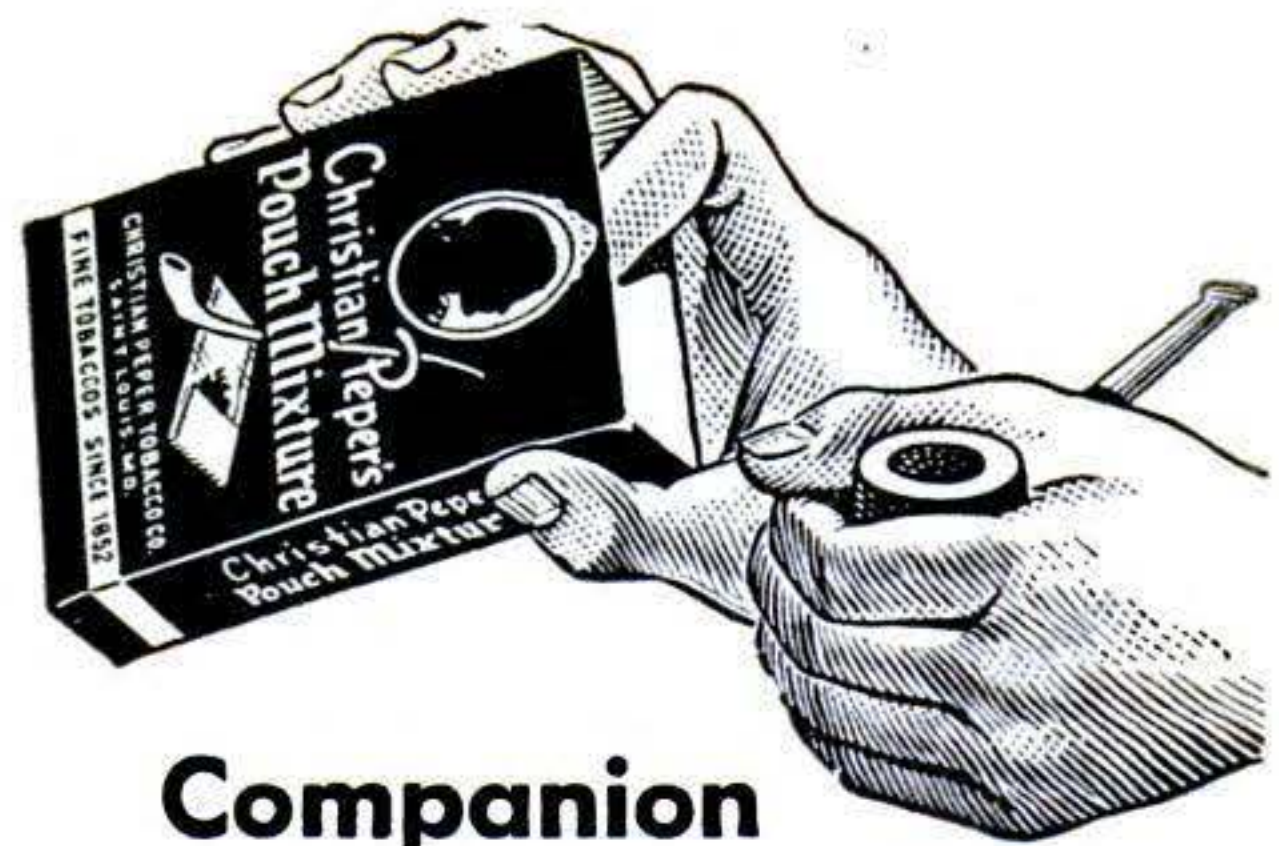


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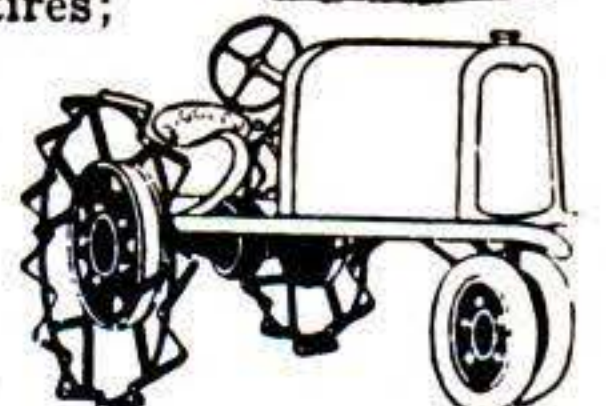
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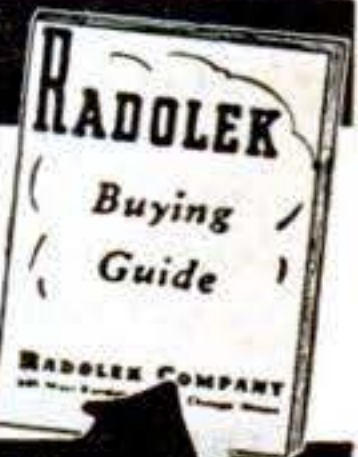
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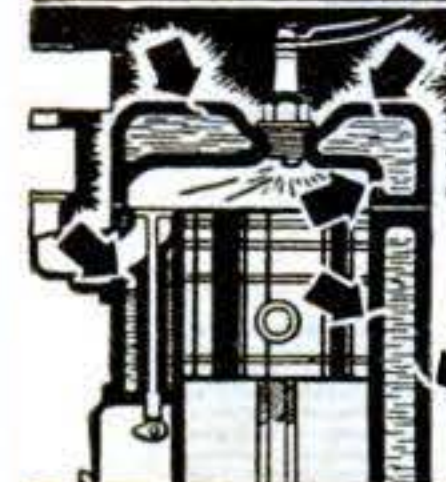
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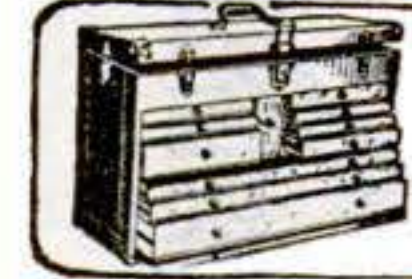
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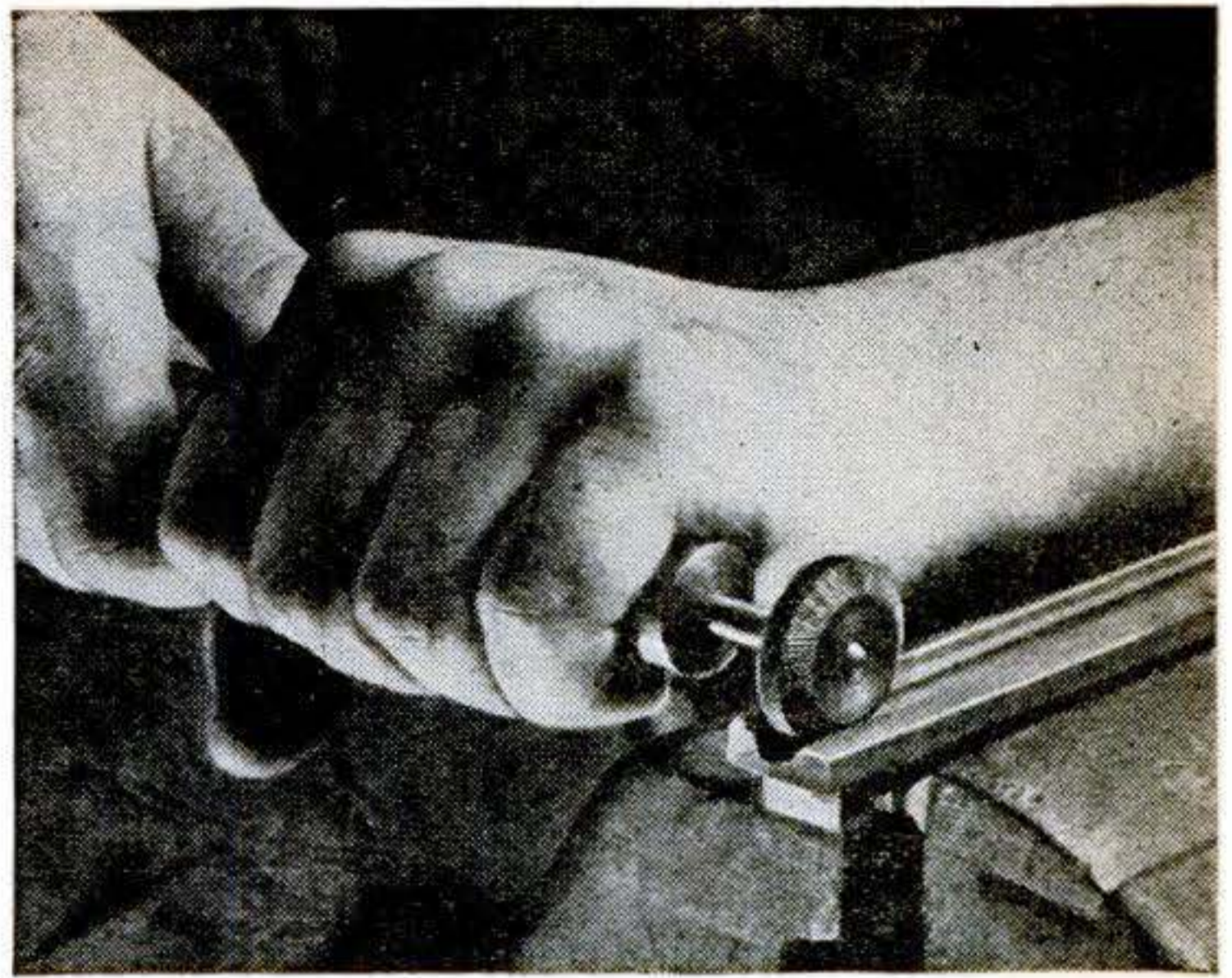
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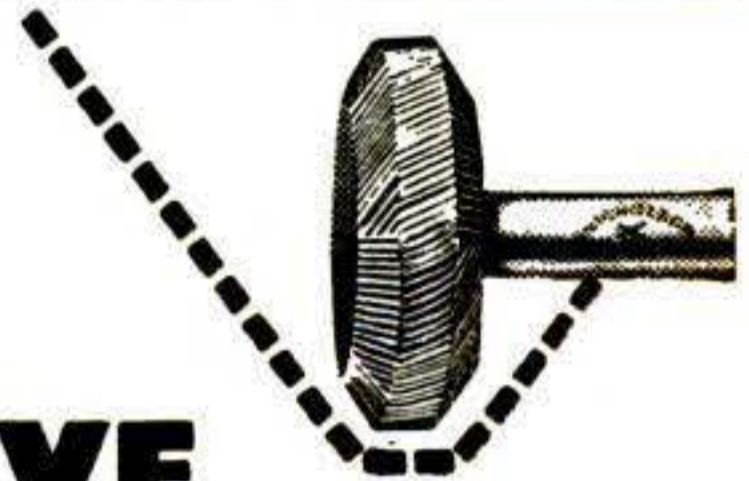
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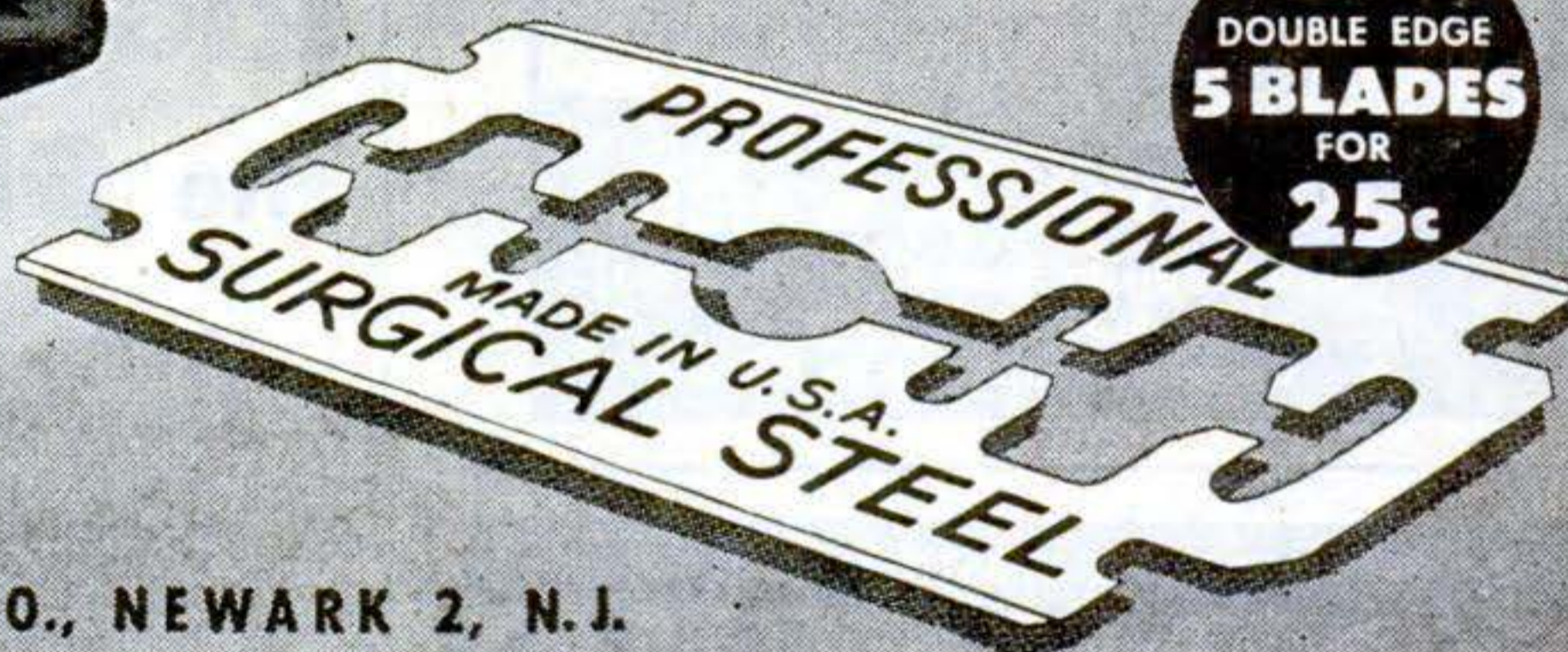


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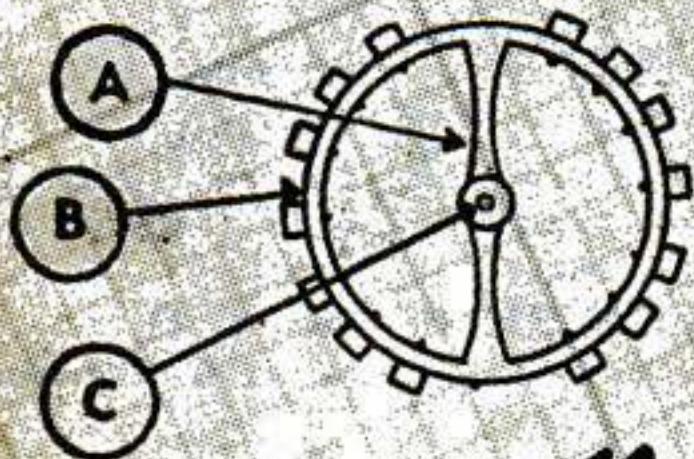
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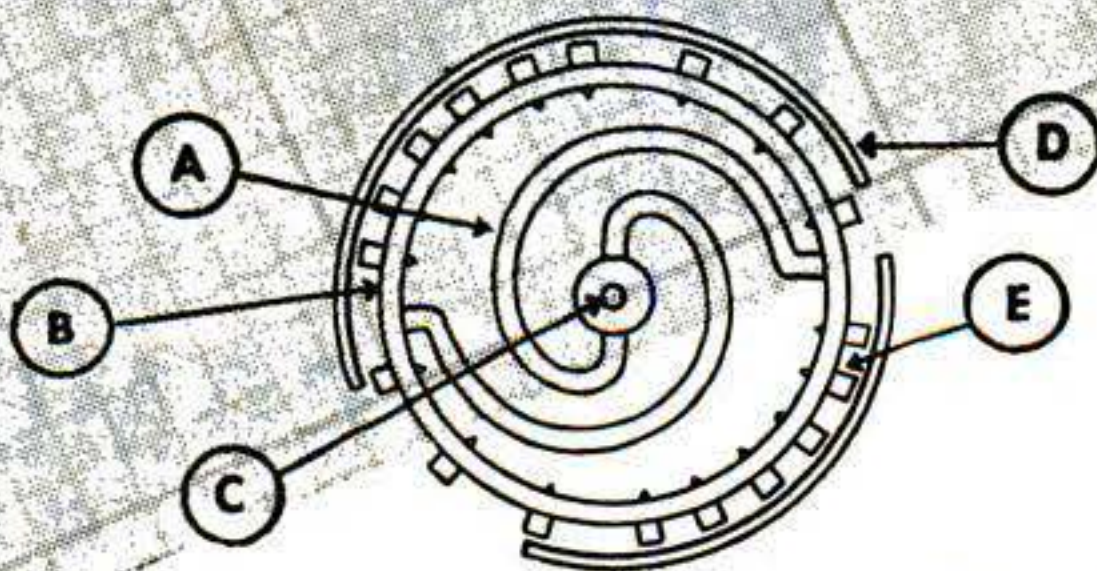
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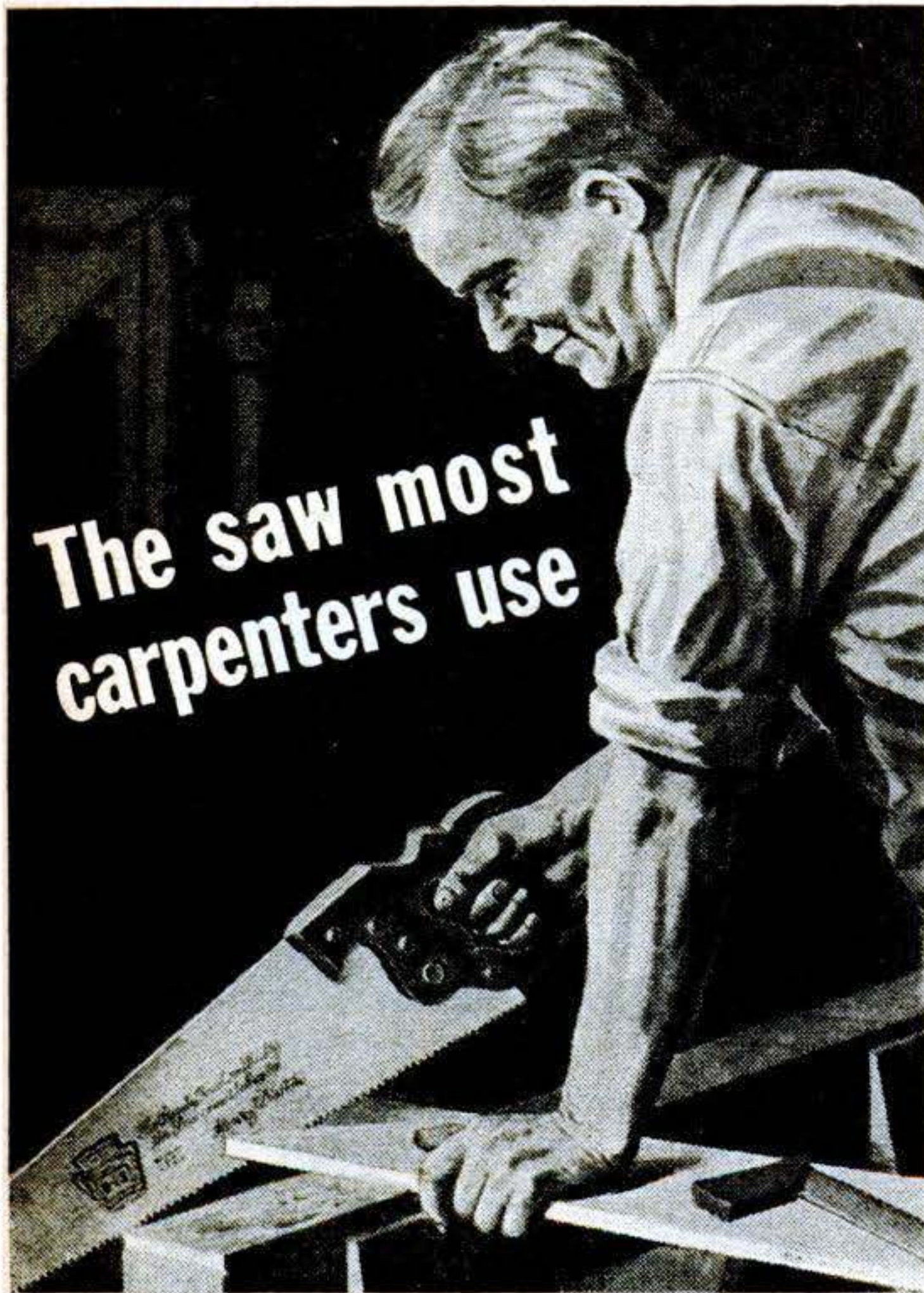
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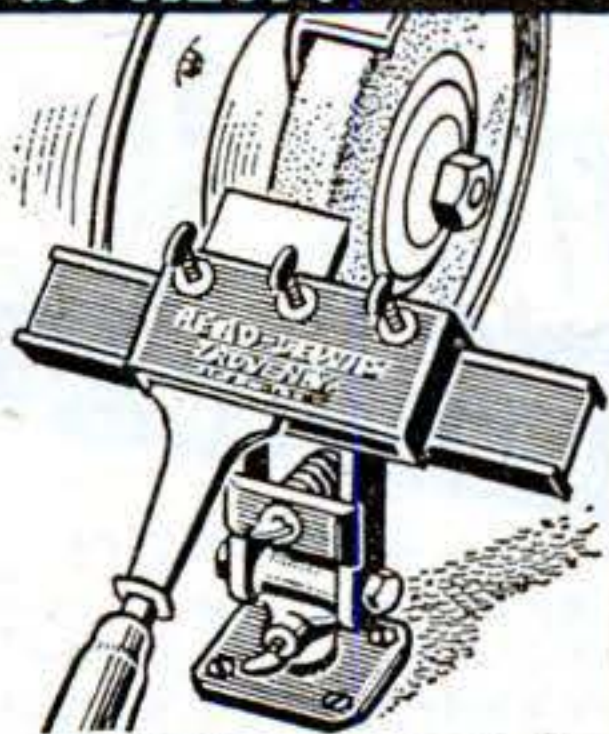
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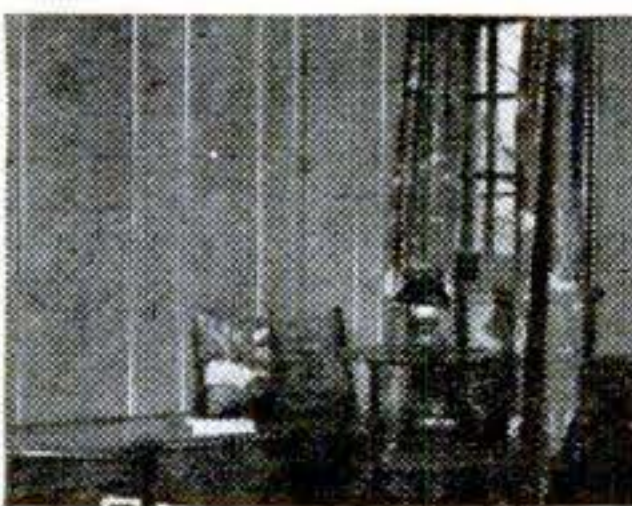
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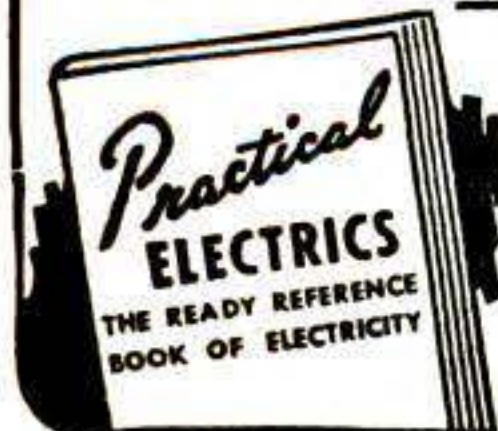
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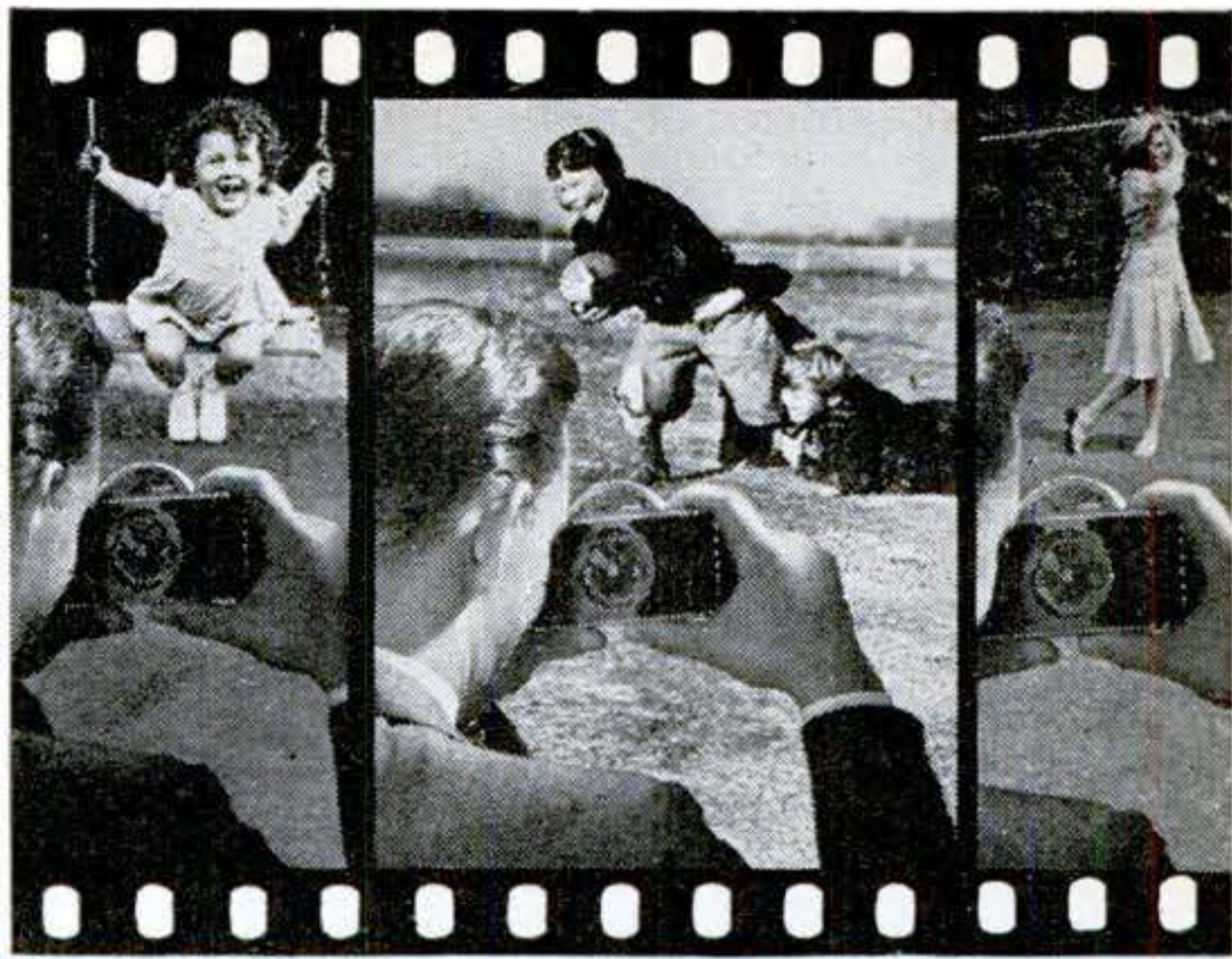


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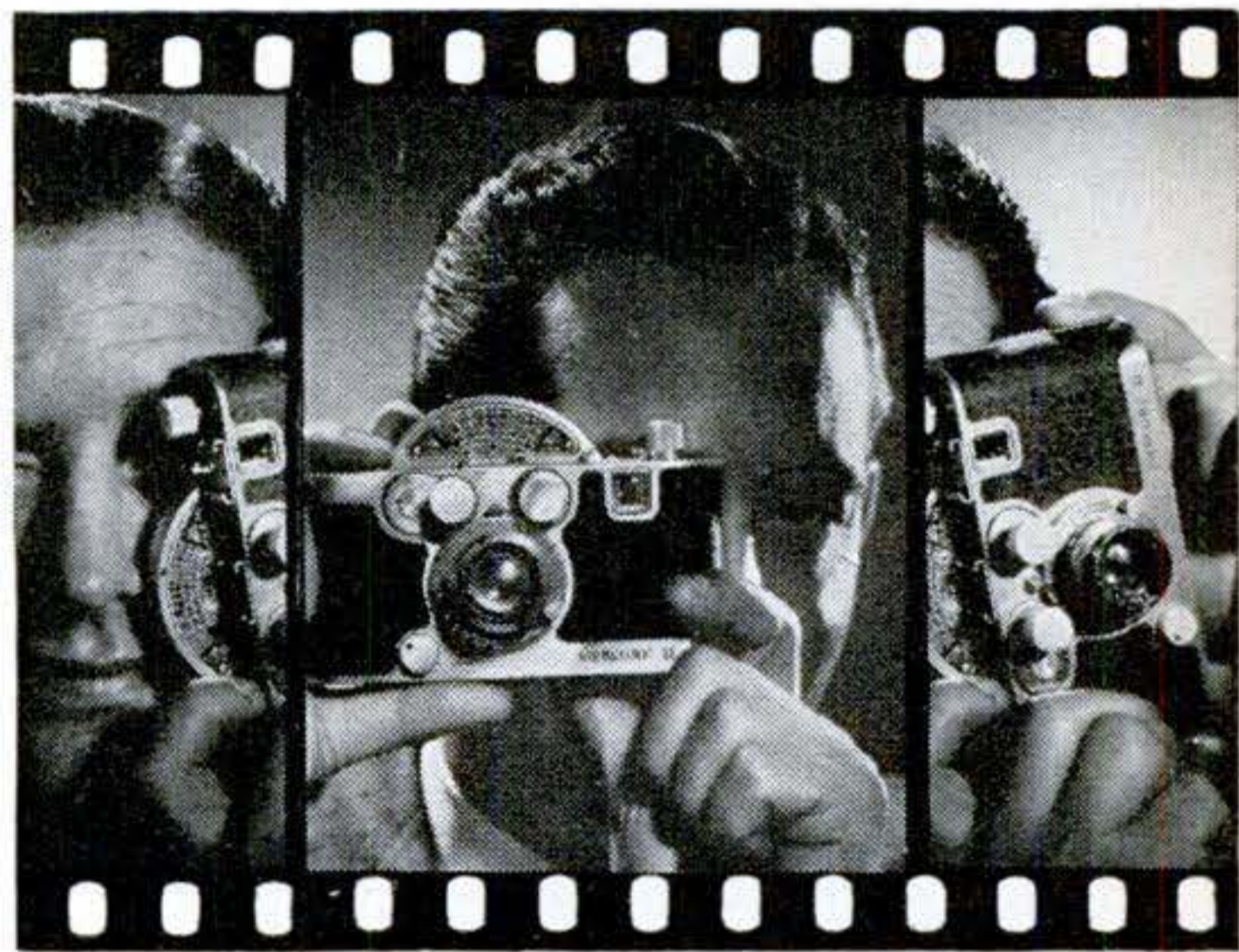
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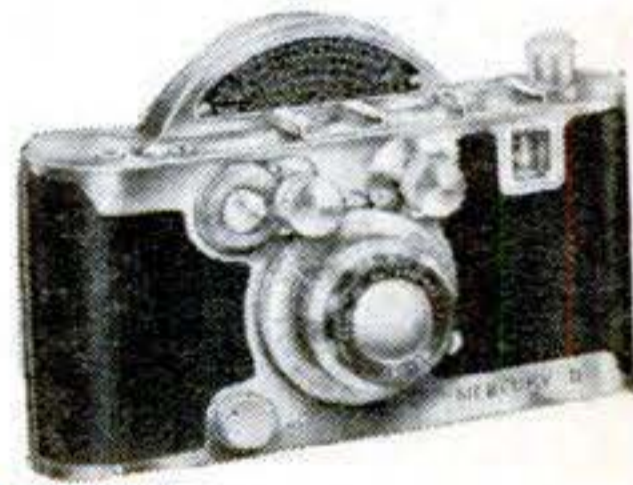


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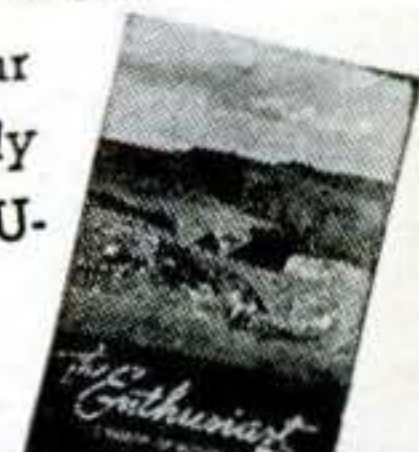


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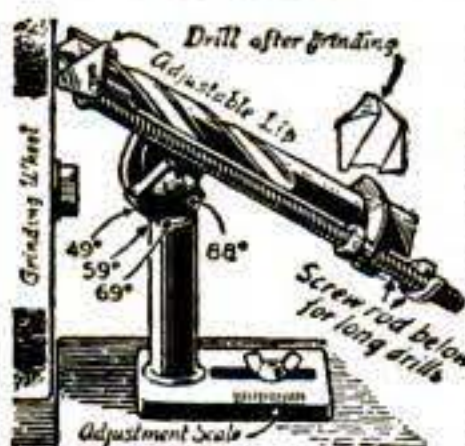
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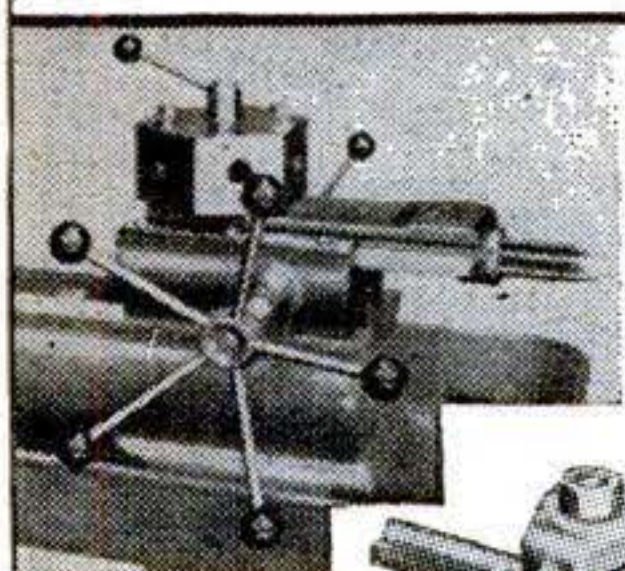
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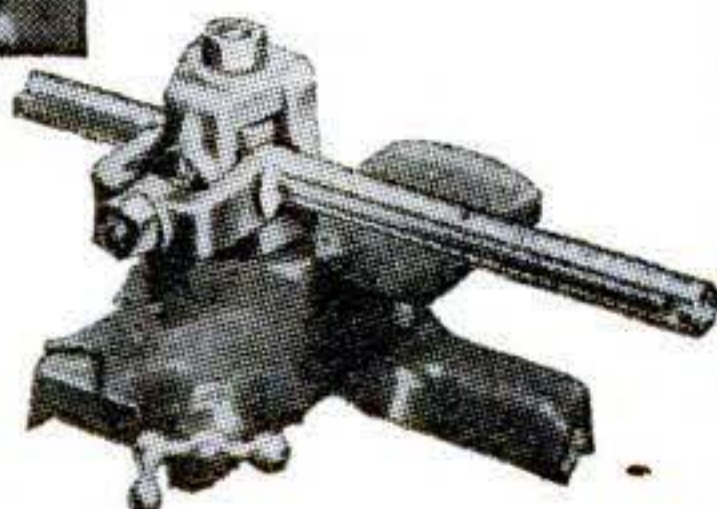
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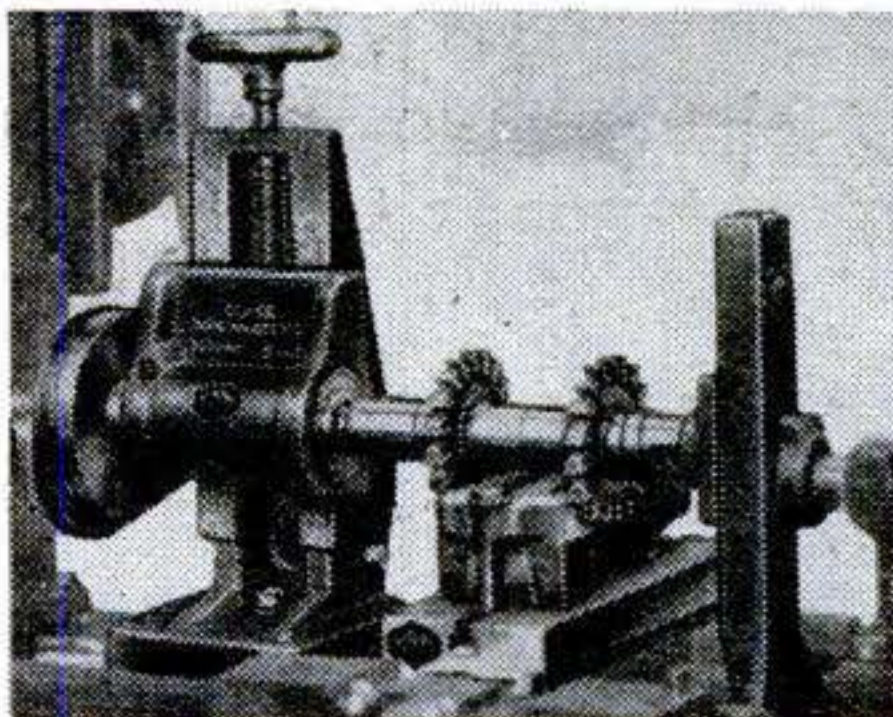
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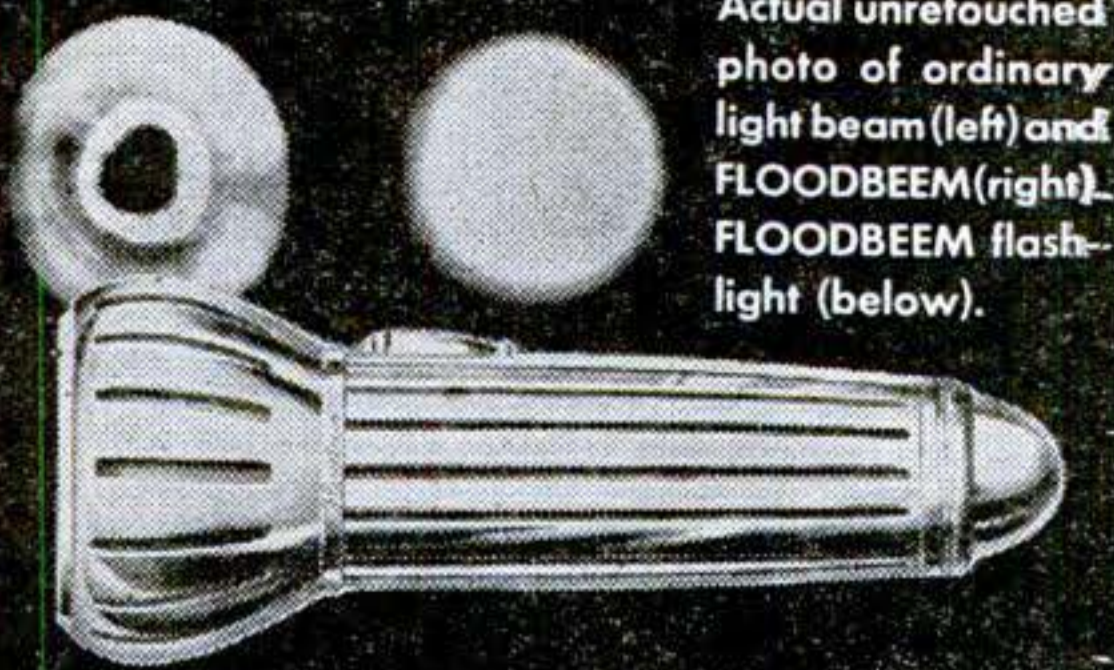
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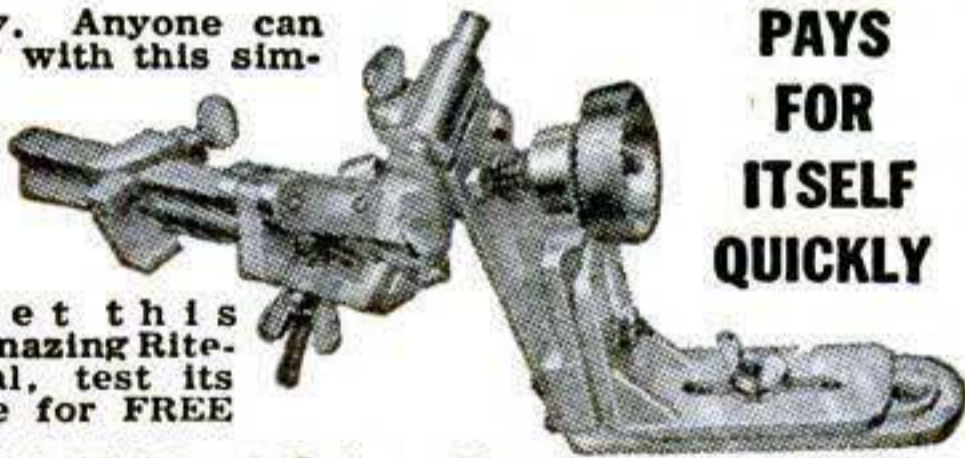


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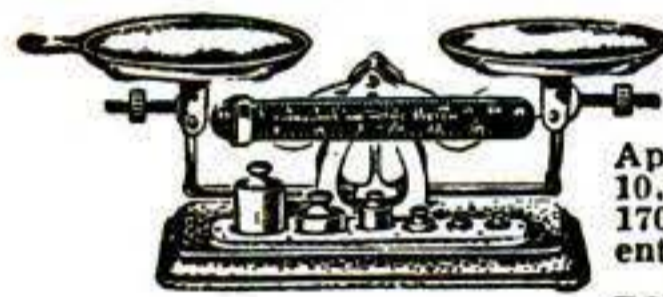
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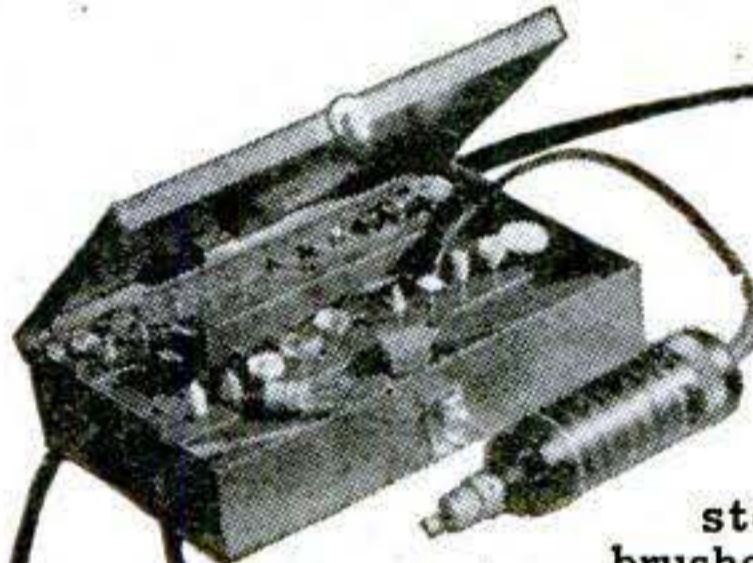
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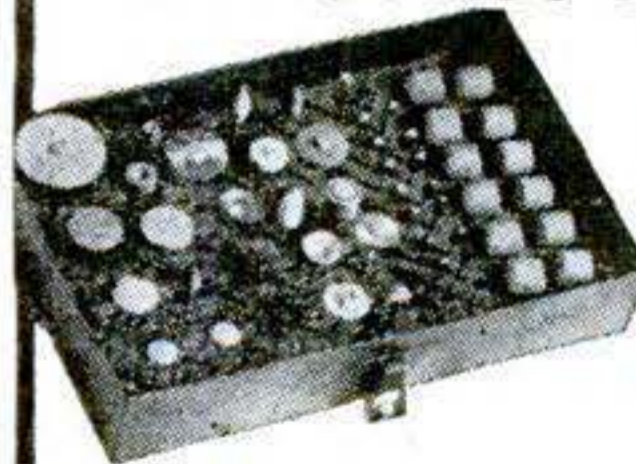
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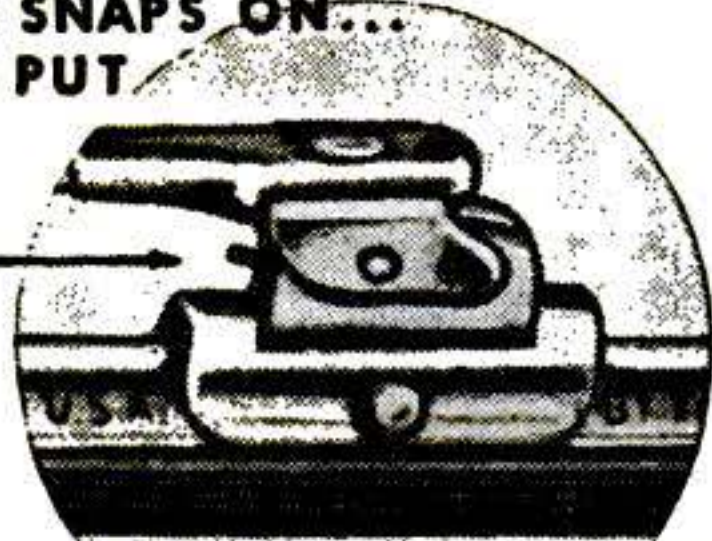
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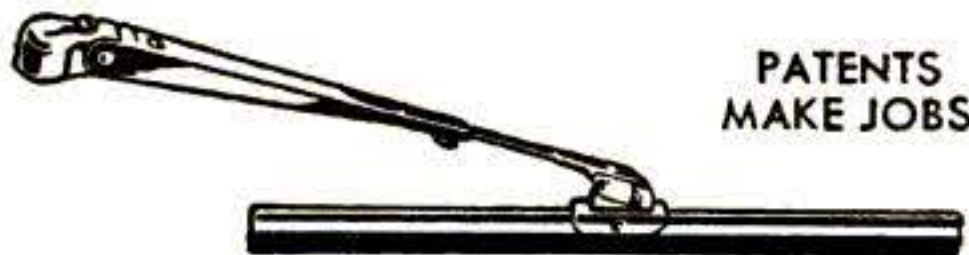


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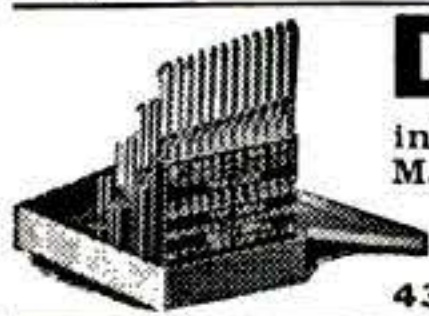
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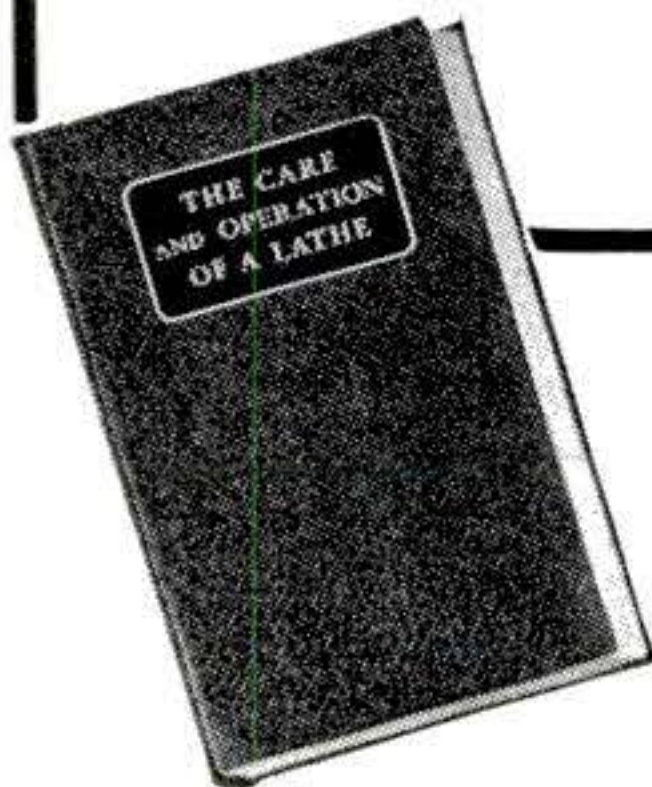
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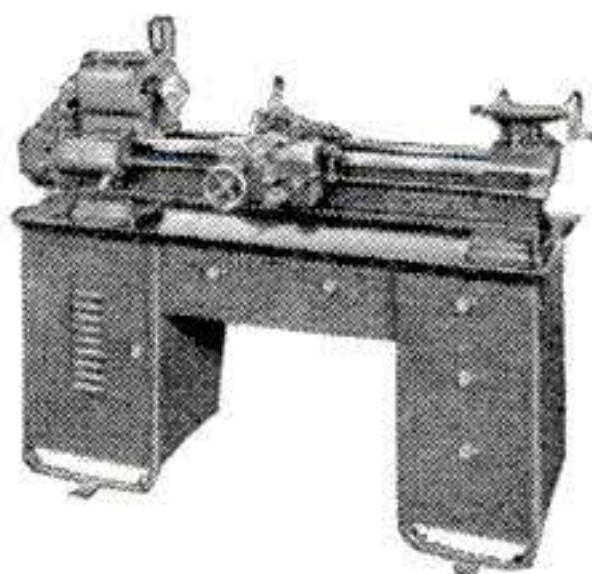
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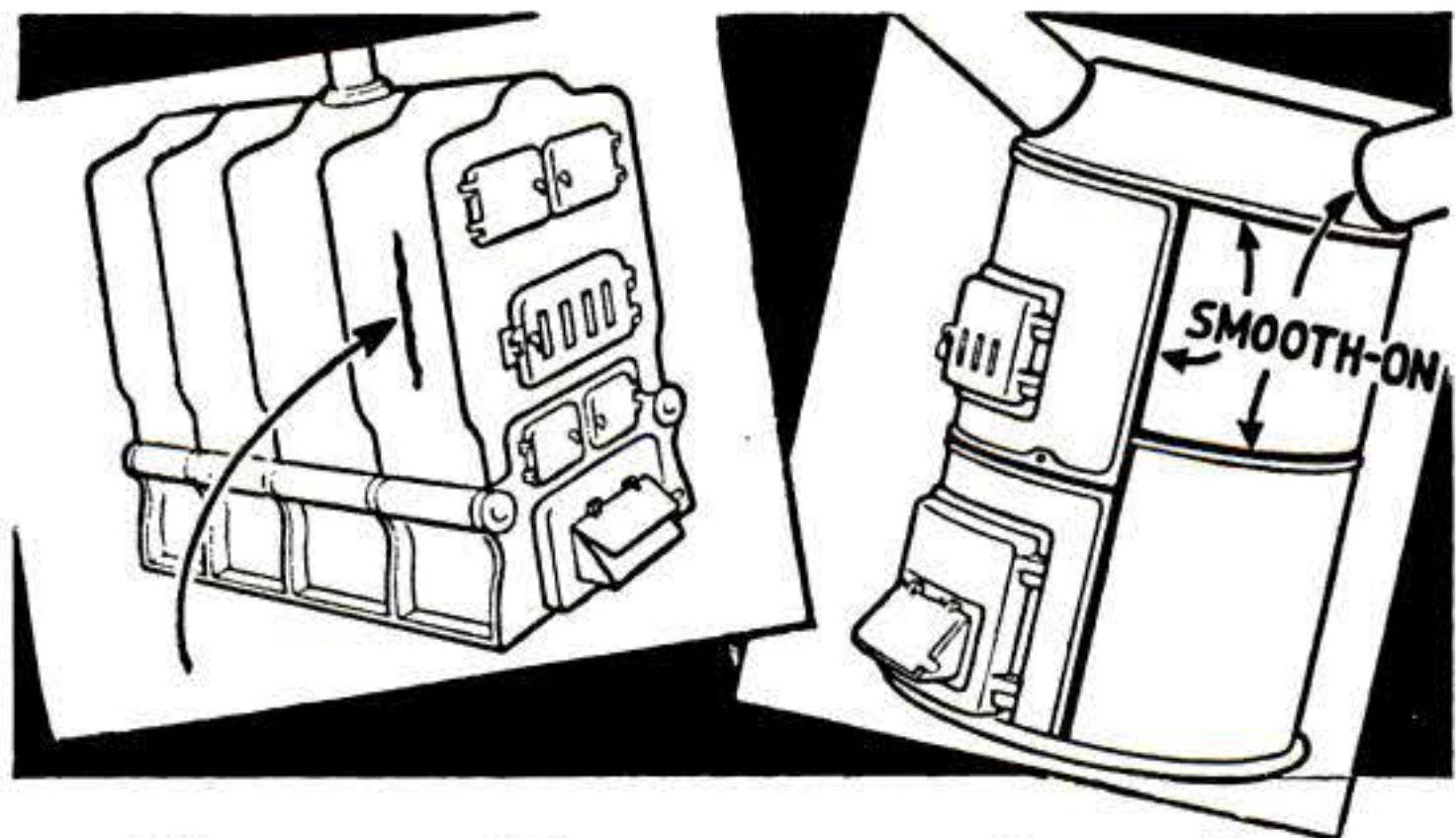
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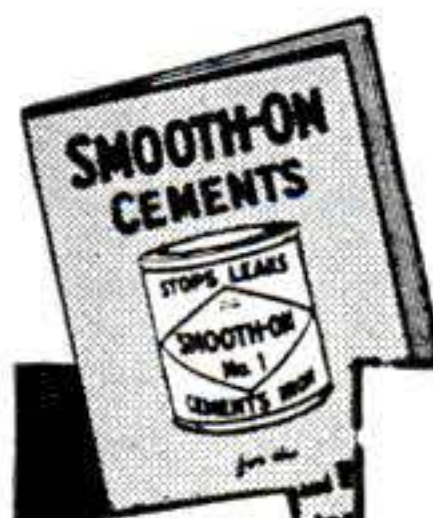
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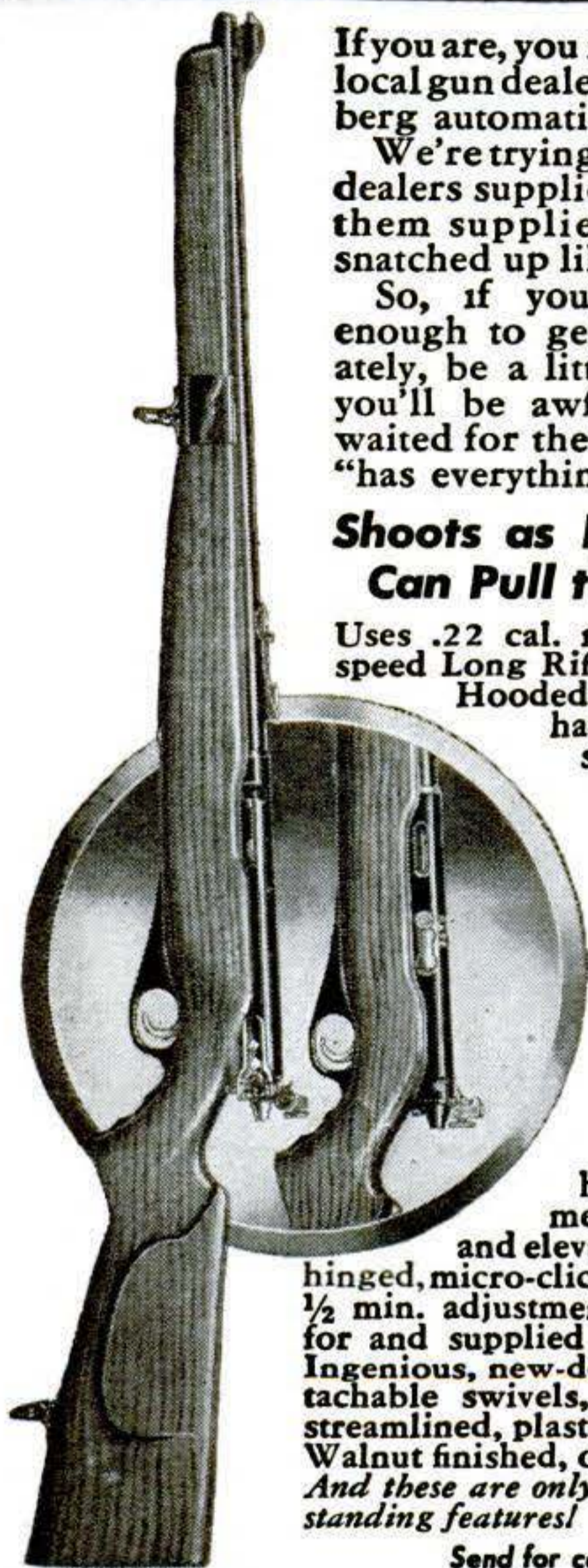
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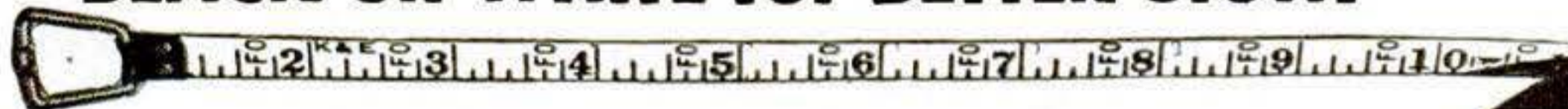
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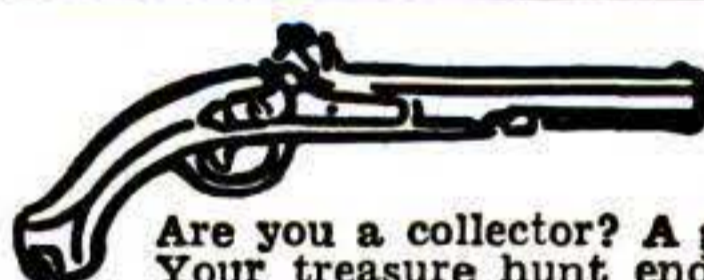
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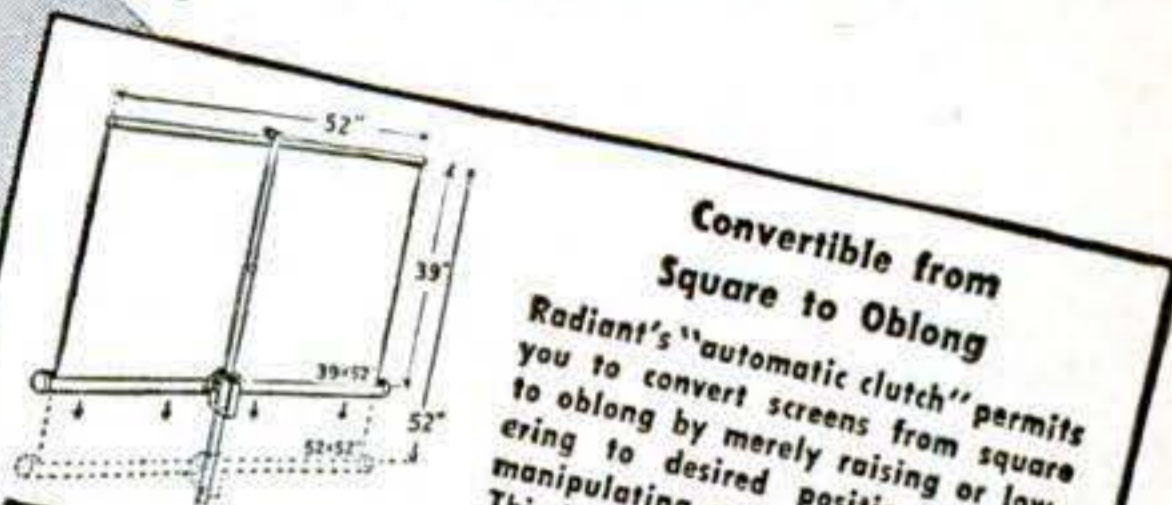
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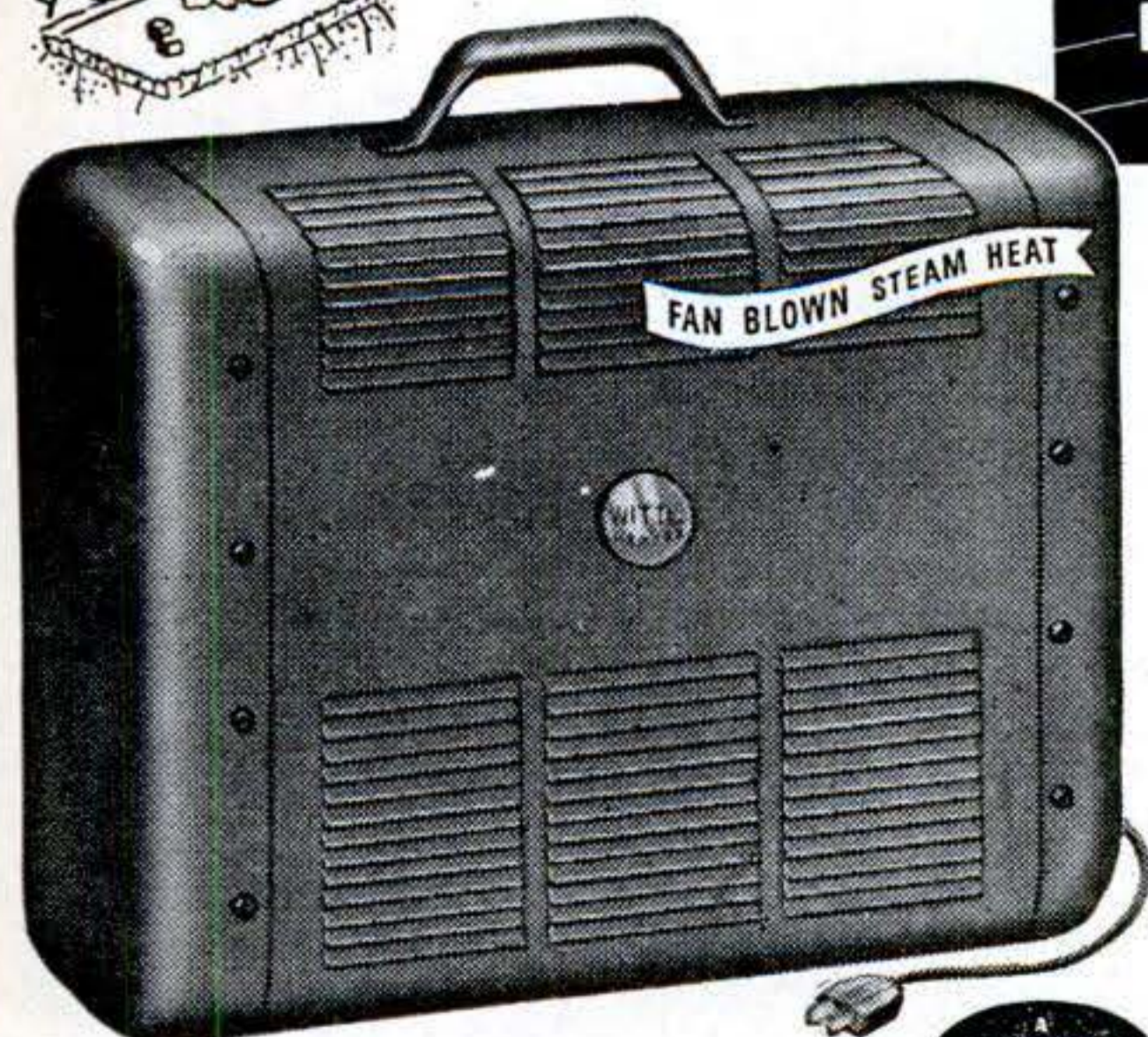
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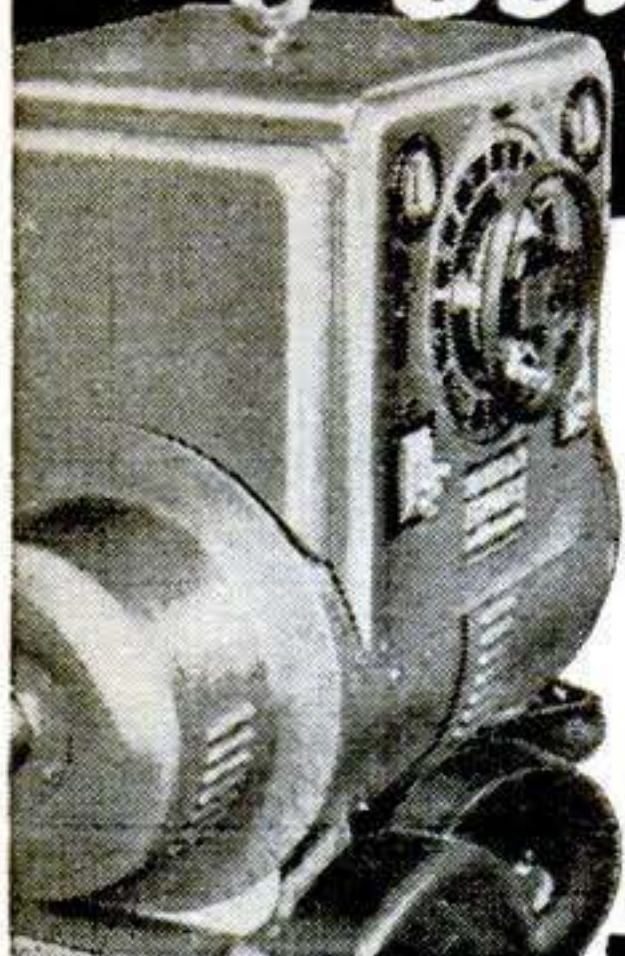
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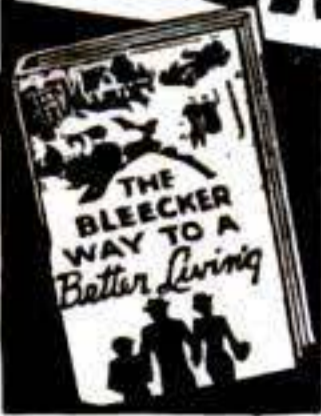
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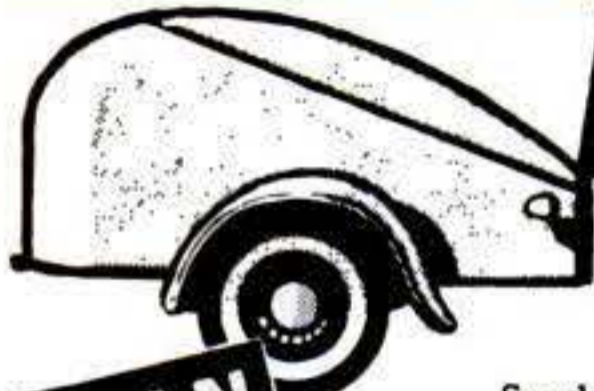
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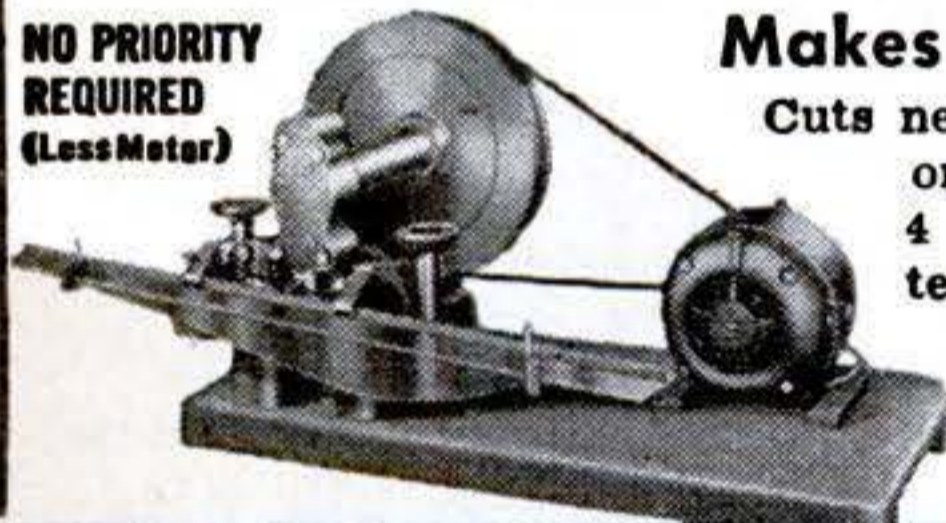
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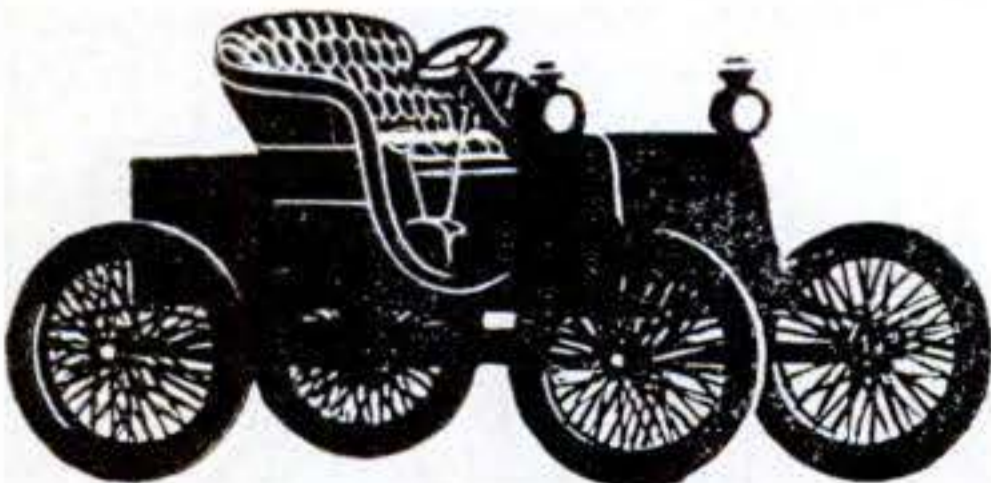


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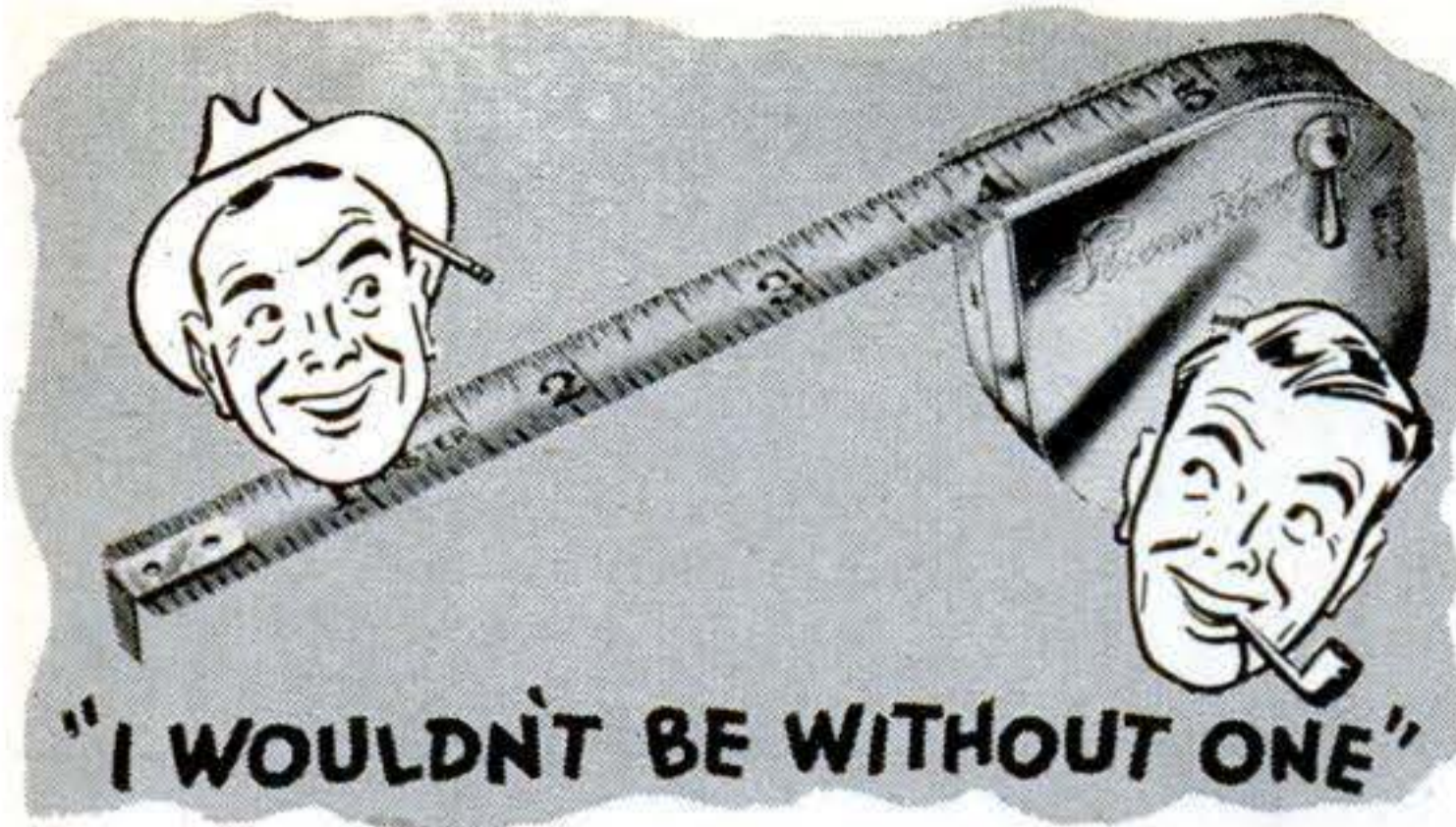
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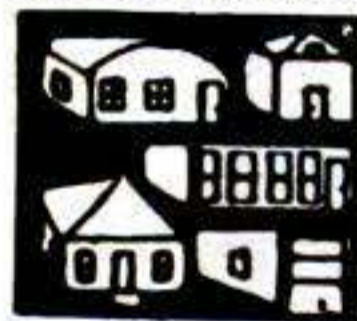
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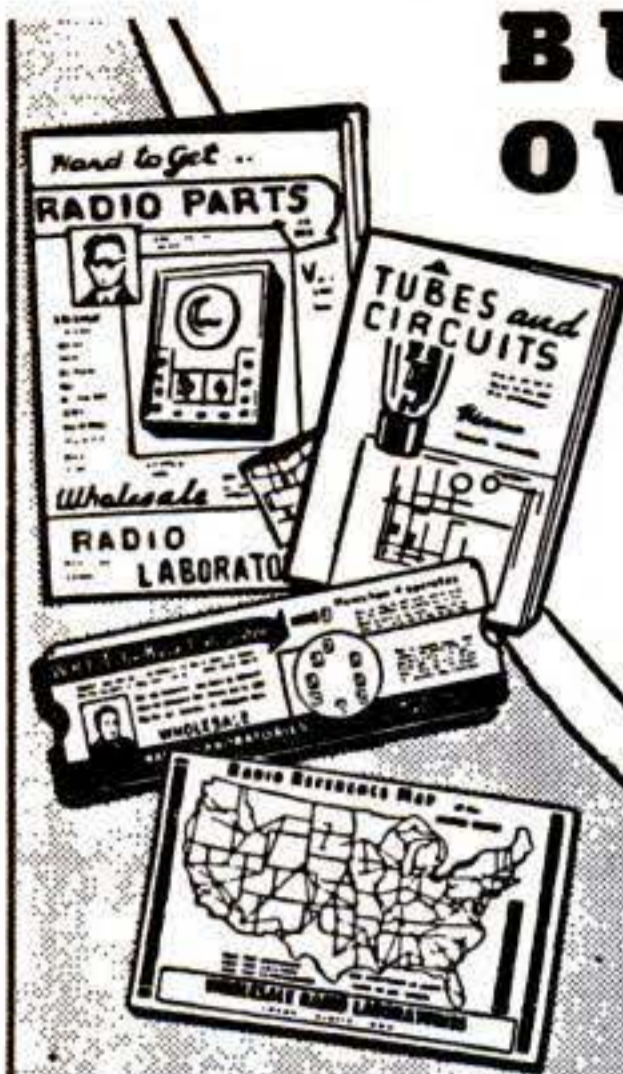
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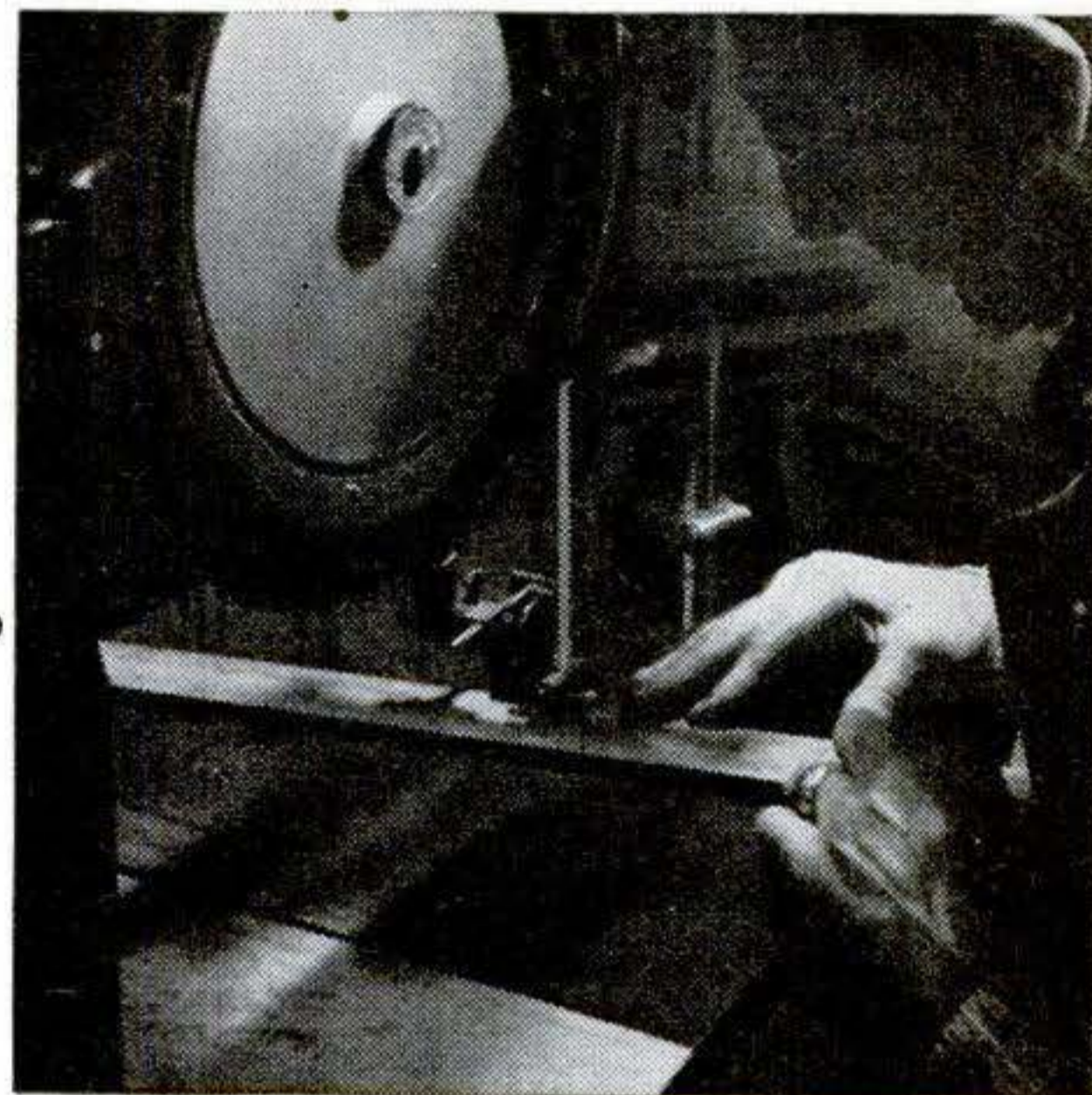
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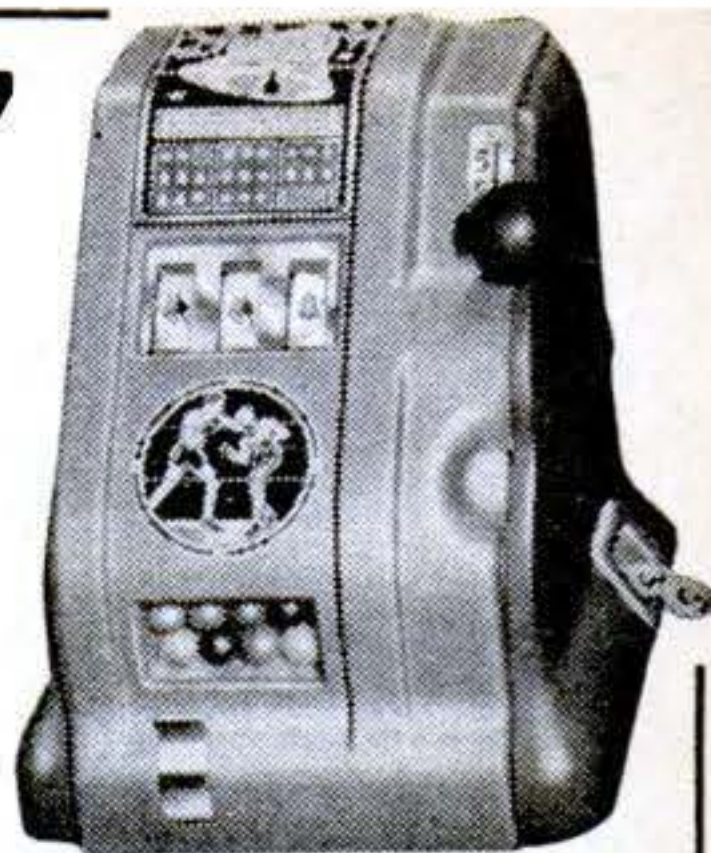
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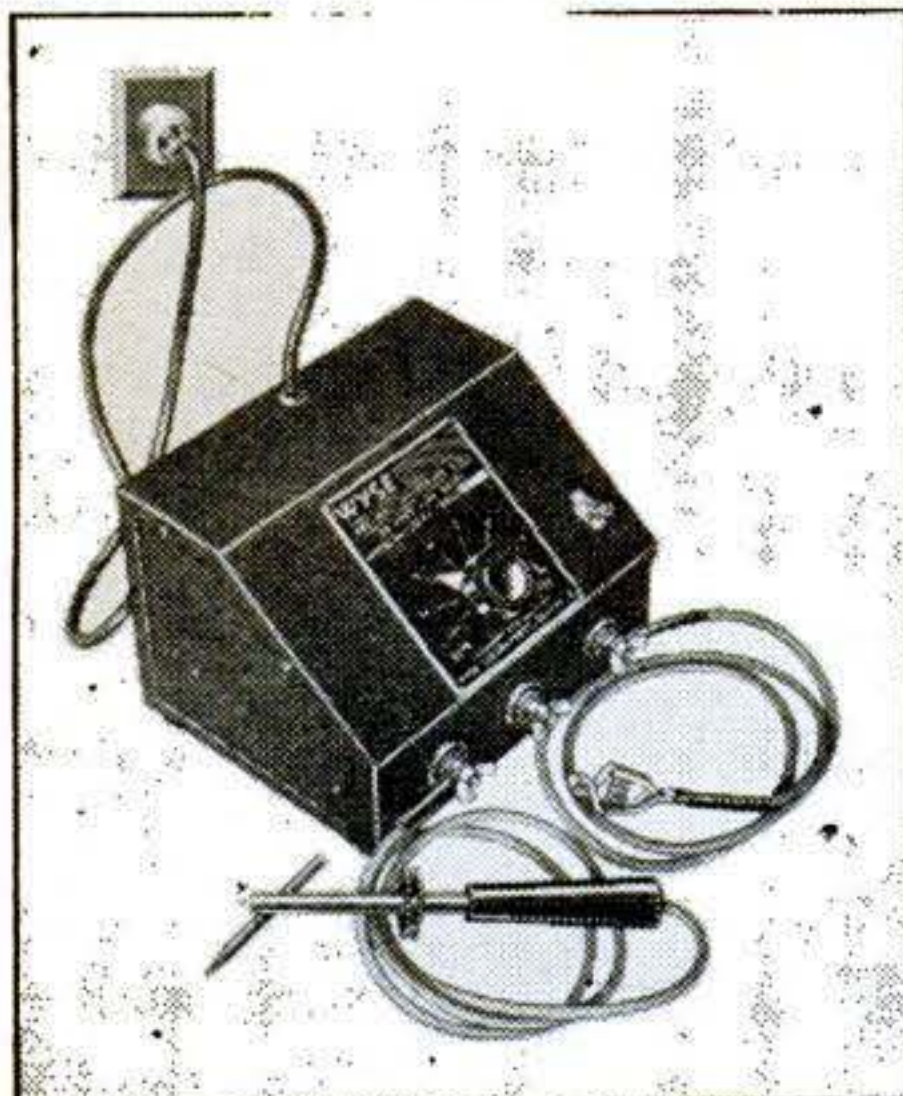
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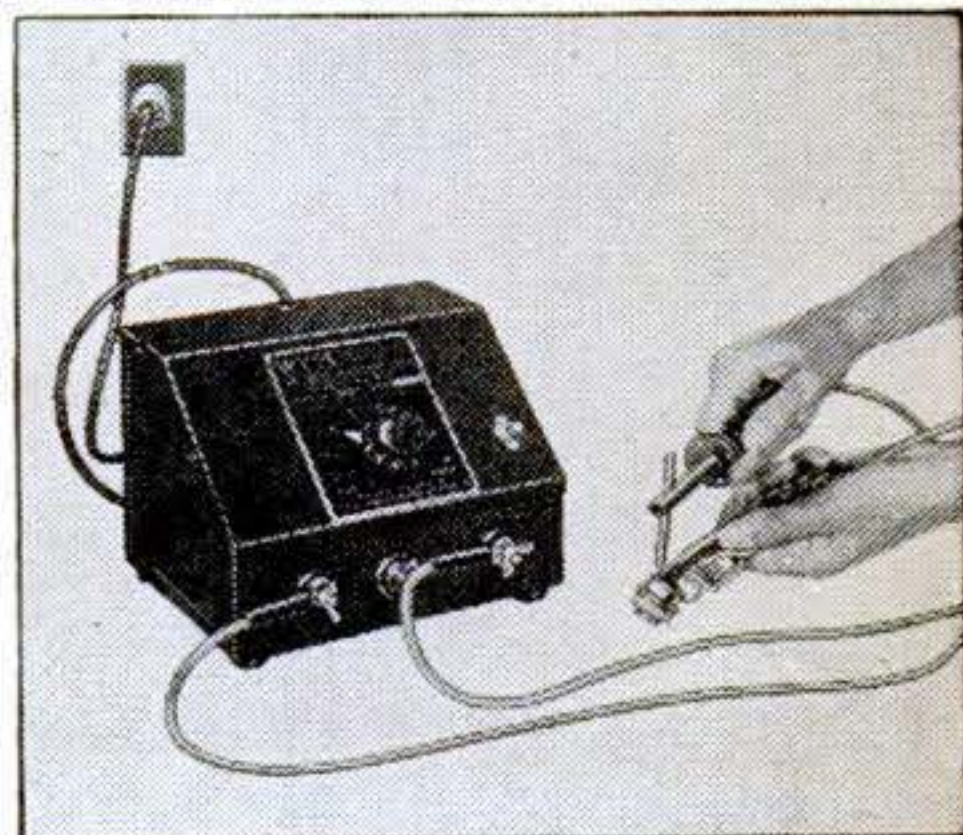
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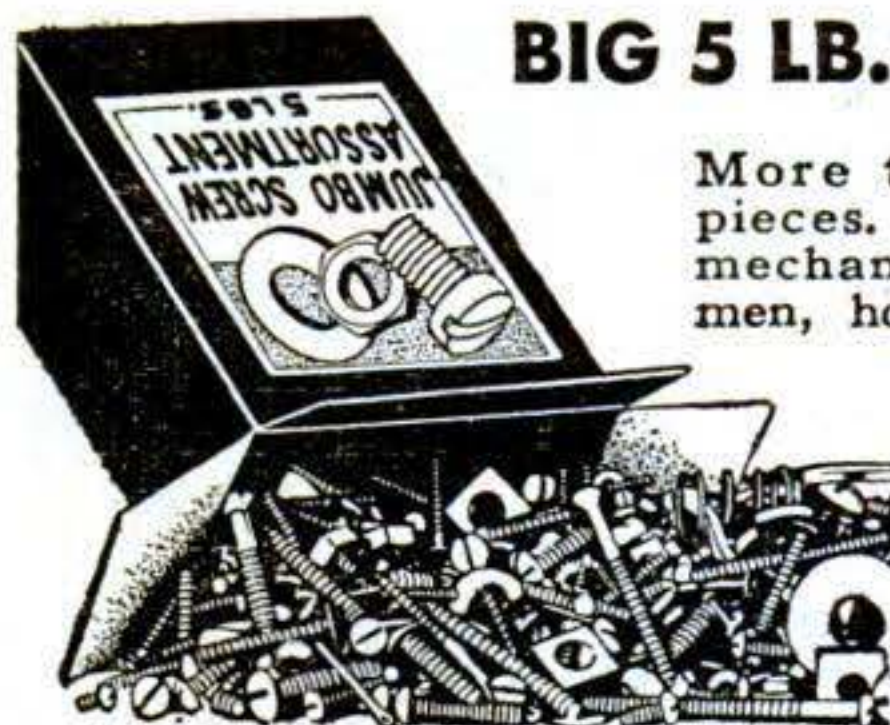
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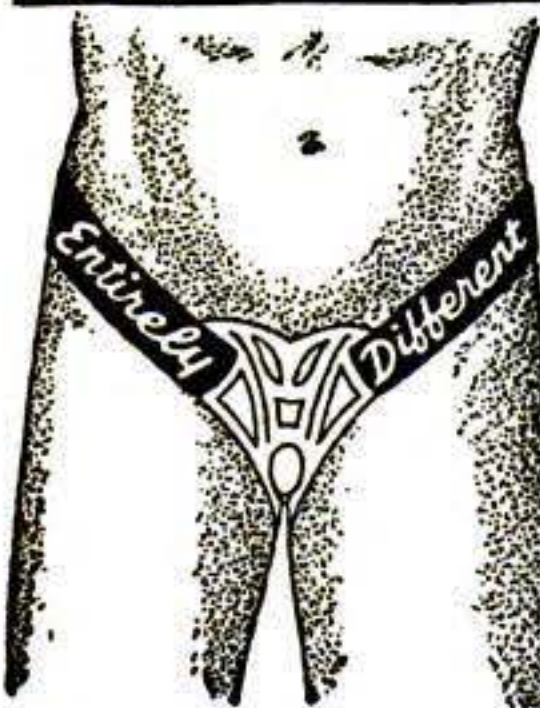


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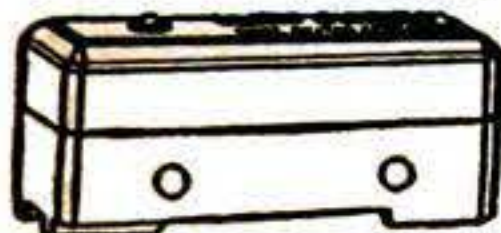
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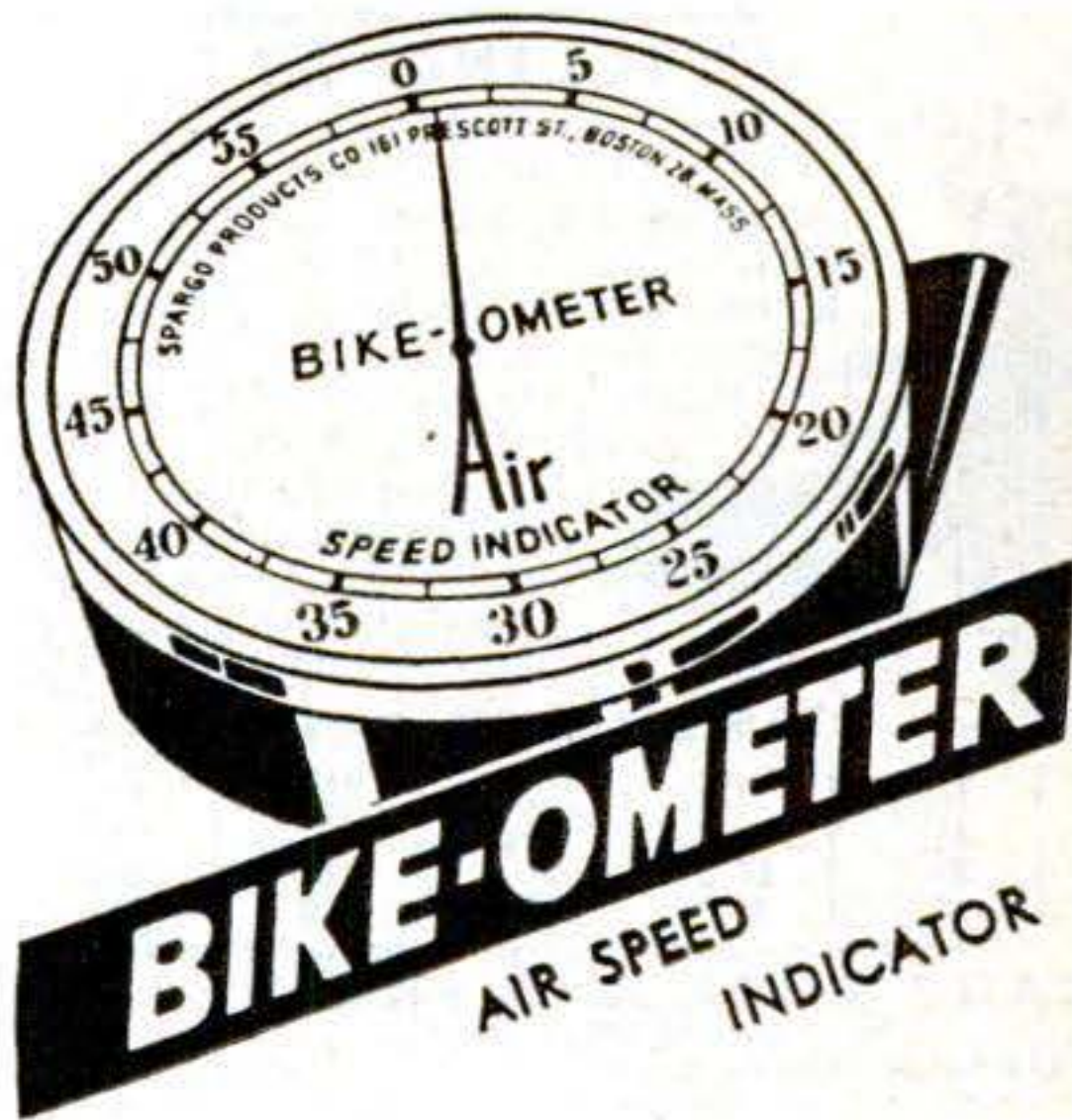
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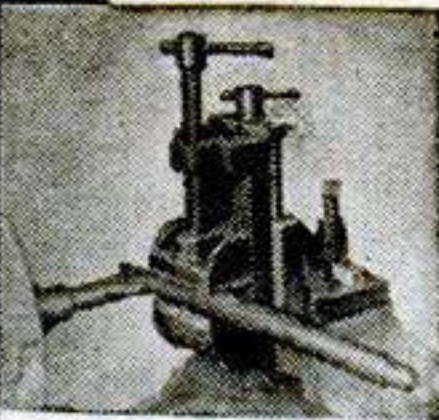
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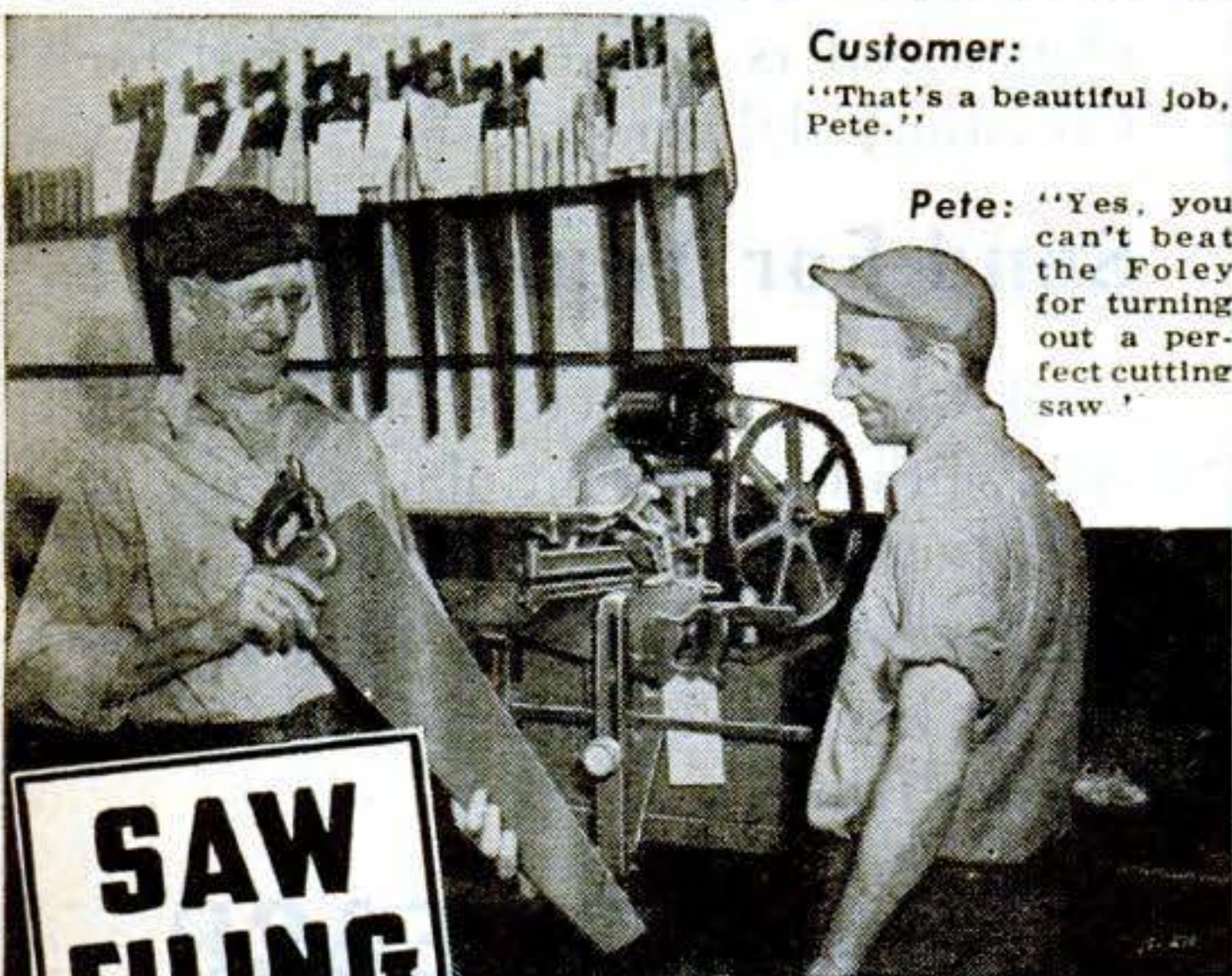
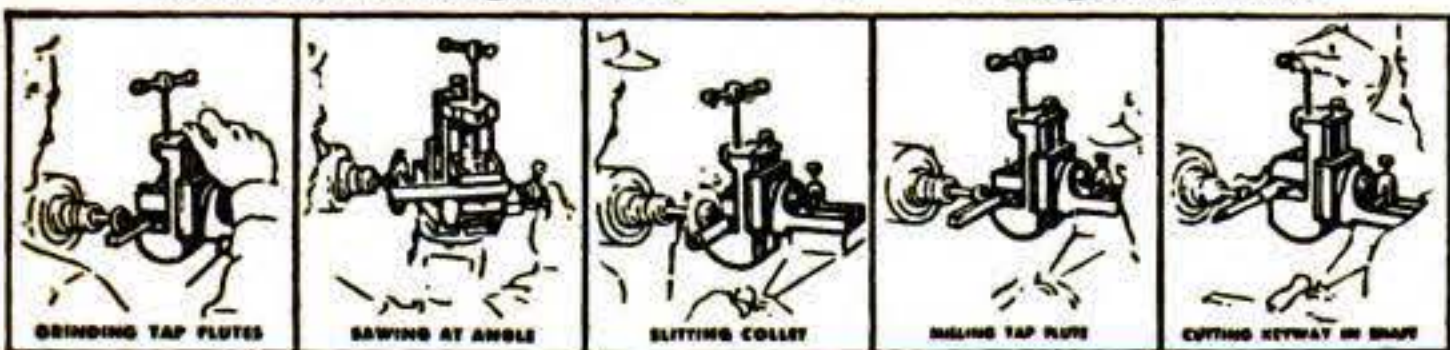
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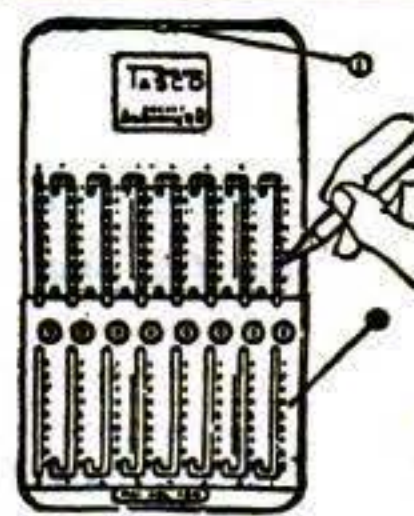
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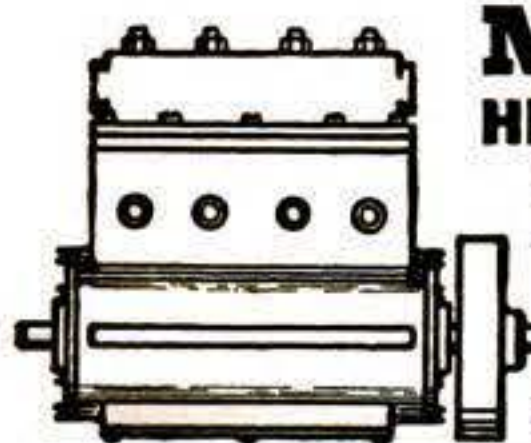
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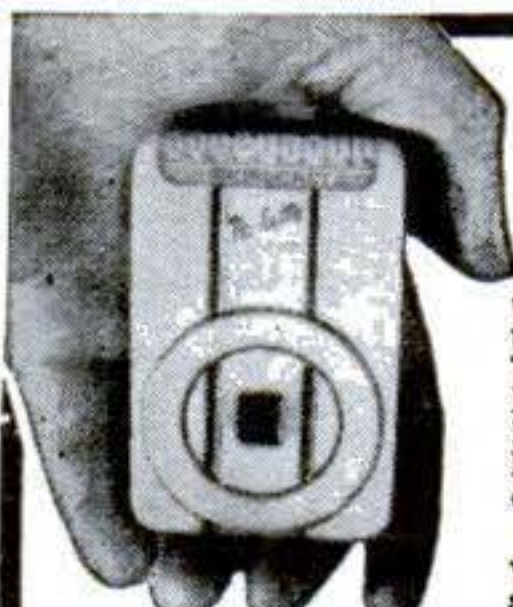
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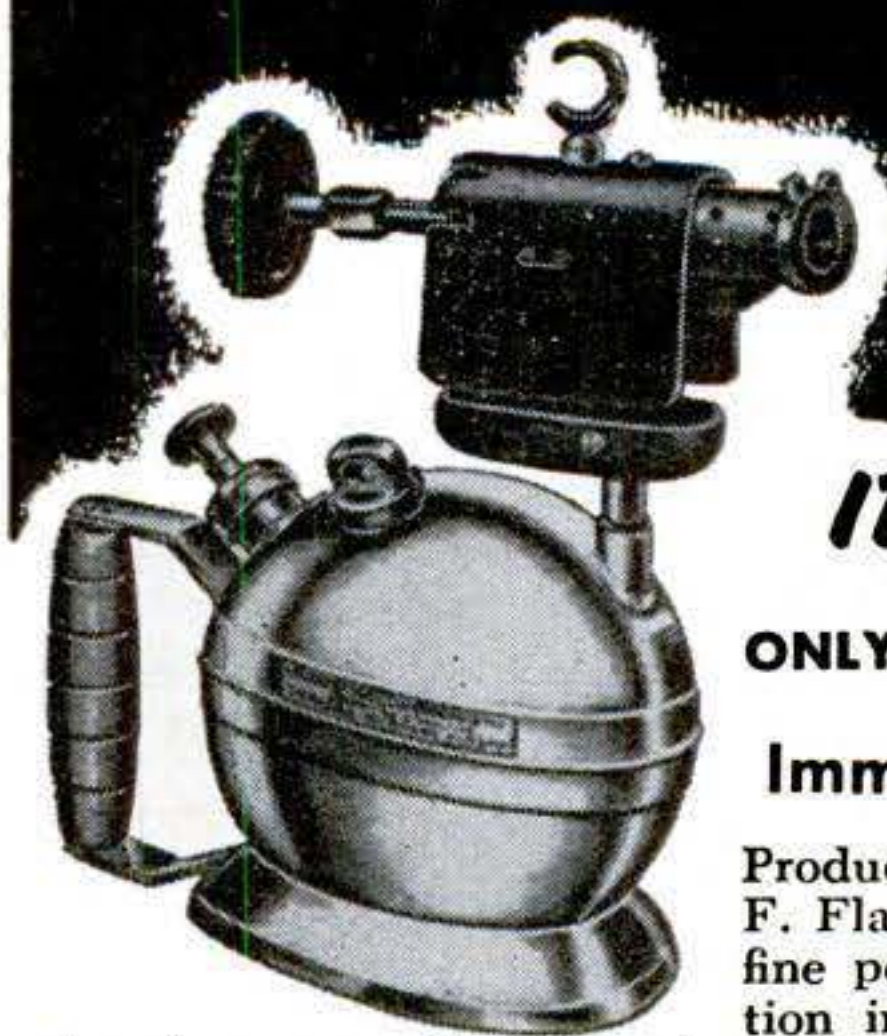


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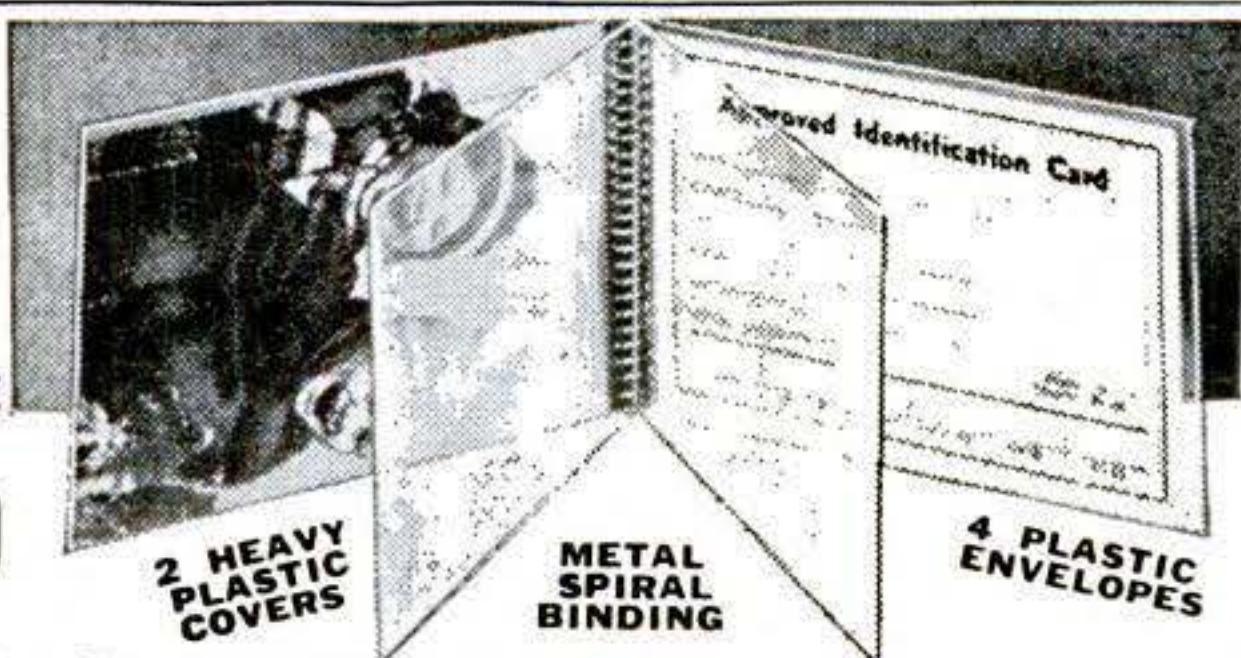
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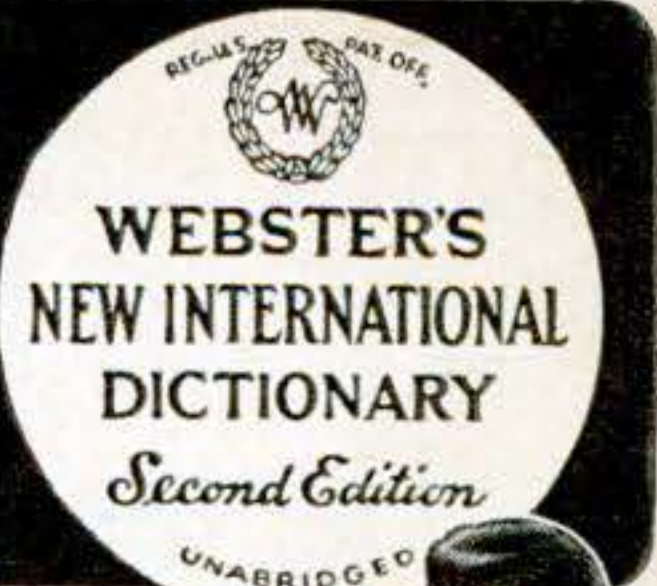
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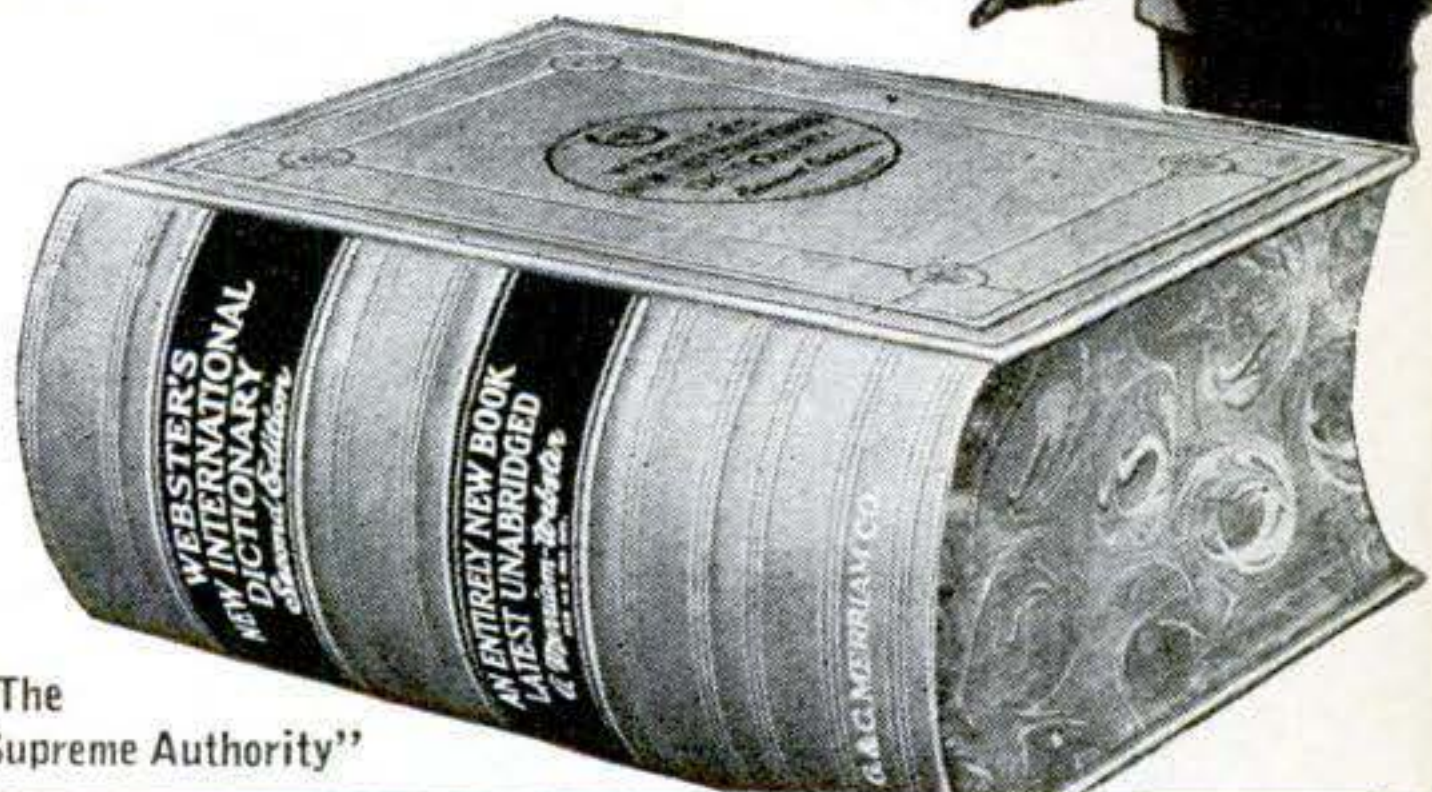
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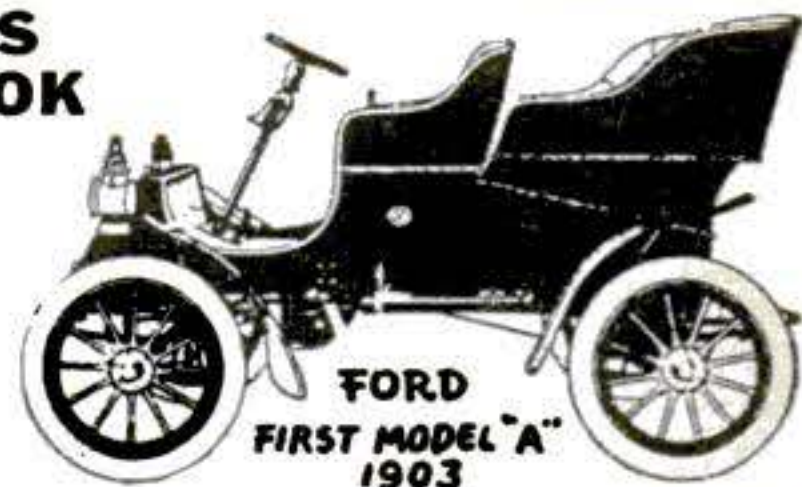


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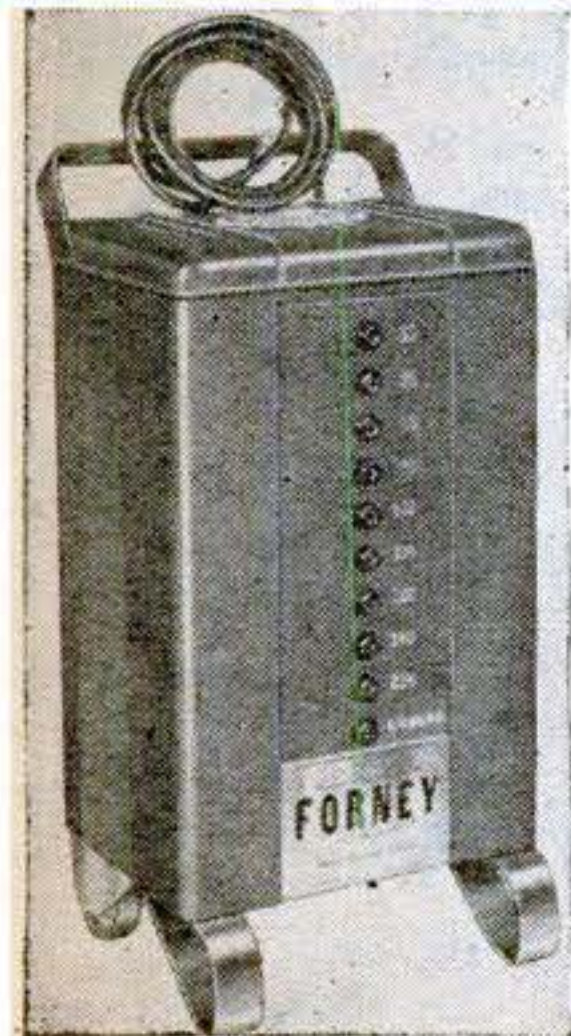
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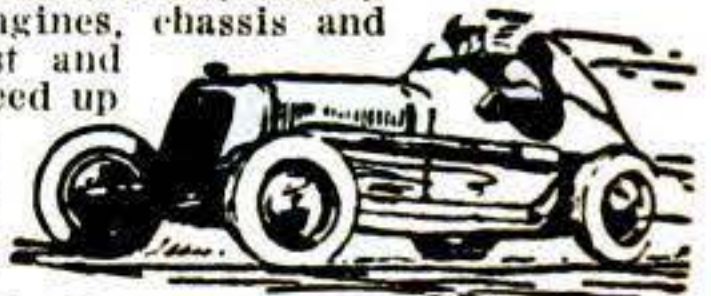
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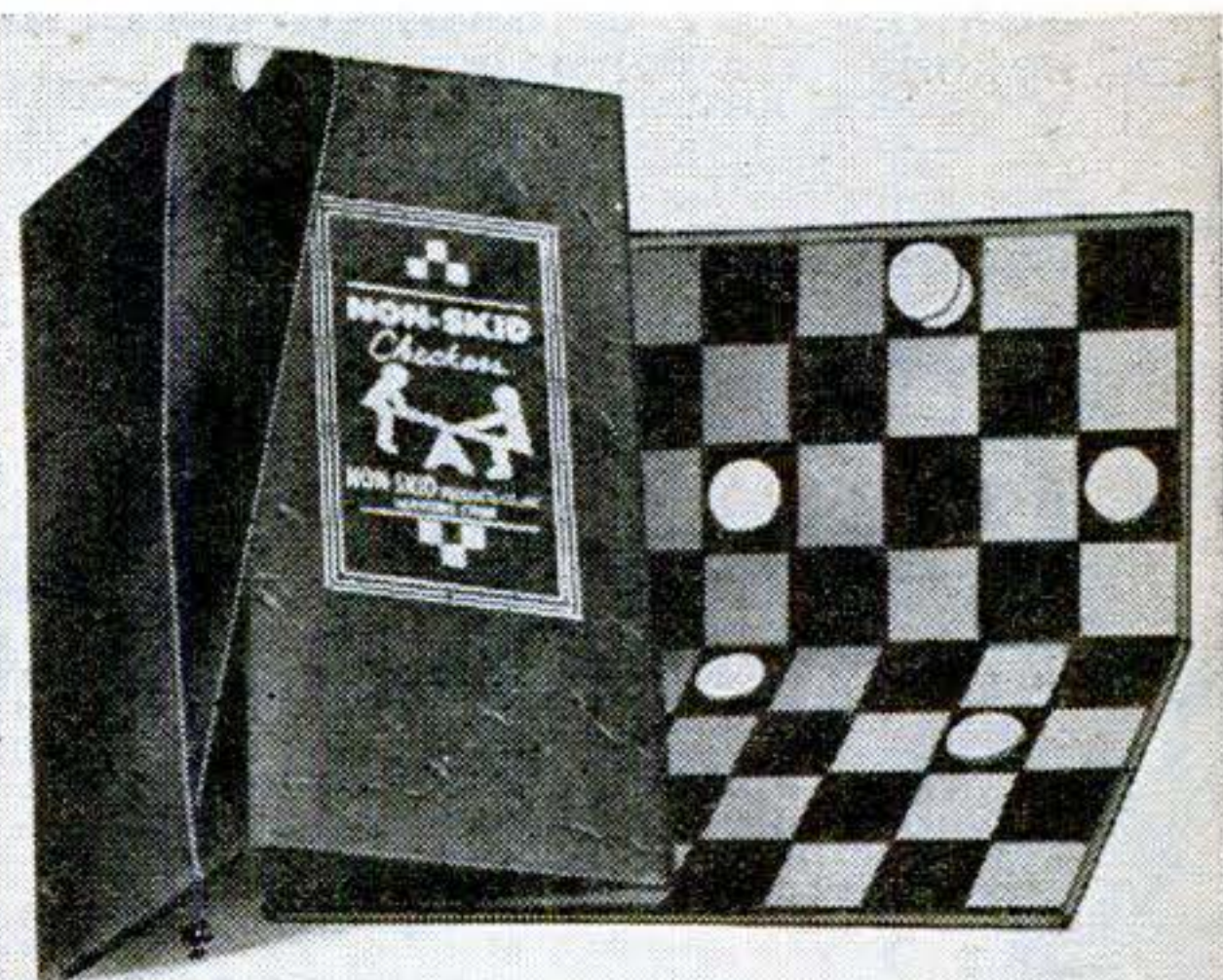
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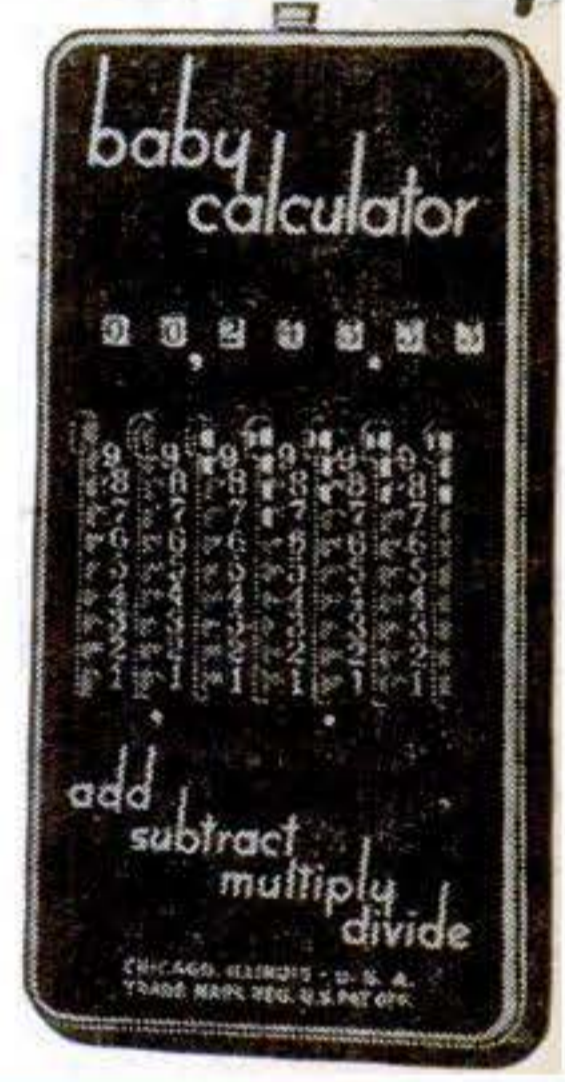
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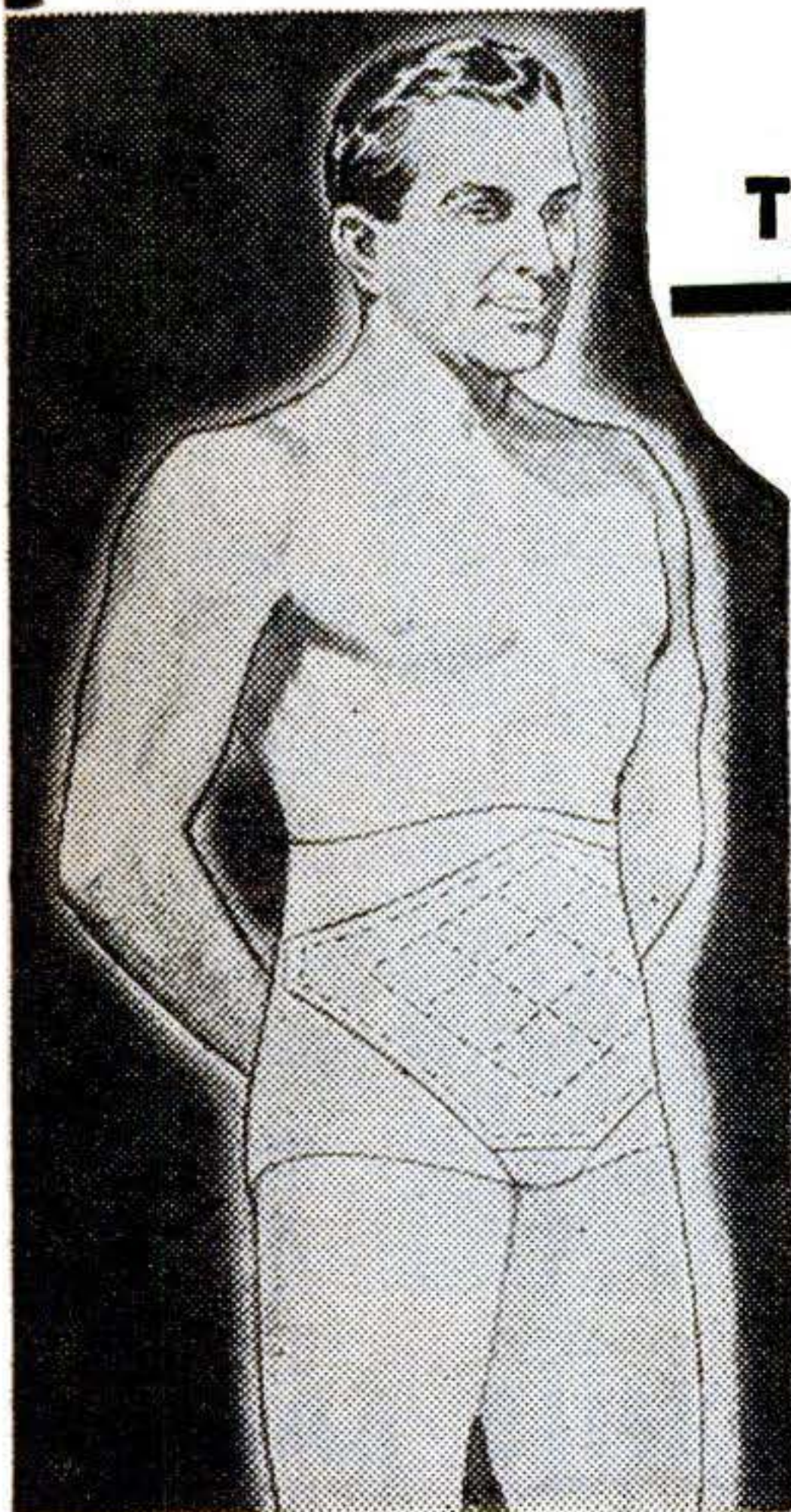
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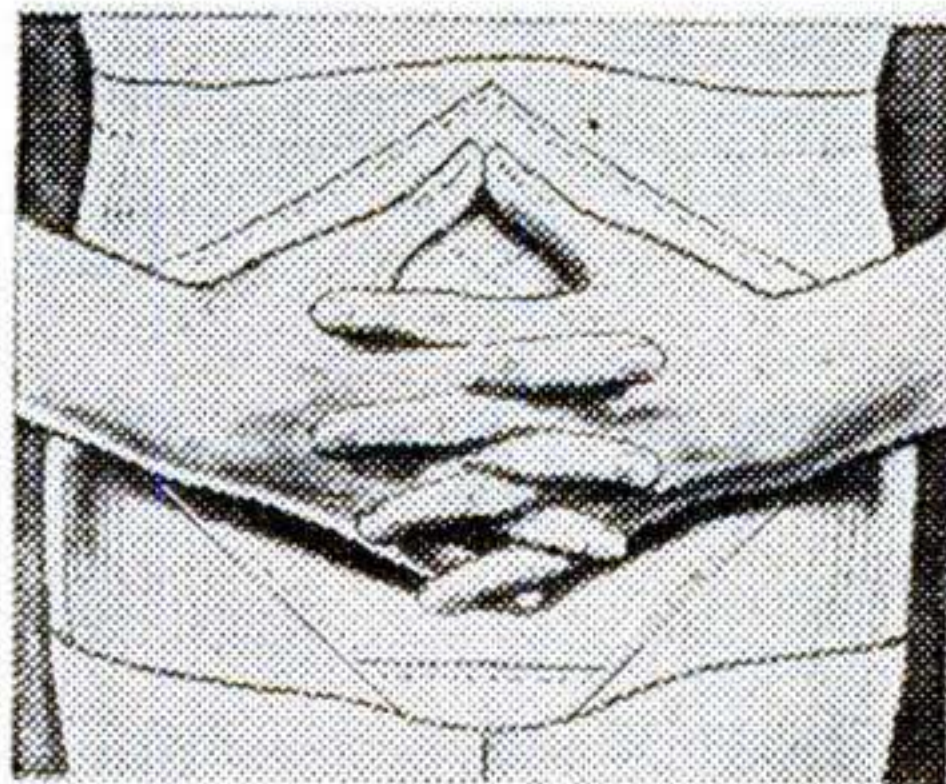
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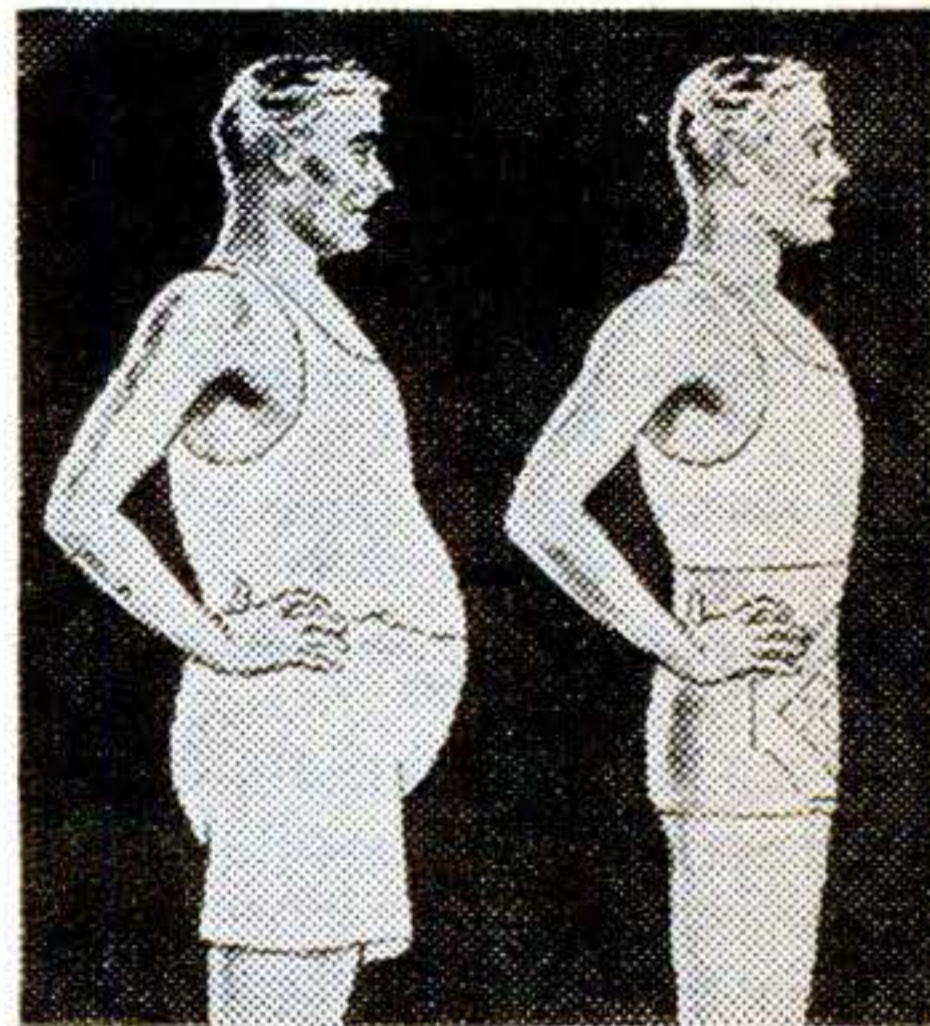
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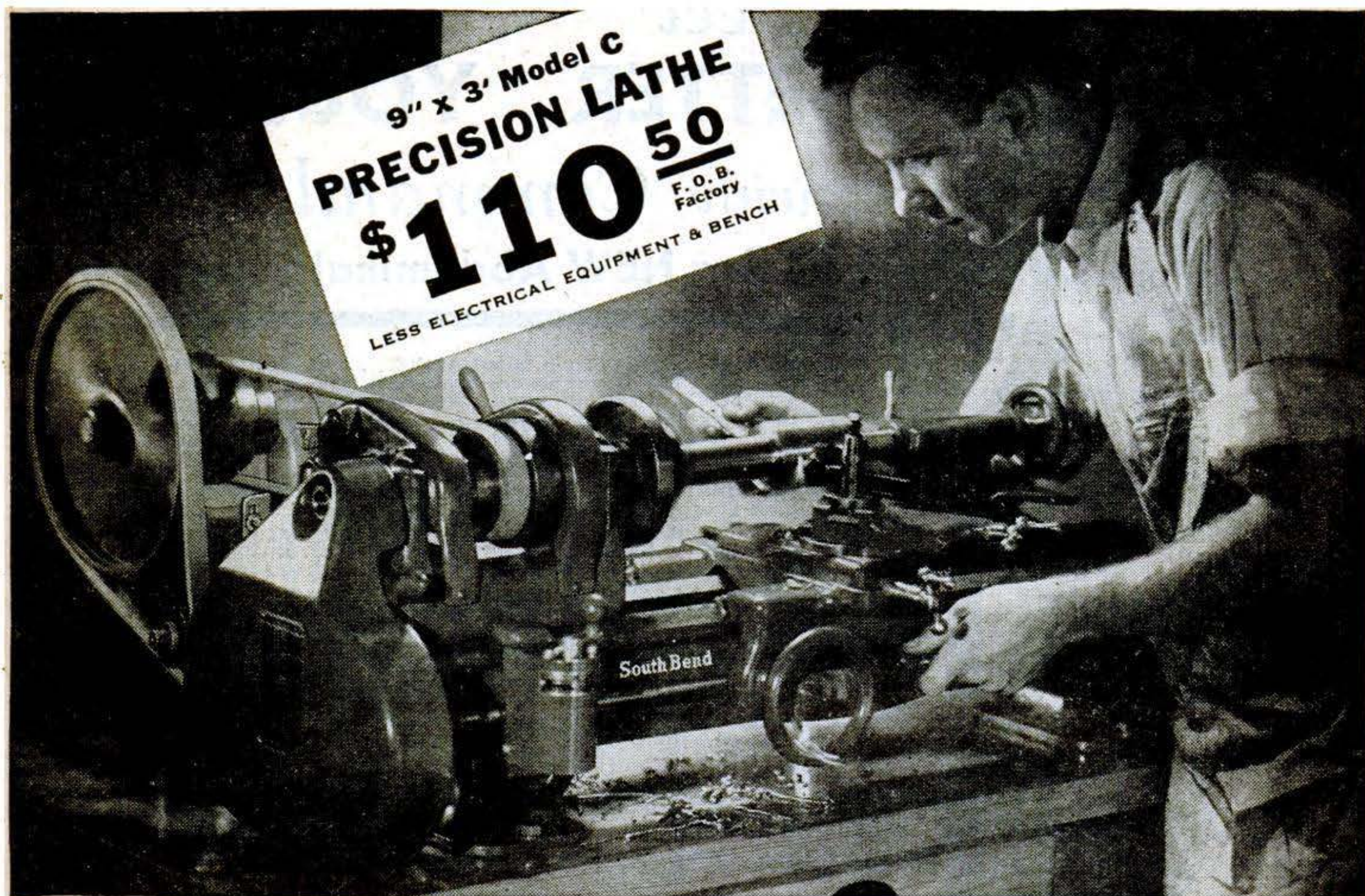
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Originally "AMERICAN WILD LIFE" was planned as a five-volume set of books. However, to keep the cost down within everyone's reach without sacrificing the quality of the illustrations or the printing, it was decided to put all five books within one set of covers. In its final form, the 778 pages are divided into sections resembling five books, each with its own frontispiece, which are represented this way: Volume One: Mammals; Volume Two: Fishes; Volume Three: Reptiles and Amphibians; Volume Four: Land Birds; Volume Five: Water Birds and General Index. See partial list of contents on outside

DO YOU KNOW . . .

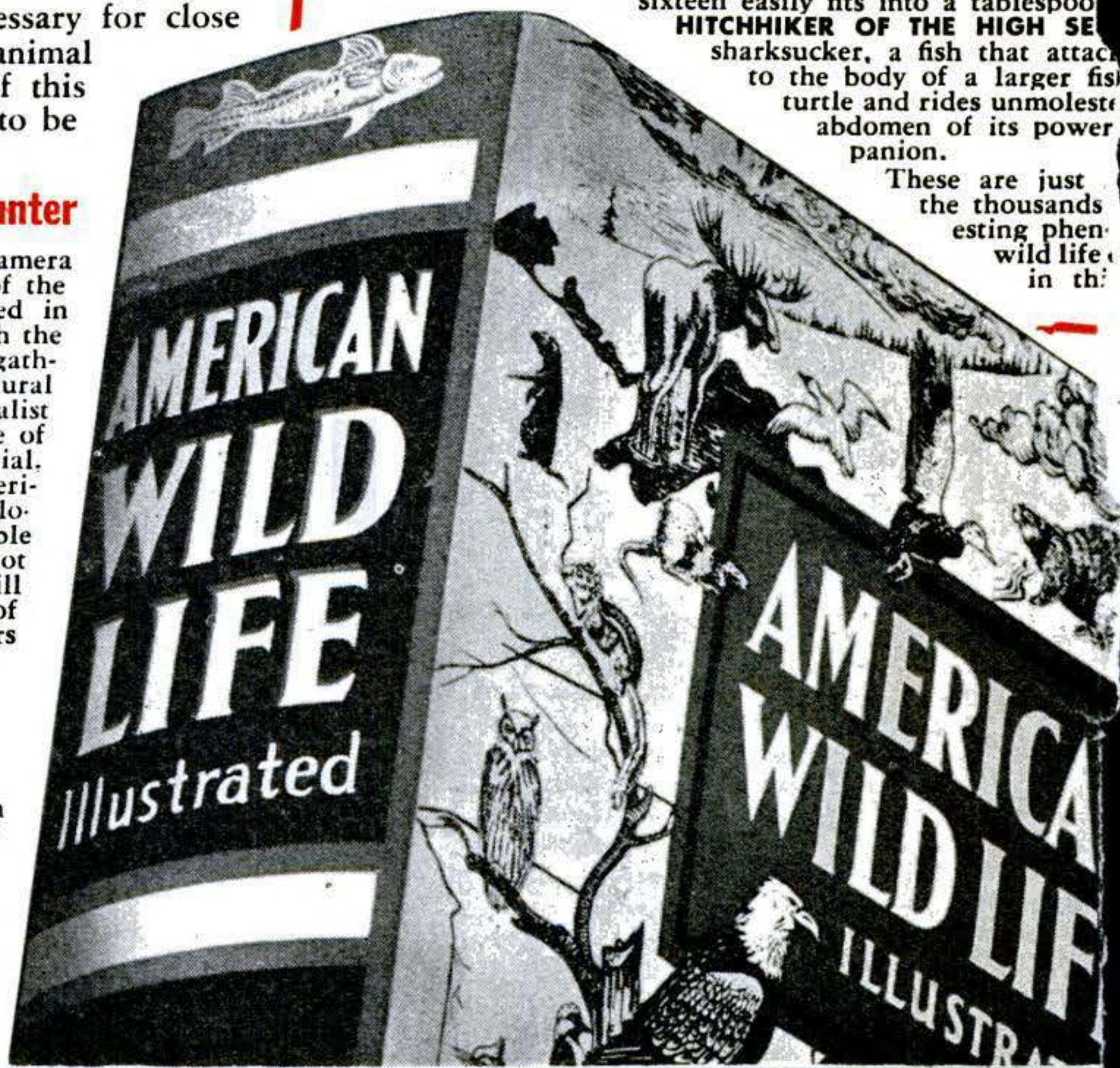
A PRAIRIE-DOG CITY, its avenues stretching for many miles, contains nothing less than a subterranean housing development on a large scale!

TO RID ITSELF OF FLEAS, the fox, taking a stick in its mouth, submerges in a pool of water. As it sinks, the fleas move to the drier regions. When only the wood remains above the surface, the fleas desert the sinking fox to take refuge on the raft. When the fox releases the stick, leaving the fleas to their fate.

THE CLASSIC BELIEF is that the bat becomes entangled in a spider's hair and cannot be removed until every one of the spider's legs is clipped to the scalp. Yet there is no actual record of this having happened!

THE YOUNG OF THE OPOSSUM are so small at birth that a dozen easily fits into a tablespoon. **HITCHHIKER OF THE HIGH SEAS**, the sharksucker, a fish that attaches itself to the body of a larger fish, such as a turtle and rides unmolested on the abdomen of its powerful companion.

These are just a few of the thousands of interesting phenomena of wild life that you will find in this book.



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