

Giant Foldout: Boeing's Huge New 747

POPULAR MECHANICS

DEC. 1969
50 CENTS

What Owners Think Of Maverick Page 92

ORBIS—New Automatic Speed Detector That Takes Your Picture

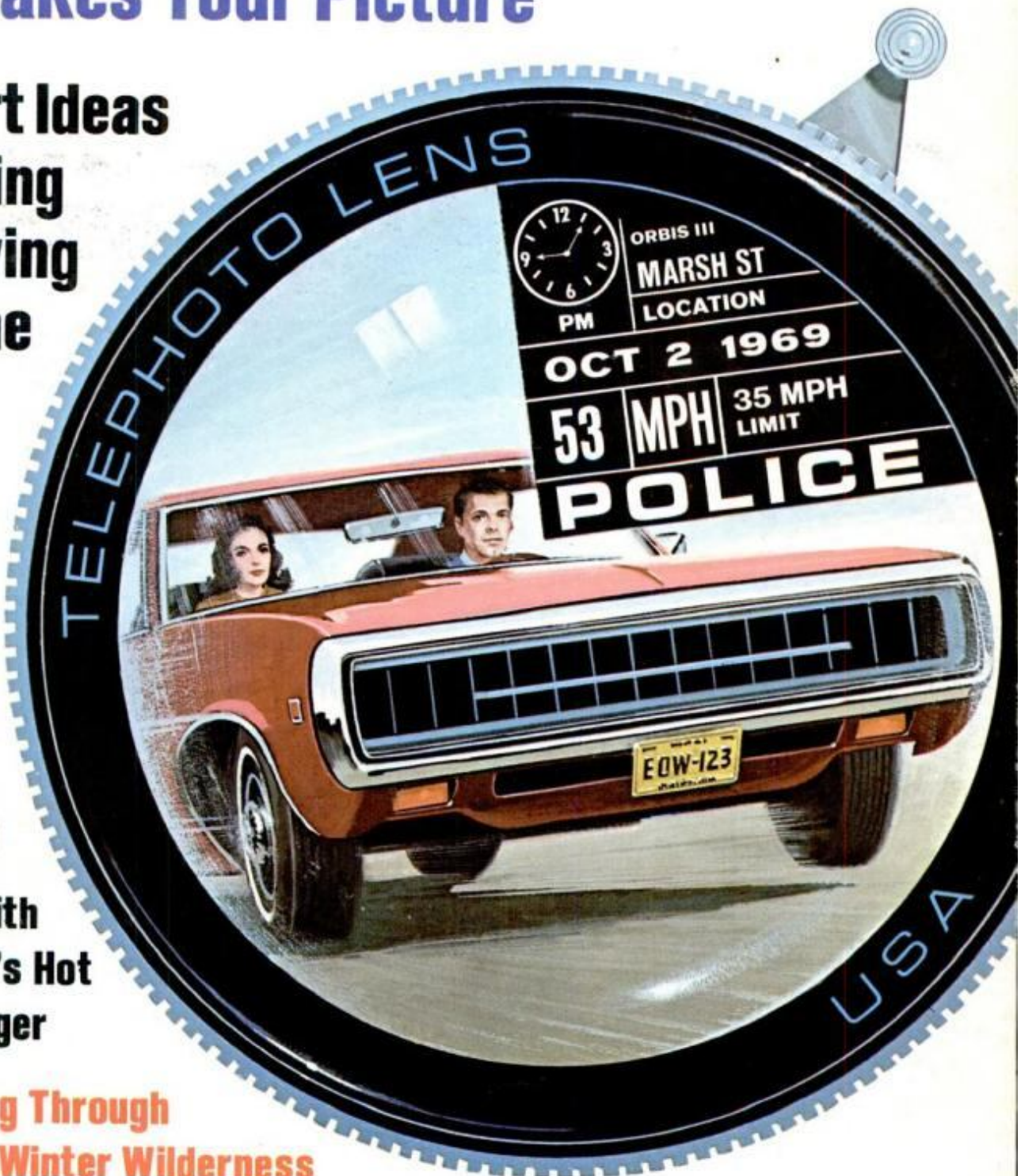
30 Smart Ideas For Getting More Living Out of the Space You've Got

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Photographed at Bradenton, Florida



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AUTOMOBILES AND DRIVING

- 12 Detroit Listening Post
- 32 Drivin' With Dan
- 66 Automobile Clinic
- 73 Smile! You Just Got a Ticket
- 88 PM Owners Report: Ford Maverick
- 96 Track-Testing Dodge's New Pony Car: the Challenger
- 132 Saturday Mechanic: How to Check Ball Joints
- 208 Canada Joins the Rotary Club: Mazda Car Test

SHOP AND CRAFTS

- 124 Electronic Music-Makers You Can Build From Kits
- 160 A Jigsaw for a Dime
- 161 New Tools You Should Know About
- 166 New Toothless Blades Cut the 'Uncuttables'
- 168 Look What You Can Do With a Belt Sander
- 172 Hints From Readers
- 178 How to Anneal, Harden and Temper Steel
- 182 Hints From Readers

SCIENCE AND INVENTIONS

- 22 Science Worldwide
- 78 'I'm Not Stuffed—I'm Freeze-Dried!'
- 82 Four-Mile Train With a Mind in the Middle
- 102 Just Patented: PM's Pick of the New Inventions

REGULAR FEATURES

- 6 Letters

HOME AND YARD

- 70 Homeowners' Clinic
- 120 Care and Feeding of Snow Throwers
- 136 Exciting New Products
- 138 30 Smart Ideas for Putting Space to Work
- 154 Finish Your Basement Like a Pro
- 158 Solving Home Problems
- 168 Look What You Can Do With a Belt Sander
- 173 The Right Way to Replace Furnace Filters
- 174 New Building Products You Should Know About

BOATING, OUTDOOR RECREATION

- 11 What's New Outdoors
- 42 On-the-Go Camping
- 116 Use What the Varmint Shooters Use
- 150 Conquering Minnesota's Wilderness by Snowmobile
- 163 Outboard-Motor Service Guide No. 3: How to Check Out Your Lower Unit

PHOTOGRAPHY

- 127 New in Photography
- 128 New Mini-Strobes: Flashguns You Can Slip in a Pocket

ELECTRONICS, RADIO AND TV

- 112 New in Electronics
- 124 Electronic Music-Makers You Can Build From Kits

SPACE, AVIATION, MILITARY

- 94 Fastest Prop in the World
- 104 Boeing's 747: First of a Great New Breed

Cover Illustration by Ed Valigursky
Orbis: New automatic speed detector that takes your picture

NEXT MONTH IN POPULAR MECHANICS

Special 64-Page Tear-Out Section: Auto Racing Guide for 1970: The cars (in color), the drivers, the tracks, the races, the rules . . . plus "argument settlers." This special section was prepared especially for PM's auto-racing fans by our automotive editors.

How We Raised the Alvin From 5000 Feet. Veteran skipper tells of deepest rescue.

Great Things to Build: Bumper-pool table, gun cabinet, mini-bike, spiral stairway.

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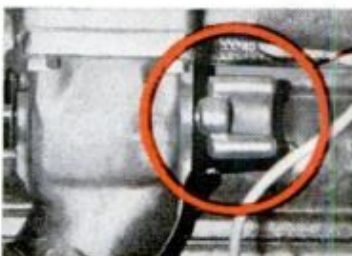
DECEMBER 1969



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LETTERS TO THE EDITOR

Lesson 2: Birds and bees

In *Secrets of the Animal World* (page 84, Sept. PM) reference is made to the worker bee as "he" and "him" on page 85. Please be advised that there are male bees, but they are only drones and do no work. The worker bee is an underdeveloped female, while the queen is a fully developed female and lays the eggs.

CANTON, MISS.

LESTER M. JAMES

Guess our bias showed. We don't mind having females (preferably developed) around to do the work, but how can a men's magazine label any gang of guys—even bees—a bunch of drones?

Not out of steam

I read *Speaking of Steam* in the *Detroit Listening Post* (page 36, Sept. PM) with considerable amusement and some sorrow for your publication. It seems the author has an uncanny ability to guess wrong.

As for my steam-car plans having evaporated, about the only thing that has evaporated so far is \$5,500,000 of well-spent money in finding out all the problems and most of the solutions.

I never professed to have a fleet of steam-powered buses at any time. However, strange as it may seem, we may have a couple pretty well along the way toward completion.

The race car was not my idea, but Ken Wallis's screwball dream on which I spent a lot of money, only to find there were no rules for racing it at Indianapolis.

The California Highway Patrol car is progressing nicely, and we are not at all chagrined over the time it takes to make something worthwhile, nor the money it costs. We went into this thing with our eyes wide open; we knew it would be a difficult objective and at the proper time we will make a creditable showing.

The author's reference to the "rock" of designing and building a suitable boiler is just too ridiculous to discuss. As a matter of fact, we have spent over \$1 million on boilers and have something to really crow about, but it is too early to do that.

Now, the funny one is the statement that I am no longer president of the company. You have no idea how important this is to me, especially in view of the fact that I own 100 percent of the company. I personally appointed Mr. Joseph Walsh,

(Please turn to page 8)

"Look who's smiling now!"

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LETTERS

(Continued from page 6)

one of the most capable individuals of my acquaintance, as president. The author failed to mention that Bill Lear is still chairman of the board, chief executive officer and sole owner of Lear Motors Corp.

I guess the author was trying to belittle me in this article.

RENO, NEV.

WILLIAM P. LEAR

Belittling? Gee, Bill, have you forgotten already that in April we printed a major story on your steam-car developments along with the first full-color painting of your racer to be published anywhere?

Better to learn again

The artificial larynx (*Mechanics of Medicine*, page 138, Oct. PM) is generally considered to be a good "last resort."

Most laryngectomees can, with proper training and patience, learn esophageal speech. It is far superior to the electro-larynx because it is almost like the natural voice, having no mechanism to detract from it.

The patient should not be given the electro-larynx because he will then lack motivation to give it up to learn esophageal speech. Writing is preferable.

CHATTANOOGA, TENN.

LYNN DANIEL, M.A.
SPEECH PATHOLOGIST

Three perfect rounders

Bob Bitner shot his perfect 300 round in 1967, not last year as was stated in *Look What's Happened to Bows and Arrows* (page 120, Sept. PM). And his "strange-looking bow" is the Golden Eagle, a take-apart bow with a die-cast aluminum handle. There were two others who shot perfect 300 rounds in that 1967 competition: Lester Gervais (whom you mentioned) and Bob Brewer.

BIG RAPIDS, MICH.

CHARLES ALLEN

PM collector

I am in the process of collecting old *Popular Mechanics* magazines. I intend to collect as many as possible. As you can guess, I am having trouble finding the older issues. I would appreciate any helpful information you or your readers can give.

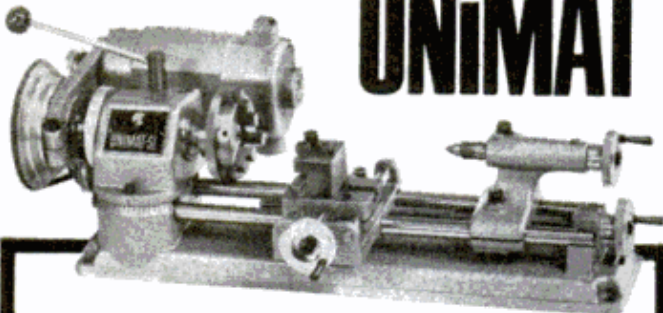
CHICO, CALIF.

FRED M. ALEXIS

To keep from inundating Mr. Alexis under a pile of paper, we'd suggest that readers who have old magazines to spare query him first: Rt. 1, Box 744A, Chico, Calif. 95926.

★★★

UNIMAT



MULTI-JOB MINIATURE LATHE

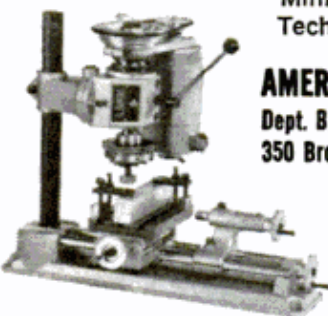
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Two ways to avoid ugly surprises. (1) Next time you need a replacement, buy the better battery. GO* will give you more life—more starting power—than batteries that come in brand new cars. Twice the power of some. Instant power for fast, sure starts. Reserve power for tough-weather starts. (2) Insist on a GO* battery in your next new car. It will be one item you'll never pay to replace. (For proof, read on.)

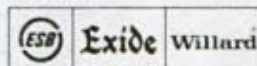
Your guarantee is dying along with your battery. Because almost all battery guarantees are prorated by the month. Say you have a \$30 battery with a 24-month guarantee. It quits at 20 months. You get four twenty-fourths, or one-sixth, of the \$30 toward a new one. A big \$5. Not much of a guarantee by then, is it?

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WHAT'S NEW **OUTDOORS** BY GEORGE REIGER

BAND-AIDS FOR SNAKE BITES? If a vaccine being developed by Drs. Clifford C. Snyder and Gary R. Hunter is successful, outdoorsmen may one day have no more fear of rattler, cottonmouth and copperhead snake bites than we now have of bee stings. These vipers presently account for between six and seven thousand snake bites reported annually in the United States, of which 15 to 20 are fatal. The two University of Utah researchers have thus far developed a vaccine that protects dogs from timber rattlers, but Dr. Snyder is at work on a polyvalent rattler vaccine that will protect people against sidewinders, diamondback and Mojave rattlers. And he foresees a day when even the dread king cobra of India may threaten man with no more than a little fright and soreness!

A NEW FLASHING SAFETY LIGHT for hunters doubles as an emergency light for snowmobilers, ice fishermen and other outdoorsmen. Bird shooters will particu-

larly appreciate its value during the deer season. The flashing red Safe Lite can be attached to the top of your cap to warn other hunters of your presence up to half a mile away. The light can be worn during the critical faint-light hours of dusk and



dawn and on dark, overcast days. Its small size and light weight make it no more bulky than a pack of cigarets—and far less hazardous to your health! Also good for boats, kids on bikes, and people walking along highways at night. Manufactured by B & G Industries, Hanover, N.H., the suggested retail price is \$3.50.

One of a kind



No other distiller makes his whiskey the same way we make Seagram's 7 Crown.

So no other whiskey has the same smooth taste.

Or the same consistently fine quality.

And guess what.

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It figures, doesn't it?

Say Seagram's and Be Sure.

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65% Grain Neutral Spirits.

DETROIT

LISTENING POST

BY BILL KILPATRICK

A FORD GAS TURBINE ENGINE prototype has been installed in a Continental Trailways bus and right now is undergoing final tests before being placed in regularly scheduled passenger service. Installation of the engine—dubbed the 707—was completed last month at Ford's Engineering and Research Center. Following a number of "shake-down" cruises between various Michigan points, the bus was driven to Trailways' Dallas headquarters. It will be placed in long-haul service—probably between Dallas and Los Angeles—after a period of further testing and exhibition. Insiders report the most notable features of the new turbine bus from a passenger's point of view are its quietness and lack of vibration.

USED CAR AND TRUCK TIRES, long a blight on the American landscape—so much so that archaeologists of the future could understandably consider them the principal artifact of the 20th century—have been proven a valuable source of such raw materials as oil liquids, gasses and tar. Joint research by Firestone and the U.S. Bureau of Mines has developed a "destructive distillation" process found to be a "technically feasible method of disposing of, and obtaining potentially valuable products from, scrap automobile and truck tires." The "distillation" is accomplished by heating scrapped tires in a reactor normally used to test the coking properties of coal. Shredded, the tires are fed into a closed reactor where, as they are heated, they break down into various chemical compounds. The Bureau of Mines reported that the highest yield of liquid products resulting from the process was obtained at about 500° Centigrade (930° F.), whereas the highest yield of solid and gaseous products was obtained at about 900° C. (1650° F.). In one test, a ton of used tires resulted in as much as 140 gallons of liquid oils, in another, 1500 cu. ft. of gas. Ultimate goal of the project, according to Firestone's Dr. J. A. Beckman, would be to have such reclaim facilities set up all over the country. Big effort right now, says Dr. Beckman, is to make the process and facilities economically feasible.

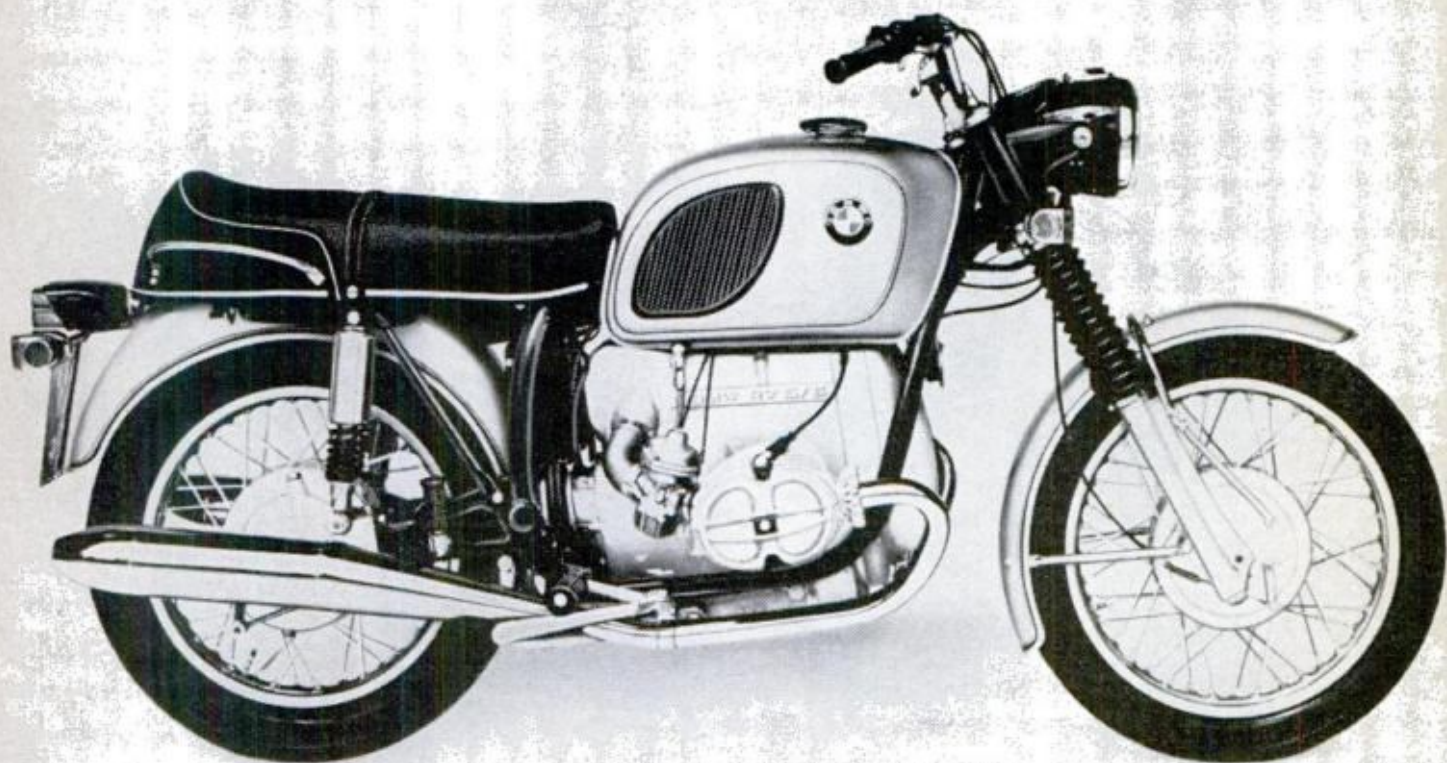
THE BATTLE OVER AIR POLLUTION caused by cars is far from over, despite statements issued by auto-industry public relations departments. Research at Ohio State University indicates that present automobile engines spew about 29 pounds of deadly carbon monoxide into the atmosphere for each ten gallons of gasoline burned. OSU's studies, sponsored by the National Air Pollution Control Administration of the U.S. Public Health Service, are aimed at determining the chemical reactions and rates of removal of carbon monoxide, sulphur dioxide and other common pollutants from the atmosphere.

"Right now," says OSU chemistry professor Jack G. Calvert, "we don't know exactly how or how fast carbon monoxide removes itself from the air. We're trying to find out what happens." Calvert says monoxide's potential threat comes from the length of time it stays in the atmosphere and the toxicity of the transition products occurring as it passes into a harmless substance. "Naturally occurring reactions in the atmosphere remove most pollutants," Calvert points out, "but if they are dumped in faster than they are taken out, they can build to toxic levels." And Calvert thinks carbon monoxide—to mention just one pollutant—is being dumped in the air faster than it's being taken out, with the main culprit being internal combustion auto and truck engines.

His contention contrasts sharply with that advanced earlier this year by Charles M. Heinen, Chrysler's chief engineer for emissions control and chemical development. Heinen claims the main battle against car-caused air pollution has been won, that if there were no cars on the road except 1969-70 models, "we would—overnight—breathe the same clean air we had in 1940 as far as the automobile contribution is concerned." But Calvert says a perfectly-tuned test car, regardless of model year, has little relation

(Please turn to page 20)

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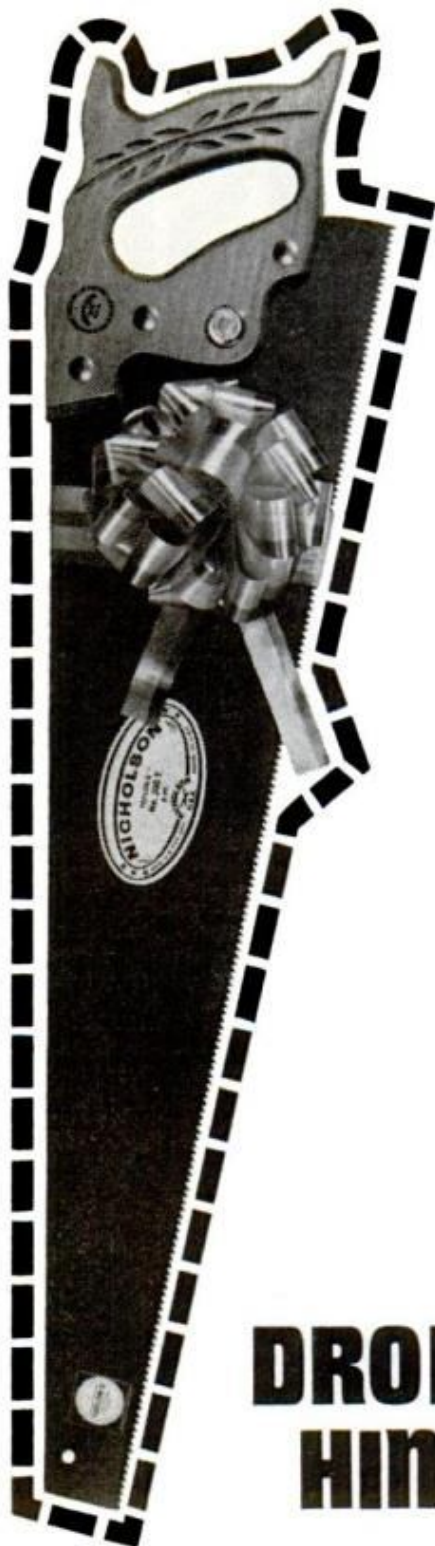
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DETROIT LISTENING POST

(Continued from page 12)

to the average vehicle on the road. So, despite the government's recent and apparent go-easy attitude on carmakers regarding air pollution, the issue is far from dead and you can look forward to the exchange of some hot charges and counter-charges. One possible upshot? The end of leaded gasolines.

THAT BELL you hear tolling ominously in the background could be for the automobile and driving as we know them. An ever-increasing number of individuals and organizations are expressing alarm over the proliferation of cars. No less an august group than the National Geographic Society is on record as saying the end of the road for the automobile—one big traffic jam—may be just ahead. The Society cites a number of "trouble spots" in various cities throughout the world (including Agana, the capital of Guam, which each day goes through the agonies of rush-hour traffic), quotes the head traffic man of Washington, D.C., as saying, "By 1975 every single center city area of every big city will be absolutely choked with automobiles." The "traffic mess" is being bounced off the walls of Congress these days, a possible result being that manufacturers may one day be restricted to producing only as many cars as are junked in a given year.

LOOK FOR DODGE to bow with a new van in the next couple of months. The new vehicle, as opposed to the present '68 series of vans, will feature a longer wheelbase, bigger cargo capacity, increased passenger space. As yet unnamed, it'll join the industry's new spate of so-called "super-vans."

AUTO BUFFS, car nuts—whatever you want to call them (and us)—can spend many happy hours these cold winter nights poring over the pages of Leo Levine's great book, *Ford: The Dust of the Glory, A Racing History*. Over 600 pages of delightful, informative reading, plus many, many illustrations, some appearing for the first time, the book traces the story of auto racing from its earliest days on frozen Michigan lakes to modern super speedways. Although concentrating primarily on Ford, the man and the company, the book covers just about all the men and machines that have roared through racing's history. I found it fascinating, often funny, and so might someone on your Christmas list. It's in bookshops, published by Macmillan. ★ ★ ★

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A soft landing on Mars by an unmanned Viking spacecraft is planned for 1973, according to NASA. Upon arrival at Mars, the spacecraft will go into orbit to search for a good landing area. Following release of the landing module, the orbiter portion of the spacecraft will continue to gather scientific data. The Viking project will benefit from information gathered in the Mariner 6 and 7 Mars missions, and from the Mariner '71 orbiter flights currently being developed. The Langley Research Center, Hampton, Va., has management responsibility for Viking.

Do smart people live longer? They tend to, according to a 12-year study of 47 men at the Philadelphia Geriatric Center. Those still alive at the age of 80 have higher IQs than those who died, says the center's psychologist, Samuel Granick. The men showed no apparent differences in physical health when they were examined at the start of the study in 1956. Nutritional differences also were ruled out. Intelligence may be a factor in longevity, thinks Dr. Granick, because it may be related to the strength of the nervous system.

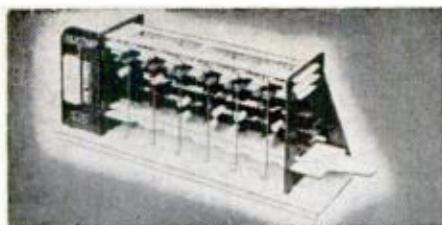
Construction of a 440-foot fully steerable radio telescope is called for in a report recently released by the National Science Foundation. Prepared by a special panel, the report warns that if the construction of the telescope and other modern instruments is not started immediately, the momentum of the U.S. effort in radio astronomy will be lost. This loss would affect the fields of chemistry and physics, too, because many discoveries in astronomy—the pulsars, for one—add to our understanding of the fundamental nature of matter. The panel notes that there has been no significant construction of major new radio telescopes in the United States in recent years, but that several large telescopes are being built in Great Britain, the Netherlands, West Germany and India.

A breakthrough in gumdrop and jelly-bean production is on the horizon as a result of the work of Prof. Thomas J. Schoch of New York's Cornell University. In the standard method, a starch-sugar syrup is cooked, injected into molds and stored at 95°F. for two days until it has jelled. Since fatty acids in the cornstarch slow the jelling process, Prof. Schoch has devised a way to remove them before the starch is mixed with the sugar syrup. Result: gum drops and jelly beans become firm within 30 minutes, ready for sugar-coating and packaging.

Mount Rainier is exhibiting signs of geologic restlessness. That report comes from U.S. Geological Survey scientists who cite as evidence a new warm spot on the summit cone of the 14,410-foot volcanic mountain. Detected by an infrared-sensing plane, the warm spot could indicate steam emissions, capable of melting glacier ice and causing the flashflooding of streams. "The current signs of increased restlessness do not necessarily mean that another eruption is likely to occur in the near future," says Dr. Dallas Peck, the Survey's assistant chief geologist, "but they do require close watching." Since the Ice Age, which ended about 10,000 years ago, Mount Rainier has had long quiet periods punctuated by brief episodes of activity. The last one—an eruption of clouds of ash—occurred about 75 years ago.

A chemical that makes male rats permanently sterile has been developed by the Upjohn Co., Kalamazoo, Mich. A member of a family of chemicals called the chlorohydrins, the drug causes lesions in the rat's reproductive tract, resulting in the blockage of sperm. But this doesn't affect the animal's health. He continues to compete for territory, food, social order and sexual partners. After mating with a sterile rat, females have false pregnancies, precluding for a while sexual activity with other males. Upjohn scientists say the drug, which can be mixed with food or dissolved in water, may have the potential of controlling rat populations the way sterilization of males has successfully limited the growth of screwworm fly populations.

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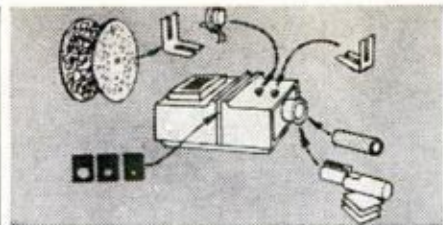
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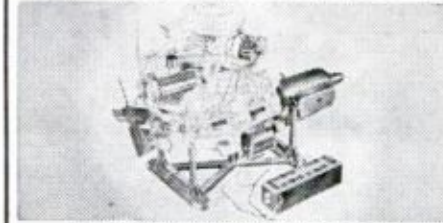
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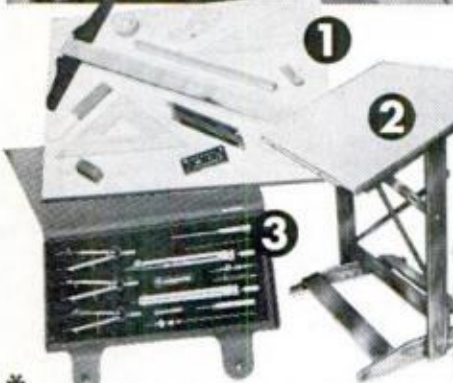
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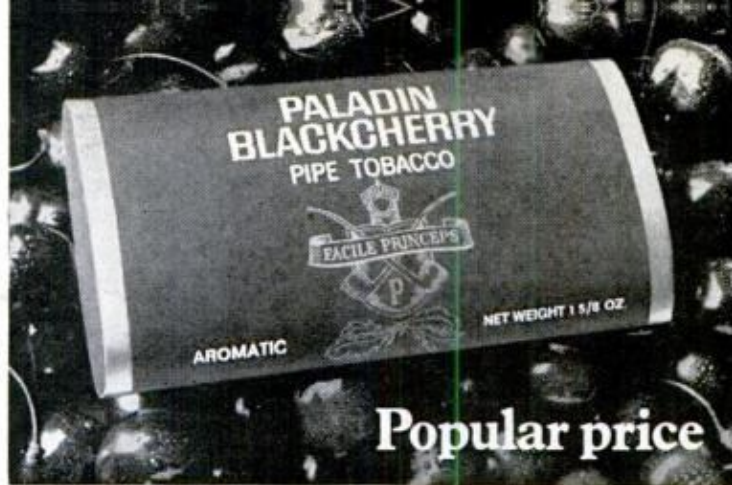


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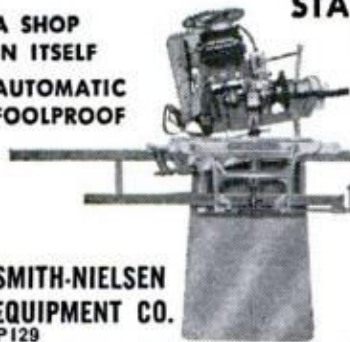


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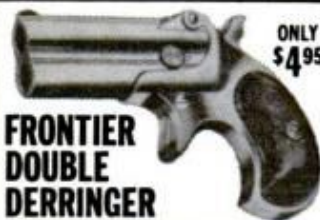
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Drivin' with Dan

Will McLaren-car domination hurt Can-Am? If better, why are disc brakes used only on front wheels? Are dune buggies practical for use on the street? Dan Gurney answers these and other automotive questions

Q. Do you feel the McLaren domination of the Can-Am series the last two years has hurt this type of racing?—Dottie Dickenson, Irvine, Calif.

A. Frankly, no. For the same reason I don't think the New York Yankees' domination in baseball, or the Boston Celtics' domination in basketball hurt those sports. On the contrary, I believe it has a lot of pull for Can-Am racing and that people are keenly interested to see who will be the one to finally knock them off. I'm sort of interested to find out myself.

Q. Why are six-cylinder engines always "economy" engines? Can't Detroit make them perform like V8s?—Ben Abernathy, Lakeland, Fla.

A. Apparently the V8 is a more compact (lighter) package. The crank is lighter and stronger in proportion to a six. The V8 seems to be a better compromise. Of course, a Six is less expensive to build. There are always exceptions. LeMans and Indy have been won by Sixes. Some great Honda G.P. motorcycles were six-cylinder jobs.

Q. If disc brakes are better, why do cars just have

them on the front wheels, with drums on the back?—Fred Little, Dover, Del.

A. I'm not sure, but I've been told that it involves the difficulty of designing and building an inexpensive parking brake utilizing a disc in the rear. Most racers use them all the way around. It is interesting that Nascar Grand National stock cars have not changed over to them yet. Apparently the available drums are superior in that particular case.

Q. What have you done with your Formula 1 Eagle in which you won the Belgian Grand Prix in 1967?—R. C. Reece, Philadelphia, Pa.

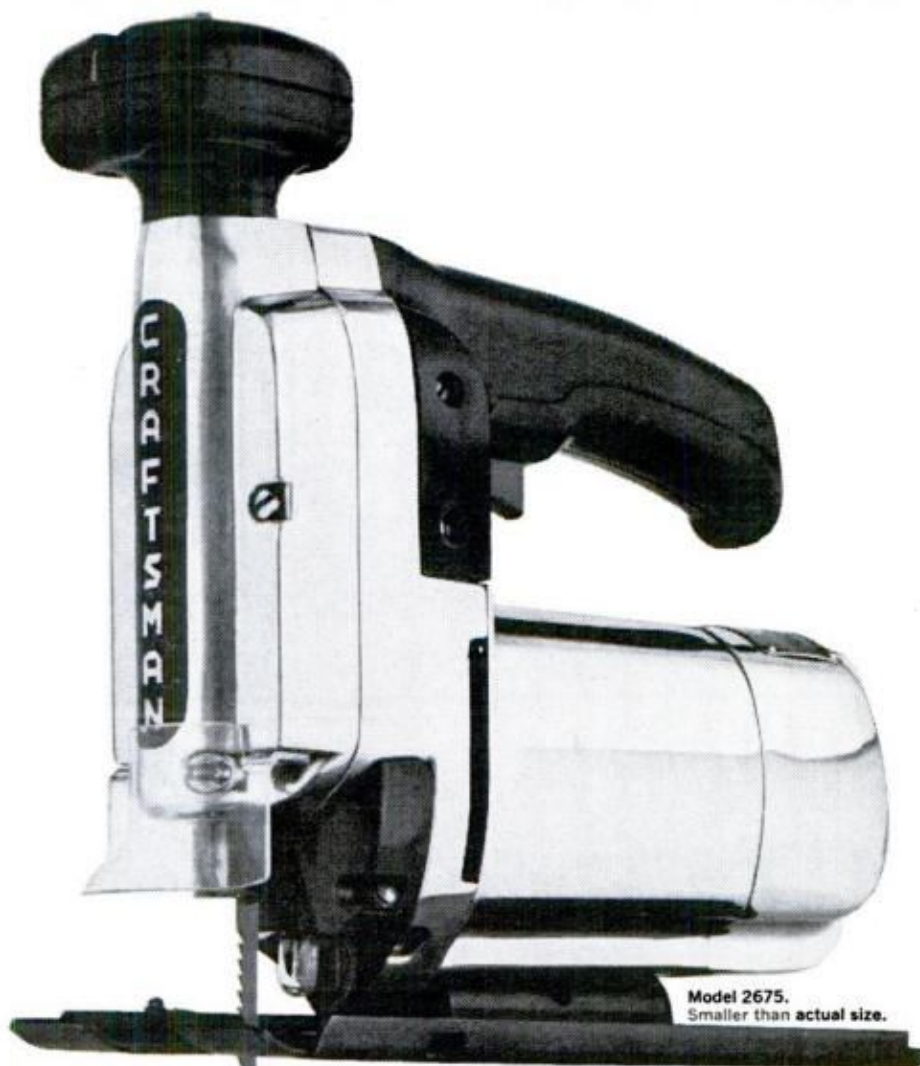
A. She sits in a special place of honor in Briggs Cunningham's Auto Museum in Costa Mesa, Calif. The curators of this outstanding museum maintain her in tip-top, ready-to-battle condition, and every once in a while she is rolled out to grace a press conference or a special automotive show. She is still very beautiful, and looks as though she could sit on the pole today without many changes.

Q. Are dune buggies practical for street use or (Please turn to page 36A)



OUR DAN in his "McLeagle" (McLaren/Eagle) Can-Am car, powered by a 427-CID Chevy engine. The switch marks first time in seven years of much varied competition Dan has used anything but Fords

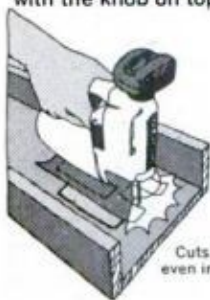
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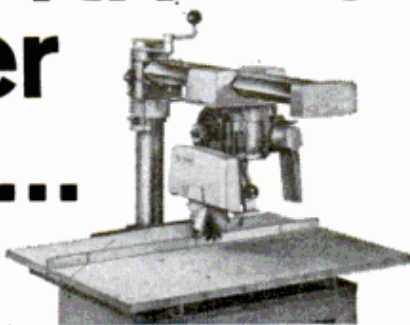
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DRIVIN' WITH DAN

(Continued from page 32)

in the cold weather areas?—Bart Floyd, Sioux City, Iowa.

A. I don't see why not. I see a lot of them on the road in California. I should think they would be great fun in the snow. They can be heated easily.

Q. *After studying results of the major NASCAR races it looks like Ford's best record is at the Riverside 500, where they have never been beaten. Is that as good as it sounds, or does anyone else try hard?—Roger Robertson, Atlanta.*

A. It's a good record. Everyone tries hard in racing. A Pontiac won a 300-mile USAC race on the same circuit after the winning Chevy (mine) was disqualified due to a political squabble. The Chrysler-Plymouth-Dodge cars have the best chance of snapping the Ford win streak in 1970.

Q. *Do you think the Plymouth Barracuda you are going to race in Trans-Am will be competitive against the Camaro, Mustang and Javelin teams which have much more experience?—Ronald Cox, Los Angeles.*

A. Although the teams you name, plus the Pontiac Firebird, do have a big edge in experience, I definitely feel the Barracuda has the potential to give them all a run for their money before the 1970 season is finished. I think the 'Cuda is the best thing to come along since sliced bread. The car makes a lot of sense, and it has a lot of built-in heritage from both engineering and styling standpoints.

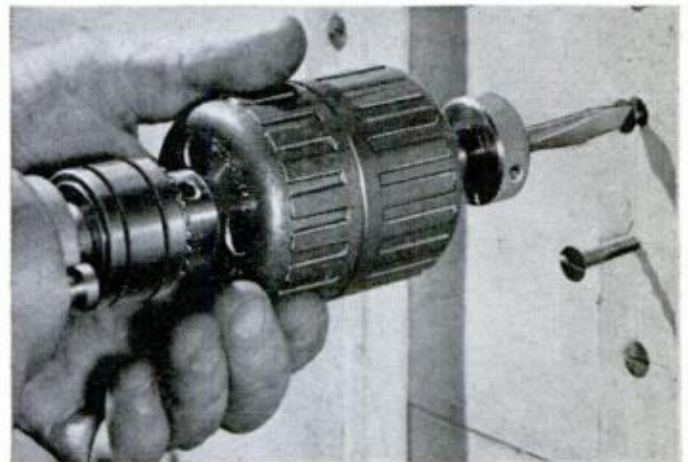
Q. *How many kinds of Eagles have you built, and do you ever plan on making a street version?—Charles Walter, Spartanburg, S. C.*

A. Thus far at our All American Racers facilities in Santa Ana, Calif., we have manufactured Formula 1 Grand Prix Eagles, USAC Championship (Indianapolis) Eagles, and Formula A Eagles. And we are very proud of the success each has achieved. You may well see a Group 7 or Can-Am Eagle by 1970, but we have no plans at present for a street version, thank you.

Q. *I read where Bruce McLaren said the preparations of Can-Am cars, with the exception of Roger*
(Please turn to page 36D)

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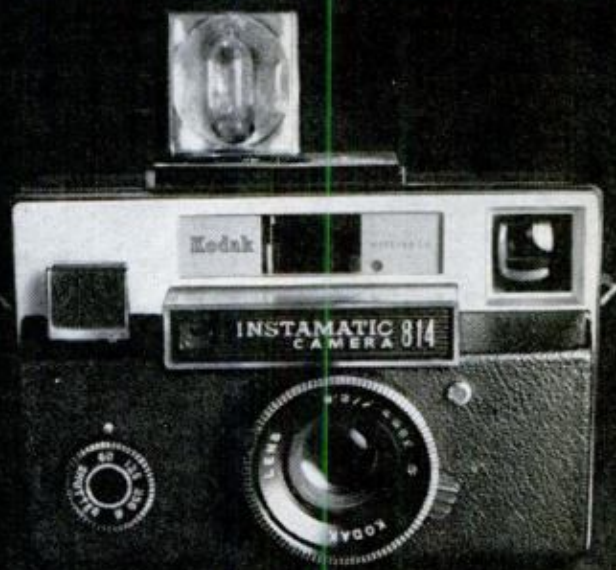
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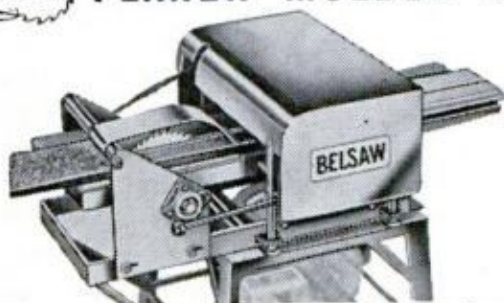


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DRIVIN' WITH DAN

(Continued from page 36A)

Penske's, was pretty sloppy. He also said that American mechanics thought they knew it all, but ought to take lessons from European F-1 mechanics. Do you agree?—Tom Baxter, Birmingham, Mich.

A. No! First-class racing mechanics are a very rare breed. You will find them wherever you find consistent race winners. They exist in America as well as in other parts of the world.

Q. Do you think A. J. Foyt is a tough competitor in the Indy 500? If so, why?—Tony Nestor, Willowdale, Ont.

A. A.J. is a very tough competitor. Anyone who has won as many races as he has, has got to be plenty tough. He is very experienced and wise. He understands a great deal about what makes a car tick, and he is a superstrong competitor with lots of drive and instinctive driving talent. He hates to lose and has always gathered top people for his team.

Q. I've always been interested in what the favorite leisure pastimes of athletes are. What do you do for relaxation, hobby, and so forth?—Sara Singleton, Denver.

A. I'm a motorcycle enthusiast. I love cow trailing and exploring and riding dirt fire roads in the California hills. Swimming, skiing (I'm very new at it), the movies, books, music, television, food, and, last but not least, my business, All American Racers.

Q. Do you need a state driver's license to become a competition driver?—Joe Bartle, Louisville, Ky.

A. Most of the top sanctioning bodies in the U.S. make that stipulation or reference to it. However, there are many cases when drivers have competed professionally before actually receiving a state license. You are talking about two very different types of driving, and owning a competition license does not necessarily make you a qualified highway driver, and vice versa. ★ ★ ★

If you have questions on racing, high-performance and everyday driving techniques, send them to "Drivin' with Dan," c/o Popular Mechanics, 224 West 57th St., New York, N.Y. 10019. Questions cannot be answered by individual letters. Questions on maintenance and repair should be addressed to the Auto Clinic (see page 66).

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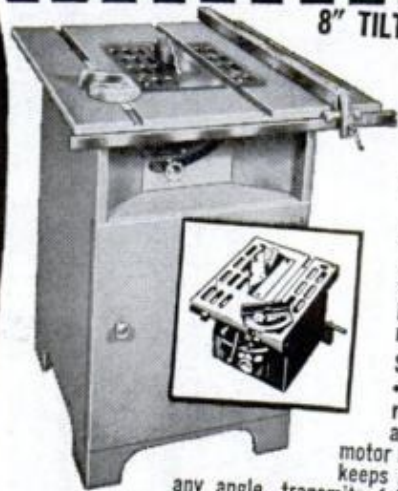
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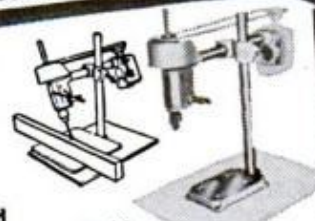
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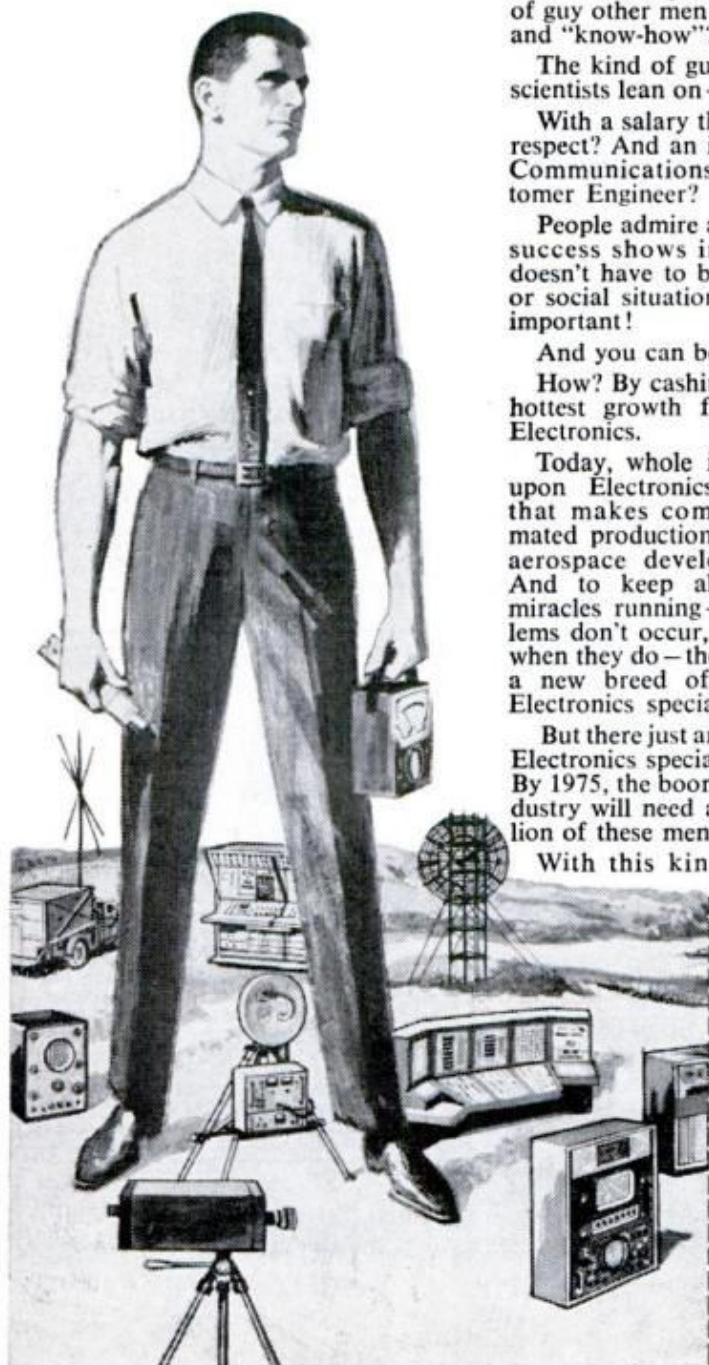
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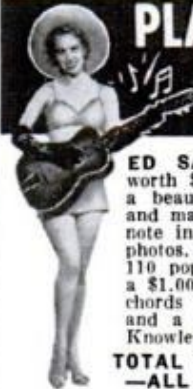
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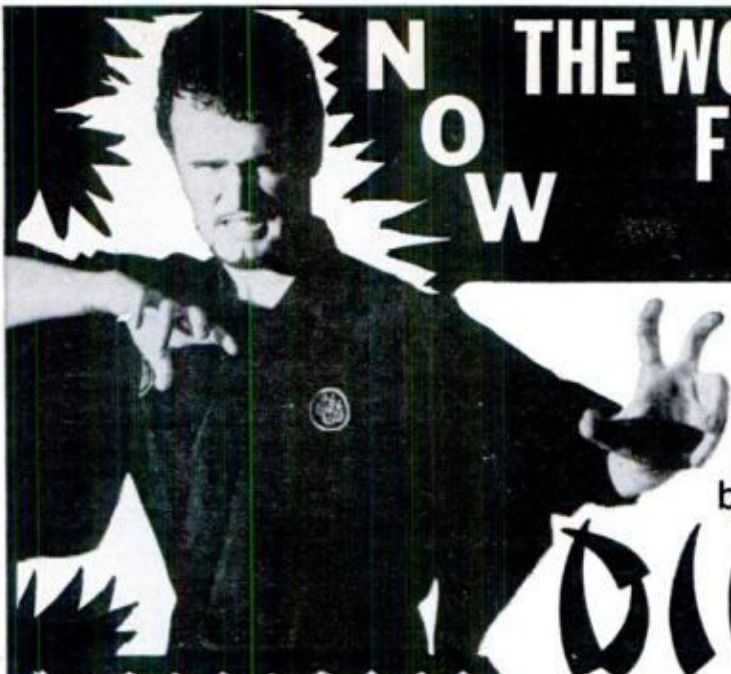


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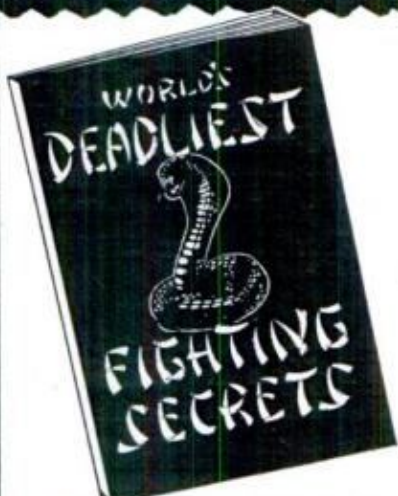
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ON-THE-GO

CAMPING

BY WADE MITCHELL

DODGE DIV. FROWNS WHEN WE ASK . . . but coach manufacturers insist that Dodge field representatives have contacted them about a *front-drive* van! Rumors have circulated for over 12 months. This reporter is convinced such a van is in the works, regardless of half-hearted official denials. Big advantages afforded by a front-drive van are a lower silhouette and a flat cargo floor, made possible by elimination of a driveline tunnel.

WORLD'S LARGEST RV SERVICE CENTER UNDERWAY. Frank Lee, of Kent, Wash., is reportedly building a huge recreational vehicle service center that will entail an investment of roughly \$750,000 and contain six large "bays" where all types of RV service, repairs and maintenance can be handled. Called the Valley Garage, this new RV service center is being closely watched by all segments of the RV industry. Frank Lee is a Winnebago dealer, but reportedly will handle all makes of motor homes, trailers and campers in his service clinic. We have long anticipated such a venture and predict a booming future.

NEW ELECTRONIC SAFEGUARDS FOR RV POWER SYSTEMS. Unless great care is exercised, a new RV owner can forget to switch over from 12-volt to 110-volt operation when connecting to park sources. The result is instant battery and wire burn-out. Now new systems are available whereby the owner can switch from 12-volt to 110-volt operation with full automatic protection. Sensors immediately change circuits when the voltage changes. This burn-out protection is long overdue.

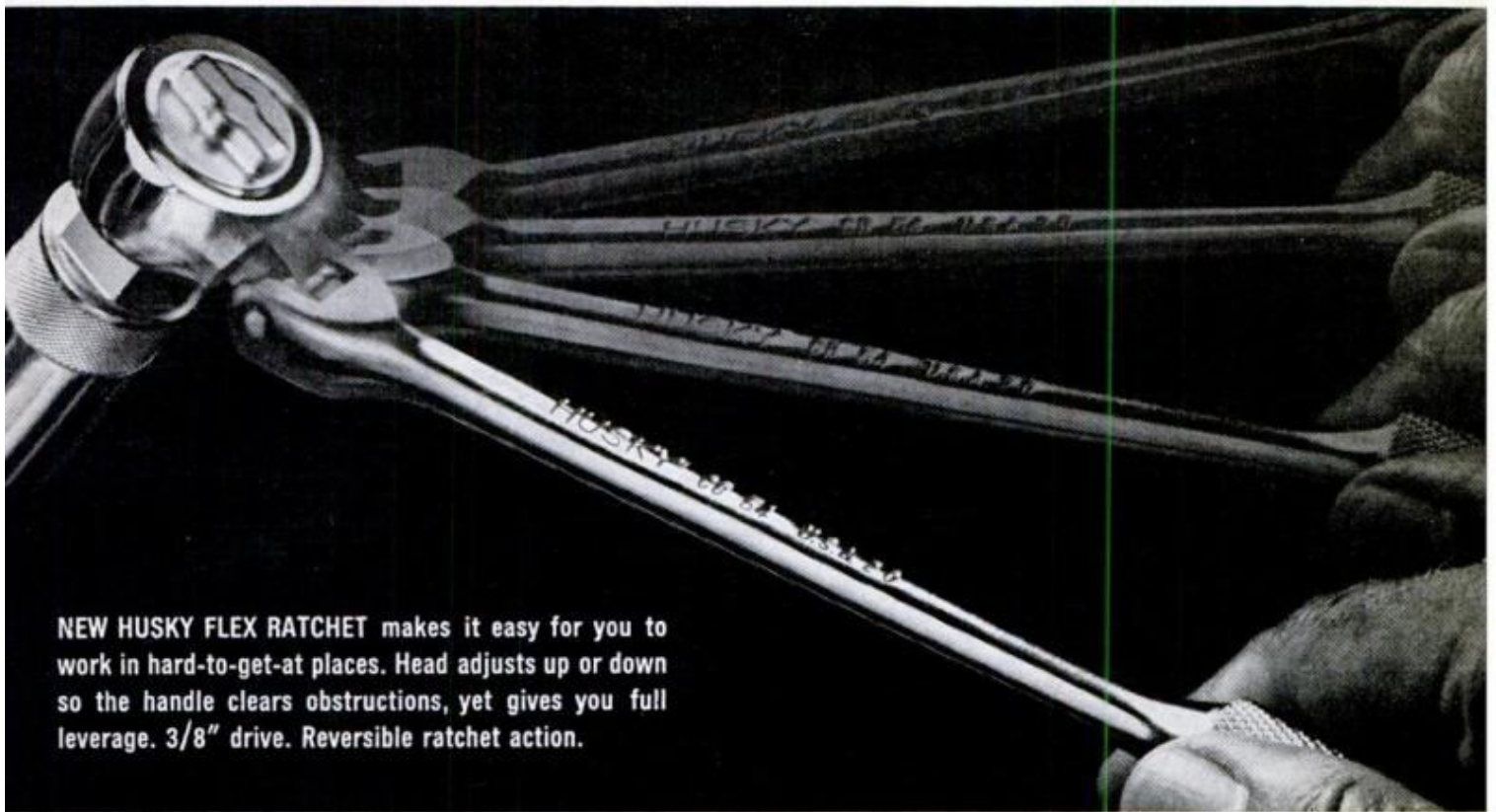
THIS TENT TRAILER FLOATS! The NaviCamper is a new amphibious fold-out trailer. The owner can tow it like any trailer-camper, but at the water's edge, he simply cranks down pontoons and it becomes a boat. Motors as large as 55 hp can be used to water-ski, fish or cruise. The NaviCamper has an aluminum roof, roll-down canvas back and front, and sleeping space for up to six people. Amphibious units may solve some of the problems fishermen face where waterside campsites are scarce. (NaviCamper, 5518 S. Country Rd. 18, Minnetonka, Minn. 55343).

NEW RANCH CAMPS COMING. Some of the new private campground chains are planning dude-ranch-style camping for 1970. Their campgrounds will resemble western cattle ranches, with wagons, riding stables, hay rides, barns and growing crops on the property. Overnight side trips by horseback with ranch-hand guides, western pit barbecue, square dancing, and other Western pastimes will be offered as regular fare. As one campground planner emphasizes: "A modern campground should be a *way of life*, not merely a place to park the family overnight."

BEVY OF NEW RV PUBLICATIONS. The Trail-R-Club of America has published three informative books for the RV owner or would-be owner: *How to Buy Recreational Vehicles and How to Select a Car or Truck for Trailer Towing*, both by Jack Kneass, and *Trailer Owners Handbook* by Jesse Dipboye. For prices and details write the Trail-R-Club, Box 1376, Beverly Hills, Calif. 90213.

WATCH FOR NEW SUPER-LUXURY OPTION PACKAGES ON RVs. The word is that 1970 will see the first general offering of flashy-trim options for campers, trailers and motor homes. Such packages will range from about \$125 to \$1000 or more per recreational vehicle—but strictly at the buyer's request. Such luxuries as larger refrigerators, deep-pile carpeting, higher-quality drapes, and stereo-music systems are only a few of the possible extras. ★★ ★

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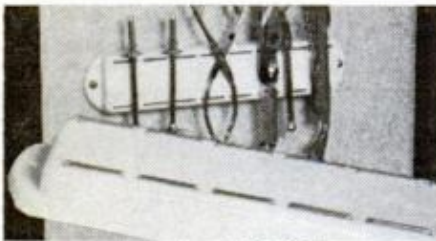
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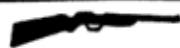
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Hundreds of WSA students and graduates are now earning money with their artwork. Richard White of Zelienople, Pa., was promoted from the welding department to the art department in his company. Alicia Jane Bailey of Miami Beach, Fla., opened her own art and decorating shop with some friends. Mrs. Wallace T. Ahlborn of Munising, Mich., reports she has sold over \$2000 worth of paintings in just two summers alone. Ben Blackson of Pittsburgh, Pa., is now a successful muralist, and has sold his work to General Electric. And there are many other success stories like these.

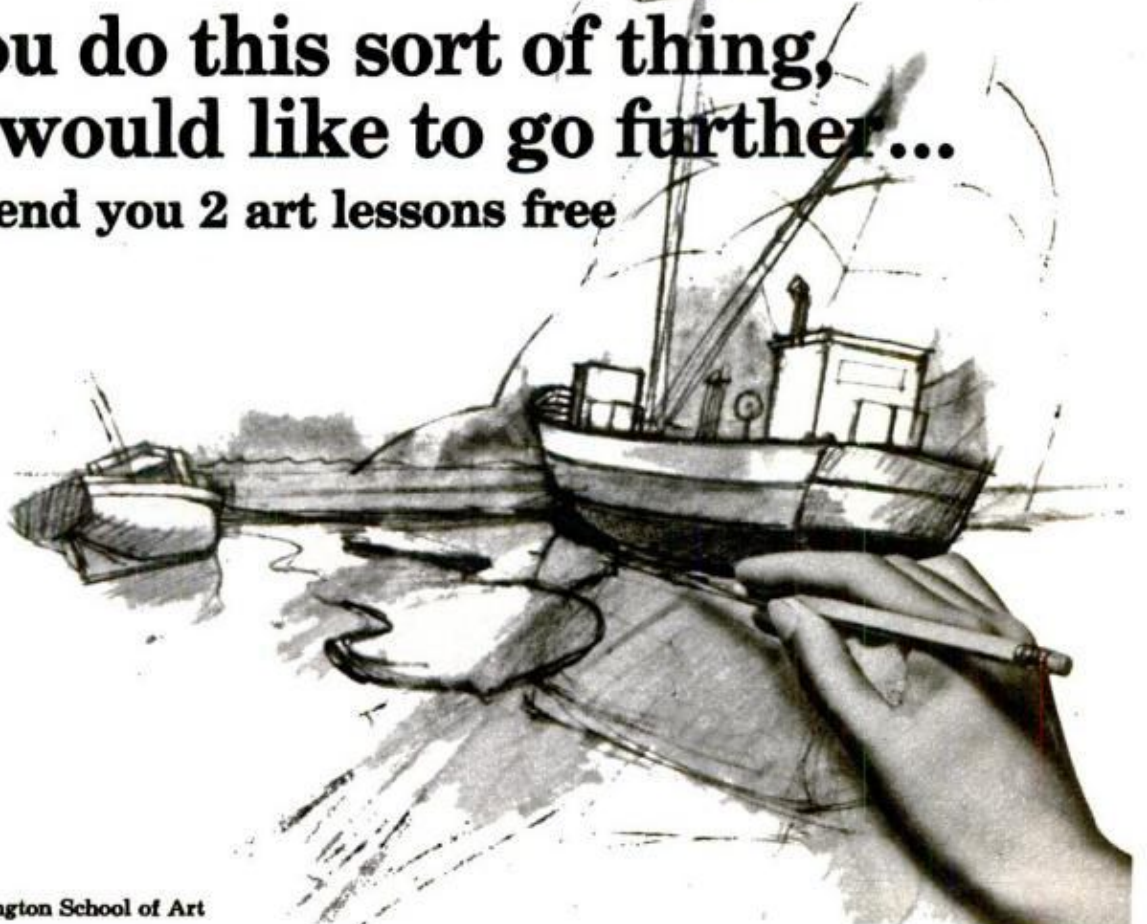
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SOLUTIONS FOR MECHANICAL HEADACHES

AUTOMOBILE CLINIC

BY MORT SCHULTZ

Double check

The owner's manual says the crankcase oil capacity of my 1967 250 Ford pickup with 352-cu.-in. engine is five quarts without a filter change and six quarts with. The dipstick reads one quart over the full mark. Which is wrong, specs or dipstick?—R. J. Andrlich, Omaha, Neb.

Keep in mind that before you check the oil level you should allow the engine to run a few minutes to fill the oil filter. That's where the "extra" quart goes. However, if this doesn't give you the correct dipstick reading, compare the height of the dipstick tube as it extends from the sump with that of a dipstick in another 352-cu.-in. engine. In some cases, the tube is pushed down too far during assembly, which allows the dipstick to be overinserted.

Expensive economy

My Volvo P1800S needs an overdrive and rear end. The overdrive is sealed to the transmission and will probably be very expensive to repair. I think overdrives are ridiculous, anyway. Could I put a different transmission and rear end on this car and save myself money?

—Brian Benwick, Tampa, Fla.

I think the first thing you'd better do is get some prices. Replacing the transmission-rear end setup with a new one without overdrive is going to cost about \$800. You can get what you now have fixed for about \$300. It's your choice.

Fickle freeze plugs

I bought a 1967 Dodge Monaco 500 about 1½ years ago. I've had three different freeze plugs rust out and now a fourth is starting to leak. The dealer says it's due to a rusting condition in the cooling system, despite the fact that the best grade of permanent antifreeze with rust inhibitor is always used, and the cooling system is cleaned out and refilled twice a year. The engine doesn't overheat except when I plug leaks and I lose coolant. The dealer says this is common with new cars. What can I do?

—Mrs. Joan Samler, Huntington, N.Y.

First, don't believe the dealer. This is

certainly not a common problem with new cars or otherwise. In fact, it's one of the strangest I've run across in some time. I doubt if the plugs are rusting out because of a mechanical malfunction. If, for example, the problem was a combustion leak, the engine would be overheating. The only reason I can see for the condition is that the inside of the engine may have been coated with rust to begin with. I think you should demand that your dealer get in touch with the manufacturer. You may have a claim here for a new engine under your five-year, 50,000-mile warranty.

Roll out the barrels

Performance of my 1968 Buick LeSabre becomes rough as the back two barrels of the four-barrel carburetor start to open. Speed falls off slightly. When the back barrels are about half open, performance smooths out. Tune-ups haven't helped.

—D. F. Arnold, Sunnyside, Wash.

This sounds like there's dirt in the secondary. If I'm right, performance will eventually get so bad you'll have to do a complete carburetor cleaning.

Choked off

I've had a dangerous problem with my 1966 Pontiac with two-barrel carburetor since the day it was new. There's a period between closed choke and open choke when, upon acceleration, the engine bogs down and actually dies. Tune-ups and a carburetor overhaul haven't helped. Do you know what's causing this?

—Nick Strelchuk, Chicago

Yes: inability of your present automatic choke control to open fast enough to prevent a mild flooding condition as the engine warms up. A choke kit was issued to cure the trouble, and I'm surprised that your dealer hasn't said anything about it. Maybe you had better remind him that there's a new thermostatic spring, choke piston and choke arm that have to be installed.

Chatterbox

I get a chatter from the antispin rear end of my 1968 Oldsmobile, especially when I go around a curve or corner. I



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After Shave and Cologne Gift Sets in regular, oriental lime and oriental spice. Also, regular after shave with soap on a rope.

want the dealer to call an Olds representative, but he says this is normal. What should I do?—Cal Felton, Peoria, Ill.

This is not unusual, but it isn't exactly normal. In breaking in this car, something caused an excessive temperature increase in the differential, resulting in a breakdown of the axle lubricant. Did you, for example, haul a trailer? In any event, here's what to do: Drain all the old lube. Clean the assembly with mineral spirits or kerosene, using an air liquid siphon gun. Air-dry the assembly to remove all the cleaning solvent. Now apply new anti-spin differential lubricant and drive the car for 50-75 miles to let the lube work through the unit. By this time, the chatter will have disappeared.

Horizontal filter

When I take the oil filter off my 1968 Corvair, oil spills on the engine shroud, and it smells awful until it finally evaporates. Is there a way to avoid this?

—George Lincroft, Kansas City, Mo.

The trouble, of course, is that the filter is mounted horizontally, rather than vertically. To avoid this, remove the adapter with the filter and make sure that the assembly (filter and adapter) is kept level. The drawback is that you'll have to replace both adapter gaskets every time you replace the filter. The part number for the inner gasket is 5575514, while that for the outer gasket is 3838401.

Heads up

My car is a 1968 International Scout. I've had to replace the header pipe and exhaust more times than I'd care to tell because they start to leak fumes. What do you think is causing the damage?

—Neil Walton, Glenville, Minn.

Have you checked the exhaust manifold flange (header) for warpage? You'd better pull the exhaust manifold to do this; I'm almost sure you'll find this to be the trouble. If so, replace the manifold.

Under pressure

I have a 1966 Volkswagen 1600, bought used, with 65,000 miles now on it. I overhauled the engine at 38,000 for bearing troubles. My oil-pressure gauge shows 40

pounds per square inch cold and 23-25 at 55 mph in fourth gear. However, under heavy load, such as a fast run on an interstate or full-throttle mountain climbing, pressure drops to 17-20 p.s.i. Is this okay or should I expect trouble?

—Eugene Ramsey, Waynesboro, Va.

VW oil-pressure specifications call for 28 p.s.i. at 3000 rpm with the engine warmed to an operating temperature of 185° F. This puts you just on the short end of things, but slightly, and I think you can live with it. There are no specs provided for mountain climbing, but 17-20 p.s.i. would appear adequate to me. I'd say not to worry unless things get worse.

Service Tips

● **Mercury** warns about a false low oil reading on the 1969 Montego and Cougar with 428-cu.-in. Cobra Jet engine. Watch how that dipstick is put back into the tube after the oil level has been read. If the end of the stick is bent accidentally or if the stick is inserted backward into the tube, you'll get a wrong reading the next time you check the oil. The curl of the handle must be toward the front of the engine and the blade must be kept straight.

● **Chrysler Corp.** cars (Dodge, Plymouth, Chrysler and Imperial) have been having problems with their three-speed windshield wipers. Two repair kits have now been issued to clear up short-circuit, binding and failure-to-park difficulties. They carry part Nos. 3420870 and 3420871.

● **American Motors** has issued a notice to keep in mind if you ever need to have an automatic transmission overhauled. After transmission bands and clutches have been washed in solvent, make sure they are allowed to dry only by plain old, ordinary, atmospheric air. Compressed air causes protective material on those clutch parts to separate. This material protects these parts against the high temperature generated in a transmission.

● **Chevrolet** recommends that the Powerglide transmission throttle-valve override linkage of 1967, 1968 and 1969 Sixes now be lubricated, so add this tip to your lube chart. The job's to be done every 6000 miles or four months with water-resistant EP chassis lubricant. This linkage has caused some binding problems that lubricating will prevent. ★ ★ ★

GOT A PROBLEM WITH YOUR CAR? Ask Mort about it. Send your question to Auto Clinic, Popular Mechanics, 224 West 57th St., New York, N.Y. 10019. Letters cannot be answered individually, but problems of general interest will be published in the column.



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HOMEOWNERS' CLINIC

BY W. CLYDE LAMMEY

Painter's bane

I'm going to paint my house. The old paint is blistered and I'm told to sand down the edges of the blistered areas—"feather" them. Okay, I do this until the paint film is thin. Then it breaks off, and I have an unsightly square "shoulder"—the same scabby look as before, even under two coats of new paint. Just how is this trick done?—R. E., Mass.

Blisters are the bane of house painters, both pros and amateurs. They scrape, sand, chip and sand again and some finally give up, knock off the loose pieces and paint right over what's left. I've found that a small sanding block of $\frac{3}{4}$ -in. stock cut to about 2 in. long and $1\frac{1}{4}$ in. wide, with one end cut at an angle, and a sandpaper strip thumbtacked to the block, does the best job of feathering those unsightly edges. With it, you can sand a minimum area and get the edge sufficiently thin to prevent it from casting the shadow which causes the unsightly appearance.

There's another way: Remove all the loose paint film and coat the edges with a paint remover. As soon as the old paint has been softened, work outward from the center of the blister with a putty knife. If you're careful you can peel off the paint at the edges to a film so very thin that it will not cast a shadow when painted over. Use a thick-paste, wash-off remover, rinse the surface immediately and wait until it's thoroughly dry before applying new paint.

Dewaxing linoleum

The linoleum kitchen floor at my new address is covered with something that's a dirty, brownish color I simply can't live with. Washing and scouring seems to have no effect. What can I try next?

—M. R., Mont.

I'd guess right away that the coating must be either multiple coats of wax or a linoleum varnish that has been neglected, so that the dirt is literally embedded in the coating. This is impossible to remove by ordinary means. What to do next depends on the condition of the linoleum. If it is still good, you may find an at-

tempt to salvage it worthwhile. If the coating is linoleum wax, turpentine applied liberally will remove it. But remember, when using turpentine there's both a health and fire hazard. Have the windows and doors open and, if necessary, place a fan to provide air circulation. As a rule, the turps will soften the wax within a few minutes so that it can be wiped off readily. Treat only a small area at a time. On the other hand, if the coating is linoleum varnish, it will be more satisfactory in the end to replace the old linoleum.

Whitening 'rock roof'

My home has what is referred to locally as a "rock roof"—that is, white crushed stone over layers of roll roofing. It's now discolored by dirt, dust and other debris. I'd like to wash, paint or otherwise whiten it to its original color. What do I use and how do I go about it?—L. B., Miss.

A strong spray from the garden hose should get rid of most of the dust accumulation and possibly lighten the covering. Otherwise I would use a stucco paint or any water-soluble white paint. Perhaps the stucco paint would be best. Ask your building materials dealer to tell you what is used locally. Very likely you could use your knapsack sprayer for application, but with only $3\frac{1}{2}$ -gal. capacity this would be a rather slow process. You also would have to thin the paint to a sprayable consistency and possibly use a nozzle with a larger opening than normally supplied with such units. Were I doing this job myself I would spray one coat, then turn the loose material with a rake and apply another coat, just to make sure all surfaces of the individual particles were covered. Most stucco and water-soluble paints require that the surface be wet or at least damp immediately before application. Follow instructions on the container.

Wintertime green thumb

I want to grow tuberous begonias next season but I don't know when to start them for the earliest blooms. Some say midwinter, others say later on, some plant directly in open ground after frost. Can you suggest a procedure?—O. L., Ind.

I've only limited experience with these plants, but I've learned that the blooms will be much later in season unless you give the plants an early start indoors. If the season breaks right with an early spring, you should do all right by planting directly in open ground. ★★★



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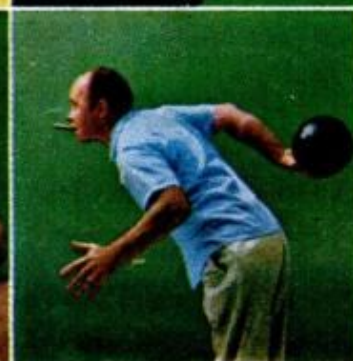
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Next Month in Popular Mechanics

How We Raised the Alvin From 5000 Feet

In an exclusive report, William O. Rainnie describes how the *Alvin*, deep-diving submersible, was recovered from the ocean bottom after being submerged nearly a year following an accidental sinking. Rainnie, deep-diving expert at the Woods Hole Oceanographic Institution, tells how the Navy, Woods Hole personnel and other civilian organizations recovered the largest object ever brought up from such a depth.

A Hot New Fighter for the Navy

The F-14 is designed to roll and turn at supersonic speeds and outshoot planes threatening our fleet. It's the Navy's substitute for the controversial F-111.

An Old Pro Tries Out the World's Most Advanced Car

John Fitch, the only American to race for Mercedes-Benz in the glorious days of Fangio and Moss, takes some fast laps at Hockenheim in their new experimental, mid-engine sports car.

How to Catch a Hippopotamus

. . . or an elephant or a zebra or a buffalo. Game wardens in South Africa's Kruger National Park do it every day. All you need is a helicopter or a bulldozer, a crossbow, a quiver of tranquilizing darts and a steady aim. It also helps to take a tranquilizer yourself.

Fantastic Farm Machinery

New machines plant seed with a roll of plastic tape, pick tomatoes, select only ripe heads of lettuce—and drop two tons of blueberries an hour into crates.

Shoot Glareless Pictures With Polarized Light

Those annoying reflections you get off glass and other shiny surfaces can be eliminated with easy-to-make filters over your photofloods.

Special Roundup: Great New Ideas from the Hardware Show

PM editors scouted the National Hardware Show to see what new—and updated—items would be available for the home, yard and shop in 1970. The January issue tells what they found.

Put a Speed Control on Your Windshield Wipers

Slowing down your blades' sweep rate gives you a clearer, safer view in light rain or muddy road spatter. This easy-to-make device will work on any car with electric wipers.

Rotary Print Washer Anyone Can Build

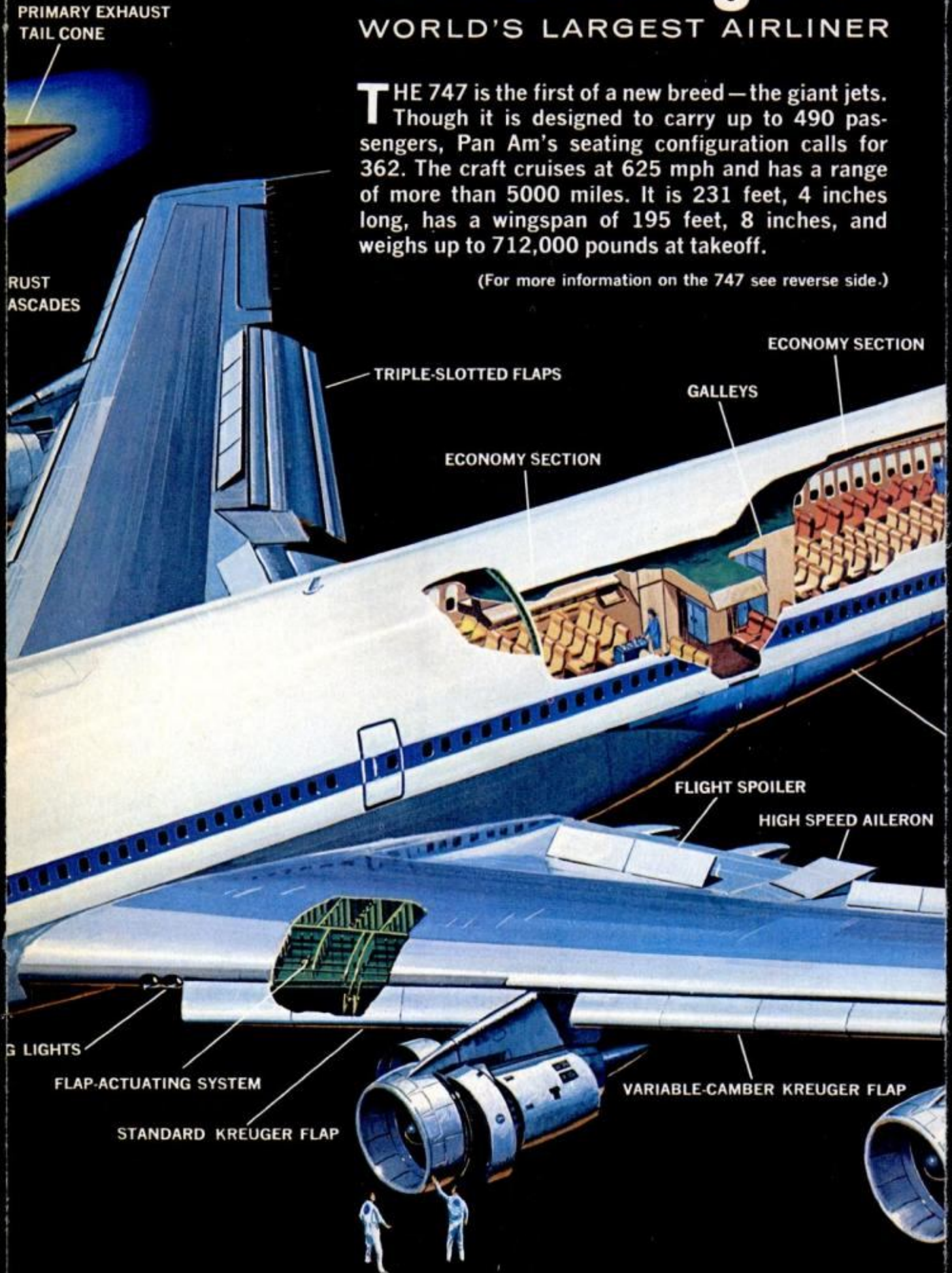
A plastic laundry tub and some hose fittings can give you a professional-type, swirling-action washer for \$5.

The Boeing 747

WORLD'S LARGEST AIRLINER

THE 747 is the first of a new breed—the giant jets. Though it is designed to carry up to 490 passengers, Pan Am's seating configuration calls for 362. The craft cruises at 625 mph and has a range of more than 5000 miles. It is 231 feet, 4 inches long, has a wingspan of 195 feet, 8 inches, and weighs up to 712,000 pounds at takeoff.

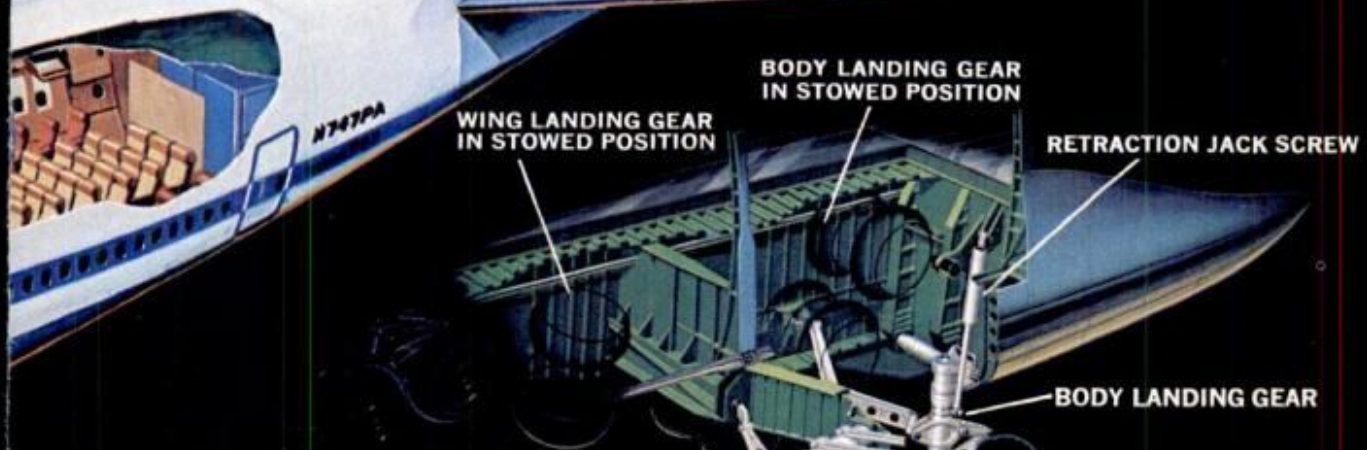
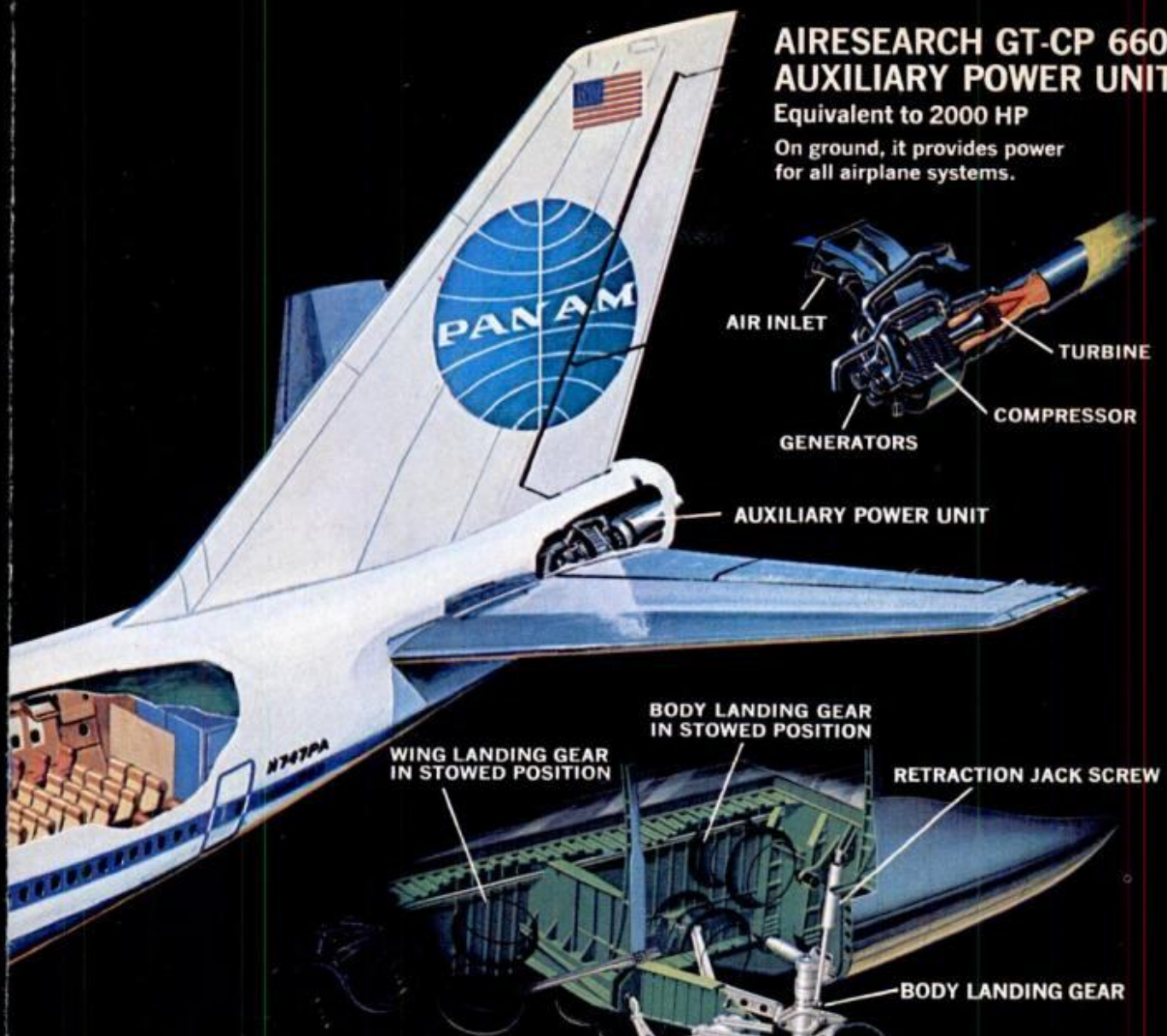
(For more information on the 747 see reverse side.)



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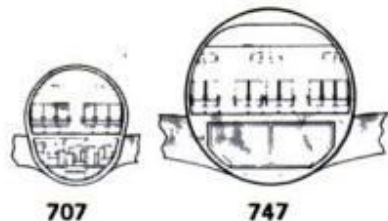
New Era in Air Travel

By JOHN F. PEARSON



AIR TRAVEL WAS REVOLUTIONIZED when the jets replaced piston craft. Now another new era is at hand: the era of the giant jet. Boeing's 747 is the first of the big birds and promises to be a workhorse in long-range travel for years to come. Among its enthusiastic supporters is Najeeb E. Halaby, president of Pan American World Airways, who predicts that there will be three times as many passengers flying by the late 1970s as there are today. Since Pan Am is an international carrier, it needs large-capacity planes. The company helped to make the 747 a reality by placing a substantial initial order for the big plane.

How big is big? The photo at the top of this page shows a 747 next to a Boeing 707, one of today's most widely used long-haul jets. Almost 80 feet shorter than the 747, the 707 can carry a maximum of 187 passengers in an all-economy configuration. The 747's capacity is 490. But Pan Am, the first airline to put the plane into service, has no intention of "packing 'em in." Pan Am's planes will normally carry 362 passengers: 58 in first class and 304 in economy. The cabin, nearly 20 feet wide (7 feet wider than the 707) and 186 feet long, is partitioned into five sections to give passengers the feeling of being seated in something resembling a small theater rather than the customary tubular cabin. Economy seating is nine abreast, as shown in drawing at right. Two aisles, each 20 inches wide, permit passengers to move about relatively freely and make food-dispensing chores easier for the 14 stewardesses. There are six galleys and 12 lavatories.



Economy seats on Pan Am's 747 are 10 percent wider—19 inches in all—than on current Pan Am jets. Entertainment facilities have been upgraded, too. Each passenger has a choice of 10 audio channels, carrying everything from travel tips to classical music, that he can listen to on his headphones. In addition, movies are shown on six separate screens on the plane's main deck.

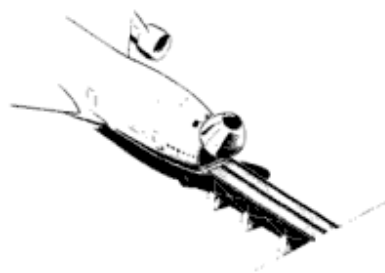
The 747 has 10 doors, five on each side, but Pan Am plans to use only three for boarding. Doors are huge by airliner standards—42 inches wide and 76 high—allowing two passengers to board at the same time. It's estimated that boarding will be accomplished in 17 minutes, about the same time required by current jets. Bridges (shown in drawing) or mobile covered ramps will be used.



Plans call for splitting some terminal waiting rooms into two or three lounges, each serving a different door of the plane.

On the standard 747, baggage is carried in 16 color-coded containers in the forward hold. Containerized cargo is carried in the aft hold and bulk cargo in a rear compartment. Total payload, including passengers, hits about 124,000 pounds.

The plane also comes in freighter or convertible (passengers and/or freight) versions. These models have a nose that swings up to allow cargo pallets or 8-by-8-foot containers, in lengths up to 40 feet, to be loaded straight in. Loading systems for both the main deck and lower hold are mechanized, the freight moving in on powered wheels and tracks containing casters. Only two men, one at the nose and one inside, are needed to load and unload the main deck. The freighter can carry a payload of 260,000 pounds, more than twice that of current jets, for a distance of about 2900 miles. It will carry more than 200,000 pounds nearly 4000 miles.



The 747 requires extensive ground support. Pan Am mechanics and other ground personnel will work with some of the most sophisticated servicing equipment ever devised.

A four-wheel-drive tractor weighing 108,000 pounds—some 1000 pounds heavier than the maximum gross weight of a DC-6B airliner—is used to tow the 713,000-pound giant from the terminal to taxiways. Through the use of a ballast system, the weight of the tractor can be boosted to 155,000 pounds to increase traction on slick taxiways.

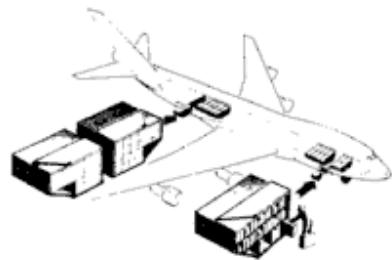
Pan Am uses prepacked galley modules to handle the food and drink for the 747. The modules, some of them over seven feet wide and nearly three feet deep, are packed at a ground commissary and transported by scissor-lift trucks to the aircraft. Once aboard, the modules are simply “plugged” into the six galleys.

At a major airport like Kennedy International, servicing for an originating flight requires about two hours. Some 64,000 pounds of containerized baggage and cargo is placed aboard the aircraft and 46,770 gallons of fuel pumped into its huge tanks.

Noticeably absent from the array of supporting equipment are the familiar air compressor “start cart,” the airconditioning truck and the electrical power truck. These functions are handled by the 747’s auxiliary power unit (APU), located in the tail.

Many innovations and technical improvements help to make the 747 what it is. It is the first airliner, for example, to have an inertial navigation system (INS) as standard equipment. Similar to the guidance system used on the Apollo moon rockets, the INS needs no outside signals in guiding the plane. Tests have shown the system to be five times more accurate than the standard method of navigation.

Shaded areas in drawing (above) indicate fiberglass honeycomb panel-



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Portable Electric Tools Division

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SMILE! You Just Got a Ticket

A computerized camera provides the evidence: a picture of the speeder, his car, license, speed at which he was clocked, time, place and speed limit. No muss and no fuzz; he gets the ticket in the mail

By MICHAEL LAMM

START CHECKING YOUR MAILBOX for speeding tickets. Evidence will be a picture of you and your car high-tailing it past a computerized roadside camera.

True, it'll take all the fun out of speeding, but look at the bright side. There'll be no patrolman to yessir, no reprimands, no excuses to think up—just a clean, straightforward, automatic, unfixable ticket.

If the Orbis speed monitoring system comes off as planned, speeding will be a thing of the past. The system's computer gauges speed in a flash. The photo shows: 1) an identifiable mug shot of the driver, 2) license plate, 3) make and type of car, 4) your speed in mph, 5) the legal, posted speed limit, 6) date and time, and 7) location. That's it, man—you've had it.

Shattering as it might seem, Orbis (Latin for circle or orb, secondarily meaning eyeball) can and will save lives. It'll also save money and manpower. *PM* flew me to Dallas to see the thing work. It's being developed by LTV Aerospace Corp.'s Missiles and Space Div. in Grand Prairie, Tex. There was only one Orbis unit in



MOBILE DEMONSTRATION UNIT of Orbis has its own power, can be used in school zones, suburban areas

existence at the time, but two more were being assembled, and production versions will be very similar—more refined, yet identical in all essentials.

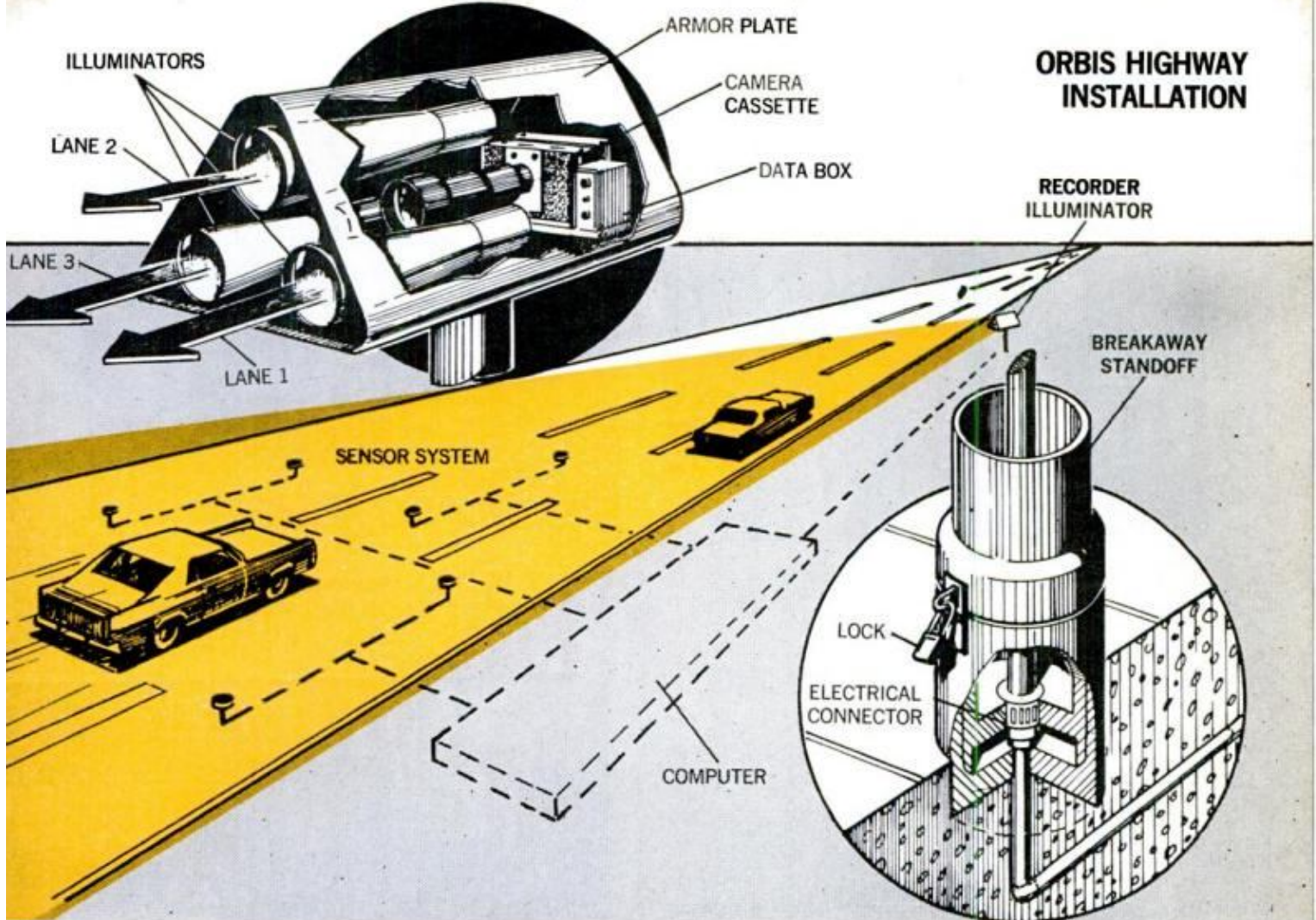
I must say the Orbis works with marvelous efficiency. It's unemotional, unbiased, direct and completely accurate. In fact, I now hold the dubious distinction of being among the first of its victims. To see how it worked, I flashed past the Orbis truck in my rented VW. A little red light winked at me as I streaked through a 35-mph zone at 53 mph. That wink was about as bright as someone blipping his brake light for an instant. It meant I'd been zapped and my speed and picture had been recorded. The result is shown on the previous page.

Two types of Orbis installations are planned for production: mobile and stationary. The stationary unit will stand beside a highway, permanently encased in a bulletproof, practically in-

destructible fixture. Electromagnetic sensors will be buried in the pavement, one set under each lane. The reason everything will be concealed and armored is because some people will feel less than friendly toward these little snapshooters. But about the only way to kill a permanent Orbis installation will be to ram it briskly with your car, shearing the breakaway mount. Otherwise, there's nothing much you can do to jam it or outfox the system.

The existing mobile prototype carries the Orbis camera, computer, illuminators, a self-contained darkroom, plus such accessories as two-way radio and airconditioning. Its projected price with this equipment comes to \$13,000-\$15,000 complete (1970 Chevy Custom 10 wagon with 350 V8 and all extras). Fixed installations will sell between \$4500 and \$6000.

To set up the Orbis mobile unit, LTV technicians first placed two pressure



ORBIS HIGHWAY INSTALLATION

HIGHWAY INSTALLATION will have sensors in roadway, camera protected from vandals by armor plate

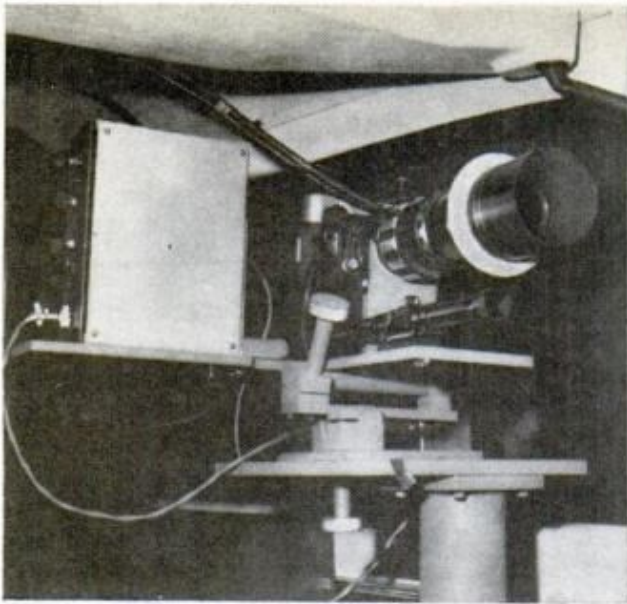
sensor strips across one lane of Route 303 southeast of Dallas. These sensors are unlike those to be buried with the fixed installation. They're more like the hoses stretched across gas-station driveways. In either case, sensors are spaced 14 feet apart and stand about 117 feet in front of the Orbis camera.

Inside the truck, there's a little computer mounted right beside the camera. This measures the time it takes a car's front wheels to roll from one sensor strip to the next—14 feet. Like similar systems used to time drag races, the computer translates this time span into mph. If car speed is more than the posted limit, the computer automatically trips the camera shutter, at the same instant flashing the two powerful (yet nearly invisible) red illuminators.

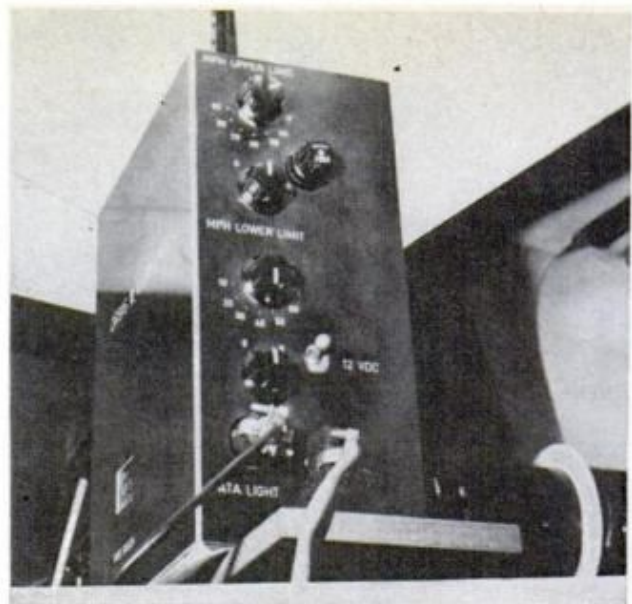
Now here's the astute part. If the computer notes that the car *isn't* speeding, nothing happens. Orbis is interested only in speeders. The officer can

dial the posted speed limit with a simple knob on the computer. If he wants to, he can also set another knob to give a minimum speed limit. The computer has a little window that shows the exact speed of each passing car, whether it's speeding or not. If this is above (or below) the posted limit, though, the computer read-out (the number that shows in the little window) is carried via a system of small mirrors into a secondary lens of the camera so its image passes into the camera itself. Here it's captured on the same film frame as the speeding car. Now that's pretty clever, you've got to admit.

The Orbis illuminators are interesting, too. They act as strobes. Their light tends toward the red end of the visible spectrum, as does the camera's sensitivity. The camera uses a commercially available 35-mm film, but filters inside the lens make it partial to red light. The red beam works well in daytime,



REWORKED 35-MM CAMERA has separate lens on side next to computer (left) to record mph, violation data

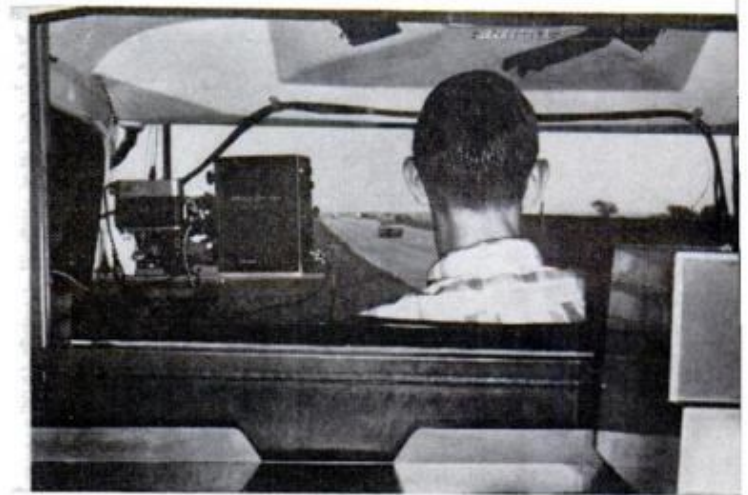


BRAIN OF SYSTEM is computer, with dials to set upper and lower limits. It trips camera, illuminators

but it's even more effective at night. It penetrates beyond the glare of headlights and easily pierces windshield reflections and tints. All the speeder sees in passing is that brief blip of red, not bright enough to dazzle, yet noticeable. In addition to illuminating, the red becomes a warning. When Orbis installations become common, dummy units with only the red blipper might be just as effective as the real thing.

LTV's manager of technology applications, Dave Lee, told me that during an early demonstration given for law-enforcement agencies, Orbis photographed 276 speeders during one three-hour period. This was along the same fairly deserted stretch of highway where they set up the demo for me. Mostly, Dave said, speeders were going only two or three mph over the limit, but the system as now set up has the capability of recording any speed up to 199 mph. Film and camera can also capture clear images at that speed. The winner, so far, of the Orbis Speed Award, goes to a driver who registered 132 mph in a 70 zone.

As first planned, LTV engineers had hoped a film cassette of 1500 frames would have enough capacity to monitor an average three-lane highway for eight hours. Along some routes, though, speeders are so common that 1500



VIEW FROM DARKROOM of mobile unit shows camera and computer ready as speeder nears sensor system

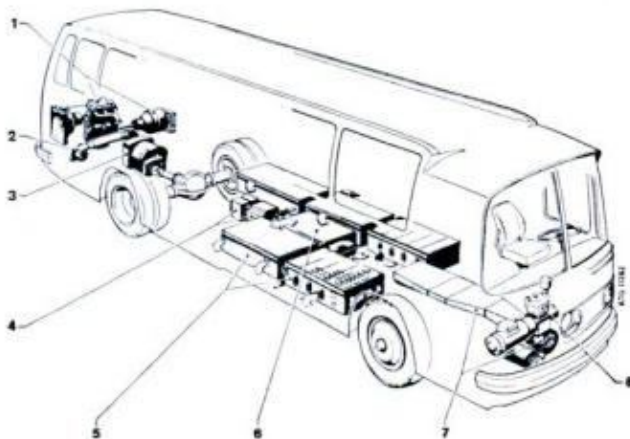
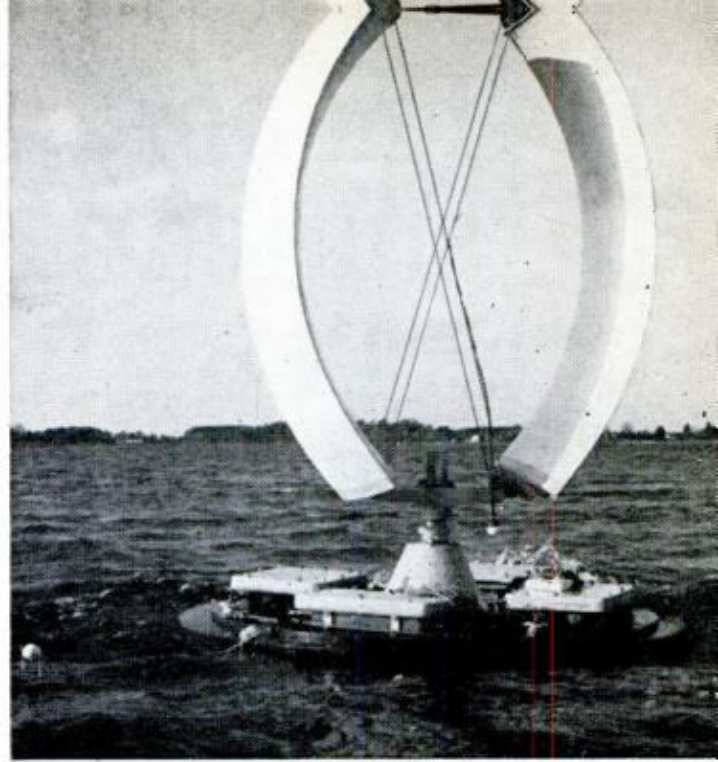
frames would last only about three hours. Of course, once the Orbis system becomes known, traffic will probably slow to meet cassette capacity.

Most state vehicle bureaus are now in the process of computerizing their auto registration records. When that's finished a few years from now, it'll be a simple matter to match photo-recorded license numbers with car owners' names and addresses. And that's how speeding tickets will be passed out by mail. Still, law enforcement agencies might not want to cite all violators shot by Orbis. Depending on circumstances, perhaps they'll want to ticket only drivers caught speeding again and again—the

(Please turn to page 194)

Robot sailboat

A unique robot sailboat developed by RCA can navigate itself unmanned to any point on the seas of the world and keep its station without a mooring. It can remain in one position for as much as a year and return home on a command sent by radio. While in position, it could carry out such scientific chores as monitoring weather or such military tasks as detecting submarines. Named SKAMP (for Station Keeping and Mobile Platform), the 16-foot-tall prototype navigates over water guided by a computer that acts as an automatic "helmsman." The computer sends signals that cause the rigid sail to rotate at its base and the craft's two rudders to move to maneuver the vessel so it takes best advantage of the wind. Spokesmen for RCA's Astro-Electronics Div. say they plan to test a self-contained navigation system that receives signals from Navy satellites.



1. OM 314 engine with generator.
2. Cooling blower for traction engine.
3. Electrical traction engine with reduction gear.
4. High-tension section.
5. Five lead batteries.
6. Electronic control.
7. Cooling blower for batteries.
8. Air compressor and servo steering pump.

'Hybrid drive' electric bus

"A city bus with a hybrid drive" is the way Daimler-Benz describes its new Mercedes-Benz OE 302 electrically powered bus. Carrying 3½ tons of lead batteries, the 66 passenger experimental vehicle can reach a top speed of 43½ mph. There are two principal reasons for developing an electric bus, says the firm: Electric drive is quiet and is free from exhaust-gas emission. While operating within city limits, the vehicle gets its energy from the storage batteries; while in intercity travel, a large share of the energy is supplied by a diesel engine and generator combination that is insulated to cut down noise and vibration. Daimler-Benz has developed an electronic control that minimizes the energy losses common to electric-drive vehicles in the past. The firm has announced no plans yet for manufacturing the electric buses for commercial use.

'I'm not stuffed— I'm freeze-dried!'



SHINER MINNOW is about to become meal for belted kingfisher. Exhibit was made by freeze-drying method

The lifelike, frozen-in-action poses of the new wildlife specimens in the Smithsonian Institution are the result of freeze-drying, a process that leaves animals and birds perfectly preserved

By **WILLIAM O'NEILL**

Photos by James Pickerell

IF YOU HAVE EVER VISITED your local natural history museum, you probably were impressed by the lifelike appearance of the wildlife displayed there. But if you gave the credit to the taxidermist, you may have been wrong. More museums today are experimenting with freeze-drying to keep animals permanently in true-to-life poses without all the trouble of cutting them open, eviscerating them and mounting their skins.

Hunters in Alaska are familiar with freeze-drying. Ducks hung outside overnight in winter will be completely dehydrated by morning. The liquids in the birds will have frozen, then been drawn off as vapor by the cold wind blowing across them. Blood plasma and antibiotics are freeze-dried for preservation, storage and shipment. Campers and hikers appreciate packaged, freeze-dried foods because of their lighter weight and smaller size.

Credit for adapting the process for museum use goes to Rolland Hower, 40, an exhibits specialist at the Smithsonian Institution in Washington, D.C. Hower was introduced to freeze-drying by Dr. Harold T. Merryman of the U.S. Navy Medical Research Institute's Biophysics Div., and has been working with it at the Smithsonian since 1960, modifying and improving the procedure as he goes along.

The Smithsonian's freeze-drying equipment consists of a specimen chamber, a condenser chamber and a vacuum pump. The refrigerated, airtight

specimen chamber is nine feet long and five feet in diameter, and can hold up to 100 specimens at a time. When a specimen—which can be an animal, reptile, fish, bird or insect—is received by the museum for exhibit, Hower puts it into one of the two large deep-freezers that occupy one wall of his laboratory. To prepare it for display, Hower's assistant, Bob Winkelman, 21, thaws out the specimen and fixes it in the desired pose. He will run wires into the feet of a bird or raccoon, for example, so that it can be attached to a tree branch. Winkelman also replaces the eyes with artificial ones.

He then places the specimens inside the chamber, seals the chamber and drops the temperature in it to minus 4° F. Water freezes at 32° F. but the lower temperature is necessary to insure that every drop of body fluids in the museum specimens turns to solid ice. After this subfreezing temperature is reached, air is pumped out of the chamber until its atmospheric pressure is .039 pounds per square inch, compared with a normal pressure at sea level of 14.7 pounds. In this near-vacuum, the ice inside the specimens "boils" and evaporates.

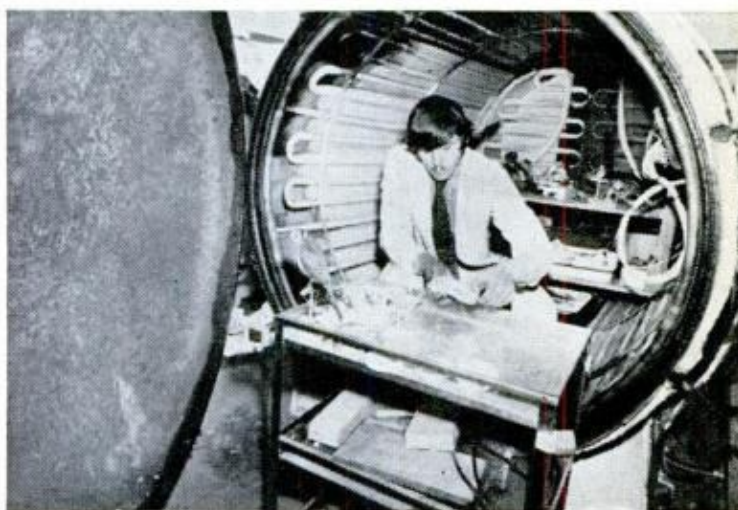
The boiling point of a liquid is the point at which it changes into a vapor. Water changes into steam at 212° F. under normal atmospheric pressure at sea level. But on top of Mount Everest, 29,028 feet above sea level, the atmospheric pressure is considerably lighter and water will boil at only 162° F. Decreasing the pressure still further will take the boiling point so low that a frozen liquid will go right from the ice to the vapor state. This is the key to freeze-drying.

In the Smithsonian's refrigerated vacuum chamber, the liquids in the bodies of the specimens—now frozen into ice crystals—are given off as vapor, starting at the surface of the skin and gradually working in to the center. Since they change directly from ice to vapor, bypassing the liquid stage, there is no chance for blood vessels and tis-

DECEMBER 1969



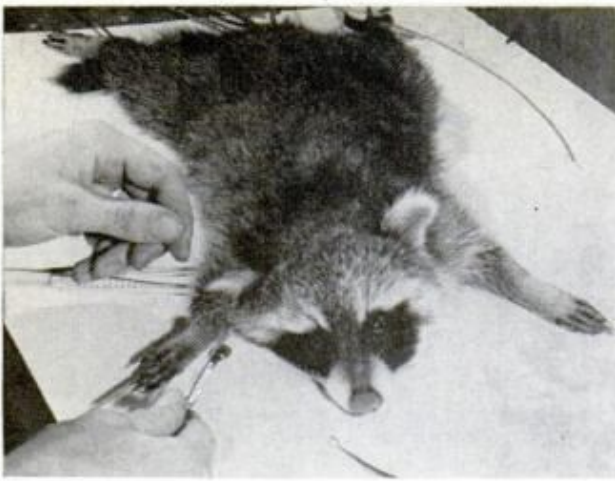
READY FOR DISPLAY, a yellow-shafted flicker has his back feathers smoothed by laboratory assistant



FOR GREATER EFFICIENCY, the specimens are processed in batches. Loaded trays go into chamber



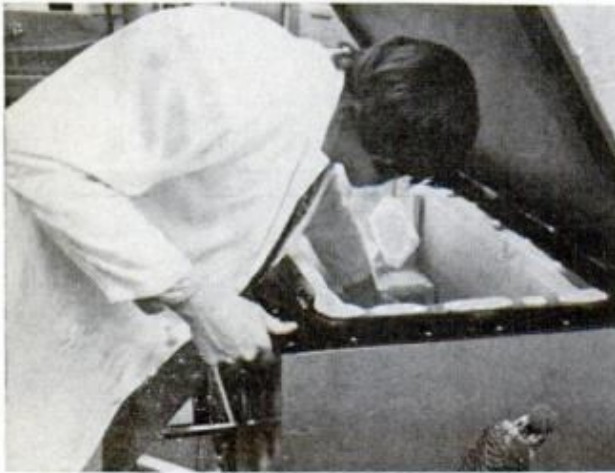
RED SHOULDERED HAWK alights on branch—pose in which the bird was placed before being freeze-dried



TWEEZERS GRIP artificial eye about to be placed in empty socket. Eyes are inserted before freezing



HOLES IN BOARD permit insertion of wires used to hold the specimen in pose during freeze-drying



FREEZERS HOLD mammals, reptiles, birds, fish, insects—specimens awaiting mounting and processing



SPECIMENS DRY OUT in chilled vacuum chamber, a key step in process. Drying takes about two weeks

sues to collapse, shrink and change shape, as would normally occur during dehydration. Such reduced size may be ideal for the frozen-food maker, but the distortion would be disastrous in a specimen to be displayed in a museum.

If the vapor given off by all the specimens were allowed to accumulate in the chamber, it would build up the atmospheric pressure until the process slowed down and finally stopped. In the heavier atmosphere, no more vapor would escape from the specimens, even though ice crystals still remained in their bodies. To keep the process moving, a condenser chamber is attached to the specimen chamber and is kept at about minus 58° F.

The vapor is attracted to the colder chamber, where it forms ice around the condenser coil. By the time the freeze-dry process is complete, the temperature in the two connected chambers

will have about averaged out, but will still have been adequate to completely dry out the frozen specimens. Since outward appearance of the specimens remains unchanged during the process, Hower and Winkelmann enter the freeze-dry chamber at intervals of from one to two weeks and bring specimens out to be weighed. The specimens become lighter as dehydration progresses. When a specimen shows no further weight loss, it has been completely freeze-dried and is ready for exhibit. Another specimen replaces it in the chamber and the process continues.

It takes about 10 days to freeze-dry an insect, two to three weeks for a robin, and about twice that long for a fox. The finished specimens are rigid, lightweight and perfectly preserved against decay. Because fewer man-hours are required to prepare specimens by freeze-drying, as compared



WEIGHT LOSS indicates evaporation of body fluids. Freeze-drying is completed when weight loss stops



FINISHED EXHIBIT is a lifelike raccoon. Success of the method has prompted other museums to try it

with taxidermy, the process represents a financial saving to museums.

A skilled taxidermist can mount from 50 to 100 animals in a year. Winkelman can produce more than 400 finished specimens in that time by freeze-drying, and Hower estimates that more than 3000 specimens have been freeze-dried for Smithsonian exhibits in the past eight years.

The lighter weight, greater realism and fewer man-hours involved are not the only advantages museums derive from freeze-drying. Insects and small, soft-bodied specimens that formerly had to be preserved in jars of alcohol, now can be shown in their natural surroundings. Snakes in museum exhibits previously were painted plaster casts, but freeze-drying enables curators to put the real thing on display.

The largest specimen Hower has freeze-dried was a six-foot-long alliga-

tor, but he sees no size limitations. Given enough time, a larger vacuum chamber and the necessary block and tackle, Hower would be willing to freeze-dry an elephant if the Smithsonian requested it. The specimens that continue to give him trouble are fish. While some fish freeze-dry perfectly, others change the color of their scales, and Hower and his assistants are still checking ways to prevent this.

Museums frequently contact Hower for advice on setting up freeze-dry laboratories. The Smithsonian Press has published a paper in which he gives a detailed description of the equipment required. A museum in London now freeze-dries its specimens, as do some museums in the United States, and the Australian Museum is preparing to construct a freeze-dry chamber.

Last year, Hower began working with the George Washington University School of Medicine, Washington, D.C., freeze-drying hearts, stomachs, livers and other pathological specimens for use in classroom instruction. Previously, medical students learned from studying human organs kept in alcohol jars or from plaster and plastic replicas. Now, freeze-dried specimens will help train new generations of doctors. ★ ★ ★

DEVELOPER of Smithsonian process, exhibits officer Rolland Hower, holds freeze-dried human organs



Four-Mile Train With

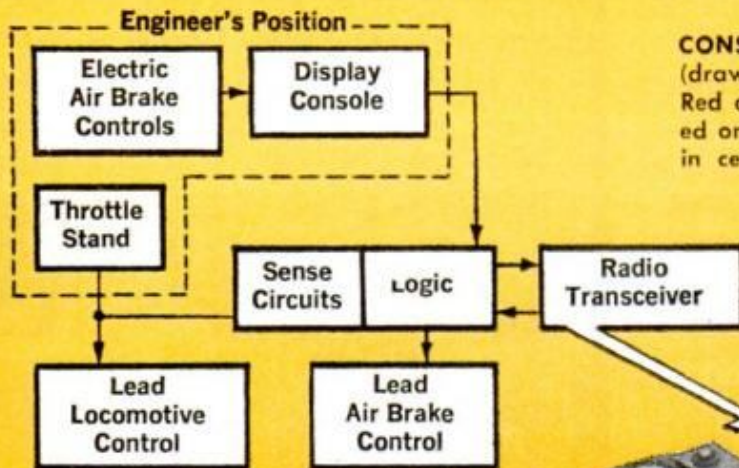
More than two miles behind the locomotive, a string of diesels responds instantly to engineer's throttle and brake. UHF, VHF slaves are now working on the railroad

By HENRY COMSTOCK / Illustrations by the Author

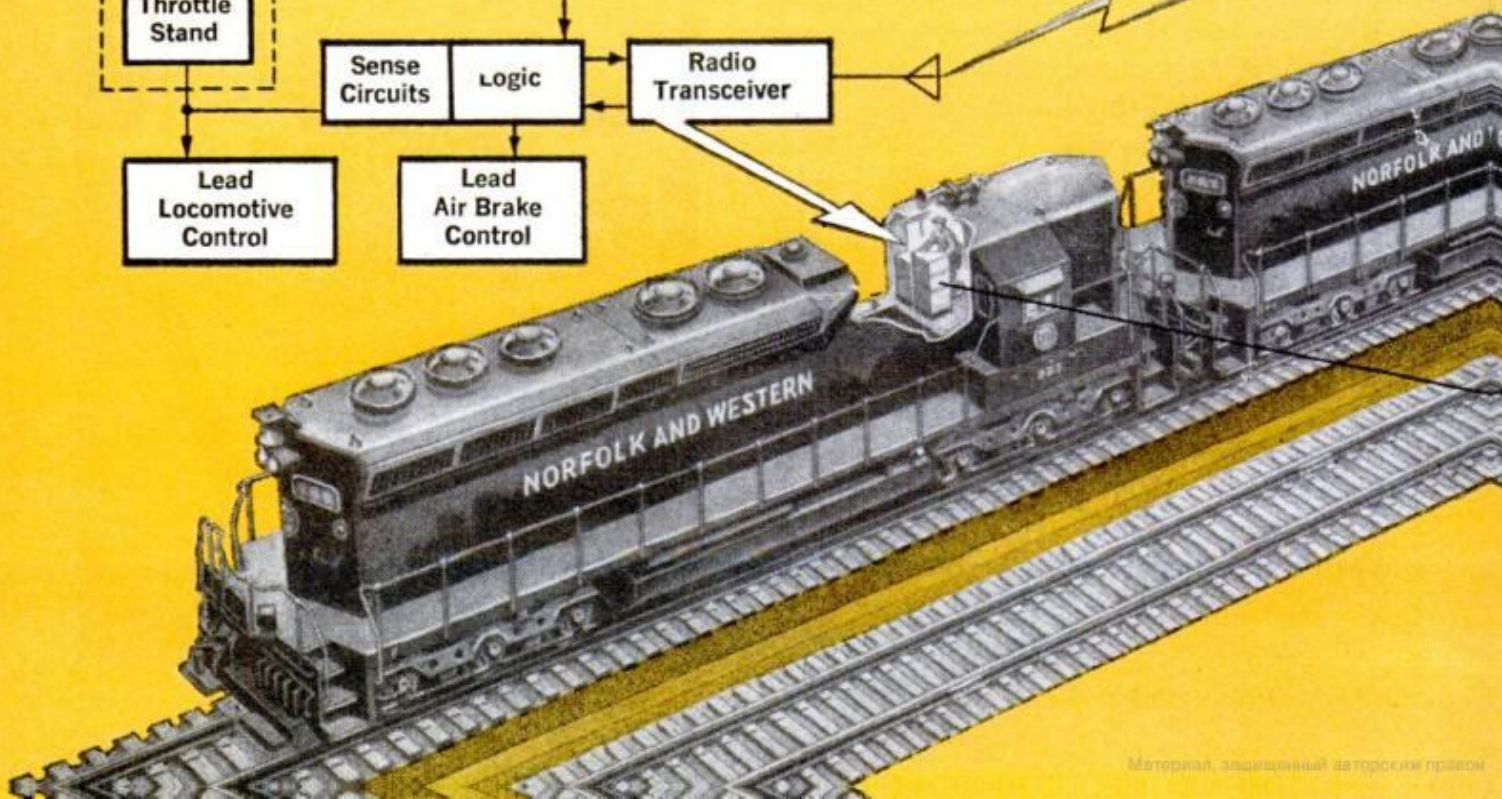
PICTURE A COAL TRAIN four miles long. Stowed in its 500 hopper and gondola cars is enough bituminous coal to generate all the electricity a city the size of Boston uses in a month. The gross weight is close to 50,000 tons.

Up front, a single engineer holds the reins on six diesel locomotive units cranking out 21,600 hp. At the train's originating yard in Iaeger, W. Va., he spends four minutes picking up the slack in a thousand couplers, and he is 480 feet on his way to Portsmouth, Ohio, before the cabooses begins to roll.

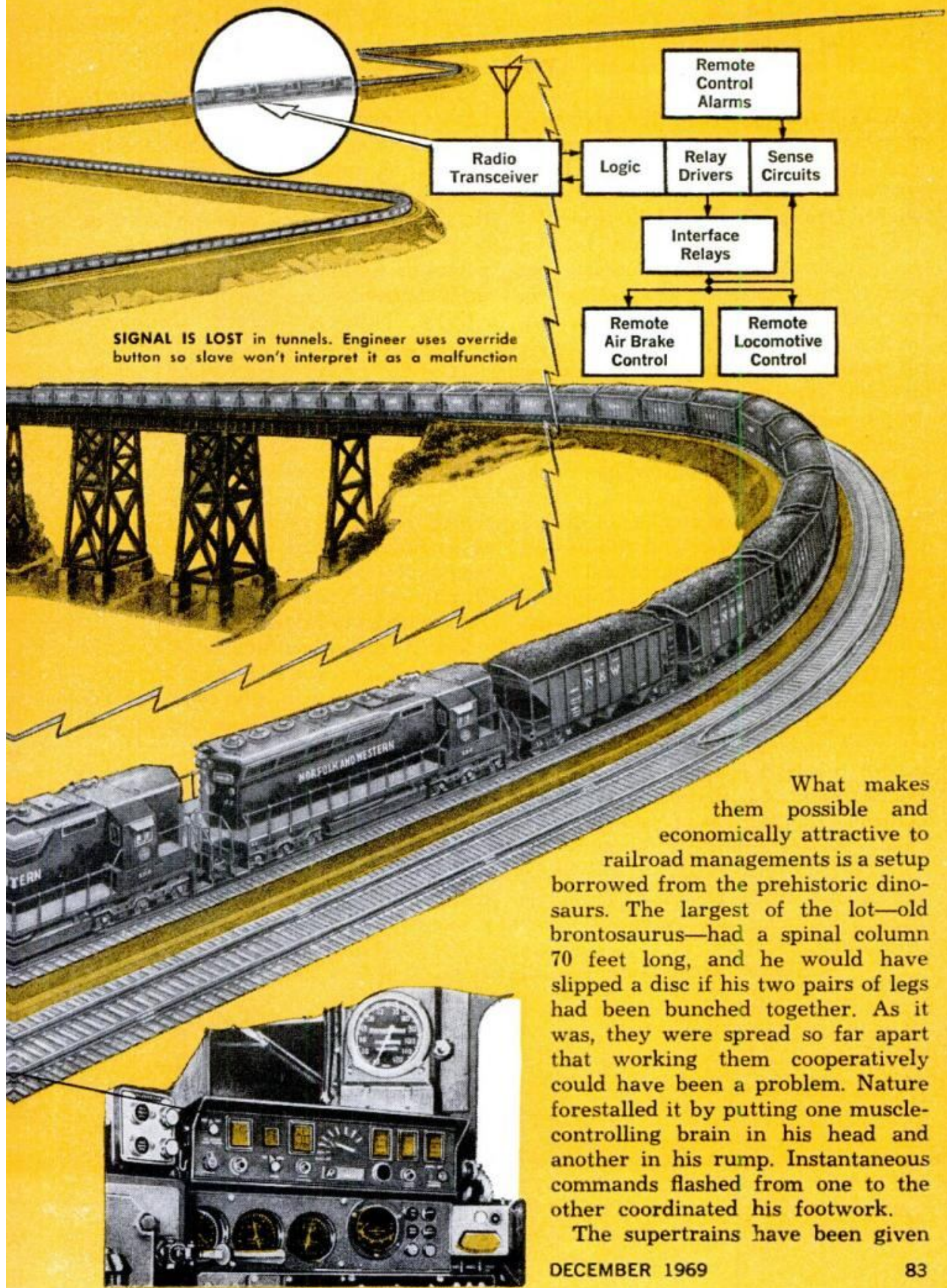
This is no crystal-ball glimpse into the future. The run actually took place on the Norfolk & Western Railway over a year ago. Admittedly it was an experiment, and the regular operation of such land monsters must wait until terminals and block-signal systems are revamped. Nevertheless, superfreight trains almost as impressive are now being tested, and in some cases routinely dispatched, on a score of U.S. and Canadian lines.



CONSOLE IN FRONT CAB of Locotrol-equipped train (drawing, opposite page) controls all operations. Red and green lights keep the engineer posted on slave locomotive. Selector switch in center is the throttle



a Mind in the Middle



SIGNAL IS LOST in tunnels. Engineer uses override button so slave won't interpret it as a malfunction

What makes them possible and economically attractive to railroad managements is a setup borrowed from the prehistoric dinosaurs. The largest of the lot—old brontosaurus—had a spinal column 70 feet long, and he would have slipped a disc if his two pairs of legs had been bunched together. As it was, they were spread so far apart that working them cooperatively could have been a problem. Nature forestalled it by putting one muscle-controlling brain in his head and another in his rump. Instantaneous commands flashed from one to the other coordinated his footwork.

The supertrains have been given

the same arrangement, brought up to date with electronic think boxes developed by two manufacturers. The pioneering outfit—Radiation Inc.—calls its bundles of solid-state circuitry *Locotrol*. The competition—Westinghouse Communications—counters with *RMU*, short for Remote Multiple Unit.

With either product, the string of diesels assigned to a miles-long train is split into two groups, or locomotives. One is placed up front; the other, sandwiched into the cars far to the rear.

That part of the dinosaur hookup isn't new; conventional tonnage has been tooled over heavy grades this way for years; not of choice, but as a concession to railroad couplers. Knuckle all of the horses to the head end and the drawbar directly behind them would be plucked from its pocket like a baby tooth.

Spreading out the power has never brought cheer to the top brass, however. For, while any number of diesels can be linked together and run as one, until now it has been impractical to extend multiple-unit operation from one locomotive back over a train to another. Each has called for its own engineer.

Locotrol and RMU change the picture. A cluster of consoles, or a "master station group," is placed in the forward cab of the lead engine, where it supplements and in part replaces the usual controls. Another set of cabinets, or a "slave station group," is linked to the throttle and brake valves governing the second batch of units. There no human hand ever flips levers.

Instead, whenever the lone engineer 100 or more cars ahead readjusts his controller switch, the master station takes note and snaps the information by VHF or UHF radio to the slaves. Within milliseconds they duplicate the setting.

The same thing happens during air-brake applications and releases. Here the layman might question the need for railroading robots to get into the act, because today's sophisticated pneumatic systems do a first-rate job of tying down conventional consists. But the supertrains are more than a match for the most ingenious pipe circuitry and sensitively balanced valves. Responses would be slow at the rear, with the last cars either giving their forward mates the battering-ram treatment or dragging their shoes and causing pull-in-twos.

The only solution is to apply or kick off the brakes simultaneously at two widely separated control stands. A pair of engineers often out of sight and sound of one another couldn't do it. But the electronic equipment collaborates with hair-trigger speed.

There's a dividend unrelated to radio control. Every diesel has an air compressor, and collectively these pumps can charge the train line and storage reservoirs of all of the cars a parade of units can haul. The farther back the air must be pushed, however, the slower the chore becomes, due to leakage at hose connections.

For example, in a recent Penn Central test it took 20 minutes to build up pressure in 75 cars, and a full hour to

CANADIAN PACIFIC can quickly convert any diesel units on its roster into automated locomotives by coupling them to an unpowered robot car equipped with an electronic-slave station



charge 150. In both cases, all of the power was at the head end. Then half of the engine units were moved two-thirds of the way to the rear of the longer train. With that setup the first locomotive's compressors rammed air a bit more than a third of the distance to the caboose. At the same time, the pumps in the second locomotive shoved their output in both directions. The freight was ready to roll in 15 minutes.

Both Locotrol and RMU meet every other demand of dual-station control. On locomotives whose traction motors can be converted into reluctantly turning dynamos for frictionless braking, a selector switch offers whatever retarding force is needed, front and rear.

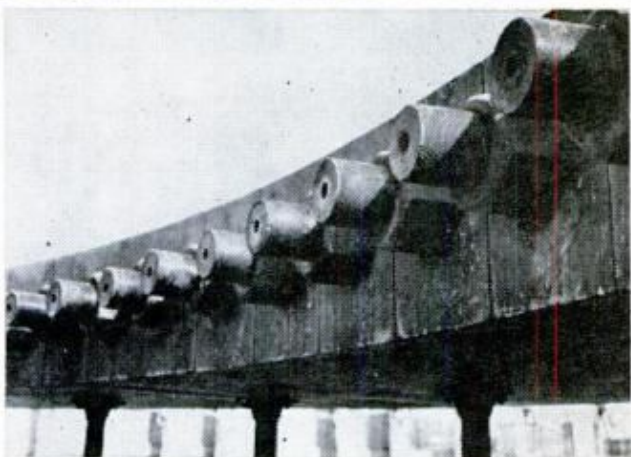
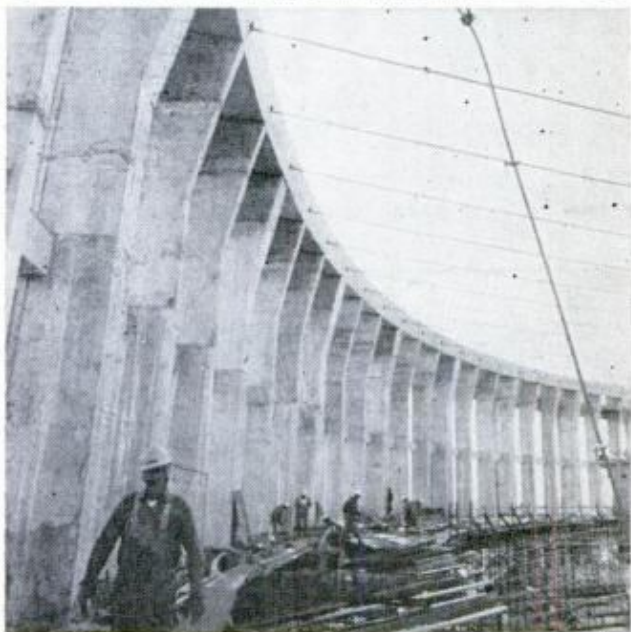
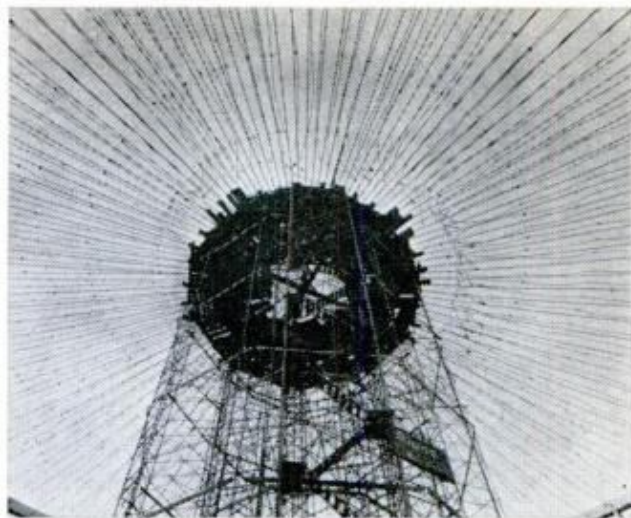
A more vital safeguard prevents two passing trains from scrambling their signals with spectacular results. A pre-wired selector card in each master station sends out an address code unlike any other. Only a slave locomotive whose transceiver has been properly dialed will respond to its commands.

This dialing feature permits a convenient interchange of trailing power. But for even greater flexibility, more and more roads are placing slave-station groups in "idler" or "robot" cars. Jumper-cable-connected to any diesels on the roster, these units convert them into automated locomotives.

What about radio blackouts in tunnels? Under normal conditions, a master station repeats its last instructions at frequent intervals to maintain continuity. But when a malfunction or physical obstruction interrupts the signals for more than 47 seconds the slaves advise the engineer. Alerted by a red light and a pinging bell, he knows they are about to cut the second locomotive's big combustion engines back to idling speed and turn the entire braking system over to him. If, as in the case of a tunnel, he sees no need for such drastic action, he thumbs an override button and maintains the status quo.

Finally, there is the matter of undu-

(Please turn to page 194)



Cables support palace roof

The roof of Salt Lake City's new convention hall, the Salt Palace, is held up by 216 thick steel cables, strung like the spokes of a bicycle wheel (top photo). Two huge outer compression rings of reinforced concrete, 385 feet in diameter, form the rims of this wheel; they're mounted on concrete columns (center photo). Tension is applied to the cables by turning huge nuts inside the wheel hub—a concrete ring 45 feet in diameter (lower photo).



Supermarket for automobile parts

An enterprising New Yorker has turned his scrapped-car lot into a supermarket for car parts. Customers push carts through the lot, selecting parts from the display racks much



Pitching machine

By varying the speed of one of the two counterrotating wheels on the Curvemaster pitching machine, a baseball can be made to curve right or left. The machine also throws knuckle-balls for batting practice.



Identification in minutes

Case records, fingerprints and photos filed on videotape will be available for immediate viewing in 15 facilities of the Los Angeles County Sheriff's Dept. when the Ampex Videofile system is installed next year. Here an officer studies suspect's photo on screen; printer (background) can print photo.



Lone oarsman rows Atlantic

Rowing this specially outfitted boat, John Fairfax, British big-game hunter, crossed the Atlantic in six months. He traveled from the Canary Islands to Florida, to become the first man to row across alone.



the way they would do in a grocery store. The owner, James Lodato, says he gets cars from several sources: auctions of abandoned cars held by the Sanitation Dept., insurance companies selling stolen and wrecked vehicles and the like. Lodato adds that no matter how badly wrecked the car, there's usually some part he can salvage—and put up for sale.



Airy Aero is the first open Opel

First open version of the Opel GT is the Aero GT, shown at the Frankfurt auto show. The removable roof can be stored in the trunk; the portion that remains in place serves as a rollbar. Other features include an electrically operated rear window and wider wheel track.



Gas mask for a discotheque

The operator of an English discotheque offers free oxygen to overly tired dancers to revitalize them. He calls it "moon gas."



One-horse Volks

Well, it's about the only way to go when you're missing the engine and steering wheel. A Dutch farmer did the "conversion."

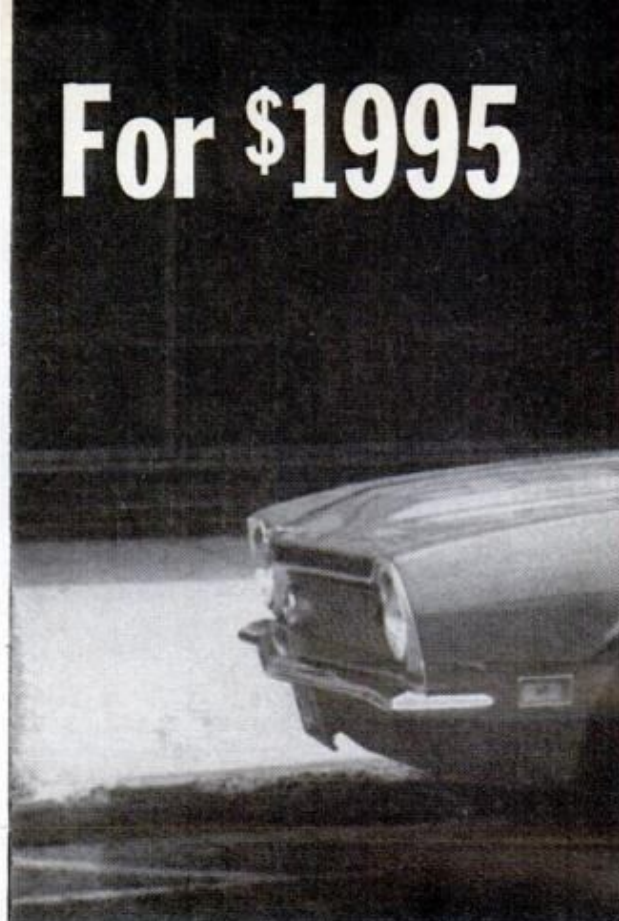
PM OWNERS REPORT FORD MAVERICK

A Nationwide Survey Based on
1,260,000 Owner-Driven Miles

By **BILL HARTFORD**, Technical Auto Editor



FAMILIAR, FALCON-LIKE HANDLING is liked second to economy



Photos by Irv Dolin

IF YOU'VE BEEN LOOKING for a used Volkswagen, you might find one at your local Ford dealer. You can see a good recent-model-year Bug on a dealer's lot in Oakland: "I had a 1968 VW before I traded it in on the Maverick," says the previous owner, a California iron-worker. He's got 2700 miles on his new subcompact, gets from 24 to 26 mpg and has no complaints.

Back East, a Maryland analyst with a growing family refers to the fact that he "owned a VW before." He finds the Maverick workmanship not up to that of the VW but prefers the size, luggage space and ride.

Down South, a Florida superintendent says his dealer couldn't have been more generous: "Good trade-in for my 1968 VW."

In the Midwest, an Iowa engineering technician explains: "I wanted a bigger car with more engine than my VW had." A safety and security officer from the same state traded in his Karmann-Ghia for a Maverick. And another Iowan couldn't be more emphatic about his preference: "Believe me I wouldn't

trade in my Maverick for two VWs!"

The reasons given by owners who switched to a Maverick fall into three categories. Some are emotional: "I got sick of shifting," says a Michigan student. Other decisions were based more on product evaluation: "I had a very good Volkswagen," says an Illinois student, "but after seeing the Maverick I felt I had found a 'better Volkswagen,' so to speak, in terms of gas mileage, parking ease, engine, etc." An Illinois airline pilot didn't own a VW to begin with, but came close to buying one. He finally decided on the Maverick, how-



FULL-WIDTH SHELF is no substitute for real glove box which is sorely missed by many Maverick owners

You Want a Glove Box, Too?



SUPERSAVINGS in price, operation and maintenance is the promise of Maverick; so far so good, say owners

ever: "We wanted VW economy all around. The Maverick is as close as a U.S. manufacturer has come. We felt the better ride and additional hp offset the additional cost."

A third reason given by ex-VW owners and other Maverick owners who wouldn't even look at an imported car is the fact that the Maverick is, as an Illinois truck driver emphasizes, "American-made." "I like its being American," confesses a Louisiana student. And a California stock clerk says, "I wanted a U.S.-made economy car."

It's economy, coming and going, that

owners tout. High advertised fuel mileage, a tantalizing price tag of \$1995 (although a good percentage of owners paid upward of \$2800 with all the options they specified), and the promise of simple maintenance and repair of an uncluttered domestic vehicle all add up to overall economy in the eyes of the prospective buyer.

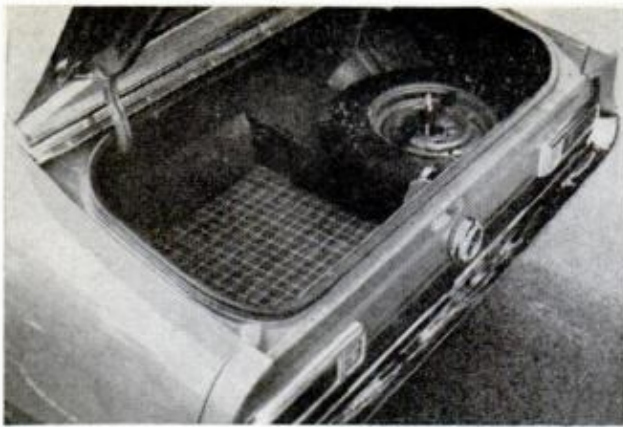
All the promises are borne out on the road, owners tell us. Averages of 21.5 and 24.5 mpg are reported for the 170-cu.-in. Six that over three quarters of Maverick owners are fueling. A California naval officer likes "the simplic-



EASY DO-IT-YOURSELF MAINTENANCE on six-cylinder engines is liked. Rod in front keeps up hood



REAR-SEAT ROOM, for the type of car, is praised. Few comfort complaints are for inadequate padding



TRUNK SPACE is sufficient but use of fuel tank as floor for trunk drew many complaints from owners

ity of it." And that says a lot. As the first "subcompact" among the half dozen or so that will have been introduced between 1969 and 1971, the Maverick, with its excellent sales kickoff and acceptance, portends nothing but success for the concept. It's a "return to rationality" for a Minnesota inspector who also likes the "common-sense arrangement of components under the hood."

A California carpentry foreman who, in fact, bought a Maverick so he might do his own work, says he's "disgusted with service cost at garages." A Kentucky lab inspector couldn't get satisfactory repair of a sticking carburetor float at his dealer; he says he'll fix it himself. In fact, he'll do almost all of his future maintenance and service because of "the high cost of service at the dealer's shop." A Delaware barber

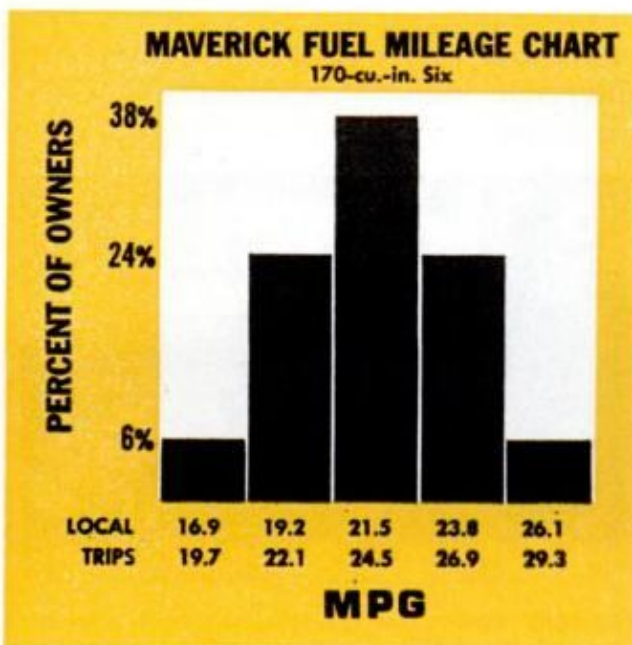


DRIVING POSITION and three-speed stick are okay, but bucket seats, four-on-floor are desired options

wraps it up with a statement that he bought his Maverick hoping it would be "the answer to all our car problems."

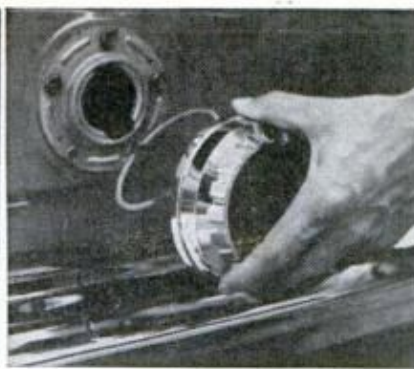
Not too many owners would be so hopeful, yet with the Maverick they might have a chance this would actually be the case. Four of five owners report having had no mechanical problems whatsoever. The percentage—81.6—is actually a little better than that of the Cadillac Eldorado owners report (page 125, July '69 PM).

Any complaints that owners do have refer mostly to the design of the car and occasionally to the production techniques that enable the Maverick to be sold for the low price they bought it for in the first place. The lack of a glove box, for example, is the biggest sore point with the owners. They expect every car to have a glove box, right? Wrong! In Detroit, economy car means just that. It costs money for all those hinges, catches and plastic pieces. If you want a Maverick for less than \$2000, you'll have to live with a shelf that runs along the underside of the dash and along which your flashlight, maps, large bulbs, fuses and other





REAR VISIBILITY is limited due to rear deck and backlight styling; head restraints don't help



GAS-CAP LANYARD is optional. Some owners weren't told of this, other options they could order



REAR WINDOW hinges out slightly for very little ventilation; catch and window rattle when open

glove-box gear will slide in every turn. And how about the air vents over the shelf on either side of the car: Things blow off the shelf whenever the vents are open!

Counterbalanced hinges for the Maverick's engine bonnet also cost money, so they're not used. Instead, a support rod is swung into place to hold up the hood. It saves money and only a few owners complain. A Colorado secretary, though, says: "Gas-station men almost drop it on their heads every time they open it!"

There's nothing else about the car itself that really upsets owners. "Next

time I take a lawyer to the dealer's with me!" says an Illinois engineer. And "all salesman lie a lot," observes a Minnesota housewife.

A tree and lawn serviceman does want a spoiler on his Maverick, however. At sixteen, he's one of the youngest owners, many of whom are students. For getting a haircut and shaving his beard, a New York college student got a loaded Maverick a year early as a graduation present. Then there's a 17-year-old Michigan girl whose Maverick is also a present: graduation from high school! Imagine. Whatever happened to the wristwatch? ★★★

Summary of 1969 Ford Maverick Owners Reports*

Total miles driven1,260,821

Average miles per gallon:

170-cu.-in. Six,
local driving 21.5
long trips... 24.5

200-cu.-in. Six,
local driving 20.0
long trips... 22.6

Specific likes:

Economy 62.0%
Handling 48.2
Style 40.4
Ride 16.8
Comfort 13.8
Size 10.5
Price 8.7
Performance 8.1

Specific dislikes:

Rattles 9.0%
No glove compartment 8.0
Rear visibility 7.4
Vent system 6.5
Workmanship 5.2
Finish 3.1
Trunk space 3.1
Gas mileage 3.1

What changes would you like?

Glove compartment added 20.2%
Rear visibility 9.6

Bigger engine 7.9
Better vent system 6.8
Ashtray location 5.5
Bucket seats 5.1
Styling 4.4

Engine:

170-cu.-in. Six 77.2%
200-cu.-in. Six 22.8

Transmission:

3-speed manual 70.6
Automatic 29.4

Had any mechanical trouble?

No 81.6%
Yes 18.4

What kind of trouble?

Heater 20.0%
Carburetor 14.6
Transmission 10.9
Electrical 9.1
Shift 7.3
Clutch 7.3

Dealer repair satisfactory?

Yes 78.9%
No 21.1

Why the Maverick?

Economy 72.8%
Style 27.2

Size 18.1
Price 5.6
Handling 3.2
Comfort 2.0

Is the Maverick your only car?

No 60.0
Yes 40.0

Other cars owned:

Ford 32.8%
Chevrolet 24.2
Pontiac 11.1
Oldsmobile 6.8
Buick 6.8
Mercury 5.8
Plymouth 5.3
Volkswagen 5.3
Mustang 4.8

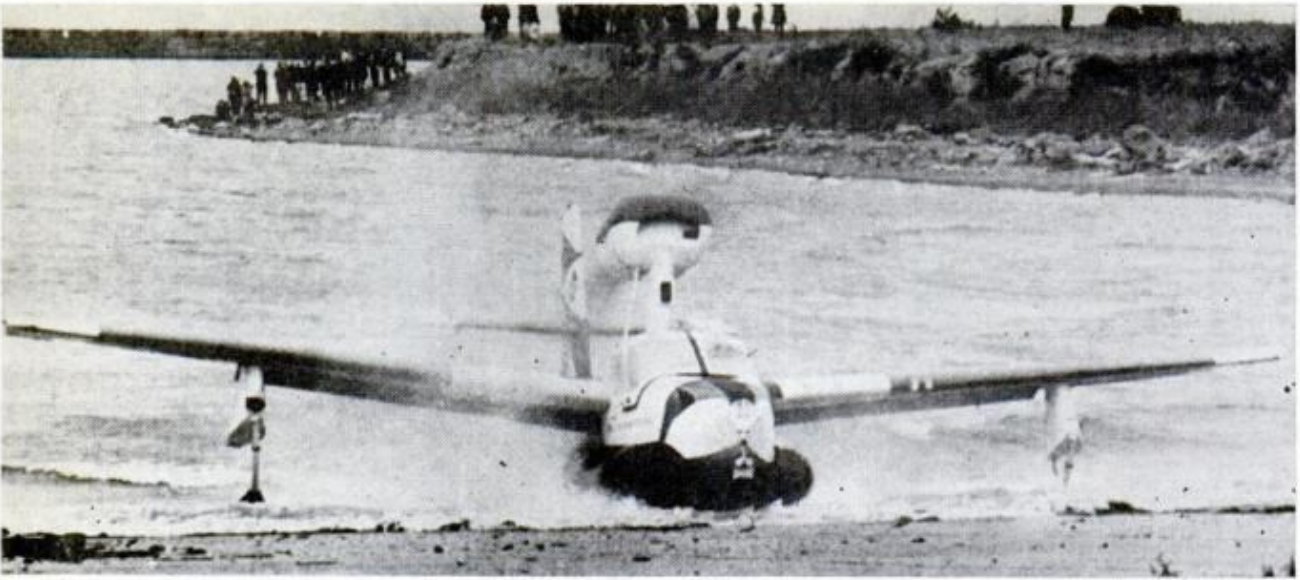
What options/accessories?

Radio 71.2%
Whitewall tires 33.7
Oversize tires 22.7
Accent group 11.3
Floor shift 10.0
Cigaret lighter 7.8
Carpet 7.8

Age distribution of owners:

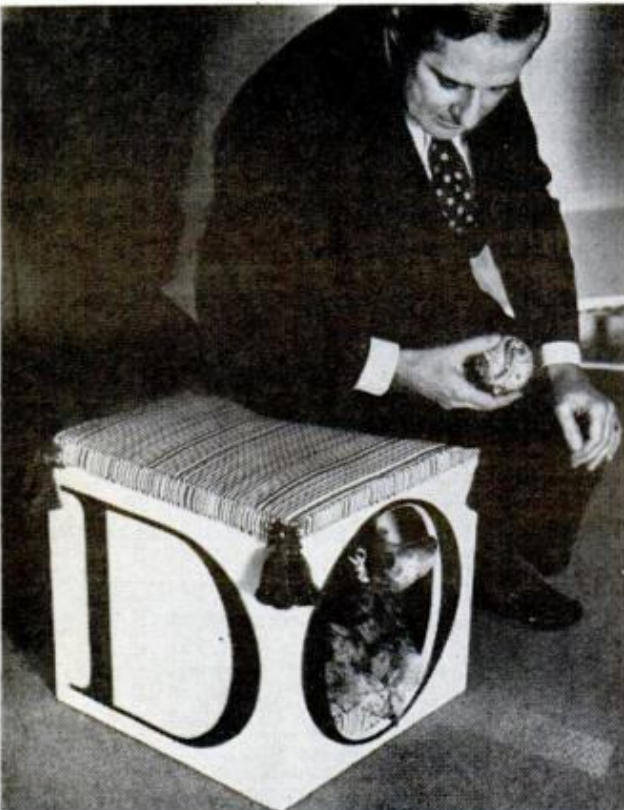
15-29 46.7%
30-49 35.0
50 plus 18.3

*Where applicable, percentages may not equal 100 percent due to rounding and/or insufficient sample.



Air-cushion plane operates successfully from water

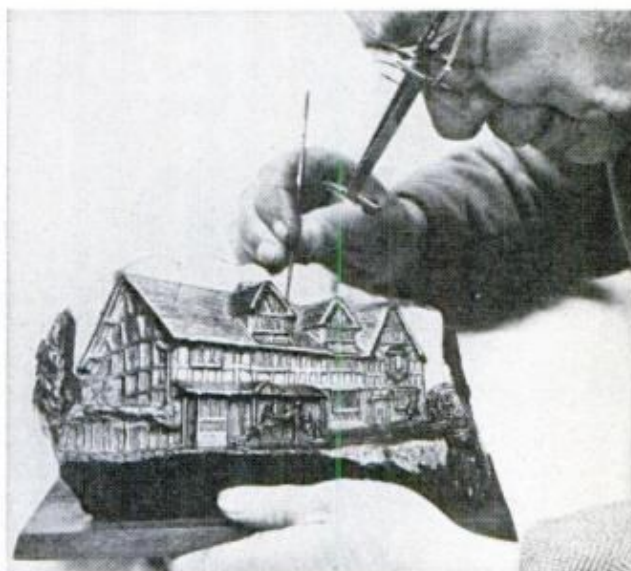
A Lake amphibian, redesigned with an air-cushion "landing gear," took off and landed in the choppy waters of Buffalo harbor in a recent demonstration. Developed by Bell Aero-systems Co., the air-cushion device consists of a large rubber bag under the plane's belly. A separate engine and fan force air into the bag; the air then shoots out through thousands of jet nozzles, providing the cushion of air. Earlier tests were on land, ice, snow and mud.



Poshest doghouses in town

Dogs should be housed indoors—and in fancy doghouses that match the decor. That's the contention of James De Vries who operates a New York furnishings shop. He cautions, however, that the dogs should be cocker spaniel size or smaller. Among his creations are a modern one (above) for \$264; a lacquered Ming Dynasty table bed (upper right), \$670; and a wicker one for \$330.





Coal sculptor practices an ancient art

Sculpting in coal, or coal carving as it was called, was a popular art form in northern England in the 17th and 18th centuries. Now, however, there's only one known exponent who has the necessary patience and skill. He's Ernest Holder of Portslade in Sussex. Coal is a difficult medium since it's full of veins and splits, so Holder must select pieces carefully (upper left-hand photo). At upper right, he makes the first cut with a touch that's as skilled as a diamond cutter's. Final polishing is done with emery dust to give the porcelainlike finish apparent in the Napoleon bust and the lion and Tudor cottage carvings.



FASTEST PROP IN THE WORLD

By RALPH L. EMERSON



DARRYL GREENAMYER, 33-year-old Lockheed test pilot, flies such exotic craft as the SR-71 and YF-12A at speeds of 2000 mph and altitudes of 80,000 feet.

But his favorite kind of flying is a few feet off the ground in an obsolete Grumman F8F-2 Bearcat, a 24-year-old fighter developed by the Navy to operate from a carrier. It was in his highly modified Bearcat, the *Conquest 1*, that he set a new world's piston-engine air-speed record of 483.041 mph at Edwards Air Force Base, Calif., in August.

Streaking through the shimmering heat above a dry lake bed at an altitude of about 50 feet while baking in a cockpit that warmed up to 140° and more during runs, Greenamyer made four passes over the three-kilometer (1.86 miles) course—at 510.236 mph, 458.849 mph, 508.458 mph and 454.622 mph—to set the record.

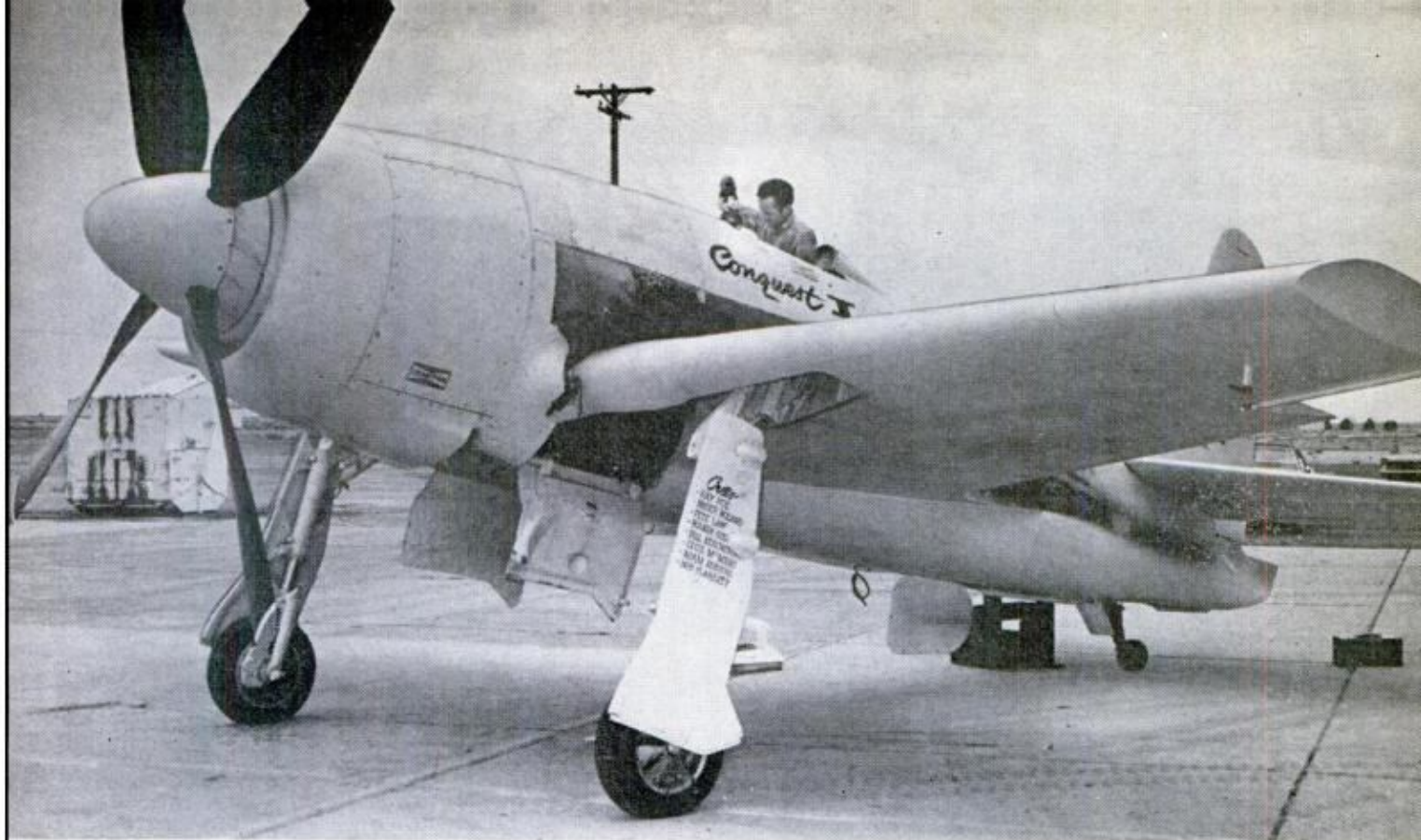
The new speed mark is the result of several years' effort by Greenamyer to crack the long-standing record of 469.22 mph set in 1939 by Luftwaffe pilot Fritz Wendel in a modified Messerschmitt 109R.

Greenamyer's *Conquest 1* is considerably different from the Navy version. For one thing, the entire hydraulic system has been removed except for cylinder rams on the landing gear. At take-off, high-pressure nitrogen blows the gear into raised position; the pilot must yaw the plane to get wheels locked down for landing.

The new 13½-foot propeller—12 inches longer than the original—sweeps so close to the ground that the pilot must take off and land in a three-point position.

When special low-drag wingtips were added (mainly for pylon racing), the wings were cut back 3½ feet on each end. This modification left only 21 inches of aileron. Another set of controls, the landing flaps and related gear,

CONQUEST 1 streaked as low as 50 feet (photo, top left) at speeds up to 510 mph as Darryl Greenamyer set piston-engine speed record. At left, Greenamyer adjusts special, tiny canopy on his converted Bearcat



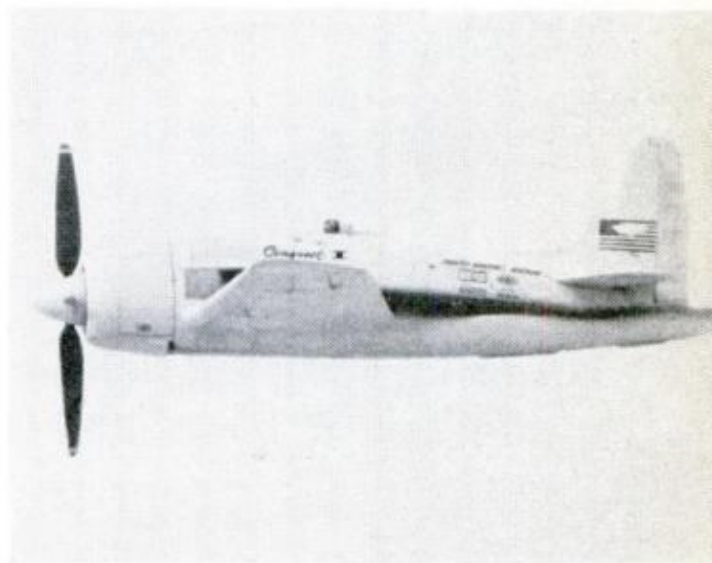
GREENAMYER'S BEARCAT, once a carrier-based Navy fighter, underwent many modifications, including addition of larger propeller and spinner, cutting back of wingtips, closing of air inlets and gunports

were removed to cut the plane's weight.

Other modifications that help reduce drag include the addition of a spinner from a P-51 ahead of the propeller plus an inner spinner from a Lockheed Constellation in front of the engine. The gunports of the fighter were covered, as were the oil-cooler inlets. Now there's a heat exchanger located behind the cockpit to cool the oil.

The engine is a Pratt & Whitney R-2800 Wasp. Fuel is 145-octane aviation gas with a combustion improver raising the effective octane to 180. ★ ★ ★

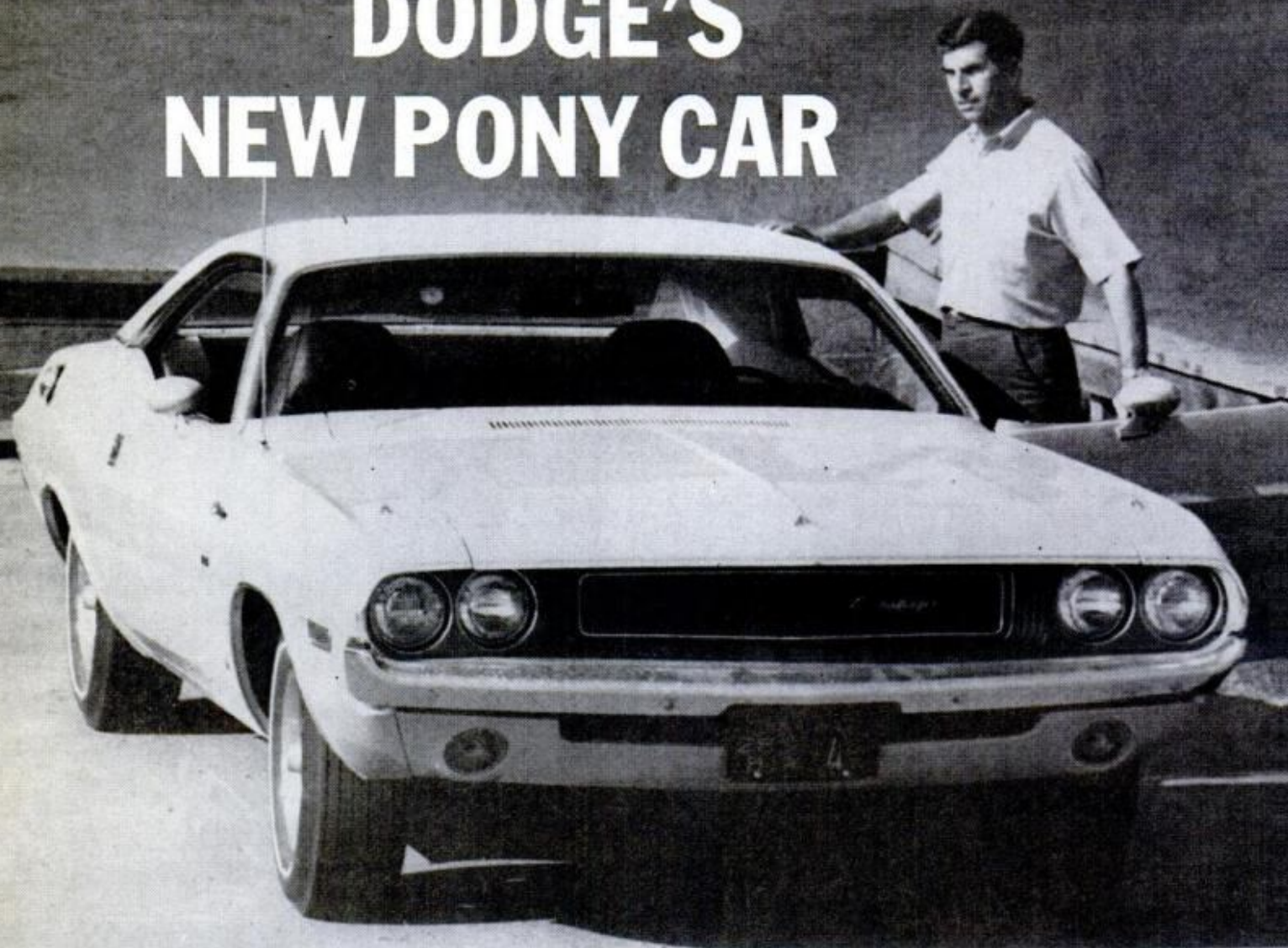
PRETTY GROUND 'CREWMAN', Sue Johnson, scrubbed plane before it was waxed for speed attempt. Paint here was burned away by extreme heat of exhaust



HUGE PROP appears to stand still in high-speed photo (above). It barely cleared ground (below) as crew turned engine to make sure cylinders were clear



TRACK-TESTING DODGE'S NEW PONY CAR



Racing star Paul Goldsmith puts the new Challenger through its paces and reports there's a lot to like

By PAUL GOLDSMITH

ACTUALLY, I'm new at this road-test business. But on the other hand, I subconsciously test every car I drive. Whether it's a rental from the airport in a strange town, or my own Grand National stocker, I just naturally pick out little things I like or dislike every time I fire up and head out.

I had to join the jet set to test the Challenger because the only one suited for the purpose was in Southern California. You can bet I didn't mind that, so the day after Richard Brickhouse brought my new Daytona Charger home the winner in the inaugural Talladega 500, there I was in Los Angeles, sampling a brand-new car.

My first reaction to climbing behind the steering wheel of this 340-CID V8-engined car was that it just didn't seem like a so-called "pony car." The hood length was just too much, or so I thought. One reason for this is that the hood comes back and over the windshield wiper arms. Those wipers are really hidden. The rear lip of the hood sweeps up an inch or two and the gap for the wipers to move through isn't great, meaning there shouldn't be a lot of snow caught there. This, of course, is a guess on my part, but I'm no stranger to snow and the troubles



THE CHALLENGER proved quick off the dime, my 0-60-mph times being respectable at under seven seconds

that it can whip up in a hurry on the highway.

Once out and moving on the roads of southern California, the car impressed me with its unusual quietness. Later I discovered why. It's all due to some very interesting engineering. That wiper-hiding hood is one contributor. Air hits the steeply angled windshield without contacting any chrome trim or other obstacle that could set up buffeting. The chrome trim around the top and sides of the front glass is flush, eliminating any catch spots. The car I tested had a vinyl roof cover that fills in the front "A" pillar, making it a flush panel from windshield to drip rail. There just isn't a rough spot anywhere along the way. These are wind-cheating tricks we've used for many years in stock-car racing, and it's obvious Chrysler designers have been doing more than just watching races when they come to the track. In fact, the Challenger is pretty slippery all the way to the rear end—side glass is smooth and curved inward at the top, door handles are flush and the tail is chopped off clean with a minimum of overhang.

The only offender to the good wind shape is the grille—the worst possible spot for a poor air shape. At the center, it is seven inches inset and all the frontal air is caught under the nose of the hood. At very, very high speeds this can cause lift. The front valance panel (below the bumper) is angled rearward, which isn't in good race-car tradition. It should be more blunt, or, better yet, angled forward at the bottom to keep air from passing beneath the car. But then I'm looking at this from a racer's viewpoint. As a passenger car, this front end isn't about to cause any trouble. The Challenger's present good

DECEMBER 1969



FLUSH-MOUNTED WINDSHIELD is one of several wind-cheaters on the Challenger



FUEL-FILL PIPE on Challenger offers optional lock, is located on right side



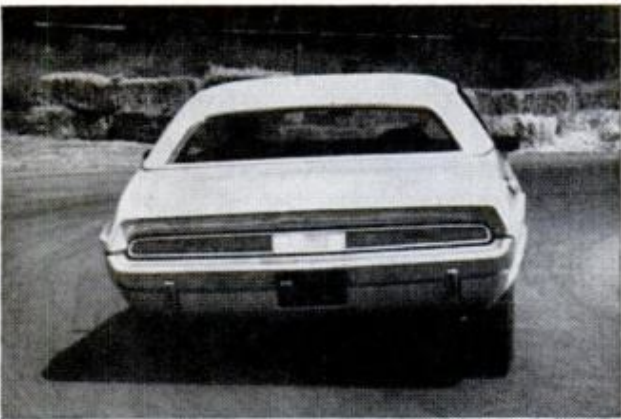
TRUNK surprised me with its roominess, thanks mainly to collapsible spare tire



GOT IT HUNG OUT a little bit here, a condition I had to induce as the Challenger tends to stick well



I REALLY SLAMMED Challenger around, became convinced it's at home on open road or in switchbacks



BODY LEAN is at a minimum in hard cornering, yet stiffer springs don't give a feeling of a rough ride



ONLY OFFENDER to overall fine wind shape is grille, inset of which catches frontal air under hood nose

front-end appearance would probably look pretty bad if they made it the way I wanted them to.

If you've ever ridden in short-wheelbase cars, you're aware of how choppy the ride can be sometimes. I expected a bit of this from the 110-inch-wheelbase Challenger, but found none. My test car had rallye suspension, wide-rim wheels and F70-14 tires (which look like they're for a much bigger car). I found it one of the smoothest driving and riding cars I've ever experienced. I don't like really soft riding cars, but the other extreme isn't any better. This one showed no up-and-down action over washboard surfaces, no airborne tricks when crossing railroad tracks, no kidney-jarring shocks, and never a trace of a too-firm ride. Some carmakers make the mistake of putting high-rate springs on their cars so they can call them performance models. That's not the real answer. It takes a correct combination of firm

springing and good shock absorbers as well as a firm front-stabilizer bar. I'm sure the suspension I tested could be made race-ready with just stiffer front torsion bars added. A sturdy rear-stabilizer bar and adjustable shock absorbers would guarantee the car a spot on most starting grids.

This may sound a little far out, I know, but I had a chance to really drive the car. I pushed it so hard through some of the turns at Orange County International Raceway, I was sure the California landscape was going to bear my tire tracks, but the car never left the pattern I set. The result of my race-like driving is a solid endorsement of this Challenger model as an outstanding highway and twisting road car. It's highly predictable, very stable and sure handling.

I've noticed in most Chrysler-made cars over the years that the front wheels don't always care to stay in a



MY TEST CHALLENGER caught admiring looks wherever I went with it. I think it's a sleek, sporty-looking car

straight line ahead without the driver keeping his mind and hands concentrated on the wheel. This isn't necessarily bad, but the Challenger is a bit easier to handle in this respect. It seems as though Dodge has added more caster to the front wheels, allowing them to run straight without too much action in the steering department. Caster is the degree of king-pin inclination in relation to a vertical line perpendicular to the ground. The more caster, the more easily the wheels will run in a straight set course. The less caster, the easier it is for the wheels to move "off-center." Dragsters, for example, have a great deal of caster so the driver doesn't have to make too many corrections. But they have so much caster that the front wheels won't return to a straight-ahead attitude without a lot of struggling. The Challenger setup is a happy medium—no effort with wheel control in any position.

The test car was built with a relatively low rear-axle ratio of 3.90 to 1, which is a good choice for in-town driving or for weekend use at a drag strip. However, mileage suffers because engine speed is rather high at expressway speeds. Constant high-speed running calls for something less, like a 3.23 or 3.50 to 1 ratio. With a four-speed transmission linked to the potent 340 engine, my test car cut 0-60-mph times in less than 7 seconds, and quarter-mile

elapsed times in the 14-second bracket, both very respectable. If you want good performance, make sure such a car has a Sure-Grip differential. It also makes for safer driving in bad weather.

After a couple of hours of wringing it out, I took particular note of the Challenger's interior room. There's lots, especially up front. The back seat is a bit tight for six-footers, but I wouldn't object to riding there providing it wasn't for a long time. The front bucket seats are very comfortable, with head restraints being a part of the seat backs. They reminded me somewhat of a jet aircraft pilot's seat. I'm not sure what they call the six-way adjustable seat setup my test car had, but my helmet's off to the man who dreamed it up. It's a manual adjuster that allows up, down, tilt forward or rearward positioning, plus the regular fore and aft adjustments. It doesn't cost much, and it'll very definitely be in my next car. If it happens you run out of front leg-room, chances are you should be playing for the New York Knicks.

Steering-wheel position is low, which I like, because the top of the rim doesn't interfere with forward vision. The wood-rimmed wheel in this particular Challenger had a rim-blow horn. The horn ring is buried inside the inner rim and can be operated at any point around the wheel. Neat idea,

(Please turn to page 196)



Add-on shipbuilding produces unusual vessel

When you want a bigger ship, you simply graft two smaller ones together. At least that was the technique employed by a shipyard in Slikerveer, Holland, when it produced this unusual "coaster" with three prows and two sterns. Starting with two 15-year-old coasters (shallow-draft vessels capable of carrying heavy loads), the firm welded them together and then added further cargo space in the center, plus a third prow.



Quiet motorbike

A battery and starter motor added to a standard bicycle by Edward Roy, Largo, Fla., turned the vehicle into a silent, smooth-operating motorbike. Power from the 9-volt starter motor is transmitted to the front wheel by a spool-shaped fiberglass roller that is lowered onto the front tire.



High-speed office

A British designer has turned this car's interior into an office on wheels. Equipment includes a radiotelephone, TV, dictaphone, typing desk, file cabinet and food cabinet.



WATER JETS (above) spaced on slope make "snow" more slippery. Lift (below) takes skiers to the top



EXPERT SKIERS can reach speeds of 50 mph on the 180-meter slope. There are also slopes for beginners



BATHING SUITS are standard attire in the 90° heat, and there's a pool at the foot of the slope (below)

Skiing without snow

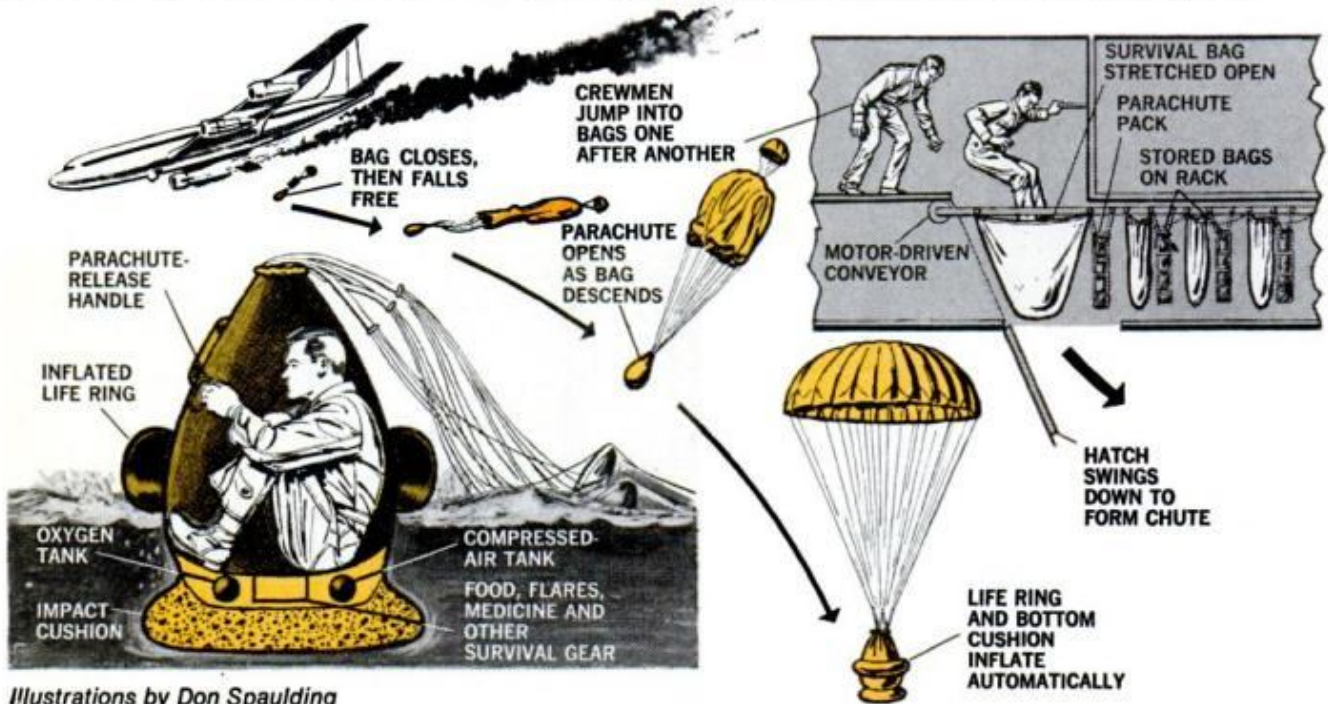
It's white, powdery, slippery and great for skiing. It looks like snow and feels somewhat like snow—but it's not. It's quartz sand, and that explains the appearance of bikini-clad skiers on the slopes under a hot summer sun. A large china factory at Hirschau, West Germany, produces 1000 tons of the sand daily as a waste product. Now the "dump"—formerly an eyesore—has become the center of a ski resort. The sand mountain, made up of some 10 million tons of the stuff, stands over 350 feet high.



Just patented

PM'S PICK OF THE NEW INVENTIONS

Prepared in cooperation with Roger S. Shashoua, Director, International Inventors Assn., Inc.



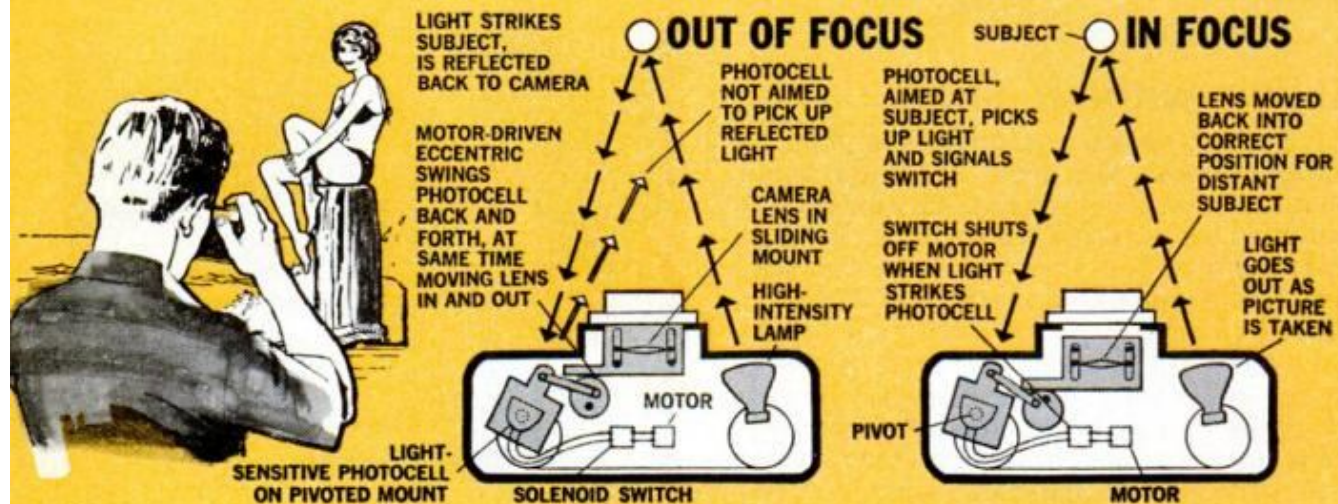
Illustrations by Don Spaulding

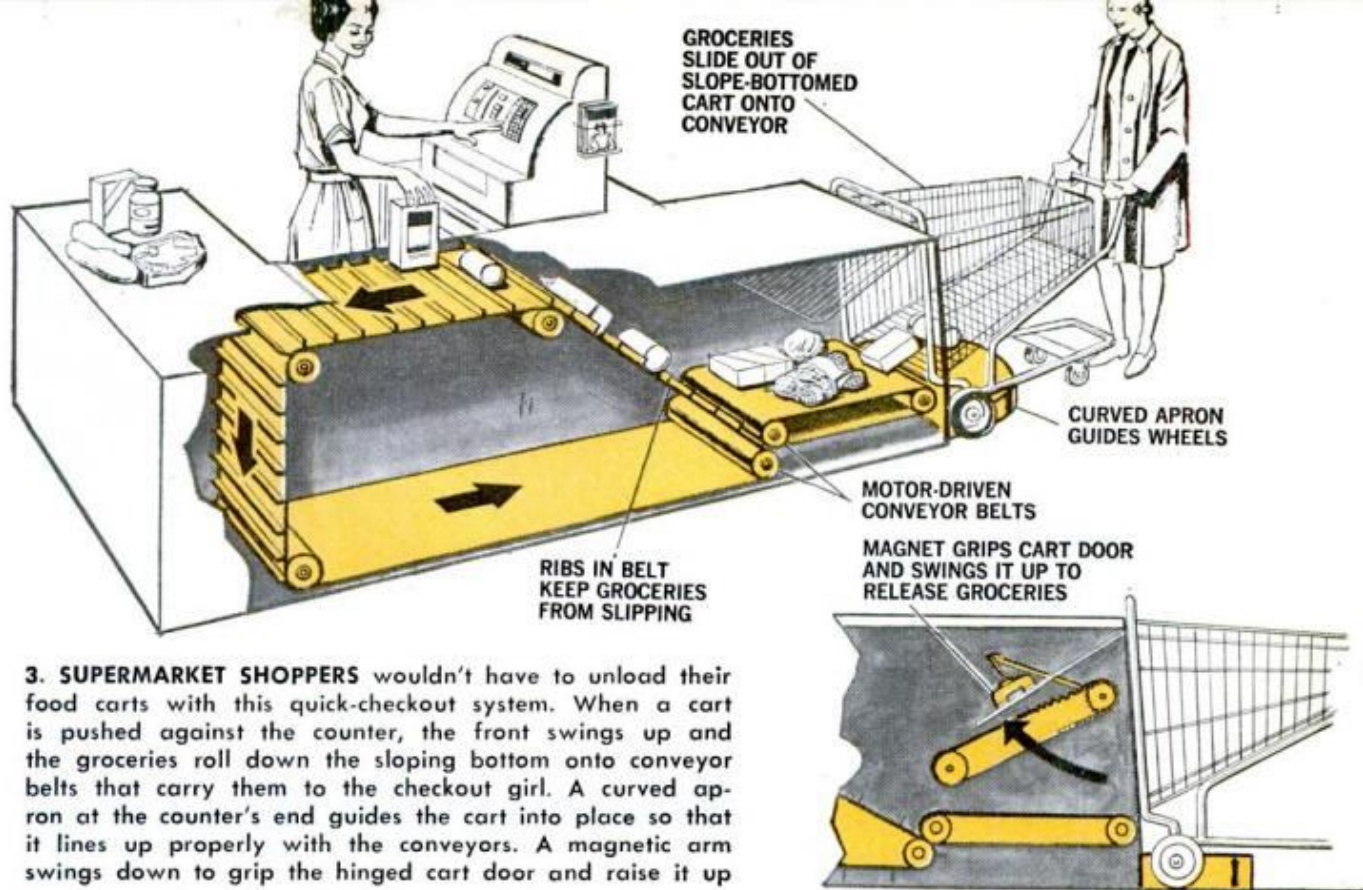
1. INSTANT ESCAPE SYSTEM for crewmen bailing out of a disabled aircraft eliminates the need to wear or put on cumbersome parachute packs and other survival gear. In an emergency, a trap door opens and each man merely jumps into a bag stretched across the opening. This trips a release, causing the bag to drop clear of the plane. As it falls, the top is drawn closed over the airman's head and a

parachute pops out. On the way down, a buoyant life ring and an air cushion on the bottom inflate automatically. The cushion softens the impact if the bag comes down on land and the life ring supports it in water. Once down, the bag also serves as an emergency shelter until rescuers arrive. Food, medicine, chemical heaters, flares and a radio are stored in a compartment in the bag's floor

2. AUTOMATIC FOCUSING for cameras is the object of the ingenious invention below. A tiny, high-intensity light is aimed at the subject and reflected back to the camera. A pivoted photocell linked to a motor-driven eccentric swings rapidly back and forth, scanning the scene for the reflected light. At the same time, the eccentric also racks the lens elements in and out, constantly changing the

focus. At the point where the photocell picks up the strongest reflections from the subject, it triggers a solenoid switch, stopping the motor. Since the angle of reflected light depends on how far away the subject is, this stops the lens at the point of correct focus for a subject at that distance. The light goes out as you snap the picture, then it comes on again, ready for the next shot

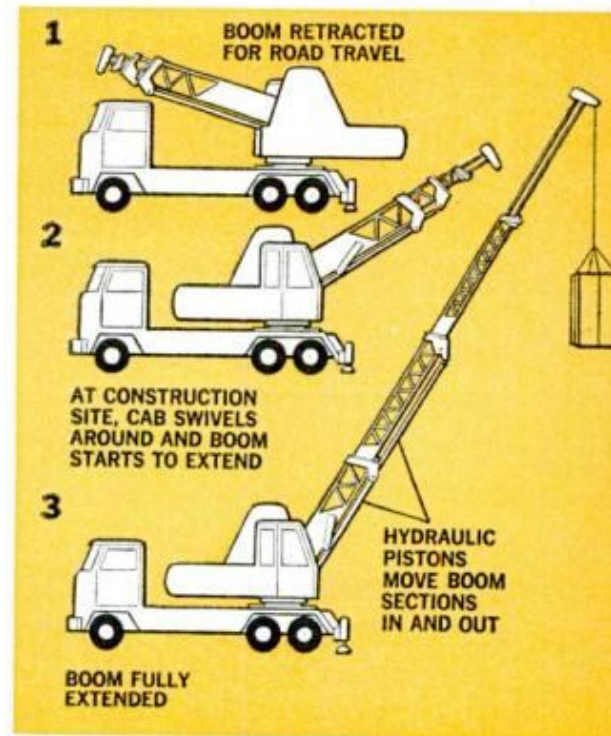




3. SUPERMARKET SHOPPERS wouldn't have to unload their food carts with this quick-checkout system. When a cart is pushed against the counter, the front swings up and the groceries roll down the sloping bottom onto conveyor belts that carry them to the checkout girl. A curved apron at the counter's end guides the cart into place so that it lines up properly with the conveyors. A magnetic arm swings down to grip the hinged cart door and raise it up



4. ONE LEG DOES THE JOB OF TWO in this interlocking arrangement for sectional furniture. One half of the leg slips into a groove in one section and the other half locks into a similar groove in an adjacent section, joining the two firmly together. The single leg looks trim, keeps the sections from slipping apart and permits shipping furniture without the legs attached, eliminating the chance of their breaking off



5. TELESCOPING BOOM on the crane above can place a load more precisely because it can vary its length as well as its angle of tilt. It's also safer than long fixed booms since it can be shortened for unusually heavy loads to avoid buckling. For road travel, the boom is simply retracted and it need not be folded or dismantled as with conventional booms

Inventors of the items shown on these pages are as follows 1. Robert G. McIntyre, Manhattan Beach, Calif. (No. 3,438,601); 2. Armin B. Pagel, Janesville, Wis. (No. 3,442,193); 3. Harold J. Ruttenberg, Pittsburgh, Pa., and Garth Close, Lubbock, Tex. (No. 3,437,176); 4. Henry P. Glass,

666 Lake Shore Drive, Chicago, Ill. (No. 3,033,635); 5. Lyle D. Grider, New Berlin, Wis., and Gottfried Reuter and George W. Mark, South Milwaukee, Wis. Roger Shashoua can be reached at the International Inventors Assn., Inc., 680 Fifth Ave., New York, N.Y. 10019



First of a Great New Breed

Slated to start service this winter, Boeing's giant jet will carry more passengers — up to 490 in all — and more cargo than any airliner in history.

By JOHN F. PEARSON, Science Editor

EARLY NEXT YEAR A NEW PLANE WILL ANGLE across the busy sky over Kennedy International Airport. It shouldn't be hard to spot, for it's sure to be the single biggest object cutting through the New York smog. The plane is the Boeing 747, newest and largest airliner in the world, capable of carrying as many as 490 passengers. Sporting the blue and white livery of Pan American, it will be configured to carry 362 and be bound for London and Frankfurt on its first commercial flight.

The 747 is the first of a new breed. It is *not* America's answer to the French-English Concorde or Russia's TU-144, needle-nosed supersonic darts now being tested. Rather, it is a bigger, faster, more stable, more comfortable version of today's subsonic jets.

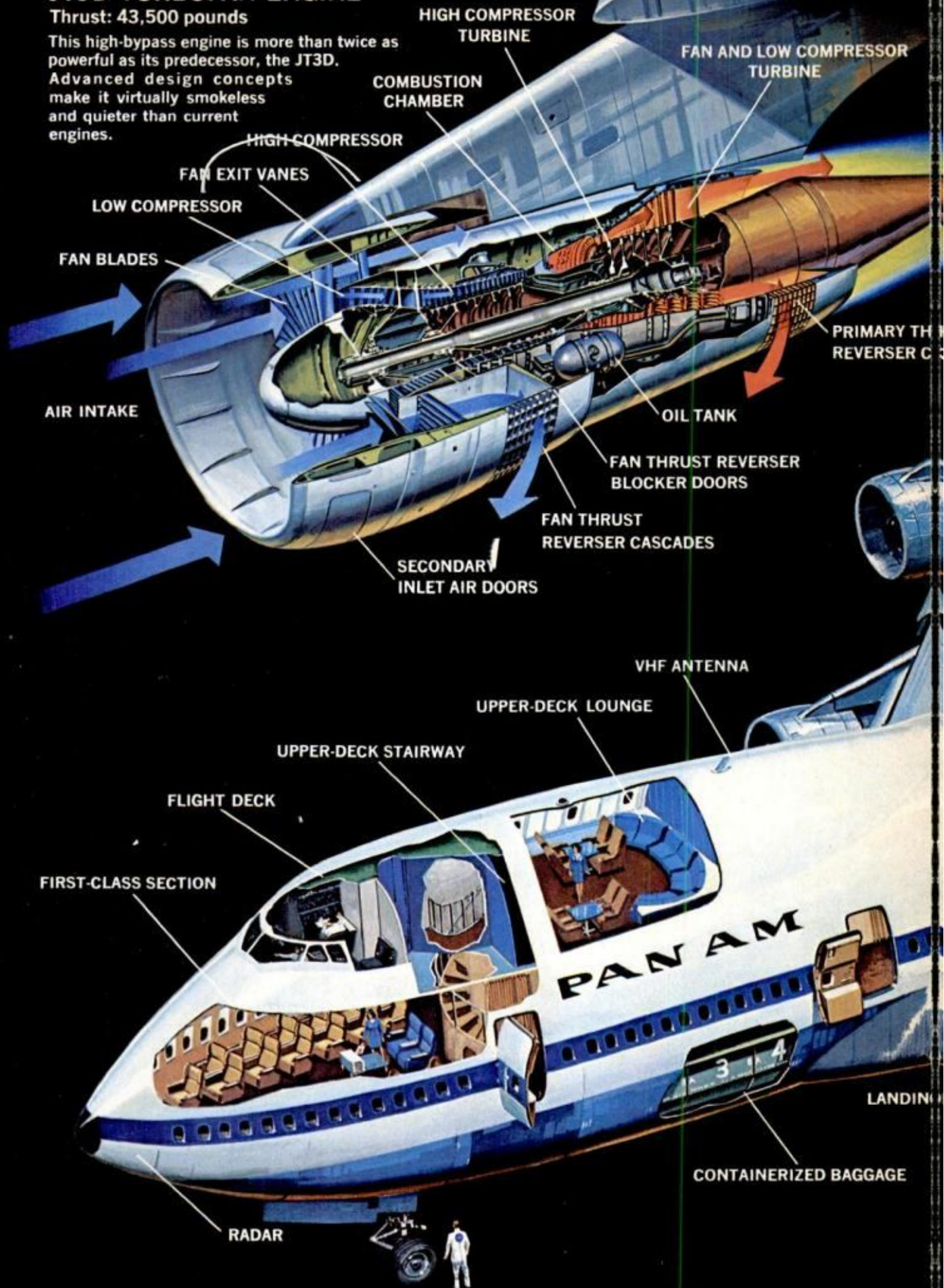
But that ho-hum description doesn't do the 747 justice. It's an exciting plane, even awesome and majestic. That's the impression I came away with after two days of examining test planes and those in various stages of completion at Boeing's huge facility north of Seattle. Stand toward the rear of a 747 and you have to bend your head back to see the top of its tail, which juts as high as a five-story building. You walk under wings that stretch almost 200 feet from tip to tip, and look into engine intakes eight feet in diameter, more than big enough to permit Wilt Chamberlain to stand inside wearing a top hat. The craft is so big and solid-looking that you wonder how it can be supported by anything as insubstantial as air.

But fly it does, and very well. On takeoff you notice that it is quieter than current jets and that the engines are almost smokeless. Despite its bulk, the 747 requires even less takeoff runway—about (*Text continues on page 111*)

PRATT & WHITNEY AIRCRAFT JT9D TURBOFAN ENGINE

Thrust: 43,500 pounds

This high-bypass engine is more than twice as powerful as its predecessor, the JT3D. Advanced design concepts make it virtually smokeless and quieter than current engines.



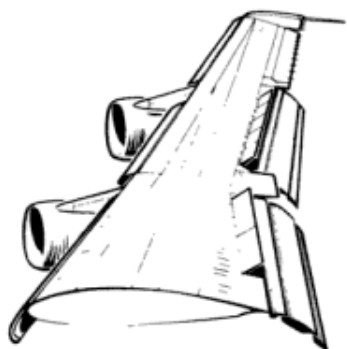
Art Concept Created for Popular Mechanics by Ed Valigursky, Fred Wolff, Howard Schafer, Roger Metcalf and Peter Trojan.

Материал, защищенный авторским правом

ing, used in a greater proportion in the 747 than in any previous airliner. Aluminum honeycomb is also used.

The 747 can operate from runways used by the 707 and the DC-8. This capability is due, partly, to high-lift devices in the wings. Flaps on leading and trailing edges add to wing area and direct the flow of air so as to give the plane increased lift as it speeds down the runway.

The engines also do their share. The big bird has four Pratt & Whitney JT9D turbofan units that are each capable of producing 43,500 pounds



thrust, more than double that of the JT3D on the 707. Though the JT9D has an intake almost twice the diameter of the JT3D, it is six inches shorter than the latter and more efficient. Design advances in the combustion and compressor sections make the difference. Because individual compressor stages, for example, produce higher pressures than achieved in earlier models, fewer such stages are needed. Growth versions of the engine, with thrusts up

to 47,000 pounds, are in the works.

Research also has achieved a quieter engine. By lowering jet-exhaust velocity, engine roar was lessened; the elimination of inlet guide vanes (stationary inlet struts) and a reduction in the speed of the fan at the front of the engine minimized the ear-splitting siren sound that is characteristic of turbofan engines. In addition, sound absorbent material was installed in the engine cowling, ahead of and behind the fan.

The 747's maximum cruise speed is 625 mph, a 10 percent increase over the 575 mph of the 707. Thus, flight time from New York to London will be reduced to 5 hours and 45 minutes, slicing 30 minutes from current schedules. The 747 is rated for flying at 45,000 feet.

When Pan Am's first 747 leaves Kennedy for London, passengers can rest assured that they are aboard the most thoroughly tested plane in the history of commercial aviation.

In addition to laboratory tests of separate parts and components, two complete airframes were used for static and fatigue tests. In the static tests the airframe was subjected to stresses and loads far in excess of those experienced in airline service. In the fatigue testing program, the airframe was subjected to repeated operation of its flight controls and cabin pressurization systems. The equivalent of years of operation was compressed into months. The goal of these programs was to prove an airframe life of 60,000 hours for the 747—the equivalent of 15 years of normal operation.

In another major phase of the test program, Boeing built a full-scale operating replica of the plane's flight control systems. This "iron bird" precisely duplicated the operation and responses of the 747's controls, enabling engineers to refine the systems well ahead of installation in the first plane and giving test pilots a chance to get the "feel" of the controls. Finally, five of the big jets were flight-tested for some 1400 hours. ★★★



First of a Great New Breed *(Continued)*

10,000 feet—than some current craft. It will be able to operate from runways now used by 707s and DC-8s. This capability derives from high-lift devices built into the 747's wings and from turbofan engines that individually develop a thrust of 43,500 pounds, more than twice that of the turbofans on the 707. (For more technical information, please see the accompanying foldout.)

"It would have been impossible to build this plane 15 or even 10 years ago," says Brien Wygle, Boeing's assistant director of flight operations. "We now know more about stability and how to attain it without excessive structural weight and complexity. And we know much more about how to control a plane."

The 747 is simply too big to control manually. Since there are no manual controls to fall back on in the event of a power-assist system failure, Boeing has put in four independent hydraulic systems to actuate primary controls. In test flights, the plane has been flown with three of the systems shut off.

After his first flight, Jack Waddell, 747 project pilot, commented: "The plane is ridiculously easy to fly. It almost lands itself."

But before that fact was established, there had been concern expressed by officials of airlines, the Federal Aviation Administration and Boeing. "The question was," says Wygle, "whether a pilot could manage a plane this big with the same margins that he has had in past airplanes. Well, the evidence that we have gained from flying the 747—and this includes not only our experience but that of FAA, military and other non-Boeing pilots—is that it is as easy to operate as other planes. We've had nothing but good landings out of people on the very first try."

The plane exhibits exceptional stability in flight, say test pilots. Its weight and aerodynamic qualities made it less sensitive to gusts and turbulences than smaller jets.

The cockpit, which occupies part of a short top deck, bristles with electronic gear, about \$1 million worth. (A complete plane, if you're in the market, costs about \$20 million.) In addition to such more familiar equipment as radar scope, radio compass, autopilot, altimeter and so on, the 747 is the first plane to have an inertial guidance system (INS) as standard equipment.

The INS is similar to that used for navigation on Polaris submarines and the Saturn moon rockets. One of its main advantages is that it needs no outside signals. Key elements in the system, a piece of hardware no larger than

The cockpit . . . bristles with electronic gear, about \$1 million worth

a standard file drawer, are a precision inertial reference unit and a digital computer.

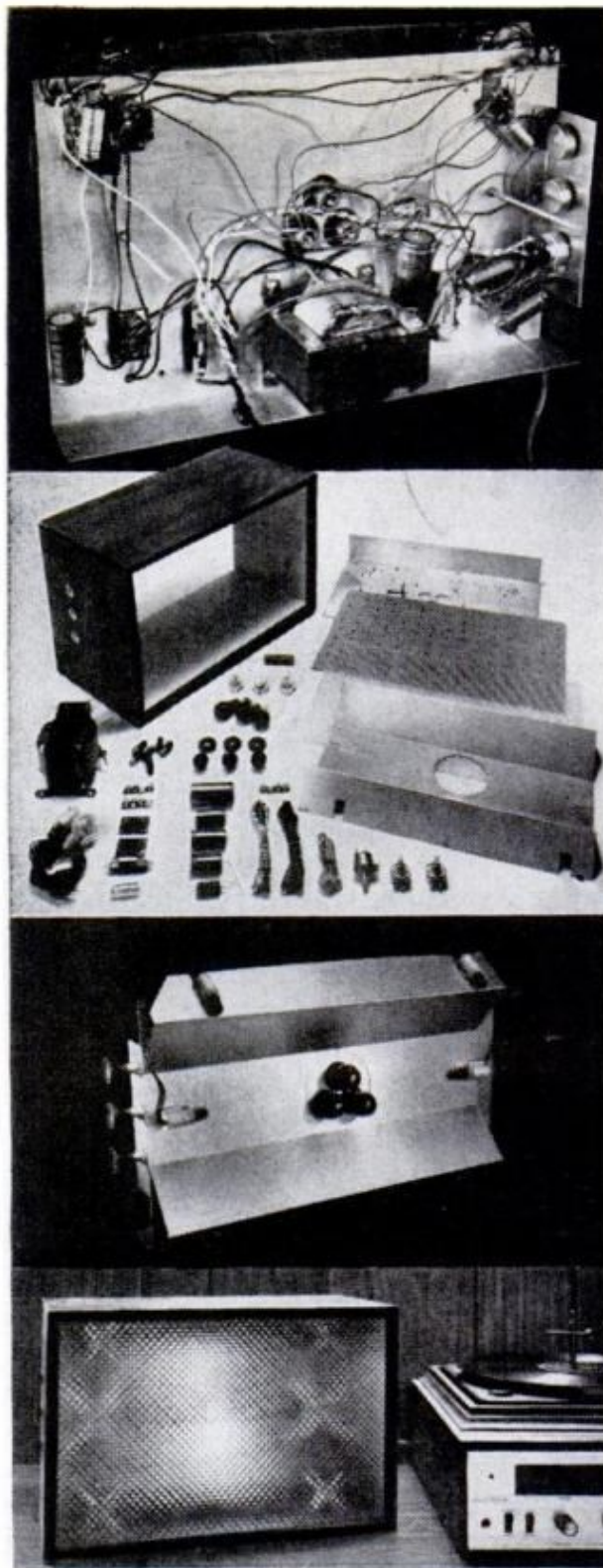
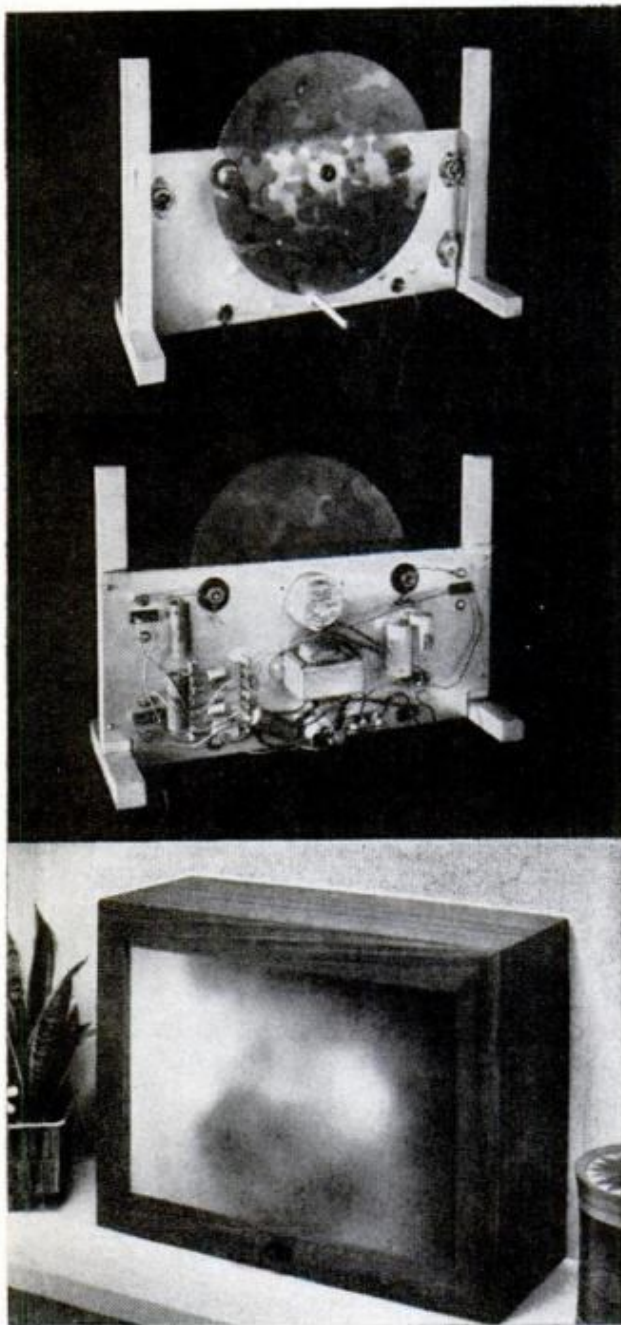
In the reference unit, gyros and accelerometers are mounted on a platform set within gimbals that allow it to turn in any direction. Spinning at 24,000 rpm, the gyros stabilize the platform to a known, fixed reference, such as the latitude and longitude of an airport. Whenever the plane strays off course, the gyros give off an error signal.

The starting point and a series of waypoints are fed into the INS before takeoff. The system's computer calculates the shortest course from waypoint to waypoint, and finally to the destination. When connected to the autopilot, the INS actually flies the plane, leaving the pilot free to monitor a continuously updated control and display unit.

Boeing pilots and engineers stress the fact that the 747 is the end result of a steady evolution, incorporating all the technical improvements initially used in the 707, 727 and 737, plus some new ones. Boeing first started thinking "big"

(Please turn to page 188)

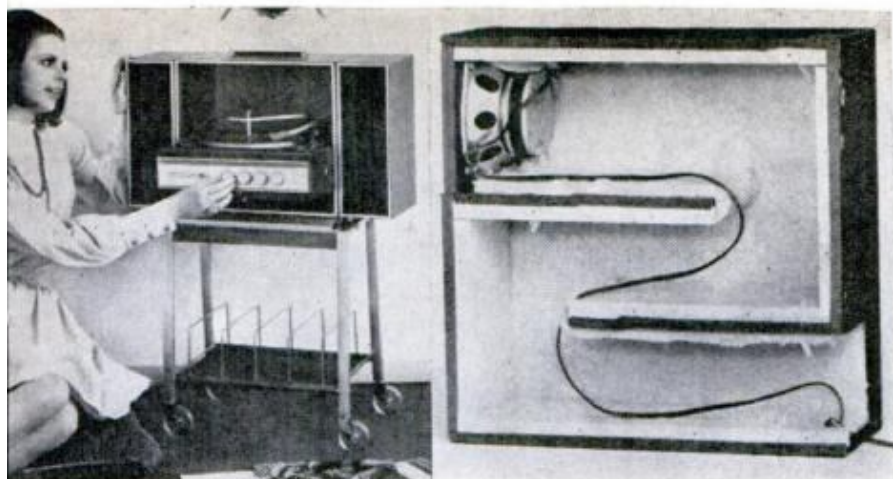
NEW IN ELECTRONICS



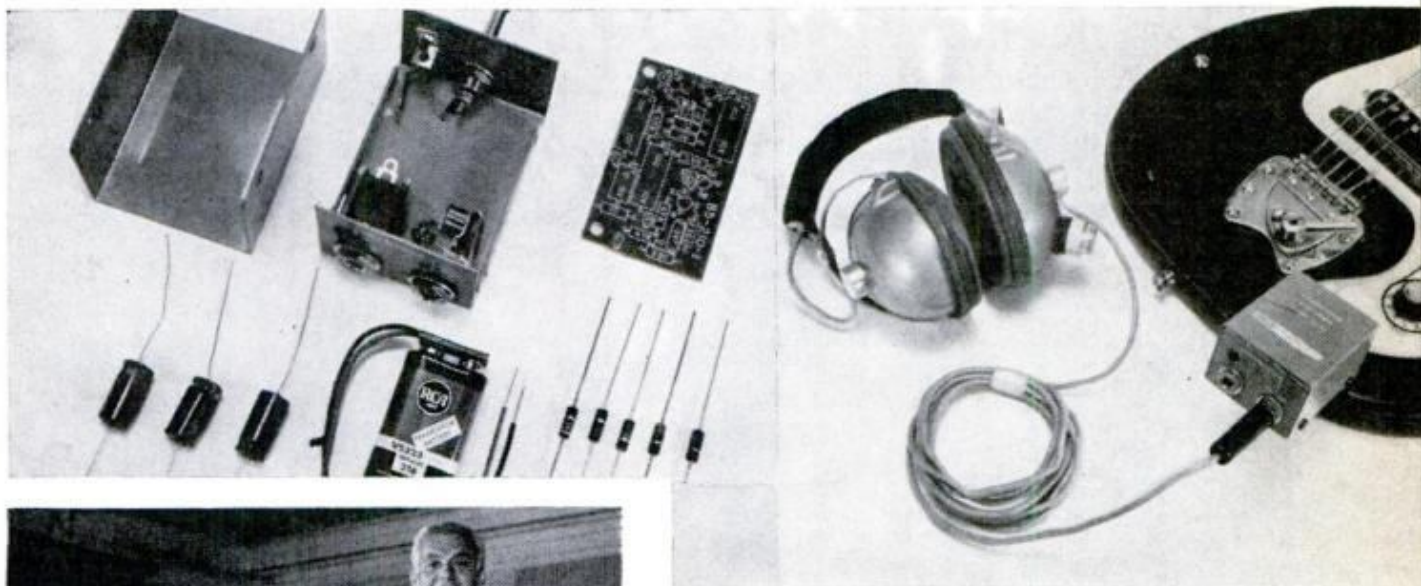
Two Psychedelic Lights You Can Build From Kits

If you've been intrigued by those wild colored lights that dance in time to music, here are two you can assemble yourself. They work on different principles, but produce similar effects. The Conar model at left uses a rotating color wheel backed by two white lights that pulse on and off with the music's beat. The flashing lights and turning wheel give the appearance of changing colors on a translucent screen. The Eico model at right has no moving wheel, but uses different-colored lights in a metal reflector. The lights not only

flicker in time to the music, but different colors flash on and off depending on the frequencies of the notes played. The result is an eerie, ever-changing pattern of pulsing colors. The Conar unit sells for \$44.95 in kit form and \$54.95 assembled. Conar, 3939 Wisconsin Ave., Washington, D. C. The Eico is \$49.95 in kit form and \$79.95 assembled. Eico Electronic Instrument Co., 283 Malta St., Brooklyn, N. Y. Each runs on house current and needs but a simple connection to the speaker terminals on any radio or phonograph.



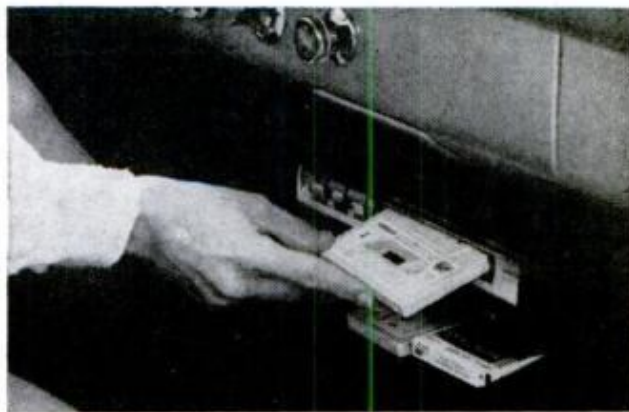
BIG SOUND from small speakers is the object of a new speaker enclosure developed by Admiral for its 1970 line of radios and phonographs. The speaker is mounted in a tall, thin box with a labyrinth of baffles forming a long, resonant tunnel. This reinforces low frequencies, providing a deep, rich base. With a 4-in. speaker, frequency response is from 15,000 cycles down to 30. The result is better sound for portable and table models that, due to size, are limited to tiny speakers.



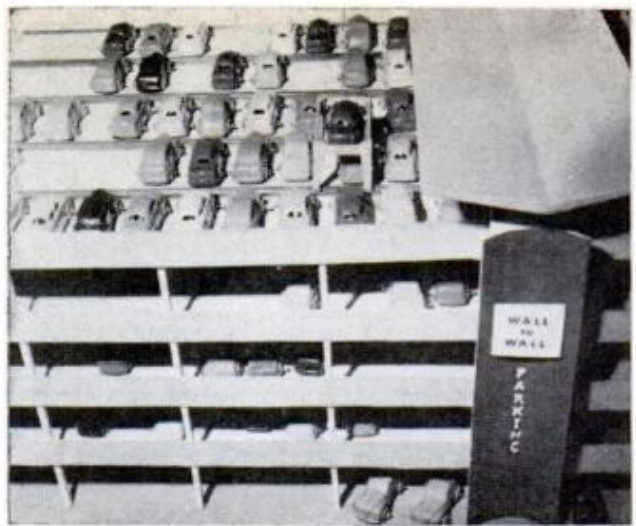
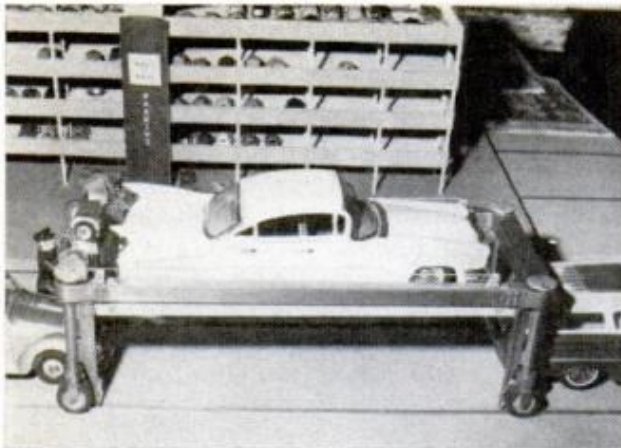
YOU CAN HEAR YOURSELF play an electric guitar with this tiny amplifier and a pair of headphones. The idea is to permit quiet practice sessions that won't disturb others. The battery-powered device plugs into the guitar's input and has two phone jacks. It's \$9.95 in kit form from Heath Co., Benton Harbor, Mich.



YOU DON'T GO ANYWHERE, but you can tell how fast and far you're traveling with this electronic jog meter. As you jog in place on a mat, the rate shows on a dial so you can maintain a steady pace. Device permits indoor jogging in bad weather or city apartments. \$120. Central Quality Industries, Polo, Ill.



ADDING TAPED MUSIC to your car is easy with this cassette unit designed to mount under the dash. It plays stereo, records monaurally and has a handy lower shelf for extra cassettes. Price is \$119.95. A similar playback-only model is available for \$99.95. Ampex Corp., 2201 Estes Ave., Elk Grove Village, Ill.



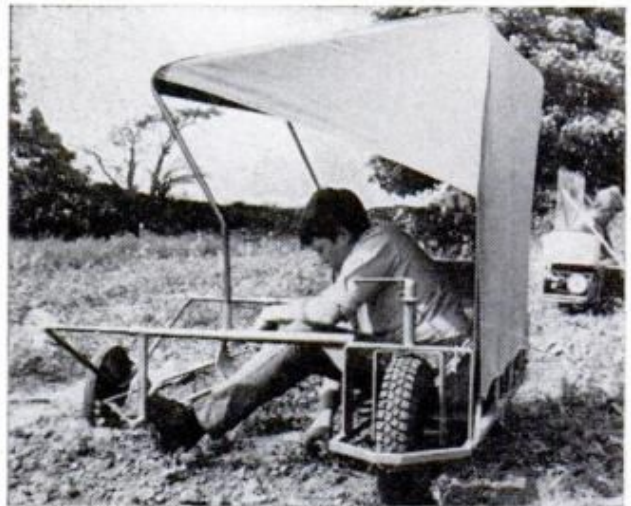
Parking machine would pack cars 'wall to wall'

This model illustrates engineer Glen Diehl's "wall-to-wall" parking machine that utilizes almost 100 percent of a building's parking space. The machine, on rails, picks up cars to take them to parking spaces and return them. Elevators lift the carrier to upper floors.



Beach and yard shelter

This plastic shelter was built by a German inventor to protect occupants against cool breezes at the beach or in a back yard.



Gardener's go-cart

The battery-powered Horticar enables English nursery employees to do weeding and planting without bending over all day.



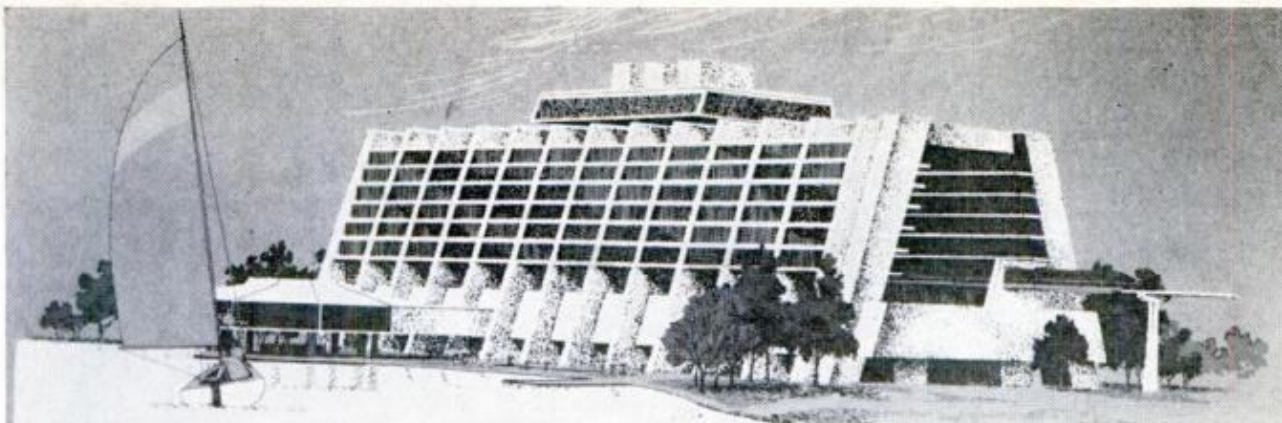
'Cigar' for world cruise

This is the hull of a 36-foot, cigar-shaped boat that Californian William Bonner is building to sail around the world.



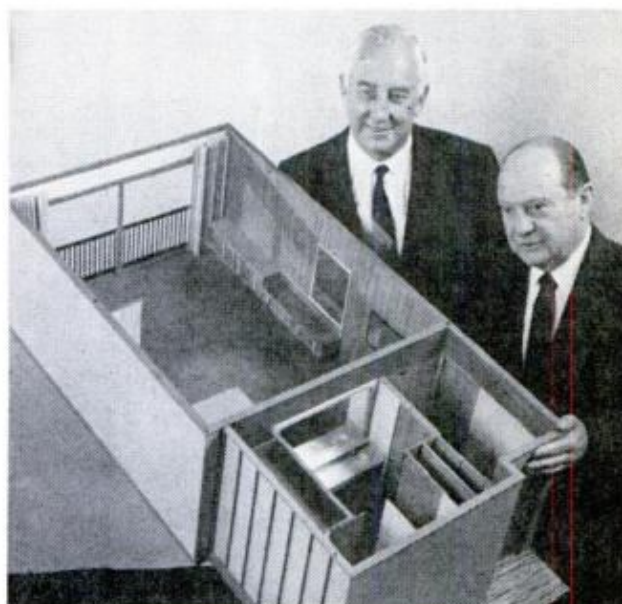
Four-engine homebuilt

Four go-cart engines, totaling 35 hp, power the metal-tubing-and-fiberglass plane built by Vernon and Verlon Weber of Cuba City, Wis.



Steel modules for Disney hotel

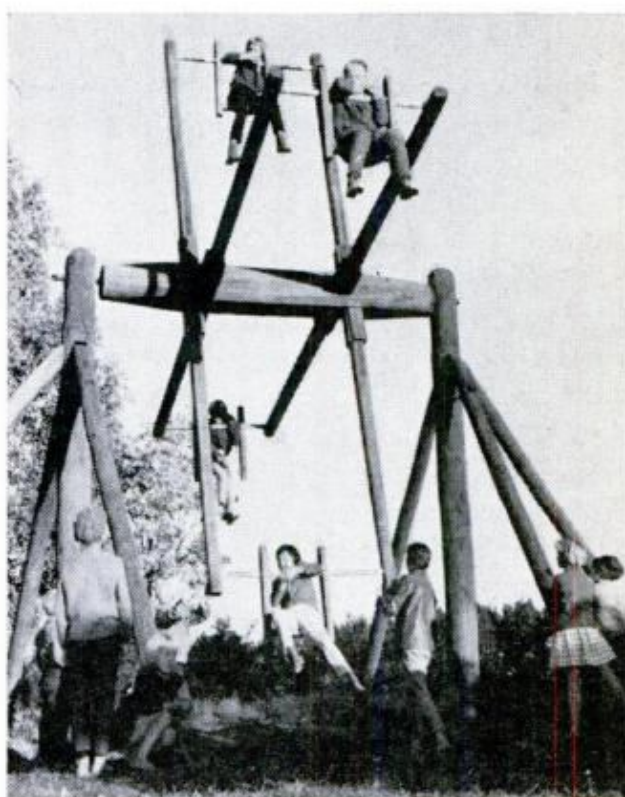
The first two "theme resort hotels" to be built in Walt Disney World at Orlando, Fla., will utilize the world's first major use of steel-framed modular construction. Shown in the drawing above is the Contemporary theme resort; at right is a model of modular hotel room that has been developed by United States Steel for this project. Some 1450 hotel rooms of this type will be built at an on-site facility and lifted into place in the first two hotels. The Contemporary resort shown here will have 750 rooms, rise 10 stories and feature an open-mall lobby longer than a football field and 80 feet high. Monorail trains linking this hotel and others at Walt Disney World with the theme park will travel directly through the lobby.



Bentley in fiberglass

An English manufacturer has introduced an electrically powered fiberglass model of the 1929 Bentley for young motorists.

DECEMBER 1969



Playground in Finland

Youngsters in a Finnish rural community don't need city parks; they have this home-built "Ferris wheel" for thrills.

Varmint hunting is now a big-time sport with special rifles for special jobs. Here's what you should know about them

THERE WAS A TIME when a hunter shot varmints only when nothing else was in season. If he couldn't shoot deer or bear, he might keep in practice by knocking off an occasional woodchuck with his 30-30. But now the varmint specialist is usually a more expert rifleman than the average big-game hunter. Varmints are small targets compared to moose and elk, and you must often hit them at long range with a small bullet sensitive to wind deflection.

Favorite target of the varmint shooter is the woodchuck or groundhog. In the West, he's called the rock chuck due to the type of terrain he frequents. Western varminters have two additional targets to shoot at in the jackrabbit and coyote.

The Northwest has the little ground squirrel. He's small and hard to hit. But the guns and marksmanship required are identical to those needed for woodchuck.

Crow shooting with rifles is also popular, but sometimes hazardous to other people. Since crows are often fired at when perched in a tree, a miss may send your bullet into the next county. Obviously, you must examine what's behind your target with great care.

If you're like most other hunters, the fun begins when you go shopping for a rifle. First choice you'll make is caliber, and a good rifle for the beginner is the .22 rimfire. Most hunters who tote a sophisticated custom model started with the .22. And it kills varmints. But its trajectory (arched line of flight) is

not flat enough for reliability at much beyond 75 yards. In addition, it simply hasn't got the punch needed to kill a woodchuck instantly unless you put a long-rifle, hollow-point slug directly into a vital spot. A more likely choice for the novice varminter is the .22 Winchester rimfire magnum, which will hit reliably at 100 yards or more. Its

copper-jacket 40-grain bullet, made specifically for varminting, has a muzzle velocity of 2000 feet per second, 635 f.p.s. faster than the .22 hollow point. Available in several fine guns costing little more than the inexpensive .22s, the Winchester rimfire magnum packs a substantial wallop.

Incidentally, when the name of a manufacturer is used as part of a caliber designation, it simply indicates the company that developed the cartridge. Usually, all manufacturers will produce the cartridge, no matter which one developed it.

From this point on, we are talking to the man who is, or wants to become, an expert at long-range shooting. The smallest cartridge he will choose is the .222 Remington. This round sends out a 50-grain bullet at 3200 feet per second and is one of the most accurate ever developed. Its light recoil makes it a pleasure to shoot, and its low cost per round is easy on your pocketbook. It hits reliably and kills cleanly out to well over 200 yards.

A slight step-up in power is represented by two cartridges which have almost identical ballistics—the .223 and

USE WHAT THE VARMINT SHOOTERS USE

By ART MAHER

FIVE TOPNOTCH VARMINT RIFLES (from left to right): Remington Model 700 BDL .222, Browning Safari Grade .243, Mossberg Model 800BV .22-250, Winchester .225, Savage Model 65-M .22 Rimfire Magnum.

SCOPES (at top, left to right): Redfield 2X to 7X variable, Weaver 4X to 12X variable, Savage 4X, Tasco 10X



the .222 Remington magnum. The former is a civilian version of the military's M16 round; the latter a .222 with elongated case. Both fire 55-grain bullets at 3300 f.p.s. The extra five grains of weight enables the bullet to retain its velocity better than the plain .222 and it increases resistance to wind drift. Some say these two cartridges provide 50 yards more range than the .222.

With the next larger caliber—the .225 Winchester—we're definitely in a high-velocity class. Its 55-grain bullets take off at 3650 f.p.s., making 300 yards a reasonable range. Then there's the .22-250 Varminter which fires the same weight bullet at 3810 f.p.s. You should use these cartridges only in sparsely

Broad fore end of a varmint stock provides for steady holds on far-off targets.

populated areas where a loud report won't bring the townspeople down on you or frighten the cows out of a week's milk!

For ranges exceeding 300 yards, you'll have to step up from the .22-type calibers. While the faster bullets have trajectories sufficiently flat to simplify aiming, wind drift becomes increasingly significant at long ranges. The little .22 slugs don't have the weight or shape to resist deflection by air currents.

A 6-mm cartridge is your best bet for distances over 350 yards. There are two on the market—the .243 Winchester and the 6-mm Remington. They fire 80-grain varmint bullets at speeds of 3500 and 3450 f.p.s., respectively. Their greater mass and weight give you increased resistance to wind drift.

An added advantage of the 6-mm cartridge is that it comes in heavier loads for hunting deer and other large animals. Thus, either the .243 or the 6-mm Remington makes a good choice for the man who wants one gun for both varmints and medium-sized game. But, never use 100-grain medium-game

loadings for varmint shooting. Varmint slugs need light jackets, which have an explosive effect when they hit a small animal and will shatter if they miss and hit the ground. Bullets for large game have heavier jackets and will often ricochet off hard surfaces, making them unsafe for pasturelands.

As you shop around, you may run into some second-hand rifles in discontinued varmint calibers. The .218 Bee (fine in populous, noise-sensitive areas) the .219 Zipper, .220 Swift, .250-3000 and .257 Roberts are all excellent rifles. The latter two, especially the .257, are good substitutes for the 6-mm.

Of course, some larger calibers such as the .270 Winchester, .280 Remington, .264 Winchester Magnum and 6.5-mm Remington Magnum are widely used for varmint shooting. But these rifles were created with larger game in mind.

When you get up into .30-cal. varmint loadings, you approach the realm of overkill. In addition, 110-grain .30-cal. slugs are not good wind buckers, nor is their shape particularly accurate. The .30s will do for varmints, but they're hardly your best choice.

Your best bet in an action is the bolt type. An exception is a custom-grade single-shot which might have a lever or falling-block-type action. Another is the pump-action or semi-automatic action favored by jackrabbit and coyote gunners. These animals often require a quick-firing gun, and are seldom shot at ranges beyond 150 yards. The bolt-action's improved accuracy serves little advantage in hunting these fleet-footed targets which are often killed within 150 yards only after several rounds have been sent after them.

The stock of your varmint rifle is important. The specialist usually chooses a varmint stock, a cross between a medium-weight hunting stock and a hefty target stock. One important feature is the broad, or beavertail fore end that provides a substantial wood grip for steady holds on far-off targets. Another is its high comb (top edge of the butt). When you aim a high-combed

rifle, the comb supports your head so you can align your eye comfortably with the rear end of a telescopic sight.

Don't forget a sling. Besides helping to carry the gun, it assists you with your aim, especially when prone.

Finally, you'll need a good scope. Open sights and peeps won't do the job.

The .22 rimfire or rimfire magnum is easily outfitted with an inexpensive 4X or 6X scope in 3/4-inch diameter with a tip-off mount to fit the parallel grooves you'll find in the receiver of the rifle. The 4X is probably the better choice, as the 6X has a smaller field of view and lacks its visibility.

For 6-mms and .22 centerfires to be used on varmints only, the connoisseur's choice would be a target-type scope. These range in power from 8X to 30X, and offer very accurate adjustments. They help you get every bit of potential out of your rifle. Your next best choice is a regular hunting scope in 8X to 12X. Anything less powerful would handicap the difficult long-range sniping you'll often encounter with varmints.

Incidentally, don't believe anyone who tells you that low-light visibility is better with a low-power scope than with one of higher power. A powerful scope will help you see better in any light. The only time a varmint hunter wants a lower-power scope—say, about 4X—is when he's hunting jackrabbits or coyotes. He's got to line up fast on these two, and a low-power scope will help him do that.

The scope to buy for the rifle that shoots both varmints and big game is a variable of 3X or 4X at the low end of its range and at least 7X at the high end. Use low power in deep woods where your glimpses of game are brief; use high power for varmints.

There's a lot more to buying a good varmint rifle than going into a store and saying, "Gimmee." But the time spent in finding out which rifle and scope are best suited for you will more than pay for itself in the great enjoyment found in this growing sport. ★★

DECEMBER 1969



Fast sub hunter

Scheduled to go into service in 1972 is Navy's new carrier-based antisubmarine warfare plane, the S-3A. Top speed will be over 400 knots and range, 2000 miles. This illustration is an artist's concept.



New undersea craft

The Vickers-Pisces, a British two-man submersible, will be able to work at depths down to 3500 feet. It's shown here during tests.



Monster hunter

The most recent entrant in the perennial search for the Loch Ness monster is Dan Taylor with his 20-foot fibreglass submarine. At last report, there were no sightings.

119



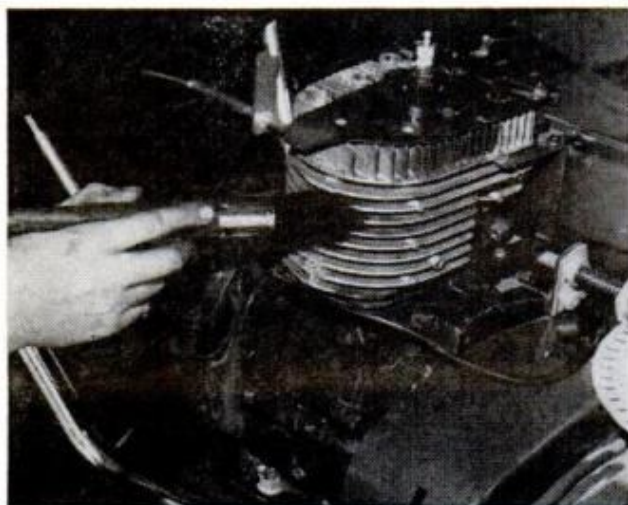
Care and Feeding Of Snow Throwers

Now's the time to make sure your snow thrower is ready to go to work—and keep working through the snows ahead. Here's a simple checkout for that most vital part—the engine—plus a handy troubleshooting guide

By MORT SCHULTZ

MOST MANUFACTURERS of snow throwers do a fine job of telling you how to take care of the auger, the chute control and the other snow-handling parts of your machine. But what about the engine? Most manuals merely advise you to take the rig to a repair shop if the engine needs service.

Actually, working on the engine is usually no more difficult than maintaining the other parts, and obviously it's the engine that has to go if you're going to throw snow in the coming winter. Here,



CLEAN COOLING FINS with a stiff-bristle brush. Despite frigid winter weather, the engine can overheat dangerously if fins are clogged with debris

120



COVER OVER CARBURETOR is found on most snow throwers to keep moisture from getting in and freezing. Remove cover if carburetor needs an adjustment

POPULAR MECHANICS

then, are some helpful pointers on getting an engine in shape and troubleshooting tips if a failure should occur.

If you stored your equipment properly last year, you should have no trouble getting it started now. Prestorage preparation involves draining fuel, replacing crankcase oil in four-cycle engines and lubricating the upper cylinder by pouring some SAE 10W oil in through the spark-plug port. If you should have difficulty waking up a sleeping engine, check the accompanying troubleshooting guide for possible causes.

Even if the engine starts easily, there are several maintenance steps that must be taken to be sure it will give trouble-free service all winter long. Start by checking the sparkplug for damage and correct gap adjustment. Bad plugs are the second major reason why two and four-cycle gasoline engines refuse to start. (The first reason, ironically, is an empty tank.)

Discard the plug if the insulator is cracked or the electrodes are broken or badly worn. If the plug looks usable, clean the electrodes with a wire brush and file the center one bright with an ignition point file. Only one or two passes are necessary.

Gap the plug to .030-.035 inches. Before reinstalling it, apply a little graph-grease to the threads to keep the plug from sticking in the engine in cold weather. Screw the plug in finger-tight, then give it an additional half turn with a wrench.

Remove the fuel line, fuel tank and

gas filter if there is one. Wash them in kerosene. Make sure the vent hole in the fuel-tank cap is unclogged. While you have the fuel tank off, clean debris from the cylinder's cooling fins with a stiff-bristle brush to guard against engine overheating.

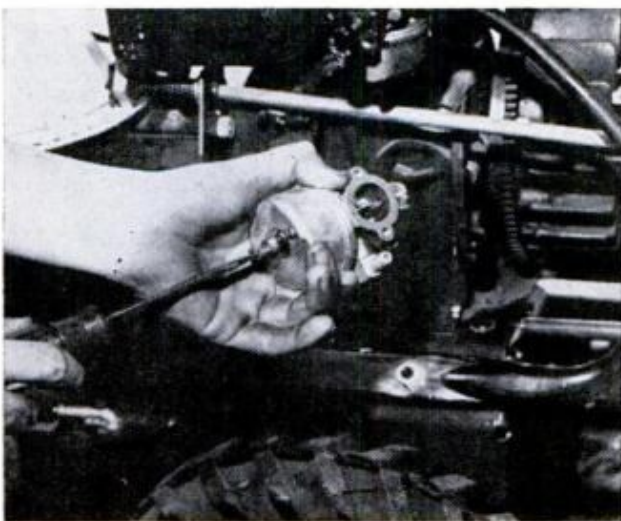
Fill the machine with the correct lubricant and fuel. Keep in mind that the recommendations on the viscosity of oil to use are important if you want the engine to start easily throughout the winter. One of the main reasons why engines fail to start is that some owners substitute heavier oil than the grade called for. This puts a drag on engine parts.

If your machine has a two-cycle engine, oil and gasoline must be mixed together before they are put into the fuel tank. Use an SAE 30 outboard motor oil or a two-cycle engine oil. Don't use a multi-viscosity automobile oil such as SAE5W-30. It contains additives that leave carbon inside two-cycle engines.

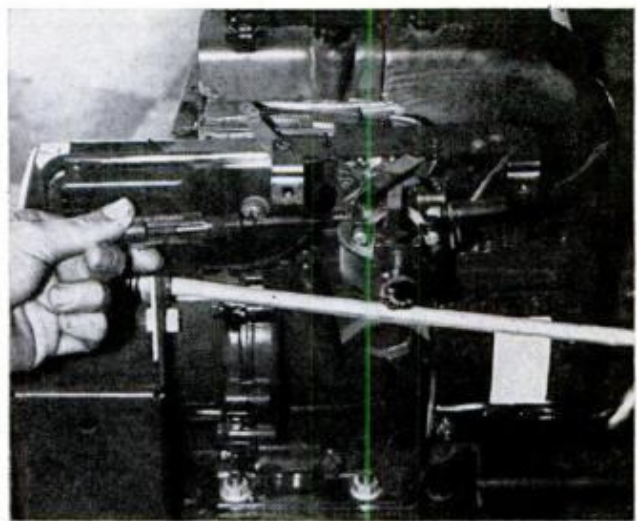
The gasoline should be regular grade and fresh. Never use gas that's been stored. Gum forms in stored gas and will plug the carburetor. Also, be sure the gas you buy is a winter grade. Gasoline sold for warm-weather use is less volatile and will make starting difficult.

Mix the oil and gas in a clean container and shake thoroughly. Mixing should be done at room temperature. Generally, a half pint of oil to a gallon of gas is the correct ratio. Check your manual.

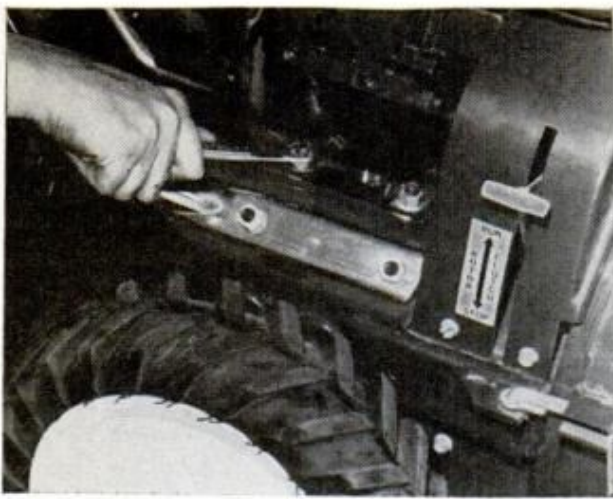
If your engine is a four-cycle, fill the crankcase with SAE 5W-30 or SAE 10W motor oil that's designated for MS ser-



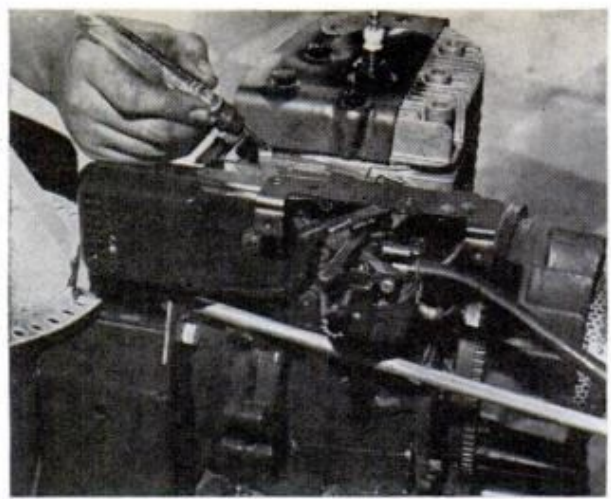
HIGH-SPEED ADJUSTING SCREW is sometimes under the carburetor in the bowl. If you remove the bowl to replace needle and seat, remove this screw, too



AFTER MAKING the high-speed adjustment, set the idle by turning the idle-speed adjusting screw until you get the smoothest possible engine idling



EXCESSIVE VIBRATION can actually damage an engine. Tighten all bolts to prevent looseness. Handiest tool for this is an open-end or socket wrench



USE LIGHT MACHINE OIL on governor, throttle and choke-linkage pivot points. Don't put on too much, though. A drop at each point of movement is plenty

vice. This means that the oil is for engines that are used under severe operating conditions.

In starting your engine for the first time, let it warm up, then run it through its various speed ranges. If it starts and runs without stalling or faltering, leave it alone. If not, readjust the carburetor. If you have a two-cycle engine, allow it to run at top speed and turn the high-speed mixture screw to the closed position. Then open it one full turn. Now turn the idle-speed mixture screw to the closed position, then open it $1\frac{1}{8}$ to $1\frac{1}{4}$ of a turn. Hold the throttle closed and turn the idle-speed regulating screw clockwise until the engine idles smoothly. When you use the machine at the first snowfall, a slight readjustment may be necessary if the engine stalls.

To adjust the carburetor of a four-

cycle engine, run the engine at top rpm and close the high-speed adjusting screw until the engine just starts to lose speed. Slowly open the screw past the point of smoothest operation until the engine just begins to run unevenly. Set the engine speed to idle and turn the idle-speed adjusting screw until a smooth idle is obtained.

This should be the correct carburetor adjustment for a four-cycle engine, but you'll have to test it during the first snowfall with the engine under load just as with a two-cycle engine. If the engine stalls, the mixture is too lean, so open up the high-speed adjusting screw slightly even though you will probably get an uneven idle.

Tighten all fasteners, especially mounting bolts. A part that vibrates excessively

(Please turn to page 198)



FLYWHEEL PULLER uses leverage to pry flywheel off the engine shaft so you can reach the magneto. Never use hammer; you may wreck entire assembly



COMPRESSION TEST can tell you if engine needs major work, such as on valves and rings. Pressure shows on a gauge as engine is turned over by hand

TROUBLESHOOTING GUIDE FOR SNOW-THROWER ENGINES

Cause

Remedy

ENGINE FAILS TO START OR IS HARD TO START

- | | |
|------------------------------------|--|
| 1. No fuel in tank | Fill it up. |
| 2. Shutoff valve closed | Some engines have a shutoff valve between the fuel tank and carburetor. Be sure it's open. |
| 3. Grounding clip shorted | This allows stopping of the engine. Be sure it's not in the "stop" position. |
| 4. Engine overchoked | Engine might be flooded, especially if you smell gas. Shut fuel shutoff valve and turn engine over several times, or let it sit for a while. |
| 5. Fuel-tank cap vent plugged | Use a bristle from a wire brush to ream dirt out of vent hole. |
| 6. Sparkplug lead loose | Be sure high-tension lead is firmly connected to the plug. |
| 7. Water in fuel | Hold a few drops of fuel in your hand. If water remains after fuel evaporates, drain and clean the tank. Refill. |
| 8. Sparkplug loose | Tighten finger-tight, then give half turn with wrench. |
| 9. Sparkplug cracked | Replace. |
| 10. Sparkplug fouled | Clean and regap. |
| 11. Improper carburetor adjustment | Readjust. |
| 12. Obstructed carburetor | Wash in kerosene. Replace needle, seat and gaskets. |
| 13. Faulty magneto | Points and condenser give the most trouble. Replace, gap points and set timing. |
| 14. Poor compression | Overhaul engine. |

ENGINE KNOCKS

- | | |
|---------------------------------|---|
| 1. Bad fuel | Dump and refill with fresh gas. |
| 2. Incorrect magneto timing | Time magneto to specification. |
| 3. Loose flywheel | Check flywheel key and keyway and replace parts if worn. Be sure flywheel nut is tight. |
| 4. Carbon in combustion chamber | Remove cylinder head and clean carbon from head and piston. |
| 5. Worn connecting rod | Replace. |
| 6. Worn cylinder | Have cylinder rebored and replace piston with one that's properly oversize. |

ENGINE MISSES UNDER LOAD

- | | |
|--|-----------------------------------|
| 1. Sparkplug cracked | Replace. |
| 2. Sparkplug fouled or improperly gapped | Clean and regap. |
| 3. Improper carburetor adjustment | Readjust. |
| 4. Faulty magneto breaker points | Replace (replace condenser, too). |
| 5. Faulty condenser | Replace. |
| 6. Improper valve clearance | Adjust. |
| 7. Weak valve spring | Replace. |

ENGINE LACKS POWER

- | | |
|---|---------------------------------------|
| 1. Improper amount of oil in fuel mixture (2-cycle) | Mix new batch in correct proportions. |
| 2. Lack of lubrication (4-cycle) | Fill crankcase to correct level. |
| 3. Choke partially closed | Make sure choke opens freely. |
| 4. Improper carburetor adjustment | Readjust. |
| 5. Magneto improperly timed | Time to specification. |
| 6. Leaky valves | Grind valves. |
| 7. Worn pistons or rings | Replace faulty parts. |

ENGINE OVERHEATS

- | | |
|-----------------------------------|--|
| 1. Lack of lubrication | Fill crankcase to proper level (4-cycle); be sure oil-to-gas ratio is correct (2-cycle). |
| 2. Clogged cooling fins | Clean debris from cooling fins. |
| 3. Carburetor improperly adjusted | Readjust. |
| 4. Incorrect timing | Time magneto. |
| 5. Carbon in combustion chamber | Remove cylinder head and clean carbon from head and piston. |

ENGINE SURGES OR RUNS UNEVENLY

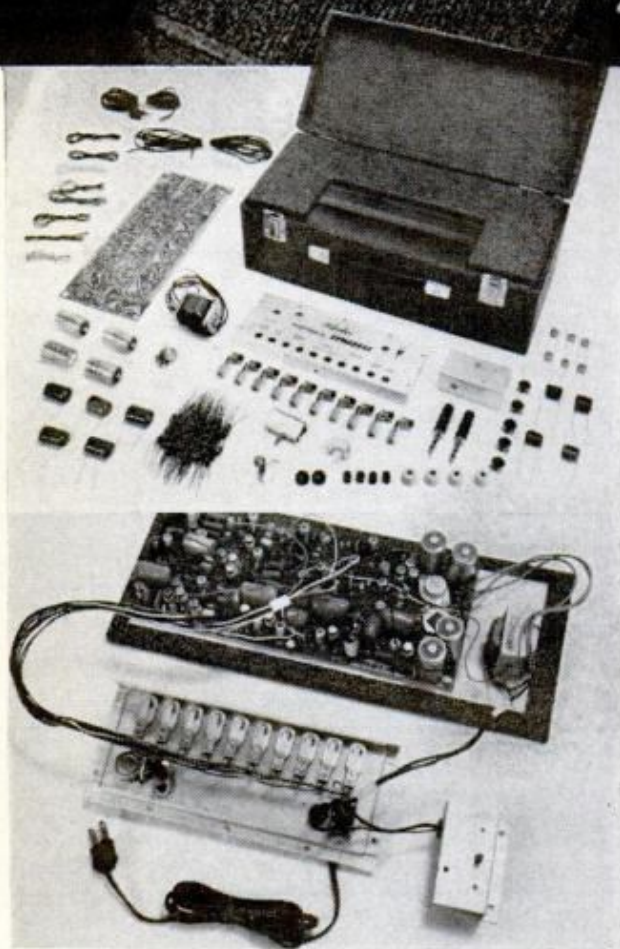
- | | |
|---|---|
| 1. Fuel-tank cap vent plugged | Use a bristle from a wire brush to ream dirt out of vent hole. |
| 2. Governor parts sticking | Clean. If parts are damaged, replace. |
| 3. Carburetor throttle linkage or throttle shaft and/or butterfly binds or sticks | Clean, lubricate or adjust. Deburr throttle shaft or butterfly. |

ENGINE VIBRATES EXCESSIVELY

- | | |
|---|---|
| 1. Engine not securely mounted | Tighten loose mounting bolts. |
| 2. Snow-handling equipment out of balance | Readjust in accordance with instructions in owner's manual. |
| 3. Bent crankshaft | Replace. |

Electronic Music-Makers You Can Build From Kits

By SHELDON M. GALLAGER



DYNABEAT KIT, most complicated of the three, is shown completed at top of page and in parts in lower views. Photo immediately above shows printed-circuit board and underside of 10-switch keyboard

Press a button and you can beat out a drum rhythm like a pro or create notes that sound like an organ. Here are three fun-to-build, fun-to-play instruments that let you join in the merrymaking whether you're a musician or not.

DO-IT-YOURSELF MUSIC is rapidly becoming a major form of adult recreation and relaxation for people who never made it past sixth-grade lessons on the violin or tuba. All over, grownups are gathering at parties and family get-togethers to sing songs around a piano or record player, beating out simple rhythms



DRUMBEATS are produced electronically by Knight-Kit's Combo Sideman. Knobs control rhythm, tempo and volume. Kit comes with pre-wired circuit board, takes only an hour or so to assemble. Accessory foot switch is also included. Instrument is shown connected to a Knight-Kit guitar amplifier, one of the many types of amplifiers that you can use

on a pair of bongos or an old washtub.

Here are three kit-built electronic instruments that can add a lot of fun at such sessions without requiring either musical or electrical know-how. They're not only easy to play, but offer the satisfaction of putting something together yourself. All three produce musical sounds through the use of ingenious solid-state circuits. Two are percussion rhythm instruments that provide realistic drum, cymbal, brush and bongo sounds at the touch of a button. The third has a simplified piano keyboard that produces rich, vibrant organlike tones.

The instruments are ideal for adding your own accompaniment to a phonograph, piano, guitar or accordion. All three can be played through any hi-fi amplifier or receiver that has external inputs for mike, phono, tape or similar equipment. All you do is run a standard mike or phono connector cable from the instrument to the input jack on the amplifier.

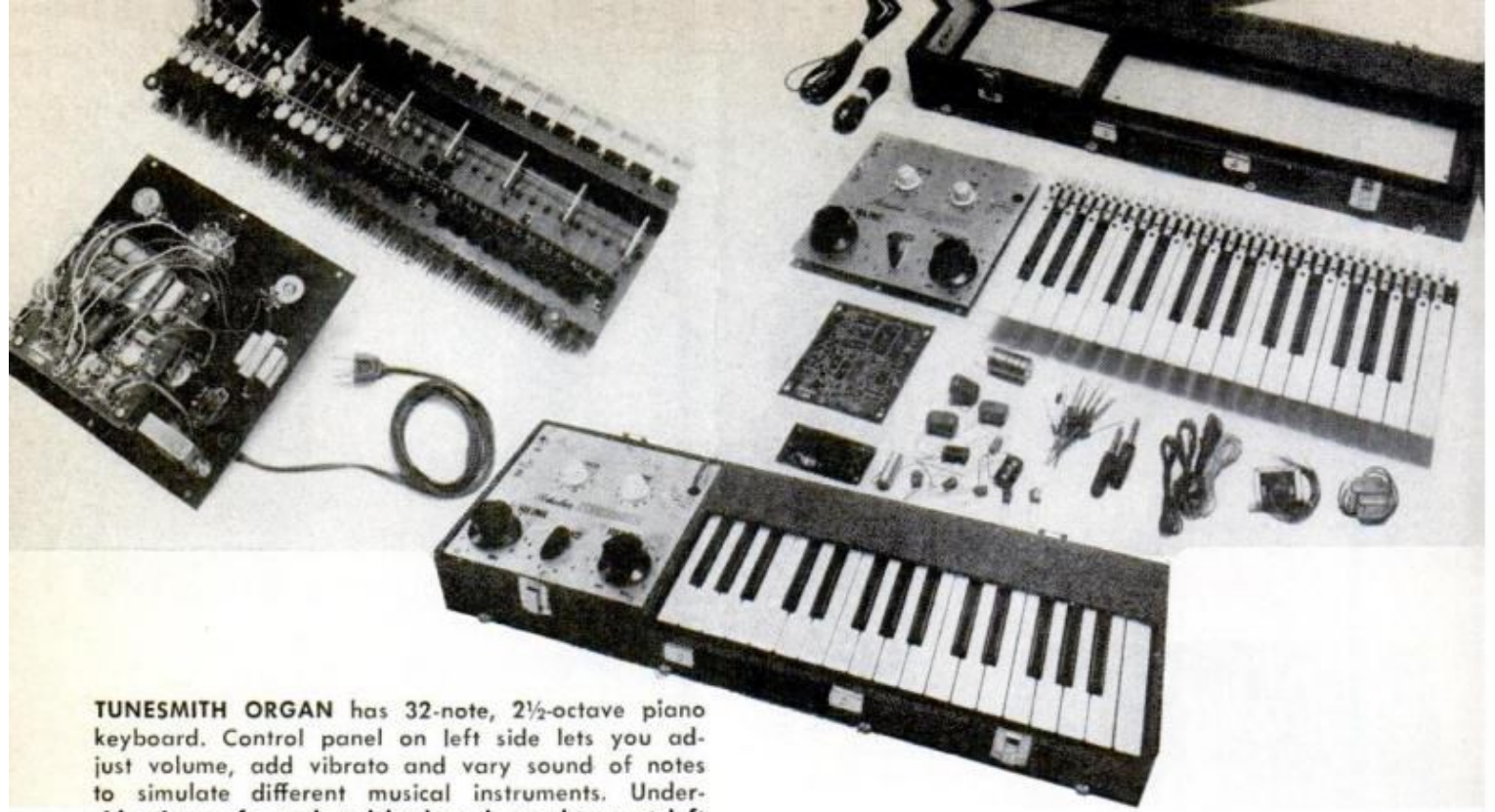
Simplest of the three kits is Allied's Knight-Kit Model KG-392 Combo Sideman. This produces three percussion sounds—bass drum, snare drum and

cymbal—in any of six rhythm patterns. You don't have to keep the beat yourself. You just select the rhythm you want, press a button and out it comes. The clever part is that you can adjust the speed of the beat so it exactly matches the tempo of the music you're singing or playing. The result is that it sounds as if someone is playing the drums right along with you.

You can also play the instrument manually by tapping a button with your finger. This provides a single drumbeat or a continuous roll depending on how long you hold the button down. Both the manual and automatic functions can be controlled by foot switches, leaving your hands free to play another instrument.

The Combo Sideman comes partially assembled to speed the work. You merely solder connections between a prewired circuit board and the controls. The job can easily be done in an evening. Kit price is \$49.95 from Allied Radio Corp., 100 N. Western Ave., Chicago, Ill. 60680.

A more advanced electronic percussion instrument is the Dynabeat developed by Schober, famous maker of electronic organs. In this case, you provide the rhythm



TUNESMITH ORGAN has 32-note, 2½-octave piano keyboard. Control panel on left side lets you adjust volume, add vibrato and vary sound of notes to simulate different musical instruments. Under-side views of panel and keyboard are shown at left

and tempo yourself, and you have a wider range of percussion sounds. A 10-button keyboard gives you a choice of bass drum, snare drum, tom-tom, brush cymbal, crash cymbal, castanets, two types of wood block sounds and two bongo sounds.

By playing the buttons with several fingers at a time, you can produce different combinations of sounds in rapid succession. Some of the buttons, such as the bass drum and tom-tom, provide a single beat with each tap. With others, you can hold the button down and get a continuous series of sounds, such as a dramatic drum roll or repetitive cymbal crashes. The tempo is determined by how fast you tap the buttons. You can provide a professional-like accompaniment merely by flicking the buttons in time with the music.

The Dynabeat is a highly sophisticated instrument and consequently a fairly hefty kitbuilding job. You can't rush it. There are, for instance, 145 resistors alone to install along with a number of other parts. A printed-circuit board speeds the wiring, however, and makes for a neat, trim job. Assembly time was found to be about 35 hours—comparable, say, to a small radio chassis.

The Dynabeat's sounds are produced by phase-shift oscillators, in some cases combined with multivibrators and diodes. They are extremely lifelike and make anyone who has ever dreamed of being a

drummer really sound like one. Price for the Dynabeat kit is \$139.50 from the Schober Organ Corp., 43 W. 61st St., New York, N. Y. 10023. A ready-built version is available for \$169.50.

Anyone who can tap out simple tunes with one finger on the piano can play the Tunesmith, also made by Schober. Although not a full-fledged electronic organ, it produces organlike tones from a 32-note, 2½-octave keyboard. The only limitation is that you must play the notes singly, one at a time. You can't press several keys simultaneously to create chords.

A control panel on the Tunesmith, operated with your left hand, lets you vary the character of the notes as you play them. One knob gives you a choice of different organ voices like trumpet, flute, oboe, violin and cello. Another allows you to add a mellow vibrato effect. You can also tune the organ to match any other instrument you're playing it with.

The Tunesmith is a relatively easy assembly job, simpler than the Dynabeat. Working steadily, you can complete it over a weekend. It's price is \$149.50 in kit form and \$189.50 assembled. Both the Tunesmith and Dynabeat include handsome, simulated-leather carrying cases with removable covers. They operate on 115-volt a.c. In the case of the Combo Sideman, no external power is required as it runs on a built-in battery. ★★★

NEW IN PHOTOGRAPHY



PORTABLE MOVIE LIGHT operates on rechargeable batteries, enabling you to shoot night or other scenes away from a power source. The Sylvania SG77 Sun Gun comes with a shoulder pack that can be recharged in an hour from either 115-v. house current or 12-v. d.c. from a car's cigaret-lighter socket. The lamp runs 10 minutes on a charge—enough for two 50-foot rolls of film. \$119.95.

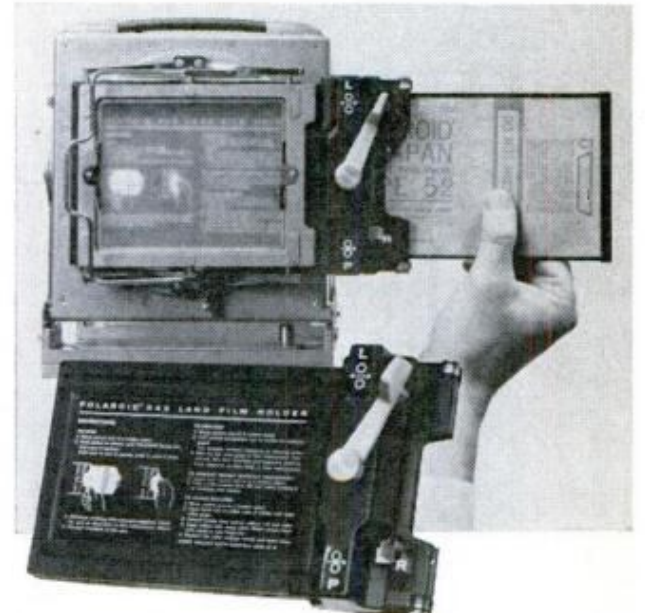


HORIZONTAL HAND GRIP is an unusual feature on a new line of Anscomatic Super-8 movie cameras. Designed to be grasped with your wrist in a vertical position, it has a built-in shutter trigger, is said to permit easier, steadier holding. Prices range from \$44.50 for fixed-focus model above to \$249.50 for an advanced version with electric zoom and fading control. GAF, New York.



POLAROID OWNERS can now use electronic flash with models not originally equipped for such units. This GE strobe is designed to fit all 100, 200 and 300-series folding Polaroid pack cameras except the 360, which has its own flash. A novel two-level light control gives you full power for distant shots or half power for close-ups. Flash comes with special mounting bracket and shutter cord. \$50.95.

DECEMBER 1969



NEW ADAPTER HOLDER for using instant Polaroid film in 4x5 press and view cameras is said to be simpler and easier to use than earlier models. The load process mechanism is enclosed to prevent its being touched accidentally and spoiling the results during removal of the film. A new clip holder eliminates the chance of clip jamming, and a safety catch prevents premature film withdrawal.

127

PHOTOGRAPHY



New Mini-Strobes: Flashguns

By BURT MURPHY



MINI-STROBES like the Bauer E-160 (above) clip easily onto your camera and weigh only a few ounces

THE FIRST electronic flashguns were bulky affairs with a battery pack slung over your shoulder that felt like a bucket of lead. Now they weigh only a few ounces and are slim enough to slip into a shirt pocket. The batteries are built-in and can be recharged in a few hours with a small accessory charger that plugs into any 115-volt wall outlet. The result is a new freedom and convenience in flash photography not possible before.

These new-generation mini-strobes are ideal for the casual vacation or party-bound snaphooter who doesn't want to carry or invest in a lot of expensive gear. They do, however, have their limitations and it's important to be aware of these. As a class, pocket strobes are not as powerful as full-size electronic flashguns, and can't be expected to be. Their light won't reach as far or cover as broad an area. To compensate for this lower level of illumination, you have to use larger lens openings, thus sacrificing some sharpness and depth of field.

Mini-strobes also vary widely among themselves in capacity, as their prices indicate. You can pay

PM MINI
MITE
\$24.95

METZ 184
\$74.95

BRAUN
F-280
\$79.50

MINOLTA
\$34.95

BROOKS
BLITZ
\$49.95

HONEYWELL
STROBONAR 330
\$89.50



LINE-UP OF POPULAR MINI-STROBES shows the wide variety of models available, ranging in price from

as little as \$20 to more than four times that. Guide numbers, an indication of light output, also vary con-

Not much bigger than a pack of cigarettes, they're easy to carry, handy to use and moderately priced. Here are helpful pointers on buying and using one

You Can Slip in a Pocket

anywhere from \$20 to nearly \$90 for one. What you get in the higher-price units are greater light output and, usually, such things as more flashes per charge, faster recycling time and special convenience features. On the average, prices for most of the minis fall in the \$50 to \$60 range.

The exposure guide numbers supplied with each strobe are one helpful indication of available power. The higher the number, the greater the light output. For the units shown here, the guide numbers range all the way from 30 to 69 for ASA 25, the film speed for Kodachrome II color film. The average is between 35 and 45 for ASA 25. By comparison, the guide number for a typical standard-size strobe gun (Honeywell's Strobonar 880) is 80 for ASA 25. At 10 feet, a common shooting distance for small groups, the big

strobe would provide a lens opening of $f/8$, while the minis would need larger openings of $f/4$ or $f/3.5$.

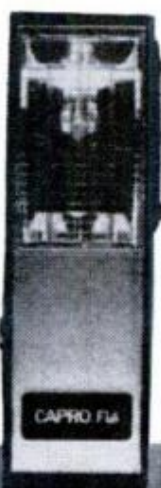
What the minis lack in capacity, however, they make up for in convenience. They not only let you take pictures indoors and at night, but they're perfect for carrying along on daytime outings when you wouldn't normally think of needing flash equipment. They'll add sparkle to shots when the weather turns dreary and cloudy or provide fill-in light to soften harsh shadows. You can compensate for their limited output by taking advantage of today's high-speed films. These, by requiring less light, will enable you to shoot at smaller lens openings for sharper pictures and greater depth of field.

Flash duration—in effect, the speed at which the picture is taken—is im-

PM POWER
MITE
\$49.95



CAPRO FL4
\$20



BRAUN
F-210
\$59.95



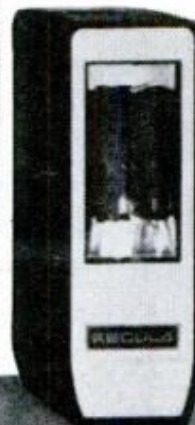
BRAUN
F-110
\$39.95



BAUER
E-160
\$59.95



REGULA
VARIANT FM
\$59.95



METZ
180
\$49.95

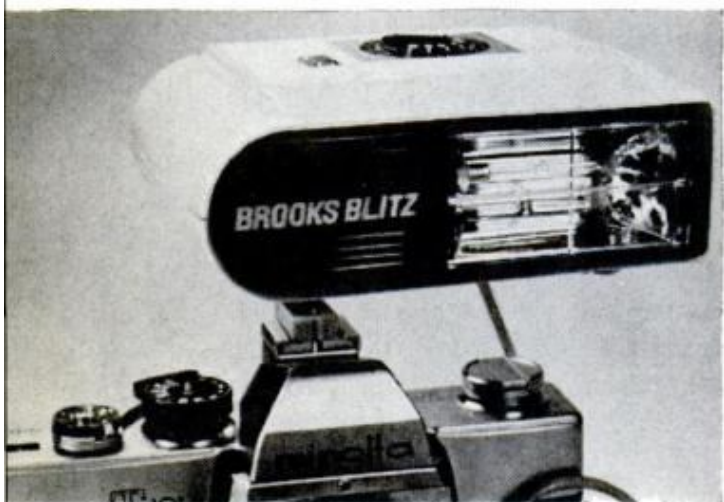


siderably from 30 to 69. Recycle time—the number of seconds you have to wait between flashes—is

another important factor to check on when you select a unit. Prices shown above are approximate



ACCESSORY CHARGER plugs into wall outlet, rejuvenates strobe batteries overnight. In most cases, same charger can also be used to run strobe on 115-volt a.c. to save batteries when shooting indoors



REVOLVING SHOE on some models, like this Brooks Blitz, lets you turn strobe vertically or horizontally. In horizontal position, light coverage is slightly broader, which is useful when shooting wide scenes



LIGHT-SENSING STROBE, Honeywell's Auto-Strobonar 330, automatically provides the right amount of flash for any scene from 2 to 14 feet. A switch on the front (above) also permits manual operation

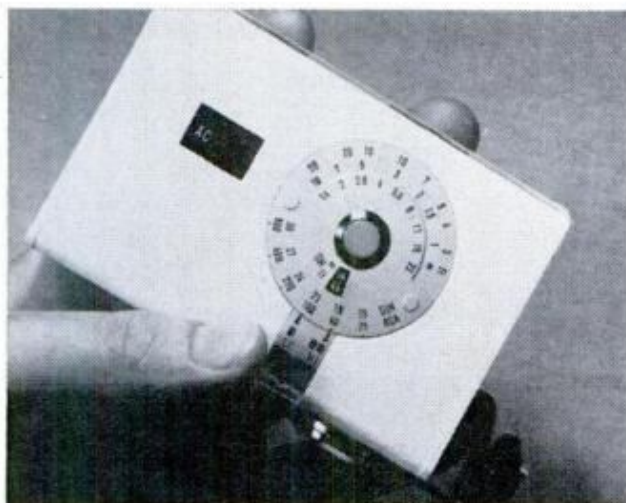
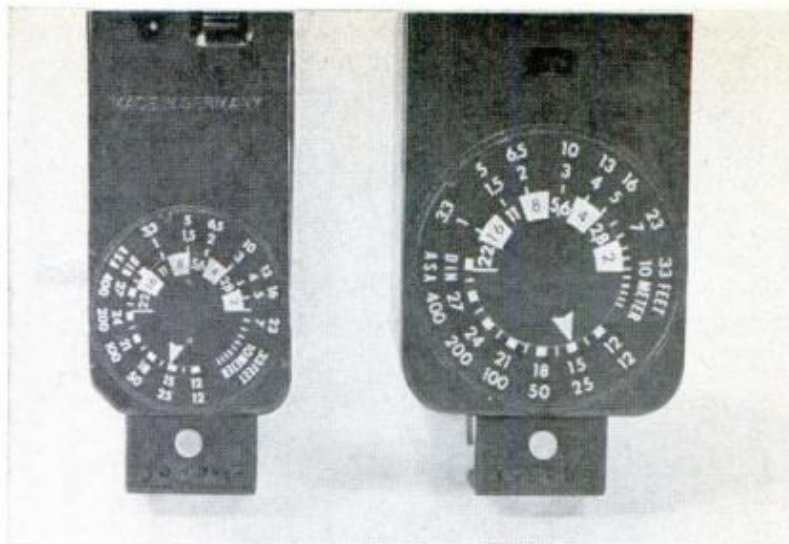
portant to consider if you're going to be shooting fast-moving subjects. Most pocket strobes range from 1/500th of a second to 1/2000th in duration. A speed of 1/500th will stop average action, but 1/1000th or better will give greater assurance of freezing very fast motion.

Flashes per charge run from about 40 to 60, with a few manufacturers claiming up to 150. At the minimum of 40, you're covered for at least one 36-exposure roll of 35-mm film—in most cases, probably all you'd want to shoot at one session anyway. Also, you can extend your shooting time and save your batteries by operating on 115-volt a.c. whenever you're near a wall outlet. The same accessory charger unit that's used to restore the batteries can be plugged in to give you unlimited flashes on house current. Recharging with the unit takes anywhere from a few hours to overnight.

Recycle time—the period you have to wait between flashes—varies from about 3 to 10 seconds on batteries and usually a little less on 115-volt current. You want fast recycling if you're trying to catch action that can't be repeated, such as sports events or possibly a wedding ceremony. Ten seconds can seem like an eternity if you're in a hurry. But for most around-the-home and party shooting, this factor is not too critical.

Most mini-strobes have a handy exposure calculator that gives you the proper lens opening without your having to do any mental arithmetic. You turn a dial to the film speed you're using and simply read the appropriate lens opening opposite the lens-to-subject distance.

Beyond these basic characteristics, mini-strobes differ mainly in the added conveniences they offer. One unusually slick model, Honeywell's Auto-Strobonar 330, provides automatic exposure. A scaled-down version of Honeywell's bigger automatic guns, it measures the amount of flash illumination reflected from a subject and regu-



HANDY EXPOSURE CALCULATOR is found on back or side of most mini-strobes. You set dial to your film speed, then read proper lens opening opposite the distance to your subject in feet. Dial on side of Minolta Electroflash at left has added feature—a Hi-Lo indicator that lets you compensate for weak batteries. If unit is fully charged, Hi setting lights up and you turn dial pointer to it. If batteries are running down, Lo setting lights up and you switch dial to it, giving one stop extra exposure. How similar strobes can differ in light output is shown by two Metz units above. Both are set to a film speed of ASA 25, yet larger 184 model on the right indicates a lens opening of f/4 at 13 feet, while smaller 180 model on the left reads f/2.8 for same distance. Thus the larger strobe model has a greater light output since it gets by with smaller lens openings

lates its own duration to produce the correct exposure for any given film speed and subject distance. Naturally, this extra feature puts the 330 at the top of the price pile at \$89.50.

All of the minis are equipped with a standard attachment shoe that slips into a matching clip on many cameras. If your camera doesn't have such a clip, the flash can be attached with an L-shaped accessory bracket of which many types are readily available. For added convenience, some of the Minis have a so-called "hot" shoe—the current that triggers the flash travels right through an electrical contact in the shoe itself, eliminating the need for a separate tripper cord. This cordless arrangement is clean and neat, but obviously is useful only if your camera is equipped with a corresponding hot clip. If it isn't, the strobe can be controlled in the conventional way with a tripper cord. All of the hot-shoe mod-

els have provision for cord operation as well.

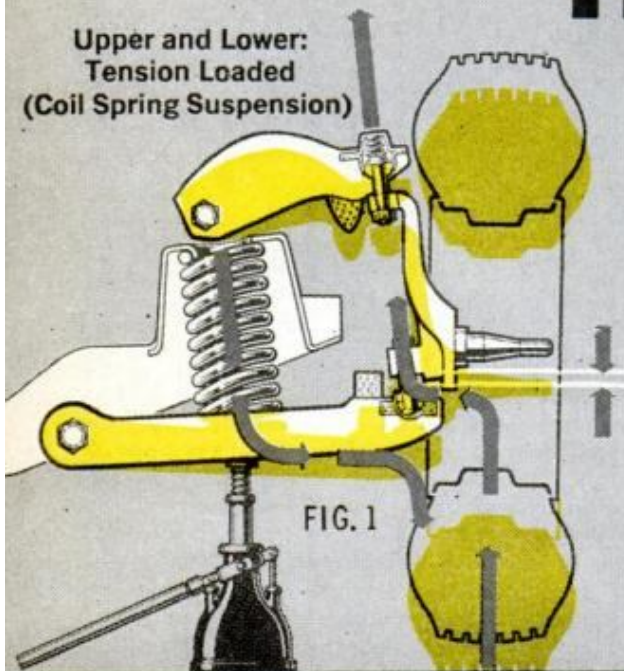
Because mini-strobes are typically tall and thin, their angle of flash coverage varies somewhat depending on whether a unit is turned vertically or horizontally. The coverage averages about 50° in the normal vertical position and 60 to 65° when the flash is tilted sideways. Some units come with a swiveling shoe that lets you use the flash in either position. You can flip the flash over on its side for a broader coverage on wide scenes or turn the camera sideways and still have the flash in an upright position.

One disadvantage of mini-strobes is that they can't easily be removed for off-camera flash as can a regular gun with a quick-release bracket. This limits you to the more static, flat-lighted shots typical of on-camera flash. You can, however, use a pocket strobe off

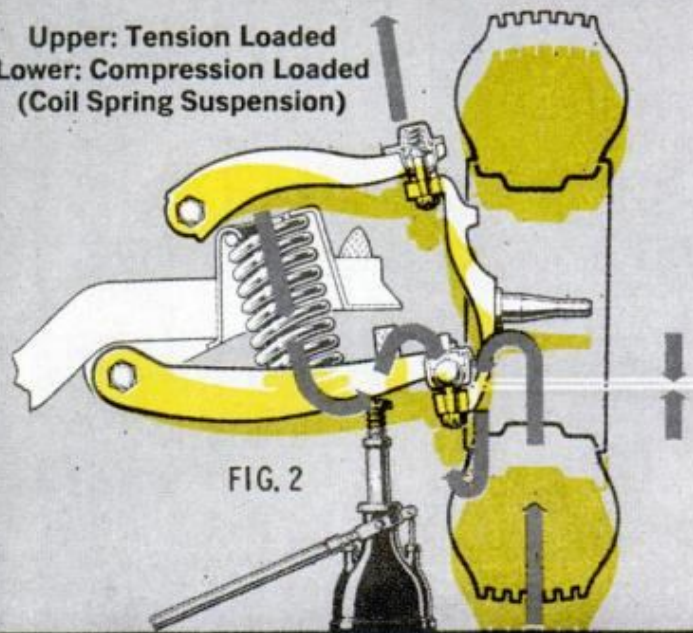
(Please turn to page 188)

How to Check

Upper and Lower:
Tension Loaded
(Coil Spring Suspension)



Upper: Tension Loaded
Lower: Compression Loaded
(Coil Spring Suspension)



FOUR TYPES OF SUSPENSIONS are shown in Figs. 1-4. In each illustration, the suspension appears both

in the jacked-up position and with the weight of car on the suspension (shown in yellow). Gray ar-

A SERIOUS ARGUMENT is still taking place between some independent garages and the automobile manufacturers. Although ball-joint front suspensions are over a dozen years old, much controversy rages over what constitutes a bad ball joint.

And the car owner winds up coping with the difference of opinion: "A garage told me I needed new ball joints. The dealer said I didn't. Who do I believe?"

Recently, I noticed a manufacturer's service bulletin that pulled no punches in warning against the expensive approach—that of indiscriminately replacing ball joints:

"... dealers are often confronted by a customer who has been 'sold' new ball joints by an independent garage; yet the removed ball joints are perfectly good in every respect."

The other side of the story is voiced by representatives of some independent front-end shops I contacted. They caution that car manufacturers provide too much latitude in ball-joint looseness before the part is condemned and replaced.

"Loose ball joints are extremely hazardous and have led to serious accidents," one man told me. "I frankly don't want to

be the cause of someone's death simply because I didn't recommend replacing a ball joint."

I'm jumping into the middle of this squabble, because replacing is expensive. Conversely, not replacing ball joints when they need replacing is dangerous.

The problem boils down to getting answers to these two questions:

1. How do you tell when your ball joints are loose?
2. How loose is too loose?

Forces on ball joints

Ball joints are loaded in two ways: compression and tension. In a compression-loaded ball joint, forces push the stud head against the top of the housing. In a tension-loaded ball joint, forces try to pull the stud out of the housing.

When a ball joint is new, the stud is fitted closely to the housing. There is hardly any (if any) play. In time, wear takes place—and it will be hastened if water gets into the joint housing and dilutes the grease.

You can't check a ball joint for looseness when it is loaded. The load must be removed. Depending upon the type of ball joint and suspension you have in your car,

Ball Joints

By MORT SCHULTZ

Upper: Tension Loaded
Lower: Compression Loaded
(Torsion Bar Suspension)

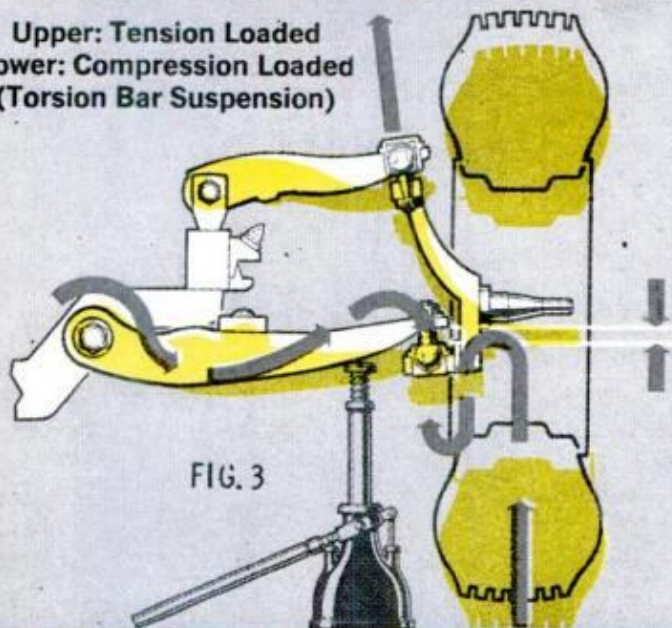


FIG. 3

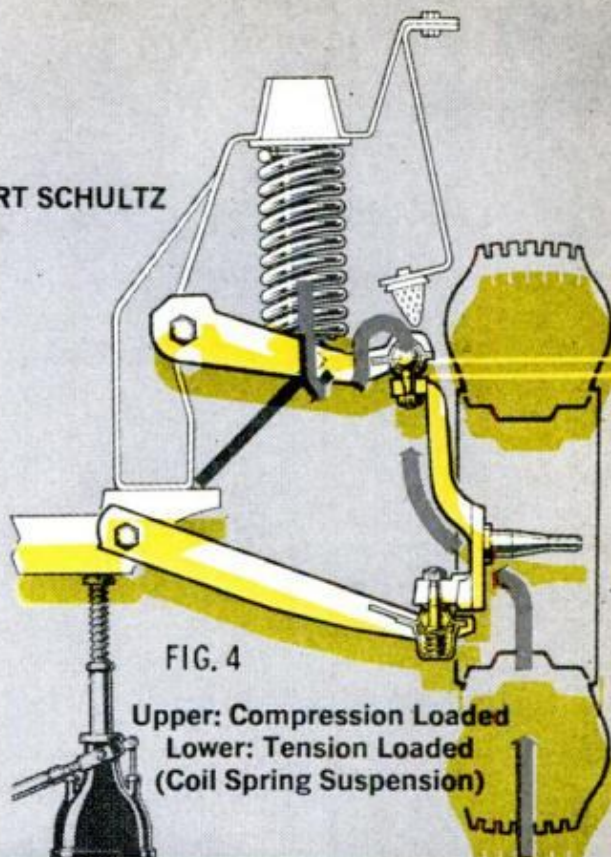


FIG. 4

Upper: Compression Loaded
Lower: Tension Loaded
(Coil Spring Suspension)

rows indicate the force (compression or tension) acting on the ball joints when the car is on the ground.

Axial movement or looseness of the load-carrying ball joint is measured with jack positioned as shown

the load is taken off a joint in one of three ways. By comparing the illustrations here with the underside of your car, you will be able to determine which unloading method you have to use.

tems and will be discussed after all four are described.

Upper, lower joints tension-loaded

Upper ball joint tension-loaded

In one system (Fig. 1) the coil spring is positioned on top of the lower control arm, and both upper and lower ball joints are tension-loaded. To test for ball-joint looseness, the load must be removed from the lower ball joint, which is the prime load-carrying member.

The second and third systems, with the upper ball joint tension-loaded and the lower compression-loaded, are checked for ball joint looseness in the same manner even though one system uses coil spring suspension (Fig. 2) and the other uses torsion bar suspension (Fig. 3).

The prime load-carrying ball joint is the one that takes practically all of the punishment and fails first. The other ball joint—in this assembly, the upper joint—is the follower or guiding member. It's checked and replaced, if necessary, only when the prime load-carrying joint is removed from the car for replacement.

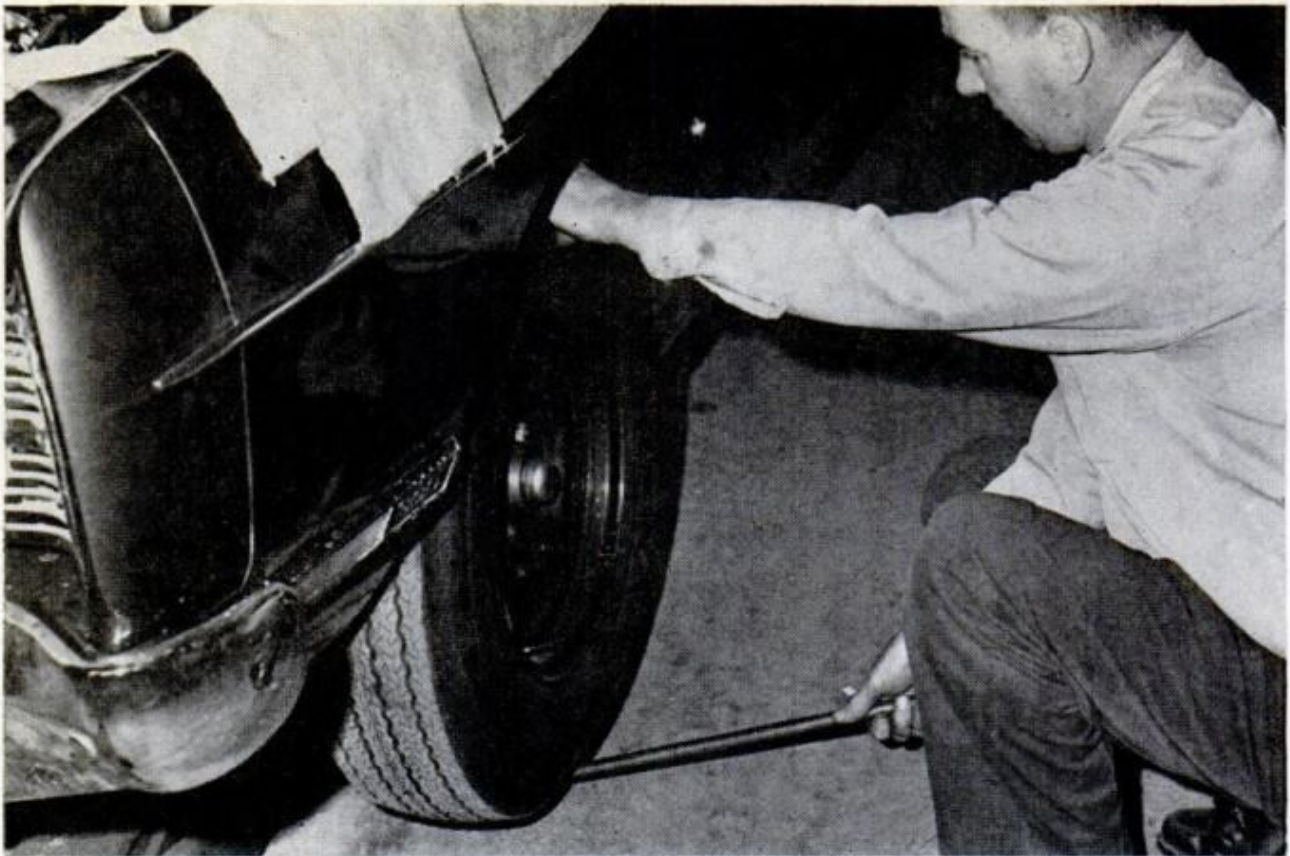
With coil-spring suspension, the spring is positioned on top of the lower control arm. With torsion-bar suspension, the bar is fixed to the lower control arm. In both instances, the lower ball joint is compression loaded and the upper ball joint is tension loaded. To check the lower ball joint, which is the prime load-carrying member, raise the wheel by positioning a jack as close to the wheel as possible.

To check the lower ball joint of this setup, raise the wheel by placing a jack beneath the lower control arm as close as possible to the center line of the spring, as shown. This unloads the joint to permit checking of stud-end play or axial movement. Measuring axial movement is done the same for all front-end suspension sys-

Upper ball joint compression-loaded

In the fourth system (Fig. 4), the coil spring is positioned on top of the upper control arm. The upper ball joint is compression loaded and is the prime load-carrying member. The lower ball joint is tension loaded and is the follower member.

Since the coil spring is mounted on the



UP-AND-DOWN MOVEMENT of ball joint is checked using a pry bar beneath tire to force wheel up and down

upper control arm, you have to lock out the force of the spring against the control arm to unload the upper ball joint. Place a support wedge between the upper control arm and the front cross member. The wheel is raised by placing a jack beneath the front cross member.

Checking for looseness

Whichever assembly your car possesses, the procedure for checking looseness is the same. The wheel and tire must be off the ground, and the car must be raised high enough to provide clearance for the rubber rebound bumpers.

Rubber rebound bumpers are shock-absorbing elements that are mounted to the frame. If they remain in contact, they place a load on the ball joint, and an inaccurate measurement results.

Place a pry bar beneath the wheel and tire, and force the assembly upward. Note the amount of axial (up-and-down) movement. To get the most accurate measurement, it's best to use a dial indicator that you mount to the wheel. You can buy one at an auto supply store for about \$5.

Allowable axial movement

Now for that most important question:

How much looseness should you permit in a ball joint before replacing it?

I'm of the opinion that some looseness has to be expected as a ball joint does its job over a period of time. If you replaced joints as soon as they started to show some end play, you'd have to have a fat bankroll. Still, you don't want to approach that area of looseness where a ball joint is liable to collapse and leave you without control of your car.

I compromise at .050 inch. If ball joints show more than a .050-inch axial movement, I replace them.

A ball joint that demonstrates .050 inch axial play is not one that's in a critically dangerous stage. However, if a joint gets much looser than this, not only does it start to become a hazard, but steering problems develop.

Some mechanics recommend that ball-joint looseness be checked by measuring side-to-side (radial) movement. I don't agree, because this method of measuring looseness is just not as reliable as measuring axial play. For one thing, axial movement is the true direction in which a ball-joint stud moves within the housing. Furthermore, wheel-bearing looseness has no effect on the measurement as it does when you check radial play.

To sum up the answers to the two questions:

1. To check ball-joint looseness, the ball

joint must be unloaded as described for your setup. (Keep in mind that this is true only when checking ball joints. When inspecting the steering and rest of the suspension system, a load can be maintained on the ball joints.)

2. If axial play exceeds .050 inch, replace the joints.

To round out this discussion, there are two other questions that we should cover. How often should you check ball joints for looseness and should you get involved in replacing bad ball joints?

Periodic inspection

Ball joints should be visually inspected when the car is on a lift for whatever purpose, and whenever you change the oil. Make sure that no grease is oozing from the joint, which would signify a ruptured seal and necessitate replacement of the joint.

The task of checking for looseness can be done whenever you desire. I make it a point to check joints before I lubricate the suspension.

Certainly, you should check them as soon as the car demonstrates symptoms of bad ball joints. These symptoms include excessive play in the steering, scuffed or cupped tires, front-wheel shimmy and wander.

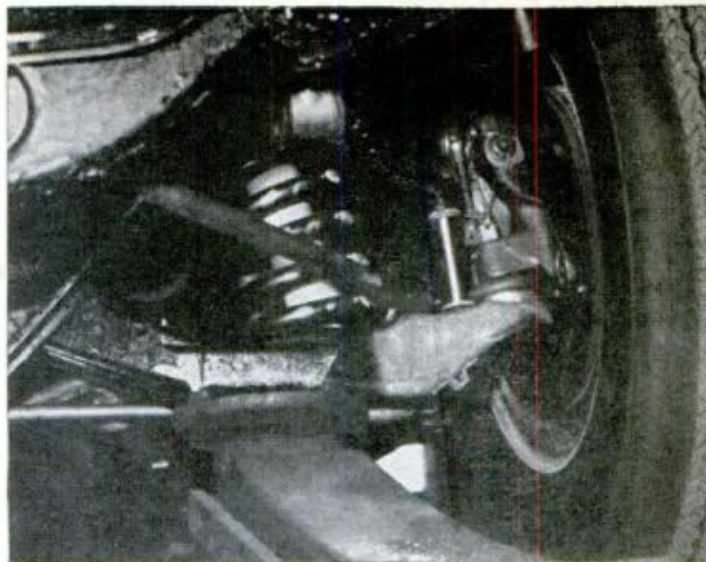
I personally replace ball joints, but I have the tools to do it. Those tools you need depend on how your joints are mounted and fastened. Ball joints are bolted, riveted, screwed or pressed into position.

Joints that are screwed into place require large sockets (1 $\frac{1}{16}$ to 1 $\frac{5}{8}$ in.) for replacement. Those that are pressed into position are removed with special pullers and drive sleeves. Riveted ball joints usually require center punching and hollow drilling.

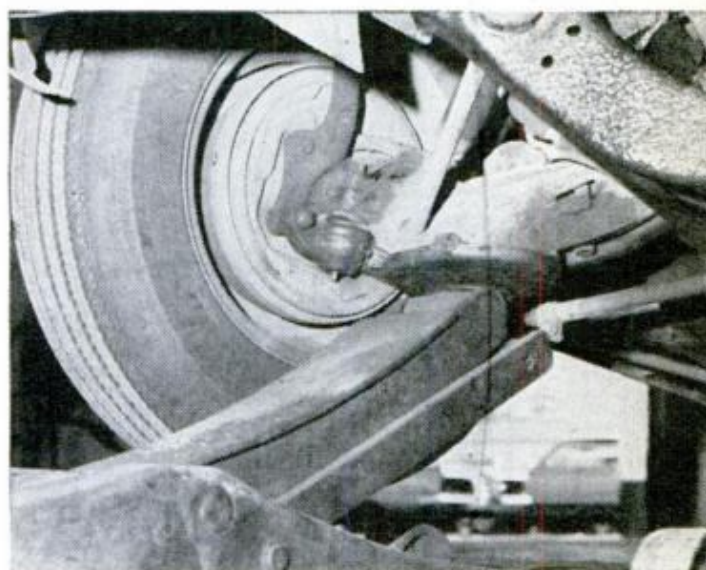
Since there are several variations and I don't have space to cover them all, I can only advise that you get the service manual for your car and consult that if you're interested in replacing ball joints. In most cases, you shouldn't have trouble if you follow manual instructions.

Once new ball joints have been installed, immediately apply grease to them with a low-pressure hand gun. That done, the front end should then be checked for proper alignment, and the wheels should be balanced.

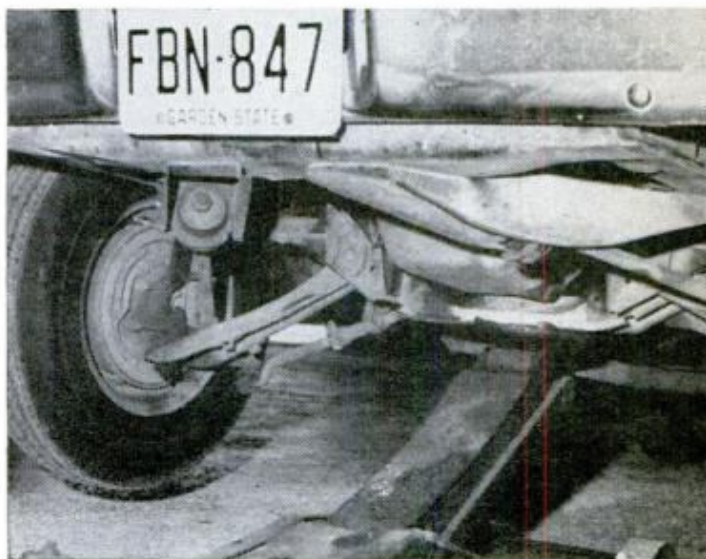
★★★



JACK IS PLACED as close as possible to center line of spring to check lower tension-loaded ball joint. Coil spring is on lower control arm. Car is '69 Ford



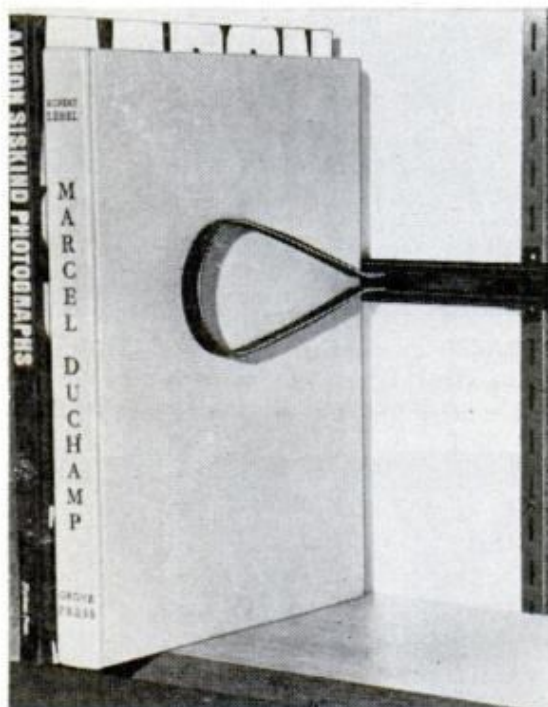
TO CHECK lower compression-loaded ball joint of this 1965 Dodge (which has torsion-bar suspension), jack is placed as close as possible to the wheel



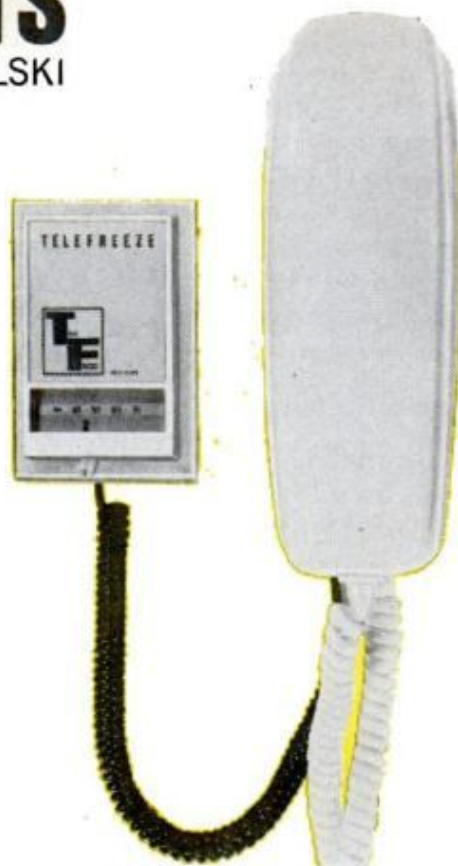
JACK IS PLACED beneath the front cross member to check upper compression-loaded ball joint on this 1967 Falcon. Coil spring is on the upper control arm

EXCITING NEW PRODUCTS

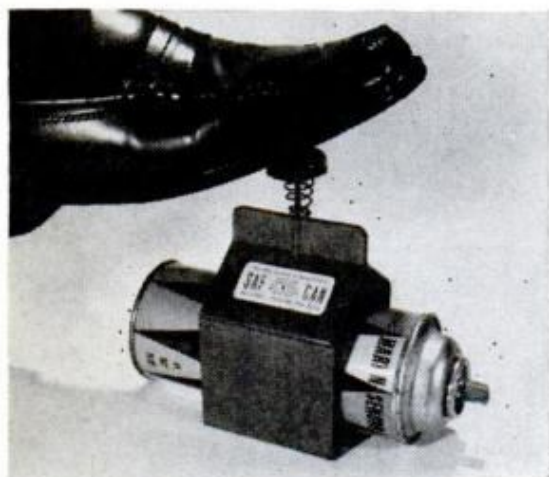
By CATHERINE BILSKI



STOP FALLING BOOKS! Unlike ordinary bookends, Protect-A-Book offers two anodized aluminum loops that "squeeze" the books, never let them slip. When compressed slightly, the end loop moves, making possible the addition or removal of books. Prices range from \$3.03 to \$4.78 from Wylde and Co., 333 N. Michigan Ave., Chicago, Ill. 60601.



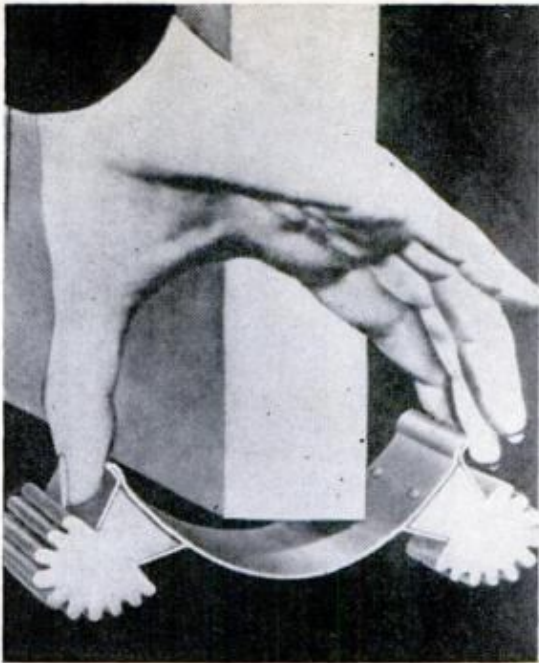
PREVENT PLUMBING FREEZE-UP with a warning system called Telefreeze. The unit enables someone away from home to check if his house-heating system is working. He calls home; if the phone rings, the system is working. If it doesn't ring, his oil supplier should be alerted. The no-heat signal is about \$19.95, the signal with a thermostat about \$35. both from Telefreeze Div. of Ema, Inc., 200 Park Ave., New York.



DISPOSE OF AEROSOL CANS the safe way with Saf-Can. Just insert the empty can in the holder and step on a spring plunger. Pierced hole in side of can releases gas, prevents explosion when can is accidentally tossed in incinerator. Unit sells for \$1.75 postpaid from Saf-Can Sales, 8405 Holser Rd., Grabill, Ind. 46741.



AN ANTI-FREEZE that not only guards against cooling-system freeze-ups and corrosion, but also seals radiator leaks (and keeps them sealed), is Du Pont's new Anti-Leak "Zerex" Anti-Freeze. Other products to help winterize your car are Windshield Washer Anti-Freeze and Cleaner, Windshield De-Icer, and Gas Line Anti-Freeze. All are made by E. I. du Pont de Nemours & Co., Inc., Consumer Products Div., Wilmington, Del. 19898.



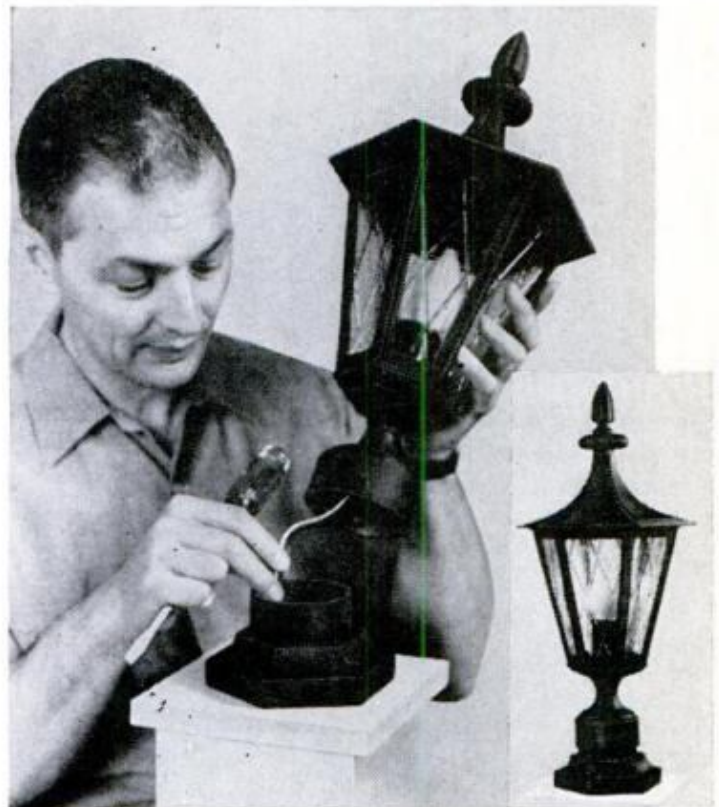
HOLD DOORS OPEN at any desired position with this simple, flexible device. Made of spring steel with non-marring rubber grippers, it can't scratch floors or hurt carpets. Sells for \$1.25 from Craft-Mark Products, Station A, Box 113, Flushing, N.Y. 11358.



YOUR CHRISTMAS TREE can be kept fresh and green throughout the holiday season with a preservative made from regular chlorinated bleach, light corn syrup and a horticultural micronized iron called Green Garde. The latter is available at garden-supply, florist, hardware and variety stores. Made by Encap Products Co., Box 425, Park Ridge, Ill.



AVOID COSTLY FREEZE-UP DAMAGE to outside faucets or hydrants with Little Dropper, a thermostatic unit that lets an open faucet drip water whenever the temperature drops to the freezing point. Sold for \$5.10 postpaid by Del-Mar Products, Box 26663, Houston, Tex. 77032.



A SIMPLE BASE for mounting post lanterns is being marketed by Artolier Div. of Emerson Electric. The attractive base, constructed of rugged, durable cast aluminum, is ideal for gateposts and wall installation. It's available in six finishes to match that of your lantern. For more information, write to Artolier Lighting Div., Emerson Electric Co., 141 Lanza Ave., Garfield, N.J.



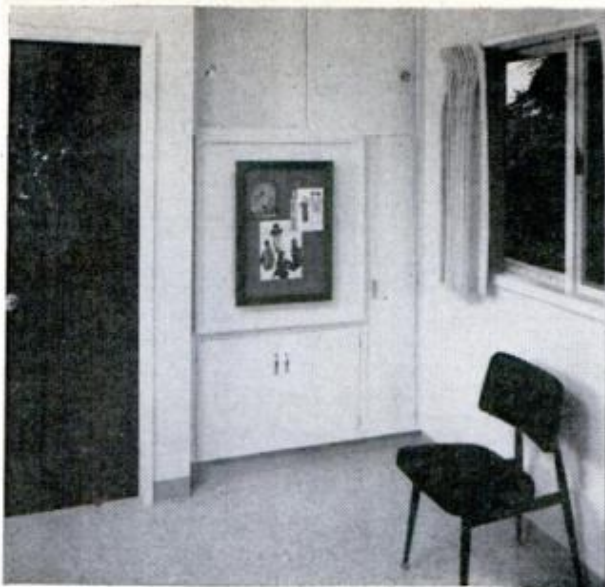
**Special 12-Page
SAVE-IT SECTION**

Garage-Wall Storage With a Place to Fix Things, Too

DOUBLE-DUTY BUILT-IN provides both work and storage space, takes only two feet off the end of a garage. Long benchtop is handy for car and yard-tool fix-it jobs. Detailed plans (No. AE-101) are available from Masonite Corp.

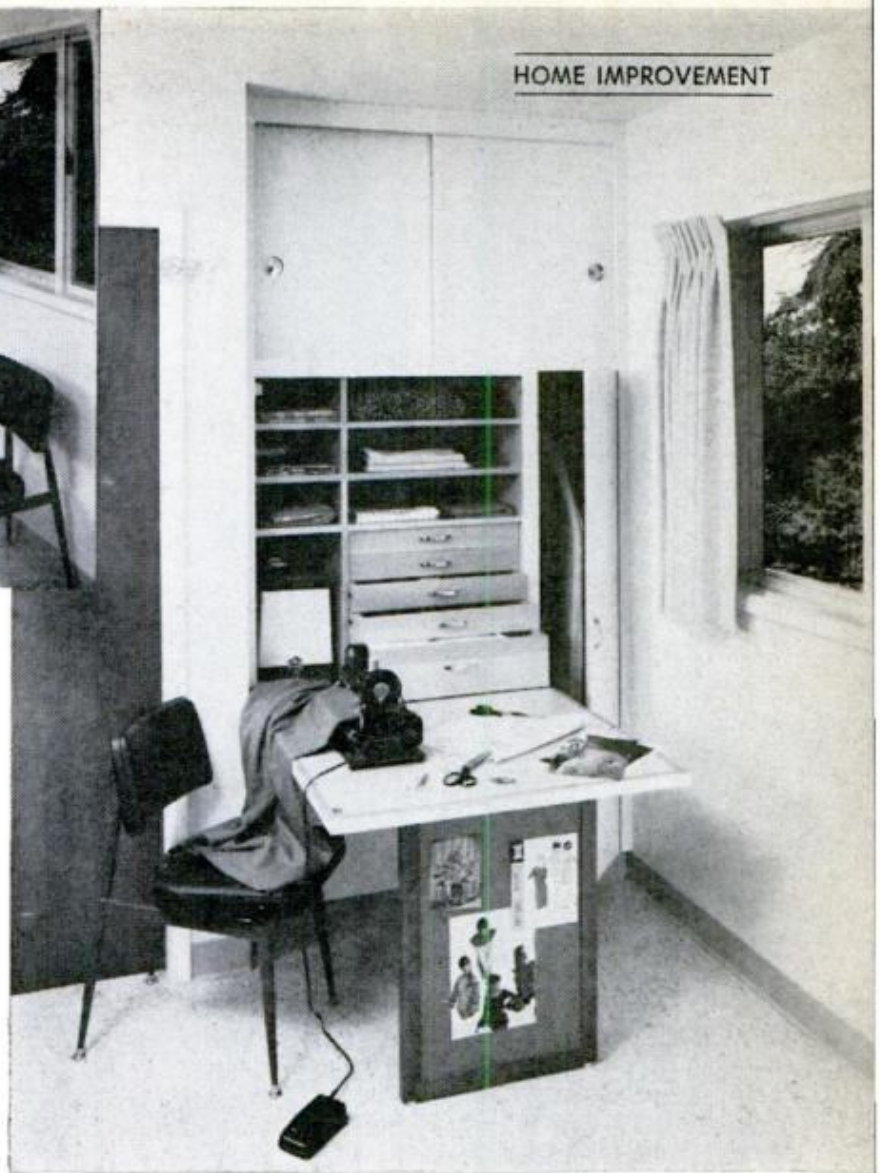
30 SMART IDEAS FOR PUTTING SPACE TO WORK

Looking for more storage room? Today, the answer isn't just another trunk in the attic. In the modern equipment-packed home, you need to hide things away and still have them at your fingertips, ready for instant use. There's the movie projector, the hi-fi rig, your prized fishing, hunting and photographic gear, countless tools and toys, games and hobby supplies, skis and tennis rackets and baseball bats, kitchen and laundry appliances, a model train or road-race set—all must have their place yet be kept handy if you're going to use and enjoy them. Here, PM brings you 12 pages of versatile, space-saving storage arrangements that can make living more efficient and more fun.



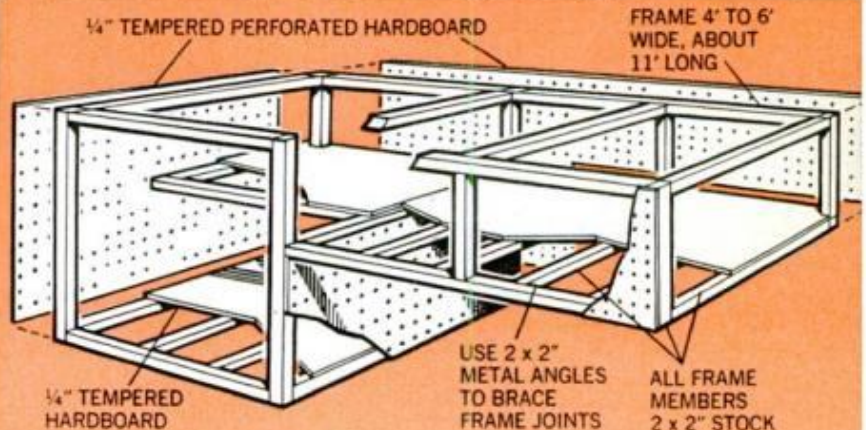
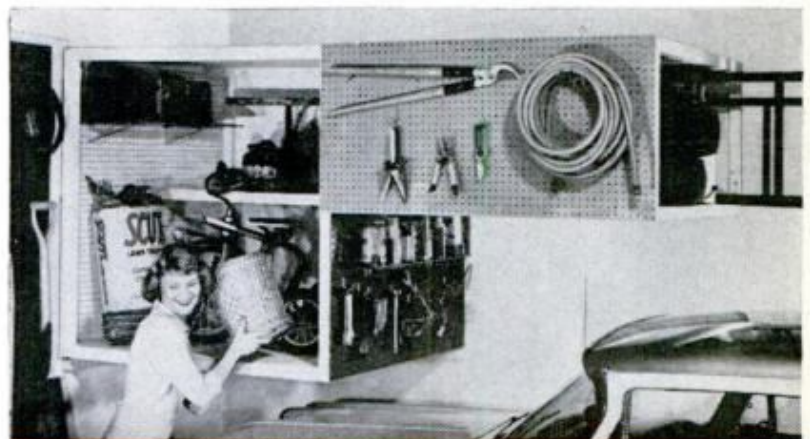
A Work or Hobby Center With a Drop-Down Table

HIDDEN NEATLY in the wall, this fold-out work center is ready in an instant for Mom's sewing or family hobbies. Shelves and drawers behind the drop-down worktable store supplies. Tall cupboard at right-hand end is big enough to take an ironing board or guns and fishing rods. Hinged leg, designed to look like a decorative wall panel, swings out to support the table's outer end.



Make Use of the Space Over a Car

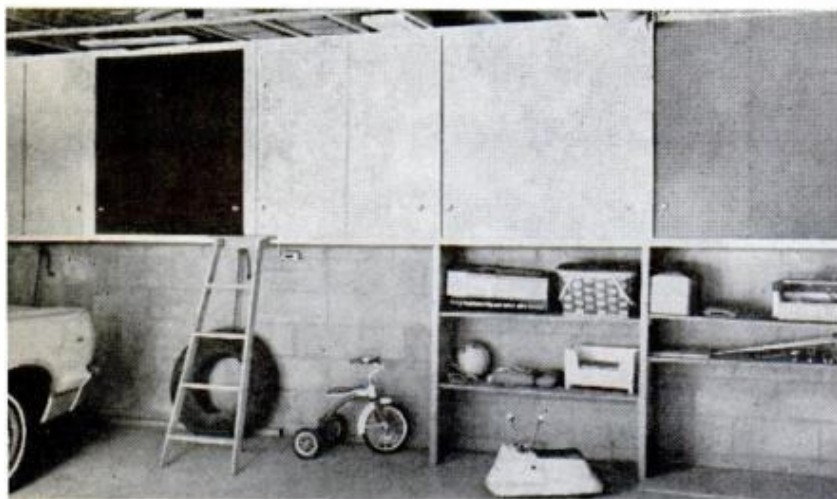
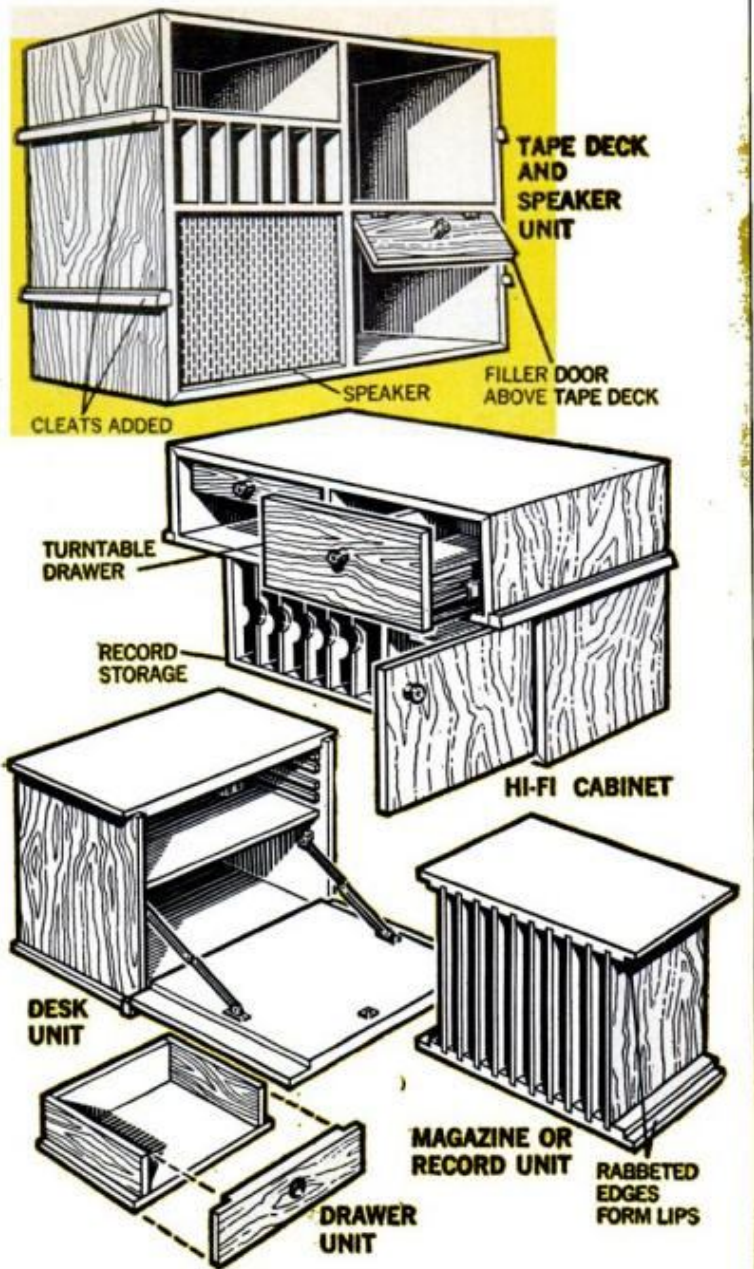
DESIGNED TO HANG over the hood of a car, this L-shaped storage unit takes advantage of normally wasted garage space. It's perfect for garden supplies, extra tires, folding patio chairs and similar items. Side panels of Masonite perforated hardboard (Pegboard) provide additional space on the outside for hanging tools. If ceiling is low enough, you can fasten the unit directly to it. If not, suspend the outer end on chains or cables anchored to the ceiling with screw hooks. Inner end of unit is fastened to wall, either with screws into studs or expansion anchors into masonry. Complete construction plans for this project are available from Masonite Corp., 29 N. Wacker Dr., Chicago, Ill. 60606.





Two Slick Tricks for Building Storage Walls

INTERCHANGEABLE STORAGE UNITS slide in and out on tracks in two clever walls above. At left, strips of grooved Texture 1-11 plywood provide ready-made slots. Get plans for 10 cents from American Plywood Assn., 1119 A St., Tacoma, Wash. Right, bevel siding nailed upside down forms support ledges. Plans are 10 cents, Western Wood Products, Yeon Bldg., Portland, Ore.



Overhead Cabinets Hide Clutter Along a Garage Wall

HIGH OFF THE FLOOR, wall-hung cupboards don't block car, leave parking space underneath for bikes and other bulky gear. Each 3-foot-wide section is a different color for a gay appearance. Doors of perforated hard-

board cost little and provide ventilation to prevent mildew inside. Front half of an old stepladder rested against cabinets is handy for reaching upper shelves. For added storage, full-length cabinets (right) can line side walls.



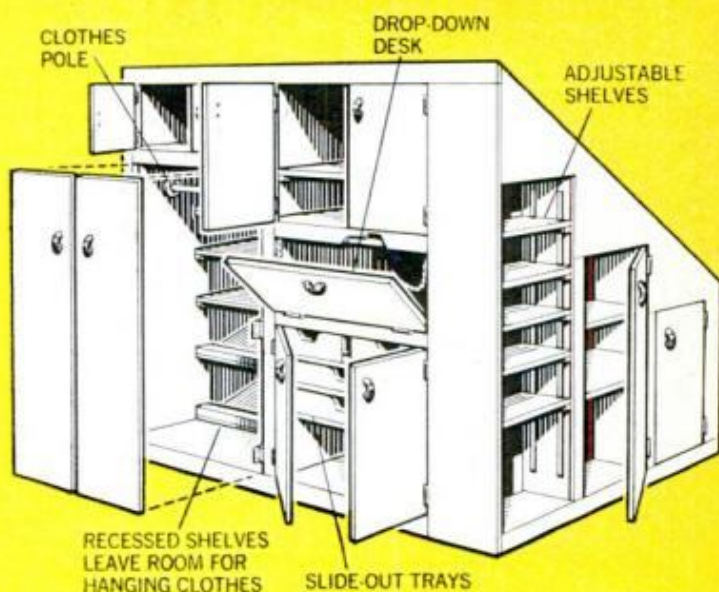
30 SMART STORAGE IDEAS



Two Ways to Use Wasted Attic Space

LOW-HEADROOM NOOKS under the eaves can be put to good use for storage. Scallop-topped "fence" at left, above conceals a row of shelves and clothes poles. Leaving top part open to the ceiling makes room seem larger than if it were closed in. Tree branches painted on wall behind give illusion of a distant garden scene to increase feeling of space.

SLOPING BUILT-IN at right packs a lot of storage in a little space, even has a drop-down desk. Side doors give access to rear compartments. Plans are available from American Plywood Assn.



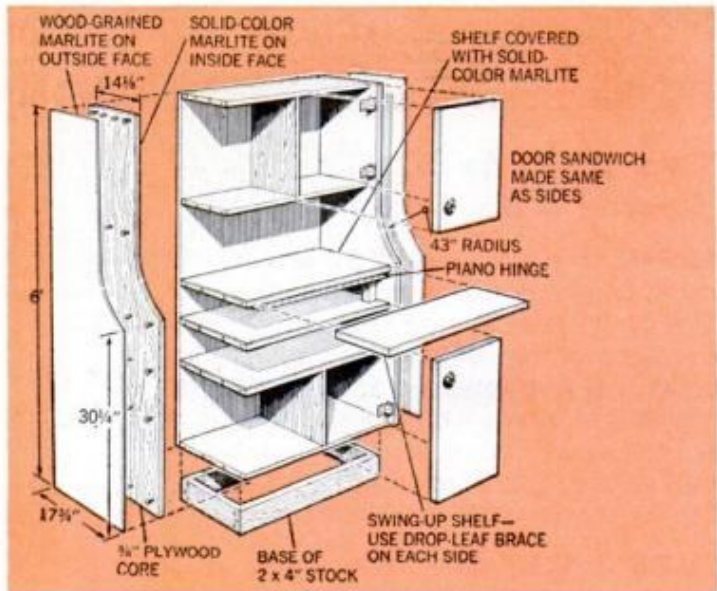
Three Ways to Make Kitchen Cupboards More Efficient

SLANTED SHELVES in cupboard at left work like supermarket racks. Cans, stored on their sides, roll down to you as you lift front ones out. In center photo, shallow shelves are used in place of conventional overhead cabinets.

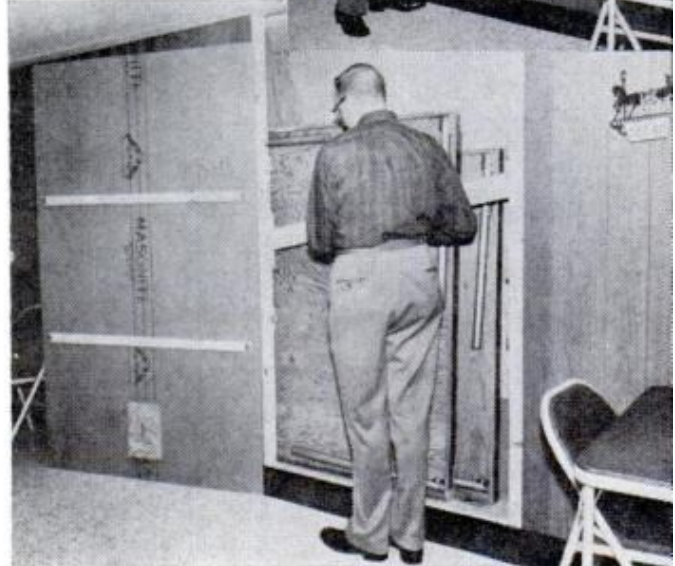
Cans and jars are easy to see, can be reached without having to move items in front to get at others in back. In cupboard at right, closely spaced shelves and vertical dividers keep trays, platters and flat pans neatly sorted

An Appliance Center That's Also a Convenient Snack Bar

THIS MODERN HUTCH stores appliances and lets you use them at the same time. Outlets at the back enable you to keep toaster, percolator, food blender and other electrical appliances plugged in, ready for use. A hinged panel swings up to form a serving counter. Doors and sides are a clever sandwich of $\frac{3}{8}$ -in. plywood with two kinds of Marlite paneling cemented to it—wood-grained outside, solid color inside. Get plans from Marlite Paneling, Dover, Ohio 44622, or West Bend Co., West Bend, Wis. 53095.



HOLLOW SPACES behind false walls can hide hard-to-store items like the Ping-Pong table at right, below. If you're paneling a wall, especially in a basement, it's often a good idea to locate your framing so it leaves a few inches between it and the old wall. This will provide room for recessed shelves, built-in hi-fi equipment or storage compartments such as the one here. In the wall shown, one four-foot-wide sheet of hardboard paneling is removable, creating a big opening so the Ping-Pong table can easily be slipped in and out. Magnetized catches hold the paneling so there's nothing to show from outside.

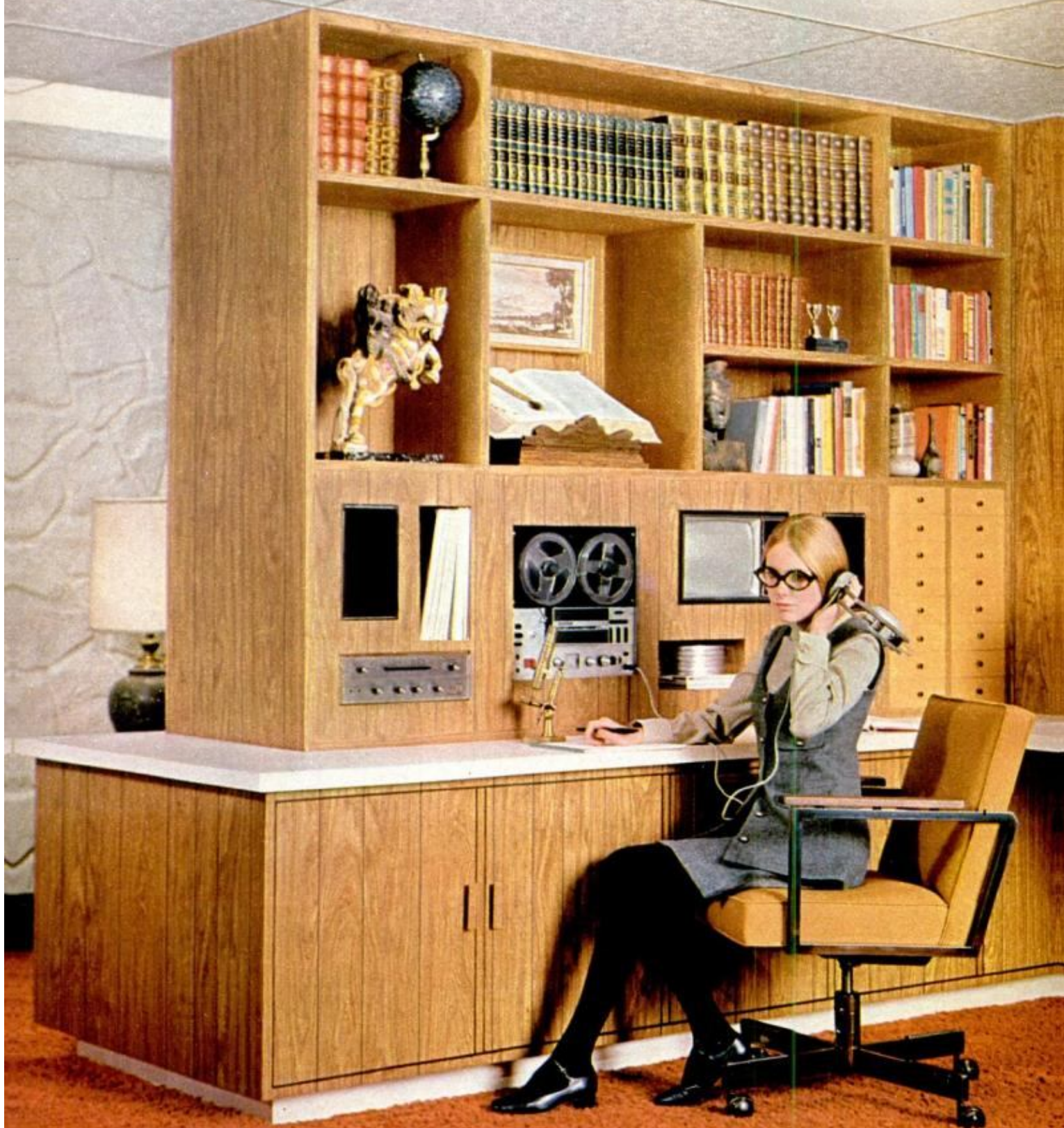


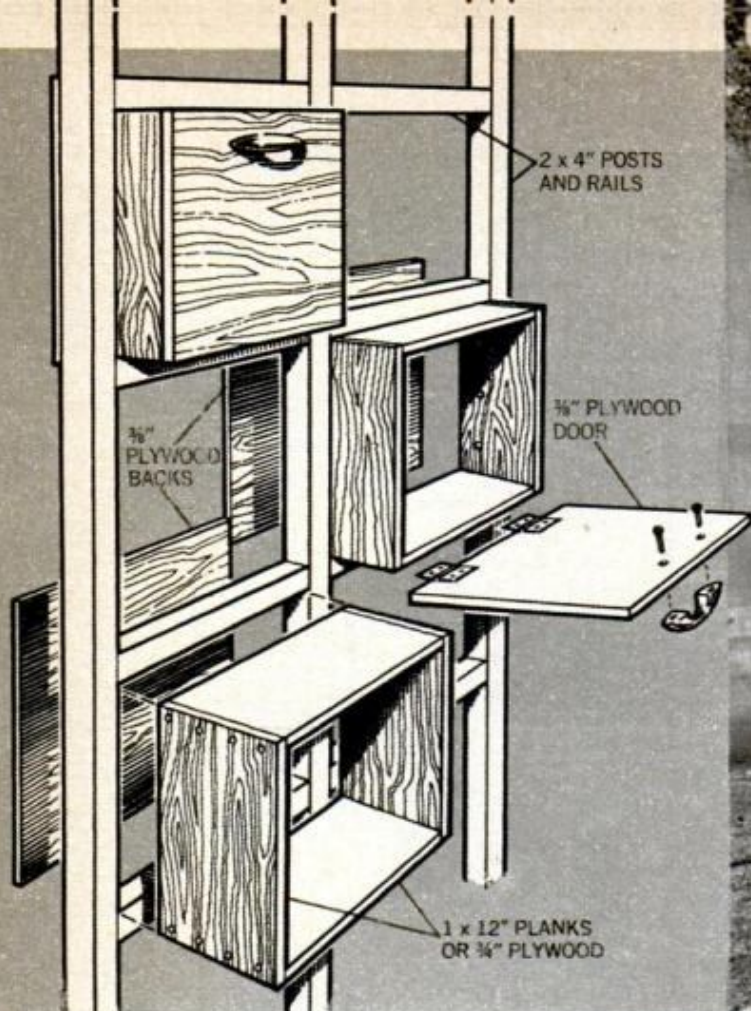
STORAGE CAN BE HANDSOME as well as functional. These open shelves at the foot of a stairway display decorative objects, while the larger base cabinet conceals less-showy items behind louvered doors. Such a unit not only adds storage space, but can also serve as an attractive room divider, in this case helping to screen off the stairway from an adjoining living room.

Entertainment Wall With a Handy Work and Study Counter

MULTIPURPOSE BUILT-IN is room divider, storage wall, hi-fi center and worktable all rolled into one. Front panels house tape deck, amplifier, stereo speakers, TV set. Surrounding counter adds workspace for editing tapes, doing school homework and similar chores. Wood-grained Celotex panels give wall handsome appearance, yet are inexpensive.

30
SMART
STORAGE
IDEAS





30
SMART
STORAGE
IDEAS

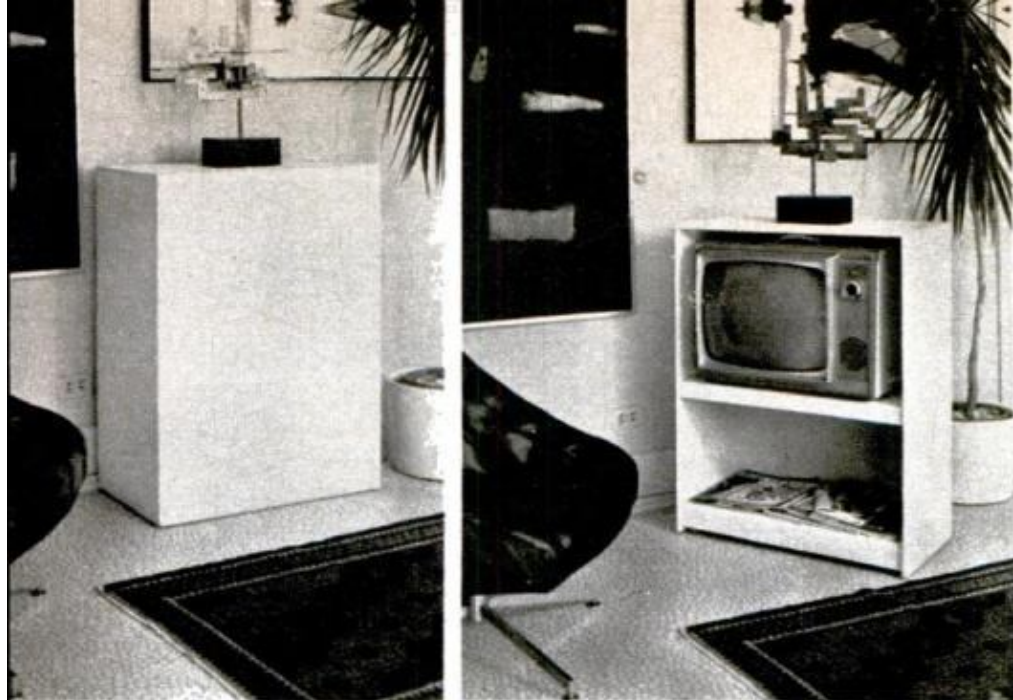
A Privacy Wall That Stores Things, Too

WALL OF CABINETS in a pleasing staggered arrangement gives shade and privacy and at the same time stores garden supplies, barbecue utensils and other outdoor items. Cabinets can be built under an existing structure, such as along the open side of a carport or porch, or they can be part of a garden shelter, as here. If wall is load-bearing, use four-by-four posts instead of two-by-fours shown in drawing. Note that backs of cabinets are extended to overlap posts and cross rails. This adds extra bracing and helps strengthen wall. Simpson Timber Co., Seattle, Wash., designed the storage fence around use of redwood planks and posts for good resistance to rot and weathering.

Build Your Own Home Movie Theater

MINIATURE PROJECTION BOOTH—actually an unused cellar alcove closed in with pine paneling—not only stores photo equipment out of the way, but lets you leave it set up for quick use. Swiveling projector platform at right holds a Kodak Instamatic Super-8 machine alongside a 16-mm model so either can be run without disturbing other. A slide and movie projector could be paired in the same way. Left-hand photo on opposite page shows projection window and smaller viewing port for operator to see. Screen is mounted behind doors at far end of cellar (photo, far right).





TV Caddy Puts Best Face Forward

MOUNTED ON CASTERS, this mobile cart for a TV set can be turned to give the best viewing angle, depending on where watchers are seated, or even rolled from room to room. When not in use, TV can be turned to face the wall, as at far left, to conceal its blank screen. Casters, mounted underneath a recessed bottom, are fixed in front and swivel at back for easy maneuvering. Cart of plywood is covered with painted burlap.



HOME LAUNDRY CENTER like one at left designed by Maytag combines washer and dryer with shelves and a work counter for easing washday chores and storing supplies attractively. Wall of perforated hardboard at back supports shelf brackets and other hook-in fixtures. Three-section tilt-out bin under counter makes it easy to sort soiled clothes.



HANDY BOOT CUPBOARD at right keeps wet and muddy overshoes out of sight, lets them drain harmlessly into bottom drip pan. Boots rest on slide-out rack of perforated hardboard; removable baking tin below catches drips.





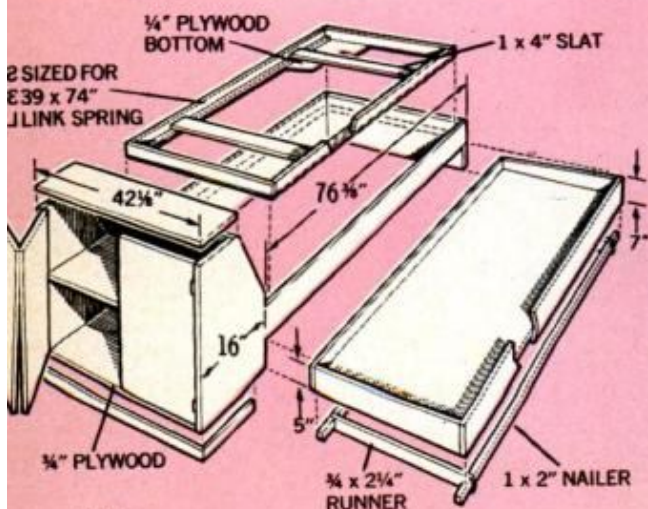
Double-Decker Bunk Is Also Room Divider

FACING OPPOSITE WAYS, these over-under bunkbeds help to divide a room for youngsters of different ages and interests. On one side, lower bunk doubles as couch when area is used for teenage get-togethers. On other side, a train board drops down. Study desk swings out from end. Celotex V-grooved panels cover bunks and walls.

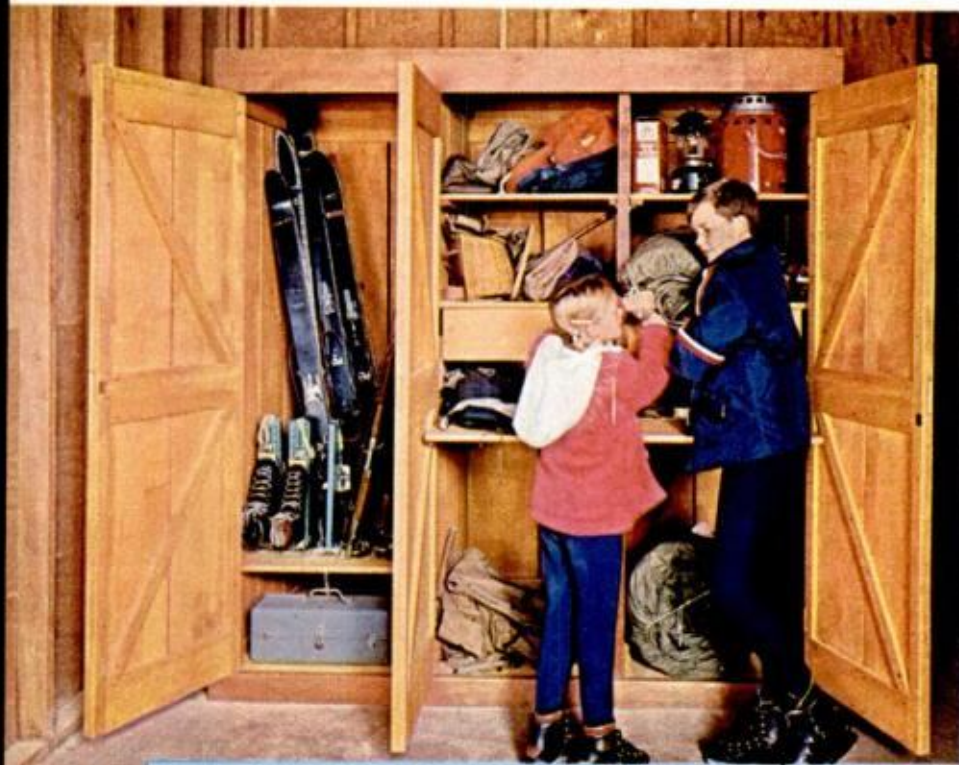


SLIDE-OUT TRAIN BOARD goes to bed along with its owner, storing neatly away underneath. Its sloping design lets it fill the opening under the bed when pushed in for a trim appearance, while leaving the sides and back unobstructed for reaching the trains easily. Extra train equipment is kept in cupboard that forms bed's headboard. For plans, write to American Plywood Assn., 1119 A St., Tacoma, Wash. 98401.

Under-Bed Hideaway for Model Trains

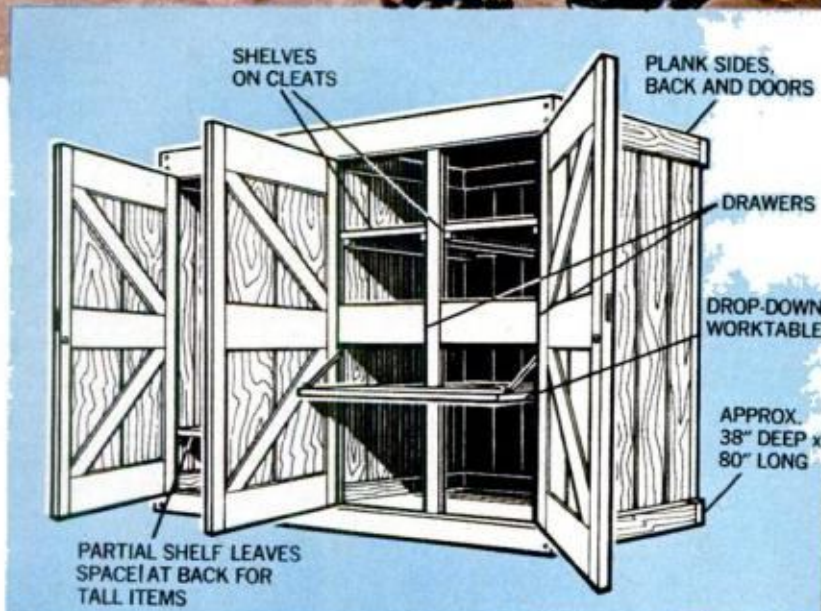


30 SMART STORAGE IDEAS



Sportsman's Catchall For Hard-to-Store Outdoor Equipment

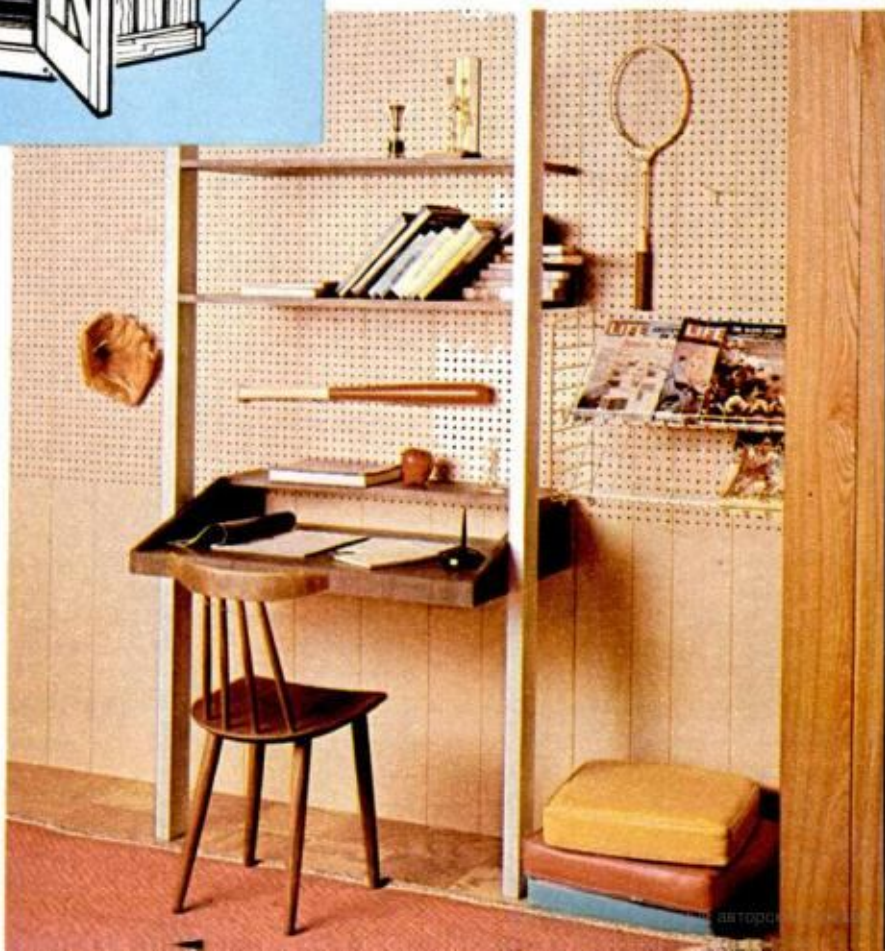
SPECIAL COMPARTMENTS in this roomy storage unit take all the bulky things that never seem to fit anywhere—campstoves, sleeping bags, fishing-tackle boxes, ski boots, life jackets and similar outdoor gear. The tall section on the left side lets you slip skis, fishing poles, boat oars and other long items down behind a shelf where they're kept out of the way at the back. A hinged shelf swings out to provide space for working on equipment. Above this are two drawers for small items like fishing reels and ski goggles. Plans for the closet are available for 25 cents from Western Wood Products Assn., 535 American Bank Bldg., Portland, Ore. 97205.



Easy Way to Put A Wall to Work

A COMBINATION of perforated paneling and floor-to-ceiling poles creates this unusual storage arrangement for a playroom, den or boy's bedroom. The square two-by-two poles, spaced about a foot away from the wall, support the front edges of shelves, while the rear edges rest on shelf brackets hooked into the paneling's holes. A small desk is also suspended between the poles. Special Georgia-Pacific V-grooved hardboard paneling has perforations in upper two-thirds and is solid at bottom for a trim wainscot look.

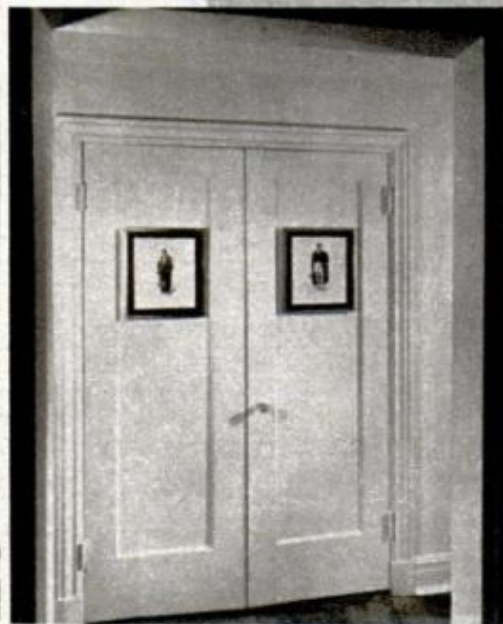
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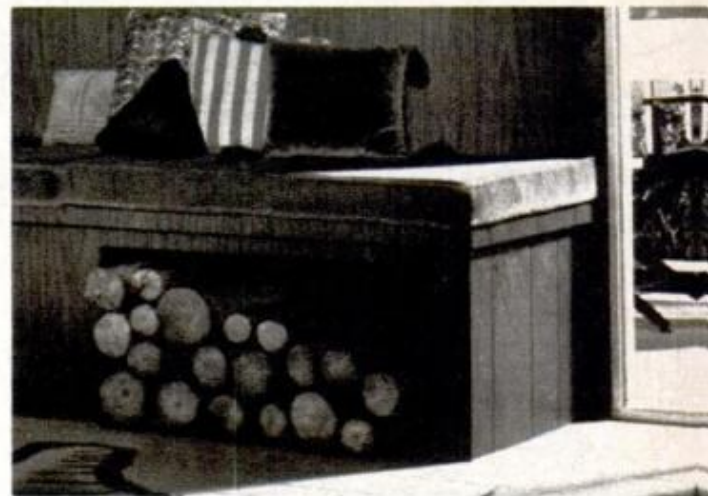
Three Ways to Turn a Closet Into Added Living Space

AN UNUSED DOUBLE CLOSET becomes a small home office at left. Lined with a bright checkered wallpaper pattern, it provides enough room for a typing table and file cabinet. With doors closed, it's quickly hidden from view.

A similar closet is converted into an attractive vanity alcove in left-hand photo on opposite page. Shallow shelves and drawers at back hold toiletries, yet still leave space for hanging clothes. Inset photo shows handy sloping shoe rack under drawers. Makeup mirror is indirectly lighted from recessed fixture above. At far right, single closet with doors removed becomes a bookcase, helping to make small room seem bigger.

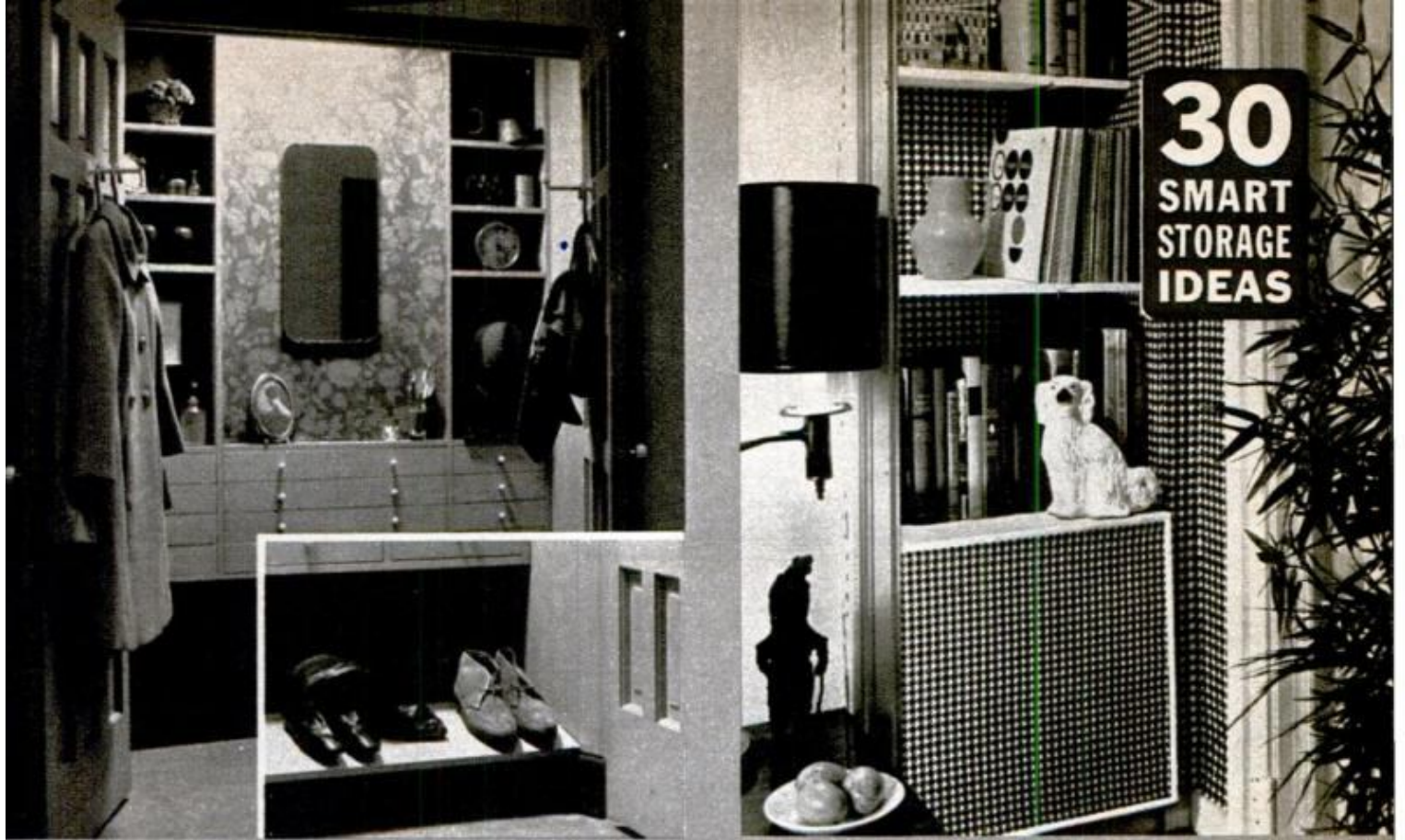


PADDED BENCHES along a wall are an easy way to gain extra seating space and at the same time add storage room inside. Bench at right makes use of space at one end as a bin for fireplace logs. Additional compartments along the bench hide assorted household items behind cupboard doors. Lift-up seat-tops are another good way to get at space inside a bench and save the framing and fitting required for doors. Such under-bench bins are ideal for holding a slide or movie projector, musical instruments, record collections and stacks of sheet music or old magazines. Slide-out drawers can also house a phonograph and other hi-fi equipment. Bench can be sized to take stock cushions, usually available in 18, 20 and 24-inch squares.

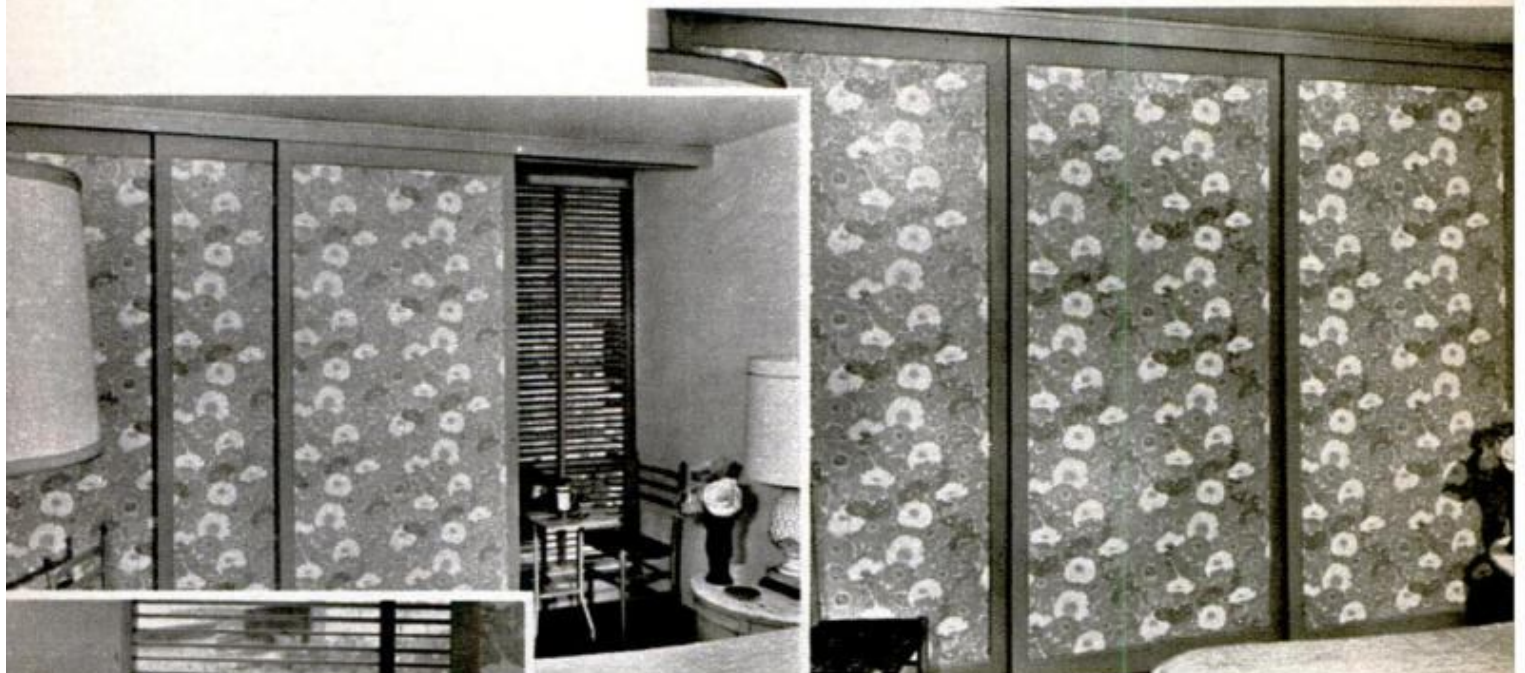


SWING-UP TOP on this versatile hobby bench opens to provide a convenient work area underneath for building models, electronic kits and other small projects. With the top closed, delicate parts and partially assembled projects are protected from damage between sessions. Upper surface also serves as a desktop for doing homework. The design permits quick cleanup since tools and parts don't have to be put away—you just close the lid down over them. Sides around the work area keep tiny pieces from getting lost. Adjustable shelf standards on the walls store supplies and display completed projects handsomely. They can be put up in various irregular arrangements, as here.





**30
SMART
STORAGE
IDEAS**



**Can't Find a Place for It?
Put It Behind a Sliding Wall**

STEALING A SMALL SLICE off an existing room can often give you needed space for special activities. A sliding partition like one above can hide a sewing nook for Mom, a hobby bench for Dad, a bar for parties and similar equipment that must be readily available without sticking out like a sore thumb. It's also useful for screening off a TV set or airconditioner, as at left. Wall shown here is made of framed plywood panels wallpapered and sliding in floor and ceiling tracks.

Conquering Minnesota's

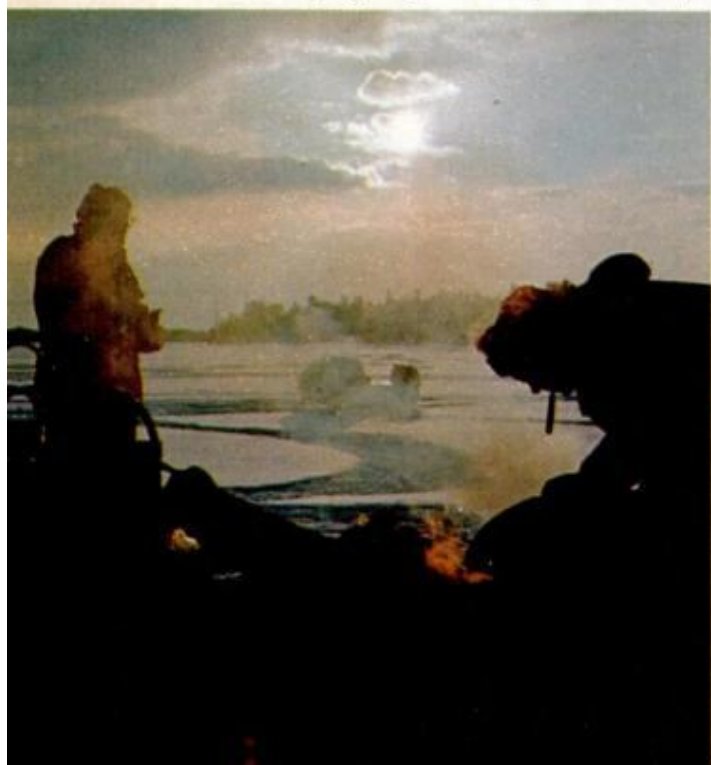
Few travel this route in summer, let alone in winter. But now you can penetrate this tough, deep-freeze paradise



CHARGING from the smooth surface of a frozen lake to the tough terrain of a snow-covered portage is a real test of men and equipment. Our wilderness trail, a canoe route in the summer, took us over several such portages

AT DUSK you start a campfire, tell a few stories, then head for sleeping bags as temperature drops

THE SNO-CRUISER is like a tent-trailer. The tent folds down into a low-profile sled for towing



Wilderness by Snowmobile

By DAN FALES

Photos by Rohn Eng

WOLVES, NORTHERN LIGHTS, lake trout, frosty trees and freezing cold are all part of any snowmobile trip into the wild, wild Minnesota wilderness.

By penetrating the Boundary Waters Canoe Area in winter, you can enter a silent world that's seldom seen even in summer. The canoe wilderness is a mammoth section along the Minnesota-Canada border. Protected by law from motors, most of the "park" is accessible only to canoeists or snowshoers. But there are several trails open to motorized vehicles—outboards in summer, snowmobiles in winter. The portages in both seasons are tough. But in winter, "portaging" (as the local guides call it) with a snowmobile really tests your skill and equipment, even though you don't physically carry the snowmobile over your head like a canoe to get from one lake to another.

If your machines are good, if the weather holds, if you want to go deep into the wilderness in winter, this is the place to come, be it weekend or longer. However, traveling this country is no cakewalk. Things go wrong. Experts Curley Kruger and Dick Marsh make my trip possible.

Dick is general manager of Canadian Waters, an outfitting company in Ely,

SPEEDING over the flat lake ice is the easiest part of the trip. We make good time on these stretches



ON PORTAGES the moguls and hills can make it tough. We found we had to push a lot to get through





A TIMBER WOLF is carted out of the wilderness on a snowmobile by a game warden we meet during trip

MAP shows section of the Boundary Waters Canoe Area that we traveled. This is not the only route for snowmobiles; several others are open to machines

Minn., owned by energetic brothers Dan and Jon Waters. Curley is an old-time bosun's mate who's found "home" surrounded by the land of the United States and Canada, plus hundreds of freshwater lakes. He's chief "doer" for the Waters.

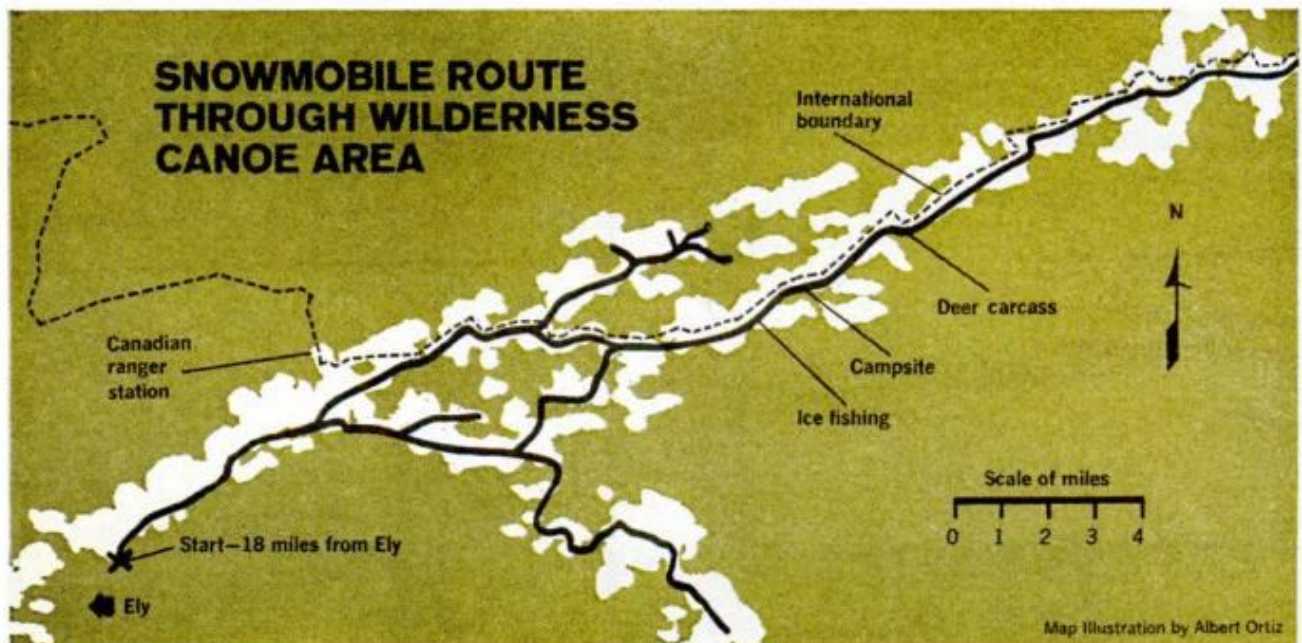
It's with these two as guides and with Rohn Eng as photographer that I enter the wilderness on frozen Moose Lake about 20 miles northeast of Ely. From here we will travel over seven lakes and six land bridges to our base on Knife Lake.

Speeding over the flat lake ice is easy. Our four snowmobiles pull two supply sleds and a Sno-Cruiser—a fold-up tent that's easy to tow on snowmobile runners.

Trouble hits on the first portage. After a mile of traveling over unbelievable, six-foot-high snow mounds, called moguls, a sled hitch breaks. We quickly bring up the free snowmobile, hook up the sled and travel on. Before we get back home, we will have overcome three broken hitches, a broken sparkplug wire, a sheared transmission pin, a broken windshield due to a roll-over on a portage, a pulled-out starter rope, a frozen carburetor, a frozen tool-pouch zipper—and abandoned one supply sled because of hitch trouble. Given the tough weather and tough terrain, it's amazing that our trip goes so smoothly.

Six hours after starting, we set up camp on Knife Lake. We now jig for lake trout through holes in the ice; have dinner of trout and stew; feel the temperature drop to 15 below, and watch the sky in awe as the northern lights play tricks after dark.

By 9:00 p.m. I'm bedded down, having made a foolish mistake as the temperature





DEER CARCASSES are evidence of continuing struggle in the wilderness. This one was apparently cornered by wolves and then attacked. You can follow tracks of deer and wolves on all the frozen lakes of the area

goes to 25 below. Though I wisely removed all but my long johns before piling into my sleeping bag, I left my socks on. They're damp from use. By midnight my feet are freezing. My socks are still not dry, so I yank them off. I put them under my back along with the inner felts of my snowmobile boots. Boot felts, I am wise enough to know, need nighttime placement in a sleeping bag. If they're left in your boots, you'll never get the frozen forms on your feet come morning.

The other item that should be carefully put in sleeping bags at night is spark-plugs. Nonfrozen plugs are needed to start frozen snowmobile engines in the morning. I must admit I didn't do that the first night. Even so, my Mercury started without much trouble the next day, though for some unknown reason I could only start it in reverse.

The next day I roam out looking for wildlife. And do I find it!

It's only an hour after breakfast that a game warden zips by with a dead timber wolf strapped to his snowmobile. And an hour after that I spot the carcass of a deer recently felled by a pack of wolves.

Soon we reach our destination in the wilderness and turn back over the portages and the lake ice. Finally, we push the machines into pickup trucks.

Now, at a typewriter months later, I realize I miss this wilderness in winter.

If you are the kind who likes a wilderness trip sprinkled with a little adventure and a little work, then you should tackle the Canoe Area this winter. But I strongly suggest that you take along a guide who knows the North, who knows the cold, who knows how to handle a blizzard. Be prepared, for it's all worth it. ★★★



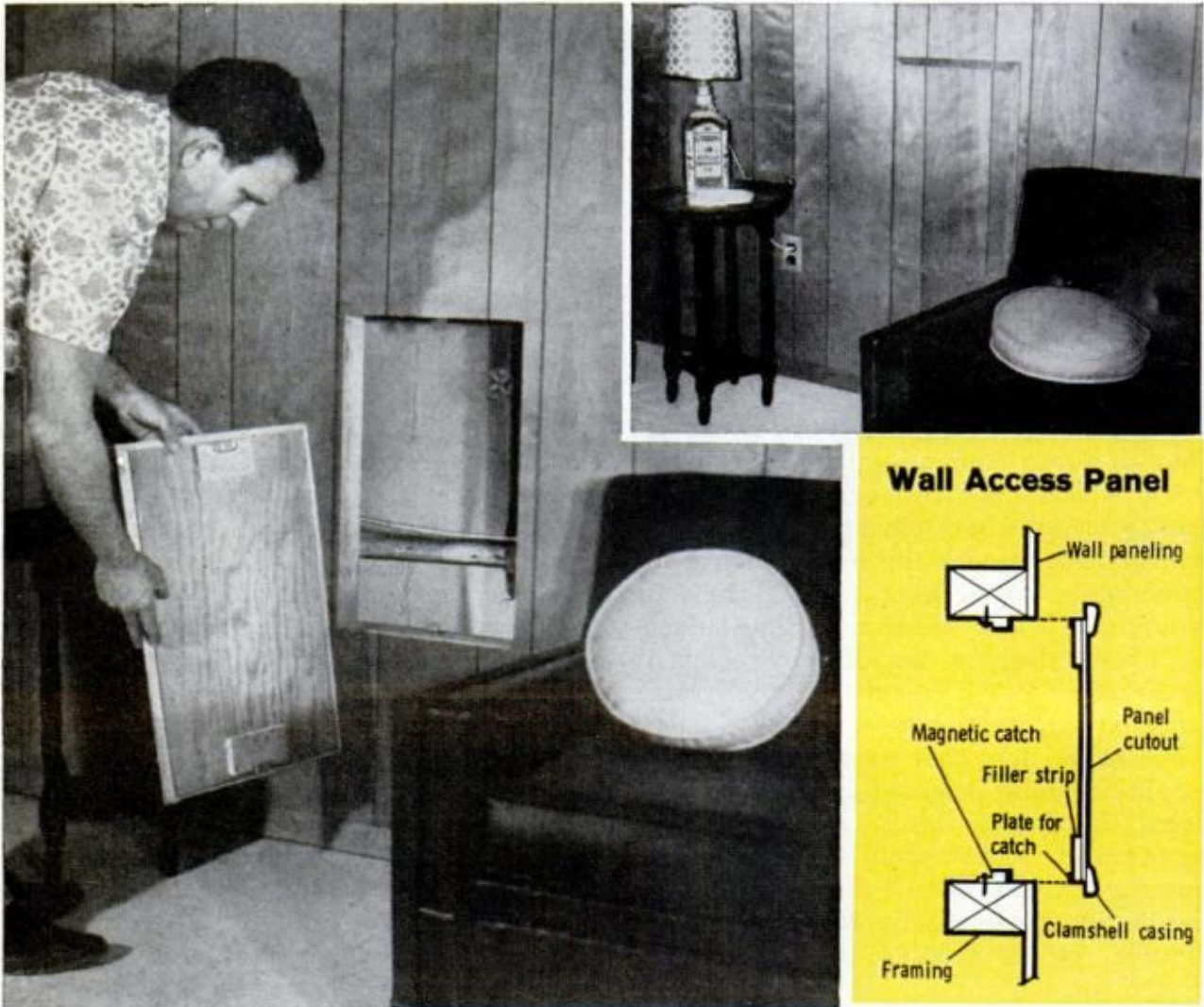
TAKING NOTES is part of my daily routine in camp. Snowshoes (by tent) are a must for a wilderness trip



RELAXING in the "warm" winter sun and listening to the wilderness sounds is also part of my routine

Swipe a few ideas from the trades and solve your tricky basement problems easily. Here's how you can . . .

Finish Your



WATER SHUTOFF VALVE is hidden by panel that is practically invisible because there is no exterior hardware. The "door" removes quickly—a feature that is a must in an emergency; two magnetic catches hold it in place and cost only pennies to install. To minimize the chance of $\frac{1}{4}$ -in. paneling warping in a warm basement, use contact cement to glue cutout to $\frac{1}{2}$ -in. particleboard before fitting magnetic catches

By **JOHN GAYNOR** and **HARRY WICKS**

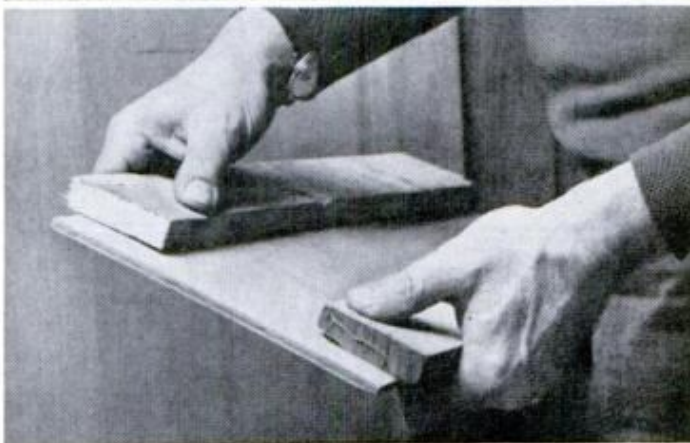
THOUGH MANY do-it-yourself magazine articles make it seem that finishing a basement is a snap, it's not all that easy. It takes hard work and, more important, thorough planning before the job ever starts. Framing and paneling the walls are probably the easiest parts of the job; how to handle finish details attractively is what usually stumps the average man remodeling his first basement.

In most basements (particularly in older homes), many access doors and some

intricate framing around pipes and stairs are called for. This sets up a good rule of thumb: Wherever possible, keep eye and dust-catching hardware to a minimum. The ideas on these pages—used by the professionals—accomplish just that.

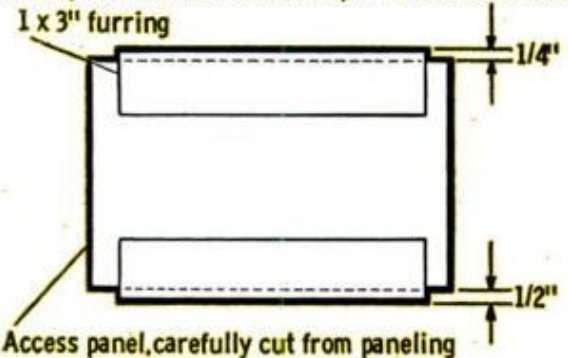
The three "door" treatments shown can solve just about any concealment problem, yet they boast a flexibility that lets you adapt to suit a particular problem. There are two important points to remember: First, make sure that all access openings are framed large enough so that it will not be necessary to rip out a wall if

Basement Like a Pro

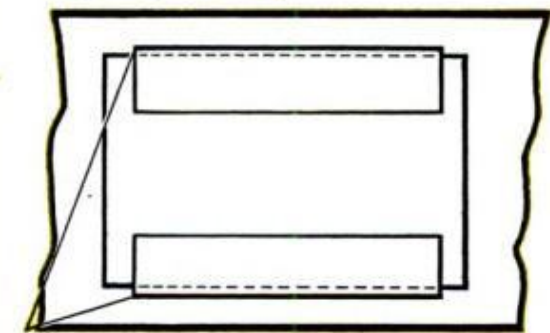


Soffit Access Panel

Access panel viewed from above (size of cutout to suit)



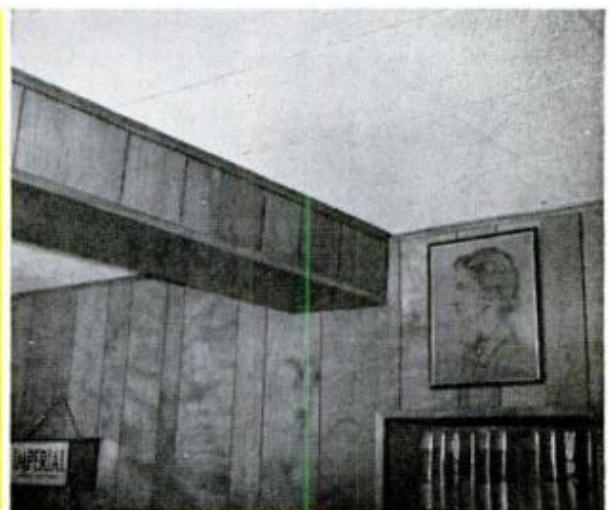
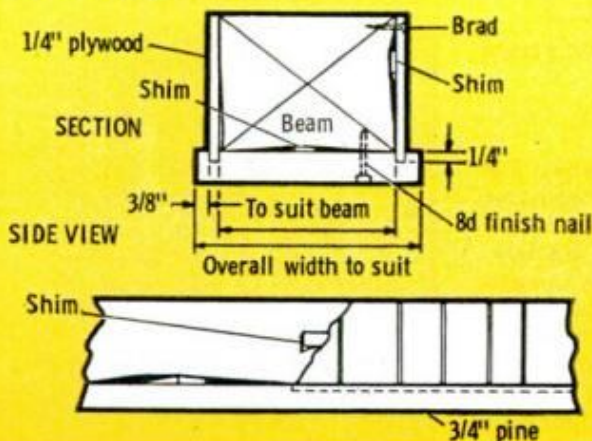
In place (from above)



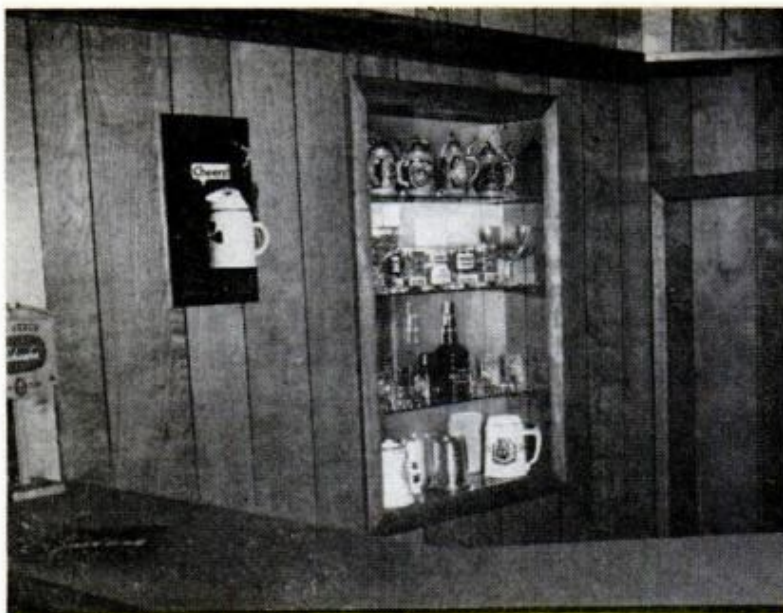
Furring rests on soffit paneling

HARD-TO-SPOT ACCESS PANEL in box around heat pipes is simply pushed up, then lowered for removal. Here, since the joint is not concealed by molding, the panel should be cut from the drop ceiling to insure a splinterfree straightedge. Size of panel is determined by opening requirements; furring strips are fastened with glue and brads. Access panels shown are cut to insure V-groove alignment between panel and cutout

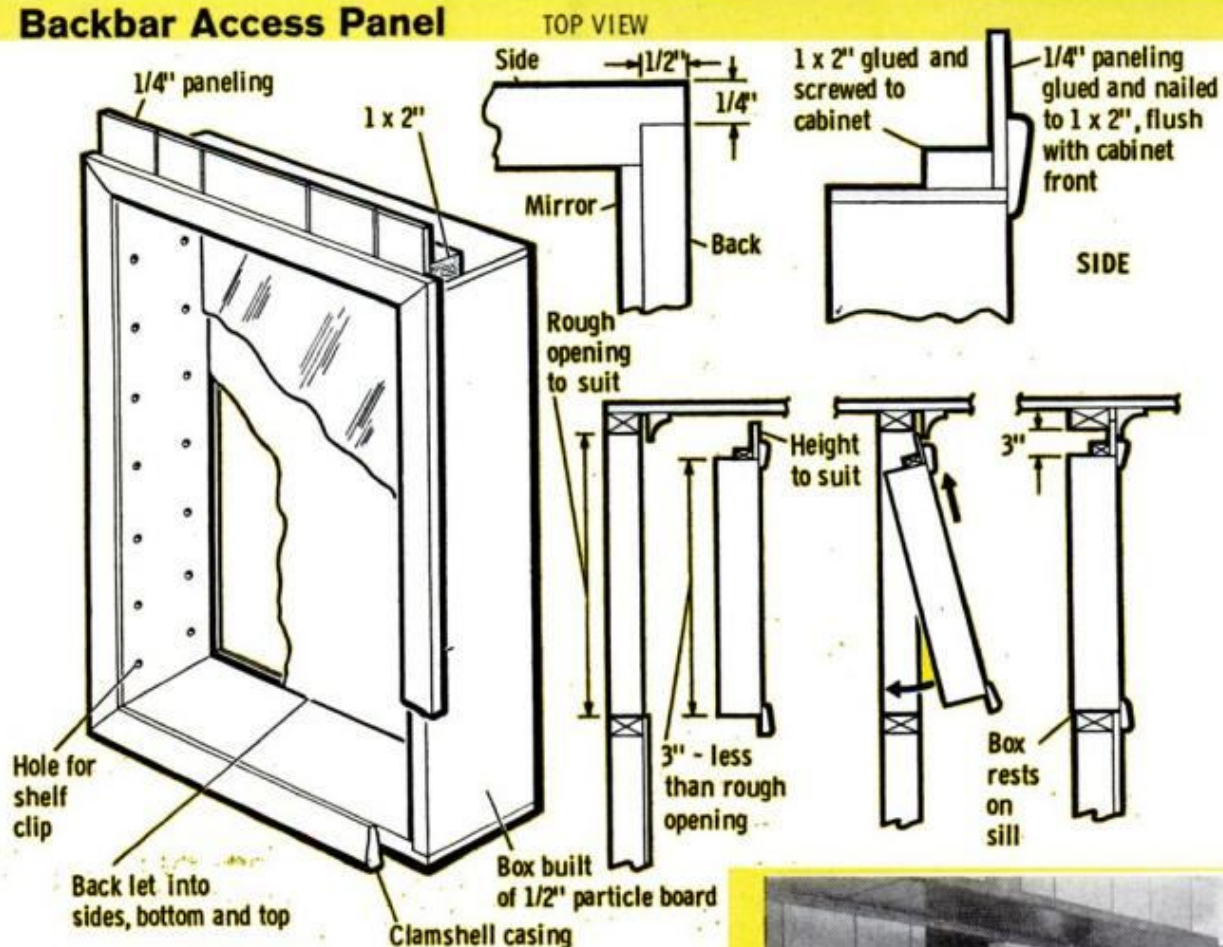
Paneling a Beam



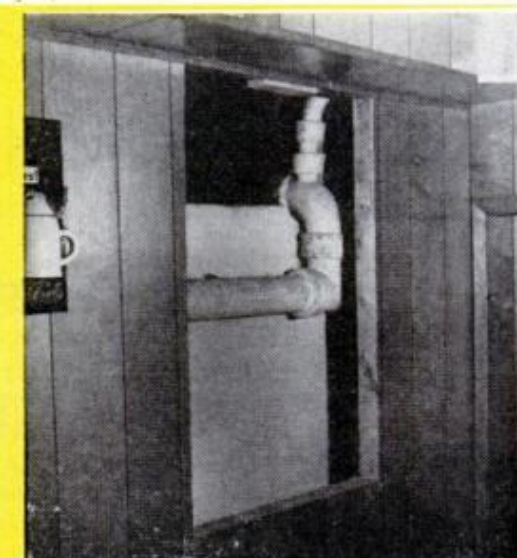
GOOD-LOOKING WAY TO BOX IN A BEAM eliminates time-consuming framing, costs less to do. Tack the clear pine temporarily to the beam's underside, level it with shims and drop the plywood panels into the grooves. Then, using undercourse shingles as shims, plumb the paneling, tack it at top and nail the pine in place. For best results, panel both sides of the beam completely before you drive nails home in the pine

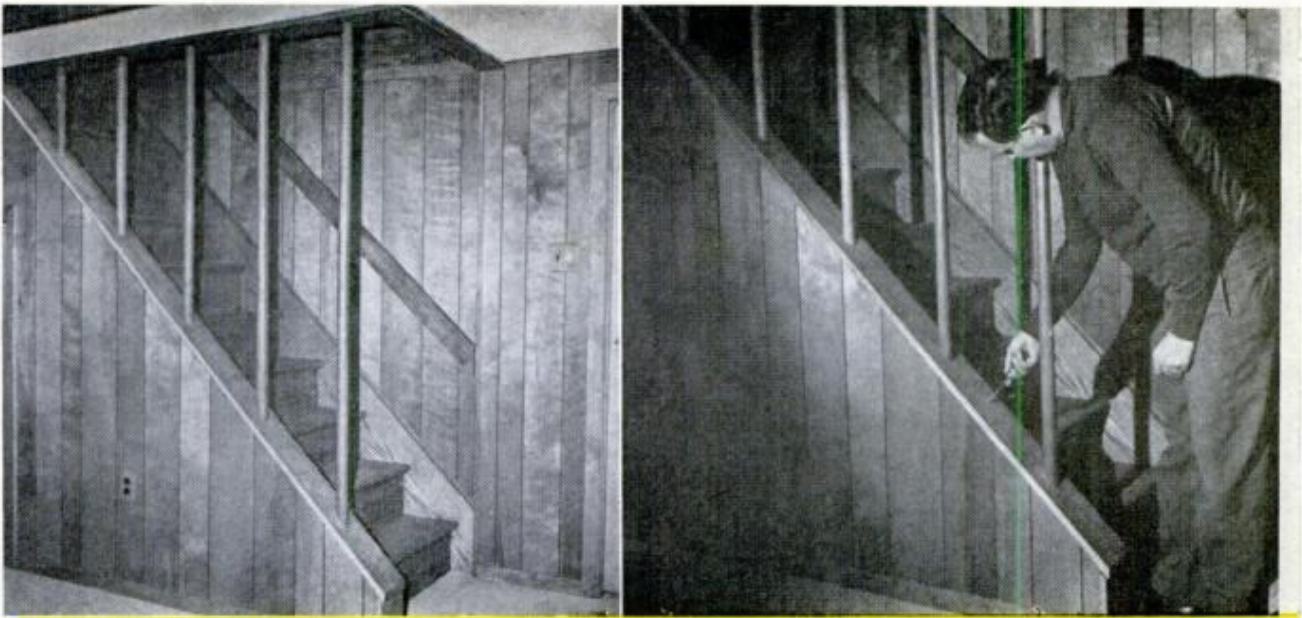


Backbar Access Panel

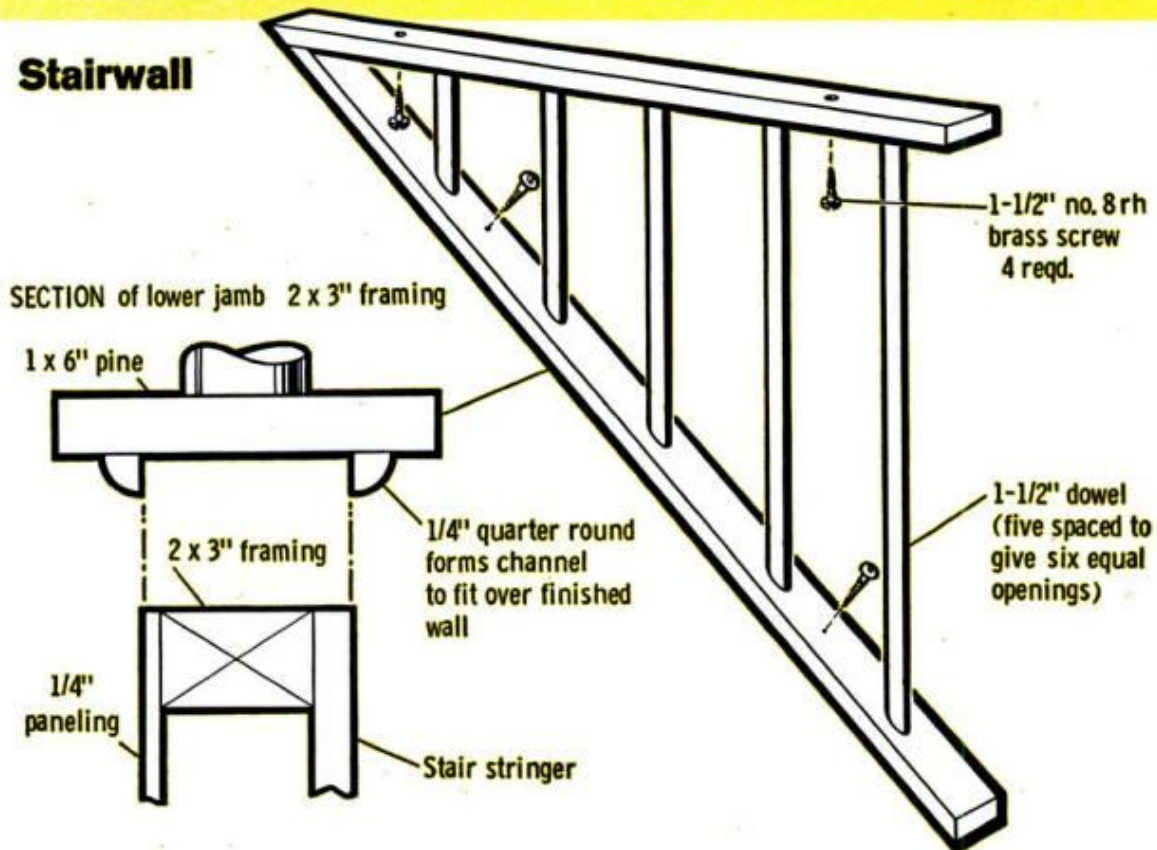


ACCESS TO CRAWLSPACE and cleanout plug in waste line doesn't have to be an ordinary hinged door. Handsome backbar at top left holds bar supplies, stands double duty. No tools are needed to remove or replace this box-like built-in. Once it's removed, the rough opening remaining (right) affords ample clearance for swinging a wrench or manipulating a snake to clean out a waste line. Use this method of construction where fast or frequent removal is not of prime concern. Though a mirror was installed on the cabinet back here, you could use paneling or, for a touch of decorator color, a painted hardboard. If a larger opening is called for, you could build the backbar in sections to lighten the load during removal





Stairwall



DOWEL TREATMENT along one stairwall permits light to enter from above, eliminates dark, cave-like look found in many basements. To remove the "wall," the lowest screw through the pine frame into stringer is last removed (above right). Stairwall should be framed and paneled first, then removable section built to fit. Quarter-round molding (above) brackets stringer and wall, guides unit when removing or replacing

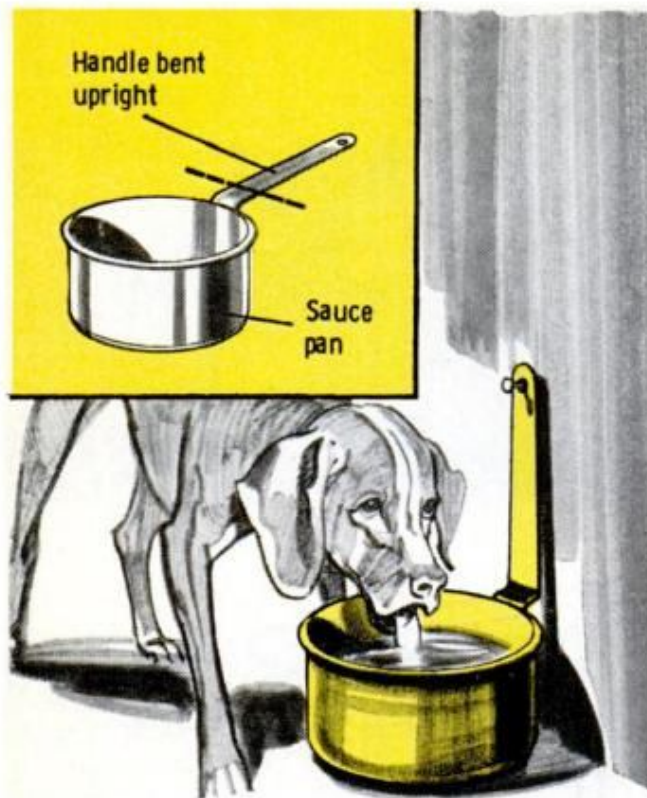
plumbing or electrical repairs are ever needed. Second, after the framing in front of foundation walls is up, walk around the room and double-check to insure that all valves, cutoffs and the like have been provided with an adequate rough opening.

Though there are several methods for boxing-in a girder (ladderlike framing is perhaps the most common), the technique on page 155 is far simpler and saves materials. To insure a good-looking job, the

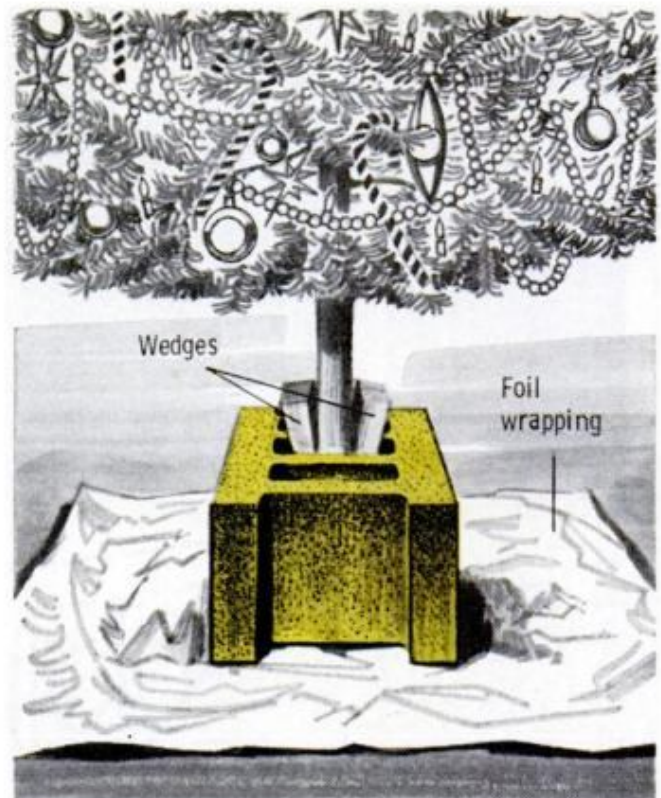
pine on the underside should be clear.

Finally, it's a mistake to close-in both sides of the cellar stairs permanently, since this restricts the size of furniture you can move in or out. Instead, finish the room side up to the top of the stringer only and build a removable frame with four or five heavy dowels (such as closet poles). If your basement has a center stairway, consider making both sides removable. ★★★

Solving home problems



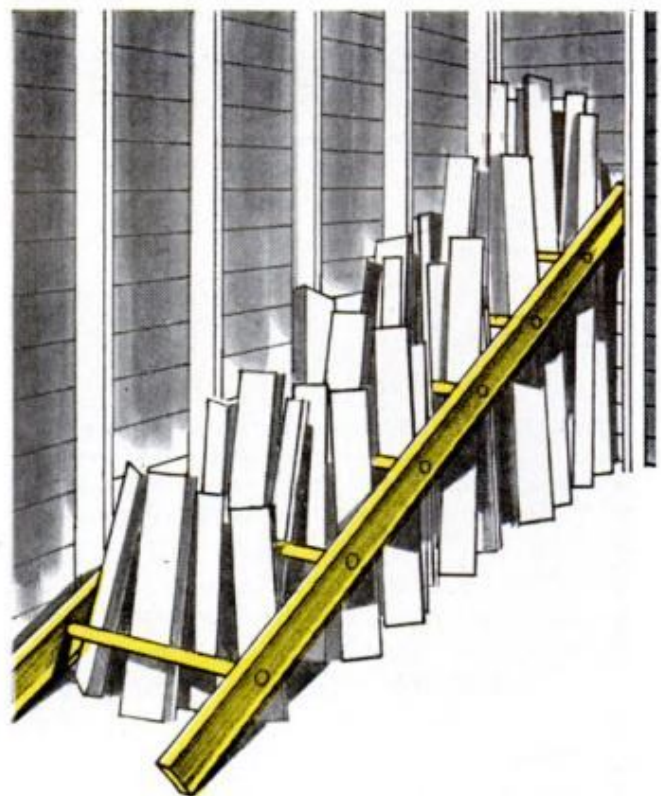
A SAUCE PAN makes the best nontip dog dish. Heat the handle near the rim of the pan and make a sharp 90° bend. Use the hole in the end of the handle to hang the pan on a nail. It can't upset.—Ray Beck



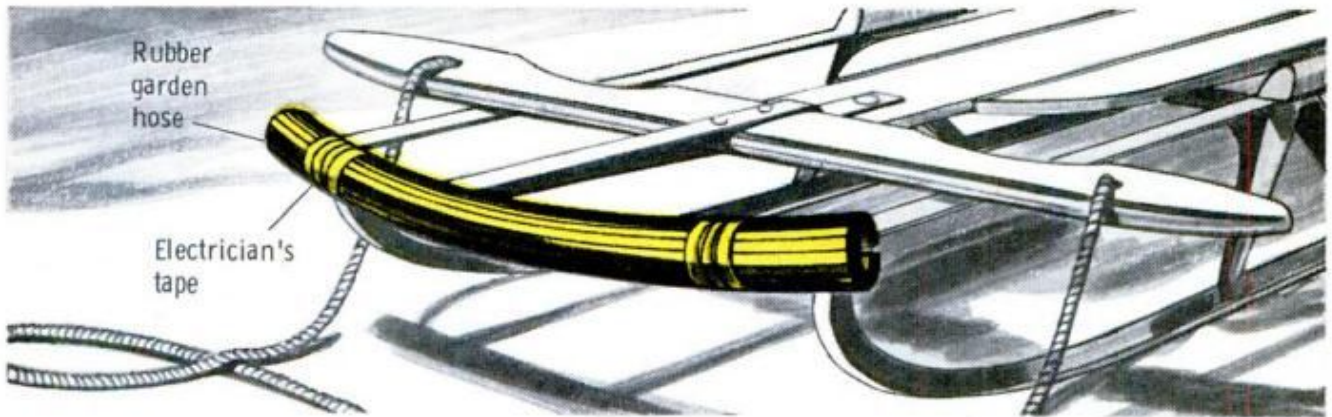
WHEN IT COMES TO HOLDING a Christmas tree, you can't beat a concrete block. Whittle down the trunk to fit the center core hole and secure with wedges. Wrap entire block in a colorful foil.—Victor H. Lamoy



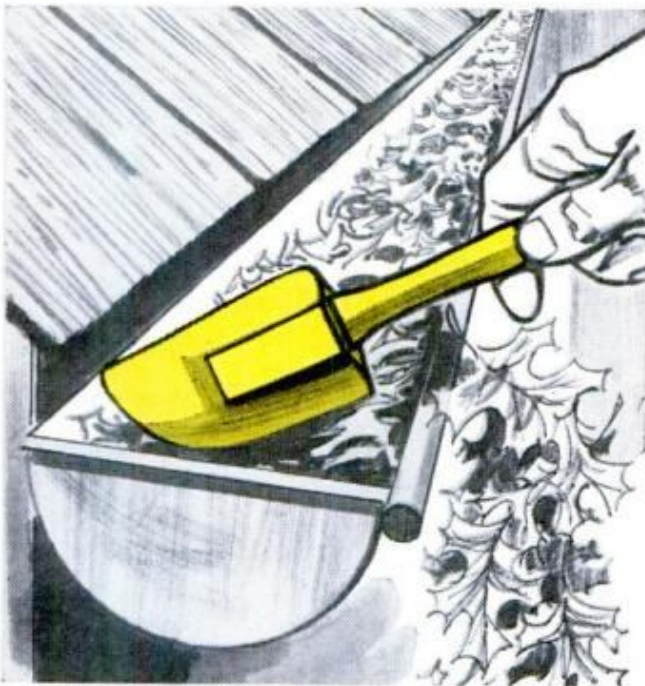
IF YOU ARE ON THE ROAD and get caught without a bottle opener, remember to look in your car trunk. There's a slot in the base of most all bumper jacks which will fit a bottle cap perfectly.—P. F. Atwood



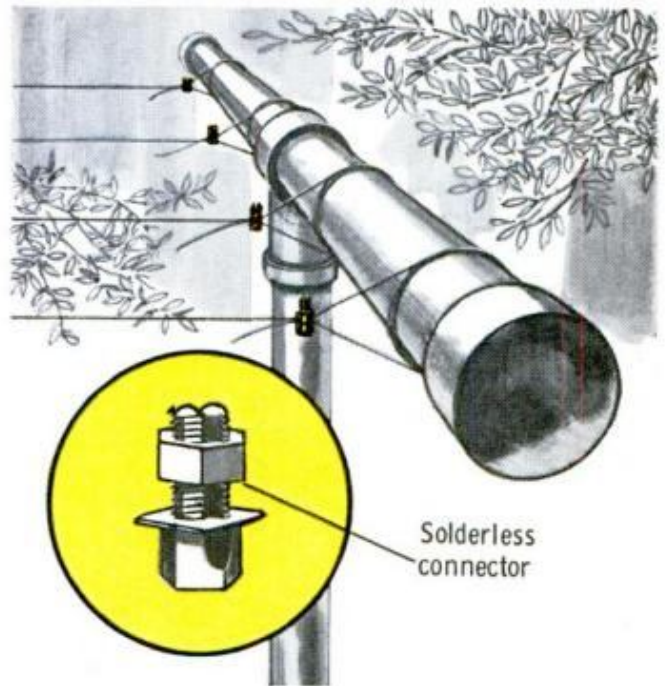
LOOKING FOR A WAY to store short lengths of lumber in an orderly manner? Lean and anchor a ladder against garage wall and stand pieces between the rungs. It will hold a lot of scraps.—Victor H. Lamoy



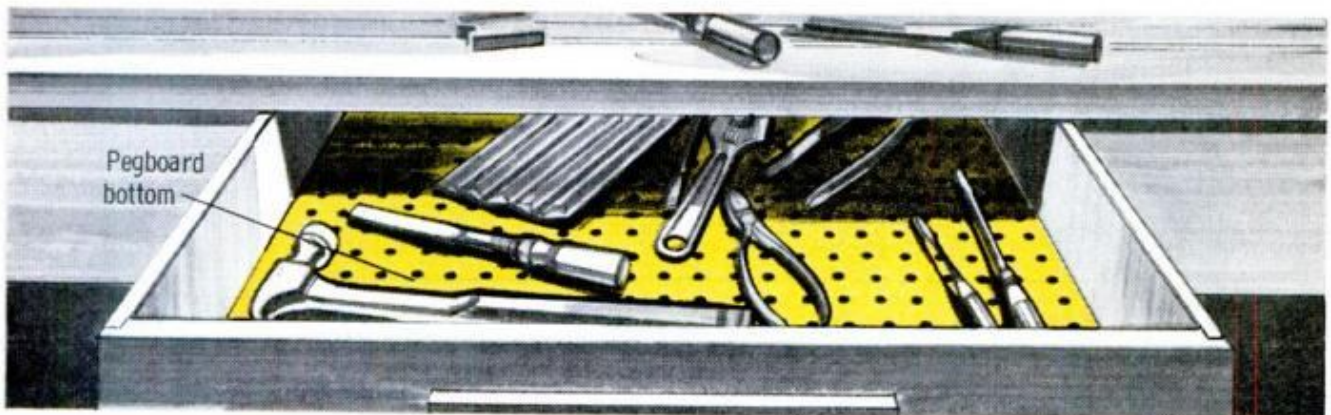
TAKE TIME TO PAD the steel bumper on your kid's sled with rubber and it will cushion a shin should he run into a playmate. Slit a piece of garden hose to fit over the bumper and bind it with tape.—*Harley L. Sachs*



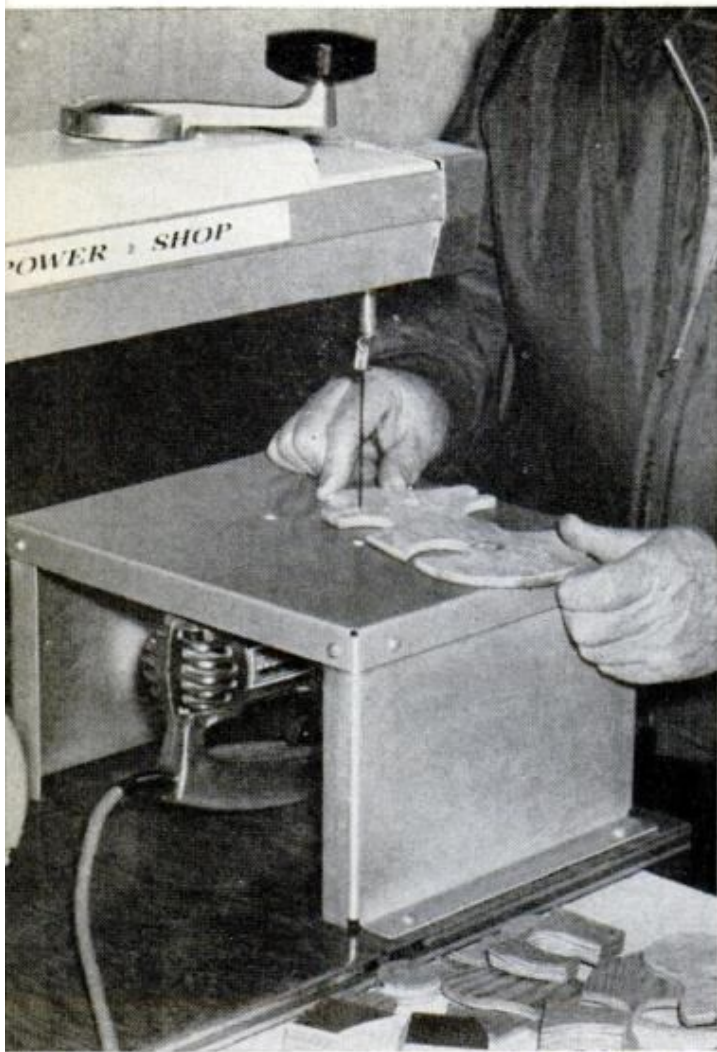
PERFECT TOOL FOR CLEANING leaves and muck from half-round gutters is a kitchen plate scraper. Made of rubber it won't scratch the paint lining and its rounded shape fits the gutter.—*A. E. Davidson*



GOOD WAY TO ANCHOR wire clothesline to a post is with solderless connectors. Electricians use them to join wires. They can't rust because they're made of Bakelite. Use the large size.—*Clarence Breitenfeldt*



WORKBENCH DRAWERS have a way of collecting sawdust, but not if they have bottoms of perforated hardboard. Dust falls right through holes to shop floor; hand tools stay bright and dust free.—*C. Wayne Close*



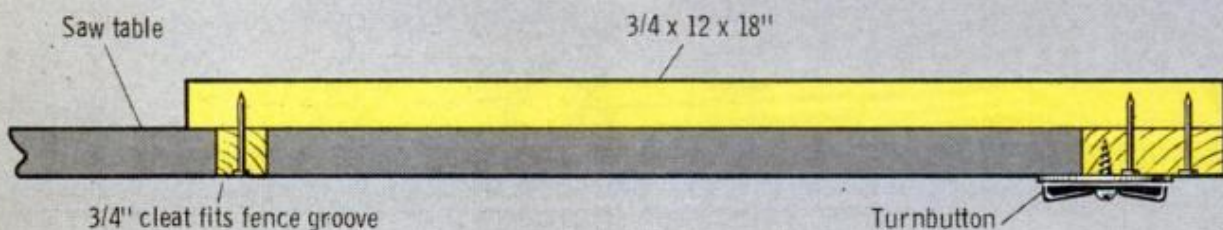
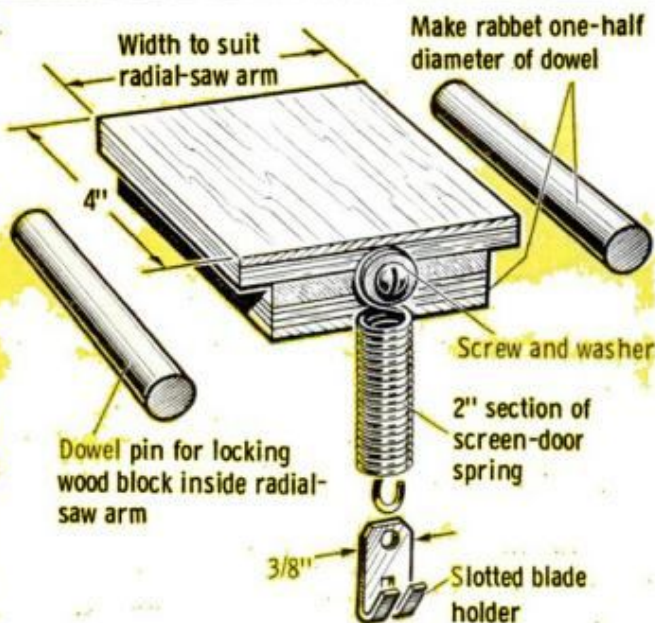
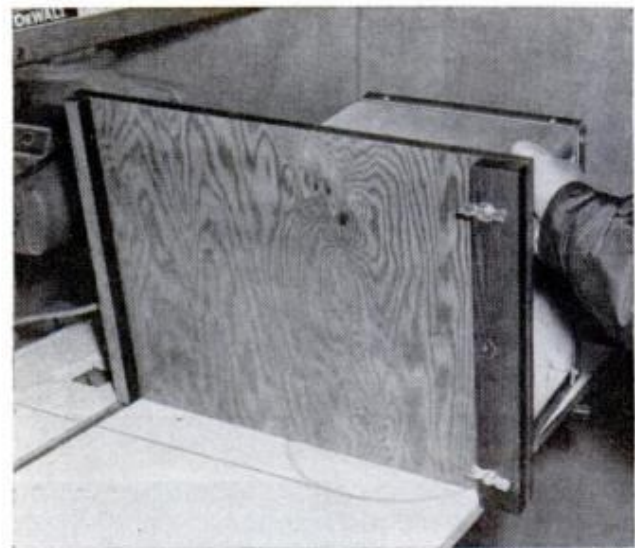
A JIGSAW FOR A DIME

WHEN YOUR PROJECT involves intricate work and tight, curved cuts, a jigsaw is the only tool for the job. For the price of a coil-spring you can adapt equipment you already have—the radial arm saw and a stand-mounted sabre saw—to fashion a jigsaw for your shop. The setup shown uses an ordinary coping-saw blade with the bottom end snipped off so that it can be held in the sabre-saw chuck. To hold the coping blade secure, simply break off the end of a worn sabre-saw blade and leave it in the chuck.

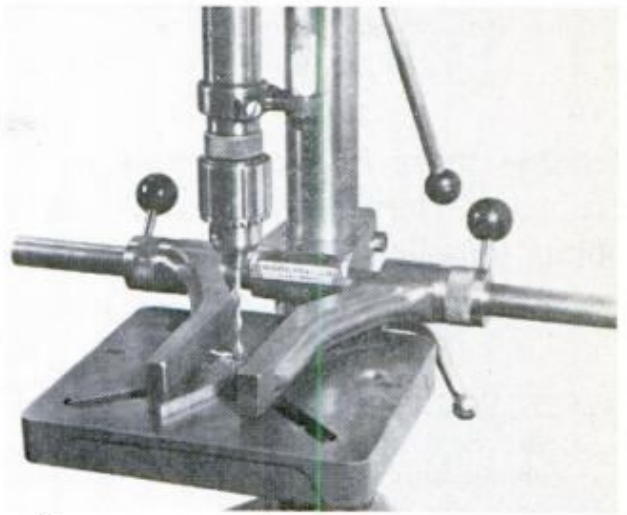
Use a block of $\frac{3}{4}$ -in. plywood to fasten the spring underneath, and inside, the arm of your radial saw. Then rabbet as shown for the hardwood dowels. The block carries the spring that returns the blade to its original position after each stroke.

—William G. Waggoner

PLYWOOD BASE is fitted with strip that rides in saw-table groove. Turnbuttons hold it at the front

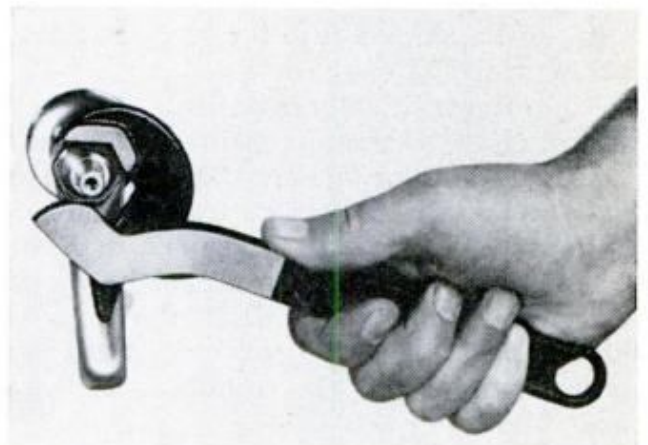
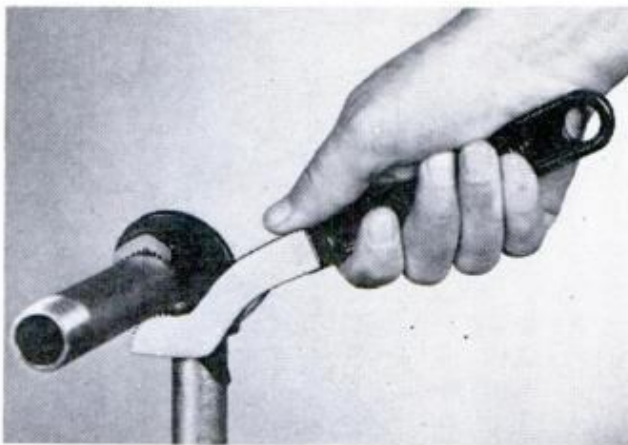


New tools you should know about



Drill-press workholder increases safety, fits most equipment

Instantly adjustable because a mere quarter-turn of the handles locks the arms, the drill-press workholder above holds any shape workpiece securely. Featuring a split collar, it can be installed without disturbing the machine. Prices start at \$67 for a unit to fit 1 $\frac{5}{8}$ -in. round column; six other sizes are offered. Universal Vise and Tool Co., Parma, Mich. 49269.

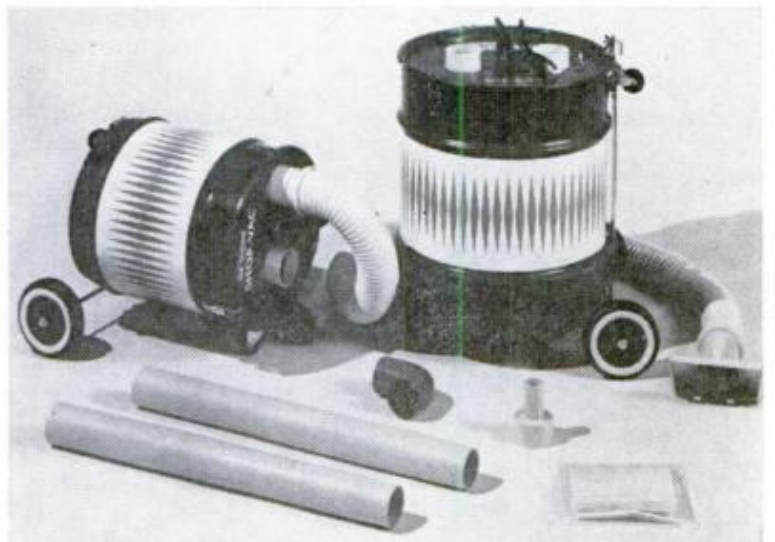


Wrench that lets you do it with one hand, even under wash basins

Claimed to be the fastest wrenches for pipe or nuts, Witherby's One-Hander self-adjusting ratchet wrenches are available with serrated or smooth jaws in sizes to fit pipes $\frac{1}{8}$ to 2 $\frac{1}{4}$ in. and nuts $\frac{3}{16}$ to 1 $\frac{5}{8}$ in. Simply slip wrench on the part, grip and turn. Available from 6 to 20 in. long, with prices starting at \$3.25. Witherby Tool Co., Inc., Trumbull, Conn. 06611.

Vac features unique dolly

Two deluxe shop vacuum cleaners have been added to Shop-Vac's 5 and 10-gallon vac line. Ease of handling is provided by a dolly dubbed Two-Way Four-Wheel Dolly by the maker. Swivel casters, plus two 4-in. fixed wheels, let you use vac vertically or horizontally. Offered in three colors—cocoa brown, orange and beige—deluxe versions sell for \$40 and \$45, respectively including \$15 worth of accessories; standard models cost \$5 less. For nearest dealer, write Shop-Vac Corp., 1 Industrial Rd. Wood-Ridge, N.J. 07075



How to Check Out

Trouble there is second only to ignition problems. Here's how to deal with water-pump impeller, gears and the propeller

By HENRY B. NOTROM
 Technical Art by Fred L. Wolff

ENEMY NUMBER ONE of a lower unit is lack of proper maintenance. Failure to use the correct lubricant as recommended by the manufacturer is a greater cause of damage to your lower unit than those occasional under-water obstructions you may bump over.

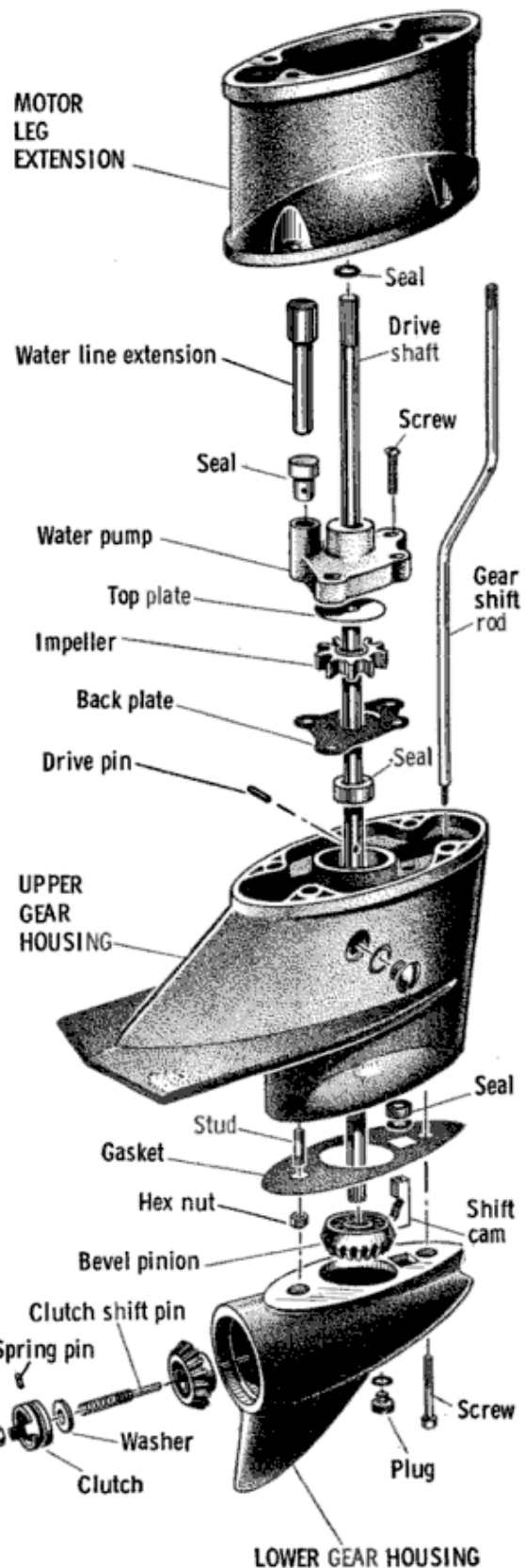
Lower-unit trouble can be detected in one of three ways:

1. The engine won't shift into forward and/or reverse.
2. It can be shifted into forward, but not back into neutral.
3. It jumps continually in and out of gear.

Do you have a remote-control shifting arrangement? Before tearing into that gearcase, better make certain the remote control mechanism isn't the cause of your problem. To test it, disconnect the remote-control unit cable at the motor and shift the motor by hand. If the engine now shifts properly, the problem is the remote control unit. If not, the trouble is in the gearcase.

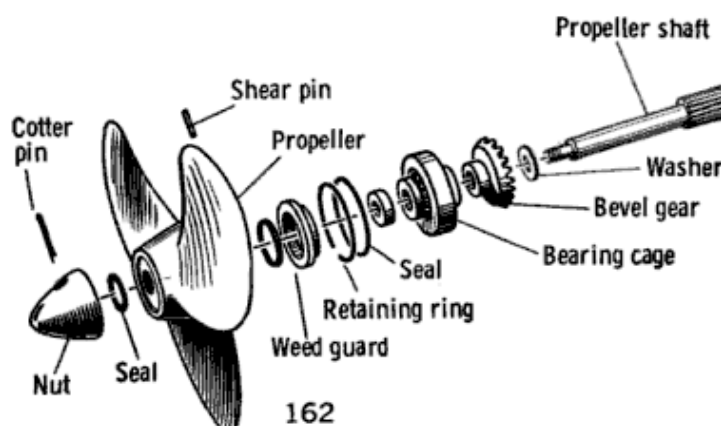
You need no special tools to disassemble a mechanically operated lower unit. But you do need patience, a go-slow approach and a keen eye, especially in your first attempt at lower-unit work. If you observe the following guidelines, you should have little trouble:

- As you disassemble, make notes and diagrams of what you've done so that reassembly will be easier.
- As you take down each part, examine it



TYPICAL LOWER UNIT

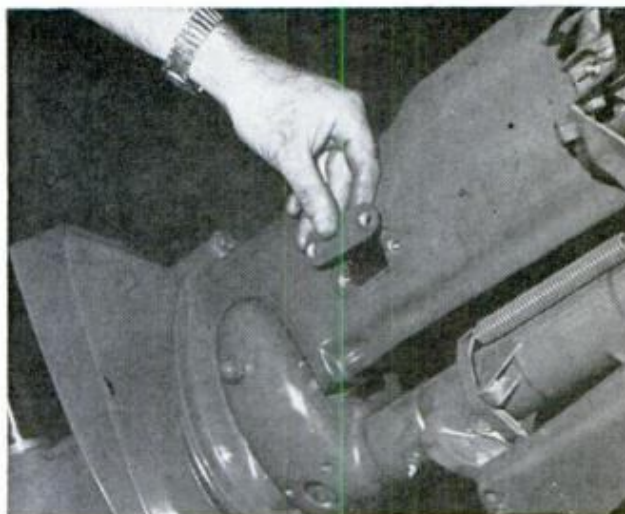
POPULAR MECHANICS



Your Lower Unit



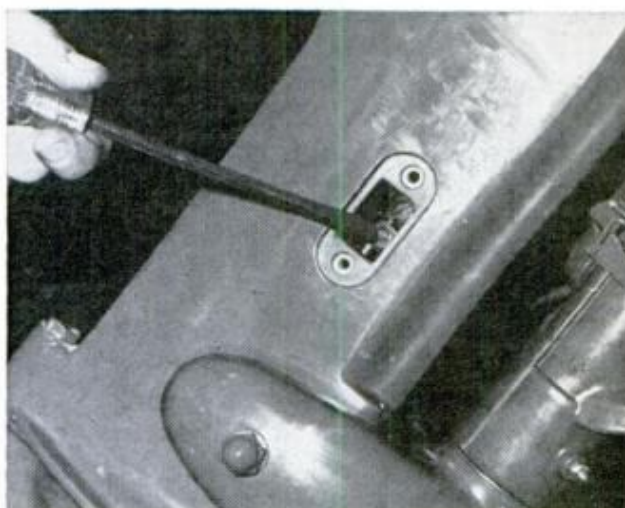
1. EXAMINE EACH PART CAREFULLY on disassembly so you'll be better prepared to reassemble it right



2. THIS INSPECTION PLATE is found primarily on Chrysler, Johnson and Evinrude outboard motors



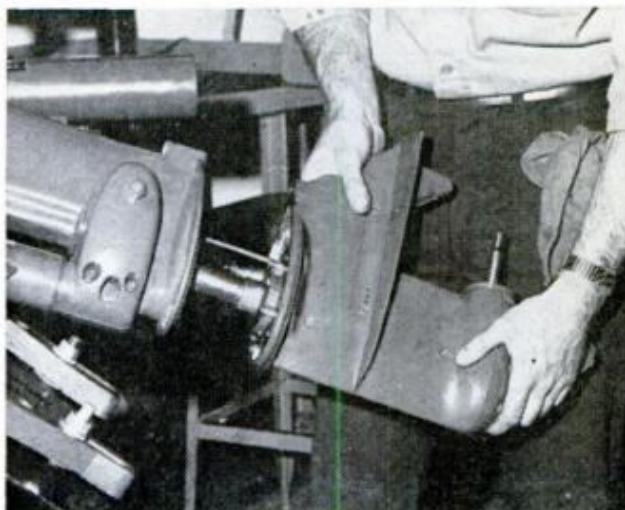
3. BEGIN LOWER-UNIT REPAIR WORK by removing the propeller and draining the gearcase of lubricant



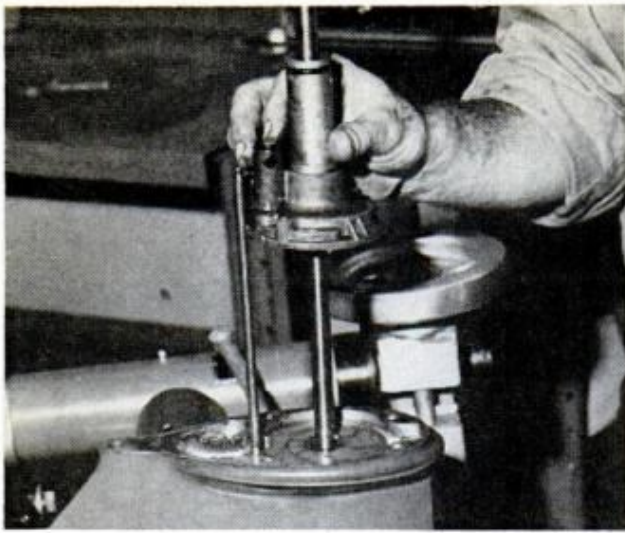
4. IF YOUR UNIT IS THIS TYPE, remove inspection cover and unscrew lower pin to disengage shift rod



5. REMOVE FASTENERS that hold gearcase to the exhaust housing; place in handy place for reassembly



6. PULL GEARCASE FREE of exhaust housing. Let a pro inspect the machined surfaces of each for nicks



7. DETACH WATER-PUMP HOUSING, slide off shaft

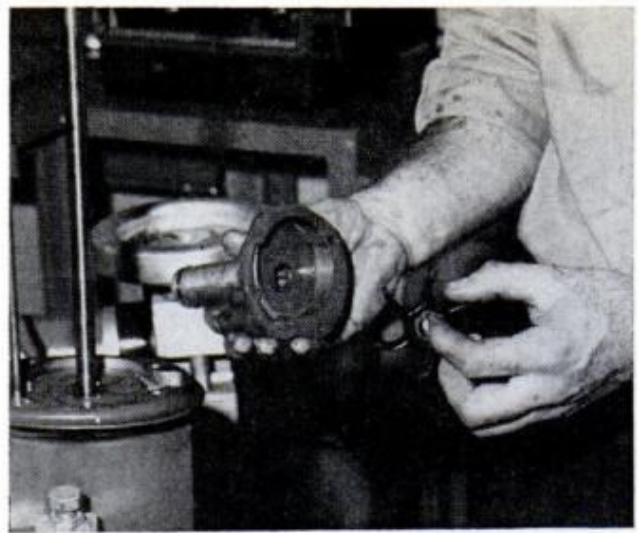
carefully to determine if there's anything special about the way it goes together. For example, in the 18-hp Evinrude used in the illustrations, there's a slot in the front roller bearing that has to fit into a small dowel pin in the gearcase. Otherwise the entire gear train is thrown out of line!

- Keep everything clean, especially when reassembling. If dirt gets on the gears, they will grind themselves to pieces.

- Discard all old seals, O-rings and gaskets for new ones. Most manufacturers issue these in kit form, and you can get them from a dealer of marine supplies.

- If any component, such as a water-pump impeller, is bad, buy it separately.

Basically, there are two types of lower units. One employs a spring-loaded ratchet-type shift dog in forward gear. Mercury makes wide use of it. The other type has a nonspring-loaded, ratchet-type shift dog in forward gear. You'll find



8. REMOVE IMPELLER from the water-pump housing

it primarily on OMC and Chrysler motors. Its shift rod has to be disconnected before you can drop the lower unit.

To tell which setup you have, examine the lower-unit case. If you find a little inspection cover, your unit is a nonspring-loaded type (Fig. 2).

Follow the step-by-step plan of our illustrations to take your lower unit apart. Clean all parts in a solvent—kerosene is okay—and let dry. Compressed-air drying is best, but normal air will do. Inspect all parts carefully. If you're not sure whether a part is damaged, don't take a chance. Get rid of it.

Here are a few tips for inspecting lower-unit parts:

- Inspect the driveshaft splines for wear and replace the shaft if it's bent.

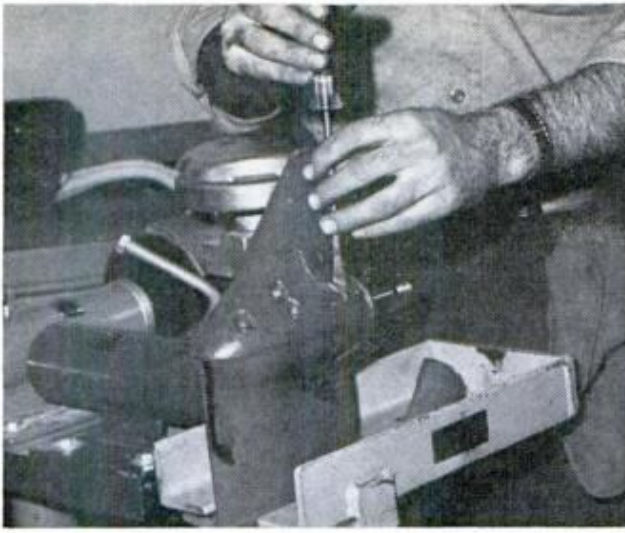
- Inspect the gearcase. If it's nicked on any machined surface, the damage must be repaired and the case face resurfaced. The same applies to the surface of the

9. REMOVE PIVOT PIN and screws to free the skeg



10. EXPOSED GEAR TRAIN, after removal of the skeg





11. LIFT GEAR TRAIN carefully from the gearcase

exhaust housing. Let a professional do this. He has the surface plate, surface gauge and scribe needed for such work. If the gearcase is bent, replace it.

- Inspect water tube for obstructions.
- Inspect the water-pump impeller and replace it if vanes are damaged or worn.
- Inspect water-pump housing, drive gears, clutch dog, pinion gear, bearings, brushings and thrust washers for wear. Replace all damaged parts.
- Don't forget the propeller. Minor nicks can be removed with a file. But a broken or cracked blade means that the propeller should be replaced. It's also a good idea to check the prop pitch on a pitch block.

When reassembling remember that machined surfaces between two parts, primarily between skeg and gearcase, and gearcase and exhaust housing, must be sealed with a marine sealer. Also be sure that screws holding these components are sealed. Dip them in a sealer, such as Per-

13. REMOVE DRIVESHAFT and, if bent, replace it



DECEMBER 1969



12. REMOVE PINION GEAR, then the thrust washer

fect Seal No. 4, before they're run up tight.

When the lower unit is reassembled, refill it with gearcase lubricant. It's wise to lubricate all other parts relating to the unit, such as clamp screws, swivel-bracket fittings, throttle-shaft bushings and gears. See the owners' manual lube chart.

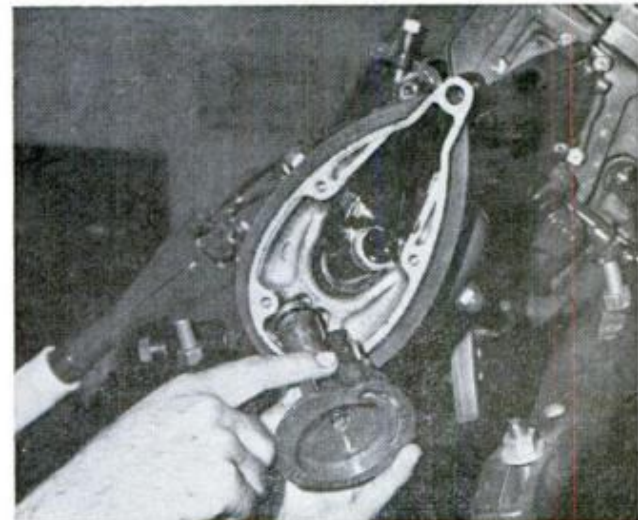
Finally, outboard-engine manufacturers stress two basic rules for proper handling of the gearshift. If observed, the chances of a lower unit being damaged will be greatly reduced.

1. Shift at recommended idle speed only. (Consult your owner's manual—it's usually 600 rpm, plus or minus 100.)

2. Shift smartly with a quick motion of the gearshift lever. Don't ease into gear, and don't wrench your control over.

If you follow these guidelines and the manufacturer's suggestions, your take-down of an outboard motor's lower unit should be limited to a once-in-a-lifetime experience. ★★★

14. CHECK WATER TUBE fit in water-pump housing

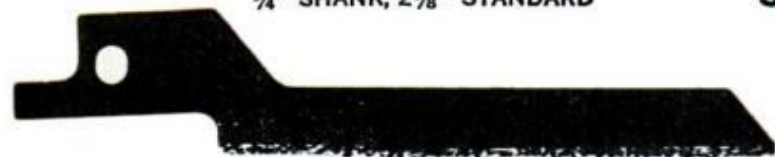


165

New Toothless Blades



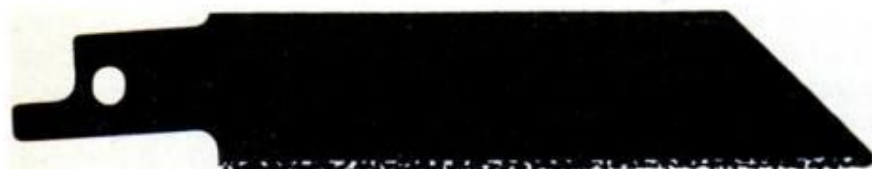
1/4" SHANK, 2 7/8" STANDARD



1/2" SHANK, 3 1/2" SCROLL



1/4" SHANK, 4" FLUSH CUT



1/2" SHANK, 4" STANDARD



1/2" SHANK, 6" STANDARD

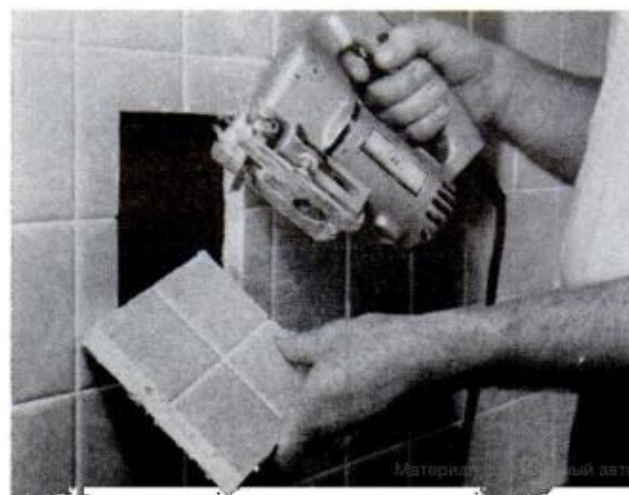
Really tough-to-cut stuff, such as laminate, ceramic tile, asbestos cement, slate and fiberglass, is easy prey for the amazing sabre-saw blades that cut just like diamonds

YOU'VE NEVER SEEN a sabre-saw blade like this, nor the way it cuts. In place of teeth it has a cutting edge that's coated with hundreds of tungsten-carbide particles, a man-made substance of diamond hardness, which multiplies tenfold the cutting power of any sabre saw.

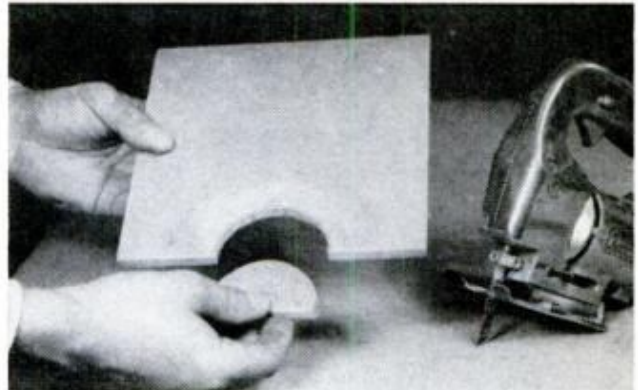
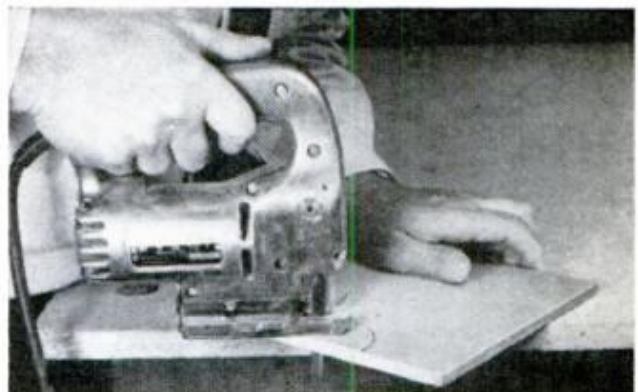
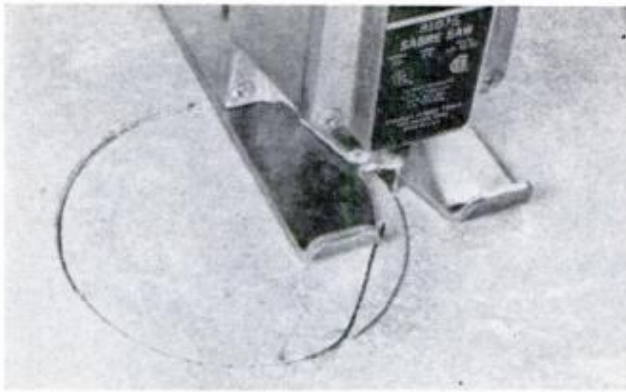
Developed by Remington Arms, Inc., of Bridgeport, Conn. 06602, the same people who make the tungsten-carbide rod saw, this new blade will cut its way through tough, hard abrasive materials that break

and blunt ordinary tooth blades. Not only does it wade through hardwood like butter, but, since it cuts on both reverse and forward strokes, the abrasive coated blade actually sands as it cuts to produce a smooth, chipfree edge. Of the five shapes shown, blades A and B are available to the do-it-yourselfer at most hardware stores. The others are available industrially. The 1/4-in. blades fit most sabre saws; blade A sells for \$2; blade B, \$2.40.—*Wayne C. Leckey, Home and Shop Editor*

ONCE THE HARDEST PART of adding a new soap dish or towel bar, cutting a hole in ceramic-tile wall is now plain easy. Toothless blade is started by holding saw at angle and easing blade into the hard tile

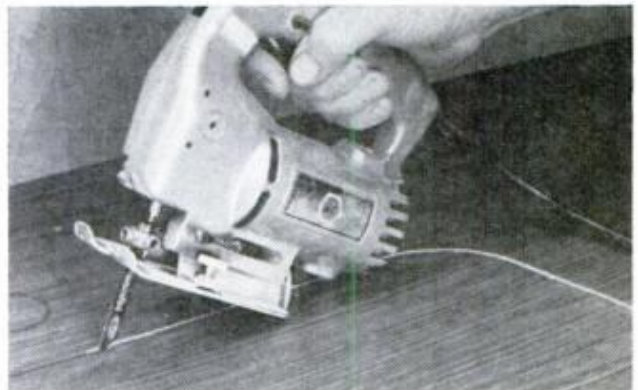
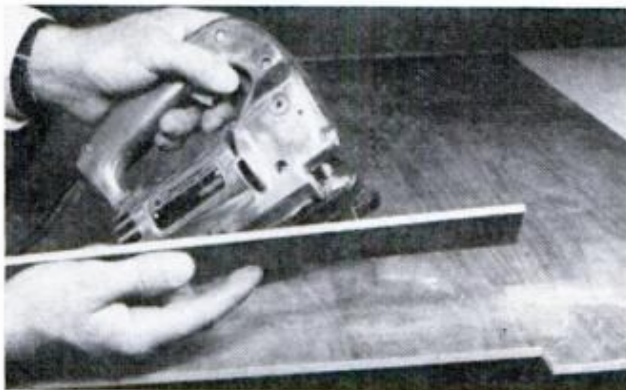


Cut the 'Uncuttables'



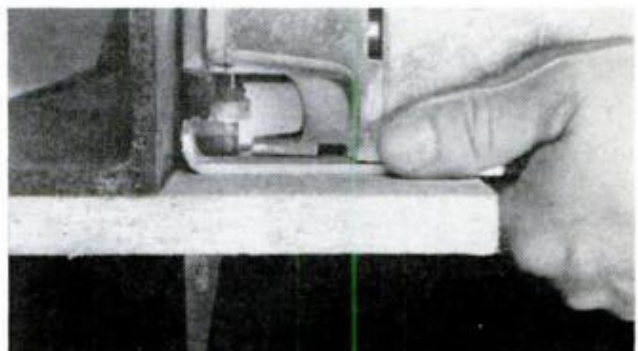
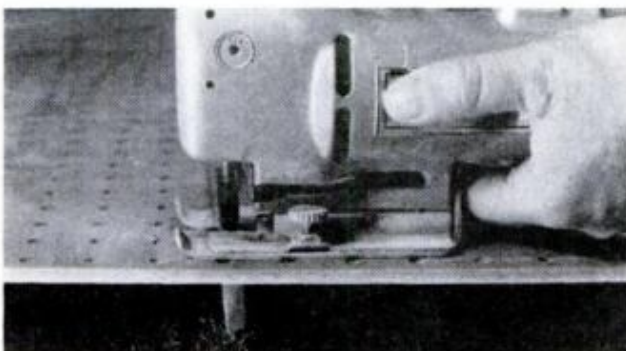
CUTTING A PIPE HOLE through "pane" of asbestos cement when venting a dryer through a basement window is a cinch by making plunge cut in material

SAWING QUARRY TILE when fitting it around floor pipes and other obstructions is no problem. Here abrasive-coated blade works best at a slow speed



SINCE BLADE CUTS on both forward and reverse strokes, kerf in plywood is sand-smooth, splinter-free

FINE-GRIT BLADE cuts brittle countertop material without chipping, leaving a relatively smooth edge



ABRASIVE PARTICLES used in banding perforated hardboard soon dull regular blade, not Remington's

SHAPE OF FLUSH-CUT BLADE lets you cut right up to a vertical surface without saw interference

Look What You Can Do With a BELT SANDER

It's a rugged tool you can use for rough or finishing chores



By BURT MURPHY

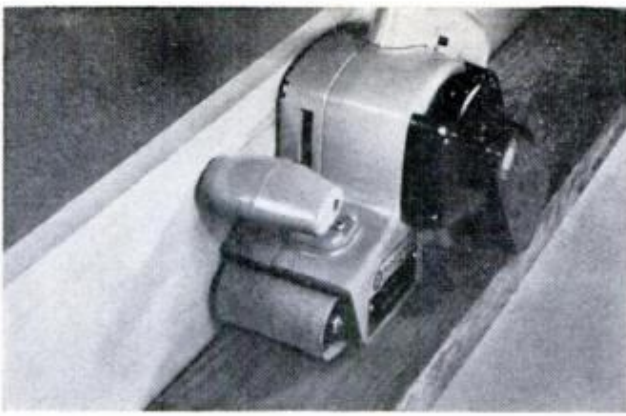
THE BELT SANDER is a workhorse of a tool. Faced with a job that would be dirty and tedious by hand, a belt sander will literally chew its way through the chore effortlessly. Actually, once you own one, you'll wonder how you ever got along without it.

Using a belt sander, you will find that with a little practice you'll spend a lot less time on such tasks as:

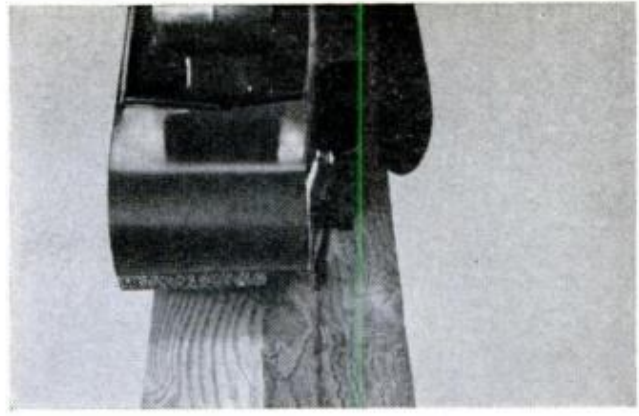
- Sanding rough stock smooth.
- Removing an old finish.
- Putting a bevel on a door.
- Reducing stock thickness.
- Back-cutting miter cuts for neater joints (casings, for example).
- Dressing up a poor saw cut.
- Polishing and buffing.

If you have never used a belt sander before, take the time to familiarize yourself with it when you first get one. Since a belt sander is larger, livelier and heavier than a pad sander or drill-disc combination, it does take some getting used to. Hefting, changing belts, adjusting belt tracking and the pull as the sanding belt digs into the workpiece will all be new to you. To gain this experience, use the tool on various materials: hard and soft woods, metals, plastic laminate and any others that you usually work with.

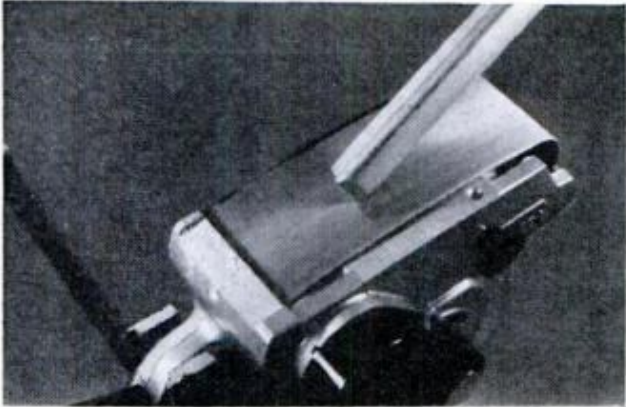
The belt sander should always be turned on before contact is made with the workpiece and turned off after it is lifted off. When lowering the sander to the material, you should keep the flat platen parallel to



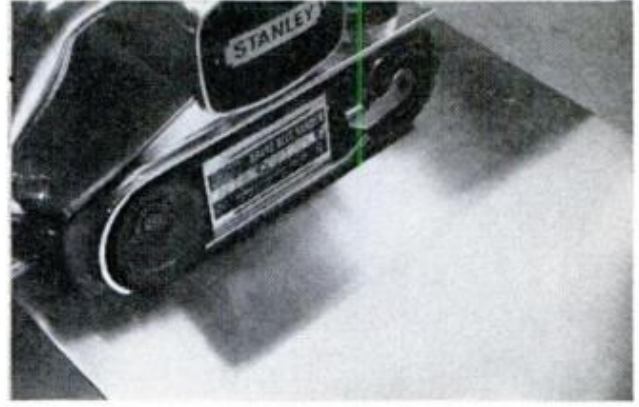
LATEST DESIGN TREND by most makers lets you use power for flush sanding next to a vertical surface



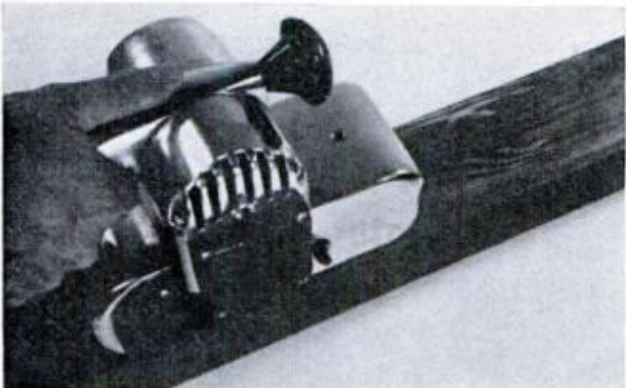
COARSE-GRIT BELT sands rough stock smooth in few minutes. Finer-grit belts are used to finish the job



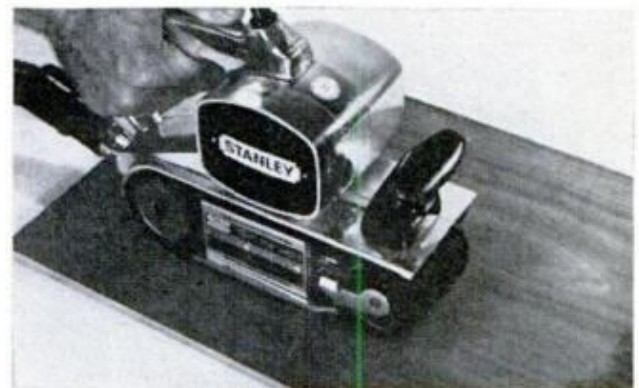
TO WORK SMALL PIECES, sander can be clamped upside down on the workbench to free both hands



EVENLY POLISHED FINISHES on metal are possible in home workshop using special belts and lubricant



TO STRIP PAINT, use a coarse, open paper to start, then complete the job with finer, closed-coat belt



NYLON WEB BELT and small amount of cutting oil clean dirty-plywood surface, produce even tones

the work. Once it contacts the workpiece, keep the sander moving to prevent "dishing out." The weight of the sander itself provides adequate pressure; all you need do is guide the machine. Bearing down on the sander can, in fact, cause damage. When working with wood, move the sander with the grain of the wood, never across. Work the entire surface, overlapping each succeeding pass. If you attempt to complete a 3-in. strip and then move over for successive strips, you will end up with a wavy surface.

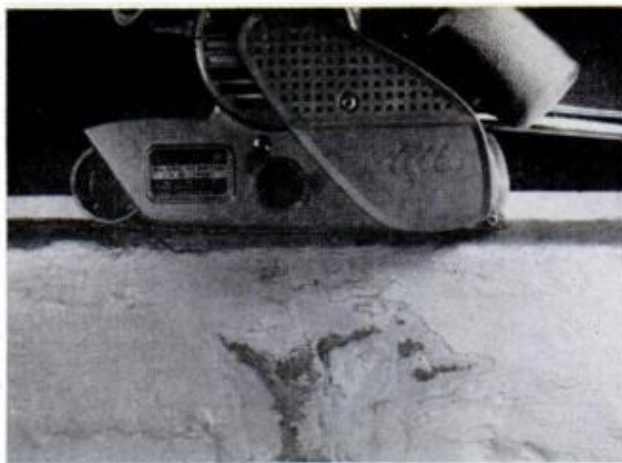
The sanders shown on these pages are all

basically the same, with slight design variations. Most manufacturers offer at least one model equipped with a dust collector. It's a good feature and it adds little to the total cost. If you do a lot of sanding or, if your wife hasn't been too happy with the dust settling in the laundry room, the extra couple of dollars that a collector costs will be money well spent.

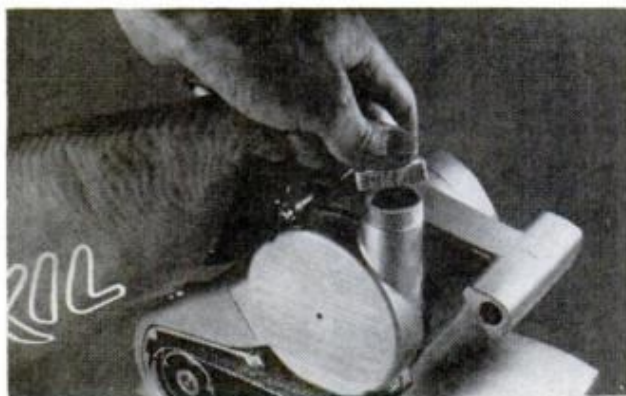
In addition to on-the-job uses, a sander can also be rigged with clamps for use as a bench-type power sander. Small-size workpieces can then be brought to the sander and, since you are saved the task



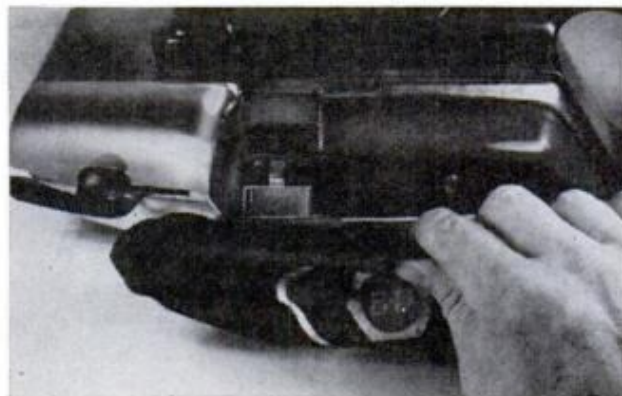
CONCRETE FLOOR STAINS can be cleaned with a belt sander. Tool's not limited to wood and metal chores



LUMPY CONCRETE on basement window sill is removed using coarse grit. Here dust collector pays off



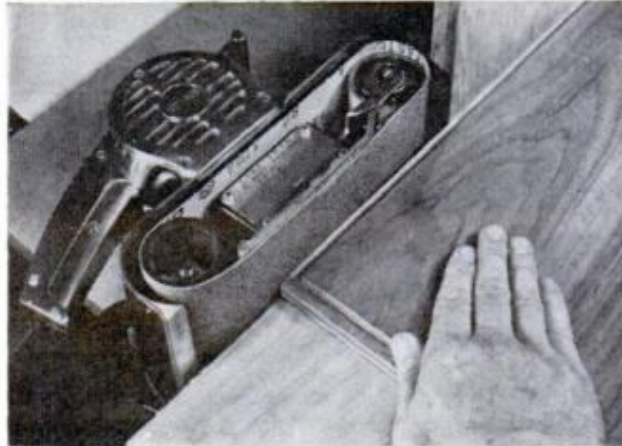
DUST COLLECTOR on Skil's sander is a tube and bag connected to unit with a threaded, knurled ring



A SPRING-TENSIONED SLIP-IN NOZZLE is connected to the collection bag on the Black & Decker model



HOSE AND NOZZLE serve as dust collector on the Stanley sander—they're attached to vacuum cleaner



CLAMPED ON ITS SIDE, the belt sander can be used for "planing" jobs. Vertical board serves as a fence

of hefting the tool, both hands are free to guide the work against the belt.

Both general and special-purpose abrasive papers are manufactured for use with belt sanders. For a roundup of abrasives, see *What You Should Know About Choosing and Using Abrasives*, page 186, April PM. Aluminum oxide, manufactured in a wide variety of grits, is the type you will use most often. Or, you can use special-purpose belts to convert the belt sander for use as a cleaner, buffer and polisher

for metals, woods, plastics and laminates.

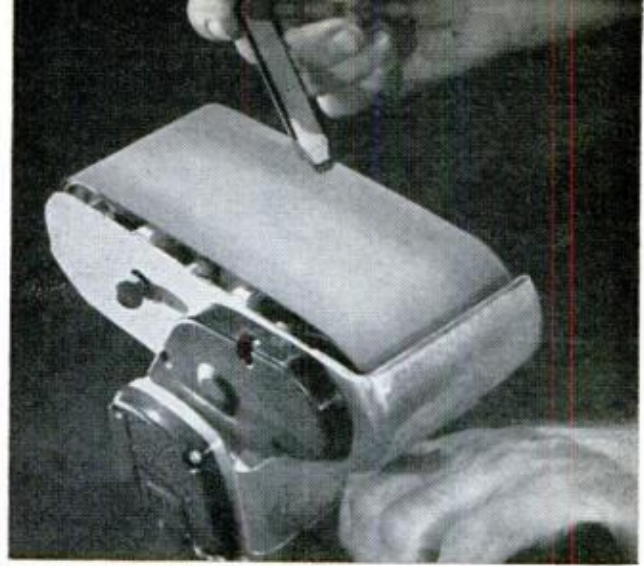
Belt sanding facts you should know:

- *Wood finishing.* For final finishing of furniture or cabinetry, use as many progressively finer grits as possible. The object here is to remove any marks left by the coarser belt that preceded the one being used.

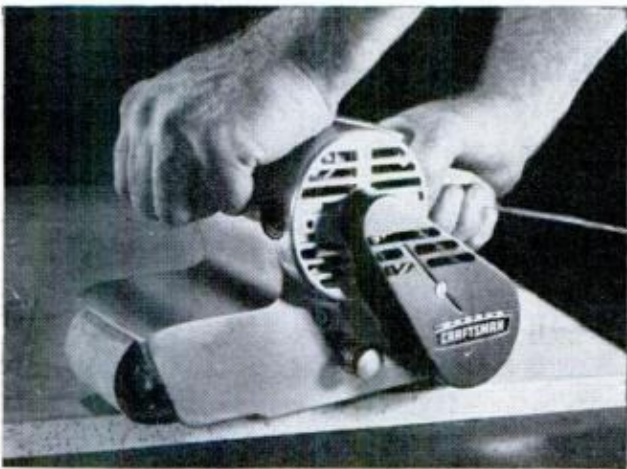
- *Metal finishing.* Beeswax or tallow are recommended for use as lubricants for metal sanding, polishing or stain finishing. Several manufacturers market commer-



LEFT IN ONE SPOT TOO LONG, belt sander will plow a deep groove (shown across the grain here)



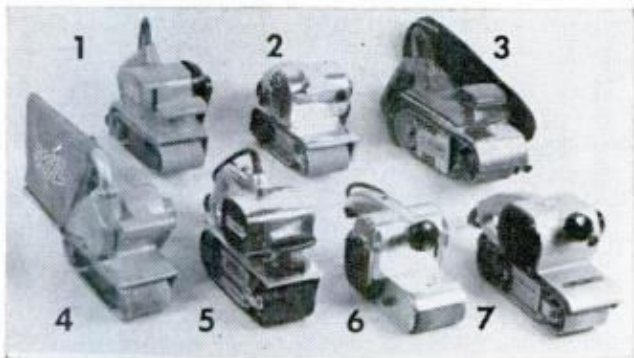
CARPENTERS on construction jobs find that sander offers a fast way to sharpen pencil to a keen point



USING AN 80-GRIT BELT, plastic laminate self-edge is quickly and easily smoothed flush with plywood



WORKBENCH STAND comes with accurate miter gauge, secures sander. The one shown is by Rockwell



cial lubricants for metal sanding. Black & Decker, for example, offers Luster-lube belt lubricant and the Stanley Works markets two products, Tripoli and Greastick, for use with its Stanbrite belts.

● *Refinishing*: When removing paint, varnish or lacquer, use a coarse grade, open-coat belt for the initial stripping. Then change to closed-coat belts as the material shows through the coating. Use short, light strokes to avoid burning the coating and for longer belt life. ★★★

DECEMBER 1969

ALL MAJOR MANUFACTURERS listed offer quality manufactured, rugged belt sanders. If you can't locate the brand you want locally, write the maker for buying information.

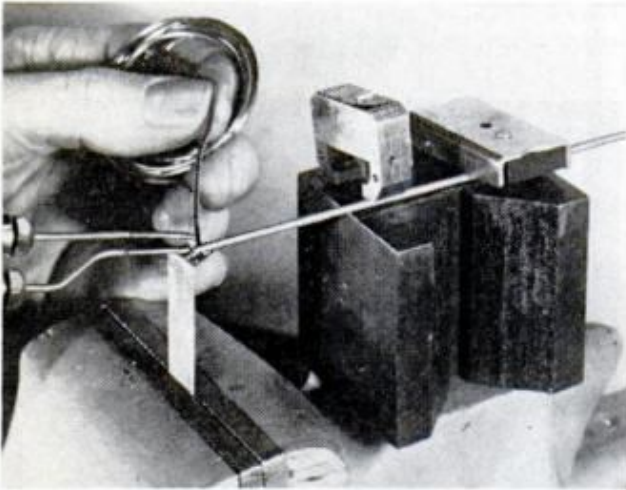
- 1 Rockwell Mfg. Co., Model 91, type 1
411 N. Lexington Ave.
Pittsburgh, Pa. 15200
- 2 Sears, Roebuck and Co., Model 315-22420
925 So. Homan Ave.
Chicago, Ill. 60607
- 3 Black & Decker Mfg. Co., Model U-244
Towson, Md. 21204
- 4 Skil Corp., Model 595
5033 Elston Ave.
Chicago, Ill. 60630
- 5 The Stanley Works, Model 80493
195 Lake St.
New Britain, Conn. 06050
- 6 Wen Pdts. Corp., Model 910
5812 N.W. Hwy.
Chicago, Ill. 60631
- 7 Millers-Falls Company, 830 Model C
Greenfield, Mass. 01301

HINTS FROM READERS



Wire mesh aids spray painting

Ordinarily, when you spray-paint small parts, the final step of the job is prying them loose from the work surface after they have dried. But, if you lay them on a platform made from hardware cloth, the problem is eliminated. The wire screen should be bent or supported to keep it 1 in. above paper spread below to catch overspray.—*Walter E. Burton*



Magnets serve as third 'hand'

It's a waste to throw away an old permanent magnet; it can be used in the shop for holding various things. The photo at left shows how two magnets—one a horseshoe type, the other a unit from a cabinet catch—were used to steady a rod being soldered to a metal strip. The magnets are clamped to a V-block that rests on the vise anvil.—*Walter E. Burton*

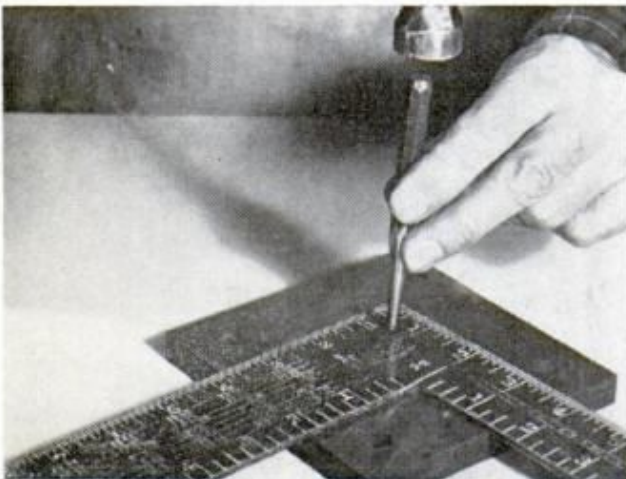


Faster kickback-guard adjustment

Before turning on your radial saw you normally have to heft a large piece of lumber to be cut onto the table so you can adjust the kickback guard. Instead, cut a set of 2x3-in. scraps of the material you usually work with. Fitted with screw eyes, they can be hung near the saw for speedy, easy to handle changes.—*Sidney J. Riskin*

Stencils made from photo film

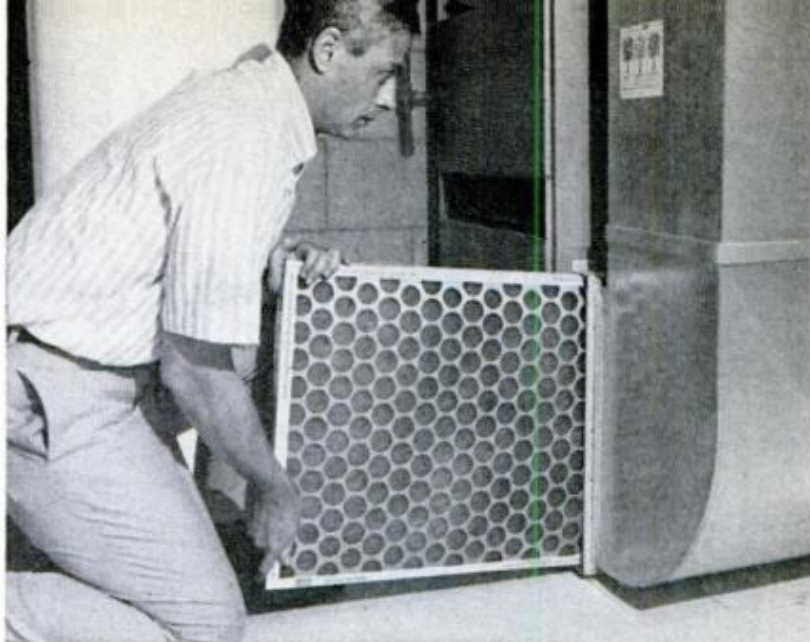
Discarded photographic film can be used as practical erasing shields or stencils simply by cutting appropriate openings in it. Round openings can be formed with punches, other shapes with a pointed knife. The erasing shield on the right is being used to correct a drawing; on the left is a punched-hole stencil and a sample of work done with it.—*Walter E. Burton*



Resquaring a framing square

Since a framing square occasionally goes out-of-square, it should be checked periodically with a second square. If not true, it can be corrected by placing the square on an anvil and peening it with a punch. To close the legs, strike the back of the corner as shown; to spread them, punch the inside edge. Check for square after each blow.—*Lloyd L. Long*

The Right Way to Replace Furnace Filters



HOMEOWNERS with forced warm-air furnaces and airconditioning systems know the importance of replacing air filters frequently. However, there's a right and a wrong way to put them in. Improperly installed, a filter does only half the job and lasts only half as long.

What difference does it make how an air filter is installed? In the case of fiberglass disposable air filters of the common type shown above, a dust-catching adhesive, "Corsol" is applied to only one side of the filter media. If the adhesive-treated side is installed incorrectly, dust will quickly accumulate on the face of the filter and greatly reduce air flow. Thus, the air filter will become useless in a very short time.

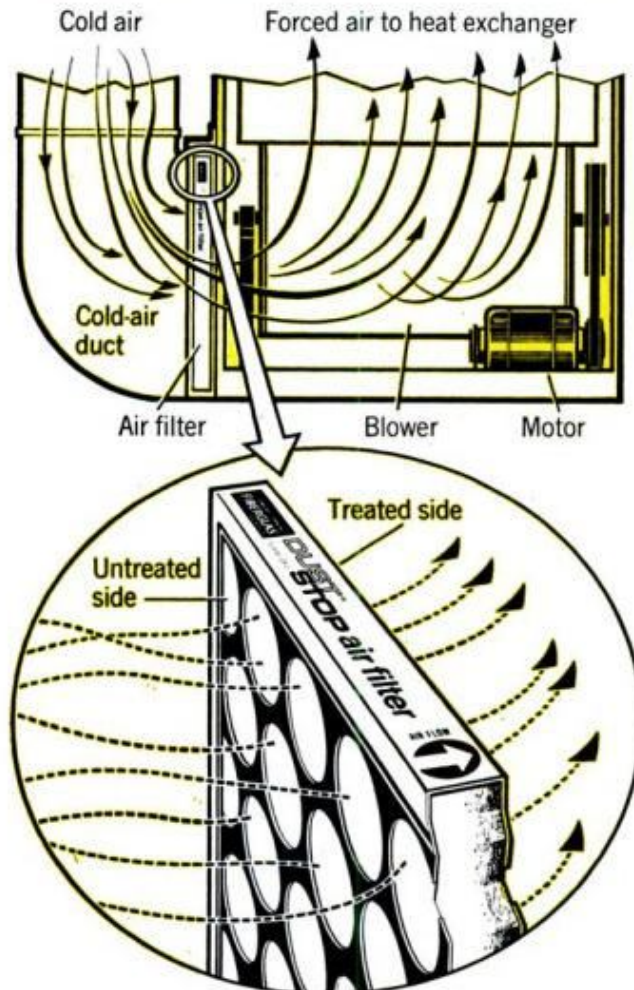
When the air filter is properly installed, dust will be carried through the entire thickness of the filter media. The dust will then start building up from the rear to the front of the filter, holding more dust and providing longer, more efficient life. An air-flow arrow is printed on the frame of all dust-stop air filters which instruct the user as to the proper insertion in heating and cooling equipment. This arrow should always point in the same direction as the flow of cold air into the furnace.

Tests conducted by the world's largest disposable air-filter manufacturer, Owens-Corning Fiberglas Corp., indicate that air filters should be changed at least three times a year and about once a month during peak heating and cooling periods. A dirty, clogged air filter will restrict air flow and cut down equipment efficiency.

In the case of a furnace which uses a hammock-style filter (the blower being

cradled in a blanket of fiberglass) the throwaway filter media comes tinted blue on one side. Here it is important to see that the filter material is installed with the tinted side on the outside so the air will enter the tinted side. Such filtering material comes in 20-ft. rolls and is cut off as needed when the filter is renewed. ★ ★ ★

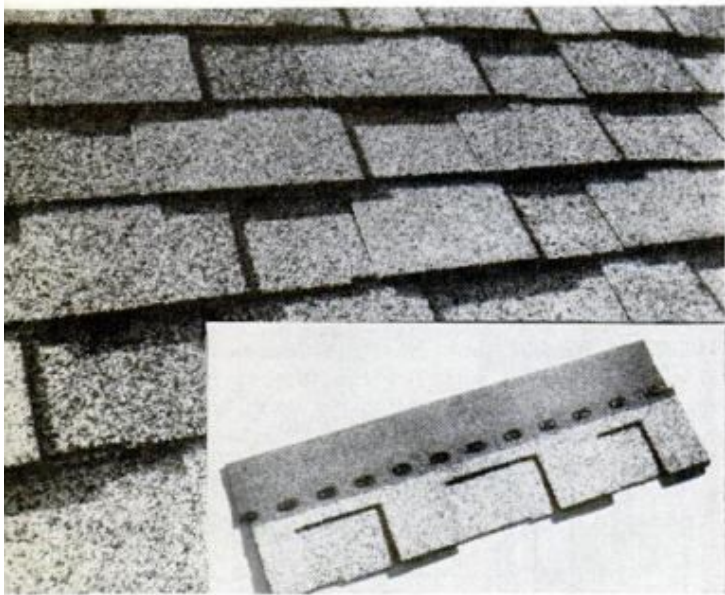
DIAGRAMS BELOW show how dust-laden cold air is pulled through the filter by the blower and then forced up through the furnace's heat exchanger



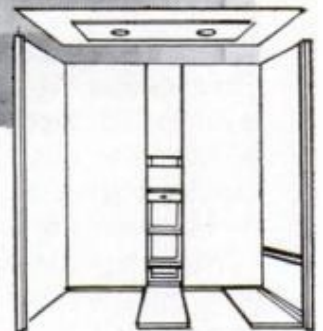
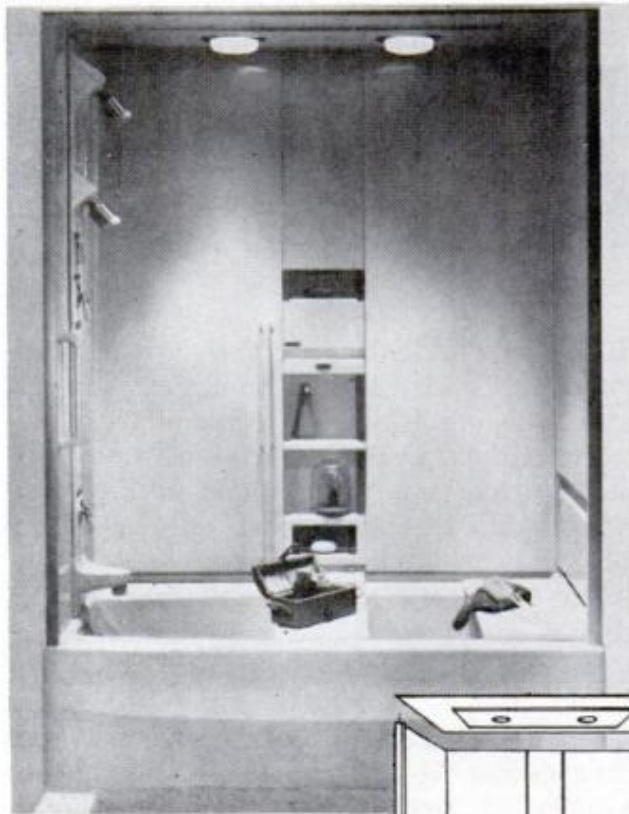
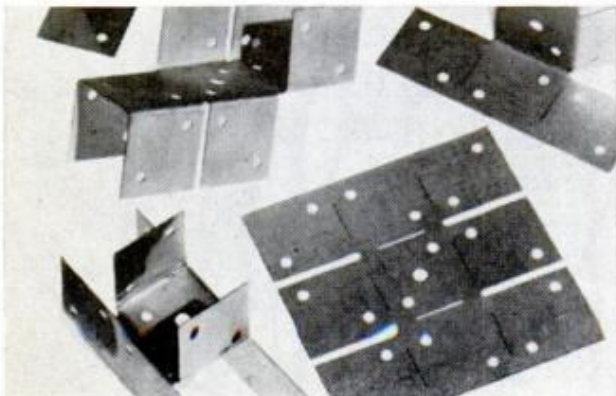
New Building Products You Should Know About

SPECIAL ROUNDUP

Four pages of new building materials for updating old homes and making new homes better



LATEST MANUFACTURER to hop on the "looks-like-wood-shakes-but-isn't" bandwagon is Bird & Son, Inc., East Walpole, Mass. Its asphalt shingles closely resemble wood, boast sturdy double-strip construction and self-sealing adhesive spots for maximum lift resistance. Labeled Architect 70, shingles carry UL class C ratings for wind and fire resistance. Sold with a 25-year warranty against imperfection, shingles weigh 345 lbs. per square, have 5-in. exposed surface and 2-in. headlap.

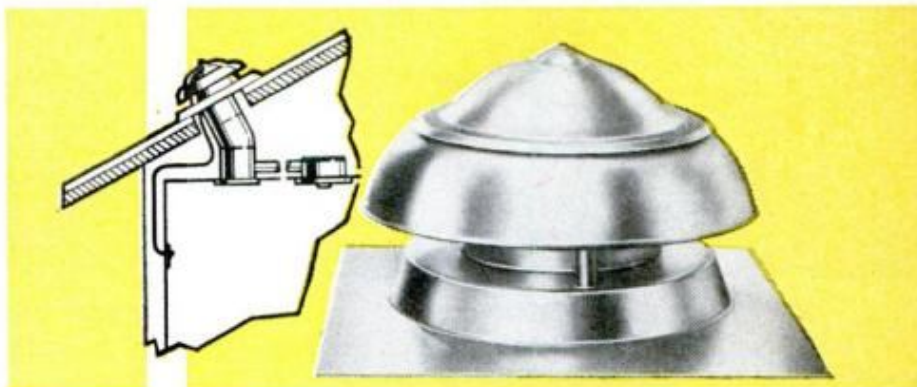


HERE'S A TUB that does everything but take your bath for you. Dubbed Spectra 70 by American Standard, the tub add-on unit (see sketch) fits any 32x60-in. bathtub. Of reinforced fiberglass, the Triwall Surround has two lighting fixtures in the ceiling, two safety bars, drop-down seat and counter. The Shower Tower boasts twin adjustable showerheads, hide-away body spray and the usual bath spout. Complete setup sold through plumbing dealers is about \$825 (in white) or \$900 (in color).

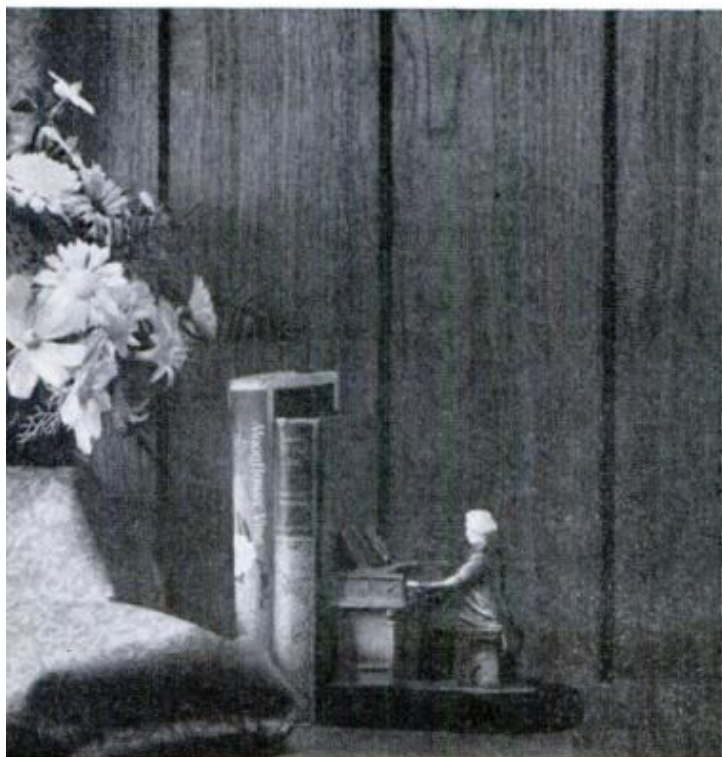
DEVELOPED FOR USE on practically any structural wood joint, this steel plate replaces clumsy, and time-consuming, wood braces. Called Quickform, it is made as a flat plate divided into nine segments. The resulting flaps, and the center section, are dotted with nail holes; thus, the flaps can be bent independently and nailed as needed. Of 20-ga. galvanized steel, the plate can be used for shelf and table-leg braces, joining studs to plates, and headers to joists. Wood Connector Products, 240 W. Colfax St., Palatine, Ill. 60067.



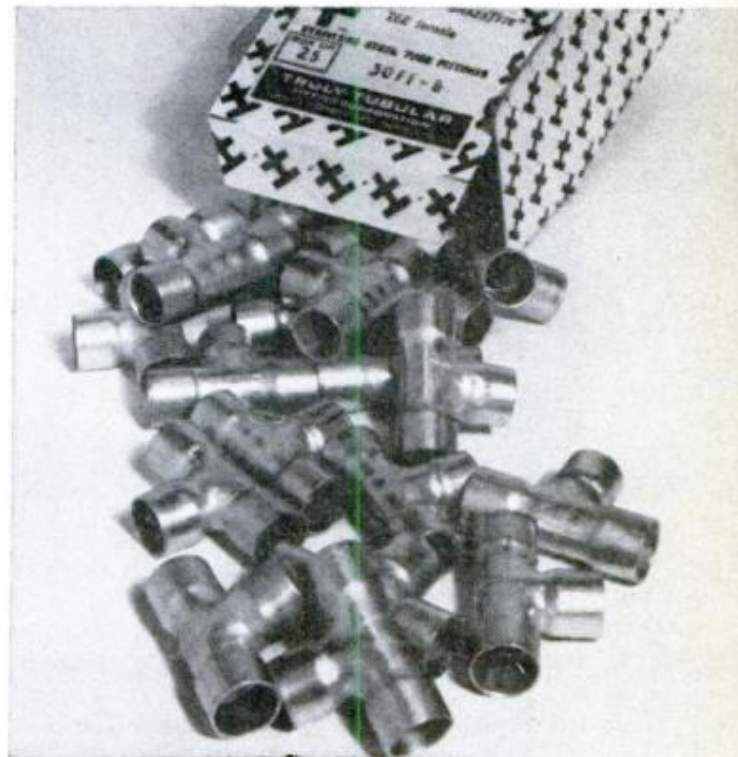
IF YOU LIKE THE LOOK, but not the twist, of bi-fold doors you might consider a pair of nonwarping steel doors. Called Chateau, the doors at left are designed to operate on a top track only. They come complete with hardware and a factory baked-on enamel which can be used as is or as a prime coat when matching decor. Prices start at about \$35. General Products Co., Inc., Box 887, Fredericksburg, Va.



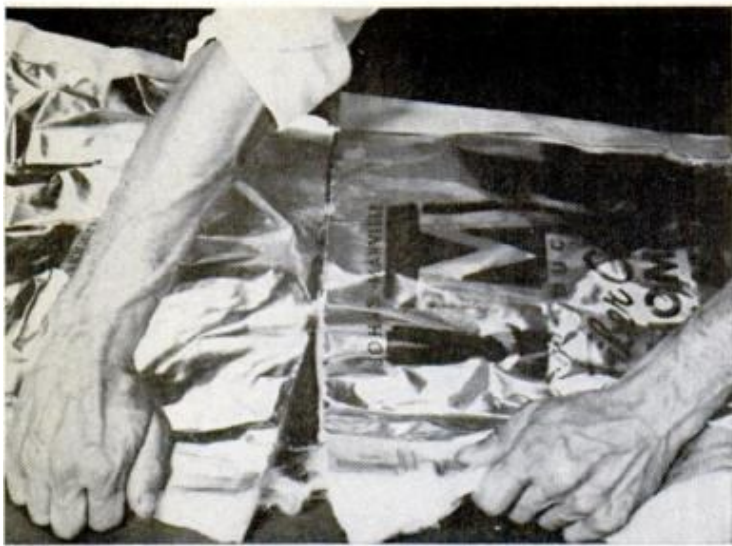
EXTERIOR-MOUNTED ROOF BLOWER FAN is quieter because all motor sound is outside the home. Ideal for central systems that ventilate two or more areas, Model RF-IN moves 632 c.f.m. of air, can be installed on flat or pitched roofs with 10-in. duct. Optional extra, a solid-state speed control (Model VS-65), adjusts air-delivery to venting needs. Nutone, Madison and Red Bank Rds., Cincinnati, Ohio 45227.



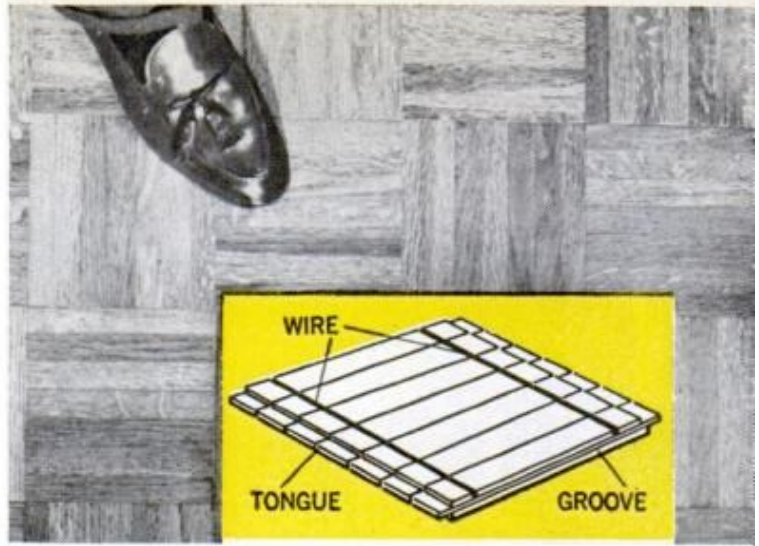
NOW YOU CAN "PANEL" A WALL without driving a nail or squirting a gun. The wall shown above is covered with styrene panels, called Wood Tone Paneling, measuring 6x24 in. each. You simply peel off the paper backing and stick the panel in place. In Spanish oak, Indian teak, white oak, rosewood, traditional and contemporary walnut—with simulated grain and grooves. Six panels, \$4. Decro-Wall, Executive Blvd., Elmsford, N.Y.



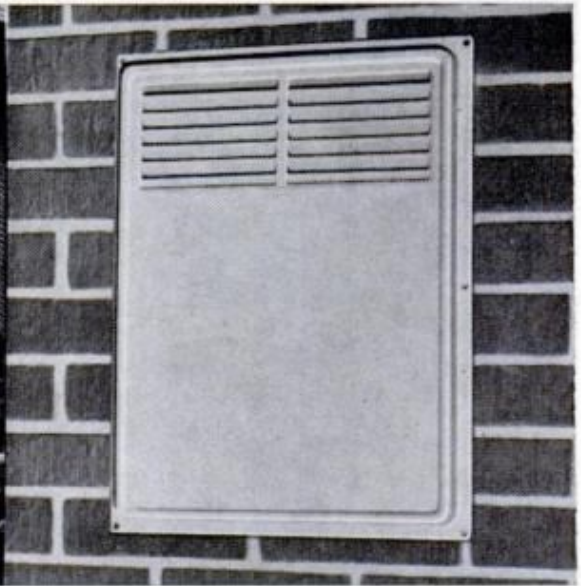
PLASTIC SEWER AND DRAIN FITTINGS molded for 6-in. drain and waste lines have been developed by Olin Evanite Plastics, Carrollton, Ohio, with a versatility to enable homeowner and plumber to handle any sewer drain installation. Fittings include 1/16, 1/8 and 1/4-in. bends in hub-by-hub, hub-by-spigot and spigot-by-spigot combinations, also tees, wyes, couplings and O-ring bell adapters. Now made of ABS, fittings will be offered in PVC in 1970.



NO KNIFE IS NEEDED to cut this insulation. Johns-Manville's new Snap/Pak fiberglass insulation comes in rolls perforated so they may be snapped apart into batt lengths. Faced with either foil or kraft paper, packages are labeled to show the R (resistance) value for specific part of room insulated. At building supply dealers and lumberyards.

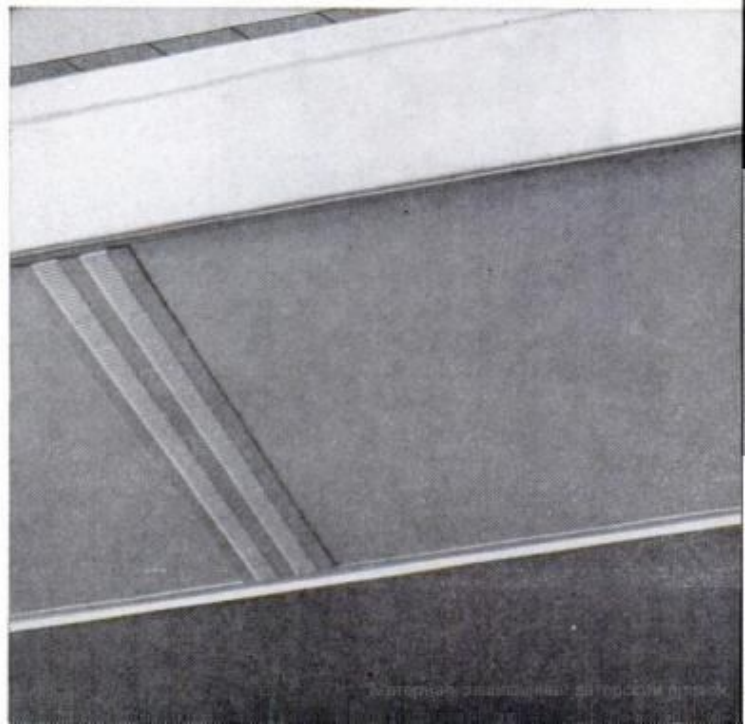


WEAR RESISTANCE superior even to marble is the boast made for this space-age parquet flooring. Called Gammite, the irradiated wood has natural beauty of a fine hardwood floor, requires no waxing or varnishing. Each flexible square contains seven narrow strips held by wires set in dadoes in bottom. Radiation Machinery Corp., Route 46, Parsippany, N.J.



WOULD YOU BELIEVE it's a wall fan? Flush-mounted on the inside, Model 8150 projects outside less than an inch. The smooth aluminum center panel can be left as is or finished to match room decor. Fan is concealed in walls 5 to 10 in. thick; outside louvers deflect air from wall. Nutone Div., Scovill, Madison and Red Bank Rds., Cincinnati, Ohio 45227.

FOUR SOFFIT COMPONENTS—angle molding, drip edge, flashing and plain and louvered soffit supports—made of heavy-gauge aluminum, provide a complete soffit system when used with Vinyl-Bond, rough-sawn Philippine mahogany or other Insulite siding. In factory-finish white, guaranteed for 10 years. Available at building materials suppliers. For illustrated brochure, write Boise Cascade Building Products, Box 7727, Boise, Idaho 83707.



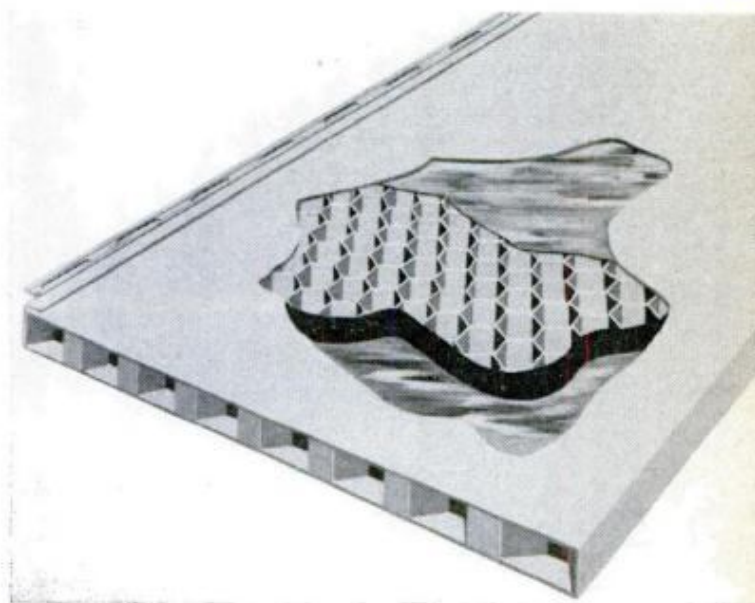


STAINLESS STEEL TUBULAR FITTINGS now come in 28 different styles. Sizes range from $\frac{1}{4}$ in. o.d. with an .025-in. wall thickness up to $1\frac{1}{2}$ in. o.d. in an .049 thickness. Styles include both male and female endings, a combination of the two, and special swivel endings for use with the flare-type union. Truly Tubular Fitting Corp., Mount Vernon, N.Y.

RADCLIFFE WATER CLOSET features a ventilating device installed in tank and operated by lifting the flush handle. This starts water flowing through a venturi tube and negative pressure created draws air from bowl, through rim punching and vents, into outlet of bowl. Venting stops when toilet is flushed. Crane Co., 4100 S. Kedzie Ave., Chicago, Ill.

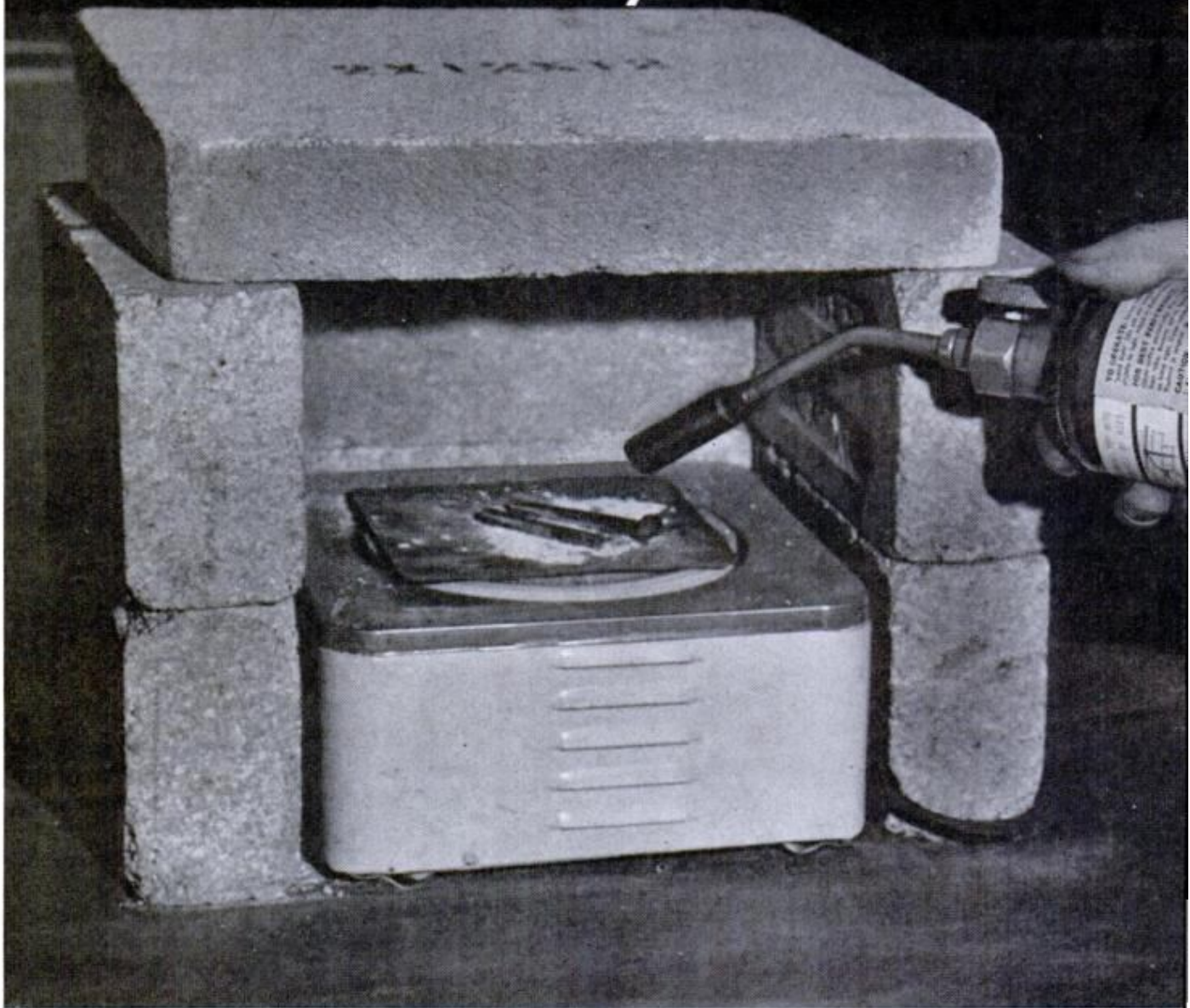


AN ATTIC SCUTTLE can now do more than provide access to the attic. A new light fixture from Emerson Electric Co., Box 22179, 6263 Randolph St., Los Angeles 90037, lets you retain easy access while providing two-way illumination plus a convenience outlet in the attic. Fixture uses three 60-watt lamps to light attic when you remove diffusing panel and flip top scuttle over into the attic. Cost: about \$30.

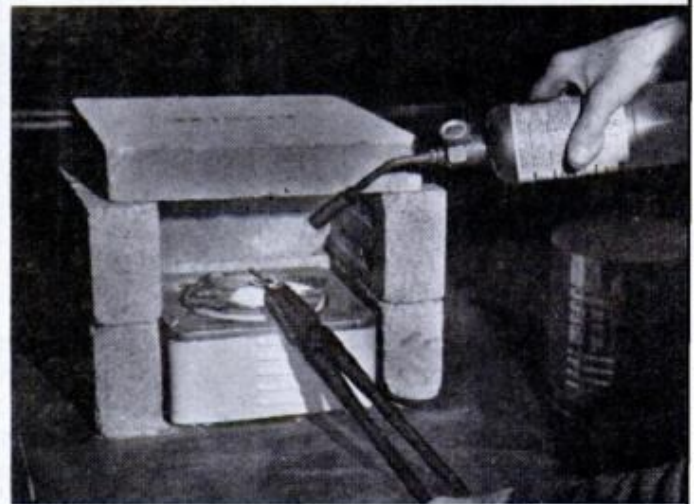


CUTAWAY DIAGRAM shows the construction of what is claimed to be the first pure vinyl siding with a honeycomb backer. Noncorrosive (the backer is like that used in space-capsule bulkheads), the siding also provides thermal and soundproofing. With color through plastic, material has high dent and fire resistance, eliminates painting. U.S. Aluminum Corp., 11440 W. Addison St., Franklin Park, Ill.

How to Anneal, Harden and



ANNEALING AND HARDENING TOOLS are furnace, torch, oil, dehydrated lime and pair of tongs. Asbestos can be substituted for the oven bricks if necessary



FLAME IS PLAYED back and forth until parts are cherry red, then parts are immersed immediately. Here, flame regains the heat loss caused by tongs

Temper Steel

It's no great mystery.
Using a simple furnace
you can do all
three in your shop.

By **FREDERICK W. SCHLUETER**
Master Machinist, Stevens
Institute of Technology

H EAT TREATING, the process of annealing, hardening and tempering steel, is actually a comparatively simple operation. All three steps can be done in your workshop. Since these procedures are not hazardous and do not create obnoxious odors, there's no reason why your shop shouldn't have a heat-treating setup.

The basic needs are few and, from the investment angle, the small cash outlay will serve your needs for years.

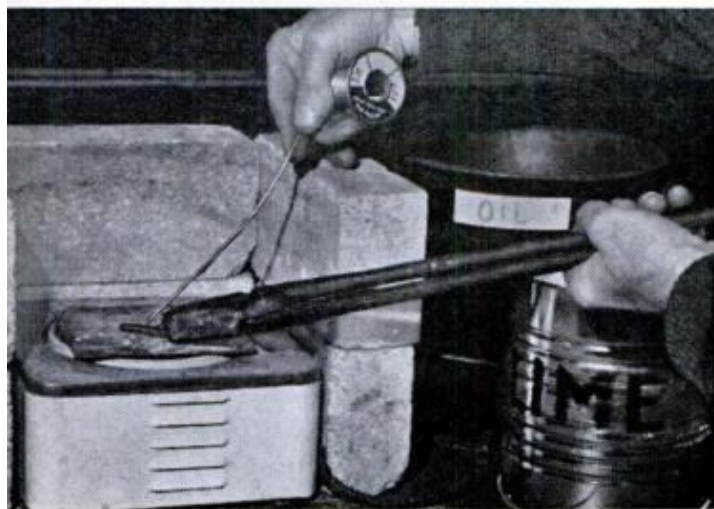
There are many annealing applications. You not only can soften steel but you can also relieve it of strains and stresses attributed to a variety of materials. Technically, the latter is a tempering process, but it is loosely defined here as annealing. For our purpose, annealing will mean just that: to make soft the metals you, as a home craftsman, will most often encounter. These metals could be working parts of locks, guns, screws, bolts, chisels and so on. By annealing, you make them workable; then by hardening, you put them back into their previous state.

To do it you need a furnace. You can improvise one from an old single-burner gas or electric stove by surrounding it with yellow firebricks to make an enclosure. And, since the heat requirements for both annealing and hardening are about 1450° F. you'll also need a small torch. A propane-gas torch will do nicely.

To insure an even heat from the burner and a spot to rest your work on, cut a small piece of sheet steel to rest on the burner. This can be square or round, but drill a couple of small holes to encircle the part placed on it. This part prevents burning of the steel, causing a loss of carbon.

If you lack a thermometer, you can rely on color sequences as a guide to temperatures. If you observe closely, after placing a piece of steel on the furnace plate, you will see an array of colors developing.

Since the colors are important guides, you should know them. Though there are



TEMPERING TECHNIQUE. Punch is tested with piece of solder for correct drawing of heat. Solder begins melting and starts flowing at approximately 400° F.

a number of specified colors (see chart) you need only to memorize three that apply to annealing, hardening and tempering. They are light cherry red—both for annealing and hardening; straw color for tempering and cherry red. The latter occurs at 1450° while light cherry red is about 1500° —the limit for proper carbonization. The reading for straw yellow is 460° which is the correct temperature for drawing (this reduces the brittleness caused by hardening). Variations from slate-gray to deep-blue cover a range of about 200° ($400-600^{\circ}$) and each indicates a 10° difference.

For annealing you'll need some dehydrated lime in which you immerse a treated part for cooling. A 5-lb. bag, obtainable at hardware stores, should be adequate to serve all your future needs.

Slowly heat the piece, shifting and turning it to prevent burning, then grip it with the tongs and play the flame of your torch back and forth to reach the critical moment of light cherry red. Then, quickly submerge it in the lime. Make sure it is well covered on all sides and do not dis-

turb it until it is fully cooled (at least five or six hours). The annealing process is completed.

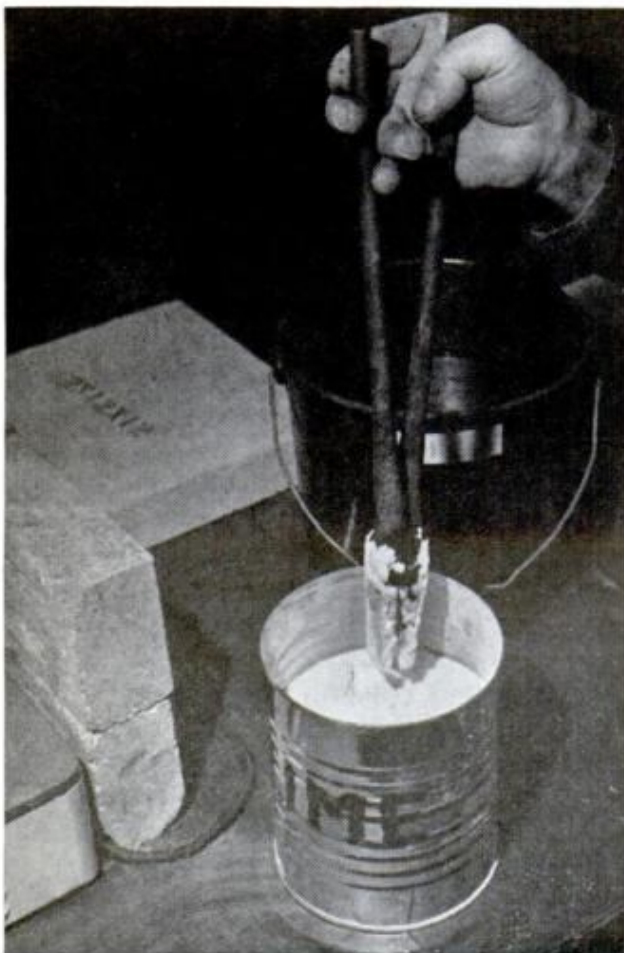
The art of hardening, developed centuries ago, was a closely guarded secret of the skilled, ancient practitioners—and passed on only to their heirs. The technique is common knowledge today. And, if instructions are carefully followed, it is failureproof.

Have on hand about 1 gal. of quenching oil, enough to cool your metal without undue overheating of the oil. The procedures for hardening are much the same as for softening (the same degree of heat is required) except that instead of lime, the part is immersed in the oil and constantly agitated. Swishing it in a figure-eight motion will cool it evenly and in about five minutes the part can be removed.

Here are a few points to remember. Grip the steel only at those points where hardness is not critical—the spalling end of a chisel, for example. And, to insure the hardness of the critical parts, quickly immerse those sections first. If both ends are important, grip the middle and dunk the

ANNEALED PARTS are immersed in lime mixture after heating to required color. A part should be fully covered with lime, left to cool for five or six hours

TEMPERED PARTS are plunged in quenching oil, take less time to cool. Heated part should be swished around in figure-eight fashion until completely cooled



part horizontally. *Speedy immersing is important.*

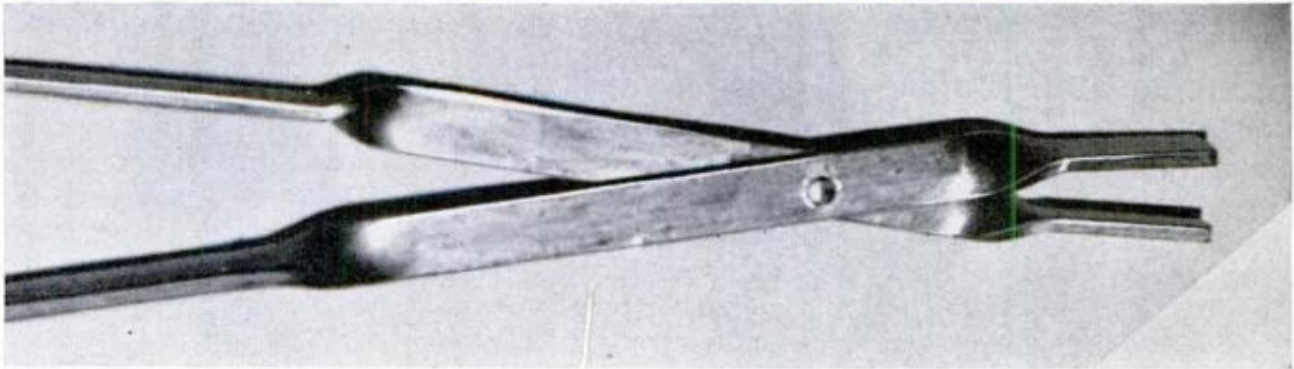
Done properly, the piece will look like mottled slate—indicating scale. This is good but it has to be polished-off before tempering. To test its hardness, run a three-cornered file over the edge. If it sings, you know it is hard, and your file will not scratch it.

Tempering is the final step. As it is now, the part is *too hard and brittle* and will break under the slightest strain. It therefore requires tempering.

For this, the furnace serves again, but without the bricks that roofed it for the first two steps. First, polish the piece to a

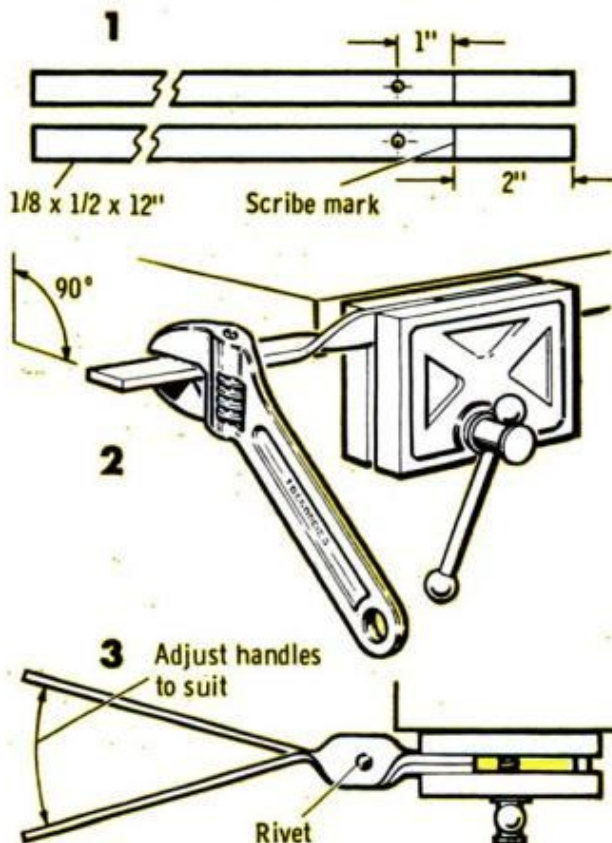
whiteness, using emery cloth; this lets you distinguish the color changes. Next, place it on the burner plate without disturbing it further. Unroll a safe length of solder and play it back and forth on the piece. (No torch is needed if the part is small). Watch the color as the piece changes from gray to yellow. Be prepared to grip the piece with the tongs when the solder starts melting. The moment it reaches straw-yellow, quickly immerse it in oil.

Again, speed is important to prevent heat loss. Though somewhat less time is needed for cooling, follow the procedure of constant agitation when cooling. ★★★



TO MAKE TONGS, scribe both pieces of metal for bending and drill the rivet holes. Clamp the metal in a vise and bend the jaws and handles, using a wrench. After riveting the pieces together, vise the jaws and adjust the handle spread to suit. For protection from heat, the tongs should be at least 12 in. long

HOW TO MAKE TONGS



COLOR HEAT SCALE

COLOR	DEGREES
Dark Gray	400
Medium Gray	410
Light Gray	420
Very Pale Yellow	430
Light Yellow	440
Pale Straw Yellow	450
Straw Yellow	460
Deep Straw Yellow	470
Dark Straw Yellow	480
Yellow Brown	490
Brown Yellow	500
Spotted Red Brown	510
Brown Purple	520
Light Purple	530
Full Purple	540
Dark Purple	550
Full Blue	560
Dark Blue	570
Very Dark Blue	600
Cherry Red	1450
Light Cherry Red	1500
White Hot	1700

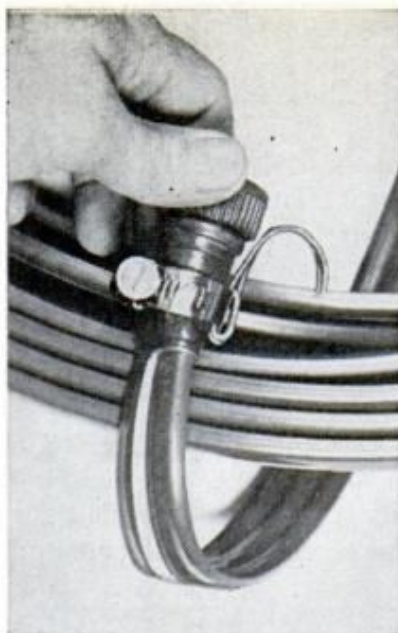
HINTS FROM READERS



Accurate straightedge

The next time you have to trim a few inches off the long edge of a piece of plasterboard, don't throw the scrap away. Kept handy in the workshop, it can be used whenever you need a straightedge for laying out a job. The sheets are factory-formed with a finished edge that can be used for any carpentry job. If used to cut plasterboard, move the knife carefully.

—Herbert Y. Moon



Anchor for soaker hose

To correctly position a soaker hose with its perforations topside where they ought to be, you have to walk the length of the hose, bending frequently. But, if you attach a hook as shown with a hose-clamp, you can anchor one end then simply tug on the other end, twisting the hose as necessary, to align the holes. The anchor holds firmly and allows easy repositioning.

—C. W. Gaston



Discharge extension

Recently, when my wife threw away her worn-out hair dryer, I salvaged the hose for use in my shop. Fastened to the elbow discharge on my radial-arm saw, it directs sawdust away from the workpiece and my face. Use either plastic or electrician's tape on the fitting and guard to hold the hose securely out of the path of the traveling saw and blade.

—Arthur L. Ramos

NEXT MONTH IN SHOP AND CRAFTS

TINY TRAINS HAVE MADE THE GRADE. Needing only one-fourth the space of HO, the new microgauge trains have taken model railroaders by storm. Being so small, they let you build and operate a complete railroad empire in a minimum of space. A two-part story beginning in January shows you how to start setting up an N-gauge system by first building a space-saving, swing-up train board.

A SPIRAL STAIRWAY YOU CAN BUILD. Though circular stairways have always been popular, high cost has kept them out of most homes. Ingeniously designed, here's our version which can be built by a do-it-yourselfer for less than \$60. Pick up a copy of the January *PM* and see for yourself.

A CABINET FOR YOUR GUNS. This beautiful glass-front, oak cabinet in Mediterranean styling will hold up to six guns with plenty of storage below for ammunition, scopes and cleaning tools. If guns are not your cup of tea, the cabinet can be fitted with shelves and used to display your prized china, trophies or bound volumes. Complete details for building the cabinet are in the January issue.

BUILD A BUMPER-POOL TABLE. Playing bumper pool is just plain fun. And, since the entire family can share in the enjoyment, the game has taken the country by storm. To get *PM* readers in on the fun, we've designed and built a table that's easy to copy. It's in next month's *PM*.

PLUS: A Mini-Motor Bike, Lathe Angle Post, and more, much more.

new breed of scat

The Bobcat, from Evinrude



Evinrude driver takes the Bobcat over a test jump. (Leave this to the "pros" — it's tricky.)

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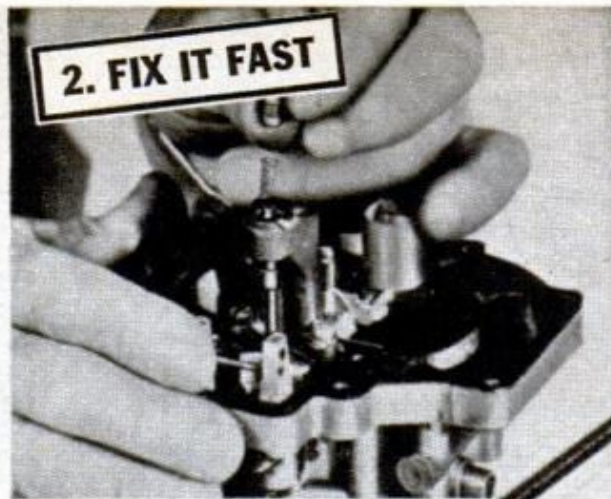
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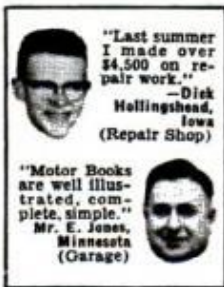


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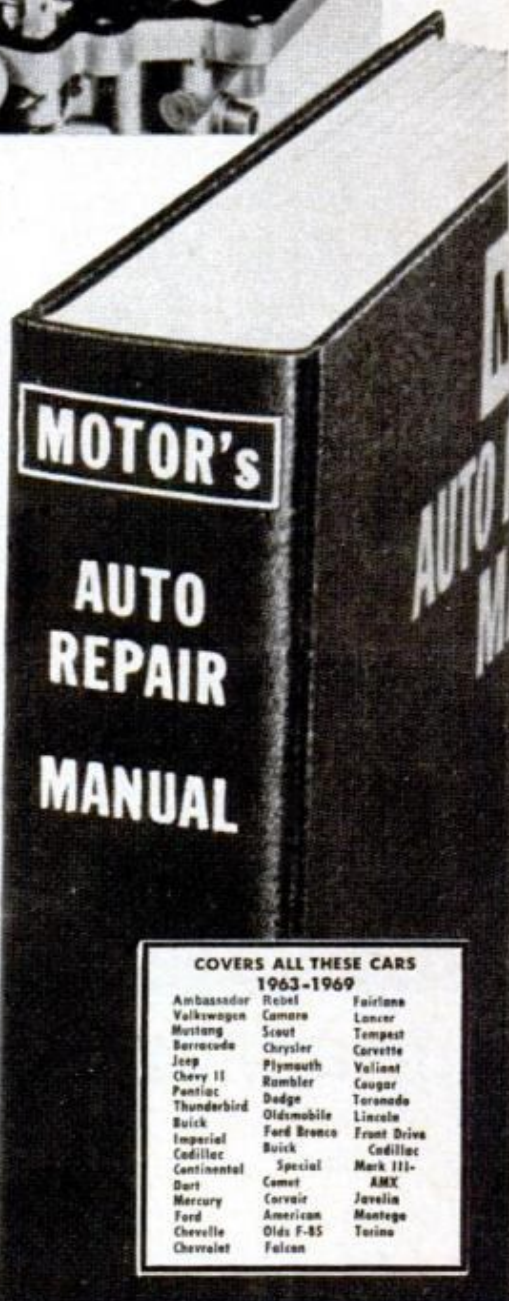
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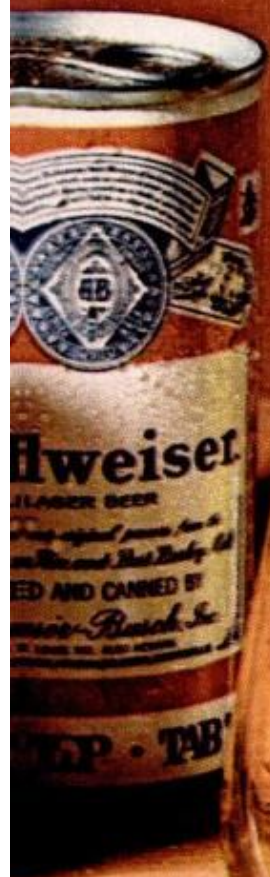
Busy body.

Would everybody
taste the difference
if we stopped
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Bud tomorrow?



Shown above: beech wood ... the kind used in
Beechwood Ageing, the exclusive process that
gives Bud the taste, smoothness and drinkability
you find in no other beer of any price.

(Well . . . maybe not everybody.)



FIRST OF A GREAT NEW BREED

(Continued from page 111)

back in the early '60s when it competed with Lockheed for an Air Force contract to produce a long-range, big-capacity transport. Lockheed won the competition, and its huge C-5A is a reality today.

Boeing then turned its thoughts to the passenger-plane market, hoping to make use of the expensive research and development already carried out. The manufacturer became convinced that there was a need for a big subsonic craft in the long-haul market and that the plane would still be needed when the SSTs came into service in the '70s. The first Concorde models are designed to carry only 132 passengers, compared with the 490 maximum capacity of the 747. (Pan Am's seating configuration allows for 362 passengers.) Boeing also thought in terms of the big bird functioning as a cargo ship, another reason for its size.

With a go-ahead decision made, the 747 reached formal project status in March,

Laser beams make sure that long parts go in straight into jumbo freight cars

1966. A month later Pan Am announced the purchase of 25 of the superjets.

The history of the 747 is also a history of meeting and solving big problems. One hurdle had to be faced immediately: where to build the monsters. Boeing bought 780 acres in Everett, 30 miles north of Seattle, and built a \$200-million manufacturing facility that includes the world's largest building, even more spacious than the huge Saturn assembly building at Kennedy Space Center. Used as a manufacturing and assembly facility, the building encloses 160 million cubic feet. It is so vast that some workers use bikes to get around.

But before the plant could be put up, Boeing had to build a three-mile rail spur to the site. The spur climbs a 5.6 percent grade, making it the second steepest stretch of standard-gauge track in the country.

Structural parts of the plane are manufactured in many sections of the country and shipped to Seattle for assembly. This operation was hampered in the beginning because the parts were so huge. Standard-sized freight cars could not carry the larger parts, so special oversized cars had to be made. And even loading these jumbo cars is tricky. Tolerances are so fine that

laser beams are used to make sure that long parts go in straight. Crooked loading could result in damage.

Boeing's decision to build the 747 has stood up. At this writing, over 180 orders from the world's major airlines are on the books. With 33 of the big birds on order, Pan Am is by far the biggest buyer.

Though almost all the orders are for the passenger plane, a few have come in for the convertible (passengers and/or cargo) and the freighter versions, models that are sure to grow in importance as more goods are shipped by air. The freighter will be able to carry a maximum payload of 260,000 pounds for a distance of about 2900 miles, or 200,000 pounds nearly 4000 miles.

The convertible can be changed over from freight to passengers, or vice versa, in about 10 hours. Because special weight-adding equipment is needed to provide the versatility, the convertible will carry a somewhat smaller payload than the pure freighter. As a passenger plane, it will be able to carry 374 passengers, plus baggage and 40,000 pounds of cargo, for better than 5000 miles. These alternate versions will have engines with slightly more thrust than the first 747s off the line.

The potential of the 747 doesn't end there. If the future passenger market really booms, the big plane could possibly be expanded by stretching the fuselage 50 feet or by running the second deck—now long enough to contain only a lounge in addition to the cockpit—almost all the way back to the tail. The expanded plane could carry as many as 700 passengers.

But even if that never comes to pass, one thing is certain: While the bugs are being worked out of the SSTs, the 747s and other big subsonic birds will be busy carrying record numbers of people all over the world. ★★★

NEW MINI-STROBES

(Continued from page 131)

the camera for open-flash pictures. In this case, there is no connection to the camera at all. You open the shutter, flash the strobe by pressing a separate button on the unit itself, then close the shutter. Most minis have a flash-test button on the back that can be used for this purpose. While the technique is limited mainly to still-life scenes, it can produce some interesting effects. You can, for instance, flash the strobe several times in succession with the shutter open to "paint" a scene with light that's too large to be covered by a single flash. ★★★



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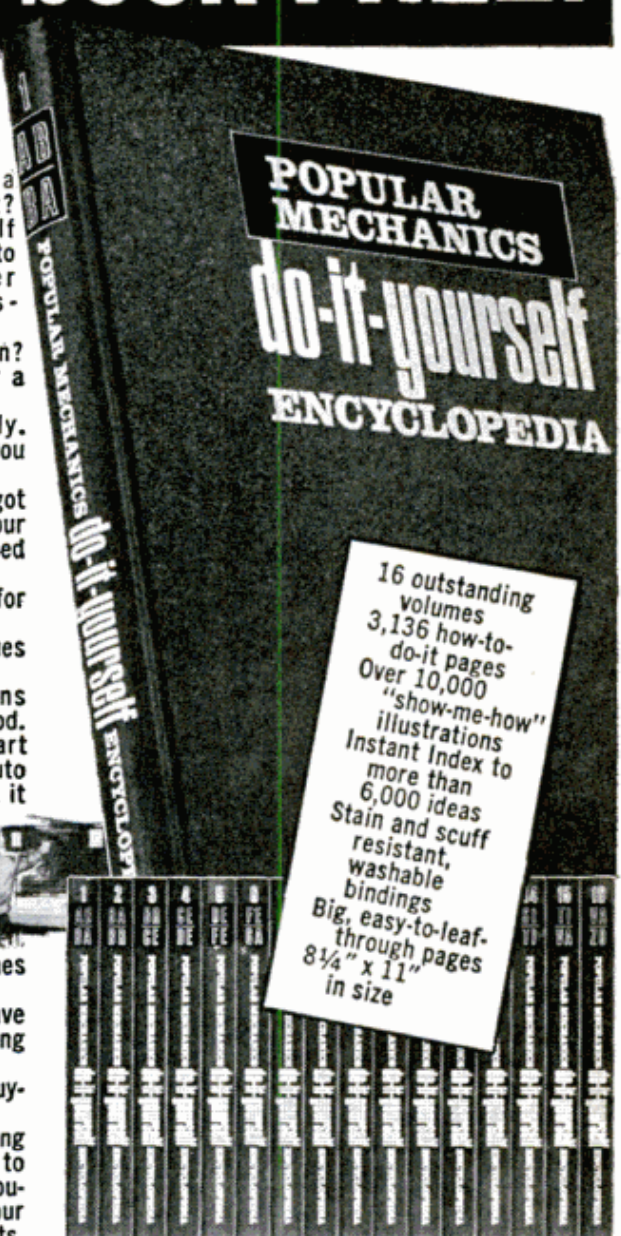
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SMILE! YOU JUST GOT A TICKET

(Continued from page 76)

habitual leadfoot. Maybe they'll ignore the guy who's doing only a few mph above the limit. In any event, Orbis won't be accused of favoritism, inaccuracy, or bad manners. Whether Orbis photos will be admissible in court as valid evidence remains to be seen, but there's no reason to doubt it. There's been no trouble with radar, and radar doesn't include a picture—only the officer's word.

Several other uses for Orbis have already come to mind. Businessmen hope it can tell them where to locate new shopping centers, billboards, filling stations, motels and the like. Also, by evaluating types of traffic, not just numbers, Orbis will aid in highway planning, traffic control, border patrol, surface maintenance, and even help spot stolen vehicles.

Surveys via Orbis might even bring about higher speed limits. As Dave Lee mentioned, "If by constant surveillance of a particular stretch of highway we find everybody is speeding, yet there aren't more accidents than normal, that might be good justification for changing the speed limit." So it isn't total gloom after all. ★★

FOUR-MILE TRAIN

(Continued from page 85)

lating trackage, which calls for one locomotive to pour on power while the other pinches down the wheels. To take care of that, both Locotrol and RMU offer the engineer independent control of the master and slave stations. But here he and his Brotherhood draw the line, maintaining that it is both hazardous and unreasonable to add this responsibility to his one-man-band routine.

There is a likely solution. Prior to radio control, experiments were made with less versatile slave locomotives in which a stress-sensing device measured the tug or slack at the forward coupler and actuated the throttle and brake valve accordingly. Diplomatically, a similar triggering mechanism could and probably will be tied into future slave-station setups.

Sad to say, that will only hasten the day of the fully-automated freight train. Then who will acknowledge a small boy's trackside wave? ★★★

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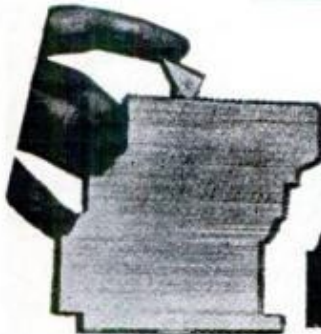
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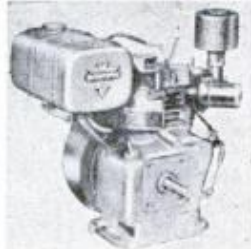
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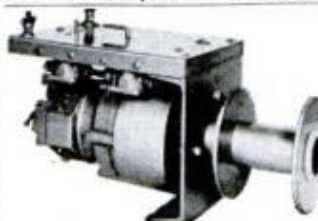
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DODGE'S NEW PONY CAR

(Continued from page 99)

though it can cause a surprise until you get used to it. I honked it several times—at the wrong time.

Dashboard instruments and controls are fine, all logically placed. You can have full instrumentation with the rallye cluster or go with the standard setup. I'd like to see a combination of gauges and warning lights, however. That way the light would signal trouble and the gauges would let a driver know just exactly how everything was going under the hood.

The four-speed transmission control sports a handgrip rather than the usual knob. It's close at hand to the driver, and I really like the new grip coupled to the Hurst linkage.

Noise level within the car is moderate. What noise there is is a combination of exhaust and air-cleaner sounds. The 340 V8 has a low restriction filter and a pair of low restriction mufflers. But I sure wouldn't call it an offensive sound. Personally, I enjoy hearing a bit of "music" from a thoroughbred powerplant.

Trunk room is surprising. A collapsible spare is used and it takes up very little room. The bumper jack is held in place with a spring to keep it from rattling. The fuel fill pipe, which can and should (I think) have the optional lock, barely intrudes in the trunk area. That right-side gas fill will be appreciated by anyone who's ever run out of gas and had to tip a gallon can into a left-side filler while traffic rushed by. Taillight bulbs are replaced from underneath the pods inside the trunk. They're put there to keep from being smashed by anything in the trunk.

You don't have to read between the lines to know I'm impressed with the Challenger. I like a lot of cars, and now here's another to add to my list. I can't get over how well this one handles. The small-block 340, combined with a decent suspension, really gave me a good ride. The Challenger seems to have a great deal of personality. It can have a lot of different ones, since every engine from the small six-cylinder to the big 440-CID V8 can be put in the car. You can even install the racing Hemi 426.

Everybody looked at my test car while I was driving it, partly—I suppose—because of its good looks, and partly because of its brilliant Lime-Fire paint. Most of the people who really took a close look weren't old, but they weren't real young either. That's probably a good sign. It made me feel sort of "in." At least it made me very sure this car is no retirement-village special. It's everything but that. ★★

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CARE OF SNOW THROWERS

(Continued from page 122)

because of looseness can easily be damaged. Finally, place a drop of lightweight machine oil on the governor, throttle and choke linkage pivot points to keep them working free and easy, despite the cold weather.

The chart on page 123 will help you troubleshoot typical engine problems. Usually, the cause is minor and easily corrected.

Sometimes, however, a major component, such as the carburetor or magneto needs repair or replacement. How can you tell which one is the culprit? If none of the simple cures proves successful, remove the sparkplug after priming the carburetor and see if the tip of the plug is wet with gas. If it isn't, the hangup is somewhere in the fuel system, probably the carburetor. This should be disassembled and soaked in kerosene. Replace the needle, seat and gaskets with new parts.

If the tip of the plug is wet with gas, the problem is probably in the ignition. To make sure, hold the plug 1/4 inch away from the side of the cylinder or other grounded part and pull the starter rope. If a spark doesn't jump the gap, the magneto needs attention.

Magneto needs special tools

Magneto work requires some special tools, such as a flywheel puller so you can remove the flywheel and get at the magneto inside. Such pullers usually cost about \$10, but you may be able to rent or borrow one for a day.

If you can reach the magneto, you can replace the points and condenser—the two most likely sources of trouble. These parts can be obtained from a dealer who stocks replacements for your make of engine or thrower. Gap the points according to the manufacturer's specification. You'll also have to set the timing. Instructions for doing this are usually included in the owner's manual.

If you don't want to bother trying to remove the flywheel, this is the time to make a trip to the repair shop. You will at least have saved some of the repairman's time by localizing the problem for him. If you should find that both the fuel and ignition systems are okay and the engine still won't run, the cause is probably inside the engine itself. Have it compression-tested to determine if it meets the specs for your engine. If it doesn't, an engine overhaul is in order. This may involve new piston rings, valve grinding and possibly a reboring job on your cylinder.

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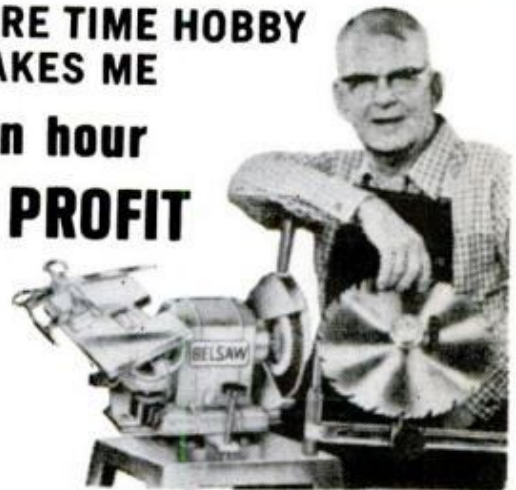
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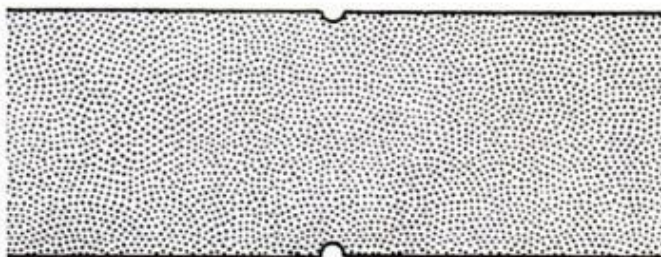
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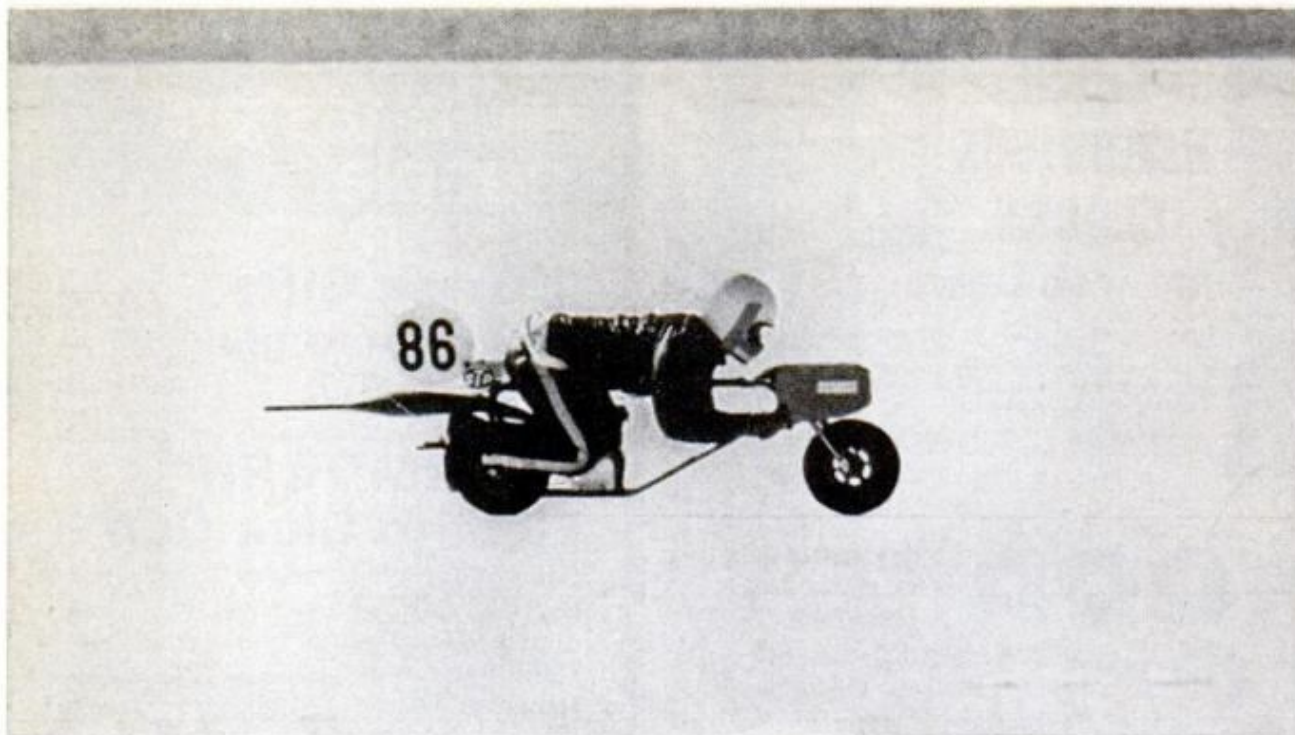
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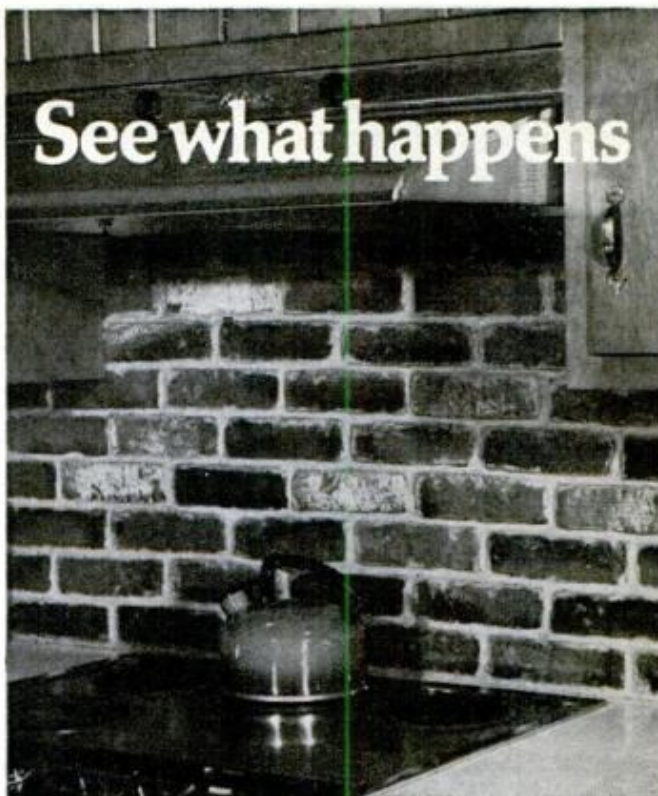
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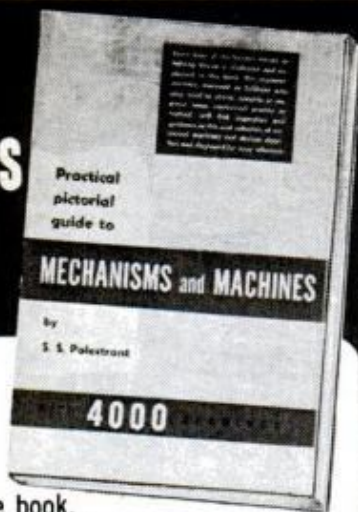
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CANADA JOINS THE ROTARY CLUB

By MICHAEL LAMM

Photos by the Author

PM tests the first Wankel engine production car to reach North America and finds it smooth, quiet and economical

I FLEW UP TO VANCOUVER this fall to drive Mazda's new R-100 coupe—the first twin-rotary production car ever to reach the Western Hemisphere.

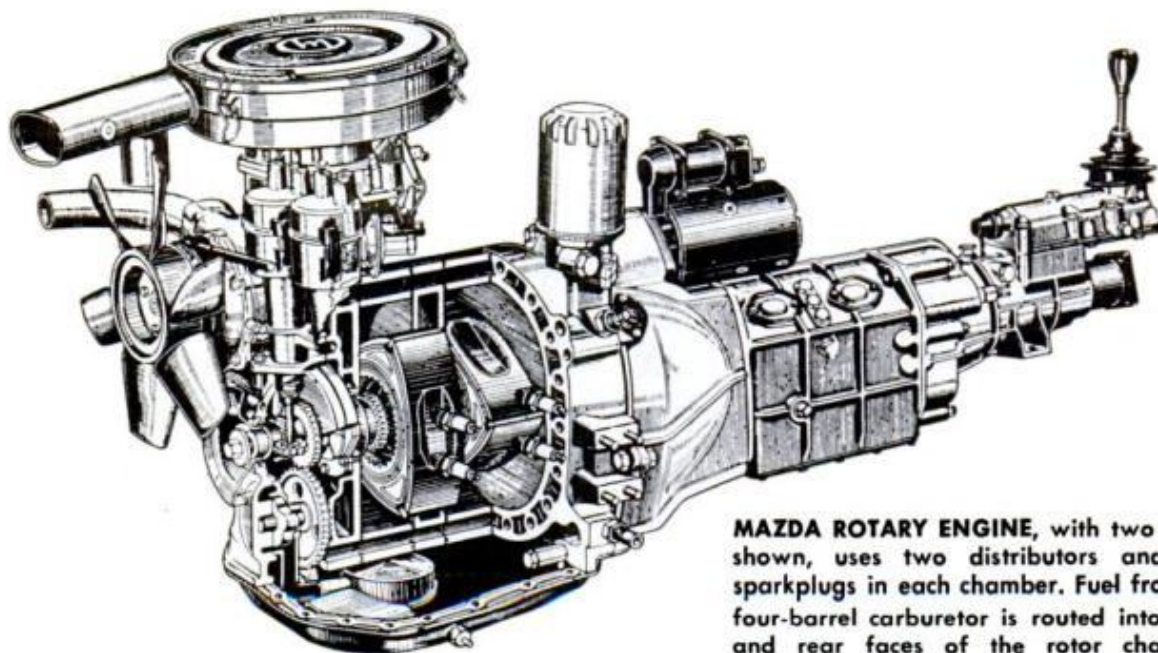
The Wankel-powered Mazda R-100 is just starting to enter Canada. Mazda hopes to begin selling rotaries in the States soon. It remains for its engineers to bring emission levels down to U.S. standards.

The R-100 coupe weighs only 1775 pounds and its 110 horses give it plenty of kick. The engine idles with such extreme

smoothness and silence, it's hard to tell when it's running. Blipping the throttle makes the rotary give out with a purring sound, like a well muffled two-stroke but without annoying back-popping.

The first generation of Wankel-engined cars, represented by the NSU Prinz of 1961, wouldn't idle worth a darn. One reason the Mazda rotary idles so smoothly is that it has twin ignition. The engine uses two distributors and two sparkplugs

(Please turn to page 210)



MAZDA ROTARY ENGINE, with two rotors shown, uses two distributors and two sparkplugs in each chamber. Fuel from the four-barrel carburetor is routed into front and rear faces of the rotor chambers

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CANADA JOINS ROTARY CLUB

(Continued from page 208)

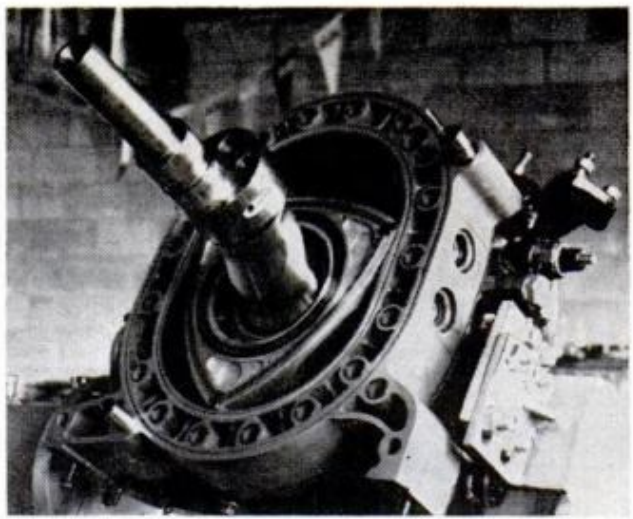
in each combustion chamber. This is because, as rpm increases, the actual position of the combustion chamber inside the rotary engine *moves*. So there's a leading and a trailing plug to catch up with this movement. Both fire simultaneously, one for low rpm and one for high.

The rpm characteristics of this engine take some getting used to. The Mazda rotary's power surge starts coming in strongly at about 2000 rpm and keeps climbing to red-line at 6500. If you tromp the gas and hold it there, power increases as speed increases. The R-100 goes from 70 to 90 mph in 15.1 seconds. Yet 80-90 takes only 5.8 seconds, so you can see where the surge comes in.

Since this engine has no valves, therefore no valve float, it would keep revving higher and higher until it blew itself apart. At least it would if there weren't a safety system built into it. A warning buzzer sounds at 7000 rpm, and at the same time the secondary barrels of the four-barrel carb automatically shut themselves.

This brings us to one more reason for the R-100's smooth idling and general engine flexibility: The intake ports are routed into the front and rear faces of the rotor chambers, not into the edge as in the old NSU. NSU's Prinz was plagued with rough idle and lack of power at low rpm; Mazda's R-100 isn't.

Oil consumption is no problem with the R-100. Sealing technology has advanced considerably since the Prinz's day, and normal consumption for the Mazda is about a pint every 1200 miles. However, the sump, oil cooler and filter hold only 5.5 quarts and recommended oil changes



ONE CHAMBER OF TWIN ROTARY (second is mounted in front of this) showing surrounding water jacket. Water passages are between round holes for studs

are every 2000 miles. The R-100 has a separate oil cooler just below the radiator.

The Mazda coupe, with its engine up front, uses a conventional and very smooth wide-ratio, all-synchro four-speed gearbox. This transmission proved relatively quick-shifting and unquirksome. The small amount of stick sloppiness came from indirect linkage, but you notice this only in full-bore acceleration.

My acceleration figures are fairly representative of the R-100 in normal tune, with street equipment, some cargo, and on a typical road. At that, 0-30 mph came up in low gear alone in 4.6 seconds, while 0-60 demanded two shifts and a very respectable 12.2 seconds.

The R-100's ride is amazingly gentle and quiet. There's the usual choppy rock and roll that any short-wheelbase car suffers. The R-100 hangs into long, sweeping curves

(Please turn to page 212)



COCKPIT LAYOUT has 8000-rpm tachometer left of speedometer. All other gauges, switches, radio and shift lever are in central pod. Wheel is real wood



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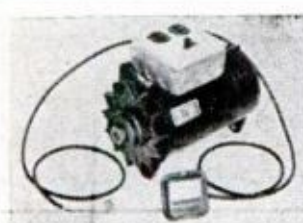
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CANADA JOINS ROTARY CLUB

(Continued from page 210)

and the standard Dunlop radial tires help quite a bit. They squeal a lot but absolutely refuse to slideslip on dry pavement. Cornering remains flat, very neutral and completely predictable.

Suspension uses MacPherson struts up front. The entire shock assembly becomes a kingpin and rotates with the steering knuckle (as well as doing up-and-down chores). There's a heavy stabilizer bar up front, and that helps keep body roll to a minimum. Around back, springing is conventional, by leaves.

The R-100 uses disc brakes in front, with drums in back. I wasn't able to fade them, even on repeated downhill stops. My only objection in the brake department was that the pedal pad is too near its suspending arm.

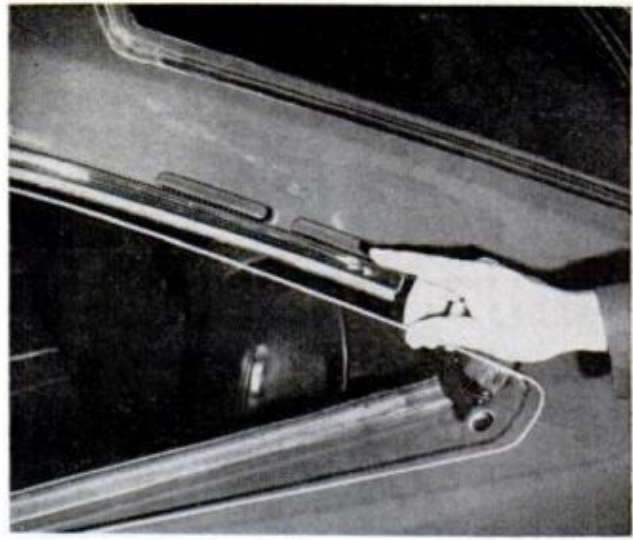
The rotary engine offers several advantages:

1. *Lightness*—the R-100 Wankel weighs only 269 pounds complete, comparing favorably with, say, the Datsun ohc Four, which puts out 96 bhp and weighs 421 pounds.

2. *Compactness*—generally speaking, a rotary engine takes up about half as much cubic volume as a piston engine.

3. *Simplicity*—there's half the number of internal working parts (comparing a single-rotor Wankel with a one-cylinder overhead-valve piston engine—less than half with multi-cylinder engines).

Now, transcribing directly from my drive-test notes: "Instrumentation complete, readable. Seats comfortable, tiltable, almost infinitely adjustable. Fit and finish inside and out first-rate. Decor sporting a



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Overall fuel consumption came to 24.8 mpg, for which, considering that my driving included city, freeway, acceleration and braking tests, repositioning the car for photo-taking, and a good deal of just plain idling, I give the R-100 top marks in fuel economy. With a light foot, the conscientious driver should get 30-34 mpg easily.

The R-100 coupe sells for \$2929 p.o.e. Vancouver. I view this as a very fair price. In U.S. dollars, that comes to \$2709—even fairer. ★★★

SPECIFICATIONS AND PERFORMANCE

1970 Mazda R-100 coupe, Toyo Kogyo Co., Ltd., Hiroshima, Japan. Price: \$2929 (\$2709 U.S.) p.o.e. Vancouver, B.C.

ENGINE—Type: Wankel 2-rotor, in-line, water-cooled.

Bore and stroke: none.

Displacement: 59.6 cu.in. (491 cc each chamber).

Horsepower: 110 bhp @ 7000 rpm.

Torque: 100 ft.-lb. @ 4000 rpm.

Compression ratio: 9.4:1.

Valves: none.

Carburetion: Hitachi KCB-306 4-bbl., two-stage.

Fuel pump: Electric pulse-type.

Electrical system: 12-v. battery/coil, two complete ignition systems.

CLUTCH—Type: single dry plate.

Outside diameter: 7.874 in.

Actuation: hydraulic, pedal activated.

TRANSMISSION—Type: four-speed manual, floor shift.

Ratios: 1st, 3.737:1; 2nd, 2.202:1; 3rd, 1.435:1; 4th, 1.000:1; reverse, 4.024:1.

DIFFERENTIAL—Type: spiral-bevel, hypoid.

Final drive ratio: 3.7:1.

Drive axles: semifloating.

STEERING—Type: recirculating ball and nut.

Turns lock to lock: 2.25. Turning diameter: 27.2 ft.

BRAKES—Hydraulic, disc and drum, tandem master cylinders; disc dia. (front), 9.6 in.; drum dia. (rear), 7.9 in.

CHASSIS—Front suspension: independent by MacPherson strut with high-mounted coil spring, hydraulic shock absorber, single lower suspension arm with lower ball joint.

Rear suspension: longitudinal semi-elliptic leaf springs, hydraulic tubular shock absorbers.

DIMENSIONS—Wheelbase, 89.0 in.; overall length, 149.0 in.; front/rear track, 47.0/46.0 in.; width, 58.2 in.; height loaded, 54.0 in.; ground clearance, 6.0 in.

WEIGHTS—Curb weight, 1775 lbs.; engine, 269 lbs. Total test weight, 1925 lbs.

CAPACITIES—Crankcase, oil cooler, filter, 5.5 qts. Cooling system, 14.7 pts.; gas tank, 15.85 gal.

PERFORMANCE—Acceleration: 0-30 mph, 4.6 sec.; 0-40, 8.3 sec.; 0-50, 10.1 sec.; 0-60, 12.2 sec.; 0-70, 16.8. Max. mph in gears: 1st, 27; 2nd, 54; 3rd, 83; 4th, 112.

FUEL CONSUMPTION—Test, 24.8 mpg; range, 22-34 mpg.

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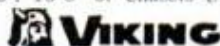
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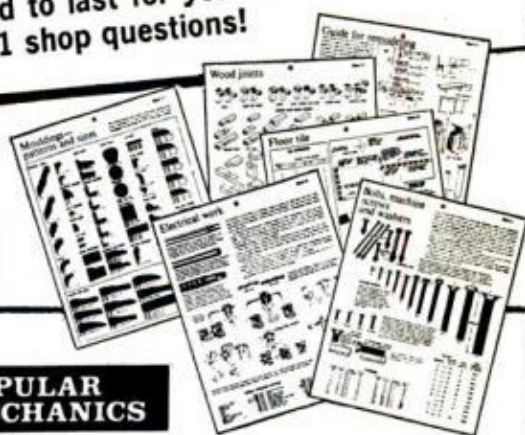
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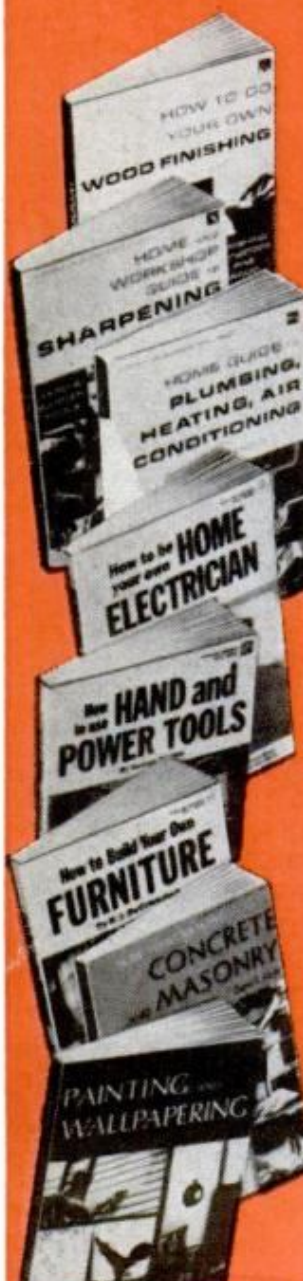
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*ANSWERS 1. lever 2. pulley 3. wheel-and-axle 4. inclined plane 5. wedge 6. screw

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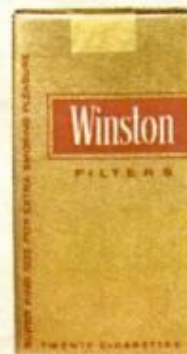


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