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FORD FIESTA:
After 1/2 million miles,
owners say it's great!

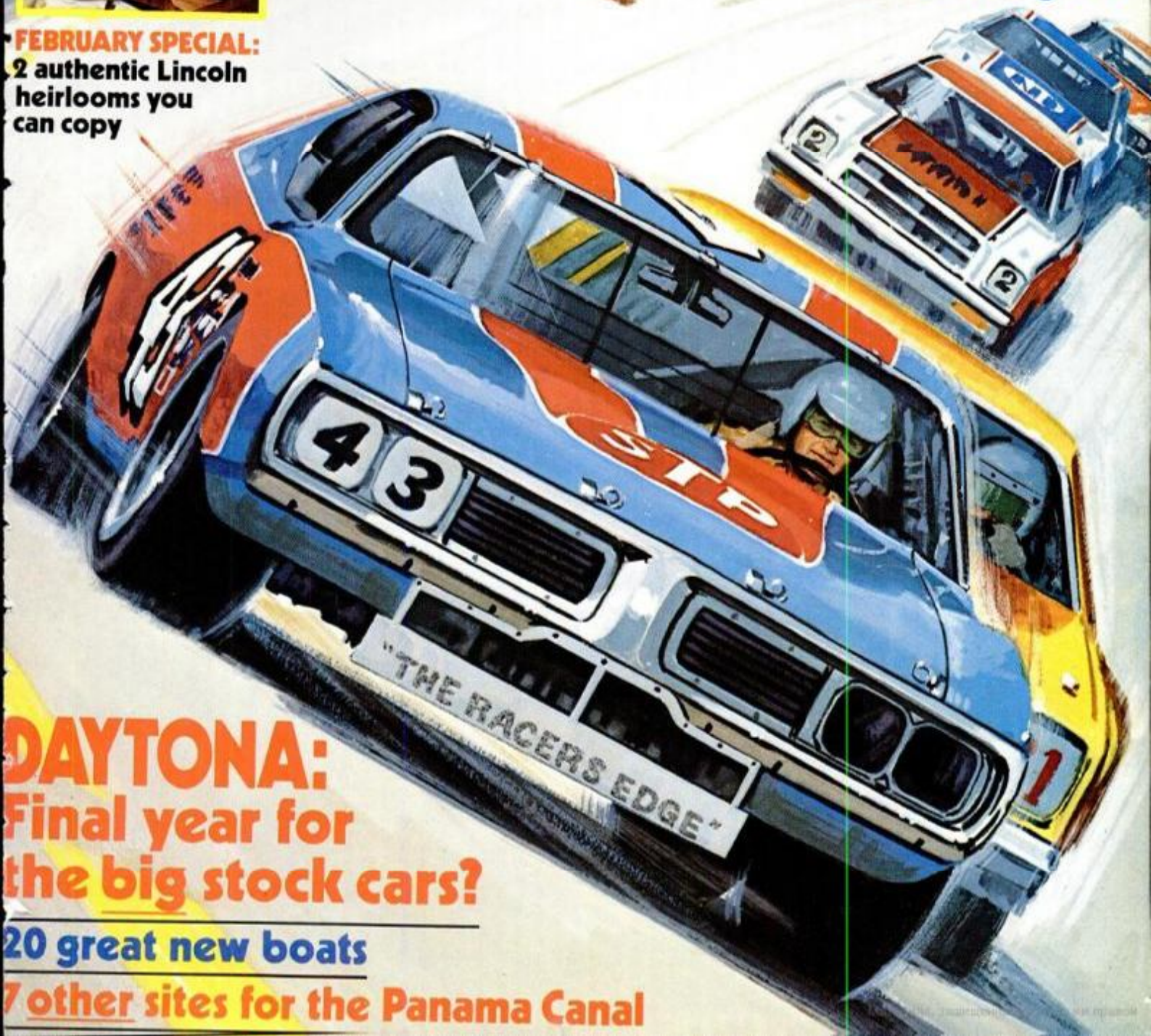
FLYWHEELS:
Super push
for motors

7 EXCITING PROJECTS

- Homemade 5¢ chisels
- Radial-saw bench
- Handsome hang-ups
for sports gear



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2 authentic Lincoln
heirlooms you
can copy



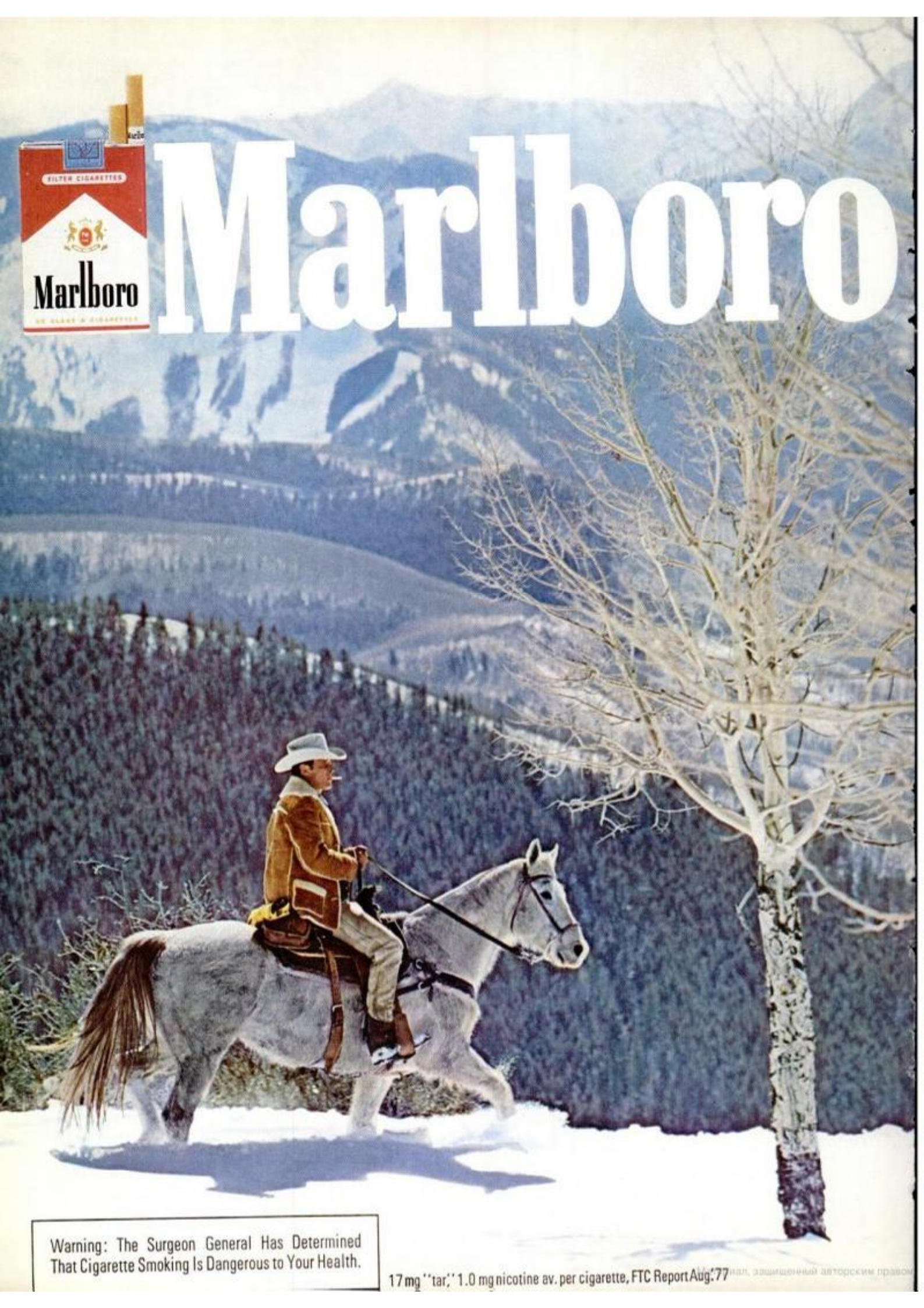
DAYTONA:
Final year for
the big stock cars?

20 great new boats

7 other sites for the Panama Canal



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Tilt-wheel steering makes me feel like I'm being treated like a lady when I get in and out of my new Grand Prix.

*Barbara Taylor
Denver, Colorado*

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**Saginaw Steering Gear Division
General Motors Corporation**



THE EQUALIZER



This One



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Popular Mechanics[®]

On the cover
This month's Daytona Speed Weeks and the rest of the season will see the big stockers in their last competition before Detroit down-sizing comes to NASCAR. But on-track competition is due to be stiffer than ever—page 86.
—Painting by Ed Valigursky



FEBRUARY 1978

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Looking for more ideas and information? See page 173.

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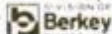
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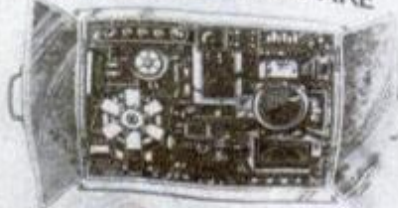
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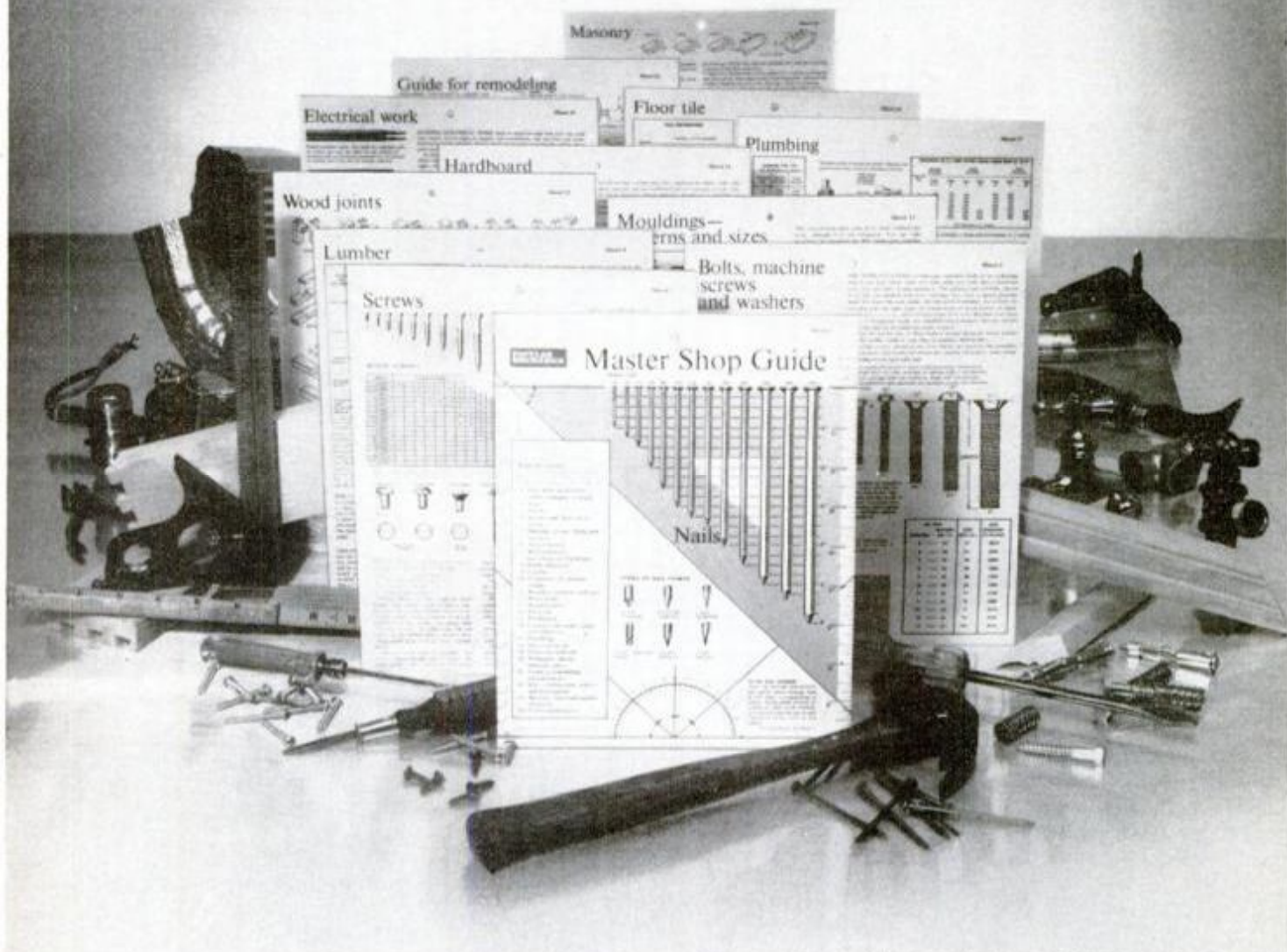
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LETTERS TO THE EDITOR

Putting Virginia on the map

The article *Giant Miners for a New Coal Age* (page 77, Oct. '77) proved to be very informative on how the coal industry is striving to increase its production across the nation. However, the map of the United States showing where our coal exists is very misleading and inaccurate.

Last year, the state of Virginia produced 40 million tons of coal and ranked sixth among the coal-producing states of our great country. According to your map, Virginia doesn't have enough coal to fire up a pot-bellied stove.

L. BLAINE CARTER
PRESIDENT
THE VIRGINIA COAL ASSN.

More on Chrysler Sure-Grip

Your advice on how to eliminate chatter in the Sure-Grip differential in Chrysler Corp. cars (*Car Clinic*, page 22, Oct. '77) was excellent and 99 percent correct. The part number for the Hypoil lubricant should read 3744994, and the new number for the silicone rubber sealant is 4026070.

Also, when the lubricant is changed, Chrysler now recommends adding a 4-ounce container of Mopar Hypoil Gear Oil Additive Friction Modifier (P/N 4057100) to assure required lubrication of the Sure-Grip clutch.

JOSEPH J. WALILKO
FAIRWAY DODGE
RIDGWOOD, N.J.

Too young to fly?

In *Spruce Goose—Pterodactyl of World War II* (page 83, Nov. '77), Capt. Charles Barton refers to Howard Hughes as a "famed World War I aviator." According to the latest edition of the *World Book Encyclopedia*, Hughes was born in 1905. At 10 to 13 years of age, he could hardly have been a pilot during WW I. He became famous as a pilot, according to the encyclopedia, during the '30s and '40s, but not as a military pilot.

LUTHER C. INGE
OKLAHOMA CITY, OKLA.

Reader Inge is correct. Though Howard Hughes was something of a boy wonder, even he wasn't precocious enough to become a mili-

tary pilot at 13. A gremlin in the editing process—not author Barton—is to blame for the error.

Calling all speed demons

Thanks for the great article on the human-powered speed championships (*Staying Under 55 mph—But*



Dr. Abbott and his record-breaking bike.

Not by Much, page 104, Sept. '77). One of the participants—Allan Abbott, a young physician from Dana Point, Calif.—recently retired from active competition (after breaking two world bicycle speed records).

He now offers a \$2500 prize to anyone who can break 55 mph in a human-powered vehicle. Any machine is legal provided there is no stored energy of any kind used. For further details on the Abbott Prize, readers should write to International Human Powered Vehicle Assn., c/o Chester R. Kyle, Mechanical Engineering Dept., California State University, Long Beach, Calif., 90840.

CHESTER R. KYLE
LONG BEACH, CALIF.

A timely medical report

It was interesting that *Science Worldwide* (page 14, Oct. '77) should carry a short article on the mucocutaneous lymph node syn-

drome. Our 11-year-old son contracted this virus in September and was an extremely ill child who required hospitalization. There is no known antibiotic to counteract the disease, as it has been impossible to isolate the virus.

Friends in Omaha, Neb., had read the article about four days before they heard of our son's illness. Thanks to PM, they were the only individuals we know, other than our doctors, who had ever heard of the disease.

MARILYN THIES
AMES, IOWA

A memorable gas bag

Better wrap reader Elroy Cormack (*Letters*, page 6, Nov. '77) in cotton batting—he remembers the ZMC-2 (*Big Boom in Gas Bags*, page 64, July '77). That makes him a *rara avis*.

The ZMC-2 was a wonderful craft and a workhorse of the anti-submarine patrol off the East Coast during World War II, which she survived in fine shape only to go to the airship breakers after the war.

They said she was in such fine condition that she could have continued to sail the skies for many years. According to the news media at the time, this inspired the remark by some Washington pundit that they would never build another because she lasted too long.

D. H. HOWARD
PONTIAC, MICH.

No more creamy complexion

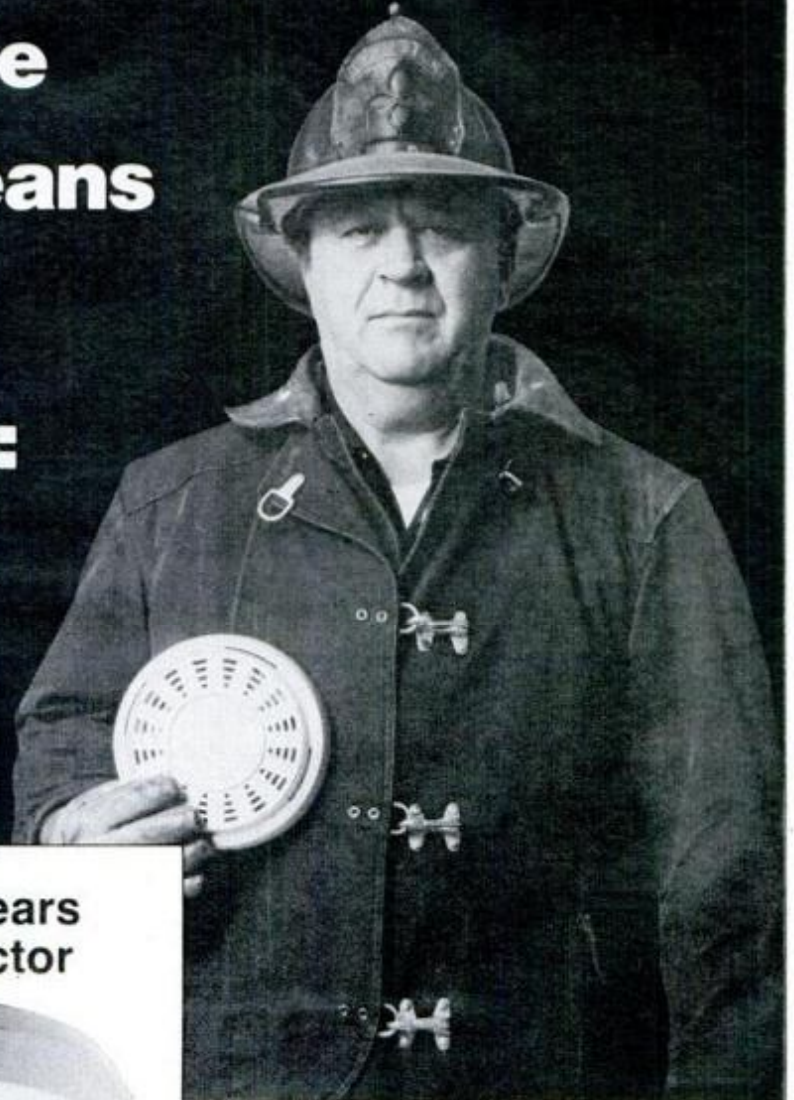
This is in reference to the *Car Clinic* letter (page 34, Nov. '77) in which a reader asked for advice on preventing the milky discoloration of the vinyl side panels on his new station wagon.

Armor All, made by Very Important Products, Inc., Newport Beach, Calif. 92660, works miracles on putting an almost new look to the milky vinyl panels on my family wagon. I didn't find out about this product until the buggy looked like I'd run over the milkman, so I can't vouch for its ability to keep new panels looking new. But it sure works like magic in taking the milky look out of the old.

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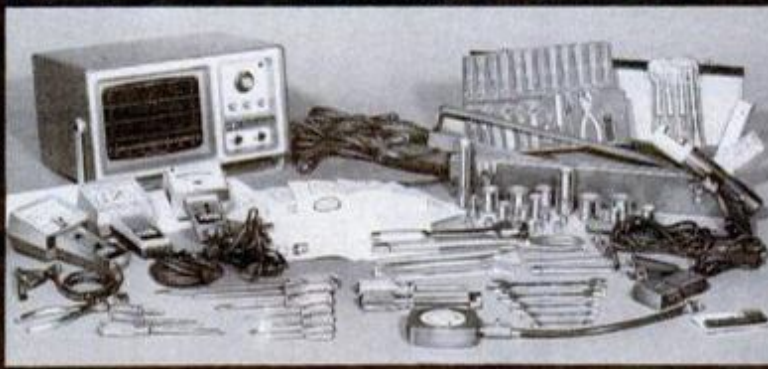
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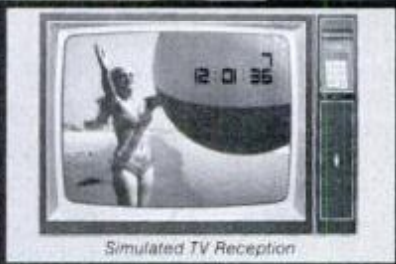
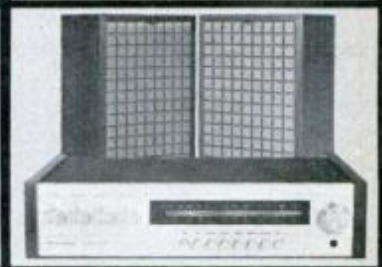
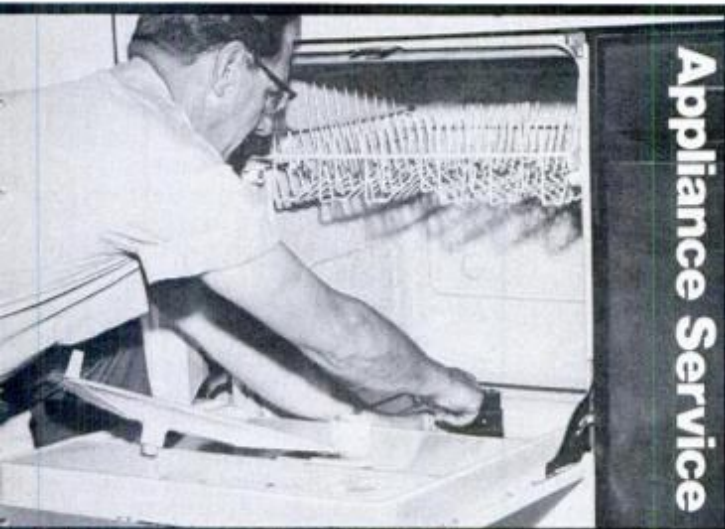
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Decision time

I have a Maytag automatic washer (Model A702), which is leaking oil. How can I repair it?—Thaddeus A. Rusiecki, Chicopee, Mass.

"What's wrong" is a damaged O-ring seal inside the transmission that has to be replaced, and here's the rub. Unless you know how to disassemble a washing machine and transmission you won't be able to do the job yourself. We asked Maytag for an off-the-cuff estimate for professional service. The job will cost you about \$100. The cost of a new machine comparable to the A702 is about \$400. The decision is yours.

Briny deep

Our Sears water softener, which is not quite three years old, doesn't seem to soften water as it once did. I have it programmed to regenerate twice a week. The brine metering system is set to deliver three pounds of salt. I'm told that our water hardness is 5 gpg (grains per gram). Can you help?—Harvey L. Felber, Bloomington, Minn.

It depends on whether you are conjecturing that your unit isn't "softening water as it once did" or whether a malfunction actually exists. Certainly, three pounds of salt twice a week to treat water of medium-to-low hardness, which is what yours is, should be an ample dose unless there is a mechanical failure.

There are two malfunctions in particular that will prevent full treatment. They are as follows:

- A partially plugged injector. You should remove the injector and injector screen and flush them both.
- An air check valve that closes prematurely. Place your control momentarily into "brine refill" to see if you can't free the valve. If this doesn't work, replace the valve.

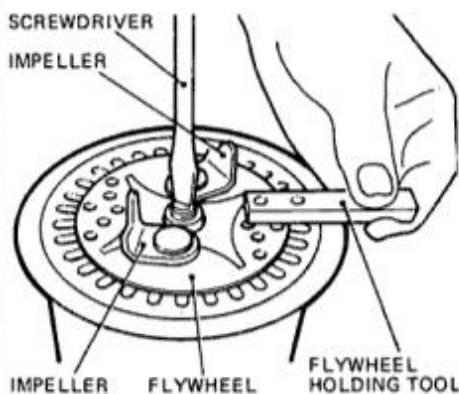
Hammers fly the coop

The hammers on the rotating wheel of our General Electric garbage disposer (Model FC) have broken off. Can these be replaced?—Anthony F. Leonardo, Bonita Springs, Fla.

Before we tell you, let's straighten out our nomenclature. What you refer to as "rotating wheel" is called flywheel by appliance tradespeople. What you call "hammers"

are technically known as impellers.

Can the impellers be replaced? That depends on whether they are held by nuts and bolts or are riveted on. You can replace impellers



Removing the flywheel assembly.

held by nuts and bolts. Impellers held by rivets are not removable and the flywheel will have to be replaced. It's not a tough job.

Drop the hopper assembly. Hold the flywheel or flywheel assembly nut and loosen the rotor shaft. This loosens the flywheel assembly nut, which is taken off to remove the flywheel.

The illustration shows the procedure. The tool you see is Robinair tool 14221, which you may be able to get from a GE dealer. It's used to hold the flywheel during removal and installation. You can accomplish the same thing by holding the flywheel assembly nut with a wrench.

Hold your nose

When we turn on our furnace at the beginning of the heating season, it emits an odor. Is there a remedy?—Orrie Hofstetter, Kearney, Neb.

The odor is probably caused by a mixture of condensation and dust. The remedy is to leave the pilot light burning in the furnace during the summer. Those who say that it's a needless use of energy should be aware that a pilot light that's kept burning will help prevent rust forming inside the furnace—not to mention the odor.

Dipsy dishwasher detergent

No matter how much or how little detergent I use, soap granules remain on dishes, especially on those in the upper rack, after our dishwasher completes its cycle. Each

dish has to be hand-rinsed and then returned to the machine for drying. The unit is a Waste-King Universal. What causes the problem and what can I do about it?—Martha Ellin, Ellington, Conn.

The problem frequently occurs when old detergent is used. As it sits in the box, detergent has a tendency to clump, making it more difficult to dissolve. The solution: buy a box of fresh detergent.

Other times, the problem occurs because water temperature is too low. The ideal water temperature for a dishwasher is between 140° and 150° F. Check yours.

Another cause is an unsuitable brand of detergent. According to one manufacturer of dishwashers, "Some detergents have less dissolving power than others." Switch brands and see what happens.

Another reason for the trouble is stacking dishes improperly. This prevents a full flow of water, especially to dishes on the top.

SERVICE TIPS

Here are two tips that apply to refrigerators which you may find helpful:

The first is a safety item applying to Amana side-by-side refrigerator-freezers with model numbers SR 17, SR 19, SR 22, SR 25, SD 19, SD 22 and SD 25. The units—about 240,000 of them—were manufactured between February 1969 and September 1974. There is danger that a hinge wire in the door may wear bare from frequent door openings and come in contact with the inside of the door. This could result in an electric shock. If you have one of these models, get in touch with a dealer or the company (Amana Refrigeration, Inc., Amana, Iowa 52203).

The second tip concerns a long-standing problem—refrigerator odors that persist despite a good washing and treatment with baking soda. The first thing to do is wash out the drip pan under the unit to make certain the smell isn't coming from there. A container of activated charcoal, which is available at aquarium supply stores, placed in the unit should do the job. If it doesn't, place a few drops of wintergreen oil in a dish and put that in the refrigerator. You can buy wintergreen oil in a drugstore. **PM**

If you have a question about any appliance, send it to Appliance Clinic, Popular Mechanics, 224 West 57th St., New York, N.Y. 10019. Sorry, but letters cannot be answered individually. Problems of wide interest will be discussed in this column.

We're about to shatter an image.

If you're one of those people who think that the sun rises and sets on Jeep, you've come to the right ad. It'll tell you that there just might be something better. Like an International Harvester Scout® II.

Big words, no doubt. But then, there are some big facts to back them.

Scout's axle ratings, for instance, are much higher than Jeep CJ-7's. 500 pounds more up front. 450 pounds more in back. Meaning Scout can really take a pounding.

Scout's got a two-foot tighter turning circle. An advantage that hardly needs elaboration.

Scout's got better seating capacity. Five big men can ride in comfort.

Scout's got a 20-inch longer cargo bed



than CJ-7. Power front disc brakes instead of drums.

A 19-gallon gas tank versus 15.5. And a removable steel roof instead of no roof at all (if you want one, Jeep makes you pay extra).

What's more, they're all differences that make a difference. A recent survey of 4-wheel drive vehicle owners showed that, on the measure of "very satisfied," Scout outscored Jeep by 25%.

So there you have it. Hard facts. And the opinion of people just like you.

Just goes to show that some images are more fragile than you think.



Scout® leads the way.

There's only so much an ad can tell you about this much machine. So we're offering you free brochures with full information telling how all Scouts lead the way. Check the one you're interested in and we'll get it to you, pronto.

- | | |
|--|---|
| <input type="checkbox"/> Scout® II | <input type="checkbox"/> Scout® Diesels |
| <input type="checkbox"/> Scout Traveler* | <input type="checkbox"/> Scout® Towing |
| <input type="checkbox"/> Scout Terra™ Pickup | <input type="checkbox"/> Scout® SS II |

802LBPM

Your name _____ (please print)

Phone _____

Address _____

City _____ State _____ Zip _____

Mail to: Scout Brochure, International Harvester
P.O. Box 1909, Mossville, Ill. 61552



INTERNATIONAL HARVESTER

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THE PM GARAGE

CAPSULE REPORTS ON NEW AUTO PRODUCTS BY THE EDITORS

Windshield washer pump

Pumps for windshield washer systems have a notorious habit of dying when you most need them. And it's usually expensive to have the dealer replace or repair a defective factory pump.

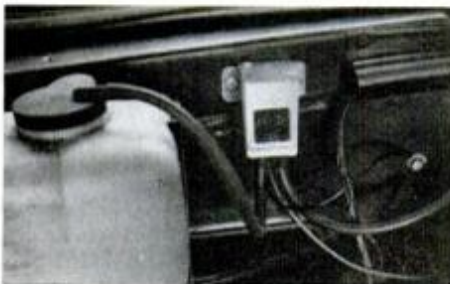
For \$8.49 and about 20 minutes of spare time, you can install an accessory Roberk pump. It's a compact, 12-volt unit that comes with two hose fittings and about 18 inches of tubing. It mounts almost anywhere.



This replacement windshield washer pump is packaged for display.

I found it more powerful than my old pump. On some GM cars, you'll have to install a new switch (not supplied), because the stock switch will not

work. The Roberk washer pump can easily be adapted to most cars' rear window, too. You can find the Roberk Model P50 pump at most parts counters or order one directly from Parker Automotive Div., Parker Hannifin Corp., Shelton, Conn. 06484.—M.L.



Installation of the pump was made on firewall next to fluid reservoir.

Light-up your wife

Right after the Seville came out, a Cadillac salesman told me that the one item that sold the ladies was a light-up vanity on the passenger's sun visor. Now you don't have to buy a Seville to get this extra. Hollywood Accessories sells a nice one for only \$2.25. It uses two penlight batteries (not included) and clips onto any visor. One screw releases the battery pack, and my wife found the bulb bright



Lighted vanity mirror is new add-on.

yet flattering. The vanity is sold by most auto departments or by the manufacturer, Hollywood Accessories, Compton, Calif. 90220.—M.L.

Vanity/service log/calendar

A vanity mirror with motor minder that costs only \$1.09 contains a service and mileage log, a calendar and a mirror. The ensemble straps



Three-in-one clip-on accessory for your visor includes a calendar, service reminder and vanity mirror.

to your sun visor via an elastic band. I find it handy and an amazingly good value. Many stores carry it, or you can order one from Molar Products Co., 151 Eisenhower Lane, Lombard, Ill. 60148.—M.L.

Backup alarm

If you've got small children and have to back your car, van or pickup out of a driveway every morning, here's a safety item to help your peace of mind. It's an electric beeper that hooks into the wiring harness of your backup light. It beeps an 87-decibel warning every time you shift into reverse.

Called Warn-A-Larm, it's compact, completely weather and dust-proof, and easy to install. Just tap into your backup-lamp wire and mount the alarm anywhere near the rear end of your vehicle. Warn-A-Larm sells for \$9.50 at most

stores or can be ordered from Warn Industries, 19450 68th Ave., S., Kent, Wash. 98031.—M.L.



Backup alarm is safety must for anyone with vehicle with poor rear visibility.

To reduce the shock

Later this year some of the Volkswagens that appear on United States roads will have been built right here—in VW's new plant in Pennsylvania. For many years German-built VWs have used parts supplied by U.S. manufacturers. Indeed, many imported-car manufacturers use a lot of Yankee hardware and employ a lot of Americans. Long-established importers have become part of the family and the "hard-to-get-parts" criticism of imported cars is of dubious validity. In fact, competition for the parts after-market is making it easier than ever to find replacement parts at a price that won't prove too shocking. A case in point: Monroe Auto Equipment Co. just introduced a new series of gas-pressurized shock absorbers for



Monroe gas shock for imported cars.

imported cars, making shocks for cars like BMW, Datsun, Mazda, Mercedes-Benz and Toyota even more widely available. The gas shocks list at \$24 each. Monroe Auto Equipment Co., International Drive, Monroe, Mich. 48161.—B.H.

Experience beautiful seclusion. For the highways of your mind. Oldsmobile Cutlass Supreme '78.

For '78, it's more Supreme than ever.

Take a moment to appreciate the Supreme's beautiful new shape. Crisp, formal roofline. Trim new style.

Settle into comfortable new seats. Stretch out in a spacious interior with increased headroom* and legroom over last year's Supreme Coupe. Scan the beautiful new bi-level instrument panel.

It's a contemporary classic, with a practical nature. EPA estimates: 27 mpg highway, 19 city, 22 combined, with an available 260 V8 and automatic transmission. EPA ratings are estimates; your mileage depends on how and where you drive, your car's condition and equipment. (EPA estimates are lower in California.)

Now, set the new Cutlass Supreme in motion. Experience its



impressive maneuverability in city traffic. The smooth ride.

Suddenly, any road you've ever dreamed about becomes a reality. That endless stretch of freeway. The winding 2-lane through farmland. Along the highways of your mind.

Take time to discover that great Cutlass feeling. Seclusion has never been more beautiful.

Note: The Cutlass Supreme is equipped with GM-built engines produced by various divisions. See your dealer for details.

*Available sunroof reduces headroom.



Oldsmobile

Cutlass Supreme '78.

Can we build one for you?



HOMEOWNERS' CLINIC

QUESTIONS ANSWERED

Make way for the spray

I would like to install a new sink faucet with spray attachment, but my present sink doesn't have the hole needed for the attachment. Can a hole be drilled in the sink apron, and, if so, how?—Stephen C. Coffman, Melbourne, Fla.

You do not say what type of material your sink is, but if it's the older porcelain on iron or steel type, then I'm doubtful about making the hole. It's better to buy a new sink having the hole for a spray unit. If the sink is of the stainless-steel type (although most of these are supplied with hole and ferrule), then it should be possible to drill and ream a hole to the proper size.

Auxiliary fireplace units

I'm interested in increasing the efficiency of my fireplace by installing an auxiliary heating unit, such as the tube-type grate and the motorized dispensers now offered. Am I wasting money or are they effective?—Larry Dreaden, Warner Robins, Ga.

Auxiliary equipment properly installed and used as directed does increase the heat output of the fireplace.

However, there are other factors you should consider. If you have central heating, either oil or gas-fired, the installation of auxiliary heating units in the fireplace may affect the thermostat, especially if the stat is in the same room as the fireplace. Other rooms will become cooler and the extra fuel required to raise the temperature in these rooms can offset any gain made by the extra heat from the fireplace. This is true, of course, of fireplaces that are not equipped with extra heating units, but not in such large measure.

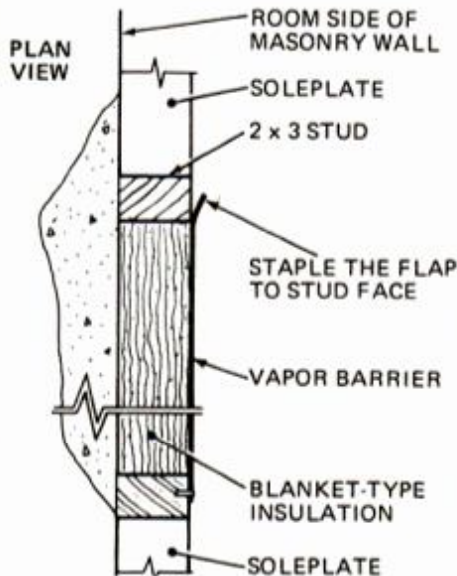
Vapor barrier in or out?

I plan to install insulation over cinder-block basement walls before finishing them with paneling. My walls are waterproofed with Sta-Dri. Side walls are half underground and half above. Should the vapor barrier on the blanket insulation face the room side or the exterior side?—Thomas A. Lutke, Sterling, Va.

The barrier, or foil, on the insulation should face the room side,

as illustrated in the plan view drawing below.

The Energy Research and Development Administration (ERDA) is experimenting using vapor barrier facing the house exterior in areas of the country where airconditioning is used throughout the year. But as of this writing neither positive nor detrimental effects have



been recorded while this procedure was tested.

When installing the insulation, be careful to staple the flaps on the insulating blanket over the wood studs.

Firing up a Franklin heater

I've installed a Franklin woodburning heater in a room I've added to my home. I've extended the natural-gas line under the floor of the addition to make it easy to light the logs. Can you tell me where to buy a burner suitable for this use, or how I can make one?—William B. Sarrof, College Park, Md.

I take it you plan to use the gas burner as an "igniter" for natural logs. I wouldn't feel comfortable recommending a do-it-yourself construction of a gas burner for this

Do you have a home maintenance or repair problem? Send it to Homeowners' Clinic, Popular Mechanics, 224 West 57th St., New York, N.Y. 10019. Letters cannot be answered individually, but problems of wide interest will be discussed in this column. For more home repair and maintenance help, get PM's Home Care Guide, \$4.95 postpaid. Send order(s) to PM, Dept. HCG, Box 1014, New York, N.Y. 10019.

purpose. I would suggest rather that you use the so-called starter sticks that provide easy, quick ignition of wood kindling. If these are not available locally, you can contact Brookstone Co., 127 Vose Farm Rd., Peterborough, N.H. 03458.

If you intend to use artificial fireplace logs, look in the classified pages of your telephone directory under "Fireplace equipment" for suppliers of these units complete and ready for service. You should also check your local building codes and get the recommendations of your local utility.

Inexpensive weathered finish

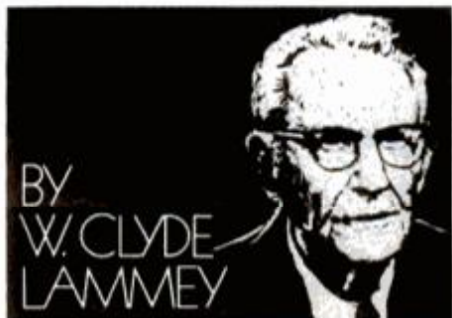
In a recent issue you advised a reader to mix a stain using color pigment for matching the cut surfaces of old pine with the uncut part. I've found that a formula from an old text gives similar results, and it's easy to concoct.

Place a handful of steel wool in a pint or so of vinegar. Keep it in a covered container for 24 hours. Rubbed lightly on pine, it produces a dull gray that nicely matches weathering.—Dr. Joseph T. Ponesca, Moorestown, N.J.

Film on shower-stall doors

After several years we have a soap film on shower-stall doors that seems to defy all efforts at removal. Every cleaner I've tried has failed. Have you a suggestion?—Carl Lampl, Tavares, Fla.

If it is, as you say, a soap film, then it should yield to any household cleaner containing a fine abrasive, such as "Soilax." The film might, however, be due to mineral content in the water—which may take a more active solvent, such as alcohol. You might also try a commercial glass cleaner. In any case, rub vigorously and rinse with water to get the original clarity. **PM**



LIGHTS: 12 mg. "tar", 0.9 mg. nicotine
av. per cigarette, FTC Report AUG '77.
LIGHT 100's: 13 mg. "tar", 1.0 mg. nicotine
av. per cigarette by FTC method.

I want low tar. But taste is a must.

I wanted less tar. But not less taste.
I found Winston Lights. I get the low tar numbers
I want, and the taste I like. If it wasn't for
Winston Lights, I wouldn't smoke.

Warning: The Surgeon General Has Determined
That Cigarette Smoking Is Dangerous to Your Health.

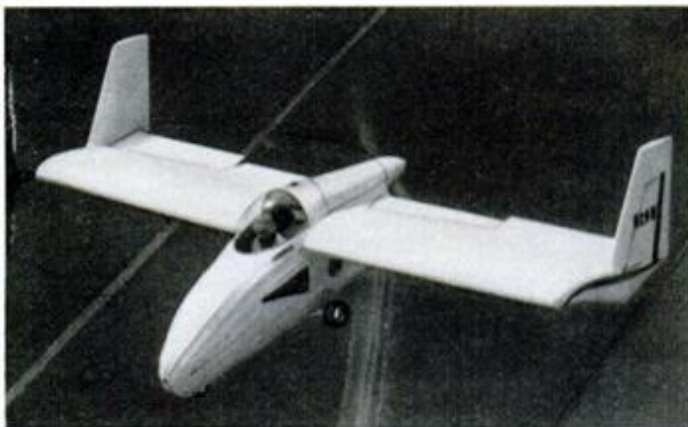


Winston Lights. Winston Light 100's.

IT'S NEW
NOW

Pushy performer

This offbeat single-seater resulted when two Texas flying enthusiasts put their skills together. A 40-hp engine turns the pusher prop, allowing for maximum level flight of 109 mph. The wood and fabric wing is 21 feet long. Empty, the compact homebuilt weighs 400 pounds.



That's a clock?

Parisians can now tell time by looking at a large sphere that rotates on its vertical axis. The small white sphere, fixed to the surface of the larger one, points to hour markers on the ground.



Egg on a shaft

Two linked towers—one 183 feet high, making it one of Israel's tallest structures—house a new nuclear accelerator at the Weizmann Institute. Eggshaped unit encloses lab and visitors gallery.

Jewels from the scrap heap

Britisher Bill Flynn uses only bits of scrap metal—from old bikes, washing machines and the like—in building his model steam engines. Working with simple hand tools, the 58-year-old gardener has made 14 models recently.



For cleaner carpets

A new Kenmore unit sprays hot cleaning solution into carpets and simultaneously vacuums dirty liquid from them. It weighs less than 45 pounds filled and sells for under \$130 at Sears.



**Energy Crunch
Creates New Jobs
in Solar Heating,
Heat Pumps, Air
Conditioning,
Refrigeration,
and Heating**



**NRI Can Train You at Home
for a Good Paying Job in
this Expanding Field**

The energy shortage has stimulated dozens of new technologies, created thousands of new job opportunities in energy-sensitive areas like air conditioning, heating, and refrigeration. And NRI has kept up by adding timely lessons in solar technology and heat pumps to its home-study course in this booming area. By 1985, well over 90,000* new technicians will be needed. And NRI can start you on your way to success. *U.S. Dept. of Labor Bulletin 1824

**Training Includes
Professional Tools,
Your Own Air Conditioner**

NRI's Master Course includes professional tools for learning and earning... training kits that teach you how to work on controls, work with tubing and make joints, trace and repair electrical problems, detect leaks, and analyze systems. You even get a 5,000 Btu air conditioner for experiments and practice.

**Optional Resident Training
at Famous York Institute**

NRI's program was developed with technical advice and consultation of the York Division of the Borg-Warner Corporation. In addition to special "bite-size" lessons for faster learning and understanding, graduates of our Master Course may take advanced training at the York Institute Resident School at no extra charge. You'll get practical experience with expert instructors equal to months of on-the-job work.

**FREE CATALOG
MAIL CARD**

Just check the postage-paid card.
No salesman will call.

If it feels like somebody else is making all the money, maybe it's time you looked at NRI home training for TV and audio technicians.

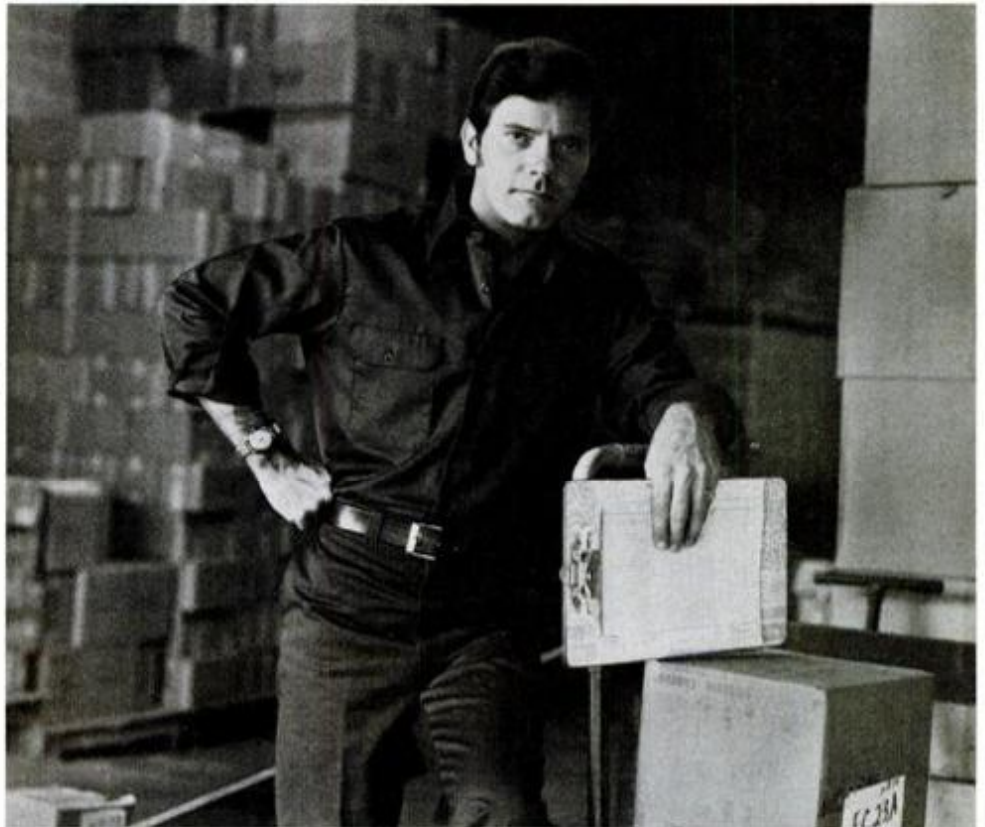
No matter how hard you try, there are some jobs that just seem to go nowhere. And others so monotonous, they drive you up the wall. While all around, you see people enjoying what they do and making a good living at it.

NRI Can Set You Free

There's a way out of the rut. NRI home-training in TV and audio servicing. At home, in your spare time, you can learn to become a TV electronics technician. Qualified to hold down a good paying job as a serviceman or troubleshooter. Even start your own full- or part-time business. And you learn at your own pace without quitting your present job.

Learn by Doing, Actual Bench Experience

NRI is more than book learning. Sure, we give you all the fundamentals and theory. But it's reinforced with practical experience every step of the way. In our Master Course, you build actual electronic circuits and test them. You construct a 4-channel audio center, a 25" diagonal solid state



color TV, introduce and correct typical service problems. You even assemble test instruments that you use for learning and earning.

Your equipment includes a transistorized Volt-Ohm Meter, TV color pattern generator, advanced design 5" triggered sweep oscilloscope and CMOS digital frequency counter... the basic tools of the pro. In addition, you build the 4-channel audio center and 25" color TV while performing more than 35 in-set, power-on experiments that give you real bench experience while you learn.

Ask the Professionals

A documented national survey confirms for the second time that almost half the professional TV servicemen have had home-training. And among them, they recommend NRI as first or only choice by more than 3 to 1! That's because NRI training works, as

it has for 63 years and more than a million students.

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Get all the facts on how NRI career training can mean new opportunities for you. Send for our free catalog describing lessons and equipment, other courses in digital computer electronics, CB radio servicing, communications, and more. No salesman will call. Mail the postage-paid card today and see if you can't make more of yourself in this wide-open field. If card has been removed, write to:



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Seagram's V.O.

Bottled in Canada. Preferred throughout the world.

CANADIAN WHISKY. A BLEND OF CANADA'S FINEST WHISKIES. 6 YEARS OLD. 86.8 PROOF. SEAGRAM DISTILLERS CO., N.Y.C.

Материал, защищенный авторским правом

ALL OUTDOORS

Going light

Our first outdoorsmen—the pioneers—traveled light because they didn't own much to carry. Today's hikers, bikers, year-round campers, canoeists and cross-country skiers, however, tote considerable equipment to make a trip safe and comfortable. Fortunately, much recent gear has been designed for minimum poundage. If you have to portage your supplies, it still makes sense to keep them to a minimum and look over the ultralight items now available.

Birds would never get off the ground if they didn't wear the lightest in feathers and warm down, and it's no secret that down is still the most efficient insulation around for parkas, sleeping bags and comforters. It's also the most expensive, and new synthetics like Hollofil, Kodel, Kodofil and PolarGuard are only slightly heavier, slightly less warm, considerably less costly and a whole lot better under wet conditions. This time of year particularly, they deserve special consideration.

The first settlers carried muskets because they had no choice. Now rifles and shotguns are light and getting lighter. Remington, for ex-

.22 long rifle rounds. They also make what they call the world's most powerful handgun: the .454 Casull.

For light footwork, by far the most featherweight insulated



Lightfoot boots, new from Royal Red Ball, are half the weight of similar insulated models, have tie-tops to bar snow.

quality boots we've found are Royal Red Ball's Lightfoots, from Uniroyal Specialty Markets, Rubber Ave., Naugatuck, Conn. 06770. At under 2½ pounds, they're literally less than half the weight of any other boots we have tested. Made of one of the new superplastics to



Recognize this gun? It's Kentucky muzzle-loader reproduction 50-shot (BB) rifle. \$10. Ultra-Hi Prod.



In special new limited edition, Winchester Legendary Lawmen Model 94 lever-action carbine 30-30 cal. \$375.

ample, has nylon-stocked autoloader .22s that weigh only four pounds, and Model 1100 Lightweight 20-gauge shotguns that, at 6¼ pounds, are a pound less to carry than the standard auto. Many hunters find that less weight not only is easier to lug along but also seems to improve marksmanship.

Lightest, smallest handgun is the claim by North American Arms, of Freedom, Wyo., for its 4-ounce, 3½-inch Mini-Derringer .22-cal. five-shot revolver. Small enough to fit in the corner of a tackle box, it's strong enough to finish off a rat or rattler with a .22 short. Same weight and ½-inch longer, their Long Rifle Mini can fire five

Army foot-soldier specifications, they've been successfully checked out down to -30° F., though not yet by us. Fabric tops tie to keep out splash and snow, and their weight, warmth and design may make them a breakthrough in outdoor wear.

Offshore Sherlocks

No one likes to do unpleasant chores that they're not required and equipped to do, but recently the Department of Transportation's Coast Guard Div. agreed to help with the difficult detective task of tracking down stolen boats.

Since you don't mount a license plate to identify your boat, it's easy for a boatnapper to repaint

and change the figures on the bow. Builders are now required to carve in a hull identification number (HIN) that is harder to change. Even the home builder should apply for a HIN—the Coast Guard booklet *Safety Standards for Backyard Boat Builders*, CG-466, tells how.

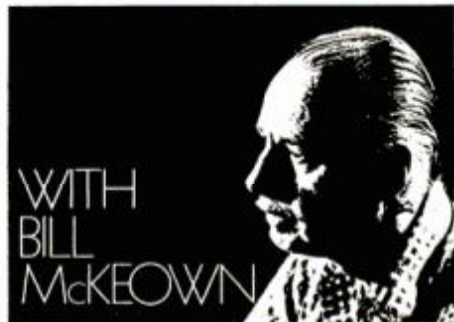
In the past, the theft had to violate a federal law for the Coast Guard to become involved. Now, under new guidelines, it will keep a file on any stolen vessel reported, issue a vessel lookout, conduct appropriate harbor checks, and coordinate action with federal, state and local authorities. Chances have just been increased that you might get back a missing boat, and at least you know somebody cares.

Inside action

When the weather is unpleasant this season, there are several new indoor ways to plan for pleasant days ahead. One is called *The National Parks*, a big and particularly colorful album of David Muench's photos and Michael Frome's comments covering the most picturesque of our national resources. The \$30 Rand McNally book isn't expensive if you compare it to the cost of revisiting these beauty spots any other way any time you want.

Also at bookstores is *The Power of Plants* by Brendan Lehane, published by McGraw-Hill at \$40. It, too, is a definitive and exceptionally well-illustrated volume that explains how plants grow and provide everything from food and drink to drugs, poisons and hallucinogens.

And for a look at the best of boating all year long, it's not too late to order a 1978 Beken of Cowes Calendar from Force Four Marine, Cranford, N.J. You select tall ships, racing yachts or offshore powerboats, and for your \$9.95 you get a dozen photos worth framing, plus 365 days. **PM**



Carve these sea gulls in flight



You don't have to be a master carver adept with chisels and gouges to make handsome wood carvings. Using a hand-held power tool you can shape these graceful sea gulls and other objects faster and easier than you may imagine.

The only accessories you attach to the tool for this project are a drum sander to shape the birds and a bit to bore holes. Other accessories you may want for future projects are: cutters, polishers, brushes and routers. Power tools such as the Dremel Moto-Tool pictured are available in hobby shops. You'll also need a jigsaw. *Wear safety goggles and a dust mask to work.*

1. Draw the pattern. Begin by making a full-scale drawing of the sea gull. With carbon paper transfer the outline to basswood or other soft, easy-to-shape wood, use 1½ in.-thick wood for the bodies and ¾-in.-thick wood for the wings.

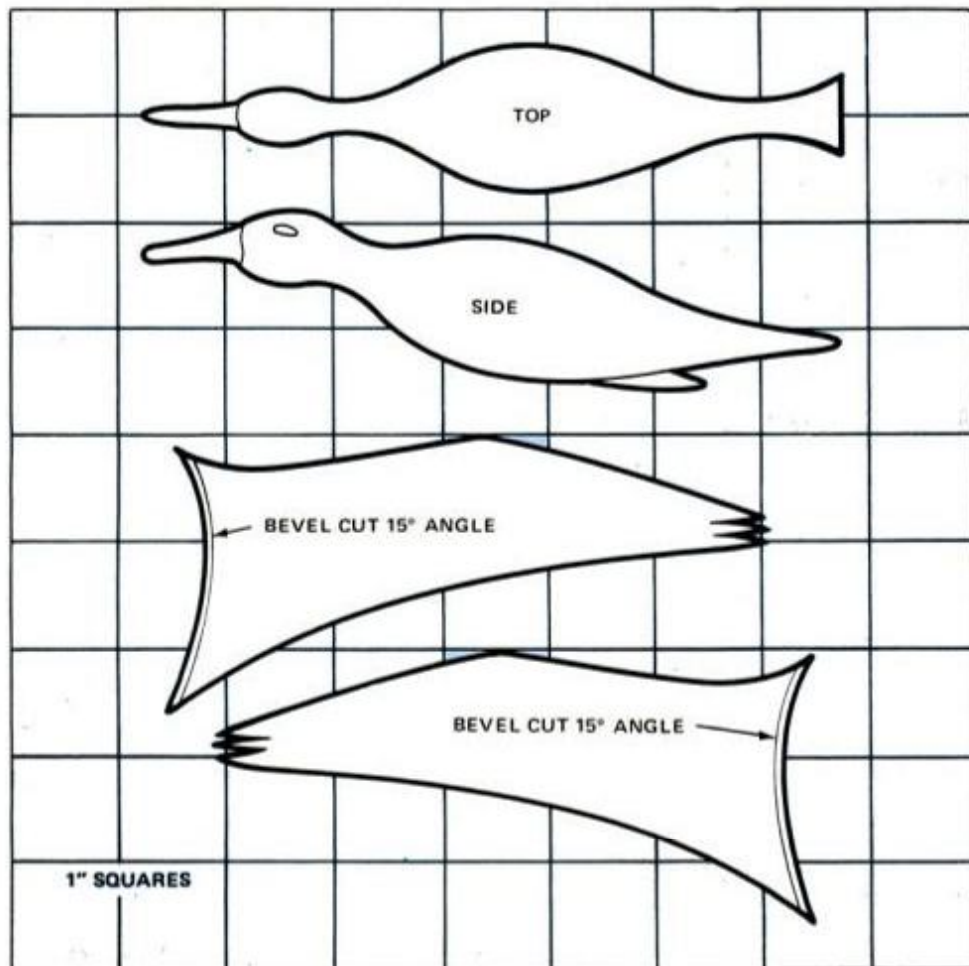
2. Cut out the pieces. Secure the work to your bench and with a jigsaw cut out the pieces. Bevel cut the wings at a 15° angle where they join the body.

3. Glue the wings to the body. Apply Elmer's Glue-All to mating surfaces and wait a few minutes until glue gets tacky. Then press parts together. Done this way parts won't slide. Let dry overnight.

4. Shape the bird. Use the drum sander attachment in the power tool to shape the bird. Don't apply pressure—let the sander remove the wood. After you've shaped the birds use a bit attachment to bore a hole the diameter of coathanger wire in the bottom of each bird.

5. Apply finish. First brush white alkyd primer on the birds and base. When dry apply an oil stain in the shade you want. Make highlights while stain is wet by rubbing with a turpentine-soaked rag.

Bore holes in the base for the attaching wires. Cut coathanger wire to 5-, 6- and 7-in. lengths; attach birds to the base.—James Finneran



Cut out the three pieces of each bird.



Glue pieces together and let them dry.



Shape the birds with a hand power tool.

THERE ISN'T ONE GOOD REASON FOR BUYING A TOUGH CHEVY VAN.

SO HOW ABOUT 12?

We can go on and on about our tough Chevy Vans. And the features that help make them ideal for business or personal use. But we'll stop with an even dozen. And let you

discover even more reasons to buy when you see and drive a Chevy Van. At your dealer now.



BUILT TO STAY TOUGH



R. L. Polk & Co., July 1, 1976.
1977 statistics not available.

Built to last. Look at the record.

95.7% of all Chevy trucks, in the ten most recent years recorded, were still on the job. This is based on the latest available industry registration statistics through July 1, 1976.

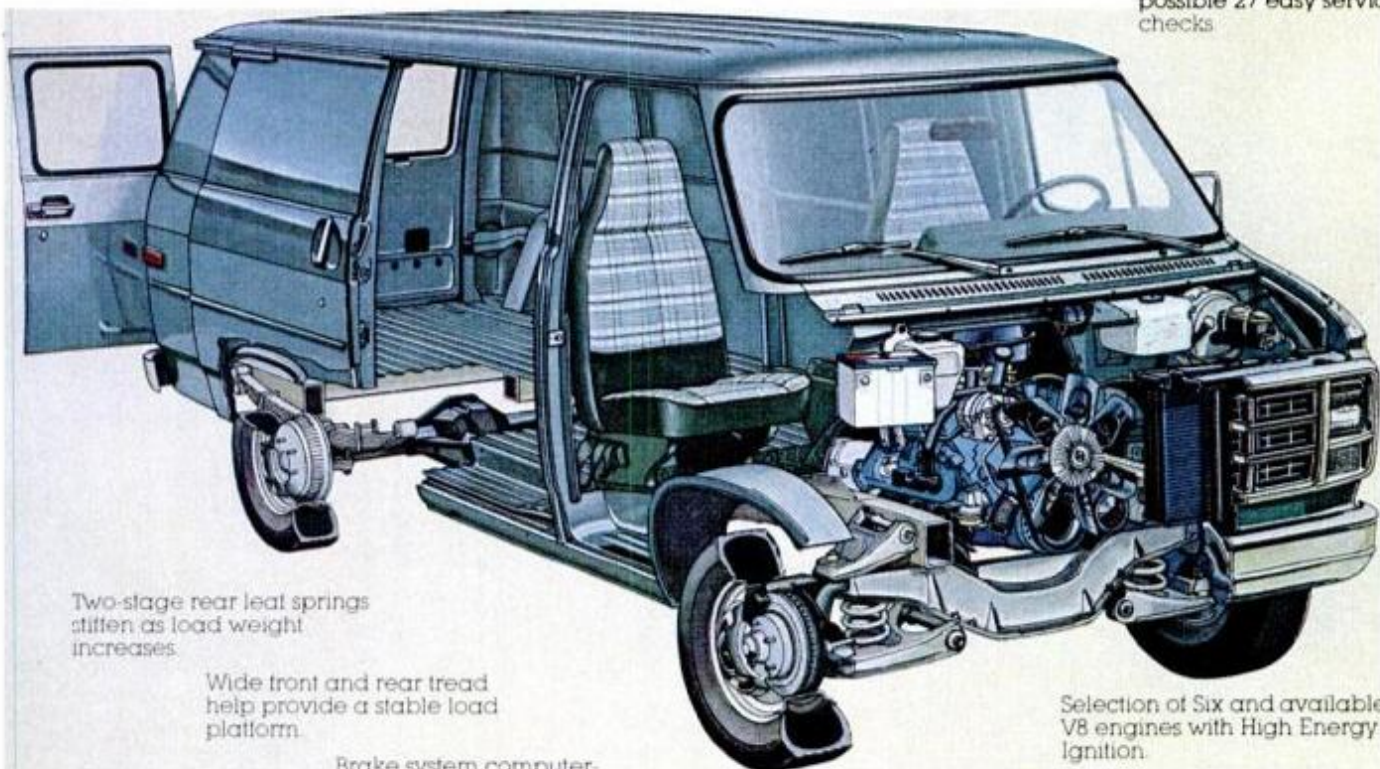
Up to 12 feet of load space and 296 cu. ft. of cargo space on 125" wheelbase models.

Rear door opening measures over 4 feet high and 4-1/2 feet wide for easy loading.

Electrocoating helps guard against corrosion.

Sliding side door requires only 4-1/2 inches of clearance.

Extended hood makes possible 27 easy service checks.



Two-stage rear leaf springs stiffen as load weight increases.

Wide front and rear tread help provide a stable load platform.

Brake system computer-matched to the GVWR of the van you order.

110" wheelbase models have tight 42.0-ft. turning diameter. 125" wheelbase models require only 46.8 ft., curb to curb.

Massive Girder Beam independent front suspension provides firm, easy ride.


Unitized body frame design which utilizes heavy-gage steel side rails, cross sills and outriggers.

Selection of Six and available V8 engines with High Energy Ignition.

Chevrolet vans are equipped with GM-built engines produced by various divisions. See your dealer for details.



Warning: The Surgeon General Has Determined
That Cigarette Smoking Is Dangerous to Your Health.



The most
refreshing taste
you can get
in any cigarette.



No wonder it's America's #1 menthol.

Kings, 17 mg. "tar", 1.3 mg. nicotine; Longs, 18 mg.
"tar", 1.3 mg. nicotine; FOB, 17 mg. "tar", 1.3 mg.
nicotine av. per cigarette. FTC Report Aug. '77

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Good soldering begins with the right solder selection

Different soldering applications require different alloys and different fluxes. Even different combinations of the two. You can't solder stainless steel, a pc board or aluminum with the same material. It just won't work. And that's a fact.

Now Multicore makes soldering easy. Not only to select the right solder. But to use it also. The flux is included in the solder as multiple cores. And in just the right ratios. There's no mess. Nothing to add. Think of it. Multiple cores for better distribution of the flux. You solder faster. Use less solder. Get better results. And that's a fact too.

Prove it to yourself.



Send For Your Solder Sampler Kit

Consists of 5 special solders each in a feed-out metal dispenser. Totals over 60 ft. for every solder requirement.

ELECTRICAL: Best general purpose solder with non-corrosive rosin flux for all types of wiring. Savbit® formula protects soldering iron tip from wearing out.

ELECTRONIC: A 60/40 tin/lead alloy, but extra thin (22 gauge) for electronic applications. Non-corrosive rosin flux cores.

STAINLESS STEEL AND SILVER JEWELRY: A tin/silver alloy with special flux; contains no lead. Blends in so well, you can hardly tell where its been used.

ALUMINUM: Special flux and silver alloy combination for soldering aluminum. There's nothing like it on the market.

PLUMBING AND SHEET METAL: For most metal joining applications except aluminum. Uses acid type flux.

ALL 5 FOR \$8.95 Shipping and handling included

Plus Bonus Pak of Emergency Solder

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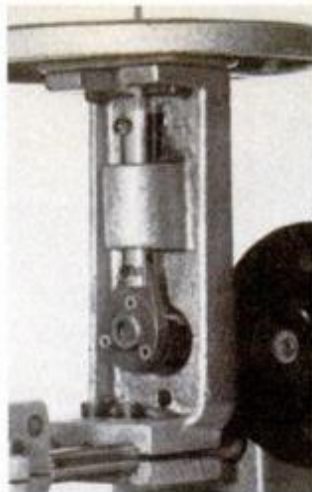
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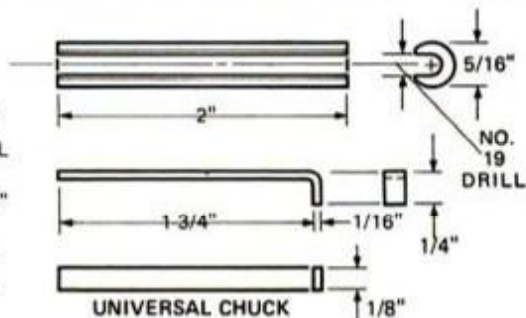
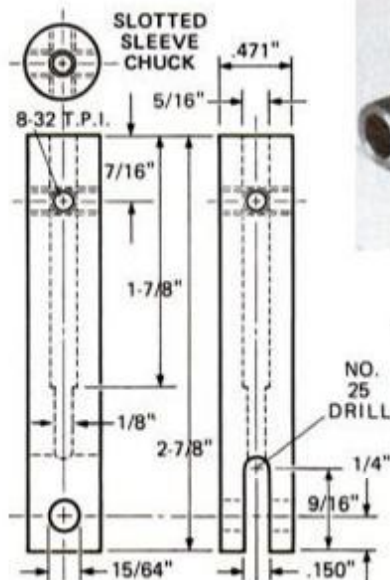
Homemade chuck added to a Unimat's jigsaw attachment lets you file small parts precisely, with clear view of cutting line. It replaces saw's original reciprocating rod, fits connecting pin. Chuck holds round-shank files and other types with use of "universal" adapter.



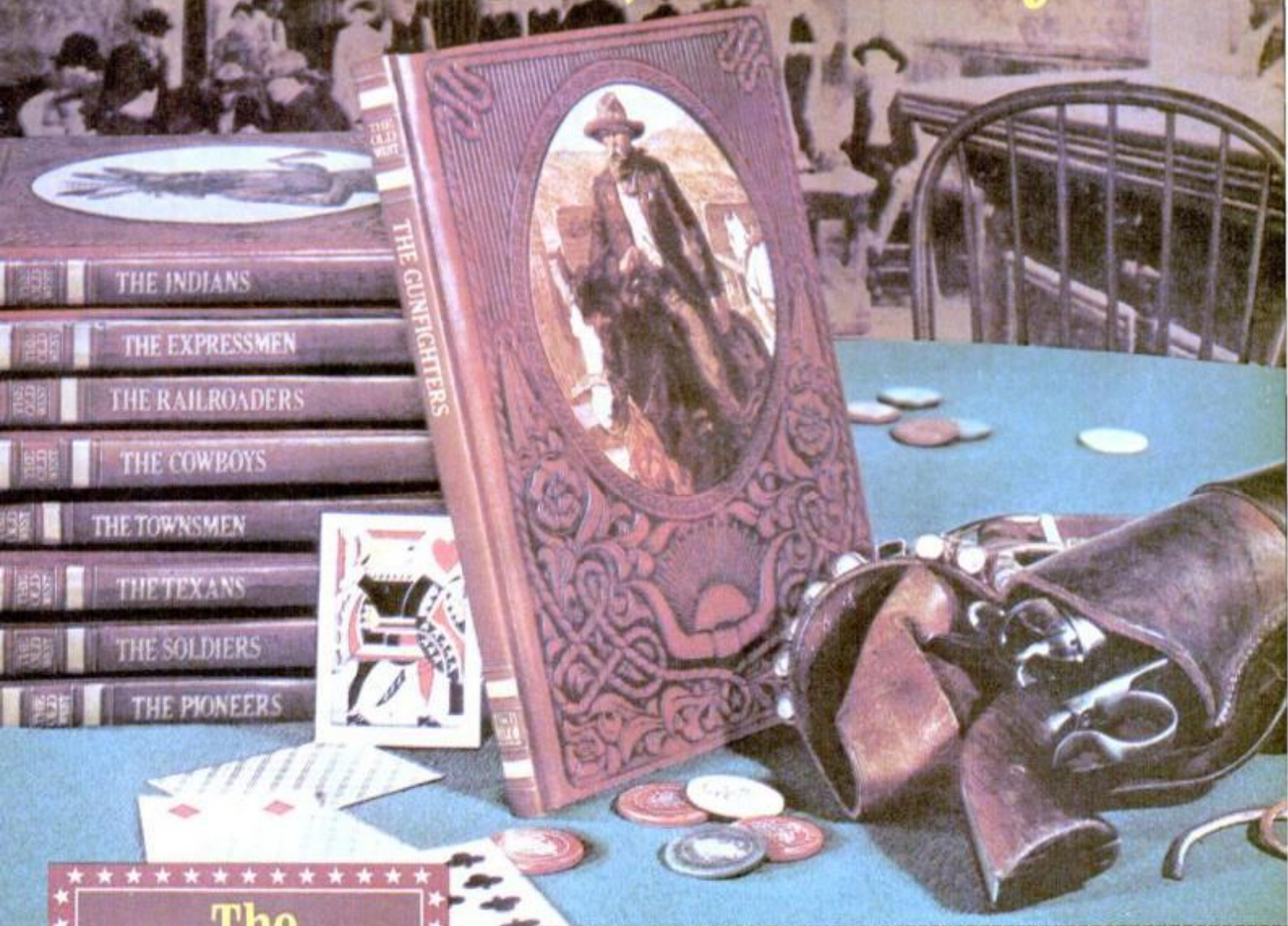
Sleeve chuck permits filing on Unimat lathe

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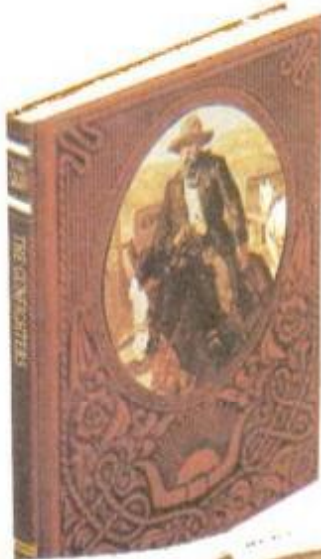


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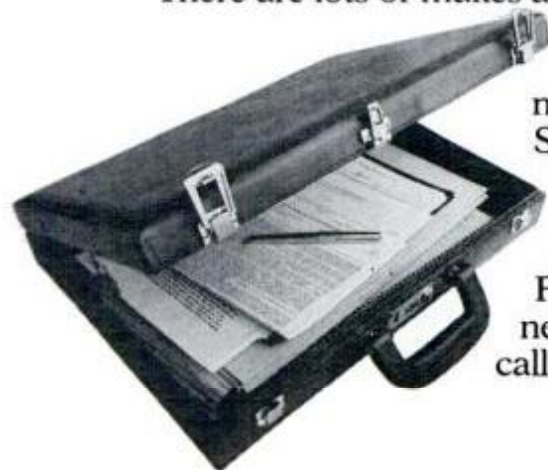
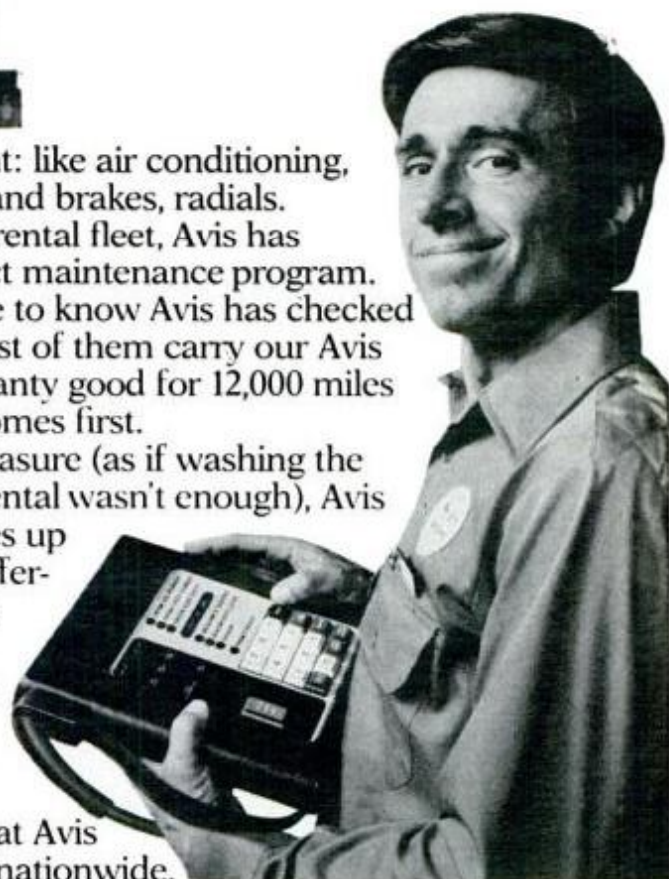
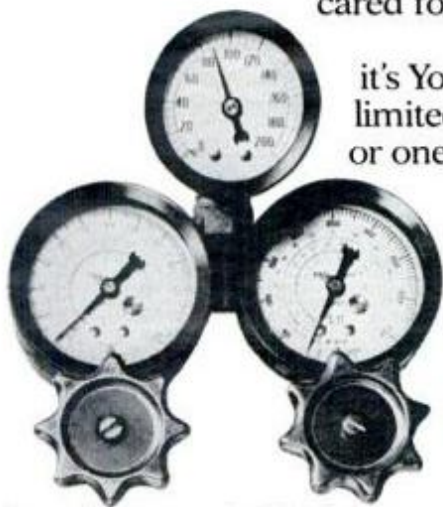
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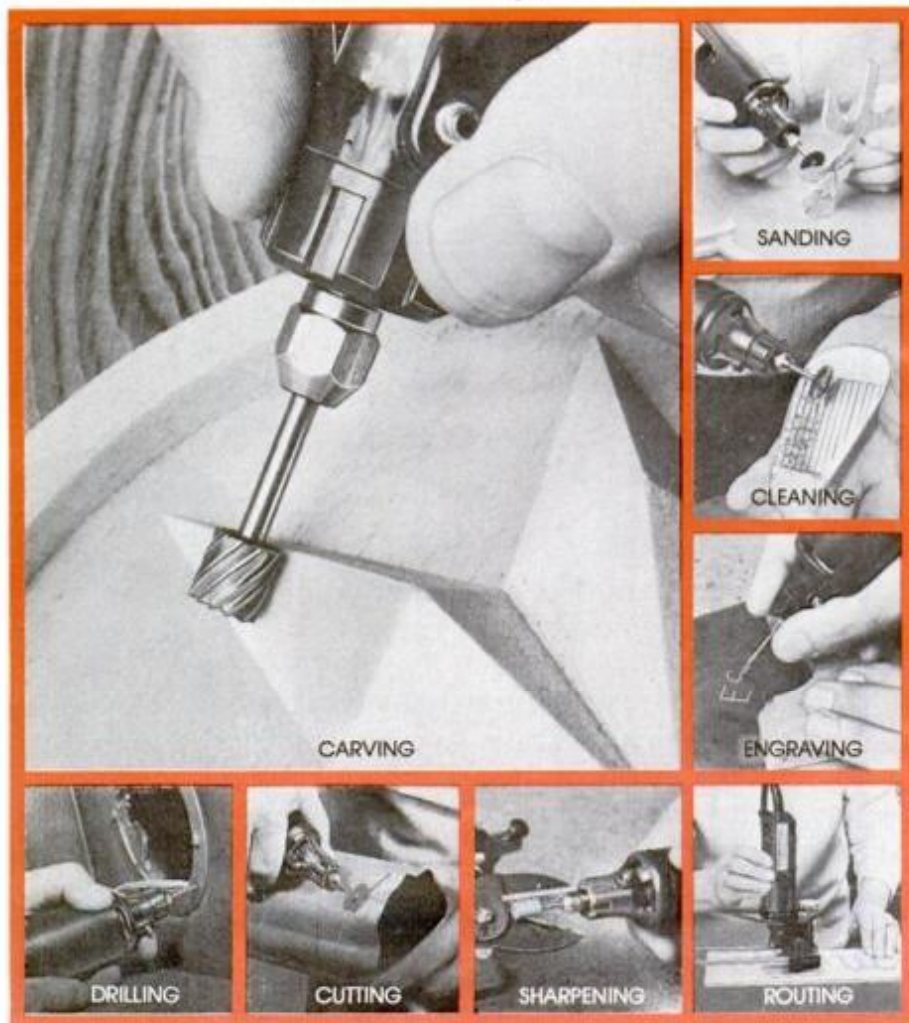


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- Best Of Jim Reeves .. 00267
- Platters: Gold .. 01129
- Perry Como: Gold .. 03908
- Tavares: Love Storm .. 24180
- Best Of Eddy Arnold .. 02318
- Bros. Johnson: #1 .. 23713
- H. Williams: Gr. Hits V. 2 23658
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Camper that goes cruising

This versatile RV can go boating in an hour.

by Simon Schwartz

From driving down the highway to cruising up a waterway in less than an hour? That's the claim of Geneva, Ind., inventor Bruce Schlagenhaut. He does it with his self-contained truck camper which converts to a 24-foot houseboat in 40 minutes. 24-foot houseboat in 40 minutes.

Schlagenhaut hopes to cut this set-up time in half with new improvements of production models. So many people have wanted the float-and-shore camper that he has started the Lan-See Cruiser Corp., and is having his patented recreational rig assembled by the Olympic Marine Manufacturing Co. of Topeka, Ind.

For cross-country camping, the unit is slid into a pickup truck, the four pontoons secured on the roof, and off you go. Once you see an appealing body of water, you park at a flat spot along the shore. Wheels at four corners of the camper are then cranked down, the rig jacked up, and the truck driven out from under the camper. Next the four pontoons are slid off the roof of the rig, crossarms installed on the pontoons, and the unit lowered down onto these crossbars. Front and back decks are dropped down, hand rails are secured, and the outboard is taken out of the motor box and clamped on the stern motor mount.

Now the unit is ready to be pushed or rolled to the water. Once it's launched and afloat, the wheels are removed, and the amphibian is ready to get underway. A remote-control helm position is installed behind a large 30x30-inch forward window in the cabin.

Overall length of the cruiser, with pontoons mounted, is 23½ feet, beam is eight feet, weight 2400

With outboard mounted, rig is rolled into water and wheels are removed. Foredeck and roof hold sun-bathers.



Ready for the road, the afloat-ashore RV only gives away its dual purpose with the four pontoons secured on camper roof.



Firm level ground along shore is needed for quick-change from camper to houseboat. Wheels are lowered, body jacked.



With slide-in camper raised, pickup truck drives out from under and pontoon floats are slid from roof of houseboat-to-be.



Cross-member braces are secured across four pontoons to hold them together and act as cabin foundation. Decks hinge.



pounds, price approximately \$6500. The cabin is about 7x11 feet and sleeps four. Aft deck is 3x8 feet and the larger forward deck is 5x8 feet and can be enclosed with an optional canopy and curtains. On the front deck, a ladder can also be mounted for reaching the Astro Turf-carpeted sun deck on the roof of the cabin.

Waterproof carpeting is used for both cabin and decks. Additional standard equipment includes bunks, pedestal table, refrigerator, two-burner gas stove with vented hood, stainless-steel sink, 12-gallon water tank, 30-amp. converter system and 12/110-volt outlets with breaker panel fusing, 7000 BTU heater, LP gas system. The screened windows are provided with drapes; lockers, storage cabinets and galley cupboards are built in.

Like many recreational vehicles and boats, interior lighting can be provided from 12-volt batteries or 110-volt campsite or dockside hook-ups. Both bow and stern exterior navigation lights for night cruising and clearance lights for night driving ashore are installed. Heavy-duty 26-inch high anodized aluminum safety rails surround the forward and after decks to help keep crew members aboard. Options include an air conditioner, portable toilet, rail-mounted charcoal grill, front deck rail gates, boarding ladder for swimmers, and a customized trailer so that the rig can be towed by a car to campground or launching ramp without the use of a pickup truck.

A lockable outboard motor storage compartment is also provided; about 35 horsepower is the largest motor recommended. While the craft is designed for sheltered inland waters, it is reported to be stable, dry-running and comfortable.

An ideal cross between a land and water vehicle? No boat or RV is perfect for all uses, but this Lan-See Cruiser appears to be an interesting compromise. **PM**

How to bike by the numbers

Build this inexpensive digital speedometer to find how fast your bike is going.

by Jeffery Sandler

Now the thrill of knowing exactly how fast you're traveling isn't limited to racing cyclists. The PM bike-by-the-numbers speedometer can be built in two hours in a clean tuna-fish tin. It will give you a precision read-out in seven-segment liquid-crystal (LCD) display up to 99 mph. It has the latest solid-state digital electronics and battery-saver circuitry.

Considering what is available today in speedometers, it's surprising there are as many around as there are. A speedometer adds weight to a bike that engineers spent years taking off. The cumbersome, friction-producing cable saps the rider's precious energy.

No friction

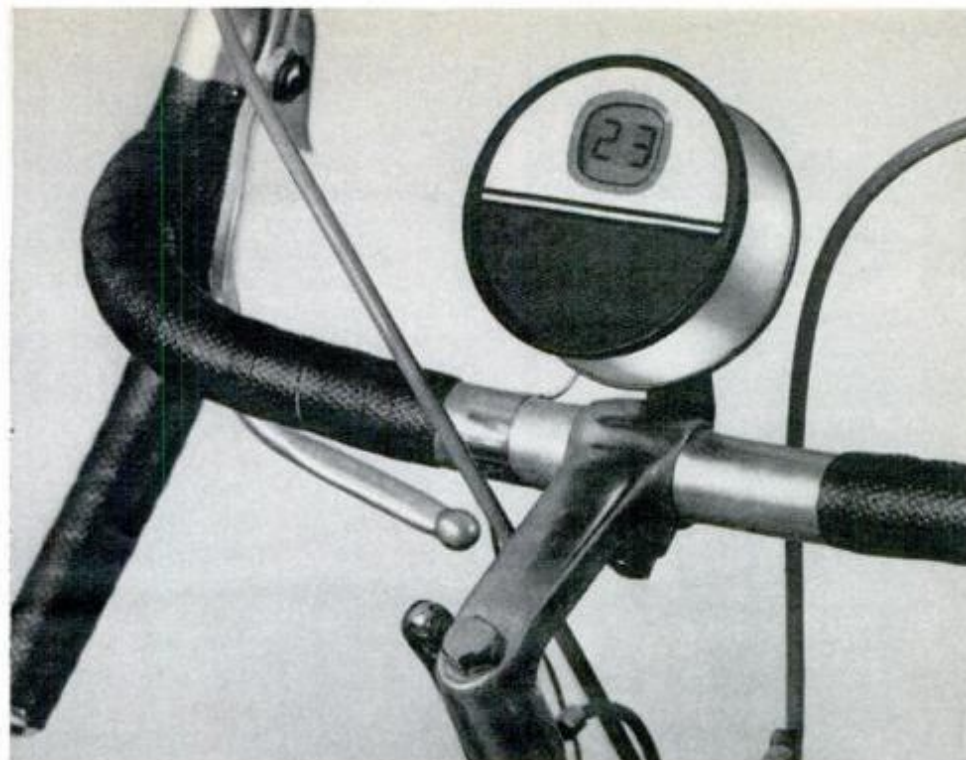
The mechanical cable to the wheel must be eliminated. The meter should be light and accurate to within one-half mile per hour. And a digital readout would be nice. You can't buy one, but you can construct one easily, at reasonable cost.

The operation of our digital speedometer is completely different from older mechanical types. Mechanical devices bring rotary motion from the wheel to the speedo via cable. Speed reading is not very accurate.

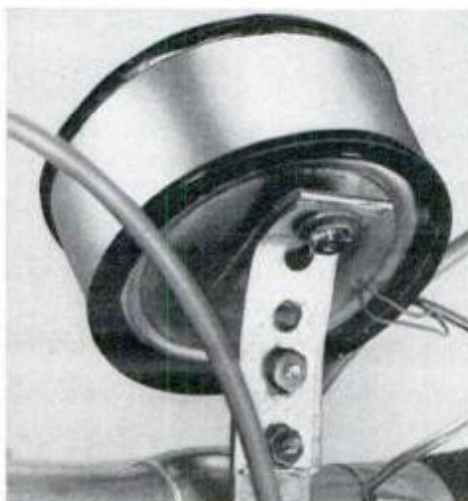
The PM digital speedo, on the other hand, counts the number of times the wheel revolves, converting the count to exact mph reading. There is no error in the counting process, so speedometer accuracy is very high.

There isn't even a physical link to the wheel to add friction. Instead, a magnetic reed switch mounted on the fork closes each time one of the two magnets mounted on the wheel spokes passes. Each relay closure sends a pulse back to be counted by the speedometer circuit.

No electronics knowledge is need-



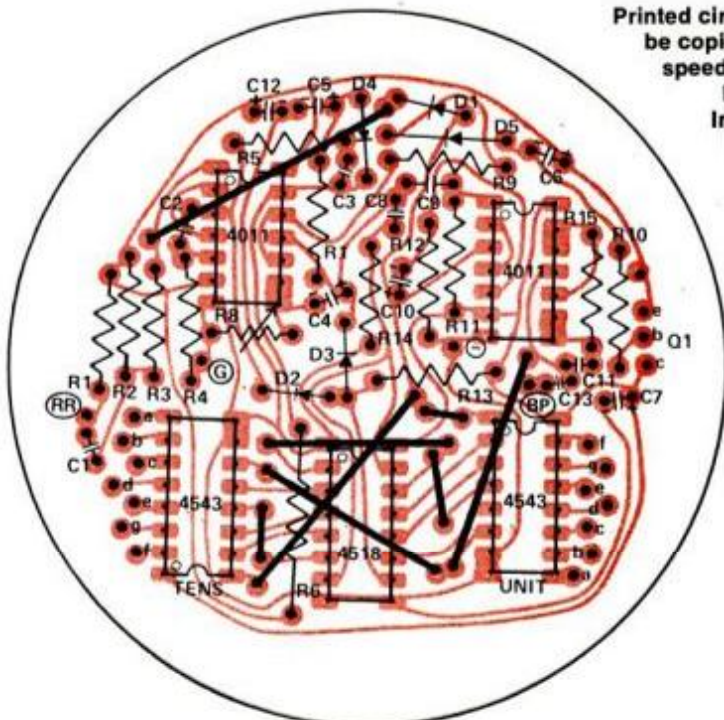
Liquid-crystal display (LCD) uses much less power than light-emitting diodes (LEDs), increasing battery life in speedo (above); mounted to handlebars (left).



ed and only two hours of construction time is required, including calibration. A 30-watt or less soldering iron is used.

The pulses from the reed switch are counted by a digital IC (4518). The count goes on for a period of time which is calibrated so that the number of pulses counted will exactly correspond with the mph or kph reading.

(Please turn to page 38H)



Printed circuit (left, in color) may be copied to make your digital speedometer. Place parts on PC board as in overlay. Integrated circuits (ICs) are CMOS types 4011, 4518 and 4543. Resistors (R), capacitors (C) and diodes (D) are specified in the parts list

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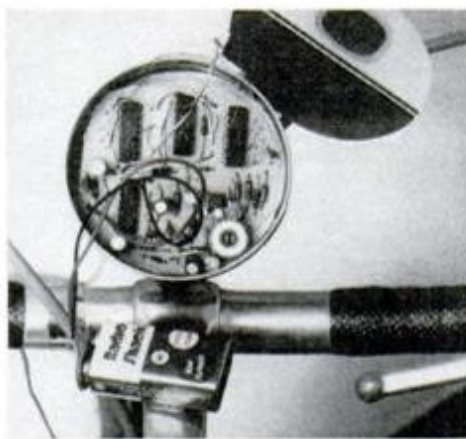
HOW TO BIKE BY THE NUMBERS (Continued from page 38G)

CMOS ICs

The 4543 ICs convert the digital count into a seven segment format which is displayed on the LCD. The mph appears as a two digit number on the LCD display.

The 4011 ICs set up the necessary timing periods, and also send the pulses to the correct locations in the counting ICs. In addition they are part of an automatic shut-off circuit.

There is no on-off switch in the speedometer. When you start mov-



Digital speedometer is easy to build. No electronic knowledge is necessary. Clean tunafish tin makes attractive case (above).

ing the bicycle, the speedometer automatically "turns on" and when the bike stops it "turns off". This combined with the very low power consumption of CMOS ICs enables the speedometer to operate for up to a year on a single nine-volt transistor radio battery.

How to build it

Construction is straightforward. A printed circuit board greatly reduces chances of error, as the parts layout is printed right on the top surface of the board. It is merely a matter of plugging the parts in the indicated location and soldering, using a low wattage iron of 30-watts or less. The battery clip is soldered to the location marked + and -. The four-foot wires that go to the reed switch are soldered to the points marked RS on the circuit board. The

LCD display is gently inserted into its holder, and 4-inch lengths of wire are used to connect its labeled pins to the corresponding labeled holes on the circuit board.

The free end of the four-foot length of wire is soldered to the reed switch mounted on the fork. The magnets are mounted on the spoke as close to 180° apart as possible.

Enclose the components in a can. Once the battery is connected, the numbers should come up within a few seconds after the wheel is turned. Once the wheel stops the numbers will fade away after a few seconds.

Tiger's tail

Some high-quality phonograph sets have a strobe of black and white

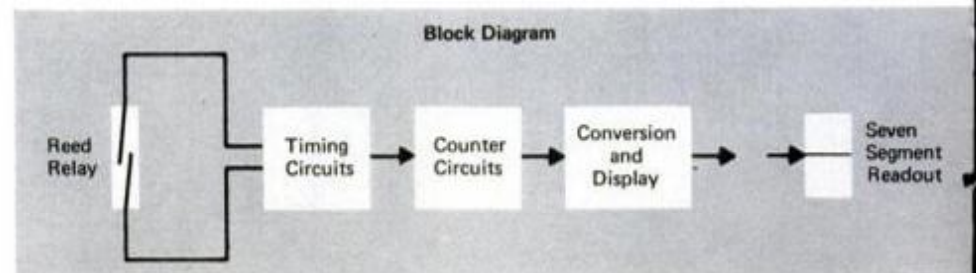


Electronic speedo adds no mechanical friction drag to wheel. A tiny computer counts wheel revs, converts to mph.

strips on the turntable to indicate turning at the correct speed. At the correct speed the strips appear to stand still. It is extremely accurate, and the same method that we use to calibrate the bicycle speedometer.

A "tiger's tail" strip of paper with black and white stripes is taped to the outside of the tire. When viewed under fluorescent light, the stripes appear to stand still when the speed of rotation of the bike wheel *exactly* equals 15 mph. Since the strip is

(Please turn to page 38J)



Spoke magnets pass relay, send pulses to timing circuit. Revs are counted, con-

verted to miles per hour for display on LCD. Circuit is solid-state.

You can get . . . Five Major Woodworking Tools in 12 sq. ft. - with Shopsmith!

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many things and ends up doing nothing well. It is
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parts that make up every stationary
power tool: 1) a motor 2) a spindle 3) a table
rest in the lathe 4) and bench.

Attaching various tools (saw blades, drill
bits, etc.) to the spindle and changing the
relationship of the operating tool to the
table. Shopsmith performs each tool opera-
tion in the conventional tool manner.

Simple to Use

Equipped with every machine is a well illus-
trated book that takes you step-by-step
through the tool changeovers. After a few
minutes of practice you'll be making change-
overs in less than 60 seconds.

**Don't be confused. Some critic's ob-
ject that you're "always changing over"
isn't so! Woodworking isn't done by
switching from one tool to another, you plan
your projects so you do your sawing, then
drilling, etc.**

Shopsmith owner Fred Wescott of North
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about frequent lengthy changeovers from
people who do not own Shopsmith, but I've
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Different tools and operations require differ-
ent speeds. The Shopsmith exclusive speed
control allows for speed adjustment, while motor
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craftsman or beginner, the Mark V will do the
same for both. Precision positive stops,
ability for micro-adjustments, and convenient
ready-to-use jigs make it possible.

It's Costly To Duplicate

Compare Shopsmith feature to feature and
capacity to capacity to individual power
tools. You're in for a real surprise! To dupli-
cate the features and capacities of the Mark V
in individual tools, would require buying
commercial tools at three times the cost of a
Mark V. Many features can't be duplicated at
any price!

Of course you could purchase a table saw,
sander, drill press, and lathe at less than
commercial prices. But, even then, the table
saw and drill press would cost as much or
more than a Mark V.

Project Savings Justify

Over the years the Mark V will pay for itself
many times over. No matter how small or big
your project is, your Mark V and you can
do it for less than hiring it done or buying it.
From making a bird house to building a
grandfather clock, you'll save by doing-it-
yourself.

Commercial Uses

The versatility and accuracy plus the space
saving feature of the Mark V make it the ideal
tool for maintenance departments of hospi-
tals, schools, industrial plants, apartment
complexes, or anywhere a woodworking shop
must be set up in limited space and on a lim-
ited budget.

Shopsmith Mark V's are used in schools to
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Wherever there is a need for a woodworking
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We know the Mark V is the best tool for you.
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other woodworkers have made the decision
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tool(s) for you. Send for informative bro-
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The Mark V as a 10" table saw, gives
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mits power sawing of hardwoods.
Use your Mark V for ripping, cross-
cutting, mitering, beveling, molding,
tenoning, grooving, rabbeting and
dadoing.

The Mark V as a 12" disc
sander gives you opera-
tions not possible on
other sanders. Like fin-
ishing edges to precise
dimensions. It's actually
a jointing operation and
is done by setting the rip
fence at a slight angle to
the disc. Sanding dupli-
cate pieces to exact
lengths is another Mark V
exclusive.



The Mark V as a lathe
offers exceptional ca-
pacity with a 16½" swing
for faceplate turning. Ex-
clusive Speed Dial allows
a speed range of 700 to
5200 rpm. Use your
SHOPSMITH Mark V for
spindle turning, faceplate
turning, concentric drill-
ing, taper turning, and
metal spinning.



The Mark V as a horizon-
tal boring machine per-
mits perfect dowelling.
Material is laid flat on
large 14" x 18-3/8" table
and backed up by rip
fence. Exclusive feed
stop assures all holes
will be exactly the same
depth. Lock the table at
a specific height for perfect
alignment of holes at
same level. Unlimited ca-
pacity for mortising and
concentric drilling.



The Mark V as a 16½"
vertical drill press can be
setup to drill perfect
screw pockets. The rip
fence and tilting table
form a V-block for hold-
ing material. Time is
saved on every drilling
operation because the
Mark V has depth control
dial, ready made jigs, and
the right speed for every
operation without belt
changes. Use your Mark
V for drilling, mortising,
routing, shaping, metal
drilling, reaming.



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Dept. 1580, Vandalia, Ohio 45377

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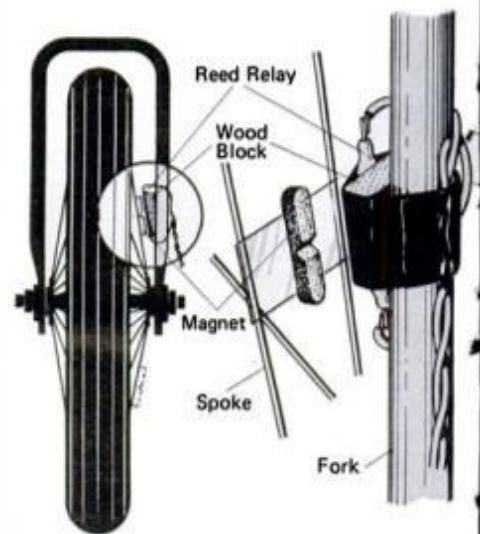
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HOW TO BIKE BY THE NUMBERS

(Continued from page 38H)

taped to the outside of the tire, variations in wheel size have no effect on the calibration, as they would in cable speedometers.

The potentiometer is adjusted until the speedometer reads 15 mph



Reed switch on fork closes when one of two magnets on spokes passes. Closing sends pulses counted by speed computer.

while the wheel is turning and the stripes seem to be standing still. Once this is done, you can assume the speedometer is calibrated for all speeds. A cover can be placed over the can case.

Resistors, capacitors, diodes, ICs and other electronic parts for the speedometer are available in electronics hobby stores, such as Radio Shack. If you haven't printed your own circuit boards before, an etched and drilled board for the speedometer, as well as LCD and tiger's tail calibrator, is available from LAT Enterprises, Box 12, Meacham Branch, Elmont, N.Y. 11003.

Just remember, when you take your first speed sprint, watch out for trees and cars!

PARTS LIST

Resistors

R3 and R5 are 10,000 ohms. R2, R6, R7, and R10 are 30,000 ohms. R1, R11, R12, and R15 are 300,000 ohms. R13 and R14 are 100,000 ohms. R9 is 3,300 ohms. R4 is one megohm. R8 is a 500,000-ohm potentiometer.

Capacitors

C1, C2, C3, C8, C9, C11 and C13 are .01 microfarad disc ceramics. C4, C6, C7 and C12 are 10 microfarad. C5 and C10 are 1 microfarad.

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5/16 No. 10 No. 8 No. 6
5/16 No. 10 No. 8 No. 6
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260 Flat washers	3mm to 8mm
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HINTS FROM READERS

Hoof pick is good shop tool



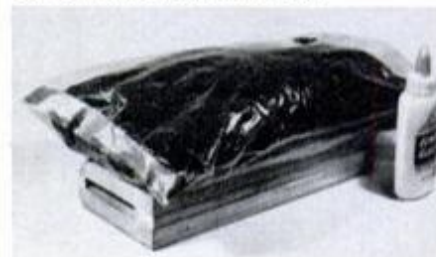
A horse hoof pick ground or filed to a point (or squared) can help scrape surfaces, pry pieces apart and more.—*Clyde L. Sargent* (If you can't get picks, send \$2.75 plus 85 cents handling per pick to Kennedy-Foster, 855 Bloomfield Ave., Clifton, N.J. 07012.)

Oil inconvenient places



To reach hard-to-get-at oil cups, slip a small-bore tube from a hospital intravenous setup over a pump oilcan spout. Insert brass or copper tubing in other end. On the metal tube end, file a hook to lift oil cap.—*Parry Yob*

Cover for shop sandbag



Improve a sandbag used in the shop or around the house by covering it with a plastic bag. This helps confine any fine sand that sifts through the cloth bag and shields the cloth from glue, paint and grease.—*Walter E. Burton*



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IMPORTS & MOTORSPORTS



Volvo 262C features first production application of Lambda-sond to a Vee engine.

1978 Volvos

Imagine those fierce, no-nonsense Vikings, builders of swift, seaworthy craft, tripping off to Venice to study the art of gondola styling. Preposterous. But the modern-day Vikings who designed the respected Volvo sedans did go off to Italy to try to pretty up a 260 sedan so it could be sold as a prestige car. They got it gondolized all right, by Italian coachbuilder, Bertone. The squashed-roof coupe is in showrooms now and is called the 262C. If you go in to test it, Volvo fans, compress your necks (at least the gaily striped shelters in gondolas have good headroom!), gaze on all that pleated upholstery and elm veneer, contemplate the regal crown that's stuck on the vinyl roof, and wonder whether this \$15,000 car will turn the heads of car shoppers with a Mark V mentality. It's supposed to. But if it doesn't, and if the prestige market doesn't appreciate the Volvo heart under the Bertone skin, then the 262C will go down as just another over-made-up face and Volvo will have learned the hard way to stick to the solid sedans they know how to do so well.

The 264GL sedan for 1978, and 265GL wagon are prestigious enough, I would think, for Volvo not to need this new "flagship" at all. Even the 240 series—the 242DL, 244DL and 245DL—are substantial, if not glamorous cars



Best of the breed: 1978 Volvo 242GT.

for car buyers who are looking for more value and function and fewer frills.

The real star of the '78 model lineup is the 242GT—an enthusiast's version of the two-door sedan. It's done in eye-catching silver, but it ain't just paint that distinguishes this GT from the 242DLs. Between you and the road are stiffer springs and shocks; thicker, competition anti-sway bar up front; Pirelli CN-36s and rack and pinion steering with power (but not enough to get between your fingertips and the road). The extraordinary roadability and handling make you want to find excuses to drive it all day. It's the 242GT that's really the flagship of the Vikings' 1978 model lineup.

Diesels—how economical?



Mileage champs. For mpg see text.

"Here's a gallon of fuel, see how far you can go!" That's a challenge that's become harder and harder to resist. In fact, it's turned into something of a fad for bright students to pick up the fuel-economy gauntlet and ease on down, ease on down the road. If you read PM's December '77 issue (*Talk About Mileage . . . Would You Believe 1000 MPG?* page 80), you know that the 1000-mpg barrier was broken by several machines powered by gasoline engines. Well, a follow-up to that competition was held for diesel-powered vehicles. The winner ran an air-cooled, single-cylinder diesel

of less than one horsepower in the vehicle shown below, left, and he hit . . . I'd like to keep you guessing longer . . . and hit: one-thousand, five-hundred and eighty-five miles per gallon! That's 1585 mpg. At that rate, if the winner had a one-gallon reserve tank, he could have crossed the United States!

The second-placer (left in the photo) got 1470 miles with his gallon. Both vehicles were designed and built by apprentices in Daimler-Benz's training program in Germany. The winner drove his 125-pound, bicycle-wheeled machine using the "burst" technique: He accelerated slowly up to about 30 mph and then coasted until his speed dropped to 18 mph and then eased up to 30 again. Rudolf Diesel would be proud.

What's that clunker worth?

If I had kept my 1948 Pontiac convertible it would be thirty years old this year . . . and worth \$2500. If I had let it go to pot, but still restorable, it would be worth about \$400. How do I know? All the going prices for cars from 1900 to 1960 are in Old Cars' 1978 Price Guide. Prices are given on a 1 to 5 scale depending on condition, and the price of this

Good reference.

fascinating, 130-page book is only \$1.95. Another goody from the same publisher is the '78 Old Cars calendar (\$2). Each month features a different old car photo in color, and significant dates are flagged. What happened Feb. 16th? The Studebaker Co. was established . . . in 1852. Next question? Krause Publications, 700 East State St., Iola, Wis. 54945. **PM**



Economical Family Transportation Doesn't Have To Be Dull.

IT'S MORE FUN TO TAKE THE BUS.

Has the size of your family driven you into a car you can't afford? Does the car that fits your budget squeeze the fun out of your family? If so, you've missed the Bus. The 1978 Volkswagen Bus.

The '78 Bus costs less than most big station wagons. And to run, it's ahead by miles. The Bus' peppy, fuel-injected, two-liter engine is not only quiet, it's also very economical. It helps the Bus deliver an estimated 25 mpg on the highway, 17 in the city with standard transmission, according to the 1978 EPA tests. (Of course, actual mileage may vary

depending on how and where you drive, optional equipment, such as automatic transmission, and the condition of your Bus.)

And nothing beats the Bus for family fun. It's easy to park, easy to handle, and it gives everyone in your family enough elbow room to relax in comfort. With space left over for your dog, your luggage, or just about anything else you want to carry. The Bus is 70% roomier inside than a full-sized domestic station wagon. And with the Bus' eight picture windows, everyone in the family gets the best seat in the

house. And that's not all. The VW Bus is very versatile. The rear seat folds down to provide extra carrying space and that rear hatch and big sliding door lets you load everything from antiques to zithers.

So, when you want to uncramp your family's style, nothing compares to the Bus.

See your Volkswagen dealer today. And prove to yourself it's more fun to take the Bus. The 1978 Volkswagen Bus.

©Volkswagen of America, Inc.



DETROIT LISTENING POST

Why new cars take longer

Engineers working on down-the-road cars say it is becoming increasingly difficult to stay flexible and innovate as new cars take shape. The normal incubation period for a new car used to be three to four years. Give or take. Several years ago General Motors developed a computer program for designing cars that speeded the time up to something like 27 months. But that was pushing it and the average time from scratch pad to job one was three to four years.

There are so many government regulations automakers have to observe, regulations that have to be dovetailed with other regulations, that the start-to-finish time for a new car is now approaching seven years. It's not that any one rule is so tough. The tough part is integrating each individual regulation with all the other regulations. The 1985 cars are all but locked up right now. If something really new comes along between now and 1985, the companies can still squeeze it in. But that's a costly proposition because if a late change is made on car A, it has to be related to cars B, C and D. You can't reposition one domino without knocking down the other dominoes.

Chrysler to take big crown

Chrysler figures to have the biggest cars produced in the United States after 1980. Not by much, but by an inch or two. Chrysler's turn at shrinking its full-size cars will come next fall. They will be 11 inches shorter than the current cars. But Ford will still be the King of Big for another year, until 1980 when Lincoln and Continental are sized down. Ford will follow GM's lead of last year and reduce overall big-car length 12 to 14 inches.

GM goes to six-year cycle

GM has confirmed that its B cars—the big jobs—will undergo a major reworking for the 1983 model year. GM says the cars will be 700 pounds lighter than present versions. The interesting angle on this is that GM has put its big cars on a six-year cycle. The Bs were all-new for 1977—that is, fall of 1976—and the next change will be fall of 1982. All carmakers are stretching the

time between major redos. Ten years ago a body would be used for three years. The cycle now is five to six years minimum. A few vintage jobs haven't had a major body change in seven to eight years.

Old engines plague engineers

On the subject of making cars lighter, a la GM's 1983 products, the part of the car giving engineers the biggest headache is the engine. Most engines used today were designed for big cars—bigger than the '78s—and there's only so much that can be done to rework them for smaller cars. It's like trying to shrink the works from an alarm clock to fit in a wristwatch. What's needed is a new generation of engines. Nothing exotic, but designs that will take advantage of new technology, new materials, miniaturization, simplification. "What we'd like to do," to quote a guy at Chrysler, "is junk everything and start all over." If that's what it takes, why not do it? Because of the cost of starting over. A new engine and a new line to turn it out can easily run \$100 million. New engines will come along, but it will take something like eight to 10 years to weed out all the old-timers.

GM's goal to curb rust

All the companies are making a strong pitch this year about steps they've taken to protect cars against rust. But if you read the fine print, you will notice nobody guarantees the car against rusting out. The new cars are more resistant to rust, but not rustproof. The experts doubt Detroit will ever offer a car guaranteed not to rust under any and all conditions. But the companies expect to do a lot better. Paul Pender, a GM v.p. who heads up Fisher Body, says GM's goal is to build a car that will not show "cosmetic corrosion" for five years and no rust penetration for 10 years. I'd settle for that.

Olds diesel on target

There's a rumor going around that Oldsmobile is having trouble with its diesel engine. Not so. The story got started because people who have ordered diesel cars can't get dealers to give a date on when the cars will be delivered. The customers figure

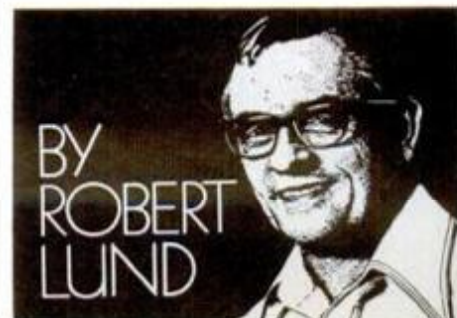
if the dealer can't get a delivery date out of the factory, something is wrong. I checked with Olds and the company admits they got off to a slow start with the new engine. The day I called they were turning diesels out at a rate of only 35 a day. That has since accelerated. GM has a bundle riding on the success or failure of the Olds engine. If there's a goof-up at the beginning, GM will have problems selling diesel cars for umpteen years to come. So Olds is taking it easy on the first run of oil-burners to make them as goofproof as possible.

Fiesta in short supply

Another car that's difficult to get a delivery date on is Ford's Fiesta. The waiting list on Fiesta was three to four months as of the time this issue of PM went to press. Ford isn't eager to increase imports of the car from Europe for two reasons: 1. Ford of Europe says it could sell all the cars it can build without shipping a single unit to the United States. 2. The government will allow Ford to count only 75,200 Fiestas in determining the company's CAFE number. CAFE stands for Corporate Average Fuel Economy. All cars produced by a company during the '78 model run must average out to no less than 18 mpg. So there's no advantage to Ford in bringing in more Fiestas—over the 75,000—to hike its CAFE count.

Ford aiming high on MPG

Son-of-Pinto coming in 1980 or '81 as a replacement for Fiesta will give the best gas mileage of any vehicle Ford has produced in 75 years of automaking. The highway rating will surpass 50 mpg and could be as high as 55 mpg. Combined City/highway rating will top 40 mpg. **PM**



Warning: The Surgeon General Has Determined
That Cigarette Smoking Is Dangerous to Your Health.

16-mg. "tar", 1.0 mg. nicotine av.
per cigarette, FTC Report Aug. '77

Viceroy

More Tobacco, Less 'Tar'
than Winston or Marlboro.

Rich, full flavor
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And it's a promise that Viceroy keeps.
The method for delivering flavor is
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'tar' blend than Winston or Marlboro.

The result is a mild, fully packed
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And, yes, lower 'tar' than Winston
or Marlboro.



VICEROY 16 MGS. TAR; WINSTON 19 MGS. TAR; MARLBORO 17
MGS. TAR; AVERAGE PER CIGARETTE, FTC REPORT, AUG. 1977

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Leads the way.

Limited time offer expires March 31, 1978. Claims postmarked after April 15, 1978 will not be honored.

The Coleman Company, Inc., Recreational Vehicle Products, Wichita, Kansas 67201

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SCIENCE WORLDWIDE

New organism discovered

Tiny marine animals never before seen by man have been recovered alive from the mud under the ice-covered Ross Sea in Antarctica, according to the National Science Foundation. The one-celled, gray-brown organisms resemble miniature trees whose branches reach out to catch food. They are as yet unnamed.

Paging windmill owners

If you own a windmill that is used to produce electricity, you can help the Dept. of Energy by contacting Prof. Robert Ferber at the University of Illinois. He is conducting a nationwide study to determine how many such windmills there are, where they are and who made them.

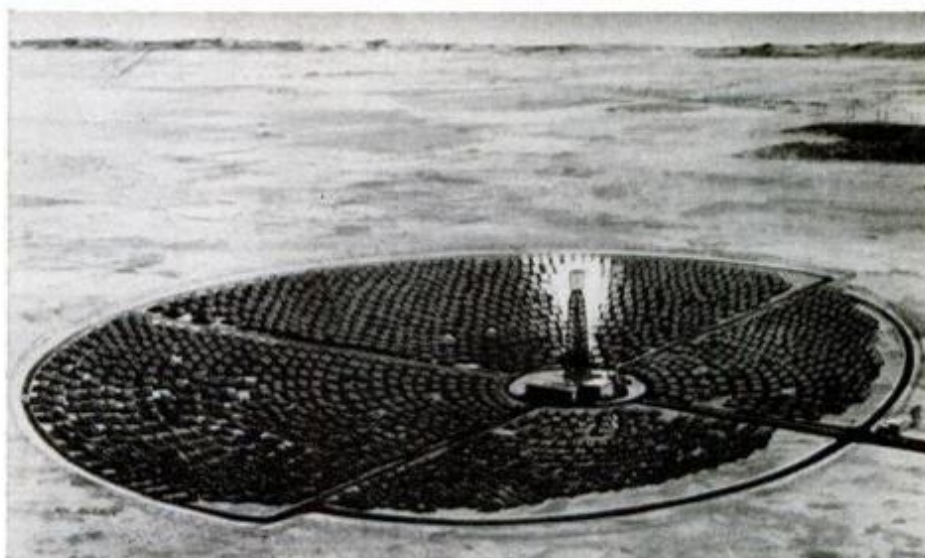
The experience of owners will indicate under what conditions privately owned windmills are most effective and the benefits and problems that future owners might expect to encounter. The information should also help in the design and improvement of windmills used in the generation of electricity. If you own such a rig and want to participate, write to: Prof. R. Ferber, Survey Research Laboratory, University of Illinois, 414 David Kinley Hall, Urbana, Ill. 61801.



Researcher checks contour of mountain.

Move mountain into the lab

These days, even mountain air may be less than bracing—and thus deserving of intensified study. One lab where such work is in progress is located at Research Triangle Park, N.C., where Northrop Corp. researchers build precision models of mountains. Using a wind tunnel, the scientists study the complex flow characteristics of pollutants and atmospheric turbulence in the vicinity of a mountain.



New solar power concept: Boiler on tower is target of 1800 sun-reflecting mirrors.

More facts for consumers

A pilot program aimed at providing consumers with more meaningful information about products they buy is being formulated by the Department of Commerce. The department is soliciting advice from consumers and industry on products that should be labeled and what the labels should say to allow shoppers to compare how different brands will perform. The National Bureau of Standards is providing technical support to the program.

Examples of information that might be incorporated into labels include vacuum cleaner noise levels, durability of textiles and carpeting, and breaking strength of toys.

A transplant scorecard

Of the 338 individuals who received heart transplants in the past decade, 77 are still alive, with the longest survival time recorded as 8.7 years. These statistics were reported in a recent issue of the *Journal of the American Medical Assn.* The report also states that 302 individuals received transplanted livers and that 47 of these patients are still alive; longest survival time: 7.5 years.

The record is poor for persons receiving transplanted lungs. None of the 37 individuals given new lungs during the decade is now alive. The longest survival with a donor lung was 10 months.

Future solar powerplant

Solar power schemes are a dime a dozen these days. Some are destined

never to make it off the drawing board, but some undoubtedly will see the light of day and become scapes. One that may alter the scene, near Barstow, Calif., is shown above.

It's a concept for a solar powerplant that uses 1800 mirrors to concentrate the sun's rays on a boiler atop a 283-foot tower. Though the mirrors appear tiny in the drawing above, each is designed to be more than 400 square feet in area.

The mirrors will be controlled by a computer so that they will continuously follow the sun to beam heat at the boiler. Boiler heat then will be used for the generation of electricity.

The Energy Research and Development Administration (ERDA) plans to award contracts this year for the experimental 10-megawatt plant. It's hoped the installation will be ready for operation late in 1980 or early in 1981. The concept was developed for ERDA by scientists at the McDonnell Douglas Corp. **PM**

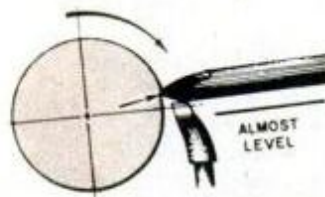
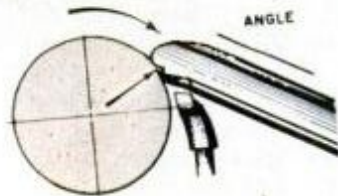


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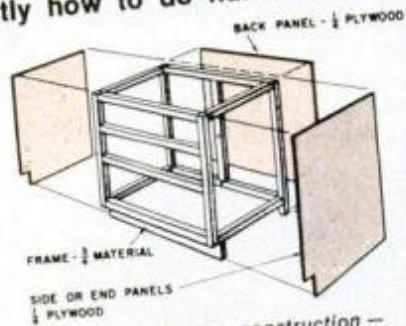
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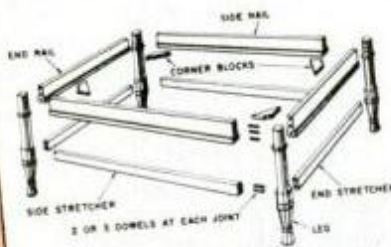
The two basic methods of turning on a lathe: cutting (top) and scraping.



This is frame construction—often used in kitchen cabinets.



When sharpening a hand saw, make sure the file is level as the stroke is made.



Exploded view of coffee table showing leg-and-nail construction using dowels and corner blocks.

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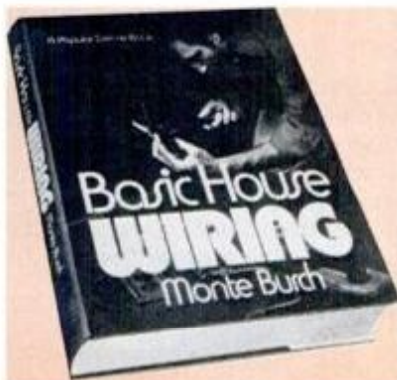
If you're like most do-it-yourselfers, you probably do most of the routine woodworking jobs around the house yourself and *pay* to get the fancier work done. Yet the real satisfaction of woodworking comes from doing those fancy jobs yourself: making a wall of handsomely grained built-ins . . . wood-panelling an entire room . . . constructing a table with a perfectly matched veneer top. Yes, you can do all of these fancy jobs yourself *even without experience* when you've got a copy of **CABINETMAKING AND MILLWORK** as your guide.

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This brand-new book was custom written especially for Popular Science Book Club. It tells you everything you need to know to install, repair, improve and troubleshoot the entire electrical system in your home.

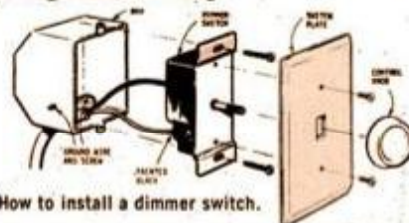
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Nova, with its standard 250 Cu. In. 6-cylinder engine and manual transmission, achieved those EPA estimates. Manual transmission not available in California, where estimates are 21 mpg highway, 15 city, with available automatic transmission. Your mileage depends on how and where you drive, your car's condition and

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*Manufacturer's suggested retail price for Nova Coupe, including dealer preparation. Available full wheel covers (\$37) and white stripe tires (\$36) shown. Tax, license, destination charges and available equipment are additional. Priced higher in California.

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PM WORKBENCH

PM EXAMINES PRODUCTS AND SERVICES

Carbide sharpening tool

I learned about this handy aid at the National Hardware Show. It's a hand tool for sharpening carbide cutters such as circular-saw blades, masonry drills, reamers, inserts and other carbide products. The sharp-



A few strokes across tooth restore edge



Sharpener comes in blister package.

ening surface—which consists of diamond particles embedded in resinous glues—is claimed to give service indefinitely when properly used. \$5.95 at hardware stores or write to Lifetime Carbide Co., Colton, Ore. 97017 for nearest dealer.—H.W.

Wood-stove manual

How to select or build the proper wood stove for your needs and tips on using it for maximum benefit are discussed in *Wood Stoves: How to*

Make and Use Them, by Ole Wik.

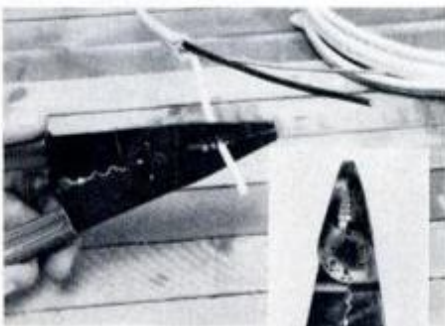
Part I tells the variety of stoves, ovens, stovepipes and accessories available. It also gives useful information on firewood—where to get it and how to use it for best results in homemade and commercial stoves—whether the stove is used as a cooking range, oven or heater.

Part II gives step-by-step instructions for building the widely used three-way oil barrel stove (designed so it functions with either cooking surface up, or set upright as a heater). The paperback book is \$5.95 from Alaska Northwest Publishing Co., Box 4-EEE, Anchorage, Alaska 99509.—P.A.

Save energy, feel warmer

When humidity in your home is increased, you will feel more comfortable. With a room temperature of 60° F. and a recommended relative humidity of 35 percent when the outside temperature is 20° F. or above, you will feel as comfortable as if the temperature were higher and the relative humidity were only 15 percent. For more data, send for *Humidification Facts*, Research Products Corp., Box 1467, Madison, Wis. 53701. It's free.—H.W.

First-class wire tool



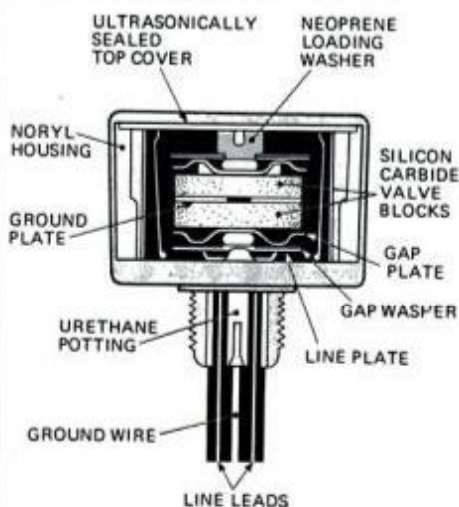
Tool strips wire without harming conductor.

Channellock's newest wire tool has a lot going for it. You can strip electric wire, cut small bolts and wire, crimp insulated and non-insulated wires for solderless connections and turn tight radii in wire with its longnose jaws. The cushion-grip plastic handles make this a comfortable tool to use—I learned that on a recent all-day wiring session. At hardware stores, Model 908-G \$8.90. Channellock, Inc., Meadville, Pa. 16335—H.W.

Secondary surge arrester



Small device gives big protection.



Silicon carbide valve blocks provide lightning surges with a low-resistance path to ground. Insulating ceramic collar assures surge current containment; metalized contact surfaces distribute surge currents evenly within block.

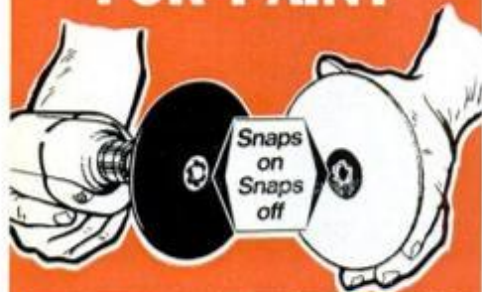
Millions of dollars in damage occur every year because of lightning damage to residences, farms and businesses. A secondary surge protector diverts lightning and power surges quickly and safely to the ground.

This version is easily installed on the house service entrance panel by mounting it in a side knockout; for single-phase 240-volt service, you attach its white wire to ground bus and the black wire to incoming power.

Model J9200-10, \$15 at hardware and electrical stores. For information, write Joslyn Mfg. and Supply Co., 2 North Riverside, Chicago, Ill. 60606.—H.W.

If you've come across a new product with some special features, let us know about it. Write to PM Workbench, Popular Mechanics, 224 West 57th St., New York, N.Y. 10019.

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Cleans easily
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Won't snag on
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10 to 1

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Please send one Power-Lock Kit No. PLK-5. Contains three 5" dia. discs in asst. grits and 1/4" shank holder. . . . **\$5.29**

Replacement discs, 5" dia., four discs per pack: Coarse 40 grit Medium 80 Fine 120 per pkg. **\$3.49**
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Sorry, no C.O.D's.

PM

IT'S NEW NOW

Easy-mount motorcycle carrier

Haul your motorcycle on a ramp rack that attaches to vans and motor homes. Two models: \$149.95 and \$249.95. Hall-Rack Corp., 304 North Water St., Kent, Ohio 44240.



Bathtub puddle preventer

Plastic splash guard channels shower spray into bathtub to help avoid water damage and slipping on wet floor. Kit of two, about \$9.95. Waterguide, Inc., 8700 Southwest 26th, Portland, Ore. 97219.



Noble steed comes 'round again

Real horse power can be harnessed for needed energy, as a U.N. exhibit in Geneva shows. A horse, with generator and gears, provides enough electricity to light about 12 60-watt bulbs.



Bicycling nowhere at high speed

Riding high in Belgium these days is a new sport—racing stationary bicycles. Mounted on rollers, they can top 70 mph. A clock (right) hooked to bikes shows who pedaled the "course" first. Observers pay admission to bet on their favorites.

For outstanding engineering achievement in television, General Electric has won an Emmy.



The National Academy of Television Arts and Sciences has honored General Electric for 'The First Application of the Vertical Interval Reference (VIR) Signal System to Television Receivers.'

The VIR signal was designed by a TV industry committee to correct distortions in the TV color signal as it passed from network sources, through communications systems, to homes. The development of VIR was a big step in color broadcasting.

The next challenge was to design a TV set that could use it. General Electric developed the VIR Broadcast Controlled Color System. And won an Emmy for being the first to use VIR in TV sets.

GE VIR color sets have computer-like circuitry

which uses the broadcaster's VIR signal to automatically adjust color and tint, sixty times a second, on many programs.

You owe it to yourself to see GE VIR color TV in action before you buy a new set. See a demonstration today.



Cabinet Walnut finish on high impact plastic

THIS IS GE PERFORMANCE TELEVISION

GENERAL  ELECTRIC

New gadgets to outguess fish

What waters do fish favor?
Analysis meters try to tell.

by Bill McKeown
OUTDOORS EDITOR

Now there's a pHish Meter (pronounced "fish")—said to be the newest, most sophisticated answer for catching those lunkers.

First came Fathometers, those clever electronic sonar devices designed to warn steamships of icebergs and later found to locate water depths, submarines—and fish. One of the first amateur-size units to be marketed after World War II was the Lowrance Fish Lo-K-Tor. Then came meters that read water temperature, water color, water oxygen content and even show "pictures" of your lunker on recording graph paper or a TV-type screen, a kind of underwater radar that has an adjustable-angle sweep to point which direction fish are from a boat, and about how far, how deep and how big.

Electronic water tasting

But this latest invention goes one big step farther. Lowrance Electronics in Tulsa, Okla., largest of the sport fishing sonar manufacturers, is introducing the \$199 device that measures the degree of acidity or basicity (alkalinity) in freshwater that bass seem to prefer. Research for 12 years by Dr. Loren Hill, ichthyologist at the University of Oklahoma, and for five years at Lowrance indicates that the base or acid condition of water—the pH content—is 50 percent more significant than the dissolved oxygen content and 30 percent more significant than temperature. At least it is to a fish if he has a choice, according to laboratory and lake experiments.

The four important factors that control pH content of a lake, reservoir or pond, are the photosynthesis of plant life in the water, rainfall, decomposition of plant life in the water and seasonal changes. Tests seem to show that if the pH content is too high, bass may be unable to "breathe" even in oxygen-rich water



Performance test of the Lowrance LPH-100 pHish Meter (top) gets under way in the deep waters of Lake Powell, Ariz., as Russ Jensen, Wahweap Marina fishing guide, Bill Akers, Lowrance Electronics, and meter developer Dr. Loren Hill, Oklahoma U. professor, rig up their outboard to locate bass area with best chemical balance.

and may move to an area with less oxygen but better pH conditions.

Locating happy bass

Water that is neutral in pH content with equal acid and alkaline concentrations is rated at pH 7. If the new pHish Meter reads pH 8, the water is 10 times more alkaline; a reading of 6 indicates 10 times more acidity than the neutral 7 condition. A small change in meter readings will show a large chemical difference in the water.

So where are the fish? Researchers have found that bass prefer a pH range of 6.7 to 9.6. Their favorite area would be nearly neutral water with a touch of alkalinity that would show up on the meter between 7.5 to 7.9. This is given as a reason why fish concentrations are sometimes found where oxygen and/or temperature conditions are less favorable.

Extra accuracy is claimed for Humminbird depth sounders with new Techsonic transducer that mounts under trolling motor.



How it works

For the fishing detective tracking bass to their favorite hole the procedure is to lower the probe unit on the end of a wire from the Lowrance LPH-100 pHish Meter. The meter dial can be mounted flush on the dash of a bass boat or any other convenient location it can be seen. Powered by the boat's 12-volt battery system, the instrument is reported to give accurate readings even at cruising speed, but presumably it will be read while it is slowly working over an area.

Lowered to a depth to be checked, the probe acts as a small battery and produces millivolts created by the pH conditions. At 7 no voltage is created; at an acidic pH 6, the unit turns out 60 positive millivolts, while at an alkaline 8, it would produce 60 negative millivolts.

Obviously the new meter will not replace the other electronic aids that delight ardent bass fishermen, but it should be a major aid in indicating where fish prefer to be. Now how about a meter showing how hungry the fish are and what they'd prefer for breakfast?

Also newly available are waterproof fish finders, more sensitive underwater scanners and troll-motor-mounted transducers. All should help keep fishermen busy when the fish aren't biting.

Face the facts... and you'll buy a Jeep Pickup



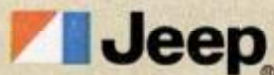
There are 4-wheel drive pickups and there is the 4-wheel drive **Jeep J-10 Pickup**. If you think they're the same, you're in for an education. Jeep Pickup has **4-wheel drive that's built-in**, not added on like an option—that's the only way we make them. Jeep Pickup is the only pickup to offer optional **Quadra-Trac™**, Jeep's exclusive automatic 4-wheel drive, the system that's unsurpassed by the competition—to give you super traction. Jeep Pickup's **load capacity is 2199 lbs.*** That's greater than Ford, Chevy or Dodge!! Jeep Pickup has a **higher ground clearance** than all its



competitors so rocks won't stop you. Jeep Pickup does not have to recalibrate its springs like the competition to gain greater ground clearance, so you get a **more stable ride** without that "on-stilts" look. Jeep Pickup has a **long wheelbase** for a smoother ride on road or off. Jeep Pickup has a **lower tailgate loading height** for convenience and a **short hood** for better visibility. Jeep Pickup has **more engine choices** than the competition. You pick the size you need. Face the facts—the 4-wheel drive **Jeep Pickup has no competition!**

*Based on available specifications, June 1977

Jeep Corporation is a subsidiary of American Motors Corp.



Jeep wrote the book on 4-wheel drive .

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CAR CLINIC

SOLUTIONS FOR MECHANICAL HEADACHES

BY MORT SCHULTZ



Charge it to experience

My 1973 Dodge Charger (318-cu.-in. engine) doesn't like water pumps. It has ruined three in four years and is now in the process of killing off another. When the last pump was replaced late in 1976, I noticed that the face of the engine block was marked as if something had been scraping against it. Is this indicative of something? Mechanics here just replace pumps, but no one can tell me why it's happening or how to keep it from recurring. Can you?—Edward C. Ziomek, Sterling Heights, Mich.

Why sure. It's happening because of an unbalanced condition. One or more cooling fan blades have probably been bent, throwing the water pump impeller out of balance. Marks on the engine block indicate that the impeller has been scraping against the block—not particularly healthy for a water pump.

What bent the fan blades in the first place? Maybe something from the road thrown against them, but more likely carelessness by someone working under the hood. Rx: replace the water pump and the fan-blade assembly.

Spicy advice

My problem has professional mechanics stumped. We own a 1974 Mercury Montego which recently had its disc brake pads replaced. Everything seems correct. However, when the brake pedal is applied, a high-pitched squeal is heard. What baffles us even more is that there are occasions when the brakes function quietly. New pads were put on three times, both discs were checked carefully and only one needed to be resurfaced, and the complete system has been checked many times. Can you offer us some much needed advice?—F. Spicer, Millville, N.J.

The condition is normal. My advice is that you stop spending money and learn to live with the occasional squeal.

Ford Motor Co. agrees. Here is what it says:

"Brake friction materials inherently generate noise and heat to dissipate energy. As a result, occasional squeal is normal and is aggravated by severe environmental conditions, such as cold, heat, wet, snow, salt, mud, etc. This occasional squeal is not a functional problem and does not indicate any loss in brake effectiveness."

Tarnished Eldorado

My problem is with the left rear tire of my 1970 Cadillac Eldorado. I'm on my third radial. Each one has worn itself down to the cord on the inside shoulder only. The outside stays practically new. I've had the frame and axle checked three different times. Help! Radial tires don't come cheap.—E.J. Wooters, Burlington, N.J.

From your description, it seems to me that an excessive negative camber condition exists. In the rear, this is caused by a damaged suspension or axle part. The part may be a bent wheel, damaged axle shaft, damaged hub assembly, bent axle tube, damaged upper or lower

control arms, worn stop bumper or maybe even a bad spring. Have someone expert in the mechanical makeup of the Eldorado check these possibilities again. Keep trying and you will find the offending part sooner or later.

Cramps in the plumbing

When my 1977 Aspen (225-cu.-in. engine with two-barrel carburetor) is cold, it starts right up. When it's hot and I let it sit longer than five minutes between starts, it is hard to start. Why?—Len Runnels, Roxana, Ill.

Because it has cramps in its bowl vent-to-charcoal canister plumbing. Fuel vapors that build up in the carburetor when a warm engine is shut down are supposed to escape from the bowl and be routed through a hose to a charcoal canister for filtration. If vapors can't escape, a percolation condition results, which is tantamount to choking the engine with fuel. The result is hard starting.

Check the system from bowl vent to canister, but before you tear things apart to look inside, examine those hoses. One of the main causes of this problem is improper routing of canister hoses. Hoses must not be higher than the canister. If they are, lower them. Vapors cannot negotiate a high hose and will back up into the carburetor bowl. After hose routing is verified, check ports on the bowl and canister to make sure they aren't clogged.

Keeping a steady pace

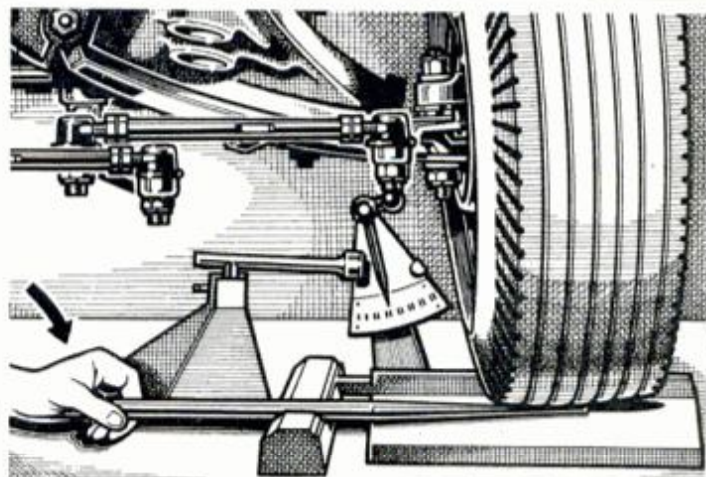
I own a 1975 AMC Pacer that is "governed" not to exceed 55 mph. Sound funny? Listen to this: When

(Please turn to page 62)



Balled facts

Inspecting ball joints is one job you may not be able to do yourself if you lack the necessary gauge, but it should be done every 15,000 miles. Ball joints of late-model GM cars have built-in gauges, but others have to be checked for looseness as shown here. If a ball joint should break suddenly, it can cause loss of steering and a serious accident. Ball joints can be tested when the front end of your car is having its wheel alignment adjusted.



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CAR CLINIC

(Continued from page 61)

the car goes at or above 55 mph for a while, the sparkplugs suddenly sound as if they have stopped firing. Sometimes the engine even stalls. But when I slow down, operation returns to normal. Have you ever heard of anything so ridiculous?—J. Schweiger, Baltimore.

I could tell you it's a government plot to keep everyone at the double nickel, but I won't. However, I will tell you that the car may have a weak ignition coil or fuel pump, either of which could be breaking down at higher speeds. And these two possibilities should be kept in mind, although there are other conditions I think may be really causing your problem.

AMC has been having trouble with the fuel-tank pickup filter clogging because of what is called Santa Claus fuzz (don't ask me why). This is minute sediment from gasoline that collects on the filter and blocks the flow of gas required for higher speed driving. The pickup filter originally put in this car at the factory was a 50-micron filter. It should be replaced with a newer, 62-micron filter.

If this doesn't straighten matters out, consider another possibility: Breakdown of AMC's Breakerless Inductive Discharge (BID) ignition (made for AMC by Prestolite). The symptoms you describe suggest a failure in the solid-state ignition unit box. The only accurate way to verify this is with a test instrument made by Prestolite. Maybe an AMC dealer in your area has one. If not, your alternative is to replace the box and hope for the best.

Tipping in

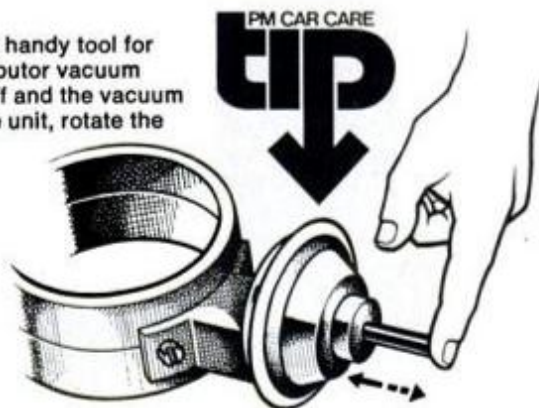
A 5-cent neoprene gasket bushing connecting the wiper motor arm to the wiper bracket assembly on my 1971 Ford Econoline van deteriorated. Ford dealers couldn't supply it, and wanted to replace the whole bracket assembly for both wipers. Cost? Get this—\$27 plus labor!

Determined to beat this ripoff, I applied 25 cents' worth of polyester putty used to repair fiberglass boats. You can get it from a marine supply dealer. It has held up and

PM finger tip

The tip of your index finger makes a handy tool for checking the operation of the distributor vacuum advance. With the distributor cap off and the vacuum line disconnected from the advance unit, rotate the distributor breaker plate until it reaches the limit of its full travel. Press your finger tightly over the nipple of the advance unit, and release and watch the breaker plate. Look for:

- A breaker plate that may move slightly, but remains in the advanced position. The vacuum advance unit is okay.
- A breaker plate that snaps back to its original position. The diaphragm in the advance unit has ruptured, and the unit should be replaced.



performed well for over two years.
—Joe Lessard, Zephyrhills, Fla.

Who says American ingenuity is dead? Good going, Joe.

Vexing Volare

My 1976 Plymouth Volare six-cylinder engine makes a valve-tapping sound when idling. I'm told a washer has been issued for placement on the rocker shaft to eliminate the noise. Do you know about this?—Carl O. Helstrom, Renovo, Pa.

No. Neither does Chrysler. I do know that if valves in this car aren't adjusted *exactly* to spec, you'll get noise. Specs call for .010 inch for intakes, .020 inch for exhausts. Adjustment is made with the engine hot.

Another critical adjustment is valve spring height. The distance from spring seat to retainer must be 1 5/8 to 1 11/16 inch. A 1/16-inch spacer is issued for this.

Service with a smile

My experience in solving a problem with my 1973 Ford service van with 360-cu.-in. engine could benefit other businessmen having the same trouble. In hot weather the engine refuses to start without long crank-

ing periods after it has been shut off for 5 to 15 minutes. This condition proved embarrassing to me, a refrigerator serviceman who makes frequent short stops.

If I let the truck sit idle for 30 minutes after stopping, the engine would respond immediately and start. I rebuilt the carburetor twice and gave the engine several tune-ups. I was about to give up when I noticed that the air-breather assembly was larger and sat lower on the engine than the one in my previous truck. On a hunch, I installed a custom breather, which is smaller and higher. The engine now fires promptly, no matter how long or short the downtime.—D. Alger, Crown Point, Ind.

Any time excessive heat concentrates near the carburetor, it will cause fuel to percolate, which floods the engine. Your solution is sound, but a less expensive one may be possible and should be tried before replacing the air breather. Lean out the fuel concentration by holding the accelerator pedal to the floor as you crank the engine.

SERVICE TIPS

■ If you own a 1978 Ford Fiesta, this tip can save you trouble and money. The

tire-wheel assembly bolts for this car must be tightened to between 52 and 70 foot-pounds. Further tightening can cause thread damage or broken bolts. The ½-in.-drive impact wrench used by service stations and garages are set at 100 to 120 foot-pounds. Get the picture? Don't let anyone use this wrench on your Fiesta.

■ Volkswagen has asked me to tell all you Beetle owners that although the Bug will no longer be sold in the United States you shouldn't worry about getting parts. Ulrich Fahrur, who is vice president of the corporate parts division, says, "Replacement parts—even for earlier models—will still be produced and will be available through the more than 1000 franchised dealers around the country."

■ Toe-in specs for your 1977 full-size Chevrolet have been changed. The old specification for resetting toe-in was 1/16 inch ± 1/16 inch, or 0.06 ± 0.06° (per wheel). The new specification is 1/8 inch ± 1/16 inch, or 0.12° ± 0.06°. Make a note. **PM**

GOT A PROBLEM WITH YOUR CAR?

Just ask Mort about it. Send your question to the Car Clinic, Popular Mechanics, 224 West 57th St., New York, N.Y. 10019. While letters cannot be answered individually, problems that are of general interest will be published in the column.

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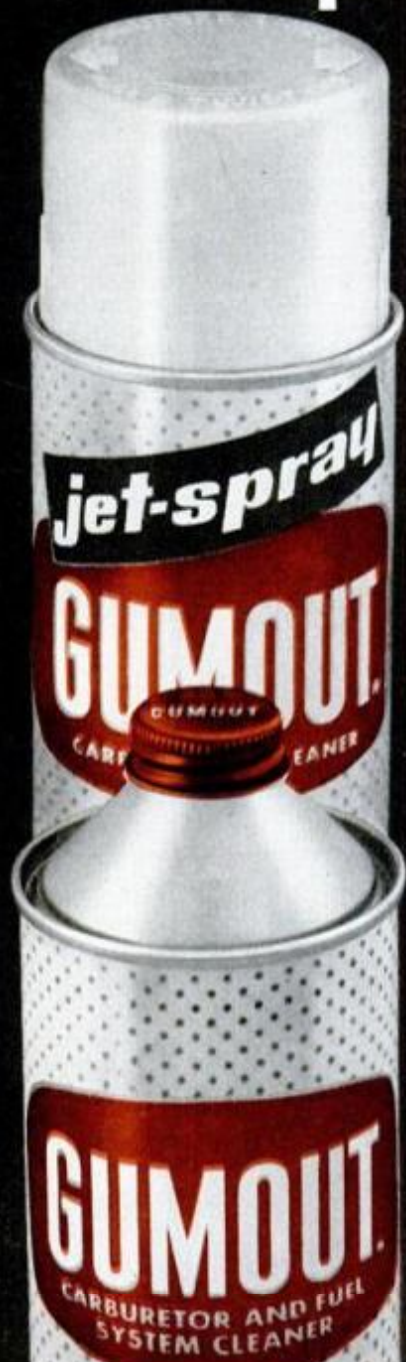
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IT'S NEW NOW



Eyeballing a missile

A new British-made system for the visual control of a missile is "worn" by a technician. A special lens is used for tracking the missile. Electronics in the helmet transmit the guidance signal.

No pain in the neck

As many photographers have learned to their annoyance, two cameras slung from the neck that keep banging together can be awkward. The Embee Carry-Pod provides stability and yet allows for quick switching from one camera to the other. The pod weighs but five ounces, costs \$19.95. The supplier is Antique and Classic Cameras, 403 Broadway, Kingston, N.Y. 12401.



Blimey, a flippin' flapjack!

As a promotional stunt, a new London restaurant arranged for the flipping of a 6-foot-diameter pancake, said to be the biggest ever made. The mammoth project required a specially made pan and flipping mechanism, both of which worked admirably. The 3½ gallons of batter contained 90 eggs.



One-piece wing skin

The largest composite part ever built for an aircraft, according to the maker, the McDonnell Douglas Corp., is a graphite-epoxy wing skin for the AV-8A Harrier, a V/STOL military plane scheduled for its first flight soon.



Look closely and you can actually see where we hid a case of Canadian Club.



There are more than 7 million stories in the Big Apple. And one of them is a hidden case of Canadian Club whisky that is yours ...if you can find it.

Begin your search for the world's finest tasting whisky at the

bottom of the world's 3rd tallest building. Immediately proceed by taxi in as straight a line as possible toward "The House that Ruth Built." Get out the second the meter reads \$3.65 and walk toward the wonderful sound of 196 fountains. Hop onto the nearest double-decker bus and ride the same number of blocks as there are bridges out of town.

You're getting very close.

Now stroll over to a familiar mounted officer and climb into one of the cabs waiting for you. Tell the driver to make a right, a left and a right.

It is now time to board a train that some think was named after the smoothest whisky in 87 lands. Get off at a station near Adam Van Den Berg's cow pasture. Without paying another fare, take another train three stops.

Say, "C.C., please" and the case is yours.

Walk two blocks toward the setting sun and half that distance toward the nearest city reservoir. There, at a very prominent address, higher up than the eye can see, someone is ready to hand you the case of Canadian Club when you say, "C.C., please."

But if for some reason you should get a little weary along the way, don't panic. The New York area has 10,848 bars and restaurants that will be delighted to serve you Canada's favorite Canadian.

Canadian Club

"The Best In The House"® in 87 lands.



Realizing your next car should be a truck.



There you were, strolling along the sidewalk, when all of a sudden you saw it, all big and red and tough and shiny, right in the middle of the showroom floor: a GMC pickup. Buy a truck—you? Oh well, it can't hurt to look can it?

What you'll discover first is how civilized a GMC is. Doesn't seem like a truck inside at all. The seating's really comfortable. The instrument panel's as nice as you'd find in a car. Look at all the creature comforts GMC makes available: power steering, automatic transmission, air conditioning, stereo, cruise control. And hey—vent windows!

Take it out for a test drive? Sure, what's life without a little adventure? Besides, anything with that good a view of the road is bound to be a ball to drive.

Sure is smooth-riding up here. What's that? You say it has coil spring front suspension? Nice. And all that cargo space—just imagine all the stuff a guy could haul back there.

Let's see now: it's comfortable, it's fun to drive, it's practical, and the whole thing just exudes character. You know, this GMC makes more sense every minute.

Besides, I always did like red. Sign me up.

GMC TRUCKS NEW & USED



GMC

Notnin' goes truckin' like a GMC.



MARK OF EXCELLENCE

IT'S NEW NOW

This was a small truck?

Yep, it was a Honda utility job—until a British design consultant replaced the body with a fiberglass shell to create a beach buggy. The rig seats five, gets 48 mpg, reportedly is a rugged performer. Back seats can be removed for hauling cargo. Roll bar provides protection.

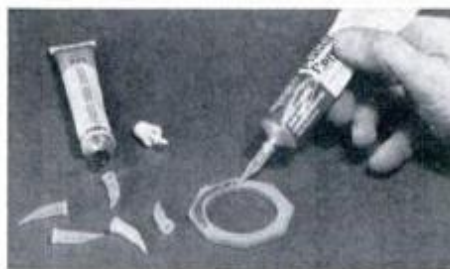


New boat has four hulls

A smooth ride—even in rough water—is said to be achieved by using two torpedo-like hulls, one above the other, on each side of a 72-passenger "seabus" catamaran under test in the West Indies.

A precision glue spreader

An angled plastic tip that fits most adhesive tubes makes it easy to glue small items. Tip curvature can be adjusted. Pack of 20 Mikro-Tips, \$2. Educational Products, Box 606, Mineola, N.Y. 11501.

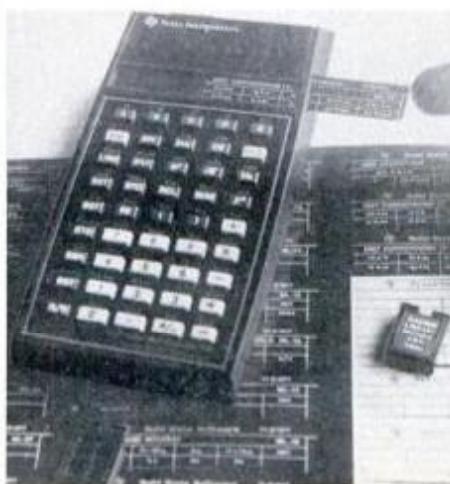


Just focus and shoot

Minolta's new XD-11 35-mm automatic SLR lets you choose either aperture or shutter speed—and the camera does the rest. An auto winder is one of many accessories. Price with f/1.7 lens: \$545.

Sophisticated calculator

The latest generation of pocket calculators—like Texas Instruments' TI-58—use plug-in modules (unit at lower right) to provide programs the calculator can draw on. The TI-58 retails for \$124.95.



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Like a professional rig, the OX5000 uses a combination of oxygen and compressed gas in separate cylinders. It's the only do-it-yourself rig that lets you control the fuel flow.

And like a professional rig, the BernzOmatic OX5000 can cut, weld, braze and solder. It even lets you do the work of a professional repairman.

The BernzOmatic OX5000 offers the added convenience of one-tip cutting and welding. It lights with one spark and can be turned off at any time. There are no hoses to crimp or break, no filters to clog plus you have a choice of either propane or Mapp® gas.

Get the professional welding rig that lets you do more yourself: the BernzOmatic OX5000. Now at your BernzOmatic dealer.



BERNZOMATIC®

*Registered trademark of AirCO, Inc.

PHOTO HINTS

Labeling film cans



Before I go afield with my cameras, I remove all the paper packing from my film. This cuts down on gadget-bag clutter, speeds re-loading and prevents littering. I stick small, pressure-sensitive labels on the film-can lids and mark them with abbreviations that tell me what's inside. When exposed film goes back into its can, I mark an X across the label and can tell used from unused film at a glance.

—Ken Oberrecht

Filter for chemicals

Aquarium filter wool makes an excellent filter material for dark-room chemicals poured back into their bottles for reuse. It's less expensive than absorbent cotton and drains faster. Moisten the filter wool slightly before placing it in the funnel, and use a separate chunk for each chemical you use.

—Grace Weinstein

Large-print trays



Occasionally you'll want to make a print larger than your biggest developing trays. Use cardboard water troughs (sold for wetting pre-pasted wallpaper), and seesaw the print quickly for even development. These trays sell in paint stores for about 50 cents, require little solution because they're narrow, and can be reused.—Ken Patterson

Richard Petty says,

"If you really want to learn how to repair cars, check out NRI home training."

You learn in your spare time and they give you the training and equipment you need to get you started in a hurry.

My Dad made auto mechanics out of us long before he'd let us enter a race... so I learned the importance of a good mechanic early... and the opportunities that are out there for well-trained men. That's why I'm sure glad to see training like the two NRI courses come along. With NRI, you learn at home in your spare time, at your own pace. And get solid, hands-on training for practical experience. It's a lot of training for the money.

Learn Auto Servicing Fast.

NRI's Basic Professional Repair Course covers the basics of auto repair in 30 "bite-size" lessons. From headlight to tail-light, you'll learn all you need to know, quickly. Your training includes important service equipment like an Inductive Pick-Up DC Timing Light, Diagnostic Analysis and Tune-Up Instrument, tune-up tool kit, and more.

Become a Professional Mechanic.

NRI's 70-lesson Master Automotive Technician Course includes all the equipment, tools, and training you need to be a real pro. In addition to carefully planned,

easy-to-digest lessons, you receive all the tools and equipment in the basic course plus a precise Ignition Analyzer Scope, Carburetor Air-Fuel Tester, and a Silent Vacuum Test Pump that helps you detect even the slightest air leakage. You'll learn to service electronic ignitions systems, vacuum controls, pollution control systems, fuel injection systems, auto air conditioning, brakes, and much more.

Train with the Leaders—NRI and McGraw-Hill.

No other school has NRI's experience in home training or McGraw-Hill's background in continuing education. Mail the coupon for a free catalog showing all the facts and describing the complete course. Over a million students have trained at home the NRI way. You can too. If the



Richard Petty,
NRI Automotive
Consultant,
and America's
Winningest
Stock Car
Driver.

postcard has been removed, write to address below. No salesman will call.

Or check out these other growing fields.

Small Engine Repair

There's plenty of opportunity for the man who can service lawn mowers, garden tractors, chain saws, tillers, outboards, mopeds, motorcycles and other small engines. NRI training includes professional tools... inductive tachometer, volt-ohm meter, torque wrench, valve spring and ring compressors and more. And you learn by doing, actually building a 3 1/2 HP engine as part of your training. Choice of basic and advanced courses. Check postcard for catalog.

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Gets you into a wide-open, fast-growing area with practical training that includes lessons on solar heating, heat pumps, etc. Course is complete with professional tools and window air conditioning unit for demonstration and troubleshooting practice.

Two courses, with Master Course including optional training at York Institute Resident School at no extra charge. Check card for catalog.

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Good appliance repairmen are hard to come by. NRI trains you for your own full- or part-time business in fixing everything from toasters to refrigerators and freezers. Step-by-step training includes professional appliance tester for fast troubleshooting. Check card for catalog.



NRI Schools
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3939 Wisconsin Avenue
Washington, D.C. 20016

Meet Ernest Borgnine, the famous stamp collector.



50th Anniversary Year of Talking Pictures (Oct. 7, 1977)



Surrender at Saratoga 1777 by Trumbull

US Bicentennial 13cents

Surrender at Saratoga (Oct. 18, 1977)

Everyone knows Ernest Borgnine, the famous actor. But did you know he collects stamps? Off the screen, it's one of his most interesting and rewarding activities.

Stamp collecting can give you that same kind of enjoyment. And U.S. Commemorative stamps are an easy, affordable way to start building your collection.

Through the years, Commemorative stamps have shown the history and people who have helped make America, America. And you can buy them right at your local Post Office. New

Commemoratives are issued every few weeks. (There's even a guidebook called *Stamps & Stories* to tell you how to get started.)

Start collecting now, with the 50th Anniversary Year of Talking Pictures and the Surrender at Saratoga Commemoratives. You'll be building a collection you and your family will treasure for years.

As Ernest Borgnine says, "I hope that someday my children will enjoy stamp collecting as much as I do."

U.S. Postal Service 

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Collect U.S. Commemoratives. They're fun. They're history. They're America.

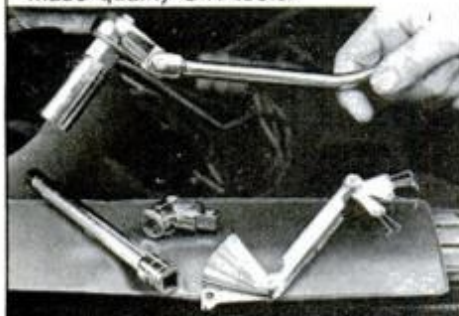
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NASCAR CHAMPS



Driver Cale Yarborough, Hall of Fame mechanic Herb Nab and S-K® Tools put it all together!

When you want the job done right, act like the Great Ones. Use American-made quality S-K tools.



SAVE \$11.29 OVER 34%*

5 pc. 3/8 in. dr. Tune-Up Set. No. 4505-77. Handy set changes car plugs etc. Special tight spot ratchet. Total value if purchased separately \$32.88. **\$2159** Suggested User Price

SAVE \$30.53 OVER 51%*

20 pc. 3/8 in. dr. Socket Set. No. 4520-77. Handles cars, garden tractors. Total value if purchased separately \$59.41. **\$2888** Suggested User Price

SAVE \$13.06 OVER 43%*

13 pc. 1/4 in. dr. Socket Set. No. 4913-77. For cars, wash. machines, small nuts & bolts. Total value if purchased separately \$30.04. **\$1698** Suggested User Price.

SAVE \$8.69 OVER 47%*

5 pc. Combination Wrench Set. No. 1705-77. Takes on jobs from motorcycles to power mowers. Total value if purchased separately \$18.28. **\$959** Suggested User Price.

*All savings based on piece by piece purchase at suggested user prices.

GET WINNERS' CHOICE SPECIALS ON S-K TOOLS AT AUTO PARTS AND HARDWARE STORES

FULL LIFETIME WARRANTY

SATISFACTION GUARANTEED. If you the consumer are not completely satisfied with any tool in any S-K set, simply notify the place of purchase for a free exchange during the life of the tool. This warranty gives you specific legal rights and you may also have other rights which vary from state to state.



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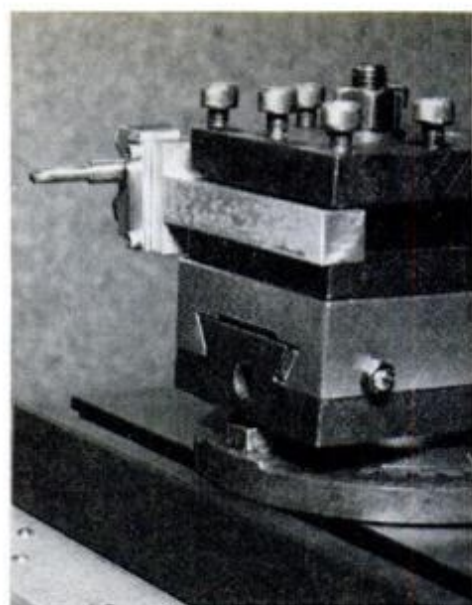


BORING-BAR SET

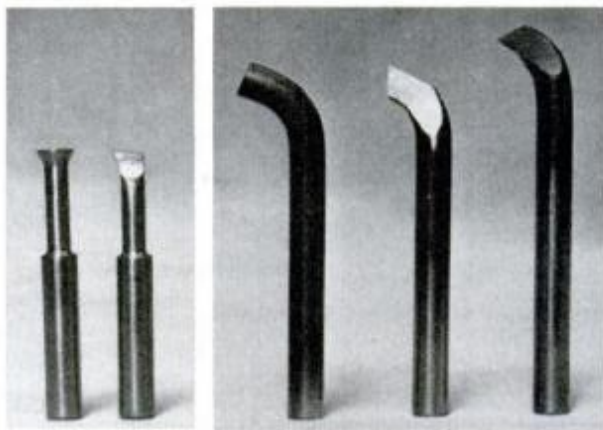
(Continued from page 72)

to a bright-red color and quenching it in water to which a little table salt has been added to prevent soft spots. Remove surface discoloration with abrasive cloth, and draw the hardened end by heating the bar with a low flame until the end is a light straw color, then quench again in water. Apply heat about 3/4 in. from the end and watch the color crawl to the cutting edge. Overheating (to a dark straw or blue color) will make the edge too soft; reharden and re-draw if this happens.

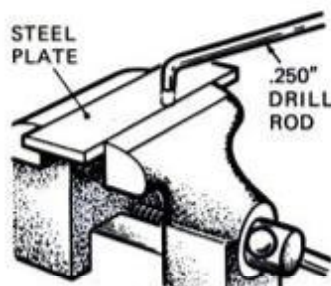
After hardening and drawing the end, grind the cutting edge and hone it with an oilstone. Do not overheat when grinding or the cutting edge will soften. Because this is carbon steel and not alloy steel, the bars will not take high heat—so use low speeds and feeds when machining with them. ★★★



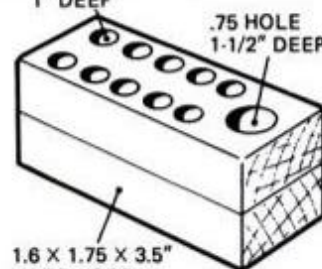
Toolholder's 3-in. shank allows it to be clamped firmly into the toolpost.



Blanks and their finished boring bars: Above, left: turned blank and bit made from it. Above, right: forged blank and bit; bit at right is threading tool.

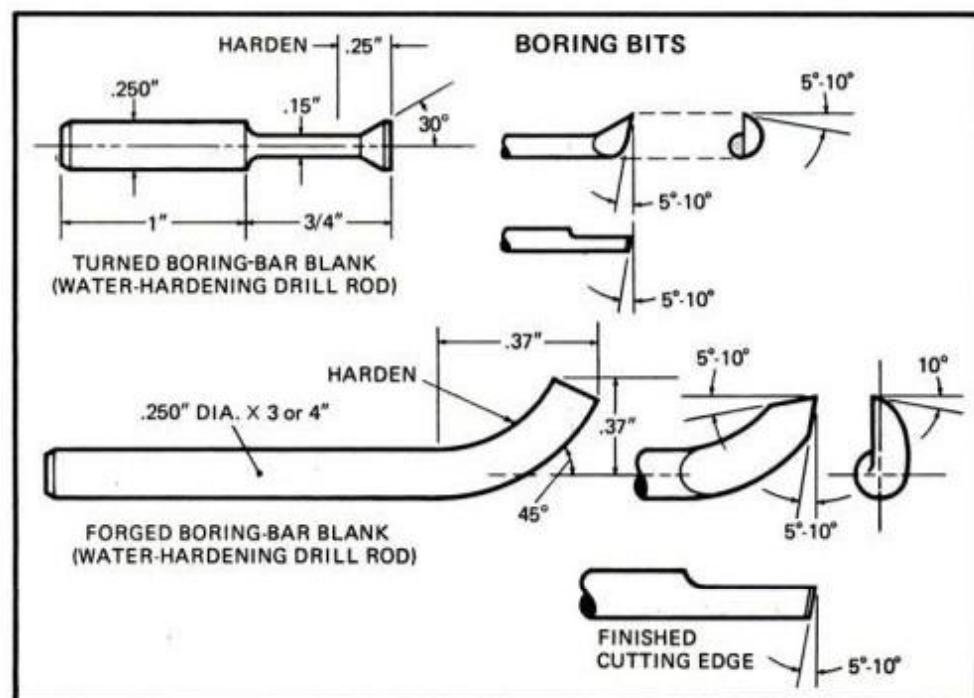


10 HOLES, .26 DIA. X 1" DEEP



1.6 X 1.75 X 3.5" HARDWOOD

STAND



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FORD DIVISION



FORD LTD LANDAU

For the millions who need a full-size car: The 1978 Ford LTD.

If you need six-passenger space—
look into the luxurious stretch-out space you'll find in LTD.

If you need a roomy, full-size trunk—
you'll find you can pack up to eight pieces of luggage and two sets of golf clubs in an LTD.

If you need lots of towing capacity—
you'll get up to 7,000 pounds with the LTD optional towing package.

And if you want mileage like this—
*22 mpg highway, 15 mpg city**

Then the full-size 1978 Ford LTD could be just the car for you!



Full-size interior



Full-size trunk

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When America needs
a better idea,
Ford puts it on wheels.

*EPA estimates with standard 5.0 litre engine. Your mileage may vary depending on your car's condition, optional equipment, where and how you drive. Not available in California.

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DIGI-CLOC

The Precision Solid State Digital Clock with Built-in Elapsed Timer

This Space-Age, Super Clock has brilliant, easy-to-read, TWIN 6-DIGIT L.E.D. DISPLAYS $\frac{3}{8}$ " High, recording both LOCAL and ELAPSED TIME in Hours, Minutes and Seconds.

Designed for easy mounting IN, ON or UNDER the dash, DIGI-CLOC operates on 12 or 24 volt battery and is quartz crystal controlled for exceptional accuracy to WITHIN 5 SECONDS PER MONTH.

- Perfect for Car, Truck, Van, Boat, RV or Trailer.
- Large digit UPPER DISPLAY shows LOCAL TIME.
- Large digit LOWER DISPLAY records ELAPSED TIME for rallies or trips UP TO 24 HOURS.
- Digits are bright enough to be visible in direct sunlight.

- Display can be set to dim for night driving.

- Operates even when battery is too low for display or ignition is off.

- Handy push button controls set both displays.

- 1-YEAR FULL FACTORY WARRANTY and MONEY BACK GUARANTEE.

Special Extension Cables are available for IN-DASH installation allowing DIGI-CLOC face (approx. $4\frac{1}{4}$ " x $2\frac{1}{2}$ "") to be set into the dash and the operating mechanism to be placed beneath the dash.

Made of finest electronic components and High-Impact plastic, the Super Accurate, brilliant read-out DIGI-CLOC is available in both 12 and 24 Hour Clock Models.



Under Dash



In Dash



On Dash

Please rush me the following Super Accurate Solid State DIGI-CLOCs with Built-in Elapsed Timer:

_____ 12 Hour Clock (s) @ \$79.95 each. _____ 24 Hour Clock (s) @ \$89.95 each.

For IN-DASH MOUNTING with operating mechanism installed beneath dash please send me:

_____ 3 Foot Standard Extension cables @ \$10.00 each. Longer custom cables may be ordered for \$1.00 per foot additional charge; Send _____ feet cable. Please add \$5.00 for 24 volt operation. (Please add \$2.00 for Postage & Handling. Colorado Residents add 3% sales tax)

Enclosed is my check or Money Order for \$ _____

Or please charge my BankAmericard (VISA) Master Charge

Card Number _____ Master Charge Bank # _____

Expiration Date _____ Signature _____

Name _____ Address _____

City _____ State _____ Zip _____

MONEY BACK GUARANTEE If not completely satisfied return within 30 days for immediate refund.

1-YEAR FACTORY WARRANTY against defects in material and workmanship when installed and used according to instructions. Return to DIGI-CLOC CORPORATION for repair without charge.

Dealer Inquiries invited.

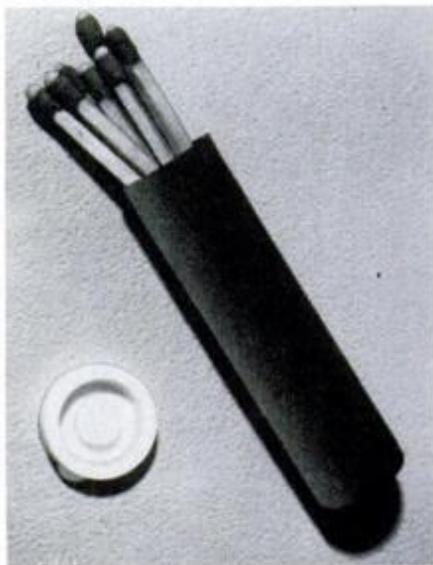
DIGI-CLOC

3812 East Pikes Peak
Colorado Springs, Colorado 80930

PM 2

HINTS FROM READERS

Waterproof match holder



A rinsed tube that held wiper for Polaroid prints is a good waterproof match safe for camping trips.—*Parry Yob*

Paint deodorizer

To eliminate most odor from enamel paint, add a teaspoon of vanilla extract to a gallon of paint and mix thoroughly. This is good when painting soon-to-be-occupied bedrooms.—*Susan Plesko*

File cleaning

Before you file aluminum or other soft materials that tend to plug the cutting teeth, rub chalk on the file to eliminate particle build-up.—*Dan Daehlin*

Cleaning picture tubes



Swab TV picture tubes about once a month using a fluid window cleaner and soft cloth. This removes a static-cling film of dirt, thus brightening the picture.

—*R.E. Clark*

THE DEPENDABLE MID-RANGE MERCURY OUTBOARDS FOR 1978.

OUTBOARD ENGINEERING TO RIVAL THE MOST DISTINCTIVE STANDARDS OF AUTOMOTIVE ENGINEERING.



One of these symbols is famous the world over for the ultimate in automotive engineering achievement.

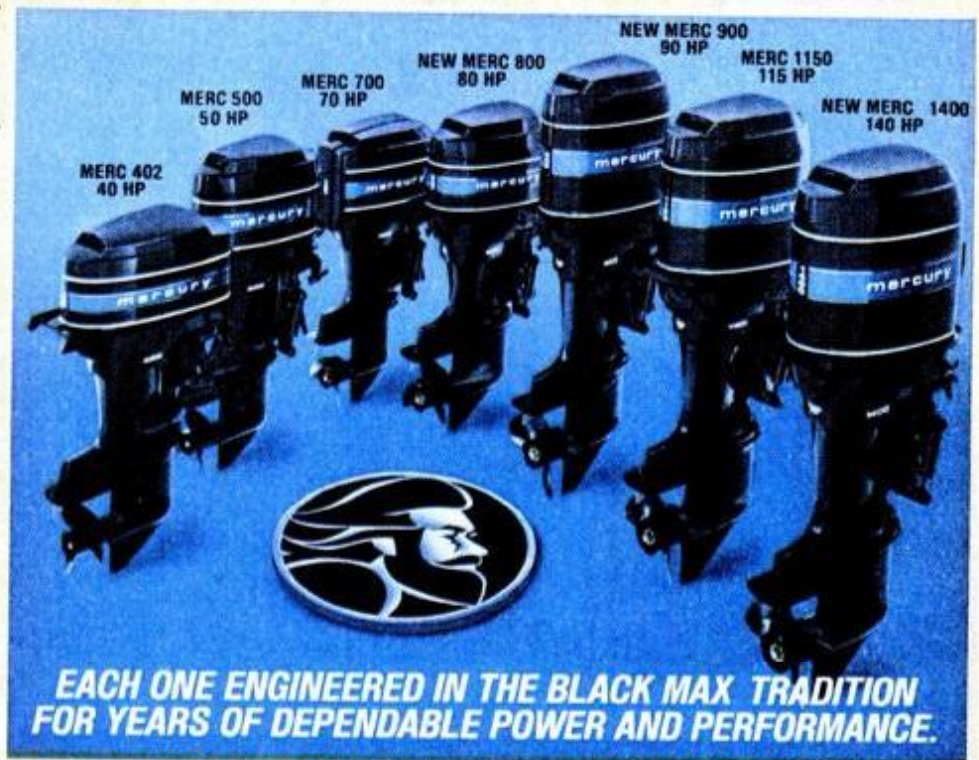
The other is carving out the same excellent reputation in outboard engines.

Black Max.[®] Symbol of the new Mercury[®] Black Max Series. Three top-of-the-line outboards—150, 175 and 200 hp—with compact 60° V-6 engine design. The product of six years of uncompromising engineering, refining and testing.

HOW BLACK MAX MAKES EVERY MERCURY A LITTLE BETTER.

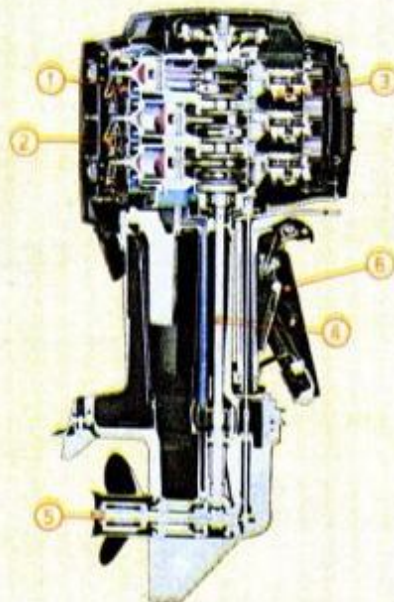
Now the same standards of engineering excellence achieved with Black Max have been applied to every Mercury outboard—from fast, dependable starts through remarkable fuel economy to ease of operation.

Mercury has gone all out to make the outboard of your choice—whether it's a small fishing Merc, a new 80-hp model, or a mighty Black Max—an extraordinarily dependable performer.



EACH ONE ENGINEERED IN THE BLACK MAX TRADITION FOR YEARS OF DEPENDABLE POWER AND PERFORMANCE.

DEPENDABILITY THROUGHOUT, FROM THUNDERBOLT IGNITION TO SHOCK-ABSORBING PROPELLER HUB.



(1) You'll get fast, sure starts with Thunderbolt[®] CD sealed ignition. (2) Clean-firing Perma Gap[®] plugs almost eliminate tune-ups. (3) And for smooth, trouble-free running, fixed jet carburetion meters a steady, even flow of fuel, from idling to high-speed running. (4) The stainless steel shift shaft, drive shaft and prop shaft combat corrosion. (5) And your Merc can keep on going despite most unexpected bumps and thumps because of the sturdy lower unit housing and the shock-absorbing propeller hub. You can't shear a pin—because there aren't any. (6) All Mercs from 50 hp to 140 hp have Dyna Shock[™] absorber systems, providing an extra margin of safety should your engine be kicked up by high-speed impact with a heavy obstacle in or under the water.

MORE 6-CYLINDER MODELS THAN ANY OTHER OUTBOARD MANUFACTURER.

In high-horsepower outboards, less horsepower per cylinder means less wear and longer engine life.

That's why now, for 1978, the Mercury mid-range lineup includes three in-line 6's to choose from—a wider choice by far than any other outboard manufacturer.

SEE THE WIDEST SELECTION OF MID-RANGE OUTBOARD POWER IN THE INDUSTRY AT YOUR MERCURY DEALER.

With seven power choices from 40 hp all the way to 140 hp, 1978 offers you the finest Mercury mid-range lineup ever. And that includes three new Merc models at 80, 90 and 140 hp.

Your Mercury dealer will help you make your choice of a Merc with exactly the power you want, whether it's for fishing, skiing, cruising or high-performance running. See him soon.

MERCURY OUTBOARDS

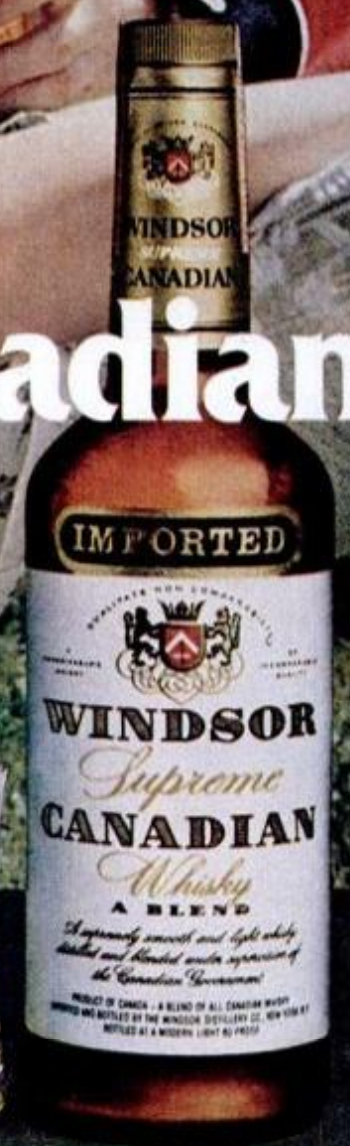
A BRUNSWICK COMPANY

CANADIAN WHISKY - A BLEND - 80 PROOF - IMPORTED AND BOTTLED BY THE WINDSOR DISTILLERY COMPANY, NEW YORK, N. Y.

The smooth Canadian.

This Canadian has a reputation for smoothness. So you won't catch him drinking anything less than the smoothest whisky around. Windsor. A whisky made with glacier-fed spring water and aged in the clear, clean air of the Canadian Rockies.

Try Windsor. It's got a reputation for smoothness.



About 500 men died for every mile of the 50-mile-long Panama Canal, four-fifths of them under the old French canal company. Yellow fever and malaria were prime causes, but even with disease under control the construction of the canal was a struggle.

Men, steam shovels and dirt trains strained and slipped in the mud and rain at the bottom of the deep trench—the nine-mile Gaillard Cut—through the continental divide. The total excavation was enormous—310 million cubic yards, counting the French effort. The spoil would fill dirt trains encircling the Earth four times at the equator, or build a pyramid seven times higher than the Washington Monument.

More explosive energy than had been used in all the nation's wars up to 1914—the year the canal opened—was needed to blast the cut through high elevations. And time after time thousands of tons of rock and dirt cascaded down onto men and machines as the sides of fractured mountains suddenly and unexpectedly slid into the cut.

Today the Panama Canal is quiet, the din long since gone. From a vantage point on the deck of a freighter, one watches the big lock gates swing open; the peace is disturbed only by the muffled whine of winches as the electric mules haul the ship through. Nothing disturbs the beauty of Gatun Lake. The water laps gently at the edges of the jungle as ships pass. Even Gaillard Cut, scene of many a landslide, has been relatively quiet since 1975.

Ahead of its time

The Panama Canal has served world trade and national defense for nearly 64 years. While its design was far ahead of its time, ship traffic and technology have been catching up, especially in the last two decades.

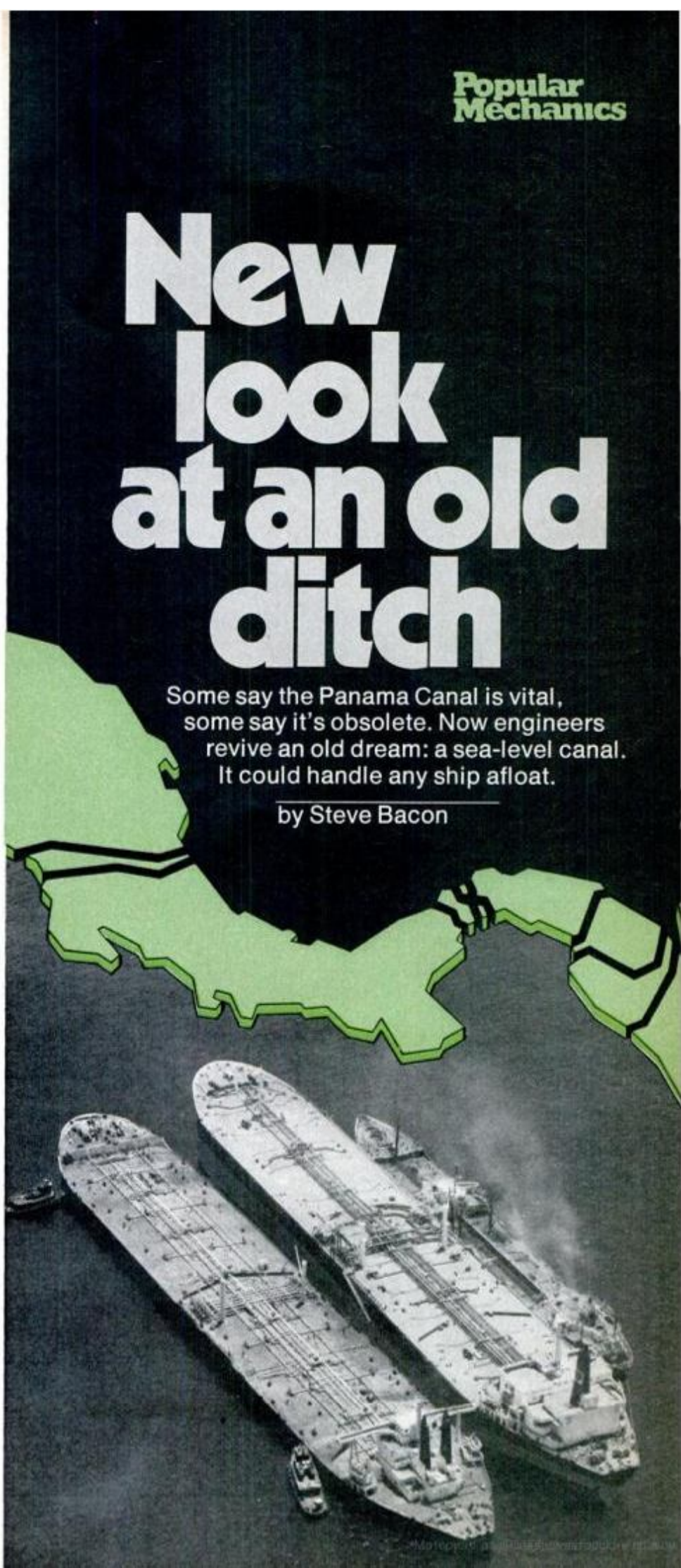
The number of ships using the

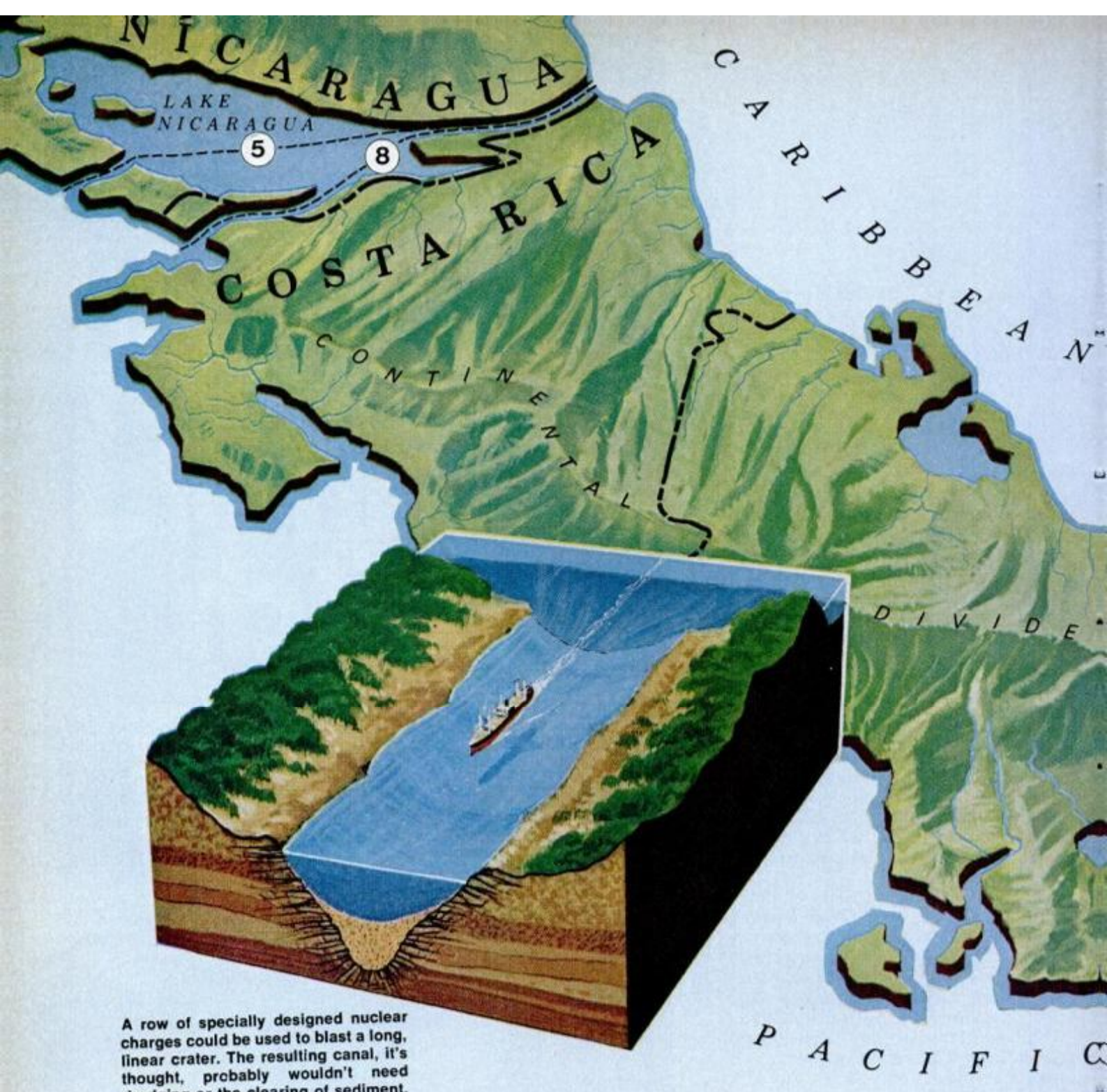
New look at an old ditch

Some say the Panama Canal is vital, some say it's obsolete. Now engineers revive an old dream: a sea-level canal. It could handle any ship afloat.

by Steve Bacon

Supertankered to Panama, Alaskan oil must be pumped to storage tanker (center) for transfer to carriers that fit the canal.





A row of specially designed nuclear charges could be used to blast a long, linear crater. The resulting canal, it's thought, probably wouldn't need dredging or the clearing of sediment.

canal more than doubled between 1950 and 1970, and the cargo carried through it increased by nearly 400 percent. Despite the fact that the waterway has been lighted its entire length and put on a 24-hour schedule, it will reach the saturation point—26,800 ships annually—some time between 1989 and 2000.

Although the canal could handle the biggest ship afloat in 1914—the 52,000-ton, 5500-passenger *Imperator*, larger than the *Titanic*—vessels have begun to crowd the 110-by-1000-foot locks. The reason: Ore and grain carriers, container ships and oil tankers have grown to sizes that

would have been beyond comprehension as recent as a dozen years ago.

The problem is highlighted by North Slope oil bound for the lower 48 states. Just last August a tanker of 265,000 deadweight tons (DWT, ship cargo capacity in *long tons*), arrived off Panama. It was the S.S. *New York* with the first oil from Port Valdez, Alaska. The only way to get crude through the canal is to use a seagoing "petroleum depot" and a fleet of smaller tankers.

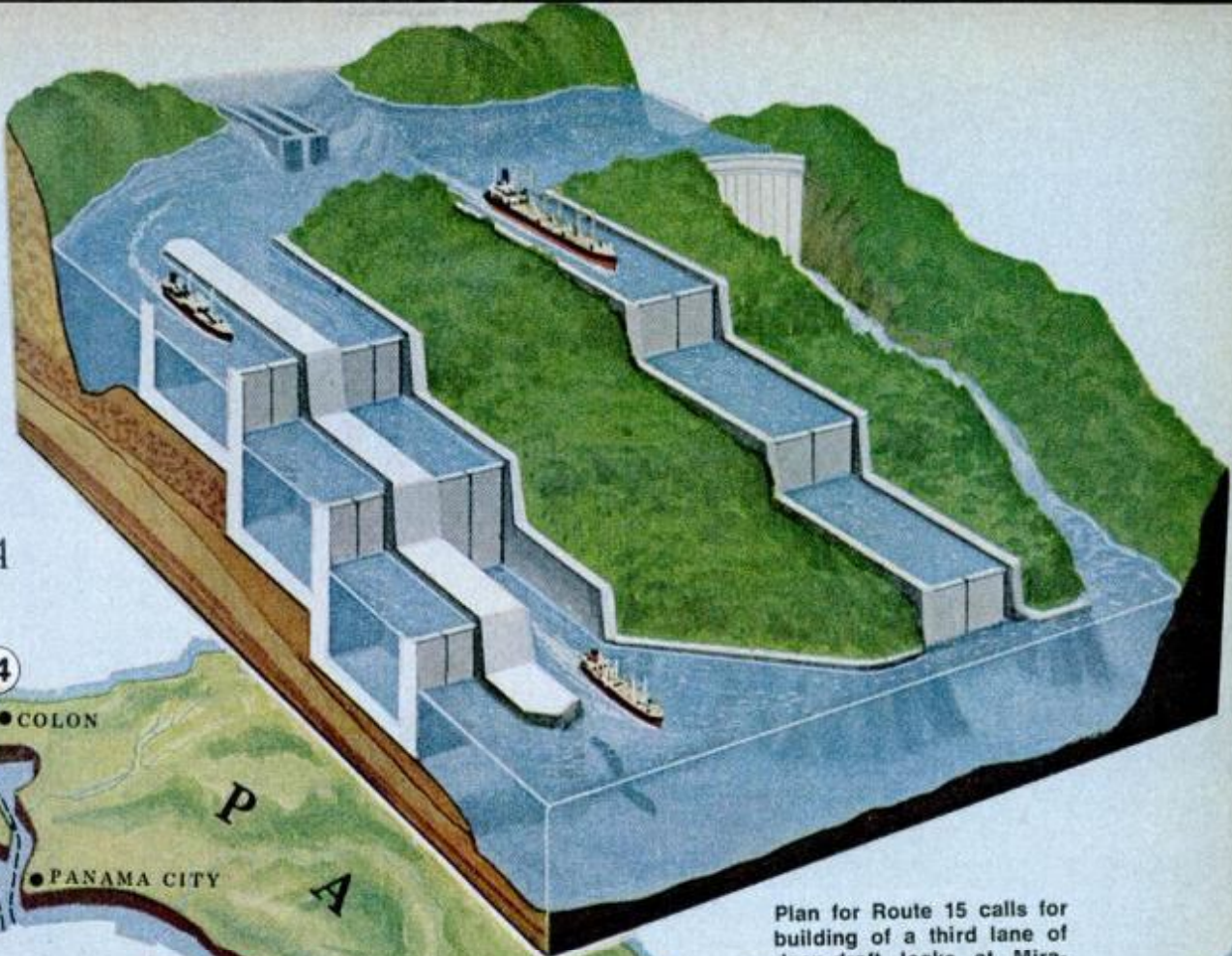
Serving as the depot is the super-tanker M.V. *British Resolution*, which will remain anchored 65 miles

from the canal until a land-based oil terminal can be built. It took on 1.8 million barrels of oil from the *New York* and pumped it into smaller shuttle tankers bound for the Gulf Coast via the canal.

Carriers can't make locks

As early as 1970 a survey revealed that a total of 1300 ships were then too wide for the Panama locks. (To this figure add all of the U.S. Navy's aircraft carriers.) Yet another 1750 vessels were unable to go through the canal fully loaded, for their capacity exceeded the canal limit of 65,000 DWT.

S E A



Plan for Route 15 calls for building of a third lane of deep-draft locks at Miraflores Lake. There are two problems: water supply and vulnerability to attack.

O C E A N



By the year 2000 it is estimated that fully 50 percent of the world's tankers will be too large for the present waterway.

"For the rest of its life the canal will serve trade and peace," wrote a Presidential commission, "but that life is now limited. The canal is growing old."

The dream of seafarers has been not a lock canal, but a sea-level passage between the Atlantic and Pacific. Hearing Balboa's 16th century account of traveling across what later became Panama, King Charles V of Spain suggested digging a waterway to join the oceans. Nearly



Instability of Isthmus soil is a problem facing engineers even today, as it did during construction of the present canal. In the continental divide, mountainsides tumbled into excavation (above). Among other precautions, extensive drainage systems protect some sections (top, right). The spectacular Gaillard Cut (formerly called Culebra Cut) through continental divide claimed many thousands of lives and caused endless grief as material from steep sidewalls kept sliding into deep channel.



four centuries later, Ferdinand de Lesseps, fresh from his triumph as builder of the Suez Canal, resolved to do the job.

Thus it was that on March 28, 1878, just 100 years ago, a formal contract for construction of a sea-level canal was signed by the French syndicate headed by de Lesseps and the president of Colombia (Panama was a part of Colombia then).

The vision of joining the oceans at sea level persisted after the French suffered their disastrous failure. Theodore Roosevelt was dissuaded from it only after engineer John Stevens pointed out in 1906 that the idea would take billions more dollars and a decade longer than a lock canal.

While a wide sea-level canal could handle supertankers and other large ships, how would a channel containing six or more times the amount of earth removed for the present

In a sea-level canal, the tidal differences between the two oceans would cause currents that could create problems in the handling of large ships. A proposed solution would be the use of floating tidal checks. When needed, they would be floated into position in the channel.

canal be excavated? What about the problems of joining the oceans, the Pacific with tides up to 11 feet above sea level and as much as 10 feet below? Wouldn't it be better to consider a new or enlarged lock canal instead?

Landmark study in 1970

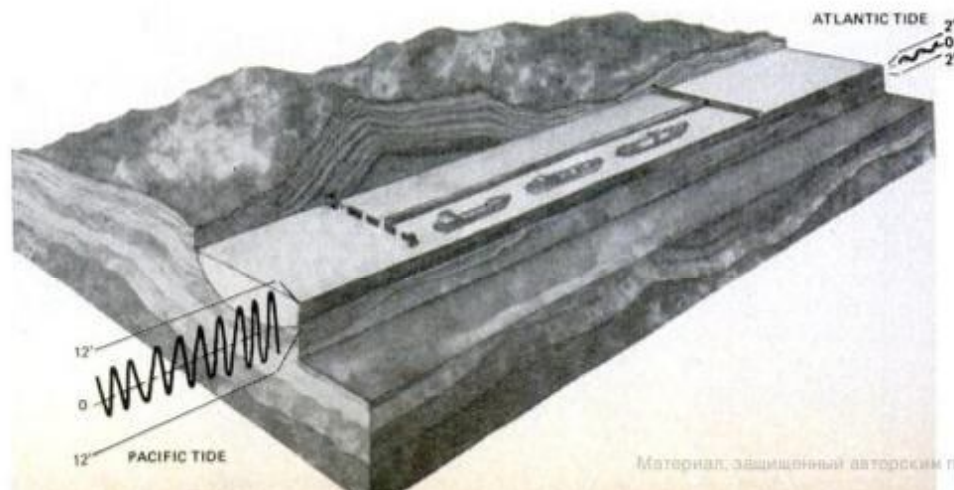
To answer these questions, Congress established in 1964 an Atlantic-Pacific Interoceanic Canal Study Commission to gather data, evaluate possible routes and report on nuclear and other excavation techniques. The Commission's report, produced

in 1970, still stands as a landmark.

While postwar surveys have identified some 30 potential canal routes crisscrossing Central America from Mexico all the way down to Colombia, the Commission settled on just eight, later eliminating half of them:

- Route 5, stretching 167 miles through Nicaragua and part of Lake Nicaragua, would require locks. The cost would be \$4 billion in 1970 dollars to accommodate ships only up to 110,000 DWT. (An ideal capacity for a new canal would be 250,000 DWT.)

- Prohibitively expensive, a Route



8 passage through Nicaragua and Costa Rica would run \$11 billion, although nuclear excavation could possibly cut this in half.

■ Route 17 is just 100 miles east of the present canal (most of Panama stretches east-west). It could be built for \$3.1 billion using nuclear and conventional means—but permission from Panama to dig a canal far from her economic centers and to use the power of the atom would not be likely.

■ Discarded because of its 146-mile length was Route 23, a sea-level passage needing both conventional and nuclear excavation.

The four final selections include:

■ Route 25, a trans-Colombian waterway some 200 miles east of the

Panama Canal. This 101-mile passage would follow rivers for much of its length and could be dug partly with inexpensive hydraulic dredging.

One sticky problem: The 20-mile stretch of Route 25 through the continental divide would have to be cleared with nuclear explosives to make the canal economically feasible.

Nuclear devices could provide the intense, low-cost energy needed to dig a huge canal—dig it far more cheaply than is possible by conventional methods. A row of specially designed charges, engineered to minimize the production of radioactive materials and fallout, would be used to blast a long, linear crater. Because the finished canal would be up to 380 feet deep at center and

twice as wide as a shovel-dug passage, its size would probably eliminate the need for dredging sediment or clearing landslides. Even wrecked ships could be allowed to remain on the bottom.

Blasting through the divide

One nuclear plan would use up to 50 small explosive devices of about 100 kilotons set off simultaneously to excavate from one to six miles of canal. Larger devices—up to 15 megatons—would create a channel as deep as 1200 feet through the continental divide.

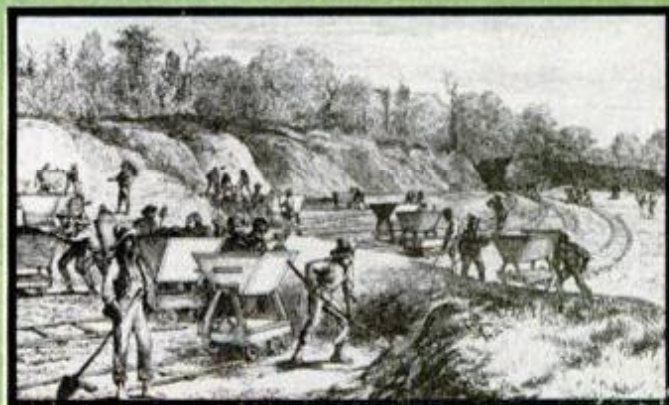
"A cut this deep by any means would be an engineering achievement of the first magnitude," wrote

(Please turn to page 142)

BIG DITCH—EVEN SHIP TUNNELS AND PIGGYBACK RAILS WERE PROPOSED



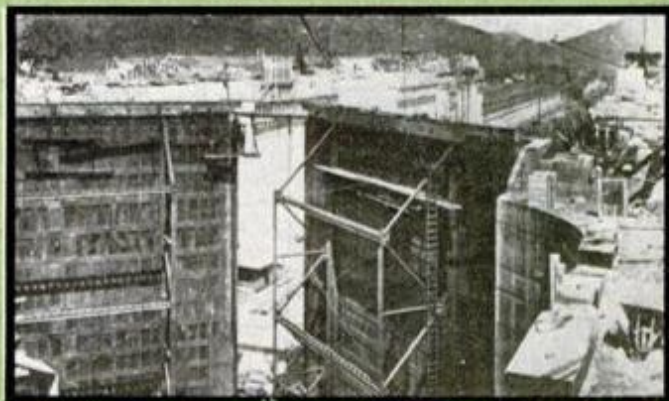
Canal project saw development of earth-moving giants . . .



. . . but much digging was done by picks, shovels and men.



Giant locks had to accommodate biggest oceangoing ships.



Double-leaved gates "big as skyscrapers" swung on hinges.

Interest in a waterway between the Atlantic and Pacific oceans, piercing the isthmus joining the Americas, goes back much farther than the 19th century, when most of the big promotion began. Sixteenth century explorers who followed Columbus proposed it when they realized the new continents blocked a possible route westward to the Orient. In 1523, Charles V started a movement to build such a canal and sent out many expeditions to investigate possible routes for it.

Through the centuries that followed many serious plans were proposed, involving more than 30 possible routes, from Mexico (popular with Americans even after Panama was chosen) to Colombia. Among scores of fanciful projects put on paper, consideration was frequently given to boring tunnels through the formidable continental divide to effect a sea-level waterway. One idea that received more than casual notice proposed a gigantic railroad with multiple tracks, spaced some

100 feet abreast, on which mammoth wheeled "cradles" would piggyback oceangoing ships overland from one ocean to the other. Even the relatively modest canal that finally materialized in 1914 required the construction of a complete railroad, presented the best engineering minds in the world with gargantuan mountain-moving problems, saw several giant corporations tumble into bankruptcy, cost the lives of thousands of men and almost a billion high-value dollars.



Curving in past the beach at Bimini, the new Volvo powerplant pushes a new Crestliner cruiser with runabout performance.

PM test: Little new diesel for little boats

The crew that tested the world's first sterndrive repeats the run 18 years later with an exciting new lightweight diesel version.

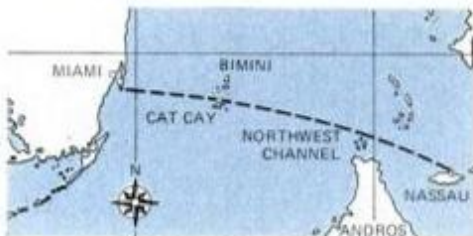
by Bill McKeown
BOATING EDITOR

Can history repeat itself on the water? We decided on a PM off-shore test to find out.

Eighteen years ago, a new pleasure boating era had been introduced by a little 18-foot hull with a funny gearbox sticking out the back. Invented by Miami engineer-innovator Jim Wynne, this was the first successful inboard-outboard drive. Wynne hooked it up to a small 80-hp Volvo Penta marine engine and entered the prototype in what is called the world's roughest boating test—the Miami-Nassau ocean marathon. That run across 180 miles of tumbling seas took 17 brutal nonstop hours, but the little mill pushed through without missing a beat and

won its single-engine class. The sterndrive boom had begun.

Today, with high performance from low fuel consumption particularly important afloat and ashore, another breakthrough is needed, and diesel has been suggested as an answer for future power. But how good would it be for popular small



craft? What about the diesel problems of plodding output, extra weight, extra cost? Could the Miami-Nassau endurance course prove the point again?

Inspiration for the test was a new lightweight diesel engine, again from Volvo Penta, with notable claims for speed and economy. It is now available as the AQD40, a 130-hp six-cylinder turbocharged model hooked up to Volvo's 280 sterndrive.

A straight inboard version, the TMD 40, can be installed as well. For a comparison test to measure the advanced state of the art, we felt the original run should be duplicated as much as feasible.

But to carry the new engine-drive combo, an AMF Crestliner 2455 Crusader cabin cruiser was selected. The deep-V 24-footer designed by Jim Wynne would be a lot smoother than the original 1959 cathedral Thunderbird. This Crestliner was fitted out for family cruising, however, rather than stripped for racing, and it carried bunks, head, galley and bags of duffel in the cabin, full seats in the cockpit. Other makes of diesel stern-



This small and light 130-hp turbocharged diesel makes boat handling a snap.



Without requiring more space or flotation than a gas engine, the little 210-cu.-in. freshwater-cooled diesel showed Wynne, McKeown and Allen fast, dependable performance—at lower fuel consumption.

PM photos: Lorraine McKeown

Crestliner's Crusader 2455, fully fitted out and canvassed for a cruise rather than an endurance run, proved it could handle the new engine and big seas of the open Atlantic.



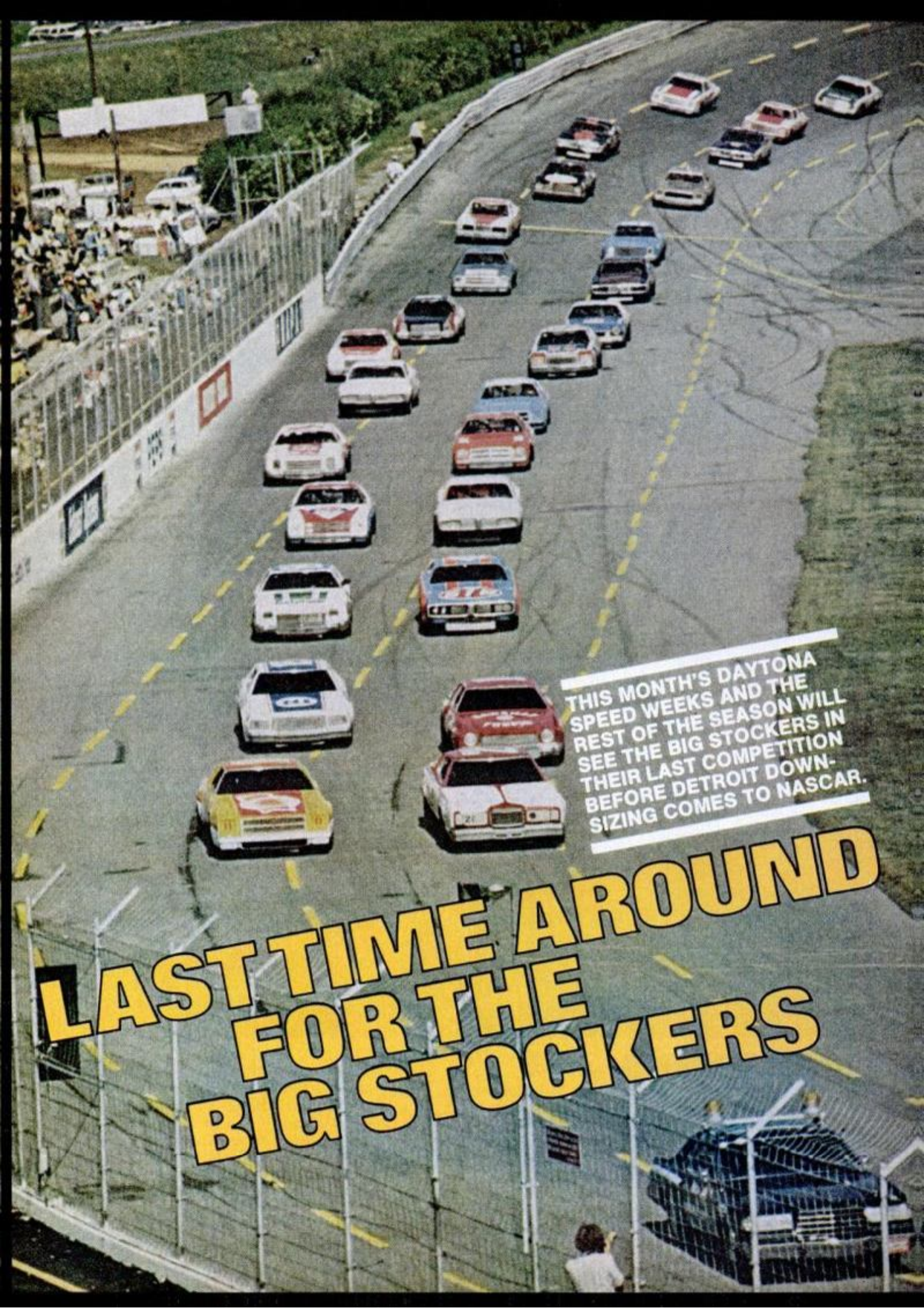
Loaded down with nine passengers, the new rig planes off easily in Nassau harbor.

drives are available, but this new light Volvo package at 1075 pounds, about the same as for a V8 gasoline inboard engine, made it practical for a trailer-boat hull.

Crew for our test was to be the same unlikely trio as 18 years ago. Skipper Jim Wynne, now the leading designer of deep-V boats, was already famous in 1959 as the first to cross the Atlantic by outboard—a somewhat reckless adventure for

an MIT engineering graduate and former head test engineer for Mercury Motors. This *Popular Mechanics* editor and Skip Allen, publisher of *Southern Boating*, were to be the other two older and hopefully wiser Miami-Nassau crew members once again.

This time we weren't out to provide any men-and-machine-against-the-sea saga. Instead, we hoped the [\(Please turn to page 140\)](#)



THIS MONTH'S DAYTONA SPEED WEEKS AND THE REST OF THE SEASON WILL SEE THE BIG STOCKERS IN THEIR LAST COMPETITION BEFORE DETROIT DOWN-SIZING COMES TO NASCAR.

LAST TIME AROUND FOR THE BIG STOCKERS



Big Chevrolet Laguna, typical of current Grand National stock cars running in NASCAR events, is powered by a 350-cu.-in. V8 and weighs about 3700 pounds. That's Benny Parsons at the wheel winning the 1977 National 500 at Charlotte.

Photos by the author

by Glenn Howell

Anyone who's seen a NASCAR superspeedway race recently knows it's one of the greatest shows on earth. Brave and talented drivers align their racers in multicar chains, often swapping positions several times a lap. The cars jockey for position within inches of each other, all at speeds three times the double nickel. The sport has made drivers like Richard Petty and David Pearson wealthy superstars, even though they've never driven over the hallowed bricks of Indianapolis.

The appeal of stockers

One of the basic attractions of stock-car racing is the resemblance of the race cars to the cars that most people drive on the street. Even though the cars have long since been even remotely "stock," the sheet metal looks pretty much the same as it does when sitting on the showroom floor.

You're surely aware of the great downsizing spiral Detroit is going through. The next generation of automobiles will feature smaller engines and more compact dimensions. And it's only a matter of time until stock-car racing is using these new, smaller automobiles.

Come on down!—in size

By the beginning of the next decade, the stock cars prowling the high banks of Daytona and the serpentine esses of Riverside will be considerably smaller. And they'll be powered by smaller and less powerful engines.

But that doesn't mean the on-track

competition will suffer. In fact, it'll probably get stiffer if history is any indication.

NASCAR first did a shrinking act over 10 years ago when the industry began moving toward smaller family cars, then called "intermediates." Up to that time the mainstay of NASCAR had been the big Pontiacs and Fords.

Plymouth and Dodge introduced new smaller cars in 1962 (and also dropped all large models, just as they have for 1978) and were already racing a somewhat smaller car than the competition.

Change is almost always a slow, evolutionary process and so it was with NASCAR. Petty's small Plymouth became indecently fast with the hemi-head engine of 1964 and some of the Chevrolet drivers began trying the new, smaller Chevelles in place of the larger Impalas.

By 1966 it was the small Chevys, Plymouths and Dodges against the big Fords. Ford, which needed a more powerful engine to pull the big car through the air, boycotted NASCAR later that year when their special super engine was prohibited.

Moore thinks small

Bud Moore, long-time stock car mechanic and builder, decided the only way to beat the prohibition was to build a smaller car around the approved Ford and Mercury engine. So when the fall Southern 500 rolled around, Moore was on hand with a privately entered Mercury Comet for Darel Dieringer to drive.

Moore, who had been part of the Mercury factory effort in 1963 and 1964, proved that a small car was exactly what Ford needed. The red

and black Mercury Comet came home a winner in its first superspeedway race on the NASCAR circuit.

Ford saw that it could win with its engine in a smaller car. It made a couple of successful entries late in '66 and by January of 1967 the revolution was complete. At the opening Riverside race an armada of Ford Fairlanes, bursting with 427-cu.-in. engines, greeted the NASCAR regulars. Sprinkled among the Fords were two factory Mercury entries: a pair of Comets from—you guessed it—Bud Moore.

Smaller engines, too

Although downsized, the NASCAR engines were still monstrously large. It wasn't until five years later that engines got smaller, and (curiously enough) the leader was none other than our good friend Bud Moore.

After a stint of preparing Trans Am Mustangs for Ford, Moore became a big booster of the smaller engine. When the '72 season opened, Moore was there with a new Torino fastback powered by a 351-cu.-in. motor. In many respects, it was an upscaled version of the Boss 302 Mustang.

NASCAR, sensing it was time to move toward smaller engines and slow the cars down a bit (they were lapping at almost 200 mph at Daytona and Talladega), came up with a sliding scale of weight to engine size.

It meant that the smaller the engine, the less the car had to weigh. And less weight could mean less tire wear and better fuel mileage, and that might mean one less pit stop.

The little-engined Ford didn't win in 1972, but it was strong and com-

petitive. So NASCAR moved to phase out the large seven-liter (427-cu.-in.) engines by restricting them with carburetor plates and later smaller carburetors.

Small-block phase-in

It is important that when NASCAR makes a change of this magnitude it takes into consideration the financial costs of the competitors. It would be much easier to make one broad and sweeping rule change and be done with it. But the little guys can't afford to scrap everything and start over.

That's why it took close to three years for the small-block engine to be found under the hood of every NASCAR racer. Today's standard stocker is an intermediate-sized car with a six-liter (about 360-cu.-in.) engine.

Depending on what Detroit builds and how quickly NASCAR reacts, the days of such a racer are numbered.

Rewriting the rules

"I think we're all going to have to get adjusted to smaller automobiles," says Bill Gazaway, NASCAR Grand National competition director.

"Of course, it depends on what the manufacturers build, but I think you're going to see us come down with engine sizes and dimensions."

And as NASCAR contemplates what rules to establish in the future, the car builders are already planning for smaller cars.

"Yeah, they're going to downsize the cars naturally when Detroit downsizes, like they're doing right now," says Moore. "I'd say by 1980 we'll be running the small cars."

Interestingly, NASCAR is already gaining experience with the smaller race cars. In the last couple of years it has allowed 112-inch-wheelbase cars in its Late Model Sportsman division, traditionally the place former Grand National stockers find a home when they are too old for that division.

Grand National car of the future will be sized like this Chrysler Kit Car at the Charlotte Motor Speedway.

Chrysler's Kit Car

For this class, Chrysler Corp. makes a Kit Car which looks like an Aspen or Volare but resembles a Grand National car underneath. It also uses a six-liter engine just like the big stock cars.

It doesn't take too much imagination to see this car as the Grand National stock car of the '80s. The dimensions might be slightly less (around 108-inch wheelbase) to incorporate the new Ford and GM cars as well as AMC products.

Powering these new cars will be engines of about five liters (305 cu. in.) and maybe something other than a V8 design.

"I think the cubic inches will be down to 300 and that by then we'll be looking at the V6," says Moore with conviction.



***'When we're running the small cars, I think the cubic inches will be down to 300 and that by then will be looking at the V6.'*—carbuilder Bud Moore**

Even GM admits that the Corvette may be the only V8-engined car it builds by the mid-'80s, and Ford is already planning to build some V6 engines.

Still a spectacular show

Will the shift to smaller cars have any noticeable effect on the competitiveness of the racing? Probably not, say knowledgeable competitors.

"If all the major teams ran small cars, you'd immediately sort out the problems and everybody would be back like they are now," says NASCAR veteran Bobby Allison.

Is 1978 the last year for the big stockers? Well, it's probably the last year they'll have the racetracks all to themselves. By 1979 NASCAR should be phasing in the new smaller cars with smaller engines.

"We're going to have to go through a transition period where the current cars that we run will be equit-

able with a smaller car, and then the teams will have a choice of which way to go," says Gazaway.

"The problem that NASCAR has is to try not to obsolete all the cars everybody has right now," cautions Moore. "I think economics is going to dictate what we're going to do," admits Gazaway.

It does seem inevitable then that within a couple of years the Grand National racer of today will be as rare as certified mastodons.

Your favorite stock-car driver will soon be wheeling a smaller, lighter, slightly slower car than ever before. But the competition will undoubtedly be just as keen as it is today, with a dozen cars hurtling through the corners as if tied on a tether, each looking for a rich NASCAR super-speedway win.

The cars may get smaller, but the crowds and purses will almost certainly be bigger than ever. **PM**



IT'S NEW NOW



From bed to bike

Through the years, a California bike builder named Bob Brown has constructed bicycles with 20, 30 and even 80 speeds. Among his "fun" machines is this oddball three-seater, built from a steel bedframe discovered in a dump. "With a bit of practice, it's easy to ride," claims Brown. "The youngsters just love it. I may build more."



For firm ladders

One way to avoid injury working on a ladder is to use common sense. Another is to provide added support for the ladder—and that's what Ladderite braces are designed to do. Attached to 6, 8 or 10-foot ladders, they give stability on irregular surface. \$29.50 set. A. Henry Stewart Co., 2215 Meekland Ave., Hayward, Calif. 94541.

On with the dance

Turn your living room into a ballroom by covering the carpeting with a portable hardwood floor measuring 7½ feet on a side, large enough for about five couples. It stores in a closet and is assembled without tools. The basic model costs \$595. Hooper Enterprises, Box 4205, Mountain View, Calif. 94040.



Speedy new Navy missile ship

The Navy's new hydrofoil missile ship has joined the fleet. The *Pegasus* has a 132-foot-long aluminum hull. Stainless-steel foils allow speed exceeding 40 knots. Ship has 76-mm gun forward and surface-to-surface missile launcher astern. The crew totals 21.



Handy energy calculator

The Capitol calculator makes it easy to figure how much money you would save by equipping your home with energy-efficient windows. U-values for different types of windows and other key data are imprinted on calculator. \$1; Capitol Products Corp., Box 69, Mechanicsburg, Pa. 17055.



More efficient fluorescent

What appears to be a big honeycomb is actually phosphor-coated tubes for GE's Watt-Miser II fluorescents, said to be capable of cutting lighting energy costs by 14 percent. GE researcher (top) examines new phosphor used in Watt-Miser.

Smithsonian Institution scientists, among the world's most knowledgeable, have a collection of odd devices they call 'what's-its' because no one knows what they are. You are invited to try your hand at identifying any of them.

by Richard F. Dempewolf

Silvio Bedini, a scholarly gentleman with iron-gray hair and a voice vibrant with enthusiasm, shuffled through several photographs of a calibrated circular metal gadget—obviously very old—and handed them to me across his desk. The device, he informed me, was of timepiece quality and about 7 inches in diameter. It had been handcrafted of brass and steel. A smaller dial, inset in a larger circle, appeared to be some sort of counter. On the reverse side, two pointer hands were geared to a sliding bar. By cranking the larger hand with the tiny brass knob near its tip, it would move the slotted rod this way or that.

"It's a real puzzler," said Bedini, who is deputy director of the Smithsonian Institution's Museum of His-

tory and Technology in Washington, D.C. "It appears to be some sort of scale measurer, probably a nautical instrument. None of our experts can figure out what it was supposed to do, nor can the people at the National Maritime Museum.

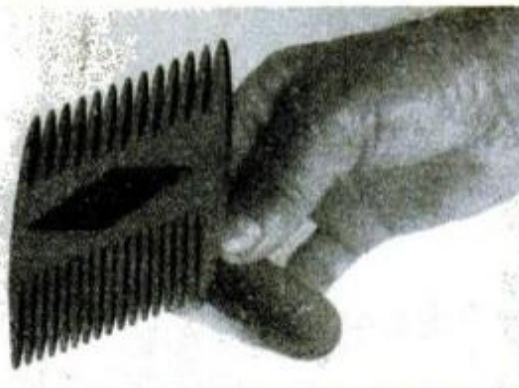
"One of our slide rule experts," he continued, "has calculated that we have some 16 million objects on exhibit or stored away in this building. We can tell you everything you want to know about practically all of them. But the device you're looking at is one of about 20 that no one can identify." These, he explained, constitute a collection of unidentified Smithsonian objects (USOs?) officially known as the museum's "what's-its."

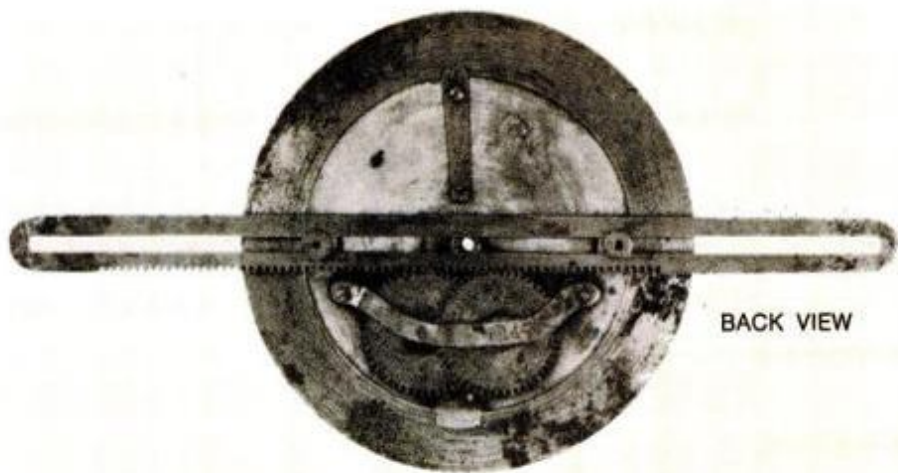
I already had seen some of the

1 Carved wooden comb (below) might have been used to curry horses or to card wool, but experts say it wasn't. Ever see one like it?

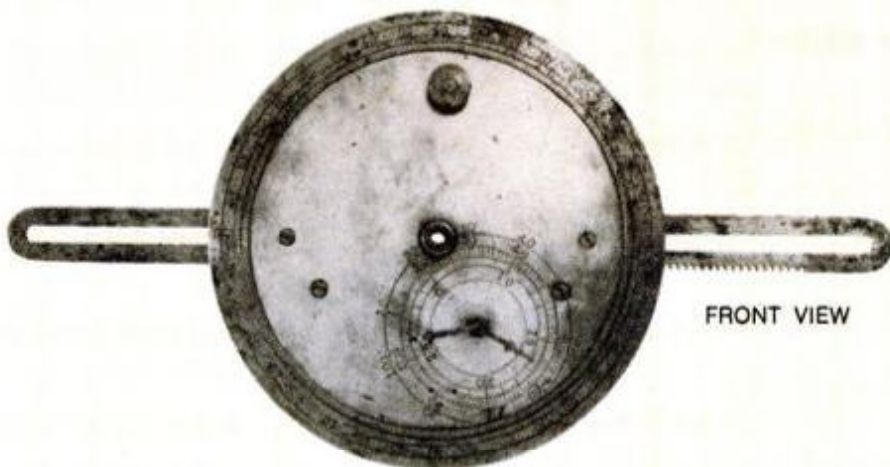
2 Hand-forged iron fork at bottom was not a crabbing or shellfish tool, but may have been a marine gadget for some other purpose.

3 Vertical part of crude wooden device hinges down to form tapered cylinder with bottom half. Is it an asparagus buncher? There's no proof.





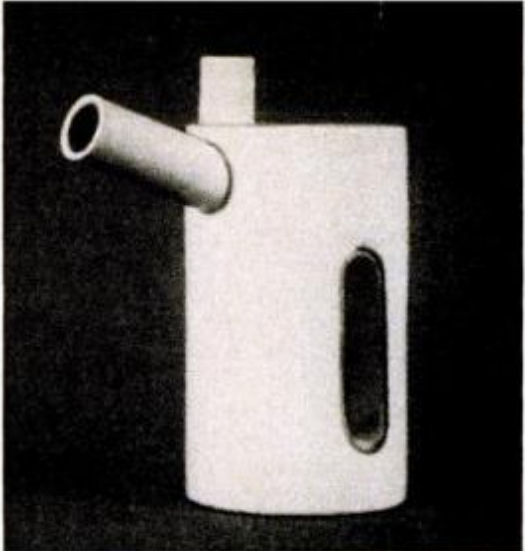
BACK VIEW



FRONT VIEW

4 Prize mystery is instrument above. The dial seems to measure units of distance. When large hand on inset dial is turned, geared bar moves.

5 Four sets of hand-blown glass globules in groups of three (one broken) rotate on a suspended axle above a circular mirrored base.

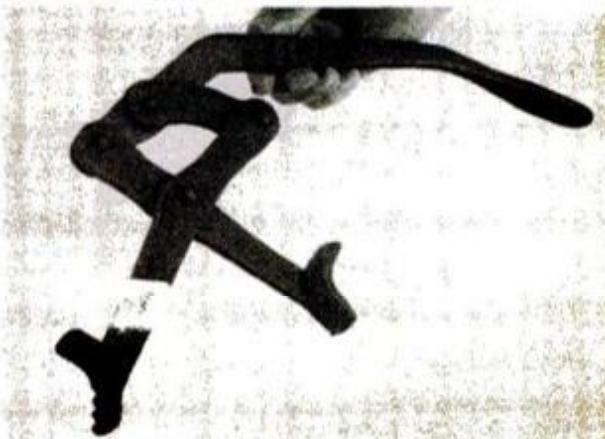


6 Porcelain jacket for whatever has a pair of spouts—one probably an intake, the other an outlet for the substance that probably flowed through it, if anything ever did.

7 Hand-carved of polished walnut, the hinged paddles have corrugated grooves that fit snugly when closed. It may have been a hair curler. No one really knows.



8 Lever arm on this hand-forged iron device spreads the two jaws apart when it is pressed down. Was it used to force boards together when laying floors? Maybe. Maybe not.



other what's-its: a wrought-iron gizmo with a lever that spreads two iron arms—for what?; a wooden clammer of some sort with hinged halves and a handle to open and close them; another hinged affair of polished walnut with interlocking corrugations; a small wooden dowel-toothed gear with an iron crankshaft that could have been a small power takeoff on an ancient wind or water mill—but what for? And so it went. All of the items I examined that day are in the Smithsonian's what's-it collection shown on these pages.

Where did they all come from, and what's a what's-it collection for, anyway? It is *not* just for chuckles by any means. Unusual collections of

art, instruments, machines and all sorts of objects are donated to the famous museum regularly, Bedini explained. Some what's-its are things that have been found mixed in with donations of more readily identifiable antiquities. And, occasionally, the mail brings an odd item with a note saying something such as: ". . . I don't know what this is, but I found it in my great-grandfather's attic and you can keep it if you'll tell me what it was used for."

Several things have been brought in by museum staff members poking around antique shops during their travels—like Bedini's calibrated mystery dial, which he discovered in a second-hand shop on the Connecti-

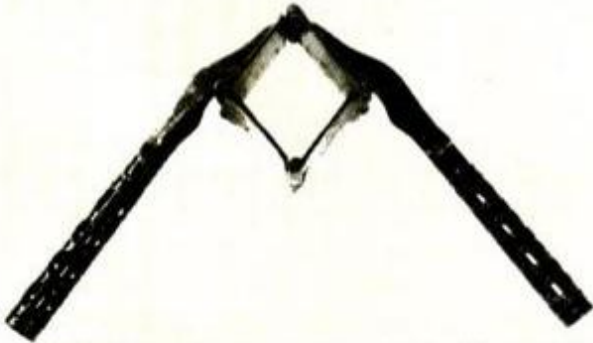
cut shore. It's all hand-tooled metal and forged parts, he pointed out—"a piece of jewelry for its time," which he pegged as "late 18th or early 19th century."

"Early settlers," Bedini said, "couldn't buy imported instruments, and they had no domestic brass. So they made their own surveying and nautical devices by whittling them out of native hardwoods and trimming them up with any used metal they could lay their hands on and rework."

One New England collector picked up a carefully calibrated wooden device at an antique show and sent it to the Smithsonian to see if they could identify it. "We had similar



10 Far-out iron tool with pivoted appendages probably was invented by the smithy who made it. So far, no one has been able to identify it.



11 Nutcracker for square walnuts it's not. The ventilated handles seem designed to dissipate heat, but purpose of the tool is not known.

12 Round wooden handle was inserted in hole at the top of this—well, what is it, anyway?



13 They're pinch tweezers of a sort, but their purpose is lost in American history.



14 Whether this is a spanner tool or iron adornment remains a mystery. What do you think?



15 Polished cattle horn with stick through the middle has lined slate attached. Device is thought to have been a kind of game. How it was played or scored no one knows.



9 Wooden gear wheel with dowel peg teeth is mounted on a forged iron crankshaft. Apparently a power takeoff—for what?



16 Four-foot-long shovel-like tool has been called everything from an ice chopper to a switch-thrower for streetcar tracks. You guess.



17 An anvil for peening scythe blades? That's one suggestion and it may stick. If diagnosis is confirmed, a what's-it becomes an "it."

ones and were able to tell him he'd found an early handmade surveying compass," the deputy director recalled.

Early do-it-yourselfers

No early do-it-yourselfer created a what's-it for nothing, Bedini said; the handmade tools were designed to perform specific jobs for the maker. Many such instruments, therefore, were ingenious inventions of their creators and are one-of-a-kind, which, of course, makes identification very difficult.

For years, Bedini explained, the museum followed a regular procedure with unidentified items. "We sent them around to our 42 curator

(Please turn to page 155)



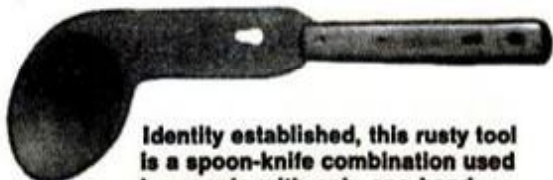
Walnut disc with inlaid ivory divisions and calibrations was acquired by the museum's deputy director and identified by him through research as a surveying tool used by medieval masons to lay out forts.



No longer a what's-it, this oddly shaped metal tool was identified by a Maryland collector as a "crab shank shoe laster" for shoemaking.



Unique Rube Goldberg what's-it, adorned with a confusion of wheels, gears and pinions, turned out to be a patent model for a multiuse agricultural machine.



Identity established, this rusty tool is a spoon-knife combination used by people with only one hand.

One Fiesta owner we surveyed figures he's going to wind up getting his car for free.

"I drive 300-400 miles a week in my work," reasons a 27-year-old South Carolina insurance agent. "My car payments are only \$3 more a month than they used to be on my previous Maverick. I'm saving about \$75 a month on gasoline. So that's \$900 a year, and in four years I'll have saved \$3600.

"I figure the Fiesta's resale value at the end of those four years will pay me back everything I put into it. So it won't cost me *anything* to drive this Fiesta. It's FREE! That's the best thing about the car; the 'F' in Fiesta stands for FREE!"



Fiesta's four levels of trim include sport model with firm suspension.



Well, not every owner figures he's getting a free car, but 69.5 percent chose the car for its basic economy, and 63.8 percent list economy as a best feature.

In terms of fuel mileage, that translates into a better around-town figure than the EPA posts—31.9 mpg versus 30.0 listed by the government agency. That's very unusual. Ordinarily EPA figures tend to be higher than those of our owners.

Out on the highway, however, the EPA's posted 43 mpg did top the 38.7 mpg averaged by the Fiesta owners we queried. Yet no one voiced disappointment in the "em-peegee" department.

Compliments poured in on this

car—in an abundance and volume we rarely see in this age of grumbling with the mechanical, service and quality aspects of automobiles.

"I don't get the impression that this is a 'cheap' compact," says a Michigan tax attorney, "and after years of owning Japanese cars, the Fiesta finally has them all beat."

A North Carolina homemaker purrs, "When we looked at the Fiesta for the first time, we sat in the rear seat, and the spaciousness was the car's selling point."

A New York IBM technician: "Looks like a handbuilt car: doors, hood, trunk, and all components fit well; it's tight and quiet."

A South Bend architect: "Handling is fantastic—a very good feel on the road; ride is also smooth for a small car, and the upright seats give a fine view in all directions."

An Alabama steel mill supervisor: "I've been over this car from bumper to bumper, and the Fiesta's workmanship is so much better than the 1974 AMC Hornet I traded in. I also wanted to cast my 'vote' for small cars—to help bring the public's wants and needs to the attention of our major automobile manufacturers."

Many owners mentioned the Ford nameplate as a major reason for

BY MICHAEL LAMM WEST COAST EDITOR

One owner summed it up for the rest: 'I think Ford finally put a small car together right!'

Removable, optional sunroof offers a drop-in smoked-glass panel. Both open part way.

Owners praise tall windows for visibility in all directions. Optional ventipanes aid ventilation.

Front-wheel drive proves its mettle on ice and snow.

Aluminum sport wheels reduce unsprung weight, but show dust from brake pads.

Fiesta's wheelbase is 4.5 inches shorter than Rabbit's, yet interior space amazes owners.



buying the Fiesta: the fact that dealer service was available to them nationwide.

A New York university director says, "I had experienced difficulties at foreign-car dealers and was attracted to the Fiesta because it can be serviced anywhere."

A livestock feed manager in Ne-



All models use 1600-cc ohc Four, which gives good performance. Fuel mileage in town exceeds EPA figure.

braska summed it up for many owners: "The reason I picked the Fiesta was that we finally had a Ford dealer here in Albion (pop.: 2100) where I could get service without driving at least 50 miles to a Dat-

sun, Toyota, Volkswagen or other dealership."

Opinions on Ford dealer service got good marks generally, but there were some complaints on lack of parts. "I was told that parts and service would be no problem," says a New York account clerk, "but this is definitely not the case. The heater-cable clip broke, and the dealer hasn't been able to get a new one. When I took the car in for a 1500-mile service, they didn't have an oil filter for it, either."

Carburetor problems plagued 17.6 percent of the owners we queried—mostly hesitation when cold and surge at cruising speeds. "The dealership has not been able to satisfactorily tune or adjust the carburetion," complains an Indiana telephone worker. A North Carolina nurse grumbles, "Engine sometimes feels like it is pulsating when accelerating in lower gears."

Performance received good marks from many owners. A public health nurse from South Carolina enthuses, "The Fiesta is the most fun car to drive I've had in years—its ease of handling plus the pep and getup are really its best features. Add to that its space and comfort and you have a neat little car."



Tach, gauges, fancy steering wheel grace the upper Fiestas, but their owners report that they miss a locking glovebox and a day/night mirror.

Spaciousness and comfort indeed amazed many owners. Considering that the Fiesta is 8.2 inches shorter than the VW Rabbit, it's amazingly roomy, even in the back seat. "I'm 6-1," smiles a 22-year-old loan officer, "220 pounds, and I can sit in the front or rear seat in complete comfort." A New York correction of-

NATIONWIDE SURVEY BASED ON 445,307 OWNER-DRIVEN MILES



Defroster and rear washer/wiper can be ordered separately.

Car ends at rear window, takes some guesswork out of parking.

Dropped back axle gives lots of cargo room with rear seat folded against front seatbacks.

PM photos: Dave Gooley

Ford's formula for the Fiesta:
A car that over 90 percent of owners would buy again

The Fiesta represents Ford's "World Car"—assembled from parts made in Germany, England and Spain. Overseas versions use 957- and 1117-cc engines, while the U.S. model carries a 1600-cc power plant.

Fiesta research began in 1969, when American and European Ford engineers and product planners worked out the basic package. The finished car, introduced in Europe in 1976 and here last August, looks remarkably like the Rabbit, Civic and Omni/Horizon. Front-wheel drive plus maximum interior space and very flat sheet-metal stampings give relatively little leeway in shape and ornamentation.

Ford's idea with this car, as with the original Mustang, is to provide one good, utilitarian base model and then let buyers tailor it with trim packages and options. The Fiesta's four trim levels range from plain to sporty to luxurious, the Ghia being at the top.

Options include airconditioning, ventipanes, various radios, power brakes, and full instrumentation. An automatic transmission is in the works and will debut soon.

ficer: "It rides better than many big cars, and with more room." An Indiana teacher points out, "We owned a Pinto previously and find the Fiesta has more usable rear-seat legroom."

Owners seem pleased, too, with the way the Fiesta is put together. "This is the first new car we've ever owned," notes an Indiana claims clerk, "that we couldn't find something wrong with." An Indiana college professor: "I expected to find loose screws and examples of poor workmanship. I found none. I'm still looking, but this car continues to amaze me."

And an Alabama health inspector for the Air Force: "The Fiesta seems to be put together very well; no signs of rattles or squeaks of any kind."

When we asked owners to list exactly what they don't like about the car, nearly 30 percent had no complaints—a remarkably high percentage. Among those who did, 8.8 percent said they felt the ventilation and heating system wasn't quite up to snuff. A New York physical therapist reports: "During the summer months, ventilation is very poor—stifling."

Several owners suggested adding ventipanes to remedy this problem, perhaps without realizing that the front windings are an optional extra and that they do come in certain models.

We then asked respondents to list any changes they'd like to see in their Fiestas. Twenty-four percent said, "Leave it alone!" But we received the following suggestions from the rest.

"I think fuel injection might fix the troubles with cold running and surging."—South Carolina letter carrier. "Larger fuel tank—10 gallons aren't enough for long trips. Also, the thermostatically controlled



Sunroof panels can be removed without leaving car, tuck into padded . . .



. . . vinyl pouch, then stow in hatch. Low liftover sill eases loading.

fan is too loud and scares pedestrians when it switches on suddenly while I'm stopped at red lights. One fellow looked up in terror and was sure I was about to run over him."—North Carolina greenhouse supervisor.

"I'd like to see the steering col-

umn lined up with the center of the driver's seat. I'm still not used to it standing off to the right."—Texas dental technician. "I'd like a longer shift lever and a five-speed transmission."—Vermont office worker. (She might not know that Fiesta's fourth gear is an overdrive ratio—0.88:1.)

"The factory radio is installed in a little console under the ashtray ahead of the gearshift lever."—Alabama fireman. "This location creates a safety hazard, because I have to bend down to reach the knobs. Despite Fiesta's flat floor, the car desperately needs a central console with an armrest, lighter and ashtray.

"Also, the seats should have more side support and need to be a little softer. After a long trip, my back aches from the firmness (the Sport Fiesta's suspension is very unforgiving and stiff anyway; I feel every bump). Finally, the gearbox needs better shift linkage, because it's impossible to shift quickly into third gear."

Taken overall, though, the Fiesta drew the highest praise from most of its owners. A New York social worker, for example, feels "It's obviously the best-thought-out car on the road and the most fun I have ever experienced in any car under \$8000."

And an Indiana postman offers: "I think the Fiesta is the car of the future. Front-wheel drive has a tremendous advantage over conventional Detroit automobiles, particularly in snow and on ice. People will come to realize they don't really need all that room. For 95-percent of my driving needs, the Fiesta is just the ticket. The advantages far overshadow the disadvantages. I don't think I'll ever buy another big car." **FM**

SUMMARY OF 1978 FORD FIESTA OWNERS REPORTS*

Total miles driven	445,307	Specific dislikes:	Vent/heater system	8.8%	Very good	42.6	Number of vehicles owned:	
Average miles per gallon		Vent/heater system	Poor dealer service	5.8	Good	25.6	Fiesta only	28.2%
In town (EPA 30 mpg)	31.9	Vent/heater system	Inferior radio mounts	5.8	Fair	3.9	Two cars	56.3
Long trips (EPA 43 mpg)	38.7	What changes would you like?			Poor	0.8	Three cars	12.7
Model choices		Better vent/heater system			Had any mechanical trouble?		Four cars	2.1
Standard	48.6%	Different seat shape			No	36.4%	Five or more cars	0.7
Decor	30.4				Yes	63.6	Makes of cars owned:	
Sport	15.9	Workmanship opinion:			What type of trouble?		Ford	18.6%
Ghia	5.1	Excellent			Carburetor	17.6%	Chevrolet	16.7
Why did you choose the Fiesta?		Good			Vent/heater system	13.7	Buick	11.8
Economy	69.5%	Average			Brakes	9.8	Volkswagen	10.8
Handling	18.4	Fair			Dealer repairs satisfactory?		Mercury	9.8
Size	15.6	Poor			Yes	60.4%	Age distribution of owners:	
Performance	12.1	Comfort opinion (front seat):			No	39.6	15-29 years	28.6%
Specific likes:		Excellent			Dealer service opinion:		30-49 years	43.5
Economy	63.8%	Very good			Excellent	27.0%	50-plus	27.9
Handling	58.0	Good			Good	34.4	Would you buy another Fiesta	
Comfort	25.4	Fair			Average	19.7	next time?	
Performance	19.6	Poor			Fair	7.4	Yes	94.2%
Roominess	19.6	Comfort opinion (rear seat):			Poor	11.5	No	5.8
		Excellent						

*Percentages might not equal 100% due to rounding or insufficient data.

Lifesaving switch: Skis become a sled



1 Only one pair of skis, two poles, two spacers and 100 feet of nylon line are needed for basic sled. Extras shown here assemble into full-length model.

by Doug Newman

Fortunately, accidents don't happen often on a cross-country ski tour. When injury or illness occurs, however, your group may be a long way from immediate aid, and sending for assistance can involve a cold overnight wait.

Self-evacuation is the other option, and the quickly assembled sled shown here makes it possible. Skis, poles and cord are the essentials, and you probably already have them along.

Among the other useful items are two or three 14-inch cross braces, two 5x $\frac{3}{8}$ -inch carriage bolts, four nuts and washers, two 3-inch spacers made from $\frac{3}{8}$ -inch-diameter nylon dryer vent tubing to slip over the carriage bolts, about 130 feet of $\frac{1}{8}$ -inch nylon line, and friction or duct tape. For tools, a pair of pliers, a hacksaw blade and a Swiss Army knife are useful.

Drill before you ski

Thirty seconds of preparation at home can get you ready. That's the time it takes to drill a $\frac{1}{4}$ -inch hole in the tips of both skis. Seal the wood with pine tar or epoxy. Choose the longest skis of a cross-country group for drilling since they can best carry the tallest skier. Make-shift cross braces could be cut from ski poles or branches in the field, but precut bars 13 or 14 inches long can easily be carried with the nylon cord in your rucksack. Two lengths, with one tied across the tips and one lashed to the bindings, plus the longest ski poles in your party secured lengthwise over the skis, will form a frame for a basic sled. Line is then laced across the frame, with a clove hitch tied each time the line wraps



2 Key to safety sled is predrilling $\frac{1}{4}$ -inch holes in tips of skis as anchor points for line. Wood is sealed with pine tar or epoxy. Holes don't weaken skis.



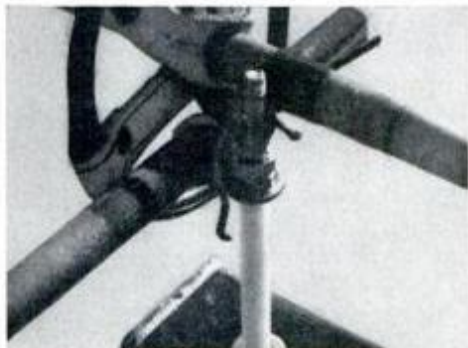
3 Two 14-inch spacers (three for a super-sled), precut from old bamboo poles, are carried in pack. One is tied with cord to tips of skis to hold them apart.



4 Second spacer is tied on top of cross-country binding using accessory holes or hooks. Lashing should not go under skis—it could slow sled, chafe off.



5 Using longest poles available, hook basket end over each ski tip and lash as far apart as possible for wide platform. Grips of poles tie to binding crossbar.



6 To extend litter platform so feet don't drag, super-sled lengthens bed area with carriage bolts and spacers through holes at back of skis for third brace.



7 With pole framework tied in place, line is laced back and forth between poles to form litter bed. Super-sled (above) uses rear poles for full-length bed.



8 Tarp or Space Blanket is positioned on sled and cushioned with foam sleeping pads. Victim is wrapped and tow-yoke of two ski poles or line tied on.

around a pole, and a litter is formed that carries an accident victim's body head first while his feet trail along in the snow.

The super-sled arrangement provides full-length support. Ski-pole

baskets are hooked over the ski tips and lashed to the front and binding cross braces, as with the standard sled. But then 5-inch carriage bolts are inserted through holes that have been drilled 1 inch forward of the tail of each ski. A washer and nut are secured on each bolt; the 3-inch-tube sleeve spacers are dropped on the two bolts and fastened with the second washer and nut. The third cross brace can now be secured to the top of each of these anchor posts, two more ski poles lashed on with grips at the bindings and baskets at anchor posts. A tow yoke of line or two ski poles is attached at the front.

FM

FLYWHEELS: NEW BOOST

Adding a flywheel to the drive train of a car, bus or train—gas-powered or electric—recoups energy from braking for better mileage.

by Richard F. Dempewolff

Last October Professor Andy Frank, of the University of Wisconsin's College of Engineering, shook up 150 colleagues during an engineering symposium in San Francisco. He turned off the ignition of a 1976 Pinto—modified by himself and colleagues Norman Beachley, T.C. Hausenbauer and P. Ting—and let the engine die. Then he backed his car out of a slot in the parking lot and took off at the city speed limit along the avenue.

Downhill? If anything, the grade was up. Professor Frank's car is different. After a short run, it can be driven full out for about five minutes without using the engine at all. With the engine, it can beat the pants off a standard version on acceleration, and gets up to 58-percent better gas mileage. How? It picks up and stores energy when slowing down, for use later. That's how. And that's only part of the story.

On a tarmac apron behind the Los Angeles research facility that produced the vital components for Professor Frank's "gee-whiz" Pinto, there's something that looks like an ordinary blue and white Postal Service vehicle.

Vehicle not ordinary

It is not ordinary. Beneath its hood nestles the same 5000-year-old energy storage device that kicks Andy Frank's Pinto along with or without engine. This one is linked to a battery-driven electric powerplant, enabling the vehicle to make more than 500 stops and starts along a postal route on which the Post Office's standard electrics make only 350 before requiring battery recharge. What's more, it can be zapped up to 50 mph for passing—

First experimental flywheel system for a postal mail wagon was retrofitted in standard fleet model electric, shown (right) with hood raised at Garrett plant, Torrance, Calif. New model will extend delivery stops from 350 to 500 on a single battery charge, is built from chassis up. At far right, flywheel assembly is mounted.

though a 30-mph cruise is all the Post Office requires.

No "pie-in-the-sky," the first production prototype of the vehicle is due for delivery to the Postal Service as you read this. Its unique propulsion system, known as "hybrid electric," promises to take electric cars out of the golf-cart category once and for all in range, speed and acceleration—at a cost to fit any pocketbook. At least, that's the goal at the AiResearch Division of Garrett Engineering, a subsidiary of Signal Companies, Inc., in Torrance, Calif. That's where the system was developed, under the Energy Research and Development Administration's wide-ranging "Electric and Hybrid Vehicle Demonstration Project." The project involved some 7500 test vehicles from here and abroad.

Currently under construction at Garrett is an even more interesting advanced-design electric car using the new system. This project is half of an ERDA-sponsored program aimed at developing two types of electric-powered family vehicles. The other half, using advanced electronics to create an efficient and smooth-running standard electric car, is under way at General Electric labs in New York.

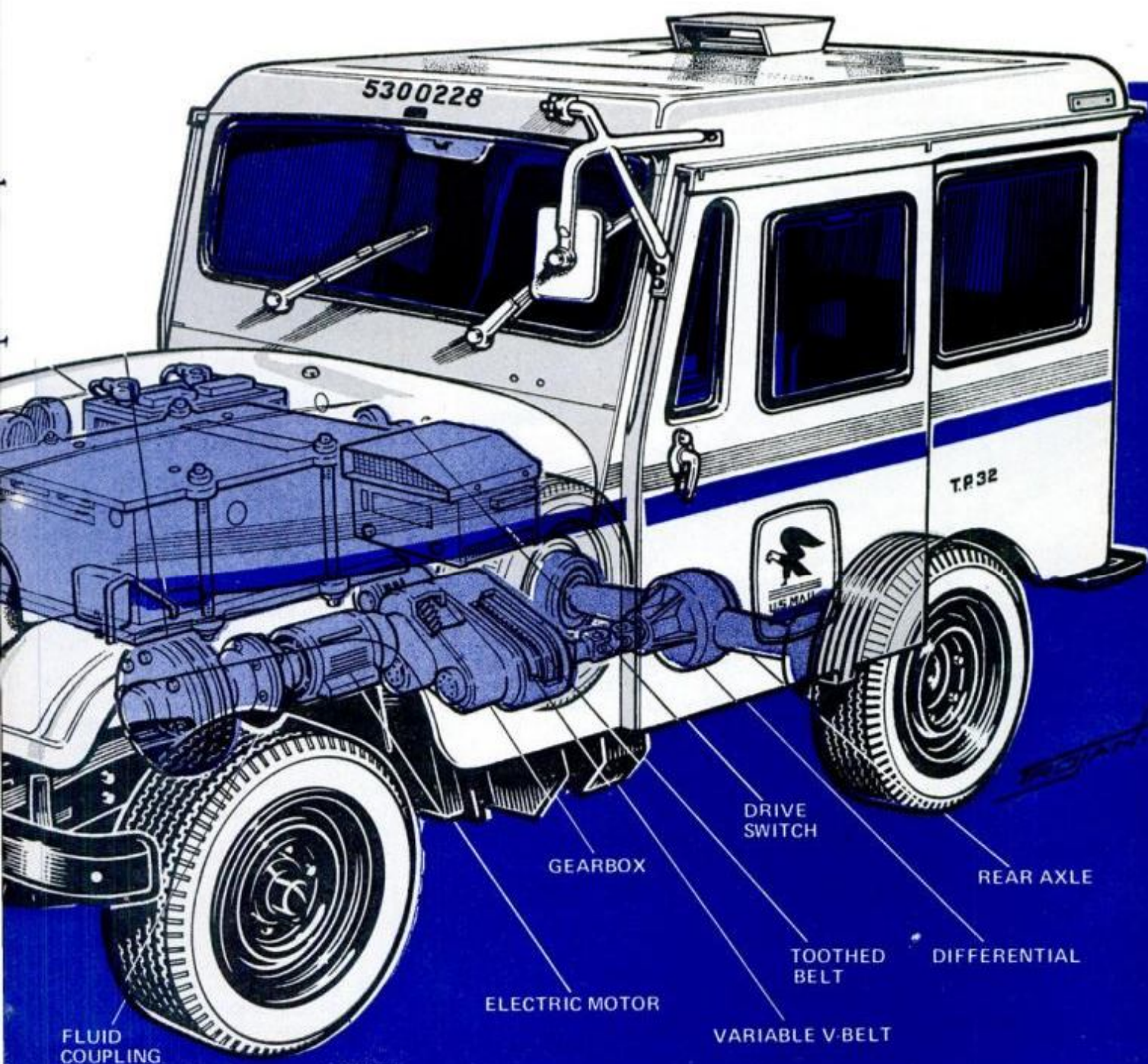
Garrett's electric car has been designed from the ground up to accommodate the new hybrid powerplant, which is the one we're concerned with in this article. The



Hybrid electric postal car designed by the Garrett Corp. in Los Angeles, under an ERDA-sponsored program, uses flywheel technology to generate and store electrical energy during deceleration. It helps build speed, using less battery power during starts in stop-and-go traffic.



FOR ENGINE POWER



sleek, streamlined, four-passenger vehicle will boast front-seat leg and head room comparable to a Cadillac's. It will cruise at 55 mph, with a passing speed of 70, and will maintain 50 mph on a 5-percent grade. Range is expected to approach 100 miles with standard lead-acid batteries. Ownership cost would run about 15 cents per mile, and the price of the vehicle probably will be about \$5000.

Key component of these hybrid vehicles, of course, is that "5000-year-old device"—the flywheel, used since the dawn of civilization as the heavy, whirling disc on which the

potters have spun their clay bowls.

Versatility is a notable flywheel virtue. It is adaptable, for instance, to mass transport buses and even trains. In fact, Garrett hybrid electric drives have been in test operation for more than a year on two prototype cars in New York City's Metropolitan Transport Authority subway complex. Their 14,000-mile performance to date indicates that if all cars in the system were so equipped, some 30 percent of the electrical energy currently consumed by the subway would be saved.

Just what is it that these spinning

heavyweight "tops" do, and how?"

"Flywheels improve an engine's performance by allowing it to run at its highest efficiency," explains Beb Rowlett, a Garrett engineer.

The system design may vary according to performance requirements. But one requirement most automotive flywheel systems have in common is a special transmission in addition to the one transferring energy from engine to wheels. In a standard vehicle, the engine revs up to accelerate it. In a flywheel vehicle, the flywheel slows down as it gives up energy to accelerate the

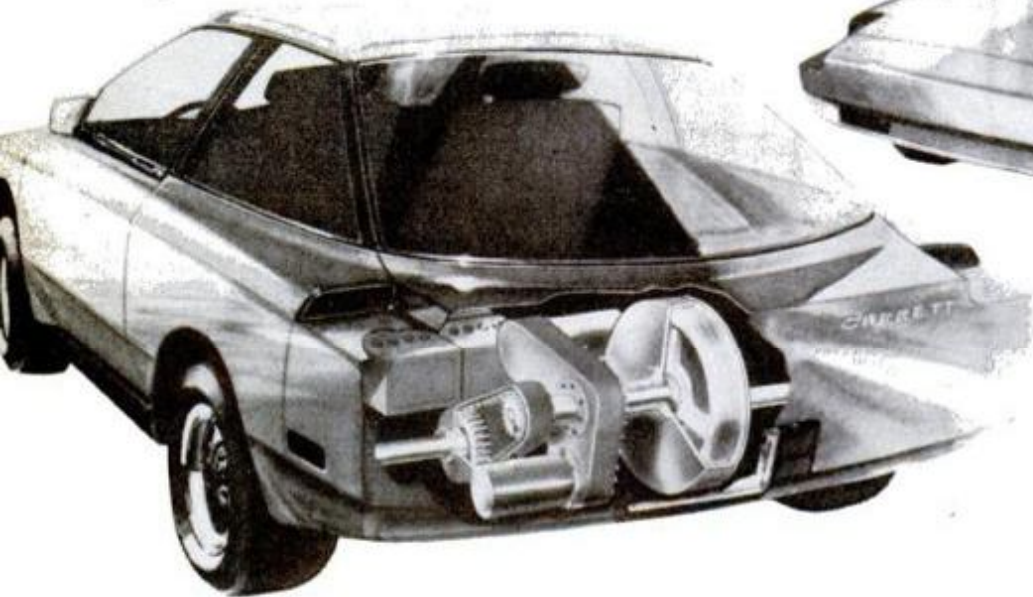
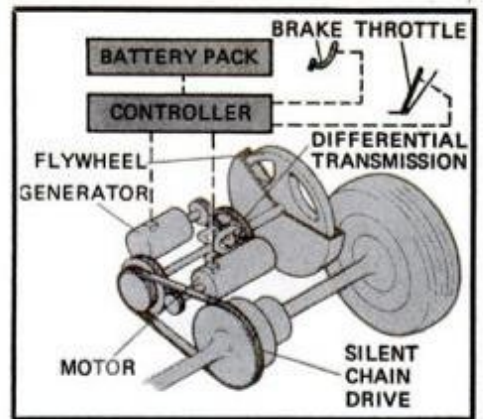
car. Hence, a variable-speed transmission must be added to accommodate it.

In the postal wagon, a variable V-belt transmission plus a fluid coupling between the flywheel and the system (see cutaway) solve the problem. At start-up, the car's 27-pound flywheel, 7.5 inches in diameter, is quickly brought to its operating speed of 36,000 rpm by a 14-hp electric traction motor.

"Once at speed, the whole system operates at 36,000 rpm regardless of the speed of the vehicle," Rowlett explains, unfolding a map across his desk. "Here's the simulated postal route. Let's say, starting at zero time, the postman accelerates to 30

mph in 12½ seconds by pressing his accelerator pedal, which controls the V-belt. That takes 50 hp. The 14-hp motor can only take it to 5 mph. The rest must come from the flywheel."

If, after 20 seconds, the postman wants to stop, instead of applying friction brakes, his foot pedal changes the ratio of the V-belt drive, and he starts to slow down. This imposes a force on the flywheel, which starts to speed up, regaining some of the energy it lost during acceleration. When the belt reaches its minimum ratio, the driver slips the coupling and the vehicle comes to a halt with the friction brakes, which



New four-passenger flywheel electric boasts sleek, spacious design and Garrett powerplant (top), with performance that's comparable to piston-engined family-size automobiles.

will come into play automatically.

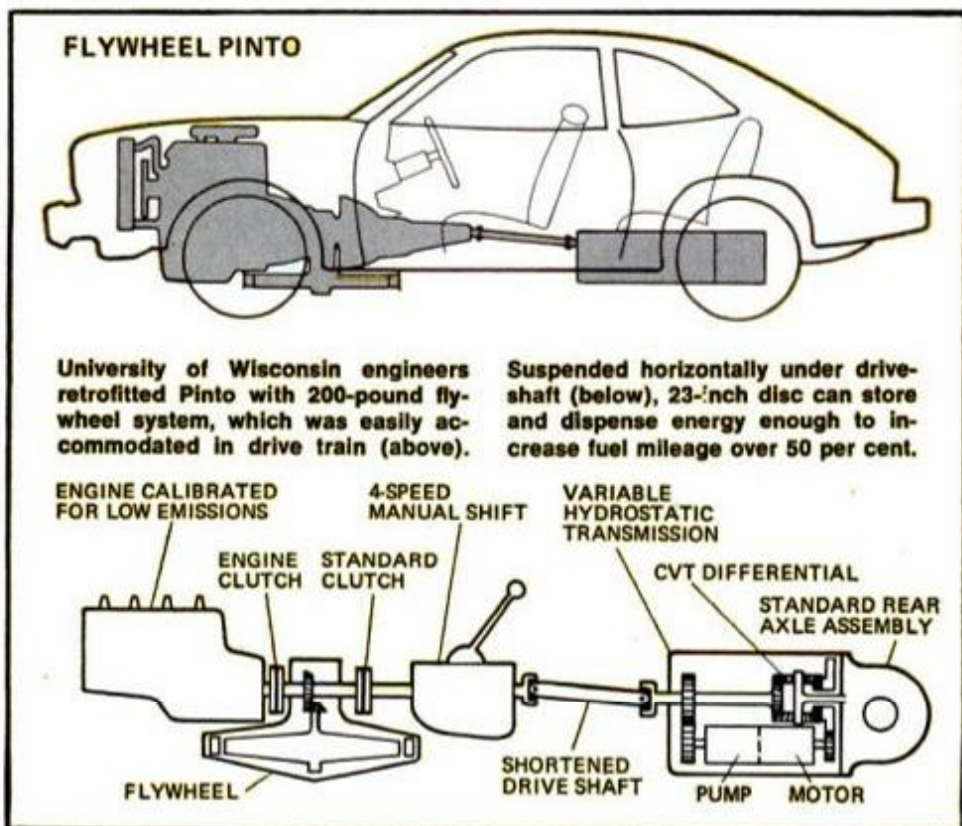
The process, known as "regenerative braking," is what provides all those extra stops and starts in the postal vehicle; all the added miles per gallon in the Wisconsin Pinto; the energy savings in those subway cars; and the extra speed and range designed into the upcoming Garrett family electric. In standard vehicles, energy from deceleration is thrown away as heat.

An important feature of the postal vehicle, according to another Garrett engineer, Roy Brown, is that the flywheel assembly operates in partial vacuum. "At the flywheel speeds used," he says, "losses would be horrendous if the system were operated under normal atmospheric pressure."

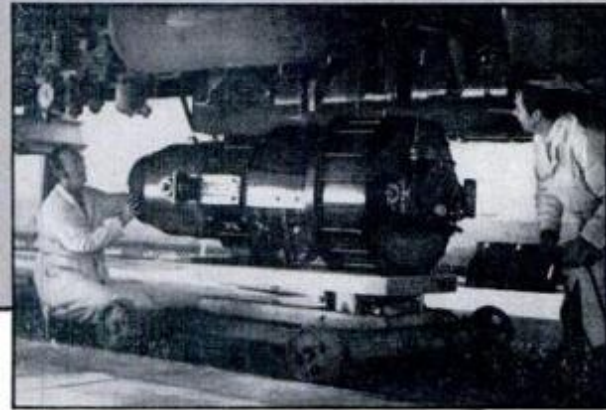
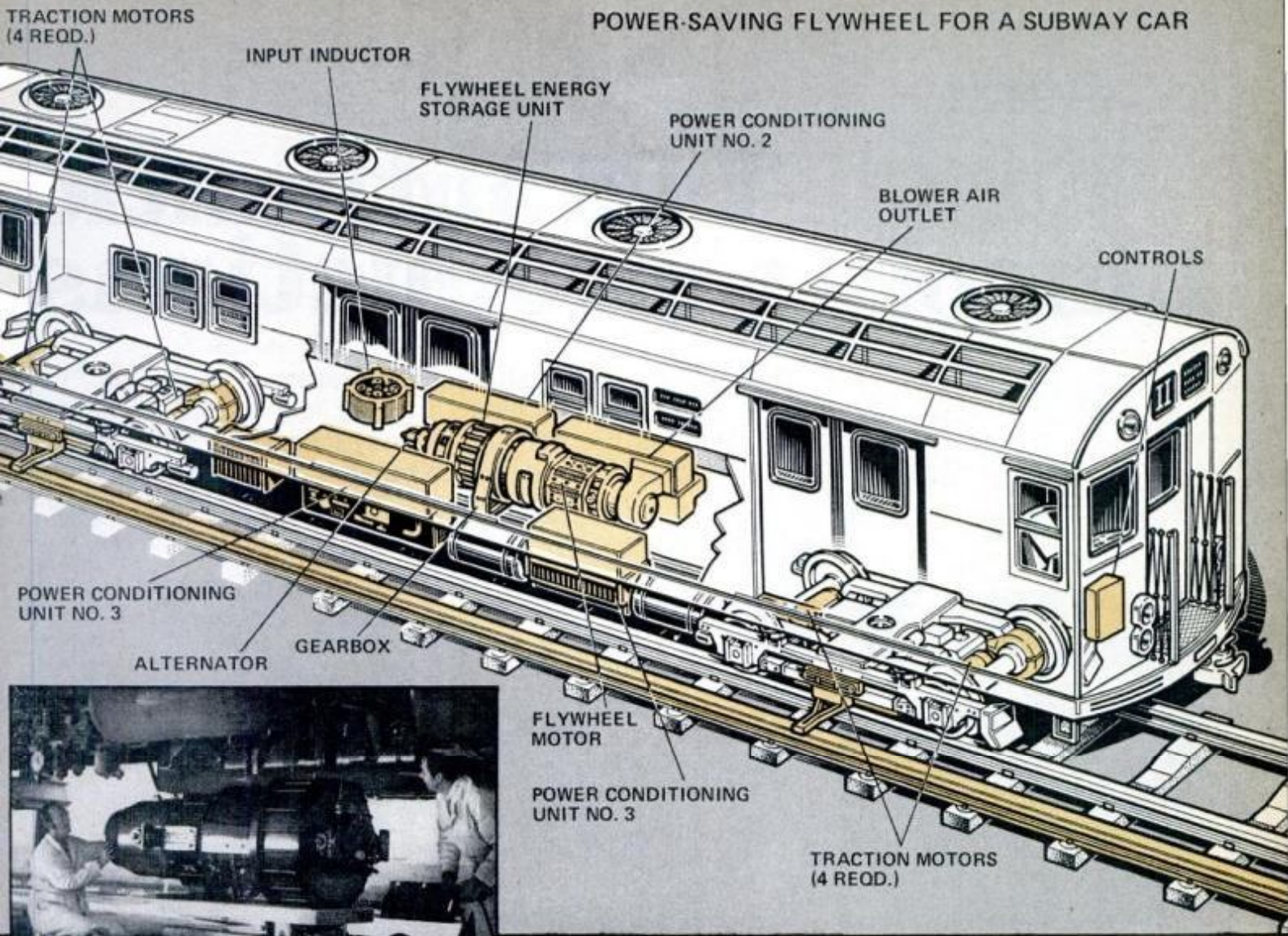
Flywheel acts as load-leveler

What the flywheel provides is a load-leveling effect on the battery, increasing the number of start-stop mail delivery cycles without sacrificing range, and conserving energy by regenerating flywheel speed during deceleration. Improved acceleration makes the vehicle safer to drive in normal traffic, and the variable-speed transmission enables the driver to control the entire operation with the accelerator and brake pedals.

A characteristic of flywheels that has hindered their use in automotive



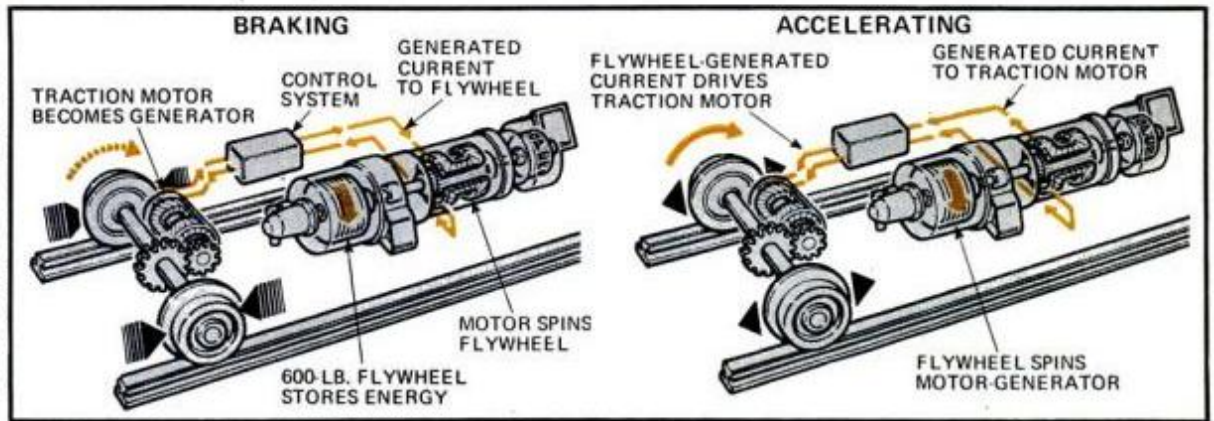
POWER-SAVING FLYWHEEL FOR A SUBWAY CAR



Two New York City subway cars, fitted with 6000-pound flywheel propulsion units (left), have undergone a year of workout on MTA system tracks. They have operated on 30-percent less third-rail current than present trains.

HOW SUBWAY SYSTEM WORKS

During braking, normally wasted energy is saved for use. Traction motor, instead of driving train wheels, is driven by wheels, generating electrical power to speed up flywheel. On acceleration, flywheel feeds stored power back to train wheels to help reduce current drawn from the third rail.



applications until recently is that, although they can store more and more energy as they turn faster and faster, they will burst if the centrifugal force of rotation exceeds the tensile strength of their structural material. Such disintegration of a solid steel wheel, spinning at 20,000 to 40,000 rpm, can rival a shrapnel shell as an instrument of destruction. Enclosing the device in a heavily armored case is one obvious answer, but the added

weight in an electric vehicle is not desirable.

In regenerative braking, a runaway flywheel is entirely possible unless foolproof safety measures are taken. To solve that problem, AiResearch has designed a whole new family of flywheels. The kind used in both the postal car and the University of Wisconsin Pinto—which has a 200-pound, 10,000-rpm, 23-inch wheel mouted horizontally under the

driveshaft—is made up of thin discs of high strength alloy steel. In a runaway situation, Roy Brown explains, the probability is that only one disc will fail, though the containment case—20 pounds lighter than normally required—is designed to take two simultaneous failures.

As an added precaution, the discs are heated to 1000° F. and dropped onto the shaft, which has been cooled

(Please turn to page 153)

Two authentic Lincoln reproductions

PM received permission for our craftsman to measure two mirrors from the Lincoln Springfield house: Abraham's shaving mirror and Mary's vanity mirror. We've drawn the plans so readers can build accurate reproductions.

by David Warren

These homemade reproductions will reward their present-day creators with a sense of the past that is often missing from spiritless, manufactured reproductions. The original bureau mirrors represented here were used in the Lincolns' Springfield, Ill., home.

When the President-elect and his wife, Mary, were preparing to move to Washington in 1861, Mr. Lincoln gave his shaving mirror to his family's seamstress as a memento for her service. She gave it to her niece, who in turn gave it to her brother. It was then sold to its present owner, the Illinois State Historical Library. Mary Lincoln's niece inherited the vanity mirror and later willed it to the same library.

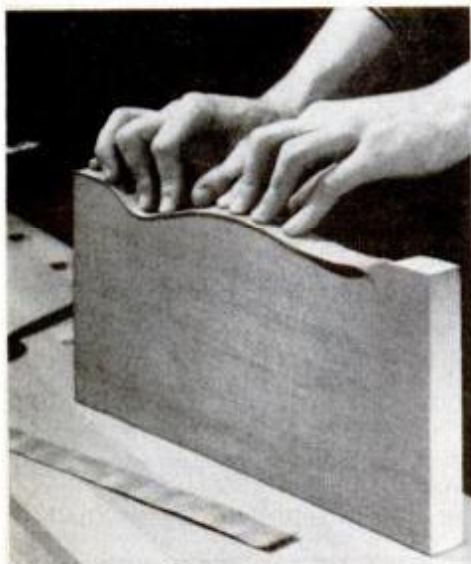
Your reproduction will also become a coveted heirloom—and would make a fine gift for someone right now.

Both projects are constructed of Honduras mahogany, which is available by mail from Craftsman's Wood Service, 2729 South Mary St., Chicago, Ill.

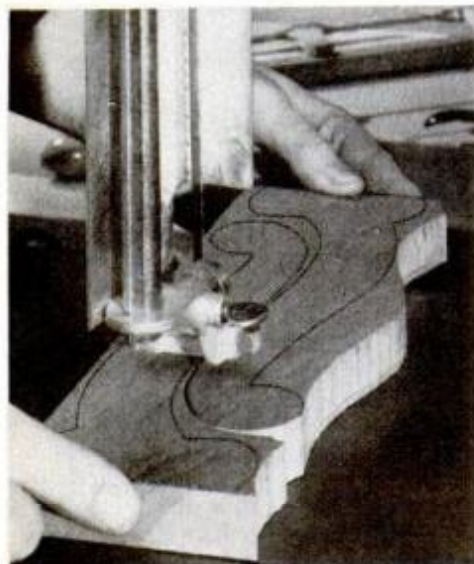
MATERIALS LIST—SHAVING MIRROR

Pcs.	Size (Use)
1	1 1/4 x 6 7/8 x 14 in. (Base)
1	3/4 x 6 x 8 3/4 in. (Uprights)
1	3/4 x 3/4 x 50 in. (Frame)
1	1/4 x 1-1/32 x 40 in. (Molding)
1	1/4 x 1/2 x 50 in. (Back strips)
1	1/2 x 10 x 12 1/4 in. (Filler panel)
1	3 sq. ft. (Veneer, plain striped)
2	1 1/4 x 1 1/4 x 8 in. (Feet)
2	1 1/4 x 1 1/4 x 3 in. (Knobs)

Misc.—1/4-in.-dia. x 4-in. dowel, 3/8-in.-dia. x 4-in. dowel, 2 wood washers (use scraps), 2 2-in. No. 8 fh wood screws, 1/4-in. mirror cut slightly shy for easy fitting, plastic resin glue, contact cement, mahogany stain (or lye), orange shellac, linseed oil.



Face front edge of the shaving mirror base with veneer cut so grain pattern runs vertically. Leave 1/16-in. excess on each edge, apply glue and then sand it flush.



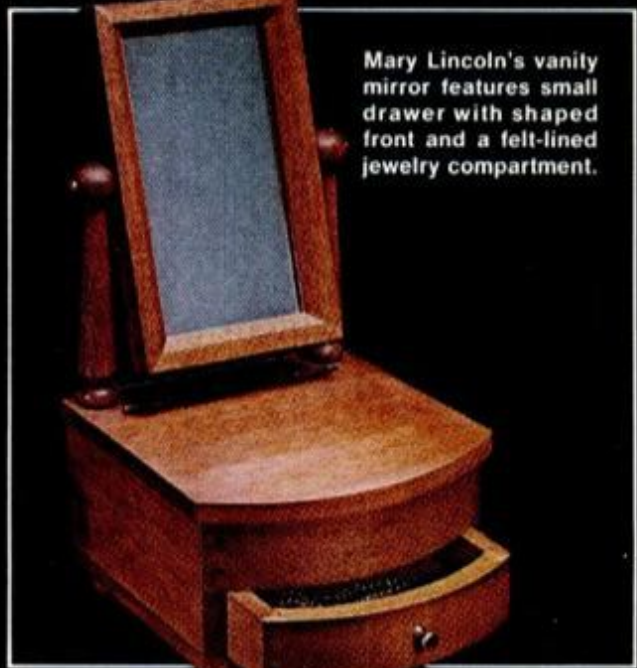
Cut out the uprights with a bandsaw or jigsaw. Shape with spokeshave and rasp.



Wood screw on knob is threaded with woodcutting die, holds mirror at any angle.



Uprights are glued, doweled and screwed to base. See text for alignment procedure.



Mary Lincoln's vanity mirror features small drawer with shaped front and a felt-lined jewelry compartment.

Antique buffs will welcome the opportunity of reproducing the his-and-her mirrors of Abraham and Mary Lincoln. Through the courtesy of the Illinois State Historical Library in the Old State Capitol Building, Springfield, Illinois, PM is able to show you how you can reproduce these personal mirrors that were used in Lincoln's Springfield home. Plans for both pieces are on the following pages and directions for building start on the facing page.



Caul, hollowed with rounding plane, will insure bond of veneer glued to molding.



face of the base stock. Draw the serpentine front using the scaled-down grid in plans and cut with a bandsaw. Smooth concave curves with a drum sander and convex ones with a disc sander or Sand-O-Flex.

Next, cut a veneer strip for the front edge (see photo). If 15-in.-wide veneer isn't available, use two pieces. To do so, select a pleasing grain pattern for a centered butt joint. Then overlap the two strips and cut through both at the point selected to get a joint that butts perfectly. Use contact cement to fasten veneer to the serpentine front. Sand edges of veneer flush, stroking sandpaper toward the base to avoid splintering the veneer.

For all other glued joints, use plastic resin. Plastic resin oozings will accept stain reasonably well if they are wiped clean with a hot, damp cloth before the glue sets.

Now, lay out two uprights on 3/4-in. stock and cut out as shown. Shape and smooth the sides and edges. To join uprights to the base, bore 3/8-in. blind dowel holes in top of the base and corresponding holes in bottom of the uprights. Cut four dowels to fit. Bore 5/32-in. shank holes through the base. Assemble uprights dry and mark corresponding pilot holes in

bottoms of the uprights with a nail. Then bore 7/64-in. pilot holes in uprights. Glue and screw uprights to base. Complete base/upright assembly by turning the four feet and fastening them with dowel pegs.

To accommodate angle-adjusting knobs, bore 3/8-in. pivot hole in right upright. Bore a 5/16-in. hole in the left upright and tap with a 3/8-in. wood-cutting tap. Cut 3/8-in. threads on the end of the left knob. (After you start threads, you must remove the cone-shaped front guide in order to cut threads to the base of the knob.) If it is impractical to obtain woodcutting taps and dies, a good alternative is to use a tight friction fit at pivots.

Construct the mirror frame by cutting stock to length, mitering corners and gluing them together with picture-frame corner clamps. Cut backing board to the same size as the opening in the mirror frame. Make 1/4 x 1/2-in. strips to hold mirror and backing in the frame, and miter these corners, too.

Form a molding for the frame by shaping strips with a flat-soled jack plane as indicated in cross section. Sand smooth. This operation requires that molding strips be temporarily reinforced with 3/4 x 1-in.

scrap before clamping between bench dogs. Hold scrap to the molding with 7/8-in. brads nailed up through the scrap.

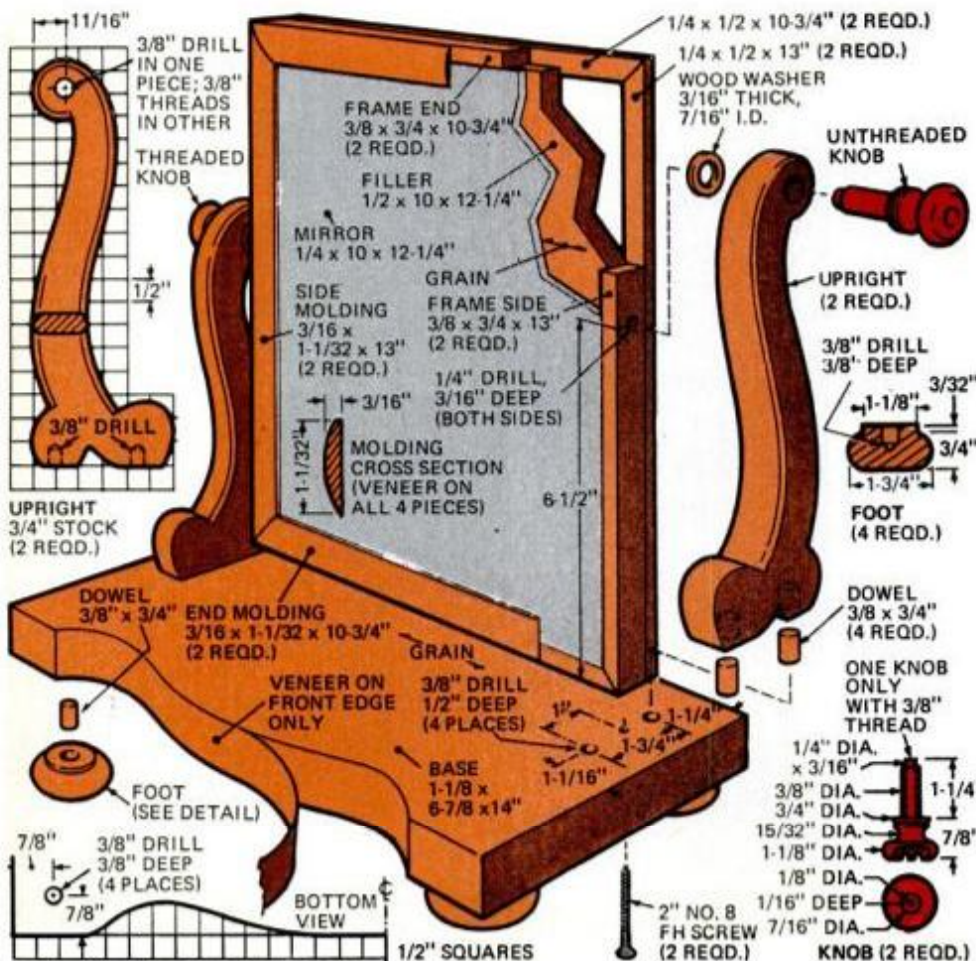
Gluing veneer to the frame molding requires a caul formed from a molding face. (See photo, page 103.) Cut the veneer strips slightly oversize with the grain running in the short direction. Then apply plastic resin glue to a dampened veneer. Bend the veneer over the molding by clamping a sandwich of caul, wax paper, veneer, molding and cover with a flat 2x4. Let this dry 24 hours before removing clamps. Sand veneer with the grain using 150-grit paper and miter four veneered pieces to length. (The veneer is fragile at the point of the miter. To lessen its tendency to splinter, saw it on the pull stroke or use a miter-trimmer.) Glue molding to the frame.

Insert the mirror into the frame and place backing board over it. Fasten mitered strips over the backing with 1/2-in. brads. Finally, drill 1/4-in. holes in the mirror frame and mount the frame between the uprights with two wooden washers and knobs as shown.

MATERIALS LIST—VANITY MIRROR

- Pcs. Size (Use)**
- 1 3/8 x 6 1/4 x 6 3/8 in. (Case bottom)
 - 1 3/8 x 6 3/8 x 6 3/8 in. (Case top)
 - 2 3/8 x 2 3/8 x 5 3/8 in. (Case sides)
 - 1 3/8 x 2 3/8 x 5 3/8 in. (Case back)
 - 1 1 1/4 x 1-5/16 x 6 1/4 in. (Case front)
 - 1 1/4 x 5 3/8 x 6 1/4 in. (Compartment bottom)
 - 1 3/8 x 3/8 x 25 in. (Mirror frame)
 - 1 3/32 x 3 3/4 x 5 3/8 in. (Backing)
 - 2 1 1/4 x 1 1/4 x 6 in. (Uprights)
 - 1 1 x 1 x 6 in. (Feet)
 - 1 1 1/4 x 1-5/16 x 5-5/16 in. (Drawer front)
 - 2 3/8 x 1-5/16 x 5 1/4 in. (Drawer sides)
 - 1 3/8 x 3/8 x 4-9/16 in. (Drawer back)
 - 1 1/4 x 4-15/16 x 5 3/8 in. (Drawer bottom)
- Misc.—2 3/8 x 1-in. brass hinges, 1 3/8-in.-dia. brass pull, 2 1-in. No. 5 rh brass wood screws, 1/2-in. mirror cut to fit, plastic resin glue, white glue, mahogany stain (or dye), orange shellac, linseed oil, 10 x 10-in. piece of green felt.

ABRAHAM LINCOLN'S SHAVING MIRROR



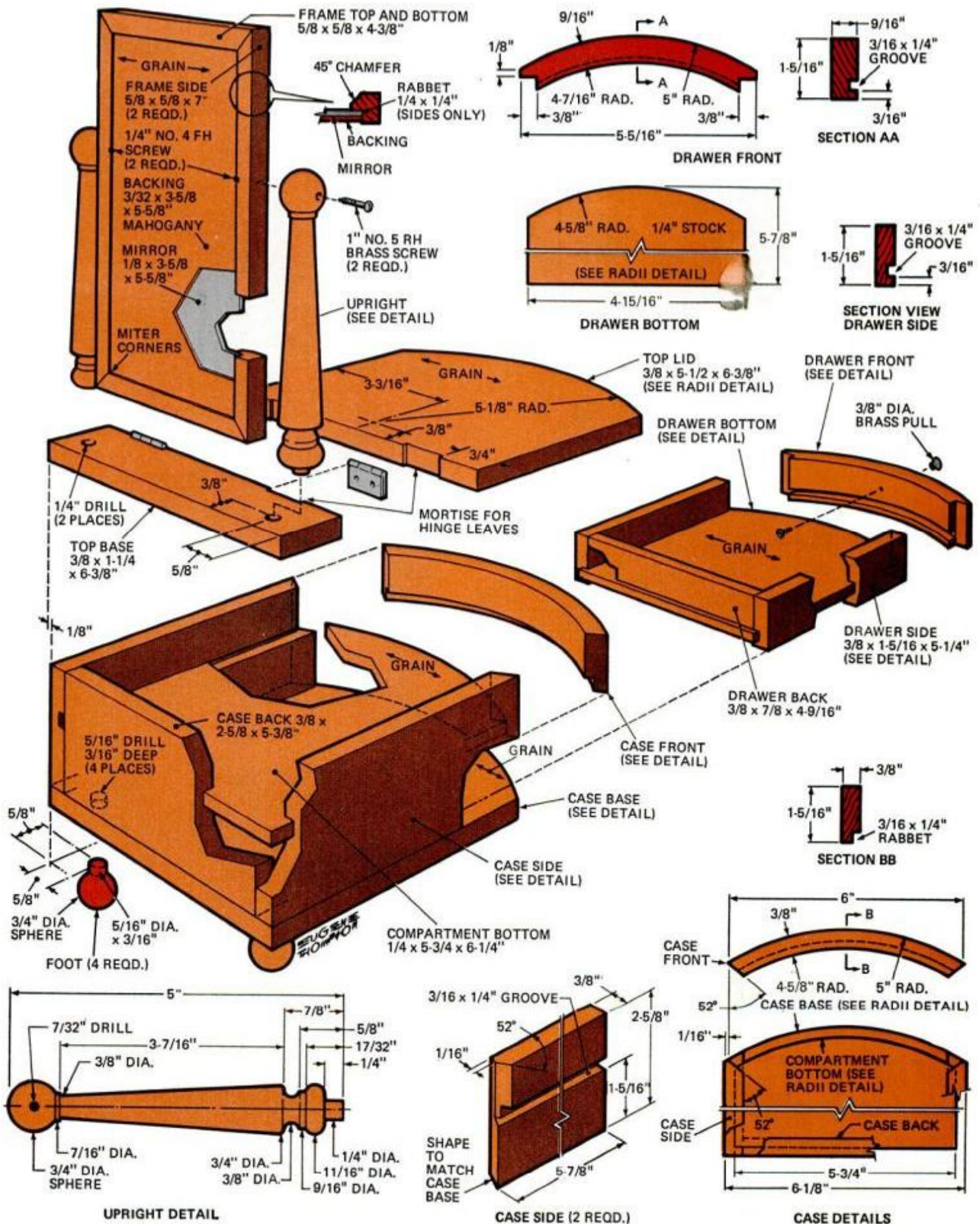
Building the vanity mirror

Begin construction of the case by cutting the sides and back. Note that the angle of the edge where the sides and front join is 52°. Groove the sides for the compartment bottom. Cut the curved front piece with a bandsaw and smooth the inside curve with a drum sander. Next, rout a rabbet on the bottom inside edge of the front piece. To do this, clamp parallel fences of scrap wood on the drill-press table. Chuck a 1/4-in. router bit and feed the piece through, removing about 1/16 in. of stock with each pass.

Cut out top/lid and base pieces according to the drawing and radii detail. To assure matched graining on top, cut the two pieces as one,

(Please turn to page 148)

MARY TODD LINCOLN'S VANITY MIRROR

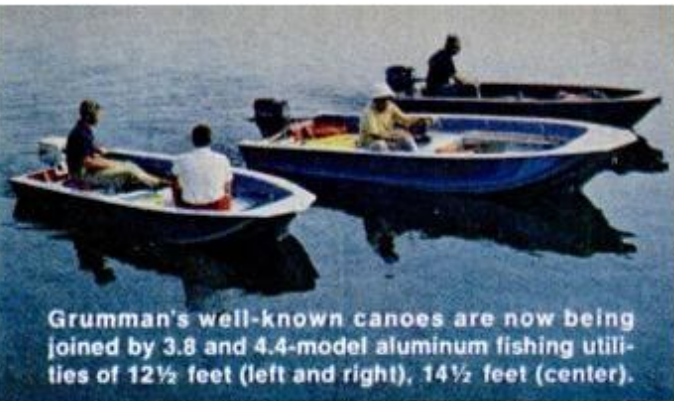


All radius measurements are made from a single point and are used to help determine the overall lengths of the rounded com-

ponents and also to insure a consistent curve. Use the radii detail shown on page 150 when laying out these parts.



Sterndrive power is now packed in to push smaller runabouts like this 18-foot Cobra King from Ski Boats, Inc. that tops 62 mph with MerCruiser 250.



Grumman's well-known canoes are now being joined by 3.8 and 4.4-model aluminum fishing utilities of 12½ feet (left and right), 14½ feet (center).



And larger hulls can move right along with outboard engines. Steury's T523 Houseboat can sleep five aboard its 23-foot length but is trailerable.



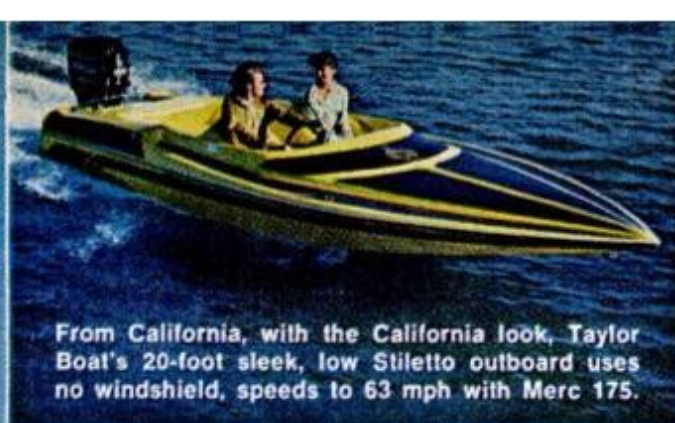
The Wellcraft's 165 Airlot Fisherman combines a smooth ride with clever walkway around console.

Boating
'78

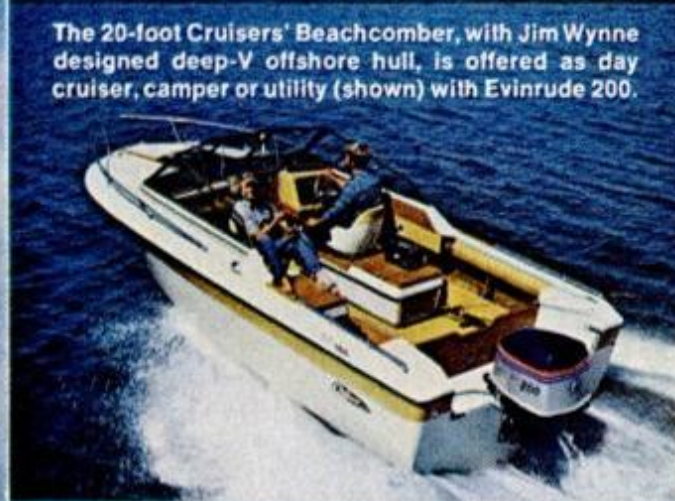
PM's pick: 20 that are tops for '78

For cruisers, campers, fishermen and skiers, there's plenty that's new for the season afloat.

by Bill McKeown
BOATING EDITOR



From California, with the California look, Taylor Boat's 20-foot sleek, low Stiletto outboard uses no windshield, speeds to 63 mph with Merc 175.



The 20-foot Cruisers' Beachcomber, with Jim Wynne designed deep-V offshore hull, is offered as day cruiser, camper or utility (shown) with Evinrude 200.



Fin & Fun is Chrysler's name for a new 16-footer designed as a tournament-type fishing boat, ski boat or family craft matched to 115-hp Charger.



A 19-foot runabout that can clock 44 mph with a Merc 150, Camper Craft from Miami converts to cruiser sleeping four with head, shower for \$5000.



Slickest of sleek speedsters for '78, the Glastron/Carlson CV-23HT (for hard top) is a trailerable day cruiser with stern lounge and water-ski locker, built-in bar, forward convertible sleeping cuddy with a white fur ceiling. Power steering guides jet or I/O; speeds to 58.

Pick any pastime on the water and this year's selection of new pleasure craft should be able to fit the action.

Bigger hulls are more popular, but the bigger powerplants clamped on the back or installed aboard should provide more performance for the same amount of fuel, or even less. Outboards, sterndrives and water jets are all available in horsepower ranges

that can make almost any craft a successful ski boat.

High styling is favored if it does not limit the number of passengers who can be carried, and a number of our selections feature the open bow-rider foredecks that increase carrying capacity.

A number of the larger builders not represented here—Reinell, Sea Ray, Bayliner,

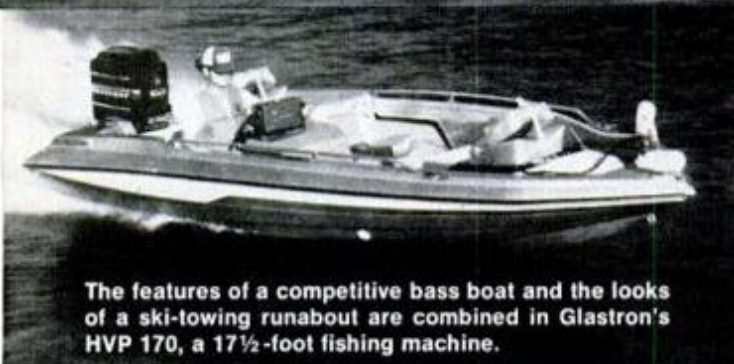


Inflatables offer portable boating, and bigger models like the Bonair III, a 14½-foot outboard skiff, can handle this Johnson 25 and other motors up to 40 hp.

Boating '78

Chris-Craft and others—are also fitting more berths into the compact cabins of trailerable (eight-foot beam) boats. Look for quarter berths under foredecks and cockpits to add extra accommodations for a big family. Boats for 1978 show improved construction, and with level safety flotation now required by law, all should still be afloat next year, too.

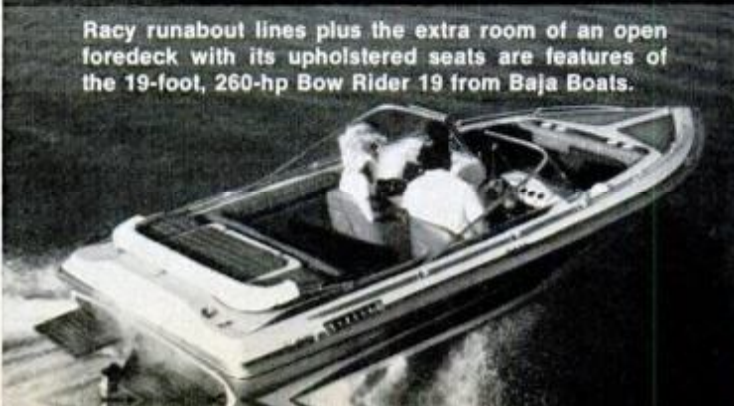
Hulls that can mount the biggest of the new outboards often can handle open seas. The Boston Whaler Outrage has new deeper center section for an even smoother ride.



The features of a competitive bass boat and the looks of a ski-towing runabout are combined in Glastron's HVP 170, a 17½-foot fishing machine.



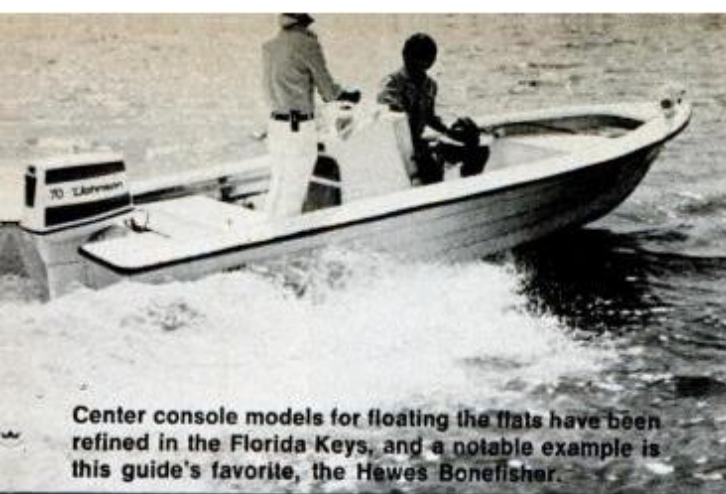
This year, designers are stressing the feel and look of speed by using low freeboards, racy lines, no wind-screens and long side rails as on this Baja.



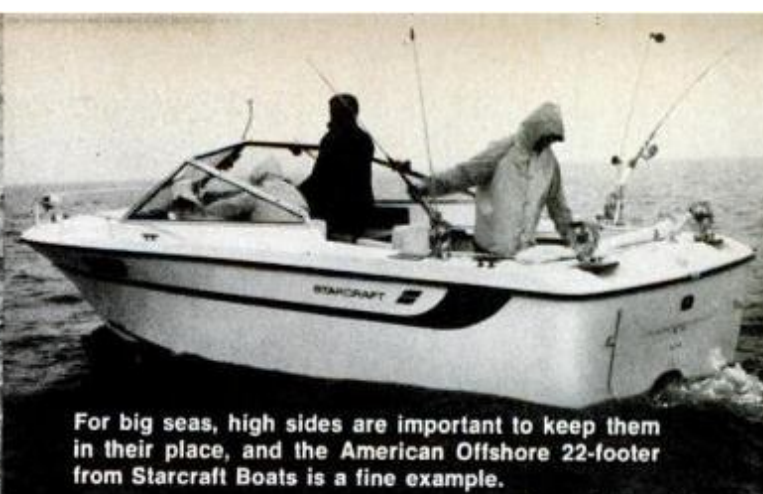
Racy runabout lines plus the extra room of an open foredeck with its upholstered seats are features of the 19-foot, 260-hp Bow Rider 19 from Baja Boats.



Cruisers with speed and sporty look distinguish the Wellcraft Nova Line. The 250XL imports the padded afterdeck popular on the French Riviera.



Center console models for floating the flats have been refined in the Florida Keys, and a notable example is this guide's favorite, the Hewes Bonefisher.



For big seas, high sides are important to keep them in their place, and the American Offshore 22-footer from Starcraft Boats is a fine example.

The customizing trend in cars and boats is shown here with a Corvette towing an Aristocrat ski boat (from

Sleek Craft of Santa Fe Springs, Calif.) powered with a Johnson, ready for launching in Florida.



Transom platforms, a useful development from Australia, are now being styled into a functional attractive addition to boat design. Glastron does it here with its Carlson CVX 20 Sprint, a 59-mph model with 175 hp.



A bug for all hulls and seasons, Merc's little Gnat supplies sufficient push to power along a dinghy, canoe, skiff or inflatable. Steering by tiller takes practice, but proved to be easy.

PM photos: Gene Wagner

Advantage of pump-up inflatable is versatile light weight, and the 36-pound, 4-hp Merc is small enough for true portability and strong enough to propel a 12-footer at useful speed.

Boating
78

New mini-outboards: good—but how good?

Tests indicate some overlooked, undersized mills may be boating's best bargains.

by Bill McKeown BOATING EDITOR



While bigger Mercurys aim the noted yellow test-base hulls offshore, PM's McKeown fits a 4-hp on a dinghy for a trial.



Servicing proves to be simple with a k'cker that's small enough to tilt in, lift in or adjust for performance while on transom.

Sales figures for outboard motors show the most popular horsepower ratings getting bigger and bigger. But the little kickers that first made it possible for boatmen to "throw away the oars" are also still very much around—and better than ever. They're being neglected, however, and we find that they deserve a closer look.

Gene Wagner and his engineers at MerCabo, Mercury Marine's test base on the Gulf Coast of Florida, assembled a variety of small craft from their extensive fleet for PM's evaluation. All were rigged with the 4-hp Mercury Gnat 40, smallest in the line. We did not want to measure how fast a hull might go or the number of hours the Gnat could idle along with its 1.25-liter gas tank. These figures would vary with every load and bottom shape. Also, this year's Gnat can mount an accessory fuel pump and then use external tanks to run nonstop for days. Instead, we wanted to revisit basic boating and see how far the little knuckle-buster has come.

Starting a mini today is only a one or two-pull affair, and the new Gnat has a fuel-metering adjustment for cold starts as well. Its shift has a neutral position for safe starting, unlike some other mini outboards; full swivel; and a hinge-up tiller that makes reversing easy. Idling has been smoothed and the breakerless CD Thunderbolt ignition brought down from the big engines gives reliable starts and long plug life at trolling speeds without fouling. The big mills have also contributed water cooling, "Jet Prop" exhaust through the propeller hub, intake silencing, dampened vibration, and a rubber shock-absorbing hub instead of shear pins.

But the power is the reason this engine is worth \$450 and deserves a place in a car trunk ready for action on a rental skiff or a friend's day sailer. As an emergency motor, it can come out of a locker to idle home a houseboat or cruiser.

■ On a fishing skiff—we found it could provide 10 mph, with easy mounting and handling.

■ On a dinghy—it was light and responsive, though a tiller extension would make steering easier if you are alone and sit amidships.

■ For an inflatable—it's equally portable and an ideal match, with enough power to feel like it's planing the flat-bottomed hull.

■ Pushing a canoe—it seems like too much power. Steer gently and use only partial throttle until you have the feel. Use tilt-under trim with caution.

For all boats—a great first or second choice for a family mill. **PM**

More zip from compact kickers

by Ray Gill

Minimum weight, modest thirst for gasoline, moderate price and dependable performance are among the features that give this year's new undersize outboards their special appeal. Look for models with tilt-up shallow-water drive or an extra-long-shaft lower unit to mount as auxiliary power on a sailboat transom for bonus versatility. These, and more, are to be available for 1978 boating.

Last fall PM reported on the big guns in the horsepower race. Here is a survey of the smaller handy multi-purpose models:

4 is loop-charged and water-cooled, and the 6 and 8 have CD ignition and 15 or 20-inch lower units and 60-watt a.c. alternators. A Sailor 150 and 250, based on the 6 and 8, have big three-blade props for extra forward and reverse thrust while handling big hulls and sailboats, plus pull-from-any-angle rewind starters.

■ Clinton Engines this year will include a 14-pound 1.5 hp, plus a 2, 3.5, 5.5 and an air-and-water-cooled 7.5 in their compact line. Deluxe 7.5-hp K753 and 9-horse K900 models with remote fuel tanks will also be offered.



Trolling up to planing speeds is possible with a larger mini mounted on a flat-bottomed craft. Chrysler's Six (above) also comes in long-shaft sailboat models.

■ Brunswick's new Mariner line will include seven flyweights—a 2-hp, a 3.5, 5, 8, 15, 15W and a 20. The 15W is a workhorse model and, like its 48, is intended for heavy-duty commercial work. Other Mariners now range in power up to 140 hp.

■ Mercurys, from Brunswick, have five "function-engineered" models in their Fishpower category. These muscular lightweights include the 4-hp Gnat and 4.5, 7.5, 9.8 and 20-hp models. Names for these are the Merc 40, 45, 75; Merc 110 for the 9.8 and Merc 200 for the 20. Recommended for auxiliary power for sailboats are the 45, 75 and 110 in short or long-shaft units. These also offer running light and battery charging current from an alternator. The Mercury 402 is a 40-hp unit suggested for family fishing.

■ Chrysler Marine offers seven small ones—a 4-hp, new 6 and 8-hp motors, 10, 15, 25 and 35-hp units. The little

■ Eska has a number of new models, including new standard and deluxe 5-hp models and new deluxe motors of 7.5, 9.9 and 15 hp. These are in addition to its regular line of 3.5, 7.5 and 9.9 hp units plus its twin-cylinder standard 15 hp model. All feature tilt-locks for trailering and shallow-water drive with pin adjustment. The two larger motors are liquid-cooled and have solid-state ignition.

■ After three years of testing, Evinrude has announced a Windjammer 9.9-hp in 20-inch auxiliary shaft length especially for sailboats. Top-mounted controls and optional electric start are added features. Evinrude will also supply 2-hp and weedless fishing 4, 6, 9.9, 15, 25 and 35-hp models.

■ Johnson's new auxiliary power 10 is called the SailMaster. Designed for extra reverse thrust for stopping or backing a big sailboat, it has a special stop

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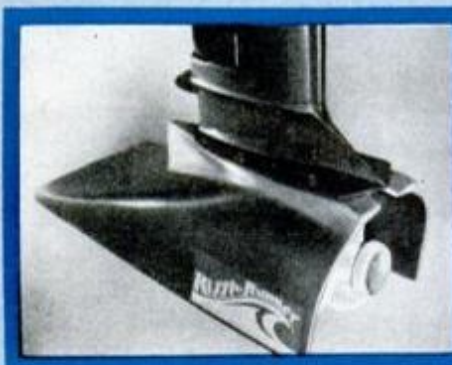
New gadgets to go to sea

Add-ons to dress up, speed up and fix up your boat are among the new accessories for the coming season. Some save fuel, some save effort on the part of the skipper and crew, and some save hours of maintenance work ashore. Most are made to resist saltwater attack and to provide bonus durability for freshwater boating.

Electronic aids—depth finders,

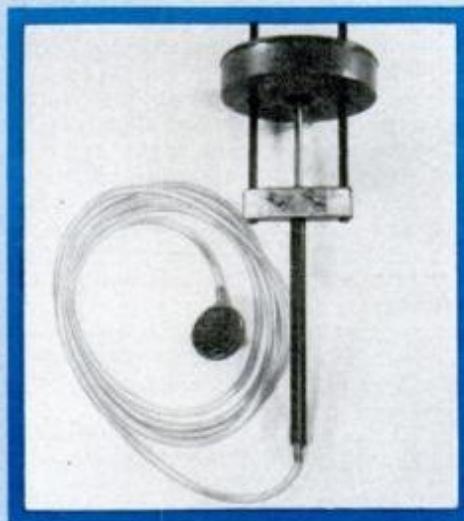


Freshwater flush for outboards used in salt or silted water is easier with an OMC Outboard Flushing Kit from Johnson, Evinrude dealers. Remove prop, rev 2500 rpm.



Shallow water damage is said to be reduced for outboards to 25 hp with \$200 Riffle Runner fiberglass scoop used in 6-inch shoals. Water World, Roseburg, Ore.

Pouring without spilling is simpler with OMC's flexible fuel spout for pouring from three or six-gallon tank. New 12-inch self-venting cap with spout replaces tank's cap during fuel transfer.



Water pumps water out of your boat as wave action works this Tumbalens floating bilge pump tied to mooring line alongside. It's imported by Nautilus Co.



Electro-Eliminator, mounted on the prop shaft of inboard or I/O, has been found to prevent electrolysis and radio interference. Sun-lite Marine, Industries. \$30.



An ice chest that doesn't skate your ice around the cockpit, the new Igloo deluxe all-white 48-quart chest comes with floor-mount brackets, tie-down cords, cushion.



Big motor steers the little motor with Trolling Motor Connector Rod from Westwind Products. With large outboard or I/O shut off, helm wheel still aims troll mill.



Better control of new high-horsepower outboards is the claim for Morse Controls Command 2 Twin Drive with dual adjustable cables to reduce fishtailing, backlash.



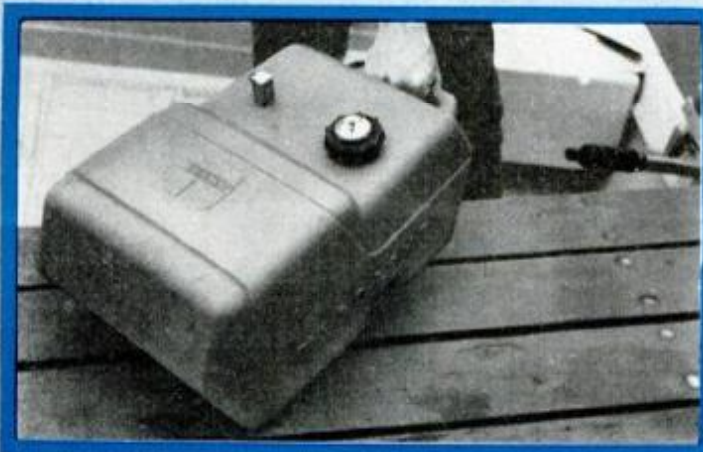
Single-handling small outboards to 25 hp is easier with Gilco Kwik-Shift. It bolts crossbar and shift lever from left to right side next to throttle and tiller.



Fuel economy is infinite with a K-Mac Man-U-Troll, an \$80 trolling "motor" that uses muscle power for speeds to 5 mph, is legal for lakes prohibiting gas motors.



Clamping on a transom like an outboard motor, the Cosom Loner Boat, a 9-pound \$33 accessory, allows one person to turn over and launch or haul out a light hull like a big wheelbarrow.



Extra gas in a convenient package is available in this new 6-gallon Tempo Products auxiliary fuel tank designed for easy carrying. The \$24 unit has reserve supply, gauge in fill cap.



Gilco outboard handle extends 27 to 38 inches, lets driver sit forward. Fits Johnson, Evinrude, Mercury, Chrysler, Clinton, Eska, Suzuki, Honda, Mariner, most Volvo Penta twist-grip units.



Metal flake finish styles the OMC Silver Streak SST propeller, called a bass boat bow-lifter that reportedly levels ride of 140-hp motors at speeds over 55 mph.



For mooring boats of 12 to 24 feet, Sternmoor hinged boarding ramps snap to transom brackets, allow easy boarding, work on tilted-up prop. \$150 from Frog Hooks.

CBs and radio/telephones, direction finders, bilge sniffers, bilge pumps, fish-well circulators, searchlights, and even auto-steering, radar and loran for bigger craft—all involve wiring and grounding. They can induce electrolytic corrosion unless sacrificial anodes or some of the new electrolysis preventers now available are employed.

The manufacturers listed below can supply addresses of nearby dealers stocking their products.

Cosom, 7317 Cahill Rd., Edina, Minn. 55435; Frog Hooks, Box 150, South Salem, N.Y. 10590; Gilco, 3715 Minnehaha Ave., Minneapolis, Minn. 55406; Igloo Corp., Box 19322, Houston, Tex. 77024; K-Mac & Co., 15404 Dooley Rd., Addison, Tex. 75001; Morse Controls, 21 Clinton St., Hudson, Ohio 44236; Nautilus Trading Co., 495 E. 7th St., Brooklyn, N.Y. 11218; OMC Parts & Accessories, Box 88, Beloit, Wis. 53511; Sun-Lite Marine Ind., 10524 S.W. 184th Terrace, Miami, Fla. 33157; Tempo Products, 6200 Cochran Rd., Cleveland, Ohio 44139; Westwind Products, 150 Tejon St., Denver, Colo. 80223; Water World of Roseburg, 909 S.E. Stephens St., Roseburg, Ore. 97470.

Next: Power company robots that turn your appliances on or off

Computers are leveling peak loads by programming power use in city skyscrapers. Now they've begun talking to water heaters, washers and dryers in private homes.

by Richard F. Dempewolff

Your friendly power company would like to open a line of communication with your electric water heater, airconditioner, clothes dryer and . . ."

If you got a letter like that from your local utility, it might shake you up a little—right?

The chances are you won't. Still, during the past five years the soar-

ing cost of energy has spurred the creation of a rash of sophisticated electronic surveillance and control "monitoring programs," systems, studies and the like—aimed at leveling the erratic peaks and valleys in power demand from residential as well as commercial buildings.

Though critical peaks may occur for only one or two short periods in

a day, utilities must maintain enough backup power continuously to meet them when they hit. That's expensive for both utility and consumers, and a huge waste of energy.

First targets in the new load-shedding drive were the large commercial buildings in central cities. These buildings consume some 15 percent of all our energy—a lot of it waste-

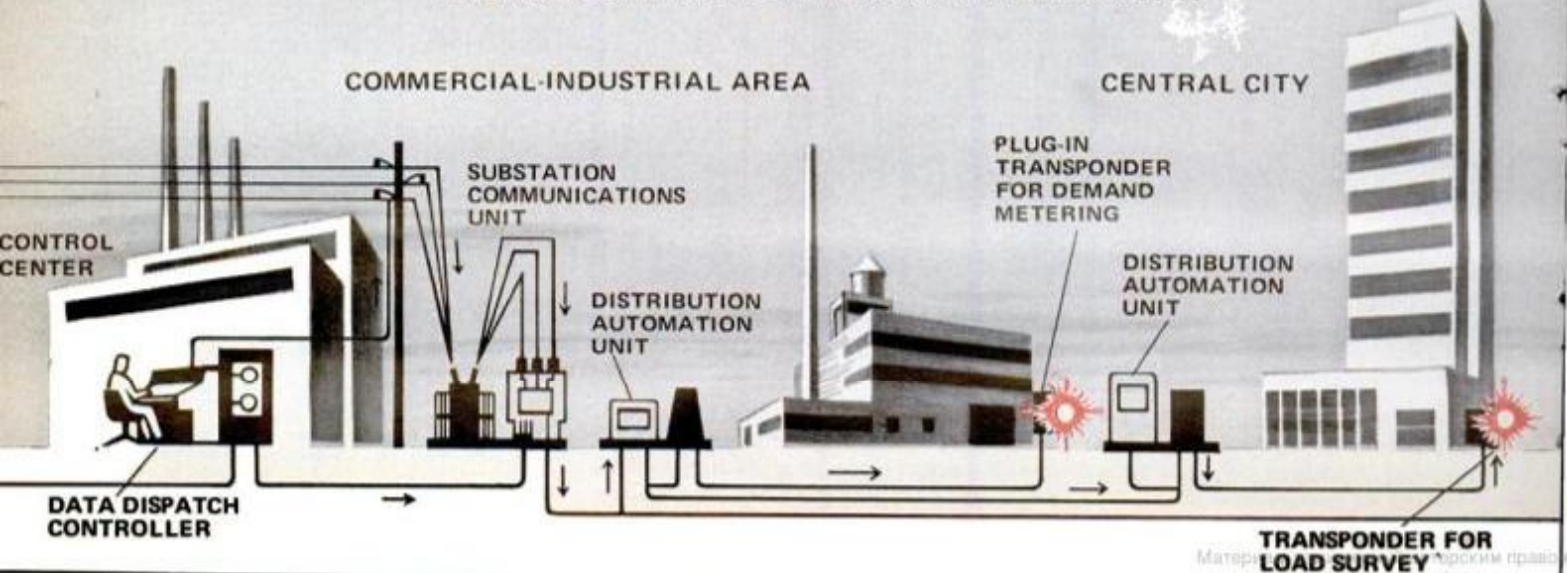


Computer control center (left) for a water heater control project in Wisconsin senses power demand in two villages. Before demand peaks, operator types code "Scat-O." Water heaters in some 200 homes shut down.



Unit at right performs the switching operation in private homes in Cedar Grove and Belgium, Wis., involved in a load-shedding operation designed by the local utility company to level peak loads.

ENERGY CONTROL COMMUNICATIONS NETWORK



fully. Companies like Honeywell and IBM moved in on large building owners offering special computers and systems designed to monitor and program the use of energy-gobbling fans, lighting, heating, airconditioning, elevators and so on, to help slash staggering fuel and utility bills. Hardware and software systems varied from expensive computerized sequential timers doing little more than switch things off and on on a programmed schedule to more complex electronic arrangements. Some, like Honeywell's BOSS system, can sense approaching power-consumption peaks and automatically shut down low-priority loads until the crisis passes. Such systems have helped; others cost more than they saved.

Remote-control computers

These have been followed by smaller, less expensive systems, using simple computers enabling building operators with minimal training to "control the controls," as one of them puts it.

In California, a relatively small outfit called the Engineering Supervision Co. (ESCO) and its vocal, ubiquitous founder and president, John B. Phillips, have devised a system that eliminates the need for

any on-site computers. At the company's own time-sharing computer center in Newport Beach, south of Los Angeles, data pour in over leased lines from each building on the network. Messages go out from Newport Beach to terminals in each network building (ESCO's remote control service reaches out to building operators in Chicago, Washington, D.C., Salt Lake City and other distant points) advising the building operator what he can do to trim his demand at any given moment, in order to save money and energy.

By 1975, the system had been working so well for the buildings—and the utility companies serving them—that the Energy Research and Development Administration funded ESCO with \$530,000 to run an 11-building two-year test in center city Los Angeles. If it works, there's a good chance the federal government will push the system nationally in all major cities, according to Phillips.

So far, it's going like gangbusters. As of last August, the Los Angeles network went automatic, and peak power demand level dropped more than 10 percent—a boon for the Southern California Gas and Electric Co. and each building manager.

Meanwhile, a number of projects are now afoot to monitor and, in

some cases, control energy consumption in private homes. Such programs to date are purely voluntary on the homeowners' part.

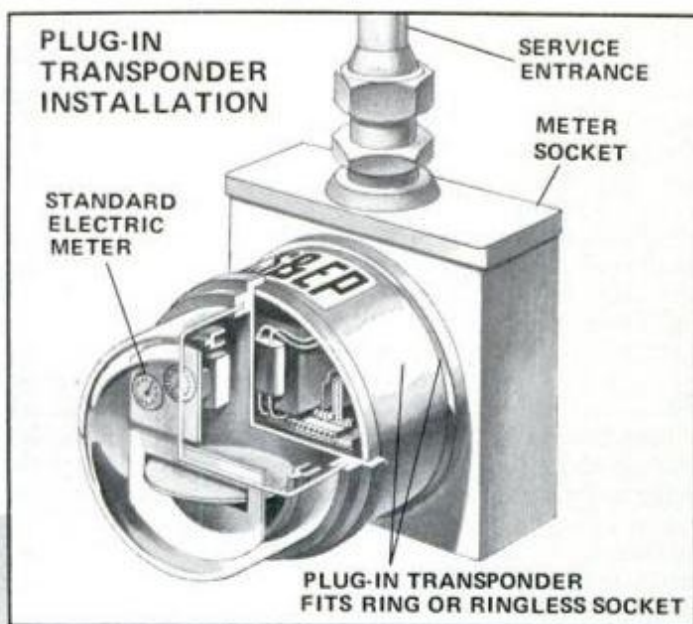
In the villages of Belgium and Cedar Grove, Wis., 500 customers of the Wisconsin Electric Co. agreed to let the utility install remote-control units called "transponders" on their individual electric systems. The units plug into customers' electric meters (see diagram) to give the company direct control over each dwelling's water heater by way of a remote-controlled switch inside the house near the service entrance.

Water heater wastes energy

Why control a water heater? It's a greedy energy gobbler that consumes power even when no hot water has been used. It must do this to overcome heat loss through the tank insulation. Interrupting service for short periods, the utility claims, doesn't affect the quantity of hot water available, nor does its temperature drop significantly.

Under the remote-control system, a Wisconsin Electric computer operator punches out the code word "Scat-O" on the console keys of the utility's "Data Dispatch" mini-computer control center. A signal goes

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Plug-in transponder that allows a computer to "communicate" with home appliances fits like a collar behind any standard home electric meter (left). Unit is quickly installed (far left) at service entrance. Flow diagram below illustrates how data for monitoring flow between control center (left) and sensing points in commercial, residential and farm buildings helps set up power profiles.



What you should know about underhood cables and wiring

by Mort Schultz

Let's define terms. By cables we mean sparkplug cables and battery cables. By wiring we mean ignition-system primary wiring to and from the ignition coil.

One of the demands made by battery cables and primary wiring, in particular, is that their connections be clean and tight. If connections aren't clean and tight, resistance to current flow will be high, and hard starting and stalling are likely to result.

Not many car owners and professional mechanics give cables and wiring the attention they need. People seem more concerned with the sparkplugs, distributor, coil, battery and starter motor than their cables and wiring. Yet, study after study proves that cables and wiring contribute to annoying engine problems and excessive fuel consumption.

For example, a recent survey of several hundred cars by Champion Spark Plug Co. showed that almost 35 percent had sparkplug cables that were in poor or nearly poor condition. Faulty sparkplug cables cause hard starting and misfiring.

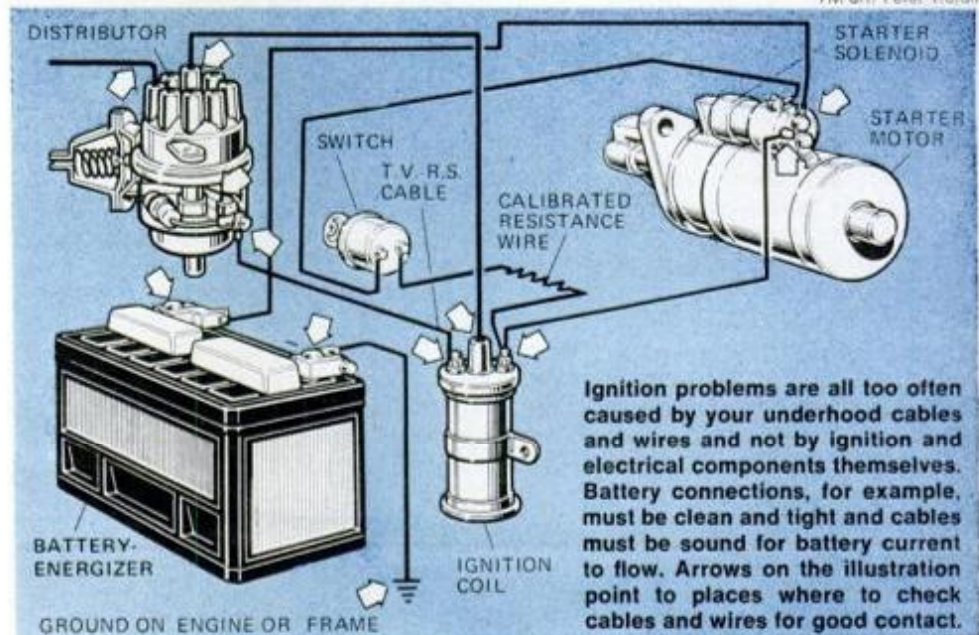
Cause of sudden stalls

Primary wiring has been the cause of one of the most baffling failures experienced by car owners. Suppose you are rolling blissfully down the road when—pfft—just like that, the engine stalls. You brake to a halt, turn off the ignition key, scratch your head, turn on the key and crank the engine.

It starts, and the problem doesn't occur again until some later time. What may be causing it?

A loose primary connection could be the reason. Or maybe primary wire insulation has worn down and bare wire is shorting against the distributor housing.

Primary wiring must be kept in good condition. If it shorts out, there will be no voltage, no ignition and no go. Would you think to look inside the distributor for a bare wire?



Ignition problems are all too often caused by your underhood cables and wires and not by ignition and electrical components themselves. Battery connections, for example, must be clean and tight and cables must be sound for battery current to flow. Arrows on the illustration point to places where to check cables and wires for good contact.

The rest of this article deals with other pertinent facts you should know so you will never again be stymied by a bad cable or wiring.

Sparkplug cables

Obviously, sparkplug cables extend from the distributor cap to the sparkplugs. However, included in this designation is the single high-tension cable that runs from the tower of the ignition coil to the center tower of the distributor cap. Don't forget about it. When it fails, your engine won't start.

Cables don't last forever. They

wear out as they get older because they are exposed to high underhood temperature, oil splash and moisture. These cause insulation to become brittle and crack, which gives electricity an area of least resistance to penetrate. Electricity will arc through cracks in the insulation and, accordingly, will be diverted from the sparkplugs.

Reduced current leads to a decrease in combustion efficiency and an increase in fuel consumption. When a sparkplug fails to ignite the fuel mixture, fuel in the affected cylinder is thrown out the exhaust. It is wasted. This is what's known as misfire.

Environment isn't the only factor leading to cable failure. Mechanics employing bad work habits are another. Cables should not be tugged on when they are being disconnected. Strain causes conductive strands to separate, which leads to excessive resistance to current flow. Again, this will result in engine misfire.



Treat your sparkplug cables gently and they won't let you down. Don't yank off by pulling the cable (left); use a special pliers or grasp the boot firmly.

Handling cables properly

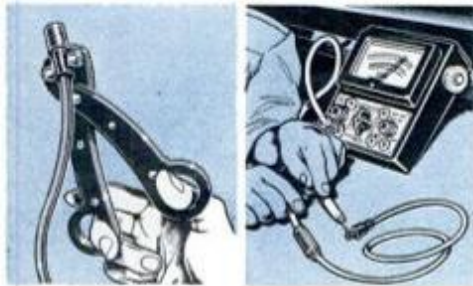
To handle cables properly, use a pair of sparkplug cable pliers. The

tool costs a few dollars, but is worth the money. It helps prevent accidents that can cause cable damage and makes it easier for you to remove them.

To remove cables from sparkplugs using these pliers, grasp the boot covering the plug with the tool, and twist back and forth as you pull the boot from the sparkplug.

If sparkplug cable pliers aren't available, remove cables by firmly grasping the boot and twisting back and forth as you pull. Do not pull the cables. Pull only on the boots!

Cables have two ends. It's just as



Sparkplug pliers (left) are the best way to pull boots. Use an ohmmeter (right) when you measure the resistance of your sparkplug cables and other wires.

important to treat them properly at the distributor end as it is at sparkplugs. To remove a cable at the distributor, grasp the boot over the tower. Twist it back and forth as you pull. Do not pull the cables. Pull only on the boots!

Testing cables

I've seen recommendations that sparkplug cables be replaced indiscriminately after three years. I suggest you replace cables when it becomes necessary to replace them!

To avoid indiscriminate cable replacement, test cables when you do an engine tuneup. Testing is done in two ways: by inspection and with an ohmmeter.

Look for cracks in insulation. And don't forget the boots. A boot is part of a cable and tends to dry out and crack, too. A bad boot will cause flashover: Electricity will take the path of least resistance and come out through a crack in the boot, sparking across the outside of the sparkplug insulator. Electricity won't get to where it's needed—to the electrode end of the sparkplug.

Unfortunately, visual inspection isn't a foolproof test. That is why I like the probing method, which will reveal a bad cable when failure isn't apparent to the eye.

You need a good-size screwdriver and a jumper wire that has an alligator clip on each end. Fasten the alligator clip on one end to the

shank of the screwdriver and fasten the other end to a clean ground on the engine.

Start the engine. Remove a cable from a sparkplug. Probe the disconnected cable and its boot with the tip of the screwdriver. A spark that jumps from the cable to the screwdriver reveals an area of weakness. After testing one cable, reconnect it and test another until you have tested all the cables.

Current leak

After testing the final cable, leave it or any one sparkplug cable disconnected as you probe the cable and boots between the coil and the center tower of the distributor. One sparkplug cable must remain disconnected while you check the coil-to-distributor cable so that one of the paths of least resistance which the ignition spark would normally follow is removed. Thus if there is a current leak in the coil-to-distributor cable it will jump to the screwdriver once during each revolution of the distributor rotor.

Caution: If your car is equipped with a catalytic converter, don't keep sparkplug cables disconnected for any longer than 30 seconds at a time to avoid catalytic converter overheating. Test as many cables as you can in 30 seconds and then test the others after the converter cools down.

If one or more cables are found defective, replace them all. If one bad cable is uncovered, chances are that the others will soon peak out.

When checking sparkplug cables, it is important that you inspect the metal connectors inside the boots on both ends. Corroded or burned connectors will cause excessive resistance. Replace the cables if this damage exists.

Secure cable connections

Important: The main reason for a burned connector (it will be black)

is failure to connect cables securely. Keep this in mind whenever you are reconnecting a cable to its sparkplug or seat in the distributor.

After examining cables, test them for excessive resistance to electricity with an ohmmeter that has a scale which reads in thousands of ohms. Lay the cable on a workbench. Turn the ohmmeter on and connect its leads to each end of the cable.

The amount of allowable resistance depends on the length of the cable and may even be marked on the cable. Generally, however, if re-



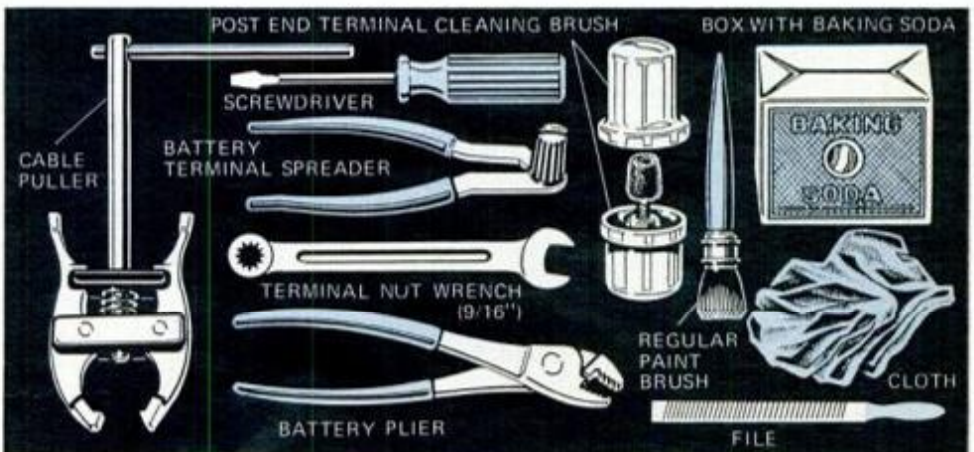
Improvised probe (see text) is best way to discover current leakage from cable.

sistance is greater than 25,000 ohms, discard the cable.

After testing one cable, reinstall it before removing another. This will prevent you from connecting a sparkplug to a wrong tower of the distributor, which will result in out of turn plug firing and possible engine damage.

When you reconnect cables, be sure they don't rest against a part that can cut or burn them, such as

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Be smart: Be sure to have the right tools and equipment before you service a battery.

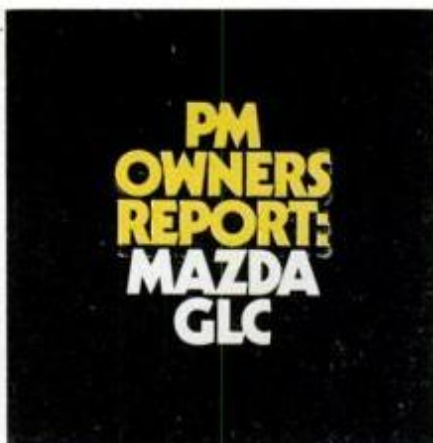
I used to be very happy with my big, luxurious Continental Mark IV, so I was afraid I'd be dissatisfied with a small car," says a Florida painting instructor. "But the \$10 to \$15 it cost me each time I pulled into a filling station finally got to me, so I traded down. I haven't been sorry for one minute. The name aptly fits the GLC. It really is a Great Little Car. Patriotism often calls for sacrifice. In my case I'm conserving fuel but sacrificing nothing but snob appeal!"

An Iowa attorney concurs: "I am



GLC doesn't share boxiness of many imports, has bold, uncluttered front.

much happier with my Great Little Car than I expected to be with a small automobile. I've spent as long as four hours behind the wheel on trips and, despite being 6-3, I'm surprised at the comfort. The five-



speed transmission is a good option, and I've received several compliments on the looks of my GLC. I bought the car for economy and am getting more than I expected."

"It rides as well as my Buick and handles better," opines a Maine truck driver. "Gas mileage is superb. My wife and I both have plenty of room, and I've had people over 6 feet tall in the back seat and they were comfortable."

Most owners certainly agree with GLC ad writers and consider their cars at least "Great." Several suggested that Mazda rename this their "Excellent Little Car."

Workmanship received very high praise, with 89.6 percent of re-

spondents rating it good to excellent. That beats all U.S. cars we reviewed last year, and only one import, the Honda Accord, topped it. Observes a New York hair stylist, "It's solid. While commuting, I travel some pretty lousy roads. It's a pleasure to hit potholes and not feel the car shaking and rattling itself apart—something I couldn't say for my twice-as-heavy Grand Prix."

However, 17.7 percent of owners expressed disappointment when their gas mileage didn't match EPA figures. To quote a New York religious-education administrator: "I really like the GLC, but those EPA numbers don't mean a thing. I, as a consumer, feel they should be abolished unless a car can actually live up to the estimates. The EPA says I should be getting 46 highway, 35 city. I average 35 and 25—roughly 30 percent below the estimates."

The GLC's optional five-speed overdrive transmission, which over half our owners ordered, gave slightly better mileage than the four-speed and automatic. Yet most owners who expressed disappointment had the five-speed. Moreover, a significant percentage of five-speed owners felt their cars lacked power on the highway for passing

By MICHAEL LAMM WESTCOAST EDITOR

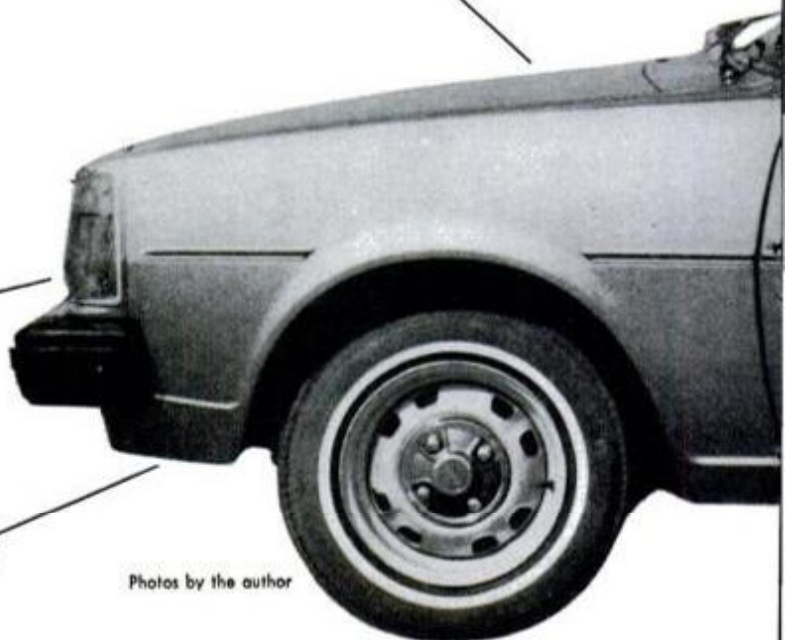
How great is Mazda's Great Little Car?

Some respondents would appreciate a stronger engine, which Mazda says will likely come this year.

Many GLC owners bought their cars because of styling, not despite it.

MacPherson-strut front suspension and variable-ratio steering help GLC's good ride and handling.

Photos by the author





Split rear bench folds in halves so one passenger can ride beside cargo.

and hills. For example, a Colorado registered nurse mentions, "Terrible gas mileage. Nowhere near the 35 to 45 mpg advertised. Also car lacks power." We suspect that five-speed drivers are lugging their engines and not shifting down to prevent floorboarding. In fairness to the EPA, good mileage depends as much on the driver as on the car.

Size and spaciousness became significant reasons for buying the GLC, so we asked owners what they think of the car's comfort. "My wife and I live in New York," says an upstate businessman, "but we bought this car in Arizona. We were incredibly impressed with the way it drives, the economy and excellent use of space. We drove home 3000

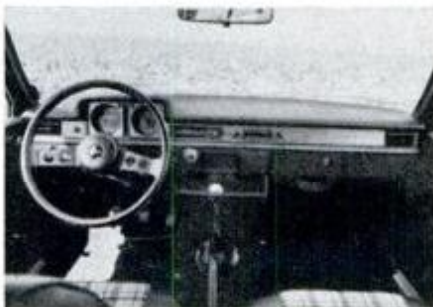
miles on our first trip, and our passenger, who's 5-11 and 190 pounds, loved it!"

Part of what people appreciate about the GLC are those unexpected extra little touches. A California-based Navy officer said, "I leave my car outside and use the rear-window wiper and defroster every morning in wintertime; also like the split rear seats that fold, the reclining front seats, the remote hatch release, the manual choke that gives me some control while starting, the wiper and dimmer controls on the turn-signal stalk. . . ."

What changes would you like? "Maybe a little more power—a 1600-cc engine instead of the 1300," suggests a New Mexico

(Please turn to page 160)

Highly adjustable seats give plenty of legroom for drivers over 6 feet.



STYLED FOR THE U.S. MARKET

After the public cooled its romance with Mazda's rotary-engined cars, Toyo Kogyo began pushing piston-powered models, notably the Mizer in 1975 and the GLC (Great Little Car), introduced in April 1977 as a three-door hatchback and now available as a five-door hatchback as well.

The GLC, like so many Japanese imports, has been tailored for the U.S. market. Its styling—inside and out—reflects American tastes. Toyo Kogyo has also added numerous extras, making the GLC Deluxe a budgeter's version of the Honda Accord. In addition to items mentioned by our owners (see text) are variable-ratio steering, a coin receptacle, cloth-with-vinyl seats (velour in some models), front power disc brakes, and an ohc engine.

Considering the GLC's front-engine/rear-drive configuration, there's an amazing amount of space inside.

The 1272-cc Four, basically the same as in the Mizer, uses an aluminum head on a cast-iron block. The optional five-speed transmission puts a 0.83:1 overdrive in the standard four-speed box, and there's a Jatco three-speed automatic available, too.

Suspension is by MacPherson struts up front and four-link coils aft. Good sound insulation makes this one of the quieter imports in its class. So for the money it seems indeed a GLC—something the owners concur in.

A NATIONWIDE SURVEY BASED ON 1,291,436 OWNER-DRIVEN MILES



Standard wiper, washer and defroster grace rear window. Button at driver's seat in Deluxe models releases hatch.

Five-door GLC introduced for 1978, shares wheelbase with the two-door.

Driver knows where car ends because window ends there, too.

Build this shock detector for your home and car

It's a visible and audible tester that squeals on home shock hazards—also tests continuity, auto grounds.

by Jeffrey Sandler

For about \$10, you can make a compact, convenient device that performs these five functions and might even save your life:

- Detects current leakage—the sign of defective grounding or a loose hot wire and thus a shock hazard—in 110-v. home appliances and power tools.
- Works as an audible continuity tester for electrical and electronic circuits—letting you keep your eyes on what you're testing.
- Reveals the faulty grounds that make for quirky misbehavior of car lights and accessories.
- Tests batteries.
- Checks circuit components, including semiconductors.

Shock-hazard testing

The most important of the five functions is detection of a.c. current leakage. It's an unfortunate fact of life that not all tools and appliances are used, stored or maintained as their manufacturers and the national safety organizations would like. Through abuse—or just age—any electrical device can develop a bad ground or loose wire that could give you or another member of your family a lethal shock.

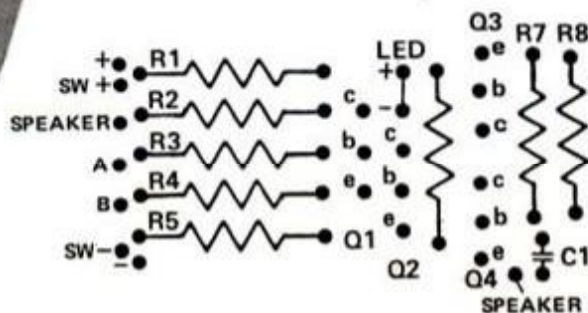
As soon as you've assembled your shock detector, you can test the tools and appliances around the house—not forgetting stationary power tools



Setup to test appliances: one probe connected to ground, other touching conductive parts of plugged-in appliance. Handle with care until you're sure appliance is safe.



Prototype tester was built in 1½ by 2½ by 3¼-inch mini-box, with test leads attached to a miniature phone plug. (Jack and plug could be omitted.) Diagram at right shows component placement on unplated side of printed-circuit board.

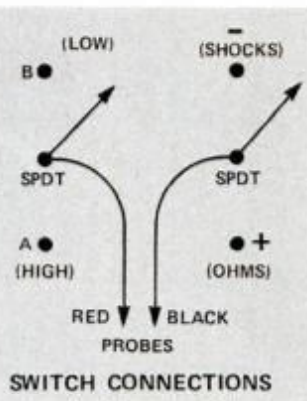
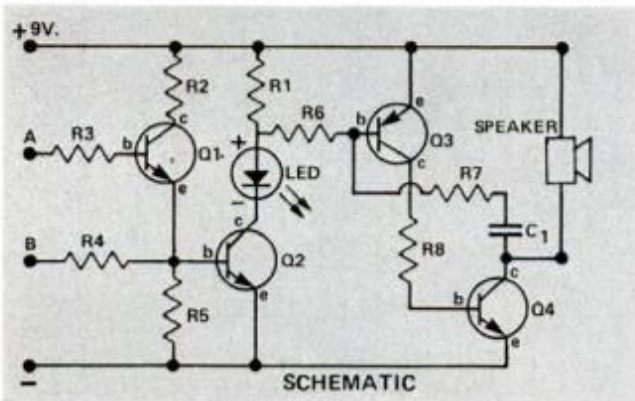




Components fit snugly but workably inside minibox; leads can be soldered to 9-v. battery if standard clip won't fit. Beneath speaker, switch and jack connections, LED leads are covered with electrical tape.



Switch tester to "ohms" for audible continuity checks of fuses, light bulbs, line cords, appliance components. A part like a fuse, if good, should give light and tone on both "high" and "low" settings.

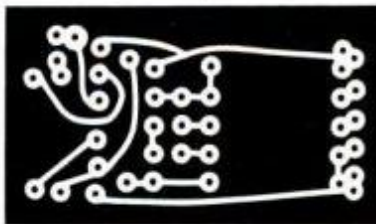


PARTS LIST

C1—.01-mfd. ceramic disc capacitor
 LED—Any LED rated for 20 ma. or more
 Q1, Q2, Q4—2N2222 or 2N3904 NPN silicon transistors
 Q3—2N3906 PNP silicon transistor
 R1—470-ohm, 1/4-w. carbon resistor
 R2, R5—6800-ohm, 1/4-w. carbon resistors
 R3, R4—30 K, 1/2-w. carbon resistors

R6—300 K, 1/4-w. carbon resistor
 R7, R8—1000-ohm, 1/4-w. carbon resistors
 Switches—Two s.p.d.t. toggle switches
 Speaker—2-in.-dia., 8-ohm speaker
 Misc.—9-v. battery, battery clip, PC board or perfboard, case, jack, plug, probes with leads, LED clip, stranded hookup wire, electrical tape.

Right: actual-size etching and drilling guide for printed-circuit board.



Completed PC board, battery and speaker require no attachment to box—jack and switch locations shown just allow them to fit inside box. It's also necessary to drill a pattern of holes in the box's metal cover so you can hear the speaker.

Use light, stranded hookup wire or putting components into box will be difficult. Be certain no bare wires or PC-board connections touch the cover, speaker or battery case; tape helps here.

and their motors. A typical test set-up is shown on the preceding page.

To begin with, you must assume that each tool or appliance is electrically hot and dangerous until it's been proven safe. (Remember also that testing an appliance and finding it okay doesn't give license to use it improperly afterward or assume it will always be safe.)

Connect either probe to a good ground (metal water pipe is fine), set the tester's mode switch on "shocks" and its sensitivity switch on "high," plug the appliance in, and touch its conducting surfaces with the other probe. (Use the probe point to reach metal under paint; bright metal parts can just be touched.)

If, at any time, the tone sounds and the light-emitting diode (LED) lights, the appliance is leaking at least 5 microamperes and is hot and possibly dangerous. If the tone and light persist when you flip the sensitivity switch to "low," the appliance is leaking at least 0.2 milliampere—and definitely indicates a dangerous condition. Unplug it and see to it that repairs are made.

Sometimes appliances will be hot only when controls are on a particular setting, so repeat the test for each control position. Also, if the appliance has a two-prong plug, rather than a three-prong grounding plug, you should repeat tests with the plug reversed in the wall socket if possible (there are some two-prong plugs, however, that cannot be reversed).

Construction and operation

Construction of the tester is simple and requires no detailed electronics knowledge. All parts are readily available (at Radio Shack stores, for example). Alternatively, you can buy a complete kit for \$9.95 postpaid or a printed circuit board for \$1.75 to which you add your own components. Both are sold by Delta Electronics, Box 2, 7 Oakland St., Amesbury, Mass. 01913. Assembly should take less than an evening. If you want to make your own PC board, the etching and drilling diagram is actual size.

What you're building is a two-stage current amplifier that triggers an LED and an audio oscillator. (On the "low" sensitivity setting, only the second stage of the amplifier is used.) In its "shocks" mode, the circuit senses current produced by an external voltage source, either a.c. or d.c. In the "ohms" mode, the tester's own 9-v. battery is the voltage source; output current in this mode is limited to 0.3 ma., so it's all right to use the tester on

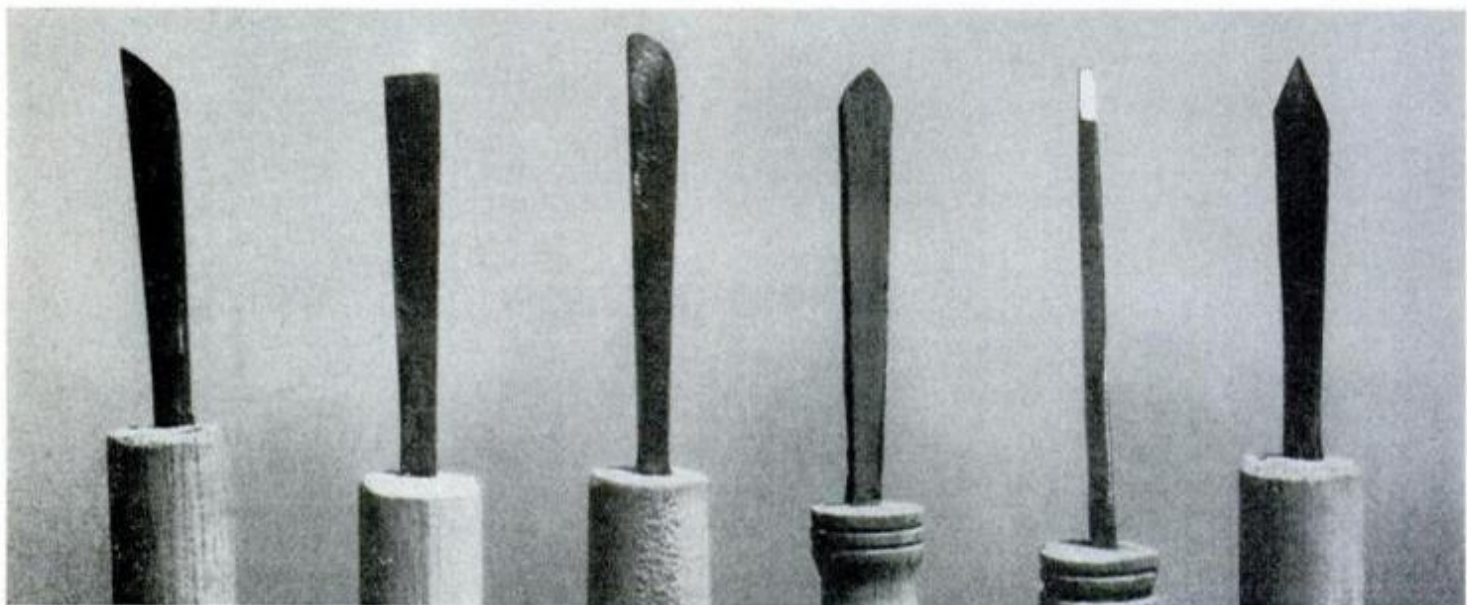
(Please turn to page 164)

What the country needs: A good 5¢ chisel

You can make these
lathe turning tools
from cut nails and
pieces of dowel.

by Earl L. Pringle

Author favored his set of chisels so much he made a wooden case for them (right). Samples below are typical chisel points you can create for your collection. From left to right: regular skew, square point, round skew, round point, parting tool and diamond head or spear point. Chisels are perfect for turning with mini-lathes.



Most woodworkers eventually need a set of small wood chisels—whether it be for fine inlaying, carving or turning miniatures. For years, I've been searching for the right kind of steel to make my own and finally decided to use flat, hard-steel 8d masonry (or cut) nails. These can be found at your local hardware store or lumberyard. Buy 1 lb. along with three 3-ft. lengths of 1/2-in. diameter dowel.

Happily, you can make a fairly complete set for less than one store-bought chisel. They are quick and easy to make, as can be seen in the photos on the facing page. It took

me about three hours to make my assortment of 20 different sizes and shapes.

It is a must that you wear protective eye gear while grinding and polishing because the hard but brittle masonry nails may break. Grind the bevel for 1/16-in.-wide points on the thin edge of the nail. For widths 1/16 in. to 1/4 in., grind the bevel on the wide side. Generally, the width of the bevel is ground slightly more than the thickness of the blade.

To sharpen points after grinding and polishing, hold chisel with bevel face down on oilstone and hone in a circular motion until a burr is

raised. Reverse blade flat against stone and loosen burr. Finally, draw the sharpened edge across the corner of a piece of wood and strop on leather.

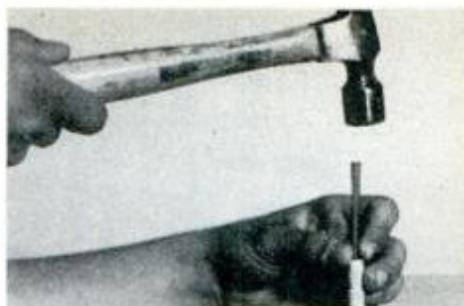
Bent chisels or gouges can also be fashioned from masonry nails. First clamp a smoothly ground nail into a machinist's vise. Carefully heat it with a propane torch until it glows red and, while it's still secured in the vise, use pliers to bend to desired shape. Dip the nail in quenching bucket of water and, when cool, glue into handle. Proceed to grind the shape of your point, then polish and hone it. **PM**



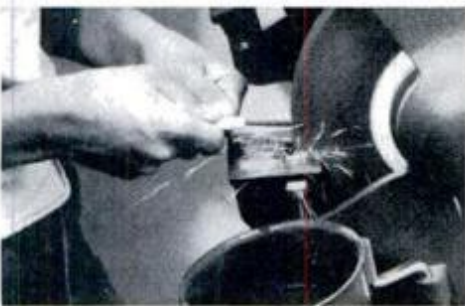
Start by cutting 1/2-in.-dia. hardwood dowels into 4-in. lengths for handles.



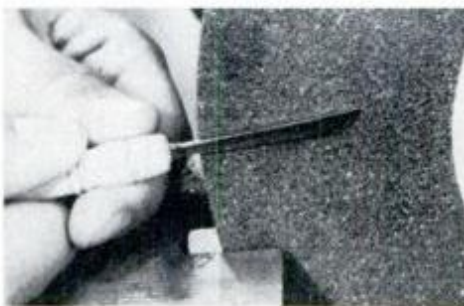
Center and bore 1/8-in.-dia. hole 1/2-in. deep. Handle was turned on mini-lathe.



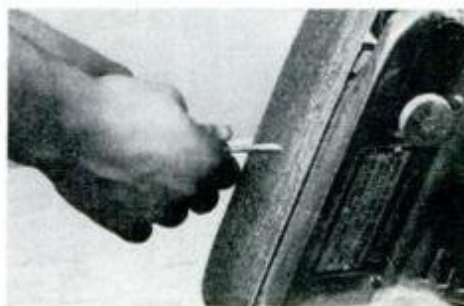
Use small dab of epoxy and tap nail carefully into the dowel to avoid splitting.



Wearing goggles, you grind four sides of nail smooth. Quench in water as you work.



Then grind to the desired shape in widths ranging from 1/16 in to 1/4 in.



For final grinding use belt sander mounted in vise and fine aluminum oxide belt.



To finish cutting edges, hone on an oilstone. See notes on sharpening in text.

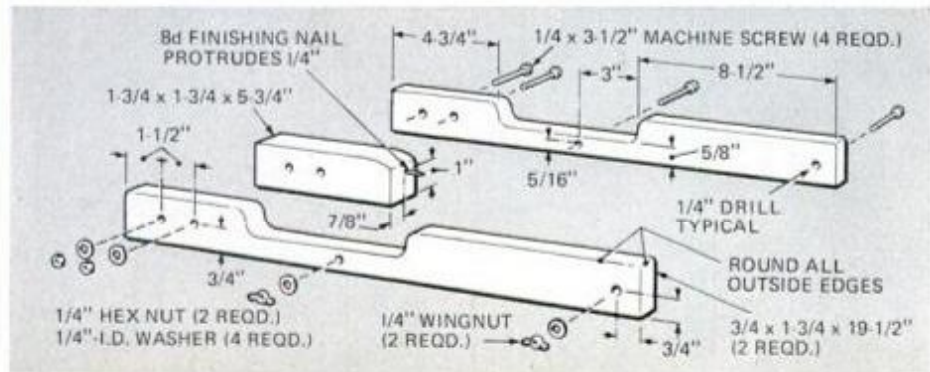
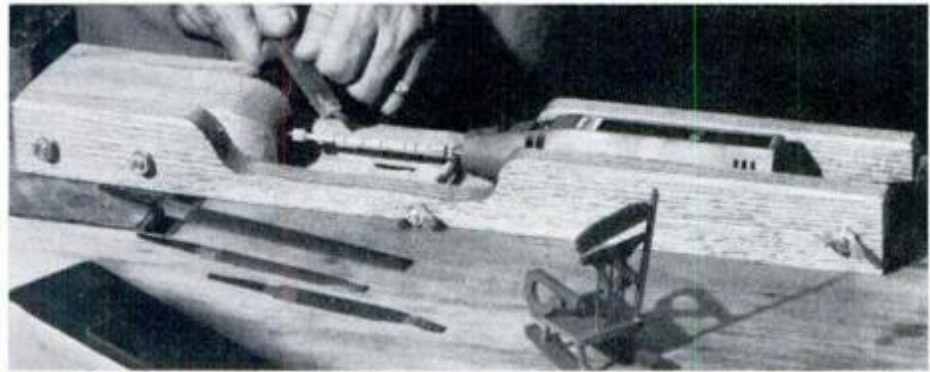


Tools are perfect for turning decorative miniatures using the Dremel Mini-Lathe.



Fun project: Turn a miniature version of a finely crafted imported screwdriver.

TINY LATHE FOR TURNING MINIATURES



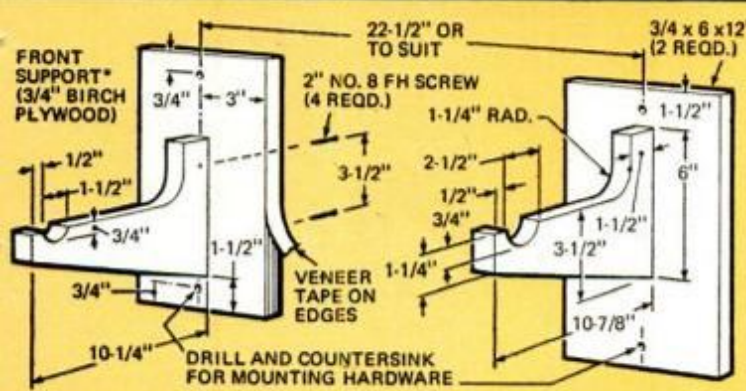
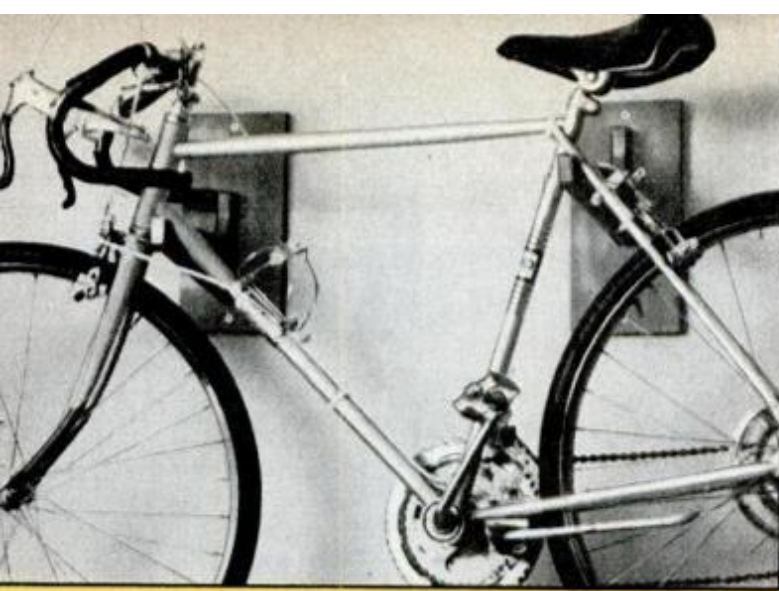
You can convert Weller's Mini-Shop into a lathe for turning wooden jewelry, doll-house furniture parts, chess pieces, or tool handles as shown above. The simple jig is constructed from recycled oak stock that had originally been used as base pallets in crating major appliances. It's available for the asking at many local appliance stores. Assemble with machine screws, plane bottom edges flush, finish with two coats of shellac.

To make the dead center, cut the head off an 8d finishing nail, chuck it in the drill and polish its end with a fine file. Then bore a 1/8-in.-dia. pilot hole 3 in. deep in dead center with the Mini-Shop by sliding it between assembled sides so that dead and live centers are precisely in line. Fill the hole with epoxy glue and push the sharpened nail in until the point protrudes 1/4 in.

Make the lathe's live screw center with a 3/4-in. No 4 wood screw. Grind circumference of head until its diameter equals that of shank. Retain remainder of slot for screwing into stock to be turned. Insert screw into largest collet.

To use lathe, clamp Mini-Shop in jig as shown. Turn to slowest speed and use your 5-cent chisels (or files) for turning.

—David Warren



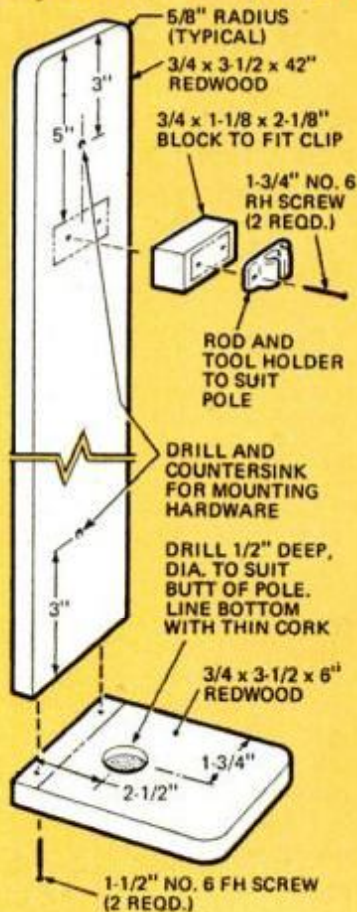
* ALL DIMENSIONS NOT SHOWN ON FRONT SUPPORT ARE THE SAME AS ON THE REAR SUPPORT

3 BIKE RACK

A gleaming, 10-speed bicycle on a wall is not only sculptural, but also a smart way to keep bike and tires in good condition. You'll need 11 ft. of birch veneer tape to cover visible edges of plywood. Supports are glued and screwed back as shown. Sand smooth and finish as desired. Use rubber cement to apply thin protective foam pads on cutouts where bike rests. Mount brackets with toggle bolts; space them to suit bike frame.

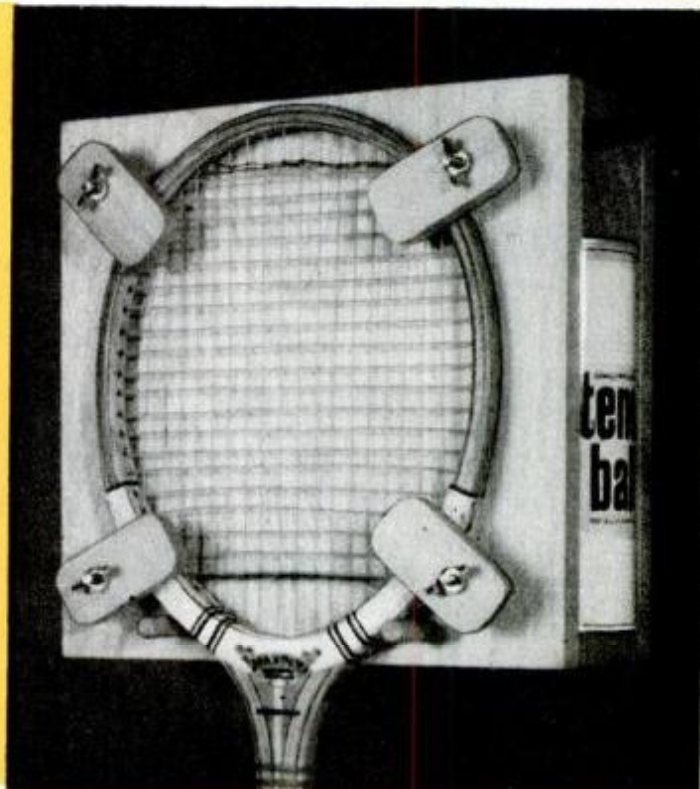
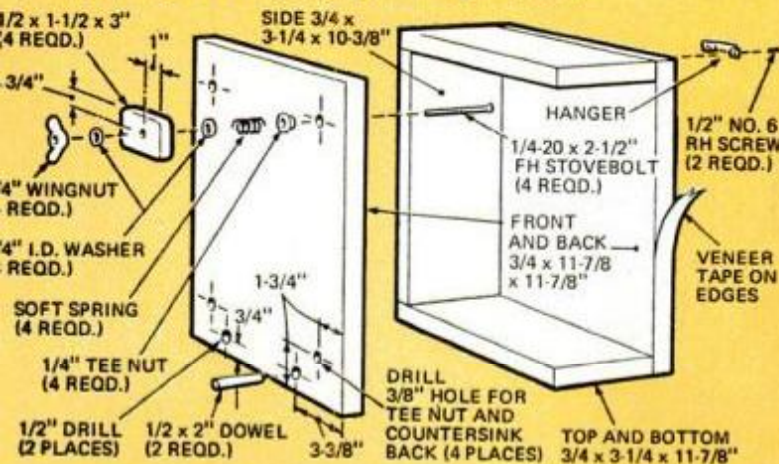
5 FISHING ROD HOLDER

Many rods and reels are beautifully crafted. Build this simple rod holder from a 4-ft. piece of 1x4 clear redwood. Sand pieces smooth; use screws and white glue to fasten base. Finish with polyurethane varnish. You can adjust height of rod and tool holder (sold at marine hardware stores) to suit your pole.



4 RACKET HOLDER WITH PRESS AND BALL STORAGE

This compact hang-up not only displays your prize racket and prevents it from warping, but also stores three cans of balls. Made with birch plywood, it's assembled using white glue and 4d finishing nails. Blocks for clamps are from scraps of one-by-pine planed to 1/2 in. After sanding and finishing, hammer Tee-nuts in place and complete by installing hardware.



Backward airconditioners take a front seat

More than 100-percent efficient, heat pumps are now challenging conventional home heating nationwide.

by Alan R. Trellis

It looks like a something-for-nothing appliance. In a way, it's a solar device. It's an airconditioner that works backward and forward. It's a heat pump—the old idea for home heating and cooling that's been getting lots of new attention.

It doesn't really give you something for nothing, but it does operate at more than 100-percent efficiency. It does use solar energy, although indirectly. Recently, it has been touted as the energy-saving way to heat homes, and the case for it is often convincing.

But what is it and how does it work? How can it deliver more energy than is put into it? Is it practical for today's homes?

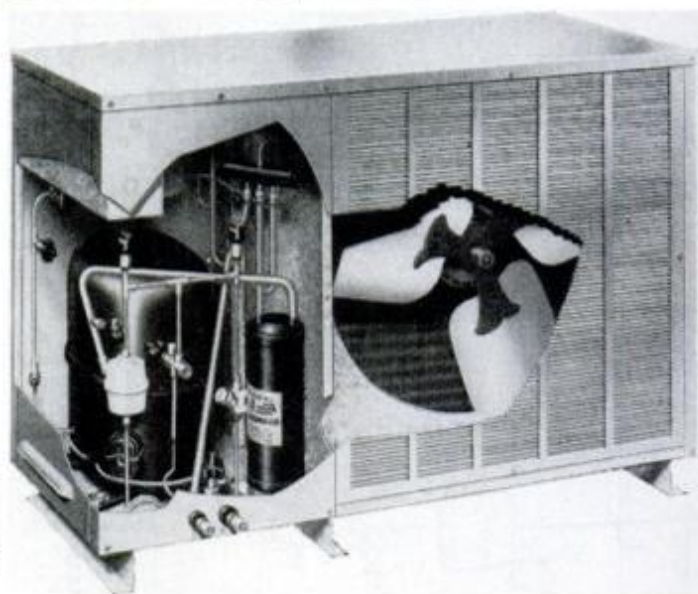
What and how?

The heat pump is a refrigeration machine, like an airconditioner, refrigerator or freezer. It absorbs heat from one environment and transfers it to another. When this process is used to take heat from within a building and put it outdoors, we call it airconditioning. To supply heat to a building, the heat pump reverses the flow, absorbs heat from outdoors and feeds it to the building interior.

At the most basic level, a heat pump is a solar device, because the environmental heat it picks up outdoors is the result of solar radiation. That's where the efficiency of more than 100 percent comes from—the energy absorbed and moved is greater than the energy the unit requires to operate.

Virtually all residential heat pumps sold today are the air-to-air type. That is, they remove heat from air and transfer it to air. The drawing on page 127 shows typical operating cycles of such a unit

Outdoor section of typical split-system heat pump contains compressor, coil, reversing valve and controls.



in both heating and cooling modes.

Although outdoor temperatures of 20° F. or 30° F. are quite cold compared to our body temperatures, they are warm compared to the extremely cold refrigerant used in the heat pump. Since heat will always flow from warm surfaces or objects to colder ones, the cold refrigerant moving through the outdoor coil absorbs heat from the outdoor air. This temperature difference between air and refrigerant is a key factor in heat-pump performance. The amount of heat the equipment can remove from outdoor air is roughly proportional to this difference and thus to outdoor temperature—the warmer

the air, the more heat is available.

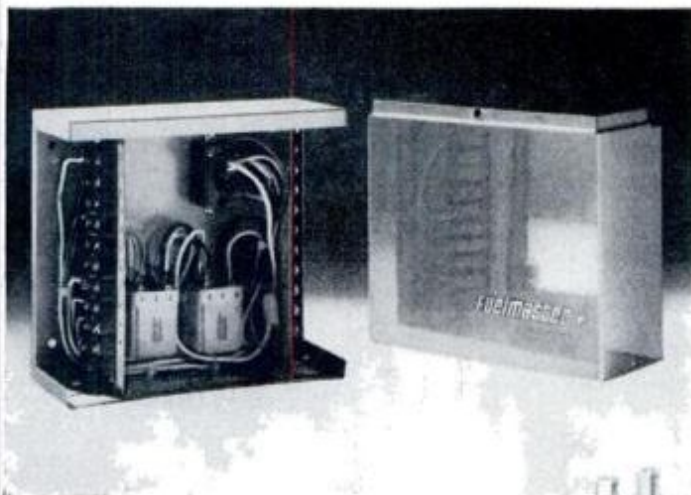
Unfortunately, this situation is contrary to the demands placed on the heating equipment. As outdoor temperatures drop, the need for heat inside the building increases while the heat available from the outdoor air decreases. The point at which the heating capacity of the heat pump just equals the heat requirement of the building is known as the balance point. Below this point, usually around 35° F., the heat-pump output must be supplemented with heat from another source. This extra heat is most often provided by electric resistance elements—but may be from a gas or oil furnace.

The outdoor section of a modern heat pump like this GE Weathertron unit is modest in size, relatively unobtrusive.



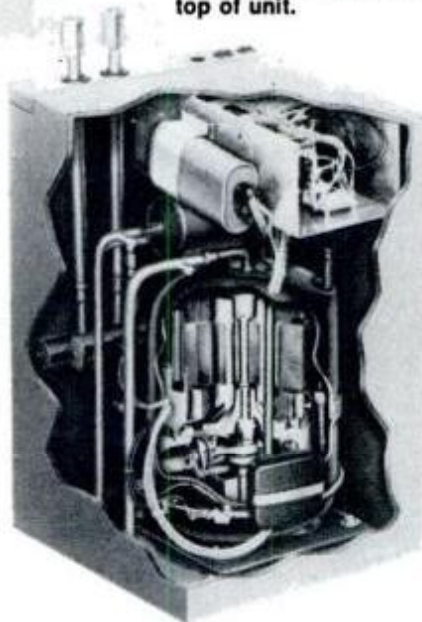
Unitary (one-piece) heat pump will heat and cool a cottage or mobile home. Several can be used for a larger house.





Sophisticated controls (left) make add-on heat pumps for existing furnaces, like Lennox Fuelmaster +, possible. Furnace runs only when heat pump cannot meet heat demand.

Indoor compressor unit (below and at center of photo at right) contains compressor, controls, valve. Electrical and refrigerant connections are accessible at top of unit.



Carrier's deluxe Weathermaster III line of heat pumps brings the compressor and all controls indoors to improve reliability, make bad-weather servicing easier.

Heat pumps give maximum performance in areas with mild climates. In regions where temperatures are below the balance point a lot of the time, heat-pump efficiency is reduced and supplemental heat is needed more often. The map on page 128 is based on recorded weather data and shows heat-pump seasonal performance factors (SPFs) throughout the 48 contiguous states. An SPF of 1 is equal to a seasonal efficiency of 100 percent; 1.5 means 150 percent, and so forth.

In colder climates, during cold, humid weather, frost can form on a heat pump's outdoor coil just as it forms in your refrigerator. So the heat pump periodically defrosts itself by temporarily operating on the cooling cycle, forcing hot refrigerant through the outdoor coil. During the defrost cycle, the supplemental heat source is used to maintain the indoor temperature.

Quick history

While the basic principles were known 70 years ago, it wasn't until the 1930s that heat pumps became

practical. The 1950s saw increased promotion and sales of the devices. But then, as service records and performance data became available, it was apparent that many units were underdesigned and incapable of reliable performance, particularly in the North, where heating was the primary function of the equipment. By the early 1960s the situation had

deteriorated so far that several manufacturers stopped selling heat pumps in many northern states.

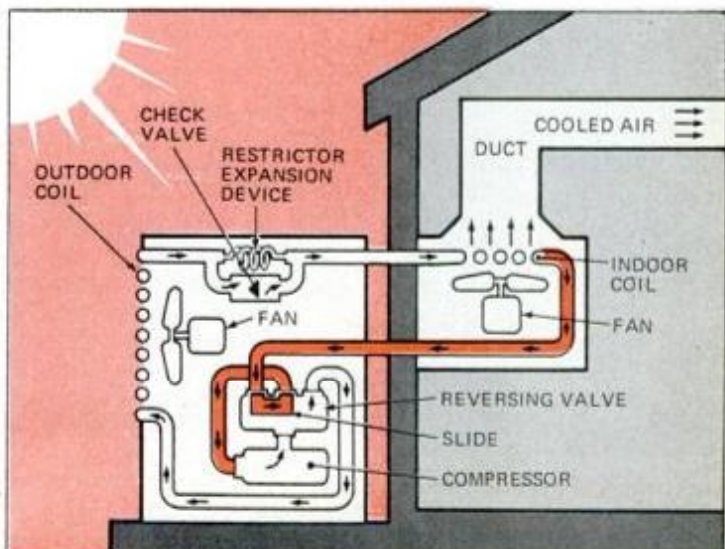
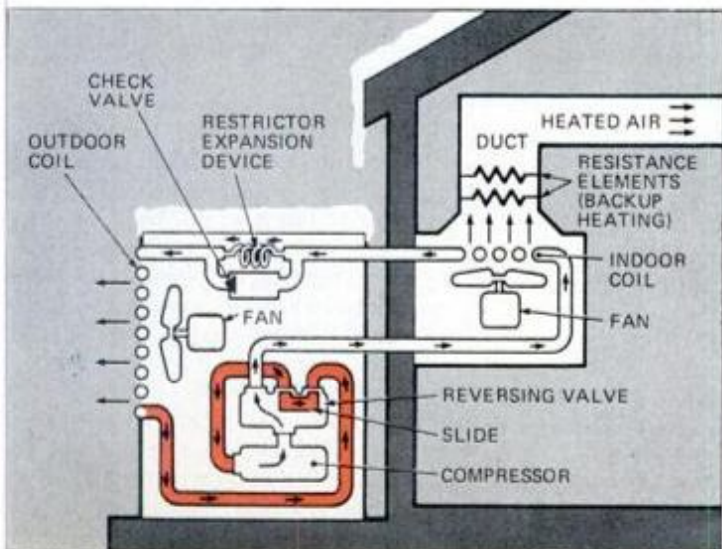
Because of these costly lessons, substantial improvements were made during the 1960s. Stronger compressors, improved control systems and many other features have been incorporated into the "second generation" heat pumps now being sold to builders and homeowners.

Because the equipment is more sophisticated, better training of installers and servicemen is important. Many makers now conduct nationwide "schools" to assure the availability of well-trained heat-pump mechanics.

As proof of the reliability of today's heat pumps, manufacturers

In winter operation, cold liquid refrigerant is pumped to the outdoor coil where it evaporates, absorbing heat. This heat is given up at the house by the refrigerant at the indoor coil.

In summer, the direction of heat movement is reversed. Cold refrigerant absorbs heat from house interior, then gives it up to outdoor air at the outdoor coil—just as in an air conditioner.



are standing behind their products: Almost all units are warranted for one year on all parts and five years on the compressor. Additionally, service contracts for years two through five are offered at prices equal to those for comparably sized gas and electric furnaces and central air-conditioning systems.

Pros and cons

Behind all the ballyhoo, several strong advantages of heat pumps can be seen:

■ *Heat pumps save energy and money.* Their over-100-percent efficiency translates into substantial dollar savings when compared to electric resistance forced-air heating. Energy savings of 25 to 50 percent can easily mean hundreds of dollars per year.

■ *Heat pumps are electric systems.* With restrictions on new natural-gas connections in many parts of the country, more and more totally electric homes are being built. Heat pumps offer a useful alternative to oil heat for those who cannot obtain natural gas. Additionally, in the long run, heat pumps can help improve the mix of our natural energy consumption. A heat pump, unlike a gas or oil furnace, can operate on electric energy created from coal or nuclear fission.

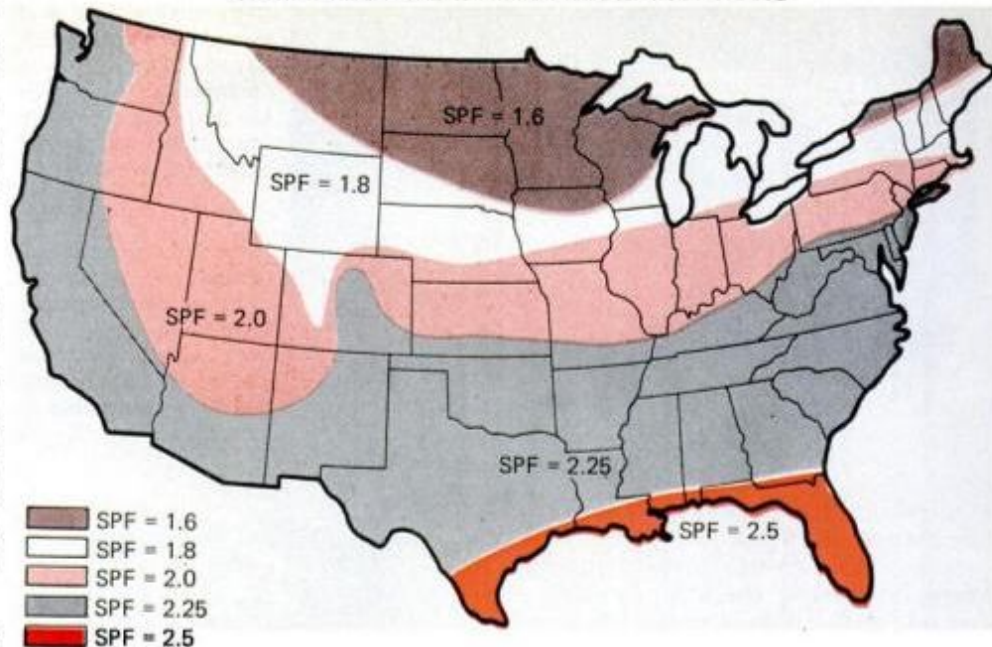
■ *Heat pumps are central forced-air systems.* As such, they're compatible with humidifiers and electronic air purifiers. Heating systems without ductwork require separate installation of ductwork for those functions, or for central airconditioning.

Critics of heat pumps have also been vocal, most often raising the following objections:



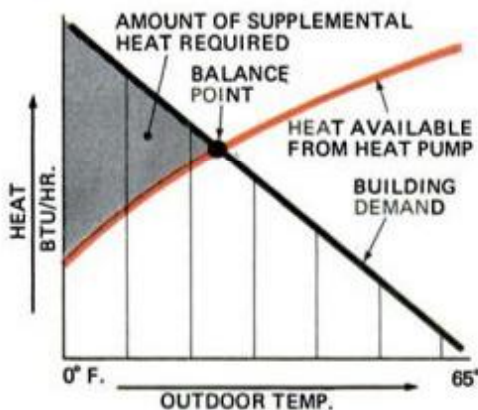
Indoor coil of York MaxiMizer add-on heat pump fits onto a fossil-fuel, forced-air furnace like an airconditioning coil.

SEASONAL PERFORMANCE FACTORS



The seasonal performance factor (SPF), which takes climate into account, is the realistic measure of heat-pump efficiency.

The number is the ratio of energy put out by the system (as heat) to energy put in, over the course of the heating season.



As outdoor temperature rises, heat-pump output (colored line) increases, while building's heat requirement (black line) decreases. Below the balance-point temperature, the heat pump cannot meet the building's heat demand, and a source of supplemental heat must be turned on.

■ *Heat pumps are inefficient as air-conditioners.* To provide reliable, low-cost heat pumps, some manufacturers have sold products whose efficiency in the cooling mode is lower than that of other central airconditioning equipment. Many heat pumps, however, have excellent energy efficiency ratios (EERs). The potential buyer should carefully evaluate EERs, for both heating and cooling. (EER ratings are certified by the Airconditioning and Refrigeration Institute and are published in product literature or are available on request from the manufacturer.)

■ *Heat pumps cost more than other systems.* The initial cost of a heat pump in a new home will normally be \$300 to \$600 more than the cost of an electric-resistance, gas or oil forced-air system plus central air-

conditioning. A comparison of total cost for the life of the equipment is virtually impossible to calculate, however, because of uncertain fuel prices. In my opinion, though, electricity should prove to be one of the more price-stable energy sources, and the economic advantages of heat pumps should be excellent in the years ahead.

■ *Heat pumps force the purchase of central airconditioning.* Since heat pumps operate as both heating and airconditioning systems, their total energy consumption on an annual basis may be greater than that of a less efficient heating system without airconditioning. But, in general, the cost of a heat pump compared to the cost of other heating without central airconditioning will be sufficiently high to dissuade those who had not planned on central airconditioning from buying a heat pump. For those who do buy heat pumps for their heating efficiency, self-control is the only way to minimize airconditioning use.

Existing houses

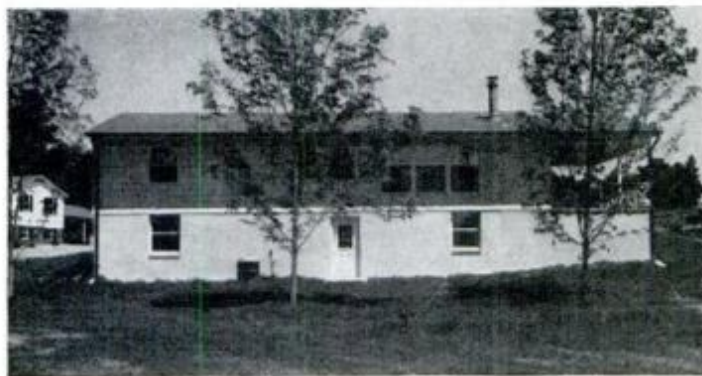
Startling utility bills have made many homeowners consider installing heat pumps in their present homes. While each case must be considered individually, the cases below are those in which conversion to heat pumps is most likely to be cost-effective:

■ *Adding central airconditioning to previously unairconditioned homes.* Heat pumps are particularly attractive for houses currently using forced-air, electric-resistance heat-

(Please turn to page 161)

Builders show how today's technology can save energy

Trade group's house should use 33 to 50 percent less energy than conventional homes of comparable size.



Energy-efficient house is a normal-looking ranch. At its front—north side of house—(above) only clue to its nature is reduced window area. At its rear—south side of house—(left) there's extra window space protected from summer sun by broad-leaf trees and 2-foot roof overhang.

There's nothing exotic about this house. No far-out new technology, no solar collectors, no building materials that aren't already on the market. But it should use only two-thirds to a half as much energy as a conventionally built house the same size.

Developed by the research arm of the National Assn. of Home Builders, the Energy Efficient Residence in Mount Airy, Md., has dozens of energy-saving features. Here are some of them:

- Compact rectangular plan to minimize heating and cooling loads.
- Unheated vestibule and storage room to buffer east wall, isolate heated space.
- Lowered (7½-foot) ceiling to reduce heated volume.
- Heat pump for heating and cooling (see *Backward Airconditioners Take a Front Seat*, page 126).
- A "family retreat" area that closes off from the rest of the house and can be separately heated and airconditioned.

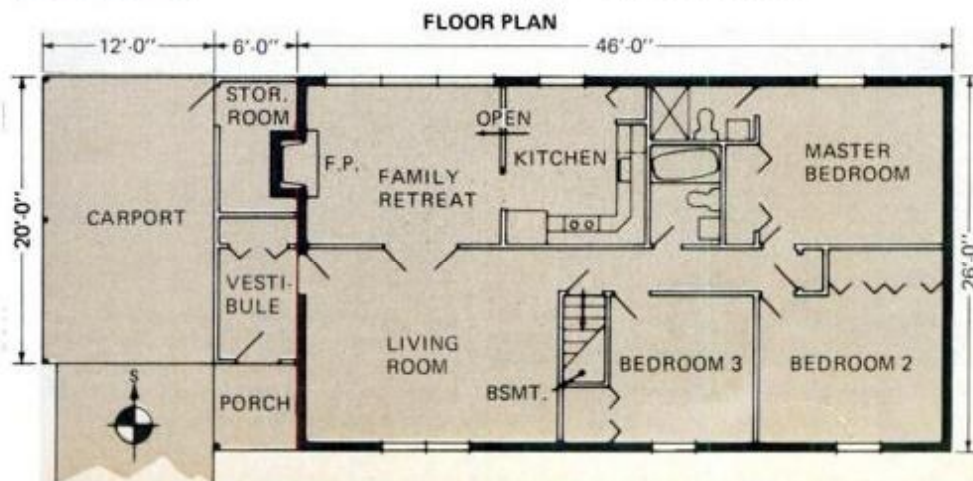
- Fireplace that uses outdoor air for combustion.
- Extra south-facing window area to pick up winter sunlight; reduced north-facing window area.
- Triple-glazed windows.
- Plenty of insulation: R-19 in exposed walls, R-11 in below-grade walls, R-38 in the ceiling; insulation in normally uninsulated spaces—corners, for example.
- Vapor barriers behind drywall and below ceiling insulation; polyethylene film below slab and behind backfilled concrete block.
- Water-saving fixtures and high-efficiency appliances.

Materials and labor cost of the extra features came to between \$3000 and \$4000—recoverable in five to seven years with no increase in energy price, or even faster as the cost of electricity rises.

At this writing, comparison tests were about to begin with families in the Energy Efficient Residence and the conventionally built house next door.—*Stephen Walton*



Above, Mark Shaurette of NAHB Research Foundation checks monitoring meters. Below, unheated vestibule helps to prevent the loss of heated (or cooled) air.



Install this interference-free garage-door opener

PM photos: Abe Dulberg

You can do it yourself
in just three hours.

by Joshua Mark

You really appreciate an automatic garage-door opener when the weather is at its worst. You never have to step outside the car or garage to open or close the door.

The new, interference-free garage-door opener for do-it-yourselfers from Stanley Vemco is one you can install in a matter of hours with just a few common tools. It sells for about \$189. All components come in a carry-under-your-arm carton just 32 in. long.

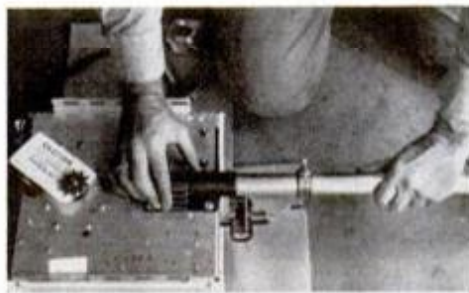
The opener will operate one-piece



One touch on transmitter button raises garage door; another closes it again.



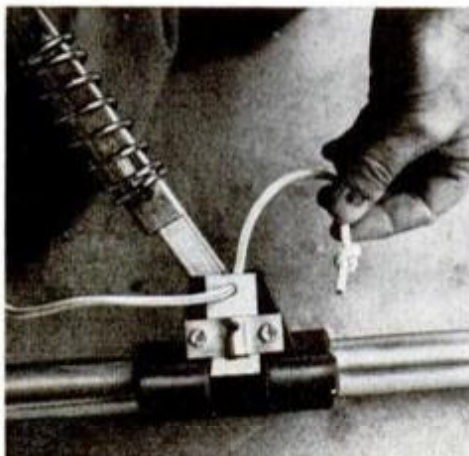
1 After reading instructions and familiarizing yourself with the components, start the installation by assembling the four tube sections. If the tube fit is tight, tap the tube ends lightly with a hammer and a block of wood.



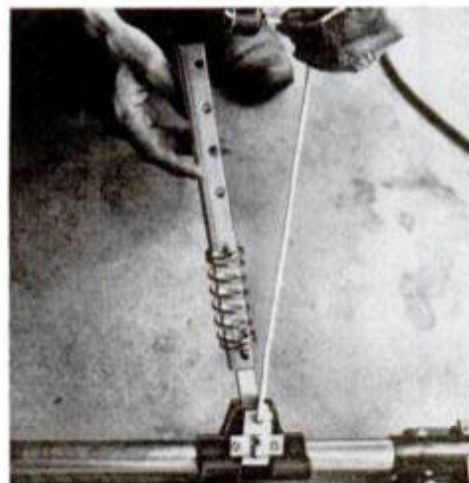
2 Insert the tube plug into one end of the tube assembly and install rubber bumper on tube. With the power unit on the garage floor, insert the plugged end of the tube into the tube support on the power unit. It may be necessary to ease the tube clamp screw, but do not remove it. After tightening or retightening the screw, slide the rubber bumper until it is positioned 3 to 4 in. from the front of the tube support.



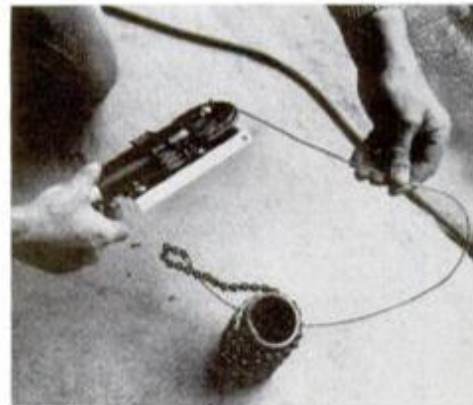
3 Slide the traveler and linkage assembly onto the tube assembly, making sure that the arrow on the traveler points toward the garage door. Slide the idler assembly onto the tube assembly as far as possible. Ease the clamp screw if necessary, but don't remove it.



4 Slide the traveler assembly until it's 1 to 2 ft. from the power unit. Insert the pull cord and knot one end.



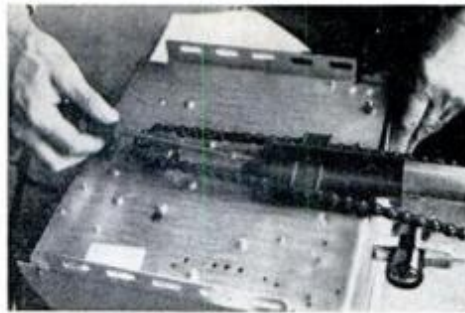
5 Pull the cord taut. Slide on the knob and make a knot to attach it.



6 To attach the chain and cable, first secure the turnbuckle by pushing it into the traveler until it is caught by the latch. Then carefully unroll the chain and loop it around the cable idler.



7 Continue unrolling the chain and engage it with drive sprocket on the power unit. Then loop chain around the sprocket and connect the other end to the free end of the turnbuckle with the masterlink assembly. The retaining clip must be attached on top of the chain.



8 Adjust the chain for about $\frac{1}{2}$ in. of sag at the midpoint by tightening the chain-adjust screw on the tube support. Then tighten the clamp screws on both the tube support and idler assembly, and put the chain guard over the drive sprocket.



9 To install the header bracket, locate and mark the centerline of the door opening. Then raise the door and find the highest point it reaches when open. Mark this point with a horizontal line on the door header, intersecting the centerline. Next, mount the header bracket on the centerline at least 1 in. above the intersection. Attach the opener to the header bracket with the carriage bolt and locknut supplied. Do not overtighten the nut and bolt—the idler assembly must be allowed to move freely.



10 To position the opener, raise it and place the power unit on a step ladder. Then open the door fully and place a 2x4 on edge between the door and the tube to assure that the opener will be mounted at the correct height. Use angle iron or straps and attach the opener to an overhead beam or the ceiling.

or sectional overhead doors of any composition—wood, metal or fiberglass—up to 18 ft. wide and 7 ft. high. An advanced digital radio control using pulse code modulation prevents signal interference. You select your own code from 1024 possible combinations, and your opener responds only to that code—no matter how many CBs or other openers in the area overlap the frequency. If it turns out that someone else in the neighborhood is using the same code, you can easily reset yours.

The door opener also features an instant-reverse safety device that automatically opens the door all the way if it hits an obstacle. A disconnect system allows you to operate the door manually in the event of a power failure.

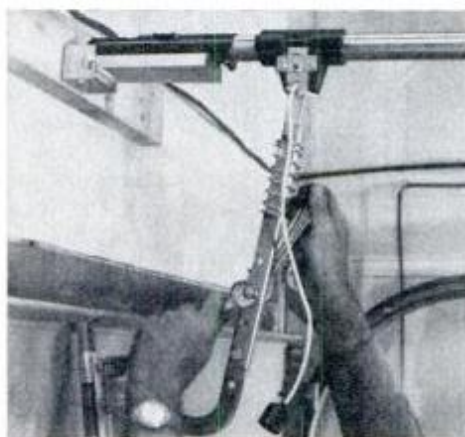
Once the opener is installed, you
(Please turn to page 162)



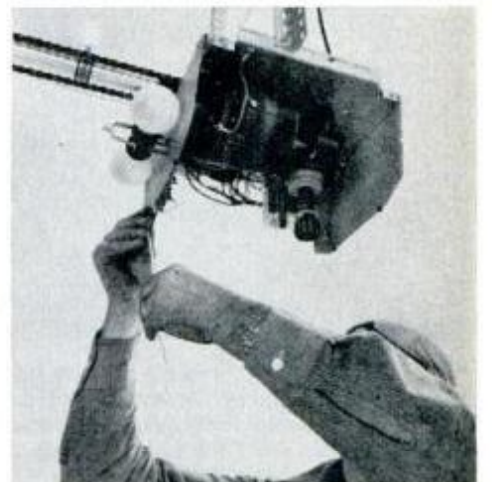
11 Installation kit provides all the hardware—bolts, nuts, lockwashers and lagscrews—for mounting the opener.



12, 13 Remove the 2x4 and operate the door a few times to make sure that it travels freely. Disable the existing locking mechanism by pinning it in the open position. Drill (above), then place heavy-duty screws in the holes. With the door fully closed, attach the door bracket on the door's centerline as close as possible to the centerline of the top door rollers. Use carriage bolts, hex nuts and lockwashers on wood doors. Use hex bolts, nuts and lockwashers on metal doors. Attach the door arm to the door bracket with shoulder bolt, lockwasher and hex nut. By pulling the disconnect



cord and cocking it to one side, disconnect the traveler and move it toward the door to the position shown above. Then, with the door closed, attach the door bracket assembly to the traveler and linkage assembly. If necessary, raise the door by hand until the holes line up.



14 Mount the pushbutton in a convenient location, then make the wire connections at the terminal board at the rear of the opener, using the bell wire and staples that are provided.



Build this radial saw bench and get storage too

by Larry Kellam



No-nonsense, 16-ft. radial-arm saw bench has flip-away fence for oversize ripping. Generous-size drawers and storage tray offer ample space for saw's accessories and in-progress work. Hefty casters make the bench mobile and it's easy to align.

A radial-arm saw bench that's close to being perfection can be yours by building this version for half the price of commercial models. The cost is about \$175, using construction-grade, 2-inch stock for legs and rails. Drawers, cabinet front, cross members and tray edges are of 1-in. spruce stock. Drawer bottoms and cabinet sides are AC (good-one-side) plywood. The top surface is cut from a 4x10-ft. sheet of 1½-in. particleboard. Hardwood ties stabilize legs.

To begin, build the base, which has a front and rear rail, and eight connecting cross members glued into the dadoed rails. Clamp overnight. Notch the back rail and set ledgers at the correct height for your saw. Attach the eight legs, after checking that each measures exactly 32 in. from the top of its respective rail to the floor. In other words, the lap joint at the top of each leg must be set 2 in. below the rail's top edge. Next, glue and clamp the cabinet front, sides and back (½-in. AC plywood) into previously routed grooves in legs and bottom edges of rails.

Dress the fronts, sides and backs of the drawers to ½ in. and lay out as in drawing. The fronts may be rabbeted flush to their openings and dovetailed to sides, or built with butt joints and a screwed-on false front. (Use 2d nails and white glue at butt joints and ¾-in. No. 6 fh screws with white glue to attach the false front.) Pulls and slides used are the single-channel, three-roller type—standard hardware items.

Construct the storage tray separately. Slip the bottom into 1/4-in.-deep grooves in the 1x4 sides and join at corners. Simple butt joints will do, but I opted to use dovetails for extra strength. Fit the completed tray component into previously cut leg notches.

Now add hardwood ties to the leg bottoms, with ample projection for heavy-duty casters. Secure casters with 1/4 x 3 1/2-in. lagbolts threaded into previously embedded 3/8-in.-dia. dowels.

When you need a wide rip or extra-wide crosscut, you can lift the hinged fence extensions, adjust your saw (including moving its central fence to the rear position) and begin ripping. To construct, mortise for and glue six hardwood mounting blocks into the particle-board table extensions to obtain solid hinge mounts. Position as on surface plan, page 163. Cut the six hardwood fence extensions and carefully countersink for a 1 x 3/8-in.-dia. carriage bolt through the center of the routed lap. Hinge fence extensions to the mounting blocks.

The fences are made from a straight 14-ft. piece of 1x6 clear pine cut in 104-in. and 44-in. lengths. Rip

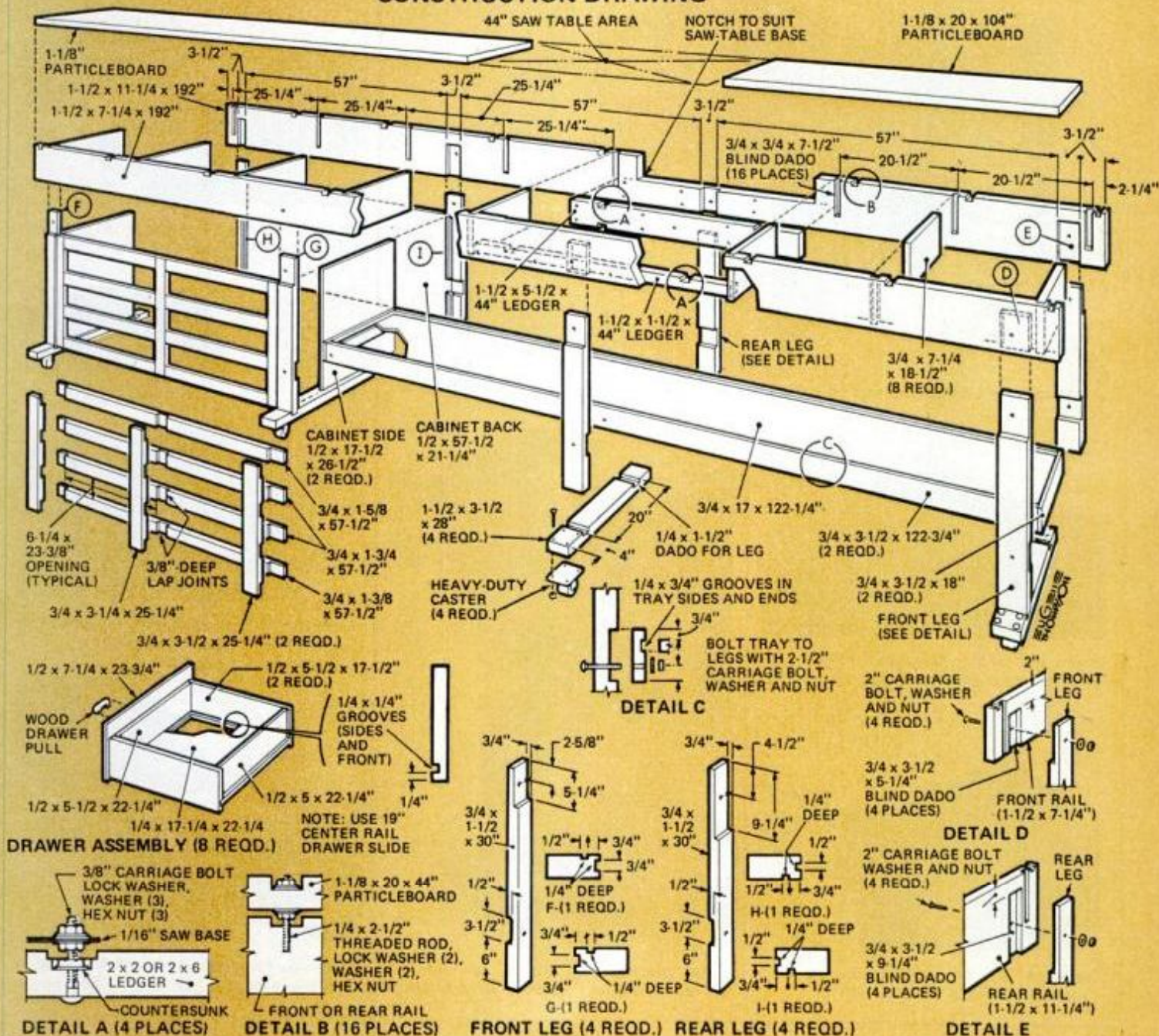
a 3-in. width off the two pieces for the two fence bases. Then rip a 2-in.-wide strip from each remaining piece for the two fences and join these pieces to bases with tongue-and-groove joints. The lip between fence bottom and the underside of its base should equal the gap between hinge leaves (see detail, page 163) or the fence will not sit at 90° to the table.

Center and cut six slits into the completed fence sections. Flip the sections and rout out six recesses for corresponding hardwood extensions. Secure fences to extensions with bolts, washers and nuts.

To align, start by leveling the bench, using the storage tray as a base. Set up your saw according to manufacturer's instructions; then level the saw table by raising or lowering the nuts on the saw lifts. Carefully level each table extension to the tabletop. Gently move the saw and the two extensions into alignment. Check alignment of fence sections with a long piece of black thread. Tighten nuts firmly on saw lifts, extension lifts and fence adjustments.

This bench is designed around a Craftsman 12-in. radial-arm saw, but you can adapt it to almost any (Please turn to page 163)

CONSTRUCTION DRAWING



WORKSHOP MINI-COURSE

FINISHING WITH VARNISH

For several reasons I think that varnish is the best finish choice for home craftsmen:

- Varnish does not dry too quickly, so you have plenty of time for achieving a smooth surface.

- It gives a durable, tough finish that resists water, alcohol and many other chemicals.

There are some minor drawbacks with varnish, however:

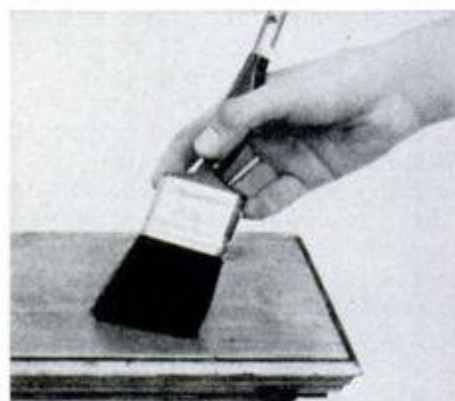
- Because it takes time to set up, more dust will settle on varnish than on a fast-drying finish like shellac.

- Though it goes on clear, varnish

does have the tendency to darken with age.

For some reason, several veteran craftsmen I know have resisted the newer polyurethane varnishes. They shouldn't. In general, these are worked much the same as a conventional varnish. Happily, major varnish manufacturers have introduced a wide selection of finishes in the urethanes ranging from high gloss to an antique-like low luster. I have used all types and have had good results with all of them.—

Harry Wicks, Home and Shop Editor



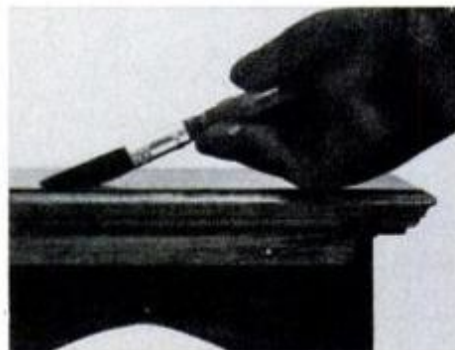
The correct way to hold a varnish brush—much like you grasp a pencil.



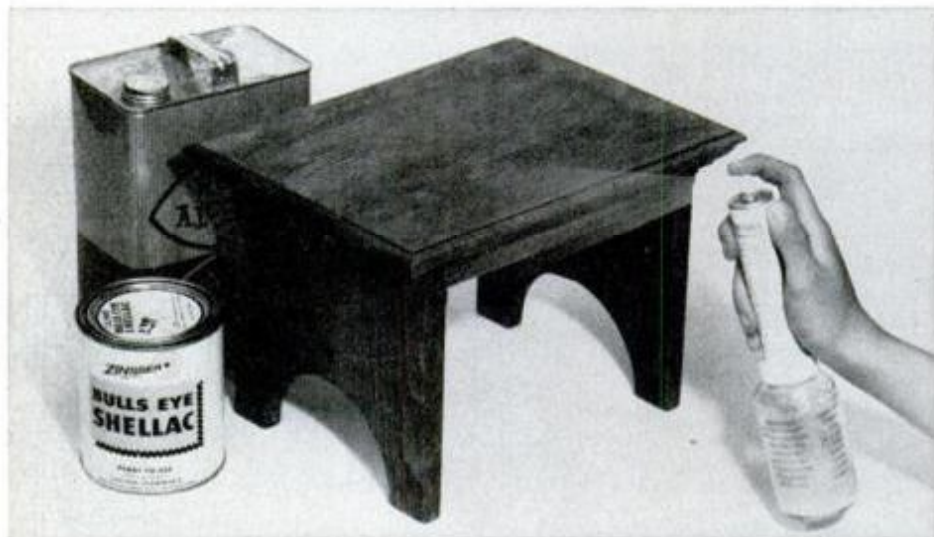
Brush on liberal amounts of varnish using with-the-grain strokes.



Then level the varnish with the brush by using strokes across the grain.



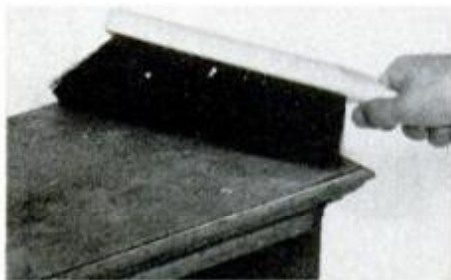
Finish by "tipping off"—drawing almost-dry brush across surface at 30° angle.



Sealer coat of shellac thinned 50 percent with denatured alcohol can be sprayed on.



When dry, sealer is rubbed lightly with 00 steel wool to remove any roughness.

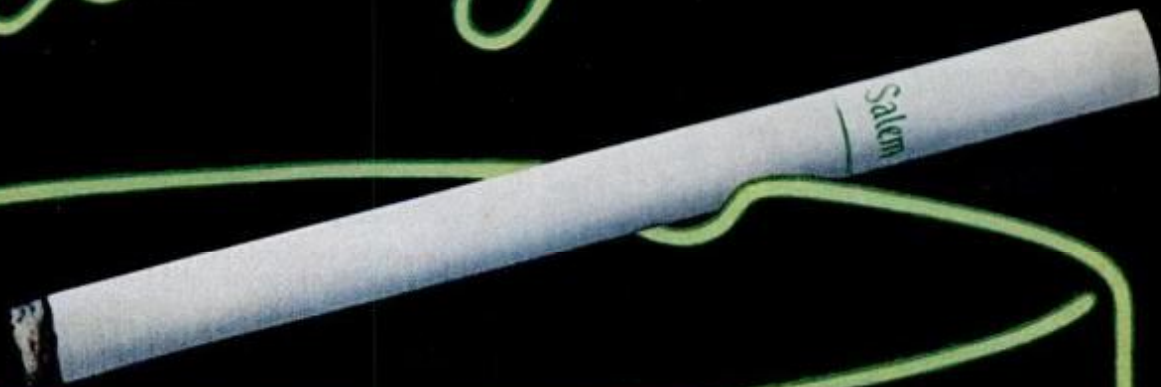


Particles left by steel wool are then brushed off using a clean brush.



Final preparation step is to wipe all surfaces with a commercial tack cloth.

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NEW MINI-OUTBOARDS: GOOD—BUT HOW GOOD?

(Continued from page 111)



Offset shaft of new Johnson 12/24V trolling electric is said to help steering.

to allow full throttle in reverse and a lock to keep the engine from lifting while backing. Johnson will have its Sea-Horse 2 hp, the 4 available in straight or weed-shedding Anglematic drive, plus a new long-shaft 4, a 6, 9.9, 15, 25 and 35. All Johnsons from 6 hp up have a pump-function indicator that squirts a stream of water.

■ Sears, Roebuck's Gamefisher line will catalog motors from 1.2, 3, 5, 7.5 and 9.9 hp up to its all-new 15-hp unit with low profile, new choke, and twist-grip control with automatic switch to prevent flooding at low speeds. Optional long-leg lower-unit shafts are also available for sailboats.



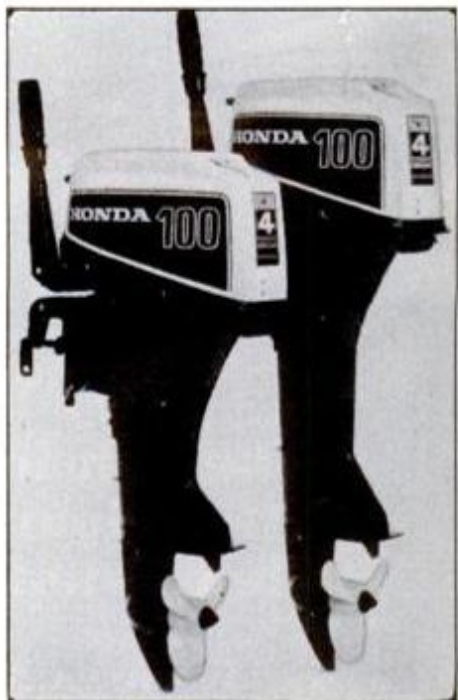
In Volvo Penta seven-outboard line: 9- and 3.6 hp long-shaft sailboat models.



At 48 pounds, Clinton's K753 model with air and water cooling produces 7.5 hp.

■ AquaBug International's 1.4-hp AquaBug has an adjustable shaft for shallow-water running. Twice the thrust of the 1.4 is claimed for its 2-hp SuperBug.

■ Aero Marine's 4-hp 4000 will be air-cooled. British Seagull's light and field-serviceable models will come in 2, 3, 4.5 and 5.5-hp models. Cruise-N-Carry has a single-cylinder 1.7 with adjustable shaft length. Honda's special four-stroke 7.5 and 9.9 mills come in two shaft lengths, three color styles. Tas



Long and short of Honda's BF-100 offers 9.9 hp from the only four-cycle outboard.

Industries has air-cooled 1.2 and 2.5-hp motors. Ter Mar's 1.7-hp Mighty Mite offers two shaft lengths.

■ Volvo Penta's ratings approximate 3.6, 6, 9, 4.5 and 20 hp. Montgomery Ward's Sea Kings will include 1.5, 3.5, 5, 7.5, 10, 15, 25 and 35-horse outboards. And from Arctic Enterprises, look for models of 2, 5, 9.9, 16, 20, 25, 50 and 65 hp made by Suzuki. **PM**

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HYDE TOOLS

PM TEST: LITTLE DIESEL FOR LITTLE BOATS *(Continued from page 85)*

boat might demonstrate how a modern pleasure craft could perform safely, dependably, economically. Speed runs through a measured mile along Miami's Government Cut showed that the fully loaded boat with fuel tanks topped off could put out an impressive 31 miles an hour.

Yet even without the apprehension before an ocean race, we found ourselves tensed up again as we powered out into the pre-dawn dark of the open Atlantic and the Gulf Stream seas edging the "Bermuda Triangle." Only flying fish broke the long swells, however, as the coast lights of Florida dropped behind us, the sun rose between showers and rainbows, and within two hours the little engine had us approaching the slot between Gun Cay Light and Cat Cay for our only stop—10 minutes ashore to clear customs into the Bahamas.

Recommended cruising speed for this high-performance mill was only 200 rpm below full-throttle 3600,

and our Crestliner knifed smoothly through the 40 miles of chop that took us to the marker beacon Northwest Channel Light. Here an underwater canyon lowers soundings from a few feet to hundreds as the full sweep of the Atlantic rolls in to the Tongue of the Ocean. Jim slowed us down slightly for an easier ride into the big seas—we weren't trying to set a speed record—yet three hours later clouds along the horizon ahead darkened into a line of land and soon the white hulls of cruise ships clustered off the New Providence entrance to Nassau harbor, right where we'd left it years before.

Slicing down the clear waters between Paradise Island and the fishing smacks tied up along Bay Street, we saw we had beat our most hopeful time estimates. This time, instead of 17 hours it was seven and a half as we tied up at the Yacht Haven docks of the Pilot House Club. Nassau Port Director Leon Flowers stepped aboard as pre-arranged to welcome us, monitor our refueling and officially certify our diesel consumption. It was only lunch time, but from the crowd on the dock above, Gordon Lomer of the Bahamas Ministry of Tourism thoughtfully refueled PM's test crew with a celebration toast of champagne.

Our tank gauges were showing half empty when we shut down the reliable little engine, and it took 54 gallons of diesel fuel to refill them. Quick figuring showed we had used only 7.2 gallons per hour and had covered 3.33 miles of ocean running for each gallon. Average speed worked out to an impressive 24 miles an hour. A gasoline engine to provide an equal performance would have used an estimated 30 percent more fuel. Dependable? Last summer Allen Cargile used this same diesel in his 30-foot cutter to cross 4500 miles from New York to Paris.

After the 1959 race we cruised on down through the Bahamas Exuma Island chain with the little Volvo gas engine and outdrive. At the annual Out Island Regatta, Great Britain's Prince Philip had been interested in this new invention and had taken his entourage on a ride with us around the harbor. For our 1977 test under diesel power, we headed back for Bimini and Miami instead, and our unofficial fuel figures bore out the certified ones.

Diesel mills now cost about twice as much as gas engines, but are estimated to last more than twice as long. With the light weight and fuel economy this turbocharged Volvo can offer, however, diesels may ride the waves of the future. **PM**



Fuel consumed on the PM test run is measured as Wynne retops the tanks at Nassau under the port director's supervision while the crew relaxes.



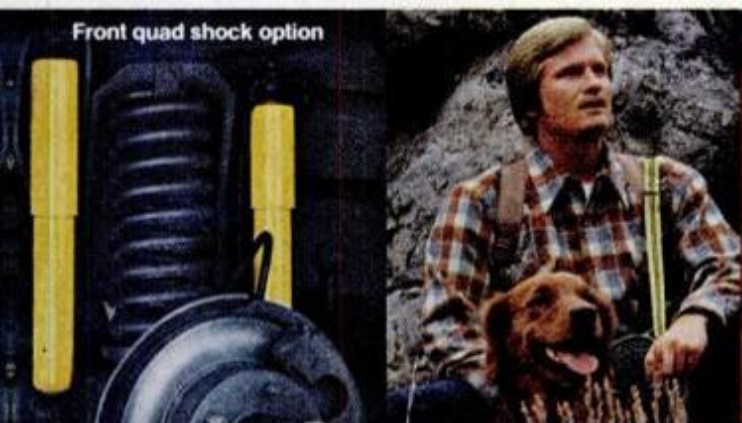
Aboard the prototype 1959 sterndrive, Britain's Prince Philip, his aides and the Bahamas governor take a ride with Wynne, McKeown and Allen.

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Front quad shock option



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Of all Ford Trucks registered over the last 12 years, 93 out of 100 are still on the job. (Based on cumulative registrations as of 7/1/76.)

FORD
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Montvale, New Jersey 07645

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Please rush full details immediately.

Name _____
Address _____
City _____
State _____ Zip _____

NEW LOOK AT AN OLD DITCH (Continued from page 83)

Col. Ernest Graves of the Army Corps of Engineers some years ago. "To do it in less than a minute with a single explosion staggers the imagination. Nevertheless, the scientists and engineers who have studied the problem believe firmly that it can be done."

Will it come to pass? While fallout can be reduced to low levels, it would still be necessary to evacuate thousands of people for up to three months. Larger excavation devices would have to be tested, international test ban treaties modified and other problems resolved. For these reasons nuclear techniques remain only a possibility.

■ Although they're labeled with separate numbers, Routes 14 and 15 actually center on the present Panama Canal. As Route 15, it would become a deep-draft lock canal capable of handling ships of 150,000 DWT at a rate of 35,000 ships a year. This approach would require a third lane of locks 65 by 160 by 1450 feet each, new approach channels and a land cut of 36 miles.

Vulnerability to attack and water supply problems are two drawbacks to building Route 15 or continuing to rely exclusively on the present canal. Damage to the locks or dam holding back Gatun Lake, the canal's operating reservoir, could drain it and put the waterway out of operation for up to two years.

The limited water supply is already a problem. Large ships require 26 million gallons, a day's supply for a major city, to climb to Gatun Lake. The same amount is used to descend to sea level.

Follow present channel

How about Route 14, actually a scheme for converting the Panama Canal to a sea-level channel? Different versions of 14 all follow the present canal. On the Atlantic side, the channel would be deepened and straightened somewhat. The major change, however, would be enlarging the Gaillard Cut or digging a new parallel lane through the mountains. In a final step, plugs would be removed at either end of Gatun Lake to bring the canal to sea level.

Unfortunately, Route 14 could only be built by closing the present canal for long periods of time. The draining of Gatun Lake would create a severe slide hazard and even more delays.

■ Route 10, a brand-new sea-level canal 10 miles west of the present Panama Canal, received strong endorsement in 1970 and may still be the best choice. Running between

Lagarto on the Caribbean and La Chorrera and Puerto Caimito on the Pacific, the route passes through an underdeveloped area with only a few farms breaking into the jungle.

A mountain of spoil

The mammoth construction job, a 14-year, \$3 billion project, would use barrier dams to isolate the work from Gatun Lake. An awesome 1.9 billion cubic yards of rock and dirt—six times the amount removed to build the original canal—would be excavated to dig a 36-mile single-lane channel and 17 miles of two-lane approach channels. While the channel would be different, the digging methods would be reminders of the past—power shovels and endless dirt trains to move the spoil.

The present canal would remain in use and be operated in combination with the new route to increase the capacity of both.

While Atlantic tides along the isthmus are gentle and irregular (about 1.3 feet above and below mean sea level), the Pacific rises from 5 to 11 feet and falls from 4 to 10 feet twice a day. As a result, the mean level of the Pacific is slightly higher; it's 8 inches higher at Balboa, for example, than the Atlantic is at Cristobal.

A sea-level canal would thus produce a gentle sloshing back and forth, but the ultimate result would be the movement of some water from the Pacific to the Atlantic. If a completely unobstructed canal was built at Route 10, for example, the maximum flow of water would be about 45,000 cubic feet per second, some 10,000 less than the Missouri flowing past Kansas City.

Migrating marine life

What hazards would canal currents present to large ships negotiating a narrow passage? What are the chances and possible consequences of biotic interchange, the migration of marine organisms between oceans?

With tidal currents estimated as ranging between 3.7 and 5.1 knots on Route 10, navigation would be possible even without control measures. For safety, however, devices known as tidal checks would be installed to keep currents below 2 knots. These would simply be large barriers that would be rolled or floated across a sea-level canal as tides change, moving back out of the way of oncoming ships traveling in convoys.

While tidal checks operating in
(Please turn to page 146)

Two ways to make graduation a beginning.

The Active Army

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NEW LOOK AT AN OLD DITCH

(Continued from page 142)

synchronization with the tides would reduce the net flow of water to almost nothing, a sea-level canal could speed biotic interchange. Would the result be possible disaster as predicted by some marine biologists, or could it lead to beneficial changes, as others maintain?

Hot water a barrier

Although our knowledge of the various species of fish and other organisms that inhabit the coastal regions on either side of the isthmus is too limited to make predictions, biotic interchange might be prevented simply by heating the canal water at some point or by reducing its salt content. The hot condenser water from a powerplant would provide the heating, and the rivers along Route 10 could dilute salty ocean water.

An effective freshwater barrier already exists at the present Panama Canal, for ships emerge from Gatun Lake with their hulls cleansed of barnacles and other organisms.

Finally, other examples of biotic interchange are somewhat reassuring. No ill effects have been traced to the limited migration that has been taking place since the present canal opened, this in the variety of small plants and animals carried in ship ballast water from one ocean to another. The result of connecting the Red Sea and the Mediterranean through the Suez Canal over 100 years ago has been the migration of 24 Red Sea fish species. While no harmful effects have been noted to date, 11 of the 24 types are now commercially important to Mediterranean fishermen.

A supreme achievement

"The creation of a water passage across Panama was one of the supreme human achievements of all time," writes author David McCullough in *The Path Between the Seas*, a history of the Panama Canal published last year. "It was the culmination of a heroic dream of 400 years and of more than 20 years of phenomenal effort and sacrifices. The 50 miles between the oceans were among the hardest ever won by human effort and ingenuity, and no statistics on tonnage or tolls can begin to convey the grandeur of what was accomplished."

As we approach the 21st century, our nation faces an even greater challenge: that of building a broad new passage capable of handling the seagoing giants of today and tomorrow.

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That told us a lot, right there. But those same prospective buyers told us a lot more than that. After looking over two of the Sun-Cruiser's major competitors, those people were asked to rate all three models in the following areas: overall exterior, spacious appearance, texture and type of upholstery, and price estimate. We hate to brag, but

the Itasca won hands down in every category. And when we asked for an overall preference, Itasca fans outnumbered fans of the other two models combined by more than three to one.

To tell you the truth, these results came as no surprise to us. We knew the Sun-Cruiser had a lot going for it. It's a sizeable 23 feet long. And it has a bright new interior with a wide choice of floor plans. All for a suggested list price of \$13,249. Dealer prep, taxes, license and options are extra.

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allowing for thickness of the saw kerf. Then rip off the back end. Mortise for the butt hinge leaves and assemble the top. Cut out the compartment bottom (see radii detail).

After all pieces have been cut and sanded (except the upper front, which may be left rough-sawn), assemble the cabinet with glue and 1/2-in. finishing brads. Clamp and let dry overnight.

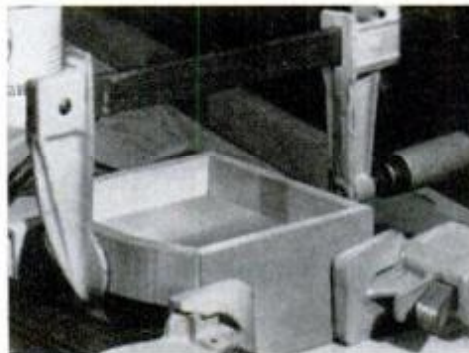
To make the drawer, first cut out sides, back and front. Use a bandsaw to cut the front, making it just over 9/16 in. thick to allow for sanding. Smooth the inside curve with a drum sander. Next, rout a groove in the front on a drill press the same way you routed the rabbet in the cabinet front. Then rout grooves in sides of the drawer so the bottom can be fitted.

When laying out the drawer bottom, let it protrude from the back

to act as a drawer stop. Plane it down later for the final fit. Chamfer all edges of the drawer bottom about 1/16 in. so it will fit snugly into the 3/16-in. grooves. Glue the drawer together; check it for squareness and let it dry overnight.

When the cabinet is glued, and the drawer fitted, smooth the front curve of the vanity on a disc sander until saw marks are removed and all elements are flush. Paper wedges inserted on either side of the drawer will hold it tightly in its opening while you're sanding. Turn two uprights and four feet on your lathe following specifications in the drawing. After sanding, burnish all turnings with wood shavings held against the revolving work. Bore 7/32-in. screw holes in the top sphere of each upright for mounting the mirror.

Make the mirror frame molding as



Assemble cabinet with plastic resin glue and 1/2-in. brads. Clamp, let dry overnight.



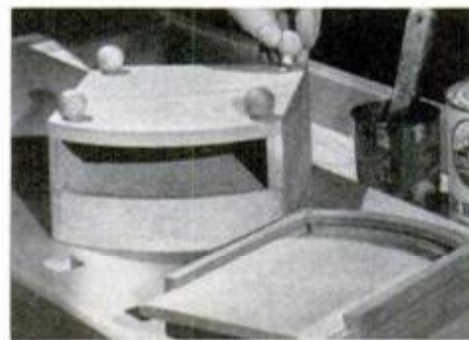
Next, use disc sander to remove saw marks, smooth curved cabinet front flush.



Slight variations in lathe-turned parts are expected, enhance handcrafted quality.



Hand plane a chamfer on edge of a wide board. Then rip 3/4-in. molding for frame.



Tenons on feet should be a push fit. Be sure they sit flush to surface before gluing.

shown in photo and cut rabbet for mirror and backing. Miter corners of the molding to length and assemble with glue. Install the mirror and cover it with 3/32-in. backing. Hold backing with 3/4-in. finishing brads or screw wedges as shown. To complete the assembly, mark and bore holes in the bottom for feet and in the top for uprights. Glue feet and top base in place. Then glue uprights to the top. Hold mirror in place between the glued uprights while they

(Please turn to page 150)

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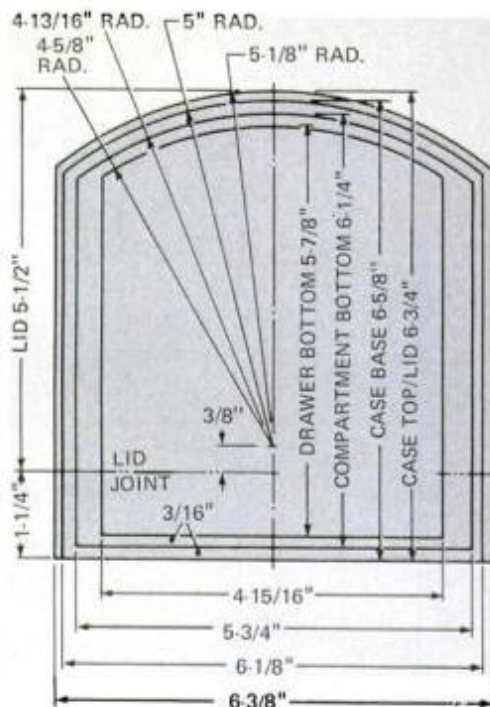
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LINCOLN MIRRORS

(Continued from page 148)



RADI DETAIL

dry. After they are dry, mark location of screw-hole locations on the mirror frame, bore the holes and install screws.

Apply the finish except for the inside compartment. (See next section.) Then line the jewelry compartment with green felt. Cut the felt sides to the 1/16 in. below the upper edge. Hold the felt in place with white glue applied sparingly to complete your reproduction.

Finishing the mirrors

Seal all exposed end grain with oil and stain the pieces a traditional mahogany color. A typical mid-Victorian way to stain mahogany is to brush on a lye solution (about one part lye to four parts water). Wait about 10 minutes, or until you reach the shade of red desired. (The stronger the lye solution and the longer it is left on, the darker it gets.) Then wash off the lye solution with clear water. If the red shade is too deep, wash it with vinegar in order to neutralize the lye and reduce the redness.

(Caution: Use extreme care when you're working with lye. Wear safety goggles and gloves, and wash up carefully afterward.)

When the finish is dry, sand it lightly with 220-grit sandpaper, then use a 4/0 steel wool pad to polish in several coats of a 70/30 solution of orange shellac and linseed oil. When this is dry, buff on carnauba wax. In due time, the natural oxidation will impart the fine patina on the originals.

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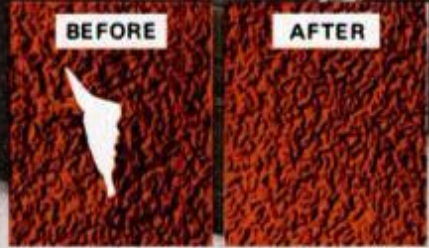
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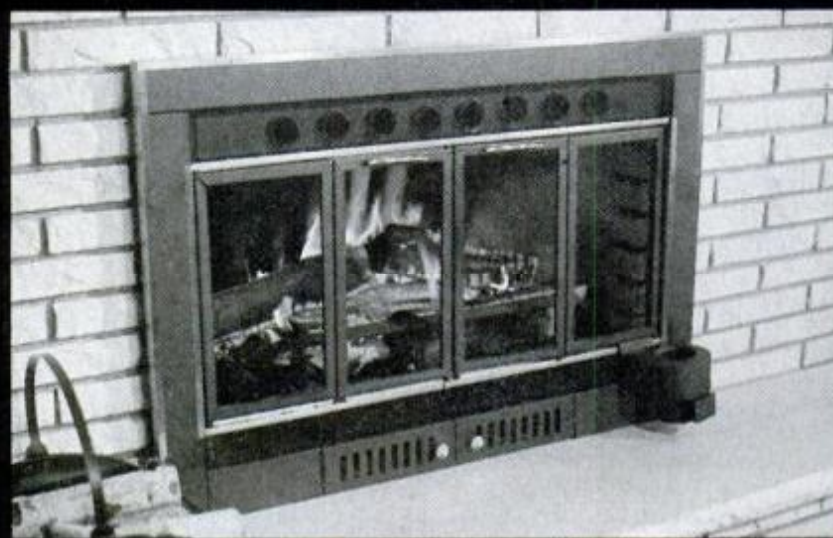
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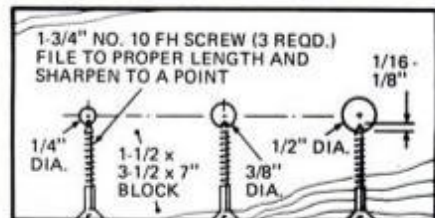
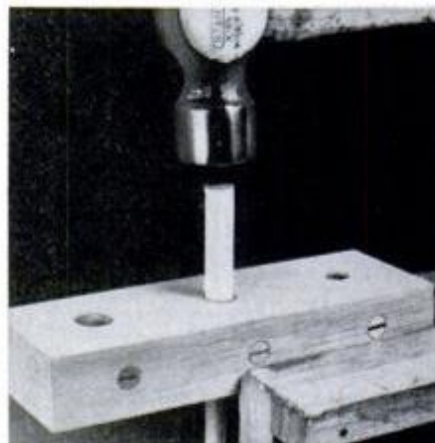
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HINTS FROM READERS

Make a dowel plate



Section view: Top of wood block.

Old-time cabinetmakers used a steel dowel plate to make or true dowels to sizes wanted. The plate had nibs that cut glue-escape grooves. You can make this tool of wood and screws filed to groove the dowel.—*Kenneth Wells*

Garbage-can rust retardant

Before you use a new metal garbage can, spray primer inside on the bottom and 6 inches up sides to inhibit rust.—*R. Whittaker*

Filter cleans fuel tank



Clean accumulated dirt from the fuel reservoir of your chain saw. Filter gasoline into tank through a clean paint filter. Fill and empty tank until it's clean. Continue to use a filter each time you gas up.—*David W. Roberts*

in liquid nitrogen. Hence, the multi-disc wheel is shrunk tightly in place, making one solid unit. "If the flywheel should happen to overspeed," says Brown, "the discs will expand and slip on the shaft before going critical."

Garrett engineers are even more enthusiastic about their new "composite" flywheel, made of fiber-epoxy compound. "If that one overspeeds," says Brown, "all you get is a ball of fluff."

This is the wheel—23 inches in diameter, with a maximum speed of 25,000 rpm—that will be used by AiResearch in their all-new four-passenger car for ERDA's "Near Term Electric Vehicle Program." Since all the hardware associated with reciprocating engines (block, clutch, transmission, carburetor, fuel system) have been eliminated, the unique vehicle features dramatic passenger space for its size. It is 158 inches long overall and 57 inches high. With the power package in the rear, the forward compartment is vast. The battery pack, consisting of 16 standard lead-acid units, is split fore and aft for weight distribution. Those in front sit low in the chassis, providing space above them for storage and instrument modules.

Luxury touches

Unique finishing touches will include an electronic speedometer with digital readout on the rear-vision mirror, and a pedal-height rest for the left foot. The rear seat folds forward to become an extension of the luggage compartment. Behind a hinged lid under the dash on the passenger's side, a 30-inch-deep compartment is big enough to accommodate clothing, tennis rackets, knapsacks, food or other travel items. It is essentially a king-size glove compartment.

The Garrett/AiResearch-ERDA family electric will provide far more flexibility and refinement than the postal car—or any existing family electric car, for that matter. Here's how it will work:

Flywheel start-up is initiated by the 13.7-hp generator, functioning as a motor and drawing on the battery bank. When the flywheel reaches 25,000 rpm, the regular 13.7-hp motor is switched on to start moving the vehicle. During acceleration, the generator, operating in normal mode, supplies most of the current, powered largely by the flywheel with minimal battery assist. As the car gains speed, the flywheel decelerates and the motor is brought gradually into play by the controller unit. Max-

imum acceleration is reached automatically—oddly—by switching off of the battery current. This increases generator output to maximum—drawing all its oomph from the flywheel.

Electrical braking

Electrical braking is used to decelerate, recovering much of the lost flywheel energy. As the car slows, armature current is reversed by the controller. The motor becomes a generator, feeding current to the real generator which, acting like a motor accelerates the flywheel. The process begins when the driver lifts his foot off the throttle. The sensation is like the "engine compression" you'd feel in a decelerating piston-engine car. Pressure on the brake pedal increases electrical deceleration to maximum, where friction braking blends in to halt the car.

In passing and hill climbing, the flywheel functions to provide power input much as it does during acceleration, supplying most of the energy and saving battery drain. On a long climb, when the flywheel slows appreciably, the batteries automatically assume more of the load.

Garrett engineers believe that the flywheel will provide a new opportunity to get a truly practical electric car off and running. But it goes well beyond that. The 14,000-mile test of two 6000-pound Garrett units with 600-pound flywheels on New York's MTA subway cars last year indicates a promising potential for wide use of such systems in mass transportation. The MTA already is considering installation of the units in 200 of its cars.

In electric trains, as in smaller vehicles, deceleration speeds up the flywheel. When the train starts again, the flywheel, regenerated to some 14,000 rpm, drives a big electric generator that feeds current to operate the motors, eliminating the heavy surge usually drawn from the third rail to get the mass moving. Savings in power consumption over the life of each drive car using the new units could amount to half a million dollars, according to Garrett engineers. Since much of the heat in the subway tunnels during summer is due to friction braking of present trains, additional savings would accrue thanks to a much lighter air-conditioning load that flywheel cars would make possible.

Flywheel for emergency power

Another advantage: Though flywheel-equipped subway cars won't

(Please turn to page 154)



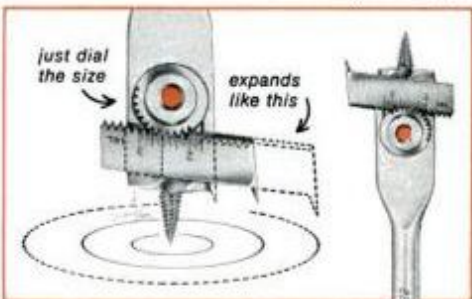
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FLYWHEELS: NEW BOOST FOR ENGINE POWER

(Continued from page 153)

often have occasion to run purely on flywheel power, they *can*. In a blackout or other power failure, for instance, a flywheel train can (like Prof. Frank's Pinto) travel far enough on flywheel power alone in order to reach the next station from any interim point, thus enabling its riders to disembark instead of staying holed up in a tunnel.

As for that Pinto, it already has demonstrated that the flywheel concept is adaptable to standard cars with reciprocating engines, and that it can produce substantial savings during urban driving, plus a vast improvement in efficiency. What's more, retrofit installations are possible.

Steel enclosure for safety

To insure safety, the Wisconsin vehicle's flywheel is enclosed in a 3/4-inch steel containment. In an accident, the car's developers admit, there is some remote risk of rupture, though "less hazard than a gasoline tank," they insist. The big wheel, Frank and his coworkers point out, stores more than two-thirds of a horsepower-hour of energy, which can be drawn upon to advantage in stop-and-go driving and hill climbing, as well as acceleration.

As with electric cars, regenerative braking keeps a flywheel at speed. The developers acknowledge that fuel savings are greater in urban stop-and-go than in cross-country, where the engine runs at speed and most regeneration occurs only when braking on steep downgrades and sharp curves. Even so, they insist, overall savings can amount to 50 percent with a potential of doubling fuel mileage.

Unnerving at first

Is driving a flywheel car any different? It can be unnerving at first, experts note, until you get used to the freewheeling engine suddenly coming to full throttle in creeping traffic as it kicks in automatically to wind up the flywheel.

Because stop-and-go driving is where the automotive flywheel shines, developers of the systems believe the first applications will be in utility and commercial vehicles. But some people also are betting that within a decade they may be on the new car you buy—electric or piston-engined. The price? Approximately 10 percent more than the amount a standard car will cost in that year.

What about all those eight-hour "recharge" stops for the electric car? Battery manufacturers are hot on the trail of new, compact units that they claim will double present capacities. Scientists at Rockwell International's Atomic Div. in Canoga Park, Calif., will happily show you their tightly layered lithium-iron-sulfide battery which, in tests, has delivered 36 watt-hours per pound, compared with 15 for standard lead-acid. Many other exotic batteries are "near term," as their inventors call them. Most people in the business agree that a battery breakthrough is possible.

Fill 'er up—with fresh juice

More likely, however, for that "near term," should electrics catch on, will be service stations where you simply turn in your rundown battery pack for an identical fully charged one that the attendant rolls into place in minutes. It would be like stopping for gas. Such relay stations could create a whole new industry for mobile America. And so, for that matter, might flywheels.

PM

CAN YOU NAME THESE 'WHAT'S-ITS'?
(Continued from page 93)

experts in a wide variety of fields. If none of them could identify an object, we simply put it aside. Some sat on shelves gathering dust; others, if they were interesting, might be kept on the desk of the curator who received it. It made a good conversation piece and, now and then, a visiting expert might just recognize the thing and tell us what it was.

"Then, about three years ago, we rounded up 21 such items, put them on exhibit in a display case, and invited museum visitors to tell us what they thought they might be."

Upshot of this brainstorm was that hundreds of museum-goers slipped their ideas into a convenient slotted box, with the result that a respectable number of what's-its are now no longer what's-its.

One item became a known "it" when a knowledgeable museum visitor spotted it as a "crab shank shoe laster," used to grip the shank of a

went back to the 1500s when it had been sold at auction as the former property of the wife of Austria's Emperor Rudolph II. When the Brussels collector couldn't establish what it was, he sent it to Professor Derek Price, a noted historian at Yale, and told him he could have it if he identified it. Unable to figure it out, Dr. Price held onto the instrument hoping someone would turn up who might know what the 16th-century antiquity had been used for.

That's when Bedini visited his friend Derek Price, saw the instrument, and offered to identify it if Price would trade it to him for something else.

"Derek's wife wanted to make a lazy Susan out of it," Bedini recalls with horror. He offered his friend an antique French marble clock for it, and Price accepted the deal.

"That huge old clock weighed 200 pounds," Bedini recalls. "We nearly broke our necks slipping and sliding across a wet stone floor in the basement where it was stored."

'Lazy Susan' identified

But Professor Price got his clock, and Bedini rescued a unique what's-it from a lazy Susan future, adding it to his private collection. What's more, he finally identified it as an early geometric instrument used by medieval stonemasons for surveying structures such as polygonal forts. The identification was not made by any sudden inspiration or insight, but through tedious and lengthy library research. It finally was pinned down, on the basis of known construction techniques used by medieval stonemasons. When the instrument was tested against those techniques, the numbers on the surface made some sense at last.

What's-it hints

A curious thing about the what's-its is that many look exactly like something you're sure you've seen before (but haven't). The purpose of some can be guessed in a general way, but that doesn't count at the Smithsonian. The exact work the device performed must be specified before it can be considered identified. A number of educated guesses have been made about most of the items and *seem* to make sense. But without accompanying proof, or convincing personal knowledge to back up the identification, the object remains a what's-it.

Number 7, for instance, could well have been a hair-curler press that

(Please turn to page 156)

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CAN YOU NAME THESE 'WHAT'S-ITS'?

(Continued from page 155)

clamped over the dampened locks of colonial ladies when they retired, as has been proposed. So far, no one has ever seen one before, or been able to prove the hypothesis. A tough one, No. 15, is obviously some sort of homemade game with attached lined slate for tallying scores. The spindle coming through the center of the horn indicates a possible ring-toss type of activity. But how the game was played, or scores kept, no one knows.

'Asparagus buncher'

Someone, according to Bedini, has suggested that No. 3 might be an "asparagus buncher." The tapered wooden cylinder formed by dropping the handle, and the vertical board at the left, for butting asparagus ends evenly, make sense but not positive identification. Number 8 has been proposed as a tool used to force boards close together when laying a floor, but some features, such as the toothed metal on one of the jaws that could mar wooden edges, cast doubts. Number 16 has been called everything from a tool used to chop holes for ice fishermen to a key-handle for throwing street-car track switches.

Number 17, collected with a group of mining tools in the coal region of Pennsylvania, will very likely switch from what's-it to "it," thanks to a recent letter to the museum from Dr. George W. Preckshot, chairman of the Dept. of Chemical Engineering at the University of Missouri.

"I have such a what's-it in my office," wrote Dr. Preckshot (enclosing a dimensioned sketch of a nearly identical device), "... used by my late father to peen scythe blades to razor thinness... The spindle... was placed in a hole in a narrow bench and this anvil was held by the knees at the narrow middle portion to keep it from rotating. The position of the steel wedge at the top was adjusted to give direction and support to the area of the blade being peened. Both hands thus were free to do the peening."

That kind of identification the Smithsonian loves to get, to place a what's-it in its proper niche.

If any of the devices in the pictures on these pages are similar to things you've seen, or know about, send a letter like Dr. Preckshot's to What's-Its, Smithsonian Institution, National Museum of History and Technology, Constitution Ave., Washington, D.C. 20560. Perhaps you can help contribute to the cultural history of our country. **PM**

UNDERHOOD CABLES AND WIRING

(Continued from page 117)

the throttle linkage or exhaust manifold. See that cables criss-cross one another to prevent crossfire.

Crossing up crossfire

Crossfire, which is also called induction leakage, occurs when spark-plug cables are grouped close together and run parallel. Crossfire causes engine roughness, backfiring and detonation. Engine and spark-plug damage may result.

Crossfire refers to a sparkplug firing out of time because of induction. This means that the strong magnetic electrical field that envelops a sparkplug cable will be absorbed by an adjacent sparkplug to fire out of turn. The condition prevails between two *consecutively* firing cylinders.

The best way to avoid crossfire is to make sure that cables criss-cross as they approach sparkplugs so no two physically adjacent cables run parallel. Most automobile manufacturers equip cars with engine-mounted looms that hold cable and help maintain a proper arrangement. If a loom is damaged or lost, replace it.

Suppression vs. nonsuppression

The ignition system of every internal combustion engine radiates a certain amount of RFI (radio frequency interference). In other words, more than 100 million vehicles from east to west and north to south actually do act like radio transmitters.

Unsuppressed, all of this energy floating through the air would interfere with home radios and TV sets, automobile radios, radar-detection units and two-way radios, and even disrupt the operation of electronic garage-door openers.

To offset this, television-radio suppression ignition cable (T.V.-R.S.) was developed in the early 1960s. Essentially, the solid metallic conductor wire—usually copper—that was used was replaced by carbon-impregnated fiber strands such as linen. The newer cable, which has been universally used by automobile manufacturers for about 10 years, is in compliance with Federal Communication Commission standards and controls RFI without having any effect on engine performance.

Another fact that will put to rest the arguments of pro-metallic cable buffs is this: Suppression cable will last every bit as long as copper ca-
(Please turn to page 158)

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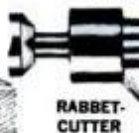
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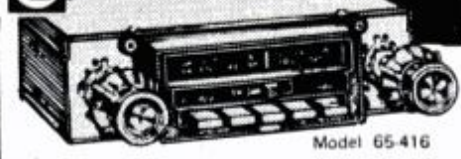
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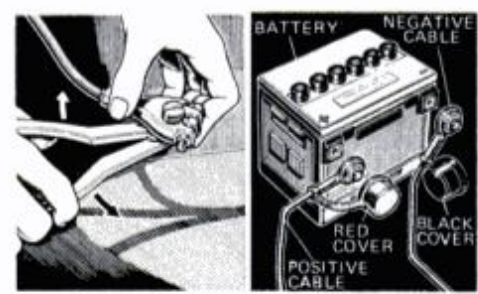
UNDERHOOD CABLES AND WIRING

(Continued from page 157)

ble if you treat it with respect. Fiber-strand cable will be pulled apart if you play tug-of-war when you disconnect them.

Furthermore, never puncture a suppression cable with a sharp tool. For example, when you are timing the ignition, use a magnetic pickup-equipped timing light or connect an adapter between the reference spark-plug and cable and hook your timing light to that.

Don't substitute nonsuppression cable for suppression cable when replacing cables. The ignition of your car may affect nearby radios and TVs. RFI can also foul up your own



Battery terminal spreader (left) is needed to replace terminals easily and without hammering. Side terminal batteries (right) have cables connected as shown.

vehicle's radio reception and CB performance.

Battery cables

What you should know about battery cables can be summarized as follows:

1. The cable parts of battery cables don't cause problems nearly as often as the terminal parts of battery cables, especially at battery posts.

2. The best way to prevent trouble from battery-cable terminals is to service them semiannually to prevent corrosion that interferes with electrical flow. Take cables off the battery posts. Useful tools you should consider purchasing if battery posts are on top of your battery are the following:

- Terminal nut wrench and battery pliers to loosen the terminals' bolts and nuts. Hold the bolt stationary with the wrench and turn the nut with the pliers. Always remove the negative cable first and connect it last, because the path to ground is broken and thus the shock hazard is reduced.

- A terminal puller whose jaws engage the bottom of the terminal so when the tool's screw is tightened, the terminal is drawn evenly off the battery post.

Caution: Don't bang on the termi-

nal with a hammer to loosen it, and don't try prying it off with a screwdriver. That's an excellent way to ruin the battery.

- A battery cleaning tool to polish terminals and posts. Wash terminals and battery posts with a baking soda solution. Then polish the insides of the terminals with the terminal brush end of the battery cleaning tool. Use the battery post brush end of the cleaning tool to polish posts.

- A terminal spreader to facilitate putting terminals back on posts. Do not bang the terminals into place with a hammer. You may ruin the battery.

With terminals on battery posts, tighten them securely and spread a light coat of petroleum jelly over them to help retard corrosion.

Wrong torquing

3. The biggest problem that has been encountered with side battery terminals has been improper torquing, which causes high resistance and hard starting. To service side terminals properly, do the following:

- Unscrew the negative battery cable.
- Clean the threads and end of the cable screw thoroughly with a wire brush.

- If necessary, clean the internal threads in the battery case. Use a small wire brush or a 3/8-16 bottoming tap. If you use a bottoming tap, do not tighten it beyond 70-inch-pounds.

- Service the positive cable next.
- Install the positive cable and tighten it to 70-inch-pounds. Then install the negative cable.

4. You should replace a battery cable when insulation wears or cracks, or wires become exposed around terminals. Note the size of the cable you are buying to make sure it's the same size as the old cable.

Battery cables must be sized properly so they are able to carry the extremely heavy starting current with a minimum loss of voltage. Cranking speed depends on the voltage made available to the starting motor by current carried by cables.

Primary ignition wiring

The only point to remember is to inspect wiring when you do an engine tuneup. Make sure insulation isn't disturbed and that connections are clean and tight at the coil and distributor. When replacing the distributor cap, make sure you don't pinch the primary wire. **PM**

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teacher. (Mazda will probably offer a larger engine later this year.)

A Wisconsin machinist would like "Better interior lighting and a lamp that comes on when you open the hatch."

Most owners, though, want to leave the GLC just the way it is. A Wisconsin real-estate broker says,

"All the family loves it. I chose it over Honda, Toyota, Datsun, etc.—shopped all over, saw the GLC first, shopped again and still picked it."

A final word from a Michigan college student: "I think many Americans feel they don't want to give up the luxury of big cars. If they only knew that not all small cars are

'cardboard boxes on wheels.' For the money, you can't beat the GLC. I only hope more people will drive smaller cars like my Mazda, because I'm sure it would convince them. Imagine going from Michigan to Florida on \$20 worth of gas! I did it in my Great Little Car, and you can't knock that!" **PM**

SUMMARY OF 1977 MAZDA GLC OWNERS REPORTS*

Total miles driven 1,291,436	Interior roominess 16.2	Comfort opinion (front seat):	Dealer repairs satisfactory?
Average miles per gallon	Specific likes:	Excellent 41.0%	Yes 63.1%
Five-speed manual	Economy 58.2%	Very good 46.0%	No 36.9%
In town (EPA 35) 28.4	Handling 45.5	Good 11.0	Dealer service opinion:
Long trips (EPA 46) 34.6	Styling 24.7	Fair 2.0	Excellent 22.2%
Four-speed manual	Comfort 23.6	Poor 0.0	Good 40.5
In town (EPA 34) 27.8	Roominess 21.6	Comfort opinion (rear seat):	Average 21.8
Long trips (EPA 43) 33.5	Specific dislikes:	Excellent 22.3%	Fair 8.2
Three-speed automatic	Lack of horsepower 19.8%	Very good 45.0	Poor 7.4
In town (EPA 30) 24.3	Gas mileage lower than EPA 17.7	Good 24.5	Number of vehicles owned:
Long trips (EPA 36) 29.3	Hard starts when cold 12.4	Fair 7.4	Mazda GLC only 44.1%
Transmission choices:	Rattles 7.1	Poor 0.7	Two cars 41.1
Five-speed manual 51.2%	What changes would you like?	Had any mechanical trouble?	Three cars 12.0
Four-speed manual 27.8	More power, bigger engine 16.3%	No 69.91%	Four or more cars 2.6
Three-speed automatic 21.0	Better gas mileage 7.2	Yes 30.1	Makes of other cars owned:
Model choices:	Automatic choke 4.7	What type of trouble?	Chevrolet 17.4%
Three-door hatchback 96.9%	Better tires 4.3	Airconditioning 15.7%	Ford 15.0
GLC Sport 1.7	Workmanship opinion:	Choke 14.6	Oldsmobile 9.0
Five-door hatchback 1.4	Excellent 44.1%	Dimmer switch 10.1	Age distribution of owners:
Why did you choose the Mazda GLC?	Good 45.5	Carburetor 6.7	15-29 years 50.5%
Economy 65.0%	Average 7.0	Did you repair it yourself?	30-49 years 34.5
Price 31.6	Fair 2.3	No 89.8%	50-plus 14.9
Styling 29.6	Poor 1.0	Yes 10.2	Would you buy another Mazda GLC?
Size 18.9			Yes 76.4%
			No 23.6

*Percentages might not equal 100% due to rounding or insufficient data. All 1977 GLC's were three-door models; the five-door is new for 1978.

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BACKWARD AIRCONDITIONING

(Continued from page 128)

ing. Also worth considering are add-on heat-pump systems if the house is currently heated with oil. These use the heat pump during mild weather, activating the oil furnace only when outdoor temperatures drop below a predetermined level.

■ *Major central-airconditioning repairs or replacement of compressor necessary.* The cost of major air-conditioning repairs may help to justify the cost of a new heat pump. The key factor in the decision must be potential savings in heating costs. Here again, at today's prices, savings will be greatest in homes now using electric resistance heating.

Heat pumps are relatively costly pieces of equipment which offer substantial operating efficiencies. Unfortunately, they use electricity, which in many areas is much more expensive than other forms of energy such as natural gas. While time will erode these artificial price differences (which result primarily from government regulation), the fact remains that until gas prices do rise considerably, gas-to-heat-pump conversion cannot usually be justified.

On the horizon

Heat pumps have come a long way in the past decade, but the potential for still better efficiency and performance in the "third generation" is staggering. Research now underway could radically change the entire heating and cooling picture. Noteworthy projects include:

Variable-capacity heat pump: With a compressor that can change its effective size, a unit sized correctly for cooling could grow to supply heat in winter with little or no supplementary heat. The increase in SPF would be large.

Heating-only heat pump: A unit designed just for heating could cost less than current models with air-conditioning capability. Such heat pumps could become popular in areas where airconditioning is not customarily needed.

Solar-assisted heat pump: Many possibilities exist here; all center on the basic idea of using solar energy to increase heat-pump efficiency. Putting the outdoor coil in the attic is one way to do this, and a test in Lincoln, Neb., of a modified Carrier heat pump has yielded excellent preliminary results.

Hot water with heat pumps: In summer, heat that would otherwise be wasted could be used to produce domestic hot water. Hardware to do this is now under test. **PM**

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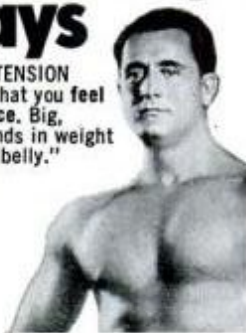
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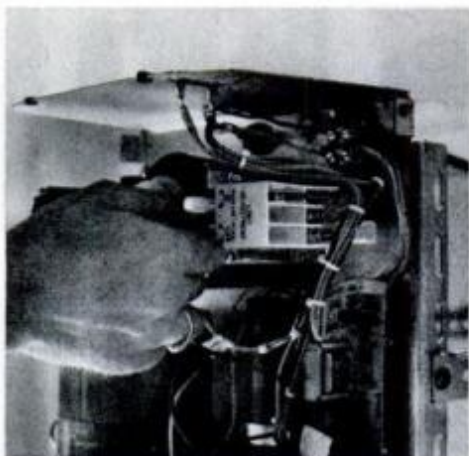
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GARAGE-DOOR OPENER

(Continued from page 131)



15 To set your own code on the receiver, loosen (but do not remove) the four screws holding the cover on the base and slide the cover off. Locate the radio receiver and use a pen or pencil to press any combination of switches. Do not put all the switches in the same position and do not leave them in the as-purchased positions. Record the combination and replace the cover on the receiver.



16 To set your code on the transmitter, remove the screws and transmitter cover, and locate switches. Use a pen or pencil to position the switches exactly as in the receiver. If the switch positions do not match, the transmitter will not operate the door. Now you're ready to test operation of the complete system.

just press the button on your transmitter and the unit opens the door, turns on self-contained lights and, after another touch on the button, smoothly closes the door.

The new Deluxe U-Install unit, Model 3000, has a 1/3-hp motor and dual courtesy lights with two-minute delay.

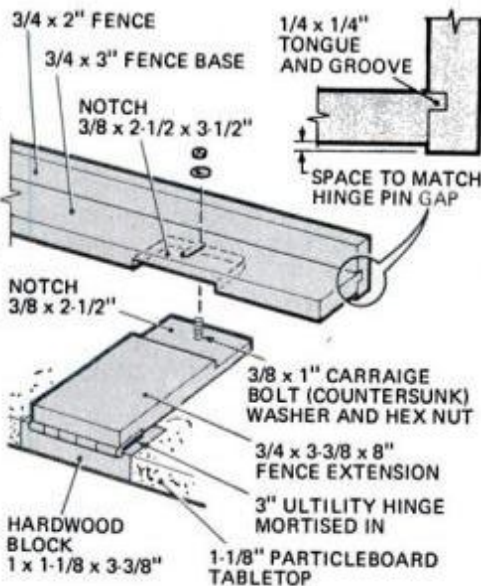
Installation took three hours. It required only a drill and twist bits, hammer, screwdriver, adjustable wrench, socket wrenches and a short length of 2x4. Everything else was in the package, including step-by-step instructions.

For more information, write to Stanley Vemco, 31623 Stephenson Hwy., Madison, Mich. 48071. **PM**

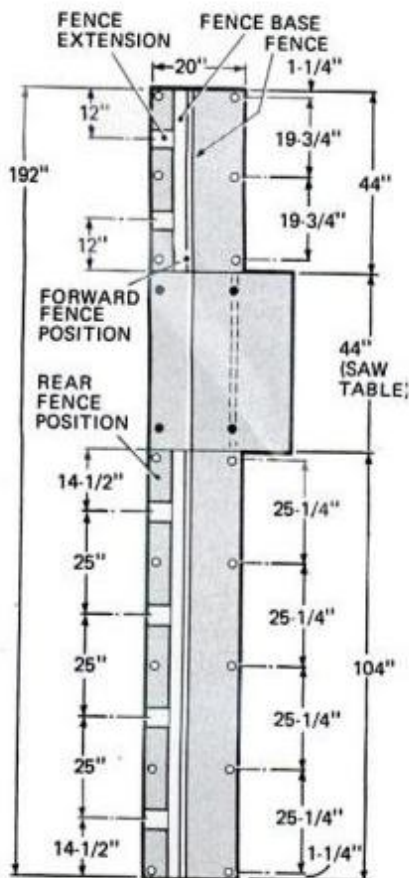
BUILD THIS RADIAL-SAW BENCH

(Continued from page 133)

other model. The critical changes depend on the saw-base dimensions and adjustment-crank positions. Saw-base ledgers and the saw-base notch in the rear rail would be most likely to need modification. **PM**



FENCE EXTENSION DETAIL



- EXTENSION LIFTS MOUNTED IN RAILS
 - SAW LIFTS MOUNTED THROUGH LEDGERS
- SURFACE PLAN**

Arrange saw lifts at corners of your saw base to suit, and extension lifts according to plan above. Saw 16 2½-in. lengths of ¼-in. threaded rod for latter—it costs less than sawing off bolt heads.

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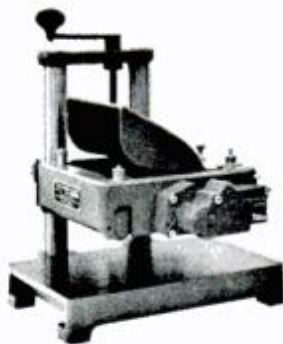
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BUILD THIS SHOCK DETECTOR FOR YOUR HOME AND CAR

(Continued from page 121)

most transistors and semiconductor diodes.

I built the prototype circuit on a PC board and fitted everything into a small minibox, but a perfboard version in a slightly larger box would be easy to make and would, of course, work just as well.

Assuming you're going the PC-board-and-minibox route, here are a few construction pointers:

Use only a good rosin-core solder and be careful not to make solder bridges between copper strips that are not connected. Use heat sinks when soldering transistors and LED.

Components mount on the unplated side of the board, but leads to the switches, LED, speaker and battery should be soldered to the plated side—or the board may not fit inside the box. Tin stranded hookup wire before soldering.

Connection points of toggle switches of the type used in the prototype can be confusing. The diagram on page 121 is for connections as seen looking into the box and toward the jack—they'll give you the correct switch positions.

Cover LED, switch and jack connections with electrical tape to prevent contact with the speaker.

The other functions

Battery tests: On "shocks" and "high," 1½ v.d.c. will trigger the tester, so it's a quick dry-cell checker. On "shocks" and "low," any 9-v. battery that can't reach the tester's 6-v. threshold is really shot. In each case, the red probe goes to the battery's positive side.

Auto ground: An imperfect ground can reverse turn signals, or make the radio play only when the brake pedal is held down. Use "shocks"/"high" to find small voltage drops that shouldn't be there. Often cleaning a dirty ground connection is all it takes to solve a problem.

Sometimes you'll run into an auto wire that needs testing, either for ground or for full voltage (use "shocks"/"low"), but there's no un-insulated spot to touch the probe to. Take a thin sewing needle and pierce the insulation to make an opening for the probe point. The tiny hole does no harm and can't even be seen afterward—but this trick is for *low-voltage car wiring only*. The red probe is positive for these auto-wiring checks.

Continuity tests: Use "ohms" and either "low" or "high." When testing most electrical circuits, probe polarity can be ignored.

Components testing: The tester

doesn't give numerical readouts, but it will tell you when components of many kinds have failed completely. Resistors, for example, usually fail in the "open" mode, so you can use "ohms"/"high" to check them for continuity up to values of about 1 megohm.

Capacitors behave as open circuits to d.c. voltages, so they should all read open on the tester, using the "ohms" mode again. Large-value capacitors (over .01 mfd.) may light the tester *briefly*. Be sure you observe the marked polarity of electrolytic capacitors; in this mode, the black probe is positive.

Diodes are easy to check. Use "ohms"/"low" for germanium, "ohms"/"high" for silicon. The diode should trigger the tester when probes are applied to its leads in one direction and not in the other. A diode is bad if the tester lights both ways, or doesn't light either way. A transistor can be checked by treating it as a pair of diodes (see *Yes, You Can Test Your Own Transistors*, page 39, March '77).

Functions for fun

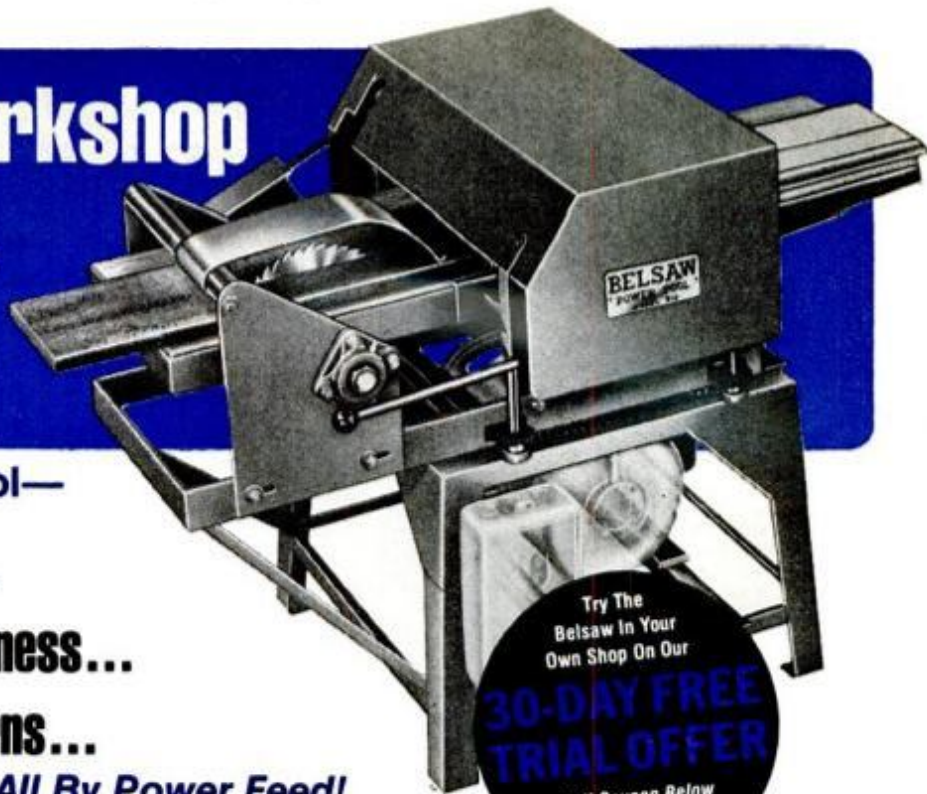
The resistance range that is tested on "ohms"/"high" is roughly the same as that of human skin resistance. Lie detectors base their results partly on skin resistance, so your tester is also a very simple lie detector. Holding the probe tips can produce a tone, depending on the person and his or her emotional state. You may sometimes even get a response this way on "ohms"/"low."

Finally, you can make your tester work as a primitive electronic organ. You'll need a large-value variable resistance—which you can make by drawing it. Draw a narrow but heavy pencil line several inches long on paper—soft lead in a fine-point, sliding-sleeve pencil works best. (The shape of the line is, of course, irrelevant, as long as it doesn't cross itself.)

Now set your tester on "ohms"/"high" and hold one probe point on one end of the line while you touch different parts of the line with the other probe point. As the resistance of the segment of line you're using approaches the maximum to which the tester can respond, you should hear the tone descend in pitch before it falls off completely.

You should be able to get a range of a couple of octaves. You can mark a do-re-mi scale or even tune your pencil line with a piano and play recognizable melodies. **PM**

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POWER COMPANY ROBOTS

(Continued from page 115)

out to all transponders on the network, telling them to close the shut-off switches. Shutdowns will happen during periods when demand for electricity is highest. In summer, that's usually between 10:00 a.m. and 3:00 p.m. They'll also shut down during other periods of high demand, and in emergencies affecting the utility's generating capacity.



Wisconsin transponders are in box below customer's meter. Water-heater remote switch is located beside electric meter.



Desktop control center for Honeywell's energy management (and/or fire-security) system programs power-use needs.

How are the people of Belgium and Cedar Grove reacting to a "Big Brother" phenomenon inside their homes? Cooperatively, for the most part, according to utility officials. Among homeowners contacted, the company boasts a 90-percent acceptance of the idea. Some people who were not on the original list called and asked to be included. One housewife's comment reflected the general attitude: It was, she said, "a good thing to try . . . to accomplish a good purpose." The installation has given her "no problems," she insists.

During the test, participating customers receive a modest rebate on energy saved. But the real mu-

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tual benefit, according to the utility, is the "realization of load management to eliminate some demand during peak hours, perhaps deferring the need for new generating capacity"—a cost that would have to be passed along to consumers.

Could save 120 megawatts

Already program results are being evaluated. If the test proves successful, utility officials say the program could be offered to all of its 173,000 water-heating customers, with an anticipated acceptance of "up to 75 percent." If that happens, the company's senior vice president, N. A. Ricci, predicts a drop in peak demand of 120 megawatts.

More significant, perhaps, is the utility's observation that "the program later could be expanded to include control of additional loads such as residential and commercial air-conditioning" and the like. Further bonuses, they point out, would include the "ability to automatically control some voltage management equipment by computer . . . to read customers' meters remotely and measure load demand at any given moment from the control center."

Many other residential power demand monitoring programs by computer are almost underway. In California, the San Diego Gas and Electric Co. is in the process of "communicating" with water heaters, central airconditioning units, electric space heaters and swimming-pool pumps and heaters in some 750 homes in a large suburban development of that city. Meters will be read remotely and transponders will send in data for analysis and production of power consumption curves on all the items mentioned, according to Lewis McDonald, the company's load management project director. Remote computer control of those units would be a logical "next step" to achieve load-leveling effects and their rewards.

Leveling out power demands

In most load-management programs to date, cost saving is the carrot held out to customers by the utilities concerned. Energy "conservation" would seem to be implicit, but it isn't, necessarily. While load-shedding does lessen the need for a utility to carry huge, often unused, power reserves, it doesn't mean it would stop producing that power. That power could be released for sale elsewhere. Utilities are in a profit-making position.

One interesting residential monitoring program that is aimed at energy conservation in the home in-

(Please turn to page 168)

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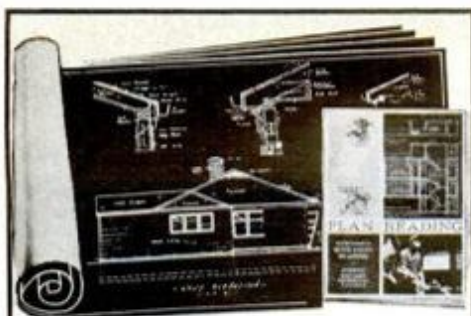
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POWER COMPANY ROBOTS

(Continued from page 167)

volves some 200 fourth, fifth and sixth-grade youngsters at the elementary school in Laguna Beach, Calif. It all started when Mike Carroll, the school's principal, got talking with ESCO's John Phillips (who has a child in the school) about energy monitoring. Out of that meeting a unique project was launched and is now in full swing. Transponders attached to meters in the Orange County homes of children and parents voluntarily participating are monitoring a complete demand profile for gas, electric and water consumption in each dwelling—telling where, how much and at what times of the day these commodities are being consumed.

Information is telemetered to ESCO's computer center in Newport Beach for analysis and relay to computer terminals at the school.

Kids learn about own homes

"It's great," says Phillips, with a satisfied grin. "When a kid walks in on Thursday morning, he sits at a computer monitor, types in the proper code and pulls out the operating profile of his own home the day before. That night he'll take it home and compare it with the read-out from the previous day, to see if his energy conservation measures made a difference—and where.

"He can query the computer and see—projected on the screen—how much energy, for instance, his mother's washing machine used on the family laundry. The computer will tell him whether it might have been better to space the loads out or do them all at a different time to conserve energy. And you can be sure mom will hear about it.

"It's exciting. Those kids eat up that computer technology—and so do the parents, who are fascinated by the whole idea and are helping the kids make their conservation efforts look good.

"Think of it: We will generate from this system operating profiles of every one of those homes. Most utilities have never seen a complete operating profile on a home in their whole life . . ."

ESCO helped the faculty set up a complete energy conservation curriculum at the school and hired a special instructor who's on loan to the school as a consultant. The program involves regular classwork and field trips to utility companies so that, as school principal Carroll points out, "the kids get to see and touch what's happening out there in the field of energy."

As Phillips sees it, "Instead of just telling kids it's a good idea not to waste energy, they tackle the problem directly and learn what they can do. What's more, it's the first time a teacher has been able to measure his teaching impact with precision. It's a closed loop between home activity and classroom."

Private companies pay the bill

Another interesting thing: The project is financed—computer and all—by the private sector, not local taxpayers. The Southern California Edison Co. and another large company in the area, Fluor Corp., started this with \$50,000 last spring.

Just as unique in its own way is ESCO's, ERDA's and John Phillips' central-city project in Los Angeles. The plan, developed by Phillips and the city's Department of Water and Power—which had earlier sounded an alarm over a runaway demand situation—is based on ESCO's central computer in Newport Beach. Here, the energy requirements of all buildings in the project are monitored. These include Occidental Life's four-building complex dominated by a 32-story high rise; a 15-story tower housing the Department of Water and Power; United California Bank's 62-story skyscraper; Southern California Gas Co. four-building home base, and the May Co. nine-story department store. It encompasses 5 million square feet of floor space—an impressive chunk of downtown Los Angeles.

Since most midtown buildings open and close about the same time, their energy demands "gang up," as Phillips says. "That's what causes demand peaks that must be spread out or suppressed," he explains. "Just lopping them off saves nothing; you move them elsewhere when you do that."

Balancing loads

As data feed into Newport Beach via leased phone lines from each building, the central computer analyzes each requirement in relation to all the others, and continuously balances the loads to affect energy savings and reduce the "ganged-up" peak demands.

"It's a real cooperative venture," says Phillips. "What we do is measure all the demands and spread them out. Occidental may get a message to start up their chillers in certain time frames, and United California Bank will get a message from the computer to start theirs in other time slots, so there's no concentration of demand at critical hours. The building operators often are asked

(Please turn to page 170)

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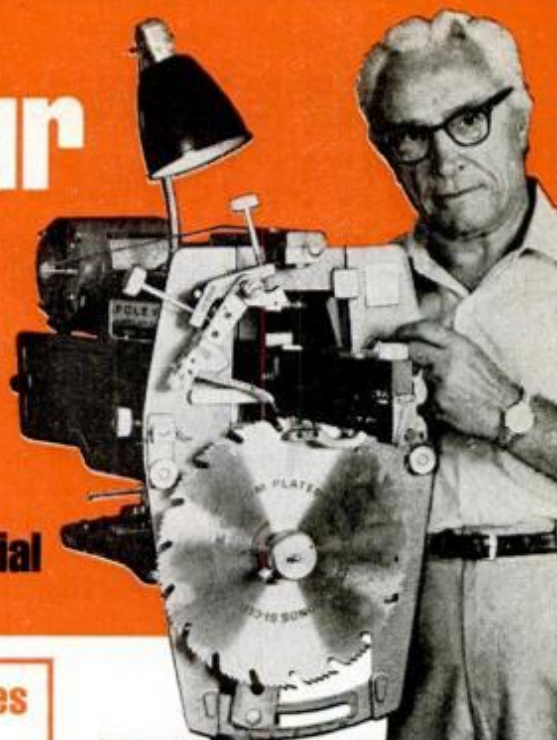
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POWER COMPANY ROBOTS

(Continued from page 168)

to dump certain nonpriority equipment so that some other guy on the network, who's in trouble, can raise his demand without causing a bulge in the overall city profile."

To see how this works, all you need do is stand behind a building operator at his monitor and watch the system in action.

Computer talk

In the basement of the Occidental Building, the computer terminal blinks and buzzes. John, the operator there, watches the green fluorescent words spill across the screen from the Newport Beach computer:

"? Please input chilling water supply and return temp."

John gets readings from nearby instruments and pecks out: "48° and 54°"

Back comes the computer: "? input max running amps."

John fires back, "235 amps."

Then the computer asks: "? input number amps running."

That turns out to be 128, which is fed in.

Minutes go by, then the computer comes back: "? how many chilling pumps on line."

"Two."

Now there's a long pause. Finally, the computer, having made its power reduction decision, returns: "Please stop tower fan S-18 for 15 minutes."

John does this. Fifteen minutes later the computer terminal alert sounds off again: "Restart S-18. Thanks. May Co. is off the hook."

"What it all amounts to," says Phillips, "is a constant trade-off between buildings. At different times different people pick up other people's load-leveling responsibilities to suppress the overall demand from peaking out. We simply provide the tool."

It hasn't been a breeze. Besides the original technical problem of interfacing vast quantities of statistical data with human communication at the building terminals (which developed a brand-new kind of micro-processor), there have been formidable people problems. Building managers and operators don't always take kindly to a computer 1000 miles away telling them how to run their business, Phillips explains.

What's going on at 6:00 a.m.?

In one of the network buildings, the computer turned up a spectacular demand "spike" at 6:00 a.m., in an otherwise normal profile.

"I got on the phone to the oper-



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ating engineer," Phillips recalls, "and asked him 'how come?' He didn't know—and didn't want to find out. 'We don't do anything here at 6:00 a.m.," he said. I told him that the spike was a 5:1 ratio—nothing little. He wouldn't budge. I had to go to his boss, the building manager, who was no less indifferent and suggested my equipment was out of whack. I told him it didn't show any such aberration in the other buildings, but he was still stubborn."

After several days of cajoling and coaxing by Phillips, the manager did check and call back. "I'm embarrassed," he said. "I found out that at 6:00 a.m. the fry cook comes into the all-electric kitchen, hits the circuit breaker and turns on everything in the damn place whether it will be used or not. Guy's been doing it for years. Please play it down. I got to take care of this."

"Whoever thought a fry cook would have anything to do with energy conservation or load-leveling in a major city?" asks Phillips. "Our system picked it up at the start of the program, but it made that building manager resentful. It gave him problems he didn't need. And it took a long time to get him friendly again. The whole program depends on everyone's cooperation, so we have to tread lightly and try not to act 'smart'."

Not everything comes out as well as the fry-cook episode. Phillips has had to put a clinical psychologist on the staff to provide advice on people-handling. "He tells me to let these guys use me for a punching bag," Phillips grins. "So, I'm a punching bag."

Despite problems, bright future

Despite the problems, Phillips does not hesitate to predict a brilliant future for ESCO programs. "There are 65 major high-density areas," he points out. "The buildings in each are dependent on each other. They'll have to work together to achieve efficient operation. Our projection on a national base is that about \$150 billion worth of capital cost in new utilities will not need to be built between now and the year 2020, if this program is implemented in those 65 major cities. That's 100,000 megawatts of power that can be saved.

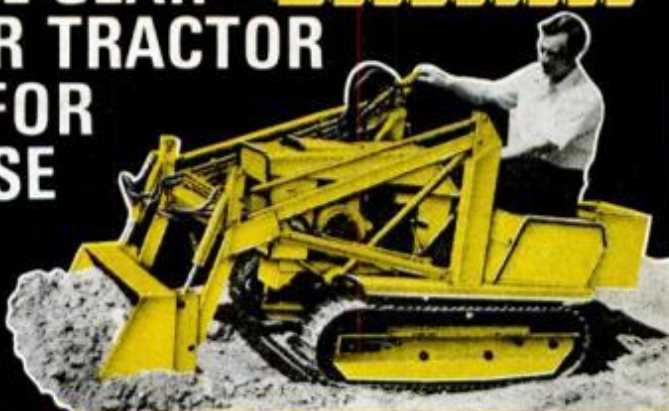
"And it's not just fuel savings we're looking at. It's an extension of the useful life of existing utility plants by 10 to 20 percent. It's just a better utilization of what we've got—not a whole new energy source.

"And it's not 'big brother,'" he emphasizes, "It's an information center!"

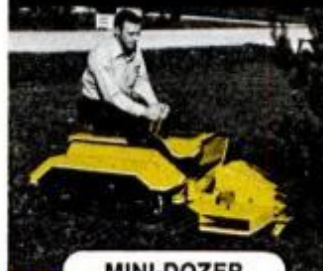
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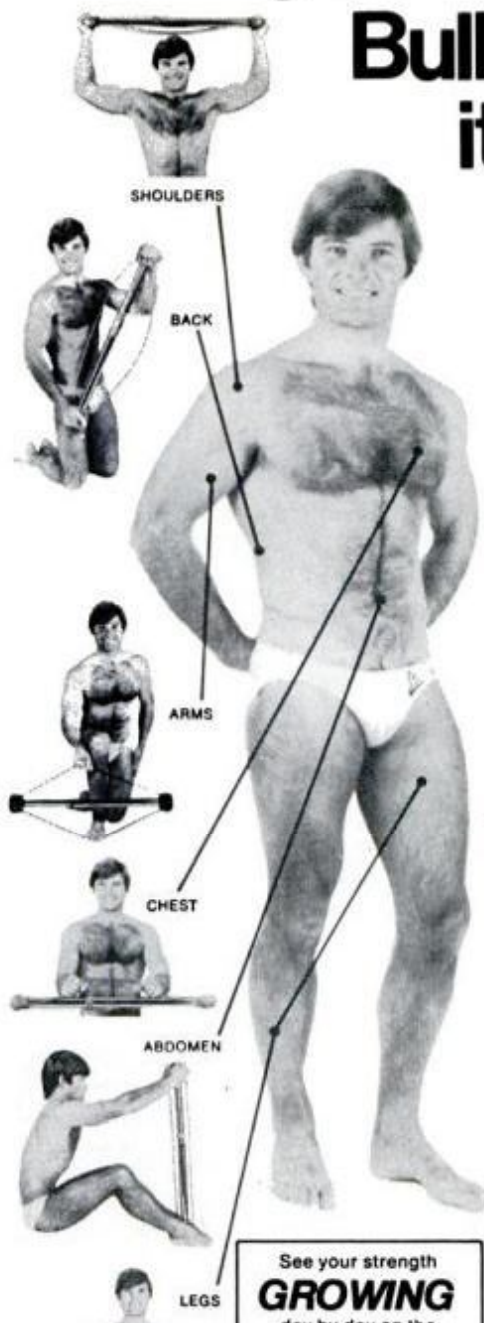
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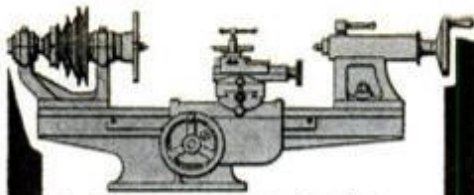
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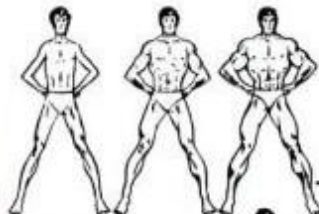
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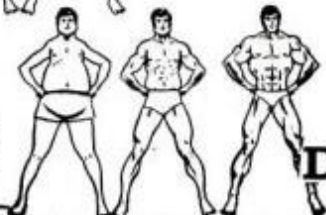
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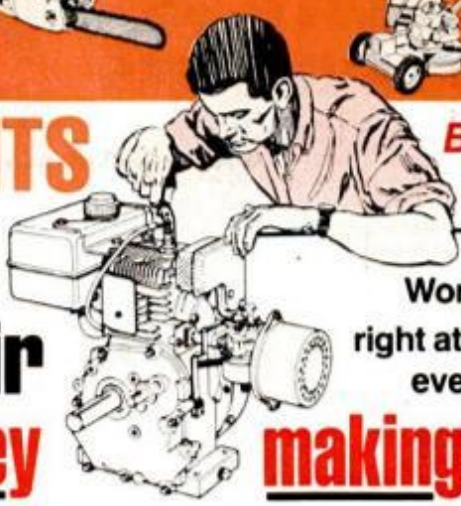
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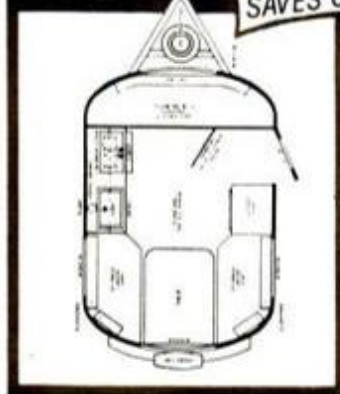
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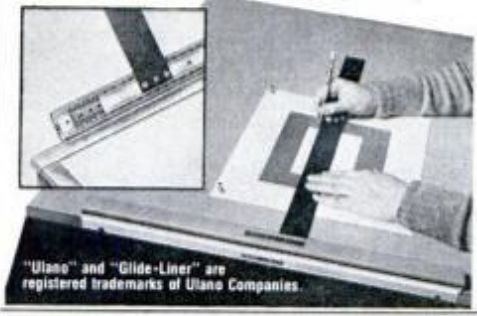
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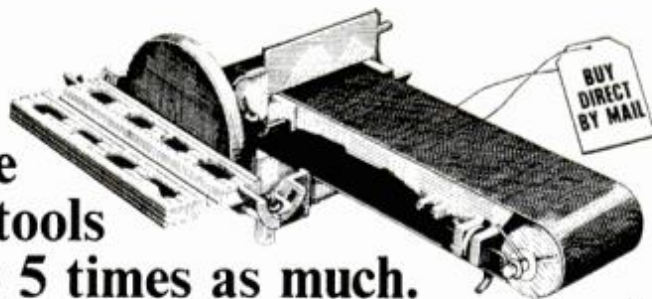
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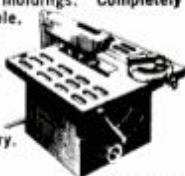
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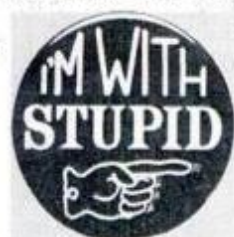
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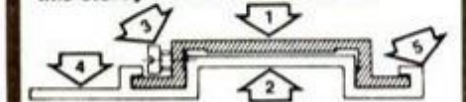
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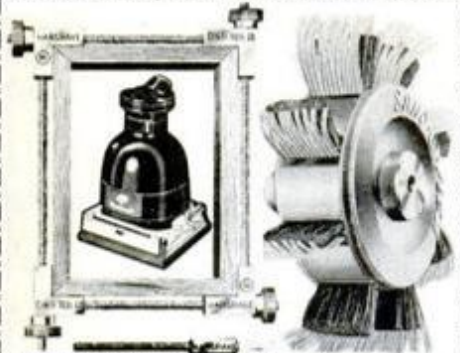
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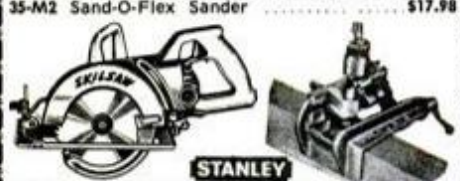


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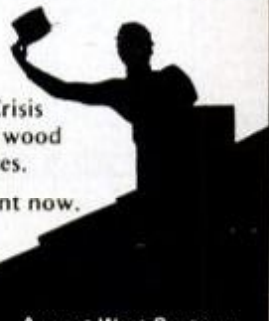
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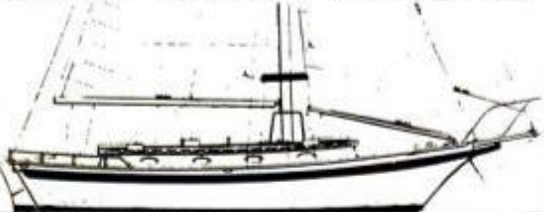
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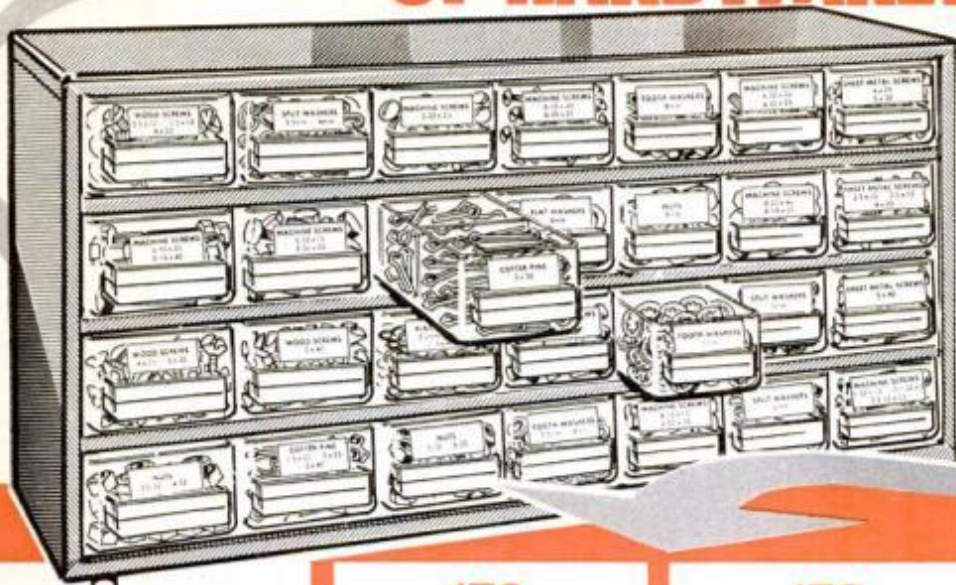
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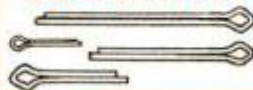
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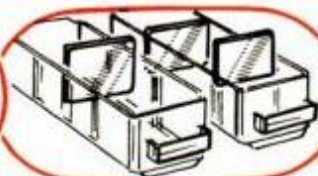
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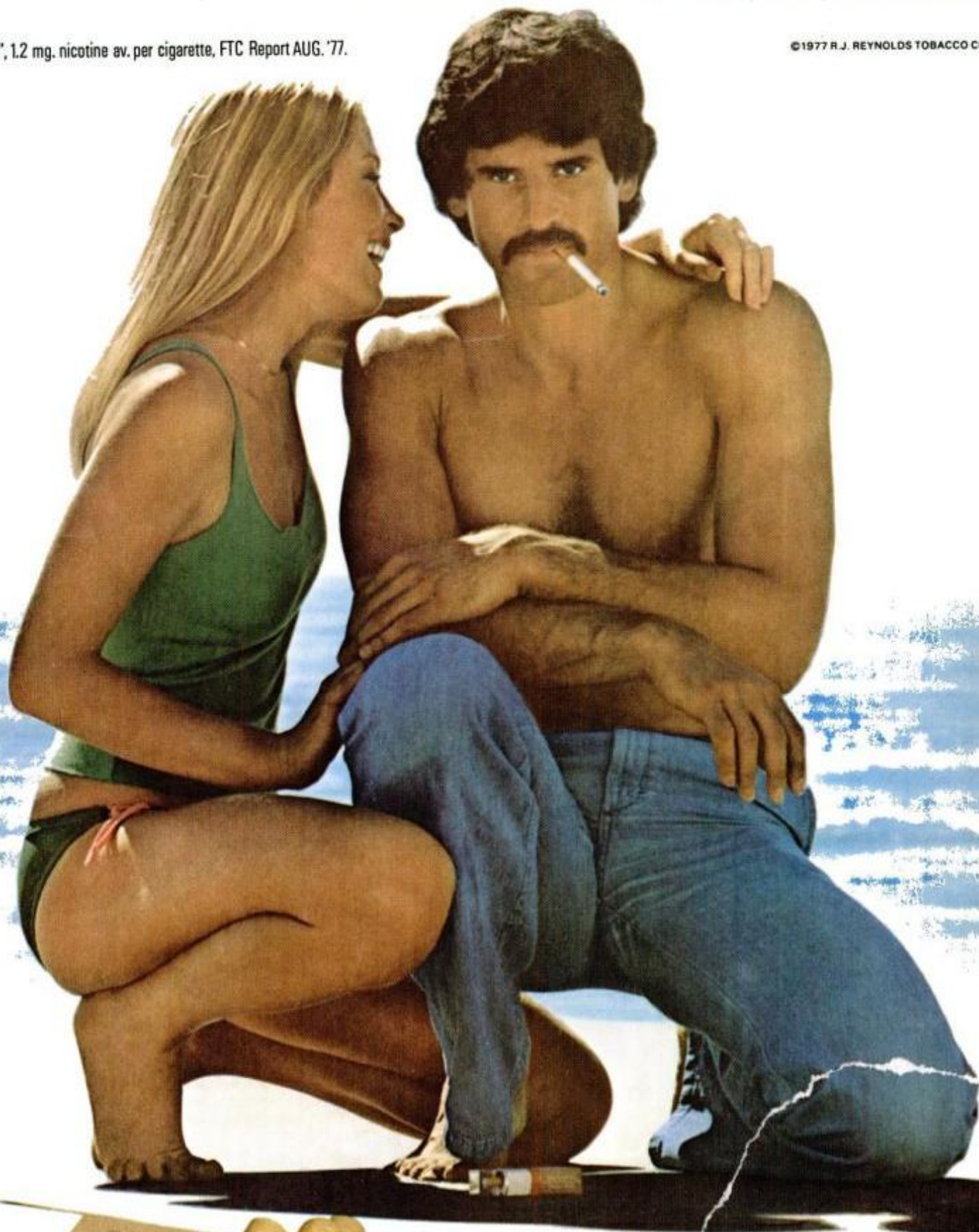
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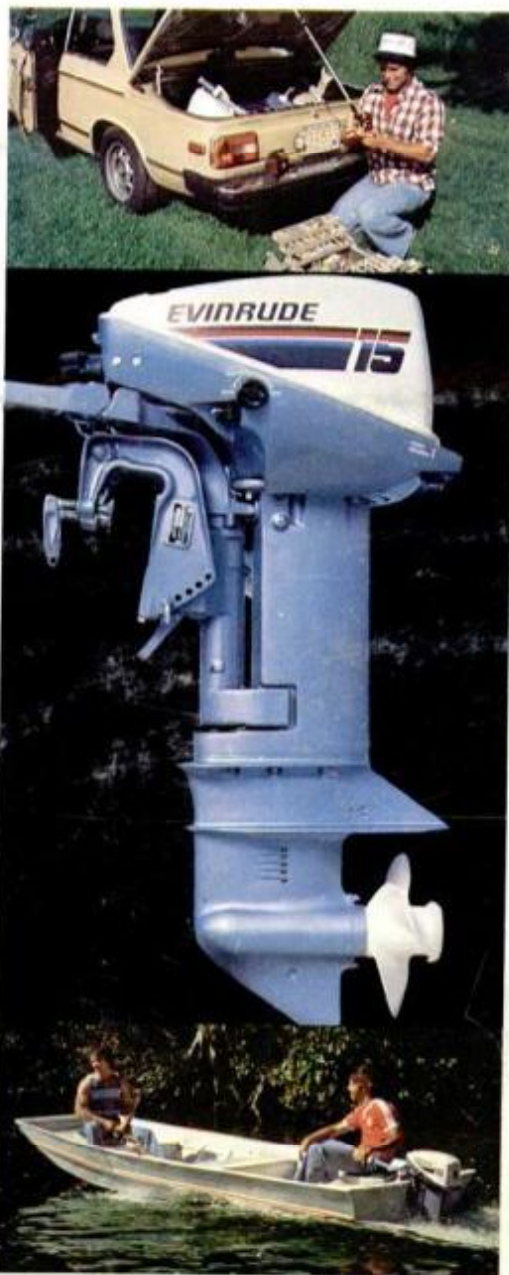
THE MOTOR IN YOUR TRUNK MAY BE MORE SOPHISTICATED THAN THE ONE UNDER YOUR HOOD.

It produces substantially more power per cubic inch of displacement and per lb. of engine weight.

It has fewer moving parts, and some of the parts that aren't there are the ones that can cause the most problems.

Its second generation electronic ignition operates without breaker points or wearing mechanical parts. And it's designed to stay in factory firing tune without the need for periodic adjustment.

The alternator generates current without belts, pulleys, or wearing mechanical parts. Patented pressure-back piston rings seal with combustion pressure instead of spring tension. The motor is lubricated without an oil sump to check or drain, or worry about when you lay the motor on its side.



The engine block is precision die cast of aluminum, with cast-in cylinder sleeves; to give you a motor with the light weight of aluminum and the durability of iron. And it's designed to operate in a salt water environment that would be big trouble for your car.

Why are we telling you all these things?

Because, if you're a fisherman, or a skier, or a boater — or are thinking of becoming one — and you haven't seen or run a new Evinrude motor lately, you could have some mighty pleasant surprises in store.

They're waiting for you now, at your Evinrude dealer.



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