

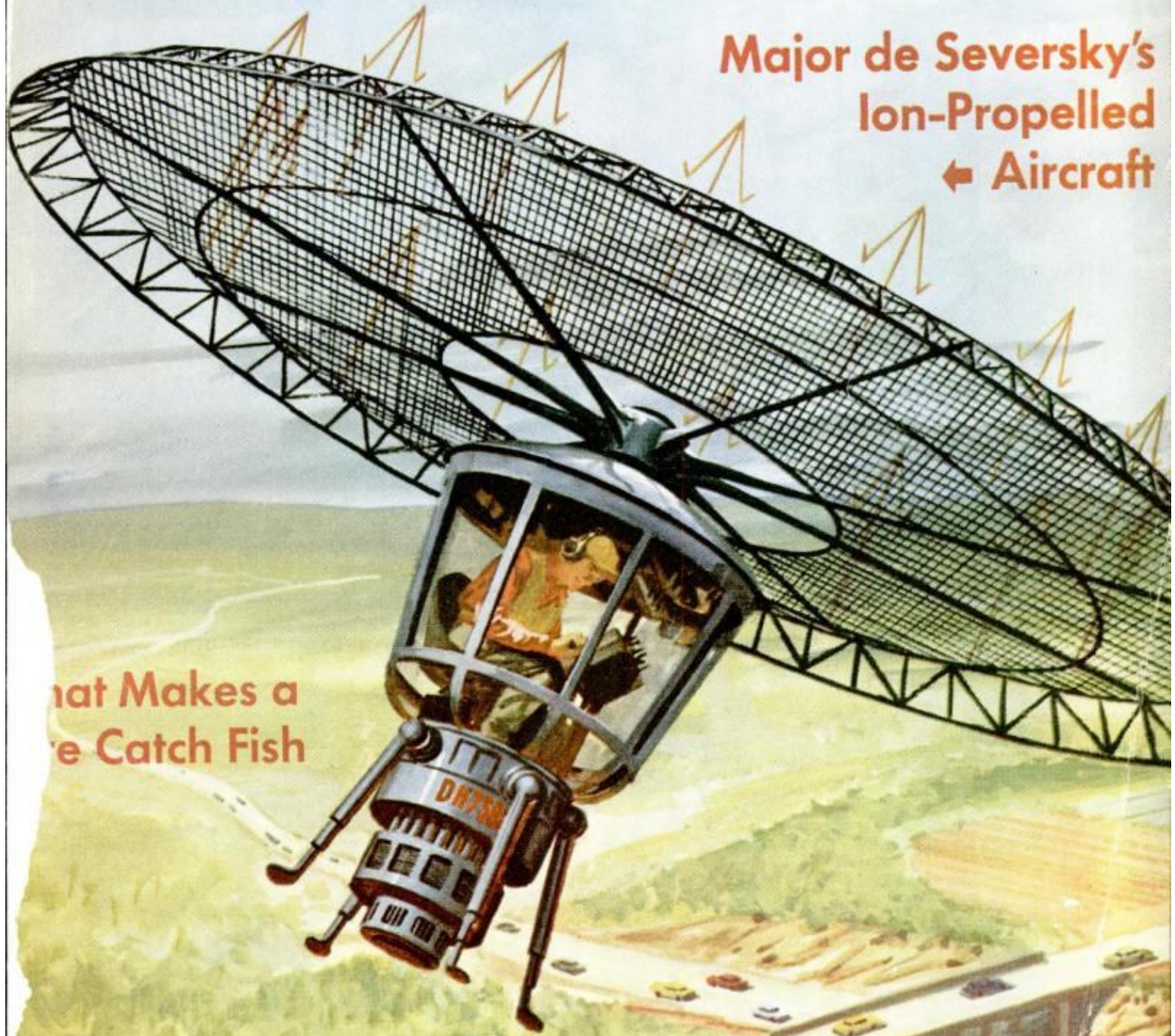
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POPULAR MECHANICS

AUG. 1964
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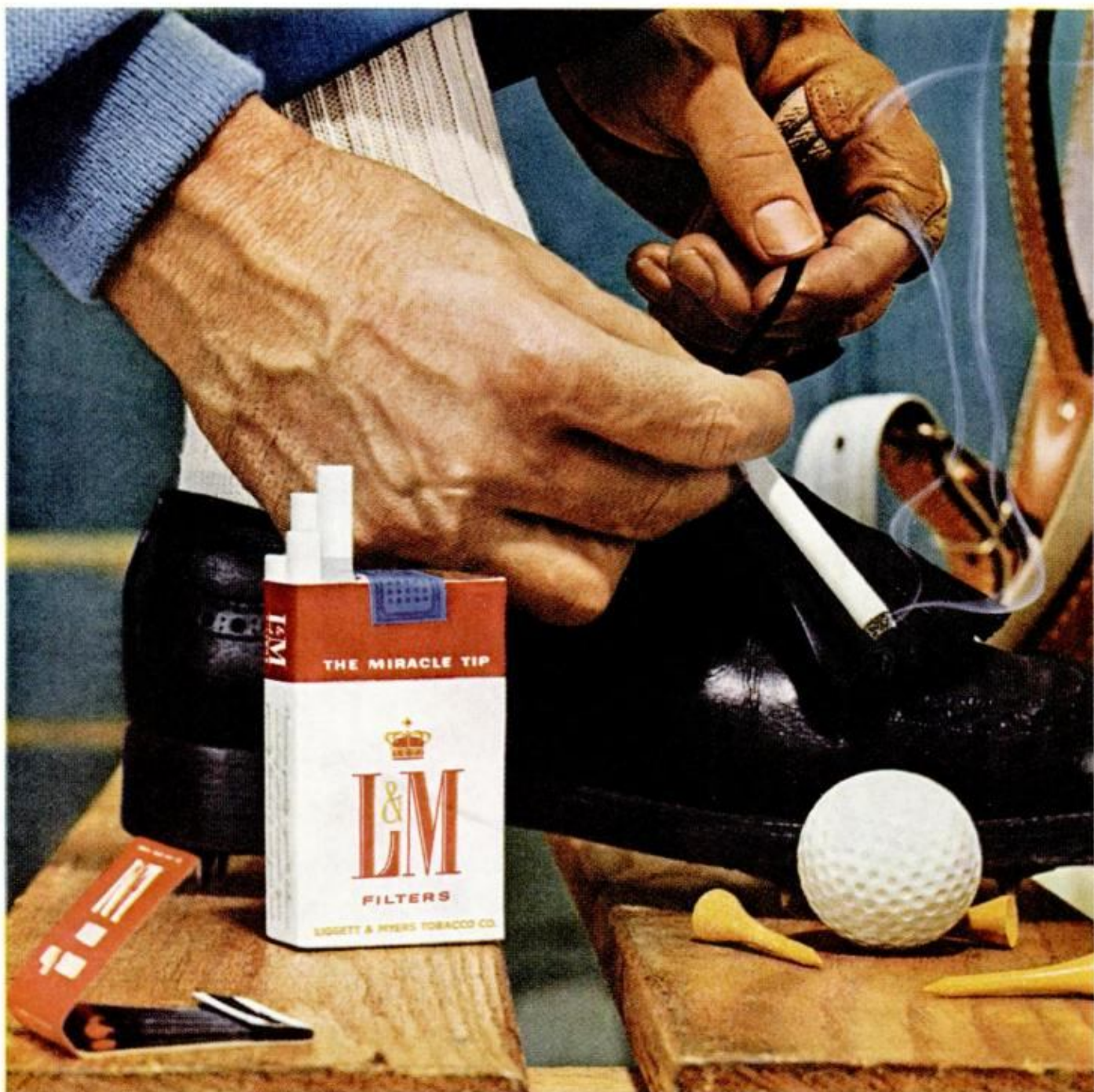
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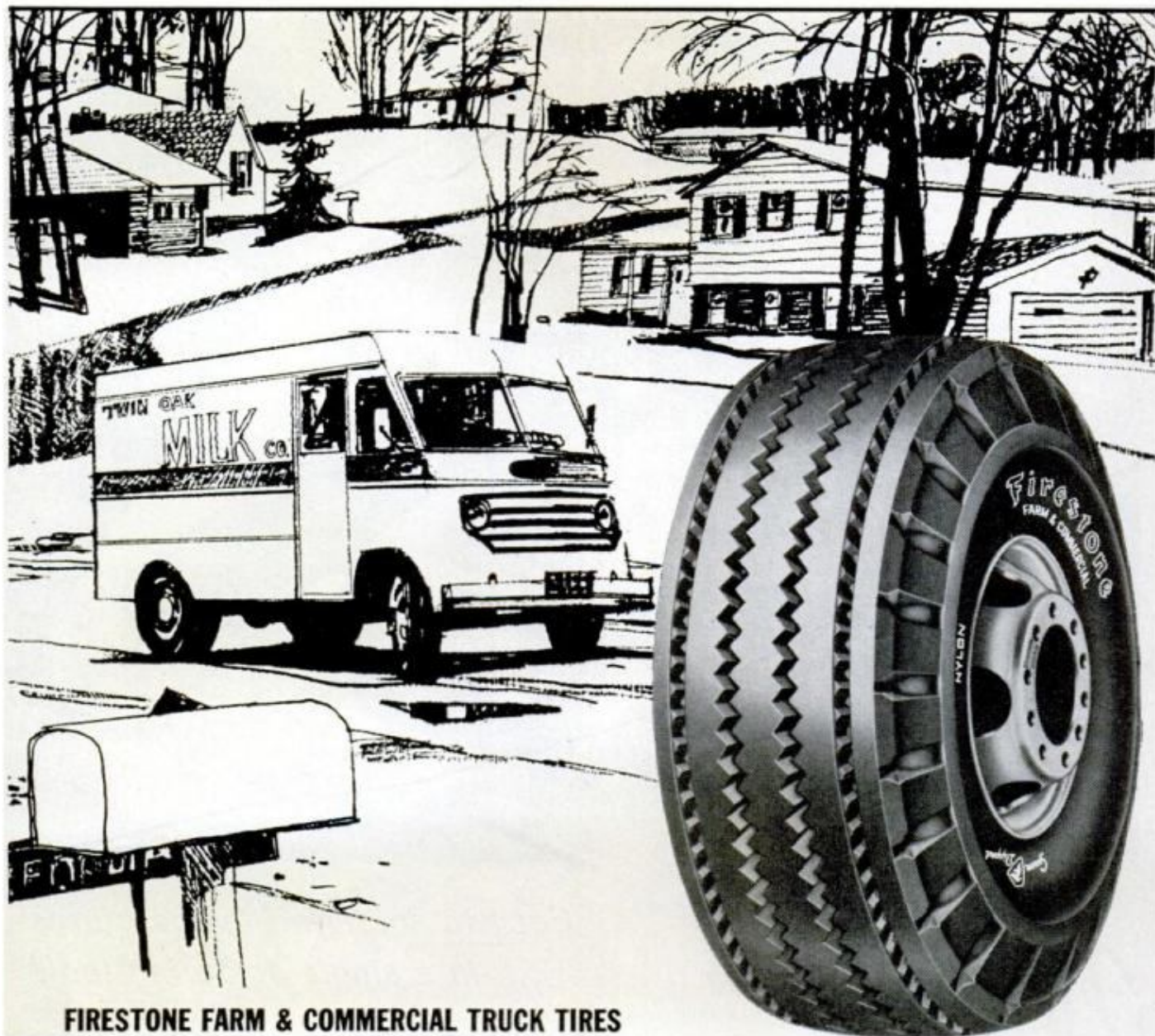


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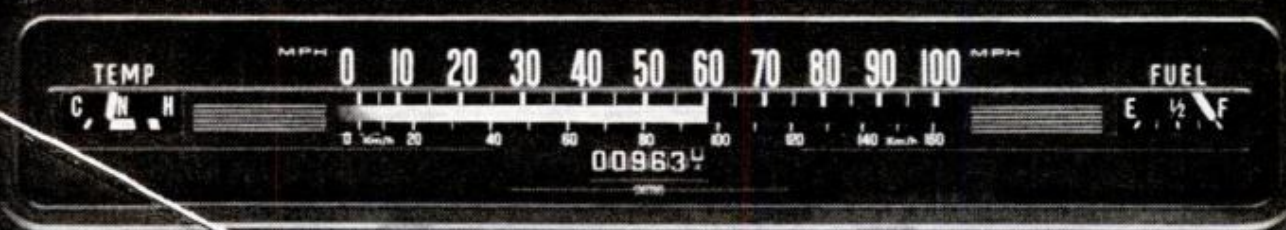
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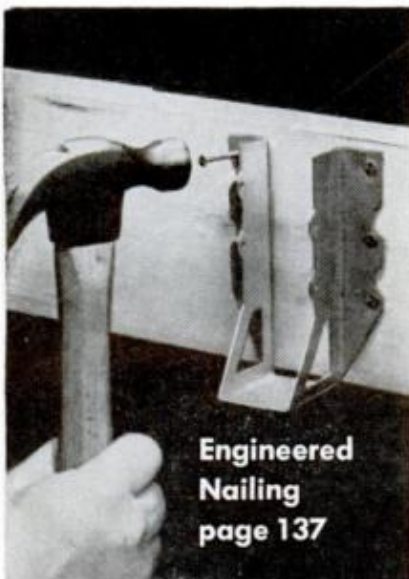
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NEXT MONTH—Well-designed Built-Outs add room to your home, without giving it that tacked-on look. September PM also shows ways to stretch garage space, how to frame add-on rooms and what's new in remodeling materials. There's also a Mustang owners report, a cockpit report on a channel-wing plane, plus plans for a sailing cat

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Over the Editor's Desk

One-Upmanship



I built the *Hi-Cycle* (page 169, April PM) and it has given me a lot of fun.

Dozens of people, both driving cars and walking, have turned around to stare—which, of course, boosts my spirits and makes the whole thing really worthwhile. Oxnard, Calif. MICHAEL O'CONNOR

I hate to inform you, but an inverted bicycle is against the law in California. I know; I was arrested riding the same bike you pictured and given a ticket for it. I was taken out of school to appear in court and was fined \$15. Gardena, Calif. DIRK KLOVER

At this point, it appears that the law is a little more lenient in Oxnard than it is in Gardena. But keep an eye peeled, Mike. Or better yet, go ask the police. Seems that it could have something to do with the amount of traffic on a street.

No Damp Camps

Snug Camping in Foul Weather (page 118, May PM) is a fine article. There are many good hints, but I feel something should be said about "ditching" a tent.

Nowadays, both conservation-minded people and those who try to level someone else's ditches feel that it is best left undone. Most camp areas are used a lot during a season, and repeated ditching would turn a nice grassy area into a plot

of dead grass—and a quagmire in rain. Ditching is a don't for our Boy Scout troop camp-outs.

Madison, Wis.

F. E. McNALLY
Asst. Scoutmaster

It was one of the best and most informative articles on camping that I have read in a long time.

However, there was one point that was left out. I have found through experience that a sheet of plastic under the tent floor serves remarkably well in keeping the dampness from coming up.

Bridgeport, Pa.

EDDY MUNSON

Water Shortage

In your April issue, *Science Worldwide* (page 14) states that the Amazon River dumps an average of eight million cubic feet of water per second (3,600,000 gallons a minute) into the ocean. My figure for the total gallons per minute is 3,600,000,000. Clinton, Iowa L. D. FARLEY

Your figure is correct, of course. We zeroed out when we should've zeroed in.

Good Knight for Camping

This *Sea Knight* (page 164, May 1957 PM) was built in the spring of 1960 and has been cruising the Saint John River for the past three summers. It has proven to be a very excellent hull.

Powered with a 40-horsepower Mercury



and fully loaded with my family and camping equipment, the boat cruises approximately 20 miles per hour. Without camping equipment, the top speed is 27 m.p.h. Lancaster, N.B. MURRAY J. WHITE

Bigger Fat Tire Scooter

Being six feet, four inches tall, I enlarged the *Fat-Tire Scooter* (page 151, April 1963 PM) 15 percent.

I built it of $\frac{3}{4}$ -inch black iron pipe, bent

(Please turn to page 8)

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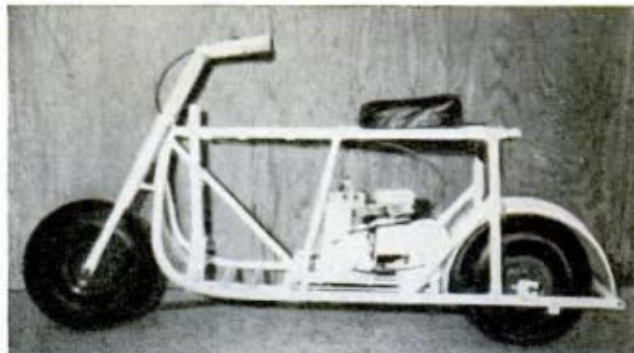
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Over the Editor's Desk

(Continued from page 6)

with a hand conduit bender. I made the handlebar assembly easily removable so that I can take off the handlebars and seat



and run the scooter up a plank into my Olds station wagon.

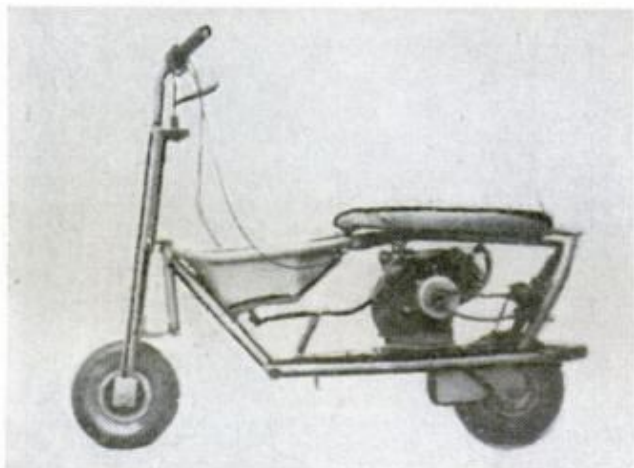
A three-horsepower engine gives ample power. Total building time was 46 hours and cost was \$165.

I use the scooter to patrol a wooded and hilly oil lease, and I can go anywhere with a five-gallon can of gasoline and 100 pounds of tools.

Shipperville, Pa. REX R. ANDERSON

We built the *Fat-Tire Scooter* for about \$60. As you can see, we did not follow the plans exactly.

We found we had to use a jack-shaft to transmit power to the wheel because the



motor we bought (for \$5), if coupled directly to the wheel, would have projected and interfered with the driver's legs.

Top speed is 22 m.p.h.

The photo gives you a good idea of what it looks like, but under no circumstances will it illustrate the father-and-son hours of enjoyment spent together in planning and assembling and testing.

Huntsville, Ala. DONALD H. DENHOLM

Careful with That Blasting

In regard to *How Nuclear Blasts Will Dig a New Panama Canal* (page 67, June

PM), it may be well to consider the effect of these terrific explosions on the interior of the earth. Consideration should be given to the major fault lines in the location of the proposed excavation; reactions from explosions could have worldwide effect. Palo Alto, Calif. DONALD L. WEST

Low-Flying Cans

Your March issue carried a very interesting article, *Those Handy Aerosols Can Be Dangerous* (page 85).

We have had a number of instances lately where aerosol cans of various types have been thrown into the hospital incinerator with the predictable results. In one case, the door of the incinerator was blown off, and in another instance the bricks were loosened inside the incinerator. Unfortunately, in one instance there was an injury.

I would like to get this article into the hands of every one of our employees.

Trinity Lutheran Hospital
Kansas City, Mo. R. W. WESTERGRENN,
Administrator

Why aren't manufacturers required to incorporate some sort of safety plug or rupture disk in these cans so that—like the fuse in an electrical circuit—only the plug or disk gives way? These weak spots would "blow" to prevent a more violent explosion when the container is subjected to abnormal internal pressure through exposure to heat.

Philadelphia, Pa. ANDREW VENA

One of the most encouraging bits of news to report since the article appeared is the introduction of a new plastic container for a wide variety of aerosol products.

Executive Editor Dick Dempewolf, who wrote the March article, witnessed a demonstration of the new "Celcon" container at the Celanese Polymer Company lab in New Jersey.

"Filled and under 40 pounds per square inch of pressure, the tough plastic bottle refused to smash after six successive drops onto concrete from a height of 17 feet," Dick reported.

"A container of 24 bottles thrown on a fire proved fairly dramatically that when subjected to high heat, the containers did give way at one pinhole weak spot. The contents hissed away, but no jagged pieces flew more than two or three feet through the air, and even these did not have sharp edges.

"Whether plastic is the answer remains to be seen, but the Celanese demonstrations were impressive," he concluded.

The Editor

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Long-distance diagnosis of heart ailments is an established procedure at George Washington University in Washington, D.C., making it possible to help patients thousands of miles away. Information from the patient's cardiogram is transmitted by phone and fed into a computer that has been programmed with diagnostic criteria. The machine provides a quick diagnosis and one that's more accurate, George Washington cardiologists told *PM*, than most general doctors can produce.

Police technicians use rabbits to tag suspicious blood smears. A sample of the smear is injected into the animal, causing it to produce antibodies. The animal's system generates different kinds of antibodies in reaction to different kinds of foreign tissue. Thus, analysis tells if the smear came from a sheep, dog, cow, human or other critter.

British bone specialists report that a recent fossil find in the Olduvai Gorge of northern Tanganyika may represent the oldest human ancestor discovered yet. Radioactive dating tests show he lived 1,750,000 years ago. He was fully capable, say the scientists, of shaping the quartz and lava tools found with the skull, hand, leg and foot bones.

An electronic drafting machine that converts taped engineering data into finished drawings has been developed by Hughes Aircraft. It can turn sketches into finished drawings and produce wiring schematics and complex charts. Not only is the machine's work of a superior quality, says a company official, but it can do tasks in hours that often take human draftsmen days or weeks to finish.

Magnetism may be essential to your health. That wouldn't be surprising, since life has developed under the influence of the earth's magnetic field. Though that field is not strong, space scientists are afraid of what the absence of it may do

to astronauts. In one experiment, a group of men were kept for two weeks in a chamber shielded from the earth's magnetic field. Their chief complaint: trouble with their eyesight. Fortunately, they all quickly recovered after returning to daily life in their normal magnetic environment.

Department of Agriculture researchers think the use of amplified sound may prove an effective nonchemical method of controlling some insects. Indian-meal moths, pests in stored foods, were subjected to low-frequency sound waves for a four-day period. As a result, the hatching rate of their eggs was far below normal. And among those that hatched, nearly half died the first day, an unusually high mortality rate.

A new material developed by General Electric can withstand temperatures up to 1400 degrees F. and is said to be almost as strong as steel, pound for pound. Called "inorganic bonded mica mat," it's made of thin, laminated sheets of reconstituted mica and can be machined and molded.

The country's first nuclear-powered lighthouse beacon was recently put into operation in Chesapeake Bay, south of Baltimore, Md. Power is provided by a 60-watt generator that is fueled by about 20 pounds of strontium titanate. Designed to operate unattended for 10 years, the generator supplants batteries that had to be replaced every year.

An invisible ghost star may have been detected by a rocket recently fired from the New Mexico desert. The rocket reported picking up X rays from a point in space where even radio telescopes have failed to locate any kind of celestial body. Some scientists believe the rays may come from a neutron star—the cold remains of a supernova, a star that liberates most of its energy through a catastrophic explosion.

A special opening was built into the wall of the Smithsonian's new \$36,000,000 Museum of History and Technology in Washington, D.C. It was needed to permit bees in two hives to come and go in their pursuit of pollen. The colonies, which are housed in clear plastic hives so visitors can view them, are part of a government bee-breeding research program.

Spiders with damaged brains spin lopsided webs—the more damaged the brain, the more irregular the web. Researchers at the Upstate Medical Center in Syracuse, N.Y., make the brain lesions with a laser

(Please turn to page 12)

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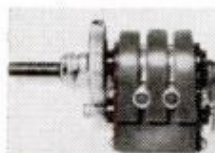
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Science Worldwide

(Continued from page 10)

that shoots a beam of powerful light more slender than the finest needle. It's all part of an investigation that ultimately may throw light on how humans weave their sometimes twisted behavior patterns.

▼ ▼ ▼
An X-ray unit small enough to fit into your pocket has been developed by scientists in Chicago. Because the rays come from a radioactive source—promethium 147—the machine needs no electricity. It can be used for on-the-spot tests of electronic equipment and aerospace parts after they've been installed.

▼ ▼ ▼
A recent investigation by an Israeli scientist reveals how camels are able to withstand desert heat. They don't perspire until their body temperature reaches 105 degrees F. and their blood has the ability to absorb and store enormous quantities of water. The hump? That's fat.

▼ ▼ ▼
A pressure maintenance plant costing \$6,500,000 is expected to extend the productive life of a Texas oil field for many years. The plant replaces oil taken from the ground with water. As oil is tapped, the natural pressures existing in underground rock formations are diminished. The injection of water maintains the pressures, which are needed to push the oil to the producing well.

▼ ▼ ▼
Artificial insemination has been carried a step further. Doctors at Philadelphia's Albert Einstein Medical Center report using spermatozoa that had been frozen and preserved for almost six months. Four out of six women participating in the investigation gave birth to full-term, apparently normal children. The other two miscarried. The study, say the researchers, may prove useful in establishing human sperm banks.

▼ ▼ ▼
Life on Mercury? Some space scientists think that a narrow "twilight zone" on Mercury, closest planet to the sun, may provide conditions moderate enough to support living organisms. But they'd have to keep on the move—to avoid being burned up or frozen outside the zone, which moves as the planet rotates.

▼ ▼ ▼
A patient who must rely on an electric pacemaker to keep his heart beating need not fear that the battery in the mechanism will suddenly go dead. A doctor at Johns Hopkins estimates that fewer than one percent of the small devices have caused difficulty through mechanical fail-

ure. In addition, the wearer is warned of approaching battery failure by a slowing of the pulse rate, which is recorded daily.

▼ ▼ ▼
Now they're tampering with our cheese. University of Wisconsin researchers report that they can speed up the process of making cottage cheese by adding hydrochloric acid to the milk. They say this method produces finished cheese in about 20 minutes, as opposed to the six hours or more the usual bacterial process takes.

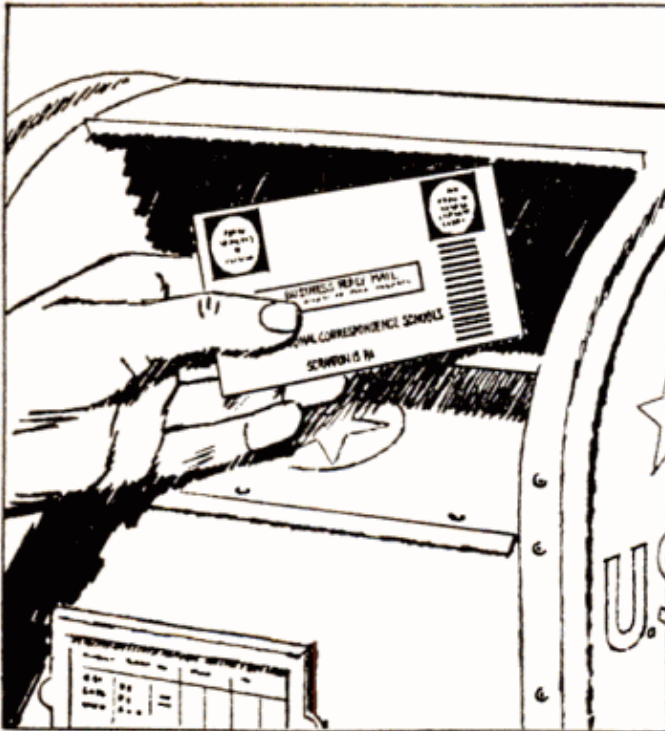
▼ ▼ ▼
With five demonstration plants successfully operating, the U.S. is a leader in converting salt water to fresh. What progress have the Russians made? We should find that out when experts from the two countries meet this summer, as announced by President Johnson, to explore ways of cooperating in this field. Certain to be discussed are nuclear plants that can produce both electricity and fresh water. For a report on recent developments, read *Fresh Water From the Sea: Can We Afford It?*, beginning on page 96.

▼ ▼ ▼
New worlds are being sought with a new "astrometric" telescope which can spot distant planets by charting the orbits of their parent stars. The U.S. Naval Observatory instrument in Flagstaff, Ariz., measures exact distances to small, dim stars by an adaptation of the surveyor's triangulation method, using the width of the earth's orbit as a base line. If the orbits of such stars show a slight wiggle, astronomers are alerted to look for an accompanying planet; its gravitational pull causes the wiggle.

▼ ▼ ▼
Single men are more apt to stay home from work when sick than are single women, according to the A.M.A. Sick absence rate among single men was 4.3 days per person per year, compared to 3.9 days for single women in a two-year study involving 35,000 households. As soon as women marry, however, they show a higher absence rate, reflecting their family responsibilities, of 6.1 days.

▼ ▼ ▼
The comparatively high cost of research rockets may be on the way down. A West German physicist reports having developed a technique for producing plastic rockets that will cost less than a third as much as comparable metal jobs. Flight tests are set for the fall.


Science Editor



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Sheer coincidence placed stories about the incredible ionocraft (page 58) and air pollution (page 81) in the same issue of *Popular Mechanics*, but it happens that Major Alexander de Seversky's amazing ion-propelled machine grew out of his work in fighting air pollution.

He refuses to talk about the latter work, although it's known that his electrostatic air-cleaning device is being used somewhere on Long Island. He does admit, however, that he noticed the air flow between electrodes on this device, and this led to further studies to take advantage of the flow for propulsion. The result was the ionocraft.

Bye, Bye, Birdie. We keep hearing stories about how birds invade aircraft hangars to build nests, much to the annoyance of the men working down below.

The latest one is from the Navy, and the Navy admits it's all its own fault. Years ago, in the age of dirigibles, the Navy used homing pigeons to send back messages from the airships when they were away from the base. Today the airships are gone but the pigeons (or their descendants) are still around. The problem, as always, is how to get rid of them.

We've heard lots of solutions, most of them from crackpots, but the best and most economical seems to be the one used at another Navy base. It has paper bags, hung by strings from the rafters, which sway with the breeze whenever the hangar doors are open. The swaying motion apparently is enough to discourage birds.

Fighter aces are a select group, and it took one Air Force pilot 18 years to make the grade. He shot down two Japanese planes one day—his fourth and fifth kills—but ran out of film before recording the second one. Unconfirmed, the kill was not allowed, and he ended the war credited with four.

Years later a relative toured the area where the dogfight took place, found witnesses who recalled the fight and even found the pilot's grave. So 18 years after it happened, the victorious Air Force man was confirmed an ace by the board for correction of military records.

Kevin V. Brown
Aviation Editor

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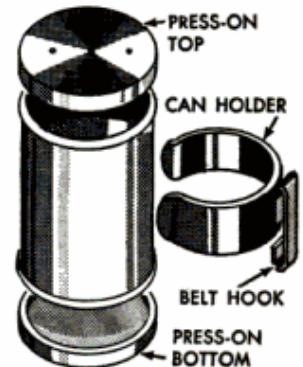


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Items from All Outdoors

Target plinking is fun, we found, with the new Crosman CO₂ replica of a .38-caliber target pistol. It is a beautiful pistol, closely simulating the .38 in size, weight and action. It shoots a .22-caliber pellet, and is powered by a 12.5-gram CO₂ cartridge. It's well worth the \$24.95 price. We have only one reservation about its value as an indoor training gun for competition shooting. It lacks the kick of a competition pistol, and this could be a drawback for serious training. There's also a progressive dwindling of power of the CO₂ cartridge, which makes it almost impossible to sight accurately for more than 10 or 15 shots.

Worms that are used for bait are sometimes elusive and make their way to the bottom of the bait can. Frank Bartonek of Independence, Mo., solves the problem of getting at them by using a coffee can with a plastic lid. He cuts off the bottom and adds a second plastic lid, punching holes in both lids for air. When the worms settle to the bottom, he just turns the can over and they're easy to get to. The Daisy Bait Co. of Sunland, Calif. has a clever rig that sells for \$1. It is a plastic top and bottom for any standard size pop or beer can that has the ends removed. There is a holder for the can and a clip that attaches to the belt. In the same way, you can get to the bait from either end.



Kentucky has instigated a program to create more water for fishing and boating. When building a new highway across a valley, they build a dam to carry the roadway, and install small drains for excess water. Flooding creates a chain of small lakes which the state stocks with fish.

Novice hikers and campers will be interested in a U.S. Forest Service booklet that gives solid advice on how to plan, organize and equip a family backpacking trip. It also gives a run-down on all U.S. wilderness. It costs 35 cents from U.S. Government Printing Office, Washington, D.C.

STUART JAMES

Outdoors Editor

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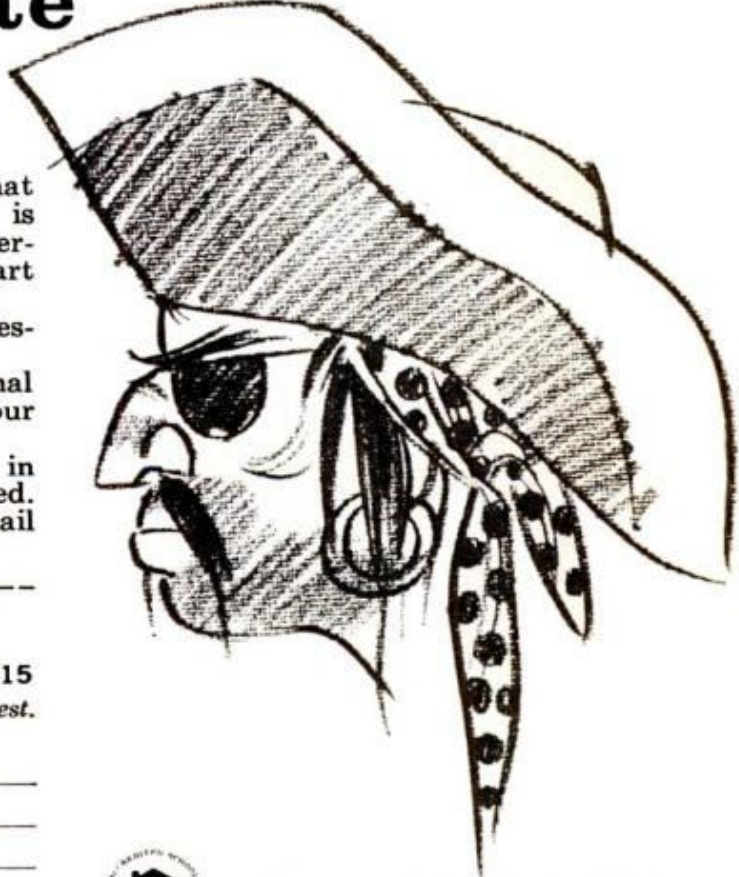
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By Ed Nelson

Headlights Have Their Ups and Downs on '65 Models. What Really Threw Clark and Gurney Out of Indy?

The four-eyed stare of American cars will still be very evident on 1965 models, but more of them will show up as over-and-under teams rather than side-by-side. Credit the handsome sales figures of the **Pontiac Grand Prix** for the revival of the vertical pairing. According to rumor, you'll see the over-under treatment on both Ford and Rambler Ambassador next year, as well as on some of the **Chrysler Corporation** lines. And Pontiac has no intention of giving up this styling touch.

Both **Lincoln** and **Imperial** used the up-and-down motif some years back, of course, but with a difference: They slanted theirs.

A young man who gets a flat on the way to an important date might also get a faint taste of how Colin Chapman's top drivers—Jim Clark and Dan Gurney—felt during this year's Indianapolis 500. Chapman elected to have them run on tires from British countrymen at Dunlop. And the tires let them down.

There's a certain amount of mystery involved in the tires' performance and Dunlop and Chapman specialists will undoubtedly still be working on it as you read this.

To start with, Clark generally is easier on tires than Dan Gurney. Yet Jim Clark had the first tire trouble, not Dan. And the inside tire gets less beating than the outside, yet it was Clark's *inside* rear tire that lost its tread rubber three-quarters of the way around the tire. As Jim put it, "there was a lot of vibration, then everything went to pieces."

When the tread began to peel away, it flailed around and around, battering and breaking the upper control arm that keeps the top of the wheel away from the car. Other rear suspension parts took a beating, too. The wheel collapsed. One of the world's finest drivers, Clark guided his car toward the infield on three wheels with sparks shooting up from the left rear corner of the car.

As business organizations, Dunlop and Chapman then got their chance to show a special kind of commercial heroism. Clark's and Gurney's **Lotus** cars were the only ones using Dunlop tires. And Clark's

report back to the pits was that the small remaining section of tread on his left rear had thumb-sized chunks missing. Gurney had just made a pit stop and, although plenty of tread remained, his right rear tire had started to lose similar chunks. It had been changed. Dunlop's racing director, Vic Barlow, hurried down to the first turn for a look at Clark's tires, then hustled back for a conference with Colin Chapman. Dunlop recommended that Gurney's car be pulled out of the race. Chapman agreed.

As Pete Smith (chief of Dunlop's U.S. operation) pointed out, "Two men—Sachs and MacDonald—already were dead. Motor racing had had a black enough day at Indianapolis already. We weren't about to risk another life for a possible commercial advantage."

Yet Jim O'Connor, Dunlop's technical director, told me, "There's no question that there was plenty of tread left on Dan's tires. Including the under-tread compound—and we were fully prepared to race on that, too—there was enough tread left for 700 or 800 miles." And both O'Connor and Smith agreed that temperature wasn't the problem. "Any tire has a fail temperature, although we don't like to talk about it. But we weren't within 20° of it here—in Centigrade. Stress was our problem, not the temperature of the tire."

Indianapolis was also alive with rumors that Clark had chosen to run on softer tread than other drivers. But Smith explains it this way:

"There's absolutely nothing to the idea (a common one in the U. S.) that harder tread rubber wears longer. We simply build what we consider the best tire, combining all the characteristics we want, and this is the hardness we get. But hardness means nothing as far as identifying the tread compound itself."

USAC identification tests indicated that, cold, the Dunlops of Clark and Gurney were about five points softer than the Firestones being used by 29 of the 33 cars. Passenger tires of a given manufacturer, by the way, usually have a spread of about two points on the same Durometer scale.

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Sidelights from the SERVICES

By William R. Kreh

A giant checker board at the Navy's Ship Missile Systems Engineering Station, Port Hueneme, Calif., combines the brainwork of checkers with good old-fashioned physical exercise. The squares were painted on a concrete deck 12 feet square. The "men" are old gallon paint cans filled with concrete and with handles made of salvaged electrical conduit. Each one weighs about 20 pounds and by the time you've played a complete game, you use about the same energy it takes to move a ton of coal. What happens when you "king" a man? Use two of them on the same square—and use twice the energy.

Hypnosis can keep a man as warm as an overcoat. The Air Force made eight experiments on five volunteers, exposing them to 40-degree temperature in a moving air stream for an hour in each test. They wore only light clothing. They were lightly hypnotized for four tests and not at all for the other four. Biggest difference, Air Force scientists said, was the almost complete lack of shivering while in the hypnotic state. On awakening, the men reported they hadn't felt the cold at all.

Tiny nylon threads strengthen concrete even more than steel does. In Army tests, the impact strength of concrete was increased 27 times by blending in numerous nylon fibers one to three inches long. Blocks six inches long and 1½ inches square did not shatter under 50 blows of a sledge hammer.

A "pony-size" space rocket, of from 50 to 500 pounds thrust, has been developed for the Air Force. The low-power unit is intended for small manned or unmanned space vehicles which would taxi about, tow spaceships in distress, shove satellites back into proper orbit, etc.

Pink elephants have been spotted by the Marines in Vietnam. No fooling! A helicopter pilot told officers he had sighted a pink elephant on a recent flight and was nearly laughed out of camp. Later, a fellow chopper pilot confided to the chastened flier that he, too, had seen the pink pachyderm, but had been reluctant to report it. However, he had noted the spot on the map and on a later flight both pilots carried cameras with color film to obtain

proof. They succeeded. Photo-interpreters were shown pictures of the beasts wallowing in a muddy pool. Their report: the elephant wallow contained a sticky, pinkish mud that made the beasts look like something out of an alcoholic nightmare.

Army engineers are investigating the possibility of using aerial photographs to help detect underground nuclear explosions. Stereoscopic observation and measurement of photos have been made at a test site before and after a blast. Using complex stereophotogrammetric measurements, the engineers found that, after one test, the radius of 150 feet around the ground-zero point had risen between 18 and 24 inches.

Skin divers can get some valuable tips from a new Navy diving manual. It covers such subjects as underwater physics and physiology; basic diving procedure; decompression tables; hazards (including a general description of appearance, behavior, and localities where hazardous marine life is most likely to be found); and general safety precautions, including first aid instructions, mouth-to-mouth resuscitation and several methods of artificial respiration. The manual can be ordered for \$3.25 from the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402.

A **king-sized ventilated** plastic bag is being tested by the Army as an isolator for patients with highly communicable diseases and for burn patients and those undergoing organ transplants to protect them from outside germs. The patient lies on an electrically operated bed which is encased in an inflated cylinder of transparent plastic. A pair of gloves is molded into the plastic and there is enough play in the enclosure to permit the gloves to reach any point on the bed, enabling medics to render any necessary treatment. It has a self-contained ventilating system and air locks through which food, surgical equipment and bandages can be passed. Material passed through the air lock is irradiated by ultraviolet rays. By clamping adapters to the side of the bag, doctors can use diagnostic devices such as the electrocardiograph and can administer oxygen or intravenous solutions.

Paper wipers may replace the venerable rag for Army mechanics. A new paper wiper has been developed by Army scientists that is rayon-reinforced, lint free and pliable. It may be dipped in solvent, wrung out and reused. The paper rags are said to be cheaper and take less storage space.

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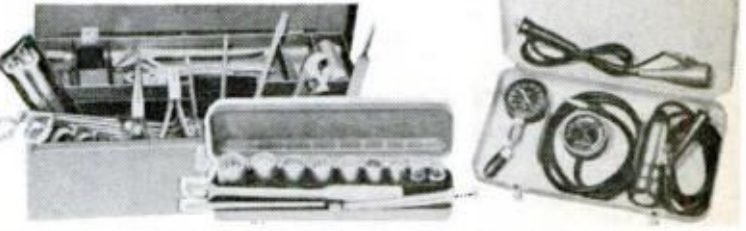
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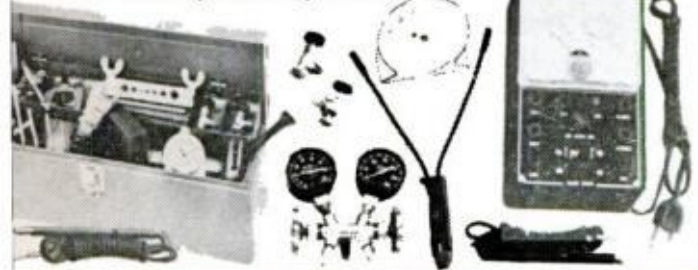
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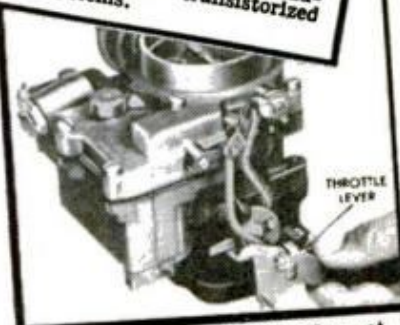


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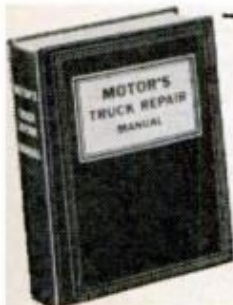
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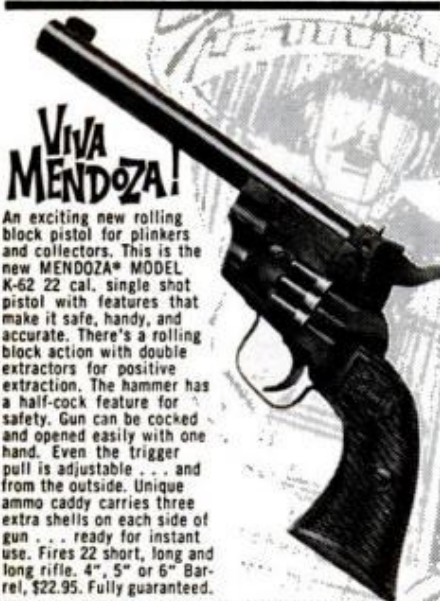
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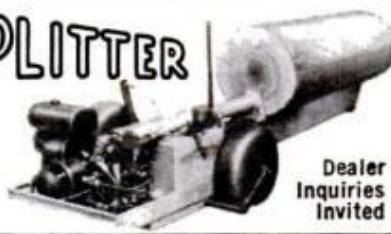
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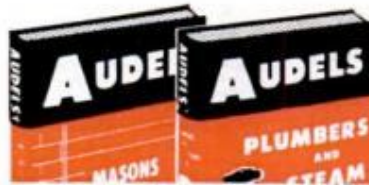
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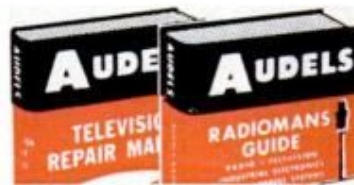
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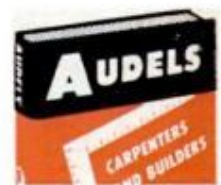
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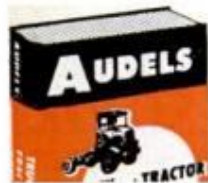
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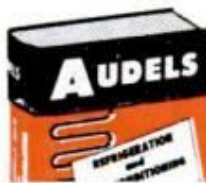
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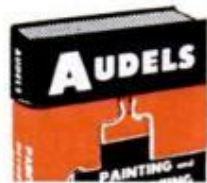
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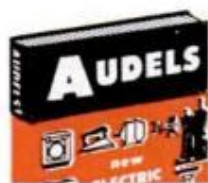
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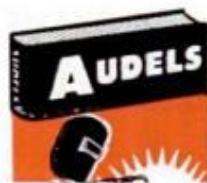
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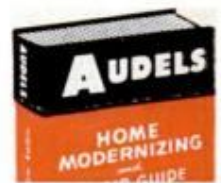
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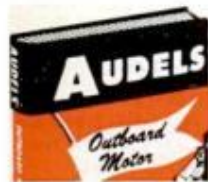
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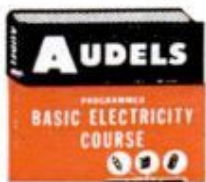
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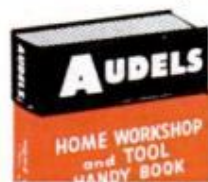
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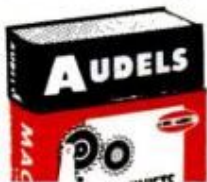
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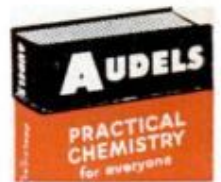
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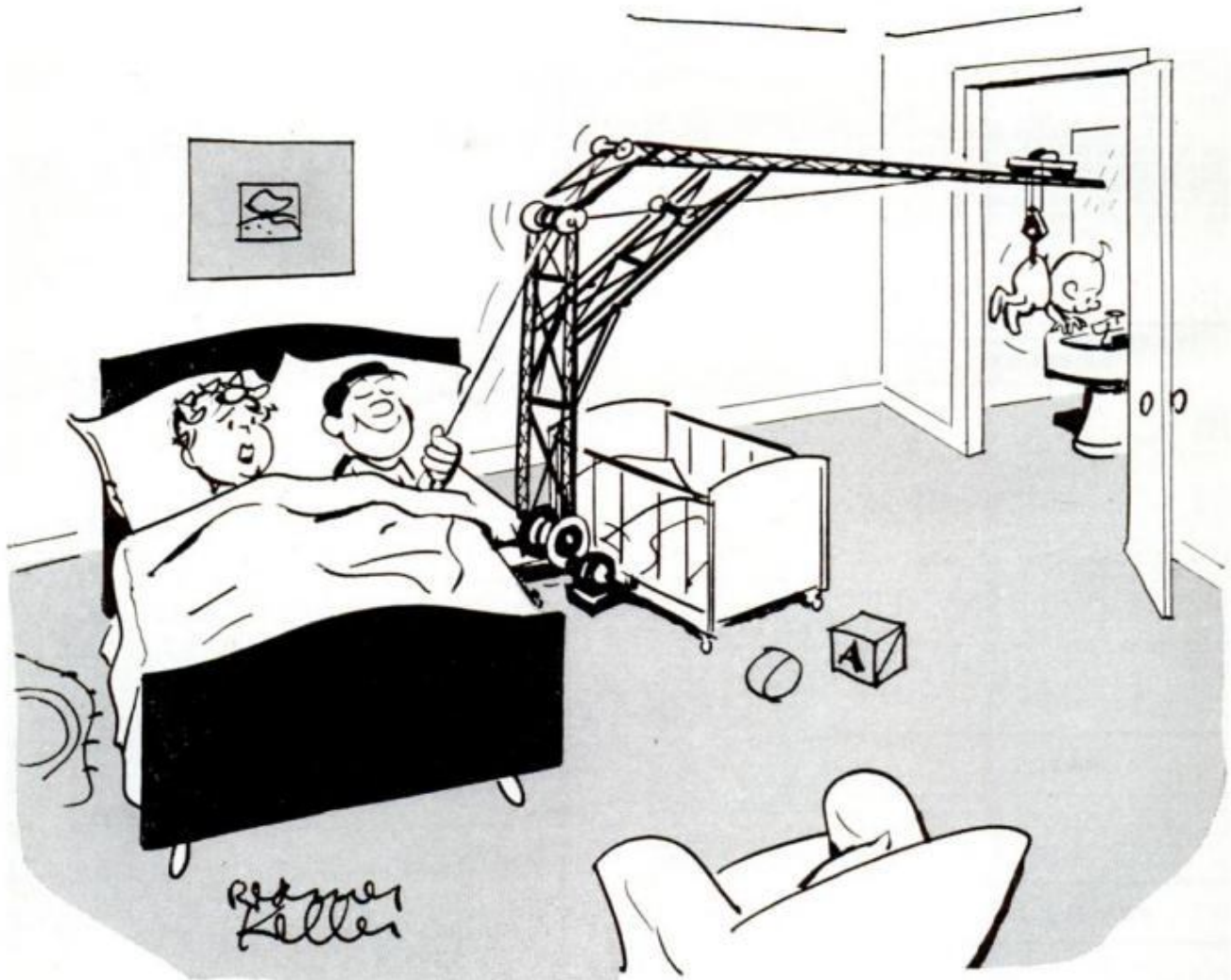
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MAN vs MACHINE in the

Checker Game of the Century

Can a computer learn to surpass a clever human being? Is lack of imagination its fatal flaw?

By John Pfeiffer

RECENTLY, ROBERT NEALEY of Stamford, Conn., won a checker match against a stubborn and resourceful adversary.

In a sense, the victory came as no surprise. Nealey does not lose often. Although he has been almost totally blind for years, he can more than hold his own against most sighted players and is currently Connecticut state champion as well as blind champion of the United States and Europe.

It was the identity of the loser, not the victor, that made this a noteworthy match. Nealey's opponent holds no titles and, in fact, is ineligible for tournament play. Nealey's opponent happens to be a machine—IBM's 7094 computer.

Men had played against computers before—games such as

BEFORE THE MATCH, conducted by mail, a test game was played at the research center. Checker champ Robert Nealey studies move while Dr. Arthur Samuel, IBM research consultant, pushes computer button





PROGRAMMING the IBM 7094 for the six-game match was no small task. Dr. Samuel shows a PM editor a single line of instruction in list, typed out by the machine itself, requiring a roll of paper 150 feet long

PUNCH CARDS to fill over two drawers were initially made up. They were condensed to the few researcher holds, called "squeeze deck" among computer men



ticktacktoe, gin rummy and blackjack—but not on a serious, fully competitive basis. Nealey, who has played and studied checkers for 46 years, conceded nothing to the 7094. He won one game, drew the other five, and knew he was in a fight every inch of the way.

“The games were very exciting,” he reports. “I set many traps, some of them planned 10 to 15 moves in advance, but the 7094 would not walk into any of them. Timing and intellectual tightrope walking characterized the match.”

One interesting aspect of this experiment is that if the Connecticut champion played the 7094 again, chances are he would lose. The computer gets better all the time. It not only plays first-rate checkers, but is also capable of automatically improving itself. That is one reason why computer scientists and checker enthusiasts will be studying the historic series of games for some time to come.

The man behind the machine is Dr. Arthur Samuel, IBM research consultant and a specialist in studies of artificial intelligence. He selected checkers for his basic investigations because the play is sufficiently complicated to call for considerable insight and analytical ability and an above-average memory.

For more than 10 years, Dr. Samuel has been working on systems of electronic

learning. He has succeeded in demonstrating that machines are capable of an activity that would certainly be called high-level thinking if exhibited by a human being. He is justly proud of the 7094's performance: “Of course, I wish the machine had managed to win one game. But I'm tremendously surprised. I didn't really expect it to do so well. It has definitely improved itself since a year ago; at that time it might have lost three games to Nealey.”

Strictly speaking, the 7094 is not a checker-playing machine but a general-purpose computer. It does what it is told to do, obeying sets of detailed instructions represented by numerical codes on punch cards. It spent only about 15 minutes a week on the match with Nealey. The rest of the time it handled a host of technical problems for IBM scientists, including calculations for the design of circuits for more-advanced computers, thus paving the way for its own eventual obsolescence.

As far as checkers is concerned, Dr. Samuel has developed two programs for the machine, identified simply as CKL (checker-learning) and CKP (checker-playing). The CKL program consists of a deck of about 500 instruction-bearing punch cards. Some of the instructions deal simply with fundamentals, describing the

FROM CARDS, instructions were transferred to magnetic tapes, shown on rack and on machines in background. Components of 7094 take up the entire room

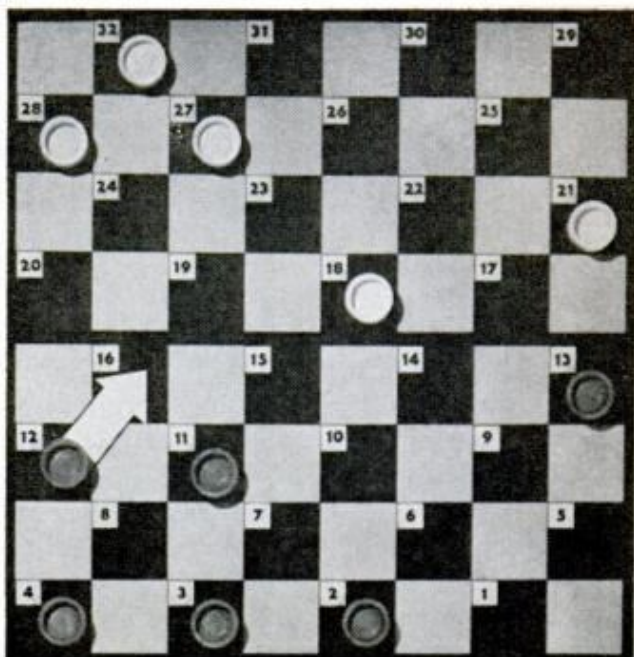
DURING MATCH by mail, Dr. Samuel played Nealey's moves on board. He fed this information into the big computer, which then spun out its countermoves



AUGUST 1964



The Machine Goofs



IN THE FIRST GAME, the computer played well up to the 27th move. That was a weak move, says Nealey, "and the start of the chain that led to the loss"

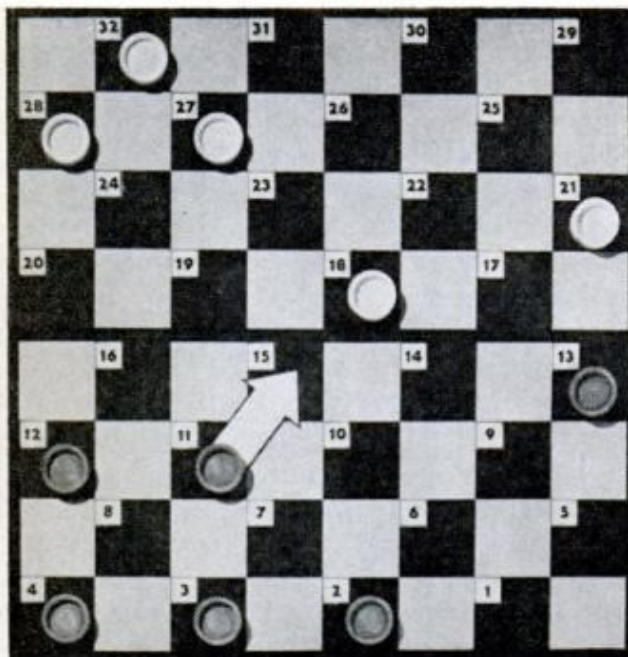
board and the rules of the game. Other instructions tell the machine how to go about the business of learning.

To get a rough idea of how CKL works, imagine that you are a beginner confronted with checkers arranged in a certain pattern and that your objective is to find the best move. You're given various criteria for making judgments, each criterion having a specified value. Thus a well-protected back row might be worth 9 points; threatening your opponent with a jump, 4 points; control of the center of the board, 7 points, and so on.

Next you examine every one of your possible moves in turn, and figure out scores for each of them. The move with the highest score should, of course, be your best move—but just to make sure, you look up the position in a checker text, which presents the accumulated knowledge of decades of master play.

Suppose you find that your contemplated move doesn't correspond to the book move. This indicates something is wrong with your scoring system. You change the values of your criteria so that now they actually do give the highest score to the book move. This way, you can keep learning as you go, examining position after position and comparing your moves with the book moves and continually readjusting the values of your criteria.

Here's the Correct Play



THE MOVE the machine should have made, according to the blind champion, was from square 11 to 15. But he thinks that the 2-6 also would have worked

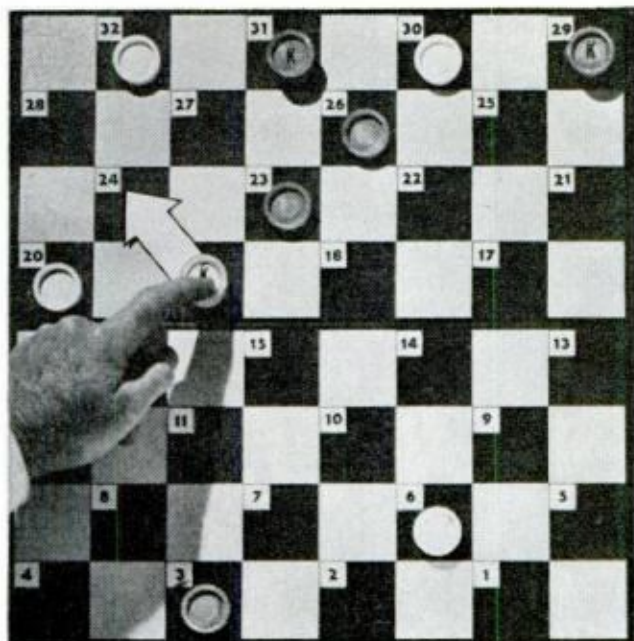
Generally, that is how the 7094 learns as it follows the detailed instructions of the CKL program, though the actual program is far more complex than we have indicated. The machine considers 31 different criteria, increasing or decreasing their relative values as it evaluates different positions and compares its moves with the masters' moves given in the textbooks. Notice what is happening. Samuel, working through his program, does not tell the machine how to play advanced checkers. He tells it how to *learn* to play advanced checkers, which is something else again.

Pupil Beats the Teacher

It so happens that the IBM researcher couldn't teach the 7094 much in a direct way since he knows almost nothing about the fine points of the game. He could beat the machine in the beginning, when it was a novice, but now he would be drubbed. Bright pupil that it is, the computer has far outstripped its teacher.

To ready the 7094 for its first full-fledged match with a nonelectronic expert, Samuel started it from scratch on the CKL program. At first, say after only five or 10 minutes, it would have lost to a mere beginner. But it rapidly became more sophisticated, automatically improving its scoring system and developing a stronger game. After a total of six hours of high-

How the Man Wins



NEALEY'S 68TH MOVE was 19-24. The machine did not respond. Having been well tutored in the rules of the game, it seemed to know that it was all over

speed calculating and the examination of more than 130,000 book games, the machine was ready—or almost ready—for Nealey.

The match started last fall and lasted more than five months. Playing at his home, Nealey sat at a checkerboard and studied present positions in each of the six games. (Though he isn't completely blind, he identifies the pieces by feel as much as by sight, largely playing with "my hands and my brains.") After selecting his moves, Nealey typed them on a postcard—he's a skilled touch-typist—and mailed them to the IBM Watson Research Center in Yorktown Heights, N.Y., where the computer is housed.

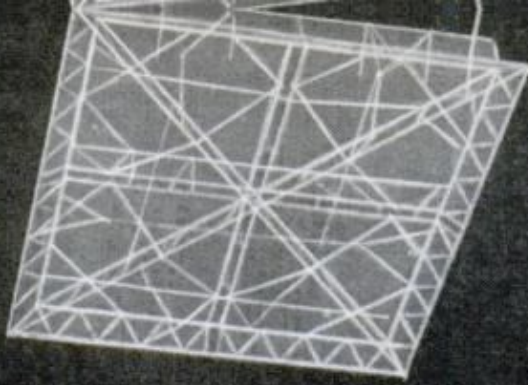
Then the 7094 went into action. It had reached a high level of proficiency during its training period with the aid of Samuel's CKL program, but it did not improve during the match itself. In other words, it played throughout at the same level by following the CKP, or checker-playing, program. This special set of instructions, also embodied in a deck of punchcards, calls for some prodigious calculating.

IBM technicians fed the computer two punch cards for each game, one indicating the present board position and the other

[\(Please turn to page 172\)](#)

A **CHART** of first game appears at right. A year later, Nealey can still recite most of the moves

| GAME MOVE | BLACK COMPUTER | WHITE NEALEY |
|-----------|----------------|--------------|
| 1 | 10-15 | |
| 2 | | 22-17 |
| 3 | 15-19 | |
| 4 | | 24-15 |
| 5 | 11-18 | |
| 6 | | 23-14 |
| 7 | 9-18 | |
| 8 | | 26-23 |
| 9 | 6-9 | |
| 10 | | 23-14 |
| 11 | 9-18 | |
| 12 | | 31-26 |
| 13 | 5-9 | |
| 14 | | 26-23 |
| 15 | 9-14 | |
| 16 | | 17-10 |
| 17 | 7-14 | |
| 18 | | 25-22 |
| 19 | 18-25 | |
| 20 | | 29-22 |
| 21 | 8-11 | |
| 22 | | 22-18 |
| 23 | 1-6 | |
| 24 | | 18-9 |
| 25 | 6-13 | |
| 26 | | 23-18 |
| 27 | 12-16 | |
| 28 | | 18-14 |
| 29 | 13-17 | |
| 30 | | 14-9 |
| 31 | 17-22 | |
| 32 | | 28-24 |
| 33 | 11-15 | |
| 34 | | 9-5 |
| 35 | 16-19 | |
| 36 | | 24-20 |
| 37 | 19-24 | |
| 38 | | 27-23 |
| 39 | 22-25 | |
| 40 | | 23-19 |
| 41 | 15-18 | |
| 42 | | 21-17 |
| 43 | 25-29 | |
| 44 | | 17-13 |
| 45 | 4-8 | |
| 46 | | 5-1 |
| 47 | 18-23 | |
| 48 | | 13-9 |
| 49 | 24-27 | |
| 50 | | 1-5 |
| 51 | 27-31 | |
| 52 | | 9-6 |
| 53 | 2-9 | |
| 54 | | 5-14 |
| 55 | 31-27 | |
| 56 | | 19-15 |
| 57 | 27-31 | |
| 58 | | 15-10 |
| 59 | 8-11 | |
| 60 | | 10-6 |
| 61 | 11-15 | |
| 62 | | 14-10 |
| 63 | 15-18 | |
| 64 | | 10-15 |
| 65 | 18-22 | |
| 66 | | 15-19 |
| 67 | 22-26 | |
| 68 | | 19-24 |



Major de Seversky's Ion-Propelled Aircraft

An ion-generated wind will lift and propel this incredible magic carpet of the future

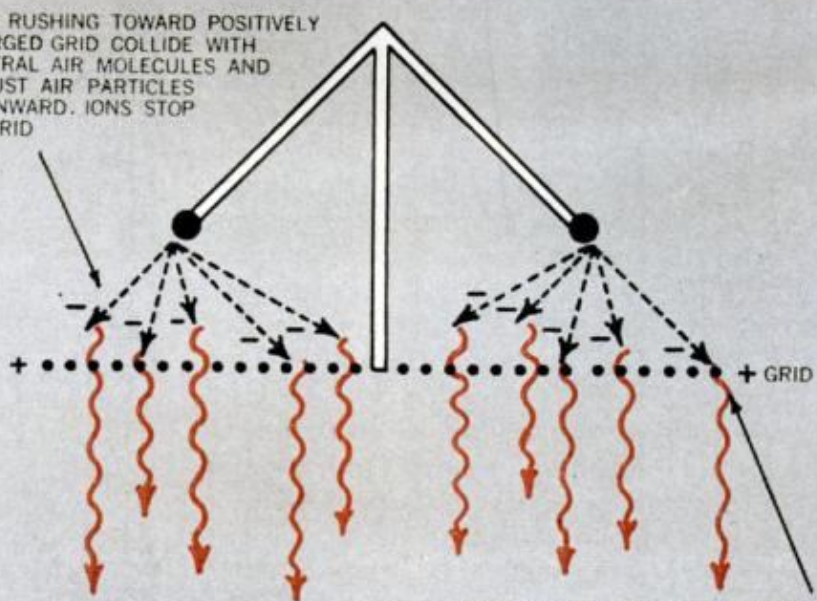
By Hans Fantel

IT WAS DOWNRIGHT SPOOKY. Without a sound, the peculiar, spiky contraption rose straight up, hovered awhile, climbed higher. Then it did a few graceful turns, stopped again, and just sat there silently in midair.

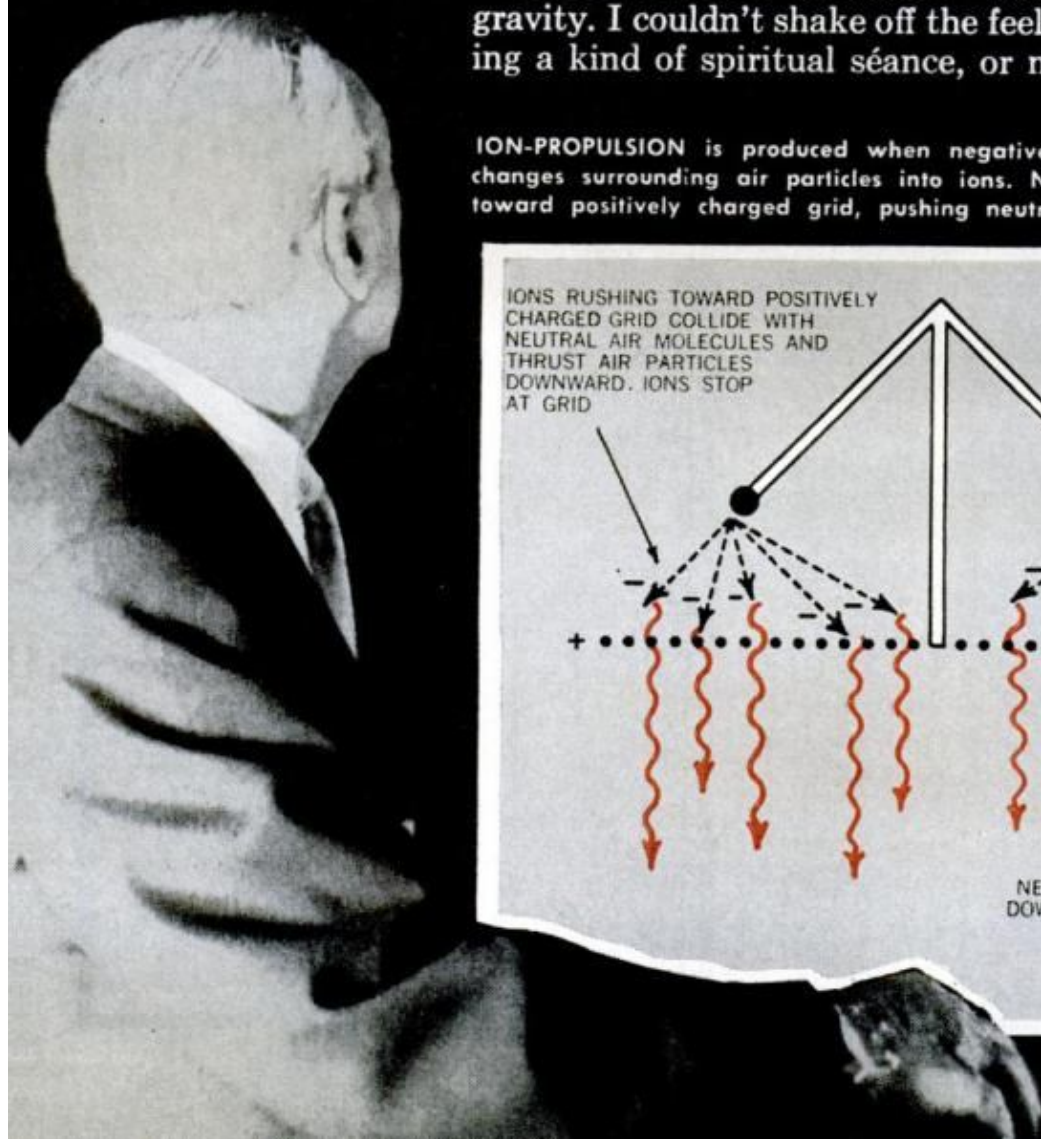
It seemed like levitation — some trick to overcome gravity. I couldn't shake off the feeling that I was attending a kind of spiritual séance, or maybe a Buck Rogers

ION-PROPULSION is produced when negative charge from upright arms changes surrounding air particles into ions. Negatively charged ions rush toward positively charged grid, pushing neutral air particles before them

IONS RUSHING TOWARD POSITIVELY CHARGED GRID COLLIDE WITH NEUTRAL AIR MOLECULES AND THRUST AIR PARTICLES DOWNWARD. IONS STOP AT GRID



NEUTRAL AIR MOLECULES, WHACKED DOWNWARD BY IONS, PASS THROUGH MESH OF ION-ACCEPTOR GRID. DOWNWASH OF AIR KEEPS IONOCRAFT ALOFT



show, instead of an engineering demonstration.

The eerie scene took place in the big, barnlike laboratory of Electronatom, Inc., a research firm in Long Island City, New York, devoted to the development of a new kind of flying machine. I had been invited to watch a scale model being put through its paces by remote control. What we saw was by far the oddest aircraft since the Wright Brothers' motorized kite. It had no prop. No jet. No wings. In fact, it had no moving parts at all. Looking somewhat like an old-fashioned bedspring, the rectangular rig is the nearest thing to a magic carpet. It needs no runway, takes off vertically, and is expected to climb as high as 60 miles. It can crawl through the air like a snail, or go faster than a jet. Nobody yet knows its speed limit.

After a while, I closed my mouth. But David Yorysh, one of the project engineers, noticed my puzzlement.

"Any questions?" he grinned.

"Yes. What holds it up?"

"Ions," said Yorysh, as he launched

into an explanation of a wholly new flight concept.

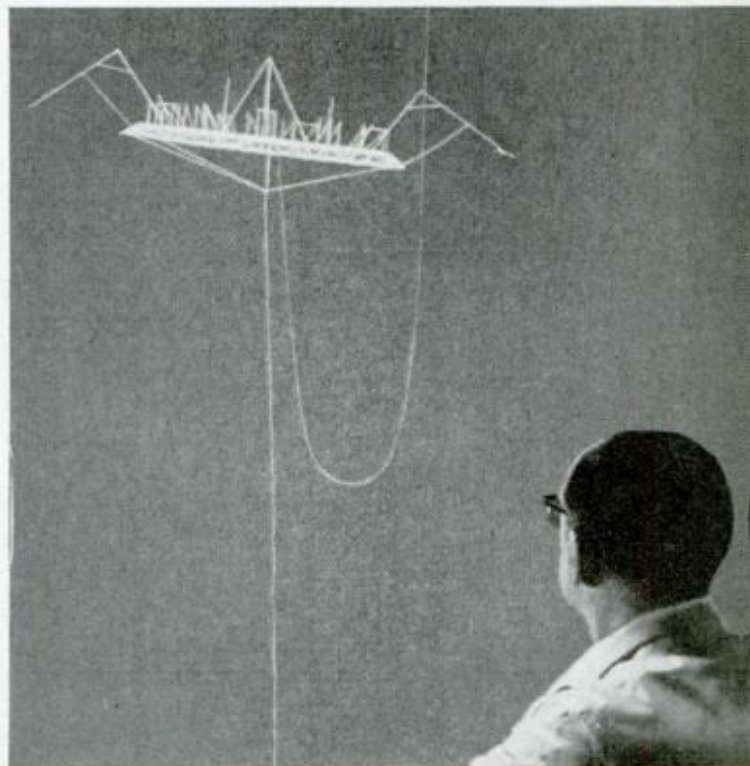
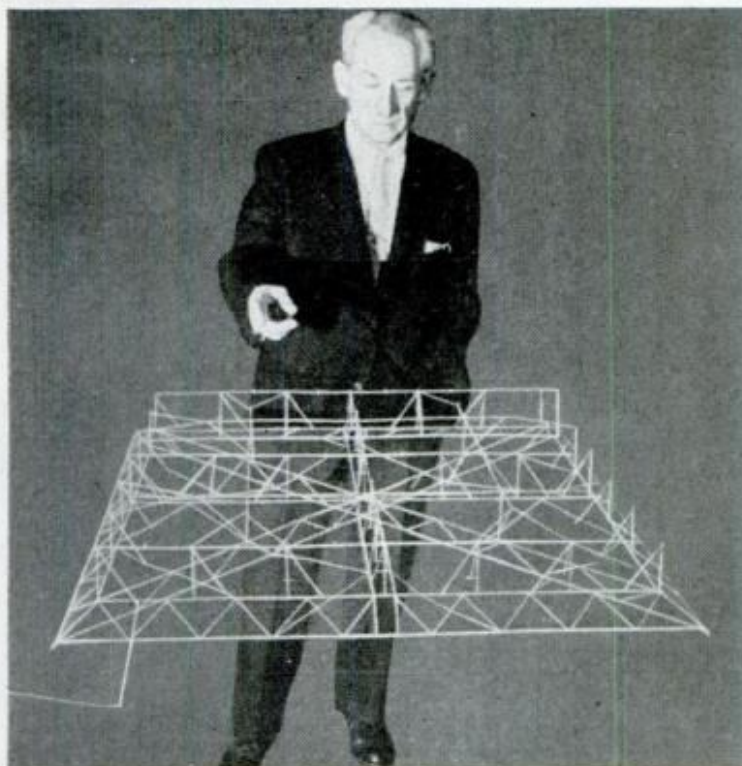
The magic carpet, called the Ionocraft, flies on pure electricity. It depends specifically on the fundamental principle of electricity that electric current always flows from negative to positive, and it uses two basic pieces of equipment to take advantage of this principle — tall metal spikes that are installed above an open wire-mesh grid. High negative voltage is shot from the spikes toward the positively charged wire grid, just like the negative and positive poles on an ordinary battery. As the negative charge leaves the spike arms, it peppers the surrounding air like buckshot, putting a negative charge on some of the air particles. Such negatively charged air particles are called ions, and these are attracted downward by the positively charged grid.

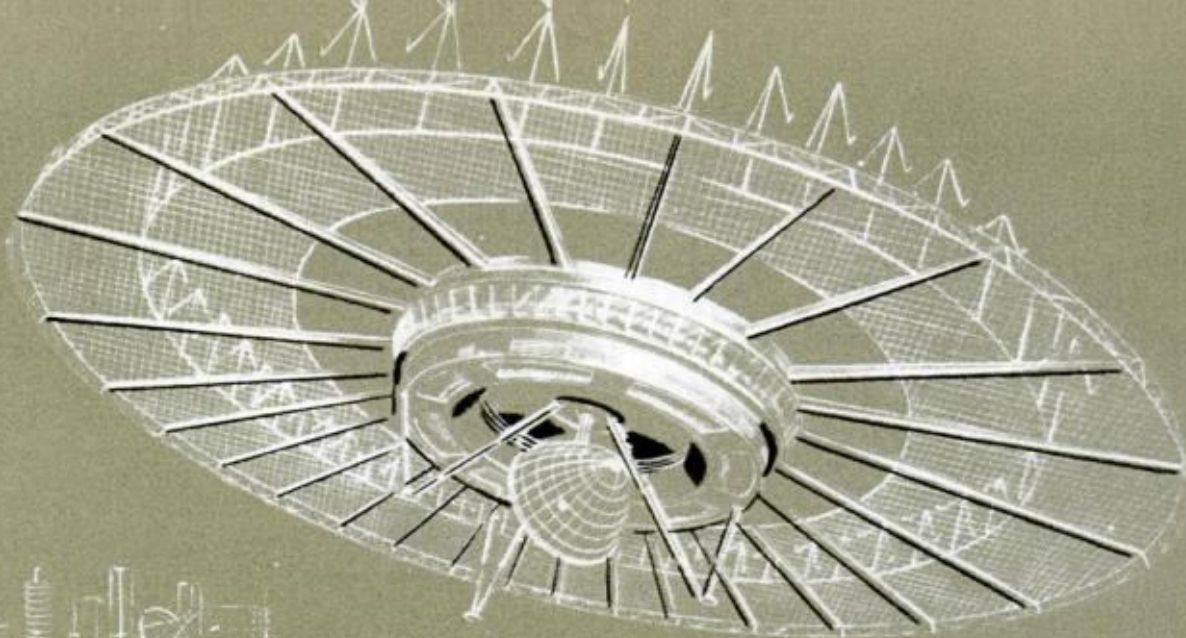
"Okay," I said. "But I still don't see what holds it up."

"I'm getting to that," Yorysh assured me as he spelled out the rest of the Ionocraft principle. In their mad rush from the ion emitter to the main

MAJOR DE SEVERSKY became interested in ion propulsion when he noticed air flow between two electrodes while working on another of his inventions

IONOCRAFT MODEL takes to air, completely unsupported except for downwash of air. Next step is to develop model that can carry its own power supply





IONOCRAFT COMMUTER may be solution for suburbanites of the future in congested areas, speeding hundreds of them short distances over heavy city traffic. Power would be supplied by chain of ground-based maser stations

grid, the ions bump into neutral air molecules—air particles without electric charge. The terrific wallop in these collisions hurls a mass of neutral air downward along with the ions. When they reach the main grid, the ions, being negative, are trapped by the positive charge on the grid. But the grid has no attraction for the neutral air particles that got bumped along. So the air flows right through the open grid mesh, making a downdraft beneath the ionocraft. The contraption rides on this shaft of air, getting its lift just like a helicopter—by sucking air down from the top.

"Aerodynamically, it works just like a chopper," Yorysh summed it up. "But instead of using a rotor and blades, we create the downward airflow electrically by means of an ionic discharge. The ions act on the air like a man treading water. They just push down."

The engineers working on the Ionocraft are the first to admit that their present rig is still a long way from any kind of practical aircraft. The model we saw measures only 1296 square inches and consists of about \$5 worth of balsa wood and aluminum wire. But the principle holds an important promise for the future of aviation.

The problem now is improving efficiency—getting enough lift from a given grid area and a given amount of energy. Present models cannot yet lift their own electric generators. They get power through a

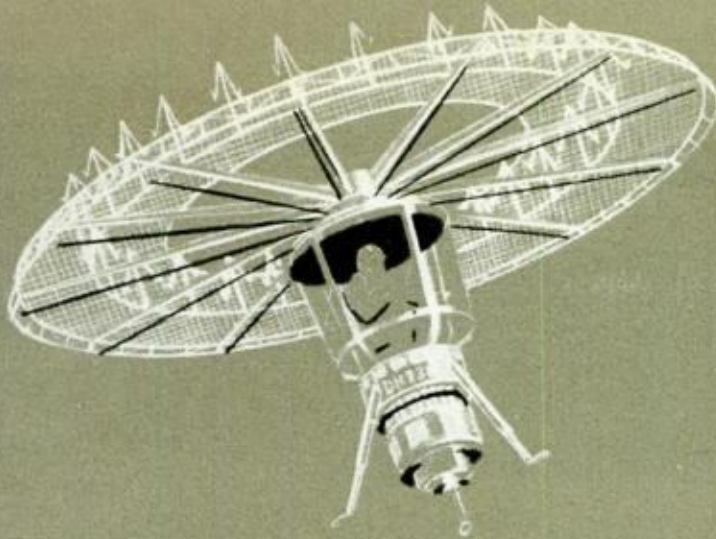
feeder cable, dangling down like an umbilical cord. Ionocraft engineers tend to be close-mouthed on performance figures. But they will tell you that at present it takes 90 watts (30,000 volts at 3 milliamperes) to fly a two-ounce model. Translated into ordinary power-to-weight ratios, this works out to roughly .96 hp. per pound, as compared with a typical .1 hp. per pound of helicopter or .065 hp. for a pound of Piper Cub.

But Ionocraft designers are hard at work upping efficiency. One possible power-boosting technique is to pulse the power in short high-energy bursts rather than to apply steady voltage. They are also trying out various grid patterns and ion-emitter layouts to minimize energy loss through turbulence in the downdraft.

Despite such unresolved problems, the development crew almost bristles with optimism, and the most optimistic of all is the Ionocraft's inventor, Major Alexander P. de Seversky. No crackpot, Major de Seversky is a practical visionary who in many areas has been far in front of his field.

"We hope to fly a model with self-contained power, perhaps by the end of the year," he told me, confidently. "Ultimately, the ionic drive will prove more efficient than either propeller or jet as a method of aircraft propulsion.

"It will achieve lift at less expenditure of energy and fuel than any other existing



ONE-MAN IONOCRAFT could be tomorrow's traffic patrol car or, in combat, hovering vehicle for guerrilla wars, all but impervious to some minor grid damage

form of aircraft. In fact, it will prove the most efficient method of converting electricity into motion."

Coming from a man of de Seversky's background, such a statement has an almost prophetic ring. A leading aircraft designer and ace flyer for the past 50 years, de Seversky's ideas have often been ahead of their time—sometimes to the embarrassment of other aviation experts. Losing his right leg during his first flying mission in World War I didn't deter him from downing 13 enemy aircraft in later flights. After coming to the United States from his native Russia, de Seversky developed bombsights and course computers during the 1920s that were the forerunners of today's inertial guidance systems.

Worked with Billy Mitchell

Later he pioneered the design of the cantilever-skin stressed wing that is now in general use. He was a consultant to General Billy Mitchell in the historic airplane-versus-battleship tactical experiments of the 1920s, and as a special consultant to the U.S. Chiefs of Staff helped formulate basic concepts of air strategy in World War II. He also contributed to the designs of the P-35 and P-43 which led to the development of the P-47 Thunderbolt, one of America's most effective wartime fighter planes. Now a trim and sprightly man of 70, he still likes to take out experimental jet planes for a spin.

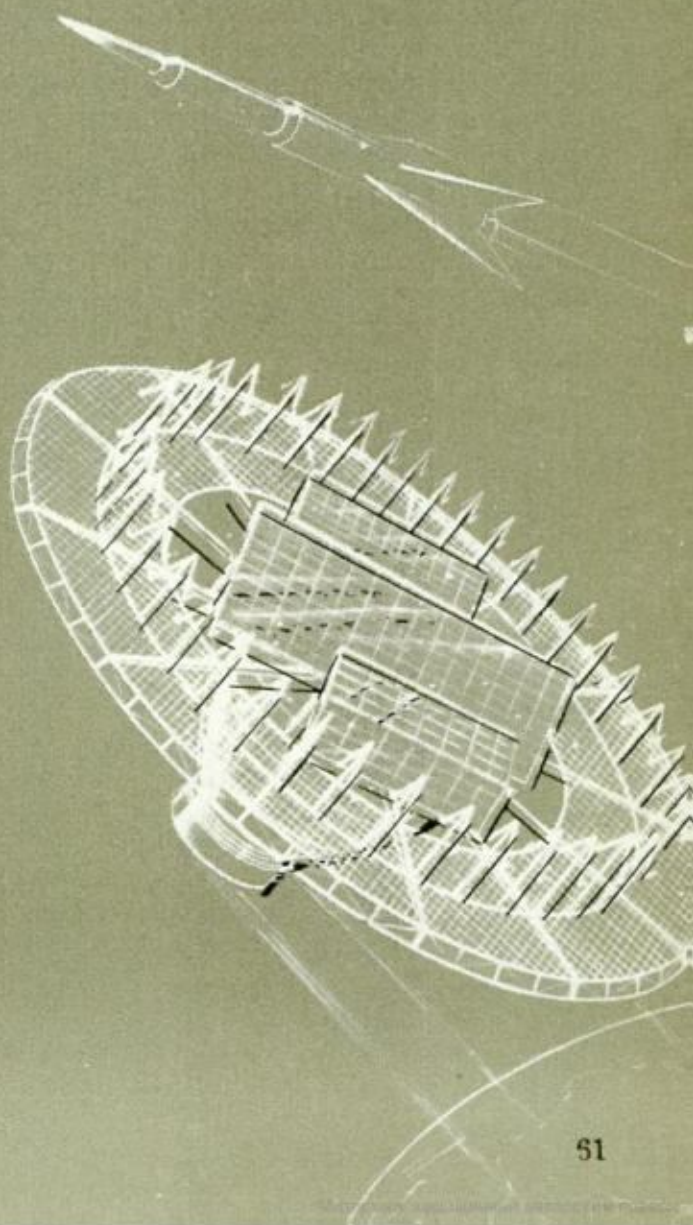
"The idea hit me as I was working on an electrostatic air-cleaning device which I had invented," the major recalled. "That gadget was designed to fight air pollution by electrically charging the particles in industrial smoke and then trapping them on a liquid electrode with the opposite charge." De Seversky noticed an air flow developing between the two electrodes, caused by the ionization process previously explained. "To an old flyer like me," said the major, "anything that stirs up a wind is a flying machine. So I began to develop the idea."

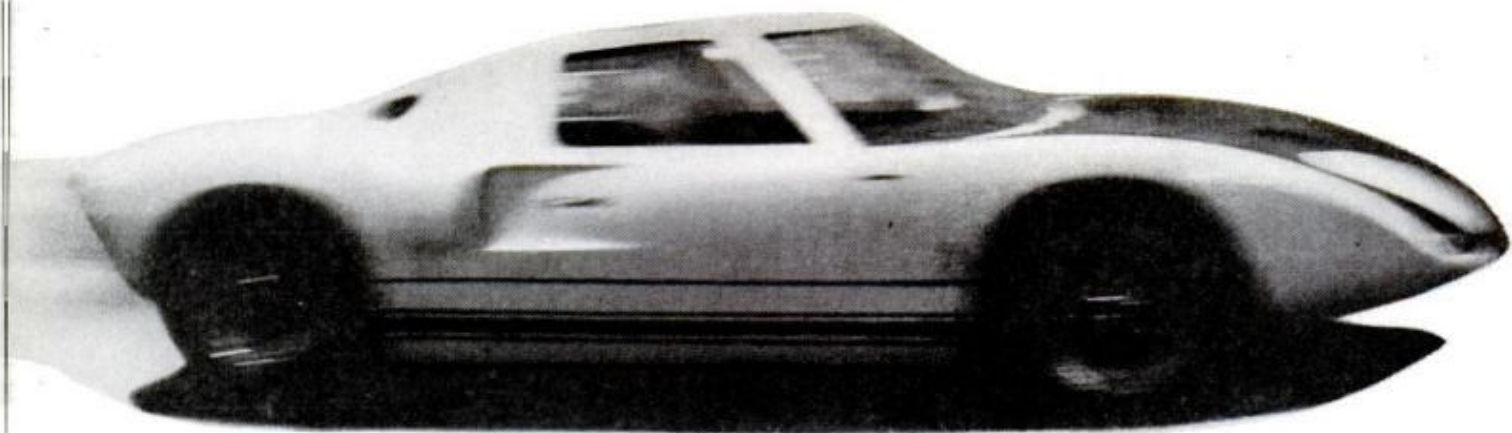
The major seemed concerned that the Ionocraft might be mistaken for a kind of space vehicle.

"This is not a spacecraft," he explained emphatically to forestall any possible misunderstanding. "It's an airplane, designed to operate within the atmosphere. But it

(Please turn to page 194)

ANTI-MISSILE IONOCRAFT, powered by sunlight, could hover indefinitely in upper atmosphere, then home in on incoming warhead and blast it out of sky





WIND-TUNNEL TESTS dictated the shape of the GT cars, Ford says, as well as the locations of the intake and exhaust for the engine and cooling air flow. New car is a larger, closed version of the Mustang I sports car

Ford on the GT Track

Seats inflate and pedals and steering column adjust in these new 200-m.p.h., 350-hp. racing cars

THREE new grand touring cars by Ford are running on European road racing tracks this summer, trying to add 200-m. p. h. racing-car luster to Ford's "total performance" claims.

The road team was scheduled to run in the 1000-kilometer (621-mile) German Nurburgring race just after Memorial Day and in the 24-hour LeMans endurance race in June. Their U.S. debut will be at Bridgehampton, N.Y., in September.

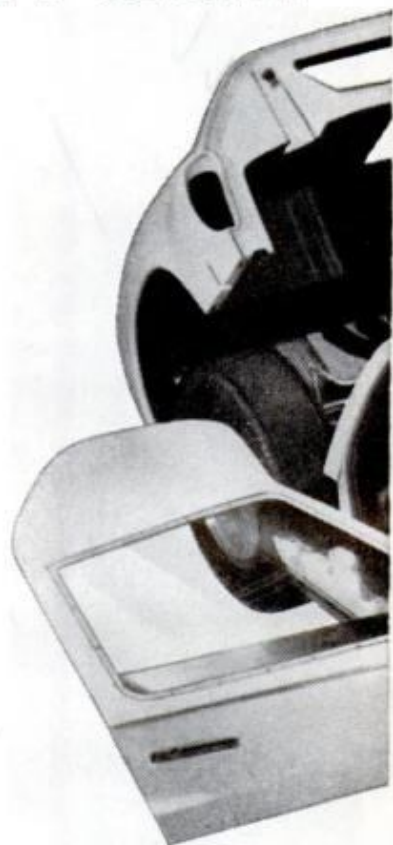
Entered as "manufacturer's prototypes," the Ford cars are immune from the requirement—applied to other classes—that they be produced in volume. Racing's international governing body (FIA) requires that at least 1000 identical cars be produced to qualify a manufacturer's entry as a production model.

As in Ford's experimental Mustang I, the GTs have seats integrated with the frame and allow for driver variations by making the pedals and steering column length adjustable—while running. Also, as in the first Mustang, the engine is between the driver and the rear axle for superior weight distribution. But the radiator is in front, with coolant circulated back to the block. Air is taken in below the car's nose and exhausted at a natural low-pressure area just forward of the windshield.

The engine is a 256-cubic-inch pushrod V8 similar to the Fairlane offshoot adapted for Indianapolis. The GT cars each have four big, two-barrel Weber downdraft carburetors. Ford says the engines develop "well over 350 horsepower at 7200 r. p. m." The cars weigh 1825 pounds without fuel, with only 42 percent on the front wheels.

The four-speed-forward Culloti transmission has ratios packed closely between the 2.50:1 First and 1:1 Low. One rear axle has a 3.09:1 ratio, the other 3.55:1.

A hand pump in the cockpit lets the driver change position slightly by inflating the pneumatic seats.—*Ed Nelson*





FUEL TANKS, with a 37-gallon capacity, are in the door sills. The brake handle operates horizontally. Air flows to the car's interior through body channels



SINGLE, SMALL SUITCASE will rest on an asbestos shelf over the engine to comply with the requirement for "luggage space" in grand touring cars



HIGH-SPEED PIT STOP SERVICING will be aided by car's large removable body sections. A multi-connector plug at each end feeds the lights. Beefed-up suspension system is adjustable so that it can be tailored for different tracks

THE TAMING



By James Joseph

This irascible metal ruined saws, resisted dies, turned brittle when welded. But it also met the fiery test of flight at Mach-3 speeds

WHEN THE TOP-SECRET A-11 was unveiled early this year, headlines acclaimed it as the "world's fastest and highest flying jet." And it probably is, with a speed of over 2000 m.p.h. and an estimated top altitude above the 100,000-foot mark.

But the headlines tended to obscure the most significant fact of all: The A-11 was constructed largely of *titanium*, the Space Age's craziest, most cantankerous metal.

More than one metallurgist has grown old before his time, trying to tame titanium.

Saw the metal, and it "work hardens"—grows harder the longer you saw it. Bend cold titanium and it "sneaks" back to its original shape. Heat a thin sheet of it and, instead of expanding as steel or aluminum do, it wrinkles.

To weld titanium in air is to invite disaster. It is highly reactive to atmospheric gases—oxygen, hydrogen and nitrogen—which easily contaminate it. As a result, the metal becomes so brittle that you can break it with your hands.

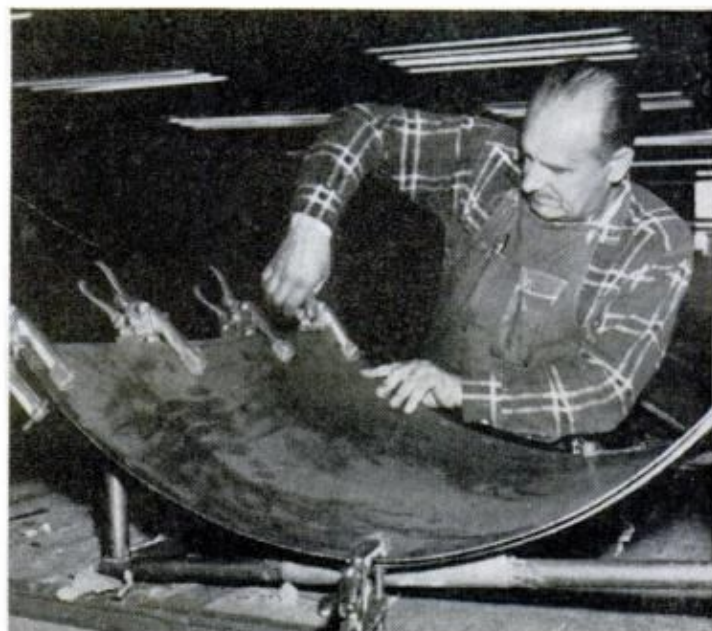
"It took us months to learn how to grind titanium without cracking it," says an engineer who works on jet engines for Pratt & Whitney, producer of the A-11's power plant. "And other machining problems

were just as great. We had to develop new cutting tools and new fabricating techniques."

Even if parts made from the metal didn't crack while being shaped, they often did just sitting on a shelf. This might occur days after the part had been made, or even years later.

Though titanium was a metallurgist's nightmare, its potential was too great to ignore. It has properties that suit it almost ideally to the Mach-3 speeds of tomorrow's supersonic transports and today's A-11. Titanium is nearly as strong as steel, but is 44 percent lighter. And it can withstand Mach-3 temperatures—450-650 degrees F.—without losing its strength. In that range of heat, even the

MACHINIST vs. titanium. It sometimes was a wrestling match between man and metal in shaping parts for A-11. Here, metal sheet is clamped to template



POPULAR MECHANICS

OF TITANIUM



THE NEEDLE-NOSED A-11 points the way to new capabilities of flight. A titanium skin permits the plane to do better than 2000 m.p.h. for sustained periods

best aluminum alloys weaken. At 400 degrees, for example, aircraft aluminum has less than half of the structural strength that it has at room temperature.

In addition, titanium resists corrosion, a quality that makes it useful for marine application. In time, it may be the basic metal for submarine hulls.

It took about a decade of hard-headed research, much of it in the early 1950's, to gradually bring titanium under control. As technology improved, more of the metal was used in planes, for such parts as fire walls, jet tail pipes, landing-gear parts and air conditioning ducts.

More than 580 pounds of titanium, 16 percent of the total weight, were used in Pratt & Whitney's J-57—the jet engine

that powers the Air Force's venerable KC-135 aerial tankers, predecessors of the Boeing 707 jetliner. Some 1200 titanium parts went into our first supersonic fighter, North American's F-100. More than 12,000 pounds of the remarkable metal are incorporated in the new B-70 supersonic bomber. In addition, there's plenty of titanium in the second stage rocket case of the Minuteman and in both the Mercury and Gemini spacecraft.

But the needle-nosed A-11 is the first plane to be made almost entirely of titanium alloys. It has a titanium skin, and there's more of the metal in its wing spars, small hardware and its twin J-58 Pratt & Whitney turbojet engines.

Though titanium's behavior is singular,

BECAUSE AIR CONTAMINATES IT, titanium must be shielded during welding. One way: Surround metal with plastic and "blanket" the part with inert gas



AUGUST 1964

THE TWO-MAN GEMINI spacecraft, shown here under construction, depends on titanium for strength and resistance to tremendous temperatures of re-entry



65

its occurrence is not. The silvery metal is found in most rocks and is distributed all over the earth. It is the ninth most common element and the fourth most common structural metal. There are two main ores—ilmenite and rutile, which looks like coarse black sand to the miner.

Little Dab Does It In

But the balkiness of titanium shows up early—at the stage where the ore is refined. Great care must be taken to avoid contaminating the metal. One problem of delayed cracking, for example, was traced to an acid wash that liberated hydrogen. The molten titanium and the gas readily combined, introducing a weakness into the metal. “All it takes is a dab of hydrogen,” explains one researcher, who pointed out the problem has now been licked, however.

Working the metal is no picnic either. Titanium undergoes changes in its crystalline structure at very high temperatures. In its *alpha* phase—below 1625 degrees F.—the metal has great strength but is almost unworkable. In its *beta* phase—above 1625 degrees F.—it is easy to work but is comparatively weak. Once heated above its critical temperature, titanium never regains its original strength.

Researchers finally found a way to get around this. By adding other metals, they were able to produce workable but strong alloys. “What you’re after,” explains a scientist employed by the Titanium Metals Corporation of America, “is an alpha-beta alloy which contains enough beta stabilizers—say, vanadium or molybdenum—to give the titanium a significant degree of beta characteristics at room temperature.”

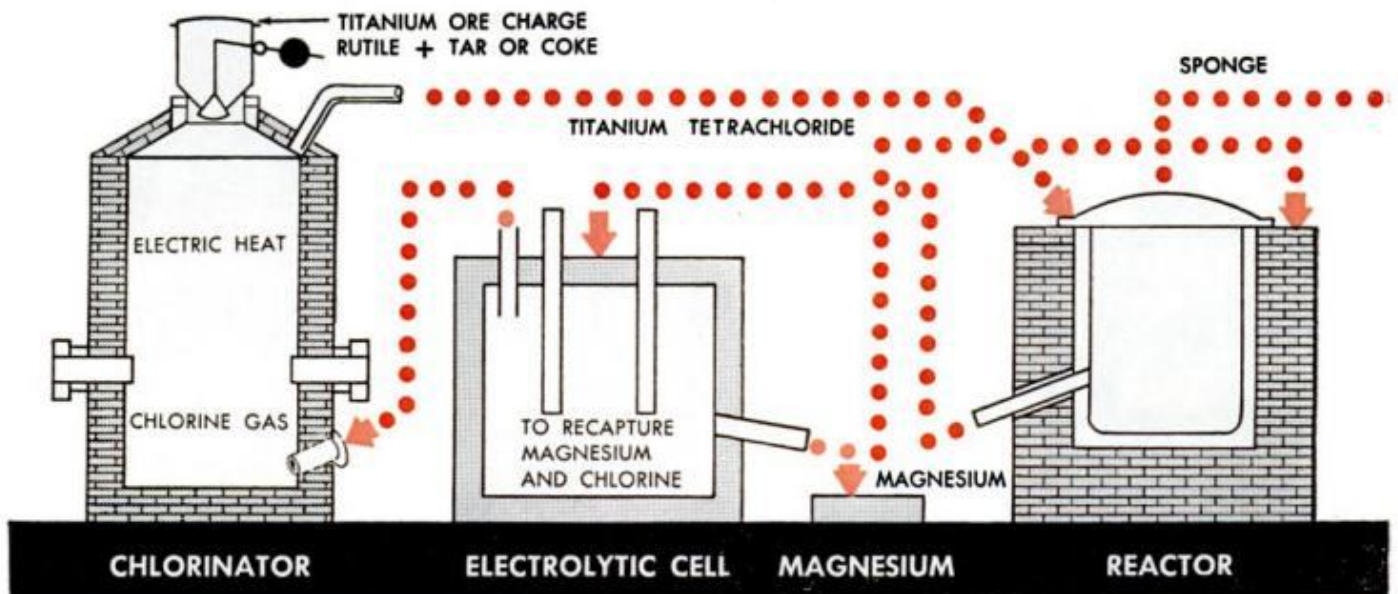
A relatively small amount of stabilizing

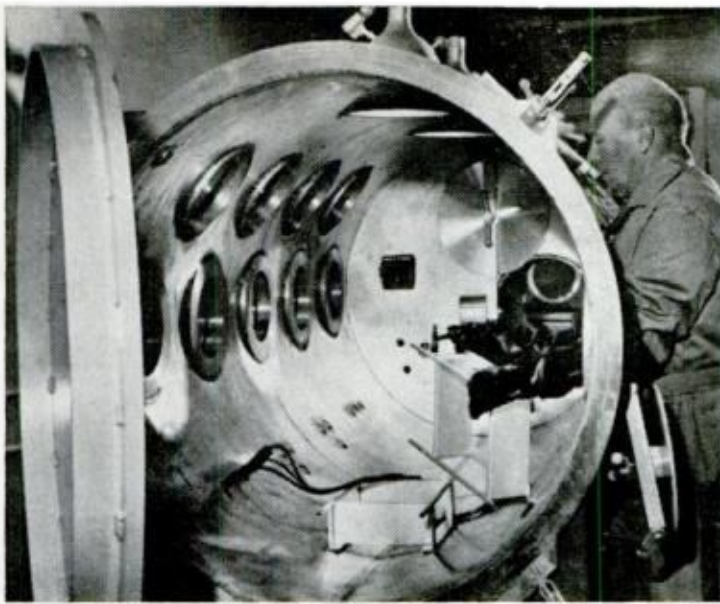


WELDER CAN WORK in the open with this torch. It has dual concentric shields that duct argon gas over the weld, shutting out the contaminating air

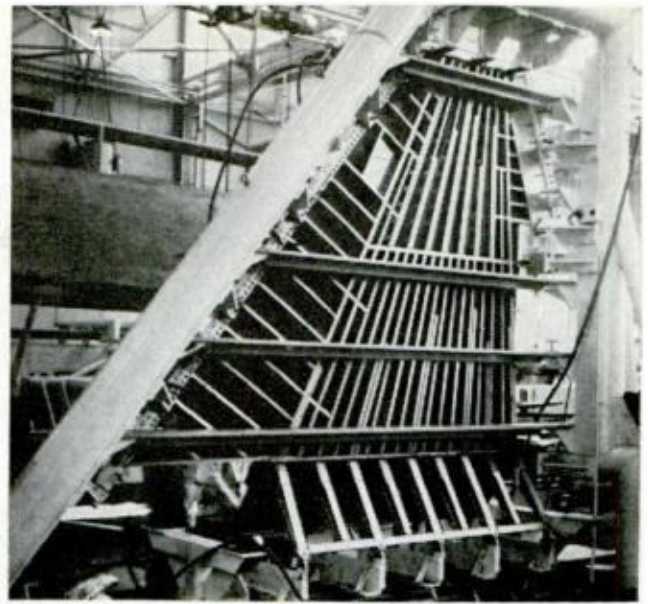
agent will produce the wanted characteristics. For example, Ti-6Al-4V—the most common alpha-beta alloy in commercial use—contains 6 percent aluminum, 4 percent vanadium and 90 percent titanium. It’s more than likely that a lot of the “4-6” alloy, as well as half a dozen others, are used in the A-11. And at least some of those alloys were thoroughly tested in the rocket-powered X-15 research aircraft that has hit 4000 m.p.h. for short periods. It is reported that 18 percent of the X-15 is made of titanium alloys.

But, once you have the desired alloy of titanium you encounter more problems when you begin to work with it. When molten or red hot—as under the welder’s torch—titanium turns into a metallic blotter. Unless shielded from the atmosphere,





THIS VACUUM CHAMBER helped Lockheed lick welding problems. Welders work through ports fitted with long, air-tight gloves. In use, the door is closed



TITANIUM was used for spars and ribs of this wing being built for the X-15 rocket plane. X-15 technology paved the way for engineering of the A-11

it becomes contaminated and brittle.

To counteract this, some titanium stock is annealed in special vacuum furnaces. Or an easier, less costly method is to roll sheets and bar stock to a larger dimension than is required. Once cool, the contaminated outer surface is ground off. Sometimes, as much as a hundredth of an inch of "brittled" metal must be wasted.

Silicate Cocoon

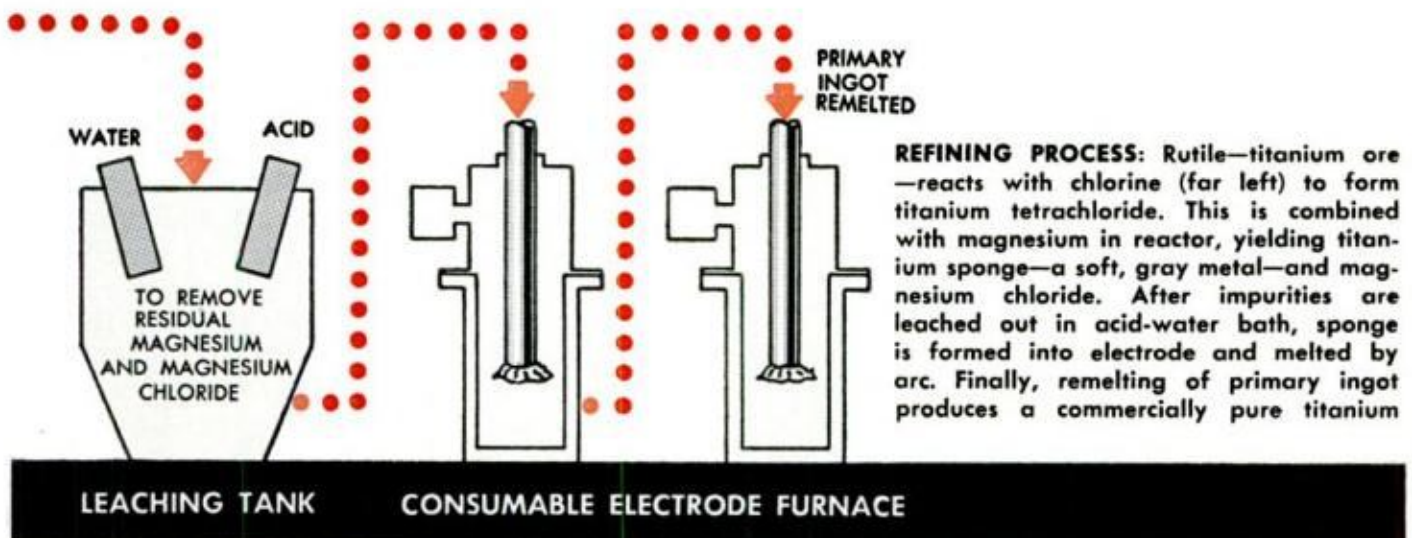
Plane makers, who simply can't put their plants into vacuum chambers, have found other solutions. North American Aviation, a pioneer titanium user and developer, sprays the touchy metal with a thousandth-inch coating of a silicate compound that seals out the air.

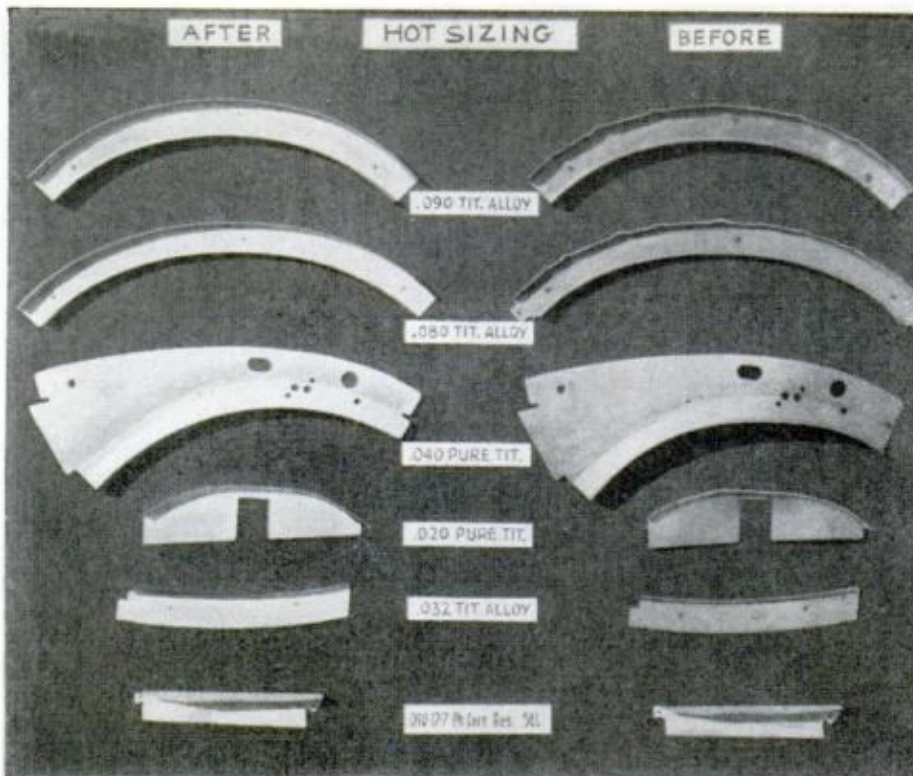
"It works perfectly," says Wayne A.

Reinsch, metals supervisor for the B-70. "Coated with the compound, titanium can be heated for upwards of three hours at 1100 degrees F. without contamination."

Another titanium processor—Basic Industries, Inc., of Gardena, Calif.—presses titanium to shape at temperatures up to about 1400 degrees F. The heat leaves a layer of oxidation scale on the metal's surface. But a blast of aluminum oxide and glass pellets, shot from a sandblast-type nozzle, descales the metal and gets down to unaffected alloy.

Trickiest of all titanium's problems is the one of welding. "It's more the art of shielding than it is the science of joining," is how one engineer described it. All the air surrounding the weld must be removed and replaced with a noncontaminating, in-





TEMPERATURE is key factor in fabricating titanium. Parts lined up at right in photo were made at room temperature—and they wrinkled and sprang out of shape. Defects were corrected by heating parts to 1200° F. and reshaping them as shown at left

ert gas such as helium or argon. Small parts are often welded in a vacuum chamber filled with argon. The welder stands outside the chamber, with his hands in special gloves that protrude inside. Windows permit him to see what he's doing.

Lockheed, the A-11's builder, operates such a chamber. But many sections of the A-11's airframe wouldn't fit into the eight-foot-long chamber, requiring new techniques and tools: welding torches with an extra nozzle that blankets the weld with inert gas, and boxlike chambers that enclose the weld, shielding it from the air and bathing it with argon gas.

North American Aviation welders surround titanium parts with clear plastic and their torches work inside the plastic cocoon.

Toughest of all problems, though, is welding titanium pipe. It's not enough to shield the pipe's exterior surface; the inside must be protected, too. The pipe has to be sealed, purged of air, and filled with argon. One titanium fabricator recommends the use of six times as much inert gas as the air it replaces.

Wrapping in Glass

When processors extrude titanium into angles and tubes, they begin by wrapping starting billets in glass, which acts as a lubricant and protects the fiery metal (heated to about 1800 degrees F.) from air-contamination. This way, as much as

1000 feet of tubing can be extruded in less than a minute. When the extrusions have cooled, the glass and any oxidation scale are either removed by a chemical process or they are blasted off.

Finding the Ghost

Sheet-metal titanium is not workable at room temperatures. When pressed into a shape, it will "sneak" back. The metal must be heated, perhaps as high as 1400 degrees F., before being pressed between heated dies. "The trick," explains one metallurgist, "is in knowing precisely at what temperature the alloy you're working with gives up the ghost and behaves."

Drilling, sawing and turning titanium can be frustrating. If a machinist slows or stops the tool, the maverick metal hardens and becomes impossible to cut through. But Boeing, an old hand with titanium, now says that the metal is no harder to machine than stainless steel. Still, it's slow-going, with the emphasis on slow speeds, a lot of pressure and plenty of coolants. Some machinists cool their cutting tools in a bath of carbon dioxide at -109 degrees F.

Nothing is easy in working with this contrary, nonconformist—but highly useful—metal. It resists every inch of the way: it resists being refined, milled, shaped and welded. But today it's safe to say that titanium has been tamed. The A-11 is flying proof of that. ★★★

How It Feels to Drive TOMORROW'S CAR

An amazing trio of power steering, brakes and throttle can give you pushbutton driving now

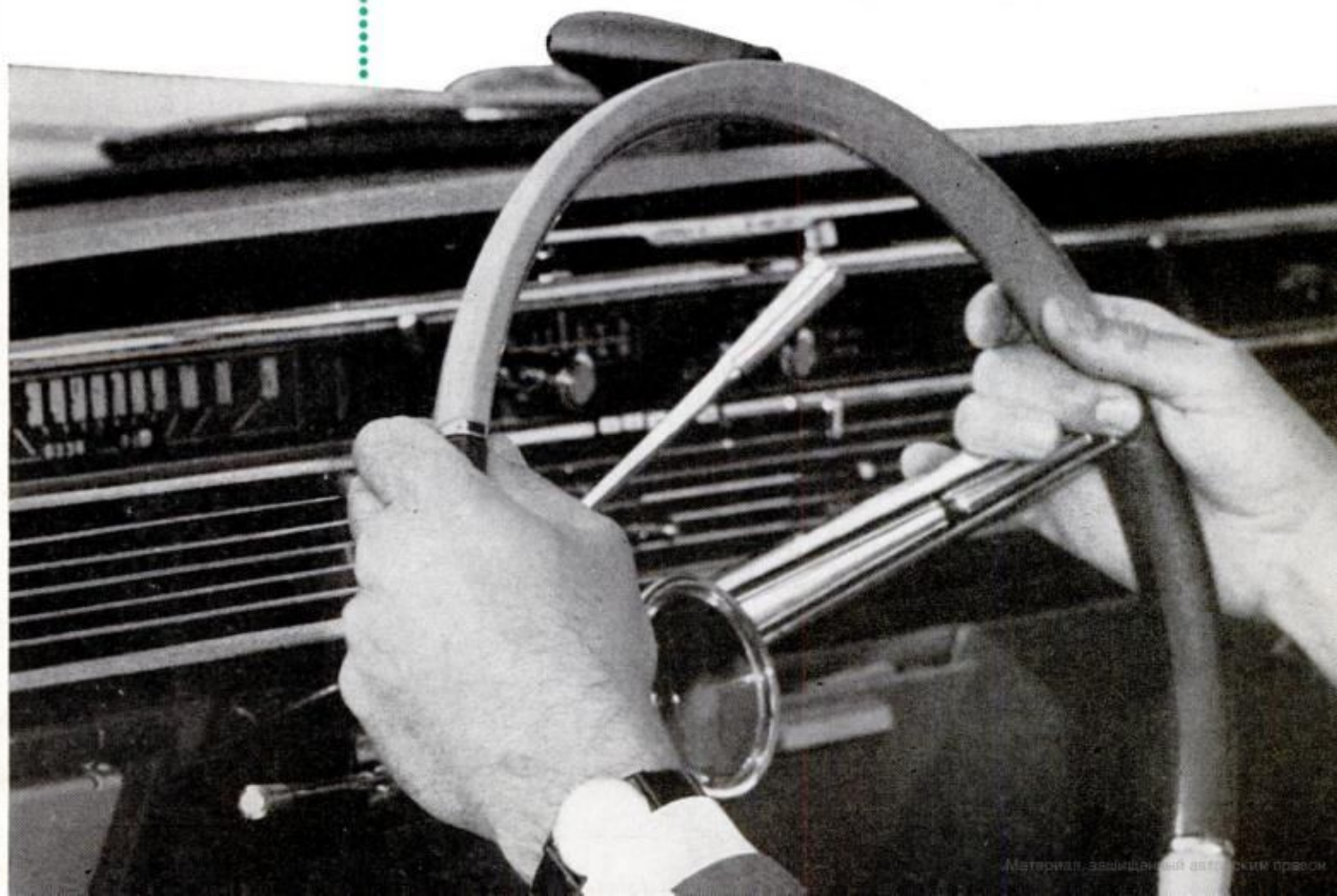
By Jim Whipple

HAVEN'T YOU EVER WISHED for a car that steered as directly and maneuvered as quickly as your bicycle did? Or a car with controls so responsive that it would stop or go securely, almost at the instant that your mind triggered your muscles?

This would really be the car of tomorrow, requiring no hand-over-hand winding of the wheel rim, no awkward lifting of your foot and stabbing at the brake pedal, no tiresome pumping of the accelerator pedal or aching heel tendon on long drives.

Recently, we drove just such a "car of tomorrow" through the streets of South Bend, Indiana.

Actually, there are several of these cars of tomorrow on the roads of northern Indiana. There's a Rambler, a Pontiac, a Thunderbird, a Cadillac and others. These cars are '64 models



right off the assembly line, but they've been specially equipped with some amazing components designed by the Bendix Products Automotive Division of South Bend.

Three new control systems make up the Bendix package for their "car of tomorrow"; the Varamatic power steering gear, and "No Travel" Brake-and-Throttle systems which feature full power hydraulic brake and vacuum-powered throttle.

This "package" doesn't alter the appearance, comfort or performance of the car in any way. In fact, the only thing that's "different" about the car as you slide behind the wheel is the absence of conventional pedals jutting up from the floorboard. In their place are rubber-covered treadles placed side by side flush with the slanted toeboard and comfortably convenient for your right foot to rest upon. The steering wheel is original in every way, so there are no new or unnatural positions for your hands and feet to become accustomed to before driving.

The Feel of Tomorrow's Driving

When we started up our first Bendix-equipped car of tomorrow, a '64 Thunderbird, we were cautioned to be alert for the "no travel" response of brake and accelerator treadles. "Steering," said Bendix engineer Dick Chwalek, "will be quite natural for you. Although it's different, there's nothing really new to learn."

He was right—and wrong. What there was for me to learn was something very old—the direct, natural steering response of a well-balanced bicycle!

I touched the accelerator pedal, squeezed gently, and the car moved off down the parking lot. Easing back slowed the car down and I shuffled my foot somewhat gingerly over to the left on the brake treadle and pushed down with moderate force. The brakes took hold right now and brought me up against the seat belt as all four wheels clawed gravel.

"You were prepared to follow the pedal down," said Chwalek. "You don't need to. Just press on the treadle."

Now I was ready for my first turn with Varamatic power steering. I moved my hand to the left and the car started to turn immediately. It took no more than a quarter of a turn of the wheel to make the car turn 90 degrees left out of the parking lot!

As I headed into the street I made a quarter turn to the right and swung the

T-Bird's nose from due East to South. Then a squeeze on the accelerator with my right toes and we were rolling down the street at 30 m.p.h.

After slowing down for a couple of intersections, I oriented my reactions to the brake and accelerator treadles.

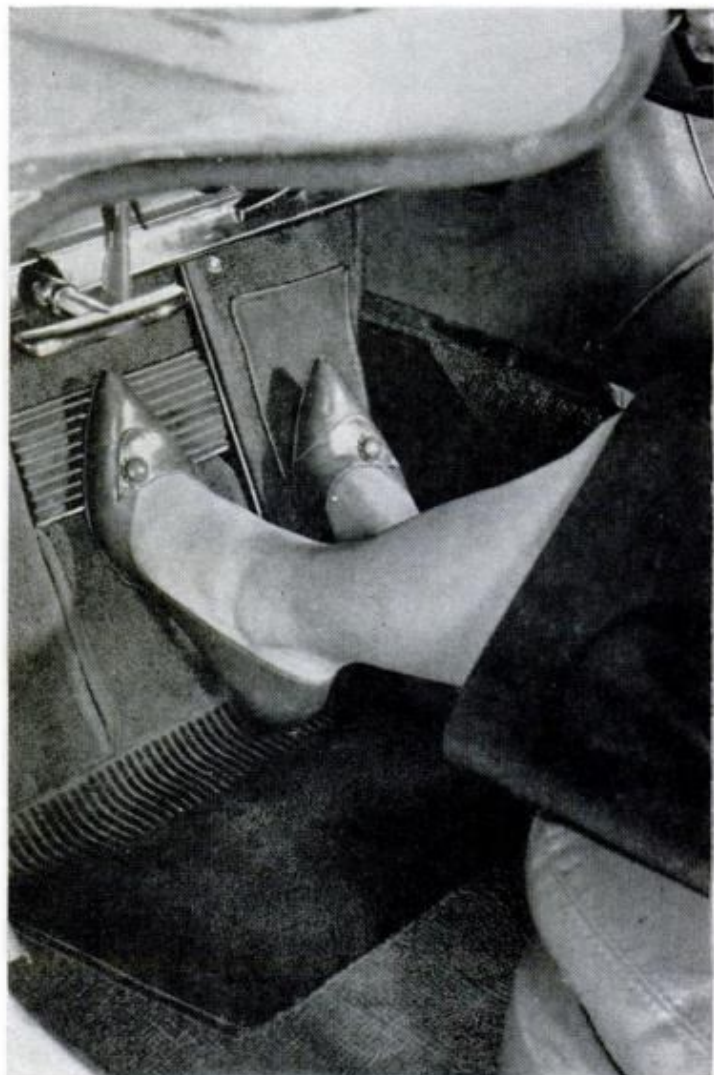
"Those pedals are moving less than $\frac{3}{8}$ ths of an inch," Chwalek told me. "We finally have the pushbutton principle built into an automobile."

As I tooled the T-Bird through South Bend's traffic-clotted downtown streets, my reflexes became more and more attuned to the "tomorrowness" of the control systems.

If a stop light flashed on the car ahead it seemed that the T-Bird was already slowing down as the reaction time—the fractional second needed in ordinary cars to lift the right foot up off the accelerator, swing over and stab down on the brake—was eliminated.

Suddenly my reaction times seemed

TREADLES—not pedals—control stopping and going in Bendix-equipped "car of tomorrow". Only about $\frac{3}{8}$ -inch travel is needed to put brakes on full back



speeded up and I felt an amazing increase in confidence and mastery over the car and the traffic situation.

Steering, too, could only be described as a relaxed joy. If another car cut suddenly out from the curb in front of me, I had only to "point" my hand to the left (about 1/8th turn of the T-Bird's wheel) and I was safe in the outside lane.

Thinking the Car Around

The lack of physical motion of my right foot became more and more natural. It seemed after a half hour behind the wheel that I was "thinking" the car to stop and go. Steering was equally natural. There was a direct and natural orientation between the movement of my shoulders to right or left and the car's eager desire to "follow."

Here again, it was more like "thinking" your way around the corner. Whole areas of eye and muscle activity needed (with

conventional steering systems) to compute the amount of turn of the steering wheel in taking a given curve were eliminated. Steering-wheel-turn to car-turn was a direct, natural relationship.

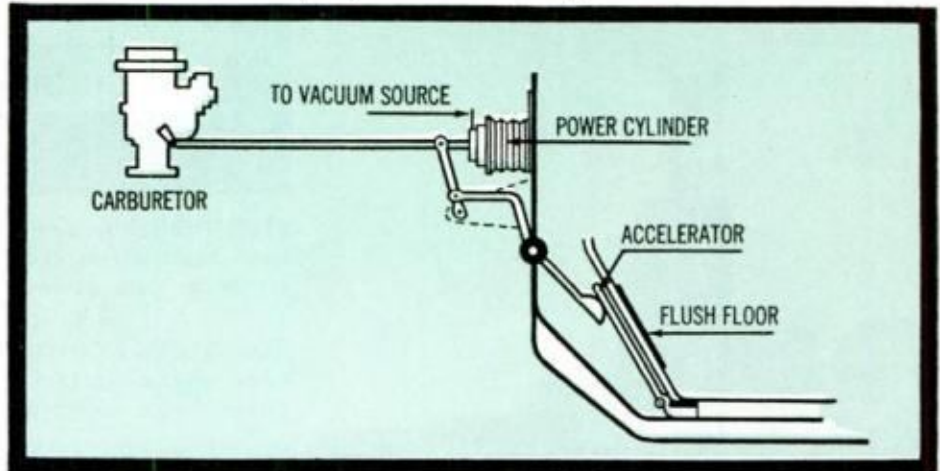
"It's like steering with a tiller!" I exclaimed to Chwalek who smiled and replied, "I'm not surprised that you picked that comparison. The direct action of the tiller was what we were trying for."

"Incidentally," he continued, "the ratio of that wheel you're holding adds up to 1 1/2 turns lock to lock."

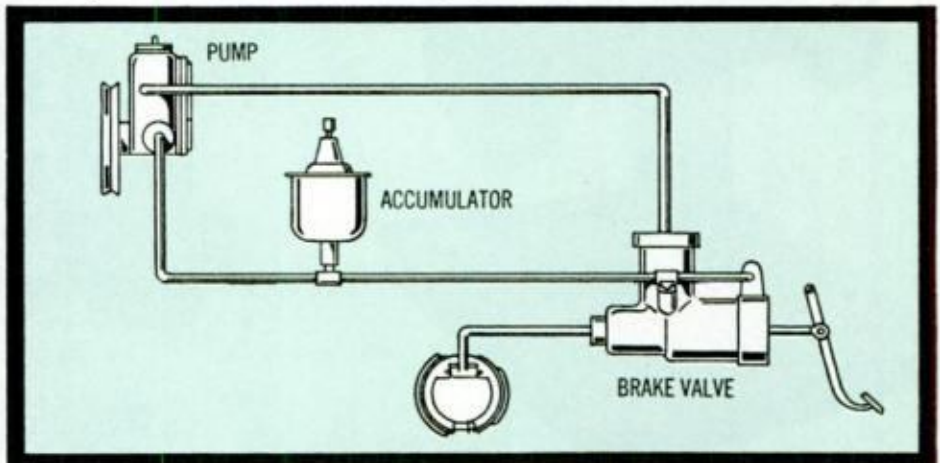
Had Dick told me this before I started out I'd have been afraid to take the wheel, as my "quick" steering little MG at home requires almost three full turns. (Most U.S. passenger cars have ratios requiring over five turns with manual steering, about four with power.)

However, in spite of this instant response ratio, the T-Bird did not permit you to oversteer. It did not seem oversensitive.

NO-TRAVEL THROTTLE SYSTEM converts the customary, long-travel gas and brake into a pressure treadle, flush with the floorboards, which moves only 3/8ths of an inch. A simple piston uses the engine vacuum to do the work



THE FULL POWER brake system which has been designed and tested by Bendix admits fluid at 1800 p. s. i. from the pump and accumulator to the wheel cylinders by means of a valve which is connected to the driver's foot treadle



How Oversteer is Avoided

Chwalek explained that Bendix engineers had carefully tailored the amount of power assist so that a moderate amount of effort was required to turn the steering wheel—enough so that I never felt worried about turning too far or too fast, involuntarily. Wheel rim effort worked out to between $3\frac{1}{2}$ and $3\frac{3}{4}$ pounds, Dick Chwalek told me.

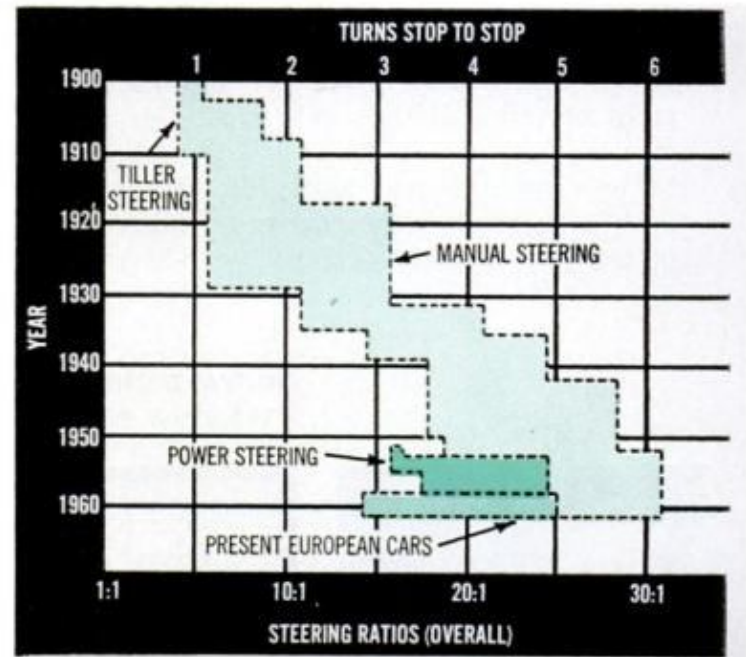
Out on the open highway, Varamatic's road manners proved perfect. As I increased our speed, the need for turning the front wheels to follow curves in the road decreased so that the steering wheel remained on, or near, the straight-ahead position. In this area Varamatic isn't as responsive and the steering wheel must be moved farther to effect a given angle of turn of the front wheels than in either sharp left or sharp right turns.

This is the "secret" behind Varamatic and the source of its name—the steering ratio varies automatically as the wheels are turned from lock to lock.

For example, on the T-Bird's gear the "straight ahead" over-all ratio is 17.1 to 1 while in full right or left lock it drops to

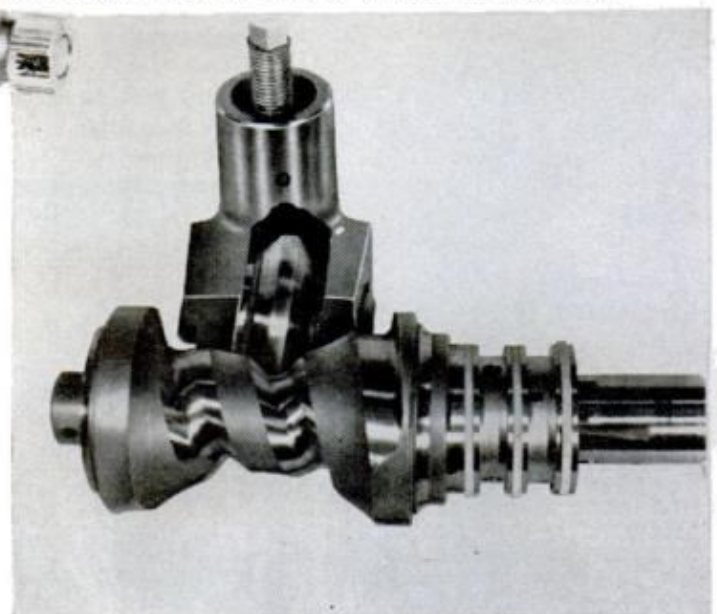
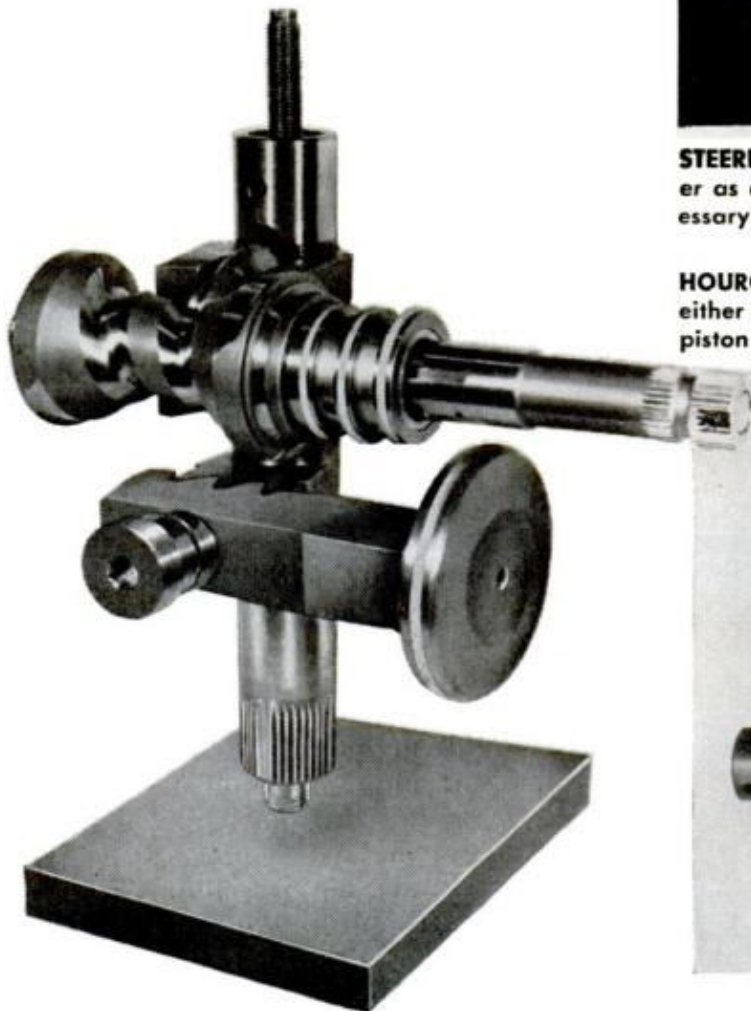
5.4 to 1. Thus, when you are making sharper turns at lower speeds in traffic, the steering gets "quicker" requiring constantly less distance of wheel rim turning to move the front wheels through a greater number of degrees of their arc.

Steering effort, however, remains constant; you do not need to pull harder on the steering wheel rim even though your "steering" has become faster as the mechanical advantage drops off. The power steering pump takes up the slack as a steering-column-activated valve admits more oil to the operating piston.



STEERING has become slower as cars have grown faster as chart shows. Higher numerical ratios were necessary as cars grew heavier though power helped

HOURGLASS WORM GEAR with pitch increasing at either end, is key to Varamatic steering. Boost of the piston makes up for a loss of mechanical advantage



How is that changing ratio accomplished? The secret is in a specially designed "hourglass" worm gear with the worm's screw closely spaced at the middle and with its spirals gradually increasing their pitch (the angle across the worm's axis decreases from 90°). This worm is connected to the steering wheel and moves the steering linkage by "threading" a roller back and forth on its length just as a bolt will move a nut to left or right if it is turned and the nut held.

As a worm spiral assumes a greater pitch toward either end, the roller is

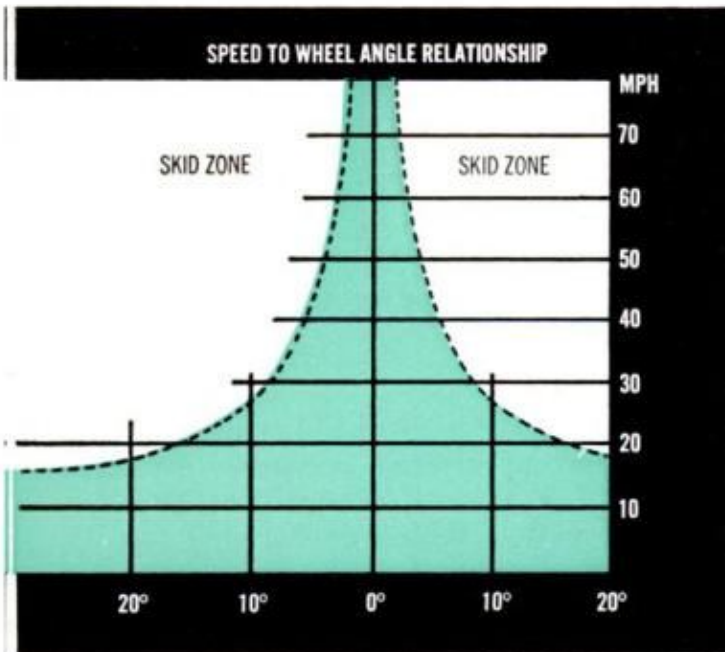
moved a greater distance along the screw's axis. The roller, in turn, is fixed to a crank on a shaft which turns the Pitman (steering) arm and moves the wheels.

Thus, it can be seen that the worm actuates the steering linkage more quickly at each end. It has a "low" gear in its middle and increasingly "higher" gearing at either end.

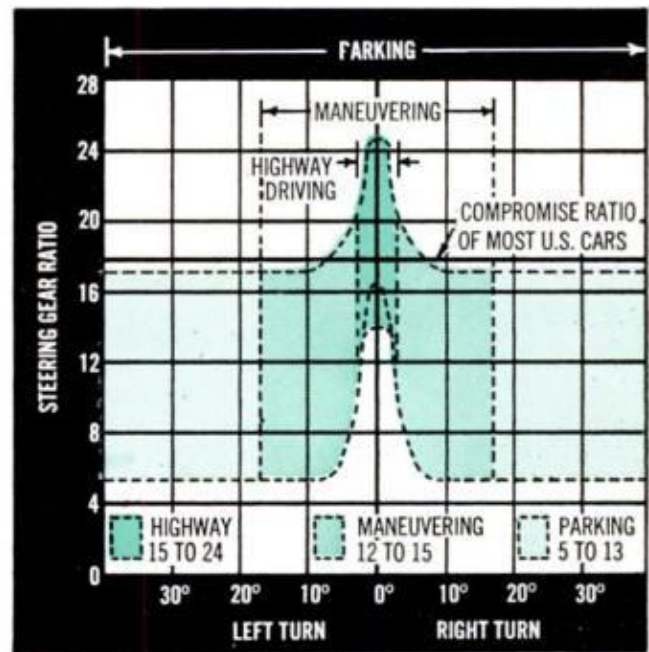
These changing ratios were chosen on the basis of data compiled by Cornell Aeronautical Laboratories of Buffalo, N. Y.

Cornell noted that maximum permissible

[\(Please turn to page 184\)](#)

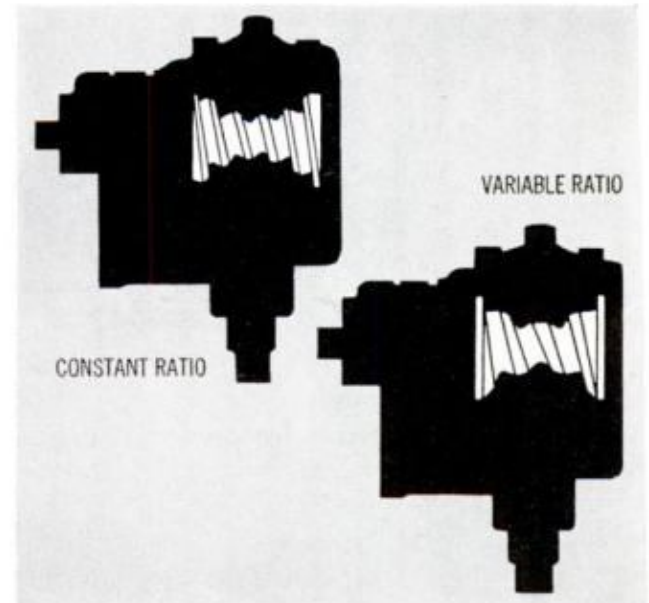
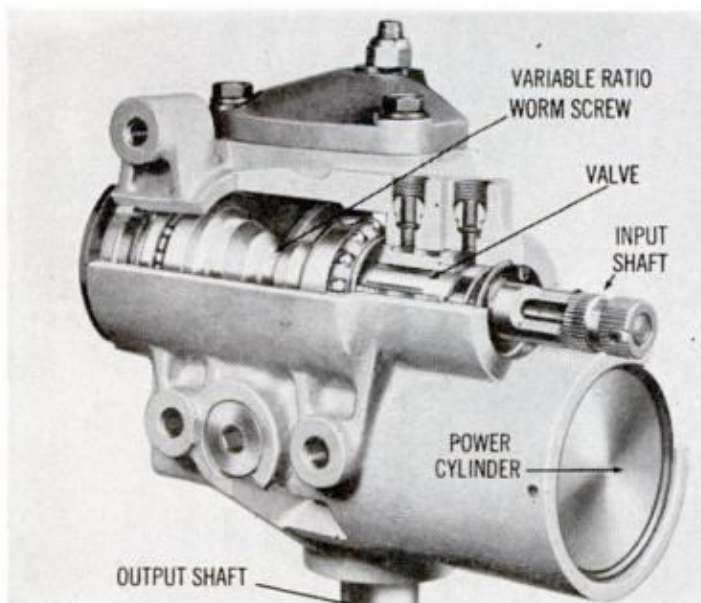


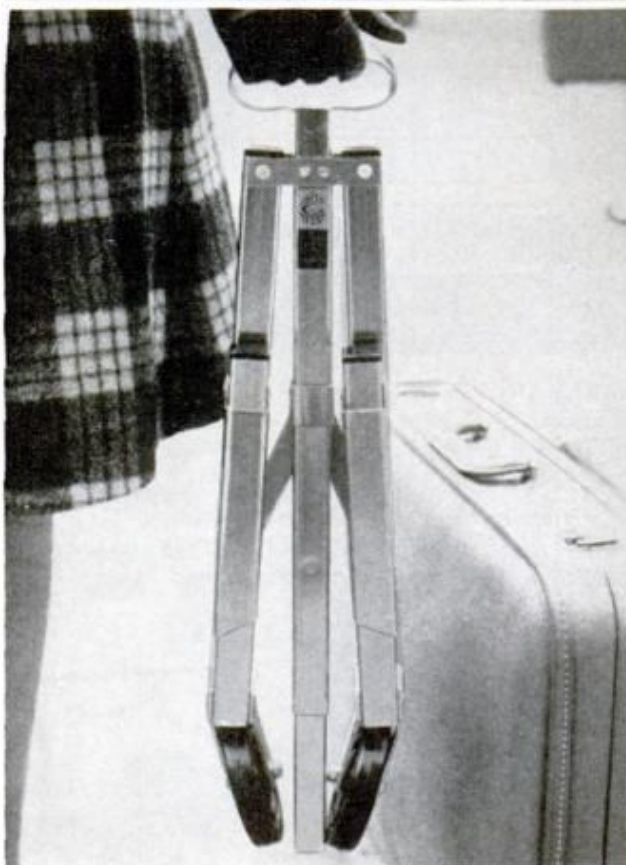
STEERING AND SPEED relationships are shown on graph developed by Cornell. As speed increases, the angle of safe wheel turn decreases. Turn more and you skid



VARAMATIC steering's three different ratio ranges for parking, maneuvering, driving. Note the compromise ratio of U.S. cars at an average of 17 to 1

DESIGN of Varamatic power steering box, cutaway below left, is such that different ratio worm gears may be installed to suit the characteristics of different car weights and wheelbases. Power cylinder is located below worm





Collapsible Luggage Carrier

Small enough to be packed inside a suitcase, but strong enough to haul 150 pounds of luggage, a collapsible luggage cart takes the strain out of carrying bags around airports and railway stations.

Made by Grip Toter, 12221 S. Indiana Ave., Chicago, Ill., the luggage carrier sells for \$19.95.



Fighting Bulldozer

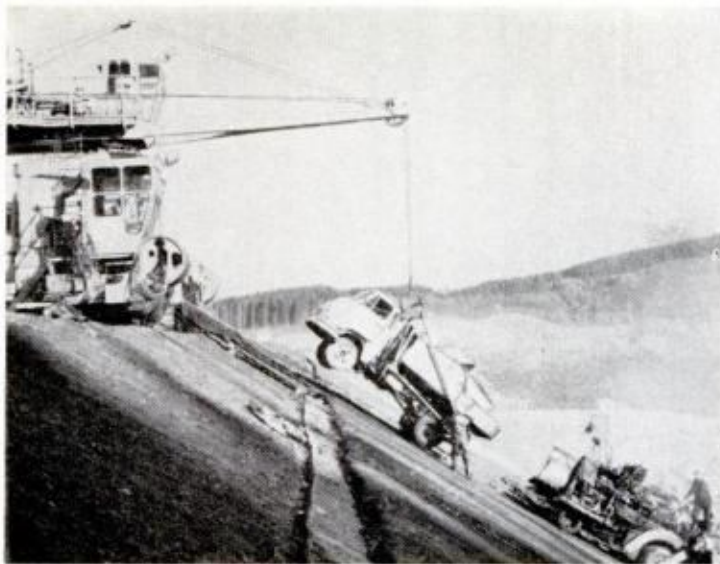
Carrying a 165-mm. assault gun, a new combat-engineer vehicle also is equipped with an A-frame boom for lifting up to 30,000-pound loads and a bulldozer blade. Three of the 57-ton machines are being built by Chrysler Corporation.

It'll Float, Too

Resembling an up-ended bathtub, a beach chair of molded polyester plastic adjusts to a variety of positions. It is equipped with a table and variable sunshade, and according to the German manufacturer, in the event of a flood it will float.



POPULAR MECHANICS



Dumping Dump Trucks

Trucks bringing construction materials for a German dam are lifted and emptied as if they were scoops on a giant power shovel. Materials poured from the trucks this way include macadam, used for water-proofing. The new dam is near Olpe.



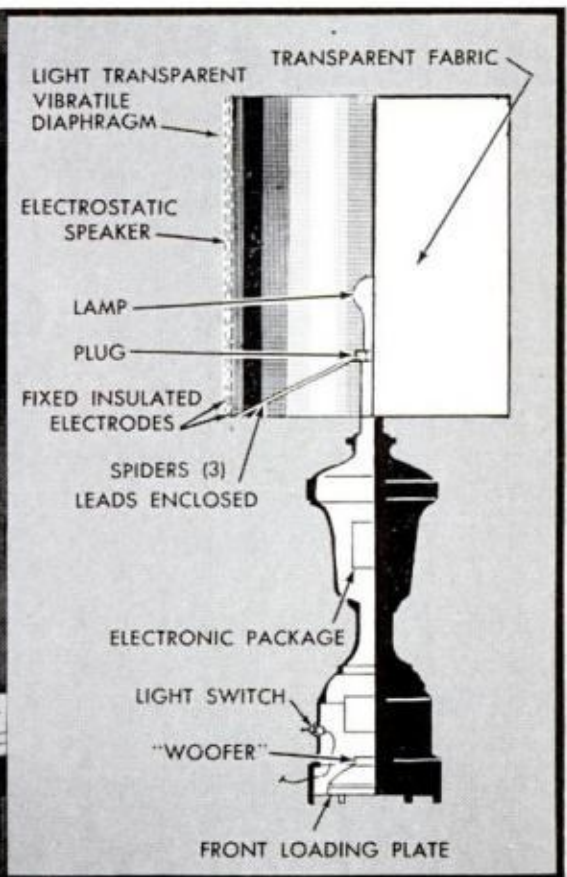
Automated File Girl

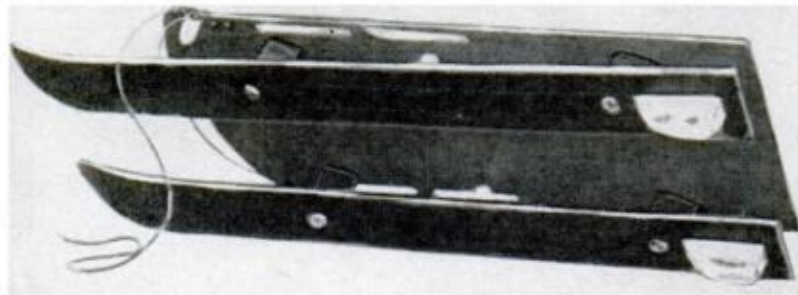
A new electrically powered desk does away with stooping and climbing to get to files. Capable of lateral and vertical movement, it permits the seated clerk to work at any needed file. It is made by the Supreme Steel Eqpmt. Corp., Brooklyn, N.Y.

Table Lamp Is a 360-Degree Hi-Fi Speaker

An ordinary appearing lampshade is a high-fidelity electrostatic speaker in disguise. It radiates sound uniformly from the entire surface of the shade in a 360-degree pattern. The Acoustia Associates' Omnisonic unit consists of a cylindrical

electrostatic speaker in the form of a translucent lampshade less than 1/4-inch thick and a special woofer in the lamp base. Frequency range is from below 40 cycles to over 25,000 cycles. Lamp prices range slightly above \$200.





WATER-SLEDDING requires little skill, offers enough speed and thrills for anyone. Sweega-Mama, the skimmer sled shown here, can be ridden prone, sitting or even standing up. Trick sledders go in for handstands and tandem acrobatics borrowed from surfing. Ski-runners are removable for skiing use



BODY PLANING with an old inner tube is a hairy-chested sport reserved for those who love a rough ride. To steer, you shift your weight and use your body as a rudder. The two-man doughnut, above, is from an aircraft tire. Normally, however, it's one man to a tube and plenty of tow power up front



Zany Skimmers:

Jitterboards, ski sleds and old inner tubes are a few of the wave-skimming vehicles that can give you a wild and woolly ride when hitched behind your boat

By Art Mikesell

76

TREADING WATER, you watch the bright yellow tow rope straighten as the boat idles slowly out ahead, taking up slack. At the first gentle tug you holler, "Hit it!" The next instant you are ricocheting along the rough edge of the wake, arms wrapped around an inner tube that bucks like a wild bronco.

This madcap water sport is known as body planing, and it is one of the more rough-and-tumble tow-stunts. It may not be your cup of tea, but there are many other varieties, and chances are there's one

POPULAR MECHANICS

Материал, защищенный авторским правом



AQUAPLANING is easier to learn than skiing, gets you out of beginner's class fast. According to water-sport folklore, the first skier was a surprised aqua-plane rider who looked down to find his board split



BOAT SURFING takes nine parts skill and balance to every one part muscle. Towing the surfer, the boat plows along just short of a plane until the wake is heavy enough to ride and line can be tossed away

Fun Behind a Boat

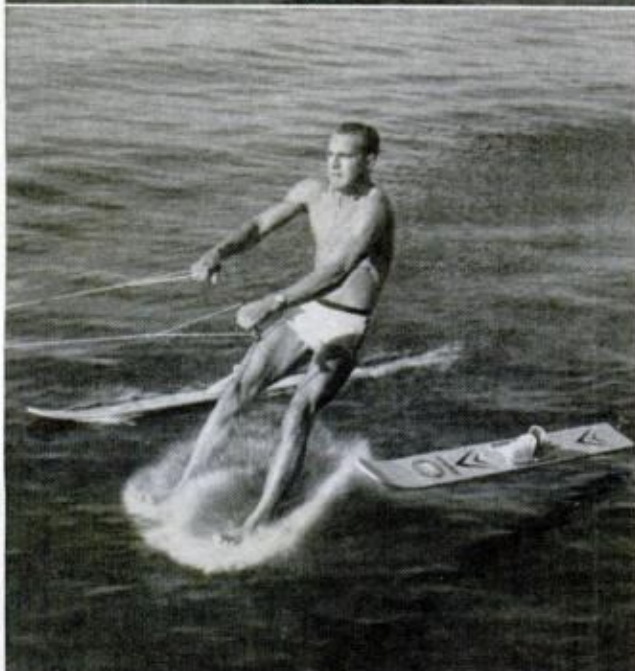
that will suit your taste and ability.

Basically, all of these boat-powered rides are alternatives to straight skiing. Almost anything with a reasonably flat surface will plane if you hook it up to enough power. Even your bare feet will skim the chop and keep you aloft if you're moving fast enough. With this in mind, manufacturers of water-sports equipment have come up with a weird assortment of sleds and boards to tempt the bored skier.

Many devices have been used in ski shows for a number of years and are just

beginning to filter down to the general public. Shoe skis and saucers are good examples. Others, like the aquaplane, have been around a lot longer than water skis and is still very popular.

Boat surfing, currently the hottest thing in water frolic, is an inland version of a centuries old sport. While on vacation in California last year, a professional tow-boat driver from Florida's Cypress Gardens Ski Show happened to see some surfers in action and got the idea that it might be possible to ride the wake of a boat.



BAREFOOT SKIING is a rare skill, even among the pros, but Mike Osborn of Cypress Gardens goes most of them one better and does it on one foot. According to Mike, this is just good clean fun, but don't try it unless you're prepared to take a dunking on the first few hundred attempts. Not for amateurs



SHOE SKIING is like barefoot skiing with big flat feet. Actually, it's much easier, since these 16-in. shingles provide many times the planing surface of a normal foot. Most pros use special "take-off" skis to launch themselves on a barefoot or shoe run

DUBBED "JITTERBOARD" at Cypress Gardens, this slim planer falls somewhere between an oversized ski and a narrow aquaplane. The tow rope is attached to the front, making this a no-hands ride. Balance is the main key, so it's something like "powered surfing"



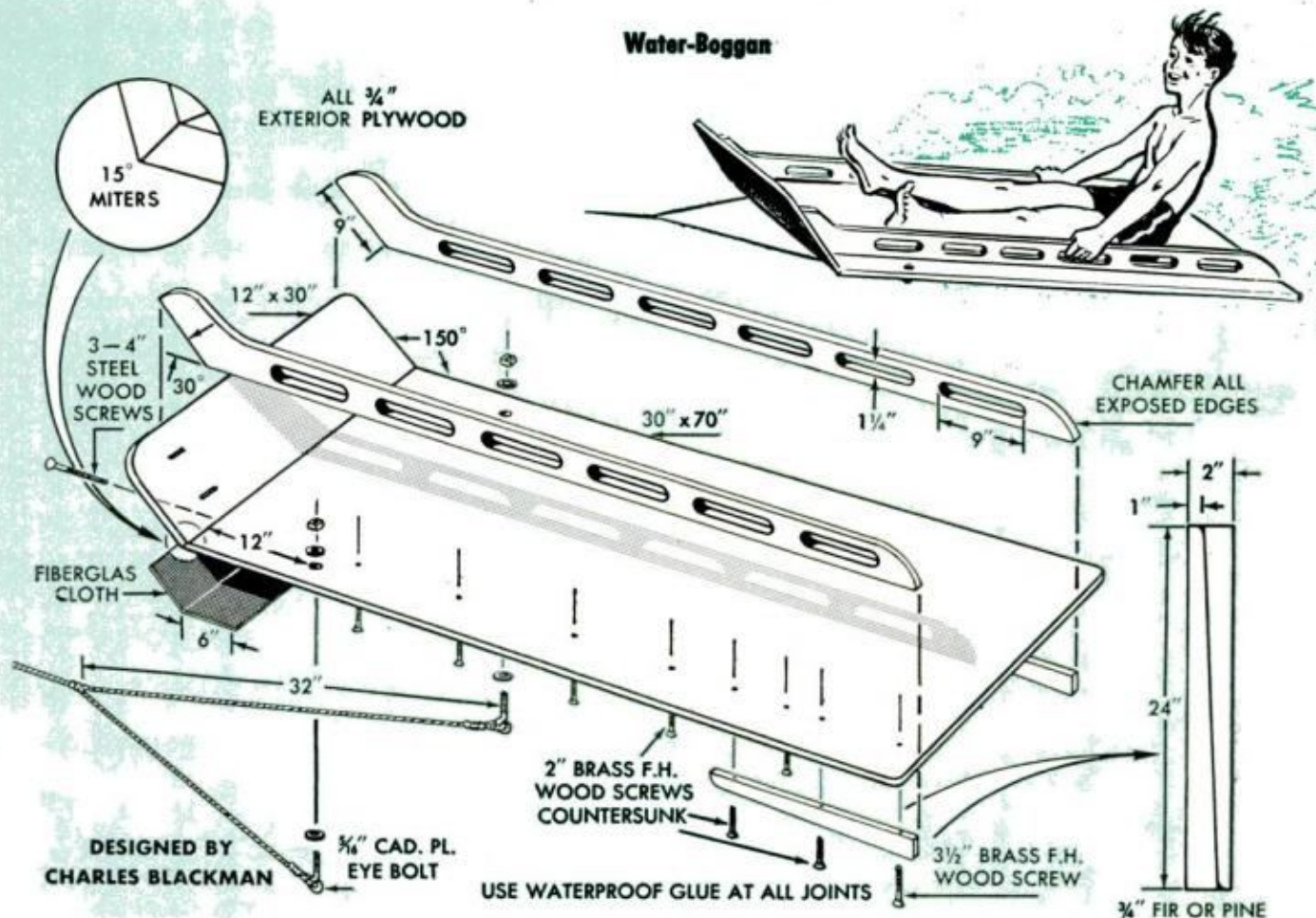


SIT-DOWN SKIING sounds like a sedate activity for senior citizens, but it's more like driving a sports car. The Water Ski Sled's flexible action makes possible everything from wake jumping to sharp whip-cracking turns. Each ski has twin anti-skid fins



FLYING SAUCER, a 3-ft. plywood disk, with or without toe bindings, has a wide planing surface which makes it an easy tow, even for low-horsepower motors. The trick possibilities are endless, especially if you like to do the plain or fancy turnarounds

HOME-BUILT SLED, below, is fun for kids and grownups alike, costs almost nothing to build. All parts can be cut from a 4 x 8-ft. sheet of $\frac{3}{4}$ -in. plywood and a scrap of 1-in. stock. Round all exposed edges slightly and finish with at least two coats of marine enamel. Be especially careful when fibreglassing the joint at the front, since this must be able to take a lot of punishment





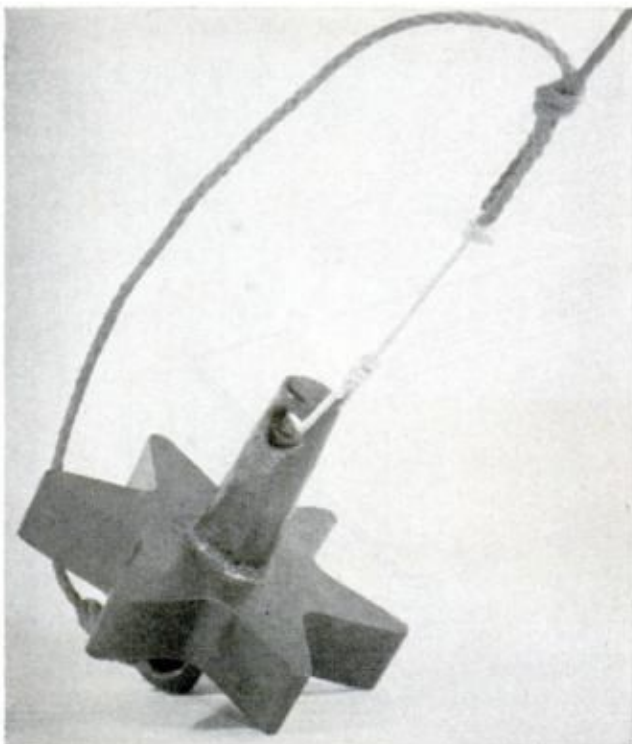
The 850: A Bigger Small Fiat

Fiat's new, 42-hp. 850, fueled up, gets one horsepower for each 35.2 pounds. In comparison, Fiat's little 600, stripped to shipping weight, had 41.6 pounds for each horse. The 850 will be welcomed by U.S. fans of Fiat economy. The 51-inch Four should approach the claimed 40 miles per

gallon at a steady 45 m.p.h. (over-all mileage will be less, of course). The car isn't tiny, however. It's 145.75 inches long overall on a 70.92-inch wheelbase. At the Italian introduction in early summer, Fiat said export would be in "a few months," but units aren't expected here until spring.

Star Hook Flips When Snagged

When fouled, a new star-shaped anchor can be freed by snapping the upper trip line so that tension is transferred to the bottom end. Available in \$2.98 10-lb. and \$4.75 20-lb. sizes, the Sav-It Star is made by Bayview Casting, Alviso, Calif.



Artificial Wind

Rigged from a surplus swamp glider, a wind machine gives paratroops and other flight personnel a vivid demonstration of what it's like to be blown across the ground after a parachute landing. The rig is at Hamilton Air Force Base, Calif.



The Air Around Us

How It Is Changing

Once local, air pollution has gone global; it may now be changing us and our world

By Clifford B. Hicks

O POSSUMS, once seldom seen above the Mason-Dixon Line, now are a common nuisance as back-yard garbage can upsetters in many parts of Canada. Mocking birds, cardinals and other birds, considered "Southerners" a generation or so ago, are spilling over throughout New England. Temperatures in Northern New England have climbed an average of $3\frac{1}{2}$ degrees during the past 60 years, which of course is the thing that makes those



latitudes interesting to wildlife "Southerners" nowadays. But why is it warmer?

And why, in England, have a good many species of moths changed from a light color to dark over a long period of years?

Then, there's another odd thing happening: A few generations ago, our atmosphere had a slightly negative electrical charge; today it is slightly positive.

These three seemingly unrelated facts have one thing in common:

They are the first dirty straws in the wind that air pollution may be causing dangerous long-range effects in the Earth's climate, effects that might be irreversible.

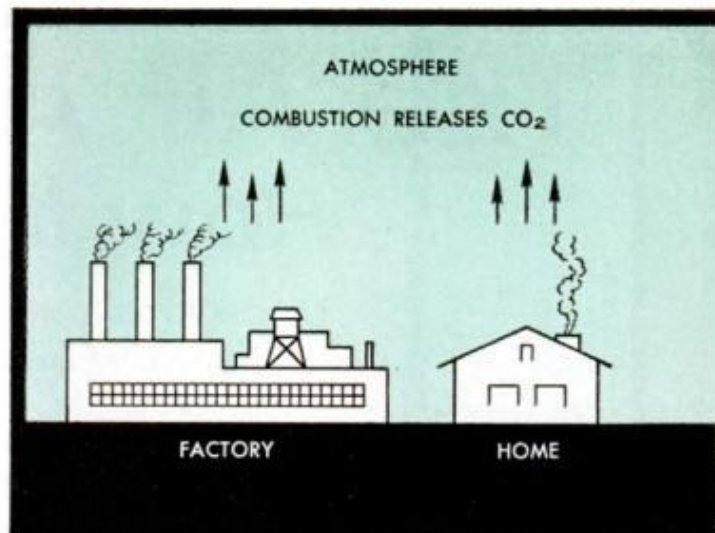
Such effects could profoundly alter plants, animals—and human beings.

Until recently, air pollution has been considered a current problem involving irritated eyes and lungs, tumbling property values and an average American cleaning bill of \$65 per year. Under the worst conditions, we know it can kill (London's poisonous smog of December, 1952, snuffed out 4000 lives and hastened the deaths of an estimated 8000 persons). Without question, cosmopolites are fouling their nests, and despite dedicated efforts and the expenditure of billions of dollars, the problem is getting worse.

But eye irritation, high cleaning bills—and even choking death—are only a hint of things to come. Thoughtful scientists have grown increasingly alarmed about the *long-range* effects of air pollution. We may, many of them believe, be making an open sewer of our sky literally producing a gaseous brew that could make our atmosphere untenable for our children's children.

Dr. H. E. Landsberg, Director of the Weather Bureau's Office of Climatology, has painted a thoroughly frightening picture of the city of the future. Unless we mend our ways, he has said, our cities may well turn out to be giant pestholes—places where to breathe is to commit slow suicide. The population "will be an allergic lot, with subacute carbon monoxide and lead poisoning, suffering from chronic bronchitis and emphysema, and dying from sulphur-dioxide-induced cardio-respiratory insufficiency or from benz-pyrene-stimulated cancer."

These hyphenated hazards could be the long-range results of the chemical reactions taking place in the air around us right now. Here are a few of the things that *may* be happening:



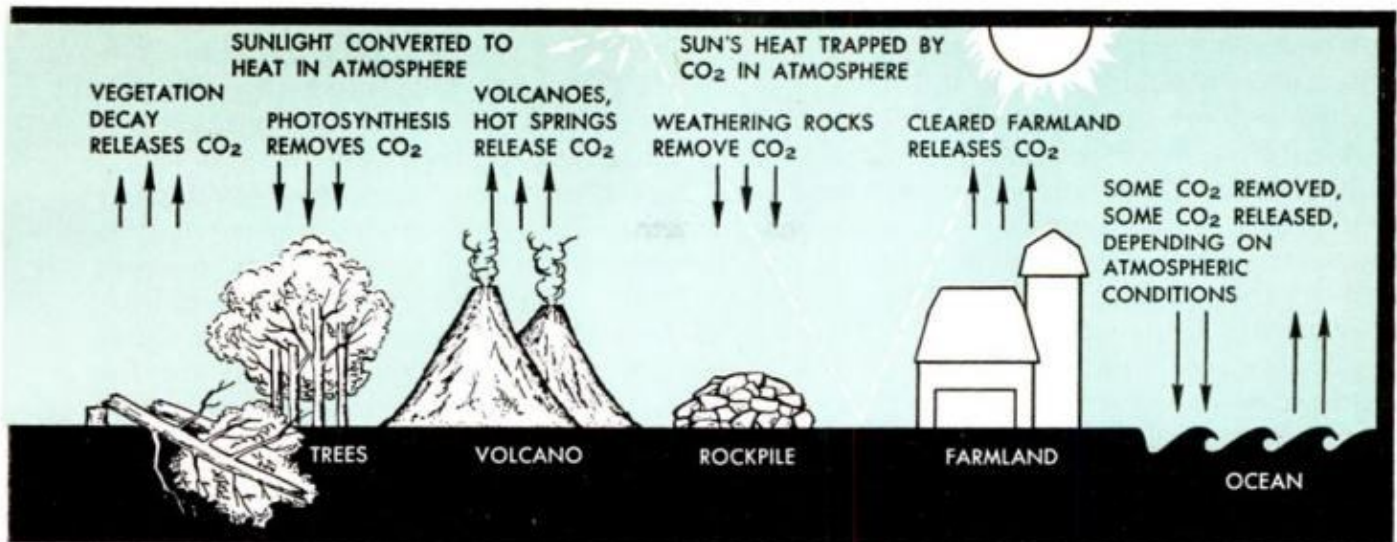
DIRTY PROOF of air pollution is the filter, below right, which was originally white like one at left, until it spent 24 hours in air sampling device (center)



Some scientists suspect that we may be altering earth's climate by tampering with nature's delicately balanced oxygen-CO₂ cycle in which plants take carbon dioxide from the atmosphere, use it and give back oxygen, and animals including man take oxygen from the atmosphere, use it and give back carbon dioxide. When you burn anything such as fuel for heat or power you also take oxygen from the atmosphere and give back carbon dioxide.

The past three or four generations of mankind have ripped out millions of square miles of vegetation all over the world and covered the exposed surfaces with supermarkets and superhighways, airports, housing developments, factories and parking lots.

Meanwhile, we've been burning hydrocarbon fuels—oil, coal, gasoline and natu-



MAN'S TAMPERING with nature has thrown earth's CO₂ cycle (above) out of balance. A prime offender, researchers agree, is the automobile. Below, scientists at Wayne State University use this giant sampling machine to study auto's effect. Duct arches over Detroit street, draws in air for measurement of exhaust content



ral gas—at a staggering rate that is climbing each year.

We can blame the population explosion and the industrial and scientific revolutions, but the fact remains that we've been pushing nature down a one-way street with both hands. We spout more and more carbon dioxide into the atmosphere; at the same time we rip out more and more plant life that could remove it.

Inexorably, the level of carbon dioxide in the atmosphere is going up. According to one estimate, it is rising about six billion tons every year.

Six billion tons isn't really very much; the earth's atmosphere as a whole contains about 2300 billion tons of the stuff. With the possible exception of city dwellers who are exposed to it in high concentrations, the additional carbon dioxide isn't going to

affect your health directly. But with the passage of years it could profoundly alter the planet's climate through what has been dubbed, ironically, the "greenhouse effect."

The glass roof of a greenhouse permits light energy from the sun to pass right through. When this radiant energy strikes a surface inside the greenhouse, it is converted into heat. However, the glass roof will not permit the passage of much heat, so some of the sun's radiant heat energy has thus been trapped.

In the same way, the swirling atmosphere acts like the glass in a greenhouse roof. Carbon dioxide is the principle element providing the "glass." It lets the sun's light through but, like a blanket, prevents the infrared heat energy from escaping upward.

If the "greenhouse effect" really is op-

erating in the transparent canopy above our heads, the carbon dioxide level of the atmosphere should be rising, and so should earth's average temperature. Are they?

According to a recent report by the Conservation Foundation, the carbon dioxide level of our atmospheric cocoon has increased from 290 parts per million in 1890 to about 315 parts per million today. It currently is rising at a rate of .7 parts per million each year. Even such a small increase in the carbon-dioxide level should trap a great deal more heat. Does it?

There is no conclusive evidence, but Weather Bureau statistics show that average winter temperatures in the northeast section of the United States have climbed 3.5 degrees in 60 years. The worldwide average is a temperature rise of one degree during the past century. This is precisely the increase that could be predicted from the "greenhouse effect."

The figures may, of course, represent only a normal warming cycle, which will be cancelled out by a cooling cycle in the near future. This has frequently occurred in the earth's history. On the other hand, it could also be the effect of stirring more carbon dioxide into the ocean of air.

According to the Foundation, there is some concern that, in the not too distant future, the increase in the carbon dioxide level may cause the average temperature of the planet to rise as much as 12 to 13 degrees F.

"A change of even half this great," says the report, "would be more than sufficient to cause vast changes in the climates of the Earth; the polar ice caps would almost surely melt, inundating many densely settled coastal areas, including the cities of New York and London . . . Many life forms would be annihilated both on land and in

the sea."

Thus the dirty hand of polluted air may be tinkering at this moment with the world's climate. It may also be operating in other long-range ways.

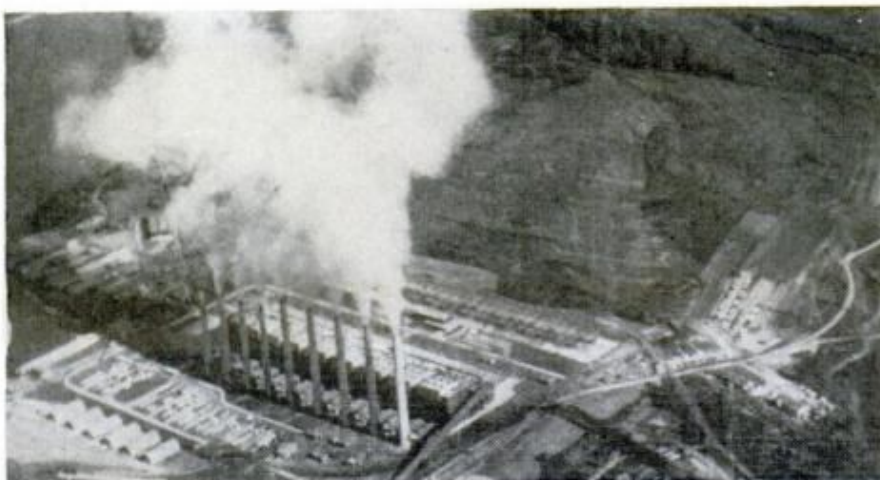
Biologists are beginning to wonder whether the same smudgy fingers may be reaching into the evolutionary process.

Those moths over in England have little to do with the atmosphere's carbon dioxide content, but they do prove a point: Air pollution *can* affect evolution. Some 70 species of tree-living moths, since they first came to the attention of zoologists, have been light in color. In recent years the trees in which they live have been blackened by smog. The latest generations of these species are very dark in color.

This is a small thing in itself, and certainly doesn't indicate that, in the long reach of evolution, air pollution is going to change the color of man. Nature doesn't camouflage him to his environment. However, it is striking evidence that air pollution *may* cause an evolutionary change, and therefore may—in other ways—be working its subtle black magic upon man himself. Over several generations, this might take the nature of permanent changes in the human lungs or eyes.

Man's Eyes May Change

Eyes might be altered because they are sensitive to a particular part of the radiation spectrum, and polluted air absorbs a different part of that spectrum than pure air. Aircraft bearing delicate instruments recently soared through the skies over London. Scientists inside were checking whether there was a difference in infrared absorption between the gray smog-belt of the city and the relatively pure air of the nearby countryside. In some cases they



IN INDUSTRIAL CITIES air pollution reaches staggering proportions. For example, it is estimated that in an average month, the fallout of air-polluting solids on such a city runs as high as 100 tons per square mile



WHEN THE TEMPERATURE INVERSION is more than 4000 feet above Los Angeles, all is bright and gay, as in the photo at left. When the layer is less than 1000 feet, however, smog takes over, as in photo at right

found profound differences that could account for a ground-temperature differential as much as nine degrees F. Over a period of generations, such a difference in infrared-radiation absorption might affect the eyesight of those living under it. The other end of the spectrum is affected, too. In winter, ultraviolet radiation is 30 per cent less in the city than the country.

A research satellite recently radioed back information that it had discovered a layer of sulphurous gas around the earth about 13 miles above the surface. Calculations later showed that this would be about as much sulphurous pollution as would be produced by the burning of sulphurous fuels on earth. Could this polluted layer have any effect on the climate of the earth, or on human evolution? No one knows, but it is a new factor in our environment.

Another big question mark is the change in the atmosphere's electrical charge due to air pollution. In this case it is not gases but solid particles that produce the effect. Those particles vary greatly in concentration throughout the world, but consider the *average* fallout for most industrial cities: About 100 tons of solid particles fall from the air on each square mile each

month. This is truly a staggering figure. Anyone living in this fallout inhales at least 10 million million particles into his air passages *every day*.

But the effect of these particles while they are still in the air is unknown. Dr. Landsberg has pointed out that in "natural" air there usually is a small surplus of *negative* charges. The solid particles of air pollution change the ionization balance preponderantly to heavy ions, and this produces a slight surplus of *positive* charges. Can this change in the electrical charge of our environment affect human beings, now or in the future? Again, no one knows.

Although the long-range effects of polluted atmosphere have not been *proven*, even the distant possibilities are profoundly alarming. Prof. Barry Commoner of Washington University, representing the American Association for the Advancement of Science, has said:

"We have been massively intervening in the natural world without being aware of many of the biological consequences until the act has been performed, and its effects—which are difficult to understand and

(Please turn to page 178)



DIVING DOWN TO 150 FEET, specimen collectors in Scuba gear use nets to catch rockfish, which, if brought to the surface without decompression, would die from the "bends" or gas-bladder expansion



FISH ARE CAUGHT by net or hook and line, and are then placed in the decompression chamber. When the catch is complete, the divers close the tank, securely bolting down the tank's airtight cover plate



They're Beating the

A pressure cooker was the key to bringing specimen fish up alive from 300 feet. Now Marineland's catches are taken through decompression just like human divers

By Bob Grant and John E. Boykin

TAKING A TIP from deep-sea divers, specimen collectors for Marineland of the Pacific are bringing deep-dwelling fish to the surface and protecting them from death by the "bends" by using a piscatorial decompression chamber.

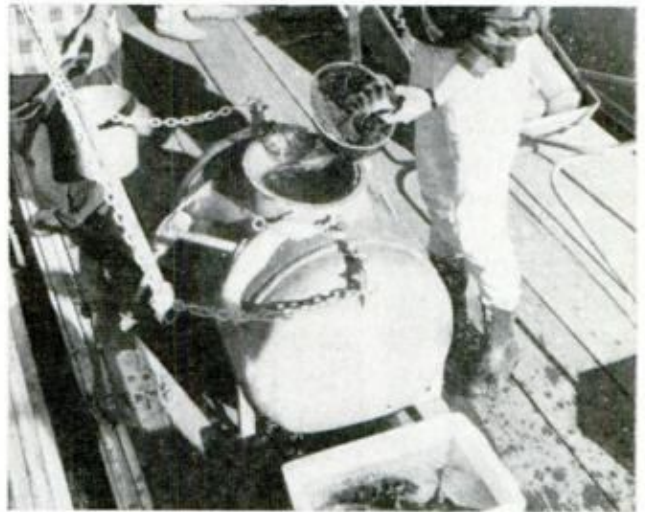
Early attempts to collect colorful rockfish from depths of 150 and 200 feet had resulted in the death of the fish through gas-bladder expansion (most fish have a pressurized gas bladder—like a submarine's ballast tank—which enables them to remain at chosen depths), and the "bends," caused by gases escaping from the body at a rate that creates deadly



COLLECTED in plastic bags, fish specimens are transferred to the decompression chamber, which is then sealed to maintain the normal deep-sea pressure



FILLED WITH FISH that normally live 150 feet below ocean's surface, the unique decompression chamber is lifted to the boat's deck by a mechanical winch



AFTER 20 HOURS of slowly lowering pressure inside the chamber to surface pressure, the hatch is opened and the healthy fish specimens are then removed

Fish Bends

bubbles in the blood.

Deciding to try decompression on specimens, Marineland curator, John Prescott, made a decompression tank out of his wife's pressure cooker, fitting it with valves for adding pressurized oxygen and gauges for determining inside pressure. The experiment worked.

Working out a decompression table for fish, Prescott found that it compares almost exactly with the standard U.S. Navy decompression chart for human divers.

The makeshift pressure-cooker chamber was used for eight months; then Prescott designed and built a special decompression

chamber that lifts fish from 300 feet.

This tank is made of $\frac{3}{8}$ -inch galvanized boiler steel, with standard boiler heads for ends, and a boiler manhole and cover for an opening. The 50-gallon tank, which weighs 400 pounds, is fitted with valves for oxygen and compressed air.

Fish at great depths are caught by hook and line and raised to 150-foot depth, where divers remove them from the hooks and place them in the chamber, which is then brought up to the deck of a boat. The pressure inside the tank is gradually lowered to surface pressure, a process that can take as long as 20 hours.

Sculpture Keeps Eye on Visitors

Visitors to the Ideal Home exhibition in London were greeted at the entrance by an optical illusion, a sculptured bust of William Shakespeare that seemed to keep an eye on them no matter where they moved in the room.

Created by Major Lewen Tugwell, and given the name "Sculptorama," the bust is a bas relief (method used for coins) with a convex shape, and is set into the wall. From any point it seems that the eyes are staring at the viewer.



Up the Creek Without a Pump?

The telescoping handle of a new collapsible paddle is actually an efficient bilge pump. Approved by the Coast Guard, the 4-foot paddle requires only 20 inches of stowage space. Accessories include an air hose for inflating air mattresses, etc., and a boat-hook tip containing a double-acting valve which makes it possible to use the paddle with a pair of hoses as a transfer pump. Hoses stow in the handle.

Available at most marine dealers, the basic Paddle-Pump sells for \$10.95; with accessories, \$14.95. It's made by GMS, Inc., 8647 Sepulveda Blvd., Sepulveda, Calif.



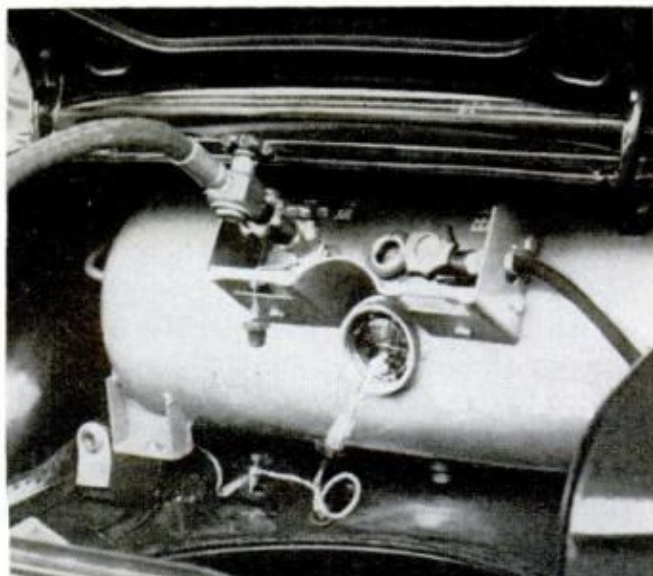
Tokyo Taxis Run on Liquefied Propane

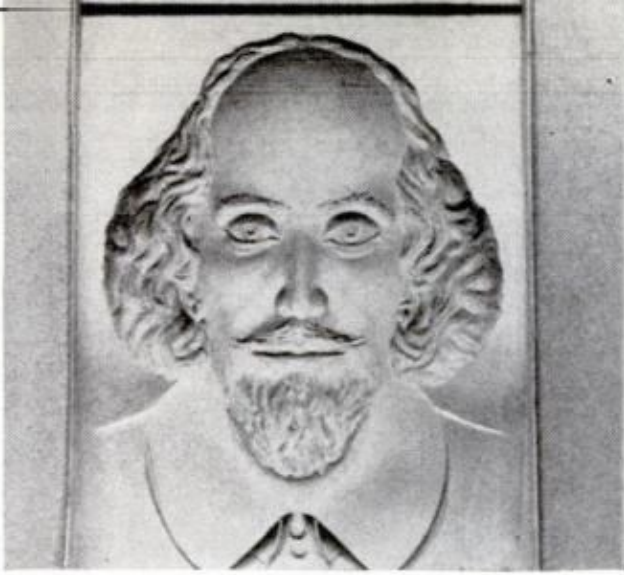
Despite the fact that there have been explosions as a result of escaping gas, one-third of the taxis in Tokyo are now running on liquefied propane gas.

Converting from gasoline to L.P.G. has cut operating costs for the taxis in half.

The Japanese L.P.G. is mostly butane gas and is relatively inexpensive.

But some Japanese object to possibilities of blasting off when they merely want to get across town, and all converted cabs must carry an L.P.G. label.





Close Support

Skimming over the turrets of advancing tanks, a U.S. Air Force F-100 practices very close infantry air support, zooming just a few feet above the ground so that it can effectively knock out enemy ground positions with rockets.



AUGUST 1964

Wheelbarrow Goes to War

The wheelbarrow has been converted to an Army transport. The seven-foot cucumber-shaped fiberglass shell is mounted on a single balloon tire and has handles on both ends. Opened, the barrow serves as a boat with the handles as paddles.



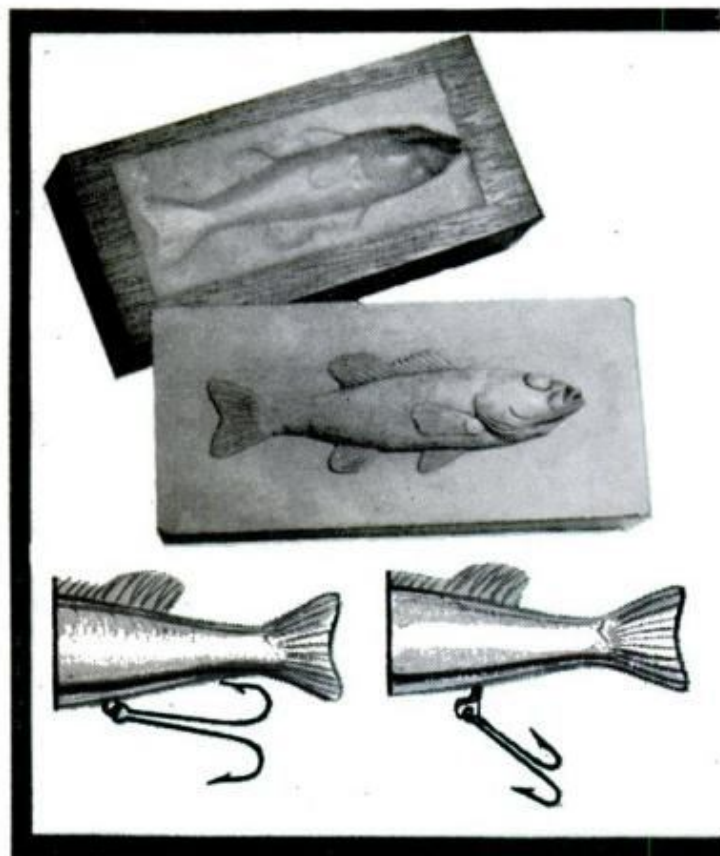
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The Lore Of Lures

What makes a lure catch fish? Two leading manufacturers tell how they design the "hot" ones

By Stuart James
PM Outdoors Editor

LURE MAKERS Dick Kotis and John Oney examine result of several years' work, a successful lure that duplicates appearance and action of a water snake



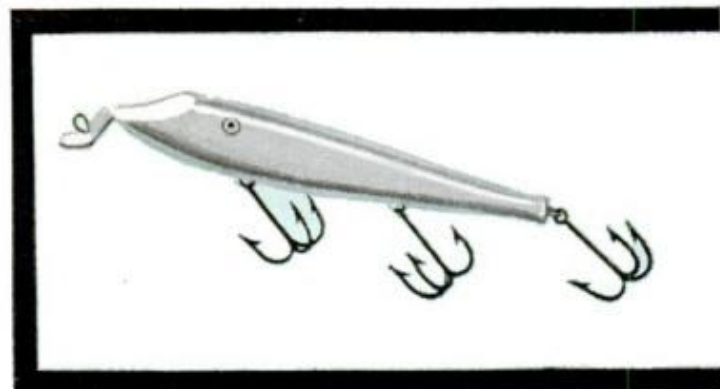
CREATED from a cast of a real minnow, the hook attachment on this lure had to be redesigned to keep the hooks from catching in the soft polyethylene body

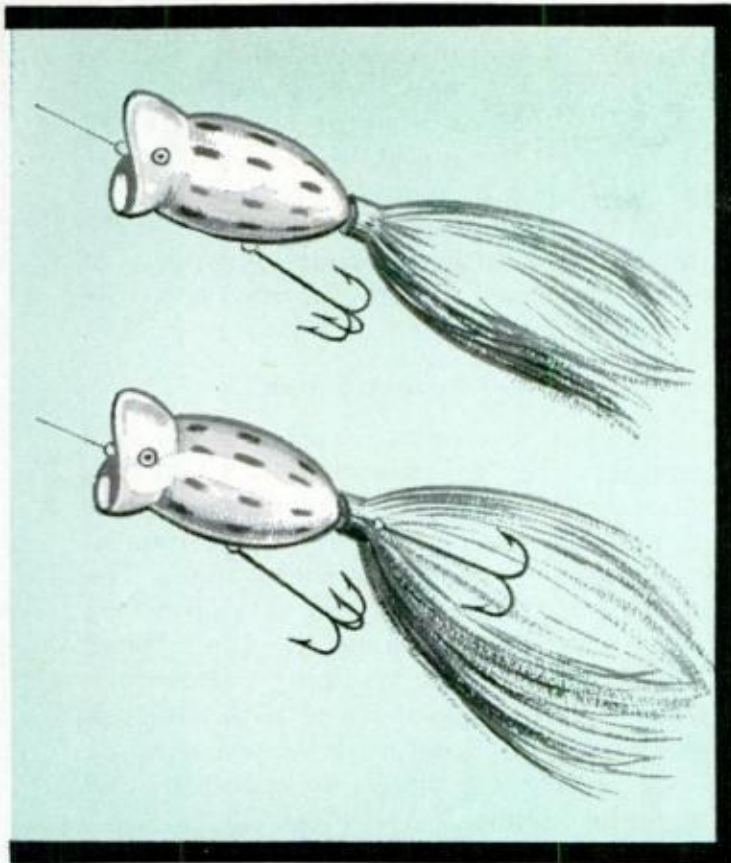
FISHING LURES, the old saying goes, are designed to catch fishermen.

"That's true," says John Oney, researcher for Fred Arbogast Co., "but if a lure is going to keep catching fishermen, it better also catch some fish."

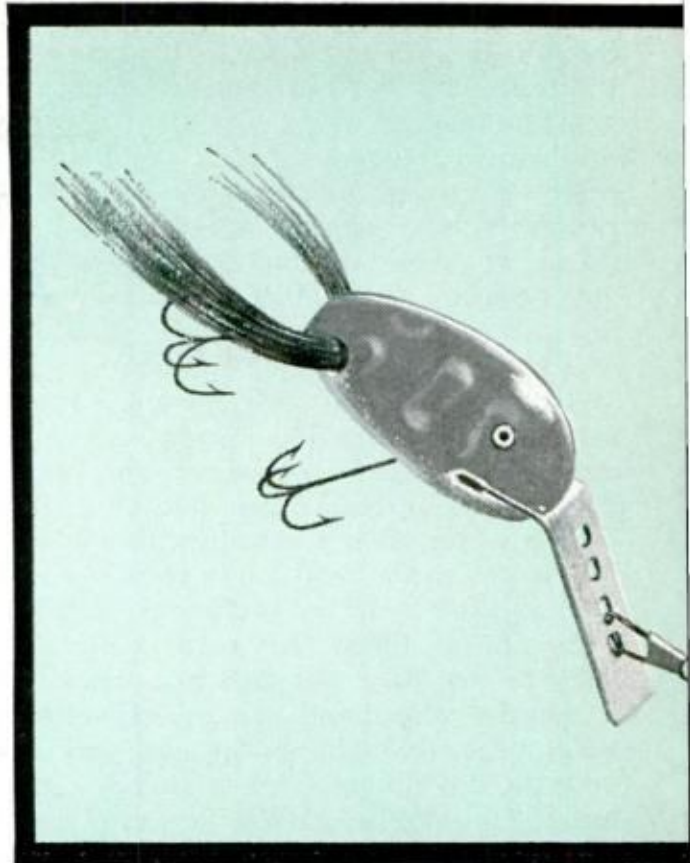
There are hundreds of lures on the market today. Many of them, like the Pikie Minnow, Flatfish, Abu Reflex, Lazy Ike, Hawaiian Wiggler and Bass-Oreno, have been around for years and have become famous. But every year there are new lures. Some catch more fishermen than fish and they disappear. Others, like the Rapala, which arrived from Finland a few

EVOLUTION OF A LURE is shown by the Pikie Minnow (below and at right), a lure that has been famous for over 50 years for use on the big northern species





WHEN FISHERMEN complained the Hula Popper was missing catches because fish were striking the skirt, a double hook was added to the end of the lure



CREEK CHUB'S Ding Bat ran into trouble when hooks fouled in the bucktail, a problem solved by thinning the tails and using a superior grade, soft bucktail

years ago, establish themselves overnight, and stick around for a long time.

But what makes a lure catch fish? Why are there so many sizes and shapes and colors? How does a manufacturer go about deciding that a lure is ready for the fisherman's tackle box? A lure, like anything, has to have a beginning; how do they go about developing it?

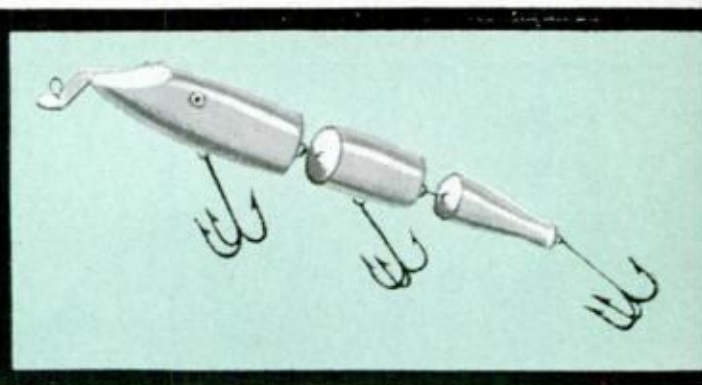
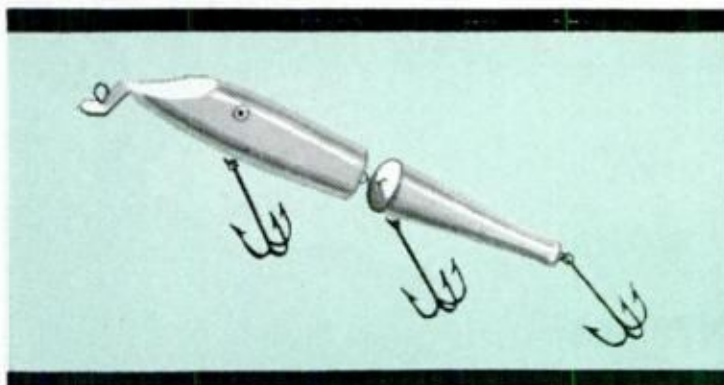
Looking for answers, we went out to Garrett, Indiana and talked with Harry Heinzerling, president of Creek Chub Bait Co. We asked him point-blank what makes a lure catch fish, and, without any hesitation, he answered, "Hell, I don't know."

But after some thought, he became more specific. "A lure is an imitation of something a fish likes to eat. If it looks appetizing enough the fish is going to go after it. Our Pikie, for instance, looks and swims like a minnow, a natural bait food."

Wandering through the small factory, we watched the lures being turned on a lathe, noticed they were made of white cedar, and asked why. "I honestly don't know," Harry said. "Most lures are just made of white cedar. I guess they always have been."

"It's a good wood to work with," said Austin Van Houten, shop foreman for

WHEN FISHERMEN requested more action in the Pikie (left), the manufacturer simply cut the original in half (below) to give it a jointed body, which produced an entirely new wobble. Success of the jointed Pikie brought requests for more action. A third section was added (right), and the Pikie was then a three-piece lure



Creek Chub, and the man who whittles the first lure on a new idea. "It turns well. It's light, but it's also sturdy enough to hold the hooks."

When we passed through the painting room where a group of women were decorating the lures in a variety of finishes, we asked why color is important. How does anyone know that a fish can tell color?

Which Colors Are Best?

"Nobody can say for certain," Harry said, "but some colors work and some don't. The Pikie in rainbow colors won't do anything in fresh water, but it's a killer in salt water. You start off with the natural colors of the bait you're trying to imitate, and then you try variations. Red and white, for instance, are good colors. Nobody knows why, but fish like them.

"On the other hand, some days walleyes will hit the silver shiner, but bass will only take the dark lures. This is purely a matter of trial and error. Why are dark lures better at night? We don't know, but over the years dark lures have been so much more successful at night that it has become a matter of fact.

"Here's an example. We had a letter from a fisherman in the East who wanted a yellow Pikie. We made one up special and asked him to let us know how he did with it. When he said it was a success, we made some more and sent them off to some fishermen to give them a try. It worked for them, so we added yellow to the line."

When we asked Harry what sort of research went into the development of a

new lure, he smiled and said, "It's not what you'd call an exact science. We sort of bumble our way through, but we do manage to get results. For instance, I say to Van that we ought to have a plunker for lightweight spinning tackle. We discuss pretty generally what it ought to do, then Van whittles one out of a piece of cedar, attaches a mouthpiece and the hooks, and then he fishes it.

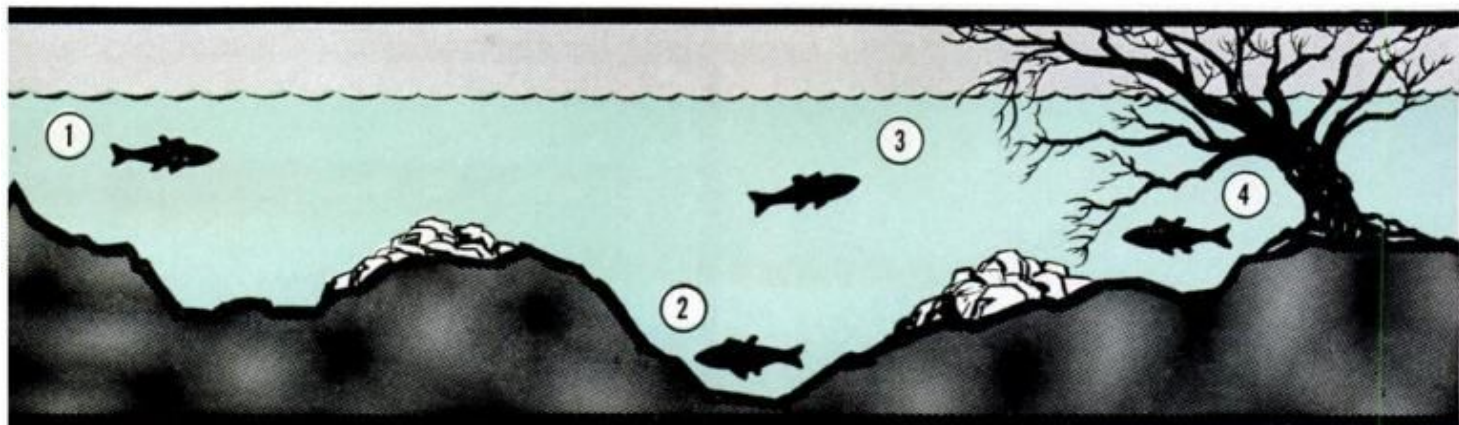
Not Enough Plunk!

"After a few days I ask him how it's coming, and he growls, 'Not enough plunk!' This can go on for a week or a month. The size and position of the mouthpiece might be changed twenty times. The hooks get switched around, as well as the screw eye for attaching the line. When Van figures he's got the 'plunk' down pat, we try it together. If we're both satisfied, we decide on a color—let's say a white body with a red head—we paint it, and then the fellows in the plant fish it.

"This is the first real test; will it catch fish? The results might show that it just doesn't work. So then we'd experiment with different colors. Let's say we try a frog finish and fish strike it consistently. It looks like a winner, so we make a couple dozen and send them to expert fishermen who will try them out.

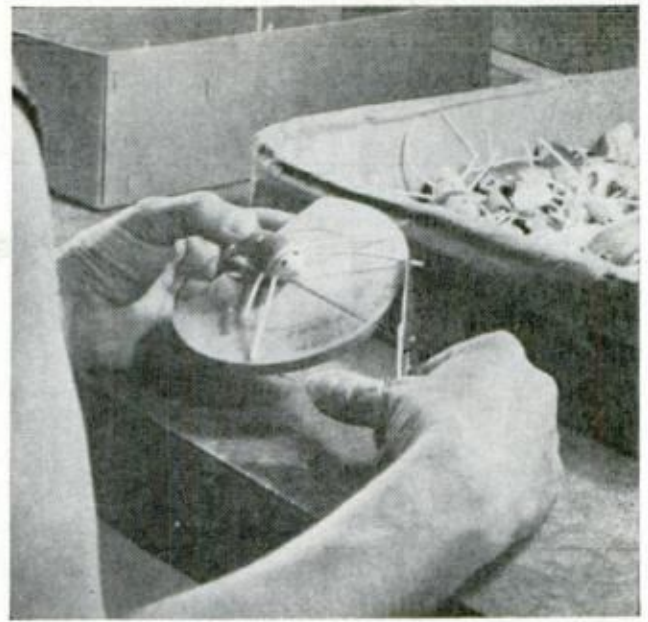
"When the reports come in we have a better idea of what we've got. Criticisms can mean major changes in design, or even scrapping the thing entirely and starting over. But if the report is good, we'll make another hundred and send them out to more experts to give it a thorough going over.

FISHING CONDITIONS DICTATE the choice of a lure, and a single lake will always require variety. For steep dropoffs (1) metal lures like the Bomber and Abu Reflex or any number of spoons would be effective. For deep holes (2) a bottom bouncer like the Dardevle or a deep-diving lure will get down to the fish. Medium depths (3) require something like the Flatfish; any lure that can be regulated by the speed of the retrieve





UNIQUE PRODUCTION METHODS are necessary in making lures. The fish-scale effect is created by hand-spraying each lure through a screen of metal mesh



ACHIEVING AUTHENTICITY that will fool fish requires an individual approach, each lure being worked to specifications that have proved a success

"It can run into a year or more before a lure has proven itself sufficiently to be marketed. In that time there will be all sorts of changes from the original, maybe nothing will be left but the 'plunk.' To be successful, a lure must take fish in a great variety of conditions."

Bird and Mouse Lures

But what about the beginning; where do the ideas for new lures come from?

"Fishing," Harry answered. "Fishing and observing. One time I was fishing thick lily pads for bass when I saw a red-wing blackbird light on a lily pad, and a second later a big largemouth came clear out of the water and took the bird. There

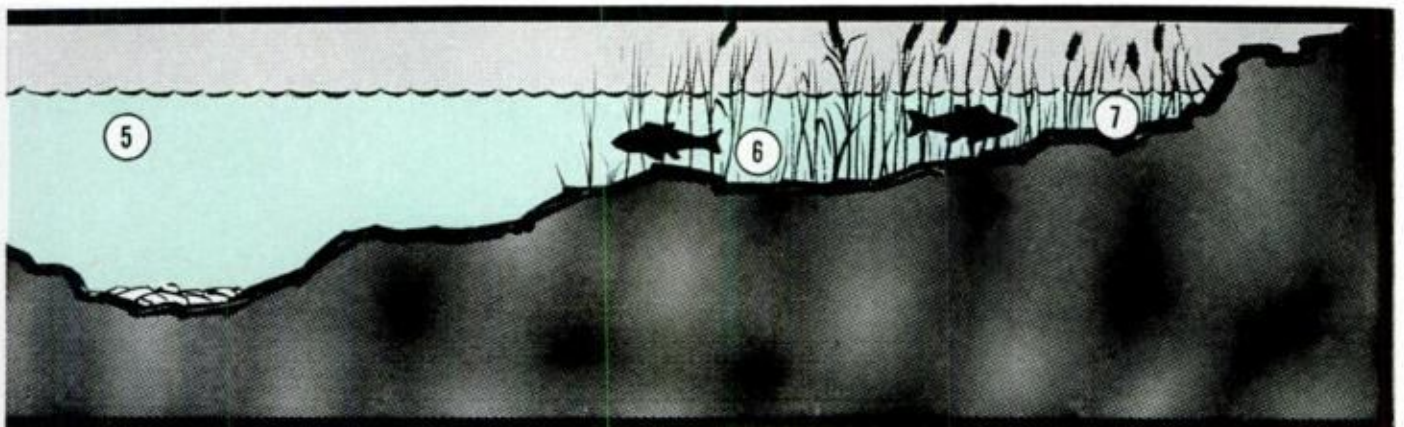
was a great idea for a lure. But I could never figure out how to make it. On the other hand, I had seen bass take a swimming field mouse on many occasions, so all we needed there was a surface lure that looked and moved like a mouse."

We asked the inevitable question: Will lures take more fish than live bait?

"I wouldn't say that," Harry said. "I know a lot of men who fish with worms. They enjoy it and they catch fish. It's all according to what you want out of fishing. If you're a meat fisherman, worms are fine. I don't use them, myself. To me, there seems to be more sport in trying to fool the fish, and you haven't really fished

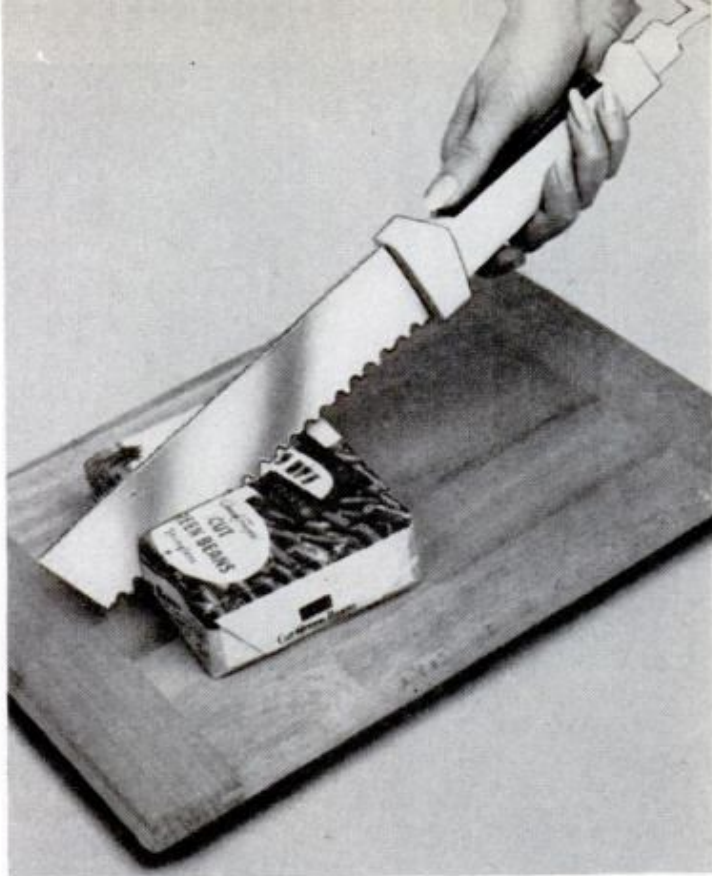
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DIFFICULT SITUATIONS such as sunken trees (4), must be fished with a snag-proof lure such as the Hawaiian Wiggler that can run down into the branches to get the fish. Open shallow water (5) is perfect for something like the erratic floating-diving Bass-Oreno. Noisy surface poppers are effective in open spaces in lily pads (6), and for heavy weeds and cattails (7) you need a weedless lure to slip through with a natural action



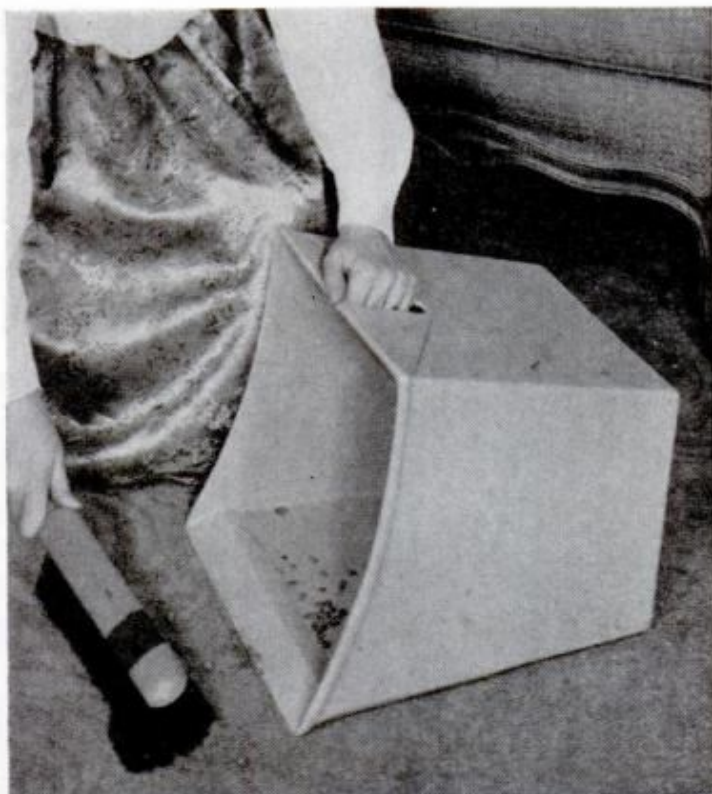
New for Your Home

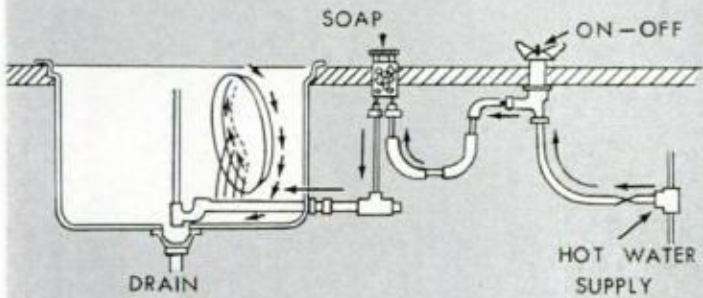
FOLDABLE OUTDOOR GRILL uses paper for fuel. Air vents in steel basket cause draft to fan intense heat that melts meat fat, keeps flame going. Wadded news sheets broil a medium-thick 2½-lb. steak in 6 minutes. \$7.95; Boone Mfg., 1701 Boone Ave., Bronx 60, N.Y.



ELECTRIC HEAT KNIFE cuts at up to 500° F. through frozen or hot food. Pushbutton operates 10-inch stainless blade with two cutting edges—serrated and saw-type. A six-foot cord detaches for table carving. \$14.95 from Osrow Products, Hazel Street, Glen Cove, N.Y.

WASTEBASKET/DUSTPAN combination with built-in hand grip lets you tilt basket on its side, sweep into it and then stand it up for regular use. Height of polyethylene unit is 22 inches; price: \$1.98. Made by Republic Molding Corp., 6330 Touhy Ave., Niles, Ill.

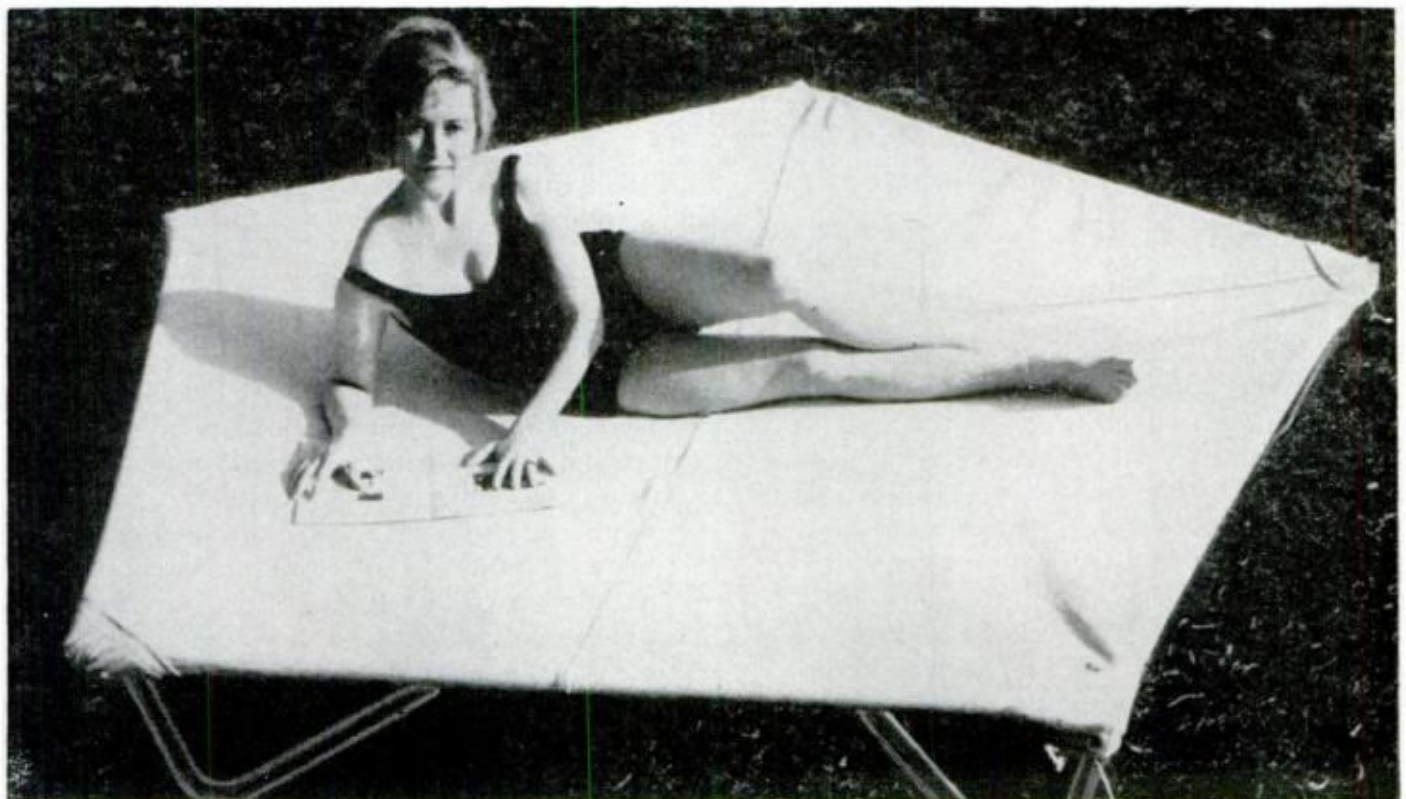




THREE-MINUTE DISH WASHER operates on water pressure alone, not electricity, and holds 32 pieces plus cutlery. Size and installation adapt to any kitchen; washer uses less than 6 gals. of water. Price: \$109 through Jara Mfg. Inc., 149 David Dr., Palatine, Ill.

SLIDING SPICE RACK holds 12 spice cans in under-shelf space in cabinets. White vinyl-coated, it's mounted with three screws to underside of shelf, takes a 7 by 12-inch space. slides out for easy choice. Price: \$1.98. Available from Grayline Houseware, Inc., Elgin, Ill.

FIVE-SIDED SUN COT with 92-inch span holds two adults or three children, assembles in minutes, weighs 40 lbs. Fabric and lightweight steel tubing become rigid with just six bolts; a fabric prestressing technique allows for take-up of slack. Cot is held down in high winds by ground anchor. Price: \$39; optional tent attaches directly to the cot frame. Made by Clevlab, Box 8282, Lexington, Kentucky.



Fresh Water from the Sea

Can We Afford It?



How improved desalting techniques — coupled with by-products ranging from tomatoes to electricity—are cutting costs

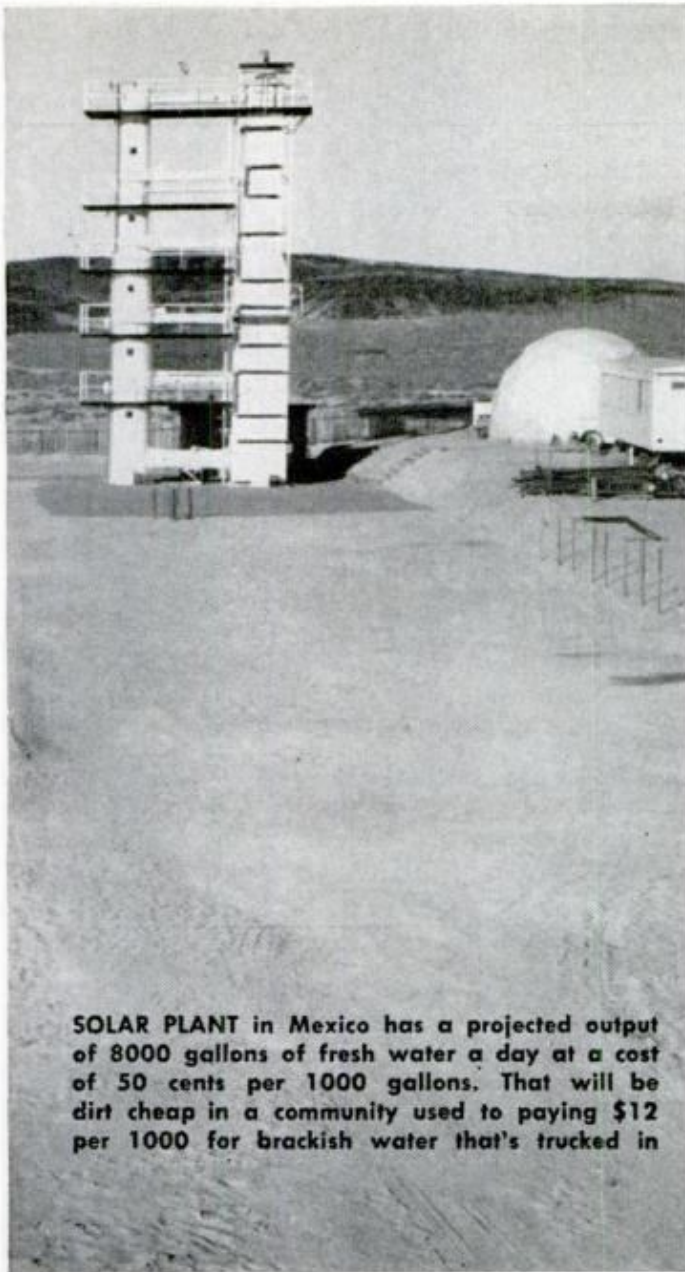
By Thomas E. Stimson

WHEN CUBA'S CASTRO shut off the river water that supplied our Guantanamo naval base, he got a reaction that he undoubtedly didn't expect. Instead of resorting to diplomatic dickering for a restoration of service, the United States decided to get its fresh water directly from the Caribbean Sea.

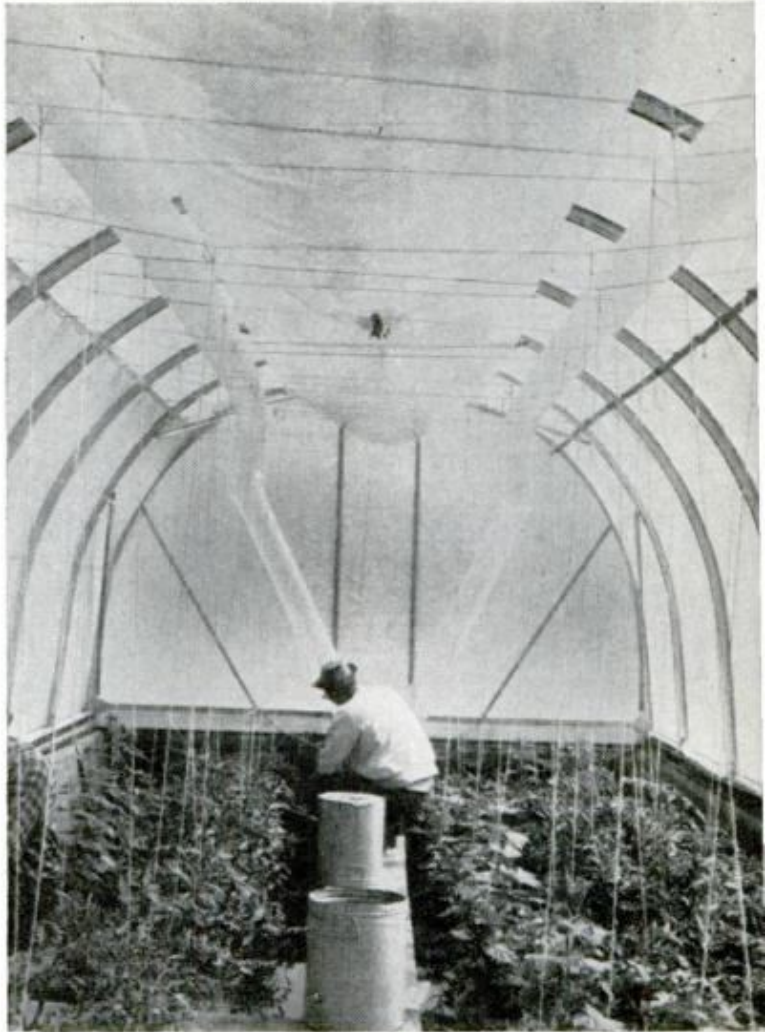
A sea-water distillation plant in operation at San Diego, California, was shipped to Cuba and reassembled at Gitmo. As you read this, a government official told *PM*, the plant should be in full operation, pro-

ducing about one million gallons of drinking water a day.

Though Castro had nothing humanitarian in mind, his act called attention to the growing worldwide need for efficient methods of extracting fresh water, both from the sea and from brackish sources inland. Experts tell us that 99 percent of the 320 million cubic miles of water on the earth's crust is salty, useless for irrigation by present methods and for the majority of man's other needs. And expanding populations and increased industrialization have cut into our own fresh-water supply to the point where a Congressional committee has warned that the U.S. "may be in real water difficulties by the early 1970s." At the present time, though, our problems are largely regional. The Southwest and southern California are especially arid. But the key question is whether cus-



SOLAR PLANT in Mexico has a projected output of 8000 gallons of fresh water a day at a cost of 50 cents per 1000 gallons. That will be dirt cheap in a community used to paying \$12 per 1000 for brackish water that's trucked in



TOMATOES and other vegetables thrive in greenhouse at the University of Arizona. Heat and fresh water are taken from brine supplied by desalting plant

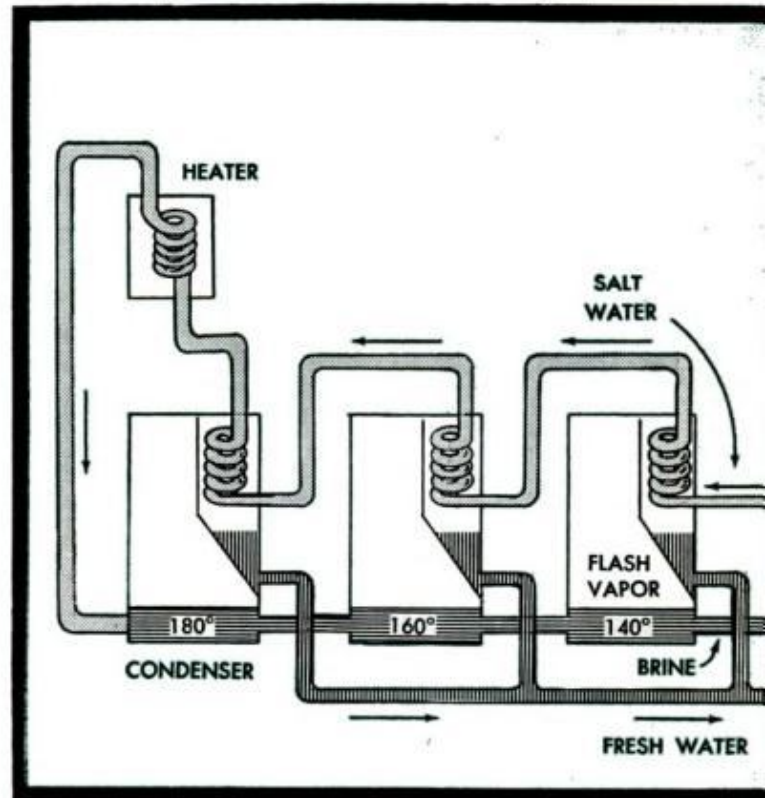
HERE IS a typical flash distillation setup. Heated sea water "flashes" into steam when it hits chamber where pressure is just below boiling point

tomers can afford to pay the presumably higher costs of desalted water. The picture is getting brighter.

Plants set up ten years ago converted sea water into fresh water at a cost of \$4 per 1000 gallons. Before it was moved, the San Diego plant had lowered the rate per thousand to \$1.17. Engineers say that new techniques will reduce the figure to 50 cents. (That cost has already been reached in converting brackish inland water, which contains a much lower concentration of salt than sea water.)

How do these rates compare with production costs for natural fresh water? According to the American Water Works Association, it costs 15 cents per 1000 gallons in New York City, and costs throughout the country average about 35 cents.

"But comparing costs for natural water and for desalted water is like comparing



apples and oranges," comments Pat O'Meara, staff assistant in the Department of Interior's Office of Saline Water. "It's hard to pinpoint what does or doesn't go into the figures given for the production of natural water. Is the use of general municipal funds, for example, counted in? The important thing, of course, is what it will cost for new water to meet tomorrow's greater demands." O'Meara is certain that in many areas desalination will produce the cheaper "new" water.

Happy with the Price

Even today's prices satisfy some people. Over a year ago, the citizens of Buckeye, Ariz., fed up with water that corroded pipes and loaded cooking vessels with scale, voted a bond issue for a desalting plant. Today, they're still happy with the installation, which produces 650,000 gallons a day at a rate of about 50 cents per 1000 gallons.

Research in desalination is producing some interesting and useful byproducts which may affect the desalting costs. At one university, scientists are using waste brine to grow tomatoes and other vegetables. And in the Canary Islands, engineers are putting up a facility that will turn out fresh water as a companion product to electricity. Westinghouse is building the plant for a local public utility. It will create 650,000 gallons of fresh water and 1500 kilowatts of power per day.

Another intriguing scheme is now being

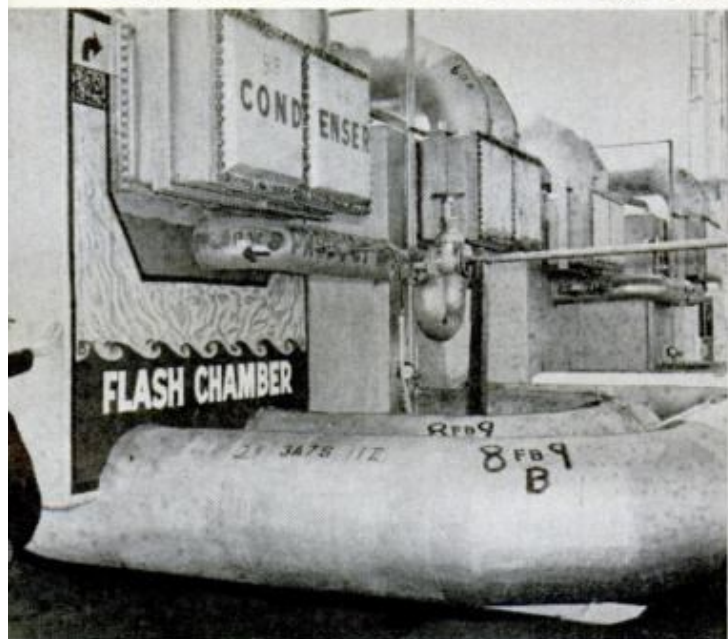
tested at the little fishing village of Puerto Penasco on Mexico's west coast. There, scientists of the University of Arizona are extracting fresh water from the sea with solar energy.

Puerto Penasco's 4000 people have been paying as much as \$12 per 1000 gallons for brackish water that is trucked in from wells 18 miles away. During the summer the trucks operated 24 hours per day. Now, pure water is being supplied to the town's hospital and school, and when the new solar plant is in full operation, it will produce as much as 8000 gallons per day at close to half a dollar per thousand gallons.

The University of Arizona's system is both ingenious and simple. It was perfected by Carl N. Hodges and other engineers of the school's Solar Energy Laboratory over a three-year period. It can produce a steady stream of fresh water night and day, even though the sun shines an average of only eight hours a day. This is because enough water can be heated daily and stored in insulated tanks to permit continuous operation.

The Puerto Penasco plant has three main elements: an evaporator tower, a condenser tower and a solar water heater that consists of 300 feet of 6-foot wide black plastic sheeting, laid on the ground between curbs, over which two inches of water slowly flows. A transparent plastic sheet on the water's surface prevents evaporation and a second transparent

THIS IS PART of the plant that wound up in Cuba. Labels and lively paint job helped explain process to public when plant was on San Diego scene



ENGINEER at San Diego takes a sample of residual brine being discharged into ocean. Analysis of the sample tells how efficiently plant is working



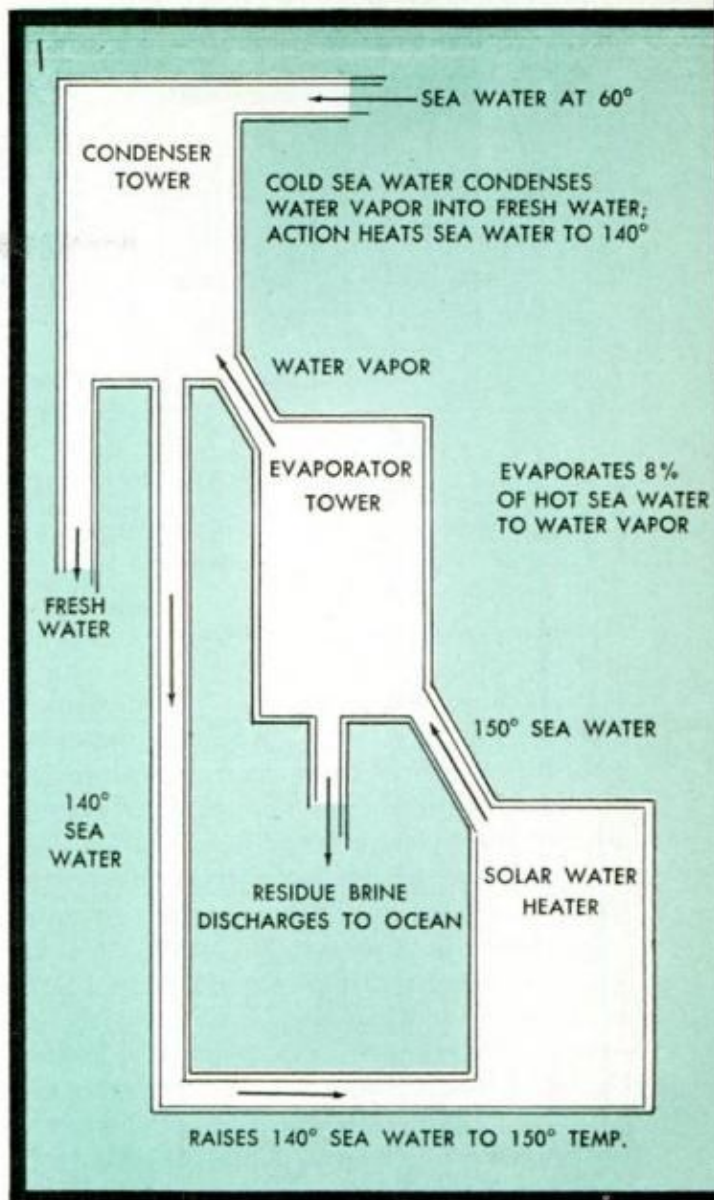
sheet, supported above it by pressure from an air pump, keeps cool breezes away.

Sea water heats up to 150 degrees F. in this solar energy collector and is then sprayed into the top of the evaporator tower. The tower is filled with short lengths of perforated plastic pipe, dumped in at random, that provide surfaces over which the hot water can trickle. A current of air blows upward through the tower and evaporates a portion of the water.

The water vapor that is created this way is ducted to the condenser tower where it forms into droplets of pure water on the outside surfaces of finned tubes through which cold sea water flows. The fresh water collects in the bottom of the tower and is pumped to storage.

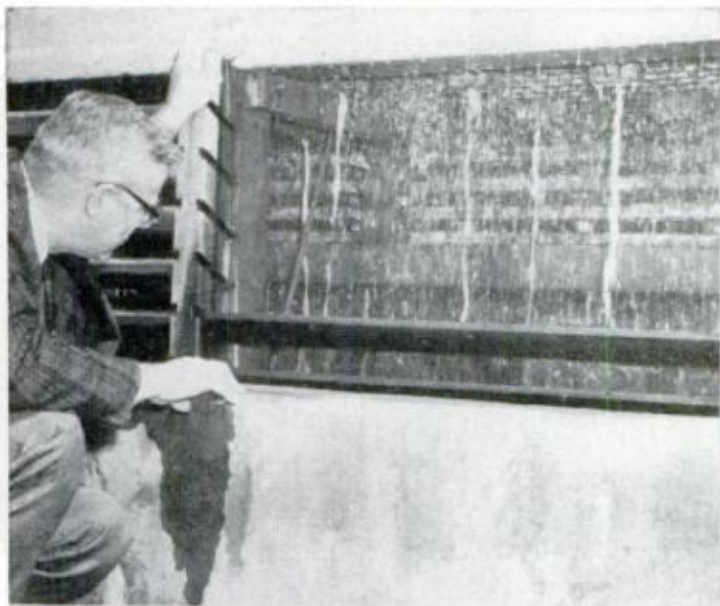
Meanwhile, the cold sea water that entered the condenser at 60 degrees acquires latent heat and leaves the condenser at 140 degrees. From there it is pumped to the solar heater where its temperature is raised another 10 degrees before it goes to the evaporator. The action is continuous.

Only eight percent of the 150-degree water that enters the evaporator is converted into water vapor and carried over to the condenser. The remaining 92 percent, with its original load of sea salts but now cooled to 70 degrees, is discharged from the bottom of the evaporator back to the ocean. Carl Hodges explains that a greater percentage of water vapor could be obtained but that this isn't desired at present because of the danger

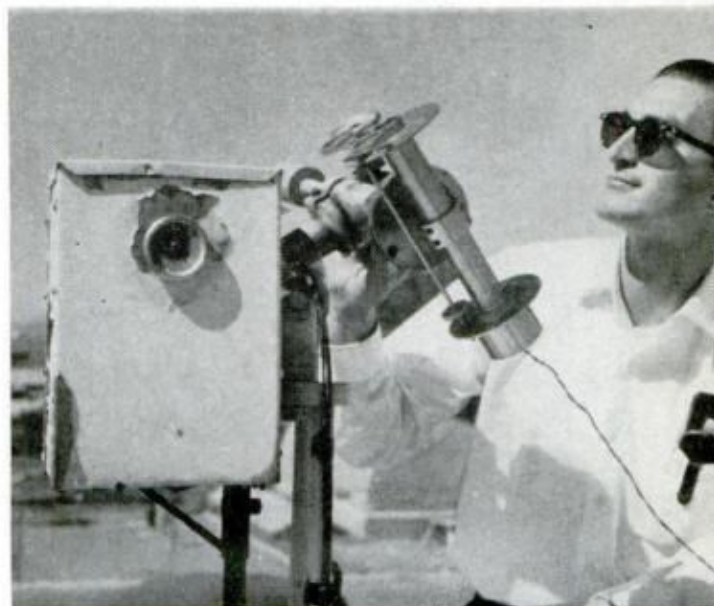


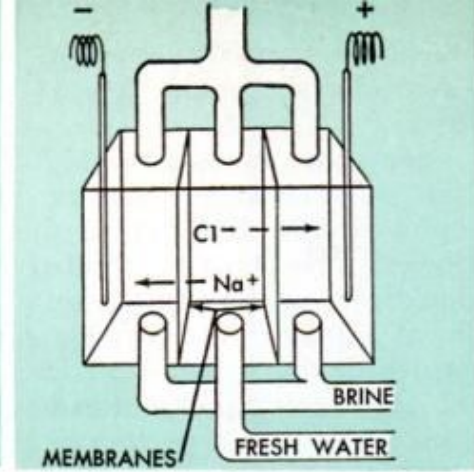
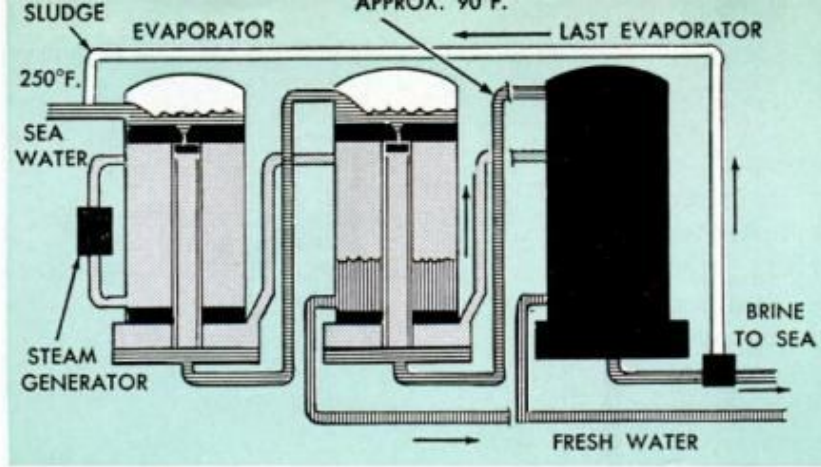
FLOW CHART shows how solar heat is used to extract fresh water from the ocean. This system was developed by scientists from the University of Arizona

FRESH WATER from the flash distillation plant is too hot to pipe directly into the San Diego system. Its temperature is lowered here in cooling tower



ARIZONA ENGINEER adjusts solar measuring device that tracks the sun across the Mexican sky. By using stored hot water, plant can operate at night





FLOW CHART (left) shows how the long tube-vertical process works. It is used to desalt sea water at a plant in Texas and the electrodesalination method (right) is employed in North Dakota on brackish water. Electrodesalination takes advantage of the fact that dissolved salts are present in the form of ions

of forcing some of the salts out of solution and clogging the evaporator.

Hodges expects that the pilot plant at Puerto Penasco will produce water at something more than half a dollar per thousand gallons. This plant, however, is merely the forerunner of a million-gallon-a-day setup, which may drop the cost of fresh water below 50 cents per thousand.

Throughout the world, areas that are water-deficient almost always have plenty of sunshine, and so the University of Arizona's experiment (in which Mexico's University of Sonora is cooperating) is being watched with great interest by water engineers in South America, Australia and the Near East.

To a great extent the cost of distilled water depends on the size of the plant. The greater the volume, the lower the cost per gallon. This is the basis for an enormous water-and-power plant that has just

been proposed by the Atomic Energy Commission and the Department of Interior. The inter-agency study suggests building a huge, nuclear-fired plant on the California coast that would produce a river of fresh water from the sea and at the same time create enough electricity to serve a population of a million people.

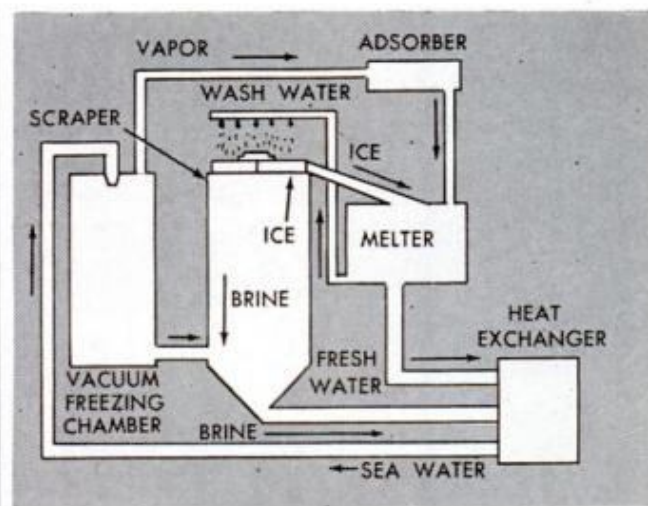
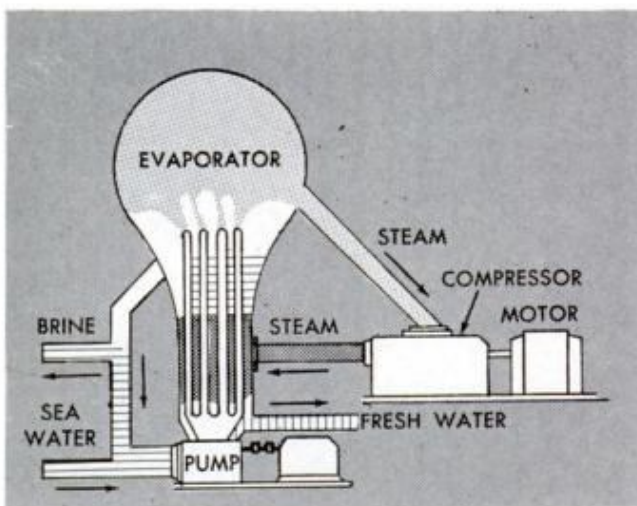
An indication of the giant size of the plant is that its waste heat, pumped back into the water, would raise the temperature of the ocean from the existing 52 degrees to at least 70 degrees, along 40 miles of coast and half a mile out to sea.

The dual-purpose plant would desalt up to 800 million gallons of water per day at an estimated cost of 22 cents per 1000 gallons at the plant site, and at the same time produce as much as one and a half million kilowatts of power.

The study shows that the California

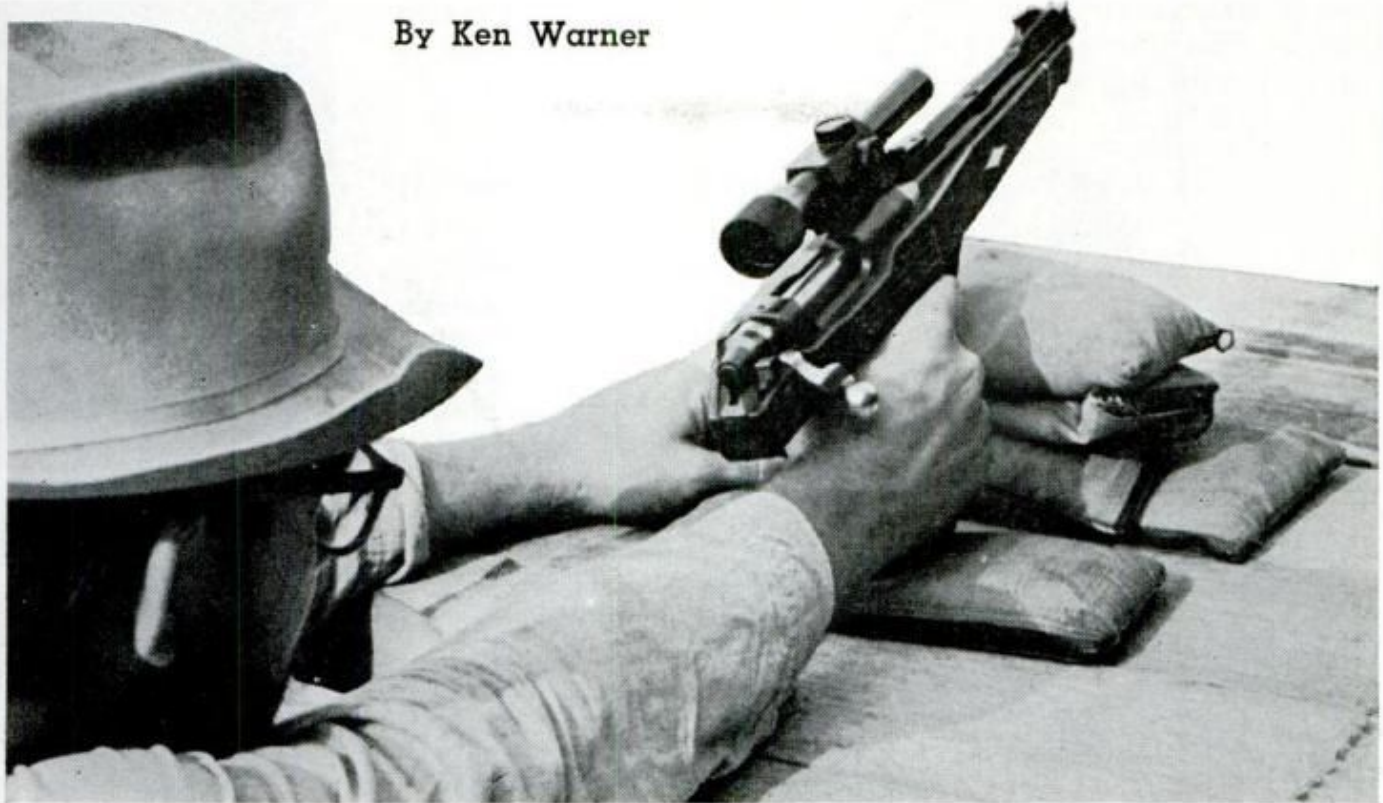
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HEAT INPUT IS USED efficiently in the forced-circulation vapor-compression process (left) because compression increases energy content of the vapor. New Mexico has plant using this method. A freezing plant, also diagramed, will open in North Carolina. Freezing method is new and said to have good potential



Test Firing the XP-100

By Ken Warner



A MODERNISTIC SAWED-off varmint rifle, the Remington XP-100 is a single-shot, bolt-action handgun that packs more long-range wallop and accuracy and flat trajectory than any other handgun built.

Weighing $3\frac{3}{4}$ pounds, and $16\frac{3}{4}$ inches long, the XP-100 shoots a 50-grain .221 bullet at 2650-f.p.s. muzzle velocity. With a Bushnell 1.3X telescopic sight, I shot six groups at 100 yards, and stayed under three inches for five shots.

Major difficulty was getting the hang of

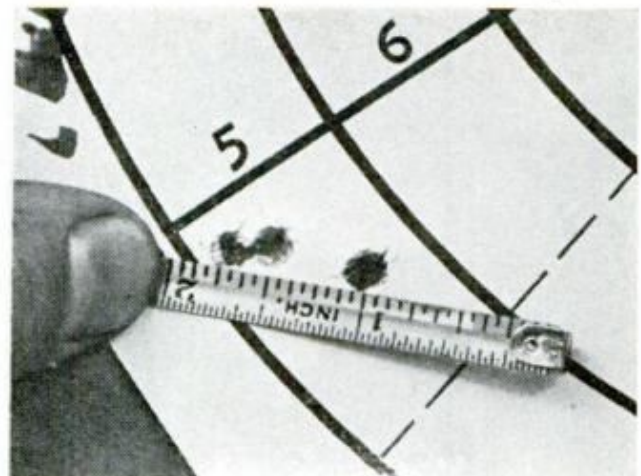
controlling a $3\frac{3}{4}$ pound gun that will give the accuracy of a rifle. The least little twitch is embarrassing. But this was mastered with practice, and then I easily blasted quart oil cans at 100 yards as well as gallon cans at 150 and 175 yards. I shot a Florida buzzard, the first varmint target, at about 140 yards.

Though it's not as easy to hold as a rifle, it would take an excellent varmint rifle to match the XP-100's accuracy—an unusual quality in any handgun.

ONE-PIECE stock permits precision barrel bedding. Inset: large .221-cal. cartridge and .22 long rifle



THREE SHOTS fired from bench-rest at 100 yards measure just under $\frac{3}{4}$ inch from center to center



Tape Produces Light by the Yard

Flexible Tape-Lite by the foot, yard or mile lights almost anything. It's a long strip of luminescent panel made by Sylvania. The panel consists of a thin strip of aluminum foil, a layer of phosphors and a transparent conductive coating sandwiched between clear plastic. Plug it in and it lights. Tape-Lite is $\frac{1}{32}$ inch thick and has an inch-wide lighted area.



Quick Splint Uses Air

A sportsman can now immobilize a broken limb with an air splint—a double-walled plastic tube with a zipper down one side. Inflated, the tube presses evenly against the injured limb. Prices start at \$4.95. The maker is Development, Inc., 3535 Lee Road, Cleveland 20, Ohio. Splints come in half and full-length sizes for arm or leg.



Sweden's Amphibious Troop Carrier for Atom War

Fully enclosed with armor plating and mounting a 20-mm. automatic cannon with a 360-degree range, an amphibious troop carrier suited to tactical nuclear combat has been developed for the Swedish army.

Powered by a 270-horsepower diesel en-

gine, the Pbv 302 has a top speed of 40 m.p.h. on a smooth road. The steering system works on a clutch-brake system and suspension is arranged through torsion bars and hydraulic shock absorbers. It will hold 10 fully equipped soldiers.





See-as-You-Talk Telephone

Want to see whom you're talking to? The new Bell Picturephone makes it possible. Pick up the receiver, push two buttons and punch out the number you're calling. That does it. Screen, camera and speaker are contained in the oval chassis.



AUGUST 1964



Sea-Going Tractor

Designed for dense marsh areas and terrain that must be reached by crossing rivers, a four-ton Ford tractor floats to its destination. It is equipped with ballast tanks and huge, deep-lug tires that aid in flotation and add paddlewheel propulsion.

Thin-Air "Rudder"

Holding a parachutist in vertical position until he is ready to open his parachute, a drag balloon—the Ballute—has been developed by Goodyear Aerospace for use by Gemini astronauts who might be forced to bail out in rarified atmosphere.



103



The
Old
BIG TOP
Rolls
Again

One worry restorers of circus classics have is keeping tigers out of termite-riddled cages

By Bill Wilson

EACH YEAR, ON JULY 4TH, Wisconsin's largest city welcomes a half-million wide-eyed visitors to its annual "Day In Old Milwaukee." Highlighting the gala occasions is an old-time circus parade complete with blaring bands, gaily-bedecked lumbering elephants, zany clowns, wild animals, Indians, an honest-to-goodness steam calliope and 35 completely restored, elaborately decorated circus wagons—the identical ornate wagons which delighted youngsters and grown-ups throughout America when Grandpa was a boy.

The three-mile-long parade, featuring all of the nostalgic sights, sounds and smells of a half-century ago, moves west from Milwaukee's lake front along a five-mile route through the city's downtown section. It passes a reviewing stand at the Municipal Auditorium where Ringling Brothers and Barnum and Bailey's circus is rounding out a week's engagement, and turns back again toward the lake. No motor vehicles pull the historic old parade wagons. Instead, big eight-horse teams of draft animals and saucy little Shetland ponies provide the motive power. Since horse-drawn circus parades disappeared from the American scene 40 years ago, Milwaukee's completely authentic, live re-enactment constitutes the largest animated museum exhibit in America today.

Guiding genius behind Milwaukee's adventure in nostalgia

RESTORING ORIGINAL circus wagons is much more tedious than recreating them from new materials, but for circus buffs it makes nostalgia authentic





OLD WOMAN who lived in shoe lived in very old shoe indeed. But after job of refurbishing and repainting shoe and children, she had a new home

is C. P. "Chappie" Fox, who is director of the Circus World Museum at Baraboo, Wis. Here in original buildings which were for 34 years the winter quarters of Ringling Brothers Circus, Fox and his staff have collected and restored 35 historic parade vehicles dating from as early as 1880. When brought to the museum, all of the wagons had suffered in varying degrees from the ravages of old age, fire and vermin. Today, after much complicated rebuilding, and resplendent in brilliant new coats of paint and gold leaf, they are rolling again.

"Our job would have been considerably easier," Fox points out, "if we were concerned only with exhibiting the wagons here at the museum. It's comparatively easy to fill up their holes and cracks with putty and apply a coat or two of fresh paint. They'd look nice and new again. But putting them in safe operating condition is an entirely different matter, particularly when our cage wagons carry live wild animals, and when they will all be subjected to the jerks and bumps of a 125-mile truck ride, loading and unloading, in addition to the stresses of the actual parade. This means that we had to rebuild our wagons just like new.

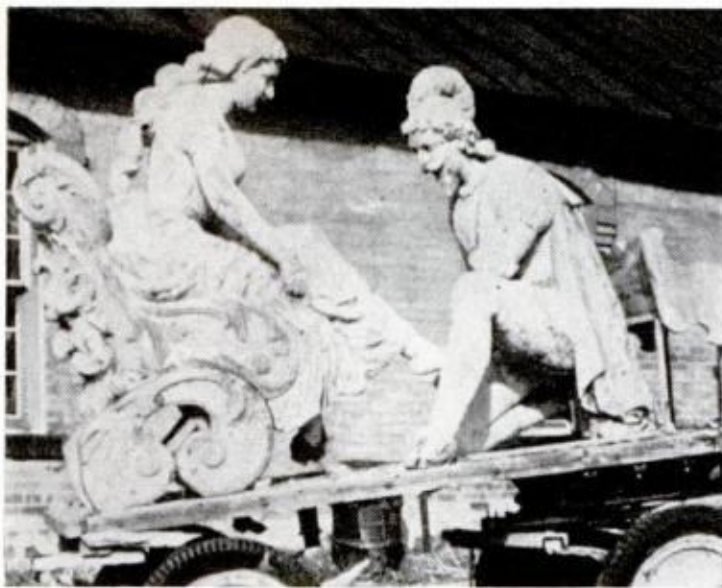
"Take one of our cage wagons, for instance. When it came in from California we thought it was in remarkably good shape for its age. After some work on its brakes and wheels, we thought it could safely carry a couple of lions or tigers in the Milwaukee parade. Then we discovered

that its corner support beams had been infested by termites, and while we were replacing these, we decided to take a look under the floor.

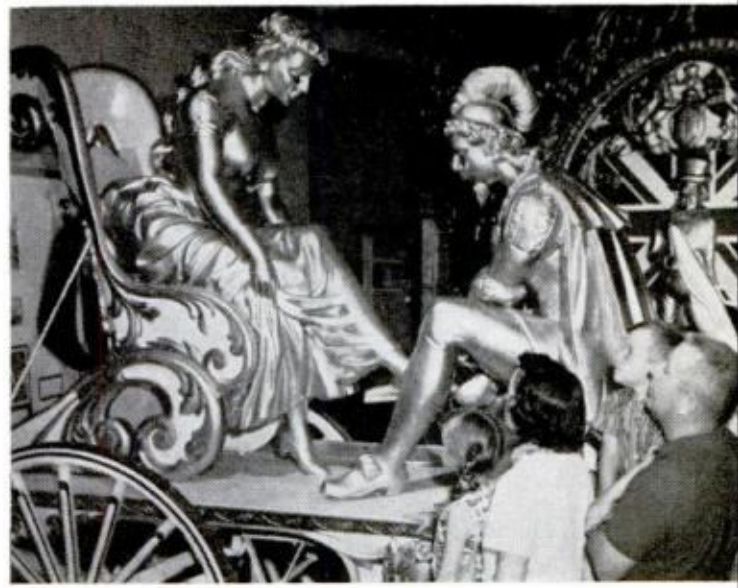
"The wagon had seen service with a number of circuses over a period of about 40 years," Fox explained. "When we ripped up the flooring we found that urine from the caged animals had penetrated through the floor and that the $\frac{5}{8}$ -in. bolts in bolsters which supported the main running gear of the wagon were rusted down to less than $\frac{1}{4}$ -in. in diameter. The wooden bolsters, while they looked all right from underneath, were rotted out inside to such an extent that a severe jerk or other unusual strain on the wagon during a parade might have pulled it completely apart. Naturally we had to begin rebuilding it almost from scratch."

Seven-Ton Calliope

The museum's ornate parade wagons range in size from a light-weight llama cart to the ponderous seven-ton steam calliope, "America," and the parade features at least one vehicle from every major circus which ever exhibited in the United States. Each bears a proud old circus name: Forepaugh-Sells, Ringling, Cole Bros., Gollmar, Barnum and Bailey, John Robinson, and a host of others. Most wagons have served with several circuses. The oldest, the Lion-and-Mirror Bandwagon No. 1, was built in 1880 for the Adam Forepaugh Circus as a tableau wagon portraying St. George slaying a



CINDERELLA BEFORE restoration was extremely shabby scullery maid, and so was Prince Charming. Even wagon on which they rode had four ancient flat tires



CINDERELLA AFTER restoration is handsome, gilded lily, with handsome Prince to (put on her) boot. This picture was taken at Baraboo's Circus Museum

huge dragon. Its gilt carvings still stand out in bold eight inch relief, and its present weight is slightly over 5½ tons. In 1892 it was converted into a bandwagon by the Ringling Brothers, and was used by them through 1920. Later it served with the Cole Bros. and Christy Bros. Circuses. On parade, the Lion-and-Mirror Bandwagon is drawn by eight bay Clydesdales.

Cinderella and Queen Victoria

Most popular of the museum's parade vehicles is "Cinderella," an exquisitely carved gold, white and blue float drawn by 16 prancing ponies. Cinderella, Mother Goose and the Old Woman in the Shoe are the sole survivors of seven Fairyland floats built for the Barnum and London Circus during the reign of Queen Victoria.

During the week preceding Independence Day, these and the museum's other restored parade wagons are loaded aboard huge flat-bed trailers and transported—with state police escort—the 115 miles from Baraboo to Milwaukee. And rolling in from all over the midwest and southern Canada, truck vans arrive with the multiple hitch teams of draft horses and ponies, numbering 300. Following a two-day orientation period for horses, riders and drivers, it is time to furl back history.

Early in the morning the cages of wild animals arrive: six tigers from the Ringling Brothers and Barnum and Bailey Circus in their compact traveling cages. A fork truck lifts each cage to the level of the wagon door. Cage and wagon are

lashed together with rope, then the doors are slid aside and the animals transferred. And then there are bears, and deer and hippopotamuses—ten wagons in all.

The Grand Marshall gives his signal. Gaudily uniformed bandsmen lift glittering instruments. Banners fluttering, spangled ladies smiling, the march blares out and horses muscle into their harness.

Sometimes slowing down or stopping a five-ton circus wagon can become as serious a problem as pulling it, according to Fox. "Our lighter wagons and parade floats all have foot brakes," he points out.

TABLEAU WAGON with charging tiger is typical of wagons used in circus parades of long ago. Some 35 of these historic wagons were rebuilt at museum





IRON TIRES, or rims, were used on larger wagons in old-time parades. Job of refitting them to wheels employed wheelwright's tool (left) to measure wheel, then placing red-hot rim on wheel, then in water, to shrink rim to size

"The big ones use brakes which are chain-operated by means of a hand wheel, and when they are working properly these brakes can skid the wheels of the heaviest wagon. The driver may have six or eight horses out in front, but only the two closest to the wagon can do any holding back. Thus brakes are mighty important.

"All of a circus wagon's brake rigging is bolted to wood, and on one that is 60 or 70 years old, some of this wood gets pretty tired. It may look sound, but when you're going down grade and applying the brakes, a key bolt could pull right through the wood, leaving the driver with no brakes at all. Brakes on all of our wagons have had to be completely rebuilt."

Often as many as 40 coats of paint have been removed prior to refinishing the museum's parade vehicles. In actual circus use they were repainted every year, and no paint was ever removed until the wagons arrived at the Baraboo museum. Scraping away a half-century's accumulation of paint has accentuated the wagons' relief carvings and has enabled the museum to recreate them in their original brilliant paint or gold leaf. This gives the vehicles an elegance all their own.

In several instances carved figures of considerable size have had to be replaced. The museum's green-and-gold cage wagon, built in 1886 for Barnum, Bailey and Hutchinson's Circus, suffered extensive fire and theft damage prior to being added to the Baraboo collection. Two of its four-foot, gilded figures of page boys, the wagon's corner carvings, were lost. Main-

tenance Superintendent Ernest Zimmerly restored the remaining carvings, copies of which were then cast from fiberglass molds of the wagon's other two corners.

Wheels too have had to be re-tired, rebuilt or completely replaced. "It takes a mighty sturdy wheel to support our big hippo tank," Fox says. "The wagon alone weighs in the neighborhood of 9000 pounds, and when you add the 3500-pound animal and 2500 pounds of sloshing water plus the combined weights of driver and brakeman, you want to be absolutely sure that those wheel spokes and rims will do their job.

"Our big bandwagons must carry 18 bandsmen, their instruments, driver and

MIRROR TABLEAU, another great circus wagon from early U.S. circus, was pulled by team of horses. Wheel brake in driver's seat is similar to train's





STEAM CALLIOPE, truly nostalgic sound of great old circus parades, receives new vocal chords. Originally built in 1903, it measures six feet in length



CLOWNS, TOO! No restoration needed here, but circus parade would not be complete without them. Clowns are from Ringling Bros. and Barnum & Bailey

brakeman. Thus not only the wheels and undercarriage, but also the supporting beams, struts and crossmembers must be in first-class shape."

Elephant's Maternity Dress

Mr. Fox' problems are not limited to restoring the museum's wagons either. "Mrs. Mamie Ward, our seamstress, is a genius at reproducing elephant blankets, wagon banners, costumes and the trappings for camels and horses. She was a featured aerialist in American circuses for more than 40 years, so she knows exactly what these articles should look like, and how to go about making them. Mamie insisted that we measure every

one of Ringling's 10 elephants, each of which is a different size and shape. Thus each of her huge blankets is tailor-made for one particular elephant. Otherwise it would hang like a maternity dress."

When Milwaukee's colorful circus parade moves out each July 4th, every wagon is a completely authentic, sturdily rebuilt restoration. There are no replicas. In the museum's files are photographs of each vehicle in actual use in various circuses 50 or 60 years ago. "We also photographed them exactly as we found them," Fox says, "and again after they were restored. We use these photographs constantly. Without them I don't believe we could do the job. ★★★

PEOPLE-CARRYING wagon takes its place in line of march in Milwaukee Fourth of July parade. Originally part of Christy Bros' circus, it is one of many vehicles restored to operating condition for annual parade



Special spongy plastic makes safe, self-contained packages for gasoline and other flammables

MISSILEMEN have long known the advantages of solid fuel over liquid fuel—it's easier to transport, easier to store and safer while stored. Yet these advantages have never been exploited commercially.

Now at the Southwest Research Institute near San Antonio, Texas, scientists have found a practical method for delivering common liquid fuel in solid form. The fuel is dispersed in a plastic solution that is then jelled and cured to produce a crust. The result is a spongelike brick that is actually 95 percent fuel.

The brick is solid enough to bounce without damage, porous enough to float on water, yet it can be burned by lighting a match to its surface or it can be sliced open and the fuel squeezed out and used.

Gasoline, naphtha, kerosene, lubrication oil, home-heating oil and even ether are some of the liquids that could be stored in these bricks. Southwest, a nonprofit research organization, is not saying what the plastic solution is nor how it is processed since it is not yet patented. But it foresees several commercial applications.

Military services could use the bricks in remote areas, especially in guerilla warfare, where transportation and storage of liquid fuel is impractical. The bricks could also be used as solids for markers, emergency runway lights or as floating buoys.

Fruit growers or farmers could use them as smoke pots.

Outdoorsmen could use them for campfires, or as starters for charcoal.

If made small enough, they could be inserted in cigarette lighters.

Motorists could throw a few bricks in the trunk for emergencies.

In all cases the self-packagability for carrying and storing is the chief advantage. Also, since the plastic is organic material, it will burn along with the fuel at a controlled rate, and it is safe enough to drop from aircraft without exploding on impact.

In a corollary experiment, fuel is being put into minute bead-size capsules for even more localized application—spot dry-cleaning, fuel additives, even bleaches.

Now They're



FUEL BRICKS come in variety of colors. Each color could signify different type fuel. Hard crust locks fuel in brick's spongelike interior

EASILY CUT, bricks can be sliced like butter and used in small pieces, or cut in half like lemon and each half squeezed dry of its contents



Storing Fuel in Bricks



BURNED WHOLE, brick can be used as marker signal, runway flare or fire starter. Match applied to its crust will set it aflame safely. It burns slowly at a steady rate, unlike ordinary container which might explode

DR. JAN AL, who created plastic process, shows how fuel is squeezed out of brick so it can be used normally. Each plastic brick is 95 percent fuel

FUEL CAPSULES are small brothers to bricks. Fuel is ingeniously stored in beadlike balls for more limited applications. Beads crush easily for use

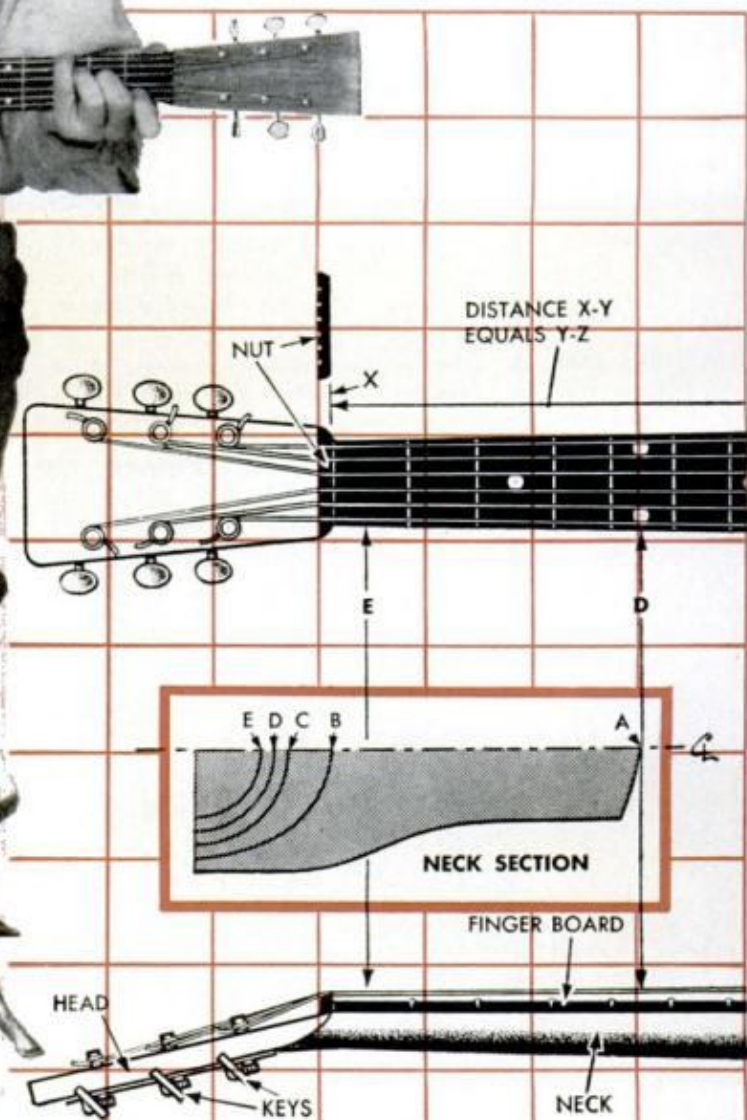
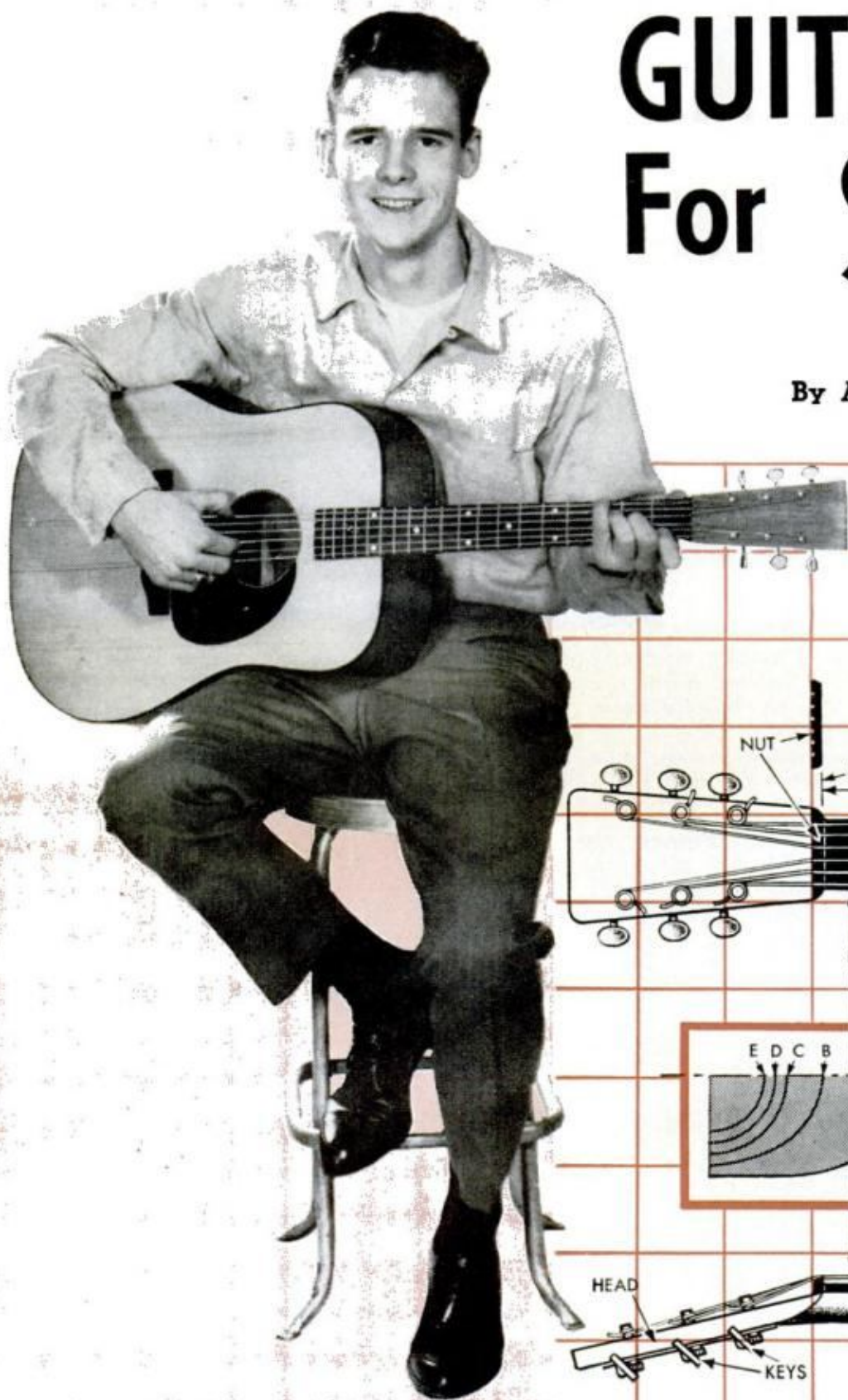


SHOP AND CRAFTS

You Can Make a

QUALITY GUITAR For \$20

By Ajay Hand



WHAT MAKES THIS a quality guitar? For one thing, the materials. The top is fine-grain spruce and the other parts are Honduras mahogany—both “musical grade” woods. Cheap models may use gumwood, birch veneer, etc., usually covered with a heavy coat of finish that is too thick for good sound.

Another quality feature is the large-size authentic “folk” shape. The size provides volume, and the shape at the “waist” lets you string the instrument “heavy” if you wish. In addition, the neck joins the body at the fourteenth fret instead of the twelfth, allowing easier fingering low on the neck.

A third quality feature is the construction. The top is braced with special “fan” bracing instead of the simpler symmetrical bracing. With fan bracing, you get extra strength where the “string loading” is heaviest. Without it, your guitar may be fine in the treble or in the bass, but rarely in both.

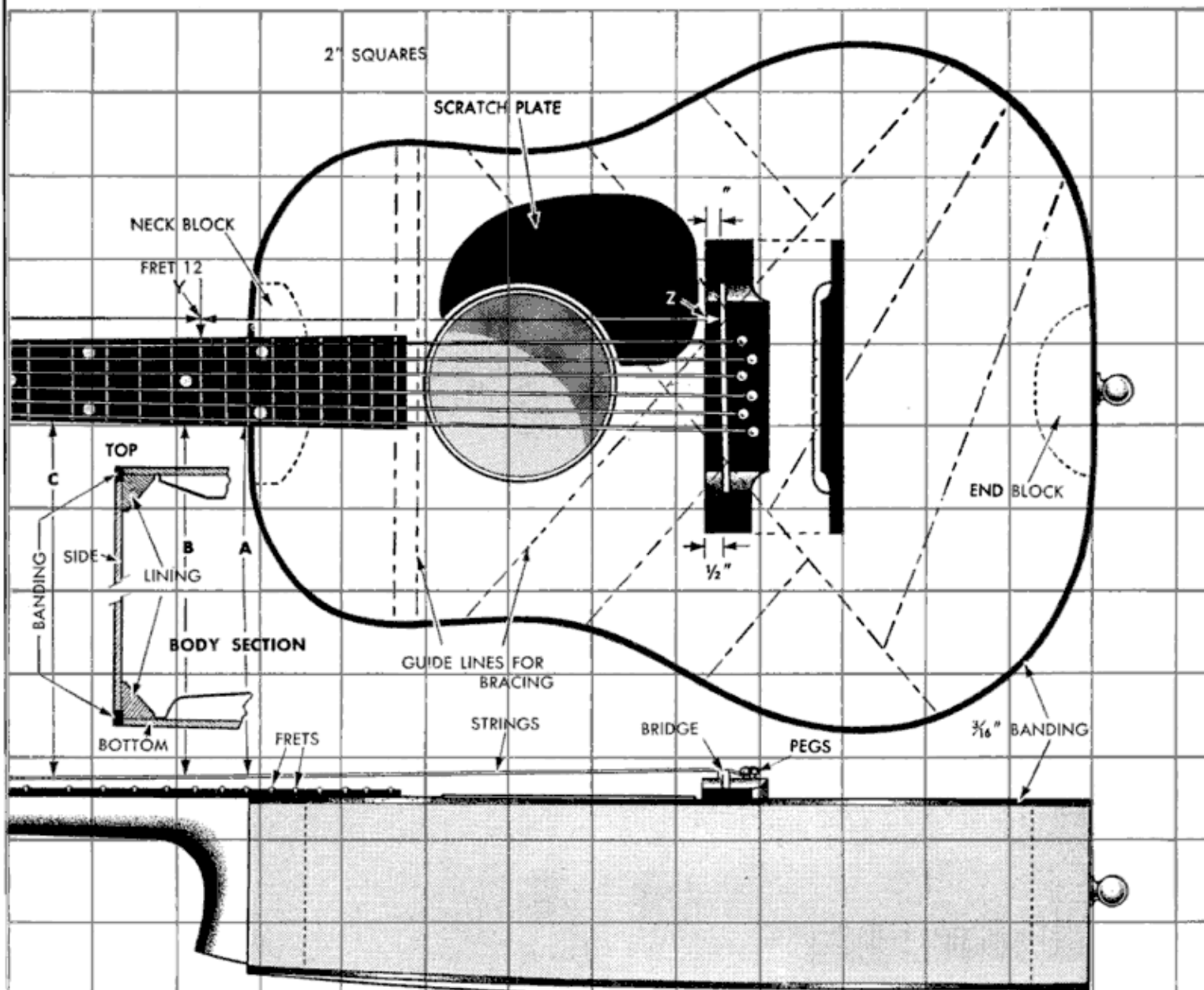
Finally, the cost is kept down by elimi-

nating the banding and purfling often used to ornament commercial guitars and which have no effect on the musical quality.

In spite of the delicate-seeming nature of any stringed instrument, a guitar is not difficult to make. The single most critical aspect is the selection of materials, and all the materials mentioned here are available in “musical instrument grade.” Prices will vary between suppliers, and the cost of the finished instrument will also depend on how much you wish to pay for a fingerboard and the tuning keys, plus the cost of a commercial bridge if you decide to buy one rather than make your own.

Turn the page for complete step-by-step photographs.

STEP A. Glue up a 20 x 24-in. open rectangle of pine 1 x 6s, six layers thick, and interlap the corners. From this thick assembly, you will cut the bending forms. Next, make up a 1-in. grid on a sheet of cardboard and enlarge the outline of the guitar, picking it up from the drawings. Then cut out the grid pattern to form a

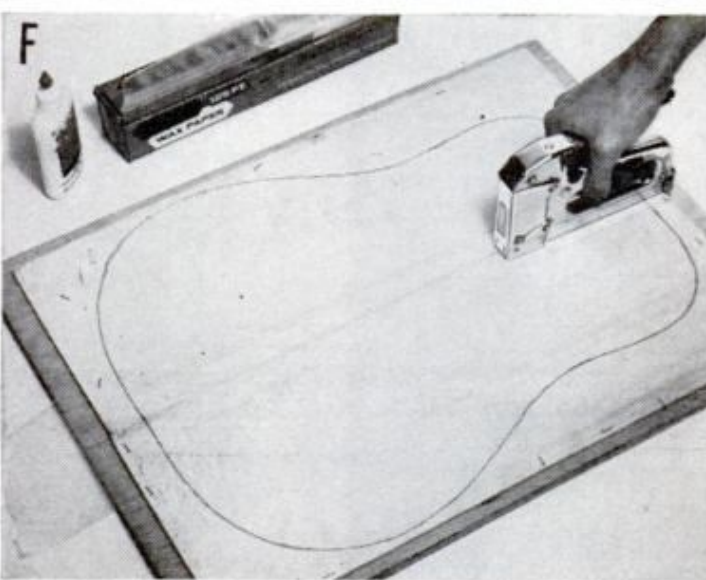
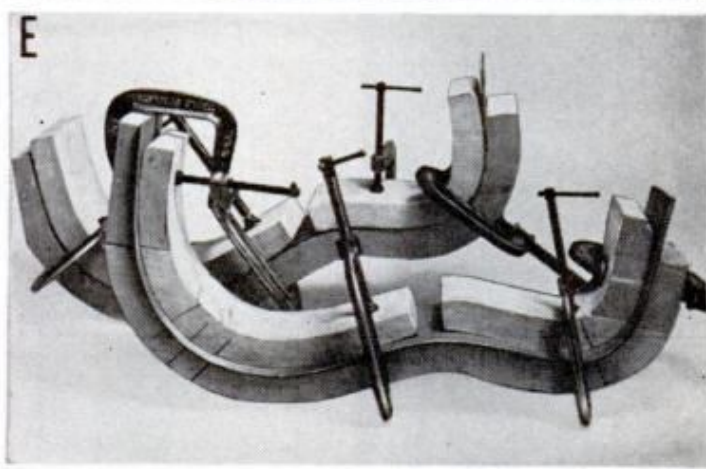
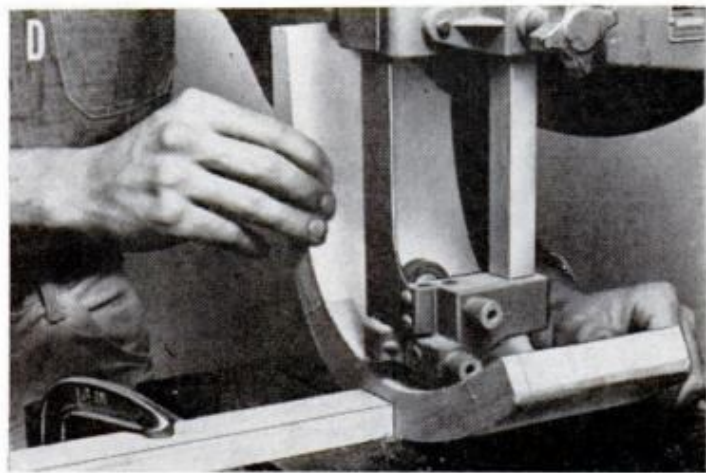
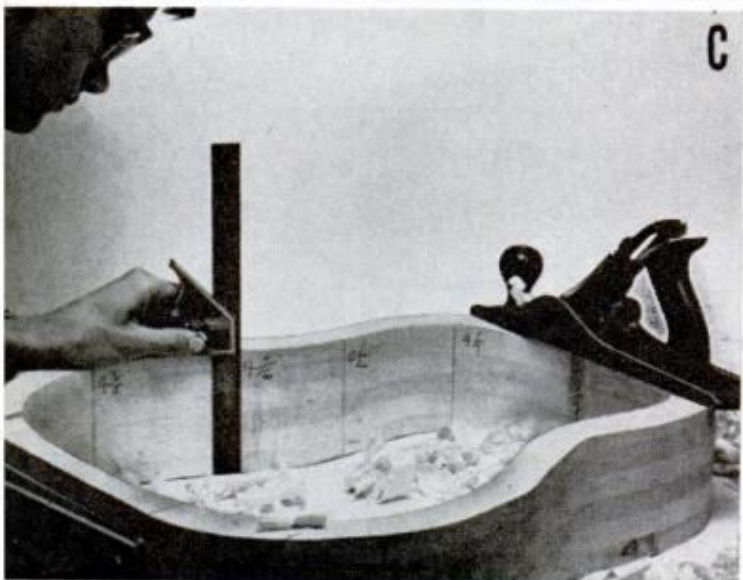
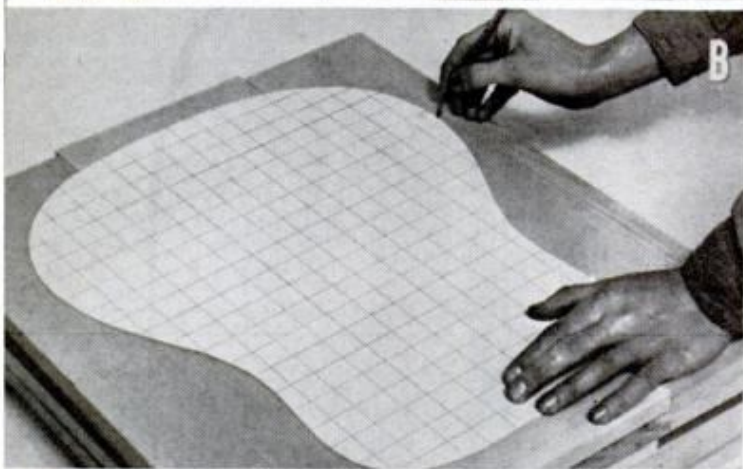
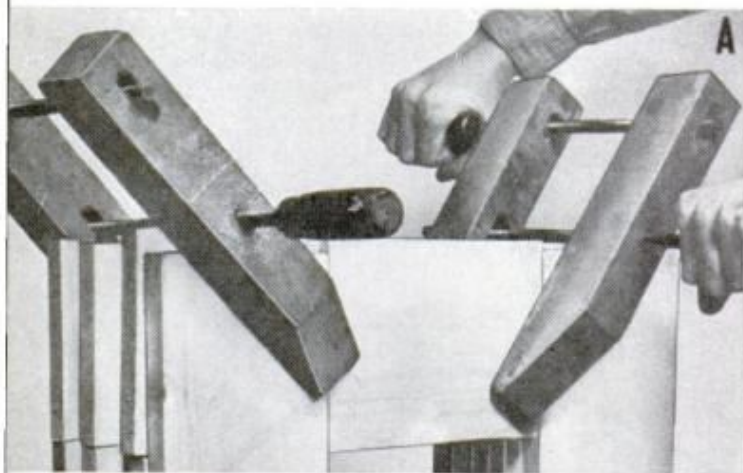


full-sized template for making the forms.

STEP B. Trace the outline of the guitar on the glued-up form. It takes three cuts on the bandsaw to produce the two bending forms. First, make a cut $1\frac{1}{2}$ in. outside the template outline. Next, make an entry cut at the center of the large end and run around $1\frac{1}{2}$ in. inside the template line. Finally, make a cut precisely on the template line. Screw a block of scrap wood to the end of the outside form across the entry cut to hold it together. Cut the inside form into four quarters. Using a rasp and block plane, smooth the surfaces of the

form so they won't crease the sides during the bending operation.

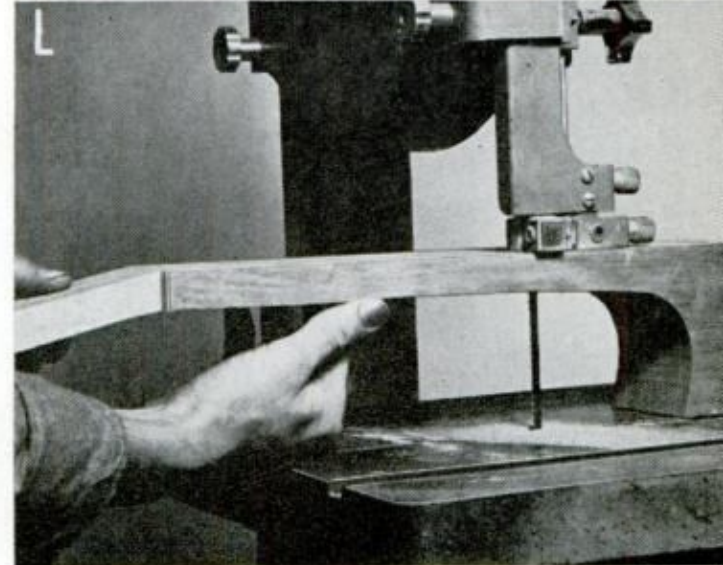
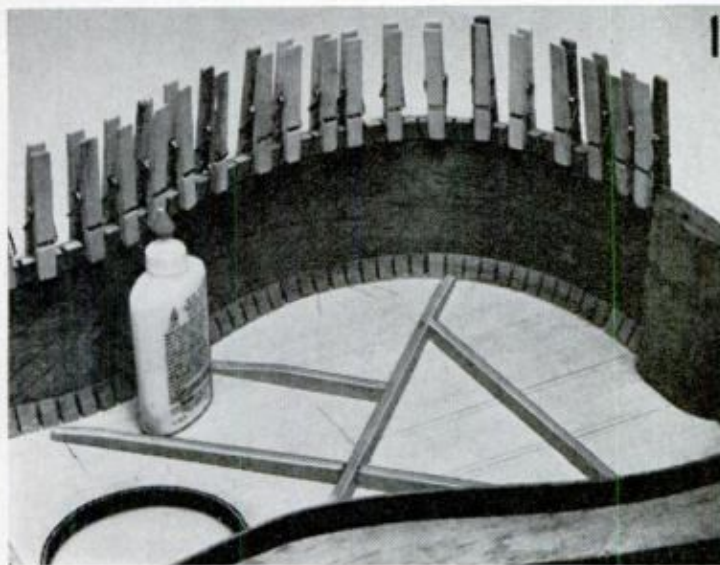
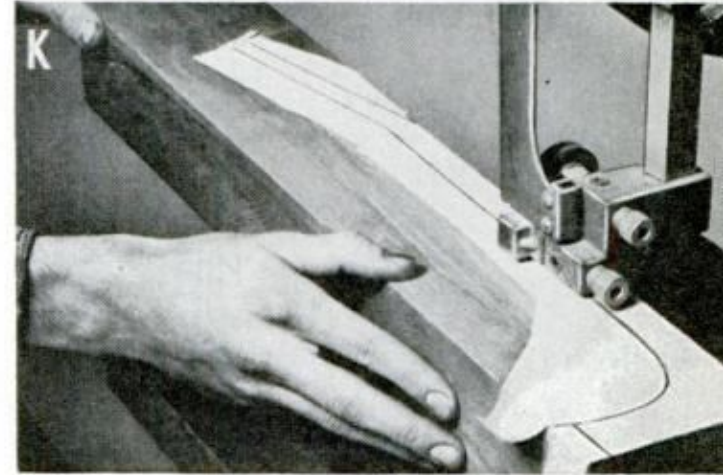
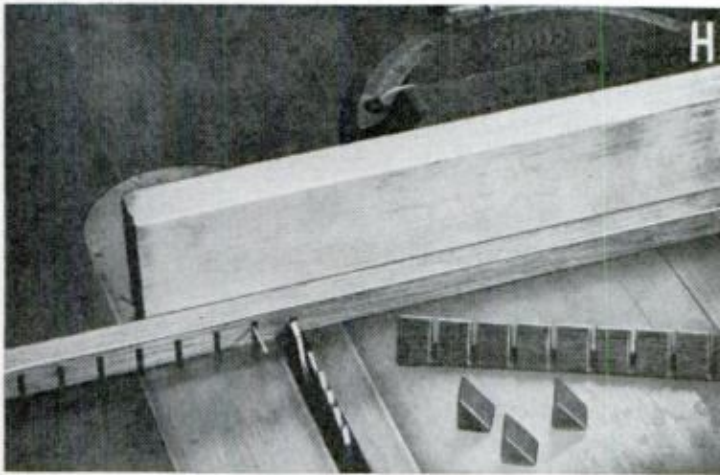
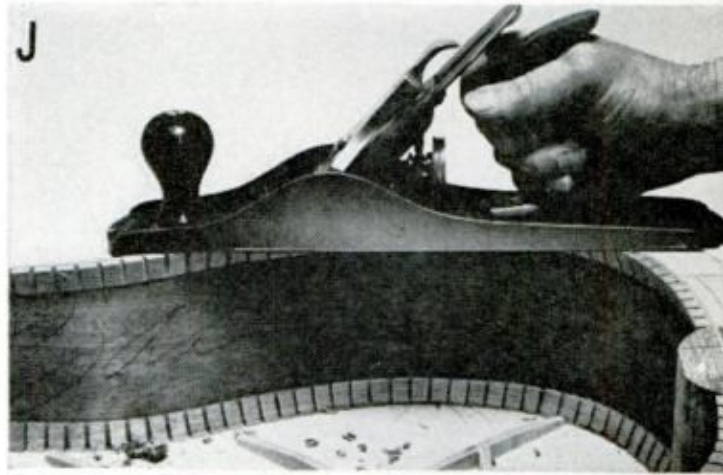
STEP C. Although the top of the guitar is absolutely flat, the bottom is bowed slightly. To achieve the proper profile divide the outside form into five equal vertical sections, and starting from the lower end, mark the depth at the end of the first section $4\frac{5}{8}$ in. At the second, the depth should be $4\frac{11}{16}$ in.; the third is $4\frac{1}{2}$ in.; and the fourth, the one nearest the neck, is $4\frac{1}{4}$ in. Strike a curve through these depth location points, and plane down the bending form to the proper profile. At this

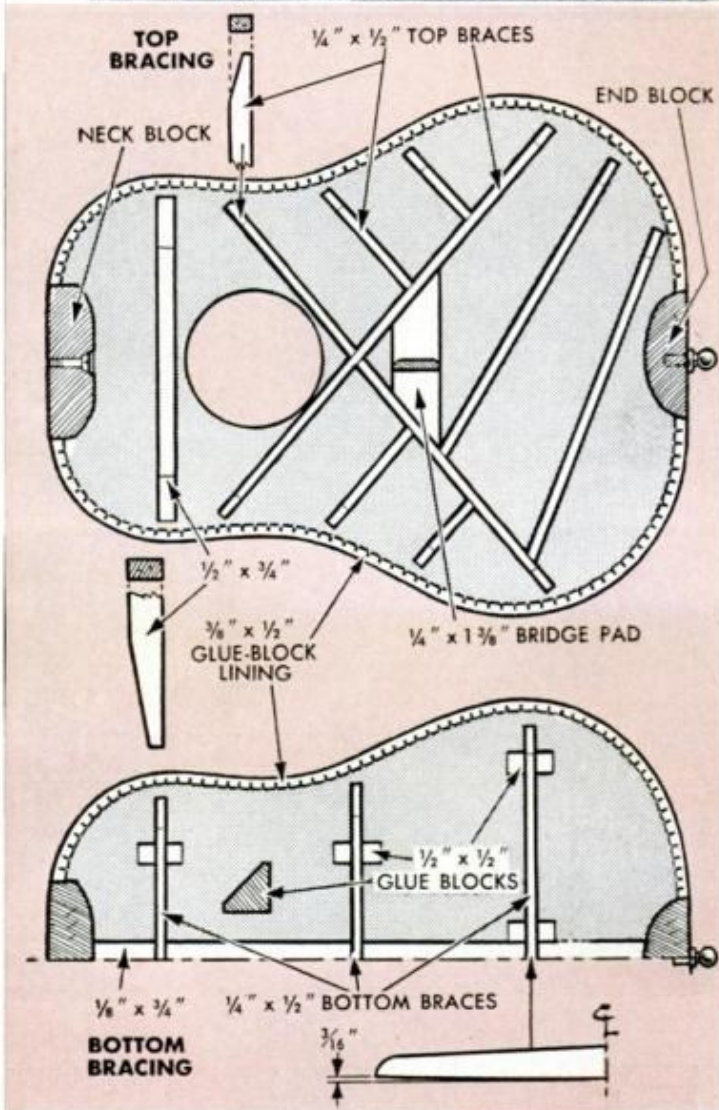
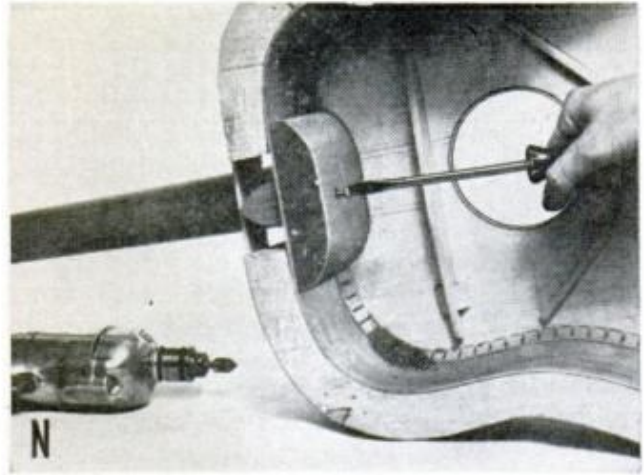
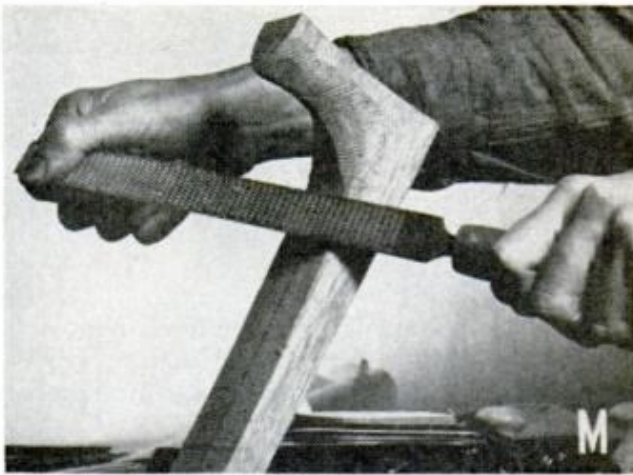


point, cut the outside form into two pieces, and provide a screwed-on block at the neck end, as you did at the large end. These blocks are required because, from time to time, you will have to take the form apart, but it must be possible to put it back together in precisely the same shape. *With these blocks in place*, now cut a 3-in. section out of the outside form in the exact center of each end. You'll work through these spaces when putting on the neck, end blocks, end knob, etc.

STEP D. Once the sides are bent, you will want to keep the assembly in the form

throughout most of the rest of construction. Therefore, the inside forms must be narrowed by about $\frac{5}{8}$ in., so they won't interfere with installation of the glue-block lining. An easy way to do this is to clamp a scrap of wood so that one end is $\frac{5}{8}$ in. from the bandsaw blade, then run the four pieces of the inside form through. Be sure to allow for the taper of the outside form. Notice in the photo that the ends of the form pieces have been rounded. This is to reduce the chance of marring or splitting the sides while they are being bent.

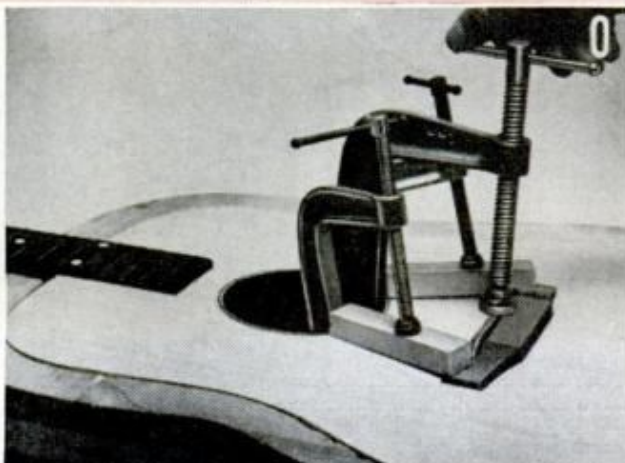


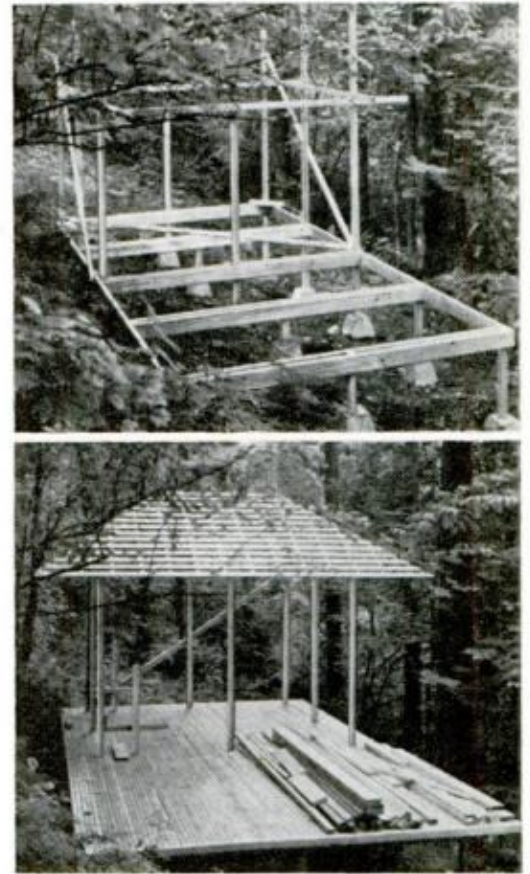


STEP E. Although the bending form is, in theory, symmetrical, it's a good idea to key each part of the inside form to its location against the outside form, as shown by the registry marks. If your materials came rough-sawed, as is likely, you must either plane them smooth by hand or take them to a shop which has a planer. The job is quite simple by hand. First, plane away all the obvious saw marks. Then mark over the entire surface of the stock with a soft pencil, and plane away the pencil marks (see photo G, showing planing the top). Continue until the sides and bottom and top are all down to $\frac{1}{8}$ in. maximum—preferably $\frac{3}{32}$ in. for good playing quality. It's important that you plane both sides smooth. (If you are working with rosewood, do not use a power planer. This wood has such a wild grain that it might shatter, and you'll be safer taking it down to thickness with a scraper.)

To prepare the sides for bending, make a tank by bending up the four sides of a 5-ft. length of aluminum flashing, fill it with water and place it across two burners of the kitchen stove. The boiling water will permeate the wood quickly so that it bends easily. Weight the side pieces down to hold them submerged. Then, working rapidly, take one side out of the water and place it in the outside form. Press it down

(Please turn to page 188)





TEA HOUSE

Under an August Moon

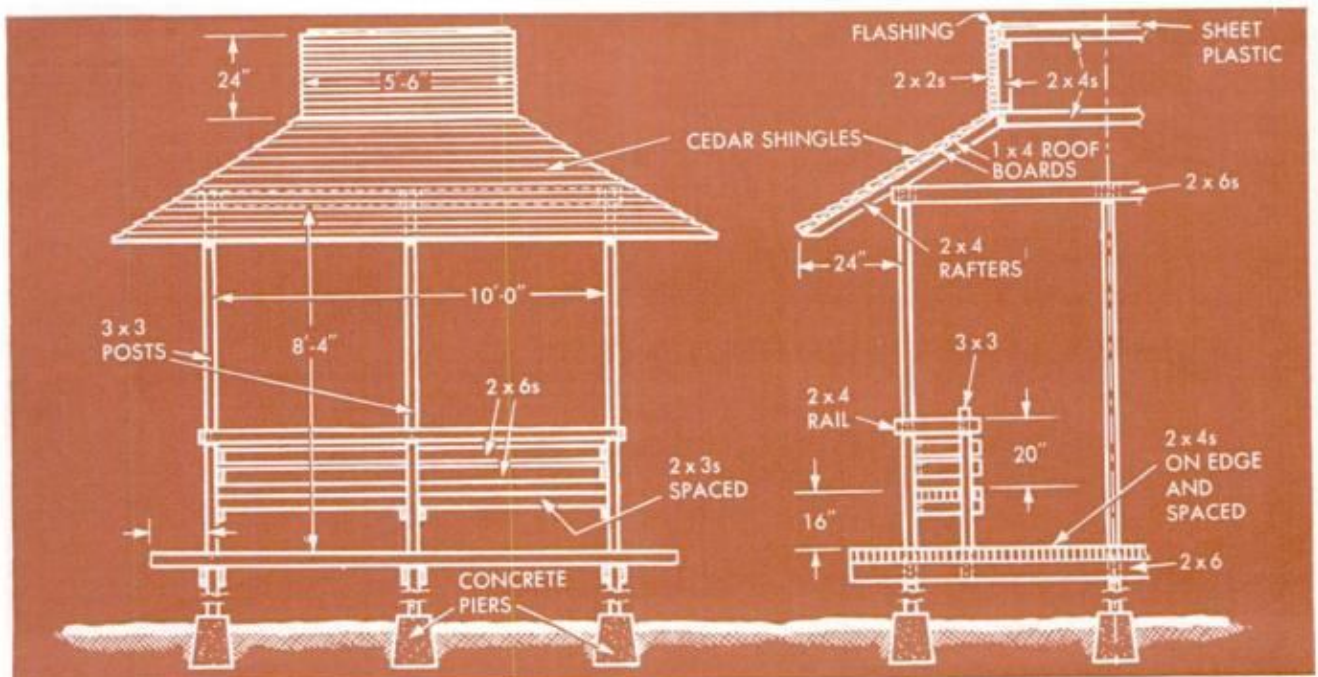
ON THE SIDE OF A HILL overlooking a green valley near Portland, Ore., is a tea house set among the trees, which lures the Zaik family and friends to come sit awhile, to relax in the quiet and coolness of a wooded area. It's a pleasant place to be.

Designed by owner-architect Saul Zaik in cooperation with the Western Pine Association, this retreat-on-stilts has a raised platform deck constructed of 2x4s spaced to allow for proper drainage. The lineal emphasis of the long wood members makes the deck look longer than it is.

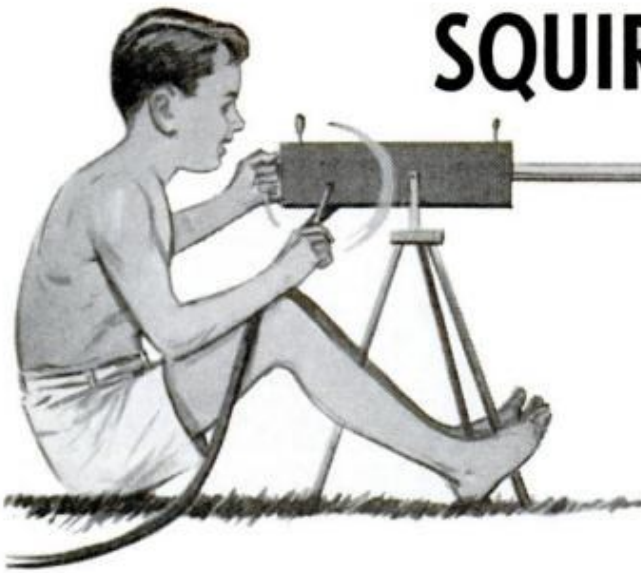
The benches provide built-in seating

space without the need for constantly juggling furniture. But if you prefer to use furniture, the same detail can be used for a simple railing. Just omit the back rest, bench and legs.

The roof beam, rafters and center structure are all of weather-resistant white fir. For extra durability, you might want to use pressure-treated lumber for beams and decking. However, it is less expensive to mop or spray the wood with a good preservative, such as pentachlorophenol. Posts should be end-dipped where they rest on concrete piers.



SQUIRT MACHINE GUN

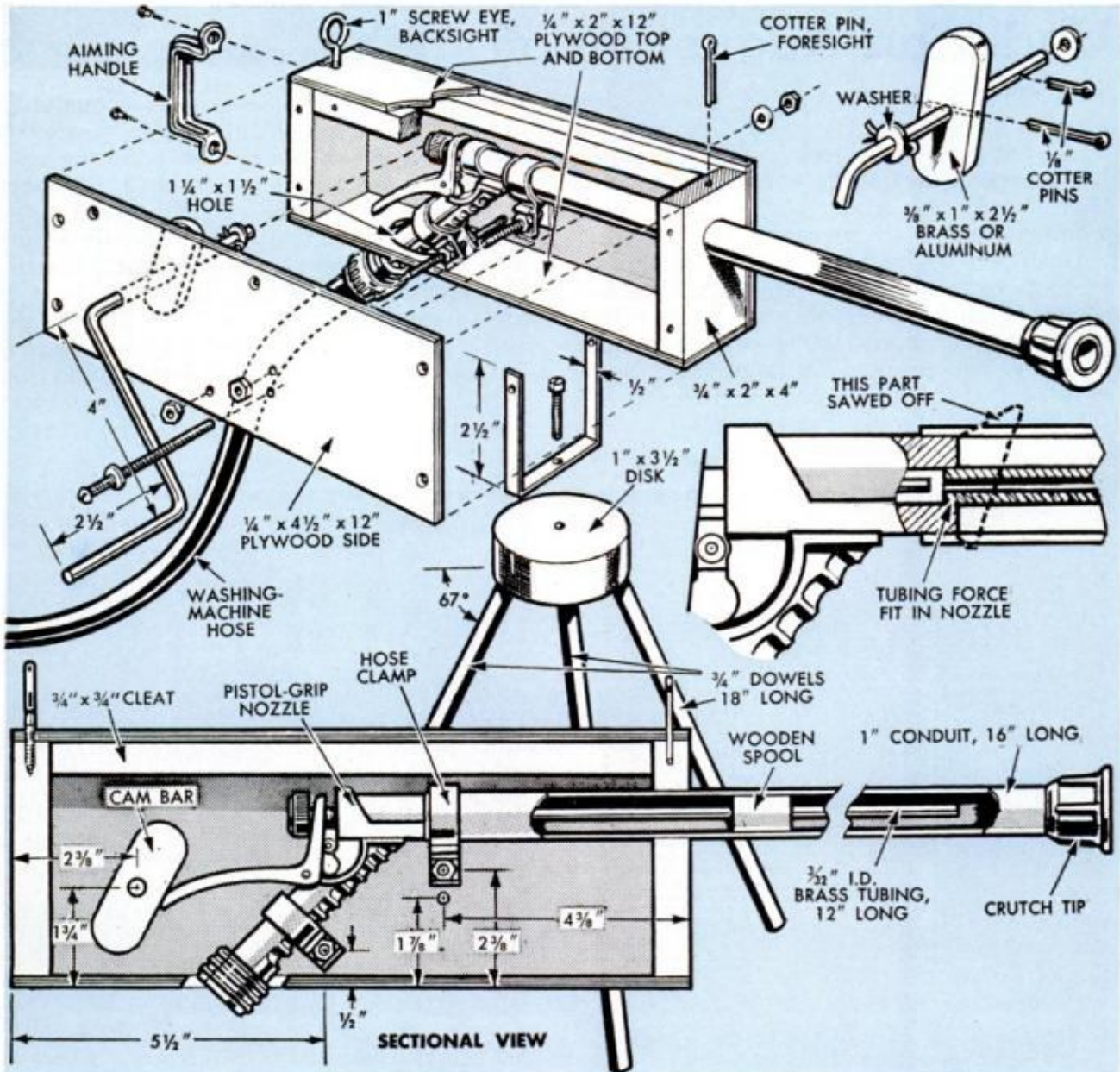


BIG SQUIRT will delight your son enough to boost your water bills, but it should guarantee a green lawn. As the gun is fired it clacks loudly and squirts a short pencil-stream of water, supplied by a hose connected to a pistol-grip nozzle. The

nozzle is triggered by a cam pinned to a crank which depresses the handle.

The hole locations and the dimensions of the housing may have to be varied slightly to suit the nozzle. The one I used is an Aqua Gun which I bought at Western Auto. The end of the nozzle requires a bit of modification; the flared portion must be cut off and the end of the nozzle tapered with a file so the conduit barrel can be forced over it. The same cut will also remove the valve's cone shaped tip.

A key part of the gun is the $\frac{3}{16}$ -in. tubing, the end of which is tapered and forced into the nozzle. The tubing's small inside diameter narrows the wide spray into forceful bursts of "fire" that travel a surprisingly long distance.—*Thomas Sikes*



Give your loved ones
a lift with this . . .

CHAIR THAT CLIMBS THE STAIRS

Steep stairways needn't be agony for the elderly or the handicapped. A chair lift is no luxury when you build one from angle iron and a battery-operated boat winch



By F. Kirk Perrow, Jr.

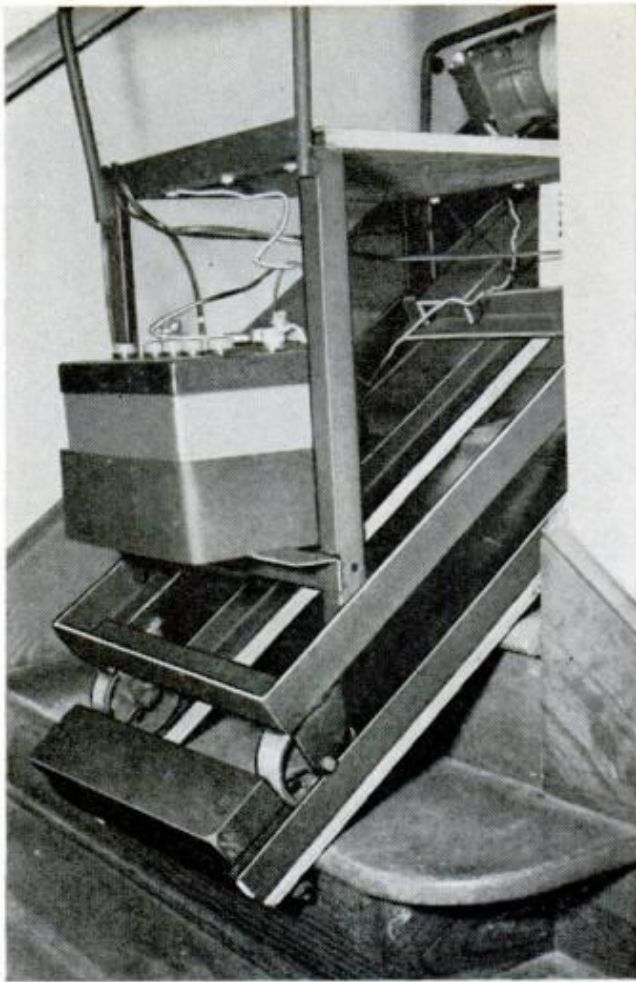
COMMERCIAL stair-climbers have been a feature in wealthy households for some years, but the purchase and installation costs have always been prohibitive for the average home.

Ironically, it's in the more modest home that a straight, steep staircase presents the greatest problem: There's seldom space to spare for a ground-floor bedroom, so the older person or convalescent must either struggle up and down the steps or become resigned to imprisonment upstairs, cut off from the life of the house.

It was our goal, therefore, to present a stair-lift made of inexpensive materials from plans simple enough for any do-it-yourselfer to follow. You don't need your own welding equipment for the assembly. The original builder merely cut the angle iron and rod to length and took these parts—plus the four casters—to a local machine shop. The welding charges came to about

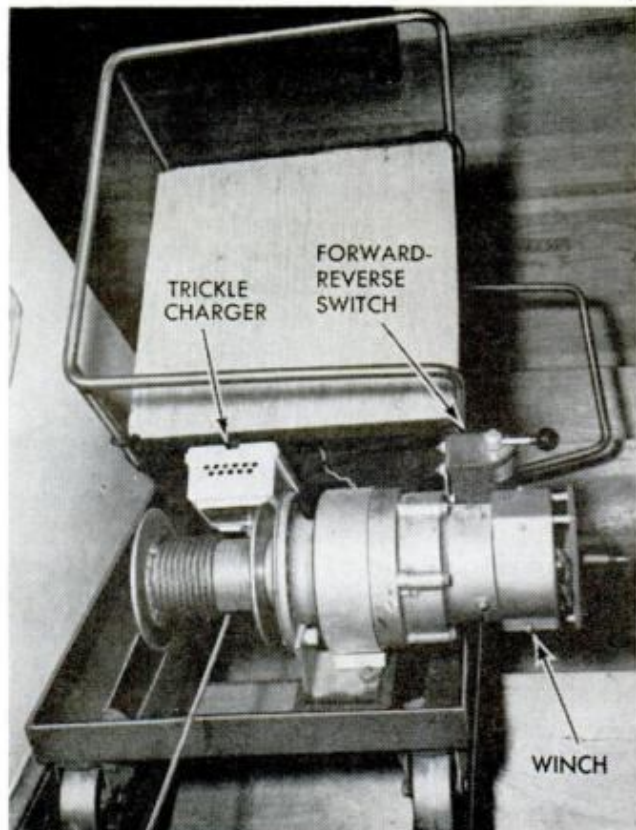
\$25. To avoid any tricky mitering or bending, all angles were cut square and lap-welded at corners. Only one joint was given special treatment—the lower end of the winch-support channel. For extra strength, the channel is locked into the cross angle by means of mating slots, prior to welding, as shown on page 121.

This homemade device can't, of course, compete with commercial models as far as appearance and compactness are concerned. Most of these have wall-hugging tracks and fold-up seats that leave the stairway unobstructed when they're not in use. Our rugged version requires permanent installation of a double track—angle iron screwed to a bed-strip that bridges the stair treads. Whether the truck is parked at the base or the top, it squats across two feet of the stair width, with a center track exposed. The stairway will still accommodate foot traffic, of course.



PARKED AT BASE of stairs, truck rests against double 2x4 spacer between tracks. Note how battery cradle is centered on the seat rail, needs no bottom

GOING UP, seat rides level while winch reels in cable, pulling truck smoothly along track. The winch switch is mounted within easy reach of passenger



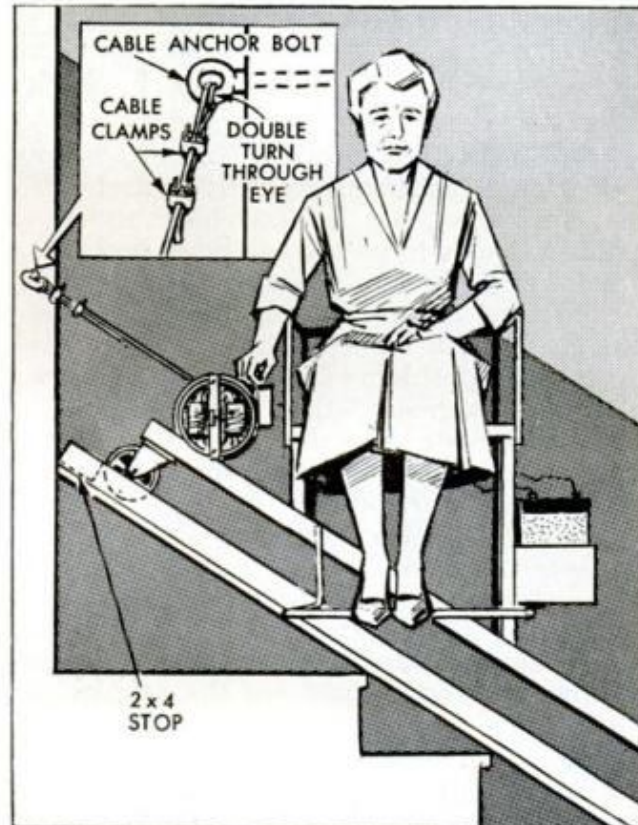
The truck is pulled up the incline by means of a cable wrapping itself around a revolving drum. The drum is a standard boat-trailer winch that operates off a 6- or 12-volt auto battery. It's activated by a 1-hp., 220-V. forward-reverse switch. A trickle charger, plugged into house current overnight twice a week, keeps the battery at full charge. As shown below, it can be attached to keep it handy.

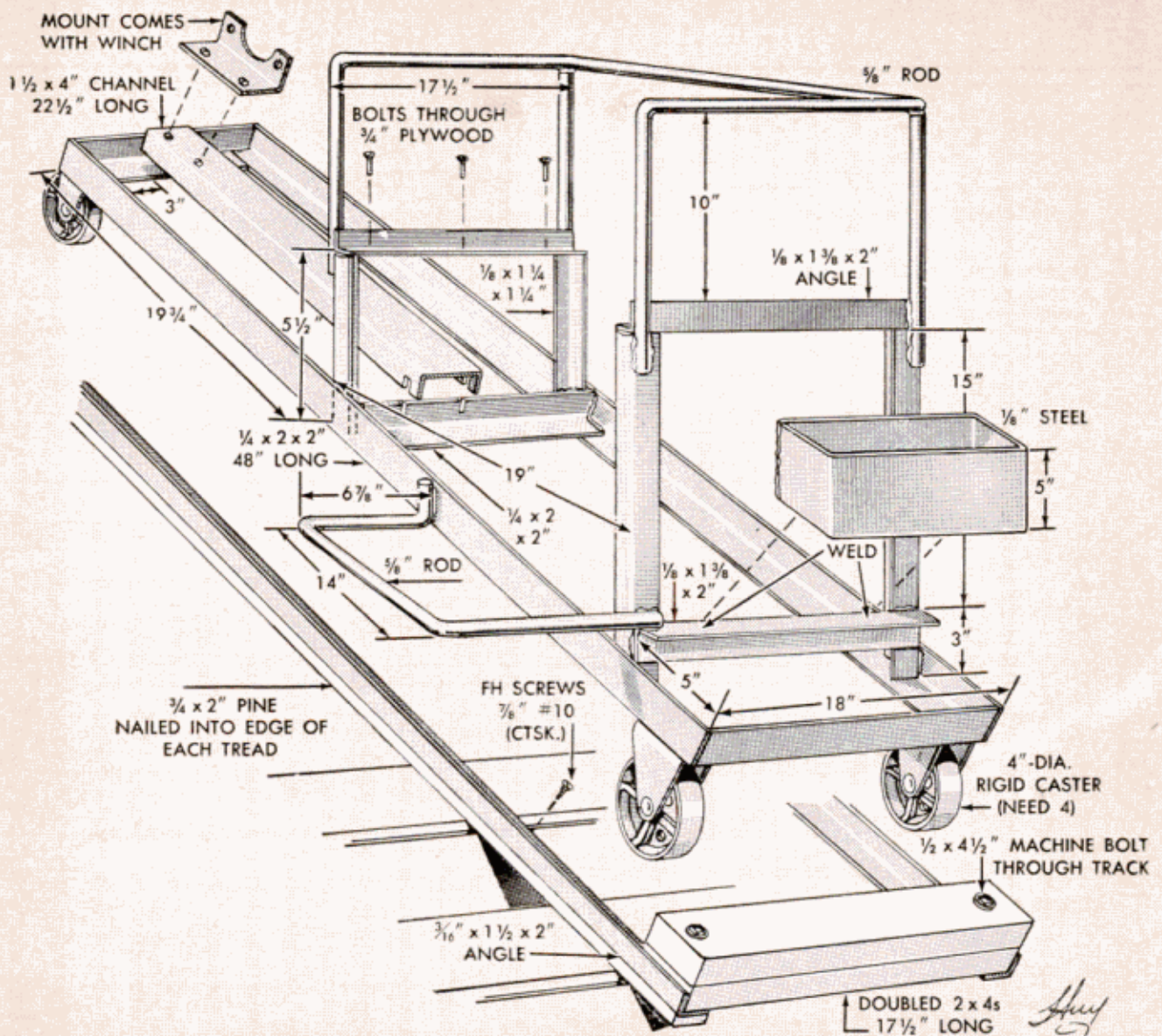
The battery hitches a ride in a cradle welded to the lower side of the seat frame. The one shown at left is a length (about 48 in.) of sheet steel wrapped around the battery and welded to the seat brace.

As shown in the upper-left photo, the track ends just below the bottom tread. You'd trip over it if it extended to the floor. To determine track length, measure from this tread to a point above the top landing that will best position the chair for stepping on and off. In most cases, this dimension will also be the cable length, but buy enough extra to allow about 10 wraps around the drum. The cable shown is 1/4-in. wire-core, capable of supporting over 5000 lbs. The winch is a government surplus item, purchased for under \$50, including the mounting bracket. A mail-order source is Airborne Sales Co., 8501 Stellar Dr., Culver City, Calif. It has a clamp inside its drum to anchor the cable.

Perhaps the most critical step in the installation is anchoring the upper end of

AT TOP OF STAIRS, upper casters nudge 2x4 stop as winch is switched off. Rider then extends one foot to landing and steps off. Top cable anchor is critical





the cable. No screw-eye or staple plate could, of course, withstand the dead-weight tug of truck-plus-rider. In the installation shown, a long anchor bolt, secured from the local power company, was passed completely through the door frame at the top of the stairs, and two nuts were locked snug against a large washer. This type of bolt has the advantage of a cast eye. Be wary of the standard wire eye-bolt with an unwelded eye you can force open.

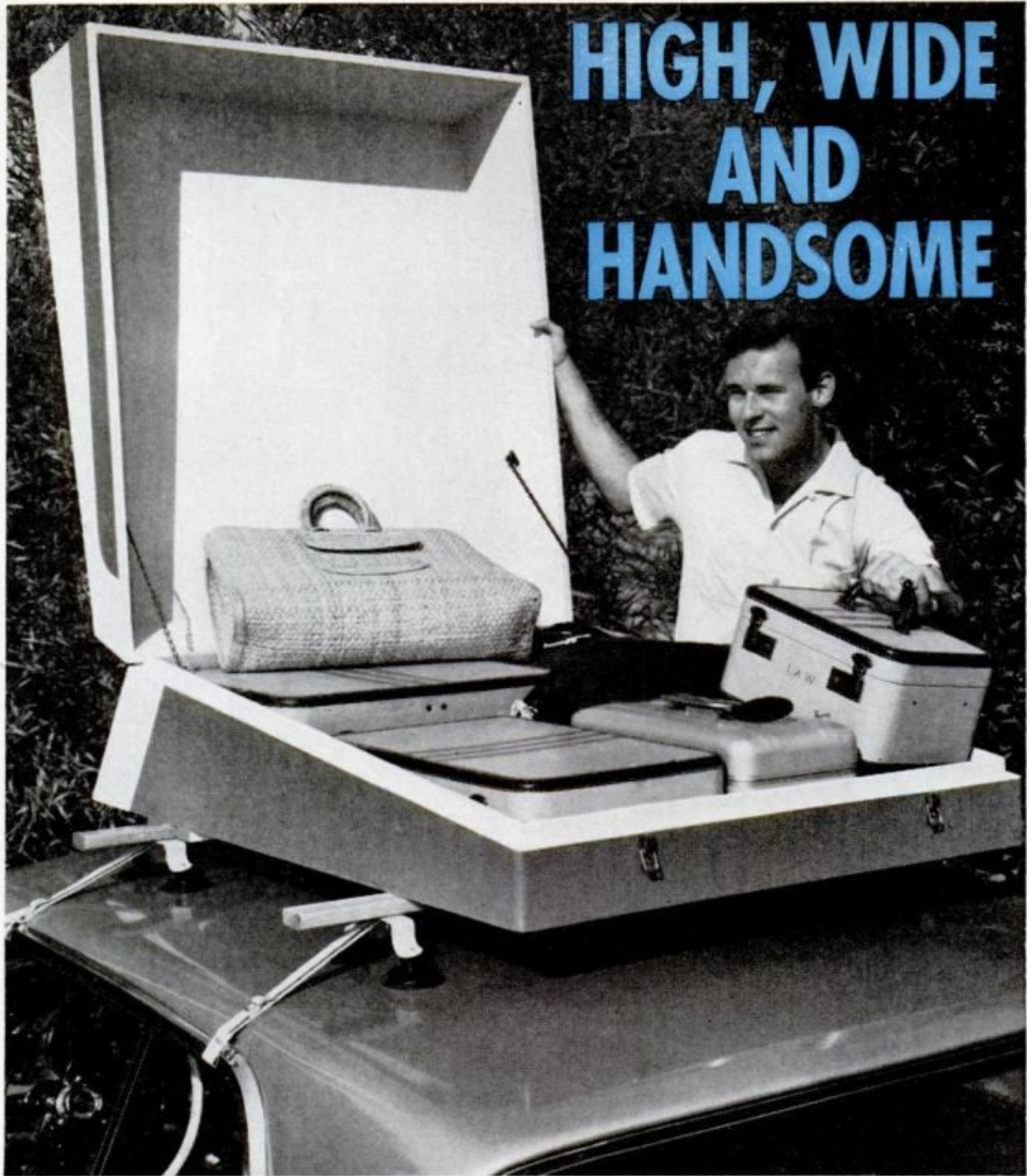
However, a heavy-duty version, formed of 1/2-in. rod, should be plenty strong without an eye weld. If you can't locate such a bolt, you can order one by mail from a building specialties concern, such as Hohmann & Barnard, Inc., 39-63 63rd St., Woodside 77, N. Y. Specify brass or steel rod, 1/2 in. dia. and shank length.

If you have to anchor at a hall corner, you may have to open a small patch of wall to discover how long a shank you'll need, and to turn the nuts against the face of the stud. The bolt must, of course, be located directly at the top of the stairs. If the stairs form a T with an upper hall, for

example, the anchor couldn't be placed on the wall facing them, since this would stretch the cable across the hall passage. The height at which the bolt is located should be such that the cable roughly parallels the incline of the track. This means the anchor will be about the height of the top of the winch drum.

In order to keep this project within the scope (and budget) of the average home workshop, construction has not been complicated with elaborate safety accessories. It is assumed you will take precautions similar to those employed by the builder who designed the original model of this lift, and has enjoyed safe operation in his home for two years. These precautions involve thorough testing after installation (before instructing any elderly persons in the mechanical operation) and frequent checking of the cable, winch and dead anchor. If there are adventurous children in the house, you may want to back up your don't-touch admonition with a practical deterrent such as a lock switch, or a hinged cover that can be padlocked. ★ ★ ★

HIGH, WIDE AND HANDSOME



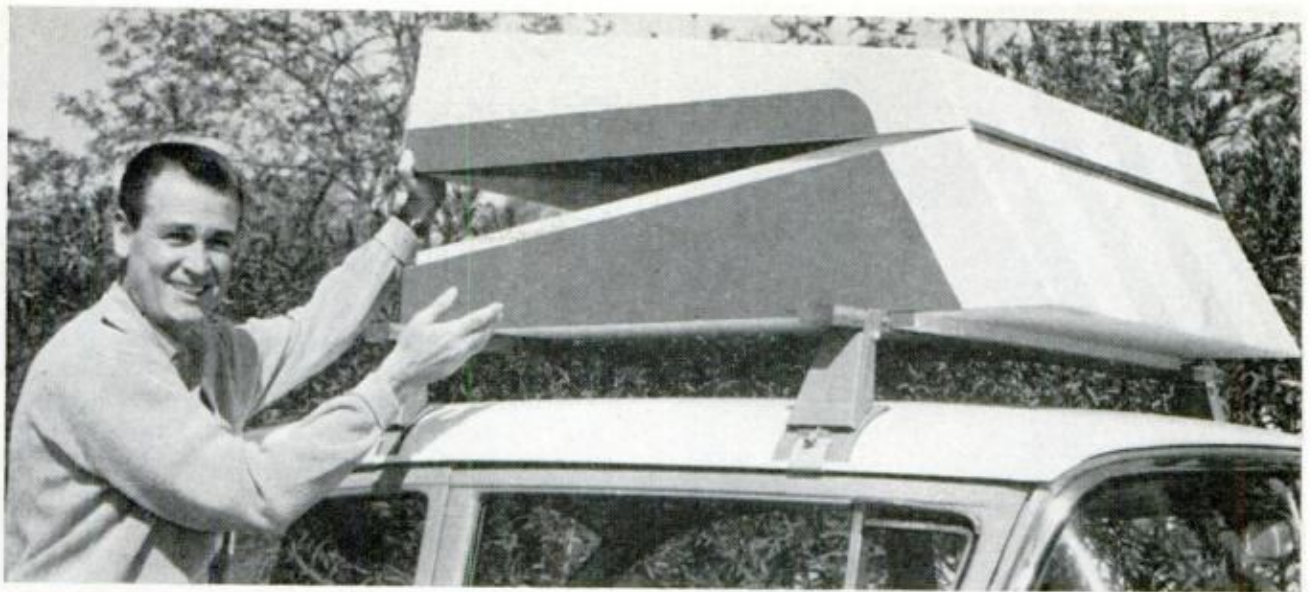
BIG ADVANTAGE of a weatherproof wooden luggage compartment over common canvas-covered luggage racks is that it can be made theft-proof by simply installing a hasp and padlock. But that's not the only virtue of this low-cost project. It's also easier to open and close, and you'll have no worries about the tarp coming loose and flapping in the wind. Furthermore, the appearance is much more pleasing, since you can paint the compartment to match the color of your car.

You'll find that a luggage box is especially useful for long trips in a station wagon, since it provides a place for carrying all of your luggage, leaving the interior

of the car free for passenger use.

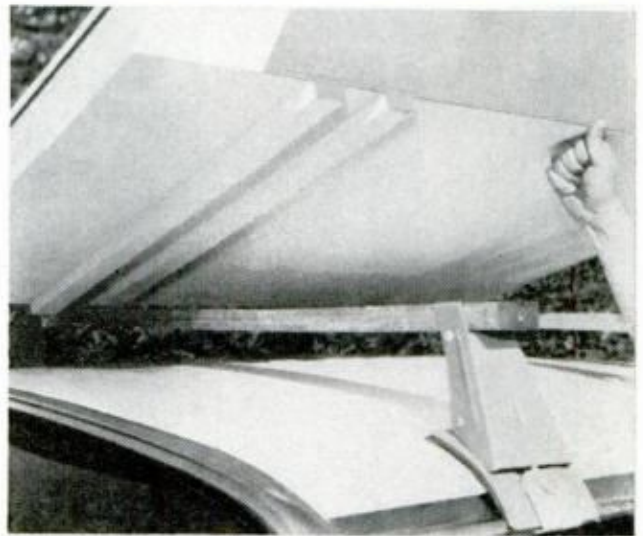
Construction is extremely simple. All joints are both glued and nailed. Set all nails and fill the holes with wood putty. Once you have assembled the box, sand all surfaces to assure a "car-body" finish when painted and round the edges slightly to prevent paint from chipping. Locate the bottom cleats (J) so that they will fit over the front carrier rail.

While the project can easily be built from the plans at right, you may wish to work from a full-sized pattern. To obtain one send \$1 to Steve Ellingson, Popular Mechanics Pattern Dept., P. O. Box 2383, Van Nuys, Calif. ★★



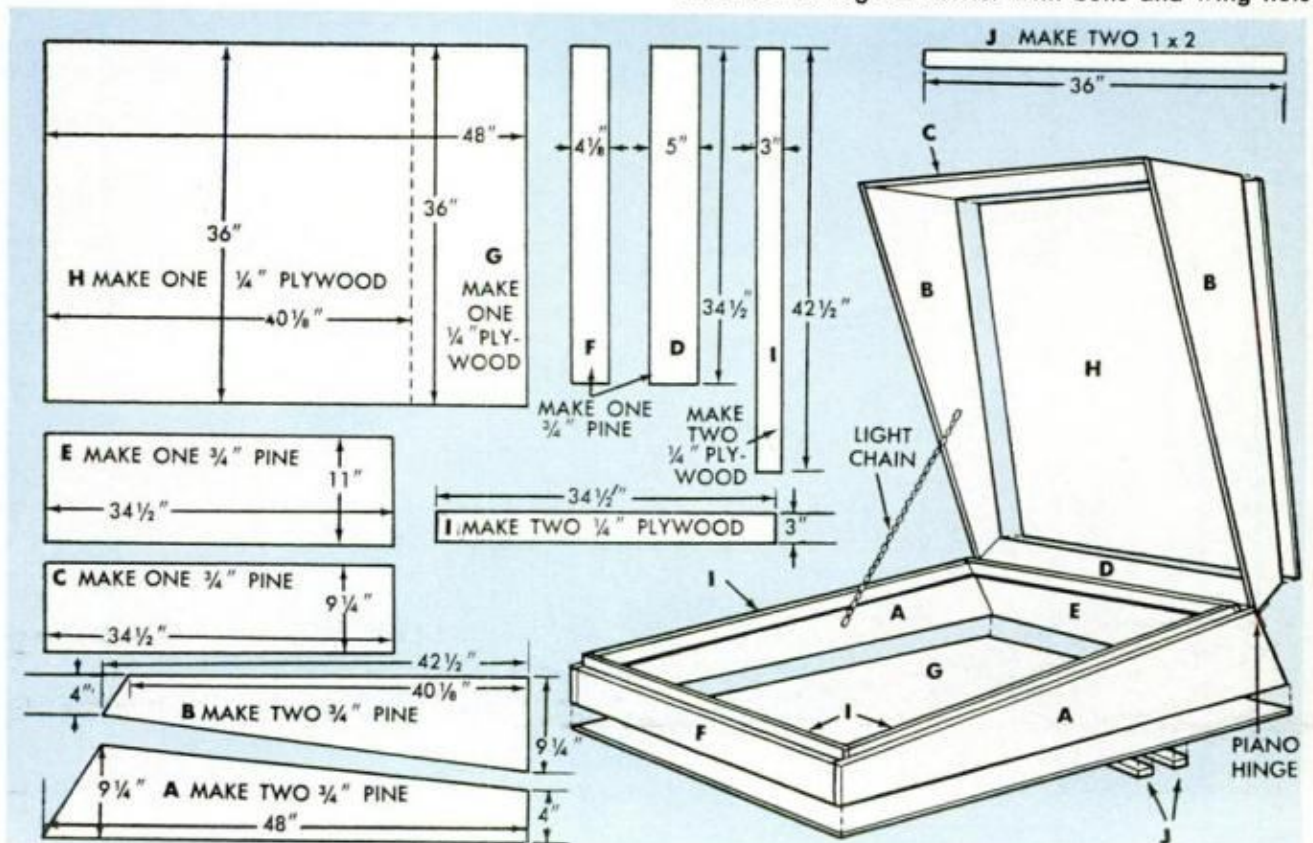
REQUIRED MATERIALS

- 1 panel $\frac{1}{4}$ " x 4' x 8' Fir plywood, exterior type, for parts G, H and I
- 21 ft. 1 x 12 Pine for parts A, B, C, D, E and F
- 6 ft. 1 x 2 Pine for parts J
- 3 ft. Piano hinge and screws
- 28 in. Light chain with screws (for stop)
- 2 pcs. Suitcase catches and screws
- 4d finishing nails, 3d galvanized nails and $\frac{3}{4}$ " wire brads
- Waterproof glue, sandpaper, plastic wood and finishing materials



By Steve Ellingson

WEATHERPROOF cartop luggage compartment is mounted on regular carrier with bolts and wing nuts





LARGE ROAST on a spit calls for the use of several layers of briquets placed toward rear of the grill

Barbecue Firemanship

YOU'LL ENJOY your next barbecue more—and find the work easier, if you follow these tips on “firemanship” suggested by Presto Charcoal.

First, get off to a good start by buying briquets. They are cleaner to handle and give more consistent heat than lump charcoal. Then, before building the fire, protect the grill with a level layer of sand, gravel or vermiculite. A depth of about 2½-in. is sufficient. This will guard against corrosion of the grille, absorb drippings and permit necessary air circulation.

Lighting the charcoal is no longer the exasperating job that sometimes made pioneering barbecuers cuss. In the first place, briquets are now made with an eye to easy starting. Secondly, there are good, inexpensive electric fire starters on the market, plus safe-to-use starting fluids. If you use a fluid, pre-soak a half-dozen briquets until they stop bubbling; pyramid six more and then light the saturated briquets. Or try soaking a brick with fluid

PATIO MUSIC WAGON

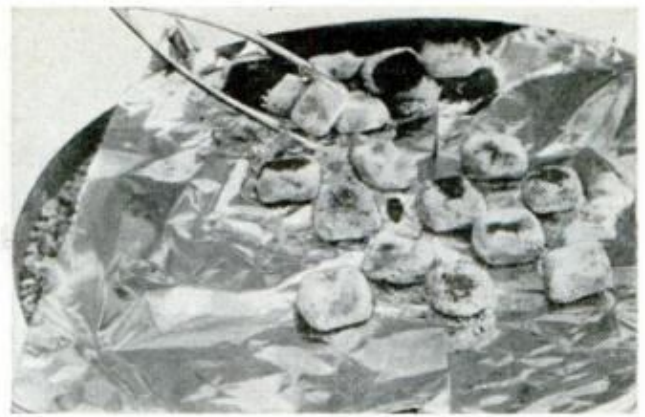
WANT TO ENJOY Beethoven with your barbecue? You can, in exchange for ten dollars and a couple of hours of spare time. The wagon makes it a cinch to wheel your hi-fi outfit from the living room out to the patio when the weather is favorable—or to beat a hasty retreat if there's a sudden thunder shower





FLAME of propane torch played on briquets placed in coffee-can chimney will get them glowing quickly

COFFEE CAN with top and bottom removed acts as a chimney and gets the fire started in a few minutes



ALUMINUM FOIL increases heat radiation, catches drippings and is easily discarded at clean-up time

and stacking briquets around it. Light the brick and remove it after the briquets are burning strongly.

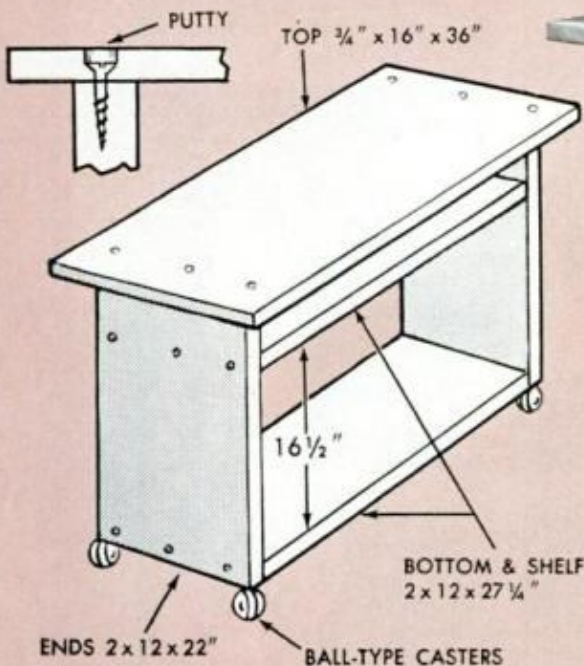
Another method is to use a coffee can as a chimney. Cut out the bottom, punch draft holes in the side and toss in six soaked briquets. Light them and after a few minutes add a few unsoaked ones. In about 15 minutes remove the can and spread the briquets in a checkerboard pattern. Such an arrangement will reduce flare-ups because drippings are more likely to fall on the firebed than on the coals. ★★★



HOLD HAND above coals to test heat. If you must pull back in less than three seconds, fire is hot enough

FOR OUTDOOR – INDOOR LIVING

IT'S A SNAP to build, but check the measurements of your components before you start. The original was tailored to accommodate a Sherwood amplifier and Jensen speaker system. Finish and wax with oil stain



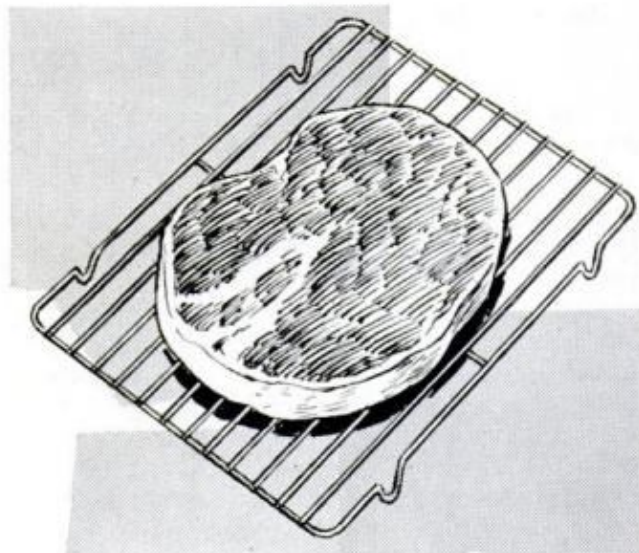


WHEN REPLACING a broken window, a propane torch will soften the old putty so it can be cleaned out with a putty knife. Protect sash with a metal shield

SNAP-ON DRIP TRAY is simply a paper plate attached to the paint can with paper clips and rubber bands. Bend paper clips so they can be pushed through rim

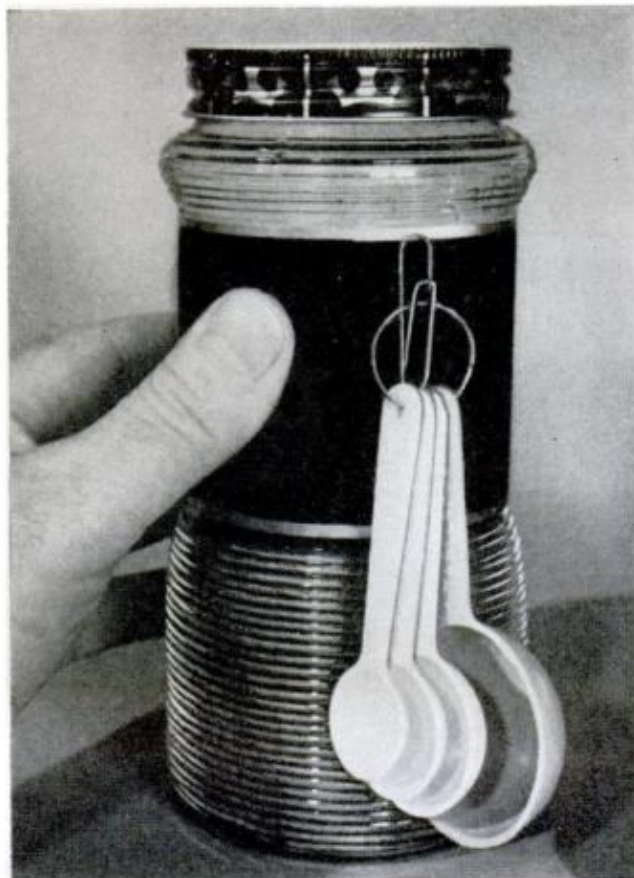


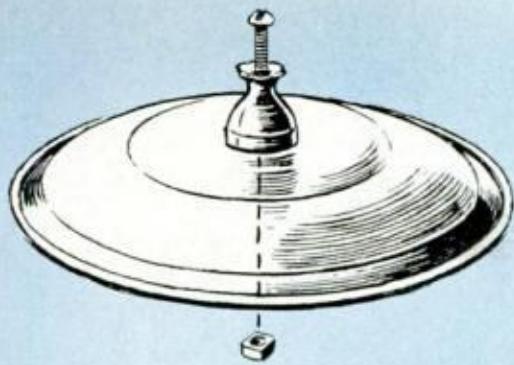
Solving HOME PROBLEMS



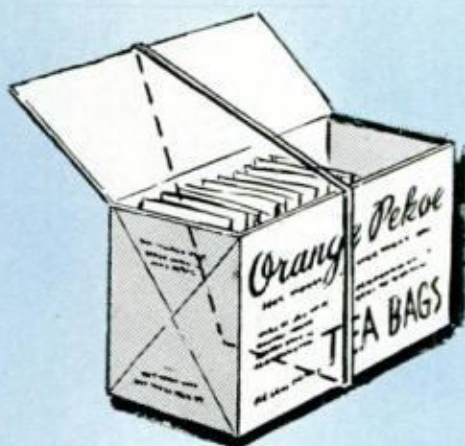
FROZEN FOODS will thaw quicker if all surfaces are exposed to free circulation of air at room temperature. A rack used for cooling cakes is ideal for this

INSTANT COFFEE takes more than an instant to prepare if you have to hunt for measuring spoons. To save time, tape paper-clip hanger on jar to hold them

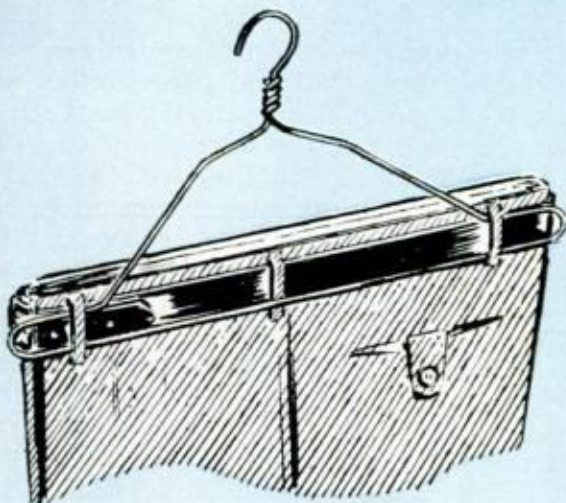




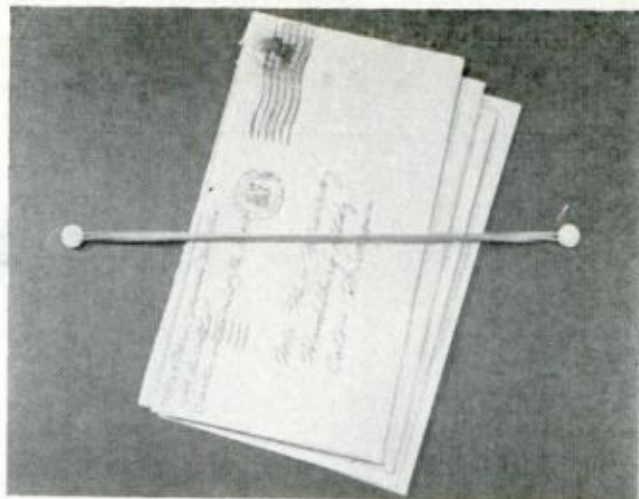
POT-COVER KNOBS do get broken and are almost impossible to replace. If your wife runs into this problem, you can solve it by bolting a stripped down electrical plug to cover



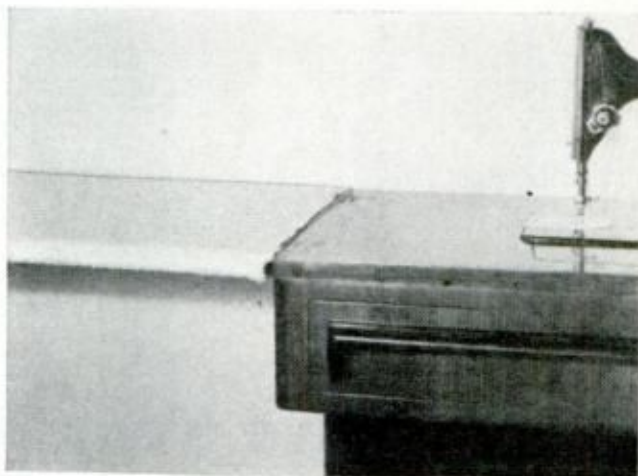
RUBBER BAND slipped over small cardboard boxes containing loose materials keeps tops tightly closed and prevents spilling. Cut around three sides of top, leaving fourth for hinge



COAT HANGER can be turned into a wrinkle-proof trouser hanger by bending the ends to fit through belt loops. Leave belt on the trousers and pull tight to hold waist in line

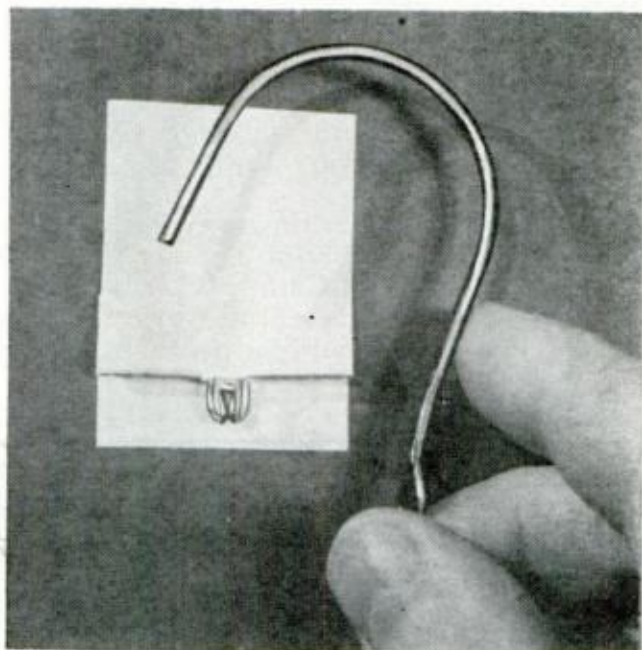


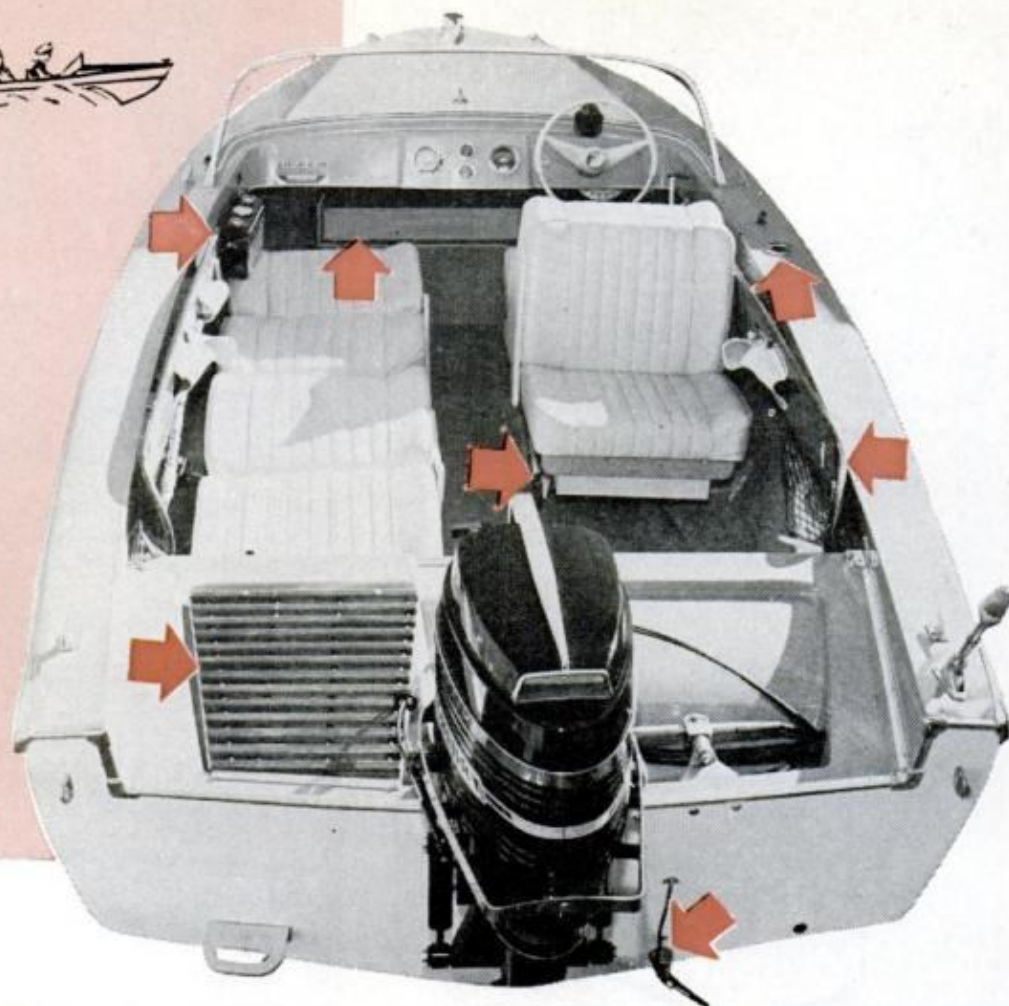
HANDY HOLDER for letters, pencils, etc., costs almost nothing. Just thumbtack a couple of stretched rubber bands to the inside of any cupboard door



SLIPPERY WORK SURFACE on a foldout console sewing machine will lose its slickness if you make a snug-fitting sleeve of cloth to slip over the foldout leaf

NO HANGER HOOK nearby? A picture hanger mounted on adhesive-backed cloth leaves no mark on a wall and will support 10-lb. load of clothing easily





How to Give Your Boat **THE PERSONAL TOUCH**

By Patrick Perrett

WHETHER your interest in boating tends toward skiing, fishing, skin diving or just plain boat riding, cockpit clutter is bound to be a problem. It's difficult enough to stow the basic equipment that every boat should carry, but add specialized gear like water skis or fishing tackle, and the result is likely to be a tangle of loose gear tumbling freely around the cockpit.

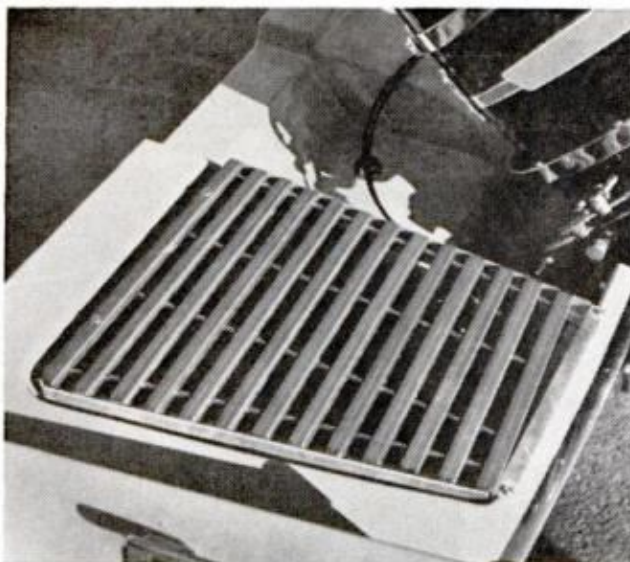
You can solve this stowage problem by following the example of Tommy Gilleen, North Hollywood, Calif., whose wide-ranging boating interests are matched by a commendable passion for neatness. After purchasing a 16-ft. Glasspar runabout recently, he immediately set about adding several simple and functional accessories to meet his personal skiing, fishing and cruising needs. A few are inexpensive commercial items, but the majority are homemade racks and compartments which could easily be tailored to fit your boat.

For instance, the multi-purpose grill mounted over one side of the motor well

is a fine place to cut bait and clean fish, because it keeps all the mess out of the cockpit proper. To clean it, just sluice scales down into the well and out the well drain. Used in conjunction with a combination hand grip and step mounted on the transom, it provides an easy route for taking skiers and swimmers into the boat.

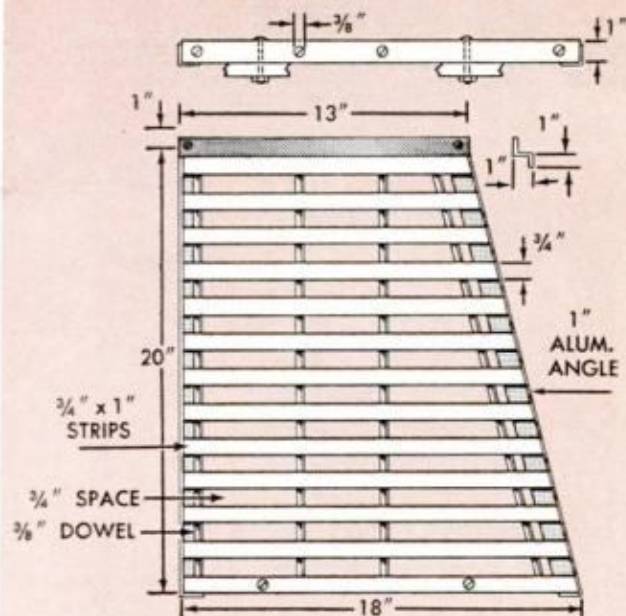
The transom seat/stowage box upholstered to match the boat's back-to-back seats will hold all sorts of gear. If you want the maximum cockpit room for fishing, don't attach it to the deck and you can slide it back partially under the well when not in use. Space on the underside of the lid is a fine spot for the boat's registration certificate and a chart of local boating waters. You can stow a first-aid kit and other need-in-a-hurry items in the tray.

Take a look at the following pages for other projects from this "idea boat." They don't involve expensive gadgetry, and with the exception of instrumentation, cost very little. Best of all, they'll put more fun in your personal brand of boating.

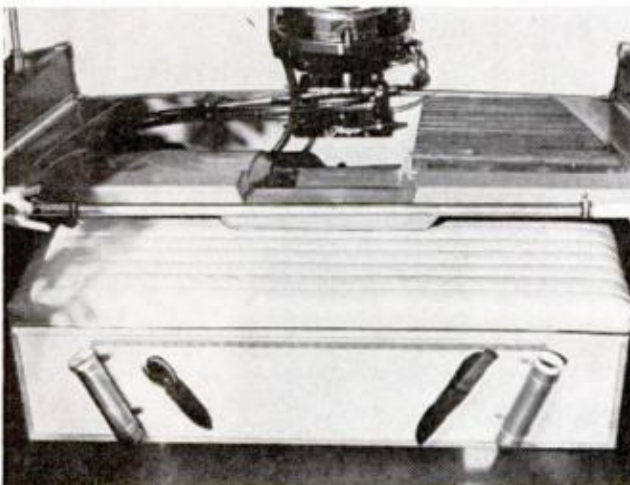


MULTI-PURPOSE GRILL makes a handy cutting board or boarding platform. Made from mahogany strips, the dimensions can be changed to fit your boat. Shallow cut down middle of each strip makes it slip proof

VARY DIMENSIONS TO SUIT WELL



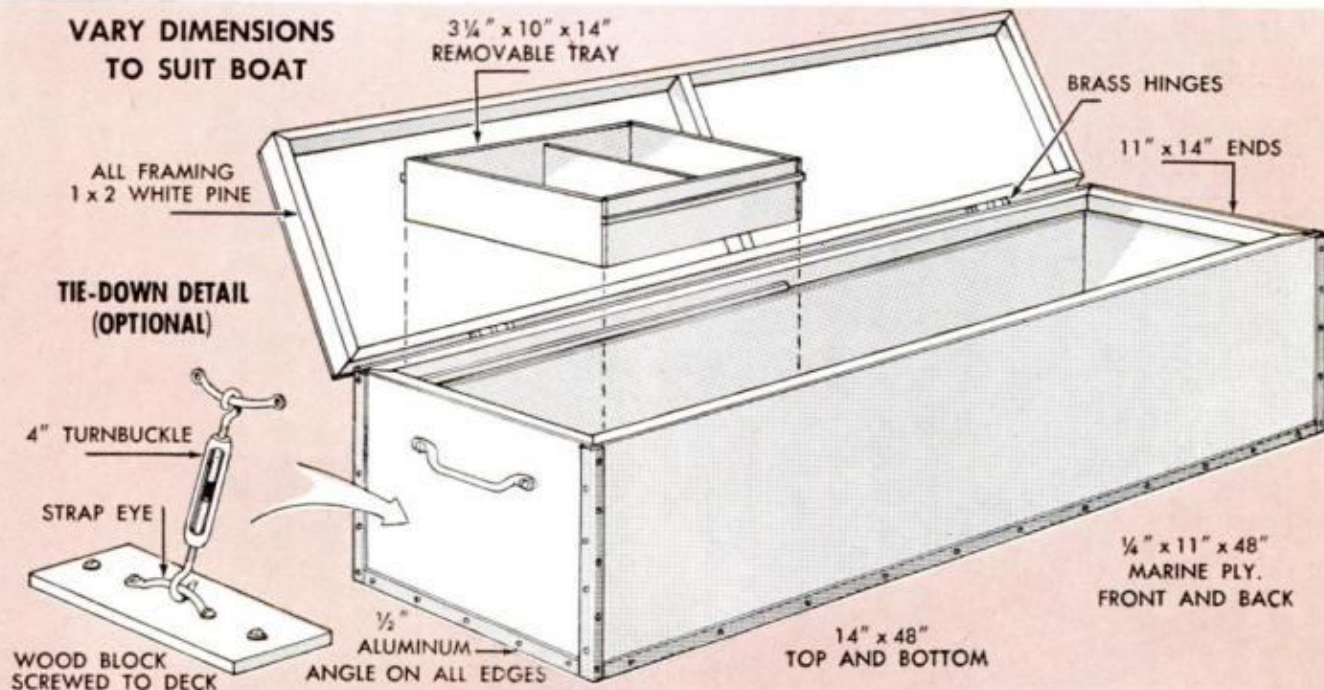
SEAT/STORAGE BOX provides mounting spot for rod holders, fish knives. Note boat hook on transom



STORAGE SPACE inside box will hold bulky gear easily. When not in use, you can slide it out of way



VARY DIMENSIONS TO SUIT BOAT



TURN THE PAGE FOR 10 MORE CUSTOMIZING TIPS



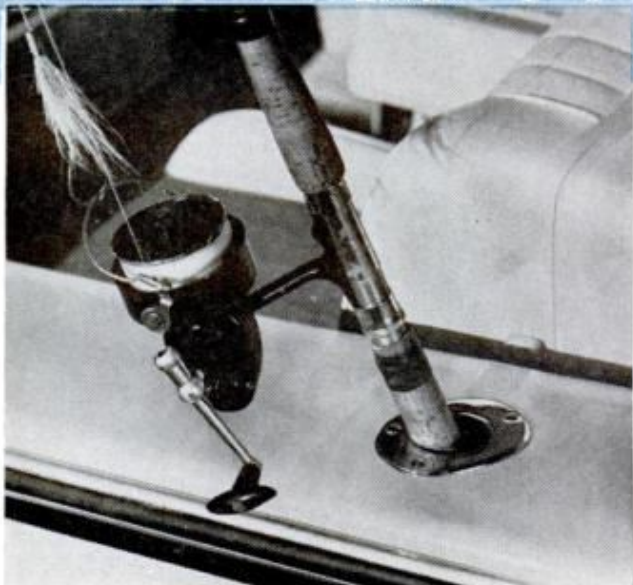
MESH HAMMOCKS slung under the gunwales hold foul-weather gear, jackets, wet suits and towels. Most marine dealers carry these, and they're hard to beat for neat out-of-the-way clothing storage space



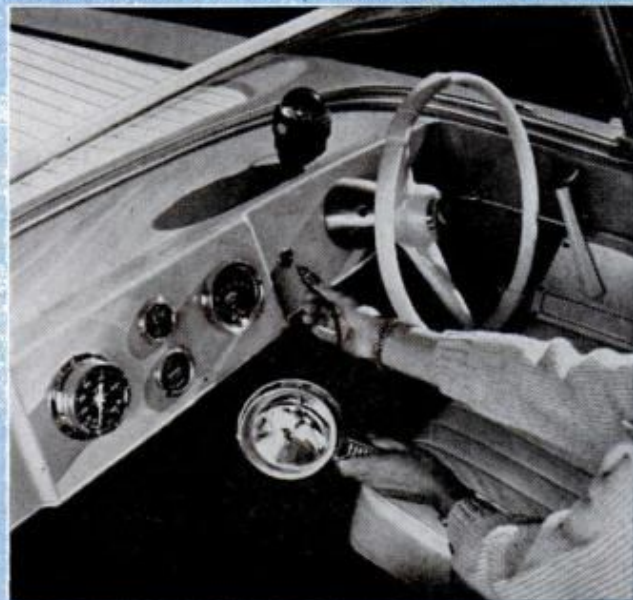
HAND-HELD SPOTLIGHT plugs into cigarette lighter in dash. Other instrumentation includes, speedometer, ammeter, engine hour meter and tach. Compass is mounted on dash shelf directly ahead of the wheel



ROD HOLDER mounted in gunwale at the pilot seat makes it possible to keep an eye on both the course and the rod at the same time. Two other rods can be placed in holders mounted on transom seat box

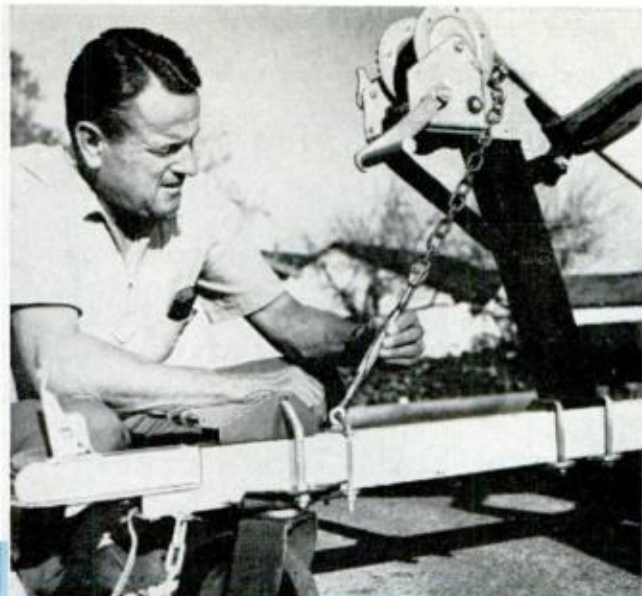


MARINE BAND RADIO sits on the padded edge of the seat to protect it against the jarring impact of a rough chop. A shock-cord snubber clipped on two eyebolts mounted on inside of coaming holds it in place

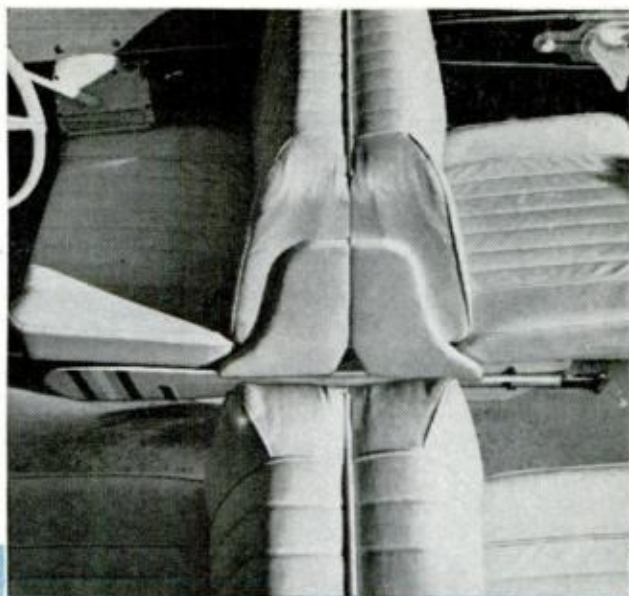


UNDER-DASH COMPARTMENT is 6 x 7-in. box running full width of dash. It's framed in the same way as the transom seat and has a hinged lid to protect items like binoculars and cameras from spray





CHAIN AND TURNBUCKLE are used to tie boat securely to the trailer as a safety measure. This removes the strain from the winch and cable, preventing damage during travel over rough backcountry roads

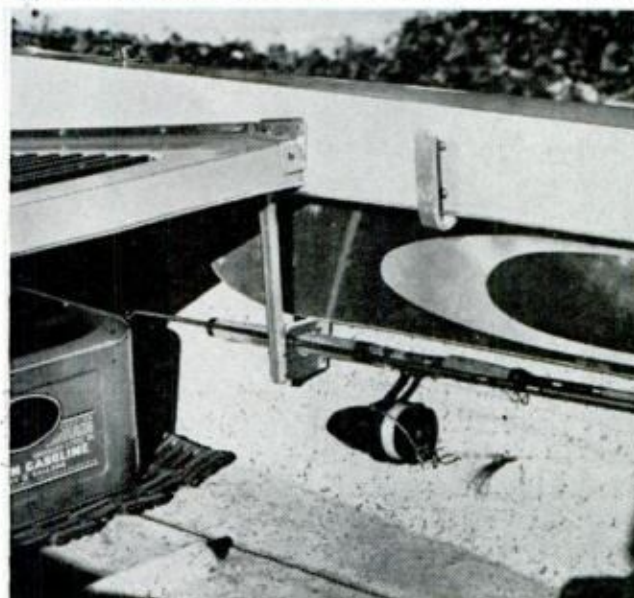


EMERGENCY PADDLE is held securely in aircraft-type clips mounted on the sides of the wooden seat supports. A similar pair of clips on the port seat supports holds a fish gaff ready for instant use

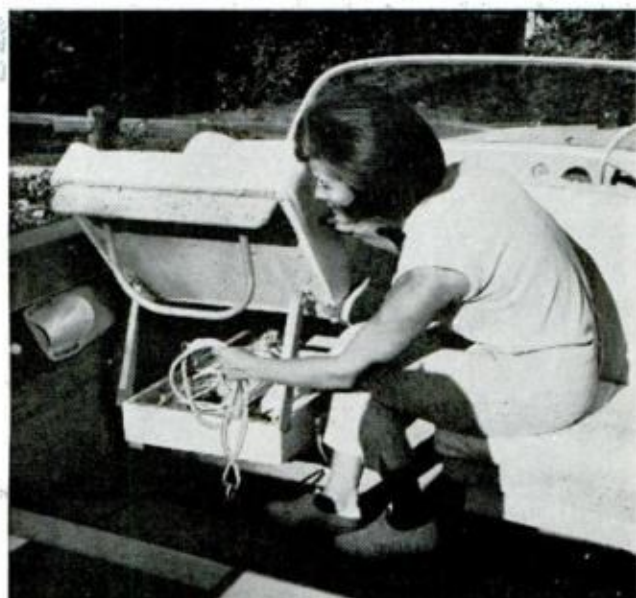


SKIS AND FISHING RODS fit neatly in rubber-padded recesses of rack constructed of aluminum channel and mahogany. Padded strip covering rod recess is hinged. Ski hooks above are made from strap aluminum

★
CUSTOM-MADE KIT for tools and spare parts fits between the twin fuel tanks under the motor well. Note that the tanks rest on rubber-link door mats to keep them from shifting and also prevent corrosion



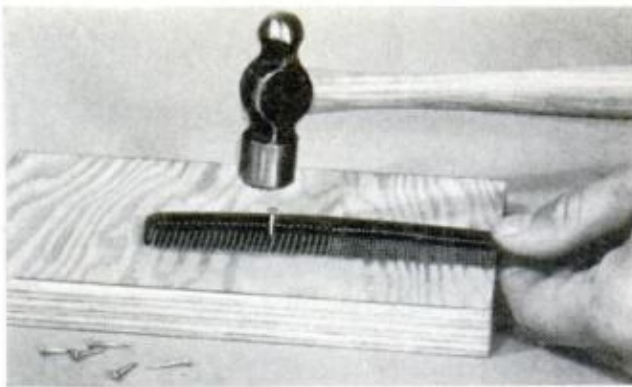
★
BOTTOM FRAME which supports the back-to-back lounge seats converts to handy off-the-deck stowage space by simply adding a bottom. It's a great place for tow lines, dock bumpers, props and bulky items.



SHOP SHORT CUTS

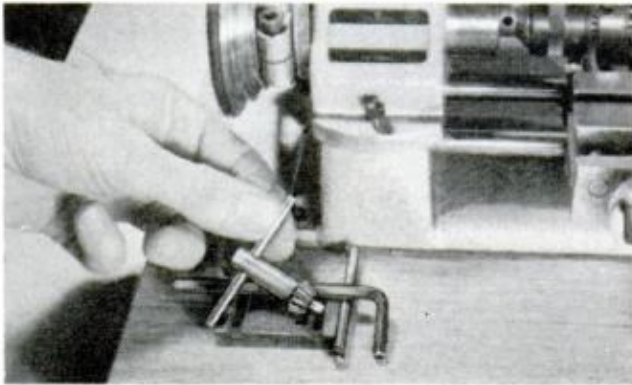
Teeth Protect Fingers

It's nearly impossible to start a small tack or brad without swatting your finger. A pocket comb offers an easy solution. Simply insert the tack between the teeth of the comb as shown in the photograph. Tap to start the tack, then remove the comb.



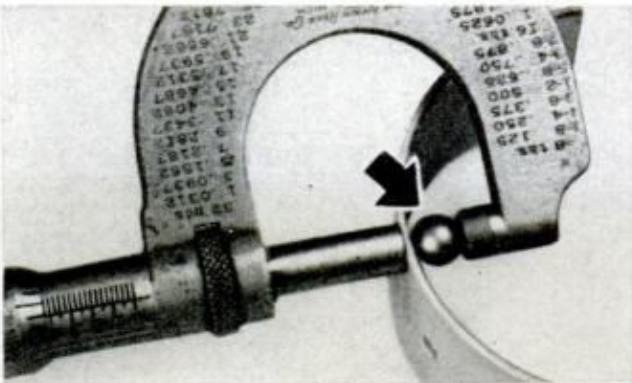
Magnet Ends Tool Hunting

Allen wrenches, chuck keys and other lathe accessories won't stray if you park them on a conveniently located permanent magnet. One of the best places to mount this is on the lathe bench, near the headstock. Either screws or contact cement will keep the magnet in place. A holder of this type is not recommended for tool bits because magnetism will cause iron and steel chips to adhere to the tool.



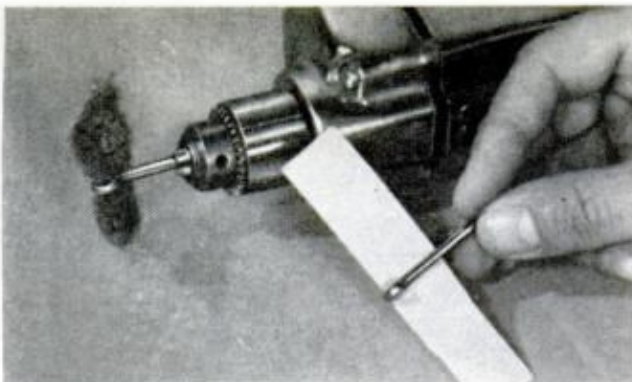
Quickie Ball Micrometer

Accurate measurement of the thickness of a curved surface calls for the use of a ball micrometer. You can improvise one with an ordinary micrometer, a button magnet and a ball bearing. The magnet sticks tightly to the anvil of the micrometer and holds the ball bearing in place. Take a reading for the ball and magnet first, then subtract this from the total.



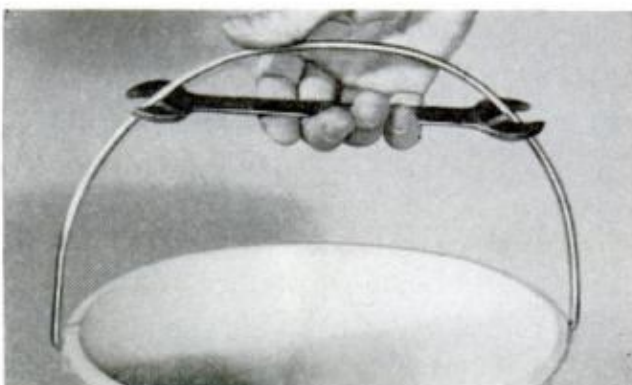
Contour Sander

Smoothing inside and concave surfaces is ordinarily a time consuming job. This tedious work becomes a snap when you rig up your electric drill as shown. A large cotter pin serves as a holder for strips of sandpaper or wads of steel wool. The abrasive is flexible enough so that hard-to-reach spots are easy to sand or polish. Sandpaper strips should be $\frac{1}{2}$ x 3 in.



Wrench Keeps Hands Happy

If you've ever had to carry a large pail of paint or a water bucket filled to the brim, you probably have no trouble remembering how the thin wire handle dug painfully into the palm of your hand. Next time you are faced with this sort of chore try using an open end wrench as an auxiliary handle. You'll find that it makes the job much easier, especially when the bucket must be carried a great distance.





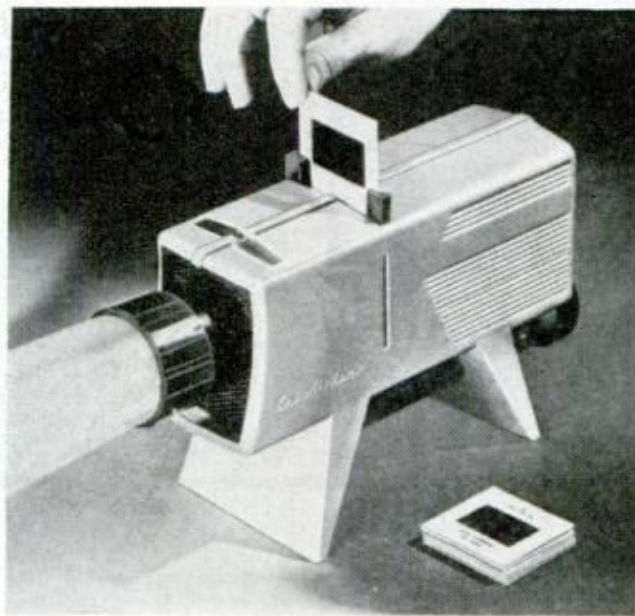
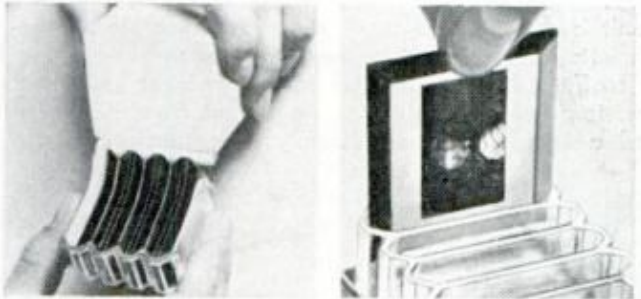
New for Camera Buffs

By Arthur J. Maher

OUTSTANDING FEATURES of the 315PZ 8-mm camera are a built-in pistol grip and a convenient fingertip control for the 9-29-mm f:1.8 zoom lens. You hold grip and work zoom with the same hand. Grip folds for carrying or use on a tripod. Under \$150. Bell & Howell, 7100 McCormick Rd., Chicago 45, Ill.

GLASS MOUNTING of slides is said to take 5 seconds per slide with the Combi Quick system. You place an adhesive-backed binding tape in the jig, then press each edge of the slide into the jig. Edges come out with binders in place. \$5.95 from Hudson Photographic Industries, Irvington-on-Hudson, N.Y.

CORDLESS SLIDE PROJECTOR, the Trav-L-Aire, is powered by three flashlight batteries. The manufacturer says it projects 35-mm slides or film strips satisfactorily up to 12x18 in. Ideal for small-group showings, sales presentations. Costs \$7.95. Vee-Gee Supply Co., Dept. 8, Box 4264, Milwaukee, Wis.



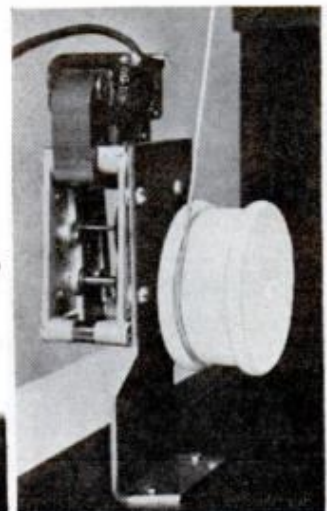
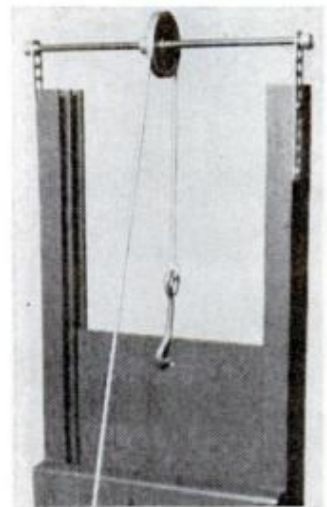
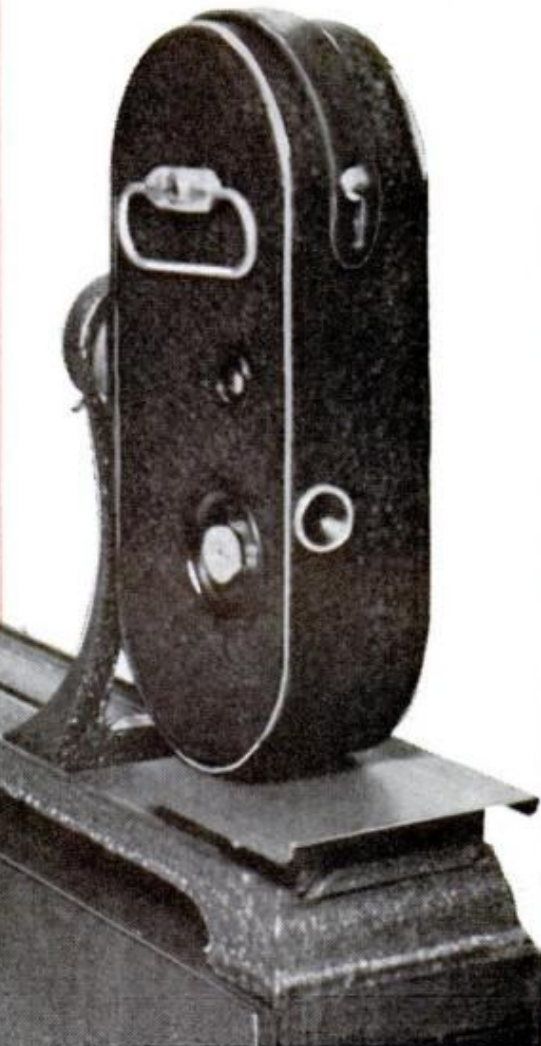
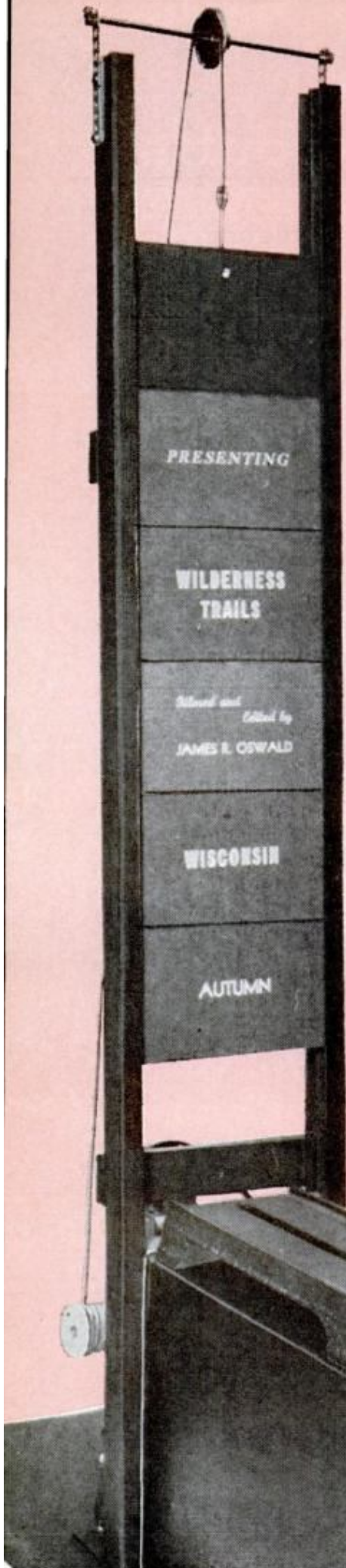
MAMMOTH LENS is a new Rokkor zoom that gives 160 to 500-mm focal lengths. Designed for any camera of Minolta's SR 35-mm series, the giant has a depth-of-field preview button and automatic diaphragm for focusing at full brightness. Under \$750. Minolta, 200 Park Ave. South, N.Y. 3, N.Y.

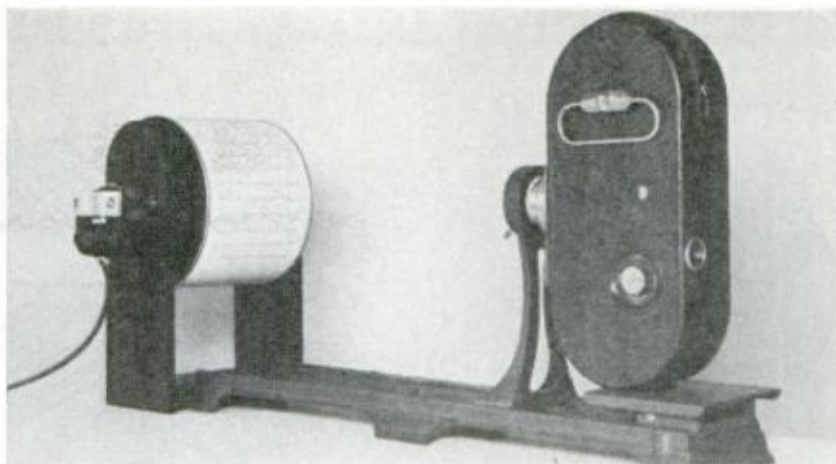
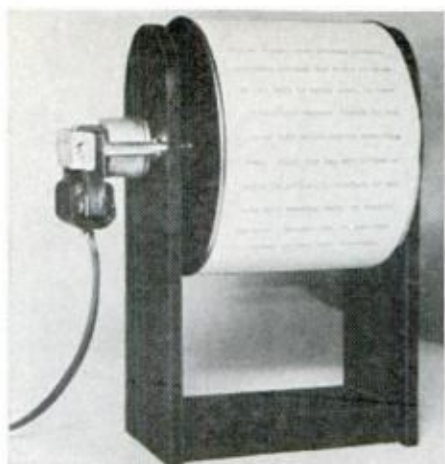
Motorized Titlers Add Class to Home Movies

THE INGENUOUS TITLING DEVICES shown here can give your home movies the Hollywood touch.

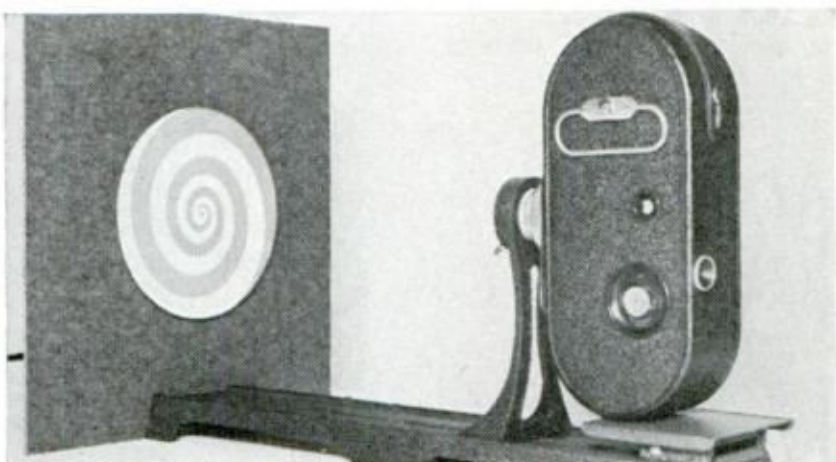
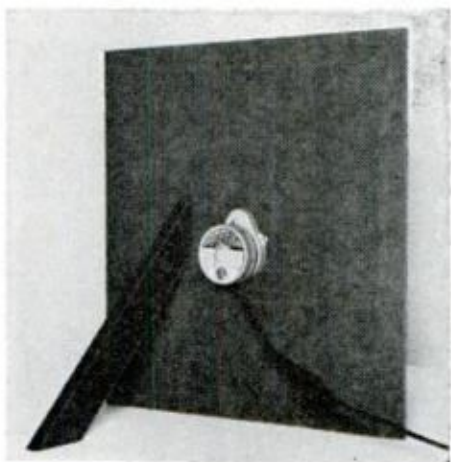
You're not likely to encounter any difficulty either in building or using these accessories, though the one powered by the electric fan may baffle you temporarily. How can you make certain that the dizzily spinning title will come to rest right side up? The secret is to place the title upside down before you start shooting. After sufficient footage has been exposed so that the title will have enough screen time, the fan is switched on and the whirling title is photographed. The processed film of the sequence is then turned end for end, reversing the action and giving the desired effect. Since processed 8mm. film has sprocket holes along one side only, when you turn it upside-down you must also flip it over. This means your original title will have to read backwards. Check it in a mirror before filming.—*J. R. Oswald*

ELEVATOR TYPE unit is driven by a slow-speed display motor. Hard-board panels with lettering cemented on are taped edge-to-edge and pulled slowly up scaffold from floor level in channels of aluminum sliding door tracks. Improved windlass is rigged up from discarded fish-line spool and a handful of parts from a toy construction set



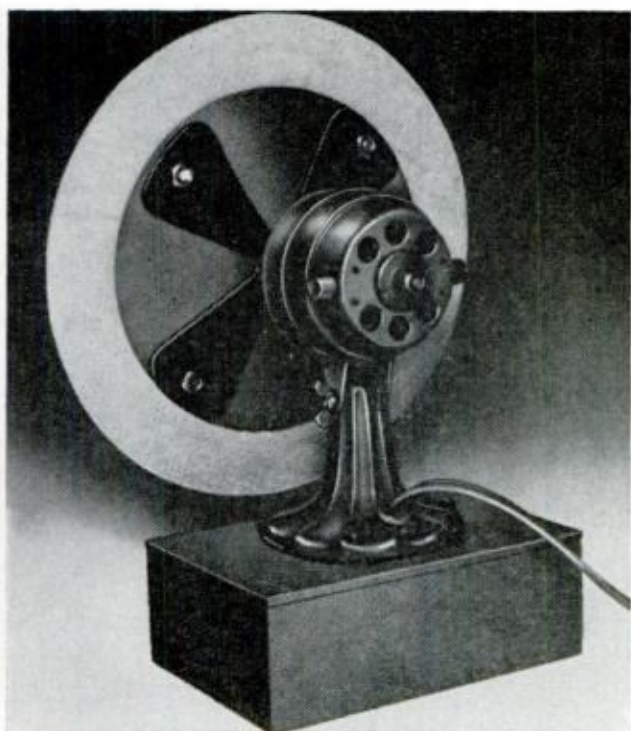


LONG TITLES are smoothly presented through the use of a revolving drum. This is simply a tobacco can turning on an axle consisting of two stove bolts. One bolt is placed through the cover and the other through the bottom. A radio-type shaft coupling permits joining the axle to a small 4-r.p.m. motor

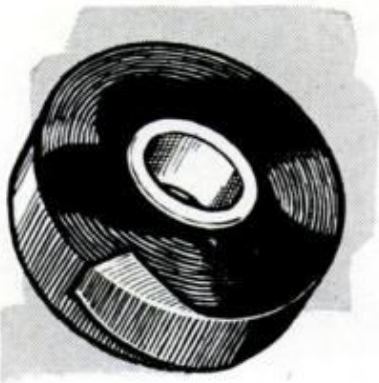


INTRIGUING BACKGROUND for superimposed titles is provided by slowly revolving disk painted with a spiral design. A plastic coupling connects the disk to a 5-r.p.m. motor. The disk, background and motor may be propped up in front of the camera in any convenient way, but tilting stand shown assures camera alignment

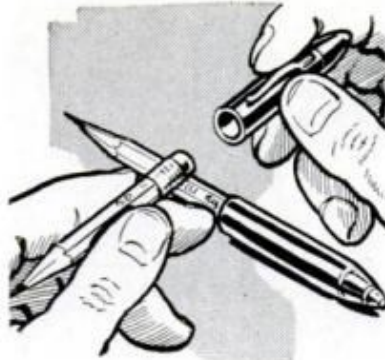
WOODEN DISK is attached to flattened fan blades with flatheaded bolts or screws so as to provide a flush mounting surface for the title. Rubber cement or similar adhesive permitting easy removal may be used to attach the letters. The auxiliary fan base fits on titler track to keep copy and camera in perfect alignment



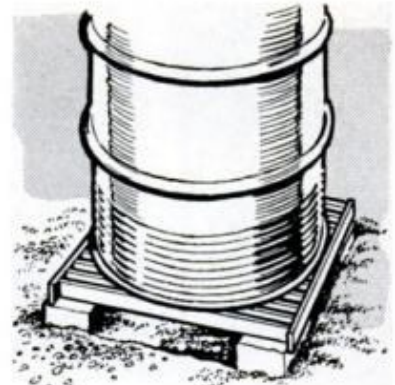
TAKE A HINT FROM READERS



YOU WON'T have a time finding and gripping the end of friction tape if you make a practice of folding the end over the edge of the roll each time you tear off a length of tape



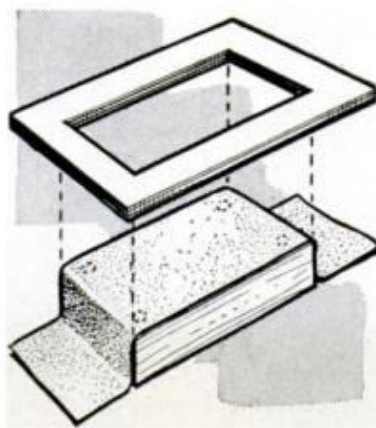
THINK TWICE about tossing away a worn-out fountain pen. The cap, used as shown, lets you get a grip on short pencil stubs. You'll find in most cases the cap fits the pencil stub snugly



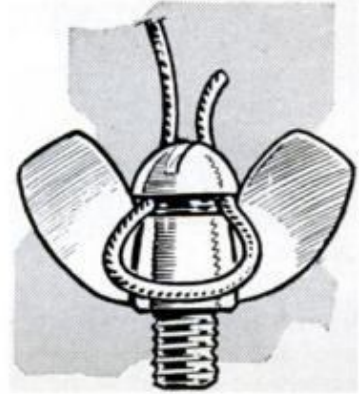
TRASH-BARREL incinerator will resist rusting, have better draft and be self-cleaning if you remove the bottom and rest the barrel on a steel grate supported by bricks over an ash pit



LOOKING for a simple tool holder for use on a ladder? Round up a juice or beer can, partially cut the top, bend back into a hook and hang it from a rung. Saves wear on pockets

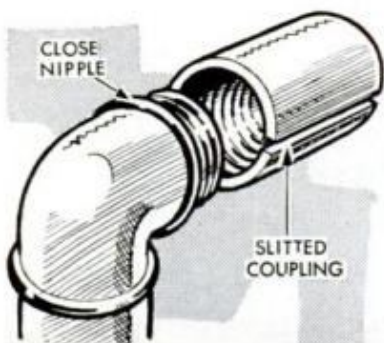


QUICK RENEWAL of abrasive strip on a sanding block used for sanding tiny parts is made easy with a press-on clamp in form of a rectangular cut-out. Block itself is nailed to bench

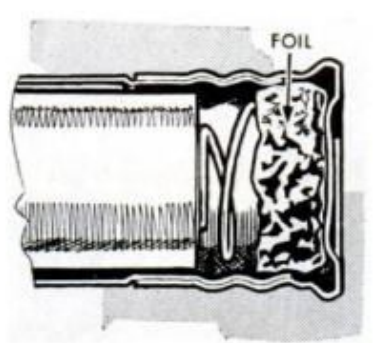


CABLE CLAMP can be improvised with a roundheaded machine bolt and a wing nut threaded on as shown. If necessary, clearance can be obtained by a bit of filing on inside of the wings

CLOSE NIPPLES can be removed without damage by threading on a coupling that has been slit with a hacksaw. Clamping the coupling in a vise will then permit removal of the nipple



ALUMINUM FOIL inserted between spring and end cap of your flashlight will prevent corrosion due to electrolytic action. If necessary, clean parts with emery cloth before inserting foil

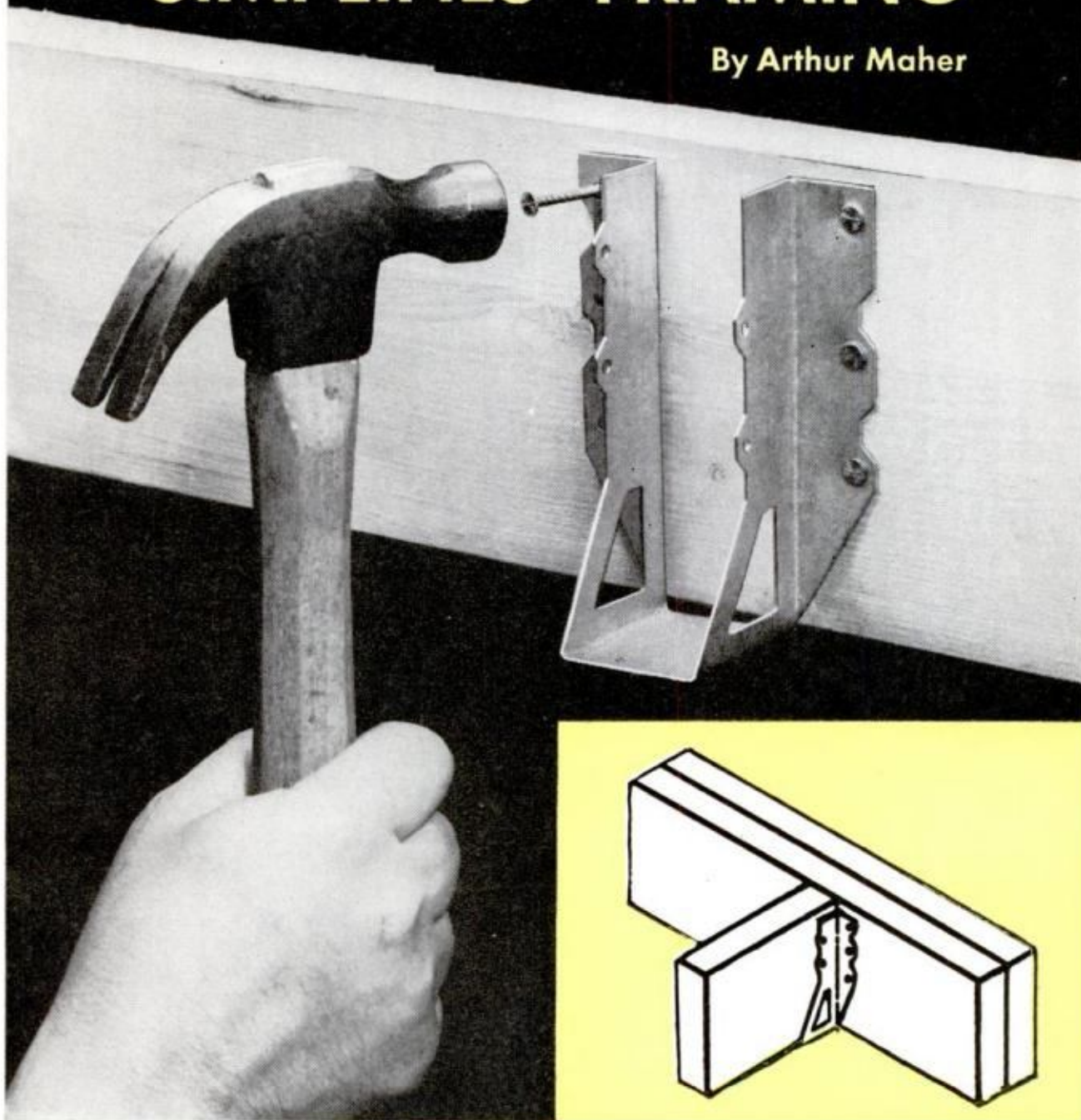


SMALL PARTS are easy to hold for soldering if they're propped up in a jar lid filled with sand. You'll find this is better than clamping the work in the jaws of a vise which draws the heat



ENGINEERED NAILING SIMPLIFIES FRAMING

By Arthur Maher

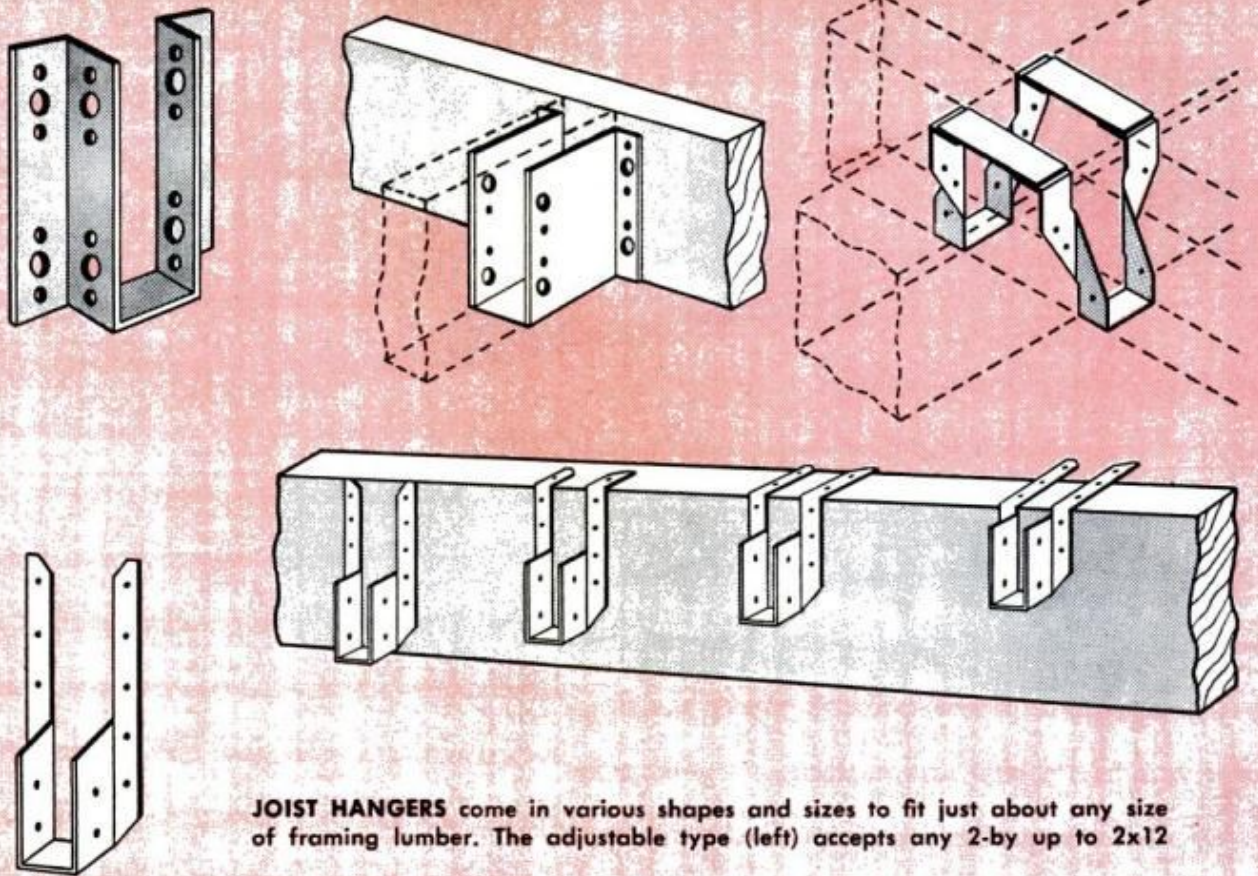


They may look like rejects from a kid's Erector Set, but these perforated products of a stamping machine are really a boon to the amateur builder planning to add a room to his house

CALLED "Building Specialties" in the trade, these sheet-metal fasteners now make it possible for the amateur to frame a house as strong as a bridge. With them, toenailing becomes a thing of the past for fastening studs, joists and rafters. Butted members become "welded"

together, so to speak, to make the joining of a house 50 percent or more stronger. And there is less chance of splitting the members while nailing.

The devices go by the names of joist hanger, framing anchor, post base, rafter anchor, etc. In most cases, they are made



JOIST HANGERS come in various shapes and sizes to fit just about any size of framing lumber. The adjustable type (left) accepts any 2-by up to 2x12

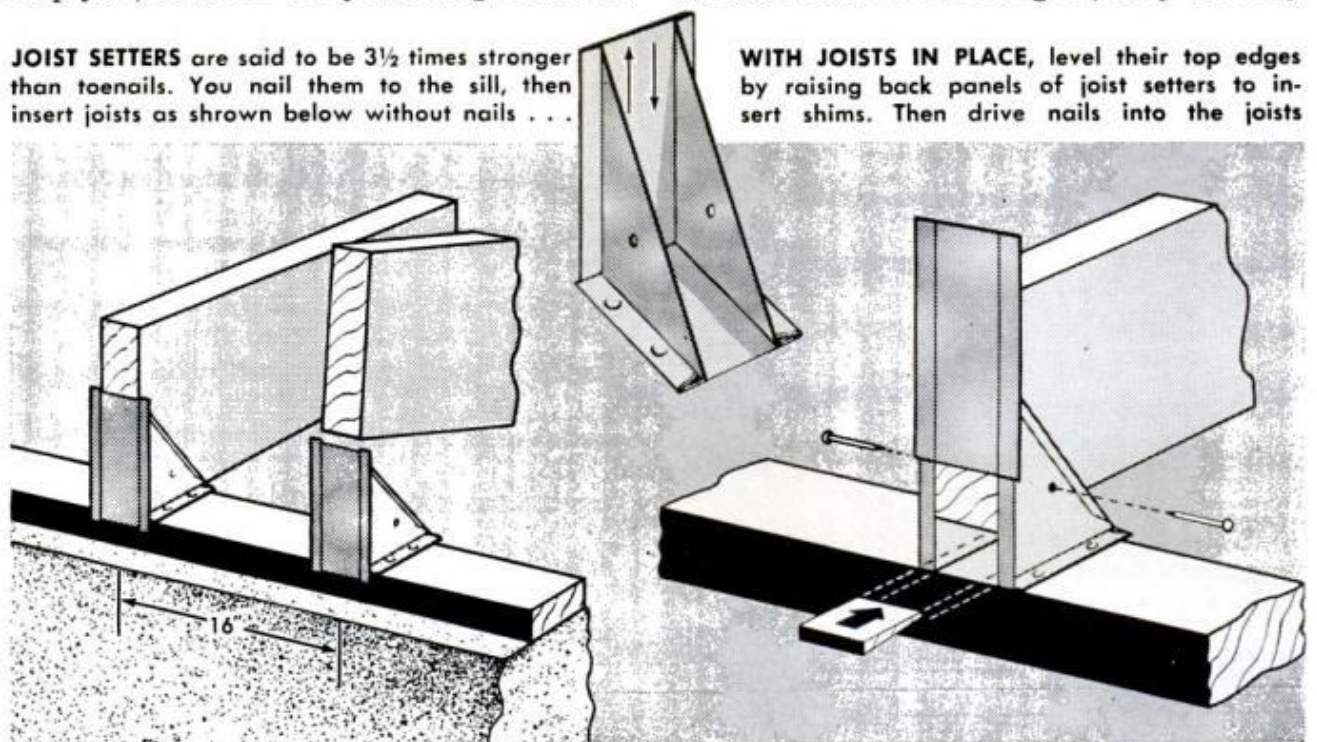
of 13 to 18-ga. galvanized steel and cost so little that ten dollars or so can buy enough for a good-sized room addition. Prospective homebuilders will find these fasteners raise the price of a dwelling comparatively little when added to the building specs, yet are well worth the additional cost in the extra strength gained.

For an idea of how these fasteners can help you, consider the joist hangers above.

Ordinarily, to butt floor joists against a timber, you'd have to toenail with 10d or larger nails—not easy without a lot of practice. And in many cases, you'd need a ledger strip, and might even have to notch each joist to fit the ledger. With joist hangers, all you do is nail the hangers to the timber, insert the joists and drive in more nails. The nails, which go in pre-drilled holes in the hangers, may be only

JOIST SETTERS are said to be 3½ times stronger than toenails. You nail them to the sill, then insert joists as shown below without nails . . .

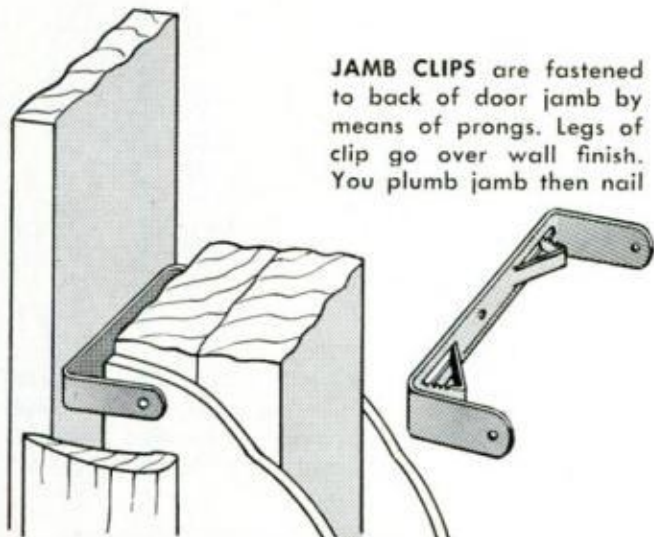
WITH JOISTS IN PLACE, level their top edges by raising back panels of joist setters to insert shims. Then drive nails into the joists



1½ in. or so long and are often supplied with the hangers. Ledger strips are out altogether, and each joint is stronger than a toenailed joint.

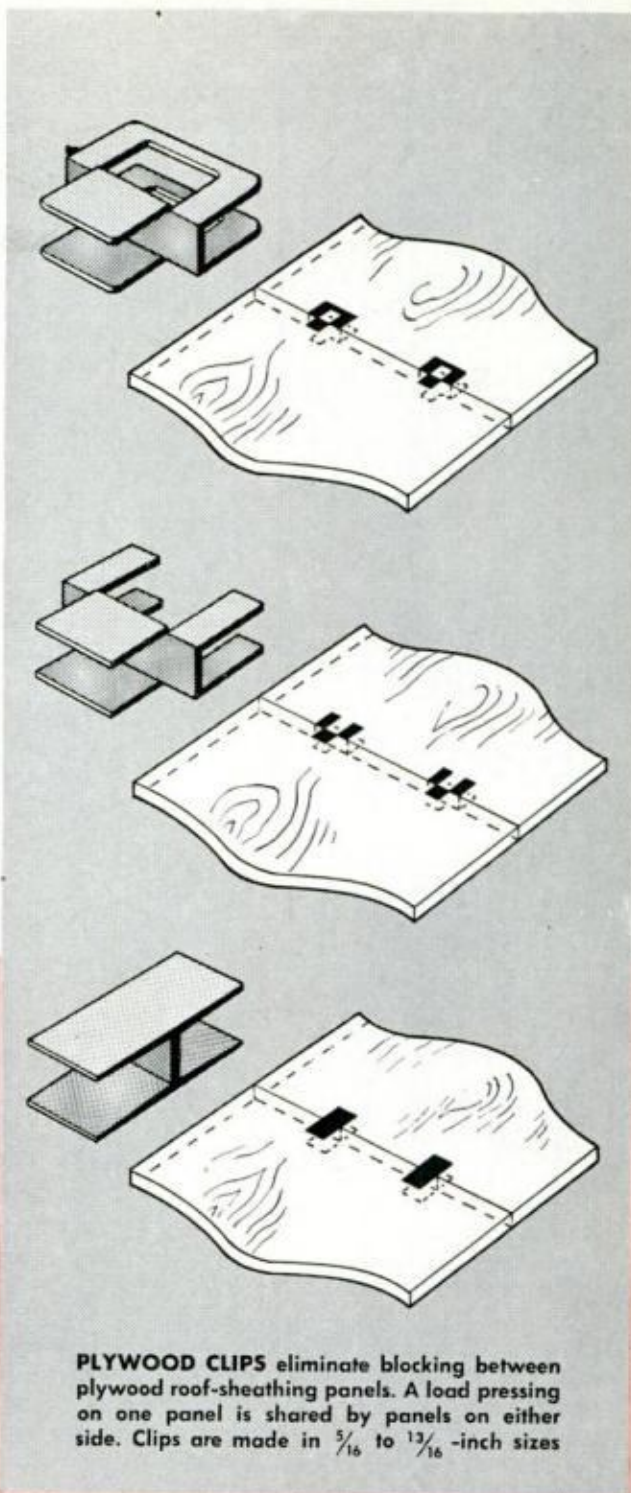
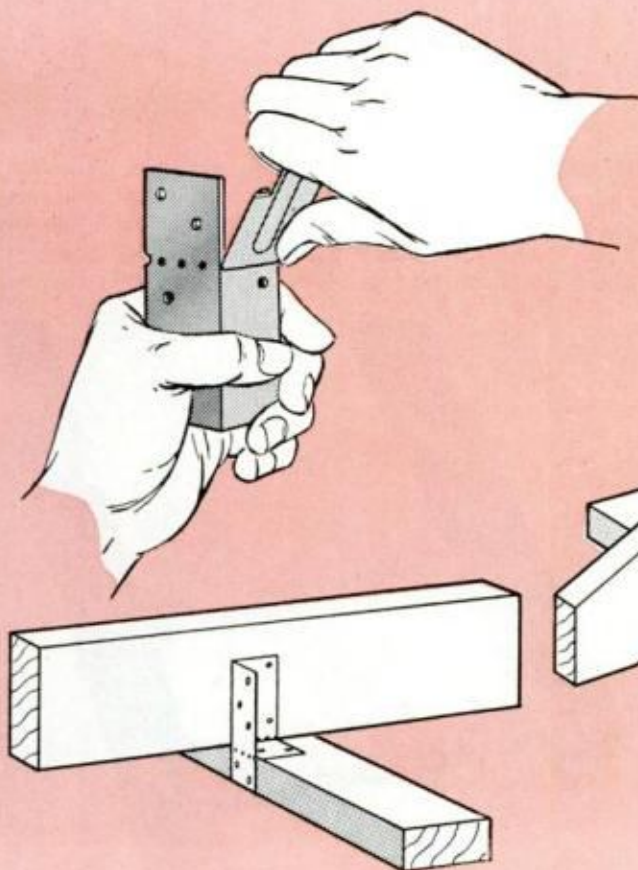
This is because loads bearing on the joint are resisted by what engineers call the shear strength of the nails (the force required to break the nails). With toenails, the loads act against the nails' withdrawal strength, which is much weaker.

Besides the joist hangers, there are a wide variety of fasteners that act in a

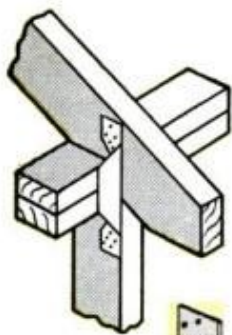


JAMB CLIPS are fastened to back of door jamb by means of prongs. Legs of clip go over wall finish. You plumb jamb then nail

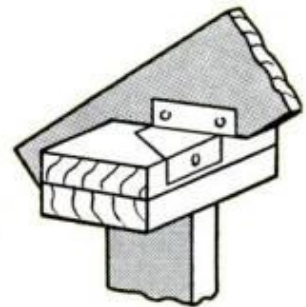
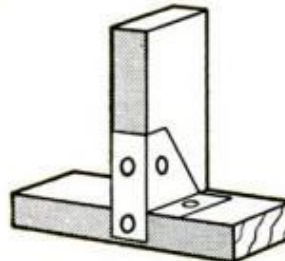
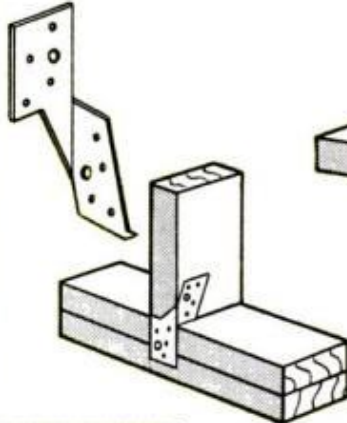
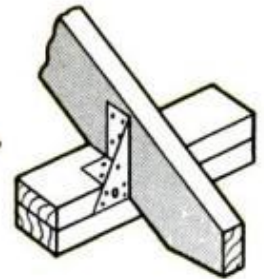
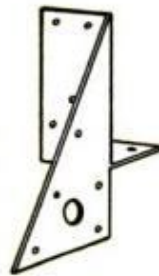
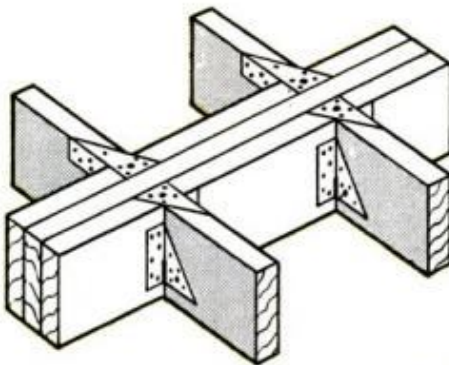
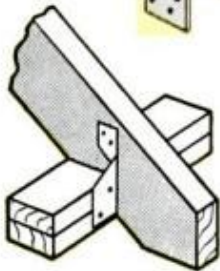
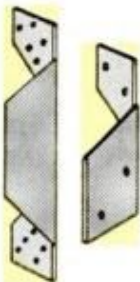
ALL-PURPOSE CONNECTORS are perforated for easy bending into many different shapes. You need only one type for studs, rafters, purlins, even joists. One manufacturer supplies a pocket-sized bending tool



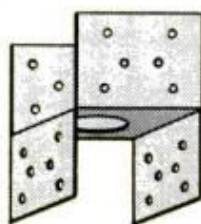
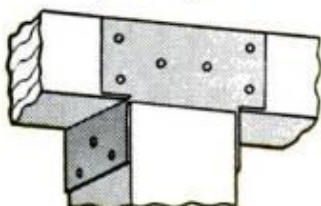
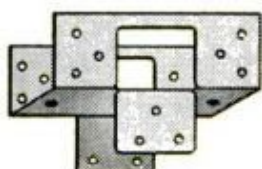
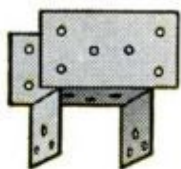
PLYWOOD CLIPS eliminate blocking between plywood roof-sheathing panels. A load pressing on one panel is shared by panels on either side. Clips are made in 5/16 to 13/16-inch sizes



RAFTER ANCHORS TIE RAFTERS TO STUDS OR PLATE

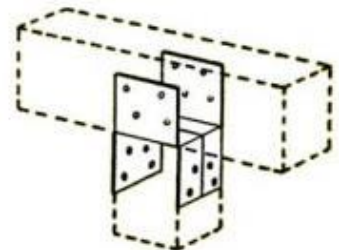
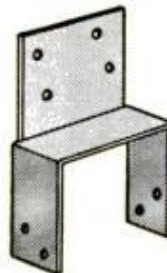


MANY FRAMING ANCHORS, like the bendable type shown on previous page, are multi-purpose. However, instead of bending, you buy them in straight, right- and left-hand models



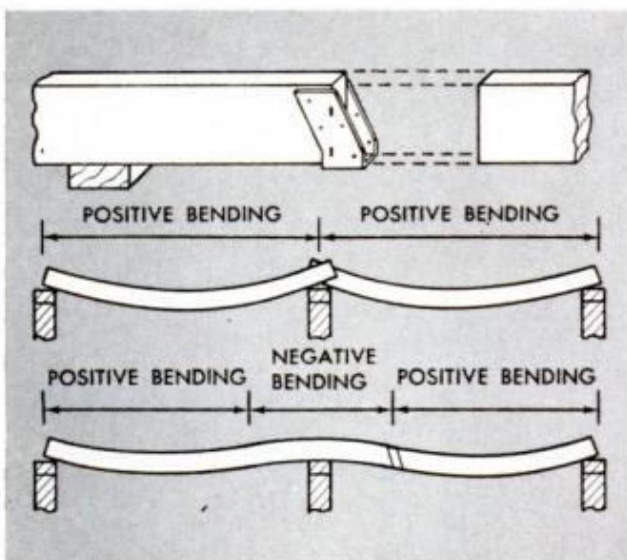
MANY DEVICES AVAILABLE FOR USE WITH TIMBERS

POST CAPS USED SINGLY AND IN PAIRS



LINE-A-JOIST stretches joists by splicing into single units. Positive (downward) bending of ordinary joists concentrates flexing at centers. Negative bending of spliced joists counteracts positive bending, which results in more even flexing of the wood

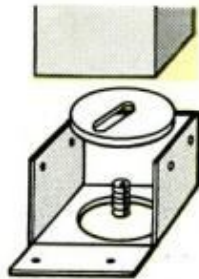
METAL STAIR STRINGERS let you put in a basement stairway in as little as 20 minutes. You nail stringers to basement walls or other support, then slide in 2x10 treads. Double-headed (removable) staging nails go into treads through holes in stringers



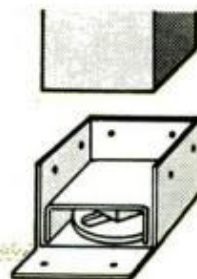
POST ANCHORS



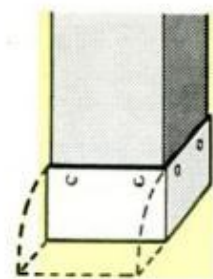
SET BOLT IN CONCRETE



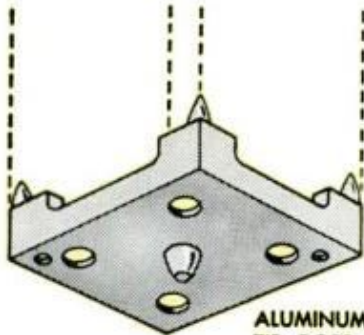
PLACE ECCENTRIC IN BOX OVER BOLT



TIGHTEN & PLACE RAISED PLATE

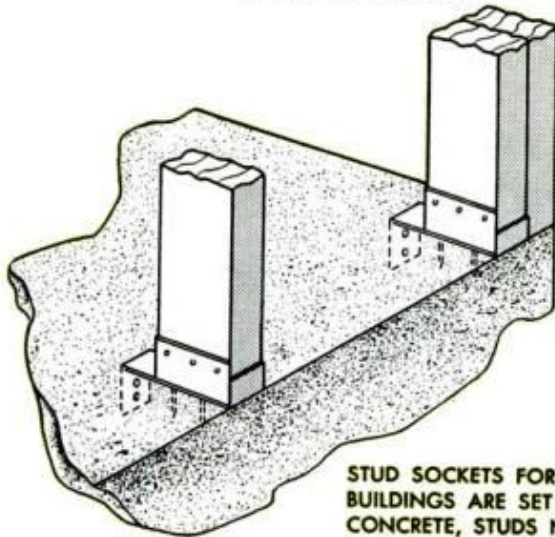
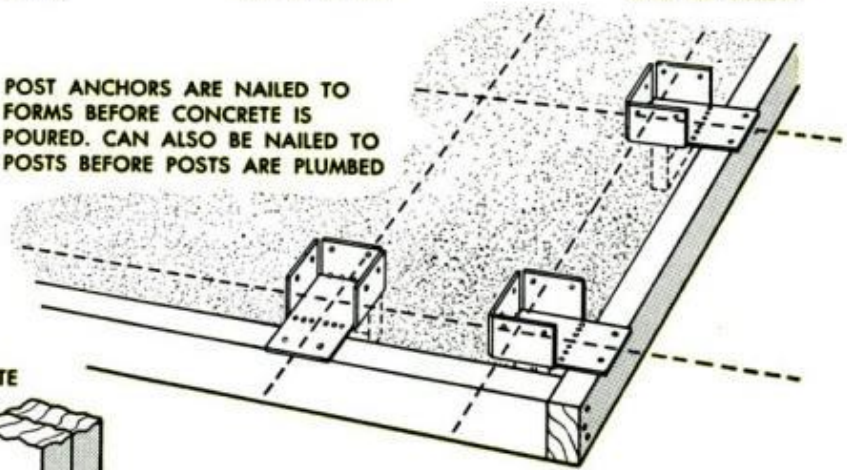


INSERT POST & NAIL OR SCREW



ALUMINUM PLATE:
TIP GOES IN HOLE
DRILLED IN CONCRETE

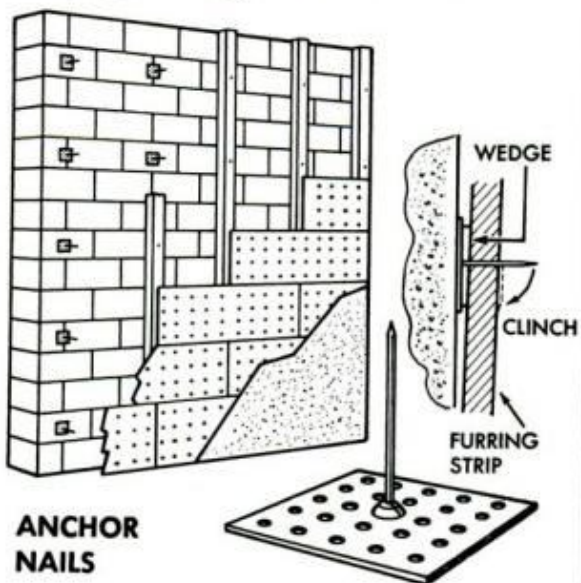
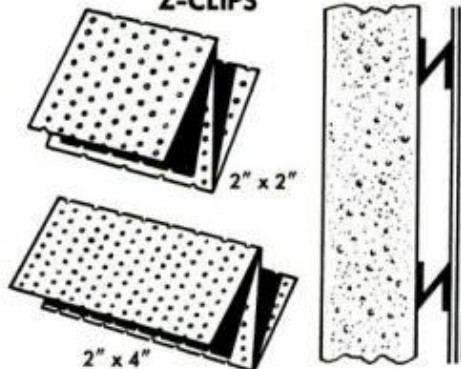
POST ANCHORS ARE NAILED TO FORMS BEFORE CONCRETE IS POURED. CAN ALSO BE NAILED TO POSTS BEFORE POSTS ARE PLUMBED



STUD SOCKETS FOR UTILITY BUILDINGS ARE SET IN WET CONCRETE, STUDS NAILED IN LATER

ANCHOR NAILS: Z-Clips are adhesive-bonded to masonry walls. Paneling is then glued to the clips. Anchor Nails are also glued to the walls, will hold standard furring strips

Z-CLIPS

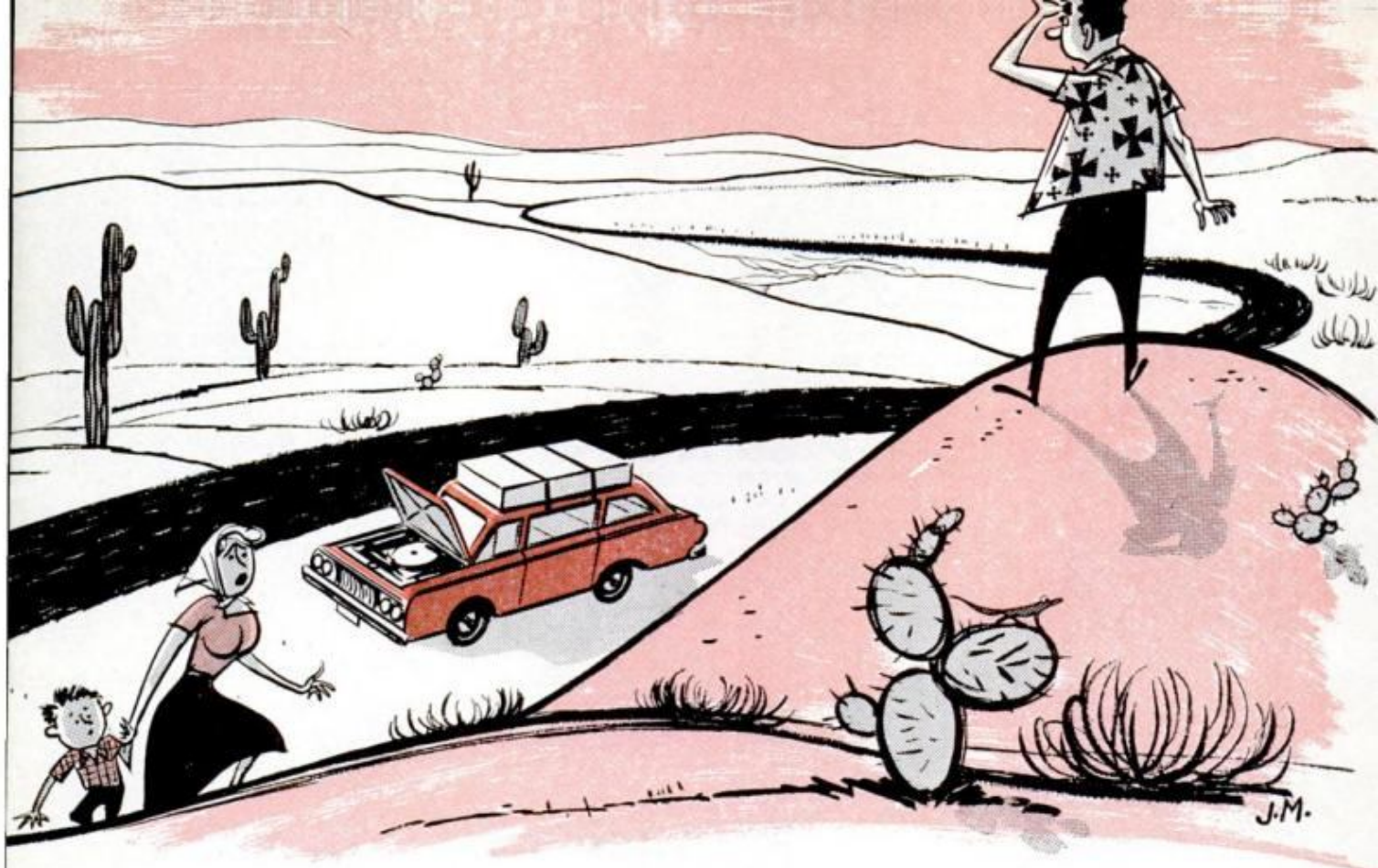


ANCHOR NAILS

similar way to anchor studs to the shoe plate, the top plate to the studs, rafters to the studs or top plate, etc.

Other fasteners do more than merely simplify the nailing job. The Line-A-Joist, for example, when used precisely as specified by its manufacturer, enables you to use joists one size smaller than you'd normally require. (For example, 2x8s instead of 2x10s.) Post bases, while helping you position and secure the posts, also protect them against termite, rot and premature failure of paint.

Unfortunately, space limitations permit us to show only a cross-section of the framing devices now on the market. There are many more, and are bound to be new ones. For a list of manufacturers and distributors, write to the PM Information Bureau. ★★★



HOW TO GET YOURSELF ROLLING AFTER A STALL

Chances are the trouble's in either the fuel system or the ignition. Here are back-to-back charts to tear out and stash in the glove compartment for on-the-road help

By Morton J. Schultz

THIS COULD HAPPEN to you! You're on a summer vacation trip. You just left a town 10 miles back and are driving through a region that, if it weren't for the strip of blacktop you're on, you'd swear no man had ever crossed before.

Suddenly the engine sputters. You shove the accelerator pedal down. The car gives a last gasp and slowly coasts to a stop for no apparent reason.

You try to start it. It revs, but that's all.

Panic grips you. You open the hood, look at the engine for a long minute (be-

cause that's what one's supposed to do, isn't it?). Nothing's so wrong it *shows*, so you peer down the long, empty road, and begin to have grim memories of those basic-training hikes they always managed to schedule for just such a sweltering day.

What are your chances of getting *yourself* started? That's hard to say, because it depends on two factors: how lucky you are and how well equipped for on-the-road stalls.

Modern cars are engineered to minimize the chances of such a stall. But it could

happen. And when it does, that modern engineering is the very thing that might prevent you from starting the engine!

In older cars, the common "bugs" that often led to a road stall were of a type that made troubleshooting easy.

Take the distributor, for example. In the old cars, all you had to do to check out a distributor was to short out an externally accessible wire attached to the distributor. If you saw that current was getting through that wire and, thus, that your trouble lay in the distributor itself, you just opened the cap, lifted off the rotor and everything was plainly visible. You could quickly file the points and, if that was your trouble, you were perking again before Junior got out of calling range.

But modern design has set in. Now, what do you have to do? In many cases, the external wire once attached to the distributor cap on the outside is no longer there. You have to take off the cap to reach it. You no longer can just lift off the rotor—you have to unscrew it. You no longer have easy access to the points: they're hidden beneath a large rotor breaker plate. To get at them—if only to file them down—you have to remove the points as an entire assembly. If you go this far, you might just as well be carrying a spare set to replace the old ones.

Does this mean that you shouldn't troubleshoot the car in the hopes of getting it started and perhaps save yourself a lot of shoe leather? Of course not. But be aware of one important fact: as refinements were built into cars over the years to diminish the chances of an on-road stall, these same refinements also diminished your chances of getting started again if the car ever *should* stall.

Troubleshooting an on-road stall is a two-part job: First, you *diagnose* the problem, probing in a logical manner until you isolate the trouble area. This is the easy part, as you'll soon see. Then, you *repair* the trouble, using whatever means you have on hand. You're not necessarily concerned with a permanent or perfect repair. Your only interest is to get rolling—at least long enough to get you within hailing distance of civilization.

The one important fact that simplifies diagnosis is that an on-road stall is almost always caused by a malfunction in one of two systems: fuel or ignition. And the *manner* in which the car stalls is your first clue as to which system's at fault.

If the car sputtered and jerked before stalling, look for a fuel failure first. If it just cut out smoothly, the problem is probably ignition.

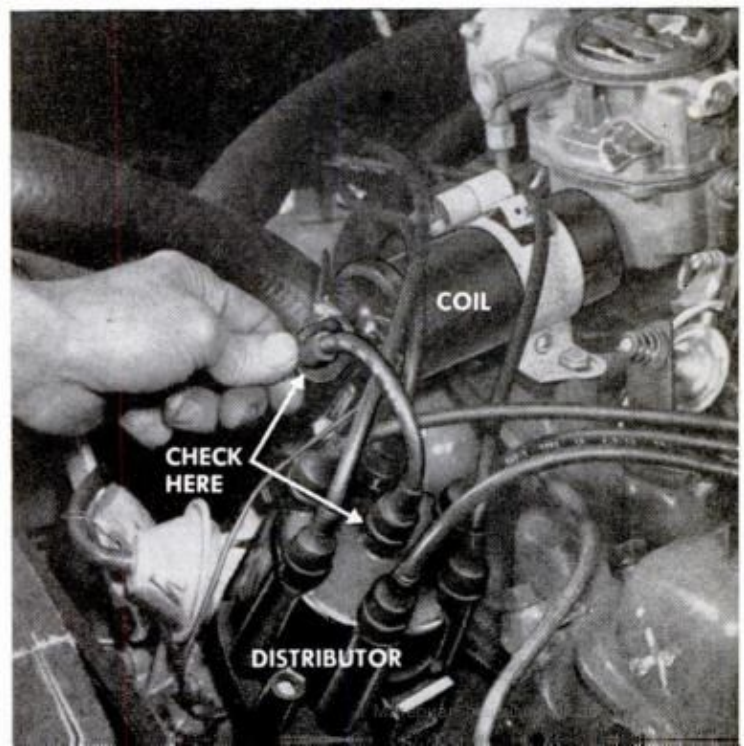


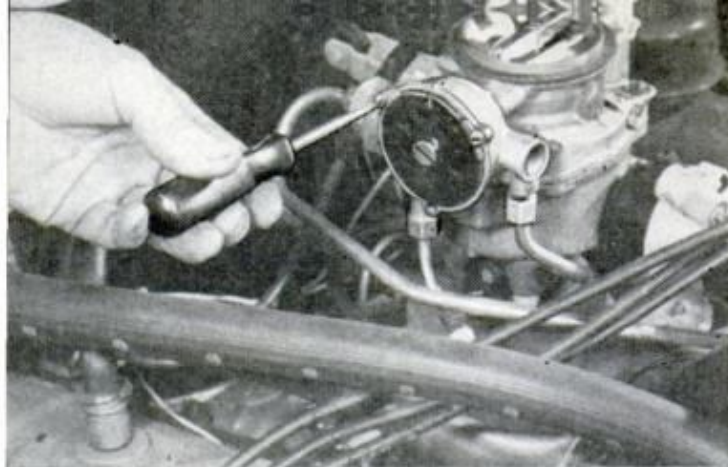
POWERFUL BATTERIES needed by today's cars often surge acid through vent caps. If this seeps between terminals and posts, it can short them out. Since cleaning is simple (above) check this first thing

There are several preliminary steps to take, depending on the circumstances, before getting involved in details. (We're assuming that you have gas. You're not, of course, going to get the car running if the tank is empty. We're also assuming the problem is more serious than vapor lock or percolation—hot-weather woes we covered in full in last month's issue.)

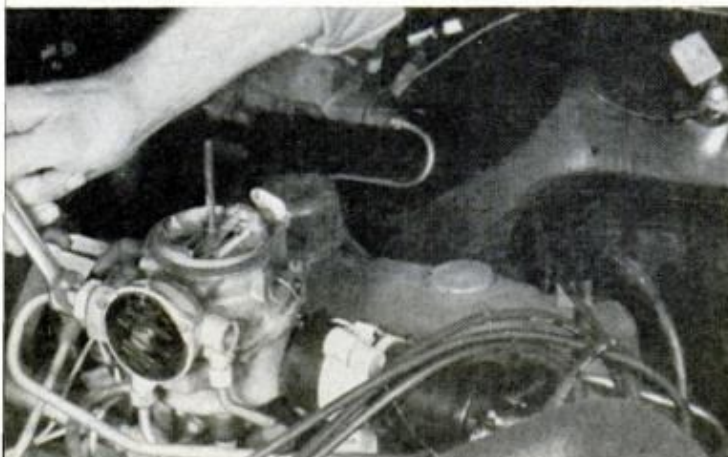
● Note the way in which the stalled engine cranks. If it doesn't crank briskly, check the battery cables. (Don't crank it for long—you don't want to add a dead battery to your problems.)

ROUGH ROAD or sharp bump cause the stall? Maybe the lead between center towers of distributor and coil was unseated. Push firmly on both plugs as shown

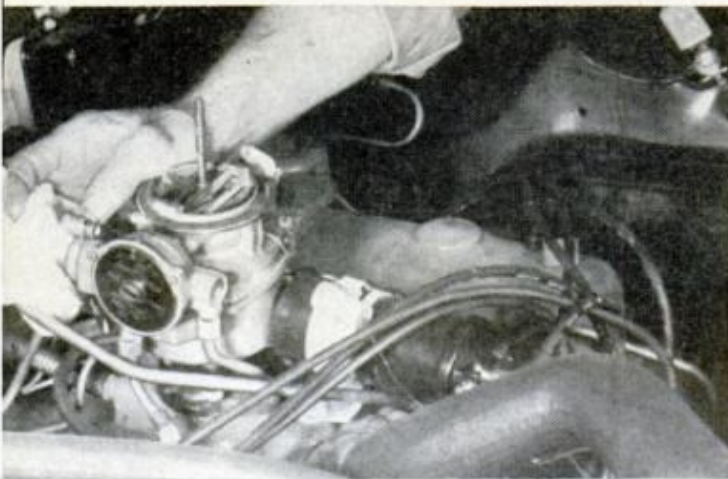




IF CHOKE WON'T STAY OPEN, loosen screws holding control cover and twist to lean side to open plate



ALWAYS CARRY A WRENCH in case you must remove the fuel line to check plugged carburetor inlet filter



WRAP DISCONNECTED LINE in rag, then crank engine and inspect the rag to see if gas is getting through

RARE IN MODERN CARS, but pump-to-carb line can clog with dirt. Disconnect the line and blow it out



Make sure the cables are clean and tight, in that order, and don't forget to check the battery ground cable where it connects to ground.

Scrape off the inside of corroded terminals with a knife, as shown on the previous page, and clean off the battery posts. Hook everything up tightly!

If you drive an older car in which the battery cables have seen miles of use, you might want to carry a spare set—or replace them before you start out on a major trip. You never know when corrosion will eat through old cables.

● If there's a chance that the plugs have gotten wet (be especially suspicious of this on a rainy day or if you've driven through a puddle), remove each boot and wipe the entire plug, including the porcelain, with a dry rag.

● If you've been driving over a rough road or hit a bump and the car suddenly conks out, check the lead going from the center tower of the distributor to the center tower of the coil. It could have unseated itself. Push it in firmly at both the coil and the distributor. Also tighten all other electrical and ignition wires.

If these preliminary steps don't help, you'll have to pursue a systematic search for either a fuel or an ignition failure. We've summed up the troubleshooting steps in two charts, the first of which is on the next page. The *ignition* troubleshooting guide is on back of that page, so that you only have to cut one page from the magazine if you want to carry this entire summary with you for on-the-spot reference. The photos at left are demonstrations of several of the steps, but you won't need them along to follow the chart's clear instructions.

You'll note that the procedures are given in a logical, step-by-step order. Follow this order—it includes short cuts to a quick start wherever possible.

From these charts, you can get a good idea of those tools you should carry. You should also consider the addition of several critical spare parts to your on-vehicle inventory. This might well save you from being victimized by the spare parts racket which we'll be discussing next month.

The charts represent the limits to which a non-professional can go to start a stalled car at roadside, without a mechanic's tools and spare parts. If you happen to be unlucky and your problem goes deeper than these solutions can reach, you can console yourself (while you're walking) with the knowledge that you at least tried.

But isn't it worth the try? Who wouldn't invest the time, even with short odds, when it might mean saving a long hike and a steep road-service charge? ★★★

CAUSES AND CURES OF FUEL-SYSTEM STALLS

| PROBLEM AREA | HOW TO INSPECT IT | HOW TO CURE IT |
|---|---|---|
| Automatic choke plate stuck closed, flooding engine | Take off the air cleaner and look at the plate. If the plate is closed when the engine's warm, you've found your problem | After pushing plate open with your fingers, step down on accelerator and keep your foot there as you crank the engine. As soon as engine unloads itself by being diluted with influx of air, car should start. If choke refuses to stay open, indicating bad choke piston or damaged linkage, try wedging it into position—or, if there's a control cover, adjust as shown in top photo at left. This should open the butterfly plate in carburetor |
| Gas not getting to carburetor | Work throttle linkage once or twice and listen. If you don't hear gas spitting into carburetor, there's an obstruction in the fuel system. If gas is getting to carb, stop here and begin ignition checks | Trace entire system back in a logical sequence, as explained below, until obstructed area is found |
| Plugged carburetor inlet filter or needle valve | Remove fuel line at carburetor (second photo at far left). Wrap it in rag and crank the engine for 2 or 3 revolutions. Inspect rag (third photo, left). If it's wet, fuel is getting to, but not through carburetor. If dry, trouble's further back in fuel system | Unscrew fuel line inlet port nut at carburetor. Remove filter screen, if there's one there, and stick it in your pocket. Hook everything up and try to start engine. If it doesn't start, tap on carburetor bowl with screwdriver handle. This might loosen any dirt clogging needle valve. If this proves futile (and carburetor bowl is type where cover can be removed without taking carb off car) remove cover, take out float and needle valve assembly, disconnect valve, and blow it out by mouth. (For a discussion of carburetors that will pinpoint parts for you, see April and May, 1964 issues of <i>PM</i>) |
| Loose fuel line connections | If rag is dry after above test, check for loose connection—particularly at fuel pump, which would let pump suck air, losing vacuum | Tighten all connections. If there's a sediment bowl on the fuel line, tighten that |
| Clogged fuel line and/or in-line fuel filter | If there's no gas on the rag, disconnect fuel line at inlet side of in-line fuel filter, if you have one. If gas pours from line, it's getting to, but not through filter. Whether or not there's a filter, fuel-pump-to-carburetor fuel line could also be clogged | <i>Filter:</i> If you have tubular type filter, take it off and blow it out. Maybe you can dislodge clogging dirt. If not, and you have no means of connecting the two ends of the lines together, there's little you can do. But even a short piece of hose wrapped tightly around ends of lines is all you need to get a flow of gas to carburetor and car running again. If you have sediment-bowl-type filter, drop glass bowl, remove ceramic filter and reconnect <i>Fuel Line:</i> Remove it and blow into it (photo at bottom left). Make sure it's reconnected tightly |
| Bad fuel pump | Unhook gas-tank-to-fuel-pump line at inlet side of pump. Crank engine. If gas pours from line, it means that it's getting to, but not through the pump | If you have manual choke, pull it all the way out, closing choke plate. You might create enough vacuum to pull some gas into carburetor and get car running for a few miles. Failing this—or with an automatic choke—if pump goes bad you must hunt up a new one |
| Clogged fuel tank filter | If no gas gets to pump, as described above, chances are that fuel tank filter (which most cars have) is clogged | Fuel tank filter is usually connected to gas line sending unit. Get beneath car. See if you can spot cover plate in bottom of tank into which unit fits. Put a receptacle beneath it, unscrew cover, and remove unit. Take off filter and shove unit back into place. But work fast. That's gas pouring out. In some cars, the sending unit lies on top of tank and it's necessary to drop tank to reach it. At roadside, of course, this is pretty much impossible. So start walking. Such hikes are rare—these fuel tank filters are coarse, seldom plug up |
| Hot weather problems | If you can spare the time, before you do any troubleshooting let the engine cool down for about half an hour. If the problem is either vapor lock or percolation the car will then start. See July '64 <i>PM</i> for tips on how to combat these problems | |

CAUSES AND CURES OF IGNITION STALLS

| TROUBLE AREA | TROUBLESHOOTING PROCEDURE AND REPAIR |
|--------------------------------------|---|
| Over-all check | Pull a spark plug wire from a plug, hold it about 1/4 inch from ground and crank engine. If spark jumps to ground, trouble is <i>not</i> ignition. Ignition problems are much more difficult to repair than fuel system troubles. If a coil burns out, or if a rotor spring clip breaks off, or if a condenser goes bad or—even in some newer cars—if points go bad, there's not much you can do unless you're prepared for it. Thus, the wise driver is one who carries spares of critical parts: points, condenser, coil (if the one now on the car has seen 30,000 or more miles of use) and just in case, a rotor. And a good spare tool is a length of ignition wire with alligator clips on each end |
| Bad coil or coil-to-distributor lead | Take off coil-to-distributor lead <i>at the distributor</i> and hold it to ground with ignition on, as shown below, left. If there's no spark, current is not getting to distributor and the coil-to-distributor lead, the coil, the ignition switch-to-coil lead or the ignition switch is bad. To find which, reconnect coil-to distributor lead and take off ignition switch-to-coil lead <i>at the coil</i> (below, center). Hold to ground with ignition on. If you get a spark, it means current is getting to coil, but not through to the distributor (see caption below.) Connect one end of alligator-clipped wire o distributor pole on the coil and other to where coil-to-distributor lead attaches to distributor. Try to start car. If it starts, it means coil-to-distributor lead is bad. If it doesn't, coil is bad and must be replaced |
| Overall condition of distributor | Suppose, when you grounded out coil-to-distributor lead at distributor, you got a spark. This means current is getting to the distributor, but not <i>into</i> it or <i>through</i> it. Several reasons for this are listed next |
| Bad points | About 80 percent of all ignition stall problems lie right here. Take off distributor cap and make sure points are in good shape, if you can see them. If they are welded together, too tightly closed, pitted, burned or dirty, they can't create proper ground needed to pull current into distributor. If you have new set of points available, don't fool with old ones—replace them. If no new points are handy, insert some sort of abrasive—a nail file, or even the striking part of a matchbook cover—between them and sand them down. Do this carefully and lightly. Then wipe them clean by sliding a piece of paper between them. Now, try to set point gap as closely as possible to that recommended, which is about .018 of an inch. Use a business card, folded once, to do this. By the way, also make sure the little pigtail which attaches points inside distributor is tightly in place and hasn't broken |
| Other distributor problems | With current definitely going through coil and distributor, and being interrupted as it should by the opening and closing of the contact points, the car still might not start if condenser, rotor or distributor cap is bad. These are things that seldom happen, although they could. Check rotor first, particularly the spring clip. It might be missing. If so, then you must replace rotor to get started. Check distributor cap. It might be cracked. If so, start walking. If, however, contacts in cap seem to be pitted and burned, you might be able to get started by rubbing them lightly with an abrasive. Everything else ruled out, condenser must be shorted or open. This means you need a new condenser in order to get started |

IGNITION TROUBLESHOOTING begins with the coil-to-distributor lead. Disconnect it and hold it to a ground (left) to test for spark. Other vital spot is battery side of coil (left arrow, center photo). Disconnect ignition-switch-to-coil lead here and hold terminal to ground; spark means current is reaching coil. Stall, then, could be due to bad coil or bad coil-to-distributor lead (second arrow shows its connection at coil)



AUTO CLINIC

Q My 1939 Chrysler Royal has all original equipment on it, including the paint. I loaned the car to a friend, he got into an accident and smashed the right headlight lens. Where can I replace it?—E.D.M., California

A We get many letters concerning the restoration of older cars, and the answer is always the same. If you can't find a part in a junkyard, then you're simply out of luck. Chrysler headlight lenses, for example, are not made anymore. As a matter of fact, in most states they're illegal, since laws governing auto safety equipment now call for sealed beams.

Q I have a 1960 DeSoto which has to be cranked a long time before starting, and the starter is very noisy. Do I need a new starter?—R.R.K. Indiana

A Probably not, unless you reach a point where the starter just refuses to start the car. Slow starting and noise are characteristic of the type of starter used in these cars. It's a direct-drive arrangement without a gear-reduction unit. There's no way to speed up its slow movement or to cut down on the noise. Starters used in most other cars are gear-driven and have a reduction unit that provides more power for quicker, quieter starts.

Q My 1962 Ford Galaxie has a terrific hum and vibration when I drive above 40 miles per hour. The dealer who sold me the car has replaced part after part at considerable expense to me, but has not solved the problem. Can you help?—E.V.B., Pa.

A Your plight is like scores of others we hear of, and it brings one unpleasant fact to light. Too many of today's "mechanics" are little more than "part changers."

Did you ever watch an old-time grease monkey work—a man that cut his eye teeth on Model As and Pierce Arrows? He was not only a mechanic, but an artful diagnostician. He'd refuse to change a part until he had probed and tested, and knew for a fact that the part was bad. By contrast, today's mechanic will often send parts flying the minute the hood's up. The irony is that

with modern testing equipment diagnosis is simpler and surer than ever—if the mechanic would take time to run checks before deciding to replace parts. We'll have more to say on today's parts "racket" in next month's issue.

In your case, I'm wondering if that mechanic knows that chances are in favor of the trouble being with an out-of-balance drive shaft. Before changing a single part, he should have pulled the shaft, put it on a jig and checked its balance.

Q In last November's Auto Clinic, you said anyone getting poor gas mileage with a '60 or '61 Valiant or Plymouth should make sure he's got carburetor gasket number 2205582 on the car. I didn't have, so I took my car to four dealers getting the same answer each time: "There's no such part." When I presented your sketch of the proper gasket, one of them even insisted the car wouldn't run with such a gasket. Who's confused?—R.F.P., Ohio

A Dealers who don't read their service bulletins. Have 'em check Plymouth Bulletin 111.

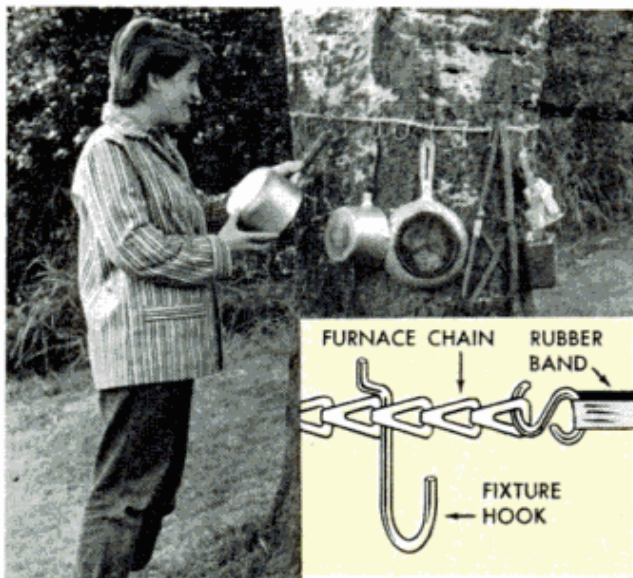
Monthly Service Tips

★ Pontiac has changed its recommended tire pressures for 1964 cars. Tires should always be checked when cold and to the following new pressures regardless of size: Pontiac and Tempest sedans and coupes, 24 front and 22 rear; Safari station wagon, 22 front and 26 rear; Tempest Safari, 24 front and 26 rear.

★ If you find yourself without tail-lights on any early-production 1964 Studebaker (except the wagon), chances are that water has entered the housing and has shorted out the lamps. The cause: improper sealing of the lens to the lamp housing or of the lamp housing to the rear fender. Your dealer has been authorized to install new tail-light lens gaskets (part number 1356262) and modify the tail-light-to-body gasket to prevent a recurrence.

At Your Service

Although only questions of broad general interest can be answered in print, we don't ignore the private, special problem. If your car is acting up, your inquiry will bring an individual reply—a free diagnosis—whether we print your letter or not. Address Auto Clinic, Popular Mechanics Magazine, 575 Lexington Ave., New York, N. Y. 10022



Handy Hanger for Campers

Driving nails into trees to provide a place to hang camping utensils is poor woodsmanship. The considerate camper prides himself on leaving no traces of his stay in the woods. The solution is to rig up a hanger made from furnace chain and a rubber band cut from an old inner tube. An S-hook fitted at each end of the rubber band permits hooking it to the chain so that the hanger may be wrapped tightly around any suitable tree. Fixture hooks of the type that are normally used for hanging tools on perforated hardboard panels, are slipped through the links of the chain to hold camping gear.—*M. Lindberg*

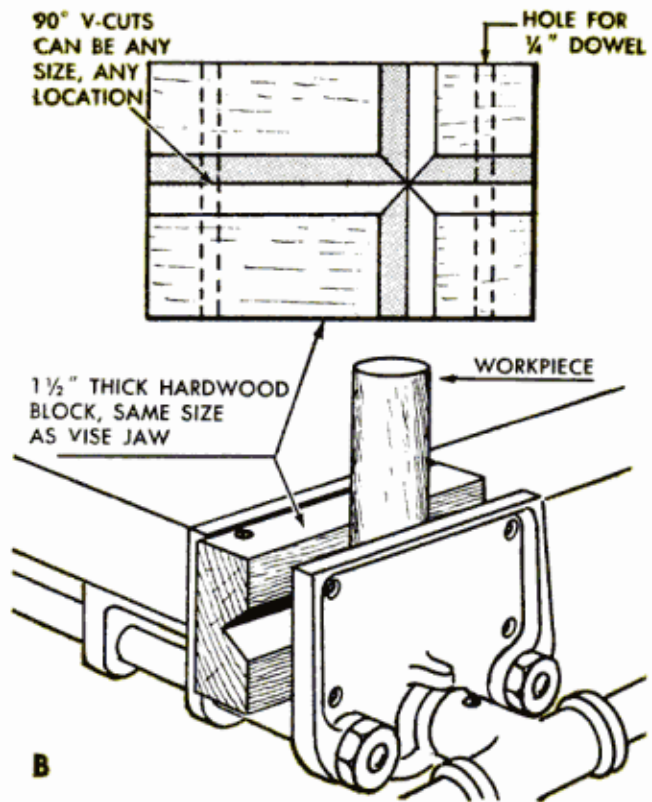
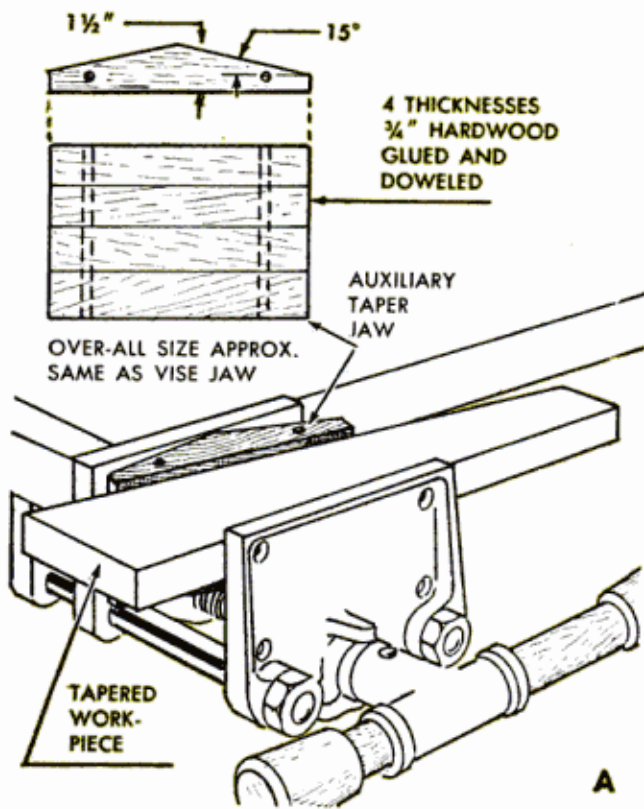


Tent Pegs from Scraps

Camping affords the greatest possible satisfaction when you use equipment that you have made yourself. If this isn't reason enough to get busy in the workshop, don't overlook the cash that you'll save by making some of your own gear. Tent pegs are especially easy to make and the three types shown in the drawing are actually superior in many respects to those that you might ordinarily purchase. Aluminum is recommended as a material because it is rustproof, easy to hacksaw and very lightweight. A search through your scrap box may produce enough pieces to make a set of pegs since in most cases they need not be more than 10 in. long. Greater length is necessary only if the tent is unusually large or where the soil is loosely packed.—*Victor H. Lamoy*

NEXT MONTH IN SHOP AND CRAFTS

- ★ **DESK IN DISGUISE.** Folded, it masquerades as a mere end table, but raise its gate-leg leaf and lift its hinged top and it's ready to serve as a home-office desk, a portable sewing-machine table or a projector stand, with built-in storage space for the machine it serves. You'll find complete plans for the desk, plus matching chair, in the September *PM*
- ★ **SAILING CATAMARAN.** After reading "The How of Those Hopped-Up Sailboats" (Feb. '64), many sailing enthusiasts wrote in asking when *PM* would publish plans for a sailing catamaran. Our answer is a 12-ft. cat carrying 120 sq. ft. of sail, and you'll find it in the September issue. Weighing only 200 lbs., it's completely demountable for car-topping
- ★ **\$7 SLIDE PROJECTOR.** Whether you use it to enlarge *PM*'s Project-a-Plans or show your collection of color slides, this easy-to-make slide projector delivers an amazingly sharp image. All optical parts are available in a kit, and we've even included plans for a kaleidoscope attachment for intermission entertainment. It's all in the September *PM*
- ★ **MORE SHRUBS BY POT LAYERING.** A modern adaptation of the ancient Chinese method of plant propagation called "air layering," this system involves potting a branch of a large shrub while it's still attached to the parent plant. Once the branch has a good start, it can be cut off and set in the ground. The September issue has all the how-to details.



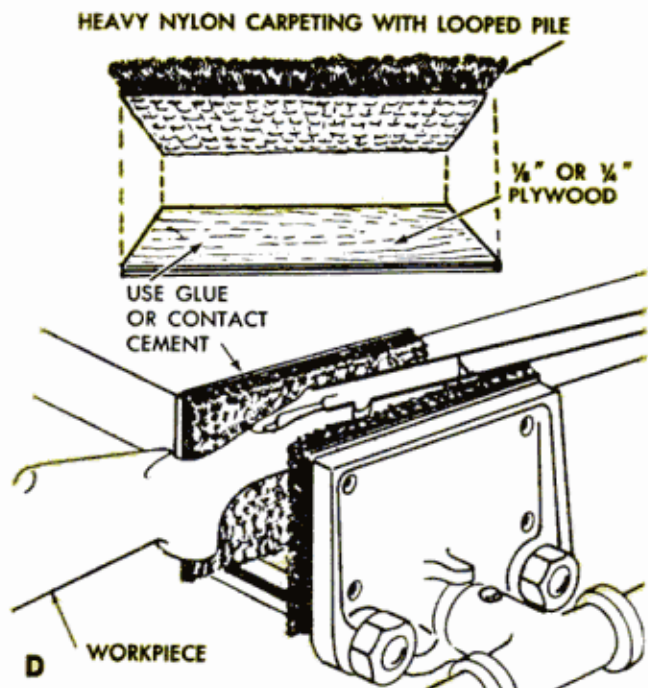
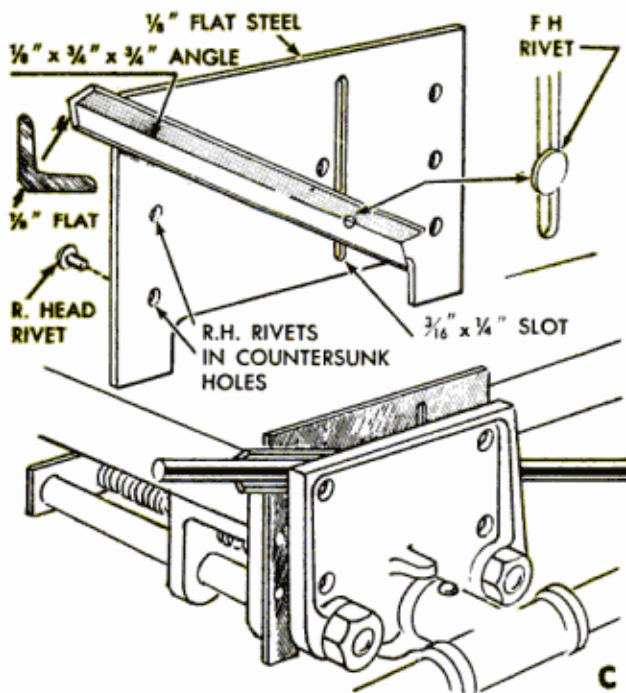
Extra Bite for Your Vise

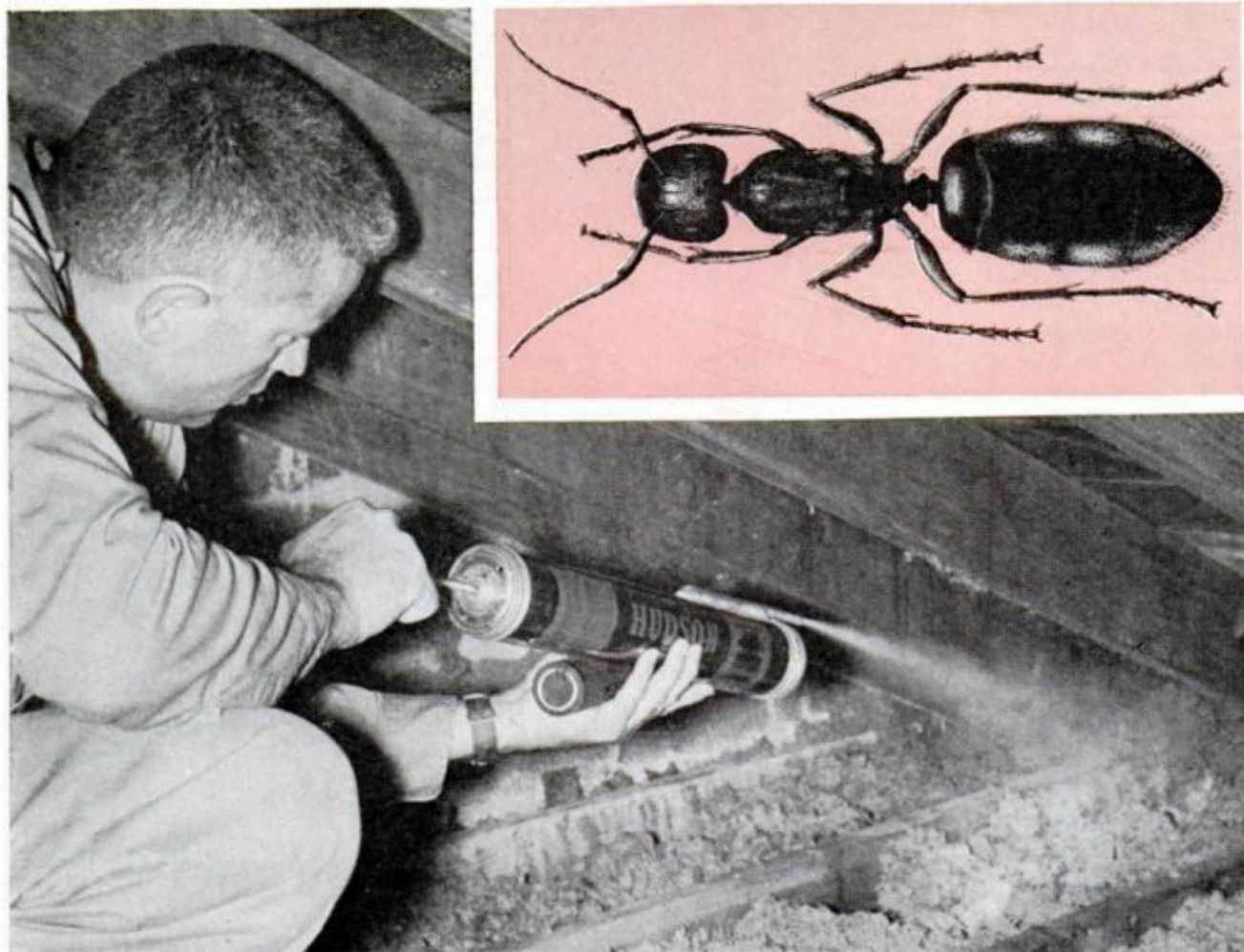
THESE AUXILIARY JAWS enable you to hold almost anything in your woodworking vise—tapers and irregular shapes, also rounds in wood or metal. And you can hold these workpieces in almost any position desired.

The taper jaw (A) will grip any piece up to a 15 degree taper for planing or any other cutting or chiseling operation. It's self adjusting; just drop the auxil-

iary jaw in place, locate the work and tighten the vise.

The carpet-padded jaws (D) will grip and hold securely almost any irregular shape, such as a gunstock, without crushing and without marring the finish. The V-jaw (B) grips rounds in the vertical or horizontal position. The horizontal Vee can be cut at an angle if desired.—W. Clyde Lammey





FOLLOW A FORAGER home to find the nest. Spray powder gives best distribution through big nest, as in attic

Ridding Your Home of the Biggest Chiseler of Them All

THE CARPENTER ANT

Based on the total number of dwellings infested, the carpenter ant, and not the termite, wins championship honors as the insect which causes the most damage to wooden structures in the United States

By Fred R. James

IF CARPENTER ANTS are such a menace, why do termites cop all the attention? Largely because when termites decide to add your house to their menu, the damage they do can be downright disastrous. The things that make our six-legged carpenter such a pest are less dramatic: he operates with far wider freedom and can be more difficult to control.

The hardy carpenter ant thrives under all climatic and topographical conditions. Abundantly located in every state, the carpenter ant is found from sea level to heights of over 9000 feet. The pest, whose

carpentry ability is solely destructive, is strong enough to withstand extremes of temperature. The remarkable queen of the colony has been known to live as long as 15 years, functioning solely as an egg-laying mechanism with a production in the tens of thousands!

Carpenter ants are the largest of the many species of North American ants ranging in size from about $\frac{1}{4}$ in. for a minor worker, to $\frac{3}{4}$ in. for a queen. The color varies from jet black to black and red. Blessed with particularly strong mandibles, they are not above taking a nip out

POPULAR MECHANICS

of any human or animal flesh that's near.

The ravenous chewing and indiscriminate chiseling of which this ant is capable has nothing to do with obtaining food. This little chisler feeds on honeydew and a variety of sweets, along with the fluid from insects that are captured and killed. The carpenter ant's excavation is purely by way of gouging out a home from which it can venture forth to seek sweets.

The size of an ant colony may run anywhere from a few members in a newly established nest, to over 3000 individuals in an older nest. Considered by scientists as among the most highly developed insects of the more than 800,000 known species, carpenter ants have a well-ordered social life that's a model of efficiency and team work. Within a single nest, depending on its size, there are one or more queens, some male and female reproductives with well-formed wings, and numerous workers who form the backbone of the interdependent city within wood. They gather the food, feed and care for the queen and her recently hatched offspring, excavate additional chambers, and defend the colony against all enemies.

Homes near wooded areas, "stump land," or freshly disturbed vacant lots are the regions most likely affected by carpenter ants, although it isn't at all uncommon to find these pests comfortably established in houses in the middle of heavy populated urban sections.

All types of dwellings of every age can be attacked by the carpenter ant, but he seems to show a preference for structures without basements or with partial basements, buildings with low foundations, rambling porches, and structures with loose construction, such as cabins.

When a carpenter ant infestation is of long enough duration and the size of the colony is large, structural damage is frequently so extensive as to require major repairs. Trees weakened by the hollowing out caused by the chiseling pests are easy prey to strong winds.

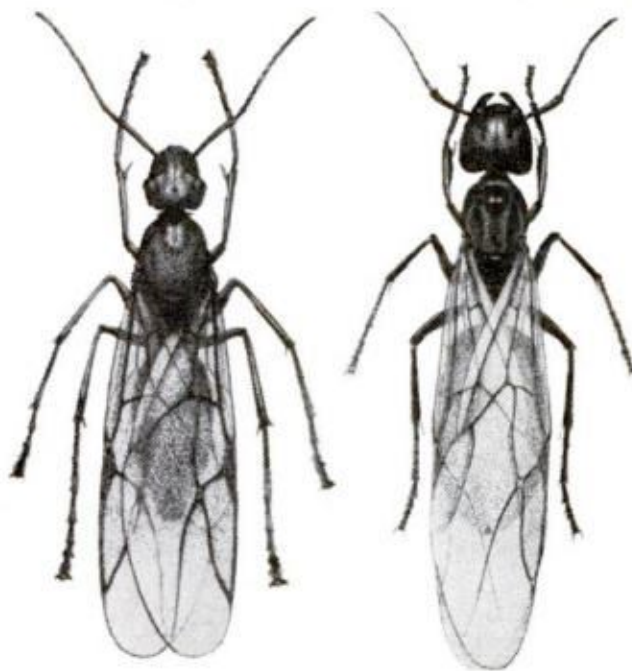
The whole trick in eliminating an infestation of carpenter ants is finding the nest. Too often stray workers will be seen walking about the house in an aimless fashion, far removed from a hidden nest of numerous brothers and sisters. For every stray killed outside the colony it seems that five replace the pest—coming, of course, from the elusive nest. But once this nest is pin-pointed it is easy to apply any one of several effective pesticides to get long-lasting relief.

An important thing to remember in warring on the wood-chiseling ants is that they consistently show a preference for moisture. Soft, damp, decayed areas of

ANT COLONY AT WORK



WINGED FEMALE (left below) and male (right) leave ant colony (above) for mating flight in spring or summer. Wingless workers remain in colony, as here



Courtesy Connecticut Agricultural Experiment Station



NESTS WITHIN WALLS can be treated by drilling ¼-in. holes every 16 in. along baseboard. Garden sprayer pumps liquid insecticide through these holes

roofs, shingles, sheathing, clapboard siding, columns, posts, pillars, window sills and frames, and other structural offsets that have been visited by dampness are typical sites of a nest. The actual rate of damage to the wood is dependent on living space required by a rapidly expanding colony. It is interesting to point out that if there is subsequent insufficient moisture, or too much water seepage, the colony will seek a new home.

What are the signs of a typical infestation? As mentioned, the homeowner becomes conscious of a persistent stream of foraging worker ants whose numbers never seem to diminish despite constant applications of insecticides.

In cases of a very heavy ant population on the premises, it is possible to hear carpenter ants with an unaided ear. A faint, rustling sound, believed to be a form of actual communication rather than audible eating noises, may occur.

The expelled borings that accumulate as wood shavings below slit-like openings in wood are a tell-tale sign.

On a warm day in spring or summer winged males and females may emerge from nowhere unexpectedly. These romantic individuals go on a mating flight, but first seek to escape out the nearest window. Incidentally, when these flyers emerge it is usually evidence that a colony is at least three years old and may contain upwards of 2000 residents.

Inasmuch as moisture plays such a vital role in attracting carpenter ant nests, it is



ELECTRONIC DETECTOR helps pinpoint location of nests by picking up sounds within the wood. Type shown is made by Sonitrol Corp., Anderson, Ind.

wise to check all spots that in any way might contribute dampness. These include:

- Sweaty plumbing.
- Damaged flashing.
- Plugged drains and gutters.
- Poorly fitted or damaged sidings, wooden shingle roofs, and areas between the roof and ceiling of flat deck porches.
- Leaking door and window frames.
- Wood in direct contact with soil such as porch supports, siding, stair risers.
- Wood in areas with faulty ventilation such as cellars, crawl spaces, attics.
- Wood scraps in dirt-filled slab porches.
- Areas where condensation directly affects wood.

Good guides to moisture elimination in homes are available in books on household maintenance available in public libraries or can be obtained by writing to the Superintendent of Documents, U.S. Printing Office, Washington 25, D.C.

Openings to the outside of buildings that might serve as avenues of direct entry for carpenter ants ought to be calked and sealed as a matter of principle. In seeking out nests or factors encouraging the propagation of these pests, inspect the area immediately surrounding the house. Overhanging tree limbs can prove a highway of entry and they should be pruned back away from the house. Climbing vines are another feature to inspect.

Trees are the natural habitat of carpenter ants and if they can be stopped here before they gain entry to the home

the control job is an easier one. Holes or "windows" in trees usually lead to a nest. These are most often found in knot holes, scars, dead sections, and crotch angles. These should be plugged with tree compound or cement.

Many cases of carpenter ant infestation in a home originate from infested firewood unwittingly carried indoors. Always make an extra check of this material, and, as an added precaution, spray the cords with insecticide.

A new device that shows promise in detecting hidden carpenter ant nests is a lightweight, portable, electronic detector. A probing needle is applied to surfaces that are suspect and the sounds of movement and "talk" can be heard.

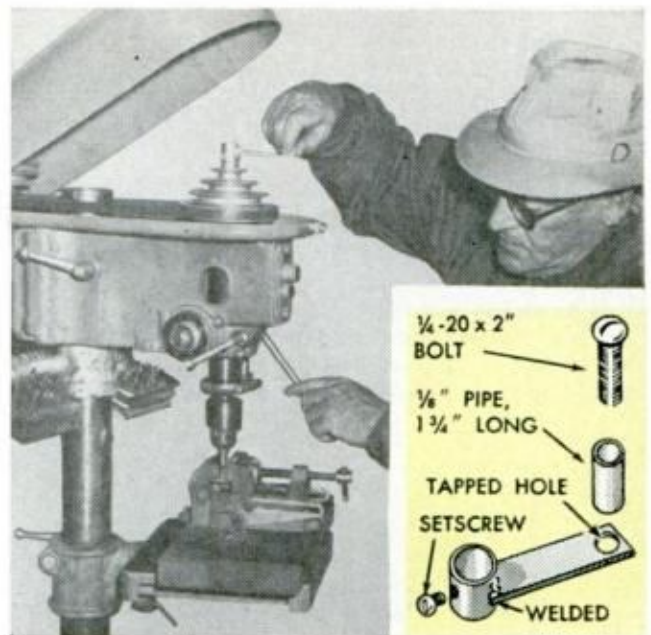
Another method of "zeroing in" on a hidden nest is through the use of insect powders and aerosol insecticides as flushing agents. If you trace the route of travel of the ants back to a point of origin in the wood of your house, you can shoot aerosol mists of pyrethrins or dusts containing 5 or 6 percent DDT or chlordane powder into all cracks and crevices in the vicinity. Where roaming ants can't be traced to a point of origin, apply pesticides to suspicious damp areas. Often, only a slight application of these chemicals will cause ants to tumble out to reveal the nest which you can then treat more thoroughly.

Chlordane is probably considered the best all-around insecticide in control of ants. The material should be liberally applied to the nest and areas immediately surrounding it. Use a compressed air sprayer to get saturation. Aerosols and mists do not leave enough residual chemical. Be absolutely certain to read and follow label instructions. Recommended mixtures are 2 percent or 3 percent oil solutions or water emulsions.

Always apply insecticides so they'll reach the maximum amount of the areas travelled by the insects. Unless there are ample existing cracks and crevices in the immediate area of a nest, it is often advisable to drill $\frac{1}{4}$ to $\frac{3}{8}$ in. holes at 12-in. intervals in infested timbers to apply chemicals for the purpose of intercepting galleries.

Chlordane, DDT, and Lindane are also available in dust formulations of 5 percent and, in the long run, when applied to galleries, are probably superior to liquids. This is because of the facility with which they can be disbursed through a "blowing" action that enables the material to reach nooks and crannies not always reached by sprays. Use a rubber bellows or garden-type duster for best results.

In treating outdoor nests with liquids, always use water-emulsion materials. Oil solutions burn vegetation. ★★★

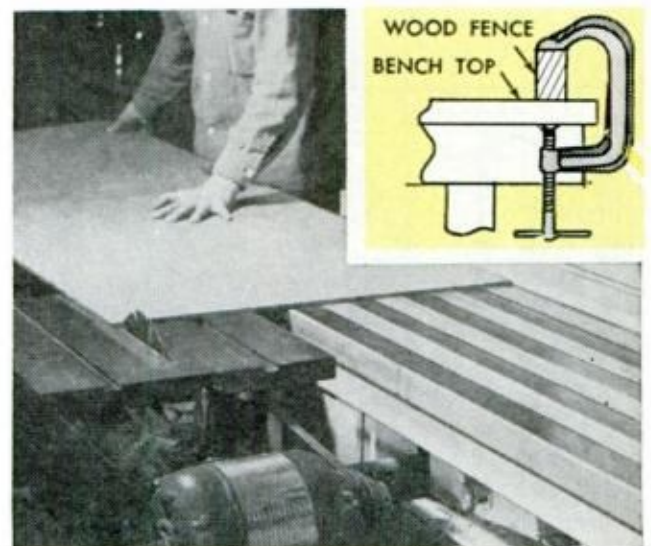


Convert Drill Press for Tapping

By adding a simple hand crank at the top of the quill, you can do perfect tapping on your drill press. After boring the hole, replace the bit with a tap and turn the quill by hand, as shown. The crank is a floating type that lets the quill pass: the setscrew projects into the groove of the quill, without binding. The crank body is flat steel, $3\frac{1}{2}$ -in. long.—W. G. Waggoner

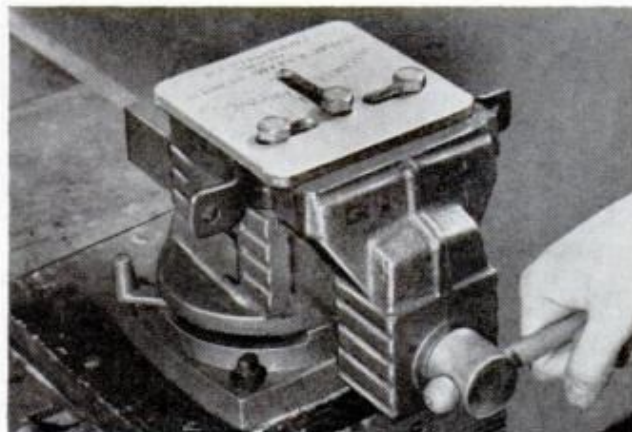
Bench Supports Wide Panel

When I need to trim the edge of a panel that's too wide to balance on my table saw, I move the saw next to my workbench and crank the table up to the bench height. Next I center a long straightedge flat against the blade and measure over onto the bench from each end of this strip, to set the width of cut. Then I clamp an auxiliary fence to the bench top (inset), keeping it parallel to the straightedge. I always back off saw's fence before sliding the panel into the blade.—R. C. Barnes



Shopping for Tools

DUAL PURPOSE DRILLS give rotary and impact motion combined, or rotary motion alone. The former speeds masonry drilling; the latter is for conventional drilling. Porter-Cable Model 590 (1-in.) costs \$129. Model 390 (¾-in.) retails at \$109.50. Rockwell Manufacturing Co., Rockwell Bldg., Pittsburgh, Pa., 15208

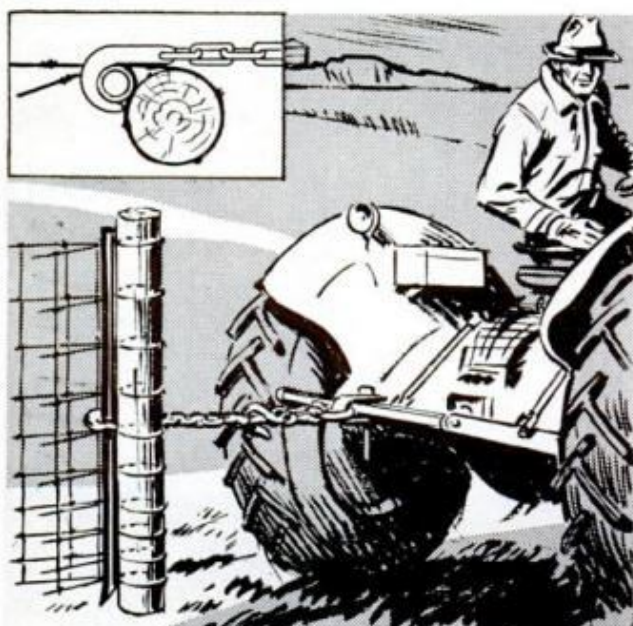


THE STRAP & CLAMP BENDER uses the force of a machinist's vise to make single or multiple bends in strap metal up to ¼x1 in. Ideal for making hangers for pipe and conduit, car exhaust clamps, tool racks and other useful items. Sells for \$11.95 F.O.B. Mitchel Products, Mfg., at Shandon Road, Paso Robles, Calif.

FARM TIMESAVERS

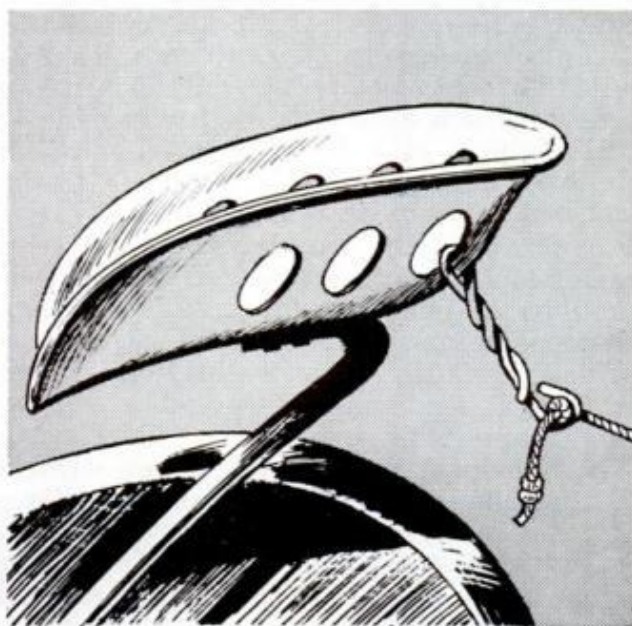
Tractor Stretches Fencing

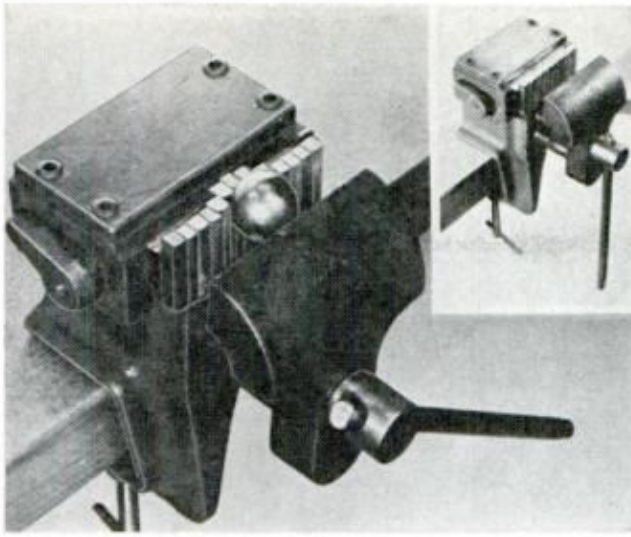
When stretching a wire fence, let your tractor pull it taut. Wrap the wire around an extra post and place a pry bar or pipe behind the post as shown. The bar, when pulled by the tractor, will wedge the wire against the post.—*J. Curol*



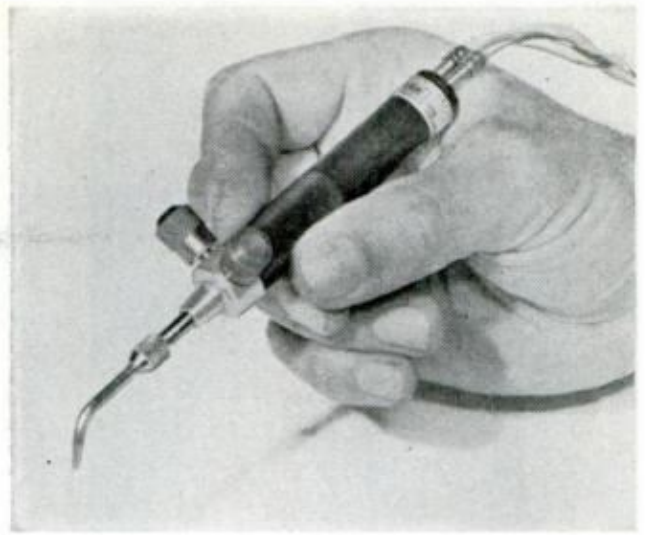
"Breakable" Hook for Trip Rope

If tied directly to the tractor seat, the trip rope of a tractor-drawn machine often breaks if the machine accidentally uncouples. To prevent this, secure the rope with a piece of wire solder, which will let go if tugged sharply.—*G. E. Hendrickson*





AS YOU TIGHTEN this vise, its tiny movable jaws conform to outline of the object being held, permitting a tight grip on any shape. When object is removed, a lever re-aligns the jaws. The unit has a 3-in. jaw opening and costs \$31.45 postpaid. American Machinery Co., Inc., Olivine Sreet, Willimansett, Mass.



"THE LITTLE TORCH" is designed for precision work. Its tiny pinpoint flame—as hot as 6300 deg. F.—can weld filaments only one mil thick or steel of 16 ga. Uses oxygen, plus acetylene, hydrogen, natural gas or LP-gas. Lists at \$59.50. Smith Div. of Tescom, 27th Ave. and 4th Street S. E., Minneapolis 14, Minnesota

CUT & SCRAPE is a fixed-blade utility knife that also serves as a scraper. One end of the knife holds blade in conventional position for cutting. Other end holds blade at right angles for scraping windows, tile, etc. Retail for 99¢ with five blades. Manufactured by the Evans Rule Company, Elizabeth, New Jersey



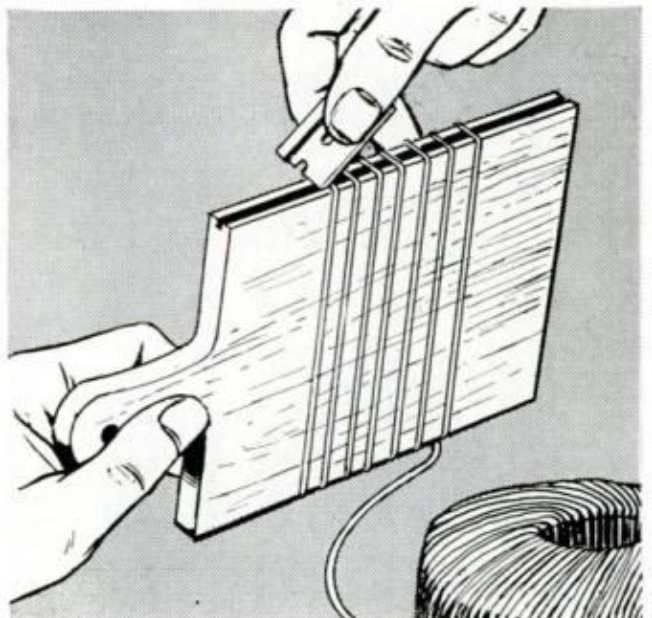
Lid Discourages Roosting

To keep chickens from fouling their own drinking water, hang the lid of an old pot over the poultry waterer. Any hen trying to perch on the lid will drop unceremoniously to the ground as the lid tilts under her weight.—Ann Zawistowski



Fast Way to Cut Sack Ties

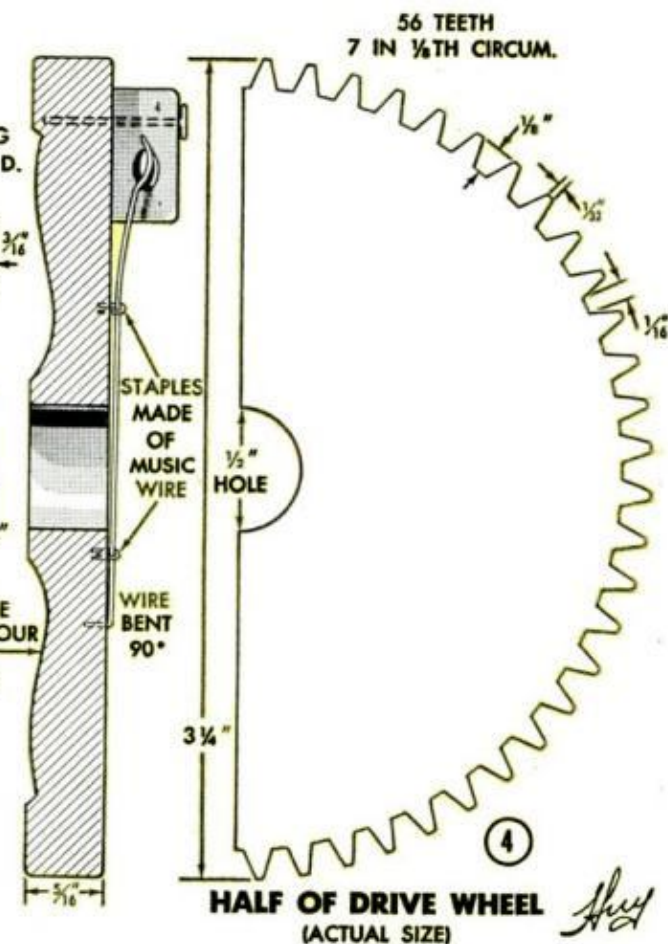
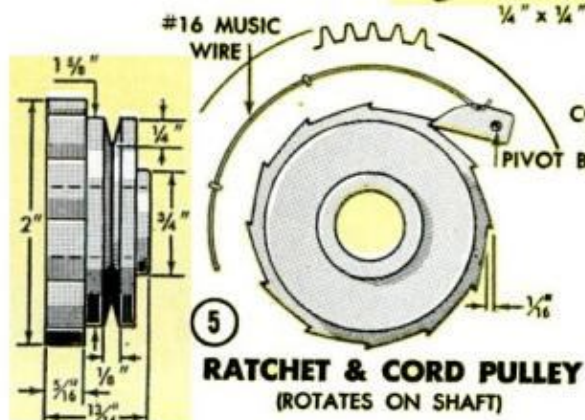
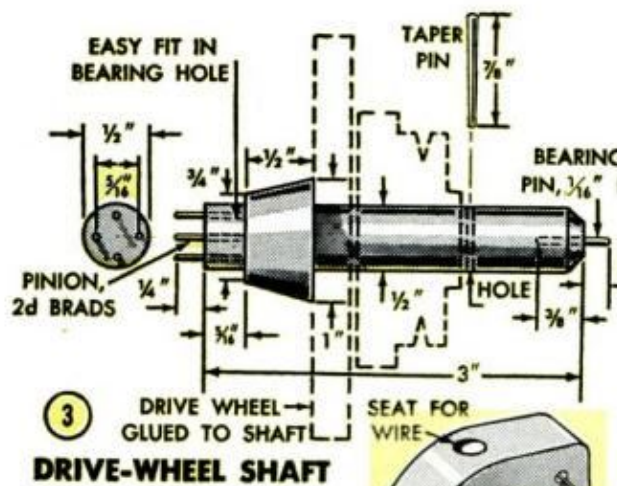
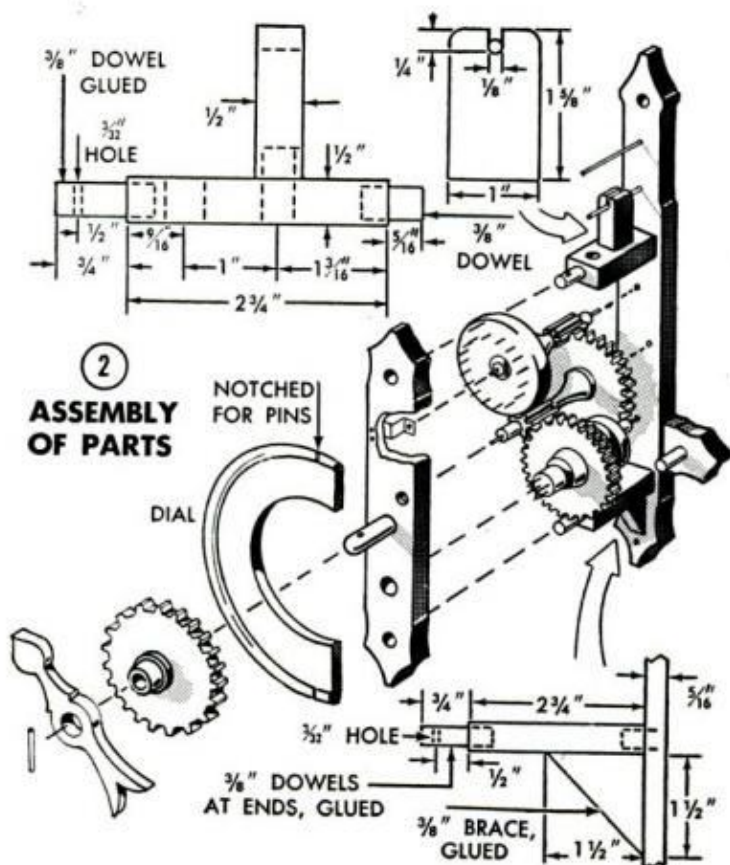
To speed cutting of the many short strings needed for sack tying, wrap the string around a grooved paddle board and run a razor blade along the groove. Make board half as wide as string length and cut groove with single pass of bench saw.

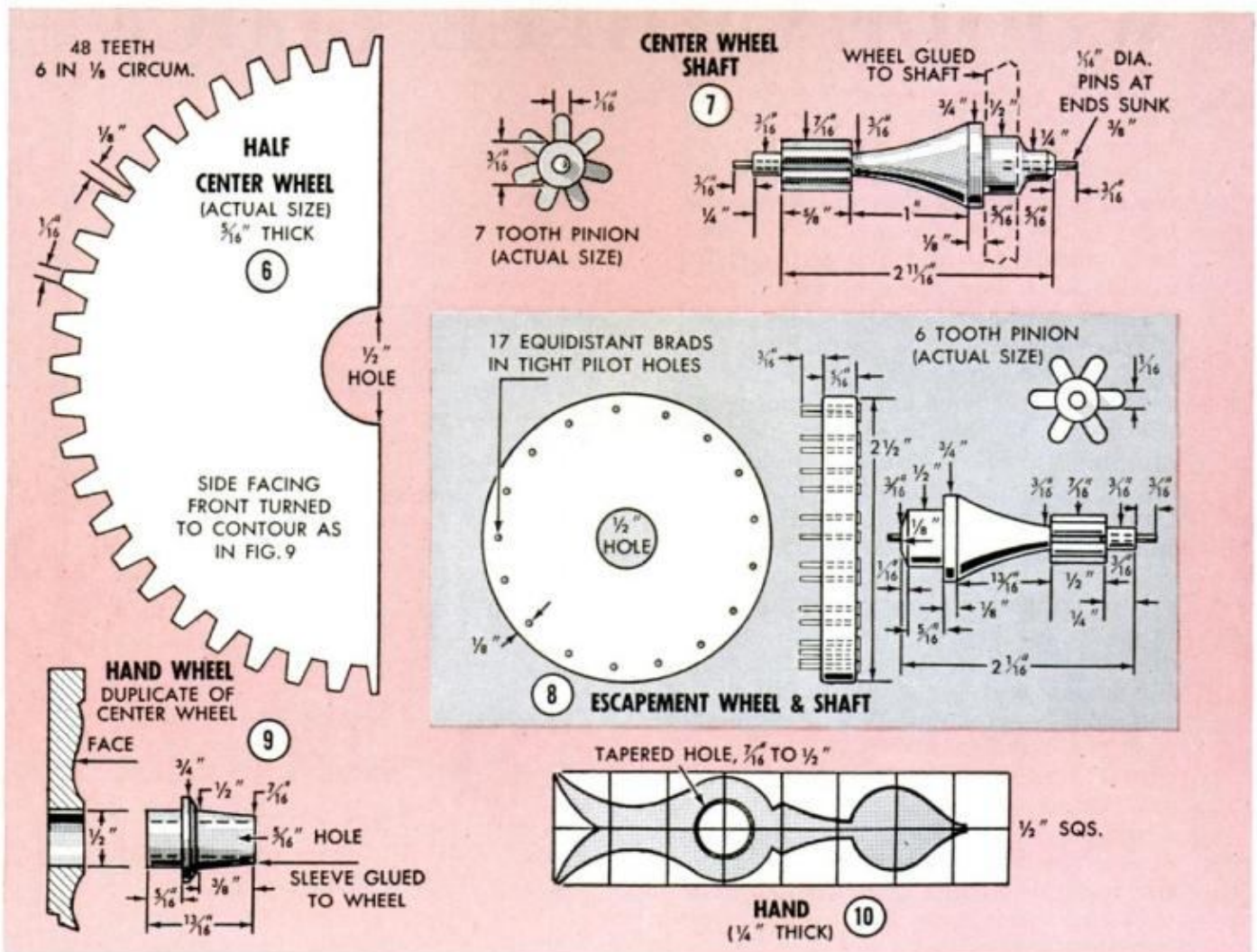


WOODEN-WHEEL CLOCK

lower end of the shaft engages a brass screw-eye bearing. The frame crosspieces are detailed in Fig. 2 which also shows the wheel assembly. Glue the crosspieces to the back plate only and at perfect right angles to it. The brace glued on prevents sagging.

Wheels and shafts: In making the three wheel shafts, Fig. 3, 7 and 8, first drill the bearing-pin holes at the ends of the blocks in perfect alignment before you do the turning. Slight misalignment can cause binding of pins in bearing and wobbling of shafts and wheels. The drive-wheel shaft, Fig. 3, has a bearing pin at one end only. The other end rotates in a hole in the front plate. You drill four pilot holes in this end for brads that serve as a pinion to turn the hour hand. All the wheels and the ratchet pulley have 1/2-in. center holes drilled before turning, and these are used to mount the work on a threaded arbor. One side of each wheel that can be seen in the assembled clock is turned to a pleasing contour. The shafts are





turned so the wheels fit them snugly. The hole in the ratchet pulley, Fig. 5, is slightly oversize so it rotates on the shaft. The ratchet pawl is pivoted on the side of the drive wheel and is kept in firm contact with the ratchet by a music-wire spring secured by two tiny staples, Figs. 4 and 5.

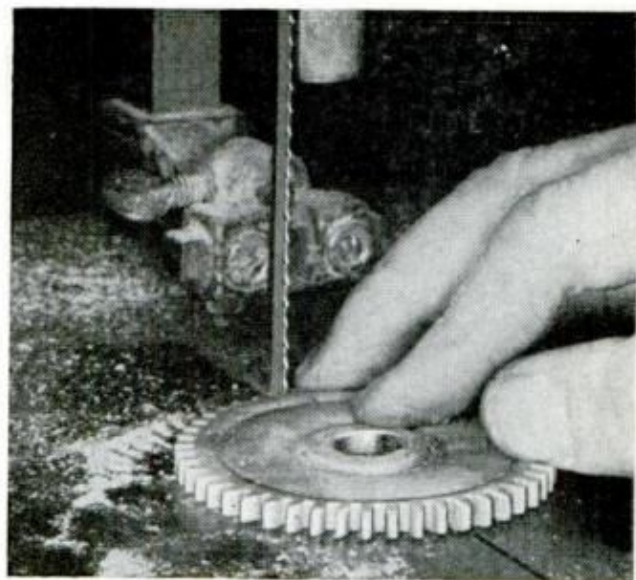
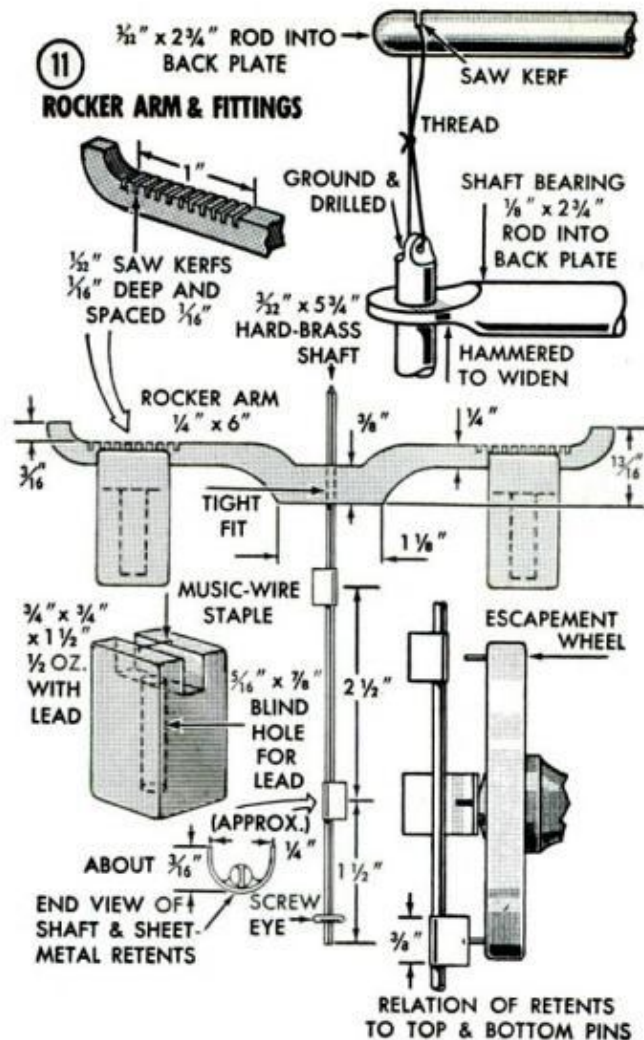
Cutting the teeth: The gear teeth can be cut in different ways. One method consists of laying off the teeth according to dimensions in Figs. 5 and 6, using a sharply pointed hard-lead pencil, or by tracing them from these drawings. Remove the waste with a fine-tooth bandsaw as shown in a photo, scrollsaw, or even a hand fret-saw, and dress down to the marked lines with a small flat file or manicure sanding stick. Another method involves the use of a router that slides on a track above the lathe, and an indexing plate on the lathe spindle having the required number of indexing holes.

Matching wheels to pinions: Check each shaft separately for easy rotation in the frame so there is no trace of binding in the bearings. Match the drive wheel to the 7-tooth pinion on the center-wheel shaft before gluing on the center wheel. The fit between wheel and pinion will probably be tight so that the wheel cannot turn freely or at all. Free the teeth by

very delicate dressing, but first blacken with ink the tip of one pinion tooth and the tips of two wheel teeth that straddle it when meshing. This assures subsequent reassembling of pinion and wheel in exactly the same relationship.

To match wheel and pinion teeth, hold the frame in a padded vise and gently apply a little pressure on the wheel in the same direction that it will rotate in the clock, at the same time putting a slight drag on the pinion to simulate actual working stresses. Carefully determine just where binding occurs both when a pinion tooth starts to engage the wheel teeth and when it disengages from them. A small piece of carbon paper fed between the meshing teeth will show up points of excessive rubbing.

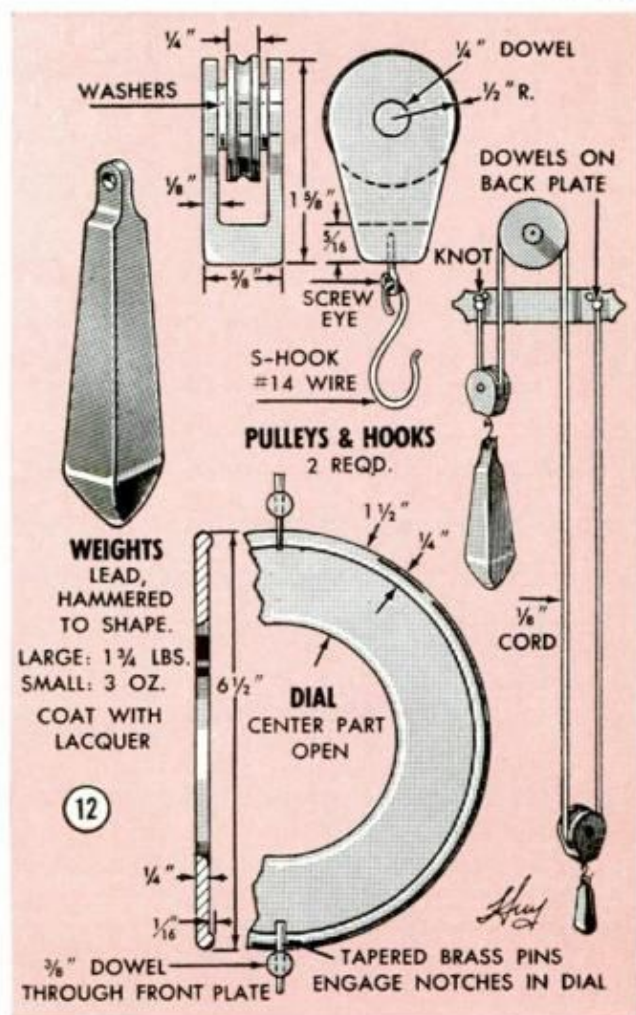
Dress only the slopes of the wheel teeth but not the tips as this reduces the wheel diameter. Too much dressing ruins a wheel because it produces excessive clearance and allows pinion teeth to strike the tips of wheel teeth. Remove all high spots from the wheel teeth that tend to slow rotation of the wheel when it is barely touched with your finger and the pinion is kept under a slight drag. The tips of pinion teeth should be semicircular in cross section and must not be dressed



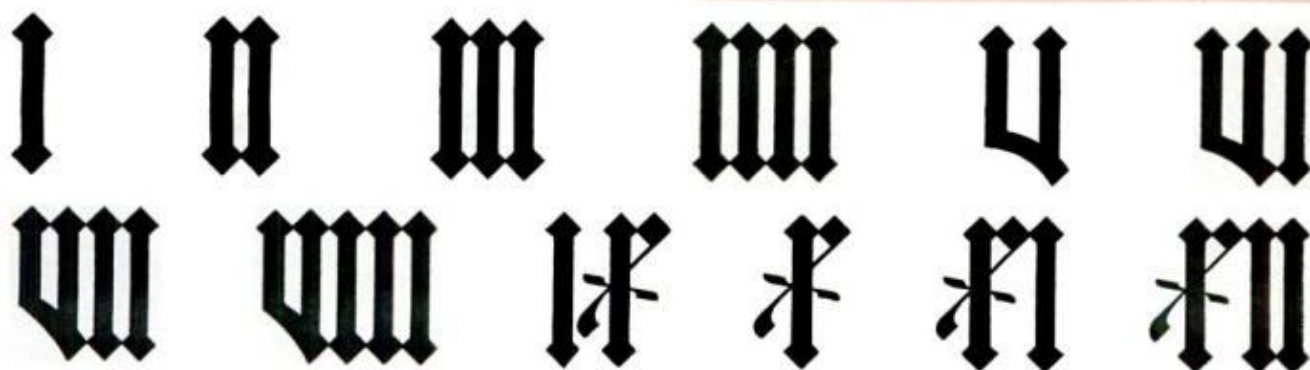
WASTE BETWEEN teeth is first removed with band or scroll saw, then filed to line with small flat file

down on the top. If the tips of the wheel teeth bind on the bottom of pinion gullets, deepen them a trifle. After matching the drive wheel to the pinion on the center-wheel shaft, glue the center wheel to its shaft and proceed to match it to the pinion on the escapement-wheel shaft. This is done while the drive wheel is removed.

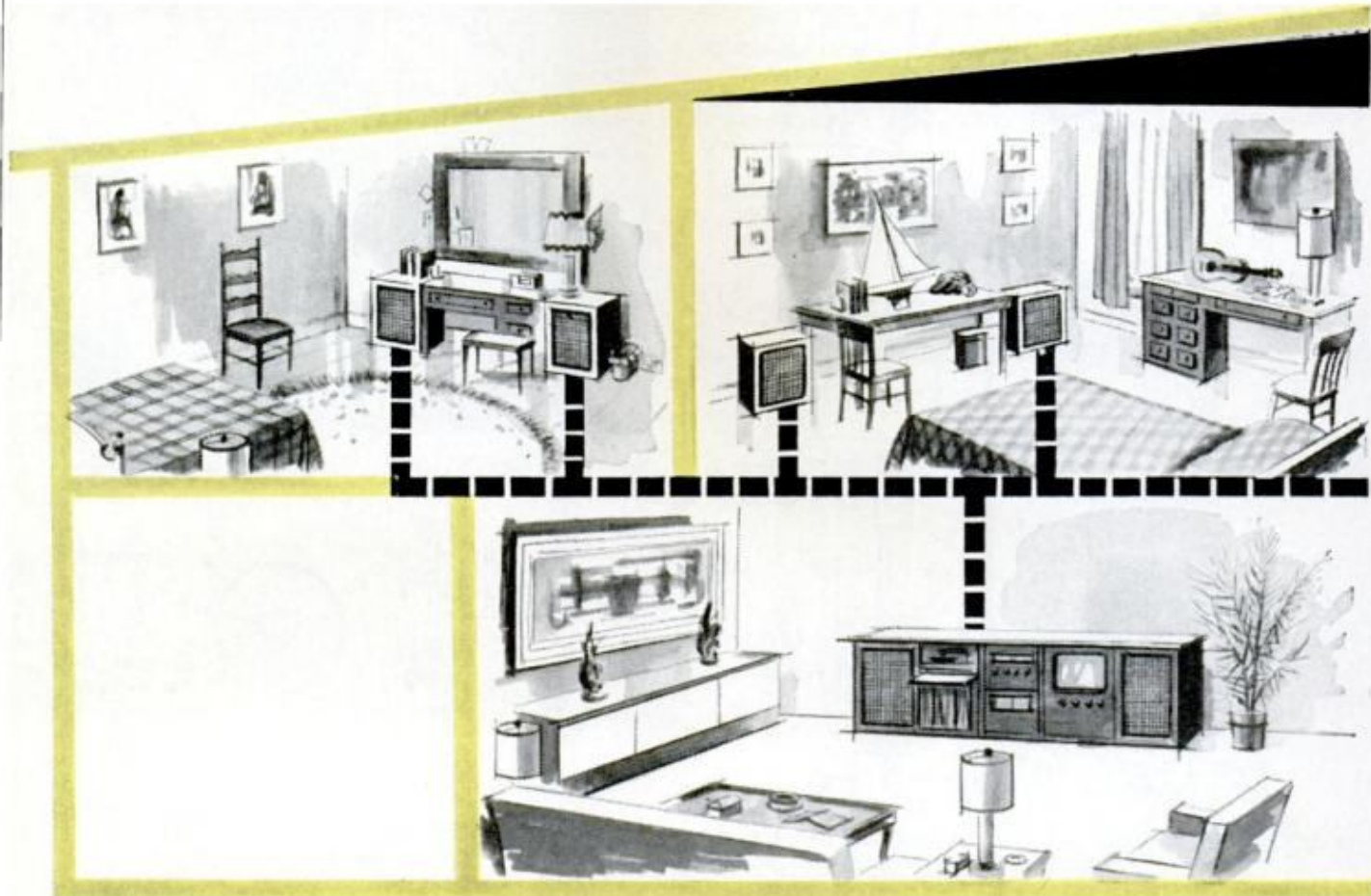
Escapement mechanism and timing: Drill pilot holes for the equidistant brads of the escapement wheel, Fig. 8, using glue on the brads for extra holding power. Uniform height is obtained by grinding. Fig. 11 shows the rocker arm and associated parts. Sheet-metal retents on the [\(Please turn to page 180\)](#)



NUMERALS (ACTUAL SIZE)



Now.. You Can Add Stereo



Put extension stereo speakers wherever you want them. Here's how to avoid the usual problems of phasing, matching, balancing

By Walter Salm

INSTALLING a single speaker system in your listening room along with the rest of your hi-fi equipment is relatively easy.

But just try adding extension stereo speakers in other rooms of your home, especially if the added systems use speakers that are not matched to the existing speakers. This can spell trouble if you're not aware of some of the finer points of speaker installation; phasing, load balancing and impedance matching.

Adding the additional speakers and wiring them through a selector switch to the stereo amplifier is no problem and no special instructions are needed. But while your present system may be phased properly, are all those pairs of extension speakers also phased properly? When two speakers are connected to the same amplifier, they are in phase if the cones of both

speakers are pushing forward at the same time. If one is pushing while the other is pulling, they are out of phase—a condition that causes serious degradation of the reproduced sound.

The simplest way to check for proper speaker phasing is with a phase-reversing switch. This switch is wired into the circuit of either one of the stereo speaker pair. Now listen to the speakers, first with

SPEAKERS with terminals marked (-) and (+) can be easily phased by connecting (-) to common (ground) and the (+) side to proper impedance terminal



POPULAR MECHANICS

All Through Your Home



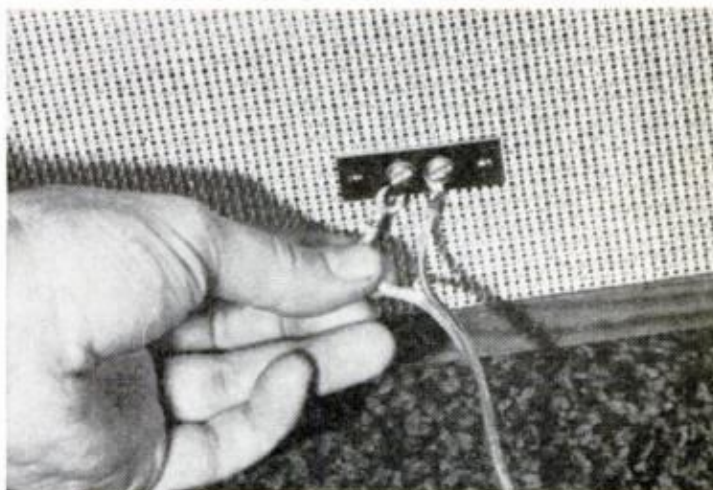
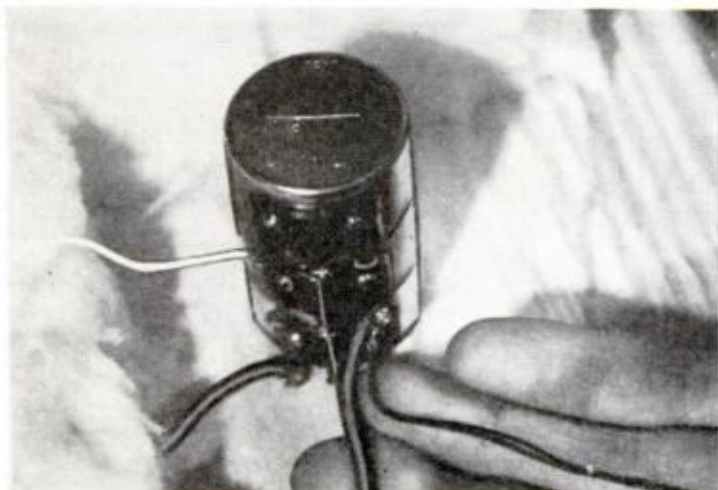
the switch in one position, then in the other. The sound will be noticeably better, fuller and richer, in one position.

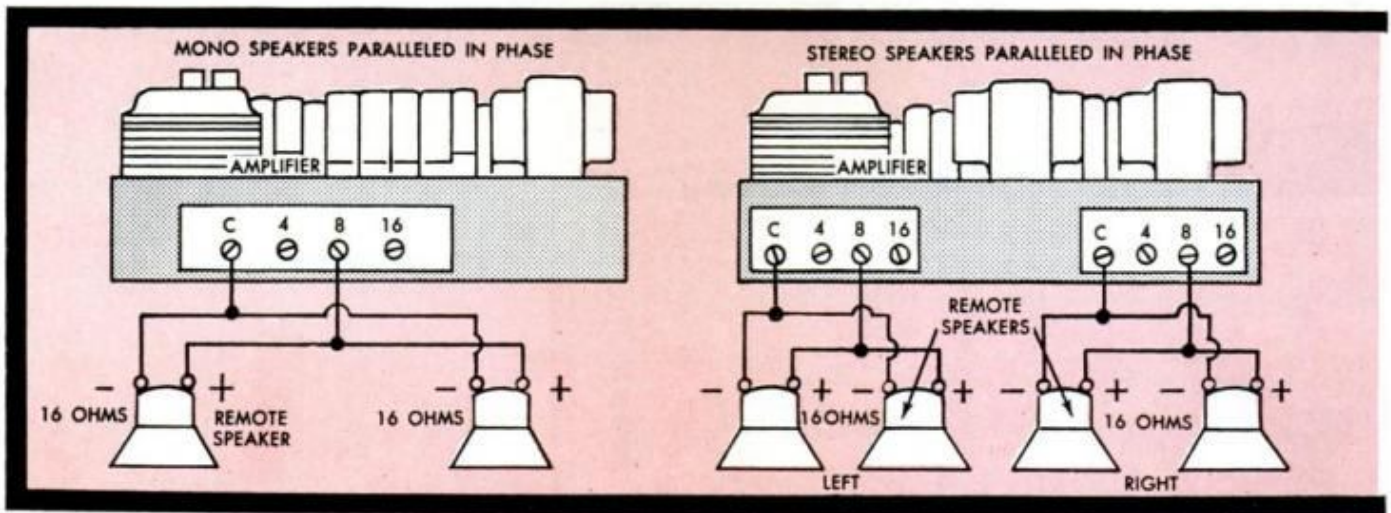
An alternative method, if the speakers are not yet mounted in their cabinets, is to connect a 1.5-volt flashlight battery across the speaker terminals. This can be done by soldering a short length of wire to each battery contact and touching these wires to the speaker terminals. When you

SPECIAL 3-section volume control—called "T-pad"—solves problem of individual speaker volume control and does not affect speaker loading in any way

do this, notice which way the speaker cone moves. If it moves forward, mark the terminals + and - corresponding to the plus and minus terminals of the battery. If the speaker cone moves backwards, reverse the battery connections and then mark the terminals. Do this for both speakers. Then connect the - terminals to the common or ground on the amplifier and the + terminals to the impedance-marked terminals

WHEN CONNECTING LEADS at the speaker, watch color coding of wires and make sure connections are secure. If you don't, speaker sound may not be right





TWO WAYS are shown for adding remote speakers to an existing amplifier without disturbing speaker impedance matching, which can result in severe distortion and permanent costly damage to amplifier output transformer

on the amplifier.

Most amplifier manufacturers tell you not to operate the unit without some sort of "load" connected to the amplifier output terminals, and for good reason. An output transformer is probably the most expensive single component in an amplifier, and running the amplifier without a load can damage it.

The load is normally a speaker, but during distortion tests, for example, you may want to run the amplifier without a speaker. In other situations you may want an on-off switch to turn off a particular extension speaker. If you have previously paralleled speakers for main and extension use, simply switching off one of the speakers will cause an impedance mismatch, distortion and a very noticeable jump in volume from the other speaker. Conversely, when the extension unit is switched in again, the main speaker volume will drop.

To avoid these problems, a loading resistor with approximately the same value as the speaker voice coil should be switched in when the speaker is turned off. A single pole-double-throw switch will do the job. The resistor should have a d.c. resistance equal to the speaker voice coil impedance. It should be a wirewound unit with a wattage rating high enough to accommodate the highest peaks that the speaker normally has to handle.

Therefore, if an amplifier normally puts out 20 watts, half this amount—10 watts—will normally be handled by the auxiliary speaker. This would mean you need a 10-watt resistor. But equipment manufacturers usually recommend a safety factor of 100 percent or more, so use a 20-watt resistor to be safe.

This arrangement works well for switching speakers in and out, but you still cannot regulate the volume without going

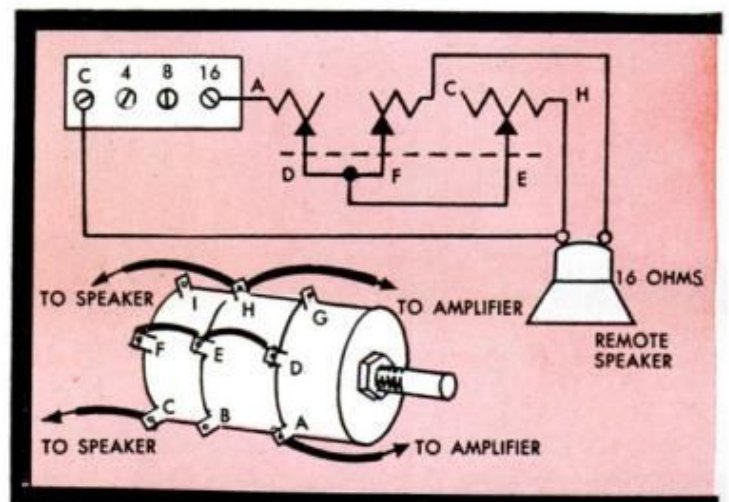
down to wherever the amplifier is located and adjusting the main volume control. This can be a pain in the neck, especially if you have to climb a flight of stairs to do so. It would be preferable to equip each speaker with its own level control.

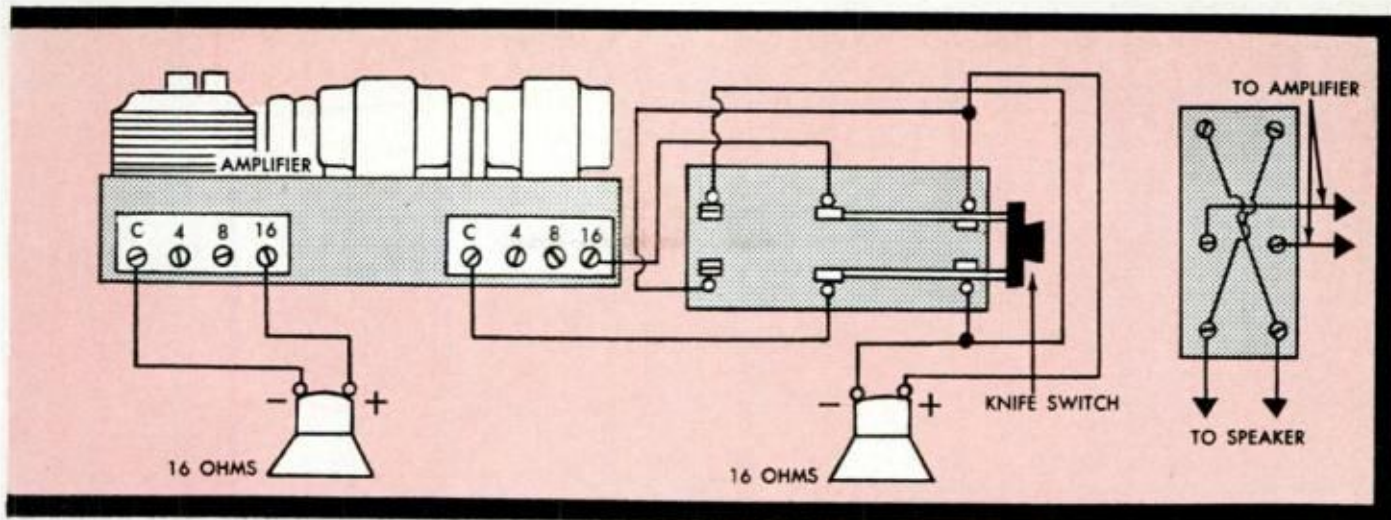
An additional application for local volume control is for balancing the two speakers in the same room for best stereo.

An ordinary volume control potentiometer inserted in series with the speaker line would certainly control the volume, but it would also cause a serious impedance mismatch both with the speaker and the output transformer. A convenient way of controlling volume without mismatching is to use a "T-pad." This variable attenuator maintains the same relative impedance on speaker and amplifier at all volume levels.

When paralleling speakers, remember that the impedances in parallel do not add. If you parallel two 16-ohm speakers, total

DRAWING shows how a T-pad should be wired into an extension speaker circuit. It will control speaker volume without disturbing impedance matching





CHECK for the proper phasing of the stereo speakers with a phase-reversing switch. Use a simple knife switch and wire it in series with one speaker by following the wiring technique which is shown in the diagram above

impedance will not be 32 ohms—it will be 8 ohms. There is a simple formula for finding the impedance of two parallel impedances that aren't the same.

$$\text{Total Imped} = \frac{\text{Imped A} \times \text{Imped B}}{\text{Imped A} + \text{Imped B}}$$

For example, if one speaker was rated at 16 ohms and the second at 8:

$$\text{Total Imped} = \frac{8 \times 16}{8 + 16} = \frac{128}{24} = 5.167 \text{ ohms}$$

This figure is reasonably close to 4-ohms so use the 4-ohm output terminals on your amplifier when connecting this pair of speakers to an amplifier. If you use a 4-ohm speaker in parallel with an 8-ohm unit, the impedance will again be only 2.67 ohms. Again you can connect them to the 4-ohm terminals. But here the total impedance is so low that it might cause a serious mismatch. An alternative would be to insert a resistor in series with the 4-ohm speaker to raise its effective impedance. Use a resistor with a wattage

rating that is at least equal to the wattage rating of the speaker.

One difficulty with this arrangement is that the series resistor consumes power and therefore reduces the efficiency of the lower impedance speaker. It will be drowned out by its larger companion. But a simple T-pad will solve this problem too.

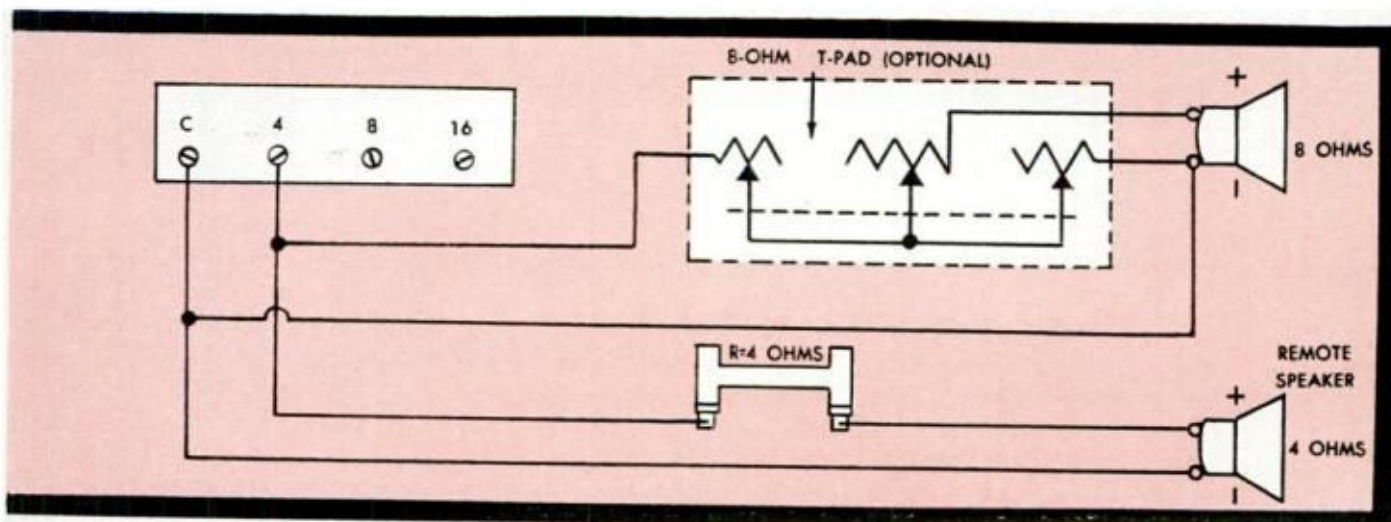
Of course, the best arrangement is to try to select speakers with impedances that can be paralleled and matched readily. To do this more easily, try to avoid speakers with 4-ohm voice coils.

As a guide, here are the total parallel impedances for speaker combinations.

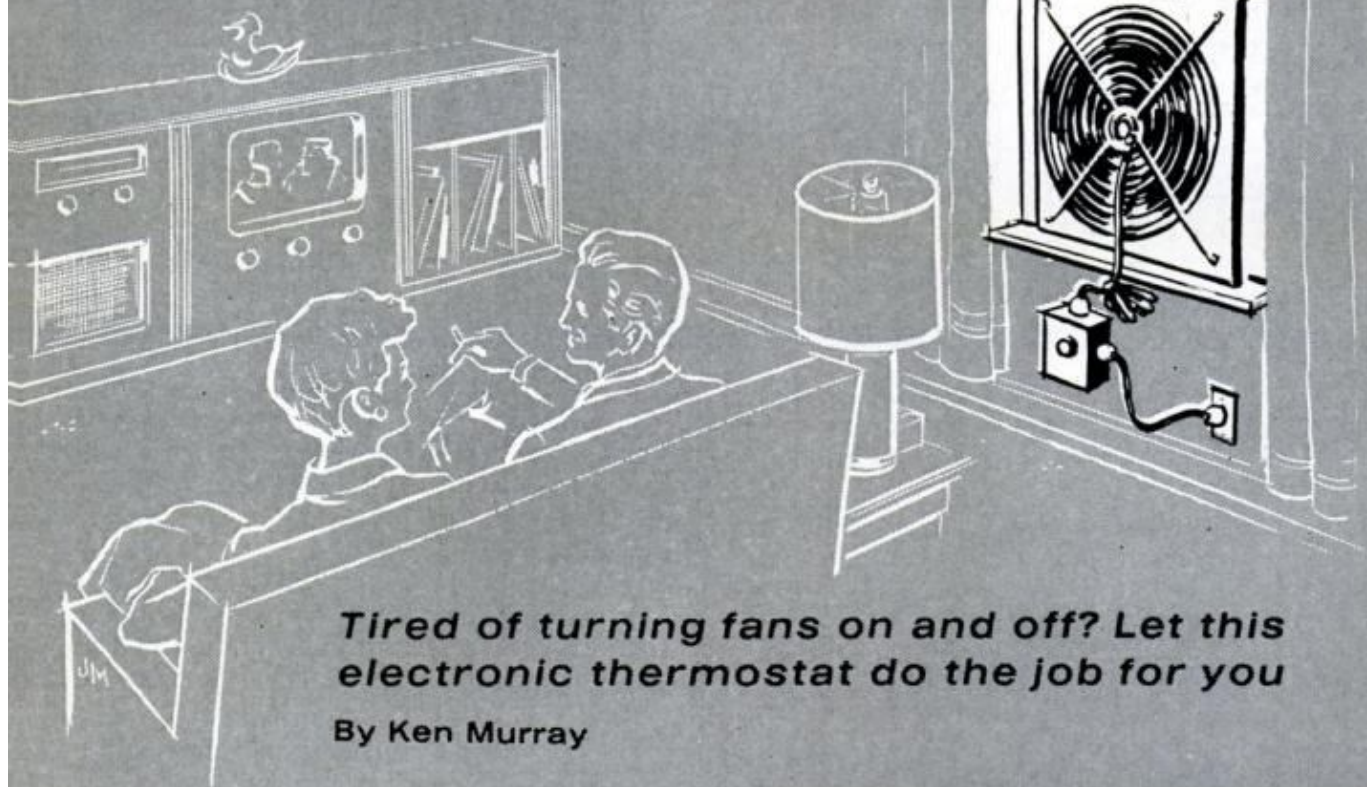
| Speaker Impedances | Total Impedance |
|--------------------|-----------------|
| 16 and 16 | 8 |
| 8 and 8 | 4 |
| 4 and 4 | 2* |
| 16 and 8 | 5 |
| 8 and 4 | 2.6* |
| 16 and 4 | 3.2 |

*requires compensating resistor.

MATCHING IMPEDANCE with an 8-ohm and a 4-ohm speaker connected in parallel is best done by inserting a 4-ohm resistor in series with the 4-ohm speaker. This will prevent distortion which would be caused by the mismatch

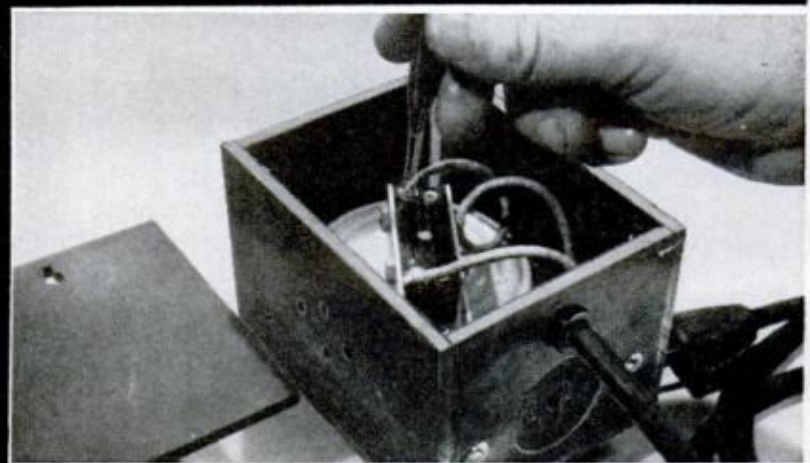
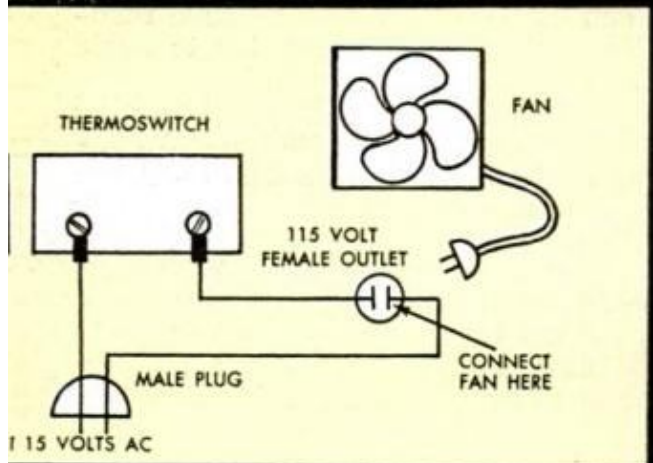


Electronic Fan Control



Tired of turning fans on and off? Let this electronic thermostat do the job for you

By Ken Murray



THE CIRCUIT WIRING (above left) is not complicated. The thermostat unit controls the outlet which in turn controls the fan. Above right: The thermostat is being mounted into place in hardboard case. Make sure fan outlet is clear

HERE'S a simple automatic control that will turn any fan on and off as room temperature changes. Just set it once and forget it. The thermal sensing unit, complete with snap-action switch, is available from hardware dealers selling brooder supplies or from Sears Roebuck. Mount the assembly in a 4" x 5" x 3" hardboard case and wire it as shown in the circuit diagram above.

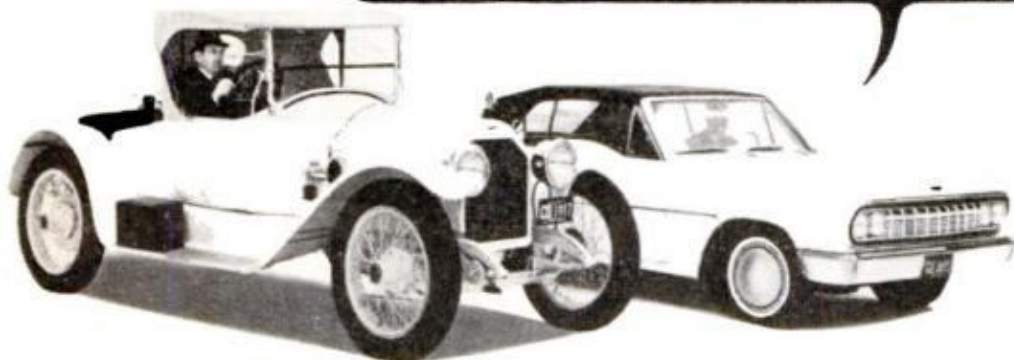
Replace the threaded control rod with a shorter headless bolt of the same thread diameter. Add a bushing over this rod so an ordinary radio knob can be slipped over it. Now plug the control into any a.c. outlet and a fan into the control. Set the thermostat and sit back for a cool rest.

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Lets you take better pictures more easily than ever before...

- Instant film loading, automatic film advance with concealed motor, coupled rangefinder, electric-eye exposure control, built-in flash, and automatic flash-exposure control...
- So complete, so automatic, you can shoot a whole cartridge of film on one winding without ever taking this camera from your eye...

Loads instantly. You never handle the film. Drop a KODAPAK Cartridge into the camera, close the back, and the camera's loaded. The film cartridge is lighttight—you can load or unload in bright sunlight. When you've finished a cartridge, there's no rewinding. Just drop it out and drop in another!

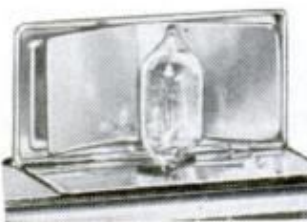


Spring-power drive. A few pulls on a tape concealed in the bottom of the camera winds the spring and stores up enough power to shoot an entire cartridge of film... as fast as one frame per second if you wish. The motor automatically positions the first frame, advances the film after each exposure, and automatically winds off the trailer after the last exposure.



Superimposed-image rangefinder. You'll see the image right in the center of the viewfinder. As you focus, two bright images merge into one. At this point, you're in perfect focus and sure of a clear, sharp picture. Your lens is a fast KODAK EKTANAR $f/2.8$, and shutter speeds run up to $1/250$ second so you can freeze fast action.

Automatic flash-exposure control. When the light is too dim for a good exposure, a needle in the viewfinder signals you that it's time to use flash. A flick of your finger releases the built-in flash holder. This action automatically sets the shutter at $1/30$ of a second and engages the automatic flash-exposure control. Then, as you focus, you automatically set the lens opening for the correct flash exposure. No flash bulb guide numbers to remember. No figuring and refiguring to do with every flash shot.



From loading to shooting to unloading, the KODAK INSTAMATIC 800 Camera makes photography completely automatic. It leaves you free to concentrate on getting the finest pictures you've ever made. Black-and-white and color prints, or color slides.

Dropping in the KODAPAK Cartridge automatically sets the camera for the correct ASA speed of the film you're using. Film name and exposure number are always in plain sight through a window in the camera back.

For perfect exposure, a photoelectric cell reads the light—then *automatically* computes and sets the lens opening. If

camera: the KODAK INSTAMATIC 800



the shutter speed is set too fast for correct exposure, the shutter *automatically* slows down after the lens opens to $f/2.8$. After the exposure, the shutter returns to its original setting.

For unusual subjects, a manual control lets you increase or decrease exposure by one full stop. Release the control and it returns to neutral position *automatically*.

If you're out to own the most advanced camera you can, see the remarkable KODAK INSTAMATIC 800 at your Kodak dealer's. Complete with batteries, flash-guard, and adjustable neck strap—less than \$130.

EASTMAN KODAK COMPANY
Rochester, N.Y.

Price subject to change without notice.

Kodak
TRADE MARK

The Lore of Lures

(Continued from page 93)

until you've had a big bass take a surface lure and go about five feet into the air. It's a real thrill."

Yes, we said, but which fisherman will catch the most fish?

"The man who fishes the most, that's who. I don't care what he's using, the man who is out there at four in the morning and still there at ten at night will catch the most fish. Like I said, it's not an exact science."

In Akron, Ohio, where we took our questions to Dick Kotis, fabled fisherman and president of Fred Arbogast Co. Inc., the atmosphere is scientific. It may not be exact, as Harry Heinzerling says, but Dick Kotis and his research man, John Oney, attack the problem of decimating the earth's fish population with the same zest, dedication and gung-ho that is found in the firing bunkers at Cape Kennedy.

Fishy Thoughts

"You have to think like a fish," says Kotis. "You have to place yourself in the eat-or-be-eaten cruel world of the fish. In developing a lure you must consider that a fish has a voracious appetite, and when he is hungry will devour whatever he recognizes as food. But you must also realize that a good-sized fish has a highly developed survival instinct, or he would never have lived to get that big."

John Oney's office contains a desk, a work bench and a test tank. A fish biologist by profession, his sole responsibility is to improve and develop lures for Arbogast.

"It takes at least three years to develop a lure," John said. "Take our little water snake, for example. We wanted a weedless lure that would naturally swim on the surface to move through beds of lily pads and cattails, an excellent feeding place for large bass, and a difficult spot for the average lure."

"We caught a number of water snakes and let them swim in the tank, studying every movement. We turned some loose in good bass water, watched their movements in the natural environment, and how the bass would strike. The small bass hit the end of the tail, but the big bass hit it right in the middle."

"Our prototype was carved from plastic and soft vinyl. The head had to rise just out of the water, with the body swimming just below the surface. It took weeks to arrive at the concave shape for the underside of the head to give it just the right buoyancy. Then there was the long search and endless tests in the tank for a vinyl of just the right pliability and a shape that

would give the swimming action.

"When we finally had it, we made a plaster cast from an actual snake skin to give the molds an absolute authenticity."

With that he cast one of the snake lures into the tank and slowly reeled it in. There was no doubt that it was a water snake.

Noise Lures

"We're very much interested in sound," John said. "We know that fish can hear, as well as see and smell. We're working with noise lures and taping the sounds they make at various underwater depths."

"But how do you know which sounds frighten or attract?" we asked.

"That," John said, emphatically, "is exactly what we'd like to know." His eyes seemed to light with missionary zeal. "Imagine it. A lure that not only looks real, but sounds real. And better than that. What we'd really like to discover is a noise that would so infuriate a fish that it would attack the object making it. And then, of course, there's odor. Scientific studies have shown that many fish use the sense of smell to track down food. Imagine a lure that incorporated sight, sound and smell. It would break every record."

Managing to bring John back to the present, we posed this hypothetical situation: Let's say you're fishing a lake and you see a large dragonfly light on a lily pad, then skip to a second pad, and as it rises for another short flight a bass comes up and takes it. This is not unusual, but you see the same thing happen maybe six more times. Now, you've got an idea for a new lure. What do you do then?

Poor Butterfly

"You'd study exactly how it landed, and then how it skipped. Then you'd find a color plate of that particular dragonfly and reproduce it in wood or plastic. But I can already tell you that you've got a problem. I already went through just about that exact situation, only it was a butterfly. I spent a lot of time on it, but it couldn't be cast. Things like that happen. You have a good idea, but some technicality fouls you up, and all your work is scrapped."

A large portion of the Arbogast research is devoted to fishing methods, the geography of fishing waters and the feeding habits of fish.

"The best lure in the world is useless unless it is presented to the fish in a natural manner," says Dick Kotis. "Good fishermen take the time to study the terrain they're going to fish, and this determines the lure that will be effective."

"If it's a hot afternoon, for instance, and

(Please turn to page 170)

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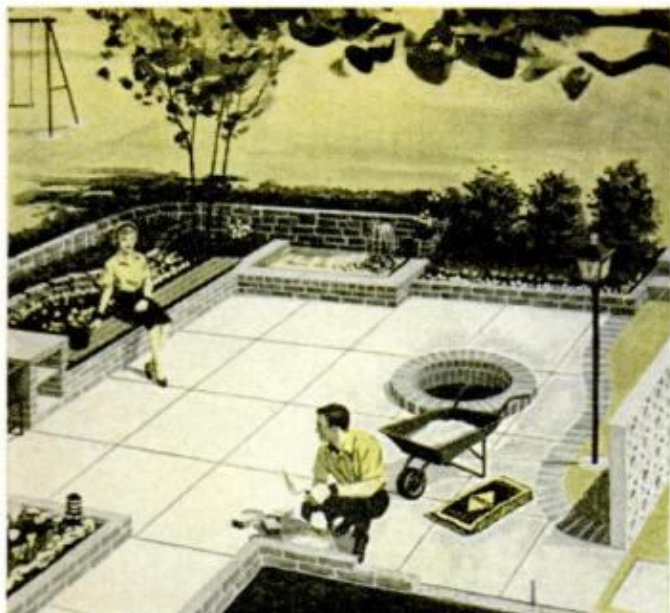


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The Lore of Lures

(Continued from page 168)

you see one end of the lake has a steep drop-off and a shady overhang, you'd want to fish that spot with a deep-running lure to get down where the fish are taking it easy in the cool water. In the evening, when fish generally feed in the shallows, and you have heavy weeds and grass, you'd want to use a weedless lure that runs shallow and slips through the grass.

"It's always worthwhile to inquire locally about any lake you're going to fish. For some reason I find that I always get the best information from service stations. There always seems to be someone there who knows the lake. It's always a good idea to have a thermometer to check water temperatures at various depths, and you can check depths easily with a heavy sinker and a cord marked off in foot lengths for quick measuring.

Vary Retrieval Speed

"Experience has proven that almost all lures are more effective if the speed of the retrieve is varied. Another important factor is the accuracy of casting. You've got to put it where you want it, and then bring it to where the fish will strike. It also helps to set up a fishing pattern, systematically working the drop-offs, underwater reefs, weedbeds, holes and inlets. And above all, you have to keep that lure in the water."

But what, we asked with slight exasperation, really makes a lure catch fish?

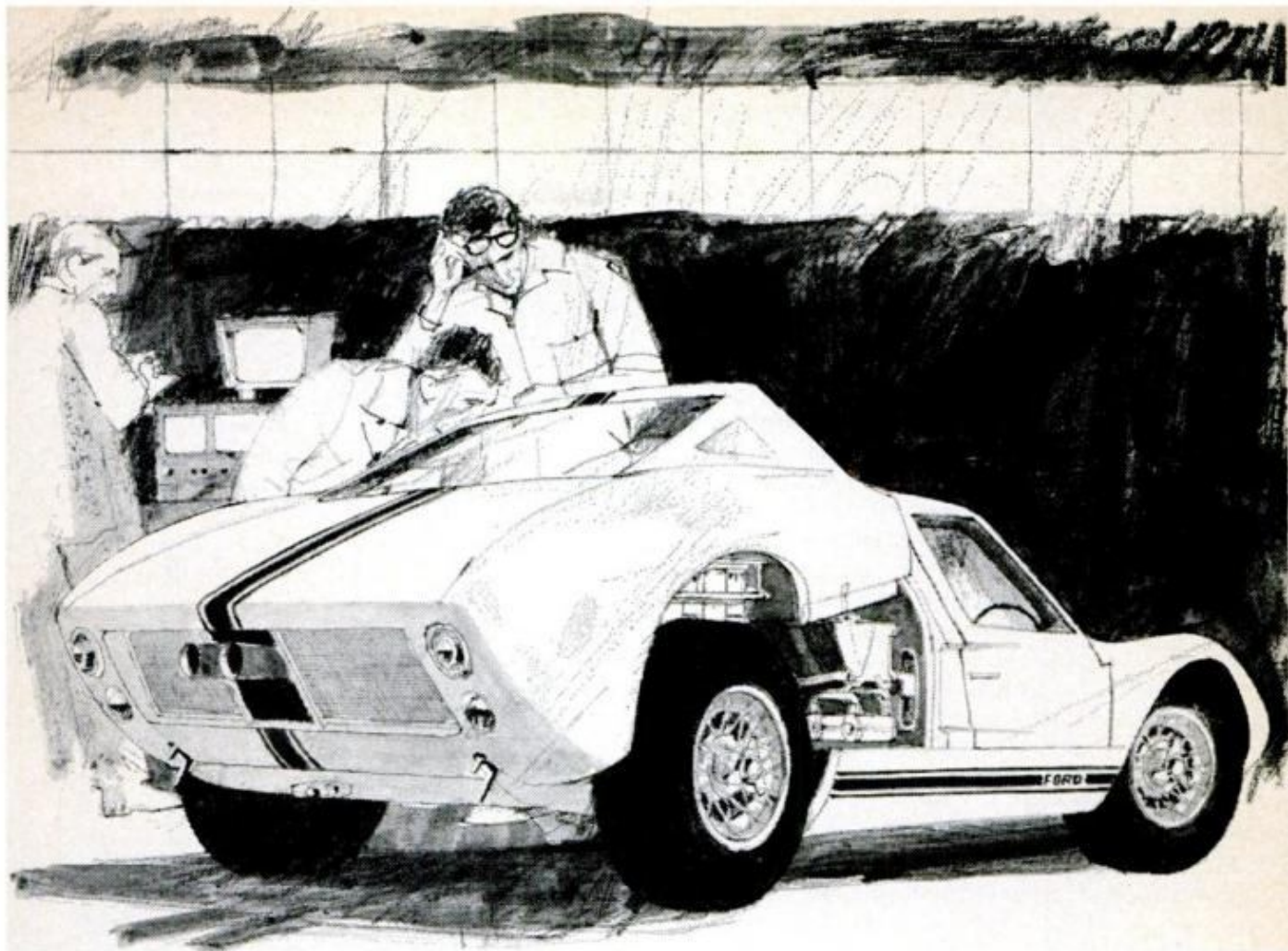
Dick Kotis and John Oney regarded each other and then shrugged. "Well," Dick said, "I guess he thinks it's something good to eat."

As Harry Heinzerling said, it's not an exact science. ★★★

Biggest Bang

An exploding galaxy, blown apart by the most gigantic bang ever known in the universe, was recently photographed on the 200-inch Hale telescope at Mt. Palomar, Calif. Light from this vast explosion has taken more than five million years to reach the earth, since the galaxy is some 5.2 million light years away.

Known to astronomers as M-82, the detonation spewed material out of the heart of the galaxy at velocities up to 20 million miles per hour. Photos show tremendous jets of matter 60 million billion miles long (or 10,000 light years) streaming from M-82's nucleus. Matter equal to five million suns is involved. Such galactic explosions may be the prime source of cosmic rays; they may also shower earth with neutrinos, sub-atomic particles.



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the right places. For greater safety, fuel is fed from flexible plastic cells located in car side-members. Ducted ventilation, forced air cooling of seats, unit seat-and-body construction, rear axle-mounted 4-speed manual transmission, disc brakes, low-rate independent springing of all four wheels—all shed new light on car design, on sharper handling and safer driving.

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Checker Game of the Century

(Continued from page 57)

indicating Nealey's latest move. The machine then did some careful studying before deciding its official move. It made a tentative move and examined the new position from the standpoint of its previously tested criteria. Adding the values for all the criteria, it arrived at a number representing a general score for the move.

But this is only the bare beginning of the CKP program. For each position in a game there are an average of seven possible moves, so the 7094 goes through the same routine to compute scores for the six other moves. From here in, things become more and more complicated. Numbers start piling up at a feverish pace, because the machine also looks ahead—and looks ahead with a vengeance. After scoring each of its seven possible moves, the machine proceeded to size up Nealey's seven possible replies to each of these moves, its seven possible countermoves to each of Nealey's replies, and so on.

The Machine's Fantastic Facts

The machine probed to a depth of at least six and at most twenty moves ahead, depending on how thorough an analysis was required. In other words, it often had to compute thousands and tens of thousands of different positions before coming up with the best over-all score indicating its official move. Such feats, of course, are impossible for the human player. The 7094 can do some 15 million additions or 6 million multiplications in a single minute, which is about as much arithmetic as a man at an ordinary adding machine could do in a year.

The computer often took only 10 or 20 seconds to select its move. (Such lightning-fast responses do not bother an opponent playing by mail, but they could be disconcerting in a face-to-face game.) Tough positions kept its transistorized circuits humming for as much as five minutes, although its average was about a minute. Nealey's average time per move was about three minutes.

The caliber of the play was impressive. There were no flamboyant double or triple jumps, sure signs of inexpert tactics. This was a tight, hard-fought match. "Checkers is an advanced exercise in problem-solving," Nealey explains. "The machine knew what it was doing, and kept me constantly on my toes. It played extremely well, especially considering that it had never seen much of the play I used—play which has been developed during the past 30 years by the great minds of

the game."

What about the game the machine lost? "I had been attacking as strongly as I could," says Nealey. "The computer got out of one loss after another by making 'star' moves—that is, the only moves possible to avoid certain defeat. Then it suddenly made an outright poor move. (See photographs, page 56.) The machine did not seem to know where to go, and I recognized the blunder at once." Every one of the 7094's moves that followed was simply an effort to stave off defeat—and the machine seemed to know it. It gave itself increasingly pessimistic scores as the end of the game approached. Apparently, once the poor move had been made, defeat was unavoidable. The exact turning point, though, has yet to be decided (Nealey feels that it was the 27th move); this game and the others are still being analyzed by checker experts.

Further analysis may also indicate whether or not the computer could actually have won a game from the Connecticut champion: "I am fairly sure the machine could have beaten me, again at the mid-game stage, in one of the five draw games. It missed a likely win when it made several moves hesitantly, as if trying to choose the best of many possibilities—and it hesitated long enough in its attack to let me escape. I consulted a textbook after the machine, playing white, had my black pieces in a position that I could not remember ever having seen before. But there was nothing in the book to guide me, and I have since learned that I had devised a new line of defense."

Imagination Can Hurt

Nealey has acquired an invaluable store of information about the subtle art of playing games with machines. For one thing, he knows that it doesn't pay to try taking advantage of the 7094's supposed lack of imagination. "I started the match with the idea that this was probably its only weakness, which is why some of the games produced some strange gambits. But I eventually learned that this 'intuitive' play hurt me more than it hurt the machine.

"By sticking to its programmed instructions, it may find an extraordinary move that a man who is gifted imaginatively might never find. It knows so much and carries its analyses to such depths that it sometimes, by the very beauty of its mathematics, comes up with a truly brilliant move. This is difficult to express, but I think the machine's complete lack of imagination is its most formidable strength!"

The machine has another strong point. Every checker game should be a draw if

played perfectly and, although perfection is as unattainable here as anywhere else, topflight players are continually trying to achieve it. They play for draws rather than wins, concentrating intensively on making the right moves and avoiding "sudden death" slip-ups. It is precisely in such a tense and demanding situation that the 7094 may enjoy an appreciable psychological edge.

"The machine does not play an involved, complex, ingenious game," Nealey emphasizes. "It is not cunning, tricky or daring. It proceeds methodically and relentlessly in play that it has seen at least once before, without the hindrance of any emotional or nervous weakness. It gives you a feeling of cold pressure that is being applied mechanically and that, if you err, will crush you. It is hard to believe the machine will ever err, even when it does."

The Machine's Key Weakness

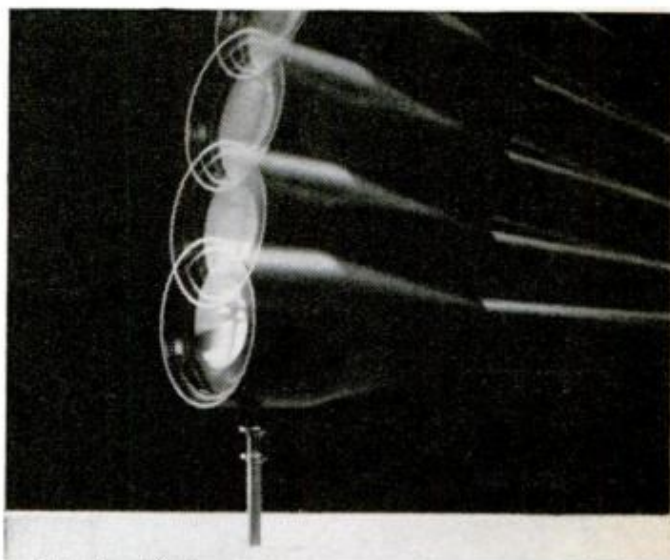
On the negative side, he points out that the computer seems to be vulnerable in mid-game play, which is when it made its losing error in one game and may have missed a possible win in another. He believes that it has so many possible positions to consider at this stage that it may not be able to do a thorough job of evaluating and fail to come up with the best of the superior moves open to it. In any case, Nealey's rule is "attack the mid-game weakness—if you can!"

But the long-range significance of this experiment extends far beyond automatic checker-playing. The full impact of the computer revolution will come with the design of advanced thinking-aids that learn to play real-life "games," thinking-aids being investigated right now by scientists at M.I.T., Stamford University, the University of Illinois, Carnegie Tech and other research centers. Diagnosing diseases, evaluating military or business strategies, analyzing public-opinion polls, detecting income-tax errors or frauds—these and many other activities involve certain basic rules of procedure and criteria. Given appropriate sets of instructions, there is no theoretical reason why computers should not be able to improve themselves in such activities and serve as high-power consultants for human beings.

The big question for the future is how far such research will take us. Can a computer improve indefinitely until it surpasses the cleverest human beings and becomes a kind of superhuman (or inhuman) intellect? Or will machines forever fall short when it comes to original thinking? Samuel's prototype checker programs may provide clues to the answers of those questions. ★★★

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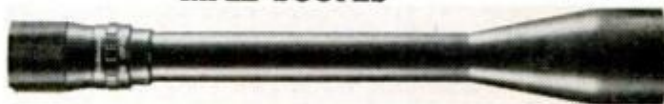
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Fresh Water from Salt Water

(Continued from page 100)

plant could be built for \$850 million and could be used as a model for at least five similar plants to be located in Arizona (using brackish ground water), along the Gulf Coast and at the eastern tip of Long Island.

Meanwhile, on a more down-to-earth basis, the Office of Saline Water is collecting data on desalination costs from "demonstration" plants that it has built to test five different purification methods.

Electrodialysis Method

One of the plants, at Webster, S. D., uses the same process as the plant in Buckeye—it's called electrodialysis. Brackish water is run between two permeable plastic membranes. An electric current is applied, and the negatively charged chloride ions move through one membrane, the positively charged sodium ions through the other. This action leaves fresh water between the two membranes.

The method seems to be effective for demineralizing relatively brackish waters but is not competitive with other methods for treating sea water with its high salt content.

Brackish waters at Roswell, N.M., are being purified by a vapor-compression method in which saline water is heated to produce water vapor. The vapor is then compressed, raising its temperature, and the steam thus produced is circulated through the evaporator to heat the incoming saline water. The steam loses much of its heat in doing this work and is then condensed into fresh water.

At Freeport, Tex., a system with a long-winded name—long tube-vertical multiple effect process—is demonstrating its value in desalting sea water. In essence, sea water is boiled in a series of evaporators each operating at a slightly reduced pressure, and the resulting vapors are condensed into fresh water.

Icy Technique

Due for operation this year at Wrightsville Beach, N.C., is a plant that freezes sea water and then separates the pure ice crystals from the salt. The process employs the direct contact of a hydrocarbon refrigerant with the sea water, causing ice to be frozen by the heat removal required to vaporize the refrigerant. This is perhaps the most promising of several freezing methods.

The fifth plant, originally at San Diego, uses the well-known multistage flash distillation process in which heated sea water flows into a chamber in which a pressure

just below the boiling point of the water is maintained. The reduced pressure causes part of the water to boil—or flash—into steam, and this vapor passes over a barrier and strikes a coil through which cold sea water flows. The vapor condenses into fresh water and is piped away.

The sea water successively passes through 35 additional chambers, in each of which more of the water flashes into steam.

S. F. Mulford, project engineer, reports that during its two years "on stream" this flash distribution plant delivered some 500 million gallons of pure water to the San Diego water supply. The water was so pure, in fact, that it had to be mixed 1 to 3 with "hard" Colorado River water before entering the municipal system. Otherwise its softness would loosen rust and scale built up over the years and clog the pipes.

Heat Up, Costs Down

As designed, the plant was to produce one million gallons of desalted water per day, at a cost estimated at \$1.25 per 1000 gallons. But, shortly after operation began, the engineers were able to raise the operating temperature from the original 200 degrees to 250 degrees. Production rose by 25 percent, to 1,250,000 gallons per day. Costs dropped to the \$1.17 figure, including plant amortization.

At present, all of the desalination plants are simply throwing away their brine residues. The brines are loaded with valuable minerals and chemicals, of course, including gold. But, to be worthwhile, a recovery plant would need to process thousands of times more brine than any of today's small plants can deliver. Research is under way now on the best ways of extracting metals, fertilizers and a host of chemicals from the brine that tomorrow's huge fresh water factories will produce.

In one unique application mentioned earlier, residual brine from a saline water conversion plant is being used to grow common vegetables and other plants. At the University of Arizona they flood the floor of a greenhouse with the 70-degree brine from an experimental desalting works on the campus. The warm brine creates a hot, humid atmosphere in the greenhouse, and much of the water vapor collects into fresh water droplets on the greenhouse roof. The pure water drips into a collecting trough and is piped to the plant trays after nutrients have been added to it.

This is ordinary hydroponics, or tank farming, of course, except that the fresh water and some of the heat are obtained

(Please turn to page 176)

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Fresh Water from Salt Water

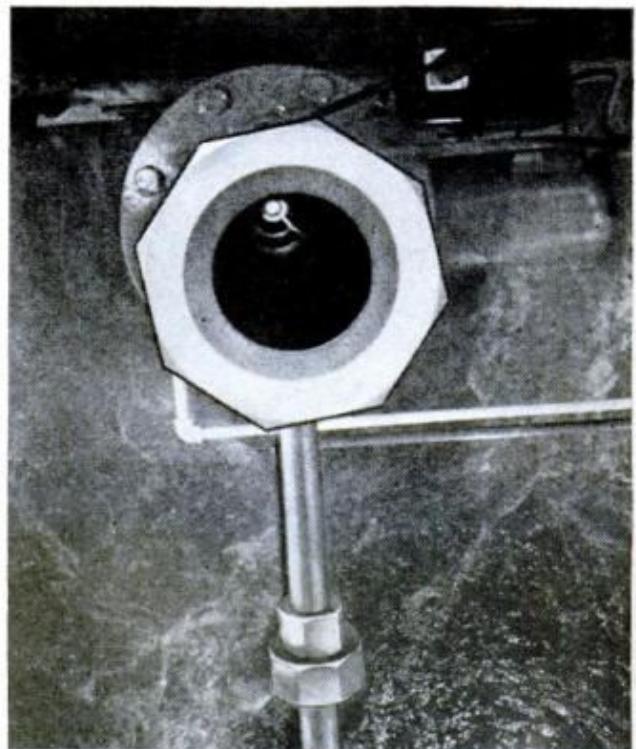
(Continued from page 174)

from waste brine. In the summer when interior temperatures would climb too high for good growth, the colder incoming salt water being pumped to the desalting works would be used instead of the warm brine. The experimental work is being done by William Jiminez under the direction of Dr. A. Richard Kassander, Jr., at Arizona's Solar Energy lab.

Nature doesn't charge a cent for evaporating tremendous quantities of ocean water and transporting it inland, where it condenses as rain. And it costs very little indeed to impound this free water and pipe it to homes, factories and farms. The trouble is that nature hasn't stepped up its production to keep pace with our needs.

One of the answers is to extract fresh water from the sea and from brackish inland sources. Fortunately, the desalination engineers are getting their costs down more and more, all the time. ★★★

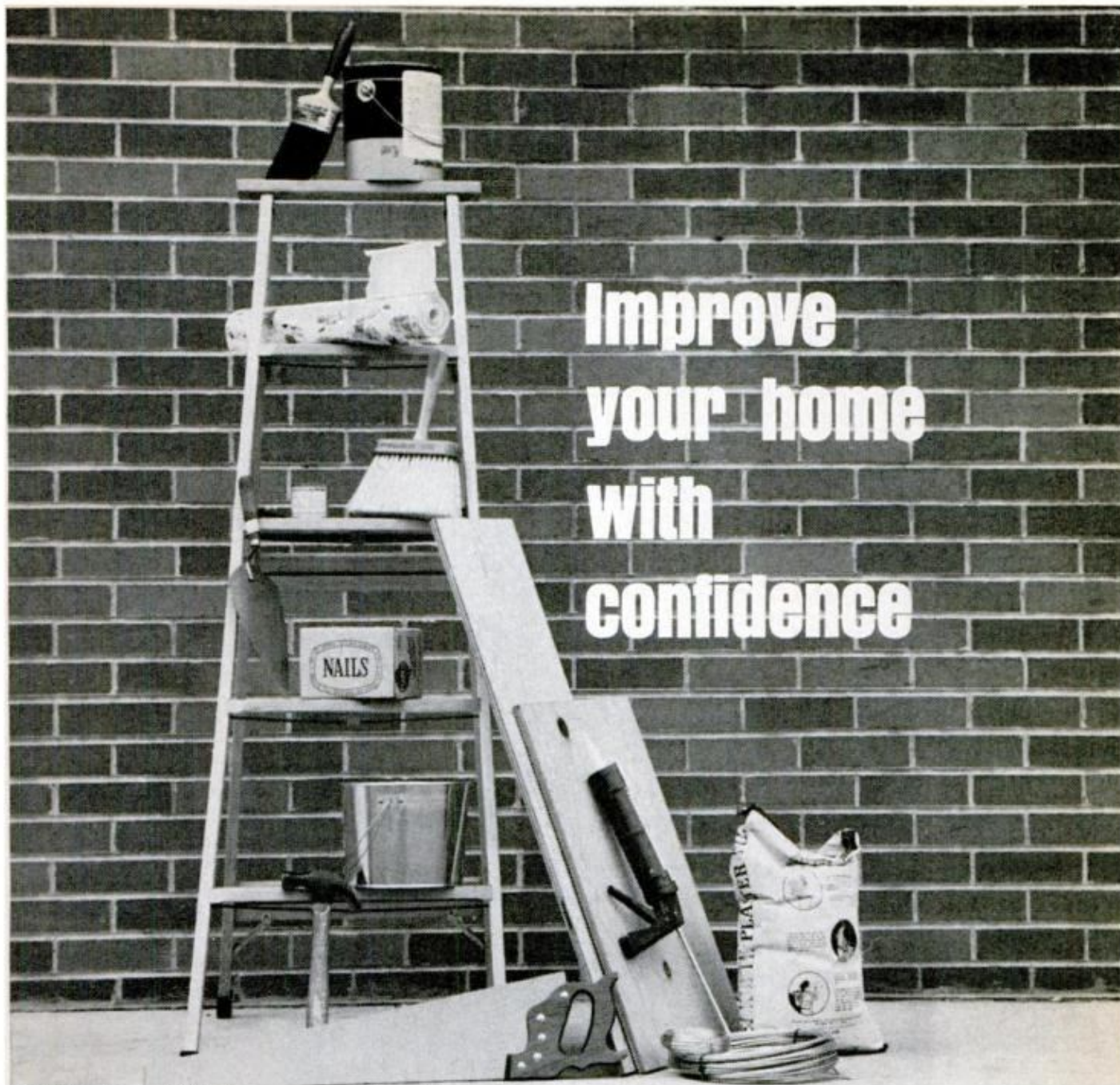
Underwater Fire



Four natural gas fires below water level are helping to soften the city water supply in Minneapolis. Gas is pumped into a T-shaped pipe, mixed with compressed air and burned in a vertical pipe column (white dot inside pipe is flame).

The flames give off carbon dioxide which reacts with calcium derivatives in the water causing them to settle out as sludge. Designed by Minneapolis-Honeywell, the system replaces the former procedure of buying liquefied carbon dioxide and is said to save city taxpayers \$45,000 a year.

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**BUILDING
SUPPLY NEWS**

The Air Around Us

(Continued from page 85)

sometimes irreversible are upon us."

But there is one understandable way that air pollution could affect the world. It might set off an international wrangle.

A few months ago, *PM's* Western Editor, Tom Stimson, was boating seven miles out in the Pacific northwest of San Diego. Looking out to sea, he saw a long, ugly bank of brown-colored fog dirtying the horizon. It wasn't sea fog. When he investigated, he found that it was an eye-irritating, lung-clogging smog that had been born in Los Angeles and blown gently out to sea. Now it was slipping down the coast.

Joins San Diego Smog

Later, as this dirty blanket drifted past San Diego, it was joined by a companion—a cloud of San Diego's own brand of smog. Now the two sooty airstreams moved side by side down the coast. The San Diego cloud drifted across the border and crept through the streets of Tiajuana. The Los Angeles cloud drifted ashore farther down the coast of Mexico. Together, they touched off fits of coughing and cursing for 75 miles along the coast.

This is striking evidence that air pollution no longer is simply a local problem, or even regional, but may be international in scope. It is the first dirty cloud on the horizon that residents of cities not only are fouling their surroundings, but now are capable of dirtying the lodgings, laundry and lungs of people hundreds of miles away. No matter how you figure it, we are exporting filth-laden air across international boundaries. So are other countries with large cities.

Such are the murky problems of air pollution, questions of possible long-term biological and international effects. Are there any answers?

No easy ones. Although smoke arresters, afterburners and a host of other anti-pollution devices can help, most authorities feel that at best they will equalize the polluting effects of our expanding population, and will merely enable us to keep our overdrawn air account at its current high level of pollution. Several scientists have pointed to the only real solution:

Stop burning fuels.

As you drive down the highway, your automobile requires five to ten million times as much air as you do, just to carry off the exhaust gases and dilute them to harmless concentrations. Last year, Americans drove their moving smog sources about 770 billion miles, thereby discharging 280,000 tons of pollutants into the atmosphere *each day*. It's conceivable,

though, that turbine engines, which eliminate much of the waste gas problem, will help solve some of the problems. So will other exotic power sources.

But take the burning of fossil fuels. In this country we accomplished more than a fivefold increase in electrical generation between 1940 and 1960, but in doing it we burned hydrocarbon fuels at a prodigious rate. We now are burning more than three times as much coal, more than five times as much oil and almost 10 times as much natural gas as we did in 1940, just for electrical generation. Both the public and private utilities have had an exceptionally good record in installing anti-pollution devices, but we still are spewing pollutants at a great rate into the overburdened air.

Dr. Philip A. Leighton, Stanford emeritus professor of chemistry, indicates what may be the only solution:

"In my opinion, the only approach short of population control is to attack, not the products of combustion, but combustion itself. We must reduce by every possible means the burning of fuels in favor of non-polluting sources of heat and power . . .

End of Gasoline Engines?

"The steps to be considered . . . would include building only nuclear power plants from now on: building for electric instead of hydrocarbon heat in homes and industry; reducing the size and number of automobiles used for commuting; revamping our transportation system and habits so as to return our cities from the automobile to the people; and above all, replacing the internal combustion engine by a nonpolluting power source such as the fuel cell . . ."

This is a large order. It implies that some time in the future it may be against the law for you to drive your car within the city limits; that regardless of cost or preference your home will be electrically heated, and that all electricity will be generated in central nuclear plants.

To accomplish such a revolution would be appallingly expensive. But is there any alternative?

Author Rachel Carson summed up the problem succinctly in a statement to the National Conference on Air Pollution: "In biological history, no organism has survived long if its environment became in some way unfit for it. But no organism before man has deliberately polluted its own environment."

A cloud of polluted air suddenly looms on the horizon as a problem of such worldwide importance that it may outweigh all the other profound problems of our whirling little planet. What's more basic than a breath of clean, pure air? ★ ★ ★

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Swiss Wooden-Wheel Clock

(Continued from page 159)

the shaft alternately stop the escapement wheel momentarily. Just before an obstructed pin is freed from one retent the opposite one swings in to obstruct the pin moving toward it. Bend the retents separately to proper shape on a nail of the same diameter as the shaft, then slip them on the shaft and solder in place. Inside surfaces of retents should be very smooth. After pressing the rocker arm on the shaft you can "snake" the latter into position down through the hole in the upper cross-piece. When the shaft is set in its bearings and hangs from the top pin by thread, the retents should swing about halfway over the pins when engaging them. Adjust for this distance by moving the bearings. Avoid contact of the shaft against the bearing pin of the escapement wheel.

The escapement mechanism will require delicate adjusting, mostly by bending the retents in or out. If spread apart too far they won't stop wheel rotation. If a retent lands and stops on the tip of a pin, the spread must be decreased slightly. When the retents are too close the pins cannot pass either of them.

Two ½-oz. weights on the rocker arm can be shifted to adjust timing. If this is not enough the rocker-arm weights are made lighter for faster movement and heavier for slower movement. Fig. 12 details the weight pulleys and cord. The latter goes through the anchor posts and is knotted above each. If the cord slips on the ratchet pulley apply some rosin. The pulleys must not bind in the sheaves, which may be enough to stop clock movement. The 3-oz. weight serves only to keep the cord taut.

Hour wheel and dial: The hour wheel is identical to the center wheel but is glued to a sleeve, Fig. 9, which fits the dowel on the front plate. Fig. 10 shows the hand which is easy to loosen and tighten for changing its position. A tapered brass pin slips through the dowel. The dial, also shown in Fig. 12, surrounds the hour wheel and is held by tapered brass pins which also hold the front plate on the crosspieces. Numerals on the dial can be done with India ink later covered with transparent lacquer. The clock pictured here is a replica of one of the first handmade, weight-operated clocks. Making a copy of it will increase your admiration of bygone craftsmen. The closeup view minus the dial, hour wheel and hand, shows the relationship of the three time-keeping wheels and the escapement mechanism. These took great skill to form before the advent of precision power tools. ★★

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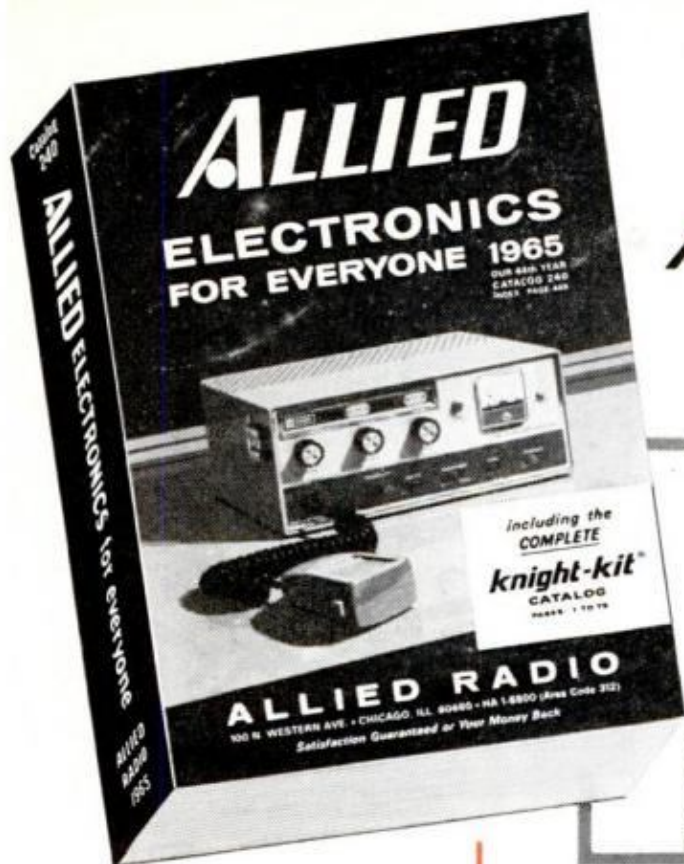
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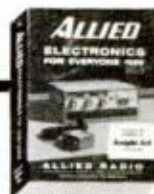
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Driving Tomorrow's Car

(Continued from page 73)

front wheel angles (to right or left) at any speed are limited by the lateral acceleration the car will develop. In short, the area above the curve (see page 73) represents speed-wheel angles which cannot be attained because they would exceed the cornering force of the tires.

The changes in steering ratios of Bendix's Varamatic gear (see page 73) are parallel to this speed wheel angle graph. At high speeds (the center peak of both graphs) it will be noted that the ratios of Varamatic are high numerically (15 to 24 to 1), thus insuring that there will be no dangerous and tiring sensitivity. At the outer ends, ratios are low numerically (5 to 13 to 1) insuring fast turning of front wheels for easier parking and traffic maneuvering.

At no point, however, does Varamatic attempt to turn the car more quickly than is safe at a given speed.

Getting the Drift

The car will slide or drift sideways, of course, if the driver should mistakenly attempt to turn the front wheels too sharply for the speed he is traveling. The Varamatic's ratio, paralleling Cornell's curve, sees to it that the car will skid before the steering ratio becomes "quicker" than the driver can handle at any given speed.

I tried Varamatic at high speeds and found that it was impossible to over-ride my own instinctive driving reactions and turn the wheel too far to right or left so that I would get into the sensitive "quick" ratios at either end of Varamatic's worm gear.

At one point I drove a Varamatic equipped Pontiac on slick, snow-covered highways at 50-55 m.p.h. Several times I deliberately put the car into a slide and reversed the steering to recover. No problems. Just the right amount of response to regain control, and no more.

Effortless Parking

Parking parallel with Varamatic is so easy that it's actually fun! You slide up and stop ahead of the space, start backward, swing the wheel to the right less than a quarter turn and as soon as your front bumper clears the car ahead, swing your wheel back to the left about $\frac{1}{3}$ rd of a turn and presto—you're in! A complete parking job with less than $\frac{2}{3}$ rds of a steering wheel turn!

When the women of America discover this goodie, Bendix will have to work three shifts to keep up with demand.

At the same time that Varamatic steering is revolutionizing your maneuvering, the "No Travel" brake and throttle controls are becoming second nature. It took me about 20 miles to accustom myself to the "squeeze treadle" way of driving as opposed to conventional pedal pumping but as the miles rolled up, I began to realize that my right leg was much more relaxed. Simply shifting the weight of my leg would adjust the accelerator load for proper cruising speed and to accelerate and pass I merely tensed my foot muscles for a moment and, zoom, I had passed.

Braking with Bendix "No Travel" system gets to you after a few miles. I found that it was easy to coordinate foot pressure with stopping effort needed at the brake drums—much easier than the conventional business of lifting your entire leg, then pressing down, feeling through the several inches of pedal travel and only then, beginning to coordinate the amount of muscular effort with the rate of deceleration of the automobile.

The "No Travel" system, in addition to being easy, is also fail safe. Here's how it works. The treadle is linked to a hydraulic valve which admits fluid under pressure of up to 1800 p.s.i. to the lines leading to brake cylinders. Where does the fluid pressure come from? Directly from an accumulator (pressure tank) under the hood. A small pump, not much bigger than an electric razor, hitches onto the back of the regular power steering pump to keep the pressure up in the accumulator. If your engine conks out there is pressure for approximately 18 full stops left in the tank. I know, because I tried it 18 times!

Fail-Safe Brakes

If you should ever lose all pressure from the accumulator and pump, the brake valve automatically becomes a master cylinder as in a conventional brake system and the treadle depresses below the level of the floor boards so that your foot follows it down and actuates the brakes just as if you were in a car with conventional, unassisted hydraulic brakes!

What about the power throttle and its "No Travel" accelerator? That is a simple vacuum cylinder which amplifies your foot-power on the treadle to permit about $\frac{1}{2}$ -inch of travel to move the throttle linkage as much as $2\frac{1}{2}$ inches of conventional pedal travel would. (You can push the throttle manually to open it before the engine starts and provides its vacuum.)

What will this system cost? No more than any ordinary power assisted car, according to Bendix officials. The Varamatic power steering requires just about the same number of parts as conventional

power steering. "No Travel," full-pressure hydraulic brakes eliminate the conventional vacuum booster and master cylinder but require the small pump, accumulator tank and combined brake valve and master cylinder.

The vacuum assisted throttle is a simple cylinder and valve that would add less than \$10 to the retail cost of the car, it is estimated.

When will Bendix's "Car of Tomorrow" package be available? As soon as some manufacturer is willing to take the plunge and present it to the public, according to Edward E. Hupp, Jr., Bendix Automotive Engineering Director. "We're ready, willing and more than able to roll," he said. "All we need is someone's signature on a contract."

After driving Bendix's "Car of Tomorrow," we can share completely Ed Hupp's eagerness to get rolling! ★ ★ ★

Tells How Clams Stay Closed

Ever wonder how a clam keeps its shell clammed up? They have learned an easy way of maintaining muscle tension over long periods without burning up excessive amounts of energy, according to Dr. Andrew G. Szent-Gyorgyi. The secret apparently is that a fibrous protein, paramyosin, "freezes" the special muscle attached to the shell.

When this protein is plastic, the muscle is flexible; if it crystallizes to a solid, the muscle locks firmly. If a clam had to lock its shell muscle the same way a man grits his teeth, according to this theory, its body would "burn out" its store of energy in three days.

CO₂ Boosts Plant Growth

Adding carbon dioxide to a greenhouse atmosphere can result in greater yields of flowers and vegetables, healthier plants and shorter nonproductive periods between crops. One experimenter reported a 300 percent increase in the harvest of one kind of long-stem rose with CO₂. Others reported flowers and vegetables maturing a week ahead of schedule.

Apparatus now on the market injects CO₂ into greenhouses from low-pressure (liquid) or high-pressure (gas) storage tanks. By one method, the gas is delivered near the tops of plants via copper tubing between rows of flowers and vegetables. With a second method, CO₂ is circulated in the air by an uncased fan eight or 10 feet above the plants. The equipment is available for about \$80 from the Chemetron Corp., 840 N. Michigan Ave., Chicago 11, Ill.

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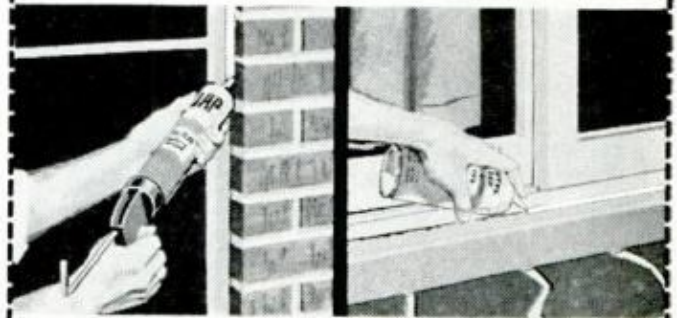
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CLINIC FOR HOMEOWNERS

Q The crank fixtures on my aluminum casement windows have become almost impossible to turn. There seems to be no way to oil them without taking them apart. Can you tell me what to do to make them work easily, as they did when new?—E.T., Md.

A Did you save the lubricating instructions that came with the units? The instructions would have told you what to do. Manufacturer's instructions for lubricating these units vary somewhat due to design variations and for this reason our suggestions can be only general. The chances are that the real trouble is in the actuating arms that open and close the window rather than in the crank operating units which usually consist of a worm gear enclosed in a metal housing. If you open the window wide you will see that the outer end of the actuating arm is fitted with a headed pin which slides in a second slotted member that is attached to the sash frame. Lubricating the sliding contact at this point usually will cure the trouble. As a rule a light grease is better than oil as it will stay in place for a longer period of time. Removing the outer housing of the crank operator and packing with a light grease will lubricate the gear.

Q The shingled roof on our new home (3 years old) appears to have buckled on the north slope, giving it a wavy uneven appearance which is most unsightly. It has not leveled as I have been told it would in time. What has caused this and how do I correct it?—A.L., Wis.

A You do not say when this defect first appeared and for this reason it is difficult for us to pinpoint a cause and suggest a way of correcting it. If, for example, the defect appeared during the past spring and the shingles have not leveled, as you have pointed out, then we would suspect that the roof deck is at fault. Such a defect is fairly common where indoor plywood has been used as roof decking. Ice dams form on the roof during the winter and the impounded water—from melting ice and snow above the dam—may seep under the shingle tabs and dampen the plywood. This continuing condition of dampness can cause the plies of the plywood to separate, swell and buckle, raising the shingles and resulting the wavy surface you have described. If our assumption is correct, then about the

only sure remedy is to re-nail the shingles, driving the nails through the shingles into the decking, then cover the whole affected slope with roll roofing cemented at the joints and re-shingle. This is about the only alternative, other than removing both roof and decking and replacing.

Q Wallpaper still peels from one room of our new home even though we removed the original papering and replaced with new. One wall seems to be affected more than the other three, although it peels from all four walls. What could possibly be the cause?—E.J., Ore.

A We are assuming, of course, that the walls are plastered and that the house is otherwise of conventional construction. Dampness is usually a cause of trouble with wallpaper and sometimes it is difficult to determine the source of the moisture. It could be due to the formation of condensate on the walls during prolonged periods of high humidity. But we think it more likely that the paper peels because of moisture in the new plaster. Some of the newer coated wallpapers act as vapor barriers, preventing the moisture still in the plaster from escaping. The trapped moisture tends to soften the paste and as a result the paper peels. Perhaps in your case it would be best to remove the damaged paper, wash the wall to remove all traces of the paste and then give the plaster ample time to dry thoroughly before repapering.

Q What is the best time to make plantings of new shrubbery and young trees? I get conflicting opinions: some say spring is best, others say plant only in the fall. I think spring is the best time. Do you agree?—T.H., Mo.

A In general, yes. However, in most localities planting of shrubs and trees can be done successfully in both spring and fall. As a rule both trees and shrubs planted in spring get more time to establish a vigorous root system and make some new growth before the coming of winter when growth ceases for the deciduous varieties. However, if you obtain balled specimens in good condition and plant according to accepted practice there is no ordinary reason why such plantings should not prove successful. Fall plantings require lots of moisture to the root systems.

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(Continued from page 116)

into the form and put the inside form blocks against it, pressing them down with your knees and hands until the clamps will reach. Once they are locked up, adjust the inside form blocks until the register-marks line up, and set the locked form aside to dry for 48 hours.

STEP F. The spruce for the top and the mahogany for the back each come in two pieces, usually matched. They must be glued together to form the two wide sheets. To make this butt joint, lay a layer of wax paper on a piece of plywood to avoid sticking, then apply glue along the edges, pull them tight together, and staple the two halves to the plywood. A tracing of the template will show where you can safely staple—the waste around the edge plus the hole area in the top. *Important:* If there is a difference in fineness of grain from one edge of a piece of spruce to the other, be sure to put the edge with the finer grain in the middle.

STEP G. Edge-grain spruce has a tendency to chip when you plane it. For that reason, keep the set of the blade thinner than paper-thin. Work the spruce down to $\frac{3}{32}$ in. thick, keeping it uniform by the method mentioned for planing the side pieces. Be sure that both sides are smooth, since reverberation inside the box is encouraged by smooth surfaces.

STEP H. The lining is actually a succession of triangular glue blocks which form the joint between the sides and the top and bottom. To make them, fasten a wood facer to your miter gauge and drive a brad into it about $\frac{1}{2}$ in. from the kerf. Make the first cut almost through the depth of $\frac{3}{8} \times \frac{1}{2}$ -in. stock, then hook that cut over the brad to achieve the proper spacing and make another cut. After cross-kerfing the lining strips, set the blade at an angle to rip the stock into triangular cross section. The mahogany for the glue-block lining comes from the scrap left over after cutting the neck. Rip a sufficient number of strips for the lining, but be sure you leave enough material for the end block and the neck block. To assemble the body, bring the two bent sides together while still clamped in the forms. Overlap the ends of the mahogany, then attach the end blocks that hold the sides of the form in place. Next, after removing the four-part inner form, cut away the scrap that overlaps, and glue the end block and neck block in place. From now on, the assembly will stay inside the outer form until the top is installed.

STEP I. Fasten the lining to the side first, using ordinary clothes pins to hold it. Notice that the tiny corner blocks are han-

dled in flexible strips, bending the thin remainder of stock around curves. If the strip should break, no harm is done as long as there is virtually continuous lining. Glue the bracing on both top and bottom before securing these pieces to the body. Many guitar experts consider the bracing of the top to be the most critical single phase of construction because of the "string-loading" variances, bass to treble. Follow the layout of the drawing exactly, making sure that the top is absolutely flat throughout the process. Hold the bracing in place while the glue dries by means of weights and clamps. After the glue dries, use a small plane to taper the ends and round off the corners. Note that the heavy brace at the neck end is double thickness and double width. (The bracing is of spruce; end block and neck block are of mahogany; bridge pad is maple.) Unlike the top, the bottom is bowed, and the bracing is symmetrical. Cut the three braces and mark each with a center line. Put them together in a vise and plane the $\frac{3}{16}$ -in. bow into all three so that they will impart a uniform bend to the bottom. To increase the glue line and to prevent the bottom braces from buckling, use spruce cornerblocks, as shown in the drawing.

STEP J. Glue the top in place using weights or clamps to hold it while the glue dries. Another method of "clamping" is to tape the top down with strips of masking tape (the bottom can't be added until after the neck is attached). To make sure that the lining is level with the sides, run a plane along the blocks after the glue is dried and plane down until a shaving of the side is removed. Support the plane at both ends across a curve to keep it at right angles to the sides. Plane the end blocks flush, also.

STEP K. Shaping the neck takes a little time and should be worked on concurrently during the construction of the body. In order for it to seat properly, the neck must be absolutely square at the end. After squaring up, run a centerline down the top and lay out the plan symmetrically to maintain the square end. The actual length of the neck is governed by the dimensions of the fingerboard you buy. Ninety-nine times out of a hundred, it will be the popular $25\frac{5}{8}$ -in. scale and you can follow the drawing exactly, leaving about $13\frac{3}{4}$ in. of flat before you turn down for the head. Draw the profile of the neck on paper, cement it to the side of the mahogany block and run it through the bandsaw.

STEP L. With the plan of the neck laid out on the top, you can make the rest of the rough cuts on the bandsaw. Be especially careful when the supporting end goes off

(Please turn to page 190)

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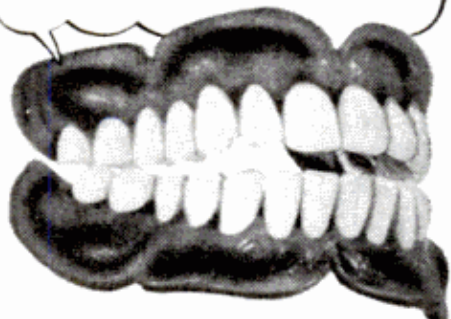
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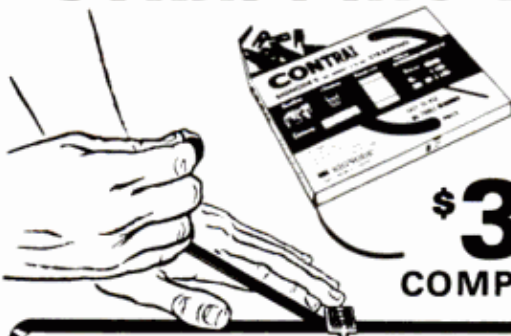
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189

Make a Quality Guitar for \$20

(Continued from page 188)

the saw table, and remember at all times to work symmetrically to a centerline which is precisely perpendicular to the squared end.

STEP M. Rasp, coping saw, surface-forming tool, plane, spokeshave, drawshave and very coarse sandpaper are some of the tools you can use to shape the neck. Follow the cross sections in the section detail of the main drawing. Be sure to mark a centerline down the "belly" of the neck as a guide. When the neck is roughed out, glue the fingerboard to it. *It must be positioned with the 14th fret exactly at the squared end.* When the glue is dry, work the neck down to shape and smoothness, leaving only final sanding.

STEP N. Fasten the neck on with two 2-in. No. 12 steel screws, countersunk. This is a critical joint, so be careful. Drill through the neck block with a shank-size bit, and continue into the neck with a core-size bit. Apply glue to both surfaces, then wax the screw and draw it up tight. Be sure the centerline of the neck is in perfect alignment with the centerline of the top. If you discover that it's slightly out of line, shim up one side or the other with thin strips of mahogany, making sure that both sides of the shim are coated with glue.

STEP O. There is only one really critical dimension in the entire construction of the guitar: the distance from the 12th fret to the "saddle" must be exactly the same as that from the nut to the 12th fret. Locate the bridge so that the center of the slightly angled saddle meets this requirement. Follow the clamping method shown, using small blocks of wood on the top with another block located inside the box between the bracing, so that clamping is hard between the bridge and the bridge pad. To install the tuning keys, place the nut in position and use a strong thread as a guide to notching the nut, lining up the stringing and positioning the holes for the pins in the bridge. Fasten the thread to the proper peg for the top string, then stretch it tight over the nut and down along the fingerboard to the saddle. Keep it parallel to the edge of the fingerboard, about $\frac{1}{16}$ in. in from the edge. Mark the point where this thread hits the bridge. Next, follow the same procedure to position the bottom string. Then determine the locations for four remaining strings spaced equally between the top and bottom. File shallow string notches in the nut, and drill the holes for the pins in the bridge. (Since the pins are tapered, you may want to fit them to the holes with a tapered reamer.)

STEP P. The banding is inset into the rim

of the body. A router is the best tool for cutting the rabbet for the banding, but if you work carefully you can do the job with hand cutting tools. Use plastic, black-dyed maple or ebony for the banding. Cut it a little bit oversize, then boil it to permit easy bending and seat it with glue. Strips of masking tape will hold the banding in place while the glue dries. Sand the banding flush, then turn the tiny wooden knob and glue it in place at the exact center of the end.

The finish you put on your guitar is a matter of personal taste. Commercially made instruments usually have stain, wood filler and many coats of rubbed lacquer. If you love the texture of wood, however, you may prefer clear penetrating resin sealer—the sort of thing they use to finish flooring. The latter was used on the guitar shown in the photographs. After finishing, apply the thin plastic scratch plate with contact cement, then tune up the strings—and happy hootenany! ★★★

What Causes Sunspots?

Sunspots have been a mystery ever since they were spotted centuries ago by Chinese astronomers. One modern explanation for these puzzling blemishes has been advanced by Dr. Horace W. Babcock of the Mt. Wilson Observatory.

The central portion of the sun is known to rotate faster than areas near the poles. Dr. Babcock thinks this rapid rotation pulls the sun's magnetic field into a spiral shape, with the top and bottom hemispheres twisted in opposite directions. This creates instabilities in the interior of the sun which periodically break through to the surface in the form of sunspots and solar flares. Every 11 years, he says, the sun's material twists back into its normal shape and the process starts all over again.

Tied-Down Continents

Instead of floating precariously on top of the earth's crust, the six continents are anchored deep inside the underlying mantle—some 300 miles down. So says Dr. Gordon J. F. MacDonald of the University of California, who made extensive calculations on a computer to formulate ideas on how the earth might have come into being.

Observations on the amount of heat flowing from the earth's interior, differences in sub-crustal densities and satellite data on variances in the earth's gravity led Dr. MacDonald to the conclusion that continental masses penetrate deep into the mantle. Differences in heat transfer from the interior under the oceans and continents vary by as much as 100 degrees centigrade.

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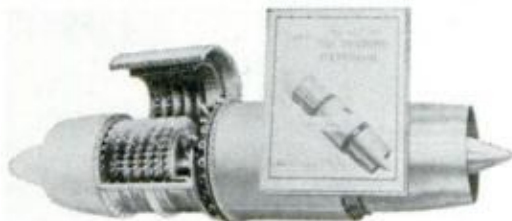
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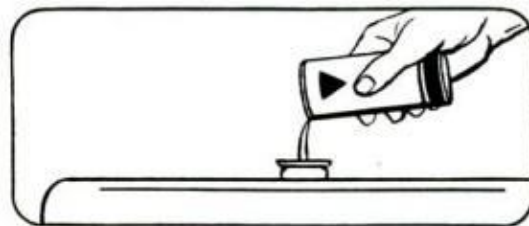
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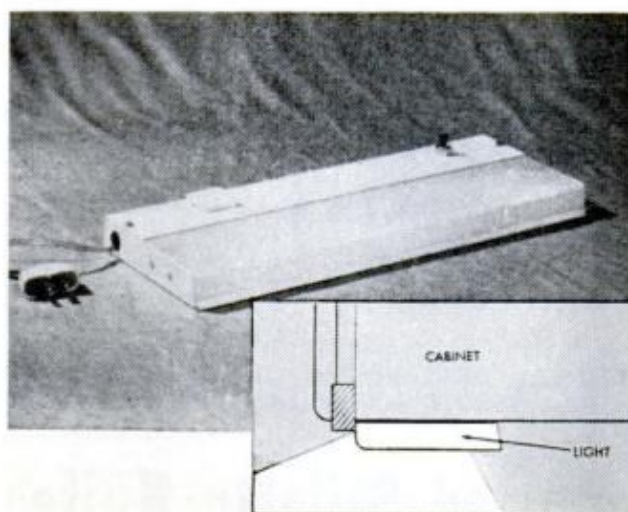
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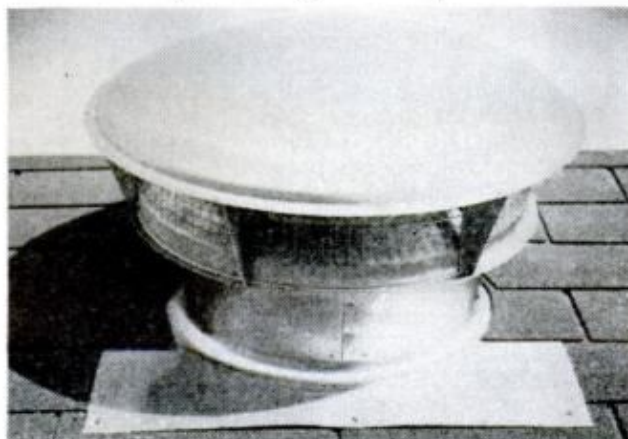
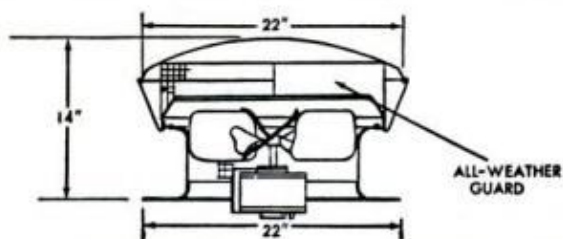
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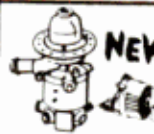
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(Continued from page 61)

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Pointing out the potential advantage of Ionocraft over conventional planes or helicopters, de Seversky ticked off a whole string of radical notions:

High-altitude flight. Helicopters whirl their blades in utter frustration at altitudes where the air gets thin. Beyond 20,000 feet, they get almost no lift. By contrast, experts calculate that the Ionocraft can kick up (or rather, kick down) enough air to stay aloft at 300,000 feet.

Unlimited size. The bigger it gets, the better it flies. Efficiency increases with grid area. Disturbing airflow around the grid edge becomes proportionately less important in larger craft. The reason: Grid area increases faster than circumference with growing size. "We'll be able to build them as big as a city block," claimed de Seversky.

High speed. No practical speed limit has yet been determined. The ions themselves flashing from emitter to grid impart to the air very high-velocity impulse. Aerodynamic grid drag would be the chief speed-limiting factor. But streamlining of the grid edge and careful contouring of the craft, could minimize air drag.

Safety. No moving parts in propulsion and no wear, mean less chance of failure, simpler maintenance.

Steering with Voltage

Steering control is accomplished by applying different voltages to various parts of the craft. The part with the high voltage gets more lift, hence tilts up. The form of the Ionocraft doesn't matter. Any shape will fly, but de Seversky assumes that round models in the form of a flying saucer will be the most easily maneuverable.

By a simple joystick control, the pilot can lift any edge of the craft, producing pitch and roll as if the Ionocraft had elevators and ailerons. He can put the craft into any flight attitude—nose up or down, or banking to either side. Like the tilt of a helicopter rotor, this inclination pushes the craft forward, rearward, or sideways.

J. F. Bruno, the technical director of de Seversky's staff, spoke of a passenger gondola in future models, suspended from gimbals below the main grid so that it remains level regardless of how the main deck is tilted. Location below the main grid also shields passengers from the high-energy flow. But, even if the passengers somehow got into the ion stream, it wouldn't electrocute them unless they were "grounded" to the main grid. "It

would be just like birds sitting on a wire," said Yorysh, the man in charge of electronic design.

Until patents for the Ionocraft were firmly nailed, de Seversky kept his ideas carefully under wraps. That's another reason no full-scale prototype has yet been built. But even present scale models set the imagination buzzing. Manned craft are envisioned for:

Commuter transport. With no size limit, you can pack trainloads of people into this VTOL craft, relieve traffic congestion around urban centers. The same type of craft used as long-distance transport—possibly at supersonic speeds—would not need big airports with long runways.

Airborne traffic monitors. Hovering above bridges and major intersections, or patrolling above highways, one-man Ionocraft would provide a panoramic view of traffic conditions, radio information to ground traffic-control centers.

Grid Is Hard to Hit

Military reconnaissance and rescue. Without moving parts, the Ionocraft is less vulnerable to small-arms fire than helicopters. The open grid makes a poor target. Most bullets would whizz right through it. Even if the grid is hit, the electric charge would be maintained despite damage to some portions. Unlike a copter with shattered blades, the Ionocraft would not crash.

Weather observation. While satellites like Tiros look down on the atmosphere from outer space, Ionocraft could sail right into the weather-making air layers, providing valuable supplemental information. Being steerable, Ionocraft would not drift with the wind like weather balloons, but could hold a position over crucial areas, making local forecasts more reliable.

Skyborne antenna. Kept aloft indefinitely in a fixed position by a ground-based energy supply, Ionocraft could also act as a skyborne antenna, extending the range of defense radar. "It would be like raising the DEW-line 60 miles up into the air," suggested de Seversky, "adding 15 to 25 minutes warning time against missiles."

Anti-missile machine. Always alert to military tactics, de Seversky believes that Ionocraft could be used as missile interceptors. Normally the craft would hover at high altitudes, scanning the horizon for a 700-mile range. As soon as it spotted and identified a hostile missile through an infrared detection system, the Ionocraft would hurl itself at the enemy rocket on a collision course and blow it out of the air.

When practical craft are built, their designers expect to have a choice of several power supply systems now under develop-

(Please turn to page 196)

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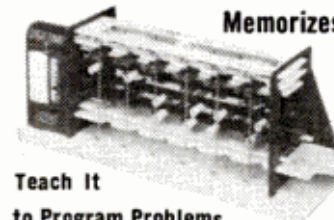
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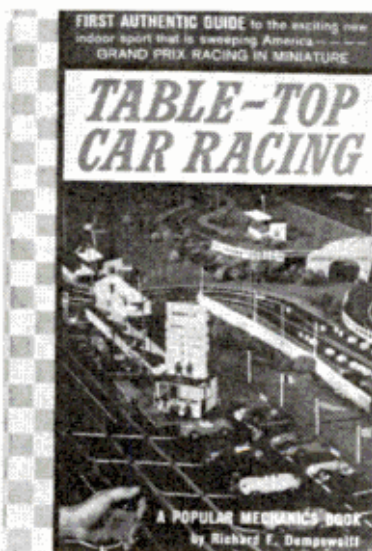
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Ion-Propelled Aircraft

(Continued from page 194)

ment for NASA's space program. Some of these include:

Gas-turbine generators. Several firms, notably General Electric and Allis-Chalmers, have come up with compact, lightweight, kerosene-fueled turbines, originally intended as power sources for spacecraft. These may be used to generate electricity aboard Ionocraft.

Fuel cells. These are chemical reactors producing electricity like a storage battery, but drawing their chemicals from external supply tanks. NASA is currently testing fuel cells converting hydrogen and oxygen to electricity, with drinking water as a byproduct.

Solar cells, directly converting sunlight to electricity—the present energy source of most satellites. When high-efficiency solar cells are available, they may keep Ionocraft aloft for indefinite periods.

Power from Boiling Mercury

Sunflower—a code name for another project aimed at deriving electric power directly from sunlight. It employs an umbrella-like reflector that focuses the sun's heat to boil mercury, which expands through a turbine and drives an electric generator. (Solar-power supplies would be back-stopped by other kinds of power generators to take over whenever no sunlight is available.)

Microwave radiation. Concentrated beams of high-frequency radio waves may transfer energy from ground stations to the Ionocraft if the craft is to be used as a hovering platform in fixed position. Raytheon has pioneered this type of energy transmission through its Amplitron tube and has recaptured as much as 72 percent of the radiated energy at the receiver site. High-power laser beams may be similarly used for transmission.

Experimental hardware has already been produced for each of these off-beat power-supply systems.

None of the men working on the Ionocraft will be pinned down to any production timetable. "It's a pretty wild project," admitted technical director Bruno, a veteran of 20 years in the missile business. "But that's what they said when we started working on rockets."

Major de Seversky, whose own career goes back to the beginnings of aviation, views his invention in historical perspective: "We are exploring an entirely new principle of flight. We're just at the spot where the Wright Brothers were in 1903. We are just beginning to see the possibilities." ★★

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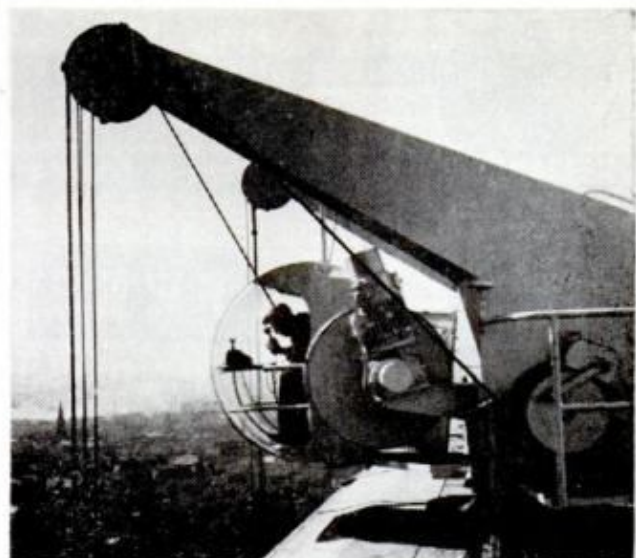


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Emotions Aid Memory

Studies at the University of Michigan indicate that anything you learn when emotionally aroused may be very difficult for you to remember two minutes later, but will be relatively easy to recall at a later date.

Prof. Edward L. Walker selected 72 women students and divided them into nine groups. Some groups were shown, by projected slides, a series of words with highly emotional connotations, such as *money, rape, kiss* and *vomit*. Other groups were shown low-arousal words such as *white, pond, berry* and *flower*. It was confirmed by measuring skin resistance (similar to one factor in a lie-detector test) that the high-arousal words did indeed raise the emotional level of the subjects more than the low-arousal words.

The subjects then were asked, at various time intervals, to recall the words they had been shown. The low-arousal words were easily recalled two minutes after the test, but showed much lower recall a day and a week later. On the other hand, the high-arousal words, possibly because of the shock stimulus, showed relatively low recall immediately after the test, but high recall a week later.

The experiments may throw light on how the memory unit of the mind functions, and how its efficiency can be increased.

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