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Popular Science

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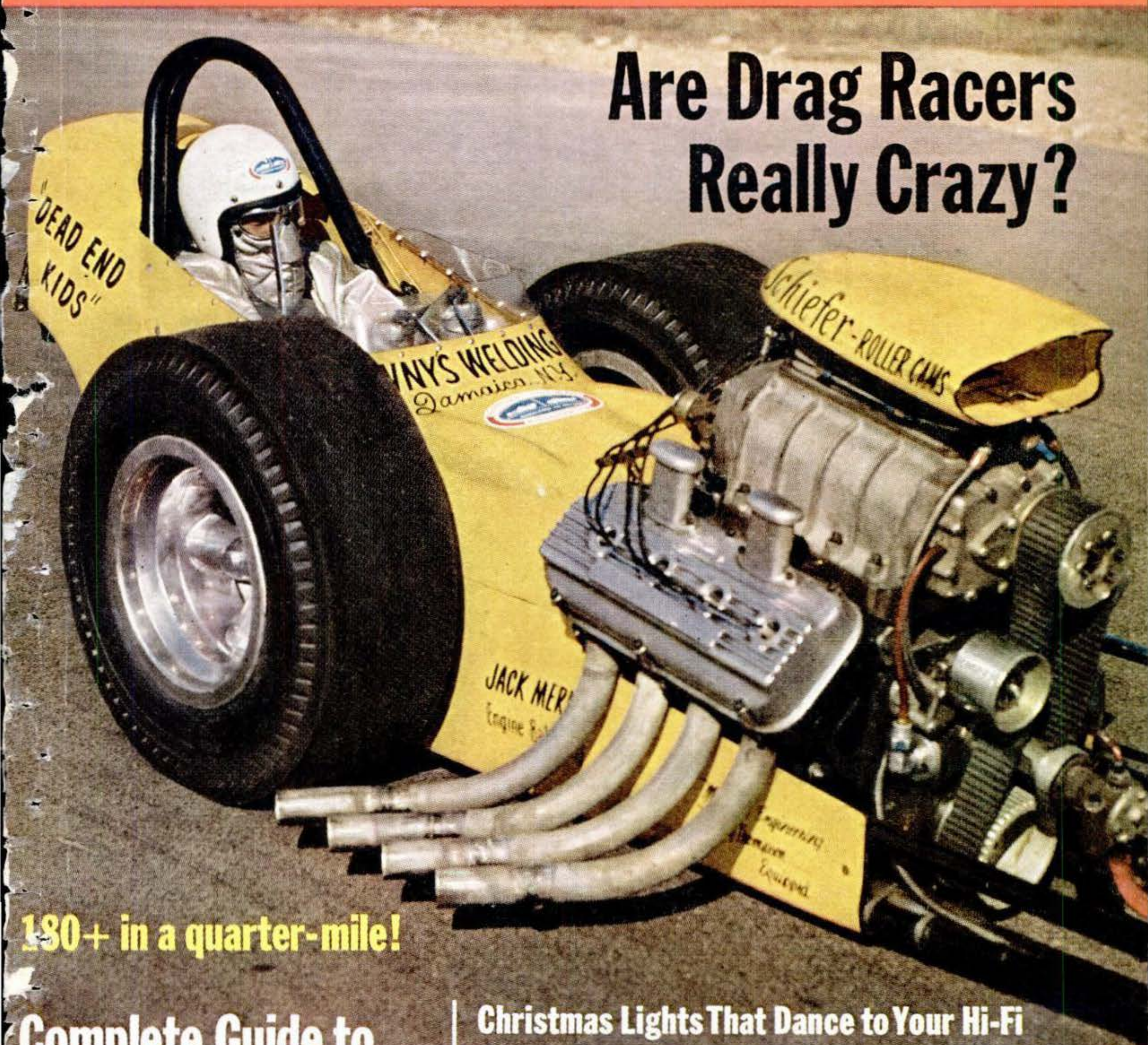
Monthly

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Are Drag Racers Really Crazy?



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Complete Guide to Portable Power Tools

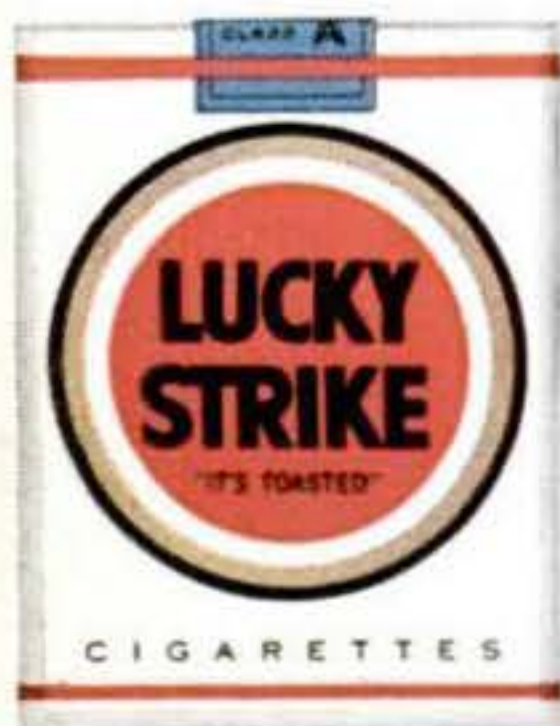
Christmas Lights That Dance to Your Hi-Fi
 Dr. von Braun Tells What It Takes to Live in Space
 How the Wright Brothers Learned to Fly



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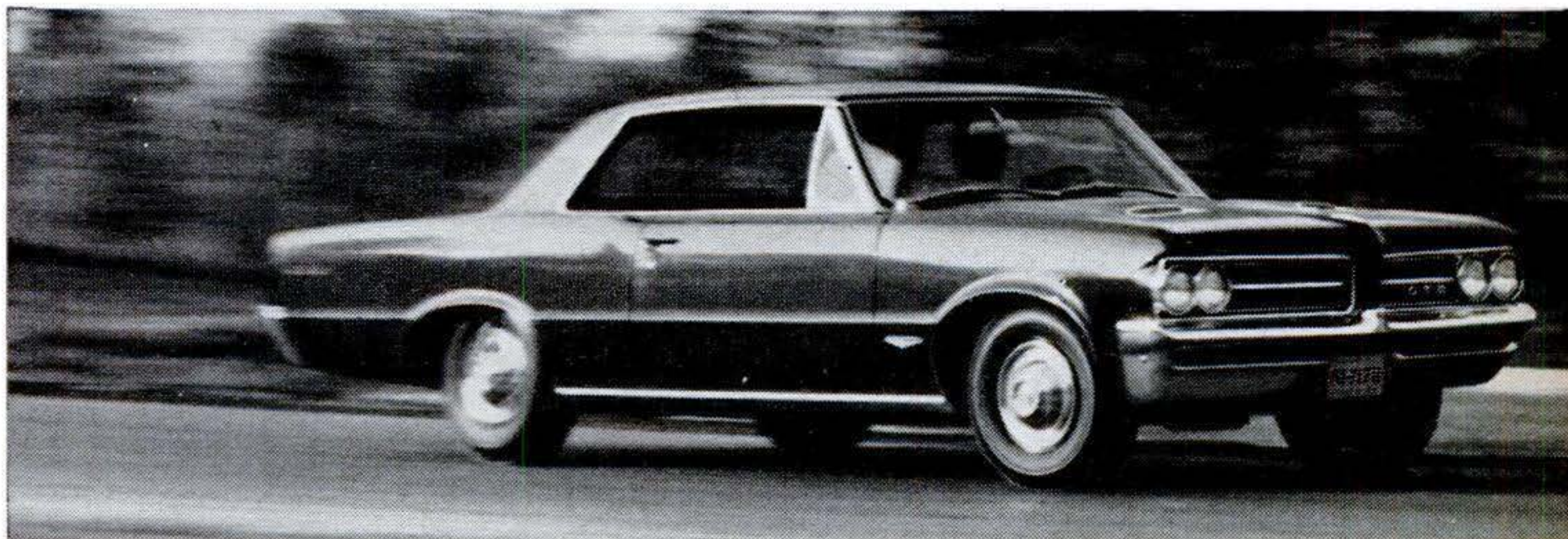
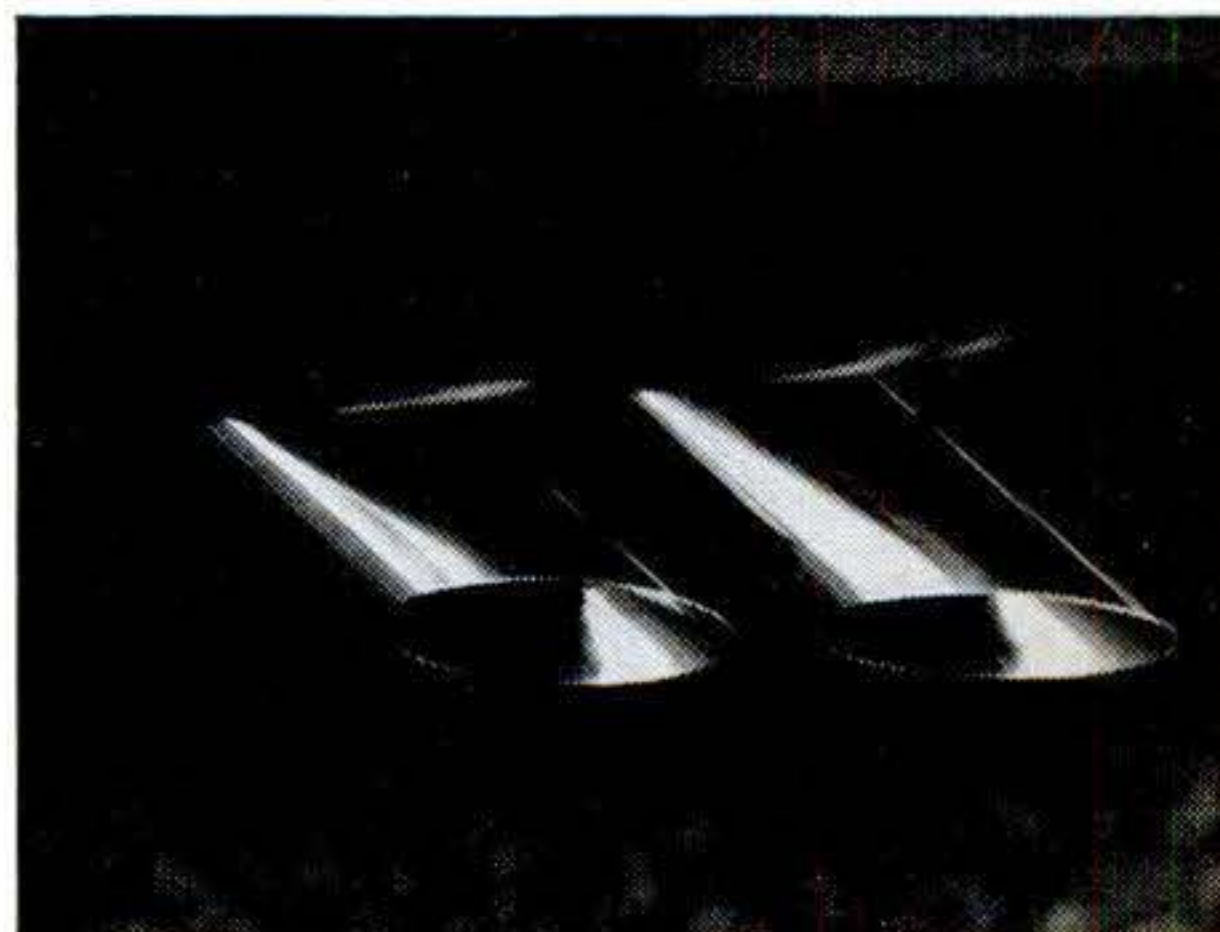
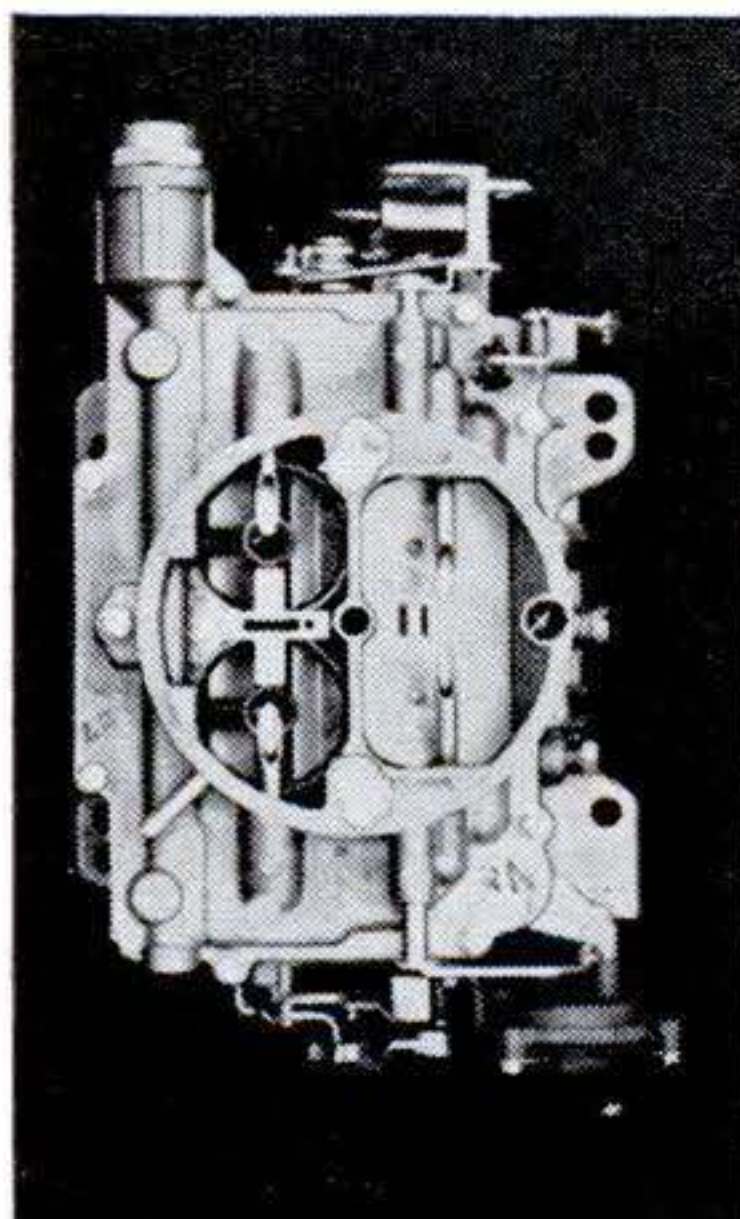
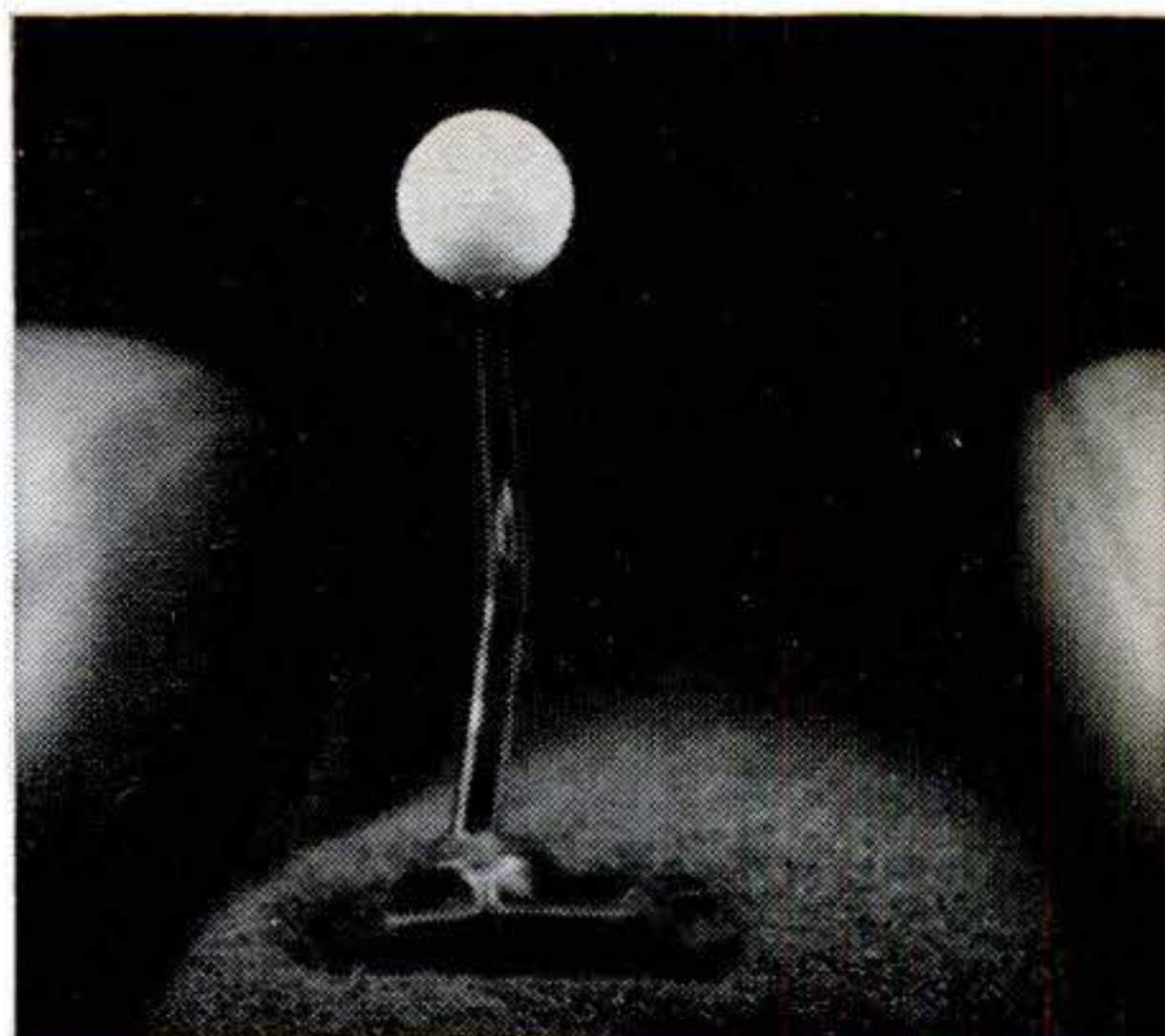
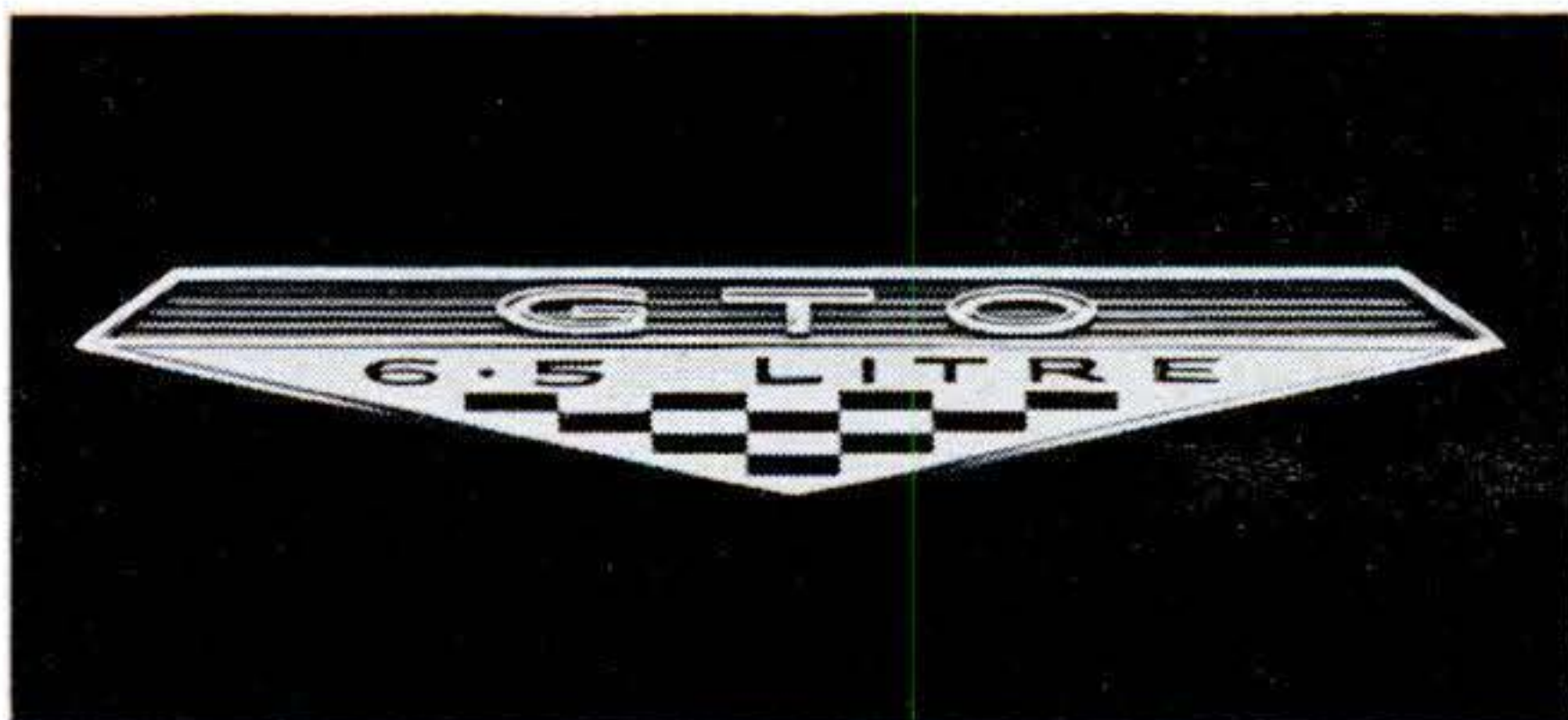


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*optional at extra cost.

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- **Dr. Wernher von Braun Starts His Second Year for PS.** Stay up-to-date on the thrilling saga of space with one of the world's leading experts.
- **How to Restore a Player Piano.** Lots of people are doing it nowadays. Could you? Sure. A man who does it professionally will show you how.
- **Surprising Facts About Hand Tools.** Part III of the big PS tool-buying guide—all about the tools you use most, and sometimes know least about.

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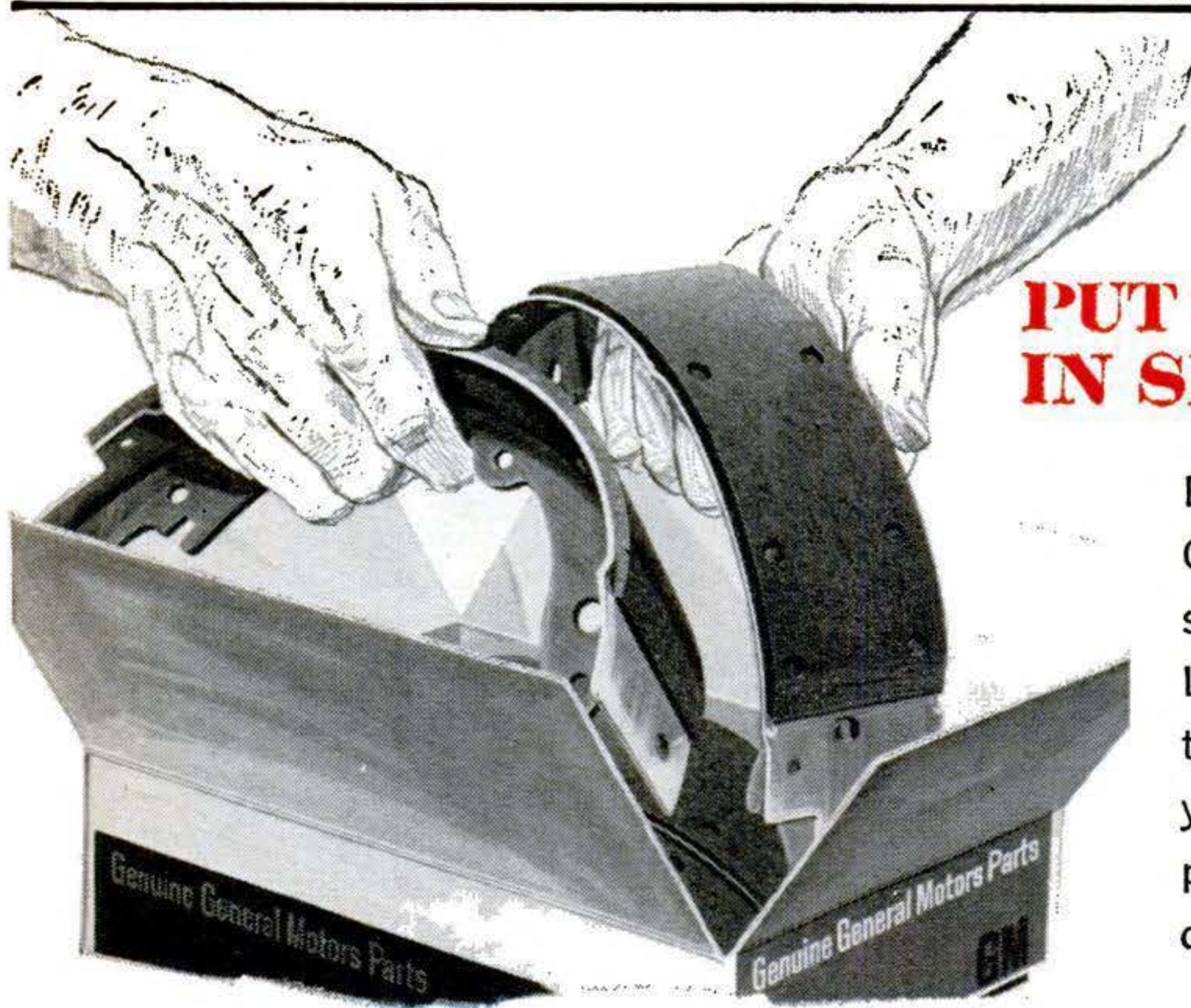
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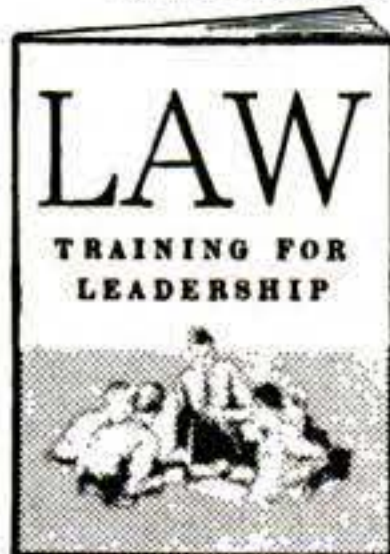
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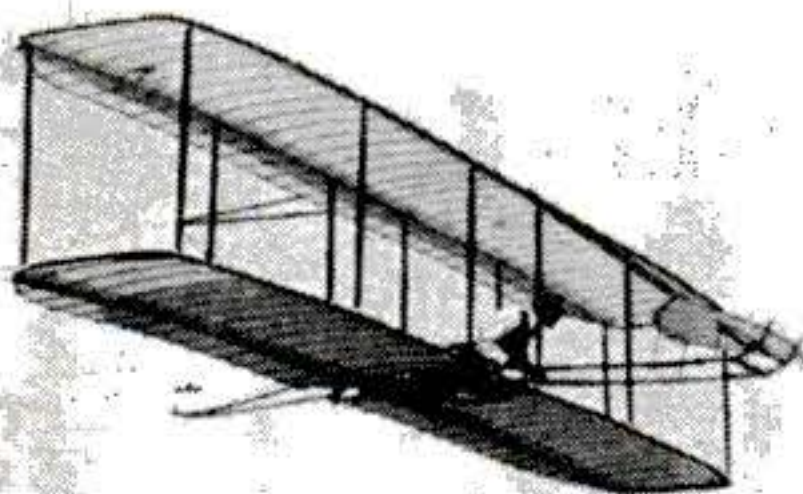
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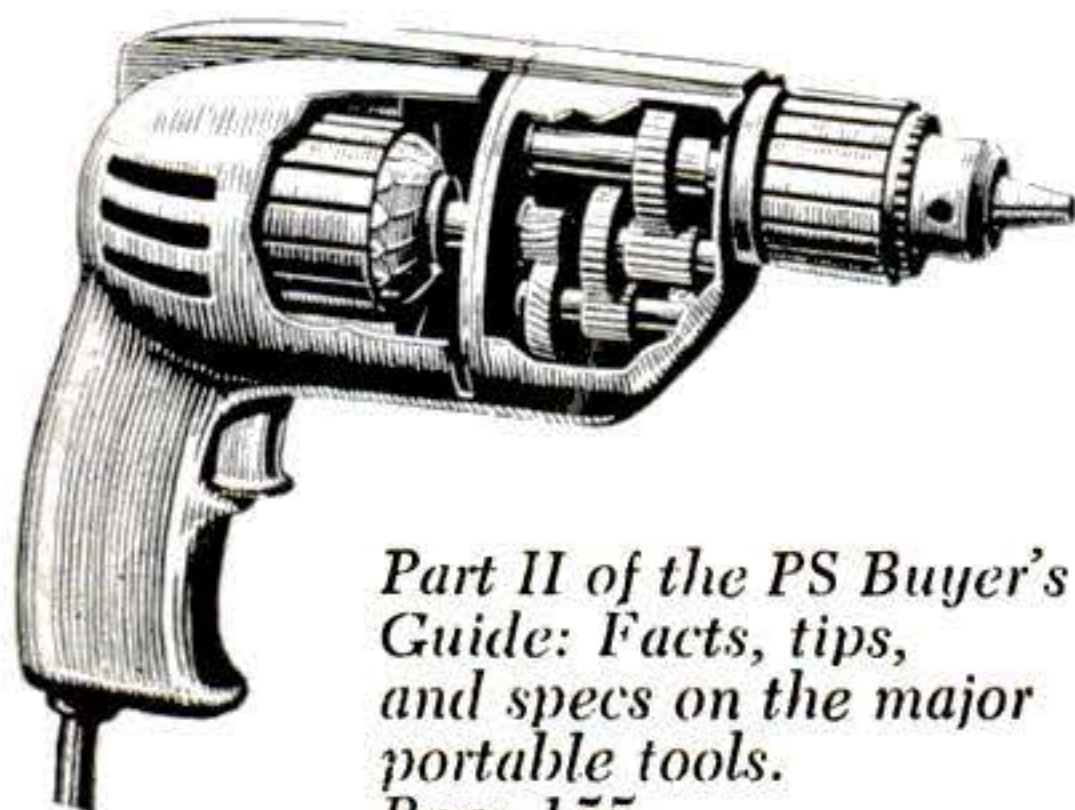
JOHN R. WHITING, Executive Vice-President and Publisher

Cover photo by Bill Morris
December 1963



Sixty years ago this month, two men and a flimsy, powered kite flew into history. Page 51.

Day and night for two tense weeks the drills bit into the earth, while the trapped miners waited and prayed. Here's the moving, eye-witness account of the Sheppton rescue by a PS reporter on the scene. Page 43.



Part II of the PS Buyer's Guide: Facts, tips, and specs on the major portable tools. Page 155.

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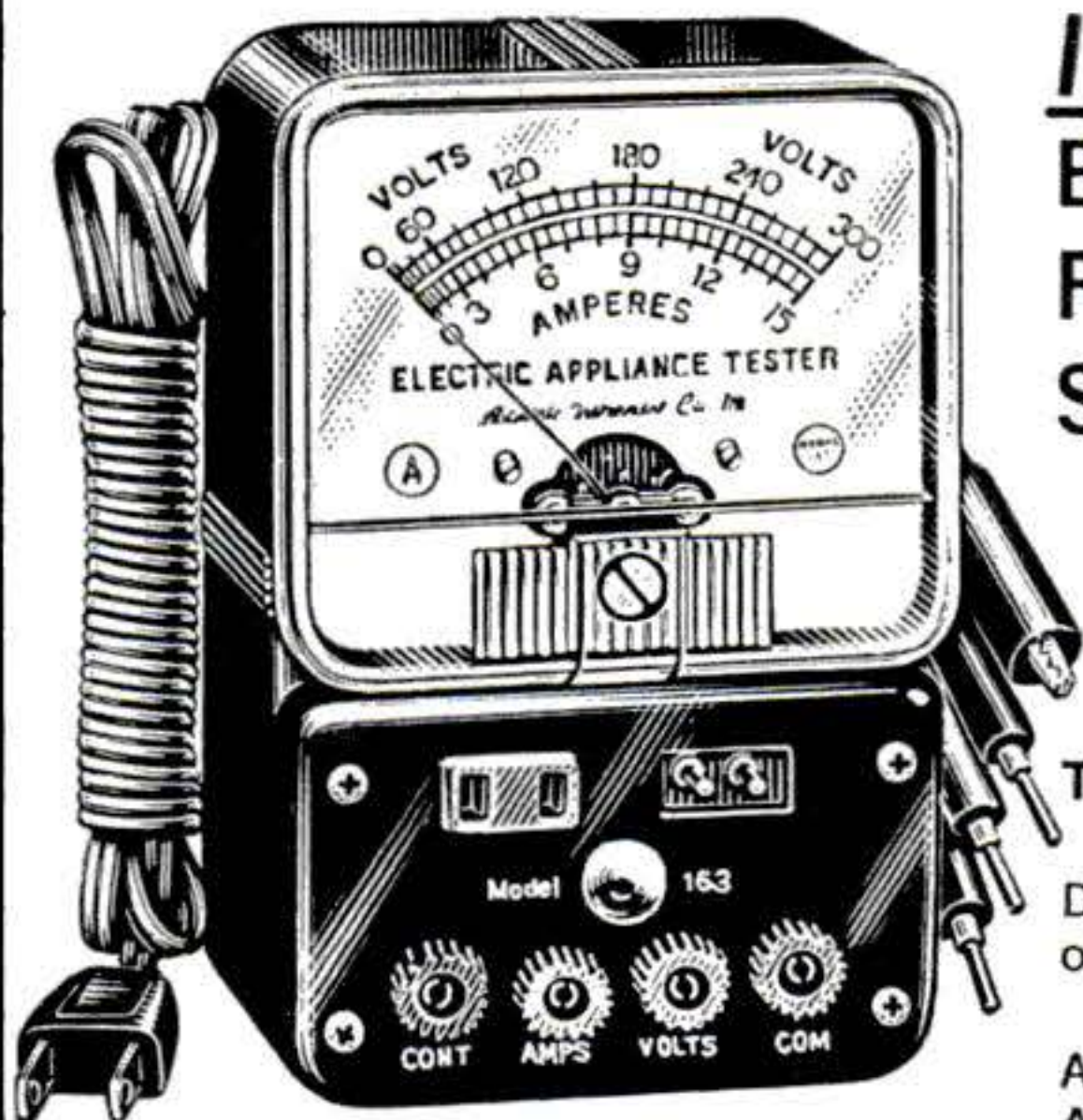
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PS readers talk back

Long-Time Inventor Still Trying

Your article "How to Cash In on Your Invention" [Oct.] makes nice reading for those who have never tried to sell a patent or idea. However, for those of us who have thrashed about in the straitjacket for some 30 or 40 years trying to bring forth new and better things for people, it will probably appear unrealistic.

Who could possibly be interested in eliminating blow-by in the internal-combustion en-



gine if it would require a departure from the engine design that was good enough for grandpa? What politician would listen to a plan for rapid transit that would transport 2½ times as many passengers per unit?

HOWARD B. PEARSON, Burlingame, Calif.

Trunk and Hood—Same Size?

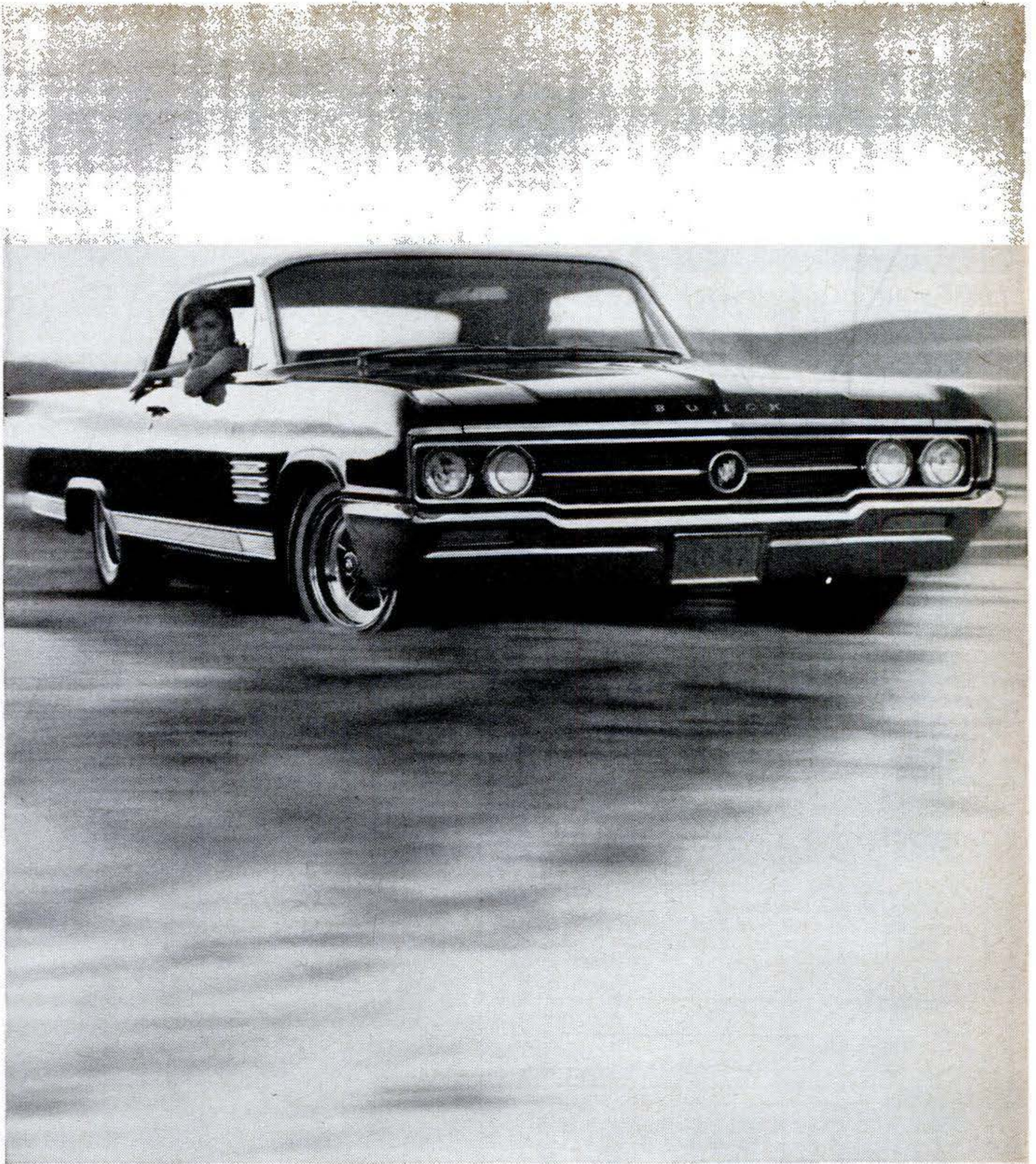
The rear end of practically all cars ["The '64 Look," Oct.] is much too long. Many of them need casters underneath to keep them from scraping on a hill or a ditch or going up a driveway. I think the rear end should be shortened 12 to 20 inches. The average front end, or hood, would make just the right size back end, or trunk. When are we going to get functional, practical cars with beauty?

MAURICE NORMAN, S. Pasadena, Calif.

Somebody Slipping?

I disagree with swimmer K. R. Bowers ["PS Readers Talk Back," Aug.]. For short distances, such as the record held by Weismuller, a well-done flip turn can cut off as much as a half-second from the time. For longer distances, an open turn is less tiring and thus more practical.

As for the "faster and narrower kick" used in the breast stroke, it is used for only one



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Our happiest problem for '64 was: how to beat a winner? According to thousands of owners, the 1963 models just about had it made in all departments. But—when your name is *Buick*—you just don't rest on your laurels. You keep pushing to make a great car greater. So . . . the '64 Buicks are new—but *new*. New engines, V-6 or V-8 (you'll like their new gas economy), new, smoother, extra-cost option, Super Turbine Transmissions (and who, but Buick, would build in an altitude compensator?). Youngest looking Fisher Bodies in town! Visit a showroom, sit in any one of the new Buicks, and practice this short easy line: "My Buick." Sounds good, doesn't it?

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PS readers talk back continued

reason: more propulsion. He should try two kicks and see the difference in power. With a "whip" kick, up to 25 percent more power can be obtained.

Bowers' theory that the crawl kick is used only for leg buoyancy doesn't hold water. Although a good swimmer will have a very efficient arm pull, there's bound to be some slippage due to water not being compressible; thus his arm would emerge behind where it was placed in the water. The swimmer observed must be a very powerful kicker for his arm to emerge at the spot where it was put in.

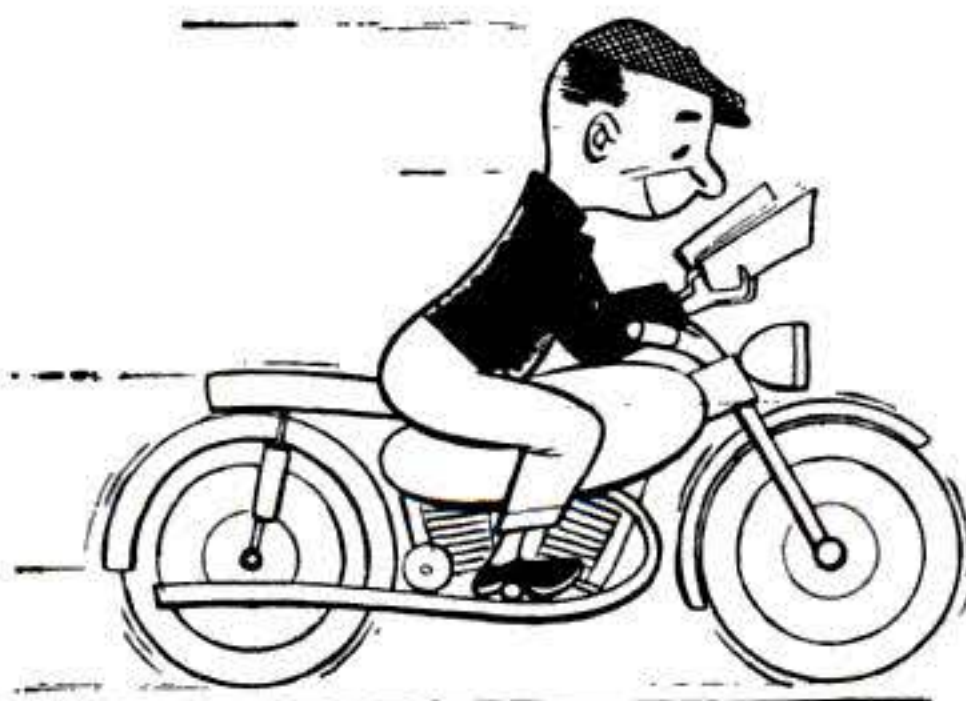
R. E. ELSTER, Coronado, Calif.

... Mr. Bowers may be up on improved swimming techniques, but he has no knowledge of hydromechanical efficiency. Elucidation of his statement, "If the legs were pushing the hand would appear beyond where it went in," surely would insult the intelligence.

I would be more than just pleased if my outboard propeller were even somewhere nearly as efficient as Bowers apparently thinks a swimmer's hand is.

A. H. BLITON, Portland, Ore.

Calming Neglected Cycle Fans



Glad to see that someone is finally testing motorcycles, ["PS Tests H-D's Spirited New Sprint," Oct.]. It's about time you realized the number of cycle fans and how much they appreciate hearing the latest.

DAVID GUSTOFSON, Hallock, Minn.

... Zero to 60 in 4.5 seconds on a Sprint? Your test driver must have had a gale wind pushing from behind!

GEORGE ROGERS, Los Angeles.

Comments author Erik H. Arctander: "Oops, the 4.5-second average was for 0-40 runs in first and second gear, not 0-60. Valve float prevents the Sprint from reaching 60 in second gear."

More Home-Workshop Suggestions

I enjoyed your big ideas in shops ["25 Pages of Big Ideas for Improving Your Shop and Home," Sept.]. I noticed one plan was very

PS readers talk back continued

close to mine—the empty room, where the floor remains clear and clean. Mine has two walls of full-width sliding door panels. The room never looks messy and can be used as a multi-purpose room without anyone knowing it's a workshop.

LARRY TUCKER, Cincinnati, Ohio.

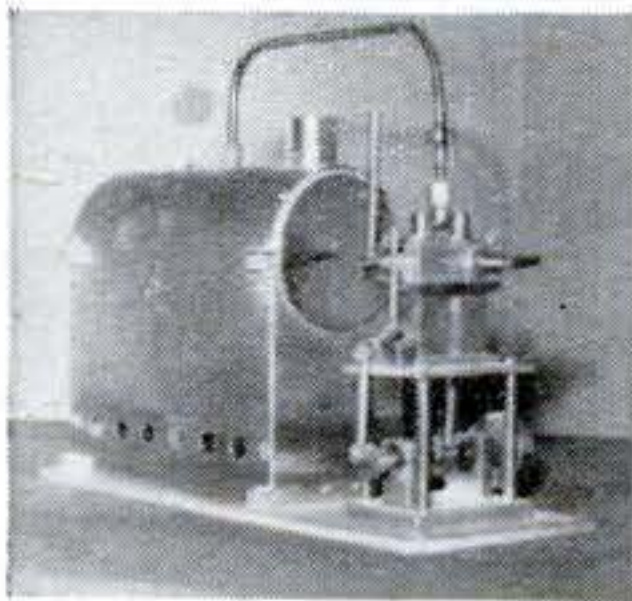
. . . Many fine and practical ideas came out of the shop floor plans. A great deal of experience must lie behind each of these developments. I have just one question. How were these layouts kept so immaculate? Not one of the shops mentioned a shop vacuum cleaner.

ROSS J. KERTSON, Tacoma, Wash.

Maybe we took it for granted everyone had already built one from the plans in Jan. '61 PS.

Old Project Blooms into Workable Model

Here's proof that many of your ideas and plans are easily followed, and not easily forgotten ["Rotary-Valve Steam Engine," Dec. '61]. A few slight alterations were made on the engine itself: exhaust manifold split between cylinders and a modified crankshaft. In addition, I have adapted a very effective boiler.



The machine performs real well and has spent lots of time driving model apparatus.

RALPH WAGNER, Butler, Pa.

Can You Top This?

In response to Mr. Yezzi ["PS Readers Talk Back," Oct.], I finally replaced my original battery at 92,000 miles in my '59 Ford 300. Also had the radiator worked over. First set of tires went 46,000 miles. Went 68,000 miles on a set of points. The original brake lining is still in excellent order at 97,000 miles. Lest you think I baby the car, I've put over 24,000 miles on it since the first of this year—not all on paved roads, either.

REV. C. E. WICHERN, Wilson Creek, Wash.

. . . My '55 Olds went 85,000 miles with the original battery. I attribute this to a set of new points and a condenser every fall. Also, never letting the water get too low in the battery.

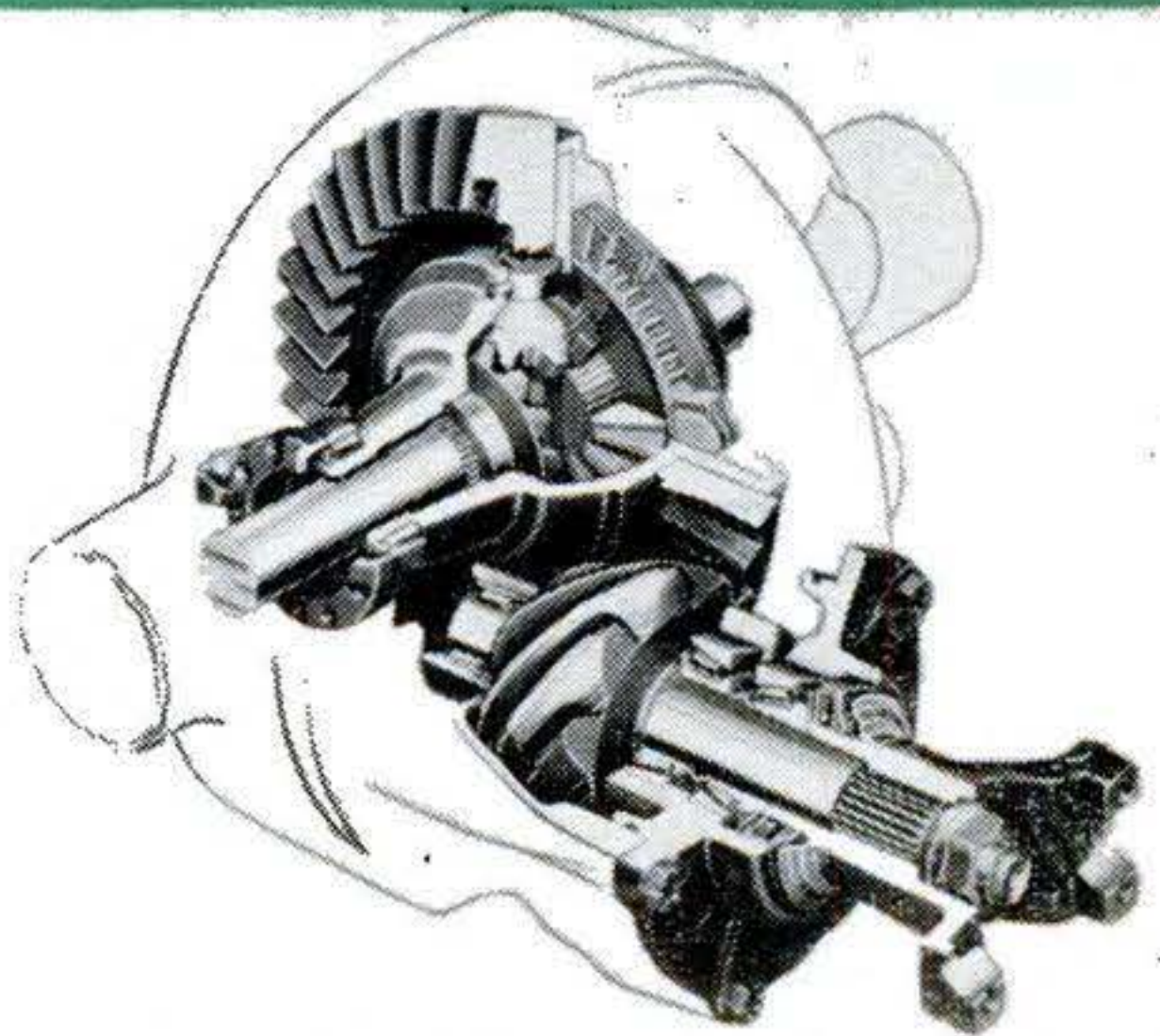
CHARLES BORDEN, Indianapolis, Ind.

Help Wanted Section

I have a '55 Plymouth I keep in good shape and check regularly. Lately when I try to put the car in reverse it stops the engine as if I had hit a tree. Then it takes 10 minutes to get it going in either direction. The garage-

CONTINUED

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PS readers talk back continued

men can't find out what the trouble is. Can anyone help?

H. J. ARMSTRONG, Fulton, N.Y.

... The best mileage I can get with my '62 Chevy II Nova 400 sport coupe with six-cylinder engine is 16-17 m.p.g. I got this mileage with my '56 eight-cylinder station wagon. Anybody else had this complaint, and found a solution?

W. W. KELLY, Los Angeles.

The Mysterious Thaler

Just got this picture of the Maria Theresa thaler ["Deadly Gadgets of the OSS," July]. In 1943, I could have had a bag of these coins which were loose in Arabia by the thousands. I was told at that time that King Saud was



paid lease money in this form and employed trusted servants to bounce the coins individually on hardwood tables to determine their silver content.

The coin is larger than a 25-cent piece, the size OSS Research Director Stanley P. Lovell claims; it's larger than a half-dollar. This one seems to have been minted in San Francisco and the date is 1780, not 1870.

PAUL F. MCGINLEY, Tucson.

Head Spinning Over Stereo?

You have finally done what I have been hoping somebody would do for a long time—made a practical comparison of component parts ["The Low-Down on Stereo Hi-Fi," Sept.]. My next major hi-fi stereo purchase will be based on information gleaned from your article.

DR. DON FENNER, Kodiak, Alaska.

... The hi-fi stereo article really hit the spot for an old coot with only one fairly good ear. Can a tuner be added to the \$125 assembly to bring in stereo FM and AM?

JOHN W. MORTON, San Rafael, Calif.

A tuner can be added quite easily to the \$125 system. We have not conducted comparison tests on tuners and so we cannot make a recommendation at this time.

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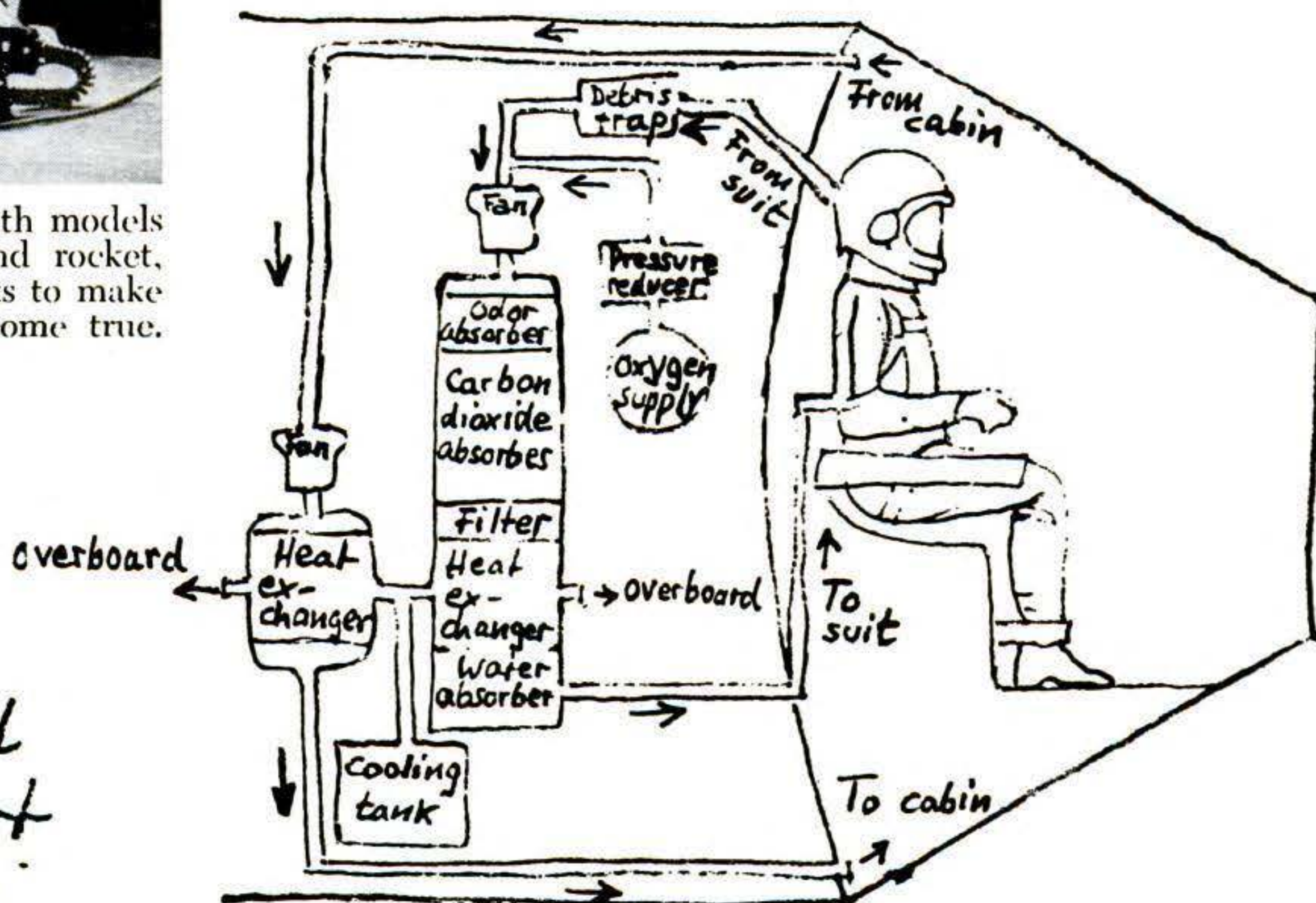
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BEP-86



At desk adorned with models of moon capsule and rocket, Dr. von Braun works to make outer-space travel come true.

Dr. Werner von Braun Tells What It Takes to Survive in Space



*Semiclosed
life support
equipment
used in Mercury spacecraft*

Q *What equipment and supplies does an astronaut need to survive in outer space?*

A Besides food and drink, he needs:

- A pressurized spacecraft cabin, with means for replenishing oxygen, removing carbon dioxide and odor, and controlling temperature and humidity.
- A contour seat, for the high accelerations and decelerations encountered during launch, mid-course maneuvers, and reentry.
- A pressure suit, as protection in case of cabin-pressure loss, and as mandatory equipment if the mission ever requires the astronaut to go outside his spacecraft.
- Sanitary accommodations in accordance with the duration of the mission.
- Some radiation protection, dependent

on the length of the mission and the flight profile. For example, an extended stay in the Van Allen Belts, or a long interplanetary voyage, demands more radiation protection than a low-altitude earth-orbit flight, which can be recalled at short notice in case of a dangerously powerful solar flare.

For very long outer-space flights, a degree of bodily mobility is also likely to be necessary. Some equipment for physical exercise—possibly of the familiar coil-spring kind—may prove indispensable, too.

Among space medical men, opinions still vary as to whether the zero-gravity condition, always prevailing during the unpowered stretches of a space voyage, will turn out to be acceptable for extended periods. Some believe the astronauts will need an "artificial G environment" in such cases.

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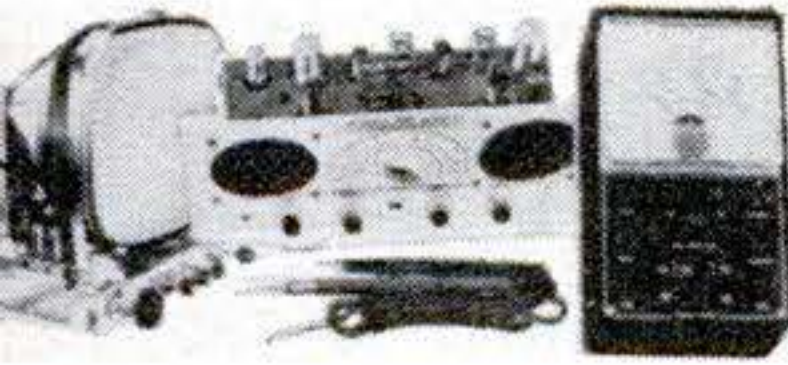


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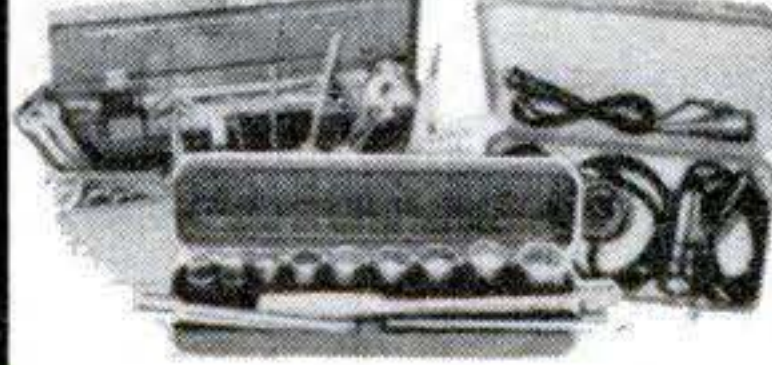
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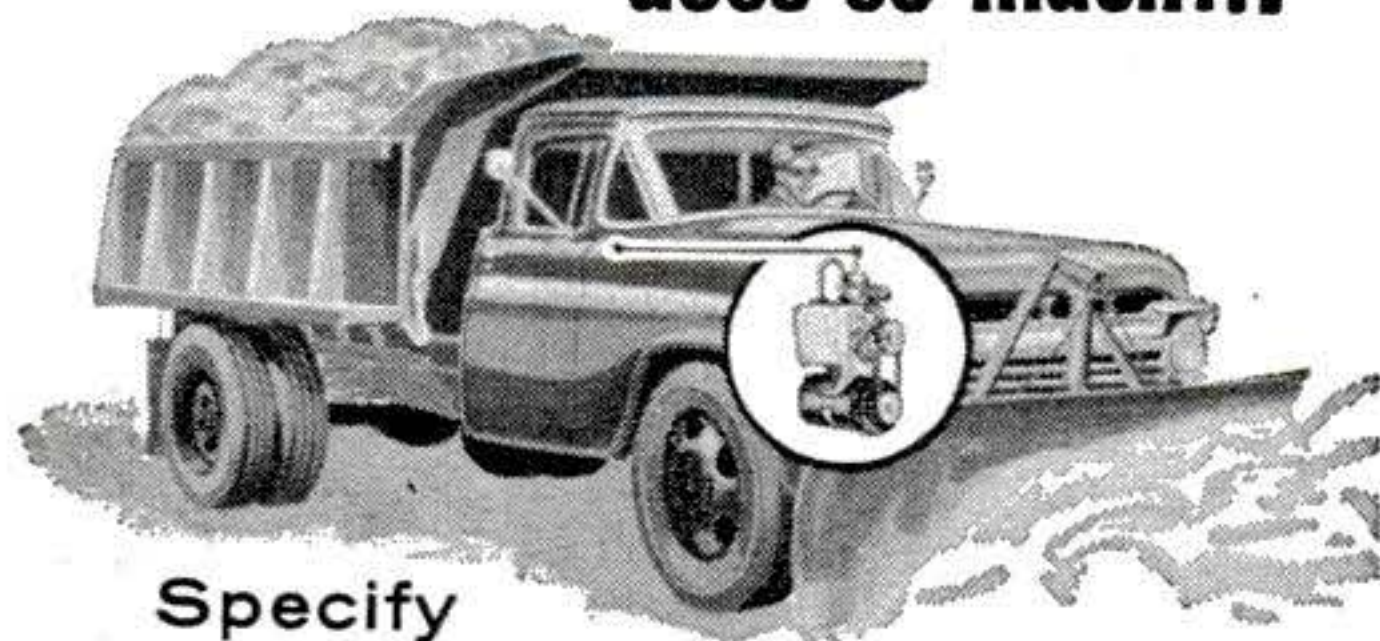
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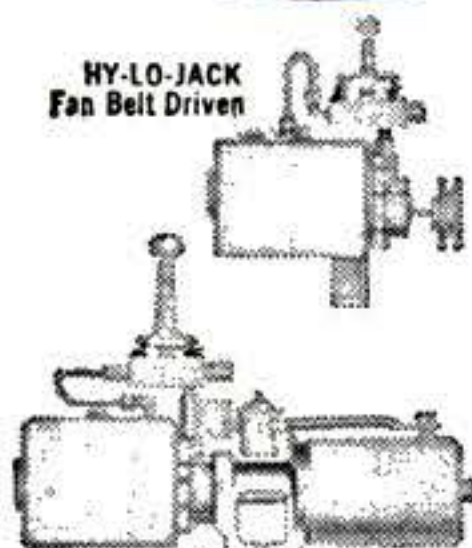
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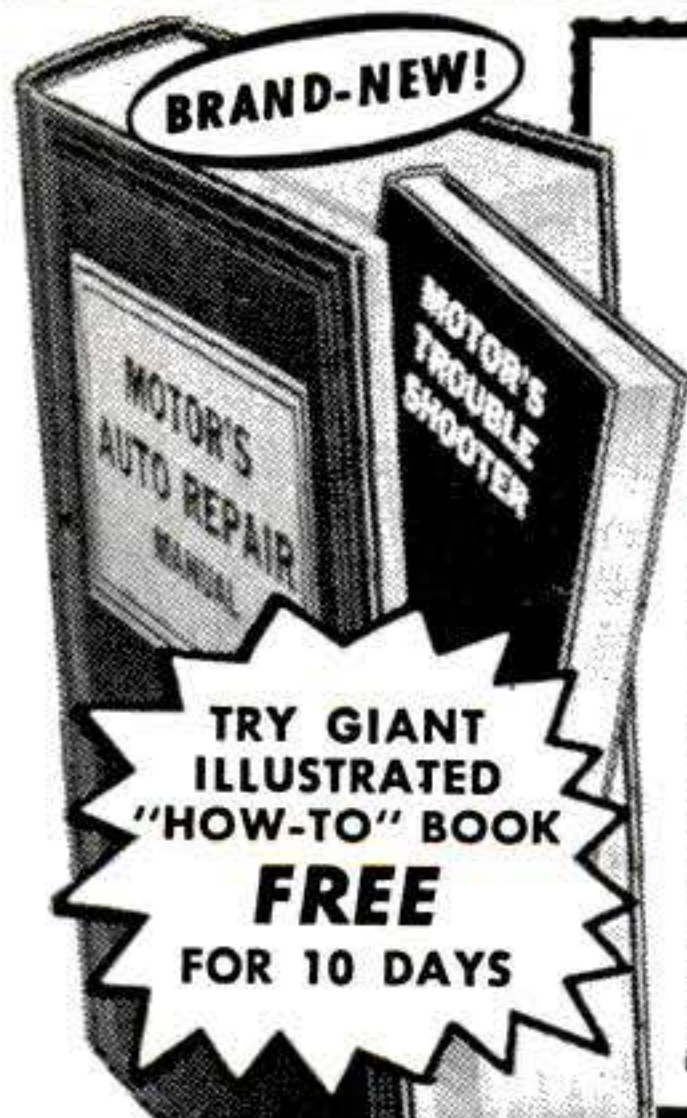
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Dr. Wernher von Braun continued

One scheme would provide a separate "re-conditioning capsule" attached by a cable to the ship's main body, and slowly spinning around it; in this capsule, centrifugal force would then simulate gravity.

Q *Beyond what altitude is it necessary to provide an artificial cabin atmosphere for spacemen?*

A The average person needs some life-support equipment above about three miles. At this altitude, along with the decreased total atmospheric pressure, the partial pressure of the air's oxygen has sunk so low that the lungs cannot absorb enough of it. Hypoxia, or oxygen deficiency in the blood, results. Breathing pure oxygen (at the same reduced total atmospheric pressure) raises the oxygen partial pressure, and provides a ready remedy.

At an altitude of 4½ miles, the unprotected human body faces another difficulty. By now, atmospheric pressure has dropped to a point where the nitrogen dissolved in our blood starts bubbling out. The physics of this is identical with what happens when we open, and thus depressurize, a warm Coke bottle. The effects, however, are decidedly more severe. Some nitrogen bubbles, as the pulsating blood stream washes them through the body, may get trapped in corners such as elbow and knee joints. As the ambient pressure keeps falling, the trapped bubbles expand further and may block off an artery. This causes painful aeroembolism, better known as the "bends." Thus, beyond a limit of 4½ miles or so, pressure cabins or pressure suits (at least, partial-pressure suits), or both, must be provided.

Ten miles up is another biological milestone. By now the atmospheric pressure has become as little as the combined partial pressures of water vapor and carbon dioxide, two substances always present in our lungs. No matter how much pure oxygen we try to breathe, the air sacs of the lungs are now completely filled with this mixture of water vapor and carbon dioxide, and no oxygen can enter the blood stream. This condition is called anoxia.

Just a little higher up, the unprotected, tortured body would virtually boil over. At an altitude of 12 miles or so the air is

so thin that the boiling point of our body fluid drops to around 100 degrees F., which is about our body temperature. Bubbles now form wherever body fluids are openly exposed on surface areas of the body, such as the mucous linings of the mouth and eyes.

While all these milestones of increasing biological hazards had tremendous practical significance in aviation, their importance for spacecraft is actually quite limited. A spacecraft's life-support system must be designed for an extended stay in completely airless outer space, anyway. In less than one minute a manned rocket clears the lower atmosphere, so there is not much chance to take advantage of the less-demanding conditions prevailing there. Hence it does not matter too much to the designer whether his craft is five or 50,000 miles high. He has to provide adequate life support for the most demanding condition, a perfect vacuum outside.

Q *What kinds of life-support systems are there?*

A We must distinguish between three different types of systems: open, closed, and a crossbreed called semiclosed.

An open system simply delivers fresh air or oxygen to a breathing mask, and vents exhaled air overboard. It makes no attempt to retain and recirculate the unused oxygen—or the 79 percent nitrogen in exhaled air. The aqualung is an example of an open life-support system, using air. The oxygen-mask system in unpressurized aircraft is an open system using pure oxygen.

A closed life-support system attempts to duplicate in capsule form the complete miraculous "ecological system" that nature operates on earth: The carbon dioxide that man and beast exhale is absorbed by plants and helps them grow and develop through an intricate process called photosynthesis—the fundamental process of life on earth. Light energy from the sun converts the carbon dioxide into plant-building carbohydrates, while oxygen is released into the air. Men and animals breathe this oxygen, and eat the plants and the fruits they bear, while their body wastes fertilize the soil on which the plants grow.

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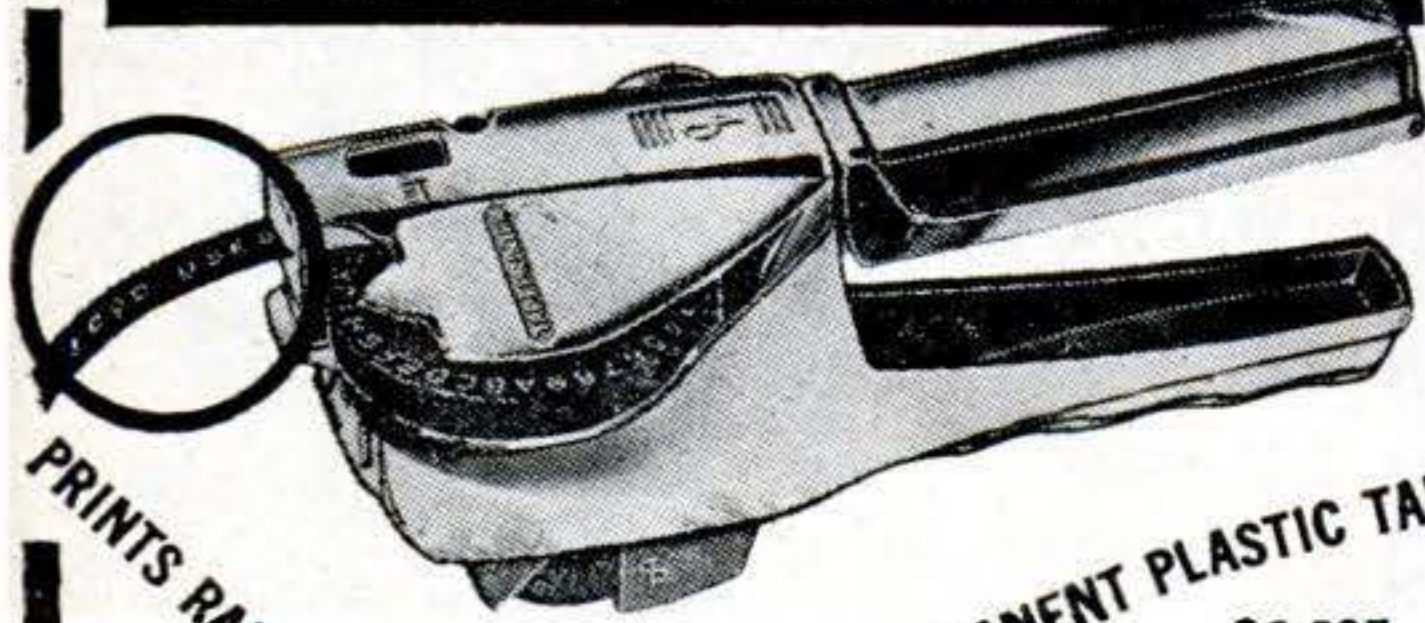
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Dr. Wernher von Braun CONTINUED

to duplicate nature's grand scheme in the laboratory. Most experimenters use certain strains of algae as the plants for the ecological cycle.

Obviously the advantage of the open life-support system lies in its simplicity. But it is very wasteful, and the weight of the air or unused oxygen vented overboard becomes prohibitive for space-flight missions of more than a few hours.

The closed system on the other hand is complicated and relatively heavy. But it is ideally suited for long operating periods, because it puts the sun to work to enable us to reclaim virtually all of the wastes. We can expect such closed systems to be used in manned interplanetary expeditions, and at a permanent base on the moon.

For the Mercury spacecraft's flights, of up to a day and a half, a semiclosed system using a pure-oxygen atmosphere was selected. This system is best explained with the help of my sketch (which I made from a description published by the maker, The Garrett Corporation of Los Angeles).

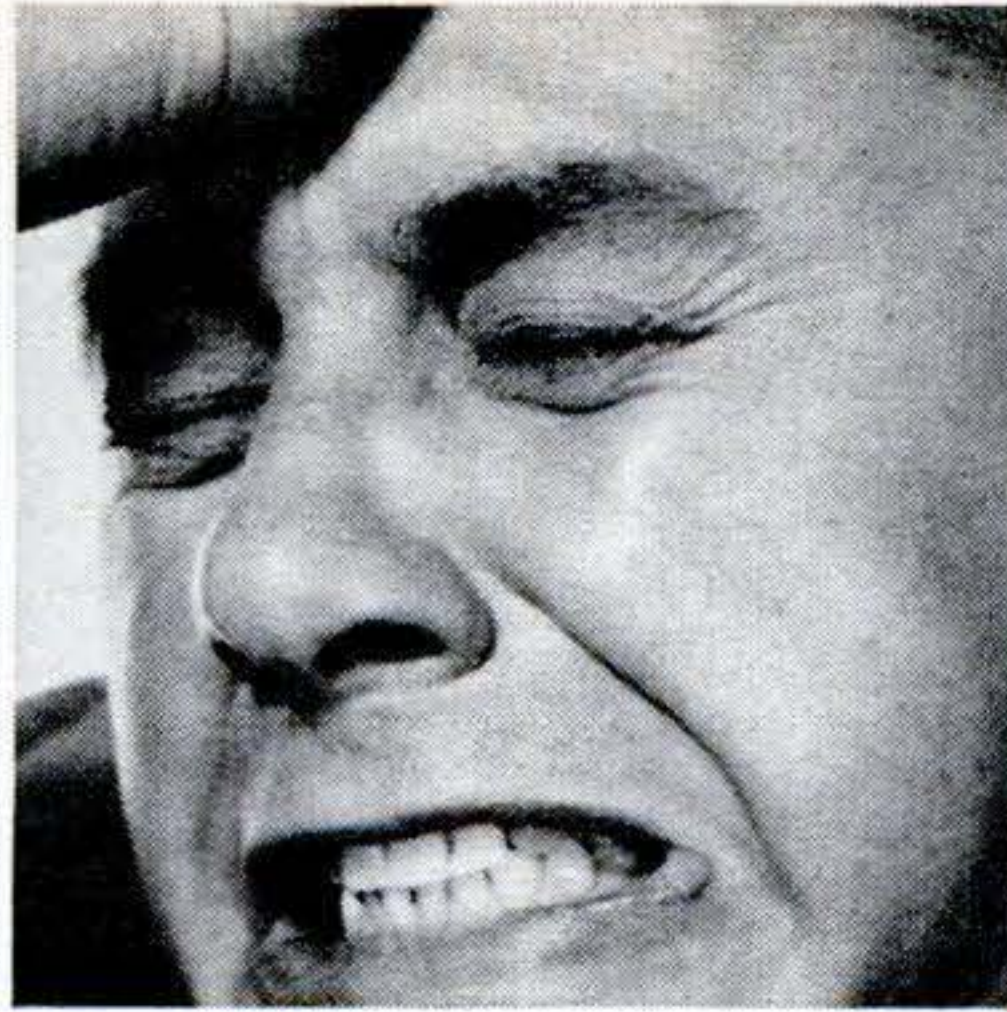
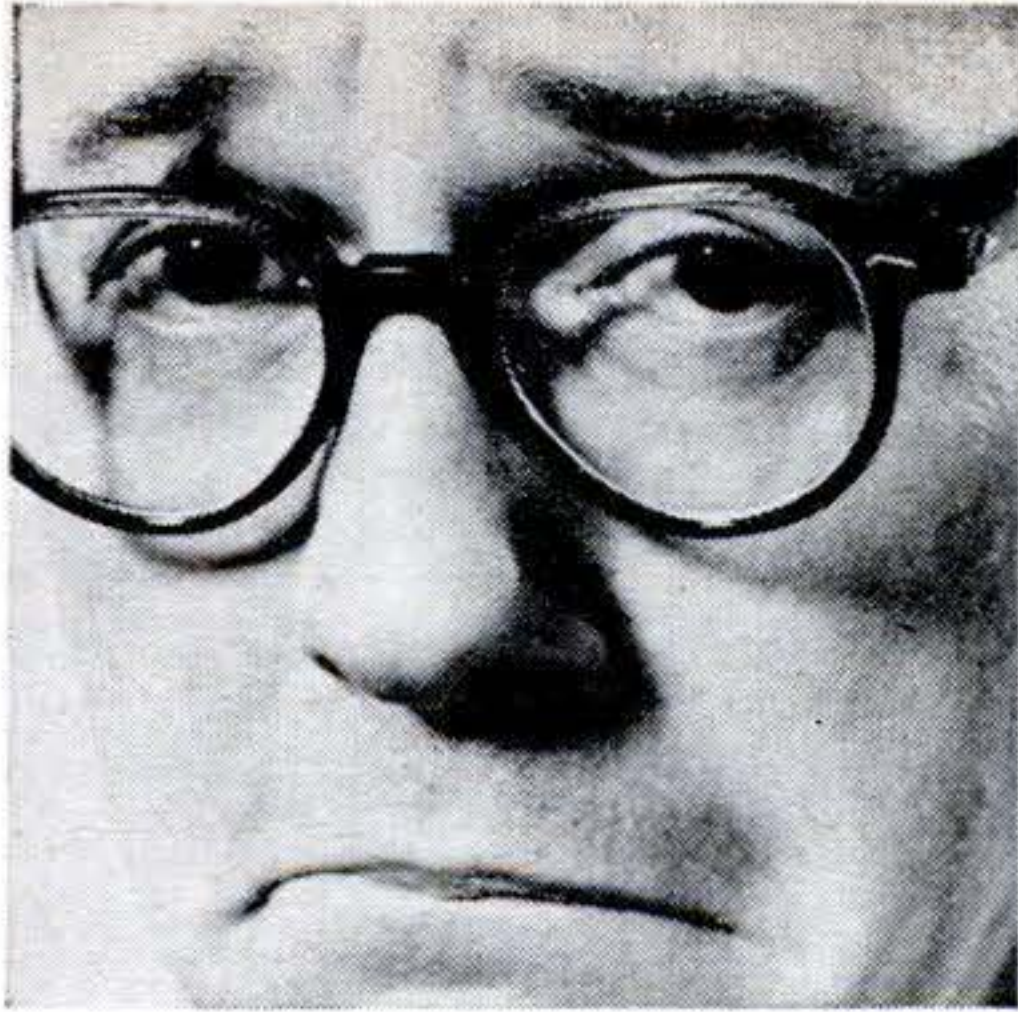
How Mercury life-support system works

As shown, there are two almost independent recirculation cycles—for the pressurized cabin and the pressurized space suit. Water-cooled heat exchangers, inserted in both cycles, dissipate the heat generated by the astronaut himself and by all the electrical gear. A supply of oxygen—carried in gaseous form at 7,500-pound pressure—replenishes the suit cycle with fresh oxygen, to the same extent that an absorber removes exhaled carbon dioxide.

This system proved entirely adequate for the limited duration of the Mercury flight missions. Many medical experts believe, however, that for flights of much longer duration it will be necessary to replace the semiclosed oxygen system with a semiclosed air system—that is, a system where the oxygen is diluted with nitrogen or other inert gases. According to Soviet reports, the man-carrying Vostok spacecraft all used semiclosed air systems. ■ ■

.....
Dr. von Braun will consider answering questions from readers of POPULAR SCIENCE in the magazine, but he cannot undertake to answer each one by mail. Letters to him should be addressed in care of POPULAR SCIENCE, 355 Lexington Ave., New York, N.Y., 10017.

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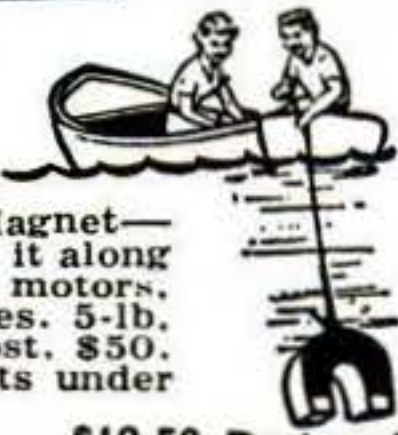
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Science newsfront

BY WALLACE CLOUD

A monthly report: What's going on in science and why it's important to you

WEAPONS

Brainwashed missiles

Has the U.S. "invested billions of dollars in a 'Magenot Line' of Atlas, Titan, and Minuteman missiles that could be rendered useless" by an "electromagnetic pulse phenomenon" in the event of Soviet nuclear attack? Allegedly, the underground missiles would not be destroyed, but their electronic systems would be paralyzed.

This specter has been raised by a series of articles in a space-industry magazine, *Missiles and Rockets*, which purport to reveal classified testimony before a Senate committee. Apprehension over the electromagnetic effect is said to be a reason for opposition to the U.S.-Soviet test-ban treaty by Gen. Thomas S. Power, chief of the Strategic Air Command.

According to *Missiles and Rockets*, "the possible effect of the burst of electromagnetic energy from an exploding high-yield weapon is . . . similar to what happens when lightning strikes a radio. It is believed to be capable of fusing wires, burning out circuits, and causing other extensive damage . . ." Target and guidance data stored on magnetic tapes and drums might also be erased.

The range over which such damage could occur is presumed to be more than 120 miles from ground zero. It's claimed that a low-yield bomb test in Nevada (less than 20 kilotons) "popped circuit breakers on power lines more than 100 miles away in California." The electromagnetic pulse would not affect Polaris missiles in submarines or nuclear bombs in aircraft far from U.S. shores.

The magazine has refused to reveal the source of much of its information, but quotes supporting statements from scientists connected with General Electric, Lawrence Radiation Laboratory, and Stanford University.

If this exposé is accurate, our "second-strike deterrent posture" may be seriously impaired, since our underground missiles

can conceivably be immobilized if the Russians ever deliver a first strike. On the other hand, it is logical to wonder if we could really make the blunder of digging all those silos without being sure the missile sites were "hardened" against all possible nuclear effects. The charges seem to strengthen the case for more roving Polaris submarines and manned aircraft capable of delivering nuclear bombs.

SPACE TECHNOLOGY

Seeing the invisible flame

The flame of pure hydrogen burning in air is so colorless and transparent, and the gas can ignite so easily, that anyone working with hydrogen could walk into the flame and be fatally burned without warning. When space boosters use liquid hydrogen for fuel, both liquid hydrogen and liquid oxygen will have to be handled on the pad—a horrifying combination.

Doing something about it has been one of the objectives of General Dynamics/
CONTINUED



Gasoline in brick form burns quietly in a demonstration at Southwest Research Institute, San Antonio, Tex., where experiments to develop a satisfactory method of solidifying gas are under way. The bricks stacked in the background are made of a spongelike material that holds the gasoline in microscopic leakproof cavities. They are about 96 percent gasoline. A possible use is in air-dropping fuel supplies to troops—the cushionlike bricks are safer to drop than tanks or cans. The liquid gasoline can be recovered by squeezing the bricks.

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Science newsfront continued

Astronautics, builder of the Centaur, the first rocket to use liquid hydrogen. GD/A engineers have come up with a system that allows surveillance of launching sites and hydrogen-fueled rockets in flight.

The method is simple and ingenious. Take a television camera and put a filtering lens system on it to transmit infrared waves but not visible light. Now you can see the heat from the invisible flame, but not its surroundings. So an ordinary TV camera is mounted beside the infrared camera, covering the same area. Electronically, the images from the two cameras are superimposed on one television screen—where the hydrogen flame now looks like any other flame.

Space slush. A mixture of liquid hydrogen and more hydrogen—frozen solid—is recommended as a rocket fuel by the Linde division of Union Carbide, a major supplier of ultracold liquefied gases. Slush containing about 50 percent hydrogen ice will flow through pipes, Linde says. Advantages over liquid hydrogen alone: a smaller tank is required for a given amount of fuel, and there's less loss through boil-off.

BIOLOGY

A prize for mixed-up science

The giant nerve cell of the squid was a subject of research for which two British scientists and an Australian will share a Nobel Prize this month—a fact that might be contemplated by congressmen too quick to ridicule far-out-sounding basic research. Good scientists are not necessarily screwballs, but they know that odd things may turn out to be important.

Another example of the crazy mixed-up science we have today is that the Nobel award in "physiology or medicine" has been going to biophysicists in recent years—men who can apply the physicist's approach to biological problems. Of the recipients this year, one, Sir John Carew Eccles of Australia, is a neurophysiologist. But the backgrounds of the others are a bit strange: In World War II, Dr. A. F. Huxley worked on the mathematics of anti-aircraft gunnery, while Dr. Alan L. Hodgkin developed radar apparatus. The strength of these men lay in

their ability to apply mathematical and electronics techniques to the study of signal transmission in nerve cells.

To get back to the squid: Some of its nerve cells are among the largest in the animal kingdom (1/50-inch in diameter), a convenience when it comes to inserting tiny electrodes to measure electrical events that take place when a nerve cell "fires." Drs. Huxley and Hodgkin found out that the basic mechanism that boosts an impulse along the nerve is the surging of sodium and potassium ions—electrically charged fragments of molecules—back and forth through the outer membrane of the cell. Dr. Eccles independently extended their findings to the transmission of signals across junctions between nerve cells, using micro-electrodes inserted into the spinal cords of anesthetized cats. Since there's a fundamental similarity between all nerve cells, both sets of research resulted in mathematical descriptions that contribute to a better scientific understanding of the human brain and nervous system.

SPACE

Future of Nimbus in doubt

An article on weather satellites in POPULAR SCIENCE last month ["The Weather Eye That Never Blinks"] hailed the forthcoming Nimbus satellite as the more advanced successor to the highly successful Tiros series. The U.S. Weather Bureau has withdrawn funds earmarked for use in NASA's Nimbus program, primarily because of the relatively short expected lifetime of Nimbus (less than a year). So Nimbus is not likely to become operational, although NASA still plans to launch two or three Nimbus spacecraft for experimental purposes.

Dilemma. PS Editor Bob Crossley, returning from the West Coast, reports that the Air Force research pilot school at Edwards AF Base had to cut back requirements for new Dyna-Soar space-pilot trainees. After figuring out what skills and experience were desirable, training officers realized anyone who could meet those requirements would have to be at least 37 years old. They're looking for men about 10 years younger than that.

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Detroit report

By Alex Markovich

A flurry of fastbacks

Fastback styling promises to become a bigger craze in Detroit than even the ubiquitous Thunderbird roof.

Chrysler will introduce a fastback sedan with Valiant chassis within a few months to compete with the 1964½ Falcon fastbacks.

Also coming is a new Corvair Monza—a two-seater with a 90- or 95-inch wheelbase.

And American Motors and General Motors are preparing fastback designs for 1965.

Littler and hotter

The talk around Daytona Beach, where our editor, Bob Crossley, had gone to watch four 1964 Comet Calientes buzz around Bill France's 2½-mile turnpike to determine how long an American car could keep going at 100 m.p.h., was mostly about "little" cars and how they are going to move in on stock-car racing in '64.

NASCAR, which had already reduced the engine limit for its Grand National class from 1963's 427.2 cu. in. to 396.5, this fall cut the wheelbase minimum from 116 inches to 114. By coincidence, this is just short enough to permit such whirlwinds as the Tempest GTO [PS, Nov. 1963], the new Chevelle (Smokey Yunick, who stuck with Chevrolet despite a famine of engines and parts, is rumored to be tinkering with a couple of Chevelles), and the Comet to run

with their big brothers. In fact, some of the big brothers may not run. As Fran Hernandez, Mercury's manager of performance and evaluation, explained to us, "Why put a 396-inch engine in a 3,600-pound Marauder when you can put it in a 2,800-pound Comet?"

Ford, rumored to feel the same, may show up at Daytona next February with a 390-incher in a Fairlane instead of the bigger Galaxie.

USAC, incidentally, will retain the old 427.2-cu.-in. engine size limit and 116-inch wheelbase minimum.

By Oct. 29, three of the Comets clicked off their 100,000th mile at an average of around 108 m.p.h. A fifth, hopped up a bit more and driven flat-out by Iggy Katona and Jack Shanklin, set new world's records for a Class C car (3,000-5,000 cc.) for both 500 and 1,000 miles the day we were there: 131.697 and 129.847 m.p.h. It later averaged 124.421 for 10,000 miles.

Next year's Fords

The number of Pontiacs undergoing tests at Ford Research is far greater than that of any other competing car, one Ford engineer reports. Ford, jealous of Pontiac's sales success with wide-track chassis, racing image, and crisp styling, is expected to introduce its version of this winning combination in its 1965 models.

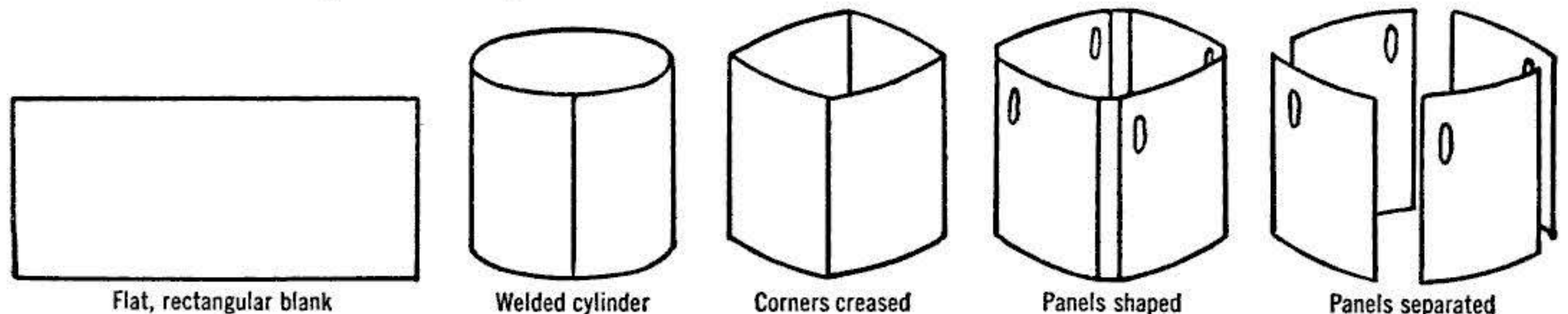
Fords and Mercurys will sport a new wide-track frame with torque-box construction and channel side rails—GM calls it a perimeter-type frame. It's lighter, cheaper, allows more interior room. Look also for four-wheel coil springing on some 1965 Ford models.

Stretched body panels save \$\$\$

Detroit is sizing up a new way of making body panels—the stretch-press method developed by Wallace Expanding Machines of Indianapolis. Flat sheets of metal are rolled and welded into open-end cylinders. Four dies inside the cylinder expand to form

four panels simultaneously. Then the panels are separated by a four-way splitter. Advantages: a saving in manpower and reduction of waste material.

British Motor Corp. has been using the method to make door panels for the MG Sports Sedan and related cars. Savings amount to as much as 50 cents a door.



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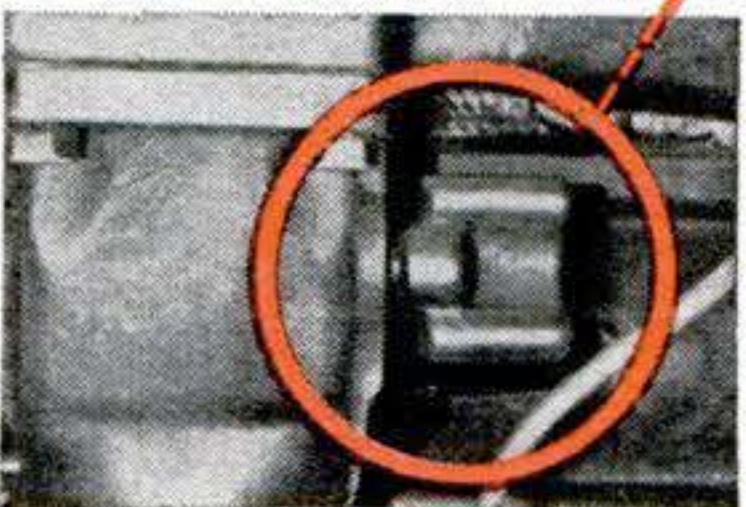
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Lovejoy's Vocational School Guide (\$2.95 paperbound, Simon and Schuster, NYC) is now available in a second edition. The 174-page handbook lists 1,059 private trade and technical

schools; 1,286 schools specializing in training for white-collar jobs; 363 schools for decorative arts; 98 for the performing arts; 2,803 for medical and health services; and many others.

Is there a doctor in the house? There may not be if the ratio of doctors to the general population doesn't improve. For the past 20 years the ratio has stood at about 133 physicians per 100,000 persons in the U.S. Trouble is, the population is now growing by leaps and

bounds while the number of doctors graduating from the country's medical schools stays constant. A group of consultants working under the Surgeon General foresees a critical shortage in the next decade. One remedy: Add at least 21 new medical schools.

What are college graduates doing two years after graduation? Here's what the National Science Foundation found after querying 41,000 graduates of 1,200 colleges:

- More than a third had attended graduate or professional school.
- About three-fourths were working,

80 percent of these in jobs classed as "professional." Most jobs were related to the college major.

- Sixty percent felt that they made considerable use of their special fields of study in their work.
- Forty-three percent felt they needed a specialized degree to get a job.

"Where can I take a correspondence course in commercial photographic-reproduction techniques?"—R.R.O., Phoenix, Ariz.

These schools, accredited by the National Home Study Council, may help:

School of Modern Photography, 721 Broadway, NYC 3.

American School of Photography, 835 Diversey Parkway, Chicago 14.

New York Institute of Photography, 10 West 33 St., NYC 1.

"I'd like to become a forester. What training is required? What high-school subjects should I take?"—R.H., Denver.

A bachelor's degree in forestry is usually the minimum educational requirement. The

Society of American Foresters accredits 28 colleges and universities in the field. Among them: Colorado State College, University of California, University of Maine. The best high-school preparation would be a broad academic program with as much English, math, and science as you can get.

"How does a person get started in auctioneering?"—J.A.C., Dubuque, Iowa.

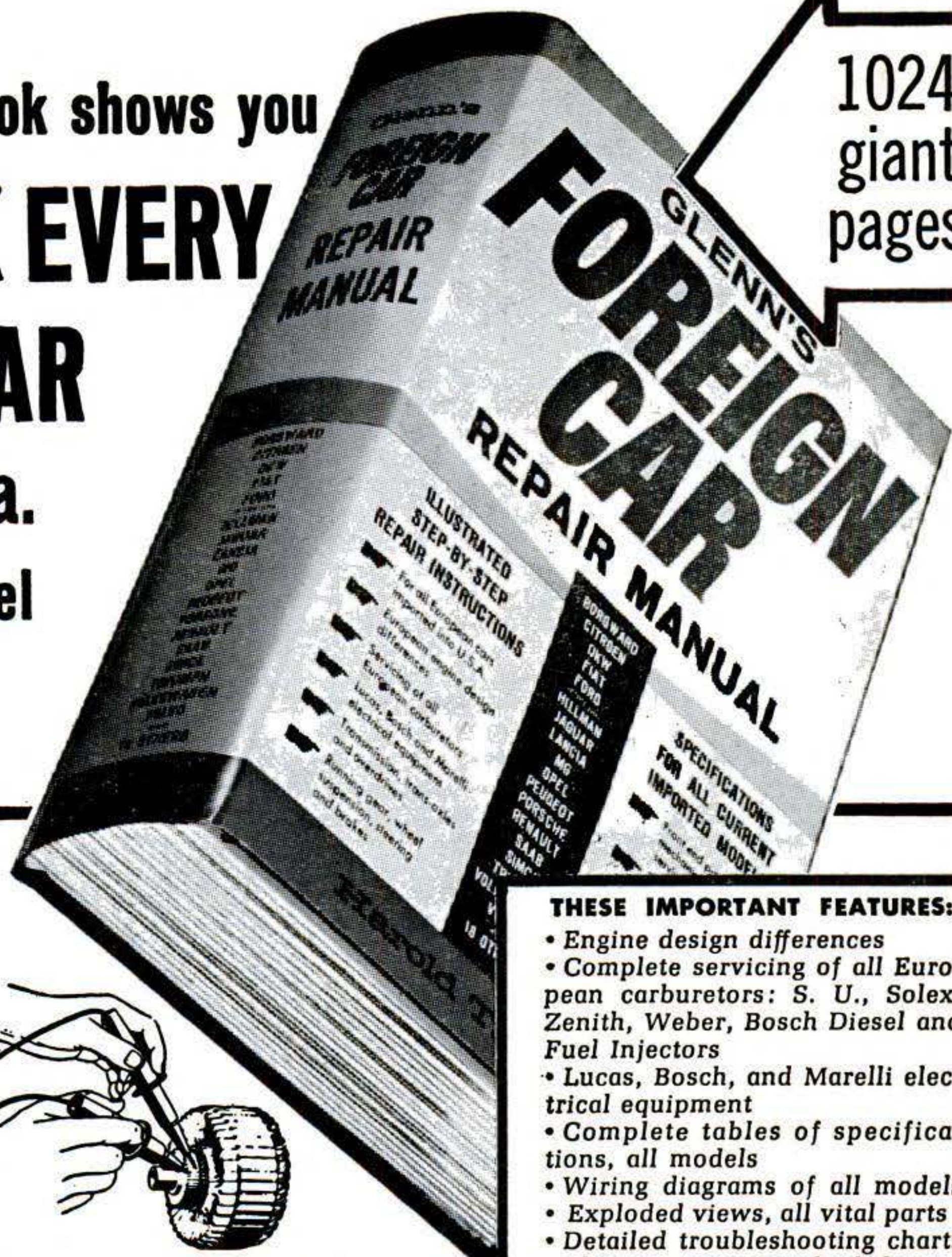
Most auctioneers learn their trade on the job. They start as clerks or assistants and work their way up. However, some schools do offer training. You might investigate:

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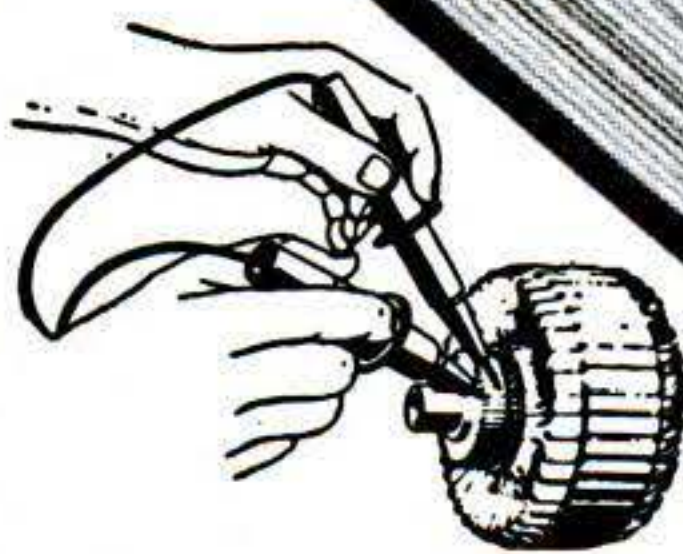
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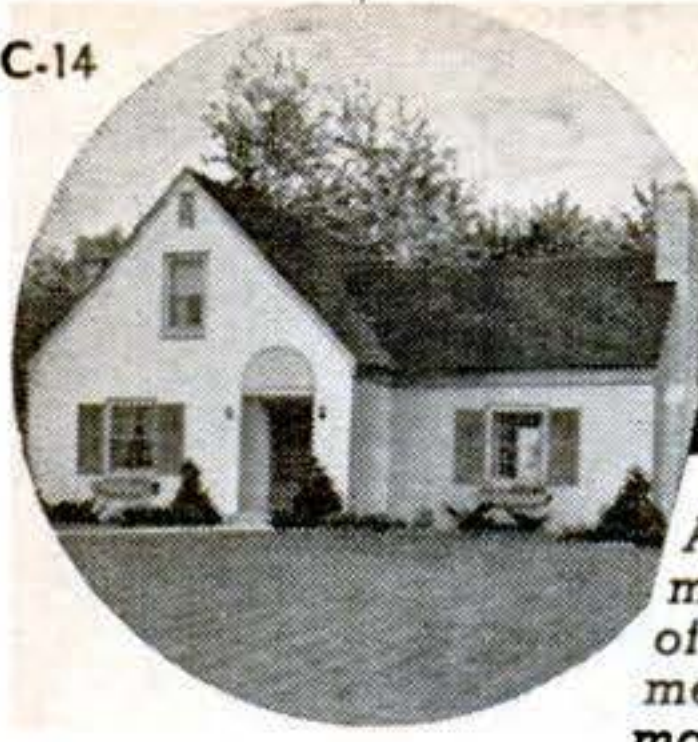
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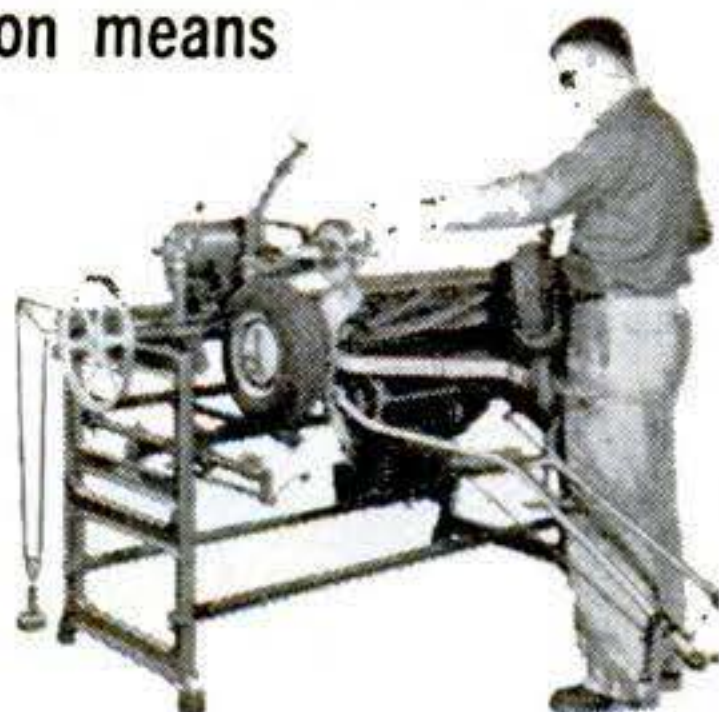
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Getting Ahead continued

Reisch American School of Auctioneering, 14 Oak Dr., Mason City, Iowa (two-week course).

Missouri Auction School, 1330 Linwood Blvd., Kansas City, Mo. (also offers home study).

I would also recommend the pamphlet *Auctioneer* (35 cents, Chronicle Guidance Publications, Inc., Moravia, N.Y.).

"An industrial firm wrote me a letter containing several phrases I didn't understand. What do they mean by 'an undergraduate degree in engineering' and 'our product-planning analysts generally have devoted three to five years to another related phase of the business'?"—L.G., Brooklyn, N.Y.

An undergraduate engineering degree is the first college degree (bachelor of science in engineering). It is obtained after satisfactorily completing four or five years of college work.

The second phrase refers to a common practice in industry of requiring certain groups of technical and supervisory personnel to have broad experience within the company. The product-planning people, for example, might be engineers already experienced in production, research, or design.

"What are the chances of a correspondence-school graduate in high-school subjects entering an accredited engineering college? Is there any special examination that could validate his grades?"—G.A.F., Hilo, Hawaii.

Most engineering colleges require graduation from an accredited high school as a prerequisite for admission. Correspondence-school courses may not meet this requirement. However, you can get a General Equivalency Diploma (G.E.D.) to validate correspondence work by taking an examination. Arrangements can be made through your local school system.

I would point out, however, that you would also have to meet certain requirements in mathematics, science, and English, as well as getting satisfactory grades in some standard exams like those given by the College Entrance Examination Board.

"I'm interested in a career in aeronautical engineering. What accredited

Getting Ahead continued

schools are there?"—B.H., Raleigh, N.C.

For general information you might read: *Aeronautical Engineering as a Career* (\$1, Institute for Research, 537 S. Dearborn, Chicago 5), or *Aeronautical Engineers* (45 cents, Science Research Associates, 57 W. Grand Ave., Chicago 10).

There are about 30 aeronautical-engineering curriculums accredited by the Engineers' Council for Professional Development. Here are some of the schools listed:

- Polytechnic Institute of Brooklyn.
- Iowa State University (Ames).
- University of Maryland (College Park).
- New York University (NYC).

A and M College of Texas (College Station).

"Where can I study marine biology?"—R.F., Hartsdale, N.Y.

About 20 U.S. colleges offer majors in marine biology and fisheries. Here are a few:

- University of Connecticut (Storrs).
- University of Miami.
- Indiana University (Bloomington).
- University of Wisconsin (Madison).

"Where can I learn shoe repairing?"—L.J.C., Cleveland.

Courses are available in some public high schools and in private trade schools. Here are three:

Illinois School of Shoe Rebuilding, 6455 South Rhodes Ave., Chicago (12-week course).

Knott's Master Shoe Service, 314 South Mulberry, Muncie, Ind. (850-hour course).

Technical Trade School, 221 Seventh Ave., Altoona, Pa. (65-week course).

"What local schools offer training in display work?"—D.H.A., Clifton, N.J.

Abbe Institute, School of Fine Arts, 170 Fifth Ave., NYC (four-year course).

Evening School of Art and Design, 1075 Second Ave., NYC (for professionals).

Traphagen School of Fashion, 1680 Broadway, NYC.

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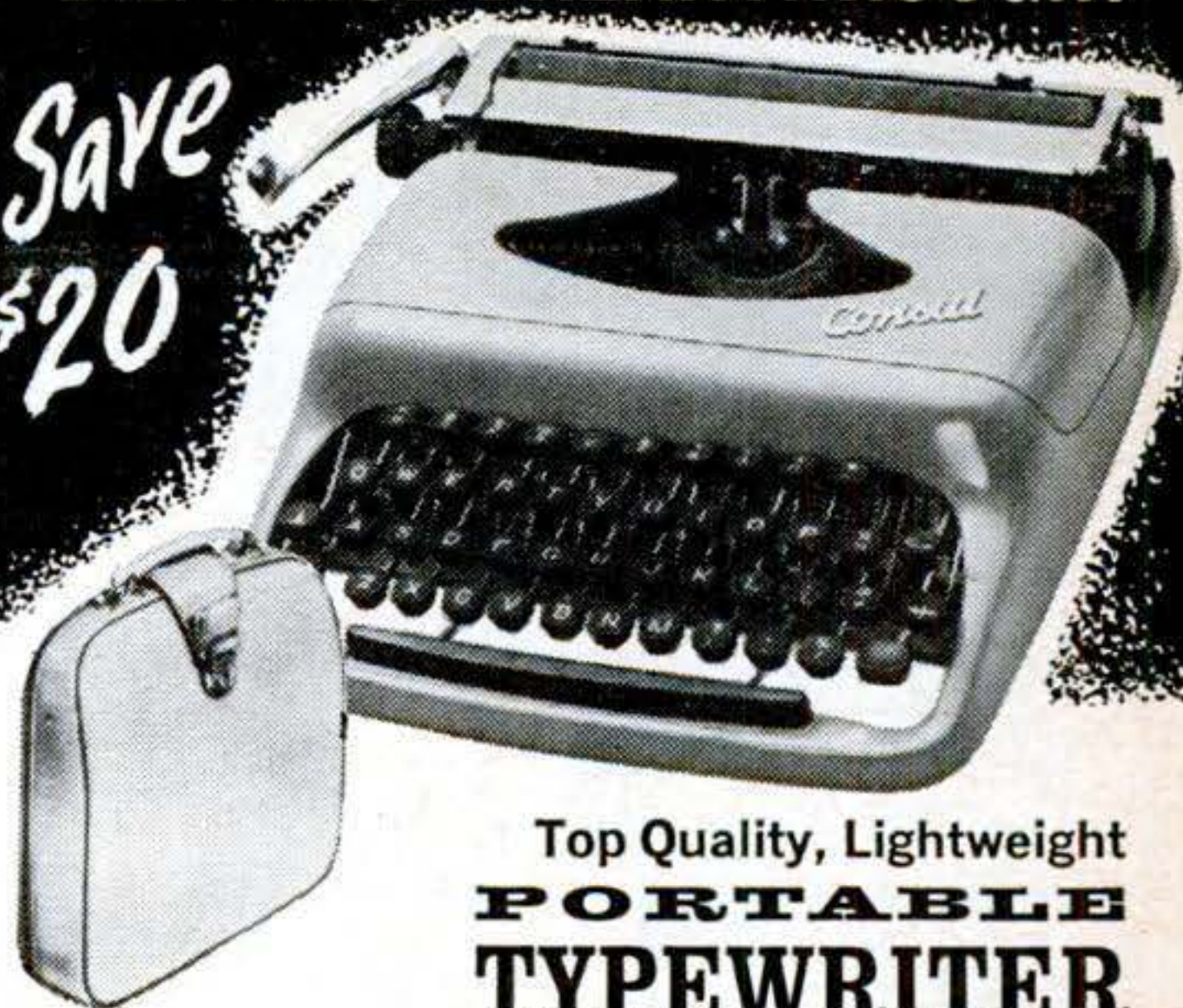
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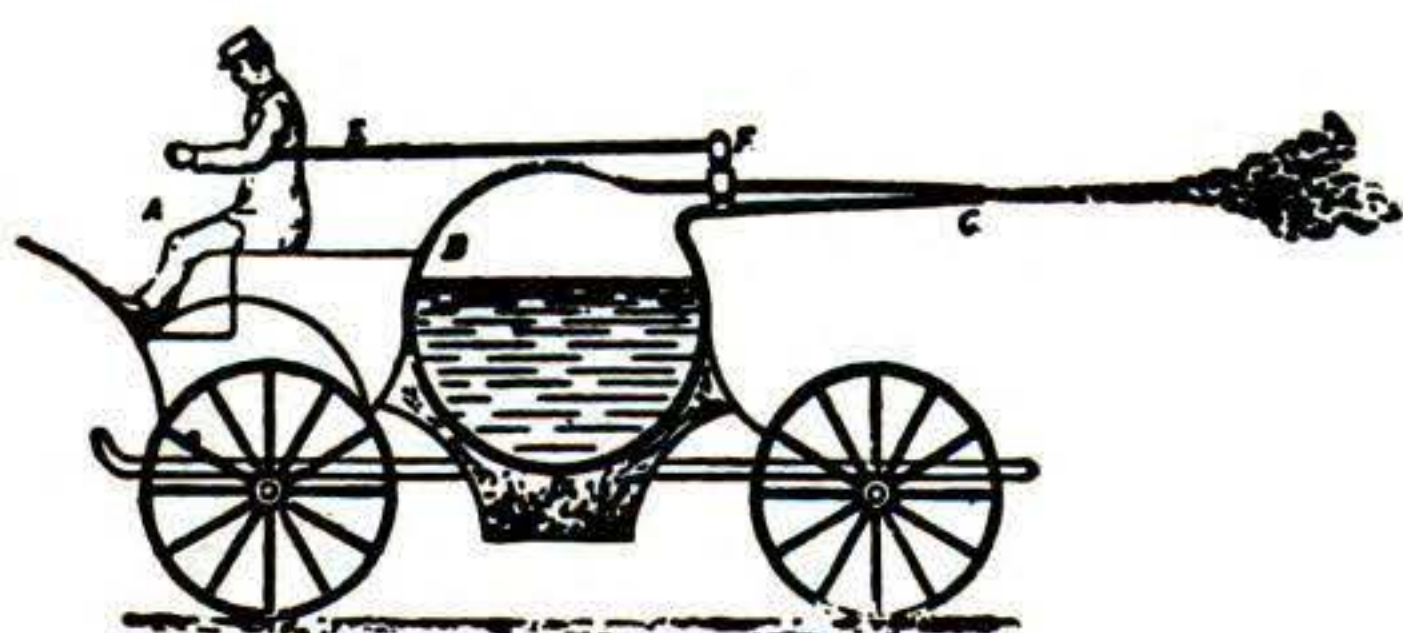
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Watchers of the Skies

By Willy Ley. Viking, \$7.50.

This informal history of astronomy from Babylon to the Space Age proves that Dr. Ley, noted for his writings in the field of rockets and missiles, is just as capable a reporter when dealing with stars and planets. Of particular value are the background stories and asides that bring a touch of human interest to the lives of the great astronomers.

Exploring the Secrets of Space

By I. M. Levitt & Dandridge M. Cole. Prentice-Hall, \$5.95.

A concise handbook of space science—just enough astronomy, physics, and math to help you understand any space problem (the math can be ignored). The authors, one an astronomer, the other a practicing space engineer, also provide descriptions of all major U.S. space projects, and go into considerable detail on rocket propulsion and spacecraft design. At the end there's a look into the future, including the controversial "Panama Theory" of strategic zones in space.

All Creatures Great and Small

By Daniel P. Mannix. McGraw-Hill, \$5.95.

When Mr. Mannix was a small boy he opened his heart and home to just about any animal he could find. His personal story concerns his life with squirrels, porcupines, and rabbits, later to be joined by snakes, hawks, and alligators. Mr. Mannix's menagerie will find a place on any animal-lover's bookshelf.

Complete Book of Camping

By Leonard Miracle with Maurice H. Decker. Outdoor Life Books, \$4.95.

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Sports Car and Competition Driving

By Paul Frere. Robert Bentley Inc., Cambridge, Mass., \$5.

This is no instruction guide for the teenager with a learner's permit. Paul Frere, Grand Prix driver and engineer, has compiled a fine manual for the competent driver who wants to try his hand at competition work—both racing and rallying. He deals briefly with theoretical matters, then proceeds to level on the finer aspects of driving.

Cars of the World in Color

By J. D. Scheel. E. P. Dutton, \$5.95.

Pictures and text combine to provide a history of the automobile from the invention of the wheel through the 1962-model cars in every major auto-producing country. About 800 cars are illustrated in color. One complete section, devoted to the history of auto racing, presents some striking shots of autos in action.

View from a Height

By Isaac Asimov. Doubleday, \$4.50.

America's most prolific science writer has written an interesting sequel to his book *Fact and Fancy*. Here are 17 essays dealing with biology, chemistry, physics, and astronomy that allow Dr. Asimov full scope for his personal evaluation of the scientific scene.

A Stress Analysis of a Strapless Evening Gown and Other Essays for a Scientific Age

Edited by Robert A. Baker. Prentice-Hall, \$3.95.

In the belief that it is not unscientific to laugh, Mr. Baker has selected an assortment of 32 essays relating to the problems of modern science and technology, prepared by such authors as Warren Weaver, C. Northcote Parkinson, Leo Szilard, and John Updike. They include "Eliza on Radioactive Ice," "Saga of a New Hormone," and "The Lab Coat as a Status Symbol." One article proves that the Abominable Snowman is a Chinese Communist.



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What's New at the

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...in GARDEN TRACTORS



By golly, it's swivel-hipped, notes reporter Jack Hand about Bolens' flashy new sharp-turning articulated job.

By Jackson Hand

ONE of the big problems, a man told me at the show, is whether a home-size tractor should look like a miniature tractor or a toy automobile. I moved on to the next booth, figuring there must be more to it than that. But you could see that it bothered nearly all the exhibitors. And that may be why the most conspicuous innovation this year is big shiny-chrome, moon-disk hubcaps. On a closer look, however, you find that this year's garden tractors have plenty to brag about besides flashy appearance.

Horsepower is up. Nearly everybody this year has a 10-horse tractor. As you'd guess, this has meant some beefing in construction.

[Continued on page 35]

...in SNOW THROWERS



Reporter Ed Fales studies the latest in comfort—a cozy canopy shown here on a Massey Ferguson riding thrower.

By E. D. Fales Jr.

IF WE don't look out, they'll take all the strain out of removing snow. That's what I discovered when I stepped off the elevator at the fourth floor into a glittering array of mechanized snow throwers.

Snow-throwing with the new '64 models could even be a pleasure. No more tussling with engines that won't start. One maker all but guarantees a 20-below-zero start. No more frozen linkages or clogged chutes. Some machines now have classy "dashboards;" at least one has a control console.

All this I noted and then, so help me, I rounded a corner and saw the new "plower's canopy." Two winters ago when I tried out snow throwers in bitter subzero Great Lakes weather, the worst thing was the

Hardware Show...

tour of the "world's largest hardware store"—the dazzling for-trade-offers a preview of new products you'll see in stores during 1964

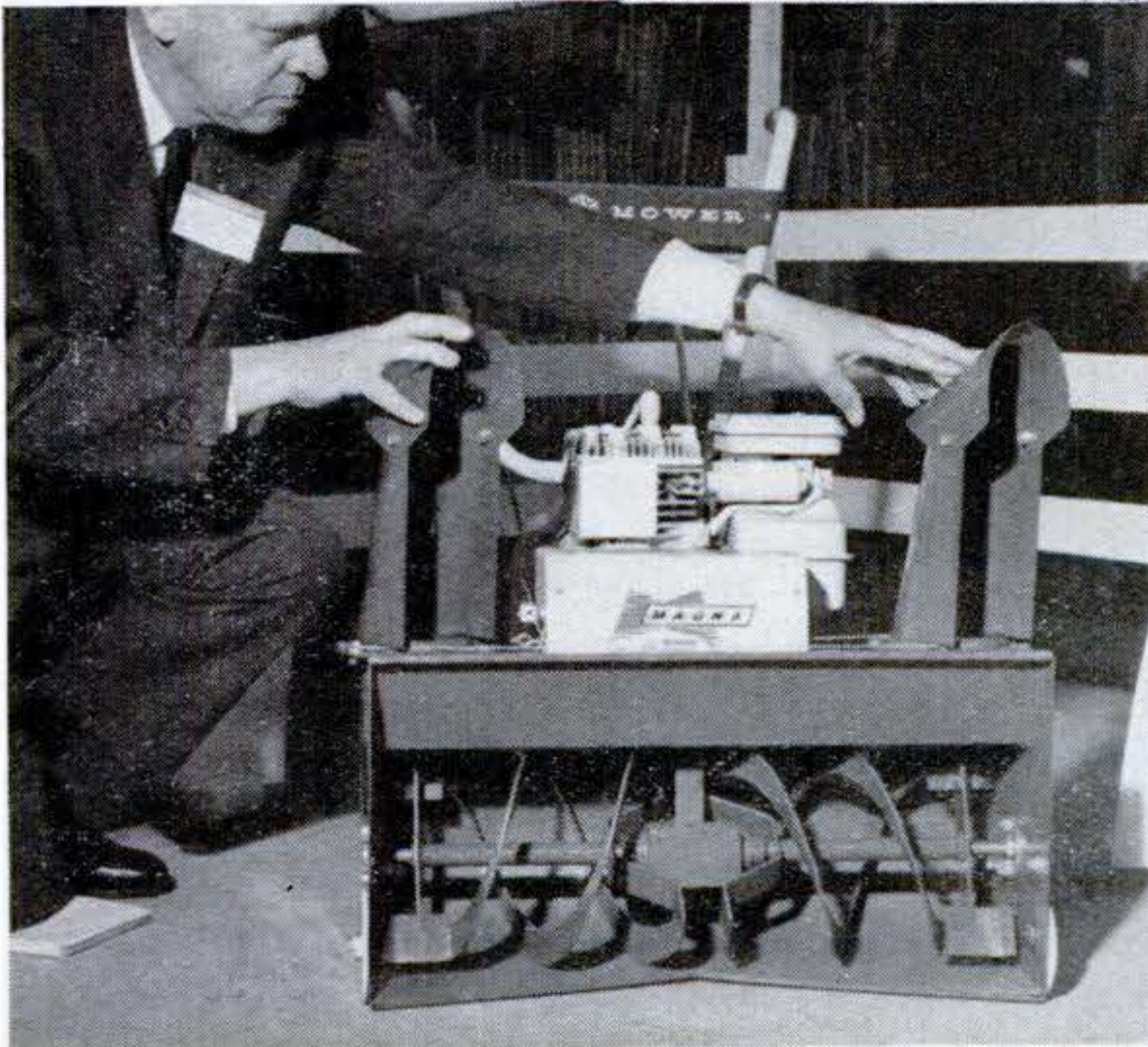
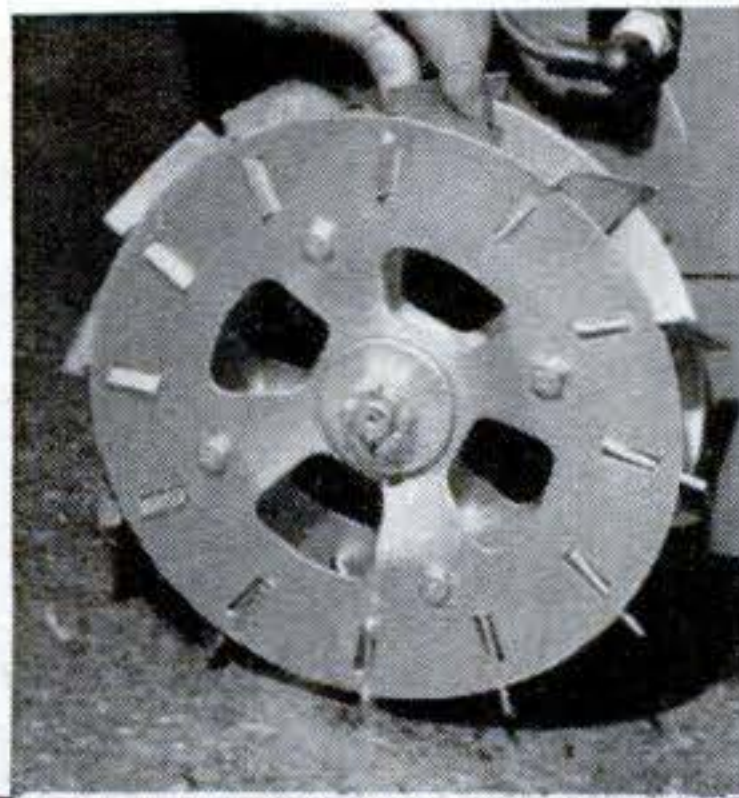
flurry of flying snow. The "plume" blew back in your eyes, ears, neck, and clothes like a Canadian blizzard.

But now an enterprising Midwesterner, Stanley Williams of the Original Tractor Cab Co., Arlington, Ind., has Massey Ferguson and others putting canopies on their riding throwers (see photo, left).

"And that isn't all," Williams says proudly. "We're now experimenting with a heater inside the canopy. And we're even getting ready to make a walking canopy." In other words, you soon may be able to walk behind your thrower and hide from all that chilly fallout beneath a canvas shield.

[\[Continued on page 32\]](#)

Two surprises:
Lawn-Boy's
antiskid steel
wheel at right,
Magna's twin
discharge chutes
below.



...in TOOLS

PS shop editor
Shel Gallagher
checks a strange,
new texture in
abrasives:
Stanley's nylon
sanding belts
for superfine
finishes on
wood or metal.



By Sheldon M. Gallagher

THE first thing you notice as you step out onto the sprawling, football-field-size main floor is that it's a big year for power tools, especially the portables. Literally hundreds of shiny, screaming, chip-spewing machines are all going at once. Out of their dust and clatter come several important trends that promise new excitement and convenience for the homeshop owner.

One of the hottest items, for instance, is a Stanley belt sander with a strange, thick, spongelike belt that looks something like a kitchen scouring pad. It's made of open-mesh nylon impregnated with fine abrasive particles. The idea: The soft nylon lets you fine-finish wood, lacquer, metal, and plastic—jobs not normally possible with a belt sander. The belts can even be used wet or charged with finishing lubricants. The sander takes conventional belts as well and comes in 3" and 4" models.

Belt sanders are doing a brisk business elsewhere, too. At Skil's booth, there's a 3" dustless model for under \$70, said to be the first at so low a price.

[\[Continued on page 186\]](#)

What's New at the Hardware Show...

SNOW THROWERS cont.

[Continued from page 31]

T. P. Milligan Co., Medfield, Mass., which markets a compact unit called a Sno Mow, has added two little headlights for use at night. The lights—really automobile backup lights—are powered by a six-volt lantern battery. On a more deluxe model, Milligan has installed the first 12-volt electrical system—which also gives you a built-in electric starter.

Engines are getting bigger. Three years ago Bolens' throwers ranged from 2¾ to



Massey Ferguson's guard keeps toes safe.

3½ hp. Now they start at 4 hp. and go up to 6 hp. This is a trend.

All in all, this year's jobs have come a long way from the clumsy models some makers were selling two and three years ago. Many were underpowered and skidded helplessly. They refused to go through snow and tried to go *over* it instead. Some wouldn't start.

The controls froze up. Snow settled on recoil starters, throttle linkage, chokes, control wires, and chute. First it melted, then it refroze—solid. Result: no go.

Keeping snow out. Recoil starters have been shielded against seepage. Control rods are huskier and nonfreezable. The knobs are bigger—so you can work them with your mittens on. Other changes:

All makers are working hard to keep snow out of carburetors—and out of mufflers

where they form drip. All are making more use of exhaust heat. Some engines are now fully shrouded, as on Magna American's Snow Mower. Engine makers such as Kohler and Briggs & Stratton have helped in many ways, too. B&S has an "easy-spin" system that holds valve-porting open until the last ¼" of travel to make cranking easier when oil is stiff.

Kohler has a brand-new "pressurized heat-pack" housing that provides warm air under pressure for the carburetor. The pressure keeps blowing moisture away through drain holes before it can freeze.

Hotter sparks, better washers to seal out moisture, and drip-proof gas caps are being used on an increasing number of makes.

New wheels. One trouble with self-propelled throwers has been small wheels and tires that lack traction to push through heavy snow. To overcome this, new tires are fatter, and wheels are bigger. Some have wide 3½" treads. Chains, optional last year, are now standard on some makes.



Battery headlights turn up on a Milligan.

"But why have tires at all?" says Outboard Marine. Its newest wheels are simply a series of flexible steel blades. These are designed to shed snow and ice and bite deep.

Some makers also use heavy steel "chevron"-treaded cast-iron wheels that weigh a husky 13 pounds each. And Jari has a neat device: a new pinion-gear drive. The pinion gears spin against the tread of the

[Continued on page 34]

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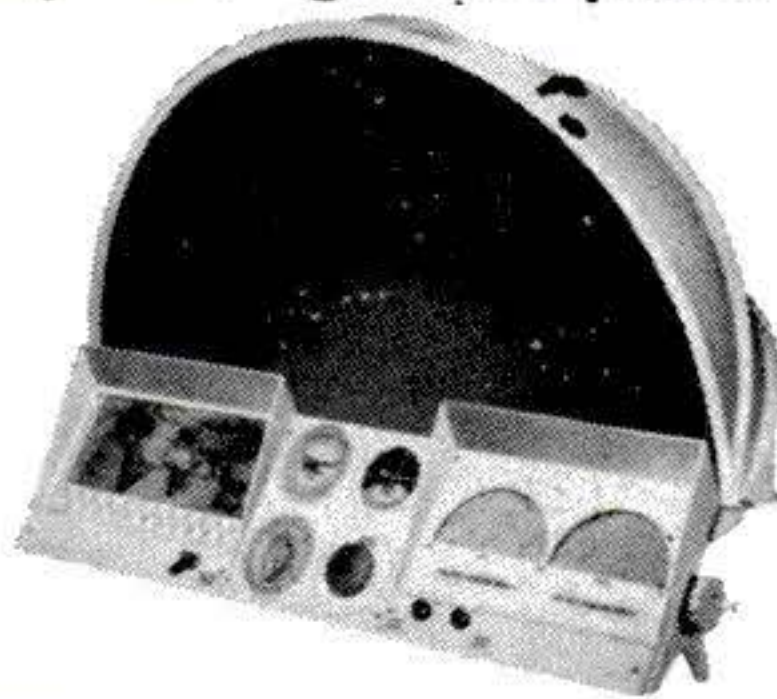
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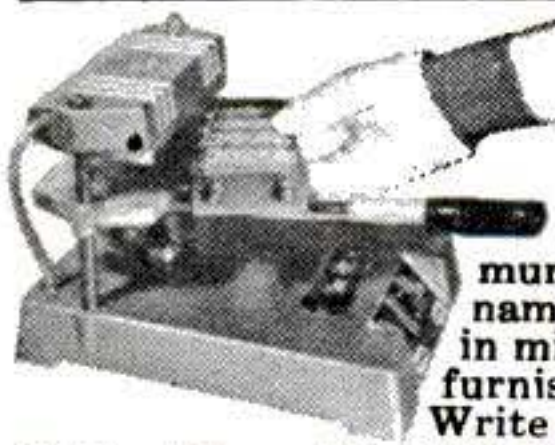
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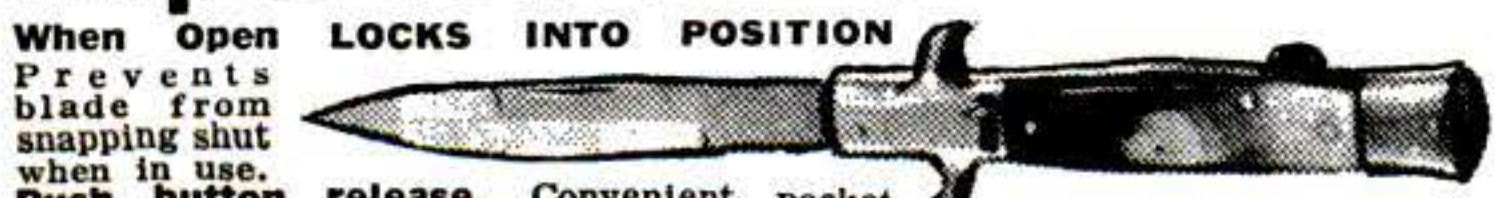
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SNOW THROWERS cont.

[Continued from page 32]

driving wheels and automatically chop off ice as fast as it forms.

Less clogging in the chute. Magna American has introduced twin chutes, claiming they clear a 24" cut where a single-chute machine could clear only an 18" cut.

Other companies have widened their chutes to stop clogging. Jari claims to have licked the clogging bugaboo by using a new automatic reversing fan. In some cases, the fan, or turbine, works fine when the chute is turned in the same direction as the snow's discharge, but it clogs when the chute is reversed. Jari's fan automatically reverses itself every time the chute is reversed, so snow moves out.

An interesting innovation in auger design is Moto Mower's dual "over-and-under" job. One trouble has been that deep snow swamps some throwers, limiting their effectiveness (for fast work) to snow less than a foot deep.

"I was driving back from a ski trip to northern Michigan where snows really run deep," says Moto Mower's Buck Coveney, "and I saw an over-and-under highway plow handling deep drifts with no trouble. I thought, 'Why wouldn't that work just as well for the little fellows?' We tried it and found we could move through much deeper snow and could throw a full ton a minute with a 6¼-hp. engine."

Any push-type throwers? There were several, but the trend this year is to self-power, wider cuts, more weight, and better balance plus higher power. Prices, as a result are moving upward, but the public doesn't seem to mind. The industry, in fact, hasn't yet recovered from the first shock of learning that people would really pay from \$100 to \$400 for a snow mover!

What comes next? Already under development are quieter engines. Someday you'll purr along, vibrationless, snug, and warm in a heated unit. And you'll use a self-starter. You may not even need electric starting. As this report was being written, Toro announced a tiny heating element that plugs into any 110-volt outlet and vaporizes a small amount of gas just before you start up. The vaporized gas, says Toro, will fire up on the first starter-rope tug—even at 20 below zero. It's standard on Toro's 5-hp., 25-in. Snowhound. ■ ■

GARDEN TRACTORS cont.

[Continued from page 30]

As a result, a standard 10-horse machine will run 5' plus in length and close to 3' in width.

Some manufacturers maintain the same overall chassis dimensions even when they drop to lower 5-hp. and 7-hp. models. In-



Colt's slick aluminum power plant looks like a miniature aircraft engine.

ternational Harvester, a big-machine maker, puts 7-hp. or 10-hp. engines on tractors that are otherwise identical. Jacobsen, Wheel Horse, Bolens, Simplicity, and others have all graded up to larger ones, too. Kohler, Wisconsin, Briggs & Stratton, and Lauson are the most common engines.

Traction is better. A 10-horse tractor can cut some pretty bad ruts traveling on ordinary narrow, cleated tires. This danger is eliminated by several manufacturers who now use broad, flat tires that are as much as 8" wide.

It's interesting, though, that some put the super-fat tires only on the back and leave the same skinny variety in front. If traction is your only worry, okay. But the small front tires can tear up the lawn.

Those manufacturers who do not have the wide rubber report that it can be put on as special equipment if you need it.

Farm tractors go suburban. Many of the big farm-equipment people like Massey-Ferguson, Allis-Chalmers, International Harvester, and John Deere are now making yard-size four-wheelers for suburban use. Generally, these in-from-the-farm makes tend to be a little more rugged, a little heavier, and also a little more costly than the others.

Three cheers for electric starting. When a tractor gets to be 10-horse, it is no longer duck soup to start with a rope, especially in cold weather. So most big machines now have electric starter-generators—slick little

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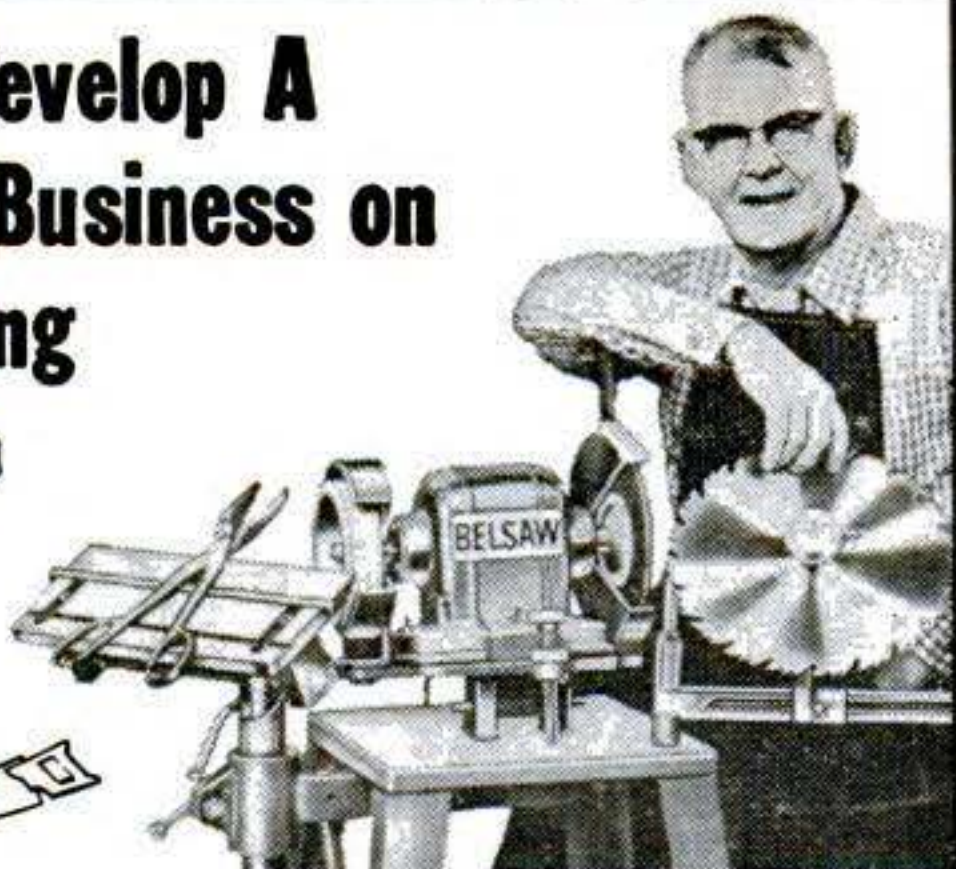
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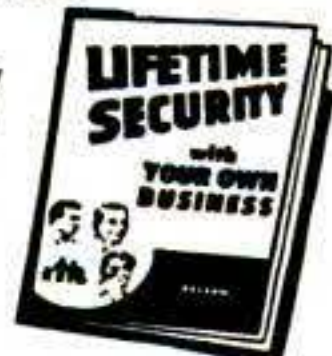


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GARDEN TRACTORS cont.

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There is no doubt that electricity on tractors will lead, in time, to still more mechanized features. For instance, an electric motor that can be temporarily overloaded to act as a starter might well be temporarily overloaded to run hoists, lifts, or shifts, which are now actuated by hand.

More jobs for tractors. One exhibitor told me industry figures show that an average of 2½ attachments are used with every tractor, the three most popular being mower, tiller, and snow thrower. Here are some of the things the show turned up: 10-inch moldboard plow, gang-reel mowers up to 8' wide, carts up to a half-ton, lawn aerator, spreader, roller, thatch remover, spike-tooth harrow, disk harrow, sickle-bar mower, snowplow, hydraulic lift, cultivator, front-end loader, planter-seeder, reel mower, and snow thrower.

In some cases, the attachments are manufactured by the tractor outfit. In other cases, the tractor maker hooks up with some attachment specialist. In almost every case, any make of attachment can be hitched to any make of tractor.

Power takeoff is bigger this year than ever. Some tractors have PTO fore and aft and amidships. Some offer it with both

Fat tires and shiny moon-disk hubcaps—two eye-catching innovations on many '64 models.



longitudinal and lateral rotation, and some on either or both sides.

Now: an articulated tractor. One of the show's biggest eye-poppers is a new Bolen's rear-engine, articulated-frame tractor called the Estate Keeper. The front and rear halves are joined by a universal coupling in the middle so the wasp-waisted vehicle literally bends in two on turns.

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[\[Continued on page 186\]](#)

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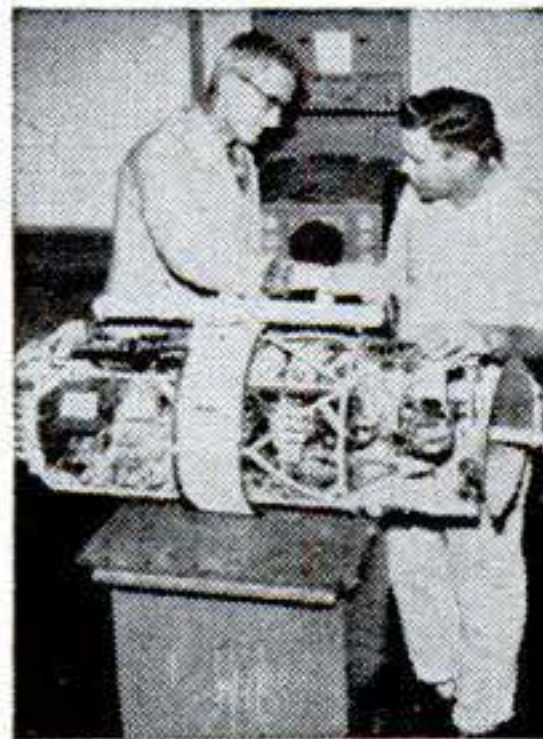
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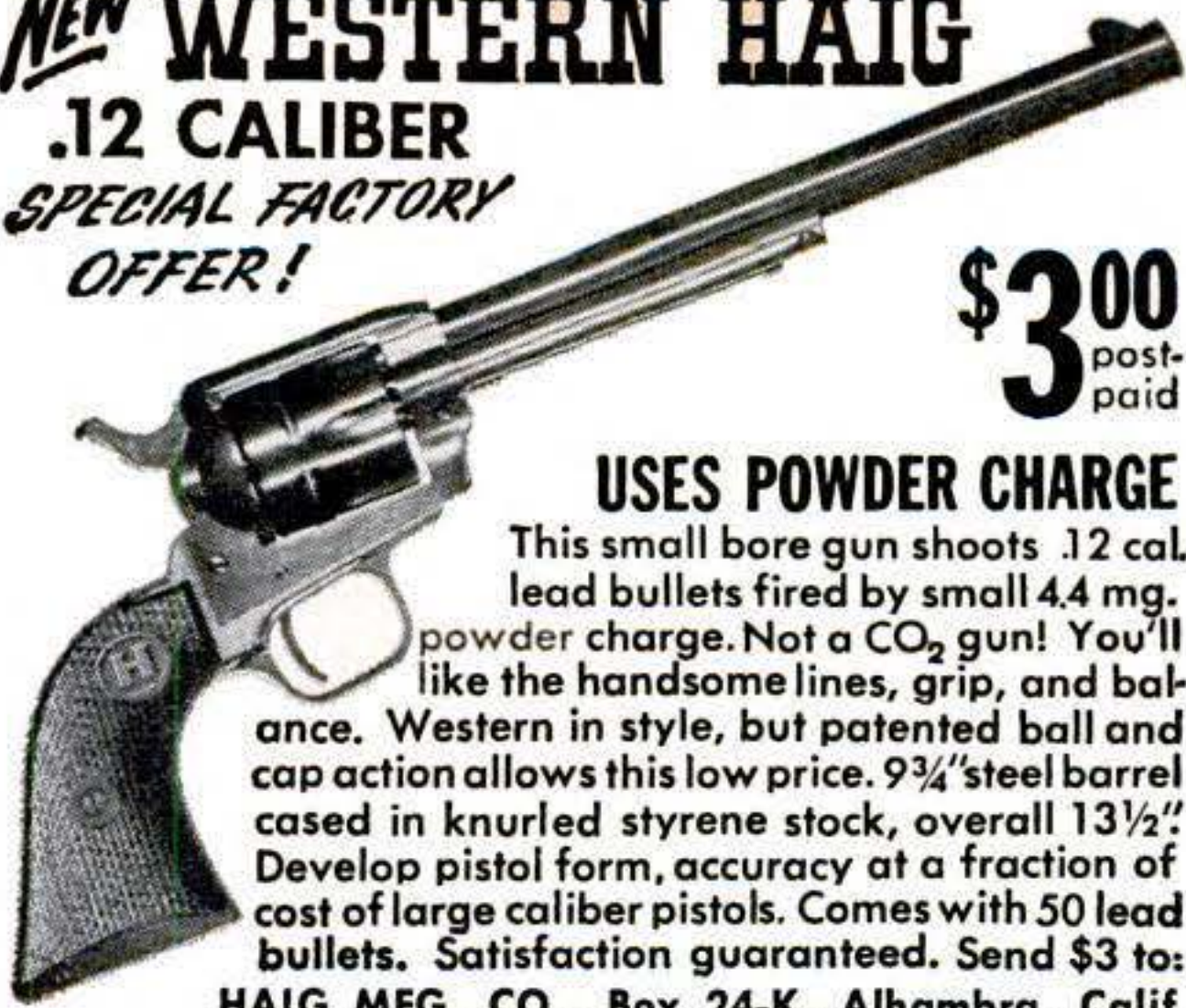
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Don't Give Up the Moon!

WE WERE in California visiting space industries when *The Saturday Evening Post* screamed: "Billions wasted on Space!" Mrs. Clare Boothe Luce was calling Apollo "The Moon Mess," a blunder the President was trying to wriggle out of. Mr. Luce disagreed; his *Life* magazine had just signed all 16 astronauts to four-year contracts for their personal stories.

Six months after Gordon Cooper's flight, economizers and fainthearts were shouting: "Stop the Moon Race!"

What—POPULAR SCIENCE asks—is wrong with a race? A lot of the world's progress has come about through races.

We were in a race with Hitler for the A-bomb. It's a good thing we won. Likewise with radar. Our railroads raced to cross the continent. Peary beat Amundsen, the Norwegian, to the North Pole. Amundsen beat the British to the South Pole. Lindbergh out-raced Chamberlin, Byrd, and assorted Frenchmen.

What about the times America sat on its tail? Remember Sputnik I?

The *Post* said we're going too fast, not testing carefully. How could anyone tour a Space facility and come to that conclusion? At the Jet Propulsion Laboratory 2,000 engineers, scientists, and technicians seem to be testing—if you include all the supporting activities—one little probe, Ranger 6. At Santa Susana, 19 stands are test-firing Rocketdyne engines. At North American, 15 "boiler plates" of the Apollo capsule are being dropped, heated, cooled, and subjected to every torture engineers can devise.

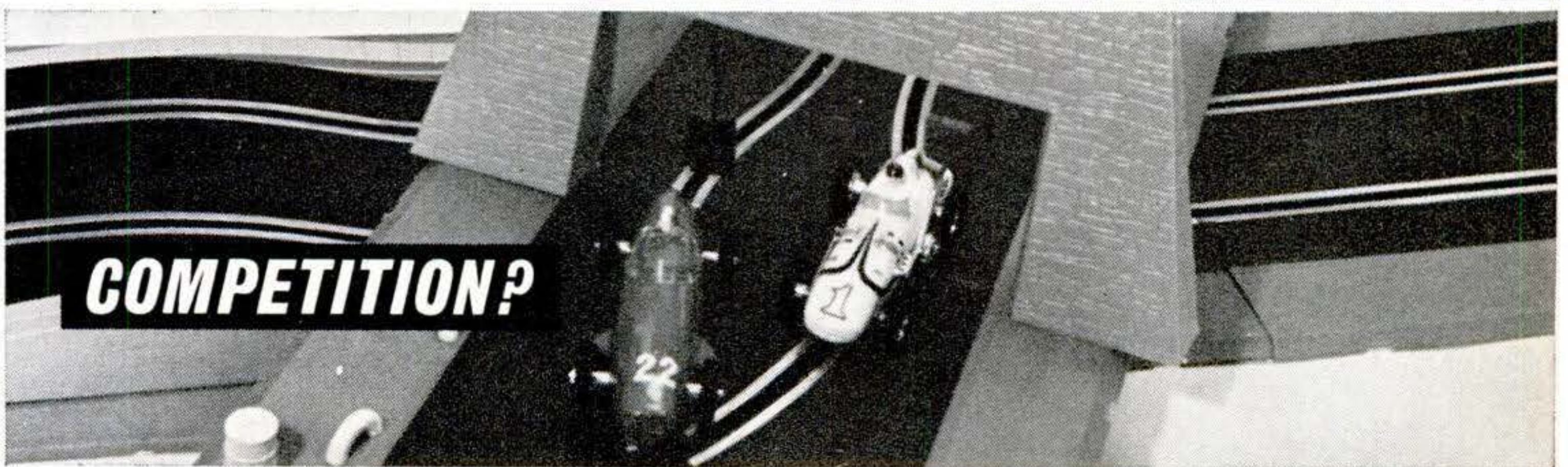
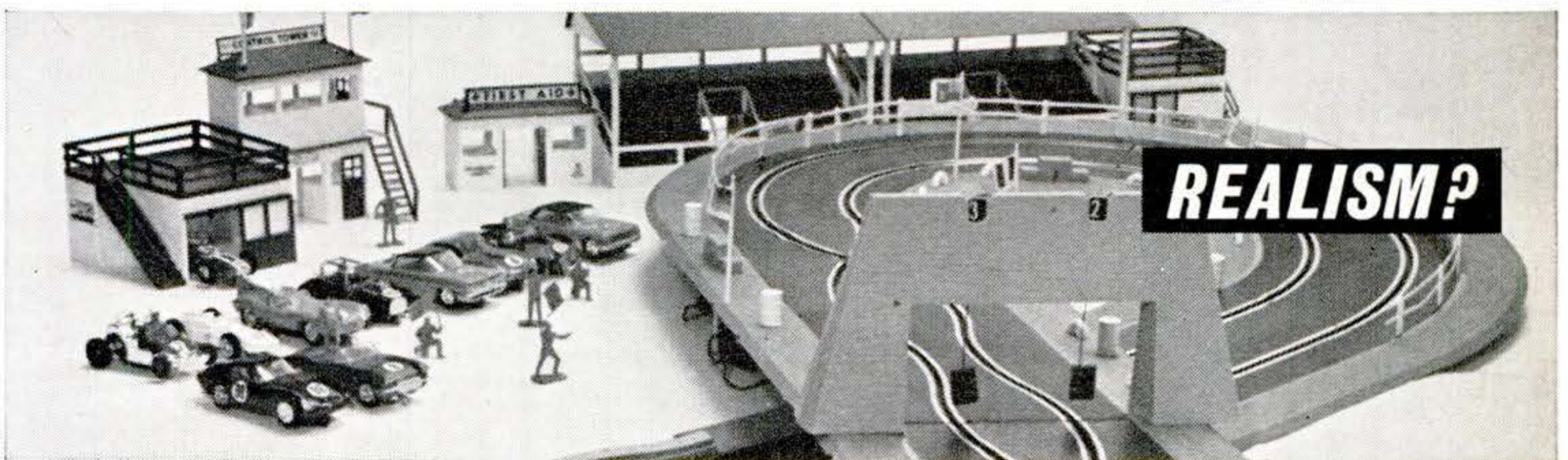
Harrison Storms, NAA's crusty Apollo boss put it this way: "One bunch says we don't test enough. Others say, 'Let's get this thing off the ground! We can't win.'"

Some charge that Space is siphoning off bright young men—leaving other fields starved for talent. For our part, we're glad America *has* an industry that creates a demand for brains and education. More youths drop out of school for lack of motivation than for lack of money.

Of course, we could give up on going to the Moon. Eighty years ago a nation that had just built the world's greatest canal started out to build another one—across the Isthmus of Panama. The going was tough. The mosquitoes were deadly. Forty thousand workers died. The builders spent \$260 million—a lot of money in the 1880s. Someone must have said it cost too much. When the U.S. came along 20 years later, the French machines lay abandoned and rusting in the jungle.


EDITOR

What do you want most in a road racing set...



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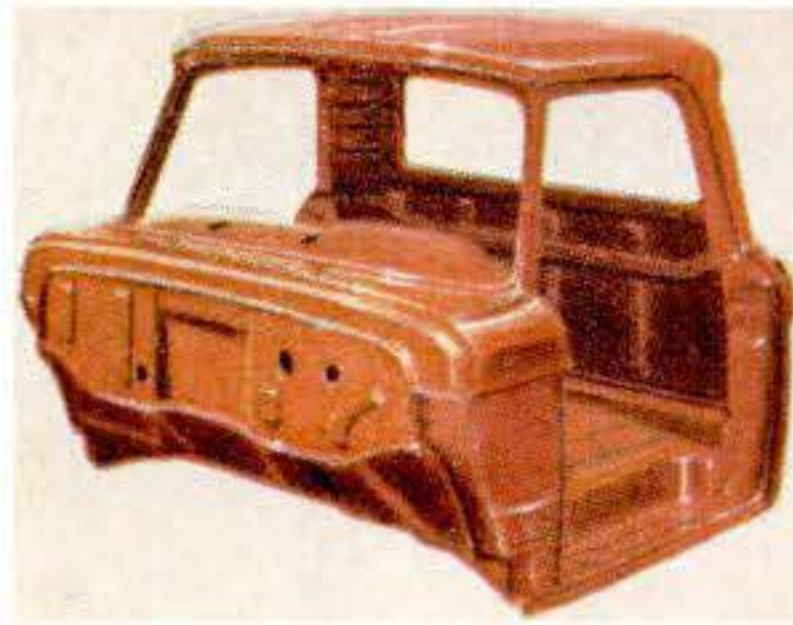
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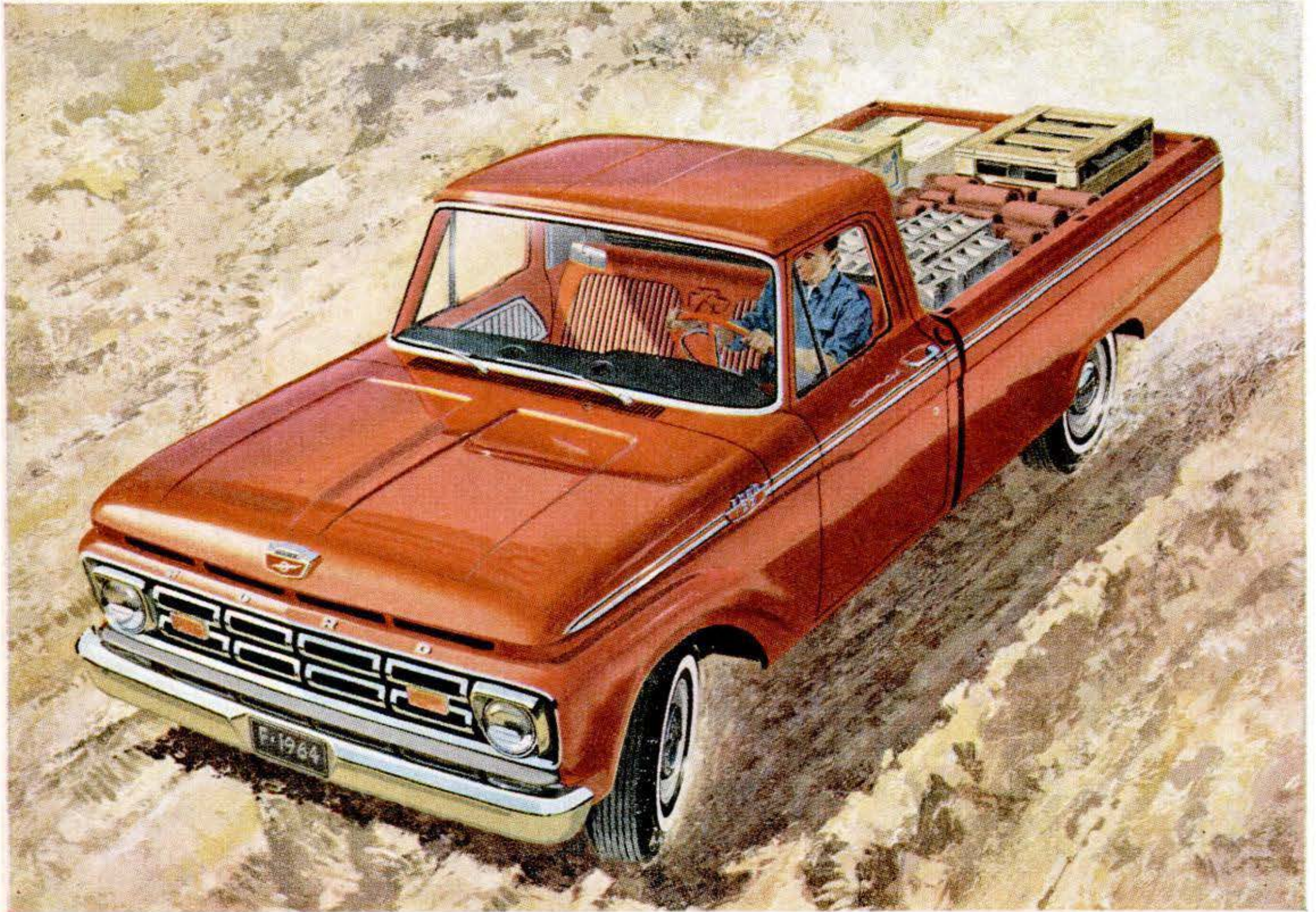
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CAVE-IN!

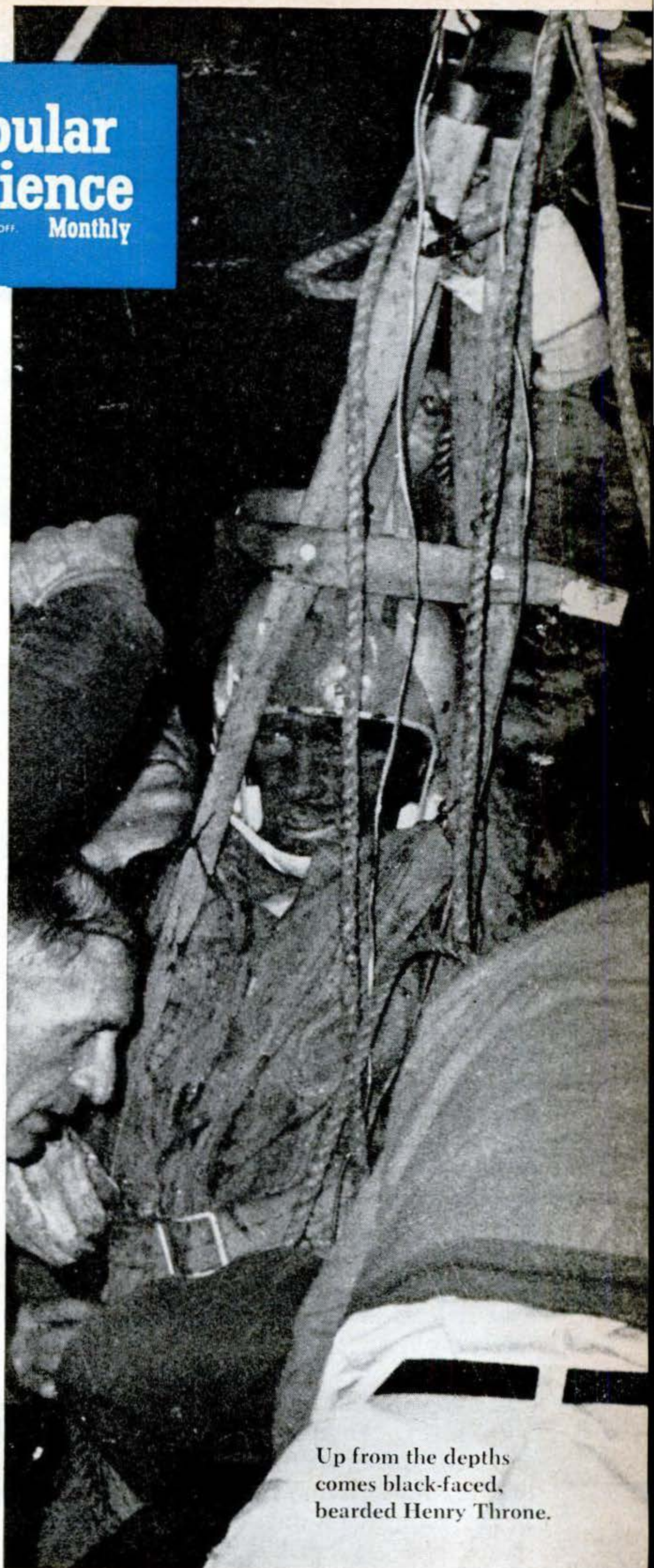
**...the complete
step-by-step
story of history's
most dramatic
mine rescue**

By Arturo F. Gonzalez Jr.

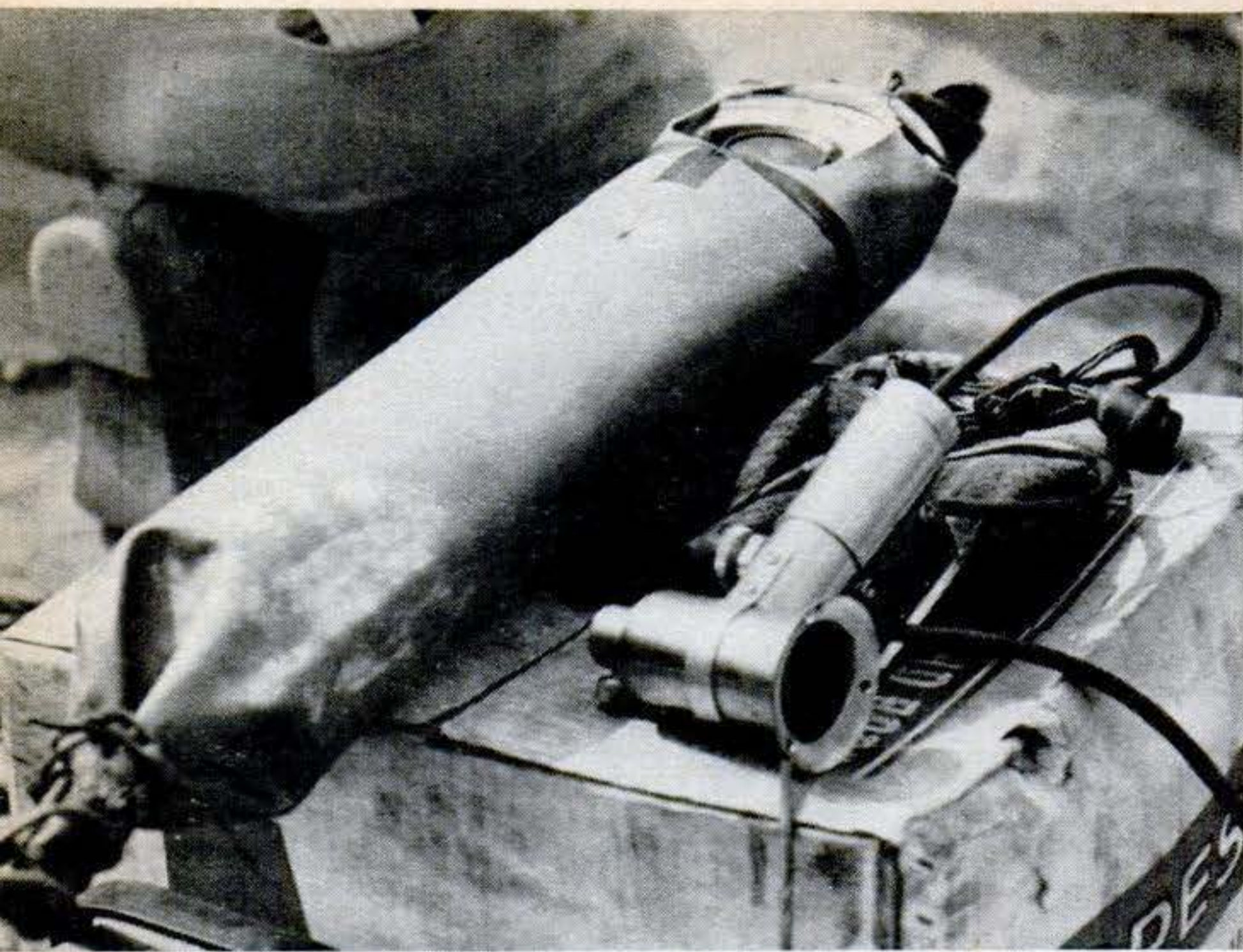
The victims were entombed 330 feet down and it looked hopeless. Then men and machinery started arriving, contact was made with the trapped miners, and the agonizing effort to bring them out alive began. Reporting the story exclusively for POPULAR SCIENCE, the author was on the scene as the day-and-night rescue operation went forward. This is his eyewitness account.

IN THE grimy, slag-covered anthracite region of Pennsylvania around Hazleton, Tuesday, August 13, dawned as just another day when men went deep into the earth to chip, pick, and poke their way through seams of coal.

CONTINUED



Up from the depths comes black-faced, bearded Henry Throne.



Rocket-shaped canisters were lifesaving projectiles for Fellin and Throne after six-inch "miracle hole" hit their chamber. Food, water, light, medical supplies were sent down until larger 12-inch rescue hole broke through.

Rescuers kept constant vigil, listening to electronic amplification of Fellin's drilling guidance from below. Light bulb (center) lit the hole site at night, and the drum (left) was used to lower supplies to the trapped pair.



Halfway between the tiny towns of Sheppton (pop. 1,100) and Oneida (pop. 500), three men entered the sloping shaft of a tiny mine. The mine had been abandoned years before by the Lehigh Valley Coal Co. whose machines had taken out just about every lump their mechanical mouths could gobble. Still, there were several solid pillars of coal left supporting the shaft. With a little careful digging, a man could make a few bucks.

The trio were "bootleg miners," freelancers willing to scramble for a small profit. Their hole officially was a Title One mine, meaning it employed less than eight and was exempt from state and federal safety regulations.

The oldest was stocky 58-year-old David Fellin. A lifetime coal digger, he had lived within three miles of Sheppton since birth. Mining was all he knew; he was part owner of the digging and boss of the crew. Henry Throne, 28, would do anything for a day's wage, even if it scared him. "I can hear the cracks," he

had told friends in describing his latest job. The third man, Lou Bova, 54, was a rugged outdoorsman who went off on three-day midwinter fishing trips without an overcoat or food.

Just before eight in the morning, the three went into the mine.

At roughly 8:45, Joe Walker, operating the gondola car from the surface, noted that it had stopped inexplicably about 200 feet from the bottom of the shaft. He descended, walking along the shaft's 35-degree slope for 65 feet and then peering down where the incline sharpened to an almost vertical 82 degrees. He saw nothing but rubble. *Cave-in!* Walker summoned help. Soon miners clustered at the mine-head tibble, and rescue parties, lights winking on their hats, probed cautiously for the missing men. More small cave-ins forced them up. Deadly black damp gas began forming, and fans were dropped down to swish it away.

Friday, August 16. There was, officially, "little hope." State and federal



authorities talked of applying the Entombment Act—sealing the mine with the approval of the missing miners' families. But one man would have none of this—Joe Fellin, Dave's brother—who, ironically, had not talked with Dave for six years after a quarrel.

Joe went to Local 803 of the IMW. Soon union officials were pressuring authorities to drill at least a few probes 330 feet to the shaft, to let air into the mine and perhaps locate the men. The only alternative suggested was to dig a parallel shaft to the cave-in area and then tunnel across. This would take an estimated 50 days, so the men in charge agreed to try the probes. Thus began a dramatic mining saga.

Saturday, August 17. Four days after the cave-in, Gordon Smith, Pennsylvania's deputy secretary for mines in the anthracite region, went deep into the crumbling shaft to get the exact measurements for drilling. "You go down a short way and listen," he said, "then you go down a little way farther. If you

don't hear any slides or shifting of coal, you go down some more." Deep down the 82-degree slope he probed and, using the data he came back with, plotted sites for the first probes.

Above ground, men and equipment appeared from all over—no pay offered, none requested. Some rain fell, and the rescuers speeded up; the mine had a reputation for filling with water. Chuffing yellow bulldozers scraped a dirt road half a mile from the nearest black-topped street. An area the size of a football field over the shaft was gashed clean of pine and scrub. The first drilling rig, a Porter six-incher from Sprague and Henwood, was hauled onto the scene. At 7:30 p.m. the drill bit into the dirt about 100 yards from the tippie, slightly to the right of where maps said the main mine shaft was.

"There's a 'monkey' [a small shaft off the main one] down there," Joe Fellin insisted after studying the mine blueprint. "That's where Dave would head." The six-inch drill whirred, and a grayish



coat of drill dust began filtering down over the area.

Sunday, August 18. At 11:25 p.m., 28 hours after the drill took its first bite, it broke into a void 331 feet below. Excitedly, the men gathered around the hole in the midnight darkness as the drill was pulled up. Gene Beaver called down the hole, "Hey, Dave."

"Who calling?" echoed a high-pitched voice from the darkness deep below.

"I damn near fell over," Beaver says. Another miner pushed to the hole, yelled down at Dave, and then screamed, "They're alive. I hear them. They're alive." Hard hats sailed into the air. The cheering rescuers could not know then that they had more than two weeks of backbreaking work ahead of them.

Fellin and Throne were jammed into a steeply slanting 14-by-9-foot chamber that ranged in height from 6 feet to 18 inches. Hungry and thirsty, they had slaked the fire inside them with brackish sulfur water off the mine walls and peeled the bark from support timbers for food. In the cold, they breathed on each other's necks for warmth. For days they had tapped the miner's S.O.S.—two long, three short—on the coal-car rails. Hallucinations almost drove them mad—they saw "little men" and "blue underground doors." The bore hole had come into their chamber at the 18-inch end, and the two men had to crawl towards the soup, coffee, sandwiches, chicken, brandy, thermal underwear, chemical hand warmers, blankets, miner's lighted helmets, medicines, and a rosary—lowered in tubular canisters. Air was pumped in; lights and a communications system were lowered. The tiny six-inch hole became the umbilical cord channeling life to them, and thus it functioned until they rose from the blackness.

Bova was about 18 feet across the debris-filled shaft, apparently injured in the hip. A six-inch probe failed to hit a

Drill breakdowns during the ill-fated attempts to reach Bova were frequent. Rescue workers labor here to get an inoperative drill running again while curiosity-seekers (rear) stand and stare.

pocket near Bova. A second one also missed. Then rescuers finally drilled through, on August 18, into a void. All work above stopped as rescuers yelled hopefully down the black opening, "Lou, Lou." Water, food, light, and a microphone went down into the opening, but were untouched. No one knows if Bova ever was in there.

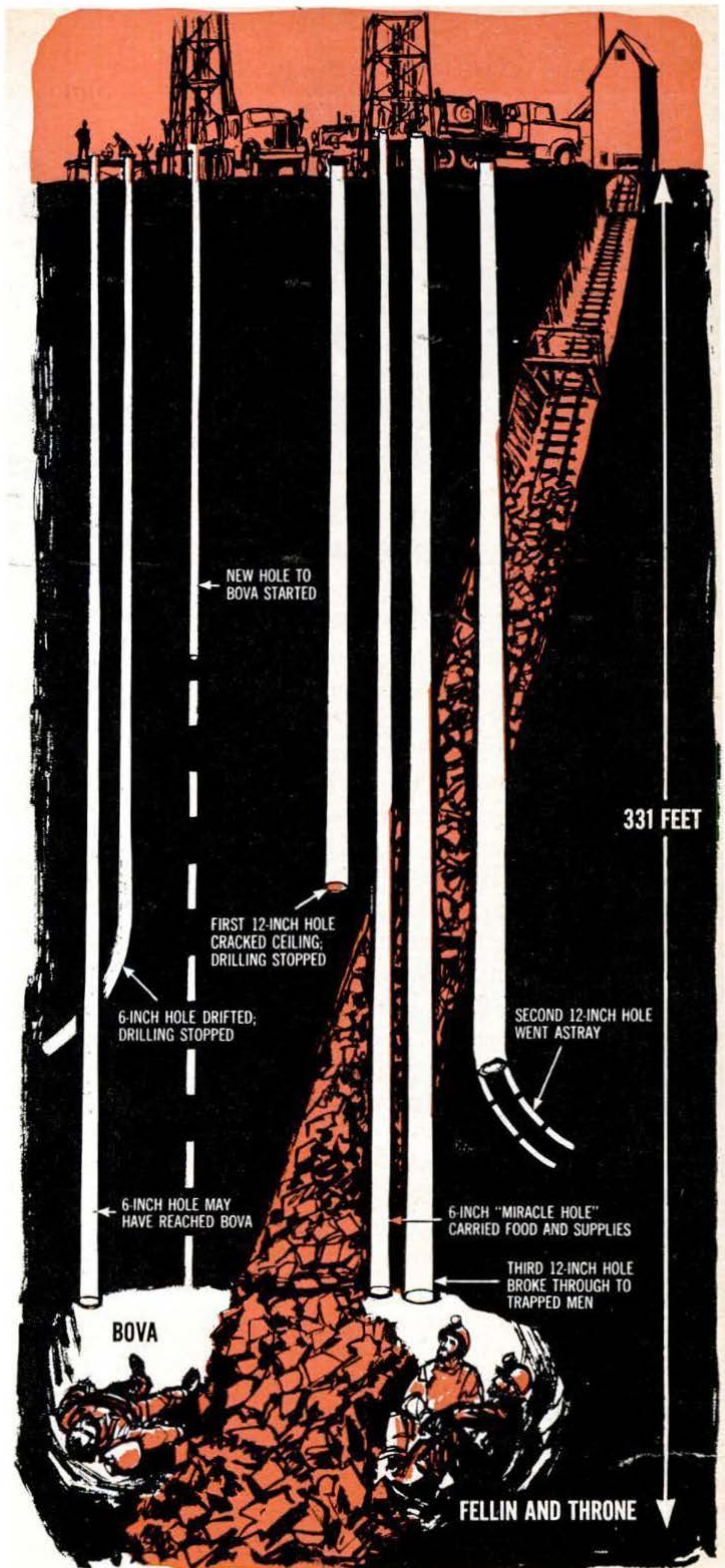
Tuesday, August 20. Fellin and Throne reported they could now hear Bova faintly tapping—after a 40-hour silence. They yelled, "Are you bleeding?" . . . "Are you covered with rock?" Bova responded with the traditional miner's two taps (no). But the responses became weaker and disappeared.

The rescue site by now had split into three distinct worlds. The first was the black world of the victims, waiting for rescue. Five or six additional cave-ins—one almost crushed them—had made their chamber so tiny they could no longer stand. On a ridge overlooking the site, their wives and families camped silently on folding chairs 100 yards away from the drills, their hands slipping over rosary beads.

The second world was that of the hangers-on: state police, politicians, and union officials, newspapermen and photographers, TV commentators and radio announcers, who descended en masse to keep order, inspect the site, or bring news of the rescue to a waiting world.

In a single day, close to 100 radio stations plus the Voice of America phoned WAZL in Hazleton for on-the-site pickups. All major wire services

CONTINUED



Ten days after cave-in, this was the situation. The six-inch "miracle hole" had been followed by two unsuccessful 12-inch holes, finally by a successful breakthrough. Whether a drill ever hit Bova's chamber was never determined.



Smiles of success and a handshake are exchanged between Clyde Machmer, who acted as foreman of the rescue crew, and Dr. H. Beecher Charmbury (right), Pennsylvania State Director of Mines, directing the rescue, after the 12-inch drill made the crucial breakthrough to Fellin and Throne 10 days after the cave-in.

were there, trailing 50,000 feet of specially installed telephone cable behind them. TV cameras atop sound trucks ranged over the scene.

And the final world was that of the rescuers—a thrown-together band from roughly two dozen firms and seven states.

The Pennsylvania State Director of Mines, Dr. H. Beecher Charmbury, a small, round man with crew-cut gray hair, directed the rescue operation. Acting as job foreman was miner Clyde Machmer, a stocky, middle-aged veteran of many mine disasters, head of the local Pennsylvania Independent Miners & Associates Union. His quick eyes, underneath eyebrows as bushy as John L. Lewis', flicked constantly over the disaster scene, noting that this line had to be run in, that a new man was needed on the phones, that lights should be set up here, compressors there.

High above the ground in the drill control cabin stood 39-year-old Mike Rank, a 6-foot, 1-inch 225-pounder whose specialty was drilling through rock with the lightweight precision of a fine artist. Based in Connecticut, he had been rushed to the scene by the Gill Drilling Co. U.S. Navy electronics experts from Washington set up a gray-green communications tent linking Throne and Fellin to the surface. They also connected the site to the Pentagon should

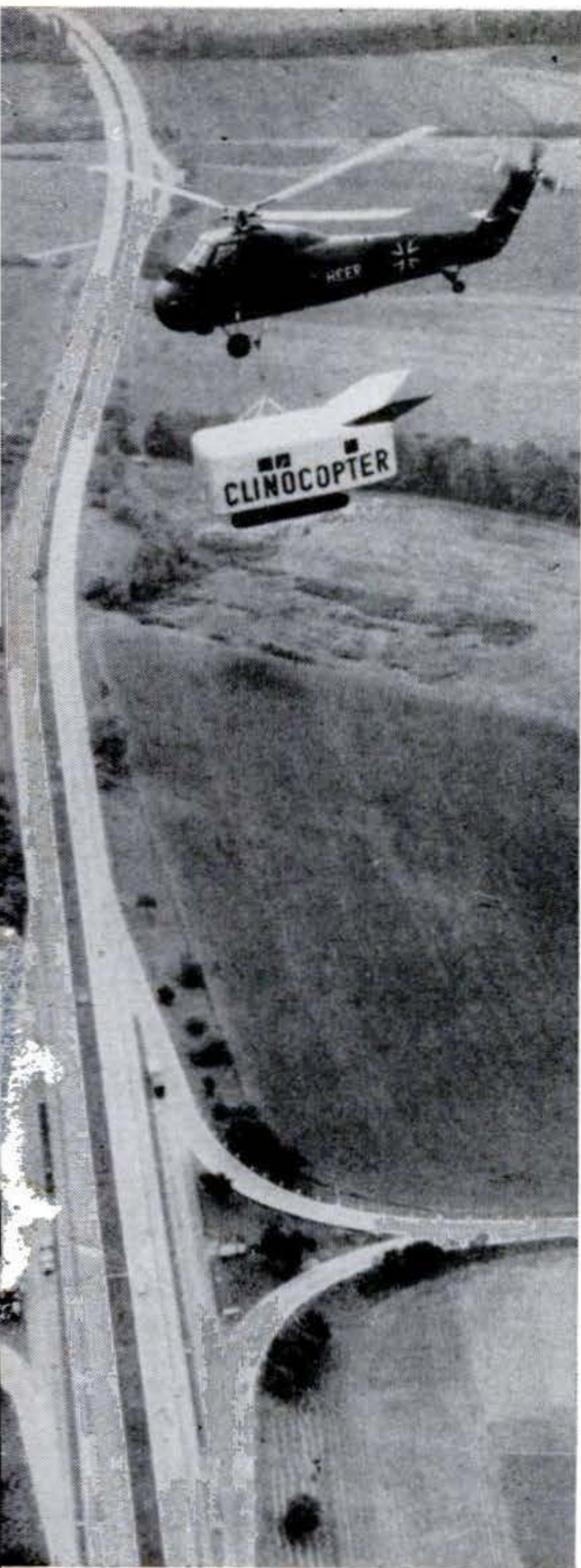
specialized gear be suddenly needed. A Navy survival expert came to advise the trapped men on how to stay alive in the dank, black cold. Special sleeping bags were flown in from Denver by jet fighter.

A 12-inch hole, 18 feet away from the 6-inch "miracle hole," was aimed at the trapped men by a huge, \$250,000 electrically operated, 65-ton, 8½-story-high, Bucyrus-Erie drill. This mammoth maroon-and-gold machine was trucked in 14 miles on a 16-wheeled flatbed trailer. Reassembled and moving on its own tracks, it began probing, its carbide bit spinning at 1,350 r.p.m. and exerting a downward pressure of 75,000 pounds.

Driving the drill was the Correale Construction Company's 1,200-kw. mobile diesel generator, a huge, noisy, yellow trailer, parked near a clump of trees. Behind it in a line were three Ingersoll-Rand compressors, each capable of pushing 900 cubic feet of air a minute down through the drill, forcing the cuttings to the surface in a white, gritty cloud that choked the air and hid the sun.

Other drill rigs from Sprague & Henwood were rushed to the scene, along with pieces of miscellaneous gear, much of it from the nearby Sullivan Trail Coal Co. Sullivan's president, Louis Pagnotti, bore much of the expense in men and equipment.

[Continued on page 202]



Air ambulance speeds road aid

When serious automobile accidents cause traffic pile-ups, a West Germany highway patrol rushes in an emergency air-ambulance unit by helicopter. The 1½-ton Clinicopter is aerodynamically shaped, stabilized in flight by tail planes, and has pontoons to permit water and swamp landings. The 25-foot-long flying "hospital" carries doctors and is equipped for minor on-the-scene surgery.



Glass-enclosed restaurant and observation deck top the tower.

Danish water tower does triple duty

A 227-foot tower not only supplies the historic city of Roskilde, near Copenhagen, with water, but contains a restaurant on top and a swimming pool at the bottom. And Ford gets in a bit of advertising, too.

The million-gallon water tank, 93 feet in diameter, is held up by eight T-shaped columns, each capable of supporting 1,500 tons. The outer cylindrical wall and the roof are insulated. Each night the tank is pumped full to meet the community's next day's water requirements.



Parabolic roof and glass ends give the pool an airy interior.



Jet boat takes swift cruises on Colorado River shallows

In water sometimes no deeper than 3 inches, this 42-foot boat will cruise at 25 m.p.h. with 55 people aboard.

Propelled by two Berkeley jet pumps powered by a pair of 409 Crusader engines, it makes daily runs down the Colorado below Moab, Utah, where the water is too shallow in places for prop-drive boats.

It's one of two cruise boats with jet drive

built by Arnold Feller, following POPULAR SCIENCE's pioneering tests of jet boats on the Green Colorado Rivers in 1962 [PS, Aug. '62]. Feller is a professional boat-builder in Grand Junction, Colorado. He acted as guide for the PS test cruise.

Feller reports his boat handles easily, has a top speed of 38 m.p.h. with 240 gallons of gas and up to 10 people aboard.



Tiny screws serve as thermometers

New screws an eighth of an inch long can be set in pistons, connecting rods, and other moving engine parts to check operating temperature without the expense of thermocouples.

Developed in England by Shell Research, the alloy Templugs screw into tapped holes, record heat by permanent change in their hardness.

Measurement on removal indicates heat up to 1,800 degrees with one-percent accuracy.

60 YEARS AGO

THIS MONTH . . .

man first found wings and a new age was born. Here are the events that led to that momentous day

How the Wright Brothers Learned to Fly

By Gardner Soule

Wilbur Wright



Orville Wright

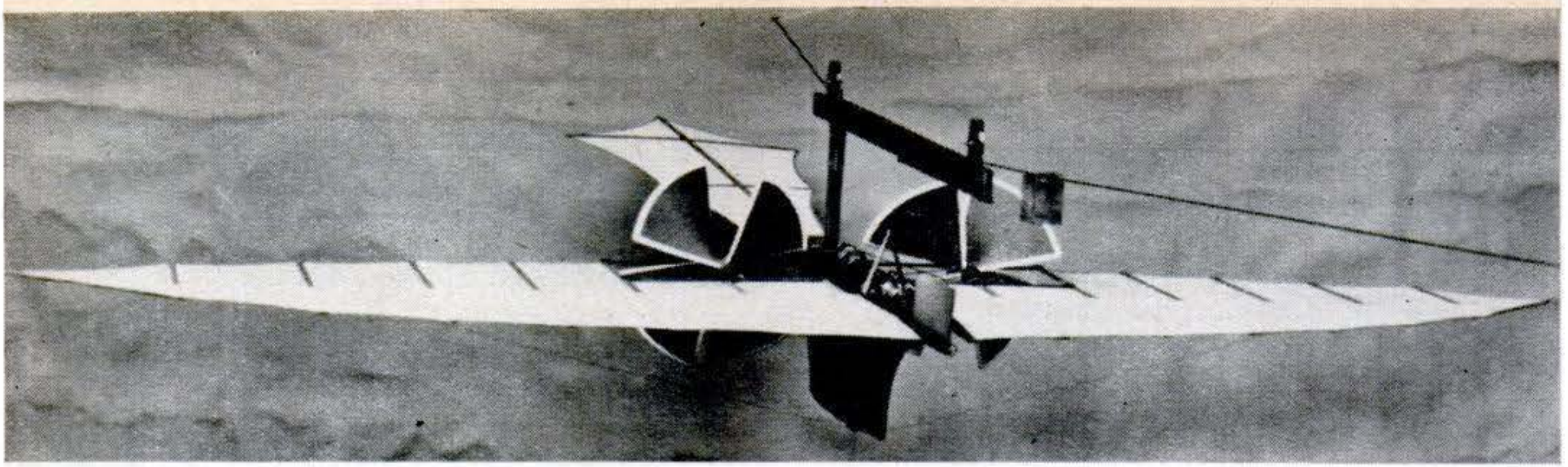
SHOULD the two young bicycle-makers give up their business and instead manufacture newfangled horseless carriages?

“No,” insisted Wilbur, 30—horseless vehicles would never be practical. “To try to build one of any account would be tackling the impossible. Why, it would be easier to build a flying machine!”

Younger brother Orville, 26, went along with Wilbur on that decision. The Wright brothers went right on making bicycles. At the same time—the year was 1897—they set out to build a flying machine.

Six years after Wilbur’s remarks, the two men got a man-carrying airplane—the first—into the air. The culmination of their efforts, the first flights—commemorated by the monument to the Wrights at Kitty Hawk, North Carolina—came in the lifetimes of many persons still living. It occurred just 60 years ago this December 17. The anniversary will be observed with a national celebration at Kitty Hawk.

Neither of the Wright brothers had finished high school. They had no engineering training. How were they able to invent the airplane? On the following six pages, in historic photographs and, largely, in the Wright brothers’ own words, *POPULAR SCIENCE* invites you to relive their faltering, yet dramatic, discouraging, and finally successful, efforts to become the first men to fly with engine-driven wings—to relive that triumphant, windy day on the lonely sand dunes of Kitty Hawk.



"Our first interest began when we were children." —ORVILLE WRIGHT, 1899.

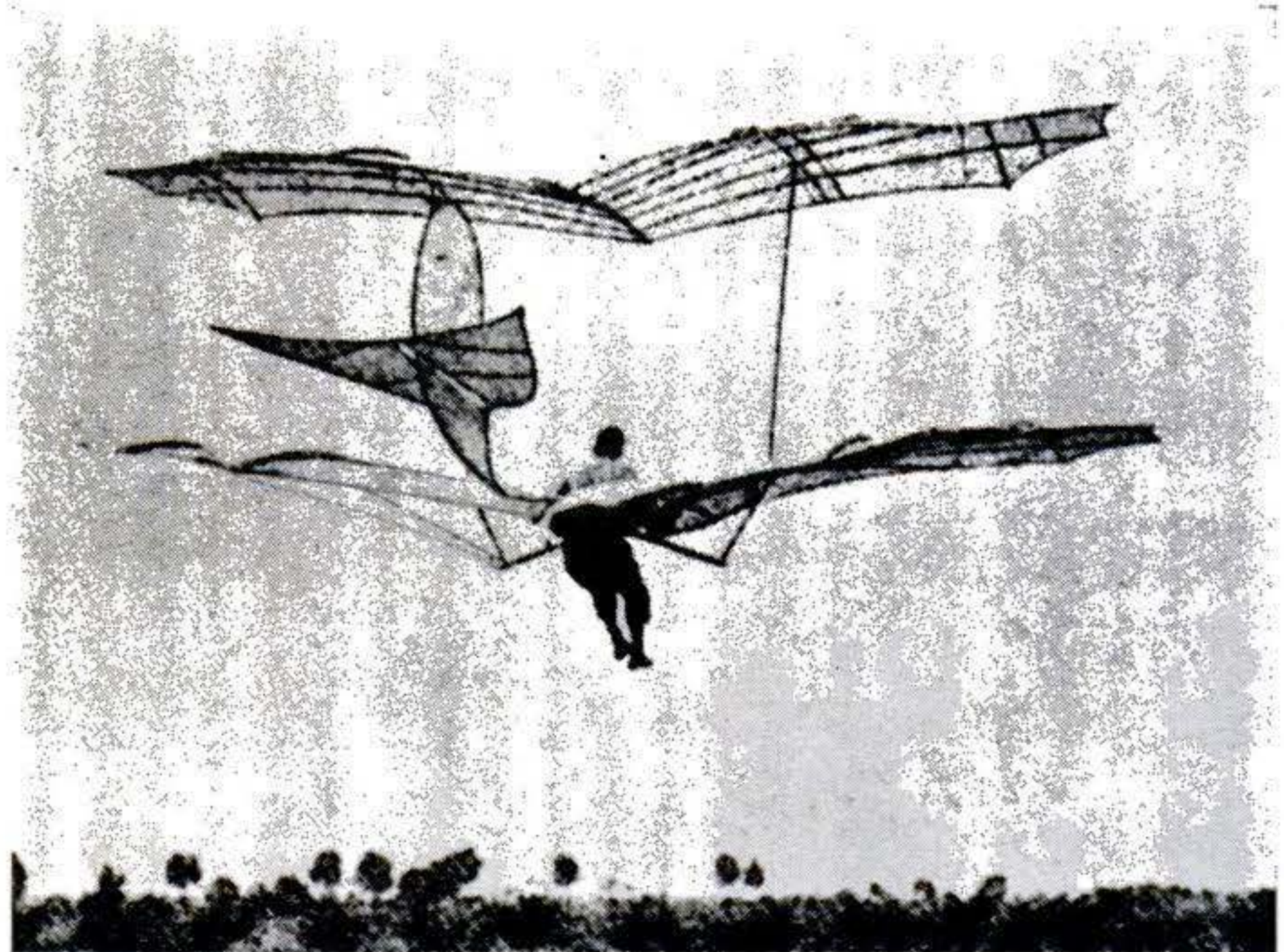
In Great Britain in 1848, long before the Wrights were born, this model airplane built by George Stringfellow had made the first powered flight in history. In a day when men still were imitating birds, uselessly trying to fly with flapping wings, Stringfellow's model gained flight

with a fixed wing, propellers, and an engine—three things that the Wrights would employ 55 years later. One day the Wright brothers' father, Milton, brought the boys a toy helicopter driven by a rubber band. That aroused the lads' interest in flying.

"Otto Lilienthal had been killed . . ."

—ORVILLE, 1899.

In Germany, Otto Lilienthal studied the flight of birds and built gliders in which he made many short flights, mostly downhill. The Wrights learned of him in newspapers or magazines—Orville did not remember which. In 1896 Lilienthal was killed when a gust of wind upset his glider. The Wrights decided that his glider had not been properly balanced and that his flights had been too brief and far apart for him to get enough practice in flight. They would try to avoid those mistakes.



"I have been afflicted with the belief that flight is possible."

—WILBUR TO HIS FATHER, 1900.

In America, Octave Chanute started to glide at 64—and designed a biplane glider (at left) the Wrights would emulate. Chanute for years corresponded with and encouraged the Wrights, and helped keep up Wilbur's confidence. Chanute had been chief engineer for the Chicago & Alton Railroad, laid out the Chicago stockyards, and superintended the first bridge across the Missouri River at Kansas City. He made 2,000 successful glider flights.

"It is only a question of knowledge and skill."

—WILBUR, MAY 30, 1899.

A bicycle was the first mechanical device many Americans owned, and it taught the first lessons in mechanics—both principles and skills—to many Americans. The Wrights learned mechanics from repairing and making bicycles in their Dayton, Ohio, shop (right), a few blocks from their home. Here, over half-a-dozen laborious years, they developed their knowledge of aerodynamics: reading everything on the subject; calculating wind pressure from the first wind tunnel ever built (they powered the fan with a small gasoline engine); figuring the best curvature and square footage for the wings; designing ribs and spars; talking out a thousand details. You could not ride a bicycle only from reading, the Wrights knew. Nor could you fly that way. They decided to practice gliding. Then they would build a flying machine.





"It is possible to fly without motors."

—WILBUR TO CHANUTE, 1900.

Frequently lying on their backs, the Wrights carefully studied the flight of birds. Wilbur's Notebook A, 1900-01, contains the results of wide-eyed observations:

"The dihedral angle [a V-shaped angle of the wings] is of advantage only in still air. It greatly increases the disturbing effects of side gusts."

"The buzzard which uses the dihedral angle  finds greater difficulty to maintain equilibrium in strong winds than eagles and hawks which hold their wings level .

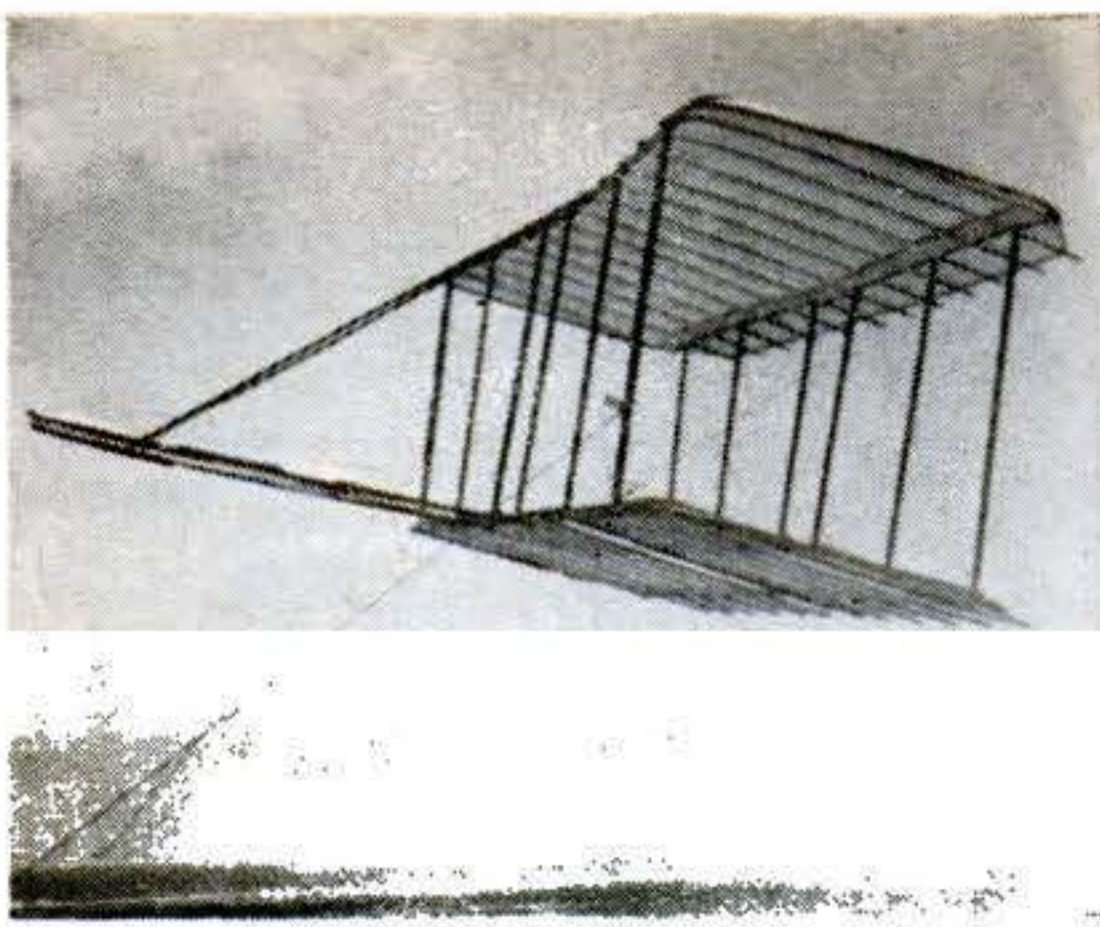
You can see in that the thought of the fixed airplane wing.

"The hen hawk can rise faster than the buzzard and its motion is steadier. It displays less effort in maintaining its balance."

"A damp day is unfavorable for soaring unless there is a high wind."

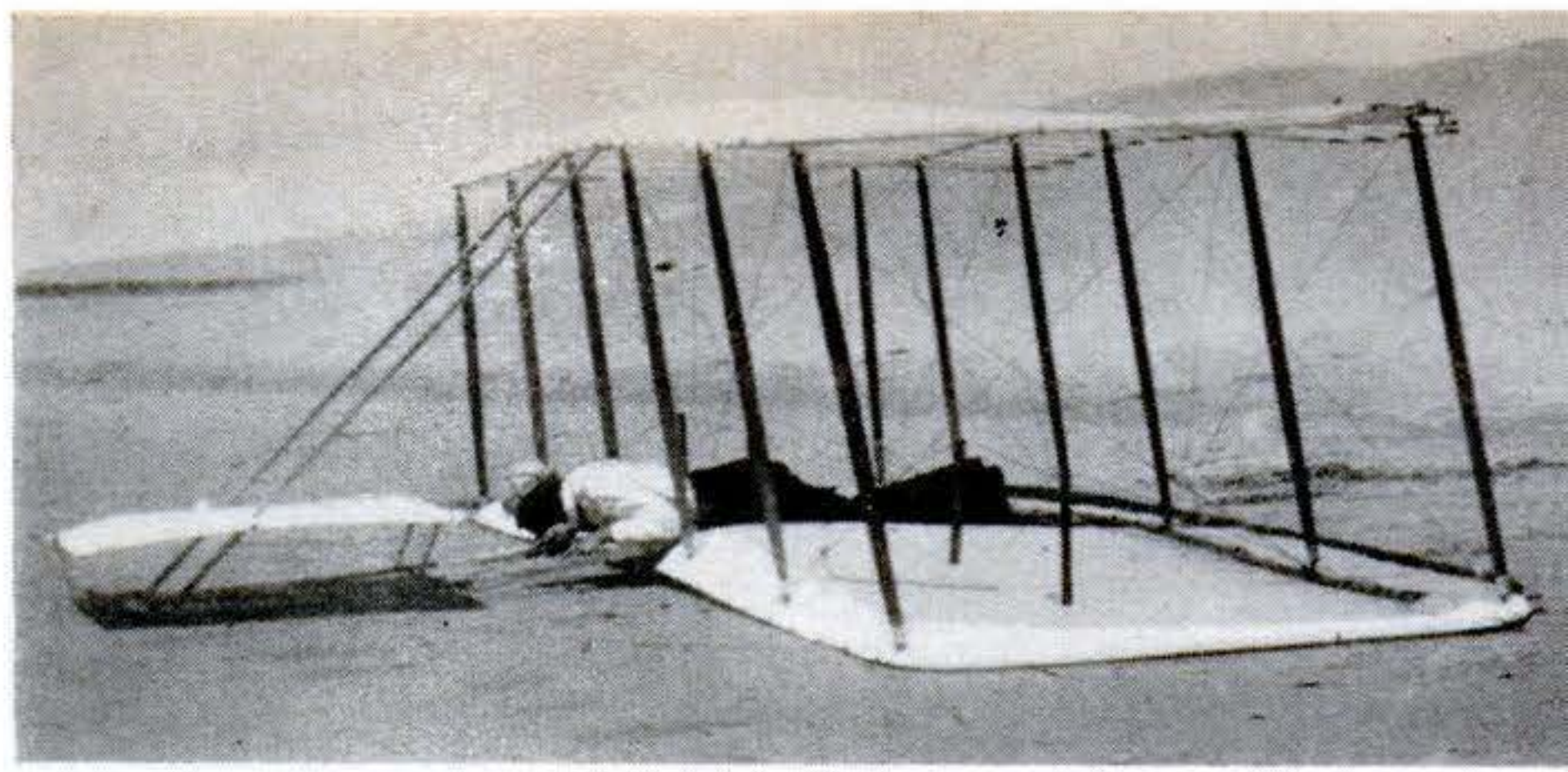
"No bird soars in a calm."

When they asked the Weather Bureau to suggest a windy spot to try out a glider, the Wrights were told of a remote place called Kitty Hawk, on the sand-dune coast of North Carolina.



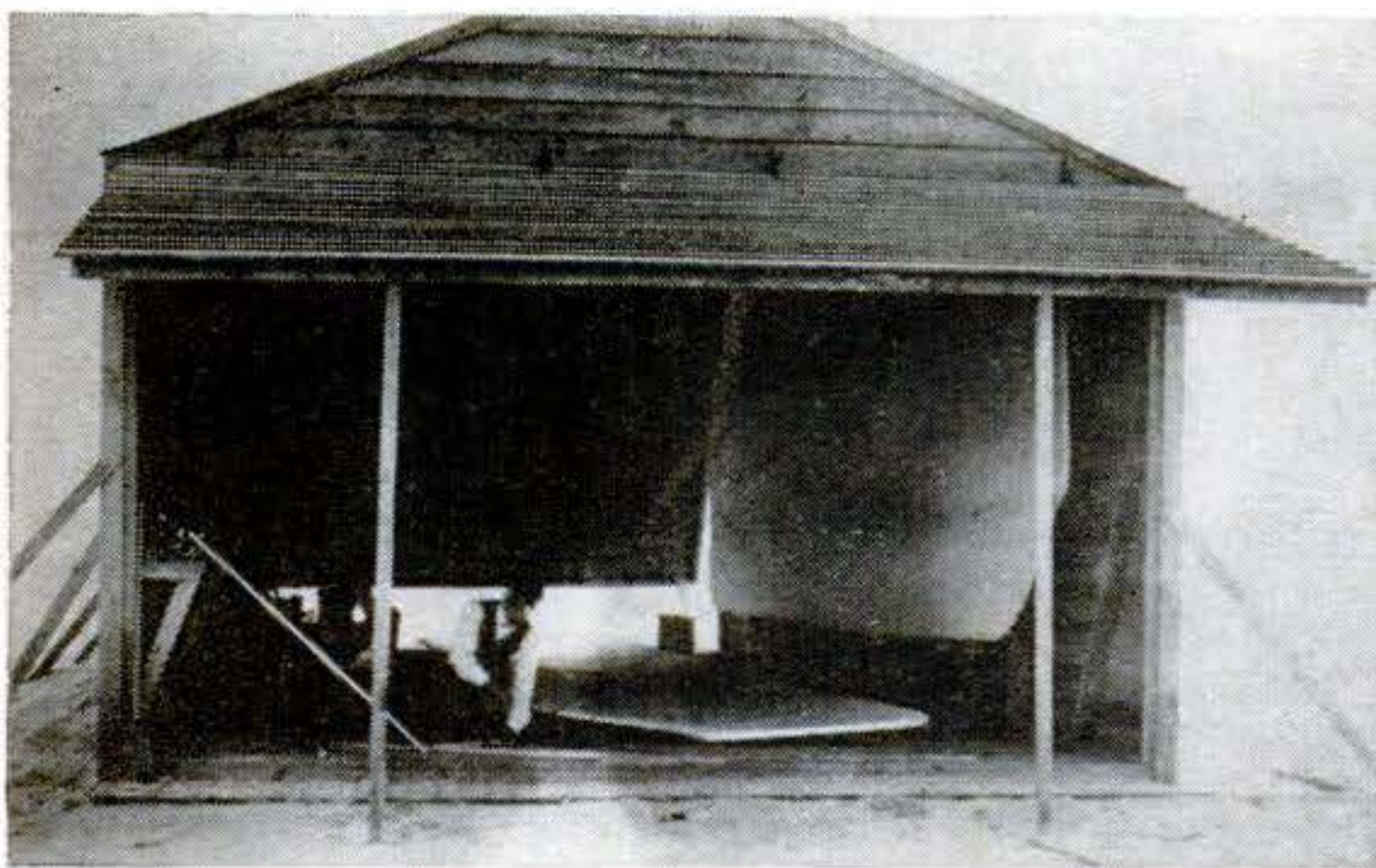
"It is safer to practice in a wind."—WILBUR TO HIS FATHER, 1900.

The Wrights took their first glider to the sand dunes and breezes of Kitty Hawk in 1900. "A Chanute double-decker," Wilbur called it. They usually flew it like a kite, at the end of a rope, studied its behavior. The Wrights flew in the kite for a total of 10 minutes in that year. When Wilbur took the first tethered glider ride, he shouted, "Lemme down! Lemme down!" Later the Wrights glided—for a total of two minutes—without the rope.



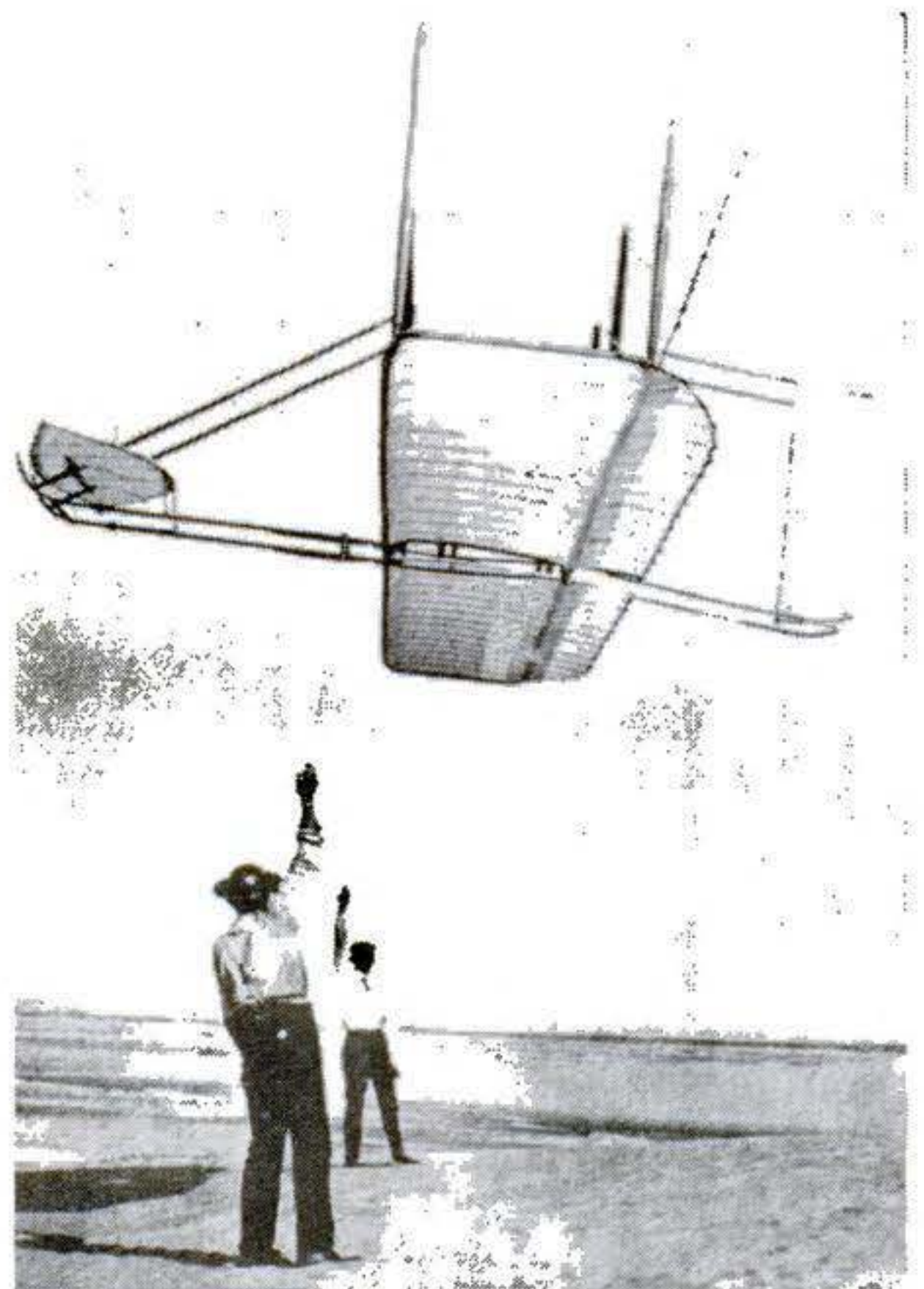
"Greater prudence is needed rather than greater skill."—WILBUR, JULY, 1901.

In 1901, the Wrights returned to Kitty Hawk with a glider about twice as big as any previous one. It had a wingspan of 22 feet. When they flew it like a kite, they did not ride in it. But when they tried it as a glider, each flew, lying on his stomach. Lying down cut a man's resistance to the wind to a fifth or tenth of upright position. Besides, lying prone helped the glider's equilibrium, and seemed to enable them to land it more safely. By 1901, tests showed the Wrights that previous calculations of wind pressure were unreliable, took them back to the bicycle shop for lots of refiguring. Wilbur said men wouldn't fly for a thousand years.



"We erected a cheap frame building."—WILBUR, SEPTEMBER, 1901.

To protect their gliders at Kitty Hawk, the brothers put up a shack. "Both ends of the building," said Wilbur, "except the gable parts, were made into doors which hinged above, so that when opened they formed an awning at each end, and left an entrance the full width of the building." Thus was constructed the first airplane hangar—born to protect their "machines" from Kitty Hawk's gusty winds.

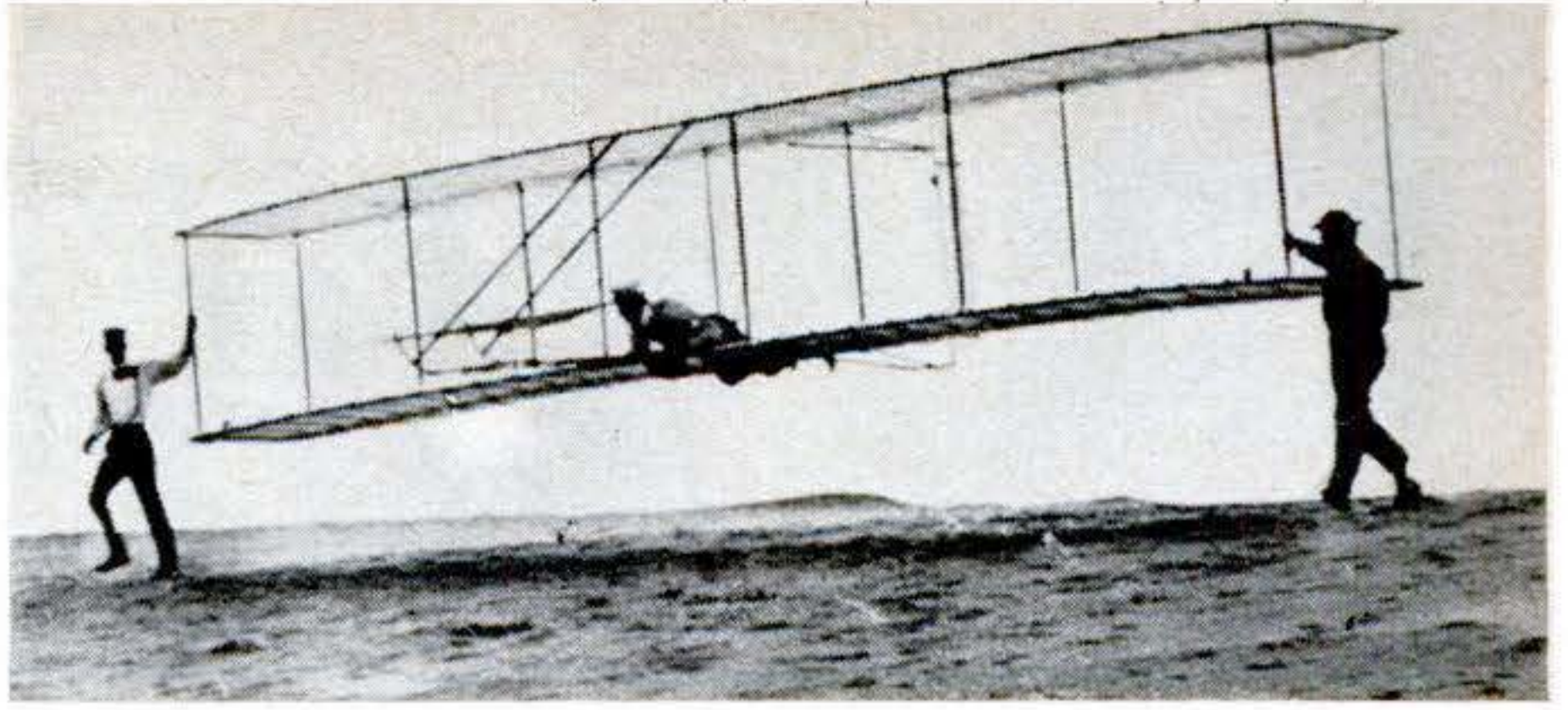


"The inability to balance and steer . . ."—WILBUR, SEPTEMBER, 1901.

That was the big problem for students of aviation, the Wrights believed. Their goal in 1902 was a completely stable, controllable machine. So they added something new—a vertical tail at the rear. At first fixed (as above), it soon became movable and adjustable—a rudder. (A man named William S. Henson had patented such a device, back in 1842.) The glider, here flown as a kite, also had an elevator in front to move it up or down, and ailerons on wingtips to enable a pilot to maintain balance.

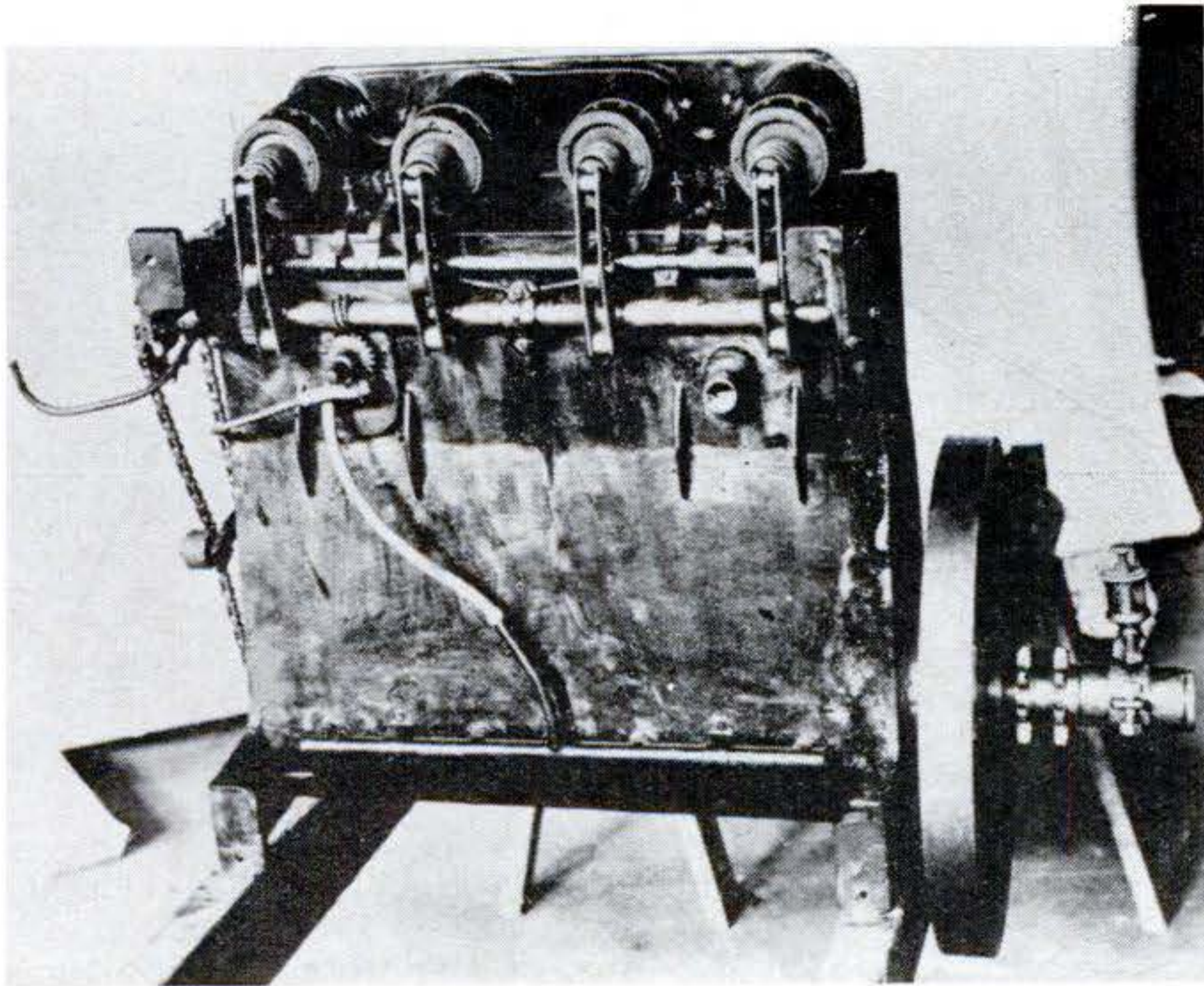
"In one glide my brother made 160 feet . . ."
—WILBUR, SEPTEMBER, 1902.

After a few experiments, the Wrights made the wires that controlled the new rudder also control the ailerons. Now the new glider, the biggest yet, was ready. They began to glide with their customary caution, at first rising only a few inches, then five or six feet, above ground (right). After 50 glides, they found their machine was at last under almost perfect control by its pilot. In the last 10 days at Kitty Hawk in 1902 they made 250 glides. The longest, 622½ feet, lasted 26 seconds. They glided against strong winds, some as high as 36 miles an hour. Said Octave Chanute, who was there in 1902: "The machine could be glided up or down or side-



ways, with the greatest ease and certainty . . ."

To Britain's Robert Baden-Powell he said the Wrights were ". . . now doing nearly as well as the vulture." The Wrights left Kitty Hawk at the end of October. They wanted to use their round-trip railroad tickets, which expired October 31. A replica of their 1902 glider can be seen today at the Kitty Hawk museum.

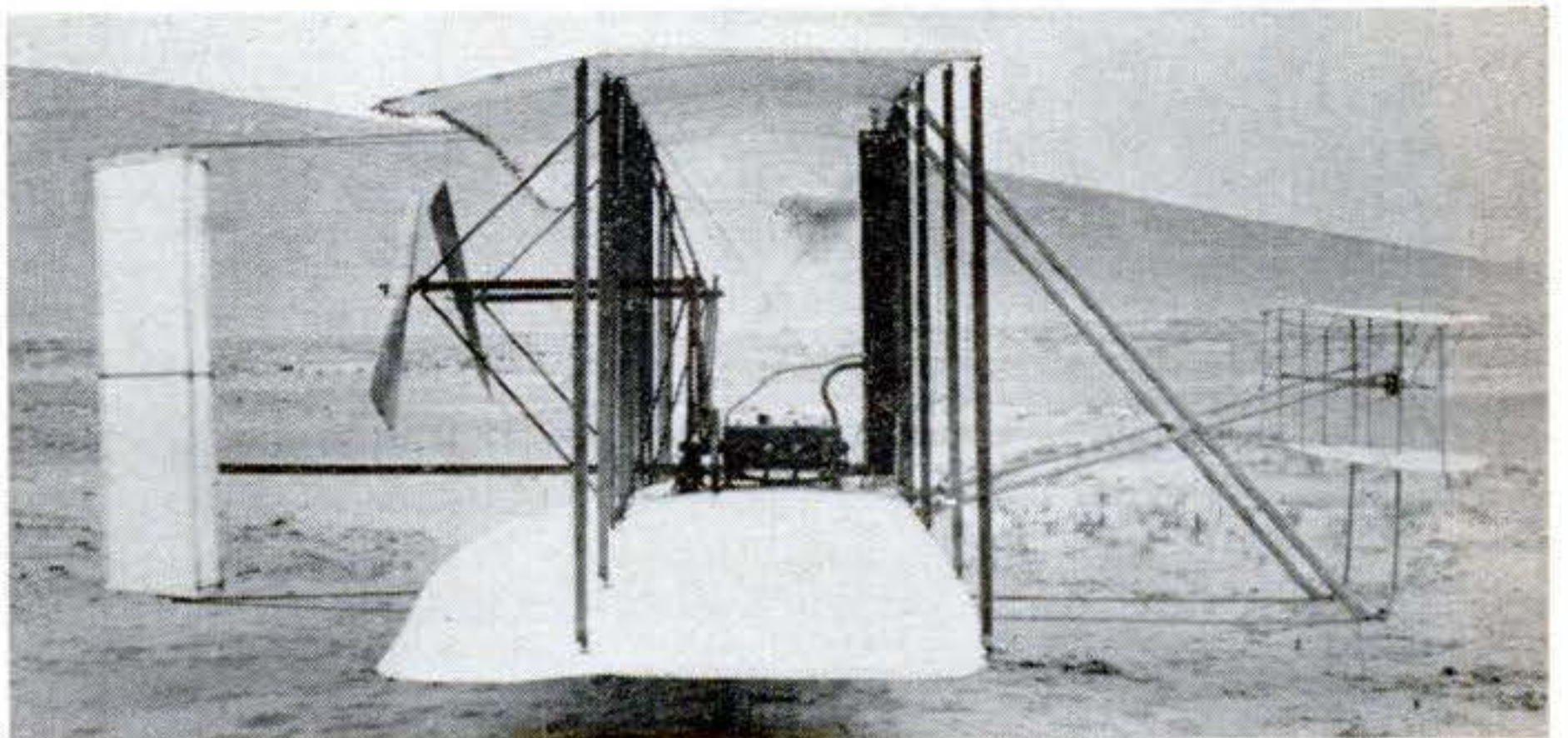


"The next step will be to apply a motor."
—WILBUR, DECEMBER, 1902

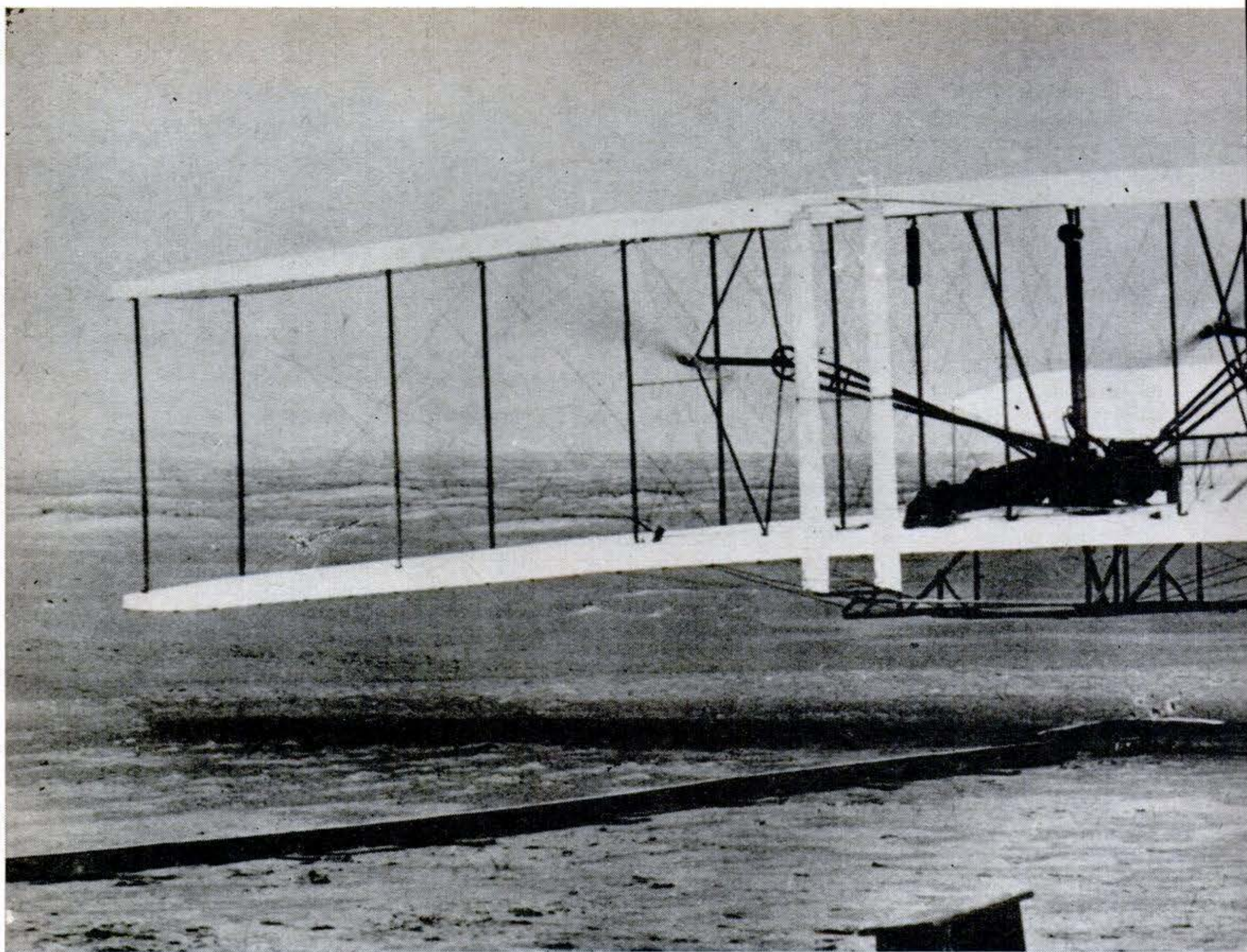
On the basis of their highly successful 1902 glider, the Wright brothers applied for a patent on a flying machine. The patent was granted in 1906. "About Christmas-time," wrote Orville, "we began the construction of the motor, which is of four cylinders." Charlie Taylor, their mechanic, helped them build what Wilbur called "an automobile motor simplified." It weighed 170 pounds, was water-cooled, and made 1,200 revolutions a minute.

"All the propellers built heretofore are all wrong."
—ORVILLE, JUNE, 1903.

Last-minute headache was how to make and shape propellers. A book by Octave Chanute listed 44 other books that supposedly told how. None did. The Wrights came up with 8½-foot-long props, 6 inches in width at the tips. "Well," said Orville, "our propellers are so different from any that have been used before that they will have to be either a good deal better, or a good deal worse." The engine and two propellers were added to the 1902 glider to turn it



into their 1903 airplane—shown here after the Wrights' return to Kitty Hawk. Another addition: sled runners, extended in front, to prevent rolling over forward on landing.



Man's first powered flight: "After running the engine and propellers a few minutes to get them in working order, I got on the machine at 10:35 for the first trial . . . the machine started off, increasing in speed to probably 7 or 8 miles. The machine lifted . . ." —ORVILLE WRIGHT'S DIARY, DECEMBER 17, 1903.

Back for the fourth and last time at Kitty Hawk the Wrights heard some news: On December 8, 1903, a plane designed by Samuel Pierpont Langley of the Smithsonian Institution failed to fly at Washington. It was Langley's last attempt. He had spent \$70,000.

The Wrights were finishing their plane, preparing for their own attempt. They had placed the engine a little to right of center so that either of them—each weighed around 145 pounds—could ride, lying flat, a little to the left, and so balance the plane. The craft had a wingspan of a few inches over 40 feet. The wings were six feet apart.

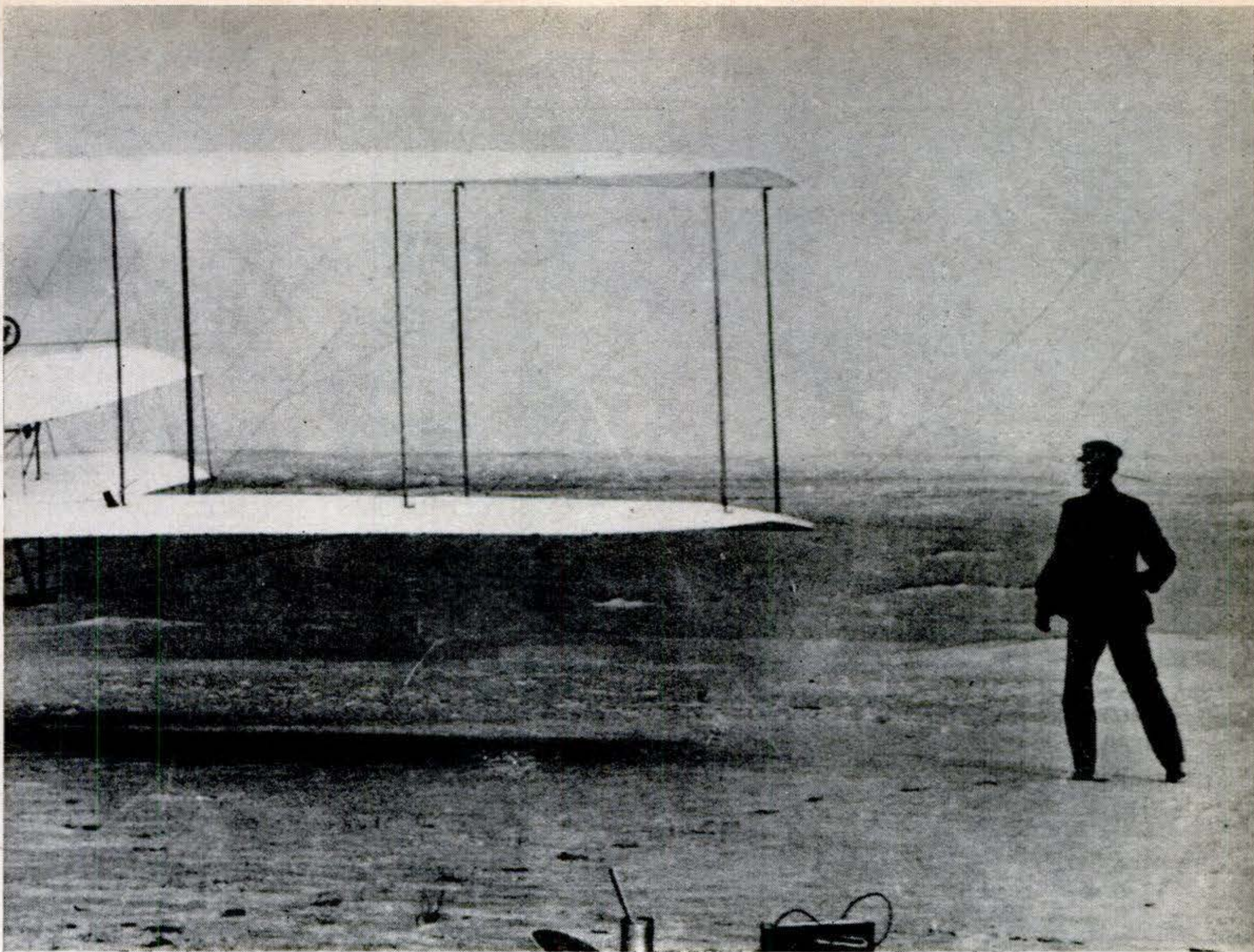
The propellers, which kept coming off their shafts, were finally held on by metal straps, wood screws, and—a cure-all for the Wright brothers—bicycle cement. Altogether, including fares to Kitty Hawk, the Wrights had spent less than \$1,000.

On December 14, six days after Langley's disaster, the Wrights made a preliminary trial of their 1903 machine. The plane, which had no landing wheels, took off by moving along a monorail track on the ground. The track was made of four 15-foot-long two-by-fours, with a

thin metal strip on top. A truck, supporting the plane, ran along the track on rollers made from modified bicycle hubs. When the plane rose, it left the truck on the ground. The plane was launched off a hill, with Wilbur aboard. It was in the air only $3\frac{1}{2}$ seconds, and landed 105 feet from the start. A landing runner and two struts were damaged. It took the next two days to repair them.

December 17, the day that would go down in history, was inclement. It was cold. The puddles of water at Kitty Hawk froze over. But the Wrights wanted to be home in Dayton for Christmas, and time was running out. By 10 o'clock that morning they decided to try the plane. They had invited everybody in the vicinity. Three men from the Kill Devil Life Saving Station, near Kitty Hawk, accepted: John T. Daniels, W. S. Dough, and A. D. Etheridge. And two other neighbors, W. C. Brinkley of Manteu and John Ward of Nags Head, showed up. One man, Bill Tate, decided there was too much wind for a flight and didn't come.

As Wilbur had made the December 14 trial, it was Orville's turn. He lay down in the plane. "I released the wire that held the machine to



the track," Orville later wrote, "and the machine started forward into the wind. Wilbur ran at the side of the machine, holding the wing to balance it on the track."

Unlike the trial run of the 14th, which had been made in a calm, the machine, facing a 27-mile wind, started very slowly. After a 40-foot run, it lifted itself off the track.

"One of the Life-Saving men snapped the camera for us, taking a picture [above] just as the machine had reached the end of the track and had risen to a height of about two feet," Orville recalled. "The slow forward speed of the machine over the ground is clearly shown in the picture by Wilbur's attitude. He stayed along beside the machine without an effort.

"The course of the flight up and down was exceedingly erratic, partly due to the irregularity of the air and partly to lack of experience in handling this machine . . . A sudden dart, when a little over 100 feet from the end of the track, or a little over 120 feet from the point at which it rose into the air, ended the flight . . .

"The flight lasted only 12 seconds, but it was nevertheless the first in the history of the world in which a machine carrying a man had raised itself by its own power into the air in full flight, had sailed forward without reduction of speed, and had finally landed at a point as high as that from which it had started."

The visitors helped carry the plane back to the starting track. The Wrights made three more

flights that day. The second one was 75 feet longer than the first; the third was over 200 feet; the fourth and last, at noon, lasted 59 seconds and covered 852 feet.

After the last trip, a gust of wind hit the plane. Its ribs and a number of other parts were broken and its engine damaged. The plane could not fly again.

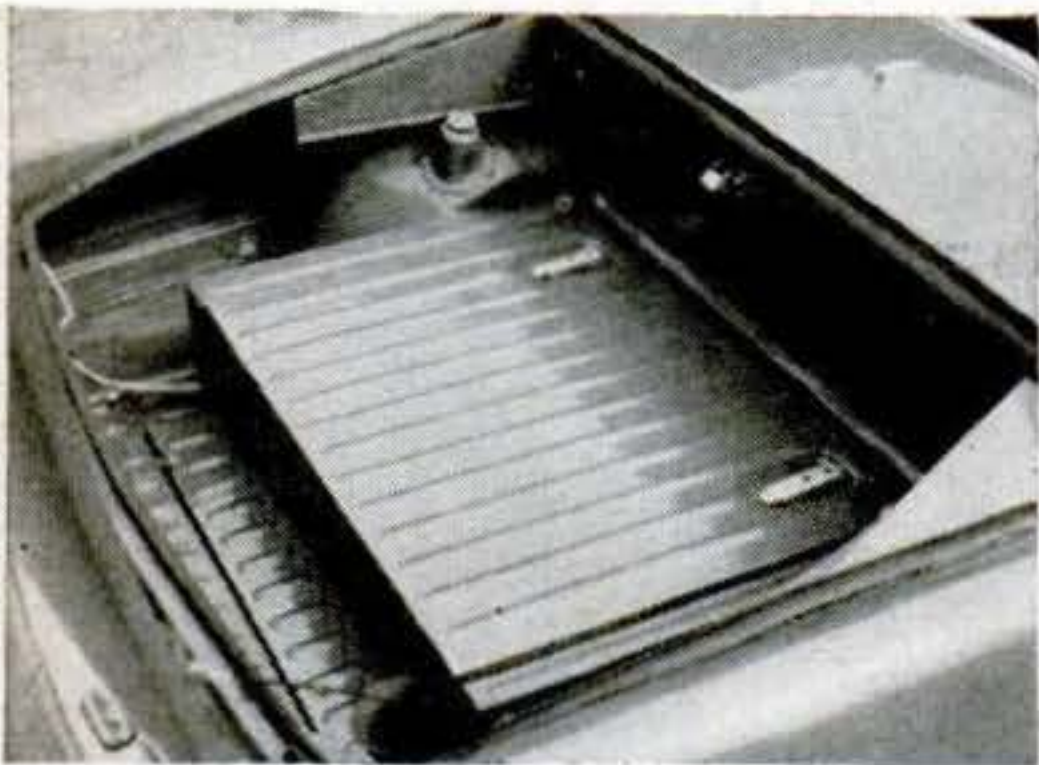
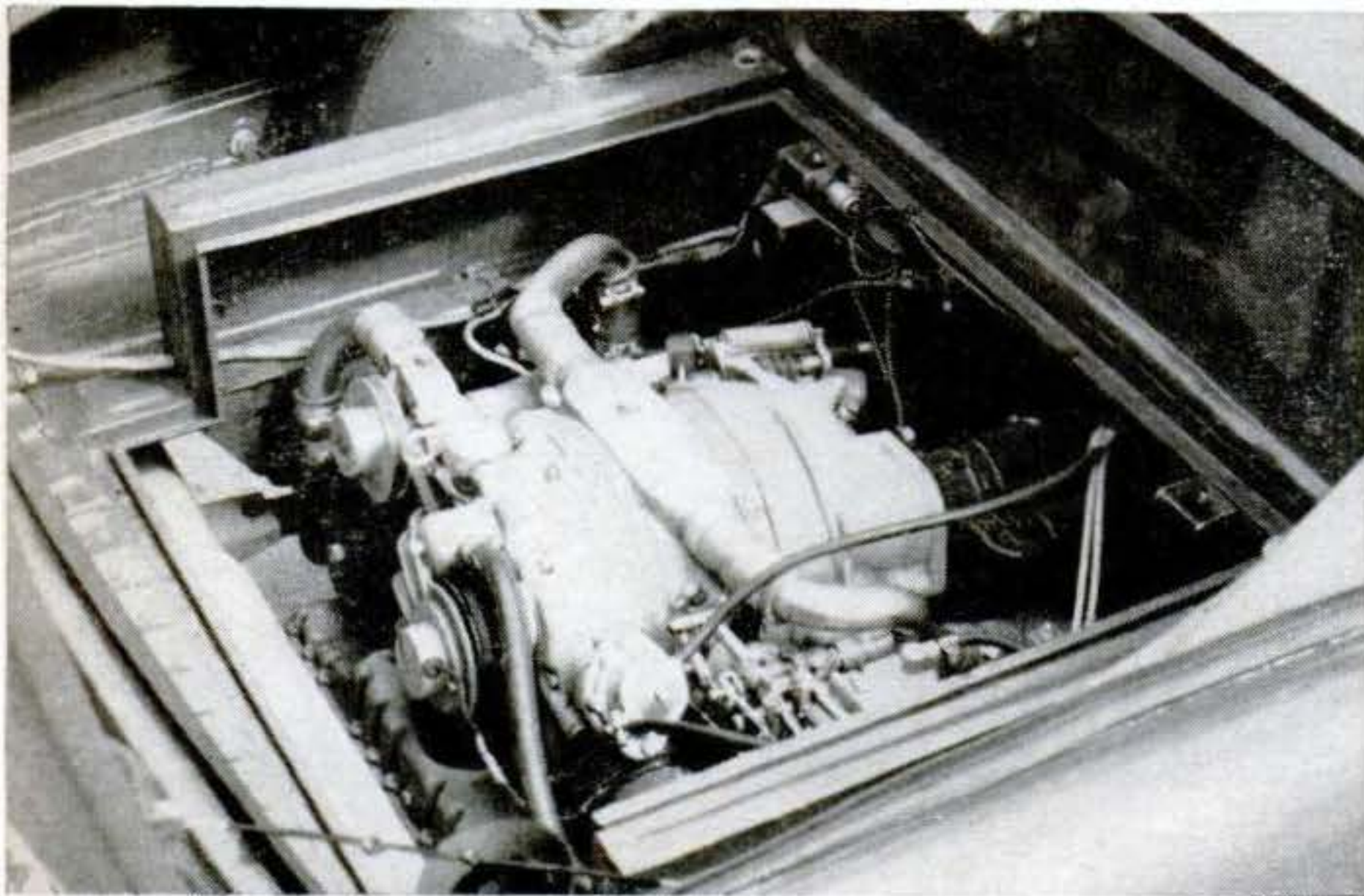
The five visitors drifted away. Orville and Wilbur Wright, now with no need to hurry, prepared and ate their lunch. Then they washed the dishes. About two o'clock they walked four or five miles to the Kitty Hawk weather station. They sent a telegram to their father in Dayton. "Success four flights," they wired, and told him they'd be back for Christmas. They were.

Langley's disaster had so dampened belief in flying that only a few newspapers made any mention of the Wrights' flights, and there were no reporters on hand when the men who had just started the age of aviation reached the railroad station at Dayton a few days later. There were no throngs and no bands. Their father met them, though, and so did their younger sister Katharine, and Lorin, one of their two older brothers. The conquerors of the air rode home, with their family, in a one-horse surrey. ■ ■

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Note: Wright brothers' quotations accompanying photographs are from *The Papers of Wilbur and Orville Wright, Volume One: 1899-1905*. McGraw-Hill Book Co., Inc., NYC.

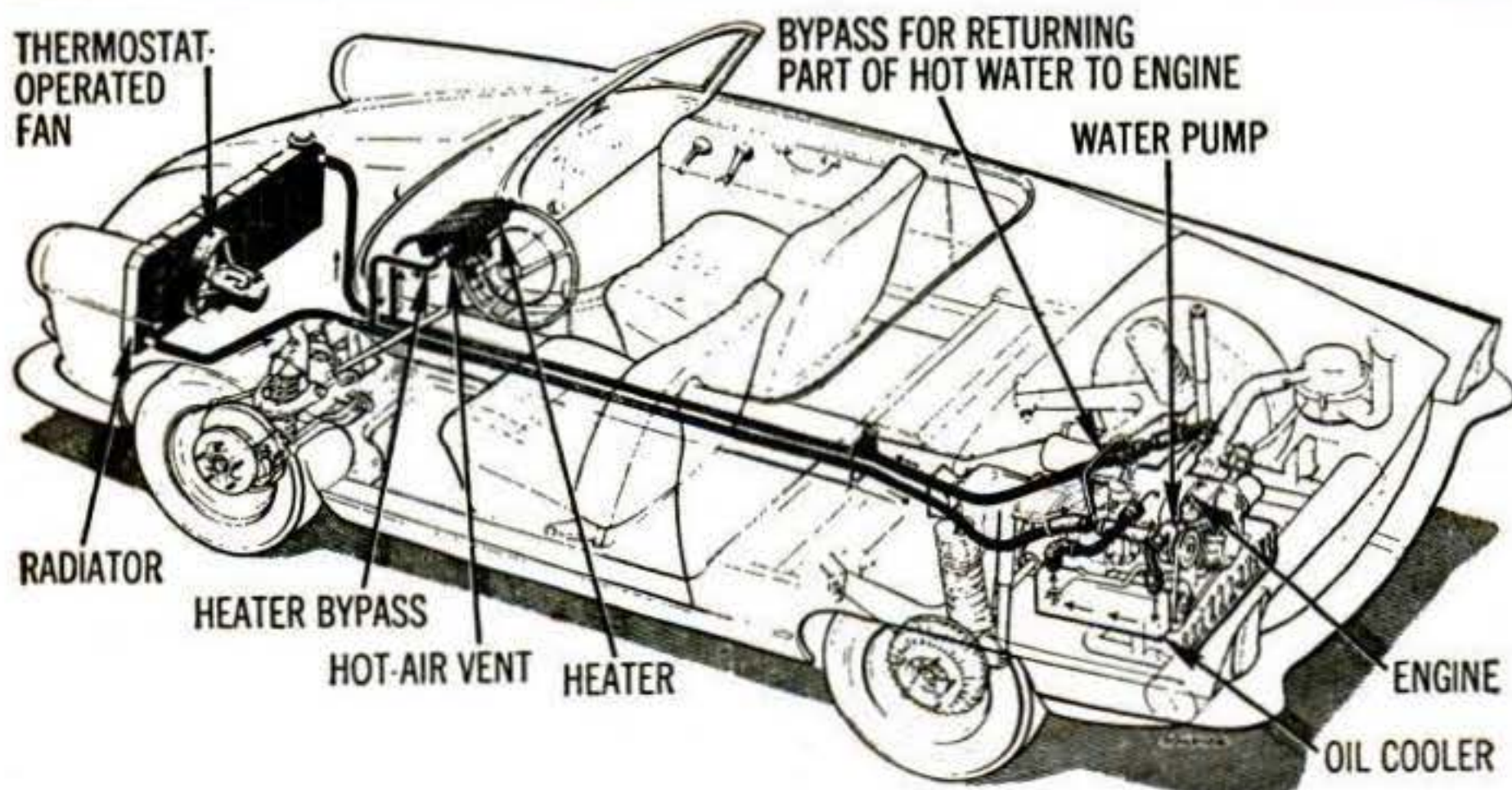


NSU Spider is powered by Wankel rotary engine



Engine is water-cooled, except for rotor, which is cooled and lubricated by oil. A single spark plug ignites the mixture.

Lower the engine cover and you still have luggage room. And there's more space in the front trunk and behind seats.



Front-mounted radiator gives more even weight distribution.

The first production car to be powered by a rotary-piston engine has been introduced by NSU of Germany.

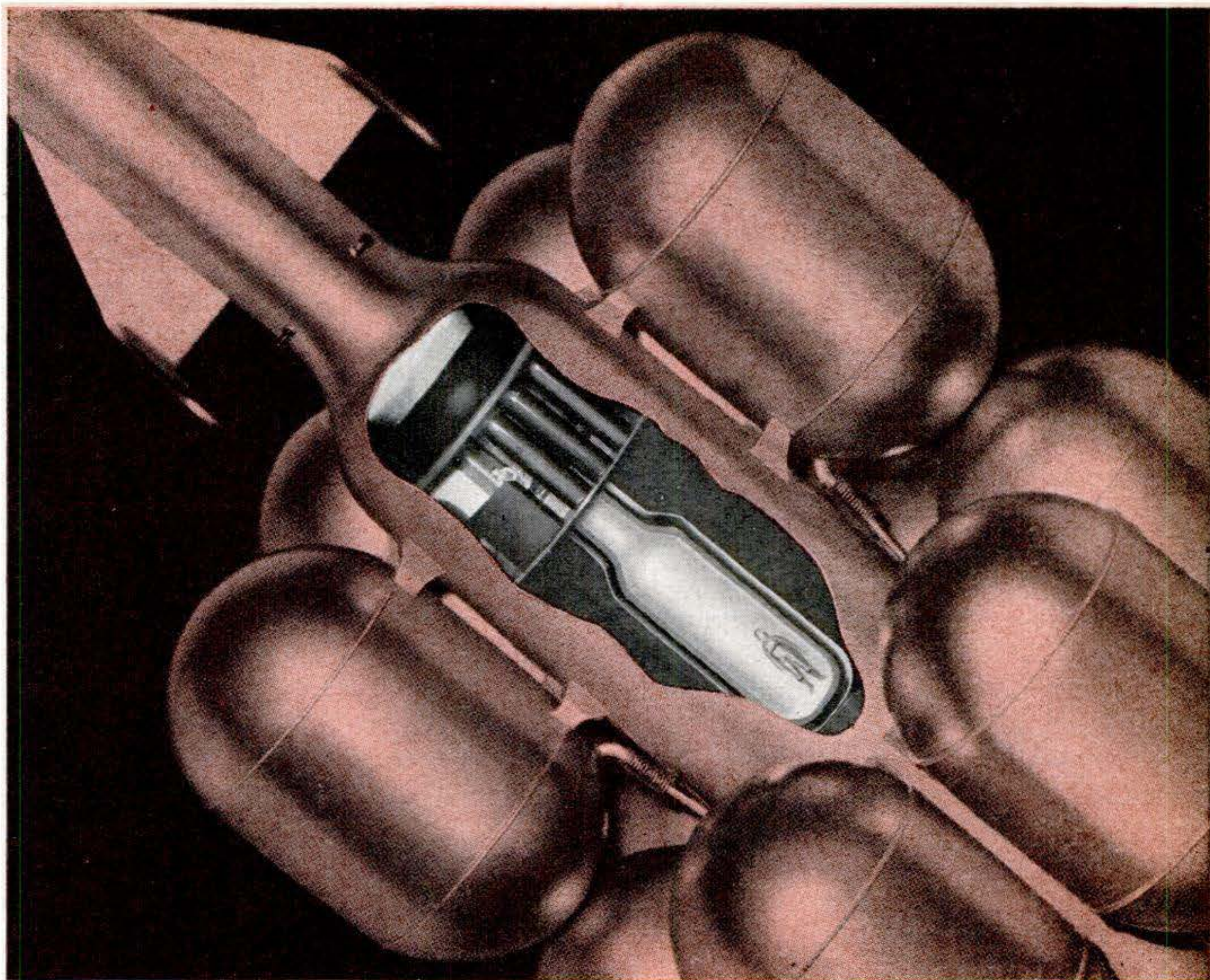
Its tiny power plant displaces about 30 cu. in. and is a simpler, more efficient version of the Wankel engine described in PS [March, 1960]. It develops 64 hp. at 5,000 r.p.m. and, according to the manufacturer, offers 95 m.p.h. top speed, 35 m.p.g. economy.

The car, called the Spider, is a convertible version of the NSU Sport Prinz. Front wheels boast coil springs and disk brakes; rear wheels are independently coil-sprung.

The manual transmission has four forward speeds, all synchronized. The clutch is hydraulically actuated.

Two important advantages of the rotary-piston engine are its compact size and its lightness. It weighs only 275 pounds complete with all accessories—far less than a reciprocating engine of the same horsepower. Also, it is claimed, it runs far smoother. In spite of its high compression ratio—8.5:1—it uses regular gas; there are no valves to heat up and cause premature ignition of fuel.

Mass production is scheduled for spring. No prices have been released.



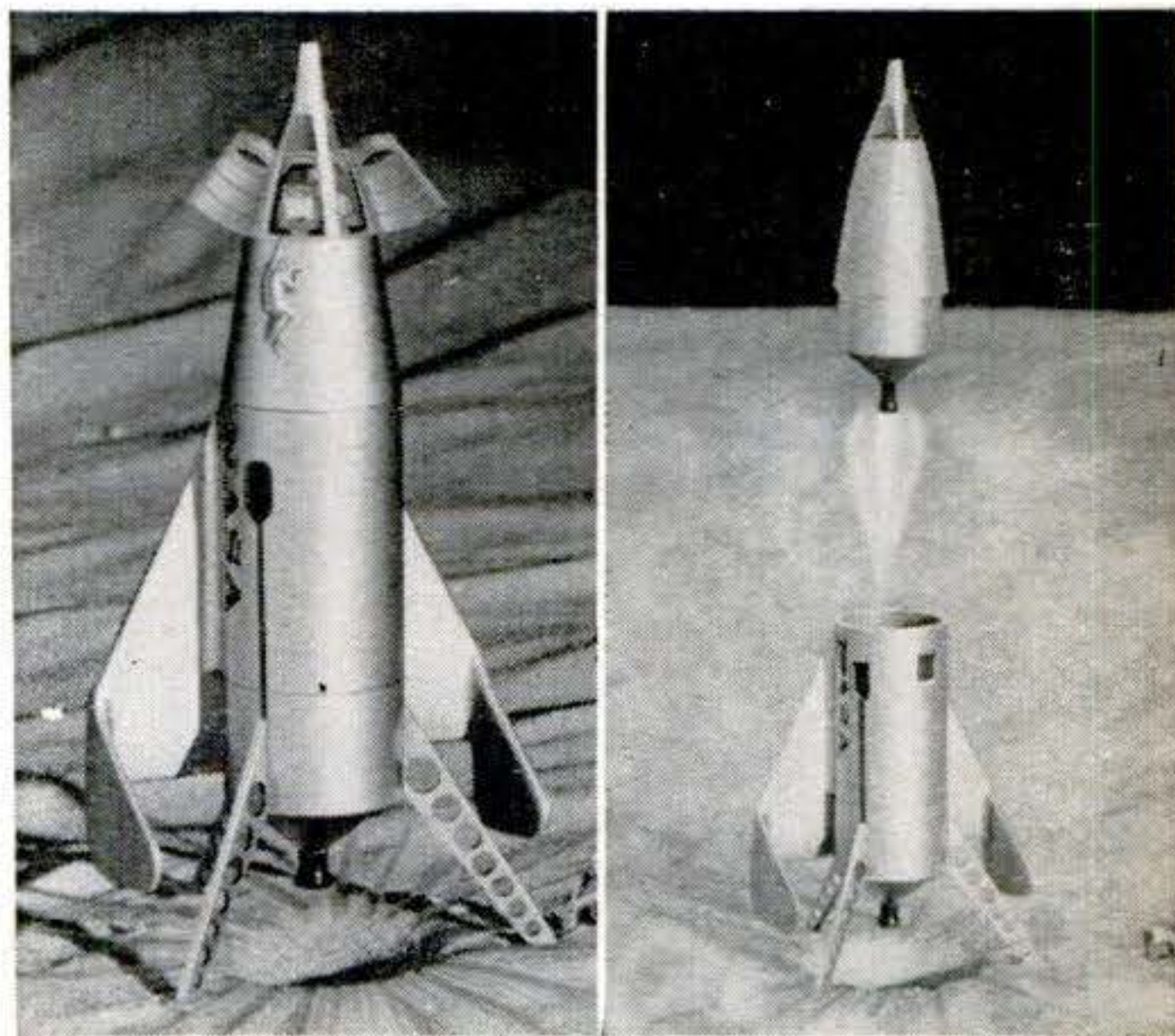
Mars ship conceived by GE has throw-away fuel tanks. The well inside is a radiation shelter.

So We Land on the Moon —Then What?

Where do we go after a lunar landing? Here's the timetable we're shooting for

By C. P. Gilmore

WILL human explorers ever reach the other planets in the solar system? It depends on which crystal ball you're looking into. The U.S. space program has become one



GE landing module has wings for braking in Martian atmosphere. Heading back to orbiting spaceship, crew capsule leaves wings behind.

CONTINUED

of the most controversial issues today. Even within the National Aeronautics and Space Administration there are two camps: a conservative faction, concerned only with practical space jobs that can be done in the near future, and the "on-to-Jupiter boys."

It's not widely known, though, that NASA has a master plan for space exploration that goes far beyond landing men on the moon—that envisions manned voyages to some of the planets within the next 25 years.

How realistic is the timetable? Let's take a look at the steps to the planets, as outlined in NASA's chart (see facing page). We'll skip over the programs in blocks 1, 2, 4, and 5, which lead up to the manned Apollo landings on the moon, and see what lies beyond.

Unmanned deep-space probes (1960s—block 3). Like Mariner II, the highly successful probe that investigated Venus last December [see "Keeping a Date with Venus," PS, Dec. '62], some of these are actually scheduled for planetary missions. A Mariner fly-by to gather data on Mars is scheduled for 1964. A bigger Mariner is also in the works, to gather more data during a fly-by in 1966 and

also to spit out a capsule for soft landing on Mars. This will, NASA hopes, deliver a gadget called Gulliver that will try to detect traces of life on the red planet. Another Mariner may land an instrument package on Venus in 1965. While these shots are difficult, they have a good chance of succeeding. NASA also anticipates the development of unmanned spacecraft that can travel to Jupiter, Saturn, and Pluto in the 1970s.

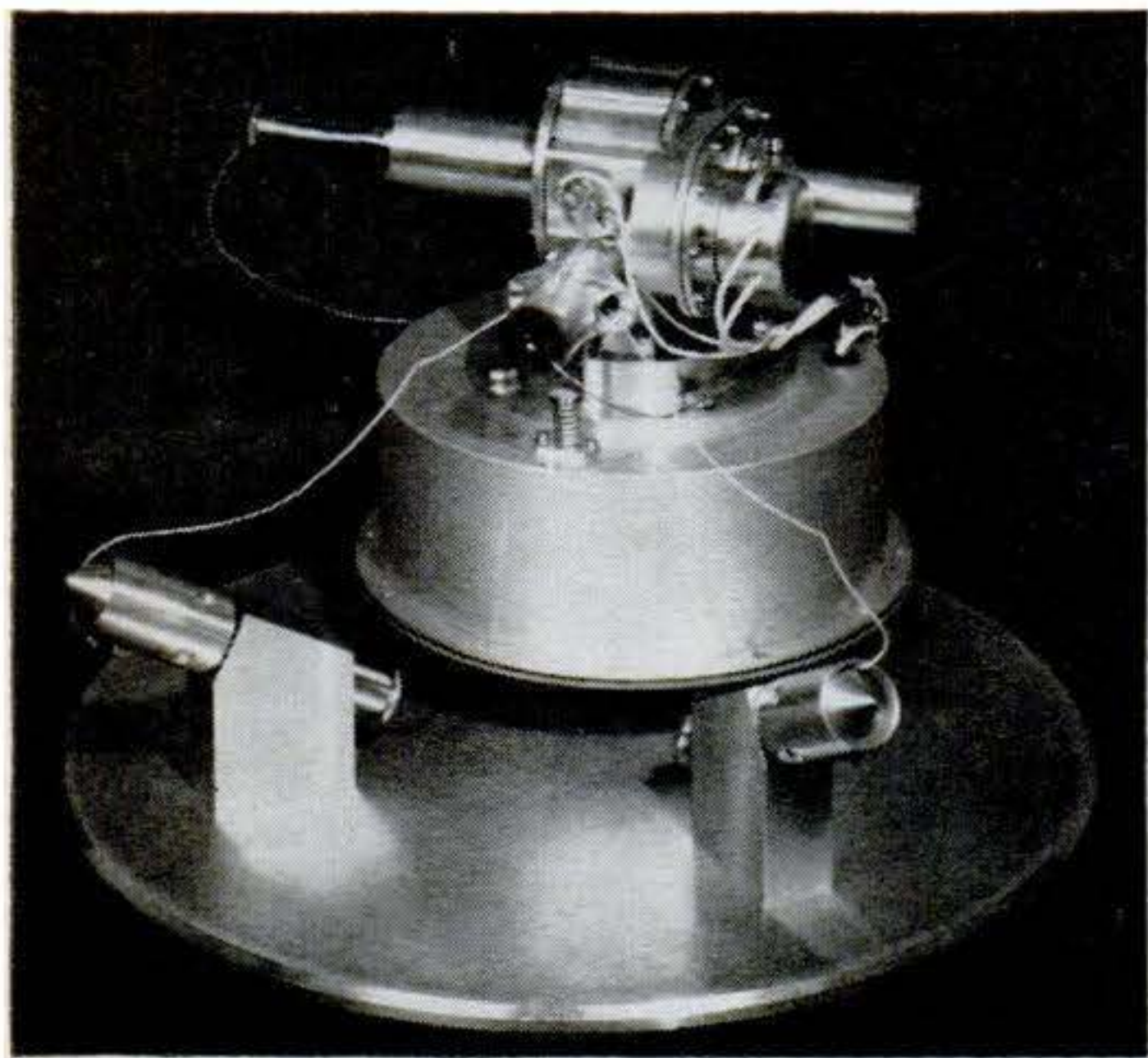
Space station (after 1968—block 7). A platform kept in orbit around the earth for long periods will give men the experience they need to go to the planets. Main question: Will an interplanetary ship need artificial gravity? Astronauts Walter Schirra and Gordon Cooper were both shaky after their Mercury flights. If weightlessness turns out to have serious physiological effects on spacemen, interplanetary ships will have to rotate in flight to produce a centrifugal-force field acting as artificial gravity; such ships would present special design problems.

Project Gemini should provide experience with maneuvering and rendezvous. Then it should be possible to design and

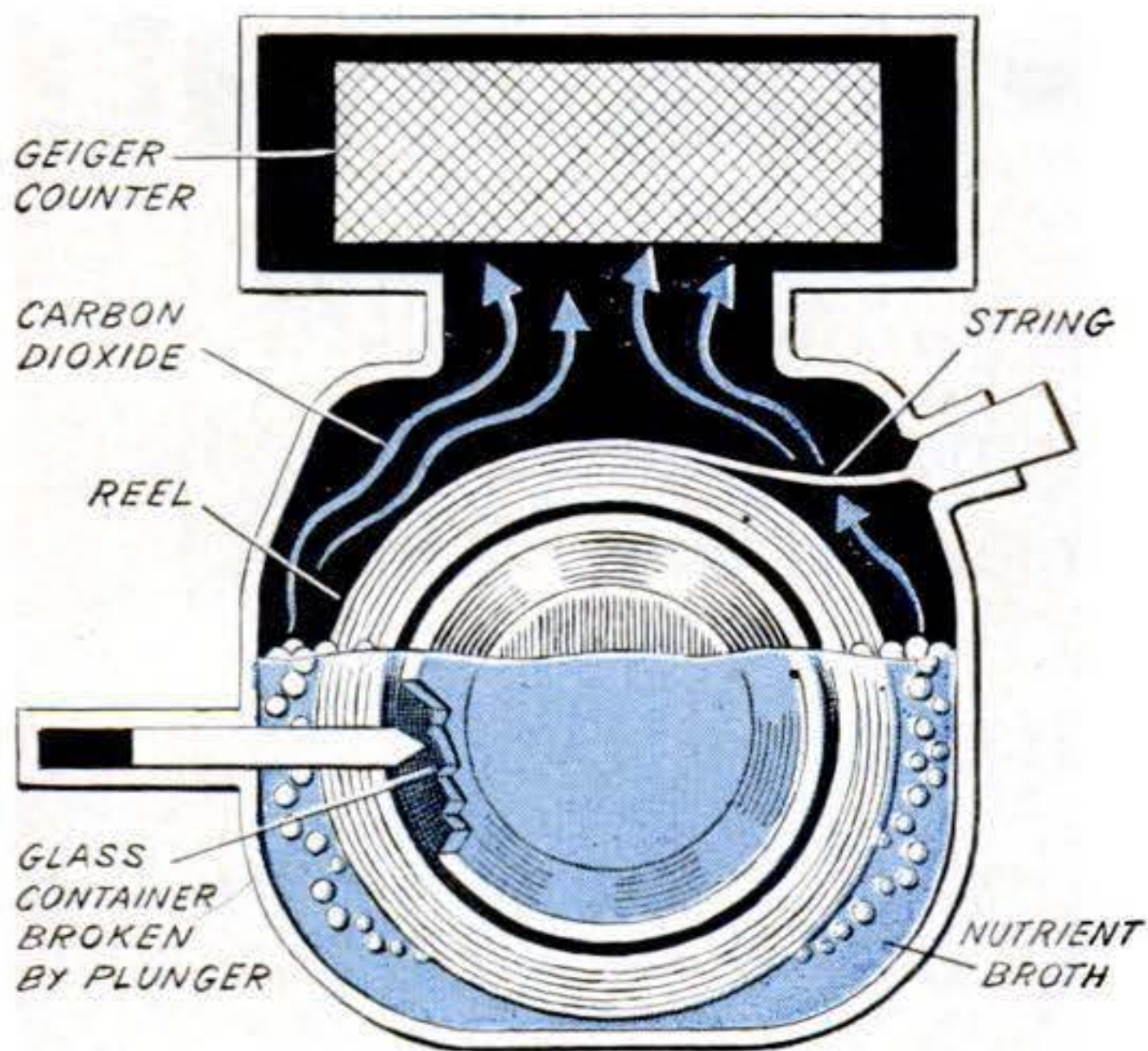
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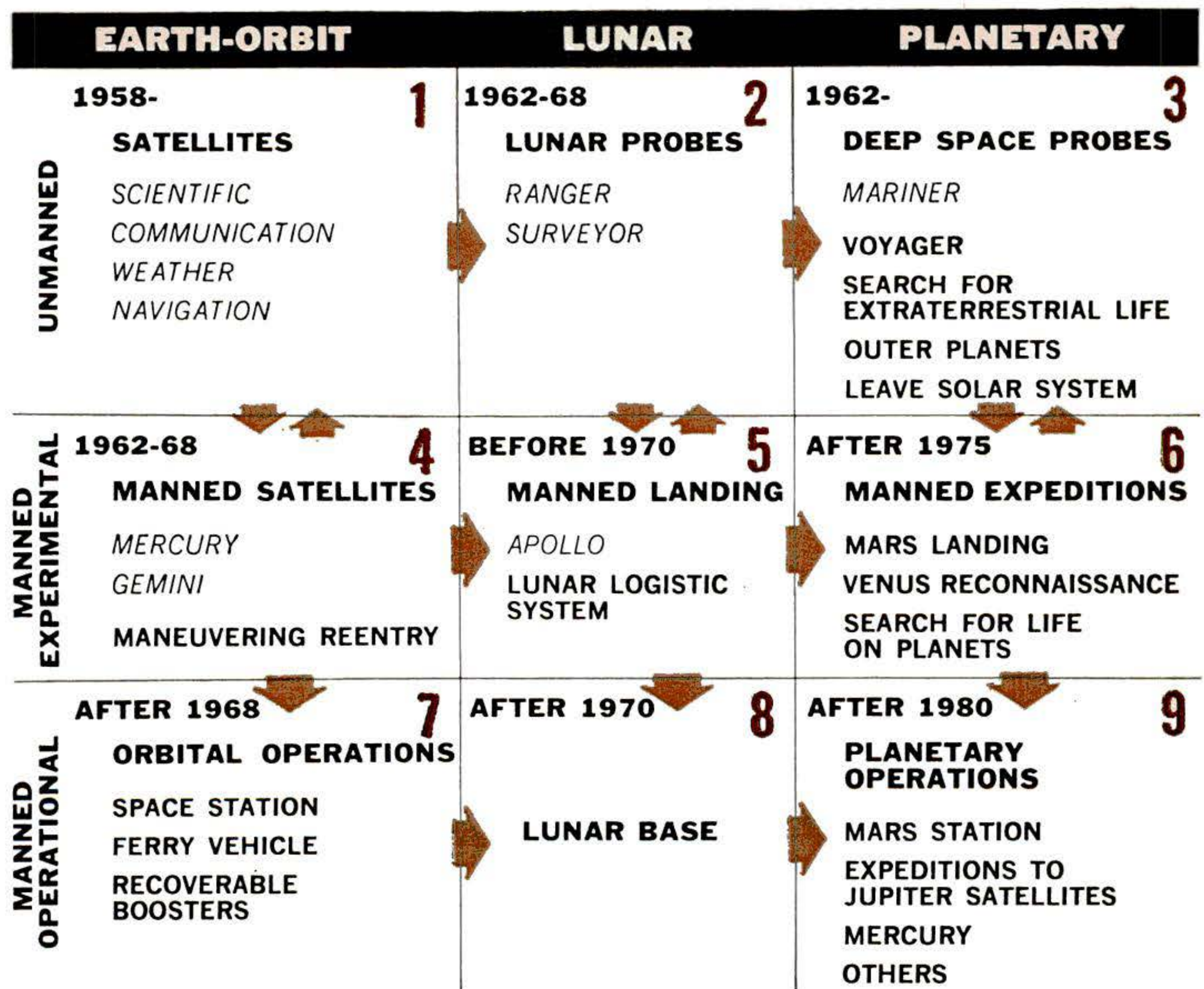
Gulliver, ambassador to the microbes of Mars



Small guns on baseplate would shoot sticky string across Martian landscape. Mechanism has been turned upside down for photo.



String is reeled in and soaked in nutrient containing carbon 14. If Geiger counter detects radioactive CO₂, there's life on Mars.



U.S. master plan for space exploration, issued by NASA, includes existing projects (in italics) and those envisioned for later. Arrows between

the blocks show how the technology developed at each stage makes possible more advanced projects or improves others.

One cold day last winter I stood in a parking lot in Alexandria, Va., and watched a drama that may soon be reenacted on the surface of the planet Mars.

Engineer Wendell Carriker of the American Machine and Foundry Company put a carburetor-size gadget called Gulliver on the ground. There was a muffled explosion and two thimble-size aluminum projectiles shot out, like miniature rockets from launching tubes. Each of the projectiles trailed 25 feet of string.

A few seconds later, a small motor began to whirl. The strings, sticky with silicone grease, slithered back toward Gulliver, coating themselves with dirt and bits of grass. They disappeared inside the mechanism through two small funnels.

Carriker picked up his toy and led the way back to the laboratory. There, using a disassembled model, he showed me what

happens inside. With the strings wound in, a second charge inside Gulliver breaks a glass container and soaks the string with a nutrient broth. Germs and other microorganisms picked up by the sticky string begin to grow and multiply.

The broth contains a small amount of radioactive carbon 14. When the microorganisms grow in this broth, they give off carbon dioxide tagged with the radioactive tracer. If a built-in Geiger counter detects sufficient radioactive gas, it's a sure sign that microbes picked up by the string are growing in the chamber.

This ingenious device, invented by Dr. Gilbert Levin of Resources Research, Inc., Washington, D.C., may well answer the big question: Is there life on Mars? Scheduled to be soft-landed there in 1966, Gulliver will radio back the news of microscopic life—if any—in the Martian soil.—C.P.G.

Hanging a Building in Air Sets New Style

Up went a pair of hollow concrete towers. Concrete beams joined them. Next came steel trusses, crosswise. From the ends, tubular steel hangers dropped nearly to the ground. Floor joists of steel were welded to the hangers, and to steel inserts in the towers.

By that novel plan a six-story office building has just been hung in mid-air at Mexico City. First of its kind, the suspended Monterrey Building will resist damage by earthquakes, which shake ordinary structures with whiplash effect at the top.

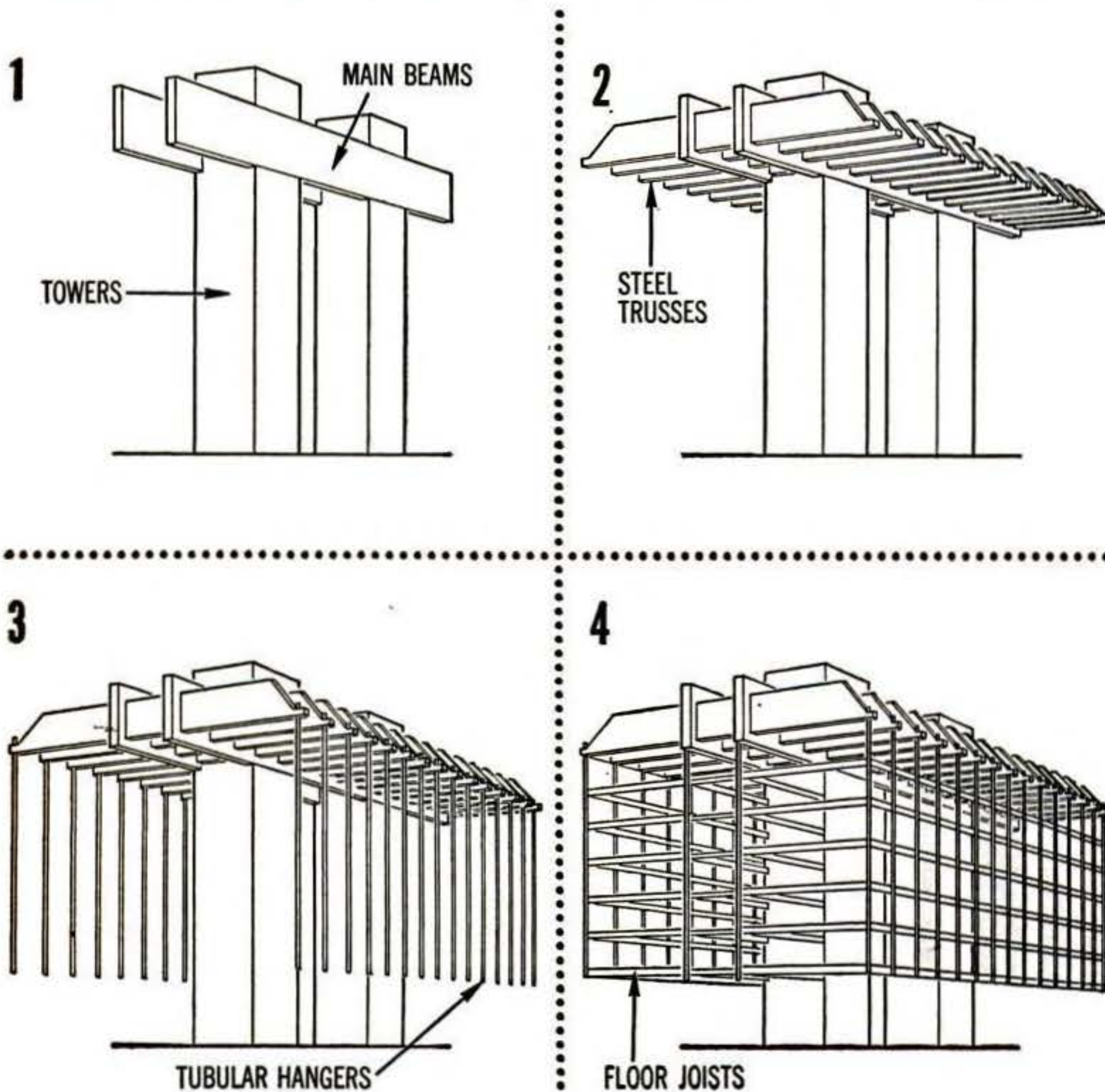
A maximum of unobstructed floor space is another advantage. Entirely free from internal columns, the 92-by-131-foot interior is pierced only by the two 19-foot-square towers.

One tower contains elevators; the other, a fire escape, air-conditioning ducts, and electric-wiring conduits. The towers' concrete-cell foundation literally floats in mud underlying the city's thin crust of soil.

Atop the building, a glass-ended restaurant does without internal columns, too. U-shaped frames support a concrete roof formed in a catenary — the natural curve of a hanging cable or flexible member. —Walter Ian Fischman.

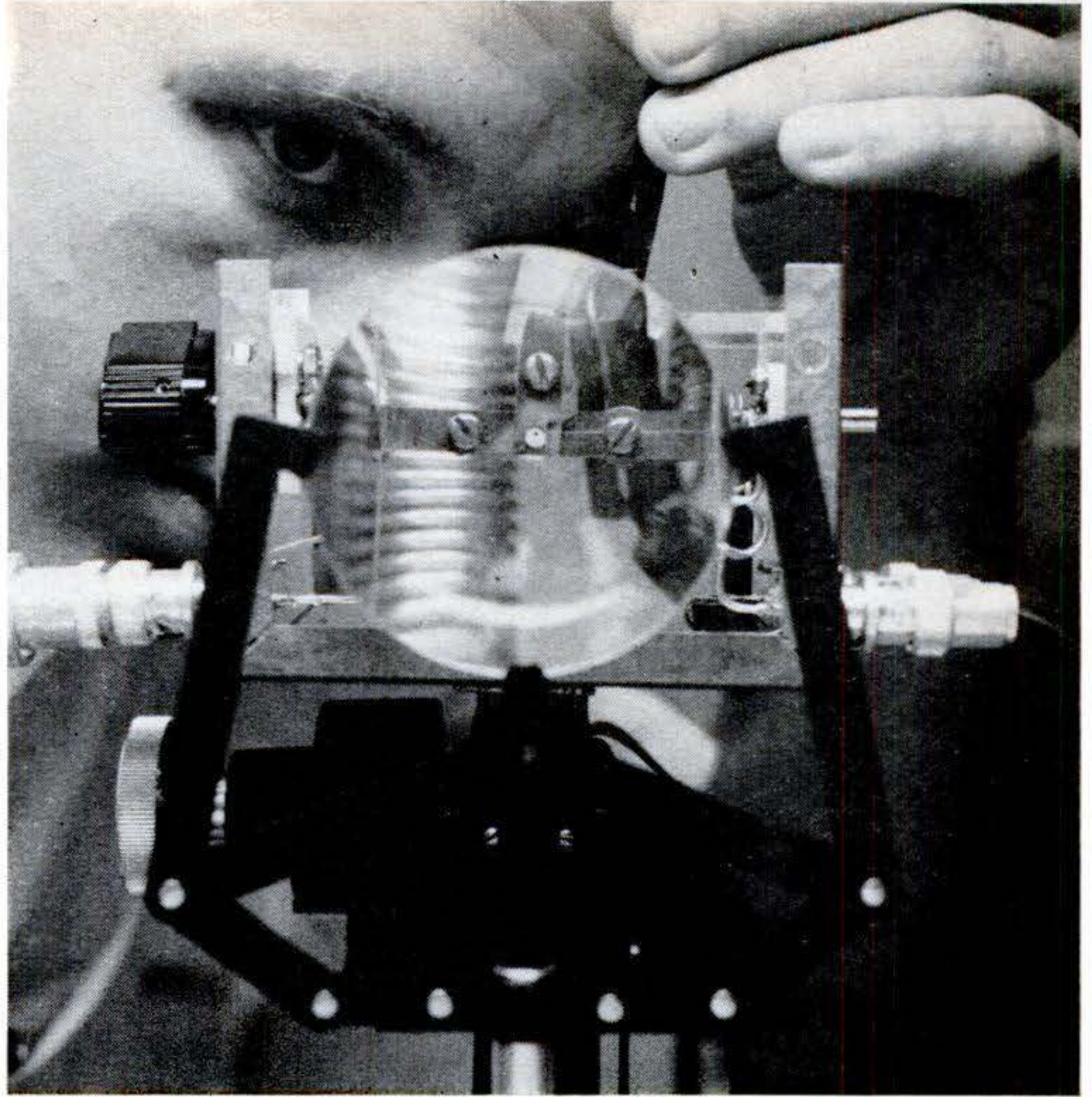


Mexico's novel hanging building, above, was put up as shown below.



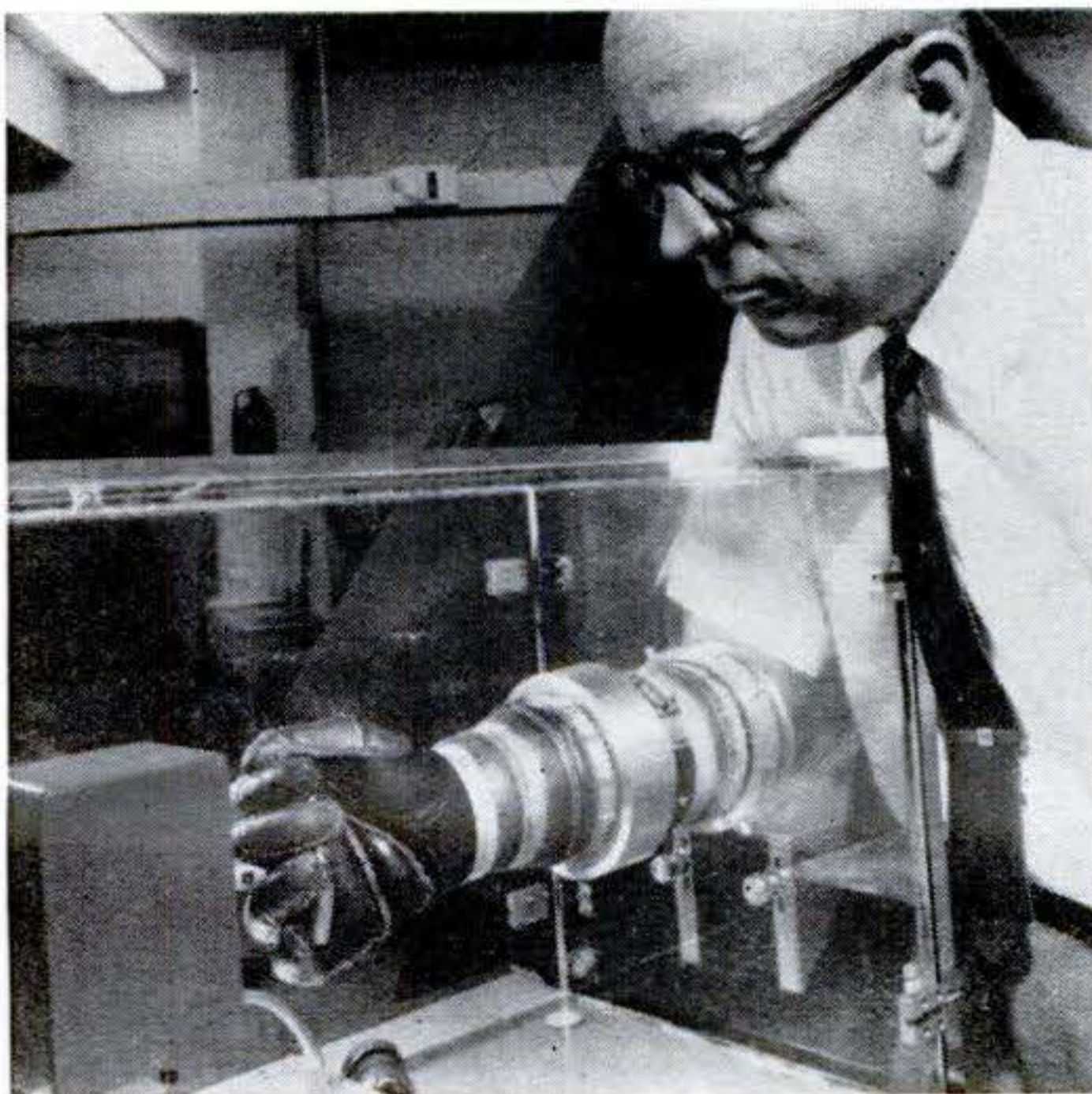
Pinhead detector for space signals

The tiny white button in the lens at right can detect and amplify, by 100 times, signals carried to it on less than a billionth of a watt of light. The transistorlike device, a quarter-inch in diameter, would be the heart of a matchbox-size receiver, enabling space systems to pick up light-borne signals beamed from millions of miles away. Sperry Rand researchers, who developed it, hope to make it still a billion times more sensitive—comparable to seeing, from the moon, the glow of a 400-watt bulb on earth.



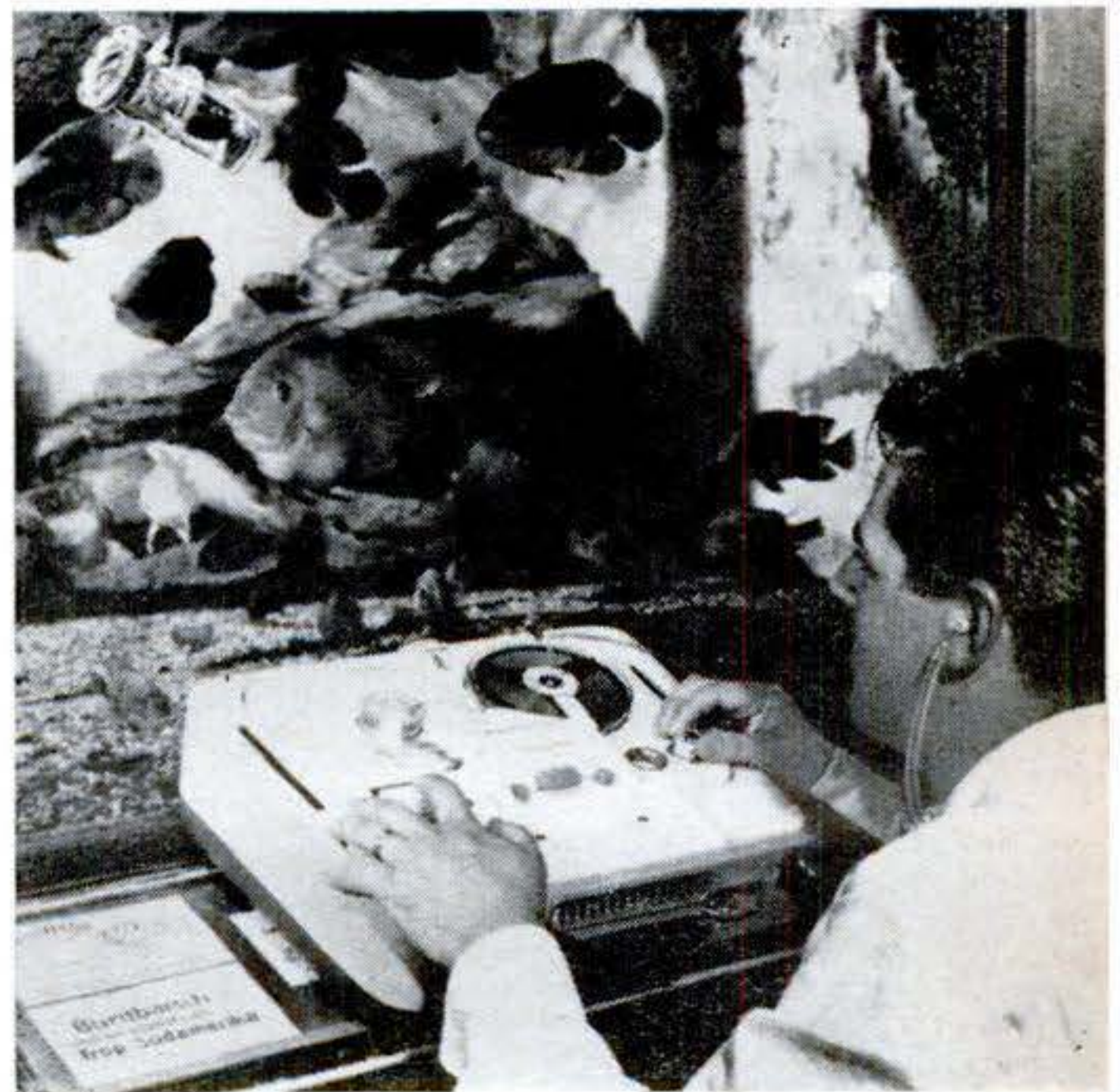
Engineers put an arm in space

What does it feel like in space? Engineers working on Project Apollo at Honeywell's Aeronautical Division in Minneapolis can find out by thrusting an arm into a pressure-suit glove set in a small plexiglas vacuum chamber and working a hand control unit. Experiencing the handicap of a pressurized space suit helps them in designing control equipment for astronauts.



Eavesdropping on fish

Naturalist Fred Methner brings the fish to the mike instead of the mike to the fish in order to record their sounds. Intrigued by the strange noises he heard while skin-diving in the tropics, he began a program of recording fish sounds in the West Berlin aquarium. Munching by the carnivorous South American piranha sounds like an excavator chewing into a pile of rocks.



DODGE:

Lots of go with plenty of whoa

By Alex Markovich

WHEN I set out to test-drive the new Dodge, my first impulse was to ask for the 426-cube Ramcharger. This, of course, is the super-hairy competition job, with rumbling exhausts, a gluttonous thirst, and an idle like a bullfrog with hiccups—the car that won the super-stock drag championship at the recent Nationals [see “Are Hot Rodders Really Crazy?” page 72].

Then I thought better of it. What we really should test, I decided, is a more sensible car—one that wouldn't grumble over a daily chuff to the train station and a hop to the drive-in.

I got a Polara 500, a 383-incher with four-barrel carb and TorqueFlite, perfect for such tasks. Surprisingly, it

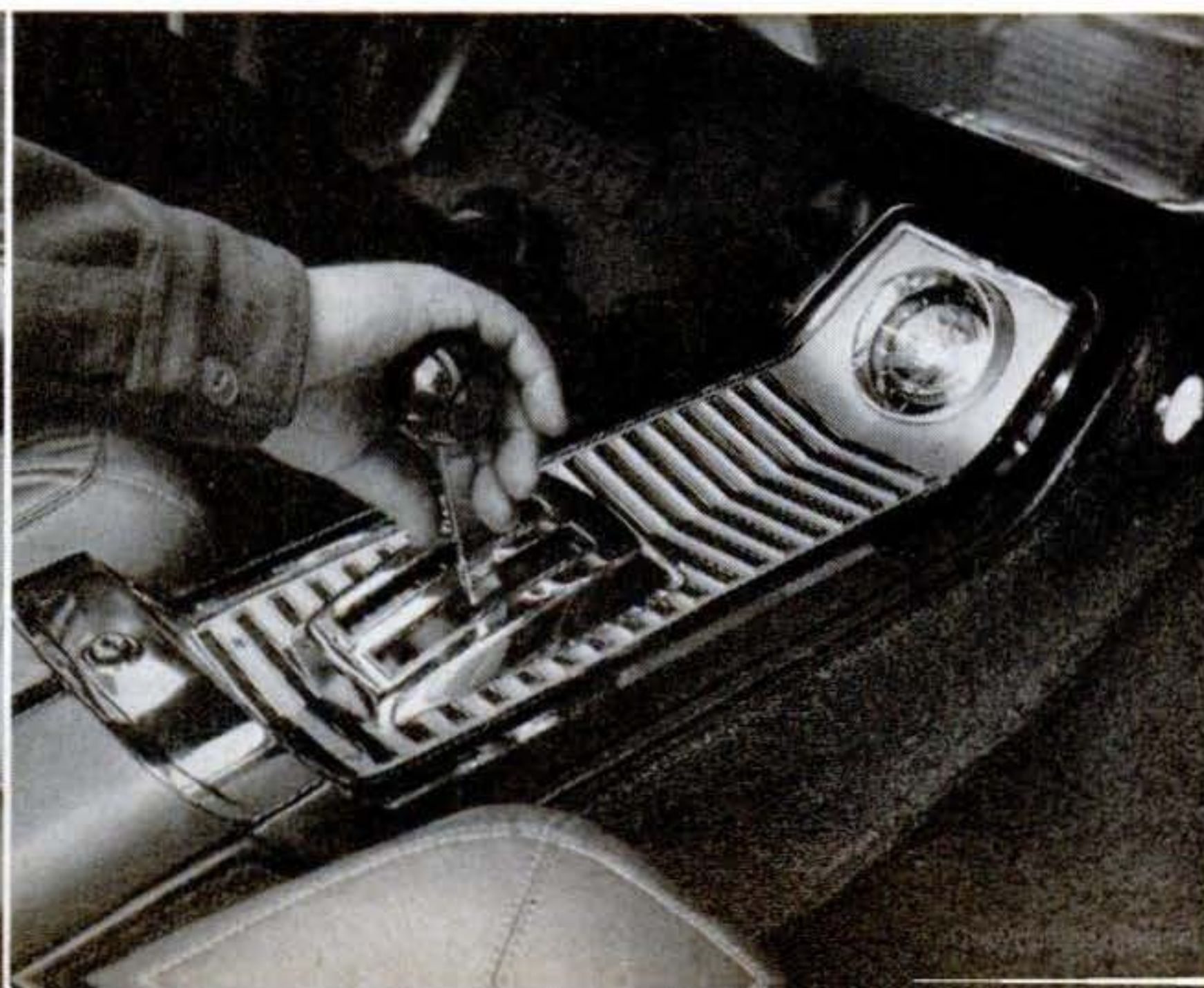
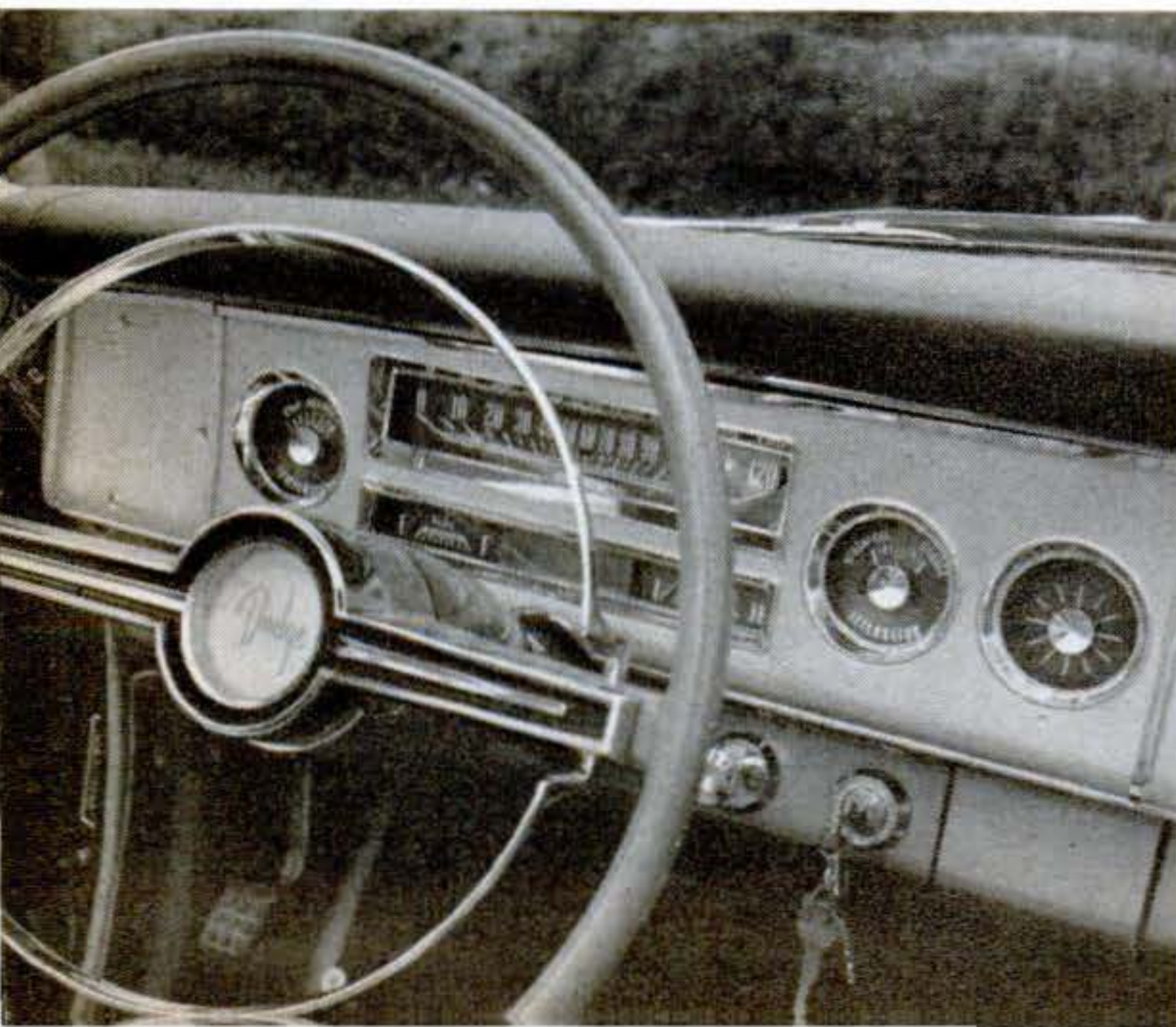
Dash is fully instrumented, but gauges aren't numbered; they're labeled low-high, cold-hot. Wish the speedo were round, too.

Flick the wheel, kick the gas, and you're Barney Oldfield. To tuck in the tail again, straighten the front wheels, ease off on the gas.

also proved to be a savage performer. Punching the throttle at any speed produced instant results, accompanied by a muted but authoritative growl. With so much power on tap, wheelspin was a problem on takeoff during acceleration runs until my right foot became educated. The optional limited-slip differential would have helped.

This is a car for people who enjoy driving. I put it through its paces at the serpentine Lime Rock race track in Con-

Optional console-mounted lever looks jazzy and is easier to operate than the nicely hidden shift buttons standard on Dodge.





necticut. Conclusion: That torsion-bar-and-leaf-spring suspension has no peer in Detroit for fast, stable cornering. The Dodge has slightly more weight on its front wheels than on its rear ones; this contributes to a mild understeer that becomes progressively more neutral as speed goes up. Oversteer can be induced easily at any time. Just flick the steering wheel and jab the loud pedal, and the tail wags obediently in an impressive-looking but completely controlled drift.

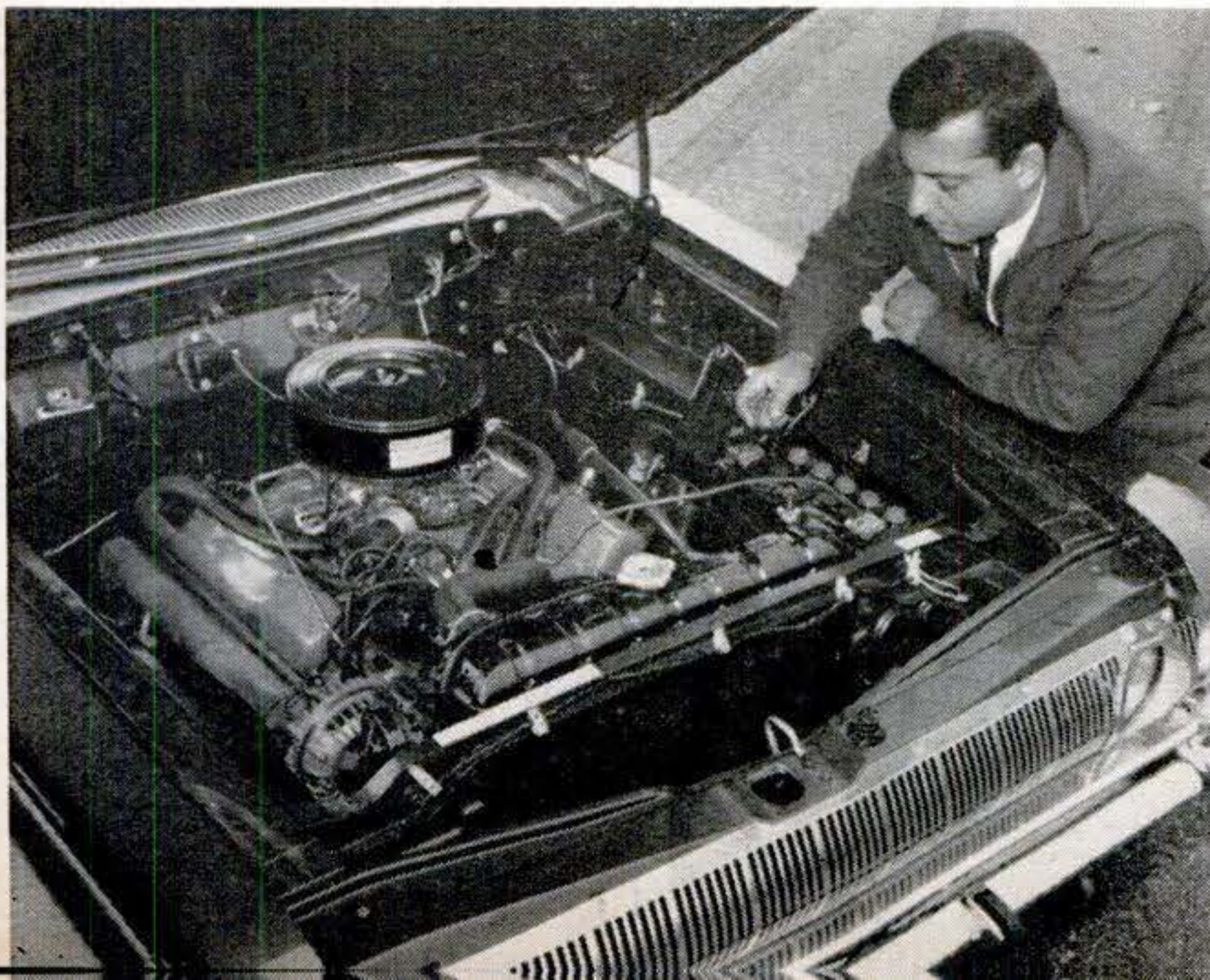
All that iron stuffed under the bonnet means engine accessibility suffers. I got toasted knuckles groping for spark plugs.

This is the real beauty of the car: After a few minutes' acquaintance you can make it sit up and do handsprings. It reacts predictably and with plenty of advance notice to every maneuver.

Ride feels slightly softer than last year, probably because of the new, longer rear leaf springs. It's still firm compared with other Detroit products, but few would find it objectionable. On rough surfaces there's little pitching, no bottoming.

CONTINUED

Lean is pronounced on corners, but tires hold well—especially with about four extra p.s.i. Seating position is good.





How big is the trunk? I climbed in to find out. There's lots of room. The spare hides discreetly under fitted cover.



There's no shortage of power, as shown by long streaks of burned rubber. For fast takeoffs I held brakes, revved engine.

Brakes provided more than adequate whoa. After half a dozen fast laps around the track with speeds topping 90, the brakes started pulling to the right slightly and pedal effort increased noticeably. But they were still in better shape than those of several competing cars that had received similar treatment around Lime Rock.

Our test car had manual brakes. I found them much better than the optional power-assisted ones, which are far too sensitive. A little extra foot pressure on the latter and your passenger may make an unscheduled exit—through the windshield.

The TorqueFlite three-speed automatic transmission is smooth during normal driving and very crisp and positive under full throttle. It's so efficient, in fact, that it often beats stick shifts at drag strips.

Visibility is excellent all around—unusual in a convertible. Front fenders are flared to help the driver gauge the width of the car. Interior room is unusually good, especially in the rear seat.

All panels and trim fit perfectly. And to prove that its cars are healthy mechanically, the corporation is continuing its five-year or 50,000-mile warranty on engine and drive train. ■ ■

FACTS ON THE DODGE

Model: Polara 500.

Factory-suggested basic price: \$2,902*; **price as equipped:** \$4,005.75.*

Engine: V-8; 330 hp. @ 4,600 r.p.m.; maximum torque, 425 pounds-feet @ 2,800 r.p.m.; bore and stroke, 4.25 by 3.38 in.; displacement, 383 cu. in.; compression ratio, 10:1; carburetion, four-barrel; weight (lb.) per hp., 10; engine revs per mile, 2,594; piston travel (ft.) per mile, 1,461; fuel required, premium; crankcase capacity, 4 qt.; fuel capacity, 19 gal.

Transmission: three-speed automatic; ratios (:1), 2.45, 1.45, 1.00; reverse, 2.20.

Axle ratio: 3.23:1. **Steering ratio (power):** 18.8:1. **Turns lock-to-lock:** 3.5. **Brake-swept area:** 314.2 sq. in. **Tire size:** 7.00 by 14.

Outside dimensions: wheelbase, 119 in.; track, 59.5 in. front, 59.6 in. rear; overall length, 209.8 in.; width, 74.9 in.; height, 54.4 in.; ground clearance, 5.3 in.

Curb weight: 3,310 lb. **Weight distribution:** front, 55%; rear, 45%.

Speedometer error:** indicated 60 m.p.h. is actual 55 m.p.h. **Odometer error**:** +3.4%.

Gas mileage at constant speeds (gallons):** 30 m.p.h., 23.4; 40 m.p.h., 22.7; 50 m.p.h., 22.2; 60 m.p.h., 18.2.

Acceleration (seconds):** 0-60 m.p.h., 7.1***; 40-60 m.p.h., 3.0; 50-70 m.p.h., 4.3. **Top speed**:** 130 m.p.h.

*Includes federal excise tax, but no state or local taxes, transportation, or dealer preparation.

**Performance figures were measured with an On-garo fifth wheel and fuel-flow meter.

***Shifting TorqueFlite manually; 7.7 seconds starting in drive range.



20,000,000 Bucks in the Suggestion Box



Got an idea that will mean bigger profits for your company?

Drop it in the box. Here's how little ideas can pay off big

By E. D. Fales Jr.

IN KENTUCKY the other day a man loaded his family aboard a new boat and shoved off for a long-overdue vacation. He'd paid for it all by dropping a numbered slip of paper into his company's suggestion box.

In Somerville, N.J., an RCA electrician made enough money from an idea to buy a second car. And in Hamilton, Ohio,

recently a man who works for Fisher Body moved into a new home—mostly paid for with suggestion-box winnings.

For decades, people have made fun of the office bright-idea box. Cartoonists still lampoon it. A recent cartoon shows a boss reaching into the suggestion box and drawing forth an idea. He reads it. "But *which* lake?" he asks.

Suddenly, however, suggestion boxes have stopped being funny. Today the

The payoffs are not all jackpots, but even simple ideas

\$10



Why didn't you think of this? "Paint an EMPLOYEES ONLY sign to keep visitors out."

\$70



A railway worker won \$70 for 30 minutes' note-taking. His total idea-money to date: \$5,000.

hard-cash fact is: At least \$20 million—and possibly much more—will be paid out by U.S. companies this year for ideas. You're missing a bet if you don't get in on the money.

To be sure, not all awards will buy boats or cars. Far from it. Many run from \$2 to \$25. Some companies, like Carnation Milk, now give movie cameras, and two Carnation employees in Waverly, Iowa, recently won a Mexican trip.

But jackpot awards are getting to be common. A Whirlpool Corp. welder recently noticed that a lot of time was wasted because tanks of argon gas used by welders soon ran empty and had to be replaced. He wrote out a note that said, in effect: "Quit using the little tanks. Install a big tank outside the shop and *pipe* the gas in to each welder." It was a simple idea—most prize winners are, as you will see—but it won \$1,000.

Ed Sutherland, a young clerk for General Motors, recently suggested a gadget that would make it easier to manufacture a remote-control outside mirror for Pontiacs. Back came a check for \$5,000—GM's maximum prize.

When his idea was used for Tempest cars, Sutherland fielded another \$3,333 prize.

Not even this can compare to what happened to Herbert Owens, 36, who

is employed by IBM in Baltimore, Md.

One day Owens tossed a small idea into the box and got a check for \$25. Encouraged, he tried again, got another \$25. On the third try, the ante went up to \$35. He decided to try some more.

Cure for the slipping wheels. Owens knew that IBM had been having a small problem with some electronic computers. You've seen computer tape-recorder wheels that whirl one way, pause, then reverse. These wheels are "searching"—rapidly scanning the tape for needed facts. To do this they must work with precision.

But under strain, some units were developing slight slippage. A wheel might not start quite fast enough—or when it stopped it might go just a hair too far. IBM machines must be right, so this was annoying to both company and customers.

It seemed to Owens that the trouble could be cured very simply—by inserting a small metal shim in the units during manufacture. It would have to be only a tiny thing a half-inch wide.

He made his suggestion. IBM gave it a try. Suddenly the wheels worked with untiring accuracy. Maintenance was cut. Customers were happy.

IBM, which possesses one of the world's most successful managements, has an idea that employees should be

have won surprised suggestion-droppers four-figure checks



Nail-polish a power belt? Seems like a crazy idea? It made a lady operator \$6,000 richer.



Two idea men shared an IBM check for \$56,013—believed to be biggest idea award.

well rewarded when they think up ways to save their company money or increase its profits. So it was that Owens, not long after his idea went in, received a staggering check: \$32,000 for a simple idea.

Or consider Charles Glancey and Lawrence Livigni, two technicians who also work for IBM, at Poughkeepsie, N.Y. At about the same time, they suggested that IBM computers really didn't need 14 of their many printed circuits.

They even figured a way to get rid of them by a bit of rewiring. IBM found the computers worked just as well—and cost less to build. A few days after Owens got his \$32,000 in Baltimore, the two in Poughkeepsie found themselves staring at a joint check for \$56,013, believed to be the highest idea award ever made.

Welcome mat for ideas. There was a time when any idea an employee had might be automatically considered the property of the company. It didn't matter that you might have worked on it at home many nights. Even patents were appropriated. Result: Thinking was discouraged. Many took the attitude, "Well, let the brass worry about everything." Some employees day after day saw costly errors, or opportunities missed, and didn't bother to suggest changes.

But today an increasing number of companies are realizing that this is all

wrong. To survive today—and grow—they know a company needs a steady flood of imaginative ideas. This helps explain why 300 of the biggest U.S. companies alone this year will shell out over \$16 million for employee ideas. Ford will distribute in the neighborhood of \$1 million, GM \$3 million. Swift, U.S. Steel, General Electric, National Cash Register, Standard Oil will again be among heavy award givers. So will Boeing and United Airlines. Even the U.S. government, the Los Angeles municipal and county governments and other units—keenly aware of growing taxes—now are buying ideas that will help save the taxpayers money.

How the idea boxes work. In some offices you merely write your idea, sign it, and toss it in the slotted box. In others you use a numbered form. You don't sign it—in order to keep you from feeling later that favoritism might have influenced the decision. But you do keep a numbered tear-off slip—and claim your idea later.

From the box your idea may go to the boss, who will assign someone to look into it. Or, in a large company, it may go direct to a special suggestion committee with authority to make an immediate award, up to \$25, assuming the idea is useful.

This award may be increased later by

executive action, or if yours is a branch of a large corporation, by the main-headquarters suggestion committee. (Some concerns now even employ full-time suggestion-system staffs.)

What ideas are wanted? The answer is: Suggest anything that will help your company. It may be a new product, a better way of making something, a more efficient tool—or a way to use waste metal or plastic. Or it may even be something as simple as a new and simpler weekly report form. Men have won money just for suggesting that certain reports be eliminated—because they were no longer needed. A great deal of time-wasting procedure exists in many companies today just because no one has ever thought to do away with it.

Your idea could be a simpler filing system, a way of making jobs safer and more pleasant, anything to improve quality—or, above all—anything to cut costs. In Niles, Ill., recently, a Sears, Roebuck store employee, Ray Anderson, got tired of sending assistants up and down ladders to change burned-out light bulbs. "Why don't we just quit using bulbs that burn out so fast and switch to the new long-life bulbs?" he suggested. "They burn three times as long."

Sears found Anderson's idea could save hundreds of dollars a year in various stores. It sent him \$1,239, his share of the savings.

In Los Angeles, recently, the McCulloch Corp. was having trouble with a high-speed flywheel-boring machine. The machine jacket was effectively cooled by a circulating water-base coolant. But the fast carbide bit was cooled by a powerful air blast. At high speed the air blast was insufficient. The bit would get too hot and break. Hence the machine had

to run at slow speed—a waste of time and money.

It seemed to operator Clyde Love that the solution was easy. "Why not tap some of the liquid coolant inside the machine itself and mix it in the air blast?" he suggested. The idea was tried, saved the company \$3,224 in 12 months, and Love received a check for \$403. He also got another, a dividend that also sometimes comes to idea-givers: a promotion.

The obvious ideas. In GM's Tech Center at Warren, Mich., is a big overhead crane with eight control buttons: NORTH, EAST, SOUTH, WEST, RAISE, LOWER, START, STOP. But the trouble is, not everybody who uses it knows which way is north.

Technician Fred Gutterman knew that someone might cause serious damage some day by sending the crane east when it was supposed to go west. So he suggested a precaution: paint a compass rose on the crane. His award: \$50.

State Farm Insurance Co. recently paid a woman employee \$10 for an even simpler idea. When visitors kept trying to use the wrong door she suggested "Paint a sign: EMPLOYEES ONLY." An absurdly simple idea, but no one had thought of it, and she collected \$10.

Don't scoff at such little ideas. Some employees make lots of money from them. David Fraser is an Illinois Central Railroad employee at Markham, Ill. Waiting for a train one day at Fulton, Ky., he looked around, listened to what people were saying, watched what they did. In 30 minutes he wrote down 12 ideas, cashed in on seven for a total of about \$70. Out of such alertness Fraser to date has collected \$5,000.

[\[Continued on page 197\]](#)

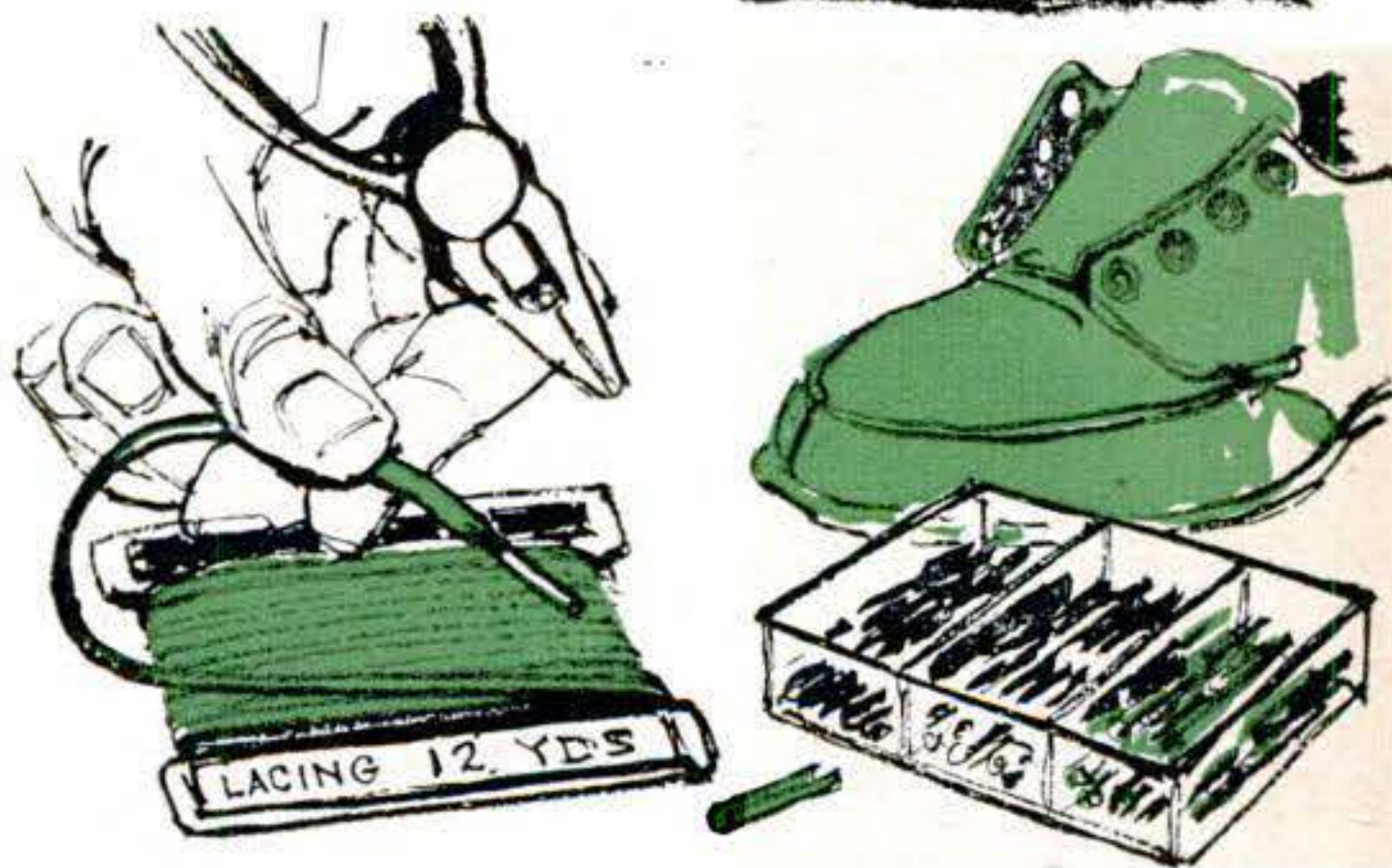
.....
: **The best prize of all** :
: In Los Angeles one day Fred :
: Deamer and Ray Grant, electricians for the Los Angeles Department of Water and Power, jointly suggested that an alarm be put on trucks—to sound whenever they began pulling electric wires or stringing them on poles. :
: The idea was immediately tried out. Two months later an employee nearly lost his life when trapped by a wire about to be hoisted. The alarm went off, warning him just in time. The two men got cash awards—but their real reward was the greatest of all: Their idea had saved a human life. :
:.....

"I'd like to see them make..."

Hand-warming snow blowers that put their hollow handles to work. The tubing ends up near the engine; why not pipe hot air through it?—Mark Stephens, Manchester, Conn.



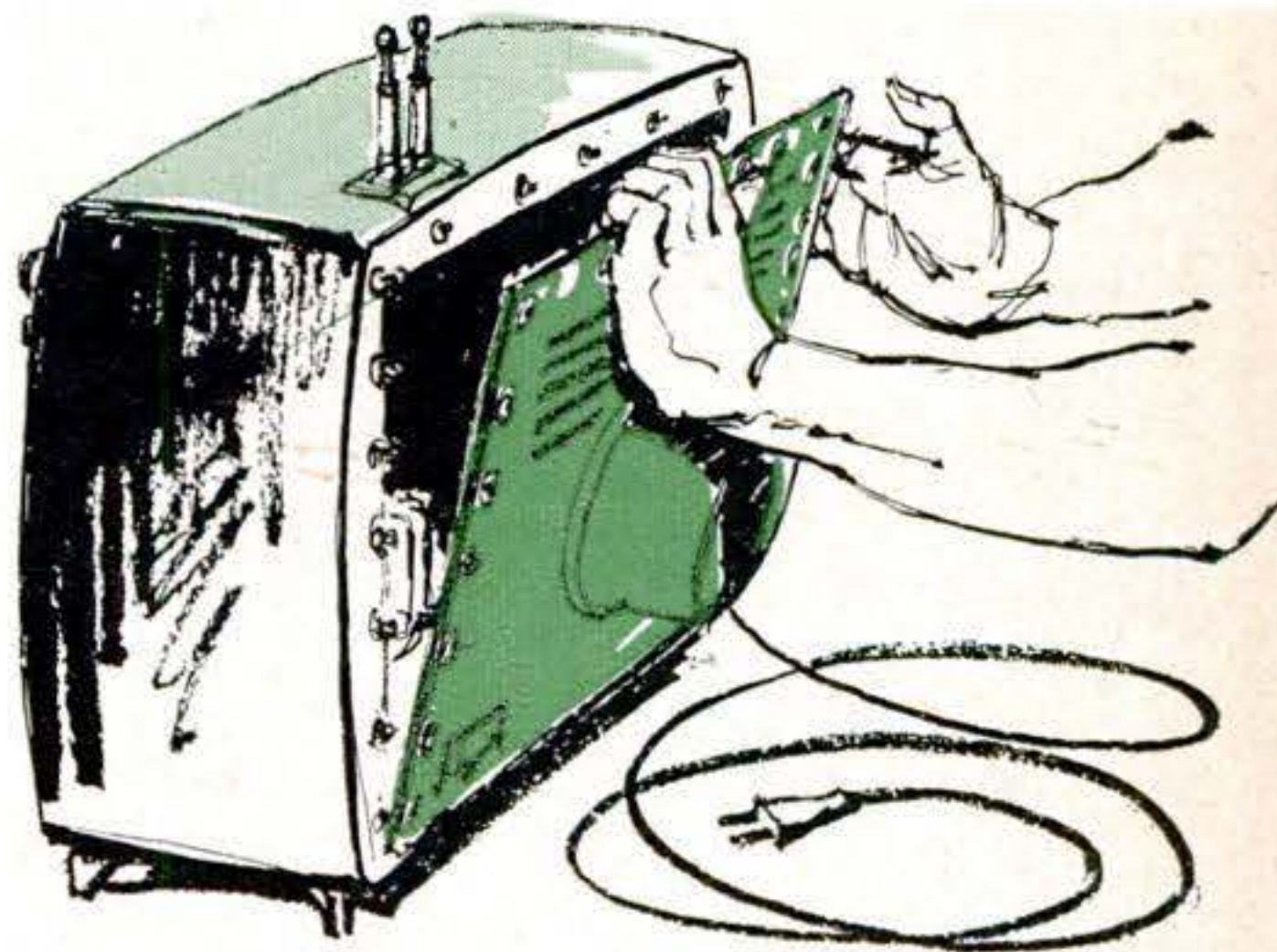
Basin-shaped floor mats for cars. They'd hold that grit from icy roads that you track into the car, and they could be lifted out and emptied easily.—S. Selsky, Massapequa Park, N.Y.



Shoelace kits with yards of lacing, metal tips, and a tip-applying tool. With several kids in the family, you never have the right-length lace.—R. Klingensmith, Monroeville, Pa.



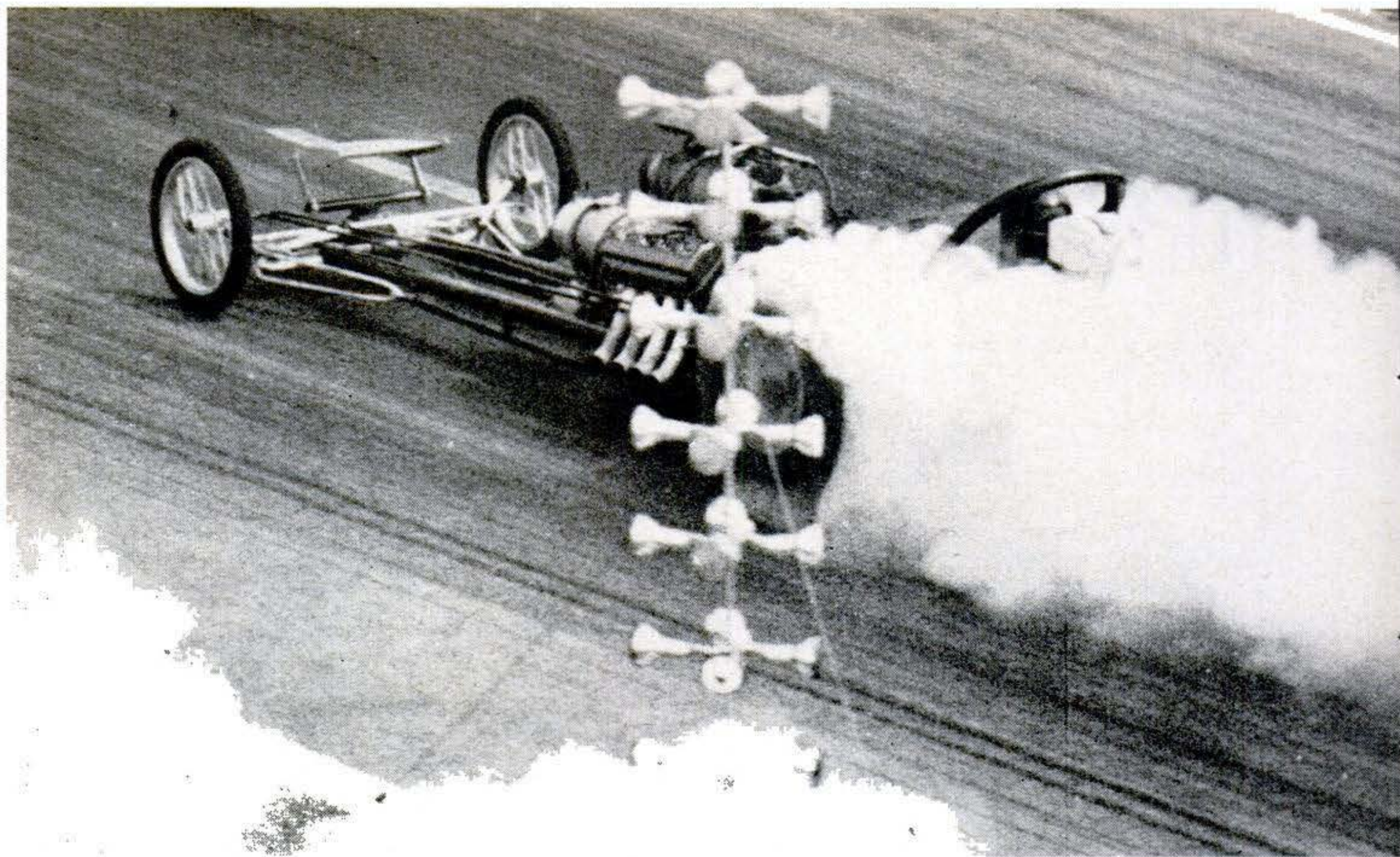
A slide-out index behind wall telephones. Often there's no flat surface near such phones, and there's no place to note frequently used numbers.—R. B. Przekop, W. Hollywood, Fla.



Gripper snaps on the back panels of TV sets and the front panels of washing machines. They'd save on repair time, and there'd be no screws to lose.—Mark Anderson, Ames, Iowa.

Everyone has his own pet idea of a gadget that he would like to see in general use. What's yours? We will pay \$5 for each one published. Please use Government postcards

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“Christmas tree” in foreground turns green—a signal for the “rail” to burn off the line in

Are Drag Racers Really Crazy?

They spend thousands of dollars and countless hours building weird-looking cars that can't be driven on the street

By Devon Francis

ON ALMOST 2,000 occasions in the year now ending, a crowd of otherwise normal citizens has gathered at a stretch of paving in the middle of nowhere and proceeded to engage in—or watch—one of the world's zaniest sports.

To an outsider, these people make no sense. The piece of asphalt where they stage their events doesn't start anyplace or end anyplace. The participants sel-

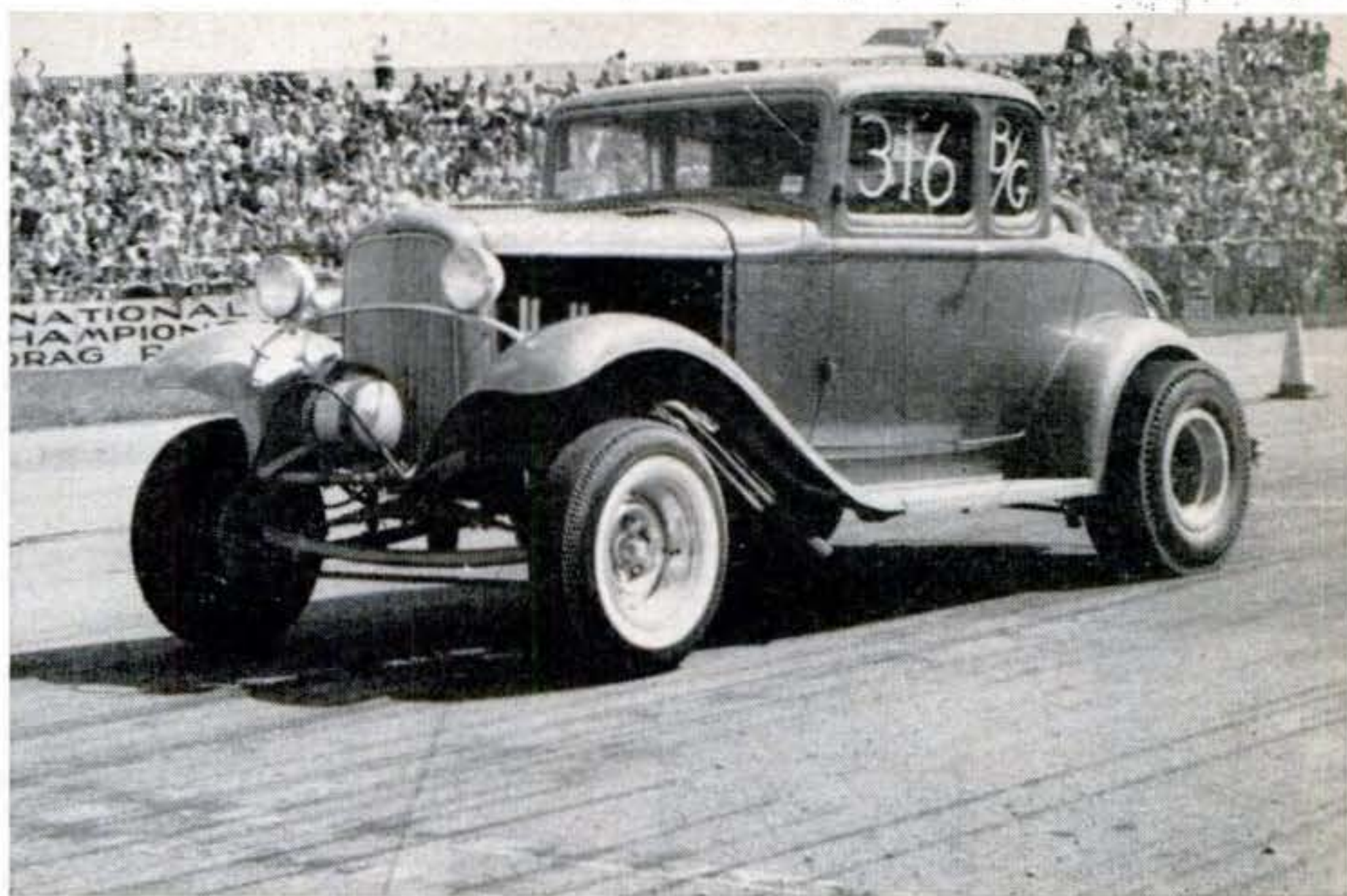
dom get money. They spend hard cash competing, and usually go home without even a door prize.

Spectators—and they are legion—yell themselves hoarse. Yet most of the time they can't keep up with who's ahead.

This nutty state of affairs describes a pursuit known as “dragging” or “hot-rodding.” It commands the energies of hundreds of thousands of people. The pieces of paving are known as drag strips. There are about 100 such sites approved by sanctioning associations,



a billow of tire smoke.



Early Fords—especially 1932s such as this—are a favorite of hot-rodders. Hargis-Kramer coupe from Elgin, Ill., has injected Chev V-8 engine, wide-rimmed rear wheels. Gas tank sits in front.

PS Editor Bob Crossley (at far left) admires Top Eliminator trophy won at NHRA Nationals by driver Bob Vodnik and owners Ken Hirata and Phil Hobbs. Vodnik, at wheel of a Chrysler-powered dragster, defeated all comers by roaring through the timing traps at 174.7 m.p.h. Elapsed time for quarter-mile: 8.62 seconds.

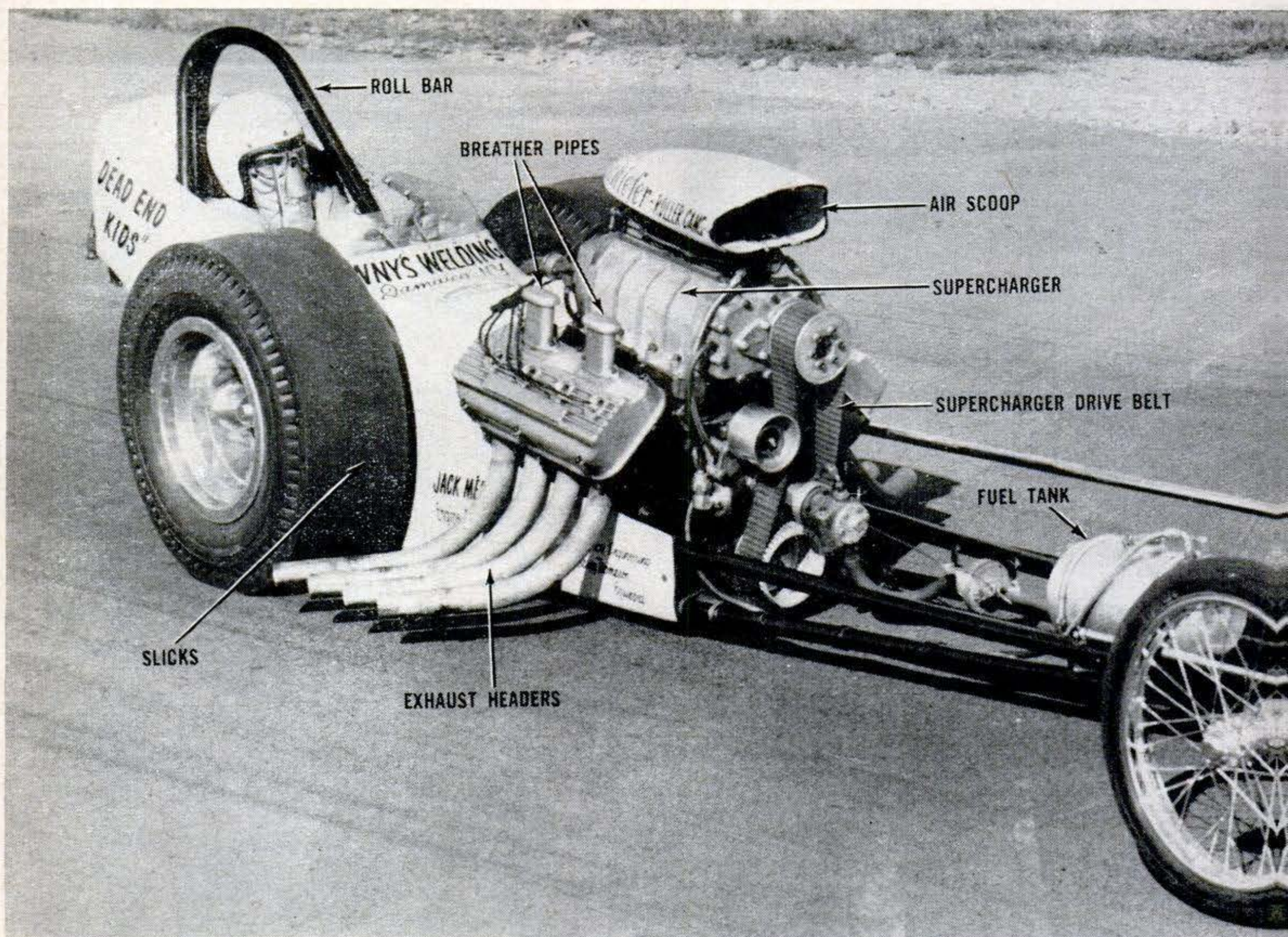


All the tuning tricks allowed in stock class are used in the 427-inch Galaxie below, owned by Tasca Ford of East Providence, R.I. Drilled-out carb jets, exhaust headers, special air intakes,

eight-quart oil pan, extra breathers, Cure-Ride shocks, traction bars, and slicks—treadless tires—improve performance. Tasca sells similar beasts—fully set up for drags—for \$4,200.

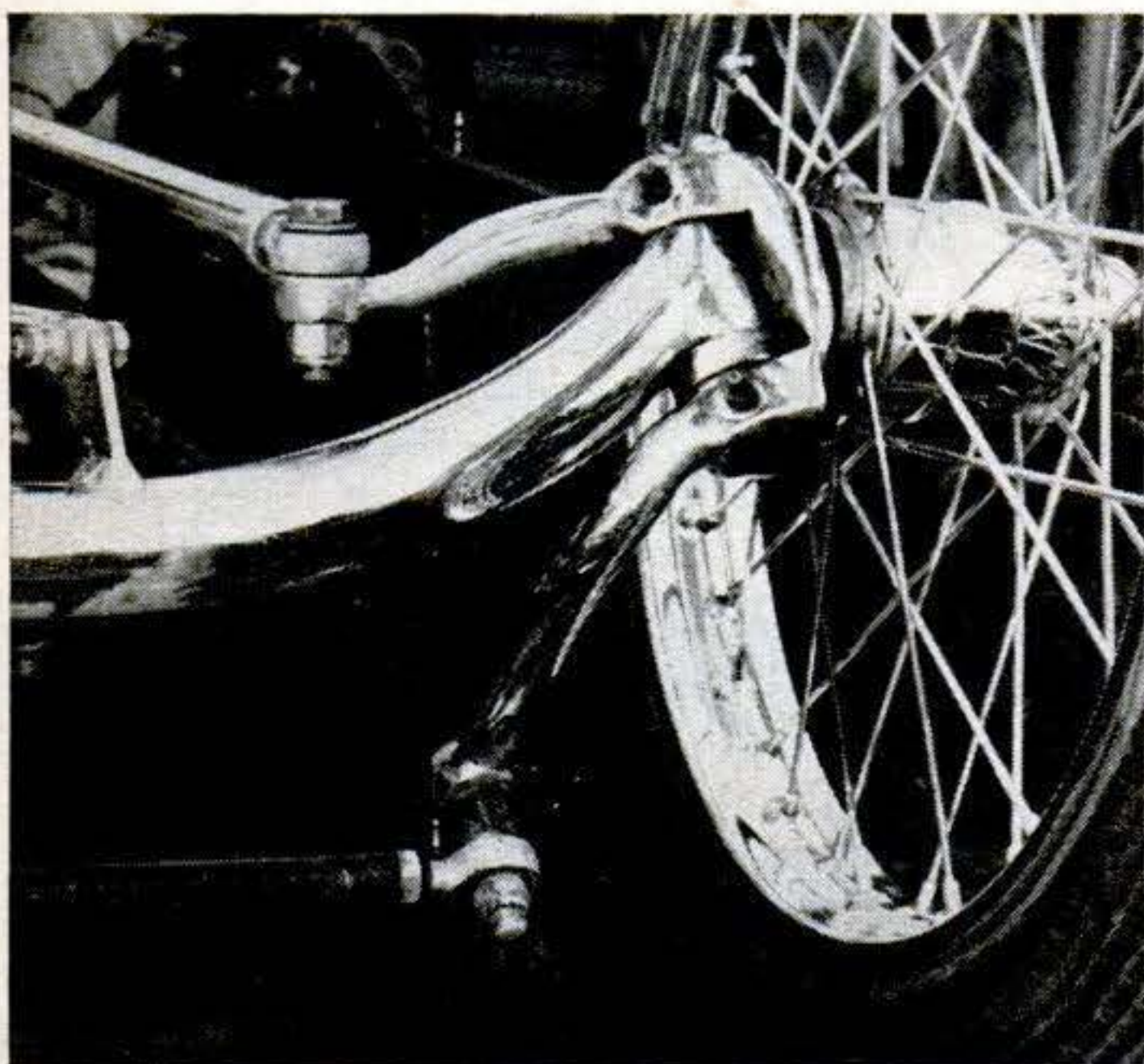


Compression ratios are pushed to where gasoline will

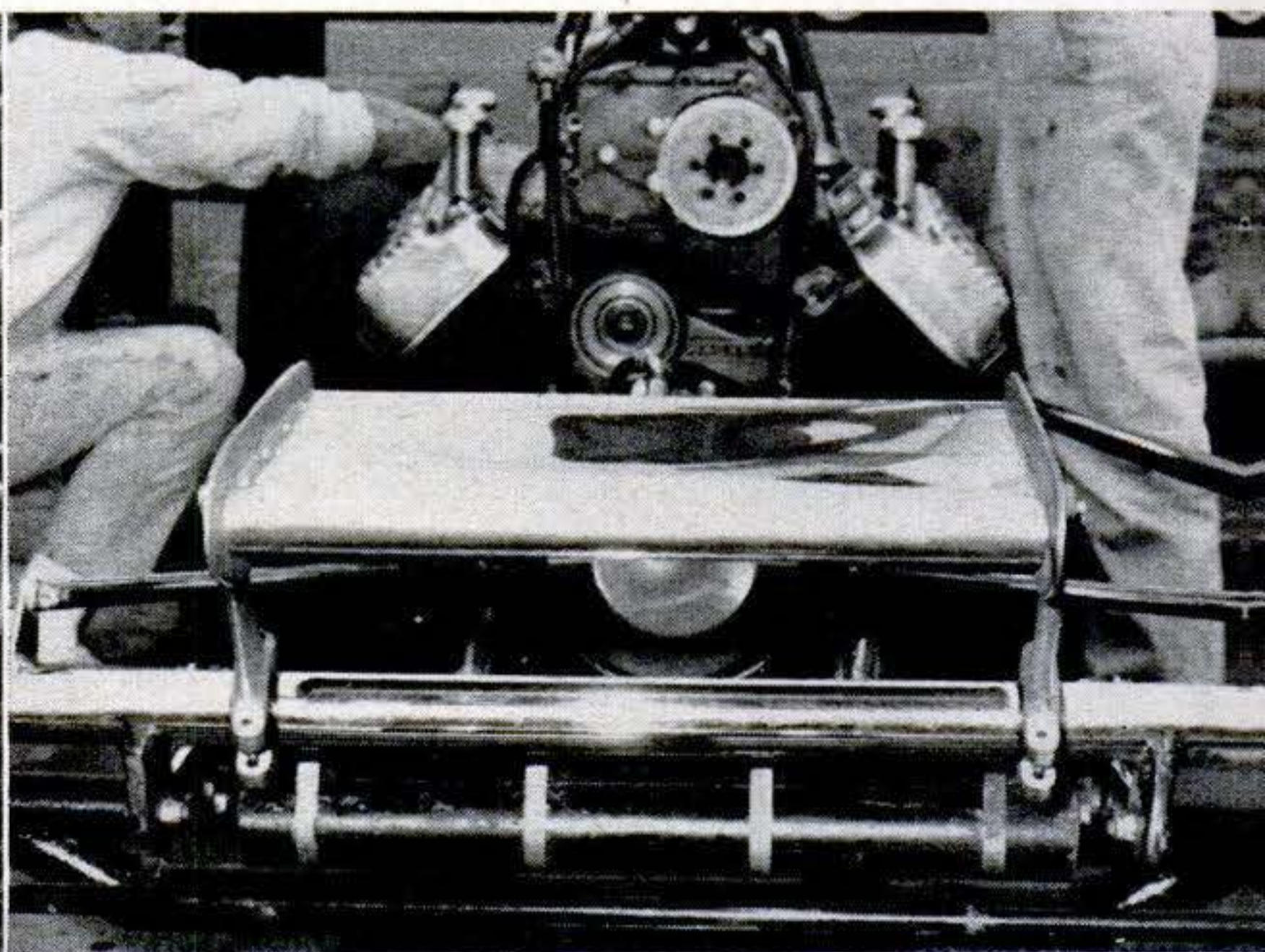


Anatomy of a dragster: For traction, 1958 Chrysler engine sits far back, driver behind rear axle. Rear slicks are 10½ inches wide. Small front wheels and tires give low rolling resistance. Engine modifications include a supercharger

from a GMC diesel, fuel injection, overbore (total displacement is 485 cu. in.), magneto, and competition camshaft, clutch, flywheel, rods, and pistons. Gas or fuel (a 60-40 mixture of nitromethane and menthanol) is used. Horse-

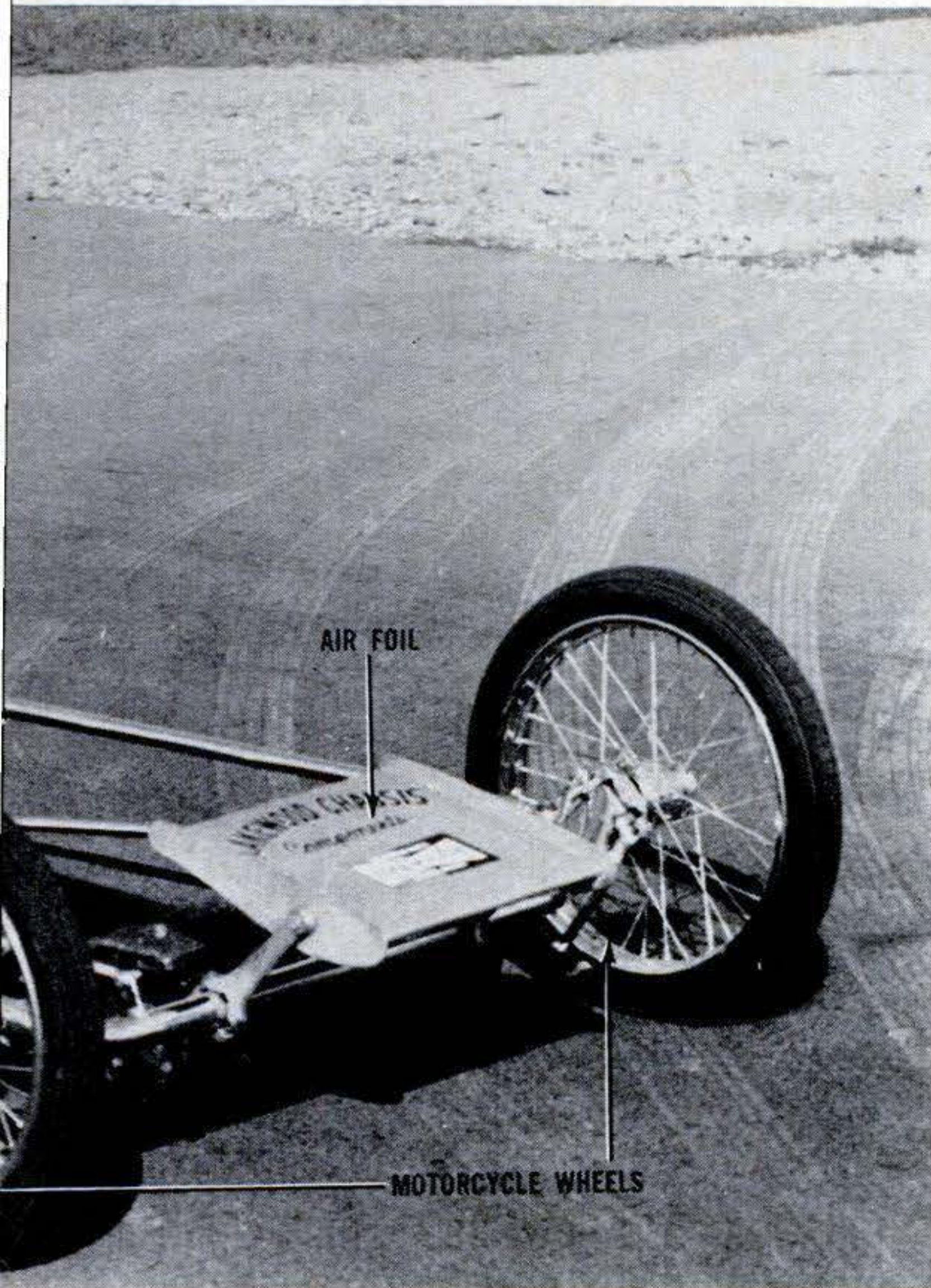


Spindles are from an old Ford. There's lots of caster for control. Motorcycle wheels were adapted with specially machined hubs.

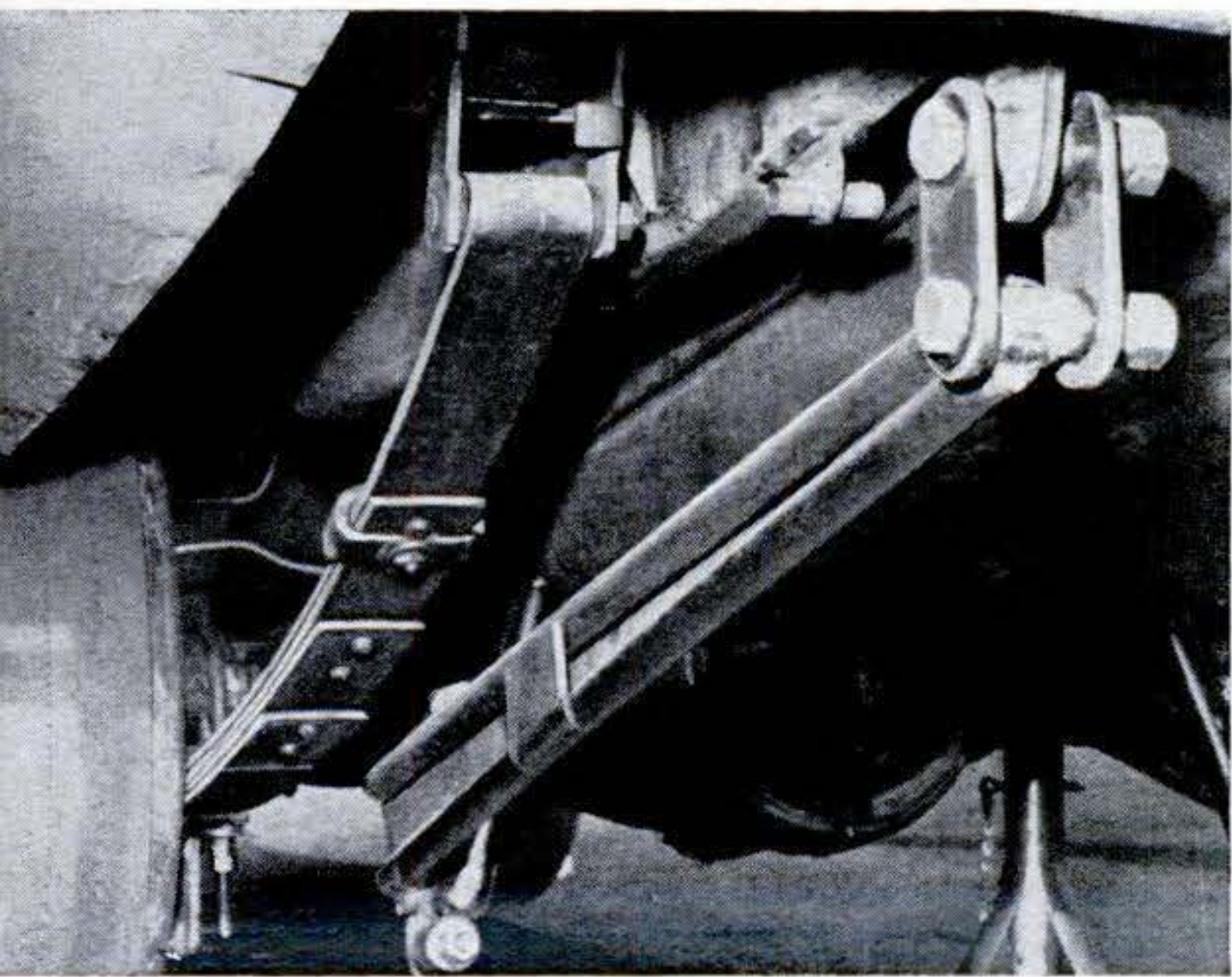


Inverted airfoil over front axle creates low-pressure area underneath to keep the lightweight front end from lifting at high speed.

almost ignite without a plug



power ranges from 900 to 1,000. Because of the tremendous torque, no transmission is needed. The car cost \$7,000 to build. It's owned by Richard Lang, Tom Dickerson, Joe Anahory of Brooklyn, N.Y., runs in AA/Dragster class.



Traction bar next to leaf spring of 1963 Dodge Super Stocker prevents axle windup. It's made by the Dragmaster Co. of Carlsbad, Calif.



Typical dragster cockpit shows driver enclosed by aluminum body, protected by rollbar. The "wheel" is chopped. There are no gauges.

many more "renegade" strips that are not.

Approved strips are exactly 60 feet wide, 3,500 feet long. Contestants are allowed 1,320 feet—a quarter of a mile—plus exactly 66 feet more, for acceleration. The remaining 2,114 feet are for slowing down.

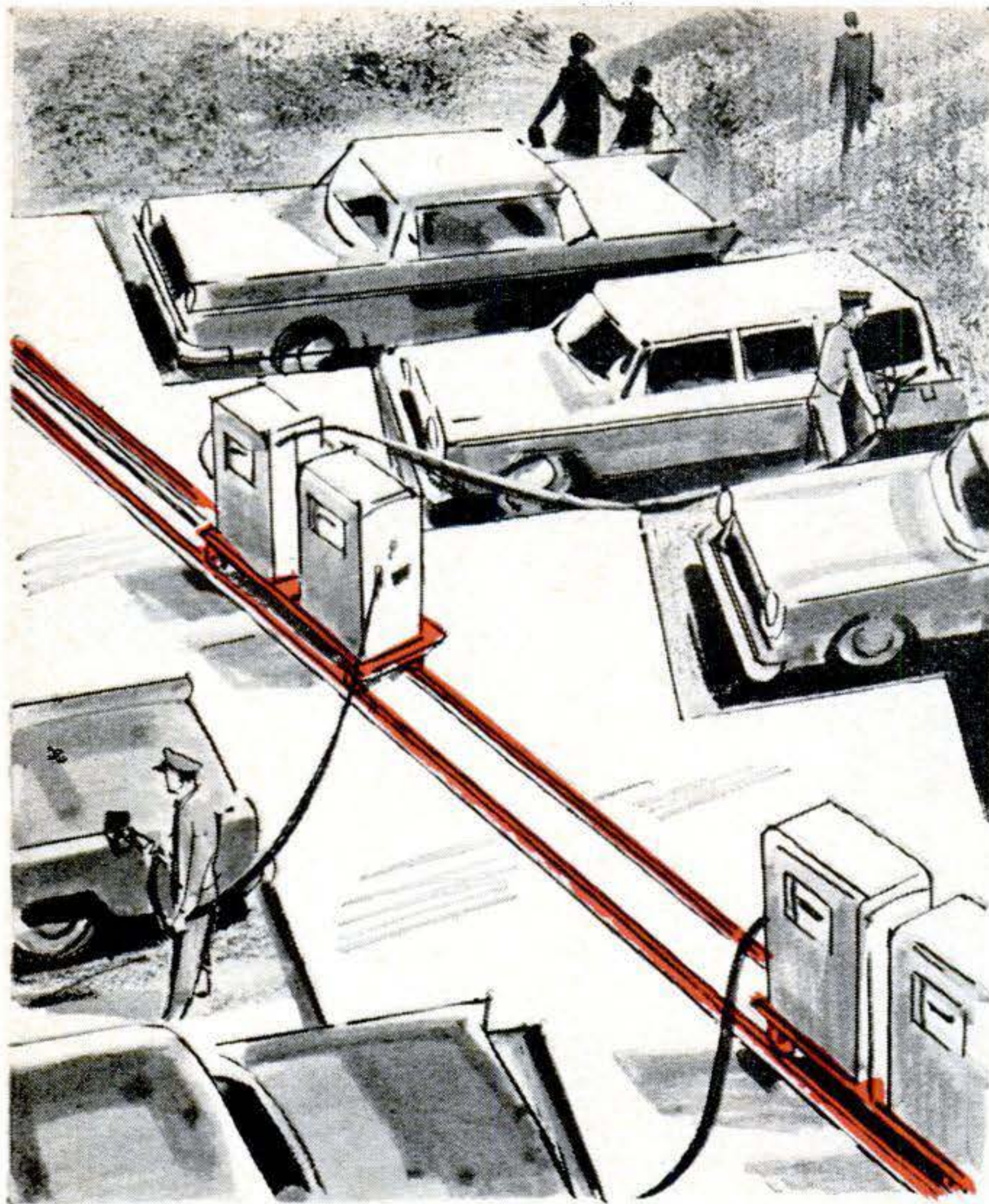
Most drag races are staged at local or regional meets. Each year come two big events: the Nationals at Indianapolis Raceway Park (several miles from the scene of the Indianapolis 500) over Labor Day weekend, and the Winternationals at Pomona, Calif., in mid-February.

With POPULAR SCIENCE'S Editor, Bob Crossley, I attended the Nationals this year. For spectacle, it was superb. The dragsters are enveloped in smoke at the starting line as tires on their driving wheels burn from slippage. Once past the timing traps, parachutes, vividly colored, blossom to kill speed and save brakes.

Speeds run high. In the approximate quarter-mile allowed for acceleration from a standing start, the most muscular dragsters reach 175 miles an hour or better. For comparison, a Boeing 707 Jetliner, during its takeoff run, is doing barely 90 m.p.h. in the same distance.

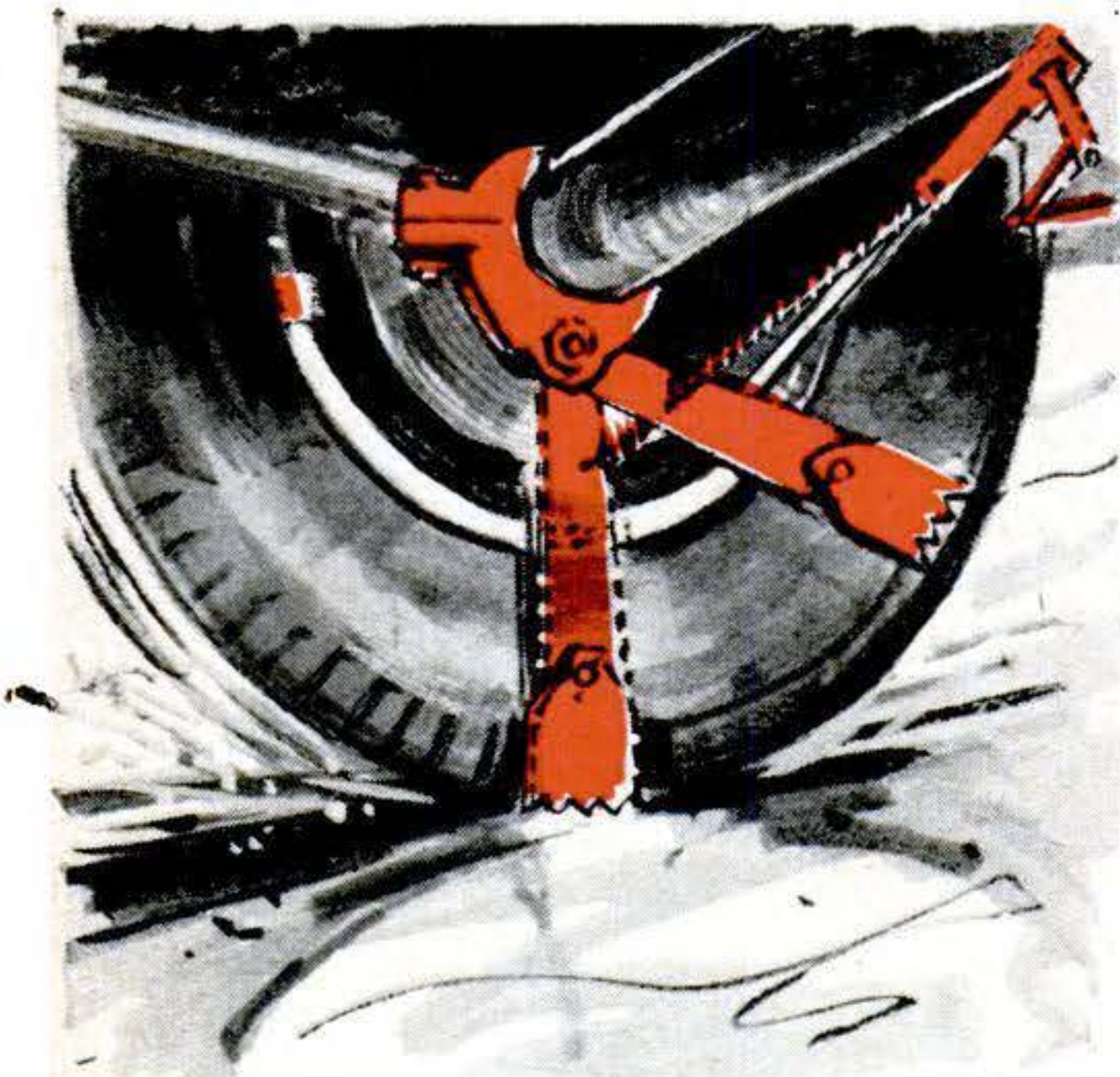
Speeds run lower, too. Some cars can clock well under 100 and still win. That's because practically anything propelled by

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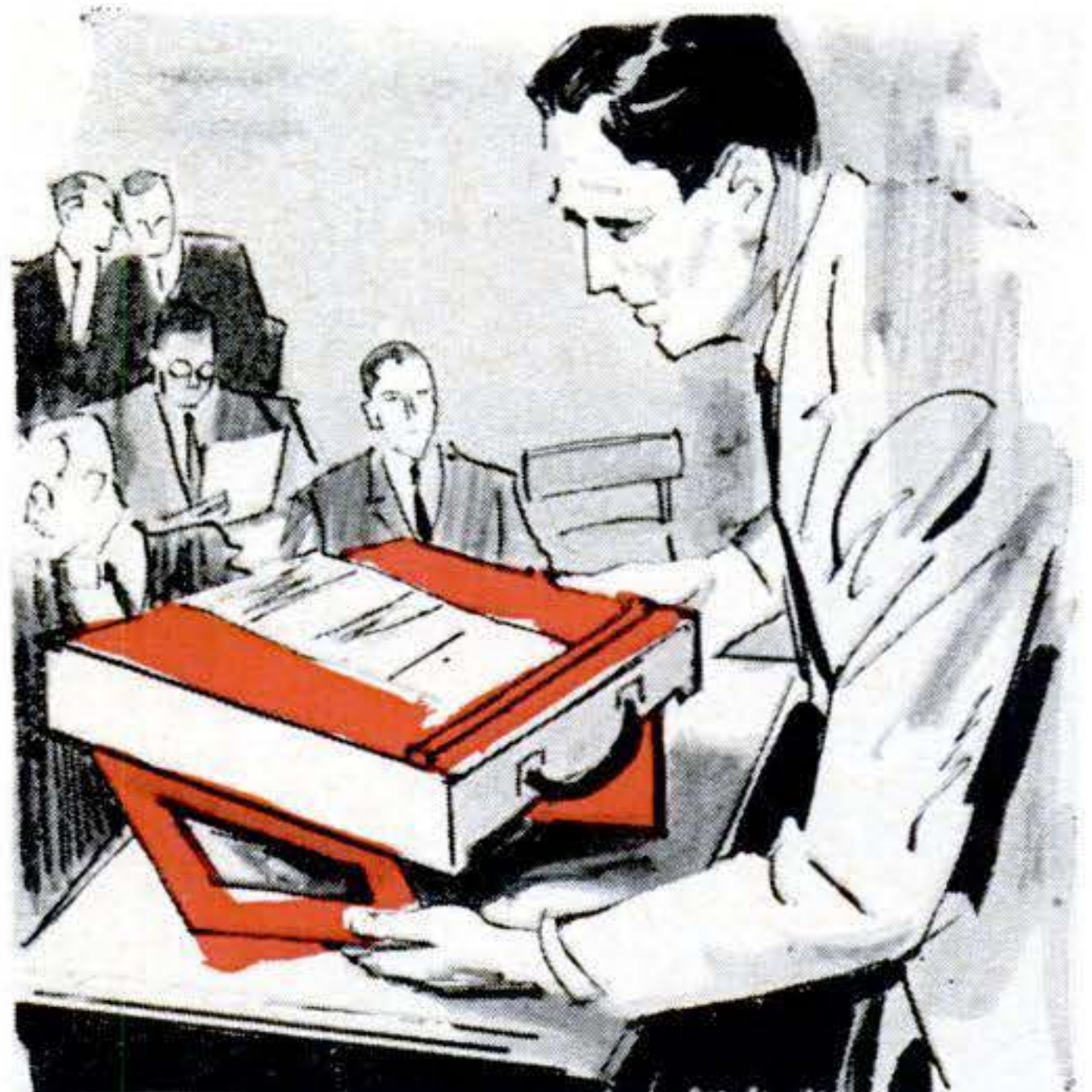


New ideas from the inventors

Gas pump moves to car. You wouldn't have to inch your way to a pump at a busy gas station that had track-mounted pumps like these. The recently patented system would let you park in any vacant bay at the service island and wait (in or out of the car) for the pump to come to you. Reel-up hoses would feed the movable pumps from a central supply.



Pivoted claw grips ice. This axle-mounted claw arm would let you start on ice by moving an inside-the-car lever. It would engage a lug on the arm with one on the wheel rim, moving wheel and claw together. At the end of its arc, the spring-retracted arm would slide free, return to rest or to reengage the wheel for another pass.



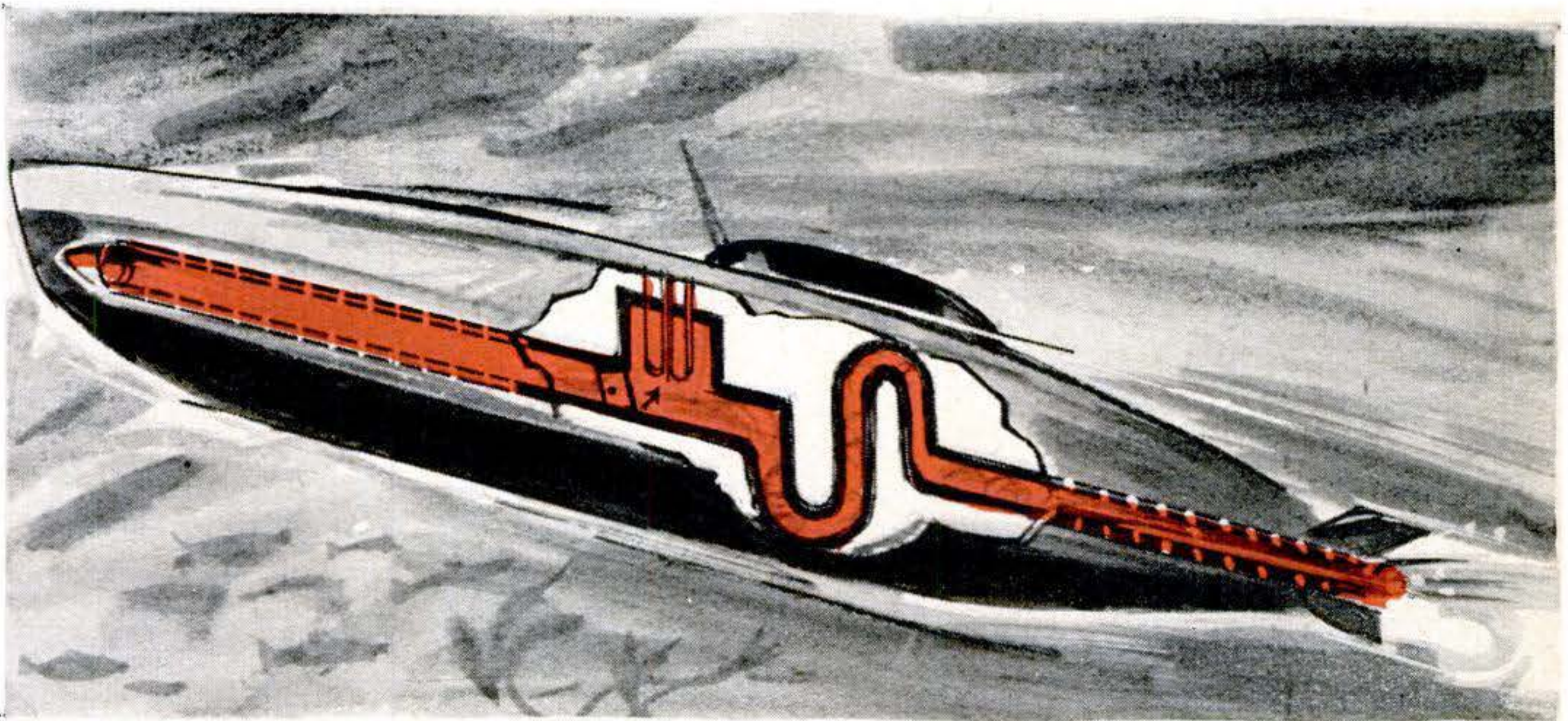
Briefcase props papers. Fold-out legs would convert this double-duty dispatch case into a reading stand or lectern that might be useful to a salesman, club officer, or the like. To expose the legs, you'd slide out a side panel from between grooved ends, then move the panel to the upper side to use its ledge for holding notes.



Float lifts bottled straw. Made short enough to fit inside a capped soda bottle, this plastic (or plastic-coated) straw would rise to sipping height when the bottle was opened. A bell-shaped float would supply lift, rising on gas bubbles. To sink the float when the bottle was being filled, the inventor suggests filling it with ice or sugar.



Training leash whistles at dog. When a puppy forgets who's boss in the family, a high-pitched whistle in his collar or harness might remind him—painlessly—to pay attention to a command. A tube would connect the whistle in this training leash to an air bulb near the handle; to signal, you'd give the bulb a squeeze.



Steam jet propels sub. Submarines and other ships might travel faster if steam were used for direct ram-jet propulsion. Here, water entering a valved, stem-to-

stern tube would pass through a steam chamber, expand, and thrust out the stern through a gooseneck. The ram action would lower pressure, admit more water.

.....

The following patents have been issued on these inventions: Movable gas pump—No. 3,079,960 to Charles E. Mays, La Porte, Texas; Skid claw—No. 3,036,649 to Ernest C. Truitt, Phoenix, Md.; Lectern case—No. 3,073,057 to Hobard A. Farber, Allentown, Pa.; Soda-pop float—No. 3,099,565 to Roy L. Neuhauser, Tucson, Ariz.; Training leash—No. 3,072,097 to Charles A.

Morchand, NYC; Steam jet—No. 3,079,751 to Neilson W. Lewis, Bala-Cynwyd, Pa.
 Copies of patents may be ordered, by number, from the Commissioner of Patents, Washington, D.C. 20231, at 25 cents each. To write to an inventor, if the address given above is insufficient, address him (by name and patent number) in care of the Commissioner of Patents.

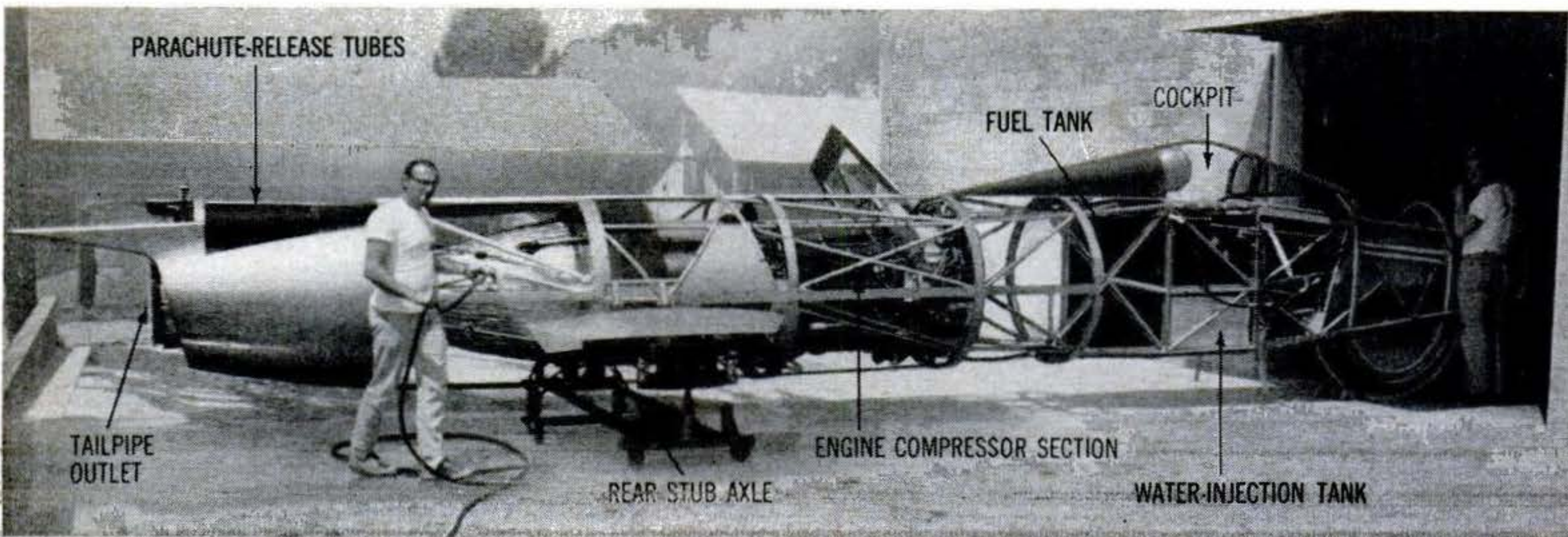
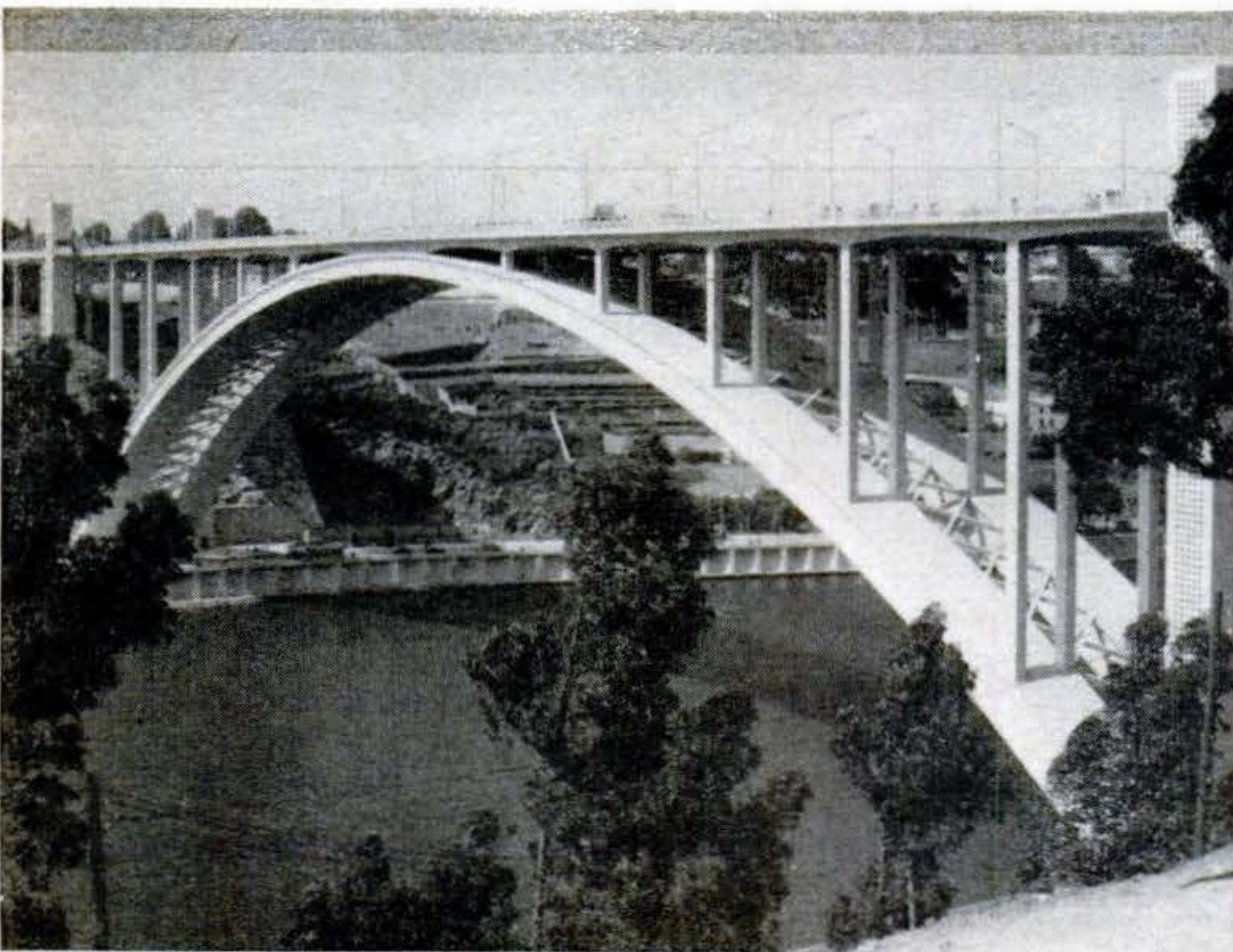


PHOTO BY T. FRAME-THOMSON, SHELL OIL CO.



Concrete bridge has single span

Beautiful Arrábida Bridge across the 1,600-foot-wide Douro River at Oporto, Portugal, is constructed of reinforced concrete with no joints.

Forms for the 169-foot-high twin arches were steel boxes, floated out from each bank and hoisted by crane. A steel lattice was strung between arches and columns added to support an 86-foot-wide roadway. The 2,000-foot bridge cost \$8.5 million.

How wheeled jet set land-vehicle record

Combine three wheels, an aircraft-type chrome-moly frame covered by a streamlined aluminum skin, and a J-47 turbojet engine developing 5,700 pounds of thrust (equivalent to 5,700 hp. at 375 m.p.h.). Stir in a quarter of a million dollars. Season with the know-how of top engineers from Shell Oil and Goodyear Tire and Rubber. You're bound to come up with a speed record.

The 30-foot-long Spirit of America, with its 26-year-old builder, Craig Breedlove, at the helm, blasted across the Bonneville (Utah) Salt Flats at a two-way average of 407.45 m.p.h., faster than John Cobb's 1947 auto mark of 394.2 m.p.h.

The car first had been tried last year, but proved unstable at speeds around 300 m.p.h. A huge fiberglass fin and steerable nose wheel (two degrees arc) solved the problem. A canard fin under the nose was retained to reduce air turbulence. A newly developed aircraft-turbine fuel by Shell was used. High-speed braking was handled by a two-stage parachute mounted in containers just over the rear of the engine and released by a powder charge. Conventional wheel brakes took over at lower speeds.

The four-foot-high Goodyear tires have 27 nylon plies and breakers (partial plies), a thin coat of rubber (mostly for appearance), and no tread. They were lab-tested at the equivalent of 600 m.p.h. Heat dissipation, surprisingly, was no problem. But centrifugal force was. Each tire would have to endure 100-ton loads.



"Flying" water skis ride on hydrofoils

Tiny hydrofoil wings attached to these skis enable the skier to bank, dip, climb, and glide at speeds up to 35 m.p.h. The foils start lifting at eight m.p.h., ride two feet above the water.

CosmoDynamics, Inc., Newton Upper Falls, Mass., developed Dynafite hydrofoils. Under the skis are a stabilizer and two "flying" wings, one of them removable for extra speed. A skier, it's claimed, can learn to use the foils in a half-hour.



Fort Belvoir engineer applies paste with calking gun . . . and detonates it to cut tree down.

Army blasts to fell trees

A paste explosive has been developed by Army Engineers for clearing a forest in a hurry or to drop trees across a road to

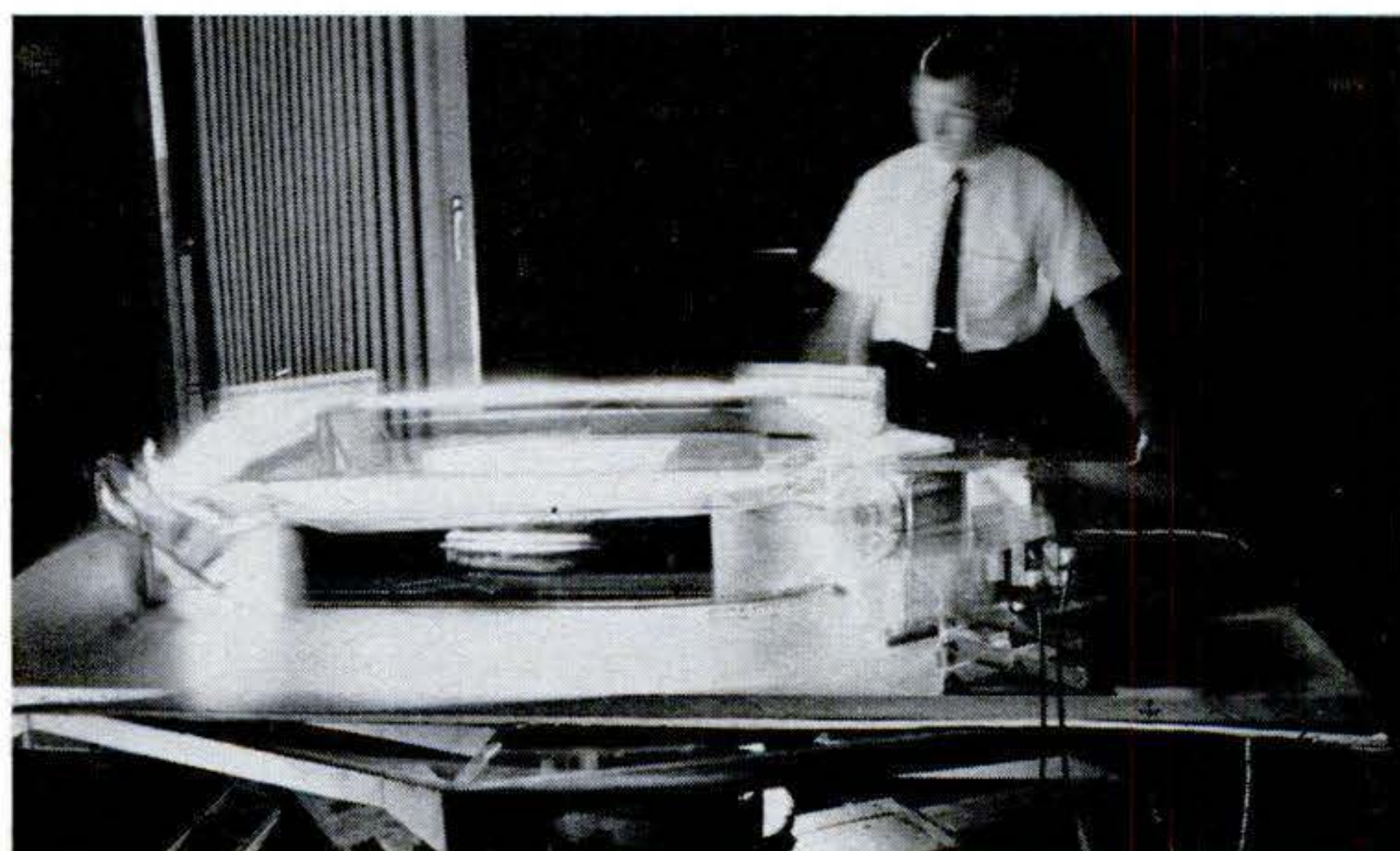
block passage of enemy vehicles. The paste can be patted around the trunk by hand or applied with a calking gun. Most-successful roadblocks occur when trees have not been completely severed from the stumps.



PHOTO BY DAN RUBIN

More than 500 labs are at work to find jobs for the amazing light beam that can pierce diamonds or measure distances smaller than the diameter of an atom

THE LASER GOES TO WORK



Light-beam gyro

Sperry's experimental ring laser, navigation gyro of the future, is mounted on a massive pivoted table. At left, engineer Richard Salamon adjusts a power coil on one of the four gas-laser tubes. Laser light beam bounces off mirrors at four corners, whirling in both directions around the square. Mirrors mounted in supports on near right-hand corner of table combine light beams and feed the light into a photomultiplier tube in the black box, which detects a difference frequency when the table is rotated, as at right.

By C.P. Gilmore

"THIS is the ring laser," said my guide, research engineer Warren Macek of Sperry Rand. I gently touched the contraption—a square of glowing glass tubes and mirrors mounted on a pivoted slab of magnesium. It squealed.

"You probably couldn't feel any motion," said Macek, "but you turned the platform slightly. A detector sensed the movement and converted it into a signal."

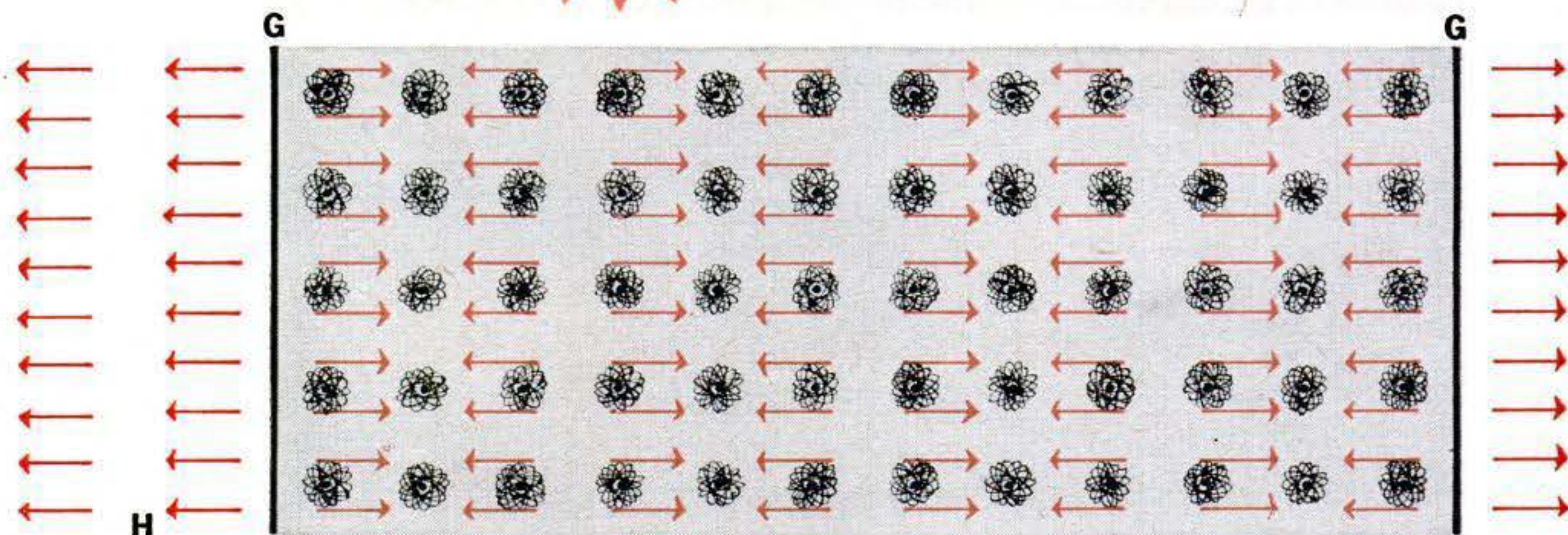
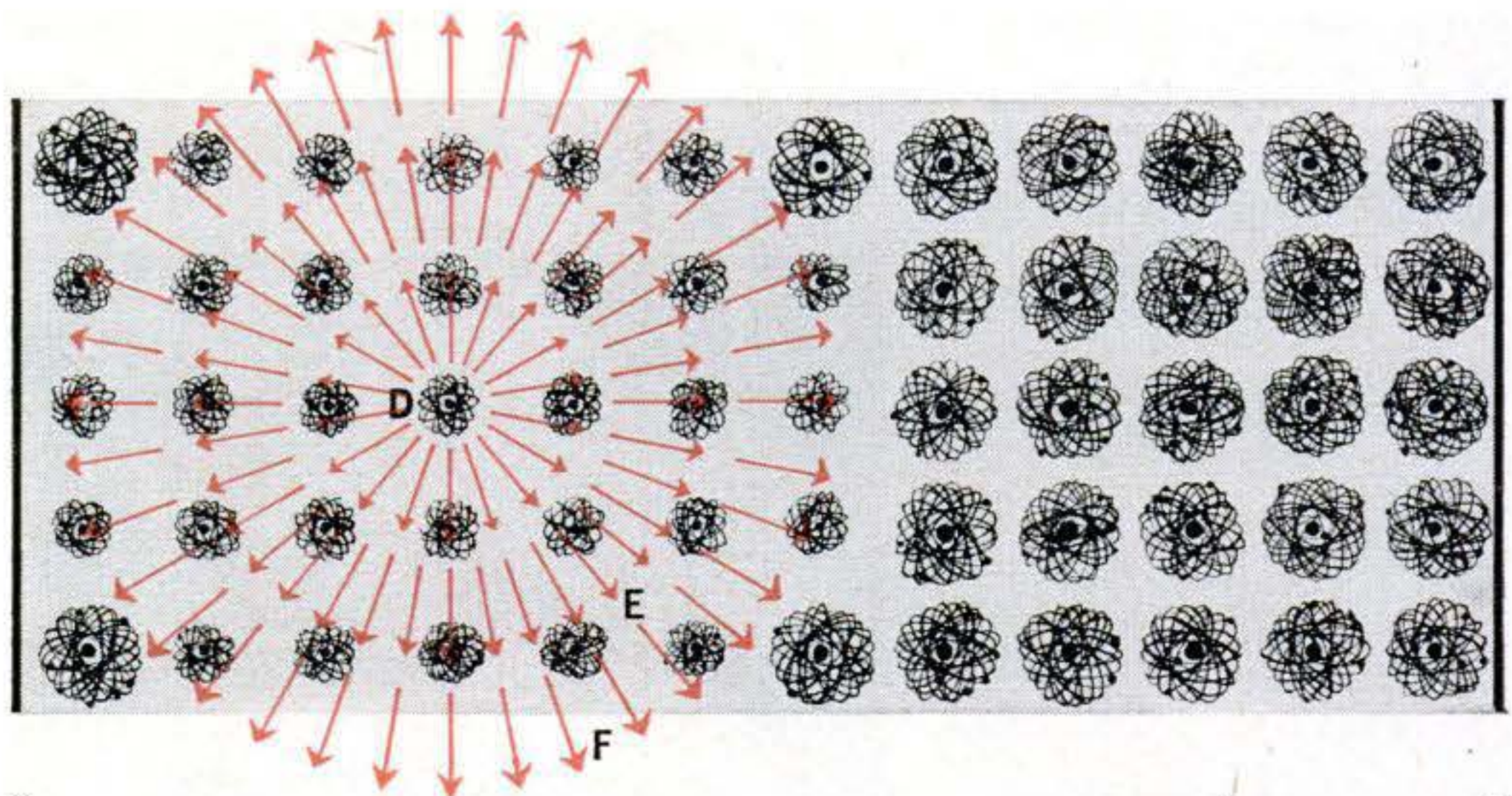
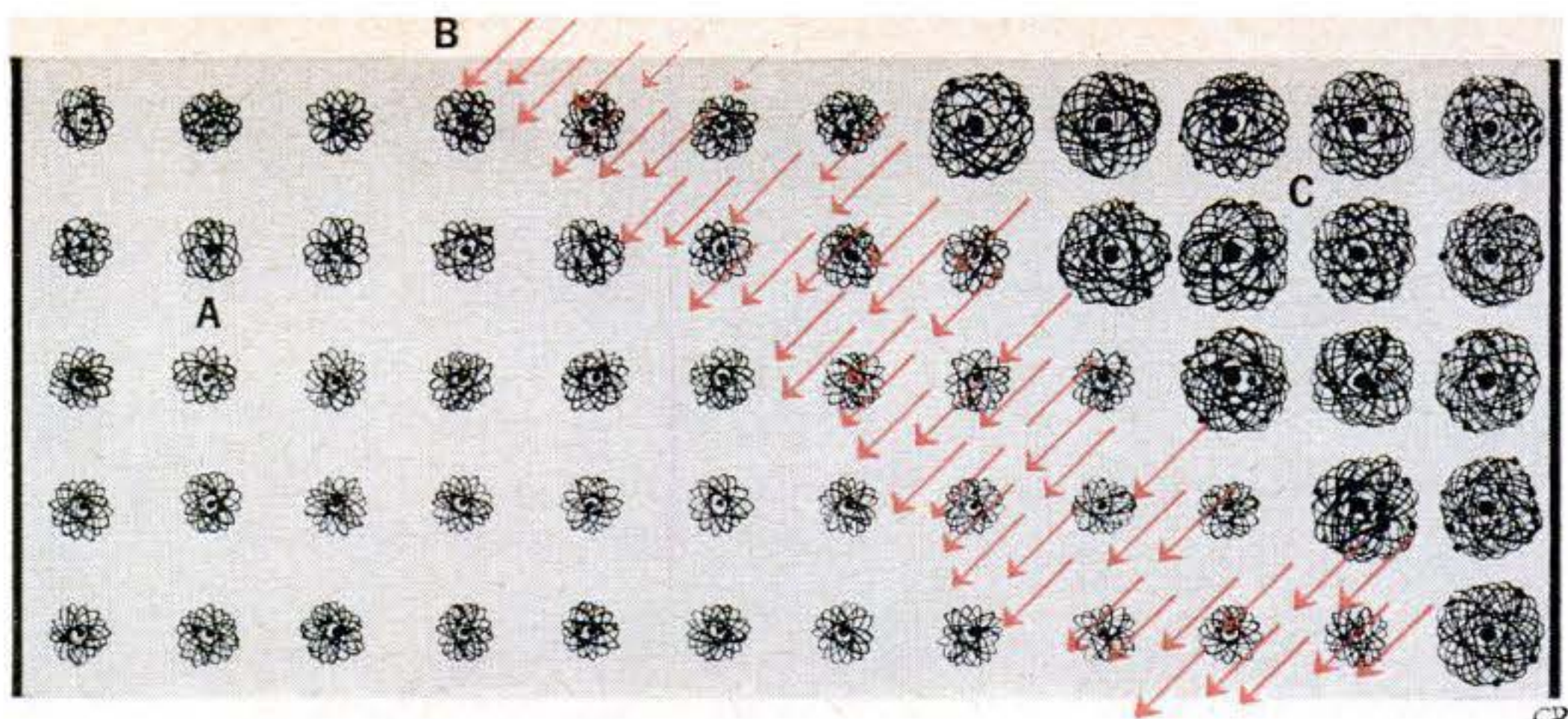
I touched the device again. It squealed a second time. I still didn't feel it move.

"Here's what's happening," Macek continued. "These four gas-laser tubes are emitting light beams of the same frequency, with their light waves all in step. Light shoots out of both ends of each tube. With 45-degree mirrors at each corner, two light beams whirl around the square in opposite directions. When the platform is stationary, the clockwise beam is exactly synchronized with the one going the other way.

"But if the system begins to rotate"—he pushed the corner of the platform and the squeal sounded again—"there's

How they lase

Solid and gas lasers work on essentially the same principle. In one made of synthetic ruby, for example, atoms of chromium in their normal state (A) are hit by photons of light (B), "packets" of energy from a stimulating light source. This excites the electrons of the atoms to a higher energy state, enlarging their orbits (C). From this unstable state, some electrons fall back (D) toward nucleus, releasing photons which hit other excited atoms to cause their electrons to collapse, releasing more photons (E). The



photons travel "in step" due to the natural vibration frequency of the atoms. Some photons exit from the sides of the rod (F), but those traveling along its axis are reflected back and forth by its silvered ends (G), hitting more excited atoms and releasing more light energy. At peak of cascade, pulses of photons in step, too powerful to be reflected back, are shot out (H).

a Doppler shift in the frequency of each light beam. That is, each light wave still travels at the speed of light, but the wave fronts traveling in the direction of motion are crowded together, while the ones going in the opposite direction are stretched apart. A photocell detector at one corner compares the frequencies; the difference, amplified, is fed to a loudspeaker."

That squeal the ring laser produces isn't for entertainment. The signal it generates may guide spaceships, planes, and submarines. The ring laser, reacting to rotation, works like a gyroscope. The Air Force recently gave Sperry Rand a contract to develop the device further. Ultimately, it should be cheaper and smaller than a regular gyro—and more dependable, with no moving parts.

The ring laser is just one of hundreds of new laser concepts and devices introduced since July, 1960, when the

world's first laser pulsed into life—in the laboratory of Theodore H. Maiman at Hughes Aircraft. An electronic Aladdin's lamp, it has become the most talked-about triumph in the recent history of science.

More than 500 research teams in this country—and hundreds more abroad—are working to learn more about the laser. Scientific journals are filled with laser articles; seminars around the world meet to talk about it; newspapers and magazines are filled with glowing reports and predictions.

So glowing have been the reports, in fact, that one important point has been largely overlooked: Despite tremendous progress, almost all laser work so far has been experimental. Only within recent months has the laser come to the threshold of practical application.

A light "never seen on earth." It's taken time to turn laser theory into practice because scientists had to get used to thinking in new ways. The laser is basically a light maker. But the light it makes is of a radical new kind, never before seen on earth.

Ordinary light—from the sun, a light bulb, a fire—is "incoherent." Its light waves are jumbled, out of step. Laser light is *coherent*. The vibrations march out steadily in a smooth stream, every wave in step.

Because it's coherent, the laser's beam can be modulated—loaded with information—like a radio or TV signal; focused into a tiny spot hotter than the sun's surface; measured with an accuracy never before possible.

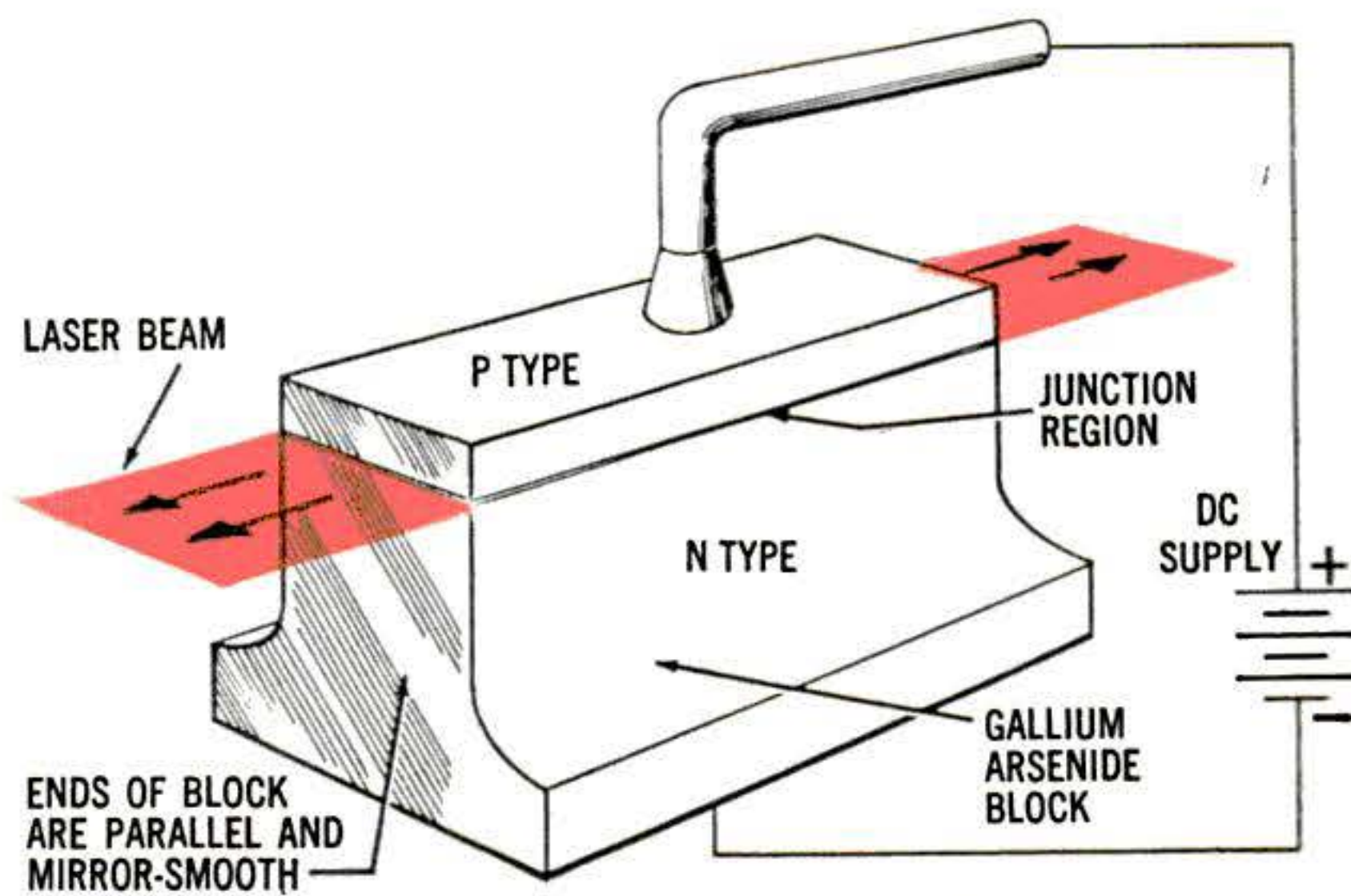
As soon as the laser was invented, scientists saw scores of ways in which light with these special properties could be put to work. But for different jobs, one laser wouldn't do. So scientists went to work and found whole new families of laser materials. Despite their outward variety, all fall into three general classes.

The light-pumped laser. First, and closest to commercial application, are the high-powered light-pumped lasers. Usually made of synthetic ruby (but more recently of glass, plastics, and liquids also) they produce powerful pulses of light. A laser used by MIT scientists in the summer of 1962 performed what may be the most spectacular feat to date: bouncing a beam of light off the moon.

As this demonstration showed, the laser is a natural for radar. Laser radar can be far smaller and lighter than the regular microwave kind. (Hughes has built a 45-pound model that can be carried into battle by a man; the Army is now trying several similar RCA prototypes, and other companies have shown working models of compact units.)

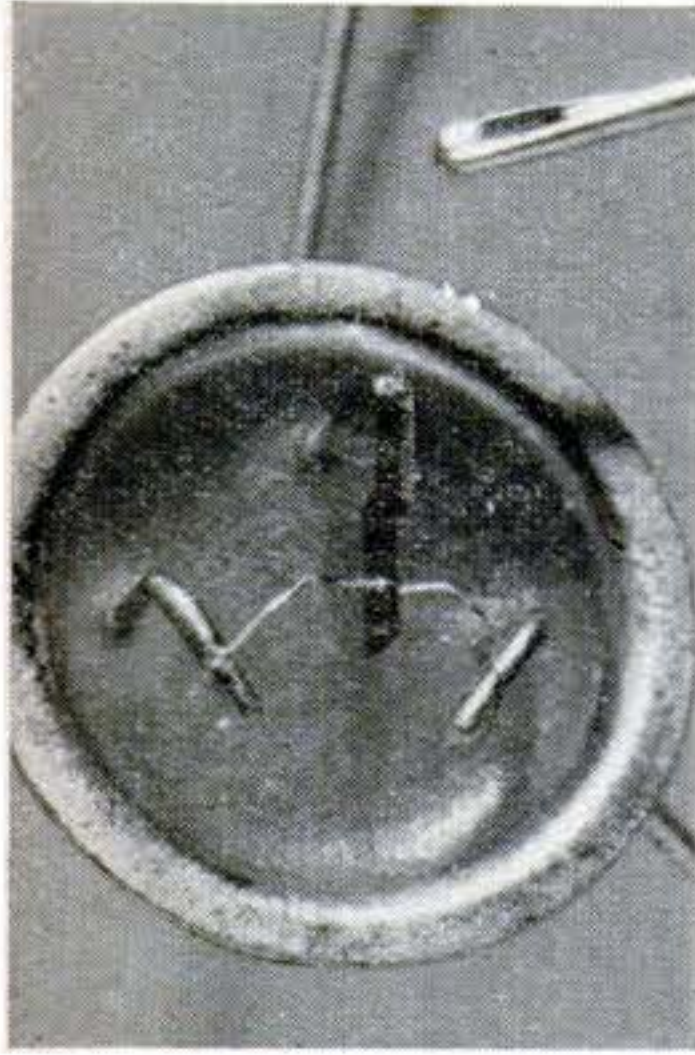
The injection laser

Newest member of the laser family is the transistorlike injection laser, a tiny block of gallium arsenide. Impurities intentionally placed in the material create an n-type zone (negative; containing an excess of electrons) and a p-type zone (positive; with an excess of "holes"—a deficiency of electrons). When direct current is applied across the block, electrons move across a junction region from the n-type material to the p-type material. An electron "falling into a hole" drops to a lower energy state, releasing energy in the form of a photon

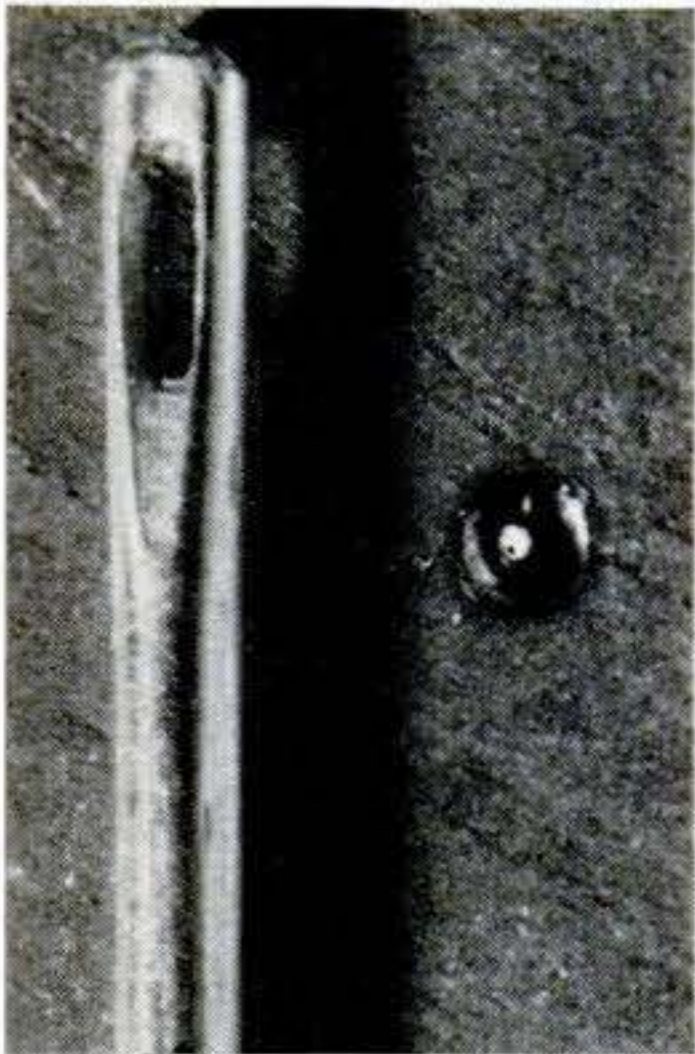


of light. Photons traveling through the junction region stimulate more electrons to make the transition, releasing more photons. Bursts of photons build up between the mirrored ends of the block, as in other lasers, and a beam of coherent light is emitted from the junction region.

Laser's microjobs



Precision welding of a transistor's hairlike lead wires, shown by Hughes Aircraft. Laser beam is delicately controlled; nothing touches the material to be welded.



Hole pierced by Hughes laser in 1/8-inch cold-rolled steel is .005 inch in diameter. Laser beam is hotter than sun's surface, and welding or piercing takes less than 1/1,000 of a second. Needle's eye is included in both photos for scale.

The beam is far narrower, too. In the MIT moon-bounce experiment, for example, the laser beam fanned out to form a spot less than two miles across on the moon's surface. The tightest microwave radar beam would spread 25,000 miles or so.

The pencil-slim laser beam makes possible radars with incredible precision. Robert D. Kroeger of Sperry says a new laser the company is building sweeps a pinpoint beam back and forth across the target and draws a picture of its outline on the screen. "Even in early experiments, we're getting dimensions accurate to within inches at ranges of a mile or more," he said. "This eventually could be useful for precise radar mapping of other planets."

The energy packed into the high-powered laser beam can also be focused to produce tremendous heat. At the drop of a hat, laser companies gleefully show this capability by blasting holes in diamonds and razor blades. For such experiments, laser power is measured in "gillettes."

For firing solid rockets. United Aircraft scientists would like to ignite solid-propellant rockets with lasers built into the launching pad. Clustered boosters could be fired simultaneously by splitting a single beam into several parts with mirrors. The usually tricky firing circuits in the rocket could be eliminated.

Hughes recently put on the market a line of lasers recommended for making welds of great delicacy. Among the results shown: a welded transistor lead so fine that it is dwarfed by the eye of a needle held next to it; tiny sapphires, tough and almost impossible to machine, neatly drilled with holes too small to stick a human hair through.

The laser's finely controlled beam is likely to be useful in medicine, too. A detached retina, which may cause blindness, can be "welded" back in place by a laser beam. After many experiments on animals, two human retinas were recently welded at Stanford Medical Center in San Francisco. The procedure takes a thousandth of a second and is completely painless.

The gas laser. A second type also shows promise. The gas laser, not as powerful as the solid version, operates continuously, and is easier to pump. Radio-frequency energy, simpler to generate and control than powerful light pumping, stimulates emission.

Most important, the gas laser's beam is far more coherent than even the best solid laser, and the frequency is more precisely fixed. It's a natural for sensitive devices such as the ring gyro. The more precise the laser's frequency to begin with, and the more coherent its beam, the greater the sensitivity of the instrument.

The extreme coherence of the gas laser also helps researchers measure distances far more accurately than ever before possible. The wave length of light generated by a glowing krypton tube has been established for several years

[Continued on page 196]

REPORT FROM THE DRIVER'S SEAT



The Bug's Big Brother

How good is the VW 1500?

By David Scott *PS European Editor*

A BIGGER beetle is about to invade America. Confined originally to Europe, it has been let loose in Canada, and a few specimens have been "smuggled" into the U.S. Within a year, there may be a horde of them.

If you're in love with the VW 1200, you're sure to feel the same about its bigger, more sophisticated brother. Everything the time-

CONTINUED



Driving position is high, visibility excellent. Buttons control accessories. Car, tested in England, has right-hand drive.



Rear-seat headroom is just enough for a six-footer, but knees are cramped. Armrest and light are standard.

ripened buzz-box can do the VW 1500 can do better; it lacks only the inelegant charm of a walnut-shell body.

The shape is Volkswagen's attempt to blend evergreen looks with styling of the Sixties. They've tried to build in *unobsolescence*; the result is pleasing but undistinguished. You could easily mistake the 1500 for a dozen other cars.

The VW 1500 is larger, faster, quieter, has more luggage space, and is loaded with electrical gadgets. It stands on the

same wheelbase and bump-cushioning 15-inch wheels, but length is stretched by 7 inches to nearly 14 feet.

You get a couple more inches for hips and elbows and about the same headroom, although the car is a shade lower. But long-legged back-seat passengers are still in for callused knees.

Latter-day styling gives you a larger trunk in front, and the pancake engine makes room for another one behind. Combined volume of about 8½ cubic



Spare-tire compartment also houses jack, windshield-wiper water bottle, brake fluid. Gas tank is under the trunk floor.



Country roads show up 1500 at its best, thanks to independent suspension, big wheels. Rear window is oversize.



Foil-lined trapdoor in rear trunk gives easy access to top layer of flat four. Combined oil filler-dipstick is outside the engine compartment, just inside the trunk sill, where it won't be covered by luggage.

feet is more than in the VW 1200, although both spaces are shallow.

Both lids release from inside the car, the rear one by a lever recessed in the door frame. This is handy, but means that contents are not secured when you leave the car unlocked in a parking lot.

Also, don't let the supermarket put your butter or ice cream in the tail compartment. I checked the temperatures with twin thermometers on a mild sunny day. After a 20-minute run, the front

trunk showed 73 degrees, but it was 86 in back.

The engine. Derived from the original Volks unit, and with 91 cu. in. and 7.8:1 compression (for cheap gas), the flat-four engine delivers a modest 53 hp. at a calm 4,000 r.p.m. It's also about three to five m.p.g. thirstier than the VW 1200. This one is really flat. They've squashed overall height to a mere 16 inches by tucking the generator, carburetor, and

[\[Continued on page 194\]](#)

FACTS ON THE VW-1500

Model: 2-door sedan.

Factory-suggested basic price (in Germany): \$1,500.

Engine: overhead-camshaft flat four; 53 hp. (SAE) at 4,000 r.p.m.; maximum torque, 83 lb.-ft. at 2,000 r.p.m.; bore and stroke, 3.27 by 2.72 in.; displacement, 91.09 cu. in.; compression ratio, 7.8:1; carburetion, 1 bbl.; weight (lb.) per hp., 36.6; engine revs per mile, 3,077; piston travel (ft.) per mile, 1,394; fuel required, regular.

Fuel capacity: 10.6 gal.

Transmission: four-speed; ratios (:1): 3.80, 2.06, 1.32, 0.89; reverse, 3.88.

Axle ratio: 4.125:1. **Steering ratio:** 14.9:1. **Turns lock-to-lock:** 3. **Brake-swept area:** 234 sq. in. **Tire size:** 6.00 by 15.

Outside dimensions: wheelbase, 94.5 in.; front track, 51.5 in.; rear track, 53 in.; overall length, 166.3 in.; width, 63.2 in.; height, 58.1 in.; ground clearance, 5.9 in.

Curb weight: 1,940 lb. **Weight distribution:** front, 43%; rear, 57%.

Speedometer error: indicated 60 m.p.h. is actual 66 m.p.h.

Gas mileage at constant speeds (m.p.g.): 30 m.p.h., 42; 40 m.p.h., 36; 50 m.p.h., 31; 60 m.p.h., 28.

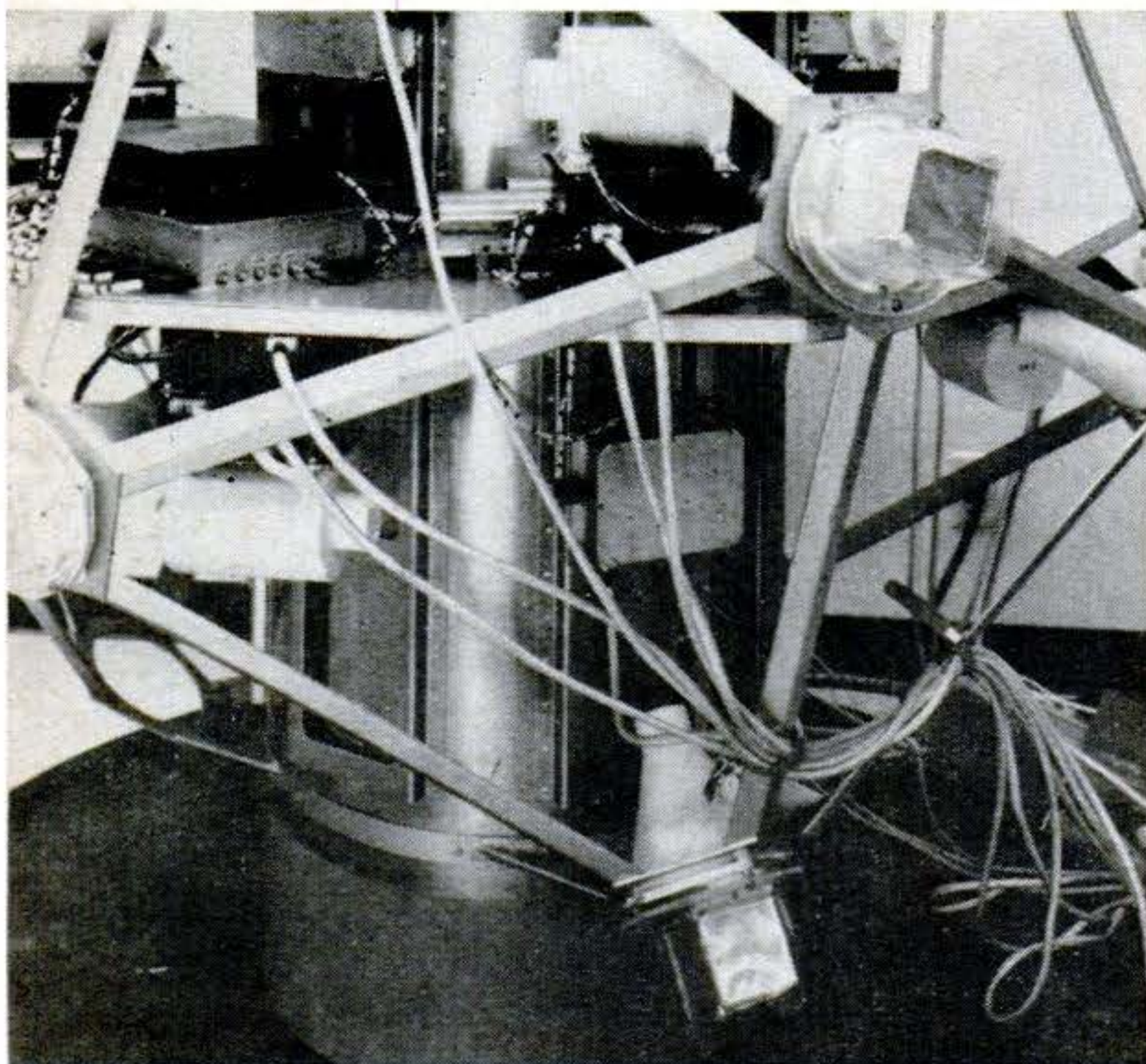
Acceleration (seconds): 0-60 m.p.h., 23; 40-60 m.p.h., 15; 50-70 m.p.h., 31.

Top speed: 80 m.p.h.

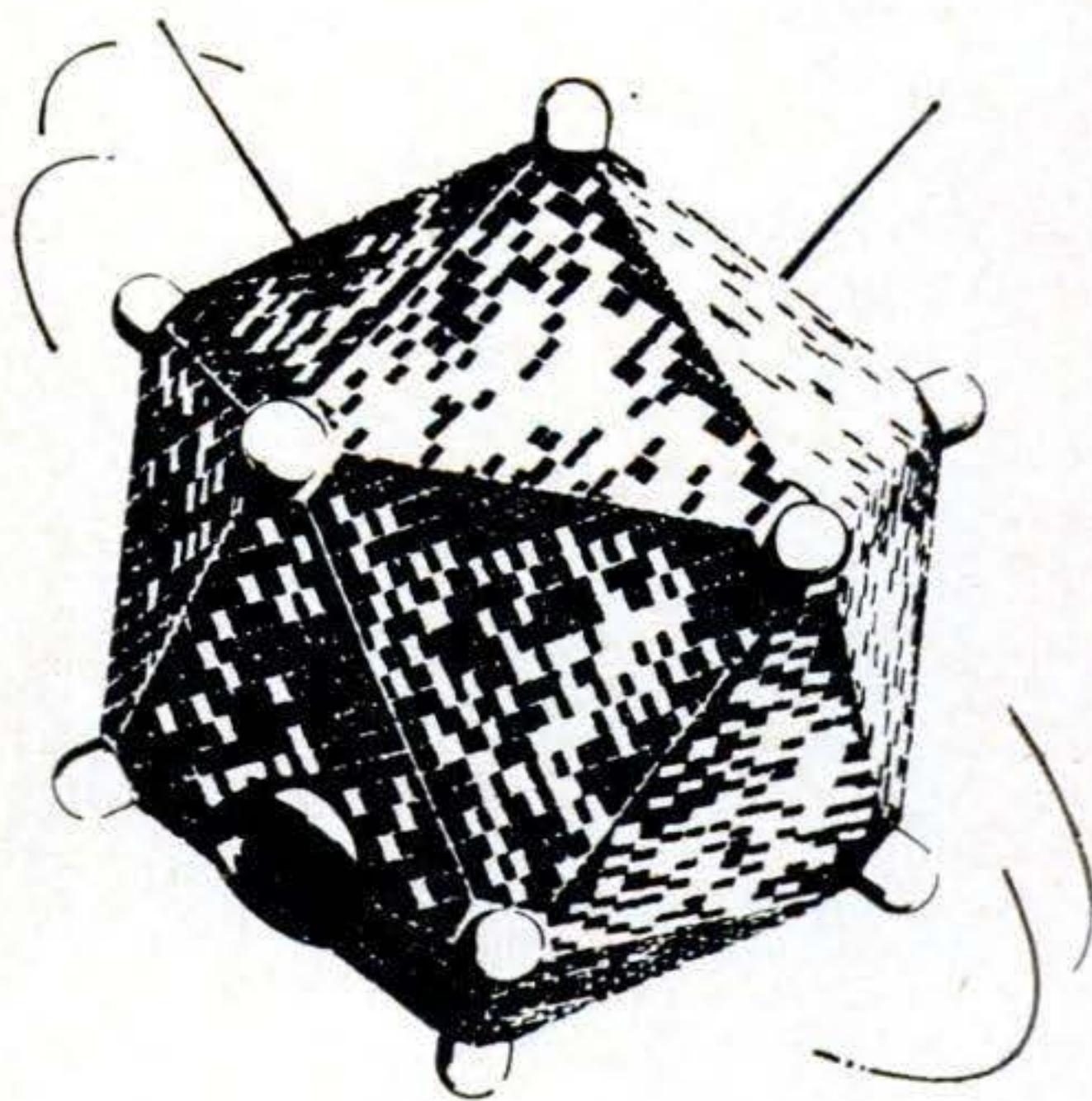
How We're Policing the A-Test Ban



Satellites can reveal sneak tests of nuclear bombs in outer space



Space-policing satellite, being readied for launching, is studded with X-ray detectors (cube-shaped protuberances), and has gamma-ray and neutron detectors within.



Looking like this, satellite will patrol heights of 50,000 to 75,000 miles. Since A-blast in space would be "dark," satellite's sensors are sensitive to the invisible rays that would make up most of its radiation.

Scientific eyes, ears, and sniffers stand guard against clandestine nuclear blasts

By Alden P. Armagnac

SATELLITES to detect nuclear blasts in space are the latest of an array of devices that will police the new U.S.-British-Soviet atomic-test-ban treaty.

To curb the nuclear arms race and radioactive fallout, these powers agree to explode no more nuclear devices in air, sea, or space. Underground tests, which do not contribute to worldwide fallout, are still permitted—because they are hard to tell from natural earthquakes at a distance. Observance of the ban on the rest can be verified by remote detecting instruments.

How our own National Detection System is doing it, so far as general principles are concerned, is no secret:

A nuclear blast in air sends telltale signals afar. Around the globe, sensitive barographs register the air wave. Seismographs detect earth tremors; radio apparatus, lightning-like static. Bearings from observing stations pinpoint the site of the big bang. Windborne radioactive particles clinch the evidence that it was nuclear.

Testing deep in the sea offers no concealment. Submerged hydrophones, strategically located, can “hear” an underwater nuclear test virtually anywhere on earth.

In the vacuum of space, a nuclear explosion will be a “dark” one instead of a sun-like fireball, mostly emitting invisible X rays, gamma rays, neutrons. But X rays from near-space tests will make the upper atmosphere glow—a clue applied by Los Alamos Scientific Laboratory in an experimental “air fluorescence detection station.”

Satellites will have to detect far-space tests by picking up the invisible rays directly, and reporting by radio. Ten such experimental U.S. satellites are to be launched in pairs in 1963-1964.

Artifices might hide some small tests, experts concede. An example: inflating a balloon of lead-impregnated plastic around a space shot, before detonation, to stop escaping X rays. But the great risk of being caught at it, if anything went awry, should discourage any such hanky-panky.

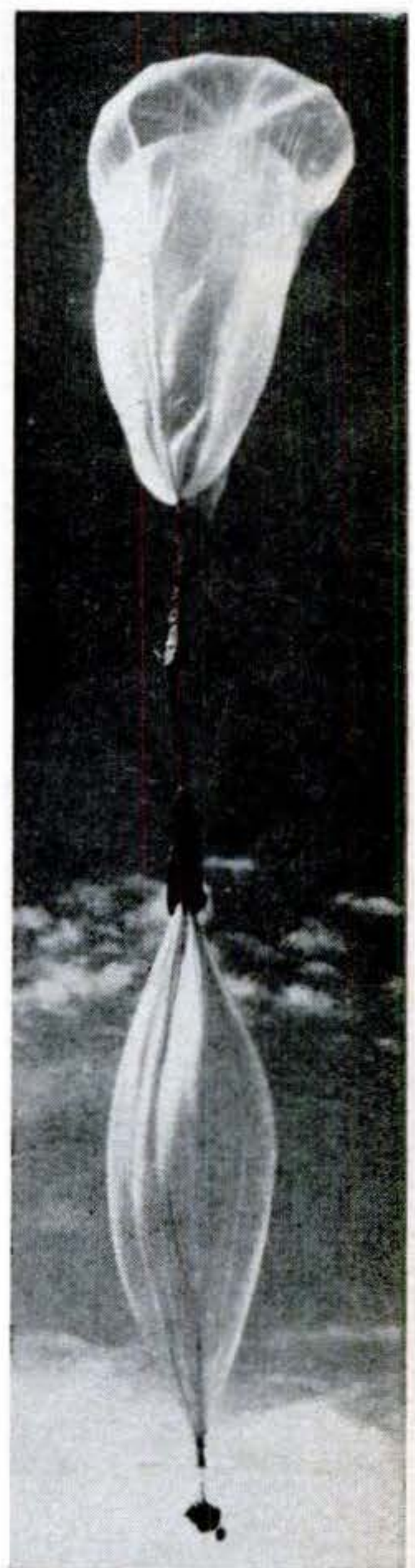
Detecting A-tests in air is easy



Radioactive dust collected from air, in ways shown here, positively confirms earlier signs of an A-test. Wingtip filter tank of Air Force B-57 plane, above, snuffs up “hot” particles. Modified U-2s get similar samples from altitudes as high as 70,000 feet.

Balloons, too, check radioactivity in upper air. Plastic balloon, right, trails collecting bag filled with 2,000-cubic-foot air sample by blower, at predetermined altitude. Fan then transfers sample to smaller armored bag, which parachutes to earth for recovery.

On ground, U.S. monitoring stations sample airborne radioactivity with device resembling midget vacuum cleaner. It sucks air through porous filter, shown detached and held in hand, which traps the particles. Analysis tells what kind of nuclear bomb was tested, and when.



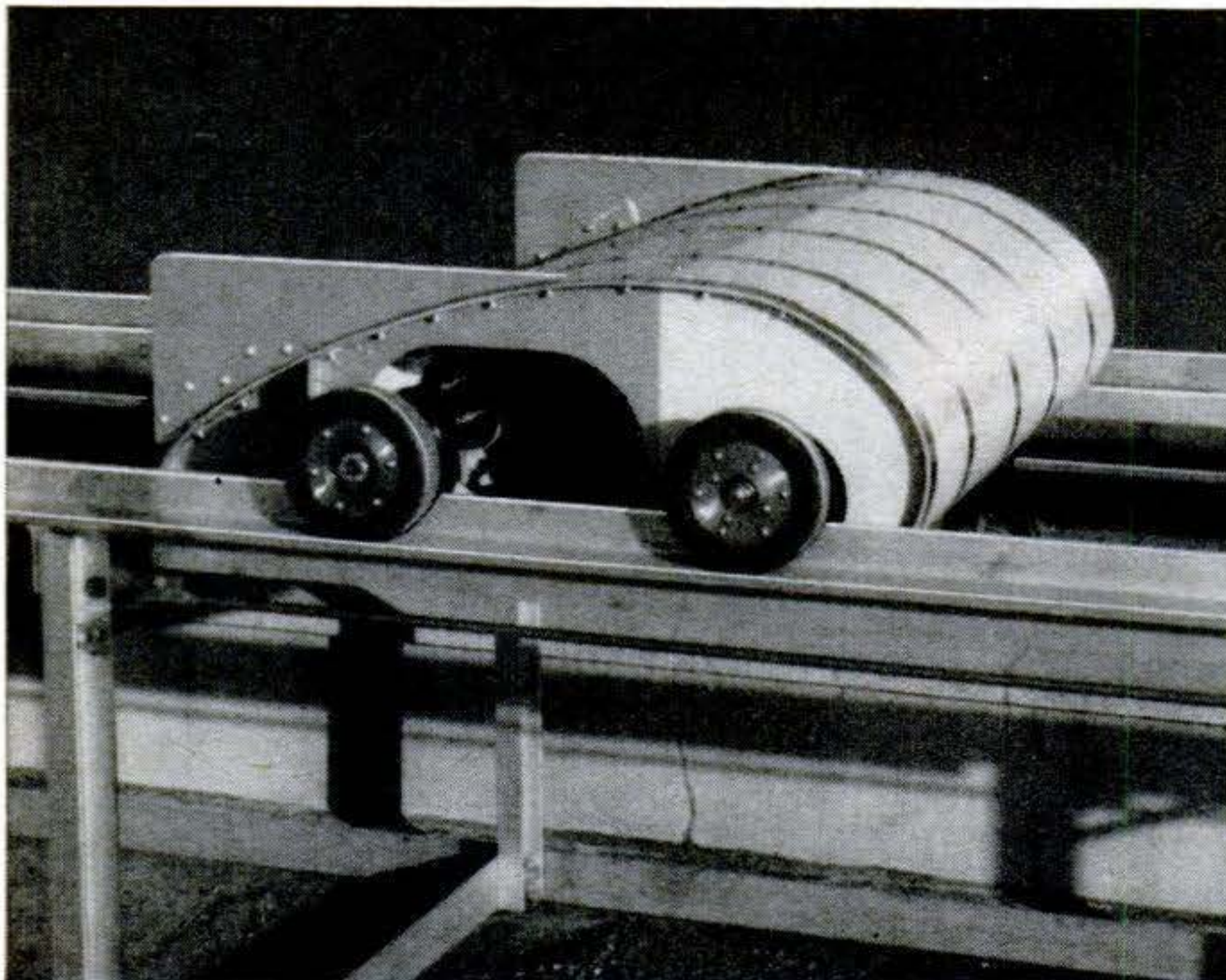


Pittsburgh's Panther Hollow today: ugly slum houses and railroad between beautiful campuses.

Huge research park to bridge mile-long ravine

One of the largest and most spectacular of the world's research centers is planned as a \$250 million Pittsburgh reclamation project. It will enclose the mile-long,

1,000-foot-wide, 150-foot-deep Panther Hollow (knifing between the campuses of the University of Pittsburgh and Carnegie Tech) with a 75-acre landscaped extension of



Wing-section railcar loses weight at speed

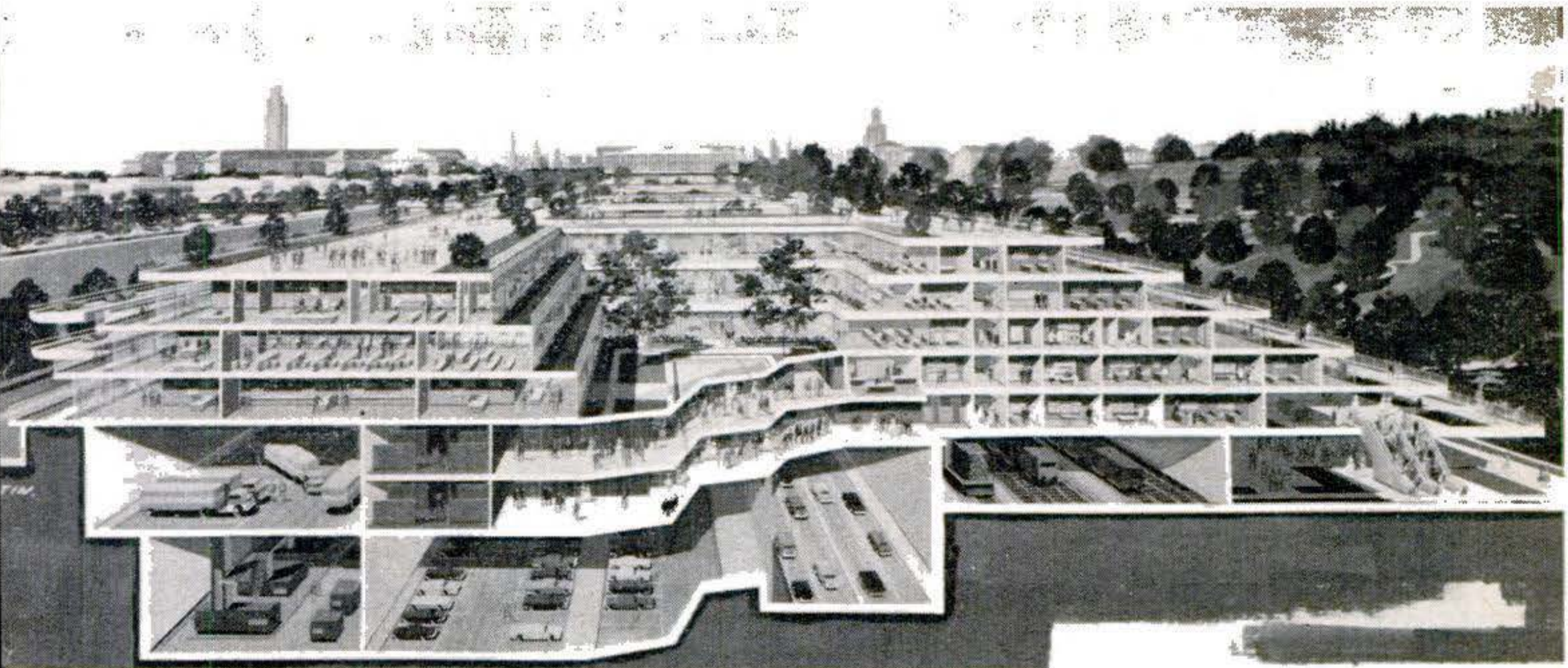
The airfoil section of this proposed Japanese railcar provides lift to reduce effective weight by two-thirds. This buoyancy, plus streamlining and lowered rolling resistance, will give the 80-passenger car a top speed of 125 m.p.h., the inventor says. Recently demonstrated in model form, the pneumatic-tired Sky Car would run on two light elevated rails at a tenth the cost of a monorail system and at twice its speed.



Stays cool on hot stroll

A leisurely walk through a 2,024-degree fire at Carswell Air Force Base in Texas demonstrates to onlookers the effectiveness of a new fire-fighting and rescue suit made of aluminized fiberglass.

The basic fiberglass fabric is woven by J. P. Stevens & Co., NYC, and aluminized by Minnesota Mining & Mfg. Co.



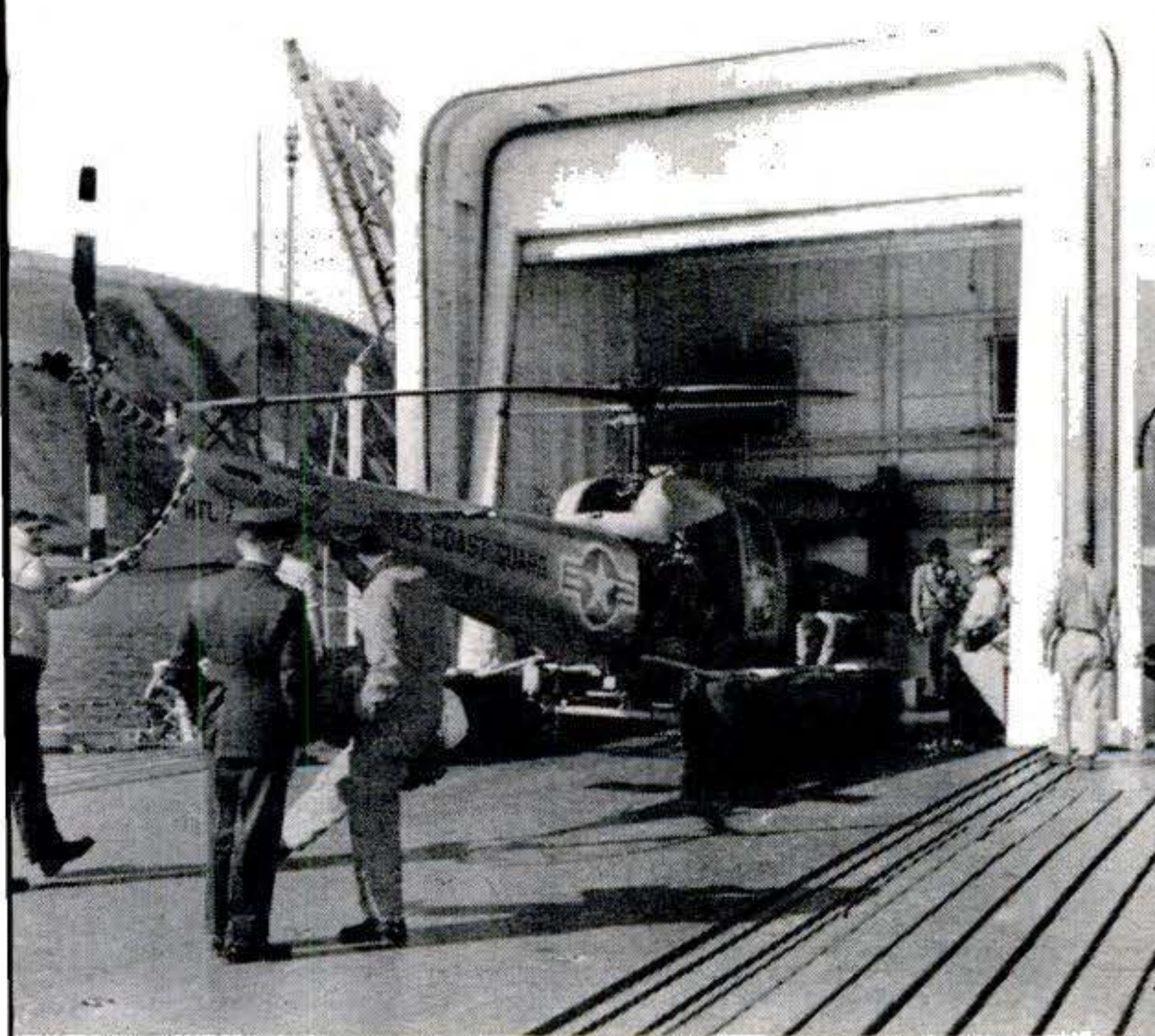
Proposed redevelopment: offices on terraces and central courts, railroads and highways below.

Schenley Park near the heart of the city.

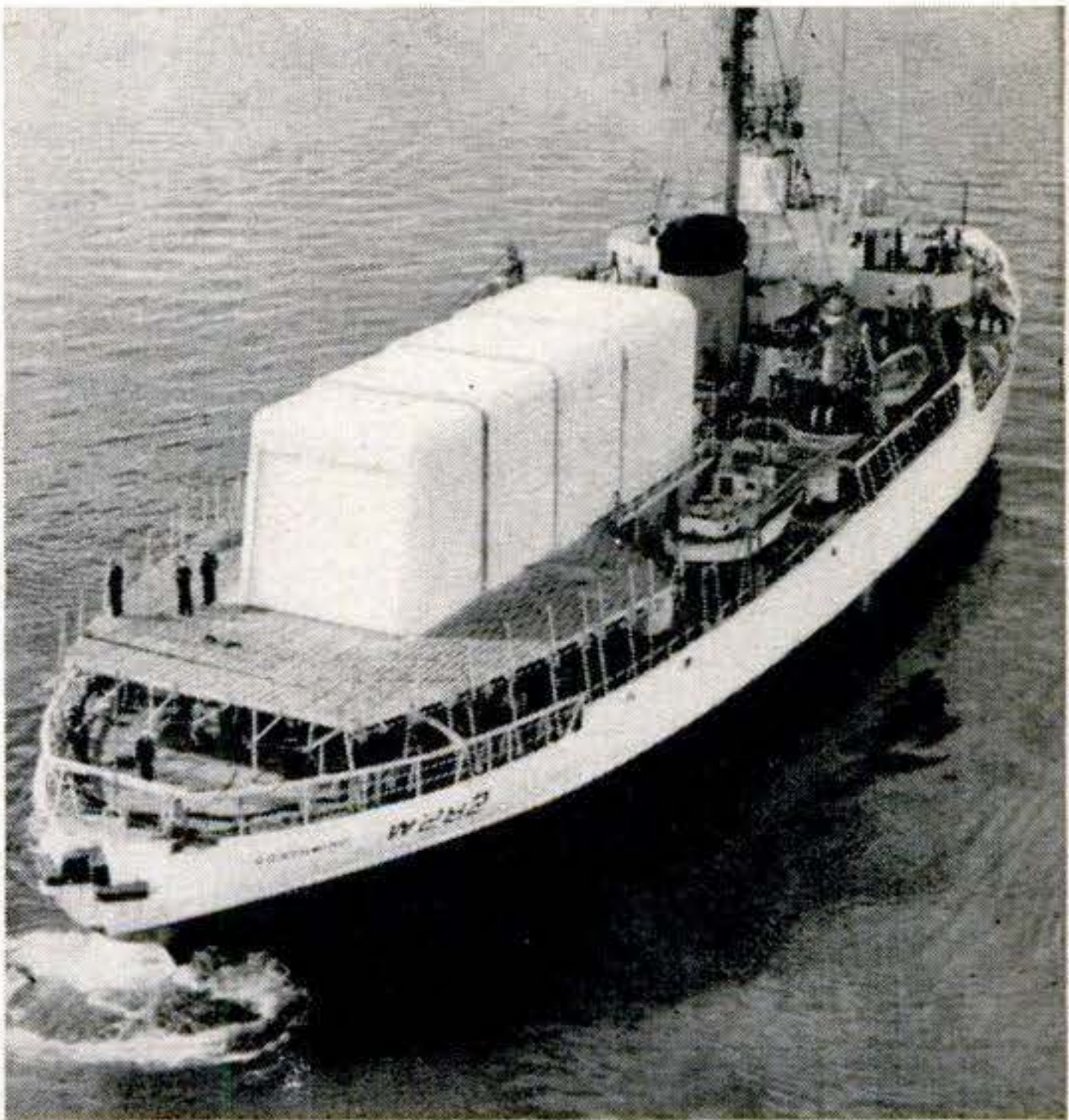
The redevelopment will contain theaters and auditoriums, an instrumentation center, a nuclear reactor, computer and data bank, and research facilities built on arches over service areas, highways, railroad

tracks, and parking space on the floor of the ravine—the equivalent of a 150-story building.

Oakland Corp., planning the project, is sponsored by the two colleges and other educational and cultural institutions.



Three sections roll into fourth on tracks in deck to let copter land, then back out to cover it.



Overhead door seals the extended unit. Like the sections, it is hydraulically operated.

Telescoping hangar keeps salt spray off ship-based helicopters

An aluminum hangar built in sections that roll into each other like a telescope is being tested aboard the U.S. Coast Guard icebreaker *Northwind*. Designed by the Canadian Navy, it's 70 feet long extended,

21 feet wide, 23 feet high, and will take two copters. Rolled back, it leaves 50 feet of deck space for landings. The hangar is expected to protect copters from corrosive salt spray and funnel gases.

▶▶▶ The car was wrapped around a tree. The girl was dead, and the driver was going to get the book thrown at him. He was driving without a license because he was 15 years old, too young to get a license in Massachusetts. The cops said he had lost control at 55 to 65 m.p.h., more than 20 over the limit. Manslaughter.

That's the story the cops had. It changed dramatically after a remarkable team of scientists and engineers arrived—the crash detectives from Harvard University. They unloaded their cameras,

ultraviolet lamps, tapes, and transit. They recorded and measured and sifted.

They followed wheel marks across the road, to a sideswipe with one tree, then smack into a second tree. Lethal, but routine—except for one short stretch. The trail of the left front wheel abruptly changed its direction for a bit. Why? Brakes okay: plenty of fluid, clear lines, sound linings. Exhaust system okay. But steering mechanism—definitely not okay.

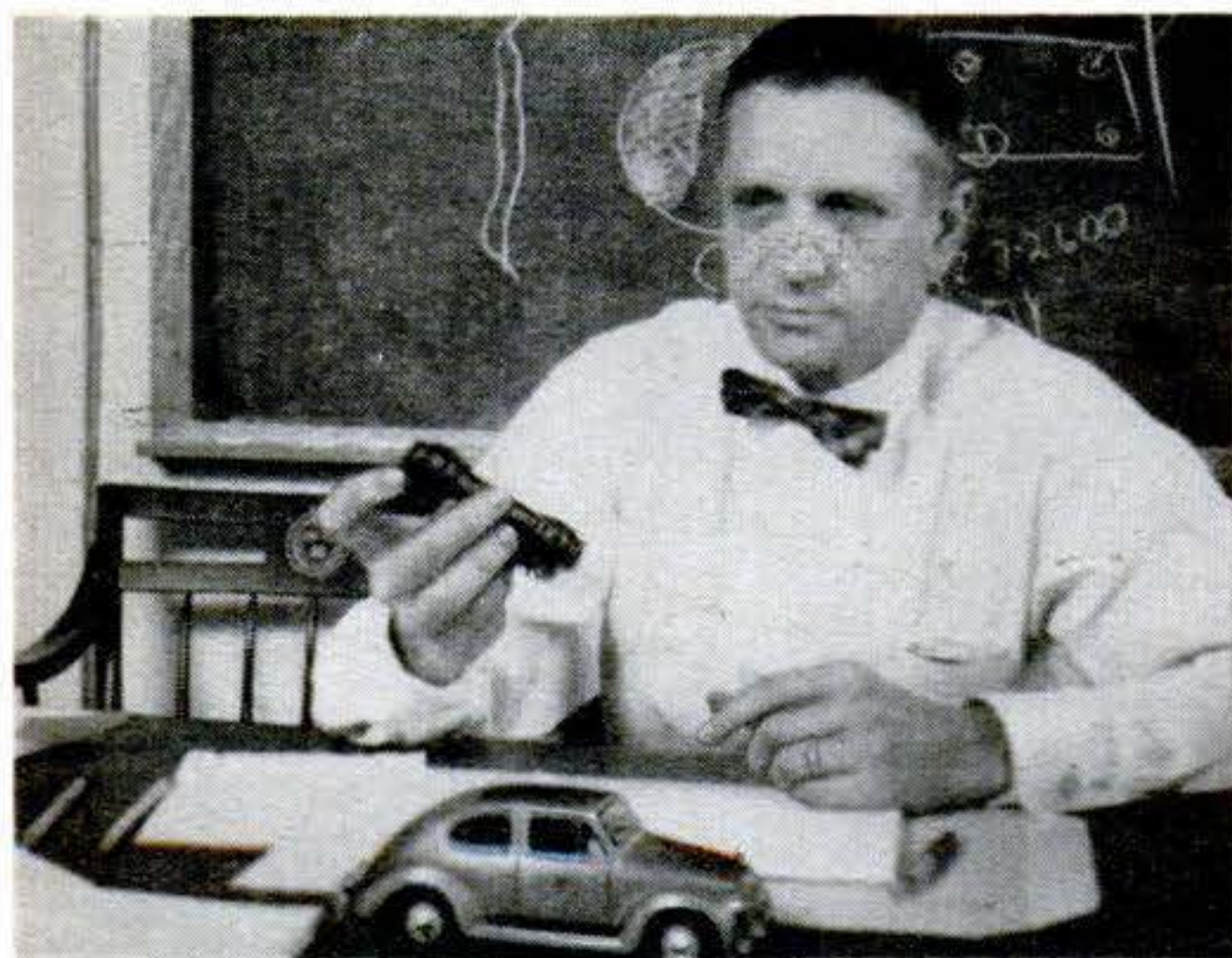
The power-steering unit was connected to the end of the tie rod through a short sleeve, threaded on the inside for a toe-in

THE TRUTH ABOUT

Are bad drivers, fatigue, drinking to blame for most fatal accidents? This exclusive PS report, based on a Harvard University study, presents some chilling new facts

By Martin Mann

READ the story at the top of these pages first. It is true. It is one of 124 crashes analyzed by the Harvard Fatal Highway Collisions project in the past five years. What these men discovered could save your life. For no one



Harvard crash detective Alfred L. Moseley.

has ever before studied real accidents with their skill and persistence. If the conclusions drawn from their mountain of evidence are correct, much of what you have been told about auto deaths is cockeyed.

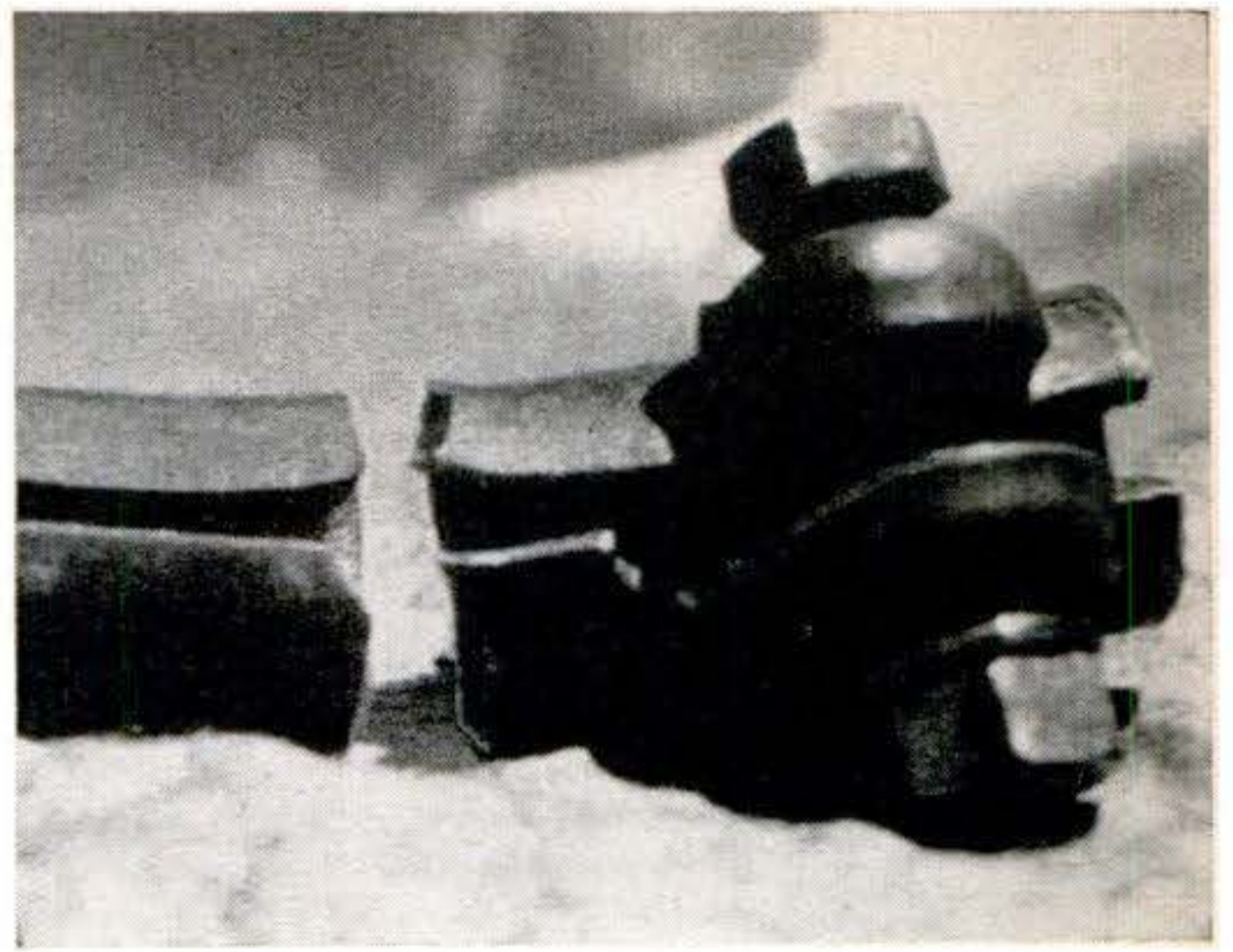
Item: The driver gets blamed for 9 out of 10 accidents; mechanical failure of the car is dismissed. The National Safety Council stopped reporting breakdown as an accident cause since it turned up so seldom in the official reports. Apparently the reason it was reported so seldom is that nobody looked very hard. The Harvard men looked. *Mechanical failure caused at least one-half the fatal accidents they studied.*

Item: You never see deliberate, intentional crashes listed in the safety statistics. Nobody thinks about it. The Harvard men did. *They consider more than 10*

and toe-out adjustment. It had rusted until it finally broke along a thread. It meant the boy couldn't steer. The left front wheel had been flopping around, unconnected to the steering control, when the car crashed.

Said one of the Harvard investigators later, "If the Governor of Massachusetts had been driving this car at this time, the failure of that component was ready to happen. It had nothing to do with the youthful driver."

The manslaughter charge was thrown out of court.



FATAL CAR CRASHES

percent of their cases "suspicious": murder, suicide, malicious attack-by-car.

Findings like these are so startlingly different they are hard to believe.

INTRIGUED by bits that leaked out in technical papers and Congressional testimony, the editors of POPULAR SCIENCE have kept after the full story for two years. We finally got it last summer: the true case histories from one of the most important studies of auto deaths ever made. These are for real; in each accident a human being died.

I rode out Boston's Huntington Avenue to a rundown old brick apartment house that quarters the Fatal Collisions project. In the fashion of 50 years ago, it had a name, "Elsie," chiseled over the door. Some of the apartments were still apartments; kids played in the hall. But three flights up No. 5 was fitted out with gray steel desks, IBM card-sorting machines, drafting tables, photo and lab equipment. Three twisted and crushed steering-wheel assemblies stood in the claw-footed tub in the bathroom.

In the crowded office I found the chief crash detective, Alfred L. Moseley, a tall,

sandy-haired Tennessean who wears wide bow ties. He thinks fast and talks fast, without inhibitions. A psychologist specializing in the relationship between men and machines, he had been investigating truck and bus accidents when he began to ponder fatal crashes.

"Everybody has always assumed that traffic-death cases are exactly the same as any other accidents except for the more severe forces involved," he told me. "But I didn't believe that. The fatals seemed to be a completely different breed. The more I looked—on my own time, this was—the more convinced I became."

MOSELEY'S ideas impressed the Public Health Service of the United States Government. In 1958 PHS granted him (by way of Harvard Medical School) \$890,000 for a five-year study of auto deaths. He enlisted a staff that grew to 18: an automotive engineer, a mechanic, a psychologist, draftsmen, other specialists. Using cajolery, pleading, and the prestige of Harvard and the federal government, he wangled police cooperation—sometimes grudging, sometimes enthusiastic. "The authorities phoned me immedi-

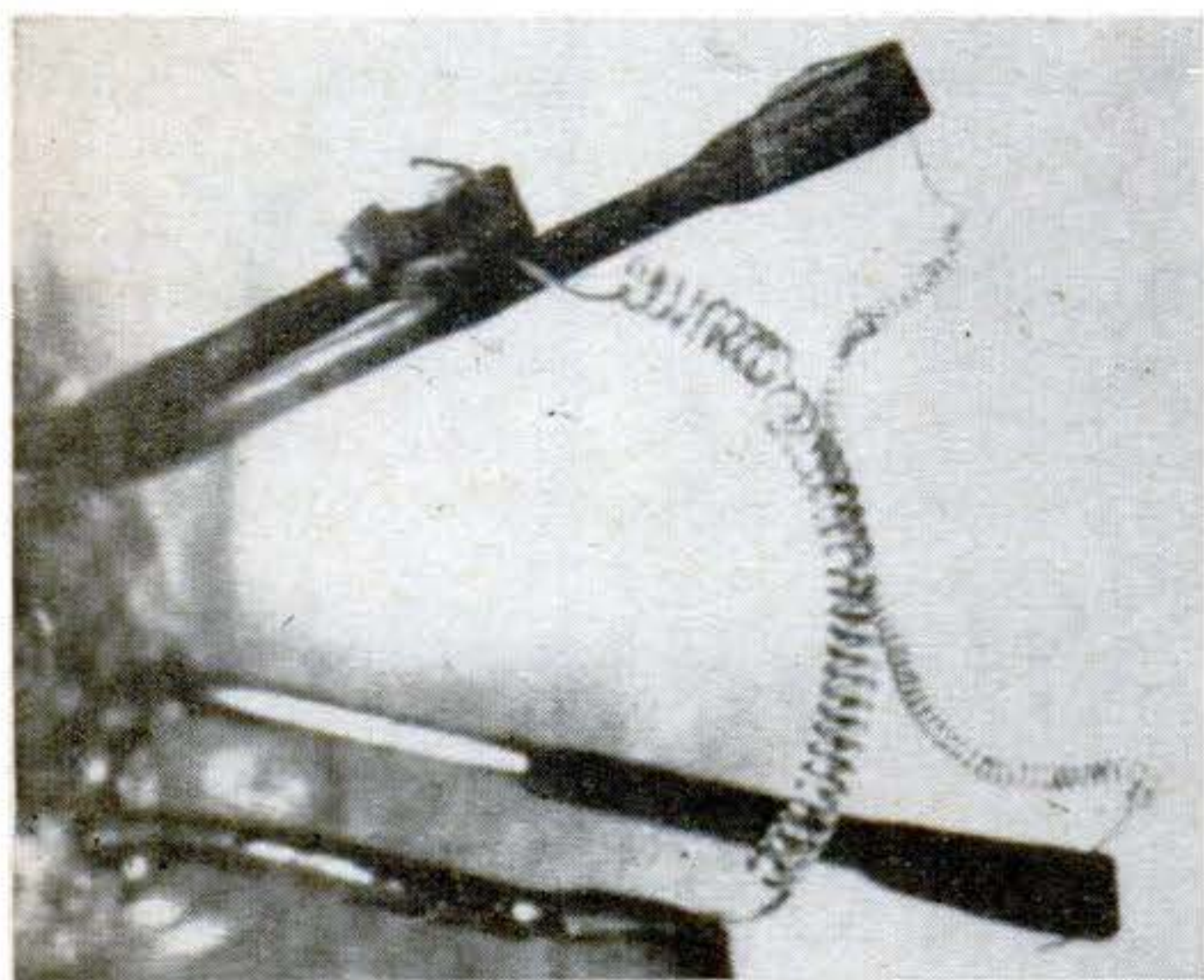
Pedal imprints on the sole of a dead driver's shoes

ately, at home or in the office, when anybody was killed on the road in the Boston area," Moseley explained. "I called one or two of the staff and they rounded up the others. If there was a faint prayer of getting to the scene before everything was hauled away, I took off."

Day or night the crash detectives converged on the accident sites in their personal cars. Each had a short-wave radio for communication with the office, and Moseley's beat-up wagon carried a state-police radio as well. They were loaded with gear: special tools for disassembling parts from wrecks, a breath analyzer to spot drunks, carbon monoxide detectors, movie and still cameras, a transit to measure grades and curves.

They quickly developed techniques for tracing the details of accidents. Like the fragments from smashed tail lights. If you can find the pieces you can follow the stages of a wreck. You take advantage of the fact that plastic lenses fluoresce brightly under ultraviolet light. With a black-light lamp you can pick out tiny bits on the ground.

Or the shape of stoplight filaments. If the brakes are on when a car hits, the



filaments should be lit, hot, and so pliable that the impact causes a distinctive bend. The same trick reveals if the headlamps were burning at the instant of the crash.

Even the soles of dead drivers' shoes

tell a story to those who know how to look. Many a dead man has been written off in the accident report with a "fell



asleep at the wheel." But if you find the pattern of the foot pedal imprinted into the leather of his shoe, you can be sure he was awake and standing on those brakes when he died.

OFTEN the most difficult task was convincing others that the meticulously collected evidence meant something. The researchers could point to a broken steering arm or a tire off its rim, only to get a shrug from the doubting Thomases. Who could tell whether the defect caused the accident or the accident caused the defect?

The Harvard men could tell in most cases. A blown tire, for instance, leaves a distinctive, wavy track: Parts of the tread pattern overlap other parts.

Broken mechanical parts are tougher to pin down. Old cracks—corroded, chipped—are a clue. The condition of nearby sections helps. If delicate splines were not bent by the shock of collision, a husky bolt could not have been snapped by it. Careful force analysis does the rest. By precise measurements of tracks, skid marks, and sheet-metal bending, the G forces in the crash can be estimated. Then you can run a test to see how much force is needed to break the suspected part. If it turns out that the crash was too gentle to cause the failure, the failure must have occurred before the crash.

Now you can see why mechanical breakdown and deliberate collisions have

reveal he was standing on his brakes when he died

until now been overlooked as accident causes. Accident statistics are based on police reports. Generally, cops have neither the time nor the training for such sophisticated scientific analysis.

Studying an accident in fine detail takes time. In one case, the Harvard crew spent 16 days analyzing the site of a wreck. Often, long hours of lab work would be needed to indict a broken part. Nearly a million dollars of tax money went to investigate 124 accidents. (That's barely one day's crop of highway deaths in the nation as a whole.)

THE most common single cause of the accidents we studied was the failure of some part of the car," Moseley says. "Sloppy maintenance was nearly always involved. Half-trained mechanics insist on patching tires that just can't be patched. They leave screws out. People save pennies on brake fluid. They don't look for pinches or cracks in hydraulic lines.

"You shouldn't lay the *whole* blame on the breakdown," he added. "An expert driver can stop without brakes, or stay on the road after a blowout. But the fact remains that the accident could not have occurred if the part did not fail."

Tires were the worst offenders, Moseley found, followed by brakes, steering mechanisms, and exhaust systems, in that order.

Number one killer: tires

What makes a tire blow?

- A cut or bruise eventually gives way.
- A repair plug pops out.
- The bead separates from the wheel rim.

When a tire blows in the wrong place at the wrong time for the wrong driver, he's had it.

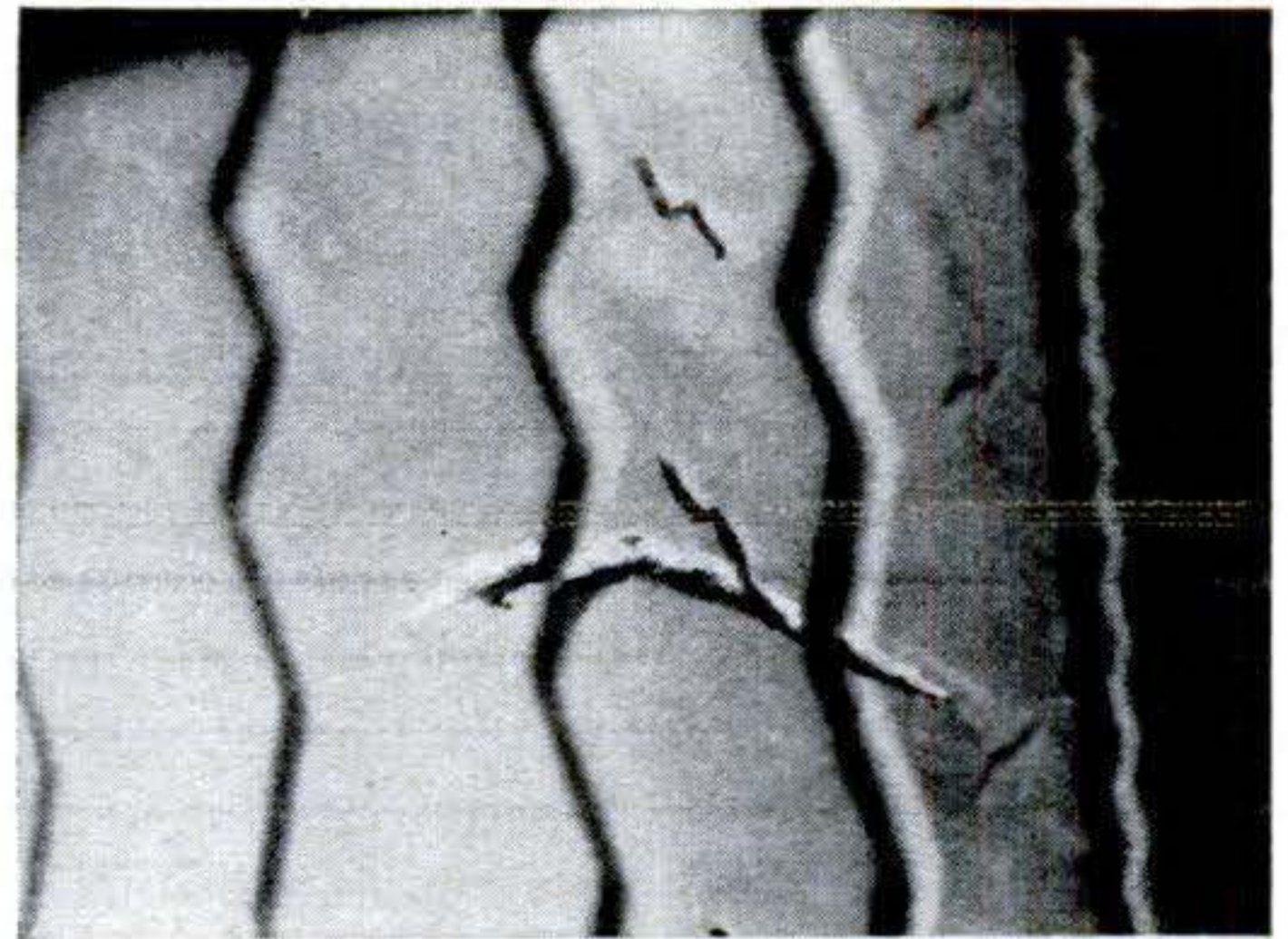
The saddest tire case was The Lady from Gloucester. She left Boston on a hot August afternoon and drove northeast on Route 128, the six-lane express

highway famous as the address of many electronics laboratories. She was in the fast lane when her right front tire blew. She lost control and veered to the right across the other two lanes onto the shoulder.

Now she got into real trouble. Frantically fighting the steering wheel, she twisted left. Her car shot back across the three northbound lanes, over the narrow divider, and in front of a southbound Ford hardtop.

Study of the wreckage showed that the guy in the Ford got his foot on the brake and tried to swing away. He didn't stand a chance. He ran into her broadside. And was hit by a third car from the rear. He got his steering post in his chest and died 29 days later, in the hospital.

The Lady from Gloucester and her



passenger were killed. Three dead. Why?

Because an unknown garageman had "repaired" a tire that should have been junked. It had a crescent-shaped cut in the middle of the tread. The inside of the casing had been smeared with some kind of gunk. To this day the Harvard chemists have been unable to figure out what was used. It does not match any commercial tire-repair compound.

The Case in the Parking Lot. This one proved that it doesn't take a traffic-loaded expressway to convert a blowout into tragedy.

One man was giving his friend a driving lesson. The left front tire blew and

Most common cause of accidents in the Harvard

they went into a tree, killing the owner of the car.

Again it was a tire that should have been junked. A hole in it had been stuffed with a plug—a standard and reasonably safe procedure. But this hole was so big that the repair plug had been bent over on itself to triple thickness to fill the space.

Mechanical failures

After tires, the killers are brakes (gummy fluid, leaky lines), steering mechanisms (broken connectors, defective hydraulic tubing), exhaust systems (burn holes in muffler or tailpipe, often at the bend over the rear axle). All of these troubles afflict nearly all cars at one time or another; none of them would cause an accident to a car that is properly cared for. But too many people—including so-called mechanics—either fail to look for trouble signs or else take a car out on the road despite obvious hints of failures-about-to-happen. Look at these capsule histories from the Harvard project's file:

The Case of the Erratic Brakes. A freshman from a New England college was driving a classmate's car on a weekend. He had been warned that the brakes were acting up. No trouble until he dozed off at the wheel. His passenger noticed the car drifting left toward the divider strip. He yelled. The driver came to, pumped the brakes, and twisted hard right. The front wheels grabbed. The car rolled. He flew out through the passenger-side door—and was killed.

The postmortem on the car revealed that the brakes had plenty of reason for acting up. The hydraulic line had rubbed against its support near the rear axle and had cracked. There was a big leak. But that's not all. The fluid was full of gummy crud. Sometimes the gum would plug up the leak and restore full braking power. Sometimes not.

The Case of the Gassed Driver. An-

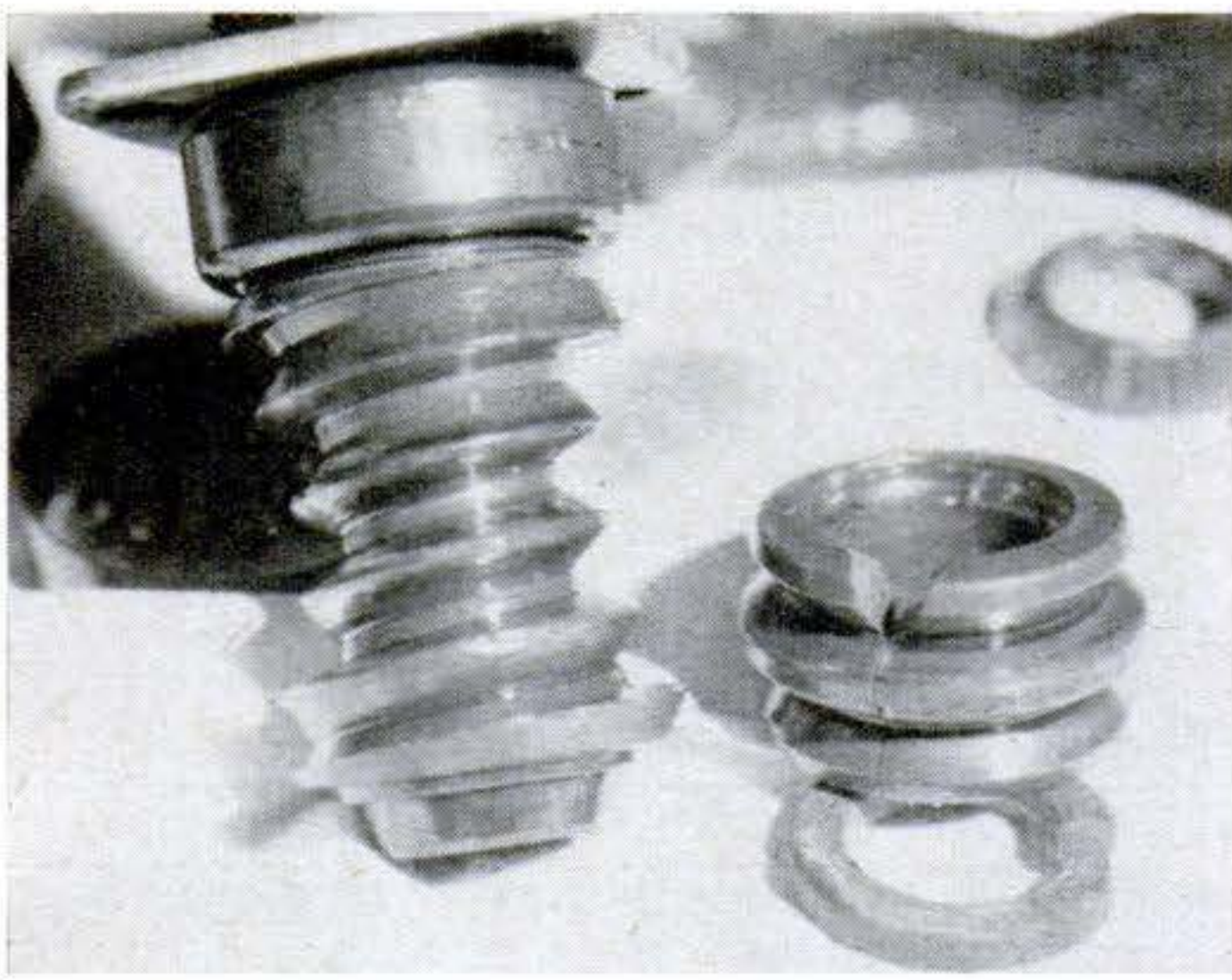
other student was wheeling his elderly car south from a college in northern New England. Outside Boston he ran over a policeman. Just like that. The cop was in the middle of the road, directing traffic at a dog-race track. It was night, but he wore wide crisscrossed straps of reflective Scotchlite. He should have been as visible as a lighthouse. Yet the young driver apparently did not see him.

Accidents like that are usually explained with a routine "asleep at the wheel." The Harvard researchers went to work.

Since the car was not damaged, Moseley himself tested it for carbon monoxide (which drastically cuts your ability to see at night). With a monoxide analyzer on the back seat, he retraced the exact route at the exact speed with the windows exactly as they had been. He reached the dog track at nightfall, as the student had done. And no wonder the driver had not seen that gleaming policeman. By that time the monoxide concentration in the car was double the danger level.

The Case of the Cracked Roller. A 47-year-old truckman was driving his station wagon off the Northshore Expressway, heading home on a winter evening. He didn't make it. His wagon went head-on into the signpost on the divider between the exit ramp and the expressway.

The trail was cold by the time the crash detectives got to the car (in a



study: car failure due to poor maintenance

junkyard). Even then it led straight to the steering mechanism. The steering wheel spun freely, without doing anything to the front wheels. When the assembly was pulled apart, two pieces of what had once been a roller gear fell out. This steering unit was a worm-and-roller type. Apparently the roller had been cracked for some time. At the fatal moment—just as the truckman started to turn into the exit ramp—it broke apart and fell out of mesh. This must have happened *before* the impact, because the collision forces had been too light to cause the break—the splines on the cross shaft weren't even jammed.

The truckman's death involved one mechanical failure that can't really be blamed on sloppy upkeep. You'd have to take things apart to inspect this kind of roller. So long as it was only cracked, the car steered normally. But when it broke in two . . .

Murder by car

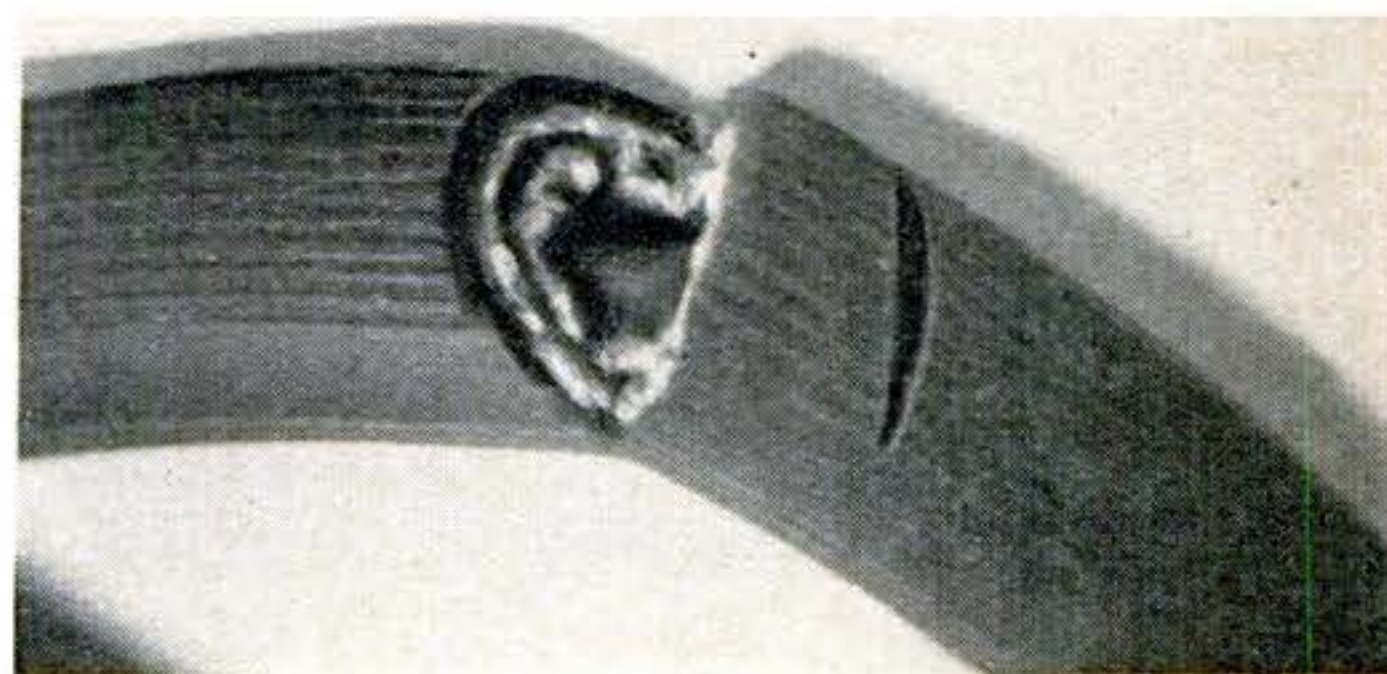
Moseley is convinced, personally, that a couple of his cases are murder—planned collisions that are intended to kill somebody and do. But, lacking courtroom evidence to back up such a charge, he will state officially only that they are “deliberate acts leading to collision deaths.” Legal technicalities aside, these real-life mysteries read like plots for “77 Sunset Strip.”

The Case of the Pickups. The scene is a tavern. Two unattached girls are sitting at the bar. In come two unattached young men. They strike up a conversation with the girls and all goes according to the script until two more men walk in. It turns out that the girls aren't really unattached. The late arrivals are their dates, claim them angrily, and stalk out.

A couple of lonely beers later, the frustrated adventurers also take off. They drive out of the parking lot, less than 100 feet down the highway, and start to pull around a car that had stopped in the

right-hand lane to let out a passenger. They hit its left rear, careen left to the wrong side of the highway, and run head on into an oncoming car. Both men are killed.

The first clue was a thin line of oily



fluid trailing back 36 feet. The garage-man who towed the wreck away smelled brake fluid. The Harvard investigators crawled under the car and found the left front brake hose slashed halfway through.

Brake pressure would pump fluid out into the street—and make the car pull unexpectedly to the right, just enough to set up the chain accident.

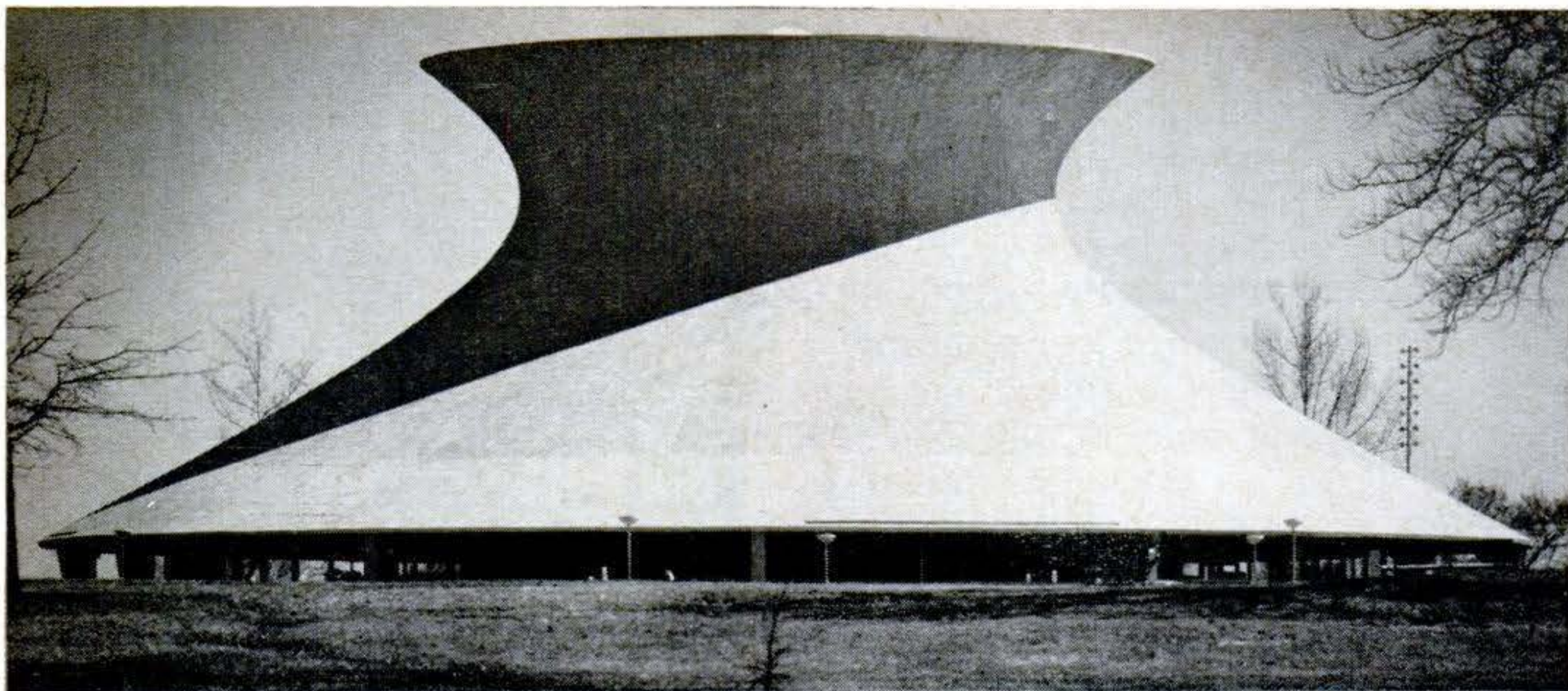
The cops and prosecuting attorney dismissed the cut hose as collision damage. Moseley disagrees. In his official report, he says:

“The nature of the cut was such as to indicate that it had been cut by a moderately sharp instrument in a sawing fashion. . . . There is no possibility that it could be collision damage.”

The Case of the Wrong Victim. One of the most sinister incidents concerned a man who was in trouble—mysterious, never explained—and felt certain that his own car was being rigged to kill him. He did not complain to the police, but he did arrange to let the Harvard team know, discreetly and indirectly.

The Harvard researchers were already in on the affair because the man's car had, indeed, just caused a death. With an 18-year-old at the wheel, it had side-swiped one car, swung over the divider strip, and run into another car coming toward it. Three passengers were thrown

[\[Continued on page 190\]](#)



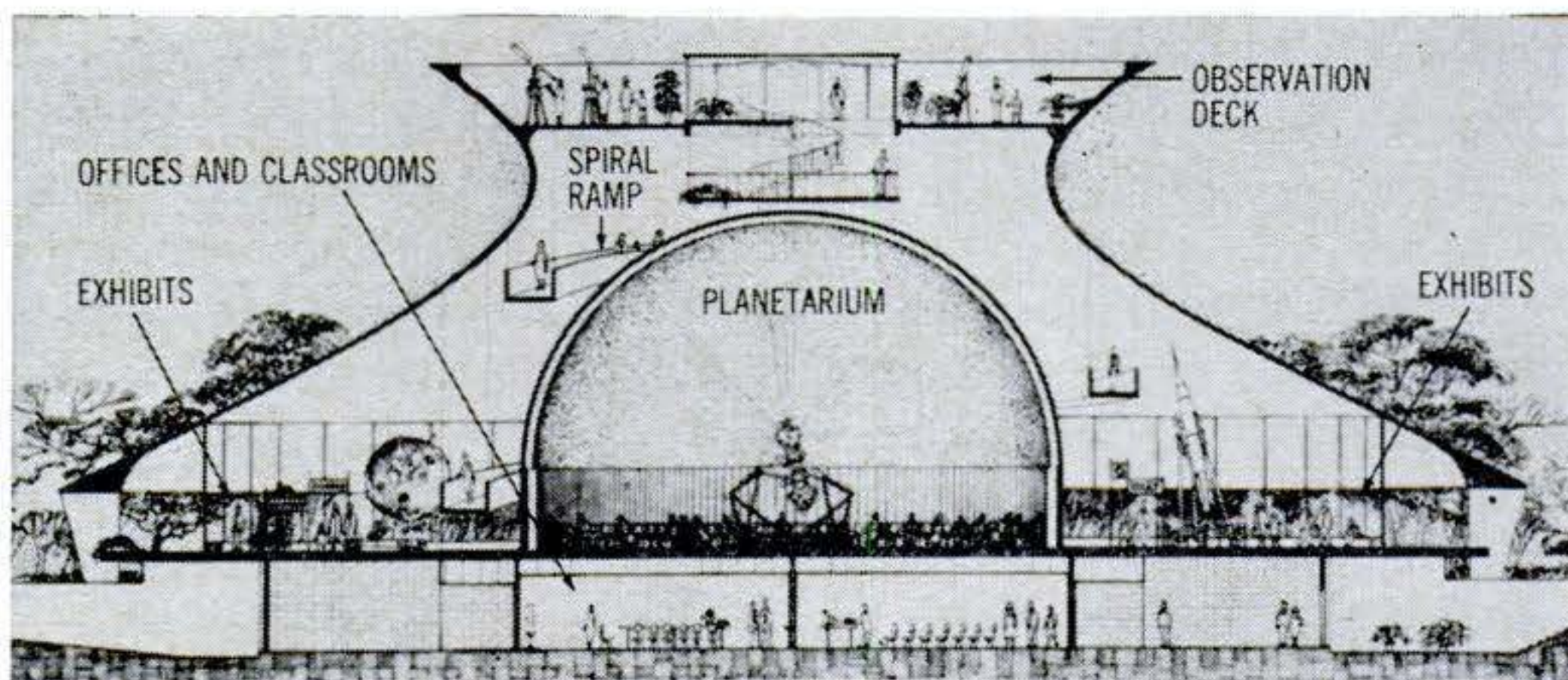
Flaring spool-shaped building houses St. Louis planetarium

Commissioned by St. Louis to plan a new planetarium for Forest Park totally unlike any other in the world, the architects came up with this spool-shape design. It's two buildings in one, with the curved shell enclosing a 450-seat conventional planetarium shell. Topping the spool is a circular observation deck shielded from glare by a seven-foot-high parapet and reached by a spiral ramp.

The thin concrete shell is 160 feet in diameter, has an average thickness of three inches. In addition to the planetarium it houses an

exhibit hall, workshops, class and conference rooms, offices, and storage space.

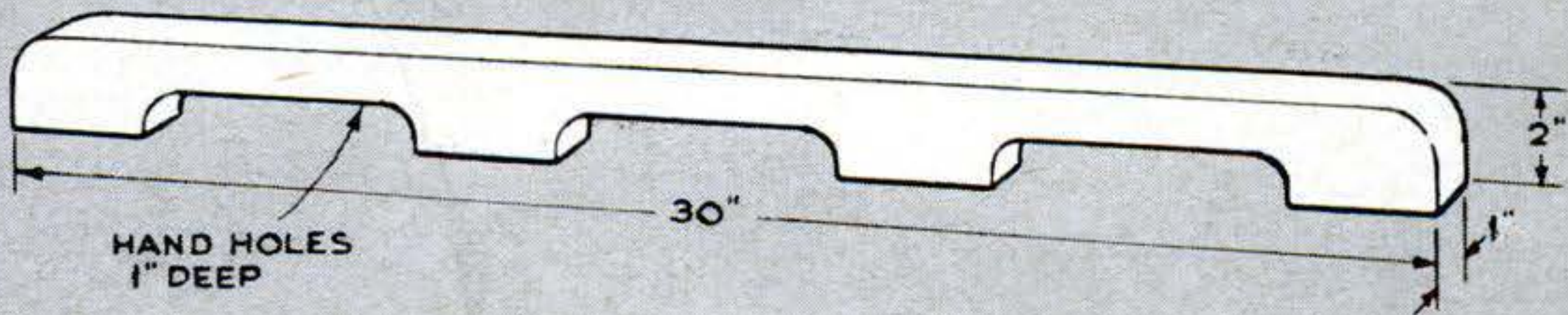
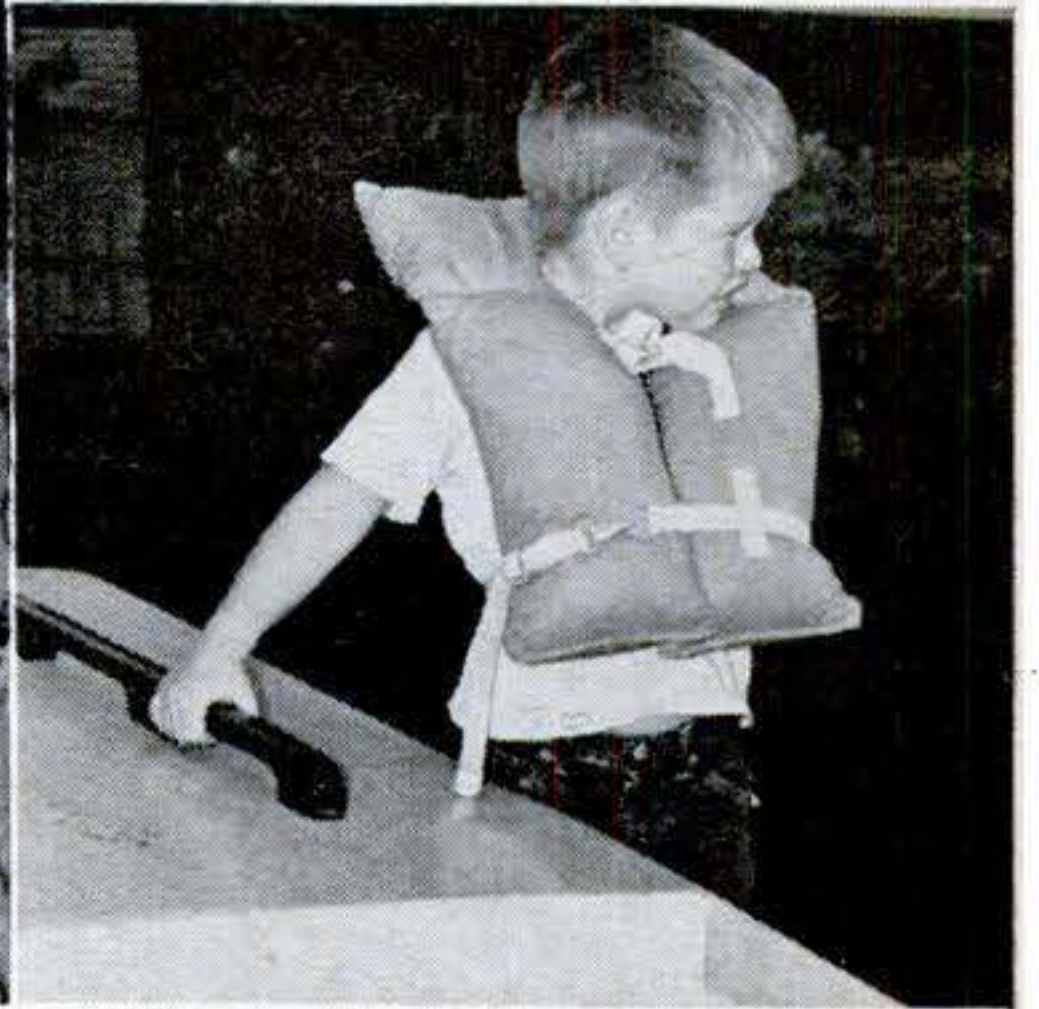
The design was created by Gyo Obata, of the St. Louis firm of Hellmuth, Obata & Kassabaum. The project cost \$1.2 million, including a \$176,000 Japanese projector.



Movie camera mounted on helmet

How do they take those movies of skiers winding down the slopes? Professional photographer Red Allin does it this way. He attaches his camera to his helmet (for a total weight of 18 pounds) and takes his pictures while skiing with his subjects.

He is shown at Mount Snow, Vt., while shooting a ski-safety film for Aetna Life Affiliates of Hartford, Conn.



Make your own boat handrails

Handrails are a necessary part of any cabin boat. Make them handsome as well as utilitarian by cutting your own from solid mahogany. Begin by measuring the area atop the cabin to determine the length of rail needed. Then cut and shape the rails, fill any cracks or cuts with a marine-type mahogany filler, sand, and finish.

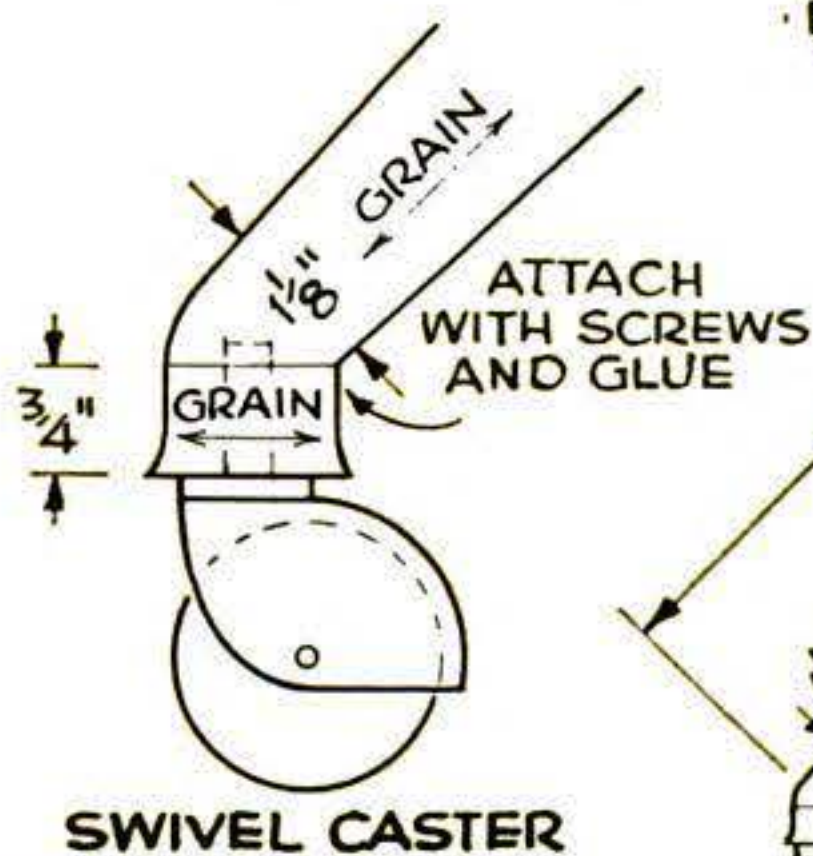
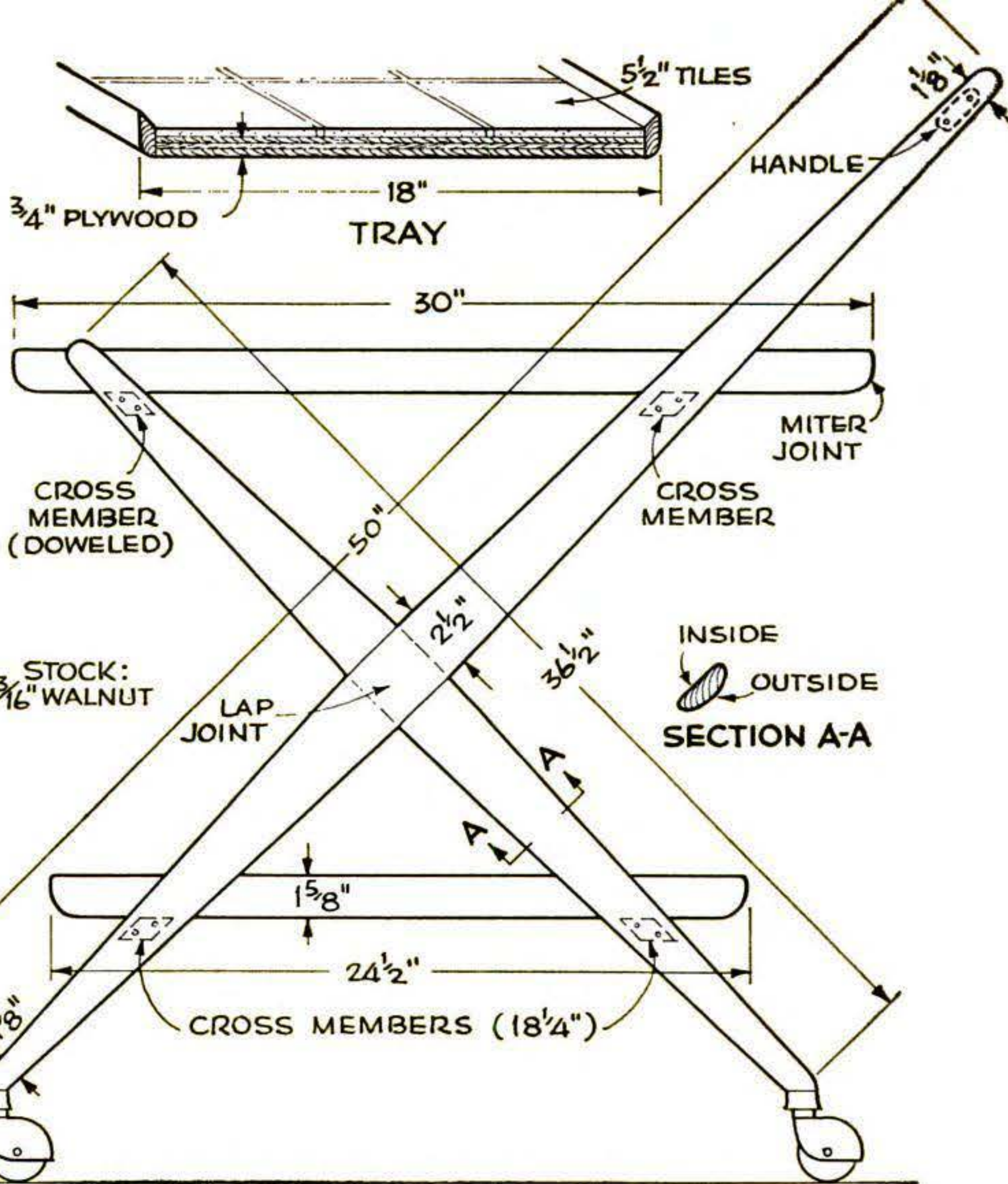
Before attaching the rails, apply elastic seam compound to the bottom for a water-tight fitting. Fasten them to the cabin within easy reaching distance from the deck. Use brass, bronze, or hot-dip galvanized bolts. Drill through the rails and cabin, and fasten nuts to the underside of the cabin roof. Countersink heads, and fill with mahogany scraps.—*Victor W. Kondra, Temple City, Calif.*

Darkroom duty for clothes dryer

When I complained that finding space for holding ferrotype tins until prints were dry posed a problem, my wife came up with a simple solution: She moved her kitchen clothes-drying rack into the darkroom. It works fine. When not in use, the rack is easy to collapse and store out of the way.—*Rudy Schulze, St. Louis.*



▶▶▶ Humidifying plates of the mineral type tend to clog up with deposited solids in areas where mineral content of the water is high. For my hot-air furnace I found cellulose sponges an excellent substitute; their capillary attraction produces a wet surface for evaporation. Use of the sponges is not recommended where air temperatures are likely to go over 180 degrees.—*C. W. Gaston, Alexandria, Va.*



SWIVEL CASTER

TEA CART

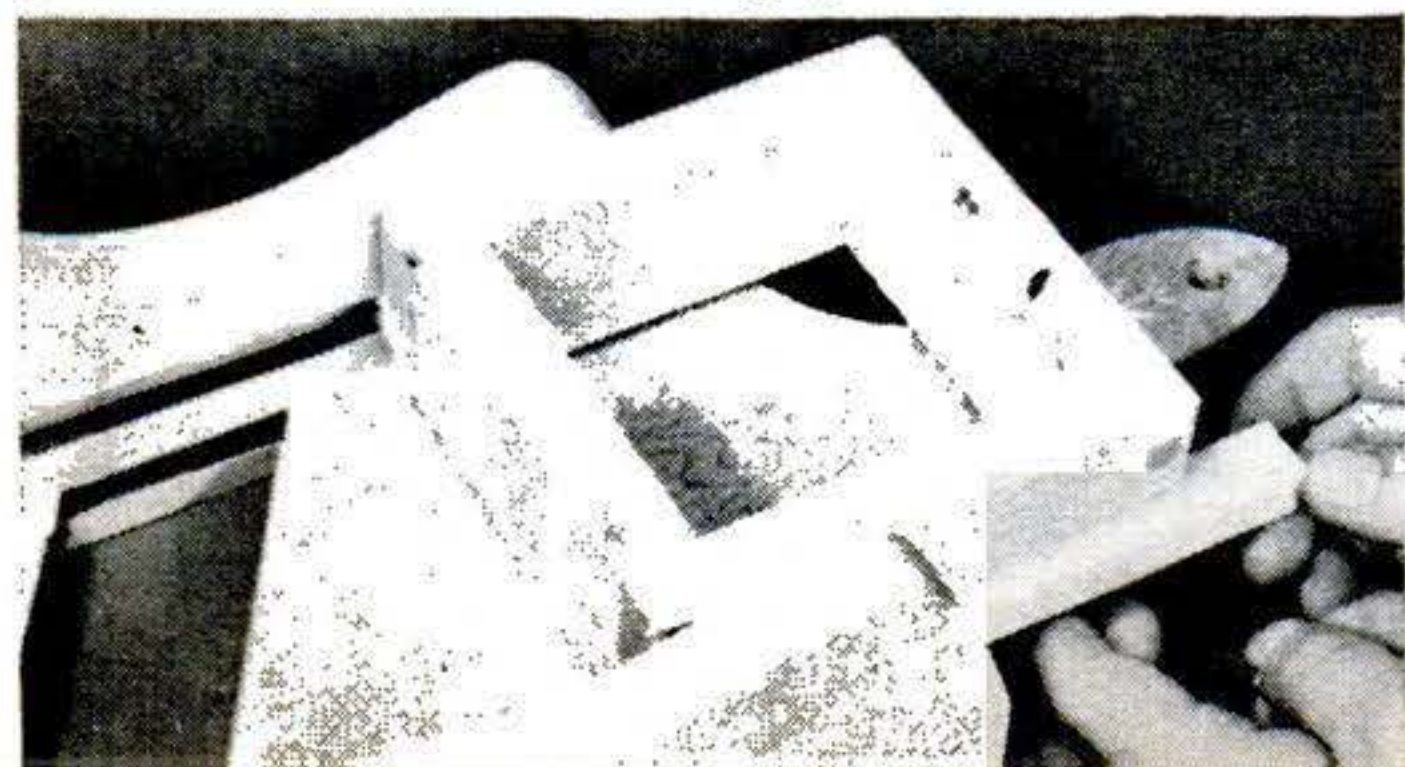
Two Homemades

FOOD SLICER

THERE'S a happy combination of the old and the new in this convenient household food slicer—Early American styling and Twentieth Century plastic guide blocks that make the slicer a breeze to use.

The plastic is Teflon, widely used in modern commercial bearings along with two other Du Pont products, Delrin and

Try Teflon slide bars for fit in grooves of slicer before assembly. Teflon is known as the slipperiest of modern bearing plastics.



nylon, and now available for home-shop projects. [See "How to Make Your Own Plastic Bearings," PS., Oct.]

All wood parts are cut from $\frac{3}{4}$ " maple. You need a piece $6\frac{1}{4}$ " by 20" for the base. After jigsawing the handle as shown on the diagram, cut $\frac{3}{8}$ "-by- $\frac{3}{8}$ " tongues on each edge, and saw the piece at 30 degrees so the two parts can be spaced to suit the stainless-steel cutter.

You'll note that $\frac{1}{2}$ "-wide grooves are needed for the Teflon sliders. Cement the two plastic bars into the sides of the food holder with epoxy. If you're unable to buy Teflon in your area, write to Cadillac Plastic Co., 15111 Second Ave., Detroit 3.

The slicer is used by placing vegetables, fruit, or blocks of meat or cheese in the slider box and holding down on the lid while you push the food against the up-raised cutter edge, cutting a slice at a time.—*Phil McCafferty.*

I DESIGNED and built this tea cart after my wife and I couldn't find one we wanted to buy. The dark walnut frame contrasts beautifully with the white of the figured ceramic tiles on the trays.

The dimensions suit tiles $5\frac{1}{2}$ " square. The upper tray, located at table height has 15 tiles, five lengthwise and three across. The bottom is one tile shorter.

The walnut is $\frac{1}{16}$ " in finished thickness. After the leg strips are cut to length, clamp each pair together and plane them down together so they'll match. Cut a lap joint and join the legs temporarily with two small brass screws placed on the inside surface. Shape the crosspieces to conform to the leg angle.

Lay a long straightedge across one set of legs and mark a line to indicate the horizontal position of each tray. Transfer the lines to the other set of legs.

Drill two dowel holes into the end of each crosspiece, using a doweling jig for accuracy. Transfer these to the legs with center points. Use spiral-groove dowels to avoid splitting. After a trial assembly, take the frame apart and finish planing and sanding the parts before final assembly with glue and clamps.

Lay out the tiles with space all around

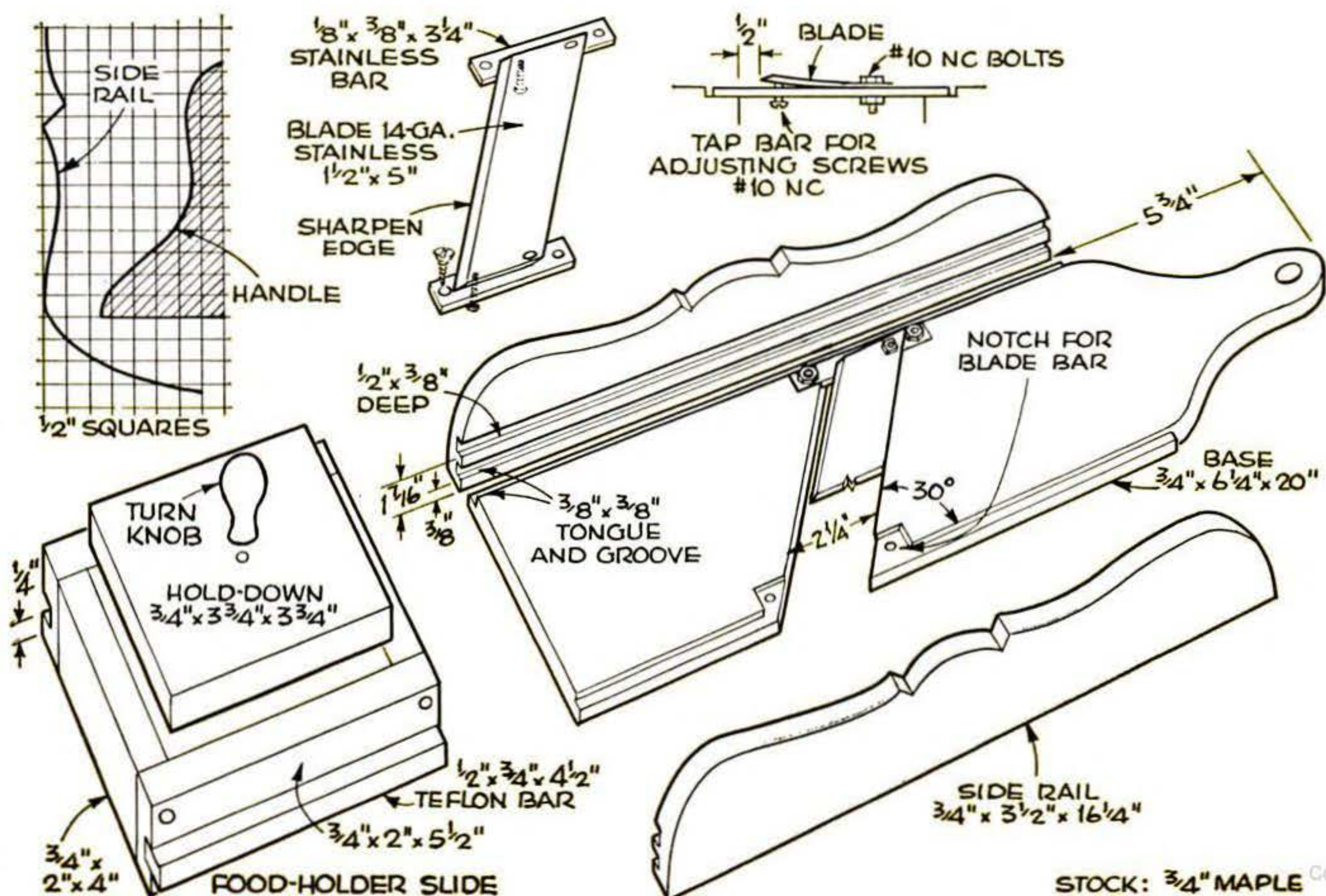


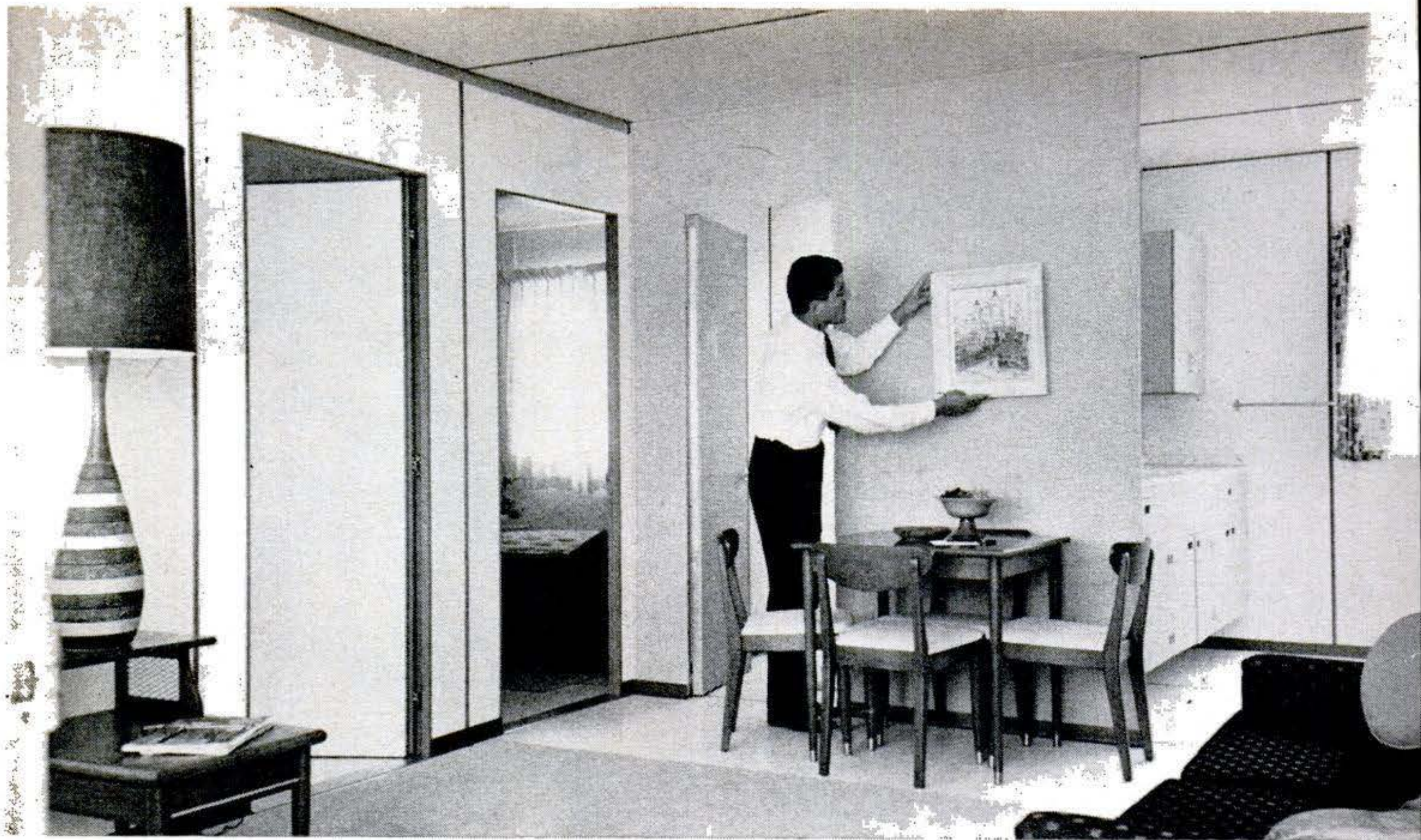
for grouting. Cement the tiles to the base, apply the edging to the trays, and grout the tiles. Lacquer the grout when dry.

Sand the wood and apply a rubbed oil finish.—Stanley Kallenbach, NYC.

PS PROJECTS

for Your House





A House You'll Build from

In two days, four men without construction knowledge can turn four packing crates into a modern house

By Bob Smallman

HOW would you like to build a full-size two-bedroom house using only a hammer and a small wrench? Suppose, what's more, you could assemble it over a weekend with the help of three friends?

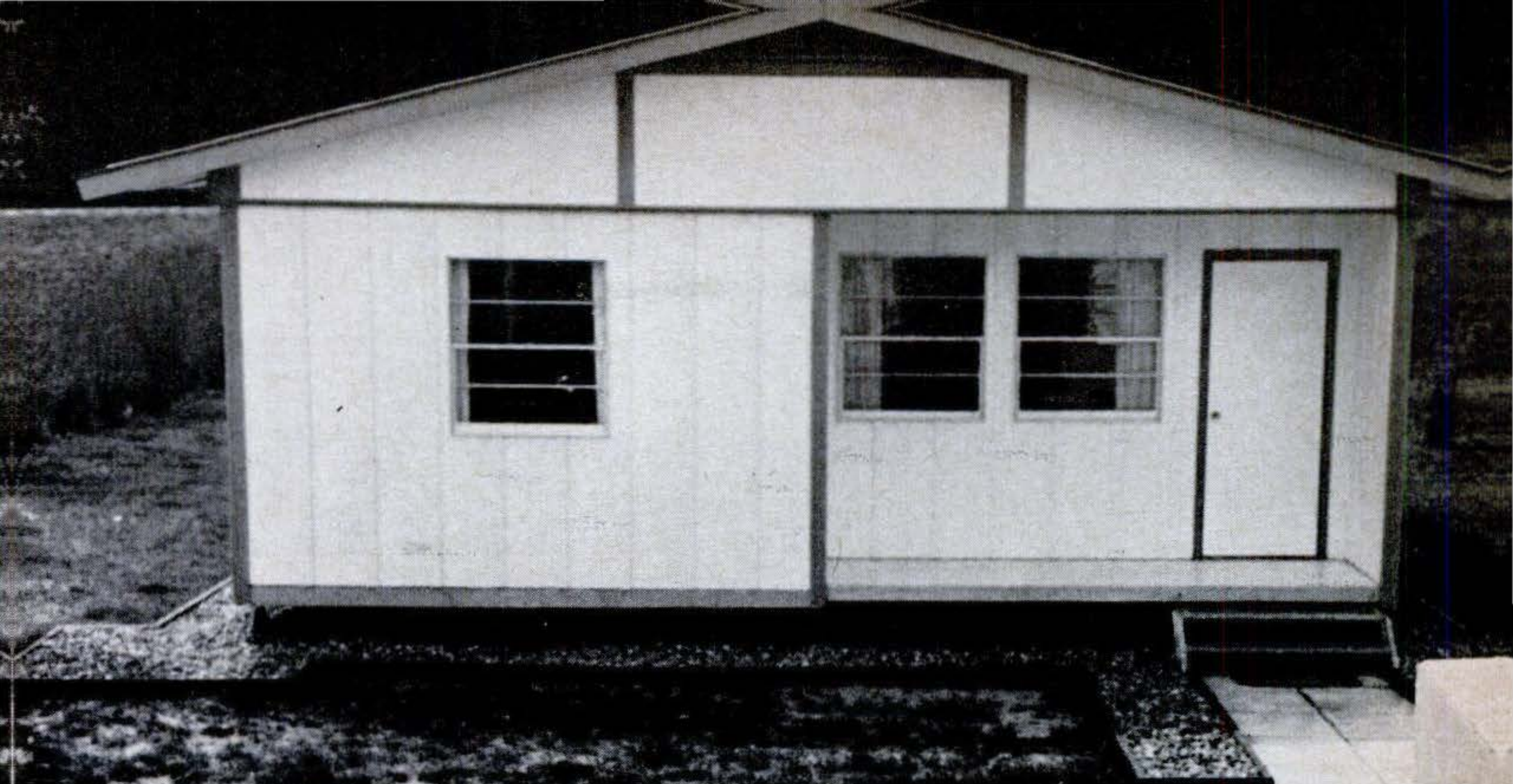
All this is possible, although not immediately available, through a versatile new construction system pioneered by Monsanto Chemical Co. The process allows unskilled workers to erect houses, barracks, offices, or motel units as easily as putting together a child's Erector set. Once up, these sturdy buildings are hurricane-proof and maintenance-free, but can be taken apart as quickly as they went together, shipped in compact boxes, and reassembled on another site.

Loc-Pac, as the system is called, owes its simplicity to modular design and com-

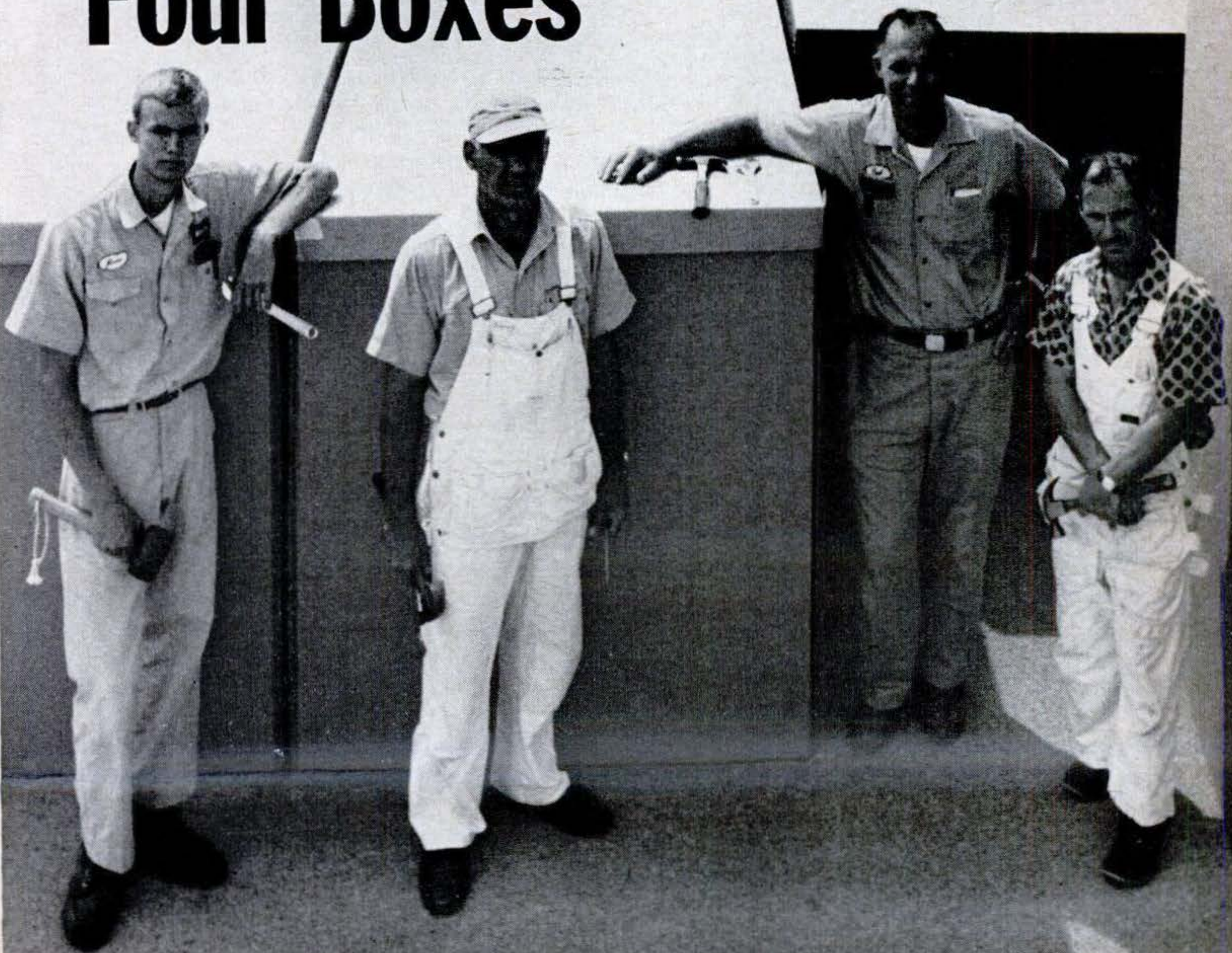
pletely load-bearing walls, eliminating need for a frame. If the idea of a frameless building seems a little shaky, its materials don't lend much reassurance—they consist of plastics, air, Kraft paper, and quarter-inch plywood! But have faith; the building pictured has been tested in 80 mile-an-hour winds (set up on jacks, at that), and a dozen Loc-Pac motel units on Chub Cay in the Bahamas have withstood tropical storms for over a year now without leaking.

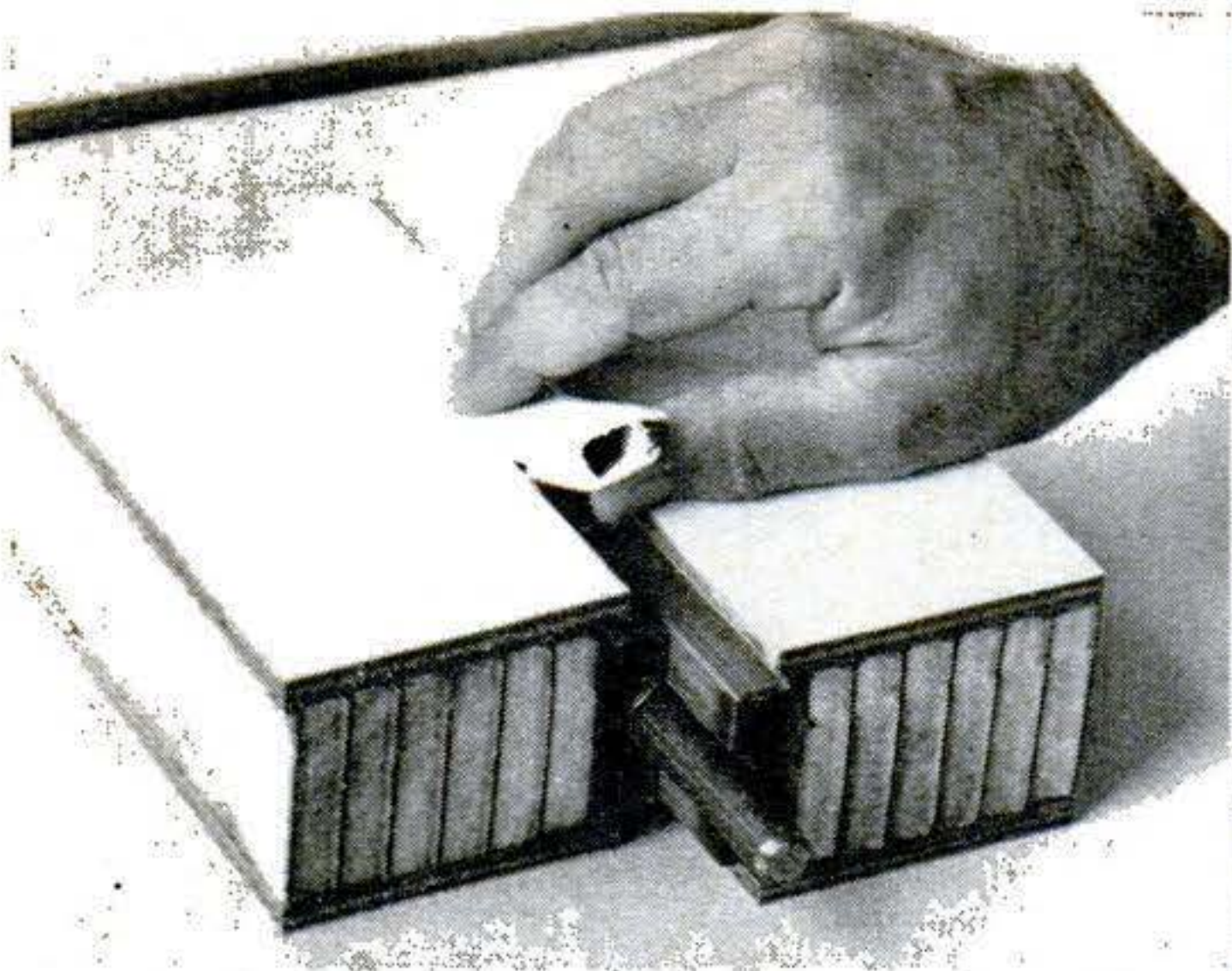
The lightweight materials are combined in 4'-by-8' wall panels as follows: a 2"-thick core is built up of narrow strips of foam polystyrene bonded to tough Kraft paper, the strips glued together with a formaldehyde-base adhesive (as used in exterior-grade plywood). The foam provides insulation and compacting strength, with the paper and glue giving rigidity and shear strength.

This core is sandwiched between two

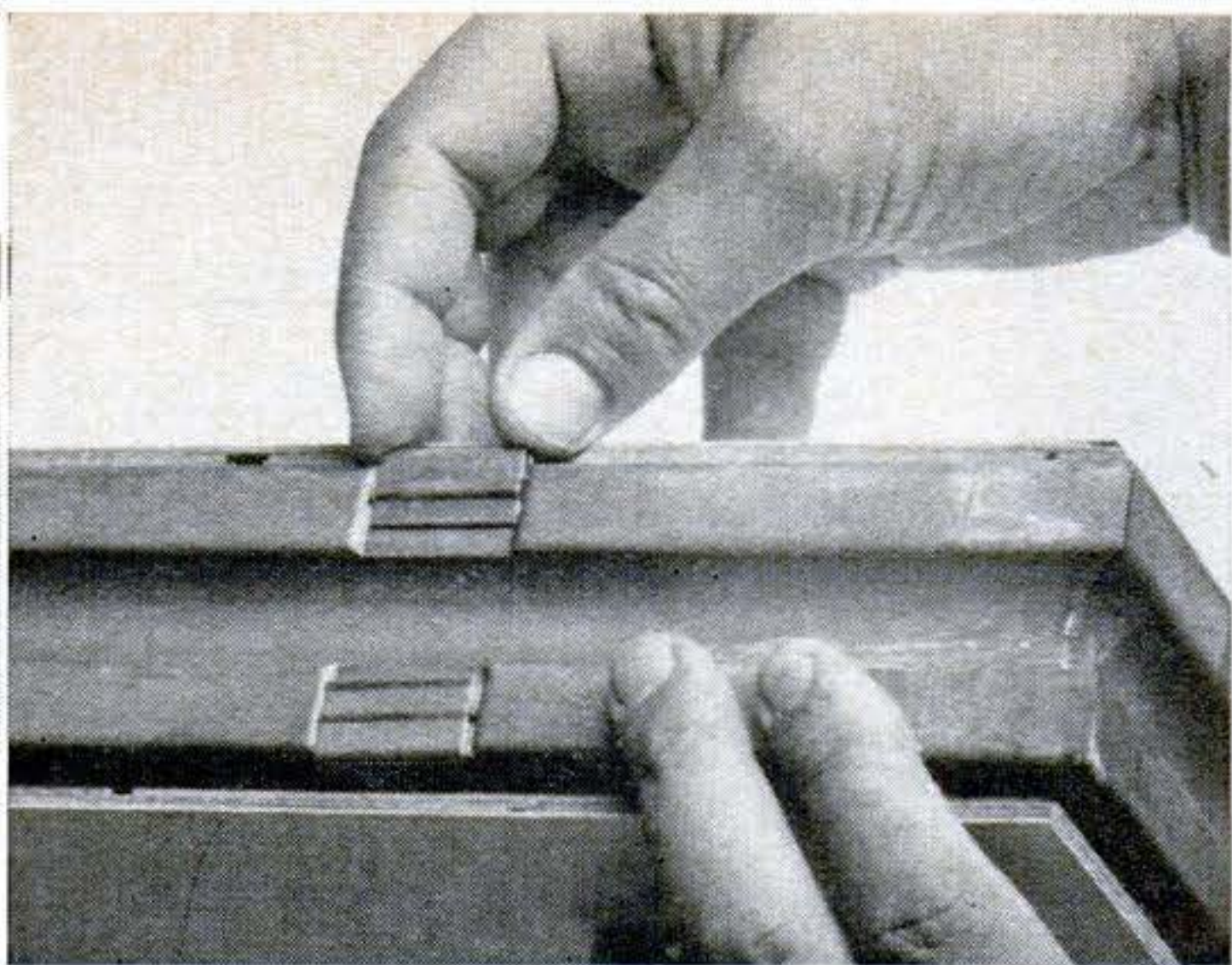


Four Boxes





Panel core, built up of strips of $\frac{1}{2}$ " polystyrene foam bonded to heavy Kraft paper, is sandwiched between sheets of vinyl-faced plywood. Flexible vinyl gasket gives a watertight seal.



Metal panel edging is notched to receive staple-like clips that snap panels together. Edge trim has groove for steel rod running between panels (visible in photo at left above).



Compact utility core packs all plumbing in a cabinet 3' wide and 1' deep. All kitchen and bathroom cabinets fold flat, so they can be easily collapsed and reerected on a new site. A structural wall of Loc-Pac panels through center of the house supports the roof panels.

sheets of plywood, the outer sides of which are sheathed in tough vinyl. No other finish is needed outside or in. Edges are finished off with a grooved metal strip containing slots through which the panels are stapled together, and flexible vinyl gaskets snap in place between panels to waterproof the joints. Wall panels are available either solid or with inset doors or windows, enabling the builder to spot these openings anywhere on a 4' module. Interior load-bearing walls use the same panels, same finish.

Interchangeable floor and roof panels have a similar cross section but are an inch thicker than the wall panels and measure 4'-by-12'. Their short ends are supported by aluminum girders running along top and bottom of the wall panels. Half-inch steel rods in grooves between all panels are bolted to the girders, holding the whole structure together.

All plumbing for the bathroom and kitchen fits into one cabinet a yard wide and a foot deep. Cabinets for both of these rooms are designed to fold flat, for easy shipping, and to make future disassembly and reassembly simple.

Since this unique system violates most building codes, Loc-Pac's most immediate use will be in isolated areas or abroad: at big construction sites (where buildings can later be demounted and moved), military bases, or as vacation homes. Price will run about \$10 a square foot, exclusive of lot and foundation. For a temporary installation the structure can be set on jacks. The two-bedroom house pictured, measuring 24' by 28', would run \$6,720. ■ ■

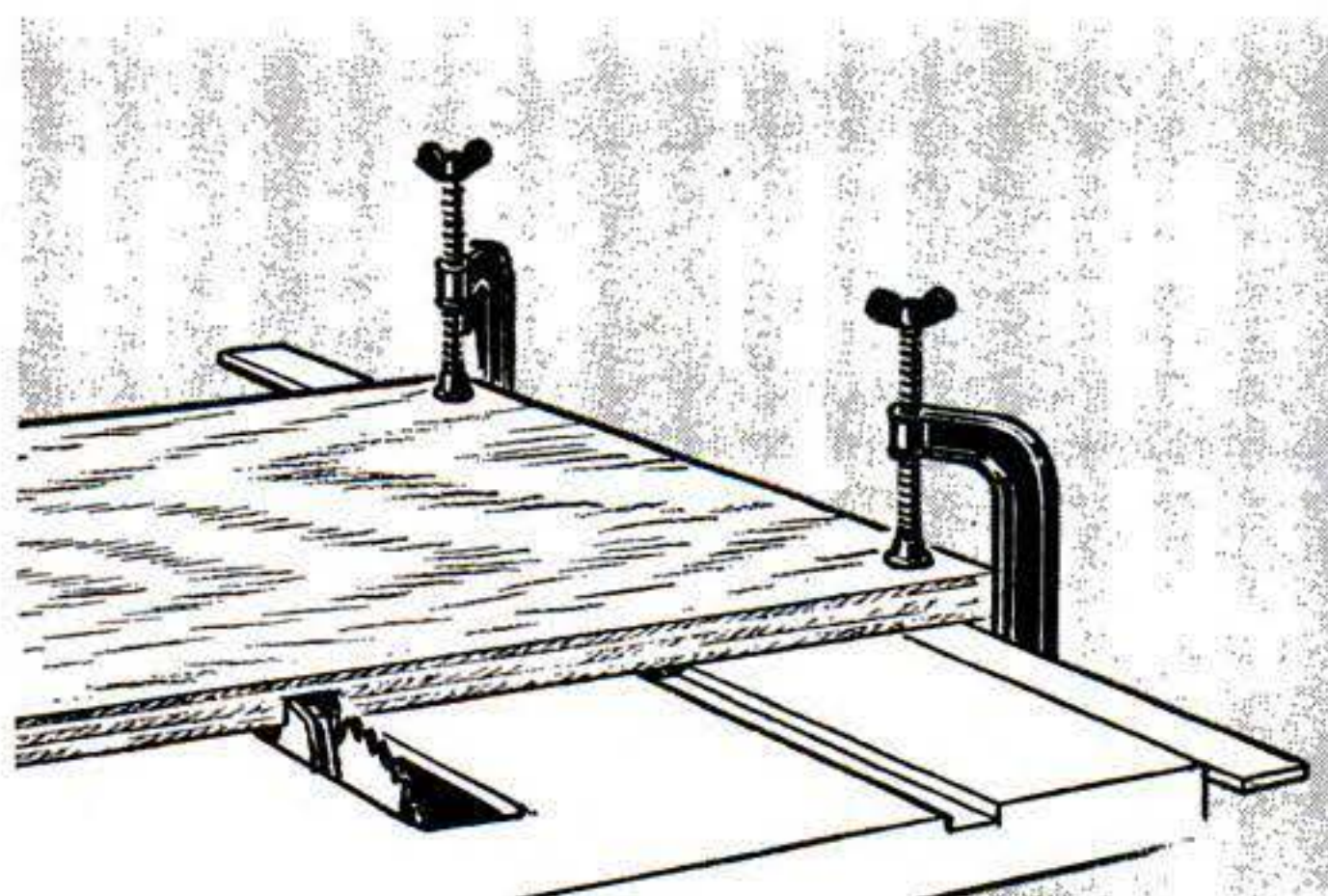
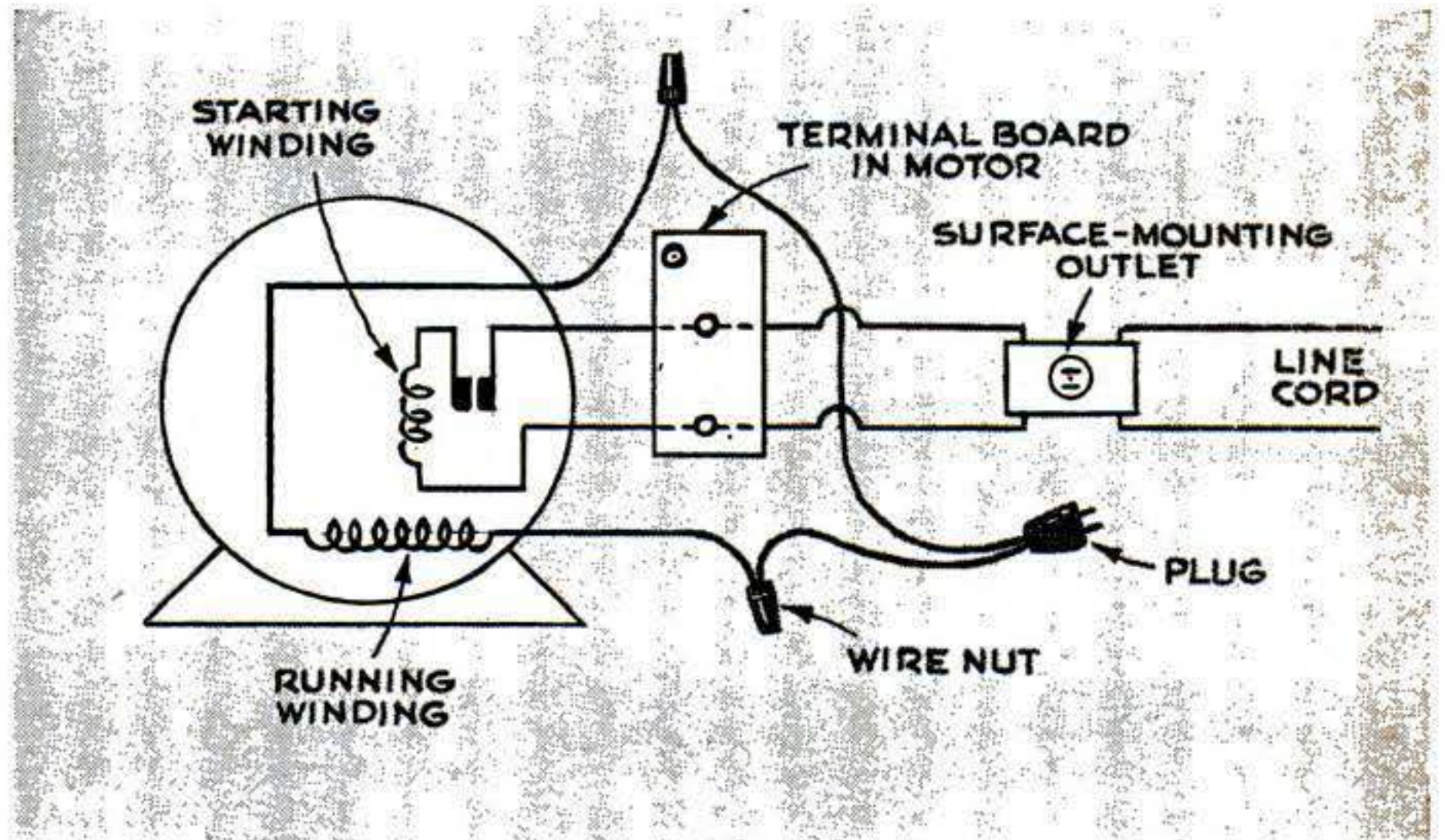


Garden sprayer dresses blacktop

The last time I applied dressing to our blacktop driveway, I used a compressed-air garden sprayer instead of a brush. It worked fine. The job went faster and I was able to get the protective coating on more evenly. The tar emulsion comes in five-gallon cans. I simply thinned it to spraying consistency with turpentine, on a hot day, and applied two coats, letting the first dry well. The sprayer must be cleaned thoroughly, and promptly, after use.—*Maurice Peacock, King of Prussia, Pa.*

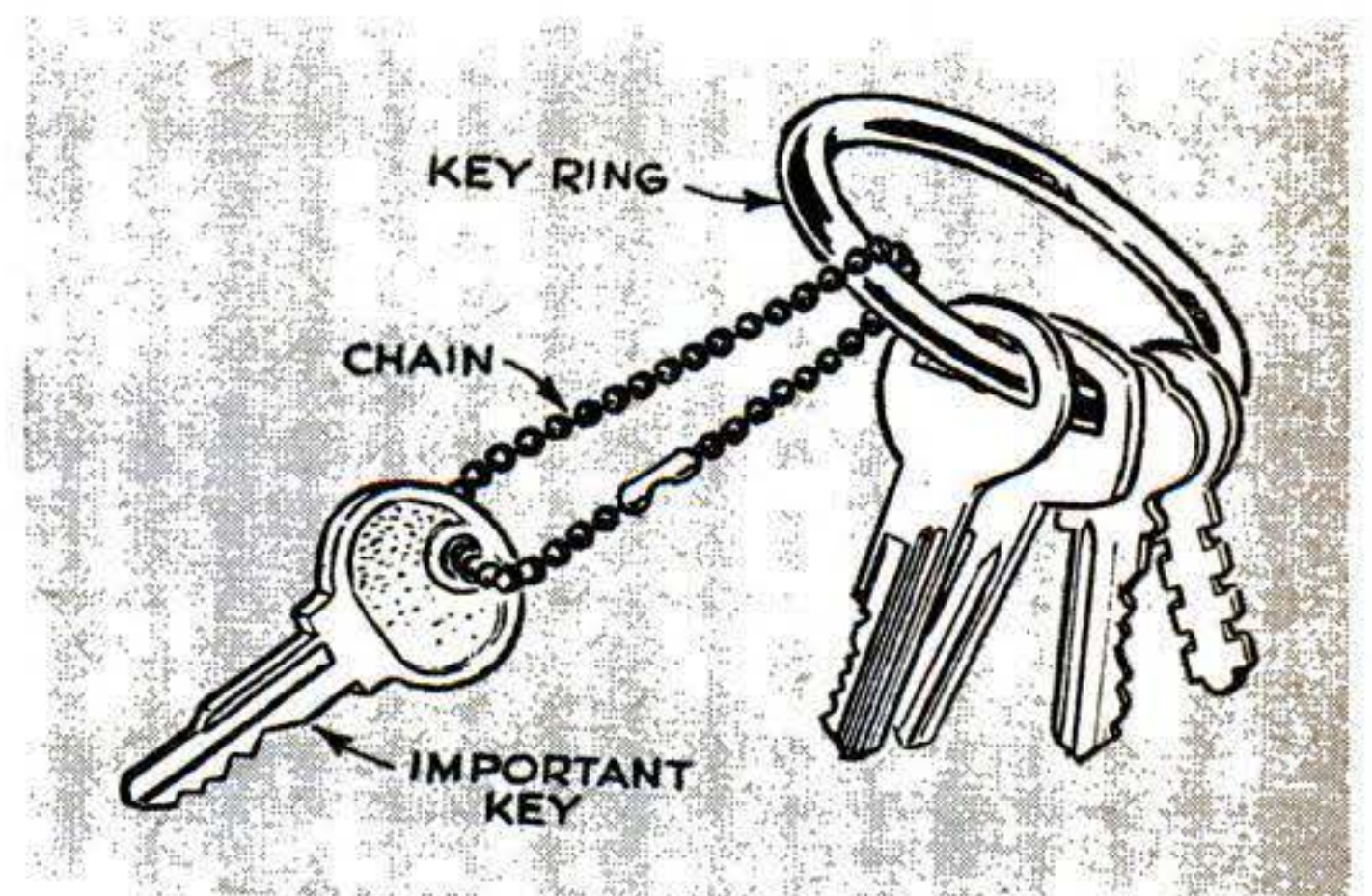
How to reverse a motor without a switch

Here's a low-cost way to reverse a split-phase or capacitor-start motor. Connect a standard AC outlet across the line to the motor, as shown. Splice heavy-duty cord to the two motor-terminal board leads. Attach the plug. Stop the motor; then reverse it by pulling, turning, and reinserting the plug.—*R. W. Grissom Sr., Savannah, Ga.*



Clamped strip is a good dado guide

How do you cut a dado in a panel of wood too large for the capacity of a circular-saw miter guide and fence? I solved the problem by clamping a straightedge under the panel and letting it slide along the table.—*E. C. Wade, Huntington, W.Va.*



Picking out the right key

Over the years, this little idea has saved me lots of time. My key ring contains many keys, but the one I use most often is easy to select without delay because I keep it on a short chain attached to the ring.—*Bob Munstedt, Needham, Mass.*

It's like gaining an extra muscle when you install one of the **New Systems to Steer Your Boat**

By Jim Roe and George Daniels

STEERING a boat has become more and more of a job as outboard motors have gotten larger. Mount a pair of 75-hp. motors aft and you swing better than 500 pounds every time you touch the wheel. So you need help. You get it from one of the new steering systems. They give you a definite mechanical advantage and all are much neater than the old pulleys and cables.

Like many other boatmen, one of the authors (Roe) switched to a mechanical system—a Teleflex—for his 22-foot Thompson cruiser, Roeboat. He's noticed a big change for the better.

What are the main advantages offered?

- Minimum steering lag. The motor begins to turn when the wheel begins to turn. You don't wait until slack has been taken up in loose cables.

- Maximum toughness. The mechanical strain is inside the unit itself (which is engineered to take it) and on a very few rugged pivot points. In contrast, any screw on any pulley of the old systems could pull out, knocking out the system.

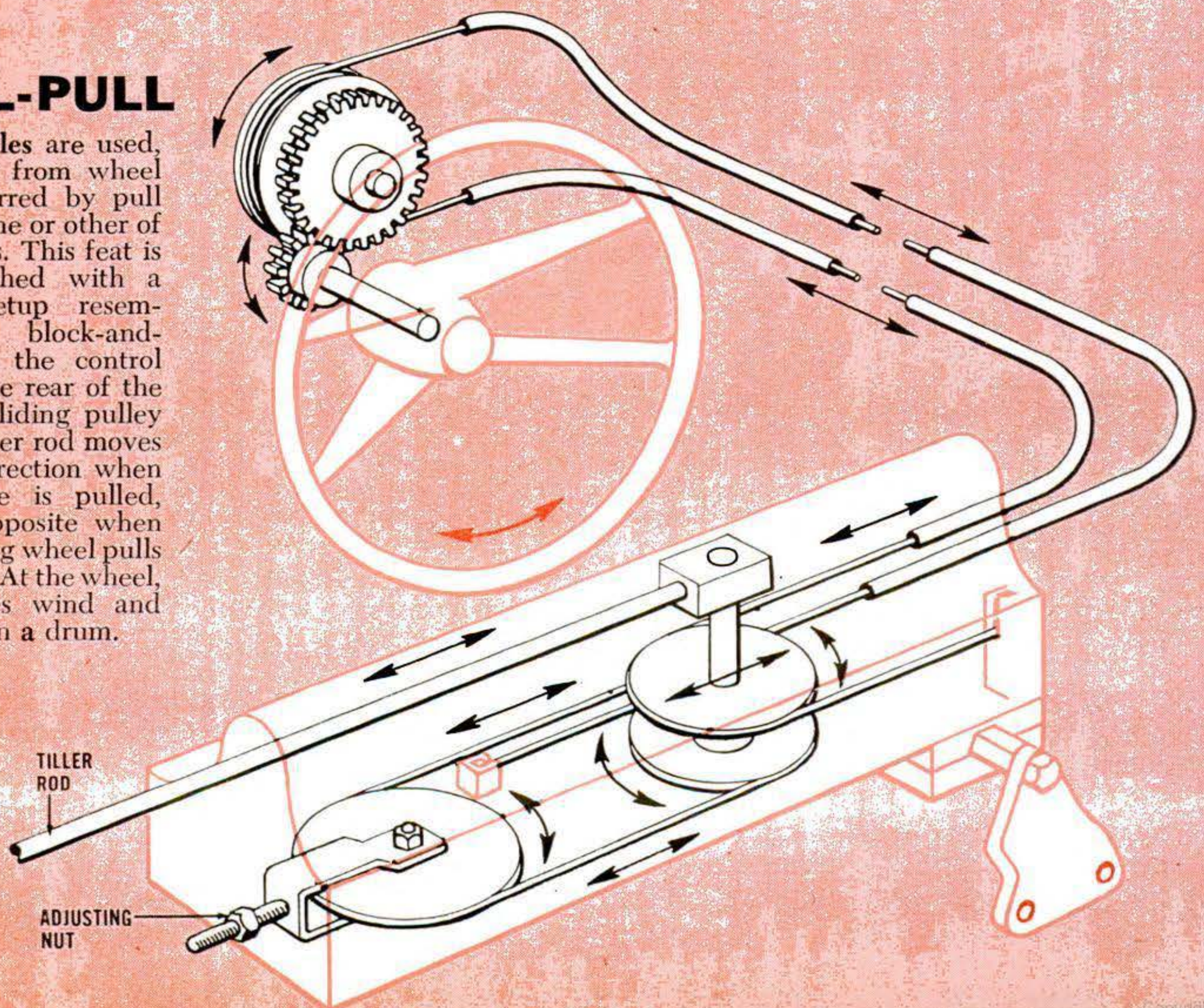
- Mechanical smoothness. In most cases you get rid of pulley creaks and groans. Some new systems have a push-pull cable, some have a pull-pull, some are hydraulic.

- Easier steering. The "feel" approaches what you get with power steering in a car.

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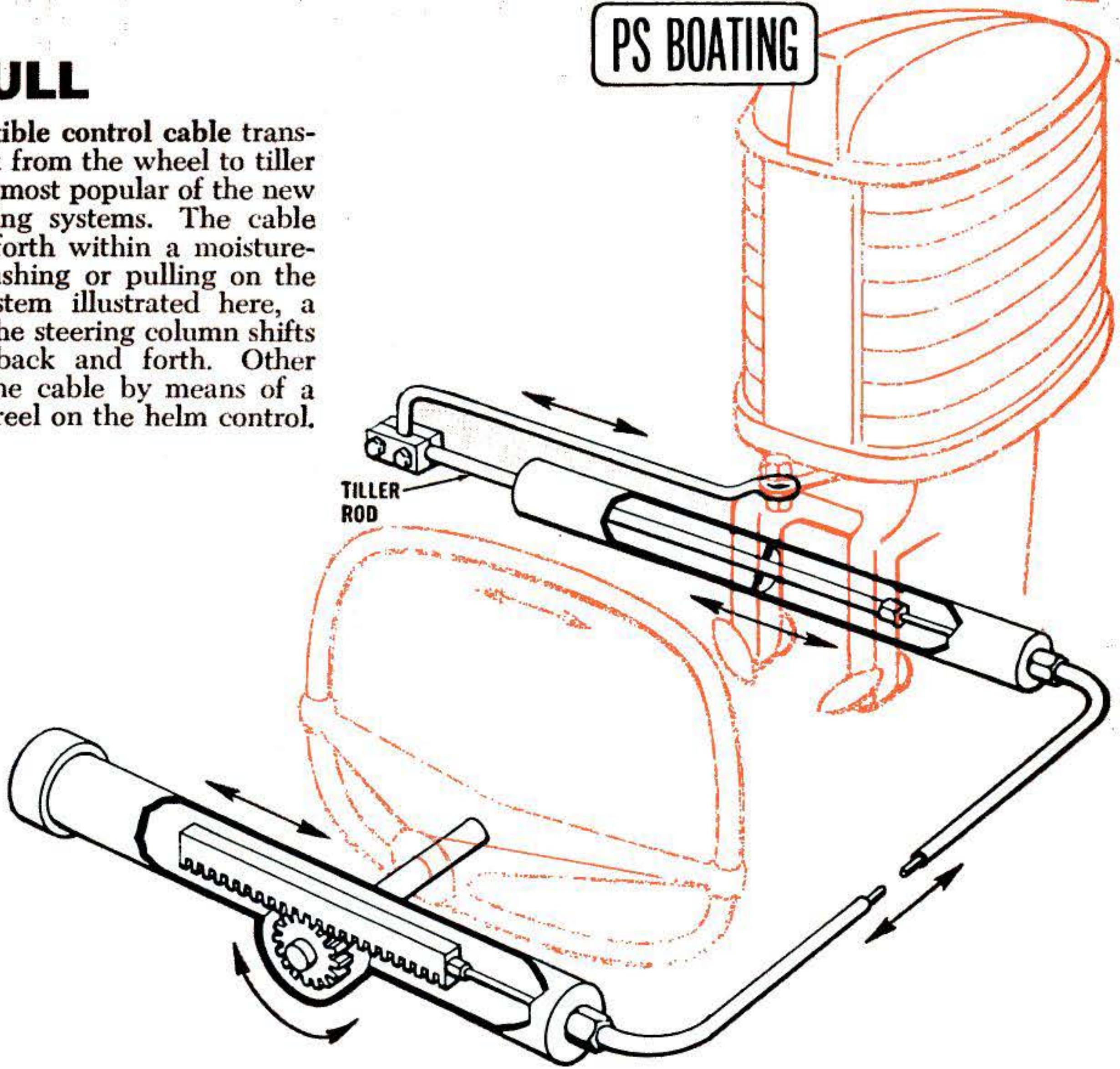
PULL-PULL

Twin cables are used, but force from wheel is transferred by pull only on one or other of the cables. This feat is accomplished with a pulley setup resembling a block-and-tackle in the control unit at the rear of the boat. A sliding pulley on the tiller rod moves in one direction when one cable is pulled, in the opposite when the turning wheel pulls the other. At the wheel, the cables wind and unwind on a drum.



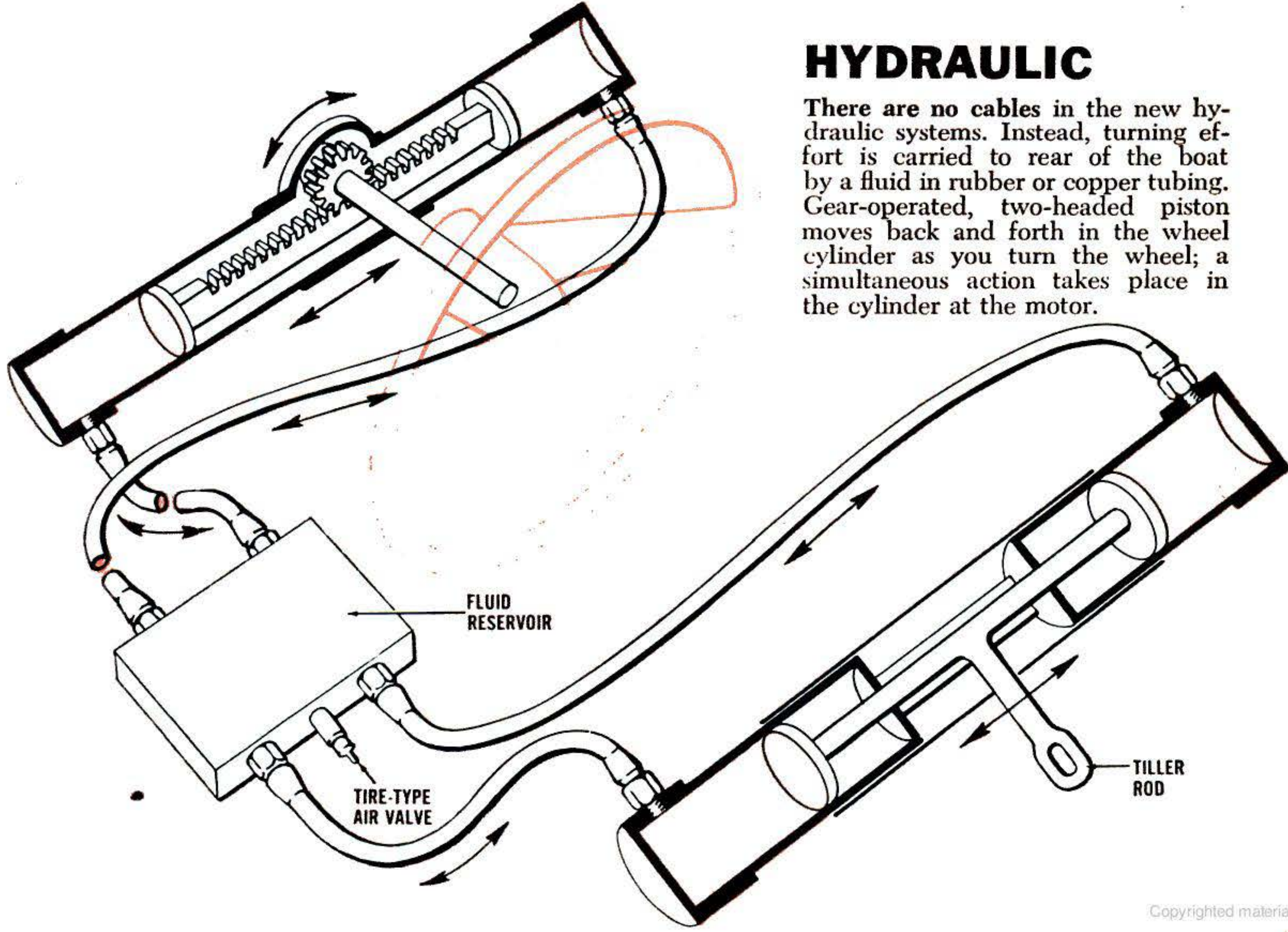
PUSH-PULL

A heavy-duty flexible control cable transfers turning effort from the wheel to tiller rod in one of the most popular of the new mechanical steering systems. The cable slides back and forth within a moisture-sealed sheath, pushing or pulling on the tiller. In the system illustrated here, a toothed gear on the steering column shifts a toothed rack back and forth. Other makers actuate the cable by means of a toothed cable or reel on the helm control.

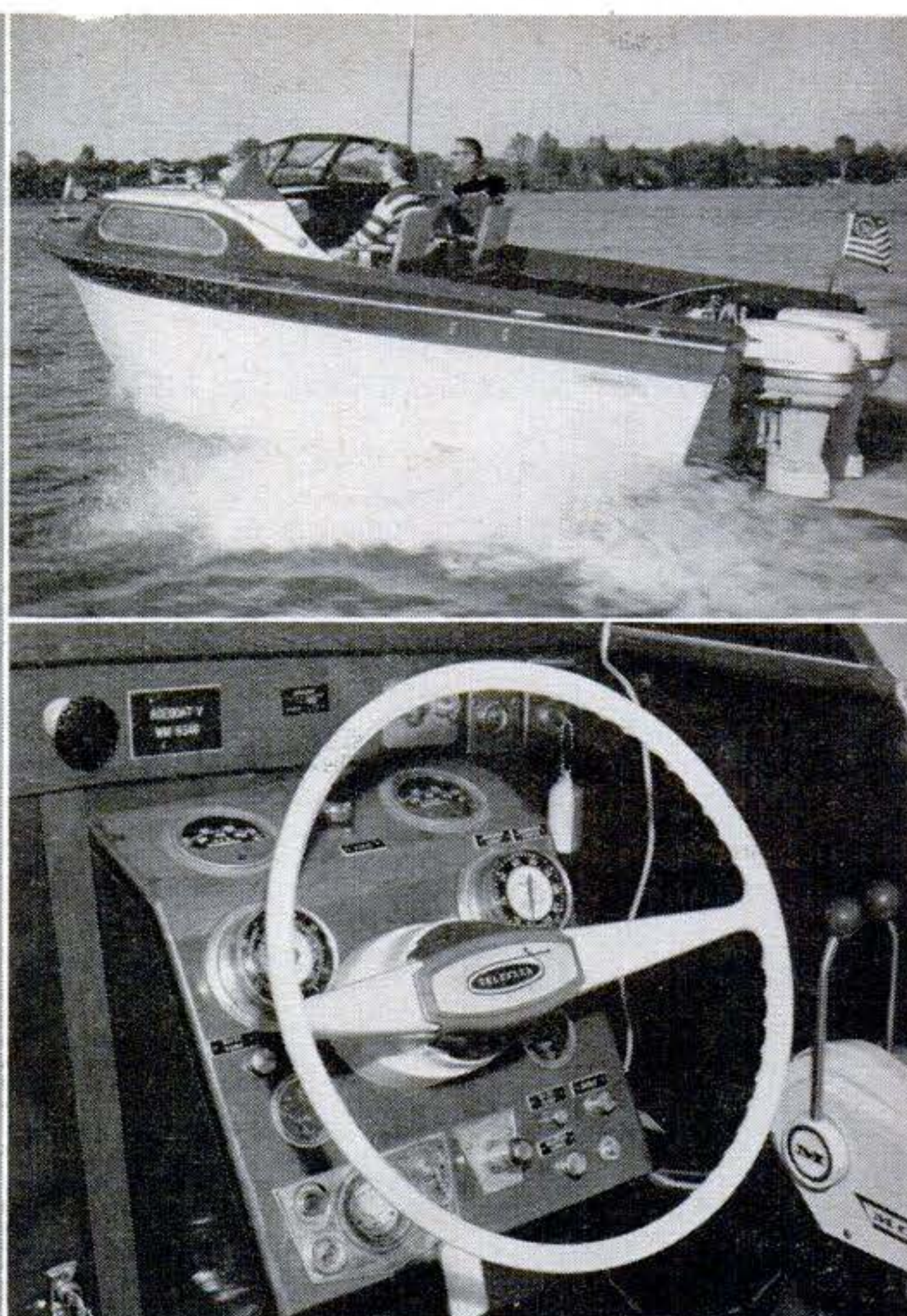
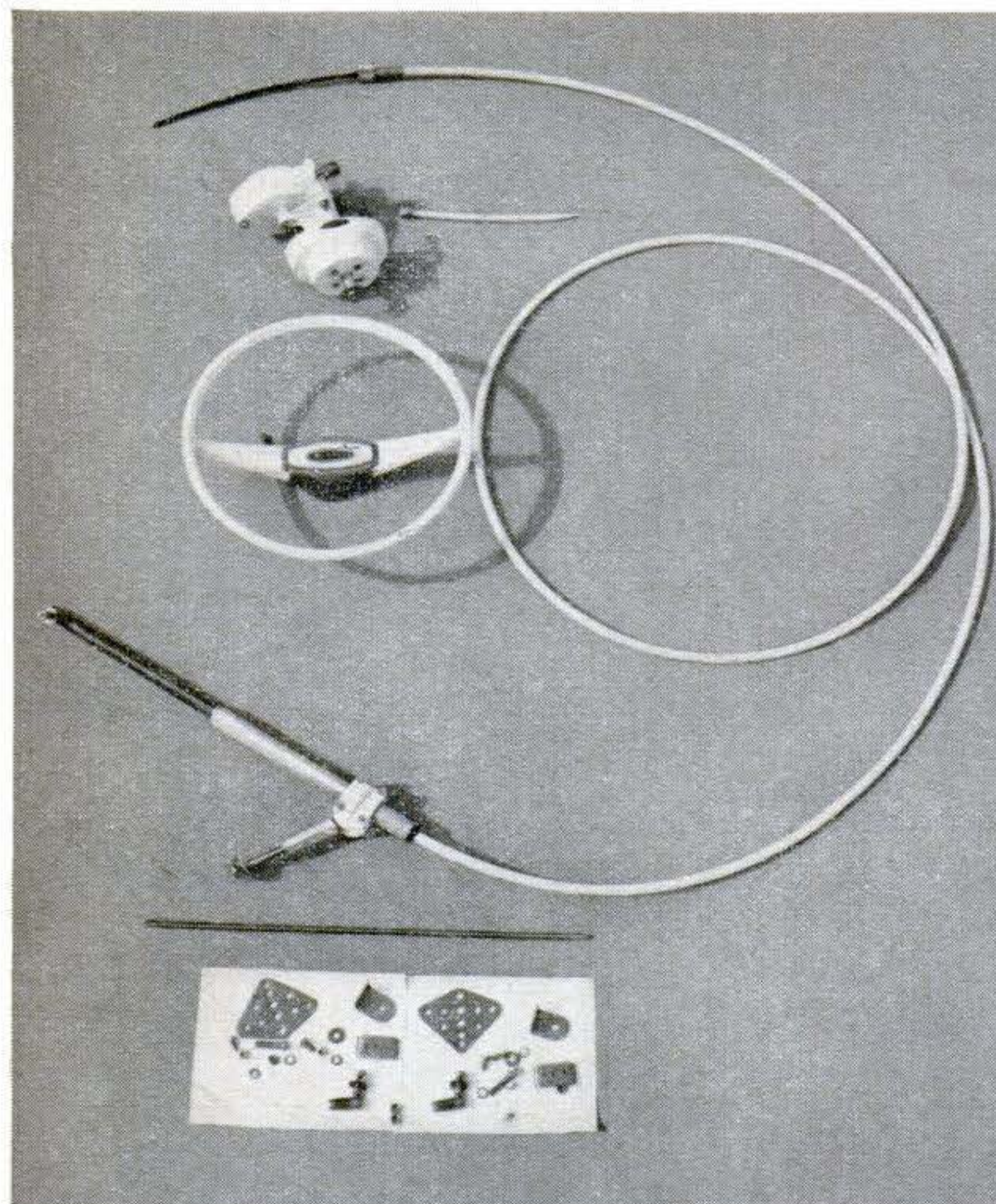


HYDRAULIC

There are no cables in the new hydraulic systems. Instead, turning effort is carried to rear of the boat by a fluid in rubber or copper tubing. Gear-operated, two-headed piston moves back and forth in the wheel cylinder as you turn the wheel; a simultaneous action takes place in the cylinder at the motor.



Come aboard Jim Roe's "Roeboat" to see a typical twin-motor push-pull steering system



Kit of materials for a Teleflex system is shown above. White housing at top goes under dash. Black end of cable feeds through, into plastic sleeve. At transom, tiller-sleeve mounting bracket allows universal sleeve motion. Big bolt goes through transom. Tie rod carries force to second motor. On cardboard: assorted hardware.

Wheel is all that shows. Gears are behind dash. Wheel unit is engineered so it can be mounted on straight or sloping dash, at variable angles. Easy steering is especially helpful when you're driving standing up.

Are they tough to install? You can put a simple system in a small boat in 15 minutes. They don't all go that fast, of course, but none is a problem. You order the unit factory-tailored to fit the boat; its pieces are already designed to slide in place easily.

Some are factory-assembled as a single unit from wheel to tiller. With these, you just hang the wheel in place and snake the flexible steering line back to the transom, dodging it around corners or obstacles like a hose. (It may actually *be* a hose.) Hook up the tiller rod, and you're done.

Are they expensive? Not for what you get. Basically you need to have two or three \$50 bills, depending on the size of your boat and the type of unit you select.

These are long-lived pieces of equipment and there's no reason why you couldn't move the system from boat to boat as you trade. (If you want to do this, be sure to keep the existing steering wheel, brackets, and

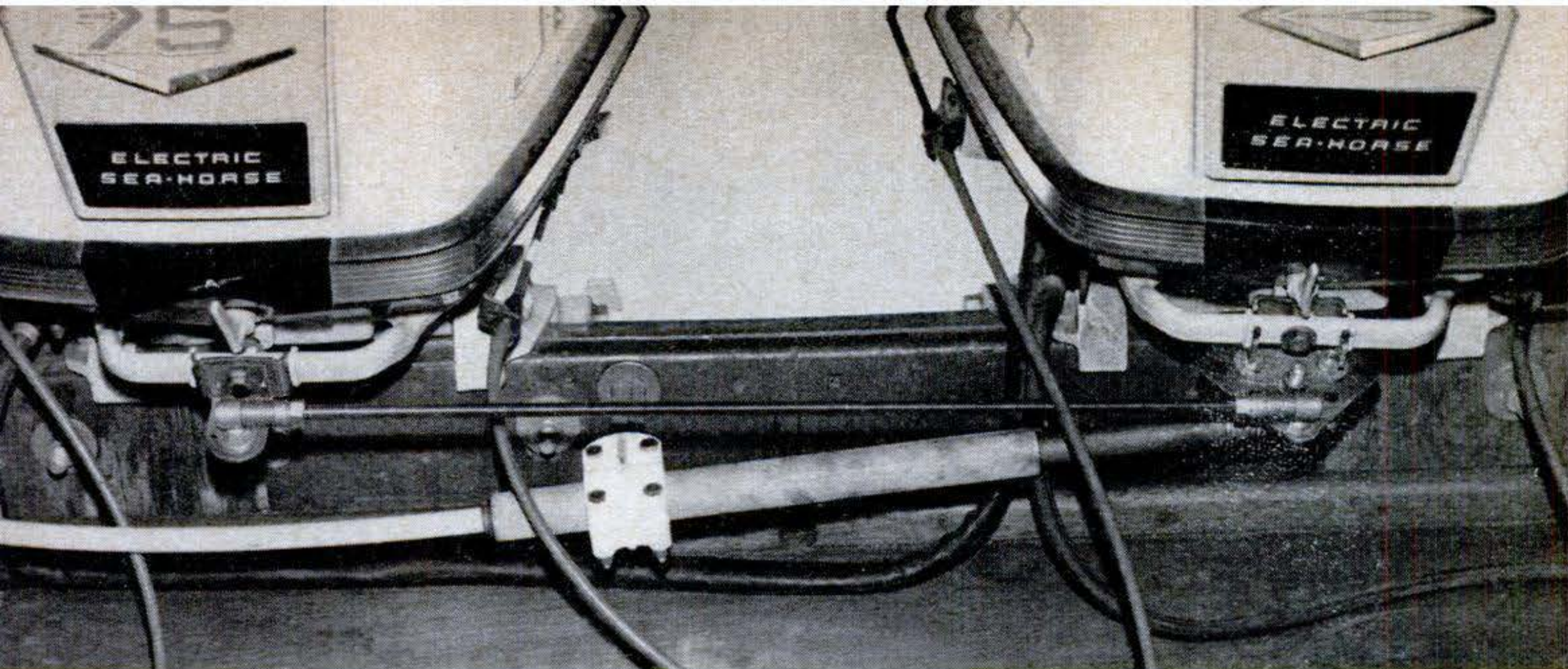
cable. Most folks don't remove the pulleys or the cable guides, so they would still be there if you wanted to shift units.)

Push-pull cable steering. This is the fast-selling pioneer of the new units. It works like a beefed-up auto choke cable, moisture-sealed with a plastic hide. Turn the wheel one way and you push the cable through its sheath (often called a conduit) to move the tiller rod at the transom. Turn the other way, you pull it back.

You have a choice of three cable-activating mechanisms at the wheel end. Morse and Ride Guide do it with a rack and pinion. This is a toothed rack shifted left or right by a pinion on the wheel shaft. A handy point with these: If you need reversed motion at the tiller—as with some inboard and stern-drive setups—you mount the rack-and-pinion unit upside down.

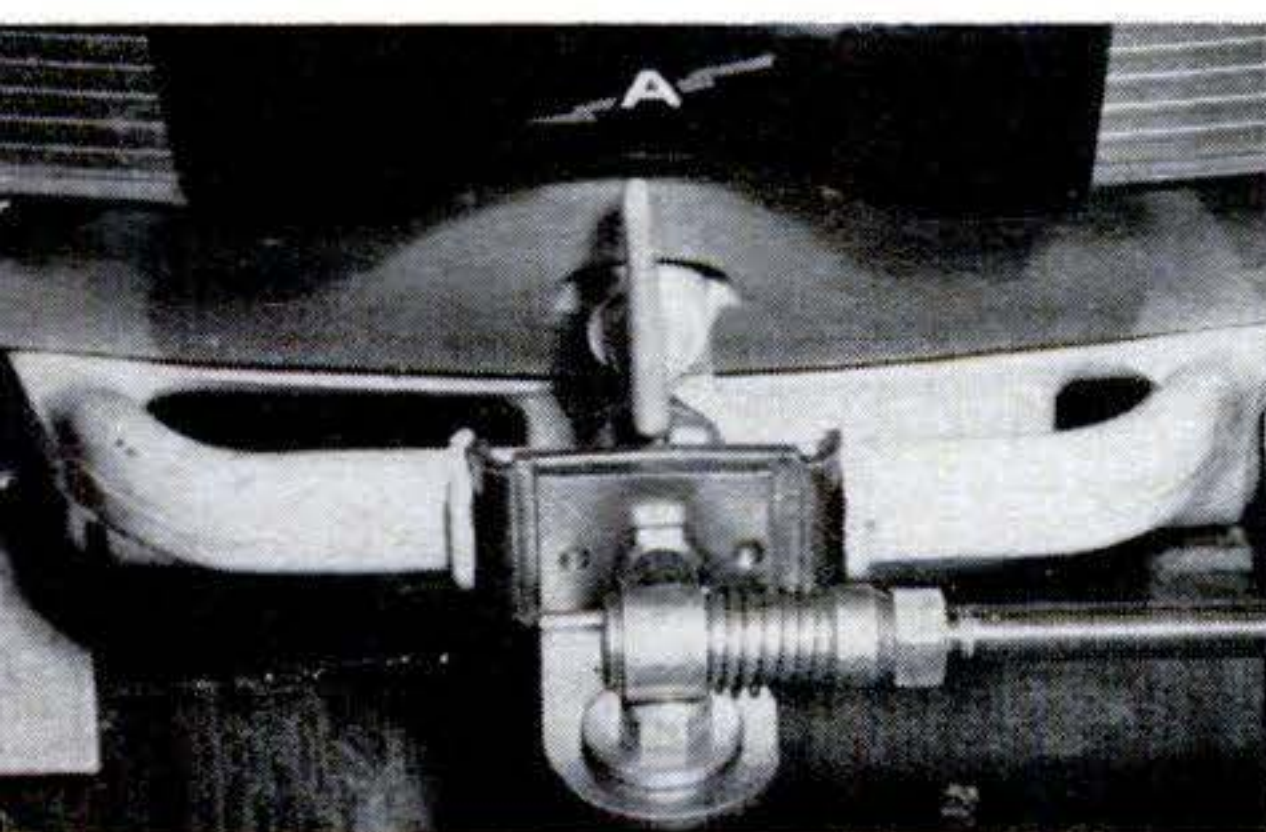
Teleflex eliminates the rack entirely by

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Tiller-sleeve mounting bracket is bolted through transom. Control arm extends beyond to control

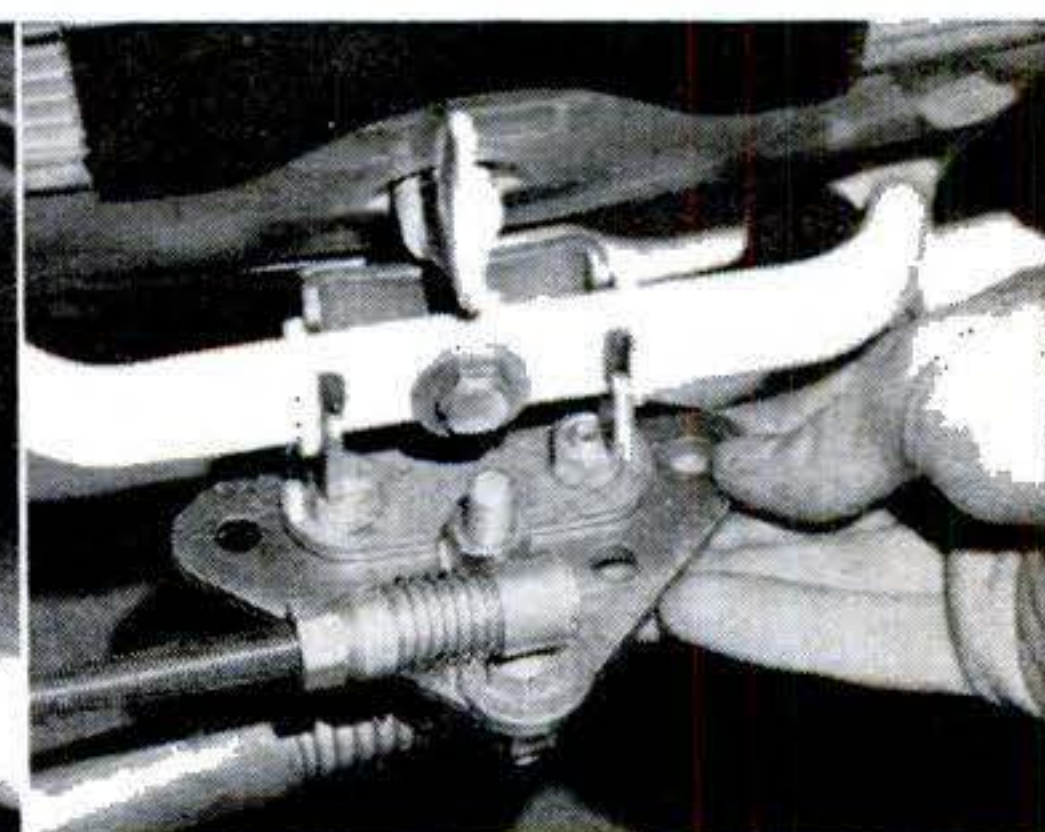
port motor. Tie rod goes back to control starboard. It is easy to attach or remove.



Main attachment plate is on starboard motor. Pushrod from conduit is attached to ball joint on bottom of vertical bolt. Tie rod to second motor permits exact dual alignment.



Detail of attachment plate for securing tie rod to second motor. There's a ball-shaped connector on motor plate. Sleeve holds rod in place, is easily removed.



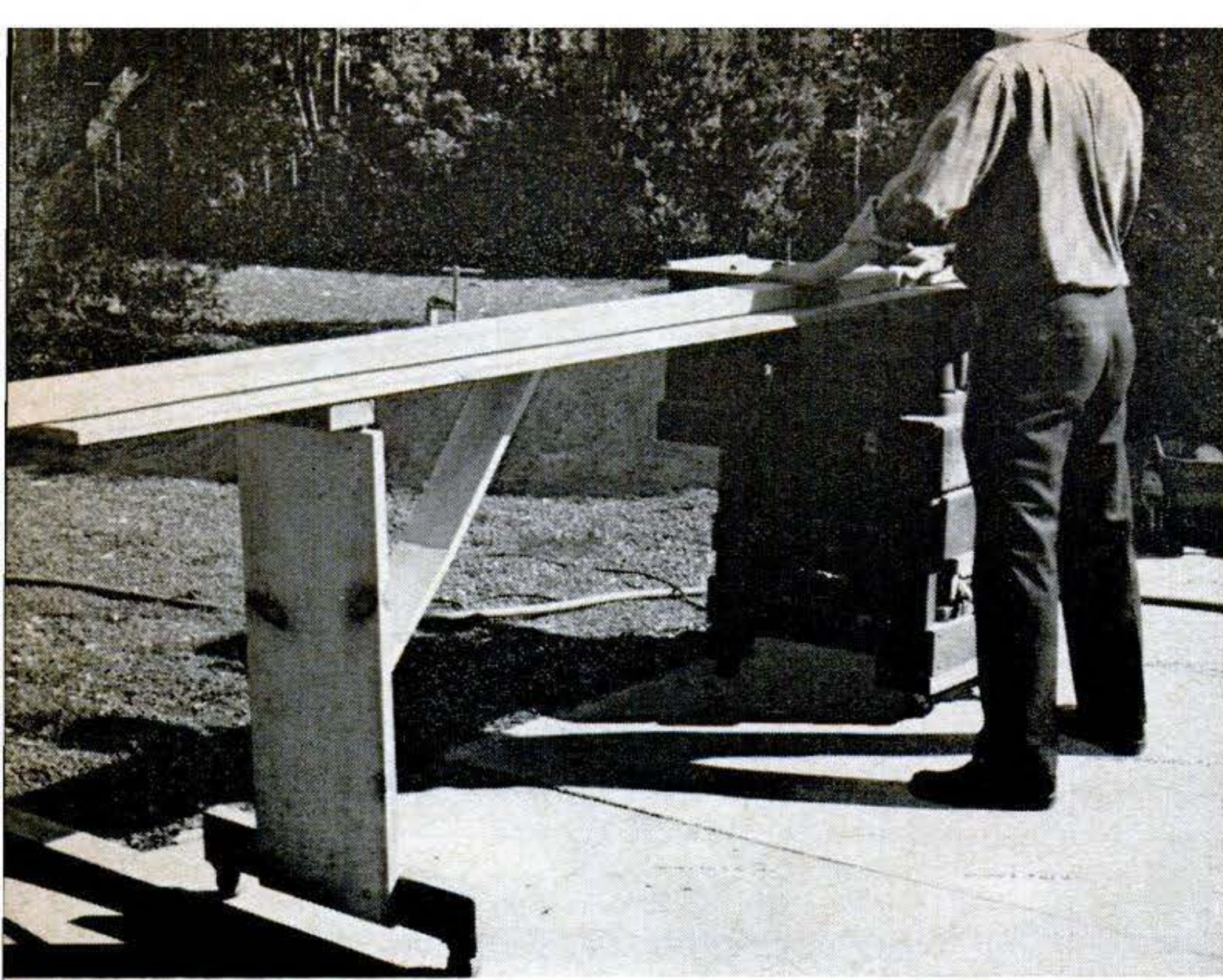
Tiller-rod sleeve bolts firmly through transom. Clamp-on bracket allows proper positioning along sleeve, so pushrod travel gives full left-to-right movement to motor tiller plate.

WHERE TO GET THEM

TYPE	NOTES	NAME	MANUFACTURER	APPROX. PRICE
Push-pull, rack and pinion	Wheel included	Ride Guide	Kiekhaefer Corp., Fond du Lac, Wis.	\$75 for 16' boat
Push-pull, rack and pinion	Wheel included; heavy duty	Morse Steerer	Morse Instrument Co., Hudson, Ohio	\$141.50
Push-pull, toothed cable	Less wheel	Teleflex Steerer	Teleflex, Church Road, North Wales, Pa.	\$100
Push-pull, reel-operated	Less wheel	SteerMaster	American Chain & Cable Co., Inc., 601 Stephenson Bldg., Detroit 2	\$80 for typical 18' boat
Pull-pull, enclosed drum	Wheel included	Safety Glide	Allan-Jervis Marine, Hicksville, N. Y.	\$89.50 with 10' of cable
Rope and pulley, split drum	Wheel and complete drum unit	Stardust Steerer	North & Judd Mfg. Co., Wilcox-Crittenden Div., Middletown, Conn.	\$17.75 for steerer only; approx. \$10 additional for wire rope and hardware for 16' boat
Hydraulic	All parts except wheel and tubing	Aqua-Trol	Hydro-Controls, 2345 4 St., Berkeley 10, Calif.	\$140

Just slide it!

Rolling Saw Table Gathers No Dust



WITH my sliding table extension I can square off two-by-eights with ease or pile several pieces of wood on it and whack them all off at the same length. Done with it, I fold it up and hang it on the wall.

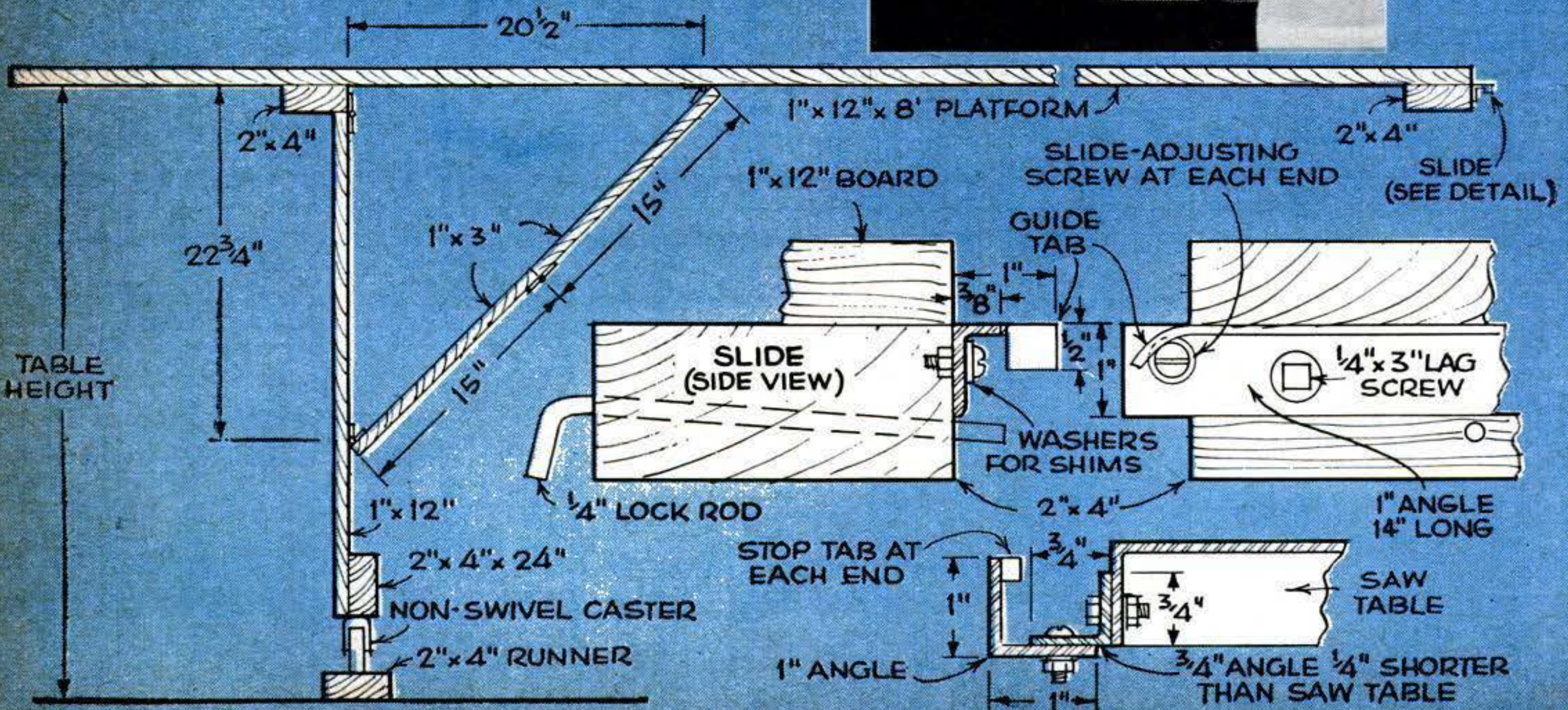
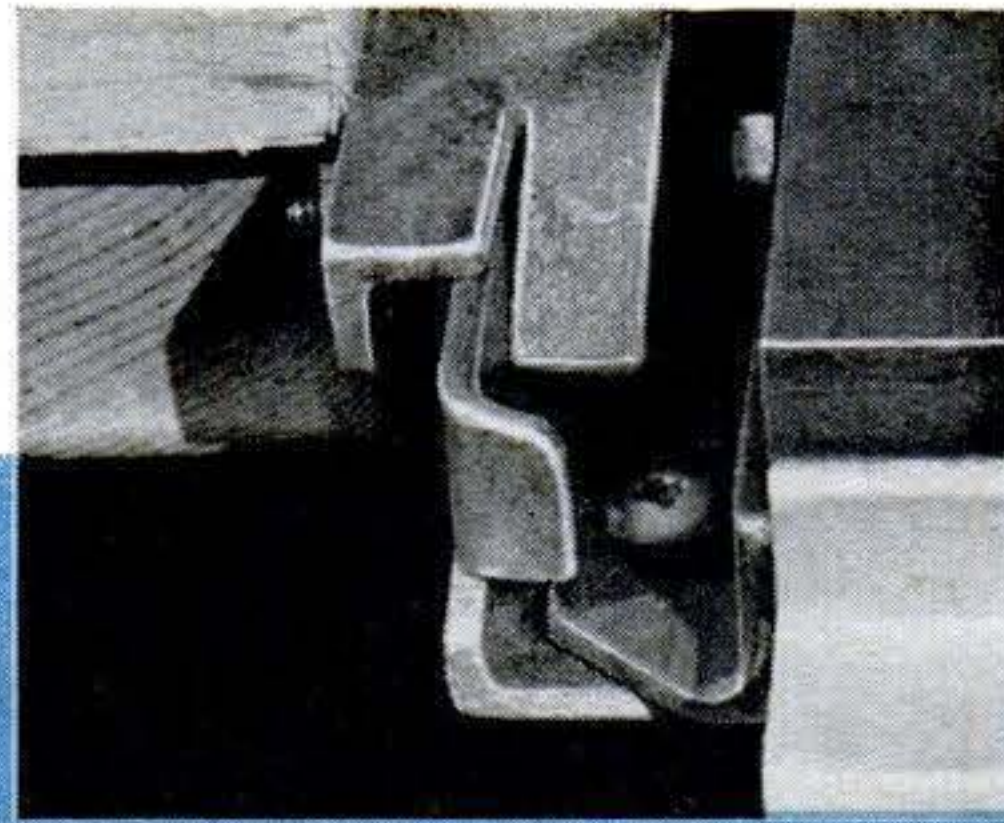
The secret of its usefulness? It slides with the work. Casters on the single leg, and mating pieces of angle iron—on the extension, and attached to the saw table proper—give it the sliding movement.

Most saw tables have holes drilled to take extensions, so attaching the track to

the table is merely a matter of drilling corresponding holes. I bolted the two angles together, on each track, so that I could make vertical adjustments, if necessary, by using shims between the angles.

The woodworking part is simple. The one-by-two platform is reinforced by two pieces of two-by-four, with the leg hinged to one piece, the angle iron lag-screwed to the other. If your floor is rough, a piece of two-by-four under the casters helps the table roll smoothly.—*R. Hoppough.*

Stops at the end of the track were made by sawing a slot $\frac{5}{16}$ " deep and bending the outer section to form a tab. Wherever the slides or bolt heads touch, they should be smoothed with a file and polished with emery cloth. Channel iron can be used instead of angle iron.



Now Anyone Can Steam- Bend Wood

New cookout
technique with
aluminum foil
produces
pleasing curves

By Loomis C. Miller

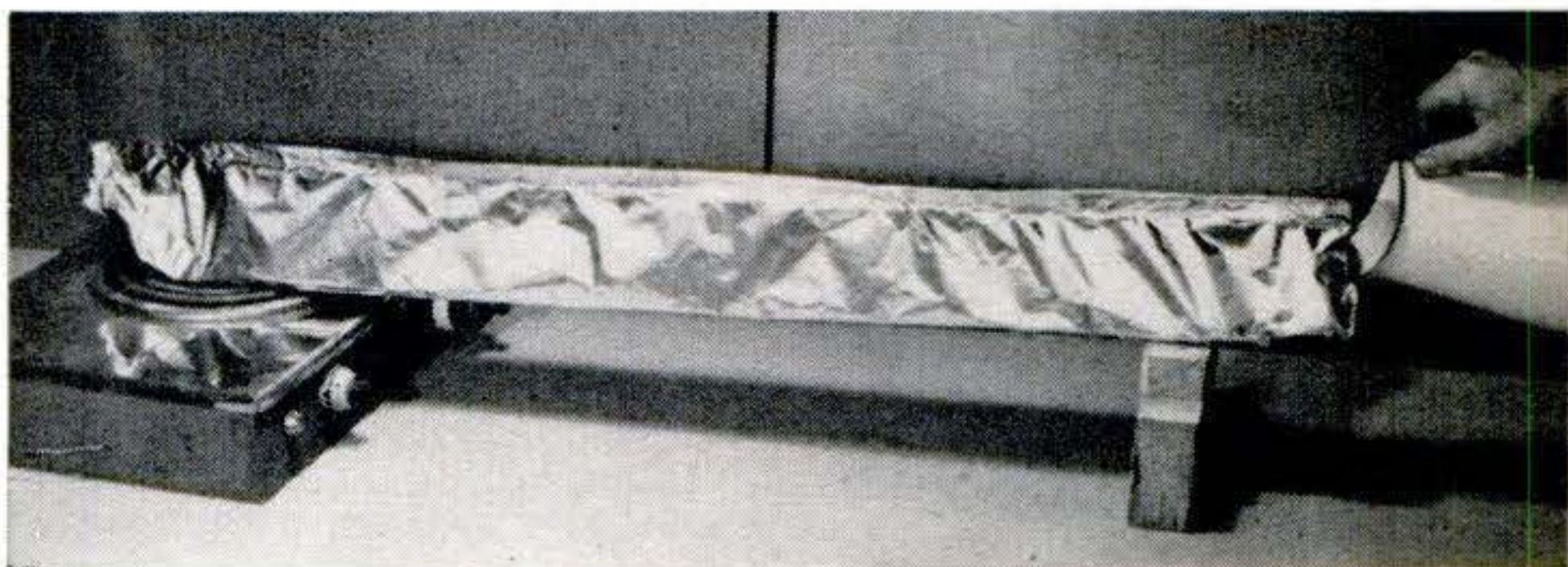
HAVE you ever envied a skilled woodworker his steam equipment for bending wood? You can get comparable results now by using common aluminum foil and any convenient source of heat.

Foil-roasting an ear of corn gives you the tip-off on how it's done. You wrap the wood in foil, add water to provide steam, and place the package in the kitchen oven or over an electric hotplate or charcoal grill. The foil traps steam around the wood until it softens.

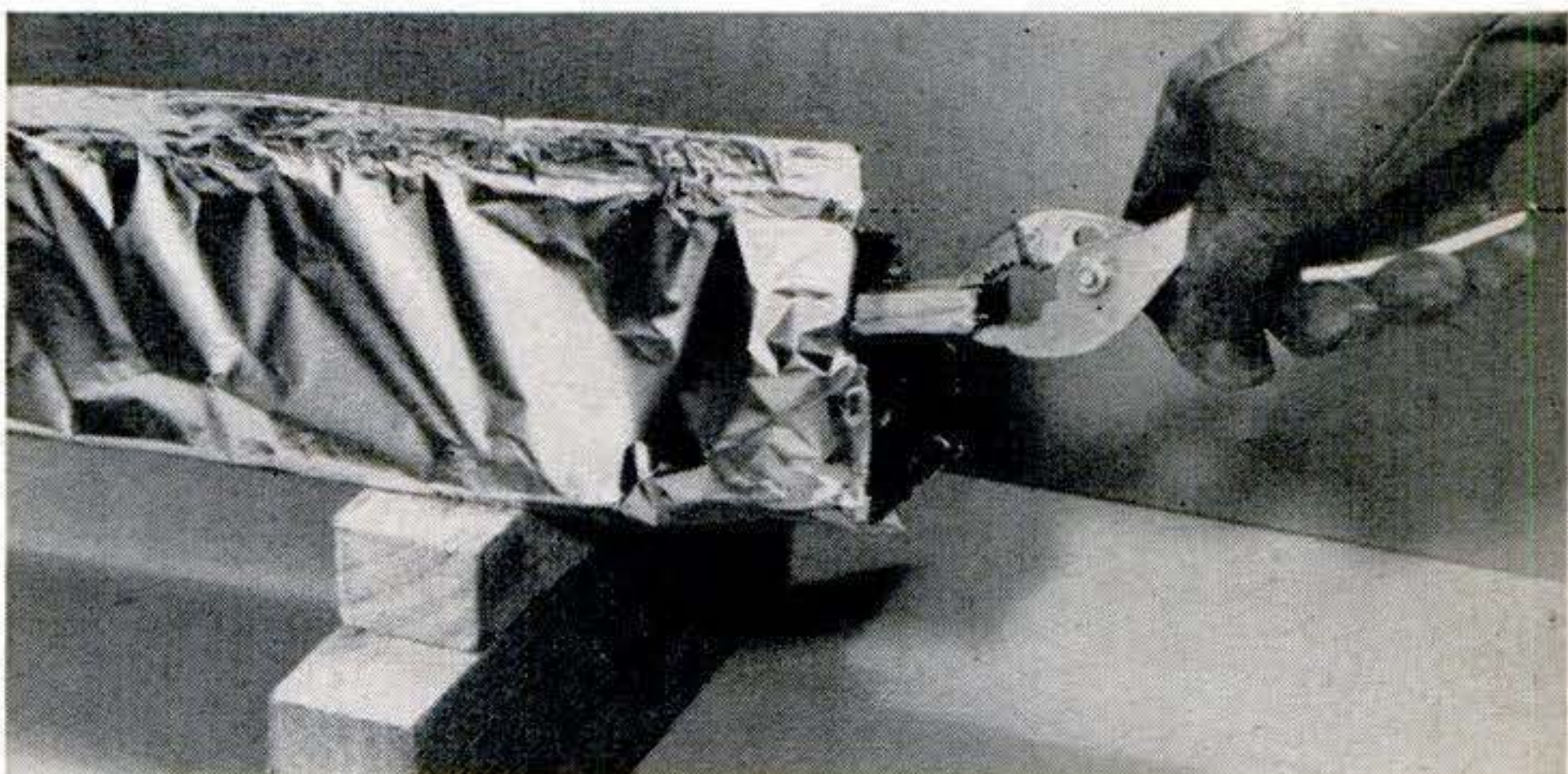
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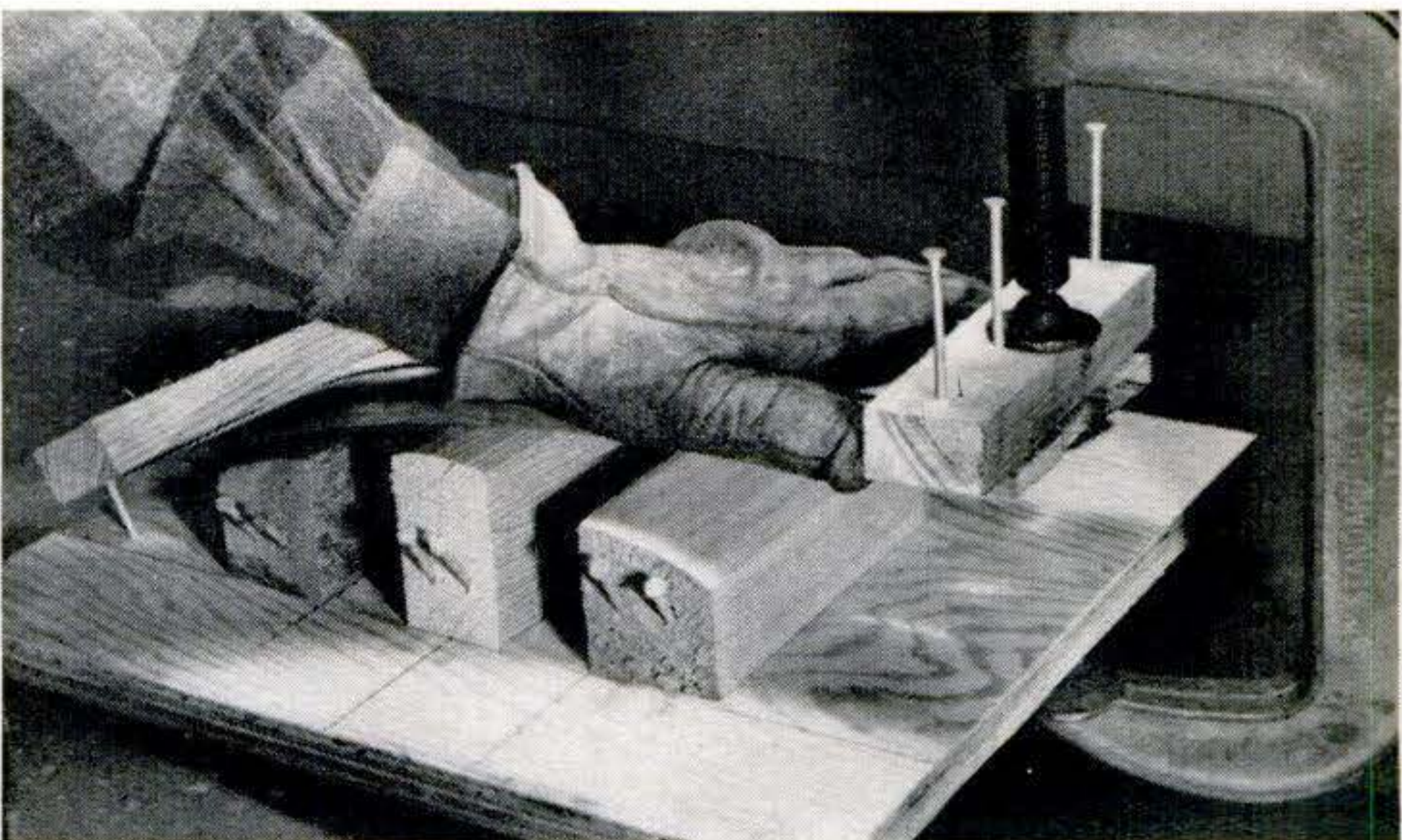
Wrap the wood in aluminum foil . . .



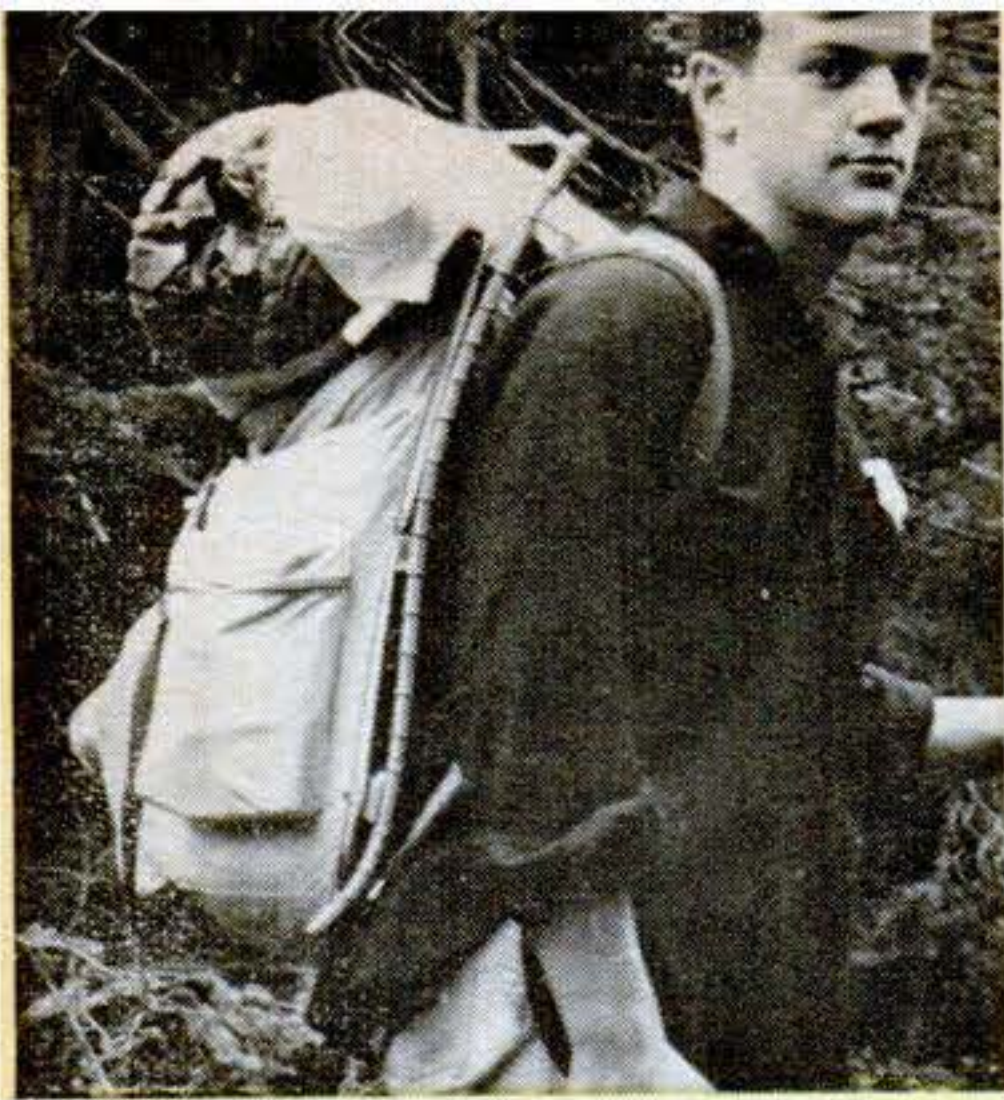
. . . pour in water, seal package, turn on heat . . .



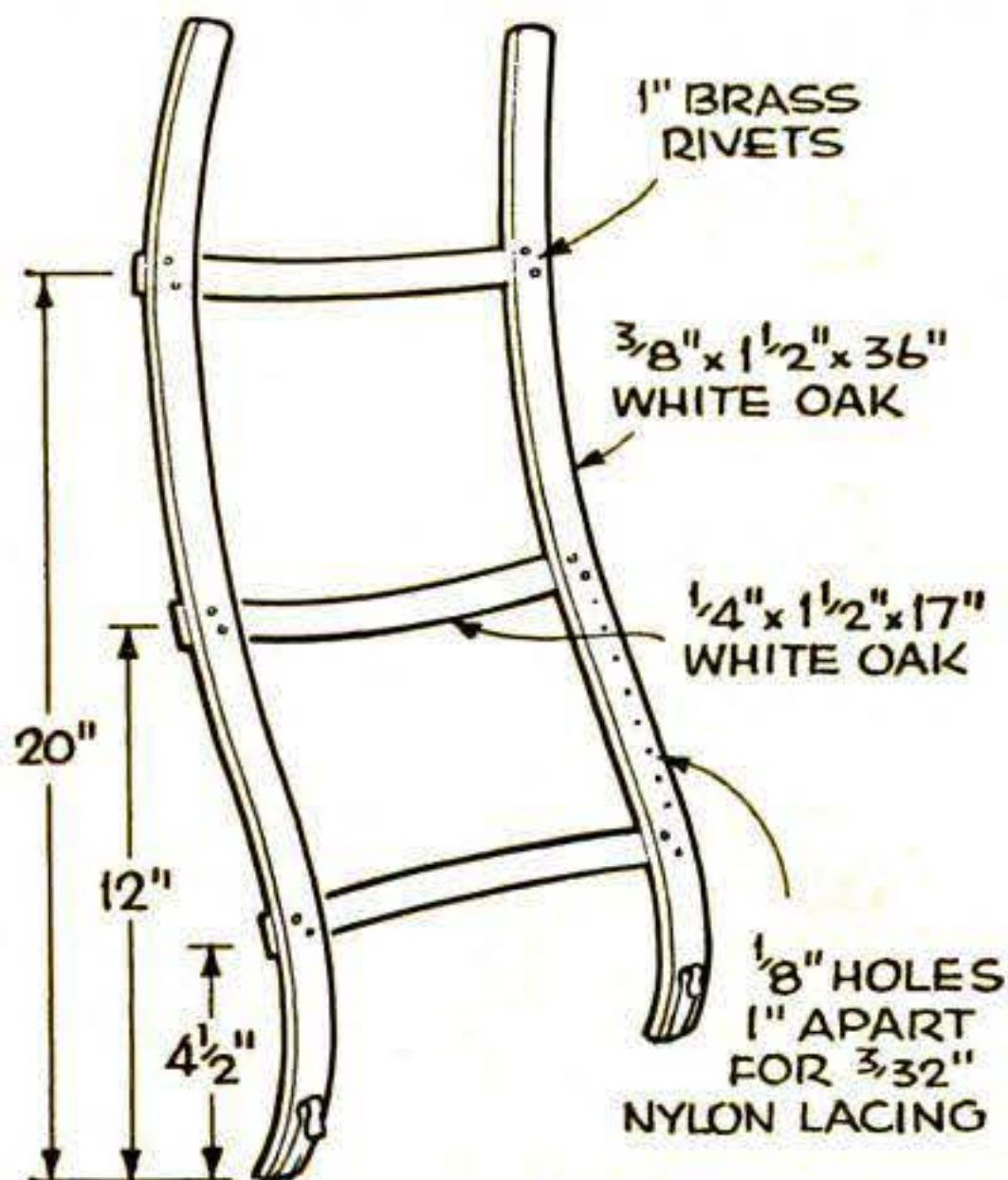
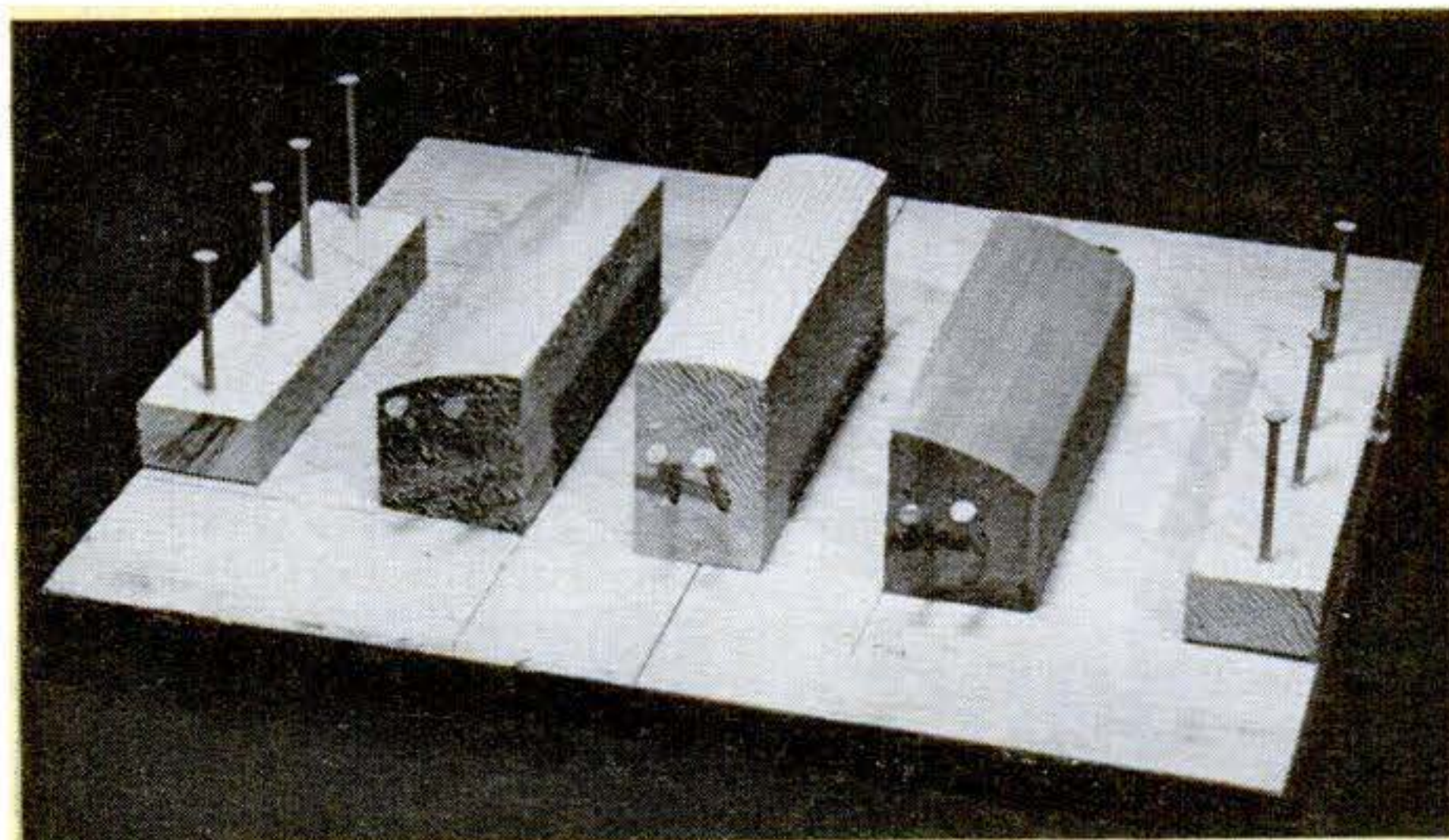
. . . take out the softened wood after half-hour . . .



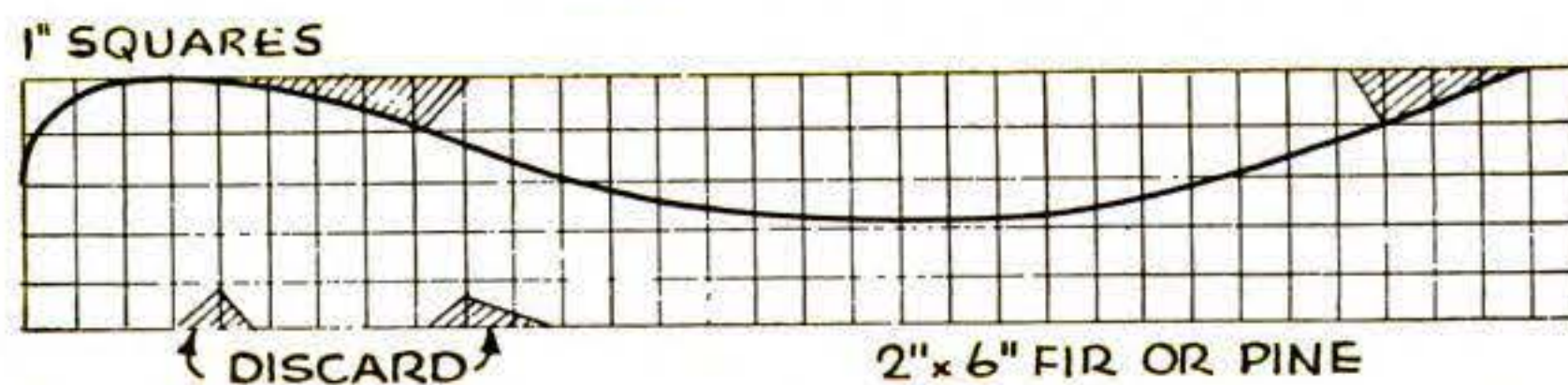
. . . and curve it over a form to dry.



Packboard is a good project for foil-steaming technique



Make jigs for bending the strips before you begin the steaming. The jig for the crosspieces (above) can be two-by-fours rounded to 24" radius. Jig below is for the uprights.



When wood bends, the inside of the curve compresses, the outside stretches. Steamed wood compresses easily but you must take steps to keep the outside of the curve from breaking. A metal strap along the outside of the curve is the simplest answer.

Plumbers' pipe strap, sold in several widths, makes an easily adjusted and inexpensive bending strap. In use the strap is adjusted to the length of the stock before it is steamed. After steaming, the wood is fitted to the strap and one end is clamped to the form around which the curve is to be made. Bending and clamping should begin

at one end and progress slowly—to allow the cells to compress.

Steam-bent wood must be held until dry. A "free" bend can usually be held by wiring the ends together but if a precise curve is needed you should clamp the wood in a jig. On free bends allow for springback after the wood is removed.

For extreme curves, the best available wood is red oak, sawed green and kept wet until used. This is sold by many lumber yards as "bending oak." If this is not available, seasoned red oak, white oak, hickory, and ash make strong curves. Other hardwoods such as walnut, gum, and some varieties of maple bend well. Softwoods do not take extreme bends, but spruce, Alaska cedar, pine, and fir withstand moderate bending.

Any household foil works, but heavy-duty or freezer weights are best. Crimping seals the foil for most jobs but you can also seal it with high-temperature masking tapes sold for car enameling (Scotch Tape No. 323).

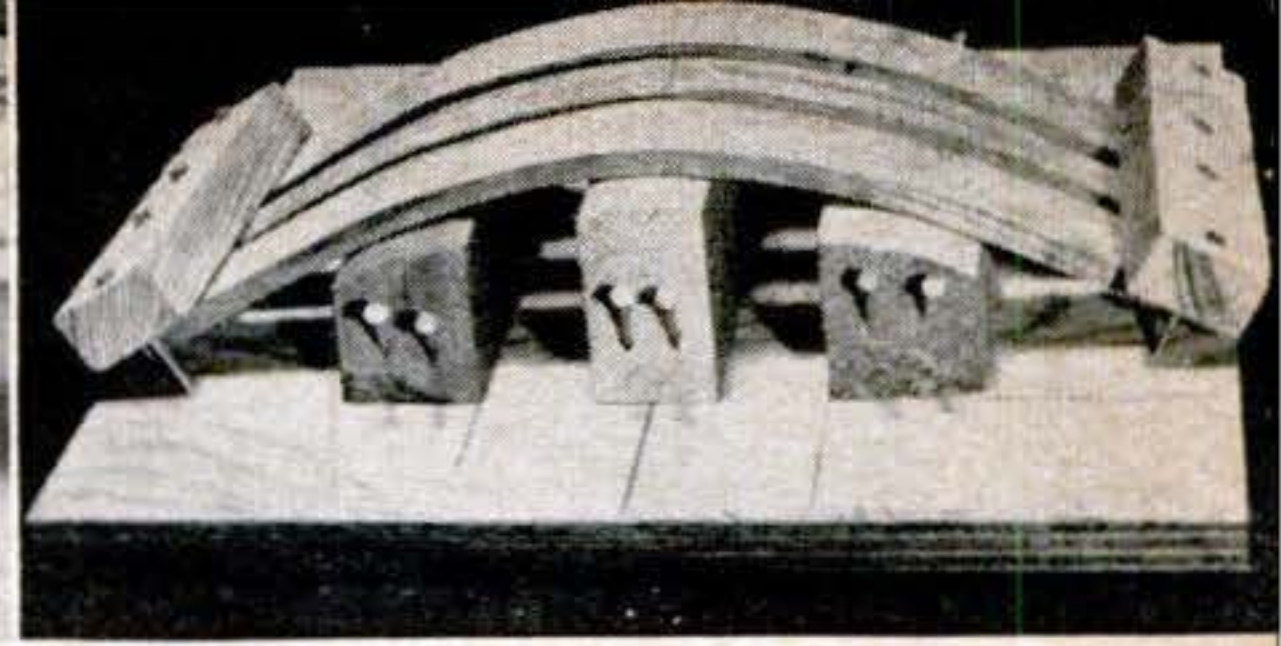
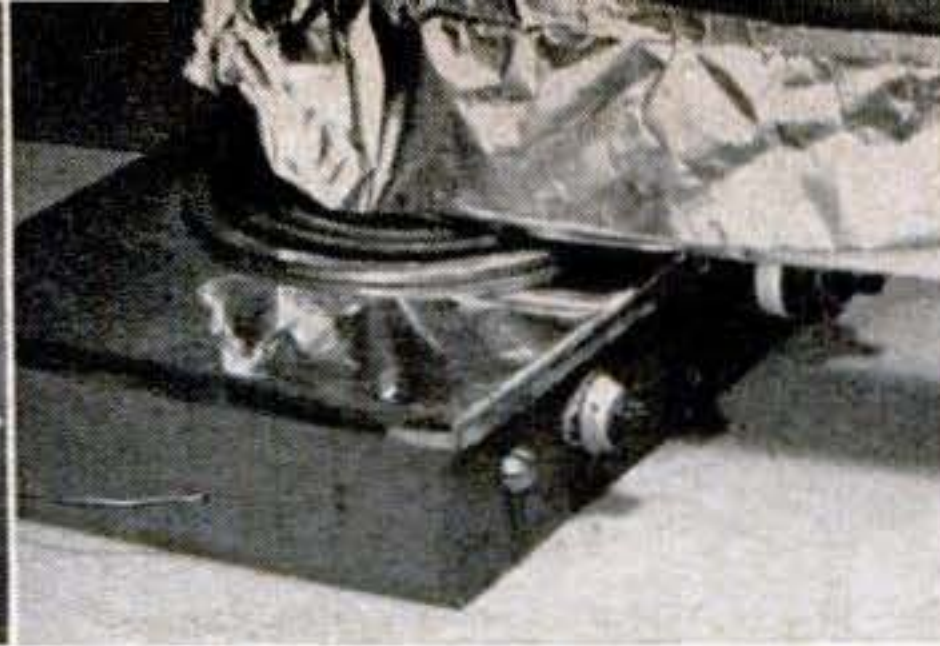
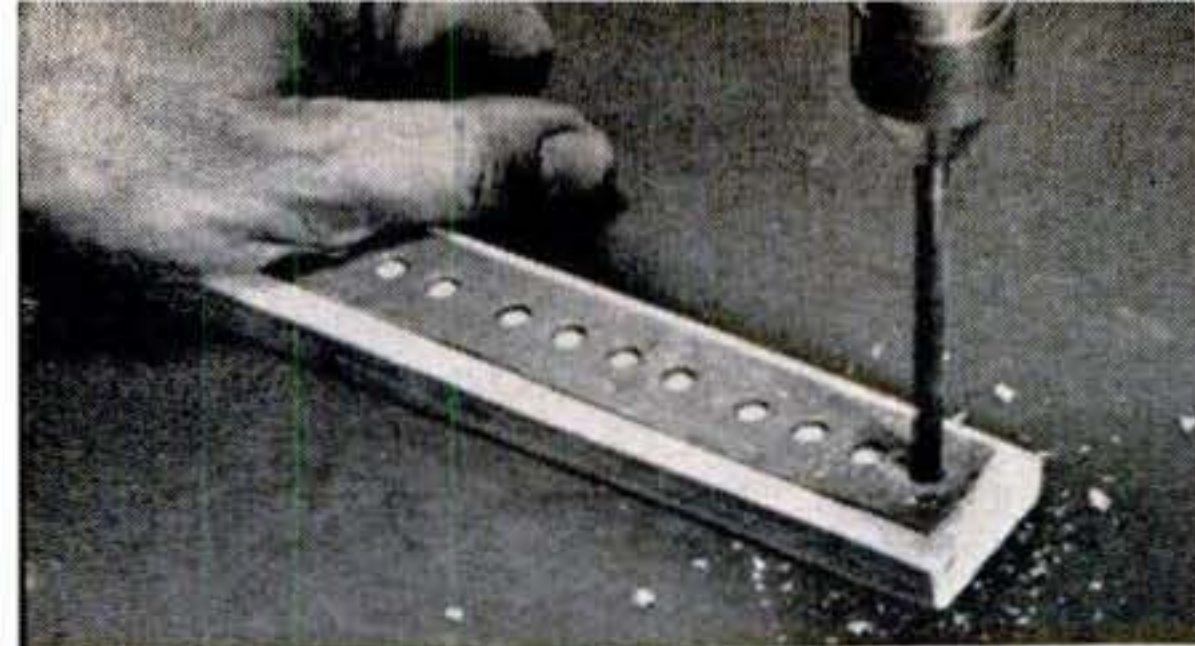
Making a packboard. The contoured mountain packboard shown in the accom-

[\[Continued on page 195\]](#)

Where to get packboard fittings

Equipment that the author used on the packboard above is available, postpaid, from Recreational Equipment, 1525 11th Ave., Seattle, Wash.

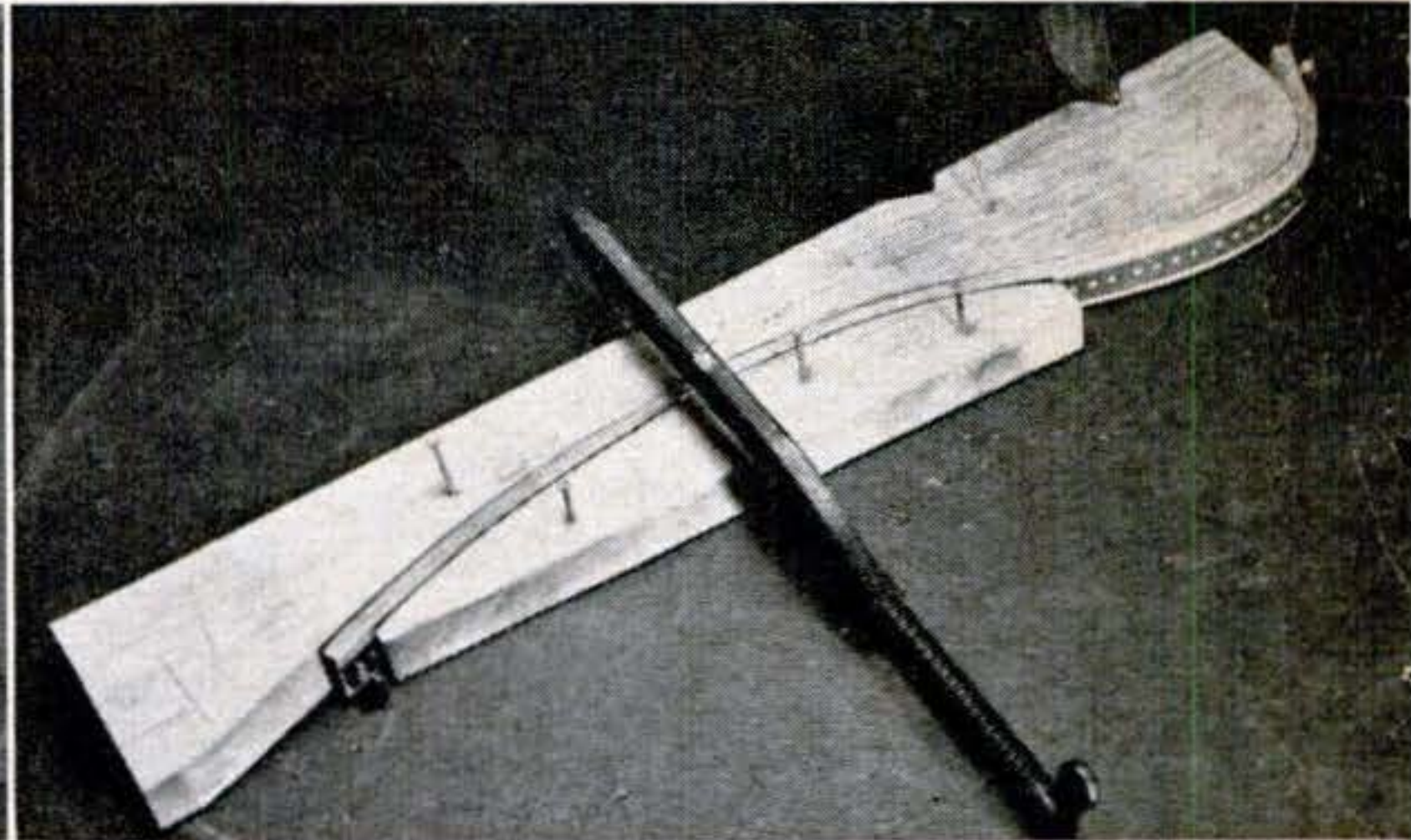
Order: a pair of shoulder straps (T.N. type), \$1.65; a bag with three zipper pockets (your choice of green, yellow, or red, T.N. No. 2), \$7.55; 40' braided nylon, "Avalanche" 3/32" red, 60 cents.



Using 1" pipe strap as guide, drill ends of upright strips for 1/4" bolts and wingnuts. These ends will be cut off after strips are bent. Metal keeps the wood from breaking under strain.

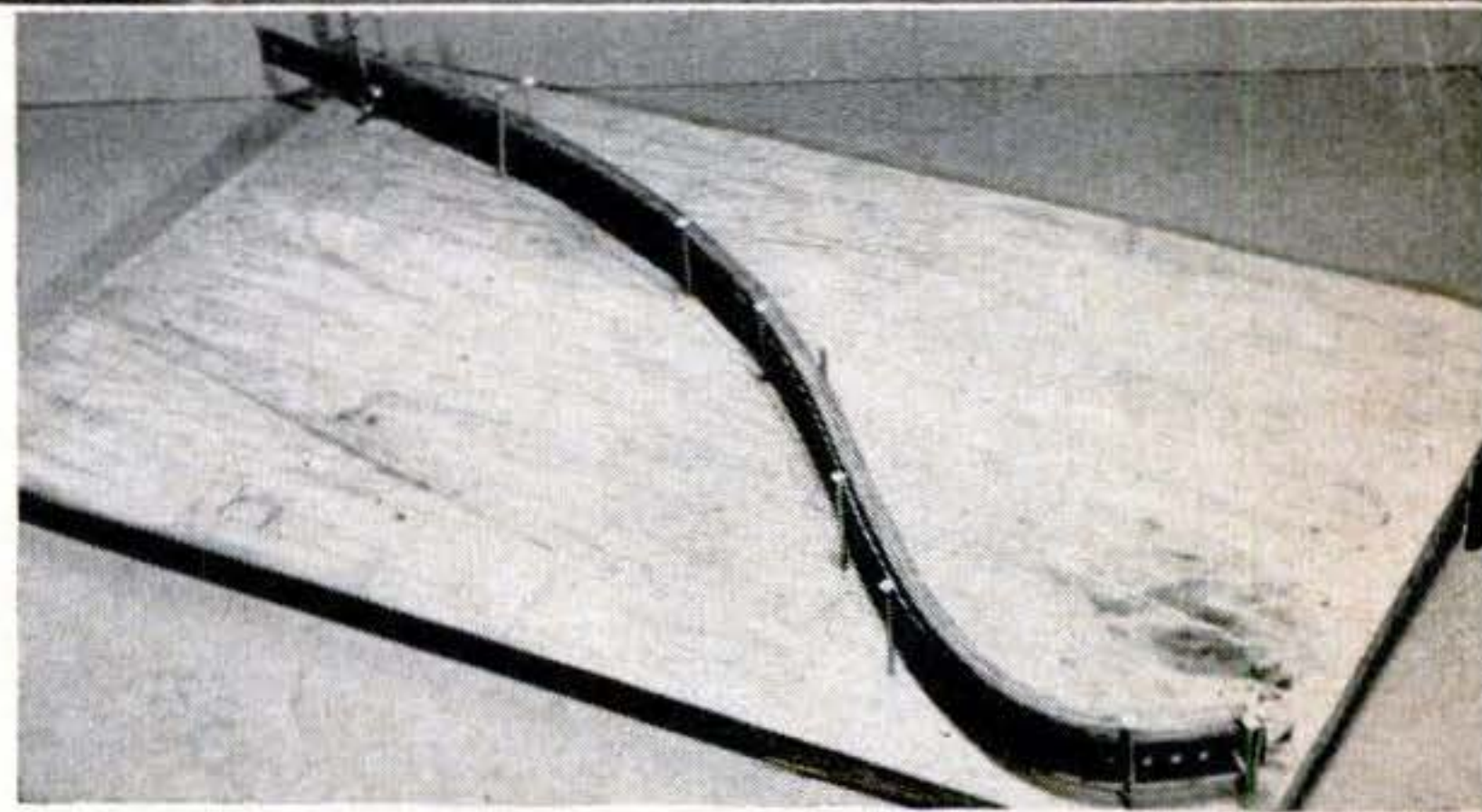
Only one end of foil-wrapped package of wood need be on hotplate. Other end is propped up slightly so water will run to heated end. Be sure water always covers foil over heat source.

The three crosspieces are bent as shown above over the jig and left to dry. Air-drying should take about 48 hours, or you can do it in an oven at 150 degrees in two or three hours.



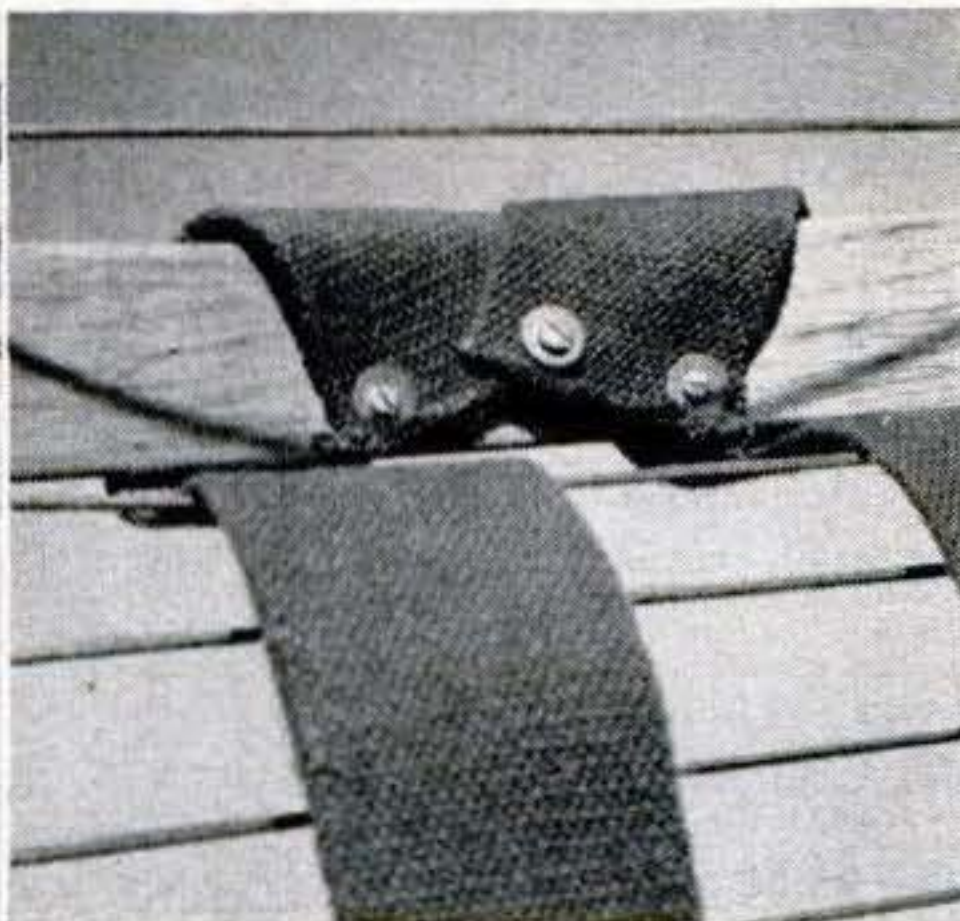
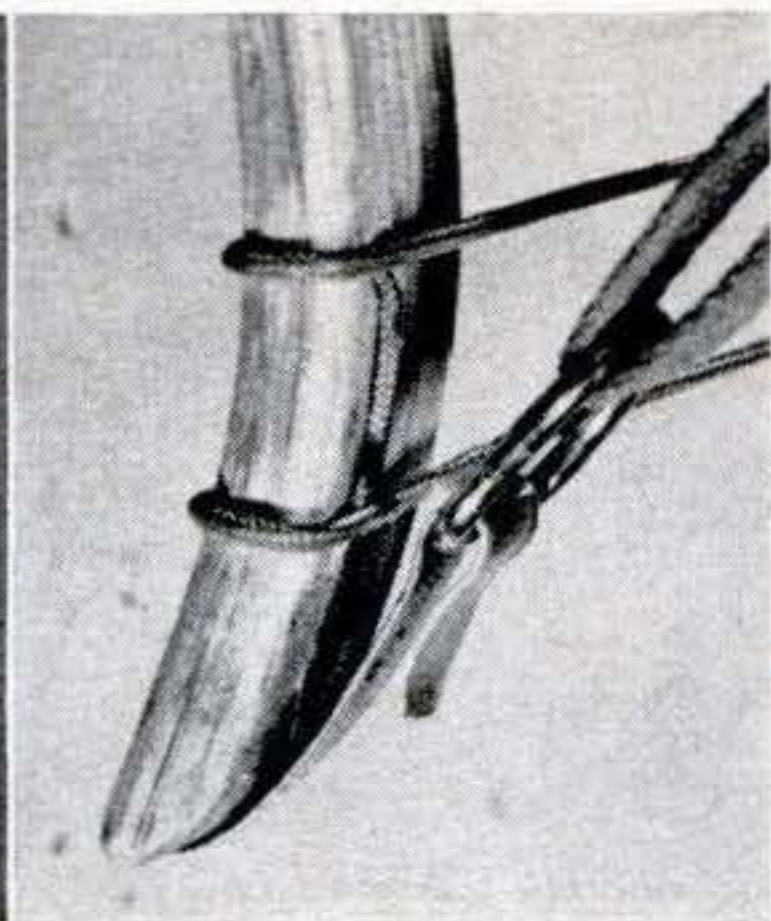
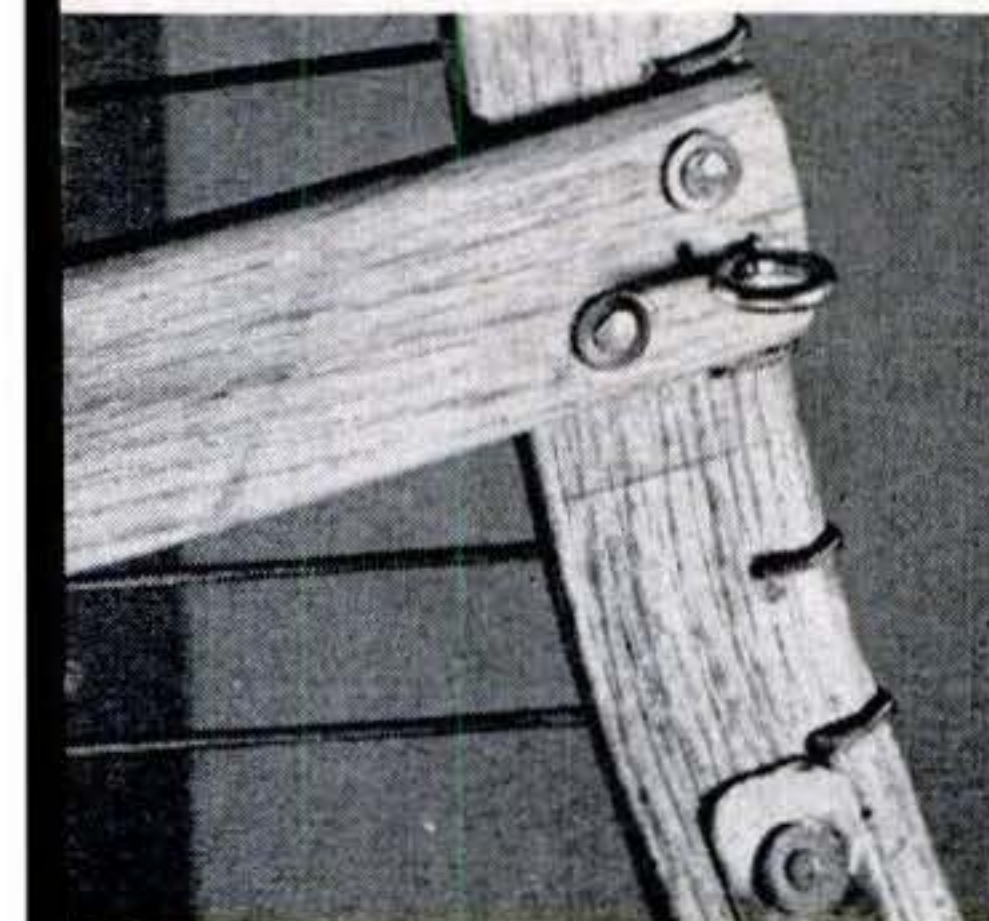
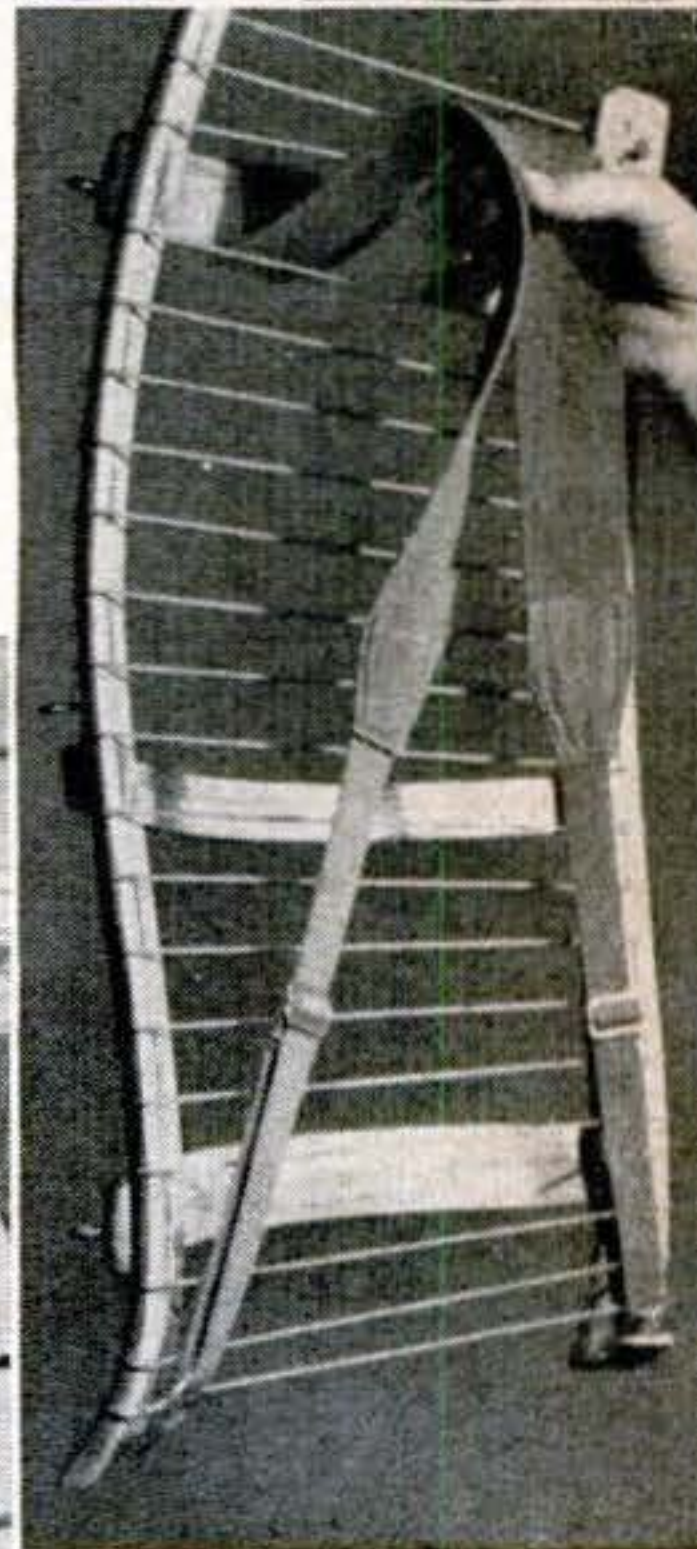
After clamping end of metal-supported upright to jig as above, force it around curve, using second clamp to pull it into deep part of curve until male part of the jig can be positioned. A clamp placed across both parts of jig (above, right) then draws strip into final shape.

For drying, the upright strip can be removed to the back of the bench or to a drying panel as at the right. First, place nails at each end of the oak strip. Then place other nails along the strip and remove the clamp parts for use in bending the second upright strip.



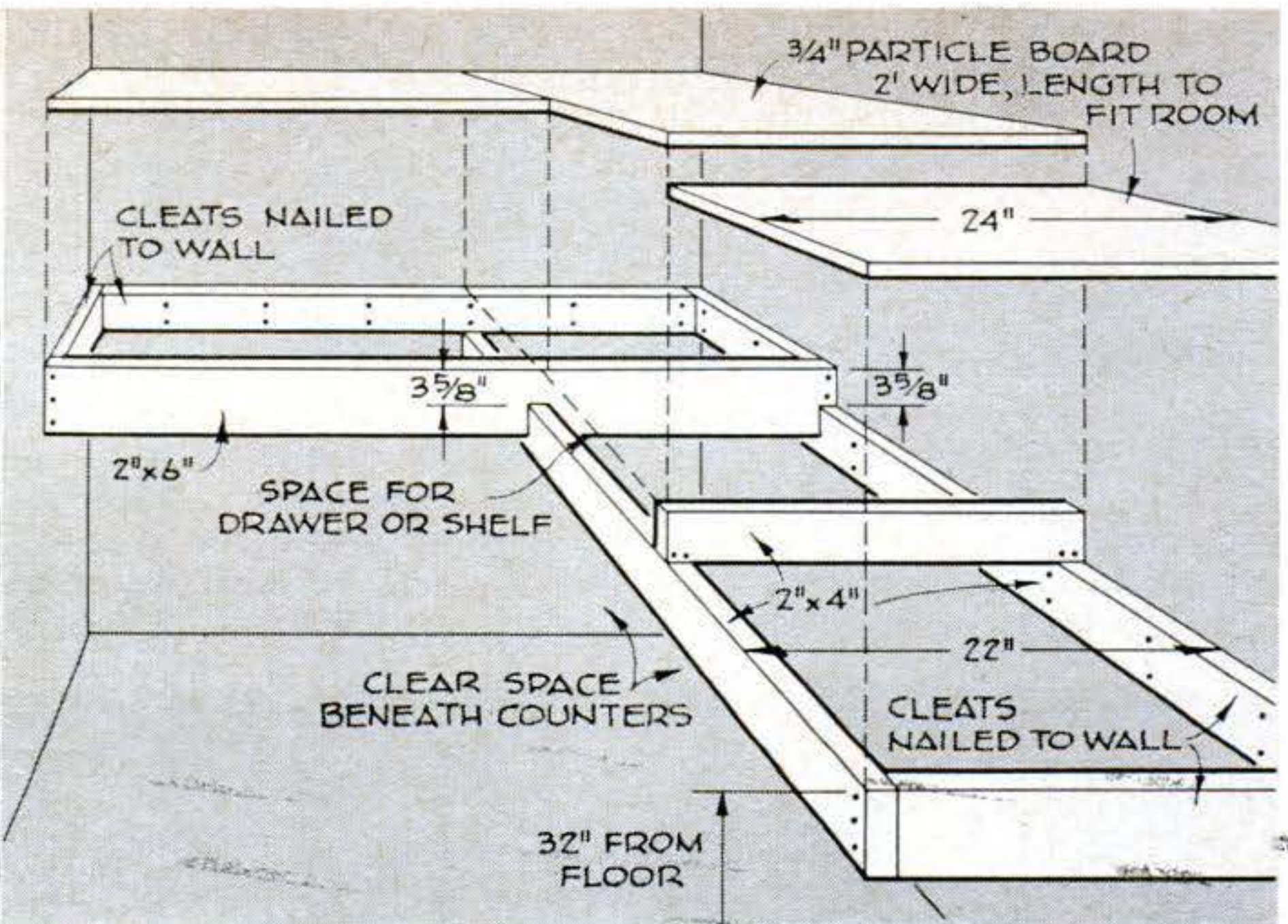
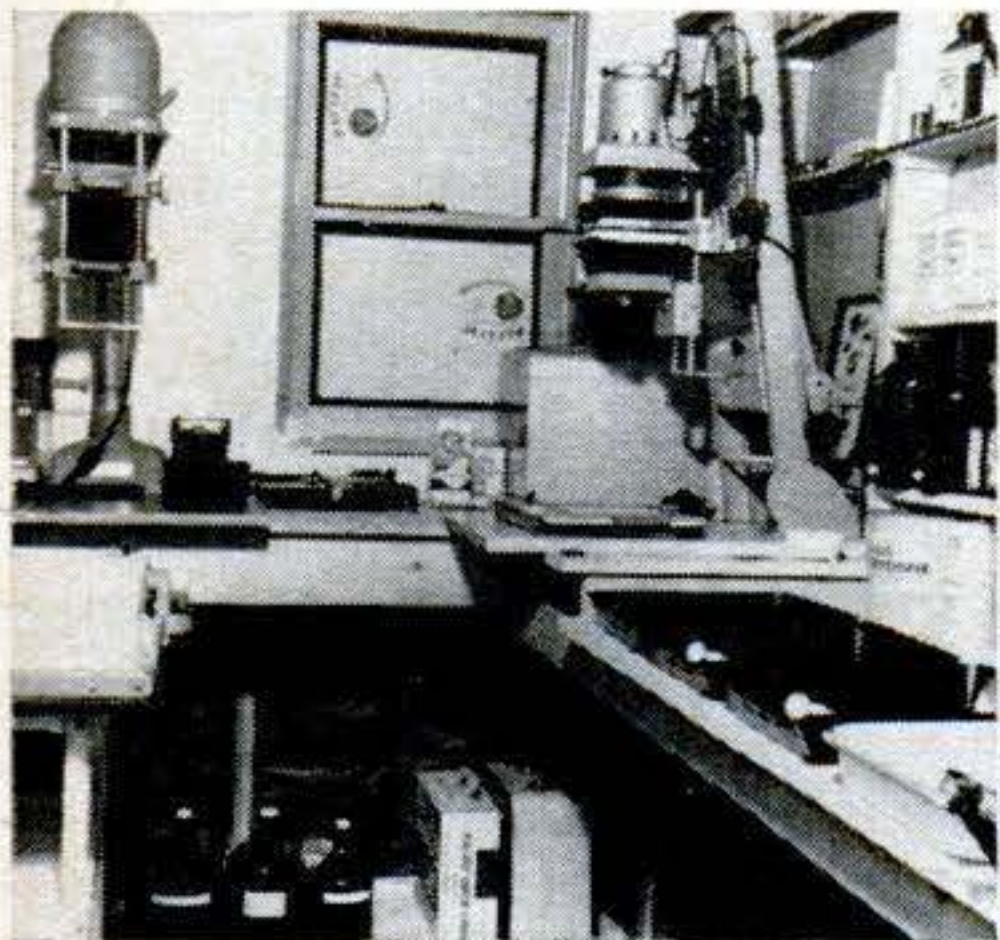
Cross members are fastened to uprights with 1" copper rivets, as below, and nylon lacing goes through holes at 1" spacing near outer edge of uprights. Smooth all edges of holes and corners of uprights to avoid wear on lacing. Metal clips at bottom of the uprights provide quick-release of shoulder strips. Make clips of stainless steel or spring brass.

Wrap upper end of shoulder straps around the top cross-piece as below and fasten with small wood screws and washers. Screw-eyes in frame pass through grommets in edge of removable bag that you can order (see box, facing page).



Short Cuts and Tips

FROM
PS
READERS



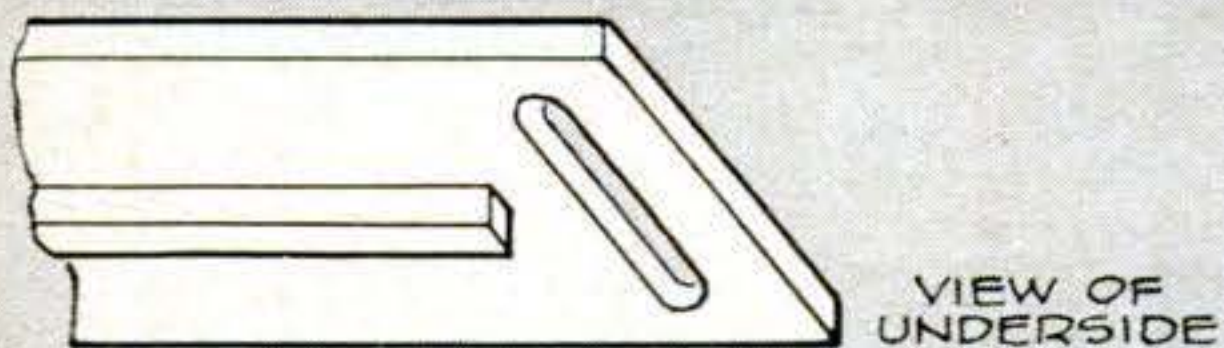
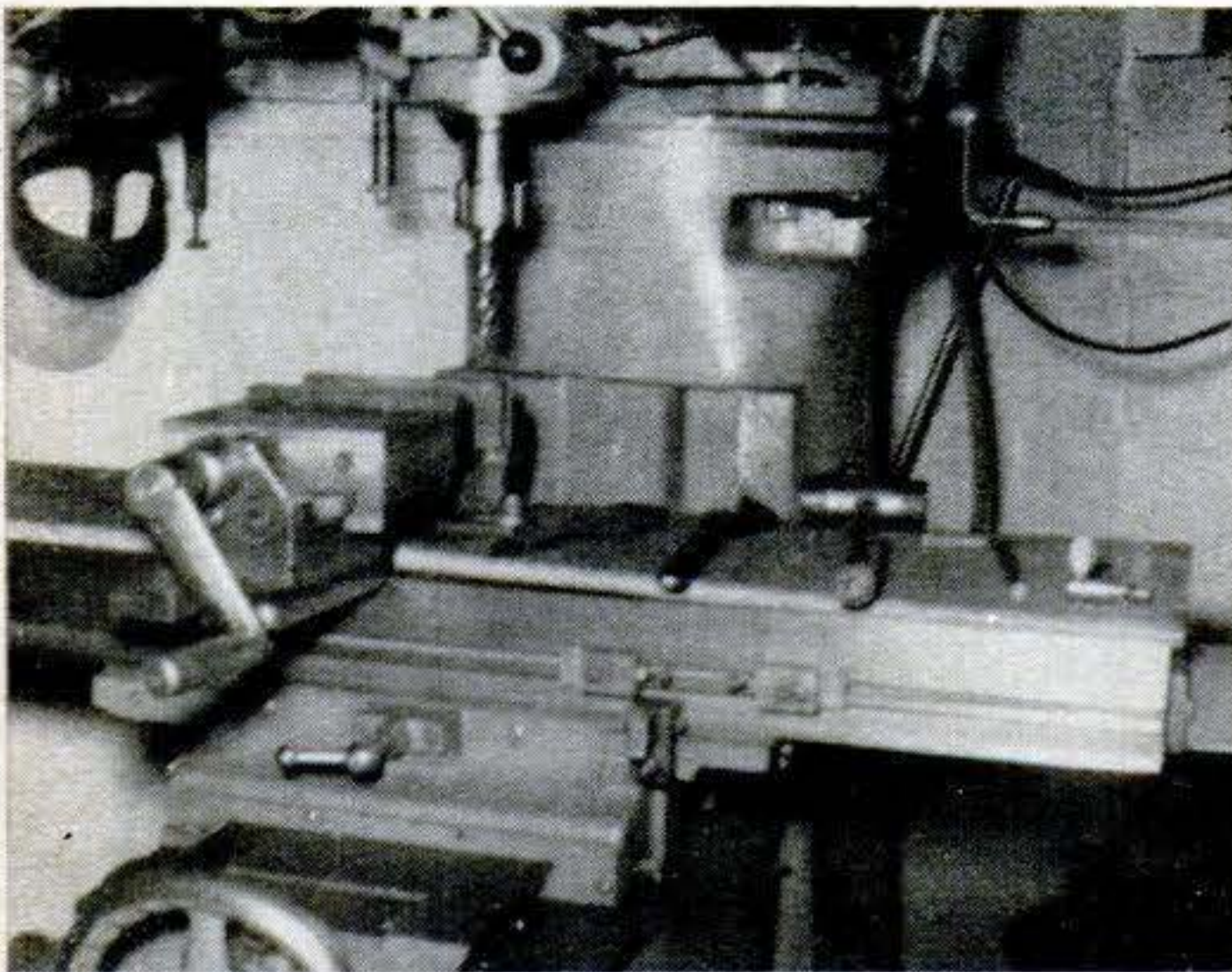
Shakeproof darkroom counter

In a basement, vibration is no problem; but upstairs, a counter is on less firm footing and may shake as you walk around.

To give my darkroom bench rigidity, I made this L-shaped design. Each section shortens the span of the other, lending support. I made one counter a step higher than

the other so the enlarger would be away from spilled solutions.

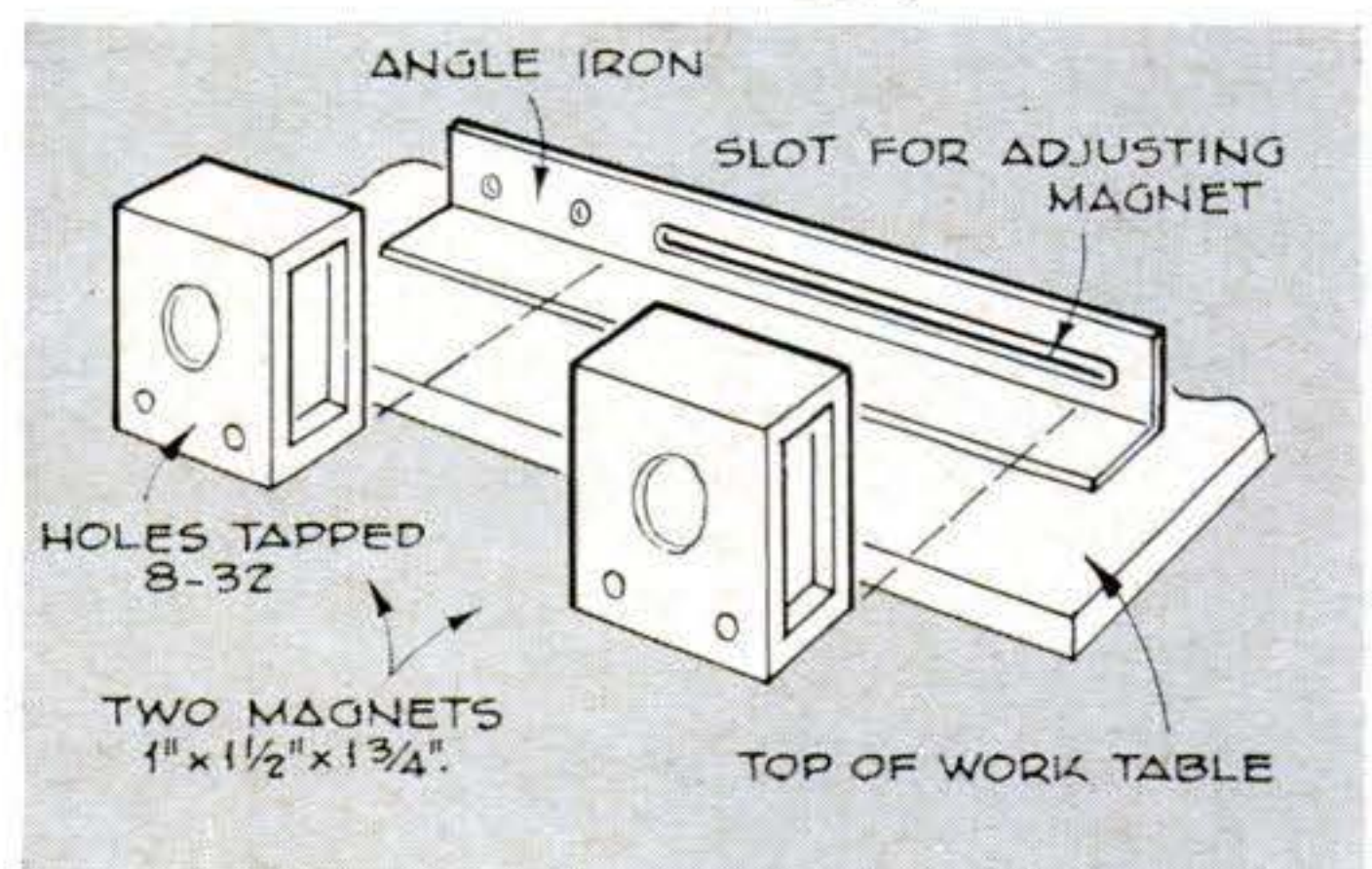
Particle board makes a surface that won't be warped by photo chemicals. Coat it with spar varnish or marine enamel to make it smoother and moistureproof. By ripping a 4'-by-8' panel down the middle, you get up to 16' of 2'-wide counter.—*Herbert R. Pfister, Glen Head, N.Y.*



Protecting a miller table top

Here's how to keep hand tools from marring the metal top of a vertical mill machine. Fit panels of $\frac{1}{2}$ " plywood over the table on either side of the detachable vise. To keep the panels steady, nail wood strips to the underside in line with the table slots. Easier cleanup, too: The slots don't fill with chips.—*R. Phillip, Oshkosh, Wis.*

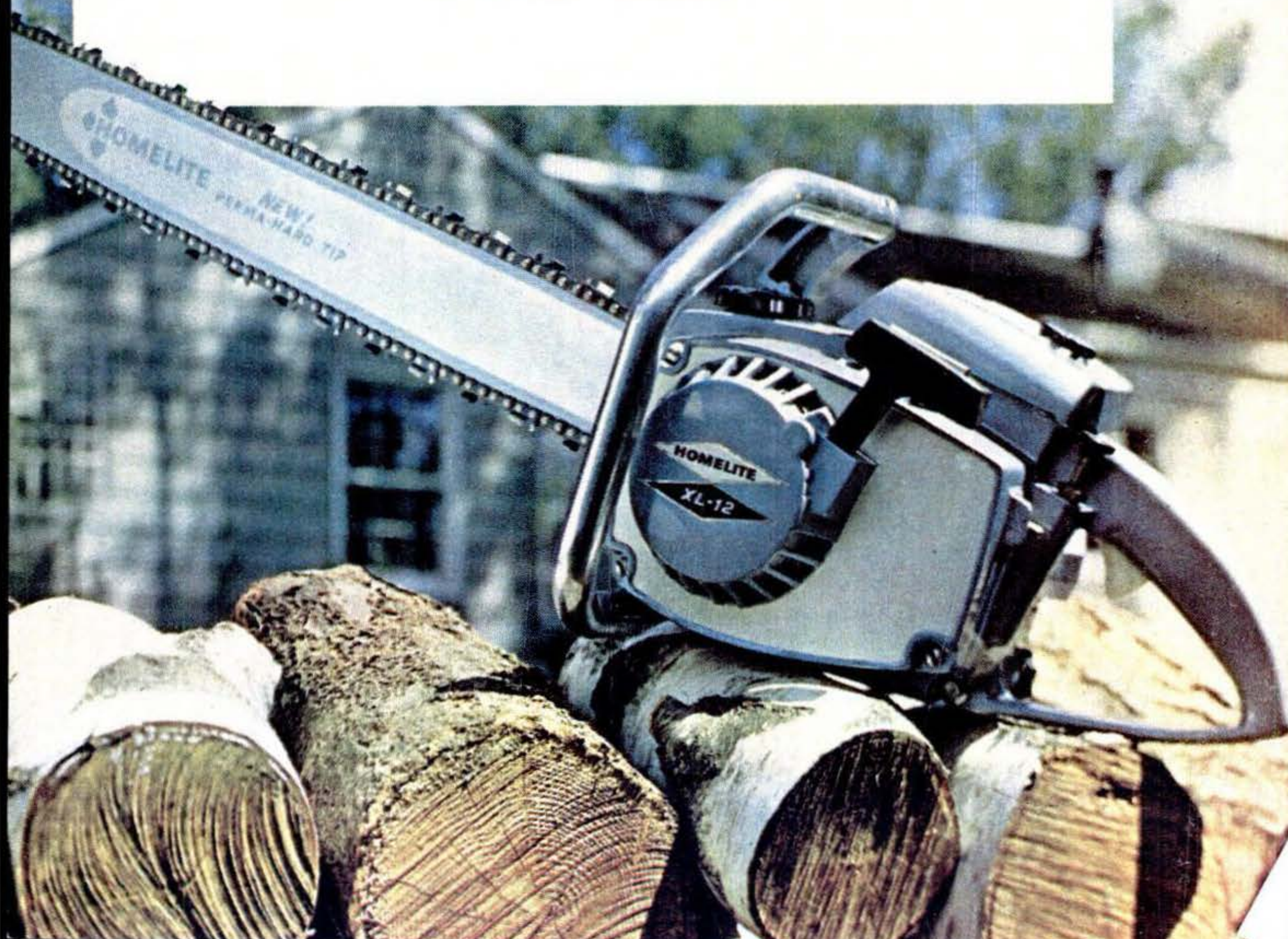
▶▶▶ I've got a trick I use when I have to bend a small bolt as much as 90 degrees. Usually it's hard to keep the bolt from breaking at the point of bend unless heat is used. I've found, however, that if I grind off a narrow band of threads where the bend will be, there's little chance of a break.—*James B. Russell, Dayton, Ohio.*



Used magnets make a welding vise

A strong, adjustable magnetic vise is a handy tool for light welding jobs. You can make one in short order. Scout the hi-fi stores for a pair of second-hand Alnico permanent magnets. They'll have plenty of juice left for your vise. You can use the finished unit as a tool holder, too.—*Peter Legon, Malden, Mass.*

**The Complete Guide
to Outdoor Woodcutting
with the
NEW HOMELITE
XL-12**



THE WORLD'S LIGHTEST

Weights only 12 pounds, cuts through 12-inch logs

THE NEW HOMELITE

Whether you're a professional pulpwood cutter or logger or you want to fill a fireplace, clear a campsite, do landscaping, repair storm damage, the Homelite XL-12 is for you. It provides the lightest, easiest, most economical way to do these and many other woodcutting jobs.

The Homelite XL-12 . . . its remarkable combination of light weight, power and performance represents the greatest advance in chain saw design and construction in the last decade. Here, for the first time, is a chain saw that has all the features that have made Homelite the top choice of professional woodcutters for years and it weighs only 12 pounds. You only have to try it in a few cuts to see how easy woodcutting can be. Even after using it for hours, you'll agree you have never handled a chain saw that cuts so fast with so little effort.



Easy Starting — weather proof ignition system with high voltage magneto and sturdy recoil starter gives you easy, instant starting in any weather, any climate.

Easy to Operate — ignition switch, chain oiler, choke and throttle can be operated by one hand in one position for fast, simple, safe operation.

Automotive Clutch and Safety Throttle — Chain stops when throttle is released and engine idles. Lock holds throttle open for fast starting, releases at a touch. Throttle pressure is required to start chain. Automatic clutch prevents engine from stalling if chain binds.

Flush Cut Handle — lets you cut level with the ground, leaves no unsightly stumps.

Narrow, Compact Design — is slim, trim and perfectly balanced for easy handling, easy cutting in any position. Safety chain guard throws chips and twigs down and out to protect operator and maintain cutting efficiency.

Built to Last — rugged die-cast construction gets maximum strength from cast-in structural members. Stands up to the toughest cutting jobs, worst possible abuse.

Direct Drive CHAIN SAW!

in 10 seconds, fells trees up to 3 feet in diameter.

XL-12 CHAIN SAW!

Famous Homelite Short-Stroke Engine — has more power-per-pound. Short piston stroke cuts friction, increases engine life, reduces gas consumption.

All-position Diaphragm Carburetor — lets you cut with the saw in any position, even upside down, with no loss of power. Butterfly choke gives positive control of air mixture for instant starting in any weather.

Easy-to-Clean Air Filter — protects your engine. Located away from flying sawdust, gives you lots of cutting time before it needs cleaning. Can be cleaned and replaced in less than a minute and re-used many times.

Positive Action Chain Oiler — operates at the touch of a button to lubricate chain and make cutting easier.

Husky Crankshaft — is mounted on case-hardened bearings for long life, and counter-balanced to eliminate vibration and reduce operator fatigue.

Pistol Grip and Guard — protect throttle from snagging, provide hold-down for easy starting.



THESE ARE JUST A FEW OF THE THE NEW HOMELITE

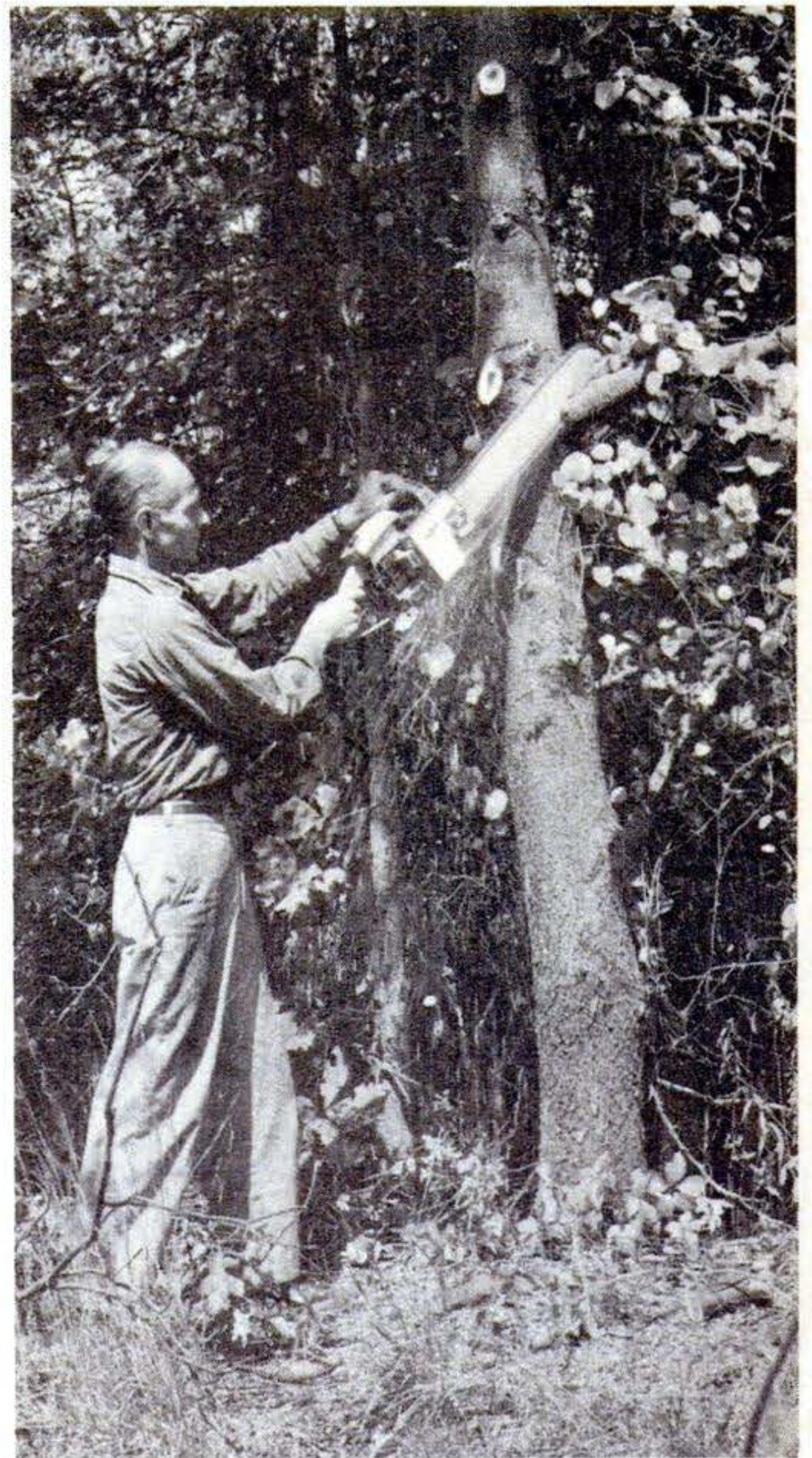


Cutting Firewood — One man with an XL-12 can cut more firewood in an hour than two men using a hand saw can cut in a day and with so much less effort. Just check the cost of cord wood in your area to find out how much you can save with the XL-12.



Repairing Storm Damage and Removing Dead Trees — With the XL-12, you can re-

move storm damaged or disease ridden trees quickly, easily and efficiently. Saves you money because it prevents further damage to property or spread of disease.



Pruning and Trimming — The XL-12 zips through 4" limbs in 2 seconds . . . makes it an easy matter to keep your orchard and shade trees healthy and attractive. The lightest direct drive chain saw in the world, it's easy to carry up into a tree. It's easier to use, too, because you can hold it at arm's length to reach distant limbs with less effort.

MANY JOBS YOU CAN DO WITH XL-12 CHAIN SAW!



Clearing a Campsite — The XL-12 is perfect for the outdoorsman. Light and easy to handle, you can carry it long distances without tiring. Lets you clear your campsite, cut firewood, cut lumber for shelters or cabins and clear fire lanes faster and easier than any other method.



Clearing for Landscaping — The flush-cut handle on the XL-12 lets you cut level with

the ground. Eliminates unsightly stumps and leaves your land neat and clean.



Professional Cutting — Pulp cutters, loggers, farmers, tree surgeons and wood lot owners will find the XL-12 a true production tool for turning trees into cash. Extreme light weight means less operator fatigue — you cut longer, faster and easier for extra income with an XL-12.

WOODCUTTING HAS NEVER THE NEW HOMELITE

A chain saw is the fastest and easiest way to cut wood. And there has never been a chain saw like the Homelite XL-12. Its remarkable light weight, power and performance represent the most significant engineering advances in chain saw design and construction in the last ten years. Until you use an XL-12, you can't imagine how easy it is to cut wood. Ask for a FREE demonstration at your Homelite Dealer's — there's one near you. Let him familiarize you with the handling characteristics of this great saw.

Anyone can cut like a professional with the XL-12. It's as easy as 1-2-3.



First, the Notch. Two quick cuts and it's done. The notch predetermines the direction in which the tree will fall.

**FOLLOW
THESE
EASY
STEPS**

FELLING

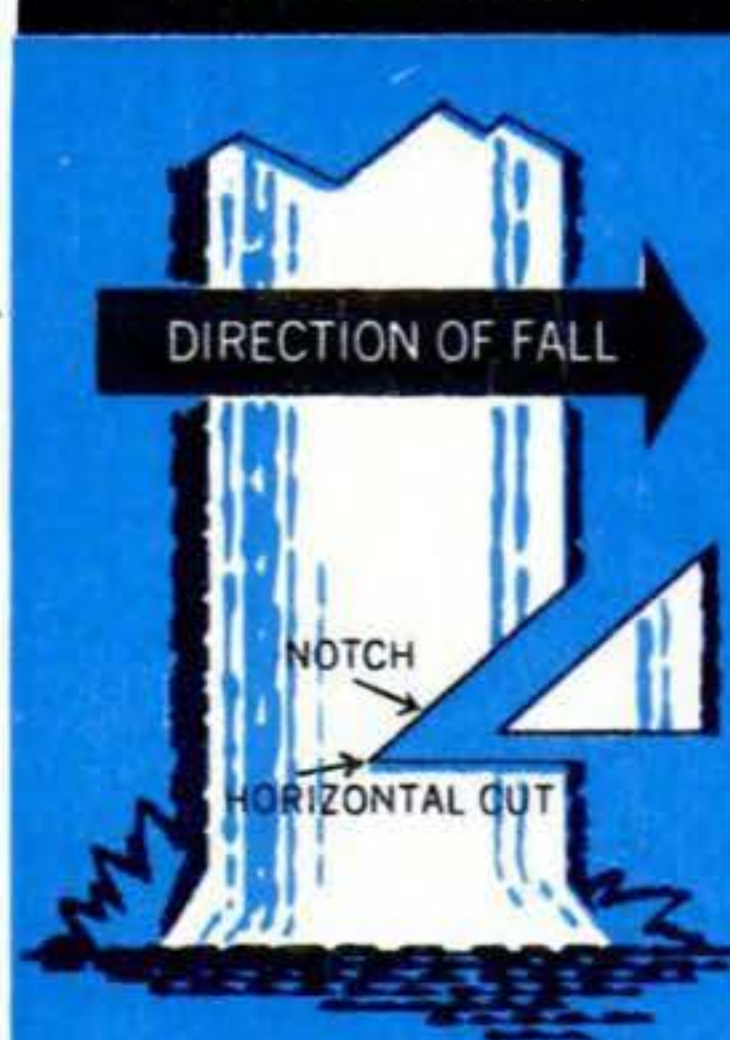


Figure 1 — Naturally you will want to clear a working area first. Then select a line on which you want the tree to fall ... giving consideration to the natural lean, wind, position of heavy branches. Cut notch on the side the tree is to fall. Notch should be $\frac{1}{4}$ to $\frac{1}{2}$ through tree.

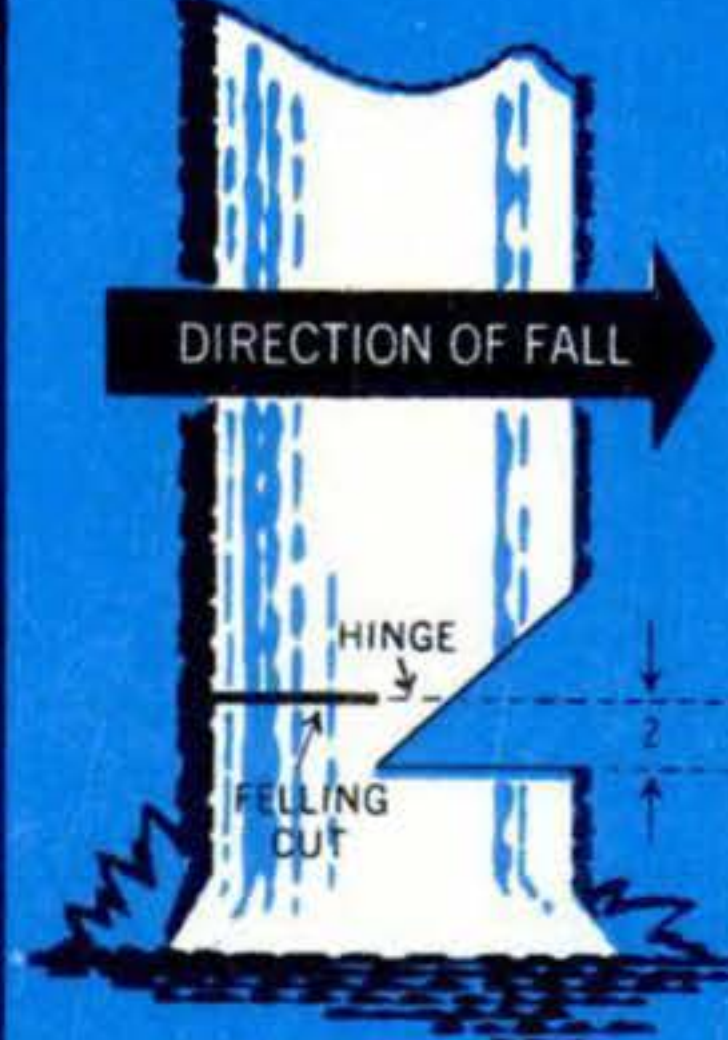
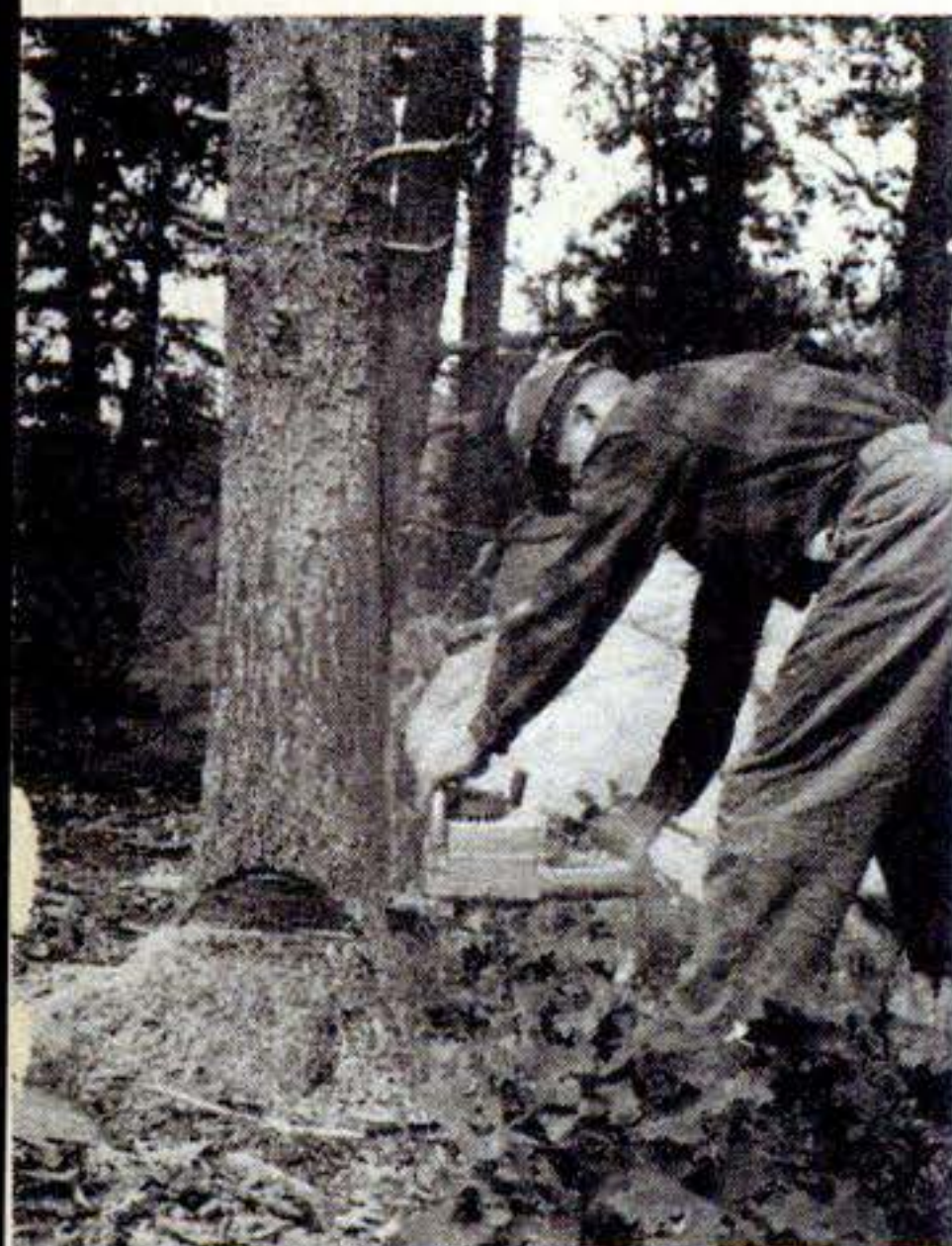


Figure 2 — Start felling cut on opposite side of tree at least 2" higher than horizontal cut of notch. (The larger the tree, the higher the felling cut should be above the notch.) Cut towards notch leaving a section of wood parallel to the notch as a hinge.

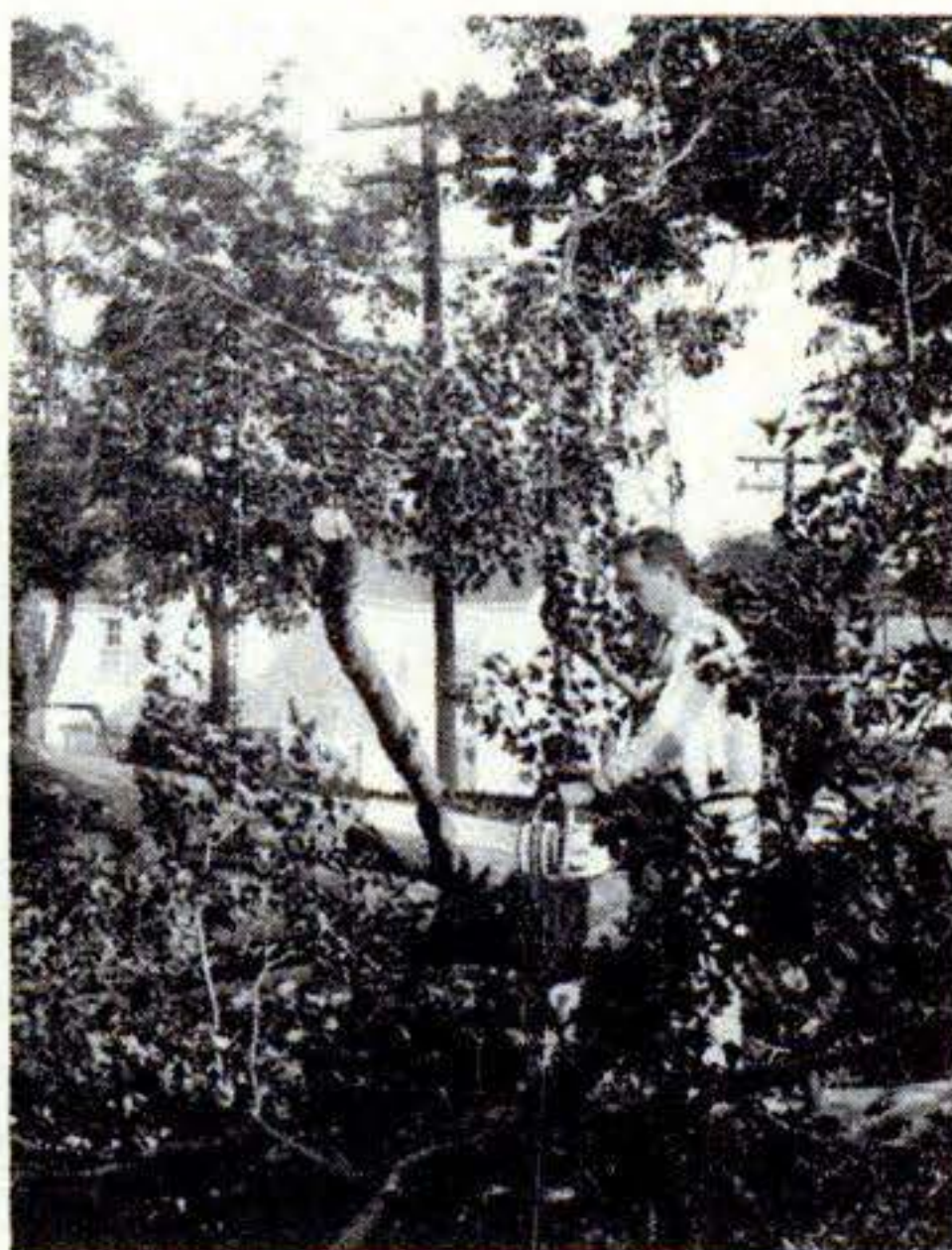


Figure 3 — Felling cut is made by placing bumper against the tree trunk, then cutting in an arc, pivoting on the bumper and keeping the cut parallel to the notch. As you cut, watch both cut and top of tree for signs of movement. The moment tree starts to tip, release throttle and get 20-25' back from the trunk. Keep alert.

BEEN SO EASY AS IT IS WITH XL-12 CHAIN SAW!



Next, the Felling Cut. Made on the side of the tree opposite the notch and slightly above it. Then, it's down she comes.



Second step, Limbing. Branches and limbs are trimmed from the trunk. The light weight XL-12 makes it quick, easy work even in cramped quarters like these.



Finally, Cut It Up. The professionals call it bucking. It means cutting the tree up into convenient lengths to fill your fireplace or for easy removal.

LIMBING



Figure 4 — Remove branches and limbs before bucking. Most cutting of small diameter limbs will be done with the end of the bar. On large diameter limbs, place bumper plate against the limb and pivot.



Figure 5 — Undercuts should be used on limbs supported at both ends. When using top or nose of saw to cut, hold your hip or thigh against rear of engine to steady the action of the blade in the cut.

BUCKING

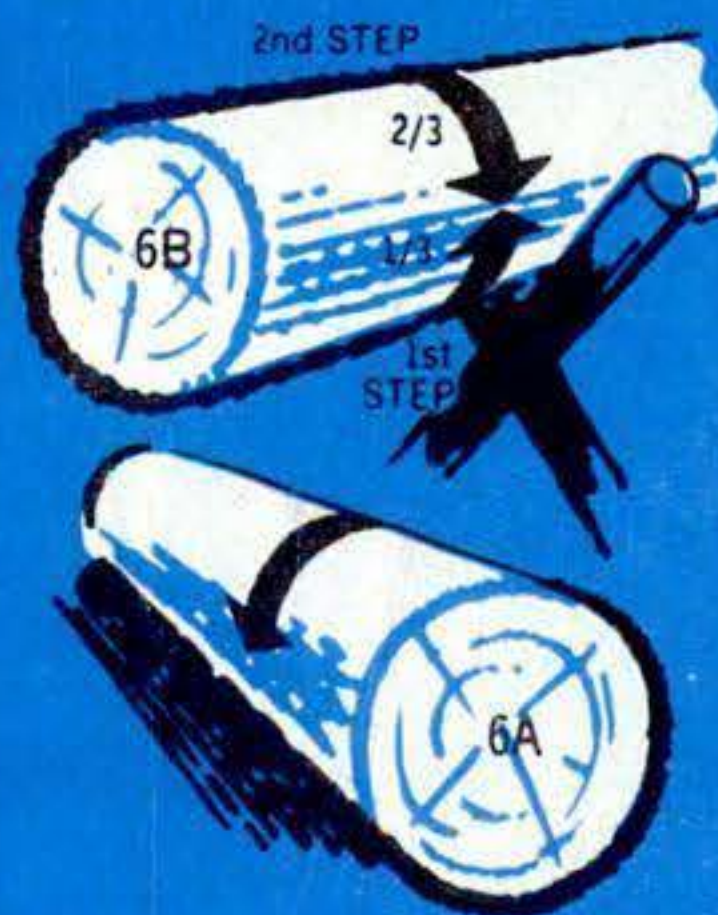
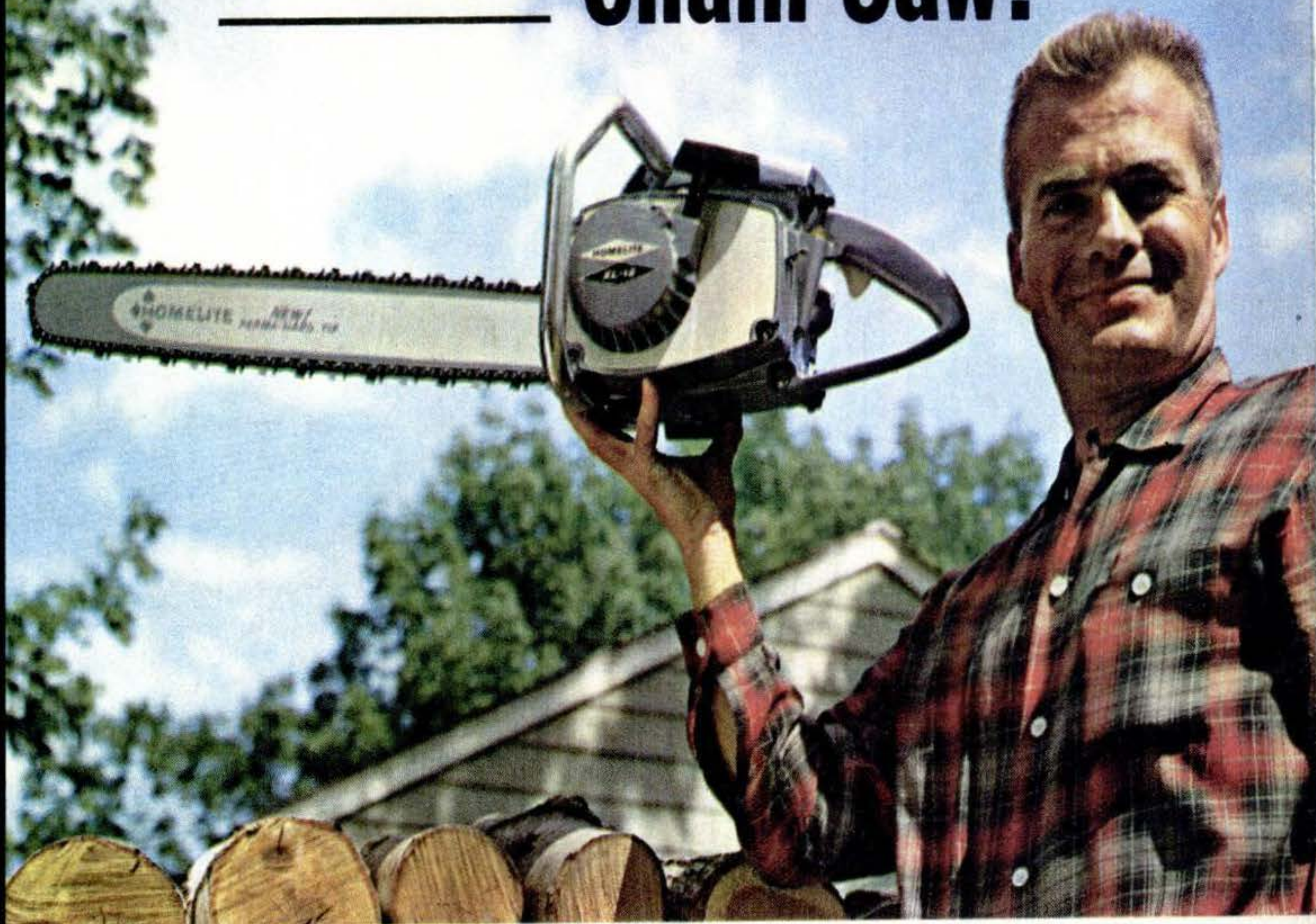


Figure 6 — Any log supported along its entire length can be cut through from the top (Fig. 6A, called overbucking). When a log is supported on one end, first cut 1/3 through from underneath, then finish bucking from the top so the log will fall away without splitting. (Fig. 6B)



Figure 7 — When the log is supported on both ends it would pinch the blade if bucked through from the top. To prevent this, cut 1/3 through from the top, then finish bucking from bottom up (called underbucking).

The World's Lightest Direct Drive Chain Saw!



HOMELITE A Textron
DIVISION
RIVERDALE AVENUE, PORT CHESTER, N.Y.

NEW HOMELITE XL-12

Only
12 lbs*

*less bar and chain

Cuts 12" Logs in 10 Seconds
Fells Trees Up to 3' in diameter

Now! A Powerful Chain Saw that Weighs Only 12 lbs.

less bar and chain



NEW HOMELITE XL-12

Try this remarkable new Homelite at your dealer's, now!

ARIZONA

Buckeye—O. S. Stapley Co.
Clifton—B & D Auto Supply
Colorado City—General Supply
Coolidge—O. S. Stapley Co.
Cottonwood—Verde Valley Lbr. Co.
Elroy—Cotton Chemical Co.
Flagstaff—Flagstaff Auto Supply Co.
Ft. Defiance—Ft. Defiance Trading Post
Fredonia—Judd Auto Service
Globe—Globe Hardware Co.
Heber—Crandell Power Saw Co.
Hereford—Nick's Place
Kingman—Bob's Auto Parts
Nogales—Escalada Bros.
Parker—Colorado River Charcoal Co.
Payson—Payson Auto Supply
Phoenix—O. S. Stapley Co.
Phoenix—Trimble Equipment Co.
Prescott—Prescott Auto Supply
Safford—Valley Electric & Machine Co.
Sawmill—Sawmill Mercantile
Snowflake—Hatch's Saw Shop
Tucson—F. Ronstadt Hardware Co.
Willcox—Willcox Auto Parts Co.
Williams—The 66 Auto Supply Co., Inc.
Winslow—Tate's Saw Shop

CALIFORNIA

Albany—Corey's
Alpine—Al Hinkle Lumber & Ranch Supplies
Alturas—Farmers Exchange of Modoc, Inc.
Anaheim—Associated Wood Sales, c/o Barney Thole
Arbuckle—Diamond National Retail Store
Armona—Danielson's Hardware
Arroyo Grande—Farm & Home Supply
Arvin—E. O. Mitchell, Inc.
Atascadero—Layton Tree Service
Atwater—Western Auto
Auburn—Sierra Saw Shop
Bakersfield—Inland Equipment Co.
Bakersfield—Janco Pump & Engine Company
Baldwin Park—C. R. Cook
Banning—Rosa's Small Engine Service
Belmont—Belmont Hardware
Biola—Biola Auto Parts
Bishop—Joe's Garage
Bodfish—Allen's Sales & Service
Brentwood—C & H Tool Center
Buellton—Thomas B. Garland
Campbell—Hitchcock's Garden Tool & Supply
Chico—Butte Pump Co.
Chico—Lassen Pumps
Chowchilla—Farmers Hardware & Supply
Cloverdale—Cloverdale Homelite Saw Center
Cloverdale—Moore Brothers Equipment Co.
Clovis—Clovis Power Tools
Coalinga—Westside Pipe & Supply Co.
Celusa—Thompson's Saw Shop
Corcoran—Sawtelle & Rosrim
Corning—Fichter & Sons
Crescent City—Marion's Saw Shop
Cutler—Cutler Saw Shop
Delano—Valley Implement Co.
Del Mar—Del Mar Patio Shop
Del Rey—Del Rey Hardware Co.
Dinuba—Smith Auto Parts
Dixon—Solano Tractor & Equipment Co., Inc.
Des Pales—Nord's Boats & Motors
Dunsmuir—Dunsmuir Auto Parts

El Cajon—Ideal Saw & Lawn Mower
Elsinore—Rollie's Garage
El Sobrante—Banducci's
Esparta—Diamond National Corp.
Eureka—Western Chain Saw Company

Fairfield—Diamond National Corp.
Fair Oaks—Diamond National Corp.
Fair Oaks—Western Auto Store
Fall Brook—Village Rentals
Felton—Felton Hardware Co.
Fillmore—Valley Ford Tractor
Folsom—Folsom Saw & Mower Shop
Ft. Bragg—Redwood Chain Saw Co.
Fort Jones—F. J. Repair Service

Gaberville—Mr. Clarence F. French
Gilroy—Jim's Sport Shop
Glennville—Ranchers Supply Co.
Goleta—Goleta Tractor Service
Grass Valley—Cook & McQuinn
Greenfield—F & S Hardware
Guadalupe—Guadalupe Hardware Co.
Gustine—Azevedo Hdwe. Co.

Hanford—Harrison Motor Parts
Happy Camp—Herman's Saw Shop
Hayfork—Sebring's
Hemet—Frank Regur Hardware
Hemet—Gibbel Hardware
Highland—Baseline Machine Works
Hollister—Hollister Tractor & Equipment Co.
Hoopa—Hoopa Saw Shop

Jackson—Spinetti Brothers
Johnsondale—Jim Hearn's Chain Saws
Julian—Cross Chevron Station
June Lake, Mono County—Sierra Sales & Service

King City—A-D-H Company
Kingsburg—Citizen's Lumber Co.
Knights Landing—Sutter Appliance & Hardware Co.

Lafayette—Modern Mower Co.
Lakeport—Puetts Garage
Lancaster—Pay-N-Save Hardware & Feed
Leggett—Turk's Chain Saw Service
Le Moore—Harrison Motor Parts
Livermore—Diamond National Corp.
Livingston—Louies' Saw Shop
Lodi—Wright's Garage
Los Angeles—Central Rentals
Los Banos—Bressler's Auto Electric
Lower Lake—Lower Lake Irrigation & Supply Co.

McArthur—Eilt's Grocery & Chain Saw
Madera—Howard Road Shop
Mariposa—Stroming Machinery Co.
Markleeville—Alpine Hotel
Martinez—Berger's Lawn Mower & Saw
Marysville—Burchell Hdw. Co.
Mendota—Westside Hardware, Inc.
Menlo Park—Leonard Bugna & Son
Merced—Parker's Hardware
Merced—A. W. Polzine
Mission San Jose—Mission Bldg. Supply
Modesto—Appliance Sales & Service
Monrovia—Saw Supply Co.
Montclair—Wolfe & Sons
Morro Bay—Hayward Lumber Co.

Napa—Lackey's Nursery
Napa—Ritz Tractor & Equipment Co.
Nevada City—Mr. Bert A. See
Norco—Taylor's Builders Mart
North Fork—North Fork Home & Auto Supply
Northridge—Purcell's Garden Equipment
Novato—Novato Equipment Service

Oakdale—Oakdale Sharpening Service
Oakhurst—Oakhurst Chain Saw Sales & Service
Oakland—Simon Hardware Co.
Oakland—U.S. Hardware & Supply Co.
Olancho—Owens Lake Garage
Orange—AAA Rentals
Orange Cove—Orange Cove Lumber Co.
Orick—Orick Saw Shop

Orland—Thomas Auto Parts
Oxnard—Maulhardt Equip. Co.
Oxnard—Maulhardt Equip. Co.

Paradise—Diamond National Corp. Store
Parlier—Jimmie's Place
Paso Robles—Paso Robles Auto Parts
Petaluma—Petaluma Pump & Well Co.
Pico Rivera—Rental Yard Supply Corp.
Placerville—Bradford Power Tool
Point Arena—Jack's Small Engine Service
Porterville—Davis Equipment & Marine Supply Co.
Poway—DeMartini's

Quincy—Addison-DuPont

Raymond—Shull's General Store
Red Bluff—Chet's Chain Saw
Redding—Stroup's Chain Saw
Reedley—Shaw's Ridgefield
Reedley—Ted's Engine & Mower Service
Richmond—Mobile Saw Service
Rio Dell—Wilson's Saw Shop
Rio Vista—Oil Wells Material Co.
Riverside—Ken's Tool & Supply Co.
Roseville—Diamond National Corp.
Ryde—McCoy's Service Shop

Sacramento—Bar Hein Trac. Co.
Sacramento—Fuji-Variety & Hardware
Sacramento—Luttig & Severson
Sacramento—Newbert Hardware & Implement Co.
St. Helena—Steves Hardware
Salinas—Fred Ash & Sons
San Andreas—Jensen's Calaveras Builders Supply
San Francisco—F. G. Norman & Sons
San Francisco—Ocean View Hardware
San Francisco—Park Presidio Sporting Goods
San Francisco—Shasta Hardware & Supply Co.
Sanger—Sanger Nursery
San Jose—Precision Saw Shop
San Leandro—Power Tool & Saw Service
San Luis Obispo—Noble Saw Service
San Mateo—Bayshore Rentals
San Rafael—Davis Saw Service
Santa Ana—Orange County Equipment Co.
Santa Maria—A-A Equipment
Santa Monica—P. O. Bahn & Sons
Santa Rosa—Gardeners Aid
Selma—Anderson's Auto Parts
Shaver Lake—Shannon's Hardware
Stockton—Nomellini Tool Rental
Stratford—Orton's Equipment Co., Inc.
Susanville—Eilts Machine Shop

Taft—Tasco Auto Parts
Tahoe City—Mr. Robert J. Wray
Tahoe Valley—St. Clair Saw Service
Tarzana—Tarzana Garden Equipment
Tehachapi—Pete Vukich Irrigation Supply
Tulare—Stuart & Sons Garage
Turlock—Farm Equipment Center
Twain Harte—Twain Harte Chain Saw

Ukiah—Stanton Equipment Co.
Visalia—Mineral King Equipment
Vista—Don Stowe

Walnut Creek—Diablo Rental
Watsonville—Zenker Hardware & Appliance
Willits—Willits Hardware & Building Materials Co.
Willows—Twin Sales & Service
Winters—Diamond National Corp.
Woodlake—Woodlake Growers Supply Co.
Woodland—Sterlang May Co.

Yreka—Houston Car & Home
Yuba City—Jim Clark's Sales & Ser.

COLORADO

Antonito—Curtis Motor Co.
Aspen—Aspen Lumber & Supply Co., Inc.

Bayfield—Cooer's Service
Boulder—Rental Service Co.
Boulder—Western Tree Service

Burns—Derby Creek Junction Store

Carbondale—Catherine Store
Castle Rock—P & H Builders
Collbran—Collbran Supply

Colorado Springs—Bishop-Hill Tool & Paint Co.
Cortez—Belden Motor Service
Craig—Grounds Repair Shop

Del Norte—Bill's Garage
Denver—Engine Clinic
Dillon—Bailey's
Dolores—Taylor Hardware
Durango—Hub Supply

Eagle—Eagle Machine & Supply Co.
Estes—Estes Park TV Co.
Estes Park—Rocky Mountain Traders
Evergreen—Evergreen Lumber Co.

Florence—Corning Repair Shop
Fort Collins—Toliver Kinney Mercantile Co.
Fraser—Bill's Repair

Glenwood Spring—Mountain Electric & Refrigeration
Golden—So. Beaver Lbr. Inc.
Golden—Meyer Hardware & Sporting Goods
Grand Junction—Odds & Ends
Grand Lake—Trail Ridge Marina
Granite—Cureton Saw Mill, Twinlakes
Greeley—Ellis-Cap Equipment Co.
Green Mountain Falls—Mr. M. L. Woods
Gunnison—Farris Chain Saw Shop
Gunnison—Gunnison Hardware

Hotchkiss—Anderson Independent Co.

Idaho Springs—Clear Creek Supply Co.
Ignacio—Wiseman Hardware & Lumber Co.

Julesburg—Mr. Judd Russell

Kremmling—Kremmling Timber Co.
Kremmling—Smokey's Lumber Co.

Lajunta—Pearsall Eng. Ser.
Lake City—Lone Pine Station & Store
Lamar—Felter Motor Co.
Laveta—Bailey's Propane

Leadville—Vienna Appliance Center
Longmont—Dave's Marine
Loveland—Klitzke Bicycle Shop

Meeker—L. E. Idol & Co.
Meredith—Howard I. Dearhamer Gen. Merch.
Montrose—Uncompahgre Trac. & Equipt. Co.

Naturita—Williams Lumber Co.
Norwood—Norwood Hardware

Pagosa Springs—San Juan Supply
Palisades—Anderson Independent Co.
Paonia—Anderson Independent Co.
Pine—C. Eden
Placerville—San Miguel Motor Co.
Pueblo—Engine & Mower Service

Rifle—Anderson Independent Co.

Salida—J. C. Patterson Hardware Co.
Steamboat Springs—L. A. Phillips
Sterling—Al's Repair & Cycle

Toponas—Mr. Earl C. Jones
Trinidad—Barney's Garage & Implement

Walden—Bob's Chain Saw Service
Woodland Park—Artcraft Shop

IDAHO

Ashton—Don Christiansen
Avery—Ed's Saw Shop

Blackfoot—Morrell's Repair Shop
Boise—Cesco
Bonners Ferry—Cook's Battery & Ele. Ser.
Burley—Bill Jones Automotive Shop

Caldwell—Service Parts Co.
Carey—Adamson's
Challis—Jenson Oil Co.
Coeur d'Alene—Kootenai Saw & Marine Supply, Inc.
Council—Council Hardware

Deary—Mick's Saw Service
Driggs—Mr. James A. Hunter

Elk City—Elk City Saw Service
Emmett—Citizens Lumber Co.

Grangeville—Tackett's Saw Service

Idaho City—Robison's Parts & Service
Idaho Falls—Young's Timber Yard & Co.

Jerome—Van Orman Hardware

Kamiah—Al's Saw Shop
Ketchum—Ketchum Chain Saw Service

Lewiston—John's Homelite Ser.

Mackay—Western Auto Supply
McCall—Service Parts Co.
Montpelier—Tri-State Inc.
Mt. Home—Service Parts Co.
Murtaugh—Starry's Market

Nampa—Campbell Tractor & Impl. Co.
Nampa—Service Parts Co.

Orofino—Orofino Saw Service
Osburn—Benson's Sportsman Supplies

Payette—Service Parts Co.
Pierce—Engles Saw Shop
Plummer—Benewah Hardware
Pocatello—Precision Saw & Tool Co.
Pottlatch—Mr. Glenn Atkison
Preston—Preston Implement Co.
Priest River—Parsons Sales & Service

St. Anthony—Jay's Tune Up
St. Maries—Charlie's Saw Shop
Salmon—Service Parts Company
Sandpoint—Ames & Oliver
Shoshone—Idaho Grange Wholesale

Tuttle—Penta Post & Treating Co.
Twin Falls—Shotwell's Utility Ser. Co.

Weiser—Service Parts Co.

MONTANA

Anaconda—Anaconda Service Station

Billings—Rental Equip. Co.
Billings—Satre Motor Ser.
Bozeman—Harold's Auto Shop
Browning—Gambles Store
Butte—Farmer's Union Trading Co.

Columbus—Automotive Service
Conrad—Arnot's

Decker—Elder Repair Shop
Deer Lodge—Davis Farm Supply

Dillon—E & H Ford Sales, Inc.
Drummond—Lacy's Supply

Eureka—Vern's Saw Repair

Fairfield—Fairfield Building Supply
Forsyth—Wallin Mercantile
Frazer—Dassonville General Merch.

Glasgow—Markle's Warehouse
Grass Range—Newberg Motor Co.
Great Falls—General Distributing Co.

Hamilton—Bill's Saw Service
Hardin—Marshall-Wells Store
Helena—Brownlow Machine Works
Helena—Fred A. Melick

Kalispell—Chain Saw Sales & Service

Lewistown—Horning Implement Co.
Libby—Parson's Sales & Service, Store #2
Lincoln—Garland's Town & Country St.
Livingston—Coast To Coast Stores

Martinsdale—J & S Repair Shop
Miles City—Smitty's Lock Key & Speedometer Service
Missoula—Missoula Chain Saw Supply

Philipsburg—Jack's Saw Shop
Plains—Don's Saw Service
Polson—Carl's Union Service

Red Lodge—Carbon Implement
Ronan—Davies Farm Supply
Roundup—G. W. Sealey Saw Sales
St. Ignatius—Gamble's Store
Sidney—Hein Implement
Superior—Don McMullin

Townsend—Neifert-White Co.
Trout Creek—Kraus' Garage

White Sulphur Springs—Castle Service
Wise River—Wise River Club

NEVADA

Carson City—Flanders Sea & Ski Shop

Elko—Elko Tractor Sales & Service
Ely—Harvey W. Young Co.

Fallon—Van's

Gardnerville—Carson Valley Mercantile Co., Inc.

Las Vegas—Blystone Equipment Co. of Nevada

Reno—Auto Electric
Reno—Commercial Hardware Co.

Winnemucca—Victory Supply Co.

Yerington—Yerington Hardware

NEW MEXICO

Albuquerque—Brown's 2-cycle Service

Cedar Crest—Twin Pines Repair

Eagle Nest—J & M Food Market
Española—Española Radio & Appliance

Farmington—Basin Builders Supply

Lindrith—Lindrith Oil Co.

Magdalena—Magdalena Trading Post
Mescalero—Big Chief Station, c/o Mr. Paul Brusulas
Mora—Mora Valley Oil Co.

Park View—Wheeler Supply Co.

Reserve—Five Bar Ranch Store
Ruidoso—Ruidoso Auto Parts

Sacramento—Buckner's Grocery
Santa Fe—Coffee Chain Saw Shop
Santa Rita—Wigwam Distributors, Wigwam Ranch

Taos—Ilfield Hardware & Furniture Co.
Taos—Taos Ski Valley, Inc.
Thoreau—Johnnie's Inn and Lumber Co.
Truchas—The Tafoya's Truchas

OREGON

Albany—Snell Tool Rental
Ashland—Eberhart's
Astoria—Svensen Saw Shop
Astoria—Lyle's Garden Center

Baker—Omer F. George, Sales
Bandon—A & B Supply
Beaverton—Beaverton Rentals Inc.
Beaverton—Snead's Rental Needs
Bend—Frank's Specialized Service
Brookings—Loring's Sales & Service

Canyonville—Harry's Saw & Sign Shop
Castle Rock—Johnson's Engine Service
Cave Junction—Lewis Saw Shop
Clatskanie—Puzey Machine & Sheet Metal Work
Coquille—Davison Filing Shed
Corvallis—Fred's Saw Shop
Cottage Grove—Wolfard Equipment Co.

Dallas—Dallas Welding & Boiler Shop
The Dalles—Dielschneider Equip. Co.
Drain—Cook's Saw Shop

Eagle Creek—Len's Rigging Shop
Enterprise—Hahn's Machinery & Supply
Eugene—Alber's Feed & Farm Supply
Eugene—Empire Chain Saw Co.

Fall City—Loiselle Saw Shop
Florence—Joe's Saw Shop

Gates—Marshall's Saw Shop
Gladstone—Clackamas County Grange Supply, Inc.
Glendale—Steve's Saw Shop
Glide—Glide Sporting Goods
Gold Beach—Remy's
Grants Pass—Pope's Saw Shop

Halfway—Western Auto Supply
Hepner—Gilliam & Bisbee Hardware Co.
Hermiston—Oregon Hardware & Sporting Goods
Hillsboro—Hillsboro Implement Co.
Hines—John Woods
Hood River—Foster's Saw Shop

Junction City—Monty's Sales & Service

Kinzua—DeMeritt's Saw Shop
Klamath Falls—A. H. Stewart Co.

Lagrange—Two G. I's Supply Center
Lakeview—Albertson Tractor Co.
Lebanon—Hosking Loggers Supply Co.

Maupin—Murray's Merchandise & Machinery Co.
McMinnville—Cascade Tractor & Implement Co.
Medford—M & W Chain Saw Sales
Milton-Freewater—Blue Mountain Logging Supply
Milwaukee—Ashland Bros. Rental
Molalla—Weeks Saw Shop
Mt. Vernon—Mt. Vernon Garage
Myrtle Point—Mike & Fritz

North Bend—Coos Bay Saw Co.
Nyssa—Service Parts Co.

Oak Grove—Oak Grove Supply Co.
Oakridge—William's Repair Service
Ontario—Service Parts Co.
Oregon City—Albers Feed & Farm Supply

Pendleton—Zimmerman & Co.
Pilot Rock—Mentzer & Elliott
Portland—Allison & Carey
Portland—Andrews & Andrews Equipt. Co.
Portland—Ever Ready Hardware
Portland—Karl's Machine Shop
Portland—Mariner's Supply
Portland—Mt. Hood Supply Co.
Portland—United Rent-Alls
Portland—Walters Hardware Co.
Portland—Weimer's
Portland—Wilson Lawn Mower Shop

Reedsport—Reedsport Outdoor Store
Roseburg—Cari Peetz Saw Shop

St. Helens—Sunset Equipment
St. Paul—Ernest Hardware
Salem—Thede's Marine
Sandy—Lewis Coast-to-Coast Hardware
Seaside—Hoyer's Homelite Sales & Ser.

Seaside—Lyle's Garden Center
Silver Lake—Silver Lake Garage
Silverton—Silverton Feed & Supply
Stayton—Bob James Mower & Tiller Shop
Sweet Home—Sweet Home Equipment

Tigard—Tidwell Sales & Mfg.
Tillamook—Engle's Saw Service
Toledo—Toledo Saw Shop

Vernonia—Keasey's Saw Shop

Wecoma Beach—Ed's Saw Service & Supply
Wheeler—Dell Curtis Moorage

UTAH

Beaver—Bradshaw Auto Parts

Cedar City—Sheffers Sales & Service

Ephraim—The Johnson Company
Escalante—Steel Enterprises, Inc.

Fairview—Mr. Keith S. Hansen
Fillmore—McBride Lumber Co., Inc.
Ft. Duchesne—Great Lake Timber Co.

Hanna—Fabrizio & Sons
Heber—Anderson Implement & Hardware
Heber City—Huber-Wilson Equipt. Co.
Hooper—Haws Sales & Service
Hurricane—Graff Mercantile

Kamas—Blizzard Lumber Co.
Kamas—Kamas Valley Lumber Co.
Kanab—Mr. Owen A. Johnson

Logan—Billmark Sporting Goods, Inc.

Manila—Mr. Lawrence P. Biorn
Manti—Manti Home Supply
Moab—Three States Supply, Inc.
Monticello—Wyman H. Redd

Neola—John E. Larson

Ogden—Darrell's Distributing
Orderville—J. E. Crofts & Sons
Orem—The Sportsman

Panguitch—Crofts & Pearson Industries
Price—Price Commission Company
Provo—Custom Engine & Machine

Randolph—Hoffmann Tractor Service
Richfield—Christensen Machine & Supply Co.
Roosevelt—Leavitt Equipment, Inc.

St. George—Pickett Lumber Company
Salinas—Allred Bros. Machine Welding Shop
Salt Lake City—Gallenson's & Associates
Salt Lake City—Joe's Sporting Goods & Equipment
Springville—Utah Service, Inc.

Tabiona—Wagstaff Lumber Co.
Tremonton—Family Farm Store

Vernal—Searle Electric & Appliance

WASHINGTON

Amboy—Neal Building Supply
Arlington—Mr. Harold T. Olson
Auburn—Bob Klontz Sporting Goods
Auburn—Valley Supply Co-Op

Battle Ground—Clark County Dairymens Coop.
Belair—Sande Boat Works
Bellevue—Bellevue United Rent-Alls
Bellevue—Eastside Mower & Rental
Bellevue—Eastside Rental & Equipment
Bellevue—Lathrop Gun Shop, Inc.
Bellevue—Reinhardt's Hardware
Bellingham—Arnett Sales
Benton City—Benton City Hardware & Appliance
Bothel—Chas. R. Waters Co.
Bothel—The Tool House
Bremerton—Stenerson's
Bridgeport—Moen's Marina
Burien—Burien United Rent Alls

Camas—Camas Welding & Machine
Carnation—Remington's Shell Service
Castle Rock—Johnson's Engine Service
Cle Elum—Mr. Andrew F. Bator
Chehalis—Buck & Son Farm Equipment Co.
Cheney—Ed's Conoco Service
Clinton—Hunter Auto Service
Colfax—Burns Auto Parts, Inc.
Colville—Dominion Motors
Concrete—Homer's Saw Shop

Davenport—Harrington Machinery Co.
Dayton—Bills Richfield Service
Deer Park—Swinyard Service
Des Moines—Blais Of Des Moines
Duvall—Duvall Motors

East Stanwood—Lake Goodwin Resort Co.
East Stanwood—Twin City Auto Parts
Edmonds—Miller's United Rent-Alls Co.
Ellensburg—Rathbun Implement Co.
Enumclaw—Hinshaw's
Ephrata—Mid-State Supply Co.
Everett—Cascade Tractor Co.
Everett—Harry "Kid" Mathews Rent All
Everett—Loggers Service & Supply

Federal Way—The Tog House, Inc.
Forks—Peninsula Loggers Supply
Friday Harbor—San Juan Agricultural Co.

Gig Harbor—Coast to Coast Stores
Gig Harbor—Len's Service
Graham—Erickson's Graham Garage
Grand Coulee—W. K. Boll
Grandview—Killingstad Hardware
Granger—Clay Bells
Goldendale—Goldendale Equipment, Inc.
Hoquiam—F. G. Foster, Inc.

Issaquah—Grange Supply Co.
Issaquah—Lewis Hardware

Kennewick—Bennett Rentals
Kennewick—Washington Hardware & Furniture Co.
Kent—Burdic Feed Stores
Kent—Gib's Cars & Rentals
Kent—Tool Crib Of Kent
Kingston—Smiley's Auto Service
Kirkland—Lakeside Hardware Co.

Leavenworth—Mottelers Farm Store
Long Beach—Bailey's Saw Shop
Longview—Manthe Equipment Co.
Longview—Valley Rentals
Lyle—Hamm's Chevron Service
Lynden—Albers Feed & Farm Supply
Lynden—Ohlson Tractor & Implement Co. Inc.
Lynnwood—Davis Equipt. Rentals Sales & Ser.
Lynnwood—Nursery 99

Manson—Chelan-Manson Co-op Ass'n, Inc.
Maple Valley—Craft Center
Maple Valley—Jim's Trading Post
Marysville—Marysville United Rent-Alls
Mercer Island—Mobile Supply Co.
Mercer Island—Western Auto Associates
Metaline—Mr. C. W. Carroll
Millwood—Karrer Gunitorium
Monroe—Monroe Hardware & Sporting Goods
Morton—Warren Logging Supply
Mt. Vernon—Bert Robinson Hardware & Appliance Co.
Mt. Vernon—Ohlson Trac. & Impl. Co. Inc.
Mt. Vernon—Skagit Co-op

Naselle—Naselle Saw Shop
North Bend—Fred Lewis Ford, Inc.
North Bend—Summit Inn, Inc.

Oak Harbor—Motor Repairs
Oak Harbor—Oak Harbor Feed Co.
Oakville—Oakville Auto
Olympia—Fourth Ave. Garage
Olympia—Lew Rents - Olympia Hardware Co., Inc.
Omak—A. L. Ward Co.

Pasco—Grigg Building Supplies
Pasco—Kelley's Lawnmower Service
Pomeroy—Hill's Honda Sales & Service
Portage—Engels Repair & Towing
Port Angeles—Ron Buck Sales
Port Orchard—Nelson's Repair
Port Orchard—T. B. M. Hardware & Furniture
Port Townsend—Olympic Natural Gas
Poulsbo—Poulsbo Lumber Co.
Prosser—Baker Implement Co.
Pullman—Pullman Tractor & Implement Co., Inc.
Puyallup—Kirk's Kozy Corner
Puyallup—Paulson Motor Co.
Puyallup—Ranier Tractor & Equipment Co.
Puyallup—Smith's Grocery Service

Quilcene—Magee's Chain Saw Service
Quincy—Owyhee Welding & Repair

Raymond—F. G. Foster Co., Inc.
Raymond—Pacific Wholesale, Inc.
Redmond—East Side Mower & Rental
Redmond—Hollingsworth Co.
Redmond—Stocum Hardware
Redondo—Redondo Marine Sales
Renton—Red & White Construction
Renton—Seattle Sporting Goods, Inc.
Renton—United Rent-Alls, Forte, Inc.
Republic—Republic Boats and Motors, Ben Butler
Ridgefield—Larson's Supply
Rosalia—Farm Supply

St. John—Ray's Appliance & TV
Seattle—Aamons United Rent-Alls
Seattle—A. A. Rentals
Seattle—Aleutian Cold Storage Co.
Seattle—Aurora Rents, Inc.
Seattle—Bon Marche
Seattle—Don Bobo's Lapidary Products
Seattle—Paul H. Eaton, Sr.
Seattle—5 Corners Service

Seattle—Eltee Tool & Supply Co.
Seattle—Empire Way Seed & Garden
Seattle—Fisheries Supply Co.
Seattle—Georgetown Hdw. Co.
Seattle—Hall's Farm Store
Seattle—Hydro Carbon Light Co.
Seattle—C. W. Johnson Sales
Seattle—Pacific Appliance Co.
Seattle—Peter Pan Seafoods, Inc.
Seattle—Rental Machinery Co.
Seattle—Rental Shop
Seattle—Rohrer's Tool Shed
Seattle—Seattle Marine & Fishing Supply Co.
Seattle—Sea-Tac Tool & Equipment, Inc.
Seattle—Skyway Equipt. Rentals
Seattle—Star Rentals
Seattle—Tommie's Cycle Shop
Seattle—Tonkin Brothers Machine Shop & Welding
Seattle—Tool Crib Co.
Seattle—Waldorf Distributors
Seattle—Winkleman Hardware
Sedro Woolley—Jacks Chain Saw Service
Shaw Island—Yansen's
Shelton—Saeger Motor Shop
Silverdale—Coast To Coast Store
Snohomish—Snohomish Valley Co-op.
Spokane—A & Z Rentals
Spokane—Diamond Drill Contracting Co.
Spokane—General Fire Equipment Co.
Spokane—Mid-Mountain Machinery, Inc.
Spokane—Moran Feed & Supply
Spokane—Northwestern Fire Apparatus Co.
Spokane—Power Tool Rental & Sales
Spokane—Rental Equipment, Inc.
Sultan—Sultan Saw Shop
Sumner—Sumner Farm Building Supply
Sunnyside—Killingstad Brothers Hardware
Suquamish—Suquamish Lumber & Hardware

Tacoma—City Rents
Tacoma—Evergreen Equipment Co.
Tacoma—Pleasure Craft Marine
Tacoma—University Equipment Rentals
Tacoma—Warter's Hdwe. & Sporting Goods
Tacoma—Wayne Buck Sales, Inc.
Tekeo—Morgan & Morgan

Vancouver—Bill & Cal's Totem Rent-All
Vancouver—Columbia Farmers Supply Ass'n
Vancouver—Vancouver Saw Service
Vancouver—Western Rentals, Inc.

Walla Walla—Walla Walla Farmers Co-Op
Wapato—R. R. Short Hardware
Wenatchee—Berg Hardware Co.
Wenatchee—Bill's Saw Shop
Wenatchee—Herb's Rent All
Wilbur—J. H. Llewellyn Warehouse Co.
Woodland—Woodland Implement Co.

Yakima—Bounds Equipment Co.
Yakima—Johnny Rents, Inc.
Yelm—Brown Bros. Garage

Zillah—Scott Fuel Yard

WYOMING

Afton—Don Wood Tractor Co.

Casper—Auto Electric & Equipment Co.
Cheyenne—Wesco
Cody—The "Y" Lumber & Hardware
Cokeville—Dayton Service & Repair

Dubois—Dubois Electric & Refrigeration

Evanston—Cazin & Houtz
Evanston—Smith & Jones Timber Co.

Fox Park—Brandt & Wicklund Forest Products

Greybull—Coast To Coast Store

Hulett—Hulett Gas & Appliance

Jackson—Bell's Handyman Shop

Lander—Quality Lumber
Laramie—Laramie Auto Parts Co.
Lingle—Chester B. Brown Co.
Lowell—Valley Feed Supply
Lusk—Frontier Lumber Co.

Mountain View—Taylor & Bullock Automotive Service

Newcastle—Hansen Equipt. Co.

Pinedale—Monte's Service

Rawlins—Lefforge Motor Co.
Rock Springs—Southwestern Wyo. Wool Warehouse

Saratoga—Shively Hardware
Sheridan—K & B Tractor Sales
Sundance—Tracy Motor Co.

Thermopolis—Wyoming Truck & Implement Co.

Worland—Fausset Implement Co.

HOMELITE BRANCH OFFICES

3000 West Valley Blvd., Alhambra, Cal. • 211 M Street, Fresno, Cal. • 2234 Auburn Blvd., Sacramento, Cal. • 727 Airport Blvd., So. San Francisco, Cal. • 1575 Carr Street, Denver 15, Colo. • 3436 S.E. Milwaukie Ave., Portland 2, Ore. • 113 North Highway 91, North Salt Lake, Utah • 1911 22nd Ave. South, Seattle 44, Wash. • E. 3927 Trent Avenue, Spokane 2, Wash.

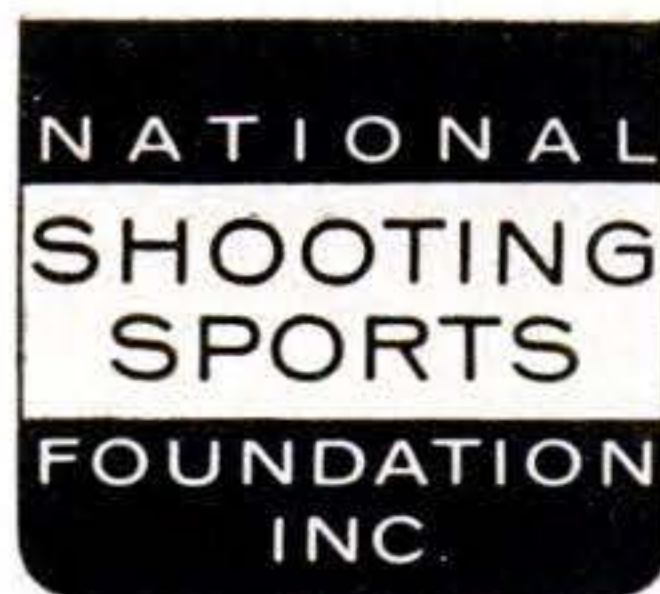


a Man in the making

He was so excited he thought he'd never fall asleep. It took him all of ten minutes.

His first all day hunting trip with his dad. It's the most wonderful thing that's happened since that gleaming new gun showed up under the Christmas tree.

That feeling of tremendous excitement will slowly wear



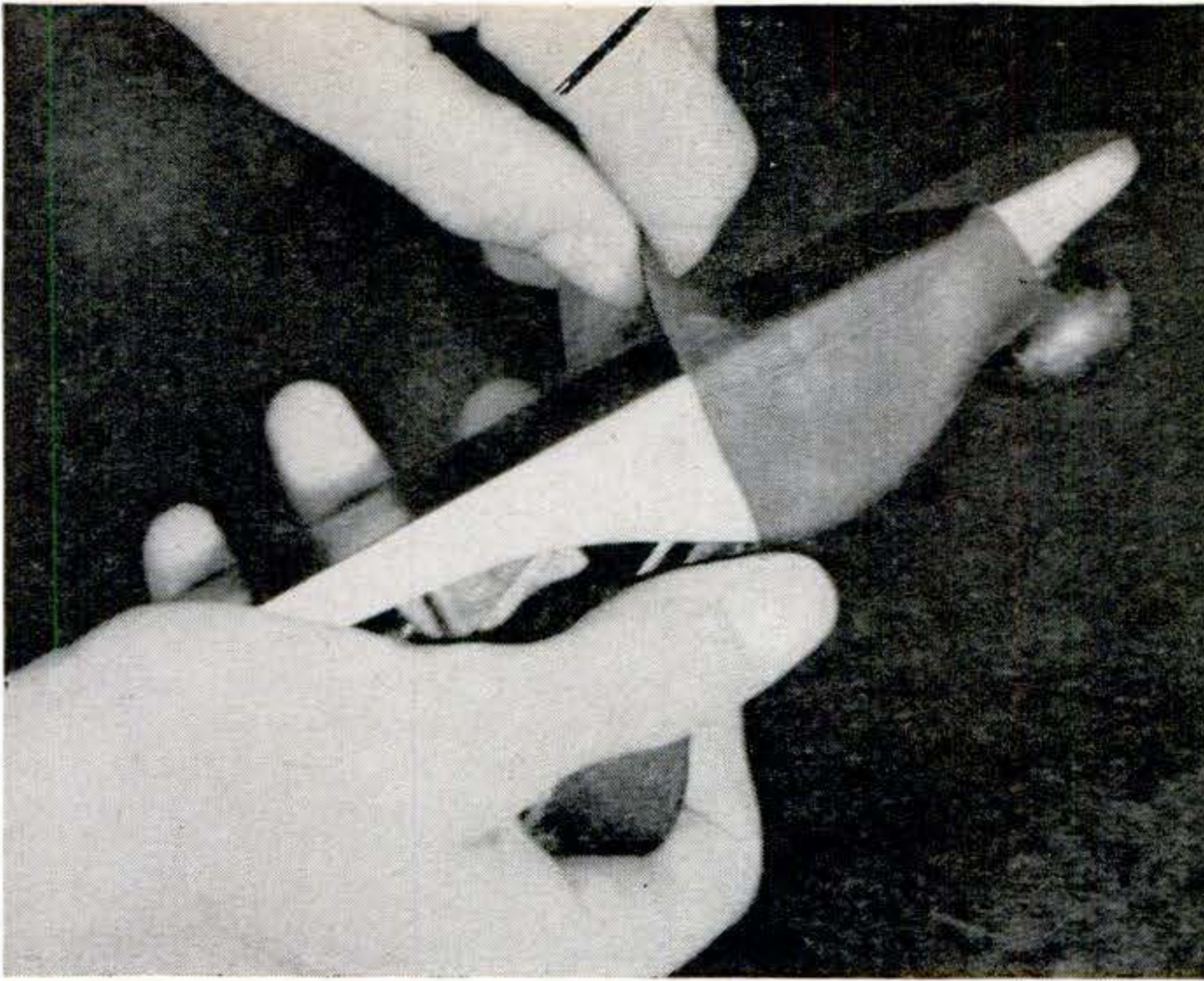
*P.O. Box 355,
Hartford 1, Connecticut*

away by the dawn's early light and in the uncomfortable icy boat. But, when the first duck comes winging in, the excitement will erupt full force, and one of life's greatest moments will be upon him.

**We are witnessing
the making of a man.**

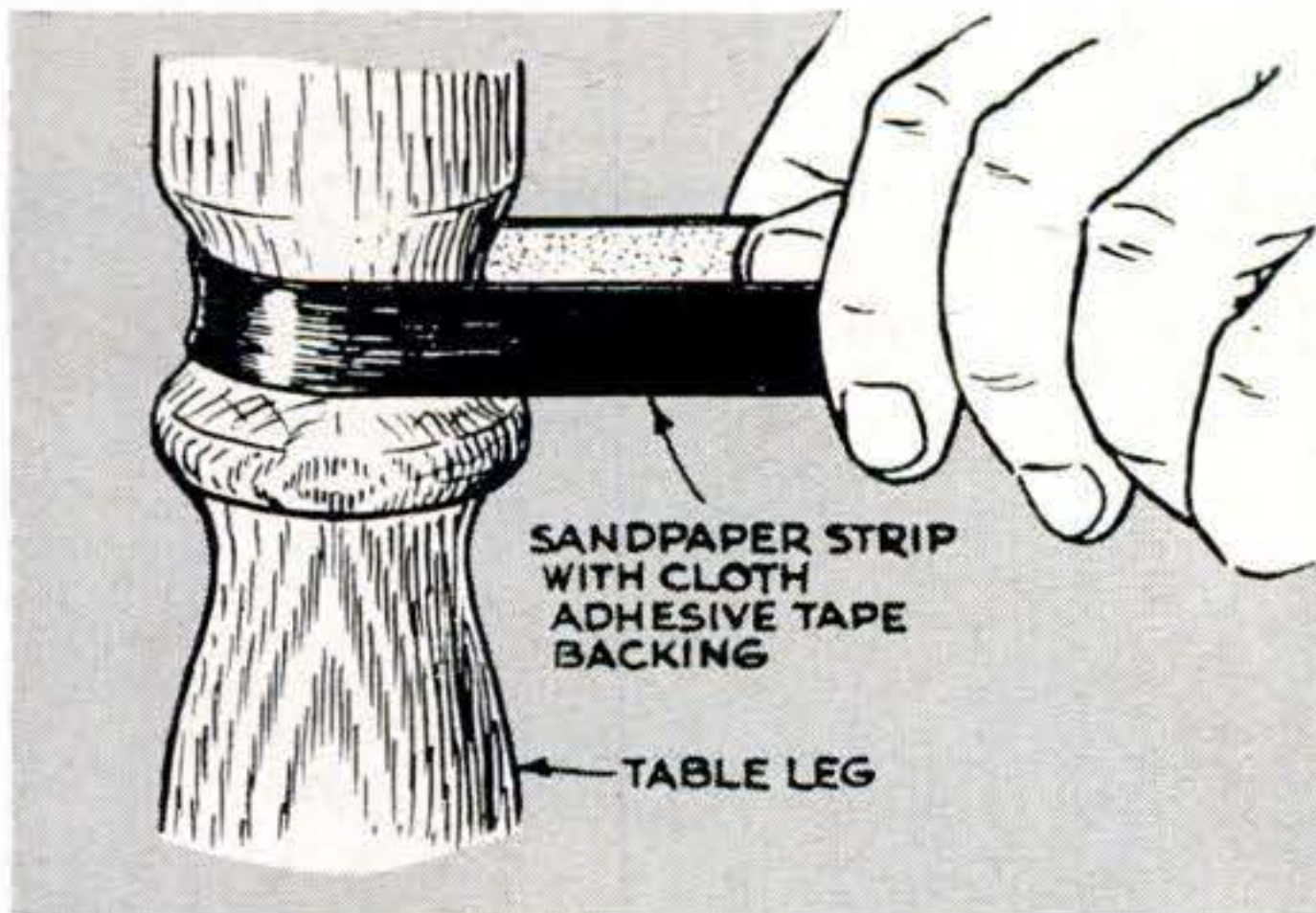
Make it a point to take a boy hunting — you'll both enjoy it.

Carry your firearm proudly. It is part of your great American heritage — a symbol of freedom.



Bike inner tube protects plane blade

Jostled around in a workshop drawer or toolbox, plane blades take a beating. To keep mine always cutting-sharp and free of nicks, I slip a wide band cut from a bicycle inner tube over the toe end of the plane body, as shown at left. When I need the plane, the guard slips off easily.—*Bob Gilmore, Sonoma, Calif.*

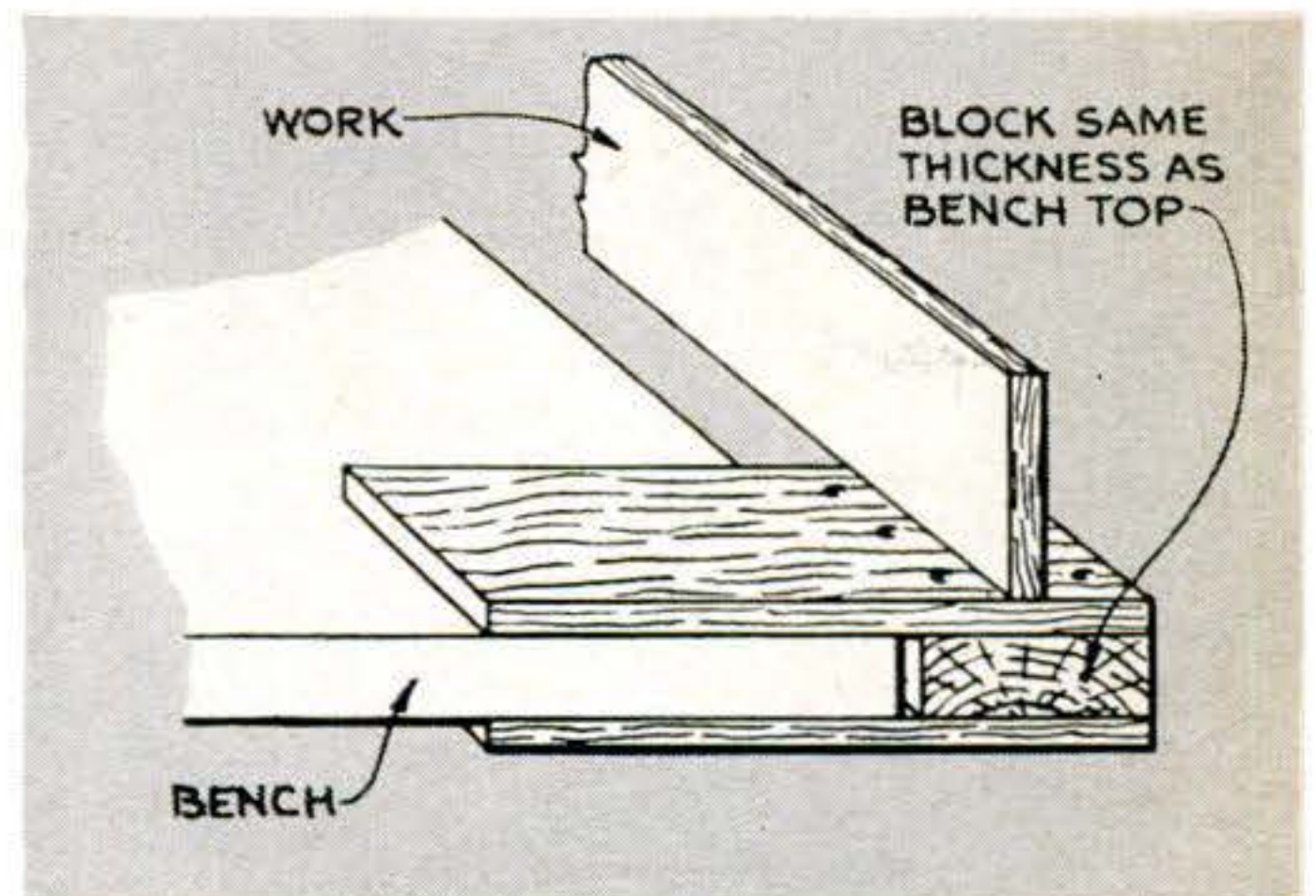


Tape adds strength to sandpaper

It was annoying to have narrow strips of sandpaper break when I was smoothing round, curved stock. No more. Now I get sturdy backup strength from cloth adhesive tape by simply pressing a length of tape to the back of a sheet of sandpaper, then scissoring off strips of the width I need for the job in hand. Colored tapes found in hardware stores are excellent for the purpose.—*Frank Shore, NYC.*

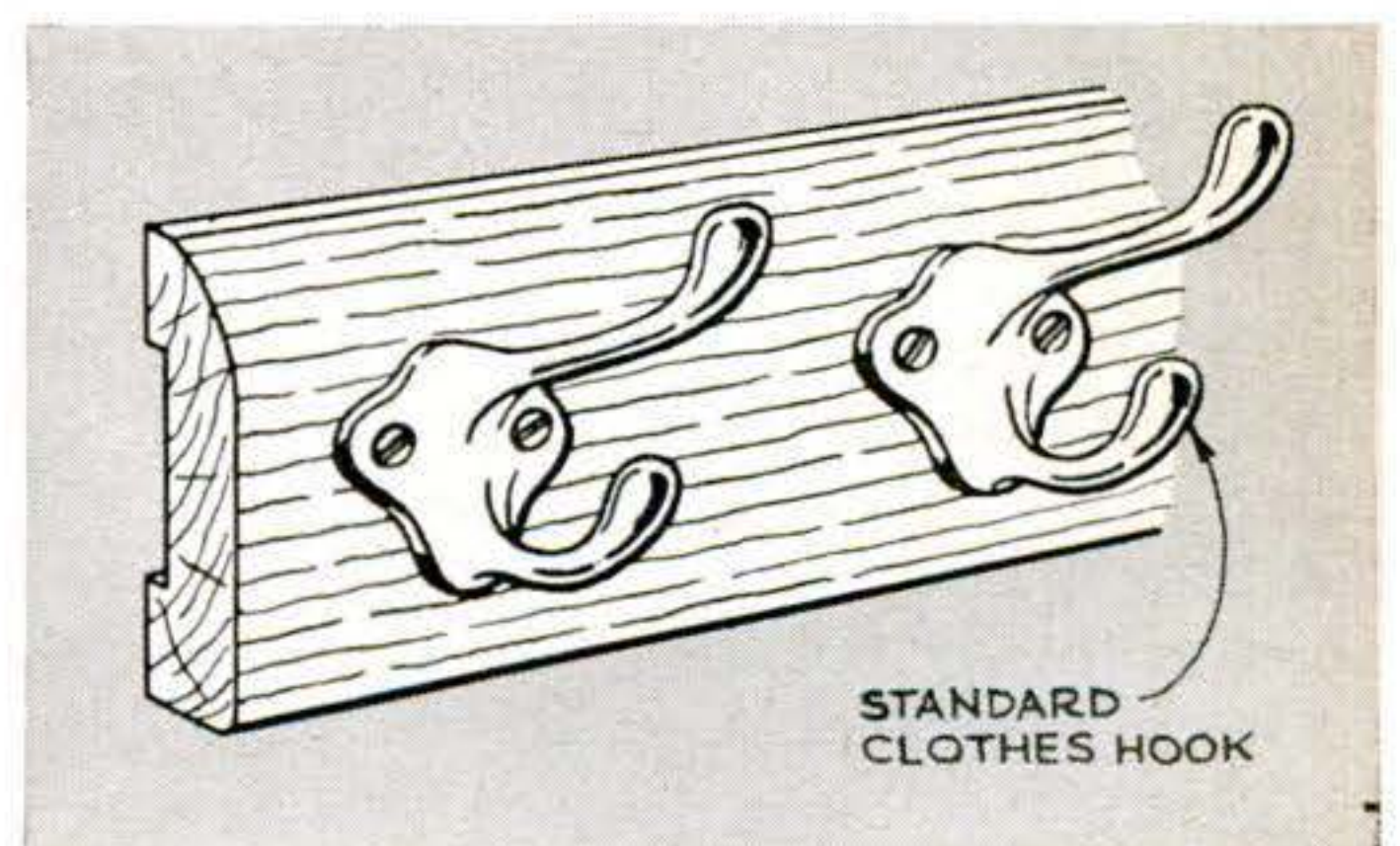
Base molding makes clothes rack

An attractive back-hall or basement clothes rack is easily made from a strip of modern base molding—available at all lumberyards in a variety of woods at 9 to 15 cents a foot. Just nail or screw a desired length to the wall and screw in standard clothes hooks at convenient intervals. The molding can be varnished or painted to match any color scheme in the house.—*Roger Isetts, Kenosha, Wis.*



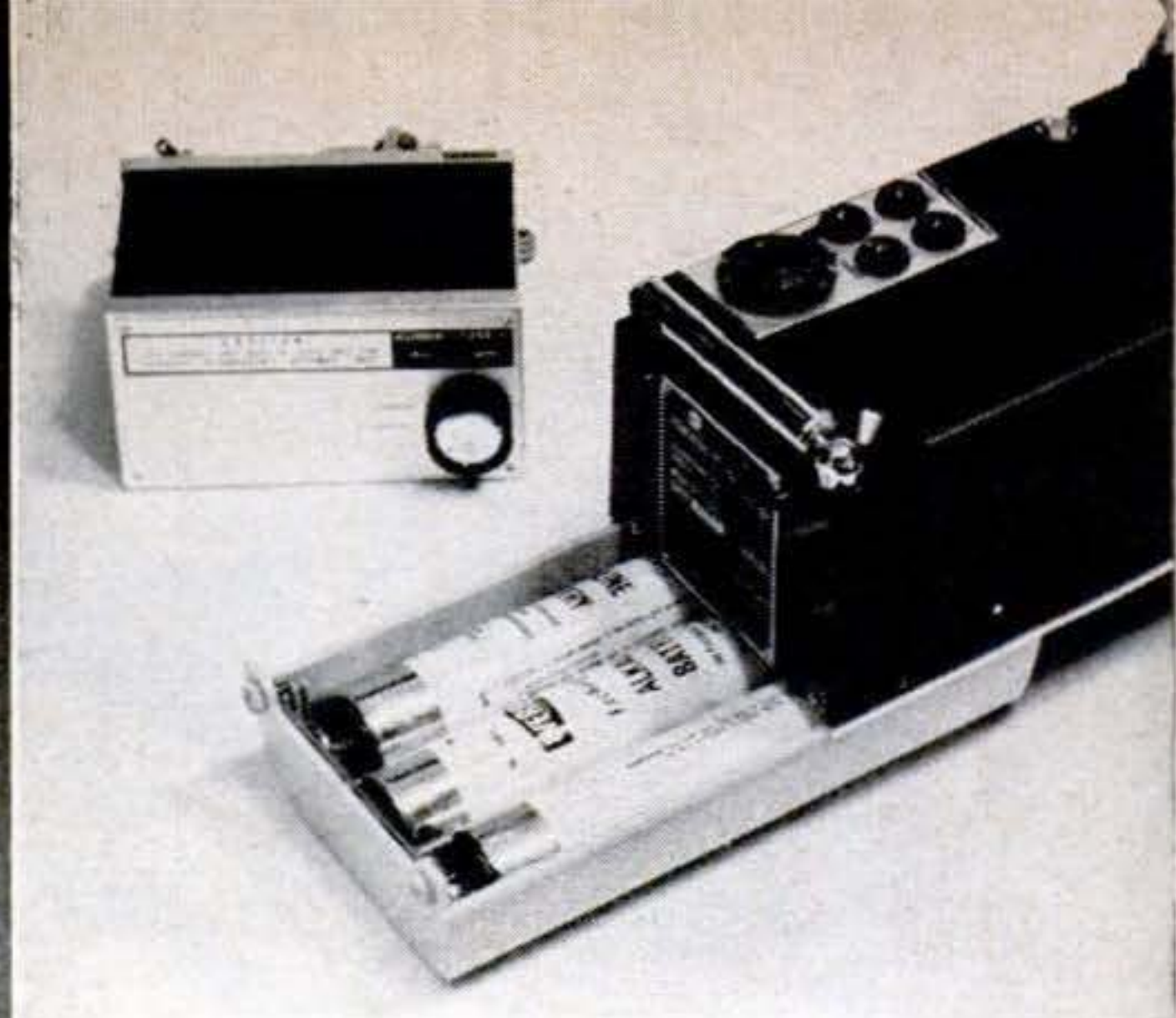
Simple support for work in vise

This "clothespin" device gives handy support to hold the free end of long stock for planing—or other work at the bench—while using the vise to clamp. For the long members of the "pin," use one-by-four pine, 12" to 16" long. The dividing block should be of the same thickness as the bench top so the support will slide easily into place and remain steady during work.—*W. C. Wilhite, Carlinville, Ill.*



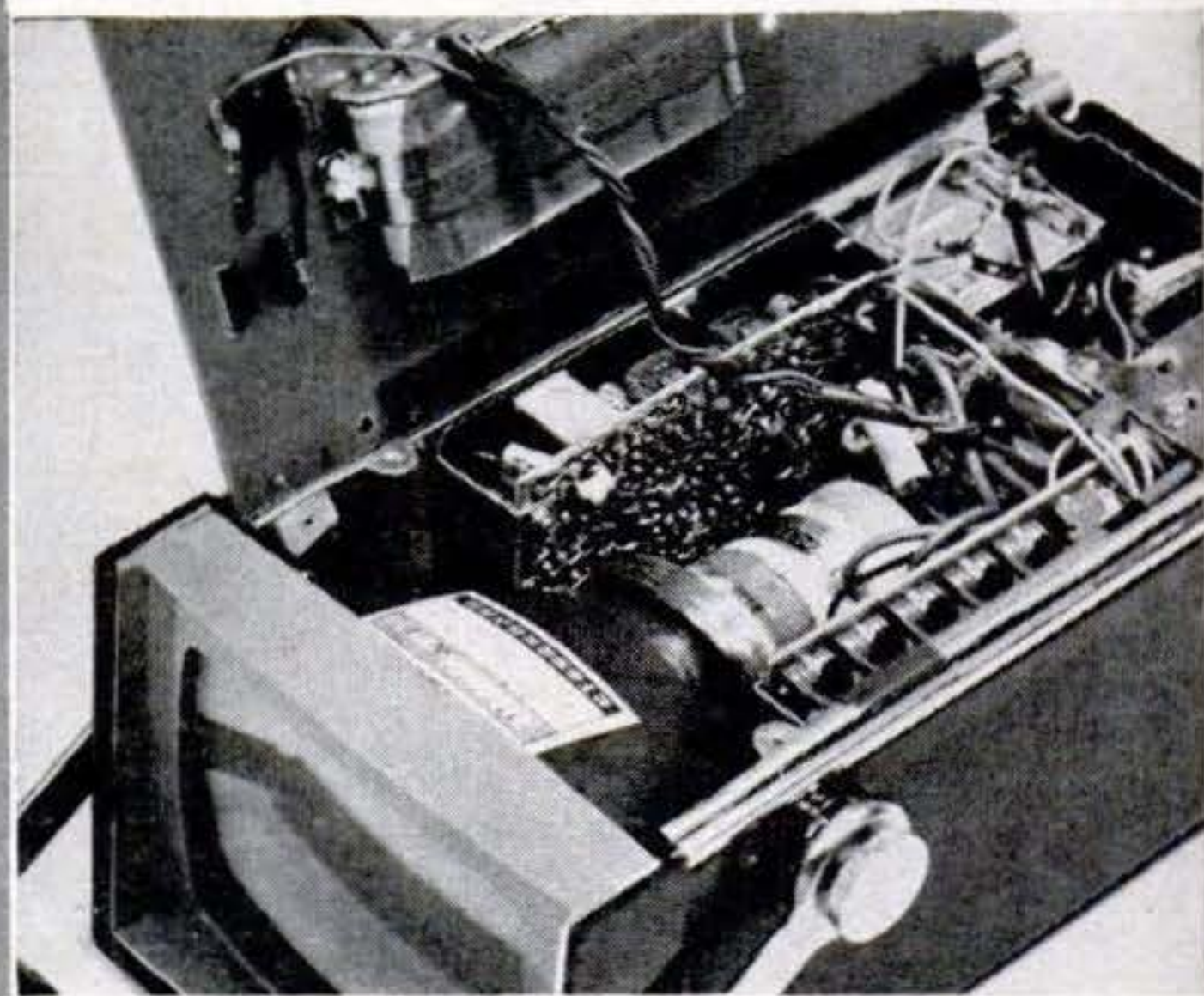
Personal-use report

Tiny TV Powered by Internal Batteries



Battery pack consists of three $4\frac{1}{2}$ -volt, rechargeable alkaline batteries in a drawerlike tray at bottom of the case. Battery charger-AC adapter is at left.

Picture tube is only six inches long. Circuitry is shoehorned into space surrounding tube neck. Row of controls (lower right) are for service adjustments.



YOU have to see this transistorized pygmy portable TV to believe it. It's only four inches wide, five inches high, nine inches long, and weighs $7\frac{1}{2}$ pounds. The batteries to operate it are inside the package. There are no dangling cords or separate battery packs.

Astonishingly bright, crisp pictures, measuring $4\frac{1}{2}$ inches on the diagonal, are presented on the diminutive screen. There is a full complement of controls plus an expander switch that will enlarge the image you see. With the set, you get a combination battery charger-AC adapter for recharging the batteries or operating the set directly from the power line. There is also an optional adapter you can plug into your car cigarette-lighter socket to oper-

ate the set from your 12-volt car battery.

During city use, I got an excellent picture using the built-in, 13-section telescoping antenna. The sound was clear and distinct with either the built-in speaker or the plug-in earphone. The weak signal sensitivity, of course, is no match for a good full-size set. As I moved away from the transmitter, I found that about 25 miles was the maximum distance at which I could get an acceptable picture on the set's own antenna. By plugging in an external antenna, however, I got good reception at that distance. The batteries lasted roughly about eight hours on one charge.

The Delmonico 4T-EOZ is sold by Delmonico International, Maspeth, N. Y. Price is about \$150.—*Hubert Luckett.*

These Xmas Lights Dance to Music



By Leon Wortman

YOUR Christmas decorations can be the talk of the neighborhood this year with the help of this easily built electronic dancing master. Simply connect two wires from the little box to the speaker of any radio, phonograph, or tape recorder and a string of lights on your tree will dance in time with the music being played.

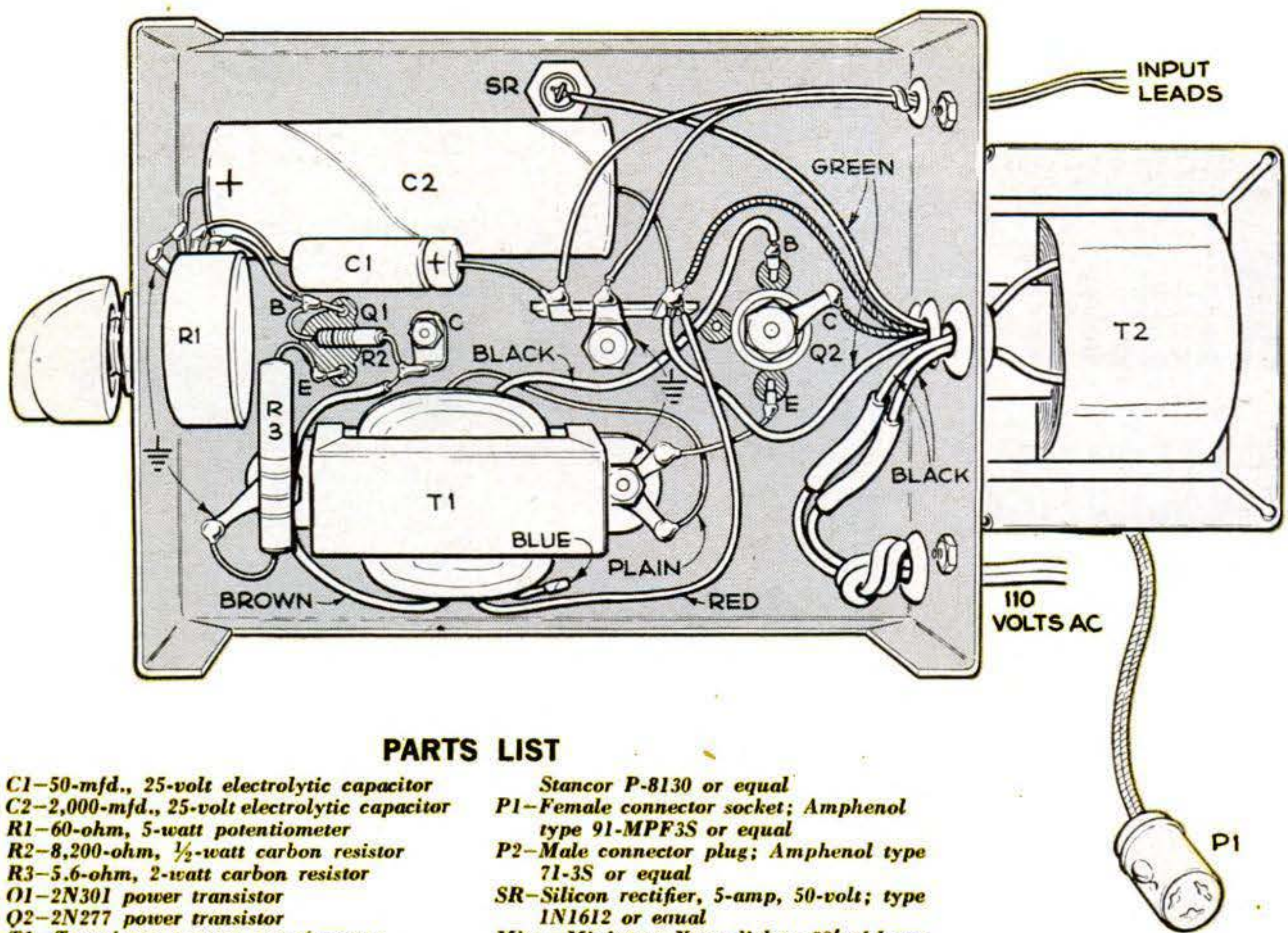
The lights don't just flash off and on, but vary in brightness from dim to brilliant with modulations in between—depending on the music. The effect is truly one of visual music.

All electronic parts are standard items, available at almost any radio-parts store or from one of the mail-order supply houses. The bulbs are the ordinary miniature Christmas lights you find in hardware and toy stores. They are low voltage, connected in a series string so they can be pugged into 110-volt house current. For use with

the control box, you must reconnect them in parallel. You can operate up to 24 of the bulbs on the box output.

Cut the two wires connected to each bulb, leaving about 3" pigtails for the new connections. You'll need about 30' of plastic-covered lamp cord—or better, the thinner wire pairs sold for low-voltage controls or speaker connections—to make a parallel string with 24 lights. Cut one 6' length and 23 pieces 12" long. Spread the ends of each length about an inch and strip $\frac{1}{2}$ " of insulation from each wire, including the wires attached to the bulbs.

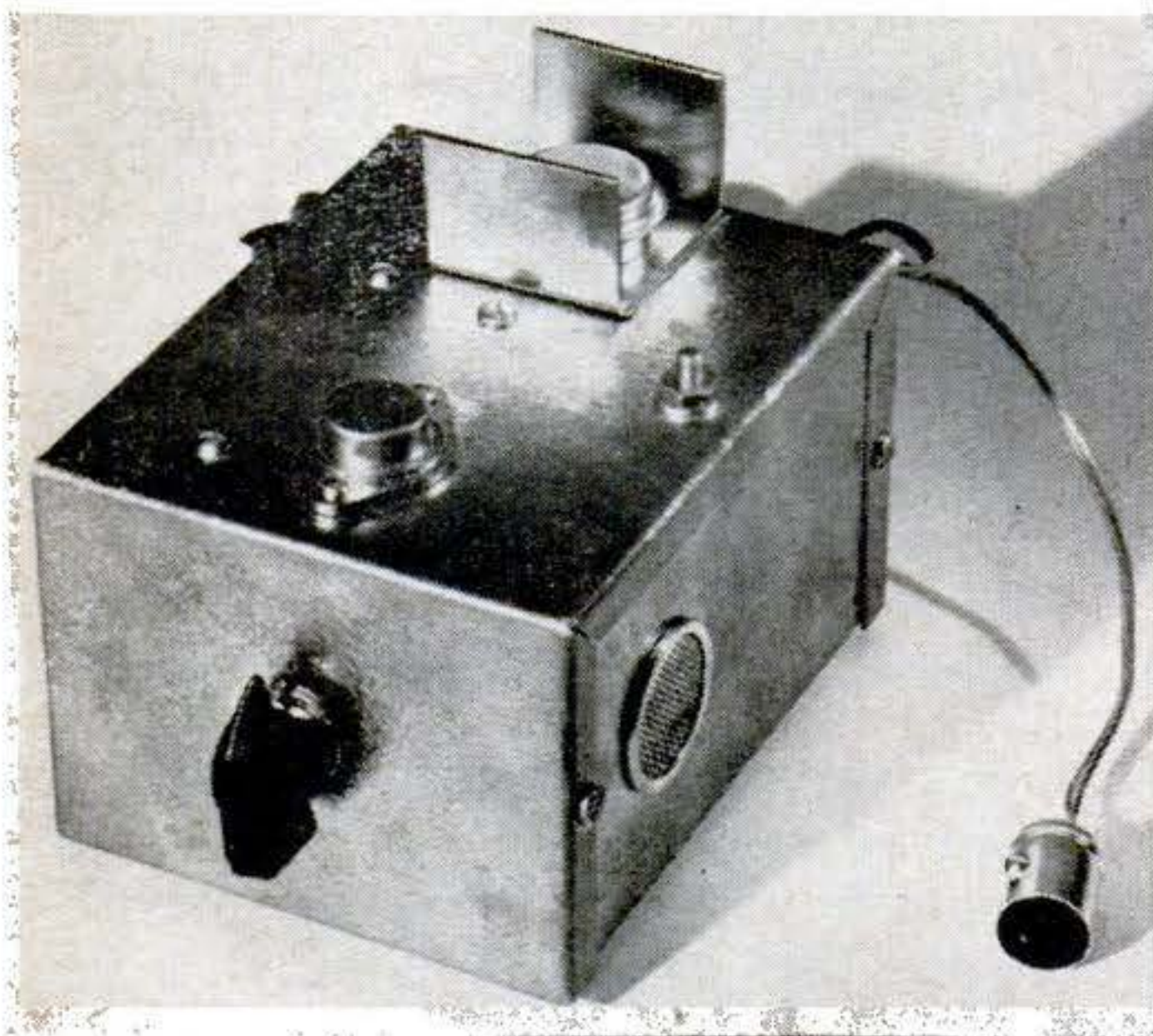
Beginning with the 6' piece, splice the pieces together so that you again have a 30' cord, but with a pair of bare spots at each end and at 23 points between. Connect the 6' end to the plug. Connect the bulb wires, one pair to each pair of bare spots. Solder and tape the connections. When you finish, you should have a 30' string of parallel-connected colored lights



PARTS LIST

C1—50-mfd., 25-volt electrolytic capacitor
C2—2,000-mfd., 25-volt electrolytic capacitor
R1—60-ohm, 5-watt potentiometer
R2—8,200-ohm, 1/2-watt carbon resistor
R3—5.6-ohm, 2-watt carbon resistor
Q1—2N301 power transistor
Q2—2N277 power transistor
T1—Transistor output transformer; Lafayette type AR-503 or equal
T2—Filament transformer: 110/115-volt primary; 12.6-volt, 2-amp secondary;

Stancor P-8130 or equal
P1—Female connector socket; Amphenol type 91-MPF3S or equal
P2—Male connector plug; Amphenol type 71-3S or equal
SR—Silicon rectifier, 5-amp, 50-volt; type 1N1612 or equal
Misc.—Miniature Xmas lights; 30' of lamp cord for light string; up to 50' of lamp cord for input leads; AC power cord; 3" x 4" x 5" metal utility box

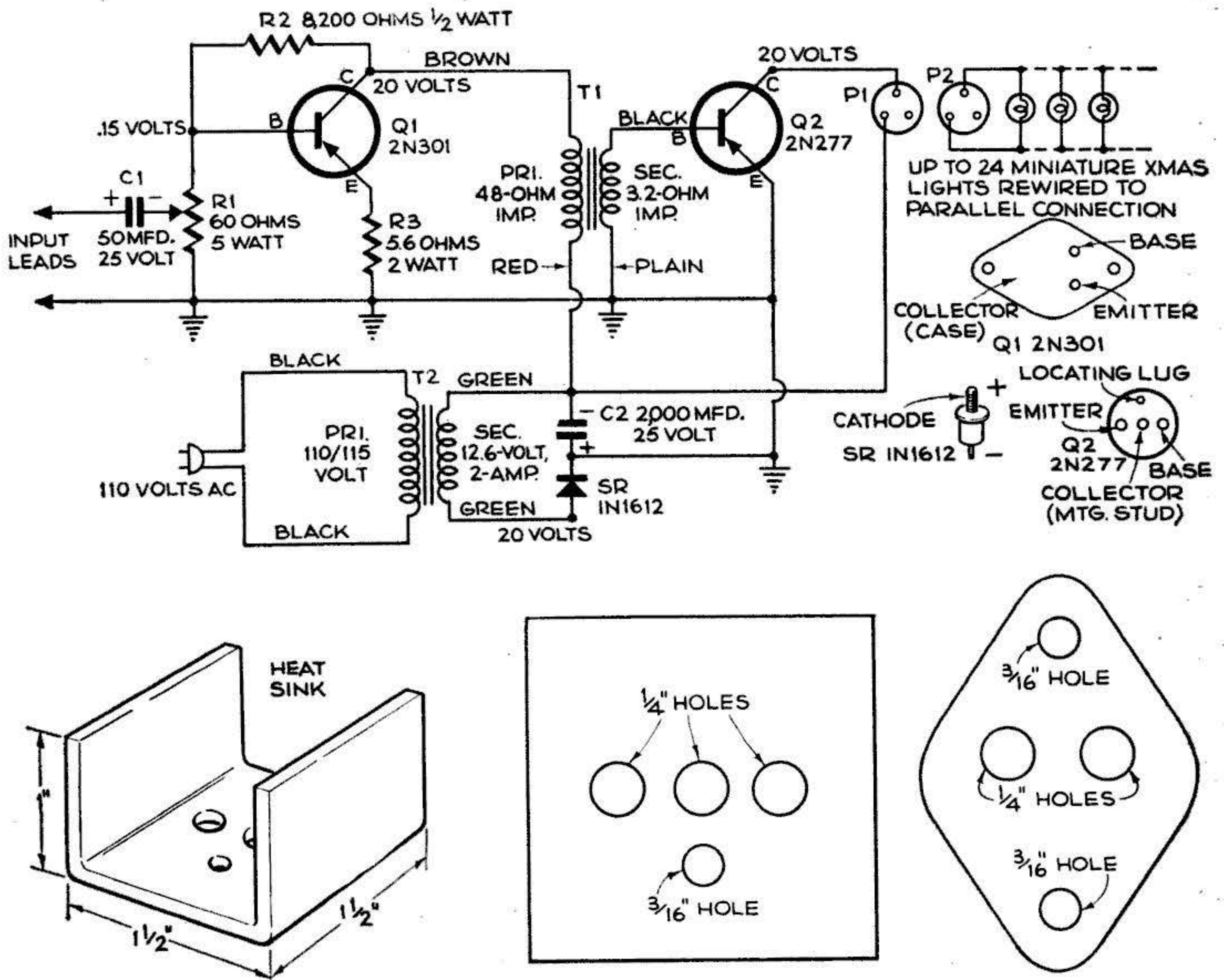


Cost of building this control box will run somewhere between \$12 and \$20, depending on how carefully you shop for bargains in parts available at surplus stores and in the mail-order catalogues. Wiring, parts, and layout are not critical. Just be sure you provide a heat sink for the output transistor and insulate the transistors if you use a metal case.

with a distance of 6' from the plug to the first bulb.

The box for the control unit need be no larger than 3" by 4" by 5". It doesn't have to be metal, but if you do use a metal box, be sure to insulate the transistors so they do not make electrical contact with the metal. Thin sheet vinyl can be used, or you can buy ready-made insulators for the transistors. The silicon rectifier can be bolted by its mounting stud directly to the metal box without an insulator. If you use a box made of insulating material, connect all indicated ground points with a wire.

The output transistor, Q2, requires a heat sink to help dissipate the heat generated in operation. You can buy a commercially made heat sink or make your own of a piece of aluminum, following the drawing. Use insulating washers under the nuts securing the mounting studs or screws, and be sure that no parts touch metal where they pass through the drilled holes. Notice that the



connections to the collector are made to mounting stud or screw contacting the transistor case.

Too much heat when soldering to the transistor leads or rectifier can ruin these parts. As a precaution, grip the leads with a pair of long-nose pliers between the solder joint and the point where the leads enter the case. The pliers act as a heat shunt to keep heat from being conducted to the semiconductor.

When connecting the capacitors, be sure to observe proper polarity as indicated on the wiring diagram.

Transistors Q1 and Q2 operate on a relatively low voltage DC. The transformer, T2, steps down the household AC power to about 13 volts AC. The rectifier, SR, converts this to DC. Although it will vary somewhat depending on the line voltage in your neighborhood, the DC voltage measured at the collector of the transistors will be somewhere in the vicinity of 20 volts

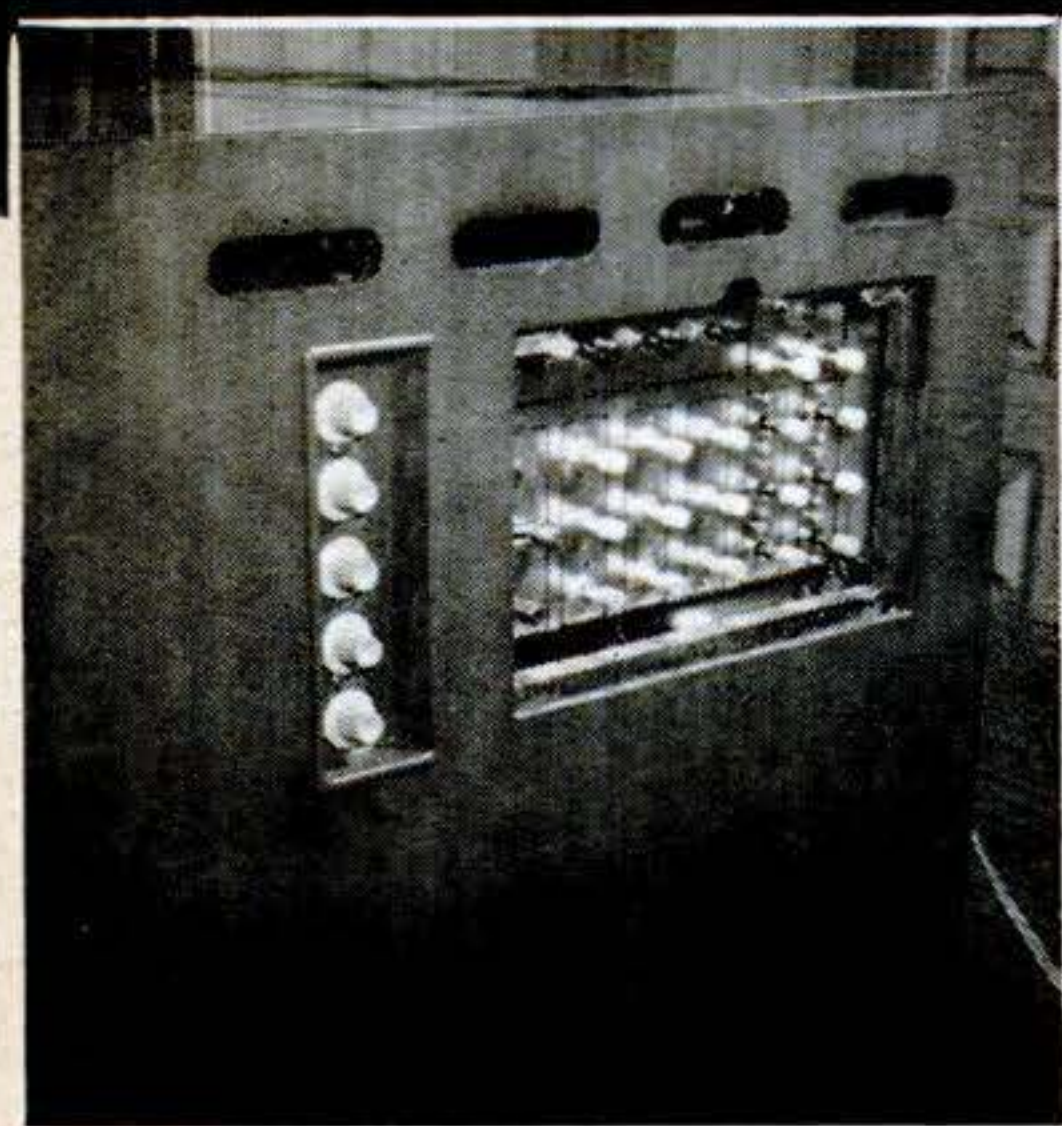
DC, negative with respect to ground.

To use the control box, connect the input leads across the voice coil of the loudspeaker. If there is an output jack for an extension speaker, you can use it for your connection. Plug the Christmas light string into the output socket and the AC line cord into a wall outlet. Start the music. Both the volume control on your radio or phonograph and the sensitivity control will affect the way the lights respond to music.

The best way is to set the volume control for the sound level you want for listening before you adjust the sensitivity control. With the controls set too high, the lights will burn brightly and steadily; set too low, they will flicker on only on the loudest passages of music. The correct setting is somewhere in between so that you can get a full range of varying brightness. When the music stops, or you disconnect the input leads from the speaker, the lights will go out.



Single-knob hue control is only color adjustment made by viewer. Service controls (left) are on side of case.



Personal-use report **A Compact Color TV from Japan**

WILL imports from Japan break the price barrier on color TV the way they did on transistor radios? One Japanese manufacturer, Toshiba, is now showing a color set they hope to bring in soon. To find out whether these sets would come up to the high performance standards expected by American TV viewers, I borrowed one from their New York office. I used it in my home for about three weeks.

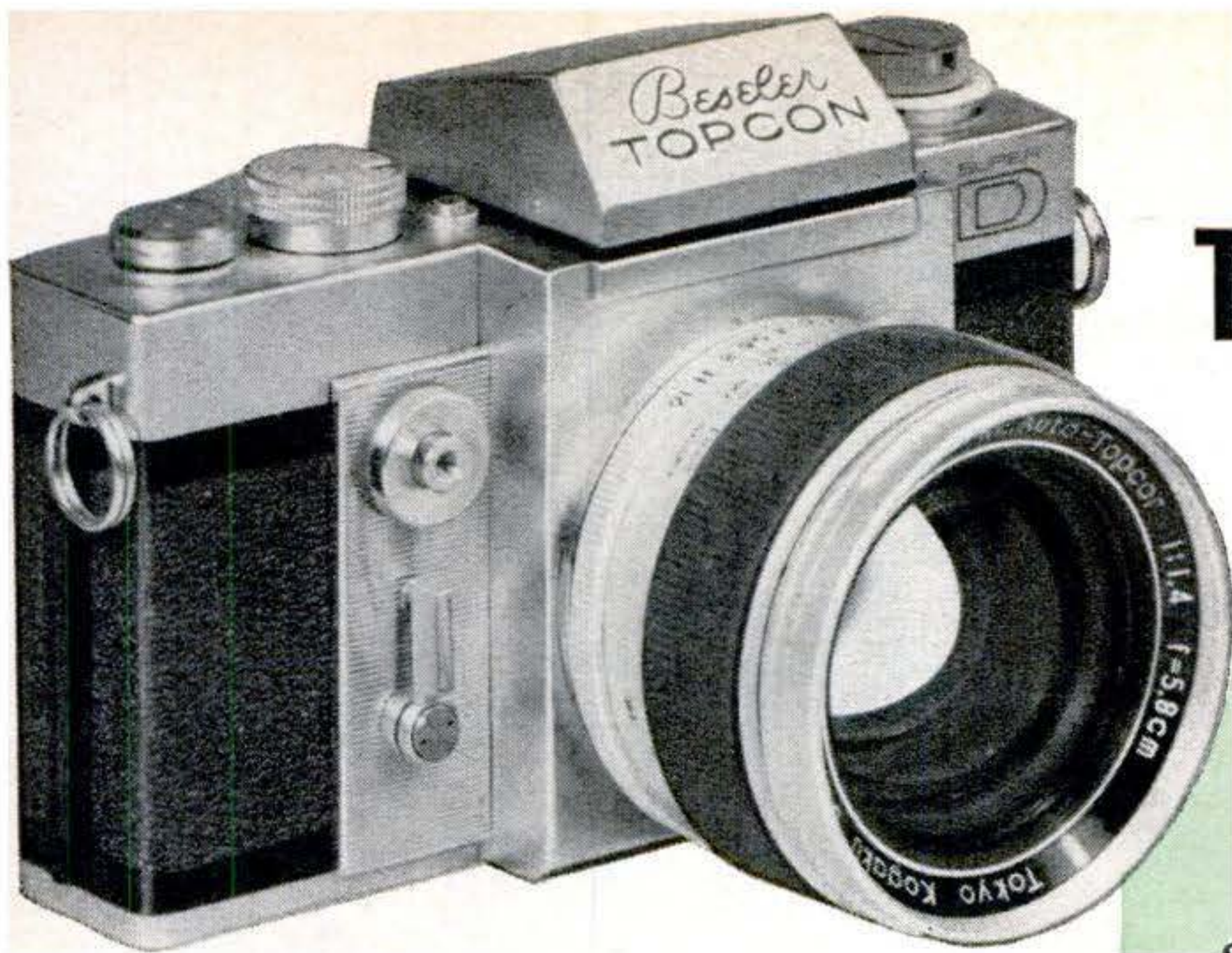
If this set is a fair sample of what is to follow, American set manufacturers are going to have a battle on their hands to retain hold of the color-set market.

The Toshiba 16WM uses a 16" rectangular color tube with sharp, square corners. This allows a much more compact cabinet than is needed to house the round tube

used in American-made sets. The number of viewer-operated controls has been reduced to only one more than the usual number on a black-and-white set. The extra knob controls the hue.

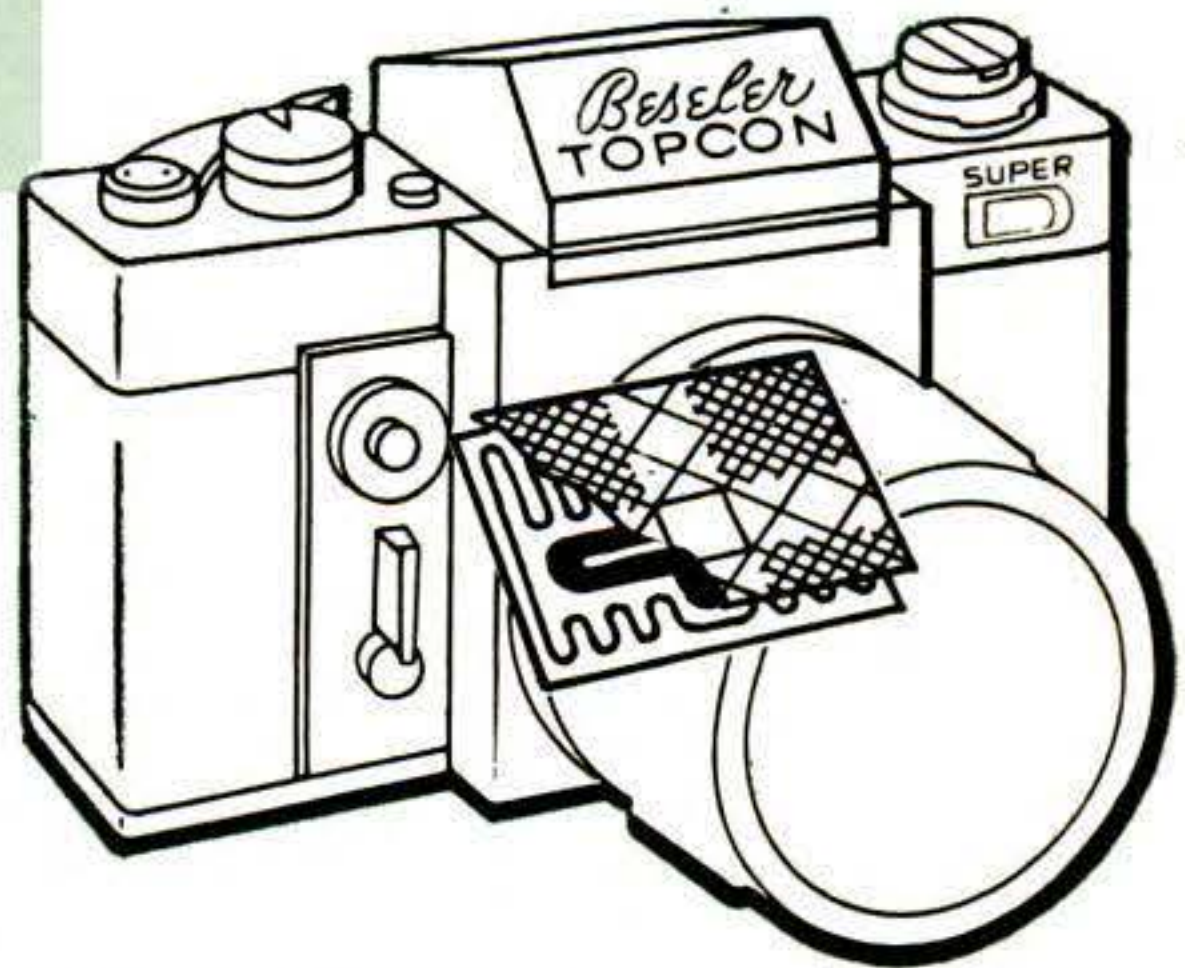
I had no trouble getting good reception 25 miles from the transmitter, using a simple antenna located in the attic. The quality of the color picture was good—as good as any I've seen on American-made sets. The black-and-white picture was excellent.

Toshiba has been selling this set in Japan for some time now. They say the service history of the set in the homes of their customers has been excellent. They have not yet set a price on it for the American market, but rumors say it will be around \$300.—*Hubert Lockett.*



First SLR Through-the-Lens Meter

PS PHOTOGRAPHY



IT WAS bound to come—a 35mm SLR camera with a through-the-lens exposure meter. For average camera fans, its unique metering system should make the Topcon Super D the most accurate exposure system now available. What's so different about it?

- It senses only the light reaching the film, taking an average reading for the full area seen through the viewfinder.

- It reads the light of any lens, regardless of the focal length, on the camera.

- It automatically measures light through a lens extended for close-ups.

- It eliminates filter-factor compensation.

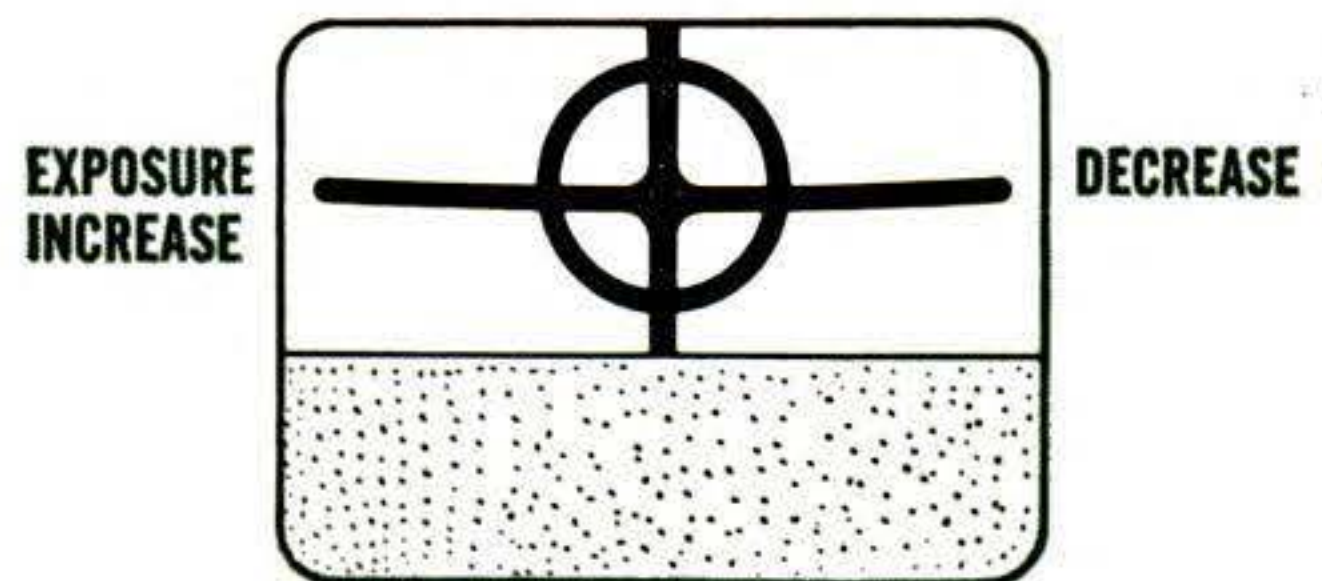
The metering system consists of a printed circuit sandwiched in the three-layer reflex mirror and hooked up with a cadmium sulfide photoresistor cell. Narrow slits, designed like overhangs, pass seven percent of the light through the mirror to the photocell. The printed-circuit grid pattern is arranged to take a good sampling of the light reflected from the subject.

The shutter-speed dial and lens diaphragm are cross-coupled with the meter.

There are four interchangeable parts: focusing screen, taking lens, viewfinder, and eyepiece. The camera comes equipped with a Fresnel screen and a split-image rangefinder. Three accessory screens are available, plus a waist-level viewfinder.

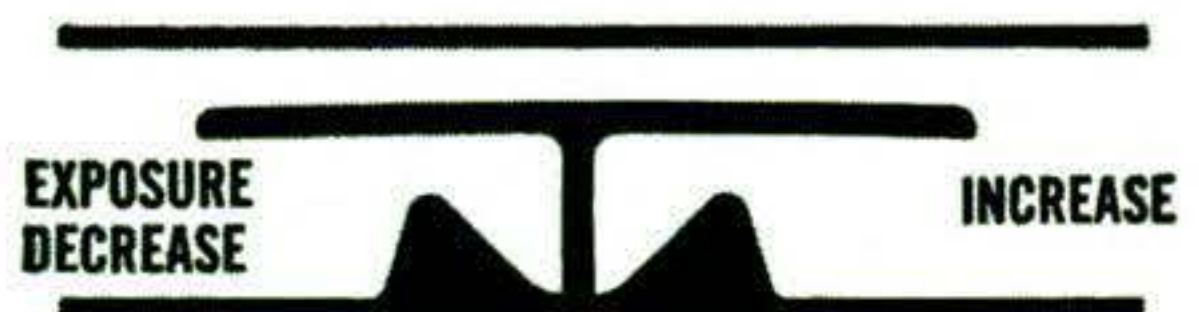
Other features: depth-of-field preview lever, instant-return mirror, and automatic lens diaphragm. With 58mm f/1.8 lens, the Super D sells for \$369. Charles Beseler Co., East Orange, N.J., is the distributor.

Exclusive feature of the Topcon Super D is the built-in, behind-the-lens metering system. The photocell is in back of the reflex mirror and internally coupled to lens diaphragm and shutter-speed control.



CAMERA TOP DECK

Meter reading is visible in two locations: It looks like this on camera deck, and shows up as below through viewfinder.



THROUGH PENTAPRISM FINDER

To set exposure, you align T-pointer in center of V-index. The legs of V in viewfinder show half-stop adjustments.



The Popular Science **SPOTLIGHT AWARD**

Popular Science's Spotlight Awards were introduced to give recognition to companies and individuals for outstanding contributions to American living, as measured by the invention, design, development, engineering, and manufacture of products, methods, and materials.

The Spotlight focuses on the range of consumer products that concern PS readers—automotive, home-improvement materials, photography, tools, boats, outdoor recreations, electronics.

The second selection of PS's Editorial Board is the—

Instamatic System of Photography

The development of a new film-loading system, combined with new film emulsions and a line of automatic cameras that accept drop-in Kodapak cartridges, has earned this Popular Science Spotlight Award for Eastman Kodak.

Readers who look to our magazine for news of mechanical and scientific developments will find the Spotlight a way of illuminating outstanding products and inventions.

The Instamatic camera system (see story at right) is a fitting recipient of the Spotlight. Eastman Kodak carried forward the design and engineering for development of a new type of film load, along with cameras to accept the loads. The new system, in eliminating threading and film handling, will benefit the entire photographic industry by adding a new dimension to still photography. In future months you will learn about other significant new products in Popular Science, the magazine that reports the results of science—those material advances that provide a better life.

Robert P. Crossley
Editor

John R. Whiting
Publisher

PS PHOTOGRAPHY

The Idea That Clicked

Foolproof picture-taking became a reality with this new instant-load cartridge-camera system

By Robert L. Hering

THEY called it Project 13. International intrigue was missing, but the idea had international overtones. The name was given to keep a new photo idea under wraps until it got to market.

About six years ago engineers at Eastman Kodak started designing a new camera and film-loading system that would make picture-taking as simple as using a pencil.

Complication and confusion are always deterrents to snapshooting, which accounts for about 80 percent of all amateur picture-taking. Reducing the bother with the mechanics of taking pictures is the best way to increase the fun of photography for most people. This Eastman set out to do.

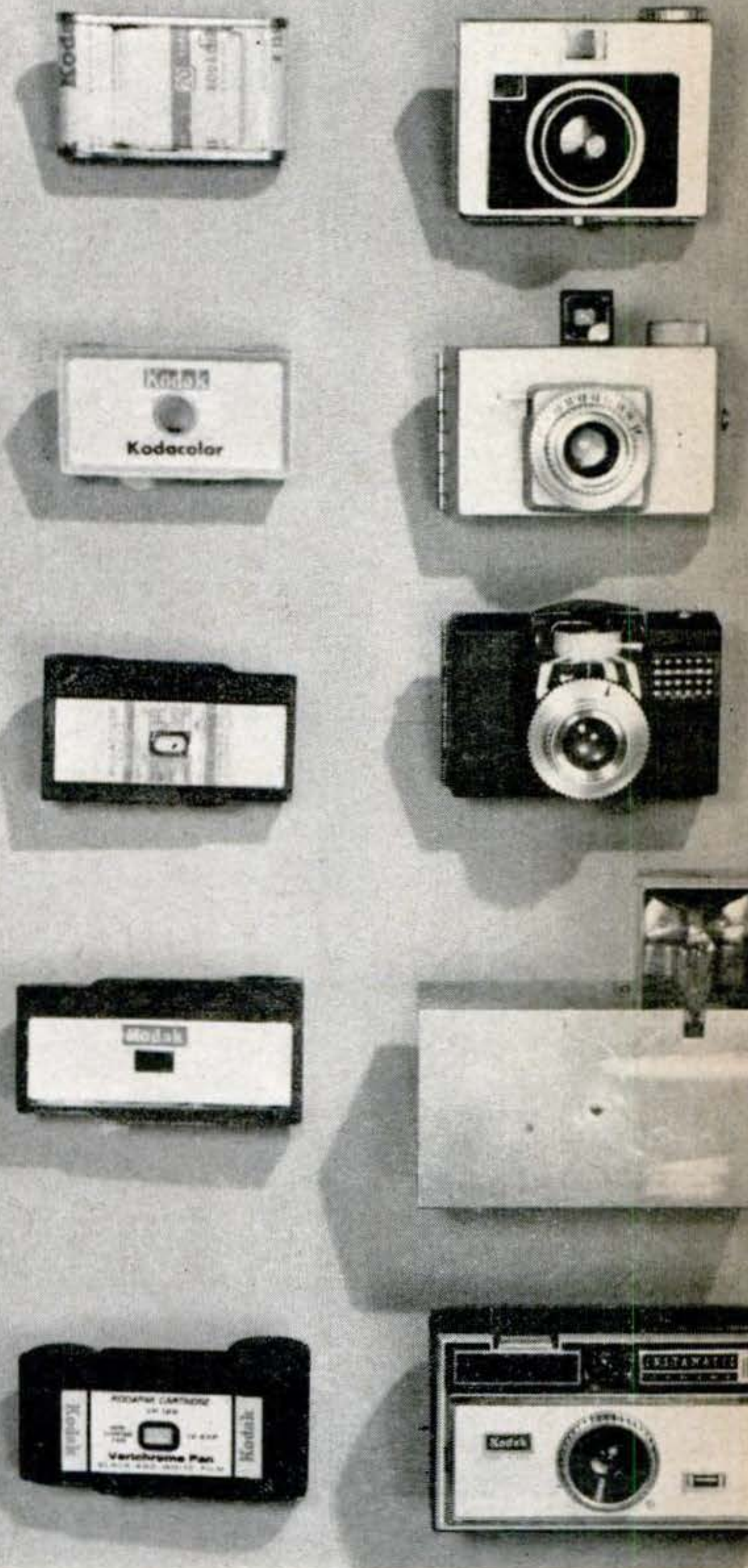
When the engineers first started kicking the idea around, it was called the quick-load program. Its goal: development of a



Evolution of Kodapak cartridge and Instamatic cameras

Cartridge development shown below left includes (from top) early metal magazine, vacuum-formed plastic cartridge with flat cover, and molded and notched cartridge. Fourth one was made to hold 20 exposures. Fifth included rounded corners, making smaller cameras feasible. Development of Instamatic cameras (right) involved these prototypes: second one senses ASA film speed; third includes electric eye; fourth, pop-up flash; fifth, Instamatic 100.

THE CARTRIDGE · THE CAMERA



new instant-load system. They wanted to:

- Simplify camera loading and unloading.

- Simplify camera operation with built-in automatic features.

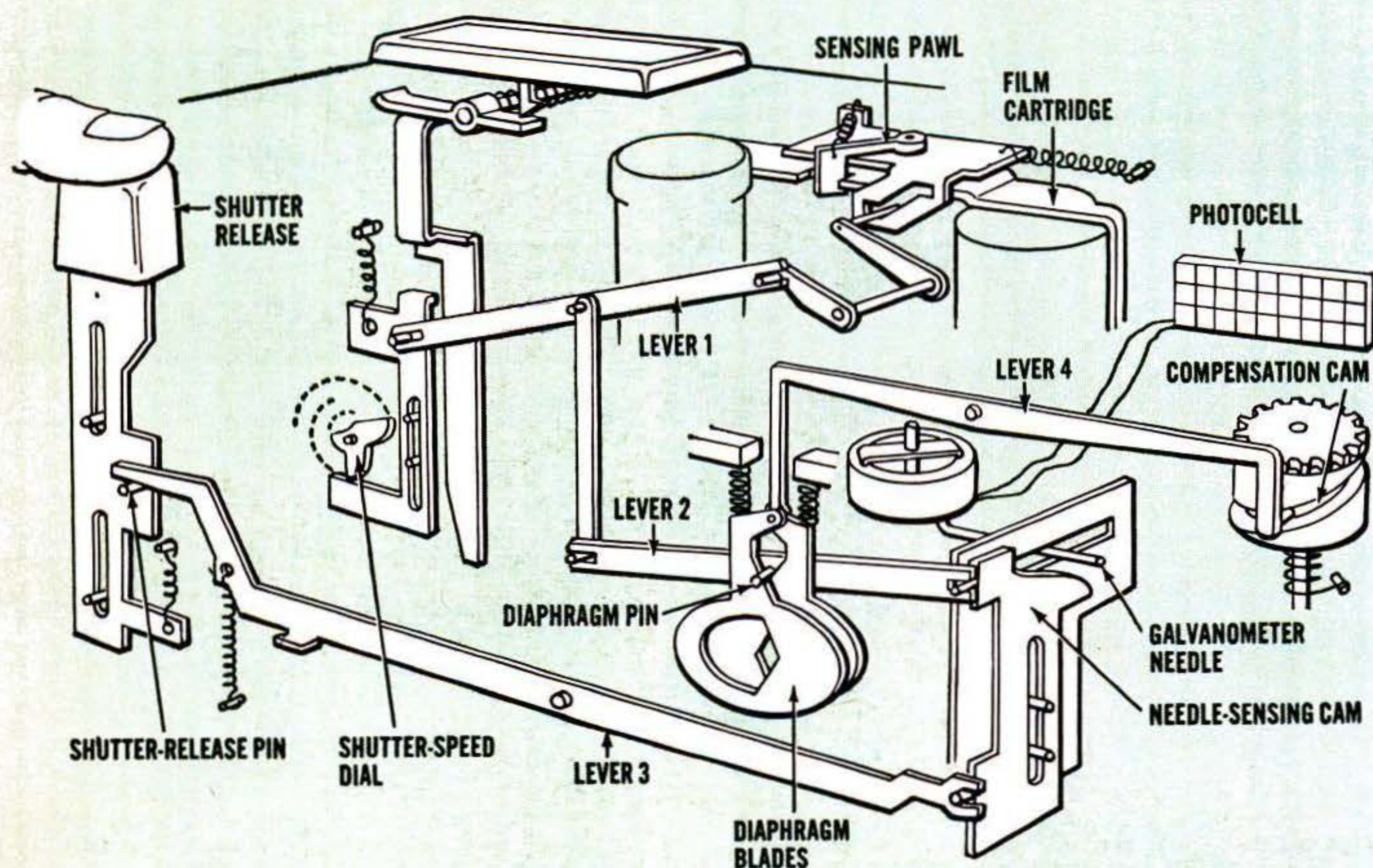
- Reduce the size of cameras.

Automation began simplifying photography when Leica used one control knob to advance the film, tension the focal-plane shutter, and advance the frame counter. But the first practical automated camera having a light-measuring cell coupled with the camera diaphragm was Eastman's Super Kodak Six-20, introduced in 1938. It was a remarkably advanced design for its time, but it died with World War II. Since then, hundreds of automatic cameras have appeared, but practically all use conventional roll film or cassettes.

The no-thread, no-fumble cartridge. Eastman engineers started developing a film

CONTINUED

How the Instamatic 700's automatic exposure system works



The only decision you need make with the Instamatic 700 is the shutter speed you want; the camera feeds in the other information it needs to make a perfect exposure—film speed and scene brightness—and computes and sets the lens opening. Here's how:

Shutter speed: Turn the shutter-speed dial to one of three possible positions (1/250, 1/125, or 1/60 sec.) and you move a cam that raises or lowers the left end of Lever 1.

Film speed: Drop a 126 film cartridge into the camera and close the back. A slide track along the edge of the cartridge stops when a sensing pawl drops into a notch. Through a linkage, this positions the other (right) end of Lever 1. (Notice here that the left end of Lever 2, which is actually attached to the pin on Lever 1, moves up and down with Lever 1.)

Scene brightness: Aim the camera. A photoelectric cell reads the light and a moving-coil galvanometer transmits this into action by means of a needle in a slot. At low light levels, the needle moves to the right. In bright sunlight, it's at the left.

Lens opening: The camera sets the aperture just before it takes the picture. Press-

ing the shutter release moves down a pin, and the left end of Lever 3 follows. The right end pivots up, driving a needle-sensing cam until it stops against the needle. The cam, simultaneously, raises the right end of Lever 2 (the left end is already set by that pin on Lever 1) and thus the diaphragm pin in the center of Lever 2. The pin, moving up, opens the scissored diaphragm blades; the higher it goes, the larger the lens opening. Further pressure on the shutter-release button trips the shutter (not shown) to take the picture.

What happens if the shutter speed you set is too fast, even with the lens fully open? Then the galvanometer needle will be out of reach of the needle-sensing cam when it rises. In that case, Lever 2 will pivot, pulling down on the center of Lever 1. Since the right end of Lever 1 is fixed (by film speed), the left end must come down, thus automatically resetting the camera to a slower shutter speed.

Can you increase or decrease exposure if you wish? Yes, by turning the compensation cam. This rotates Lever 4, moving the pivot to which the diaphragm blades are attached and opening or closing blades by the equivalent of one stop.

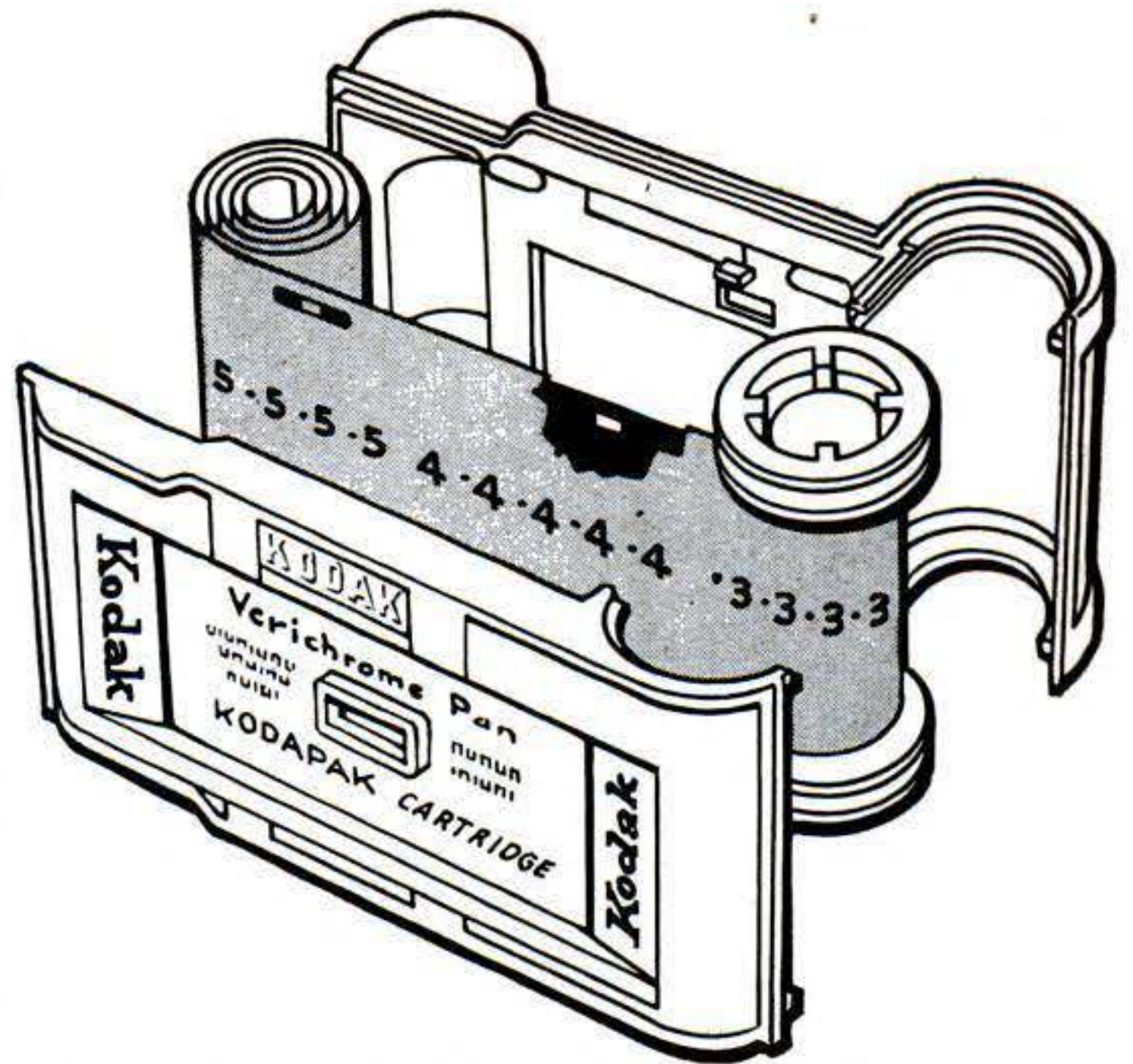
load you could drop into a camera without threading or fumbling with spools. Among the ideas considered was a 135-type cassette for 127 film. But the border was too narrow to take regular 35mm perforations on one side of 127 film for 38-by-38 super-slides. Also, it cost too much.

A major breakthrough came a few months later. Engineers suggested a double-ended throw-away film magazine that would make loading and unloading completely automatic.

In its final form, the Kodapak cartridge has a supply chamber at one end from which a free-floating roll of 35mm-width film and backing paper, without spool, winds onto a larger diameter take-up spool in the other end. Rewinding is unnecessary; exposed film is stored on the takeup spool.

Even photofinishers' needs were con-

[\[Continued on page 193\]](#)



Sealed, light-tight Kodapak cartridge has irregular shape so you can load it only the right way. Label and numbers on paper backing are visible through clear window in camera.

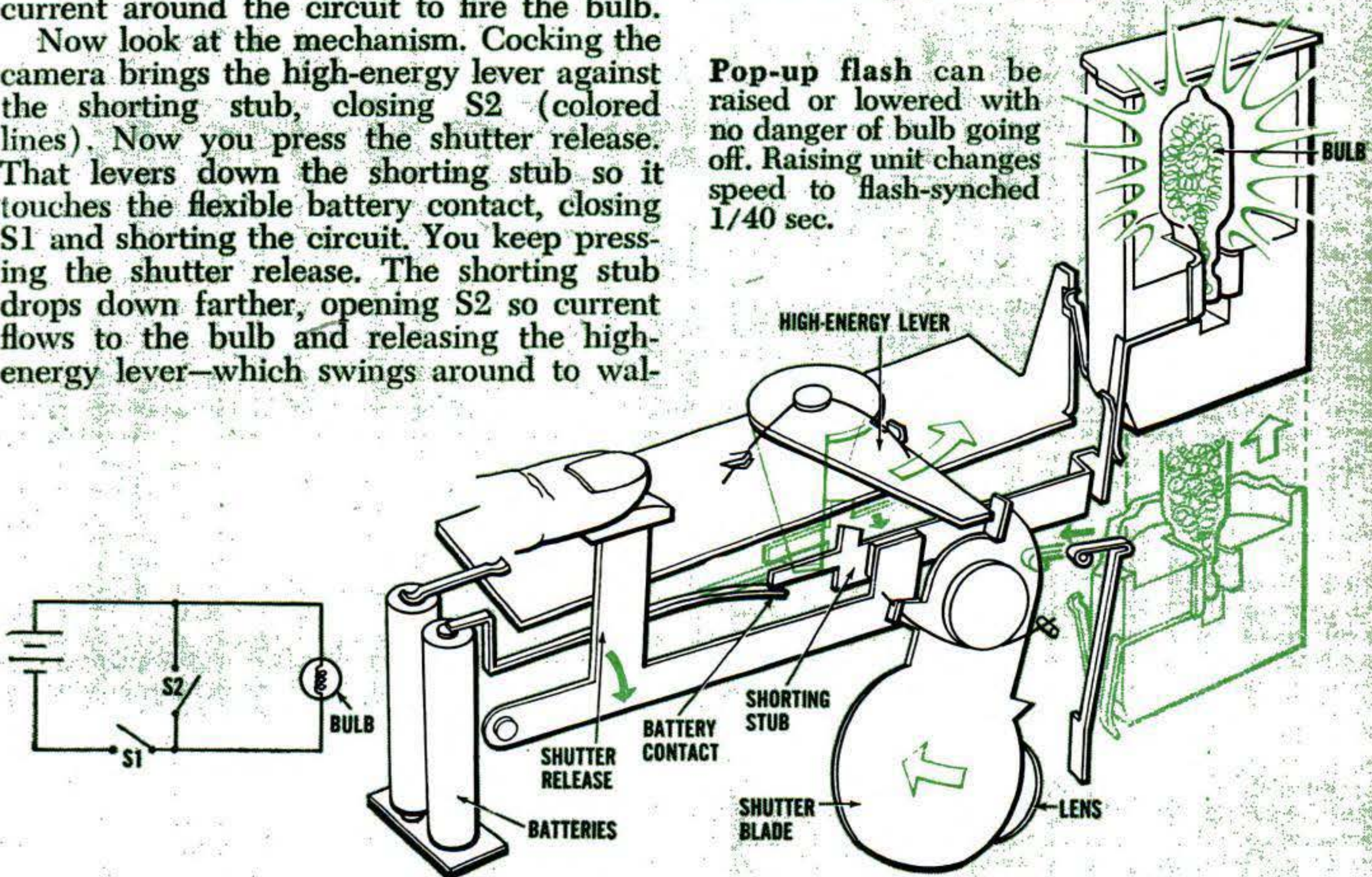
How the flash system works on the 100, 300, and 400 models

In the flash system of the Instamatic 100, 300, and 400 cameras a circuit *opens* to set off the bulb. Look at the small circuit diagram. If you close shorting switch S2 and then loop switch S1, you create a short across the battery. Open S2, and you send current around the circuit to fire the bulb.

Now look at the mechanism. Cocking the camera brings the high-energy lever against the shorting stub, closing S2 (colored lines). Now you press the shutter release. That levers down the shorting stub so it touches the flexible battery contact, closing S1 and shorting the circuit. You keep pressing the shutter release. The shorting stub drops down farther, opening S2 so current flows to the bulb and releasing the high-energy lever—which swings around to wal-

lop the shutter blade. The blade uncovers the lens, the bulb goes off, and the picture is taken. The time it takes for the lever to smack the shutter open fully is set to match the 13-15 milliseconds an AG-1 flash bulb takes to reach full brilliance.

Pop-up flash can be raised or lowered with no danger of bulb going off. Raising unit changes speed to flash-synched 1/40 sec.

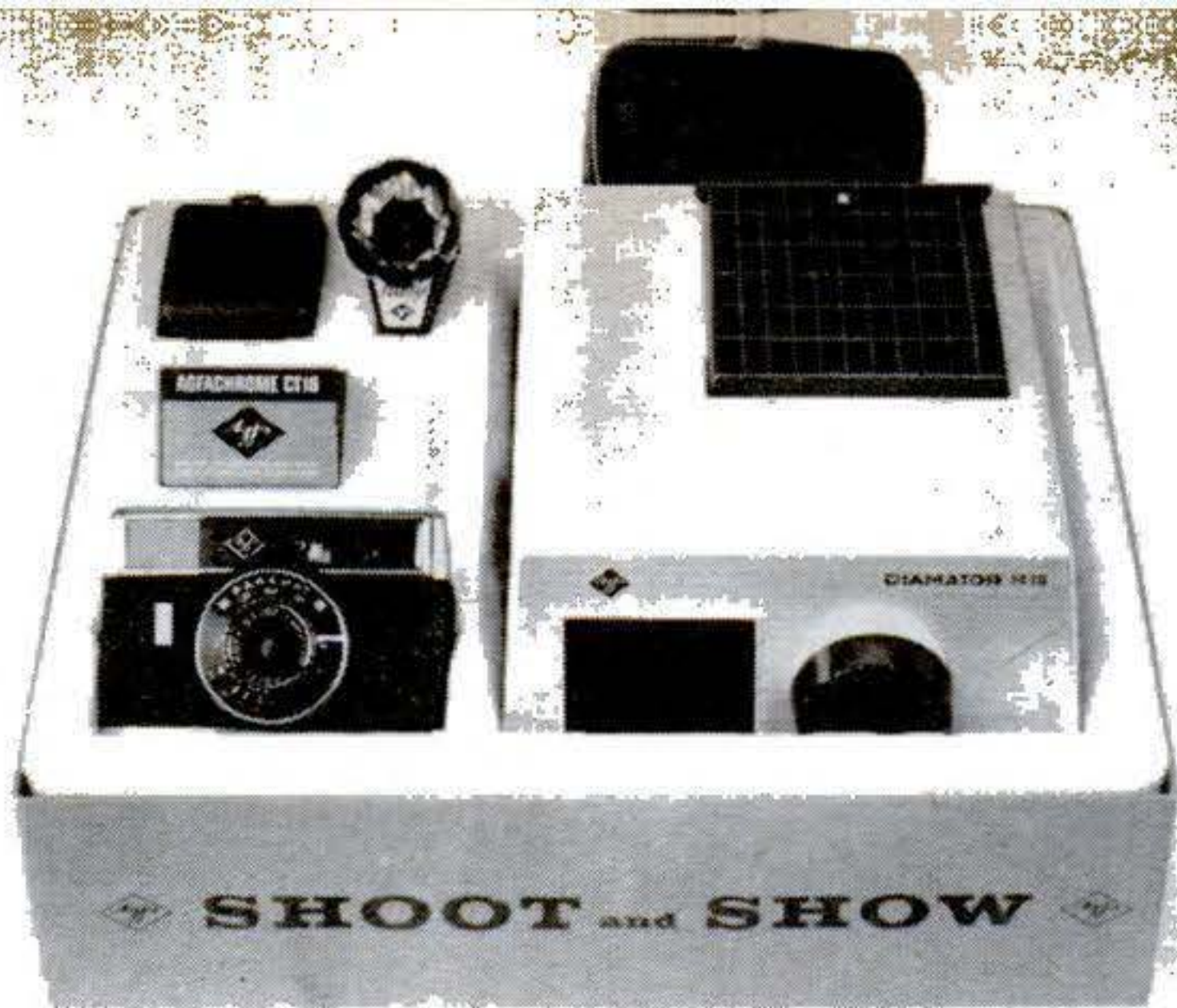


what's new

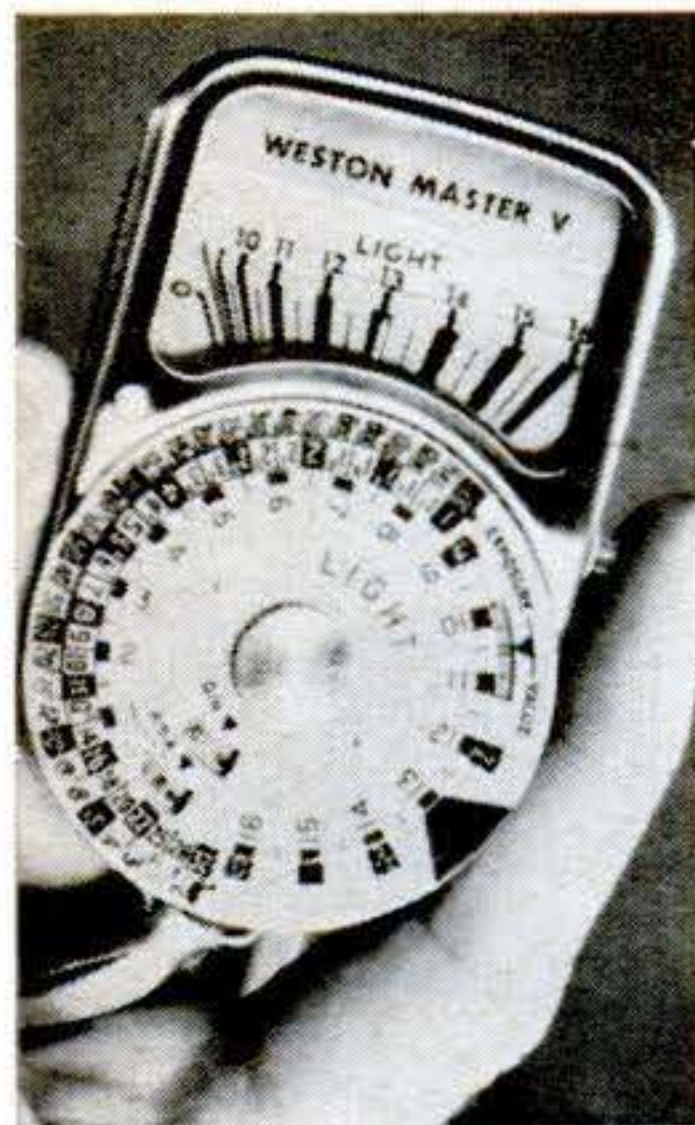
PHOTOGRAPHY

Subminiature kit has camera and projector

Been wanting a subminiature camera? Here's a complete package: Agfa's automatic electric-eye Paramet and half-frame projector. Picture size is 18 by 24mm. Camera shoots 40 pictures on a standard 20-exposure 35mm roll. A cheaper kit has a Parat camera without electric eye. The pro-



jector uses a 60mm lens and magazine with a single-lever slide advance. Cost: \$119.95 and \$89.95. Agfa, Inc., Rockleigh, N. J.

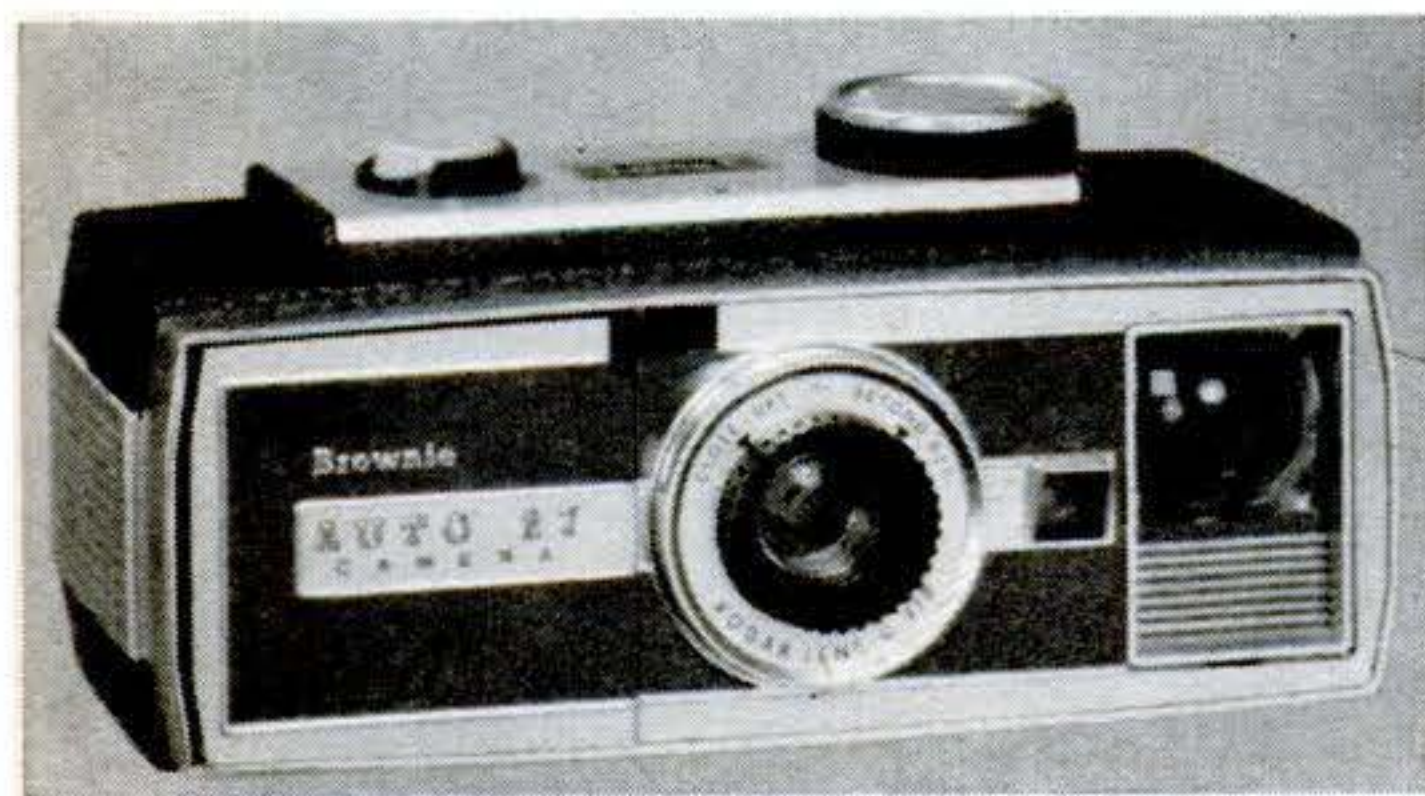
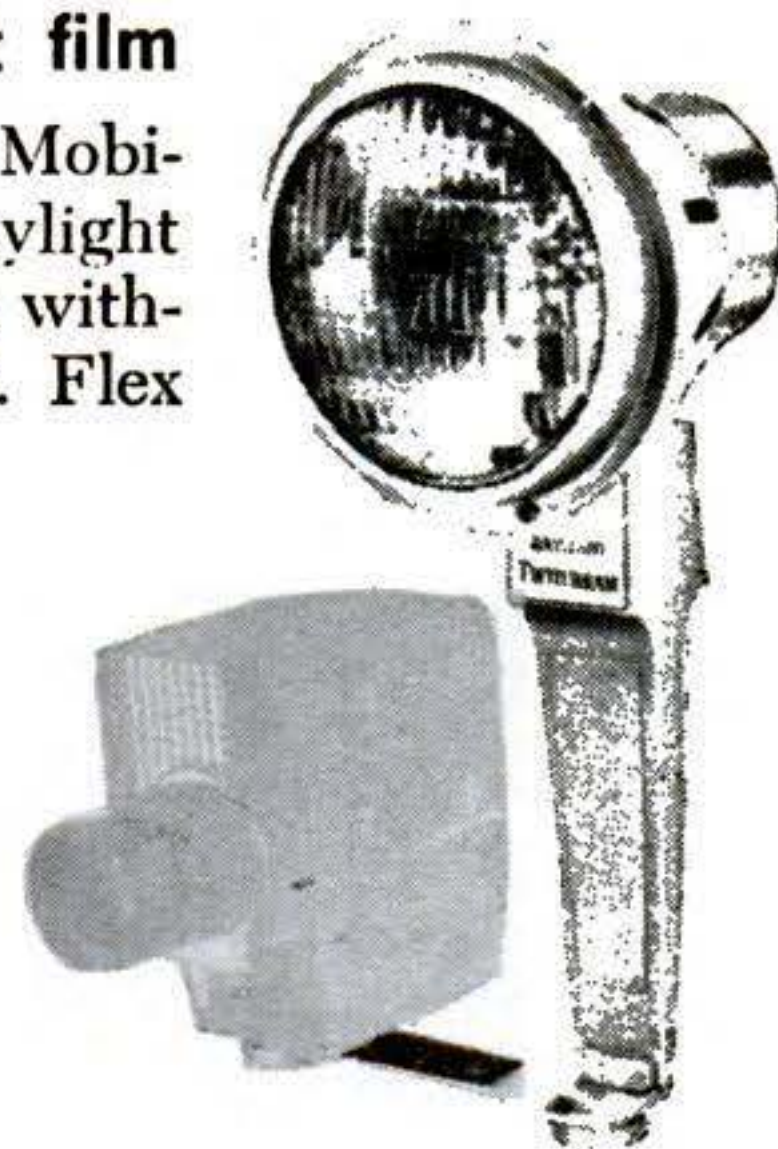


Movie light balanced for daylight film

The daylight-balanced twin-beam Mobilite lets you load a camera with daylight color film and shoot the film at night without a conversion filter. Price, \$19.95. Flex Electric, Long Island City 1, N. Y.

Weston sticks to selenium photocell

Instead of following the trend to CdS cells, Weston is retaining the selenium cell in their new Master V meter, said to give measurements in any usable light. \$36.95. Daystrom, Inc., Newark, N. J.

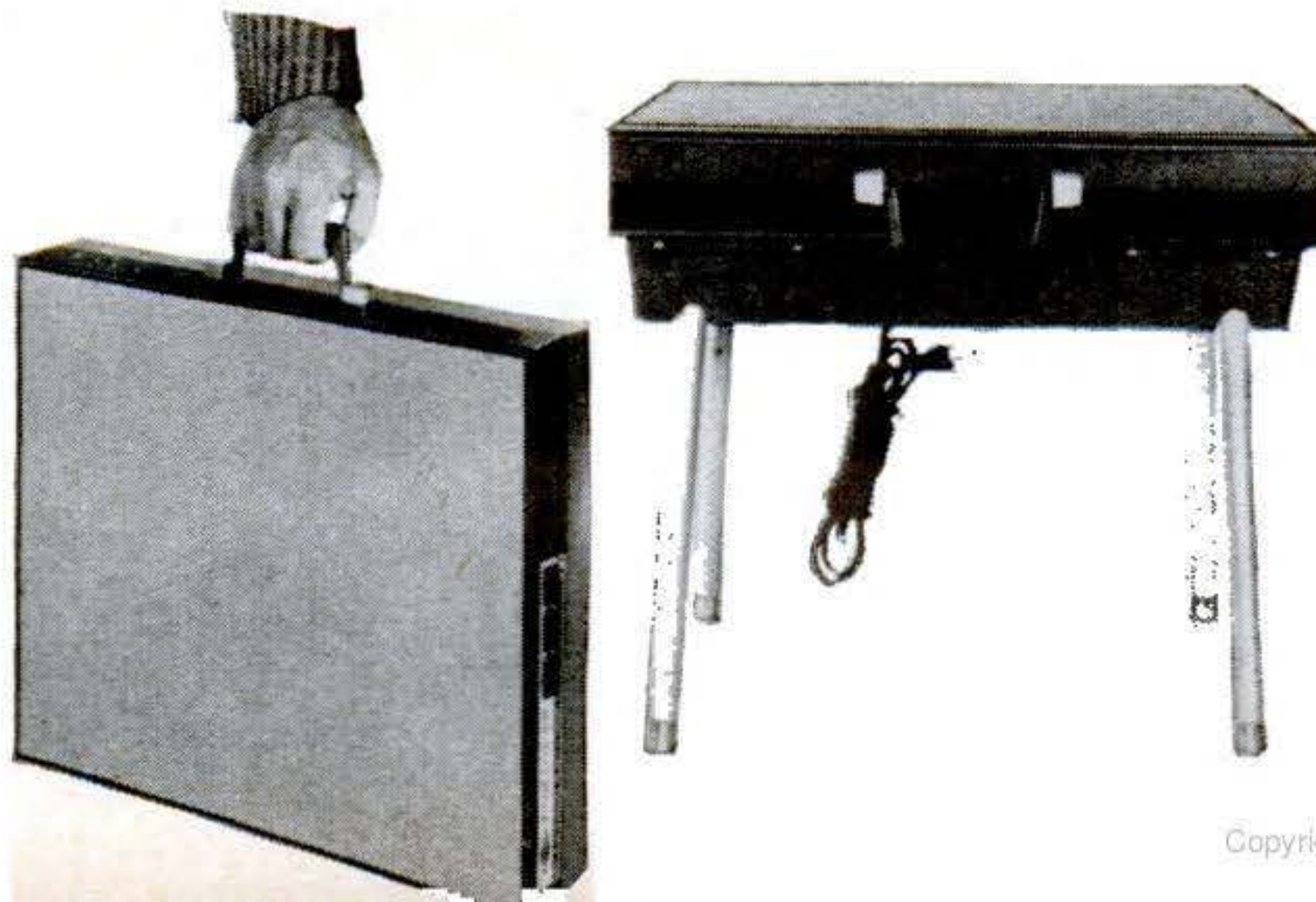


First CdS meter for Brownie cameras

The Automatic 27 is the first Brownie electric-eye still camera to use a CdS photocell. It has two automatic controls: one for daylight, another for flash. The photocell controls available-light exposures. The built-in flash holder couples to the shutter and is focus-linked to the lens. A door hides it when not in use. \$34.50. Eastman Kodak Co., Rochester, N. Y.

Projector stand handles as easily as an attaché case

Closed for carrying or storage, the Portopak is a compact 19½" by 16¼". Standard model has three outlets; deluxe, two three-way switches plus switch-controlled slide viewer. Unit has four adjustable legs. Weight: 10 lb. Sawyer's standard Portopak, \$16.95; deluxe, \$21.95. H. A. Bohm & Co., Chicago.



PHOTOGRAPHICALLY SPEAKING

By Bob Hering PS PHOTO EDITOR



Now—three new movie color films are here from Ansco

After announcing four Anscochrome films for still cameras, Ansco now offers three new motion-picture films. The company says the films have improved color quality and sharpness, with an ability to protect against exposure errors. Two films, one balanced for daylight and one for tungsten, have an ASA rating of 100. The third film is rated at 200 ASA. At present, 16mm is the smallest available size, but 8mm will undoubtedly be offered soon.

Tips for taking better holiday pictures

The Christmas holidays offer abundant picture-taking opportunities, indoors and out. This year try something more than ordinary on-the-camera flash shots. Night-time color pictures can be spectacular. Don't worry about exact color rendition.

Outdoor evening shots. For a brief period before darkness, the sky is still bright enough to register. This is the ideal time for shooting night-time color pictures. Set your camera on a tripod. Shortly after sunset, make a brief exposure at f/3.5 or faster to register the sky and a little shadow detail. Wait until dark. On the same frame and without moving the camera, take a time exposure with Christmas lights on. You'll get pictures that are closer to what you really see.

Fireplace and candlelight pictures. Have your camera on a tripod and make your subjects hold still for time exposures. Indoor film will be faster in this soft, flattering type of light. Candle flames register over a wide exposure range. You might try some shots with your subject between two or more candles. Bounce flash is good for fireplace pictures.

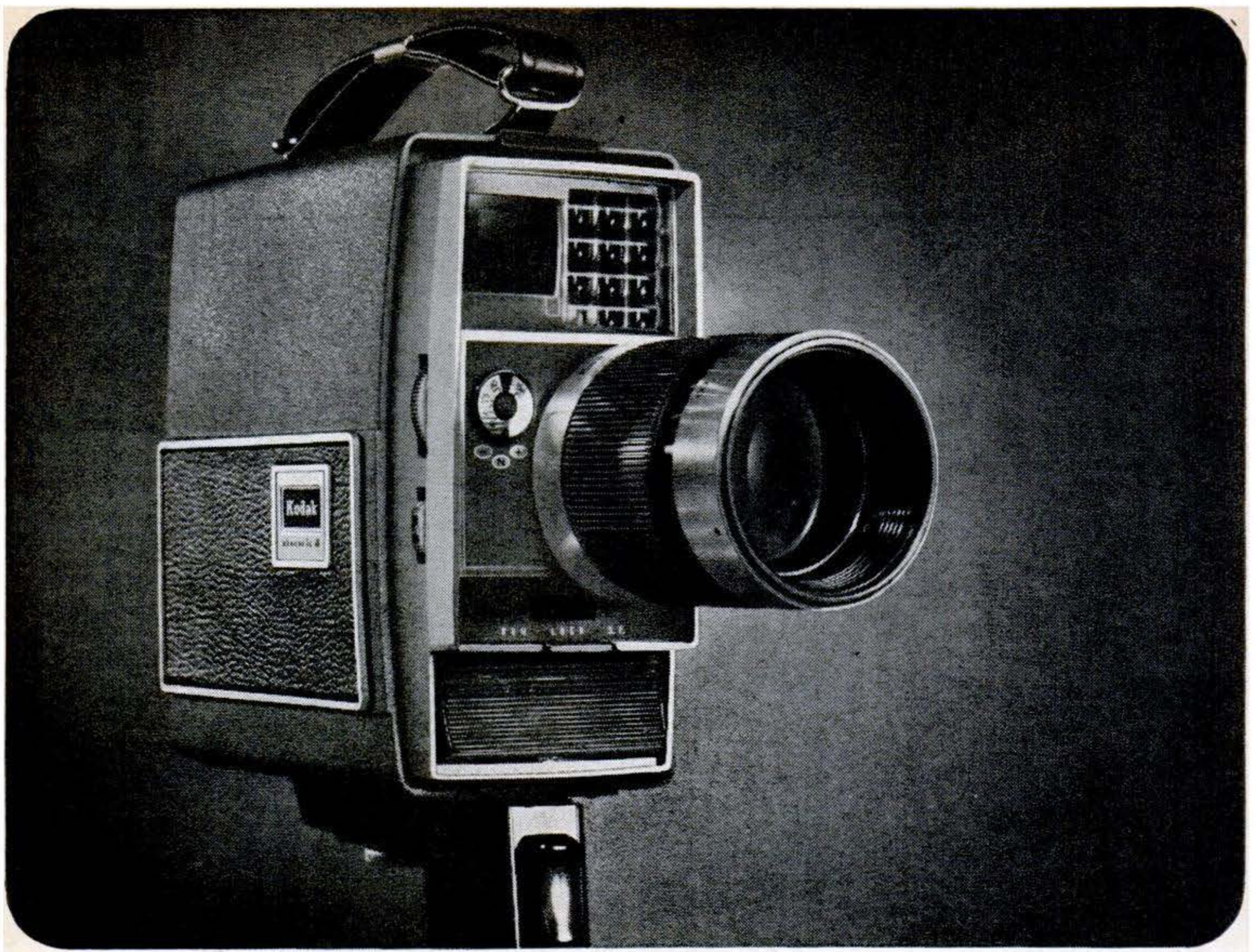
Bounce flash. With white or very light ceilings, figure exposure for on-the-camera flash and open up two stops. Christmas-tree lights and similar bulbs will register well over a wide range of shutter speeds slower than 1/50 second.

Germans develop simplified film loading to answer U.S. challenge

German camera manufacturers have developed a new simplified film-loading system for still cameras. It retains the popular film sizes. One incidental advantage is the elimination of 35mm film rewinding. But it will be next year before cameras appear using the new system. It's the German answer to Eastman's drop-in Kodapak cartridge.

Just in time for holiday use

A new data booklet, "Adventures in Indoor Color Slides," is loaded with tips on improving your color transparencies (Eastman Kodak, 75 cents). The emphasis is on recording family activities. But tricky questions about available-light pictures and how photography can work for you are also discussed. It's profusely illustrated with color pictures.



Hottest new ideas in photography—

The new quick-loading

New KODAK Electric 8 Zoom Camera

Always keeps you ready for action



New KODAK DUEX 8 Cassette uses regular 8mm roll film. No in-camera threading!



Cassette snaps into camera. Flip it over after first 25 ft.—you're set to go again!

There's nothing to slow you down when you're out to shoot action with this movie camera! The new KODAK DUEX 8 Cassette provides quick drop-in loading using standard 8mm roll film. Preload several cassettes, and you're ready for continuous filming.

Battery-powered motor drives 10 to 24 rolls of film through the camera with never a slowdown, never time out for winding.

Zoom lens lets you close in on ac-

tion—fast and smooth. And you see the zoom in the coupled viewfinder!

No worry about exposure. Sensitive electric eye sets the super-fast $f/1.6$ lens automatically—even signals when light gets too dim.

See the new KODAK Electric 8 Zoom Camera at your Kodak dealer's in time to capture your holiday fun in movies. With built-in filter, hand strap, neck strap, one cassette and pistol grip—all less than \$150! Batteries extra.

The more you know about photography...the more you will count on Kodak

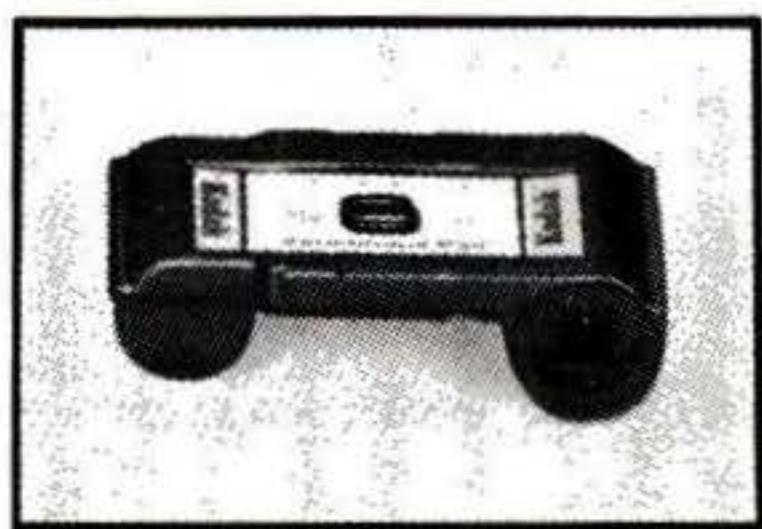
EASTMAN KODAK COMPANY



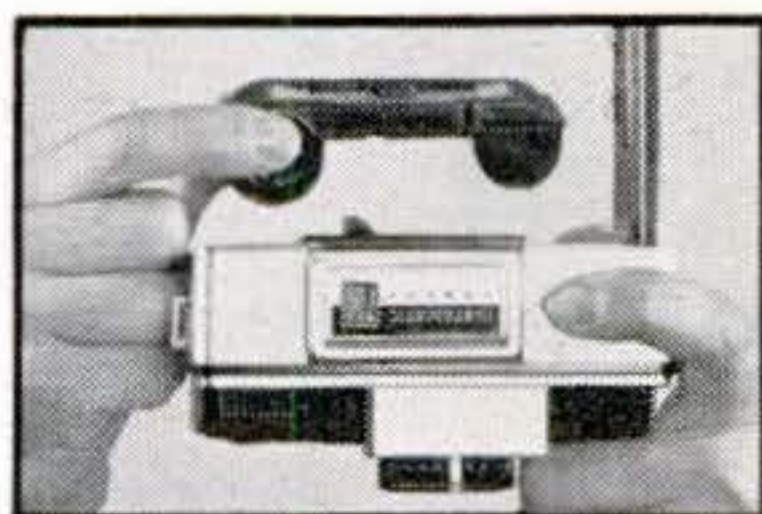
cameras from KODAK!

New KODAK INSTAMATIC 700 Camera

Easiest-to-use camera ever designed for fine pictures



KODAPAK Cartridges are factory-loaded with Kodak color or black-and-white film.



Drop in a KODAPAK Cartridge—camera's loaded! Load, unload—even in bright sun.

Why will you take better pictures with this new camera? Because all you have to think about is the picture. The KODAK INSTAMATIC 700 Camera takes care of the other details with amazing ease.

Drop in a KODAPAK Cartridge, and the camera's loaded instantly, the film speed's set into the electric eye. And, in turn, the electric eye not only sets the $f/2.8$ lens, it also adjusts the shutter speed if necessary, to insure correct exposure under a broad range of outdoor and indoor "available light" conditions.

Flash is this easy. A touch pops up the built-in flash holder, sets the shutter at $1/30$. Focus—and the lens is automatically set for a perfect flash picture.

See how much more rewarding it is to take pictures with the KODAK INSTAMATIC 700 Camera. Less than \$110. Three other new KODAK INSTAMATIC Outfits from less than \$18. All are great for Christmas giving or getting. See your Kodak dealer.

Prices subject to change without notice. Because of demand, there may be a delay on some KODAK INSTAMATIC models; if so, ask your dealer for the special INSTAMATIC Camera Gift Certificate.

Kodak
TRADE MARK

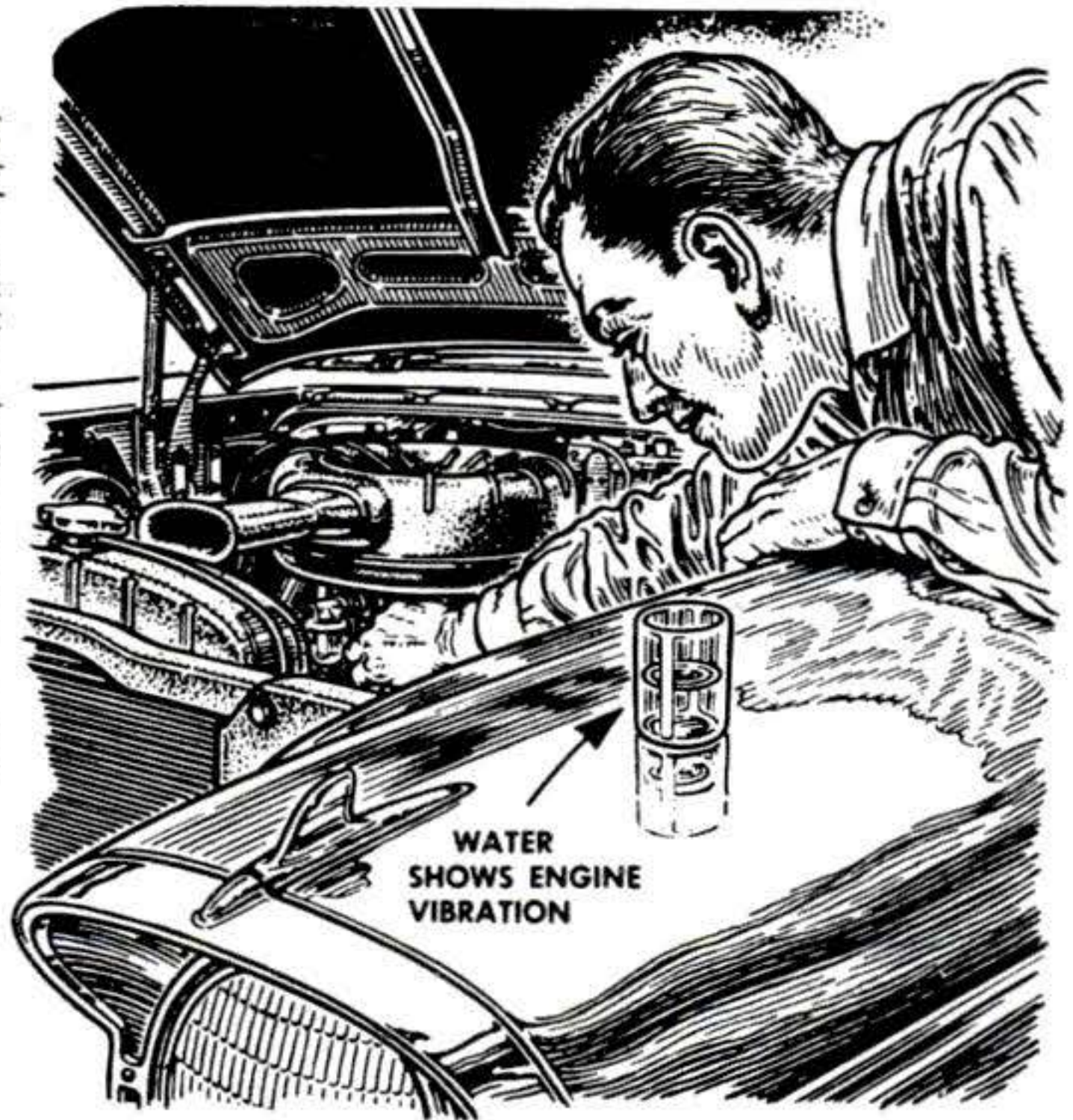
Rochester 4, N.Y.



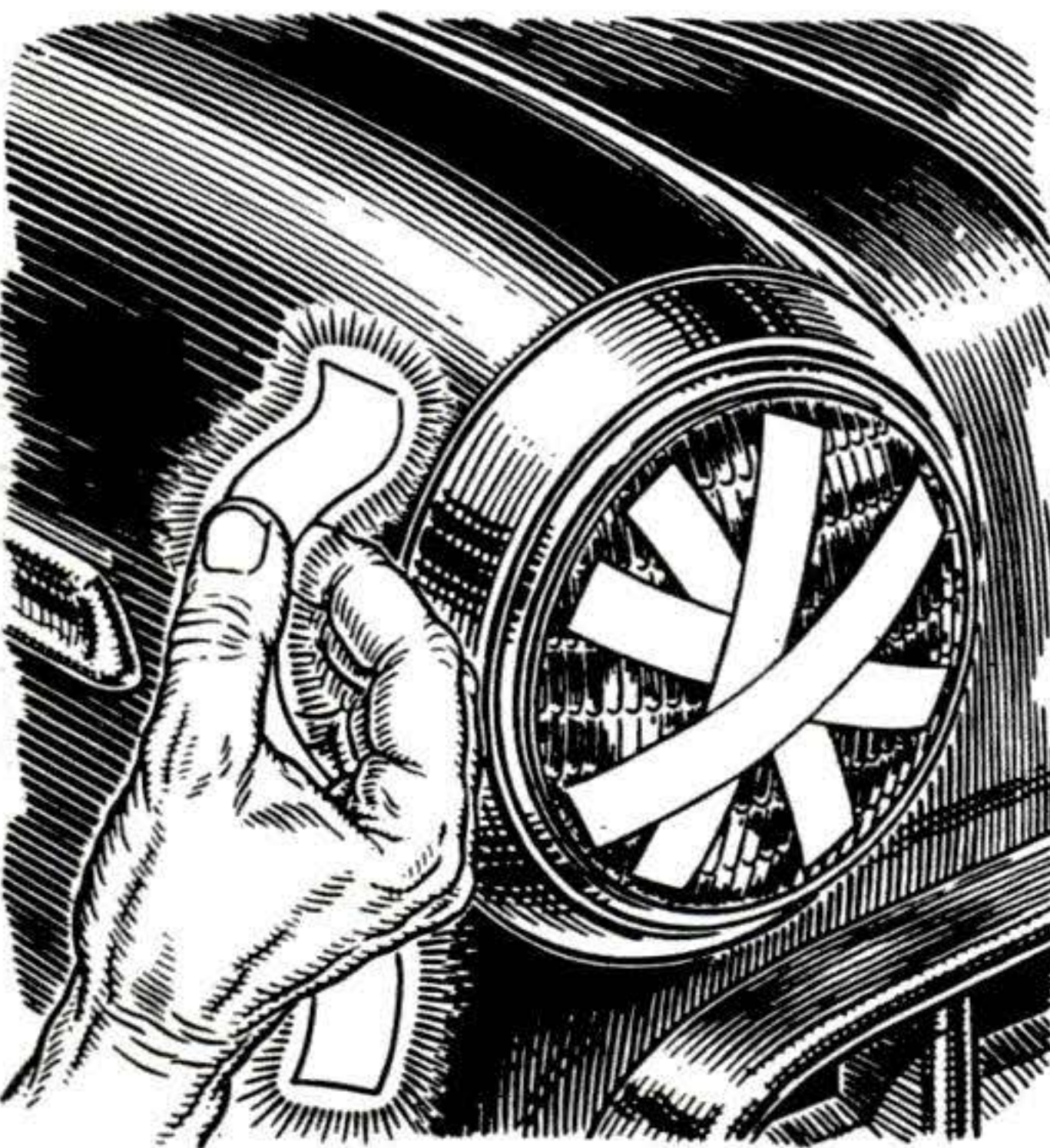
Hints from the Model Garage



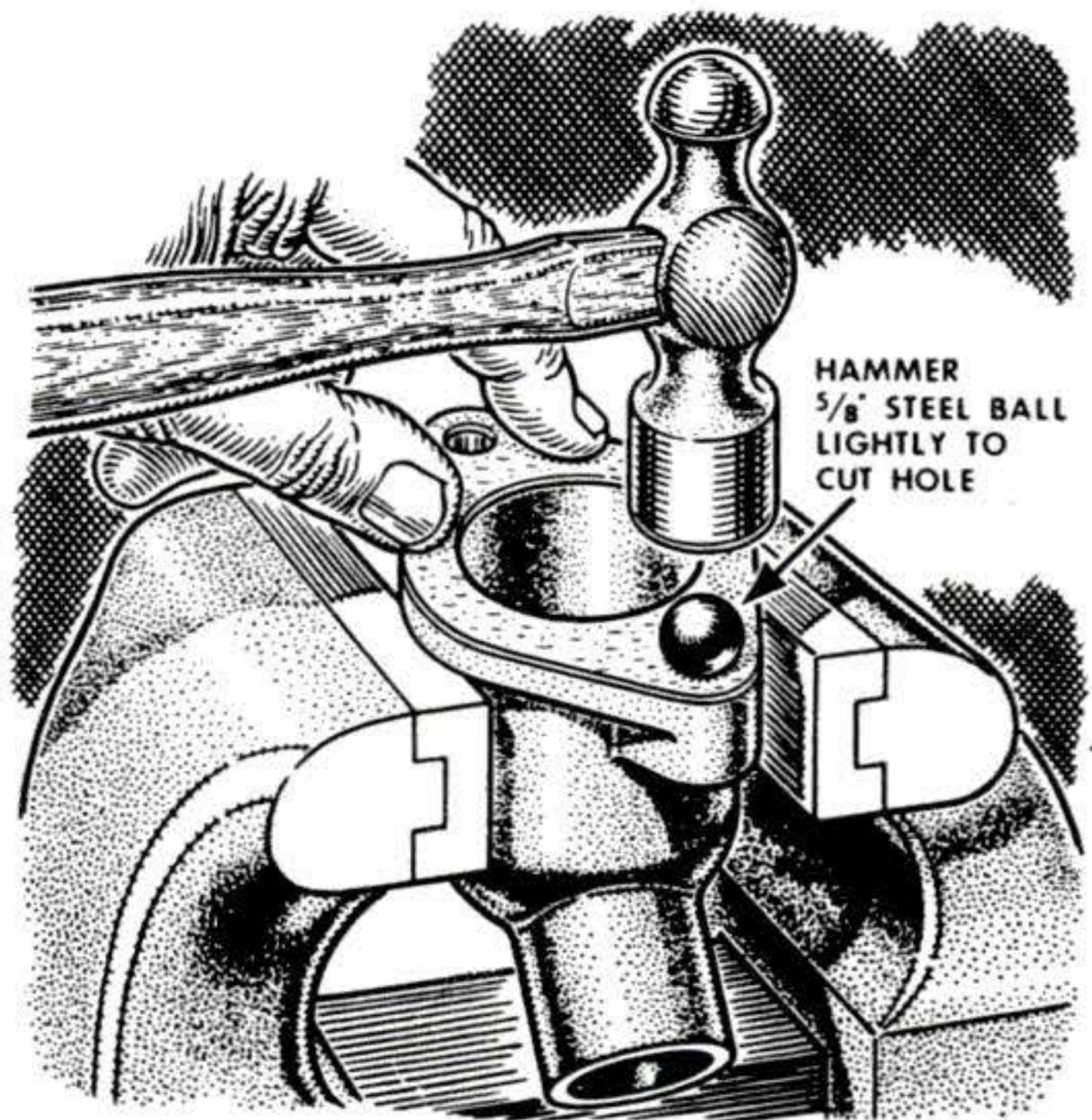
Drop a spare set of keys in the windshield-washer reservoir bag. They won't interfere with its operation. The bag makes a safe hiding place and the keys won't vibrate loose as they might if taped to the car.



A glass of water placed on the front fender will guide you when adjusting the carburetor. Turn the idling screws in or out until the water is least agitated. At this point, jets will be set for smoothest idle.



A strip of reflective tape, carried in the glove compartment, will protect you against collision if you're caught with a dead headlight. Strips pasted across the lens will show other motorists which light is out.

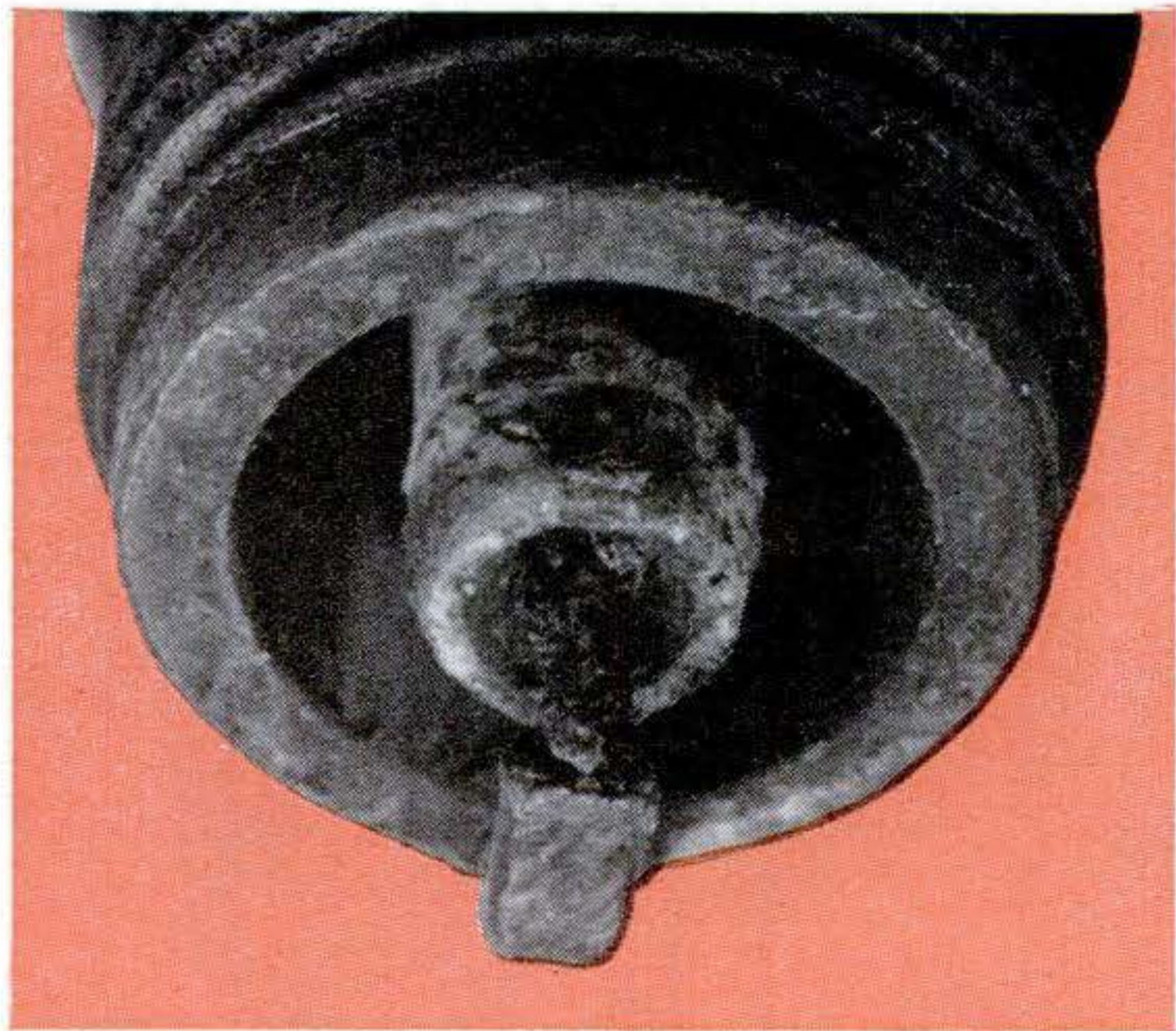


In making a gasket, you can locate and cut bolt holes in one step with a steel ball slightly larger than the hole. Shape the gasket and place it on one surface to be joined. Tap the ball lightly over the hole.

Have you tried these ideas? They're still as good today as when we first published them five or more years ago

CONTINUED

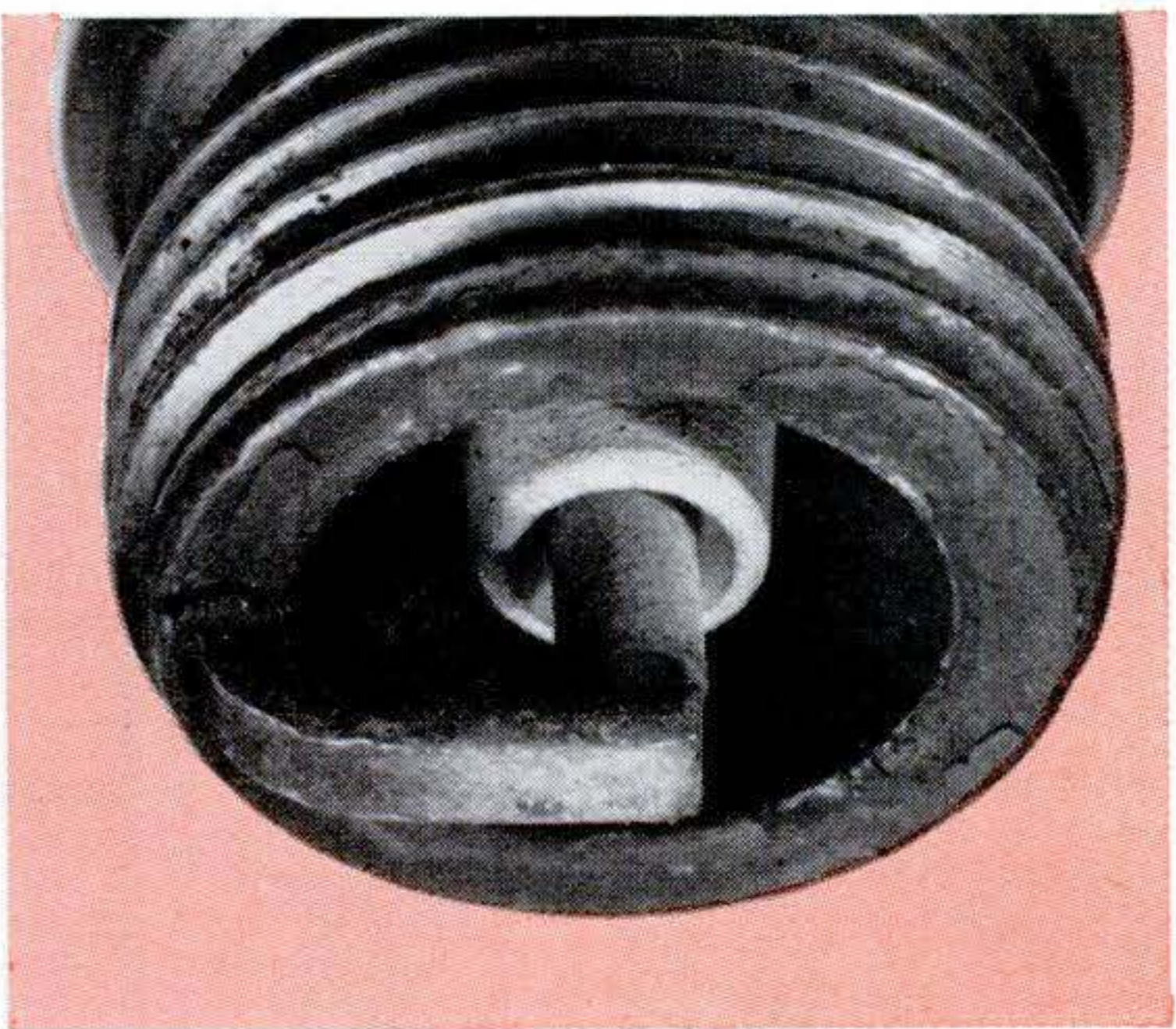
Correct "Hot and Cold" conditions with AC Spark Plugs in the right heat range



TOO HOT—Prolonged fast driving or heavy load service with spark plugs in too high a heat range are frequent causes of overheating and pre-ignition. This condition shows up in burned or blistered insulator tips and badly eroded electrodes. If this happens, switch to ACs in the next *lower* heat range.



TOO COLD—Low-speed, stop-and-go driving and prolonged idling with spark plugs in too low a heat range frequently lead to deposit fouling. This condition is indicated by red, brown, yellow and white deposits on the electrodes and insulator tips. To correct this, use ACs in the next *higher* heat range.



JUST RIGHT—Properly installed AC Fire-Ring Spark Plugs in the right heat range will eventually show brown to grayish-tan deposits on the insulator tips and slight electrode wear, indicating mixed periods of high- and low-speed driving. This means that the engine is in good working order and the spark plugs are operating at the most efficient temperatures.

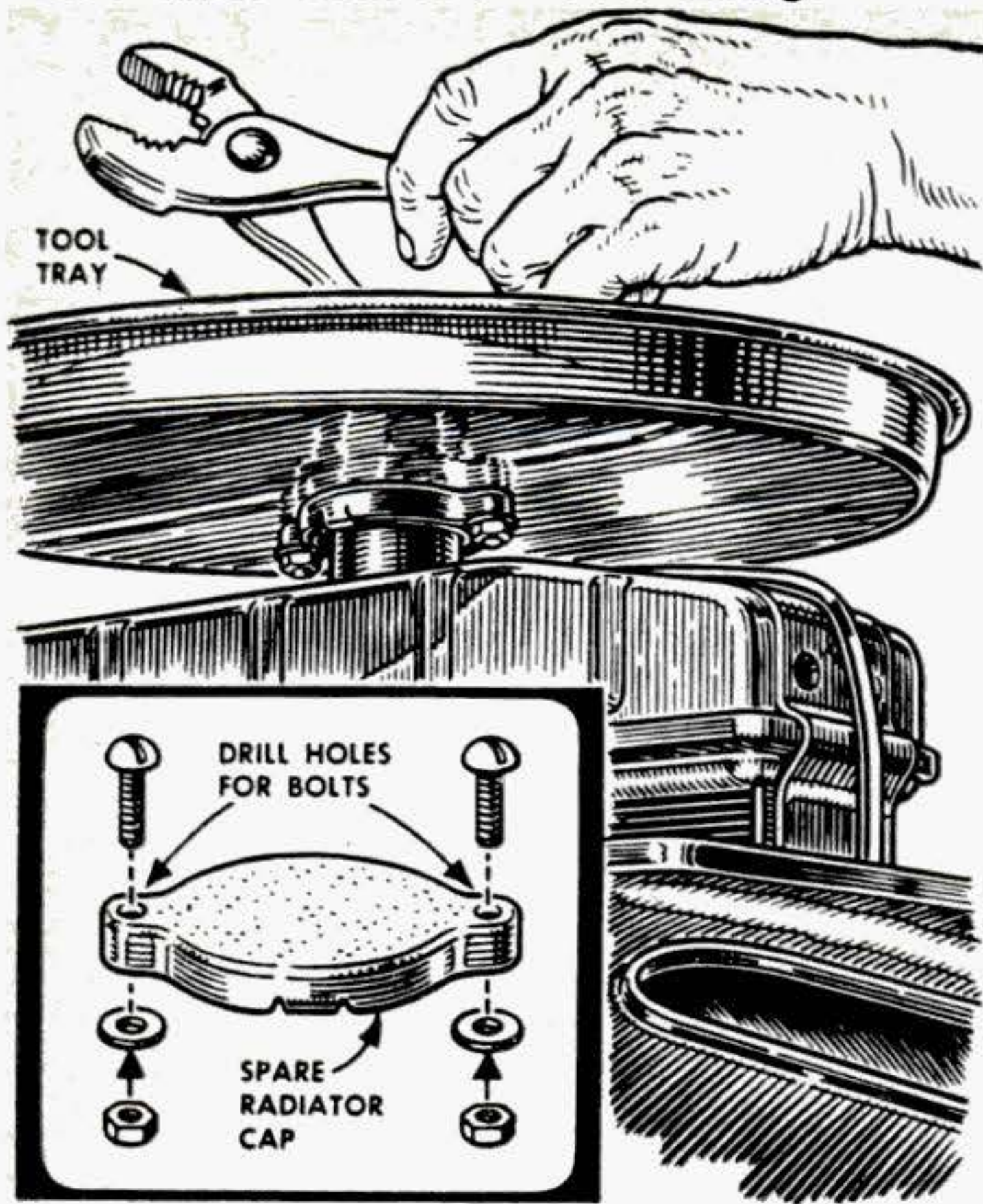
The heat range of your spark plugs (temperatures at which they operate) has an important bearing on your car's performance. While other factors sometimes cause the fouling conditions shown here, the use of spark plugs that run too hot or too cold can also result in these conditions. But AC Fire-Ring Spark Plugs in the right heat range will help give you peak power and performance. To be sure you have ACs that match your kind of driving, check your spark plugs today. Then ask for AC Fire-Ring Spark Plugs in the recommended heat range.



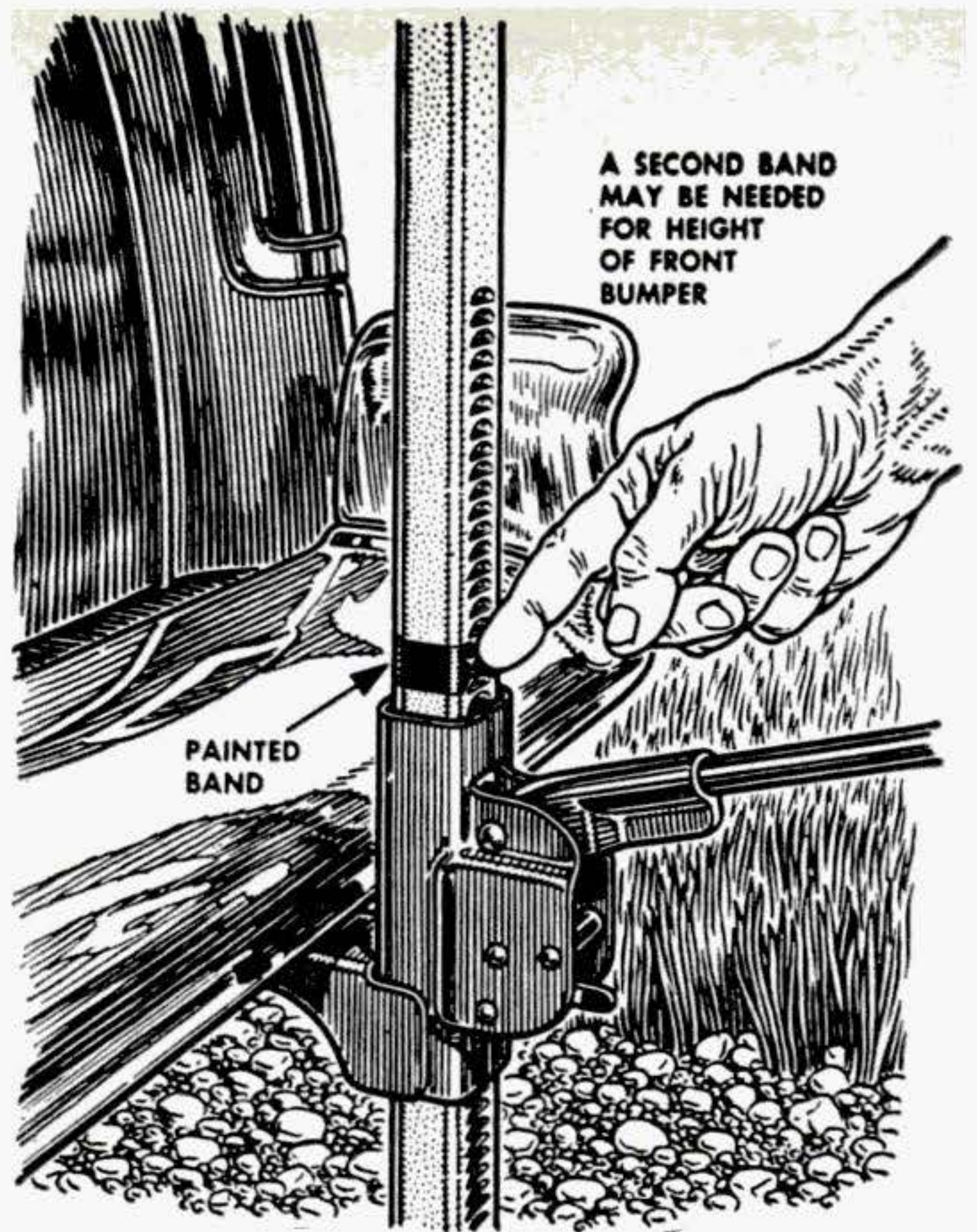
FIRE-RING SPARK PLUGS

AC SPARK PLUG  THE ELECTRONICS DIVISION OF GENERAL MOTORS

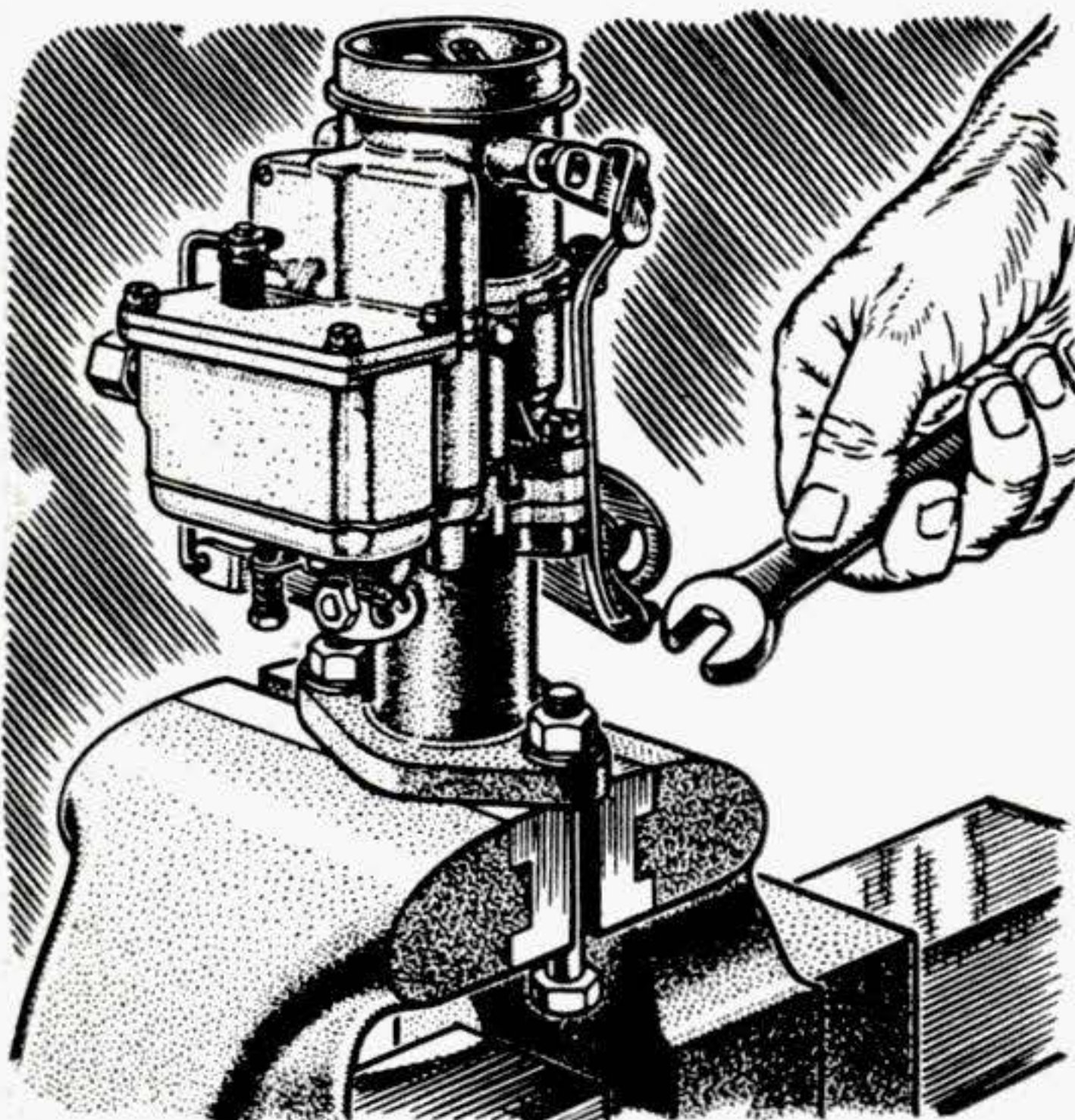
More Hints from the Model Garage



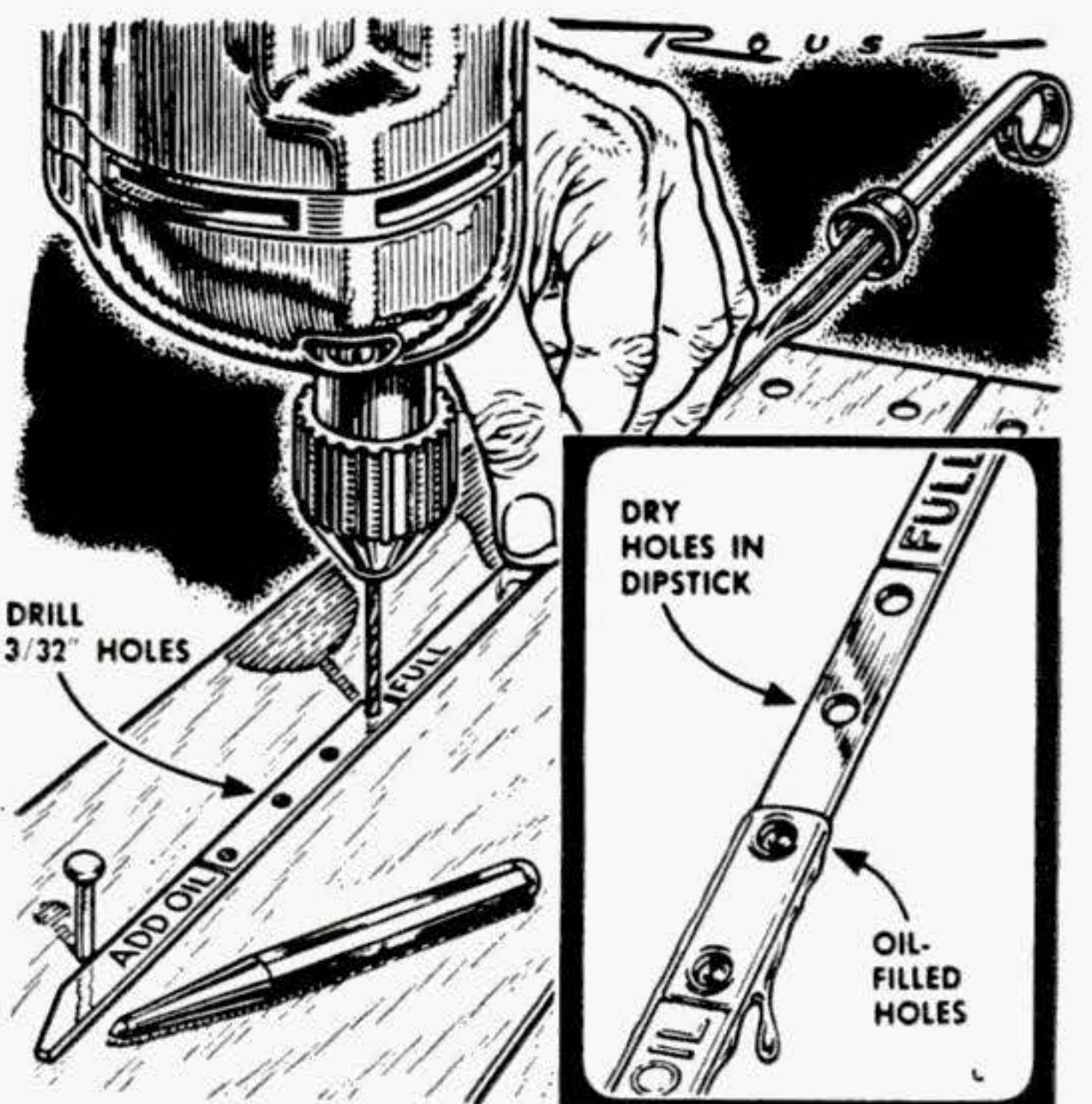
A tip-proof tool tray can be made by bolting a large pie tin or serving tray to the top of a spare radiator cap. Mounted on the radiator's filler neck in place of the regular cap, the tray is right at hand as you work in the engine compartment.



A mark painted on your bumper jack will tell you quickly just how high to raise the car to clear both the flat and the inflated spare. On some cars, two height marks may be needed, one for jacking up the front end and one for the rear.



To hold a carburetor while you work on it, clamp two $\frac{3}{8}$ " bolts in a vise and bolt the carburetor to these through the mounting holes in the flange. This will provide a very rigid work mount without any danger of damaging the carburetor.



Reading the crankcase dipstick will be easier, especially when the oil is fresh and clear, if you drill four small holes between the FULL and ADD OIL marks. The holes covered by oil will appear as tiny lenses; the others will remain open.

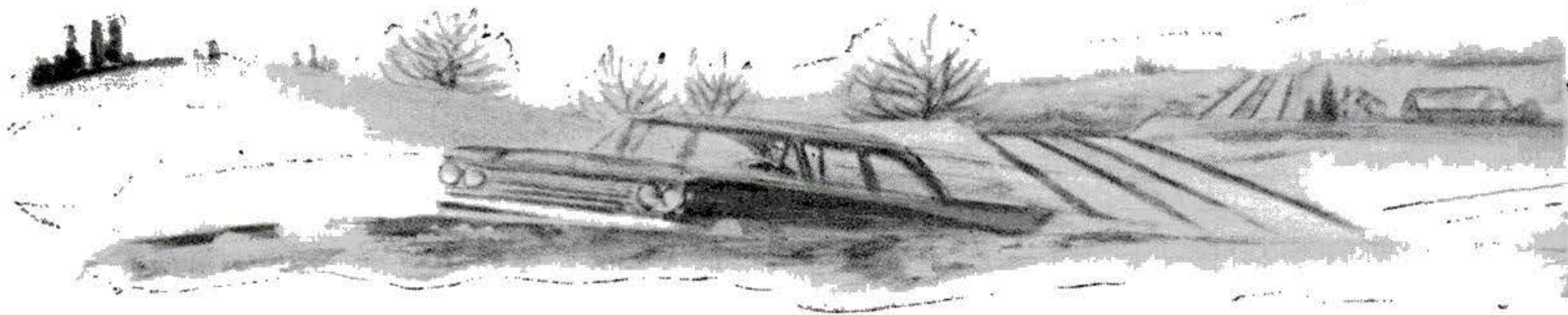
WORN SHOCKS?

Don't send your Chevy to parts unknown! When shock absorbers are worn, your car often tells you. It may nose-dive on sudden stops. Keep bouncing after bumps. Or show uneven tire wear. When it's time to replace, ask for the same kind of parts that gave your Chevy that smooth ride when it was new. Genuine Chevrolet Parts. They're built to your car's specifications, so they'll fit and work right for a long time. They're easy to get, because the people who install them have access to more than 75,000 of them for cars and trucks back to 1938. Ask for Genuine Chevrolet Parts by name at your local Chevrolet dealer's or at leading independent garages and service stations. . . . Chevrolet Division of General Motors, Detroit, Michigan. Remember . . . **It pays to keep your Chevy the Chevy-est.**



Look for this sign.

Gus Picks Up a Package of Trouble



By Martin Bunn

"HUSH, Tommy. We'll go as soon as the nice man fixes the car." Red-haired young Mrs. Fennel turned again to Stan. "I'm taking him to see Santa Claus at the County Shopping Fair. Will it take long?"

"Can't say till I know what to do," said Stan, who was in charge of the Model Garage while Gus Wilson was out on a road call. "You say the seat belt squeaks, but I never heard tell of that, Ma'am."

"Mine does. You're saying the same as they did where I bought it, when I went back to complain. Then they tried to tell me it was bad shock absorbers, so they could sell me new ones."

"It just could be," admitted Stan.

"Only it isn't! I had the seat belts put in three days ago. That's when the squeaking began. So it's the seat belt."

Helpless before this kind of logic, Stan shrugged. "Best thing is for me to road-test the car, if you don't mind waiting a few minutes."

Mrs. Fennel didn't mind, and after ejecting Tommy from the car with some difficulty, Stan drove it around a few blocks. A rasping squeak at once made itself so evident he could understand why Mrs. Fennel wanted it stopped. The noise was like the one he'd tormented schoolgirls with as a kid—the agonized squeak of chalk rubbed hard on a blackboard.

Thinking it might be the door weatherstripping or a hinge, Stan opened the door

a bit and kept driving. The squeak kept on. He drove back to the shop. Gus had returned.

"Everybody's installing seat belts these days," Mrs. Fennel was telling Gus. "So when this store had a sale I thought I'd get them there. But when they couldn't stop that awful noise, I knew I'd better come here, as my husband always does."

"We'll sure try to fix it," promised Gus as Stan checked the belt anchorages.

"I'm ashamed of that hole Fred—my husband—cut over the back seat," said Mrs. Fennel. "It's for a new kind of rear-seat speaker he ordered but hasn't got yet."

Gus glanced at the oval opening in the rear-deck panel. "Well, it beats carrying a slew of packages up there, as some people do. In a quick stop, they can fly off and hurt passengers. The hole is harmless."

Gus was to remember that speech wryly later in the day.

"Can't we go now?" put in Tommy.

Stan had removed the anchorage bolt of the left-hand strap which screwed into a threaded hole in the car floor. He looked through the hole at a frame member under it, then examined the end of the bolt. On it was a small shiny spot. The trouble light, maneuvered over the hole, revealed a like, though darker, spot on the frame member.

Putting a washer on the bolt, he screwed it back tightly; the washer would raise it enough to clear the frame. "If it squeaks when you drive out, Mrs. Fennel, come right back."



RAY QUINEY

*"Monoxide?" she said.
"But didn't you put on a
new muffler last week?"*

"Let's go!" wailed Tommy, tugging at his mother's arm.

Some hours later, Gus left on a turnpike call. Following a cold snap in November, there had been low temperatures until the last two days. Now a thaw had set in, but the air had a raw, wet edge to it.

The road call proved to be nothing but a broken ignition wire. Gus installed a new one, turned the wrecker around, and headed home.

In his mirror Gus saw the car come up,

none too steadily. It skinned past his rear bumper with little to spare, stayed abreast of him longer than it should have. The red-headed young woman driving it stared straight ahead, a cigarette hanging from her mouth, hands rigid yet twitchy on the wheel. She reminded Gus of Mrs. Fennel, but there was no child beside her. He eased off the gas to let her pass.

It was well he did, for suddenly the sedan swerved sharply in front of him, so close it would have ripped into his fender had he maintained speed. Back in the right

CONTINUED

147

lane, it roared on at turnpike speed. The trunk was partly open, its lid tied down over a package too bulky to permit it to close.

Simultaneously Gus realized several things. The car was wandering in a series of overcorrected lurches. And the driver was Mrs. Fennel. Remembering the hole in the rear deck, he made a quick decision.

Throttling down, Gus swung into the passing lane. He overhauled the sedan and blew his horn. Side by side with the car, he saw Mrs. Fennel glance at him through her closed window with no sign of recognition.

Gus made urgent signals for her to pull over. The sedan lurched closer, nearly sideswiping the truck. Staring at the pretty, vacant face, Gus sounded the horn again in staccato bursts. Something finally broke through the woman's inattention. She looked at Gus with startled recognition—and the car slowed, wavered off the road onto the shoulder.

Stopping in front of it, Gus jumped out and ran back. The driver's door was locked. He rapped on the window. Seconds crawled by as Mrs. Fennel slowly unlocked the door. Gus flung it wide, un-snapped the seat belt and hauled her out.

"Where's Tommy?" he demanded, switching off the engine.

"I—I left him—with Mother, after shopping," she said thickly. "What happened? Did I faint?"

"You're going to be all right." Spotting a blanket on the rear seat, Gus wrapped it around her and made her sit on the door sill, then opened all the other doors.

Cars whizzed by. Except for a curious look or two, nobody paid them any attention.

"I'd like a cigarette," said Mrs. Fennel after a few minutes.

"Not yet," said Gus. "Right now you

need lots of fresh air—to counteract that carbon monoxide you've been breathing."

"Monoxide?" She seemed to take the word in slowly. "But Fred's so careful about that. Didn't he have you put on a new muffler last week?"

"Yes, but this didn't happen because of a defective exhaust system," explained Gus. "It was partly due to that hole I said couldn't do any harm."

"The one Fred made in the back? How could that let in exhaust gas?"

"Your trunk was open. Monoxide would have seeped in through the rear seat back anyway. Through that hole, it got in faster. How do you feel now?"

She shuddered. "I have an awful headache, but I don't feel as sick as I did."

"The car's been aired out enough. Better get in to keep warm, but don't drive off. I'll be right back."

Gus's efforts to raise Stan on the two-way citizens-band transmitter in the wrecker failed. That wasn't surprising, as Stan listened for calls only every hour on the hour. Gus sent out a general "any-

body-listening" call.

"This is 2W7673," announced a voice. "Anything I can do?"

"This is mobile 2W4233," said Gus. "Would you phone the state police, and tell them I stopped to help a sick woman north of turnpike milestone 274? Ask if they can spare a man to drive her home. No ambulance needed. Over."

"Will do. North of 274. Right? Over."

He found Mrs. Fennel more alert and apparently recovering nicely. Untying the trunk lid, Gus lifted the huge package out and loaded it onto the wrecker. He closed the sedan's trunk and saw that it was securely locked. For good measure he crawled underneath and checked the muffler and tailpipe joints. All were sound.

In 12 minutes a state police car arrived. After brief explanations, the second trooper

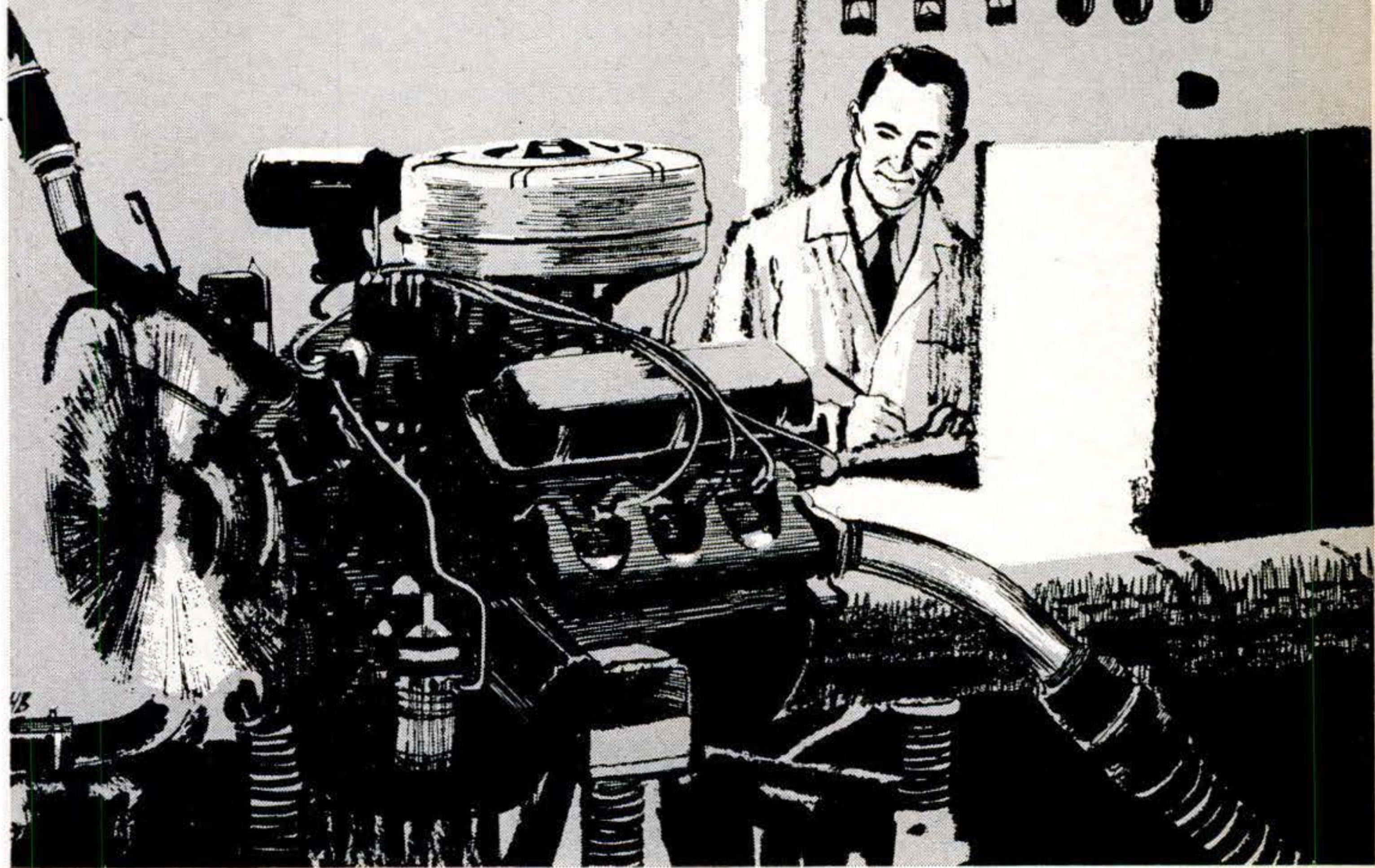


Motorized rickshaw

Through narrow, crowded alleys where rubberneck buses can't go in San Francisco's Chinatown, this three-wheeler does the job.

It combines a rickshaw from the East and a motorcycle from Germany. With three speeds forward, no reverse, it does 25 m.p.h., turns in a 90-inch radius. A loudspeaker delivers a taped tour spiel.

*Assignment: put more
pep per pound into
Ford-built engines*



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Other engineering assignments aimed at improving Ford-built cars have resulted in self-adjusting brakes,

extended major chassis lubrication intervals and other service-saving features, and use of rust-resistant galvanized steel for vital underbody parts. Engineering excellence is a big factor behind Ford Motor Company's success in bringing you quality cars that last longer, need less care and keep their value better.

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LINCOLN CONTINENTAL**



MOTOR COMPANY

**WHERE ENGINEERING LEADERSHIP
BRINGS YOU BETTER-BUILT CARS**

in it undertook to drive Mrs. Fennel to her home. With relief Gus let both cars pull away.

A late repair job claimed all his attention when he got back to the Model Garage. Only when closing up did Gus remember something important.

Today was Christmas Eve, and Mrs. Fennel's package—which he suspected was a present for Tommy—was still on the wrecker.

Pushing it through one of the wide doors of his sports coupe, he drove to the Fennel home. Fred Fennel answered the bell.

"Oh, it's you," was his comment.

"Seems we all forgot this," said Gus, lifting the heavy package over the threshold. "I figured Tommy would miss it."

Fennel swung the door wide. "Guess he would—it's his big gift. He's spending Christmas Eve with his grandmother, but she'll bring him here tomorrow. Gives him two Christmases—and us a chance to trim the tree."

"Is Mrs. Fennel feeling all right?"

"Just about." Fennel paused. "Look, I'm grateful and all that, and if it hadn't been so late I'd have come to see you."

"What's on your mind?"

"I just don't understand how it happened," Fennel burst out. "So the trunk was open and there was that hole for the speaker. Where did the exhaust come from?"

"From the car's own tailpipe."

"I don't buy that. Here's a car doing 60, running away from its own exhaust. If there weren't a leak *under* it—from a defective muffler or a bad joint, monoxide couldn't have got in. What kind of job did you do

last week that would have killed my wife—if you hadn't spotted her by sheer luck?"

Gus took a deep breath.

"Let's save the question while I explain what your wife was in no shape to hear. A moving car creates a low-pressure area behind it, a sort of suction drag. A car does *not* run away from its own exhaust. It pulls some along with it. Station wagons are especially prone to do this. Some people leave the rear window of a wagon open for ventilation. That sucks in exhaust.

"With that package holding your trunk lid open, fumes were sucked into the trunk—and then through that hole in the deck. If there'd been no hole, they'd have seeped through the seat back, but more slowly. As for your question, I checked the exhaust system on the spot. It's tight."

Fennel swallowed in obvious embarrassment. "Instead of asking dopey questions, I should be thanking you over and over. Anything I can do to make up for it?"

Gus smiled. "Sure is. Tell me what kind of toy comes in that sassy box?"

Fennel began to rip open the carton.

"A kid's electric drive-it cart. Look."

His face fell as he hauled out a collection of wood, wheels, and hardware. "Omi-gosh! It's one of those 'easy-to-assemble' things. I'll be all night putting it together."

Bemused, Gus picked up two parts and fitted them together. Fennel looked at him with sudden hope.

"Say, any chance you would—Lucy'd put on an extra plate for dinner. I know it's asking an awful lot, but . . ."

"It's Christmas, isn't it?" Gus dug out more parts. "Besides, I always did have a hankering to work on a car this size." ■ ■



Belgian police cars use smokeless fuel

Police in Brussels are running English Ford Zephyrs on liquid petroleum gas. LPG reduces air pollution from exhausts, gives longer engine life, and is much cheaper than highly taxed gasoline in the Benelux countries. Cylinder heads are modified, raising compression ratios. A cylinder in the trunk replaces the normal gasoline tank.

2 GREAT GIFTS FOR EVERY MOTORIST ON YOUR CHRISTMAS LIST!

**Popular
Science**

MAGAZINE SERVICES DIVISION

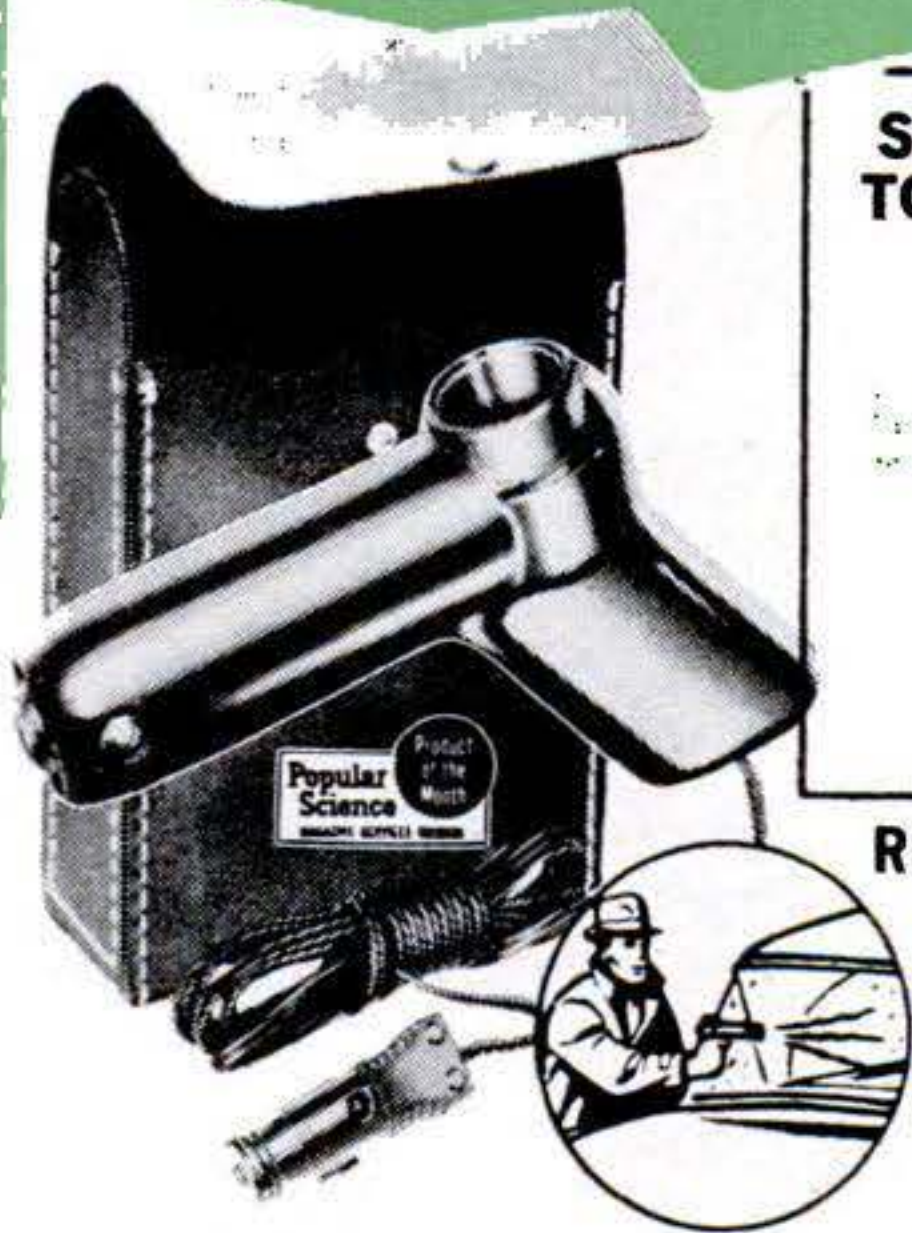
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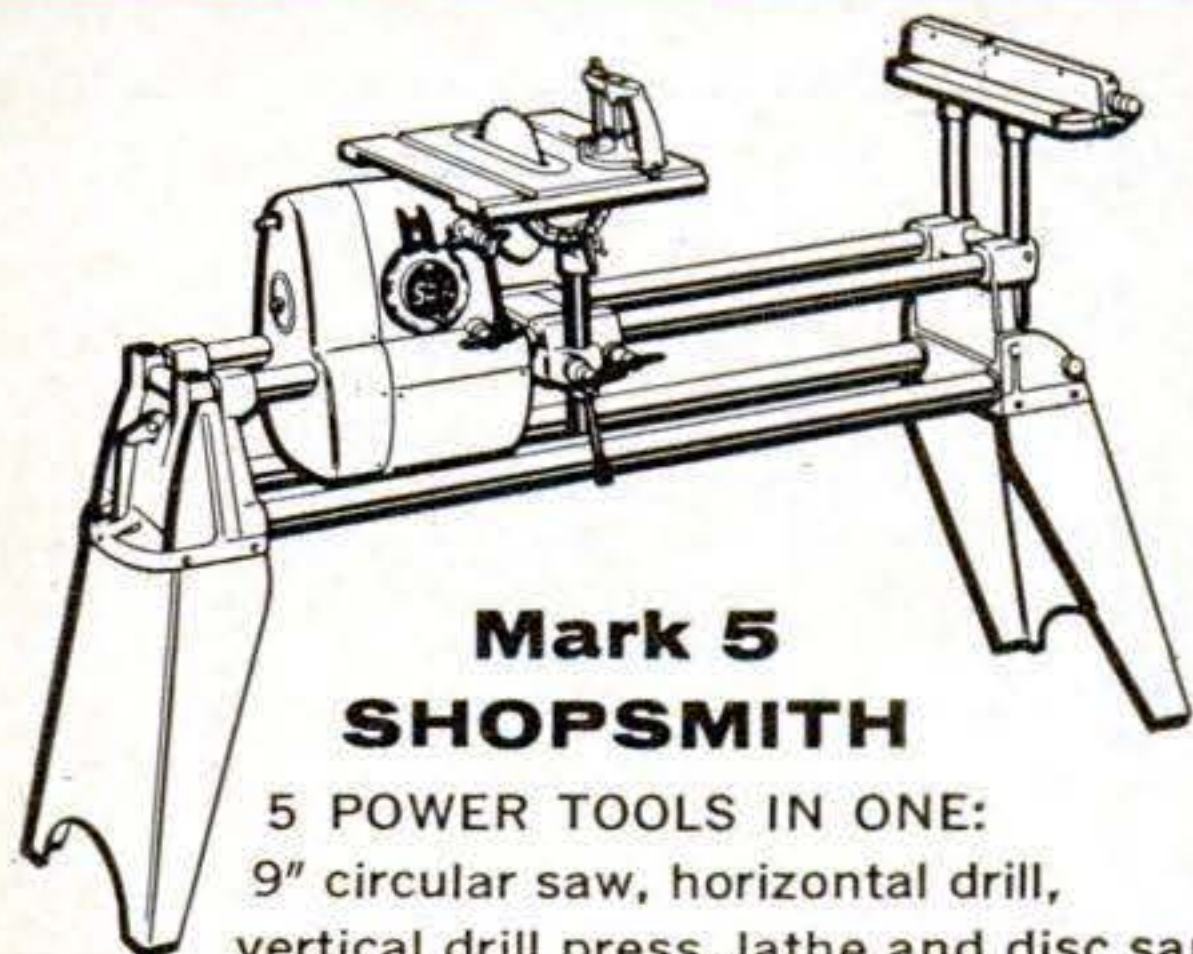
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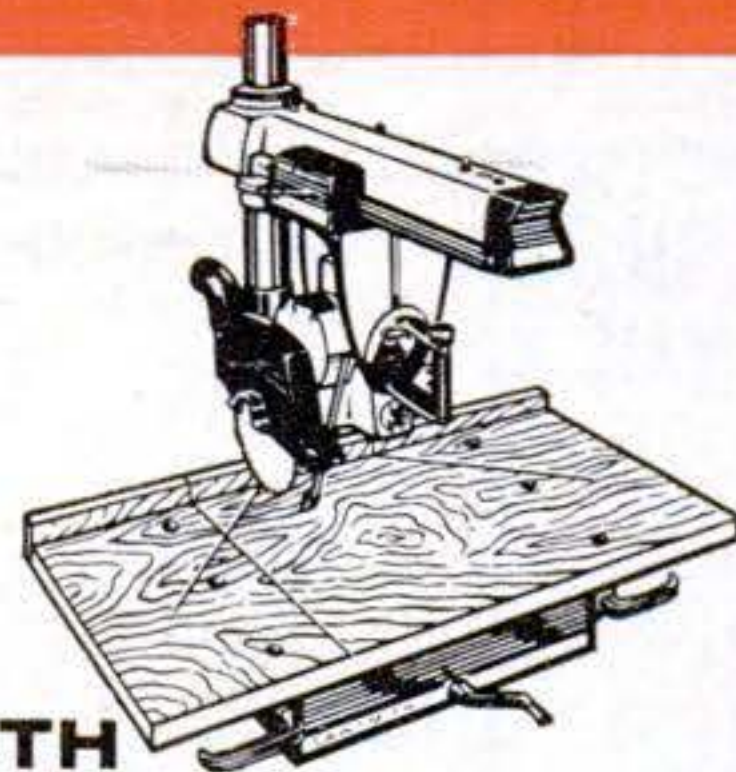
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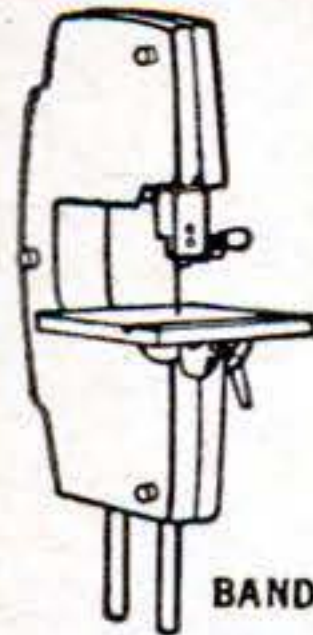
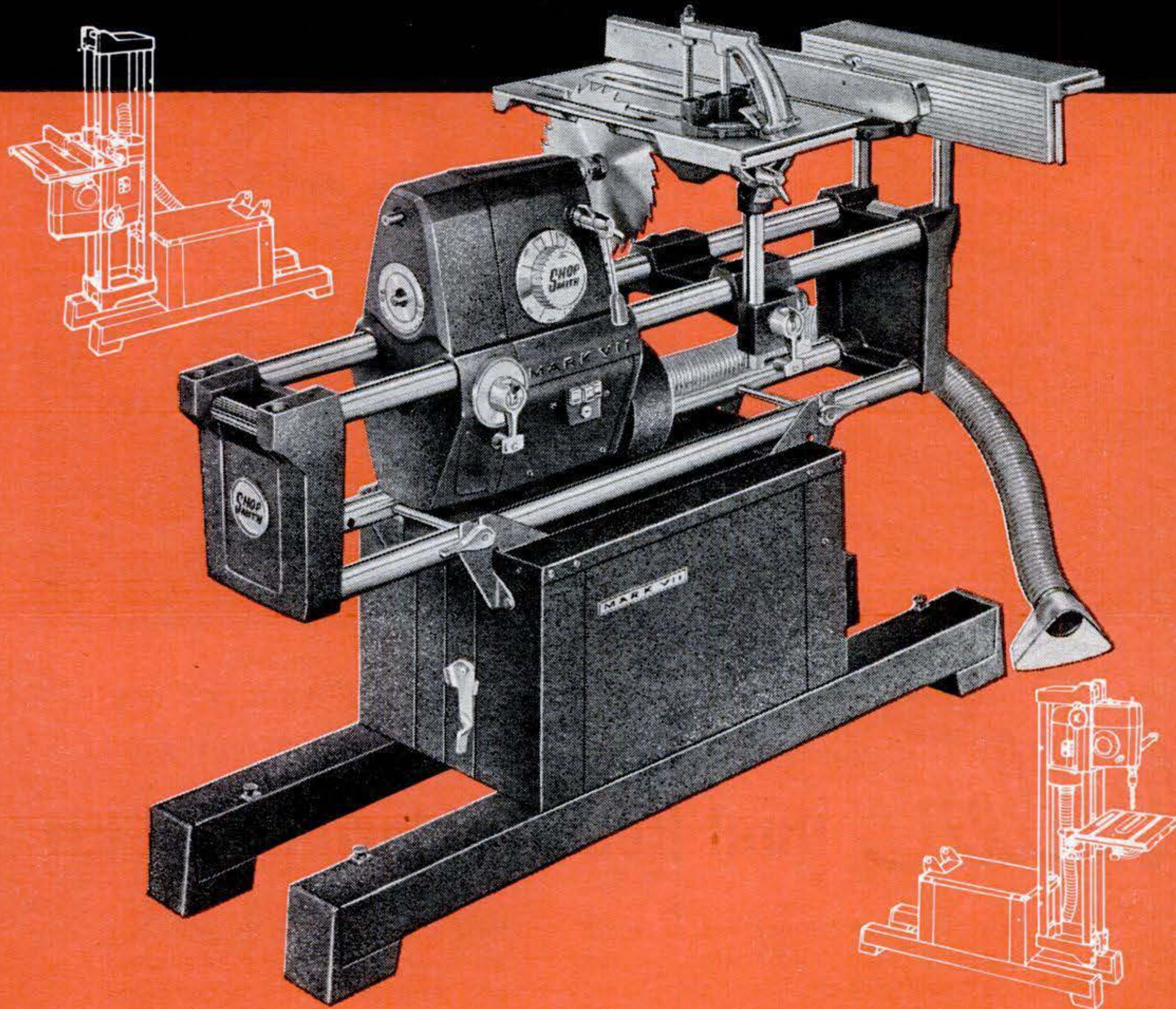
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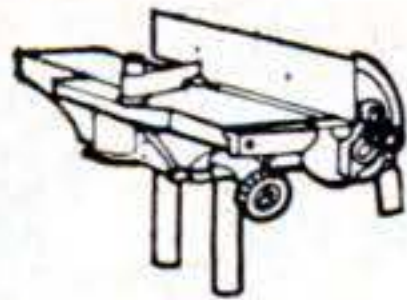


MARK VII

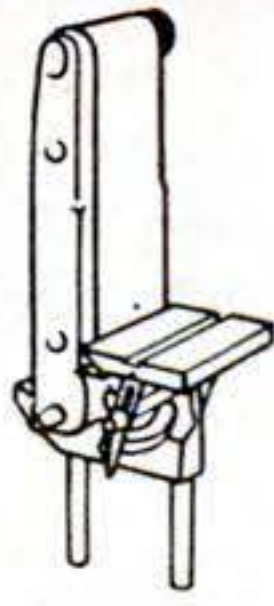
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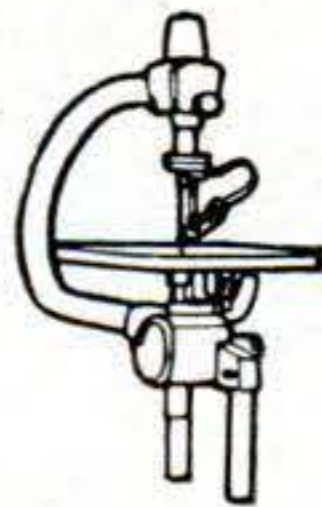
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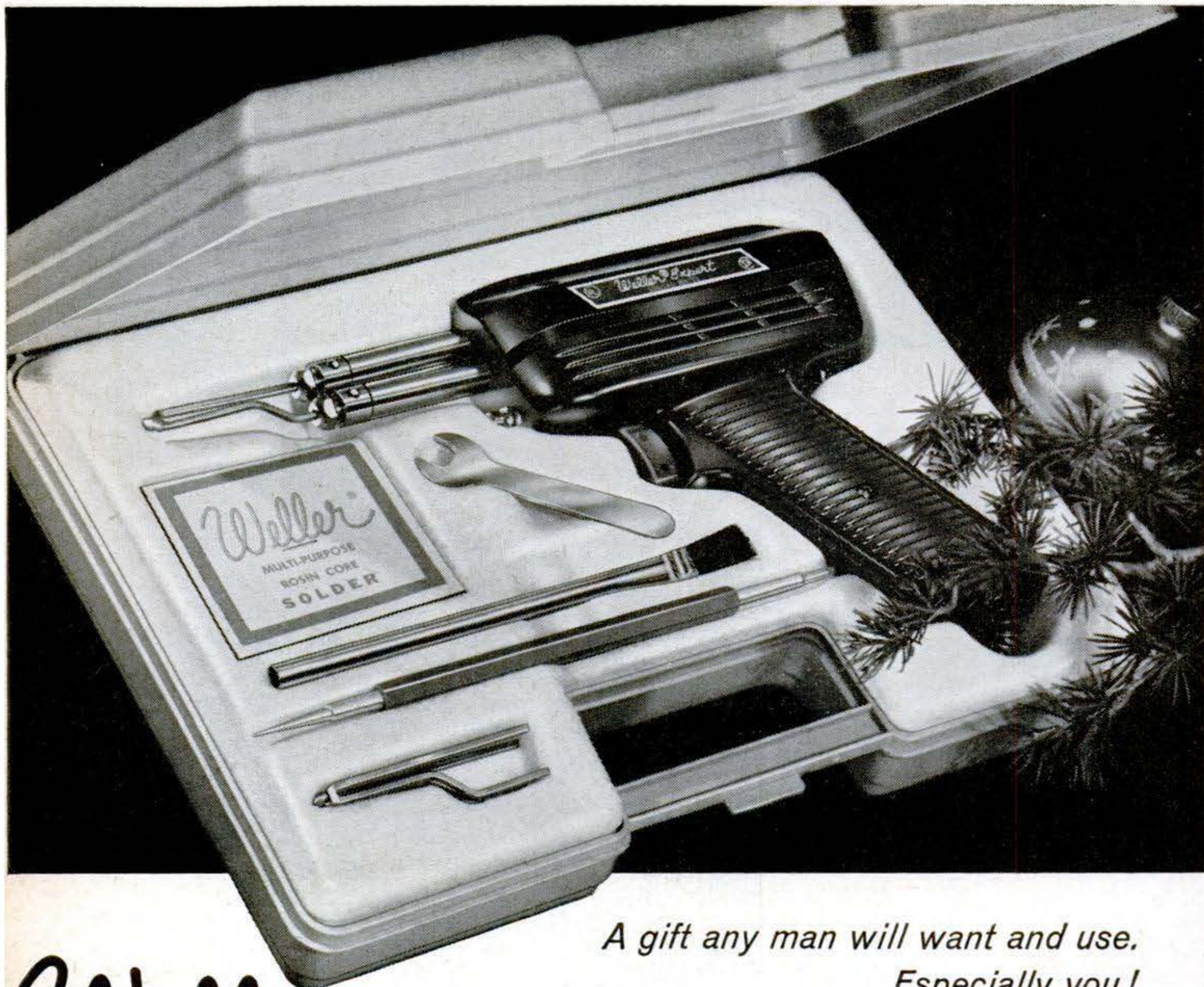
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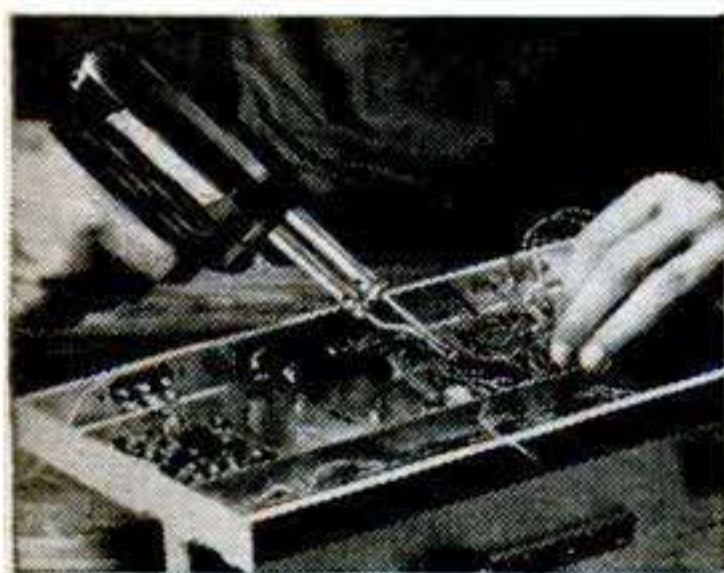
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The Popular Science Buyer's Guide to Home Shop Tools

PART 2

7

PORTABLE power tools

- ELECTRIC DRILL
- PORTABLE CIRCULAR SAW
- SABER SAW
- FINISHING SANDERS
- BELT SANDER
- ROUTER
- HAND GRINDER

7 basic bits handle any drilling job



1. **Twist drill:** Most widely used type for holes in wood and metal up to $\frac{1}{2}$ " diameter.



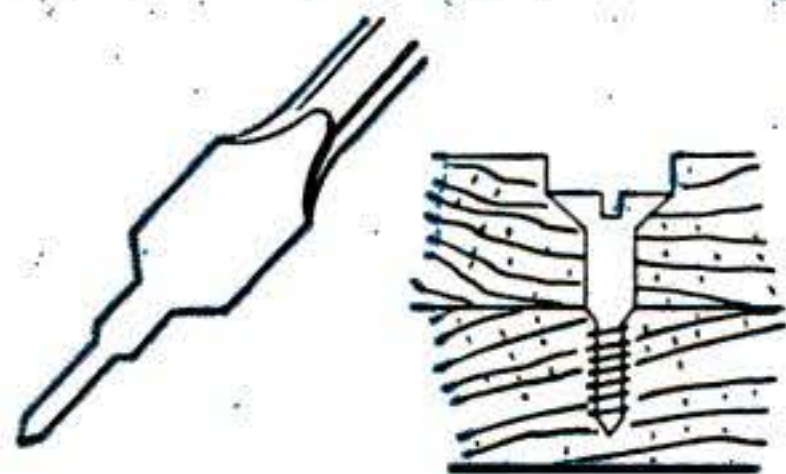
2. **Small-shank bits:** Twist drills with $\frac{1}{4}$ " shanks that permit the use of larger bit sizes in $\frac{1}{4}$ " drill chucks.



3. **Spade bits:** Broad, flat wood bits with $\frac{1}{4}$ " shanks for drilling big holes up to $1\frac{1}{4}$ ".



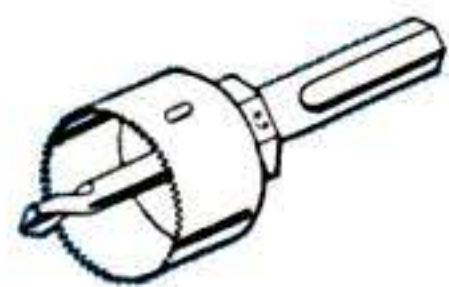
4. **Auger bits:** More expensive than spade type, but make especially smooth holes in wood up to 1" in diameter.



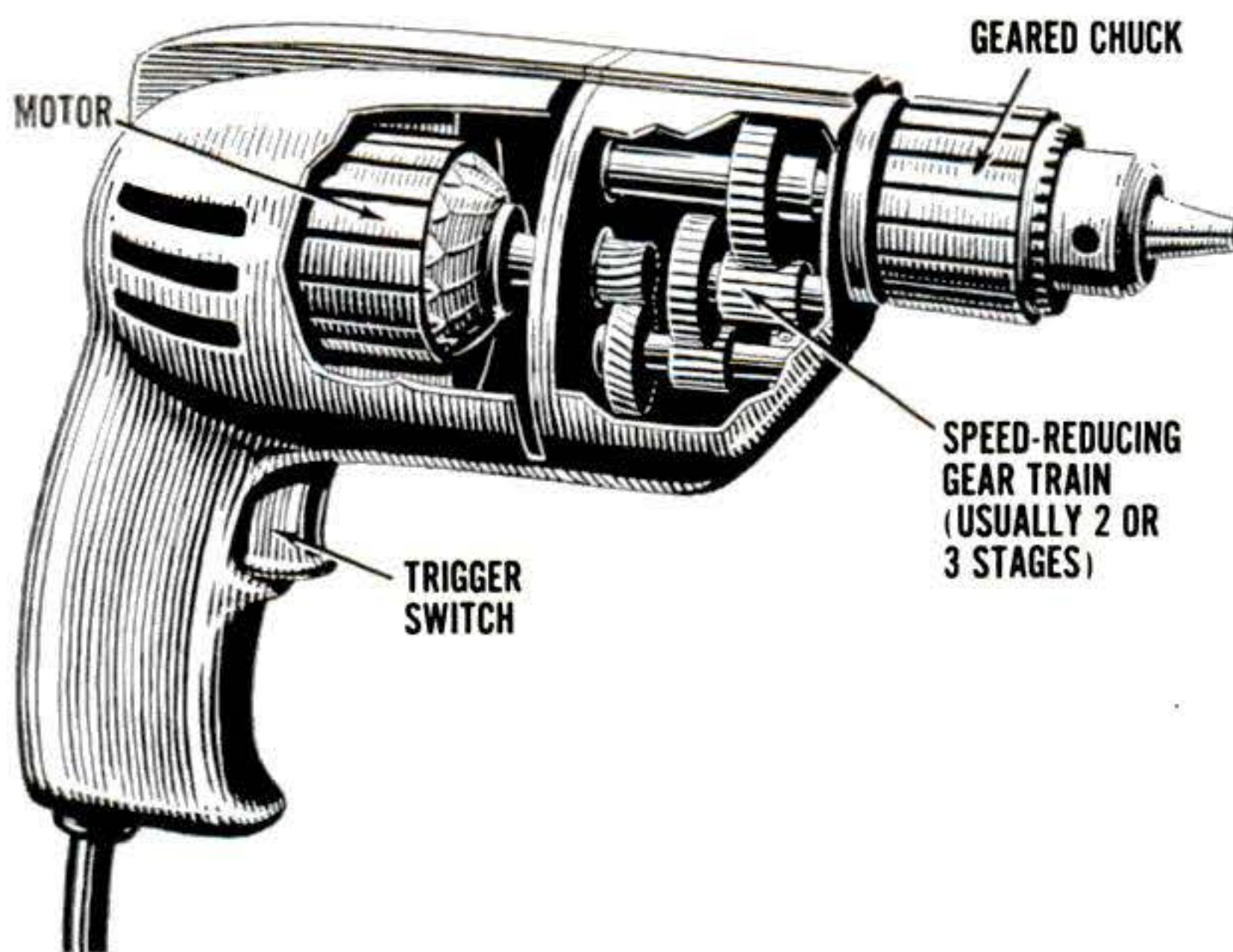
5. **Screw bits:** Combine pilot hole, clearance hole, and countersink in one for fast drilling of screw holes. For Nos. 6, 8, 10, and 12 screws.



6. **Masonry bits:** Carbide-tipped for drilling brick and concrete. Common sizes: $\frac{1}{4}$ " to $\frac{1}{2}$ " with $\frac{1}{4}$ "-diameter shanks.



7. **Hole saws:** Circular cutters for large holes up to about 3". Some are adjustable to several hole sizes; others provide one fixed size.



ELECTRIC DRILL

a jack-of-all-jobs, it's the king of the portables

MORE electric drills are sold than any other power tool—and for good reason: They do so many things. They've also done a lot of growing up in the past few years. They're more powerful than ever and come in a greater variety.

Today, the average $\frac{1}{4}$ " drill has one-fifth more muscle than it did five years ago. The present crop of drills also offers reversible and multispeed models. Being able to run a drill backward, or at two or more forward speeds, can be worth its weight in drill bits on some jobs.

The variety of drills that exists makes it important to know what you're buying. The thing to remember is that the big difference in drill size is speed rather than just chuck capacity. As a rule, the bigger the chuck size, the lower the speed and the greater the power. Many $\frac{3}{8}$ " drills, for instance, have the same motors as their $\frac{1}{4}$ " cousins, but they're geared down to provide more muscle at less speed. Different-size chucks do take bits with different-size shanks, but it's their speed that determines the jobs they do best.

For average home and shop chores, the long-popular $\frac{1}{4}$ " drill is still the best all-around performer. Its relatively high speed (1,500 to 2,400 r.p.m.) is well suited to drilling small holes in metal and up to $\frac{1}{2}$ " holes in wood, and to driving disk and drum sanders, buffers, grinding wheels, and saw attachments.

DISSTON D-38 DIAL-A-POWER

gives constant power over a full range of speeds



STEEL— $\frac{1}{2}$ " bit, 700 rpm



MASONRY— $\frac{3}{8}$ " bit, 1,000 rpm



WOOD— $\frac{1}{4}$ " bit, 1,200 rpm

speeds from 600 to 2000 rpm by turning a dial

Disston's D-38 Dial-A-Power, world's first variable speed drill, lets you choose the exact rpm you need—whether boring wood, metal, masonry or plastic. You can even adjust speed to suit the size bit you are using. You get faster, more efficient drilling, save wear and tear on bits. And at every speed, a revolutionary electronic circuit delivers full, constant power at the chuck. The Dial-A-Power eliminates the need for several drills; its powerful 4.1 amp motor drives bits up to $\frac{1}{2}$ ". Built-in overheat thermostat automatically protects motor from burnout. U.L. approved and industrially rated for rugged use. Retail at \$69.95. Hardware and Industrial Products Division, H. K. Porter Company, Inc., Porter Building, Pittsburgh, Pa. 15219.

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**HARDWARE AND INDUSTRIAL
PRODUCTS DIVISION**

H. K. PORTER COMPANY, INC.

ELECTRIC DRILL

Quick Facts About ELECTRIC DRILLS

MAKE	MODEL	CHUCK SIZE (in.)	CHUCK SPEED, NO LOAD (r.p.m.)	RATED AMPERAGE	APPROX. PRICE
AMERICAN-LINCOLN	0-50	1/4	2,400	2.5	\$23
	0-01	1/4	1,800	2.8	\$25
	3-01	3/8	1,000	2.8	\$37
	5-00	1/2	575	4.5	\$55
	5-05	1/2	575R	4.5	\$65
BLACK & DECKER	U-100	1/4	2,250	1.9	\$16
	U-200	1/4	2,250	2.0	\$27
	U-300	1/4	2,250	2.2	\$33
	U-204	1/4	3,000	2.8	\$33
	C-600	1/4	800	B	\$50
	U-120	3/8	1,000	2.0	\$27
	U-220	3/8	1,000	2.2	\$37
	U-320	3/8	1,000	3.2	\$43
	U-126	1/2	375	3.2	\$50
	U-226	1/2	500	4.5	\$60
COMET	COMET	1/2	680	G	\$100
DALTON	D250-3	1/4	1,200	2.4	\$20
	D380	3/8	900	2.4	\$30
	D500-3	1/2	600	5.7	\$45
DISSTON	D-1	1/4	2,200	2.5	\$17
	D-25	1/4	1,800	3.0	\$30
	D-38	3/8	600 to 2,000CV	4.1	\$70
DORMEYER	SD-8	1/4	2,000	1.7	\$20
	SD-7	1/4	1,700	2.5	\$23
	MD-6	3/8	1,700	2.5	\$25
DUWEL (Electro)	DW130-6	1/4	2,200	3.5	\$20
	DW840	3/8	1,250	3.8	\$28
	DW841	3/8	1,250R	3.8	\$31
	DW842	3/8	650/1,250TS	3.8	\$38
	DW860	1/2	550	4.0	\$35
	DW870	1/2	550R	4.0	\$38
	DW880	1/2	650/1,250TS	4.0	\$45
ELECTR-O (Electro)	11M-4	1/4	2,200	3.0	\$20
	238M-4	3/8	1,250	3.5	\$28
	245M-4	3/8	900/1,500TS	2.5	\$40
	250	1/2	550	3.8	\$30
	251	1/2	550R	3.8	\$33
	252	1/2	650/1,250TS	3.8	\$40
McGRAW-EDISON (Manning-Bowman)	70107	1/4	2,000	2.6	\$10
	70110	3/8	1,100	3.0	\$18
	70124	1/2	550	6.0	\$32
	70126	1/2	550R	6.0	\$35

B—Battery-powered.
CV—Continuously variable.
G—Gasoline-powered.
R—Reversible.
TS—Two-speed.

continued

This speed is higher than it should be for larger holes in wood or metal, for drilling concrete, and for using accessories such as fly cutters and hole saws. You can get by if you use care and don't have to do such jobs too often.

But if you make a habit of drilling 3/8" holes in steel, like to sink screw anchors in concrete, or do a lot of other jobs that call for extra muscle and less speed, you might better consider a 3/8" drill. It has the lower chuck speed suited to such work. Half-inch drills are even heftier and are geared for still lower speeds—good mainly for thick steel, concrete, and large holes in wood.

Adjustable-speed drills carry a higher price tag, but are useful for a wide range of jobs. Some go from 600 r.p.m. up to 2,000. Others start at 1,000 r.p.m. and go to 2,500. Some are continuously variable, while others offer two or three fixed speeds.

On most of the newer multispeed drills, the speed control is electronic: You just turn a dial or flip a switch. Thanks to the modern silicon-rectifier circuit, the motor delivers full power at any speed.

Reversible drills offer several handy features. If you've ever jammed a big twist drill, you know it can only be backed out—an onerous hand job, but easy if your drill will reverse. With some screwdriving accessories, you can remove screws as well as drive them. You can also reverse sanding disks and drums so they throw dust away from you.

Light-duty drills are ade-

Quick Facts About ELECTRIC DRILLS continued

MAKE	MODEL	CHUCK SIZE (in.)	CHUCK SPEED, NO LOAD (r.p.m.)	RATED AMPERAGE	APPROX. PRICE
MILLERS FALLS	1114	1/4	2,250	2.7	\$23
	1144	1/4	2,250	2.7	\$25
	1134	1/4	2,250	2.7	\$30
	1040	1/4	2,250	2.5	\$14
	1038	3/8	1,000	2.5	\$27
	2838	3/8	1,000	2.5	\$37
	2638	3/8	1,000	2.5	\$37
	880	3/8	3,200	5.0	\$40
	1012	1/2	450	4.5	\$40
	412	1/2	450	4.5	\$50
	412R	1/2	450R	4.5	\$55
	MILWAUKEE ELECTRIC	0100	1/4	2,000	2.5
0120		1/4	2,000	3.0	\$53
0220		3/8	650	3.0	\$58
0270		1/4	2,000	3.0	\$53
0370		3/8	650	3.0	\$58
0125		1/4	2,000	B	\$58
0225		3/8	650	B	\$63
1120		1/2	450	B	\$68
1120-1		1/2	450R	B	\$78
MODERN	SD-50*	1/4	1,900	2.5	\$90
MONTGOMERY WARD	84C92250	1/4	2,000	2.0	\$9
	84C9203	1/4	2,000	2.2	\$14
	84C9205	1/4	1,800	3.0	\$22
	84C9206	1/4	1,500R	3.0	\$27
	84C9204	3/8	1,000	2.2	\$19
	84C9207	3/8	1,000	3.4	\$27
	84C9308	3/8	800/2,400TS	3.5	\$32
	84C9226M	1/2	500	6.0	\$29
	84C9227M	1/2	500	6.0	\$35
	84C9256	1/2	650R	3.6	\$33
	84C9236M	1/2	500R	6.5	\$48
	TPC9244	3/8	800 to 2,000CV	3.6	\$40
PORTER-CABLE	107A	1/4	2,000	2.5	\$37
	515	1/4	1,800	3.0	\$55
	355	1/4	2,000	2.8	\$43
	573	1/4	2,500	3.0	\$54
	577	1/4	1,000	3.5	\$65
	141	3/8	1,000	2.7	\$30

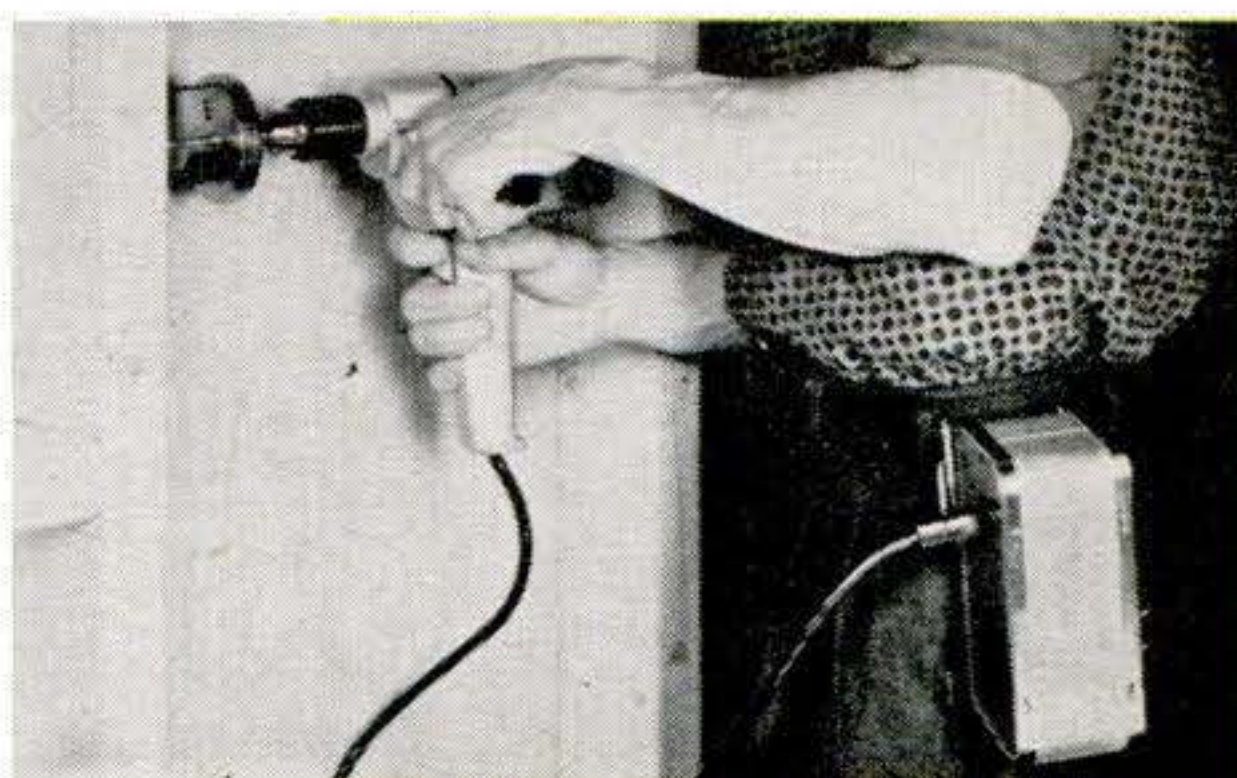
*Combination drill and saber saw.
B—Battery-powered.
CV—Continuously variable.
R—Reversible.
TS—Two-speed.

continued

There are two types of
battery-powered drills

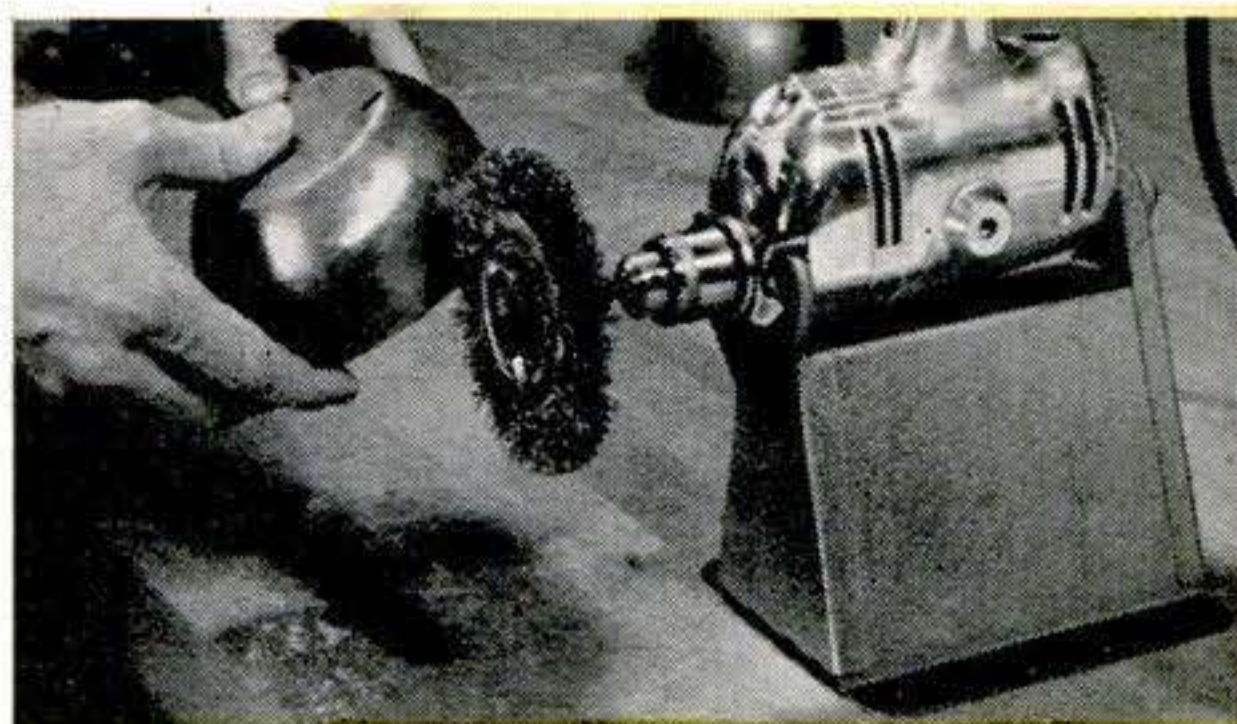


WITH BUILT-IN BATTERY

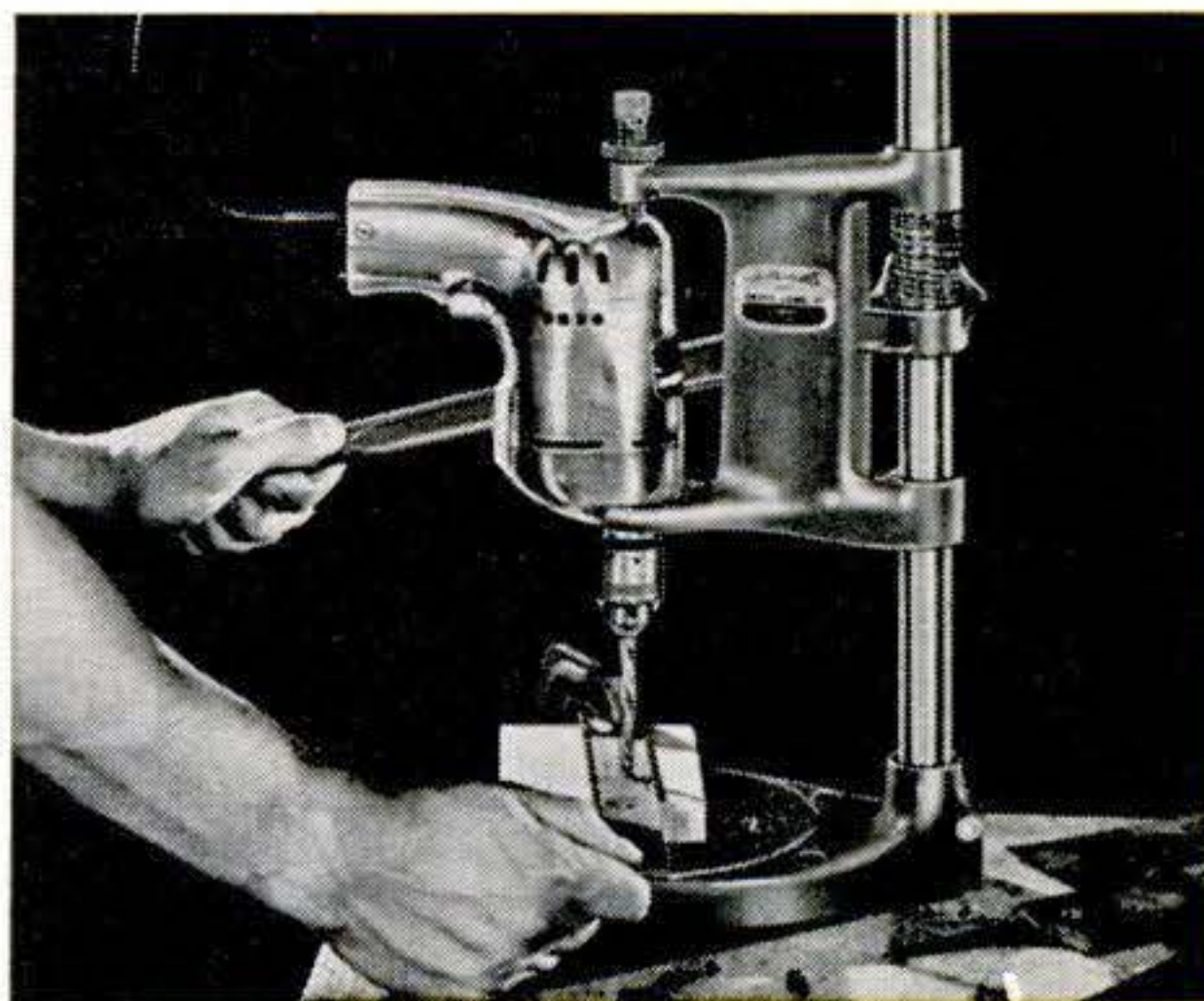


OR WITH A BATTERY PACK

And two kinds of bench
attachments to choose



HORIZONTAL STAND



DRILL-PRESS STAND

ELECTRIC DRILL

Quick Facts About ELECTRIC DRILLS continued

MAKE	MODEL	CHUCK SIZE (in.)	CHUCK SPEED, NO LOAD (r.p.m.)	RATED AMPERAGE	APPROX. PRICE
PORTER-CABLE	149	3/8	1,000	2.6	\$47
	538	3/8	750	3.5	\$69
	109	1/2	450	3.5	\$60
	516	1/2	550	6.0	\$85
	516R	1/2	550R	6.0	\$95
	42724	1/4	750	B	\$83
	42735	3/8	750	B	\$85
	42738	1/2	750	B	\$90
RAM	F-1	1/4	1,200	2.0	\$10
	R250	1/4	2,000	2.4	\$24
	F-4	3/8	1,000	2.6	\$14
	R380	3/8	1,000	2.4	\$34
	R500	1/2	550	5.7	\$50
	R550	1/2	550R	5.7	\$54
SEARS CRAFTSMAN	9G799	1/4	1,300	2.0	\$8
	9G798	1/4	2,400	2.5	\$14
	9G772	1/4	1,900	2.3	\$20
	9G1100	1/4	1,600	3.5	\$34
	9G788	3/8	1,000	3.0	\$10
	9G775	3/8	1,150	2.3	\$24
	9G1101	3/8	850	3.5	\$39
	9G1103	3/8	1,000 to 2,500CV	3.0	\$49
	9G2585	1/2	575	4.5	\$28
	9G2586	1/2	575R	4.5	\$34
	9G1102	1/2	500	3.5	\$44
9G778	1/2	575	2.7	\$45	
SHOP-CRAFT (Portable Electric)	9740	1/4	2,000	2.5	\$13
	9748	3/8	1,000	2.0	\$18
	9256	1/2	600	3.4	\$26
	9515	1/2	500	6.0	\$34
SHOPMATE (Portable Electric)	1825	1/4	2,300	3.2	\$17
	1826	1/4	2,300R	3.2	\$23
	1838	3/8	1,000	3.4	\$22
	1839	3/8	1,000R	3.4	\$27
	1903	3/8	800/2,400TS	3.5	\$39
	520	1/2	500	6.0	\$40
	1850	1/2	500	3.6	\$27
	1851	1/2	500R	3.6	\$30
	1905	1/2	500/1,500TS	3.7	\$43

B—Battery-powered.
CV—Continuously variable.
R—Reversible.
TS—Two-speed.

continued

quate for plain drilling, but they may not have the power to drive the bigger attachments. If you want a drill to perform a lot of extra tasks efficiently, it's best to buy a powerful one.

The ampere rating on a drill's nameplate is a clue to motor power in comparing models of the same make, but is of little use in comparing different makes since not all makers rate current draw in the same way. Drills that carry an industrial UL rating may or may not be more powerful than domestic-rated models, but they're usually capable of delivering their power for longer periods without overheating. Their ampere ratings are also likely to be a more accurate indication of true motor power.

Size is some help in determining power since hefty motors need larger housings. Better-quality drills naturally run higher in price.

The newer battery-operated drills offer surprisingly good power and are fine for jobs that are out of reach of house current. Their higher price, however, recommends them only where the use-anywhere feature is important. One type has a built-in battery and is completely cordless, while others operate from a separate battery pack clipped to your belt.

While you're looking over a drill, check on available accessories. Some drills have a line of attachments designed especially for them. These are likely to be properly engineered to match available power. Vertical and horizontal bench stands are available for some drills. You'll find them handy for sanding and grinding jobs.

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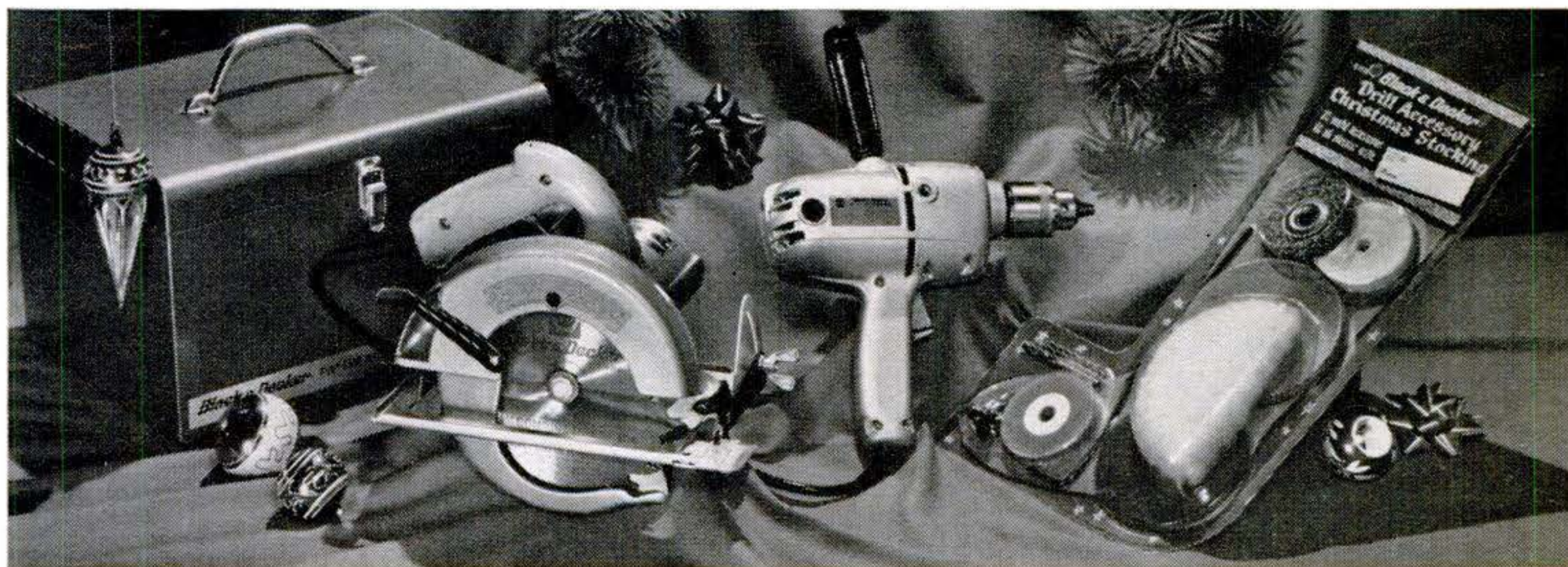
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SAVE \$10.07. Powerful orbital Black & Decker U-141 Utility Sander whisks off old paint fast. Swept-back handle. Takes 3⅝" by 9" sandpaper. Only \$19.88. (Optional dust-collecting attachment: \$8.50.)

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SAVE \$10.07—and get free steel case, too. A double bargain. Black & Decker U-137 7¼" Utility Saw (regularly \$59.95), plus combination blade and case. All safety and operating features. Only \$49.88.

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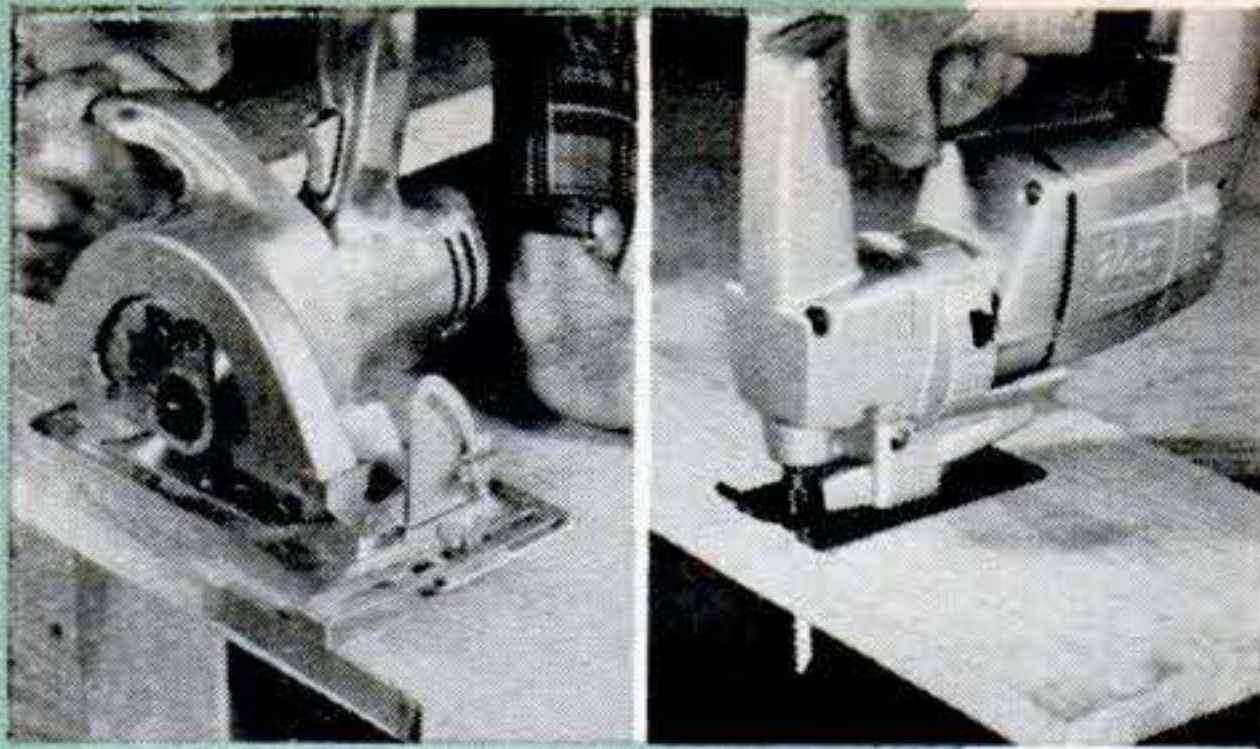
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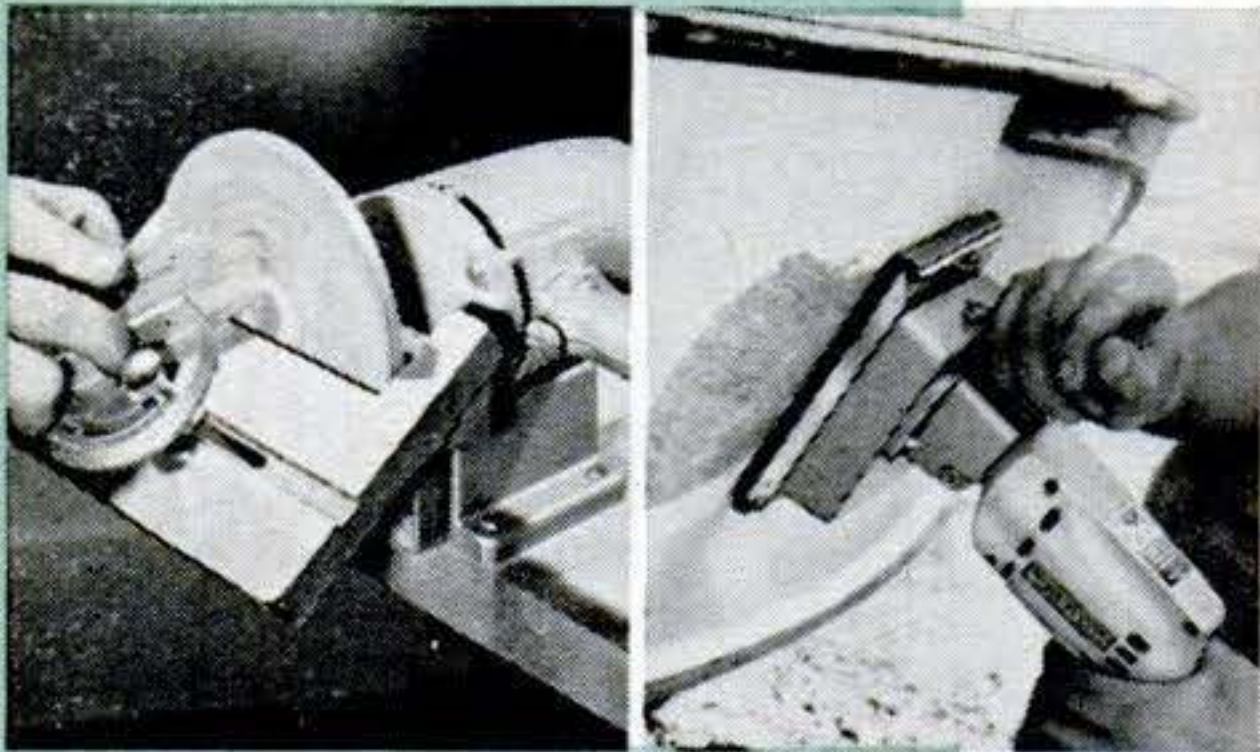
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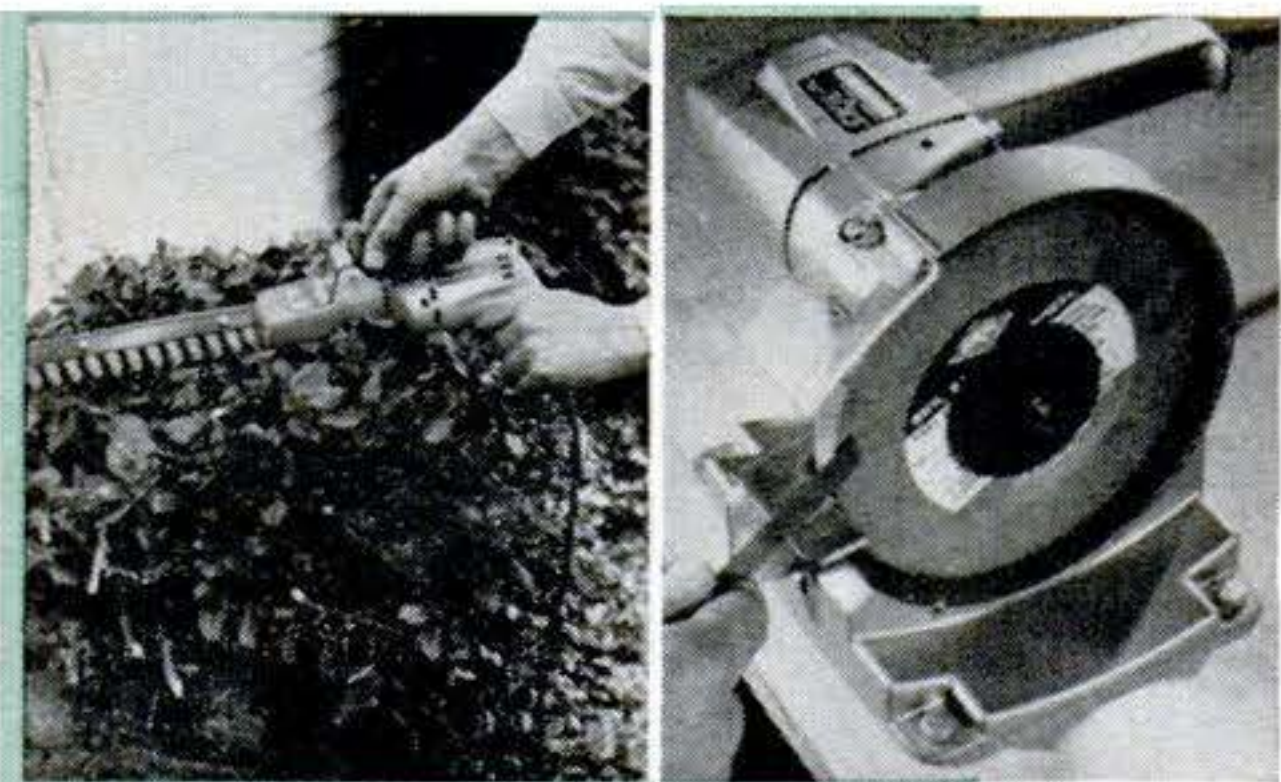
ELECTRIC DRILL



IT'S TWO KINDS OF SAWS



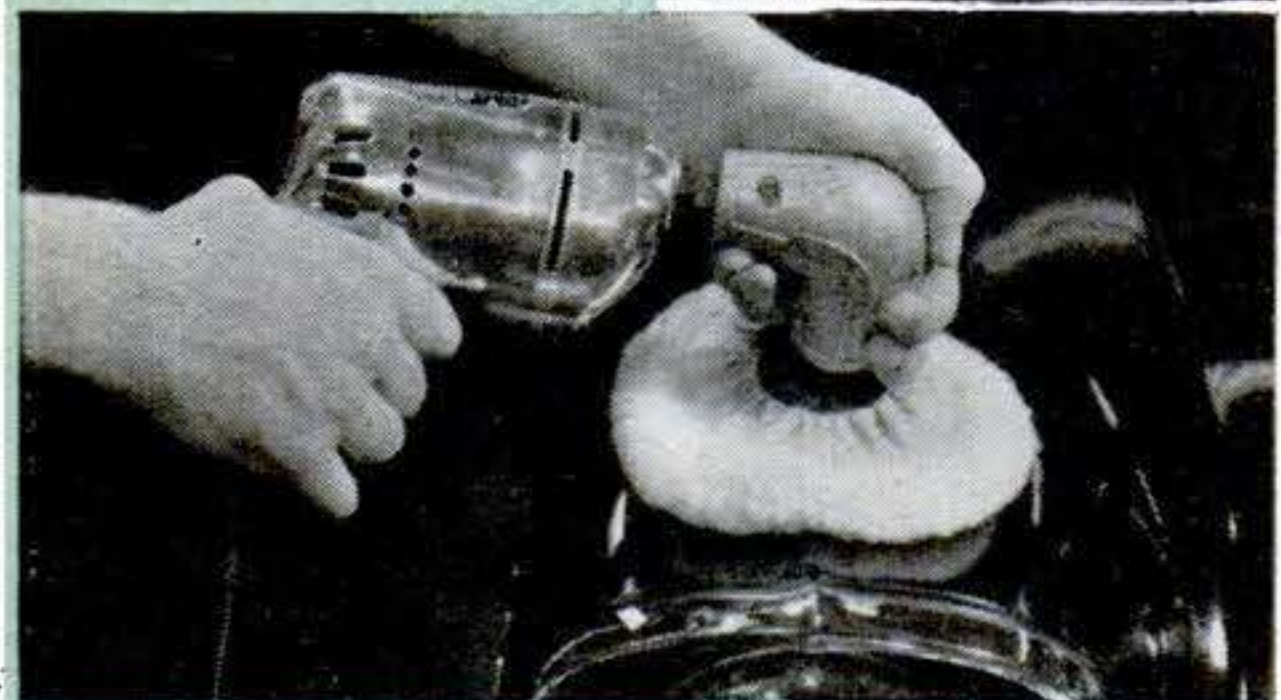
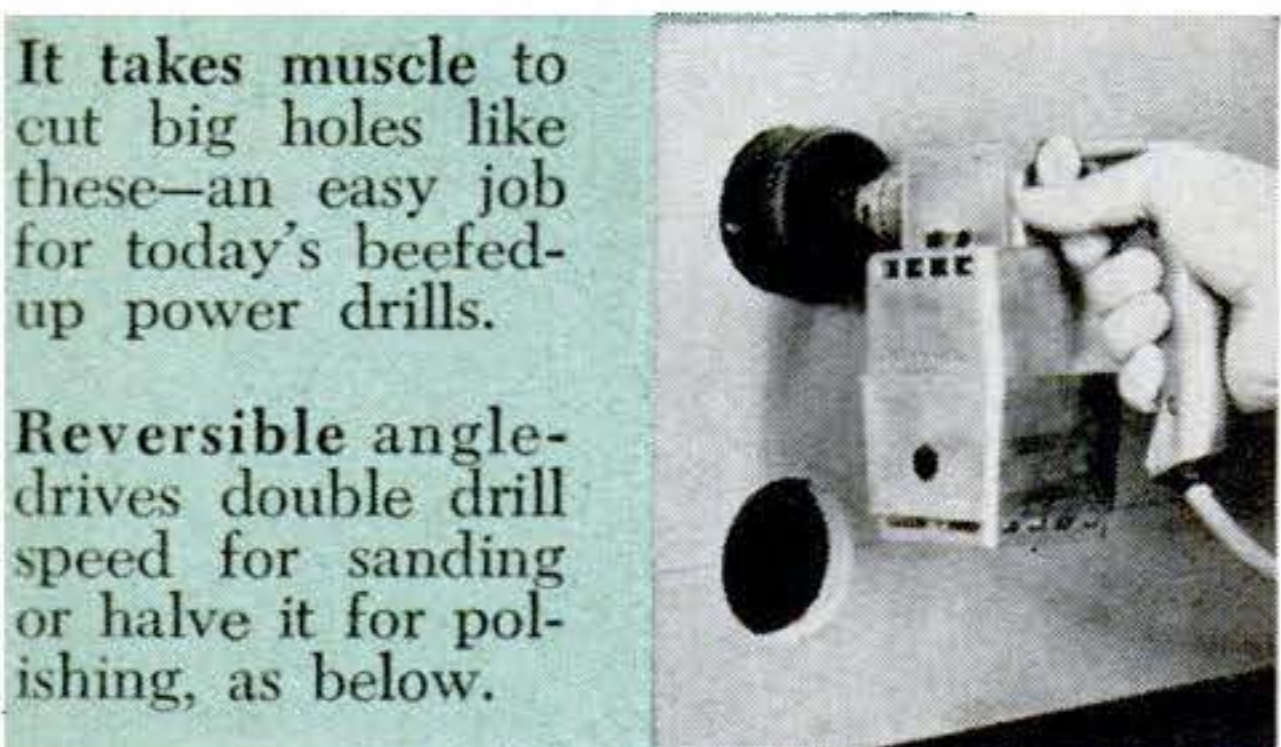
TWO KINDS OF SANDERS



OR A TRIMMER OR GRINDER

It takes muscle to cut big holes like these—an easy job for today's beefed-up power drills.

Reversible angle-drives double drill speed for sanding or halve it for polishing, as below.



Quick Facts About ELECTRIC DRILLS continued

MAKE	MODEL	CHUCK SIZE (in.)	CHUCK SPEED, NO LOAD (r p m.)	RATED AMPERAGE	APPROX. PRICE	
SKIL	503	1/4	2,500	2.5	\$20	
	550	1/4	2,500	3.0	\$40	
	560	3/8	1,000	3.0	\$35	
	541	1/2	750	3.0	\$37	
	542	1/2	500	3.5	\$50	
	468	3/8	550	B	\$50	
	203	3/8	550	B	\$60	
	SPEEDWAY (Thor)	812	1/4	2,100	2.5	\$16
522		1/4	2,100	3.0	\$21	
501		1/4	2,000	3.0	\$30	
813		3/8	1,750	3.0	\$19	
504		3/8	1,000	3.0	\$40	
880		1/2	600	3.0	\$28	
880R		1/2	600	3.0	\$32	
1420		1/2	550	6.5	\$53	
1420R		1/2	550R	6.5	\$58	
527-SC		1/4	1,750/2,200TS	2.5	\$26	
D72-SC		1/4	1,750/2,200TS	2.5	\$22	
535-SC		3/8	700/900TS	3.1	\$31	
D76-SC		3/8	700/900TS	3.0	\$27	
1435R-SC		1/2	150 to 500CVR	6.5	\$100	
STANLEY	H131	1/4	2,500	3	\$16	
	138	1/4	2,000	2.5	\$45	
	232	1/4	5,000	2.7	\$55	
	324	1/4	2,000	3.4	\$63	
	H136	3/8	800	2.5	\$42	
	237	3/8	1,000	2.7	\$67	
	338	3/8	850	3.4	\$73	
	H722	1/2	400	3.5	\$58	
	723	1/2	375R	3.4	\$68	
	123	1/2	550	4.7	\$75	
	371	1/2	475	9.0	\$105	
	SUNBEAM	170-3	1/4	2,000	3.0	\$20
		180-3	3/8	700	3.0	\$30
78		1/2	500	3.5	\$30	
HD155		1/2	550	4.3	\$40	
WEN	808	3/8	1,000/3,000TS	2.0	\$30	

B—Battery-powered.
CV—Continuously variable.
R—Reversible.
TS—Two-speed.

You can do more cutting jobs
with the
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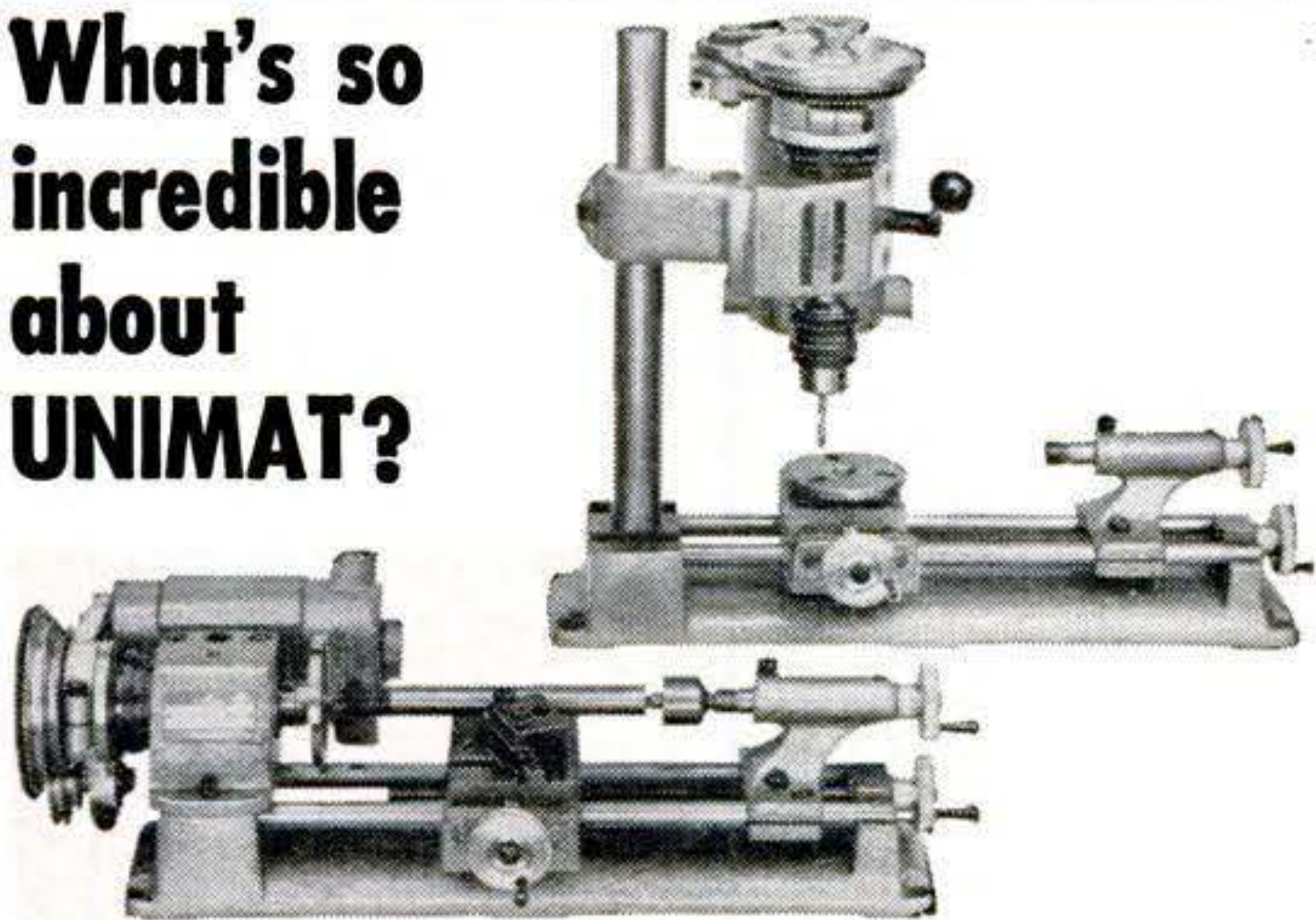
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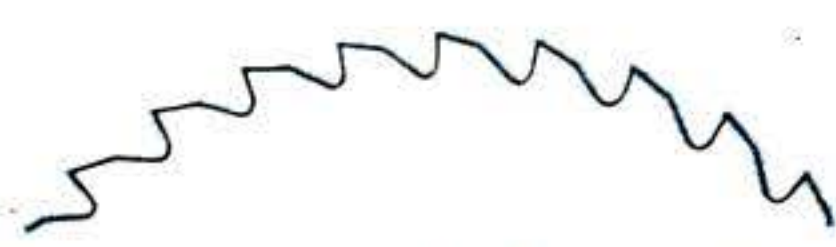
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for big panels and timbers*


Take your pick: many blades for many jobs




Combination: A fast-cutting, general-purpose blade for both rip and crosscuts—the most widely used of all types for the portable saw.




Miter or planer: A combination blade that's hollow-ground for extra-smooth cuts.



Plywood: Has fine teeth for especially smooth cuts in plywood with no splintering.



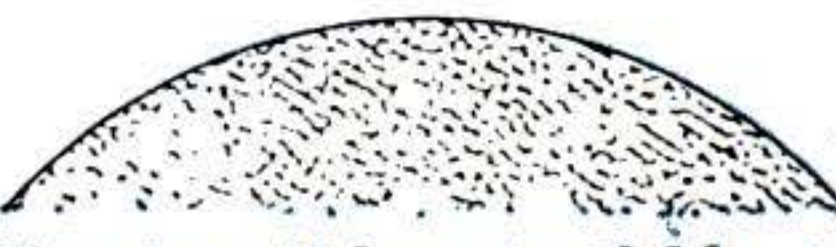
Flooring: For wood that may contain random nails, such as old lumber or flooring.



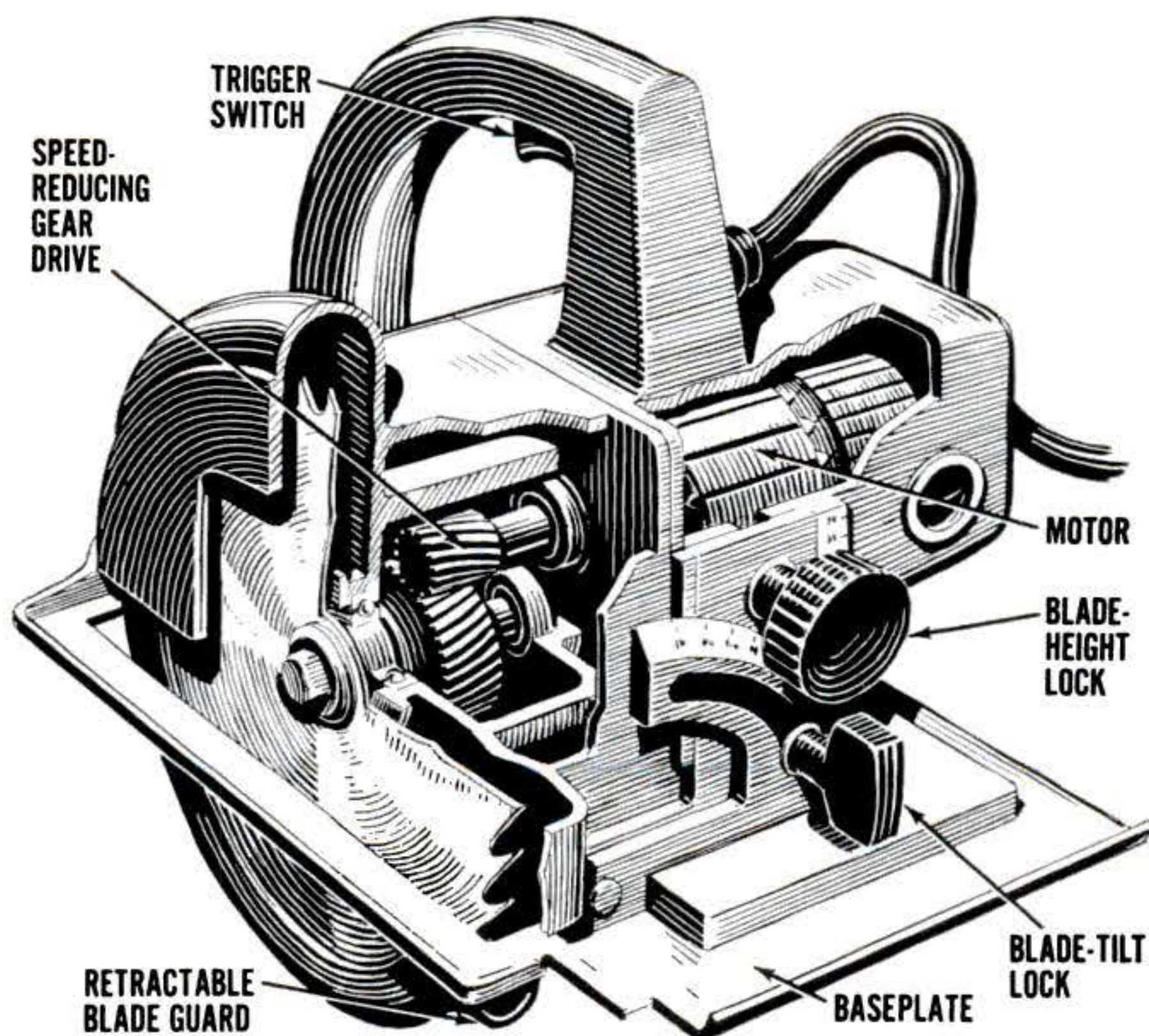
Metal-cutting: For soft, non-ferrous metals such as aluminum, copper, bronze, lead.



Carbine-tipped: Relatively expensive, but extra fast, sharp, and long-wearing. Especially good for tough materials such as asbestos, laminates, and composition boards.



Abrasive disks: Available in several types for both ferrous and nonferrous metals and masonry materials such as brick, stone, concrete, tile.



THE portable circular saw has one big virtue: You take *it* to the work, instead of the work to it. When your work is a big plywood panel, a 10' two-by-four, or a row of porch-deck boards that need trimming, portability really pays off.

Portable saws are no substitute for the cabinetmaking precision of a table saw, but they do offer the same fast, rugged, versatile cutting in a tool that travels with you. With special abrasive blades, you can even slice concrete blocks in two, trim slate for a terrace, or cut various metals.

Portable saws are rated according to the size of blade they take—from 6¼" to 8¼" or more. Naturally, the bigger the blade, the bigger the bite—although not as much as you might expect. Because only half of a blade's diameter is at work, the actual difference in cutting depth between the popular 6½" size and a big 8-incher is only ½" to ¾". All of the saws listed here will handle 2" stock, even at 45 degrees, and that's about all you need for most jobs.

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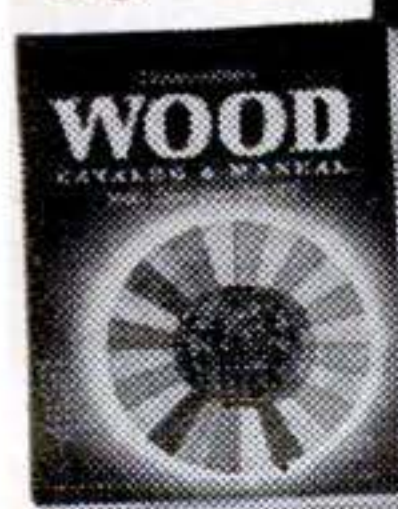


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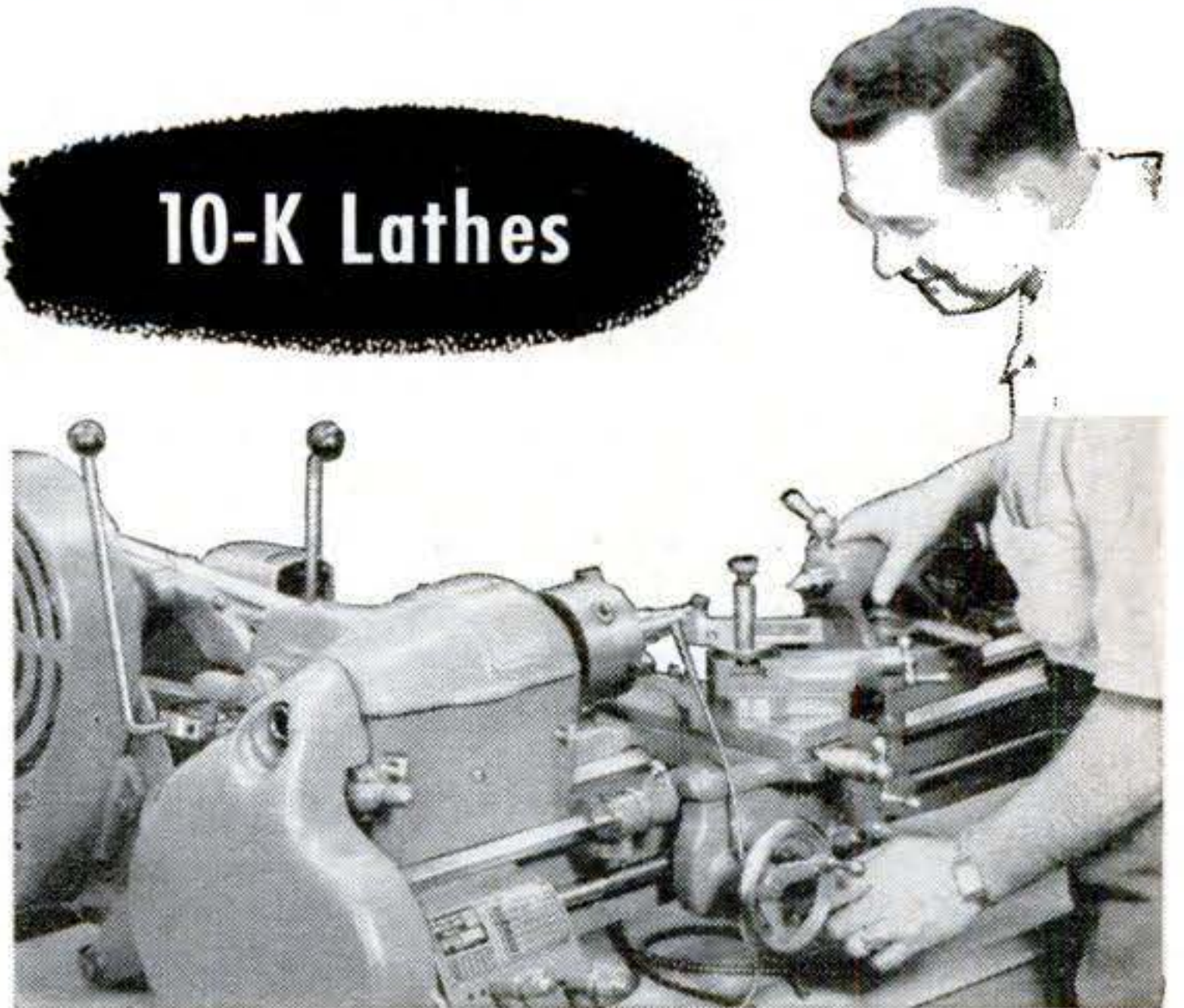
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South Bend 22, Indiana

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Up to 36 months to pay



Quick Facts About PORTABLE CIRCULAR SAWS

MAKE	MODEL	BLADE SIZE (in.)	DEPTH OF CUT (in.)		WEIGHT (lb.)	APPROX. PRICE
			AT 90°	AT 45°		
AMERICAN-LINCOLN	6-00	6½	2½	1½	11¾	\$70
	7-00	7½	2½	2½	12¾	\$83
BLACK & DECKER	U-136	6½	2½	1½	10½	\$50
	U-137	7¼	2½	2	10¾	\$60
	U-336	6½	2½	1⅞	11	\$75
	U-337	7¼	2⅝	1½	13¼	\$90
	U-338	8	2¾	2½	14⅝	\$100
COMET	COMET*	8	2⅝	1⅞	12	\$120
DALTON	D88	7	2½	2½	11	\$45
	D7B	7	2½	2½	11	\$55
DISSTON	D600	6½	2½	1⅞	13¾	\$55
	D650	6½	2½	1⅞	10½	\$70
	D725	7¼	2½	2⅝	12¾	\$85
DORMEYER	CS-20	7	2	1⅝	13½	\$45
DUWEL (Electro)	DW780-6	7	2½	2⅝	12	\$44
ELECTR-O (Electro)	701 M-4	7	2½	2⅝	12	\$44
McGRAW-EDISON (Manning-Bowman)	73102	6¼	2⅝	1¾	9	\$29
	73105	7	2½	2½	11	\$32
	PH256A	7¼	2½	2⅝	11	\$37
MILLERS FALLS	626	6½	2½	1¾	9¼	\$50
	717	7	2½	1½	10⅞	\$60
	646	6½	2	1½	11½	\$75
	747	7¼	2⅝	2	12½	\$90
	800	8¼	2⅞	2⅝	13¼	\$100
MILWAUKEE ELECTRIC	6291	6½	2⅞	none**	10	\$65
	6293	6½	2⅞	1¾	10½	\$70
	6320	6½	2⅝	1¾	14½	\$75
	6360	7¼	2⅞	2⅝	14¾	\$85
	6400	8¼	3⅝	2⅝	15	\$95
MONTGOMERY WARD	84C8900M	6½	2¼	1⅞	12½	\$25
	84C8983M	6½	2¼	1⅞	13	\$40
	84C8961M	7	2½	2	12½	\$43
	84C8984M	7	2½	2	13	\$50
	84C8902M	7½	2⅝	2½	15	\$58
	84C8982M	8	2⅝	2½	15½	\$70
PORTER-CABLE	170	7	2½	1¾	9¾	\$60
	176	6½	1½	1⅞	10	\$65
	177	7	2½	1¾	10	\$70

*Gasoline-powered. **Vertical cut only.

continued

PORTABLE CIRCULAR SAW

smoother cutting, and less chance of kickback. This is particularly important if you're going to be handling heavy stock for long periods at a time. Many saws incorporate a slip clutch that lets the blade jam without kicking back. However, most makers agree that adequate power is still the real key to safety and efficiency.

Portable saws turn at about 4,000 to 6,000 r.p.m. As a rule, the higher the blade speed, the smoother the cut—but only if a saw maintains its speed under load. If it slows down noticeably and seems to labor, it's probably underpowered. Your best bet here is to try a saw yourself before you buy.

Handle design is also important—and another point you can't judge just by picking up a saw in a store. The reason: A top-mounted handle feels comfortable for lifting, but isn't as easy to guide along the work as one that's fairly low and to the rear.

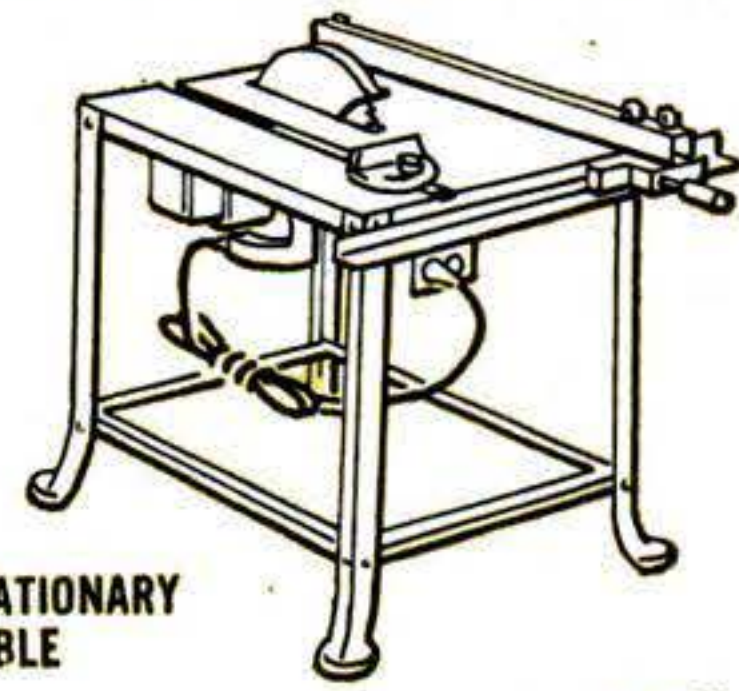
Saw weight is another paradox. In most portable tools, you want light weight and maneuverability. This isn't necessarily the case with a saw. Within reasonable limits, the heavier it is, the steadier it tracks and the more it absorbs jolts without kicking back. Heftiness in a saw is also likely to indicate a large, powerful motor.

Accessory tables and cutting guides are available for some saws—a point to check on. Be sure, too, that a good selection of blades is available. Some saws take standard round-hole blades, while others require blades with specially shaped arbor holes.

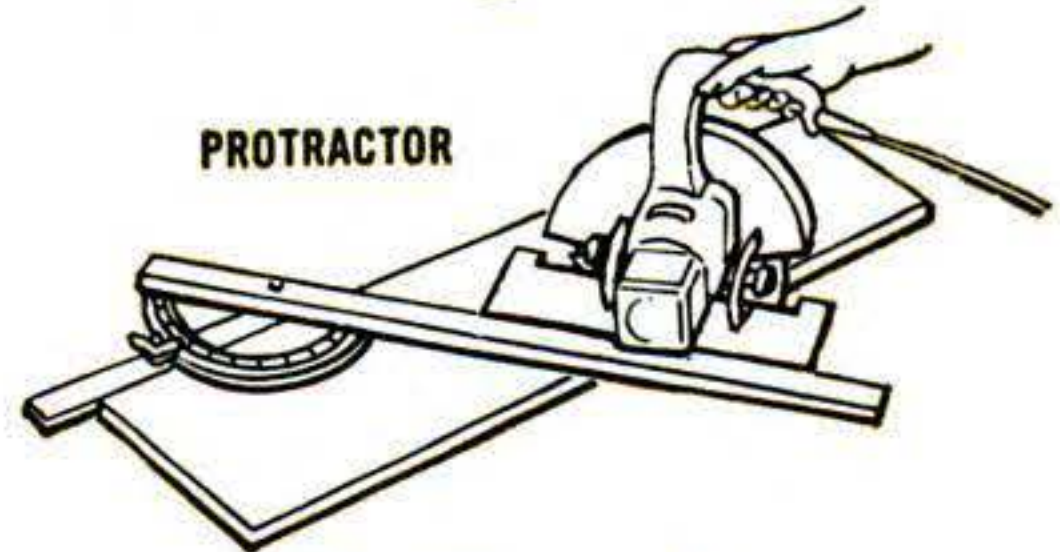
Quick Facts About PORTABLE CIRCULAR SAWS continued

MAKE	MODEL	BLADE SIZE (in.)	DEPTH OF CUT (in.)		WEIGHT (lb.)	APPROX. PRICE
			AT 90°	AT 45°		
PORTER-CABLE	596	6¾	2⅝	1⅝	14	\$90
	178	8¼	2⅞	2¼	12	\$90
	597	7¼	2⅝	1⅞	14½	\$100
	567	6¾	2⅞	1¾	14	\$120
	568	7½	2⅝	2⅝	17	\$135
	508	8	2¾	2	17	\$145
	528B	8¼	2⅞	2⅝	16	\$145
RAM	R88	7	2⅝	2⅞	11	\$50
	R7	7	2⅝	2⅞	11	\$62
	F7	7	2⅝	2	12	\$20
SEARS CRAFTSMAN	9G2781	6½	2⅞	1¾	13½	\$25
	9G2783	6½	2⅞	1¾		\$33
	9G2796C	6½	2	1⅞	12¾	\$40
	9G2789C	7½	2⅝	2⅝	15	\$58
SHOP-CRAFT (Portable Electric)	9710	7	2½	2	11	\$36
SHOPMATE (Portable Electric)	1870	7	2⅞	1⅞	12	\$40
	1875	7½	2⅞	2	12	\$41
	731	7	2⅝	2	13½	\$49
SKIL	536	6½	2⅝	1¾	9	\$50
	537	7¼	2⅞	1⅞	13¼	\$65
	552	6½	2⅝	1¾	11¼	\$75
	553	7¼	2⅞	1⅞	13½	\$90
	554	8¼	2⅞	2⅞	13¾	\$100
SPEEDWAY (Thor)	801	7	2⅞	1¾	11⅞	\$36
	450	6½	2⅝	1⅝	11¼	\$53
	460	6½	2⅝	1⅝	11¼	\$70
	475	7¼	2⅝	1¾	13⅞	\$80
	485	8	2⅝	2	14¾	\$90
STANLEY	H271	7	2⅞	2	10	\$45
	H272	7	2⅞	2	9¾	\$55
	H273	7	2⅞	2	9¾	\$75
	H274	7¼	2¼	2⅞	9¾	\$85
	H85	8	2⅞	2⅞	16	\$100
SUNBEAM	7210	6¼	2⅝	1⅝	10¼	\$50
	7220	6¼	2⅝	1⅝	10½	\$60
	7230	6¼	2⅝	1⅝	11½	\$70
	7240	7¼	2½	2⅞	13	\$80
THOR	E-700	7¼	2⅝	1⅝	14⅝	\$140

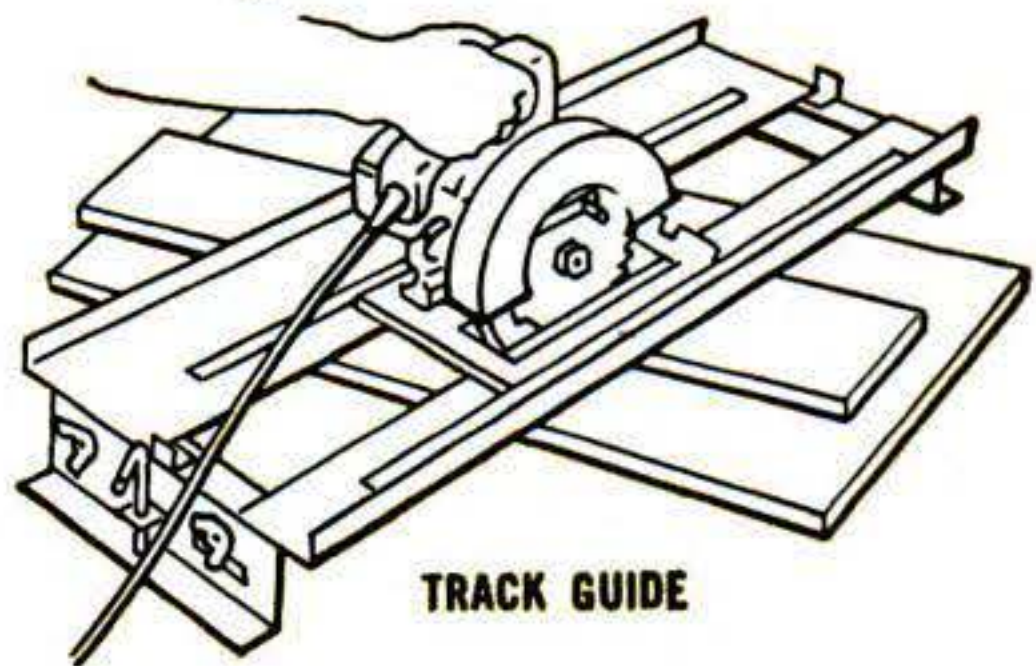
Accessories extend the use of a portable saw



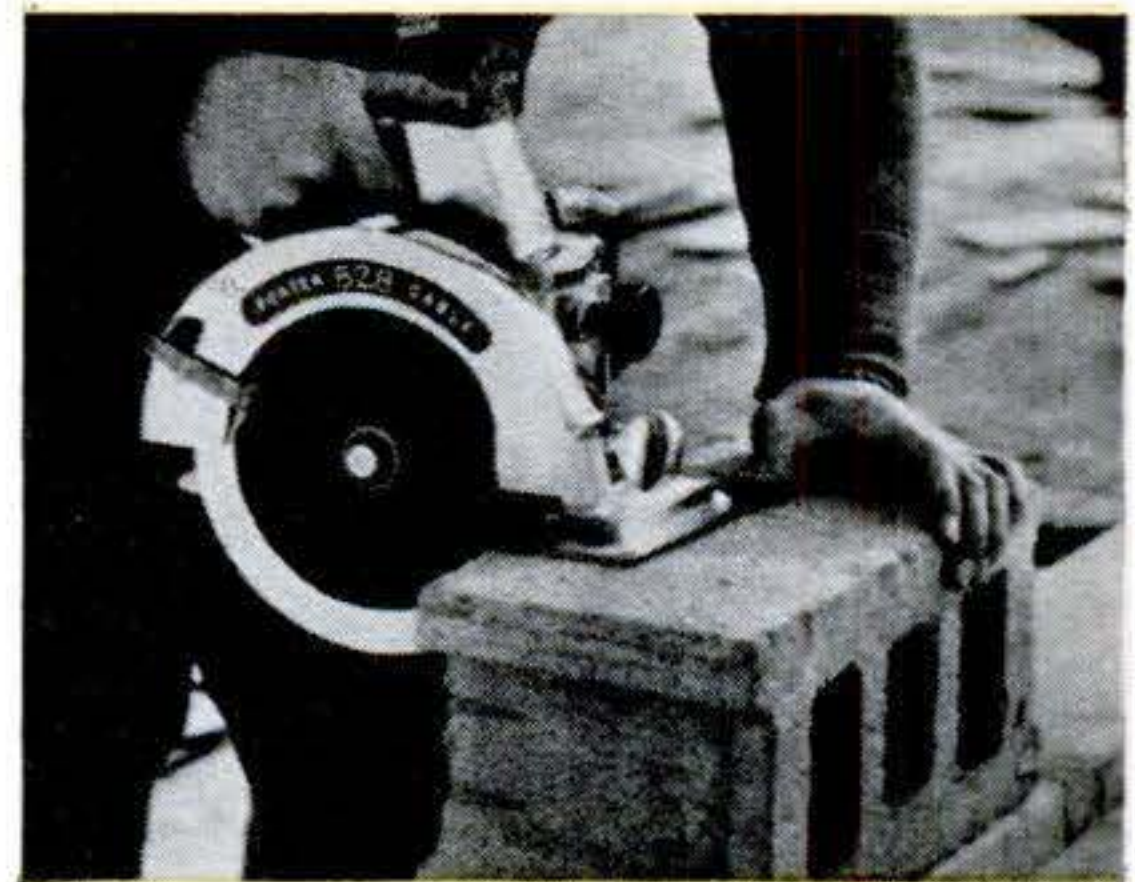
STATIONARY TABLE



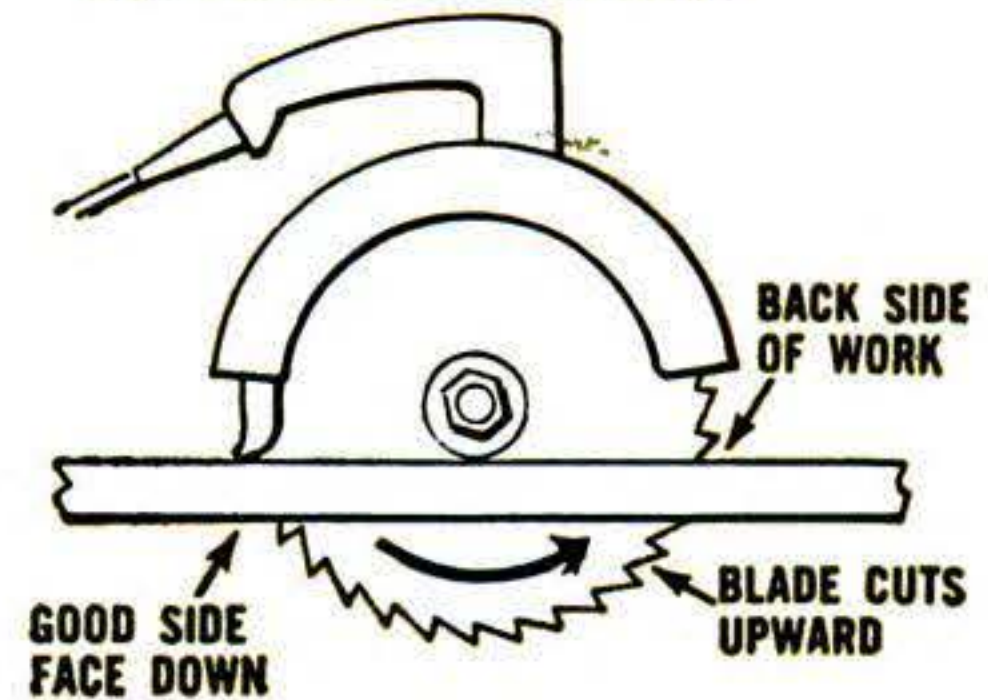
PROTRACTOR



TRACK GUIDE



A tough cutting job? Not with an abrasive blade made especially for masonry.



Portable saws cut upward—opposite of table saws—so place work good side down.

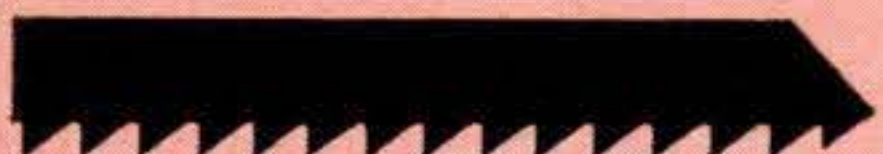
How to pick the best blade for the job



7-tooth: For fast, rough cuts in softwood, two-by-fours, and plasterboard.



7-tooth extra long: For sawing logs and timbers up to 4" thick. Usually 6" long.



10-tooth: For general cutting of hardwood or softwood, composition boards, plastics.



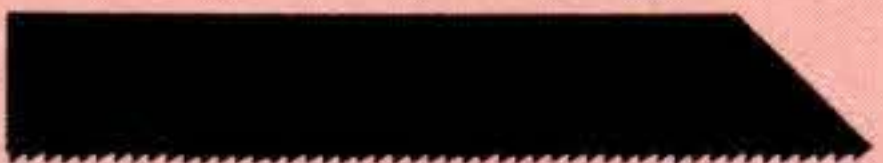
10-tooth taper-ground: For fine, finish cuts in plywood, veneers, plastic laminates.



14-tooth: For soft, nonferrous metals (aluminum, copper, brass) up to 1/4" thick.



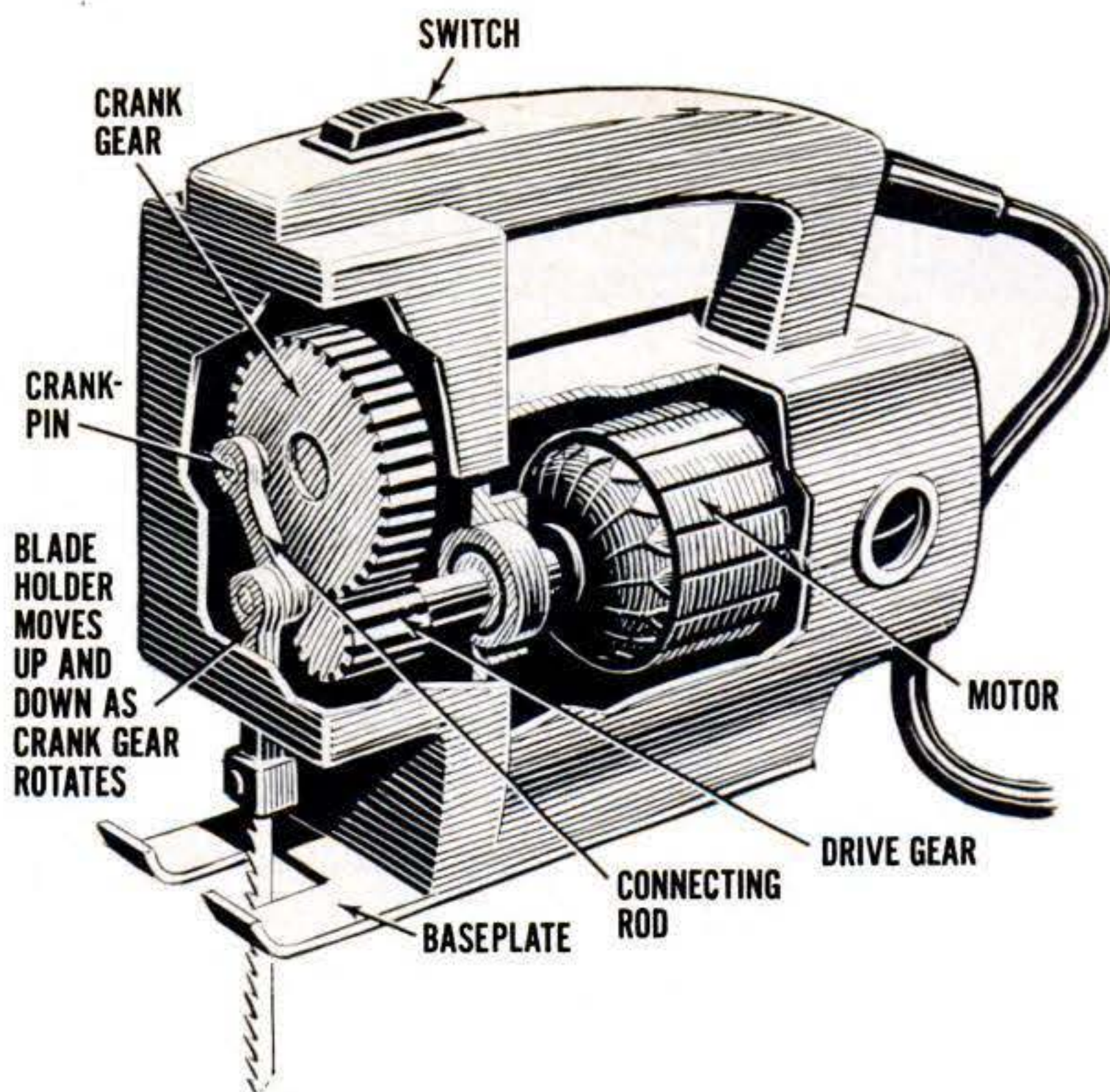
24-tooth: For fine cuts in thin sheet metal and tubing, either ferrous or nonferrous.



32-tooth: For ferrous metals (iron and steel), pipe, and solid rod and bar stock.



Knife blade: For rubber, leather, wallboard, cloth, and resilient floor tiles.



SABER SAW

it makes fancy cuts, yet handles heavy stuff, too

THE saber saw is the newest member of the portable-tool family. Yet in the short time it's been around it has already become one of the most popular, second only to the electric drill. There are good reasons why.

The first saber saws were intended mainly for fancy scrollwork. But they quickly grew into rough, tough, all-purpose tools that chomped gleefully through two-by-fours, plywood, plaster, iron pipe, hard composition boards, leather, plastics—in short, just about any material you can name.

While not a substitute for fast, rugged circular saws, they have their own special advantages. They're lighter, safer, and easier to handle. Their vertical up-and-down blade action enables you to notch beams, cut wall openings for outlets, and make other square-ended cuts not possible with a circular blade.

The type of saw you pick depends on the kind and amount of cutting you want to do. There's a wide range of prices—all the way from less than \$15 to \$100. The cheaper models are handy for light, occasional use since they're usually small and easy to manipulate. But they won't cut as fast or stand up as well under

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Address _____

City _____ Zone _____ State _____

SABER SAW

Quick Facts About SABER SAWS

MAKE	MODEL	BLADE SPEED, NO LOAD (strokes per min.)	RATED AMPERAGE	APPROX. PRICE
AMERICAN-LINCOLN	13-00	3,500	2.8	\$43
BLACK & DECKER	U-151	3,000	2.4	\$24
	U-251	3,000	2.5	\$40
	U-351	3,000	2.5	\$50
DALTON	D44	3,300	2.4	\$30
DISSTON	D20	3,800	2.75	\$55
	D23E	3,800	3.0	\$99
DORMEYER	SS-8	3,100	1.7	\$25
DUWEL (Electro)	DW810	4,800	3.8	\$30
ELECTR-O (Electro)	211	4,800	3.0	\$25
FORSBERG	707	2,650	1.5	\$20
	1	3,250	3.0	\$40
	15	2,600	3.0	\$80
LESTO	GE/UHS 33/1	2,900	2.4	\$100
	USSJ 65	3,000	2.6	\$100
	GE/UHS 33A1	650	2.4	\$135
McGRAW-EDISON (Manning-Bowman)	73103	3,000	3.0	\$18
	73109	3,000	3.0	\$19
MILLERS FALLS	360	3,000	2.5	\$30
	561	3,000	2.5	\$45
MILWAUKEE ELECTRIC	6250	3,500	4.0	\$70
MONTGOMERY WARD	84C8934	3,000	2.5	\$26
	84C28990	2,000	3.0	\$40
	84C8986	3,050	2.0	\$13
	8917	600 to 2,000	3.5	\$50
PORTER-CABLE	300	4,000	2.5	\$55
	548	4,500	3.5	\$100
RAM	R44	3,500	2.4	\$30
SEARS CRAFTSMAN	9G2773	2,650	2.0	\$14
	9G27946	3,600	2.3	\$27
	9G2772	1,000/1,900/2,700	4.1	\$49
SHOP-CRAFT (Portable Electric)	9581	2,650	2.1	\$19
	9210	3,050	2.5	\$25
SHOPMATE (Portable Electric)	1810	2,300	3.0	\$25
SPEEDWAY (Thor)	808	2,400	4.5	\$40
	805	3,000	3.0	\$22
	445	2,400	4.5	\$50
	508	3,400	3.1	\$33
	509	3,400	3.1	\$35
	511-SC	2,500/3,400	3.1	\$39
	510-SC	2,500/3,400	3.1	\$35
	JS21-SC	1,900/2,400	4.5	\$48
SKIL	524	3,700	2.3	\$35
STANLEY	H452	2,700	2.2	\$35
	H453	3,000	2.5	\$45
	454	3,100	2.7	\$45
	H75	3,300	2.5	\$45
	H76	3,600	3.0	\$60
SUNBEAM	H29	3,500	2.3	\$35
	176-3	1,780	2.0	\$40
WELLER	88	7,200	4.8	\$23
WEN	505	2,650	1.8	\$27
	909	3,400	6.0	\$45

hard wear as the bigger saws.

Higher-priced saws have bigger, more powerful motors. They cut faster and more smoothly, run cooler, and have the steadiness of good, solid heft. They also have better bearings and such refinements as auxiliary knobs for two-hand use and removable blade guides for extra accuracy on fine cuts.

Cutting capacity isn't much of a question these days, but you should look for a tool that will slice through at least 2" stock. Some tools can be fitted with special deep-cutting blades that will slice fireplace logs up to 4" thick.

What you do want to look for is a good selection of blade types. Some saws take a dozen or more different kinds, while others may be limited to three or four. A few are designed to do an especially good job on wood, but will not handle metal. Be sure, too, that your saw takes blades that are readily available.

Blade speeds range from about 2,000 to 7,000 strokes per minute, with the most common at around 3,000. High cutting speeds generally give you fine, smooth cuts in wood, while lower speeds are better suited to slogging through metals and plastics. For this reason, the average saber-saw speed is a compromise. A few of the newest saws offer a choice of high or low speeds—a luxury that naturally carries a higher price tag.

If you're interested in a particular kind of cutting, check on what accessories are available. Many saws have attachments for cutting circles, and rip guides to help you make long, straight cuts.

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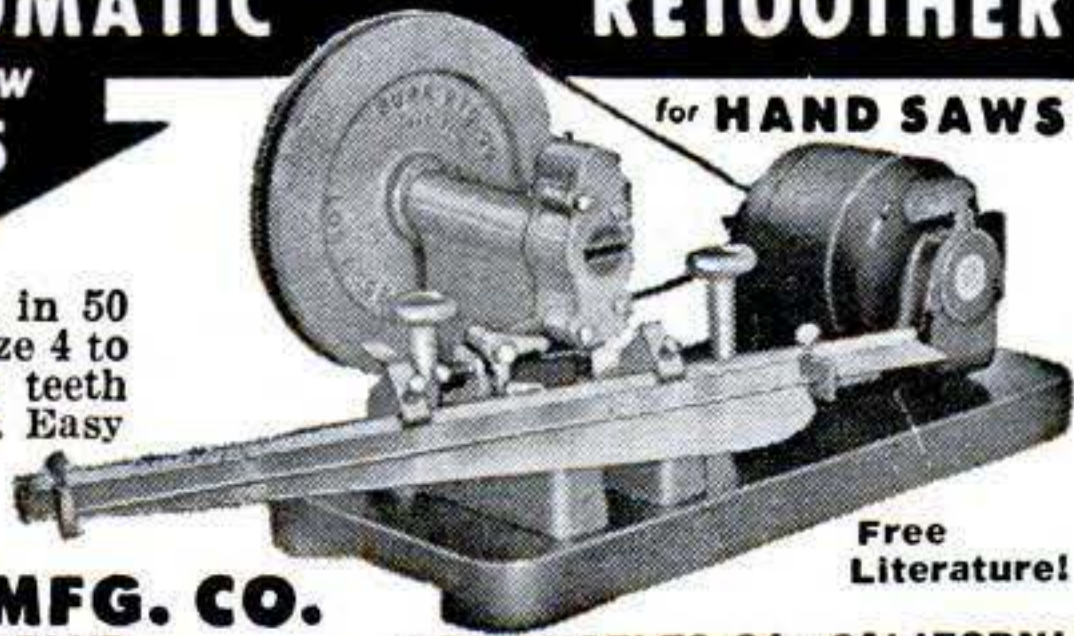
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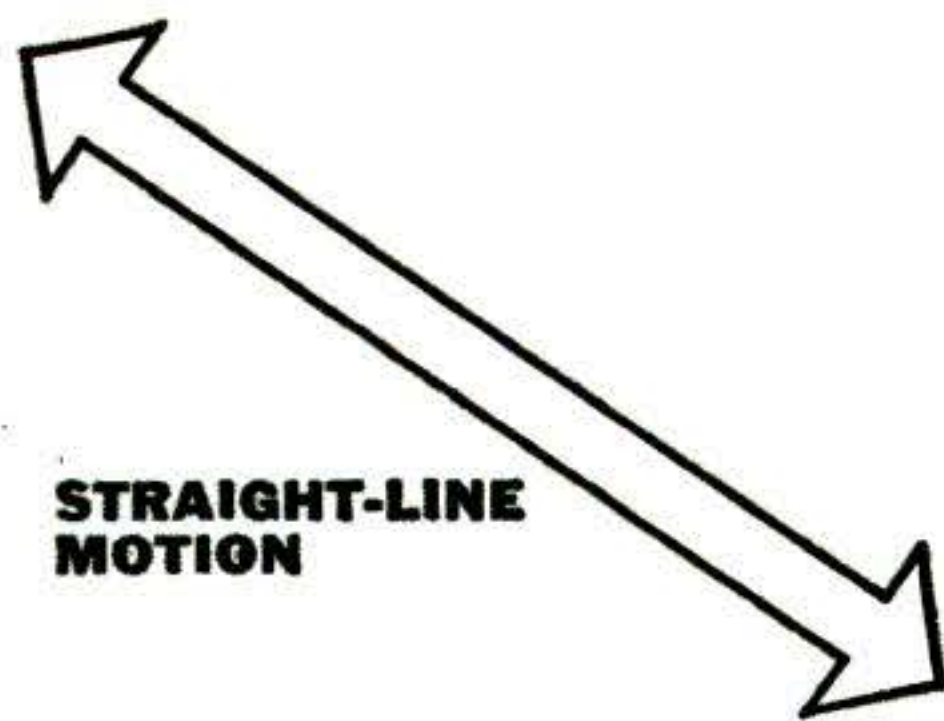
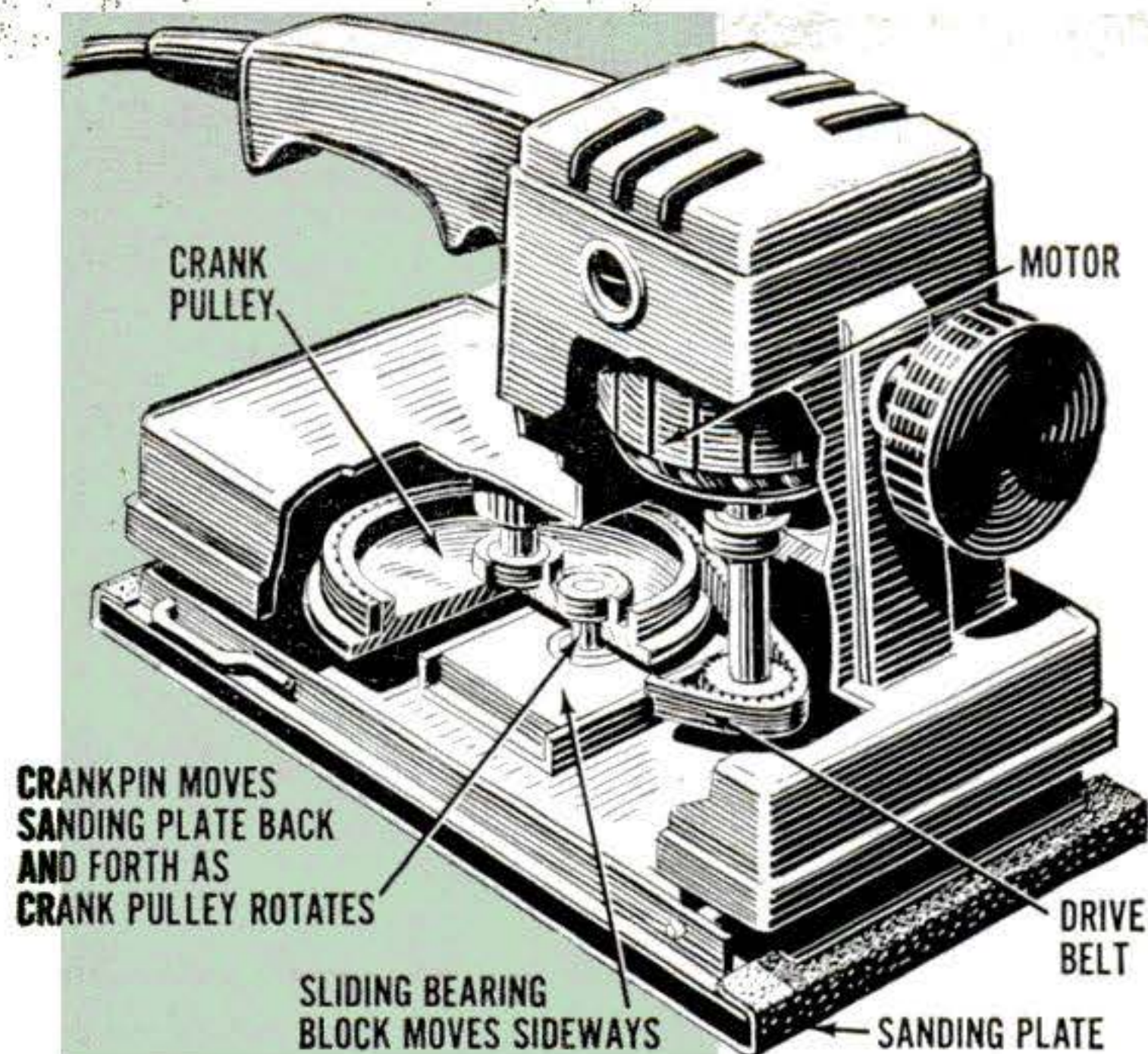
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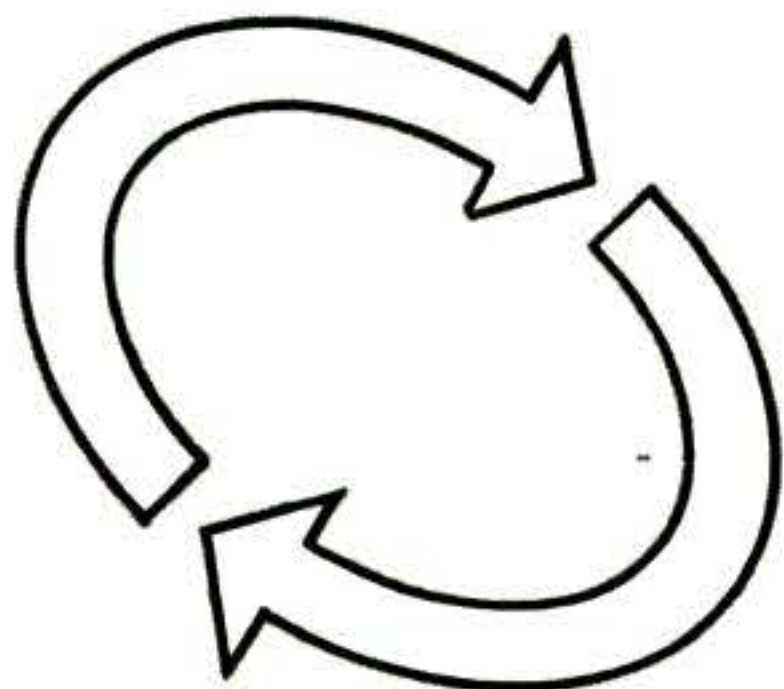
"There is nothing finer than a DIAMOND"

FINISHING SANDERS

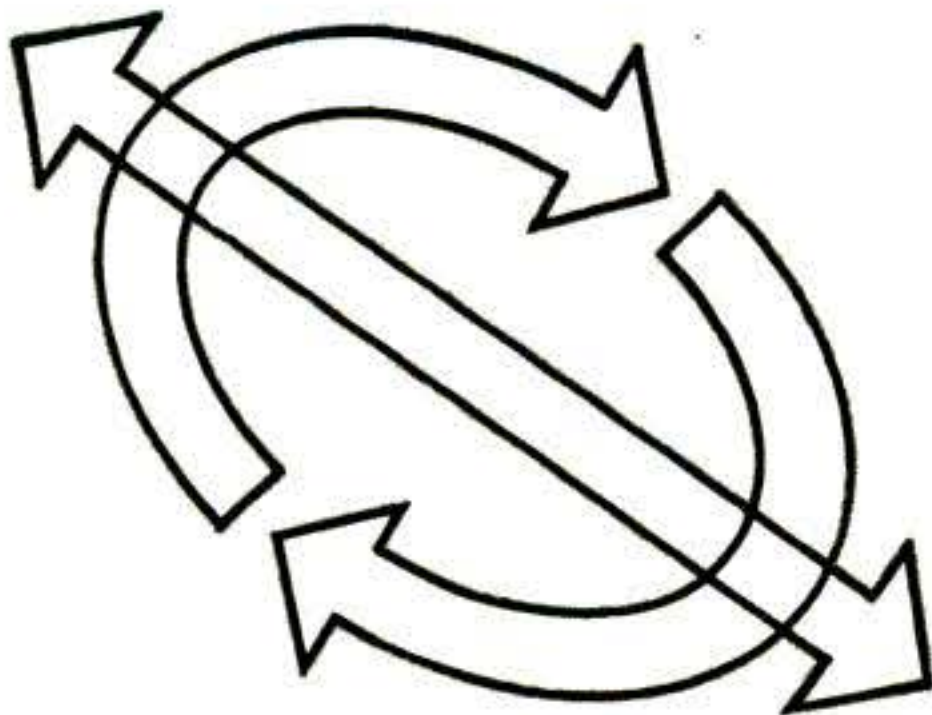
*you have a choice
of three:
straight, orbital,
or dual*



STRAIGHT-LINE MOTION



ORBITAL MOTION



DUAL MOTION

THE finishing sander, as its name implies, is the tool you need for fine smoothing and for putting an elegant, mirrorlike gleam on lacquer, varnish, or shellac. It can take a wider variety of abrasives than any other power sander and can do many jobs that other sanders can't.

While it isn't built for rugged stock removal like the belt sander, it's no sissy, either. It can do heavy work like removing old paint, especially on fine furniture, such as antiques, where either a belt or disk would gouge dangerously. Its uses range from leveling dry-wall joints to producing satin-smooth finishes on metal, plastics, and ceramics as well as wood.

It's a mistake to assume that a finishing sander is just a convenient substitute for elbow grease. While you *can* produce fine finishes by hand, it takes extreme care in addition to hard work. The broad, flat pad on a finishing sander is designed to maintain a more even, level surface than is generally possible by hand.

Finishing sanders offer two basic types of abrasive action. Oscillating sanders have an orbital or slightly circular motion. Reciprocating sanders move back and forth in a straight line. Some dual-motion models offer a choice of both actions—you flip a switch that controls the movement of the sanding pad.

The type of action you pick depends on the kind of sanding you do most. Orbital sanders work faster and are somewhat better suited to heavier removing jobs because they cut both with and across the grain. Straight-line sanders are slower-cutting, but produce extremely smooth, swirl-free results with the grain.

In practice, however, the actual difference is likely to be less than you might think. The reason is that modern orbital sanders describe a very narrow orbit,

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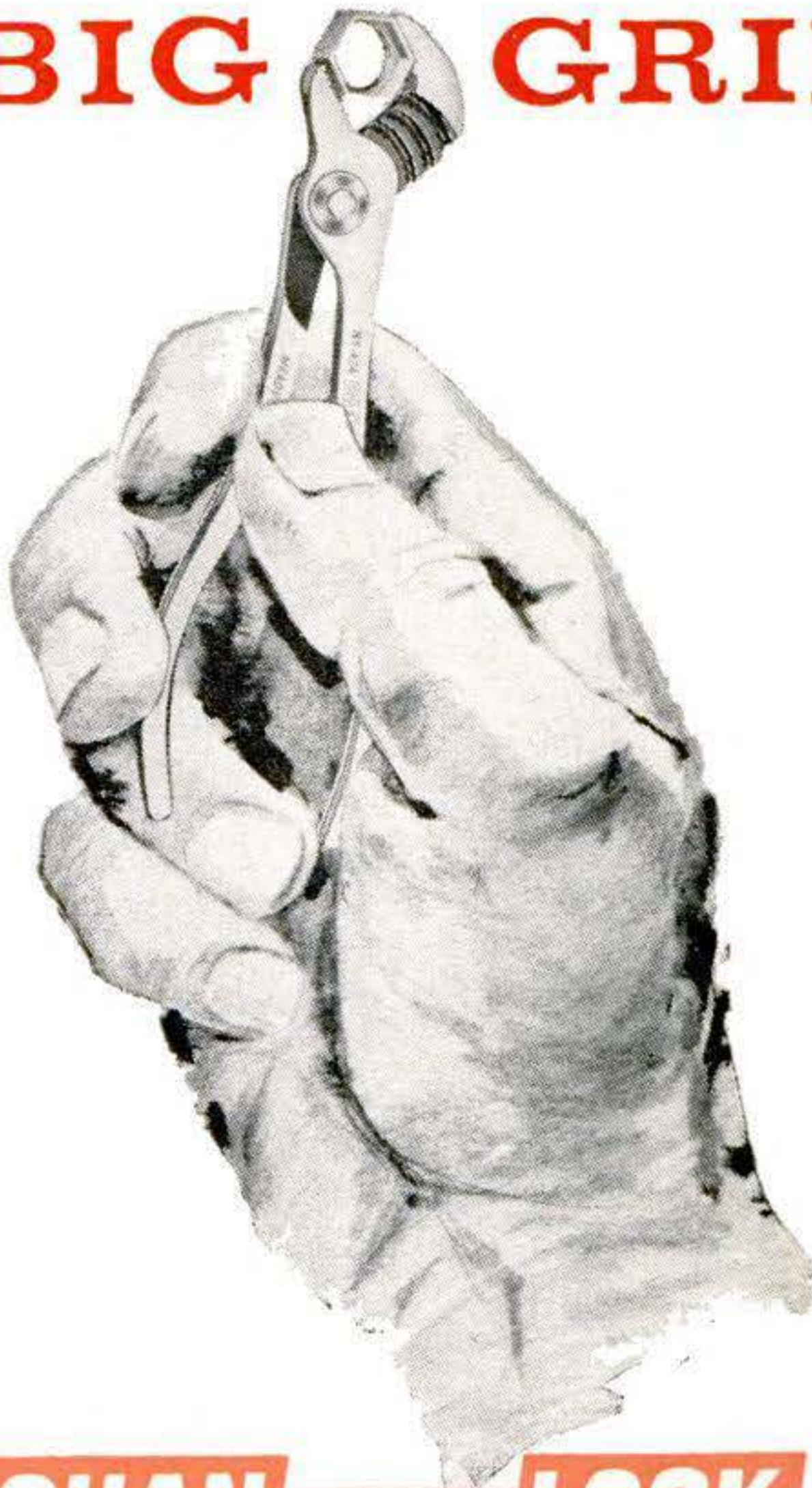
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Quick Facts About FINISHING SANDERS

MAKE	MODEL	TYPE OF ACTION	SPEED, NO LOAD (strokes per min.)	PAD AREA (sq. in.)	APPROX. PRICE
AMERICAN-LINCOLN	10-00	dual	4,600	25 $\frac{1}{3}$	\$45
BLACK & DECKER	U-141	orbital	3,500	25 $\frac{1}{3}$	\$30
	U-241	orbital	4,300	25 $\frac{1}{3}$	\$40
	U-341	orbital	4,300	40 $\frac{1}{3}$	\$50
DISSTON	DS-1	dual	5,000	40 $\frac{1}{2}$	\$40
DREMEL	300	straight line	7,200	13	\$15
	302	straight line	7,200	21	\$20
	353	straight line	6,900	25	\$38
DUWEL (Electro)	DW820	straight line	4,800	29 $\frac{1}{6}$	\$30
ELECTR-O (Electro)	221	straight line	4,800	29 $\frac{1}{6}$	\$25
McGRAW-EDISON (Manning-Bowman)	72104	straight line	14,400	18	\$12
	72107	orbital	3,000	25	\$18
MILLERS FALLS	580	orbital	4,500	27 $\frac{1}{6}$	\$40
MILWAUKEE ELECTRIC	6000	orbital	10,000	27 $\frac{1}{6}$	\$60
MONTGOMERY WARD	84C8514	straight line	14,400	14 $\frac{1}{3}$	\$12
	84C8534	orbital	3,500	26	\$19
	84C8536	orbital	4,000	26	\$24
	84C8539	dual	4,200	34	\$39
PORTER-CABLE	145	orbital	3,500	23	\$40
	106B	orbital	4,300	26 $\frac{1}{2}$	\$50
	127A	orbital	4,300	26 $\frac{1}{2}$	\$65
RAM	R120	dual	n.a.	25 $\frac{1}{3}$	\$29
SEARS CRAFTSMAN	9G762	orbital	14,400	22 $\frac{2}{3}$	\$14
	9G2581	orbital	3,500	22 $\frac{2}{3}$	\$19
	9G768	straight line	14,400	37 $\frac{1}{8}$	\$20
	9G2246	dual	4,600	25 $\frac{1}{3}$	\$32
	9G2240	dual	4,350	40 $\frac{1}{3}$	\$44
	9G2241	dual	3,950	40 $\frac{1}{3}$	\$55
SHOP-CRAFT (Portable Electric)	9280	orbital	4,000	26 $\frac{1}{3}$	\$19
SHOPMATE (Portable Electric)	1800	orbital	4,500	25 $\frac{1}{3}$	\$25
SKIL	592	orbital	5,000	25	\$40
SPEEDWAY (Thor)	821	orbital	3,450	23 $\frac{1}{6}$	\$18
	828	orbital	4,000	40 $\frac{1}{2}$	\$40
	162	orbital	6,200	31 $\frac{1}{2}$	\$38
	1500	orbital	5,500	40 $\frac{1}{2}$	\$50
	164-SC	orbital	3,000 or 4,500	31 $\frac{1}{2}$	\$40
	D25-SC	orbital	3,000 or 4,500	31 $\frac{1}{2}$	\$36
STANLEY	H37	orbital	4,000	25 $\frac{1}{3}$	\$38
	H36	orbital	4,500	25 $\frac{1}{3}$	\$50
SUNBEAM	FS	straight line	14,400	14	\$18
	74	orbital	4,000	25	\$40
WELLER	77	straight line	14,400	26	\$20
WEN	202	straight line	14,400	13 $\frac{3}{4}$	\$14
	303	straight line	14,400	13 $\frac{3}{4}$	\$17
	404	straight line	14,400	20	\$20

n.a.—Not available.

FINISHING SANDERS

less than $\frac{1}{4}$ " wide in most cases, so swirl marks are kept to a minimum. This makes the orbital a fine general-purpose sander. The straight-line sander is a good choice, on the other hand, if you're mainly interested in extra-fine finishes where speed is not as much of a factor.

One good test of a finishing sander is to turn it on and then bear down on it. If it stalls easily under moderate pressure, it may be underpowered. This, however, is for a test only. In use, the proper technique is merely to *guide* the tool, not press on it. Heavy-handed pressure simply slows its cutting action and makes it more likely to scratch rather than smooth.

The size of the sanding pad is an indication of the amount of work a sander can do. Obviously, the bigger the pad, the more area it can cover at a time. On broad, flat surfaces, this is an advantage. On the other hand, if you do a lot of work on irregular surfaces and in hard-to-reach places, a small pad is easier to maneuver.

If you're going to use a sander on vertical surfaces or for ceiling work, the type with auxiliary knobs that can be shifted to the side or front are mighty convenient. Although finishing sanders don't compete with belt sanders in kicking up dust, they do chew up their share. Some of the newer models come with a dust bag or can be fitted with a dust collector that connects by a hose to a shop vacuum or regular household vacuum cleaner.

Booklets You Can Order to Help with Hobbies

The following booklets are offered either free or at a small charge by the sources listed with each. Please order direct—not from POPULAR SCIENCE.

TOOLS

Things to Make on the Tools You Own. Rockwell Mfg. Co., Delta Power Tool Div., Dept. P, Pittsburgh 8, Pa. \$1.

AUTOMOBILES

So You're Going to Drive (handbook for young drivers). The Pure Oil Co., Dept. P, 200 East Golf Road, Palatine, Ill. Free

PHOTOGRAPHY

Better 35mm Snapshots. Eastman Kodak Co., Dept. P, Rochester 4, N.Y. 50¢

ELECTRONICS

Dictionary of Electronic Terms. Allied Radio Corp., Dept. P, 100 North Western Ave., Chicago 80. 50¢

Lower the Cost of Fun with Tape Recording. Sarkes Tarzian, Inc., Dept. P, East Hillside Dr., Bloomington, Ind. Free

HOME IMPROVEMENT

Wood Siding: How to Install It, Paint It, Care for It (Home and Garden Bulletin No. 52). U.S. Government Printing Office, Superintendent of Documents, Washington, D.C. 20402. 10¢

Get Organized Outside with an Outdoor Storage Center (plans and instructions). Western Pine Assn., Dept. P, Yeon Bldg., Portland 4, Ore. 5¢

Fences: 20 Ways to Add New Dimension and Privacy to Your Yard. Masonite Corp., Dept. P, 11 W. Washington St., Chicago 2. Free

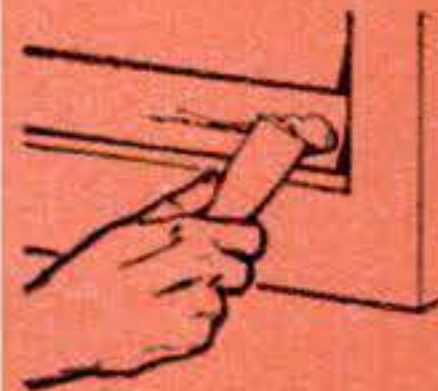
PROJECTS

Bright Ideas with Reynolds Do-It-Yourself Aluminum (plans for furniture, storage units, decorations, etc., made from aluminum). Reynolds Metals Co., P.O. Box 606-P, Richmond 5, Va. 10¢

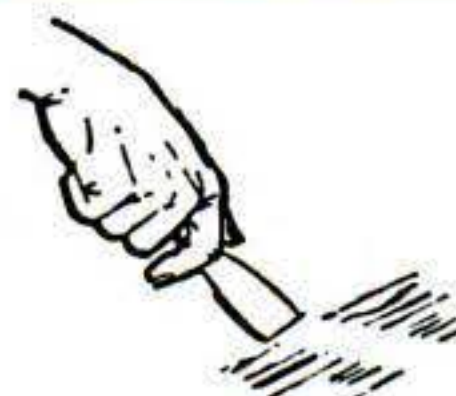
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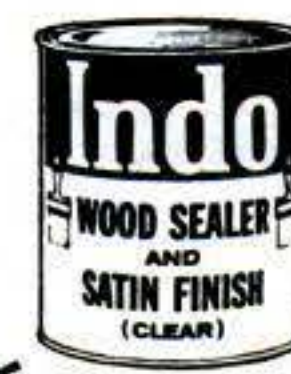
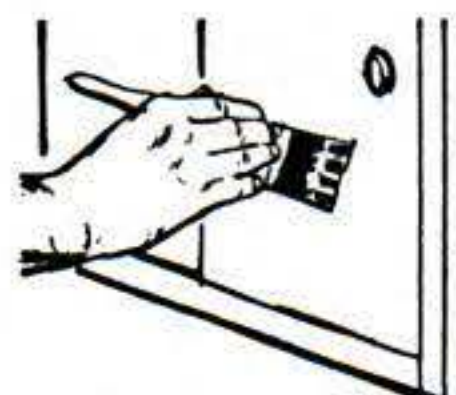
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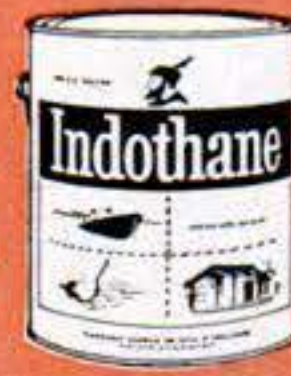
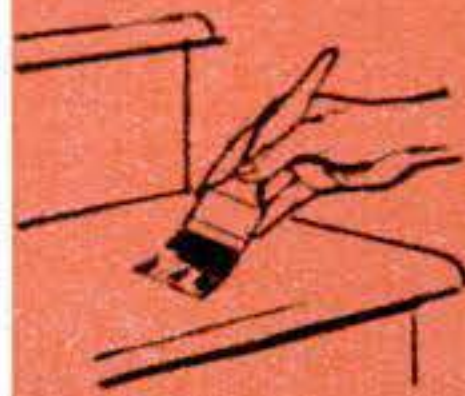
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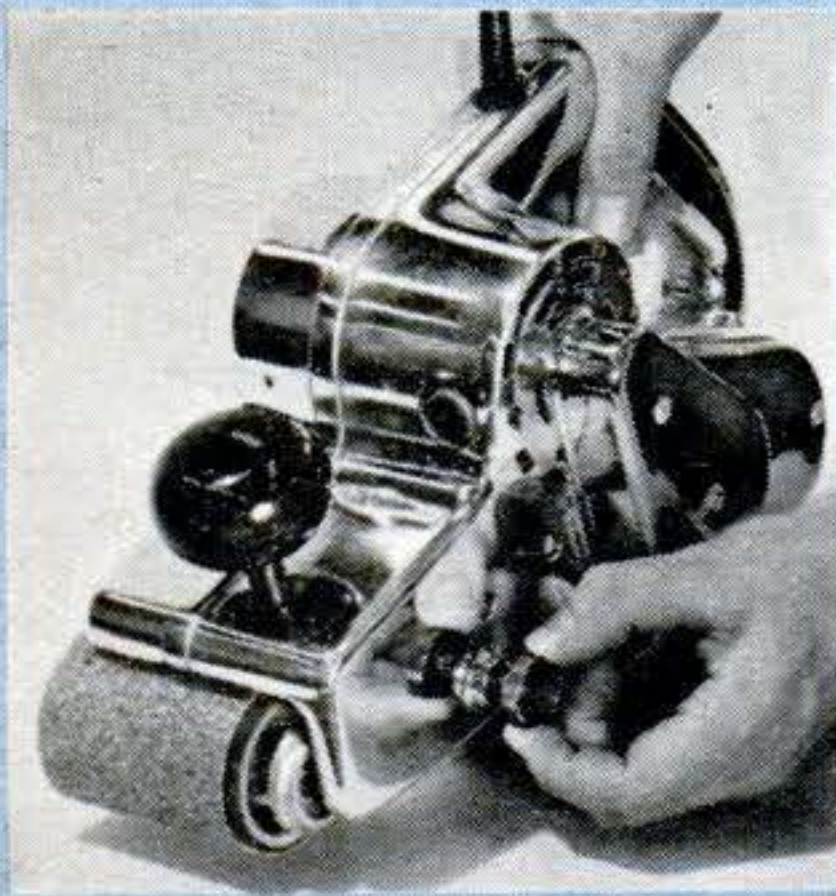
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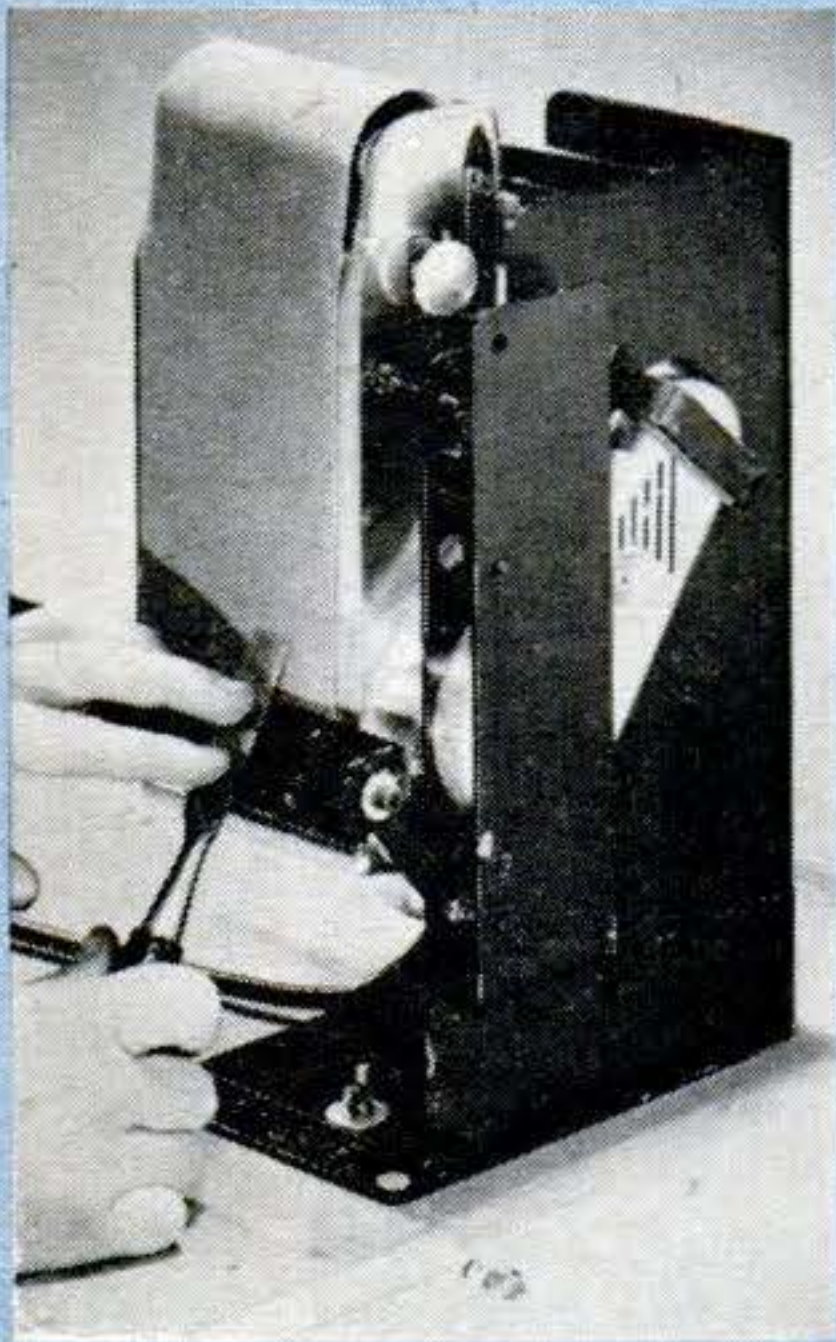
Fast belt changing makes it easy to use



Belts slip on and off without disassembling tool so you can switch them quickly.



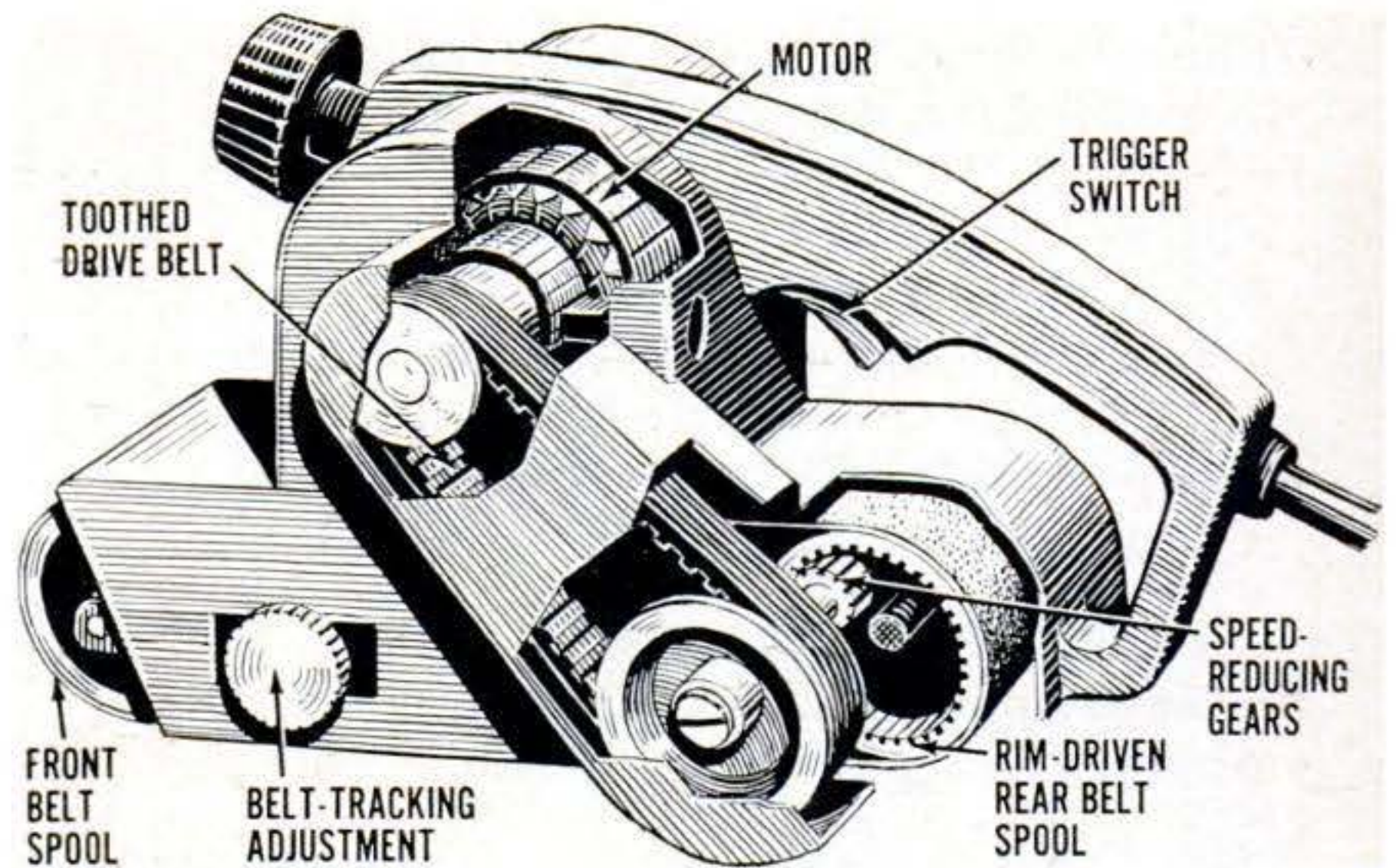
Perfect belt tracking is simple to maintain with adjustment knob on the side.



Bench stands come for some models or can be homemade to give a stationary tool.

BELT SANDER

a fast, rugged remover



THE belt sander is the most versatile and probably the most important of the various types of machine sanders for general woodworking. For some jobs, such as boatbuilding, it is almost indispensable.

It excels at rapid stock removal, making it the ideal tool for leveling and smoothing large surfaces or trimming pieces for an exact fit. It's also the fastest and most efficient tool for stripping old paint or varnish from flat surfaces. With proper choice of belt and platen, you can even sand marble, plaster, slate, stone, plastics, and metal.

Belt sanders, once an expensive tool used only by professionals, have been coming steadily down in price. With models selling for as little as \$40, the belt sander is practical for home-shop use.

When you acquire a belt sander, you'll find it does a lot more than just speed up operations you have been doing by hand. It will cause you to change your technique for many common woodworking procedures. For example: The slickest way to make a cabinet corner joint is to cut one side slightly oversize, then trim the overhang flush with the other side using the belt sander. You automatically take care of any slight warp or inaccuracies in the fit.

The portable belt sander uses a continuous belt of coated abrasive running on two pulleys, one at each end of the machine. The rear pulley is powered by the motor through a reduction drive. The working area of the belt is backed by a shoe or platen on the

bottom of the tool. The abrasive action of the belt is all in one direction—from front to back. This gives excellent control of the direction of cutting action, particularly important in working grained materials such as wood.

The speed with which stock can be removed depends on the grit size of the abrasive used and the speed of the belt. A coarse grit and high speed remove stock fastest. With a fine grit, maximum useful speed is limited by the danger of burning the wood and clogging the abrasive. Belt speed is specified in surface feet per minute.

Sizes of belt sanders are determined by the width of the belt. They are available in 2½", 3", and 4". The trend in newer models is toward the wider belts. Obviously, the wider belt will sand a large surface more quickly and is also easier to keep from gouging the surface.

Your own needs will go a long way in determining which belt sander is best for you. A powerful, heavy-duty machine may be ideal for making short work of large horizontal surfaces, but it would be a white elephant if you mainly want to sand taped joints in plasterboard walls and ceilings. Speed, too, depends somewhat on whether you're interested most in fast stock removal on large surfaces using coarse grits or will be working more with finer grits and on small jobs where high speeds are not so essential.

Try the heft and balance of a belt sander before you buy. Check the ease of changing belts and adjusting the pulleys for correct belt tracking. Find out how much of a chore it will be to keep the machine properly lubricated. If you will be working indoors, you'll want to consider a dust collector, since sanding dust is a problem with belt sanders. Some models have a bag attached, while others connect to a separate vacuum cleaner.

How to choose sheet and belt abrasives

TYPE OF JOB	ROUGH REMOVING	INTER-MEDIATE SMOOTHING	FINISH SANDING	POLISH SANDING
GRIT SIZE TO USE	50 (coarse)	80 (medium)	120* (fine)	320-400 wet-or-dry used wet*
*Applies to sheets only; fine finishing not generally attempted with belt sanders.				

Grit sizes listed above refer to both sheets and belts so chart can be used as a guide to selecting abrasives for finishing sanders as well as belt sanders.

Quick Facts About BELT SANDERS

MAKE	MODEL	BELT WIDTH (in.)	BELT SPEED, NO LOAD (ft./min.)	HAS DUST BAG	HAS VACUUM ATTACH.	APPROX. PRICE
AMERICAN-LINCOLN	11-25	4	1,100	no	yes*	\$90
BLACK & DECKER	U-346	3	1,700	no	yes*	\$98
MILLERS FALLS	830	3	1,300	yes*	no	\$80
	840	4	1,450	yes*	no	\$85
MONTGOMERY WARD	84C8555	3	850	no	no	\$40
	84C8533M	3	1,600	no	no	\$60
PORTER-CABLE	165	2½	880	no	yes*	\$60
	136	3	1,425	no	yes*	\$75
	153	3	1,425	no	yes*	\$85
	564	4	1,500	no	yes*	\$110
SEARS CRAFTSMAN	99G2239C	4	1,100	no	yes*	\$63
	99G22399C	4	1,100	yes	no	\$80
SHOPMATE (Portable Electric)	1860	4	1,400	no	no	\$45
SKIL	405	4	1,350	no	yes*	\$90
	594	3	925	no	no	\$60
	595	3	925	yes	no	\$70
SPEEDWAY (Thor)	555	3	950	no	no	\$45
STANLEY	H493	3	850	no	yes*	\$70
	H494	4	1,350	no	yes*	\$100
	496	4	1,100 or 1,275	no	yes*	\$100
	H31	3	1,600	no	no	\$100
WEN	910	3	850	no	no	\$45

*Available separately.

ROUTER

it makes difficult jobs look easy

THE router is probably the least appreciated, by the home craftsman, of all the portable power tools. Possibly this is because it is the one power tool that has no counterpart among hand tools. Until you've actually owned one, you have no idea of the kinds of jobs you can do with it.

By contrast, almost no professional cabinetmaker would try to get along without a router. More than any other single factor, a router can make the difference between furniture that looks "homemade" and that which looks professionally custom-made.

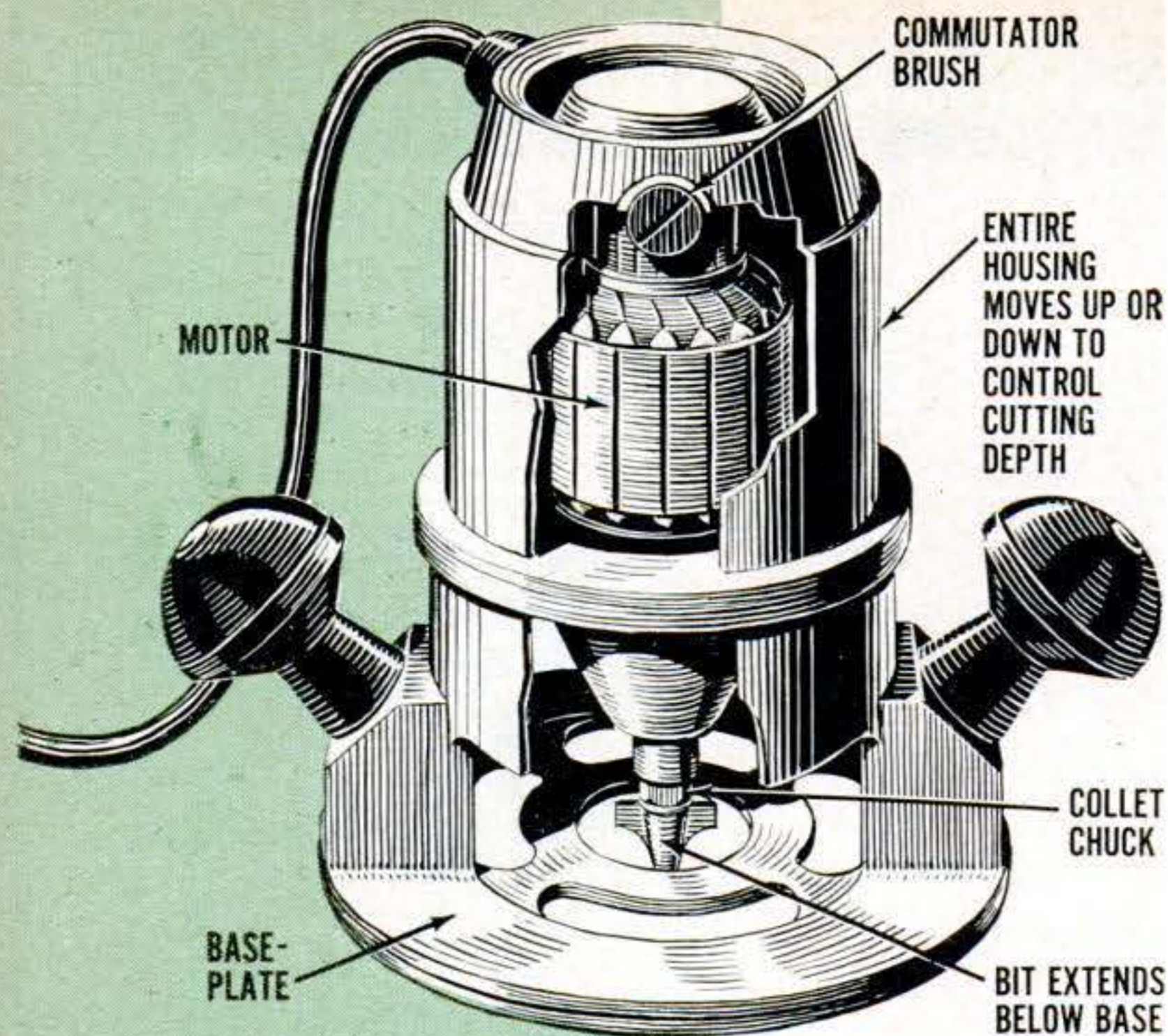
And the difference is more than skin-deep. Contrary to the notion commonly held by those who've never owned a router, it is not just a tool for adding fancy, decorative touches. It is the tool of first choice for many operations required for classic wood joinery.

That hallmark of quality furniture, the dovetail joint, for example, can only be made rapidly and efficiently with a router. With a router and dovetail jig, you can turn out dovetailed drawers almost as fast as you can nail together butt joints. You can make precision-fitted mortise-and-tenon joints as quickly as you could with the combined facilities of a table saw and drill press. Spline joints, tongue-and-groove, rule joints for drop-leaf tables, half-laps, dados, and rabbets are all made with astonishing ease using the appropriate cutter in a router.

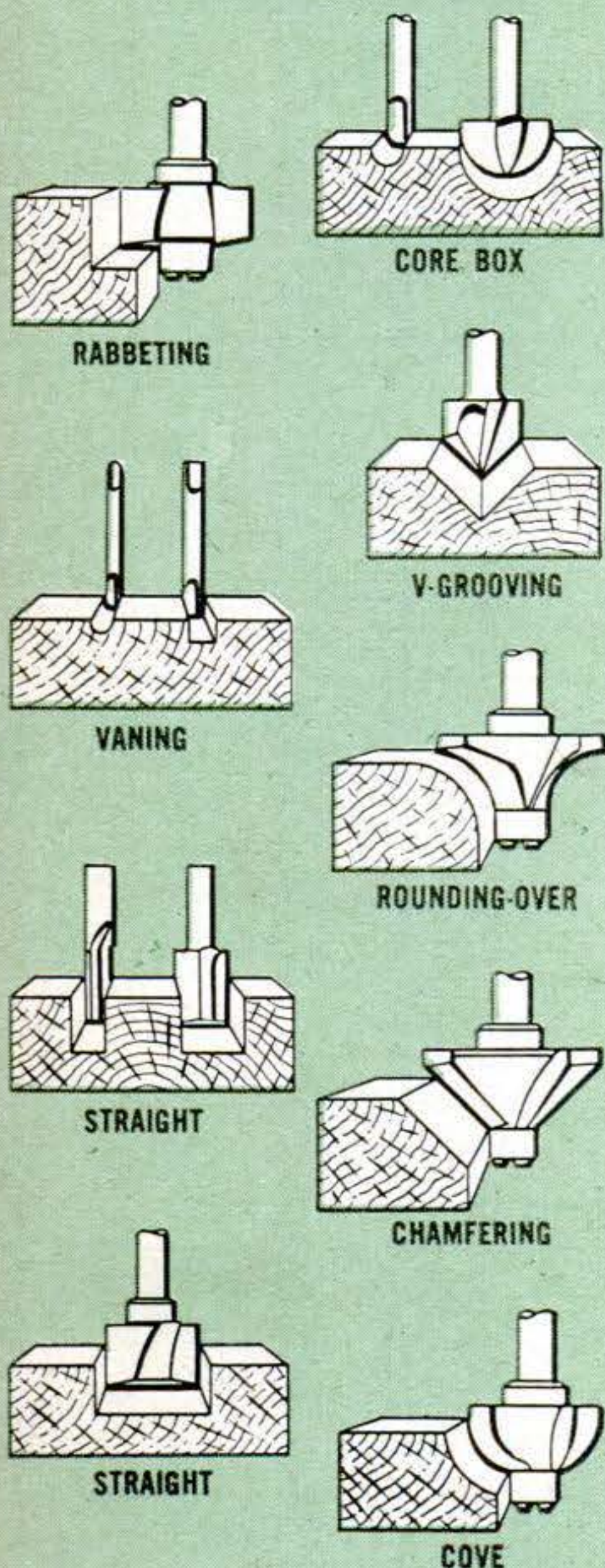
Furthermore, the router is remarkably adept at cutting shapes from plywood or other panels. You can cut a circle that will be as true and smoothly finished as though it had been turned on a lathe. Using a template guide, you can cut out as many exact duplicates of irregular shapes as you want—and the edges will have a perfect finish.

In making kitchen cabinets with plastic-laminate tops, the router is almost indispensable if you want to match the quality of professionally built units. A special carbide-tipped cutter and edging accessory enables you to trim, join, or bevel edges of the rigid plastic after it is glued in place—and this is about the only way you can get first-rate results with this material.

The graceful, flowing lines of Danish modern chairs



Some of many kinds of cuts a router can make



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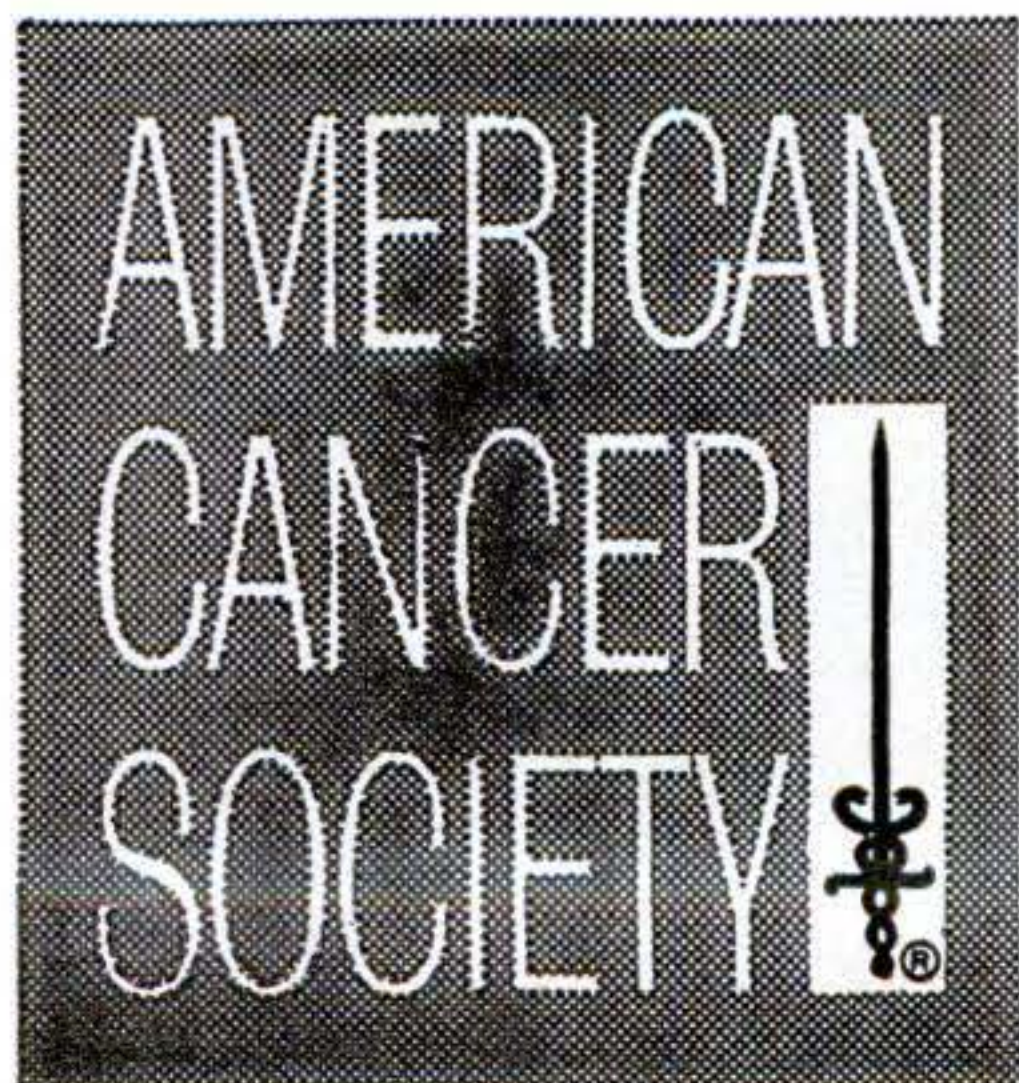
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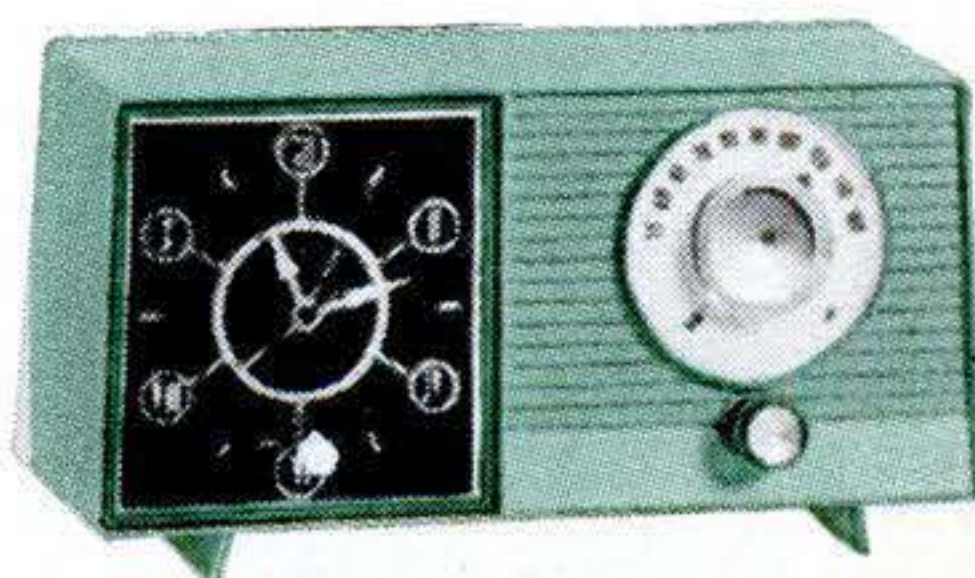
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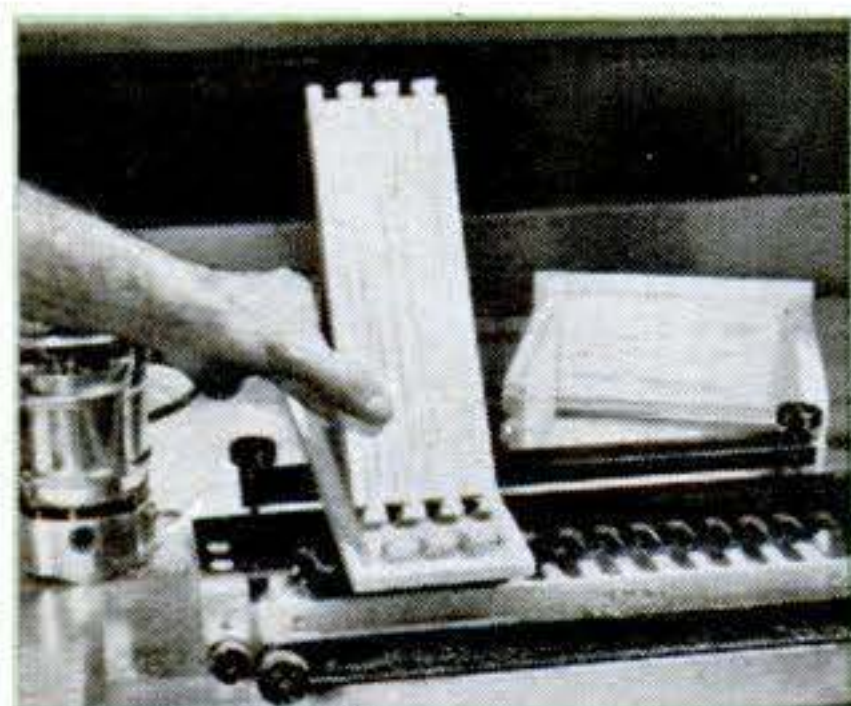
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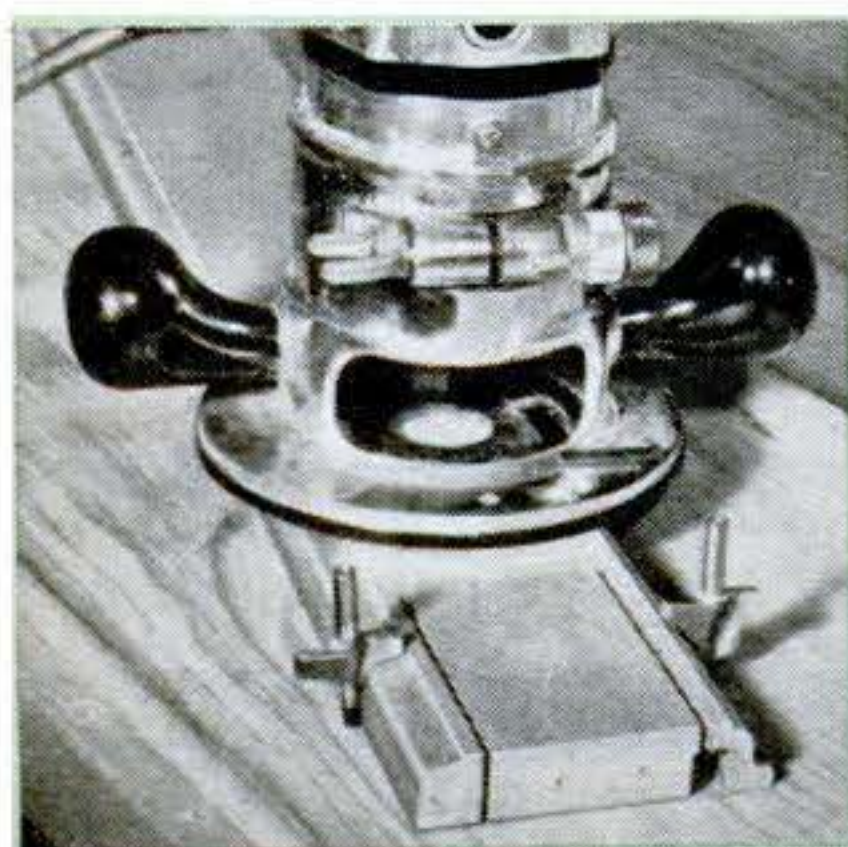
Jobs like these make the router really pay off



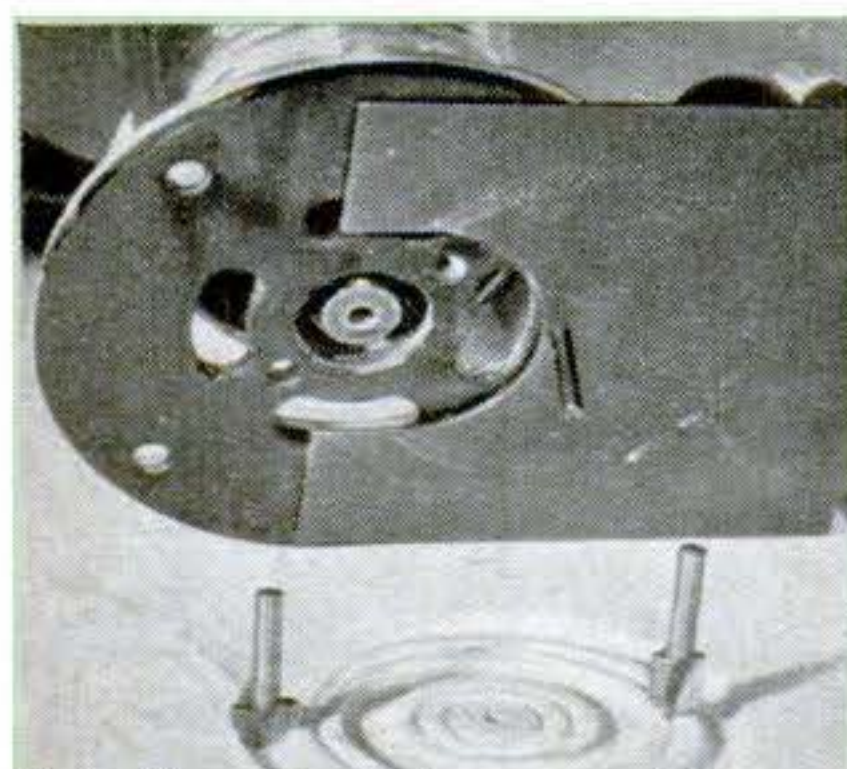
BLIND DADOES



INTRICATE DOVETAILS



FANCY EDGE MOLDING



CIRCULAR FACETING

ROUTER

or the sculptured look of contemporary Italian furniture are easily achieved with a router. You simply bandsaw the shapes of the various elements, then go over all edges with a large rounding-over cutter after the parts have been joined.

If you're serious about furniture building, you'll want a router rated at about five amps at least (approximately $\frac{3}{4}$ hp.). The less-powerful ones are all right for light-duty work, but you'll find you often have to make several passes on some cuts that can be done in one pass with a professional-size tool.

Compare several models in the store if possible. Check the feel and balance of the tool, try changing cutters, notice the method and ease of depth-of-cut adjustment. Some makes incorporate a handsaw-type grip in addition to the usual twin knobs. Other things being equal, the faster the speed the better—about 18,000 r.p.m. is a minimum for efficient router work.

When you've selected your router, don't leave the store without buying an assortment of cutters. The router is no good unless you have the right cutter for the job. Also take a close look at the many accessories available: plane, shaper table, dovetail jig, and template guides, to name a few.

Quick Facts About ROUTERS

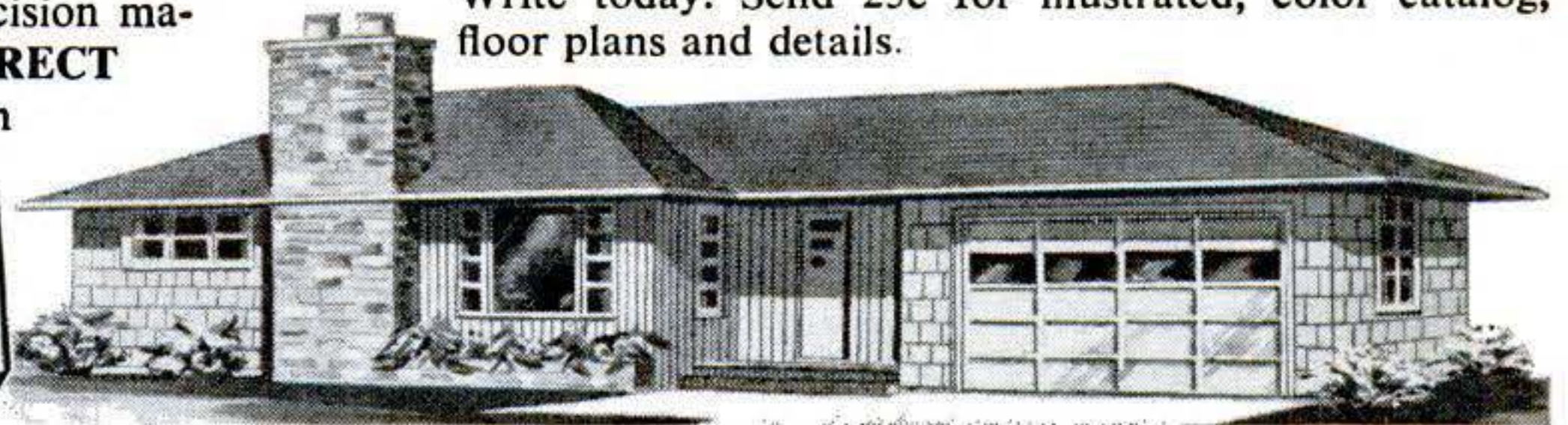
MAKE	MODEL	SPEED, NO LOAD (r.p.m.)	RATED AMPERAGE	COLLET CAPACITY (in.)	GRIP STYLE	APPROX. PRICE
BLACK & DECKER	U-365	19,000	5.5	$\frac{1}{4}$	twin knob	\$70
MILLERS FALLS	6800	30,000	3	$\frac{1}{4}$	twin knob	\$45
	7800	22,000	6	$\frac{1}{4}$	knob and handle	\$75
	7900	24,000	9	$\frac{1}{4}, \frac{3}{8}, \frac{1}{2}$	knob and handle	\$85
MONTGOMERY WARD	84C8549M	27,000	2.5	$\frac{1}{4}$	twin knob	\$40
	84C8544M	23,000	6	$\frac{1}{4}$	twin knob	\$48
PORTER-CABLE	155	23,000	4	$\frac{1}{4}$	knob and handle	\$60
	100	20,000	6.5	$\frac{1}{4}$	twin knob	\$65
	150	22,000	7.5	$\frac{1}{4}$	knob and handle	\$90
	350	24,000	8	$\frac{1}{2}$	twin knob	\$100
	537	22,000	8	$\frac{1}{4}, \frac{1}{2}$	knob and handle	\$145
RAM	R-60	20,000	n.a.	$\frac{1}{4}$	twin knob	\$40
SEARS CRAFTSMAN	9G2503	24,000	6	$\frac{1}{4}$	knob and handle	\$49
STANLEY	H15	27,000	2.5	$\frac{1}{4}$	twin knob	\$48
	H45	22,000	4	$\frac{1}{4}$	twin knob	\$60
	R8A	23,000	5	$\frac{1}{4}$	twin knob	\$65
	H264	23,000	6	$\frac{1}{4}$	twin knob	\$70
	H267	27,000	9	$\frac{1}{4}$	twin knob	\$90
	R5B	18,000	8	$\frac{1}{4}, \frac{1}{2}$	twin knob	\$130

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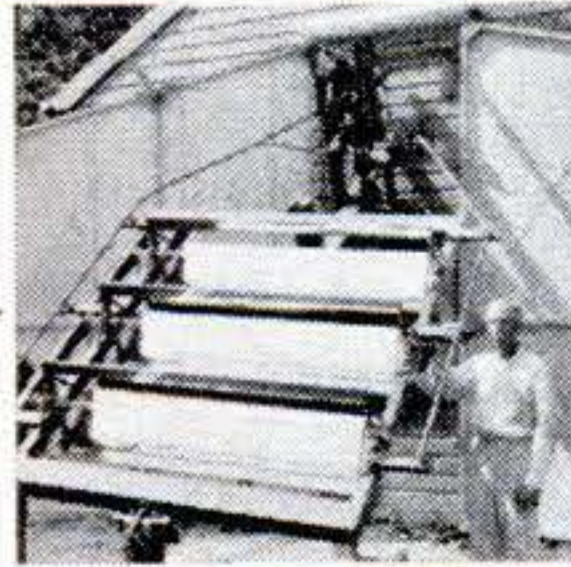


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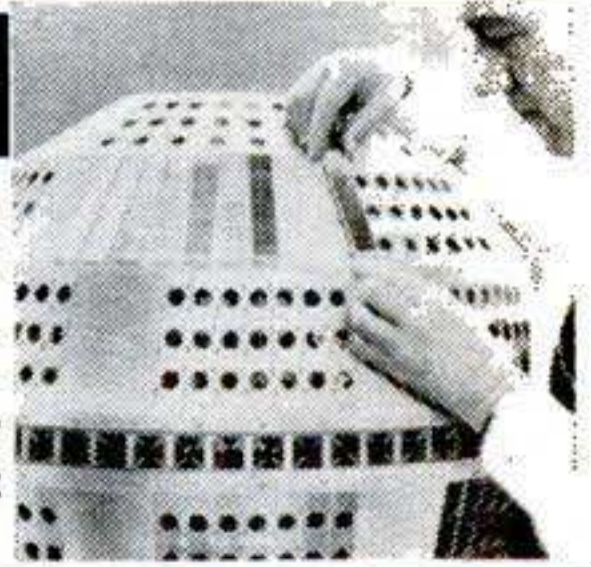
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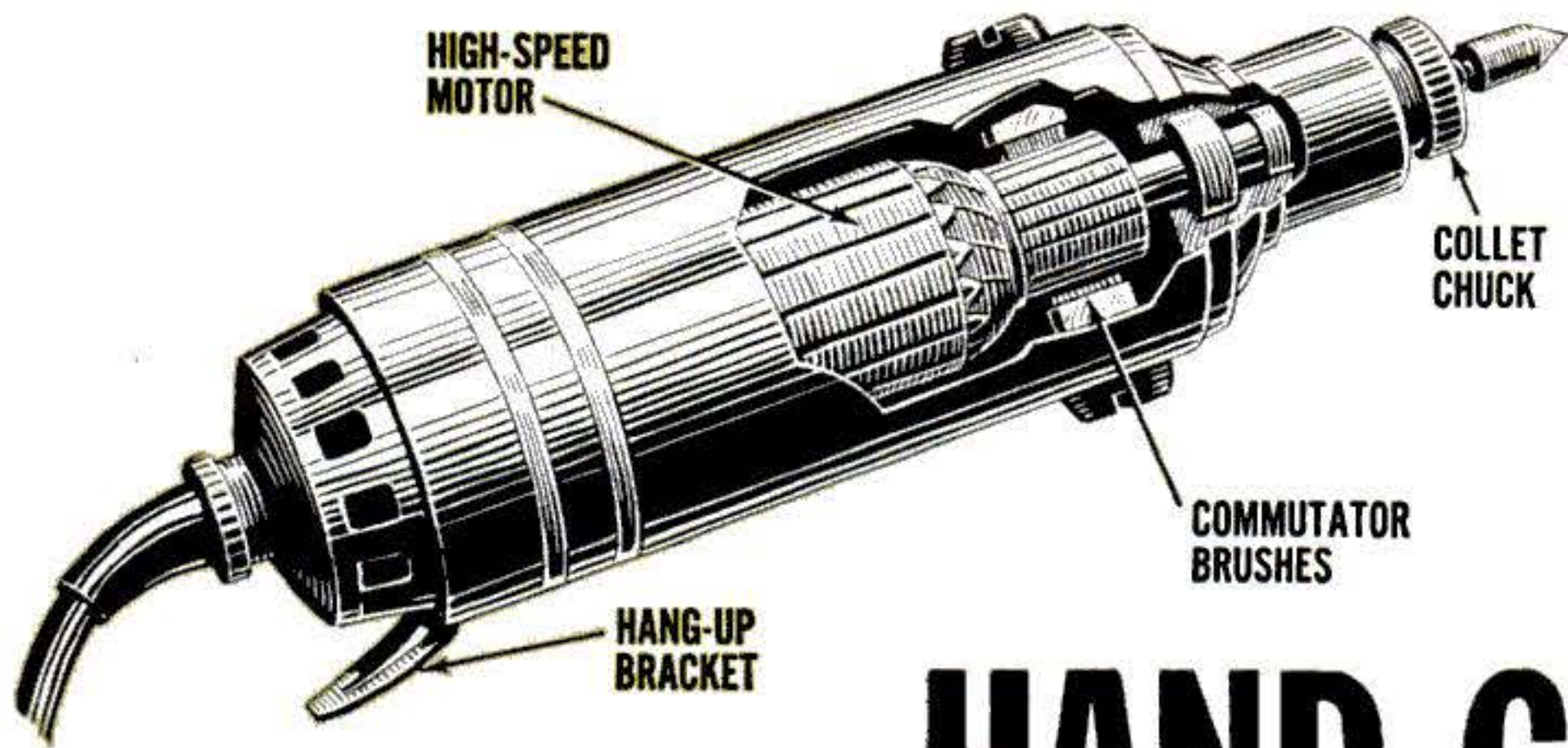
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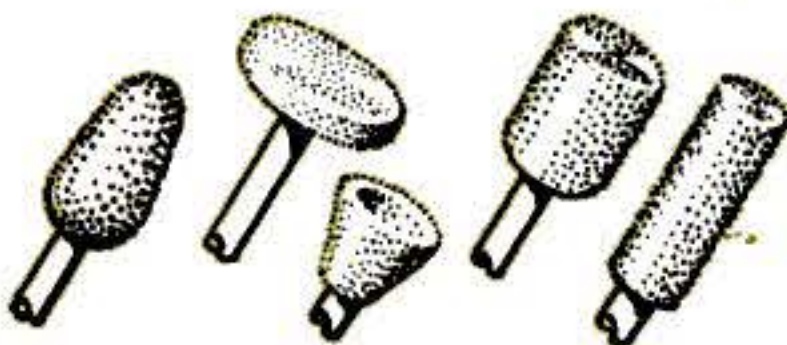
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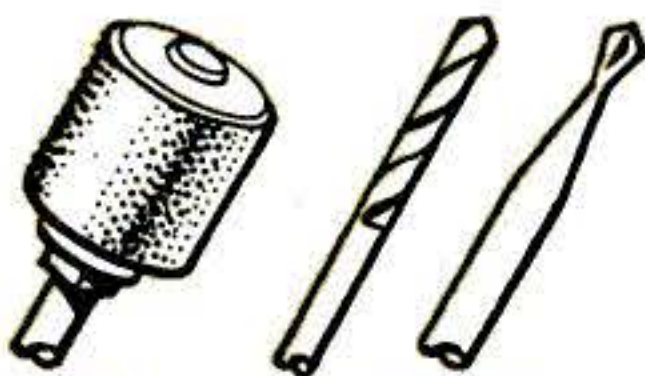
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HAND GRINDER

a high-speed shaping tool with a shopful of surprising uses

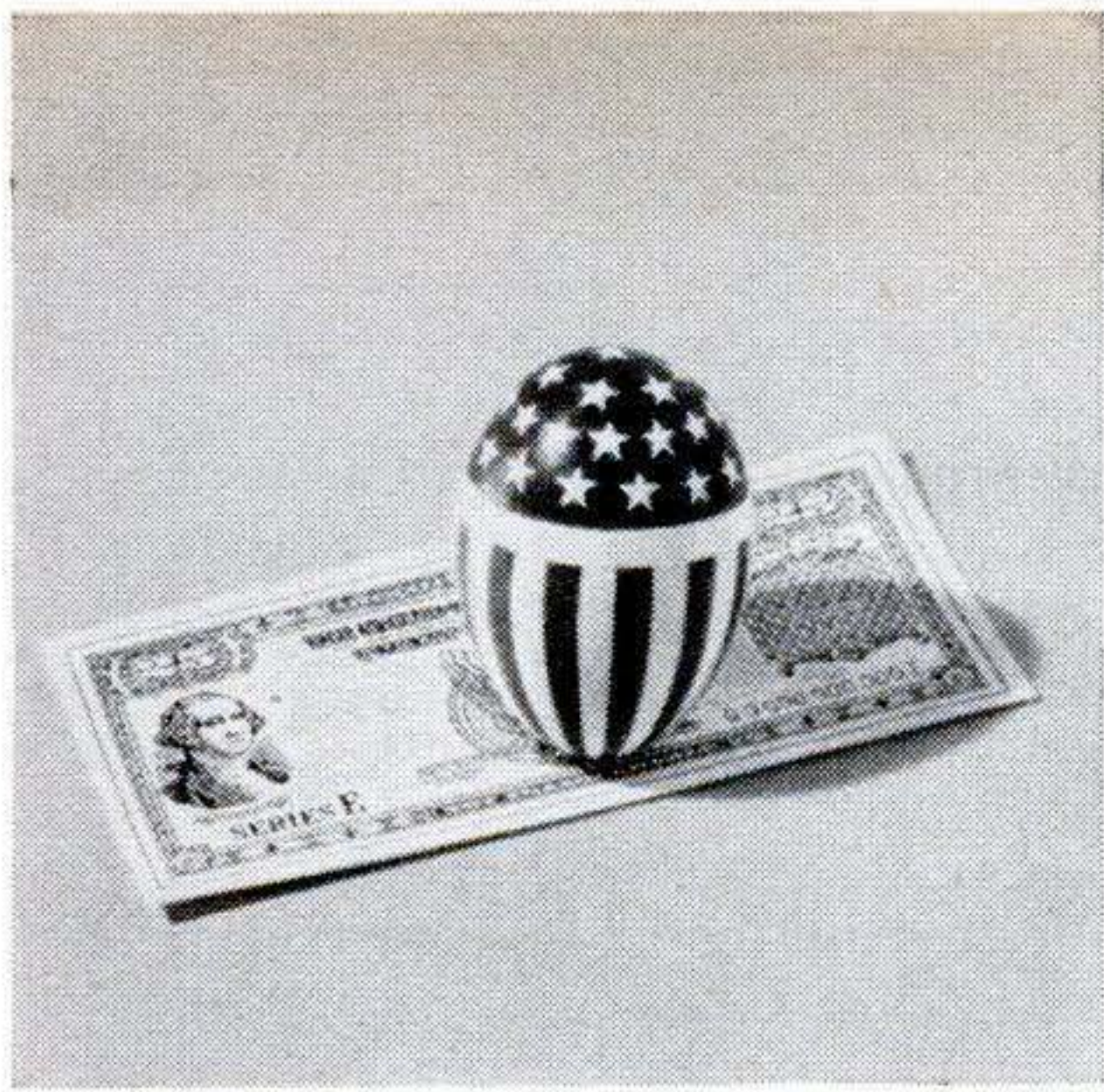
THE hand grinder is an unsung hero among shop tools. Its true talents, like the router's, are often unappreciated. The trouble: Its small size and delicate precision frequently suggest that it is mainly a hobby tool, good only for carving, model-making, and similar light craftwork.

Actually, these are the very qualities that make the grinder an important tool for basic shopwork. It can make the difference between projects that are routinely finished and those that are finely crafted. It takes over where other tools leave off, gets into places where other tools can't reach.

The name "grinder" is misleading because it suggests only one of the tool's many functions. In reality, the grinder is a versatile, high-speed shaping tool that can be fitted with an almost endless variety of bits, cutters, and abrasive wheels. It will drill, cut, smooth, polish, and machine any material. It will shape or sand intricate contours in wood or metal that you'd normally leave unfinished with conventional tools. It's also a sharpener, router, engraver, buffer, and wire brush. It's even a miniature saw. As a drill, it will make tiny holes that are difficult with heavier conventional drills.

The hand grinder is not just a "hand" tool, either. Some of its most useful and surprising functions are in combination with other power tools. Team it with a lathe or drill press, for instance, and you have a precision milling, grinding, or routing accessory that can do many jobs normally possible only with far costlier machines.

Two types of bench stands, available for most models, turn the grinder into a stationary tool. One holds it in a vertical position, much like a miniature



Red, white, and blue nest egg

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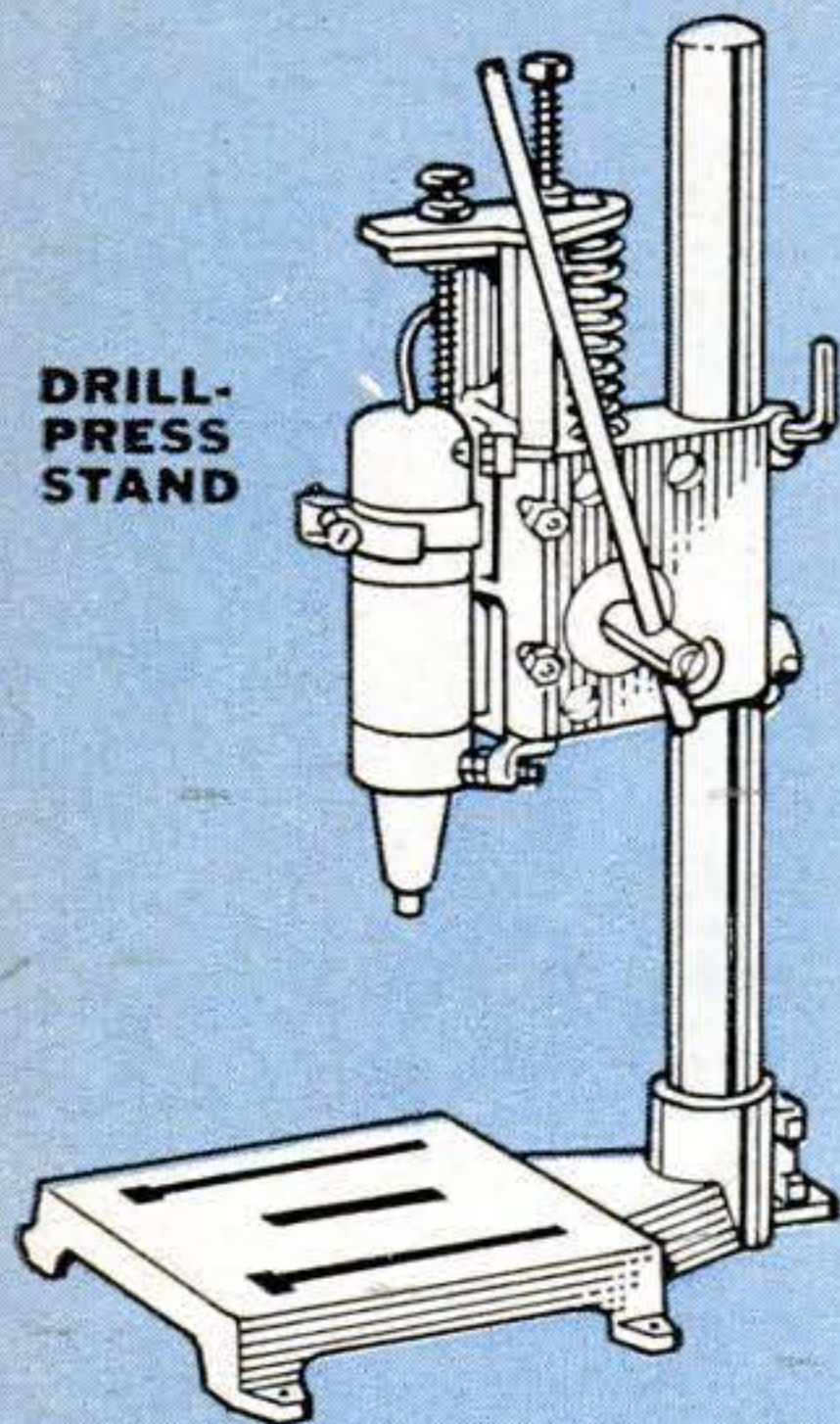
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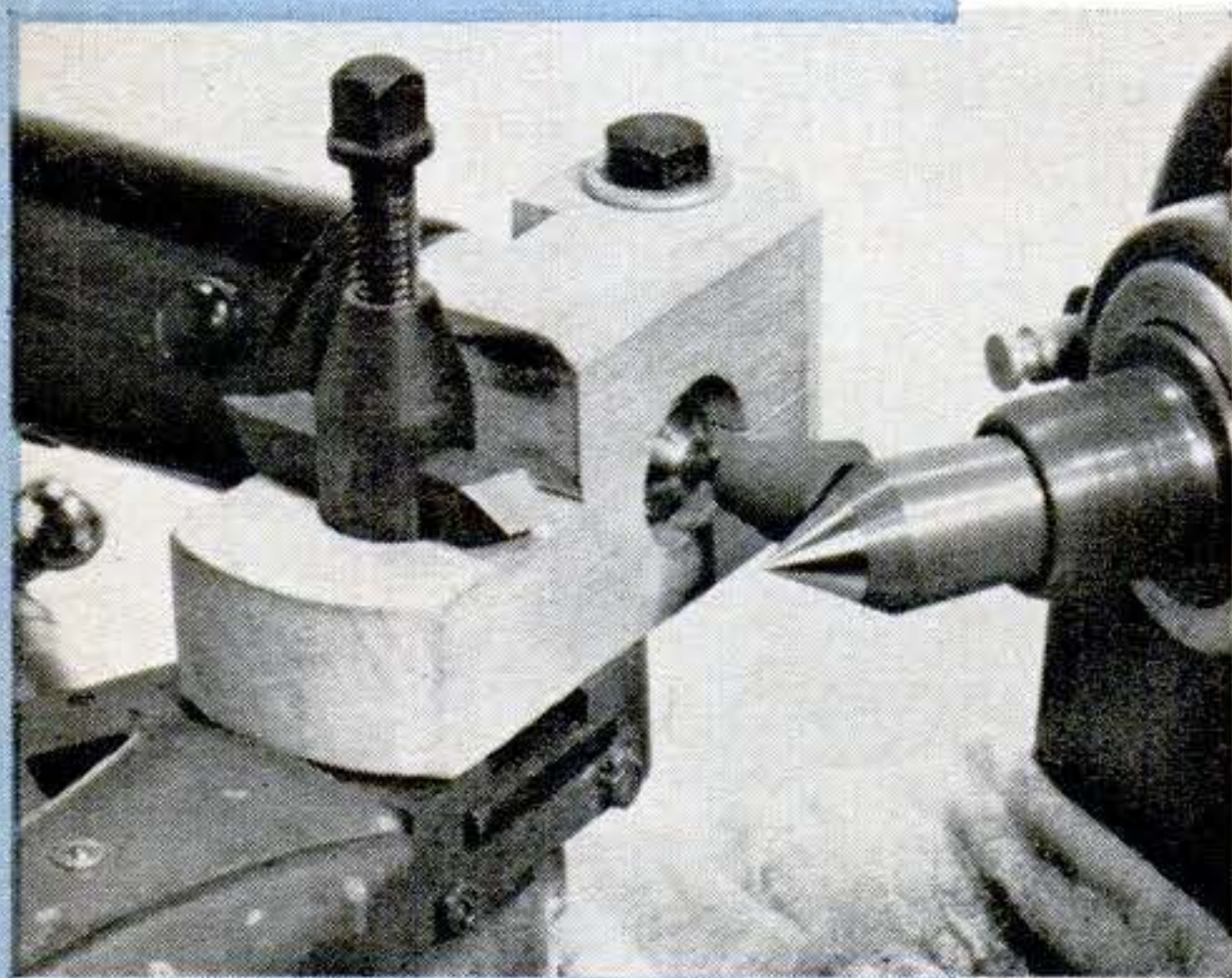
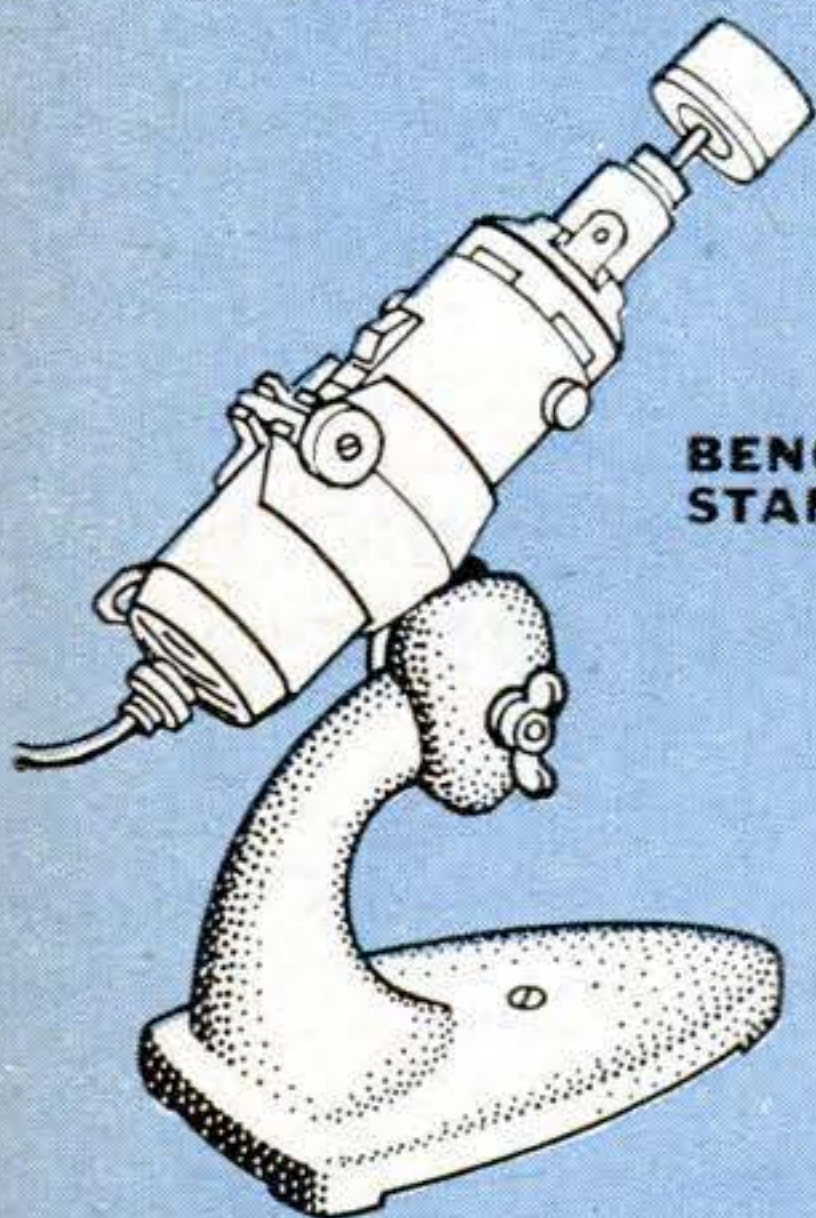
HAND GRINDER

Two types of stands give you a bench tool to boot

DRILL-PRESS STAND



BENCH STAND



It's a fine teammate for other tools, too. Here, it serves as a tool-post grinder for a lathe.

drill press. The other holds it horizontal or tipped at an angle. By clamping the tool in a rigid position and bringing the work to it, you can do many precision shaping jobs that wouldn't be possible freehand.

High speed is the secret of the grinder's fast, smooth operation. Typical speeds run from 17,000 r.p.m. to more than 30,000. Very respectable speeds are available in both low- and high-priced grinders. The more expensive models have more power and are designed for heavy-duty industrial use. But there are also many economical grinders—some for as little as \$20 or less—that offer good speed and durability for home-shop use.

Weight is an important factor, since you want as light a tool as possible for easy handling. Some of the tiniest grinders weigh barely a pound. The heavier models handle bigger jobs, but are also more of a handful on small, delicate jobs.

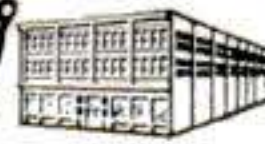
Cutting bits and other grinder accessories come in several shank diameters. The collet sizes listed in the accompanying chart indicate the shank sizes that each tool will take. While you'll find a good selection of bits in any one size, grinders that take several sizes let you use a variety of bits interchangeably.

Quick Facts About HAND GRINDERS

MAKE	MODEL	SPEED, NO LOAD (r.p.m.)	WEIGHT (lb.)	COLLET SIZE (in.)	APPROX. PRICE
DUMORE	3-011	17,000	2.25	1/4, 1/8, or 3/32	\$42
	8-011	18,000	2.25	1/8 or 0-1/8	\$44
	10-011	22,000	3.0	1/8, 1/4, or 0-1/8	\$48
	10-111	22,000	3.0	1/8, 1/4, or 0-1/8	\$58
	35-011	35,000	3.125	1/8	\$85
DREMEL MOTO-TOOL	211	25,000	0.3	1/8, 1/16, or 3/32	\$17
	221	27,000	0.7	1/8, 1/16, or 3/32	\$20
	232	27,000	1.125	1/8, 1/16, or 3/32	\$30
HANDEE (Chicago Wheel)	6000	25,000	0.875	1/8 or 3/32	\$26
	3500	18,000	7.5	1/4	\$56
	3505	18,000	7.5	1/4	\$63
MILLERS FALLS	327	20,000	2.25	1/8 or 1/4	\$55
	325	30,000	2.25	1/8 or 1/4	\$55
	323	20,000	2.75	1/8 or 1/4	\$60
	320	30,000	2.75	1/8 or 1/4	\$60
MONTGOMERY WARD	84C9298	2700	1.125	1/8	\$26
PRECISE	1130	45,000	2.2	3/16 or 1/8	\$105
SEARS CRAFTSMAN	9G2584	24,000	3.3	1/8 or 1/4	\$39

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\$195 Generator, 3000-w, 115-v DC.....	54.75
\$450 Generator, 3000-w, 115-v	139.50
\$80 Transformer, 2000-w, 115/230-v	22.90
\$40 Transformer, 1000-w, 115/230-v	15.61

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● \$90 Selsyns 115-v, 60-c.....Pr.	6.95
● 275 Gov't. 12-v 2000-lb. Winch.....	49.95
● \$80 Self Priming 1 1/2" Pump.....	19.49
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● \$450 Gov't. 12-line C.B. Switchboard..	49.50

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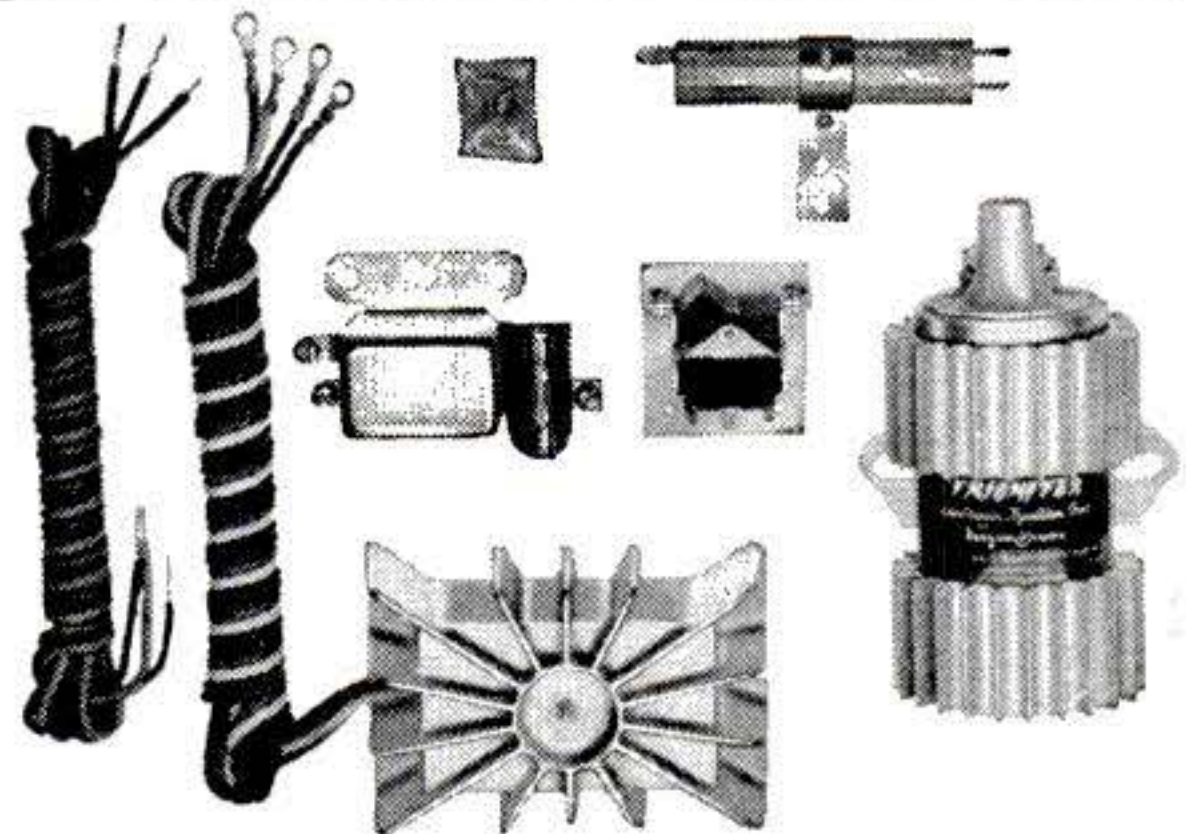
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225-AMP ARC
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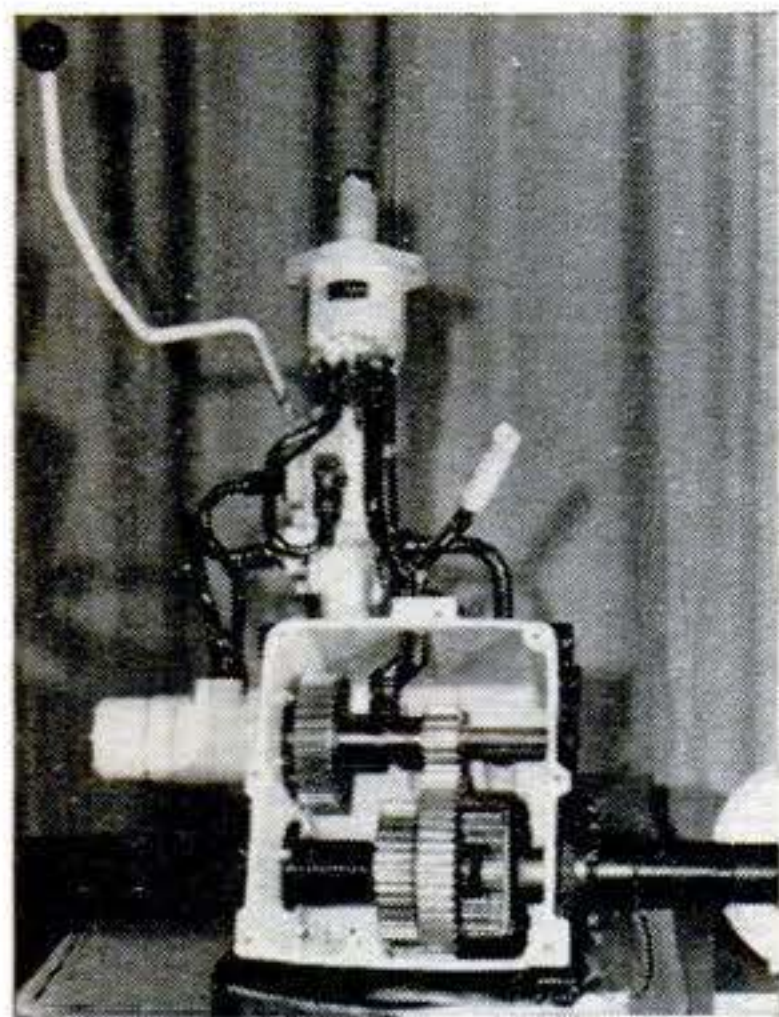
Volume production — over 3500 every month—lets us offer these Lincoln favorites at new, low prices. 180-amp machine, only \$110; 225-amp, only \$125. Larger machine handles 3/16" and fast iron-powder electrodes. Both furnished complete and ready to go. Look to Lincoln for the best in arc welding values.

**LINCOLN
WELDERS**

GARDEN TRACTORS cont.

[Continued from page 36]

so that the rear wheels turn one way when the front ones are turned the other way. Thus, the rear wheels always follow the same track as the front, making the Bolens a very sharp-turning machine that can cuddle up to trees and snake in and around other obstructions without getting hung up.



An example of sophisticated engineering: Colt's complex hydraulic-plus-gearbox drive.

New engine and transmission. Over in a corner is a handsome black tractor that catches your eye because of its unusual color. It's called a Colt, a relative newcomer made in Winneconne, Wis. Its engine is a shiny aluminum nine-hp., four-cycle OHV job by Outboard Marine.

Another Colt feature is an intriguing hydraulic transmission. The engine runs a pump. The pump forces hydraulic fluid through a hydraulic "motor." A valve controls the amount of fluid and thus the speed of the motor. Meanwhile, there's also a mechanical gearbox. Your flow of power is an unbroken curve through each of the steps in the transmission.

What do you pay? You find tractors going for several hundred up to \$1,000 and more. You get what you pay for—and that's not a snide remark, either. You buy the features you need—and you may not need them all. The big 10-horse jobs that cost a grand *are* grand. They'll do real earthmoving jobs or lug cartfuls of boulders up steep grades.

The cheaper, smaller-engined tractors won't bulldoze and they won't plow. But they *will* push a mower or a snow thrower, smartly, effortlessly, and in a way that's pure fun. And that may be just what you want from a tractor anyway. ■ ■

What's New at the



From Wen, a dual-speed sander-polisher.

[Continued from page 31]

Over at Portable Electric, there's another first: a whopping 4" Shopmate belt sander for only \$44.95. Shopmate also has a handy, portable, two-wheel bench grinder for \$24.95 that doesn't have to be bolted down. It stands on rubber feet and you can stick it anywhere.

Prices? One thing you note happily: Tool prices seem to be coming down, while quality and convenience are going up.

Another big trend this year is toward more multispeed tools. Disston, Sears, and Monty Ward all introduced variable-speed drills and/or saber saws within the past year. Now, from Thor, comes a whole new line of dual-speed machines including drills, saber saws, and finishing sanders.

Wen Products has a winner, too—a dual-speed sander-polisher. A powerful ½-horse job, it gives you a choice of 3,400 r.p.m. for sanding or 1,800 r.p.m. for polishing and buffing. Since speed is so critical on these jobs, sanders and polishers are normally separate tools selling for upwards of \$50. The Wen combo, at \$44.95, gives you two tools in one for less than the price of either alone. A slick trick.

Wen is also pioneering an ingenious new soldering pistol that combines the advantages of a quick-heat gun with those of a slim-pointed pencil iron. Like a gun, it uses a transformer for instant heat-up.

Unlike a gun, its tip is not a direct part of the circuit, so it can be shaped to a fine point without disturbing the electrical characteristics. The heating element, made of a special metal that changes its conductivity according to its temperature, acts as an automatic thermostat. If it starts to cool under a high heat drain, its resistance drops, more current flows, and back up it comes to proper temperature. Price is \$4.95.

In-and-out hole maker. Over at another booth a man is drilling holes in concrete like it's butter. The answer is an electric-drill accessory that jabs in and out as it spins—like the big impact hammers used in industry. It's due this spring from Jordan Industries, 3030 N.W. 75th St., Miami, Fla.

Speaking of drill accessories, there are two unusually low-cost drivers, one for screws and one for nuts, from Coastal Abrasive, Long Island City, N.Y. The nut driver goes for \$2, the screwdriver for \$1.20.

The propane-torch makers have something new, too. From Bernzomatic come feather-light aluminum tanks that weigh 40 percent less than steel tanks and are a lot easier to hold. The Turner people have added a neat spark lighter to their burner nozzles. You flip a wheel, the torch fires up, and the lighter retracts out of the way.

One of the biggest show crowds is gathered around one of the smallest items—a tiny wall clip for holding parts jars on a tool board. It's designed so it grips just about any kind of container you have—coffee cans, paint cans,

Edelstaal's new compact multitool gets an editor's on-the-spot trial.



A new concept in soldering: Wen's pistol.

bottles, capped or uncapped jars, etc. A dozen sells for 98 cents from Cassel Craft Co., 67 Vine Hill Rd., West Hartford, Conn.

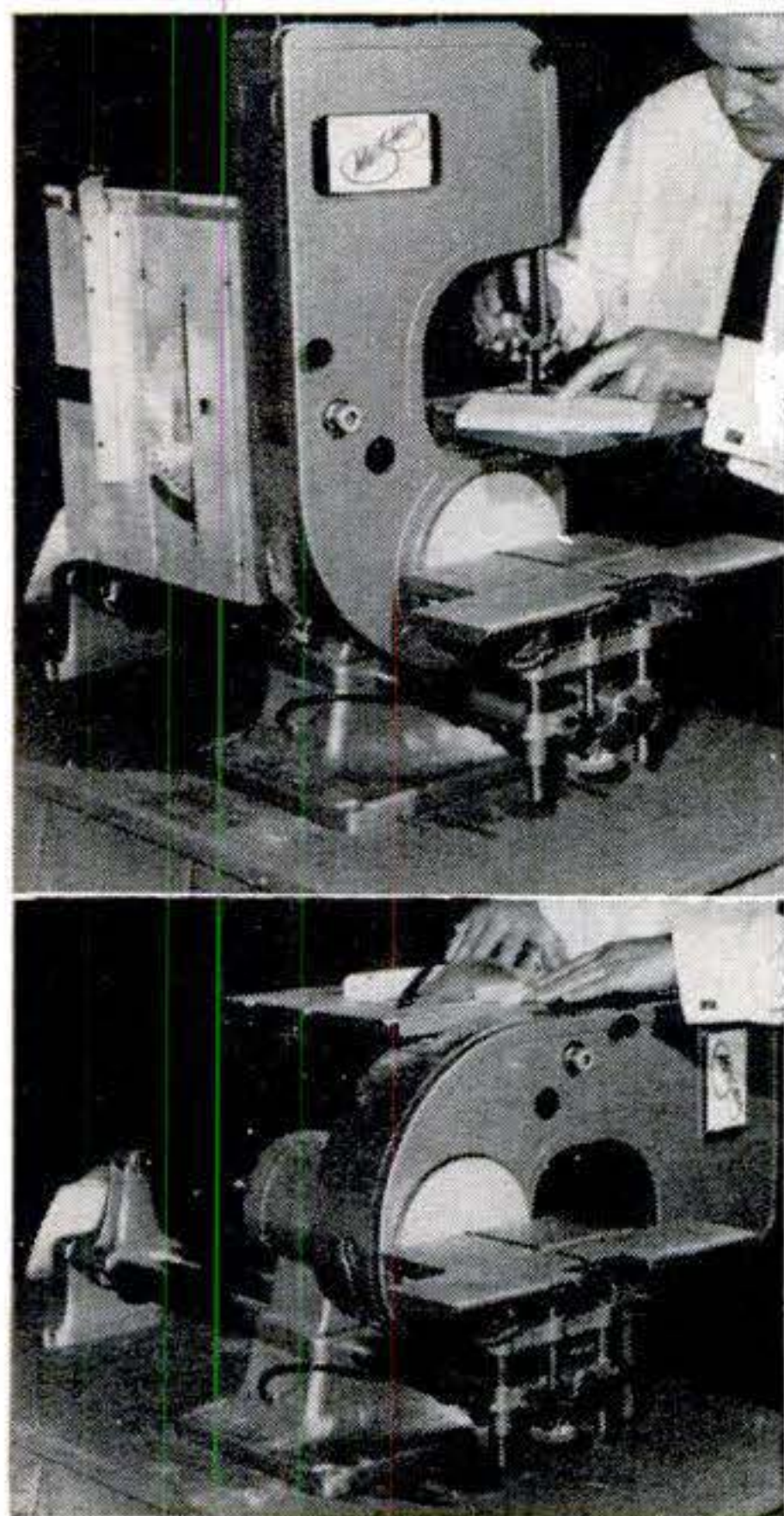
There's also news in big tools. In addition to the new Shopsmith, reported on last month, there's another new multipurpose tool—American Edelstaal's Multi-Matic 8.

For Edelstaal, famous for its Unimat metal lathe, this marks a new venture into woodworking machines. It does a trick flip-flop to change itself from an 8" table saw into a 6" bandsaw. Meanwhile, it's also a jigsaw, saber saw, molder, wood lathe, and disk and belt sander all rolled into one. Smaller than the Shopsmith, it offers multitool versatility in a table-top machine. It will sell for \$299 from American Edelstaal, 350 Broadway, NYC.

There's an unusual weatherstripping door bottom that automatically retracts as the door opens to clear the carpet, then lowers as the door is closed to seal the crack. It's made to match standard vinyl-edged, natural-wood Mortile door strip. Price is \$2.98 from Mortell Co., Kankakee, Ill.

If you're fond of prefinished plywood, but have been wondering how to match it to trim, moldings, doors, and other woods of different types, U.S. Plywood has the answer. It's a brush-on, wipe-off staining system, called Weldwood Color Tones, that lets you mix 144 shades to match any solid wood to any prefinished USP paneling.

Your flashlight may never go dead again—and that goes for portable radios, toys, photo flashguns, and other battery-operated devices, too. The secret: new rechargeable nickel-cad batteries in the three common flashlight sizes—D cell, C cell, and penlight. When they show signs of fatigue, you simply drop them into a plug-in charger and by morning they're as fresh as new. They cost \$5 to \$6 a pair from Gulton Industries, Metuchen, N.J. ■ ■



build a space station to be assembled in orbit. NASA has given study contracts for preliminary designs to Boeing and Douglas, but no funds for construction have been authorized. NASA planners hope they can get money to start on a small space station in 1965, and the Air Force wants one badly. Secretary of the Air Force Eugene M. Zuckert calls it an "absolutely critical" steppingstone to an operational space-defense system.

G. F. von Tiesenhausen, head of the Future Studies Branch of NASA's Launch Operations Center, says we'll ultimately want massive orbiting stations that can check out, fuel, and launch big spaceships on interplanetary missions. One sketch of such a station shows a telescoping "hangar" big enough to enclose a Saturn booster.

Moon base (after 1970—block 8). NASA has given Boeing a study contract to explore the problems of setting up a base camp on the moon, but many experts say we shouldn't build one at all. Construction and logistics are serious problems, and such a base would probably have to be buried underground for shielding from radiation of solar flares. Unless Ranger and Surveyor probes landing on the moon in the next few years turn up new evidence in favor of the moon base, chances are it's out.

Manned expeditions to the planets (after 1975—block 6). A mission to Mars is the first logical trip to another planet, the one most discussed in space circles. But experts disagree on when it will take place, and what kind of power it will require. David M. Hammock, who has directed much of the Mars study work at NASA's Manned Spacecraft Center, thinks we could be ready in 1971, using boosters, life-support equipment, and navigation systems now being designed and built.

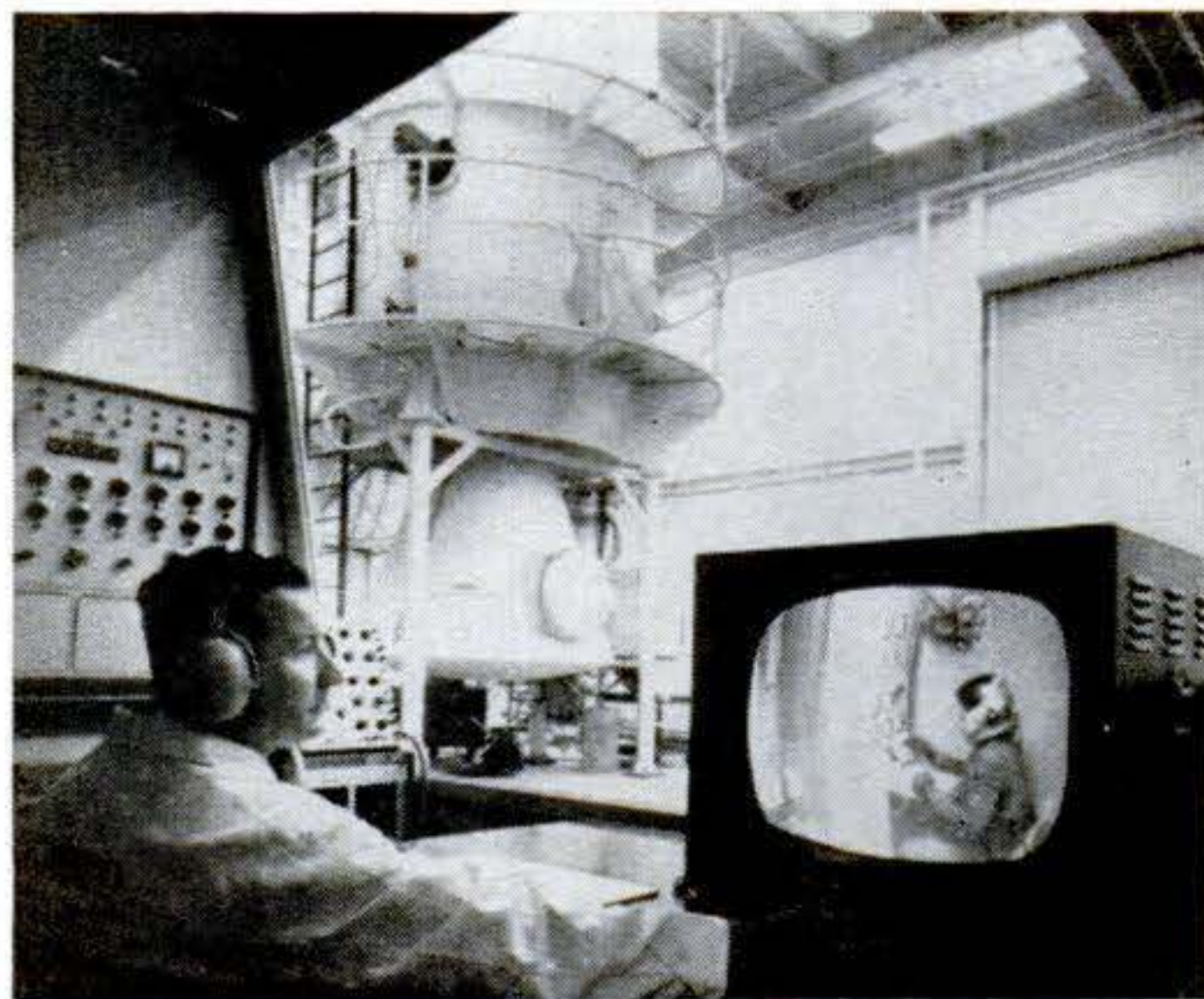
Under his plan, four Saturn rockets would boost various parts of the ship into orbit for assembly. Chemical rockets would send it to Mars. The scheme envisions a 120-day trip to Mars, a 40-day stay, and a 240-day trip home. Hammock says we have the know-how to build the ship now, with one exception: Existing heat shields won't protect crewmen as they reenter the earth's atmosphere at interplanetary speeds. The Manned Spacecraft Center has set aside a quarter of a million dollars for studies.

Other experts are less optimistic. They

say we'll need nuclear rockets or ion rockets for interplanetary travel, and they won't be ready for at least 15 years. They also point to the completely unsolved problem of shielding from radiation during long periods in deep space. According to this view, the first Mars voyage won't take place until the 1980s.

Planetary operations (after 1980—block 9). Beyond the first landings on Mars, the NASA plan is necessarily vague. There is talk of establishing a base on Mars, of expeditions to the satellites of Jupiter and to Mercury. Dandridge M. Cole of GE's Missiles and Space Division is an advocate of exploring Mercury. The dark side of Mercury, he says, may be the coldest place in the solar system, a storehouse of frozen gases useful as propellants for rocket flight. But before such ideas can be investigated seriously, men will have to accumulate many more hours of flight time in space, and more years of experience with space technology. It may also require a major breakthrough in rocket propulsion. Nevertheless, the lure of the planets is real, to officials and scientists as well as in the bemused imagination of the average guy. ■ ■

Looking inside a space station

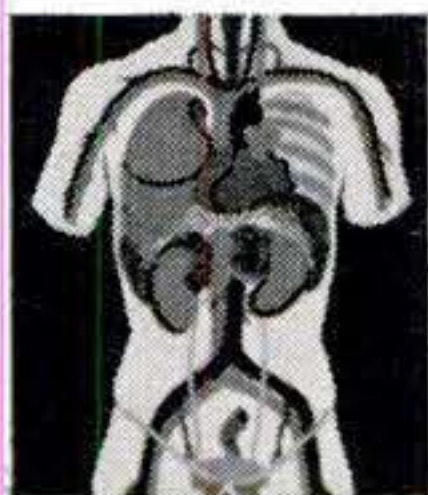
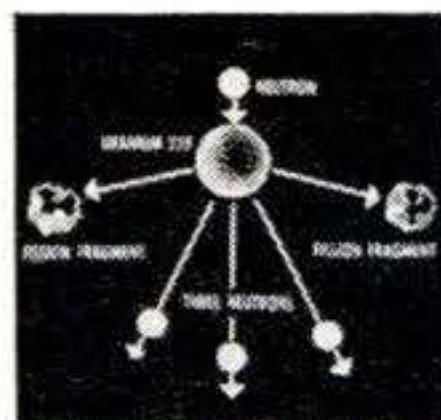


Science kept an eye on what went on during a three-day test run in a sealed simulated space station at the General Dynamics laboratory, San Diego, Calif. A camera for closed-circuit television was directed through an opening in the second-level chamber. Interior action was recorded on the screen of a TV monitor.

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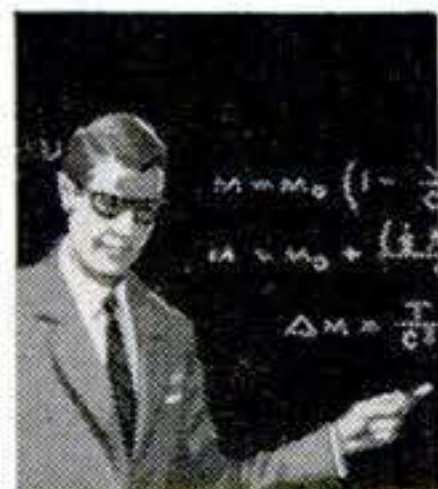
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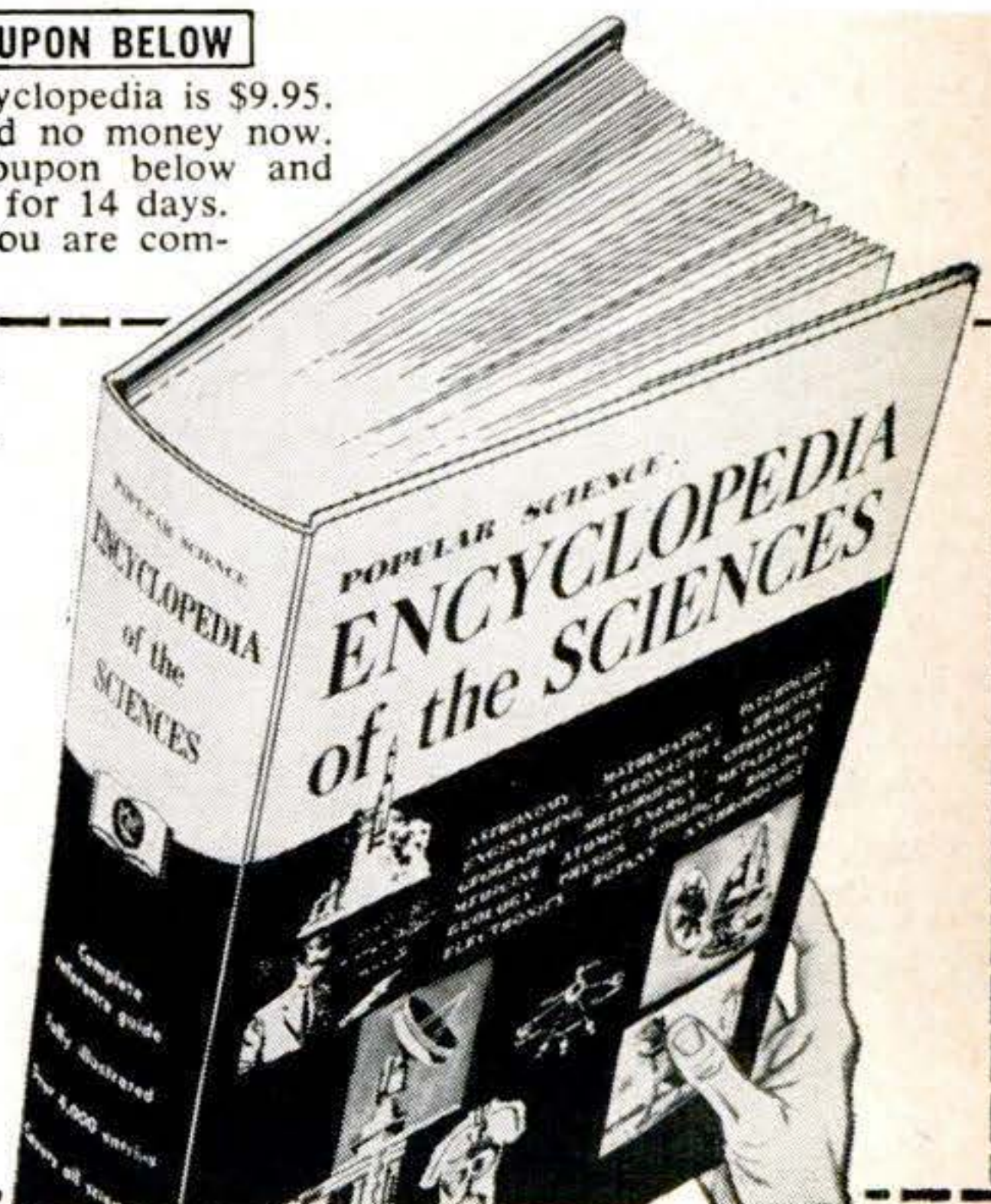
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violently into the road; one of them died.

This time it was the cops who discovered that the steering didn't work. But they suspected the mechanism had been bugged *after* the crash, to provide an alibi for the young driver.

The flexible coupling—the “rag joint” that absorbs road shock—had lost one connecting bolt and had finally broken completely. Moseley feels certain this caused the initial sideswipe. Looking further, he ordered the power-steering pump taken off. From the hydraulic reservoir spilled a thumb screw (which could clog the line). It did not belong anywhere in that mechanism. Might it have been added accidentally when fluid was poured in? Maybe. Maybe not.

And there are other cases, strange sad deaths, tantalizingly unexplained:

- The elderly man who went into a tree. Later his right front brake hose was found cut—slashed so many times it looked like a stick whittled for starting a fire.

- The woman, in frequent trouble with her husband, who ran her convertible into a tree at 2:30 a.m. She was drunk. But a cotter pin that held a lock bushing on a steering-mechanism rod was missing, and had been for some time. The bushing had gradually worked loose until finally the ball joint dropped away from the rod.

- The man who swerved off a bridge and drowned. His family thought it was suicide. But one brake line was disconnected and its spring clamp was missing. You can't remove this kind of clamp with ordinary pliers. You need a special tool, which the man did not have.

- The young man, assigned to investigate thefts at his plant, who lost control while braking on a curve, zigzagged across the road, and rolled over. Uneven braking could cause that. The brake line to his right rear wheel had been hammered shut. The line to the left rear wheel was almost shut. And the hammer marks were fresh.

And suicide

Not all the deliberate accidents are mysterious. Some are so plainly intentional that they have led to manslaughter convictions. Others are clearly suicide. For instance:

- The 20-year-old girl who, enraged by a family quarrel, dashed out of the house

wearing pajamas, slippers, and a summer coat. The temperature was 20 degrees. She drove off the road and 90 feet straight into a tree. There was no sign of braking.

- The 35-year-old woman who made it on her second suicide try. She left the road at 80 m.p.h., crossed a parking area, went through a wood-and-steel fence, and dropped nine feet into a thicket. Years before, her father had killed himself by driving down a mountainside.

- The ex-convict who, after fighting with his girl and threatening suicide, took her and some friends for a ride—very fast, at night, with the headlights off, down a steep winding street, into two telephone poles. He survived, but three of the passengers did not. The judge gave him three years for manslaughter.

The amazing thing about these cases is not merely that they occur, but that they are so numerous. Automotive suicides do get into the newspapers. You know from your own experience that tires blow and brake lines leak, with potentially dangerous consequences. You may even have read of a murder-by-car or two. But this many? By Moseley's estimate, there would be close to a thousand Americans done in every year by malevolently rigged accidents, undetected and unpunished.

Moseley's results offer powerful support for novel theories that he has been expounding to congressmen, safety engineers, reporters, anyone who will listen. He says:

“Fatal accidents are different. They happen to different people, at different times of day, in different places than other accidents. They involve not just one but a combination of factors. Always, more than one thing is wrong—mechanical failure, plus emotional instability, plus a faulty highway, plus incompetent driving.

“The highways,” he points out, “have come to represent a place of death. Many people who are looking for death—consciously or subconsciously, for themselves or for others—seek it on the road.”

Moseley sees no easy cure for the epidemic on wheels that takes 40,000 lives and more every year. But he campaigns stridently for two radical measures:

1. Every fatal auto accident should be studied by a team of experts—engineers, psychologists, pathologists—the way airplane accidents are now investigated by

The Truth About Fatal Car Crashes

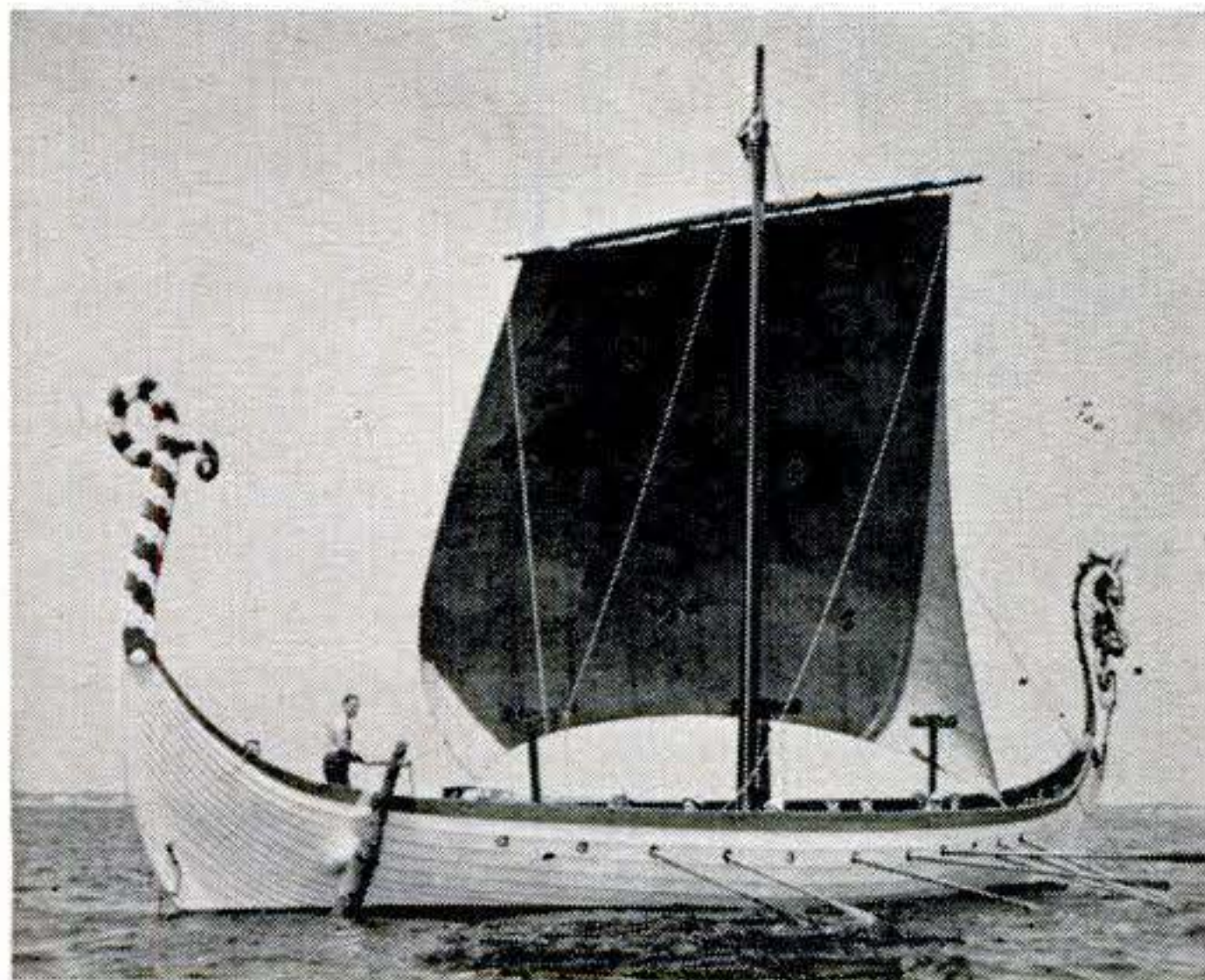
the Civil Aeronautics Board. Only thorough analysis can reveal the true causes and suggest practical remedies. Detailed investigations would also provide badly needed protection for ordinary drivers; all too often they are accused and convicted of negligence or manslaughter when they are actually not to blame.

2. Every driver should be required to practice emergencies, just as pilots practice bailouts and submariners practice escape from a sunken boat. Moseley even has a list of techniques that could be tried in a parking lot:

- Driving with one soft tire—about 10 pounds' air pressure.
- Stopping with the hand brake alone.
- Getting off the road when the ignition is abruptly turned off.
- Changing a tire safely at night.
- Reading signs (many people are killed because they miss detour signs).
- Getting back on the pavement from a soft shoulder.

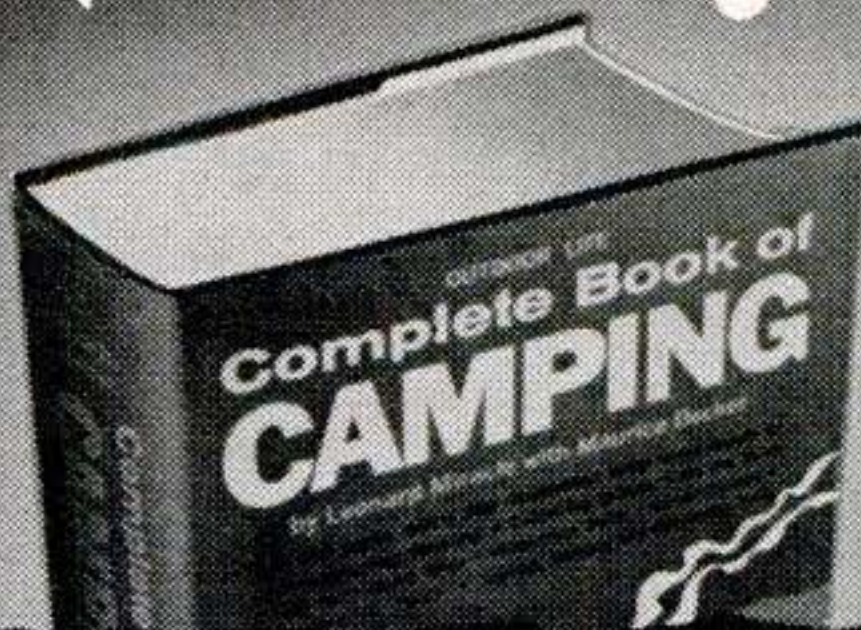
Typically, he throws in an oddball suggestion about emergencies and dogs. You're always told *not* to try to avoid hitting a dog that dashes in front of your car. You might lose control. "No," says Moseley, "dogs are good practice. If you can avoid a dog, you can probably also avoid a child." ■ ■

Viking warship makes comeback



A 65-foot, 12-ton replica of a Viking warship in a museum at Oslo, Norway, the Ormen Hing Lange II (Long Snake) is now at home on Long Island Sound. Built by United Artists for the movie "The Vikings," she was bought by Peter J. T. Nelson of Northport, N.Y., who has formed a Viking Club that mans her, using sail and oar.

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using a cable that is helically overwrapped to provide wire "teeth" all the way along. These mesh with the helm gear like a chain around a sprocket. With a few accessories it can also be used to link in another wheel, making Teleflex the first push-pull system to offer two-station steering.

American Chain & Cable's SteerMaster simply reels a smooth cable in and out on the grooved rim of the helm's ring gear, holding it in the groove with roller bearings. Both of these wraparound units (Teleflex and SteerMaster) are quite compact.

Prices range from about \$75 to \$100 for a standard Ride Guide, SteerMaster, or single-station Teleflex, all in the 16' to 20' boat range. All prices increase with longer cable length, from about \$1.75 a foot up.

Pull-pull cable steering. Two cables slide in sheaths instead of one—as in the Allan-Jervis Safety Glide. Inside the helm unit the cable wraps around a small nylon steering drum and is pinned at the mid-turn to prevent slip. Both cable ends emerge through the same side of the housing and run through parallel sheaths to the transom. There a small sliding block-and-tackle in the tiller unit moves the steering rod.

Force from the wheel is transmitted by pull (tension) only, on one cable or the other, never by push. The reason behind this: Under heavy loads (like twin outboards) more effort is needed to push a cable through a sheath than to pull it.

An interesting side feature of Safety Glide: It comes completely assembled with cable sheaths connected and factory-sealed to both wheel and tiller units. (On most units you do the connecting.) Just mount it. Price with 10' of twin cable, about \$90. Add \$2.50 per foot for extra length.

Hydraulic steering. Once strictly a big-boat luxury, it is now moving into the runabout field. The low friction gives this system a feather touch with almost no lag. And steering ease is unaffected when hydraulic lines must take a zigzag path.

All hydraulic systems permit at least two steering stations, and they can be in locations practically impossible with cable or pulley systems, because hydraulic tubing can be led anywhere on the boat.

Aqua-Trol, for example, has only three moving parts: a pinioned steering shaft, a rack-operated piston in the wheel unit, and a double-acting piston in the tiller cylinder.

The system is filled with ordinary Type A auto-transmission fluid.

Hydraulic-steerer prices start about twice as high as those of push-pull units—about \$140 for Aqua-Trol without wheel or tubing. In runabout sizes, flexible hydraulic hose (about 55 cents a foot from Aqua-Trol) makes installation simple. If you don't do the job yourself, and your boatyard is timid about hydraulics (some are), just trailer the boat to an auto-brake shop.

Hybrids. Some systems give you a choice of single or dual cables. For twin outboards, Ride Guide uses an overlength pinion to move twin racks, then runs a cable and sheath along both sides of the boat. There is a separate tiller rod for each motor. With a tie rod between motors to hold the system in slight tension, the pull-pull circuit swings two motors as easily as one. For the same tension effect, Teleflex simply adds another sheath and leads its toothed cable around the helm gear and back to another tiller unit. Added cost of the extra cable run on a typical 18-footer: about \$30.

When you buy any cable-in-sheath system, get complete measuring instructions from the dealer or manufacturer in advance. Because of factory-attached end fittings, you can't cut the cable to length on the job. And check on whether a steering wheel is included with the steerer. If not, get the shaft dimensions so you can buy one to fit. Typical auto-style boat wheels list from around \$8 up. Finally, be sure to plan your installation so the tiller movement is correct. When the wheel turns to the right the outboard motor tiller should swing left.

You can't use push-pull on some stern-drive units which have their own built-in worm-and-gear steering mechanisms. These are drum-operated and require a conventional wire-rope-and-pulley system. But, as the stern drive's drum remains stationary when the propeller unit kicks up, there's no steering-line overstretch or tension change. So rope-and-pulley problems are eliminated.

To speed this type of installation, Wilcox-Crittenden offers a new "split-drum" steerer. The drum's deep spiral grooving automatically gives the lines a true lay, and built-in clamping prevents slip. With a three-spoke auto-type wheel it lists around \$18. Lines, pulleys, and fittings add \$10 or so, depending on boat size. ■ ■

The Idea That Clicked
 [Continued from page 137]

sidered. Masks—borders around the picture area—are pre-exposed on the film.

There's a notch in the edge of the cartridge, which the camera senses and uses to set its exposure system—automatically—for the correct ASA film speed.

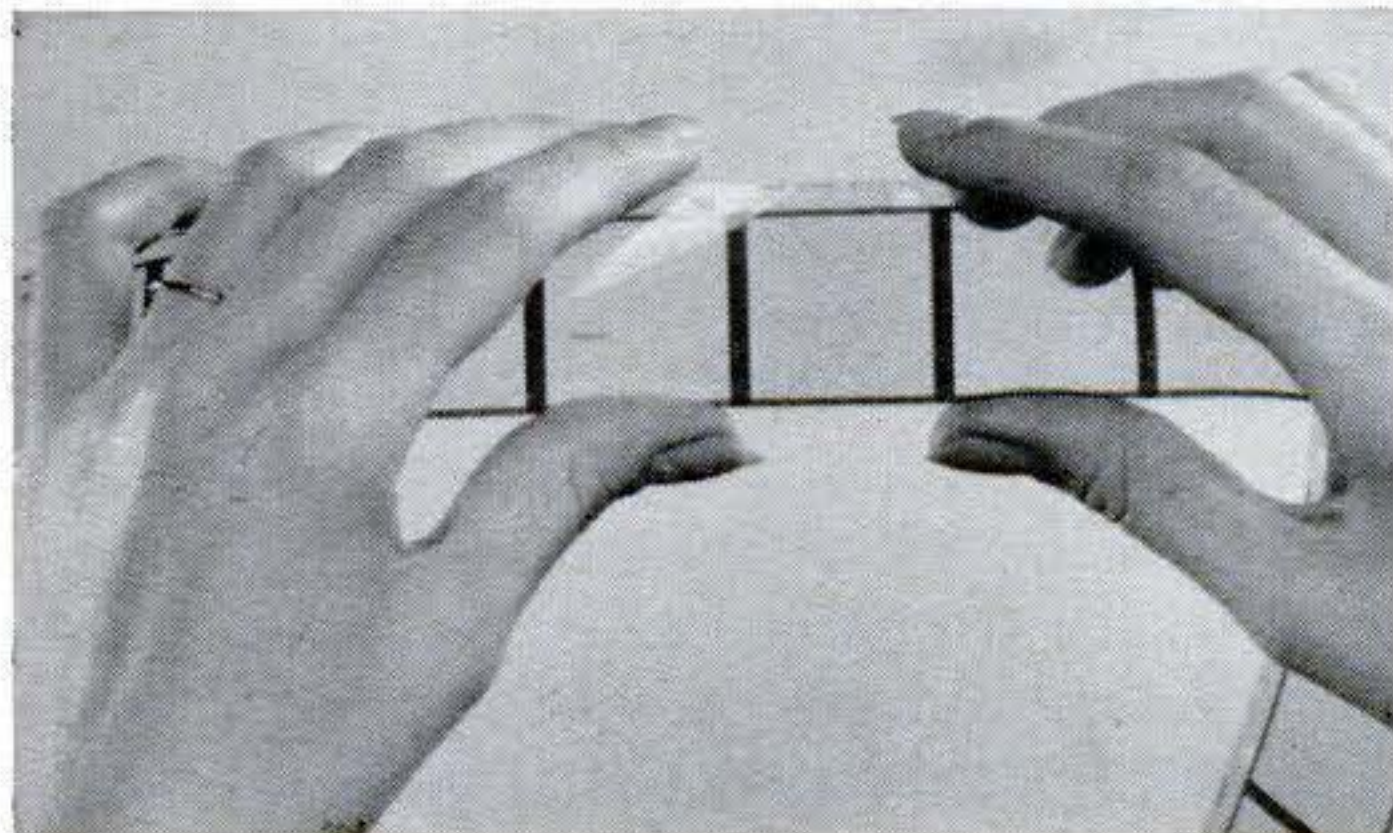
Another notch in the cartridge, designed for photofinishing use, makes automatic sorting of different films possible.

Kodapaks are tough enough to be stepped on without breaking, but they're designed so you can easily snap off the takeup spool, which splits open for processing.

A camera to match. After management accepted the cartridge design, planning got under way, in 1959, for a new series of automatic cameras to accept the Kodapak film cartridge. The result was four models, the 100, 300, 400, and 700 series Instamatics, ranging in price from \$16 to \$110.

The whole project was surrounded with the precautions that might attend the development of a new Air Force gunsight. Employees who worked on the cartridge and camera were pledged to secrecy.

Once design problems were solved, the



The border: All the 126 negative films have pre-exposed borders, which provide ready-made masks during printing. Exposure is made at time film is perforated and packaged.

way was cleared for developing the necessary automatic production equipment at Kodak Park, Eastman's big film factory in Rochester, N. Y.

One machine injects slit film, backing paper, and plastic parts, and turns them out as completely heat-sealed and labeled cartridges of spooled film. The machine cuts the film to precise length, perforates it, pre-exposes the borders, and edge-marks it; then joins it to a backing paper; coils, and tapes it to a takeup spool; and finally inserts it in the cartridge. ■ ■

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other accessories into odd corners, and putting the cooling blower on the end of the crankshaft.

Minor adjustments are easy. Distributor, fuel pump, and carb are right on top. But you have to crawl under the car to get at the valve tappets and starter.

Controls, handling, and personality are distinctly Volkswagen. The all-synchro transmission is a delight. Steering is precise and light, three turns lock-to-lock. Road irregularities are cushioned by hydraulic shock absorbers.

Poor marks for pedals, though. Brake and clutch, on high stalks sprouting through slots in the floor, are okay only if you wear a size 12 shoe or are nostalgic about Model T Fords. You lift your foot and push. Heel-swiveling doesn't work. The clutch is smooth, but you must depress the pedal fully, which slows gear changes.

Taut and reassuring describes the ride. There's a solid big-car feel, and hefty wheels on independent torsion bars iron out the meanest potholes. On jiggly roads there's a tendency to pitch.

Stability. It's fine on corners. Roll is negligible, and the oversteer you'd expect from a rear engine and swing axles just doesn't happen at normal speeds. In fact, the big Volks understeers slightly—up to a point.

Push it too hard around a corner (the uncomplaining tires utter no warning) and the bowlegged rear wheels change their mind. Tail-end breakaway comes fast, though a quick twitch of the wheel puts you back in business. And don't think the beast is happy in strong crosswinds just because it's wagging its tail.

While the slow-revving engine has more pep than you'd think, you still have to use the gearbox plenty. Acceleration up through third is brisk, and that's the gear you stay in around town.

Top is overdrive, and will take you up to a relaxed 80 m.p.h.—but not in a hurry. Brakes are reliable and fade-free, although pedal pressure rises sharply with speed.

Excellent marks for driver vision and for the snug bucket seats with adjustable backrests. The heater is a big improvement; a heat exchanger in the exhaust system warms the air further after it's blown past the engine, and does it promptly after start-up.

Warmth is piped to front and rear floor-

level vents and to windshield defrosting slots, but at low engine speeds it's barely enough. You get fresh-air ventilation, too. Three dashboard levers regulate the flow.

The gimmicks. Those elves in the Black Forest worked overtime producing cunning gimmicks for the 1500. The turn-indicator arm on the steering column does three additional jobs. When the ignition is off it works the left or right low-wattage parking light. A fingertip switch on its end flashes the headlights for signaling: high beam during the day, low beam at dusk when main parking lights are on. With headlights on, this doubles as a dimmer.

Among other electrical playthings are interlocked pushbuttons for parking and headlights that sequence selection correctly; a three-position interior light that can be turned off or on independently of the door courtesy switches; a rheostat controlling wiper speed (slow to very slow); and an engine-compartment light.

In the mixed-blessing department is the nonrepeat ignition-starter switch that prevents stripped starter gears. This requires twisting the key back to break the ignition circuit and stop the engine before re-engaging the starter. But the engine isn't so quiet that you can't tell it's running.

Further refinements. You'll also find an antitheft steering-wheel lock combined with the ignition switch (required by German law), folding central armrest in back, ashtray with a spring-loaded flap that protects the dash from misaimed butts, and an electric clock and external mirror—all as standard equipment. Pressurized windshield washer, front-passenger grab handle, and beep-beep horn are carried over from the 1200.

A novel safety feature is the trigger mechanism next to the door hinges that locks the bucket-seat tilting backrests when the doors are closed, keeping them rigid to contain rear passengers under heavy braking. Fully recessed interior door handles and locks, and soft-plastic coat hooks and window cranks are more safety details.

Latest news is that a new 1500S model has been introduced, with 13 extra horsepower and a number of deluxe features.

But in either form, the VW 1500 is a tidy package, beautifully finished and fun to drive, and should be as reliable if not as long-lived as its aging *bruder*. ■ ■

Now Anyone Can Steam-Bend Wood

[Continued from page 112]

panying photos is a good test project for the foil technique. If you have no use for a packboard, you could try a chair back or perhaps a boat seat.

Select straight-grained wood, free of knots or checks. Cut the five strips to size, round off all corners and edges, and sand the wood smooth before steaming.

In making the two-part jig for the uprights, note that the reverse curve is exaggerated to allow for springback as the oak dries.

Unroll heavy foil until it projects 6" beyond the ends of your five oak strips, the two uprights, and three crosspieces. Put a piece of hardboard about 3' long and 3" wide under the strips, centered lengthwise on the foil. Place matchsticks between the oak strips to allow steam circulation.

Bring the edges of the strip of foil up around the wood until they meet. Crimp the edges together in a double fold. Also crimp the envelope together at one end and bend up the excess foil so the seam will be above the water level when water is poured in the opposite end.

A pint of water will do for a start. Turn on the hotplate and fold the open end of the package nearly shut to contain the steam. From now on, wear gloves. Add small amounts of hot water as the water boils away. Steaming time varies with different woods, but you need about a half-hour for each inch of thickness. This package should take about a half-hour after the water boils.

At the end of that time, remove the three crosspieces from the bath, using gloves and pliers. Center them on the jig and drive nails through predrilled holes in one end block to hold the strips in place. Using a clamp, slowly pull the sections down to the curve of the jig. Drive nails through the second end block to hold the strips as shown in an accompanying photo.

Prepare for bending the first upright by nailing the large piece of the two-part jig to the workbench. Remove a strip from the steamer, bolt the backstrap in place, and bend as shown. Bend the second strip with the same jig after transferring the first to a panel of scrap wood for drying.

When the parts are dry and assembled with 1" copper rivets or brass machine screws and washers, apply a finish of boiled linseed oil, spar varnish, or paint. ■ ■

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as a standard of length, replacing the platinum meter bar. Trouble is, you can only precisely measure about 10 inches at a time with the krypton standard.

With the coherent laser beam, scientists say there is no reason why we couldn't measure 100 miles or more with tremendous precision. Already, laser distance measurements have been made over hundreds of feet to accuracies within a few millionths of an inch.

The laser's commercial success will rest on more prosaic tasks. Undoubtedly, one of its big jobs will be in communications. Since lasers operate on frequencies thousands of times higher than radio signals, they can carry many times as much information. One laser beam could carry thousands of simultaneous television signals.

Big problem, though, is modulation: attaching the information to the beam. One method demonstrated recently was passing the beam through a crystal of potassium dihydrogen phosphate—KDP, to friends. This substance changes its optical properties in an electrical field. Put an amplified signal across the crystal and it modulates the beam.

The injection laser. A more direct method may come out of a third basic type of laser—the transistorlike injection laser. Dr. Stuart A. Collins of Sperry showed me one recently. I knew it was supposed to be small, but not *how* small. I needed a magnifying glass to see it. The laser itself is a chunk of gallium arsenide smaller than a pinhead. Two sides are mirror-bright. When a direct current is applied, a beam of coherent infrared energy shoots from the mirrored surfaces.

The important thing is that the output varies in proportion to the DC input, so it's easy to modulate. At IBM recently, I saw researchers transmit speech and music across the room on the invisible beam from an injection laser. The signal-transmitting ability of the injection laser will be tested in space soon—probably in 1965.

Goal: perfection. One feature of injection lasers excites scientists: Where most lasers are inefficient—they transform only one percent or less of the pumping energy into coherent light output—the injection laser is highly efficient. Scientists see no reason they couldn't eventually approach 100-percent efficiency. The injection laser could

replace light bulbs, producing more light for less money.

While the laser is just beginning to come out of the laboratory and go to work, speculation over its ultimate uses runs wild. One observer suggested a laser tree pruner. Aim the beam at a high branch, pull the trigger, and down comes the limb. Another suggested that backfires for fighting forest fires could be set from a plane. While both may be possible, present lasers aren't powerful enough. And if they were, they'd cost more than most tree surgeons and forest-fire fighters could afford.

Missile killer? Most far-out idea to date: the radiation weapon. Everyone agrees it would be dandy to shoot down approaching missiles with a laser beam. Trouble is, even the biggest lasers don't approach the necessary power levels. The most powerful lasers announced to date generate about 1,000 joules—a joule is one watt for one second. Such units can set fire to wood, paper, and other inflammable substances at a mile or two. This is spectacular, but still fantastically short of the power required to knock down missiles.

Scientists estimate that this task would take upwards of 10 billion joules. Capacitors to store that much energy would be as big as office buildings. And nobody knows how to get rid of the heat. Any such giant laser would probably vaporize itself before it could damage a missile.

Although these problems are formidable, no one knows for sure that such a weapon is impossible. And since there's no other very promising missile killer on the horizon, military planners continue to pour money into superpower-laser research.

Ultimately, even missile destroyers may look pale beside tomorrow's laser developments. Chances are its most earth-shaking uses have not yet been dreamed of. Three years after the birth of the vacuum tube, this revolutionary device was generally considered as just another—and not very satisfactory—detector of wireless telegraphy signals. The circuits that were to launch the electronic age had not yet been conceived.

Said Sperry's Warren Macek, "A lot has happened with lasers in three years. But if we could see today the things that will be coming out five years from now, we wouldn't even be able to tell what they're for." ■ ■

20,000,000 Bucks in the Suggestion Box
 [Continued from page 70]

Where do you get ideas? Fraser's boss, the Illinois Central, offers this clue: "Question the rightness of everything." Why are things done this way? Why does it take so long? How good are the tools? Can a certain step be eliminated?

Eli Lilly & Co. is one of America's big pharmaceutical houses. Recently it was having trouble, in one manufacturing process, with a carbon slurry filter of a type long used. One employee, Jim Hodson, suggested: "Just eliminate it." His idea was tried, and it was found that in the present process the filter was actually no longer needed. Hodson got \$1,276.

Can a design be improved? Or can different—and cheaper—materials be used without impairing usefulness or quality? Anton Forster is a dispatcher at the Fisher Body plant in Cleveland. It occurred to him one day that packing-cartons, braced with the usual two-by-four lumber studs, were heavy, expensive and cumbersome. "Let's try rolled cardboard tubes," he suggested.

Fisher Body gave the idea a try. The new tubes were strong, lighter, and so much cheaper and quicker to install that Forster was paid \$2,500.

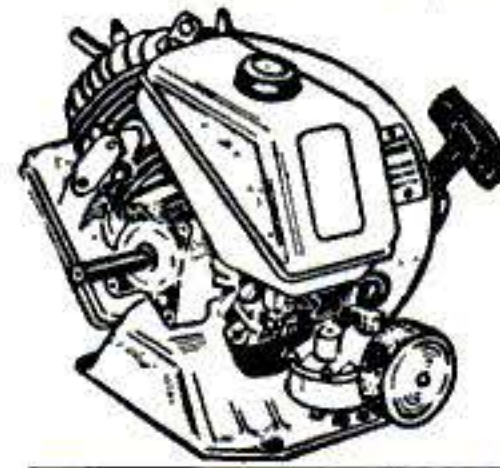
Other ideas grow out of sheer frustration. A Navy mechanic, assigned to repair truck tires, got tired of waiting for someone to come along and help him lift the heavy wheels back on the axles. He doped out a small wheel jack that would do the job for him—and got \$177.

But leave it to the ladies to come up with sheer feminine ingenuity. A female operator for Thompson Products noticed recently that a power belt that drove her machine was fraying at the edges. This so upset her sense of tidiness that she applied an old female fix-all: She dabbed the frayed edge with nail polish. Then someone persuaded her to drop the idea in the suggestion box.

When the suggestion committee got it, it seemed like a crazy idea, but luckily someone took it seriously enough to give it a try. Today, the power belts in Thompson plants are lacquered at the edges. Now they not only look tidy but last much longer—so much longer, in fact, that Thompson figured its savings at \$43,000 a year and sent its neat lady operator a thumping \$6,000.

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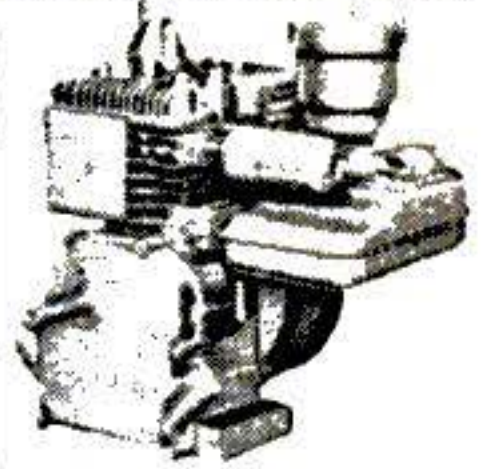
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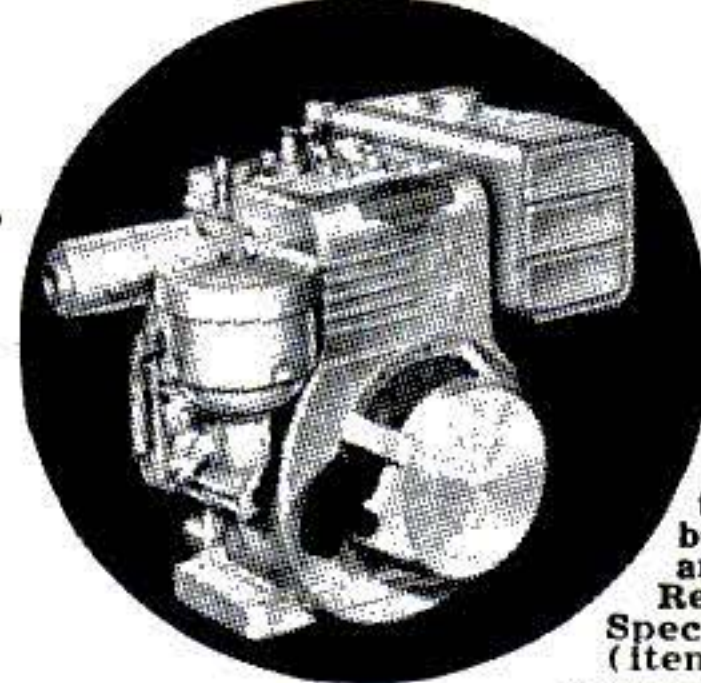
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Are Drag Racers Really Crazy?

[Continued from page 75]

an internal-combustion piston engine can compete, and win. Even pickups and station wagons drag.

In the several years since drag racing was taken off the streets, it has become one of the nation's fastest-growing sports.

The leading sanctioning body, the National Hot Rod Association, headquartered in Los Angeles, estimates that between 400,000 and 500,000 persons are involved in dragging. At local meets competitors and crews sometimes outnumber the spectators. Yet the spectator count for this year will run to 3,700,000. (Each of baseball's big leagues draws about 10,000,000.)

At this year's Nationals, 1,000 cars were entered, shepherded by 6,000 owners, drivers, and mechanics.

Reduced to simplicity, dragging is racing an electric timer. Two cars of the same class compete in elimination runs.

A "Christmas tree" of electric lights, connected by cable with three timing traps at the finish line, starts a race. The tree has 14 bulbs, 7 facing each lane, positioned vertically. The five top bulbs are yellow. The next is green, to start. The lowest is red to indicate that a driver has jumped the gun. If he does, he has no argument—an electric eye has told on him.

The light cycle, top to bottom, requires only 2½ seconds. The start for each lane can be off-timed by the control tower to provide for handicapping.

At the finish line an electric eye records the time of a run to hundredths of a second. Two other eyes record the speed for one-tenth, or 132 feet, of the quarter-mile distance. The first eye is 66 feet in front of the finish line, the second 66 feet beyond it.

A driver can record the highest speed and still lose a race; he can be faster through that last 132 feet, but have taken more time for the quarter-mile.

The action is fast. At the Nationals they run off three races a minute. The really sizzling performers, the dragsters, or "rails," consist of little more than frame, engine, drive train, and cockpit.

The commonest vehicle in dragging—seven out of every ten competing—is a stock car or "stocker." A lot of doctoring goes into them. Suspensions are beefed. Cylinders are overbored. Carburetors can have any size jet. There is no prohibition on factory-supplied camshafts or trans-

mission ratios, and heavy-duty clutches are common. Any axle ratio is permitted. Piston displacement is limited, though. The maximum permitted is 427.2 cubic inches.

Super Stocks are the top class in the stock-car division. Usually current models, they have a bigger horsepower-to-weight ratio than the other stockers. Their equipment is restricted to options available to the public. A few Super Stocks are tended and driven by factory teams. Most are individually owned but sponsored by car dealers.

Dodge swept the Super Stocks at the Nationals this year, with automatic transmissions outrunning the stick shifts.

Dragging encompasses four other "sections," or types of cars, and one subsection: a "street" section, a "moderate competition" section, a "competition" section, and stock sports cars, plus a variety known as "factory experimental."

Within these sections are 70 different classes. Among the cars at the Nationals were a 1949 Anglia and two 1923 Model Ts. One Model T and the Anglia were powered by Chevy engines, the other T by an Olds.

Some cars are polished like mirrors. A top rail will sport chrome plumbing; its crew will cap exhaust pipes against dust when their car is not in action. Other cars look fresh from a junkyard. The dressiest cars are awarded prizes.

Back-yard assembly. Many classes, where rules permit, sit high off front wheels to permit pitch on weight transfer when the accelerator goes down. Most of these cars are assembled in back yards. Their owners reshape their cams, push their compression ratios almost to the point where gasoline will ignite without a plug, drill out carburetor jets, experiment with axle ratios, and try out combinations of gears. Every excess ounce of weight is razored out.

Mechanics rough the mating surfaces of cylinder blocks and heads so that gaskets won't blow. They fiddle with timing until the racket from exhausts is pure Mendelssohn. They tinker right up to the eleventh hour. It's almost a rule that the components of a rear axle will be spread out on newspapers 30 minutes before a race.

Many cars are so highly tuned that their engines quit if they drop below 1,000 r.p.m. Drivers wipe any trace of dirt off their "slicks," treadless, soft-compound tires

Are Drag Racers Really Crazy?

on driving wheels that give maximum bite.

Fresh off a showroom floor, the huskiest of today's non-sports stock cars, without supercharger, will take at least 15 seconds to travel a quarter-mile and will be going about 95 m.p.h. By contrast, at the 1963 Nationals a '63 Chevrolet factory experimental—carrying optional equipment provided by the manufacturer but not necessarily available on the assembly line—clocked the quarter-mile in 12.7 seconds and reached 118.1 m.p.h.

A street-section '51 Anglia—certainly powered by something besides an Anglia engine—did the quarter-mile in 11.03 at 127.9 m.p.h. A street roadster with a '63 Dodge engine ran the distance in 12.17 at 121.1 m.p.h. A Chevy, supercharged, was timed at 10.45 and 138.4.

These cars won their class competition, but, then, so did a stock '57 Chevy at 14.48 seconds and 87.7 m.p.h., a stock '54 Hudson at 16.46 and 82.1, and a '58 German Opel at 18.03 and 77.

The fastest car, the "Top Eliminator," proved to be a Chrysler-powered rail owned by Ken Hirata and Phil Hobbs of Kokomo, Ind., and driven by Bob Vodnik. It streaked the quarter-mile in 8.62 seconds and was going 174.7 m.p.h. The all-time record for rails is 190.26 m.p.h.

Having no radiators, rails get hot. They have to cool off an hour between runs.

Tricks of the trade. Drivers try to rattle their opponents. Some over-rev their engines on the starting line and then feather their throttles on takeoff, hoping that the other fellow will overspin his wheels and lose a precious fraction of a second—or jump the starting signal and be disqualified. Some make slow practice runs and then, with a change of carburetor jets, spark advance, and axle ratio, flash down the strip in actual competition.

Another example of strategy: At the '63 Nationals everybody expected shrewd veteran Don Garlits—holder of that 190.26-m.p.h. record—to walk off with the big Top-Eliminator honors. Instead, he jumped the gun, was disqualified. Suspecting that Vodnik's rail was a mite faster, he had gambled on outguessing the starting light and gaining the needed split-second advantage.

The appeal of dragging is widespread among all sorts of people—including the female. Here were some of the entries at the Nationals:

Mrs. Elsie Ayres, Wayne, N.J., housewife and grandmother; Sam Parriott, city councilman, Commerce, Calif.; John E. Crews, doctor, Maitland, Fla. (his car was The Mad Medic); Bob Hall, Air Force flight-test engineer, Fairborn, Ohio; Wayne Kleb, dairy farmer, Spring, Tex.; Dick Griffin, commercial pilot, Lansing, Mich.; Ted Harbit, teacher, Frankton, Ind.

Twenty-three of the entrants were beyond the age where life begins—40. Mr. Parriott, 66, drove his car 148.5 m.p.h.

What about safety? Despite the speed, in a million and a half miles of organized dragging in 1962, only two deaths occurred. Strict supervision makes accidents rare. But cars do spin out and engines do explode.

Lending to the safety record is NHRA's insistence on car inspection and such safety devices as helmets, seat belts, and, in some classes, shoulder harnesses and flameproof suits.

Local NHRA groups discipline members found guilty of a "moving violation" of city or state laws. A pair of speeding tickets can bring temporary loss of driving permit, a punishment—for a drag racer—akin to the rack.

Drag racers do it mostly for glory and excitement, but there are prizes. The sweetest, naturally, is an automobile engine, donated by a Detroit manufacturer. Sears, Roebuck gave \$100 tool kits to all class winners at the Nationals. Other prizes commonly include piston rings, TV sets, tachometers, and the like.

Top rail drivers like record holder Don Garlits do get paid—as much as \$1,000 an appearance.

Detroit contributes more than engines. Ford and Chrysler offer advice (and equipment, for a price) to anyone with a yen to zip down a strip. This year Ford built a control tower for the Nationals.

General Motors' policy is to neither participate in nor encourage racing of any sort—even though Chevrolet engines are in a lot of hot performers on the drag strips.

Wally Parks, former editor of *Hot Rod*, is NHRA president. Ed Eaton, one-time proprietor of a "speed shop," one of the proliferating nuts-and-bolts emporiums catering to rodders, is national-events director.

The "Eliminators." The most coveted titles at country-wide meets are those of Top Eliminator, Competition Eliminator,

Are Drag Racers Really Crazy?

Middle Eliminator, Little Eliminator, Junior Eliminator, and Top Stock Eliminator.

The Top Eliminator is always an "AA" dragster—scaling 2 to 2.99 pounds of car to each cubic inch of displacement if un-supercharged, and 2.5 to 3.99 pounds if supercharged. The AA car with the quickest time is a finalist. His opponent is selected by progressive elimination among the eight quickest runners-up in races that have been run during the meet.

The Top Stock Eliminator is the survivor among 50 of the quickest stockers at the meet.

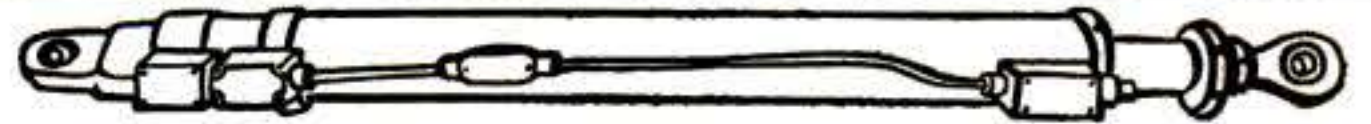
To capture one of the remaining four eliminator trophies, a car must have been the victor in its class. NHRA statisticians compile a list of national elapsed-time records, excluding those for the AA and stock sections.

They divide these records into four equal groups, such as 9.6 seconds to 11.5, then 11.6 to 13.8, and so on. On their records at the meet, the dozens of class winners automatically fall into one of the four time catchalls. The kind, type, or power of the cars count for nothing—only their times are considered. ■ ■

A drag-racing glossary

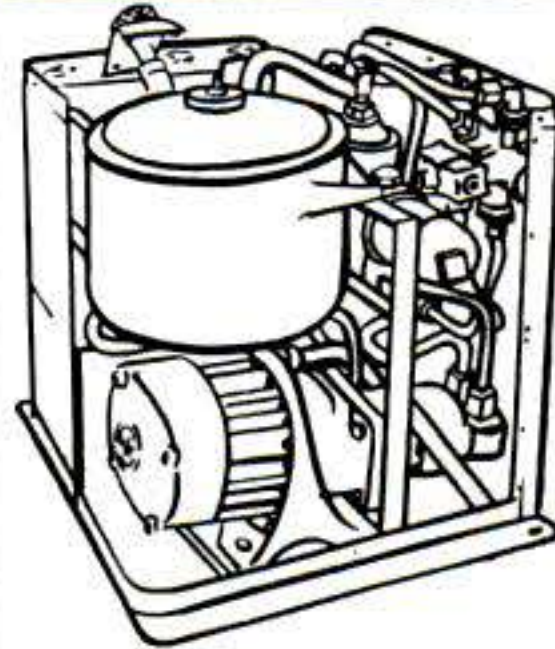
- Drop the hammer.....Full throttle
- Put your foot in it.....Full throttle
- Puffer, blower, windmill.....Supercharger
- Ratchet jawConstant talker
- Bench racingAfter-race chatter
- TypewriterPushbutton transmission
- TachTachometer
- BoxTransmission
- Juice, punchFuel mixture
- GasserHot rod using gas for fuel
- FuelerCar using exotic fuel
- SlicksTreadless tires
- LunchBlow up, as an engine
- Tube steakHot-dog sandwich
- CogAxle ratio
- SkinsTires
- Wind upGet maximum r.p.m.
- Top endHigh engine speed
- Feather footSlow driver
- FinkCheater
- In the chuteStaging area
- SpookTo unnerve a competitor
- StrokerEngine with increased stroke
- LightsMechanism for timing
- HonkTo beat another car
- Run for tinRace for trophies

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History's Most Dramatic Mine Rescue

[Continued from page 48]

The plan was to hit the men's refuge again, ream open the hole to shoulder width and then haul the pair up. Agonizingly, there were parts failures—an hour lost here, two hours there—as the drill whirred downward at 30 feet an hour. Weary rescuers grabbed cups of coffee from a Salvation Army lassie, and went back to work. Shifts lasted about 30 hours. Then the men curled up near a bonfire in the 40-degree night air, slept three or four hours.

Tuesday, August 20. Fellin—who, with 44 years in the pits, had taken charge below—screamed a warning. The roof of their tiny cavern was cracking. The drilling threatened to drop tons of rock on top of the prisoners. Disappointed, the drillers dragged their drill from the 193-foot level and began surveying for another site that would drop the drill on the outer perimeter of the hole—this was a feat comparable to a ball player trying to hit Sandy Koufax's fast ball precisely on one particular piece of seam.

Meanwhile, a special camera was being lowered down the hole towards Bova's presumed position. Eighty feet down, it jammed in the bore and had to be hauled up. The microphone dropped down and was pulled up. It came up wet; there was water in his hole, possibly a freezing three or four inches. Another hole—a four-incher this time for faster drilling—was started towards Bova.

Thursday, August 22. The big drill, poking downward some 300 feet towards Fellin and Throne in a second try, began ominously spewing up gray-white, hard-rock powder instead of black coal dust. The men's spirits both above and below drooped noticeably. Some cried openly. The bore had obviously missed the pocket. Drill holes don't go straight down; they "drift"—bend and slant—with the alternating hardness of the soil layers. The grimy, weary rescuers knew this 12-inch hole was near Fellin and Throne; the pair could hear it burring down. But in which direction? And how far away? If the second hole was close, perhaps the trapped two could dig through to it.

A compass was lowered to the imprisoned men. They circled their tiny tomb trying to see if the steel drill deflected the needle to give them a clue in which direction to hack. No luck. The drill was pulled up. Amid complete silence, all rescue engines

hushed, volunteer Atomic Energy Commission workers flown in from New York took a ½-by-1-inch piece of 120-curie cobalt 60 from its 1,200-pound lead container and lowered it down the 12-inch hole. Fellin and Throne were then dropped a Geiger counter, and again there was an attempt to try to find the respective headings of the two holes. Again, the results were nil.

For perhaps the only time during the long rescue effort, Fellin appeared to panic. "Drill the escape hatch right down the six-inch communications hole," he pleaded.

Dr. Charmbury turned this all-or-nothing plea down. "If the small hole is blocked, or caves in, the men are lost. While we have it, we can keep them alive," he insisted.

At six p.m., the mammoth drill lumbered four feet east and eight feet north of the unsuccessful hole, and began another weary 19 hours of drilling. Meanwhile, the 4-inch diamond-tipped drill continued a slow, breakdown-studded path toward Bova's presumed refuge.

Below, Fellin began joking with Throne and with rescuers on the surface in an obvious effort to keep spirits from flagging. "Massa's in the Cold, Cold Ground," they sang. When asked about the brandy they had received, Fellin laughed, said they "had put it in storage." Cigars lowered to them were chewed; lighting a match was still an explosion hazard. Waiting for the drill to break through was like the last day of a 20-year jail sentence, the two reported over the loudspeaker system.

Friday, August 23. The tired drillers had vowed to drop this third hole "right on the peaks of your hats." At 3:47 p.m., the crew miraculously did just that. For two hours previously, the drill had tapped down, a half-inch at a time, while Fellin and Throne crouched, terrified, dust masks over their faces, blankets wrapped around them to ward off the dirt sure to pour in as the drill broke through. Getting through without causing a landslide was like getting the yolk out of an egg without breaking the shell. Operator Mike Rank's hand on the throttle was as delicate as a surgeon's manipulating a scalpel.

At the surface a knot of mine men lying on the ground at the communications hole, listened to Fellin's directions and wigwagged hand signals to Rank in the cab above them. Air was forced down the hole to blow out



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An excerpt from "The Deer War," Ben East's controversial article in December Outdoor Life, America's favorite outdoor magazine. It's on sale now. Only 35c.

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History's Most Dramatic Mine Rescue

the "cuttings" and, hopefully, to give Fellin and Throne some indication as to where the drill would enter their chamber. They could feel the breeze but couldn't detect its direction.

Down, turn by agonizing turn, half-inch by excruciating half-inch, the drill bored. Finally, Fellin yelled exultantly, "Hold it! The drill is through!" On the surface the tense knot of rescuers broke into smiles. A priest yelled "Praise be to God, they're through."

The follow-up plan appeared relatively simple. Axes, timber, survival gear, more powerful lights were sent down. The timber was to be used by the pair to brace up their hole against the always threatening cave-ins. A \$3,000, 3½-by-22-inch closed-circuit TV camera was lowered, and for an eerie hour, rescue workers and bystanders peered at two monitors for glimpses of men known to most of them only as names and voices.

Pictures of the strata taken by a special Pennsylvania Drilling Co. mining camera were processed and studied. Next a plug was made, a series of wooden plates, fastened together with steel and wrapped with rubber. After the last shipment of newly cut pine timbers was sent down (old-time miners always insist on fresh pine shorings, and Fellin was no exception), the plug was rammed 298 feet down into the hole. Twelve inches of 60-minute quick-drying concrete was then poured over it. Thus, the 12-inch bore the rescuers had labored days to dig was blocked up again in a matter of hours. The plug prevented dirt from pouring in as a 26-inch, 1,350-pound reamer began cutting down into the 12-inch hole, widening it enough so that the two men could be hauled to the surface.

Saturday, August 24. At dawn, the 26-inch reamer bit into the earth for the first time. Now the final push was on.

Above, the scene became increasingly frenetic. The National Guard had to be called in to hold back the weekend throngs of curiosity seekers. Bulldozers chewed into a stand of trees nearby and leveled a landing strip for the two Marine Corps copters slated to take Fellin and Throne on an eight-minute flight to Hazleton Hospital once they came up. Medics set up a first-aid tent.

At 4:45 Saturday afternoon, a minor panic hit the camp. The 26-inch reamer had bored 38 feet down, but the hole was

ragged and a cave-in threatened. The reamer was hauled out. Welders enlarged it to 30 inches. Rushed back to the mine under police escort, it went to work again to widen the holes so steel casings could be set in to prevent slides.

Sunday, August 25. Over the communications system, the trapped men heard a radio mass for shut-ins; they definitely qualified. At a depth of 38 feet, the larger reamer was withdrawn and two steel casings, 26 inches on the outside, 19 inches on the inside, were set into the hole with Bentonite, a quick-drying plaster, binding them together. Helmeted John Adams was lowered down the hole to inspect it and came up making the "V" sign with his fingers. The hole was clean. Then a 17½-inch reamer dropped down and began boring for paydirt.

Monday, August 26. All day the reamer whirred—158 feet down at 2 a.m.; 226 feet down at dawn; 265 feet down by noon. The trapped pair removed the wooden prop they had erected under the plug above them, and finally the giant reamer began eating through the concrete, rubber, and wood, at barely "peckin'" speed, 15 r.p.m.s or less. Finally at 3:38 in the afternoon, Fellin yelled, "The plug is through." At 6:22, he called, "Take it up all the way," and the reaming was over. Jubilant drillers, covered with concrete, dust, coal, and smiles raced to the Salvation Army tent, swiped the American flag, and raised it to the top of the drill.

"We're gonna come up just like John Glenn," Fellin had said, and he was almost right. There were five possible rescue plans, and while the reamer and its 10 lengths of drilling pipe were withdrawn, the experts on the surface debated as to which one to use. Three "escape capsules," all specially fabricated from rolled steel and steel mesh, were at the site.

Shaped like double-ended artillery shells, these were hollowed out to hold a man. Attached to a winch, they would be lowered down 308 feet into the mine and pulled up like elevators with one man per trip. After several test runs these were discarded. The hole had "drifted" and the capsules were in danger of jamming in the bent bore. Finally, coveralls sewn onto parachute harnesses were selected as the escape containers and these were lowered to the men.

Hank Throne came up, greased like a

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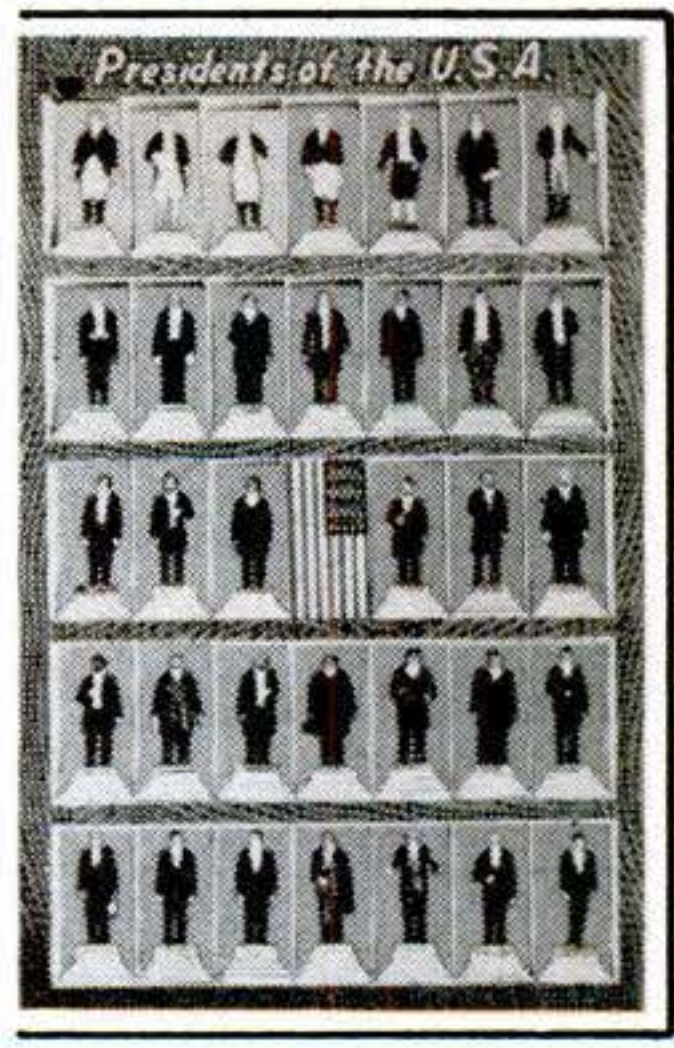
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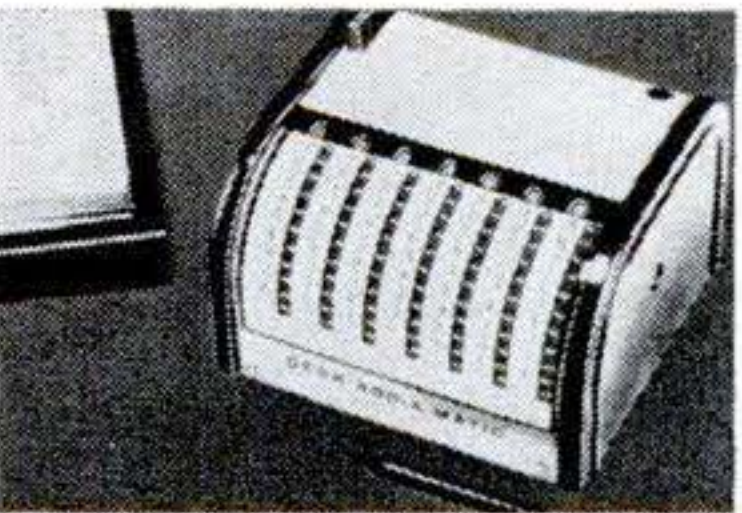
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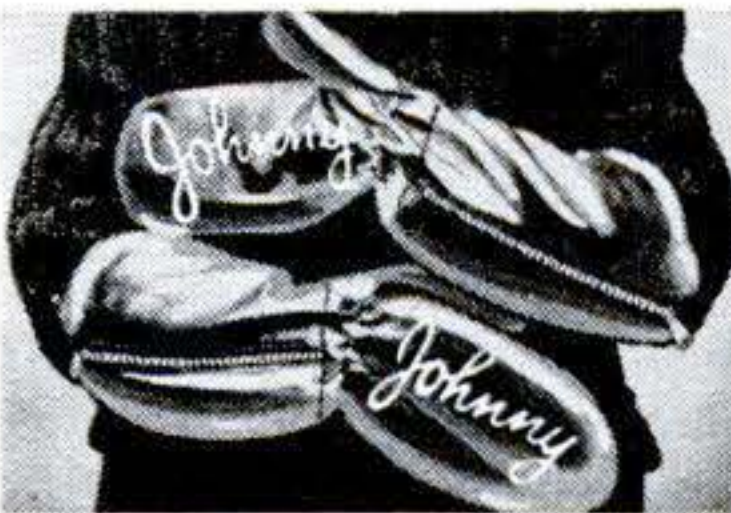
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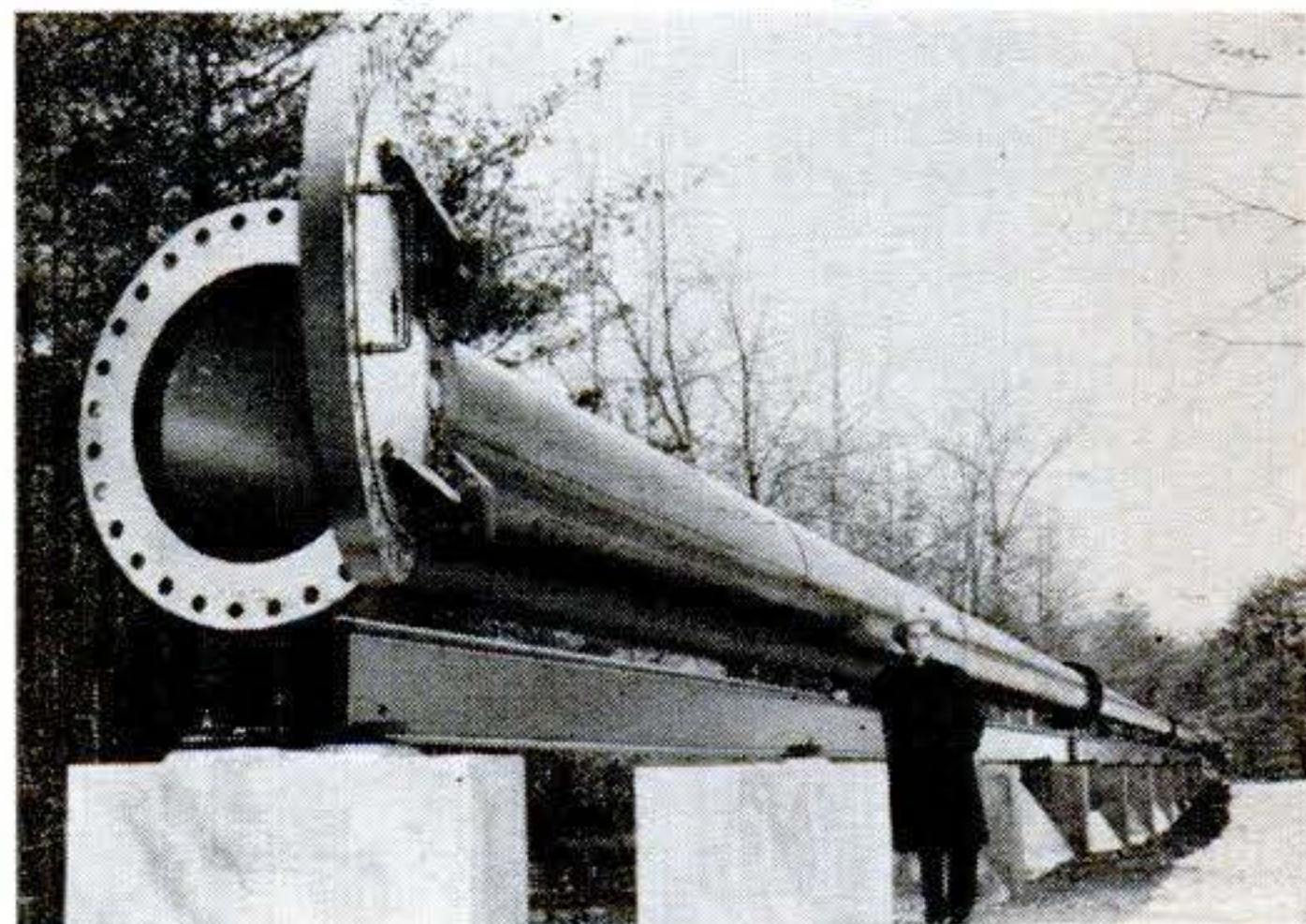
pig to avoid friction, singing lustily, an orange football helmet on his head to protect him from falling rocks. A red truck with a winch had replaced the drill over the hole. "Boy, what a ride," Throne exulted. And when his bearded face popped out of the hole after a 17-minute ascent, Navy corpsmen grabbed him, as he began to cry, lowered him onto a litter and rushed him to the first-aid tent and then to the waiting helicopter.

Next came Fellin, his trip only half as long—eight minutes. Cheers and an incongruous outburst of yodeling erupted as he emerged. It was 2:41 a.m. on the morning of Tuesday, August 27, and the men had been below just six hours short of two weeks.

Six feet east of the jubilant rescuers, the drilling for Bova, halted during the last stages of the Fellin-Throne rescue for fear of causing a cave-in, began again. This one man, dead in all probability, was still below, but as long as he remained in the damp darkness of the mine, the men above were determined to reach him. They had just seen one miracle; who could be positive that it might not happen again? ■ ■

Editor's Note: *Louis Bova was finally given up for dead by rescuers at Sheppton on Thursday September 5. Experts theorized that he died of starvation, exposure, and injuries, probably on or about August 23.*

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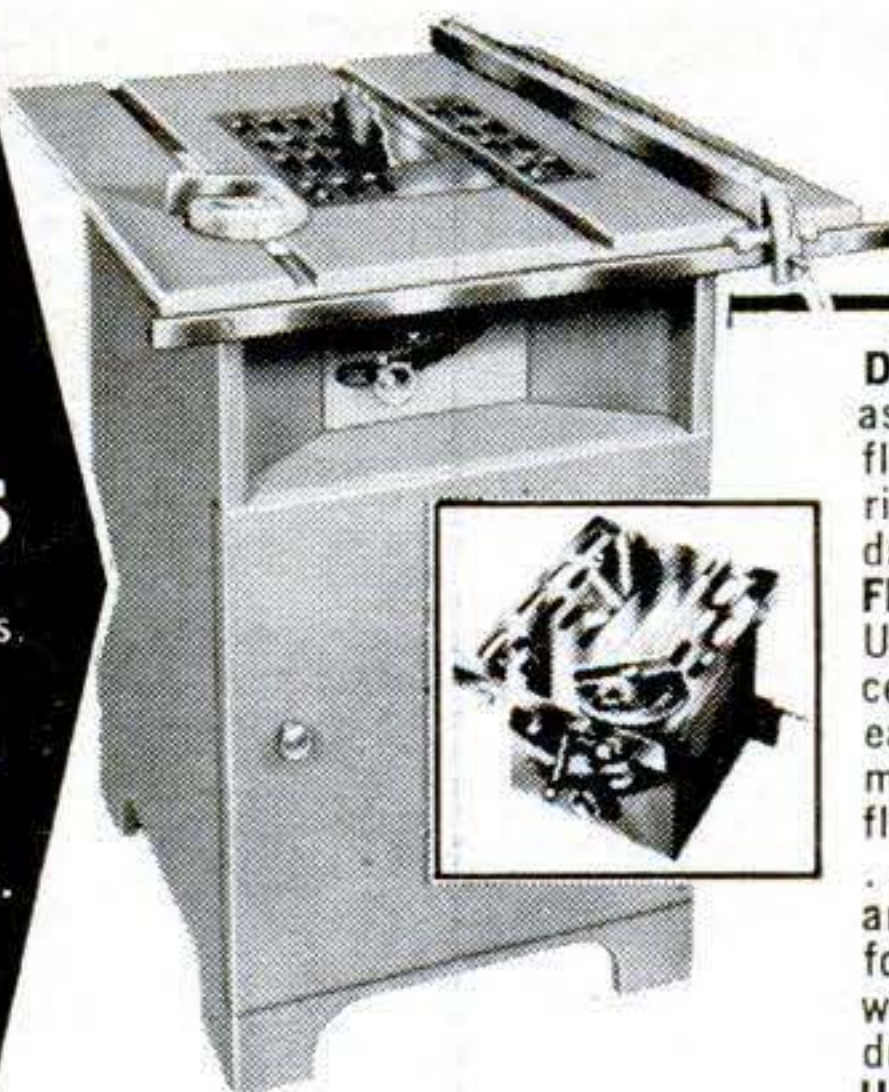


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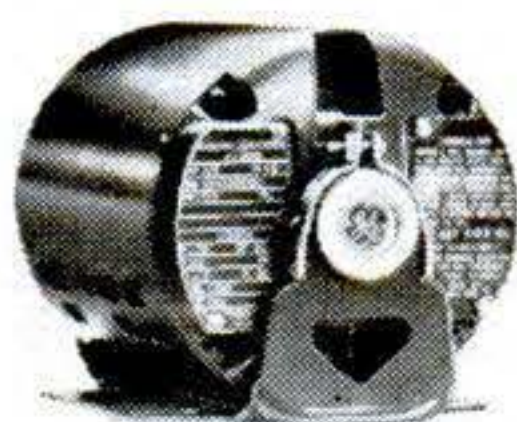
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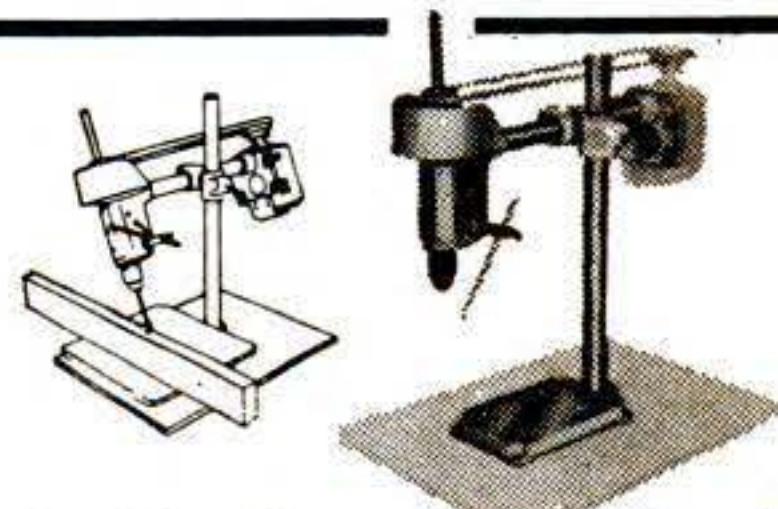
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2. MY WIFE AND I THOUGHT ABOUT IT, TALKED ABOUT IT, WORRIED ABOUT IT. WE WERE STUMPED. WE THOUGHT WE HIT A DEAD END

HAS A COURSE IN SURVEYING AND MAPPING. DO YOU SUPPOSE IT'S ANY GOOD?



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