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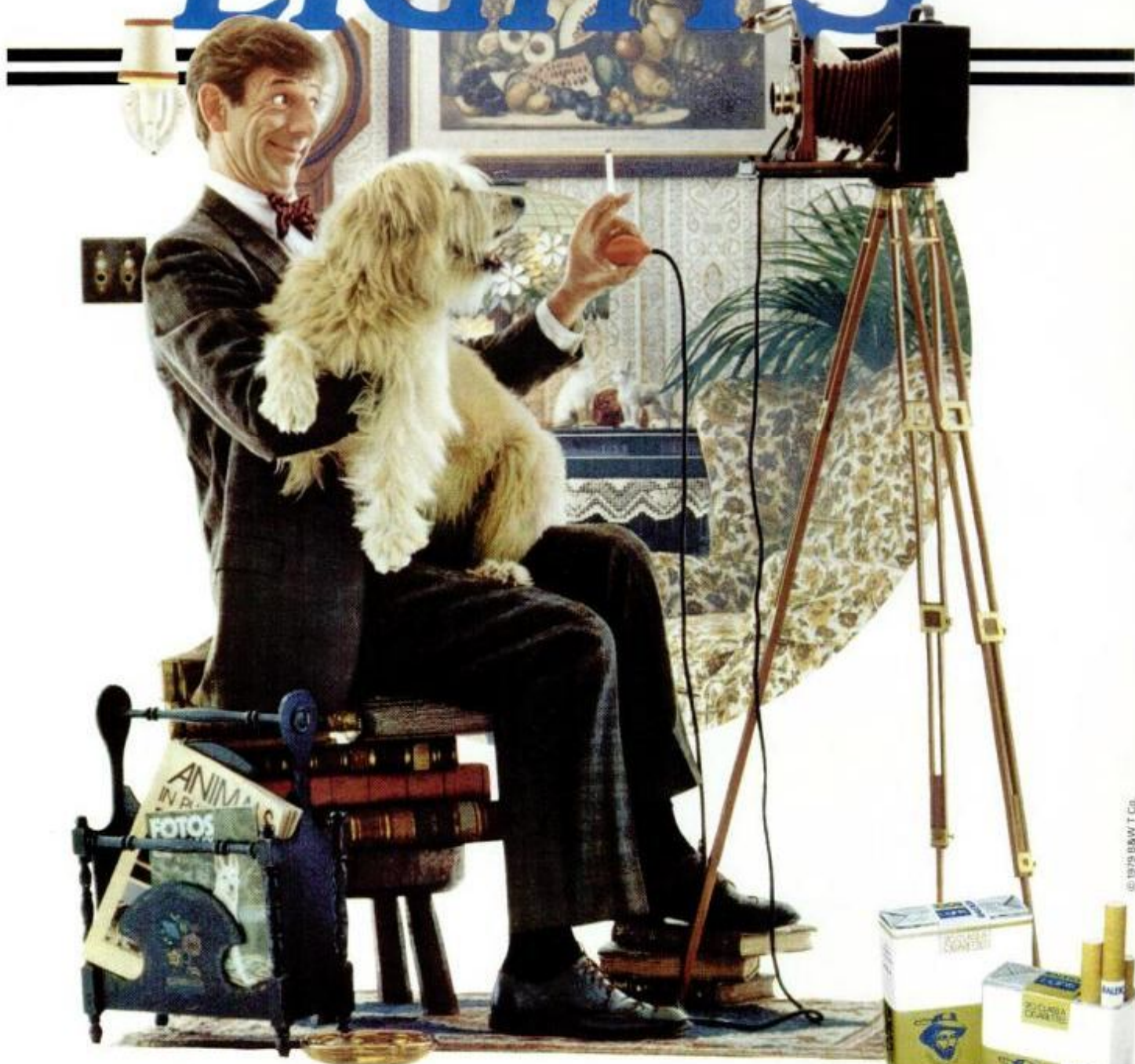
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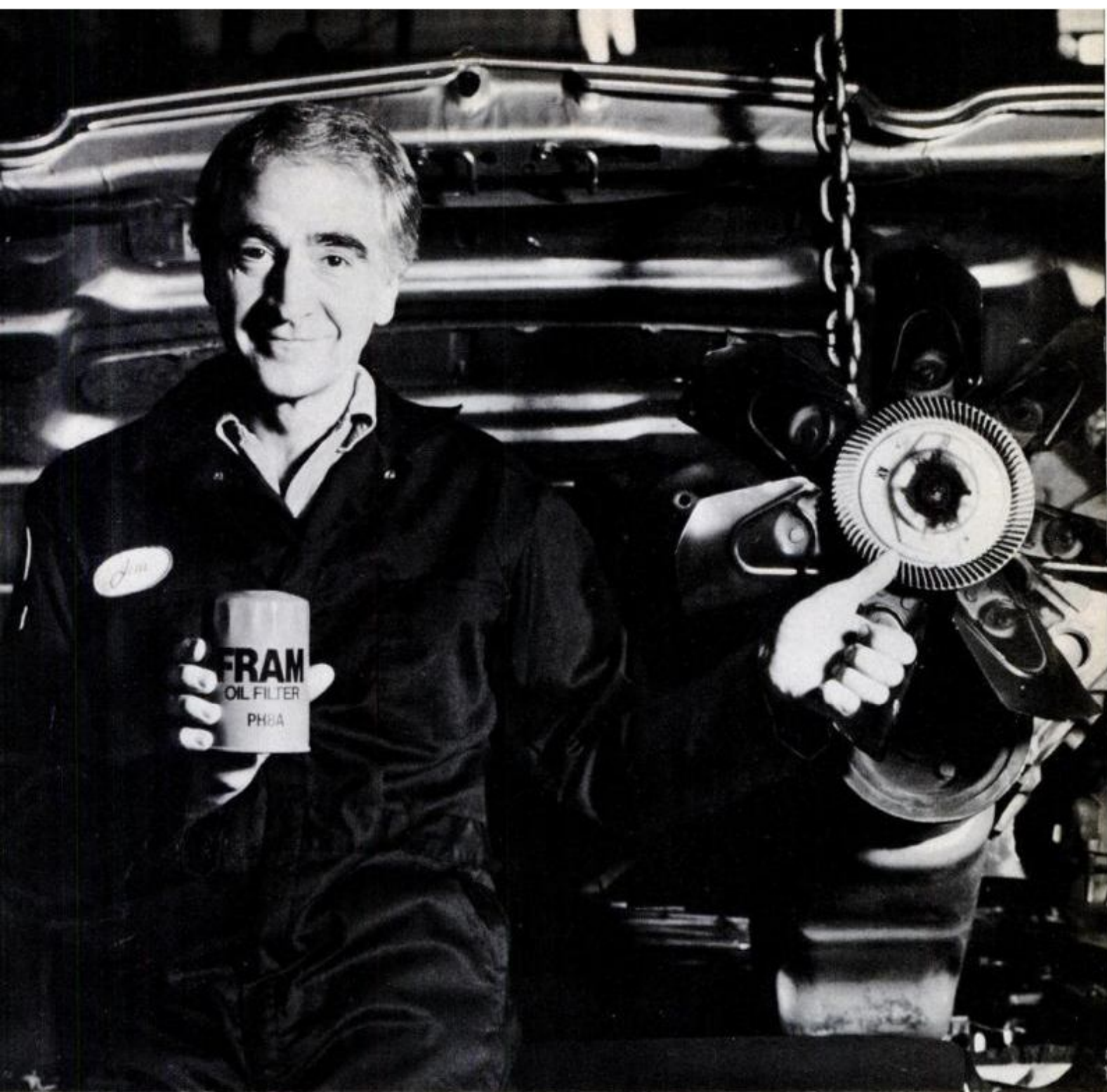
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EVEN A BRIDGE SEEMS TO BE
HEADING HOME FOR RED.

JOHNNIE WALKER RED
THE RIGHT SCOTCH WHEN ALL IS SAID AND DONE





On the cover

We've "exploded" the new AMC Eagle to show you the essential elements of the power train as well as the body styling of the first full-time four-wheel-drive sedan to be offered to American buyers. Beginning on page 92, read all about its revolutionary new design.
—PM photo by Harold Karpinski

Popular Mechanics®

SEPTEMBER 1979

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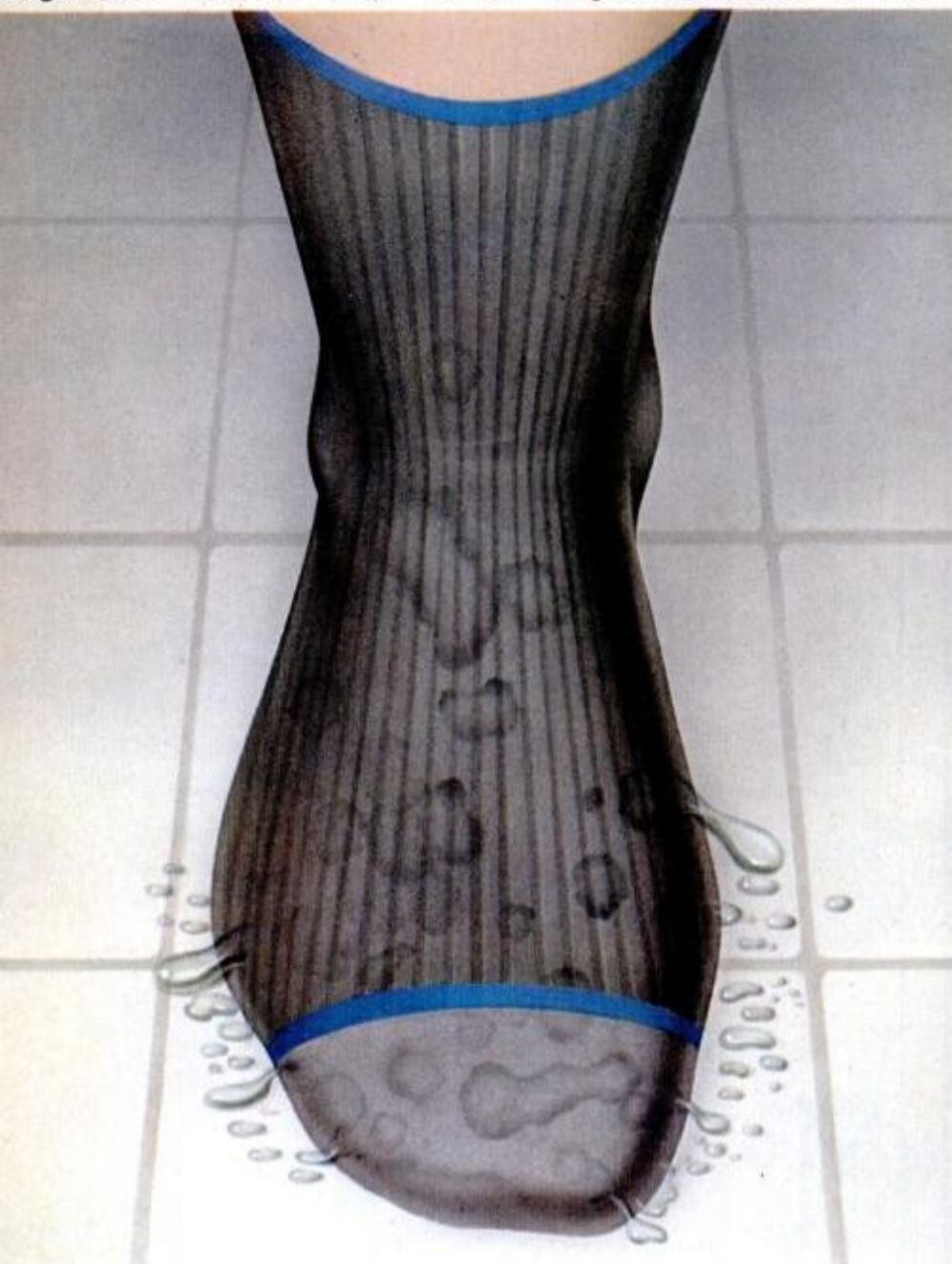
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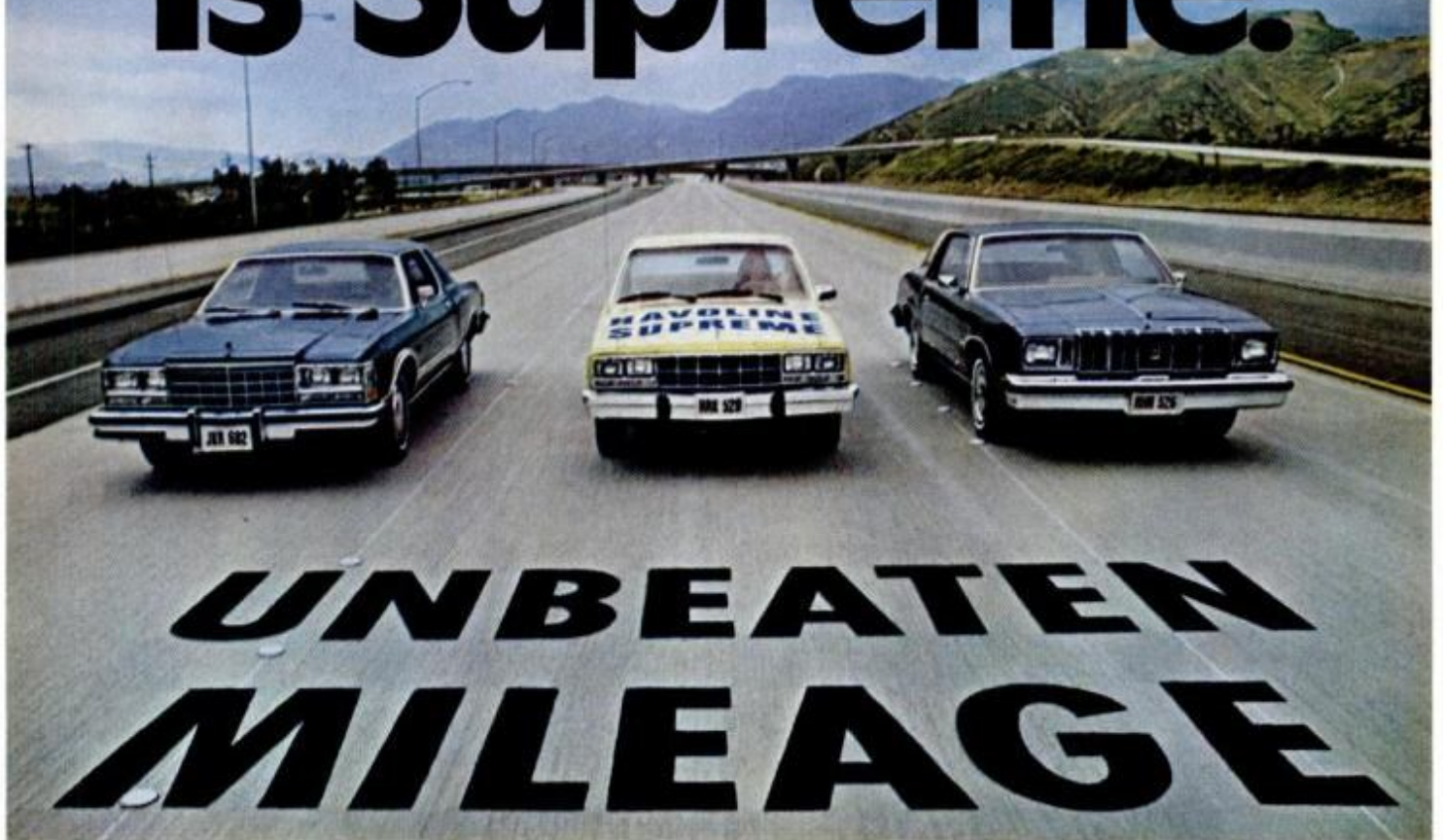
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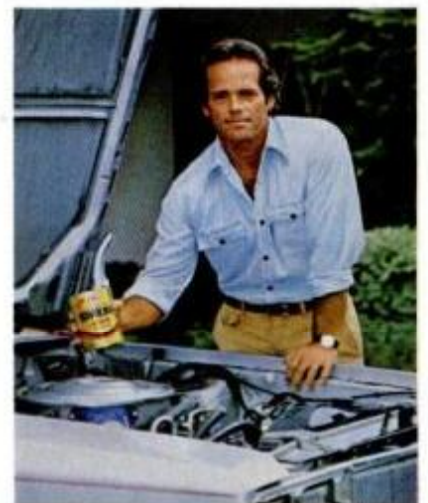


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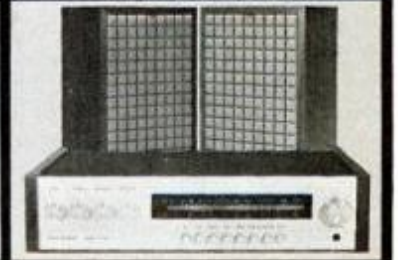
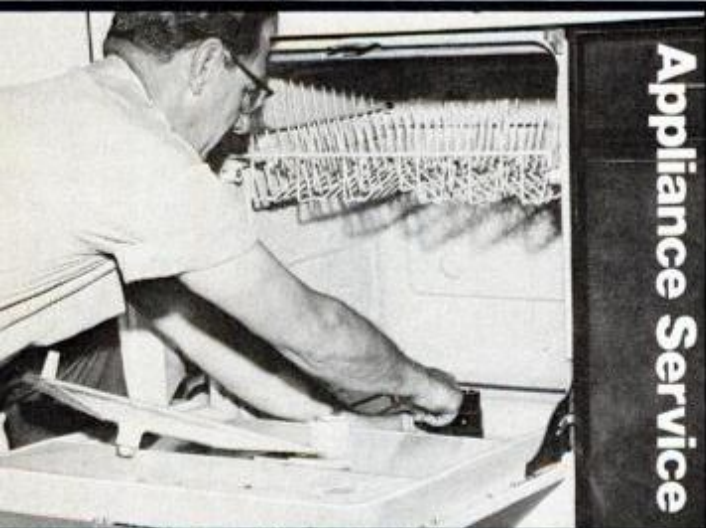
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ALL OUTDOORS

Marine machines

The waterfront rumor mills hint that by next month outboard motor companies may announce the more powerful and fuel-efficient big machines they've been grooming for several years. It may all depend on the gas-crunch climate.

Great guns

Combination guns and three-barreled drillings aren't new, but they continue to intrigue shooters and add variations. Savage has their popular rifle/shotgun combinations that take down for easy packing and storage and offer versatility as survival guns. Popular pairings are over-and-unders, like a .22 long rifle barrel over a .410 or 20-gauge or a .30-30 over a 20.

Now they've introduced a .357 magnum (.38 special) over a 20-gauge shotgun barrel. A hunter, backpacker or camper who already has a handgun of that caliber can now use the same shells in his combo rifle, plus a 20-gauge shotshell or slug load in the shotgun barrel.

Browning's interesting variation is a handsome over-and-under with interchangeable barrels. Called the Superposed Continental, it has one pair of 20-gauge modified- and full-choked barrels for shotgunning. Remove these and put on the rifled pair, and you have two .30-06 tubes in the double-barreled rifle tradition, but with superposed balance.

While the Savage combination models start at just over \$100, some import prices can get exotic. Colt brings in a glossy Sauer drilling with a pair of side-by-side 12-gauge barrels over one for .30-06 for only \$2000-plus, but some Armsport, Ferlach, Heym and Krieghoff beauties approach \$5000—though with those you can just about specify any mix of calibers and gauges.

Stove safety

This year, fold-out legs have been added to Coleman's neat little brown Peak 1 backpack stoves to give them added stability. Some of the new units may develop a fuel leak near one of the legs, however, and Coleman wants to repair them.

Only Models 400-499 that have code numbers 10-78, 1-79 or 3-79 stamped below the burner are affected. Stoves with other numbers, or with an "X" stamped in a leg channel, do not have the problem. Campers owning a Model 400-499

Peak 1 stove with the numbers involved are asked to contact their dealers or the Coleman Outing Products Div. in Wichita, Kans., at toll-free 800-835-3278. In Kansas, call 316-261-3072 collect.

Outdoor date

The fourth Saturday of this month, Sept. 22, is the date to take a look again at the growth of outdoor activities. Scouts, hunting and fishing clubs, archery, canoeing, cycling, hiking and camping groups will all have demonstrations and planned

National Hunting & Fishing Day



activities across the country. Millions of sportsmen will have a chance to show off their skills.

Just how many million is hard to determine. There are about 42 million licensed fishermen and 22 million fishing women, according to the American Fishing Tackle Manufacturers Assn., but that doesn't count kids, old folks and salt-water anglers who don't need licenses.

The National Shooting Sports Foundation estimates 21 million recreational shooters were at ranges and afield last year, and 17 million bought hunting licenses.

Other totals are harder to estimate; more bicycles than passenger cars were reported to have been sold last year. (Bicycles were rated first in a recent list of hazardous products, followed by stairs, and football, baseball and playground equipment. Firearms ranked 46th.) There were approximately 2 million canoes in use last year, and KOA Campgrounds say 18 million families were camping, 6 million in tents.

But while everyone likes to talk

about improving the environment, sportsmen have done something about it. In 1900 there were about 400,000 mule deer and 500,000 white tail. Now the numbers are 1.5 million and 12 million, respectively. Since the first duck stamps went on sale to improve flyways and habitat, \$165 million in sales have helped increase the U.S. duck population from 35 million to 100 million.

License sales and excise taxes on equipment are the major support for fish and wildlife agencies across the country. National Hunting and Fishing Day has a lot to celebrate.

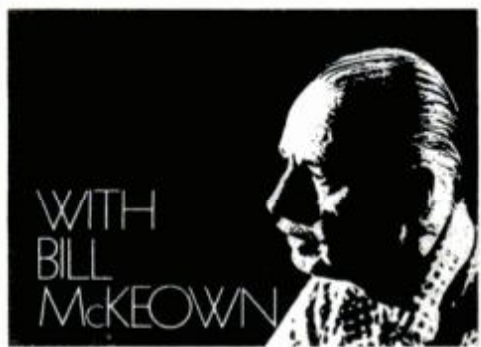
Where it's at

Savings of up to 50 percent are possible with sew-it-yourself kits, like those for parkas, tents, sleeping bags, backpacks, bicycle bags and other outdoor gear from Frostline Kits, Frostline Circle, Denver, Colo. 80241. Now Frostline is branching out, and nylon kites, a fisherman's 12-pocket vest, fly-tying kits and graphite fly casting and spinning rod kits are available for make-it-yourselfers from their catalog.

For custom rod makers who want to graduate to the latest improvement in the intricate job of wrapping guides, Production Attachment Co., Montauk Hwy., Moriches, N.Y. 11955, has a Home Rodwinder (\$122 with a two-way electric motor and foot-pedal speed control) that can handle light freshwater rods up to large ocean trolling rods.

Answers to a great many outdoor recreation questions are available at little or no cost from the government. Do you want to know where to camp in the national park system? How to pick and load a motor home, pickup camper or travel trailer for safe operation? How to avoid skin cancer while getting a tan? These are some of the subjects of 20,000 books and brochures.

Write to the Consumer Information Center, Pueblo, Colo. 81009.



IN 1950, YOU COULD BUY A STUDEBAKER, NASH, DE SOTO AND THE NEW REMINGTON MODEL 870.

These cars have become a part of history. The Remington 870 "Wingmaster" is still making history. Since 1950, more than 2½ million shooters have found that the quality built into the 870 makes it a lasting value.

Reliability is the key—and a major reason for the 870's reliability is a smooth, straight-line pump action. Double action bars prevent twisting and binding for lightning-fast pumping, quick feeding and crisp ejection. It's basic.

We start with a nine-pound billet of solid steel and machine away over seven pounds to make a light, yet strong, receiver. The barrel and barrel extension are forged as a single piece for maximum strength. Metal parts are vibrated, inside and out, for a more lustrous finish and smoother action.

Stocks and fore-ends are enriched and protected by the DuPont scratch-resistant RK-W wood finish. Handsome checkering, full beavertail fore-end, chrome-plated bolt and white line spacers enhance the overall styling. And interchangeable barrels in a variety of lengths and chokes add versatility.

Join the shooters who own 870s in all gauges, right- or left-hand versions, in field, trap, skeet, magnum and 20 gauge lightweight models and see why the 870 "Wingmaster" is



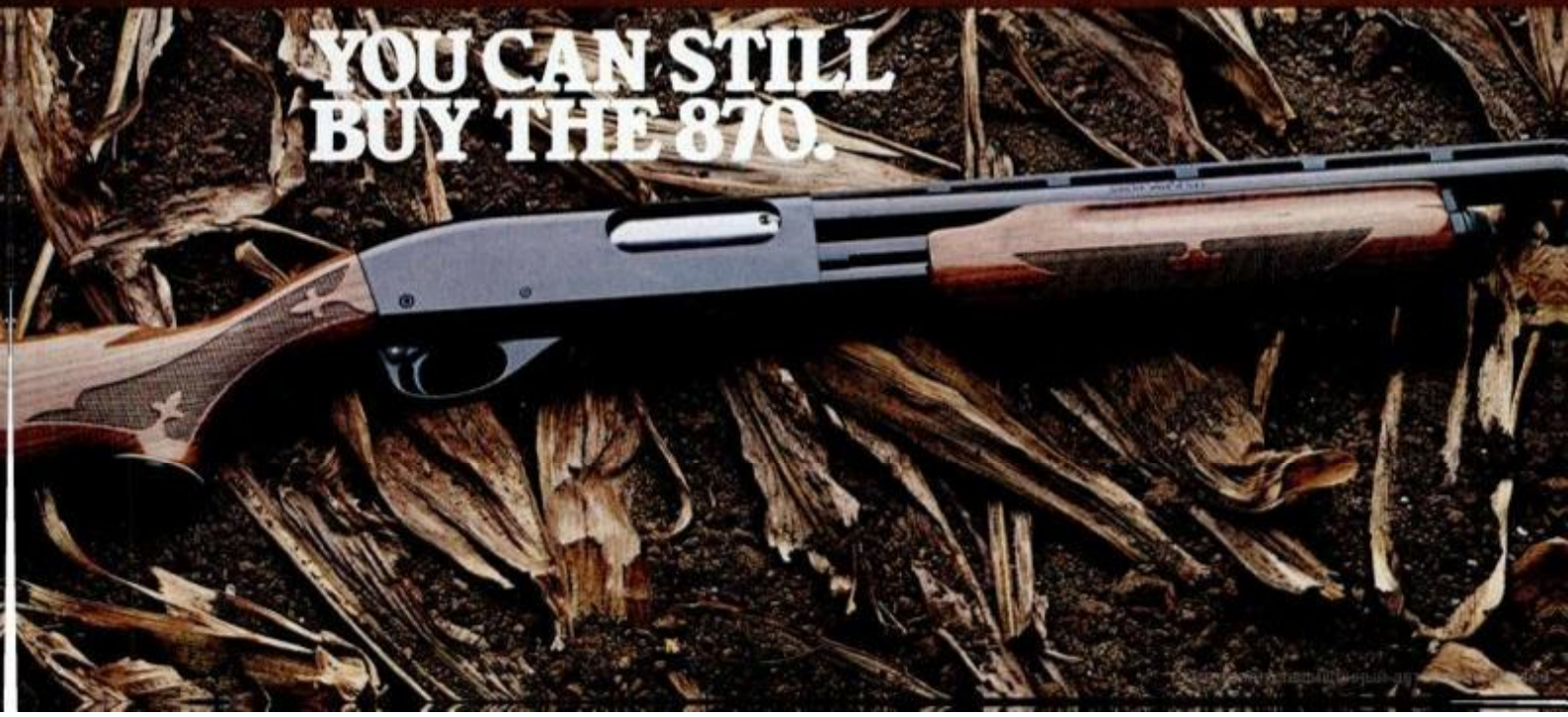
America's most popular pump action shotgun. Prove to yourself what millions of owners know... the 870 has been built right for a long time.

For more on the 870 and other Remington sporting arms, see your Remington dealer, or write for your free full color catalog to: Remington Arms Company Inc., Dept. 95, Bridgeport, Conn. 06602.

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YOU CAN STILL BUY THE 870.



LETTERS TO THE EDITOR

Don't skip the mopeds

I feel that the headline kicker "Skip over those mopeds" (*Get the Jump With A Small Motorcycle!*, page 76, July '79) is a totally unnecessary put-down of a popular product. The national median age of moped buyers is about 40; 61 percent of our buyers are buying for pleasure riding. Errand-running is another major use. The buyers are well educated and have high discretionary incomes. Many tell us they purchased a moped because it *isn't* a motorcycle.

While this article touts the speed and acceleration of a motorcycle, those factors are not of major importance to the mature moped market. They are not looking for the hassle of shifting multispeed transmissions in order to be first to the corner store. In fact, moped sales are highest in states having moped speed limits of 20 mph.

JOHN F. ROSSMAN
SACHS MOTORS CORP. OF U.S.A.
WESTLAKE, OHIO

Mr. Rossman's point is valid, but we felt obligated to point out the advantages of a full-fledged motorcycle. After all, we've been blowing the horn for mopeds for quite some time; see stories in the issues of Nov. '78, April '78, Nov. '76, Aug. '76 and Dec. '75, among others.

It all hinges on this

I finished building the saw table (*Build PM's Compact Table for Your Radial Saw*, page 122, Feb. '79) and am now in the process of building the extension tables. I am unable to find the drop-leaf hinges that are called for. The specifications say a Sears No. 7505 table hinge, but none of the stores here carry such a hinge, and the Sears catalog does not show any such hinge.

T.D. CRELLIN
SAN DIEGO, CALIF.

The hinges are available from Craftsman Wood Service Co., 2727 South Mary St., Chicago, Ill. 60608. Model No. 7505 costs \$1.96 a pair.

Quiz whiz

In the July Saturday Mechanic (*Automatic Transmission Quiz*, page 58), the answers to question 2 display a lack of preparatory care by the author, composing room,

proof readers or a saboteur at *PM*. Specifically, the approved answer, (d) Check the transmission fluid level, is transformed in the follow-up analysis to "Change transmission and filter on a regular basis." This sloppy error makes no sense whatever, and sharply reduces the credibility of the article.

WILLIAM F. DAVITT
NIASE CERTIFICATE 112493
BONITA SPRINGS, FLA.

No saboteurs here, but our printer did make a mistake on answer (d) of question 2. It should have read: "Change transmission fluid and filter on a regular basis." The word "fluid" was accidentally omitted from the follow-up analysis.

Callin' all Colins

In *Imports and Motorsports* in the May issue (page 61) you say that Colin Campbell is Mario Andretti's team manager. This is incorrect; his manager is Colin Chapman.

ERIC JOHNSON
BRIDGETON, MO.

Right you are, and we apologize to Mr. Chapman. Two Colins in one column were also too much for one of our editors, but we caught the error too late.

Filter factors

In the article *Better Photos the Easy Way—With Filters* (page 106, June '79), it says that "for a filter factor of one, increase exposure one stop; for a factor of two, two stops, and so on." This is incorrect. For a filter factor of one, no change is required. For a factor of two, double the exposure; for a factor of three, triple it.

B.C. LAWTON
GREEN VALLEY, ARIZ.

You're right, of course. The filter factor gives the number of times the exposure should be multiplied. That one somehow filtered past our editors, photographers all.

Flight of fancy

Enjoyed *The Summer They Conquered the Atlantic* (page 86, June '79). I was particularly interested in your reference to the dirigible R-34, as it brought back many fond memories.

She was built by the Wm. Beardmore Co. at Inchinnan, Scotland. My

uncle was master of works and my father was a joiner during her construction. I well remember the day she was launched. She used water ballast, and when she was returning to the airdrome from one of her trial flights, the water froze and could not be released to give proper buoyancy for landing. She crashed, driving the gondola up into the body. My father was given the job of making five officers' swagger sticks from the smashed props.

By way of contrast, my son is employed by the Jet Propulsion Laboratory and is deeply involved with the Voyager and future space probes. Some difference between 108 hours to cross the Atlantic and sending probes to photograph Jupiter, Uranus and beyond!

JOHN M. LUMSDEN
CARPINTERIA, CALIF.

Space house

Congratulations on your article *Our Year In NASA's Far-Out House* (page 77, June '79). It shows what the space program has done and continues to do. Although the NASA house is certainly not the total solution to the energy crunch, it assuredly is a step in the right direction.

I hope plans will soon be made to expand our current space program, specifically with the notion to build large Earth-orbiting space habitats in mind. Such a program might encourage average Americans to use less oil and gas, once they are given the sound knowledge and guarantee that the energy they save will be directed toward the opening up of a new frontier, essential to further human growth and economic development.

PAUL JUSTUS
MISSION, KANS.

Off again, on again

Our February Appliance Clinic said service manuals for Whirlpool washers and dryers were available from the company. A reader sent a copy of a letter from Whirlpool saying that textbooks alone weren't available without taking a correspondence course. In a follow-up conversation with a Whirlpool spokesperson, we found that the textbooks again can be bought separately. Write to Whirlpool Corp., Literature Dept., La Porte, Ind. 46350.

PM

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Triu

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

3 mg. "tar," 0.4 mg. nicotine av. per cigarette by FTC Method.

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Announcing good taste at only 3 mg. tar.

Read how new Flavor-Intensified[™] Triumph gives you taste good enough to stay with at only 3 mg. tar...one of the lowest tar levels in cigarettes.

Triumph. The first and only cigarette that delivers good taste with only 3 mg. tar.

If you've ever been disappointed by one of the very low tar cigarettes, you will understand why Triumph is quite an achievement.

Even the draw is a surprise.

The smoke comes through abundantly. The taste reaches you smoothly. Effortlessly. With none of the struggle you may have experienced in other very low tar brands. You don't have to *pull*—you just *puff* on Triumph.

No gimmicks, no miracles.

No less remarkable than Triumph itself, is the technology that enabled us to build it.

The crux of it: Instead of searching for some yet unimagined answer, Lorillard scientists

decided to take a more sensible tack.

Why not, they said, take everything we've learned about cigarettes, and push that technology further than we've ever pushed it before.

Delivering taste, limiting tar.

We found, for example, that combining two types of filter fiber produces the best combination of taste and draw.

That tiny "vents" in the filter-rim *smooth* the taste.

That lower-leaf tobaccos (shaded from the heat of the sun) tend to be milder and lower in tar than those at the top of the plant.

In short, everything we could find that might *intensify flavor* at 3 mg. tar, was built into Triumph.

Taste you won't get tired of.

What it all comes down to is this: Triumph is not one of those ultra low tars that spoil your pleasure by short-changing you on taste.

Triumph, at only 3 mg. tar, is a cigarette with a taste you can stay with. So good, we believe *you'll never want to go back to your old cigarette.*

Triumph[®]

One of the lowest tar cigarettes you can smoke.
The one with taste enough to stay with.

RISLONE HELPS ENGINES RUN BETTER



RISLONE acts fast to remove power robbing varnish, gum and deposits from engines. And RISLONE has been doing it for more than 40 years . . . That's dependability!

Most drivers feel an improvement in performance within a few miles of driving as RISLONE dissolves and disperses deposits from valve stems, lifters, piston rings and oil passages. The RISLONE treatment lasts, too, because a cleaner engine is better lubricated, runs cooler, longer, and gives better gas mileage.

Road test RISLONE yourself. You be the judge. Venture a dollar or so to find out if engine deposits are cutting your mileage and performance. You'll notice that RISLONE is a real bargain because it costs about the same as products in little cans but replaces a quart of motor oil.

GET RISLONE at your auto merchandise store now. We think you'll become a regular Booster if you give RISLONE a test drive!

Watch for these RISLONE super racers at your favorite drag strip . . . the Fabulous RISLONE Chi-Town Hustler, the stunning new RISLONE Jet of TV Tom Ivo, and the hot competition cars of John Lingenfelter and Bob Marshall!



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IT'S NEW NOW

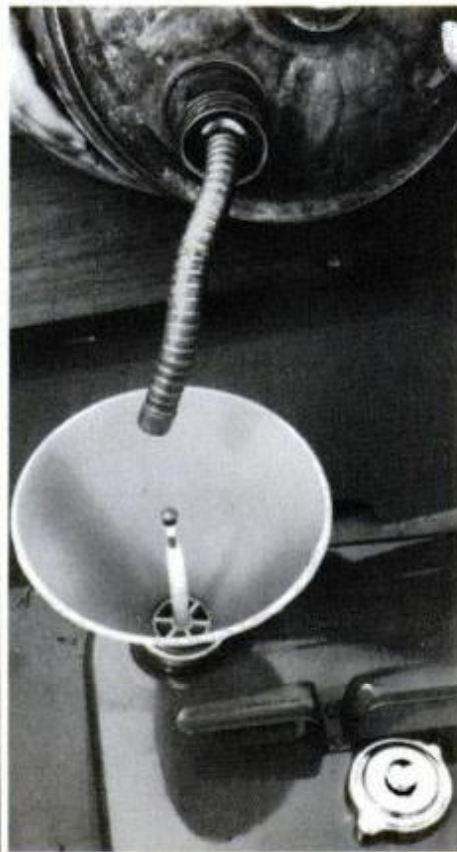


Staying warm under water

The WABA (Warm Air Breathing Apparatus) is said to keep a diver warm in cold water. It is basically a heat exchanger made of plastic with a metal tube coiled inside. When filled with three pints of hot water and installed between the air tank and regulator, it warms diver's incoming air. With boiling water, it's effective at least as long as the air in tank. About \$140. Underseas Environmentals, Inc., 131 East Redwood St., Suite 300P, Baltimore, MD. 21202.

Funnel with a fuel gauge

The Saftee Pour-Master is made with a built-in fuel gauge to indicate when an outboard motor's fuel tank is full. The neck fits snugly in the tank opening to eliminate tilting and spillage. The funnel can also be adapted for use on motorcycles and some other power equipment. About \$6 from Ken Howell Enterprise, 5138 Imperial Hwy., Lynwood, Calif. 90262.



Sniffing out trouble

Gasoline fumes in a boat's engine compartment pose a significant explosion hazard. Squeezing the bulb of the Odor Sniffer draws air from the compartment. The bulb holds air while you smell fume content. Unit mounts on boat dashboard and comes with 20 feet of flexible tubing. About \$33 from Buford Enterprises, 848 East Edna Pl., Covina, Calif. 91723.

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.

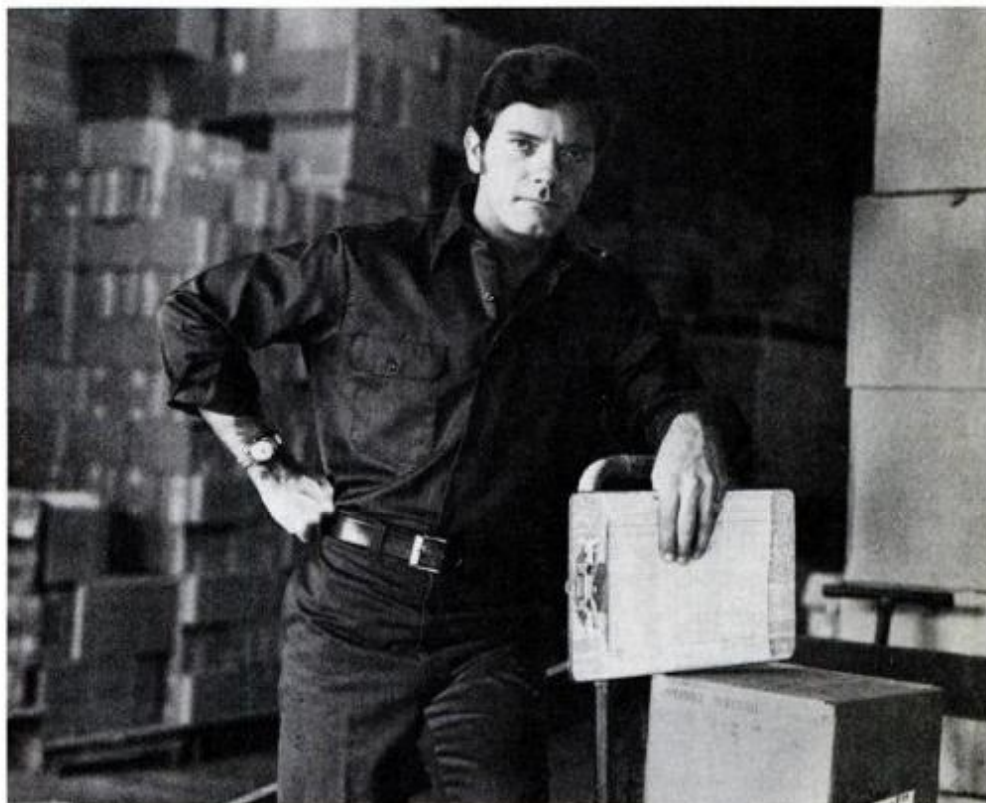
No matter how hard you try, there are some jobs that just seem to go nowhere. And others so monotonous, they drive you up the wall. While all around, you see people enjoying what they do and making a good living at it.

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 solid-state stereo and a 25" (diagonal) fully computerized programmable color TV with built-in



computer tuning that lets you program a whole evening's viewing. You even assemble test instruments for learning and earning.

Your equipment includes a transistorized volt-ohm meter, TV color pattern generator, 5" triggered sweep oscilloscope and CMOS digital frequency counter... the tools of the pro. And while you build the stereo and color TV, you perform over 140 in-set, "power-on" experiments... introduce and correct typical service problems ... gain real bench experience while you learn.

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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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SCIENCE WORLDWIDE

Volcano 'injects' stratosphere

The volcano La Soufriere injected ash and volcanic gases into the stratosphere when it erupted last April, providing NASA scientists with a valuable tracer to explore the Earth's fragile upper atmosphere.

Shortly after the volcano on the Caribbean island of St. Vincent spewed as much as an inch of dust on neighboring islands, Dr. M. Patrick McCormick of the NASA/Langley research center calculated that it would take about a month for ash and volcanic gases blown into the atmosphere to circle the Earth. His calculations appeared to be right: In mid-May, a plane carrying sophisticated monitoring equipment over the Caribbean picked up traces of volcanic material at two layers, 20 and 17 kilometers high.

In the meantime, the SAGE satellite launched last February (see *Science Worldwide*, page 14, June '79) was recording the pattern of the volcanic cloud as the emissions traveled southwest to west on winds high above the Earth.

SAGE is an acronym for Stratospheric Aerosol and Gas Experiment, a satellite project to gather data on aerosol and ozone layers in the stratosphere. Small changes in concentrations of aerosols—dust-like particles and liquid droplets—can have a magnified effect on marginal farming areas, including the northern United States.

"The volcano is a bonus for us," McCormick told *PM*. "We can follow its dispersion over the globe, like a giant tracer." The SAGE data, he said, could help predict how dust veils disperse. And that could help environmental researchers gauge pollution's effect on climate and the protective shield of ozone above us.

Highways and hypertension

Salting icy highways eases pressure on drivers in the winter months, but recent research suggests that after the thaw, the salt may raise blood pressures.

Researchers at the University of Massachusetts have found that sodium—a component of salt—in drinking water appears to increase blood-pressure rates in persons as young as 9 years old. Some of the sodium in the water may have come from salt used to clear state highways of ice and snow.

"Inadvertent contamination of



Erupting La Soufriere volcano, shown in aerial photo, shot a dark cloud into the stratosphere. Researchers are using wind-whipped cloud to map ozone-aerosol layer.

water is a serious problem," Prof. Edward Calabrese of the Division of Public Health told *PM*. "It's been growing during the proliferation of the highway system in Massachusetts since the 1950s."

In controlled studies, Calabrese and Prof. Robert Tuthill found markedly higher blood pressures in students whose water supply was high in sodium. Nationally, high blood pressure—hypertension—affects 24 million Americans.

Why walls came tumblin' down?

Several cataclysmic events reported in the Old Testament may have been connected with earthquakes, according to two scientists who have found tentative evidence of a fault line in the Holy Land.

Geophysics Prof. Amos Nur of Stanford and geologist Ze'ev Reches of Israel's Weizmann Institute said frequent earthquakes may have occurred along the north-south ground fracture over the past several thousand years, including major events every two centuries or so. The last such quake shook the area July 11, 1927, measuring 6.5 on the Richter scale.

"It is very likely that the collapse of the walls of Jericho, under Joshua's siege, was caused by an earthquake similar to the 1927 event," the investigators reported. The fault, they said, passes about five miles east of Jericho. "Aside from the proximity of the fault, there is a remarkable similarity between the (biblical) description of river-flow

cutoff, and the damming of the Jordan River by earthquake-induced mudslides observed during the past millenium."

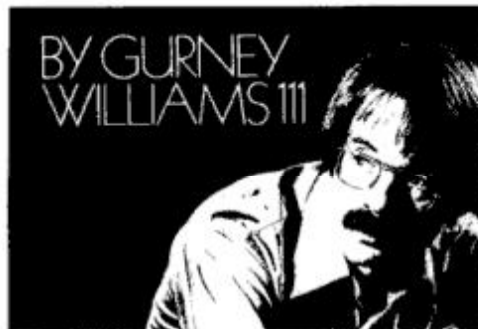
Nur and Reches also said it was "likely" that Sodom and Gomorrah, east of Jericho, fell into ruin during another earthquake some 4000 years ago.

The fuel-saving bacterium

A small bacterium found in the soil could save millions of barrels of oil a year by reducing need for fertilizer, says the Department of Agriculture.

The bacterium, rhizobia, enters legumes—soybeans and peanuts, for instance—through roots and captures nitrogen from the soil; the nitrogen normally would be provided by fertilizers. If current research to improve the bacterium pays off, rhizobia could save more than 16 million barrels of oil a year that would help make fertilizer.

But rhizobia won't solve the energy crisis: the United States now uses almost 20 million barrels of oil a day. **PM**



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There are 4 easy-to-operate Bolens diesels ranging from 15 to 24 hp. Each is water-cooled, has standard multi-speed PTO, a 3 point hitch, and your choice of 2 or 4-wheel drive. Plus, a variety of custom-matched, quick-change attachments. Like mowers, snowthrowers, tillers and more.

The Bolens Diesel and the Bolens dealer. Equally capable. Equally dependable. See them today. For the name of the Bolens Diesel dealer near you, call 800-447-4700 toll-free anytime (in Illinois, call 800-322-4400). Or write the FMC Corporation, Port Washington, Wis. 53074.

FMC

APPLIANCE CLINIC

QUESTIONS ANSWERED

Home in the range

First, the large oven of our General Electric range quit. However, the small oven and top burners continued working. Then, the small oven popped off. This time we got a burning odor. What's happening?—A. Hynson, Bethpage, N.Y.

Wires are probably failing. But why? Maybe because of wear and tear, loose terminal connections, power surges—or a mouse or rat. These critters find the warmth of a range delightful and have a fondness for chewing insulation.

Before poking your hand in a place where a mouse or rat may have established residence, turn off or disconnect electric power and pull the range away from the wall. Look for droppings. If evidence points to the presence of a rodent, get rid of it with poison or a trap before making repairs. Caution is advisable. Service technicians who have poked inside appliances with their hands to make electrical repairs have been bitten.

Racket buster

The rack in our KitchenAid model KD 1-17 dishwasher that holds the dishes has worn and rusted. The rust is getting on the dishes. Is there a way to repair the damage or must we buy a new rack?—James H. Wilson, Port Huron, Mich.

KitchenAid offers a rack repair kit through its distributors. The \$5.40 kit contains sleeves that fit longitudinal pieces, tiny tips that fit over prongs, instructions and liquid vinyl to touch up small spots. Check the classified directory for a KitchenAid distributor.

You may or may not be able to use the sleeve and tip materials on other makes of dishwashers. It depends on the dimensions of the rack parts.

Toned down

The Nutone exhaust fan in our kitchen runs slower every time we turn it on. I cleaned the blades and motor, thinking grease and dirt were causing the trouble, but they weren't. Any suggestions?—William J. Daniels, Harrisburg, Pa.

There is no mention in your letter of whether the fan is emitting an unusual noise. For this reason, your trouble is probably resulting from a shorted field. When a field shorts, a fan starts to become sluggish. You can continue to use the unit until it

dies altogether. At that time you can buy and install a replacement field. If maximum air movement is important, replace it now. If noise were accompanying the sluggishness, then either a shorted armature or a binding bearing would be causing the trouble.

Getting his kicks

Our Maytag electric clothes dryer runs about 10 minutes before the main circuit breaker kicks off. When I flip the breaker back on, it runs for another 10 minutes before it kicks off again. Any idea what the problem might be?—Mike Preston, Ankeny, Iowa.

Four ideas, Mike: (1) lint buildup around the motor, which is causing the motor to overheat; (2) a short in dryer or house wiring; (3) a weak circuit breaker; (4) a defective motor. Any of these may cause the circuit breaker to trip.

Clean around the motor. If the circuit breaker still fails to hold, test the motor and dryer wiring for shorts. If this doesn't reveal the cause of the problem, you should call an electrician to check the circuit between the circuit breaker box and dryer.

Dishing out facts

Our 12-year-old Frigidaire dishwasher works well, but it leaks through rusted areas in the liner where the rack wheels rest. Is there a repair epoxy which will withstand the extreme conditions present in a dishwasher? If not, is it practical to replace the liner? My dealer suggests I buy a new dishwasher.—E.D. Turner, Middletown, Conn.

A product called Hysol Epoxy, which is distributed by Jemline, can be used to patch rust spots. It comes in various colors to match dishwasher interiors. If you can't get the product from an appliance dealer, go to an appliance parts distributor. Look in the classified section of the phone book for one, or refer to the appliance parts distributors list that was provided in *Appliance Clinic*, April '78.

There's no guarantee the Hysol Epoxy patch will last indefinitely. Rust may spread and cause the patch to fall off. At that point, you may replace the liner if a replacement is available. Check parts distributors. The "economics" of replacing a liner are these:

■ The liner, if available, will cost between \$50 and \$90.

■ If you do it yourself, it will probably take about 10 hours to remove all parts, get the old liner out, put the new liner in and reattach parts.

■ If you hire someone to do the work, determine total cost, including labor, before proceeding. You may find that it's more practical to buy a new dishwasher. The cost of a new dishwasher is between \$200 and \$560, depending on the model.

■ A recent independent study placed the average life expectancy for a dishwasher at 12 years. Consider this before buying a replacement liner. Your dishwasher may last several more years. Then, again, it may break down the day after the liner is installed.

SERVICE TIP

Crumbs that drop inside pop-up toasters hamper operation of the cradle latch and other mechanisms. To clean out a toaster and prevent trouble, disconnect the power cord and open the clean-out trap. Brush dirt from reachable parts with a one-inch paintbrush. Do not use a knife, as it may damage delicate wire connections.



Compressed air rids toaster of crumbs.

Blow crumbs and other food matter, such as raisins, from unreachable areas with a can of compressed air fitted with a nozzle adapter. This item may be purchased from a photography shop. Use short bursts of air and don't aim nozzle directly at thin wire elements. **FM**

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.



MOTORCRAFT FILTERS ARREST DIRT AND SLUDGE!

Big city police cars take brutal punishment. That's why we chose 63 of them (Ford, GM and Chrysler products) to test our Motorcraft replacement parts. Our test ran a total of one million miles. Through a wide range of weather conditions including winter temperatures well below zero. And, because these parts were on police cars, they had to survive extreme driving conditions. From high speed runs to hours of idling that can rapidly build engine-damaging carbon deposits. How'd Motorcraft do? Magnificently. Of 185 Motorcraft Oil Filters used in the test, all but



two survived. And that includes filters made of treated paper as well as our exclusive rayon/cotton design shown here. This Motorcraft FL-1A Dual Filter uses both rayon and cotton cleaning elements.

Compared to filters with paper elements, this design can last up to three times longer!

Our Air Filters and Fuel Filters survived the same tough test... and not one filter failed!

Thanks to Motorcraft quality, every Motorcraft Air and Fuel Filter in the police car test made the grade. We believe our Air Filters did so well because we make them with a cellulose paper element and a resilient sealing surface so dirty air can't bypass the filter. Fuel Filters designed to effectively trap dirt performed without a hitch.

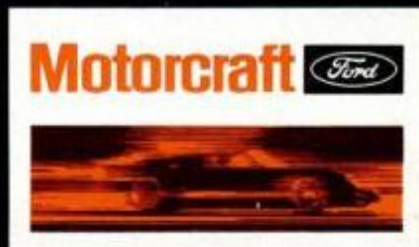


Motorcraft parts: buy 'em, don't baby 'em.

The point of all this testing is not to prove that Motorcraft makes quality parts that work well for police cars, it's just that if Motorcraft parts can survive a test like this, they should be able to take anything your kind of driving can dish out.



So if replacement parts are the last thing you want to worry about, the first thing you should do is ask for Motorcraft... quality auto parts from Ford.



**DON'T ASK FOR TROUBLE.
ASK FOR MOTORCRAFT.**

IMPORTS & MOTORSPORTS

1983 Mercedes-Benz



Mercedes-Benz miniature will have small diesel, may have front-wheel drive.

That a luxury car can come in a small package is what Mercedes-Benz intends to prove when its new compact is introduced for the 1983 model year. The photo above shows a prototype of the W201, as it's referred to within the company. The four-door sedan is on a wheelbase of 102 inches, weighs about 2200 pounds and will be powered by a small diesel that is likely to be turbocharged. Price for the quality package? It's too early to tell, but remember: Small doesn't mean cheap.

Fashioning a car



Weitz X600 will be aluminum bodied.

Doodling dream cars is just a pastime for most of us, but fashion designer John Weitz is serious about driving a car that suits him. His X600, shown above and below in clay, is being hand-formed in aluminum and the prototype should be ready next month for the auto-show



Weitz wants to wear his car. Note how wheel wells resemble flared arm vents!

circuit. The aluminum sports car is on a 108-inch wheelbase and weighs in at 2300 pounds with its 350-cu.-in. V8. The engine, drive train and suspension are off-the-shelf GM parts.

Unlike other cars with fashion designer names on them—Gucci, Cardin, Bill Blass—the X600 was styled from the ground up by Weitz. The designer Cadillacs and Continentals have only paint, upholstery and badges to distinguish them from their mass-produced counterparts.

Whether the X600 goes on sale as a high-priced, custom-made automobile is still a question. Meanwhile, John Weitz will have the prototype in his garage. It'll be his very own dream car—and not on paper.

Inevitable electrics

One of the significant automobiles in the history of cars in the United States was built in Cleveland by the Baker Motor Vehicle Co. Remember the Baker electrics? They succumbed to the cars of the Gasoline Age. Now that we realize dinosaur-and-fern fuel can't last forever, electric cars will be back. Small, mass-produced, reasonably priced electrics are still some years off, but fleet use is coming on strong—here and abroad. One car manufacturer, Daihatsu, is aiming at next year for establishment of its electric rent-a-car system in several Japanese cit-

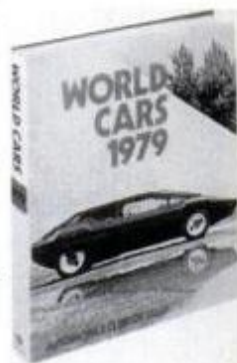


Electric rent-a-car is a Daihatsu.

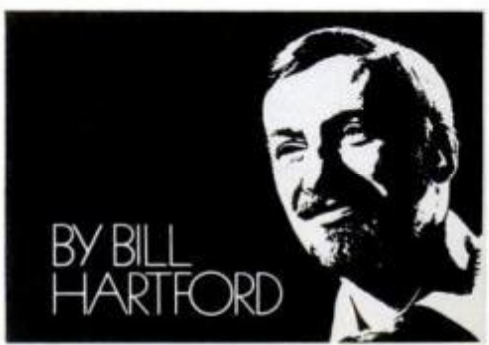
ies. The PREET system (for Public Rent Electric Towncar) would allow an almost unattended network of stations where drivers would transact the use of a car with a coded card. We'll have an update on electrics in the United States next month.

The car buff's bible

In this grand book you'll find that there are 43 builders of electric vehicles in the world, 26 of them in the United States. The 64 models built by these companies are among over 1000 cars shown in the 440-page *World Cars 1979*. (We should say that most of the electrics are experimental and not in production.) Most of the cars made worldwide are gasoline-powered, of course, but electrics, hybrids and diesels are detailed also. The scope of this volume ranges from Austria to Australia, the United States to Uruguay. Introductory pages, 72 of them, feature color coverage of coachbuilder bodies, motor racing and essays on auto production in Europe, Japan and the United States. The car buff's bible is \$29.95 retail, or from Herald Books, Box 17, Pelham, N.Y. 10803. **FM**



Car buff's book of knowledge.



BY BILL HARTFORD

Ease The SQUEEZE

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We're all having to tighten our belts and use less gas. That's why the automakers are equipping new cars with carburetors designed specifically to save fuel. They have to — our days of fuel waste are over.

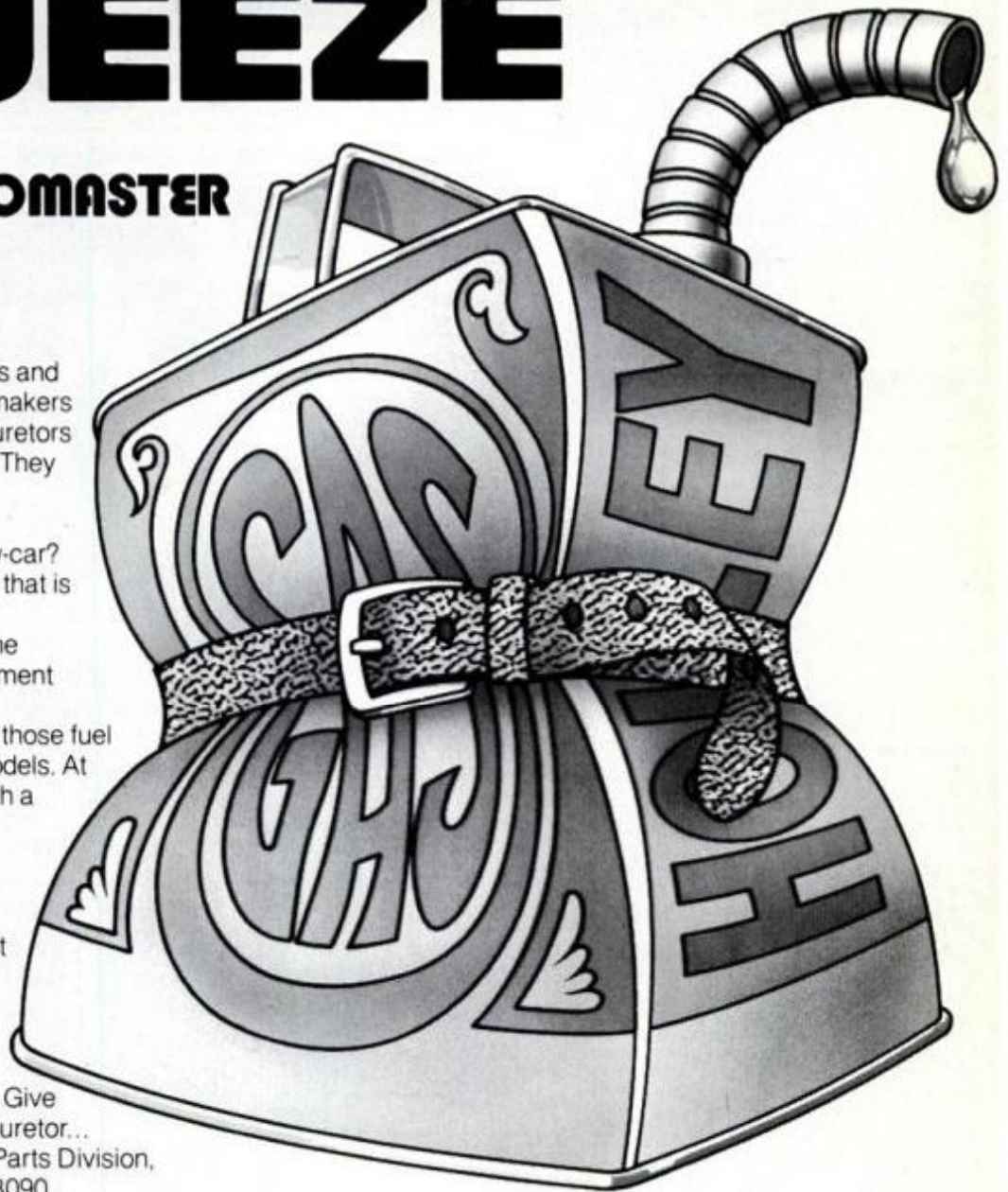
But what about your not-so-new-car? Is there a *replacement* carburetor that is designed to be stingy with fuel?

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At Holley, we're busy designing those fuel saving carburetors for the new models. At the same time, we've come up with a fuel efficient carburetor for your car, too.

Holley **ECONOMASTER** carburetors are designed to be a bolt-on replacement for your car's present carburetor. Step-by-step instructions are included to guide you through — all the way.

So give your car the fuel efficiency it needs for today's driving. Give your car an **ECONOMASTER** carburetor... from Holley. Holley Replacement Parts Division, P.O. Box 749, Warren, Michigan 48090.



Holley **ECONOMASTER** carburetors are available at leading auto parts dealers. Actual fuel economy may vary, due to application and driving conditions.



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Over 65-Million small engines are in use today, and a million new units are being built each month. This means there's plenty of business and big profits available for qualified men who can service and repair them. Industry growth has been so fast that there is a shortage of small engine repair pros. That's why NOW is the time for you to get into this profitable field where you can command hourly rates equal to any other skilled craft. The sale of parts, engines and accessory items add even more profits... profits YOU earn and keep in YOUR pockets, not someone else's.

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When you're the boss in a fulltime business of your own there's never a worry over strikes or layoffs, and you earn year round profits repairing chain saws, tillers, tractors, mowers, mini-bikes, power rakes, generators, snowmobiles, snowblowers and many more items. There is no huge investment for equipment, no expensive inventory. Work right out of your garage, basement or a spare room. Ideal for sparetime income too. In just evenings and weekends you can earn extra cash for a rainy-day or retirement fund, or use the extra money for the things you want NOW.

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No place like a dome

In a departure from the ordinary, this dome-shaped steel storage shed is said to be stronger and more wind- and snow-resistant than traditional designs. It comes ready to

assemble in 12-, 14- and 16-foot-diameter sizes. Door slides on rollers. Prices start at \$850. International Domes Ltd., Box 181, Plainfield, Ill. 60544.



Leak seeker

Aqua-Scope detects and amplifies the sound of water leaks and other leaking fluids. The portable, battery-powered, solid-state unit works with systems pressurized at 20 p.s.i. or more, the maker says. About \$950 from Heath Consultants Inc., 100 Tosca Drive, Stoughton, Mass. 02072.



No-hands magnifier

The Headband Magni-Loop is a magnifier that keeps both hands free. It weighs less than three ounces, can be adjusted for any viewing angle. Lenses come in powers from 1 1/4X to 3 1/2X. About \$10 to \$18. Edroy Products Co., 130 West 29th St., New York, N.Y. 10001.

THE ORIGINAL ROTARY DISC AIRLESS PAINT GUN

Now with Electronic Controls for Speed, Safety and Versatility! Ideal for home, farm and factory use.



PAINT A FINE LINE ONLY $\frac{1}{2}$ INCH WIDE
with a minimum of misting . . .



OR A FULL $1\frac{1}{2}$ FOOT SWATH
with practically no overspray!

Easier to use—and safer, better!

ELECTRO ROTARY DISC NO-NOZZLE/LOW PRESSURE AIRLESS PAINT GUN

The first paint gun to give you **REVOLVING DISC ACTION** and **ELECTRONIC CONTROLS** for amazing versatility! Does the work of a **\$300 industrial compressor model!**

Send today for the Revolutionary Electro® Airless Paint Gun—and you'll never want to go back to the old-fashioned method of painting! That's because it is fast, safe, and more efficient than other paint guns you can buy. Only the Electro® Airless Rotary Disc Action Paint Gun gives you precision solid state electronic controlled painting, airless spray action, and the capacity of an industrial paint gun that could cost as much as \$300.

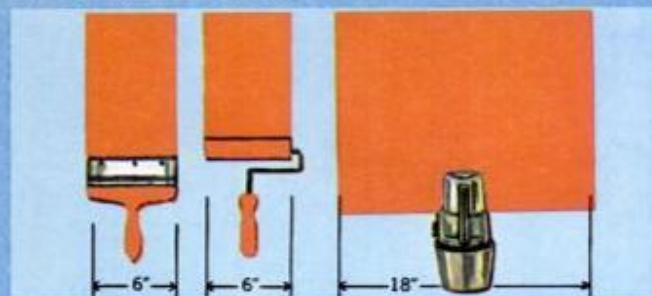
Gives you professional painting capacity for your Home, Farm or Factory!

Save money, time and paint—get professional quality painting whenever and wherever you use the Electro® Airless Paint Gun. With this gun you can cover 100 sq. ft. in just 10 minutes! The unique revolving Disc Action spins paint out so fast you complete the biggest jobs in little time. No bulky compressors, flimsy vibrators, strainers, needles, valves or nozzles . . . it won't clog in action.

It's lightweight and portable . . . only 10" high and made of sturdy-durable aluminum—compact and portable enough to take anywhere there's a really tough paint job.

Low Pressure Design for Safety!

The Electro Airless Paint Gun uses only safe centrifugal action to spin paint out at speeds up to 20,000 RPM. Uses no nozzles—valves—or high pressure build-up to squeeze paint out. As a result you get safe, easy painting, and it eliminates the danger of accidental paint injection possible with high-pressure sprayers.



Covers 300% more area than a 6" brush or roller!

Brushes and rollers can't compare with the Electro® Airless Paint Gun. Whether it's a big job—or tight precision painting—Electro® saves you time and effort.

Solid State Electronic Controls give you Versatility—Speed—Precision

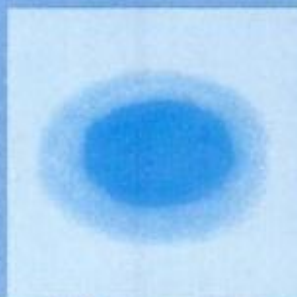
The Electro® Airless Paint Gun puts solid state electronic controls at your fingertips. All you do is pre-select the exact amount of paint you want to deliver and the width of the spray pattern you want—from ½ inch to 1½ feet. Then pull the trigger and paint! Rotary action feeds the paint up and out the gate opening for maximum control of every painting action.

Cover an entire room in just minutes—or perform precision paint jobs like frames, woodwork or furniture. All with a minimum of misting, fogging or overspray.

The Electronic Controls also compensate for varying thicknesses so you can use your Paint Gun for everything from primers to heavy paints—for indoor and garden disinfectants, for waxing floors and woodwork, and dozens of other chores. **Handles latex—oil—water soluble paints—enamel, semi-gloss, flat—light oils. Not for use with lacquer or highly volatile liquids.**

Try it at Our Risk for 14 days—FREE!

Send for your Electro® Airless Rotary Disc Paint Gun today—try it for fourteen days—and if you're not completely satisfied that it gives you the fastest, easiest, best painting results you've ever had from a paint gun, then return the Paint Gun and owe nothing.



Ordinary Paint Gun gives you an oval pattern that's hard to control. Misting, splattering and feathering require drop cloths and masking.



Electro® Airless Paint Gun gives a precise straight line fan-shaped pattern for a minimum of misting and feathering. Lets you paint like a professional.

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Paint Fences

Do a better painting job in less time...with less effort...and eliminate the mess of conventional painting!



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No brush—no roller— no other spray gun gives you the painting performance of the **ELECTRO® ROTARY DISC • NO NOZZLE • LOW PRESSURE • AIRLESS • PAINT GUN**

Compare these unique features and you'll agree—no paint gun can equal the fast, accurate, low pressure, safe painting you get with the Electro® Airless Paint Gun! Try the Electro® Paint Gun on your biggest—or smallest—painting chores and get professional results every time!



Works with almost any liquid!

The Electro® Airless Paint Gun does much more than just paint! It sprays waxes . . . disinfectants . . . polishes . . . even insecticides . . . almost any liquid. It's the most versatile spray gun you can buy. Of course, Electro® Airless always does a great job with paint!



1. New full trigger control
Easy fingertip "on/off" action trigger locks in any position—including closed. Trigger starts motor, activates gate opening. Just set the controls, pull the trigger and start painting!



2. Preset Width Control
lets you select spray width from ½ inch to 1½ feet. You can even vary width while painting



3. Self-Centering Adjustable Gate
gives you spraying widths from ½ inch to 1½ feet—from a fine line to a wide swath.



4. Solid State Precision Electronic 2 Speed Control
lets you paint as little or as much as you want. Also compensates for paint viscosity.



5. Rugged, Powerful Motor
gives you years of dependable use and the spraying capacity to match an industrial paint gun!



6. Snap Open Latches
make cleaning and disassembly quick and easy . . . latches snap back to lock your spray gun securely.



7. Twist-On Container
holds a full quart of paint or other liquid.




8. Rugged, Lightweight Aluminum Die-cast Housing
makes this the perfect "go-anywhere" Paint-Gun. Only 10" high.



9. The Best Airless Paint Gun you can Buy—
No-nozzle, adjustable gate and rotary disc action painting means the paint gun operates with almost no pressure—for safe, effortless painting every time.

Porta-Amp gives portable sound



Our Porta-Amp can be easily built to fit into almost any speaker enclosure. We show you how to make it, using both printed-circuit and perfboard techniques.

Build this little device and take your electric guitar anywhere. Be the life of your next party—even if it's a picnic in the middle of the woods.

by Herb Friedman

Take along our lightweight battery-powered Porta-Amp and you can have electric-guitar music wherever you go. It's about as portable a guitar amp as you could purchase or build and gives a clearer, richer tone than many purchased

units that cost about \$50 to \$70.

The amp works off 12 volts d.c., supplied by eight D cells, your car's cigaret lighter, or a 12-v.d.c. battery eliminator rated at least at 500 milliamperes. It delivers a maximum of about 2 watts. While not powerful enough to fill an auditorium with sound, 2 watts is more than adequate for picnics, large parties and even serious practice. The tone you'll get will be really satisfying!

Total current drain at idle is less than 15 milliamperes; at maximum volume, before distortion sets in, the drain is 500 milliamperes.

It's easy on batteries

A set of ordinary flashlight D-cell batteries will give many hours of service. A set of alkalines, though

more expensive, might even last for several months, depending on frequency of use.

The amplifier itself consists of a single integrated circuit and a few associated components. Use a 6- or 8-inch speaker. A larger one won't make much difference. Just make certain that it can be driven by 2 watts.

The speaker cabinet can be a matching "P.A. baffle" such as is available from Lafayette Electronics stores, or a box made of ¼-, ⅜- or ½-inch plywood. All the amplifier components and the D-cell battery holder are available from Radio Shack stores. An adapter for your car's cigaret-lighter socket is available at many electronics shops.

(Please turn to page 31)

INTRODUCING THE ALL NEW, 4-WHEEL DRIVE TRUCK. IT'S THE SON OF A LAND CRUISER.

Toyota's new 4-wheel drive truck. The only 4x4 that gives you all this. Practical size. Toyota quality. And Toyota's 30 years of experience building the Land Cruiser, one of the toughest 4-wheel drive vehicles going. Good reasons why we call the new 4-wheel drive truck the Son-of-a-Toyota Land Cruiser.



Now, a maneuverable 4x4.

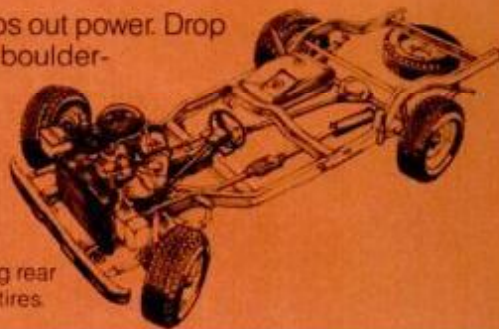
The Toyota 4-wheel drive truck is trim, agile. And those sensible dimensions pay off on narrow trails.

You'll go on ahead when others go back home.

Now, a well-equipped 4x4. Toyota's new 4-wheel drive Sport Truck has full carpeting, AM/FM radio, locking front hubs, and full instrumentation—standard. Tilt steering wheel and power steering are available options.

Now, a tough 4x4. The 2.2 liter overhead cam engine pumps out power. Drop the transfer case into "low" for tractor-like torque to climb a boulder-strewn path. Tough. That's Toyota's new 4-wheel drive truck.

It's available in 3 models—Deluxe Truck, Sport Truck, and a special Black Package Truck (all the options listed above as standard, and more).

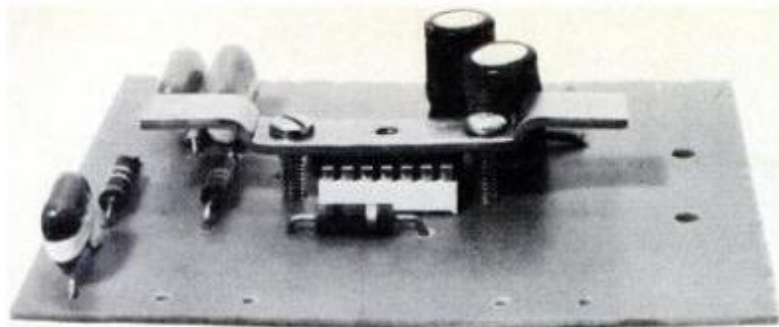


Shown below with optional rear bumper, sliding rear window and owner installed wide wheels and tires.

YOU GOT IT.



TOYOTA THE NEW 4X4.

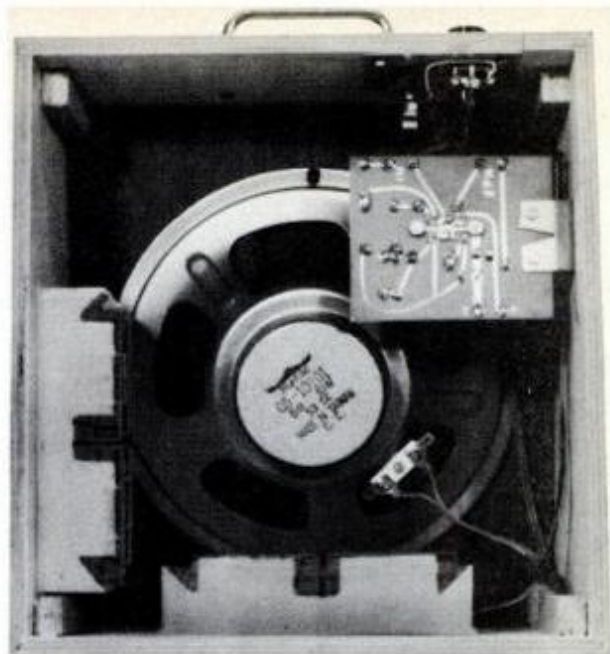


Making the good sound

The amplifier can be assembled on a 3 x 3½-inch printed-circuit board (we give you the PC pattern), or on a section of microminiature solderless perfboard (Radio Shack No. 276-1395). Either way, follow the layout shown for the printed-circuit board as closely as possible. The printed-circuit construction is more rugged than the perfboard method.

Make certain you use a socket for integrated circuit IC1; do not solder it directly to the circuit. If the IC is defective, or it blows for some unknown reason, it will be a mess to get out if it's soldered. The socket costs only a few cents and it's well worth the expense, particularly since you don't have to worry about excessive

The printed-circuit-board design will fit into any small speaker enclosure (right). The components simply mount on the side of the board opposite the foil pattern (top). This is probably the neatest method of building this amplifier.



heat when soldering socket connections—if you wait until last to plug in the IC.

A heat sink will help

While the IC doesn't normally call

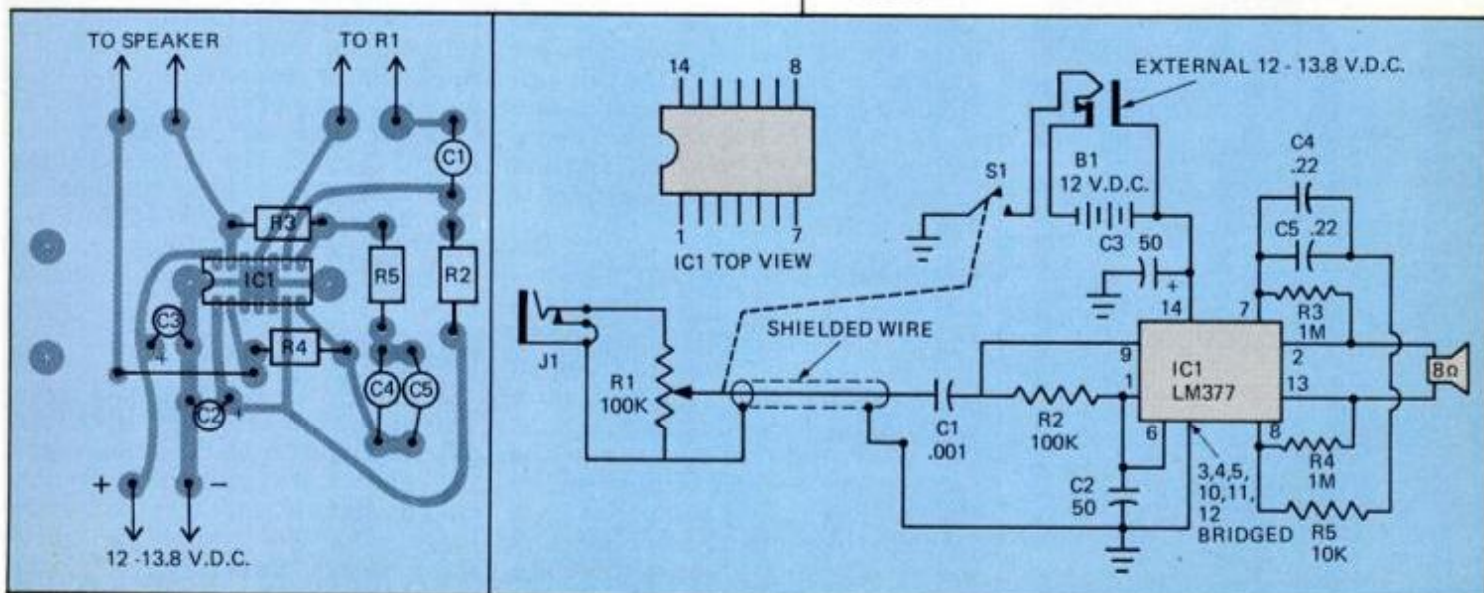
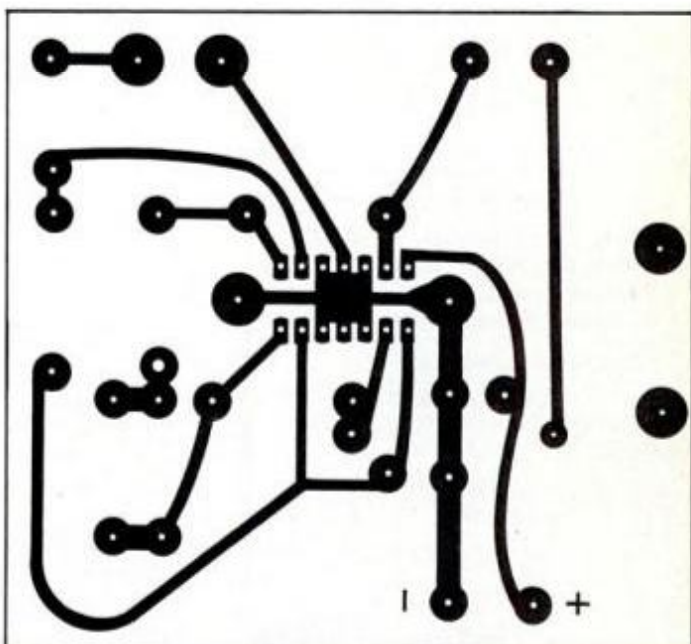
for a heat sink, pickin' on the high strings will run up the LM377's temperature, and though it has internal temperature protection, a heat sink will insure maximum power output

(Please turn to page 32)

PARTS LIST—PORTA-AMP

- B1—8 series-connected D cells (12 v.d.c.)
 - C1—.001-mfd. capacitor
 - C2, C3—50-mfd. electrolytic capacitor (15 v.d.c.)
 - C4, C5—.22-mfd. capacitor (see text)
 - IC1—LM377 dual audio amplifier integrated circuit
 - J1—closed-circuit phone jack
 - J2—coaxial adapter jack, 6 mm, Radio Shack No. 274-1549
- All resistors are ½-watt, 10% tolerance
- R1—100,000-ohm (100K) potentiometer with switch, audio taper
 - R2—100,000-ohm (100K) resistor
 - R3, R4—1,000,000-ohm (1M) resistor
 - R5—10,000-ohm (10K) resistor
 - S1—s.p.s.t. switch (part of R1)
 - SPKR—8-ohm speaker
- Misc.—Speaker cabinet, IC heat sink, wire, battery holders, matching plug for J2.

Printed-circuit-board template (right) can be used to make your own PC board photographically (see page 17, March '79, for details). Component-side view of PC board (below, left) shows where all components plug into board. It is a view looking through the side without the foil, with foil runs shown in a sort of X-ray view. If you hard-wire instead of using PC board, this view will show you how components should be connected. Schematic (below) is also a useful construction guide.



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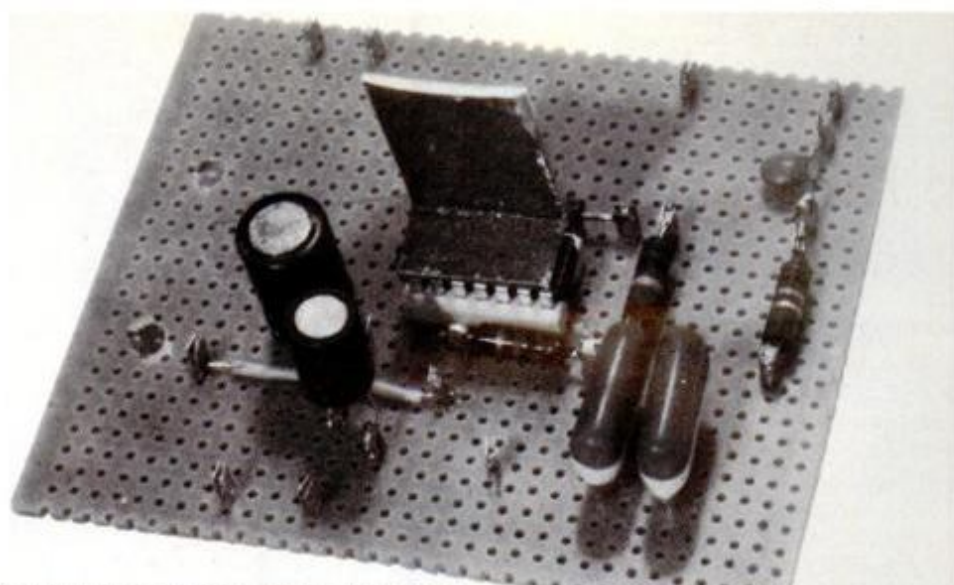
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PORTA-AMP GIVES PORTABLE SOUND (Continued from page 31)



If you'd rather not make a PC board, you can use point-to-point wiring as in this prototype of Porta-Amp (above and right). Perfboard and clips are easy to figure.

at all times. If you use printed-circuit-board construction, the heat sink can be a 1/4-inch-wide strip of metal about 1/16 in. thick and about 1 1/2 in. long. Place it directly on top of IC1 and secure it with No. 4 screws passed through the board. Use lock washers under the nuts and make the screws just finger-tight; over-tightening could cause you to crack the PC board.

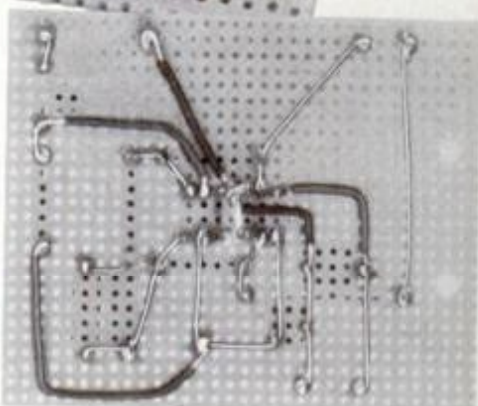
A bit of silicone grease between the sink and IC will help get rid of the heat. If you use the perfboard assembly, cut a piece of tin can or strap aluminum sheeting to about 3/4 x 1 1/4 in., bend it into an L-bracket and epoxy the bracket to the top of the IC.

One capacitor for two

Capacitors C4 and C5 can be replaced by a *single* 0.47-mfd. capacitor, the actual required component. Unfortunately, 0.47-mfd. capacitors often are not easy to locate, so we have made provision on the printed-circuit-board layout for parallel-connected 0.22-mfd. capacitors. The effective value of 0.44-mfd. is close enough; use whatever components are easiest to locate.

Mount on metal

It's more than likely that the shafts of the jack (J1) and potentiometer (R1) won't project through a wood cabinet, so mount both on a small metal plate (aluminum is fine). Cut a large access opening in the cabinet and install the plate *under* the opening, using bolts that pass through the cabinet and plate; *don't* use wood screws, because there is a good chance they will pop out the



first time you push the plug into the jack.

Connect the potentiometer to the amplifier with shielded cable. If the jack is close to the potentiometer, you can use ordinary hookup wire between the two.

The batteries are split into two "packs" of four, with each pack contained securely inside a four-cell holder.

Get the polarities right

If you plan on using your auto's battery for power, or a 12-v.d.c. battery eliminator (such as power CB sets) simply connect the adapter wires in place of the batteries. *But whatever you use as the power source, take extreme care you get the polarities correct the first time.* If you apply power to the IC with reversed polarity, the IC might not get a second chance—it will probably blow!

Remember a handle

Although the Porta-Amp is lightweight and easy to carry, it's advisable to install a small handle atop the cabinet. We used an electronics chassis handle, but a replacement luggage handle, available at hardware stores and luggage shops, works just as well.

FM

Материал, защищенный авторским правом

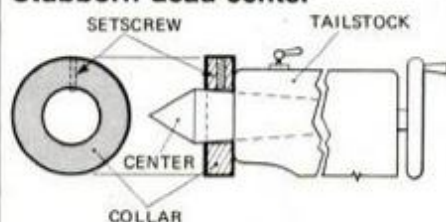
HINTS FROM READERS

Restoring threads



A nut cut in half so two flat edges rest against plier jaws will help restore damaged threads in a bolt. Fit the nut halves around the undamaged portion of the bolt threads. Squeeze with a lock-type plier so the halves make good contact with the threads and turn the bolt out. Resulting burnishing action helps smooth damaged threads.—*Bart Wilson*

Stubborn dead center



Here's how to remove a dead center that's stuck on the tailstock sleeve of a lathe. Use a collar or bushing with a setscrew. Place it over the center and turn the setscrew down tightly on the dead center. Rotate the tailstock wheel so the collar will bear against the frame of the tailstock, forcing out the dead center.—*Frank LaSarcina*

Recycling hacksaw blades

If you break a hacksaw blade and don't have a replacement, you can continue to work with the broken pieces. Overlap the two blade sections and C-clamp them. Then readjust hacksaw frame to fit shortened blade.—*E. O'Donnell*

Tool-sharpening aid

Draw a felt-tip marking pen occasionally across the surface of a tool you are sharpening and you will be able to spot low areas, bumps and other surface irregularities. Darkening the surface will help you keep proper holding angle.—*Richard T. Tafilaw*

Rich Lights

from Viceroy



The rich low 'tar.'

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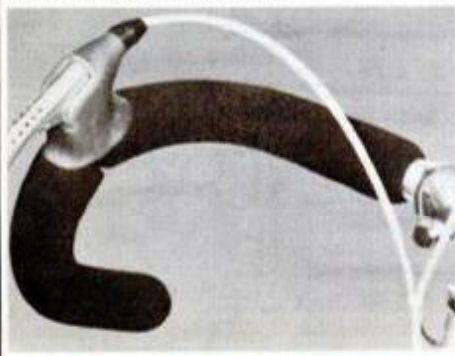
Lightweight tiller

The Chief Till-O-Matic tiller was designed for gardens that don't require a heavy-duty machine. Powered by a 3-hp, 2-stroke engine, it weighs 62 pounds, tills a 14-inch width. Chain drive turns in a sealed oil chamber. Tines can be removed for cleaning, repair or adjustment. About \$230. Clinton Engines Corp., Clark and Maple Sts., Maquoketa, Iowa 52060.



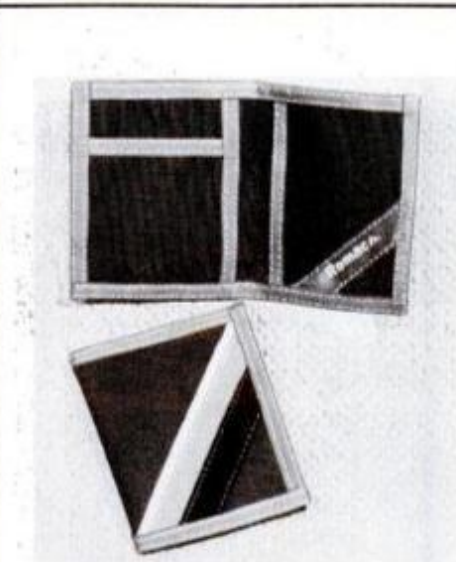
How does that grab you?

Bicyclists who prefer to grab the inner part of their handlebars may want to install Grab Ons. The foam padding is said to reduce road vibration, wrist fatigue and hand numbness. About \$9 from Neotech, Rt. 4, Walla Walla, Wash. 99362.



Many-sided terrarium

This 20-sided geodesic terrarium comes as a construction kit that includes 20 pieces of glass, tape, silicone and razor blades. One glass panel swings on a silicone hinge for access to inside. Felt pads and door handle are also included. About \$20 from Rocky Mountain Cut Glass, Box 4127, Boulder, Colo. 80302.



Slim, light, washable

Romac Wallets are made of Cordura nylon to save weight and bulk in your pocket. Water-resistant, they can be washed with mild detergent and machine-dried. The slim design allows the wallets to conform to body contours. Available in a variety of colors for about \$6 from Romac Industries, Box 1316 Spokane, Wash. 99210.

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Ask the Du Pont Car Doctor

He knows how to make a sick car well; keep a healthy car healthy. And the Du Pont Car Care Products he prescribes are good medicine for any car.



You and Du Pont. There's a lot of good chemistry between us.



Q. What do I do about those little leaks that always seem to show up the minute I put in my anti-freeze?

A. Because anti-freeze doesn't evaporate with the speed of water, it shows up any pinholes or loose hose connections. So tighten those hose clamps before the anti-freeze goes in. And add a can of Du Pont Cooling System Sealer to stop up those pinholes. Seals holes as big as 1/32" ...and that may be all you need.

Q. Put in an expensive new battery and my compact is still hard to start. With cold weather coming on, I'm worried. What's next?

A. You may need a complete tune-up. Points, plugs, timing, the works. Even the strongest battery will have trouble starting a car that's badly out of tune.

Q. This summer, I blew a radiator hose and lost all my anti-freeze. Anything I should do before refilling with anti-freeze this fall?

A. A good flushing out with Du Pont Fast Flush is what I'd suggest. It'll get out any grease, oil or loose rust that may have accumulated in your cooling system during the summer.

Q. How do you feel about radial snow tires? I've got conventional tires on now, but I'd like to try radial snows, come winter.

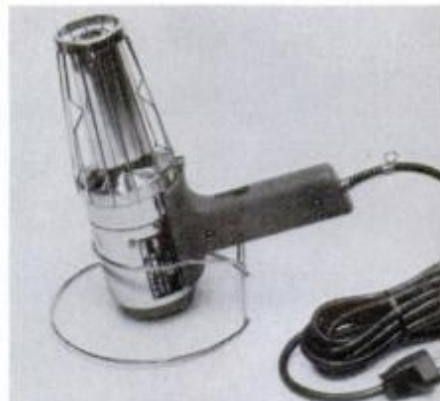
A. Radial snows are terrific...but you'll have to put on radials all around. Mixing radials with other types of tires is a no-no.

Q. Even with annual anti-freeze changes, my V-8 still gets rust in its coolant. What to do?

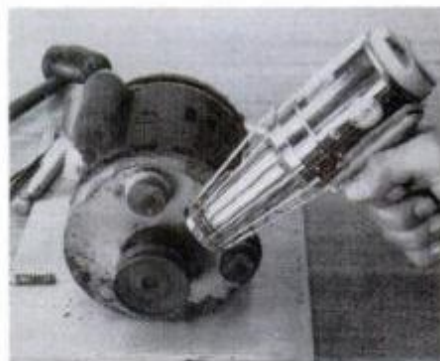
A. Put your cooling system on a diet of Du Pont Anti-Rust & Water Pump Lubricant. Works right along with your anti-freeze. Protects all the metals in your cooling system—even aluminum—against rust and corrosion. Helps quiet squealing water pumps, too.

PM LOOKS AT A SUPER HEAT GUN

For professionals, the Hejet heat gun delivers up to 1000° F. without flame; it's ideal for controlled heat, where and when you want it. Its high-velocity, 4000-ft.-per-minute blower delivers the heat forcefully. Safety features include a recessed switch to prevent accidental turn-on and a



Tool comes with stand for bench use.

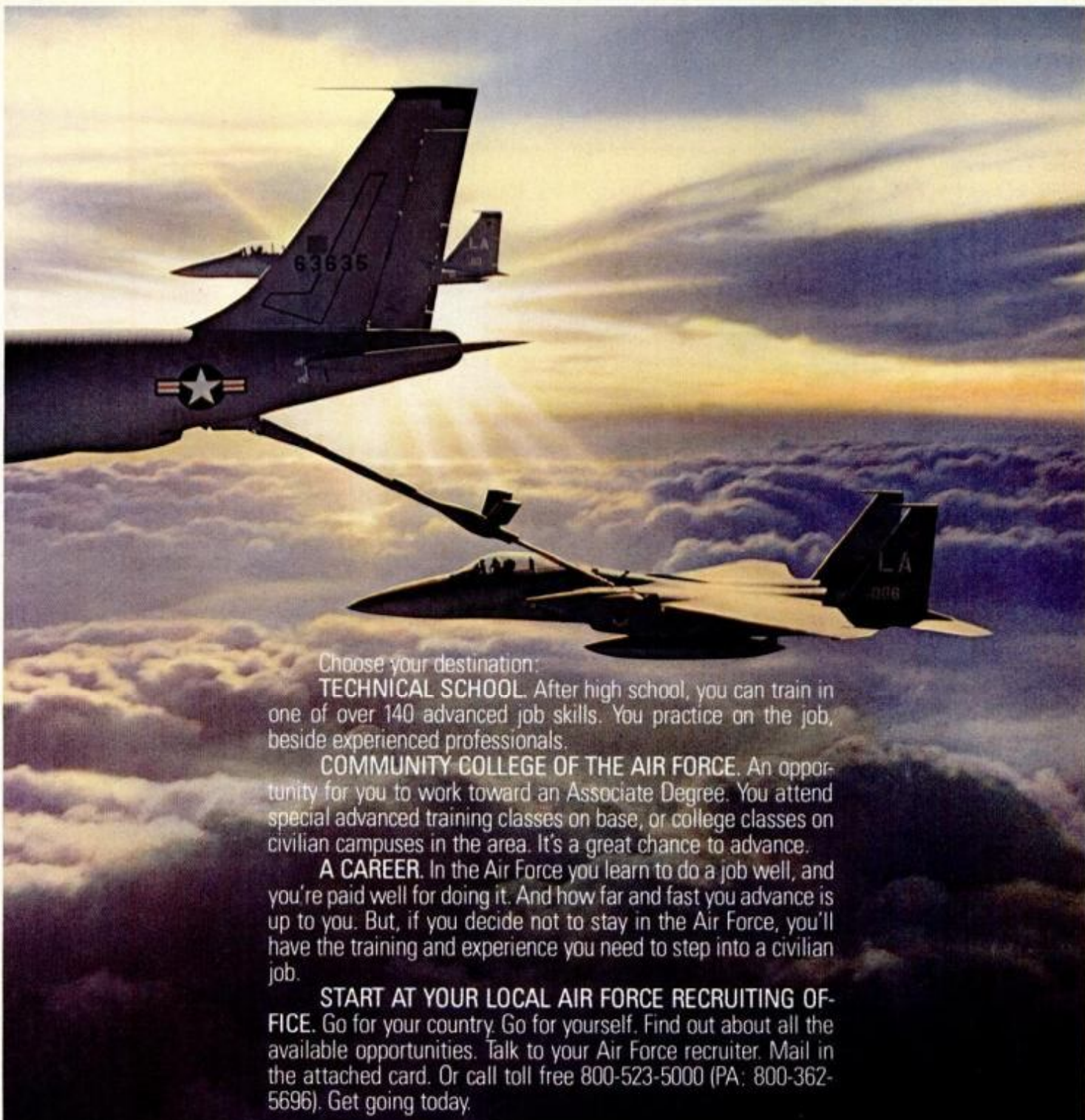


Versatile heat gun can loosen old paint and rusted parts (shown), speed up epoxy curing and paint drying, bond vinyls, thaw frozen pipes.

nozzle guard which protects against burn accidents. Two attachments—a baffle for applying shrink tubing and a 1/4-in. cone for needlepoint heat—increase the tool's efficiency even more. You can order it at local plumbing, heating, electrical or automotive supply outlets, or by mail direct from the maker.—R. Capotosto

SPECIFICATIONS—HEJET GUN

Construction: Chrome-plated steel housing and nozzle; double-insulated barrel to prevent heat loss; rubber-mounted motor for quiet, vibration-free, safe handling.
Amperage draw: 8.3 amps. to produce temperatures to 1000° F.
Voltage rating: 120 Weight: 1.14 lbs. Model: HJ 700
Size: 8 1/2 in. long x 7 1/2 in. high.
Price: \$66.95 (add \$1 for shipping on mail order).
Manufacturer: Pamran Co. Inc., 1101 Cedar Creek St., Racine, Wis. 53402.



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QUESTIONS ANSWERED

Bad vibes

The floor above my new oil-burning furnace vibrates tremendously. The air ducts are flexible and reduce vibration. However, nothing was done to the flue. My heating dealer said there was no such thing as a vibration-absorbing flue section. What can I do?—W. Blair Kennette, Richmond, Va.

A flexible flue section that could withstand high temperatures and not leak combustion gases would be hard to construct for residential use. The vibrations might be caused by your blower; a squirrel-cage blower could be out of balance, or if the blower is belt-driven, a loose belt might create vibrations.

If neither is your problem, ask your dealer about residential vibration isolators. They are about ½-in. thick and are constructed of a resilient material. When the isolators are placed under the furnace, they greatly reduce vibration transmission. Incidentally, these isolators are also used to reduce vibrations in airconditioning compressors.

Wood or asphalt shingles?

My house needs reroofing. What are the advantages and disadvantages of both asphalt and wood shingles?—Paul C. Wilde, Eagle Grove, Iowa

I'd say the advantages of red cedar shingles are: aesthetics, insulation value and longevity. The big disadvantages are: cost (roughly 2½ times the cost of 240-lb. asphalt shingles), the necessity of quality installation and the need to chemically treat the shingles at installation time. (This treatment is required where the climate is hot and humid for a considerable length of time each year.)

The 240-lb.-per-square (100 sq. ft.) asphalt shingles are less expensive and easier to install. Although I know of homes sporting 20-year-old roofs, count any years over 12 as bonus time. Either wood or asphalt shingles can be installed over an old asphalt roof.

Some manufacturers are switching to a fiberglass-based shingle which is growing in popularity. Composition shingles are now available as simulated wood shakes. These weigh as much as 380 lbs. per square.

If you want additional information on wood roofing products, write the Red Cedar Shingle and Hand-

split Shake Bureau, Suite 275, 515 116th Ave. N.E., Bellevue, Wash. 98004.

For information on the asphalt and fiberglass-based shingles, send 35 cents to the Asphalt Roofing Manufacturers' Assn., Box 3248, Grand Central Station, New York, N.Y. 10017, for the brochure, *A Homeowners' Guide to the Selection of Quality Roofing*.

Embarrassing stains

I have annoying smudge stains in my commode below the water level. The smudges are best described as similar to powdered graphite or black carbon. The inlet holes around the rim all show the same dark stains. The water company says that no one else has this complaint. We replaced the flapper valve in the hope of clearing up the stains, but it didn't help at all. Do you have any ideas?—A.F. Uhl, Pittsburgh.

I know that if it were my toilet and the smudges bothered me that much, I'd replace the whole unit. Whatever the residue is, by this time it has lined the inside of the commode.

You might try disconnecting the tank and taking the bowl to your local car wash, to thoroughly steam clean it. Then install new valves, washers and seals. Take care that you don't crack the fixture due to the use of excess heat when cleaning it.

Housing on housing

I propose to build an insulated box over my combination electric furnace/airconditioner. It now sits outside, with insulated plenums and ducts under the house. As I believe the metal housing absorbs heat in the summer and radiates heat in the winter, I think a cover might add to the unit's efficiency. Does this seem like a worthwhile effort? I could provide a hole for the air intake and discharge.—Thomas L. Denton, Madison, Ala.

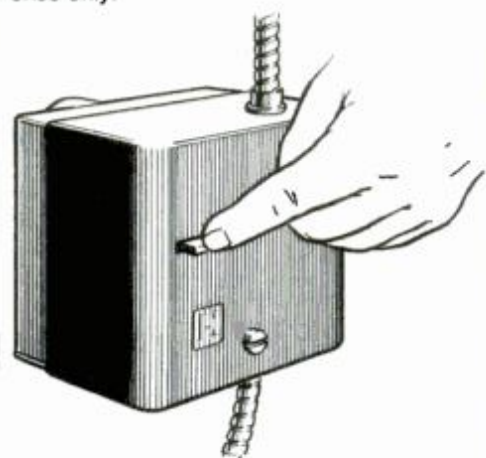
I strongly advise against covering it for the following reasons: Circula-

tion of air is extremely important around your unit. You could create a condensation problem on your housing with resultant rusting. Besides, your unit should have been insulated on the inside by the manufacturer. Reputable manufacturers will have done all they can to increase their units' EERs (Energy Efficiency Ratio). This includes proper insulation.

SERVICE TIP

If your oil burner suddenly stops running, here is action to take that may save a service call:

- See that the thermostat is set 5° above indicated room temperature and that an automatic day-night control switch hasn't been turned off.
- See that neither of the emergency switches (there are usually two) has inadvertently been turned off.
- Make sure you haven't run out of oil.
- See that the main fuse or circuit breaker hasn't blown or tripped.
- Press the overload switch on the motor, once only.

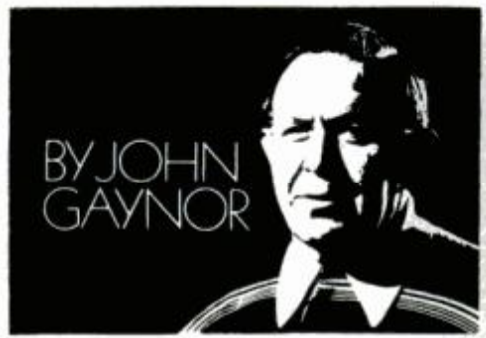


Activate the stack-control relay switch.

- If the motor fails to start, activate the stack-control relay switch, once only (see illustration).

Caution: If the motor fails to start or starts and stops, do not activate overload or stack-control switches again. You should call a serviceman. There is probably an electrical malfunction. **PM**

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.



Enjoy the taste of country fresh Salem.

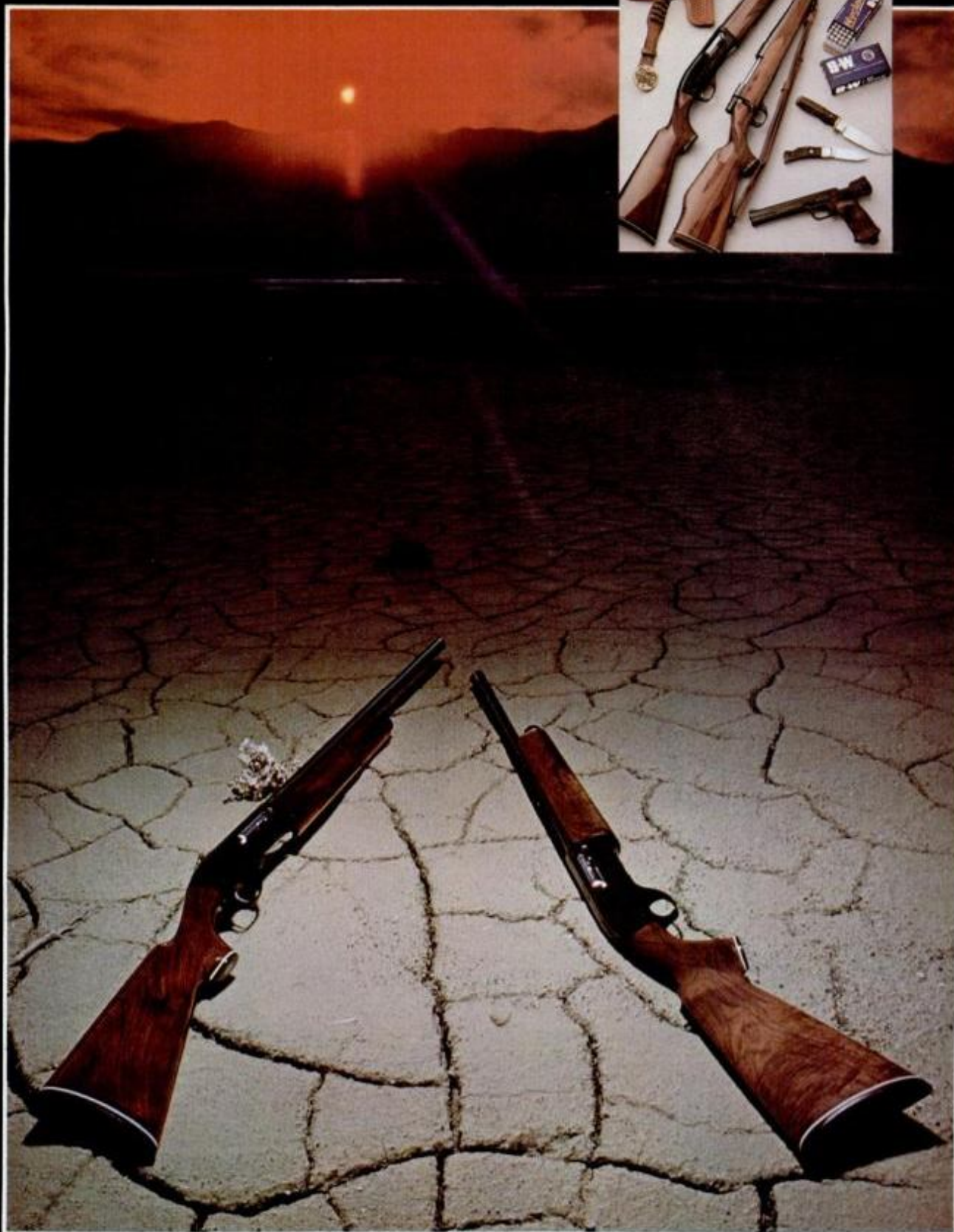


Country fresh menthol.
Mild, smooth and refreshing.
Enjoy smoking again.

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America has awakened to the functional beauty and proven quality of the Smith & Wesson Model 1000. Its balance, swing and pointing characteristics are matched by the excellence of its unique gas system. A system that provides sure performance from skeet to heavy field loads. On overheads, too. Now there's a new Model 1000. The Super Skeet. With a special recessed choke to improve patterns, fifteen vents to soften recoil and reduce muzzle jump and a host of features you'll want to awaken to yourself. Smith & Wesson, 2100 Roosevelt Avenue, Springfield, Massachusetts 01101.



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DETROIT LISTENING POST

Engagement announced: Washington and Detroit

No one's yet calling it a marriage, and it was made in the Middle East (not in heaven), but after years of adversity, our government and domestic automakers are saying they'll team up in the fight against dependence on foreign oil for transportation needs.

Following their presidential "summit conference" last spring, Detroit's top auto executives and Department of Transportation head Brock Adams are working on plans for cooperation in research toward the safer, cleaner, ultraefficient automobile of the future. Only about 5 percent of the automakers' budgets have been spent on pure research in recent years due to the tremendous expenditures required just to meet each year's safety, emissions, damage-resistance and fuel-economy standards. Now the government has agreed to plow hundreds of millions of dollars into research by the auto companies, universities and other organizations. The plan also calls for arm-twisting the oil companies into contributing some of their technical expertise toward creation of future vehicles that will use far less of their product.

GM's future family cars

We got a sneak look at a GM experimental car and a glimpse of what's coming down the road a few years hence for the family-car market. Labeled "Integrated Vehicle" and "2x3" (two passengers up front and three in back), the car is more a test bed for concepts and components than a specific model prototype, but it's most closely related to the full-size luxury sedans (Cadillac, Buick and Olds) that GM is considering building for the '84 model year.

It is powered by a small, transverse-mounted V8 driving the front wheels and features highly aerodynamic styling, a roomy interior and a rear-hatch fifth door. It is as tall as the Pontiac Bonneville we saw it parked next to, and nearly as long, but it should be capable of far better fuel economy due to lightweight design and materials throughout.

Interesting features include MacPherson-strut front suspension, rack-and-pinion steering, beam-type rear axle with trailing arms and self-leveling rear suspension,

fuel tank mounted under the rear seat (ahead of the axle), and fiberglass body panels bolted directly to a lightweight steel frame without rubber bushings.

GM's midsize cars are scheduled for their second major redesign in '83 with A-cars (Malibu, LeMans, Cutlass, Century) getting front-drive and A-specials remaining conventional-drive. The next year will see the second full-size model redo, at which time the top-line C-cars (Cadillac, Buick Electra, Olds 98),



GM '84 luxury cars (Cadillac, Olds, Buick) will have parts, materials, concepts from this "Integrated Vehicle" test car.

but not the B-cars (LeSabre, 88, Pontiac, Chevrolet), may go front-drive. The Integrated Vehicle could evolve into the 1984 C-car, but that decision is still being pondered.

More on gasohol

The 10-percent ethyl alcohol, 90-percent gasoline blend known as "gasohol" has been getting a lot of attention as one method of extending the nation's motor-fuel supplies. A small industry has sprung up to produce the fluid (using alcohol from waste grain products), an increasing number of retail outlets in the Midwest and elsewhere have begun selling it, Washington has encouraged its use, and Detroit automakers have extended their new-car warranties to cover it.

Since grain alcohol has less energy content than gasoline and tends to "lean out" the air/fuel mixture, performance of most cars suffers slightly with gasohol. Still, almost any car should be able to run on gasohol with no modifications and no damage to either engine or fuel system. Cold starting and running may be affected slightly, especially with late-model cars that are already tuned to superlean mixtures, but gasohol's slightly higher octane rating should reduce knocking and pinging in many cars. If it's available in your area, try it and see.

Propane power

Propane, a liquid petroleum gas (LPG), is a byproduct of oil drilling and is an alternate fuel for internal combustion engines that's been used for years. Recently, car owners have been clamoring for conversion information, and the subject is covered in this month's *Saturday Mechanic* on page 48A.

Other alternate fuels

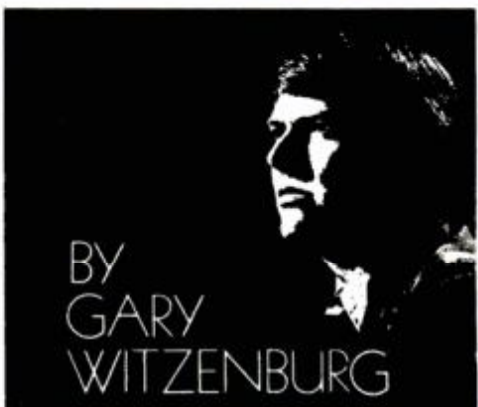
While autos and trucks are getting more fuel-efficient, and increasing usage of gasohol and propane could stretch fuel supplies to some degree, there is growing emphasis on development of entirely new fuels and production processes. Among the leading candidates are pure alcohol (either ethyl or methyl), synthetic fuels from coal and oil shale and hydrogen. Each has its problems, all are still costly, and none is very likely to supplant gasoline to any large degree for years to come. But these and other alternatives could eventually combine to ease the mounting pressure on crude-oil supplies—and the new fuels will get more cost-competitive as the price of gasoline continues to soar.

"Conservation, by itself, will not solve a scarcity," says GM president E.M. Estes. "It will only prolong it. At some point we, as a nation, obviously will be better off to put our billions into additional energy production rather than into further conservation. When a resource begins to get scarce and expensive, the thing to do is find a different resource to do the job."

Alternate engines

While some people feel there is nothing wrong with our highly developed internal-combustion engine—only

(Please turn to page 171)



**New products.
New features.
New technology.**



4.5 H.P. 9.8 H.P. 40 H.P. 70 H.P. 90 H.P. 140 H.P. 175 H.P.

MERCURY OUTBOARDS

**New for
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225
H.P.

25
H.P.

18
H.P.

3.6
H.P.

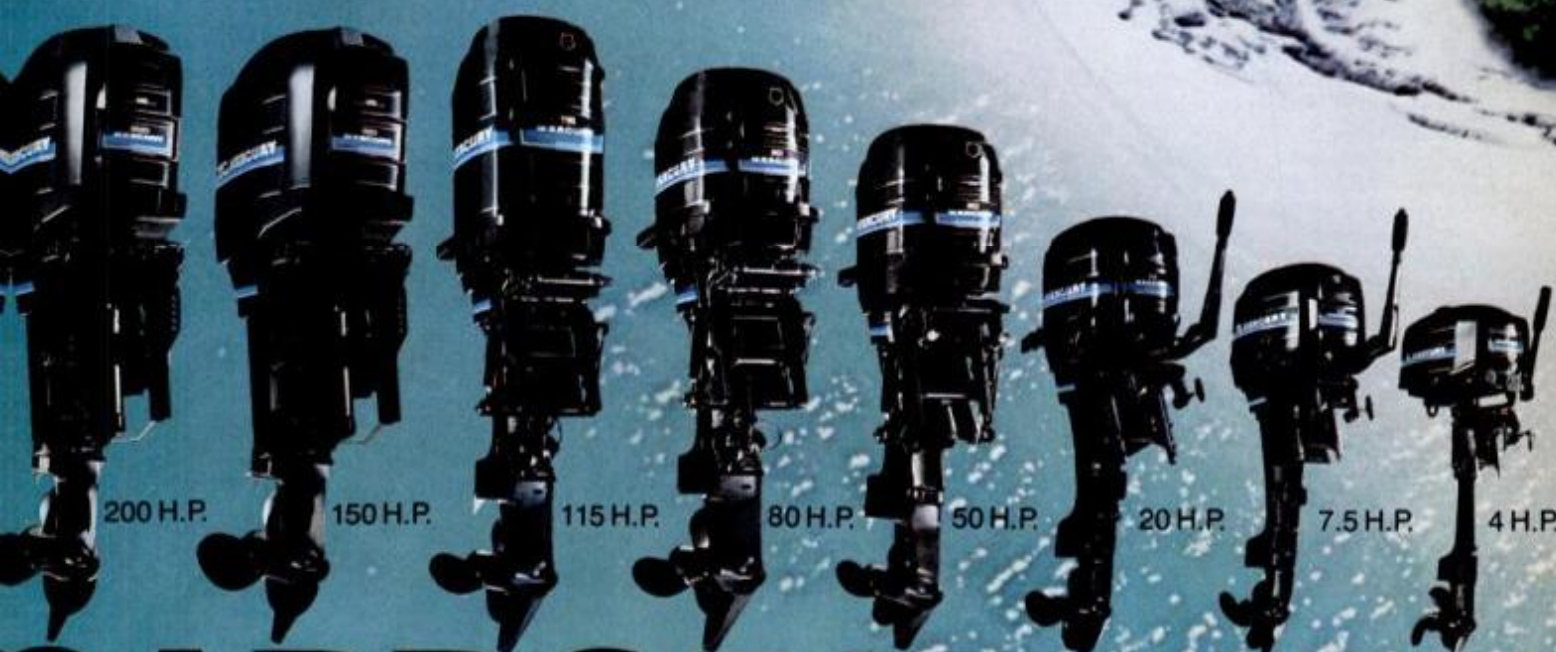
1980 is the year of the breakthrough for Mercury® outboards. Four new engines, three of them loop charged for better performance and fuel economy. Backed by 40 years of engineering for maximum reliability, and mechanical improvements throughout the line.

New Black Max.®

The new 225-hp Black Max V-6 Mercury delivers more power in a slimmer, lighter, more fuel-efficient design. And to handle all that power, it's engineered with a high-capacity, super-strong bearing system.

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200 H.P.

150 H.P.

115 H.P.

80 H.P.

50 H.P.

20 H.P.

7.5 H.P.

4 H.P.

BOARDS FOR 1980

...specially engineered for fast and easy servicing — routine maintenance requires no special tools.

Mid-range improvements.

The redesigned 40-hp Merc runs quieter than ever, but with more power and better performance. The 70-hp Merc, too, provides more performance with a new higher rpm range and a new gear ratio.

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Gleek new slimline gearcase design and new prop designs for better weed-shedding. Engines that will troll for hours without fouling the spark plugs — and that includes the high-horsepower Mercs.

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Match your needs exactly.

The 1980 Mercury line — more engines than ever before, and the broadest range of power in our history. Now you can match your needs exactly, for greatest fuel efficiency.

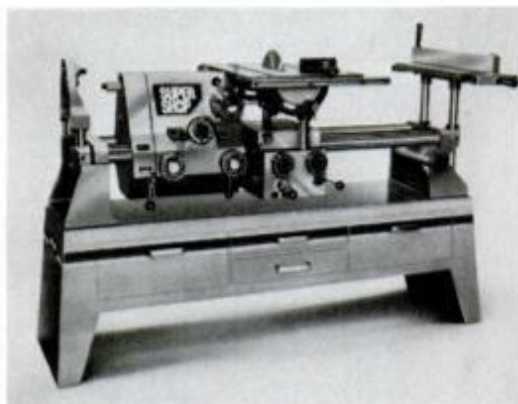
At Mercury, engineering leadership means we never stop making them better. We've given you just a few of the reasons here. Your Mercury dealer will be happy to give you the full story. Visit him soon.



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Mercury Marine, Fond du Lac, Wisconsin, Canada, Australia, Belgium

NEW NOW for home and shop



A

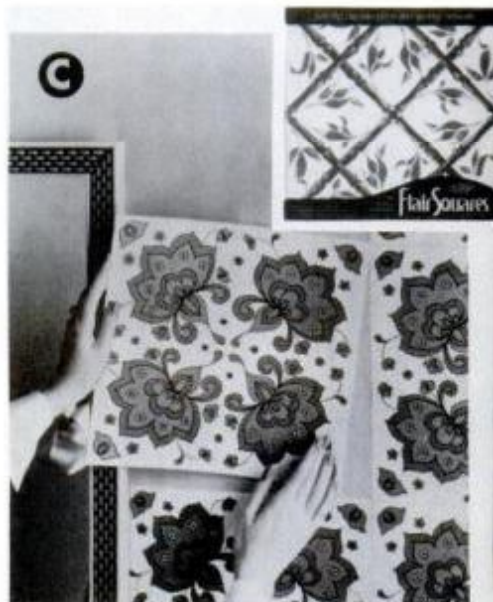


A The Fox Super Shop is a home power machine that can perform up to 15 tool functions. The basic configuration costs \$1500 and performs functions of seven tools: 10-in. table saw, wood lathe, variable-speed stationary router, 12-in. disc sander, high-speed wood shaper and vertical and horizontal drill presses. Eight accessories can be purchased for an additional \$2000. The basic machine measures 42x24x69 in. and is made for both wood- and metalworking. It plugs into 110-v. outlets and converts a.c. to d.c. The 500-lb. shop can be moved through standard-size house doors on optional ballbearing casters. It has four storage drawers. For buying information, write Fox Industries Inc., 6701 West 110th St., Bloomington, Minn. 55438.



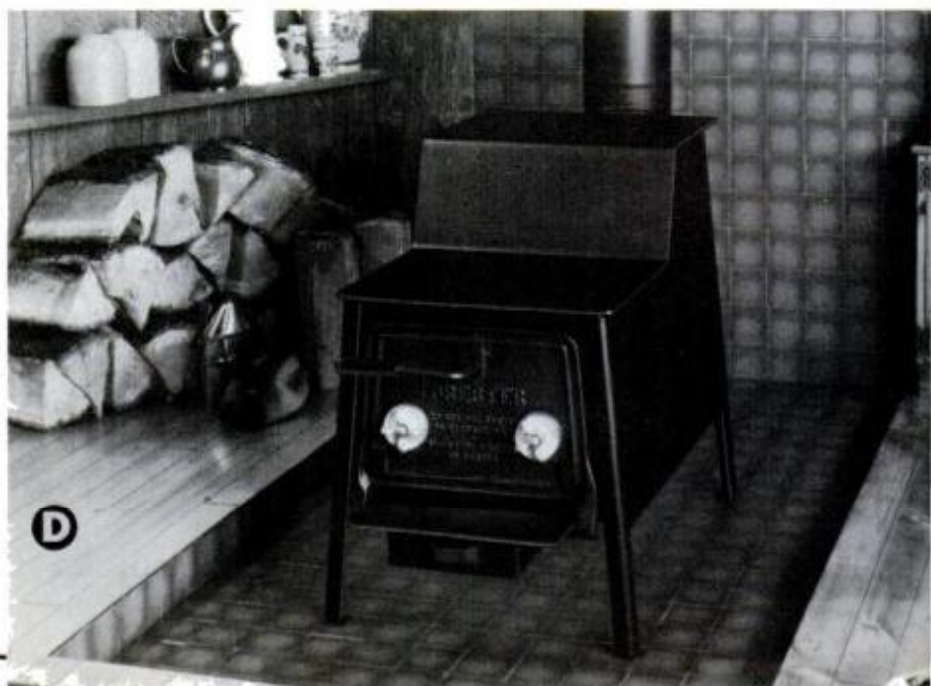
B

B A clothes hook called the Hang-Up attaches to door hinges via the hinge pin. It is made for lightweight coats, aprons and other frequently used hangables. It allows the door to swing freely. In textured neutral beige, it is made of molded plastic. Two hooks cost \$2. Stanford House, 1624 26th St., Rock Island, Ill. 61201.



C

C No special tools or skills are needed to apply Flair Square wallcoverings. Available in 24 prints, the prepaste paper tiles are designed for use in kitchens, bathrooms, entryways and similar areas. The paste is activated in water and the tiles are smoothed onto the wall. At department stores, a package of 15 squares costs about \$5. DuPont Co., 350 Fifth Ave., New York, N.Y. 10001.

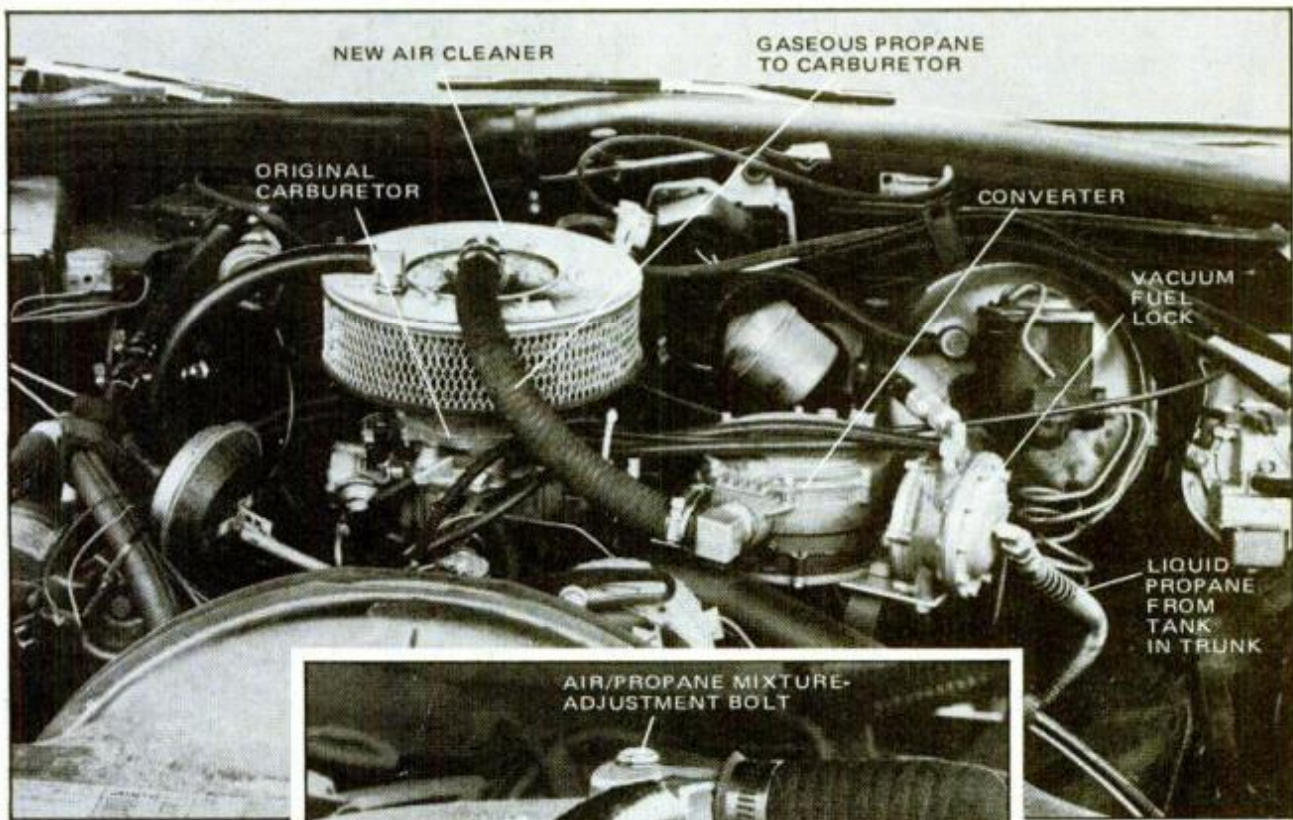


D

D This coal- or wood-fueled, steel and cast-iron stove by U.S. Stove has two top cooking surfaces and slanted sides, which are claimed to produce more radiant heat than straight-sided stoves. Two models are available: No. 280 holds logs up to 26 in., has a 6-in. flue pipe, weighs 405 lbs., is \$465; No. 320 holds logs up to 31 in., has an 8-in. flue, weighs 500 lbs., is \$590. Both have five-year written warranties against burn-out, warping or cracking of any steel or cast-iron part. U.S. Stove Co., South Pittsburg, Tenn. 37380.

FUEL FOR THE FUTURE

Answers to the questions about... CONVERTING YOUR CAR TO PROPANE



New components under the hood allow V8 to be switched between existing gasoline system and added propane system.

by Mort Schultz

Gasoline? Who needs it! I have propane." That's what Al Price told me recently.

"I converted my 1971 Cougar to propane in 1973 at the time of the last gasoline shortage," Price says. "I wanted an option and I found it in propane."

Price's Cougar had 50,000 miles on the odometer when he converted to propane. The day I saw the car in the driveway of his home in Fanwood, N.J., it had registered 110,673 miles and was still going strong.

The idea of having an alternative fuel prompted me to visit Propane Equipment Corp. in Tinton Falls,

N.J. This company is the largest installer of propane carburetion units along the East Coast and had converted Price's Cougar.

I came away from a meeting with vice-president Ron Cassell convinced that I needed the propane option for a coast-to-coast trip. I had the propane system installed before leaving. I now have, firsthand, the answers to these questions PM

readers have been asking about conversions:

Q: What's the main reason for installing a propane system?

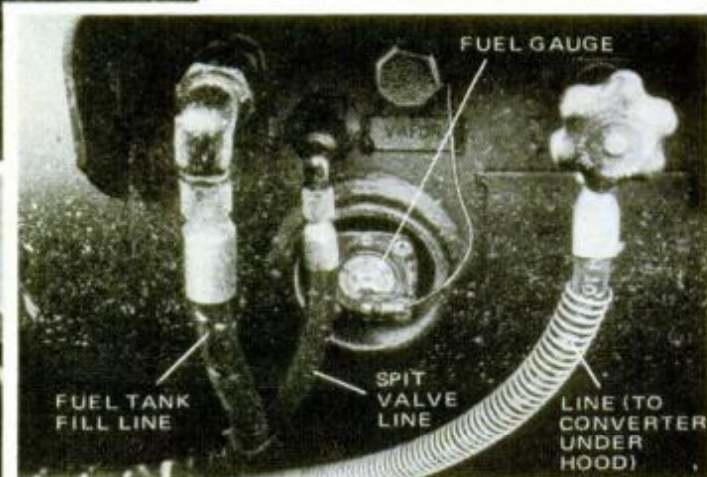
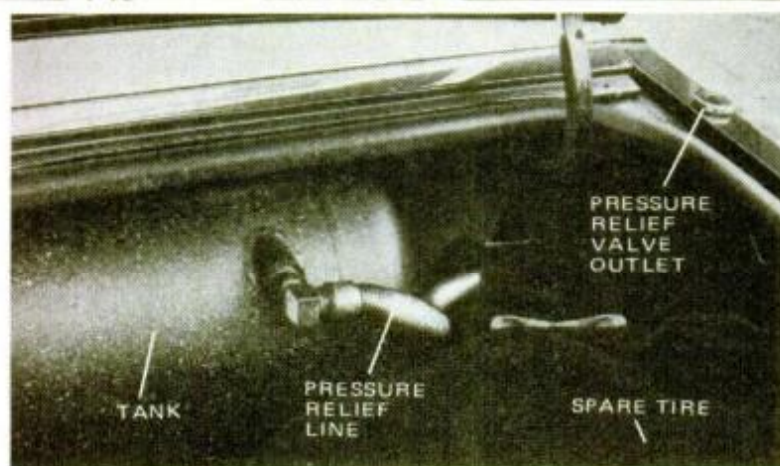
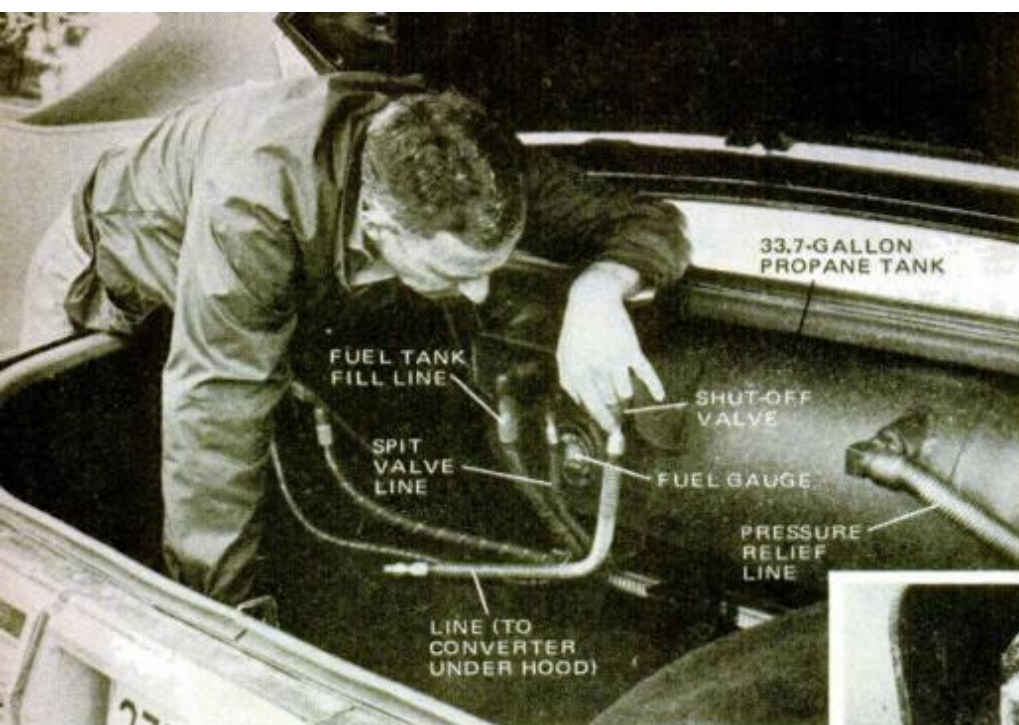
A: Availability. So far, anyway, there's an unlimited supply of propane.

Q: What's the price per gallon of propane?

A: At this time (June '79), I am paying 50 to 65 cents per gallon for propane. As with gasoline, currently selling for 86 to 95 cents per gallon of unleaded, the price of propane varies from supplier to supplier.

Q: How much does it cost to have a

(Please turn to page 48B)



Spare tire is moved to accommodate the propane tank and hardware in the trunk. Tank lies forward in the trunk (top left); firewall is added between the trunk and back seat. Detail (above) shows the lines and fuel gauge. Pressure relief line (left) is routed to valve installed in the right rear fender.

on either gasoline or propane fuel.

When changing from gasoline to propane, a control cable on the dash is moved halfway in. This closes a solenoid in the gasoline line and stops gasoline flow to the carburetor. The engine is now running on gasoline left in the float bowl of the carburetor. When this gasoline is used up and the engine falters slightly, the cable is then moved all the way in. This closes an air valve in the mixer and opens a vacuum-operated filter-fuel lock in the propane system. Liquid propane flows through a vaporizer-regulator and is drawn, upon engine demand, to

CONVERTING TO PROPANE

(Continued from page 48A)

propane fuel system installed?

A: About \$1100 to 1200 in a car; about \$800 in a pickup.

Q: What if I do it myself?

A: Even if you can get a company to sell you the hardware, installing it yourself is not wise. It is not easy to run lines, bolt the heavy fuel tank to the floor of a trunk and cut holes in the fender for the fill. Furthermore, once the installation is complete, the car should be run on a dynamometer to adjust for the optimum performance level.

But most important of all, a do-it-yourself installation generally overlooks important safety aspects. In adding equipment to my car, for instance, mechanics at Propane Equipment Corp. removed the back seat and installed a firewall between the propane tank and passenger compartment. They wrapped the fuel feed line from the propane tank to the carburetor with steel wire coil to prevent fuel-line wear. And they used a special detector to check for leaks.

Q: Isn't a propane tank likely to explode if your car is hit in the rear, and isn't propane likely to leak and catch fire if the car rolls over?

A: Not if good-quality equipment is used and the installation is done correctly. The tank is positioned well inside the trunk, up on the deck where the spare tire normally sits. If there is a rear-ender, the gasoline tank will "go" before the propane tank. Furthermore, in the event of fire, the propane tank, the walls of which are three times thicker than those of a gasoline tank, is practically impregnable. And propane won't leak in a roll-over accident since there are check valves that automatically seal lines.

Q: Where do you keep the spare tire now?

A: On the floor of the trunk. It does take up luggage space, but this is something you have to accept.

Q: Isn't the car's original fuel system removed when you add a propane system?

A: No. It stays in the car, giving me a dual-fuel system. The engine has the advantage of being operated

the mixer. The mixer is mounted adjacent to the carburetor and blends the proper amount of propane with air flowing to the engine. This air/propane mixture is fed through the throat of the carburetor into the engine.

When a fuel dealer pumps propane into the tank in my trunk, it is pumped in under a pressure of about 150 p.s.i. This pressure is maintained to keep the propane in a liquid state in the tank. The converter depressurizes and applies heat to the propane by engine coolant diverted to the converter (at the heater hose). The combination of depressurization and heat instantly transforms the liquid to vapor.

When changing from propane to gasoline, the control on the dash is moved all the way out. This opens the gasoline shutoff and air valve in the mixer. It also closes the vacuum-operated, filter-fuel lock in the propane line. The float bowl of the carburetor fills with gasoline which is the fuel the engine now uses.

Incidentally, a toggle switch on the control governs the reading of the car's fuel gauge. When the switch is flipped up, the fuel gauge

tells the amount of propane in the tank. When the switch is flipped down, the gauge shows the amount of gasoline. There is also a gauge on the propane tank.

Q: Is there ever a time when the two fuels, propane and gasoline, can mix together? If so, will the car blow up?

A: The only time the two fuels can mix is when I switch from gasoline to propane. Switching to run the engine on gasoline instead of propane, or on propane instead of gasoline, can be done as I'm driving, as well as when the engine is turned off.

When switching over to gasoline from propane, there is no chance of mixing fuels. I shut off the propane and turn on the gasoline by pulling the control handle which opens the air valve and gasoline shutoff. It takes a second or so for gasoline to fill the carburetor fuel bowl and begin flowing into the cylinders. The amount of propane left in the fuel system at the time of propane shutoff is just enough to keep the car running until the flow of gasoline begins.

However, before switching to propane from gasoline, I have to see that gasoline left in the carburetor bowl is consumed to prevent mixing the two fuels. I do this by pushing the control halfway, which shuts off the flow of gasoline to the carburetor, but does not open the propane port in the converter. The engine runs on the gasoline left in the carburetor bowl. When the engine begins to lose power as gasoline runs out, I push the control handle all the way in to open the propane filter-fuel lock in the converter to supply propane.

I learned from experience what can happen if the two fuels mix. I forgot the halfway position and pushed the control all the way to switch from gasoline to propane. No, the car didn't blow up. The engine simply stalled and wouldn't restart, because the mixture of gasoline and propane flooded the cylinders. I had to move the control handle halfway in and hold the accelerator pedal to the floor while cranking the engine to clear the cylinders. After driving a short distance, I switched to propane, using the correct procedure.

Q: What about emissions? Does propane pollute the air?

A: A lot less than gasoline. Pro-

Handle on control panel installed under dash lets driver switch from one fuel system to the other. Toggle switch connects to car's fuel gauge. In the up position, fuel level in propane tank is displayed on the gauge. In the down position, fuel level in gasoline tank can be read.

pane emits meager hydrocarbons, since 99 percent of propane is burned in the cylinders. Hydrocarbon is unburned fuel. Furthermore, with propane the engine can be adjusted so it emits only 1.0 to 1.5 percent carbon monoxide (CO) without affecting performance.

As for oxides of nitrogen (NOx), they too are very low. Oxides of nitrogen result from heat, which is controllable by adjusting the fuel mixture. With gasoline, heat is needed to control hydrocarbons, and the fuel mixture is adjusted accordingly. An exhaust-gas recirculation (EGR) system is added to the engine to control the NOx which results.

With propane, few hydrocarbons result and the fuel mixture is adjusted to reduce NOx. When an engine is running on propane, the EGR system is shut off because it isn't needed. (A vacuum switch at the propane converter shuts off vacuum from the carburetor to the EGR valve when you go into the propane mode.) Adapting the vehicle's emission control equipment to accommodate a propane system has been sanctioned by California, where emissions laws are tougher than elsewhere.

Q: How does the engine perform on propane?

A: Much better than on gasoline. Propane is a fuel of approximately

110 octane. My Pontiac 301-cu.-in. engine emits no spark knock on heavy acceleration, as it sometimes does on gasoline.

Q: Are there harmful effects on the engine?

A: None whatsoever. In fact, I've been told to expect longer engine life. Since propane in the engine doesn't form drops of liquid (like gasoline) to wash down cylinder walls and dilute motor oil, oil-change intervals may be extended. I can expect longer life from sparkplugs, too, since propane leaves no carbon. The engine is kept clean.

I'm so convinced of its beneficial effects that I use propane as my main fuel and keep gasoline in reserve. In doing this, however, I run the engine every couple of weeks on gasoline to prevent rubber parts in the carburetor from drying out, and I will make sure each tank of gasoline is consumed and replenished at least once every three months.

Q: Can I have my hatchback converted to propane?

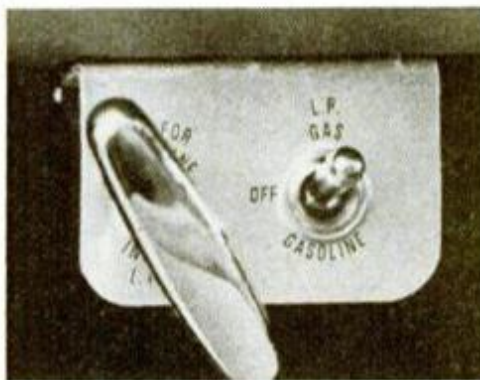
A: No. The law states that the propane tank areas has to be isolated from the passenger compartment by a metal vapor barrier. This cannot be done in a hatchback.

Q: Propane conversion of vehicles has been available for many years. You make it sound like the answer to the gasoline crisis. So why haven't more people converted their cars to propane?

A: Probably because of installation cost and these other disadvantages:

■ Mileage isn't as good as with gas-

(Please turn to page 48D)





CONVERTING TO PROPANE

(Continued from page 48C)

oline. Ron Cassell of Propane Equipment Corp. told me to expect a drop of 10 to 15 percent while operating on propane. I estimate my loss, presently, at closer to 20 percent. However, this is a rough estimate based on one tankful while operating the car over mountain roads.

Obviously, some of the loss in mpg is caused by the added weight. I have a 33.7-gallon propane tank in the trunk. When the tank is completely filled, it adds about 300 pounds to the car.

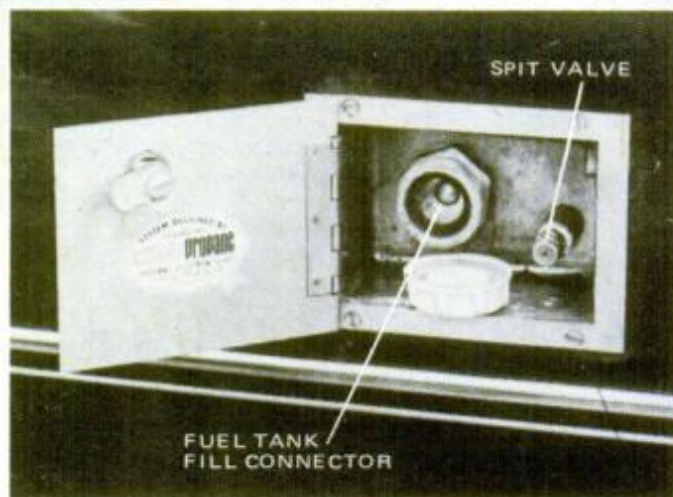
I don't find a local propane filling station on every corner. There are about 10,000 propane dealers in the United States and Canada, but only 2000 have the equipment needed to deliver propane as a motor fuel. This equipment is a special filler nozzle that seals to the propane fill on my car, allowing pressure to be maintained at the proper level, so the propane remains in the necessary liquid state.

Dealers are usually found in small towns away from major freeways. They are usually open only until 5:00 p.m. and few stay open on weekends. Incidentally, to keep from being ripped off, I patronize dealers who have fuel-delivery meters that record gallons and who let me know the exact price per gallon before delivery.

In some areas, propane-carrying vehicles are restricted from going through tunnels and over bridges. The fine for violation might be as much as \$1000. Avoiding these restricted places could result in your having to contend with some long detours.

Trunk space is reduced. Depending on the size of the propane tank,

Modifications made to install propane system include filler door cut into left-side fender. Lockable door covers the connector and spit valve, which maintain propane under pressure while filling.



there is a 20- to 30-percent loss of cargo area.

You can't "fill up" the tank. This is not actually a disadvantage, but does limit travel range between stops. (The combination of a tankful of propane and a tankful of gasoline gives me a range of about 800 miles.) The tank should be filled to only 80-percent capacity to allow for vapor expansion.

If you fill it up to the brim and excess pressure builds up, it escapes out the pressure-relief line. This line goes from the tank to a valve that was cut into the top of the right rear fender on my car. The pressure relief works similarly to the pressure-relief valve that is on a home water heater.

Q: Where can I find a dealer to install a propane system?

A: Call a dealer in your area who sells propane motor fuel (consult your local classified directory under "Gas-Liquefied Petroleum"). Make sure the installer is competent and handles reliable propane conversion equipment.

Some of the companies that make this equipment are Impco, Brummer Inc., Manchester and Century. Addresses of some propane-conversion shops are listed below, along with places to write to for more information on dealers in your area.

Keep in mind what Cassell of Pro-

pane Equipment Corp. told me: "If a fellow doesn't do the job right, he will build a potential bomb."

Installation must be done according to National Fire Protection Assn. Standard 58, *Storage and Handling of Liquefied Petroleum Gases*.

I have to warn you about something else. Installation companies I've spoken to, and those I've heard about, have waiting lists of six months to one year. They are backed up converting commercial vehicles,

including taxis, trucks, and telephone and utility-company vehicles. It seems some organizations are taking the lead from New Zealand, where practically every commercial vehicle now runs on propane. The idea behind the large-scale conversion is to provide more gasoline for passenger cars.

Q: Will I get more money for my car when I sell it if it's equipped to run on propane?

A: If the person buying the car is willing to pay your price. If not, the propane system can be removed and adapted to your new car if the car is large enough to accommodate the necessary hardware. The present cost of having this done is about \$300. **FM**

Propane-conversion shops

Propane Equipment Corp., 11 Apple St., Tinton Falls, N.J. 07724.

Alternate Energy Systems Inc., Dividend Dr., Peachtree City, Ga. 30269.

RPW Inc., 7402 L St., Omaha, Neb. 68103.

Moulden Supply Co., Box 1247, Jackson, Miss. 39205.

Tom Gorman Co., 6536 East 12th St., Tulsa, Okla. 74115.

Petrolane Clean Air Centers (There are several along the West Coast. For the one closest to you, write: Petrolane Inc., 1600 East Hill St., Long Beach, Calif. 90801.)

Petrolane Alaska, Box 2135, Fairbanks, Alaska 99701.

For more information:

National LP Gas Assn., 1301 West 22nd St., Oak Brook, Ill. 60521, or get in touch with your local LP-Gas dealer.



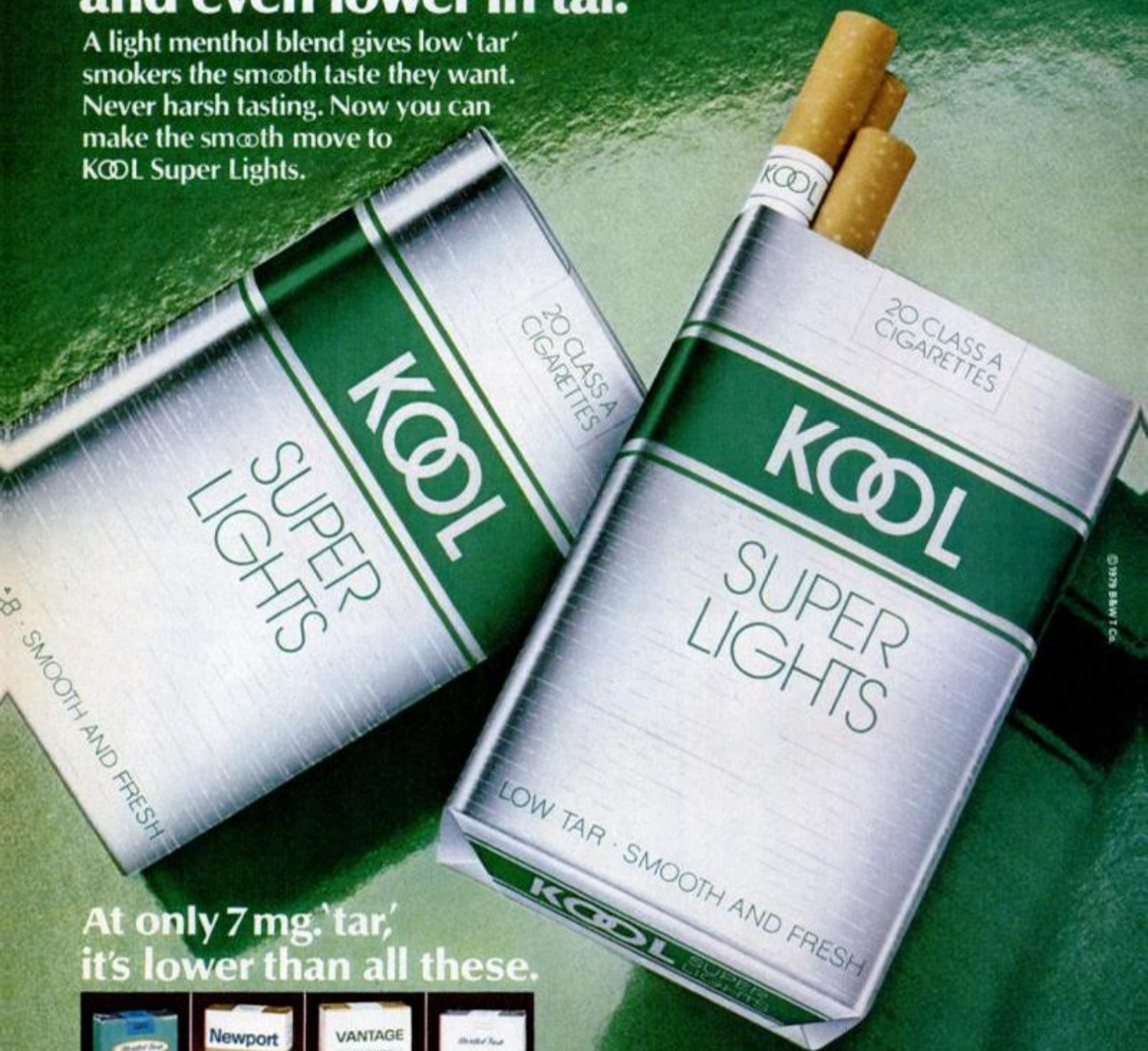
Of course you can afford it. Think of all the money you've saved drinking ordinary Scotch.

12 YEARS OLD WORLDWIDE • BLENDED SCOTCH WHISKY • 86 PROOF • GENERAL WINE & SPIRITS CO., NEW YORK, N.Y.

KOOL SUPER LIGHTS

Now smooth gets smoother
and even lower in 'tar.'

A light menthol blend gives low 'tar'
smokers the smooth taste they want.
Never harsh tasting. Now you can
make the smooth move to
KOOL Super Lights.



At only 7 mg. 'tar',
it's lower than all these.



16 mg. 'tar' 18 mg. 'tar' 11 mg. 'tar' 10 mg. 'tar'

7 mg. "tar". 0.7 mg. nicotine av. per cigarette by FTC method.

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

CAR CLINIC

SOLUTIONS FOR MECHANICAL HEADACHES

BY MORT SCHULTZ



Fair-weather friend

When my 1979 Dodge Colt with manual transmission was delivered last March, I found it difficult to shift gears. The dealer told me the trouble would go away as I used the car. He was right, because by the end of April shifting became easier. Is this what normally happens to a car with manual shift?—Ernie Brewster, Grand Rapids, Mich.

Not normally. The transmission should shift smoothly and easily from the first day. The transaxle is factory-filled with SAE 80 gear oil, which thickens in cold weather. It's this thickness that causes hard shifting in the Colt and '79 Plymouth Champ. Although it has disappeared, hard shifting will probably return when the weather turns cold again.

Chrysler suggests you drain the SAE 80 gear oil and replace it with SAE 10W-30 engine oil. Doing this will also help prevent gear noise during hot weather. Some dealers have been cutting the SAE 80 gear oil in half with automatic transmission fluid. Chrysler says, "No—don't do this." It will make oil too thin and result in a sharp decrease in the protective qualities of the lubricant.

Snow job

I bought a new 1978 Jeep Cherokee with six-cylinder engine, stick shift and locking rear end. In snow only, this vehicle shakes its back end something awful. I fear continued use will damage the rear end and universal joints. Please help.—E.A. Jarnot, Lavina, Mont.

In snow only? Start inside the locking rear end. My best guess is that one or more of the clutches are bad.

Welcome to the fold

My 1976 Ranchero has had an awful vibration at speeds of 50 mph and higher. I've had several mechanics go over the vehicle and they all swear everything that can cause vibration checks out perfectly. Do you think

that they are correct?—Doug Wall, Gastonia, N.C.

Assuming your mechanics are correct—that everything known to them has been checked—it's time to check the "unknown." Ford says high-speed vibration on this vehicle, and others (see below), can be reduced or eliminated by installing 36 dampers on each rear spring. Dampers are 1-in.-long pieces of 1½-in. o.d., 1-in. i.d. rubber hoses. Hoses and clips are contained in a drive-line vibration damper kit (part No. D2SZ-5A669-A).

Ford says, in addition, that after you check the axle shaft alignment, a rear axle vibration damper should be installed. Its part No. is D50Z-4A263-A. Finally, if vibration is not reduced to a satisfactory level, have a new ring and pinion gear set installed in the rear axle. A Ford mechanic has necessary instructions available in article No. 1419 of service bulletin 108.

The vibration you've been experiencing has also been a bother with the 1975 and 1976 Ford Torino and Elite, and Mercury Montego and Cougar. The fix outlined here ap-

plies to cars with 9-in., 3.00-to-1 rear axles, except those equipped with 460-cu.-in. engines and dual exhaust.

Posi-reaction to Posi-Traction

The Posi-Traction rear axle of my 1978 Chevrolet Caprice is chattering on turns. Advice, please.—John L. Preston, Terre Haute, Ind.

Flush and refill it, like this:

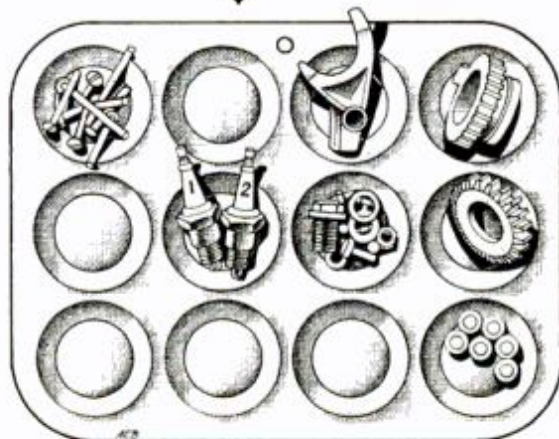
1. Drive the car until the axle is hot. About 10 miles should do it.
2. Remove the magnetic fill plug and let the lubricant drain.
3. Clean the fill plug and then reinsert it.
4. Fill the axle with GM GL-5 lubricant, which is available from a GM dealer under part No. 1052271. While at the parts counter, get four ounces of special rear axle additive, part No. 1052358, but do not add it to the axle at this time.
5. Raise both rear wheels on sturdy stands and take safety steps, such as setting the handbrake and chocking the front wheels. Run the power train in DRIVE or high gear for three or four minutes, but don't exceed a speed that's equivalent to 30 mph. Accelerate and decelerate gradually.
6. Shut off the engine and drain the lubricant.
7. Refill with fresh GL-5 lubricant, and this time add the four ounces of special rear axle additive.
8. Drive the car through a minimum of 10 figure-8 loops.

This should eliminate chatter. As mileage accumulates, you may again get chatter or noise from the rear. If this happens, you should add another four ounces of special rear axle additive.

(Please turn to page 52)

Lost weekend

A disorganized Saturday mechanic may find it takes him until Sunday to finish a job he should have completed the previous afternoon. Why? Because he lost some parts and couldn't figure out where or how others went. A solution to this dilemma can be an ordinary muffin pan. Put the various parts in the pan as they are removed and label them to indicate their position in an assembly. If necessary, make sketches of how parts fit. The few extra minutes you spend organizing work when you start out can save you hours of frustration later in the day.



CAR CLINIC

(Continued from page 51)

Five-and-dime solution

I have a 1970 Chevrolet Chevelle six-cylinder. When the car idles, it throws smoke out the exhaust pipe. The engine uses two quarts of oil every 300 miles, but there are no leaks. The Chevy garage installed new head gaskets and valve stem seals, but this didn't help. Any ideas for solving this problem?—Pat Reynolds, Tahoe City, Calif.

Yeah. Get the car to a mechanic who won't nickel-and-dime you to death. The engine is apparently a candidate for major overhaul, including rings and bearings. If you do a little bit here and a little bit there, a job that's going to cost you a bundle anyway will cost you a fortune in the end.

And the sun shone

I recently had an experience with my son's 1978 Pontiac Sunbird V6. Would you believe it had the audacity to start, stall and refuse to re-start in front of the home of PM's Car Clinic editor?

"Okay. Prove what you preach to others," Steve said. "Fix it."

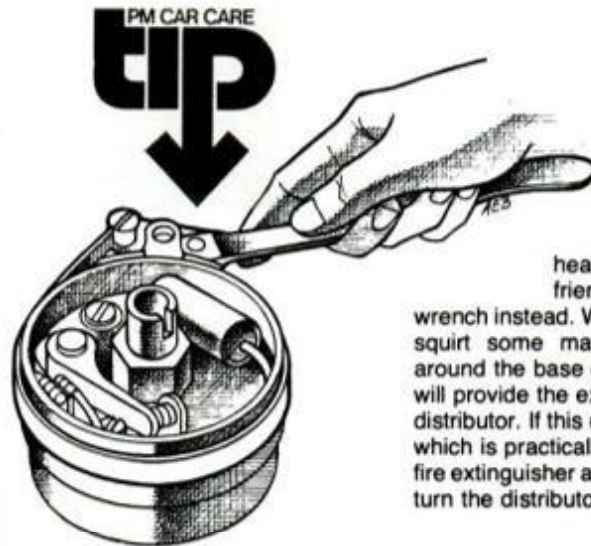
No problem establishing that gas

wasn't getting to the carburetor. A few pumps on the accelerator pedal, as I looked down the carburetor throat, told us that. "Plugged fuel filter" was my first thought, so I wrenched open the carburetor inlet, removed the filter and spring, closed up the carburetor inlet and tested my theory, which was—wrong! Still no gas.

The trouble, therefore, probably had to be a plugged fuel line (re-

mote) or (gulp!) a bad fuel pump. Not relishing the thought of running to Pontiac for a new fuel pump and installing same (it was raining), I started toward the house for a cup of coffee.

Halfway there it suddenly dawned on me that the Sunbird's blessed fuel pump is electric, and that this electric pump won't work until the engine builds up about seven pounds of oil pressure. This is a safe-



'Frozen' distributor

Next time the distributor freezes and doesn't budge as you try setting ignition timing, head for the toolbox. Not for a hammer, friend. Pick up your adjustable oil filter wrench instead. Wrap it around the distributor housing, squirt some manifold heat control valve lubricant around the base of the housing and turn. The wrench will provide the extra leverage you need to loosen the distributor. If this doesn't work, there's another method which is practically foolproof. Shoot some CO₂ from a fire extinguisher around the base of the distributor, then turn the distributor, using the oil filter wrench.

LOOK SHARP!

Stant caps protect your cooling system like no others can

When your car is checked for fall, whether you do it or your service station does, take a good look at the radiator cap. This important component is easy to overlook. But a faulty cap, or one of low quality, may not keep your cooling system pressure within safe limits. So when you replace the cap, take another good look. Look for Stant. Don't settle for just any cap. . . the safest, most dependable radiator cap available anywhere. And for extra safety, install a Stant Lev-R-Vent® Pressure Cap. . . for expert tips on cooling system care, write for "The Stant Cooling System Fact Book." Send 25¢ to:

STANT
STANT MANUFACTURING CO., INC.
Connorsville, Indiana 47331
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Collection priced from \$35 to \$60.

ty feature. If the engine loses oil pressure, the pump cuts off automatically. This stalls the engine, preventing serious damage that may occur as a result of oil pressure loss.

One thing that can cause a drop in oil pressure is an electric wire that is popping off the oil pressure sending unit.

Well, we lucked out. The wire terminal was half on, half off the sending unit. With the wire terminal properly placed, the carburetor bowl replenished itself, and the engine started. It's a good idea to keep this tip in mind if there happens to be an electric fuel pump in your family.

Return to radials

I bought a 1978 Concord four-door sedan (258-cu.-in. engine) from an authorized AMC dealer. The car had been a loan car and, at the time of purchase, had been driven 10,500 miles. The dealer replaced the car's original tires with a new set of Good-year D78x14 tires, and therein lies my problem.

After only 7000 miles of use, the tires show extensive wear. Inflation is according to recommendation and front-end misalignment has been ruled out. A front-end mechanic tells

me the tire size is too narrow for the wheel rim size (6.5 in.). He said I should switch to a wider-tread tire, possibly H size. I returned to the dealer who told me my whole trouble is being caused by wrong tire inflation pressure. I'm lost. Can you provide any help?—M.C. Cooley, Inglewood, Calif.

Your front-end mechanic has the right idea, but the wrong information. AMC doesn't use a 6.5-in. wheel size.

The nub of the problem may be that the dealer replaced the car's original radial tires with nonradials. Radial tires on the Concord require a 6-in. rim size, while nonradial tires need a 5-in. rim size.

What's the solution? Assuming your problem fits the description, replace the D78x14 tires with radials or replace the 6-in. size wheels with 5-inchers. After you have made those adjustments, recheck alignment.

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.

SERVICE AND SAFETY TIPS

■ VW has issued this warning to those owning diesel-powered Rabbits and Dashers: Do not use starting fluid, a fuel line additive or gas line antifreeze. It may very well damage the diesel engine.

■ You may have a shot at correcting drivability problems (stalling, bucking and so on.) during engine warmup of all 1974-78 Chrysler Corp. cars and trucks with six-cylinder engines. Install a vacuum delay valve (part No. 4104371) in the heated intake air door vacuum hose of the air cleaner. Cut the hose 4 inches from the vacuum motor and insert the valve with its small-diameter end toward the vacuum motor. The valve keeps the snorkel door closed for a longer period, which, in turn, helps the engine to warm up in a shorter period of time.

■ Check the front brake hoses of your 1979 Ford LTD or Mercury Marquis for chafe marks. Over 160,000 of these models are being recalled to replace wrong brake hoses that can be chafed by the turning front wheels. If you have one of these cars and haven't received a recall notice, stay on top of those hoses. If there's any sign that a hose is about to rupture, don't wait for a notice. See your dealer at once.

■ If you happen to own a 1979 Buick that's equipped with a turbocharged V6 engine, don't listen to owners of 1979 non-turbo Buick V6s. Your sparkplug gap should be .040 in.—theirs is .060 in. **PM**

Great savings on great tools.



SAVE \$34.51
OVER 49%*

This 20 pc. $\frac{3}{8}$ " dr. socket set makes general automotive and maintenance jobs go smoother. Set #4520-79

ONLY \$34.98 suggested SuperSaver user price



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This 21-pc. $\frac{1}{4}$ " dr. socket set comes with the perfect assortment that makes working on cars, appliances or around the house a breeze. Set #4921-79

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OVER 41%*

For working in tight spaces, this brand new S-K 16 pc. $\frac{1}{4}$ " & $\frac{3}{8}$ " socket set can't be beat. Comes with $\frac{3}{8}$ " stubby ratchet and $\frac{1}{4}$ " Thumbwheel ratchet. Set #4216-79.

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*Savings are based on suggested user prices of individual pieces.

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T.M.

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In the garage, around your home, S-K tools are second to none.

Ernie and Junior are the only duo ever to win three consecutive NASCAR stock car championships. Another key member of the winning team—American-made S-K tools.

Race after race, year after year, S-K tools deliver. They're dependable. Precision-acting. You can actually feel the quality when you work with them.

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FULL LIFETIME WARRANTY

SATISFACTION GUARANTEED. If you, the consumer, are not completely satisfied with any S-K[®] tool, 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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PM ELECTRONICS MONITOR

CB—getting higher?

CB of tomorrow may be nothing at all like today's often crowded, confusing operation. Instead of being lucky to talk to a fellow 20 cars ahead of you, reliable communications may stretch 20 or 30 miles with only a handheld walkie-talkie.

Seems that, at press time, the FCC was rumored to be on the verge of releasing an official Notice of Inquiry that would be concerned with opening new CB channels in the 900-MHz portion of the radio spectrum. If this sounds like more of the same after the mess and futility CB went through when the new "Top Twenty" channels were opened up, it's not. A frequency of 900 MHz is much higher than the present 27-MHz band. Because a 900-MHz band would likely be more spacious (wider) than the present band, we can assume the FCC would authorize FM communications on this new band. With FM, an entirely new form of operation becomes feasible.

Radio amateurs, on their two-meter band located at 144 MHz, use FM along with repeaters. A repeater is a station with a good antenna that picks up and rebroadcasts weaker signals. So, even though most radio waves higher than 30 MHz go only as far as line-of-sight, a repeater with a tall or high-up antenna gives reliable communications in a sphere that can be 30 miles in diameter.

The hams use their FM repeaters not only for general talking and emergency communications, but for such esoteric things as running telephone calls from their mobile radios to anyone with a phone. It is one of the most popular modes in ham radio.

A 900-MHz band might offer the same kinds of operation to CBers. However, ham operators are quite professional in their use of two-meter transceivers. Whether the FCC would risk the possibility of repeaters that repeated mostly CB chaos remains to be seen. Perhaps, if they go the FM route, a new and closer-policed form of CB license might be in order.

No matter what happens—if the 900-MHz band proposals ever solidify—CB will never be the same again!

Flash! Computers gain speed

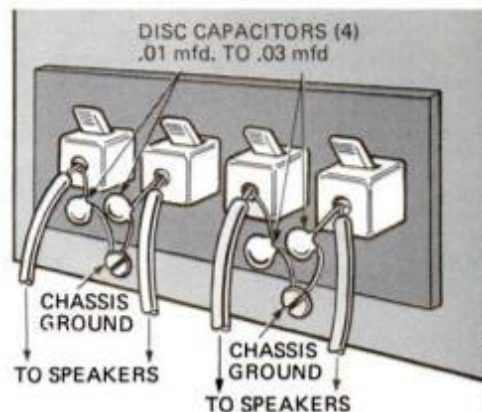
One of the limits to computer design is the speed with which a circuit can "switch" or change state

Coping with interference

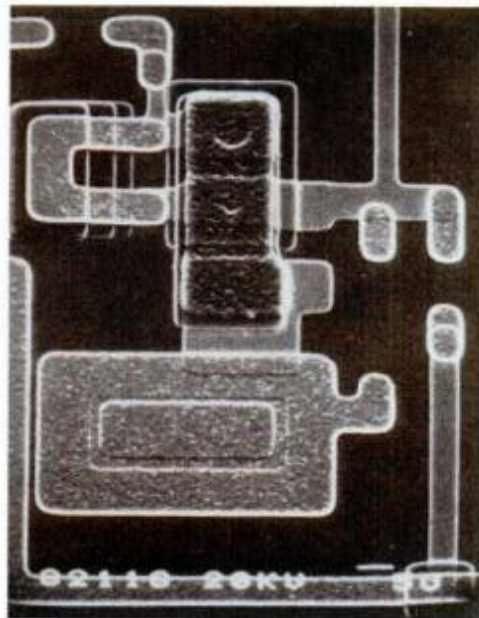
Have you ever been listening to your favorite hi-fi record or FM station only to have it interrupted by interference from a neighboring CB or ham radio set? If so, a few things might help you cope.

Turn your volume up and down. If that does not affect the volume of the interference, try our capacitor cure, illustrated here. Audio frequencies, because of an effect termed impedance, "see" the capacitors as having very high resistance, while the interfering radio signals see them as direct shorts to ground. So the capacitors switch the music and interference apart from each other.

Other things you can try are different lengths of speaker cable, cleaning the speaker terminals and using shielded cable. *The Radio Amateur's Handbook* is a good reference volume for other aids. It's available for \$9.75 from the American Radio Relay League, Newington, Conn. 06111.



Incidentally, the fault is usually in the receiver and not the transmitter. Bills are now before Congress to add better protection to receiving equipment. You might write your congressman in order to express your own views.



This is a scanning electron micrograph of one of the experimental computer circuits that operate at near the speed of light.

from negative to positive. These changes in state—translated into binary numbers—are how a computer "thinks."

Slower circuitry requires more cycling time. IBM has just announced an experimental form of the Josephson circuit which can switch at speeds very close to the speed of light. That's at least 10 times faster than everyday computer circuits. It also generates much less heat.

Applications for this technology range from artificial intelligence to automated assembly lines.

Time for talking

Windert Watch Co. has unveiled a solar-powered wristwatch that not

only tells the time conventionally—but can speak it out loud. Not only that, it is offered in a choice of four languages—French, German, English and Spanish.

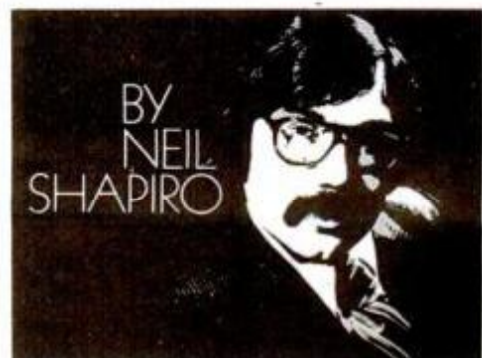
We heard its mezzo-soprano tones and were impressed. It should be available soon at a price of under \$100.

Pretty mushrooms

An impressive software program from Muse Software is titled "Three-mile Island." It puts you right in the control room of a nuclear power plant that keeps breaking down at the slightest whim. It's your job to prevent meltdown of the reactor core.

The program draws detailed views of the containment building and pump room, along with all the valves, pumps and filters. We found it to be most challenging—indeed, we never succeeded in averting final disaster. The program is available for \$39.95 from Muse Software, Box 13365, Baltimore, Md. 21203, and runs on a disc-based Apple II.

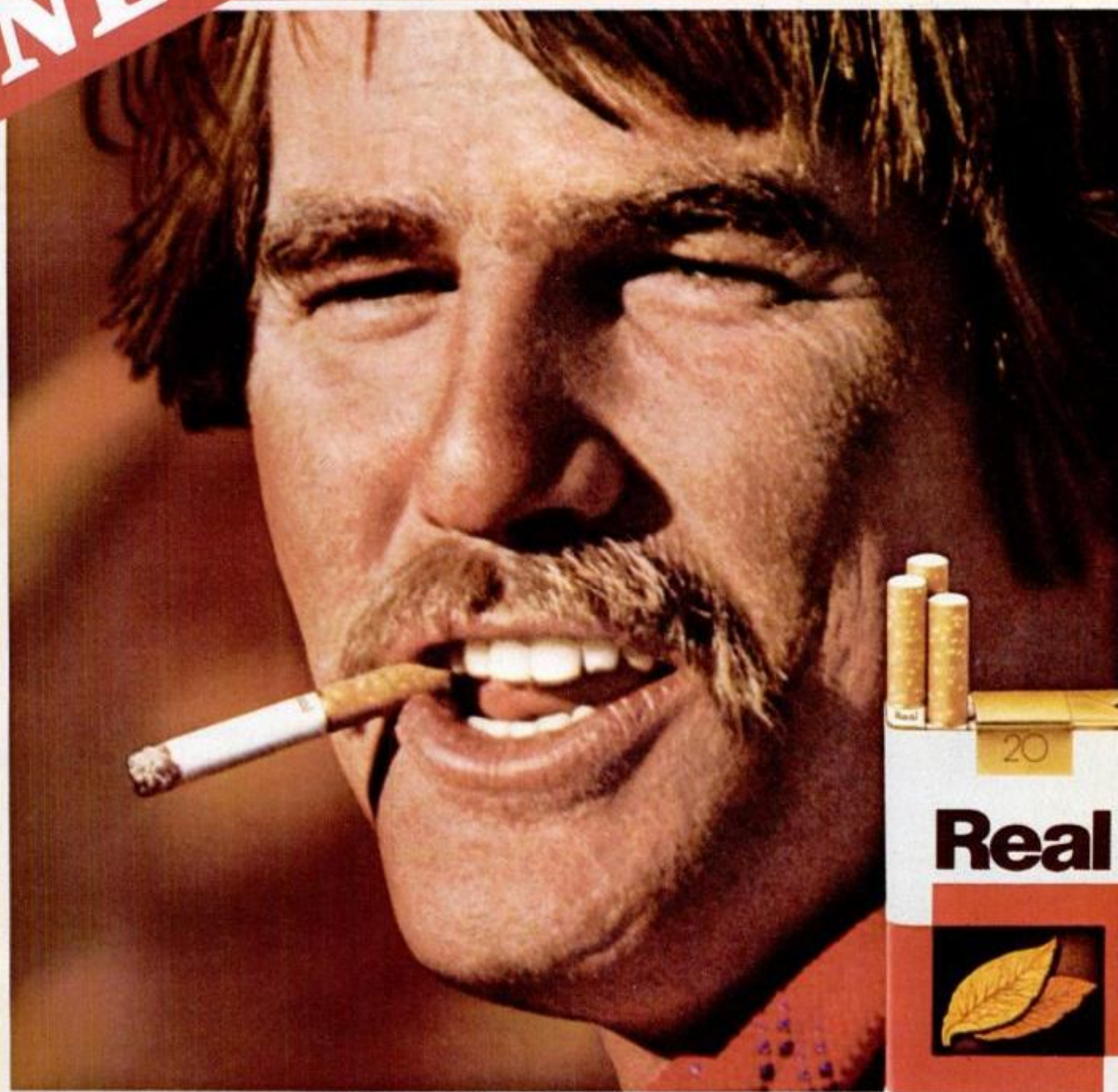
What next? How about trying to solve the gas crisis? **FM**



NEW!

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

10 mg. "tar", 0.9 mg. nicotine av. per cigarette by FTC method.



© 1979 R. J. Reynolds Tobacco Co.

***"Taste Real's new golden taste!
Richer...mellower than before"***

Real's new golden leaf tobacco blend does it.
Tastes richer...mellower...more satisfying.
A taste that's pure gold.

The smoking man's low tar

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PM WORKBENCH

PM EXAMINES PRODUCTS & SERVICES

New book for floor framers

If you're planning an add-on, you might want the latest framing booklet from the Small Homes Council in your toolbox. Its eight pages have simple illustrations about sills, beams and girders to support floor joists, joist materials (sizes and spacing), bridging between joists, subfloors and underlayment, insulation, vapor barriers, termite control and special floor systems. A copy of *Wood Frame Floor Systems* (publication F4.0) is 40 cents from Small Homes Council, University of Illinois, One East St. Mary's Rd., Champaign, Ill. 61820.—H.W.

Cabinet resurfacing panels

Trimmable U-Do-A-Door vinyl panels can be used to resurface metal, wood and painted kitchen cabinets, says the maker. The thick, durable panels are available with shaped, raised moldings stamped in the surface and in four variations of wood grain—Cortina Pecan, Presidential



Prepasted panels complete this kitchen.



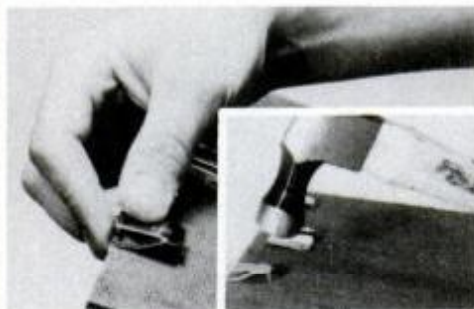
Peel, position and press protective paper.

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.

Walnut, White Cherry and Butternut. A brochure describing the product, order forms and a sample panel are \$1.95 from Galaxy Kitchens Inc., 6727 N.W. 16th Terrace, Fort Lauderdale, Fla. 33309.—H.W.

Clips that mount pictures

Swiss Clips eliminate the need for frames when hanging pictures. The matted picture shown was hung with six of them. To use them, you simply slide the clips over the edge of the picture and backing, with the



Clip is simply slipped on the picture, then locking pin is tapped into backing.



Six clips ready this picture for hanging.

tips of the springs resting on backing. With the picture on a flat surface, you then tap the pin in, as above. Four clips for small and medium pictures are \$2.50; six for large pictures, \$3. From European Supplies, 8824 East Kenyon Drive, Denver, Colo. 80237. Hangers for mounting pictures on wall are also available.—H.W.

Easy-to-use gimlets

It doesn't take too many hours in the workshop to learn that it is a must to bore pilot holes in certain woods if you want to avoid splitting them. This handy set of four gimlets in 3-, 4-, 5- and 6-mm sizes is perfect for starting wood screws and boring

holes through most fragile veneers. The set is priced at \$5, plus postage, from Fair Price Tool Co., Box 627, La Canada, Calif. 91011.—H.W.



New gimlets fit your hand comfortably. Author found them easy to use for boring starter holes for screws in easily split wood stock and veneers (left). Set of four—in 3-, 4-, 5- and 6-mm sizes (below)—is \$5. For convenience, all four can be hung on an individual toolboard-mounted nail or hook.



Helpful plumbing book

A solidly written book on plumbing has just appeared on the scene. It's *Modern Plumbing*, by E. Keith Blankenbaker, an associate professor at Ohio State University. The book includes the latest installation techniques and materials update. Over 700 illustrations. Costs \$12.80. Goodheart-Willcox, 123 West Taft Drive, South Holland, Ill. 60473.—H.W.



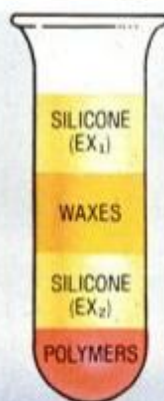
Comprehensive book is must for would-be plumbers and is available at booksellers.



“Extras” make TURTLE EXTRA® car wax extra long lasting.

TURTLE EXTRA car wax is the longest lasting car wax Turtle Wax has ever made.

Extra ingredients make a difference.



TURTLE EXTRA car wax is a combination of imported and domestic waxes, polymers and silicones that give your car's finish extra shine, extra protection.

We put in special waxes from South America for high gloss. We put in costly waxes from Europe for a long lasting shine.

We put in “space age” polymers that actually lock-on to a car's finish for extra protection.

We put in not one but two amino functional silicones. Silicones that are regarded as the most advanced shine and durability agents in the automotive industry.

TURTLE EXTRA car wax is 100% Guaranteed.

If, in your opinion, TURTLE EXTRA car wax does not out-shine, outlast, or outperform any car wax, liquid or paste, return unused portion to Turtle Wax for 100% refund.

\$2.00 Refund Offer.

Look for special refund offer on TURTLE EXTRA car wax packages. In liquid or new soft paste.



THE PM GARAGE

CAPSULE REPORTS ON NEW AUTO PRODUCTS

Make a clamp

Worm-drive hose clamps are among the handiest items you can have. Not only are they the best substitute for the cheap clamps that come with coolant hoses, but also for installing circular accessories, as a replacement for the plastic clip that holds the air cleaner snorkel duct, even as a make-your-own balance weight for propeller shafts.

You may have put two small clamps

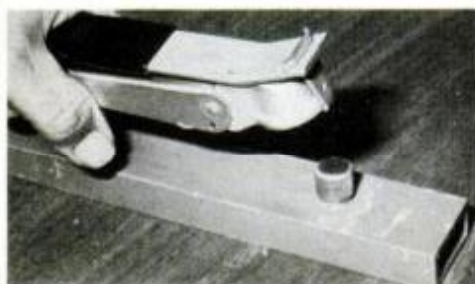


You can make your own clamps with kit.

together to make one larger one, but you often don't have the right sizes. Even more frustrating is the fact that there are two or more screw heads, making installation difficult. One manufacturer offers Mak-a-clamp, a kit that includes slotted sections, male segments to fit into the slots, and screw head sections with male segments. The kit, sold for approximately \$5 at auto supply stores, lets you make three clamps of almost any size that you would find to be useful, either on a car or around the house. The manufacturer is Breeze Clamp Co., 100 Aero-Seal Drive, Saltsburg, Pa. 15681.—*Paul Weissler*

Wiper-arm remover

Would you spend \$3 for a tool you might use only once in years, when you can do the job it performs with a screwdriver or two? Take a close look at this one before you say no.



Wiper arm detaches easily with tool.

It's a windshield wiper arm remover. It has a triangular hook that grabs the end of the arm, and once it's on, you just clamp the tool's handle against the arm (as shown) and lift up.

If you've made use of the screwdriver approach, you've surely scratched the paint all around the linkage's splined post.

I've gone years without having to pull off an arm, but there have been times I had to do the job twice in a week. This tool works so easily that even if an arm never goes bad, you'll pull it out of the toolbox to show your friends. So even as an adult toy, it definitely appears to be worth \$3. The manufacturer is the Lisle Corp., Clarinda, Iowa 51632.—*Paul Weissler*

Flexible nut driver

Nut drivers are great for turning down finely threaded screws and nuts quickly. Unfortunately, the best applications usually don't offer a straight-on approach that satisfies the driver.



Flexible nut driver is handy near engine.

A simple answer is a flexible rubber driver that accepts any 3/8-inch-drive socket. It's also possible to use it as a sparkplug starter. The price is under \$3 at your local parts store. It's made by Thexton Manufacturing Co., box 35008, 7685 Parklawn Ave., Minneapolis, Minn 55435.—*B.H.*

Silicone cartridge

The room-temperature-vulcanizing (RTV) silicone rubber is fast conquering the replacement gasket market. After all, squeezing out a bead of silicone for the thermostat housing, water pump, valve, timing and rear axle covers, oil pan, fuel pump and so on sure beats buying a separate gasket for each. Not only is the silicone cheaper, but it's always a perfect fit and it seals better and longer. Of course, squeezing it out of a toothpaste-type tube isn't the ea-



Cartridge and gun makes "gaskets" fast.

siest way, and on the factory assembly lines they use pneumatic dispensers.

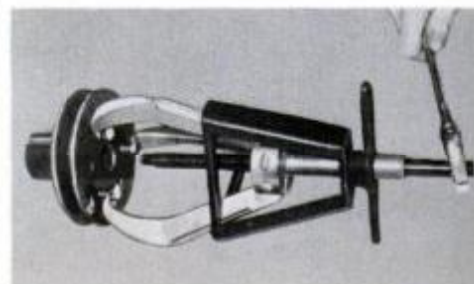
You don't really need anything that elaborate for your own garage, but there is a better way recently introduced: RTV silicone in a cartridge that fits into a caulking gun. Just squeeze the trigger and the bead comes out without the usual sweat. The price is under \$3 in discount stores.

Several manufacturers produce the cartridges, and one, Woodhill-Permatex, has been offering a cartridge in a package with a caulking gun, for the price of the cartridge alone.—*Paul Weissler*

Caged puller

One of the biggest problems with any puller is that the jaws slip off when you turn down the forcing screw.

An answer to the problem is a puller with a cage surrounding the jaws. Each brace segment of the puller has a guide slot into which the outer side of the jaw fits, and through which it slides. This type of puller doesn't have quite the flexibility in tight quarters of the type without the cage, which often has adjustable jaw positions. It does do a great job of holding, however, and at \$60 and up, it's comparably priced with other medium-size pullers. The maker is Octagon Co., Box 3003, Fargo, N.D. 58108. You can write the firm for the name of the nearest dealer.—*M.L.*

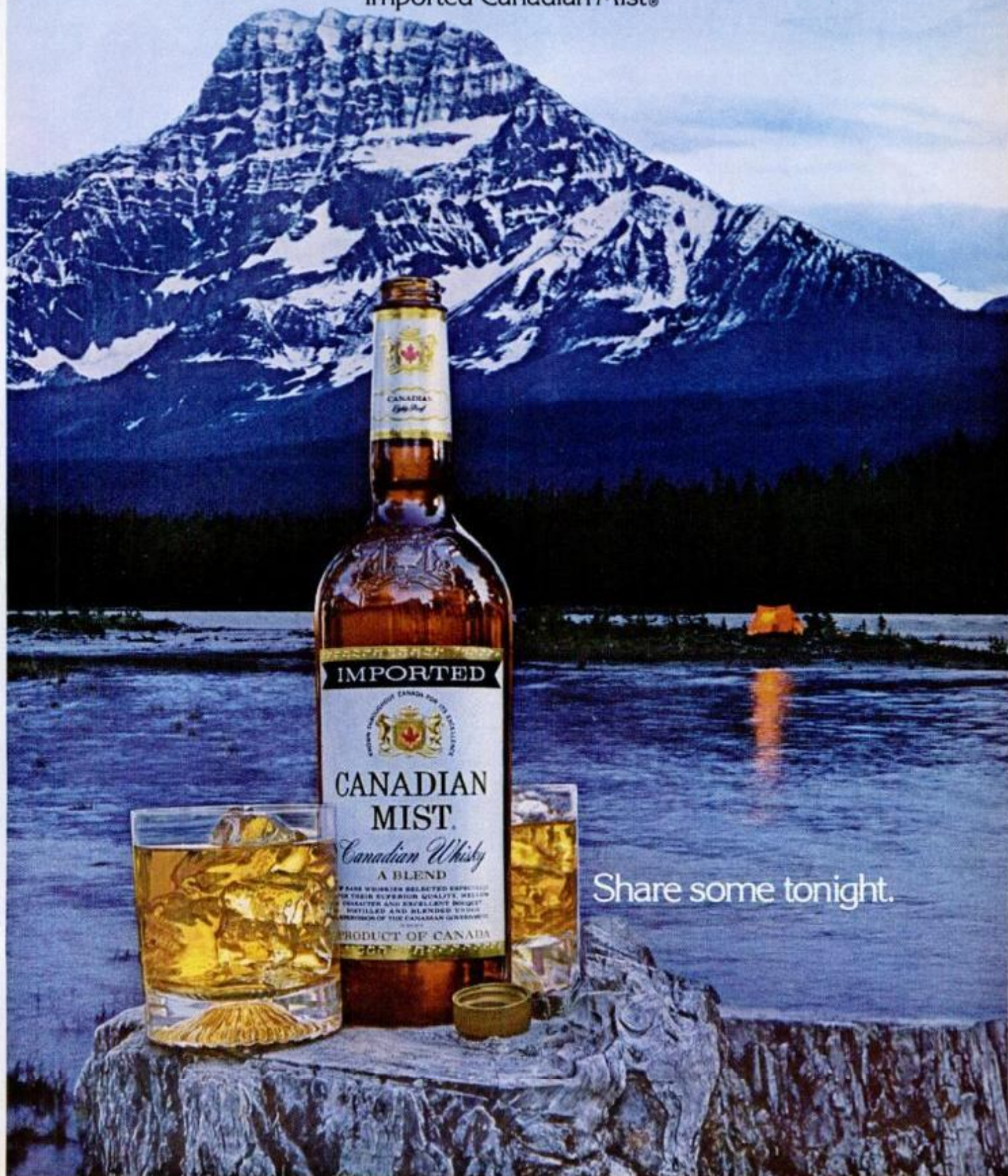


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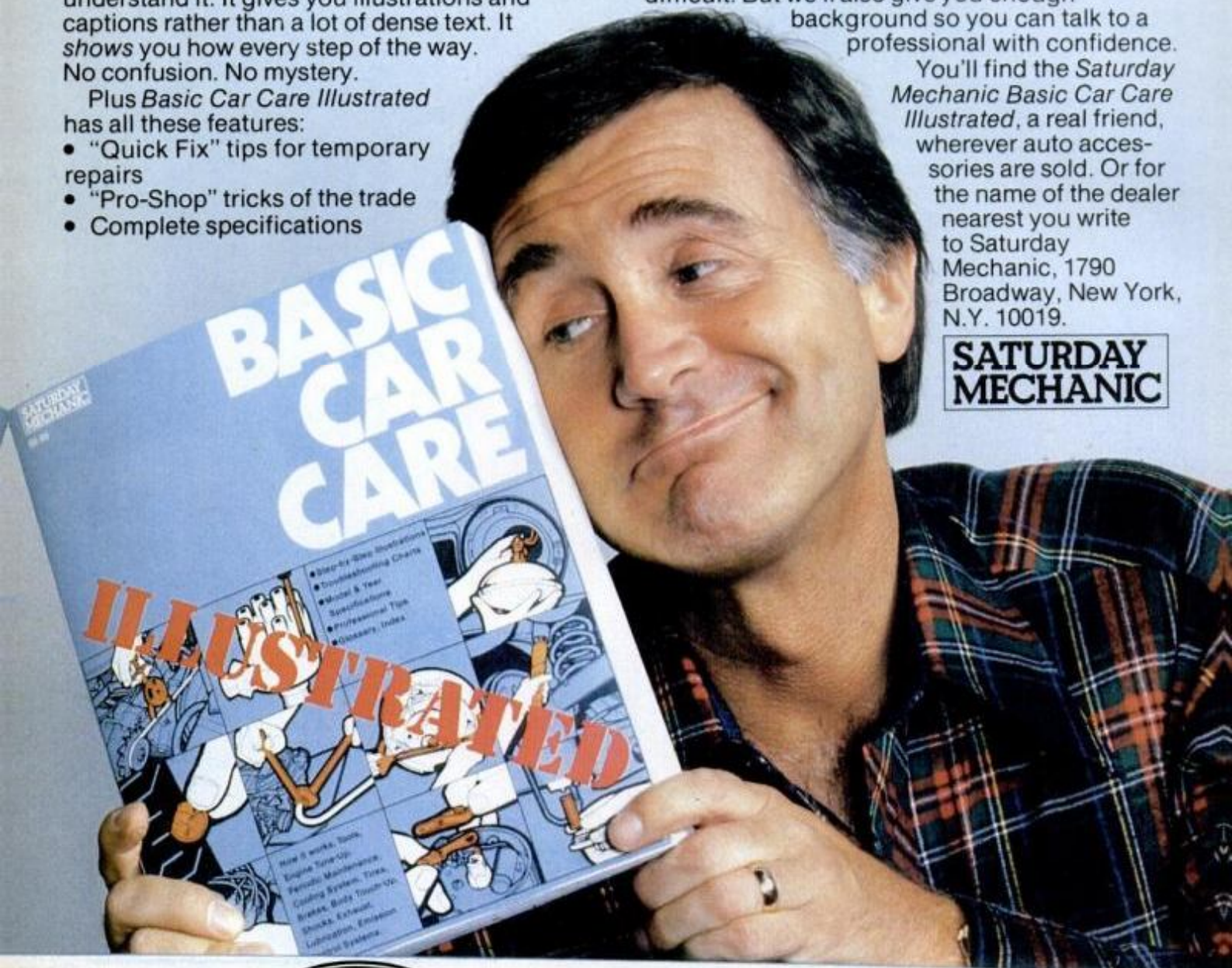
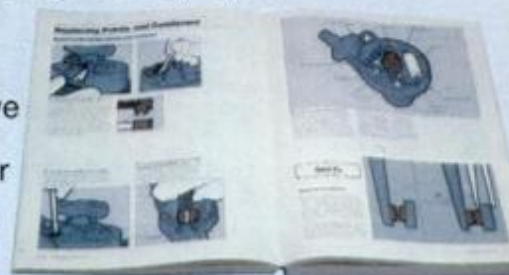
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PM LOOKS AT A GREAT TOOLBOX

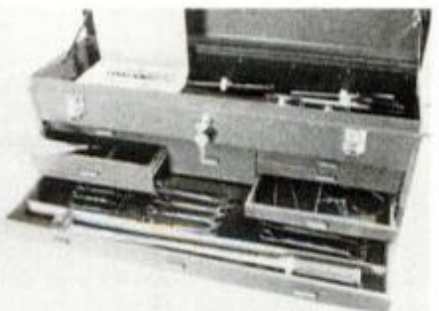
If you pride yourself on buying and using only quality tools, then both you and your tools deserve a well-made toolbox. This machinist's chest is built to last and is large enough (13 $\frac{5}{8}$ in. high, 8 $\frac{1}{2}$ in. wide, 26 $\frac{5}{8}$ in. long) to handle a real pro's tool collection. Its felt-lined compartment and drawers keep your tools in good shape. Adjustable drawer dividers let you organize your tools to suit your own needs. If the chest is not available from local hardware outlets, write maker for nearest distributor.—J.P.



Brown wrinkle finish protects box from scratches. Unit comes with two keys.



Drop-front panel locks drawers, stores under bottom drawer as box is used.



Felt-lined top till and drawers protect tools; dividers can be relocated.

SPECIFICATIONS—TOOLBOX

Drawer sizes (inches)	Depth	Width	Length
Handbook drawer	3 $\frac{1}{4}$	7 $\frac{1}{2}$	5 $\frac{1}{2}$
Top till	3 $\frac{1}{4}$	8 $\frac{3}{4}$	26 $\frac{5}{8}$
4 drawers	1 $\frac{5}{8}$	7 $\frac{1}{2}$	8 $\frac{3}{4}$
1 drawer	2	7 $\frac{1}{2}$	8 $\frac{3}{4}$
1 drawer	1 $\frac{7}{8}$	7 $\frac{1}{2}$	24 $\frac{3}{4}$
1 drawer	2 $\frac{1}{4}$	7 $\frac{1}{2}$	24 $\frac{3}{4}$

Model No. 526; weight, 36 lbs.; price, about \$75
Manufacturer: Kennedy Manufacturing Co., Box 151, Van Wert, Ohio 45891.

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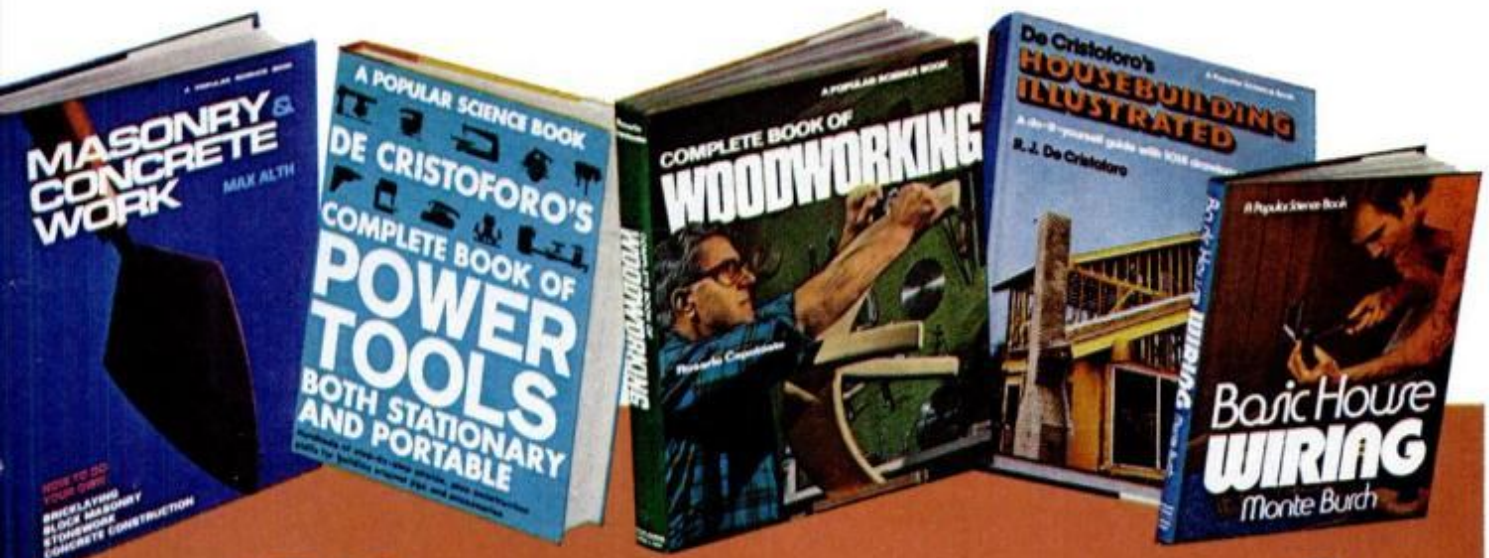
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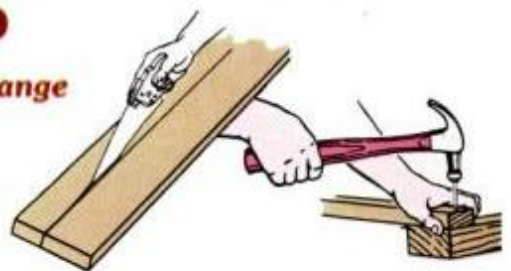
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PM's Whatsit

It looks like what we have is a massive steel structure with an unexplained 10-foot gap in it. Shall we send for the architect? What's going on here? It's a tough one to figure, but make your best guess and turn to the next page to find out how close you came.

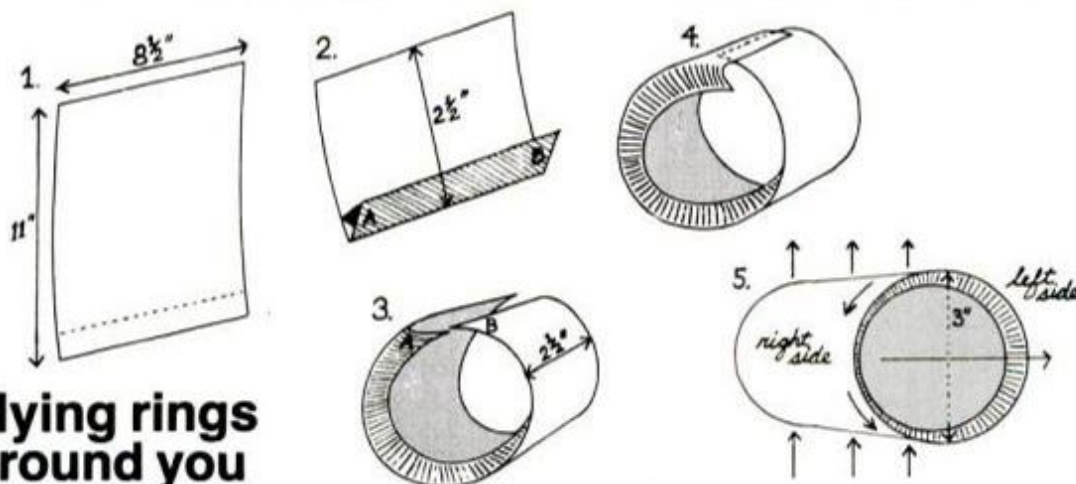
Cushioning playground falls and touchdown sprawls



Bumps and bruises are a normal part of being a kid, but the National Bureau of Standards, an agency of the Department of Commerce, found that about half the injuries that occur when youngsters fall from playground equipment are head injuries — which can be potentially serious, even fatal. This prompted NBS to run tests, through its Center for Consumer Product Technology, on what kinds of playground surfacing material provide the most protection against falls.

The major conclusion was that loose materials provide more protection than solid synthetics, such as rubber mats or artificial turf. The safest materials under playground equipment appear to be pine bark nuggets, blue stone dust, sand, shredded tires and shredded hardwood bark. The study pointed out, however, that loose materials require regular maintenance to remain effective in cushioning falls.

The fact that artificial turf, a low-maintenance material, performed poorly in the NBS tests may rekindle the ongoing gripes of professional athletes — mostly football players — against its universal adoption in major stadiums. Synthetic turf met the NBS criterion for safe impact from a drop height of only one foot, compared to 10 feet for pine bark or sand. Even pea gravel (2.4 feet) appeared to offer more protection in the NBS tests.



Flying rings around you

Want to know how hard it is to come up with something new? Ask Rutgers University and recent grad Gary Login. While studying fluid dynamics, Login designed a toy-like cylindrical object made from a simple sheet of paper and found that it flies like a paper airplane. He asked Rutgers physics professors why it flies and got opinions divided around gyroscopic action (spin) and spin-induced airflow (lift). Rutgers sent Login's specs (reproduced here for *PM* readers) for making what he had by then dubbed the "cylindrical wing" to *The New York Times*, which published it as Login's "invention."

Tsk, tsk. Within less than a week, the *Times* had heard from at least two cylindrical wing patent holders — one who registered it in the 1920s, another in 1956 who has since sold licensing rights for a

full-scale "rotary cylindrical wing" aircraft to a developer.

Too bad Login didn't ask *PM* first. We'd have told him that the Toobee Toy Co. of Berkeley, Calif., has been marketing a cylindrical flying toy made from the top two inches of beer and soda cans (rough edges smoothed off) for more than a year. We tried Login's version in the office, though, and it is fun to fly — throw it like a football or underhand with spin.

As for the physics profs at Rutgers, we'd humbly guess that the spin provides gyro stability, while the cylinder — which has an angle of attack like any other wing — simply deflects air downward, and lift is the net result.

Login, undismayed, will enter Harvard dental school this fall.



Whatsit revealed

Any guess having to do with shipbuilding counts as a good one. The men on the previous page are some of the 120 tradesmen — including boilermakers, carpenters, welders and machinists — who cut apart the Ford Motor Company's ore-carrying ship, SS *William Clay Ford*, and inserted a new 120-foot section between her bow and stern. The entire cutting and assembly job was completed in less than a week, with the men on continuous shifts. At 767 feet with her new section, the ship is Ford's largest ore vessel, and normally carries a cargo of taconite pellets from Minnesota and Wisconsin ports to Ford's plant at Dearborn, Mich. In the photo above, at Fraser Shipyards in Superior, Wis., the ship's bow is in the foreground, while the new section is floated into drydock ahead of the stern, which rides lower in the water before joining.



Far-out solar heater

Any fuel burned at the *Himalayan Rescue Center*, at an elevation of 14,000 feet on the rugged trail toward Mount Everest, has been brought up on somebody's back — even kindling wood. But the sun comes up by itself, so a solar water heater was recently "installed" at the center. It's a semi-cylindrical reflector of stainless steel around a black plastic tube, with the air space sealed by a plastic pane. One man can easily move the frame to keep the unit facing the sun. In two hours or less, five liters of water can be raised to 140° F.

Before long, all the guys in those dramatic summit-conquering photos will be clean shaven.

Boilover is S.O.P.

You can look for a lot of strange hybrids to emerge from the fuel crisis, but perhaps none as colorful — yet alarming to the average pedestrian — as 26-year-old Phil Hopes's steam car, which is seen these days on the streets of Reading, England. The first one Hopes tried to build fell apart, but on the second attempt he successfully mated a paraffin-fired steam engine built in 1904 with a 1935 Austin 10 chassis. What tends to convince unknowing people that Hopes is having big radiator trouble is that "L" on the right headlight — while a heckuva mechanic, Hopes hasn't passed his driver's test yet and must puff around Reading with his "learner" symbol ablaze.



From ominous to dire

There's a game science fiction writers like to play, known by various names which are all equivalents of the phrase, "odds against survival." Here's a recently heard variation:

All this carbon dioxide we're putting into the atmosphere — the Greenhouse Effect — is going to turn the Earth into a steam bath for sure. And then a desert.

But if we can just hold out for about 20,000 years, scientists now agree that another Ice Age will begin and cool us down, right?

Yeah, but how are we going to make it through the Ice Age if all our fossil fuels are long gone?

By then we'll have clean, safe nuclear fusion power — we can wire the whole planet like an electric blanket.

Oh yeah? All the most promising fusion methods require a rare element — lithium. Using fusion power on a worldwide scale, we'd run through all the known lithium on Earth in less than 10 years.

Give me a minute, I'll think of something.



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Here's the power and performance of Shopmate power tools at a K mart sale price. Each of these Shopmate tools features double insulation, lifetime lubrication bearings and dynamically balanced motor. They're on sale thru September 29 at over 1,400 K mart stores across the USA.

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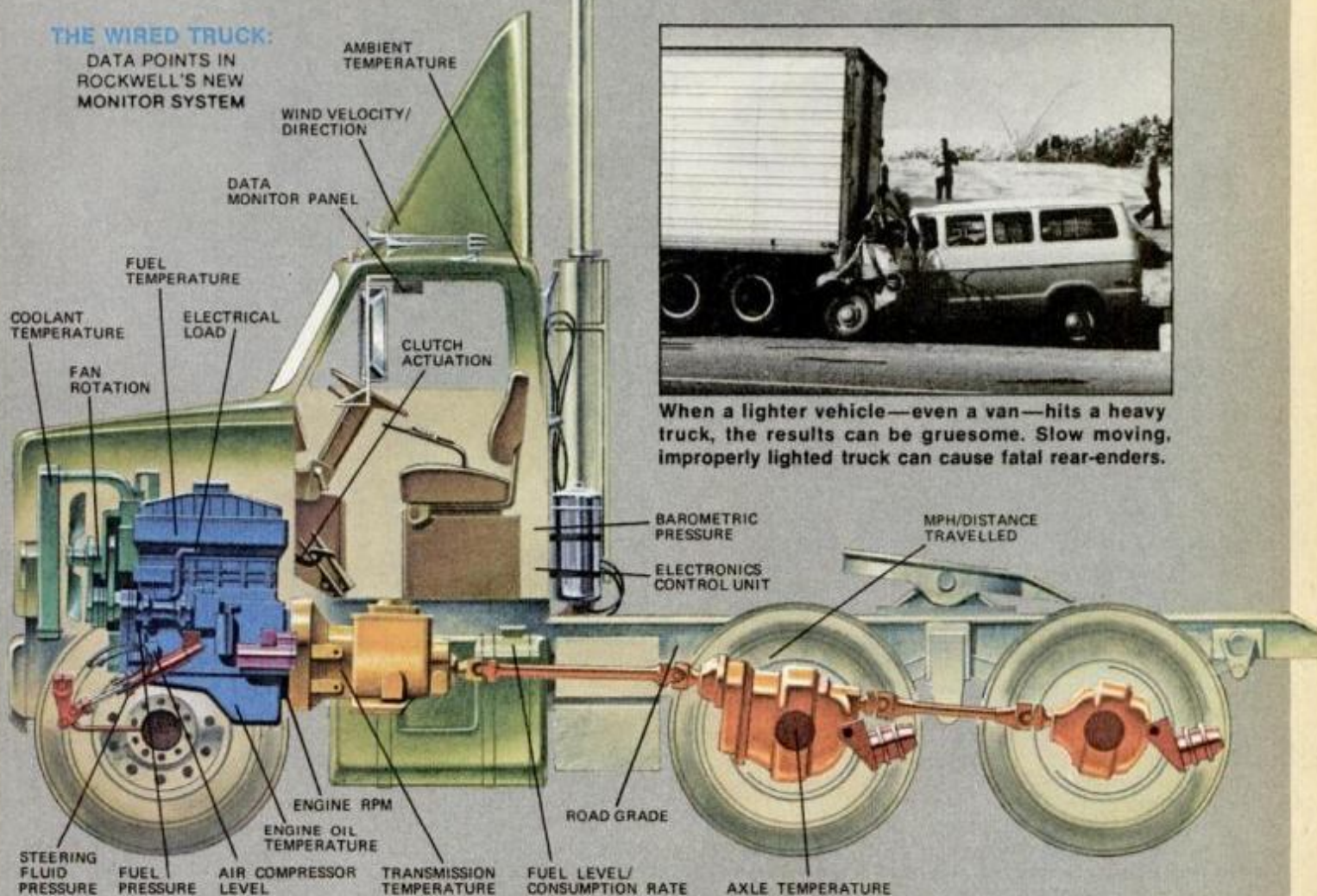
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HOW WE'LL RUN KILLER TRUCKS OFF THE ROADS

Truckers are learning new ways to keep non-existent maintenance, irresponsible drivers and mechanical failure from causing mayhem.

by Mort Schultz

THE WIRED TRUCK:
DATA POINTS IN
ROCKWELL'S NEW
MONITOR SYSTEM



When a lighter vehicle—even a van—hits a heavy truck, the results can be gruesome. Slow moving, improperly lighted truck can cause fatal rear-enders.

Back in the days before the Interstates, it was said that truckers knew the best places to eat. A dose of bicarb or two helped you get over that myth, but it was still generally accepted that a truck driver was a true knight of the highway—a knowledgeable, courteous and, above all, safe driver. That was yesterday.

What's finally changed all that—for good—is the too-often repeated image of a heavy semitrailer careening along

as an instrument of mayhem. The pressure to meet impossible schedules, to carry vastly overweight cargo loads in poorly maintained vehicles at speeds that make the simple phrase "55 mph" a straight line and punch line rolled into one giant joke has changed all that. Now, trucks scare us.

The pressure is economic, to be sure, originating not with the driver, but with the industry and the truck owners and people they serve. But no

matter where it's coming from, the results are disastrous.

Heavy trucks are killing more people than ever. In all, 5120 people died in truck-related accidents in 1978, compared to 3483 in 1975, and the increase has been consistent over the four-year period.

In an analysis of the increasing death toll, Nancy Stubbs of the National Center for Statistics and Analy-

(Text continues on page 80)

One that didn't get away

One warm, lazy summer day last year in northern California, a 2½-ton fuel truck—filled with enough propane gas to level an entire city block—crested a hill and started down on the Rim of the World Highway, about seven miles north of, and 2000 feet above, the city of San Bernardino. Driver Ron Kobs casually put some pressure on the brake as the truck picked up speed.

Nothing happened.

"Don't worry," Kobs told his partner, Lester Stuck. "I'll downshift."

He tried it. There was a sharp sound and again nothing happened. The driveshaft had broken and there was nothing he could do to stop his new truck. It soon became all he could do to keep it on the road.

As the truck flashed toward the north end of town, Kobs looked at the speedometer. The needle edged past 90.

A few miles away, Sgt. Chuck Downing, 38, of the California Highway Patrol had stopped his patrol car at a light at 30th St. and Waterman Ave. Suddenly the sound of police sirens cut through the intersection, heralding the arrival of a motorcycle cop, who jumped off his cycle and stopped traffic in both directions.

Moments later, another police motorcycle zoomed through the intersection, followed closely by the runaway truck. Inside the truck, Kobs and Stuck were blowing the horn, flashing the lights and waving and screaming frantically out of the window—doing anything they could to keep traffic away from what had become a bomb on wheels.

Downing tried to tune the static out of his radio, hoping to find out what was going on.

"From that I learned the truck had lost its brakes," said Downing, who was accompanied in the car by CHP Capt. Donald Kipp and Lt. John Travers. "I then told the captain that if he didn't mind being a few minutes late getting home we'd see if we couldn't help these people."

Downing slipped a U-turn and raced down Waterman toward the center of town after the truck. Past schools, churches, homes and freeway ramps, the truck still sped at 70 mph or more. With each block, the traffic grew heavier and the odds for an explosive accident kept going up.

"My first thought was that with both the motorcycle policemen and the patrol car, we'd have a good enough chance of warning motorists so the truck would have a clear path," Downing said.

"But as we got closer to Highland Ave. I realized that although the truck was slowing down slightly, there was a great potential for an accident before it stopped. That's when I got the idea that if I could get the patrol car in front of the truck, slow

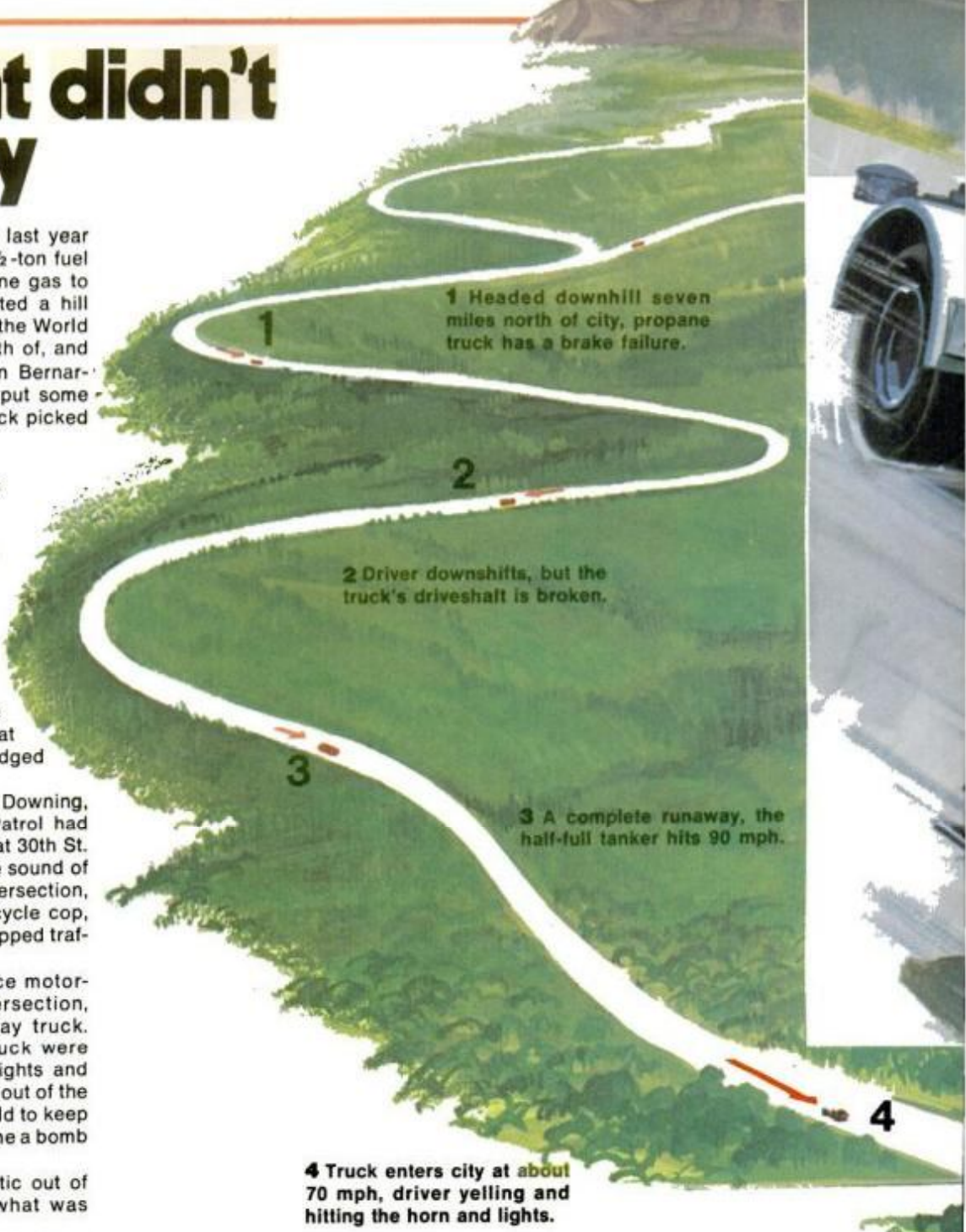
down and make contact... it might work."

As the vehicles approached Highland, where eight lanes of traffic converge next to the city's hospital, Downing floored the accelerator and maneuvered the 1977 Dodge Monaco around in front of the truck. He purposely kept slightly to the side of the street as the two vehicles roared through the intersection, to give Kobs a clear view of any obstacles that might have appeared.

But once clear of the intersection, Downing lined up the rear of the patrol car with the front of the truck, decelerated slightly from 60 mph, and the bumpers touched.

"Within 20 or 30 yards south of the intersection we made contact. It was something between a nudge and a jolt," Downing remembers.

"When we first bumped, the patrol car was shoved ahead a couple of feet and the truck slid off to the right. When we made contact a second time he was flush against our bumper and I started braking."



1 Headed downhill seven miles north of city, propane truck has a brake failure.

2 Driver downshifts, but the truck's driveshaft is broken.

3 A complete runaway, the half-full tanker hits 90 mph.

4 Truck enters city at about 70 mph, driver yelling and hitting the horn and lights.

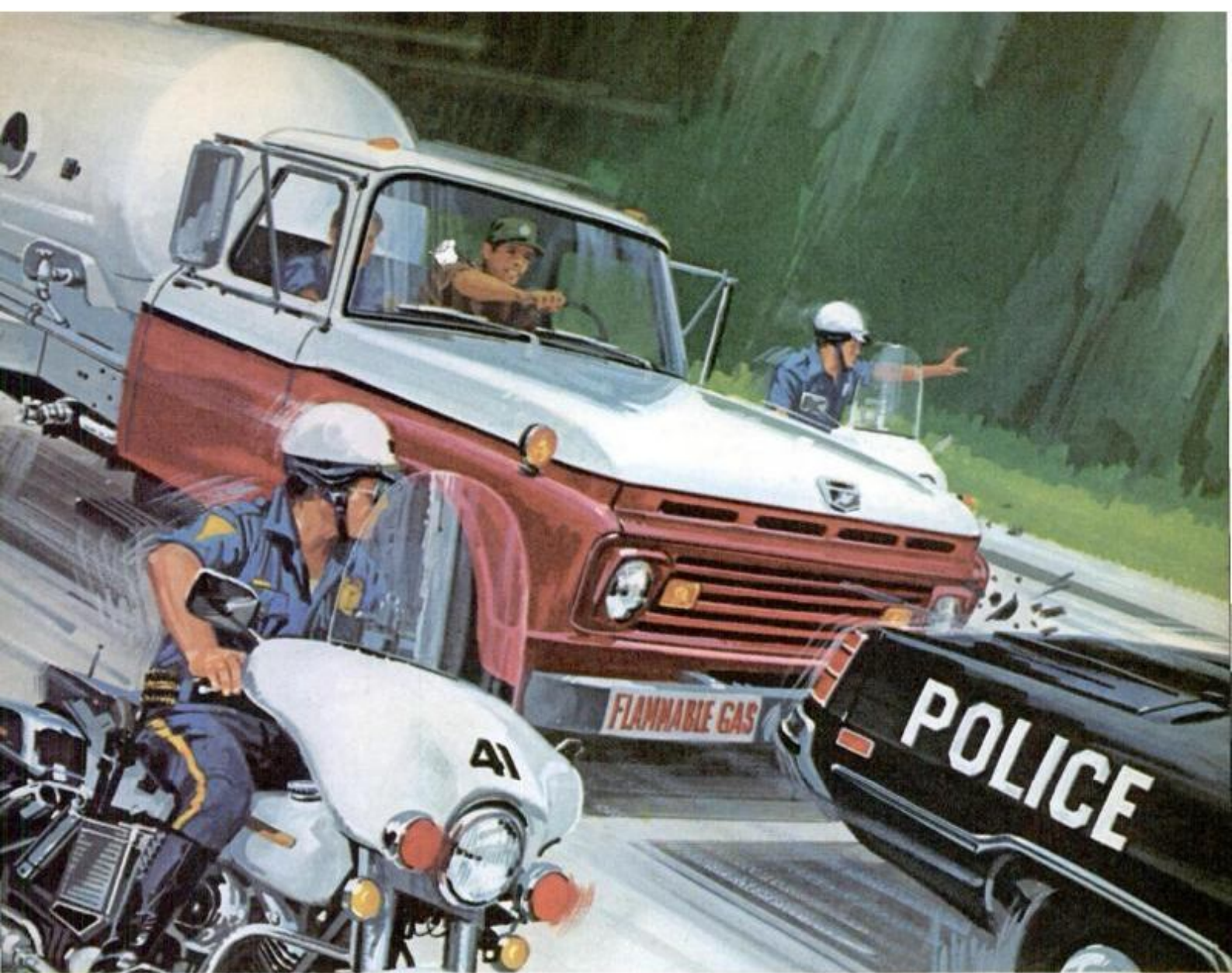
Just ahead, right in the street, a car had stalled, its driver bolting for safety. Downing racked the shift lever into low gear and prayed as he stood on the brakes. The two vehicles came to a halt not more than 15 feet from the stalled station wagon. It was several minutes later that a shaking Ron Kobs let Downing know the truck was half-filled with propane.

Downing admits he was slightly stunned in retrospect, but he doesn't think prior knowledge of the truck's contents would have deterred him from trying to stop the vehicle.

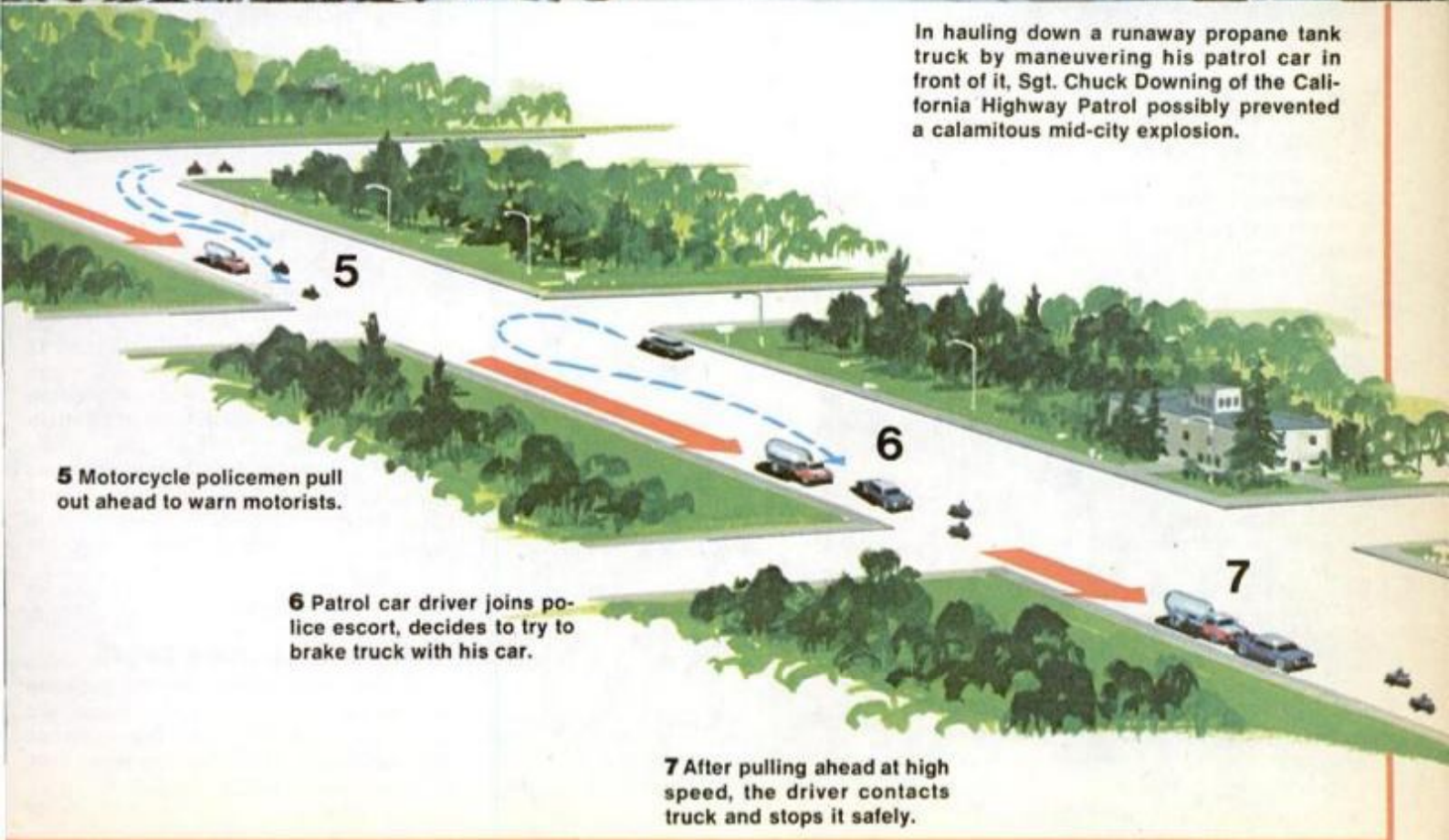
"There wasn't a whole lot of time to ponder what I did. It was a reaction type of thing."

Since the incident, Downing has received the highest honor for bravery that the State of California bestows upon its employees—the Medal of Valor with Diamond. He has also received citations from five other civic and governmental organizations.

—Christine Keller



In hauling down a runaway propane tank truck by maneuvering his patrol car in front of it, Sgt. Chuck Downing of the California Highway Patrol possibly prevented a calamitous mid-city explosion.



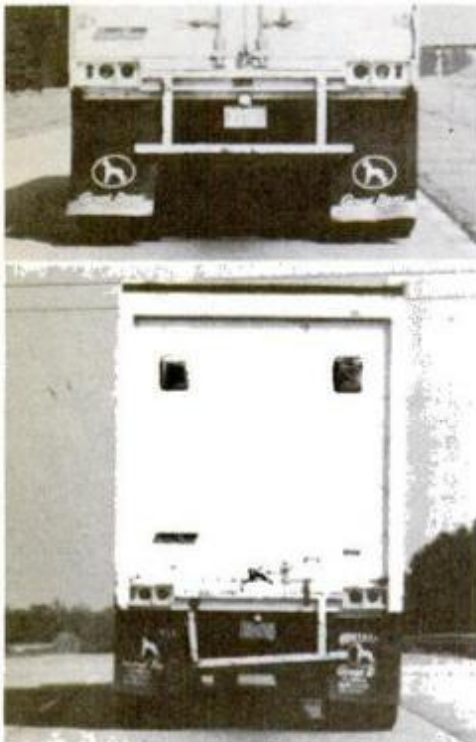
5 Motorcycle policemen pull out ahead to warn motorists.

6 Patrol car driver joins police escort, decides to try to brake truck with his car.

7 After pulling ahead at high speed, the driver contacts truck and stops it safely.

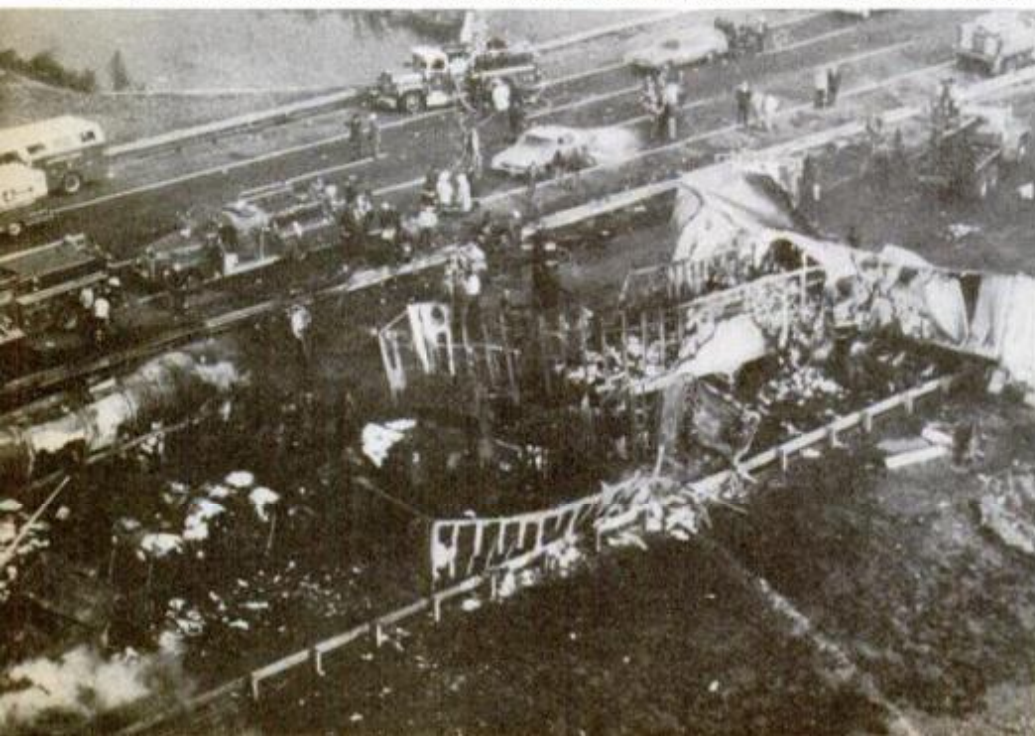
sis states, "There has been a change in the mix of traffic, with more and more truck travel. Consequently, the risk has increased for the light vehicle user." (The term "light vehicle" refers to cars, vans and light trucks.)

In 1978, the number of new heavy trucks registered in the United States hit an all-time high of 191,837, up almost 23 percent from 1977's 156,421 units. So there is some validity in the above analysis. However, on-the-spot investigations of



Intact (top), underride bar can save following driver's life. Too many are broken, like one spotted by author Schultz (above).

1973 chain-reaction crash on New Jersey T-pike. Heavy trucks were deadliest missiles.



accidents by the National Transportation Safety Board (NTSB) point out beyond any dispute that many accidents result from mechanically deficient trucks and/or irresponsible operation.

■ On Aug. 20, 1976, for example, a tractor-trailer went out of control on a steep grade along Granger Rd. in Valley View, Ohio, colliding with 10 light vehicles stopped at a traffic signal at the bottom of the hill. Eight people were crushed or burned to death, and 15 others were seriously injured in what police describe as the "worst traffic accident in the history of the Greater Cleveland area."

According to NTSB investigators, "Inadequate pretrip inspections by the driver, and the lack of required maintenance and inspection by the carrier," failed to identify an unsafe braking system. However, there also were no signs warning of the steep grade, which could have prompted the driver to take evasive action.

■ On March 8, 1977, a tractor-trailer struck the rear of a school bus on Highway 29 near Rustburg, Va. Three children died. Over a period of 17 years, it was discovered, the truck's driver had accumulated 38 violation convictions in eight states, had his license suspended six times and had been involved in four highway accidents. Twenty-one of these traffic convictions, and all suspensions and accidents, had occurred in North Carolina, the state from which the driver still held a valid license at the time of the fatal Rustburg accident.

■ On July 6, 1977, a truck with a gross weight of 52,000 pounds struck a car at an intersection on U.S. Route 206 near Vincentown, N.J. The truck driver was killed, along with six of the seven occupants of the car. According to NTSB investigators, the truck had been exceeding the speed limit and there was no evidence of preimpact braking, although the truck's brakes were in good condition. In the previous five years, that driver had been convicted of driving while under the influence of alcohol, had his license suspended and was involved in two accidents. At the time of the crash, he held a license issued by New Jersey that prohibited his driving motorcycles, school buses and certain other vehicles weighing more than 18,000 pounds. However, states NTSB, "the driver's employer was not required to, and had not checked his driving record, either before hiring or during his employment."

Safety checks spot trouble

Heavy trucks were involved in 29,936 reported accidents in 1977 (last full year for which complete figures are available). Not all accidents are reported—only those involving trucks regulated by the Interstate Commerce Commission which are in accidents resulting in injury or in property damage of \$2000 or more.

Of these almost 30,000 accidents, 1650 involved trucks having mechanical defects. Contributing to the other 28,286 accidents were truck or light-vehicle driver negligence, drinking, fatigue and highway conditions.

To try to keep potentially dangerous and defective commercial trucks and unqualified drivers off the highway, the transportation departments of federal and state governments conduct unannounced safety checks. One such check, along a Pennsylvania highway last August, gives insight into conditions that can cause fatal accidents:

In all, 711 trucks were checked. *Over half of them*—382—were found to be in "imminently hazardous condition" and were forbidden to operate until repairs were made. In addition, 24 drivers were ordered to immediately cease driving, because they had already logged excessive hours on the road.

Brake loss is primary culprit

Of the major mechanical defects uncovered, 286 involved brakes, 40 involved lights, 25 involved suspension systems, 25 involved tires, and 21 involved steering, exhaust and fuel systems.

Some of the bloodiest accidents

Keeping trucks off your back

If you're driving a light vehicle, keep in mind these defensive driving techniques to minimize the chances of an accident with a truck.

■ Don't block the passing lane. Keep to the right.

■ On two-lane highways, if a truck wants to pass, drop your speed and pull as close to the shoulder as possible.

■ Help trucks pass by using your lights. As soon as the rig has cleared your vehicle, switch on your lights for a second, then turn them off. At night, flash your high beams, ending up on the low beam. Don't put the brights in his eyes.

■ On steep grades, always be aware that a potential runaway may be bearing down on you. Keep an ear out for the continuous blast of a truck's horn, signaling that it's in trouble.

■ At major road intersections controlled by traffic signals, make sure traffic coming the other way can stop before you attempt to drive across, *regardless* of what color the light is. Don't try to get a jump on a light that has just turned yellow. A truck coming in the other direction may decide to do the same thing. You'll be the loser.

are caused by heavy trucks that lose brakes. One such accident occurred on May 12, 1977, on a steep, four-mile-long grade along U.S. Highway 221 near Marion, N.C.

As the truck, which was towing a flatbed semitrailer carrying a construction backhoe, descended the hill, it accelerated until it was out of control. At a curve in the roadway, the rig skidded sideways, throwing the semitrailer into the opposite lane of traffic. The backhoe broke from its chains and vaulted into the path of an oncoming van, killing five.

NTSB investigators cited "loss of braking effectiveness" as the cause of the accident, resulting from inoperative brakes on the semitrailer. Because of the obvious bad condition of the semitrailer brakes, "the semitrailer should not have been operating on the highways," the NTSB stated.

Ramps for runaways

As one way of averting brake-loss accidents on steep grades, NTSB urges construction of runaway "escape ramps." Some experimental ramps have existed for several years along various roadways across the country.

The ramps are offshoots from the main highway. They are about 200 yards long and are blocked at their far ends by barriers. The one on Interstate 24, north of Chattanooga, Tenn., has a base of deep, loose sand to slow down a runaway and a sand-

bag/log barrier to stop one that threatens to overshoot. It is wide enough to accommodate two trucks simultaneously.

Citing experiences with two escape ramps in North Carolina, researchers at the University of North Carolina found they had been "highly effective." From February, 1974, to September, 1977, the ramps were "used" by 116 runaway trucks. The year before the first ramp was built, 10 fatalities were attributed to brake failure along the particular stretch of roadway on U.S. 70 between Ridgecrest and Old Fort.

Other causes, other 'cures'

As this article was being prepared, the National Highway Traffic Safety Administration was revising Federal Motor Vehicle Safety Standard 121 (now called FMVSS 130). The new standard sets requirements in such areas as better resistance of truck brakes to heat buildup, a reasonable 60-mph stopping distance, and backup braking in the event of primary brake failure. Other proposals have also been offered to help reduce the heavy truck accident rate. Some are:

1. Requiring all newly manufactured trucks to have self-adjusting brakes. According to the National Transportation Safety Board, the requirement is necessary "because of the history of Board-investigated truck accidents involving failure of brakes needing adjustment."

2. Better policing to get illegal and unsafe truck drivers off the road. According to columnist Jack Anderson, the computerized National Driver Register, which was set up in 1961 to spot drivers with multiple convictions and accidents, is obsolete. "If Congress ever decides to put up the \$2 million to upgrade the driver register, all the states will probably use it," Anderson says. "Until then, unsafe drivers will continue to kill and maim on the nation's highways."

3. Tightening the limitation on hours of operation for drivers engaged in interstate commerce. According to the Federal Highway Administration, "Driver fatigue has been identified as a major contributor to commercial motor vehicle accidents."

One such accident took place when a truck driver triggered a chain-reaction crash on Interstate 285 near Atlanta that killed four people. According to NTSB investigators, the driver had only five hours' sleep between driving stints of 11½ and 14 hours.

4. Equipping interstate commercial vehicles with governing devices

so they can't travel faster than 57 mph. According to vice president D. Wayne Strout of Trailways Bus Co., which has petitioned the NHTSA for such a device, "All commercial vehicles would be controlled at a consistent speed, reducing highway speed differentials and therefore reducing accidents."

5. Installing tachographs, which would be to commercial vehicles what flight recorders are to commercial aircraft. Typical is the Tripmaster data-recording system that has been introduced by Rockwell International. The unit monitors various functions (see drawing on page 77), among them driver performance in such areas as speeding, excessive braking, acceleration and deceleration, and operation out of gear. The information is "locked in" the computer and can be transferred to a tape cassette at predesignated periods or after an accident.

6. Adopting standards to equip heavy trucks with underride protection in the rear and on the sides. According to University of Michigan



Loaded with cinder block, flatbed lost its brakes and stopped a car . . . cold.

and University of Texas studies, an estimated average of 456 fatalities occur each year because of car-into-truck underride collisions. This includes 261 rear impacts and 195 side impacts.

Underride barriers

To try to keep cars from going under trucks, many trucking companies have welded antiunderride barriers to the rear of their vehicles. However, according to the university studies, welded rear underride devices do not extend to the rear corners of trucks or trailers. Depending on the height of the underguard device and on the type of car, the underride device sometimes simply shears off the hood of the impacting car, forcing the hood through the windshield into the passenger com-

(Please turn to page 209)

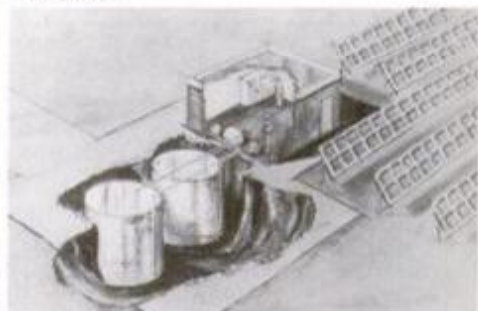
IT'S NEW NOW

A better way to store electricity

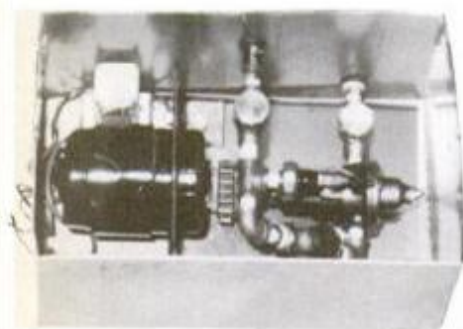


The REDOX electricity storage system, recently unveiled by NASA, is projected to cost about a fourth as much as typical lead-acid batteries and have greater reliability. In the system, solutions of chromium chloride and iron chloride are pumped through a flow cell "stack." Fluids never touch each other, but transfer the charge through a special membrane as they react at their respective inert electrodes.

To recharge, electricity is fed in via the electrodes as the fluids are pumped through. The system is thought to be most useful in load-leveling for large utilities and storage for wind-power or solar-cell facilities (see artist's concept below). One system advantage is that power and storage capacities can be designed separately for greater flexibility. A one- to two-kilowatt test unit should be operational next year.



Cut engine wear

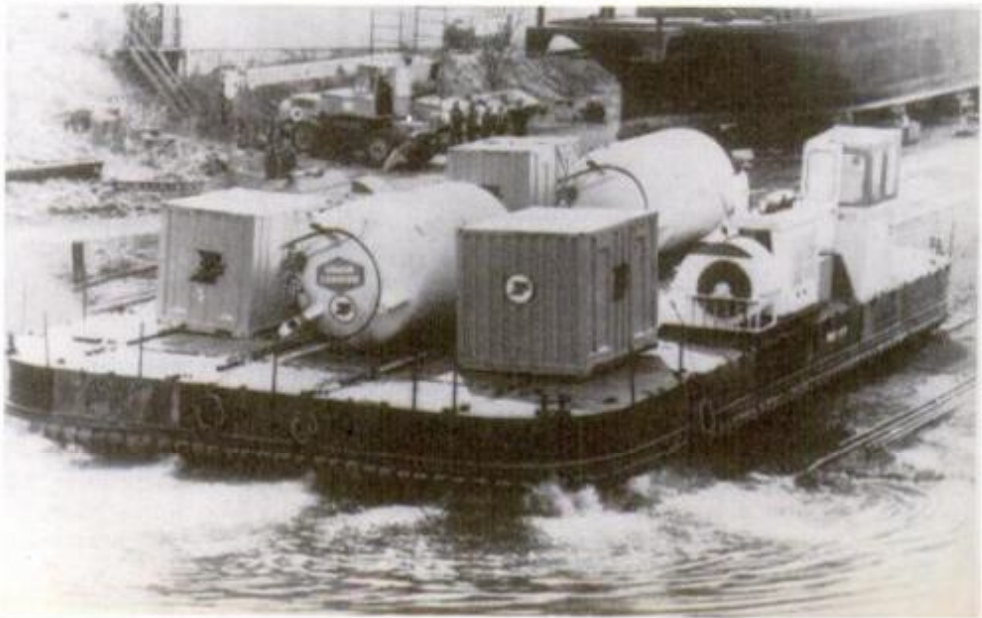


Even in well-cared-for engines, there is a brief period during startup when virtually no oil lubricates the moving parts. The inventors of the Oilstart pre-oiler claim that engine wear is greatest during such periods. They say Oilstart pumps oil throughout the engine when the key is turned just before ignition, thus preventing dry starts and reducing wear. It fits most engine compartments and connects to oil gallery and drain plug via special fittings. Intended for trucks or other fleet vehicles, the unit can also be used in a private car. It costs about \$230.

Barging-in, British style

The British continue to pursue innovative ground-effect-machine applications. This 80-ton hover-barge rides on a cushion of air to ease cargo movement where land and water meet. By skimming above the

surface, the barge can be winched or towed from ship to shore, across rivers or shallow water and over ice floes. It also moves over marshes and sand banks and can be pushed by a tug or outboard.



Sub-to-sub rescue

In a recent simulated rescue conducted by the British Royal Navy, two men 400 feet below the ocean surface were transferred from a "crippled" submarine to an intact one. The first such sub-to-sub transfer in history, it was accomplished with the aid of a Deep Submergence Rescue Vehicle (DSRV) off the coast of Scotland, without either man getting wet! The DSRV was flown from California, land trailer and all, in a C-5A. The cargo plane was chosen because it could hold the DSRV and its trailer together and could make the 5500-mile trip nonstop with in-flight refueling.



Zap! You're dead



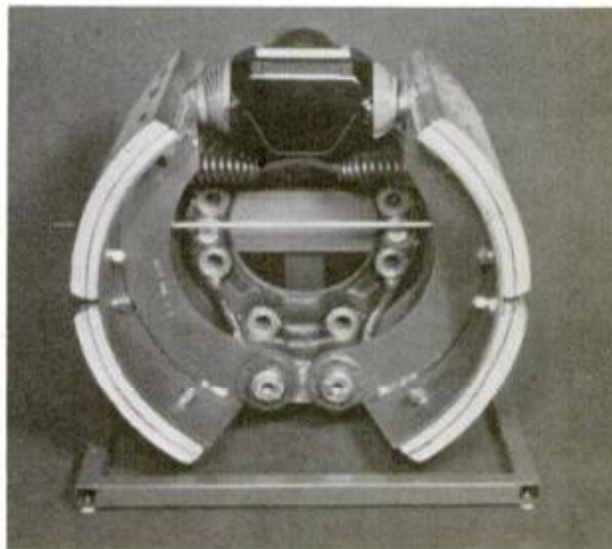
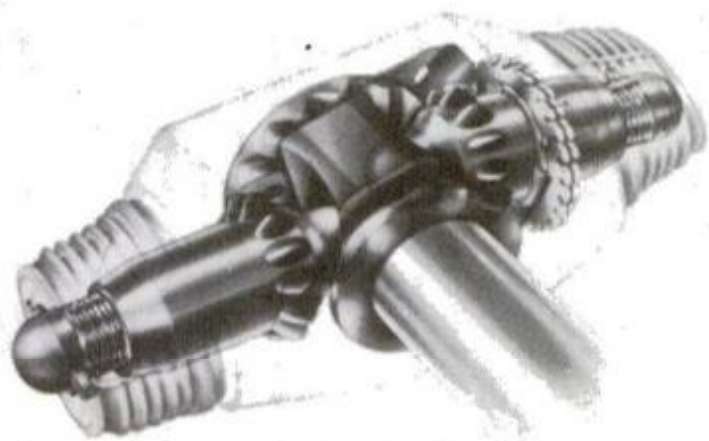
How do you realistically train security personnel to protect nuclear-material shipments without using live bullets? With lasers, of course. Specially modified M-16 rifles fire blanks and a small pulsed-beam laser in simulated terrorist ambushes conducted by Sandia Laboratories in New Mexico. "Hits" and "near-misses" are detected by sensors on the trainees' helmets and vests. The laser is said to have only $1/100$ as much power as would cause eye damage, but it can still penetrate bushes. Laser range is about 460 meters, similar to that of the M-16. The system was developed by Xerox Corp.

Cool, and well-adjusted

A brake-adjusting mechanism that is said to increase lining and drum life is now being installed on several Chicago transit buses. The Camph Brake Mechanism (CBM), invented in Sweden, automatical-

ly keeps the linings in place as they wear, via a ratchet and gear set (see drawing, below left). Thus, the linings have a greater drum clearance, reducing operating temperature by as much as 100° F. The

CBM is said to extend lining life from two to six times, allow shorter stops and reduce maintenance costs. Unit can be adjusted as little as $1/1000$ inch. (Horizontal rod in right photo is not part of unit.)



The search for cosmic

Giant aluminum bars, lasers and space probes are being called into the hunt for elusive gravity waves.

by Tom Johnson

Astrophysicists all over the world are still trying to crack one of the most exciting missing-property cases ever known. They are looking for 99 percent of the universe.

While their questions are mathematically and philosophically heavy, the substance these men and women are searching for has no known weight, no electrical charge, no luminescence. These scientists are the hunters of gravity. Specifically, they're seeking gravitational radiation or waves that, in Albert Einstein's the-

ory, pass through the universe, invisibly touching everything with a heretofore imperceptible caress.

More than a dozen research groups in nine countries are actively pursuing the elusive waves. In the United States, the National Science Foundation last year made available \$777,000 for the development of gravitational-radiation detectors, about 18 times the amount allocated in 1968. With the growth of interest and support, wave detectors are being readied in physics labs, and NASA is planning to carry the search into space. But the experimental process is often slow, the research agonizingly delicate.

Some of the equipment is so sensitive that it could be thrown off by the scratching of a cat's paw on a laboratory floor. Some designs for future apparatus call for precision measurements between robotic instruments millions of miles apart in space. Some scientists today are spending their professional lives waiting to detect a tiny jiggle in a laser beam. Others in search of the waves have become experts in reducing the bothersome background "noise" of molecules bumping into one another—an unfortunately routine event in all the forms of matter above a temperature of absolute zero.

The irony is curious. Gravity researchers are looking for an amount of mass so large that if it were con-

verted to pounds, it would require almost two lines of type on this page to print the number. Yet the instrumentation to find this mass must be sensitive enough to detect a baby's cough in the winds from the other side of the Earth.

Why bother listening for the "cough"? One reason is that the cosmic disruption caused by gravity *might be there*: That's a substantial enough incentive for most devoted scientists.

But even if the waves are *never* discovered, the research itself has already produced hardware that may be useful in down-to-Earth applications. Research challenges have led to improved transducers, for example, which are instruments sensitive to tiny vibrations.

The work has also expanded our knowledge of superconductivity, the ability of some metals and alloys at extremely low temperatures to transmit electricity with almost no resistance. It seems likely that from the quest for gravity waves, new hardware will be developed for measuring the Earth's magnetic field. And these instruments may be helpful in mineral prospecting or geologic studies.

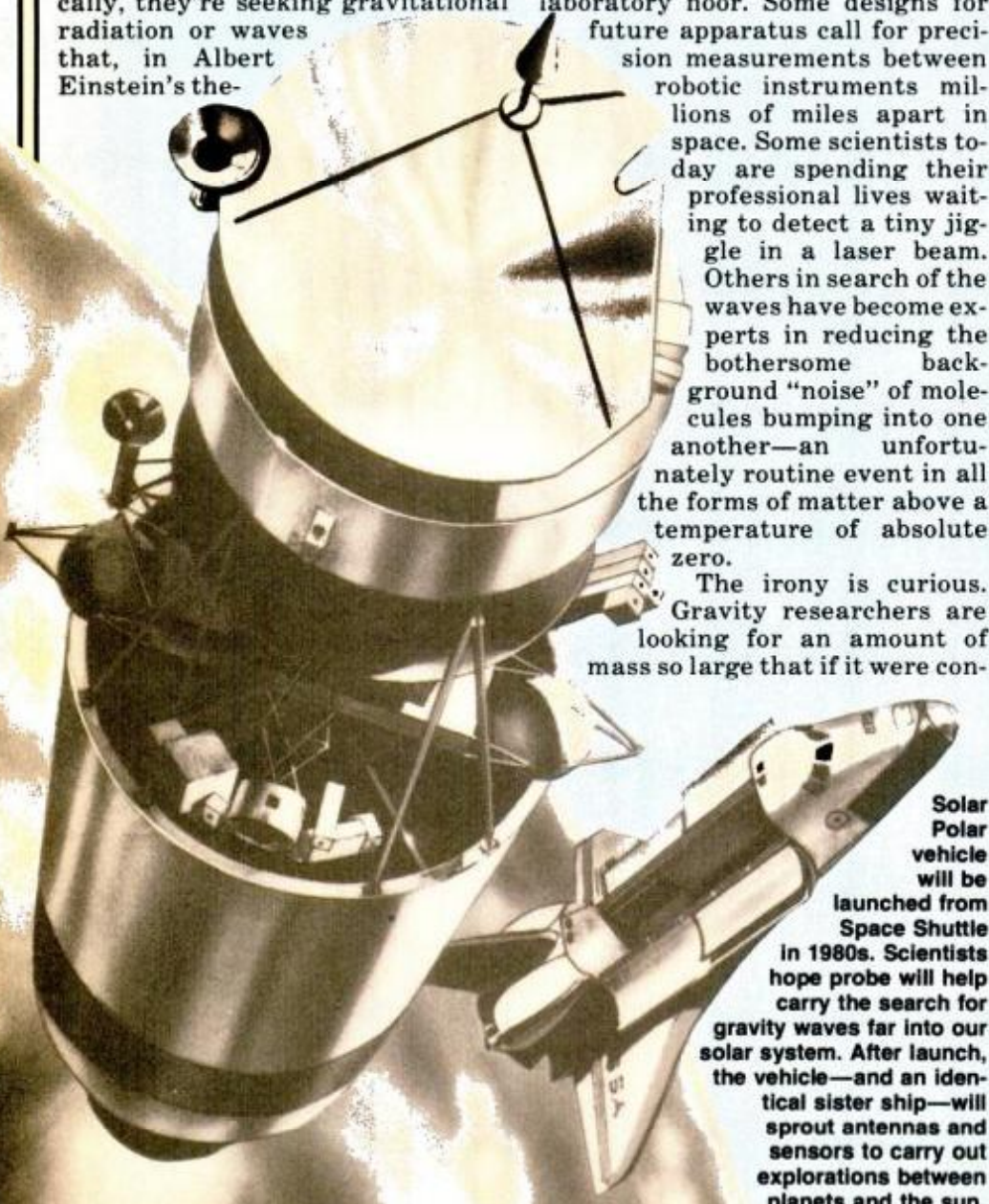
The search might also yield clues for astronomers trying to track cataclysmic changes in the masses of distant stars.

Gravity is found wherever any mass exists. Isaac Newton postulated that all bodies, or masses, have a mutual attraction—gravity. Newton also showed that the mutual attraction takes the form of a "field" or area of influence, and that the strength of attraction decreases as the masses are separated. Einstein was the first to suggest that this field can also change shape and, in doing so, emit waves.

Waving makes waves

"Any nonspherical motion of a mass—the moon going around the Earth, a bouncing ball, a man waving his arm—will emit gravity waves," says Dr. William J. Kaufmann, adjunct professor of physics at San Diego State University. "If a person's standing still, he has some mass associated with him. There is a small, weak gravitational field associated with your mass. . .

"Now if you begin waving your arms, you don't change your location, and you haven't changed your mass. So the overall strength of your gravitational field remains the same," he says. "But the detail of



Solar Polar vehicle will be launched from Space Shuttle in 1980s. Scientists hope probe will help carry the search for gravity waves far into our solar system. After launch, the vehicle—and an identical sister ship—will sprout antennas and sensors to carry out explorations between planets and the sun.

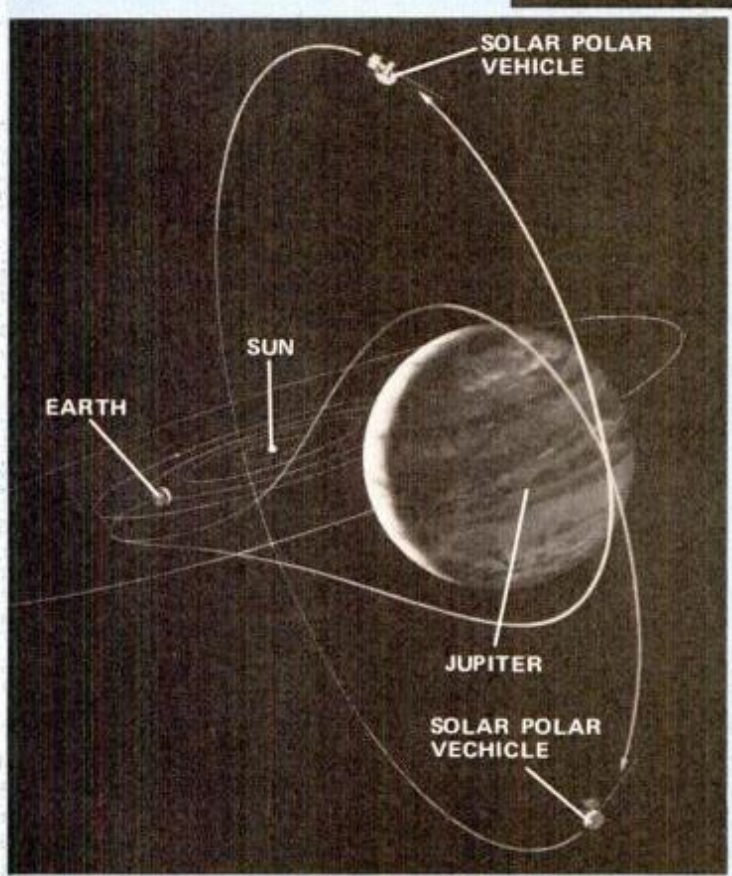
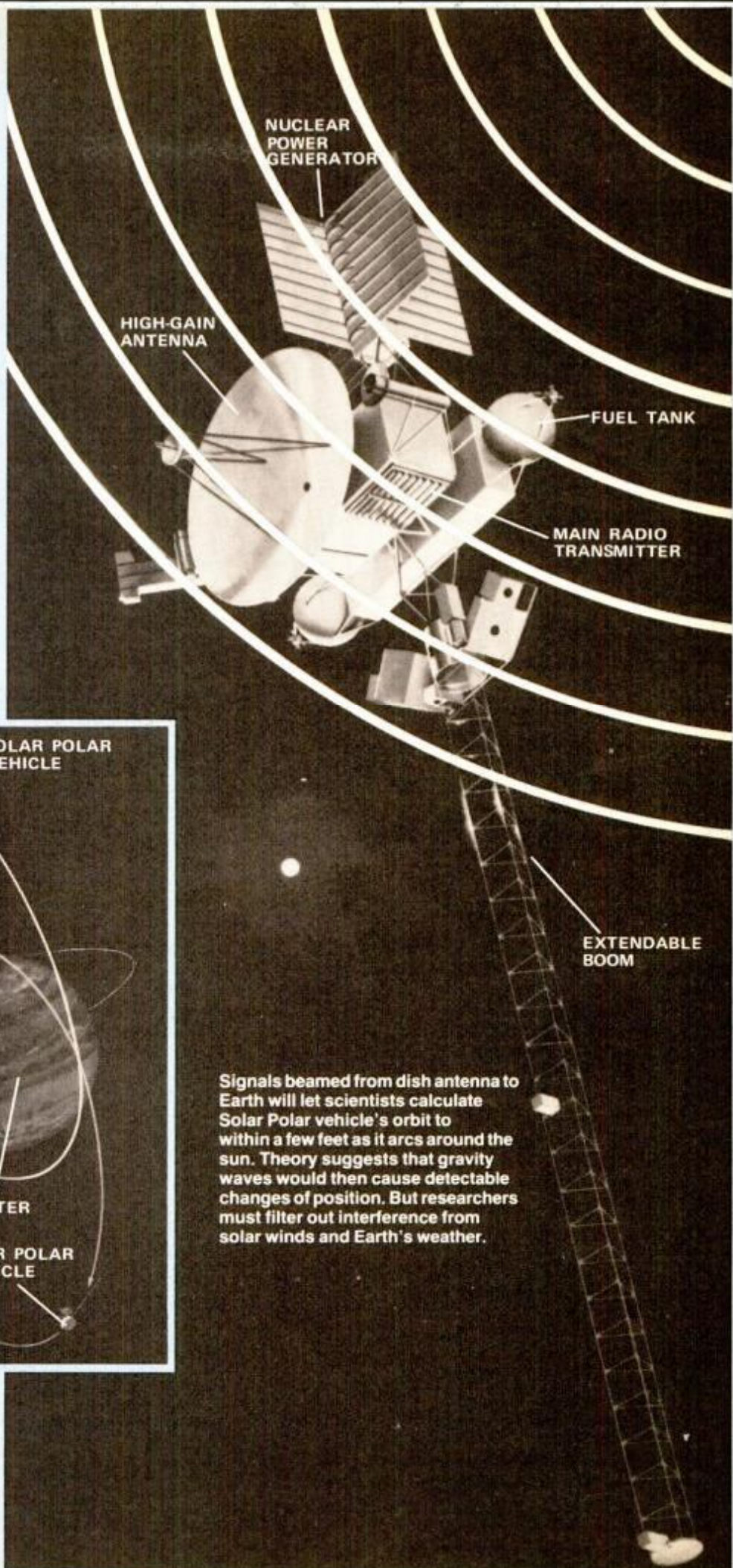
Ripples

the field, its geometry, is changing because you're waving your arms. And these tiny changes in the details of the gravitational field are emitted in the form of gravitational waves." Those waves, the theory says, always travel outward at the speed of light.

While there are no waving arms in space, many celestial events could emit bursts of gravitational radiation. A burned-up star collapsing into a black hole or neutron star, the collision of two or more nonspherical black holes, the explosion of a massive star—each could send pulses of gravitational radiation booming through space.

"When a black hole or neutron star is formed," says Princeton professor Jerry Ostriker, "more energy is emitted than anyone knows about." Scientists do know, though, that this energy in the universe does account for a great deal of mass.

Einstein showed more than 70 years ago that energy and mass



Signals beamed from dish antenna to Earth will let scientists calculate Solar Polar vehicle's orbit to within a few feet as it arcs around the sun. Theory suggests that gravity waves would then cause detectable changes of position. But researchers must filter out interference from solar winds and Earth's weather.

The twin probes, one supplied by NASA and the other by the European Space Agency, will study Jupiter during a close passage. Then they will use Jupiter's gravity to sling them out of the plane of the ecliptic, the plane on which Earth and other planets orbit. Their new paths will enable them to explore uncharted space before closing in, from opposite sides, on the sun.



might be converted, one to another—a physical law revealed most dramatically in nuclear explosions. So when researchers track gravity energy, they're actually trying to account for *mass*—99 percent of the mass in the universe, under current theory.

Assuming the waves exist, the problem for gravity's hunters is that the storm of energy from distant collapsing stars is dissipated into a faint ripple by the time it reaches Earth. The slightest technical problem can mean missing the ripple.

A glitch in frigid chamber

There was the problem at Stanford, for instance. Something had apparently gone wrong in the 15-foot-long Thermos bottle—a "dewar" in physicists' jargon—that is a major component in one type of gravitational wave detector. Filled with liquid nitrogen and then liquid helium, the dewar's interior had been cooled close to absolute zero, -460°F . At those temperatures, molecular activity inside the chamber had all but stopped. A 5-ton aluminum bar was lodged inside, dead still, connected to a sensitive device similar in principle to a microphone pickup on a guitar. If a gravity wave caused a tremor in the huge bar, the Stanford scientists hoped to hear it "ring."

It had taken two weeks to lower the temperature. Initially, all had gone well, and after two weeks the temperature had dropped to -452°F . Then the glitch showed up. A red pen scratching a record of vibrations on white graph paper twitched erratically. No one reading the graph would be able to pick out the gentle lapping of a gravity wave

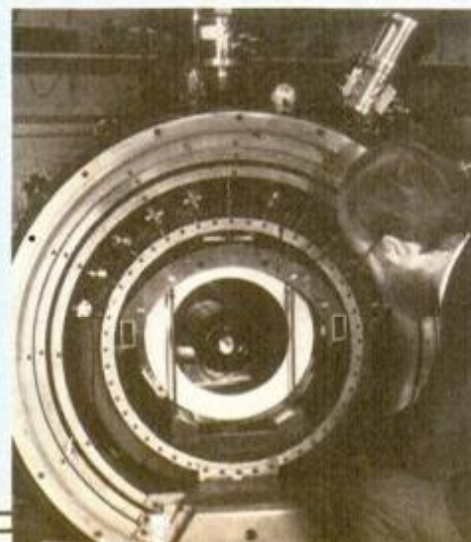
from the surf of background noise.

The only solution was to look into the dewar and troubleshoot the problem. But the procedure was agonizingly slow compared, say, with popping open the hood of your car to check your carburetor. Before opening the chamber, Stanford physics technician Bob Taber had to wait 12 days for the apparatus to warm back up to room temperature.

Finally it was warm enough. Taber punched a control button to swing the 15-ton crane into position over the dewar. The crane's hook reached down to the hoisting eye on the end cap of the cylinder.

Taber and colleague Norm Rebok watched as the crane swung the cap away from the dewar. They peeled off layers of mylar insulating the chamber's interior shell. Then they began painstaking inspection and analysis. Weeks later, they still didn't know what had gone wrong. "A speck of dust falling an infinitesimal distance would do it," Taber said.

A speck of dust can derail the



In one promising gravity-wave detector, mirrors are suspended like pendulums in three metal chambers. A laser beam passes between chambers through two metal pipes. Theory holds that gravity waves passing through the device will cause the mirrors to jiggle, deflecting the beam.

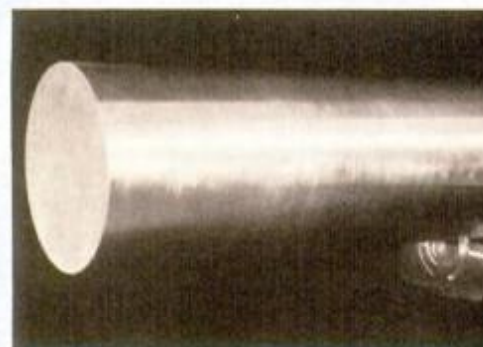
search, but even spotless detectors face tough odds.

Dr. Larry Smarr of Harvard suggests other dimensions of the challenge facing researchers like Taber and Rebok. "To measure gravity waves, you're measuring a change of fluctuation, in terms of the distance between the Earth and the sun, equal to the diameter of a human hair," Smarr says. With instruments of such small size in relation to these magnitudes—say a detector bar three feet long—this accuracy requirement demands measurement of a fluctuation $1/30$ the diameter of the *nucleus* of a hydrogen atom, smallest of all atoms.

Ringing bars, jiggling beams

The equipment to pick up these tiny fluctuations sometimes looks as massive and complex as a jet engine, but the principles are simple. "The experiments are generally of two types," says Prof. Rainer Weiss of the Massachusetts Institute of Technology. "There are detectors that are acoustically coupled, such as aluminum bars or sapphire or silicon crystals—anything with a mass whose movements can be recorded. Second, there are experiments that are electro-coupled—using light waves [supplied by a laser] to do the coupling."

The device Taber and Rebok are working on at Stanford is a typical acoustically coupled gravity wave antenna. In principle, gravity waves passing through the bar cause it to vibrate. Of course, many factors other than waves can set up oscillation in the bar—tiny vibrations caused by inherent molecular movement within the mass ("thermal noise"),



University of Rochester researchers plan to listen for gravity-wave vibrations using a 4-foot-long aluminum bar (above) and large silicon crystal encased in a cryogenic chamber (left) that lowers its temperature.

seismic activity, radio signals, the footfall of a technician, even changes in atmospheric pressure—if the bar is not isolated from such background interference.

But even the best suspension and insulation cannot satisfy the careful skepticism of physicists when such high sensitivities are required. Simultaneous "wave events" must be reported by more than one research team before the phenomenon's existence will be accepted.

Consequently, devices similar to the one at Stanford are being readied at Louisiana State University, under the direction of Dr. William O. Hamilton, and by a group of scientists in Rome. The three-detector network will greatly increase the confidence level if coincident events are reported.

The most promising work to date in the electro-coupled devices uses lasers, mirrors and precise optical technology. Called an "interferometer," the equipment can determine wave length, velocity, distance and direction. The mirrors (the "movable masses") are suspended like pendulums in vacuum chambers. The laser's beam is reflected between at least three points, and it is anticipated that the gravity waves will cause subtle but detectable shifts in the beam pattern.

According to Prof. R.W.P. Drever of Glasgow University in Scotland and the California Institute of Technology, one of the advantages of the interferometer approach is broader frequency detection. "With masses suspended like pendulums, the frequency range extends from a few cycles per second to a few thousand cycles per second, which is much wider than that of the resonant (bar) type detector," he says.

Additionally, says Prof. Weiss of MIT, "The advantages of this type of system are that it can look at the shape of waves that are transient events (coming from black-hole formation, for example), or periodic events (such as pulsars). We could also look at gravitational noise," that low-level but apparently constant gravitational radiation originating in the Big Bang of the universe's formation. "To search for gravity waves at even lower frequencies, where supermassive black holes may radiate, it would be appropriate to use still longer baselines," Prof. Drever says. The frequencies of such black-hole gravity waves, other scientists say, might be as low as one cycle every four hours.

Field work in space

"Longer baselines"—the distance between the interferometer's mir-

If black holes produce gravity waves that 'hum' at six cycles per day, we may 'hear' them with probes.

rors—can be found in outer space.

The most advanced plans for extraterrestrial detection of gravity waves are being prepared by a group of Jet Propulsion Lab (JPL), NASA and European Space Agency scientists. The physicists hope to have a gravity-wave experiment included on the Solar Polar mission to the sun set for an early 1983 launching.

A pair of spacecraft will be sent toward Jupiter. One will fly by the planet's south pole and the other by the north. The vehicles will do a semiorbit around the planet and then arc back toward the sun where they will then orbit its poles.

A signal will be sent from the Earth to the craft and back again. Given the known distance from the Earth to the craft, it is possible to calculate exactly when the signal should arrive at one point or the other. But if the spacecraft and/or Earth are hit by gravity waves, they will jiggle relative to each other and the signals will arrive back on Earth

earlier or later than was predicted.

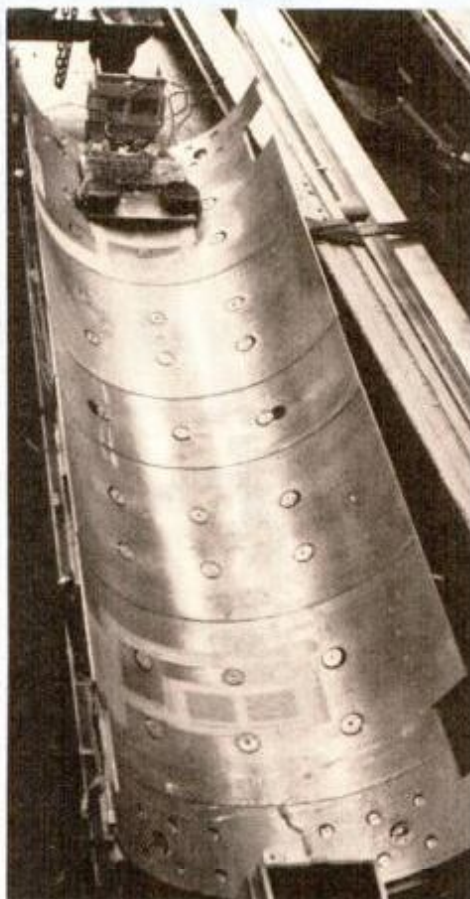
Essentially, the paths of the two craft form a space antenna millions of miles long, an instrument sensitive to mere whiffs of interference.

No one can predict now whether the waves will more likely appear on land or in deep space. But wherever they're first found, their detection may challenge existing theory concerning the nature of the universe. Dr. Kip Thorne, a leading astrophysicist at Cal Tech, thinks we're on the threshold of a new branch of science—gravity-wave astronomy.

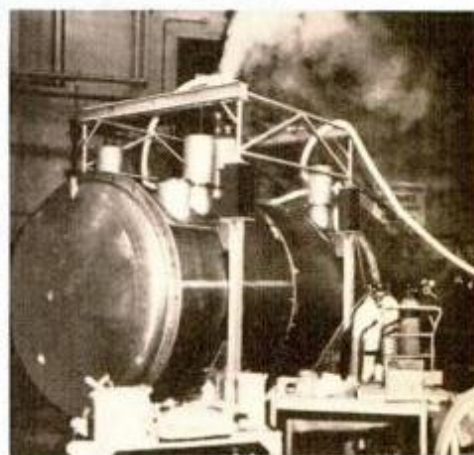
"As detectors become more sensitive, they could, in time, map out an entirely new astronomical window onto our universe," he says.

While Thorne's predictions seem quite reasonable, Prof. Drever is willing to speculate even further. "It may be possible to some day use gravitational waves for communication," he says. "If waves can be generated, there are no barriers to screen them out; they can pass right through the planets."

At best, of course, it'll be years before anyone transmits "Mr. Watson, come here . . ." on a gravity wave. For now, we've got enough challenges just listening—harder than we ever have—for whispering pulses from space. **FM**



Louisiana State University Prof. William O. Hamilton (right) works on disassembled detector. In operation, bar floats over cradle (above) in magnetic field. Vapors (above, right) result from cooling the bar.



Small boats for largemouth bass

New mini-rigs can catch the big ones with a lot less effort, cost and fuel.



Assorted shoal-draft minis, the red and green-hulled Molly Boats, Greenoe canoe and Bass Hunter are among the bargain models that can cruise shoreline shallows for big bass.

by Bill McKeown BOATING EDITOR

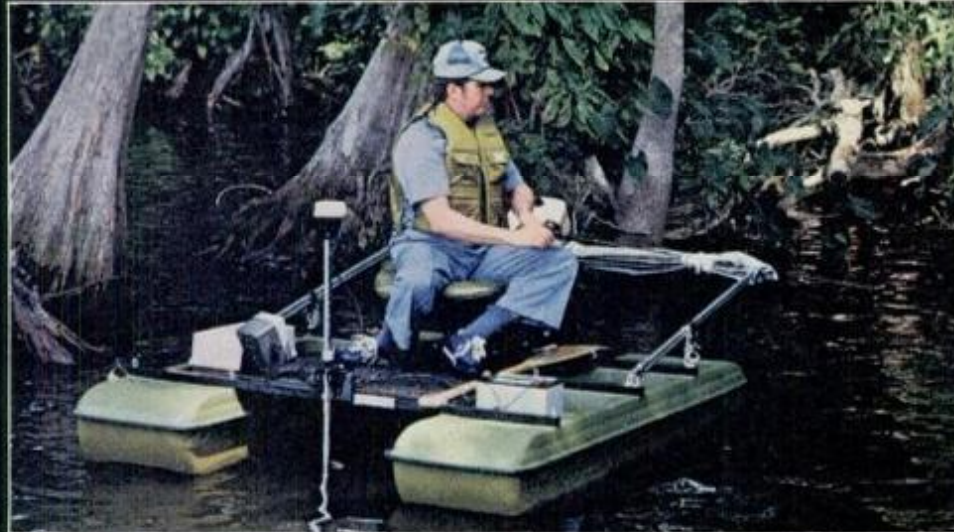
Now those big bass boats, the limousines of the lunker set, are getting competition from the compacts. Just like ashore, the rigs with the larger fuel-consuming engines are being challenged by mini one- and two-seaters that aren't

as fast or flashy, but use a lot less gas to get an angler afloat.

Best fuel economy comes from the models that use no fuel at all. Skiffs, prams, canoes, tubes and johnboats still operate efficiently on muscle power plus oars and paddles. Some take a mini-outboard that can troll all day on a tank of gas, or mount an electric instead. Electric

trolling motors can be used on the bow or transom. They are even mounted in a dual installation, with one on each side amidships on an experimental single-seater bass boat being tested by the noted tackle firm of Lew Childre and Sons.

To earn the true title of a "bass boat," however, the compact should offer big-boat features. The original specialty craft



Compact bass boats shown here are Bass Hunter (lower photo above), Molly Boat (left, upper left and top right) and the Gheenoe (bottom photos). The Bass Hunter is a 39 x 79-inch cartoppable single-seater, rated for outboard power up to the 2-hp Johnson shown. It can also carry a trolling electric. The Molly Boat is a 69 x 90-inch catamaran, riding on two 54-pound demountable pontoons that unbolt easily for transporting and storing. It can take a 5-hp outboard plus electric trolling motor, deep-cycle battery, tackle and two fishermen. A striped navy top or camouflaged duck blind can be mounted on the hull. A depth finder and swivel seats are additional options. The Gheenoe, an almost-flat-bottomed canoe of unusual stability and squared-off transom, is rated for 10-hp outboards.



PM photos. Jerry Imber, Cypress Gardens

designed for chasing largemouth lunkers earned their popularity with stability that allowed the angler to stand to cast or boat a fish. Ideally, seats are comfortable for hours of angling, and swivel for fishermen who like to cast in any direction, yet stay seated while fighting a fish. Although a cockpit isn't required, there should be space to stow or secure a tackle box,

depth finder, battery and live-bait-well/cooler.

The 16-foot, \$399 Gheenoe, from Gheen Manufacturing, Box 5306, Titusville, Fla. 32780, may look like a canoe, but its wide bottom and under-seat flotation provide a stable platform for motors to 10 hp or more. For \$229, the single-seater Bass Hunter from Bass Hunter Boats, Box

1514, Valdosta, Ga. 31601, can take a 2-hp outboard aft and a bow electric.

Advanced Marine Concept's \$652 Molly Boat comes apart into two pontoons that can be cartopped or stowed in a station wagon. Reassembly takes five minutes, and the builders (Box 6146, Arlington, Tex. 76011) recommend up to 5 hp and 700 pounds carrying capacity. **PM**

POWER TO THE PEDALS!

The 5th International Human Powered Speed Championships set a new record: 57.07 mph.

Streamlined White Lightning, No. 8, with two men up, hands and feet pedaling like crazy, copped the \$3000 Abbott Prize by being the first bike to break 55 mph. The speed achieved by Jan Russell (right) and Butch Stinton (below, wearing Schwinn shirt) was amazing 56.70 mph.



By Bill Hartford AUTO EDITOR

They don't look like wild-eyed, speed-crazed scofflaws, but several of them broke the national speed limit recently—on their "bicycles."

Pedals and sprockets are about the only things that these vehicles have in common with what you and I know as bicycles. A stock bike just doesn't have a chance when you're after a \$3000 prize for breaking 55 mph.

At the 1977 Human Powered Speed Championships (*PM*, page 104, Sept. '77) the best competitor clocked 49.93 mph. Last year White Lightning, a supine tandem, came close, with 54.43 mph. This year White Lightning was the first vehicle to whoosh past the 55-mph barrier, with a 56.70-mph clocking. That locked up the Abbott prize, named after Dr. Allan Abbott, a



Innards of White Lightning, seen with top off.



Prone machine of Chris Pollard was one of the longer-wheelbase entries. Best speed for the stretched rider was just a nick under 30 mph.

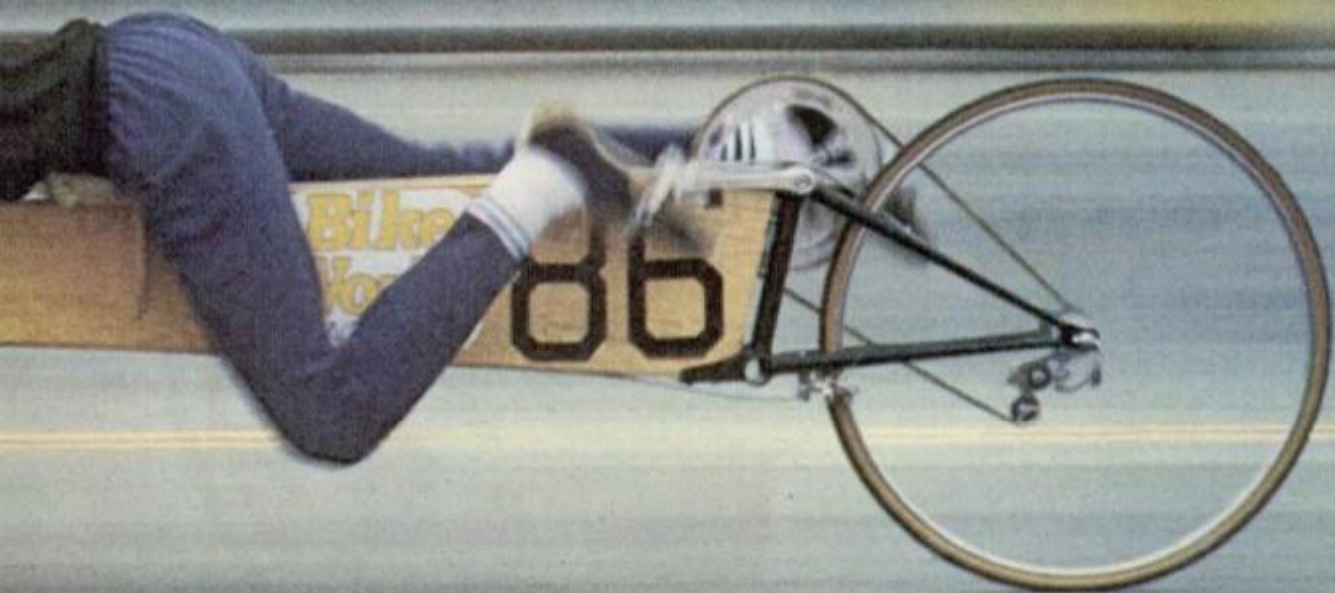
Fast pace, style and grace were displayed by youth who pedaled Doug Malewicki's beauty (right) to a best run of 29.62 mph.

Steve Ball's prone bike (middle, right) uses honeycomb wheels with polyurethane tires molded on. Linear pedals drive the front wheel; wrist motion steers the bike.

high-speed cyclist and charter member and past president of the International Human Powered Vehicle Assn.

Later in this year's competition at California's Ontario Motor Speedway, the best speed of the day was set: 57.07 mph by Vector, No. 82, a prone layout machine. While not eligible for the Abbott Prize, its riders—Dave Grylls, Scott Andrews and Leonard Nitz—were elated at the achievement of setting the highest speed ever recorded in five years of the human-powered speed runs.

This year's meet saw dozens of innovative entries—singles, multiples, prone, supine and standard. One vehicle, Steve Ball's, shown at right, used only two parts from a standard bicycle: the chain and toe clips! **PM**



Driving American Motors

by Gary Witzenburg
DETROIT AUTO EDITOR

The Eagle, the world's only *full-time* four-wheel-drive car, has landed. With this earth rover, you get in, start the engine, put the automatic transmission in gear and drive away. There are no hubs to lock or unlock, no confusing array of levers to shift this way and that. On or off the road, you just drive it and forget it; the only time you'll even realize the 4wd is there is when it gets you out of a jam no two-wheel-drive system could.

Subaru's wagon is the only other 4wd automobile on the market (see page 96). Its 4wd system is simple, too, but it must be engaged with a floor-mounted lever, is recommended for use at 50 mph and below, and has no limited-slip differential between the front and rear axles. By con-



trast, the AMC Eagle's heart is a unique, viscous-drive center differential that lets the front and rear systems run independently in normal conditions, but transfers torque to the higher-traction end when any wheel begins to slip.

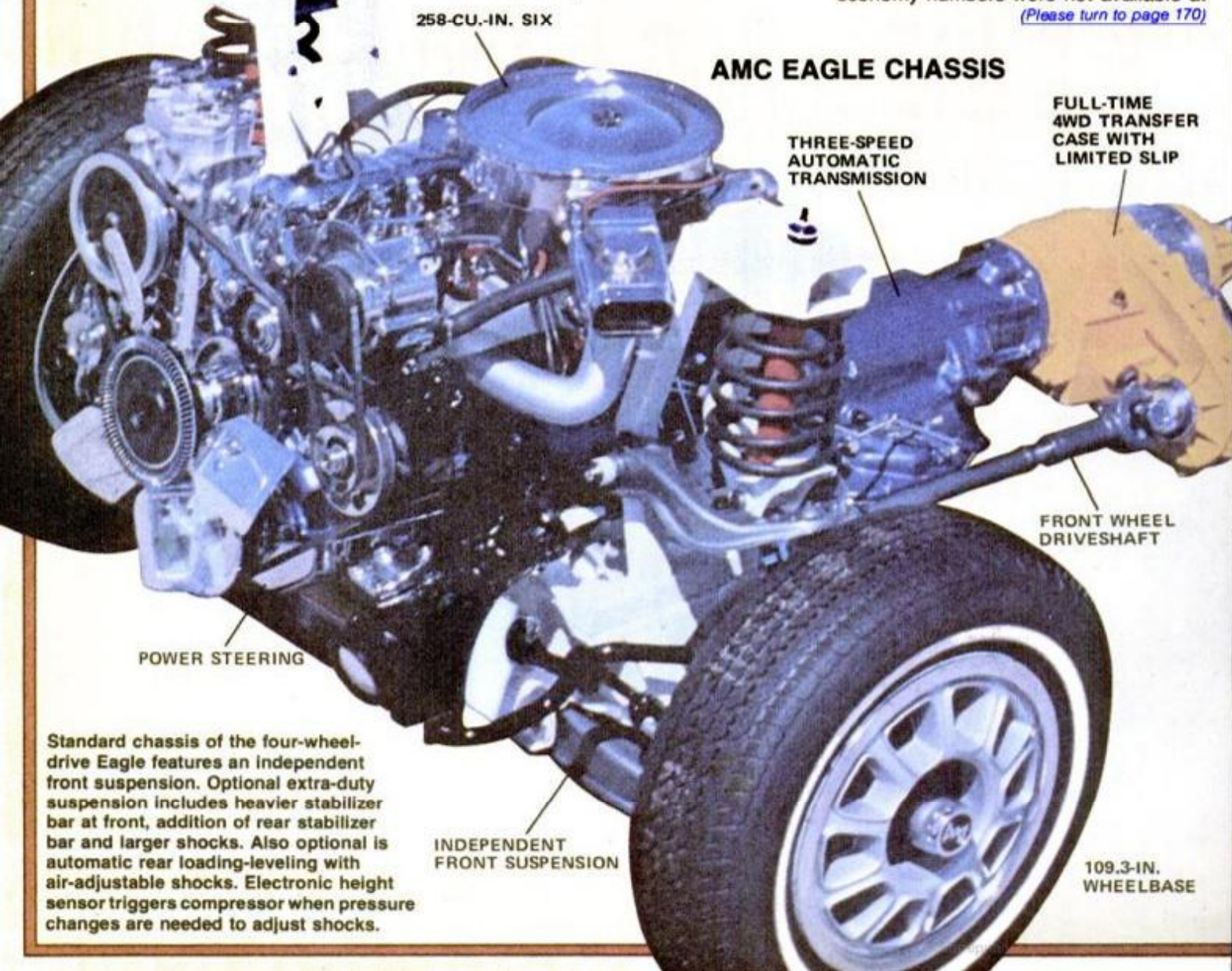
And it works amazingly well, as we discovered in a day of test driving at AMC's Burlington, Wis., proving ground. We didn't have any ice or snow to play on, but we did try it in slippery mud, sand, wet grass and on very steep hills. AMC engineers demonstrated the Eagle's pulling power by hauling an enormous 25,000-pound road grader with it on a slight up-grade on gravel—while a front-drive Citation and a rear-drive Mustang chained to-

gether just sat there and dug holes trying to move it. We even stopped our Eagle to pose for photographs on the steepest hill around, shut off the engine, then casually restarted and drove on up and over.

The Eagle is not intended to be crashed and thrashed around off-road like its cousin, the Jeep, but it *is* designed to give its owner the freedom to go almost anywhere, any time, without worrying about weather or road conditions. AMC figures there's a large market for that kind of mobility in an attractive, quiet, roomy and comfortable passenger car. Many people want to be able to get through "no-matter-what" but don't want the extra size, weight, ride harshness and fuel consumption of a truck-type 4wd or the out-back primitiveness of a Jeep.

Some may question the wisdom of introducing a 4wd car in a time of great concern over fuel cost and availability, but AMC's Eagle should be thought of as a highly economical 4wd vehicle rather than a less economical 2wd car. EPA economy numbers were not available at

(Please turn to page 170)



Standard chassis of the four-wheel-drive Eagle features an independent front suspension. Optional extra-duty suspension includes heavier stabilizer bar at front, addition of rear stabilizer bar and larger shocks. Also optional is automatic rear loading-leveling with air-adjustable shocks. Electronic height sensor triggers compressor when pressure changes are needed to adjust shocks.

four-wheel-drive Eagle



Four-door sedan is one of three body styles offered in the Eagle line. Car will be available with many luxury options, like vinyl roof (shown at left), power equipment and cruise control.

PM's test in hilly terrain revealed impressive performance. The 4wd Eagle concept balances comfort of a well-appointed passenger car with ruggedness of a four-wheel-drive chassis.



Two-door sedan, like the four-door and station wagon models, is 186.2 inches overall on a 109.3-inch wheelbase. Its height is 55.8 inches compared to 55.3 for the four-door and 55.0 for the wagon.

Station wagon model, like all Eagles, has seven-inch ground clearance. Curb weight is 3407 pounds compared to 3306 for two-door, 3361 for four-door. Width of all models is 71.94 inches.



by Paul Weissler

The American Motors Eagle, Detroit's first four-wheel-drive automobile, is like nothing else around. It's definitely not a Jeep with a car body, and although it has the sheet metal of a Concord, a lot more was done than bolt a front-drive system to the rear-drive car. It's a 4wd automobile that stands on its own, and is far different from the Subaru, the only other 4wd automobile.

What sets the Eagle apart is that it's the world's first mass-production car with full-time 4wd. A limited-slip differential on the transfer case divides the torque between front and rear axles, even if one axle has lost traction. This is similar to the limited-slip differential, optional on rear-drive cars, that transmits power to both rear wheels, even if one has lost traction.

The constant control of power to both axles contrasts with part-time 4wd, such as on Subaru and many utility vehicles (including some Jeeps). With part-time, you shift into 4wd and that locks front and

rear axles together. Equal power goes to each axle, so you are restricted to low-speed operation. Any attempt to turn (which varies the torque requirement between axles) must be done very gently or it can result in premature tire and transfer-case wear.

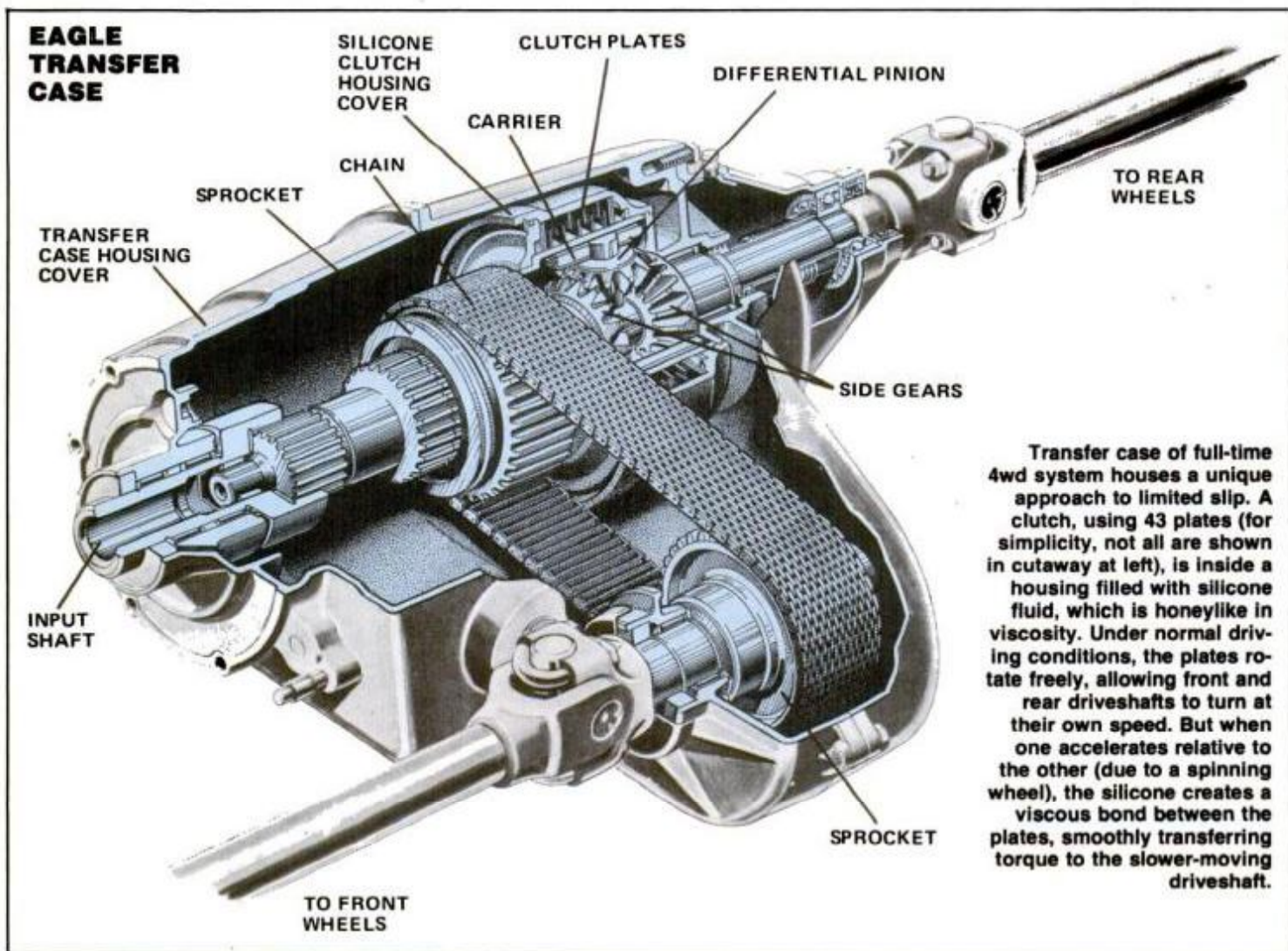
Full-time 4wd isn't new. American Motors, since 1973, has had Quadra-Trac, an advanced design that contains a limited-slip differential. The original Quadra-Trac transfer-case differential had spring-loaded cone clutches, basically similar to Posi-Traction, Sure-Grip and the other optional limited-slips offered on American rear-wheel-drive cars.

A new approach

The new Quadra-Trac transfer case, made by Chrysler's New Process Gear Div., is an English invention with a new approach. Power goes from an input shaft into the carrier of a limited-slip differential, straight out to the rear axle and also offset to the left, through a sprocket, chain and a second sprocket, to a prop shaft to the front axle.

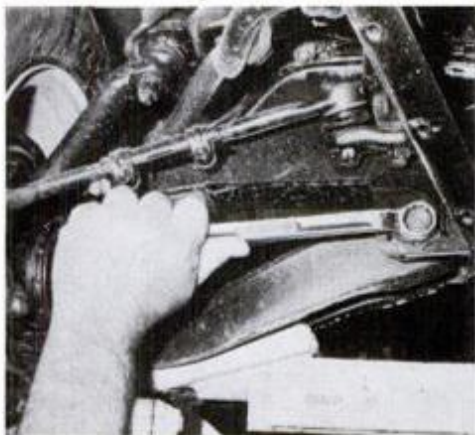
What's unique about this design is the way the limited-slip is obtained—with a multi-disc clutch (43 plates), in a housing filled with a silicone fluid that has a consistency close to that of Silly Putty at temperatures ranging from minus 40° F. to over 400° F. The plates are alternately stacked very close together. One is attached to the hub that also carries the sprocket for the drive to the front wheels. The next is attached to a housing cover that is also connected to the output shaft for the rear wheels. The differential carrier contains four gears:

- One is on the output shaft to the rear wheels. It is called a side gear.
- A second, also called a side gear, is directly opposite, on the hub to the front wheels' sprocket. (Note: In the actual layout, the sprocket hub fits around the power input shaft.)
- The third and fourth gears are on a pin in the differential carrier, and they are free to rotate. Called differential pinions, these gears are positioned at a 90° angle to each of the side gears, and are in mesh with them.



Transfer case of full-time 4wd system houses a unique approach to limited slip. A clutch, using 43 plates (for simplicity, not all are shown in cutaway at left), is inside a housing filled with silicone fluid, which is honeylike in viscosity. Under normal driving conditions, the plates rotate freely, allowing front and rear driveshafts to turn at their own speed. But when one accelerates relative to the other (due to a spinning wheel), the silicone creates a viscous bond between the plates, smoothly transferring torque to the slower-moving driveshaft.

four-wheel-drive Eagle



Caster adjustment of front wheels is an easy procedure made at strut attachment.

In simple operation—equal traction to all wheels—the power flows from the input shaft into the carrier (the shaft is held to the carrier by a pin—the same one that holds the differential pinion gears).

The carrier turns. Because power requirements to all wheels are the same, the side and pinion gears are motionless. Thus, these gears, the differential carrier, plus the output shaft and hub and the silicone-filled clutch housing, all turn as a single part.

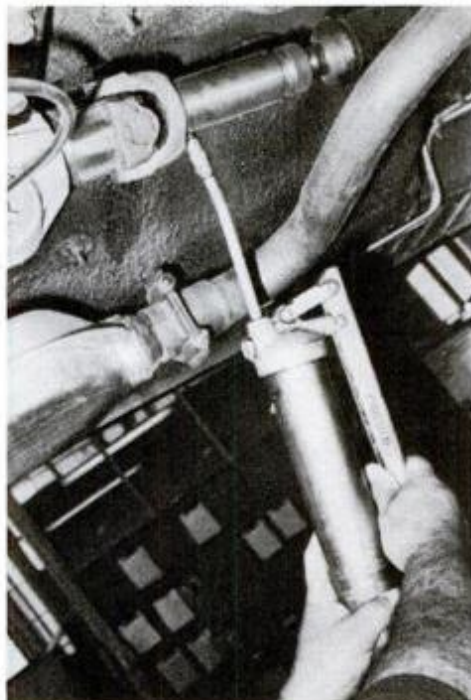
Losing rear traction

Now let's see what happens when one or both of the rear wheels lose traction. Now the output shaft to the rear wheels wants more power, which it would waste by spinning, since the rear wheel(s) do not have traction. In a conventional differential, as the input shaft spun the carrier, the output shaft and its side gear would spin furiously, forcing the differential pinion gears to run around the opposite side gear (the one to the front wheels). That side gear and the shafts to the front axle would remain motionless.

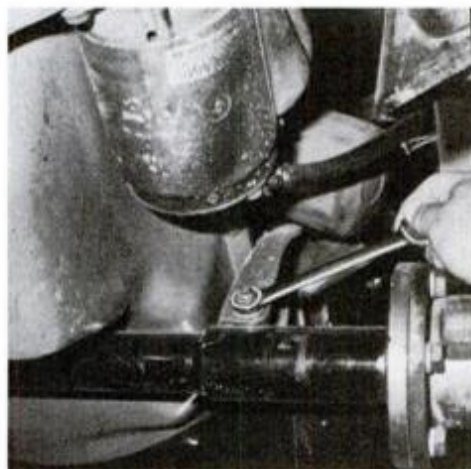
The silicone coupling won't let this happen. If the output shaft to the rear wheels tried to spin all by itself, the clutches for the shaft to the rear wheels would have to shear rapidly through the thick silicone fluid in the narrow space between the clutch plates. The resistance would be too great for this to happen, and the shaft would be slowed down, reducing its power draw. The remainder of the power would therefore go to the front wheels.

If there's only a minor difference in power requirements between the axles, then normal differential action can occur, as one set of clutch plates shears through the silicone, moving slowly relative to the other set.

Although the power transfer in a traction-lost-at-one-axle situation is initially limited, it does get better quickly. The shearing causes the silicone to heat up



Periodic maintenance includes greasing sleeve yoke on rear propeller shaft.



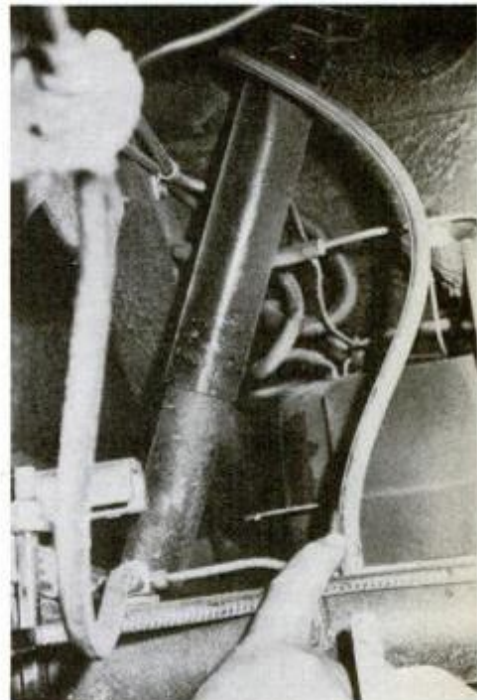
Axle-to-engine bracket nut is loosened, so axle can be lowered to remove oil pan.

and expand, increasing pressure against the clutch plates. This reduces the shearing under those conditions and makes the differential behave almost as if it were mechanically locked.

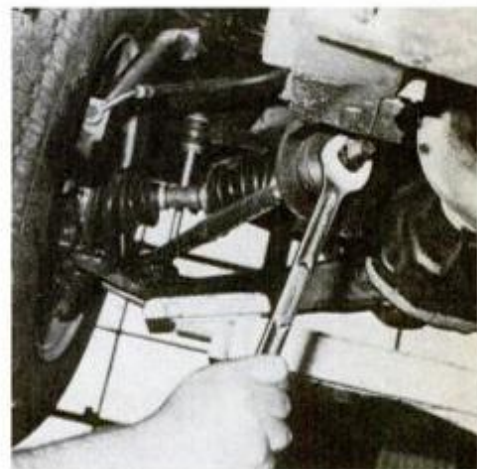
As a result, the transfer case doesn't have an arrangement to mechanically lock front and rear axles. This is a normal feature, along with a low gear ratio, on other full-time 4wd systems, including the original Q-T.

A low-gear-lockup as an emergency feature may be helpful in selling Jeeps, but it's of no real significance on an automobile with a full-time system, particularly with this transfer case. Absence of a manual lockup also is a simplification, a plus on a car that undoubtedly will be bought primarily by first-time 4wd motorists.

The silicone clutch setup is not only a



Flexible tube on axle vent goes up into car body, prevents oil contamination.



Camber adjustments are made by turning cams on the Eagle's lower control arms.

lot simpler, but comes on very smoothly, absorbs a lot of drive-line vibration and eliminates "stick-slip." This is a low-speed grunting noise that usually occurs during low-speed cornering or parking, after a long highway run or if the vehicle hasn't been used for a while. The cause is oil spinning or draining off cone clutches, so without cone clutches, it can't occur.

Although the noise was irritating, it often went away if you drove in figure-8s to recirculate the special transfer case lube. If it didn't, the only cure (not guaranteed) was to drain the transfer case, and refill with a fresh charge of that special oil. The new silicone clutch fluid fill is for life, and the clutch assembly is tightly sealed to prevent leakage into the transfer case. If a seal fails and the silicone leaks in, how-

(Please turn to page 208)

THE
4WD
PASSENGER CAR

Four-wheel drive (4wd) has moved from fad to fact in this country, especially in rough-winter areas. Suburbanites buy more four-wheelers these days than full-sized station wagons.

But the average 4x4 tends to be expensive to purchase and even more expensive to feed, which puts the 4wd Subaru wagon into a class by itself. The Subaru four-wheeler's sticker price doesn't cause heart attacks (\$5399 base). Yet it beats the socks off other 4x4s in terms of gas mileage, and it represents a nice blend of passenger-car comfort with off-road agility.

"I used to have a 4wd Chevrolet pickup to get me through the snow and slick places," says a Minnesota livestock buyer, "and it was averaging nine mpg. I now have two Subarus, can still negotiate any terrain and get between 24 and 33 mpg."

A New York bridge and tunnel lieutenant echoes, "It's the least expensive 4wd around and gets very good gas mileage—26 to 31 mpg. I checked with people who own Subarus before buying and

PM
OWNERS
REPORT:
**SUBARU
4WD
STATION
WAGON**

found they had no complaints at all."

Good point, and it brings up another Subaru virtue mentioned by a vast majority of the owners we surveyed: Very few reported needing repairs or service after



Owners rate Subaru's workmanship tops; 72.8 percent never needed dealer repairs.

sale. Only 27.2 percent mentioned mechanical problems of any sort. That's the lowest figure we've had in recent years—twice as good as the Peugeot and Audi 5000 and much better than even the Mark V Continental and Honda Accord.

All Subarus come with an unlimited-mileage, 12-month warranty, but few owners seem to need it. A California freight handler states, "Part of the reason



Tall drivers find legroom tight. Second lever allows smooth shifts between 2/4wd.

I bought my Subaru was for its reliability. I'd heard that Subaru has the best (lowest) frequency-of-repair record of any car, domestic or foreign. It must be true, because in 11,000 miles of driving, I've never needed anything done to the car except for routine service."

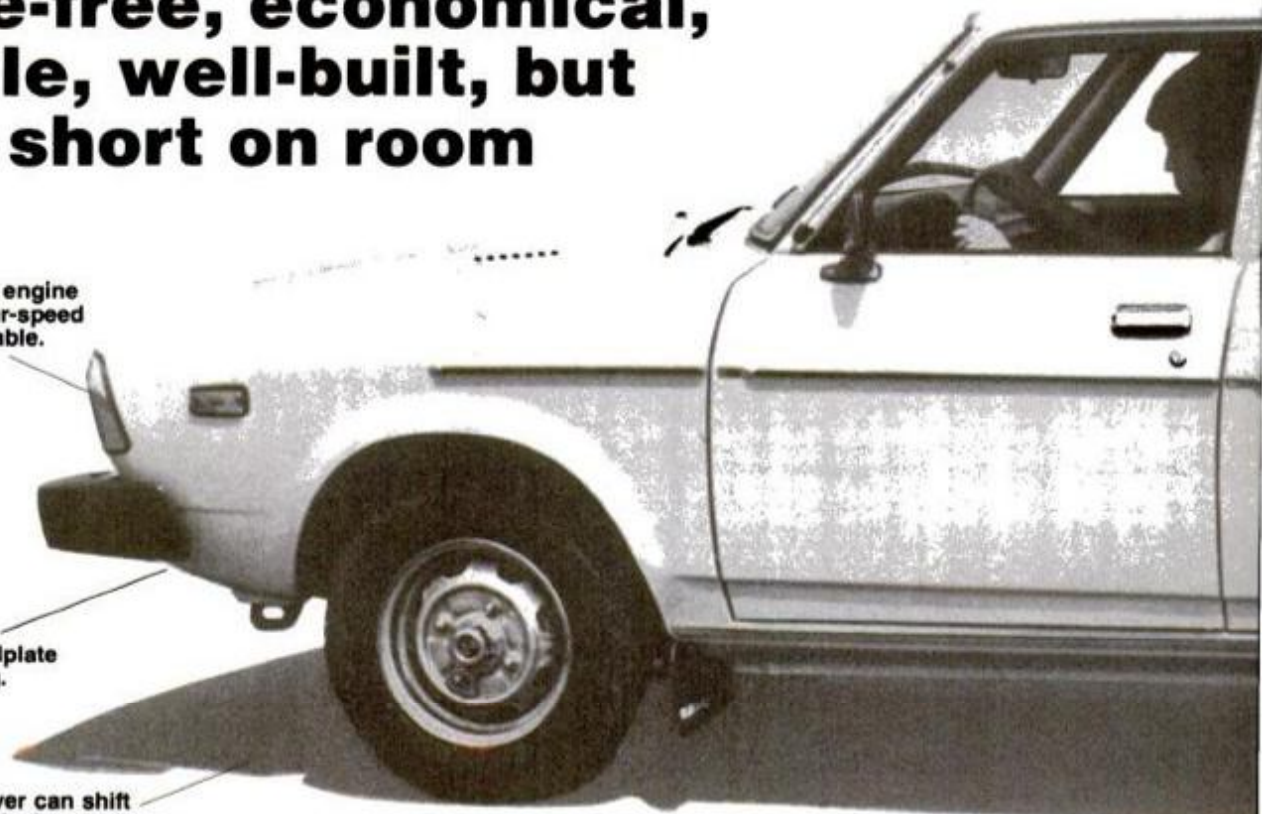
BY MICHAEL LAMM WEST COAST EDITOR

Trouble-free, economical, versatile, well-built, but a little short on room

Opposed four-cylinder engine delivers 65 hp, with four-speed the only trans available.

Subaru sells a skidplate for off-roading.

Driver can shift from fwd to 4wd at the flip of a lever.



Photos by the author.

When it comes to dealer service, 66.4 percent of our respondents rated it *good* to *excellent*. A few, though, warned of long waits for parts. And a New York fire-fighter notes, "Service seems to be better from a dealer who sells strictly Subarus. Other owners I've talked to agree. A dealer who sells imports along with American cars is hard-pressed to get good mechanics for his 'less important' lines and tends not to stock (Subaru) parts."

Subaru again enjoyed extremely high marks on quality and workmanship, with 91.3 percent of our owners rating it *good* to *excellent*. Representative comments in this area include:

"None of the bothersome little problems so common in so many new cars—no squeaks, no adjustments needed, no paint touchup, etc."—Michigan speech therapist.

"The wagon is put together well. It's also engineered simply, so it's easy to work on."—Minnesota computer programmer.

"One of the best-put-together cars I have ever owned."—New Mexico geodetic survey technician.

And a New York teacher: "Excellent quality; interior shows special care. Things function as they are supposed to; careful attention has been paid to the finishing detail."

We asked owners, too, to give their opinions about the Subaru's comfort. A

North Carolina secretary answered, "The wagon needs more legroom both front and rear, particularly in the rear." That's a prevalent feeling. Taller drivers told us they couldn't move the front seat back far enough to get comfortable, and with the rear seat folded to extend the cargo deck, even short drivers complained of insufficient legroom.

The Subaru's ride, however, was generally deemed quite comfortable, with no sacrifice in handling. A North Carolina highway construction inspector mentioned, "It handles great! It's easy for my

(Please turn to page 200)



Rear-seat bottom tucks against front back rest, gives large cargo deck with low sill.

The car with the funny name

Neil Simon wrote Subaru into the script of *The Goodbye Girl* because, he said, Subaru sounds funny. Toyota and Datsun don't sound funny. BMW and Mercedes *certainly* don't sound funny. But who can take the word Subaru seriously?

Subaru of America Inc. can appreciate the humor of its name today, because Subaru occupies the No. 5 spot in imported-auto sales, which is all the more amazing since, in the late 1960s, Subaru's first U.S. marketing adventure—with the skateboard-like 360 minicar—was a bomb.

Japan's gigantic Fuji Heavy Industries builds Subarus as sort of an aside—amongst aircraft, buses, trucks, railroad rolling stock, construction equipment, motor scooters and tractors. Fuji doesn't market Subarus in the United States—Subaru of America remains an independent importer. It's true, though, that SOA suggests improvements to Fuji to help sales in this country. Many people feel these changes put Subaru on the American map.

Subaru's current model lineup includes two- and four-door sedans, the FE coupe, GF hardtop, a four-door wagon and the Brat pickup. All Subarus come with front-wheel drive, and the wagon and Brat can be ordered with 4wd, as well.

With 4wd, a second floor lever allows instant shifting between two- and four-wheel drive at running speeds below 50 mph. Subaru's 1595-cc (97-cu. in.) flat Four runs on regular, leaded fuel except in California, where it requires a catalytic converter.

A NATIONWIDE SURVEY BASED ON 638,667 OWNER-DRIVEN MILES



Rear wiper is one of Subaru's many standard features.

Tailgate lifts on spring-loaded pneumatic cylinder.

Clean engine burns leaded regular in all states but California.

How to choose—and use—a

by Robert Perry

Programmable calculators can save you time, effort, even money. They're

Everyone, sooner or later, comes up with some repetitive mathematical task that a normal calculator is not the best tool for. When that happens to you, investigate the programmables.

Deciding which pocket programmable to buy is largely a matter of taste. Texas Instruments offers three calculators and their printers separately, Hewlett-Packard has five programmables and Sinclair Radionics makes two simpler programmables.

At first glance

Hewlett-Packard's line ranges from its HP-67 and 97 (the 97 having a built-in printer) to its new, more limited 19C-29C and 33E programmables. Texas Instruments makes three programmables: the limited TI-57, the more advanced TI-58 and the top-of-the-line TI-59. As shown on the chart (page 182), the TI-58 and 59 can both be attached to a TI printer. Sinclair's two programmables are the Enterprise and the smaller Cambridge.

I studied the HP-67, the TI-59, the Sinclair Enterprise and sampled the others for a month. There were some significant differences and some matters of taste.

Texas Instrument's machines take *Solid State Software* modules that are impressive despite their small plug-in size. Each module can hold up to 25 preprogrammed routines; up to a total of 5000 program steps. Pick the module from the field you need (and TI offers choices from

Programmables are handy to have around the house, especially in the kitchen. You can calculate dinner proportions for 6 to 60.

Home Finance to Navigation), snap it into a TI-58 or 59 and all the *hard* programming is done for you.

Hewlett-Packard competes with what they call their Application Pacs. While also extensive, they tend to pale beside the TI modules.

Everyone a programmer

I asked a friend, James Eng of AMD Consulting in New York, how the programmables could be useful

to an average consumer. It didn't take us long before we had designed a program to calculate home heat loss for energy savings. The program is available free. (See page 184.)

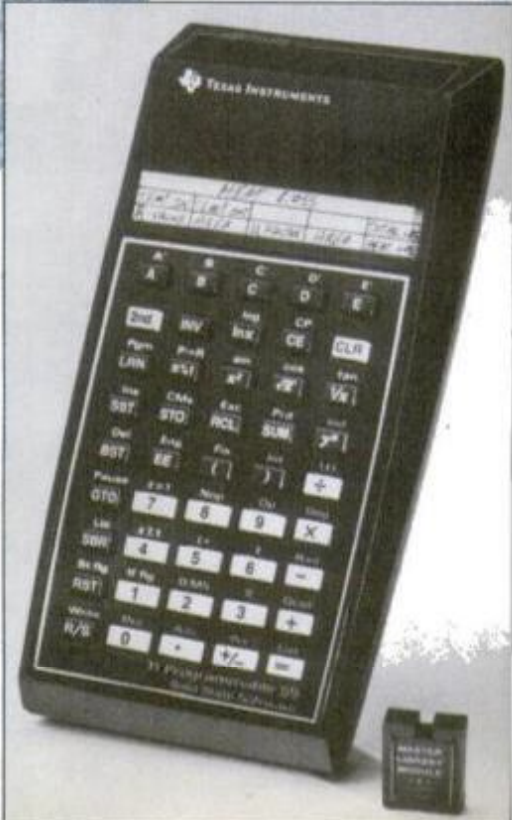
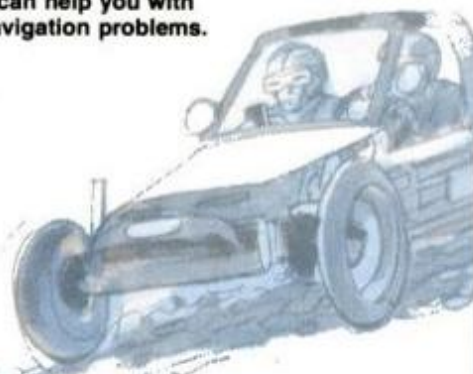
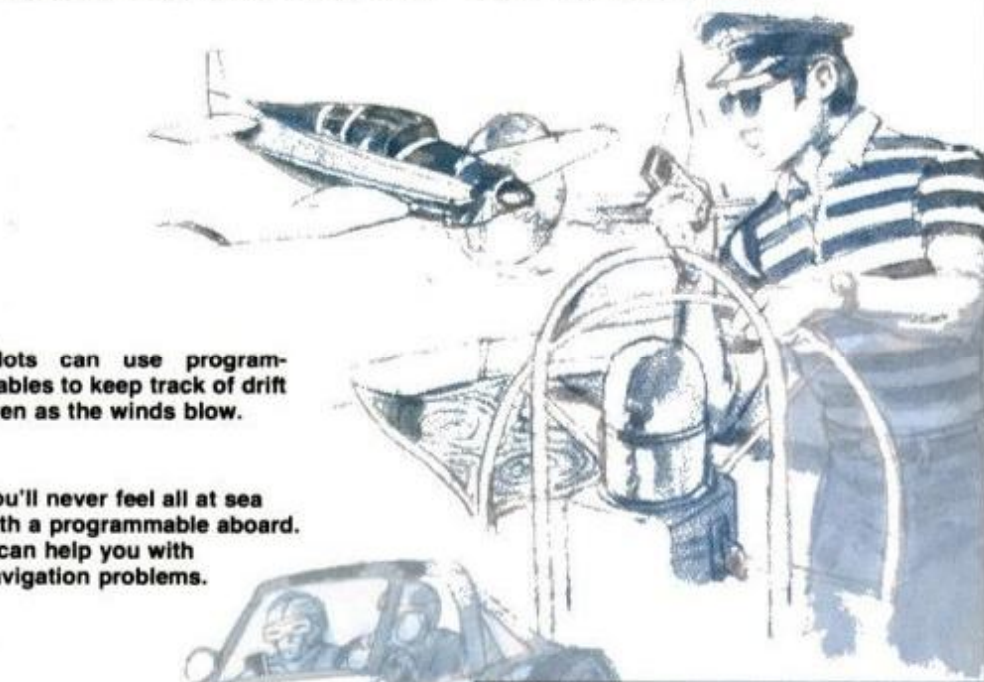
"There are numerous ways people will find to use programs repeatedly," Eng said. "Uses include home heating and airconditioning, determining the best buy in solar heating, home repairs and more."

Pilots can use programmables to keep track of drift even as the winds blow.

You'll never feel all at sea with a programmable aboard. It can help you with navigation problems.

In a road rally a programmable can figure time and distance formulas for a winning edge!

TI-58 and 59 calculators have tiny plug-in Library Modules with thousands of preprogrammed steps for everything from navigation to statistics.



programmable calculator

easy to use, but confusing to buy. We help you cut through that confusion.

Like anything else, you have to compare before you buy. And, before you can do that, you have to know a few points to look for. We suggest you start with these and with our chart.

■ **Languages.** Texas Instruments uses a modified algebraic language they call AOS. You enter a program

to solve from left to right, just as you would read it. Hewlett-Packard uses RPN, which stands for Reverse Polish Notation. RPN is more confusing to the beginner. Problems are entered as if you were writing them out. The logic is not as instantly apparent. However, RPN is preferred by many—myself included—as it

displays intermediate answers in a longer problem as you go along.

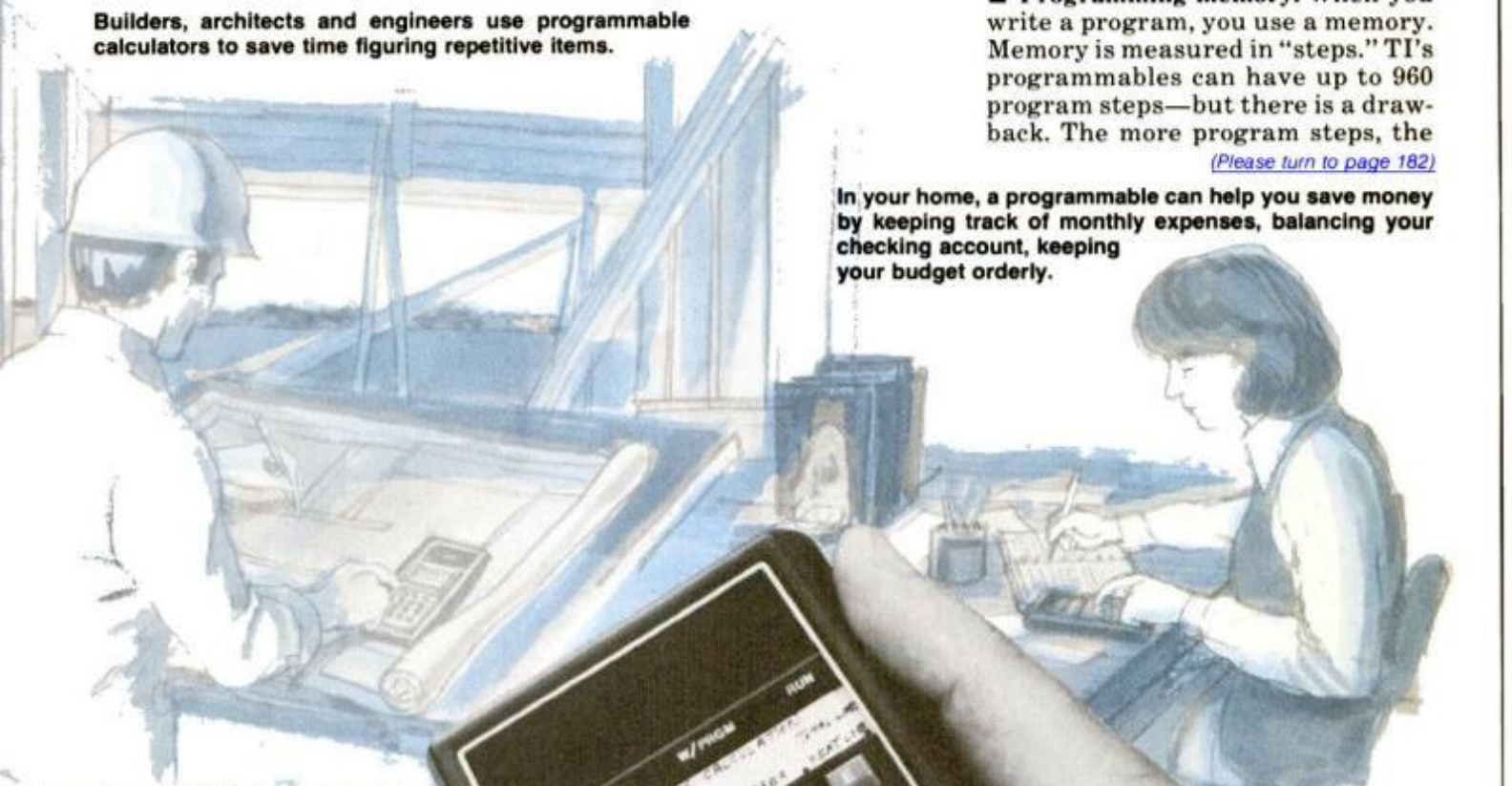
■ **Printers.** If you need hard copies of your work, you *need* a printer. The HP-97 has a built-in printer. The TI-58 and the 59 can hook up to the Texas Instruments PC-100 series printers. The main difference is that the TI printer allows words as well as numbers. Sinclair has no printer.

■ **Programming memory.** When you write a program, you use a memory. Memory is measured in "steps." TI's programmables can have up to 960 program steps—but there is a drawback. The more program steps, the

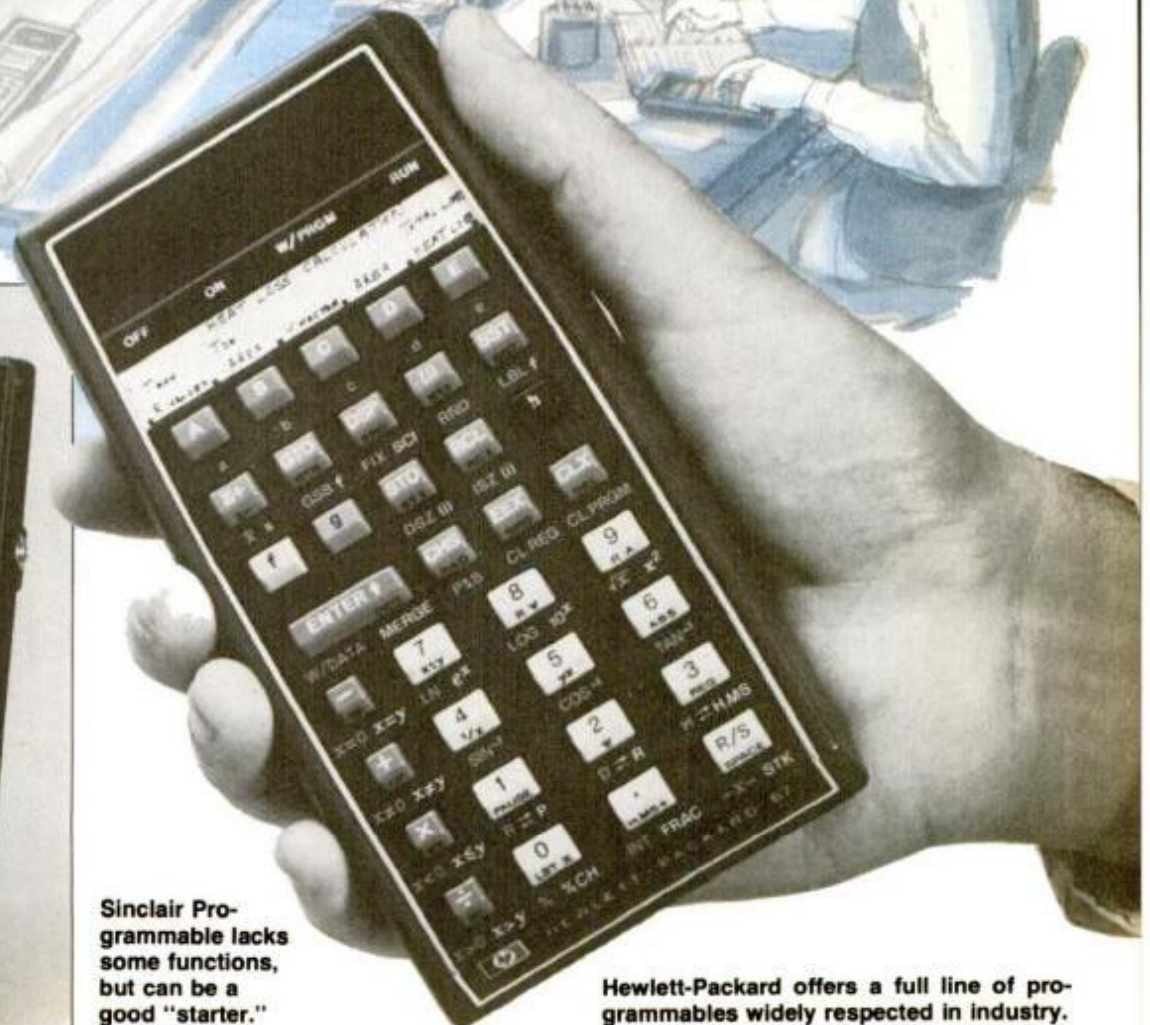
(Please turn to page 182)

In your home, a programmable can help you save money by keeping track of monthly expenses, balancing your checking account, keeping your budget orderly.

Builders, architects and engineers use programmable calculators to save time figuring repetitive items.

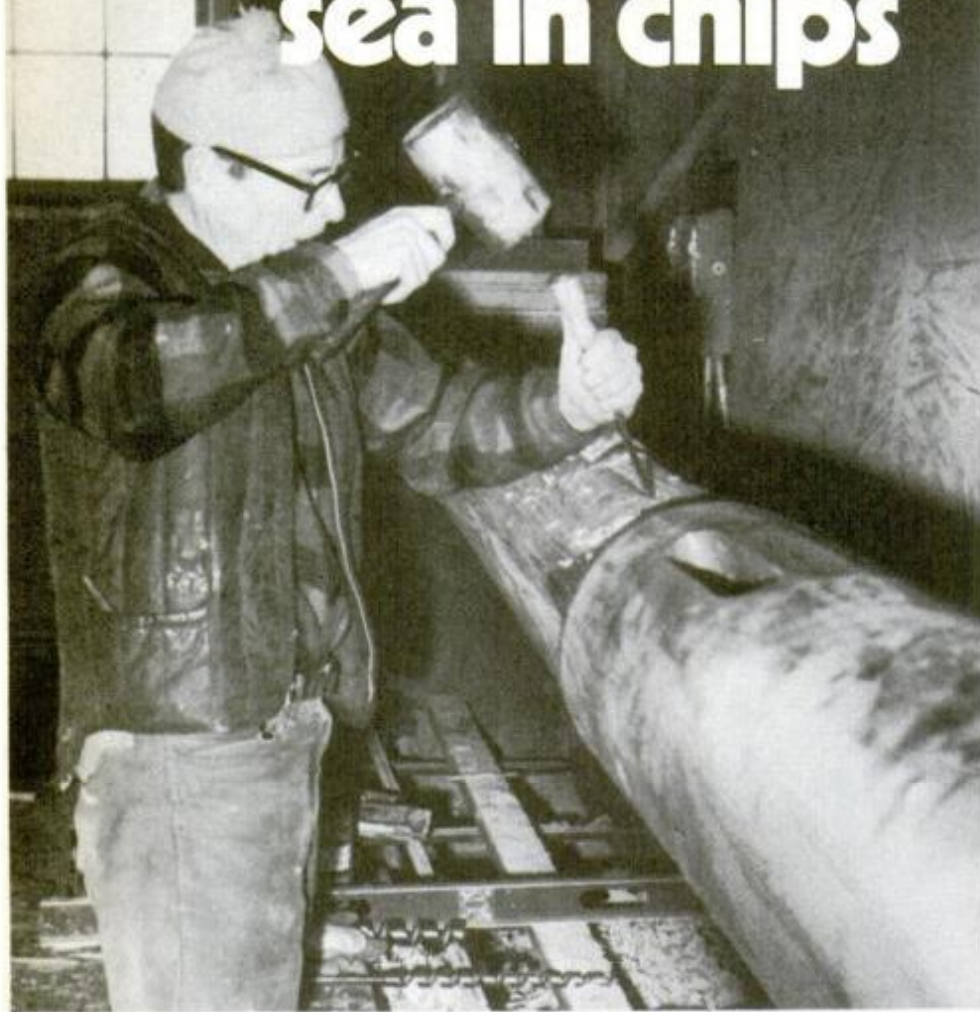


Sinclair Programmable lacks some functions, but can be a good "starter."



Hewlett-Packard offers a full line of programmables widely respected in industry.

Down to the sea in chips



Using a chisel and mallet, a Mystic Seaport shipwright hand-carves a fitting notch in a massive spar for the *Charles W. Morgan*, the only existing American whaler.

Restoring a whaling ship with traditional materials amounts to finishing a carpentry job that started a century and a half ago.

by Geoffrey Bocca

At Mystic Seaport in Mystic, Conn., they are restoring the *Charles W. Morgan*, the only surviving American whaling ship, to the condition she was in when she was built nearly 150 years ago. Shipwrights, painters, riggers and caulkers have all taken a huge step back to the principles which existed in the first half of the 19th century.

They laid down new deck planks of long-leaf yellow heart pine, and drove oakum into the deck seams. New brick "try-works" in which blubber was boiled have filled the great hole left by the old. Wooden "trunnels" (corruption of "tree nails"), some of them 16 inches long, secure planks of oak and pine. Following the traditions, shipwrights fastened the new plates with bronze deck spikes, countersunk and bunged.

Like the old days

It is perhaps the most exciting task ever undertaken to bring American maritime history back to life. Twenty-two full-time experts have worked on the ship, with several part-timers learning the crafts of wooden ship construction. The *Mor-*

Shown under sail at left, the 138-year-old *Charles W. Morgan* ended her whaling career in 1921, is now being restored at Mystic Seaport, Conn. Below, worker drives in a trunnel (tree nail or dowel) to fasten 2 $\frac{3}{4}$ -inch-thick plank to hull ribs.



gan cost nearly \$50,000 to build in 1841. Her 1867 register dimensions are recorded as: length, 105.6 feet; beam, 27.7 feet; depth of hold, 17.6 feet; gross tonnage, 313.75.

Into a ship only one-third the length and breadth of a football field, more than 30 men were packed with two years' supply of food and water, braving climates from North Pole to South Pole and around Cape Horn to the equatorial Pacific to catch that richest and most legendary of beasts, the whale.

The *Charles W. Morgan*, named after her first owner, sailed out of New Bedford, Mass., on Sept. 6, 1841, rounded the tempestuous Horn and headed into the Pacific. Three years and four months later, she returned to New Bedford with 2400 barrels of whale oil and 10,000 pounds of baleen (whalebone: from the French *baleine*, meaning whale). The cargo was worth \$56,000.

Retired and refitted

The *Morgan* made 37 voyages all around the world until she was retired in 1921. By that time she had been home to more than 1000 whalers and 21 masters. She was rescued from the wreckers by Col. Edward H.R. Green, wealthy grandson of Edward "Black Hawk" Green, who owned her from 1849 to 1859.

Green gave the ship a berth at his Massachusetts summer home, refitted her and opened her to the public. When he died in 1935, however, it was found that no funds existed to maintain her. She began to deteriorate seriously, and the 1938 hurricane almost destroyed her. She was saved by the Mystic Seaport Museum, a 40-acre wonderland devoted to America's maritime heritage. It includes 200 ships, a shipyard, craft shops, exhibits of marine art, figure-head museums and other delights for wooden-boat lovers.

On Oct. 31, 1941, the *Morgan*, then 100 years old, was towed to Mystic. She arrived just under the wire of history. The United States entered World War II five weeks later. Had the *Morgan's* voyage been delayed, no time, money or men would have been available.

But there she is today, the pride of Mystic Seaport. From 1941 until Dec. 6, 1973, she was encased on dry land in sand and gravel. The monumental job of dredging her out and refloating her fell to Maynard Bray, then supervisor of Mystic's shipyard and associate curator of ships. First, he and his crew removed 35 tons of topside ballast and took down the topmasts to lighten her further. The dredging took three weeks, followed by a long wait for an easterly storm

which would bring the extra-high tides necessary to float the ship. Six tries were made in November, but the *Morgan* remained stuck fast in the sand. Further dredging was done under the vessel, dropping her 15 inches. Finally, on Dec. 6, at 4:50 in the morning, she floated free in rain and pitch darkness. Restoration began soon after, and she was back in the water at the newly constructed Chubb's Wharf by July 4, 1976, just in time for the Bicentennial celebration, where visitors could watch restoration work as it continued.

The restoration of the *Morgan*, which has been ongoing since 1973, proved to be an immense challenge. She was built before blueprints. In those days a ship was constructed from day to day by word of mouth. "Give me more space here," an owner would say to the shipbuilder, and it was done.

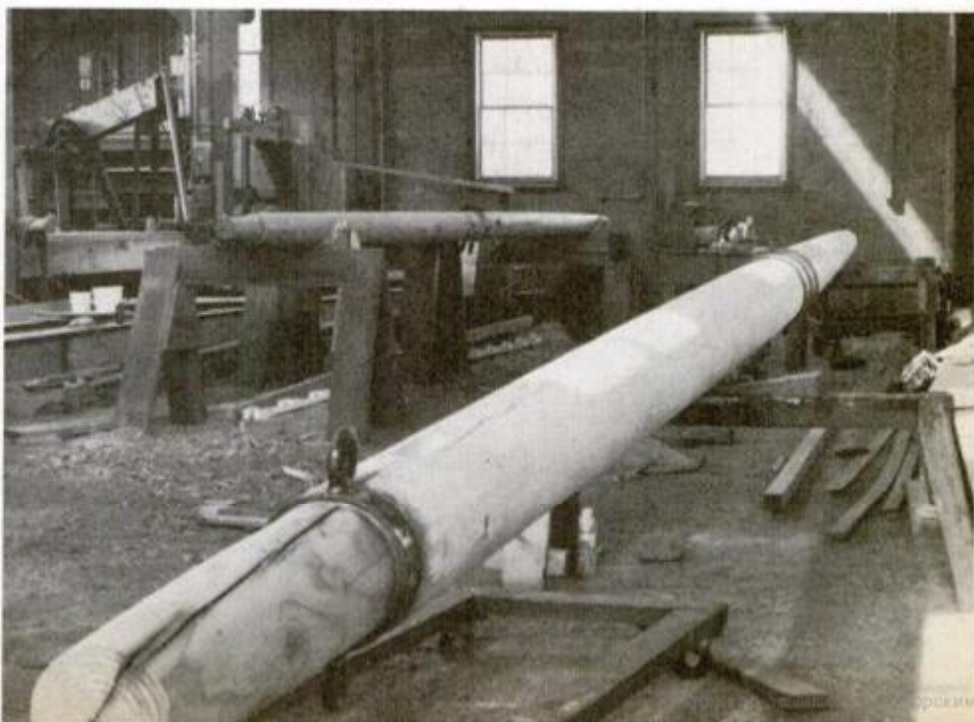
Don Robinson, director of the restoration, has combed records, illustrations, photographs, histories. "Rebuilding such a ship is detective work," he says. "The traces of an old paint line can tell us how and where the ship was painted. The pattern of

(Please turn to page 172)

Huge C-clamps hold new planking in place during fastening (upper right). Interior of hold (lower right) shows stacks of bricks used as ballast. New yard (below) was milled on museum's giant spar lathe, capable of turning timbers 85 feet long.



The *Morgan* is moved into position in a lift dock at Mystic for repairs to her hull. Restoration was started in 1973.



"It's got a lot of the Firebird in its styling," enthused a New York supervisor about his Sunbird coupe, "and from the side it looks like a smaller version of the Mercedes 450-SLC."

"I bought mine because I think it's a cute car," purrs an Illinois secretary.

"The Sunbird's styling caught my eye," asserts a South Carolina bank executive.

Virtually all owners mentioned the *influence of styling* on his or her buying decision. And 52.5 percent ranked appearance as the Sunbird's No. 1 drawing card.

The word "sporty" often found its way



The Sport Hatch has insulation and brightwork that's extra in other body types.

into our respondents' vocabulary, particularly to describe the three-door hatchback. But several owners applied "sporty" even to their Sunbird wagons.

Not that looks alone drew them into

PM
OWNERS
REPORT
PONTIAC
SUNBIRD

dealer showrooms. "I'd been looking for a car in this size range," says a Wisconsin foundry manager, "and the Sunbird offered the best price. I'd owned Pontiacs before; they're good cars."

A Colorado attorney: "I bought mine because it's one of the few small American cars into which I can fit."

An Illinois printer: "I wanted an American-made car that would give me good gas mileage. I believe in buying American."

And a self-employed North Carolinian: "I wanted a small car with good gas mileage—one that would be dependable. And I didn't want to settle for anything less sporty looking."

Sunbird owners told us that, by and large, they're pleased with their cars' gas

mileage. The "Iron Duke" four-cylinder Pontiac engine averaged 21.0 to 26.3 mpg in actual driving, the Buick-supplied V6 about three mpg less. Yet here's an economy car—usually with automatic transmission—that doesn't give limp-wristed performance. "The V6 lets the Sunbird run rings around my Grand Prix with the 350-cu.-in. V8," states an Ohio payroll auditor.

"The 2.5-liter Four gives excellent pickup for passing and also at red lights," says a North Carolina farmer. A New York optician notes, "The Sunbird V6 has a lot of power, and the car certainly handles very nicely."

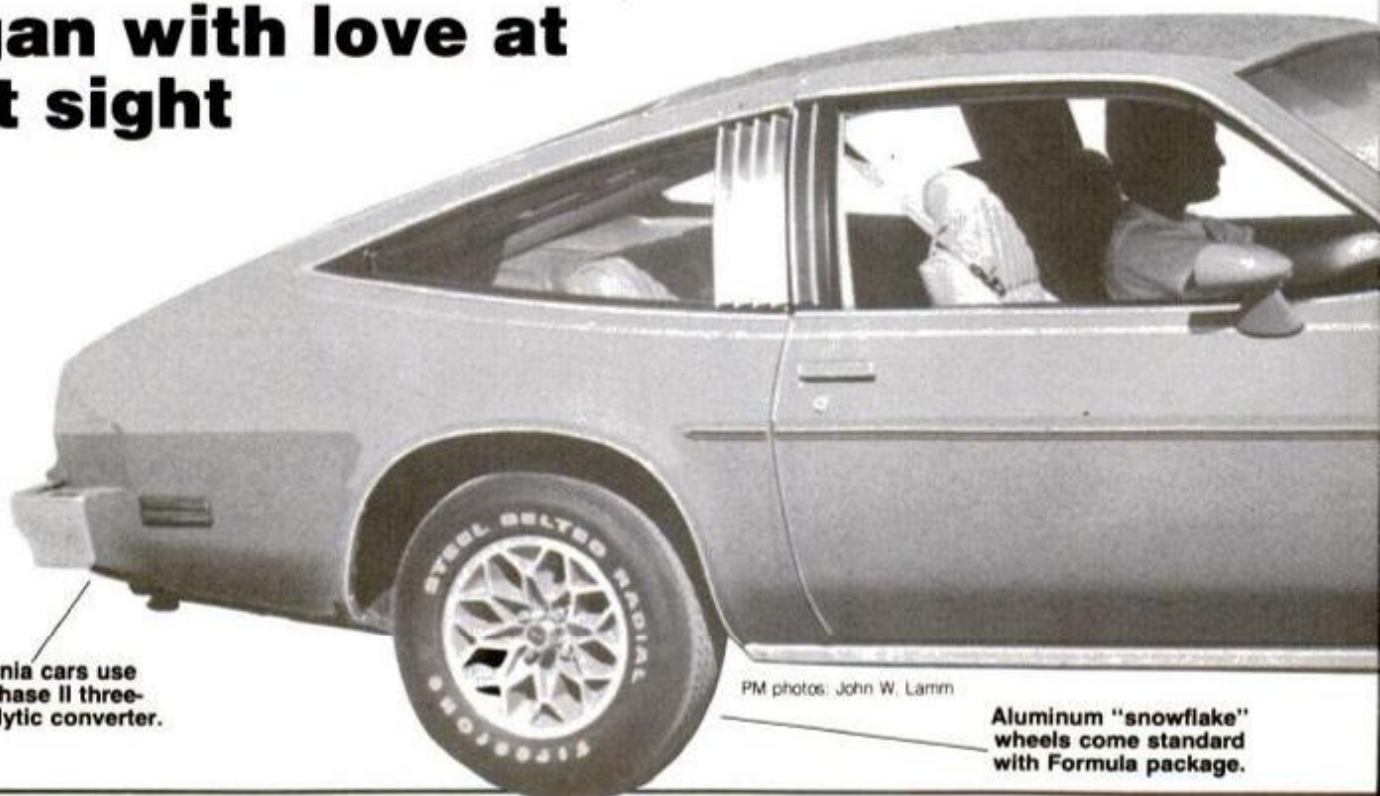


GM designers admit borrowing inspiration for fastback H-body from Italian Ferrari.

Handling became another area of praise. "Hugs the road," was jotted down by a Texas accountant. "It's an easy car to handle and park," states a New York librarian, adding "last winter my Sunbird handled well even on bad, icy roads. It

BY MICHAEL LAMM WEST COAST EDITOR

Minor mechanical maladies mar romances that began with love at first sight



California cars use GM's Phase II three-way catalytic converter.

PM photos: John W. Lamm

Aluminum "snowflake" wheels come standard with Formula package.

never tends to skid. I could stop halfway up an icy hill behind a school bus and start up again without spinning the wheels. That's saying a lot for the radial tires."

Comfort led to mixed reactions, particularly in the rear-seat area. A Colorado rancher told us, "This car is really built for two people." But an Ohio waitress rebutted, "Very comfortable ride—feels like a



With seats folded, there's room for 4 x 8 plywood, but owners miss hidden bin.

much larger car." And an Ohio legal secretary: "Supersmooth ride for a small car."

Sunbirds tend to be short on rear-seat legroom. A Michigan draftsman: "It's a very comfortable car for its size, but only if you sit up front. Rear seating is poor."

Trunk space also seemed abbreviated. Many said the coupe trunk is very shallow, and won't take grocery bags upright. As for the hatchback, a New York editor was one of several owners who suggested, "I'd like a hidden compartment, so everything isn't visible to potential thieves."

Sunbird owners did report mechanical problems; 61.7 percent had to return to their dealers within the first few months of ownership. But most maladies were minor and quickly remedied.

"My car stalled soon after I bought it," states a Michigan medical records librarian, "and I had to have it towed to the dealer. He fixed it within two hours, and I haven't had any trouble since."

Carburetor ills were the Sunbird's most-often-cited problem: hesitation, flat-spotting, surging and so on. Oil leaks plagued 11 percent of the cars and brakes 9 percent. An Illinois R.N. told us, "In my third month of ownership, the brake master cylinder needed replacement. The dealer replaced it under warranty, but three days later the pedal was again not effective when depressed. I had

(Please turn to page 192)

The Sunbird's sparkle

Pontiac's Sunbird shares GM's H-body with the Chevrolet Monza, Olds Starfire and Buick Skyhawk—has since 1975. All trace their ancestry back to the Vega.

The Sunbird comes in three body styles: hatchback coupe, notchback two-door and three-door Safari wagon. The Sunbird also offers three different engines, plus three transmissions.

The 2.5-liter, 151-cu.-in. Four was developed by Pontiac in 1977, together with the 301 V8. Nicknamed the Iron Duke, the Four represents half the V8 and uses identical pistons and rods. It boasts a fuel-efficient crossflow head and, in modified form, the Iron Duke also powers some of GM's 1980 X-Cars.

The Buick-built 231 V6 and a Chevrolet-supplied 305 V8 are optionally available in Sunbirds. Horsepower for the Four stands at 90, with the V6 delivering 115 and the V8 rated at 130 net.

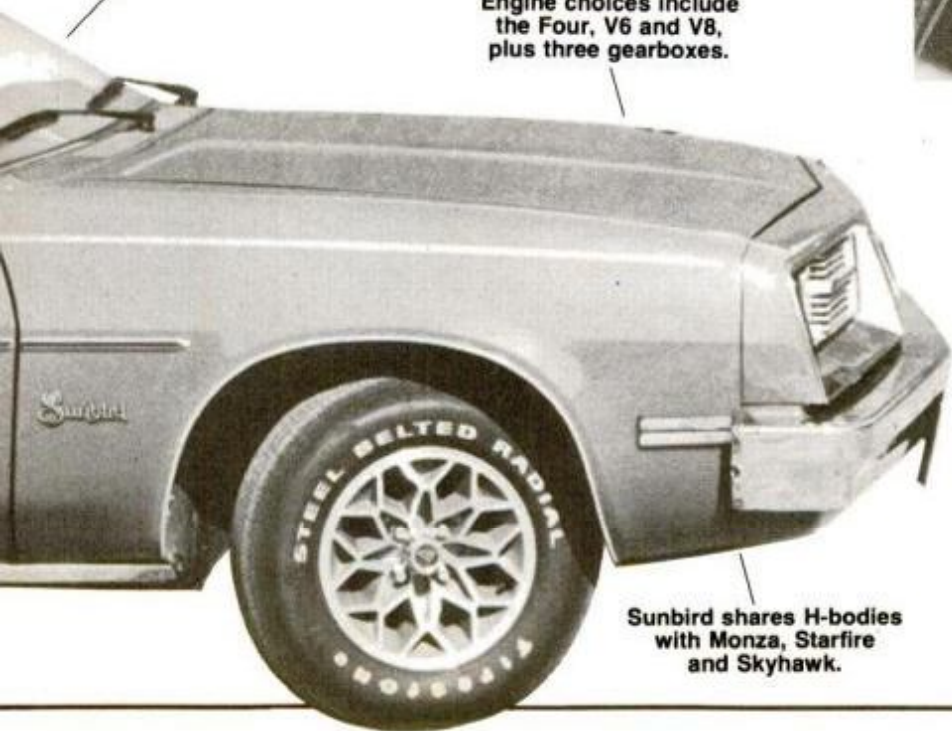
In addition to the Turbo Hydra-Matic 250 transmission, Sunbird buyers can specify a manual four-speed and an overdrive five-speed gearbox. In our sampling, the five-speed turned out to be the least popular, with only 2.9 percent ordering it. (Only 1.9 percent opted for the 305 V8.)

The Sunbird's long option list includes nearly every power and comfort accessory available in the larger Pontiacs. Also of interest: a Formula appearance package, with large rocker decals, aluminum wheels and bold paint schemes—much like the Firebird Formula graphics package.

A NATIONWIDE SURVEY BASED ON 754,342 OWNER-DRIVEN MILES

Owners rate front seats tops, but judge rear ones the pits.

Engine choices include the Four, V6 and V8, plus three gearboxes.



Sunbird shares H-bodies with Monza, Starfire and Skyhawk.



Sporty interior complements sporty exterior, with console and five-speed available. Four-cylinder Iron Duke gives good combination of performance and economy, as does Buick V6, but Sunbird V8 sampling turned out to be too small to tabulate.

Build this easy-to-use spinning wheel

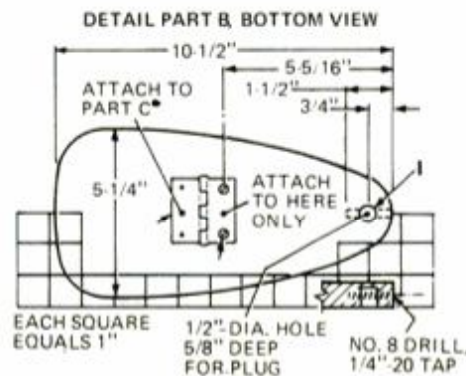
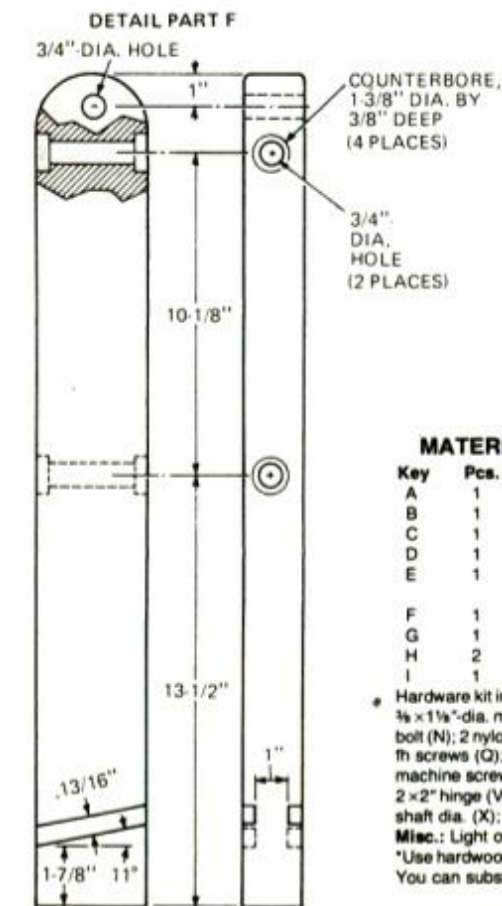
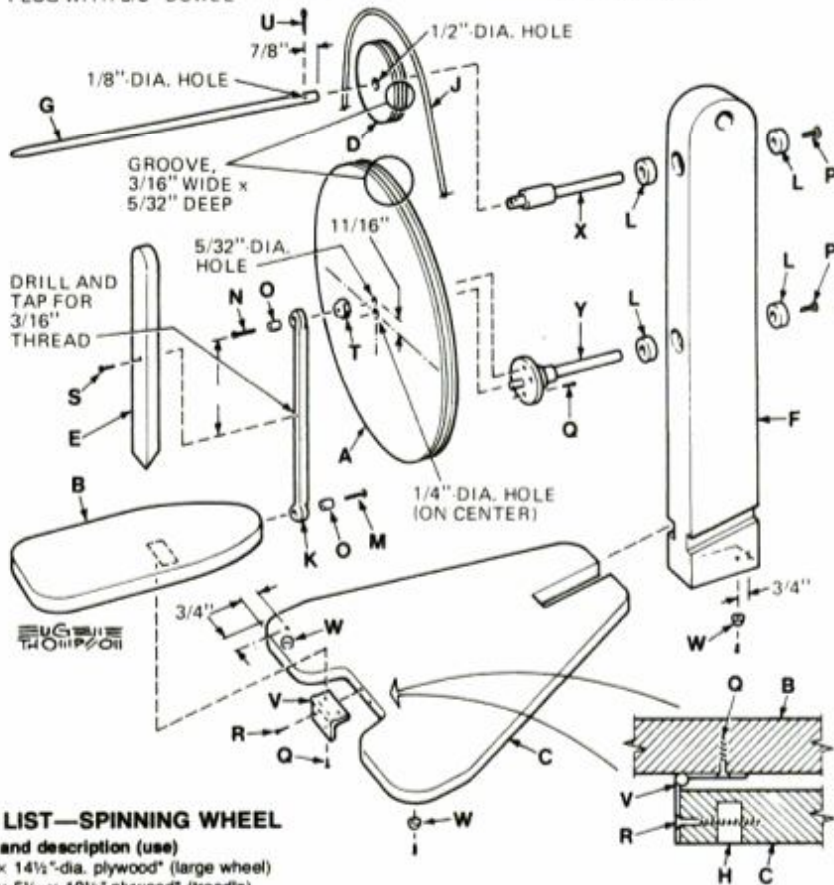
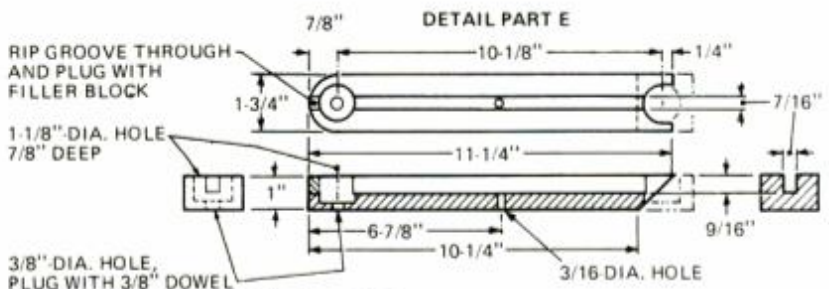
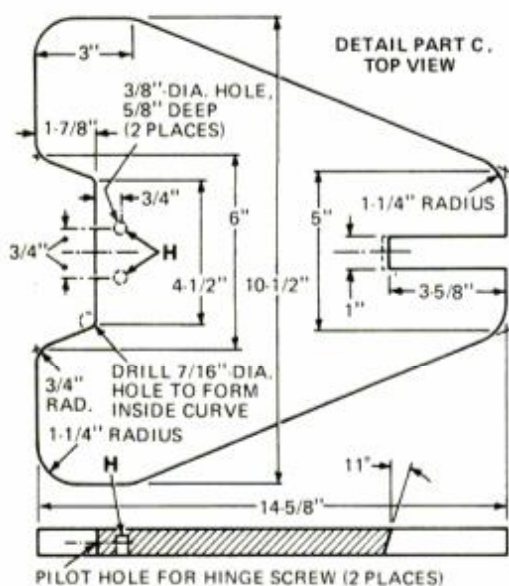
This contemporary quill-type 'Penguin Wheel' is simple to build from PM plans—and easy to use.

by Joseph R. Provey
ASSISTANT HOME AND SHOP EDITOR

I play football and baseball, have worked as a builder and don't take guff from anybody. I also like to relax by spinning wool into yarn.

Surprisingly enough, it's an easy hobby to get started in. The Penguin Wheel (so named because it resembles the familiar, web-footed bird) is a clever quill-type design that's fairly simple to learn on. Compared to the price of most ready-made wheels (\$200 and up), the Penguin is inexpensive to build. Materials will cost about \$70 if you mail-order both the plywood and hardware kit. (See sup-

SPINNING WHEEL CONSTRUCTION



MATERIALS LIST—SPINNING WHEEL

Key	Pcs.	Size and description (use)
A	1	13/16 x 14 1/2"-dia. plywood* (large wheel)
B	1	13/16 x 5 1/4 x 10 1/2" plywood* (treadle)
C	1	13/16 x 10 1/2 x 14 1/2" plywood* (base)
D	1	1/2 x 4 1/8"-dia. solid maple* (small wheel)
E	1	1 x 1 3/4 x 12" solid maple* (footman cover); rip and plane to size
F	1	1 3/4 x 3 3/8 x 26 1/2" solid maple* (upright)
G	1	3/8"-dia. x 11 3/4" dowel; taper one end (quill)
H	2	3/8"-dia. x 3/8" maple plug
I	1	1/2"-dia. x 1/2" maple plug
*Hardware kit includes 51" tubular belt (J); metal footman (K); 4 3/8 x 1 1/2"-dia. metal bearings (L); 1/4 x 1 1/2" rh bolt (M); 1/32 x 2" rh bolt (N); 2 nylon bushings (O); 2 3/8"-dia. x 3/4" rh bolts (P); 5 3/4" fh screws (Q); 2 1 1/4" fh screws (R); 3/8"-dia. x 3/8" oval-head machine screw (S); acorn nut spacer (T); brass cotter pin (U); 2 x 2" hinge (V); 3 rubber feet with screws (W); upper axle, 1/2" shaft dia. (X); lower axle, 1/4" shaft dia. (Y).		
Misc.: Light oak stain, polyurethane varnish, white glue.		
*Use hardwood (maple or birch) veneer, lumber-core plywood. You can substitute clear pine for solid maple stock.		

pliers list, page 214). The cost is less if you build the wheel from scratch. Be advised that many lumberyards will only sell the maple-veneer, lumber-core plywood by the full 4x8-ft. sheet. Unless you have other uses for the wood, you are better off mail-ordering a smaller panel.

Building the wheel

Cut all the pieces as shown in the plans on page 104. A bench saw can be used for most straight cuts, da-does and grooves. A sabre saw will do for cutting curves and slots.

There are several special cuts and borings which you should pay attention to. When cutting the upright (F), for instance, be sure the sides are squared so that the holes for the bearings can be bored accurately.

To bore the axle shaft holes, first

(Please turn to page 212)

Credits

Wheel design: Robert Oliver, former professor of design, University of Colorado; Wheel construction, black-and-white photos: Rosario Capotosto; Consultant: Greta Ahiman, spinning expert at School Products Co. Inc.; Color photos: Carl Weese; Sweater design and execution: Barbara Jacksier; Stool design and construction by the author.



Spinning is an easy skill to master on this quill-type wheel (top and left). The treadle-powered machine requires little effort to operate and is easy to build from PM's plans and hardware kit. Plans for matching stool (middle photo, above) are also provided. After you've built it, use the wheel to spin richly textured yarns for knitting or weaving garments like the sweater (above).



1 Privacy wall has display ledges

The two-level privacy wall at one end of the bathtub can display greenery or keep bath paraphernalia close at hand. It's finished with cedar planks to match the wall and topped with a handsome ceramic tile.



4 smart



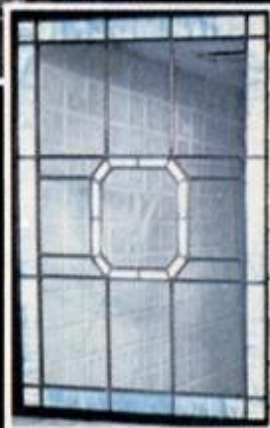
2 Closet-size bath has maxi-space

Before its redo there was no storage space and barely room to turn around in this tiny half-bath. The designer opened up the area by utilizing Eljer's corner toilet, repositioning the entry and fitting it with a pocket door that slides out of the way into a wall. The area now accommodates a large vanity and three-way mirror, with both offering storage space. Ceramic flooring, improved lighting and venting are finishing touches that add to the character of this half-bath.



3 Bath redo has storage space for all

The original problems in this bathroom made it a remodeler's delight. The tub prevented the bathroom door from opening completely, and storage space was limited. We relocated a new tub and added cabinets over the shower, toilet and in the vanity area. A stained glass insert in the partition separating tub/shower and toilet is an elegant detail. The clay tile on the floor and surrounding the bathtub provides a handsome, natural finish to complement the wood cabinets.



fixes for bath problems

by Penelope Angell
ASSISTANT HOME AND SHOP EDITOR

The bathroom may be the one room in your home where convenience is the most important feature. Too often, however, bathrooms appear to be poorly planned afterthoughts that fit into leftover space. This is apparent when a family begins to use that space. It's a reason why bath remodeling is so common.

We've selected four bathrooms in varying degrees of need. Each has its own special problem. The problems may be all too familiar to you.

The remodeled rooms incorporating our solutions are shown on this and the facing page. Design and construction notes and drawings, as well as manufacturer information, are on the following pages, so you can adapt the ideas to your needs.

(Please turn to page 165)



4 Cabinet clears up bath clutter

This 30-in.-wide redwood cabinet adds floor-to-ceiling storage space to a small bathroom and actually gives the room visual interest. The unit is designed to be built with short lengths of lumber and it can be adapted to fit wherever space is available such as over the toilet or vanity (see plans).

Photos: 1, American Plywood Assn.; 2, 3, 4, Harry Hartman Redwood cabinet design: California Redwood Assn. Construction of redwood cabinet: Rosario Capolosto.

4 smashing ideas for bedrooms



Noted interior decorator Ann Heller created four bedrooms full of ideas. We show you how to build them.

by Harry Wicks
HOME AND SHOP EDITOR

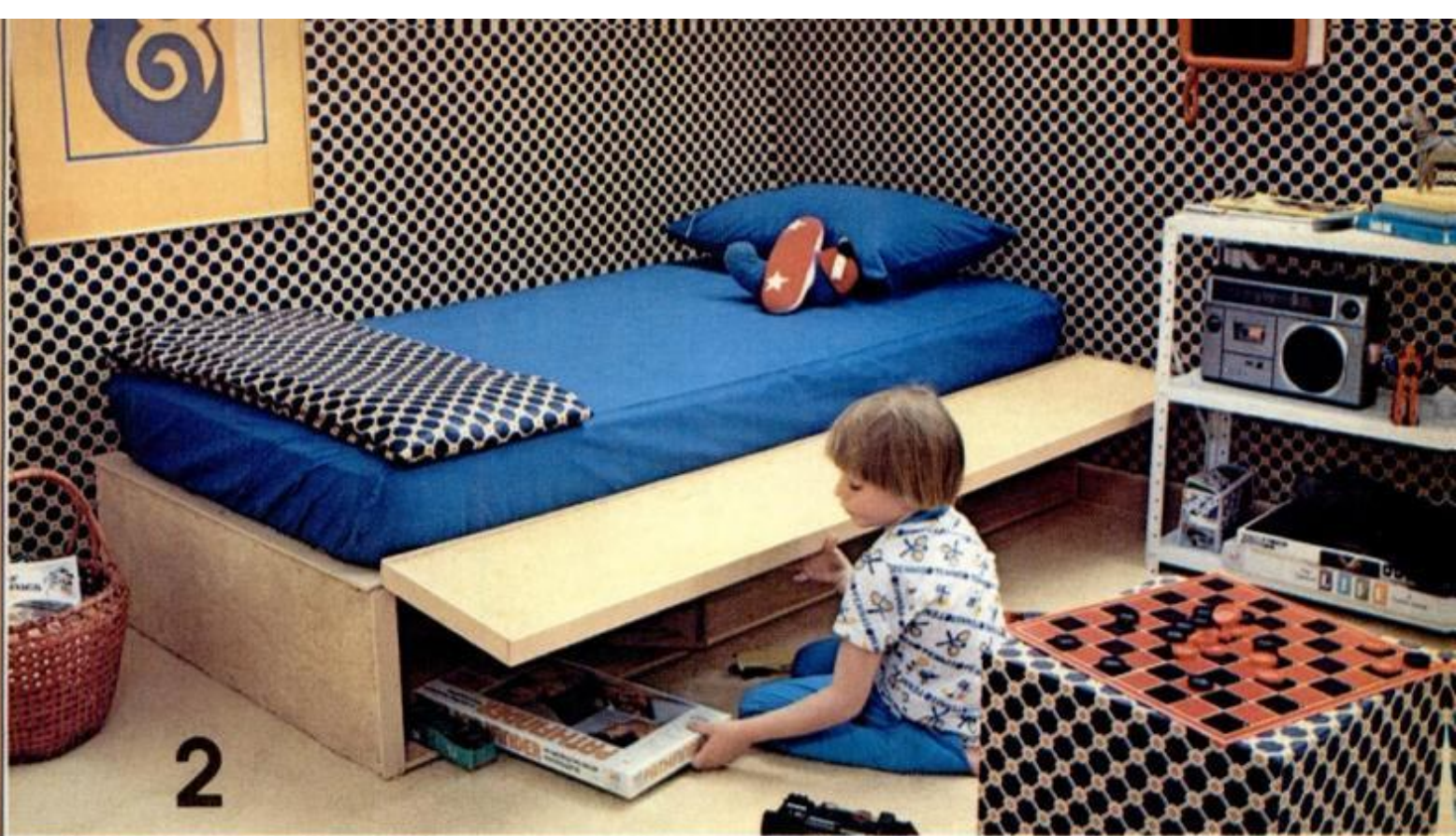
You don't have to spend a fortune to improve the looks and function of the bedrooms in your home. Using imagination and easy-to-work-with plywood, we created four rooms loaded with ideas that you can duplicate.

The teen-age girl's room with its contemporary four-poster is sure to delight your daughter. To keep a boy happy, we've developed a trundle bed system that lets him squirrel away his treasures whenever the urge strikes him. For Mom and Dad there's an elegant headboard with carpet-wrapped posts and conve-

1



1 Elegant four-poster is sure to appeal to your teen-ager. Using 1/2-in. plywood makes it a snap to build. It's finished by applying self-adhering plastic wall covering to all exposed parts.



2



2 Easy cleanup was the aim when we designed this room. Above, youngster's gear stores quickly under bed to easily achieve a clean room (left).

3 Den-guest room shows that sometimes it

can pay to be in the red. See following pages for how-to-build information.

4 Putting a queen-size bed in a pint-size room took some doing. Headboard adds pleasing, functional touch.

nient shelf for telephone, radio, TV or the like. We've also created an arrangement that quickly converts your den to a bedroom for guests.

To keep down costs, all projects are built using plywood and pine. Since most parts are then covered with either self-adhesive plastic wallcovering or carpeting, you can work with low cost C-D plywood, if desired, to keep down costs.

SHOPPING INFORMATION

Bedroom No. 1: Wallcoverings: Prissy on the bed, Flax on the walls (both from Comark's "It's a Small World" collection). Rug: Magee's Dream Weaver tufted of Anso nylon. Phone: Bell System Accent Phone.

Bedroom No. 2: Wallcovering: Old Acquaintance (and coordinated fabric for folded spread) from Comark's "Love At First Sight" collection. Rug: Salem's Reminiscent tufted of Anso NaturaLuster nylon. Phone: Bell System Noteworthy Wall Phone.

Bedroom No. 3: Wallcovering: Comark's Camille from "Love At First Sight" collection. White counter covering is Con-Tact brand adhesive. Rug: Galaxy's Touch of Velvet tufted of Anso nylon. Phone: Bell System Mickey Mouse Phone.

Bedroom No. 4: Wallcovering: Intermezzo from Comark's "Love At First Sight" collection. Rug: Aidon's Scottish Highlands tufted of Anso nylon. Phone: Bell System Sculptura Phone (brown).

All room furnishings and accessories are by J.C. Penney, 1301 Avenue of the Americas, New York, N.Y. 10019.

Styling: Ann Heiler

PM photos: color, Harry Hartman
black-and-white, Rosario Capotosto



How to create our great bedroom ideas

Due to its large size, the four-poster bed is created in modular form to permit easy, in-the-room final assembly. The bottom frame is too bulky to move when assembled, which means you should plan to join these parts in the room where the bed will remain.

Remember, the four posts should be dimensioned to ceiling height—so measure your room before cutting the plywood for the posts. Ceilings are rarely perfectly level, so you might be wise to allow an extra inch or two between the top of the posts and the ceiling. Note that the posts are $\frac{3}{8}$ in. shy of touching the bottom platform: This allows clearance for the carpeting on the bed's platform.

Once the bed is assembled, finish

by covering it with a print in the self-adhesive wallcovering collection to suit your room decor.

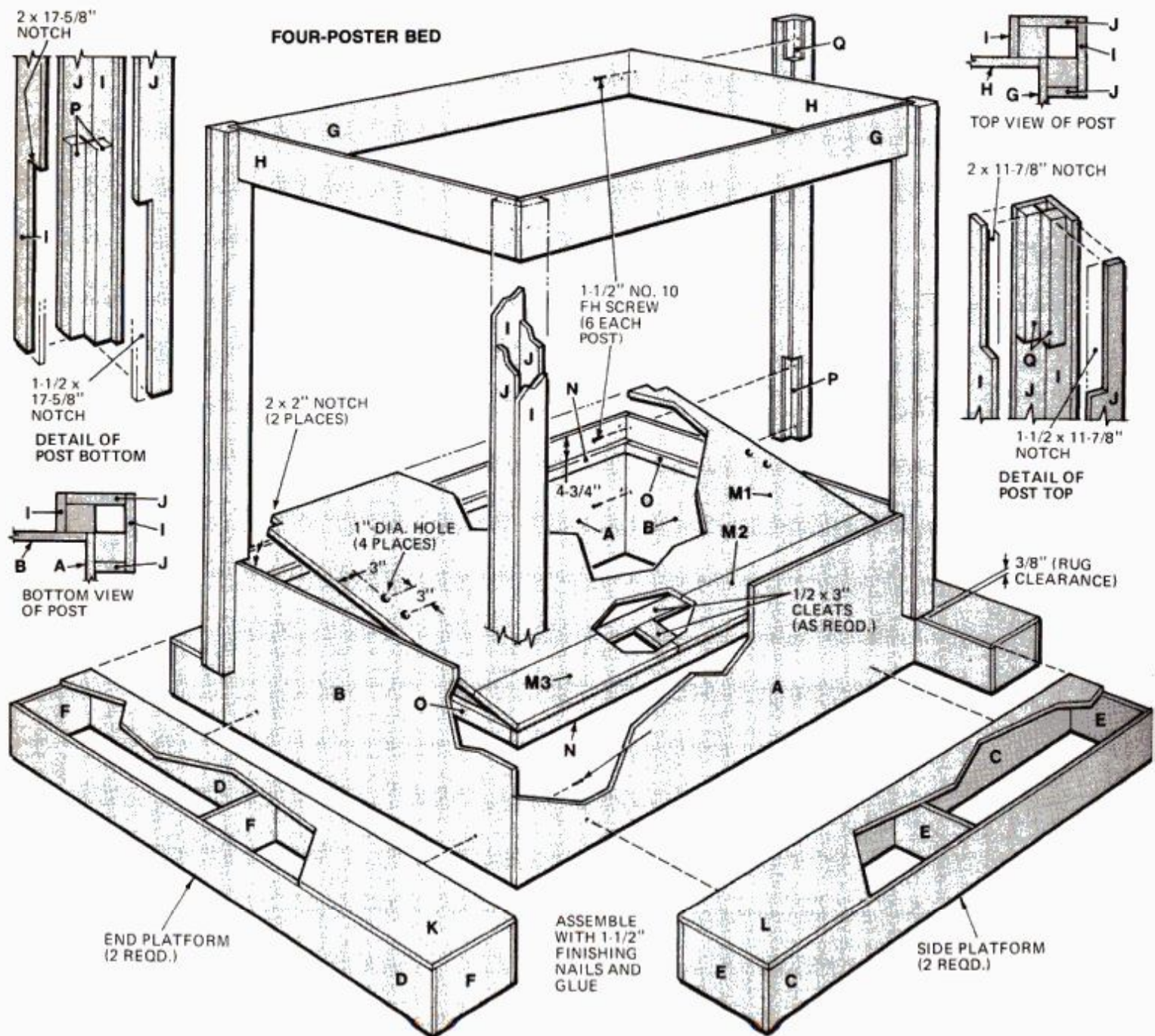
Master bedroom: If desired, lumber cost for this project can be held down by buying a 2x8-ft. $\frac{1}{2}$ -in.-plywood panel for the posts and a 4x6-ft. panel for the backboard. This will cost about \$25. For easier nailing when assembling, glue and nail the

blocks D to the inside members F before joining the posts to the center rectangle.

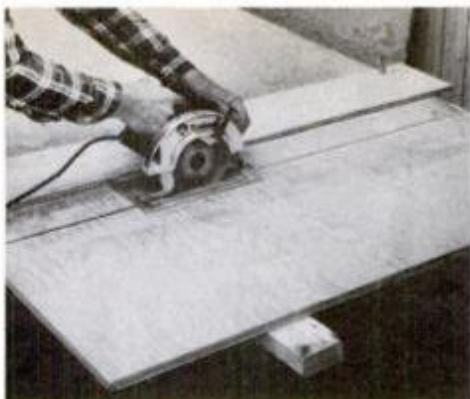
Trundle bed: Use a straightedge guide and portable circular saw to cut all pieces to size. Glue and nail the back to the sides, then add the top and bottom. Attach the continuous hinge to the top edge and to the lid face. Add support block G at cen-

MATERIALS LIST—FOUR-POSTER BED

Key	Pcs.	Size and description	Key	Pcs.	Size and description
A	2	$\frac{1}{2} \times 26 \times 77\frac{1}{2}$ " A-D plywood	L	2	$\frac{1}{2} \times 13\frac{1}{4} \times 77\frac{1}{2}$ " A-D plywood
B	2	$\frac{1}{2} \times 26 \times 55\frac{1}{2}$ " A-D plywood	M		$\frac{3}{4} \times 55\frac{1}{4} \times 76\frac{1}{4}$ " A-D plywood
C	4	$\frac{1}{2} \times 7\frac{1}{2} \times 77\frac{1}{2}$ " A-D plywood	M1		48 x 76 $\frac{1}{4}$ "
D	4	$\frac{1}{2} \times 7\frac{1}{2} \times 84$ " A-D plywood	M2		7 $\frac{1}{4}$ x 48"
E	6	$\frac{1}{2} \times 7\frac{1}{2} \times 12\frac{1}{4}$ " A-D plywood	M3		7 $\frac{1}{4}$ x 28 $\frac{1}{4}$ "
F	6	$\frac{1}{2} \times 7\frac{1}{2} \times 12\frac{1}{4}$ " A-D plywood	N	2	$\frac{3}{4} \times 1\frac{1}{2} \times 76\frac{1}{2}$ " pine
G	2	$\frac{1}{2} \times 11\frac{1}{8} \times 77\frac{1}{2}$ " A-D plywood	O	2	$\frac{3}{4} \times 1\frac{1}{2} \times 54$ " pine
H	2	$\frac{1}{2} \times 11\frac{1}{8} \times 55\frac{1}{2}$ " A-D plywood	P	8	1 $\frac{1}{2}$ x 1 $\frac{1}{2}$ x 18" pine
I	8	$\frac{1}{2} \times 4 \times 87\frac{1}{4}$ " A-D plywood	Q	8	1 $\frac{1}{2}$ x 1 $\frac{1}{2}$ x 12" pine
J	8	$\frac{1}{2} \times 3 \times 87\frac{1}{4}$ " A-D plywood	Misc.: $\frac{1}{2} \times 3$ " plywood cleats (as reqd.), 24 1 $\frac{1}{2}$ No. 10 fh screws, 8 1" No. 10 fh screws, 1 $\frac{1}{2}$ " finishing nails, glue		
K	2	$\frac{1}{2} \times 13\frac{1}{4} \times 84$ " A-D plywood			



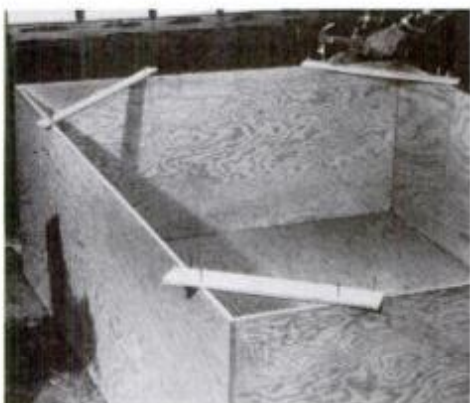
Building the contemporary four-poster



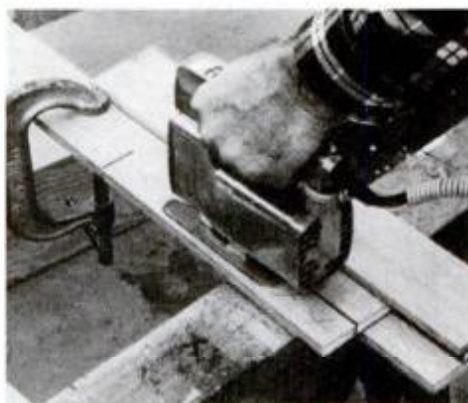
Precision crosscuts in plywood are made with a clamped straightedge. Panels are supported by three 2x4s on sawhorses.



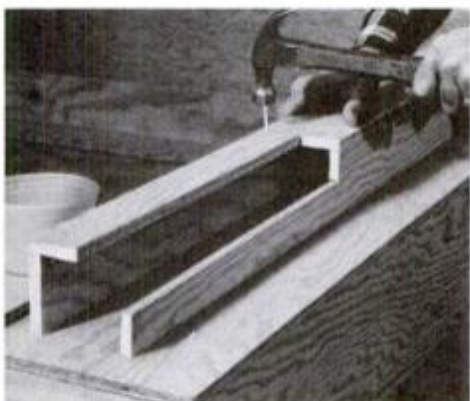
Clamps are handy for holding boards in place while nailing. A temporary center-piece permits lifting ends to apply glue.



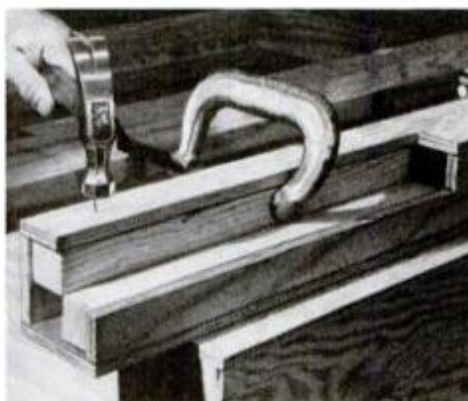
After gluing up rectangle, tack temporary diagonal braces in corners to hold it square while the glue sets overnight.



A jig wrapped around the edge of work guides sabre saw for vertical notch cut. This works better than the saw's guide.



Assemble notched posts with glue and nails. Note that notch width varies 1/2 in. between the 3 1/2- and 4-in.-wide strips.



To facilitate nailing of the post pieces, clamp a filler block as shown. Set nails and fill the depressions with wood filler.

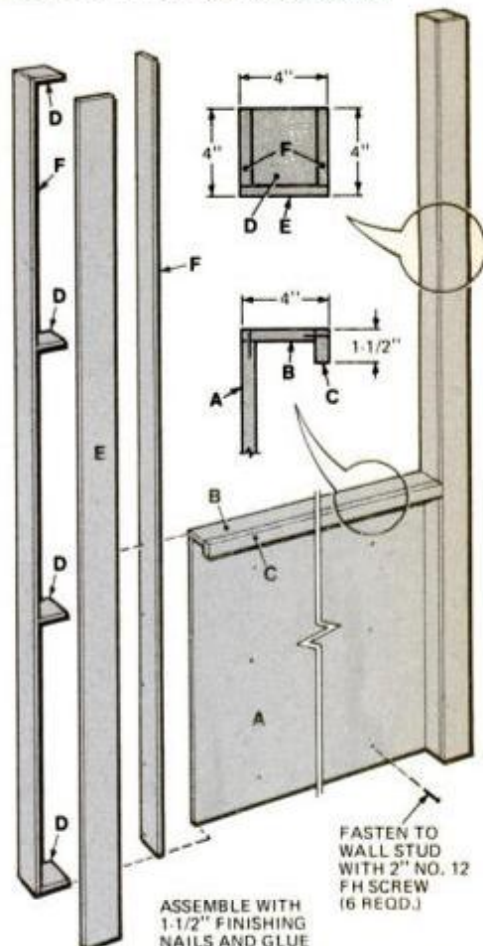


Post should be held securely in place—a C-clamp is being used here—while you bore the pilot holes for the screws.



Platforms are made up as individual units, then secured to the bed frame with nails or screws at final assembly in the bedroom.

MASTER BEDROOM HEADBOARD

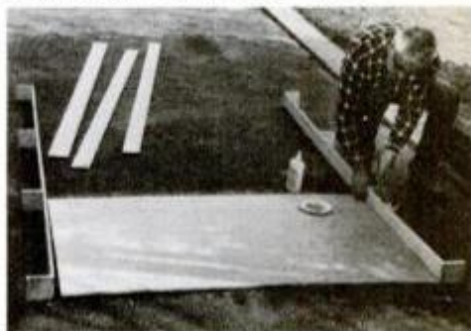


MATERIALS LIST—MASTER BEDROOM

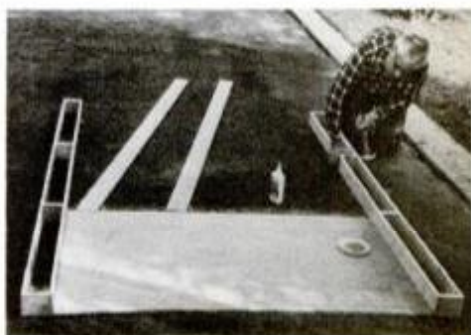
Key	Pcs.	Size and description
A	1	1/2 x 36 x 60 1/2" A-D plywood
B	1	1/2 x 3 1/4 x 60 1/2" A-D plywood
C	1	3/4 x 1 1/2 x 60 1/2" pine
D	8	3/4 x 3 x 3 1/2" pine
E	2	1/2 x 4 x 96" A-D plywood
F	4	1/2 x 3 1/2 x 96" A-D plywood

Misc.: 1 1/2" finishing nails, glue, 6 No. 12 x 2" fh screws

Building the headboard

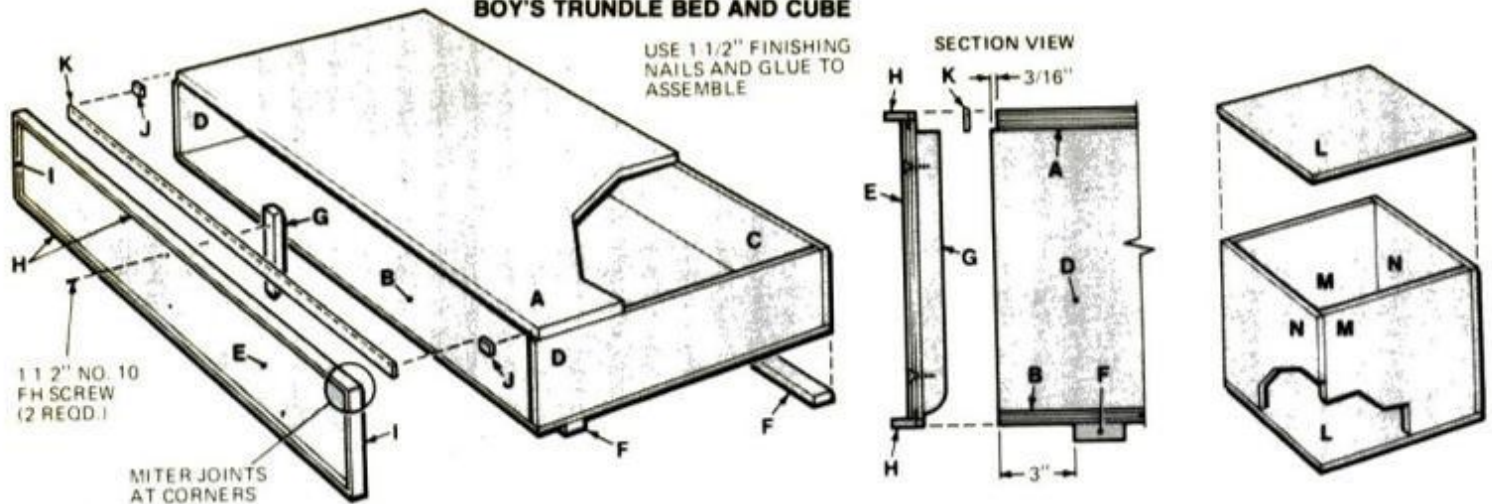


For easier hammering, fasten blocks D to inside strips before nailing to backboard.



Next, glue and nail the outer strips and then add the front pieces.

BOY'S TRUNDLE BED AND CUBE



MATERIALS LIST—TRUNDLE BED

Key	Pcs.	Size and description
A	1	3/4 x 38 1/2 x 75" A-D plywood
B	1	1/2 x 38 1/2 x 75" A-D plywood
C	1	1/2 x 10 1/4 x 75" A-D plywood
D	2	1/2 x 10 1/4 x 38" A-D plywood
E	1	1/2 x 11 1/2 x 74 1/2" A-D plywood
F	2	3/4 x 2 x 75" A-D plywood
G	1	1 1/2 x 1 1/2 x 10 1/4" pine
H	2	1/4 x 1 1/4 x 75" lattice
I	2	1/4 x 1 1/4 x 12" lattice
J	2	3/16 x 3/4 x 1 1/2" pine
K	1	1 1/2 x 72" continuous hinge

Misc.: 1 1/2" finishing nails, glue, pull (optional)

CUBE

L	2	1/2 x 16 x 16" A-D plywood
M	2	1/2 x 15 x 16" A-D plywood
N	2	1/2 x 15 x 15" A-D plywood

Misc.: 1 1/2" finishing nails, glue

Fastening a trundle bed hinge



Hold hinge in place with masking tape while you mark locations for screw holes: A self-centering punch works best.



Support block G with rounded lead edge fits snugly between the top and bottom edges to help keep the top from sagging.

ter as shown. Our bed is finished by covering all exposed surfaces with carpeting to match the floor. Check carpet thickness and make certain that lattice surround I is wide enough to hide carpet edges fully. If necessary, buy wider lattice.

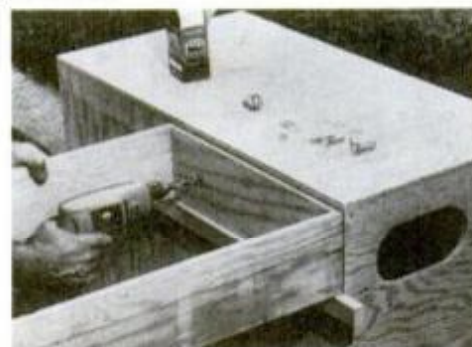
Cube: Cut the plywood parts for the cube and assemble with glue and nails. Ease all corners with a plane, sand smooth, prime and paint.

Guest room: This setup consists, basically, of two cubes with a platform (shelf) between them. Assemble parts as shown and finish by covering the exposed vertical surfaces with carpeting. Carpeting can be joined to plywood using staples, double-faced tape or both. Quality carpet tapes are available at floor-covering and hardware stores. **PM**

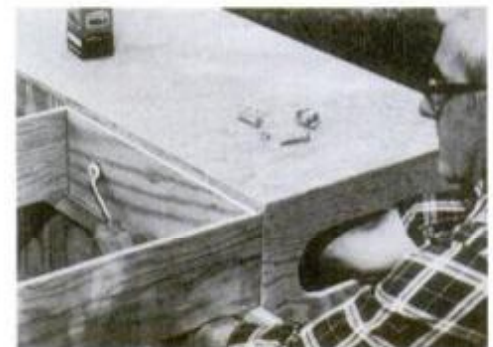
Assembling the guest-bed components



Assemble the end cubes; then, using a sabre saw, cut the access holes in the rear.

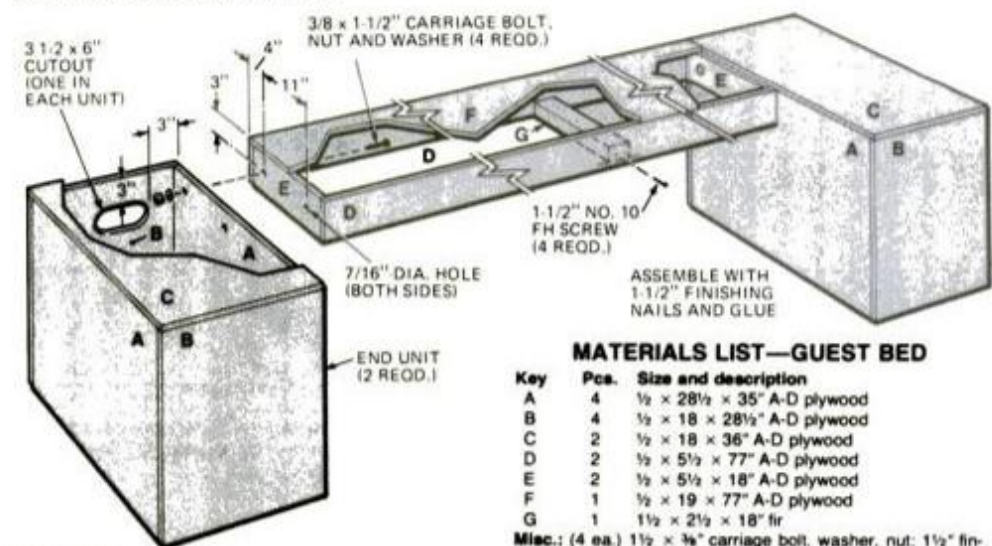


Use a temporary cleat to support the center rectangle while boring the bolt holes.



Access holes make it easy to attach the connecting bolts. The top is glued later.

DUAL-PURPOSE GUEST BED



MATERIALS LIST—GUEST BED

Key	Pcs.	Size and description
A	4	1/2 x 28 1/2 x 35" A-D plywood
B	4	1/2 x 18 x 28 1/2" A-D plywood
C	2	1/2 x 18 x 36" A-D plywood
D	2	1/2 x 5 1/2 x 77" A-D plywood
E	2	1/2 x 5 1/2 x 18" A-D plywood
F	1	1/2 x 19 x 77" A-D plywood
G	1	1 1/2 x 2 1/2 x 18" fir

Misc.: (4 ea.) 1 1/2 x 3/8" carriage bolt, washer, nut; 1 1/2" finishing nails, glue

WORKSHOP MINICOURSE

BELT SANDER BASICS

If the students in my adult education class represent an accurate cross section of do-it-yourselfers, the portable belt sander is one of the favored homeowner power tools. Surprisingly, though, many people who own the tool do not know how to get the most out of it. And that is a pity, because a belt sander can save literally hours of hard work, and provide a smoother finish than most of us have the patience to achieve when rubbing by hand.

Though available in a great variety of configurations and sizes, all belt sanders work on the same principle—a loop or belt of adhesive grit travels in a straight line around two drums and across a platen. Platen size is important because this is the actual area of the belt that is sanding when the belt is traveling. Because of the belt sander's power, it is very important that you use the tool correctly:

- Always keep the platen flat on the work or you will create gouges, bevels and the like.

- Always keep the sander moving. The test run across the grain (below) gives a dramatic example of what results when a belt sander is left running too long in one spot.

- Always push the belt sander back

and forth with the grain of the wood to avoid scratches.

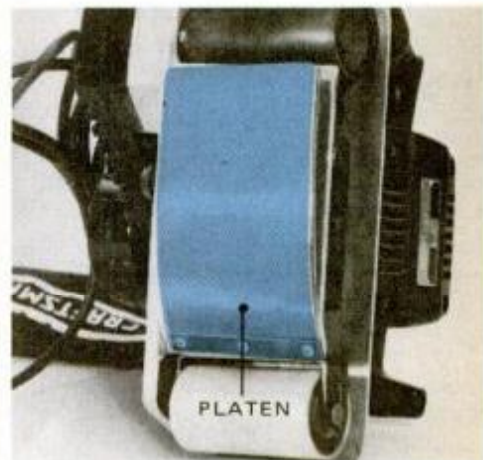
- Always make sure that you have adequate electrical cord to reach the full length of the work. If you forget to check this out beforehand, you stand a good chance of the line stopping the sander in midstroke—with inevitable gouging of work. If you should require an extension cord, make certain that you use the right size—not a lamp cord.

When you go to buy a belt sander,

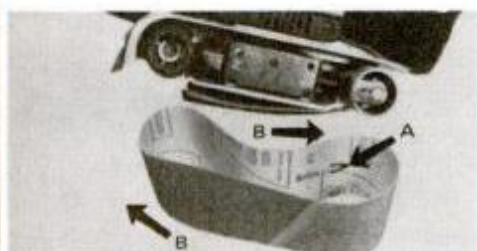
your dealer probably will stock the most popular homeowner sizes—3x21 in. and 3x24 in.—as well as some larger professional models. You are well advised to pick one of the homeowner sizes. Greater size also means greater weight you must heft around. Considering the slight increase in platen size, it isn't worth all that extra sweat. (The professionals choose the biggies because of their industrial-rated longer-life construction.) **PM**



Belt sander size (i.e. 3x24 in., above) refers to the width and length of belt that the tool will accommodate. Size of sander shown is suited for most craftsmen.



Platen size, 3x5 in. here, is the area that is being sanded when belt is moving. Platen should be held flat against the workpiece at all times to prevent dishing.



Belts are marked for correct installation. Arrow A on the belt should always travel in the direction shown by arrows B.



After you relieve drum tension according to instructions, belt simply slips on.



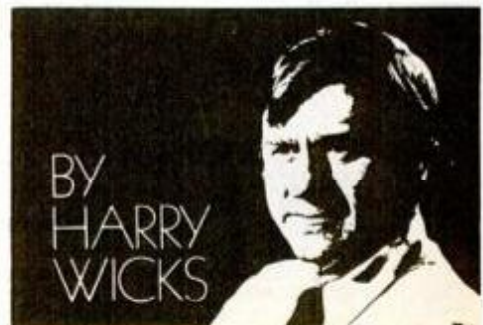
On this model, tension is created when the small latch is released (see inset photo).



Small stop—thinner than workpiece—is a must. It frees both hands for handling the tool, prevents workpiece from flying off the bench when sander is turned on.

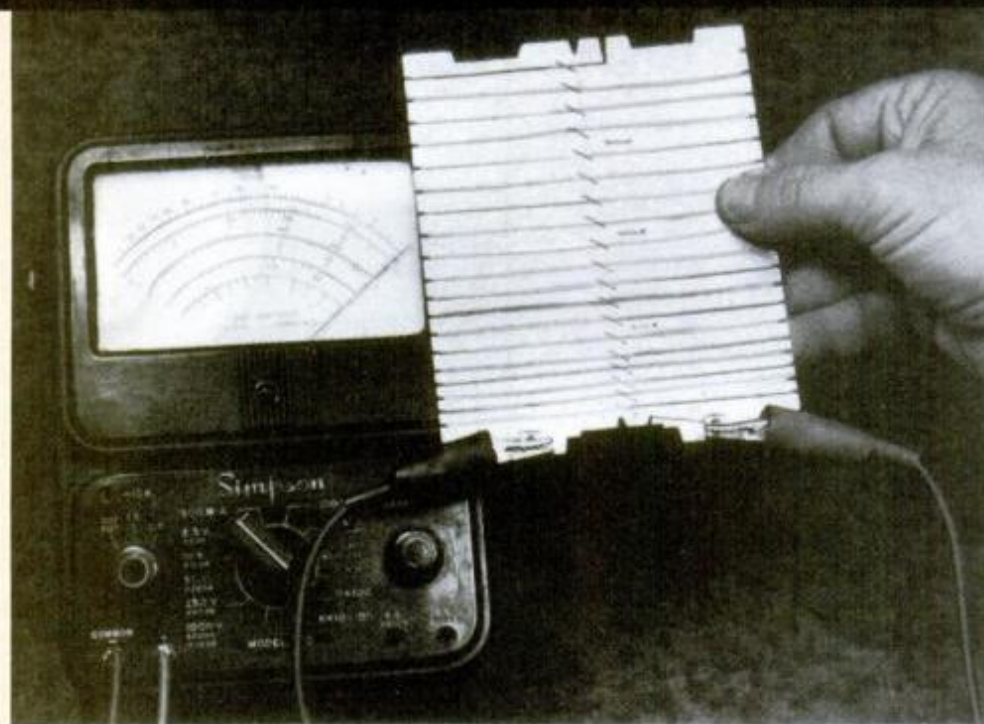


Test run shows power of a belt sander and why you should keep it moving on the work to prevent damage. Crossgrain groove was plowed in the wood in 30 seconds using an 80-grit belt on this Sears sander.

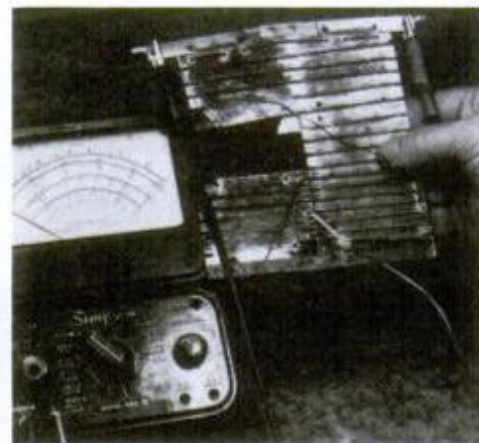


BY
HARRY
WICKS

How to test appliances for



Volt-ohm-milliammeter (VOM) at left shows that toaster element has continuity, but indicates no resistance, since its range switch is set on the R×100 scale. Place the switch on the R×1 scale to obtain an accurate ohm measurement.



Toaster element shown has no continuity. Needle at infinity indicates circuit break.

The *PM Appliance Clinic* is a well read monthly column which generates stacks of reader mail. One recent letter asked a fundamental but sensible question about electrical continuity. It read:

"You keep telling us to test continuity. Just what *is* continuity and how *do* you test it?"

Continuity, according to professional Ed Jacek, who owns City Wide Radio and Appliance Service Co. in Fort Lauderdale, Fla., "is the most important, yet easiest, way of troubleshooting an appliance."

Continuity defined

More specifically, continuity is a term for a continuous (unbroken) circuit. If current through a circuit flows from points A to B, the circuit from A to B has continuity.

If current introduced in a circuit at A does not reach B, the circuit lacks continuity. It is broken (open).

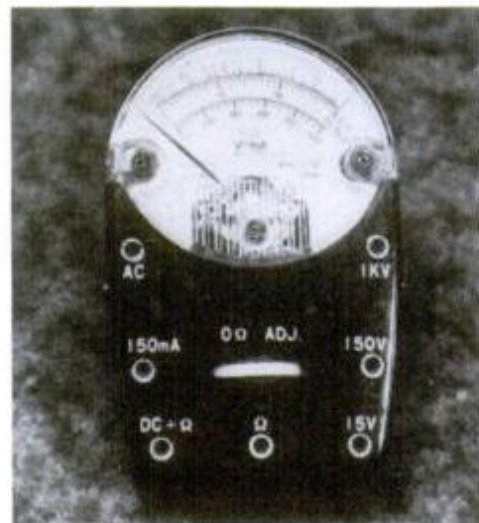
Resistance, on the other hand, is the opposition to the flow of current. It is measured in ohms with an ohmmeter.

Circuits have resistance and continuity. In some circuits, however, the presence of other than negligible resistance indicates a bad circuit. For example, consider a toaster. Let's call the electric cord from plug to the toaster element circuit A to B, and let's refer to the toaster element itself as circuit C to D.

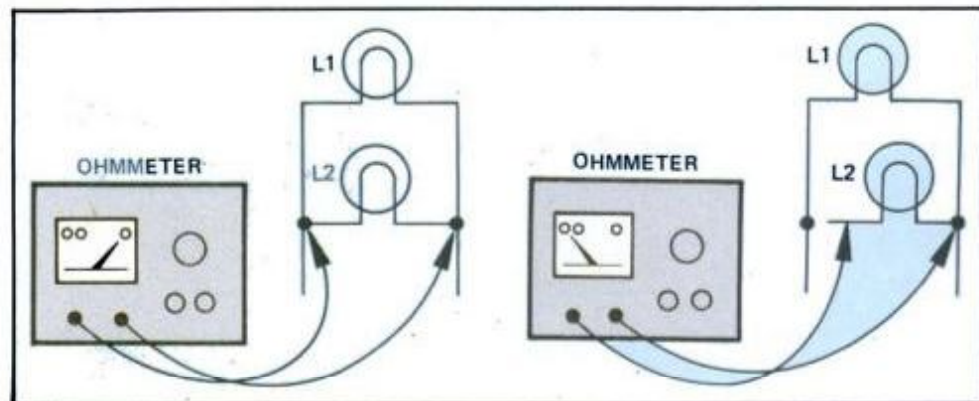
Circuit A to B consists of copper wire that has practically no resis-



VOM with R×10,000 scale can cost up to 10 times more than the meter at right.



Low-cost VOM (above) and more sophisticated types are sold at electronics shops.



The diagram to the left shows the *wrong* way to test continuity of circuit L2. The L1 circuit will affect the reading on L2 since they are connected. To avoid interference from other circuits, always disconnect circuit L1 at some point. Diagram at right shows that circuit L2, when not influenced by circuit L1, is in fact defective.

electrical continuity

by Mort Schultz

tance to current. When an ohmmeter is connected between points A and B, the scale should read 0 ohms or show only a slight deflection. (In any test for resistance, be sure to first unplug the appliance from the power source and make good metal-to-metal contact with meter leads at the circuit terminals.)

Circuit C to D consists of an element with higher resistance. This resistance is needed to put the element under an electric load, so the element will glow and toast bread.

A typical heating element used in toasters and other appliances is made of a nickel-chromium alloy, called nichrome, that has higher resistance to current flow than copper wire. Nichrome is, in fact, referred to as resistance wire.

When testing toaster circuit C to D for continuity, the needle of the ohmmeter will show a deflection indicating the resistance value of the element (about 12 ohms) if the circuit is not damaged. If the ohmmeter needle swings instead to infinity (∞) or reads 0, the circuit is defective.

Using a test light

You can also use a battery-powered test light for testing the continuity of a circuit. The test light is connected between the circuit's two terminals. If the light glows, the circuit is complete. If the light does not glow, there is a break in the circuit. However, a test light cannot measure resistance (ohms). For this, you need an ohmmeter.

An ohmmeter, consisting of the meter, several resistors and a battery or batteries, is normally combined in one instrument with a voltmeter and milliammeter, which measure volts and current, respectively. This is called a volt-ohm-milliammeter, VOM or multimeter.

A typical VOM has switch settings of $R \times 1$, $R \times 10$, $R \times 100$ and sometimes $R \times 10,000$. These settings allow you to measure low resistances (0 to 100 ohms), as well as resistances in the thousands of ohms.

Since resistances in appliance circuits are low for the most part, you won't need an ohmmeter with a $R \times 10,000$ switch setting. The setting used most often for testing the continuity of appliance circuits is $R \times 1$. If the ohmmeter needle shows the presence of resistance, the value

(Please turn to page 188)



The procedure diagrammed at the bottom of the opposite page is illustrated here. To properly test continuity of the element in this coffemaker, the circuit was disconnected, using needle-nose pliers to pull the connector from the terminal (photo, left). VOM leads were then attached to each side of the circuit (right).

APPROXIMATE RESISTANCES OF SOME APPLIANCE CIRCUITS		
Appliance	Circuit	Approximate Resistance (Ohms)
Automatic clothes washer	Inlet valve solenoid terminals	400
	Main motor terminals, high-speed	0.81
	Main motor terminals, low-speed	0.75
	Timer motor leads	1050
Blender	Motor, high-speed	20
	Motor, low-speed	40
	Motor, medium-speed	30
Dishwasher	Heating element terminals	15
	Inlet valve solenoid terminals	280
	Main motor leads, "Pump"	6
	Main motor leads, "Run"	3
	Main motor leads, "Start"	6
Pump motor leads (where pump is separate from pump)	6	
Electric clothes dryer	Heating element terminals (double-element)	15, 22
	Heating element terminals (single-element)	10
	Main motor terminals	2
	Timer motor leads	1100
Electric can opener	Motor terminals	7
Electric coffee percolator	Heating element	33
Electric fry pan	Heating element	12
Electric range	5-inch, 2-wire element	50
	9-inch, 2-wire element	30
	5-inch, 3-wire element outer coil-inner coil	60-80
	9-inch, 3-wire element outer coil-inner coil	40-65
Electric water heater	Heating element, 1000-watt	60
	Heating element, 2000-watt	30
	Heating element, 4500-watt	15
Food mixer (hand-held, three-speed)	Motor, high-speed	40
	Motor, low-speed	60
	Motor, medium-speed	50
Iron	Heating element	12
Refrigerator	Compressor motor terminals "Run"	2
	Compressor motor terminals "Start"	10
	Condenser fan motor leads	65
	Evaporator fan motor leads	50
Toaster	Heating element	12

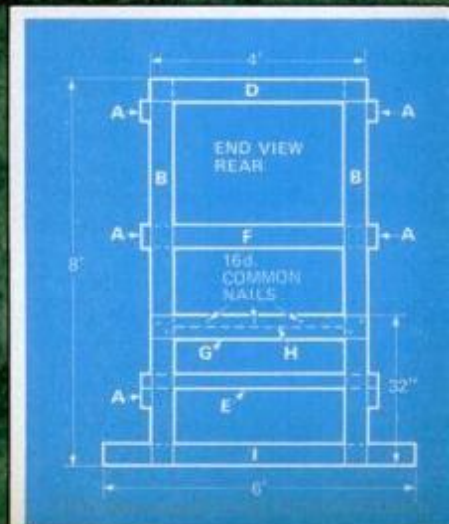
Have fun keeping fit on

Build a backyard *parcours* exercise center for building good health.



For a workout of muscles that jogging won't reach, this compact project substitutes for the cross-country stations of an obstacle course.

PM photos: Brad Hess



this homemade 'import'

by Bill Maness

Jogging has some limitations, even though it has been called the perfect conditioning activity for the heart and lungs (vigorous enough to give the cardiovascular system a good workout, yet leisurely enough for almost anyone).

But running contributes little to flexibility and doesn't develop any significant muscle tone, other than in the legs. That's why the Swedes developed *parcours* (French for "course"), which consists of several exercise stations at intervals along a jogging path. The jogger stops for activities such as sit-ups, push-ups, chinning and leg lifts; a number of U.S. municipalities have installed *parcours* layouts in parks and along trails.

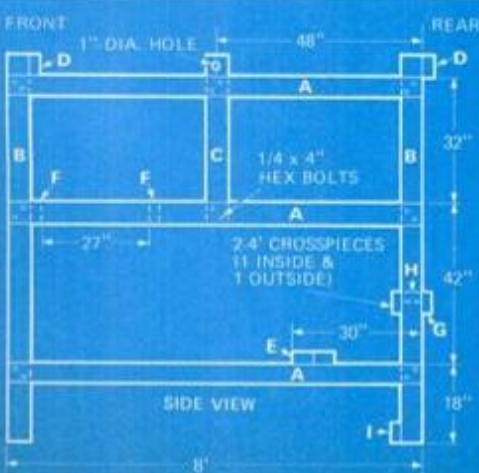
Unfortunately, the course is seldom located right in your neighborhood. But it's easy to have a backyard *parcours* of your own.

The multipurpose unit shown here combines the various exercise stations into one. It can be moved or disassembled, costs less than \$60 to build, and will exercise every major muscle group that does not get a workout from jogging.

As shown in the plans below, the [\(Please turn to page 177\)](#)

MATERIALS LIST—PARCOURS

Key	Pcs.	Size and description
A	6	2 x 4" x 8" (sidebars)
B	4	4 x 4" x 8" (upright supports)
C	2	2 x 4 x 40" (chinning bar support)
D	2	2 x 4 x 48" (front crosspiece)
E	2	2 x 4 x 51" (step)
F	2	2 x 4 x 48" (parallel bars)
G	2	2 x 4 x 48" (hamstring stretcher)
H	1	2 x 4 x 41" (hamstring spacer)
I	1	2 x 4 x 72" (rear brace)
J	1	1" o.d. x 50" galvanized bar with 2 threaded end caps (pipe chinning)
	2	1 1/4 x 6" dowel handles
	1	1/4 x 17" nylon rope
	32	1/4 x 6" hex bolts with nuts and washers or 36 16d common galvanized nails



1. Hamstring stretch

The hamstrings, the muscles in the back of your thighs, tend to tighten up during jogging. Consequently, they need to be stretched. Place the heel of one leg on the rear platform. Keeping that leg straight, bend slowly forward while trying to place your chin on your knee for about 10 seconds. Then you should repeat the exercise with the other leg.

2. Heel cord stretch

This stretches both your Achilles' tendon and calf muscle. Stand three or four feet from the front parallel bar and lean on it. Rise up on your toes, then lower your heels to the ground, holding for several seconds. As you press down, you should feel the stretching. Bend your knees slightly and hold position for a few seconds.



3. Rope pull

This exercise will tone the rhomboid muscles in your upper back that draw the arms backward. Grasp the handles on the ends of the rope and lean away from the structure with your hands together. Then spread your arms out to the sides to pull your body forward. Next, slowly bring your hands back together to return to the original position. Repeat this exercise as many times as you can comfortably, with up to 20 times a good practice session. Alternately pulling on the rope with each arm, both facing and with your back to the exercise unit, can flex and strengthen muscles in the arms, shoulders and hands. Practice with a comfortable, even rhythm.



The videodisc player offers many conveniences as shown here (top). You can return to the same scene over and over, fast-forward or reverse, even freeze-frame. The only thing you cannot do is record. Playing a prerecorded disc (bottom) is simply a matter of closing the lid and hitting play.



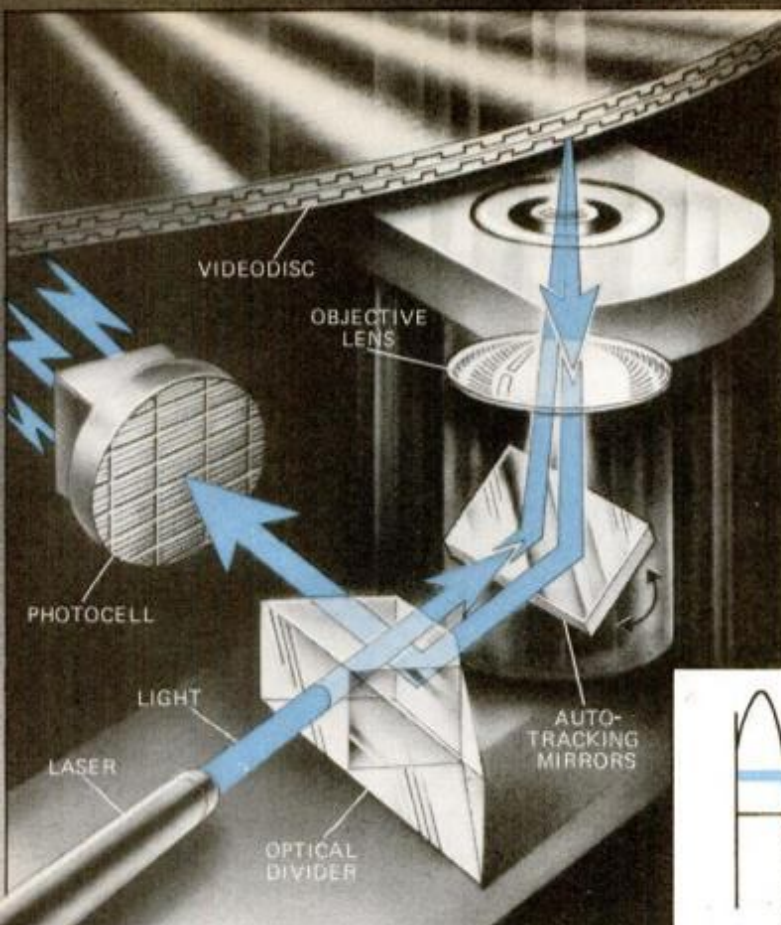
PM's complete guide to the NEW VIDEODISCS and CASSETTES



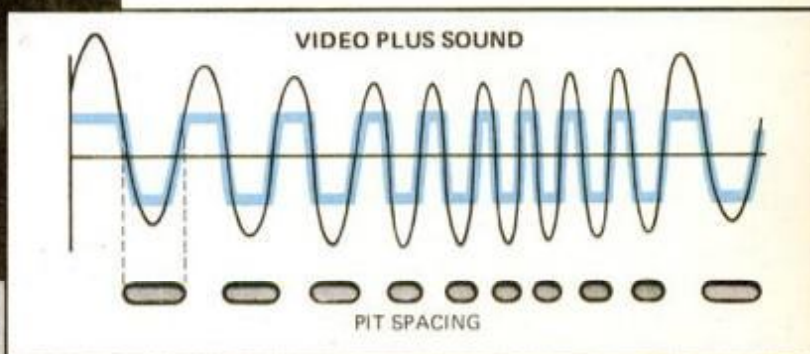
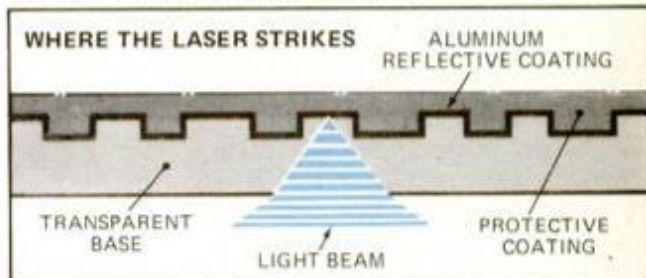
PM Photos: Frank Lusk

MAGNAVISION VIDEODISC SYSTEM

First videodisc system is Magnavision from Magnavox. It uses a laser to "read" digitally encoded discs. Laser light is focused, from below, on the spinning disc. The beam of light passes through a transparent base material which protects disc from fingerprints. It then hits optical pits on a reflective aluminum surface (backed up by a further protective coating). Light bounces back, changed by reflecting from the pits. Information contained in optical pits is further enhanced by spacing of the pits along a spiral track. Video and sound are both so encoded.



Magnavision is Magnavox's trade name for the first videodisc system to be marketed.



Choosing between one of the new videodiscs or video cassettes can be confusing. Here's what's available now—and what the near future holds in store.

by Stan Prentiss

The videodisc is out to challenge the more familiar video cassette recorder/player. At least four companies, by the middle of next year, will offer new disc systems, each slightly or significantly different from the rest.

Conflict in the marketplace results from one simple fact: Video cassettes can record and play back off a home television or, with an accessory camera, can even take home TV "movies." Videodiscs cannot record; they only play back previously recorded movies or programs from discs reminiscent of stereo records—but the discs cost less than tapes.

Magnavox is first on the market with its silvery-plattered Magnavision disc system. Production has been currently sold out in test markets, such as Atlanta and Seattle.

Priced at \$695, Magnavision operates on a laser-light system. The disc contains digitally encoded information "read" by the laser. There are



You can team Quasar's VH5200 portable with its VA515 varactor tuner. This would give you microprocessor control, along with remote channel changing.

rows of optical pits along the surface of the disc. A laser beam, focused from underneath the spinning platter, is bounced back, changed by the manner in which the pits have reflected it. It is this change which carries the information as to what the TV picture should be.

The disc is protected from fingerprints and other damage by a plastic coating. The discs are also aluminum-backed, so that they have a

startling, rainbow-like appearance.

The videodisc can hook up to any TV right at the antenna terminals. Audio output is on two separate channels which are, of course, combined by most nonstereo TVs. Future possibilities would include such things as stereo or bilingual sound tracks.

Each side of a Magnavision disc has a 30-minute playing time. Right now Magnavision offers such fea-

tures as fast forward and fast reverse, as well as slow motion in either direction. Each disc side can hold 54,000 frames. Every one of these frames has a reference or index number which can be displayed—and each frame can be frozen still. If you want to direct someone who has a videodisc to a favorite movie scene you could say, "Pull out frame 40,167 in *Casablanca*" and know exactly what he or she would see. Right now it requires fast forwarding and reversing to get to the right frame. In the future, the viewer will likely have immediate access to any single frame.

RCA is jockeying to have its own videodisc—a capacitance-stylus system—ready later this year. But informed sources do not expect to see it until 1980. The system has a diamond needle that will ride in grooves on the disc itself. It will measure the difference in electrical charge potential (capacitance).

The RCA system as yet has no capability for freeze-motion, and no slow or fast motion—only normal playing speed. It is somewhat subject to wear on both needle and disc, while a laser system (like Magnavision) has a life expectancy of at least 5000 hours of playing time.

One very important thing about the RCA system: It will likely be cheaper than its laser competition—somewhere in the \$400 to \$500 range.

Panasonic (as reported in last month's *PM Electronics Monitor* column) is currently considering a quartz needle pickup. The system would use the piezoelectric property of quartz (changing vibrations from the grooves into electrical voltage). The disc would be 9 inches in diame-



Video cassettes, such as this PV-1600 from Panasonic, point up differences between disc and cassette. As shown, this deck can use different video cameras to record home video "movies." It can also record off the air. Discs are play only.



ter and also subject to wear from the needle.

JVC (Victor of Japan) is reputed to have a highly versatile videodisc system waiting in the wings. It is a needle-type system, but is said to have "electronic grooves" so the needle won't contact the record.

Pioneer is the only company besides Magnavox that—at press time—has a videodisc system actually on the market. Pioneer's is a laser system similar to Magnavox's although discs are not interchangeable from one system to the other.

Pioneer has yet to enter the consumer field with its videodisc, but it has already sold at least 7000 systems to General Motors. The units feature all the goodies, including stop-frame indexing and slow and fast speeds. They cost about \$3000 apiece and come equipped with Zenith TVs and a big cabinet.

They will be used in promotional campaigns at the dealer level. Whether Pioneer intends to get the price down and sell to the consumer is yet to be seen.

On the cassette front

Things have not been standing still with the video cassette. The disc may threaten it, but since the disc cannot record, most see the cassette continuing for a long time to come.

What is new this year for these tape player/recorders is primarily extended playing time, some additional programming abilities and the introduction of *portables* (with both manual and electronic tuners) that can record or play for 30 to 80 minutes.

Less expensive table models feature mechanical tuners and single-channel programming, while their more expensive cousins have deluxe



Sony's SL-3000 is a portable video cassette that can team up with any Sony video camera. You can take it along, no matter where you go, for on-scene action.

features, such as seven-day programming, precise microprocessor control and brand-new tapes for 4½-, 5- and 6-hour formats. Cameras have been upgraded too, and are competitively priced.

General Electric

General Electric's new cassette recorder this year is supplied by Hitachi. GE is offering a new four-hour programmable player/recorder that has a sequence of indicator lights above the programming buttons. These lights prompt you for start times, time off and channel selection for up to four programs you wish to record. Of course, you can only record to the four-hour tape limit. There is also a built-in electronic timer, a tape counter with memory, and remote-controlled pause.

This unit will play not only its own recordings, but also those from a Panasonic (Matsushita) machine—although with some slight deterioration in definition and resolution if the units have not been adjusted exactly the same.

Quasar

There is big news from Quasar, which is now owned by Panasonic. There is microprocessor control in



Zenith has brought out one new cassette deck—Model VR900W—which has 2- or 5-hour capability. Unit is programmable, with speed-search, pause/stop and stop-frame.



RCA is offering a new compact deck, Model VDP150, that has a built-in battery, can be teamed with TDP-1000 timer-tuner.

the portables and the table model features long-term memory control. The microprocessor manages all mechanical operations such as fast forward, rewind, pause (without picture), speed changes and video and audio muting, as well as sensing the

end of the tape and identifying any injurious moisture near the video heads.

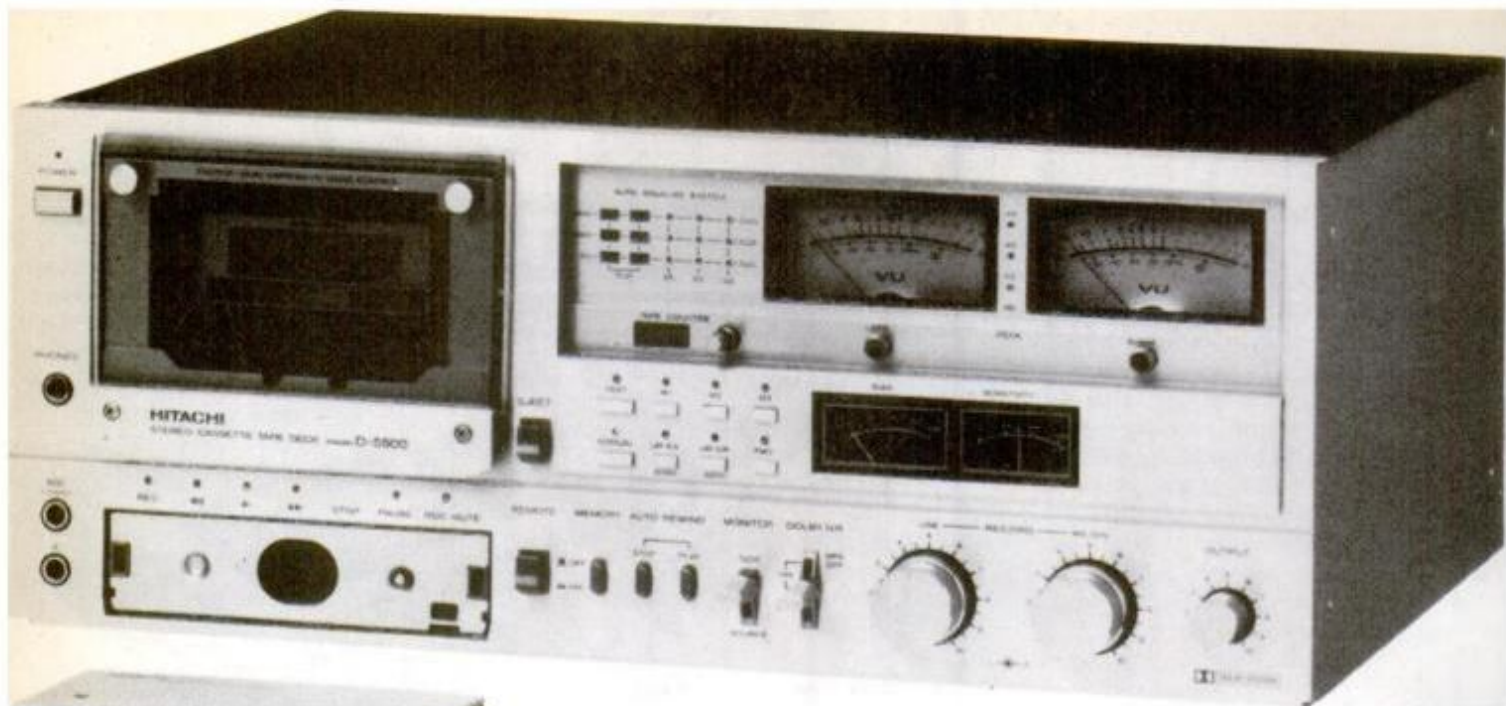
With the table model VH5100 you can really tape a tight video schedule. The unit can record up to four

(Please turn to page 174)

WHAT'S NEW IN VIDEO CASSETTE RECORDERS

Trade Name	Maker	Model	Playing Time (hrs.)	Type	Suggested Retail	Cassettes Recommended	Tape Prices	Cameras	Camera Prices
General Electric	Hitachi	IVR010W	2/4	programmable	• N/A	t-120 t-60	N/A N/A	none	none
Magnavox	Matsushita	VK8252	2/4	varactor	\$1495	AH9202	\$16.95	VJ8241	\$1295
		VK8251	2/4	mechanical	\$1395	(2 hrs.)		(6:1 zoom)	
		VJ8222	2/4/6	mechanical	N/A	AH9204	\$24.95	VJ8240	\$895
		VJ8227	2/4/6	programmable	N/A	(4 hrs.)	VJ8211	\$299	
		VJ8225	2/4/6	programmable	\$1295		(made by JVC)		
		VJA220	2/4	mechanical	\$1095				
Panasonic	Matsushita	PV-2200	2/4	electronic	\$1525	NV-T60	\$17.95	PK600	\$1000
		PV-1600	2/4/6	programmable	\$1295	(2 hrs.)		(6:1 zoom)	
		PV-1200	2/4/6	mechanical	\$1095	NV-T120	\$24.95	PK500	\$850
		PV-1100	2/4	mechanical	\$995	(2/4 hrs.)	PK400	\$700	
Quasar	Matsushita	VH5200	2/4	programmable	\$1195	VC-T120	N/A	VK700	color cameras,
		*VH5100	2/4	programmable	\$1350	(2/4 hrs.)		VK710	\$900 to
		*VH5010	2/4	mechanical	\$1195	VC-T60	N/A	VK105QE	\$1300
		+ VA515	2/4	electronic	\$430	(1/2 hrs.)			
		+ VA510	2/4	mechanical	\$300				
RCA	Hitachi	*VDP150	2/4	programmable	N/A	VK-125	\$18.95	CC003	N/A
		*TPD1000	2/4	programmable	N/A	(2 hrs.)		(4:1 zoom)	
		*PDP500	2/4	programmable	N/A	VK-250	\$26.95	CC004	N/A
	Matsushita	VDT600	2/4/6	programmable	N/A	(4 hrs.)		(6:1 zoom)	
		VET400X	2/4	programmable	N/A			B/W005	N/A
		VDT350	2/4	electronic	\$1200			(16-mm lens)	N/A
		VDT201	2/4	mechanical	\$1150			B/W007	(4:1 zoom)
Sony	Sony	SL-8600	3	mechanical	\$1150	L-250 (1 hr.)	\$13.95	HVC-1000	\$1320
		SL-3000	3	electronic	\$1350	L-500	\$16.95	(3:1 zoom)	
		SL-5400	4½	programmable	N/A	L-703 (3/5 hrs.)	\$20.95		
Zenith	Sony	VR900W	2/5	programmable	N/A	L500	\$16.95	KC1000	\$1000
						L750 (3 hrs.)	\$20.95	KC1250	\$1395
								(3:1 zoom)	

*Portable models; all others are table models. † Accessory tuners. NA Not available



by Herb Friedman

The Hitachi D-5500 uses sophisticated computer circuitry to make certain the user gets the best sound out of whatever tape he uses—within certain limits.

With almost the same fervor that men searched for the Holy Grail, high fidelity enthusiasts have searched for the perfect cassette tape—the tape that would give the widest frequency response, lowest distortion and least background noise (tape hiss).

In actual fact, there is really no “perfect tape.” Final playback sound quality is determined primarily by the recorder/tape match. The tape that delivers outstanding high fidelity sound when used with one cassette recorder might prove less than acceptable when used with a different deck. The reason for this tape-to-machine matching problem is that, at the very low tape speed of $\frac{7}{8}$ inches per second used for the cassette system, all electrical adjustments get very touchy. Just a slight variation in bias level—the high-frequency signal the machine feeds to the record head to precondition the tape for the actual sound signal—can result in an optimum flat frequency response, a response with

New deck adjusts to all tapes

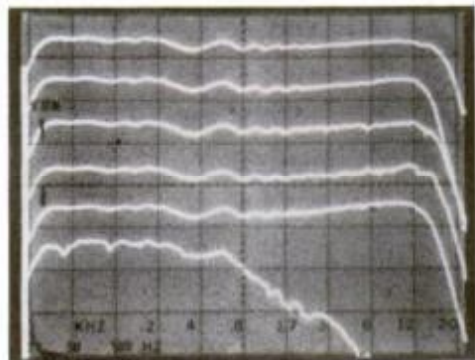
peaked (boosted) highs that shrill in your ear or a dull flat sound.

The newest solution

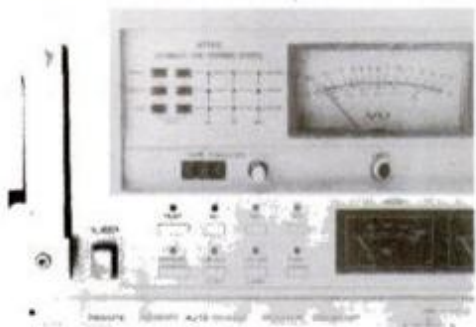
But now, thanks to the microprocessor used in the “computerized” Hitachi D-5500 stereo cassette tape deck, virtually all those recording problems vanish at the touch of a button. Simply pop a cassette into the front-loading cassette holder, press the record and play keys to start the machine in the RECORD mode, then press a button labeled TEST. Unseen and unheard, a built-in microcomputer records special test signals on the tape, which are immediately played back through a three-head simultaneous record/play system to the computer.

The computer tests the playback signals against built-in reference standards and automatically adjusts the recorder’s bias, equalization and sensitivity (which determines the Dolby tracking precision) for optimum results for the tape being tested. After a few seconds, the tape automatically stops and rewinds to where the test was started, ready for recording.

During the few seconds it takes for



Traces (above) show that Hitachi deck (top) automatically optimized performance factors for five popular brands of tape, though even it could not help cheap three-for-a-dollar tapes. LEDs (below) light to tell you the deck is processing tapes.



the microcomputer to set the recorder’s adjustments, light-emitting diodes (LEDs) and two meters indicate the status of the tests.

The test results are stored in a memory kept “alive” by two AA-cells, even when the power is turned off. If you change the brand or type of tape, just touch the test button and run a quick computer test for the new tape. The memory will now remember the latest adjustments.

In addition to the test memory,

(Please turn to page 175)

Popular Mechanics

HOME ENERGY GUIDE



Firewood: The born-again fuel: What you should know about cutting, splitting and using it. **Seven newfangled muscle-power wood-splitting tools.** Some are better than others. Here's how to pick the one that's best for you. **PM installs a solar domestic water heater.** One way to lower your fuel-oil bill is to cut down furnace time spent heating water. **Plus, a solar amenities add-on, low-cost new furnace installation** and more, lots more.

Prepared by the Popular Mechanics Home and Shop Department



Bird makes solid vinyl siding for people who love the looks of wood.

We'll be the first to admit that wood can look beautiful. It's just that taking care of it is a constant job. That's why the people who live in this house covered it with Bird solid vinyl siding.

We make siding a little differently than anybody else. The bottom of each panel is squared off to look exactly like wood clapboards. And we invented the natural woodgrain texture you see on our white Woodside™ solid vinyl siding.

But unlike wood, Bird solid vinyl siding takes care of itself. The color goes all the way through, so scratches don't show the way they can on other materials. And it can't rot, blister or peel. So it never needs painting.

We make solid vinyl siding in narrow and wide widths, with smooth and textured finishes. If you'd like a free estimate, talk to your Bird Siding Dealer. He's in the Yellow Pages, and he'd be glad to hear from you.

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Bird & Son, inc., E. Walpole, MA 02032

Please send me your revised, 36-page color booklet, "What you should know about roofing and siding before you build or remodel." I'm sending 50¢ in payment, and I'm planning to build remodel.

Name _____ Phone _____

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FIREWOOD

THE BORN-AGAIN FUEL

How to cut, split and handle it the easy way



Once again, Americans are hauling fuel from nearby forests and woods. Unlike their ancestors (left), they aren't using sledge and oxen to bring the wood in; instead, trailers such as Coleman's Versa-Trailer, with its 900-pound payload, are in use. Unit shown above costs about \$400.



by Glenn S. Hensley

Chain saws, power splitters and wood-hauling accessories are a boon if you choose the ones that are right for you.

Wood is a bargain fuel in many parts of this country if you are equipped to handle it efficiently. Assuming you have a source of timber standing or on the ground, let's take a look at what's available to help you convert it into usable fuel.

Buy saw to suit needs

The basic tool of firewood harvesting is, of course, the chain saw. Don't buy one that is too small for your needs just be-

cause it's all you can afford. You'd be better off renting a large commercial unit once a year than sinking money into something that will give you just limited use.

During the last decade, more and more manufacturers have sized models to the average homeowner's needs. To get a quick look at what these units will do—and at what cost—we examined the industry.

Light-duty saws will fell up to 10-inch-diameter trees, and are made for the homeowner who only needs them for less than 15 hours (running time) each year.



Some of hydraulic splitters offer accessory that lets you quarter log with one-cylinder cycle. Attachment shown fits Danuser units, allows no-tool change.

FIREWOOD: BORN-AGAIN FUEL

(Continued from page 125)

These popular, gas-powered units have 10- to 12-inch guidebars, and will cost you from \$90 to as much as \$150, depending on the features you desire. The average tool weight is about 9 pounds, complete with bar and chain.

If you expect to use your saw as much as 40 hours per year, you'd be better off selecting a unit with a 14- to 16-inch guidebar and chain. These saws are ideal for felling trees up to 20 inches in diameter. They'll weigh about 12 pounds and cost you in the vicinity of \$250, again depending on the features chosen. Automatic chain oiling; twin-trigger, dual throttles; antivibration systems; increased fuel and oil capacities; larger engines; longer bars and safety-stop-type chains can all vary the cost on any given saw.

Most of the new models for 1979 are careful refinements of designs that have long ago proved able to do the job. You'll find that they're safer, lighter in weight and easier to use (less vibration) than ever before. You'll also see more saws being equipped with electronic ignition systems for faster starting.

If you're planning to use your saw in finger-frosting weather (and most users do), you'll want to try a Stihl unit that allows you to divert part of the warm exhaust gas through the handle system.

Electric-powered chain saws will work well for light-duty, around-the-house chores. Don't attempt to put them into full forestry-type duty, though. Toro, for example, has both 10- and 14-inch electric models that sell for about \$50 and \$70 respectively. They'll lop limbs and section them into firewood quite satisfactorily. Be careful with those 110-volt power cords, though. Electric saws, as with all cord-powered yard tools, should be ground-fault-protected for user safety.

Power splitters speed work

Once you've cut your wood into lengths to suit your stove, fireplace or wood furnace, some large pieces may have to be split or quartered. If you're going to do a lot (several cords per session), a power splitter may be a worthwhile investment. It will certainly make splitting easier on your muscles. More and more units are being sized and priced to fit the needs of homeowners.

For instance, a typical do-it-yourself unit is Didier's LMF 19 that sells for about \$600. It's equipped with a 5-hp gas engine and a single-stage hydraulic pump. You can expect to split logs up to 19 inches long in about 25 seconds.

If you're planning heavy-duty splitting, you'll want to look at one of the more rugged units. Danuser Machine Co.'s MS-2 will split logs up to 48 inches long, pushing against a 9-inch-high, forward-sloping wedge that helps hold logs in proper position during splitting. This is not a low-cost

POWER WOOD SPLITTERS

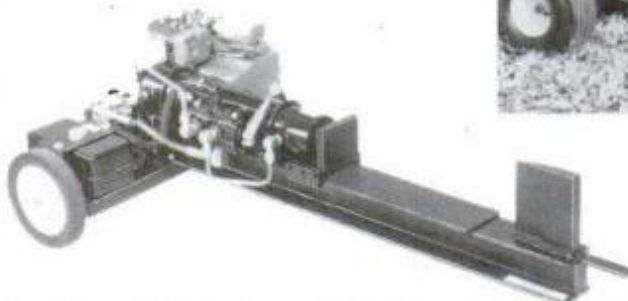
Never used a hydraulic or ram-type splitter before? Don't worry—it's easy. Just remember that you can hurt yourself with any power machine if you don't follow the manufacturer's instructions, or if you attempt to make it do jobs

for which it was not designed. It's a smart precaution to wear steel-toed boots, heavy gloves and goggles when you are working around these units, which can exert tons of force on the wood to be split.



To operate typical hydraulic log splitter, lift log into position and push one end firmly against wedge (as above). Then pull hydraulic control lever to start cycle (left). Piston will slowly push log past splitter wedge to produce instant firewood.

Didier's well-built LMF-19 (below) is suitable for home use and retails for about \$600. It exerts more than 12 tons of splitting force and is powered by a 5-hp engine.



Vertical, electric-powered, hydraulic splitter from Woodmate splits logs up to 29 inches long. Foot switch aids control.



Vertical design allows lighter-weight construction. Unit can be hand-wheeled to site, fits in car trunk or station wagon.

machine, for it's powered by a 16-hp engine. An optional accessory lets you split a log into four quarters in one cycle. Splitter with engine and trailer sells for about \$2000.

Choosing a hydraulic splitter

Hydraulic splitters for home use seem to follow three basic designs. One configuration provides for the trailer tongue to incorporate the splitting platform, wedge and cylinder. Another extends the splitting platform and wedge to the rear, away from the trailer tongue. A third design pivots up, to make the splitter operate vertically.

From experience, I'd say the units that utilize the trailer tongue as a splitting platform have the edge in convenience. You can rest the tongue on the ground as you work. Thus, you don't have to lift each heavy log so high. You can almost roll logs onto the splitting platform.

Units that extend the splitting area to the rear, away from the trailer hitch, require the operator to support the hitch at working height. I leave this type of unit hitched to a tow vehicle while it is in use. Unless a sturdy hitch support stand is provided, you could have problems with the splitter shifting position as you use it. With most of these designs, logs must be lifted to position them for splitting. There is some compensation, since you are able to work in a standing position, instead of stooped over.

Vertical units require no lifting of logs. The lower end of each log rests on a steel plate which is at ground level. Vermeer's Model LS-200 is such a machine. It mounts its cylinder above and pushes a wedge down into the log.

Splitting wood with screws

Screw-type log splitters are a relatively new market arrival. Models can be powered by everything from your car's engine to a garden tiller's driveshaft.

They're safe enough when used properly, but don't let loose clothing come in contact with the rotating auger's tip. All units are provided with an emergency stop of some kind—and they need to be. On a unit I was testing, I touched a wiping rag to the auger tip to see what would happen. It promptly twisted around the point, binding snugly to the rotating splitter cone. In an instant, though, a touch of the emergency stop button killed all axle rotation. (This is also a crucial safety feature should a car topple from its jack and careen out of control.)

Rotary screw-type splitters weigh less than the hydraulic units, are easily transported and uncomplicated to maintain or repair. Instead of expensive hydraulic pumps, valves and cylinders, the simple chain and sprocket drives need only periodic lubrication.

For \$150, you can attach a Stickler Model SV-100 splitting cone onto the left (drive) wheel of your car, let the engine

SCREW-TYPE LOG SPLITTERS

There are many varieties of screw-type log splitters, but they all have a few things in common. One is that care must be exercised while using them. The auger bit can "bite" loose clothing. A kill button is a must—especially

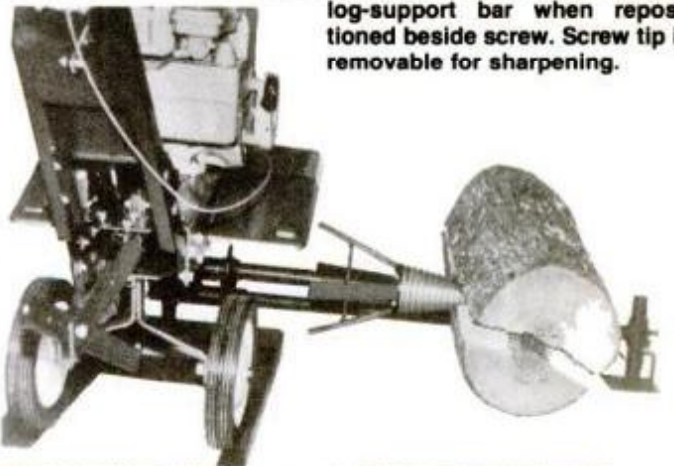
when an automobile is used for power.

Operation is relatively simple, though—just touch the log to the spinning screw auger and let the device do the rest. Most tips are removable and can be sharpened with a file.



Bark Buster 50, a self-contained, screw-type splitter, is \$400 from F.W. and Associates. It's compact enough to fit most car trunks and weighs 125 pounds. The handle, used to wheel unit, doubles as a log-support bar when repositioned beside screw. Screw tip is removable for sharpening.

Conversion kit for Magna American's garden tillers lets tillers double as log splitters. Kit costs \$148, fits Magna's units with three-step chain transmissions. Foot-operated safety switch is included.



Hub-mounted screw lets you do two-month wood supply with same amount of gasoline you'd use to mow your lawn. It splits 30-inch-diameter logs up to 24 inches long.



Arnold Industries' Stickler has an adapter plate for your car, and safety switch that lets you kill car engine while in operating position. It sells for \$150.

idle and split logs all day. Attachment to the jacked-up car takes only a few minutes. With it, you can split logs up to 24 inches in diameter and 30 inches long as fast as you can carry them.

I questioned possible strain on the car's differential and drive train. Concern was put to rest immediately, for only idle

speed is necessary to make the unit work. There's just not enough of a load involved to put any kind of strain on the car.

Hammer splitter has punch

Probably the most innovative log splitter to hit the market is FXG Corp. SS-

(Please turn to page 128)

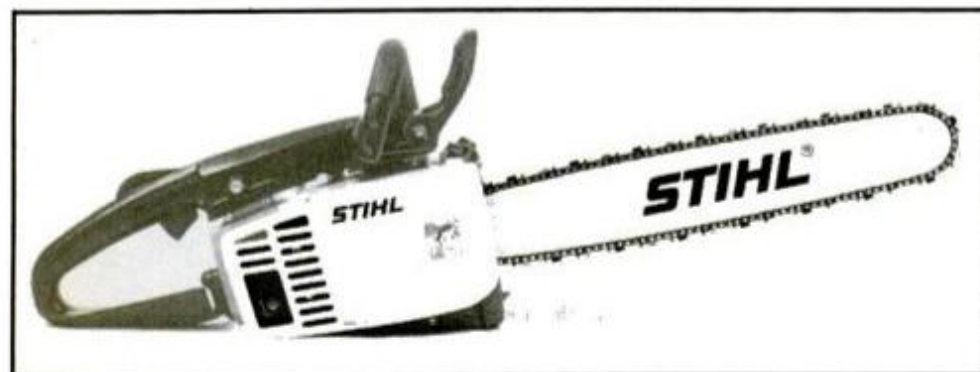
CHAIN SAWS FOR THE HOMEOWNER



One of most useful wood-cutting accessories you can buy for \$30 is a bar to hoist logs off the ground for easier, dirt-free sawing. Omark Industries' Lift 'n Cut (left) clamps to log, then provides leverage to raise it for cutting. Homelite's electric XEL model (above) is great for cutting up firewood, limbing and trimming operations. It's available in 10- and 12-inch sizes and is generally priced at approximately \$60.



Toro's compact electric saw (left) is also handy around the yard. The 10- and 14-inch models retail for \$50 and \$70 respectively. Both weigh about 6 pounds and have gauntlet-style handguards. Stihl's 015 AV with 14-inch bar (below) costs about \$200. Rubber shock absorbers cut down significantly on operator fatigue and built-in hand guards offer an extra measure of protection.



FIREWOOD: THE BORN-AGAIN FUEL *(Continued from page 127)*

24. It's been described as an electric-powered sledge hammer that slams the log against a splitting wedge, instead of smacking the wedge against the log. While hydraulic splitters can demand engines as high as 16 hp, this FXG machine is able to get by with only a 3/4-hp electric motor.

It's not a cheapie. The unit, on a trailer, will cost you approximately \$1000

(gas engine power is slightly higher).

How does it work? The electric motor spins two 70-pound flywheels, which are solidly fixed to a geared axle shaft. The shaft gear, with tremendous power advantage, is manually engaged to a rack gear by a cam lock at the beginning of a cycle.

The rack gear, when fully engaged in drive position, moves out toward the log

at 1.2 feet per second with 10 to 14 tons of force. At the end of the full 24-inch stroke, the rack, being spring-loaded upward and backward, kicks off the cam lock, goes out of gear, and immediately returns to the start position. It's then ready for another cycle.

Several cycles may be required to split a particularly tough log and there are some circumstances when the flywheel may stall from the load. But for all practical purposes, the machine does work well; it splits a fantastic amount of wood in a short time due to its two-second cycle.

If power splitters don't appeal to your budget, or if you don't split enough wood during any one session to make them worthwhile, consider purchasing one of the new hand splitting aids. See page 130 for an in-depth evaluation of what PM thinks of seven muscle-powered wood splitters.

From woodlot to woodburner

Now, once your wood has been split, you may need help to transport it home. Take a look at Coleman's VersaTrailer (see photo on page 125). With stake side extenders, the unit will handily haul a half ton of fuel. The trailer is dumpable for fast unloading. Other options include plastic top and camping package.

At home, you'll need to carry logs to the fireplace or stove. Manufacturers haven't forgotten your needs there, either.

Lambert Corp. has bent a piece of steel tubing to come up with a one-man log carrier. It's self-balancing and will haul more than 50 pounds of split logs per trip to the wood pile. When you get it back to the fireplace, it makes a neat log holder. Canvas and vinyl log carriers will cost you about \$10. Any of the carriers certainly is better than lugging logs in your arms.

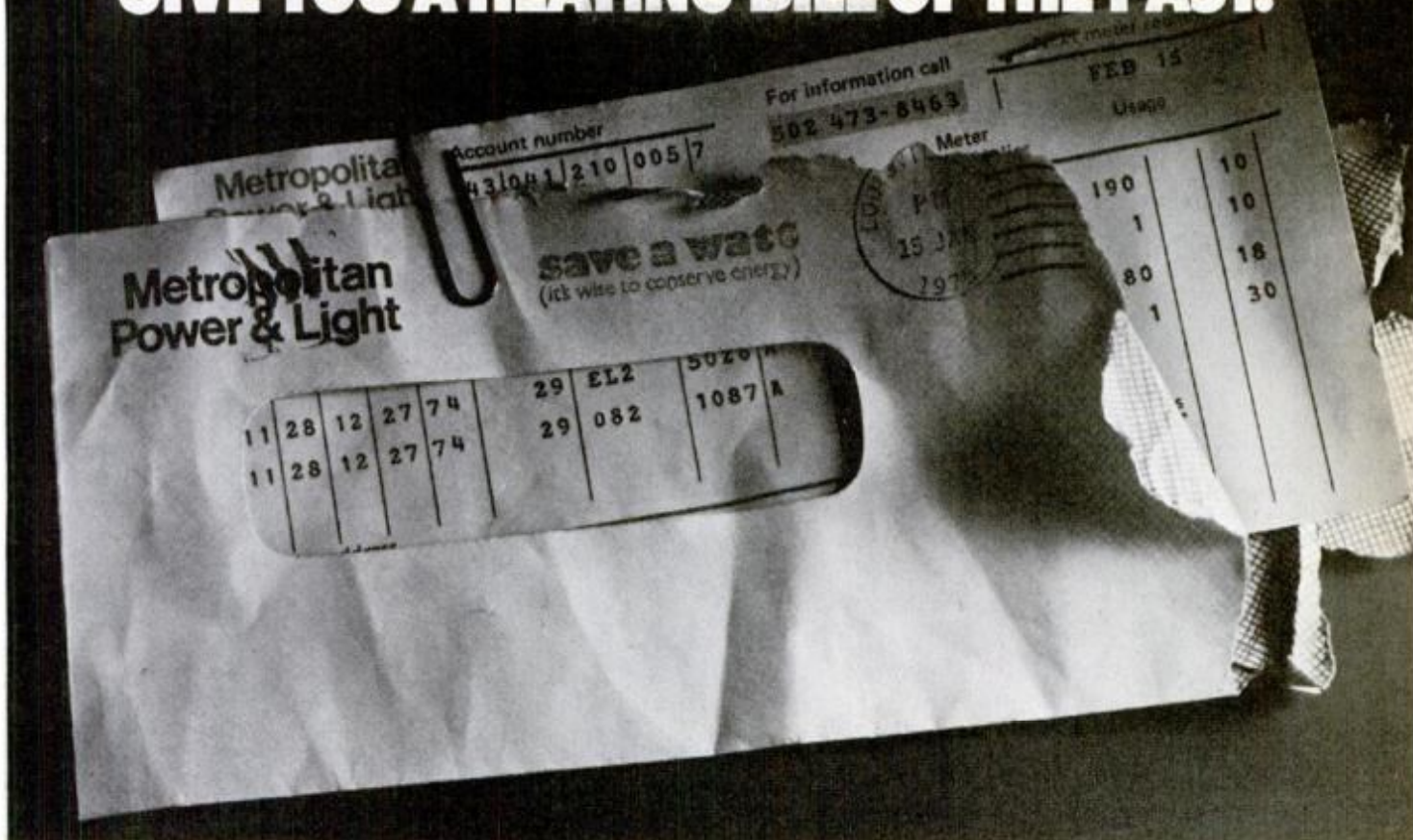
Useful reading

Finally, when you've finished sawing your fireplace or stove wood and still want to fool around with your chain saw, get a copy of Homelite's book, *22 Weekend Projects*. It's \$1.25 and will keep you busy making useful projects, ranging from a log sawbuck to a storage shed for your garden, lawn and wood-gathering gear. **PM**

MANUFACTURERS LIST

- The Coleman Co., Camping Trailer Div., Somerset, Pa. 15501.
- Danuser Machine Co., 500 East Third St., Fulton, Mo. 65251.
- Dider Mfg. Co., 8630 Industrial Drive, Franksville, Wis. 53126.
- FXG Corp. Super Split is distributed by Northland Broiler Co., Town St., East Haddam, Conn. 06423.
- F.W. & Associates Inc., 2605 West First St., Tempe, Ariz. 85281.
- Homelite, Div. of Textron, Box 7047, Charlotte, N.C. 28217.
- Lambert Corp., 519 Hunter Ave., Dayton, Ohio 45404.
- Magna American Corp., Box 90, Raymond, Miss. 39154.
- Omark Industries, 9701 S.E. McLoughlin, Portland, Ore. 97222.
- Stickler, Arnold Industries Inc., Box 2790, Toledo, Ohio 43606.
- Stihl Inc., 536 Viking Drive, Virginia Beach, Va. 23452.
- Toro Co., 8111 Lyndale Ave. S., Minneapolis, Minn. 55420.
- Vermeer Mfg. Co., Box 200, Pella, Iowa 50219.
- Woodmate Inc., Log Bridge Rd., Middleton, Mass. 01949.

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THE WEATHERTRON® HEAT PUMP SAVES 30-60% ON HEATING COMPARED TO DUCTED ELECTRIC HEAT, DEPENDING ON WHERE YOU LIVE.

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How does it work? By actually getting heat from cold air.

That's right. Even on most freezing winter days, the Weathertron heat pump extracts heat from the outdoors and transfers it indoors.

And in more moderate climates, there's more heat available in the air. That's where a heat pump can really work for you. Because that's where it can use energy most efficiently.

Depending on where you live, only one unit of electrical energy gets you 1.4 to 2.5 units of heat energy during the heating season. That's where the 30-60% savings comes in. And that's why only the heat pump can deliver ducted electric heat to your home in the most cost-efficient and energy-efficient way.

IN REVERSE, IT'S AN AIR CONDITIONER.

In warm weather, the thermostat reverses the whole process, and the Weathertron cools, using the same principle. It takes warm air from in-

side the house and transfers it outside. A system for all seasons.

GENERAL ELECTRIC HAS SPENT OVER 40 YEARS DEVELOPING THE WEATHERTRON HEAT PUMP.

Since 1932, when GE was one of the few heat pump pioneers, we've been developing and improving it. Years of research, engineering and manufacturing expertise go into every Weathertron system.

We put parts and assemblies through grueling quality-control tests and inspections. For instance, every 230-volt compressor motor must run at 170 volts. And that's only the low-voltage test. Then there are leakage tests. And our surge test, when 3,500 volts are run through the motor windings.

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No wonder the General Electric Climatuff™ compressor, the device that helps extract heat from the air, has been operating in over two million cooling as well as heating installations.

THE WEATHERTRON HEAT PUMP WILL MAKE YOUR ENERGY CRISIS LESS OF A CRISIS.

It's difficult for anyone to safely predict the availability of energy in the

future. And unfortunately, everyone can predict that the fuel available will get more and more expensive.

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The Weathertron heat pump from General Electric uses electricity and nature's heat to save you money on heating. That's why it could be one of the most important things you put in your home.

THE WEATHERTRON® HEAT PUMP AMERICA'S #1 SELLING HEAT PUMP.



GENERAL  ELECTRIC

7 newfangled muscle-powered



Each of these splitters has its good—and bad—points. Most of them can save you work, but you have to choose the one that best suits your build and temperament.

This winter a lot of people will split wood who have never done it before. Some will take the traditional approach—splitting mauls or sledge hammers and steel wedges. Others will get together with neighbors, rent power splitters for \$30 to \$40 and spend a Saturday splitting everything in sight. Still others, especially newcomers, will be lured by several relatively new devices which claim to make hand splitting easier. If you're in this last group, use the information below to help you pick which device, if any, suits you.

I first tried the Woodchomper, offered by Watson Mfg. Co. Inc. It's essentially a heavy metal sleeve on a steel pole, which has a wedge welded to one end. It's like a man-powered pile driver (the heavy-duty version, in fact, can drive steel fence posts) and has split just about everything I've tried it on.

It even split some large 18-inch-dia. black birch sections, but required up to two or three dozen strokes. On most pieces, 12 inches in diameter and less, a few strokes did the job. Advantages include accurate wedge placement, a no-strain motion, and easy portability. You can split large pieces at the site, making them easier to haul away. The Woodchomper is \$49.50 postpaid.

The main disadvantages are noise and armshock. *As with all splitters which involve banging metal against metal, ear plugs and eye protection are musts.* Steel-toed boots and work gloves also make for fewer injuries.

A truly muscle-powered splitter called the Baby Monster Maul comes from Sotz Corp. for \$22.89 postpaid. Its predecessor, called the Monster Maul, weighed in at 20 pounds, but is being phased out in favor of a lighter version. The newer 12-



To operate Woodchomper, first slide heavy metal sleeve to top of pole. The vertical, no-strain motion is easy on back muscles.



Down stroke produces split, as sleeve hits vertical wedge welded on pole's end. It takes several strokes to split 10-in.-dia. sections.



Jiffy splitter has a detachable base plate which you bolt to post for easy carrying. Handle on wedge is welcome feature.

wood splitters

pound model proved very effective once I became familiar with it. A few whacks split most pieces up to 14 inches in diameter. I particularly liked the steel handle, since it won't break. Rubber tape, sold for regripping tennis racket handles, improved the comfort of the bare metal handle. This was the quietest unit I tried—a real plus if you have nearby neighbors.

Next I tried several guided-wedge type units. Two are pictured on page 130, the Jiffy Woodsplitter (\$99.95 postpaid) from C & D Distributors and the Fast Woodsplitter (\$59.95 postpaid) from Daka Corp. A third unit, called the Hammer Splitter I (not shown), retails at hardware stores for \$42.57 and is made by Special Products Co. All units handled logs up to 24 inches long adequately. Their basic plus is that the wedge stays in one place, making it easier to hit with accuracy. The design of these units also makes it unlikely that you will hit the wedge with the neck of your maul or sledge hammer, causing the handle to fracture. Both the Jiffy and the Hammer Splitter have detachable bases, making them easier to store and transport. The Jiffy has a secondary wedge located beneath the convenient wedge handle, which helps prevent the primary wedge from getting hung up in large-diameter logs. It's also useful for splitting small pieces of wood into kindling. The Jiffy generally performed better than other similar units, but it also cost more.

The sixth hand splitter—Chopper 1—was given a workout by another member of the *PM* staff. He reported that it's a fantastic tool which works best on 8- to 12-inch-dia., 20-inch-long logs. (See photos for how it works.) This fall a new version with an indestructible handle will be introduced. A fiberglass shaft makes up

the handle core and is covered by a polypropylene molding which dampens vibrations and doesn't splinter. Price from Chopper Industries is \$39.95 postpaid.

The last device tested, called the Wood Grenade, retails for about \$13.50 at hardware and discount outlets. It is simply a conically-shaped wedge made of hardened steel. It worked fine on small-diameter stuff, but was no match for larger pieces of hardwood. The cone shape disperses the sledge hammer blows in many directions, instead of in just two directions, typical of a conventional wedge. As a result, the Grenade tended to stall in the wood after being driven a few inches.

Engineers who developed the device are working on an improved, longer ver-

sion of the conical wedge made of tough aircraft aluminum instead of steel.

—Joseph R. Provey, Assistant Home and Shop Editor

MANUFACTURERS LIST

C & D Distributors Inc., Box 766, Old Saybrook, Conn. 06475 (Jiffy Woodsplitter).
 Chopper Industries, Box 87, Easton, Pa. 18042 (Chopper 1).
 Daka Corp., Industrial Park, Pine City, Minn. 55063 (Fast Woodsplitter).
 Omark Industries Inc., Consumer Products Group, 9701 S.E. McLoughlin, Portland, Ore. 97222 (Wood Grenade).
 Sotz Corp., 13676 North Station Rd., Columbia Station, Ohio 44028 (Baby Monster Maul).
 Special Products, 15000 West 44th Ave., Golden, Colo. 80401 (heavy-duty Hammer Splitter II, \$61.59).
 Watson Mfg. Co. Inc., Box 861, Brownsville, Tenn. 38012 (heavy-duty Woodchomper weighs 36 lbs., costs \$74.50 postpaid. Plans for either unit are \$3; specify size).



Chopper 1 has a spring-loaded lever on each side of cast tool-steel head (left and above). As blade is driven into wood, levers grab at edges of parting, then rotate outward to help split log. Levers also help keep head from sticking in log.



Guided wedge makes it easier to deliver accurate blows. Jiffy unit adjusts to accommodate logs up to 2 feet long.



Hefty 12-lb. Baby Monster Maul has unbreakable steel handle. A few swings will split most 10-in.-dia. x 24-in. logs.



Wood Grenade proved to be a dud in 12-in.-dia. black birch. Engineers at Omark Industries say improved model is in the works.

PM installs a solar domestic hot-water system



Author checks lines on the completed installation. The compass (inset) shows panel relation to true south.

PM photos: Julius Spedale

Installing the collector-plate hardware



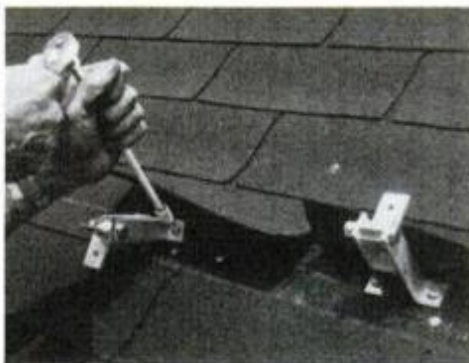
Solid fastening for collector hardware is a must. Here, cat is located and predrilled.



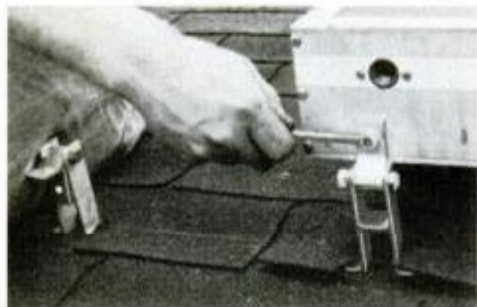
Use 16d nails to secure the cat. See art on page 135 for the blocking technique.



All brackets on the job were installed using lagscrews into rafters, cats or blocking.



Second bottom bracket is precisely located so that blocking can be installed inside.



Next, collector is hoisted to roof and is secured to brackets as shown on page 134.



Since roof is pitched 42°, short legs at top bring panels to the desirable 45° angle.

8 HOME ENERGY GUIDE

The future is here now as far as keeping home fuel bills down is concerned.

by Harry Wicks
HOME AND SHOP EDITOR

There were two reasons why I installed a solar-assisted domestic water system this summer: My oil-fired water heater had sprung a leak and was wearing out, and knowledgeable trade sources were predicting even before the great gas crunch began that home heating oil might reach \$1 per gallon by December, perhaps \$1.50 by spring. So I moved when my pocketbook was pinched.

As my first step, I selected a closed-loop solar fluid system. In it a transfer fluid transports heat from sun rays to the water heater where a heat exchanger transfers it from solar fluid to the potable water. An alternative is to run the potable water through the lines and collector plates, and back to the water heater.

Since Department of Energy figures rate solar efficiency less than 50 percent efficient in my area (near New York City), I also needed a backup system for sunless days and periods of heavy water use. I tossed out the oil guzzler and installed a gas-fired unit and glass-lined, insulated tank. The preheater tank, with exchangers is also insulated.

After some price comparing (I didn't want a system that would take 30 years before it paid off), I picked the Conservationist System made by A.O. Smith Corp. Like those of its major competitors, this



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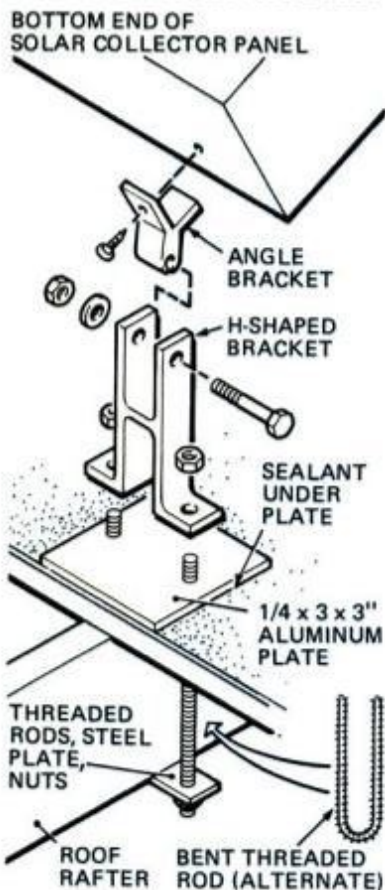
CREATORS OF



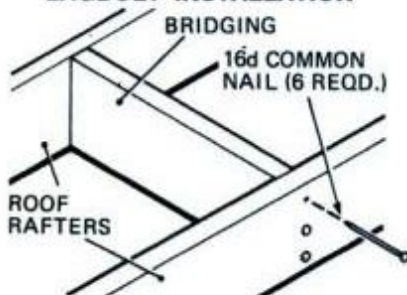
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LOWER BRACKET ASSEMBLY



ALTERNATE FRAMING FOR LAGBOLT INSTALLATION



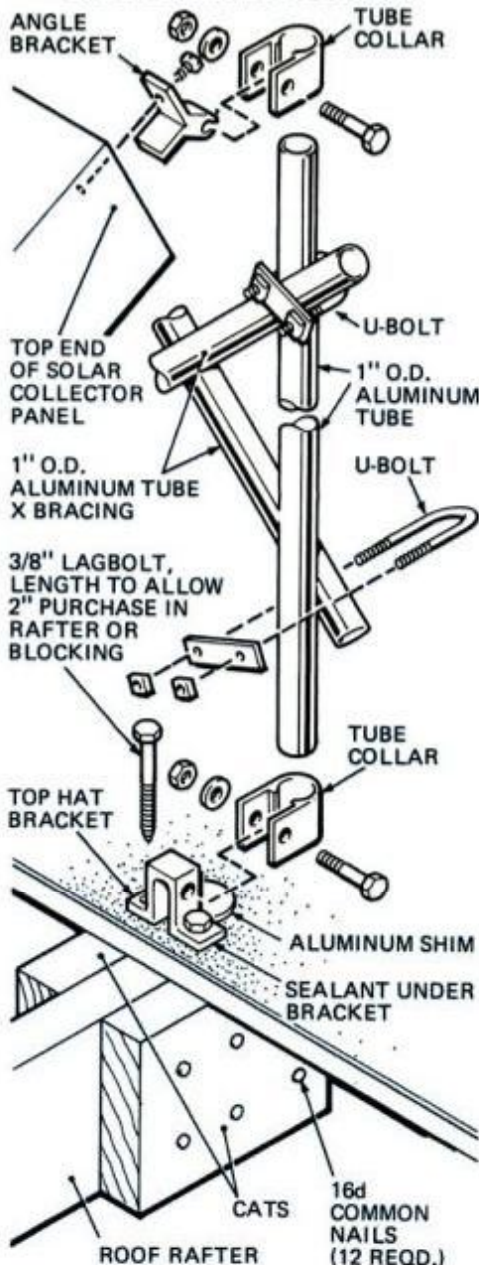
Drawings (above) show the standard panel installation method that was used.



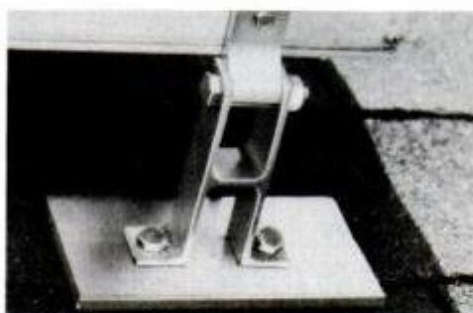
Author found collector weight tilted the brackets, which then cut into shingles.

system is well designed. Quality parts include components made by others, such as collector plates by Revere and circulating pump by Grundfos. Here are job costs: three collector plates, \$930; pre-heater and heat exchanger, \$800; back-up gas-fired water tank and heater, \$300 (not needed if your existing system is in

UPPER BRACKET ASSEMBLY



When bracket misses a rafter, you must install either cats or blocking as shown.



A 1/4 x 3 x 5-in. aluminum plate under bracket distributed weight, solved the problem.

good shape). A plumber charged \$800 for labor and piping; carpentry was do-it-yourself free, but would have added \$300 if contracted.

Choosing collectors

Solar collector panels may be almost out of sight on the roof, but you should

give them special thought. These plates can be exposed to severe temperature extremes. A flat-plate collector can be hit with temperatures below 0° F. on winter nights and over 400° F. (if not operating) on summer days. And they contend with wind, snow, sleet, rain and hail. Although there is similarity in operating principles of many solar domestic hot-water systems, each maker has certain unique or unusual features.

Laying out your panels

Collectors should be placed to receive unshaded sun during the "solar day"—9:00 a.m. to 3:00 p.m. Check your roof to see that trees or neighbors' homes won't shade your collectors. Remember, the sun changes position significantly. In winter, for example, it is much closer to the horizon and casts longer shadows.

Don't position collectors near the roof ridge because of a greater risk of damage by high winds. Locate the plates with horizontal mid-lines slightly below mid-height of the sloped roof. Keep plates close as possible to storage tanks to reduce heat loss during circulation of solar fluid.

Make certain you or your contractor check that hazards aren't created for house occupants. Points to think about:

- Antifreeze fluid, waterproofing and insulation should comply with local codes for fire safety and health under operating and nonoperating conditions.

- Storage tanks and piping that may reach temperatures above 140° F. should be insulated so passersby will not be burned should they contact those elements. Identify pressure and temperature relief valves with appropriate warnings.

- The system should withstand pressures of 150 pounds per square inch. The hot-water side should be protected against excessive temperatures.

- Equipment design should fully protect the potable water supply.

Installing the system

I handled all carpentry and brought in a local plumber for piping. Ripping out the old heater and installing plates, preheater and tank with gas heater took three men 3½ days. My guess is that contractors experienced with a system's installation could cut the labor time to two days for three men and reduce installation costs at least \$200. Much time was spent tearing paneling out of the prefinished attic room so we could install cats on rafters and blocking between the rafters to anchor the bracket-holding lagscrews securely.

Any quality manufacturer will help you determine the most efficient collector panel direction and tilt for your area. The optimum orientation of a collector in the Northern Hemisphere is true south or slightly west of it, but variations 15° east or west of true south are acceptable. The angle of inclination (tilt) needed equals the latitude of the location (in degrees) measured from the horizontal, plus or mi-

Installing the solar fluid line



Copper piping for solar fluid was run on the outside of house to avoid a mess inside.



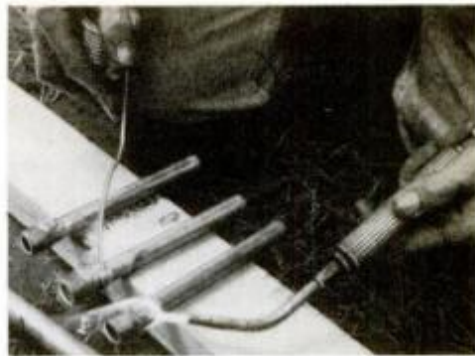
Pipe elbows around gutters. Straight run requires holes through cornice.



To minimize heat loss as fluid travels, pipe must be wrapped with insulation.



Armaflex wrapped around elbows and taped prevents heat loss at these points, too.



All joints are soldered to eliminate joint hardware and the chance of leaks.



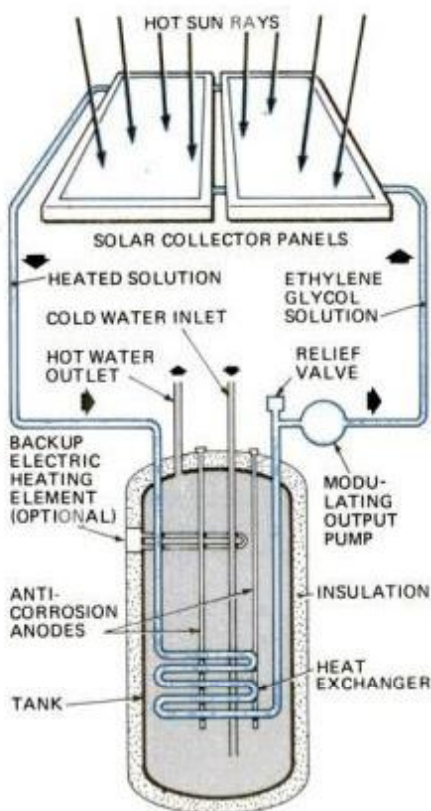
Plumber did some soldering on roof to end the need to carry assembled sections up.

How the Conservationist System works

Hot rays from the sun are absorbed by the roof-mounted collector panels to heat a special antifreeze fluid that circulates through integral copper channels. The propylene glycol eliminates any chance of freezing in cold climates during the unit's downtime (i.e., at night). The Conservationist System utilizes a closed-loop design for transfer of heated solution to the preheater and its return. The heater-mounted differential controller has a modulating output (speeds up or slows down glycol solar fluid flow depending on available energy) to collect the maximum amount of heat from the solar panels, even on cloudy days.

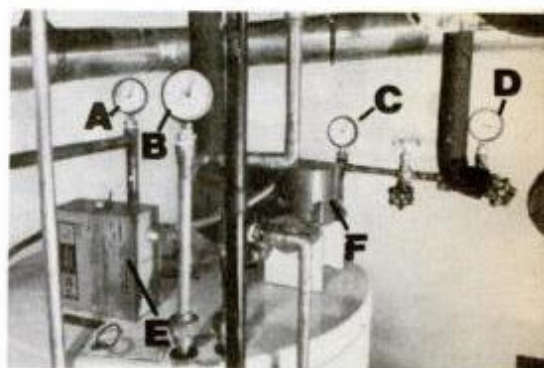
The house water service flows to the preheater tank in which the Corona heat exchanger is submerged. The heat exchanger is double-walled and electrically isolated from the tank for safety. As the solar fluid flows through the exchanger, the heat is transferred through double-walled pipes of the exchanger to the domestic water supply.

Installation can include an electric backup heat system as shown. This unit fires up to bring water temperature to preset use temperature, usually from 120° to 140°F. I opted to eliminate the electric backup system because of high prevailing rates in my area, and installed a backup gas heater and water tank instead.—H.W.



nus 10°. Since optimum tilt for my site is 45°, I could have installed my plates flat on the 42°-sloped roof. But I added short legs at the top to get a 45° tilt angle.

For more information on the Conservationist System, write to Bob Jones, A.O. Smith Corp., Box 28, Kankakee, Ill. 60901. **PM**



Impressive array of gauges (more than maker calls for, in fact) provide these readings: **A**, Pressure/temperature of preheated water to water heater; in closed loop—**B**, pressure/temperature of fluid to collectors; **C**, pressure/temperature, fluid to preheater; **D**, line pressure. **E** senses temperature differential between sensor in preheater and sensor mounted on collector plates and turns on circulator **F** to vary the flow of the solar fluid depending upon the available energy.



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new law calls "renewable energy source expenditures." These include expenditures which the Treasury may later decide uses any other form of renewable energy and which results in an overall energy saving.

This credit amounts to a whopping 30 percent of the first \$2000 and 20 percent of the next \$8000 in qualifying expenditures, adding up to a maximum credit of \$2200. In order to eliminate "undue administrative burdens" there is a \$10 minimum for any taxable year just as with the Residential Energy Credit.

Here too, an individual will be eligible for the maximum credit each time he changes his principal residence. But, again, the original use of any item must commence with the person claiming the tax credit; it must have a life expectancy of at least five years. Should there be any regulations in effect in the future, the installation must naturally meet them to qualify at that time.

The credit applies to expenditures made on or after Apr. 20, 1977, and before Jan. 1, 1986. Carryovers of credits that exceed your tax bill may extend this final date two years until Jan. 1, 1988.

In order to qualify for this credit, installations of renewable energy source equipment must be in connection with an individual's principal residence in the United States, Guam or the U.S. Virgin Islands. The credit is available for existing and newly constructed or reconstructed dwellings and owners and renters are eligible. An individual who owns stock in a cooperative housing association or is a member of a condominium management association will also be eligible.

Equipment that qualifies

The credit for solar energy property applies to solar equipment, both passive and active, which when installed in connection with a dwelling, uses solar energy to heat or cool the dwelling or to provide hot water.

The credit for wind energy property applies to wind equipment, i.e., windmill, which when installed uses wind energy to produce energy (in any form) for personal residential purposes.

The credit for geothermal energy property applies to geothermal equipment using geothermal energy to heat or cool a building or to provide hot water. This must be equipment necessary to distribute or use geothermal steam or other geothermal resources.

Renewable energy source property does not include conventional heating/cooling systems which serve to supplement renewable energy source equipment. While you can claim credit for expenditures made as far back as Apr. 20, 1977, remember that the law will expire Jan. 1, 1986. Now is the time to add up qualifying expenditures and plan future purchases so you'll save taxes while saving energy.

PM

Andersen Energy Facts



The role of windows and gliding doors in energy conservation.

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Window and gliding door energy facts from Andersen.

This 16-page, easy-to-understand booklet explains how to window plan for energy savings, and how windows can actually help heat your home and reduce annual energy bills. A special section also answers the most-asked questions on windows and energy.

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Build a live-in solar collector

This versatile solar add-on triples as greenhouse, family room or dining area—and lets you bathe in a hot tub or bask in a sauna.



HOME ENERGY GUIDE

by Joseph R. Provey
ASSISTANT HOME AND SHOP EDITOR

Most of us who would like a bigger house have to face the fact that along with construction costs, the expense of heating an additional room year after year must also be considered. The ideal addition would be self-sufficient in terms of energy—or at least nearly so. It would also be versatile enough to serve several family needs. Finally, it would be reasonable in cost to build. If the homeowner could save by doing most of the work himself, so much the better.

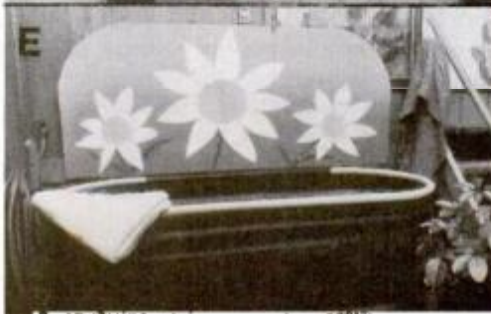
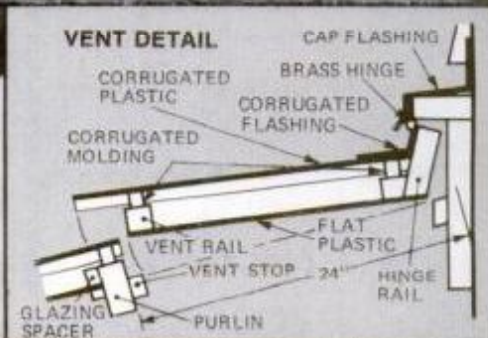
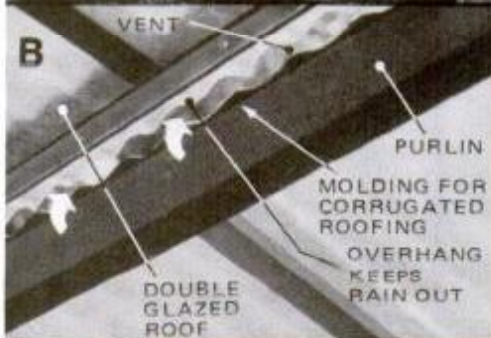
The Solar Amenities Module, which we recently visited, meets these requirements—and then some. It was primarily designed as a solar greenhouse, where much of the sun's energy (which penetrates the double-glazed ceilings and walls) is stored in black-painted tanks of water.

Other features, however, make this solar add-on much more exciting than a simple greenhouse. A kit-built sauna room with a wood-burning sauna stove, plus a hot tub, lets you choose between bathing wet or dry.

The sauna and hot tub are not just frivolous luxuries, either. Excess heat from the special, heat-retaining sauna stove supplements the solar greenhouse. Even the hot tub does double duty, since it also serves as a heat bank. Note that the tub is—or once was—a watering trough, bought through the Sears farm catalog for \$60 and painted black. Plywood and a piano hinge make the lid, while pipe insulation cushions the tub rim. Inside the tub are built-in redwood seats.

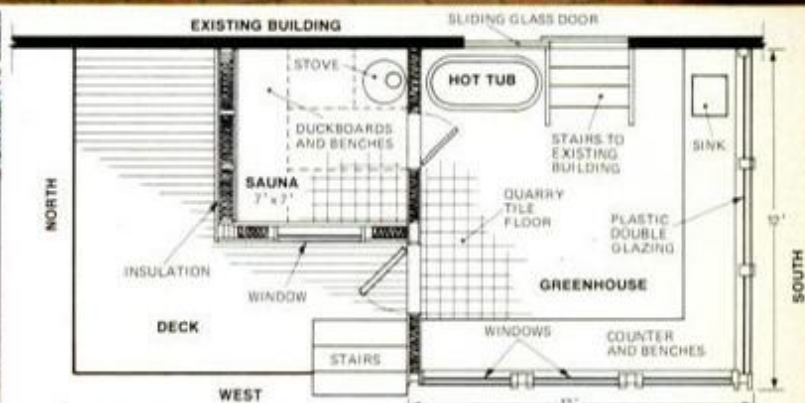
Heat from the wood-burning sauna stove can be used to boost the tub temperature, by thermosyphoning water between a copper coil wrapped around the flue and the tub. A good reference for constructing such a system is: *Hand-made Hotwater Systems*, \$4.95 from Garcia Press, Box 527, Point Arena, Calif. 95468.

Clarke Davis, owner and builder of the module, has a knack of making objects serve purposes other than what they were intended for. Colorful hooks sold to hang bicycles on walls work well as plant hangers in the greenhouse. Heavy-duty dishpans sold by restaurant suppliers make great flats for starting vegetables, once the bottoms are partially filled with stones for drainage. The dark-colored pans absorb a significant amount of the



A Double-glazed roof, windows on solar greenhouse help to retain the heat.
B Roof vents permit excess heat to escape on warm days (also see drawing).
C Water-filled tubes are heat bank.
D Excess heat from wood-burning sauna stove supplements solar heat gain.
E Cattle trough is additional heat bank. It also functions as a hot tub.

PM photos: Carl Weese
Stylist: Betina Weese
Solar Amenities Module design: Clarke Davis



South-facing add-on (left and top) lets in sun, as well as a lush view of the surrounding New Hampshire countryside. Edibles grow in flats on counters. Compact floor plan (above) squeezes a lot of space for family fun from 288 sq. ft.

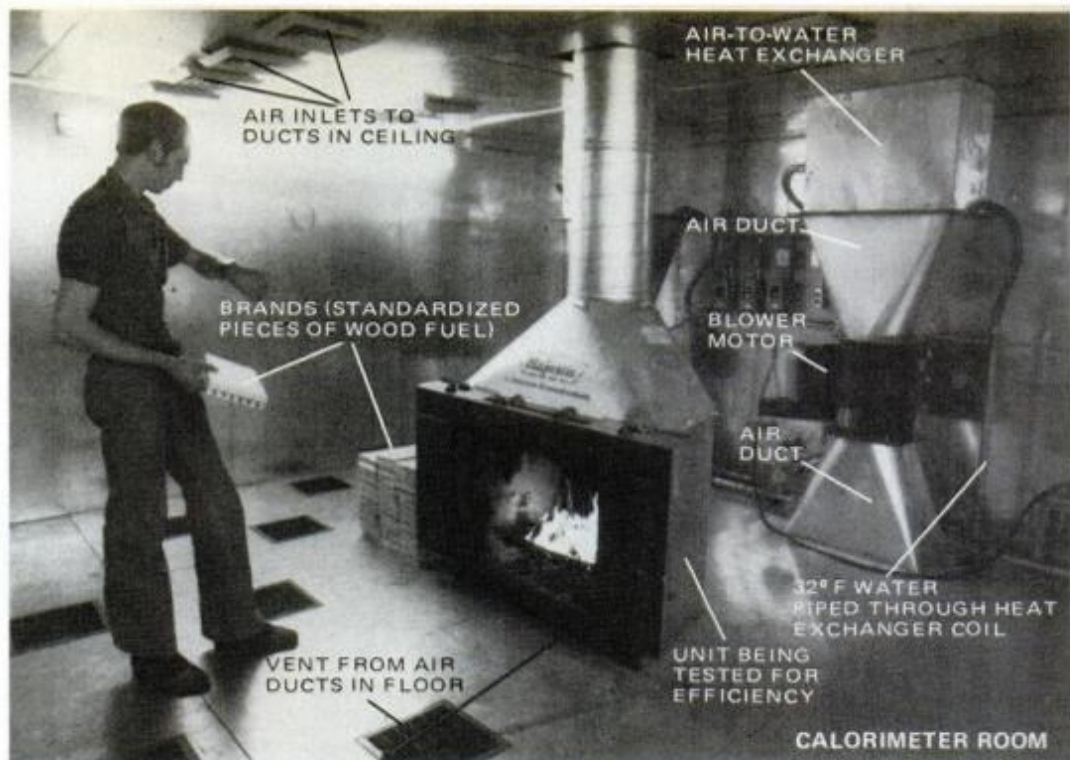
sun's heat, making soil-heating cables unnecessary in most areas. The quarry tile chosen for the floor is not only a sensible choice for a room that works overtime, but is also the best choice for absorbing and storing heat.

The module itself serves several purposes. In its role as greenhouse, it provides the perfect climate for starting seedlings and/or raising them to maturity.

When it's time to harvest the produce, knockdown furniture transforms the space into an elegant dining area. There's nothing like eating breakfast in natural, glowing light, filtered through many green, growing things. When the meal is over, the space can be turned over to the kids. Seth Davis enjoys playing in his portable sandbox—even when the weather may be uncooperative.

As far as costs go, builder Davis says that today it would cost a do-it-yourselfer \$7500 complete, including the sauna and stove. He reports he spent about 30 to 35 working days building the module and deck—and he did it on his own. A complete 16-page set of plans for the module costs \$7.50 and includes a materials list and cost estimate breakdown. Write Solar Sauna, Box 466, Hollis, N.H. 03049. **PM**

New fireplace test lab lets you compare before you buy



Unit being tested is fueled at programmed intervals. Heated air is circulated through ducts to heat exchanger. Temperature changes in exchanger water reveal relative heat output.

Fireplaces and wood-burning stoves are selling at record-breaking levels. Tubular grates, draft inducers and blowers are also being offered to the public. Some are good, but unfortunately, some are gimmicks offered by hastily formed firms hoping to profit from the energy crisis.

The Fireplace Institute, an international association of reputable manufacturers, distributors and dealers, hopes to establish a set of efficiency standards and make the test results available to consumers.

In 1978, the institute awarded a contract to Auburn University in Auburn, Ala., to build and operate a testing laboratory to fill this need.

What program means

Manufacturers will have their products tested on a voluntary basis at the test center. Units tested will be permitted to carry labels with certified output-to-input efficiency ratings similar to those displayed on airconditioners. The tests do not recommend the safety, materials or workmanship of any particular unit. Labs like Underwriters test and certify wood burners for safety. The labels will help consumers determine the amount of wood required to meet B.T.U. demand for one or more rooms by the unit being considered for purchase.

Efficiency percentages are arrived at by dividing the useful energy output (heat into the room) by the wood energy input (quantity of wood burned). Basically, this means the amount of heat produced (B.T.U.) per hour against the pounds of wood consumed per hour. The higher the

efficiency rating, or the less wood consumed per hour, the better the buy you have made.

All testing of comparable equipment will be done under identical conditions and be conducted by impartial experts at the university. The only catch is that since the program is voluntary, not all units will be tested and the facility only tests about 100 units a year. Even if a unit is tested, its manufacturer is not obligated to display the results—and he probably won't if they are potentially damaging to his sales. Hopefully, consumers will reward those manufacturers who are forthright enough to tell the truth about their fireplaces and stoves by buying only certified units.

"Fireplaces" in this text are the factory-built, zero-clearance types which, if properly engineered, operate with higher efficiency than the masonry types. Zero clearance refers to the insulating quality built into the unit which allows it to come in contact safely with wood framing members and walls.

Aside from prefabricated fireplaces and wood stoves, the Fireplace Institute's efficiency rating program will put the multitude of helper accessories to the test. They include such items as glass or fiberglass firescreens, air-circulating grates (with and without blowers) and all sorts of heat exchangers.

PM visits Auburn facility

The best way to describe the Auburn Wood Burning Testing Facility to engineers and do-it-yourselfers is to say that it is beautiful. The building is crammed with gauges, tubing, color-coded pipes, mini-

computers and wiring. The stoves and fireplaces to be tested are housed in the middle of the building. The pride and joy of the lab, however, is a 16 x 20 x 7½-foot calorimeter room.

How units are tested

The engineers at Auburn, in consultation with the Fireplace Institute engineering committee, designed this double walled, many-plenumed room for specifically testing fireplaces. During each test, measured quantities of dried wood (brands) are fed into the firebox at specified intervals. Air heated by the woodburner is circulated through floor and ceiling ducts to pass through three heat exchanger coils, in which water at 32° F. is circulated. The temperature is monitored at various times during its cycle through the coils, which in turn reveals the heat output in degrees.

The operation is far more complicated than it appears and many factors (such as heat from lamps and people) that may affect the readings are fed into the computer for analysis. The facility also has the capability to conduct tests on units for quantities and types of combustion gases, as well as for amounts of creosote collected.

The Fireplace Institute hopes to have the standardization and rating of equipment underway for this heating season. If your local woodburning equipment supplier is not a member of the Institute, you might want to write to it directly in order to obtain information about specific units. The address is: Fireplace Institute, 111 East Wacker Drive, Chicago, Ill. 60601.—*John Gaynor*



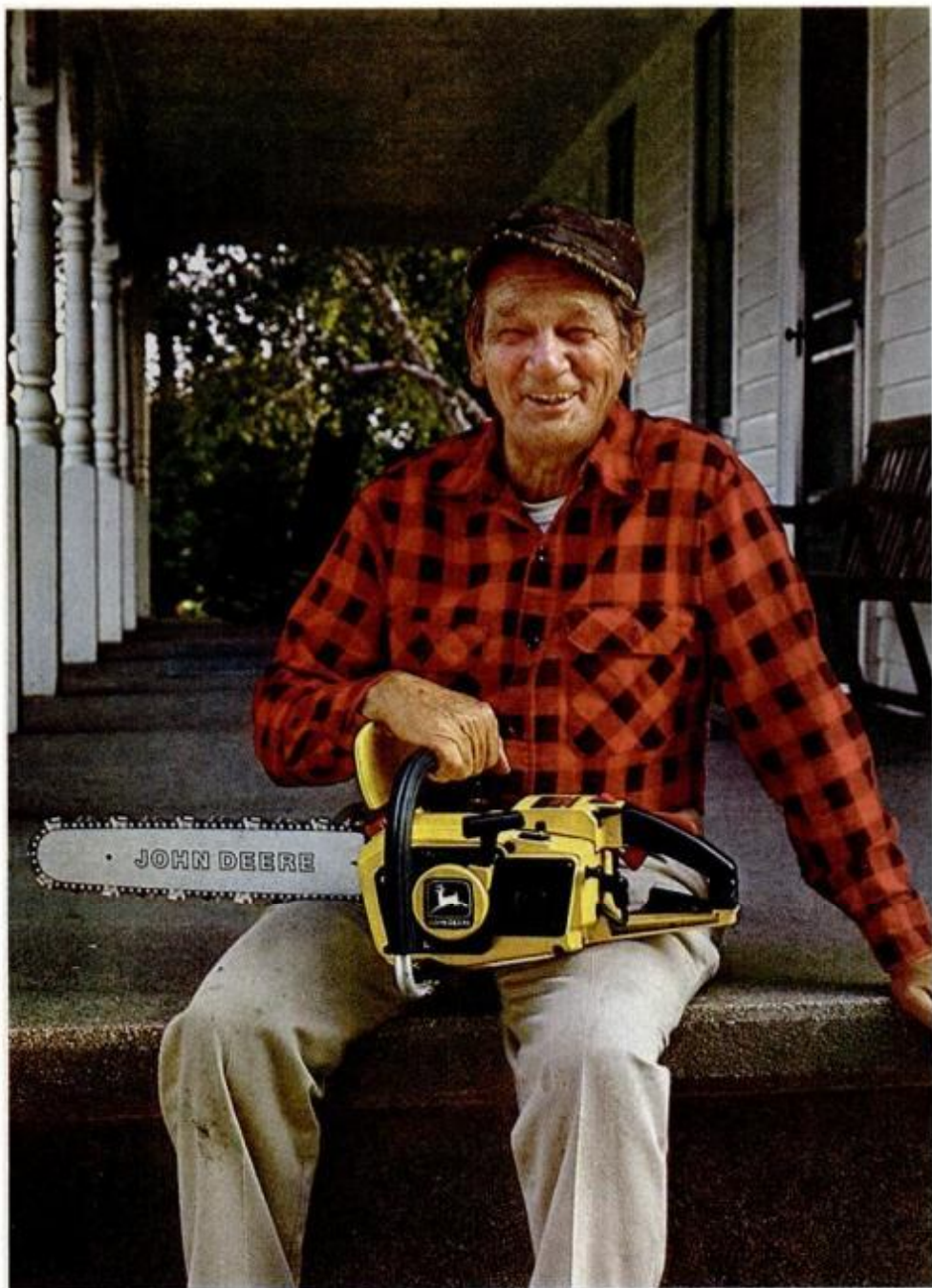
The roof on this house is made of a new kind of non-wood shingle. The edges are thick and irregular, so they cast deep random shadows. The color is soft and muted, so it blends naturally with the architecture and the surroundings.

Today's asphalt roofing shingles are among the finest products made in America. Some are made with a fiberglass base. All are handsome, durable, economical, and highly fire-resistant. And you have a wide spectrum to choose from, in a palette of colors to complement your home's exterior. Wherever you live in the West, today's roofing shingles fit in with any setting or architectural idea. Use them when building or remodeling.

Asphalt Roofing Manufacturers Association

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23 new energy-saving products



Program this Fuel Saver clock thermostat to lower heat at night and turn it on in the morning before the family awakens. The multiple-setting feature warms the home at selected times. It can be programmed for two or three temperature step-up and set-back cycles in a 24-hour period. Under \$60. Honeywell Consumer Products, Honeywell Plaza, Minneapolis, Minn. 55408.



With Energy Minder control system, you can team a heat pump with a furnace using natural gas, fuel oil or LP gas. It turns on the most economical unit, depending on temperature. This eliminates more costly electric heating element that usually backs up a split heat pump. Use Energy Minder with Bryant, Day & Night and Payne split-system heat pumps. BDP Co., 7310 West Morris St., Indianapolis, Ind. 46231.



Extend a central heating and cooling system to a room addition, basement or garage with Extend-A-Duct kit. Kit has all materials to extend existing hot-air or air-conditioning systems by up to 12 feet, including a register. About \$40. Deflecto-O Corp., Box 50057, Indianapolis, Ind. 46250.

(Please turn to page 144)

Harvey's still out back finishing his half of the sawing. Ha.

Harvey puts up with all kinds of aggravation from that chain saw of his. I wouldn't. When my mule kept acting up, I sold him. Bought a John Deere Tractor the same day.

Now that tractor never kicked or got feisty, so when it came time for me to get a chain saw, I went straight for a John Deere.

It was worth the money. It'll cut pretty near anything, and it never snags up or bogs down like Harvey's. Runs smooth as silk, too.

Truth is, I've gotten to where I feel like cutting a pile of wood is pretty near pleasurable. And I might even get myself a John Deere Log Splitter.

But no matter how much fun cutting is, I still prefer sitting.

Specially when I can hear old Harvey out there working up such a sweat.



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Money-saving furnace replacement

by Donald W. Boyd

Many homes built in the last 15 to 25 years are heated by gas-fired, forced-air furnaces. Due to recent improvements in furnace design, most of these older furnaces are obsolete. New parts don't fit the old furnaces and only minor repairs on old units are possible. These factors, combined with anxiety over continued gas availability, are causing homeowners to consider other types of heating systems.

However, the cost of changeover to another system of heating involves a major financial decision. Ductwork in a present forced-air system is rendered useless and a new delivery system must be installed when changing to hot-water, steam or electrical heating.

The combustion chamber of my gas-fired, forced-air furnace developed cracks in the welded construction. Currents from the air blower were entering the combustion chamber through these cracks and interfering with the operation of the pilot burner and thermocouple. Although the furnace could be operated manually, I rejected the idea because of the potential asphyxiation danger. Neither a replacement combustion chamber nor a similar-model furnace were available to make the repairs. In my case, removing the old furnace would also require removing a nearby hot-water heater. Added to this, winter weather necessitated immediate action.

Several furnace dealers I spoke with suggested replacing the entire furnace unit. This would require either making costly changes in the sheet-metal ductwork and venting system to install a new gas furnace, or scrapping the present system to install electrical heating.

After talking with spokesmen for the public utility which supplies both gas and electricity, I decided to buy another gas furnace. In shopping I noticed that cabinet dimensions of present models were much smaller than those of older models with the same B.T.U. rating. I decided to gut the old unit and insert a new furnace in the old furnace cabinet. This let me use the present duct and venting systems.

It took only two hours to strip the front panel, controls, burner and combustion chamber of the old furnace. The cold- and hot-air delivery systems, including a matched, double squirrel-cage blower with thermostat control and flue vent, were in good shape. So I left them intact. There was enough space to install the

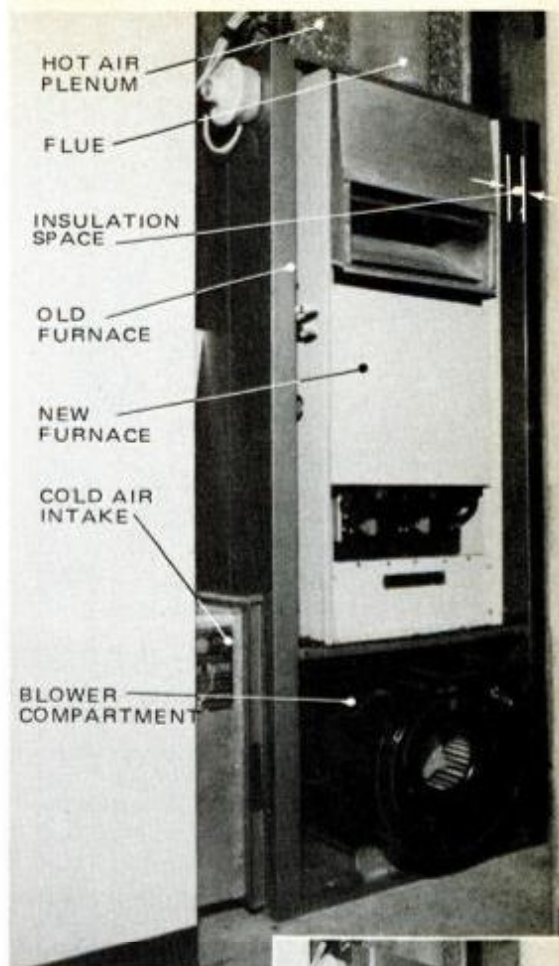
smaller furnace without disrupting the water heater.

I removed the blower and blower compartment from the new furnace. Then I placed the new furnace inside the old furnace cabinet, resting it on top of the old blower compartment so it would receive air from the blower.

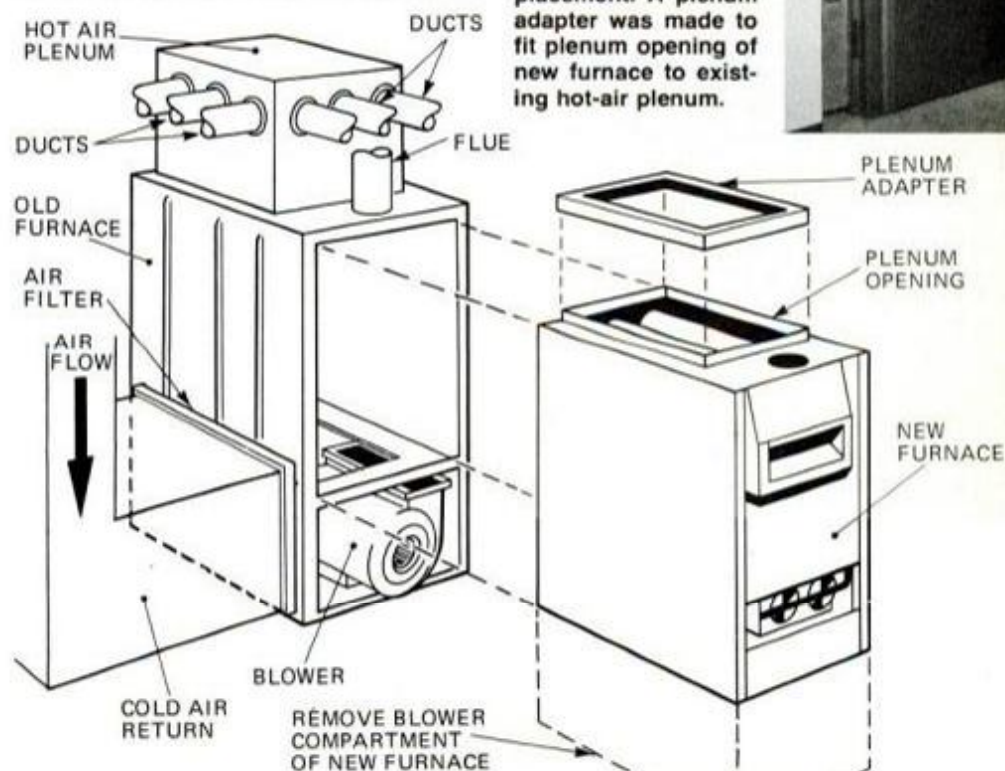
I constructed a frame-shaped adapter to fill the space between the plenum opening of the new furnace and the inside surface of the hot-air plenum of the old furnace (see drawing). Fireproof insulation filled the space between old and new furnace cabinets. Then gas piping and electricity were connected. The installation took a day. The static pressure produced by the blower checked at 0.5 in. of water, the burner air was adjusted to produce soft blue cones, and the B.T.U. input was verified by noting the time to consume one cu. ft. of gas.

An installation option was whether to use the old or new blower motor and compartment. The old furnace motor, a 1/3-hp, double-shaft, 1875-rpm motor, was in good shape. I ordered the new furnace with the least expensive motor (1/8 hp) and removed it. Check your local and state codes before making changes. **PM**

Author Donald W. Boyd is an associate professor in the College of Engineering at Montana State University, Bozeman.



Space between the new furnace and the old furnace cabinet is filled with fireproof insulation (above). At right, the furnace installation is complete and the front panel is in position. An exploded view (below) shows old furnace cabinet with new furnace replacement. A plenum adapter was made to fit plenum opening of new furnace to existing hot-air plenum.





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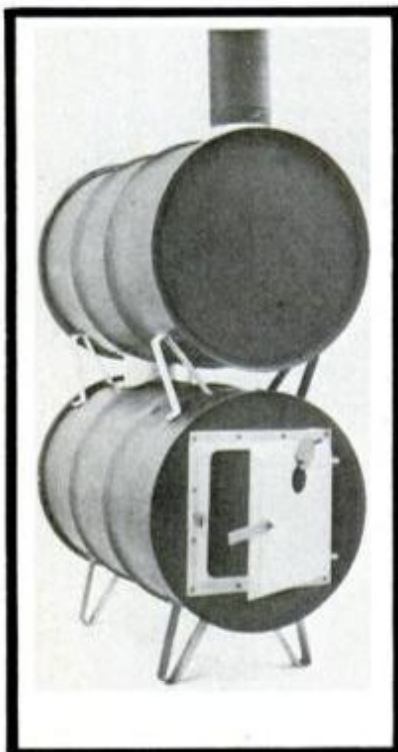


Thematic-Vents are automatic foundation vents which are designed to open and close as needed to conserve heat, and still combat moisture problems. Shutters open and close by a metal coil responding to temperature change. Approximately \$10 from Witten Automatic Vent Co. Inc., Box 2244, Gastonia, N.C. 28052.



Insulated attic door provides attic access, yet maintains an insulation barrier. The steel door has a weather seal gasket and insulation value of R19. It comes in four sizes: 20x24, 20x30, 22x24 and 22x30 inches. About \$20. Leigh Products, Inc., Coopersville, Mich. 49404.

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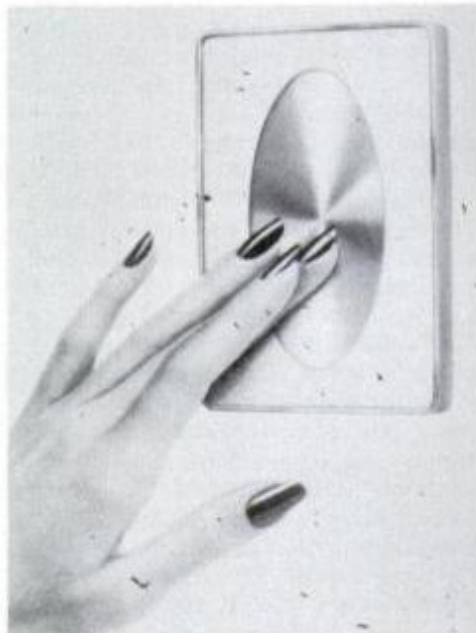
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Touch the metal plate of this light dimmer until light is at desired level, then remove your fingers. Light goes from dim to bright in repeating 2½-second cycles. Leviton Manufacturing Co. Inc., 59-25 Little Neck Pkwy., Little Neck, N.Y. 11362.

(Please turn to page 150)

Energy-saving tips from PM readers



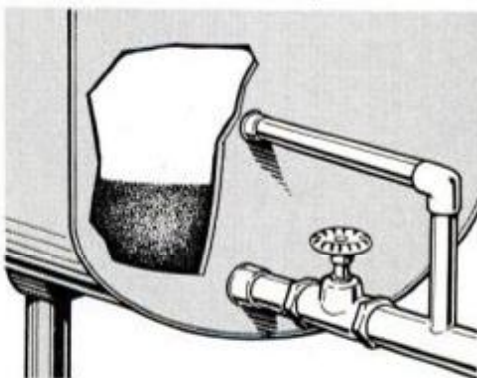
In a nutshell, better fires

Last year during the Christmas season, members of our family shelled a large quantity of black walnuts that we had picked. After sorting out the kernels, the messy problem of disposing of the shells developed. I absent-mindedly tossed several shells into some burning embers in our fireplace. To my amazement a blaze quickly followed. Now we save our nutshells and throw them by handfuls into a lazy fire to pep it up. —R.E. Murray, Circleville, Ohio

Extra oil-supply check

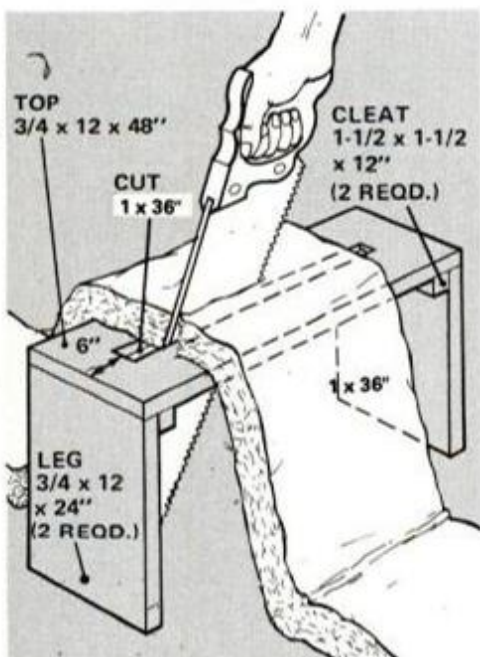
To indicate when heating oil is running low in the tank, I tapped a hole 7 in. above the feed line, added a pipe nipple and ran copper tubing with elbow joint to the feed line beyond the valve. With valve off, furnace warns when oil is low. —Edward Mayover, Sarasota, Fla.

(Editor's note: This is a good way to keep track of oil, but we recommend adding a shutoff valve at A so flow can be halted if leak starts in line.)



Keeping the cold outside

I keep drafts from entering my house by drawing draperies closed at night. I do the same during the day in rooms not getting sun. —Helen LeMunyon, Canton, Ohio



Bench for cutting insulation

While installing fiberglass insulation, I developed this handy bench for cutting the material without coming in contact with the sharp, irritating glass. Use 3/4-in. plywood and assemble the table with glue and 1 1/2-in. No. 8 fh screws. Be sure to wear eye and respiratory protection when you cut the insulation. —John K. Fulton, Broken Arrow, Okla.

Share your home energy-saving ideas. PM will pay \$25 for each publishable idea. Include sketch or photo, if necessary, and a stamped, self-addressed envelope if you want unused material returned. Send to Energy-Saving, Popular Mechanics, 224 West 57th St., New York, N.Y. 10019

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A car battery powers this house

'88 HOME ENERGY GUIDE



Car battery for house's electrical system is recharged by driving 30 minutes daily.

When the utility company told Jim Cullen it would cost \$100,000 to bring electricity to a remote building site, he decided to produce his own. The system he adapted from d.c. components designed for recreational or marine use runs everything from lamps to power tools. Range and refrigerator, however, require him to use a nonelectrical source, such as propane.

The least expensive power source for such a system is a 12-v. car battery. If the demand is not great, a fully charged car battery will last one day. The drawback with this setup is that there is always the possibility of draining the battery to a point where the car won't start. To prevent this, a battery monitor lets you check the charge at a glance. (Note: d.c. power must pass through its own wiring system and not mix with a.c. voltage.)

A more sophisticated version of this system involves the addition of an auxil-

iary 12-v. industrial battery to your car. This is charged by the alternator. When the ignition is turned off, a solenoid closes and allows power to be used from the auxiliary battery without draining the car's battery.

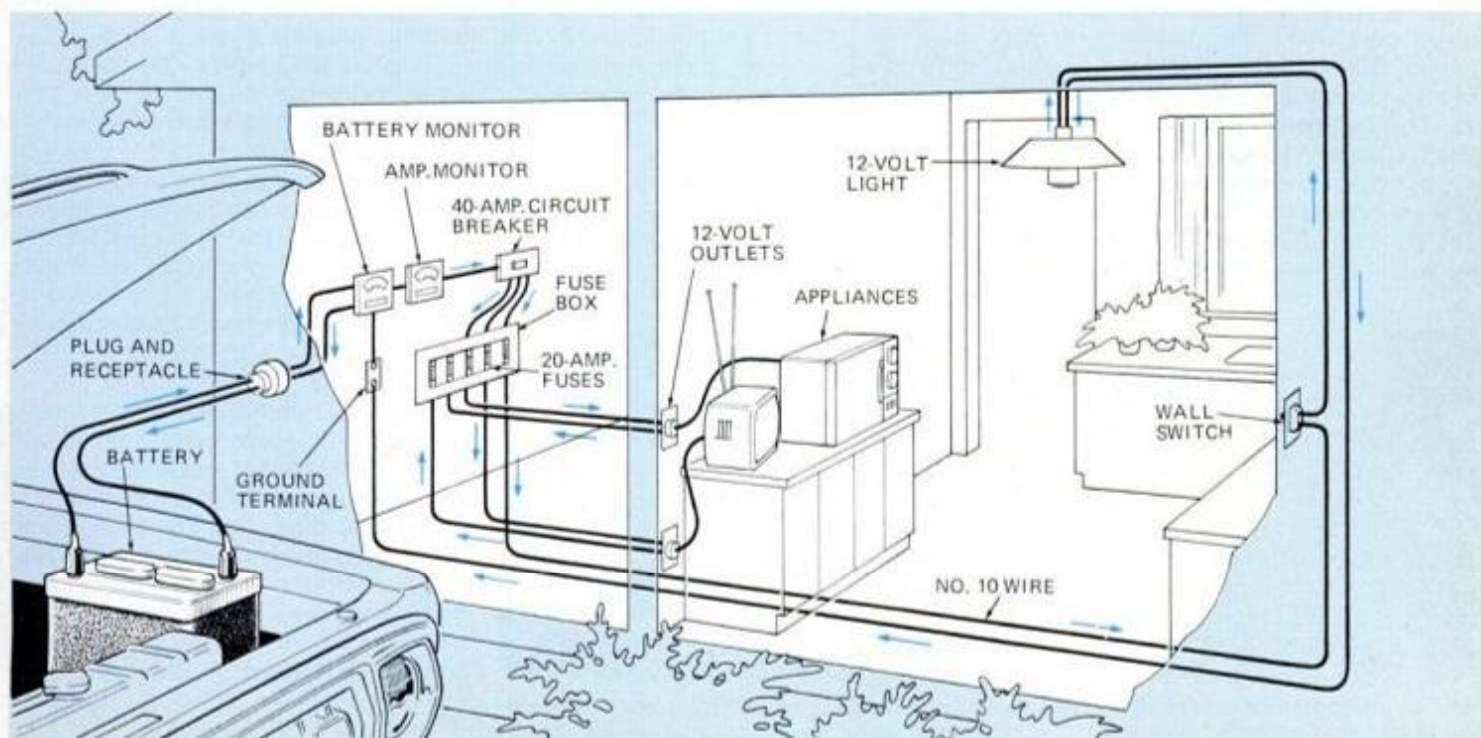
There are still drawbacks. The big one is that there is no power at home while the car is being driven. This is remedied by installing another auxiliary battery in the house. This battery can be charged by your car or by a gasoline-driven generator. Instead of using the generator's a.c. power directly, which would require the unit to run constantly, the a.c. is converted to d.c. by a special transformer.

At this point, the total system would cost about \$2000, plus a few dollars for gassing up the generator every week. It would supply most of your electrical needs, excluding only the major appliances like large refrigerators and airconditioners.

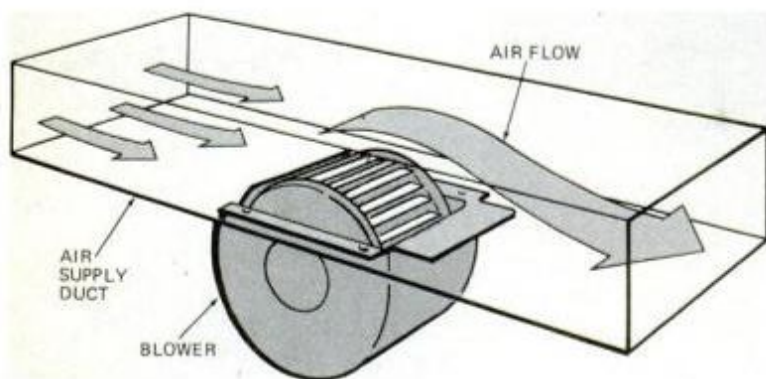


12-v. energy system powers lights, stereo, television in redwood mountain house.

The system's components can be purchased at local marine, RV or auto supply outlets. Wilderness Power Co. makes it easier by marketing the necessary hardware, along with a \$10.95 manual, which explains the system in detail. You can obtain more information by writing to Wilderness Home Power Co. Inc. Box 732, Laytonville, Calif. 95454. **PM**



Add-on blower moves air to the farthest rooms



Air-Booster has a heavy-gauge housing that attaches with sheet-metal screws over a hole you cut in the air duct.

Homeowners with central heated and cooled air systems often find that the room farthest from the system's blower doesn't receive enough heated or cooled air. The air seems to come out of the room register in a trickle. No matter what season it is, the room is never properly heated or cooled.

Solution for airless rooms

The Air-Booster is an add-on blower designed to increase both velocity and volume of air to a room that's in need. Rubber motor mounts make the unit run extremely quietly. When the booster is wired parallel to the central system's blower motor, the Air-Booster operates simultaneously with the central blower. It can also be operated apart from the central system with a thermostat (purchased separately at a heating supply house or dealer), or operated manually on another circuit with an on/off switch whenever you want it. For greatest air movement to the

problem room, the manufacturer recommends that the booster be installed on the duct nearest to the trunk supplying the room. The motor shaft must always be in a horizontal position.

My experience with the booster

I installed the blower to help deliver needed air to my garage workshop. The register in the room is approximately 40 ft. from the blower and the run to it contains five bends and ells. After installation, the room is finally comfortable.

I checked with a mechanical engineer who told me that air to the remaining rooms would be lessened no more than 8 to 10 percent after the addition of the add-on blower. But I don't even notice this.

Installing the unit

The booster can easily be installed by a do-it-yourselfer. It comes with complete instructions. The kit also contains a self-adhering template with outlines for cutting

various-size ducts, either round or rectangular. You cut a hole in the duct, fasten the unit in the opening, and then connect the unit's wiring to a power source. Don't forget to wear safety goggles while boring and sawing the duct.

To begin work, slit and fold back the insulation at the desired location. (I cleaned the duct with solvent for better template adhesion.) Peel off the adhesive backing from the mounting template and attach it to the duct in the desired location—in the center of the duct. Bore holes in increasing diameters to 1/4-in. dia., tangent to the inside of each corner of the opening you plan to cut.

Then cut the opening. Be particularly careful not to cut the opening too large. A hacksaw blade in a sabre saw makes a clean and neat cut.

Next, I slipped a piece of polystyrene (Styrofoam) between the motor and the blower housing. Then I insulated the remaining part of the housing, leaving the motor exposed. Finally, I connected the wiring according to the kit's diagrams.

Maintaining the unit

The manufacturer recommends oiling the motor once every six months with SAE 20 oil for normal operation and every two months for continuous operation. Although not convenient, I oil mine with an eye dropper and a small mirror. The benefit of a properly conditioned room more than offsets the inconvenience.

Cost of the Air-Booster is about \$45; extra wiring is about \$4. Steinen of Carolina, Inc., Airport Rd., Kinston, N.C. 28501 makes it.—John E. Gaylor



Self-adhesive template in the kit serves as a guide for cutting a hole in the duct.

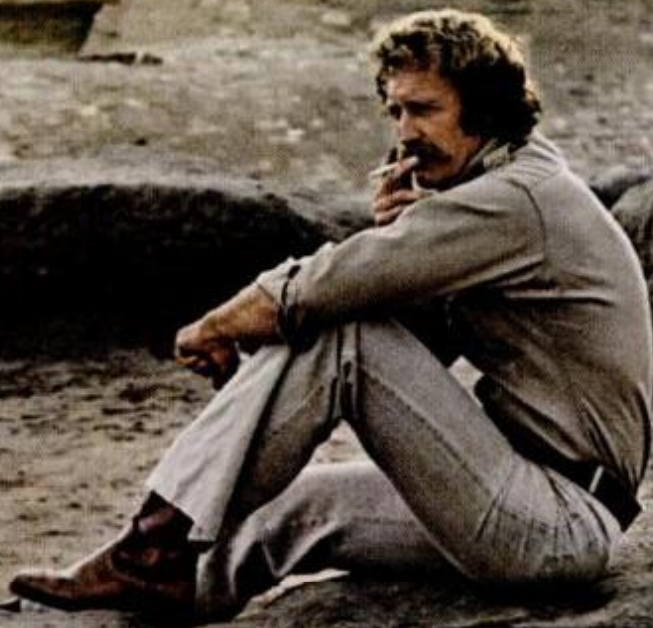


Unit's motor runs at 1550 rpm; it mounts out of the airstream to lengthen its life.

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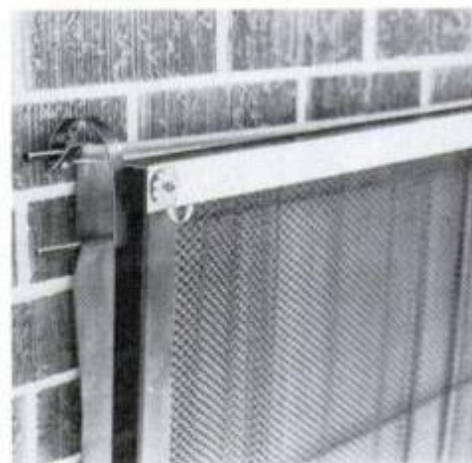
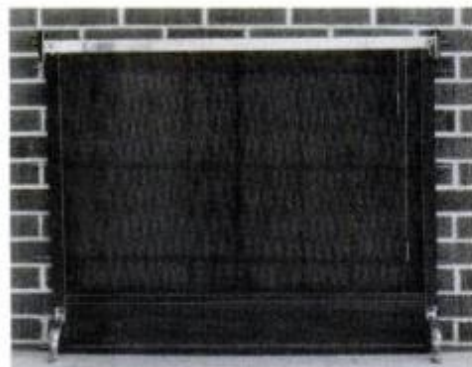
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Heat Saver fireplace curtains prevent household heat loss caused by chimney updrafts, according to the manufacturer. Made of 100-percent flame-resistant fiberglass (asbestos-free), the curtain can be trimmed with scissors so that it fits fireplace screens up to 33x43 inches. The curtain is black with brass fittings and is available for \$18. It is manufactured by New England Hardwood Firewood Corp. Inc., Little City Rd., Higganum, Conn. 06441.



The maker claims this flameproof fireplace curtain controls updrafts, smoking and heat loss through the chimney. Made of fiberglass and Teflon, it hangs from a rod cradled in brackets that are installed directly on the firescreen, or attached to the fireplace. About \$18, it covers openings up to 30x36 inches, catches popping sparks. From Firemaster, 2887 Losantiville Rd., Cincinnati, Ohio 45213.

(Please turn to page 152)

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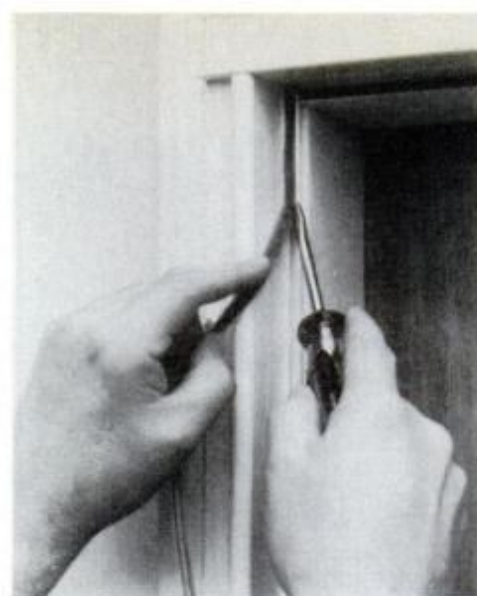
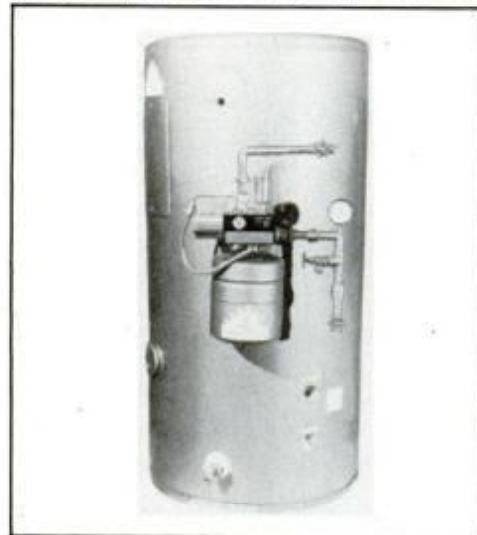
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Prewired, prepiped solar hot water unit (below) hangs from hot water tank or wall. An 80-gallon system (\$1700) serves family of four. Revere Solar and Architectural Products Inc., Box 151, Rome, N.Y. 13440.



Stop heat loss at storm doors by substituting for worn and weathered seals with Stanley's replacement seal. It is pressed into place after removing the old seal. One 30-foot roll is \$7. The Stanley Works, 195 Lake St., New Britain, Conn. 06050.

Electronic ignition eliminates fuel-wasting pilot lights in the Dyna-Vent through-the-wall gas furnace (left). Unit can be wall- or window-mounted. Decorative grille fits into any decor. Suburban Manufacturing Co., Box 399, Dayton, Tenn. 37321.

(Please turn to page 154)



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"The No. 1 priority I have established is to provide home heating oil in adequate supplies for New England this coming winter. We consider this to be a goal that must be achieved."

By Republics
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Oil reserves in doubt

Heatless homes predicted this winter

WASHINGTON (AP) — People living in Northeastern states may be forced to flee to public shelters to keep warm this winter if there is a shortage of home heating oil, says a memo released by James R. Moffett, D-Texas.

Tuesday. But in this case, they may have to go to them to get help, Moffett said.

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information

Schlesinger gave to press

adviser Jack Watson on June 1

The unsigned memo is based

May meeting between federal

officials and representatives of

the nation's major refineries.

The memo says the re-

projected some 230 million bar-

rels of heating oil and diesel fuel to

be stockpiled by October. But they

may be difficult to come up with

the reserve.

If current market trends con-

tinued, the memo said, stocks will be

down to 194 million barrels by October.

That is 86.5 percent of last year's level,

down from 83 percent of the 230 million

barrel estimate.

The 230-million barrel estimate

is 20 million barrels less than the an-

estimated amount that President Carter

has called for to ensure that supplies do

not run out during the heating season.

The memo also said that manda-

tory actions should be considered by Jus-

tice if there is not a sharp increase in

imports and mounting set-aside

of heating oil and diesel fuel.

A possible action mentioned by

the memo is allocating crude oil

refineries ready to use it and as-

signing those not operating at

capacity.

Moffett, however, told reporters

that the memo was based on his interpretation of

Heating Oil May Increase to 80¢, And Supply Could Be Inadequate

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WASHINGTON, June 19 — Consumers will pay far more for heating oil this winter, but supplies may still run short, according to experts in the oil industry. The price will be more than 80¢ a gallon, they said, but how much will depend on whether world oil prices continue to rise and how much oil is available. The average price of heating oil last winter was 48.5¢ a gallon, now it is about 72¢ a gallon. Experts estimate that



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Please send me full facts about Kero-Sun portable heaters and the name of my nearest dealer.

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Series 7700 sliding glass replacement doors from Continental Aluminum Products, Box 596, McHenry, Ill. 60050, consist of 7/8-inch insulated glass in aluminum frames. Available in bronze or white baked-on acrylic finish, double-glazed doors for existing 6- and 8-foot openings. Retail for \$563 and \$683 respectively.



Clear-Tite is a tough, clear polyethylene tape with acrylic adhesive that seals drafty windows. An alternative to rope-type caulk, Clear-Tite is available in rolls 1 inch wide by 36 feet long for \$2.98. Each roll will seal eight average windows. Clear-Tite is manufactured by Manco Tape Inc., Box 685, Cleveland, Ohio 44107.



Multi-layered Window Quilt is a thermal window shade that stops heat leaks through glass. Its maker claims heating bills are cut by as much as 50 percent. It consists of polyester and aluminized plastic film, with special airtight stitches. Fits tightly against windows. \$2.96 per square foot, with hardware. Appropriate Technology Corp., Brattleboro, Vt. 05301.

(Please turn to page 162)



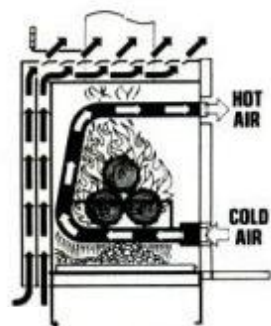
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*Actual savings may vary depending upon climate, location of home and windows, and window condition and quality.

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**Look For
Popular
Mechanics
Car Care Section
In The Oct 1979
Issue**

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Burning the barrel at both ends



A PM compendium of random energy lore to kindle your spirits on cold days.

by John H. Ingersoll

In a single day, how much energy does the United States use up? If all the barrels of oil (42 gallons each) we burn in a day were lined up end to end at sunrise beginning in Times Square, New York City, the other end would be in . . . Albuquerque? San Diego? Nope. Calcutta, India! Burned at both ends at our current rate of consumption, all the approximately 20 million barrels of oil along the line would be gone when the sun rose again.



For every two units of energy that go into America's entire energy grid, only one unit of useful work comes out.



Ah, for the age of the flapper and "23-skiddoo"! The 1929 edition of the *Encyclopedia Britannica* makes no mention of "Insulation, thermal." (A few sentences are accorded "Insulation, electrical.") In those days, who worried?



Arf factor: When asked for the best way to cut home energy costs, home-builder R. B. Fitch Jr., of Carrboro, N.C., replied, "How many dogs you got?" For the puzzled questioner, he added that no dogs means an owner won't open the door 25 times a day at the beast's bidding—and let a rush of cold air in (or out).

No furnace, no water heater. Yet a Sherborn, Mass., house has had all the space heat and hot water required for a family of four during 2½ of the worst winters New England has experienced. This is the house of inventor Robert E. Parkin, Ph.D., a man who wouldn't listen to "It-can't-be-done" advice and built a house (for \$50,000 in 1976) that combined massive concrete walls on the north side with a calculated blend of active and passive solar heating. To date, his family is healthy, content and has spent for heating fuel exactly \$0.



Same energy, more light: One 150-watt incandescent bulb puts out 2880 lumens (a measure of light intensity). Two 75-watt incandescent bulbs produce only 2380 lumens.



Less energy, more light: A 40-watt deluxe warm white fluorescent tube generates 2150 lumens. A 100-watt incandescent bulb glows with an intensity of only 1750 lumens. Point of fact: A deluxe warm white tube sheds light in the same color range as an incandescent bulb.



During the early 19th century, Nantucket whalers insulated their houses from cold Atlantic winds by stuffing into wall cavities such things as dried seaweed, horsehair and corncobs.



In Sweden, during the waning years of World War II, some 70,000 trucks, buses and autos, 15,000 farm tractors and thousands of motorboats burned wood as a fuel. A severe shortage of gasoline brought about the switch. The means was a stainless-steel cylindrical tank 1 foot in diameter and 4 feet deep in which matchbox-size blocks of wood were burned with a tightly controlled mix of air. Nearly 90 percent of the wood was converted to usable fuel (wood gas, mostly carbon monoxide). A series of filters purified the gas before it entered the carburetor. Since wood gas contains 25 percent fewer B.T.U. than gasoline, the engine compression ratio was boosted to account for the difference.

(Please turn to page 158)

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fire ...
the easy way, with
PM's Log Splitter!**

What could be more pleasant on a cold, cold day than the warmth of a roaring fire. And, you can have all the firewood you need and save time and money by splitting that firewood yourself. POPULAR MECHANICS LOG SPLITTER exerts some 10,000 lbs. of pressure and will easily split 2 ft. lengths of maple and ash logs 12 to 14 inches in diameter. With an I-beam backbone, double-acting hydraulic cylinder, control valve oil filter, 3-hp. gasoline engine and other features, you'll find this log splitter easy to build and a fun thing to use. And, you'll save your back from aching as you split logs the easy way.

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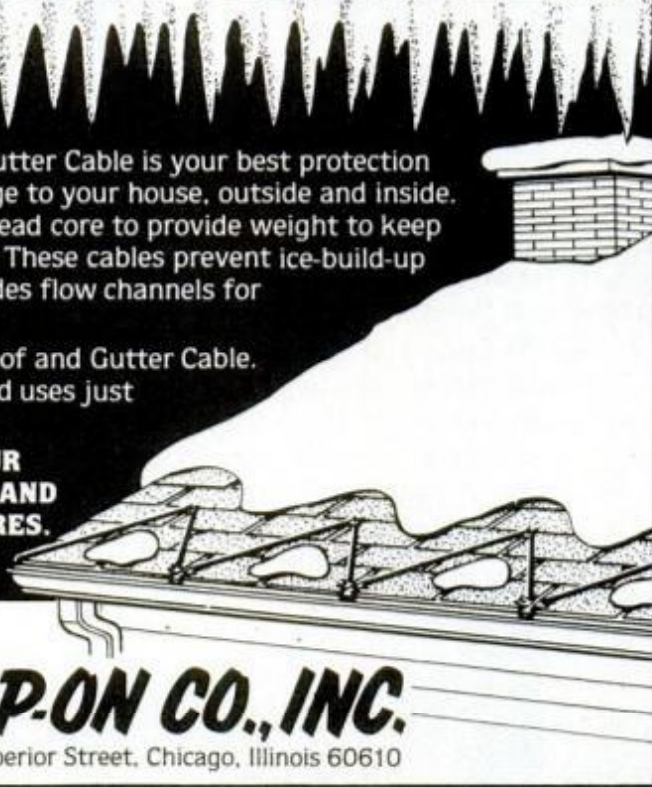
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**GET IT NOW AT YOUR
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BURNING THE BARREL

(Continued from page 156)



In a report to the American Assn. for the Advancement of Science in December 1971, Drs. John Bandwell and Tivi Meidav, consultants to the United Nations, estimated that geothermal energy in the upper 24,600 feet of the Earth's crust is equivalent to 21 million tons of oil per square kilometer of the Earth's surface. Geothermal energy is being tapped today in the United States, New Zealand, Japan, Italy, Iceland, Mexico and the Soviet Union.



You've heard about R-values, a measure of resistance to heat flow through materials? Just for the record—and be sure to take this down—eel grass rates an R-per-inch of 3.7, slightly better than sponge clippings (natural sponge) at R-34. Then there's flax shive at R-3.3 or jute at R-4.0 and coir fiber (coconut husk) at R-3.1. Sea-water at R-0.25 beats fresh water at R-0.24. But ice wins the prize for passing heat at R-0.06. For an R-38 performance around your igloo, just install 53 feet of ice.



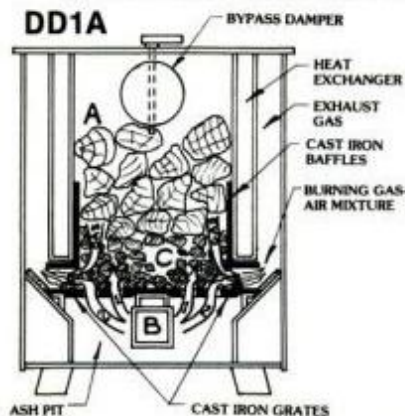
About 2500 years ago, Greek and Roman builders, knowing their main source of energy—wood—was in short supply, designed "solar" houses. They oriented the structures and designed overhangs on the south sides to take advantage of winter sun and block summer sun. Sound familiar?



A Minneapolis man waited an hour in a car line for gas. Finally, he was No. 5 in line. In dozing off momentarily, he allowed a space to open between his car and a pickup in the No. 4 spot. A passing lady deftly swung her car in front of him. His ears were smoking. He white-knuckled the wheel and held on to his composure. Then he muttered "Ha!" He got out of his car, removed his key-locked gas-tank cap, casually moved behind the lady's car, removed her cap, replaced it with his own, locked it, pocketed the key and drove off.

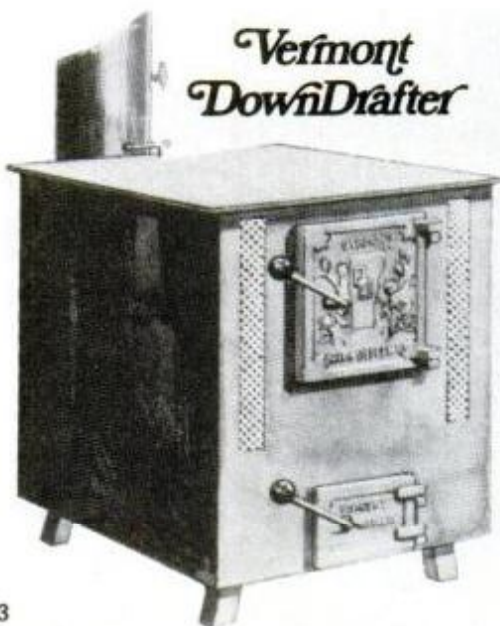
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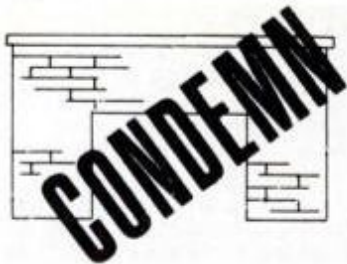
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156 Let the Sun Shine In

Bring more light into your home with a skylight. To do this Ventarama would like you to have two booklets giving ideas for every area of your home—the bedroom, bathroom, kitchen, livingroom and even the pool area. Included are complete details and specifications. Free.

157 Heating Efficiently

Here are full-color brochures on high output, high efficiency wood and coal burning fireplaces, furnace inserts and free-standing fireplace/stove. Includes complete field-test data and sizing instructions. Free from Thermograte.

158 Living with Elegance

Kohler offers a 40-page color brochure of bath and kitchen ideas for your home. Whirlpool baths, showers and tubs, environmental enclosures, lavatories, sinks, faucets and more. Helpful hints on product selection and decoration. 50¢.

159 All About Wood Heat

Many people are choosing wood heat for a number of reasons, including economy, reliability and warmth. An 8-page brochure from Columbia Products Co. tells you why and gives you information on the performance of their New America Stove. \$1.00

160 Save Energy with Windows

A 16-page booklet from Andersen Corp. explains the role of windows and gliding doors in energy conservation. Covers such topics as how to heat with windows, planning to save fuel in cold and warm climates and how to shop for windows. Free.

161 Fast and Easy Liquid Barrier

Insul-aid, a latex vapor barrier from Glidden, keeps insulation drier, reduces moisture-related exterior paint failures. All the info in a free, concise brochure.

162 For Serious Woodburners

The Vermont Woodstove Co. offers an information kit on the operation and heating advantages of woodstoves. Includes an informative "Buyer's Guide", two 6-page brochures, and details on their DownDrafter. All this for only \$1.00.

163 Fun Furniture Kits That Save Money

Full-color catalog lists all types of furniture kits that you can put together. Made from black walnut, cherry, oak and maple. Some clock kits, too! These fine kits can save you money . . . fun to assemble. From Emperor Clock Co. \$1.00.

164 An Inside Job

The In-Sider Storm Window from Plaskolite fits on the inside of your home and can reduce heat loss through windows by up to 88%! Learn how to install the do-it-yourself storm windows—saves energy and money on fuel bills. A free brochure.

165 Capture Wasted Heat

You can save on heating bills by using heat that normally goes up the chimney. Fireplace heaters and waste heat circulators from Magic Heat capture heat from fireplaces, furnaces and wood, oil or gas stoves and circulate it throughout the home. Free info.

166 You Can Do It with Genie!

Concerned about your family opening the garage door alone at night or just fed up with climbing out of the car to struggle with a heavy garage door? Genie Automatic Garage Door Opener might be the answer. Free literature from Alliance.

167 The Window Way to In-Home Insulation

Brochure tells how to conserve energy through the use of insulated drapery lining, prolong the beauty of your draperies and room furnishings. Free from Rockland Industries.

168 Bird Tells All!

"What You Should Know About Roofing and Siding Before You Build or Remodel" is a beautiful, 32-page booklet with ideas, money-saving consumer advice, and full-color illustrations. 50¢ from Bird & Son, Inc.

169 Stay Warm

Southport Stoves wants you to know that there are alternatives to regular heating systems. Fully-illustrated, color brochure tells the story and gives details on how the Belgian Efel or Danish Morsø can fit into your heating picture. Free.

170 Tools, Tools and More Tools

All 196 pages of the U.S. General Supply Corp. catalog are filled with top-name tools and handyman supplies—6,000 of them! Discounted prices, too. \$1.00 (refundable on first order).

171 Heaters to Meet Your Needs

Whatever your heating needs, Suburban Manufacturing has a solid-fuel heater to keep your home warm. A free brochure describes their wood and coal heaters, as well as a furnace unit that converts oil, gas or electric systems to a wood-burning system.

172 Get Into Inner Space

Not a new way of meditation, Inner Space is the emptiness between the walls of your home. It can be insulated to prevent heat loss, reduce fire hazards, and control noise. Learn about NASA's experience with Tripolymer foam insulation and how it can save fuel bills. Free brochure from C.P. Chemical Co.

173 What Wood Would Be Good?

An illustrated booklet from Stihl, Inc. packed with tips on finding, transporting, seasoning, cutting and burning wood. It's a practical firewood guide. Great info! Only 25¢.

174 Your TV Can Sound Off

Here's information on how to achieve simulated stereo sound from your TV. Brochure from Rhoades National Corp. tells you about their Teledapter and TV audio tuners. Good TV Listening. ⁴⁹ Free.

175 Solving Problems on the Road

A 40-page glove compartment guide tells drivers how to spot trouble while on the road and solve it. Featured are trouble-shooting tips for dozens of common car ailments and proper maintenance practices. Also included are sections on safe driving and fuel saving. 50¢ from Fram.

176 Keeping Heat In and the Weather Out

Insulating is important to control heat loss through walls, floors, and ceilings. Here's a "how to" booklet from Arrow that gives helpful advice on selecting the proper insulation, tools and what to do about weatherstripping and storm windows. 35¢

177 Type Casting

Automark of Texas, Inc. would like you to know about their metal and plastic marking typewriters. Variety of type styles and models, with production speeds ranging from 6,500 to 17,000 characters per hour. Produce ID plates, trophy engravings, tags of all kinds. Free.

178 Chimney Cleaning by Magic

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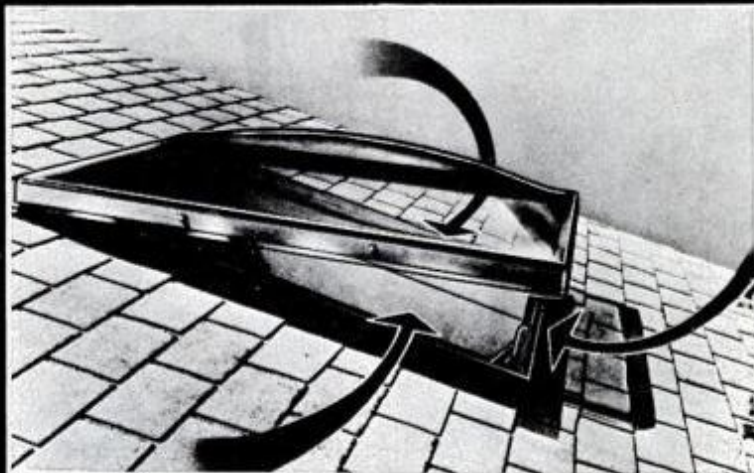
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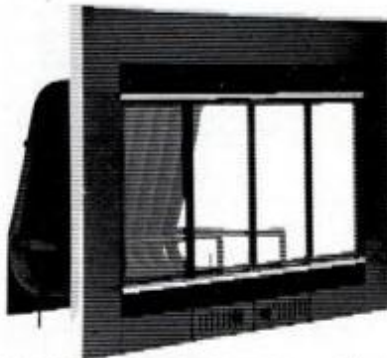
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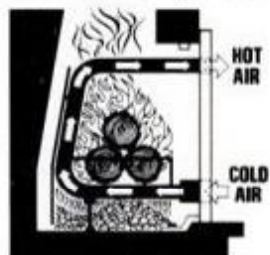
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Battery-operated Heat Sleuth detects cold air leaks that result in heat loss. It senses temperature variations as small as 1° F., according to its maker. A wand included with the \$40 device permits scanning walls, ceilings and hard-to-reach places. From Enertron Corp., 241 Crescent St., Waltham, Mass. 02154.



Condensation and heat loss from plumbing and hot water pipes are prevented with Eslon slip-on pipe insulation (right), claims Sekisui. Pre-slit and easily cut with scissors, it is sold in sizes to fit most standard pipes. Four ¾-inch-diameter x 3-foot lengths cost about \$5. Resistant to damage from paint, grease or detergents, it accommodates almost any angle shape. It withstands temperatures from -110° F to +180° F. Sekisui Products Inc., 1800 West Blancke St., Linden, N.J. 07036.

Reusable sun-control film, Scotchtint (left) is also an insulator for glass doors and windows, according to 3M Co., 135 West 50th St., New York, N.Y. 10020. Solar heat is repelled up to 75 percent. Up to 20 percent of winter heat loss is prevented. It comes in three sizes: 30x48 inches, \$13; 36x78 inches, \$24; and 48x78 inches for \$30. Apply with a squeegee and water. Film is removable for storage and reuse. Available in smoke, silver or bronze.



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Write for free booklet, "The Window Way to In-Home Insulation", Rockland Mills, Brooklandville, Md. 21022.



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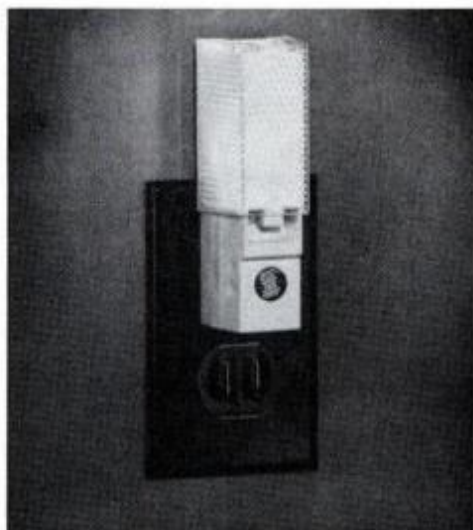
Wind-O-Cove is an all-season window-well cover that insulates and protects basement windows. Rain and debris can't get into your basement and kids won't fall into wells. The Wind-O-Cove is made of rigid, clear plastic, comes in many sizes, costs \$9 to \$35. It attaches to house wall with brackets and has a ventilating air space. BQP Industries Inc., 4747 Ironton St., Denver, Colo. 80239.



Manco self-adhesive Baseboard Seal can be used over wood, tile or carpeted floors to stop drafts and insects. It can reduce home air leakage by 25 percent, according to the maker. A 1½-inch x 10-foot roll in paintable ivory-white sells for \$4.98. Seal conforms to baseboards and shoe molding. Cut to length, peel off protective paper and press in place. Manco Tape Inc., Box 685, Cleveland, Ohio 44107.



The manufacturer of Lifetime Caulk claims that it is the first caulk to be warranted for as long as the user owns his home. It is made from an acrylic-silicone formula and will be replaced free if it cakes, peels or separates. An 11-ounce cartridge sells for approximately \$3. It is available from Red Devil Inc., 2400 Vauxhall Rd., Union, N.J. 07083.



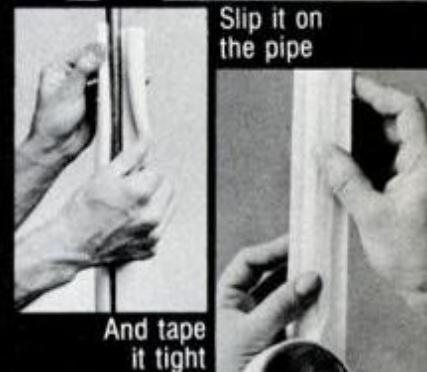
On at dusk, off at dawn, the Sensor-Lite night light automatically provides low-intensity illumination near any 110-volt outlet. Its 7.5-watt bulb, solid-state components and electronic circuitry give long life to the light, according to its maker, Cable Electric Products Inc., Box 6767, Providence, R.I. 02940. It retails in hardware stores for about \$7.

Matching the color of caulk to siding color isn't any problem with Clear Caulk adhesive caulk. It goes on white and dries clear when applied to brick or painted surfaces. It cleans up with water and retails for \$2.75. Available from Rutland Products, Box 340, Curtis Ave., Rutland, Vt. 05701.



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2-level privacy wall

The privacy wall separates the bathtub from the rest of the room and adds attractive architectural detail. The wall is made of plywood covered with cedar boards. You can build it to suit the width of your tub and available depth of space.

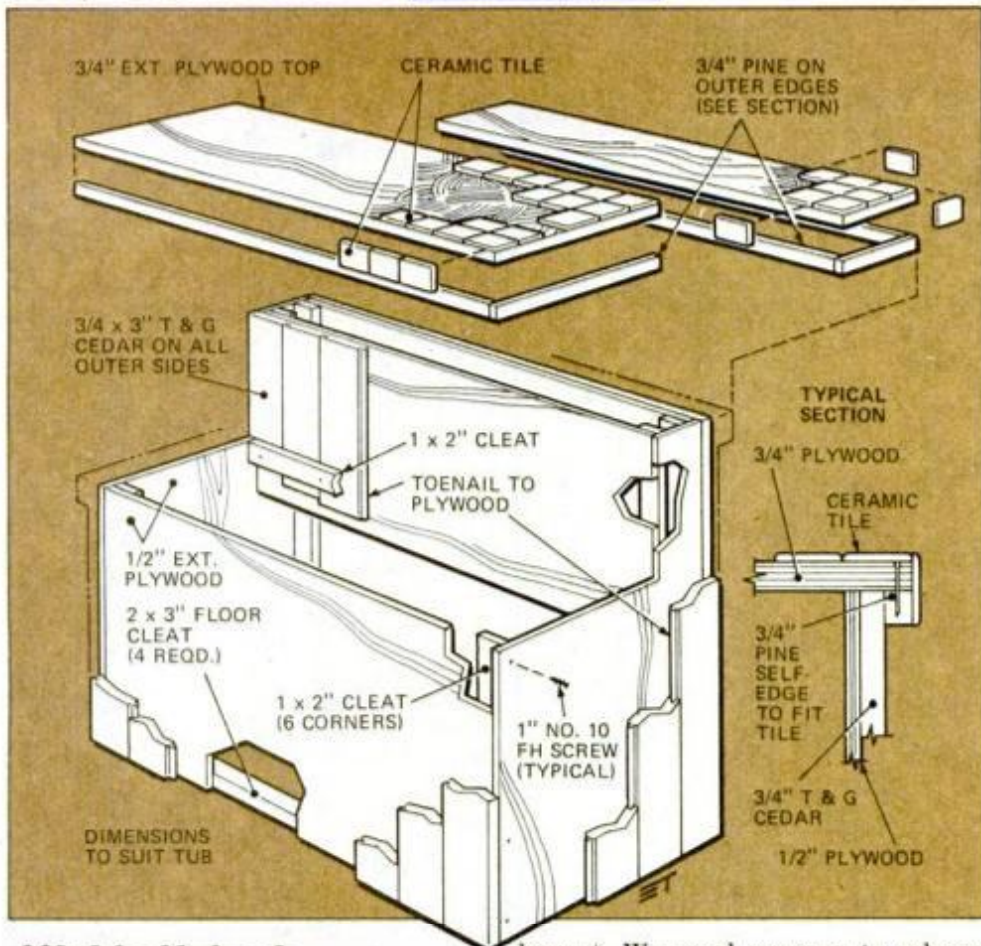
Begin work by cutting and fastening the floor cleats in place. Cut and fasten the vertical 1x2s to the plywood sides with 1-in., No. 10 flathead screws. Then join the sides.

Use resorcinol glue and 1 1/4-in. finishing nails to fasten the cedar to the plywood. With the sides covered, fasten the 1x2 cleat that supports the back edge of the larger top section.

Cut the plywood tops to size. Cut 3/4-in. pine filler strips to form an edging, sized to suit the ceramic tile you plan to use on the tops. Fasten the strips as shown, with resorcinol glue and nails.

Nail the tops to the unit. Then apply ceramic tile, following the manufacturer's instructions.

If desired, you can add a towel bar or ring to the side of the wall that faces the tub.



Mini half-bath

Many home remodelers have transformed a little-used closet or space under a staircase to accommodate the bare necessities of a half-bath. But with a little ingenuity and planning, so much more can be done. You can turn that stripped half-bath into one that has plenty of storage space, extra conveniences and a downright luxurious atmosphere.

We worked this magic on the closet-size half-bath below. The first consideration was to make the most of available space by changing the

layout. We used corners to advantage by angling the vanity in one and placing a triangular toilet in another. We relocated the door, putting it in a long wall to eliminate the narrow, confined feeling of the space. The pocket door slides neatly into the wall, taking no floor space.

Since we tapped unused corner space to locate the lavatory, we were able to fit in a much larger unit. A wide counter surrounding the lavatory with undercounter storage space was an invaluable addition. A trick that takes up zero room space and allows you to add extra accesso-

ries is the use of recessed conveniences. Two medicine cabinets are built into the wall. By recessing the tissue holder, for example, projections into the room are eliminated.

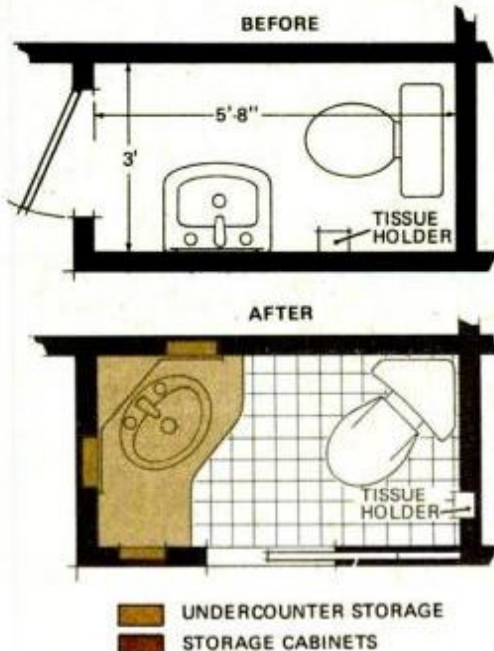
Mirrors make a small area look larger. The effect is even greater when several mirrors are used to reflect each other, as with the three-way mirror above the vanity.

The light colors of the plumbing fixtures, vanity, floor tiles and wall covering, plus decorative lighting, help to further brighten the room and give it an open feeling.

(Please turn to page 166)



Before remodeling, the half-bath had no storage space and only the basic necessities in a squeezed-in layout.



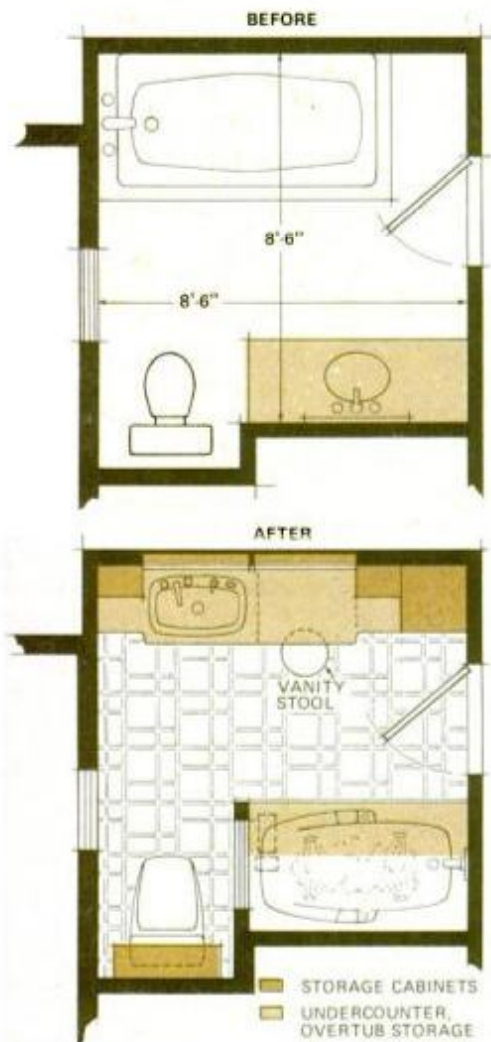
SHOPPING INFORMATION

All materials used in this bathroom are available throughout the United States. For buying information or the nearest dealer, write directly to the manufacturers who are listed below.

Plumbing fixtures, natural colors with Ultima chrome fittings and vanity cabinet, Vanessa style in antique white, Eljer Plumbingware, Wallace Murray Corp., Three Gateway Center, Pittsburgh, Pa. 15222; countertop and three-drawer base cabinet, Country Heritage style, Formco Inc., 7745 School Rd., Cincinnati, Ohio 45242; ceramic tile, Primitive Birch, American Organ Tile, Lansdale, Pa., 19446; wallcovering, Tiger Lily, Crown Wallcovering Corp., 31-17 38th Ave., Long Island City, N.Y. 11101; vent-light, Miami-Carey, 203 Garver Rd., Monroe, Ohio 45050; decorative lighting, mirrored cabinets, Nutone Housing Products, Madison and Red Bank Rds., Cincinnati, Ohio 45227; hardware, Hall Mack, Madison and Red Bank Rds., Cincinnati, Ohio 45227; pocket door hardware, Stanley Hardware, Div. Stanley Works, New Britain, Conn. 06050; Townsend walnut wall planks, Potlatch Corp., Box 916, Stuttgart, Ark. 72160; accessories, Reflections, The Fashion Center, Paramus, N.J. 07652.



"Before" photo reveals a bath that has badly mismatched design elements, including incompatible styles, colors and finishes.

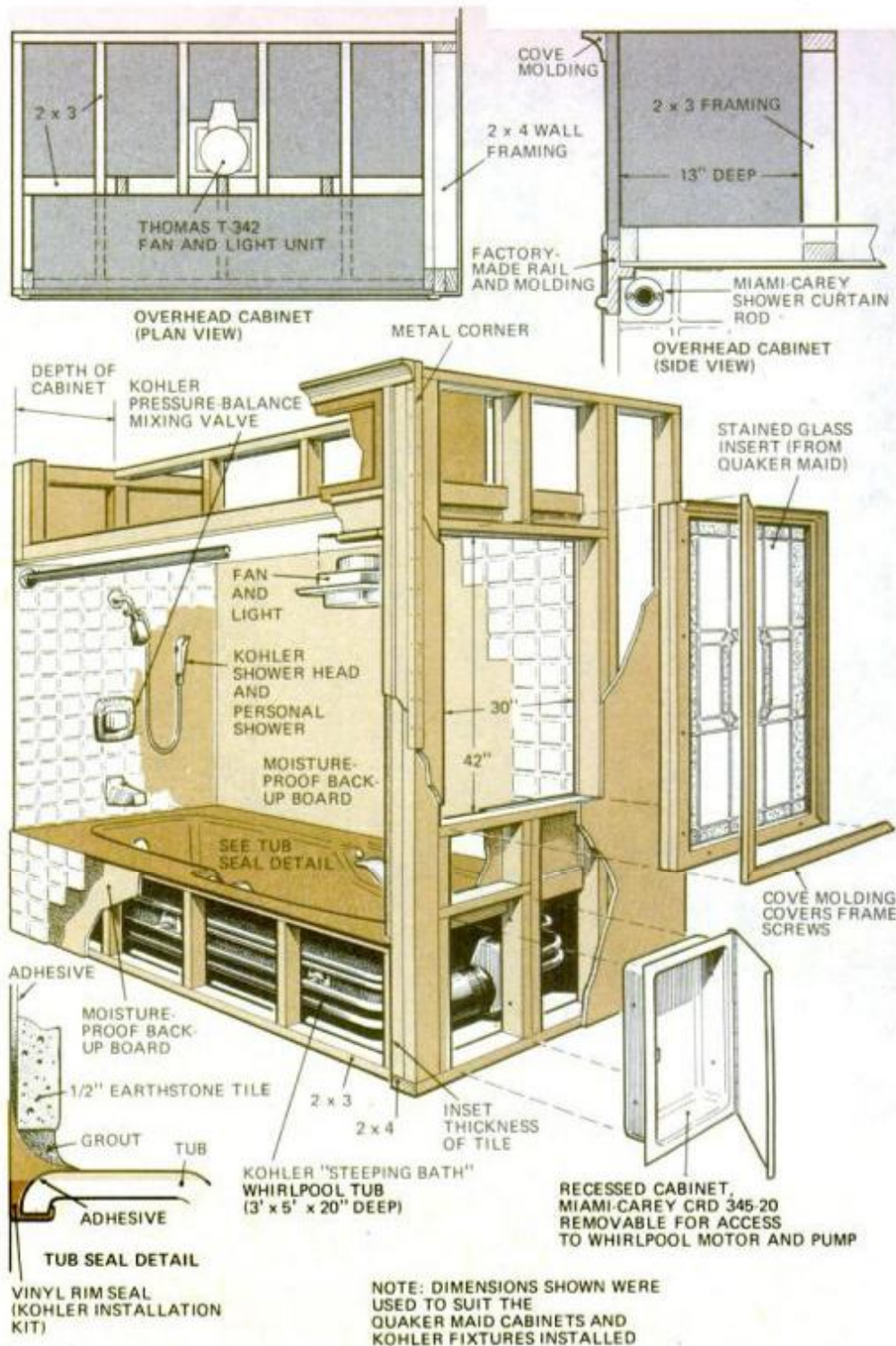


FIXES FOR BATH PROBLEMS

(Continued from page 165)

Family-size bath

There were three major problems with this bathroom (see photo above): 1. It didn't have storage space for a large family. 2. The room contained a hodgepodge of furnishings. 3. The floor plan was awkward—the entry door actually bumped into the bathtub each time



it was swung all the way open.

We solved the storage problem by using handsome cherry wood cabinetry throughout the space—over the bathtub, over the toilet and in the vanity area. This helped solve the second problem of tying the room together.

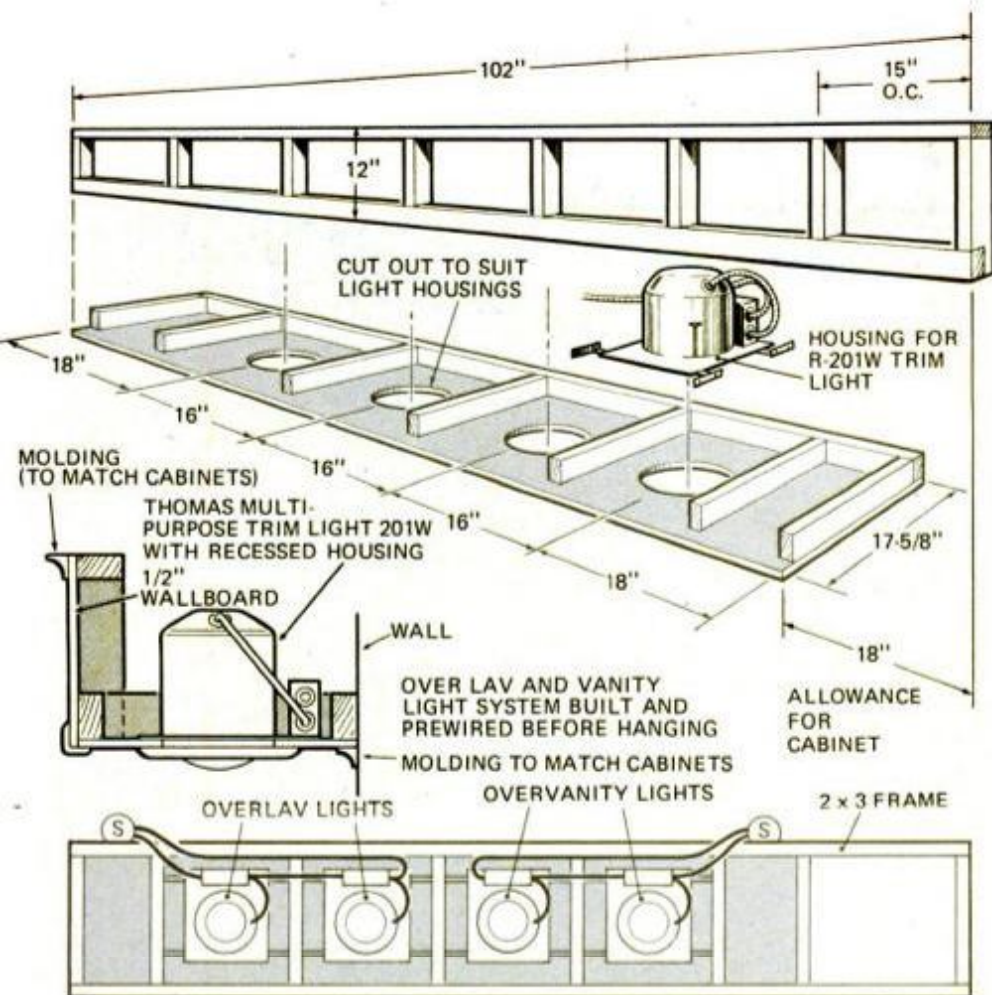
The room is also unified by the selection of compatible furnishings. For example, the blue of the plumbing fixtures is carried through in the wall covering and the clay floor tile. This clay tile in white wraps around the bathtub and up the walls in the tub area.

In the new floor plan, the bathtub is located away from the entry door. We added a whirlpool unit to the tub and put a recessed cabinet in the tile enclosure surrounding the tub. The

SHOPPING INFORMATION

All materials used in this bathroom are available throughout the United States. For buying information or the nearest dealer, write directly to the manufacturers who are listed below.

Cabinets, Clarion style of cherry wood, **stained glass insert**, Quaker Maid, Rte. 61, Leesport, Pa. 19533; **plumbing fixtures**, Cerulean blue with Alterna faucets, Kohler Co., Kohler, Wis. 53044; **clay tile**, Earthstone, Belle Isle Blue on floor and Earthstone, Alabaster White in tub enclosure, Florida Tile, Div. Sikes Corp., Box 447, Lakeland, Fla. 33802; **towel holders of antique brass** and **recessed cabinet** (see art), Miami-Carey, 203 Garver Rd., Monroe, Ohio 45050; **countertop**, Corian, duPont Co., Wilmington, Del. 19898; **lighting and ventilation**, Thomas Industries Inc., 207 East Broadway, Louisville, Ky. 40202; **wallcovering**, Spring Blossom, Standard Coated Div., American Cyanamid Co., Berdan Ave., Wayne, N.J. 07470; **window blinds**, Flexalum, Hunter Douglas Inc., 20 Campus Rd., Totowa, N.J. 07512; **grout**, Durament, C.E. Kaiser Co., 8321 Hempstead Rd., Box 94169, Houston, Tex. 77018; **accessories**, Reflections, The Fashion Center, Paramus, N.J. 07652.



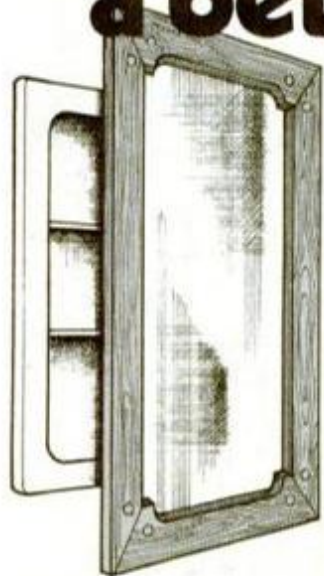
cabinet can be removed for easy access to the whirlpool motor and pump, if needed. A storage cabinet built-in over the tub holds bathroom supplies.

A wall with a stained glass insert separates the tub from the toilet area. Light shining through a nearby window highlights the stained glass. An over-toilet storage cabinet, with a built-in facial-tissue holder and both open and closed storage areas, can hold toilet tissue and other supplies.

The lavatory-vanity area is located where the tub used to be. A counter which runs the full length of the wall is much narrower than the old tub and allows the entry door to open freely. Plenty of storage space for a large family is provided by wall cabinets, under-counter cabinets and a floor-to-ceiling cabinet in this area. The counter also accommodates a large lavatory and a sit-down vanity area. Instead of the glaring lights of the old bathroom, the new lighting is overhead in the soffit. Lights were prewired before hanging, for easy installation. The soffit molding matches the storage cabinets to give the area a finished appearance. The hardware and dec-

(Please turn to page 168)

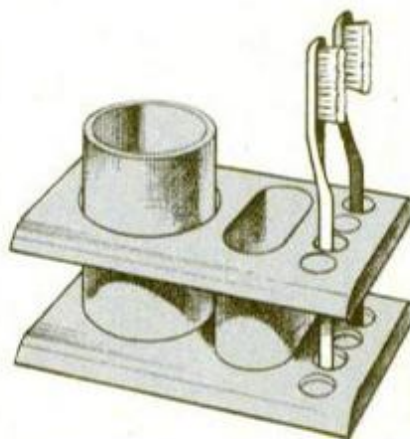
4 products for a better bath



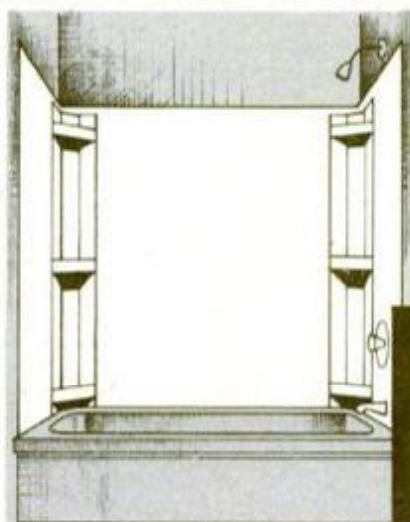
Simulated oak medicine cabinet is available in three finishes—honey, golden and white oak with a metal interior. Recessed cabinet is \$116. Monarch Metal Products Corp., 1901 Estes Ave., Elk Grove Village, Ill. 60007, makes it.



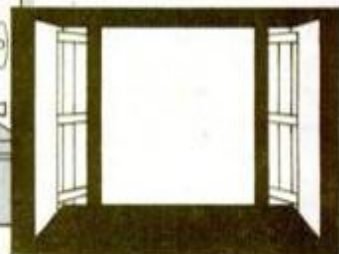
Appalachian red oak tank is sealed and finished so it's water-repellent, then combined with a white vitreous china commode to make this classic low-tank toilet from Heads Up Inc., 3201 West MacArthur Blvd., Santa Ana, Calif. 92704. Water closet is \$364; the oak toilet seat is \$84.

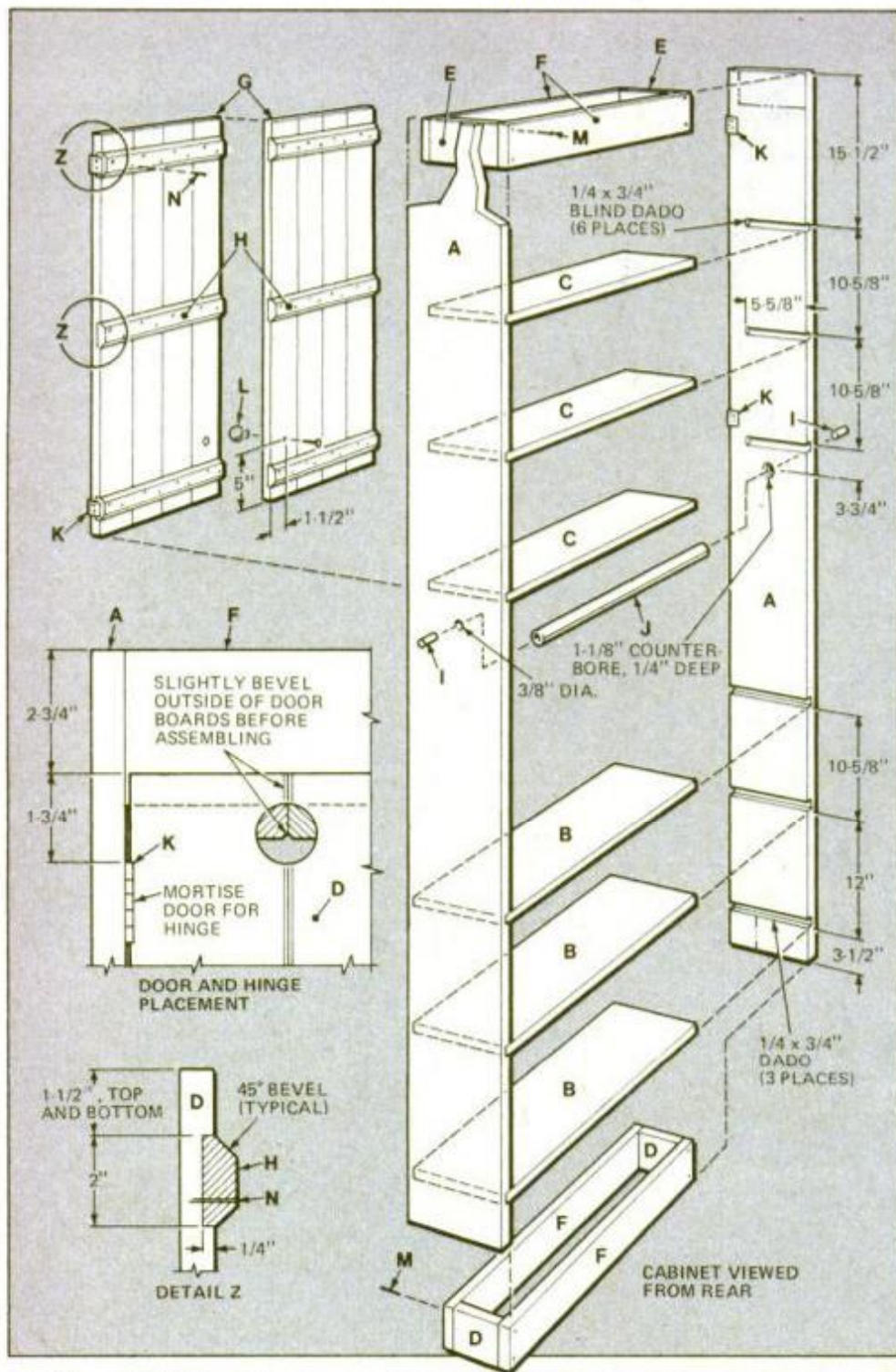


Pedestal-based soap dish, toothbrush holder and glass in contemporary styling are made of durable thermoplastic. Unit solves the problem of where to park standing bathroom accessories. Priced at \$7, it is available in white, blue, brown, lemon and ruby colors from Crayonne U.S.A., Inc., 42 Mileed Way, Avenel, N.J. 07001.



Three-piece thermoplastic wall repair kit for tub areas includes two end panels with shelves and center panel for 60-in. tubs; in white, gold, blue and natural. \$70 from Lyons Industries, Inc., 107 Beeson St., Dowagiac, Mich. 49047.





orative lighting has an antique brass finish. The small accessories are in several complementing shades of blue.

Bathroom cabinet

For looks and durability, we built this cabinet of clear all-heart redwood. Lay out and cut all members. Assemble top and bottom frames (parts E,F and D,F). Cut dados in side parts A, test-fit, disassemble, sand, assemble to one side with glue and nails. Install shelves (C,B) and J to this side, then attach second side. Use two diagonal braces to keep the cabinet square while glue dries. Edge-join stock for doors; cut dados

MATERIALS LIST—CABINET		
Key	Pcs.	Size (description)
A	2	3/4 x 7 1/4 x 90" (max.) clear redwood
B	3	3/4 x 7 1/4 x 29" clear redwood
C	3	3/4 x 5 1/2 x 29" clear redwood
D	2	3/4 x 3 1/2 x 3 1/2" clear redwood
E	2	3/4 x 3 1/2 x 5" clear redwood
F	4	3/4 x 3 1/2 x 28 1/2" clear redwood
G	2	1 1/4 x 35" redwood (make up from 1 x 4 stock)
H	6	3/4 x 2 x 14 1/2" clear redwood
I	2	3/8"-dia. x 1 1/2" dowel
J	1	1 1/2"-dia. x 29" round
K	2 pr.	1 1/2 x 2" brass butt hinge
L	2	1 1/2"-dia. ceramic knob (Amerock T727)
M	16	2" galvanized finishing nails
N	48	1" brads

Misc.: Resorcinol glue, polyurethane, magnetic catches (optional).

for cleats (H). Bevel and install cleats. Hinge the doors, add hardware and finish with polyurethane.

6 tips for making your bathroom project easier

When planning a bathroom, there are four major pieces of equipment to consider: tub-shower, stall shower, toilet and lavatory-counter. Here are tips to help you to successful bath renovating:

1. Minimize hazards. Avoid slippery foot-support surfaces; provide grab bars at tub and shower (see art below); limit hot-water temperature and protect against shocks.

2. Simplify cleaning. Choose fixtures with surfaces that are stain-resistant and easy to clean. Plan adequate clearance to clean around faucets and toilet base.

3. Consider total costs. When comparing prices, consider the initial fixture cost, installation, maintenance and operation costs for items.

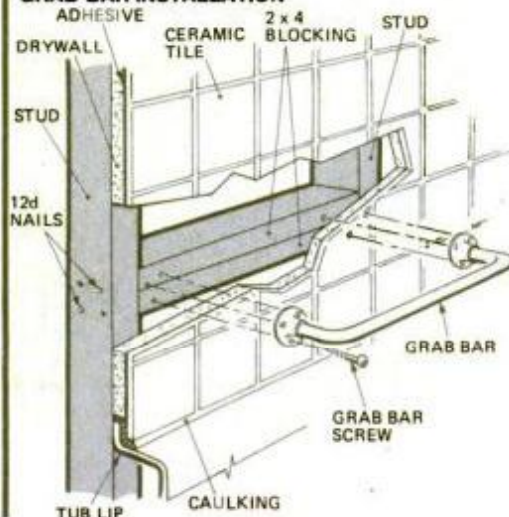
4. Appearance. The color of major fixtures should harmonize with the entire room decor. White or neutral colors allow greater freedom for future decorating.

5. Safety lock. Bathroom doors should have locks that are openable from outside in case someone inside can't open a door.

6. Outlets and switches. Install electrical outlets and switches at least 36 in. from tub or shower.

For *Bathroom Equipment* brochure from which this information was adapted, send 40 cents to: Small Homes Council, University of Illinois, 1 East St. Mary's Rd., Champaign, Ill. 61820.

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Regular, Menthol and Vantage 100's

DRIVING AMC'S 4WD EAGLE

(Continued from page 92)

press time, but AMC says the Eagle should get only about two mpg less than a comparably equipped 2wd compact, putting it in the 18- to 20-mpg range.

While the three Eagle body styles (two-door and four-door sedan and five-door wagon) obviously are derived from the corresponding Concord models (which in turn are updates of the old Hornet line), they are much more than just 4wd Concorde. Appearance differences include unique grille, taillamps and other styling cues, three-inch higher ground clearance

and 15-inch wheels and tires under the soft rubber fender flares and sill guard. But the major differences are underneath. The transmission delivers power directly to the transfer case, which then distributes it via the viscous-drive differential to both front and rear drive axles as needed. Power flow is direct to the rear wheels, while a silent-type chain connects the differential's front output shaft to the front-wheel driveshaft.

Front suspension is independent with upper and lower control arms, tube shocks and coil springs mounted above the upper arms. The front differential is mounted to the engine's left side with an

axle tube extending to the right, and short, equal-length, articulated half-shafts connecting to the wheel hubs. Constant-velocity (CV) joints are at both ends of each half-shaft to allow for seven inches of front-wheel travel. A conventional Hotchkiss live rear axle on leaf springs and tube shocks brings up the rear, with a full 9.4 inches of travel. Springs at both ends are slightly stiffer than those of a 2wd car to give the firmer ride and handling appropriate to a vehicle with off-road capabilities. Still, over-the-road ride is surprisingly comfortable. A 0.94-inch front stabilizer bar is standard, while the optional extra-duty suspension substitutes a 1.06-inch front bar and adds a 0.625-inch rear bar, stiffer shocks and slightly firmer rear springs.

The only Eagle power train for now is AMC's 2-bbl., 258-cu.-in., in-line Six with the Chrysler-built Torque Command three-speed automatic transmission used in past V8-equipped AMC cars. Four-cylinder, manual transmission versions should be available before long. The engine puts out 114 hp at 3200 rpm, giving leisurely performance in the 3400-pound Eagle, but its 210-ft.-lbs. of torque at 1800 rpm is more than adequate to haul it through or up almost anything you might encounter off-road short of a quicksand bog or a building. A final-drive ratio of 3.08:1 is standard, but a 3.54:1 ratio comes on high-altitude models and with the optional towing packages, except in California.

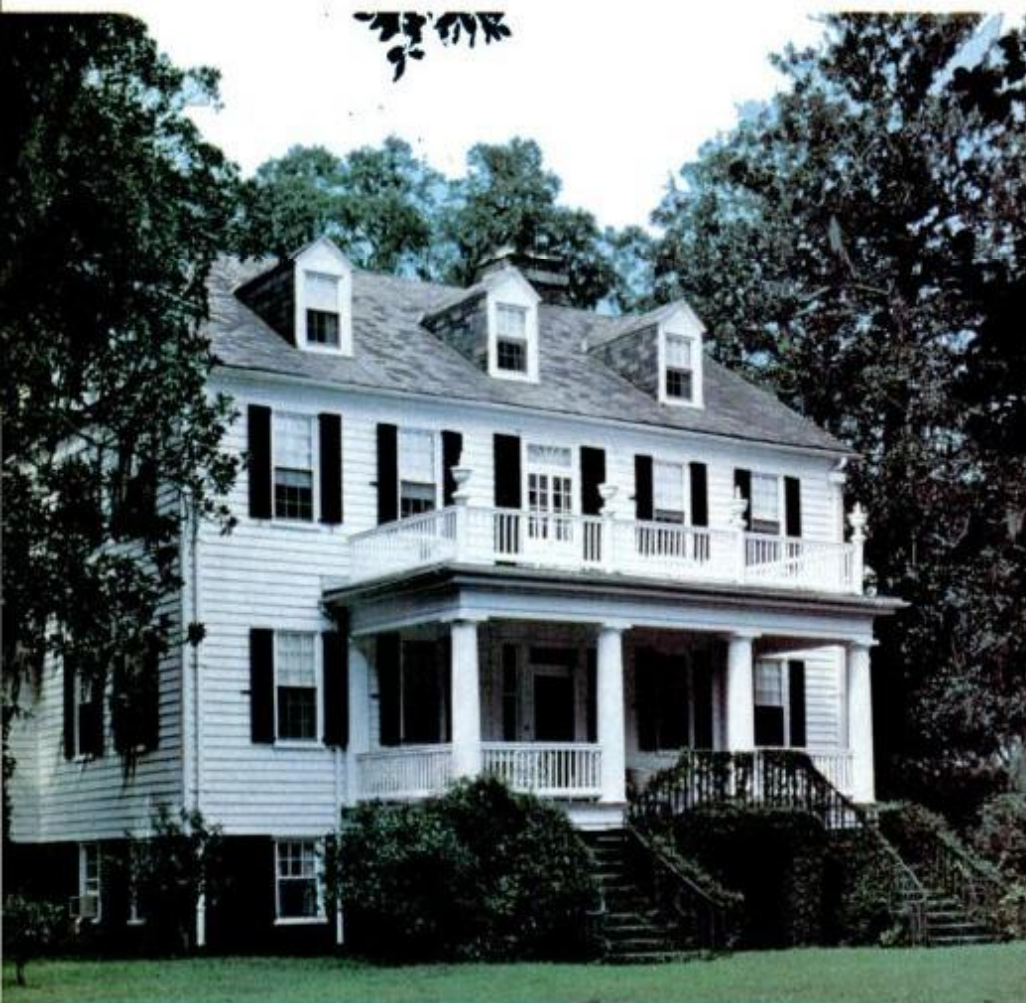
Standard tires are P195/75R15 fiberglass-belted radials on six-inch-wide rims, while steel-belted all-weather Goodyear Tiempos are an optional choice. The spare in both cases is a high-pressure, spacesaver type on a special wheel which is stored beneath the cargo floor.

The reinforced, integral body/chassis measures 186.2 inches long and 71.9 inches wide on a 109.3-inch wheelbase, with height ranging from 55.0 to 55.8 inches, depending on the body style. Power steering and brakes are standard, as is a protective plate under the transfer case.

Although Eagle will be marketed as a 4wd car, it is classified as a light-duty truck for emissions regulations because of its ground clearance and short overhangs. Unfortunately, it still requires exhaust gas recirculation (EGR), air injection and a catalytic converter to meet emissions regulations, and therefore needs unleaded gas. Prices had not been announced as this was written, but they should be less than a well-equipped, truck-type 4wd and well under the rumored \$10,000, according to AMC.

The Eagle may also become a bird of prey, likely to eat up some sales of Jeeps as well as other 4wd competitors. But AMC feels it will attract plenty of new customers who otherwise wouldn't have bought the 4wd at all. **PM**

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(Continued from page 43)

the fuel we are using to power it —others are looking at alternative engines as the best way to solve our fuel problem.

Diesels offer an alternative that's already in production, but a diesel engine only shifts your dependence from one crude-oil product to another. Major fuel-saving revisions to the internal-combustion engine, such as Ford's stratified-charge "Proco" engine, also will help when they reach production in a few years. But what about the future of electric- and turbine-powered vehicles?

The major problem with electrics can still be summed up with one word: battery. Batteries as we know them today are bulky, heavy and expensive. Moreover they have extremely short life spans when continually charged and discharged, and they are very inefficient energy-storage devices when compared to a tank of gasoline.

Some manufacturers currently are producing electric vehicles for short-range recreational and commercial delivery use. Several of these companies are working on this development independently, and others are doing it as part of government-funded, experimental programs, but all designs are of limited usefulness until a battery breakthrough can be achieved.

Electric Auto Corp. in Troy, Mich., plans to have a GM wagon-based electric luxury car in production in 16 to 18 months. It carries a small gas-powered generator on board to run accessories and pump some energy back into the batteries while driving.

The best of the practical experimental designs so far is a joint Chrysler/General Electric effort unveiled last June that boasts a range of 145 miles at a steady 55 mph or 75 miles in stop-and-go conditions.

Turbine cars, meanwhile, have been awaiting a breakthrough in ceramic-material technology so that certain parts can take the extremely high temperatures that are required for a turbine engine to be considered fuel-efficient.

Recent reports are that such a breakthrough may be close at hand, and we may yet see practical turbine cars on the road in the late 1980s. The big advantage of a turbine engine that makes it worth pursuing, of course, is the fact that it can run on almost anything from heating oil to corn whiskey and produce only a small amount of pollution in the process.

PM

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DOWN TO THE SEA IN CHIPS

(Continued from page 101)

the rotted wood below, when we took out the brick try-works, gave us invaluable information on how it was originally done. Memory, too, can be of great value. There are still three men living, very old now, who sailed in her last voyage, and they have described the ship as they knew it."

How to caulk seams

To give just one example: caulking the seams in the newly laid decks. A crew of three caulkers, armed with wooden caulking mallets, fills the seams, first with cotton, then with oakum (rolled hemp dipped in pine pitch and then pressed until most of its stickiness is gone). At the end, hot pitch is poured down the length of the deck seams to seal them.

Once the deckwork was completed, the masons went to work on the try-works, built into the forward section of the ship to encase the iron cauldron for boiling the blubber. Because the try-works was constructed to contain a live fire and because of its great weight, the deck beneath had to be specially constructed. Following the original, the masons have laid down a sheathing of white cedar, sandwiched between decay-resistant Irish felt. This is topped by a copper sheathing. For additional protection, there is a wooden trough—in whalemens' jargon "a goose pen"—filled with seawater, as a protective barrier between hot bricks and wooden deck.

Finding the best lumber

Ultimately, the biggest challenge lies in the wood itself. When the *Charles W. Morgan* was built, the east coast of America, was covered with forests. Today the lumber that built the *Morgan* must be sought all throughout the Western Hemisphere. At Mystic there is a whole section of the lumber warehouse devoted to "knees"—that angle at the base of a tree where it spreads out into roots. When planed, the knee forms a rough L shape and links bulkheads to decks and deckheads.

Without yellow pine, the ship could not be authentically rebuilt. It is a wood that was basic to American shipbuilding. To the surprise of admirals on both sides of the Atlantic, American pine generally proved superior to British oak in the sea battles of 1812. Don Robinson and his team found a yellow pine stand at Eglin Air Force Base in northwest Florida and were able to get the 8500 board feet they needed.

White oak is also vital to the ship's

restoration program, and the Seaport is getting supplies from the Rappahanock Valley in Virginia and from Arcanus, Ohio. Seaport authorities are appealing to anyone who may know further sources of both yellow pine and white oak.

Shipbuilding, despite the clattering and the hammering, is a solitary job. A visit to the berth of the *Charles W. Morgan* will show dedicated men at work, some elderly, some young, some apprentices, some men of international reputation in the field of wooden boats. They plane, saw, measure, sip from mugs of coffee and rarely talk.

No timetables

The work goes on in all seasons. When the winter winds howl and the snow falls, a tarpaulin tent, stove-heated, protects the men working on the outside of the hull. Every plank is numbered, and hurry would be self-defeating. There is no timetable, no schedule, not even a budget. Ask how much the great project will cost and one is met with shrugs. Robinson says, "There is a grant of \$450,000 a year for maintenance and restoration of all the Mystic ships. But the work and money goes where it is needed most." Robinson, a marine engineer and naval architect with degrees from Princeton and M.I.T., thinks the job may take four years, maybe five. He is not sure.

After her retirement in 1921, the *Charles W. Morgan* once enjoyed the patronage of another and most unlikely benefactor. In 1924, she formed the background for a silent movie called *Down to the Sea in Ships*. It was not an extraordinary film, save for the fact that a small part was played by Clara Bow, later to become the "It" girl of Hollywood.

A job that never ends

Is everything as it should be, however? One irate scholastic gentleman accosted Don Robinson on the project. "This is not restoration!" he fumed. "It is reconstruction, something quite different. You are building a replica, not restoring an original ship." Robinson removed himself from the five-foot-three-inch hold and straightened himself to his natural six feet. "From the time the *Morgan* put to sea," he replied, "from the time any ship puts to sea, it requires repairs. In the *Morgan's* sailing days her wooden parts were continually discarded for better wood. Timbers rotted, were stove in, splintered. They were replaced. We are carrying on in the *Charles W. Morgan* where the last shipwrights laid off. No shipwright can ever say 'This ship is finished.' "

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PM'S COMPLETE GUIDE TO THE NEW VIDEODISCS AND CASSETTES

(Continued from page 121)

different programs, on four separate channels, for up to seven days—or until you reach the end of the tape!

Magnavox

Magnavox, though heavily promoting the Magnavision disc, has not forgotten the cassette market. Trade rumor has it that an upcoming portable will be the first programmable one in the industry.

New Magnavox table models provide an external three-speed switch, and also incorporate changes in the electro-mechanical subsystems.

RCA

While also getting into discs, RCA doesn't intend to forget cassettes either. It reports an expanded product line for the fall, consisting of five models. One is a miniportable, manufactured by Hitachi, which RCA claims is 45 percent smaller than currently available competitive portables. These new portables, equipped with a video camera, will drain only 8 watts from the battery. You should be able to record up to an hour on one battery—an industry record, to date.

A tuner and timer module (TDP1000) will connect to the new portable (the VDP150) and provide electronic tuning, along with four-hour recording from broadcast programs. At press time, prices of the portables were not available. Check the chart for table-model features.

Sony

Original developer of the Beta-max play-record system, Sony has just announced the SL5400's new 4½-hour system. The unit is similar to Zenith's (which is also made by Sony). It features seven-times-regular forward and reverse search speeds, stop-frame, remote control, a 3-day timer and a 14-button, programmable tuner.

Panasonic

Four new recorder/players and three new color cameras will be in Panasonic's new lineup. The PV-1600 is the super deluxe unit. It is a six-hour long-play unit, with both four- and two-hour choices. Along with a direct-drive video-head motor (for better pictures), it features a microprocessor for clock-timer control, audio dubbing, and it will record four different programs during a week.

A second deck in Panasonic's line is a switchable two- or four-hour player/recorder portable with a.c./

d.c. and battery power and full microprocessor control. Others in the line are the PV-1200 and PV-1100, the 1200 having a six-hour playing time and 1100 two to four hours.

Panasonic refers to its six-hour decks as Omnivision VI and to its four-hour deck as Omnivision IV.

As our table shows, Matsushita is the major supplier of video cassette recorder/players to the industry.

JVC

The Vidstar HR-6700U was announced by JVC at the Consumer Electronics Show in June. It features both two- and six-hour recording times.

Because of oversized heads, the tape may remain in the stop or pause condition (with no picture) for up to seven minutes before release—while other machines might damage the tape over that long a period. There is a six-function remote control for normal play, slow motion, pause and other features.

Zenith

When it recently introduced its VR9000W cassette deck, Zenith came pretty close to narrowing the difference between tape and disc. This machine has both speed-search and pause/stop controls, which can operate at 10 times normal tape speed. It also has a complete stop-frame that can last for five minutes. A disc can freeze-frame forever, but this is the first recorder/player able to freeze any field and produce a viewable picture—though there is some horizontal-bar interference visible.

Zenith's new tapes offer five hours of viewing in a "Beta III" format. The format is, however, compatible with last year's. The Beta III machines also offer a new weekend automatic timer that can record from ½ to 3½ hours on command, or switch to recoding other programs at the same hour.

Will it be disc or cassette?

Obviously, many factors enter into making your final cassette vs. disc decision. Perhaps you could even afford both—Mom could enjoy two hours of high-definition movies, while a good football game (on tape) would be a thing of joy to Dad forever!

In the next year or two, as more disc systems become available, you will be presented with an ever-widening choice. On your decision—and the decisions of others like you—rests the fate of an industry. **PM**

NEW TAPE DECK ADJUSTS

(Continued from page 122)

there are three direct access memories that can be programmed to remember computer adjustments. In this way, you can instantly select proper adjustment for up to three commonly used tapes by simply pressing one of the buttons labeled M1, M2 or M3—meaning Memory 1, Memory 2, Memory 3. For example, you might store the test results for high-performance ferric tape in M1, the results for a ferrichrome tape in M2, and the results for chrome-bias tapes in M3. Once you have done this, you would be able to call up the correct adjustments at the touch of a button.

Adjustment range has limits

As good as the computer is, it cannot do all the work itself, since there are limits to the adjustment range the computer can deliver for each type of tape. Therefore, the computer must be told the type of tape being used. With newer tapes this is almost automatic, because the computer defaults to ferric programming when the cassette is inserted. If the cassette is loaded with chrome-bias (high-bias) tape, the shell will most likely have special coding notches in the rear that automatically program the computer for chrome-type tapes. Only if the tape you're using is ferrichrome will you have to enter the generic type (ferrichrome).

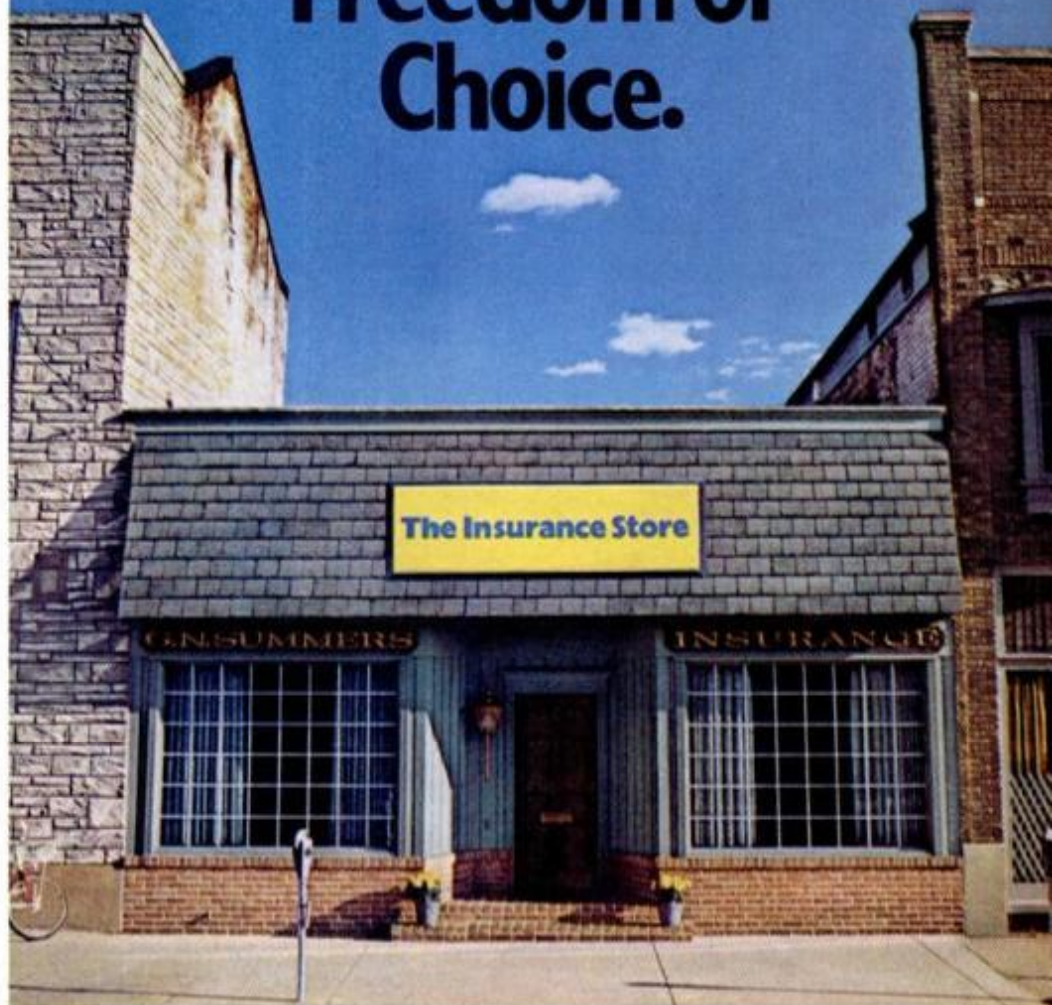
Three pushbuttons labeled NOR (ferric), FeCr (ferrichrome) and CrO₂ (chrome-bias/chrome-type) allow for manual selection or user override of the computer programming for tape type or "family."

How well the Hitachi computer optimizes cassette tape performance is graphically illustrated as a series of frequency response curves taken from several popular tapes, no two of which will generally give optimum results when used with the same recorder. From top to bottom, the traces represent in the photo on page 122, Scotch Master 1, Sony LN, Meriton (Aiwa), Memorex MrX₂, Fuji FX and anonymous three-for-\$1 "cheapies."

Note how all the standard-brand tapes deliver what is essentially outstanding Dolbyized frequency response to the 15,000- to 17,000-Hz range. The bottom trace, that of *el cheapo* three-for-\$1 tape, runs off the screen, because its inherent characteristics are beyond the computer's adjustment range; the computer "defaults" and blinks a front panel LED lamp to indicate the tape is beyond help.

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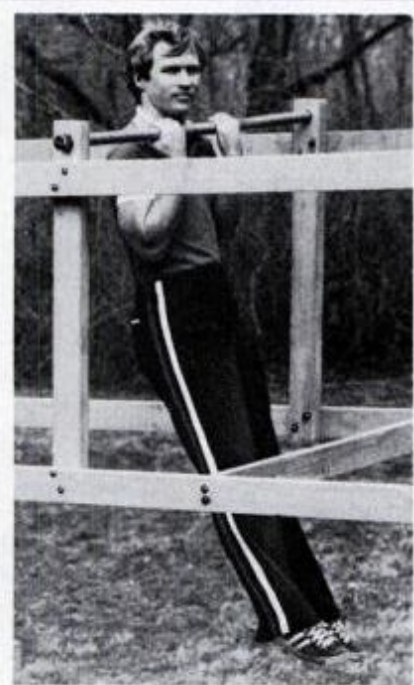


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4. Knee-ups

Your waistline will trim up as this exercise firms up the rectus abdominus. Hang from the chinning bar and slowly draw your knees up toward your chest. Then lower them again. For best results, repeat as many times as you can. Up to 20 times at each session is a good goal.



6. Chin-ups

Chinning develops front arm biceps and broad back latissimus dorsi muscles. Grasp the bar at shoulder width, palms toward you. Pull up until chin clears bar as often as you can. To increase back muscle action, pull so bar is behind your neck. Turning palms back exercises biceps. Don't arch your back.

HAVE FUN KEEPING FIT

(Continued from page 117)

backyard exerciser requires only minimal carpentry skills.

Select lumber that is straight and relatively free of knotholes. Ordinary yellow pine is satisfactory, but pressure-treated pine, which costs somewhat more, will last longer. Precut lengths of 2x4 and 4x4 can be used with little



5. Press

This two-arm exercise works out the deltoid and trapezius muscles in your shoulders. Grasp the front parallel bar on the underside at shoulder width. Press it straight overhead, lifting the front end of the structure, and then lower it. Repeat as many times as you can comfortably.

additional sawing required. Drill pilot holes for all nails or bolt holes, to prevent splitting. Make liberal use of washers under bolt heads and nuts if the unit will be bolted together. Construction time should be less than eight hours. Angle irons at corners, plus cross braces can further stiffen the structure.

Six-inch dowels of about 1 1/4-inch diameter make good grips for the rope-pull exercise. Drill each with a 1/4-inch hole through the center and thread through each end of a 17-foot length of nylon rope after running it through a 1-inch-diameter eye screwed to the top center of the front cross-

(Please turn to page 178)

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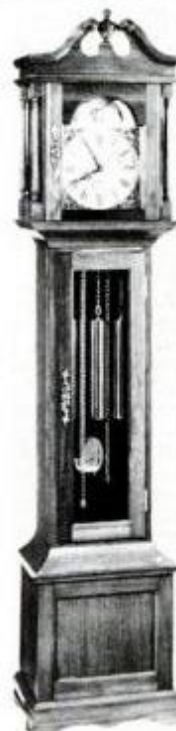
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HAVE FUN KEEPING FIT *(Continued from page 177)*

piece. Rope grips should nearly reach the ground. A knot in each end of the rope secures them.

File, sand or plane the middle 12 inches of the tops of the paral-

lel bars and other lengths used for grips or presses while exercising. Practice slowly at first as you work up stamina to supplement your jogging routine. **PM**

7. Back arches

Your lower back sacrospinalis muscle is exercised by arching. Lie across platform at rear of the structure, hooking one or both feet under the step. Raise and lower your trunk (but only if you have no lower back problems). A folded towel may be used for cushioning. Repeat a few times.



8. Step-ups

Bench stepping works out your buttock gluteus maximus and front thigh quadriceps muscles. Step up onto the bench with your right foot, then step down. Repeat 10 times with each foot.



9. Dips

Dips strengthen triceps muscles that straighten your arms. Put a hand on each parallel bar, keeping arms straight. Lower yourself slowly until shoulders almost touch your hands, then push back up.

10. Push-ups

The pectoralis major muscles of your chest are exercised by pushing your arms away from your body. Push-ups will keep chest muscles firm. With feet on the ground, place hands on stepping bench at shoulder width and assume push-up position. Raise and lower your body as often as you can comfortably.



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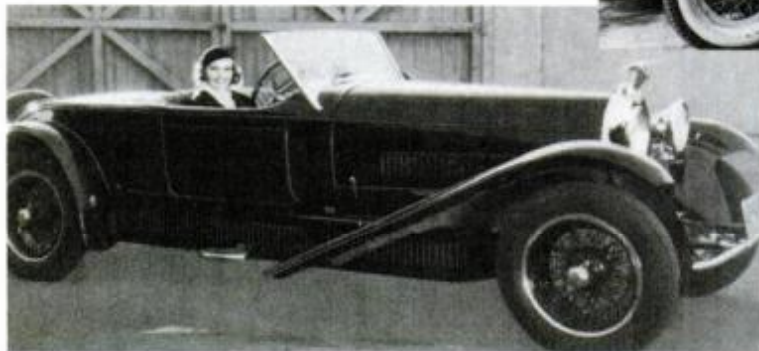
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Famous stars and their famous cars: can you name them?

The period from the late 1920s through the '30s has been called the Golden Age of many things—most notably of glamorous movie stars, elegant motorcars and spirited jazz tunes. Not even the Great Depression or Prohibition could dim the glitter of this glorious era. Here are five Hollywood celebrities and the equally famous chariots they drove. Can you name both star and car? The answers are printed upside down at the bottom of the page. **FM**



1. Best remembered for his war and Western movies, this tall, lanky film hero won Academy Awards for *Sergeant York* and *High Noon*, also starring in such epics as *A Farewell to Arms*, *Lives of a Bengal Lancer*, *Beau Geste* and *For Whom the Bell Tolls*. His powerful steed easily exceeded 100 mph, was variously known as "The fastest luxury car" or "Most luxurious fast car" of its time. If you don't have it by now, this will give it to you: It inspired the expression "It's a doozy!"



2. Her youthful looks may fool you, but her classic roadster shouldn't. Still active today, the much-celebrated actress received Academy Awards for her roles in *Morning Glory*, *The Lion in Winter* and *Guess Who's Coming to Dinner?* Among other notable achievements were *Bringing Up Baby*, *Philadelphia Story* and *The African Queen*. Her car was one of the fastest two-seaters of its day. Hint: Its name is Italian, but it was made in France.



3. The hood lines above are as much a giveaway as the moon face on this well-known comedian of the '30s. His films included *Million Dollar Legs*, *Murder at the Vanities* and *The Great Dictator*. If the car still stumps you, just "Ask the man who owns one."



4. The dapper gentlemen below starred in *A Tale of Two Cities*, *A Double Life*, *Under Two Flags* and *Lost Horizon*. His car's predecessors were Maxwells. If you remember when Lindbergh flew the Atlantic and Babe Ruth hit his 60 home runs, you'll know the year.

5. A gangster's getaway car? For some, perhaps, but the car above was also a favorite of the rich and famous. Pinning down the exact year may be tough: It remained little changed for nearly a decade prior to 1930. Its dashing driver starred in silent films and talkies. Among his successes: *Mata Hari*, *Scarabouche*, *The Big Steal* and early versions of *Ben-Hur* and *The Prisoner of Zenda*.



Answers: 1. Gary Cooper, 1931 Duesenberg; 2. Katharine Hepburn, 1932 Bugatti; 3. Jack Oakie, 1930 Packard; 4. Ronald Colman, 1927 Chrysler; 5. Ramon Novarro, 1929 Lincoln

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PROGRAMMABLE CALCULATORS

(Continued from page 99)

fewer data memories—which is where temporary data is stored. Allocating space between the two uses can be a difficult art.

HP only claims 224 memory steps, but says its memory is more efficient than TI's. A TI programmable may use three steps to store an operation that an HP calculator can store in two.

■ **Recording.** A mag card can be a handy thing—and it doesn't have anything to do with magnesium wheels! Keying-in a program can be a long and error-prone process. Every time you use the program it must be re-entered if the calculator has been turned off! Mag (magnetic) cards permanently store your programs on a strip of tape that you simply feed through a slot instead of punching another hundred buttons. They do add to the final cost—but can save a powerful lot of time!

■ **Versatility.** The kinds of programming functions offered are fascinating. *Conditionals, branching, loops and flags* may sound like plans for a race track, but they're actually descriptions of specialized functions programmables use to ease difficult calculations.

Conditionals allow a calculator to make a program decision and change its path. One popular conditional key asks, "X greater than Y?" If the answer is "Yes," the conditional continues the program. If "No," the program skips a step before continuing. For example, to balance your checking account more quickly, you can add a conditional which automatically subtracts check charges if your balance dips below a minimum. Say you have a checking account which requires a \$1000 minimum balance for free checking. In your program, you can insert the question, "Is the balance below \$1000?" with the conditional instruction. If your balance is above \$1000, the program will read "No" and subtract only the check amount. If "Yes," the program will also deduct the check charge, say 15 cents, for each check.

You can also set *flags* either on or off, depending on whether or not a variable meets a certain condition. The program can then test the flags to see if the condition has been met. They are like conditionals, but are user-defined.

Another specialized function which seems difficult and useless, but is the opposite, is a *subroutine*. You are, in effect, creating a program within a program. You may want to use the same equation, say

WE LOOK AT THE PROGRAMMABLES

Feature	Texas Instruments (TI-59)	Hewlett-Packard (HP-67)	Sinclair (Enterprise)
Language	AOS—algebraic	RPN—reverse Polish	algebraic
Program memory	960 program steps	224 program steps	79 program steps
Data registers	100 maximum (borrows from program memory)	26 data registers	7 data registers
Entry methods	solid-state module magnetic card keyboard	magnetic card keyboard	keyboard
Display format			
Characters	10 numbers	12 numbers	8 numbers
Scientific notation	yes	yes	yes
Engineering	yes	yes	yes
Program editing			
Insert/delete	yes	yes	yes
Forward/backward stepping	yes	yes	yes
Pauses	yes	yes	no
Program controls			
Conditional branching	yes	yes	yes
Conditional tests	8	8	2
Flags	10	4	2
Looping	yes	yes	no
Subroutines	6	3	no
Labels	10 user-defined keys 72 possible labels	10 user-defined keys 20 possible labels	no no
User control keys	5	2	no
Types of branching	absolute/indirect label/short form	relative/indirect label	no
Printers	PC-100A or PC-100C attached to TI-59	HP-97 (built-in printer)	no
List program keycodes	yes	yes	no
Print words/plot graph	yes	no	no
List/trace programs	yes	yes	no
Prices	\$299.95, retail \$199.95, optional printer	\$450 for HP-67 \$750 for HP-97	\$49.95, Enterprise \$29.95, Cambridge
Other models	TI-58, \$124.95 TI-57, \$79.95	HP-19C, \$225, printer HP-29C, \$175 HP-33E, \$100 (scientific programmable)	—
Software prices	modules, \$35 each pakettes, \$10 each	application pacs, \$35 each solution books, \$10 each	—

$A = \pi R^2$ for the area of a circle, several times in a program. Instead of taking up memory steps repeating the equation, you instruct the calculator to seek out the equation, as a subroutine, and use it over again. A stop or return function tells the program to continue.

Branching is simply what a program does when it reaches a "Go to" instruction. You use branches to create *loops*, which repeat an entire sequence of instructions for a fixed number of times.

■ **Services and warranty.** In this area, HP, probably in response to TI's superior modules, is stronger. It has more than 3500 individual programs available in 40 Solutions Books. HP users have written these programs and HP has organized a Users Library. You belong for \$9 a year, and get a catalog and three programs. Extra programs cost \$3 each. Each Users Library Solution Book, with up to 15 programs (without cards) is \$10. Books many people find useful are *Home Management, Small Business, Astrology and Taxes*.

A nonprofit Personal Programmers Club (PPC) makes it possible

for its 2000 members to swap HP programs, applications and techniques through a magazine. It costs \$15 a year. The address is PPC, 2541 West Camden Pl., Santa Ana, Calif. 92704.

Texas Instruments has a Professional Programmers Exchange (PPX) which costs \$18 a year. The benefits are similar to the HP users library, but TI offers fewer programs.

HP has a limited one-year warranty with an up to 60-day over-the-counter exchange for defective machines. TI has a limited one-year warranty, but has a new exchange program. If your TI programmable can't be easily fixed, you can return it to any authorized dealer and exchange it for a reconditioned model for just \$10. Your calculator, in turn, is returned to the factory, but is not returned to you. Otherwise, you have to send it to the factory for repairs.

Consultant Eng and I both feel that the HP calculators are generally better made. The quality is demonstrated in a lot of little things, such as HP's injected plastic key

(Please turn to page 184)

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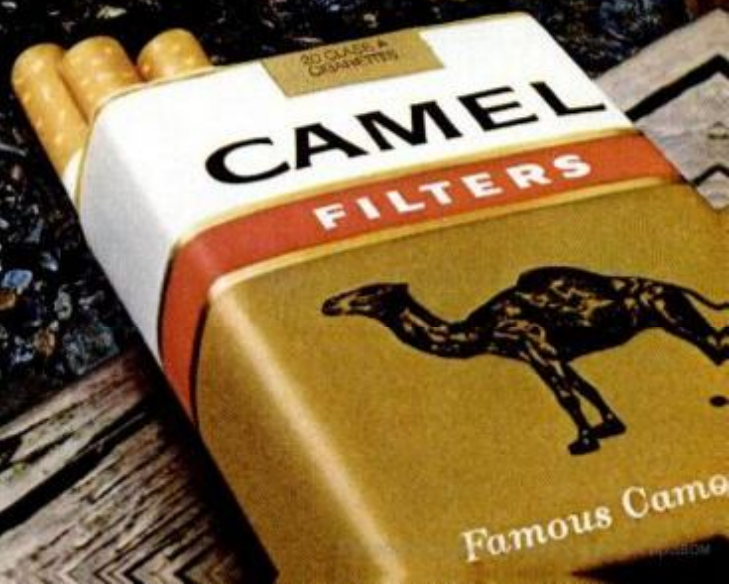


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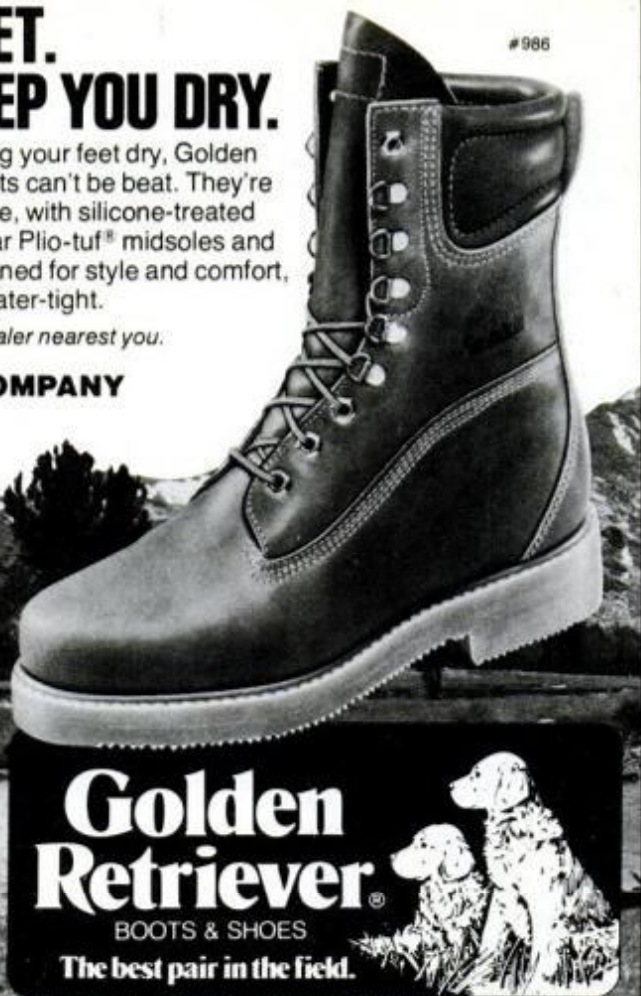


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#986

PROGRAMMABLE CALCULATORS

(Continued from page 182)

construction, its easily seen LED display, the sturdy adapter, or the quicker and more precise card reader.

Sinclair is inexpensive

The Sinclair Enterprise model calculator is a limited, though useful, programmable calculator. It is basically comparable to the TI 57 or the HP 29C. It doesn't have a printer or use magnetic recording cards. But it is inexpensive and runs short programs very well. It comes with a 310-

Programming fuel bills

We have a program available for both the Texas Instruments and Hewlett-Packard calculators that can't help but save you money. With the program you can do an entire heat loss survey of your home without paying an engineer hundreds of dollars. With it you can find out what types of insulation, windows or siding will save you energy costs. The program is too long to include here, but all you have to do is send a self-addressed, stamped envelope to the following address to obtain your copy: Popular Mechanics, Heat Loss Program, 224 West 57th St., New York, N.Y. 10019.

program library, and the instruction manual is well written and helpful. It's a good buy for beginners.

The future of programmables

Two programmables can already store at least one program while they're shut down. Both TI and HP have already introduced a simple ROM memory into their calculator lines. They're the HP 19C/29C and a new TI-58. ROM (Read Only Memory) means the calculator program is permanently etched into the integrated circuit memory. With the top calculator today, every program is lost when you turn the calculator off.

As integrated circuits become cheaper and more complex, programmable calculators will become more like hand-held personal computers. Both TI and HP models now use a 4000-bit chip. Yet, 64,000-bit chips are already in commercial production for micro-computers.

And IC technology should increase the amount of available memory up to 1 million bits per chip. That could mean the power of an IBM 360 computer in a hand-held calculator!

PM

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ELECTRICAL CONTINUITY

(Continued from page 115)

of the measured resistance is the reading multiplied by the range switch setting. Thus, a reading of 15 with the instrument set on R×1 would be 15 ohms. A reading of 15 at R×10 would be 150 ohms.



VOM is zeroed (readied for testing) by connecting and touching the leads together. The needle should fall on or near zero.

Points to remember

1. Because the ohmmeter has its own power source, you must disconnect the appliance from the wall outlet *before* connecting the ohmmeter. The ohmmeter circuit is designed to operate on low voltage. If the higher voltage power source is maintained, the VOM will be damaged.



If the needle doesn't fall on zero, turn the ohm adjust knob until it does. If adjustment cannot be made, meter is faulty.



To replace weak batteries, remove the instrument cover. This VOM has a D cell, as well as an AA cell, that may need changing. If instrument is stored for a long time, check batteries for deterioration. Leaking batteries can damage meter circuits.



The correct way to store a VOM is to disconnect leads and wrap them around case.

2. Circuits in an appliance are interrelated. Thus, a circuit lacking continuity may show a positive reading, because the VOM is indicating the continuity of an interrelated circuit. *Make sure this doesn't happen by disconnecting one end of the circuit you are testing and connecting the ohmmeter between the disconnected and connected ends.*

3. When disconnecting more than one wire, mark the wires so they can be reconnected correctly. Wrap masking or adhesive tape around the wire. On this write the designation on the terminal (numeral or let-

(Please turn to page 190)

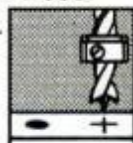
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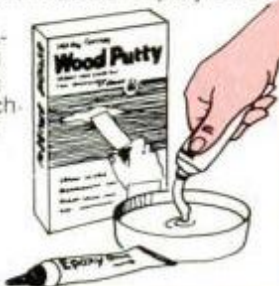


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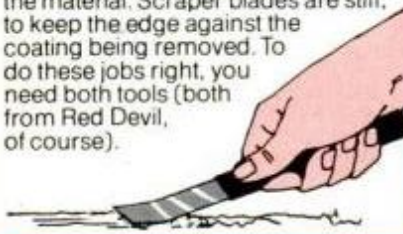
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ELECTRICAL CONTINUITY

(Continued from page 188)

ter) from which the wire is taken.

4. Learn to read wiring diagrams. The diagram is a road map to appliance circuits. To test continuity, you have to know where a circuit begins and ends. Determining this by "hand-tracing" the circuit is difficult in an appliance that has many circuits.

5. Before connecting the VOM, set the range switch to $R \times 1$. Keep the test leads out of their jacks. The meter needle should be stationary at the infinity mark, which is the "lazy eight" (∞). Most VOMs have a small screw under the needle pivot point for making slight adjustments. A needle that cannot be adjusted or one that is far off the 00 mark signifies a damaged meter.

6. Plug the test leads into jacks. The red lead is positive (+) and goes into the + jack; the black lead is negative (-), or common, and goes into the -, or COMMON, jack. Touch the ends of the leads together. The needle should move to zero. If the needle doesn't fall on zero, turn the OHMS (Ω) ADJUST knob until it does. This is called "zeroing the meter." If you cannot get the needle to zero, install new batteries.

7. When testing the continuity of a circuit supposed to have little resistance, connect the ohmmeter and set the range switch on $R \times 1$. The ohmmeter should read zero, or nearly zero. If the needle swings to infinity (∞) or shows a high resistance reading, the circuit is bad.

8. To measure resistance, connect the ohmmeter and set the range switch to get a reading— $R \times 1$ for resistances of less than 100 ohms, $R \times 10$ or $R \times 100$ for resistances above 100 ohms.

You should know the specified resistances of the circuit. This may or may not be stated on the wiring diagram of a major appliance. If it is not, or if you are working on a small appliance for which there is no diagram, a letter to the manufacturer should get you this information. When writing, remember to give the appliance model number. The chart on page 115 provides *approximate* allowable resistances of a number of commonly tested circuits.

The ohmmeter should read the specified resistance value of the circuit. If it doesn't, your trouble is confined to that circuit.

9. To protect your VOM, be careful how you store it. Unhook the leads and wrap them around the instrument. This prevents leads from accidentally shorting, which can cause the battery to discharge if the range switch is left on an "R" setting. **PM**

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to wait eight days for parts and was then told the car was ready when it wasn't. You might understand my frustration with this dealer."

Opinions about dealer service ran about 50/50 pro and con. "It was only a broken heater seal," reports a Michigan corporate planner, "but the dealer could be a lot better about keeping promised repair dates. It's not just *his* time that's valuable."

On the other hand, a Florida controller notes that, "My dealer's service manager is always polite and gets me in and out as fast as he can." And an Ohio trucker: "This Pontiac dealership is fast, efficient and thorough. The car is always ready when they say it will be."

Only 55.7 percent of the people we surveyed rated the Sunbird's workmanship *good to excellent*. Compare that with 92.3 percent for the Subaru, 73.9 percent for the Olds Toronado, and 81.5 percent for the Jaguar. In other words, it's not a total endorsement.

A Colorado accountant first rated his Sunbird's workmanship *fair*, but then switched it to *good*. "After second thought," he said in his comment, "I've changed this to *good*, because the only way to get excellent workmanship these

days is to buy a hand-built car. I don't believe any mass-produced automobile's workmanship is any better than my Sunbird's."

Sunbirds can be loaded with accessories; many in our survey were. Several owners mentioned how good the aircon-



Tall driveshaft tunnel splits rear seats, which, at best, have room for children.

ditioner was. Many said their power steering makes parking much easier than that of other small cars they'd driven.

As for suggested improvements and general comments, a West Virginia technical writer said: "It's very comfortable for a small car, with good reliability and great performance from the V6. But the Sunbird needs to be updated in space utilization. It also needs more suspension travel, and it fishtails too easily on slick surfaces. The four-speed gearbox is a bit notchy, and adjustable front seatbacks would be welcome. But I have no major complaints."

"It's an easy-handling car with good style and economy. I'd like to see Pontiac improve the workmanship, though, so the accelerator pedal and dimmer switch aren't in such awkward positions."—California salesman.

A California paper supervisor: "Our neighbors compliment us on how smoothly and quietly this Sunbird V6 runs. I also like the mpg. As for improvements, the shape of the front seatbacks should be changed so people in the back can see through the windshield."

An Arizona housewife: "My husband complains there's not enough headroom even in the front seat, much less the back. But people my size have no problem.

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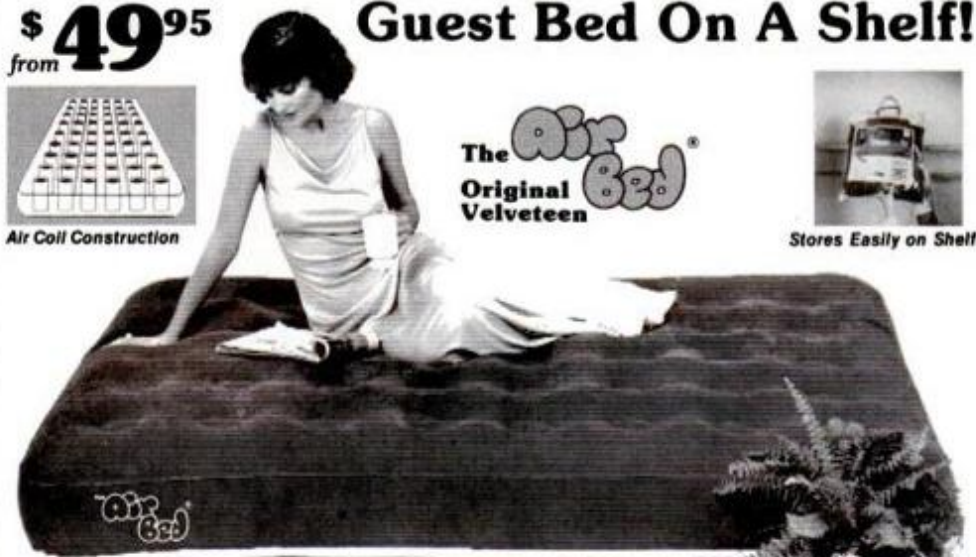
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Also, I like the way the Sunbird handles, its gas mileage, and overall comfort."

A Wisconsin naval petty officer: "To me, looks are most important. Handling runs a close second, and this car has both. The car handles remarkably well with the Radial Tuned Suspension and radial tires. I wish, though, that I didn't have to use unleaded fuel. I do a lot of

long-distance driving, and get 27 miles per gallon on the highway with the four-cylinder engine. That, along with the options available, plus the dealership, which handles all routine work cheerfully and with minimum fuss, make me a confirmed Sunbird enthusiast."

Despite the fact that most owners liked—some said loved—their Sunbirds,

44.4 percent reported they wouldn't buy another one. That's a relatively high figure, but many had growing families and a number mentioned moving up to larger autos.

A Wisconsin bank teller summed it up: "I'll probably go to a little bigger car, with better space utilization than the Sunbird, but I'll definitely stick with Pontiac." **FM**

SUMMARY OF 1979 PONTIAC SUNBIRD OWNERS REPORTS*

Total miles driven 754,342	Specific likes:	Comfort opinion (front seats):	Dealer service opinion:
Average miles per gallon	Styling 58.0%	Excellent 31.0%	Excellent 16.2%
2.5-liter Four	Economy 49.7	Very good 36.0	Good 34.5
In town 21.0	Handling 39.5	Good 23.8	Average 15.5
Long trips 26.3	Comfort 17.8	Fair 6.1	Fair 15.5
3.8-liter V6	Ride 16.6	Poor 3.0	Poor 18.2
In town 17.9	Specific dislikes:	Comfort opinion (rear seats):	Number of vehicles owned:
Long trips 22.7	Poor workmanship 17.2%	Excellent 6.0%	Sunbird only 41.1%
Engine choices:	Bad seat shape/style 11.0	Very good 8.6	Two cars 41.1
2.5-liter Four 52.5%	Not enough trunk space 8.3	Good 29.1	Three cars 10.4
3.8-liter V6 45.7	Poor dealer service 7.6	Fair 31.1	Four or more cars 7.3
5.0-liter V8 1.9	Poor, thin paint 6.9	Poor 25.2	Makes of other cars owned:
Transmission choices:	Space Saver spare 6.9	Had any mechanical trouble?	Chevrolet 30.2%
Automatic 70.1%	What changes would you like?	Yes 61.7%	Pontiac 27.1
Four-speed manual 27.4	No changes 16.6%	No 38.3	Ford 22.9
Five-speed manual 2.4	Different seats 11.3	What type of trouble?	Oldsmobile 11.5
Body style choices:	Better gas mileage 10.6	Carburetor 15.0%	Plymouth 8.3
Two-door coupe 68.6%	More trunk space 7.9	Oil leaks 11.0	Age distribution of owners:
Three-door hatchback 28.9	Better workmanship 7.3	Heater 10.0	Under 20-29 years 51.8%
Three-door wagon 2.5	Workmanship opinion:	Brakes 9.0	30-49 years 29.6
Why did you choose the Sunbird?	Excellent 14.5%	Transmission 8.0	50-plus 18.6
Styling 52.2%	Good 41.2	Electrical 8.0	Would you buy another Sunbird?
Economy 50.9	Average 24.2	Dealer repairs satisfactory?	Yes 55.6%
Size 24.8	Fair 12.7	Yes 51.6%	No 44.4
Price 19.9	Poor 7.3	No 48.4	
Past experience 8.7			

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

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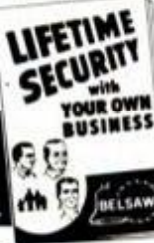
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Oil dipstick hides under spare, but engine access is good otherwise, say owners.

wife to drive, goes well in these mountains, and is excellent in the snow."

A Wisconsin lumber grader: "The Subaru handles great with front-wheel drive (fwd) and better yet in 4wd. It's good for all-year driving and pulls through as much or more snow than my dad's 4wd Jeep. When I drive larger 4x4s, I feel I'm fighting not only the terrain but also the vehicle. With my Subaru, I don't get that feeling. I enjoy it on or off the road. It's built to take it and give it!"

And a New York public-health nurse: "I'm very pleased with the way this wagon

handles. I drive in all types of weather and on all sorts of roads. The Subaru has to survive constant starts and stops, potholes and dirt roads, and it does this with style."

We also asked owners to list what they like most about their Subarus and what they dislike most. Taking specific likes first:

"I appreciate the good gas mileage," recorded a Michigan landscaper, "plus the 4wd, the nice ride for being a 4wd, the ease of shifting into and out of 4wd, the general silence of the car."

A California medical assistant: "It's a great woman's car because of the convenience of going into 4wd without getting out of the vehicle. That's a great safety feature."

A New York teacher: "Fantastic handling on snow or icy roads. It's really a superior vehicle for these conditions. The car is also well made, with careful attention to detail. The gas mileage is good, and it's a fun car to drive."

And a Montana physician: "I'm pleased by the fact that it burns regular fuel. My wife likes the reclining passenger seat."

On the negative side, here's a typical cross section of owner dislikes:

"To check the oil," notes an Ohio elec-

tronics technician, "you have to remove the spare tire from the engine compartment."

A New York store manager: "Subaru advertises its 4wd as a 'go-anywhere' vehicle, but then the manual says the warranty is invalid if I use my wagon off-road. That's pretty poor."

A West Virginia mining engineer: "The engine ought to be 15-20 percent more powerful for negotiating hills and such."

"Not enough ground clearance," grumbles an Arizona retailer.

A Vermont loan officer: "This is my sec-



Respondents judge rear legroom poor, especially with front seats pushed back.

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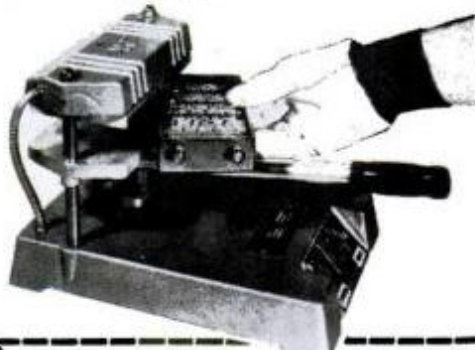
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ond 4wd Subaru wagon. I've found that they tend to use a little oil—about a quart every 1200 miles."

And a Michigan auditor: "With my long legs, I find the Subaru difficult to drive long distances. And the wagon definitely needs more legroom in the back seat."

When we asked owners to suggest changes that might improve the Subaru, we received these replies:

"The driver's seat needs more back

support," suggests a Michigan laborer, "and there ought to be more space around the foot pedals. I would also like a five-speed transmission." [Editor's note: Subaru 4wds will probably offer five-speeds for 1980.]

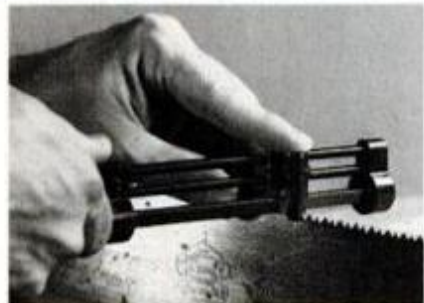
Taken all together, though, Subaru owners like their 4wd wagons a lot. A North Carolina rural mail carrier affirms, "As far as I'm concerned, the Subaru is the best wagon on the road." And a Geor-

gia air-traffic controller sums it up this way: "The 4wd Subaru wagon has become our primary family vehicle. We have owned five American cars and two British sports cars, and I find the quality of workmanship far superior to any of these. My wife, being used to U.S. cars and prices, was impressed with the many 'options' that are standard on the Subaru. All in all, I think Detroit could learn a lot from Japan." **PM**

SUMMARY OF 1979 SUBARU 4WD WAGON OWNERS REPORTS*

Total miles driven 638,667	Engine lacks power 16.2	Poor 1.0	Average 13.3
Average miles per gallon:	Not enough legroom 15.2	Comfort opinion (rear seats):	Fair 9.2
In town 25.1	Poorly shaped seats 8.1	Excellent 3.1%	Poor 11.2
Long trips 30.6	Poor dealer service 7.1	Very good 12.4	Number of vehicles owned:
Model choices:	What changes would you like?	Good 17.5	Subaru only 37.3%
DL 4wd 46.6%	More interior roominess 19.4%	Fair 40.2	Two cars 50.0
GL 4wd 53.4	More legroom 18.4	Poor 26.8	Three cars 9.8
Why did you choose Subaru?	More powerful engine 10.2	Had any mechanical troubles?	Four or more cars 3.0
Front/four-wheel drive 61.5%	Change seat shape 9.2	No 72.8%	Makes of other cars owned:
Overall economy 51.0	No changes at all 8.2	Yes 27.2	Ford 18.5%
Styling 11.5	Workmanship opinion:	What type of trouble?	Chevrolet 13.8
Handling 10.6	Excellent 56.7%	Brakes 14.3%	Volkswagen 10.8
Doesn't need unleaded fuel 9.6	Good 34.6	Transmission 14.3	Subaru 7.7
Specific likes:	Average 5.8	Electrical 10.7	Age distribution of owners:
Economy 70.9%	Fair 1.0	Dealer repairs satisfactory?	Under 20-29 years 23.7%
Handling 48.5	Poor 1.9	Yes 52.0%	30-49 years 49.5
4wd 45.6	Comfort opinion (front seats):	No 48.0	50-plus 26.7
Styling 19.4	Excellent 24.3%	Dealer service opinion:	Would you buy another Subaru?
Performance 15.5	Very good 34.0	Excellent 32.7%	Yes 89.8%
Specific dislikes:	Good 29.1	Good 33.7	No 10.2
No complaints 19.2%	Fair 11.7		

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



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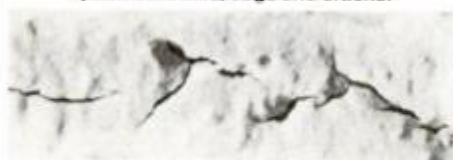
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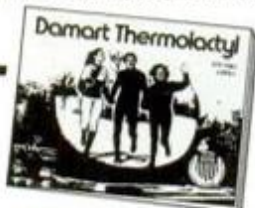
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Shop storage jars



An empty baby-food jar with a length of coat-hanger wire riveted to the lid makes a useful storage container that can hang on perforated hardboard. Bend a small circle at one end of wire and attach it to lid's center with a cold rivet. Bend second end so it stays put when pressed into hardboard hole.—*G.L. Short*

Film makes dotted lines



You can use the perforations in a scrap piece of 35-mm or other photographic film as guides to draw neatly spaced dots or dashes.—*Wilson Bayles*

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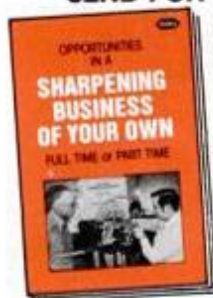
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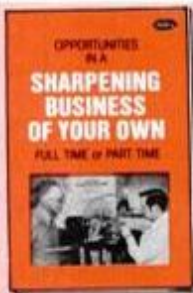
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SERVICING THE 4WD EAGLE

(Continued from page 95)

ever, the gears will not be damaged. At oil-change time, the new transfer case takes inexpensive, readily available 10W-30 engine oil.

Although stick-slip is gone, you may encounter a grunting noise on acceleration from a stop. This is usually caused by a loose drive chain. Like the Q-T-I, the Q-T-II case has an inspection hole. You remove a threaded plug in the bottom of the case for access and insert a depth gauge. If the gauge can be pushed in too far, the chain is loose. The Q-T-II has a new chain design, however, that AMC engineers claim should last a lot longer.

Front-end design

The front end of the Eagle is a conventional independent design, with upper and lower control arms and a coil spring between the upper arm and body. Independent front suspension is the minimum-acceptable design for passenger cars, because it permits each steered wheel to respond independently to road irregularities for better handling and ride.

With independent suspension, the front-driving axle cannot have rigid axle tubes to each wheel. The Eagle design, somewhat similar to the Chevy Luv truck, has the axle banjo offset to the left (to line up with the transfer-case prop shaft) and one rigid tube, which passes under the engine oil pan and ends at the right side of the engine. There's a short differential shaft on the left side and a long one on the right side (to extend through the tube). Each differential shaft ends just outside the axle housing with a flange, to which is bolted an exposed driveshaft with inner and outer constant-velocity universal joints.

The normal practice with a front-driving axle in 4wd is to bolt it to a chassis cross member. On the Eagle, however, it's attached to the engine, and the engine mounts double as axle cushions.

There's just a ¼-inch clearance between the axle tube and the oil pan on the 258-cu. in. six-cylinder (the only engine presently offered), so you can't tip down and remove the oil pan with the axle in place. If there's a problem, such as a gasket leak, unbolt the axle housing from the engine on both sides (all hardware is accessible) and you can lower the housing to provide adequate clearance for oil-pan removal.

Wheel alignment

Although most of the front suspension parts are different from the Concord, the Eagle does retain the basic mechanical arrangement. This means camber can be adjusted by turning an eccentric bolt, caster by adjustment of the strut rod and toe the usual way at the steering linkage. The Eagle is the only 4wd that permits all

three adjustments to be made in a conventional manner.

If you have to work on the front suspension, make sure you get parts specifically for the Eagle. Concord suspension bushings, shocks and springs may fit in, but only the upper control arms are the same as on the Eagle.

Tire size on the Eagle is also different from that on the Concord. Instead of a 14-incher, the Eagle has a 15. The P195/75R15 size is standard. You can squeeze in a 205 tire if you want, but some of the tire-to-under-body clearance becomes awfully tight, and if the tolerances stack up the wrong way, you could run into problems.

The control arm ball joints are a packed-for-life design, with low-friction plastic inserts, so they have no grease

WHEN IS A CAR A TRUCK?

The Eagle is a passenger car, right? Not according to the government, which classifies it as a light truck for emissions purposes, based on such things as its high ground clearance, modest overhang and four-wheel-drive system.

For safety, it's classified as a multipurpose vehicle, right along with the Subaru Brat.

American Motors has been calling it an automobile and a vehicle, but not a passenger car. Federal safety and emissions standards for trucks and multipurpose vehicles are easier than for cars. However, Eagle has been designed to meet the passenger-car safety requirements (except for the bumper system, which must be different because of the ground clearance and approach angle). The Eagle has all the emissions controls of a passenger car. However, the calibrations are designed to pass the light-truck standards.—P.W.

fittings. The car does have six fittings, however, all on the prop shafts. There's one at the front and rear universal joint of each prop shaft, plus an additional one at each sleeve yoke.

Rear suspension

The rear suspension on the Eagle is basically an upside-down version of the Concord's. Attaching the leaf spring to the top side of the axle shaft tubes, instead of the bottom, as on the Concord, raises the car body three inches, matching a lift-up made with chassis modifications at the front (to accommodate the front drive axle).

As on other AMC products, you can order the Eagle with the Delco automatic leveling rear air shock system, the same used on Eldorado-Toronado-Riviera. A height sensor on the rear suspension triggers a combination electric air compressor and solenoid valve to inflate or deflate

(Please turn to page 210)

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SERVICING THE 4WD EAGLE

(Continued from page 209)

the air shocks in accordance with changing loads.

Or you can get a heavy-duty suspension (rear sway bar, different front stabilizer bar, higher-rate rear springs and stiffer shocks all around).

If you're planning to pull a camper, one of the suspension options might make a difference. However, the Eagle is *not* a Jeep, and it's not meant for the same kind of off-road operation. By the same token, it is designed for some off-road use.

The transfer case is protected by a skid plate and if you're worried about the front, you can get an optional skid plate that will protect the front belt-driven accessories and the power steering pump and gear—standard equipment on the Eagle.

Axle vents

If you ford a shallow stream or just a deep puddle on a public road, the front and rear axle vents should prevent water contamination of the oil. Both are connected by flexible tubes to safe locations, high and dry in the car body. If you drive off-road through an area with sharp thorns and rocks, however, check that the flex lines have not been cut open.

If the water level gets up to the midpoint of the wheels, you should disassemble the front hubs and check for water contamination of the lubricant. If you find any, clean and relube the bearings.

Tow-truck techniques

There are some simple rules for towing an Eagle, and you ignore them at peril to the transfer case or transmission. For short distances (up to 15 miles), tow with all four wheels on the ground at up to 30 mph, with the transmission in NEUTRAL. For greater distances (or if you want to tow faster), remove both prop shafts. If you're towing with one pair of wheels raised, only the prop shaft to the wheels on the ground need be removed. As in the first case, the transmission must be in NEUTRAL. If you left it in PARK and tried to tow with one pair of wheels raised, the car would move; you'd probably never notice that the raised wheels were spinning in reverse. The silicone clutch, in trying to oppose the reverse movement, would be damaged.

Even in NEUTRAL, there's a problem if you tow too fast with the prop shaft connected. The prop shaft spins and the raised wheels spin in the proper direction, so the silicone clutch isn't damaged. However, just as on any automatic transmission, the transmission output shaft is turned. Because no lubricant is being circulated through the transmission, it will suffer damage if the speed is too great.

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mileage than a part-time system in the two-wheel mode. AMC engineers insist the difference is small—less than two mpg—and that the Six provides acceptable fuel economy, in the mid-teens or better, even equipped with the automatic transmission. AMC will be getting the four-cylinder Pontiac Iron Duke from GM in 1980, and a four-cylinder Eagle might generate fuel economy numbers in the 20s.

If the market demands even more economy, there's a New Process transfer case ready (albeit more costly) that can provide a choice of limited-slip full-time 4wd, an economical part-time 4wd, plus emergency low-lockup, each with the mere flick of a lever. You'll see this model make its debut with the 1980 Jeep.

It takes just a single winter of heavy snows to convince people that full-time 4wd is the surest way to go. The Eagle demonstrates that it can be a relatively simple system, incorporated into a smooth-riding car and having only straightforward, modest maintenance requirements. **PM**

KILLER TRUCKS

(Continued from page 81)

partment, with the expected gruesome results.

Self-regulation not an answer

In an attempt to police their own industry, American Trucking Associations have organized supervisory on-the-road patrols to spot irresponsible drivers. However, an ATA Safety Security Department spokesman says, "If a union driver is involved, there isn't much action that can be taken other than to put a notice of the offense in the driver's file."

Other attempts to improve safety by ATA involve safe driving meetings and distribution of literature—which engender a predictable apathetic response on the part of most drivers.

From what I have seen, it will take more than critical reports and literature to stop the rise in the truck-related fatality toll. The incompetent truck driver and the unsafe truck *must* be removed from the highway. Industry and government have been successful in keeping commercial aviation relatively free of careless pilots and unsafe aircraft. It is not unreasonable to demand that industry and government, working together, achieve a similar level of safety for the nation's highways. The sooner the better, for all of us. **PM**

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BUILD PM'S SPINNING WHEEL

(Continued from page 105)

chuck a long 1/8-in.-dia. bit into a drill press. Mark hole locations. Then bore through the width. This will provide aligned pilot holes for the larger bits.

When cutting the notch in the base (C), note that the front edge of the notch should be cut at an angle to conform to the upright. You can use either a jig or coping saw to make this cut.

To cut out the wheels, a sabre saw with a circle-cutting guide works fine. Remember that when using a pivoting type of guide, the front edge of the blade must be directly in line with the pivot point. (See *Basic Cutting with a Sabre Saw*, page 133, Mar. '78, for a detailed explanation.)

Cutting the grooves on the wheel edges can also be tricky. Construct the jig shown in photo on page 213 and clamp to the bench-saw fence. Be sure the common nail used as

pivot at wheel's center penetrates securely through the vertical board. The wheel should be snug against the board, but not tight. To make the cut, lower the dado and slide the fence into place, so the blade will cut a 3/16-in.-wide groove in the center of the wheel edge. Turn on saw and slowly elevate the dado until it contacts the workpiece. Rotate the work in the same direction as the blade spins. Make several passes, elevating the blade each time until the groove is finished. A repeated se-

How to prepare and spin raw wool



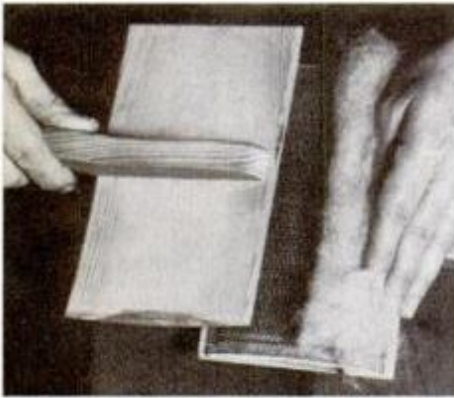
To prepare raw or washed, uncarded fleece for spinning, first pick the strands apart with fingers; remove burs.



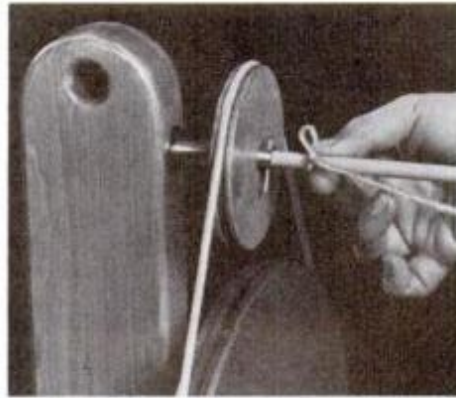
Moving from bottom to top of carder, apply picked fleece by pulling it across tiny hooks on open face of tool.



When fleece covers the face of one carder, use second carder to comb strands. Fleece must be combed several times.



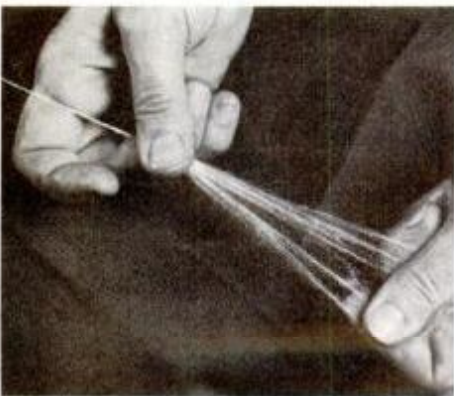
After fleece is sufficiently carded, use one carder to gently roll it into a rolag (roll of wool ready for spinning).



Tie foot-long piece of scrap yarn to quill to make leader (starter length). Begin spinning wheel clockwise, feed on rolag.



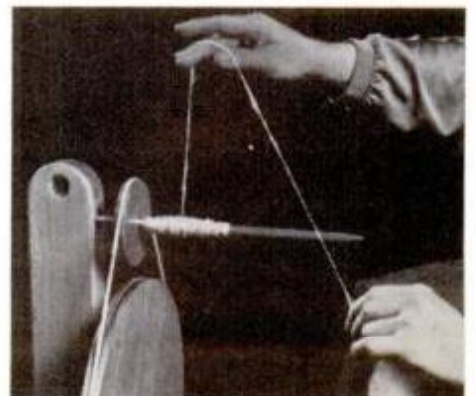
Microscopic natural hooks on wool strands are drawn into twisting leader yarn. Interlocking action halts unraveling.



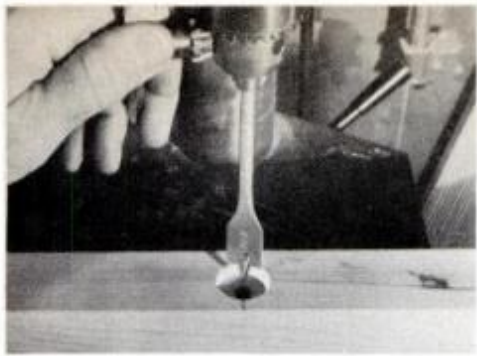
Use the thumb and forefinger of your right hand to control twisting action; left hand spreads fleece and provides even feed.



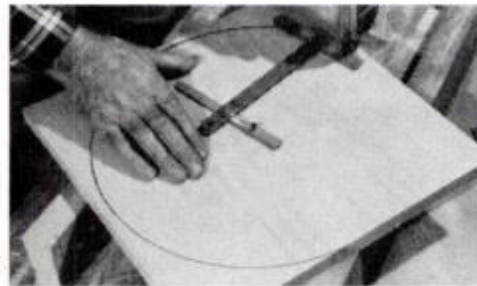
Formation of yarn takes place between right and left hands, which should eventually extend as far as possible to side.



When arm's length of yarn is spun, back up counterclockwise on pedal, collect yarn on spindle. Resume spinning.



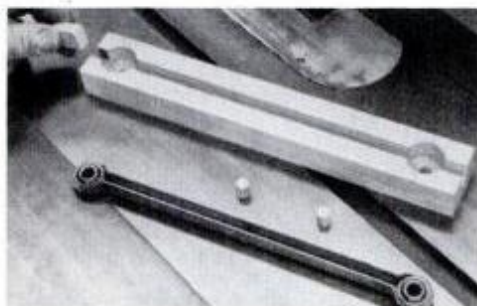
When counterboring for bearings in upright, bore larger hole first. Otherwise, centering larger bit would be impossible.



Sabre saw with pivoting guide cuts perfect circle. Position blade against outside edge of board. Then drive in pivot nail.



To cut edge groove, lower dado head and clamp jig to fence. Turn on saw, elevate cutter slowly, rotate wheel into cutter.



Glue a wood filler block into the top end of the footman cover to plug the void you made while cutting the groove.



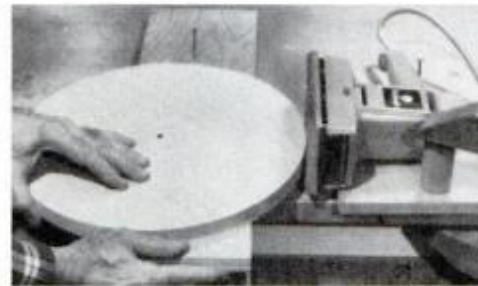
The center-to-center spacing for bearings can be double-checked by test assembling wheels and belt before drilling.

ries of passes with a single blade will also work.

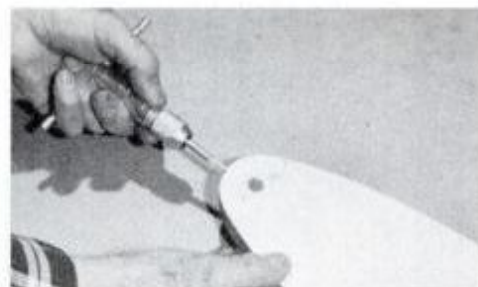
The footman cover is straightforward, but note that when you are boring the 1 1/4-in. holes, the drill point will penetrate the workpiece face. Bore 3/8-in.-dia. holes at these penetrations and plug them to conceal the holes.

After cutting out all parts, sand them smooth. Then use a router and 1/4-in. rounding-over bit to slightly break all edges. Set the bit for a shallow cut on all plywood pieces to pre-

(Please turn to page 214)



Build jig for smoothing wheel edges by clamping sander to board, nailing assembly to bench. Wheel rotates on pivot nail.



To keep threads for the footman bolt from stripping, drill and tap hole in hardwood dowel after gluing it into the treadle.



Screw offcenter bolt (N) into pretapped hole in axle hub. Note: Attach drive belt before installing the footman.

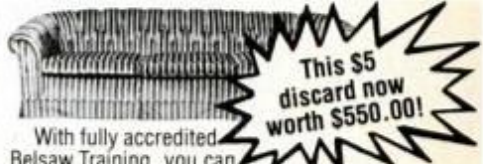
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BUILD PM'S SPINNING WHEEL

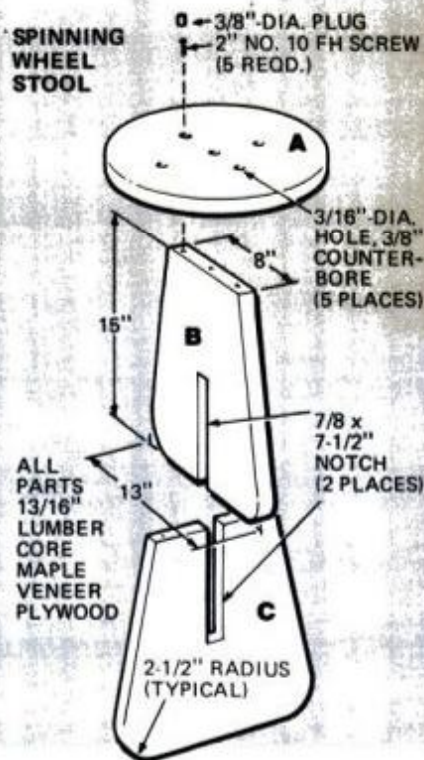
(Continued from page 213)

vent rough feathering at edges. A deeper cut can be taken on the footman cover and the upright. Note: Round the edges on upright (F) before boring the bearing holes to prevent pilot on bit from slipping into voids.

For best results, apply a stain and/or a clear finish before final assembly.

Simple stool construction

After cutting the parts using a sabre saw, ease all plywood edges, as done on the spinning wheel parts. Sand and finish pieces to match the wheel, except for the top of the seat. Assemble with screws and plug holes. Finish seat top after assembly. **PM**



MATERIALS LIST—STOOL

Key	Pcs.	Size and description (use)
A	1	13/16 x 12"-dia. plywood* (seat)
B	1	13/16 x 13 x 15" plywood* (support); cut slot at bottom
C	1	13/16 x 13 x 15" plywood* (support); cut slot at top

*Use hardwood-veneer, lumber-core plywood for best results.

Misc.: 5 3/8"-dia. plugs; 5 2" No. 10 fh screws; light oak stain and satin polyurethane varnish (or to suit); white glue

SUPPLIERS

Construction materials

Hardwood-veneer plywood: Constantine, 2050 Eastchester Rd., Bronx, N.Y. 10461. (Order a 15x60-in. plywood panel to build spinning wheel only, a 30x60-in. panel to build wheel and stool. Write for prices.)

Hardware kit for spinning wheel: \$44 postpaid from School Products Co. Inc., 1201 Broadway, New York, N.Y. 10001. (Complete wheel costs \$114.50 postpaid. Send \$1.00 for catalog of spinning supplies.)

Books on spinning

Step-by-Step Spinning and Dyeing, by Eunice Svinicki, Western Publishing Co. Inc.

Handspinning—Art and Technique, by Allen Fannin, Van Nostrand Reinhold Co.

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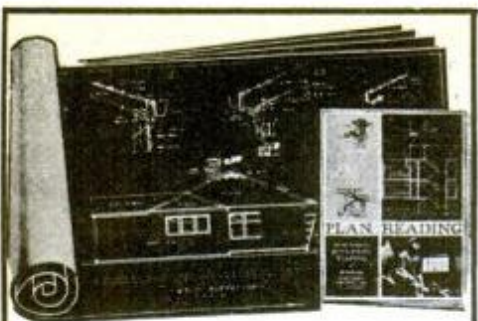
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NOTES FROM THE EDITOR

John A. Littleton

The good news is that the paper strike is over. It shut down the mill of one of our principal paper suppliers—and you've probably been aware of the result. We and most other magazine publishers have had to print portions of our publications on uncoated (hence, not glossy) paper. The supply of coated paper will be back to normal soon—and our pages will look bright as ever. (Just for the record: It takes about 1,600,000 pounds of paper to publish an average issue of PM.) Thanks for understanding.

Most of the assignments we desk-bound editors give PM contributors are offered reluctantly; we'd really rather be off doing them ourselves. Such is the trek we've sent long-time *Car Clinic* editor, Mort Schultz, on. In late spring, we pointed Mort cross-country to search for the ingenious ways in which Americans are coping with energy problems. In Florida, he drove the Moody 84-mpg diesel you read about last month. Then, in New Jersey, he had his car outfitted to burn propane (see page 48A). When we last heard from him, he was absolutely pleased with his car's performance. He has also been driving electric cars (see PM next month). By the time he crosses the United States both directions, Mort will have first-hand reports on the dozens of ideas, gadgets, devices—and real breakthroughs—we know will renew our confidence that good old American ingenuity can rise to any challenge. (After we solve the energy crisis, let's run our trains on time.)



In December 1968, PM speculated that the Navy's experimental USS *Plainview* "may be the forerunner of a fleet of . . . high-flying sub-chasers." In this case, "flying" meant raising the ship's hull out of water on hydrofoils—sort of underwater wings—and skimming along at high speed. Now, 11 years later, the Navy *does* have a fleet of six high-flyers on the way, smaller than the *Plainview* but the only such ships capable of firing missiles. I rode up the coast of Florida on the first of the new Boeing-built fleet, the USS *Pegasus* (PHN-1) at a speed of "over 40 knots" and spent much time envying the bright, young crew lucky enough to run that ship. LCDR Bill Erickson (far right) has been skipper since the ship's commissioning; soon to replace him is LCDR Charles Penque (left in photo). Both claim that *Pegasus* is the only way to fly.



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A Major New Product

Electronic Ruler



The revolutionary Panasonic Electronic Ruler is simply remarkable. Imagine being able to spread out the most intricate road map and follow every twist and turn to the same degree of accuracy with which it was drawn.

Take a ball, mark two or three points anywhere on its surface and your Panasonic Ruler follows the contour of the sphere from one point to another with uncanny precision.

Every measurement made is recorded and displayed on the unit's 8-digit, green fluorescent display. The display, itself, was selected because of its optimum visibility indoors or out, in the brightest sunlight or under the dimmest working conditions.

MORE THAN A RULER

If this compact instrument were just an electronic precision measuring tool able to measure three dimensional objects, this would make it unique. But it is a great deal more.

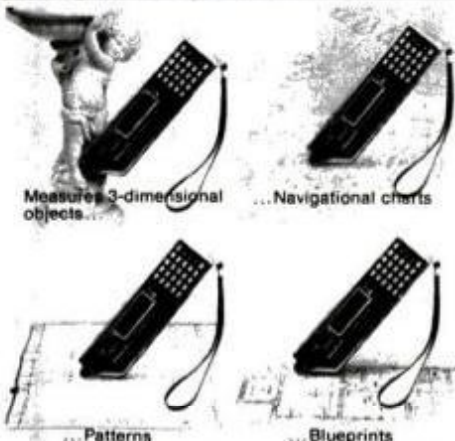
It is an instant measurement converter.

To begin, you select the metric rule to which you want to measure your chart, or sculpture, or whatever. Just slide the scale indicator to: m (meters), cm (centimeters), or mm (millimeters). Now, engage the serrated roller wheel by merely moving its slide switch. The roller is serrated, rather than smooth, so that it moves precisely over any intended surface without slipping. Press the Scale Key (scI) to prepare the unit for the measurement you are about to make. Now, do it. Move the wheel over your chart or object and watch the digits accumulate on the display. Let's say you measured the arm of a chair in millimeters and found that it was 368 mm. If you wish to read the result in inches, just touch the "in" button and "presto," the display shows 14.488 inches. Measuring a map takes one step more because you first must measure the map scale.

If your chores call for measuring volume, you will appreciate how easily the ruler converts mm³, cm³, m³ to yd³, ft³, and in³. You can precisely measure volume, length and distance, even from reduced or enlarged documents. With the Panasonic Ruler, you don't need someone to hang on to the end of a tape measure. You can store and accumulate all sorts of room and area dimensions—accurately, quickly, effortlessly.

If Panasonic's Electronic Ruler were just an electronic ruler with conversion capability, this, alone, would make it exceptional; but again it offers more.

It is a true memory, percent calculator



Measures 3-dimensional objects...

...Navigational charts

...Patterns

...Blueprints

that permits you to compute all sorts of measurement and traditional calculations. For example, a board of lumber costs 76¢ a foot. You run your electronic ruler across the piece you need and determine that it is 1.656 meters. Press F (feet), read 5.43 (feet), press X .76 = and your cost is \$4.13. You can even add or subtract percentages for taxes and discounts. The display reads 4.1268, so press X 5% + and your total cost including tax is \$4.33. Speaking of tax, because of its professional application, the Panasonic Ruler can be a tax deduction for you. Ask your accountant.

In addition to all we have mentioned, the Panasonic Ruler features a constant Pi key along with everything else you would expect to find on a first rate calculator: floating decimal, add on/discount percent, automatic squaring, chain and mixed calculations and constant computations.

Its housing is sturdy aluminum and snapped to its back is an adjustable straight edge guide for added ruling



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Auto Editor, Popular Mechanics

The Auto Editor of *Popular Mechanics Magazine* evaluated the BikeBug as an alternative to mopeds ... and his choice was the BikeBug! His two-page Product Report, (Dec. '77), was based solely on quality, design and performance. Price was never a consideration, even though mopeds cost hundreds of dollars more (Complete reprints with our free brochures).

The BikeBug engine and front-wheel-drive unit bolts in minutes to the front fork of any bike, from 10-speeders to adult tricycles. It runs up to 24 mph, gets 215 mpg, operates quietly, starts automatically, has a One-Year Warranty, and allows normal pedaling, even with the engine running.

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Another Tidy Car Success Story...

"At 18, I've got my own business, four employees and a goal to make a million before I'm 25."

Timothy Seward
Michigan

The only green that grows under Tim Seward's feet has pictures of George Washington and other so honored Presidents. His sole goal upon high school graduation was to own a business of his own and be successful at it.

He'd read an article about modern-day entrepreneur Gary Goranson, Tidy Car president, and the month he graduated he was on a plane to meet with Gary and 150 established Tidy Car dealers at a seminar in Toronto.

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"I'd saved enough money from other sales work I'd done to pay for the \$1,000 start-up cost," Tim reports. "I knew that it was exactly the type of business I'd been looking for... the kind where you could work smarter, not harder and make more money. That's my motto, you know."

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PM LOOKS AT HOMELITE STRING TRIMMER



Away from power line? This innovative trimmer carries fuel in its handle.

Because this tool costs a lot more than its electrically-powered cousins, we decided to check this string trimmer.

Powered by a compact, husky 1/3-hp two-cycle gas engine, the lightweight trimmer is nicely balanced and easy to handle. It features a unique string advancement system which feeds out line to maintain a 20-in. cutting path. Replaceable line is available at Homelite dealers and department stores. Price makes this one a tool intended for professionals and people with large grounds.—*R. Capotosto and H. Wicks*

SPECIFICATIONS—TRIMMER

Model: ST-100. Engine: 2-cycle, 1/3 hp. Fuel: gas-oil. Cutting diameter: 20 in. Price: \$149.95. Warranty: 1 year, personal; 90 days, commercial. Manufacturer: Homelite Div. of Textron Inc., Box 7047, 14401 Carowinds Blvd., Charlotte, N.C. 28217.



Filler cap is in pistol-grip handle.



Prewound spool has 80 ft. of string.



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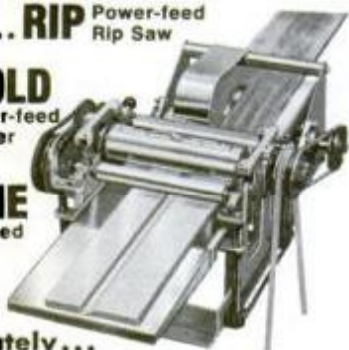
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Robert Sawyer - Roseburg, Oregon

"This machine pays for itself making money out of scrap boards. It is a very well built machine and I confess it is more than I really expected for the price. It does everything you say it will."

Stephen Schultz - Orangeville, Penna.

"I bought a batch of walnut in the rough, and after planing it on the Belsaw I figured I saved enough money to pay for two-thirds the cost of the Planer. It really does a good job."

R. S. Clark - Springfield, Ohio

"I make furniture, grandfather clocks and many other things. My Belsaw does nice work and I couldn't do my job without it. I really like it."

W. W. Robinson - Flat Rock, Illinois

...and from this well known authority -
"I recommend the Belsaw as the most useful shop tool any craftsman could own. We use one every day in the Workbench model shop... couldn't get along without it."

Jay Hedden, Editor
Workbench Magazine



PHOTO HINTS

Cool it



Photographic film and paper lasts indefinitely if stored in the freezer. Seal unopened supplies in plastic food bags; never refreeze opened packs. Thaw before opening.—Rudy and Marcia Schulze

Label fable



To save space in an equipment bag, it's wise to discard the film boxes. To know which film is in a canister, mark top with a grease pencil.—Bob Grewell

Able graduate



Half-gallon plastic containers are ideal for measuring large quantities of solution in the darkroom. They are easier, safer and cheaper than glass graduates.—Rudy and Marcia Schulze



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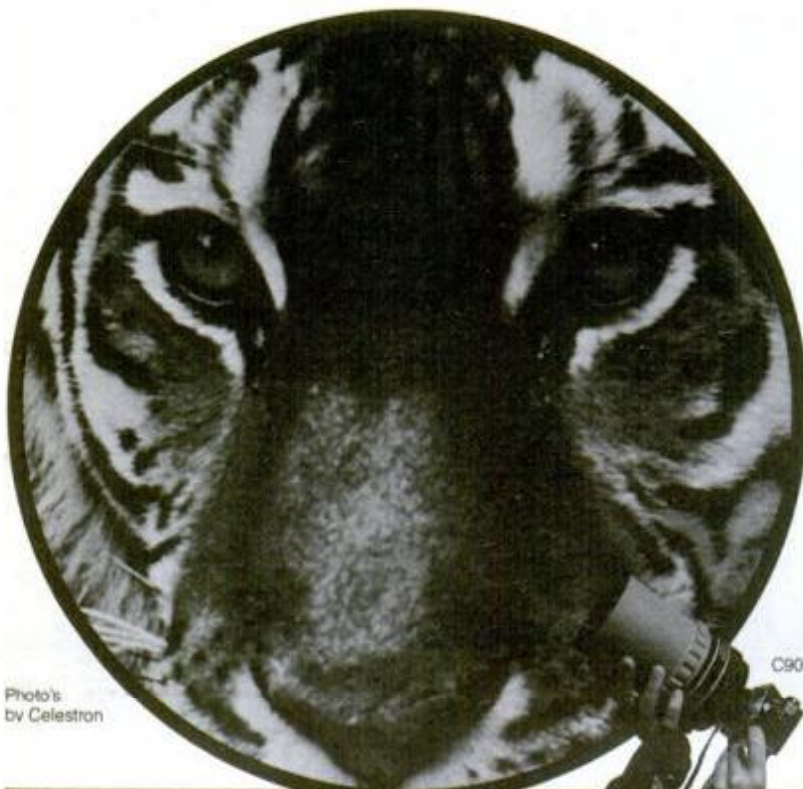
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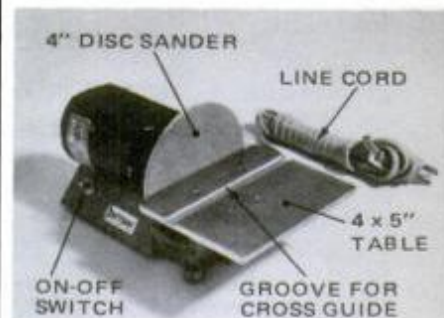
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PM LOOKS AT MINISANDER FOR HOBBYISTS

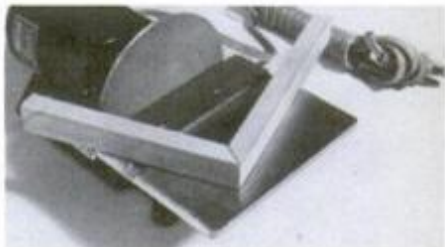


This 4-in. minisander is fine addition to serious miniature maker's workbench.

The first thing about this tool that impressed me was the accuracy and craftsmanship with which it's made. This is a tool designed and built for use by professional and serious hobbyist alike. Though the price tag may seem a bit steep at first—nearly \$60 for a miniature sander—it's a tool that is a delight to use when precise sanding is called for. Self-adhesive sanding discs are available in two grits from the manufacturer.—*H.W.*



Fine-grit, self-adhesive disc sands miter joints quickly, accurately.



Sander has a 4x5-in. table, and a 115-v. motor. A 230-v. is also available.

SPECIFICATIONS—MINI SANDER

Disc size: 4 in.
Motor: 1/16 hp, 115 v.
Weight: 6 lbs.
Price: \$59.50 (include an additional \$2 for mailing and handling)
Extra sanding discs (fine or coarse): package of three, \$2.95.
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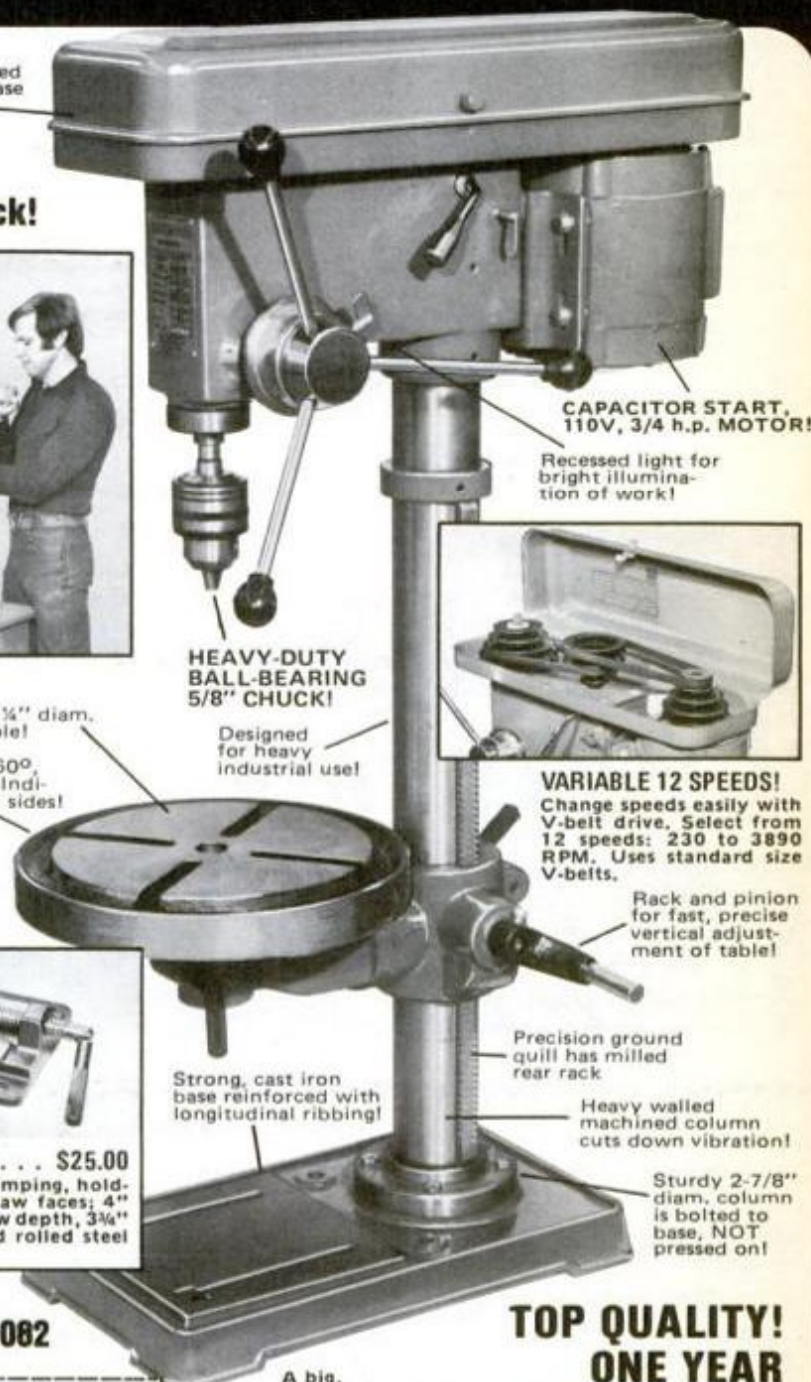
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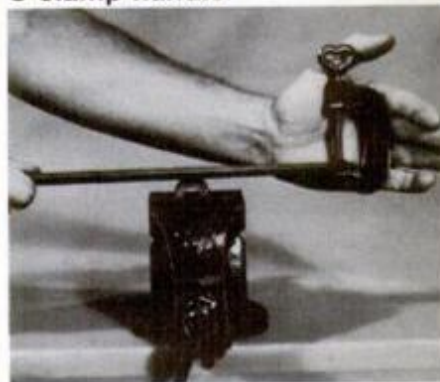
HINTS FROM READERS

Bamboo nails



Short lengths of match-stick bamboo from an old window blind, or slender bamboo dowels from pieces of bamboo pole can be used to reinforce glued joints. They're stronger than wood dowels of the same size. To make a round dowel, split a blank of bamboo and drive it through a hole about 7/64 in. in diameter bored in a steel plate. With the same size bit, bore a pilot hole in the joint; anchor bamboo with glue.—*W.E. Burton*

C-clamp handle



For more comfortable filing, add a C-clamp handle to file end as shown. Use ordinary handle on tang for safety.—*K. Patterson*

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For example, you'll discover how to advertise to bring in the prospects by the droves ...how to price your house ...17 steps in preparing your house for sale ...when and where to get an appraisal (if you need one)... what to say when a prospect calls ... how to turn a "Maybe we're interested" into a "This is just what we've been looking for!"

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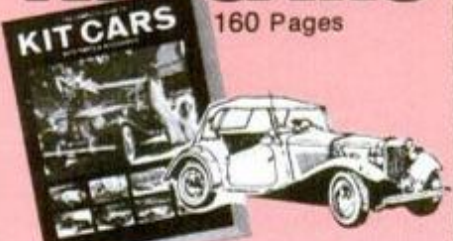
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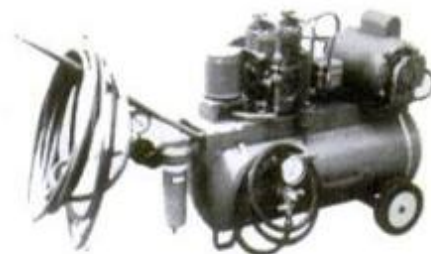
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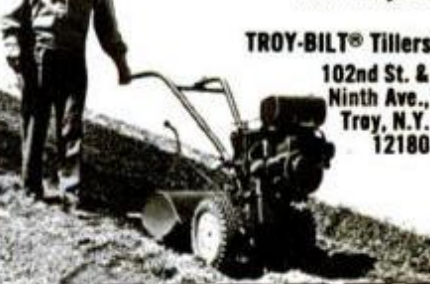
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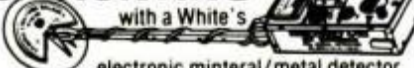
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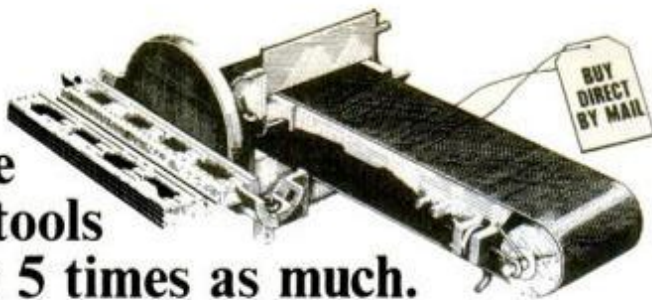
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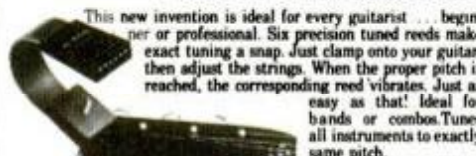


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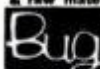


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PREVENT BURGLARY: Build electronic alarm. Plans \$3.50, P-C Board \$5.00. BC Enterprises, 2813 Delmonte, Bakersfield, California 93306

Portable refrigeration breakthrough makes ice chests obsolete!

New Solid State Refrigeration Modules no bigger than your watch, have More Cooling Power than a 10lb. Block of Ice.

Your ice chest is bulky, awkward to carry, messy and inefficient at keeping its contents cold. You have to buy ice every day, if you can find it, throw away the spoiled soggy food and drain off the water repeatedly.

Conventional portable refrigerators are either too heavy, too noisy, drain your battery too quickly or need to be kept level.

These problems and inconveniences have finally been resolved in one totally new product - the Koolatron 12 volt portable electronic refrigerator. We believe the Koolatron portable represents such a dramatic advance in refrigeration for recreational use that all existing methods are now outmoded.

USES AEROSPACE REFRIGERATION MODULES

The Koolatron portable cools your food electronically with solid state thermoelectric refrigeration modules. These same powerful modules are used by military and aerospace scientists to cool critical components in rockets and satellites. They use thermoelectric cooling because of its *absolute reliability, insensitivity to motion or level, small size & weight and minimal battery drain.*

WHY IS THE KOOLATRON PORTABLE SO MUCH BETTER THAN AN ICE CHEST?

An ice chest maintains an air temperature of 50-60 deg. F. Meat and milk spoil rapidly at temperatures above 50 deg. F. which is why the top of your meat will go bad even when it is sitting on ice. Koolatron portables maintain normal home refrigeration temperatures of 40-45 deg. F. even in 95 deg. F. weather.



Two of these miniaturized thermoelectric modules replace all the bulky, complex piping coils, compressors and motors in conventional portable refrigerators. The modules pump heat from your food into efficient heat sinks where it is dissipated by a quiet fan. They operate on a principle called the "Peltier Effect" - passing electricity through the junction of dissimilar metals causes heat to flow away from the junction.

BOATING, FISHING, CAMPING, HUNTING

Fits into virtually any boat, van or camper. Carry it on the back seat during car trips. Ideal for fishing and hunting - bring your catch back home fresh (a few loads of fish fillets could pay for your portable). Use it for grocery shopping, medicines, carrying film, salesmen's samples. Take it to the drive-in movies, auto races and other sporting events. With an inexpensive battery charger

you can use your Koolatron as a bar fridge all winter and a patio fridge in the summer. Run it in your motel room at night and enjoy a midnight snack whenever you feel like it. We have customers using our portables on construction sites, in workboats, laboratories and even in locker rooms for a "cold one" after the game.

THE ULTIMATE PORTABLE REFRIGERATOR

It weighs less than most coolers with a block of ice but holds over 40 pop cans or 40 lbs. of food in its large 36 qt. capacity. Plug it in a lighter socket in your car, boat or van or operate it from a 12 volt battery charger plugged into 110 volts. Cold contents will stay cold overnight with unit off. Draws a maximum of 4 amps., averages about 2 amps. at 70 deg. F. with the thermostat on. Keeps your food cold and dry. Exterior dimensions are 21" L x 16" W x 16" H. Interior dimensions are 16" L x 11-1/2" W x 12" H.

BUILT-IN QUALITY AND DURABILITY

The rugged "ABS" case is filled with the best insulation available - rigid urethane foam. It has a "150 lb. test" handle and non-rusting polypropylene hinge and latches, with stainless steel fasteners. The exterior is harvest gold with a white interior and has 4 non-slip rubber feet. Your portable comes with a 9 ft. detachable cord which plugs into your cigarette lighter. It also has terminals for attaching wires directly from a battery or fuse panel. The same terminals are used for your battery charger clips when operating from a charger. A reverse polarity warning light & buzzer are included. The Koolatron was designed so that the fan motor can be replaced by you with only a screwdriver. No other service should ever be required except for physical damage which can be repaired at our depots in Batavia, N.Y., or Barrie, Ontario.

GUARANTEE. 21-DAY MONEY-BACK TRIAL PERIOD

Your Koolatron comes with a written 1 year guarantee plus complete instructions and helpful information about batteries and chargers. If for any reason you are not totally satisfied, return it for a prompt refund in full.



BUY NOW AT OUR NEW LOW PRICE

Good news. Our increased sales have overcome mounting material costs. So for now we can pass on a



The Koolatron portable keeps 40 lbs. of food at household refrigeration temperature but weighs only 15 lbs. Only 21" x 16" x 16" ext. Model F1A shown.

saving of \$10.00 per unit. Formerly \$169.00. Now \$159.00 + \$7.00 handling and shipping (\$179.00 in Canada).

ADJUSTABLE THERMOSTAT OPTION

For an additional \$10.00 you can order the Koolatron portable with an adjustable thermostat in place of the standard fixed temperature thermostat - order Model F1A.

PAYS FOR ITSELF

If you are regularly using ice, your Koolatron portable will pay for itself with the money you save on ice, spoiled food, restaurant bills and the gasoline used looking for ice.

Don't Waste Another Dollar on Ice!

Phone your order in collect to

705-737-0842

Koolatron Industries Limited,
56 Harvester Ave., Batavia, New York 14020
230 Bayview Drive, Barrie, Ontario, Canada
Or use this handy order coupon.

Koolatron
INDUSTRIES
LIMITED Dept. 734

56 Harvester Ave., Batavia, New York 14020
Canada: 230 Bayview Drive, Barrie,
Ontario L4N 4Y8

Send me ___ Koolatron F1 @ \$159.00 (\$179.00 in Canada) + \$7.00 each for handling and delivery in USA or Canada. (N.Y., Ont. and Que. residents add sales tax.)

___ I want model F1A and have added \$10.00. I understand that I may return it undamaged within 21 days and get a full refund if I am not satisfied. I enclose my check money order for \$_____ or, please charge my Visa Mastercharge American Express.

Acct. No. _____

Expiry Date _____ Send brochure only

Signature _____
(necessary to ship merchandise)

Name _____

Address _____

City _____

State _____ Zip _____

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*Scout Traveler
towing a heavy boat.*

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You wait all year for that trip to the outback. But your car's usefulness begins to diminish about the time the highways become dirt roads. That's just when an International Scout becomes a bigger asset than ever.

The Complete Outdoorsman.

When mountain snow or soft sand can strand a car, Scout's four-wheel drive pulls out easily.

When towing something like a boat can give a car a backache, Scout provides an optional built-in, beefed-up towing package: 345 V-8 engine, leaf springs with a 6200-pound capacity, a truck-like rear axle, and one of the strongest frame hitches ever devised.

When room is at a premium in a car, Scout provides ample space

for five husky campers and all their gear.

When a dead-end trail can intimidate a car, Scout's 100-inch wheelbase permits U-turn maneuverability with compact-like ease. **Getting away—from the problems.** To a car, the wilderness represents a menacing piece of terrain. But to a Scout, the wilderness

represents home. And that's *any* Scout. The Scout® II, SSII, Traveler® or Terra®.

So before you escape to that great outdoors, take one side trip. To your International Harvester Scout dealer.



INTERNATIONAL HARVESTER

SCOUT.

Anything less is just a car.



TASTE WINSTON LIGHTS



**Best taste.
Low tar.**

13 mg. "tar", 0.9 mg. nicotine av. per cigarette, FTC Report MAY '78.

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