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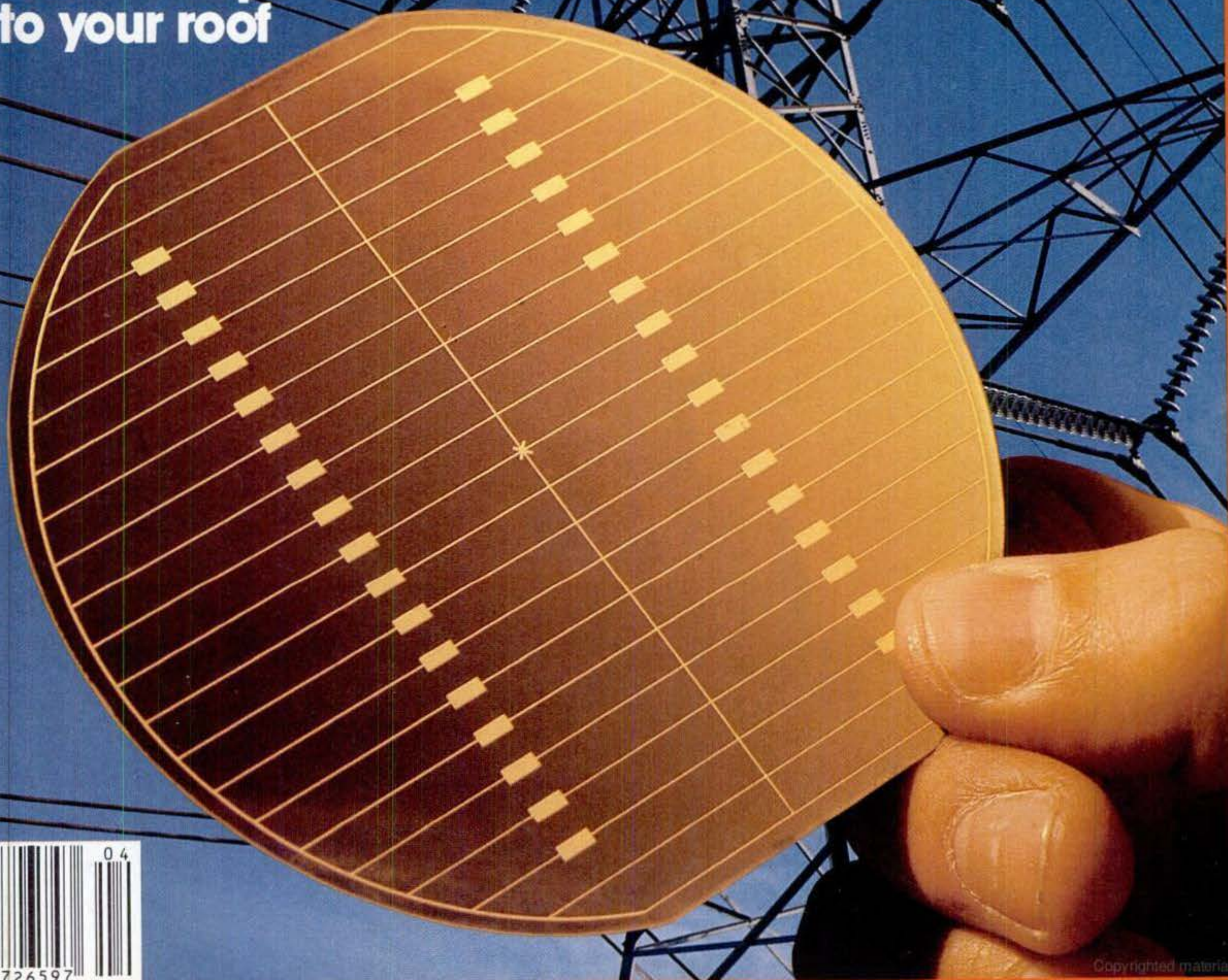
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APRIL  
1981

The **What's New** magazine

Sporty performance,  
high mpg from  
**GM's new  
J-CARS**

## Sunshine into electricity

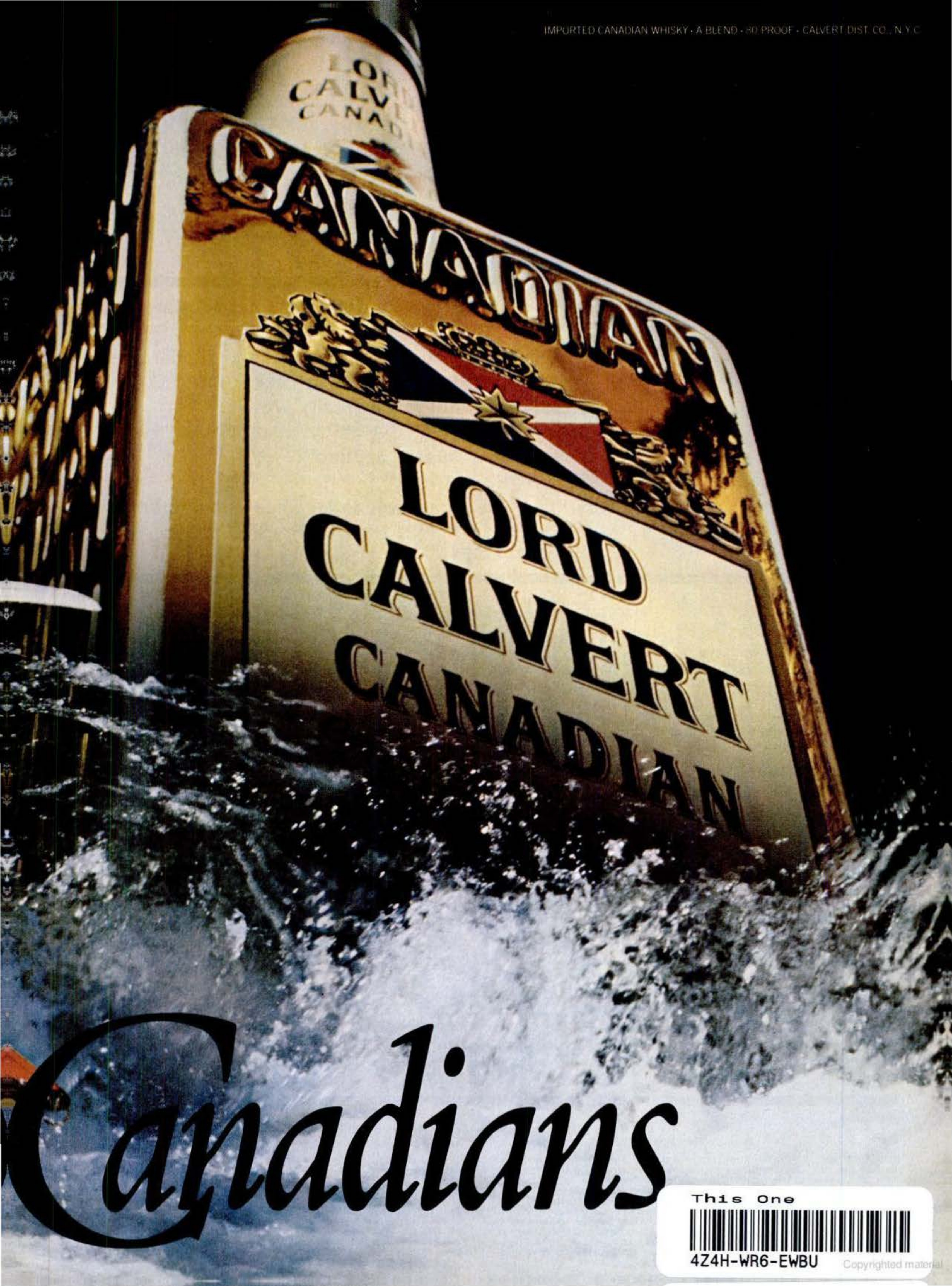
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# Popular Science

The **What's New** magazine

APRIL 1981  
Founded in 1872/ Vol. 218, No. 4

MONTHLY®

- HIGHLIGHTS** **Sunshine into electricity: Rooftop solar cells are coming**  
*OF* **New research generates hope for photovoltaic electricity at practical cost. PAGE 76**
- THIS ISSUE** **GM's J-cars: first look at a new class of subcompacts**  
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- The tantalizing quest for gravity waves**  
*Scientists are convinced they exist; special antennas may help find them. PAGE 88*
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*Tough new SF oils . . . Squeeze-and-spray car care . . . Rating radials. STARTS PAGE 97*
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COVER PHOTO BY JOHN KEATING

## CAR-CARE NEWS SPECIAL SECTION

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## PS READERS TALK BACK

Address letters for this column to: Readers Talk Back, 380 Madison Ave., New York, N.Y. 10017. Because of the large volume of mail, we are unable to acknowledge unpublished letters.

### Accidents happen

As a chemist, I take issue with the statement in "Double-Duty Heat Pump" [PS, Nov. '80] that tanks of sodium sulfide are completely safe for transport. Many chemicals that are "safe" in terms of pressure, temperature, and flammability become dangerous if they spill in a truck accident or train derailment. Spilled Na<sub>2</sub>S in contact with water containing even a bit of acid could generate considerable hydrogen sulfide, a fairly poisonous and extremely bad-smelling gas (rotten eggs). And various nasty oxides of sulfur could be generated if the accident involved a fire. No one wants accidents to happen, but given that they do, I don't think we should have truckloads of Na<sub>2</sub>S cruising the highways.

Ned Jackson, Seattle, Wash.

### More on diesels

In Richard Day's informative article, "Keeping Your Diesel Healthy" [PS, Dec. '80], there is a reference to storing your own fuel. Due to the availability of free 275-gallon oil tanks in the New England area, this is something I've been considering for some time. What are the explosion hazards? What sort of hand pump and filtering system should I use? Will I run into problems with water in the fuel due to condensation in an above-ground storage tank?

David P. Demers, Lunenburg, Mass.

A lot of people in my area are converting from oil to gas heat and selling their leftover heating oil at bargain prices. Is it feasible to use home-heating oil to fuel my diesel car?

Robert K. Colling, Fairport, N.Y.

*Author Day replies: "Diesel fuel is much safer to store than gasoline. Keep rotating your stock to keep it from going stale. If you purchase an old home-heating tank, be sure it's clean and free of water before filling it. Best bet for pumping is one of those new, small transistor pumps. They work from your car's cigarette lighter to click off about a quart a minute through*

*1/4-in. vinyl tubing. Pump with the suction tube slightly above the bottom of the tank to eliminate most water and debris. Adding a car-type fuel filter in-line will ensure added cleanliness.*

*"As for running a diesel engine on home-heating oil, don't do it. Bacterial growth is one problem. It's also unlawful for street use, since motor-fuel taxes have not been paid on heating oil. And what do you know about the heating oil's cetane rating and sulfur content?"*

### Breeder fallout

Edward Edelson's article "Do We Need the Breeder?" [PS, Nov. '80] falls short of your customary high standards in one critical area: objectivity. His emphasis on anti-breeder arguments makes it evident that his decision would be "no." He dismisses the comprehensive and successful French breeder-reactor program as an outgrowth of "relentless Gallic logic" (as if American logic in this field should be anything else). Then he quotes the assurances of a DOE official that our supplies of oil, gas, coal, and uranium make it less urgent for the U.S. to perfect this technology. It is hard for me to share his confidence when I recall that environmental considerations block the recovery of some of our most promising reserves. The crucial decisions to be made about national energy policy should be based on facts—not hunches, rumor, or irrational fear.

Gerome G. Torribio, West Covina, Calif.

Why did you give the last word in your otherwise balanced report on the breeder reactor to Pierre Zaleski, official spokesman for the French program? I think he is absolutely wrong when he says that, after four or five years of conservation, U.S. energy consumption will have to resume its growth if our economy is to grow. Indeed, the U.S. economy will be damaged if we make wasteful investments in unnecessary technologies instead of in energy-efficient ones. The French attitude seems to be "Damn economics! Damn

*Continued*

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## PS readers talk back

[Continued]

nuclear weapons proliferation! Full speed ahead."

We shouldn't be too smug about this French foolishness, however. It was the U.S. Atomic Energy Commission that sold the idea of the plutonium breeder to the world, and it is likely that the new administration will soon be out promoting it again.

Frank von Hippel, Senior Physicist  
Ctr. for Energy & Environmental Studies  
Princeton Univ., Princeton, N.J.

### The first law

How's that again, Jan? Did you really mean it when you wrote "a Btu of work input can produce two to four Btu of heat output" ["Alternate-Energy Answers," PS, Jan.]? If so, isn't this a violation of the law of conservation of energy?

G. G. Guilford, P.E., Idaho Falls, Ida.

Jan Kreider replies: "Yes I did, and no it isn't. Maybe 'produce' is the wrong word, but a heat pump does deliver more energy than it consumes—by moving heat from outside air to inside air."

### Improve yesterday's train

Charles Maurer's article "Tomorrow's Train is Running Today in Canada" [PS, Dec. '80] simply rehashes Urban Transportation Development Corp.'s promotional literature. He claims that the capacity of buses and light-rail vehicles—which he refers to by the outdated term "street-cars"—are limited to 10,000 passengers an hour. Not true: Buses can handle 15,000 and light rail 25,000 before things get too crowded. At a cost of \$25-\$30 million a mile, "tomorrow's train" is not competitive with light rail, which costs as little as \$8 million a mile. Another nice claim is that it can climb grades of six percent. The old trolleys could handle grades up to eight percent.

Peter Darwick, St. Catharines, Ont.

### Eggshells and oysters

I was amused by your item on the holographic process for determining eggshell thickness ["PS/What's News," PS, Jan.]. When I was a youngster, my father had a large chicken farm and we encountered egg-cracking problems, too. Solution? Feed the hens more calcium in the form of oyster shells. If today's egg producers are losing \$100 million a year, it's because they are trying to save perhaps \$5 million by cutting back on calcium. Now they have this new, expensive process. It seems to me to be a classic case of running around the barn to open the front door.

Norbert Corson, Land O' Lakes, Fla.

### Return of the rotorship?

The high-tech sailing ship on the Dec. '80 cover recalls Dr. Anton Flettner's rotorship, which, in 1924, successfully crossed the Atlantic. The "sails" of the rotorship

were tall cloth-covered cylinders on light wooden frames mounted on masts with bases that were rotated by electric motors powered from a diesel generator. The watch officer "made sail" or "took in sail" by changing the speed and/or direction of the masts. Apparently, the rotors performed well in strong and steady winds, but the ships could not be maneuvered in close or crowded waters.

Unfortunately, the introduction of diesel propulsion engines put an end to Flettner's experiment. But it's possible that the rotor principle might be of value today. The rotors could be controlled by the experience and judgment of the watch officer, not by a computer, which cannot, for instance, spot an approaching squall, and must deal with such emergencies only after they occur. The sea is one place where no computer programmer can foresee every possible adverse situation.

Edmund A. Milroy, Belleville, Ont.

### Fire hazards

Jim Kersten used rigid urethane foam in his "Room at the Top" [PS, Sept. '80]—an excellent choice from an insulating standpoint. But he should have installed a thermal barrier of 1/2-in. fire-resistant gypsum wallboard—or other material having a finish rating of not less than 15 minutes—on the inside of the insulation. This would protect the occupants of the home from the toxic fumes that can be emitted from this insulation when it's exposed to fire.

Charles T. Fox, P.E., Chattanooga, Tenn.

Ask any amateur fireman to take a look at your "Double-Shell Solar House" [PS, Dec. '79], and he'll tell you it's the biggest firetrap ever conceived. A house such as this could become a smoke-filled crematorium in minutes while firemen attempted to reach the house burning inside a house.

Thomas Daoust, Schenectady, N.Y.

Double-shell houses are generally designed with dampers in the airspace that close automatically when fusible links are exposed to very high temperatures.

### Decay, not fission

The headline on your January article "Fission Battery" is in technical error. Although the battery does perform as indicated, it does so by simple radioactive decay and not by fission. Fission is the splitting of an atom into two different atoms, and normally requires a neutron to initiate the process. In the case of the Radioisotope Photoelectric Generator a gamma ray is emitted, and the atom merely loses energy without splitting.

Robert M. Loesch, Director  
Nuclear Science Labs, Bel Air, Md.

**Correction:** We got our manufacturers mixed up in January's "What's New in Home Improvement." The Hot Wall heat-shield system is made and sold by Epox-on Products (929 Bransten Rd., San Carlos, Calif. 94070).





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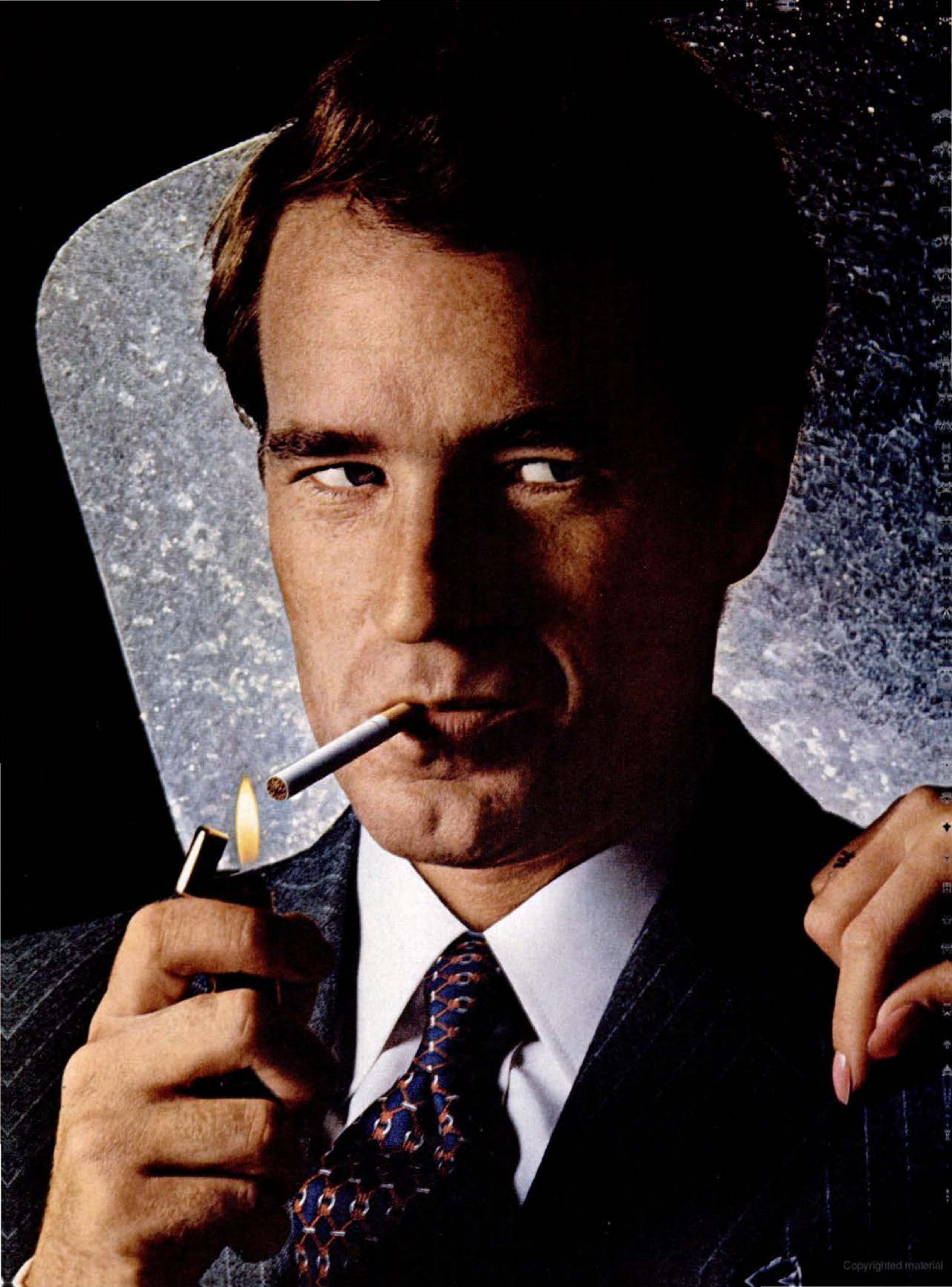
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Alas, one small problem:

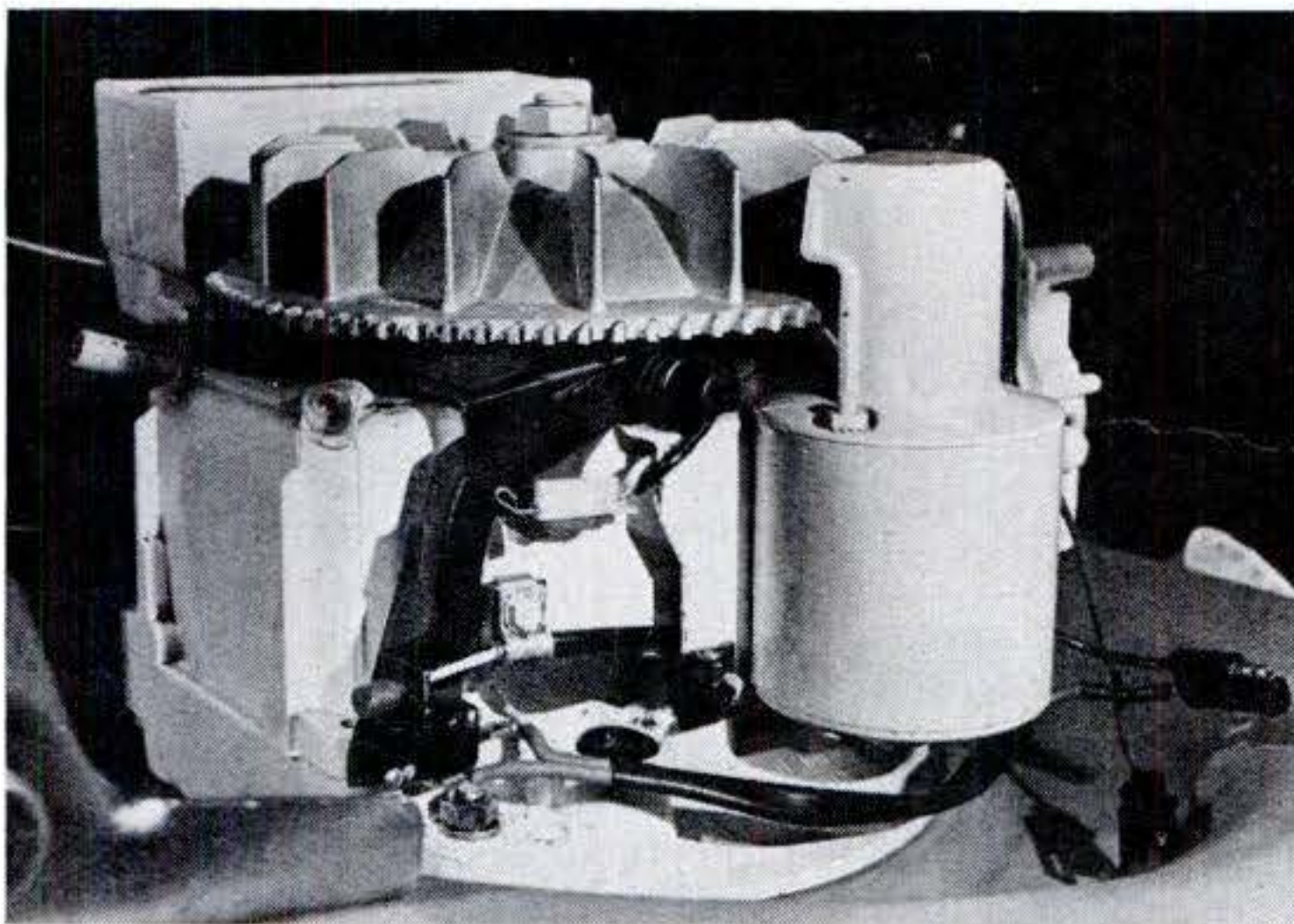
Some people still think it's funny looking.

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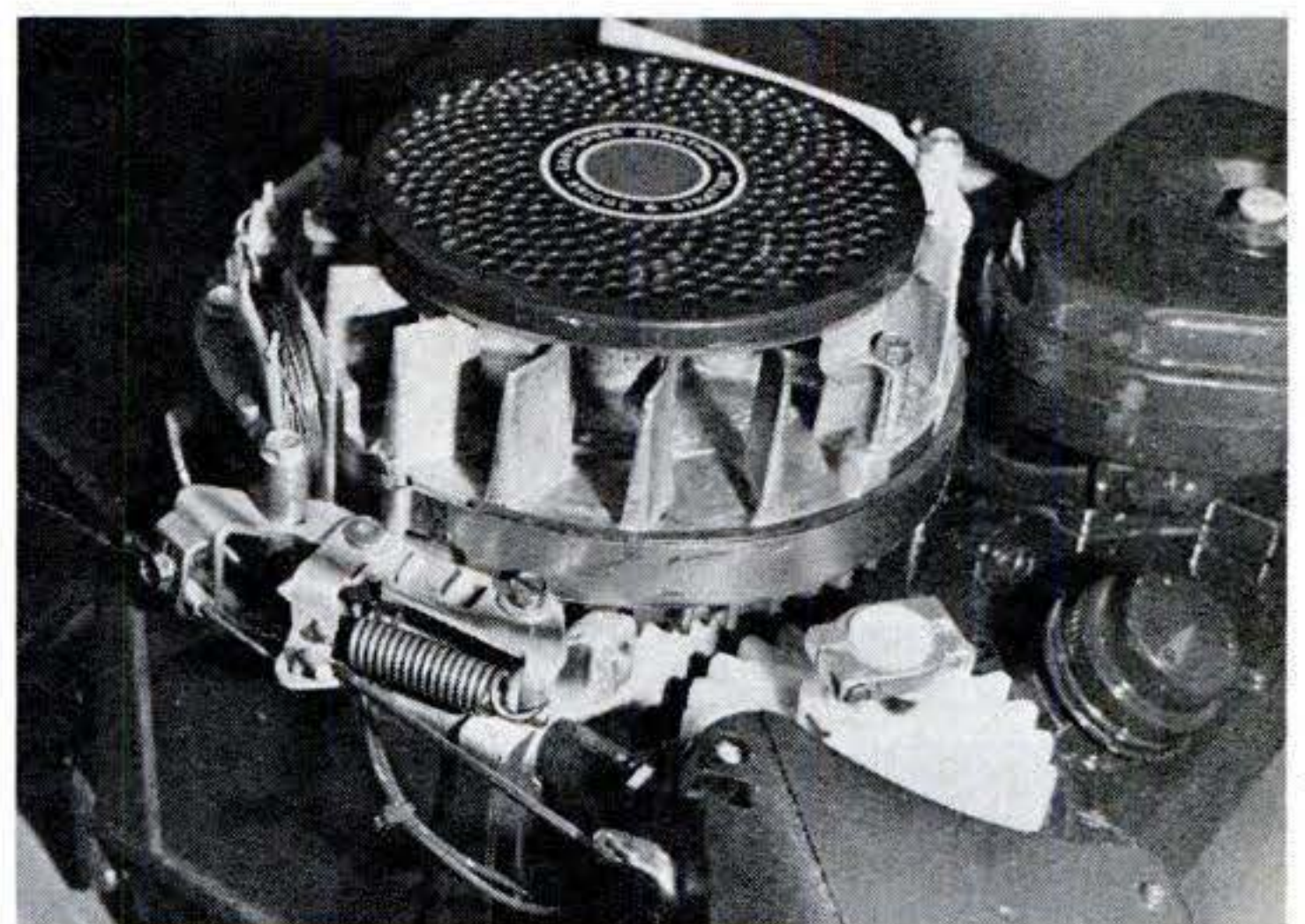


# Blade brakes

for safer mowers



**Tecumseh brake** uses small pad on arm under flywheel. It is shown here in run (disengaged) position. You must hold enough pressure on control handle to overcome the coil spring.



**Briggs & Stratton brake** has a band that wraps around a portion of the flywheel. Spring holds it engaged until you grip control handle. White gear in foreground is starter drive.

## Latest safety feature: Let go of the handle and your lawn mower stops

By E.F. LINDSLEY

Are you ready for a lawn mower that stops every time you release the handle? You should be, if you're shopping for a walk-behind mower this spring.

Release the handle to empty the bag or pick up a bit of debris, and the engine stops. So does the whirling cutter blade—all within three seconds. To start mowing again, you must grip the handle and turn the starter key. (You won't find a rope to pull on these new mowers.)

The system is called a blade brake with electric restart. It's one concession to the demand from the Consumer Product Safety Commission to reduce the 70,000 accidents per year

In Briggs system, a cable controls the brake band, stop switch, and battery to starter circuit. Unless you grip handle, all systems are dead. The Tecumseh system is similar, except for the mechanical difference in braking.

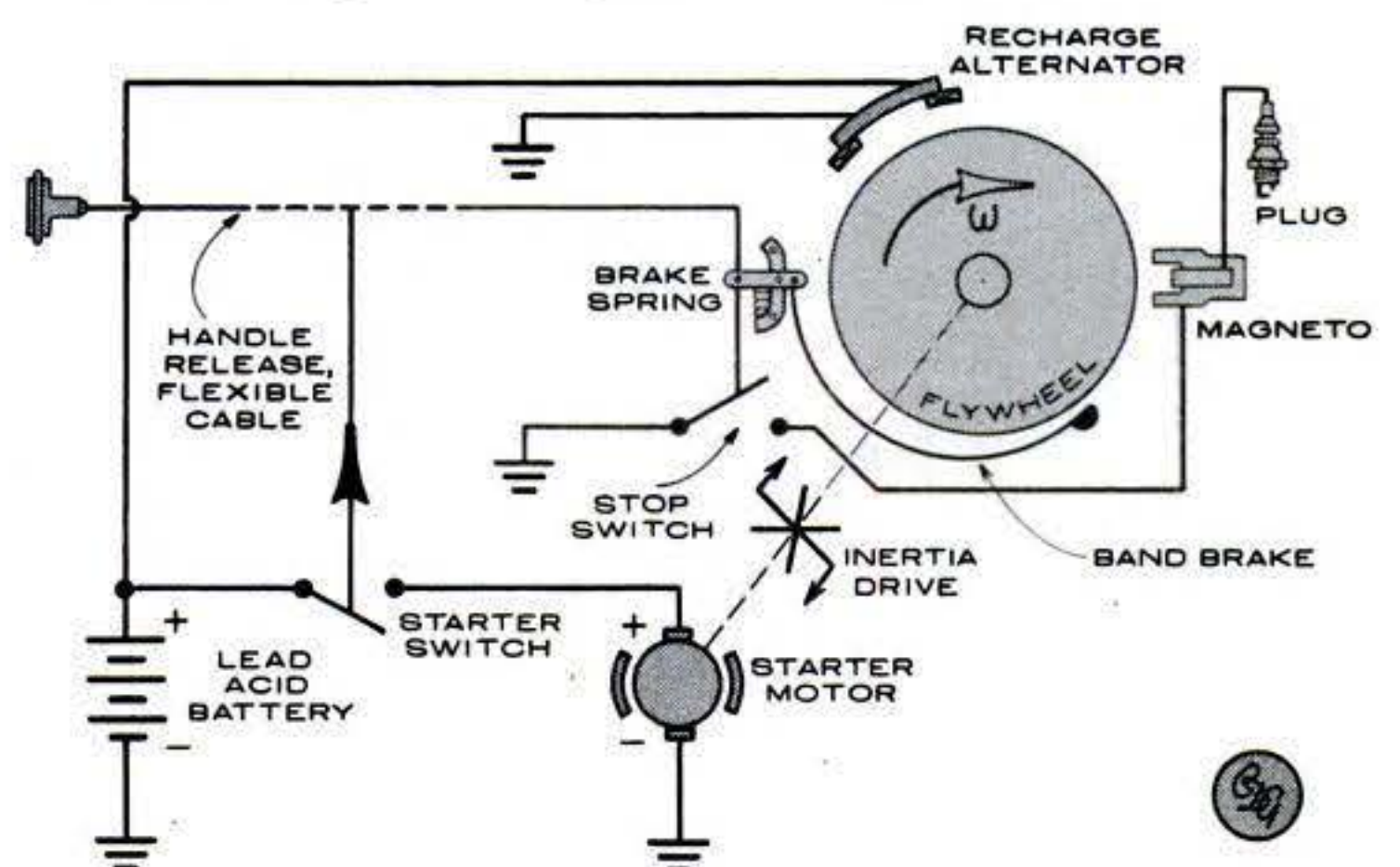
that plague rotary-mower users.

There have been past attempts to improve blade brakes [PS, Jan. '76]. Combined with clutches on the crankshaft, the earlier designs stopped the blade but allowed the engine to keep running at idle. However, both the mower builders and the engine makers say that the clutch/brakes, so far, haven't proved very reliable. (One mower maker reports he hasn't been

able to make the mechanism operate over 200 hours.)

The clutch/brake also has starting problems: The mass of the cutter blade is normally used in addition to the flywheel mass when starting the engine. But that flywheel effect is lost when you clutch the blade from the crankshaft. Add the fact that you must start the engine at an idle throttle setting,

*Continued*



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### Blade brakes

[Continued]

and it means a lot of rope tugging.

But now, both Tecumseh and Briggs & Stratton are offering new engines that use mechanical, spring-operated blade brakes that don't require the clutch system. A deadman handle control cuts the ignition and mechanically brakes the engine almost instantly. And for convenience each has electric start.

In each case, the brake is mechanically attached to the front handgrip through a flexible steel cable. As long as you're holding the grip, the cable pulls the brake away from the flywheel. Let go to do some bagging, however, and the brake spring pulls the brake lever into place.

The two manufacturers brake the mowers differently. On the Briggs machine, a steel band tightens around the circumference of the flywheel (see photo at right, previous page). On the Tecumseh, a brake pad moves up against the bottom of the flywheel (photo at left, previous page). On both machines, a mechanically operated stop switch kills the engine at the same time that braking occurs.

When you're ready to go, the brake is released and the stop switch is opened as you again grab the handle. A starter switch kicks over the engine with a 12-volt battery and starter on the Tecumseh; a six-volt battery is used on the Briggs system (which, I'm told, costs 30 percent less).

On both engines, the starting system and battery are substantially more powerful than on previous electric-start mowers. Starting an engine once or twice in the course of mowing your lawn isn't a very high demand on a system. But starting and restarting 30 times an hour while bagging, as Briggs' engineers anticipate, requires at least a nine-amp-hr battery and a huskier starter. The batteries I saw were of the sealed lead/acid type and about the size of a four-inch cube. On both systems a flywheel-alternator charges the battery as you use the machines. Also, each has a provision for a wall-outlet charger if needed.

None of this means you won't see a clutch/brake mower in the future. It still has the advantage of not requiring an elaborate and costly electric starting system since it doesn't kill the engine. And, in time, the bugs may be worked out.

Whichever way it goes, however, you'll pay for it. Wheeler Mfg. Co., the first manufacturer to use the brake (a Tecumseh), has announced a price increase: about \$50 for the device. **E**

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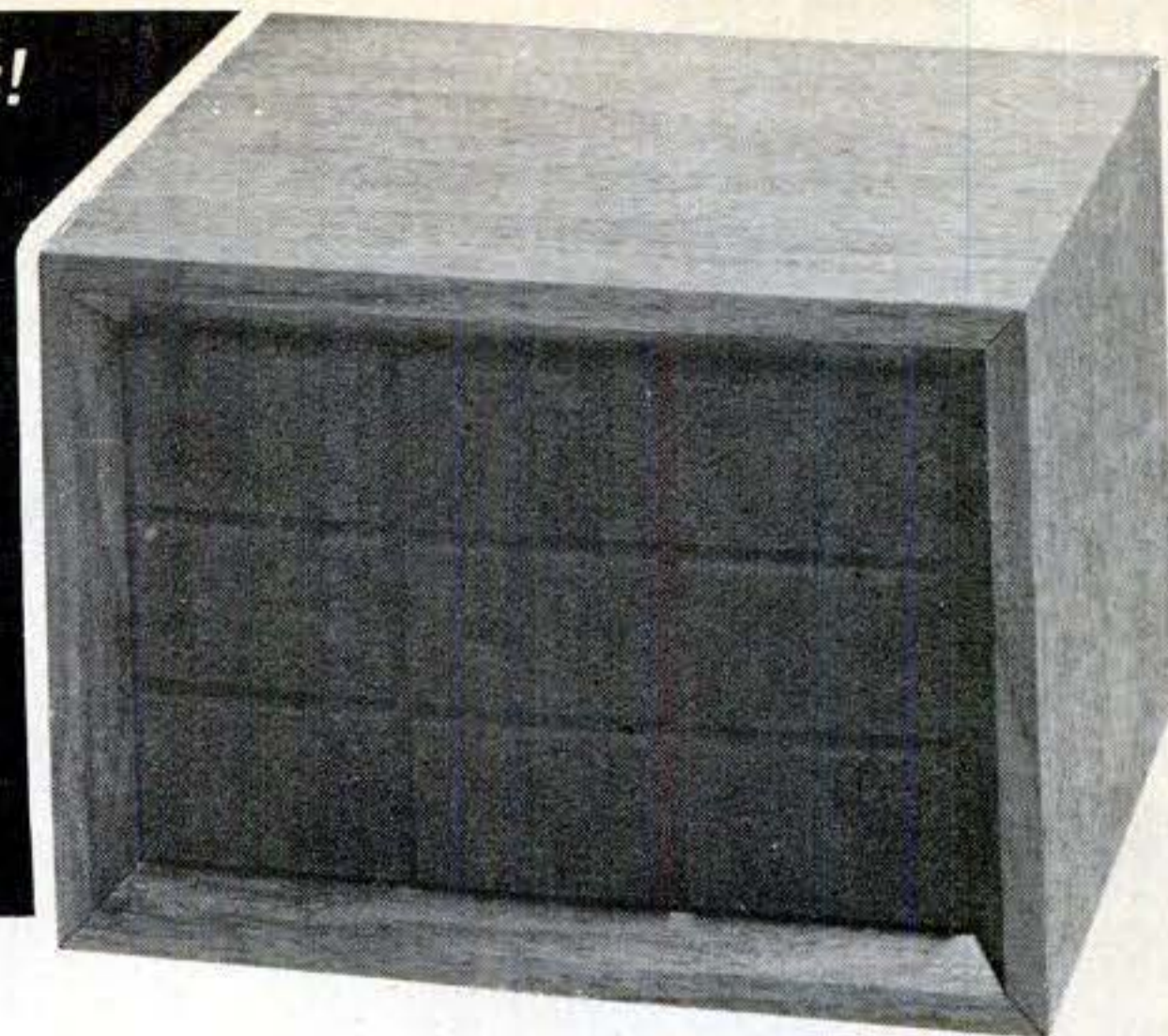
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When the first break-in type sound is detected, the system will instantly turn on lights, radio, or other electronic equipment that you have plugged into the back of the alarm. These lights or other equipment will remain on for a period of five minutes, then automatically turn off.

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*The Guardex 8000 Alarm System is walnut grained and disguised to look like a small stereo speaker (6 3/4" x 9 3/4" x 8") and weighs less than 6 1/2 pounds.*

### **EXIT AND ENTRY DELAY**

The Guardex 8000 alarm has a built-in exit delay allowing you approximately one minute to lock up and leave the building before the alarm is armed. When you enter your building you may find that just your normal entering sounds activate the siren. You may delay it from starting for up to 30 seconds by turning up the siren entry delay control.

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Burglars rarely cut power. However, to give you total protection from a burglar and possible power failure, our alarm has provisions for a battery back-up. (Batteries not included). 12 volt lantern batteries are available at most hardware stores.

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The Guardex 8000 alarm is equipped with a loud, built-in siren, but if you desire an additional siren to mount outside or in an area away from the main alarm, they are available with 50 feet of wire for \$24.95. (Connecting terminals are provided on the back of the alarm).

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*The rear control panel contains two standard AC plug receptacles for a table lamp, spot lights, radio, etc.; terminals for connecting optional outside siren and back-up battery (not included); entry delay time control and sensitivity control.*



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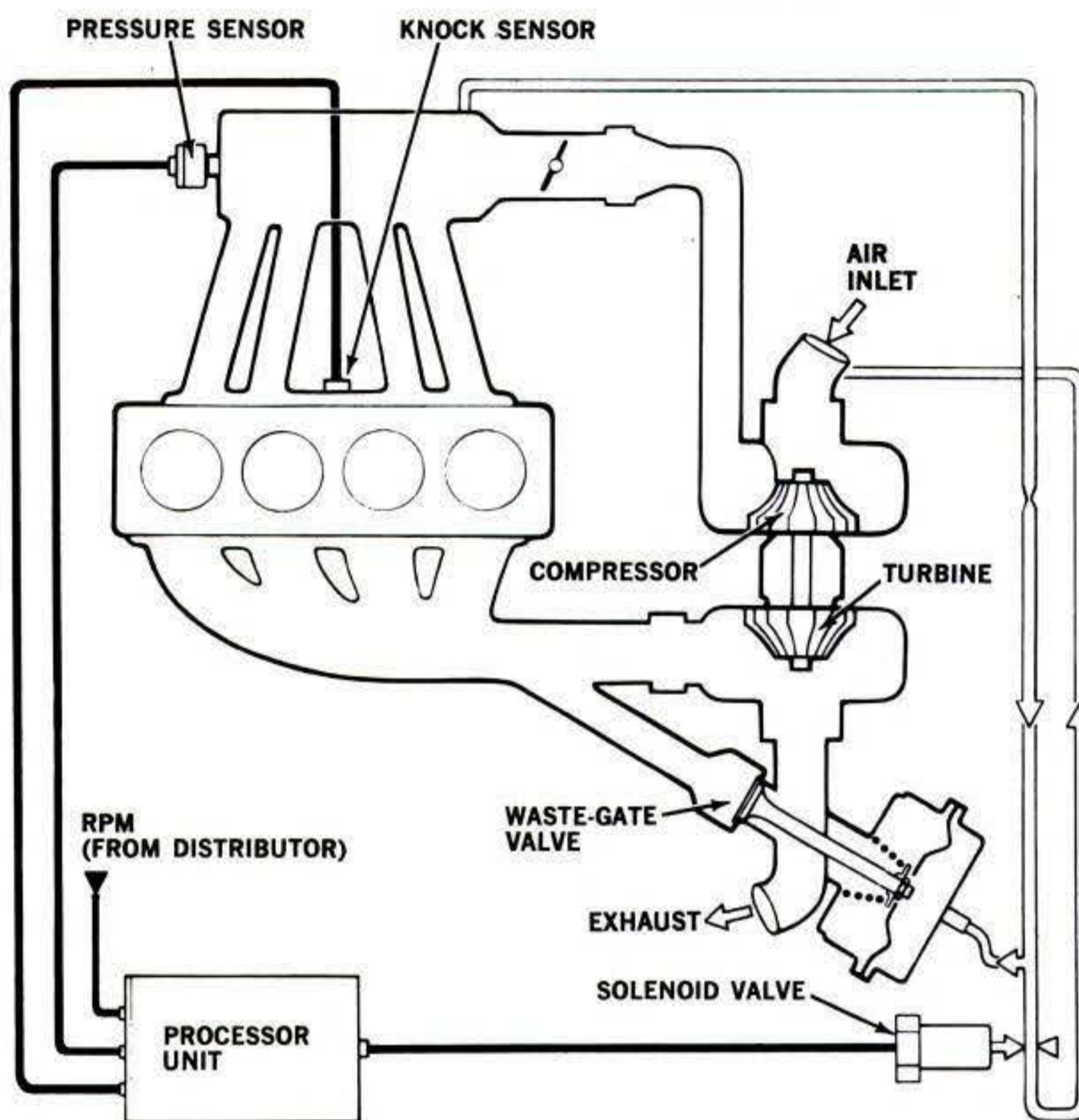
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## No-knock turbocar runs on any gas



Auto makers are moving to turbo-charging to increase power by as much as 25 percent without the penalties in fuel consumption and weight of a larger engine. Typically, an exhaust-driven turbo-compressor simply blows extra air into the cylinders for a denser explosive charge.

But there's a catch. That boosted cylinder pressure may cause detonation with low-grade gasoline, often the only fuel available. Such pre-ignition, or knocking, can seriously burn exhaust valves and pistons. Saab in Sweden solves this problem with its Automatic Performance Control system (APC), which allows the engine to run safely and at peak efficiency on any gas between 91 and 99 octane without prior adjustment. A sensor fixed to the cylinder block detects the first trace of detonation—even the inaudible type at high speeds, which is the most harmful.

This danger signal is fed into an electronic processor that then opens a solenoid valve in the air-control line to the waste-gate valve. That instantly slows the turbine and reduces the boost pressure from the turbocharger, holding the pressure at a critical level just below the knock point.

APC has been successfully tested in

the Saab two-liter engine, and will be used in the 900 Turbocar next year. It makes detuning the engine for an anti-knock safety margin unnecessary. In fact, the compression ratio is actually raised to 8.5:1 from the Turbo's present 7.2:1, which improves engine efficiency and gives snappier acceleration at low rpm before the power-boosting turbine cuts in. Fuel is always completely burned regardless of the octane number. The company claims an eight percent cut in fuel consumption.

GM tackled the same problem in the 1977 Buick Regal with an automatic spark-retard system for the turbo-charged V6. This system prevents engine damage by altering ignition timing at the onset of knock. The Swedes point to some weaknesses of that method: Engine efficiency and economy suffer; there's a risk of burning exhaust valves; and the timing control may not always respond rapidly under hard acceleration.

Saab sees its APC as a no-snap solution that requires only simple electronics, has few moving parts, and adds little to the cost of the car. With growing acceptance of turbocharging, other manufacturers may follow suit.—David Scott



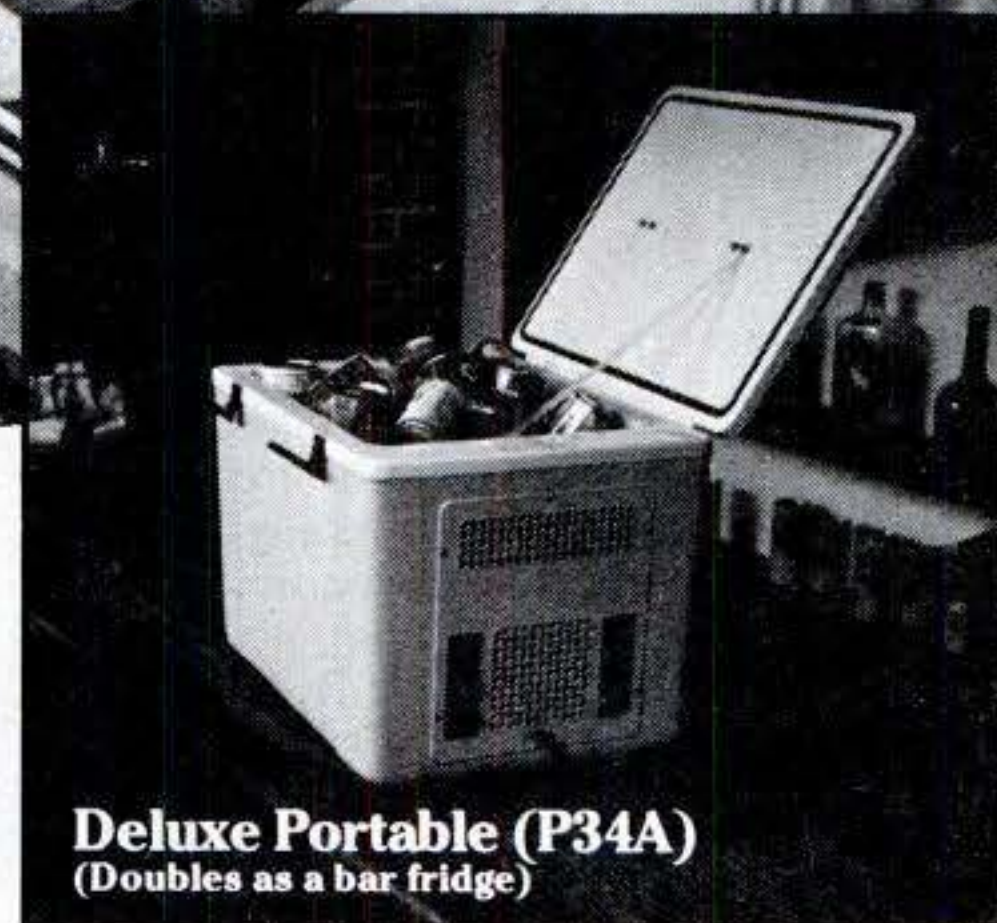
# Outdoor Fridges

Outdoor lovers all over America are discovering that what they've been waiting for is already here: portable fridges that run on something more convenient - and less messy - than blocks of melting ice.

Sportsman Fridge (P34)



Car Fridge (P10)



Deluxe Portable (P34A)  
(Doubles as a bar fridge)

What makes Koolatron portables tick is a tiny, space-age-efficient thermoelectric solid state module.

Koolatrons simply plug into 12-volt lighter sockets, or operate from house current with our optional 110 volt AC adaptor. Very easy. Very clean. And very convenient.

Whichever model you choose, a Koolatron portable is light, versatile, and surprisingly spacious. The Sportsman Fridge, for instance, weighs only 17 lbs - less than a cooler with a block of ice.

Yet it holds up to 40 lbs. of provisions, or 48 twelve-ounce pop cans.

And with the flick of a switch, two of our three models turn into food warmers.

**Take them just about anywhere, in just about anything.**

Because of its aerospace-inspired solid state refrigeration modules, a Koolatron portable is unaffected by travel, vibration or tilting.

So wherever you go, you can take your Koolatron portable with you - on vacation, camping, boat trips, hunting, fishing, cottages, the office for working lunches, the rec room as an extra fridge, even shopping.

It's really like having a smaller version of your home refrigerator. And it'll do just as good a job, keeping food at normal refrigeration temperature (40° to 45°F), even in 95° weather.

**The Car Fridge that's also a food warmer. \$139.00 (\$149.00 in Canada). (Model P10).**

The Koolatron Car Fridge holds 17 twelve-ounce pop cans or about 15 lbs. of provisions. With the flick of a switch, it warms up to 150°F to keep hot foods hot.

Vital statistics: Blue Polypro plastic, 16" x 11" x 11½" ext., 10-litre (11 qt) capacity, weighs 10 lbs., operates from 12-volt power or with our optional 12VDC/110VAC power adaptor.

**The Deluxe Portable with the works. \$199.00 (\$209.00 in Canada). (Model P34A).**

For the man who wants everything - fully adjustable temperature control, low battery warning indicator and food warming switchover.

Vital statistics: Beige ABS case, 21" x 16" x 16" ext., 34 litre (36 qt) capacity, weighs 17 lbs. (See Car Fridge above for operational details.)

**The Sportsman Fridge that takes the rough out of roughing it. \$179.00 (\$189.00 in Canada). (Model P34)**

The Koolatron Sportsman has the same dimensions as the Deluxe but does not include the food warmer or low battery warning indicator and has fixed temperature control.

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# MOTORCYCLING

By RAY HILL



## 138 mpg on Yamaha's SR 250

A moped is the mileage champ for low-speed, short-distance commuting, as many people are discovering. Unfortunately, if you must travel longer distances at highway speeds, a moped isn't the answer. But Yamaha's SR 250 Exciter motorcycle can be. It's made especially for beginning riders.

The Exciter's single-cylinder four-stroke power plant displaces 249 cc's. It doesn't have great gobs of power that can get an inexperienced rider in trouble. And it's easy to start (electric starter) and maintain. The seat is low (see photo). Even people with short legs can usually plant both feet firmly on the pavement when the machine is stopped. Carrying a passenger is no problem.

My first mileage test was a 130-mile run, mostly on turnpikes. I kept up with the fastest cars, and I got just a bit under 70 mpg. The engine was new at that time. Later, after only 250 break-in miles, I decided to try for optimum mileage. That meant no jack-rabbit starts, steady cruising speeds (no high speeds), and easy braking—the same kind of techniques you would use with any vehicle to get optimum mileage. I used no tricks, such as coasting down hills with a dead engine.

I topped off the gas tank and rode the bike 17 miles over roads near my home. Except when stopping for lights or stop signs, I kept the speed between 40 and 55 mph—mostly at about 45. After the run I topped off the tank using a calibrated container. It took exactly one pint to fill it. That works out to 138 mpg.

Oh yes, not only is the SR 250 a very economical commuter—it's also a lot of fun to ride.

## Heated handgrips

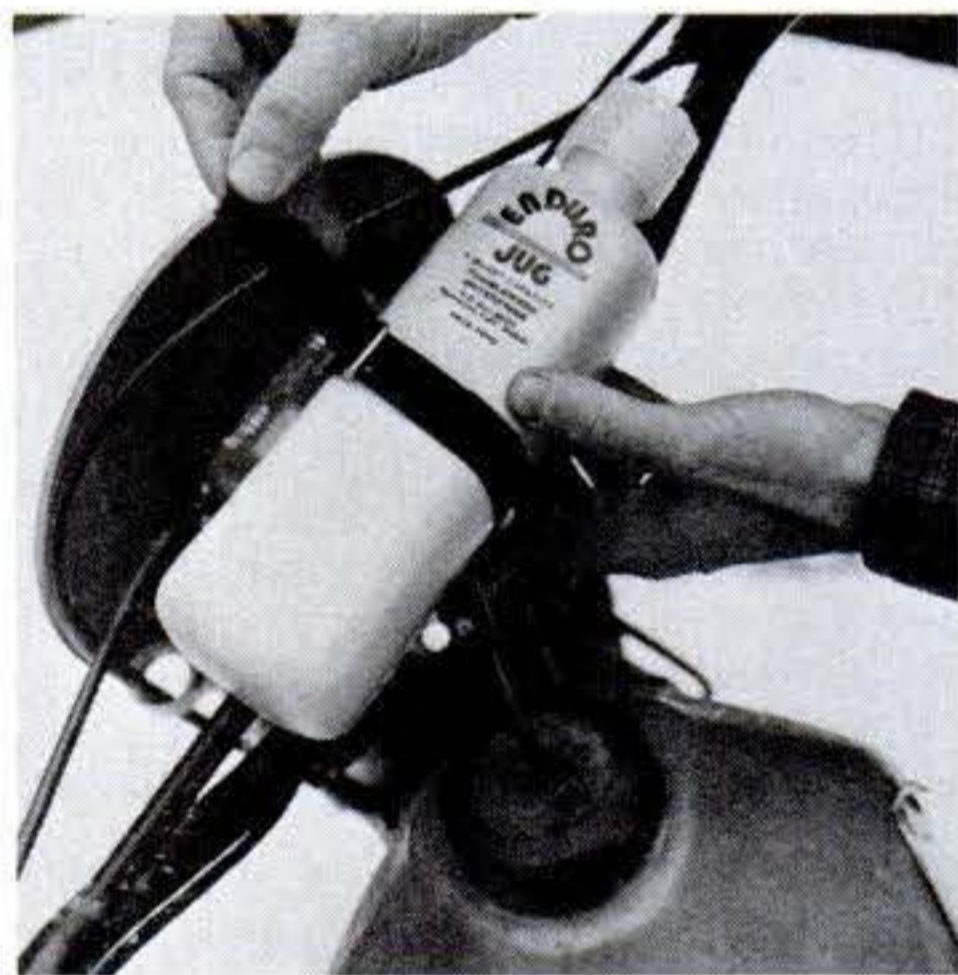
Do you suffer from cold hands on those cold-weather rides? A pair of Hot Grips from Hi-Point Racing Products may reduce your misery. These special grips have resistance-heating wires built in. When they are switched on, the grips heat, warming your hands. I haven't tried a pair, but I've received glowing reports (pardon the pun) from people who have.

Hot Grips can be used on any street motorcycle with a six- or 12-volt electrical system and on any dirt bike with a lighting coil. They cost about \$25 and are available through motorcycle shops that sell Hi-Point products.

## Water jug for dirt bikes

You can work up quite a thirst on a long trail ride. One way to solve the problem—as many do—is to carry a canteen on your belt. But if you fall, landing on your canteen is not the most pleasant of experiences. A better solution is the Enduro jug, made by Tumbleweed Enterprise in Torrance, Calif. It costs about \$13 and is sold by most motorcycle dealers.

I tried the jug on a Kawasaki KDX 175 recently. The container comes with a mounting base that clamps to the han-



dlebar cross brace with a couple of screws. The Enduro jug slips over the base and is held securely in place with a Velcro strap. Even my most spirited riding tactics failed to shake the jug loose. It doesn't leak, is made of rugged plastic, and holds one quart. I found it mighty handy about 50 miles down the trail when my throat got dry. When filled, the jug adds some weight to the handlebars. But this did not seem to adversely affect any of the excellent handling characteristics of the KDX.

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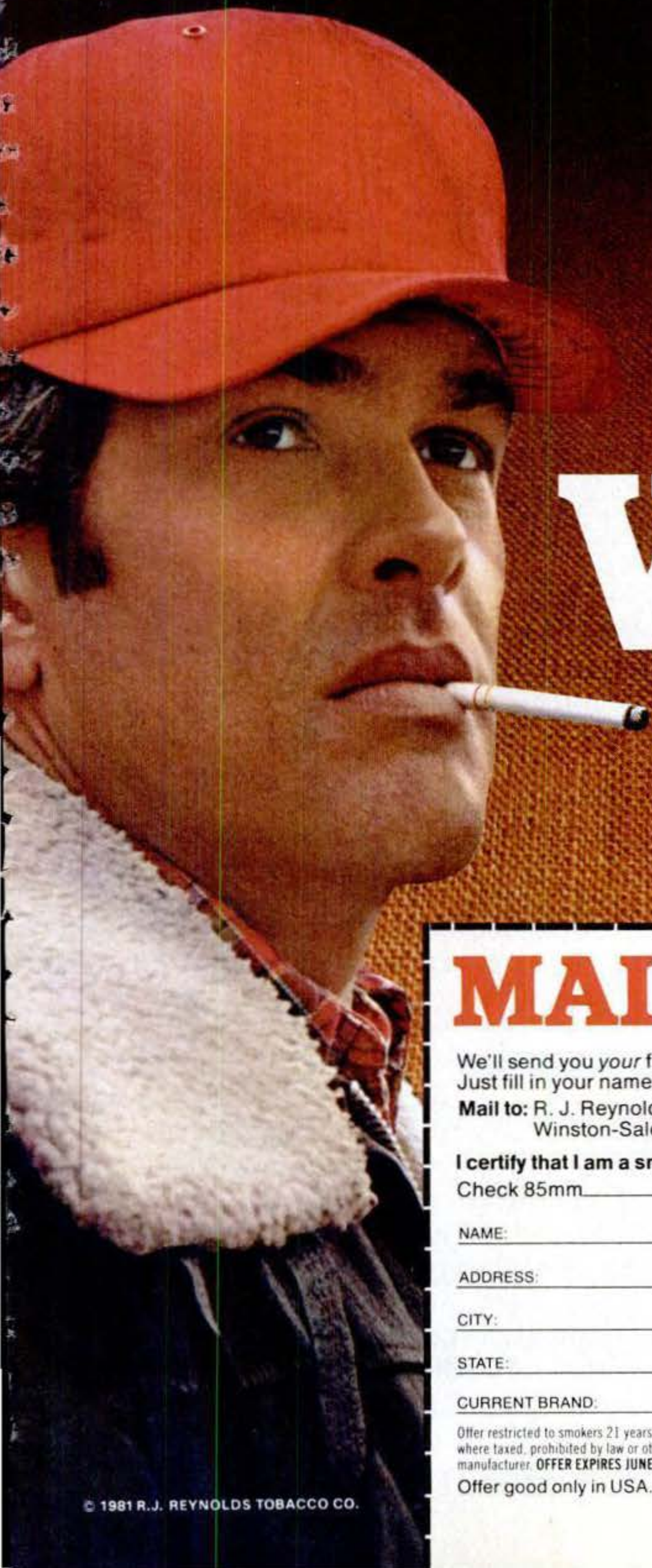
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# The real test of a lawn mower is how it performs in spring.



In the middle of summer, when grass is sparse, just about any lawn mower can do the job. It's spring that separates the quality mowers from the rest. That's when grass is at its thickest and tallest. And that's when you really appreciate a John Deere.

John Deere offers a rear bagging attachment that directs the grass clippings to the top of the bag. It's designed to prevent clogging. So the bag fills up completely, even in damp conditions.

What's more, John Deere 21-inch Mowers have powerful 3½- or 4-hp engines that don't bog down in tall grass. They have steel wheels with ball bearings so they last longer and roll easier. And like all John Deere Mowers, they're easy to start and built to last a long time.

John Deere 21-inch Mowers are available in self-propelled models with manual or electric start, and a push-type model with manual start. There are other push-type models available in 18- and 20-inch cutting widths.

See your John Deere dealer now. Before that tall spring grass gets out of hand.

For the name of the dealer nearest you, or a free folder, call 800-447-0606 toll free. (Illinois, call 800-322-0688.) Or write John Deere, Dept. 62, Moline, IL 61265.

**DOWN-TO-EARTH VALUE. SAVE \$30.** Buy any John Deere 21-inch Walk-Behind Mower before May 31 and save \$30 at a participating dealer.

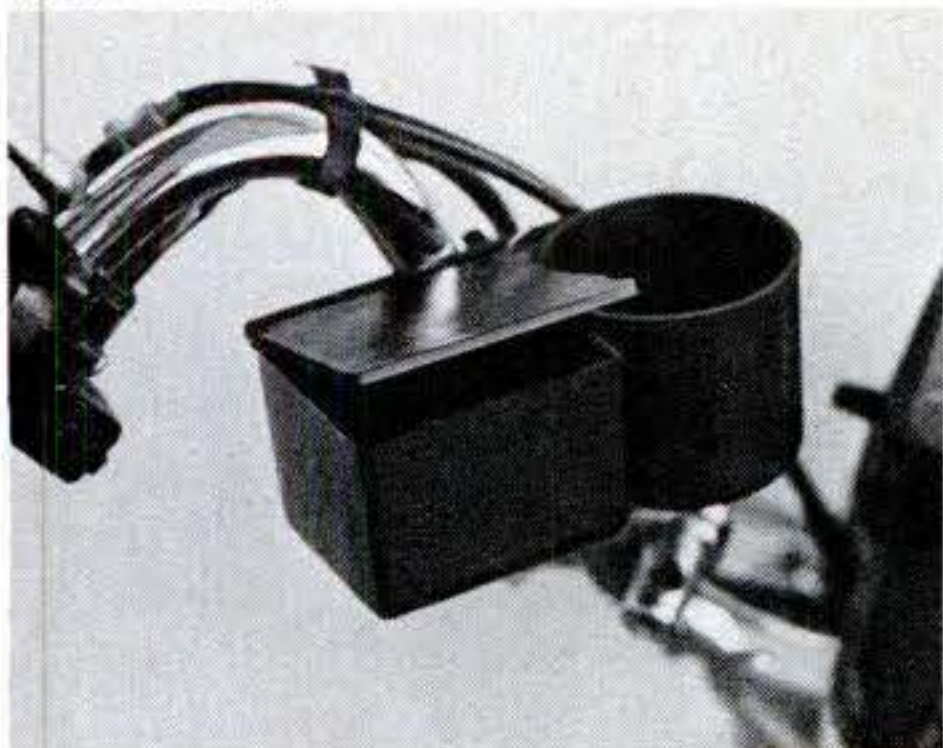
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## Motorcycling

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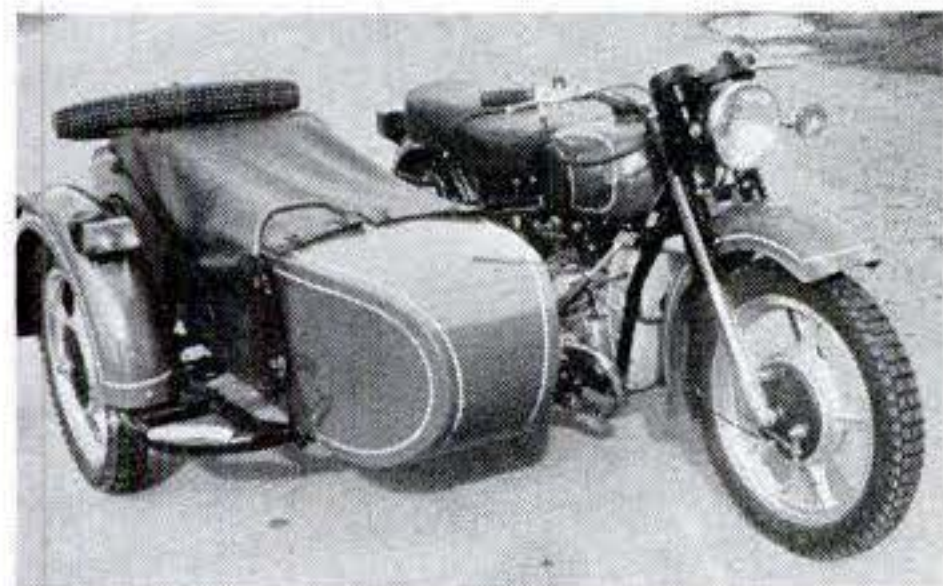
### Tray for change, keys, etc.

Digging around in your pockets for paper money, change, keys, and other such items can be a hassle when you're on a motorcycle—especially if you have a lot of heavy clothing to work through first. Cycle-Tray is designed to eliminate this problem. It measures three by six by 2½ inches and mounts on the handlebar. A lid that's held closed by spring tension keeps items from blowing away. It's \$4.50, ppd., from Cycle-Tray, Box 74, Guilford, Conn.

### A brand-new old motorcycle

The rig below is scheduled to go on sale in the U.S. at about the time you read this. It is almost an exact duplicate of a motorcycle-sidecar combo built by BMW in the 1930's. Made in Russia, it is imported into the United Kingdom by Neval, modified, and then brought into the U.S. by Sidecar Imports, Ltd., 490 Skokie Highway, Highland Park, Ill. 60035.

A 650-cc, overhead-valve, horizontally opposed twin-cylinder engine churns out a mild 36 bhp. Mileage is claimed to be in the 50-54 mpg range under normal driv-



ing conditions. If its reliability is anything like BMW's, the Neval should last forever.

A reverse gear is standard. All three alloy wheels are interchangeable. A spare wheel and extensive tool kit are included. Two versions are available: the MT-12, which costs about \$5,300 and has a driven sidecar wheel, and the MT-10, about \$4,300 with an unpowered sidecar wheel. The MT-12 is said to work very well in snow and rough or muddy terrain.

The Neval meets all EPA and DOT standards, weighs 700 pounds, and holds five gallons of gas. Tires will not have the block tread-pattern shown in the photo. They will probably be street tires made by Dunlop.

Plans call for the Neval to be sold nationwide. P 3

## MANUFACTURE THIS BEAUTIFUL CONCRETE OUTDOOR FIREPLACE Right In Your Back Yard

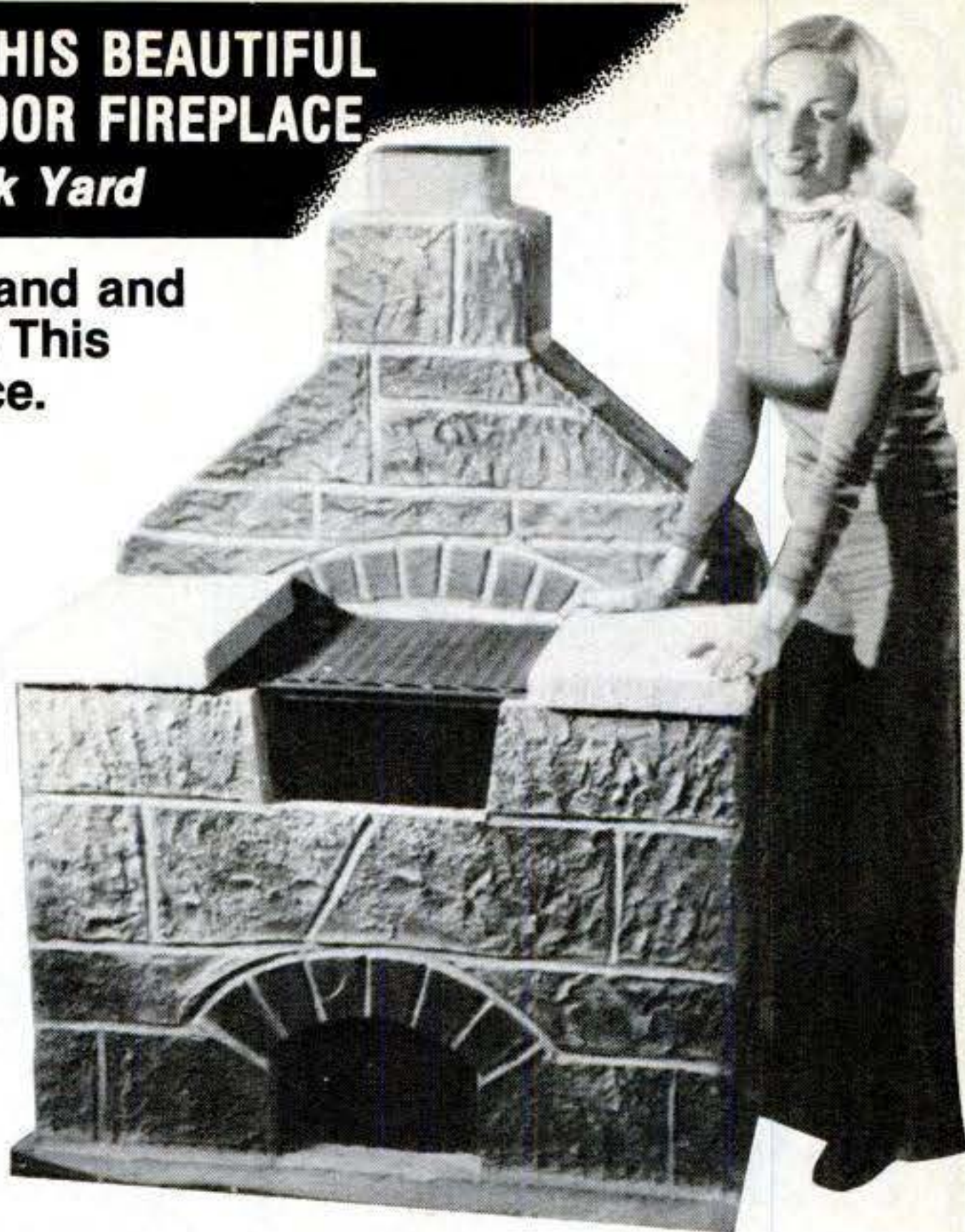
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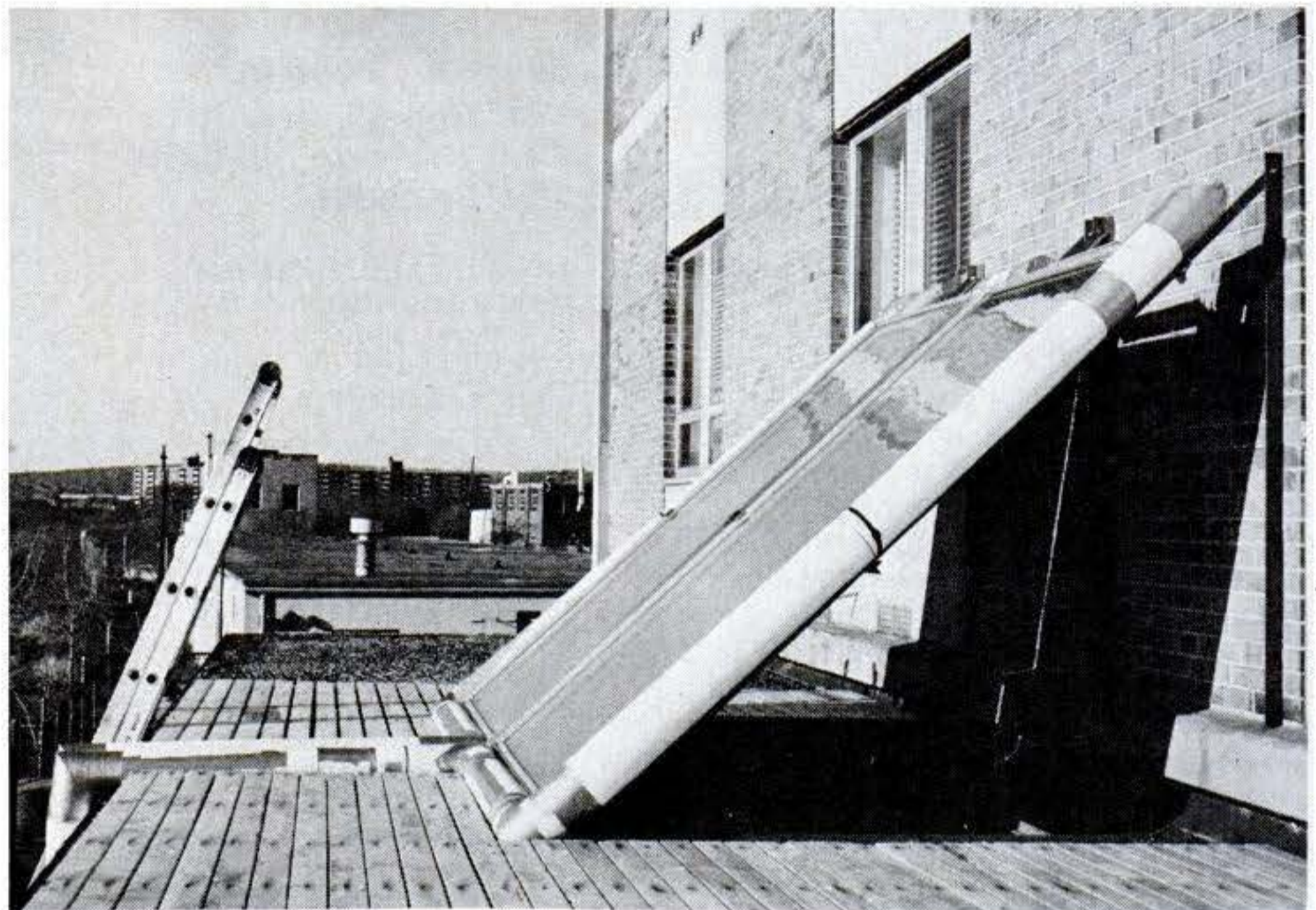
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## Solar water heater — no pumps, no tanks



Heating water with solar energy isn't difficult or expensive: Just fill a bucket, put it in the sun, and wait. The money comes in when you want to tie your bucket (collector) into your household water supply. That usually means pumps, storage tanks, heat exchangers, thermostats, and a lot of plumbing—which costs \$2,000–\$3,000 when installed in your home.

A new solar water-heating system that dispenses with much of that hardware yet is claimed to perform about as well as a conventional system should be on the market in about a year. Solaron Corp., makers of solar space- and water-heating systems, recently acquired the rights to market the simplified system developed by W. Peter Teagan of Arthur D. Little Inc., Cambridge, Mass.

Solaron has not yet announced a price for the heater, but Teagan says the installed cost should be about 40 percent less than units now available. If so, the shortened payback period could make solar water heating attractive to many homeowners.

"I realized that the cost of solar water heaters wasn't going to come down without some fundamental changes," says Teagan. His solution: Connect the collector directly to an existing hot-water system and use city water pressure for circulation. Result: The device needs no solar storage tank, circulation pump, or differential controller, and uses less piping.

The collector consists of an absorber

tank containing water and a heat exchanger. An intake pipe brings water by line pressure through the exchanger and then into the domestic hot-water tank, where it may be further heated to supply adequate temperatures at the tap.

The mystery of the system is why the water in the absorber doesn't freeze or boil. It contains no anti-freeze, and it is in direct contact with outdoor conditions. Solaron claims that insulation around the sides of the tank and the large mass of water in it prevent freezing. To eliminate overheating, a finned tube on top of the collector passes excess heat to the air and keeps the water temperature just below the boiling point.

The unit was field-tested through three New England winters without any freezing or overheating, says Teagan. On a clear day, the temperature of the absorber climbs 20–25 degrees F an hour. Due to the storage capacity of the unit, preheated water can be delivered well after sundown.

Because the storage is not isolated from ambient temperatures, collector performance is somewhat worse than with conventional units in cold months, but it may be somewhat better during hot months. How much of your water-heating needs could it supply year-round? Up to 50 percent, says the inventor. Solaron (1885 W. Dartmouth Ave., Englewood, Colo. 80110) will market the system for do-it-yourself installation.—*Ed Moslander*

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Granada has a new type of suspension for this year.

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# The New Ford Granada



# Typecorder

Paperless typewriter  
fits in a briefcase

It puts up to 120 pages of  
text on a microcassette

By WILLIAM J. HAWKINS

You type on it. That's the only similarity between Sony's Typecorder and a conventional typewriter. The differences: It's silent; it doesn't use paper; and it runs on internal batteries, so it goes where you go. It is a typewriter. But it's completely electronic.

The Typecorder has a standard keyboard. But as you type letters appear, not on paper, but on a 40-character LCD display line. Special edit keys let you correct errors instantly and add or delete words as you go. There is also a special "steno" function key. Press it, and every other key now represents an entire word. Press STENO and A, for example, and the word ABOUT instantly appears on the display.

When the line is full, it is stored in the unit's internal memory while you go on typing. When you've completed your work, you simply press a button: Up to 120 pages of text are stored on magnetic tape through a built-in microcassette recorder (which also doubles as a dictation recorder using a built-in microphone). Now you can pop in a fresh cassette or insert a previously recorded cassette to finish up something old. When you're finished, the unit is ready to give you a first "draft" of your work. You can have this in a variety of ways.

With a printer connected to the Typecorder, you get a permanent paper copy. Or the Typecorder can be connected to a paper punch—a unit that punches holes in a paper tape that can be automatically read by teletypewriter systems.

A special typewriter-actuator unit is also available. It's a clever, flat box that mounts above the keys of a standard office electric typewriter. The output of the Typecorder controls the internal solenoids of the actuator. These, in turn, press down the keys of the typewriter to produce the work.

An acoustic coupler can also be connected. This allows you to send the data from the Typecorder over a phone line (to a remote office printer, for instance). And the Typecorder can be connected to a word-processing computer (directly, or by phone line using the modem), which would add special text controls such as formatting (lines per page) or justification (left and right margins).

Battery or AC-powered and weighing just three pounds, the Typecorder goes anywhere: library, classroom, hotel, home, office—or your briefcase. Price: \$1,400. P 5



**Typecorder is just 1.5 by 8.5 by 11 in.** Keyboard has good tactile response for touch-typing. Microcassette (inset) saves text or takes dictation. When you've finished typing, completed text can be put on paper by connecting a printer to the Typecorder. Other attachments are also available (see text).



# DETROIT REPORT

By JIM DUNNE



## Here comes the P-car

GM management has given final approval for Pontiac's exciting P-car (above), and that means the midship-engine two-seater will be ready for production a year from now as a 1983 model. A number of code names have been assigned, including Sunfire, but it's expected the official christening will come later this year. The Fiat X 1/9 look-alike will use an X-car engine/transmission moved rearward, but not, as we reported earlier [PS, Feb.], turned around. By keeping the orientation intact, the same combination that powers the front-drive X-cars will drive the rear axle of the P-car—and create the desired midship layout.

## Escort bucks trend

Instead of a hatch opening, the Ford Escort four-door model to be introduced this fall (below) will feature a conventional trunk compartment. This layout—the bustle trunk tacked on the rear—is contrary to just about every other subcompact design of the last five years. The four-door joins the two-door coupe and sedan and four-door station wagon in Escort's 1982 lineup.

## A man's job?

GM plans to have as many as 2,000 robots on the job by 1984—each one costing



\$70,000. The company pioneered assembly-line robot use in 1969 when it installed one in Chevrolet's Lordstown, Ohio, Vega plant. Since then other auto makers, including those overseas, have added robots to their assembly plants—but none in the large numbers GM now plans. Robots improve quality, say the auto companies. But there are other reasons for the changeover: You don't have to pay a robot for overtime or vacations. What will happen to workers replaced by machines? The four-day work week is a solution being pushed by the unions.

## From A to X

GM's A-body sedans—Malibu, Century, Le Mans, and Cutlass—will switch to front drive and smaller size next year, and in doing so will nearly duplicate the design of the X-cars. In fact, the two car lines will share many major drive-train parts, including engine, transmission, and basic floor pan. The new A-cars will be built in only two body styles: two- and four-door sedans. Wheelbase will be 104.9 inches (the same as the X-cars), but overall length will be about 10 inches greater, giving a huskier look. Curb weight will be 500 pounds less than the older designs. Look for fuel economy to approach that of the X-cars.

## Pickup race is on

Chevy and GMC will be ready this fall with half-ton, compact pickup trucks, but Ford and Chrysler aren't far behind. Both will have versions ready for 1982½ introductions, about a year from now. Ford's entry will be called Ranger. "It just might be the most important truck ever built by Ford Motor Co.," says Ford Truck General Manager James A. Capolongo. Like the GM minis, the Ranger will have a four-cylinder engine and rear-wheel drive. Its chassis will be built on a separate frame.

Chrysler's compact will be similar to the

VW pickup; unit body, four-cylinder engine, and front-wheel drive. While the trucks are designed to compete with imports, the Ford and GM models will be sold alongside Courier and LUV, giving both companies three different vehicles in the half-ton-pickup market. Chrysler's truck is expected to sell directly against the smallest imports, so Dodge may decide to drop its imported Colt pickup.

## Mini utility truck

GM is planning to build four-wheel-drive utility vehicles based on the compact pickup being readied for 1982. The mini, which will be out the following year, will offer big fuel-economy gains over the current GM utility trucks—Blazer and Jimmy. No name has been selected for the vehicles, but it's known they'll be built for Chevrolet and GMC divisions and be powered by a four-cylinder engine. GM will take a wait-and-see approach to the future of the Blazer and Jimmy. If the new vehicles are a hit with customers, the others will be dropped.

## Turbine on deck

After GM gets its electric car into production in 1985, the next major engine project will be a new small turbine. GM, of course, has been working on turbine engines since the late 1950's. The last design, the AGT-5, has the power of a small V8. Unfortunately, it also has comparable fuel economy—and that's not good enough. So a smaller engine is the answer, but that project is behind the electric in GM's scheduling. Advantages of the turbine are less weight, cleaner exhaust, and the ability to operate on a variety of low-cost fuels, including synthetics.

## Ford drops turbo—for now

Emission problems with the turbocharged 2.3-liter four offered in Ford Mustangs and Fairmonts have led to a decision to drop the engine. But that's not the end of turbocharging at Ford. Within three years, the company will begin importing four- and six-cylinder turbodiesels from Europe. The relatively tiny 2.1- and 2.4-liter engines will go into Ford's luxury lines first, then into smaller cars.

## Paying by the mile

You won't be surprised to learn that it costs more to operate your car this year than last. But the size of the increase—an average of 6.4 cents per mile—is a record. Here are the per-mile costs, according to Hertz: subcompact cars, 38.1 cents; intermediates, 44.0 cents; standards, 48.1 cents. The figures are for normally equipped cars driven 10,000 miles a year for three years. Major causes of the 18 percent increase are higher sticker prices on new cars and higher interest rates on car loans. Note that the costs are for new-car owners only. The average operating cost for all cars on the road is far lower, about 26 cents per mile. The Hertz survey also shows that the prices of new cars have almost doubled since 1973. **5**

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## Removes water— fights gas-line freeze.

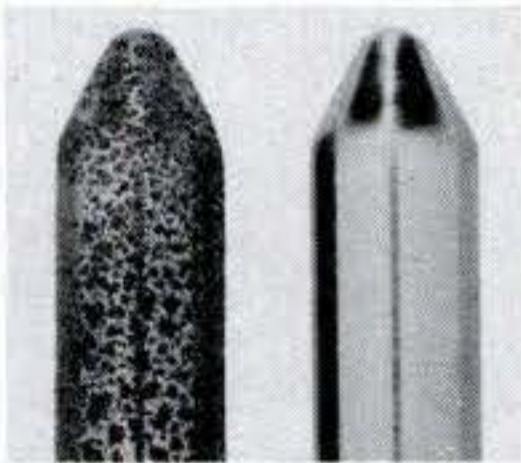
Water gets into your gas tank through condensation and, sometimes, by contamination at the pump. This water can cause poor engine performance and, in cold weather, gas-line freeze.

But the special-action formula of STP Gas Treatment used regularly works to protect your fuel system. It surrounds water droplets and helps carry them through your engine. And the less water in your fuel system, the less chance of a problem.

## Inhibits rust.

Even a little rust can cause serious fuel system problems. It can clog your fuel filter, or block your carburetor jet. This can mean hard starting, plus stalling and sputtering.

But STP Gas Treatment has a special rust and corrosion inhibitor designed to prevent these problems. Both these steel bars were soaked in gasoline plus water. But the bar on the right—the one without the rust—was protected by STP Gas Treatment. No wonder it's the Driver's Edge.



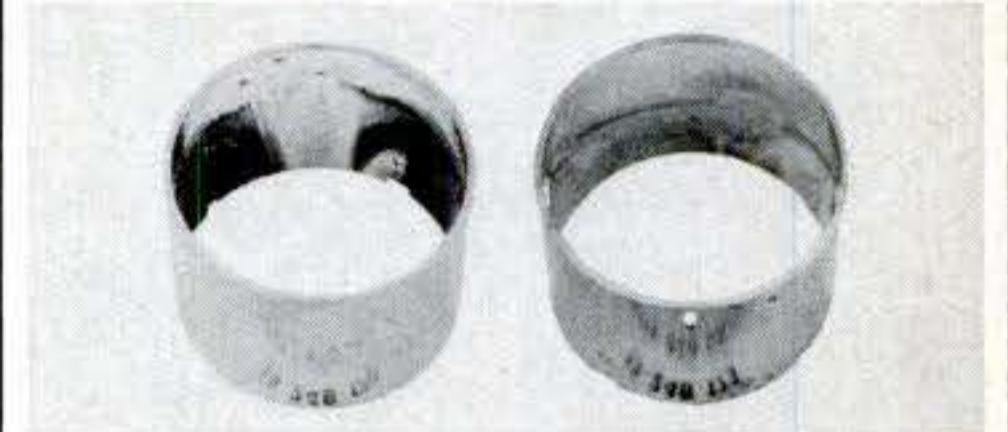
UNTREATED TREATED

## Cleans carburetors and keeps them clean.

Normal engine heat and oxidation cause gum and varnish to build up. These deposits can clog openings, reduce tolerances and harm engine efficiency.

STP Gas Treatment cleans your carburetor. And works two ways to prevent these harmful deposits from accumulating again. First, it coats

metal surfaces which works to prevent gum and varnish molecules from getting a toehold. And second, it surrounds these molecules with a stick-proof coating so they can pass harmlessly through the fuel system.

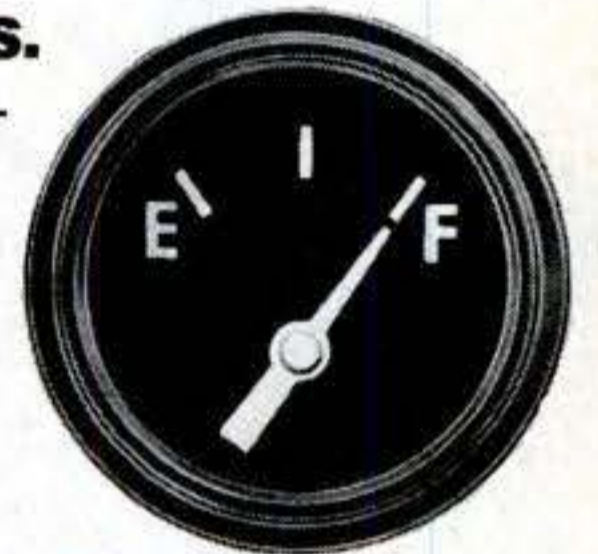


UNTREATED TREATED

The carburetor sleeve on the left shows fouling and deposit accumulation. The one on the right—the one that still looks like new—was protected by STP Gas Treatment. Which would you want in your engine?

## Saves gas.

A dirty carburetor lessens your engine's operating efficiency, reduces mileage, wastes gas.



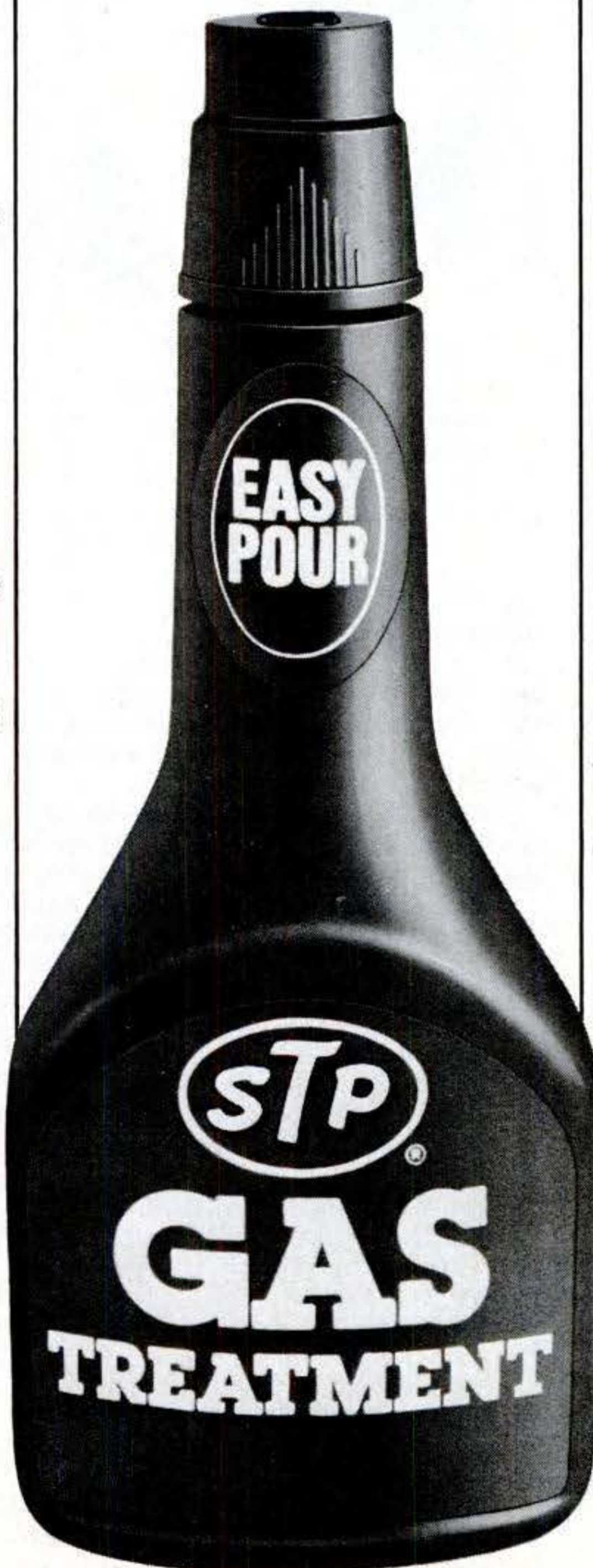
But STP Gas Treatment cleans carburetors. Intake valves and manifolds, too. And, used regularly, **keeps** them clean. Net results: improved engine efficiency and important gas savings.

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## THROUGH THE VIEWFINDER

By EVERETT H. ORTNER



List price of the MFS-1: \$39.95; the 2500 flash: \$99.95.

### All-range zoom

One lens I used with the MFS-1 is the Kiron 28-85 f/2.8/3.8 varifocal macro zoom (photo, bottom). That mouthful says that the focal length of the lens goes from a wide-angle 28 mm to a telephoto 85; that the maximum aperture of the lens decreases from f/2.8 at its

wide-angle 28 to f/3.8 at 85; that the point of sharpest focus shifts as you zoom, requiring refocusing when you've settled on the focal length at which you intend to shoot; and, finally, that you can focus close enough to shoot at 1/4 life size.

It's an enormously handy lens, a true full-range zoom. At 28 mm, you can catch the whole party in your living room: a shower, a sweet-sixteen party, or the family gathered for Thanksgiving. Pull the outer sleeve back to the 85-mm mark, and you have a perfect focal length for head-and-shoulders portraits.

The Kiron 28-85 is a one-touch zoom, which means that one hand on the sleeve both frames the picture as you pull or push the sleeve, and focuses the lens as you twist the sleeve. Most photographers prefer one-touch lenses; they enable you to support the camera and shoot with one hand while zooming and focusing with the other. I prefer two-touch zooms, with separate rings for zooming and focusing. In my plump hands, the sleeve tends to slip forward slightly just as I'm about to shoot, and I have to pause and correct.

*Continued*

### Light pipe for close-ups

The careful portrait photographer will usually take his exposure reading right off his subject's face to reduce the chances of light from other areas affecting his final judgment. Just so, in close-up photography, the photographer would prefer to take his reading off the central object—say, a flower or a butterfly—than have the background affect his reading. The need for a close reading is even more critical with flash, when additional reflections that often cannot be anticipated affect the judgment of even an automatic flash as to when to quench its light.

Now there's an ingenious device, designed to be used with flash, that limits the area from which it takes its reading.

The Vivitar MFS-1, for Macro Flash Sensor, mated with the Vivitar 2500 electronic flash, enables you to take accurately exposed close-up photographs over a continuous range from eight inches to eight feet. The MFS consists of a tiny sensor at the end of a light pipe—a fiber-optic cord—that runs back to the flash unit. A swivel unit that locks into your camera's shoe enables you to swivel the flash downward and aim its light. A PC cord (behind the flash and not visible in the photo above) connects the flash to the camera's X-synch contact.

With the MFS-1, you use an aperture four stops smaller than the flash automatic-exposure guide recommends. For example, if the guide recommends a lens opening of f/2, you'd set your lens to f/8. An advantage to the system is the increased depth of field, especially valuable in close-ups with their shallow depth of field.

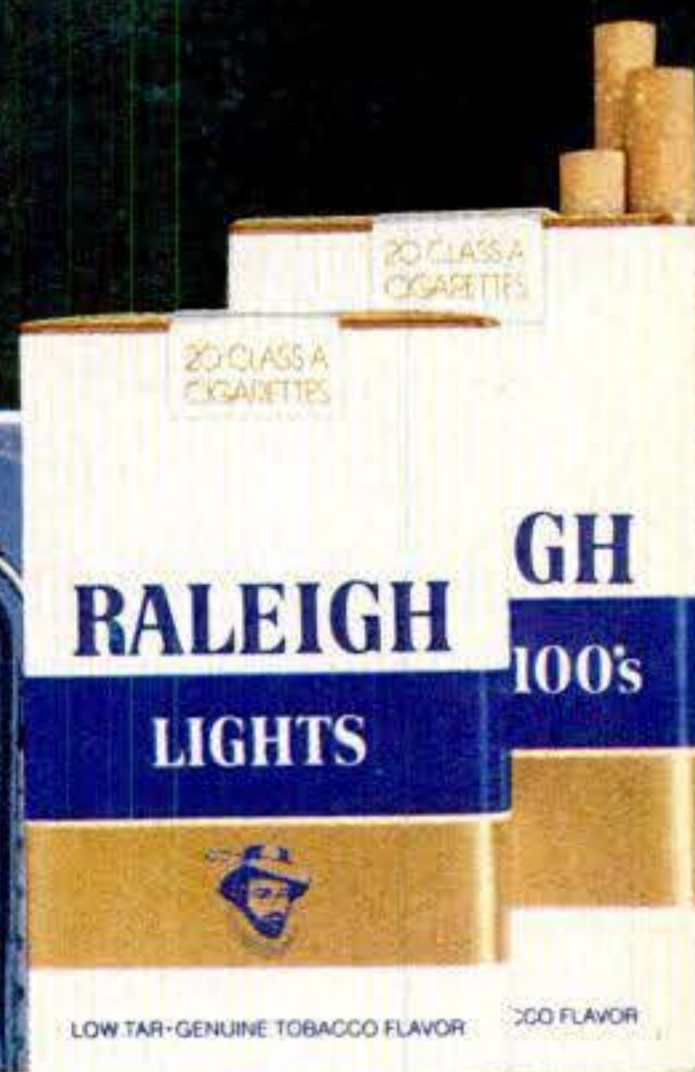


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## Through the viewfinder

[Continued]

The changing aperture of the lens has, usually, little practical effect with an automatic-exposure camera. Occasionally the slightly smaller aperture (f/3.8) may mean shooting at a marginally slow speed. If your camera has manual exposure controls, however, the varying aperture will mean a change whenever you zoom from one focal extreme to another. And the varifocal nature of the lens requires constant checking for sharpness of focus.

All in all, there's a little more fussing with such lenses than many spoiled photographers are willing to put up with. However, they are miracles of modern optical technology, and if you want a lens of this kind that will suit the laziest or least knowledgeable snap-shooter, you may have to wait another 10 years. If you're not prepared to wait, the Kiron 28-85 will set you back (list price) \$449.

Handy accessories designed to go with the lens are a set of three Macro Mate close-up accessory lenses that give you half-life-size pictures and a 1.5X Match Mate teleconverter that increases the maximum focal length from 85 mm to 128 (and the maximum aperture to f/5.6). The close-up lenses list for \$35, the teleconverter for \$79.

Any day now, too, there'll be a smaller brother to the Kiron 28-85. It's the Kiron 30-80 f/3.5/4.5, 1.7 inches shorter (at 2.5 inches) and about \$100 less.

## The crystal ball

As the largest manufacturer of photographic products anywhere, anything that Eastman Kodak does rocks the photographic world—camera makers, film makers, movie makers, photo dealers, photographers. And in 1980, the hundredth anniversary of the founding of the company, that photo world waited for a super rocker. Which never came. Did something go wrong to upset the centennial timetable? We may never know. At any rate, the rumors concerning Kodak activities (much of which was previously reported here) now sort themselves out something like this:

- Definitely coming: A new darkroom color-printing system in which you would project your color negative or slide onto an "image-transfer material" in an enlarger. Processing in a single chemical solution would yield a print of excellent quality in minutes. When? Possibly right after you read this, at the Photo Marketing Assn. (PMA) show in April.

- Strong possibility: A new film cartridge that would automatically set your camera for the right film speed and, at the end of the roll, automatically shift the camera into rewind mode. It would offer 35-mm-camera users a system comparable in convenience to the 110 system.

- Mild possibility: A photo-disc system that would use a sensitized disc instead of a roll of film. The disc would spin horizontally in the camera, and exposures would be made along the edge. Advantages: easy manufacturing, easy processing, and a convenient, easy-to-hold camera. **U.S.**

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As incredible as this may sound, there is a way to have \$10,000 CASH next week without working twenty-four hours a day for the next seven days. But because of this bold statement, I would like you the reader to be the judge.

**I promise you won't be disappointed.**

I know you are skeptical and you have a right to be. I know you have been promised instant Money in the past and when you ordered the plan, it didn't work.

Let me start by telling a little about myself and how I discovered how you can put \$10,000 cash in your hands in one week.

My name is Bob Shindler and I have lived in Herndon, Virginia for the past four years. I own a \$100,000 home, three cars and have an income of over \$100,000 a year. (My CPA has a financial statement to prove it.) My children go to school locally and I have a professional business license issued to me by the Supervisor of the County of Fairfax, Virginia. (You can check it!)

I am telling you this so you will know that I am going to be right here in Herndon, Virginia tomorrow, next week and next year to back up these statements.

If you are still with me this far, and I hope you are, I would like to share with you how I discovered this plan for putting \$10,000 cash in your checking account in one week.

Now I know you expect me to tell you about a "secret formula" I found in the attic of some old mansion or I spoke to and studied the richest and most powerful men in the country.

**I didn't do any of these things.**

I wouldn't insult your intelligence.

**Only a Select Group of People Know About It!**

What I learned, by accident, was quite the opposite from any formulas or methods you may have heard or read about. It's Brand New and only a select group of people in this country know about it.

It was 9:00 AM Monday morning about two hours before I was to open my small business. I was desperate! I was just informed I was broke, because the bank reneged on my loan at the last minute and if I didn't raise five thousand dollars in Twenty-Four hours, I would be out on the street and my investment in the business would be down the drain. I couldn't believe it! All the years I had saved to have this small business and now, to have it taken away before I even opened the doors.

Believe me when I tell you it's a terrible feeling being broke. If you have ever been in this situation, you know exactly what I mean.

**THEN IT HAPPENED!** Like a miracle from heaven a man appeared at the front door, knocking as hard as he could, trying to get in. He looked like a salesman and at that very moment a salesman was about the last person in the world I wanted to talk to. But, I let him in anyway. I had to talk to someone about my dilemma. Besides, he seemed to have more interest in my business than my banker or anyone else did. He told me as soon as he entered he was not a salesman. He informed me he represented a company that was interested in helping entrepreneurs get their new ventures off the ground. He said he had noticed that I was opening a new business and if I needed any assistance or extra cash, his company was willing to write me a check for up to \$10,000 and deposit it in my checking account tomorrow.

**I TOLD HIM TO GET OUT!** I didn't know who put him up to this joke, but to me it wasn't very funny. I told him that I was in serious financial trouble and I had no time for him or his practical joke.

He assured me he wasn't joking and his company was indeed willing to write me a check for \$10,000. And if I was willing to listen, he would show me how I WOULDNT have to pay back the \$10,000 out of any of the profits I made with it or out of any personal income I may earn with it in the future.

I still didn't believe him! I asked him to leave the premises immediately. He said he would leave, but he would like to leave his card so I could check out his company and his offer. I told him I would be more than happy to check out his company.

**What did I have to lose?**

He left me his card, phone number and detailed information on how his company program worked.

While investigating the company, I found several people in the Washington, D.C. area who were, until recently, working at meaningless jobs just trying to make ends meet. They all told me the company I was inquiring about was a very reputable corporation and that it had helped them start very profitable businesses, by using the corporation's financial assistance program. They also informed me that with this program they did not have to take any of the profits that their businesses earned to pay back the money nor did they have to invest any capital of their own to get started. It was theirs to keep and use in any way they deemed fit.

**The Concept This Company Is Using Is New, Different and Unique!**

I found that these cases were not isolated by any means. From one end of the country to the other I talked to men and women from all walks of life (all using the same program). They all started without any capital (except for the financial assistance from the corporation) and all became successful businessmen in a matter of a few years.

The man and the company with the \$10,000 check is "For Real" and so is the check.

The concept his company is using is New, Different and Unique. Who ever heard of a company giving you a check for \$10,000 and asking you NOT to pay it back out of any profits or money you may earn with it.

No gimmicks! No luck! No investment of your money! No hassle from bill collectors! (It is NOT a loan.) Just \$10,000 cash to do with as you wish, on whatever you wish.

**What's The Catch? There Isn't Any.**

Stop! Don't Rip Up this MAGAZINE. What I am telling you is the truth!

I know by now you are probably wondering what the catch is. LISTEN TO ME CAREFULLY. There isn't ANY. I checked. And I checked again. Everything I have told you is legal and above-board. This unique program is offered to anyone who is over twenty-one, in every state in the United States. There is NO special training or schools you must attend. There is NO age limit! It doesn't require "talent". It has nothing to do with any Federal Government or State Government loan program. Nor do you have to live in any particular part of the country or have experience to receive it.

What do I have to do to get the \$10,000? On page 52 of my report I will show you. Believe me there is no hard work involved. In fact, being employed is Not one of their requirements to receive it.

I know this is contrary to anything you have heard or read about in the past. But I will tell you this: anyone who does what the report tells him to do can make a substantial income every year by starting with this program and it would be foolish not to take advantage of it. Things are tough for people living on salaries. Tomorrow they'll be even tougher.

So there is no misunderstandings I would like to go over this important part again. This pro-

gram is NOT a Loan! There is NO gambling involved! It is NOT a pyramid game! There is NO buying or selling of any real estate OR products! No Investment of your money! It has absolutely NOTHING to do with mail-order! And there is no risk, because I won't cash your \$10 check or money-order for 30 days AFTER I've sent you my report.

**I Guarantee it!**

**Warning: This Opportunity May Not Last Long!**

I am not going to try and kid you and tell you this program will always be available. It won't be! Like everything else in life, circumstances change, people change and companies are bought-out by large corporations. This kind of company with a program that benefits them as much as it benefits you won't be around long before the word gets out and a big conglomerate buys it.

My advice to you is to order the report. You've got NOTHING TO LOSE and EVERYTHING TO GAIN. There is ABSOLUTELY NO RISK!

My report is 174 pages long and will take you about two hours to read. It will show you more than how to get the \$10,000. It will show you how to make a substantial income with it.

The program is available to EVERYONE no matter what financial situation you may be in.

I have already received many letters from housewives, businessmen, factory-workers and people from all walks of life who have thanked me and profited from the information in my report.

The only difference between them and you is their use of this program shown in "The Get Rich Report" and a solid lifetime income. In just one week from now you can know and have what they have.

The report is written in plain English to make it easy to read and easy to follow. You will find after reading it that you don't need any formal education with this program. Nor do you need any special experience. Both men and women, all ages, are acting on this information. And believe me when I say it does not require you to leave your present job, business or location.

**What If I Don't Like It?**

That's OK. Whatever your reasons. If you feel the Get Rich Report is not worth at least \$10,000, send the report back. I will send you a complete refund in the next day's mail. No Hassle! No Questions asked! I guarantee it!

For those who are still skeptical!

I will go one step further: POSTDATE YOUR CHECK FOR 30 DAYS FROM NOW. (That will give you plenty of time to receive the report and find out what I've been telling you is true.)

I won't cash your check or money-order for 30 days after I've sent you my report. Use the program and information for that period, and if you are not satisfied, just send the report back and I'll return your check UNCASHED.

*This report is NOT available in libraries or book stores.*

© Bob Shindler 1981

**Bob Shindler**  
Kingston Chase Estates  
Dept. AB-2, P.O. Box 607  
Herndon, Virginia 22070

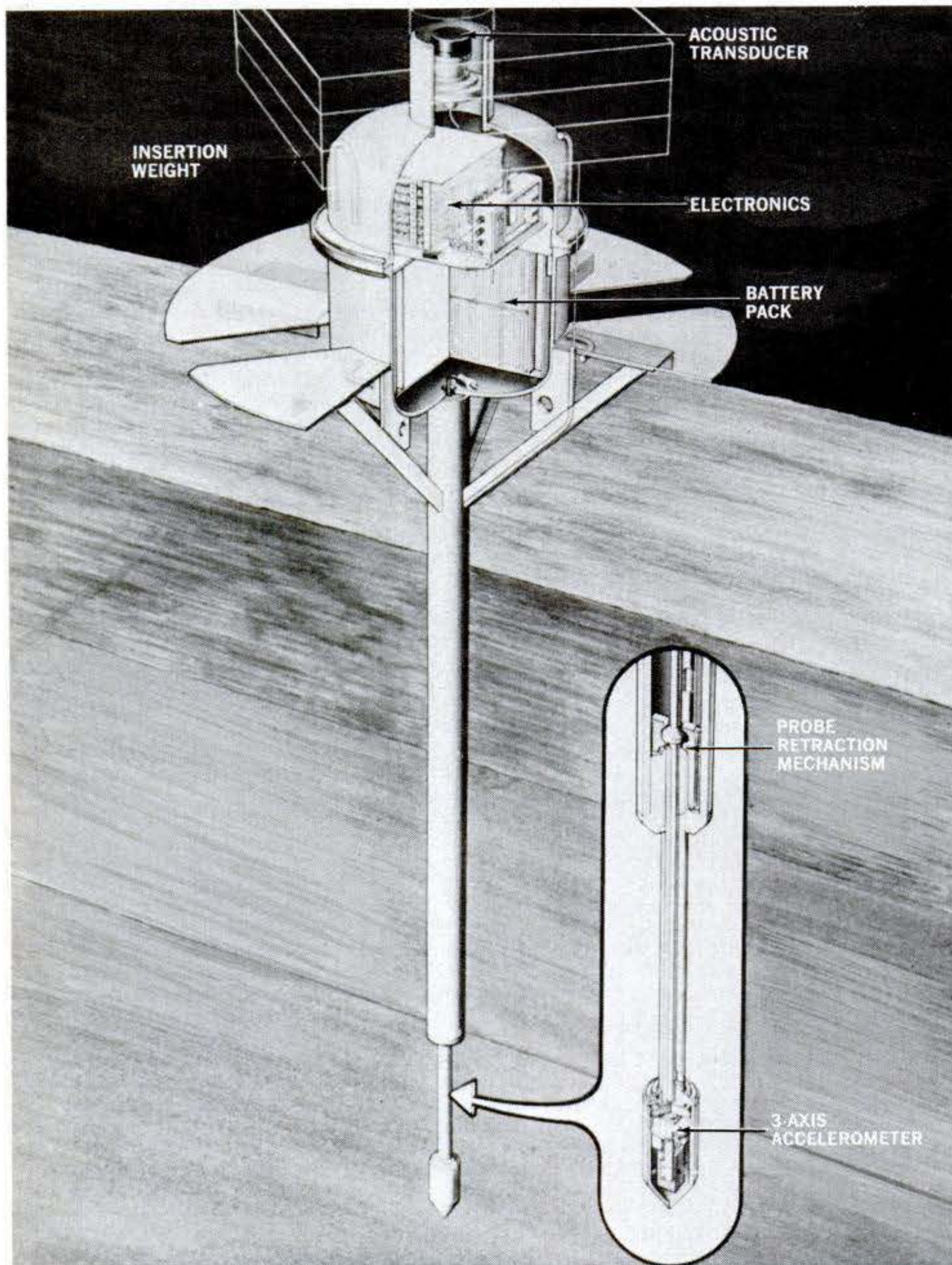
OK Bob. I still have serious doubts that your plan will work for me, but what do I have to lose. Send me a copy of The Get Rich Report, only with the understanding that you will not deposit my check or money order for 30 days after the report is mailed to me. If I am not satisfied for any reason, I simply return the report and you will return my check Uncashed. On that basis here is my ten dollars.

Name \_\_\_\_\_  
Address \_\_\_\_\_  
City \_\_\_\_\_  
State \_\_\_\_\_ Zip \_\_\_\_\_

All reports are mailed the same day received.

# SCIENCE NEWSFRONT

By ARTHUR FISHER



## Sea-floor earthquake probe

With the inevitable proliferation of off-shore-drilling efforts, there is ever-heightened concern over safety and the possibility of damaging oil spills. Earthquakes and other seismic disturbances obviously represent one source of risk. But until now, geophysicists had no precise picture of how the ocean floor itself reacts to such shocks.

Now, however, there is SEMS, short for Seafloor Earthquake Measurement System. Shown in the drawing above, the device is being tested in three locations in

the Santa Barbara Channel off the coast of Southern California, all near drilling platforms in 165 to 500 feet of water. Each of the prototype units consists of a 26-inch-by-30-inch pressure vessel surmounting a seven-foot-long probe that is pushed into seabed sediments as the SEMS is lowered to the bottom. Once implanted, the sensitive instruments in the tip can be isolated from the rest of the system; a housing is retracted, leaving only a data-transmission wire, which connects to the pressure vessel. The vessel houses a microprocessor, solid-state memory, batteries, and an acoustic telemetry system that relays seis-



mic data to a portable command system aboard a ship.

Prototypes of the SEMS were developed by Sandia National Laboratories as part of a Department of Energy/U.S. Geological Survey project. Part of the money for the program came from five oil companies—ARCO, Chevron, Gulf, Mobil, and Shell.

## Wood from bottles?

The carpenter in the photo above is testing the workability of a wood-like material that actually comes from soft-drink bottles. Work in Goodyear's Akron, Ohio, cabinet shop shows that the wood substitute can be drilled and sawed, and that it accepts nails and screws just like the real thing. It's made from polyester that has been recycled from the plastic bottles.

## Second-hand smoke

The air has been clouded recently by controversy swirling around the question of so-called "second-hand smoke." Some experts have contended that nonsmokers can be physically damaged—not just discomfited—by the fumes generated in their vicinity by smokers. These contentions have led to moves to ban smoking in all public places, and even in work places. Other experts, the tobacco industry, and smokers' defense leagues have tended to pooh-pooh such allegations, claiming that the increased risk to nonsmokers is either nonexistent or infinitesimal.

Now, however, a major scientific study, conducted in Japan, has provided strong evidence that second-hand smoke, at least over long periods and in confined spaces, is not merely harmful but life-threatening. The study followed 265,000 men and women for 14 years. It found that nonsmoking wives of heavy smokers were twice as likely to die of lung cancer as nonsmoking women married to nonsmokers. The contrast in rural areas,

*Continued*

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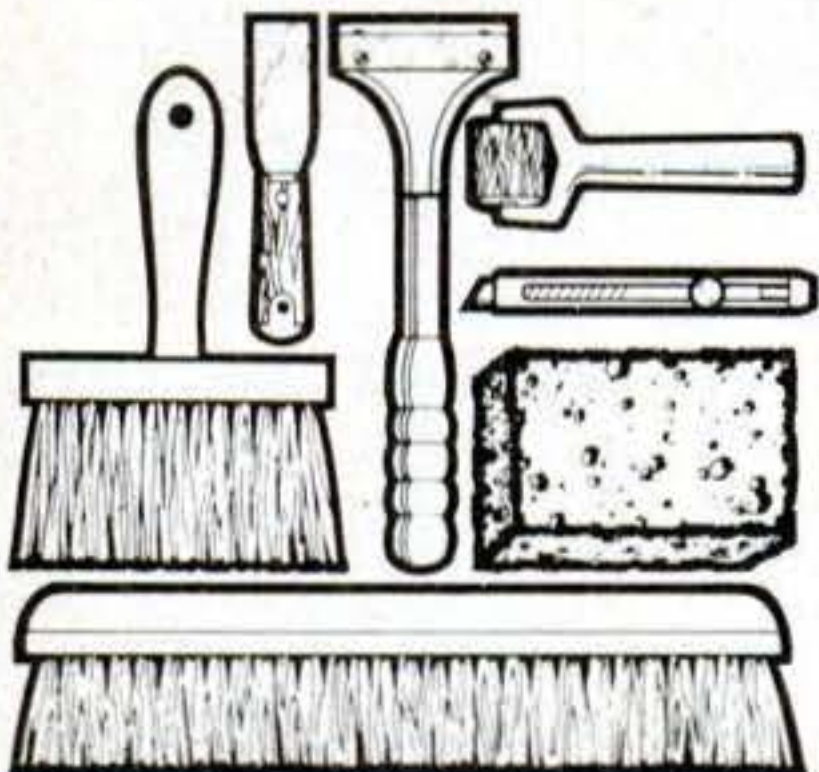
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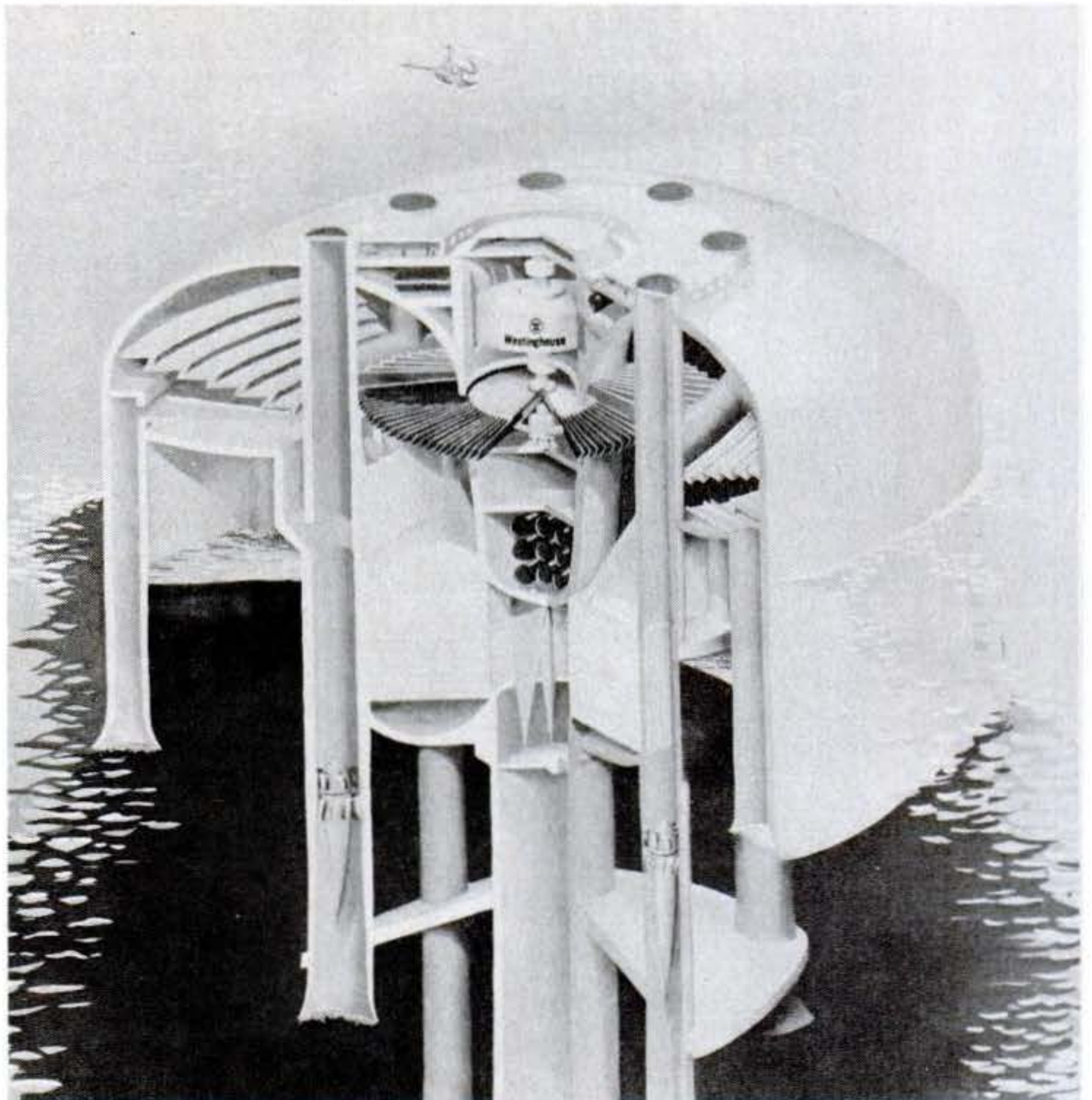
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## WE'RE SOLD ON QUALITY.

### Science newsfront

[Continued]



where there are fewer contaminants to play a role in the disease than in smoggy Japanese cities, was even more chilling. There, nonsmoking women married to heavy smokers died of lung cancer four times more often than their cleaner-breathing counterparts.

#### Open-cycle OTEC power plant

Westinghouse Electric Corporation has been awarded a \$737,000 contract by the Department of Energy's Solar Energy Research Institute (SERI) for research on an OTEC plant something like the one shown in the drawing above. It may look familiar, but there's a significant difference between this one and others you've seen recently in these pages. Most current research on OTEC (ocean thermal-energy conversion) plants concentrates on a closed-cycle system, in which the temperature differential between sun-warmed surface water and colder bottom water is used both to evaporate a working fluid, such as ammonia, and to condense the fluid after it has driven a turbine. In the open-cycle system, sea water itself is the working fluid. It flashes into steam in a very-low-pressure turbine, but then escapes to the atmosphere.

The open cycle is far less efficient than the closed cycle, and requires a turbine with enormous rotor blades, but its advocates believe it has engineering advantages over closed-cycle systems [PS, June



'75]. Westinghouse will design a prototype 300-foot-diameter, 100,000-kilowatt plant with 40-foot-long composite construction turbine blades.

#### Lasers monitor St. Helens

This crash-helmeted person is a scientist with the U.S. Geological Survey who is planting a reflector inside a moon-like crater at Mount St. Helens. The reflector will bounce back a laser beam sent from a station five miles away, in a program to monitor earth movements within the still-dangerous volcano.

13

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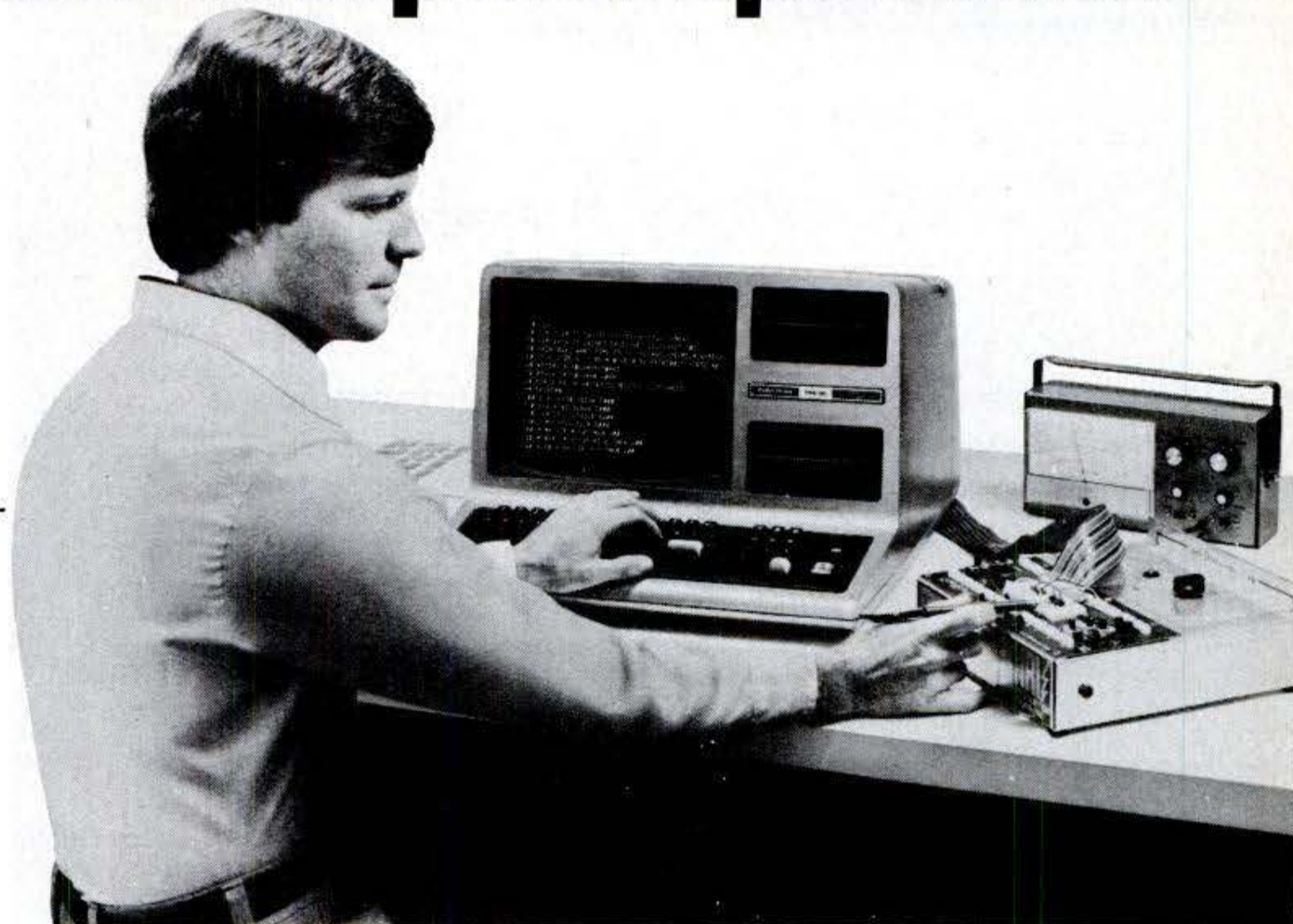
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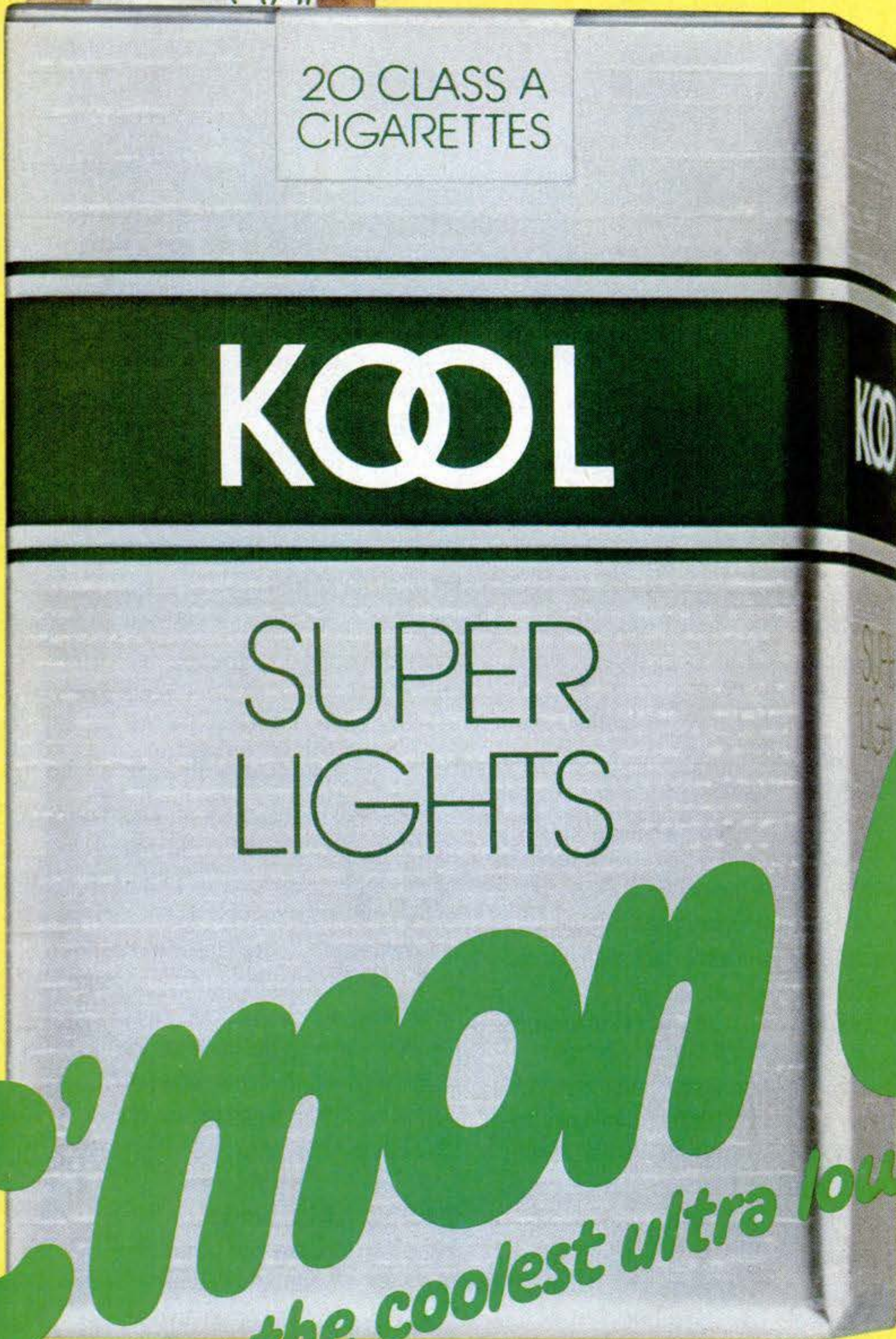
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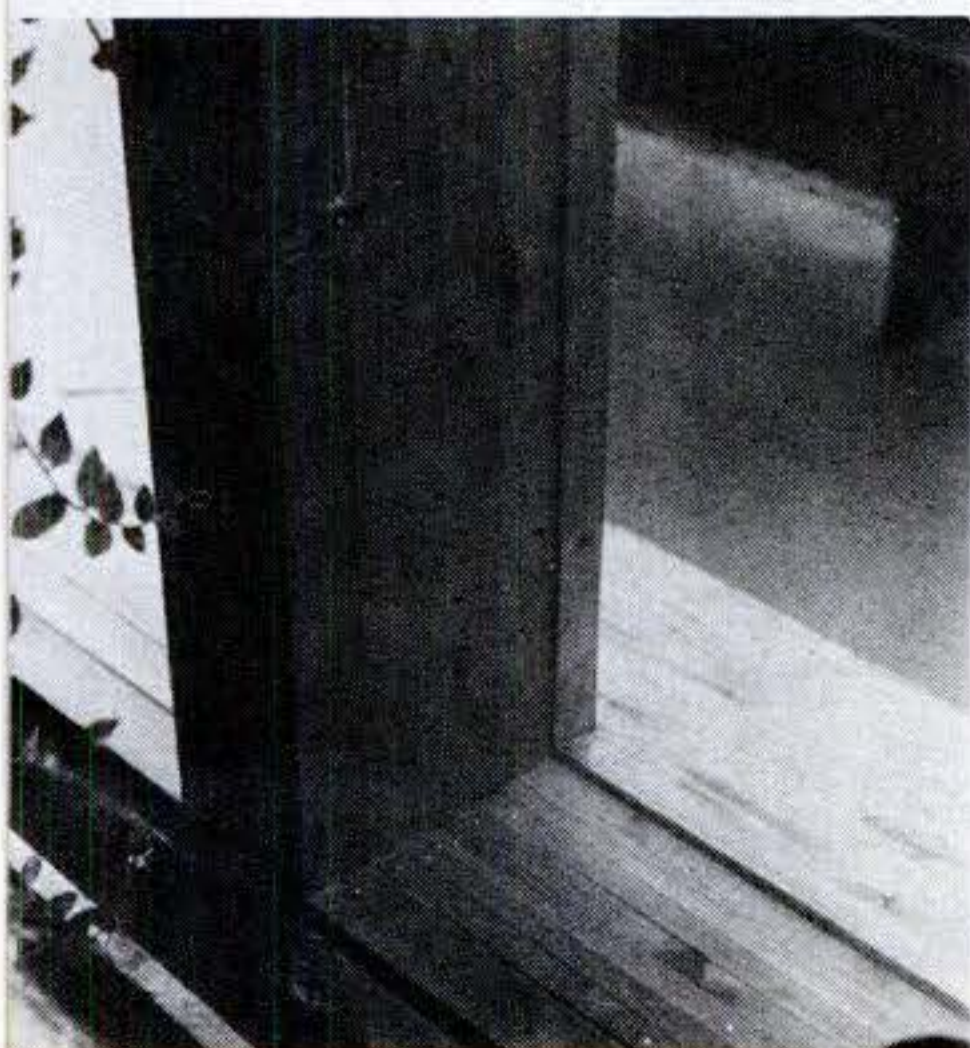
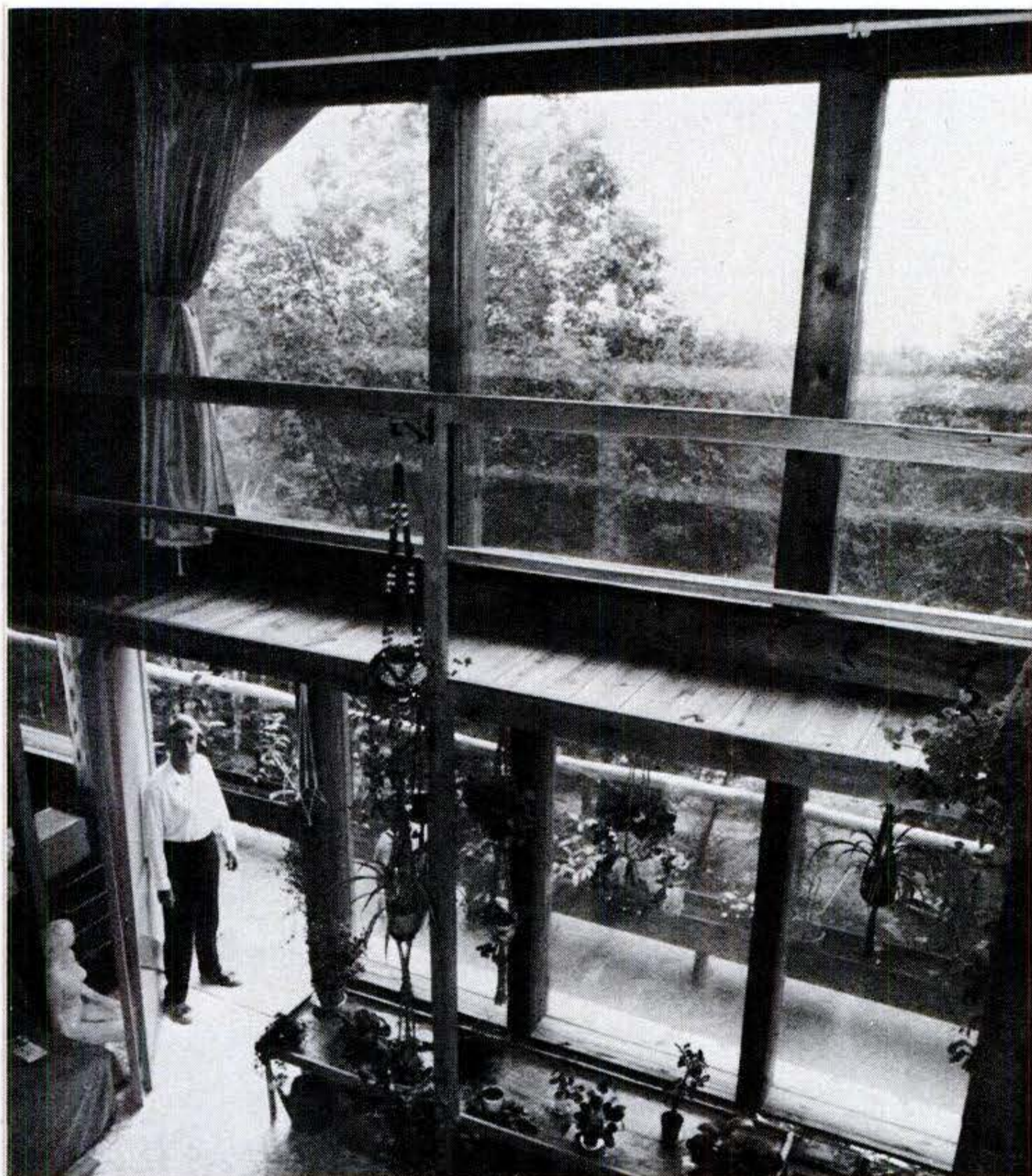
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## ADVENTURES IN ALTERNATE ENERGY

A bimonthly sampling of projects PS readers have devised to conserve or replace fossil fuels

# Multi-layered Mylar storm windows



By PAUL BOLON

Jack Stephenson knew he would have to find a way of reducing the heat loss through his large picture windows—or he'd have to burn a small forest to keep his big New Hampshire home warm in winter. His novel solution was to create many  $\frac{3}{4}$ -in. dead-air spaces in each window jamb by adding layers of clear Mylar film between the old window and a new inside pane.

Most of Stephenson's windows now have five or six layers of Mylar film between the panes. A test with thermographic photography has shown

that heat loss through the windows is now as low as through the walls. Besides being far cheaper than glass, Mylar is a much poorer conductor of heat; so each layer of the film was more effective than typical storm-window glazing.

Since Stephenson has warm-weather ventilation from the basement through the house to an attic peak, most of his windows are fixed. Thus he did not have to make sturdy frames for the Mylar that could withstand frequent opening and closing. He installed the Mylar in three different ways, but in each case he used  $\frac{3}{4}$ -by- $\frac{3}{4}$ -in. wood strips as frames. At first, he simply nailed a frame together, attached the one-mil Mylar to it with double-stick tape, and nailed it in the window jamb. This method worked all right most of the time, but because the jambs were not perfectly square the Mylar was sometimes pulled and wrinkled a little when nailing the frames. And even though the wood was well sealed, condensation sometimes collected. He had to vent those frames to get rid of the moisture.

Stephenson next tried tacking several of the covered frames together and setting them in the window as a unit. This worked well and, besides sealing the wood strips, he also wrapped the outside of the frames with thin polyvinyl packing tape to keep moisture out.

His final construction method was the easiest, he reports. First the window jamb was sealed with polyvinyl tape. The Mylar was attached to only one vertical member of the frame, with extra Mylar overlapping the other sides. The frame was put in the window jamb and the side with the Mylar already attached was nailed. Excess Mylar on the other sides was pulled gently from the inside until the film was taut within the frame. After the other sides were nailed, excess Mylar was trimmed off.

Stephenson will answer reasonable queries accompanied by a self-addressed, stamped envelope. He also sells Mylar at cost (via his \$3 mail-order camping catalog) in quantities convenient for glazing. His address: Hook Road, RFD 4, Box 145, Gilford, N.H. 03246. **PS**

### Your idea may bring you \$200

Every other month, we present a project developed by a PS reader and pay the inventor \$200. To enter, send us black-and-white glossies (one photo should show you demonstrating the device), plus a description and sketches. Include your name, address, and social-security number. No material can be returned unless you enclose a stamped, self-addressed envelope.

Since space won't permit us to present projects in detail, we'll expect inventors to answer any reasonable query from readers, if it's accompanied by a stamped envelope.

Mail entries to Energy Adventure, POPULAR SCIENCE, 380 Madison Ave., New York, N.Y. 10017.

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## Now you can buy it: **RCA's video-disc player**

It's easy to set up, use, maintain—and features a reasonable price, to boot

By **WILLIAM J. HAWKINS**

If you've been following the videodisc evolution in PS for the past few years, you know there are three major systems: Philips optical, RCA capacitance, and Matsushita's VHD. Magnavox and Pioneer are already selling players using the Philips system (both units tried by PS [Sept. '79 and Jan. '81]). And now the RCA system is available.

But that's not all. At a recent Electronics Industries Assn. dealer trade show, about a dozen different brands were shown, all using one of the three major formats. All should be available within a year. And 1981 isn't just the year for video—it's promising to be the year for the videodisc.

I've been living with the RCA system for some time now. It's simple to use and easy to hook up. One control—

a three-position lever switch—does most of the work. Push it down to the LOAD position, and a front door opens wide so you can insert the disc—jacket and all. You never touch the record. The machinery inside the player extracts the disc, and you pull out the empty plastic jacket. Then you just slide the switch up to PLAY.

This player is different from the prototype I saw a few years ago. It has additional buttons for special effects: Reverse and forward VISUAL SEARCH buttons let you scan for a scene at about 16 times normal speed. Reverse and forward RAPID ACCESS buttons let you leap through the hour-long side. You can't see the picture in this mode, but a digital display counts up or down to show how far you've gone. The last button is PAUSE, and it temporarily holds the show and blanks out the screen.

When the first side is through, you insert the disc jacket into the loading hole again. The disc is placed back in the sleeve and you pull it out. Turn it over, place it back in the hole, and

*Continued*



Disc and jacket are inserted into player. Jacket comes out, but the disc stays in.

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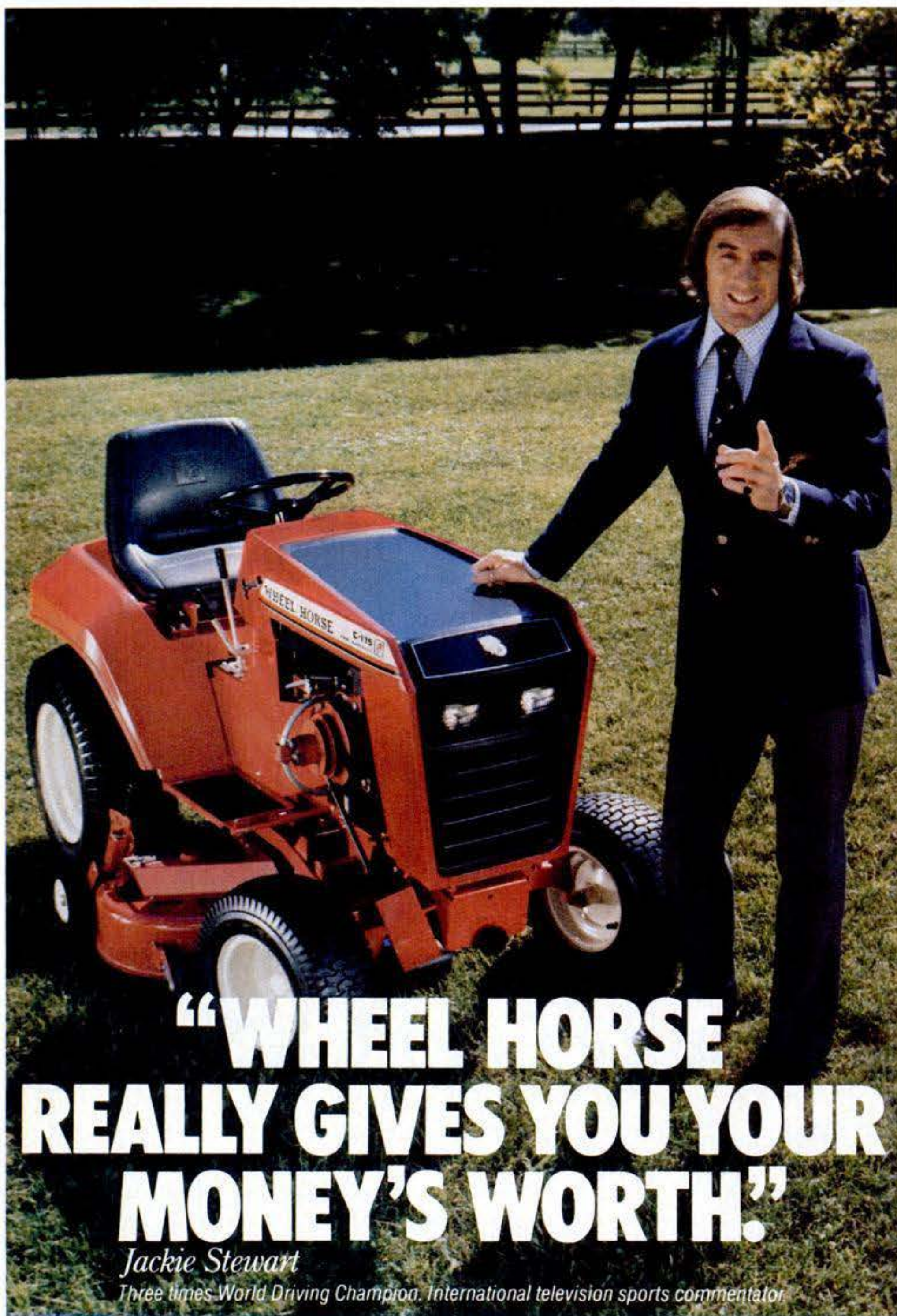
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GARDEN TRACTOR, INVEST IN ONE."**



**Wheel Horse.**

515 West Ireland Road • South Bend, IN 46614

## RCA's videodisc player

[Continued]

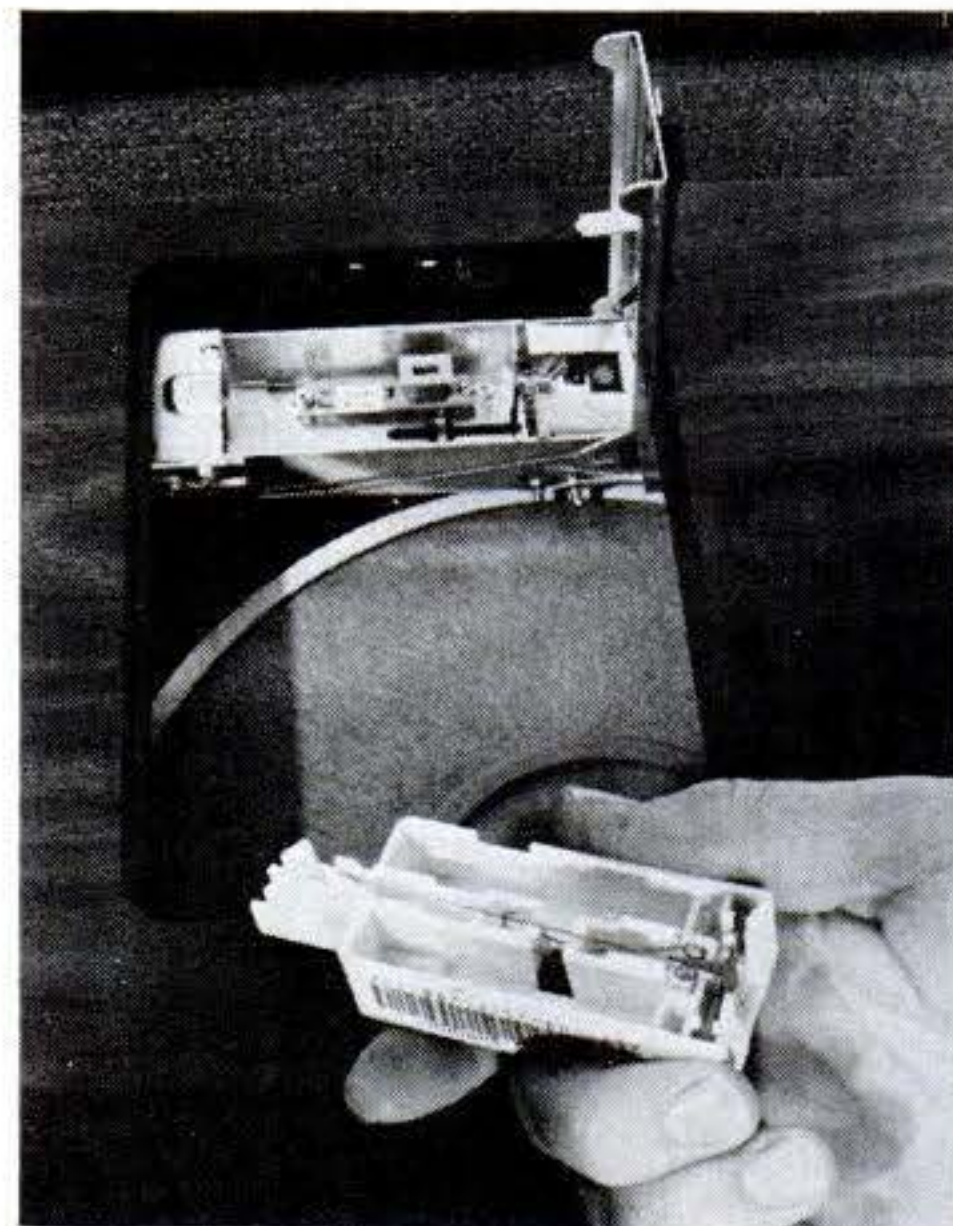
remove the empty jacket. Another hour of play is ready to go.

The RCA system uses a stylus to track the record. It will wear out eventually (after several years of normal play, according to a spokeswoman for RCA). To replace it, you lift the plastic cover from the top of the machine to expose the stylus unit. Push a lever to remove it, and drop in a new one. The whole thing is done at home in about 30 seconds. Cost of a new stylus will be approximately \$70.

Connecting the player to your TV is also simple: It goes between your antenna (or cable) and the TV-antenna terminals. The player does all the switching automatically. My only criticism: There are no video- and audio-output jacks. These would provide cleaner signals to TV's that accept them.

Nevertheless, the quality on my Heath projection TV is excellent, and audio reproduction is good. I did see an occasional glitch on one of the discs I watched. (Fast search sometimes caused a frenzied picture, cured only by turning off the player and restarting.) This may have been a disc problem and could be attributed to an early pressing. But it emphasized one important point for disc players: The quality of the programs—technically and artistically—will be the key to the players' success.

RCA has done an excellent job of keeping its player simple but useful, and reasonably priced at \$499.95. (Discs will cost between \$15 and \$25.) Still, its success, I think, will depend on deals signed in Hollywood. PS



Top door on player pops off to expose stylus holder. Changing the stylus is easier than changing an audio cartridge.

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# Special Clarion offer on in-dash AM/FM stereo cassettes

## Three good reasons to invest in quality now!

Buy any of the twelve Clarion in-dash AM/FM stereo cassette combinations before May 16 and get Clarion quality backed with a FREE THREE-YEAR WARRANTY and a FREE ALLSOP 3 CASSETTE DECK CLEANER.



**1. Clarion Quality**  
All Clarion stereo cassette combinations are precision engineered to fit shrinking in-dash spaces and incorporate advanced audio technology to bring high fidelity sound alive in your car.

The Clarion line goes from simple self-contained units to high-powered, ultra-sophisticated models with electronic scanning or computerized, fully programmable capabilities.

Many models feature Clarion's Magi-Tune™ FM with improved Signal Actuated Stereo Control (SASC) that locks into stations even in the worst reception areas.

The options are yours...Dolby® noise reduction, separate bass and treble controls, loudness control, auto reverse, tape equalization, sendust alloy heads...you name it, Clarion's got it.

Clarion systems are priced to fit every pocket, from less than \$100 to over \$1,000.

**2. Free Three-year Warranty**

Clarion backs up its product reliability by picking up the tab for the Clarion warranty extender on tape/radio combinations (parts and labor) for a total of three years.

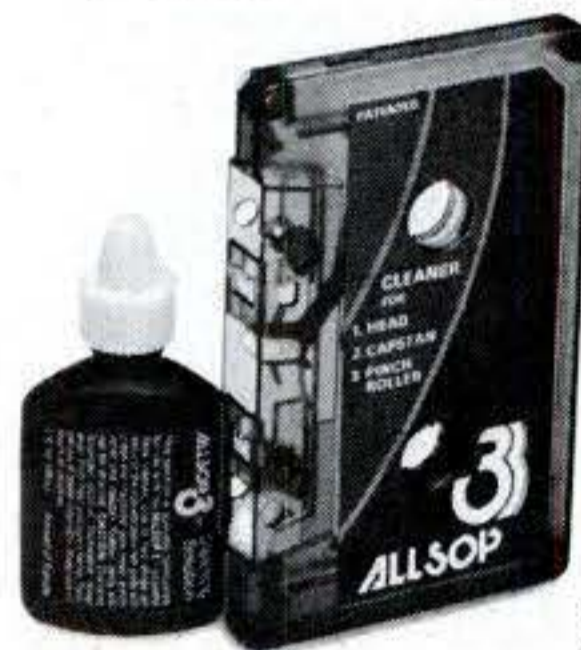
You save \$7.50 on the extender, but the real value is Clarion's commitment to your trouble-free listening pleasure.



**3. Free Allsop 3 Cassette Deck Cleaner**  
We'll pay you to take good care of your Clarion with the Allsop 3 Cassette Deck Cleaner.

Its patented action gently and effectively cleans the head, capstan and pinch roller simultaneously. Allsop 3 also eliminates dust, dirt and oxide buildup on the pinch roller, reducing "tape eating" and slippage.

You save another \$6.95 and gain added insurance for your cassettes while you maintain your Clarion's optimum performance.



### Hurry — Offer limited!

This special offer will be available at participating Clarion dealers\* for only 60 days...from March 16 through May 16 (inclusive). Save money and protect your investment by taking us up on our offer now!

\*For the name of your nearest Clarion dealer call toll free (800) 421-2119; in California (800) 272-1721. 800 numbers will be discontinued after May 16, 1981.

 **Clarion**  
It's a great deal

# Three classy coupes

— opulent and stylish  
(but don't ask about mileage)

By **JIM DUNNE** and **ED JACOBS**  
PHOTOGRAPHS BY JOHN KEATING

Rich people are different, they say. True or not, many of them drive cars that are different from the ordinary—cars that pamper, comfort, inform, and serve them beyond the limits of more mundane machines—and, quite naturally, at prices that are anything

but mundane. This month we examine three of the high-priced coupes in which the more affluent cruise the streets: Cadillac Eldorado, Chrysler Imperial, and Lincoln Continental Mark VI.

Finding rich interiors, posh seating, excellent ride comfort, and high quality in fit and finish wasn't surprising—

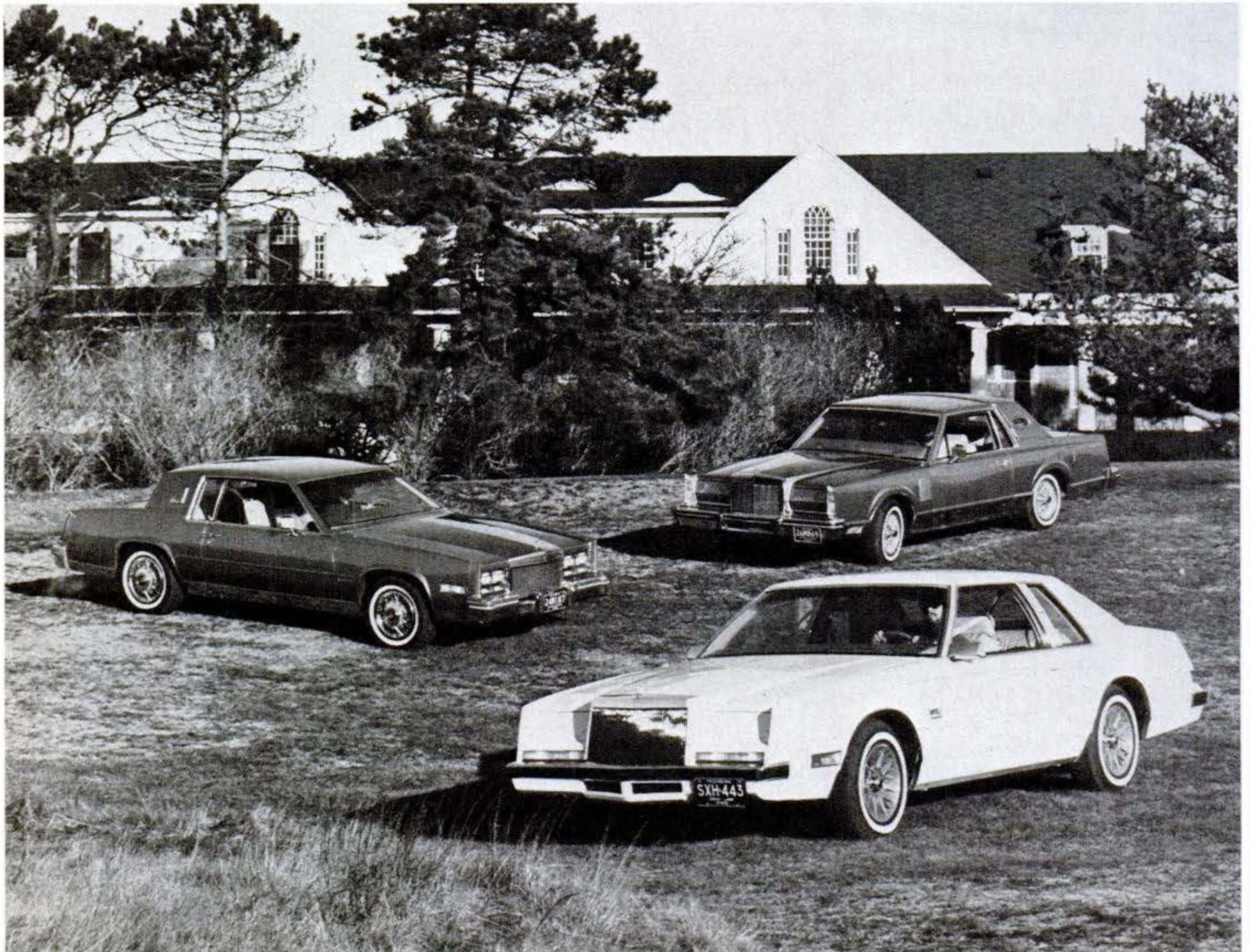
*Continued*

## PS ratings— test report in a nutshell

The ratings are based on test results and measurements. Results should be read with the understanding that they reflect tests only on our sample cars. An excellent rating is 5 points; very good, 4; good, 3; fair, 2; poor, 1; very poor, 0.

	Cadillac Eldorado	Chrysler Imperial	Lincoln Continental Mark VI
Acceleration	4	4	4
Braking	0	0	1
Handling	4	3	3
Maneuverability	5	4	4
Quietness	2	2	1
Roominess	4	4	4
Vision	2	3	1
Entry/exit ease	4	4	5
EPA economy	2	2	2
Ride comfort*	5	5	5
*Authors' opinion			

America's top status symbols include Chrysler Imperial (foreground), Cadillac Eldorado (left), and Lincoln Continental Mark VI.



# ONLY QUAKER STATE GUARANTEES NEW CAR ENGINE LUBRICATION FOR A LIFETIME. IN WRITING!

## Introducing Quaker State's Lifetime Engine Lubrication Protection Program.

Now Quaker State, the motor oil refined from Pennsylvania Grade Crude Oil, announces the most daring Protection Program available in the oil industry. It's the Lifetime Engine Lubrication Protection Program, the only program to cover your new car's engine for as long as you own it.

This exclusive program is brand new. So take a few minutes to read the following. Once you do, you'll see just how much this program can mean to you. We're sure you'll want to take advantage of it... and keep your new car staying on the road with Quaker State.

**Q. Just what is Quaker State guaranteeing?**

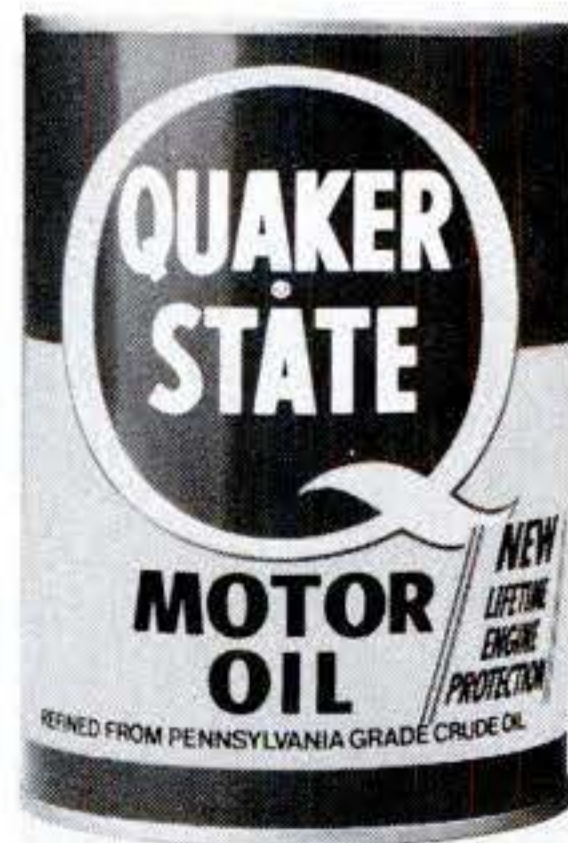
**A.** We're not only guaranteeing the quality of our motor oil, but we're guaranteeing that Quaker State will protect so well, if your engine is ever damaged because our oil fails to protect it, we'll pay for repairs or replacement of any or all of these parts: Pistons & rings, crankshaft & bearings, timing chain, rocker arms and pivots, rods and rod bearings, wrist pins & bushings, camshafts & bearings, valve stems & guides (grinding & adjustments excluded), oil pump, push rods, valve lifters, cylinder heads, cylinder lining or bore, distributor drive gear and timing gears or sprockets.

**Q. What do I have to do to get this protection plan?**

**A.** When you buy a new car, light truck or van from a participating dealer, you'll get the protection plan. To keep it in effect, all you have to do is follow these 4 steps:

1. Have all services performed by your new car dealer or other auto service center.
2. Have the oil changed according to manufacturer's recommendations, or at least every 6 months or 6,000 miles, whichever comes first.
3. Have oil filter and air cleaner replaced, and emission control system maintained, according to manufacturer's recommendations.
4. Keep all service records. These must indicate that only Quaker State Motor Oil was used with date and mileage indicated.

That's it. Now when the manufacturer's warranty ends, your Quaker State limited warranty protection begins... and continues for as long as you own the vehicle!



**Q. What won't the guarantee cover?**

**A.** It won't cover defects in manufacture, vehicles used in competition such as racing, damage caused by negligence, collision or abuse, improper installation, or engine parts not lubricated by motor oil.

**Q. Suppose something goes wrong and I'm covered. What do I have to do, and how long will it take for me to collect?**

**A.** All you have to do is notify Quaker State of a claim, by writing or calling collect. (Address and phone number are on the warranty.) Our claim representative will contact you within 24 hours. Provide the claim representative with a copy of your warranty, copies of your service records, and a statement of damage and repair cost from the dealer or any repair shop you choose. If everything is in order, the claim representative will approve the claim and make the payment.

**Q. If I don't have a brand new car, can I still get the Protection Program?**

**A.** If your car has under 6,000 miles, you can switch to Quaker State and qualify for the Protection Program at a participating new car dealer's service department. But if your car has more than 6,000 miles, it can't qualify.

**Q. If I buy a new car now, and keep it for 100,000 miles or more, will this Quaker State Protection Program be good for that long?**

**A.** Yes. Lifetime really means for as long as you own your new car—even if you keep it for a lifetime. After all, thousands of people are already driving over the 100,000 mile mark using Quaker State without this protection program. Now, you can do it with Quaker State and have this *extra* protection for as long as you own your new car.

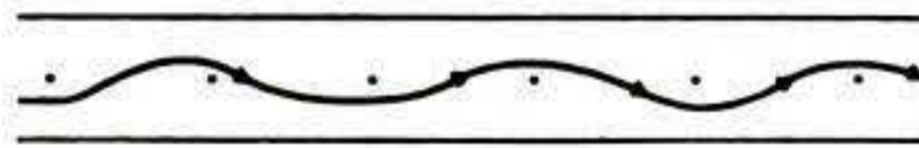
**Q. Why is Quaker State the only motor oil with a written Lifetime Engine Lubrication Protection Program?**

**A.** We've been making quality motor oil since 1910. In all that time, millions of people have depended on our ability to help them stay on the road. All that "on-the-road testing," plus our own laboratory tests through the years, are all the proof we need. Quaker State has the confidence in its product to put our promise of quality in writing.

# STAYIN' ON THE ROAD WITH QUAKER STATE



Eldorado's optional Touring Suspension produced handling and maneuverability far superior to that of the other cars. Here, it easily gets a top rating in the slalom.



at these prices, they should be there. Neither was it surprising to find the high-tech gadgetry that abounds in these cars. What was surprising, though, was their uniformly poor braking performance, the low fuel economy delivered by two of them, and the recurrence of a transmission-induced braking problem that we discovered last year—one which we were told then would be fixed.

### Braking

In last April's car test we pointed out what we felt was a potentially dangerous flaw in Ford's otherwise fine four-speed Automatic Overdrive

Transmission (AOT). (See PS, April '80 for a full description of the problem, how it occurs, and what Ford officials had to say about it.) Briefly, here's what can happen:

If the brakes are engaged fast and hard enough during panic stops made in fourth gear (only), it is possible to lock up the rear wheels and, because the coupling is 100 percent mechanical, stall the engine. If that happens, the power-steering assist is immediately lost; if the brake pedal is pumped to modulate stopping, the boost for the power brakes is lost as well. The net result is a car that can simultaneously become both difficult

to steer and hard to stop—in fact, requiring as much as 40 percent more space to stop, based on last year's testing.

The problem seems common to all Ford products with the AOT transmission; we've experienced the difficulty at least once with each model line we've checked. Ford officials told us last year that they would fix the problem on 1981 models. They now admit to PS that they didn't. We still consider it potentially serious.

Aside from this problem, the braking performance of all three cars was dismal. Their stopping distances of 200+ feet make the worst showing we've ever seen in our 13-year test program, which has included more than 500 cars and light trucks.

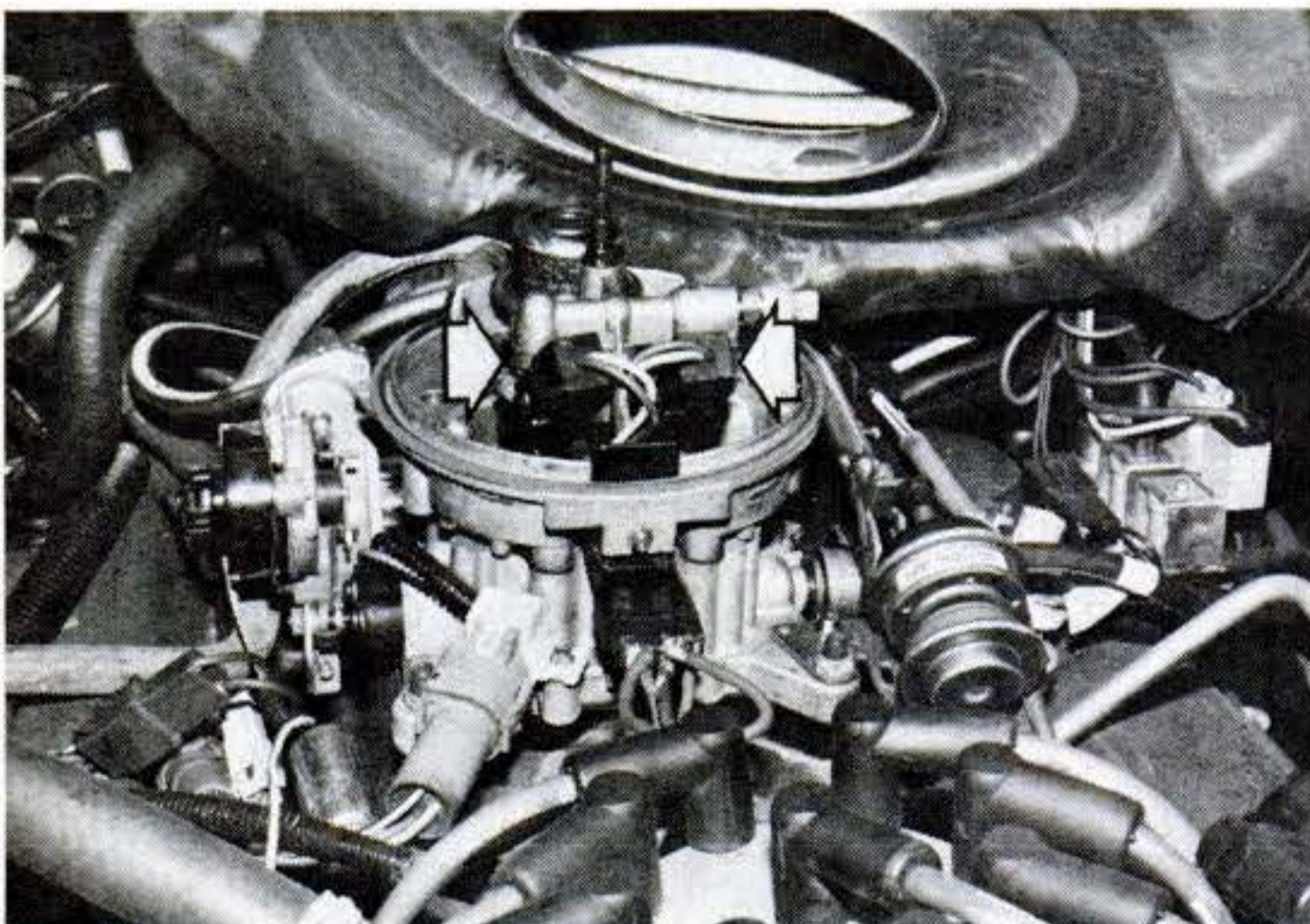
### Fuel economy

Yes, even rich folks are concerned about miles per gallon. And despite much more stringent emissions standards, they'll be getting better fuel economy this year—although perhaps not that much better.

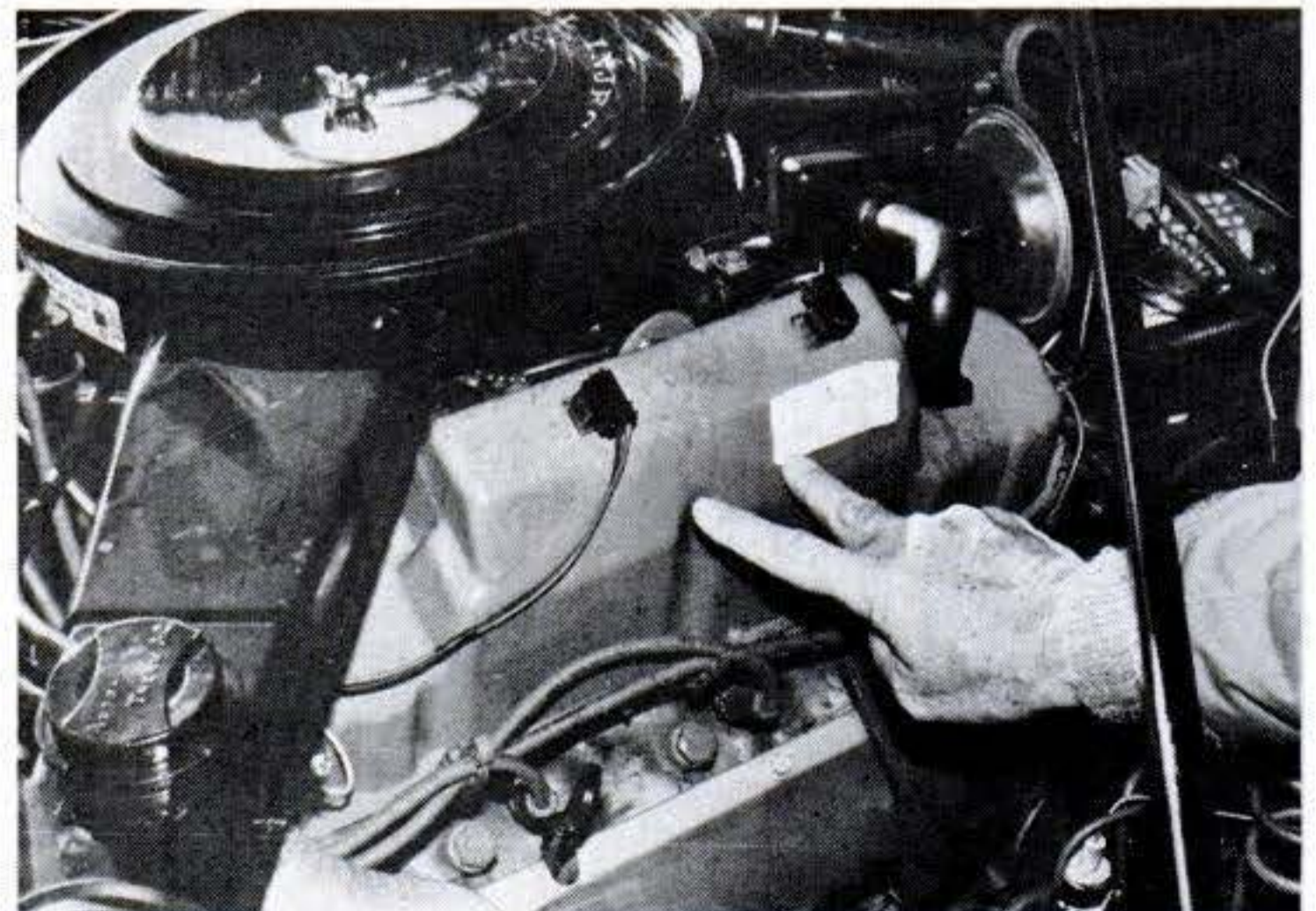
The EPA ratings for our group are impressive for cars of their size. Both Eldorado and Mark VI have posted sizable improvements in recent years. Mark VI's highway rating, for instance, has jumped a whopping 40 percent since 1979, from 17 mpg to 24. Eldorado's highway rating is also up to 24 mpg for '81. But the new Imperial, making a comeback in 1981 after being out of production for several years, edged them both out at 26 mpg.

Few cars actually meet their EPA ratings in real-life driving situations, but we were startled at the magnitude of the shortfalls served up by Eldorado

*Continued*



Throttle-body fuel injection is used in all three cars. In the Mark VI's system (shown), two injectors are mounted atop the throttle body for more thorough fuel-air mixing, better performance.



Large bulges on the Cadillac's valve covers make room for the special solenoid-controlled valve-train apparatus that selectively deactivates two or four cylinders for better economy.

# *Alive with pleasure!*



© Lorillard, U.S.A., 1981



# *Newport*

*After all, if smoking  
isn't a pleasure,  
why bother?*

Box: 16 mg. "tar", 1.2 mg. nicotine; Kings: 17 mg. "tar",  
1.2 mg. nicotine av. per cigarette, FTC Report January 1980.

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

## CHEVY IMPALA. America's lowest-priced full-size diesel wagon.\*

Full-size room, comfort and ride are yours along with impressive fuel economy. The Impala Diesel Wagon holds over 87 cubic feet of cargo, or up to eight people when you order the available third seat model. For families on the go, it's an ideal way to get there. Chevrolet Impala and Caprice: America's favorite full-size wagons. No wonder.

**33** HWY. EST. **21** EPA EST. MPG\*\*  
With available diesel engine.



Impala Diesel Wagon



Malibu Wagon

## CHEVY MALIBU. America's lowest-priced mid-size V6 wagon.\*

Mid-size means right-size for many families today. You get room for up to six plus good mileage in a size that's easy to handle in traffic and parking. A peppy V6 engine, power steering, power brakes, radial tires all yours at no extra cost. Chevy Malibu: It's a lot of wagon for not a lot of money—a real value in the true tradition of Chevrolet.

**28** HWY. EST. **20** EPA EST. MPG\*\*

# A pair of family wagons long on mileage, short on price.



\*Based on comparison of Manufacturers' Suggested Retail Prices. Level of standard equipment will vary. Destination charges may vary and affect price comparison. Diesel engine is optional equipment on Impala and Caprice models.

\*\*Use estimated MPG for comparisons. Your mileage may differ depending on speed, distance, weather. Actual highway mileage lower. Impala highway estimate lower in California, Malibu higher. Chevrolets are equipped with GM-built engines produced by various divisions. See your dealer for details.

## PS car test & driving report

and Mark VI in our steady-state testing at 35 and 55 mph.

Although its advanced-technology V8-6-4 engine [PS, Oct. '80] performed well otherwise, at 55 mph on the highway Eldorado couldn't even beat its California city rating of 16 mpg. Mark VI, with its Automatic Overdrive Transmission, was two mpg better. But it still lagged 4.5 mpg behind Imperial, which uses a lock-up torque converter and a low final-drive ratio to achieve its higher economy.

### Engineering

Each of these cars employs sophisticated technology. Cadillac's unique V8-6-4 engine was of special interest to us, and ran as slickly as expected. The 368-cu.-in. V8 is set up to run on eight cylinders up to about 35 mph under normal conditions. Approaching cruising speed, it shifts down first to six, then to four cylinders as power demand slackens. Should more power be needed for passing or hill climbing, additional cylinders are automatically reactivated. We found little noticeable reaction in the drive train when cylinders cut back in.

The idea, of course, is to run the engine on as few cylinders as possible to maximize economy. In effect, the car runs with a smaller engine much of the time and should deliver good fuel economy. We were disappointed with the economy results, however.

Mark VI's special feature is its four-speed Automatic Overdrive Transmission. Ford pioneered this type of transmission last year, but General Motors now has a similar transmission available in its larger rear-wheel-drive cars. The advantage of these units is that the top gears have overdrive ratios that allow their engines to turn slower at a given road speed and, therefore, burn less fuel.

Imperial, like the others, has electronically controlled throttle-body fuel injection. Instead of mounting one injector on the intake manifold at each cylinder, two injectors are mounted in a carburetor-like "throttle body" atop the manifold. The system combines the simplicity of a carburetor with the improved economy, reduced emissions, and crisp throttle response of fuel injection.

Handling is generally mediocre in domestic luxury cars, but our Eldorado was surprisingly good. Its optional Touring Suspension package turned it into a sure-footed, flat-cornering wonder for a car of its size, and did it without detracting from the comfortable ride you'd expect. At \$95,

### EPA fuel mileage (mpg)

	Cadillac Eldorado	Chrysler Imperial	Lincoln Continental Mark VI
Highway	24	26	24
City	17	16	16
Calif. city	16	15	16

### PS fuel-mileage tests (steady-state mpg)

	Cadillac Eldorado	Chrysler Imperial	Lincoln Continental Mark VI
35 mph	21.3	27.3	23.5
55 mph	15.8	21.3	17.8

no Eldorado should be without it.

While the handling and maneuverability of Mark VI have been significantly improved in recent years, the car isn't in the same league as Eldorado. We think it should be. Imperial is tough to make a judgment about, since it was clearly limited in both areas by its tires. For whatever reasons, the tires our car came with just did not work well with the car's suspension. It's seldom so noticeable, but the tires obviously reached their limits before the car reached its own.

### Inside story

All that need be said about comfort is that it's as good as you'd expect. Imperial's front-seat cushions could extend forward a bit more for better support. You'll find the usual extravagances in all the cars, though, such as luxurious carpeting, multiposition steering wheels, and power assists for everything from mirror adjustment to trunk closing. Even electrically heated exterior mirrors are available.

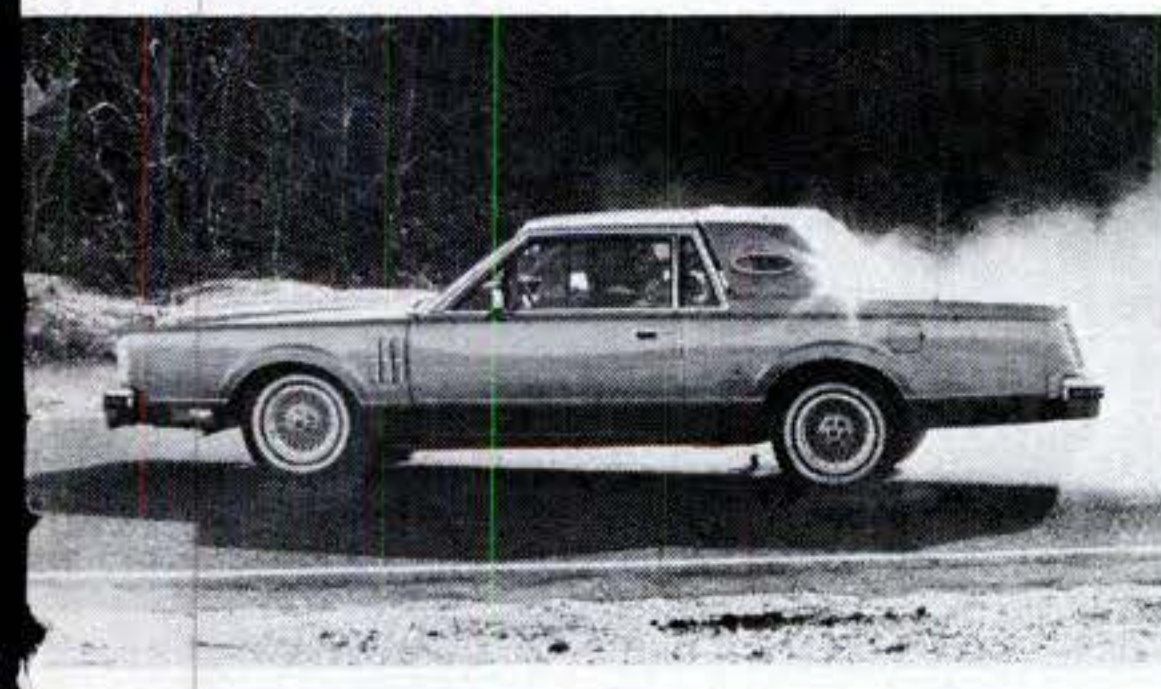
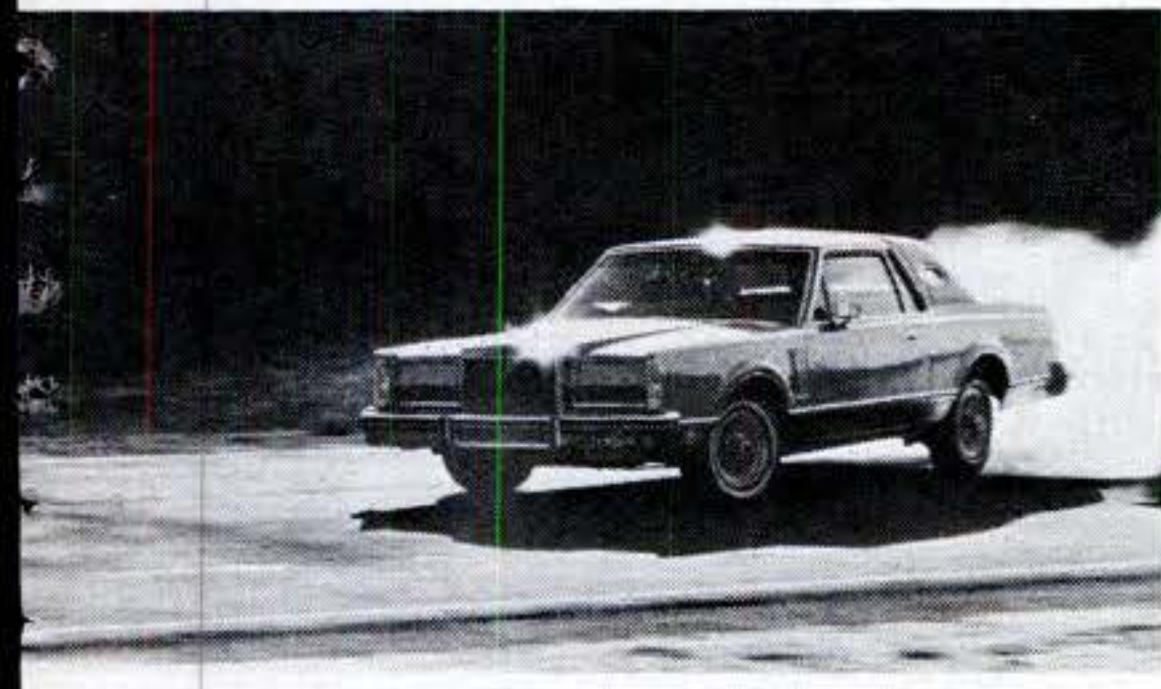
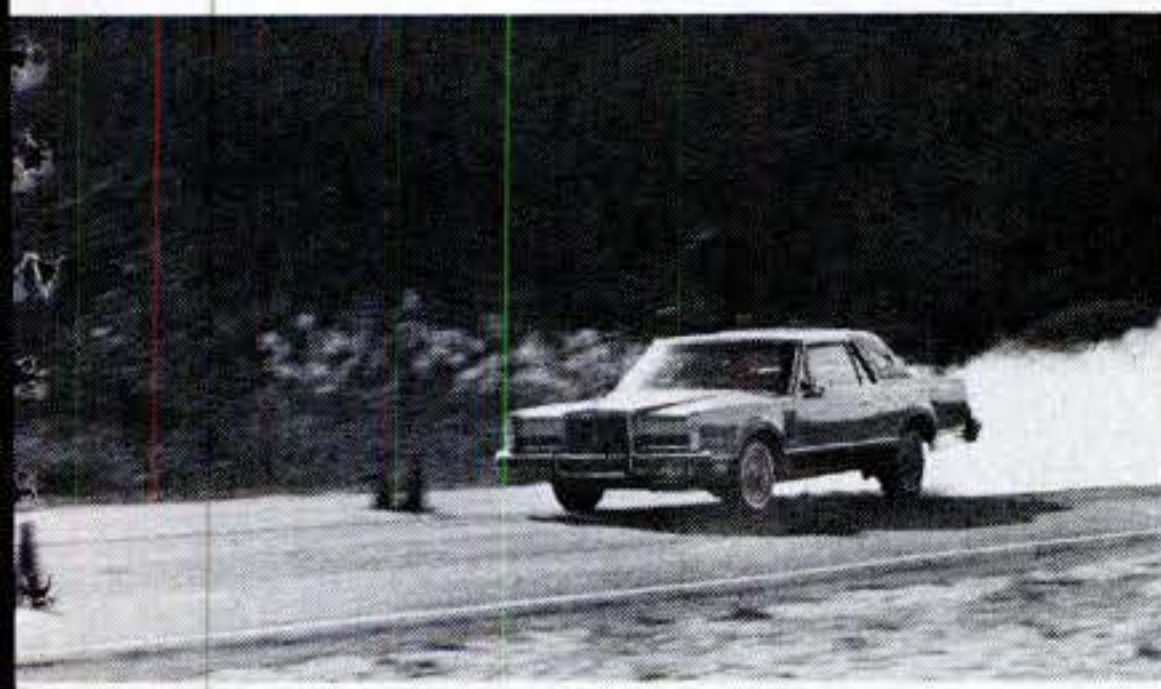
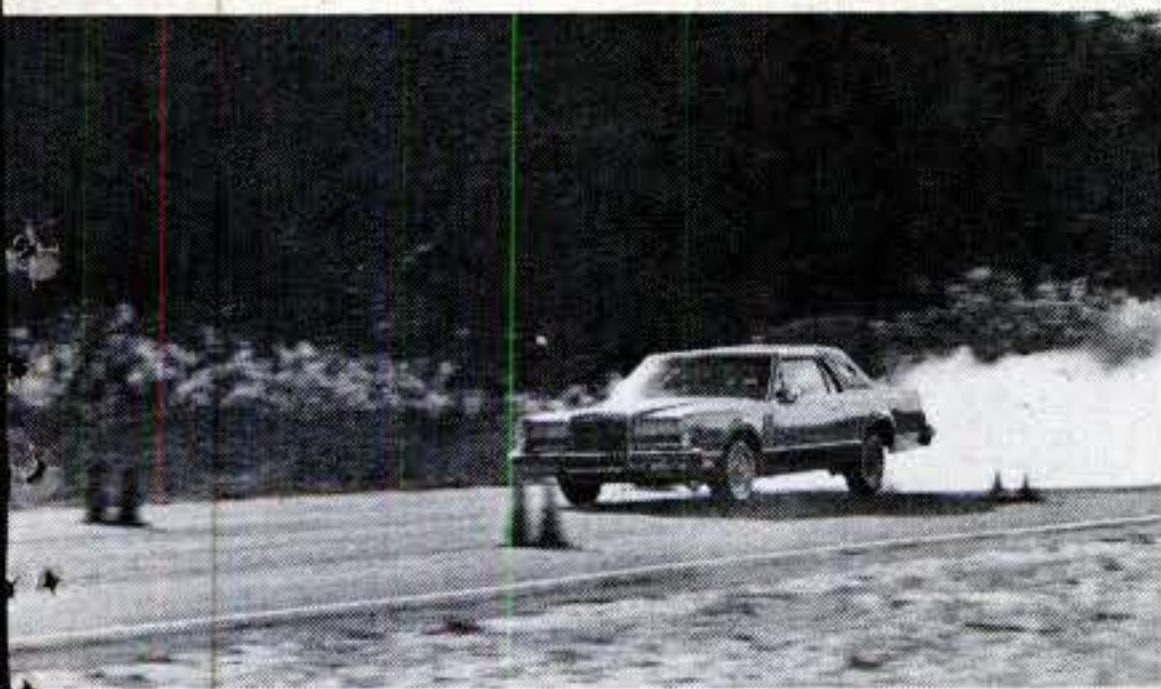
All three cars were equipped with state-of-the-art dashboards bristling with digital readouts and graphic displays. Each of these was linked to a multifunction computer, whose numerous readouts included such things as speed, instantaneous mpg, distance remaining to your destination, and even checkouts of many other on-board systems. We are impressed with these systems, but still doubt you can assess several digital displays as quickly as conventional gauges.

### Our picks

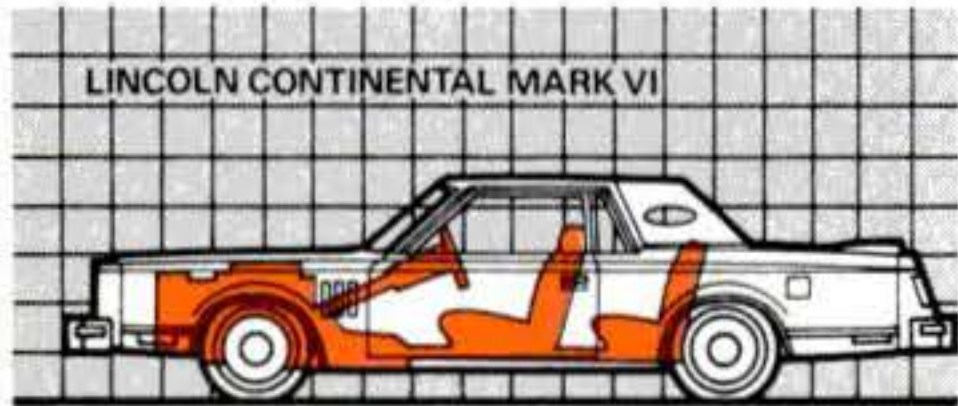
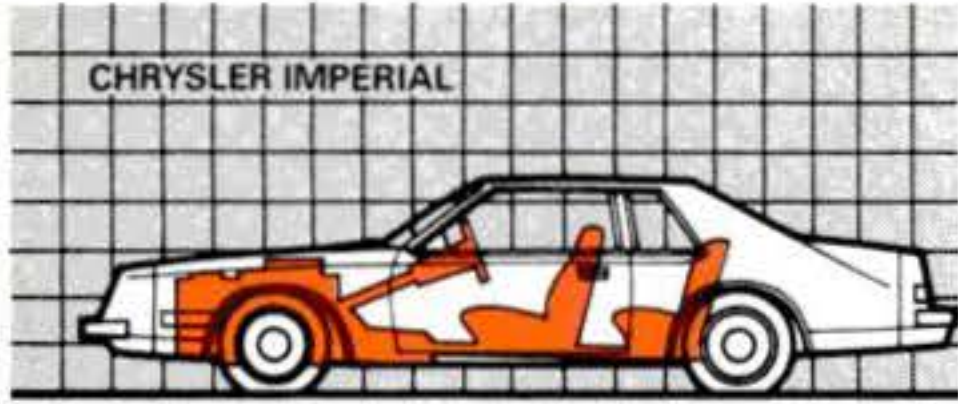
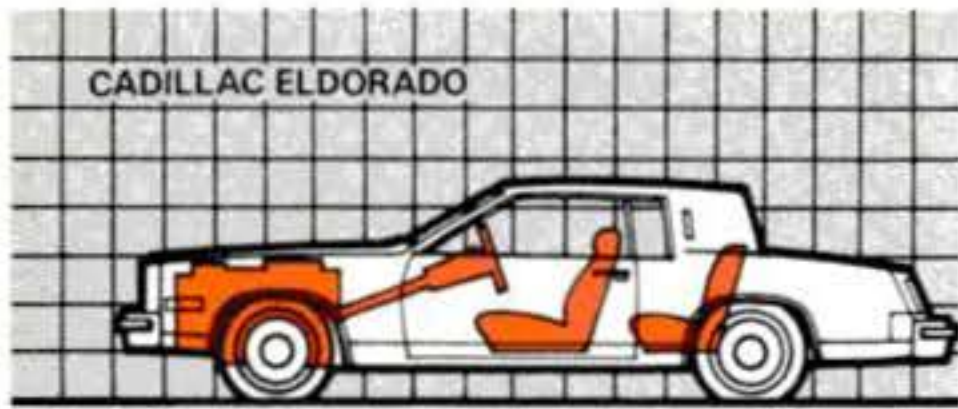
*The smaller outside dimensions and daring V8-6-4 engine make Eldorado my favorite.—J.D.*

*The contest here is between Eldorado and Imperial, and it's a tossup. Eldorado is a bit more comfortable and handles better. Imperial delivered superior economy, but handling was limited by its tires.—E. J.*

**For specs and test results, turn page**



**Mark VI's engine** stalled twice during our panic-stop testing, eliminating power-steering assist and power-brake boost. As a result, the car became both hard to control and difficult to stop. In this sequence, the engine stalls and the car's tail comes around to the right as the driver corrects, then starts back to the left in the fourth shot. The fifth shows the car's final attitude. Braking began at the far end of the double rows of pylons.



ILLUSTRATIONS BY RUSSELL VON SAUERS

**Distinctive styling** visually separates these posh coupes. Cadillac Eldorado (top) has squarish, upright design and is a foot shorter than Mark VI. Chrysler Imperial (center) tends toward a longer, more tapered and aerodynamic look. Lincoln Continental Mark VI (bottom) is longest and has squared-off lines that are reminiscent of its predecessor, Mark V.

## Cadillac Eldorado, Chrysler Imperial, and Lincoln Continental Mark VI—dimensions, specs, and test results

	Cadillac Eldorado	Chrysler Imperial	Lincoln Continental Mark VI
<b>DIMENSIONS (inches)</b>			
Wheelbase	114.0	112.7	114.3
Overall length	204.5	213.3	216.0
Overall height	54.3	52.6	55.4
Overall width	70.6	72.7	78.1
Track, F/R	59.3/60.6	60.0/59.5	62.2/62.0
Ground clearance	6.4	6.9	6.5
Front head room	37.9	37.5	37.8
Front hip room	51.8	55.6	56.5
Front leg room	42.8	43.4	43.5
Rear head room	37.9	36.5	37.8
Rear hip room	48.9	55.7	57.0
Rear leg room (min.)	38.9	35.0	36.7
Rear knee room (min.)	3.2	0.6	2.3
Couple distance	34.5	31.9	33.5

	Cadillac Eldorado	Chrysler Imperial	Lincoln Continental Mark VI
<b>SPECIFICATIONS</b>			
Engine type	V8	V8	V8
Displacement (cu. in./L)	368/6.0	318/5.2	302/5.0
Compression ratio	8.2:1	8.5:1	8.4:1
Carburetion	F.I.	F.I.	F.I.
Net hp @ rpm	140 @ 3,800	140 @ 4,000	130 @ 3,400
Net torque @ rpm	265 @ 1,400	240 @ 2,000	230 @ 2,200
Transmission	Three-speed automatic	Three-speed automatic	Four-speed automatic
Axle ratio	2.41:1	2.24:1	3.08:1
Tire make	Goodyear	Goodyear	Uniroyal
Tire type	Custom Polysteel radial	Arriva radial	Royal Seal steel-belted radial

Tire size	P225/70R15	P205/75R15	P205/75R15
Steering	Recirculating-ball, power	Recirculating-ball, power	Recirculating-ball, power
Overall steering ratio	14.0:1	18.7:1	16.4:1
Turns, lock to lock	2.9	3.5	3.4
Turn diameter (ft.)	38.4	24.7	40.0
Front suspension	Independent, control arms, torsion bars	Independent, control arms, torsion bars	Independent, unequal-length A-arms, coil springs
Rear suspension	Independent, trailing arms, coil springs	Solid axle, Hotchkiss, semi-elliptical leaf springs	Solid axle, four control links, coil springs
Front stabilizer-bar diameter (in.)	1.10	none	0.97
Rear stabilizer-bar diameter (in.)	0.87	1.00	n.a.
Trailer towing (max. lbs.)	2,000	2,000	3,500
Trailer tongue weight (max. lbs.)	200	200	500
Brakes	Disc/disc, power	Disc/drum, power	Disc/drum, power
Brake swept area (sq. in.)	395.8	355.2	385.8
Fuel tank (gal.)	20.3	18.0	18.0
Trunk space (cu. ft.)	15.0	16.1	22.4
Liftover height (in.)	28.9	n.a.	23.1
Curb weight (lbs.)	3,930	3,968	4,051
F/R weight distribution (%)	61/39	59/41	57/43
Basic price	\$16,492	\$18,311	\$16,858
Price as tested	\$18,776	\$18,311	\$20,419
Major options on test car	Power seat \$172, rear defroster \$175, cruise control \$151, tilt wheel \$147, wire wheel covers \$328, theft deterrent \$157, digital instrument panel \$200, Firemist paint \$208, vanity mirrors \$116	None	Defroster group \$135, keyless entry system \$123, headlamp convenience group \$149, reclining seats \$138, wire wheel covers \$342, premium sound system \$160, Cartier group \$2,031

	Cadillac Eldorado	Chrysler Imperial	Lincoln Continental Mark VI
<b>TEST RESULTS</b>			
Acceleration (sec.)			
0-60 mph	16.5*	15.8	16.0
25-70 mph	19.9*	18.0	21.1
Brake test (cool) 60-0 mph			
Stopping distance (ft.)	212	194	196*
Pedal pressure (lbs.)	70	85	100
Brake test (hot) 60-0 mph			
Stopping distance (ft.)	223	233	205
Pedal pressure (lbs.)	70	100	110
Interior noise @ 60 mph (dBA)	68	69	72
Handling test (mph)	62.3	60.0	59.0
Maneuverability test (mph)**	27.6+	27.4	27.0

**TEST CONDITIONS:** Ambient temperature, 25°F; relative humidity, 60 percent; barometric pressure, 30.0 inches Hg

\*Measured manually.  
 \*\*Maneuverability-test results given as 27.6+ indicate that the car exceeded our minimum for a "5" rating in the slalom. Testing at higher speeds was not performed.

### PS serviceability ratings

How easy is it to service our test cars? For example, is that heater hose clamp out in the open where it can be reached easily? To give you an approximation of how difficult it is for a typical person to perform various service operations on the cars, we examine each vehicle. Here's what the numbers mean: 1, very difficult; 2, difficult; 3, average degree of difficulty, no worse or better than most other cars; 4, easy; 5, very easy.

	Cadillac Eldorado	Chrysler Imperial	Lincoln Continental Mark VI
<b>Checking fluid levels</b>			
Battery	5	4	5
Master cylinder	5	4	4
Windshield washer	5	5	5
Engine oil	3	2	1
Coolant	5	5	5
<b>Checking the engine</b>			
Spark plugs	2	3	3
Distributor	3	1	3
Carb adjustment	F.I.	F.I.	F.I.
Oil filter	2	3	1
Oil fill	2	1	1
<b>Replacing hoses</b>			
Upper radiator hose	3	5	5
Lower radiator hose	3	4	2
Heater hoses	3	3	3
<b>Changing bulbs</b>			
Headlights	3	2	4
Taillights	3	2	3
Front running lights	3	3	4
Front parking lights	3	3	4
Front directionals	3	3	4
Rear directionals	3	2	3
Rear running lights	3	2	3
<b>Checking fuses</b>			
	2	4	4
<b>Spare-tire accessibility</b>			
	3	4	2
<b>Changing belts</b>			
	3	1	3

### Performance comparison with selected 1979 and 1980 models

	Mpg (city driving)	Acceleration 0-60 mph (sec.)	Brakes 60-0 mph (hot) (ft.)	Handling (mph)	Maneuverability (mph)	Noise @ 60 mph (dBA)
1980 Chevrolet Caprice V8	17	13.0	167	61.0	26.9	65
1980 Lincoln Continental Mark VI V8	15	12.1	194	56.3	27.6	71
1979 Cadillac Eldorado V8	14	11.5	183	58.2	27.6	64
1979 Mercedes-Benz 450SEL V8	12	12.9	163	60.0	27.6	69
1979 BMW 633CSi in-line 6	13	10.3	140	60.0	29.1	68
1979 Jaguar XJ12L V12	10	10.0	159	62.4	28.6	67
1979 Buick Riviera V6	16	14.1	140	62.4	28.1	63
1979 Oldsmobile Toronado V8 Diesel	21	17.8	134	60.0	25.3	68



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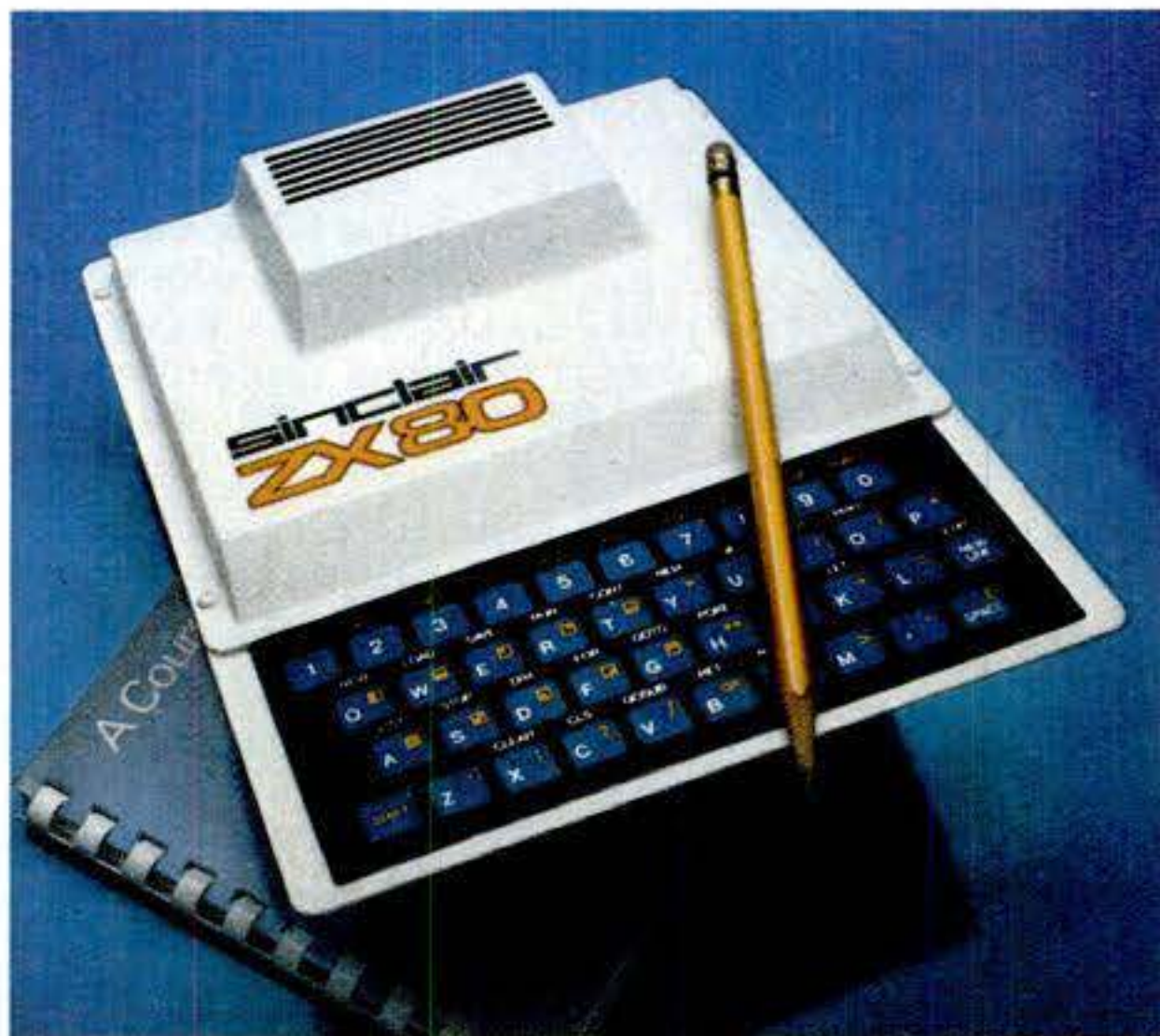
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# Wood-fired boiler holds the heat

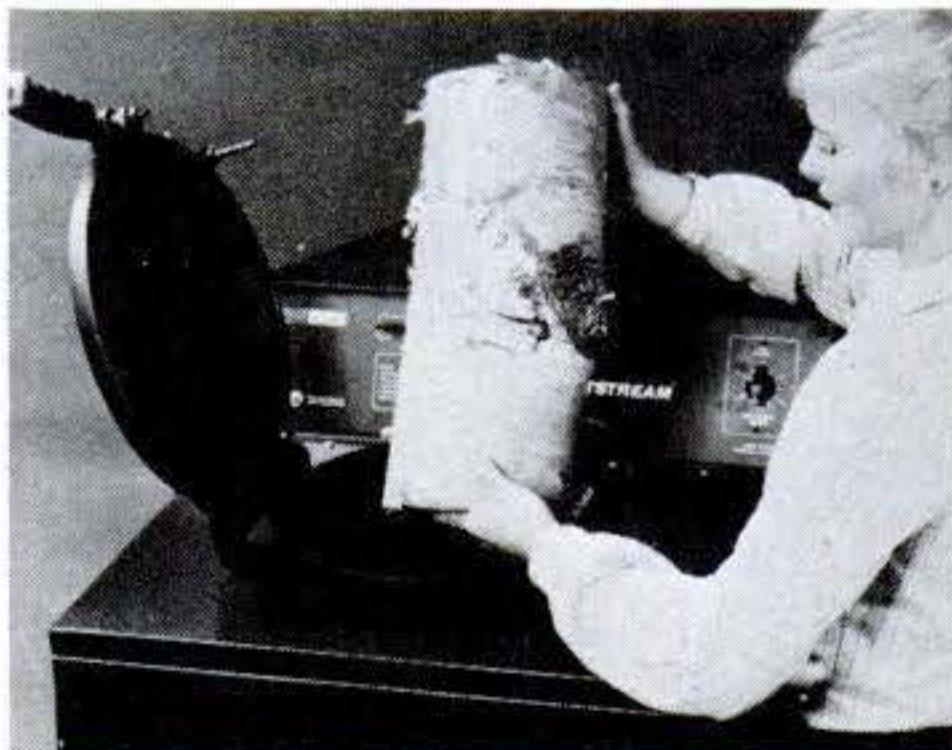
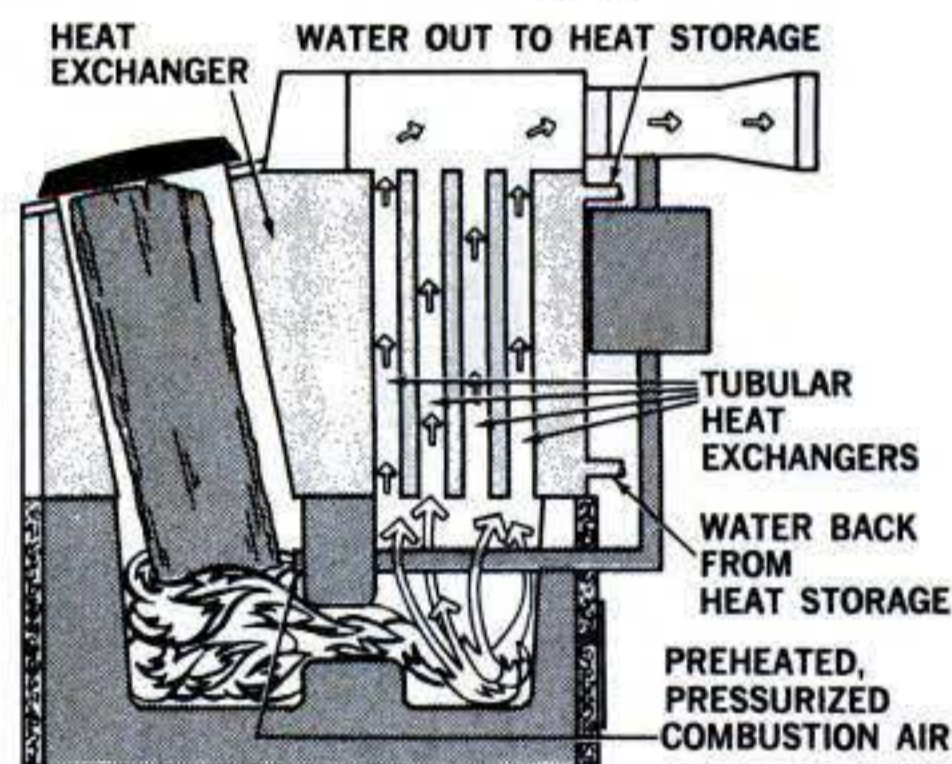
Until now, you wouldn't mix water with a wood stove unless you wanted to put out the fire. The Jetstream heating system, however, has turned the unlikely combination into a new way to keep your home fire burning.

To get the most heat energy from the wood, and to release it when and where it's needed, Hampton Technologies has paired a wood stove with an insulated water-storage tank.

According to the maker, Jetstream combines fuel and air in a turbulent, high-temperature combustion chamber that consumes wood solids, tars (creosote), and gases. Hampton claims the burning process is virtually 100 percent complete.

The Jetstream wood stove weighs 1,050 lbs. and sells for \$2,400. For the entire system, which includes the storage tank, plumbing, electrical controls, hot-water-heating equipment, and installation, Hampton says you'll pay \$5,000-\$6,000.

Hampton Technologies, Box 2277, Charlottetown, Prince Edward Island, Canada.—Marita Begley

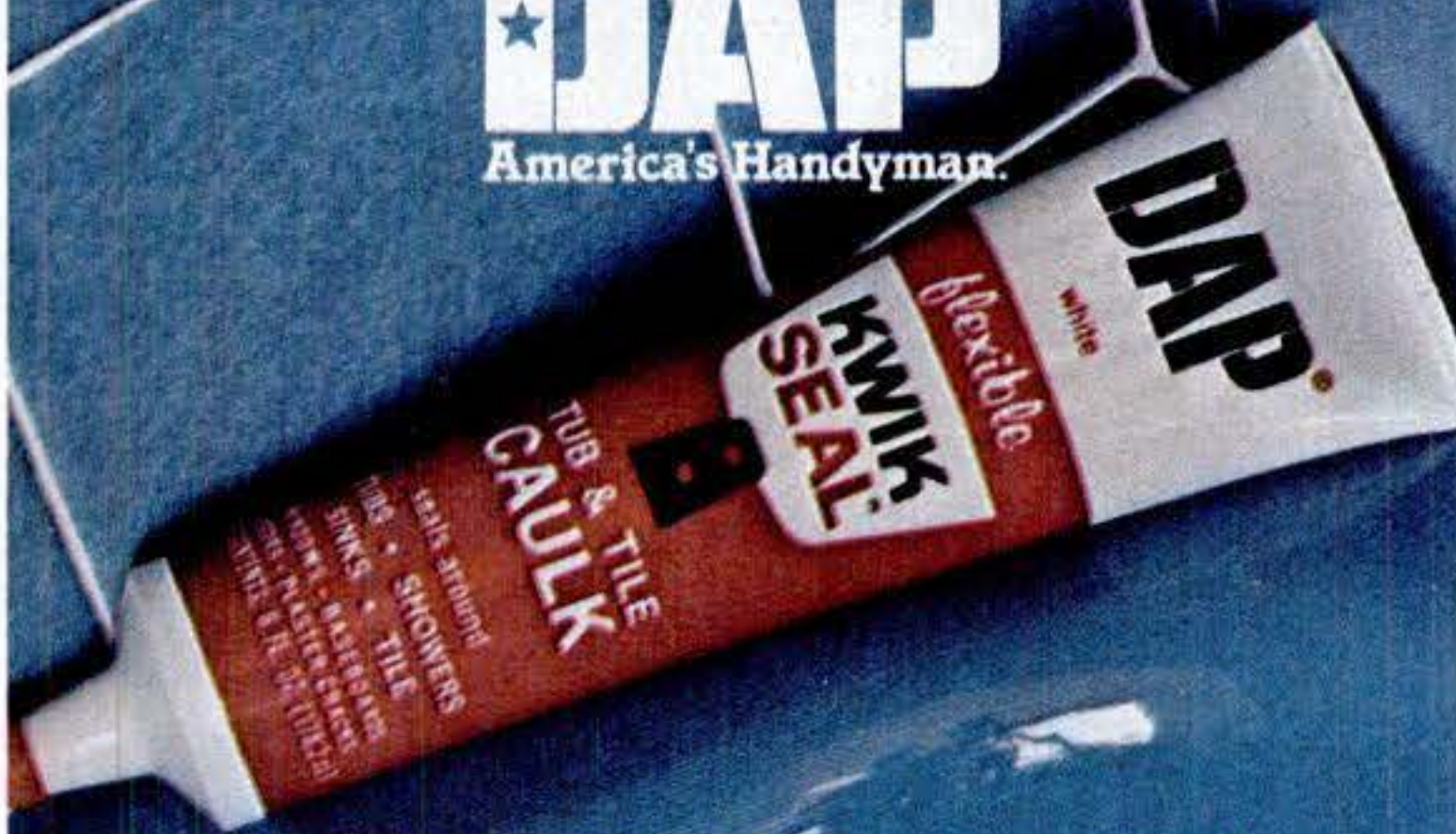


Jetstream consumes wood in a refractory combustion chamber where, the maker says, temperatures range from 1,200 to 2,000 degrees F. The resulting gases are sent through a heat exchanger that transfers the heat to piped water. The heated water passes out of the stove to a storage tank and, when needed, automatically transfers its heat to the home's existing heating system.

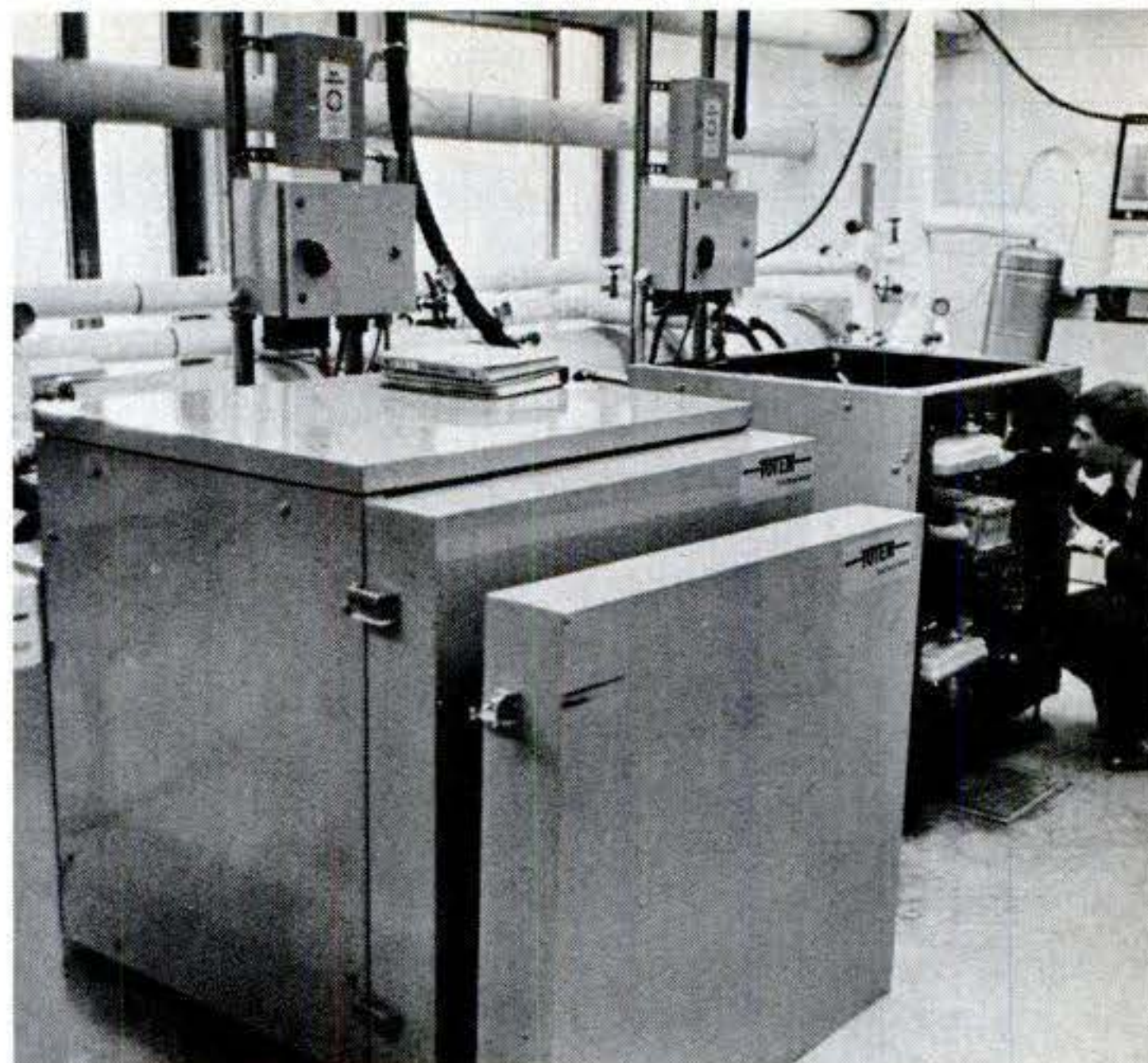
# RING AROUND THE TUB.

Kwik-Seal Tub & Tile Caulk is a handyman's favorite solution to sealing around tubs, sinks and showers. Also grouts and replaces tile, fills cracks and joints in walls, ceilings and wood trim. Dries fast. Stays flexible. Won't yellow. Resists mildew.

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Compact Totem co-generators are 42" high, 41" wide, 46" long. Size will differ on U.S. version to fit through average door.

Totem generates 131,000 Btu/hr. That's enough heat to supply hot water for 16 apartments or heat four medium-size apartments.

With a price tag of about \$10,000, Totem is well suited to apartment buildings, restaurants, hotels, hospitals, and a variety of industrial applications. Fiat hopes to introduce the Totem concept to the U.S. by selling 100-200 units.

For more information, write to Totem Project, Bob Ritacco, Brooklyn Union Gas, 195 Montague St., Brooklyn, N.Y. 11201.—*Jeanne McDermott*

## Co-generator produces heat and electricity

Co-generation—burning fuel to produce both heat and electricity—is an old conservation idea that has recently been revived and hailed as an energy-saving alternative. Now a small co-generation unit, developed and marketed by Fiat in Europe and called the Total Energy Module, or Totem [PS, Aug. '77], is available in the U.S. through Brooklyn Union Gas Co. in New York City.

The heart of Totem is a 903-cc, four-cylinder internal-combustion engine—the standard engine in the Fiat 127 automobile. But Totem's engine has been modified to burn a variety of fuels, including natural gas, biogas, and propane, as well as methanol and other alcohols. The engine drives a 15-kW induction generator, producing electricity that can be fed into a utility grid or can supply power directly to a user's own circuits. Heat is extracted from the combustion process by circulating water through four primary and secondary heat exchangers, drawing heat from the generator, engine coolant, crankcase oil, and exhaust. The recaptured heat is used for domestic hot water, space heating, or, with the help of absorption water chillers, for air conditioning.

Totem has a fixed output ratio: Two-thirds is heat, one-third is electricity. Besides a 15-kW electrical output,

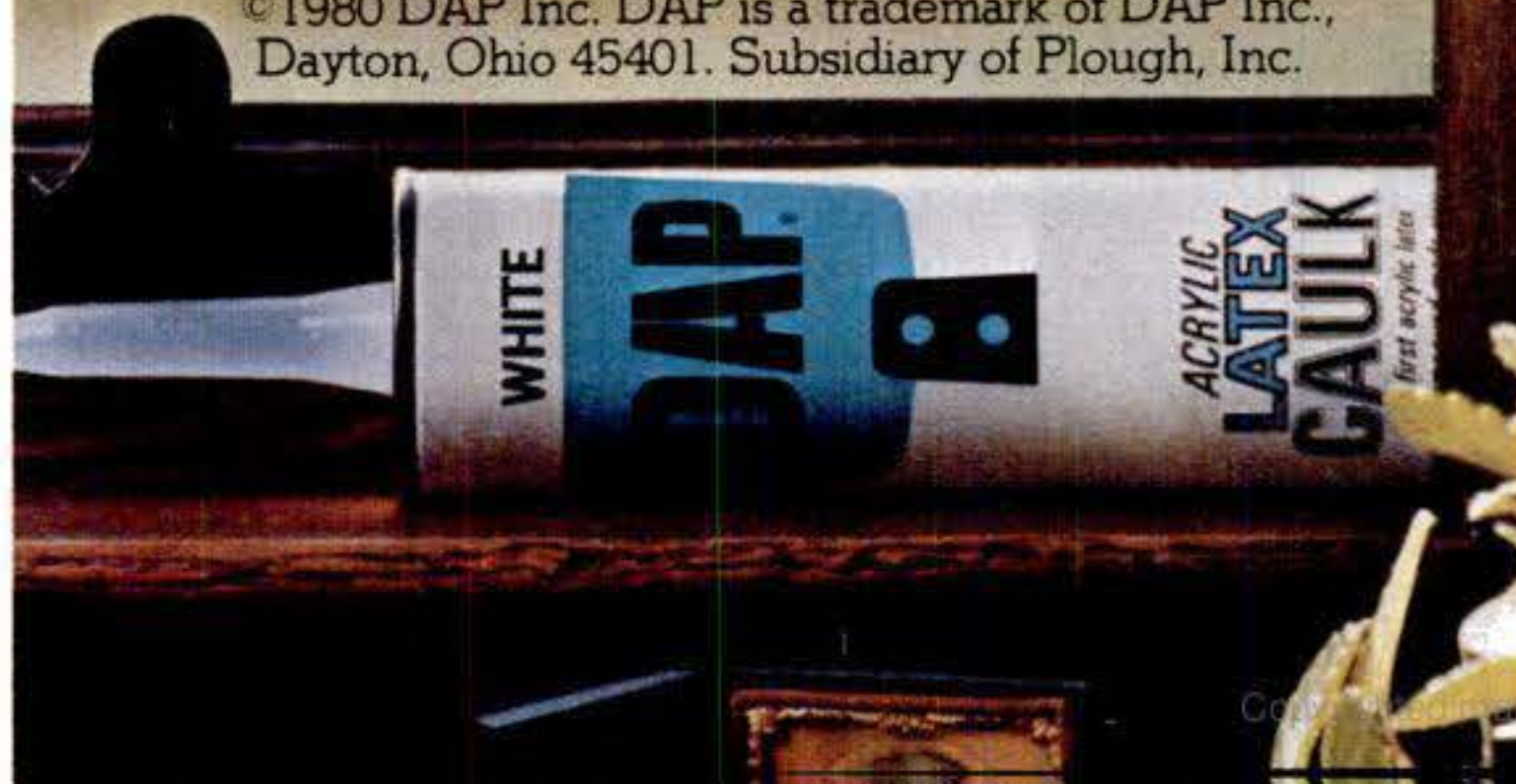
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# POWER TO CAMP OUT OR SHIP OUT.

When you're in the great outdoors, you never want to get in a position you're powerless to control. And that's where Honda comes in.

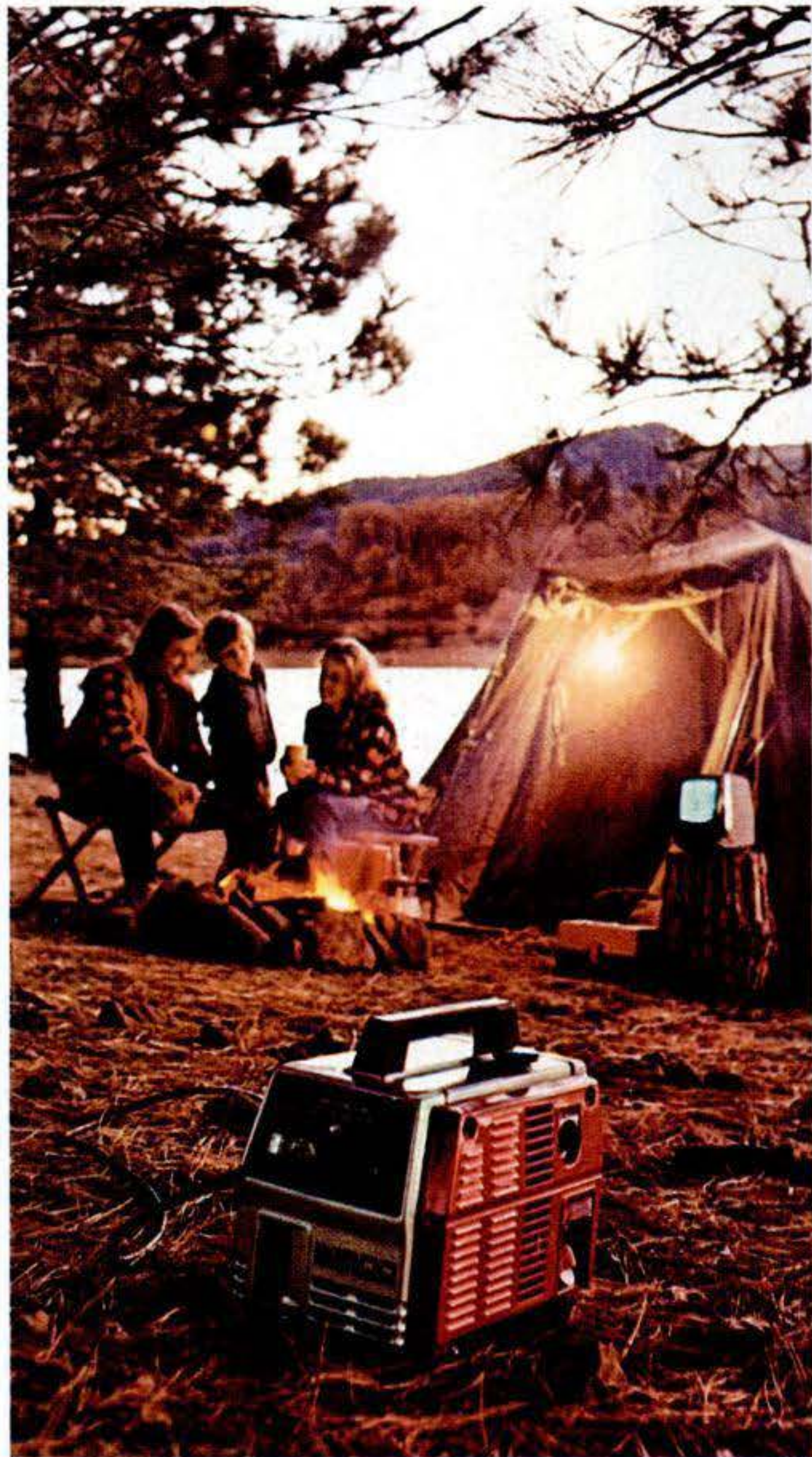
## PORTABLE POWER.

The new EM-500 portable generator is the ideal companion for campers and hunters. It gives you a maximum 500 watts of power in a lightweight 40 lb. package about the size of a portable TV.

Whether you need to power your camping accessories, charge your RV battery or just warm-up under an electric blanket, the EM-500 does it quietly and economically—about 4 hours on a tankful of gas.

It's great for small power tools, barbecue motors and electric fans, too. And it can really light-up a camp site.

In addition to the EM-500, Honda has a full line of portable generators from 400 to 4,500 watts.



## NAUTICAL POWER.

Honda has power for boaters and fishermen, too. A line of 4-stroke outboard engines that come in 7.5 and 9.9-hp models, both with short or long shaft.

Honda's 4-stroke design means quiet operation. Quick response and powerful acceleration. Maximum fuel economy—over three hours on a tankful of fuel under full throttle. Smoother operation. And less pollu-

tion because there's less oil and smoke discharge.

These engines are ideal for trolling. They have the power to keep from drifting at low RPM's without fouling the plugs.

Before you head out on your next trip, let your nearby Honda dealer tell you about Honda power. Just look in the Yellow Pages or call toll free 1-800-228-2056, ext. 640, and in Nebraska, 1-402-571-4900, ext. 640.

# IT'S A HONDA

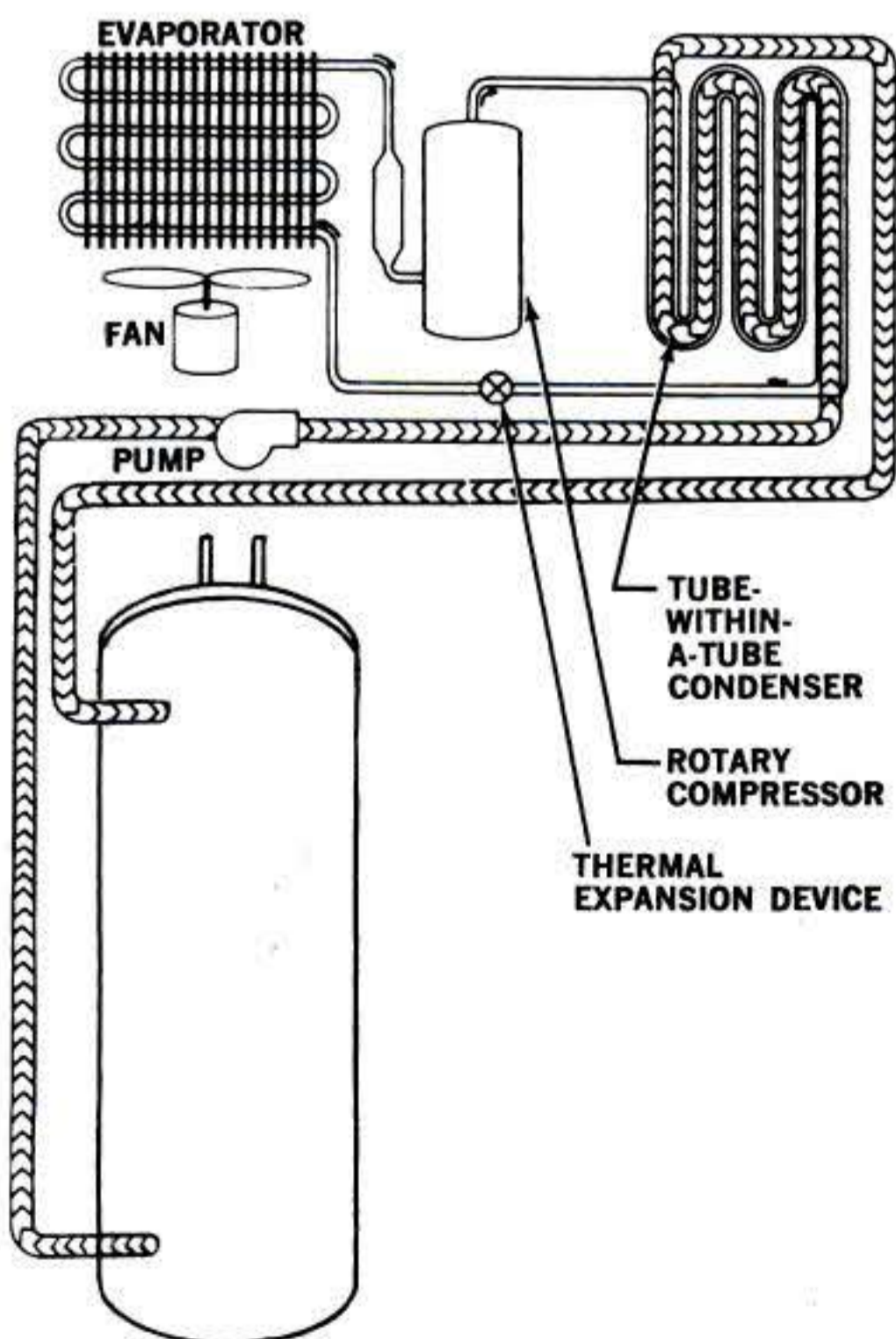
# Energy-saving heat-pump water heater

Besides winter home-heating costs, hot-water heating takes the biggest bite out of your home energy budget. But now the Fedders Corp. offers a money-saving possibility: a heat-pump water heater called the Heat Re-Cycler. It draws in existing heat from indoor air, concentrates it to higher temperatures in a rotary compressor, then deposits it in the hot-water tank (see diagram). In effect, the unit uses, rather than rejects, the unwanted heat and humidity in your home during summer months.

What about winter when every Btu is precious? The Heat Re-Cycler is most efficient when installed in a waste-heat room such as an unheated basement or utility room. According to John C. Adams, a Fedders spokesman, "The unit may produce a lot of coolness in the room initially. But once it's operating, it doesn't cycle on that frequently."

The Heat Re-Cycler constantly monitors water temperature in the tank, and is actuated only when hot water reaches a preset low level. Much of the heat it supplies is actually loss from the water tank itself. The net energy gain, says Adams, is substantial.

The Heat Re-Cycler can be used with any electric or gas water heater.—*Kathleen Murphy Lord*



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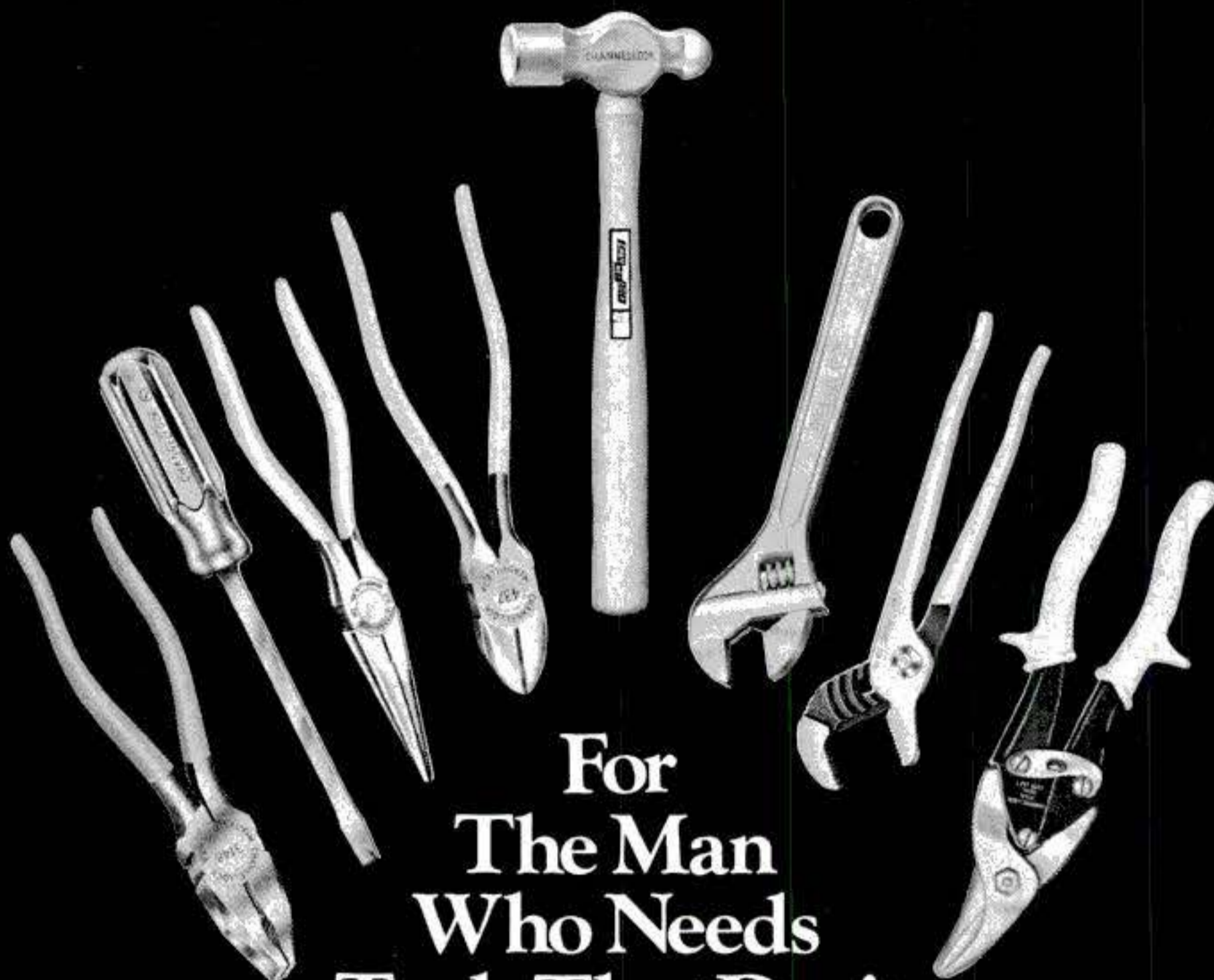
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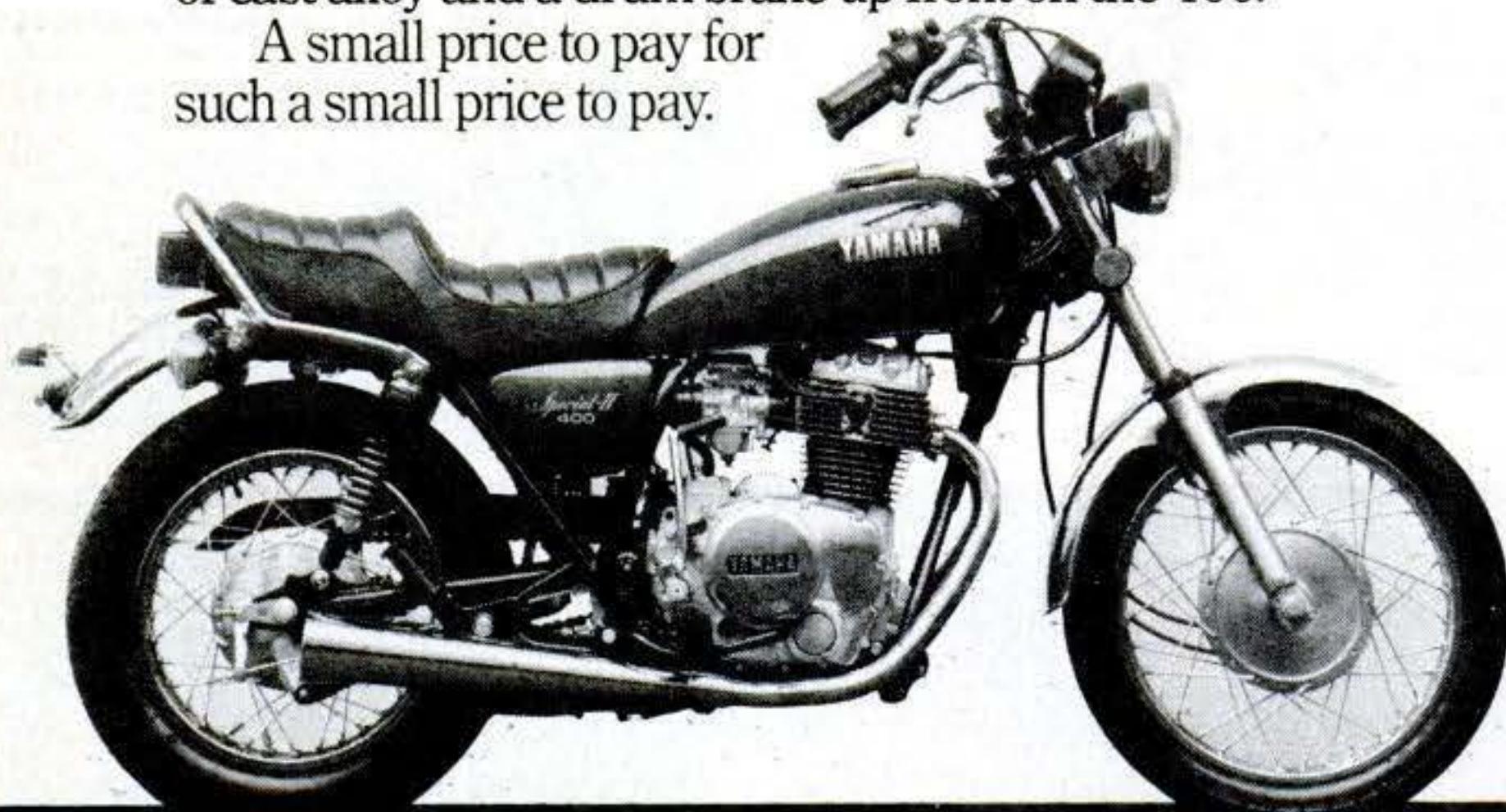
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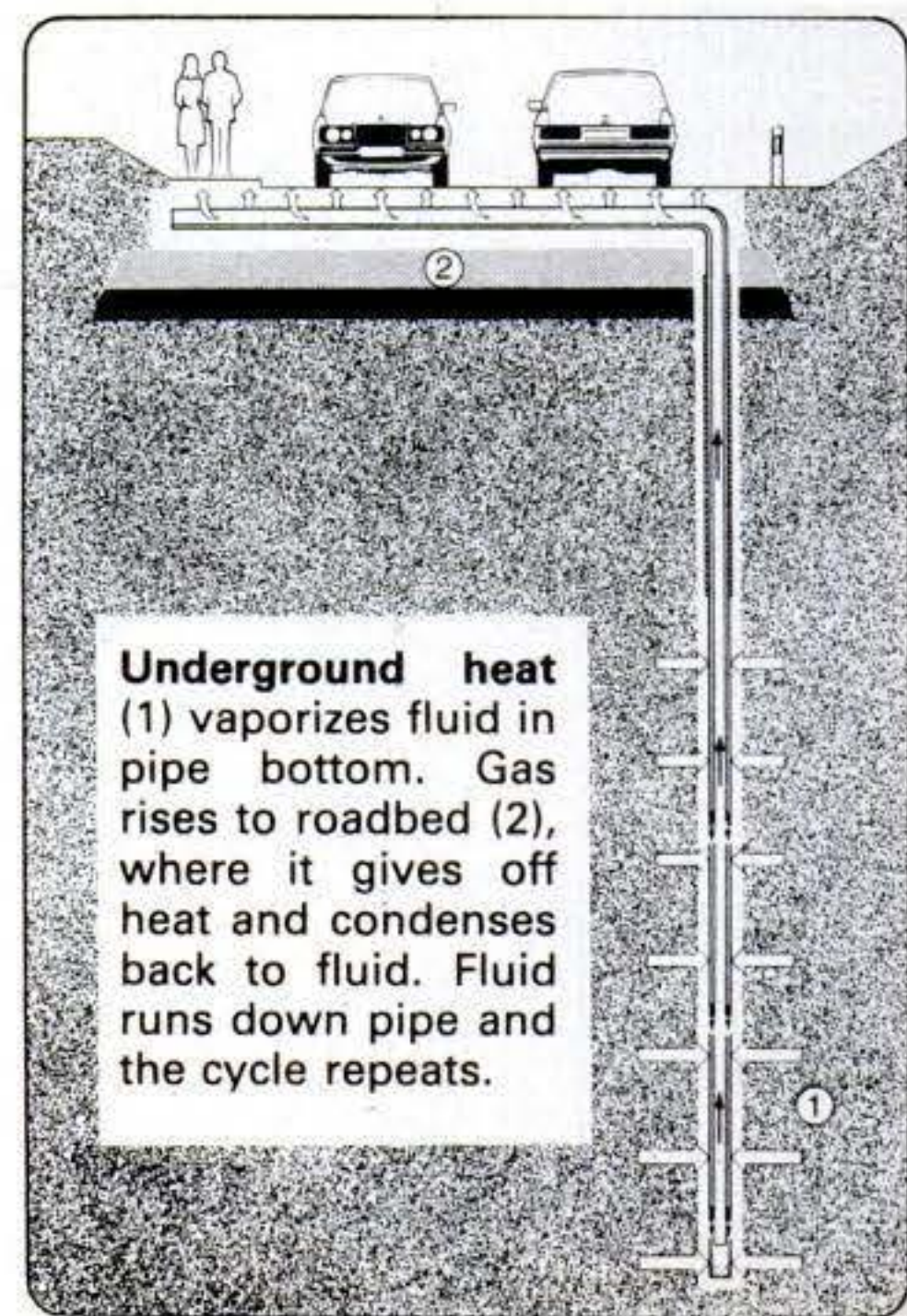
## Heat pipes make ice-free roadways

Why put up with icy roads in winter when free, limitless, underground heat could keep them warm and dry? That was the starting point for engineers at Daimler-Benz in Germany, who have sunk heat pipes 30 feet down into the earth at an experimental project at Boxberg. At that depth, the year-round temperature stays above 48 degrees F. The pipes tap this underground geothermal heat and conduct it up to warm the paving.

A heat pipe is a sealed tube partly filled with fluid, such as liquid sodium, and lined with absorbent material that acts as a wick. Heat at the bottom of the pipe is absorbed by the fluid as it evaporates. The warm vapor rises to the cold end, where it condenses. With condensation, heat is given up to the nearby roadway and the fluid returns via the wick to the bottom of the pipe.

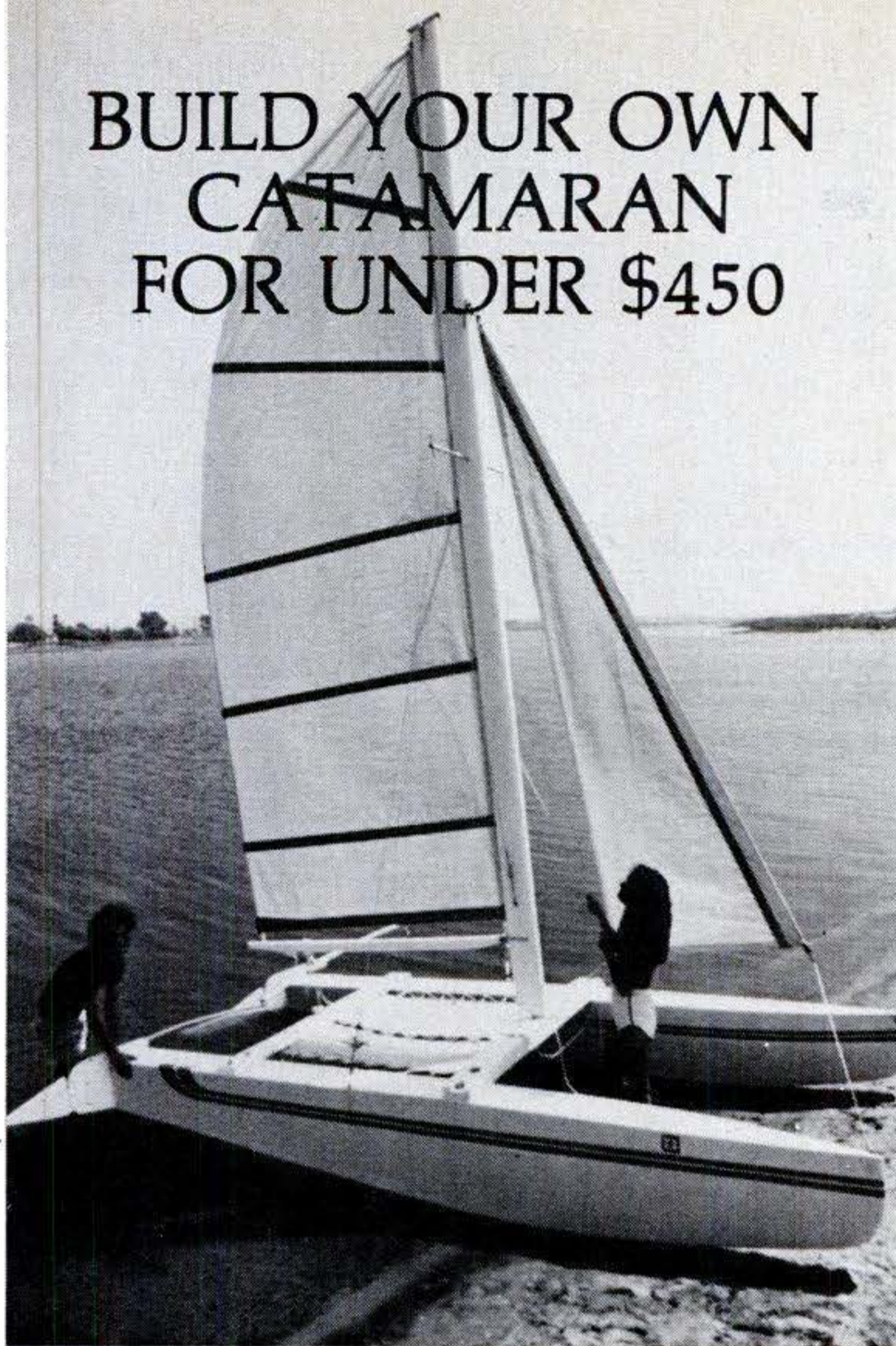
The cycle continues silently, automatically, and only when needed. When the temperature of the roadway rises in spring, no condensation takes place and the cycle stops.

So far, the system has been tested on small concrete slabs to prove the principle. Engineers are studying variables such as road-surface materials, spacing and depths of heat pipes, and soil and weather conditions for different areas. Due to cost, only critical skid-prone places such as steep gradients, dangerous curves, and intersections will have priority.—David Scott



**Underground heat**  
(1) vaporizes fluid in pipe bottom. Gas rises to roadbed (2), where it gives off heat and condenses back to fluid. Fluid runs down pipe and the cycle repeats.

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# Mine water powers heat pump

Flooded coal mines may provide commercial heating and cooling for northeastern Pennsylvania

By EDWARD MORAN

WILKES-BARRE, PA.

In January 1959, the Susquehanna River broke through the walls of a small coal mine in Port Griffith, about 10 miles northeast of here, and flooded the miles of tunnels that crisscross the Wyoming Valley of Pennsylvania. For years afterward millions of dollars were spent trying to pump the water out of the tunnels, many of which had collapsed, damaging nearby homes and businesses.

During the past year, however, enterprising individuals have been putting the flooded coal mines to use as a vast heat sink tied in with heat-pump technology to heat and cool com-

mercial buildings. Since November 1979, a 3,200-sq.-ft. Radio Shack store at the Midway Shopping Center has been heated and cooled by a heat pump using mine water as its heat source.

I visited the store and talked with consulting engineer John Yendrick of A.C.S. Industries, designer of the project. Yendrick showed me the well he bored in a field between the Radio Shack store and nearby Susquehanna Dike. Water for the project is drawn from the mine tunnels at a constant 55 degrees F. The heat pump is a conventional water-to-air system. "The heat pumps we use are not unique, but this is the first time that mine water has been used as an energy source," Yendrick explained. "The coefficient of performance [COP] of this system runs about 3:1. That translates into a saving of about 66 percent over conventional fuels."

Dr. William A. Reishtein, president of F.P.R., Inc., one of the owners of the

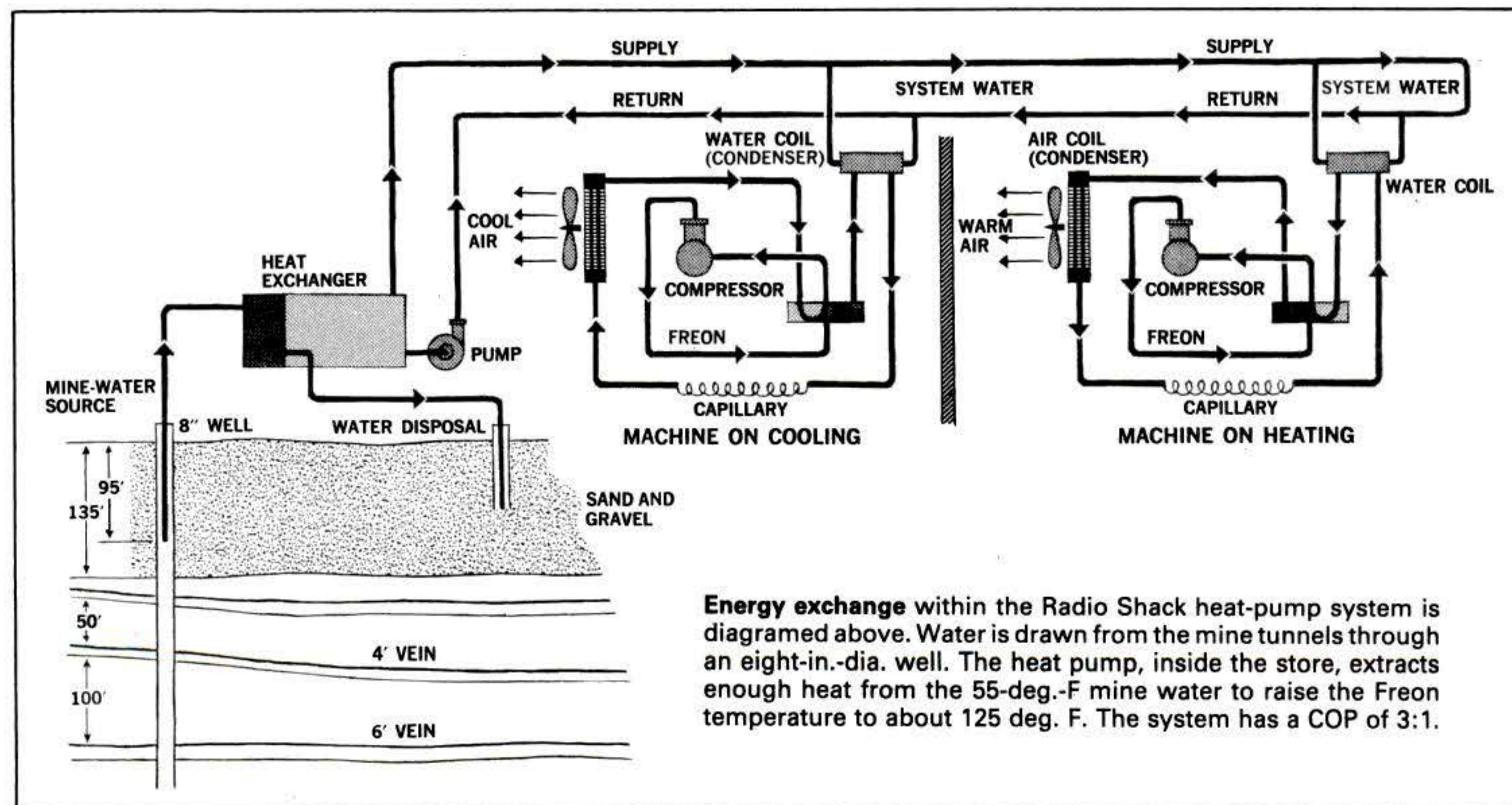
shopping center, is confident the idea can help revive the declining local economy by making available low-cost energy to businesses that are dependent on oil. Yendrick agrees: "This is only a pilot project, but the concept would be feasible for large factories that give off much heat. An alcohol plant, for example, could be tied into a closed-water-loop system that would use mine water as the basic source of energy."

The mine-water concept received added impetus when ground was broken recently for the 17,000-sq.-ft. Kingston Recreational Center nearby. The project, supported by a federal grant, will incorporate a mine-water heat-pump system and use an electric furnace as a backup during periods of peak demand.

Richard Hardy, associate with Pyros and Sanderson, the engineering firm that designed the Kingston system, explains that "using warm mine water in a water-to-air system makes heat-pump technology possible without the penalties associated with peak pricing."

Scheduled for completion this spring, the Kingston project will employ two wells 225 feet below ground, one for supply and one for return. Submersible plastic pipe will be used for the wells, and stainless-steel flat-plate heat exchangers will be installed in the heat-pump device.

If these two projects prove successful, the anthracite-coal region of northeastern Pennsylvania may get another lease on life. What was once looked on as a disaster may turn out to be a bonanza for the area. E5



Energy exchange within the Radio Shack heat-pump system is diagramed above. Water is drawn from the mine tunnels through an eight-in.-dia. well. The heat pump, inside the store, extracts enough heat from the 55-deg.-F mine water to raise the Freon temperature to about 125 deg. F. The system has a COP of 3:1.



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## "SAY, SMOKEY—"

A clinic on cars by Smokey Yunick, America's most famous mechanic

### Less rpm for more mpg

My father has a 1973 Pontiac Catalina with a 350-cu.-in. engine, automatic transmission, and power steering and brakes. The car is in excellent condition with only 32,000 miles on it. The only problem is that it's a gas hog. Is there any way to improve the economy by a lower rear-axle ratio? How about changing the final drive ratio in the automatic, or even putting in a four-speed stick? It seems to me that there are enough of these old cars around for someone to come up with a way of improving their mpg.

Kenneth W. Hirst, Louisville, Ohio

*Anything you can do (that makes dollar sense) to cut rpm down to, say, 2,000 at 55 mph will help.*

### Pops out of 4WD

I have a 1978 4WD Subaru. The transmission shifts okay, but every time I put it in four-wheel drive it pops back out. What's wrong?

John Grumer, Belvidere, N.J.

*Find out if the shifter goes into its full engagement position. It should have a positive detent. If not, you'll have to go inside.*

### Fuel disappears, it seems

I have a hard-starting problem with my '73 Plymouth 360. It has a two-barrel Holley carburetor. Whenever the car sits four hours or overnight, it seems that it can't get enough gas. I have changed the fuel pump, gas-line filter, and carb. I have to pump the gas pedal and try the starter at least three times.

Walter Knight, Hamilton, Ohio

*Let it sit four or five hours, then pull the top of the carb to check fuel level. If the fuel is gone, check the gasket under the bowl—or take the carb off when it's full and set it on paper towels to see where the fuel goes.*

### Car lower on one side

I am in the process of restoring a 1970 Olds Cutlass convertible, and have encountered a suspension problem. The driver's side of the car is a few inches lower than the passenger side (measured at the tops of the wheel openings on the fenders on both sides). I figured that after 100,000 miles the springs had just worn out, so I replaced all four—I even went with factory heavy-duty ones like those that came on the 442 models. No change.

The entire front end has been rebuilt, including new bushings and ball joints. I have the same size tires all the way around. The Oldsmobile dealer in town suggested I have the body mounts replaced because the engine torques over to the left side, which causes the mounts on that side of the frame to become depressed.

Does that make sense to you? The car does not appear to have been severely wrecked.

Chase Fell, Birmingham, Ala.

*Something is bent, such as the lower A-frame or rear frame. Don't worry about it. Shim up the spring to raise the low side. Place the shim above or below the spring seat.*

### Backfiring and detonation

I have a 1977 Regal with a V6 engine. Every morning after I start the car and drive away, it backfires. After this, it's okay for the rest of the day. The dealer has rebuilt the carb, but the problem still exists. Also, I must use premium gasoline or the engine knocks. What do you think?

Jerry Behn, Des Plaines, Ill.

*Backfire, as a rule, is caused by an exhaust valve being open when it shouldn't be. A cracked distributor cap, bad rotor, or bad plug wires can cause it, too.*

*Engine detonation is usually caused by the spark being advanced too much during load.*

### Wants diesel in his van

I have a diesel Rabbit and am very happy with it. I also have a 1976 Ford Econoline 150 van, which has only 24,000 miles on it. I would like to keep the van but it gets only 12 mpg.

Would it be possible, when diesels for vans are in production, to make a switch—a diesel for a gas engine—and do it for a price within reason?

Warren Bernard, Hicksville, N.Y.

*No way.*

### Repeated water-pump failures

I have a 1976 F-100 Ford pickup with a 302 engine. The original water pump went out at 53,000 miles. I replaced it with a new one. It lasted 200 miles. The second new one lasted 2,800 miles.

What gives? My fan's not bent, I'm not tightening the belts too tight, and I used new coolant every time. Also, the entire system has been flushed regularly. Could it be I'm into a bad batch of factory

pumps? But how could I ever find out?  
Brian McClusky, Houston, Tex.

*I don't know what to tell you. I hear and see a lot of it. Pumps sometimes seem to be short on quality these days. I'd go for a rebuilt or aftermarket pump. It can't be any worse.*

### Engine swap worthwhile?

I would like to know if it is possible to install a Chevrolet 260 V8 or V6 in a 1964 Chevrolet Impala that has a 327-cu.-in. engine with a four-speed transmission and a 3:36 rear end.

Bernie Thompson, Waukegan, Iowa

*It wouldn't be too bad if you were able to do it yourself with used parts. Using new parts and paying a garage to do it would run the cost out of sight. Also, you'd have to up the gear ratio into the high two's. That's more money.*

### About front-wheel drive

You have said that front-wheel drive is better in all ways except in a panic stop with only one person in the car. Would you elaborate?

J. F. Brown, Solana Beach, Calif.

*With driver only, front-engine, front-wheel drive is nose-heavy in a hard stop. That's because the rear wheels don't have enough weight to do their fair share of work. With weight in the back—even the weight of one passenger—the car usually stops very well.*

*Front-engine rear-drives have better front-rear weight balance and therefore would be safer in that one bad mode. This will not be solved any time soon. But in weighing positives and negatives of both types, front-wheel drive wins hands-down in my book.*

### Shocks wear out quickly

I have a '73 Le Mans station wagon with a 350 engine and no special handling package. In the last 17,000 miles the front end has gone through three pairs of Gabriel Strider shocks and now a pair of heavier-duty Gabriel E's. The shocks start going bad within three days to a week. Both shocks go, and they leak oil.

At 63,000 miles the front and back springs were replaced, heavy-duty in front and load-leveling in back. The trouble has occurred since that time. The rear transmission mount has given way three times, also. Any clues as to where to look for the trouble?

Eldon Engle, Vienna, Va.

*I'll bet the shocks are bottoming out because they are the wrong length.*

### Bucking engine

I have a 1980 Dodge Colt RS hatchback with the 1,600-cc engine. It is very peppy and gets 37 mpg on the road. But the engine cuts out or bucks under moderate acceleration, or going up slight grades. The condition improves if more throttle is applied.

*Continued*

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## "Say, Smokey—"

[Continued]

The service manager says this is to be expected, and any carburetor change would decrease the high mileage.

What do you think? The car has 3,500 miles on it, has had the 600-mile service adjustments, and another check of the carburetor at about 1,000 miles.

John D. Hightower, Tuscaloosa, Ala.

*You're lean at part-throttle. I agree: Add fuel and you'll correct the problem but lose some mileage.*

*Another thing that's used to get rid of a part-load lean condition is progressive secondary throttle. Keep air velocity up over the fuel nozzle until fuel volume increases. If you add a little fuel, it won't drop mileage much. But I believe you'll be out of emission limits.*

### About split rims

Let's have it again about those split rims—I have a '69 half-ton Chevy with a cab-over-camper permanently installed. I have split rims on the back with 700x15 LT eight-ply rated tires. I've been to Alaska, Mexico City, and traveled about 28,000 miles in the U.S., and have never had a flat. I have worn out one set of tires and replaced them with duplicate tires.

My question is, would I be safer on the solid wheels than on the split rims?

David McKinsey, Elfrida, Ariz.

*Yup, the three-piece rim fails in use and can be dangerous in mounting. Funny, we used them for 30 years and I never saw any trouble until lately. But we didn't load them and run sustained high speeds like we do now.*

### Which oil for transmission?

My new Chevy X-body Citation has the four-speed manual transmission. Yet it is filled with automatic-transmission fluid, Dexron II, type B.

Is the Dexron II strong enough for a manual transmission? I thought that the manual transmission needed a heavier gear oil.

George Holdcroft, Libertyville, Ill.

*Automatic-transmission fluid is a very good lube, and can take temperature better than mineral oil. Weight doesn't really help lubricity. I think it's good, and it helps mileage. Don't use hypoid rear-axle lube.*

### Engine overheats

I have a '70 Datsun 510 with a 1,600-cc engine that overheats. It all started when I blew a heater hose and a head gasket. I replaced the gasket and it blew again immediately. I replaced the gasket again and had the head planed. I put in the proper proportion of antifreeze and water, but after a day or so it all boiled out.

I have replaced the radiator, radiator cap, and thermostat with what was recommended for the car. I've checked the timing with car specs and it's okay.

Mike Holmes, Bradford, Vt.

[Continued on page 140]

# World's First and Only Solar-Powered Watch\*

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**The Sunwatch; acclaimed as the most accurate, most versatile, most rugged watch ever made.**

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#### Space age accuracy

Now you'll never worry about accuracy again. Because the Sunwatch will keep you on time for the rest of your life. (Accurate to within 1 sec. per month.)

#### Solar age efficiency

Miniature solar cells automatically convert sunlight, daylight or ordinary bulb light into usable energy for storage. The solar cells last virtually forever. So you'll never replace a watch battery again.

#### Programmed for over a century

The built-in computer on a chip will always display the correct time date and month. Also, it automatically adjusts the watch calendar for long and short months, leap years and it's programmed until the year 2100!

#### Easy to read

The natural side-view display lets you tell the time, day and date without twisting your arm into an uncomfortable position.

#### Numbers always visible

Four varying light intensities are built into the viewing display, allowing the Sunwatch to adjust automatically to any light. This means you can always read it, even in the brightest sunlight.

#### 10 Display functions

The Sunwatch is capable of displaying the following information: hours • minutes • seconds • months • date • day • leap year • speed calibration • AM/PM indicator • seconds count-off.

#### Extreme accuracy

Unlike other electronic watches using tuned crystals to control timing accuracy, the Sunwatch incorporates a unique, programmable, microcircuit synthesizer to make it the first watch in history that is accurate to less than 1 second per month. That's 5 times more accurate than the latest quartz Accutron.

#### The Power Source

Tiny silicon power cells, which are constantly being energized by natural sunlight, daylight or an ordinary light bulb keep the Sunwatch energy storage system charged. Should the watch not be exposed to light, it will continue to operate for months on stored power.

#### The most indestructible watch in the world

The workings of the watch: solar panels, energy cells, quartz crystal, computer on a chip, etc., are all permanently sealed in a Lexan module. This module is so unique it's protected by U.S. and foreign patents.

#### Completely waterproof

Leave the Sunwatch in salt water for months. Dive with it in depths up to 750 feet. There are no openings — magnetic slide bars activate all functions. With Sunwatch's exclusive, permanently sealed Lexan module, there are no "O" rings or seals to leak.



#### Shock resistant to 25,000 G's

You can crash it into a rug-surfaced brick wall at 90 mph with no noticeable effect. Wear it while doing heavy work, exercise or any strenuous activity.

#### Temperature resistant

Put the Sunwatch in boiling water for 30 minutes, freeze it in a block of ice for a year. Extreme temperatures will not damage your Sunwatch.

#### Pressure resistant

There are no air spaces inside the Sunwatch. Therefore, it is not susceptible to high pressures such as might be encountered diving to great depths.

#### The perfect watch for a lifetime

Imagine split-second accuracy for the rest of your life. Sunwatch is a virtually indestructible, beautifully styled, space-age timepiece, and it's available in three exciting finishes: Brushed stainless steel, Gold tone stainless steel, or a Durable black finish on stainless steel. All Sunwatches come with a matching stainless steel band with removable links and adjustable clasp.

#### Made in the United States

The Sunwatch, designed by Roger Riehl, was being worn by its inventor nearly a year before the first electronic digital watch was even available to the general public. Since that time constant engineering evaluations and design improvements have been made on the Sunwatch to incorporate the latest in digital microcircuit and solar power technology. Thus the Sunwatch today represents state-of-the-art electronics technology. It is built to the same rigid standards practiced by the manufacturer in creating sophisticated computer microcircuits for the U.S. Government and other major users of these components.

#### \* A word about other "Solar Watches"

Roger Riehl, designer of the Sunwatch, states that there is no other completely solar powered watch on the market today. Claims of solar power by other watch manufacturers are based on the use of a small solar cell. Due to their limited size, these cells can be proven, in technical terms, to be of virtually no significant value in extending the life of a watch battery. For this reason, all other so-called "solar watches" must have replaceable batteries. The Sunwatch's power storage system, however, need never be changed and is, in fact, permanently sealed to withstand abuse and the elements.

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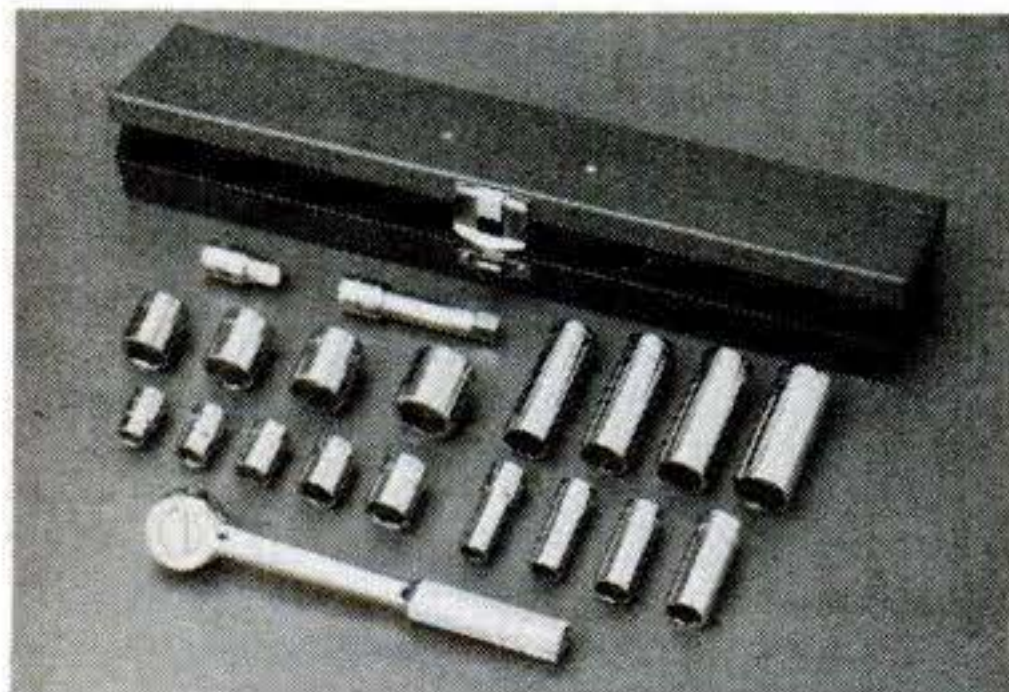
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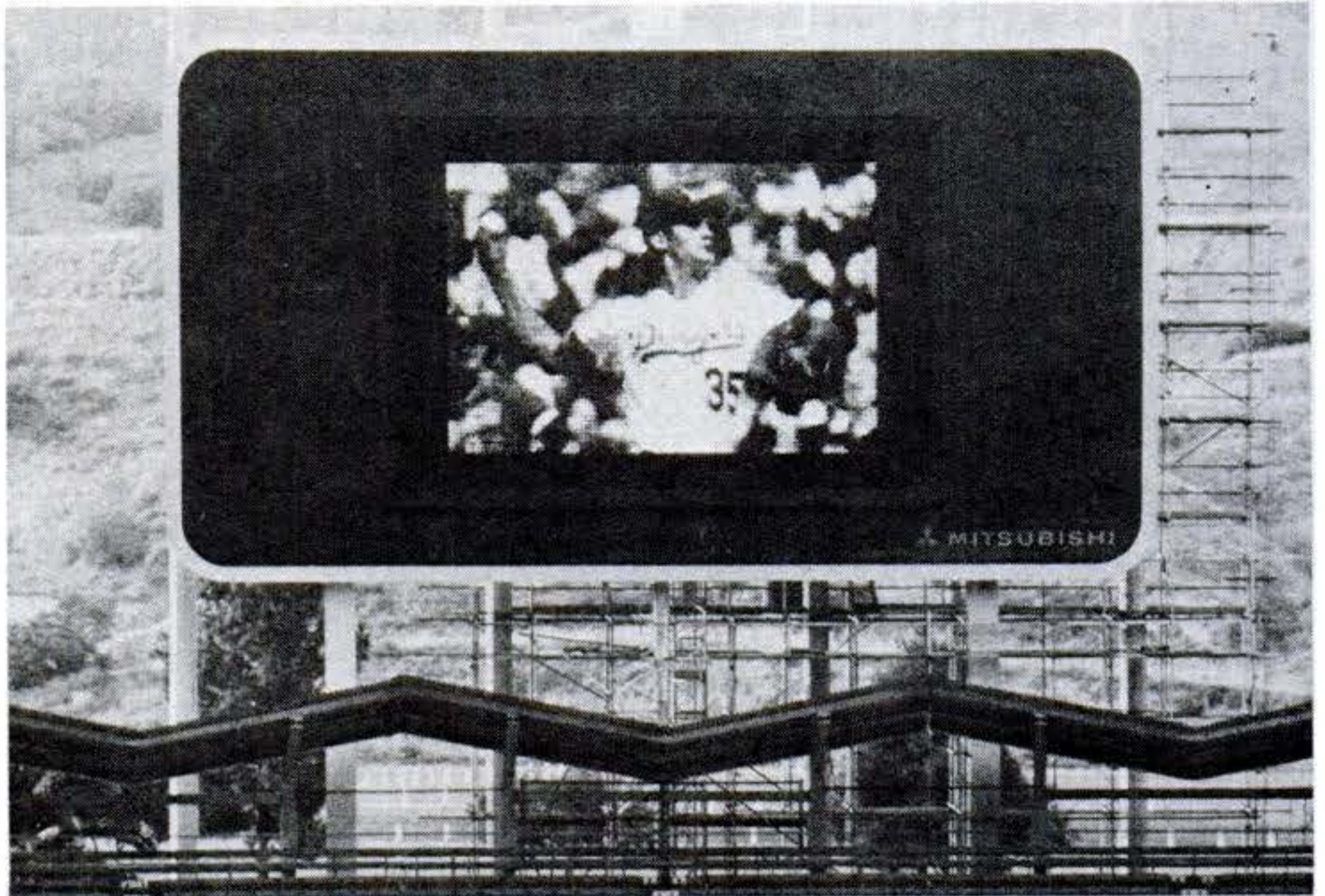


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## Giant color screen replaces bulbs with tubes



Instant replays are clear and lightning-fast on Dodger Stadium's color video display board.

It will be expanded to 25 by 33 ft. for the 1981 baseball season.

When is a color television worth three million dollars? When its screen, measuring 20 by 28 feet, is the world's largest.

The giant screen was installed last summer at Dodger Stadium in Los Angeles by Japan's Mitsubishi Electric. Among other things, it replays big plays immediately following each inning and sums up the game with video highlights afterward. Other systems in other stadiums provide similar game coverage, but the picture quality of this giant screen sets it apart from the rest. In fact, its picture is roughly comparable to home color sets, but on a much grander scale.

Until now, when outdoor systems such as matrix boards presented movement, it was in the form of cartoon figures, moving graphics, or brown-and-white video images. Fast, clear color video was impossible, because matrix boards use incandescent light bulbs. The bulbs, which glow milliseconds after power is turned off, are incapable of producing the lightning-fast movement inherent in live-action video. Mitsubishi made live-action giant-screen color video possible with the development of an electron-beam tube suitable for giant TV display.

The tube works like a small TV, complete with electron gun in back and phosphor coating up front. Each

tube corresponds to a single, tiny, colored phosphor dot on a TV screen. And each produces only one color—red, green, or blue—albeit in 32 levels of brightness. On the giant screen, 24,576 tubes are clustered in red/green/blue groups of three. A computer directs the various colors to light up and form the picture. From a distance of 200 feet, the thousands of red, green, and blue tubes resolve on the giant screen into a sharp, brilliant picture.

"The screen looks spectacular at night," says Barry Stockhammer, the Dodgers official in charge of running the mammoth screen. "And we're especially pleased with its clarity and brilliance during the day, even when the sun shines directly on it."

One reason for such a brilliant picture is that the light from an electron-beam tube shines 10 times brighter than an ordinary TV screen. And because it's not a giant version of a home video projector (like the one at King Dome in Seattle), it doesn't suffer a color shift, even when it's viewed from an oblique angle. Furthermore, each tube consumes only two watts of electricity, one-tenth the consumption of a display-board bulb.

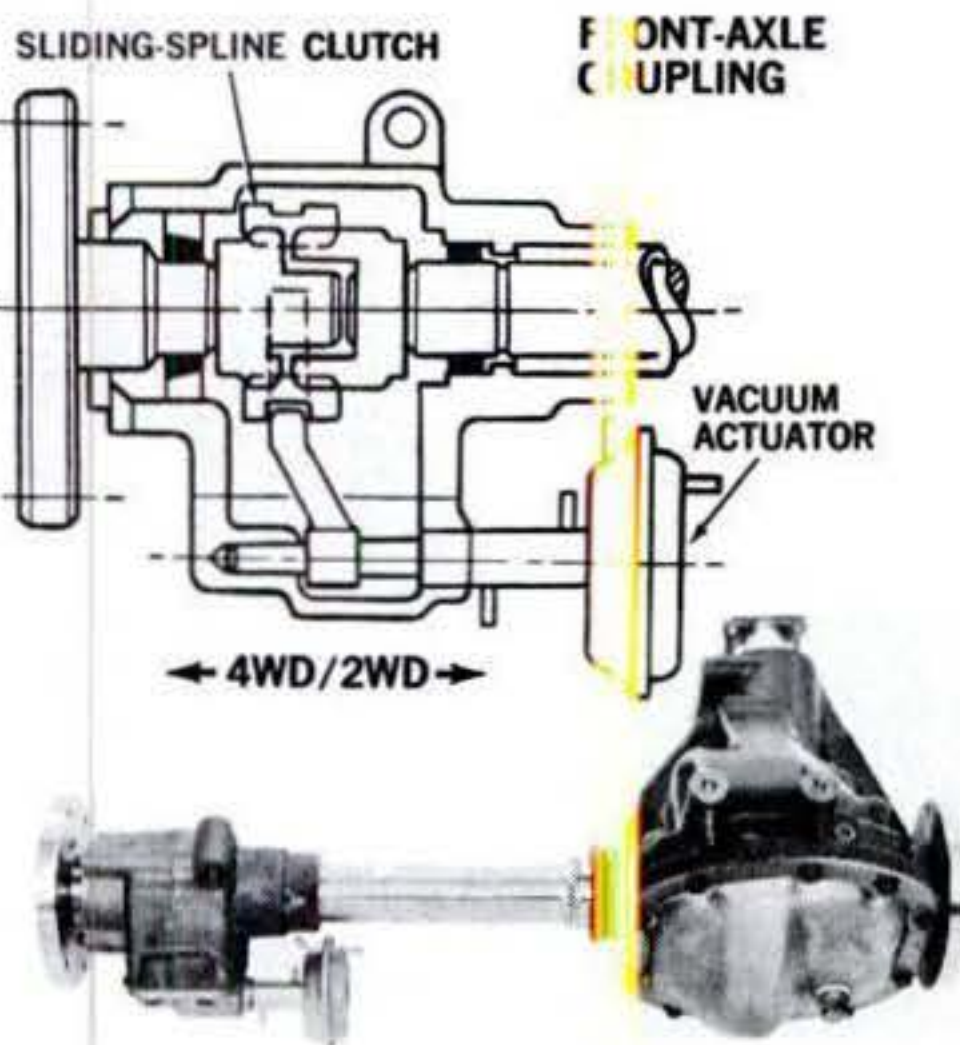
Will the screen replace the umps? Says Stockhammer: "We don't run replays that involve close judgment calls. That's not our business."  
—Danny King



## AMC Select Drive: economy 4WD

Credit American Motors with another first in four-wheel drive. AMC's new two-wheel/four-wheel Select Drive system provides more flexibility and fuel economy than full-time or part-time 4WD systems.

With Select Drive, you can switch from full-time four-wheel drive to two-wheel rear drive simply and without leaving the driver's seat. When conditions call for a changeover, you simply stop and flip a switch under the dash—no need to get out and reset any locking hubs, as you would with part-time 4WD systems. Also unlike a part-time system, you can drive on the highway in 4WD without damaging the drive train. That's because Select



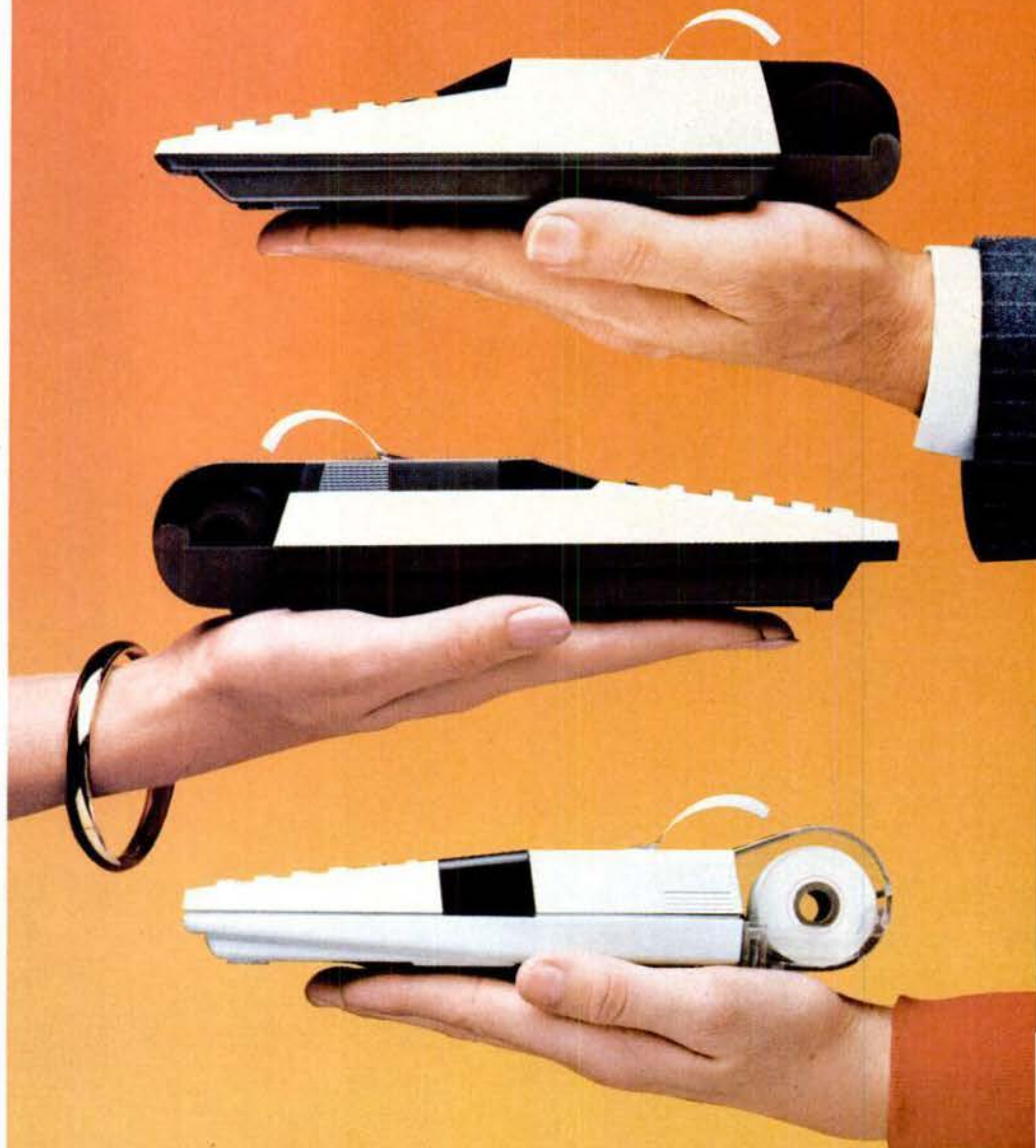
Drive is basically the same full-time system now in use on AMC vehicles.

The difference is a novel disconnect apparatus that allows the entire front drive train to roll freely when not needed, thereby boosting fuel economy. One part consists of a vacuum-operated sliding-spline clutch (see photo and cutaway) controlled by the dash-mounted switch. When 4WD isn't needed, the actuator slides the clutch to uncouple the front axles and let the wheels roll independently.

At the same time, a second sliding-spline clutch (not shown in the main transfer case—near the transmission—disconnects the front driveshaft and power train. That reduces power drain and, according to AMC engineers, allows up to 10 percent better economy. If you wish, though, you can leave 4WD engaged at all times—but at a fuel-economy penalty.

Select Drive is optional on any AMC Eagle and costs about \$150 with any drive train.—*Jim Dunne*

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## PS | What's News

"I knew I had a lot of reading to do when they wheeled that 40-pound carton into my office on a dolly," said POPULAR SCIENCE Senior Editor John Free. "That carton" contained more than a dozen hefty publications—technical reports from just one of the large research laboratories with government-funded subcontracts to help develop solar panels and other hardware associated with photovoltaics. As readers of POPULAR SCIENCE know, photovoltaics is the general term covering the techniques (and arts) required to turn sunlight directly into electricity. That carton of reports was only a small part of the avalanche of documents that has since descended on John, reflecting the enormous activity in the field.

Much of the activity has been generated since he last wrote a major report on the subject back in December, 1974. That was just before the U.S. Energy Research and Development Agency (ERDA—remember it?) began its program to pinpoint and develop the most promising solar-cell concepts. In 1978, ERDA's successor, the Department of Energy, initiated a 10-year program to explore the social, technical, environmental, legal, and other issues that will arise with widespread use of photovoltaics.

What can you expect in the future? One possibility (mentioned to Free during a Westinghouse briefing): Some electric utility companies are thinking in terms of sharing the solar-cell electricity produced on the rooftops of private homes rather than setting up their own arrays of panels at one location. That would make possible an interesting variety of ownership arrangements. For other glimpses into the future of photovoltaics, read John Free's article starting on page 76.

### Problems with gasohol

Must there always be a tunnel at the end of the light? Cynical E. F. Lindsley, our Senior Editor for Engineering, notes the depressing conclusions of several new studies concerning gasohol that appeared in *Automotive Engineering*, the publication of the Society of Automotive Engineers:

- "A Comparative Assessment of Current Gasohol Fuel Economy Data," by W. J. Shaddis and P. W. McCallum, Mueller Associates, Inc.—A summary and analysis of all currently available comparative

gasohol fuel-consumption data, from 16 different test programs by both public and private organizations. Ten programs used chassis dynamometers; six used road tests. "Results . . . indicate that in closely controlled tests, gasohol use yields a significant decrease in fuel economy."

- "Gasohol: Technical, Economic, or Political Panacea?" by Thomas C. Austin and Gary Rubenstein, California Air Resources Board—" . . . a systems analysis of the gasohol production processes indicates that gasohol is increasing rather than decreasing the nation's dependence on crude oil . . . At the present time, every gallon of oil 'saved' by substituting ethanol for gasoline results in need to import approximately two gallons of crude oil."

- "Gasohol: Laboratory and Fleet Test Evaluation," by M. D. Gurney and J. R. Allsup, U.S. Dept. of Energy, Bartlesville Energy Technology Center; and C. L. Merlotti, Southwestern Bell Telephone Co.—"No difference was detected in vehicle fuel economy at actual load weights . . . A larger quantity of copper was found in the crankcase oil of the vehicles operating on gasohol when compared to the vehicles operating on gasoline. Drivability was poorer with gasohol, especially during the winter and summer seasons."

### Differences in black doughnuts

"Some tires may vary in price by as much as \$30 apiece, yet offer the same performance, as measured by the tire-grading system," said Joan Claybrook, head of the National Highway Traffic Safety Admn. at the Dec. '80 news conference when the new federal Uniform Tire Grading List was introduced. The latest list deals with radial tires. Previous lists dealt with bias-ply and bias-belted tires, and were published in POPULAR SCIENCE in April last year ("Grading Tire Quality"). The big U.S. tire companies, who held up federal grading standards for years through court action, now appear to be doing a turnabout and welcoming the new standards, particularly when their products score high. "What people really want to know," said one tire-company vice-president to PS Executive Editor Herbert Shuldiner, who prepared both our current and last year's tire-grading articles, "is what makes one black doughnut different from another." Our article on page 107 will help you find out what makes one radial different from

another. It is part of our special section, "Car Care News," which covers those items you buy for your car after you have bought the car.

### Honors for PS

Sharp-eyed readers of this page may have noticed that the signature at the bottom, beginning with the July 1980 issue, bore a new title: Editor-in-Chief. Yes, C. P. Gilmore, an occasional author of "What's News" when he bore the title of Editor, had been promoted to Editor-in-Chief, succeeding Hubert P. Lockett, who sat in that chair of authority for nine years.

Ken Gilmore, as he is universally known, has long been one of the nation's leading science writers and TV journalists. His articles have appeared (and still appear) in a wide range of leading magazines. He has written several books. And New York-area TV watchers may be surprised to learn that C. P. Gilmore of POPULAR SCIENCE and Ken Gilmore of WNEW-TV (Channel 5) are one and the same. Ken was science editor of WNEW-TV from 1967 to 1971, when he came to POPULAR SCIENCE as executive editor, and he occasionally still appears there.

Ken has won many awards. Among them: Albert Lasker Award for Medical Writing, Blakeslee Award of the American Heart Assn., American Institute of Physics Award for Writing in Physics and Astronomy, Special Commendation of the American Medical Assn. (twice), Regional Award of the Aviation and Space Writers (TV), etc., etc.

Now Ken has won the nation's most prestigious science-writing honor: The 1980 American Assn. for the Advancement of Science-Westinghouse Science Writing Award for an article in a general-circulation magazine. We are proud that the Editor-in-Chief won this award, and we are doubly proud that the article appeared in POPULAR SCIENCE. It was "After 63 Years, Why Are They Still Testing Einstein?" in PS, December 1979.



# Sunshine into electricity

## New research brings solar-cell power closer to your roof

A flood of new devices and technology points the way to sun-powered rooftop systems during the 1980's

By JOHN FREE

LARGE, PA.

Growing crystalline solar-cell ribbons that convert sunlight directly into electricity is an unexciting, slow-motion process. At Westinghouse's advanced energy systems division here, I peeked into a small furnace containing white-hot silicon. A grayish, one-inch-wide ribbon was emerging from it and a row of other furnaces at a barely perceptible four inches per minute.

Westinghouse's ribbon-pulling process, called dendritic-web growth, was a laboratory curiosity several years ago. But the snail-pace ribbon growth at this pre-pilot production line near Pittsburgh belies the excitement among photovoltaic (solar-cell) researchers about recent advances in dendritic growth. Westinghouse believes these new developments can eventually cut solar-cell costs—currently a major stumbling block to large-scale cell use—enough for practical power generation.

But Westinghouse can expect intense competition from other photovoltaic technologies. As a result of the 1978 solar photovoltaics act, the Department of Energy has undertaken a 10-year, \$1.5-billion effort to develop various solar-cell systems. Contracts to dozens of institutions and firms have produced an explosive growth in research: Announcements of significant advances and "breakthroughs" occur almost every week.

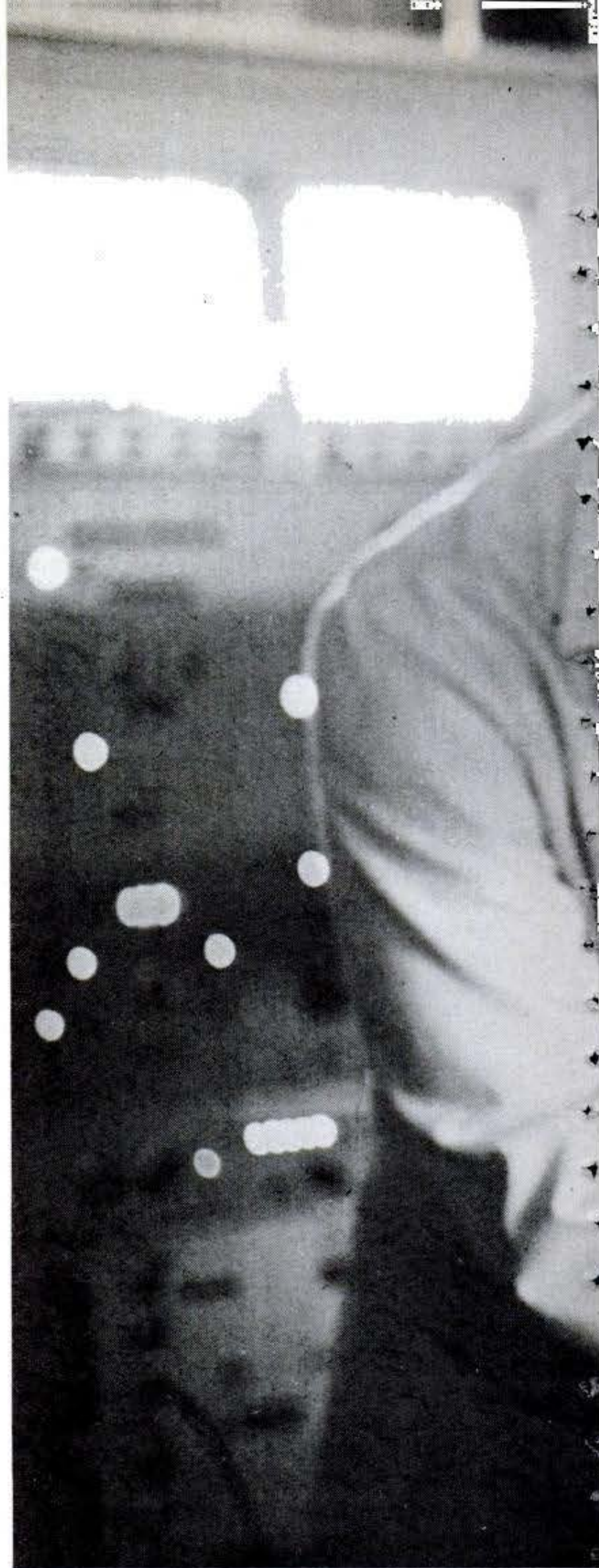
Automation of production, for example, is trimming the costs of traditional circular cells sliced from ingots of silicon, such as the Arco device shown on the cover. Another very promising technology I observed recently at RCA Laboratories in Princeton, N.J. is concerned with thin films: cells with layers so skimpy you can see through them.

Still another approach uses concentrators (instead of flat panels of cells): optics to focus solar energy and boost cell efficiency. And other technologies rely on exotic, costly cell materials or construction methods that capture portions of the solar spectrum that are usually wasted.

How significant are these developments? Can solar cells be counted on by the turn of the century—as experts hope—to supply a substantial portion of the energy this nation will need? I've just visited solar-cell research centers around the country to learn about recent advances and the future outlook. And it is becoming clear that those in the field are bristling with new optimism. They are confident that they will soon reach the old, elusive goal of producing solar cells that can turn solar energy into electricity at a cost that makes it practical.

### Ribbons vs. wafers

Today, the high cost of solar cells makes them practical only for applications such as powering isolated communications stations or producing electricity in countries with limited conventional utility power. That's because almost all such cells are made by slicing thin wafers cut from so-called Czochralski silicon ingots. This produces reliable, high-efficiency solar cells of the type used by space satellites and in a few specialized land-



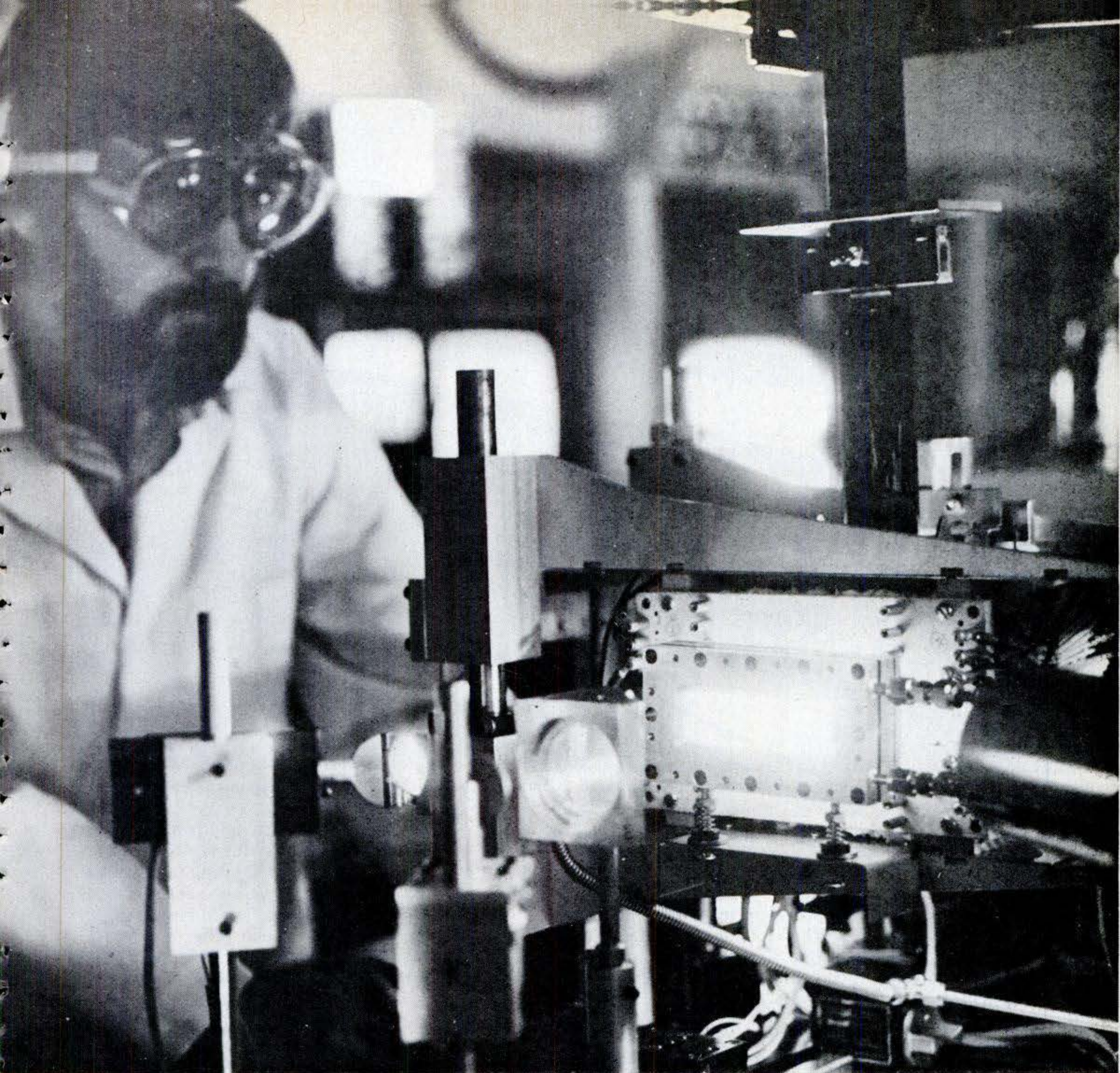
A Motorola researcher uses a pair of focused

based applications. But a lot of expensive single-crystal silicon is wasted as wafers are cut from ingots, polished, and cleaned. So the cells produced are expensive—perhaps 10 times too expensive to compete with conventional forms of electrical generation.

The Westinghouse dendritic-growth approach promises to bring down the production cost of solar cells drastically.

The present, essentially hand-operated line is really a learning tool. This year it's expected to turn out cells capable of providing 27 kilowatts (kW) of power—about half its full capacity.

Raw material for the ribbons is a nearly (99.999 percent) pure polysilicon that costs about \$100 per kilo-



carbon dioxide laser beams to melt polysilicon. A large-grain ribbon of silicon (upper right) is pulled for use with solar cells.

gram. The gray, metallic polysilicon ingots are sliced into tiny pellets and fed continuously into furnaces. A seed filament crystal fixed to a belt on a large spool is lowered into the vat of molten silicon. Then, with controlled movements and temperature changes, the crystal magic starts.

The filament crystal widens as it "grows," and narrow filaments or dendrites at its edges poke into the hot silicon. As the seed pellet is pulled up, the dendrites continue to grow. A smooth web of single-crystal silicon six thousandths of an inch thick also forms between the dendrites—like soap film between a pair of wires. From 1977 to 1980, Westinghouse researchers accelerated by 10 times the maximum rate at which this crys-

tal ribbon can be grown—to 10 inches per minute.

Was there a key development or technique responsible for this major gain in ribbon growth rate? "It was the computer," Dr. Dan Muss, head of Westinghouse's silicon-cell research, had told me earlier in New York. "It was our ability to model the growth process by computer and optimize the temperature shields." These metal shields just above the molten silicon regulate ribbon cooling. Using ordinary cut-and-try design methods, Muss said, would have taken significantly longer.

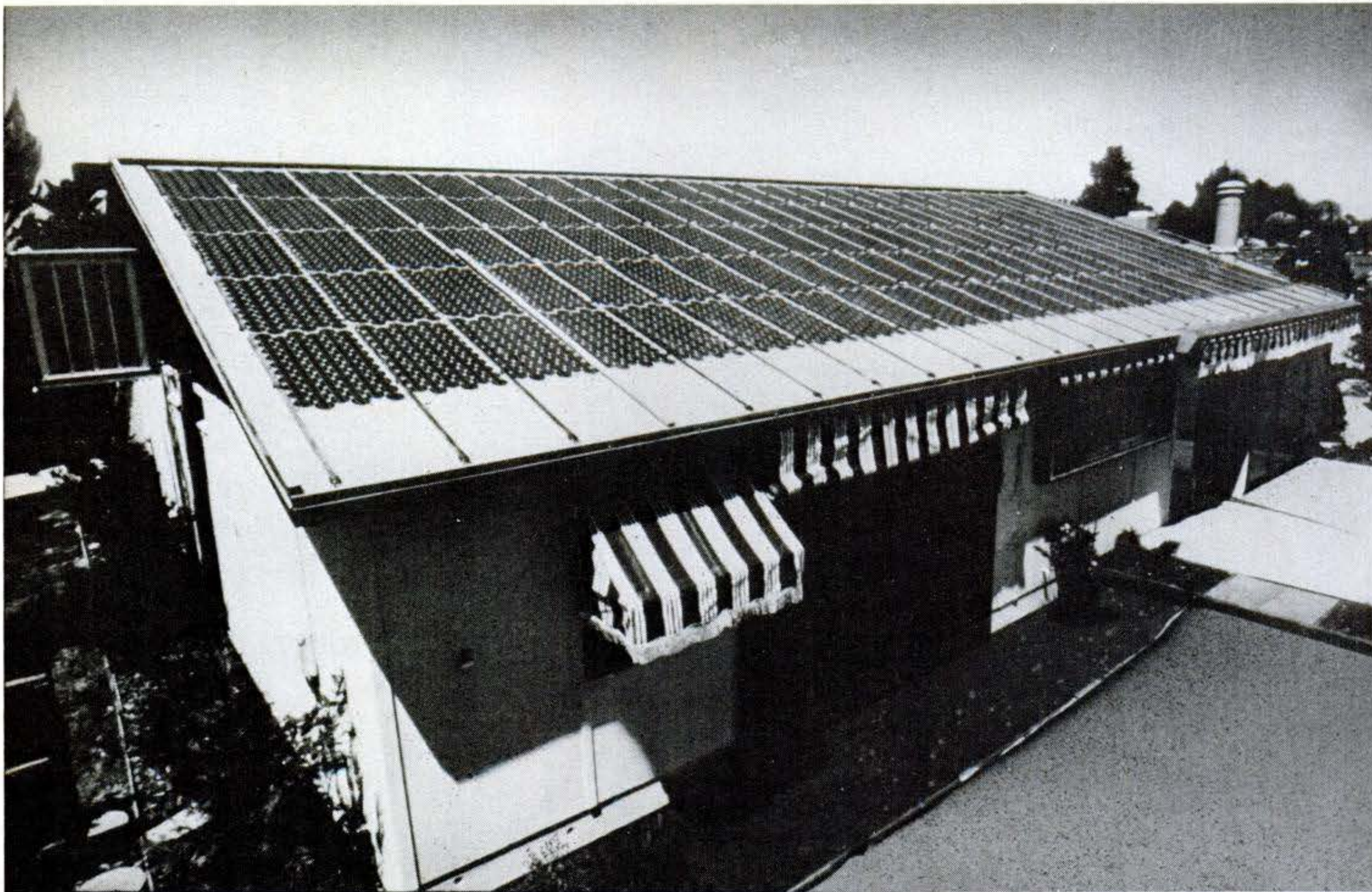
Once a long silicon ribbon is pulled from a furnace onto a spool, several additional steps are required to make a solar cell. I watched a technician use

a laser to cut off the dendrites from ribbon sections. Next, the mirror-like pieces of crystal silicon undergo a chemical diffusion and baking process.

This diffusion step creates two different semiconductor layers—silicon "doped" with phosphorus on the front, silicon with boron on the back of the ribbon. Light striking the front frees electrons near the junction of these two layers.

Instead of the diffusion step I saw, which involves baking the cells in an oven, semiconductor impurities can be added to the silicon much faster with a high-energy ion beam. Slamming boron or phosphorous ions into the silicon is more efficient, but it

*Continued*



Rooftop solar-cell system on Phoenix, Ariz. home, which is one of many under test by the DOE, has a seven-kilowatt capacity.

damages the cell surface. This requires a baking stage for repair.

But for later mass production, Westinghouse could adopt a new technique discovered by the Dutch that doesn't involve delays for baking. The Institute for Atomic and Molecular Physics near Amsterdam revealed that a low-cost laser can quickly repair the surface of silicon crystals after bombardment with ions. This bombardment/laser-healing process could take place in one vacuum chamber, providing the required semiconductor layers for development of electron charges.

Add cell electrical contacts, and these electrons can flow through a load and perform work—just like a chemical cell battery lighting a bulb or running a DC motor. Westinghouse coats the rear of its cells with a metal contact and etches a computer-designed, fan-shaped metal grid on the front. The cells are also coated with an anti-reflection layer to capture more sunlight and boost sunlight-to-electrical conversion efficiency by 50 percent.

Cell efficiency is critical. The cost of cells is only 15 to 20 percent of the cost of a complete system. So low-efficiency cells (under 10 percent) require more cell area and costly panel materials; this makes them uneconomical. Westinghouse has achieved

spectacular efficiency results: 16 percent, with 18 percent conversion efficiency expected shortly.

"In production, with cell efficiencies up to 18 percent, overall solar-panel efficiency should be about 16 percent," said George Hardigg, vice president of the firm's advanced power-systems division. "That exceeds the DOE goal of 12.9 percent by a significant margin." A square foot of panel could deliver about 16 watts (peak) of electric power on a clear day at noon.

When I visited Westinghouse's small pre-pilot line, technicians were preparing to build their first large panel. It contains 196 cells, is 16 by 48 inches, and produces 60 watts at 30 volts DC. The small cells are matched for electrical properties and hand-wired into place.

But by 1984 Westinghouse is committed to building a new semi-automatic line for annual production of panels that can deliver one megawatt (1,000 kW) of electricity. In 1984 the firm will also start designing a fully automated production line with a 25-MW capacity. By then, the company hopes to be using a low-cost grade of polysilicon (about \$10 per kilogram).

"Considering the high efficiency achieved and lower production cost for dendritic web, the DOE 70-cent-per-watt goal (in 1980 dollars) may be

achieved or improved upon by 1986," said Hardigg. "By the late 1980's dendritic growth is not going to be a technological curiosity, but a real source of electricity," says Bob Maxwell, director of division solar programs.

That 70-cent-per-watt figure quoted by Hardigg refers to cell-module cost. The DOE 1986 goal for a complete solar-panel system is \$1.60 to \$2.70 per watt—figures experts believe are practical for some residential uses. In the 1990's, DOE's goal is for a 15- to 50-cent-per-watt module and \$1.10- to \$1.30-per-watt completed-system cost. While estimates vary, at these reduced costs solar cells might supply six to 12 percent of residential electrical power by the year 2000 and up to four percent of the nation's total demand for electricity.

What would it cost you to build a complete home solar-cell system today with commercial components? Dr. Muss, using a \$12-per-watt figure for modules (big-volume purchases would be less), estimates \$120,000 just for cells. A complete, wired, 10-kW system (including a solid-state power conditioner to convert the DC output of cells into AC for appliances) would cost \$150,000 to \$200,000, he estimates.

Workers at the production facility here have a frequent reminder of a

similar but competing cell technology: wafers cut from Czochralski silicon ingots. To monitor the quality of polysilicon shipments, an ingot is "grown" from each order. Then silicon wafers are prepared with the same methods used by the semiconductor industry and 95 percent of solar-cell firms. An inescapable disadvantage of this cell-preparation method is the waste of precious single-crystal silicon as wafers are cut from ingots, polished, and cleaned.

### Thin-film cells

At RCA's Princeton, N.J. research laboratories I saw cells being made that require far less silicon—which is, incidentally, the second-most abundant element on earth (after oxygen). RCA and researchers elsewhere are devising ways of depositing incredibly thin layers of silicon—under one micron (millionth of a meter)—on metal and glass substrates.

Walk into several equipment-packed RCA labs and you'll detect the acidic, darkroom odor of development chemicals. You'll also hear the periodic click of relays, followed by whooshes of compressed gas. The gas comes from tanks labeled silane, phosphine, and diborane. As it's needed, the gas is precisely metered into chambers and subjected to either a strong radio-frequency (RF) field or a high DC voltage.

The ionized plasma created forms ultrathin layers of so-called amorphous silicon ["Semiconductors Made from Glass," PS, April '78] on a substrate. This silicon has a chaotic atomic structure like that of glass instead of the orderly arrangement of atoms in single-crystal silicon. The most important gas is silane ( $\text{SiH}_4$ ), a combination of silicon and hydrogen. By varying how the silicon is "doped" with the other gases and how it's deposited, a tremendous variety of solar cells can be made.

So far, both RCA and Energy Conversion Devices (in Troy, Mich.) have made cells with conversion efficiencies just over six percent. Dave Carlson, who has pioneered amorphous-silicon work at RCA, seemed confident that efficiencies can be pushed steadily higher. One advantage to making amorphous-silicon cells, Carlson told me, is that less energy is required: Gases need be heated only to between 200 and 350 degrees C versus the 1,410 degrees C needed to melt polysilicon. Also, of course, far less silicon goes into thin-film cells.

"Research in the field of amorphous semiconductors is presently in a dynamic phase involving a succession of

new discoveries and concepts," Carlson notes. He said the Japanese are moving quickly to produce this new type of cell. To dramatize the point, he handed me a new, light-powered Sanyo calculator with an amorphous-silicon cell.

Later, in Dr. Joseph Hanak's RCA lab, I discovered other advantages to thin-film technology. I was curious how large the cells could be made. "We intend eventually to go to this size," Hanak said, gesturing to the surface of a medium-size table before us. Moreover, mammoth cells like this could be formed in an automated operation requiring only six minutes.

Hanak passed me a pocketbook-size version of these huge silicon cells of the future. Formed on a glass substrate, its thin translucent layers appeared orange when held up to a window. Instead of a metal grid on its front surface, this cell had a translucent metal oxide layer. Hanak then connected a portable radio to the cell and operated it with sunlight.

Conventional single solar cells can't produce the voltage necessary for such a demonstration. But the amorphous silicon can be deposited as a series of

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“One 12-cell module uses Fresnel lenses to focus the equivalent of 400 suns on cells”

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parallel, connected strips, created with photolithographic techniques such as those used to make complex integrated circuits. This produces a solar-cell panel in one fabrication sequence.

Another potential advantage to thin films is that several types of layers can be "stacked" one atop the other, Hanak said. "The idea behind stacked cells is one of matching different ranges of the solar spectrum to band gaps of the cell." But so far, anticipated gains with this technique have not materialized. RCA is also looking at a technique of capturing sunlight that passes through thin-film cells with parabolic reflectors, then using it to heat fluids.

Many other organizations are investigating thin films. Last summer, the University of Delaware's Institute of Energy Conversion announced that it has produced a thin film with 10 percent efficiency using different materials: cadmium-zinc sulfide and

copper sulfide. The institute, with financial help from Chevron Research Co., is developing the technology needed to mass-produce these thin-film cells.

Yet while many researchers are struggling to achieve 10 percent conversion efficiency, several contractors for DOE are working on advanced cell designs for a spectacular 30 percent efficiency. Varian Associates (in Palo Alto, Calif.), for example, devised a lab setup that uses a selective filter to break sunlight into red (long wavelength) and blue (short wavelength) components. Selected silicon and gallium arsenide cells then achieved 28 percent conversion efficiency.

Under a Sandia National Laboratories contract, Varian Associates also built a 12-cell solar module that uses Fresnel lenses to focus the equivalent of 400 suns on cells. The gallium arsenide cells achieved a 16.4 percent conversion efficiency and delivered an impressive 100 watts of DC power. A side benefit is the thermal energy from water used to cool the cells in the 67-pound module, which is designed to track the sun.

Meanwhile, Bell Telephone Laboratories in Murray Hill, N.J., which invented the first practical silicon solar cell in 1954, has made significant improvements in liquid-junction cells. These devices, which combine liquids and solids, promise easier construction, less-expensive materials, and potentially longer cell life. But most liquid-junction cells tend to be destroyed by surface corrosion caused by intense light. With the Bell Labs device, sunlight actually *enhances* its longevity.

"Our cell uses indium phosphide as a photocathode, and with future materials specifically designed for liquid-junction cells, these devices could cost much less than single-crystal silicon cells," says Klaus Bachmann, a member of the research team.

"We are very excited about this new cell," says Adam Heller, head of Bell Labs' electronic materials research applications. But he adds a cautionary note voiced by other researchers: "It should be emphasized that even major research breakthroughs today could not be expected to make a significant contribution to the nation's energy needs for some time." ■

#### FOR FURTHER READING

*Solar Energy in Review*, issued by the Solar Energy Research Institute, Golden CO (has a good photovoltaics overview chapter by David Redfield of RCA Labs).  
*Solar Energy Technology Handbook*, William Dickinson and Paul Cheremisinoff, eds., 1980, Marcel Dekker, Inc., 270 Madison Ave, New York NY 10016 (has three chapters on solar cells in Part A). Price: \$85.  
Edmund Scientific, 101 E. Gloucester Pike, Barrington NJ 08007 (offers basic books on solar cells, hardware).

# GM's J-cars

## First look at a new class of subcompacts

The dream: sports-car spunk with high mpg. Do these cars make it?

By JIM DUNNE

Must a car be stripped to bare essentials to provide top fuel economy? General Motors thinks not. Next month the industry giant is introducing a new line of subcompacts with sporty styling outside and a higher level of trim inside to prove the point. GM hopes that its J-cars—Chevrolet Cavalier, Pontiac J-2000, and Cadillac Cimarron—will cut into import sales in the one-step-up economy-car market.

Although the basic design of the cars is fairly predictable—transverse four-cylinder engine and front-wheel drive—many of the components are new designs. The new 1.8-liter engine provides more power and speed than you would expect from a pushrod valve train. The steering mechanics and geometry are different from anything GM has ever built before. And the modified X-car rear suspension uses a unique “twisting” axle for improved ride and handling. The interior holds four passengers, period—with no compromise in comfort to squeeze a third passenger into the rear seat. I drove a prototype Cavalier and found it smooth and amply powerful, though unexciting. (I’ll talk more about handling later.)

The most interesting mechanical system is the engine. It’s a pushrod type, but the Chevy engineers who designed it say it has all the high-speed capability of an overhead-cam without the added cost.

“We have a rigid valve train with no big angles in the valve area,” said

staff engineer Joe Bertsch. “That lets the valve train maintain dimension at high speed.”

Because the valve train is held tightly in place, the engine can run up to 6,000 rpm with no problem. In comparison, the 2.5-liter, four-cylinder engine used in the X-cars peaks out at about 4,500 rpm.

### Close to the best

Why shoot for more engine speed? More power. In the J-car, engine output is 88 hp at 5,100 rpm, or just over 48 hp per liter—on a par with the high-output V6 used in the Citation, one of GM’s most efficient engines.

“We figure that 50 horsepower per liter of displacement is close to the best we can expect out of an engine,” said Bertsch. “When we come up with 48 in a standard production engine like the 1.8, we feel we’ve done a good job.”

“Another key is cross-flow breathing. That’s a necessity to get the fuel in and the exhaust out quickly. It’s not new—our 2.5 engine has it—but we couldn’t do the job without the flow layout.”

Under the hood, the four is set sideways, with the carburetor in the rear and the exhaust manifold in front—similar to the X-car layout. Like all GM engines, the 1.8 is controlled by a computer, which ensures smoothness and helps deliver high economy and low emissions.

Fuel-economy results are not ready for release yet, but Russ Gee, Chevy’s chief engineer for engines, believes the J-cars will get better highway economy than the Chevette, or more than 42 mpg in the EPA test.

“We’re learning more about fuel economy each time we design a new engine,” said Gee. “That’s why a

2,340-pound car like the Cavalier will test so efficiently. We can also get away with a 9:1 compression ratio on this engine and still meet the standards for hydrocarbon emissions. That helps fuel economy a lot and is directly traceable to our ability to control the air-fuel feed and ignition timing with a computer.”

Improving economy with new control techniques allows the designers to avoid risks elsewhere: Chevy sticks with iron castings for the engine block and cylinder head. But a fairly new technique, room-temperature vulcanizing, is used for sealing the engine. Instead of gaskets, a bead of plastic sealant is squeezed where major parts come together. “That means we get virtually no leakage of oil or coolant,” said Gee, “and we get that right from the first production job.”

Changes in steering geometry for the J-cars produce a more positive feel and stronger steering-wheel return. The rack and pinion are mounted high up on the fire wall, extremely close to the steering wheel. The effect is a direct connection—no universal gears—between the steering shaft and the gear, so there’s less play in the steering wheel.

Also, the high-rack system is rigidly connected to the fire wall, where it

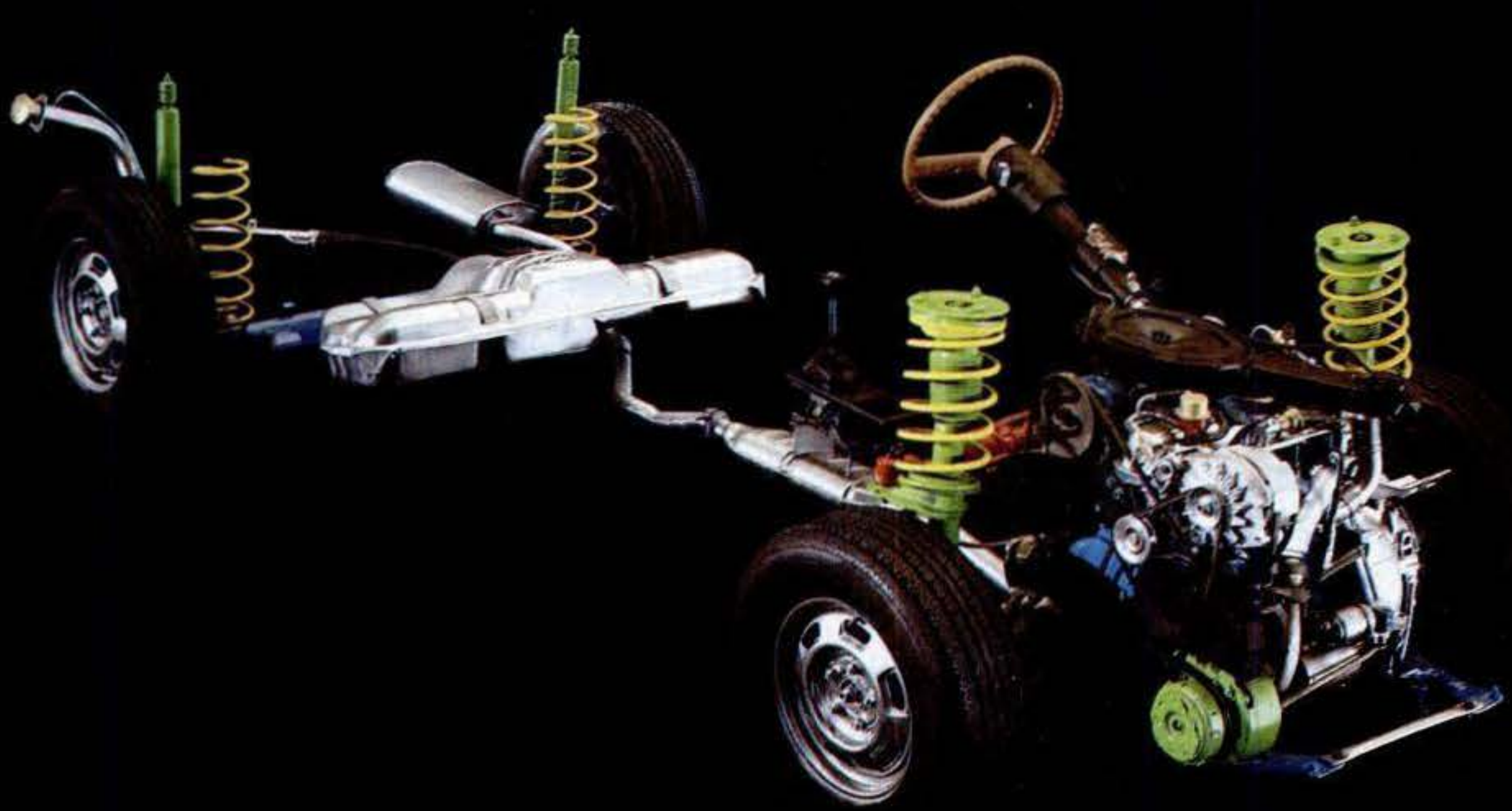
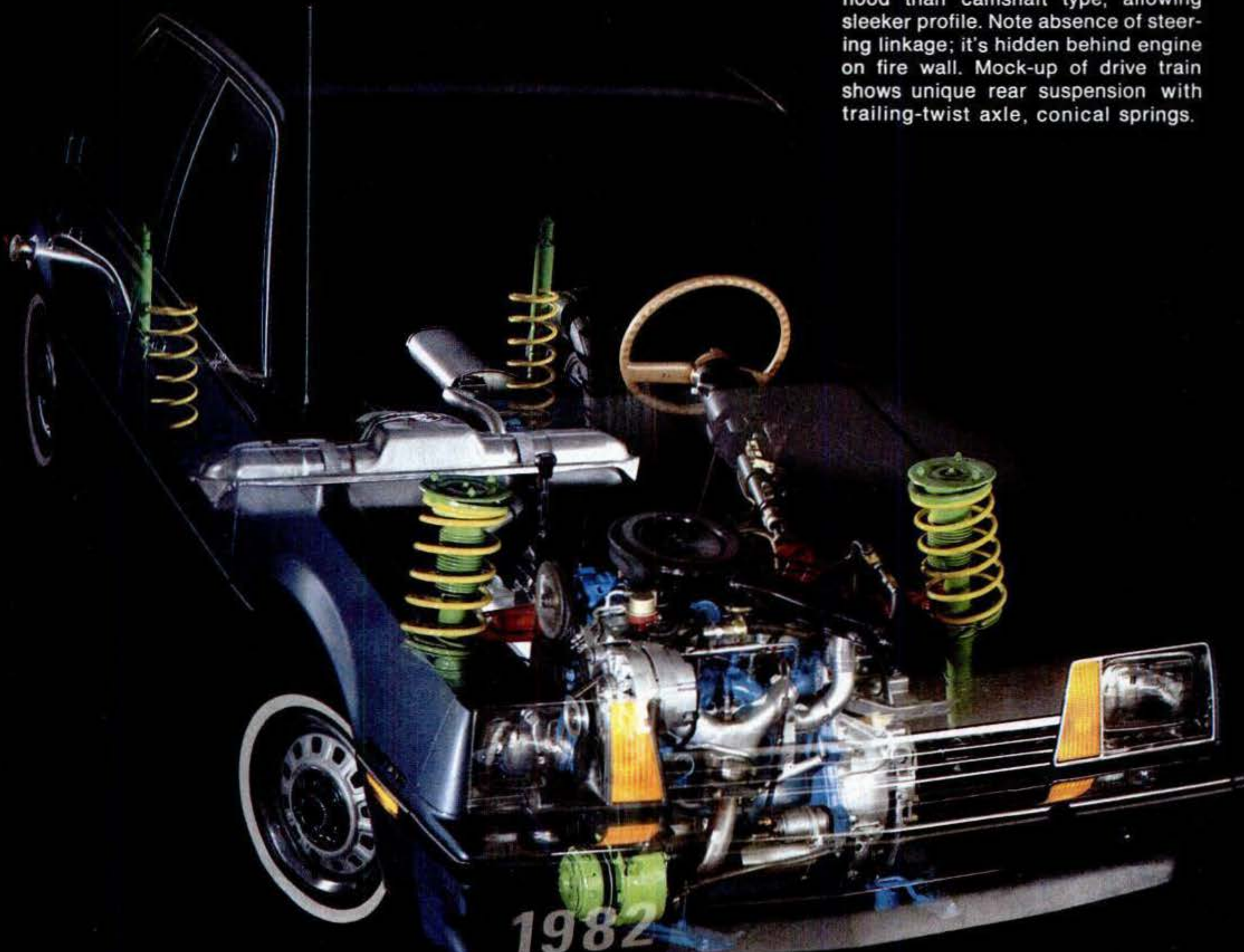
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J-car vs. Chevy's other small sedans

	Cavalier	Chevette	Citation
Wheelbase (in.)	101.9	97.3	104.9
Length (in.)	170.0	164.9	176.7
Weight (lbs.)	2,350 (est.)	2,002	2,508
Capacity (passengers)	4	4	5
Engine	1.8-liter 4	1.6-liter 4	2.5-liter 4, 2.8-liter V6
Drive train	Front engine, front drive	Front engine, rear drive	Front engine, front drive



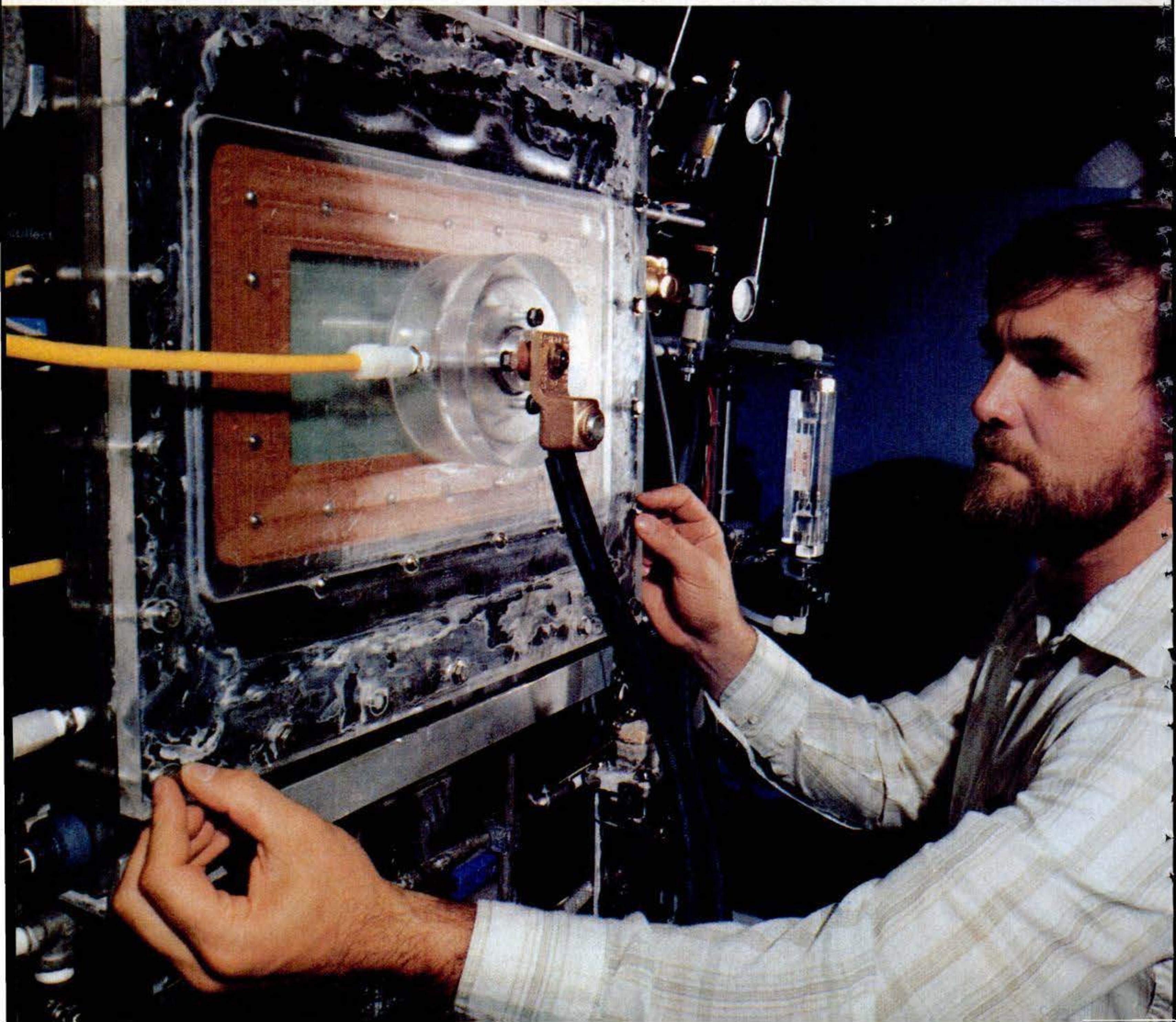
Designed for sporty handling and four-passenger comfort, the J-car is still expected to top 40 mpg on the highway. Phantom photo reveals a conventional front-drive layout with new 1.8-liter four-cylinder engine mounted sideways. Pushrod engine sits two or three inches lower under hood than camshaft type, allowing sleeker profile. Note absence of steering linkage; it's hidden behind engine on fire wall. Mock-up of drive train shows unique rear suspension with trailing-twist axle, conical springs.



# Best battery yet?

Power, range, and quick  
recharging for  
electric cars

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# No overnight plug-ins for this electric-car cell. Just change the metal plate

By **TOM JOHNSON**  
DRAWING BY RAY PIOCH

LIVERMORE, CALIF.

The sign on the door of Room 1868 at Lawrence Livermore National Laboratory made me hesitate: "Caution. Eye Protection Required. Sodium Hydroxide Solution."

Yet the cluttered tables and benches beyond the door gave the benign appearance of an electrician's shop. Scattered about were clear-plastic tubes and sheets, electrical testing equipment, mini-computers, and ribbed plastic trays that looked like the shelves in my refrigerator.

But this wasn't the workbench of a neighborhood fix-it man. I was visiting the lab of research chemist Dr. John Cooper, who is making encouraging progress in developing a new kind of battery that promises the energy density and power to make electric cars competitive with those powered by gasoline engines.

Cooper's aluminum-air cell is just one of many batteries under development in what has become a race to make electric autos practical ["Exotic New Batteries," PS, Feb. '79]. General Motors has announced plans to have an electric commuter car powered by zinc-nickel oxide batteries on the market in 1985. Gulf & Western is working on a zinc-chlorine system, which, it says, will power a car at 55 mph for 150 miles between charges.

## Pound for pound

Those two batteries, and most others on the horizon, have specific energies (which determine the distance a car can go on a charge) ranging from 30 to 90 watt-hours per pound. The aluminum-air battery puts out about 200 W·h/lb.

Since it packs so much energy into comparatively little weight, enough cells could be put in a five-passenger car to drive it 3,000 miles at 55 mph before the aluminum would need to be replaced. That's sufficient range, Cooper believes, to serve everyone from child-shuttling housewives to Texas ranchers. And his battery would do this without using exotic materials, so the cost would be competitive with petroleum-based fuels.

**More watts** from less weight: Dr. John Cooper checks the aluminum-air cell on its test stand at Lawrence Livermore Lab. Pound for pound, it produces 10 to 15 times the energy of lead-acid cells.

Perhaps the Livermore device shouldn't be called a "battery," because it doesn't store an electric charge, as does the six- or 12-volt lead-acid battery under the hood of your car. Cooper prefers to call it a "fuel cell," a device that converts the chemical energy in a substance to electrical energy by exposing it to oxygen and hydrogen in the presence of a current-carrying electrolyte.

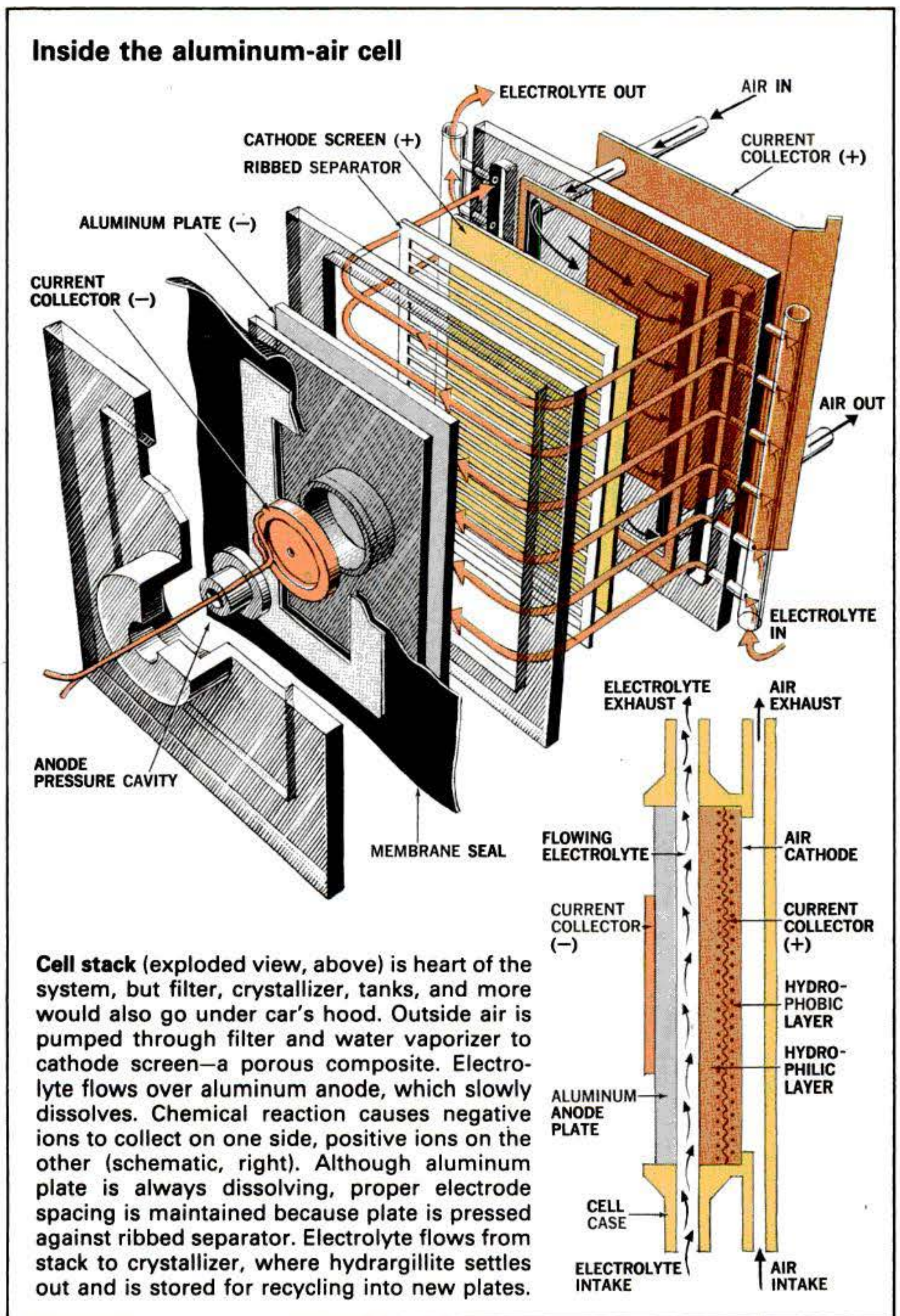
In this cell, the fuel is aluminum and the reactant is humid air. When the two are placed in close proximity, with electrolyte in between, both give up ions to the electrolyte—and electrical potential is created. The electrolyte is a solution containing sodium hydroxide (the same caustic lye that's in Drano—hence the warning).

"Aluminum, water, and oxygen

tend to react spontaneously," Cooper told me. "In the cell, this tendency creates a negative-charge buildup on the aluminum anode plate and an equivalent positive buildup on the cathode collector screen. When the aluminum and screen are wired together externally to the cell, a flow of electricity results, which can be put to work, say, driving an electric motor."

During the reaction, the aluminum plate slowly dissolves into the electrolyte, so when it leaves the cell after performing its electrochemical sleight of hand, the sodium solution contains oxides of aluminum. The solution is routed to a crystallizer where crystals of aluminum trihydroxide—commonly called hydrargillite—settle out.

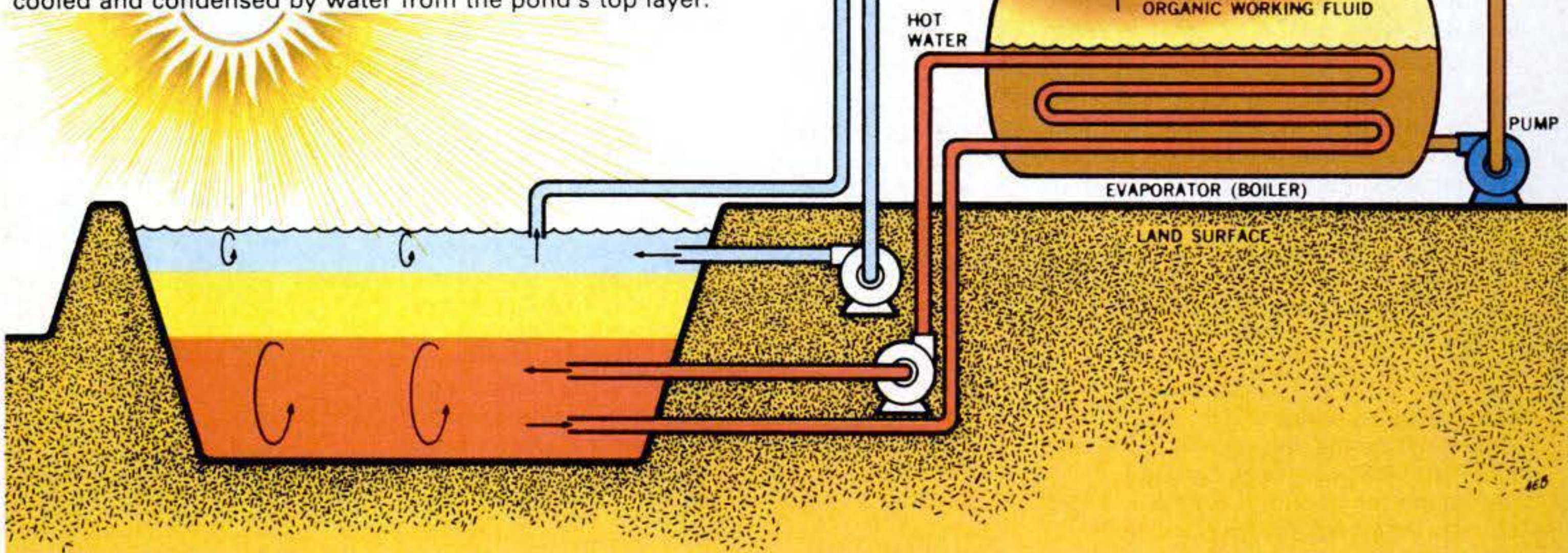
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# Power from the Dead Sea via solar ponds

Looking across the solar pond at Ein Bokek (above), you can see Ormat's low-temperature turbogenerator on the far shore. Floating plastic netting on top of the pond damps wind-induced waves, which could cause mixing. Solar ponds maintain three distinct layers of water (diagram below). The top zone (blue) is fresh water about 12 inches deep. The salt-gradient middle layer (yellow) is about three feet thick; its salinity and temperature increase steadily with depth, suppressing convection until at its lower boundary the water is as hot and briny as the bottom layer (red)—20 percent salinity and over 90 deg. C. Convection currents in the top and bottom layers are confined within each zone. The middle layer provides insulation, about equal to 2½ inches of plastic foam. Ormat's turbine (right) is a single-stage type with an organic working fluid. Hot brine from the pond boils the fluid. The high-pressure vapor then spins the turbine before being cooled and condensed by water from the pond's top layer.



## Israel harvests power from the desert with briny ponds and a new low-temperature turbogenerator

By PAUL BOLON

DRAWING BY ADOLPH BROTMAN

"To stand on the shore opposite Israel's newest generating plant is an unusual, even unnerving, experience," says Bob French of Caltech's Jet Propulsion Laboratory. "It's still—almost perfectly quiet. No men about, no tall stacks spewing smoke, no sign of activity. You can't even hear the whine of the turbine from over there."

At Ein Bokek on the shore of the Dead Sea, surrounded by the desert hills of the Negev, the power plant is nothing more than a square, shallow pond with an odd assemblage of tanks near the water's edge. Large pipes stretch out into the pond and disappear below its surface. And since there are none of the usual telltale hints of mechanical motion or burning, it becomes evident—if you didn't know beforehand—that the generator somehow draws its energy from the pond.

"If you walk to the top of the small mound of desert that was scooped up to make the pond's dike and stick your hand in the water, it feels warm—normal enough," says French. "Putting your hand in deeper, say up to your elbow, the water gets pretty hot. If you plunged your arm in all the way, your hand would be badly scalded. The water a meter down is about 90 degrees Celsius [195 F]."

This new power system is based on two concepts originally developed in Israel: solar ponds and the low-temperature, Rankine-cycle turbogenerator made by Ormat Turbines, a research and development company in Israel. Solar ponds have been built and studied by Israeli and American scientists, working independently, for years ["Solar Ponds," Dec. '77]. Israel is the first to generate electricity from the enormous quantities of heat that solar ponds can store. American scientists have focused their efforts on direct use of the ponds' thermal energy, as for space heating and industrial process heat. But Israel and Ormat Turbines have begun a program to construct enormous pond systems in the desert for central-station generating plants. This tantalizing idea has already spawned U.S. plans for similar projects in several western states. Some American scientists, however, doubt whether generating electric power is the best use of solar

ponds—or even economically viable.

About solar ponds themselves there is basic agreement: They work, combining the functions of solar collector and storage medium in one. They can be maintained with little upkeep and can be incredibly cheap to build.

Solar ponds were discovered in 1899, in Transylvania, by a scientist named A. V. Kalecsinsky, who was puzzled by the unusual temperatures in Lake Medve. Water up to 70 degrees C (150 F) could be found at the bottom of the lake. Kalecsinsky analyzed water samples and found that the lake was stratified into three non-mixing layers, with each deeper zone having a higher temperature and salinity. That temperature profile was the opposite of a normal pond, in which less dense, warmer water is convected to the surface. Kalecsinsky also determined the cause of the inversion: Although water in the middle zone gradually became hotter with depth, it also became saltier—or denser. The result: no convection. That salt-gradient, nonconvecting middle zone blocked convection from the hot bottom zone to the surface, trapping its sun-generated heat. That's what makes a pond a solar pond.

Since Kalecsinsky's discovery, a few more natural salt-gradient ponds have been found: in the state of Washington, in Venezuela, one even in Antarctica trapped beneath a permanent cover of ice. But little work was done on solar ponds until the 1950's, when Israel embarked on an ambitious program of solar research. One of the projects was solar ponds, another was the development of a low-temperature turbine to produce electricity—the forerunner of Ormat's generator.

In 1959, Israel built the first man-made solar pond, and scientists there worked out a theory of the pond's structure and equilibrium (see schematic). The turbine project produced a working model of a self-contained turbogenerator that used an organic compound, like Freon, as the working fluid. Both the solar-pond project and turbogenerator were dropped in the late 1960's. Oil was just too cheap to make them feasible.

### Unique generator

However, when the Israeli government ended work on the turbine, Lucien Bronicki, who headed the turbine group, did not give up. He formed his own company, Ormat Turbines, to produce the machine. "Bronicki began by making and selling turbines for solar-powered pumping of water in arid lands," Haim Hershman, manager of research and development at Ormat, told me. "The generator at the

time was quite small, but it had two unique features: It needed only 90-degree-C water to produce electricity, and the generator was very reliable. It was designed with just one moving part: the turbine. The bearings were lubricated with the same organic fluid that powered the turbine. It could run for thousands of hours without maintenance.

"But Bronicki sold only one solar-powered turbine. However, another market was soon found where, instead of a shortage of skilled men and water, there might be no men at all. Several thousand generators have now been sold to power remote weather stations, emergency systems, microwave relay stations, even areas along the Alaska pipeline. These turbines were adapted to run on fossil fuels."

After the Yom Kippur War in 1973, Israel's uncertain supply of oil and skyrocketing crude prices threatened the strategic and economic stability of the country. The solar-pond project was resurrected and linked with the development of much bigger turbogenerators from Ormat. The project was made a national program.

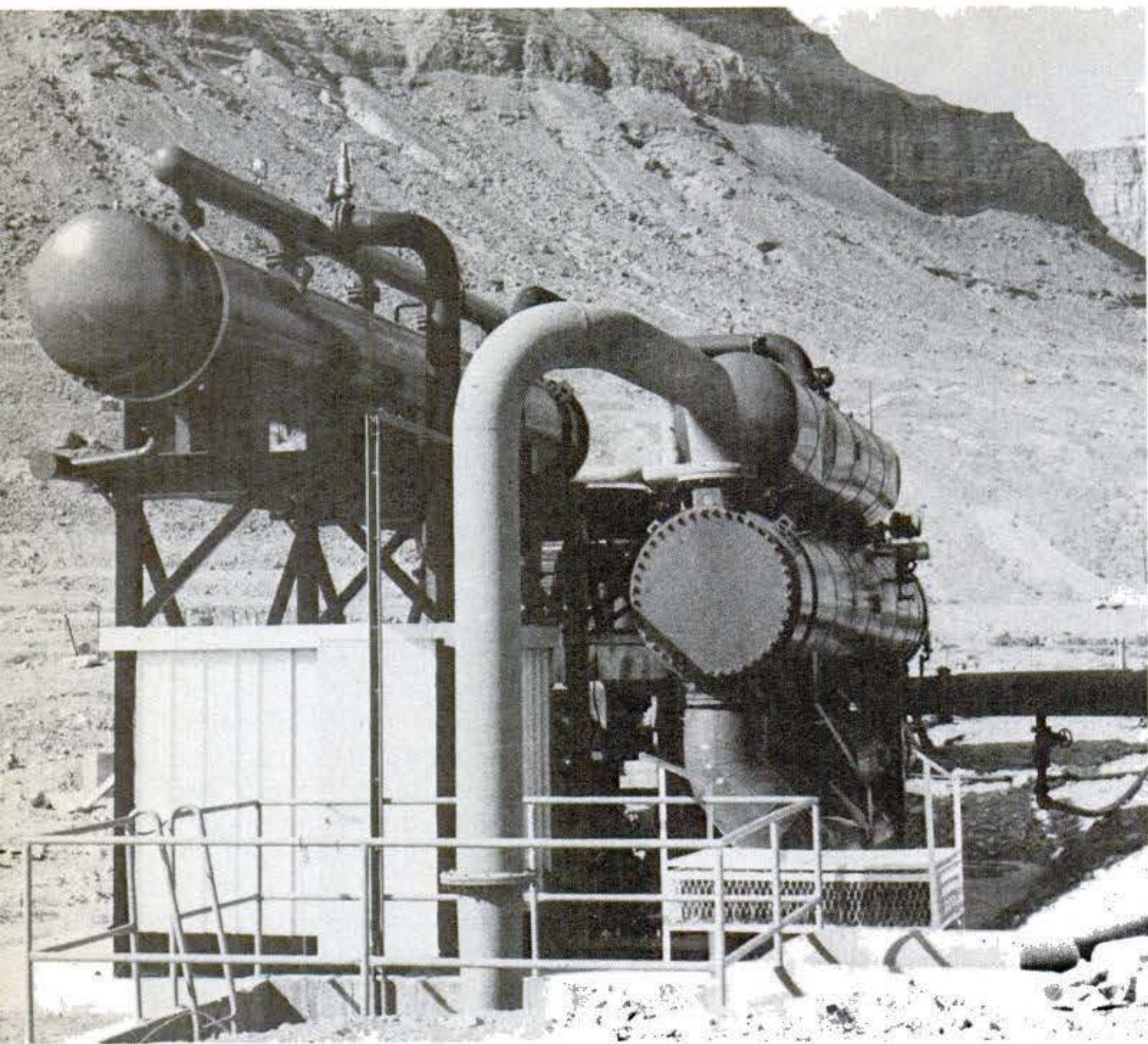
### Ponds for the future

At Ein Bokek, a 150-kW turbine has been running almost continuously since December 1979—although at an output well below its rating—feeding off the heat stored in the 7,500-square-meter pond. But that's just a small, intermediate step in the design. Here's the timetable for the future:

- 1982—Ormat will build a ¼-square-kilometer pond with a five-megawatt (MW) generator.
- 1983—a one-square-kilometer pond with a 20-MW generator.
- 1985—a pond of four square kilometers with a 50-MW generator.

And once the optimum size of solar ponds and generators is found (expected to be between 20 and 50 MW), modular pond-and-generator units will be added near the Dead Sea, up to a total capacity of 2,000 MW (Israel's present use) by the end of the century. The solar ponds necessary to power that capacity will total an estimated 500 square kilometers (190 sq. miles). But by that time, the Dead Sea itself may be used as a "solar lake" with many separate ponds floating on top of its briny, lifeless water. And water from the Mediterranean Sea will be coursing through a tunnel and canal to supply water for the ponds on the Dead Sea (1,200 feet below sea level) while generating 200 MW of power. Brine in the Dead Sea is so concentrated (20–25 percent salinity) that sea

*Continued*



In the Ormat generating unit at Ein Bokek, the condenser is the tank at upper left.

Large pipe in the foreground feeds hot water from the pond to the boiler.

water (three percent salinity) can be used as "fresh" water for solar ponds.

Intriguing. The sun shines, the pond warms, and the turbine spins—making electricity. Day and night power from a solar collector and generator that is practically maintenance-free. "Free" electricity—no fuel costs—once the pond is built.

Is this concept applicable to the U.S.? Maybe. In California, the state government and Southern California Edison are planning a five-MW generating plant near the Salton Sea, a salty terminal lake in the Imperial Valley. If that unit is successful and economically viable, capacity may be extended to as much as 600 MW. The ponds will also be used to concentrate salts away from the Salton Sea, which otherwise will soon become too salty to support marine life. Congress has appropriated \$1.2 million for a pond and generator at the Great Salt Lake, but it's not yet certain whether it will be built.

Bob French is a member of the JPL group that's responsible for the first phase of the Salton Sea design, a feasibility study. So far, the project appears to be technically sound. About the cost, French says: "Our report estimates that the first prototype five-MW plant will produce pow-

er for 15¢ per kW-hr. For commercial-size plants we estimate the power would cost in the range of seven to 10 cents per kW-hr, nearly competitive with other types of plants." Ormat's predictions have been even lower.

The cost of the pond has the greatest effect on the price of electricity. Building a pond requires several ingredients: land, water and salt (or brine), excavation, and a plastic liner that keeps water from seeping into the ground. If the soil is an impermeable clay needing no liner and a source of free brine is available, then large ponds may cost as little as \$5 per square meter. The upper limit for large ponds is estimated at about \$35 per square meter.

U.S. scientists say that even though solar ponds seem very promising, applied research on ponds is still in its early stages. Scientists here also believe that estimates for electricity production may be over-optimistic, but they can't be sure because data from Israel's basic pond research are not available to scientists here.

And other types of solar ponds are being investigated: saltless ponds, saturated salt ponds that have no fresh top layer, and ponds that have a cover such as a plastic membrane or gel layer (see the following article on

gel ponds). Perhaps because solar ponds are unglamorous, low-technology collectors, U.S. funding for pond research has been low and sporadic, scattered among many agencies. However, a coherent national program is now being planned by DOE.

American scientists are much more enthusiastic about applying pond heat directly to thermal end-uses. Miamisburg, Ohio, has a solar pond that heats the city's public swimming pool. At Ramapo College in New Jersey, a solar pond will be built to heat hot water for a new dormitory.

### Electricity and heat?

Peter Fynn, who does research on a pond project in Wooster, Ohio, had this to say about the possible applications of solar ponds: "The big strength of solar ponds is that they produce low-grade heat, and lots of it. As a source of heat, ponds could have a far greater impact than a generating station in Southern California.

"If you are going to take the heat from solar ponds and convert it to electricity, and then use that electricity to heat homes, you don't use 90 percent of the heat energy available."

Ormat has reported a pond efficiency of 17 percent at Ein Bokek, taking heat out of the pond on a daily basis. However, the efficiency of the turbine is limited to eight to 10 percent due to its low working temperatures. So the Ormat generator converts only about 1.5 percent of the total insolation into electricity. Direct thermal application can use much more of the pond's stored energy. Researchers believe that eventually ponds will be built with an efficiency of 30 percent.

"You have to get a perspective of the problem Israel faces," explains Fynn. "All of its oil is imported—50 percent from Egypt. That's why it is very aggressive about alternate ways of making electricity—even if the efficiency is low."

Bob French also sees room for both kinds of solar-pond applications. "I see a large application for ponds in process heat in the thermal applications," he says. "And the efficiencies of ponds are such that an industry can afford to build a pond anywhere if it has the land. But you cannot take that pond and economically generate power. If you move out into areas of land that can't be used, it makes sense to use that land to generate electricity.

"In order to generate electricity, the cost of the solar pond has to be much lower than you'd be willing to pay for thermal energy. You have to have some conditions occurring naturally, then take advantage of them." ■

# Gel ponds

trap heat  
under a blanket of plastic

A polymer surface "glaze" increases performance of small solar ponds

By ROB PHILLIPS

What do gelatin desserts and innovations in solar energy have in common? Quite a bit—for Dr. Ebtisam Wilkins at the University of New Mexico. She has just built the first solar pond with a gel top layer. But she couldn't have done it without inspiration from the bouncy dessert.

Scientists have sought for years to "glaze" or cover the surface of solar ponds to make them more efficient. But what material—or structure—

could do the job cheaply and last? Dr. Wilkins got her idea one day at lunchtime while eating her gelatin dessert. Years of trial and error followed in pursuit of the right polymer.

To build her solar pond, Wilkins mixed the polymer with water and pumped the resulting viscous mixture—almost solid, she says—over the top of brine already in the pond's bottom. The gel is lighter than brine; so it floats. Sunlight now passes through the transparent gel and heats the brine, with the gel layer both insulating the brine and stopping its convection currents from reaching the atmosphere. Heat will be extracted by circulating hot brine through a heat exchanger.

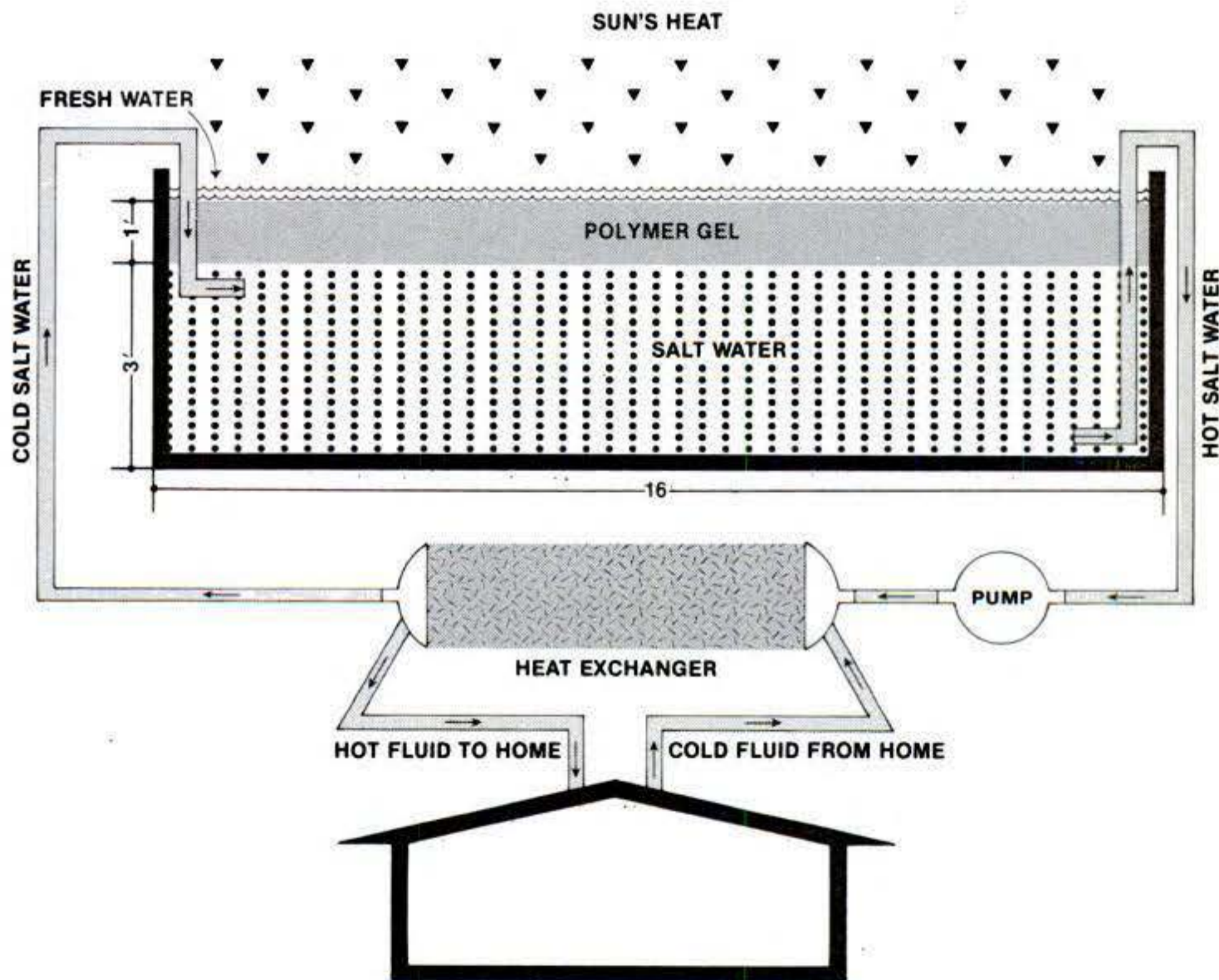
Gel ponds may represent a significant advance over the salt-gradient solar pond (see preceding article). Evaporation from an open pond can be substantial, and salt from brine migrates slowly to the fresher layers. Open ponds thus need periodic additions of fresh water and reconcentration of their brines. Open ponds also have environmental drawbacks—dust, algae, and wind-generated waves—although these have largely been overcome.

Gel ponds, on the other hand, need no infusions of brine or water. Dust can easily be washed off, and waves don't form at all. Although the gel pond is initially more costly than a salt-gradient pond—the polymer for the test pond cost \$200—its operating costs should be less. But still more important is that the gel layer may produce much higher pond efficiency. In a salt-gradient pond, the top two zones (about four feet thick) absorb over half of the incident radiation. With a thinner, clear gel layer over the brine, Wilkins says that about 30 percent more sunlight will penetrate to the storage zone.

After trying hundreds of polymers for the gel, Wilkins found just three that were clear, less dense than brine, and viscous enough to suppress convection from below. She estimates that the gel will last at least three years in the pond. PS



Clarity of her pond's polymer gel (top half in the cylinder) is demonstrated by Dr. Wilkins. Gels are still being tested for durability in ultraviolet light.



THE GEL POND: HOW IT WORKS

Albuquerque gel pond (schematic above) is 16 feet across and about four feet deep—sized to heat an average home. Dr. Wilkins keeps a few inches of fresh water on top of

the gel to wash off dust and debris. She expects the storage layer to reach near-boiling temperatures by late summer. Optimum depth of gel is about one foot.

# The tantalizing quest for gravity waves

When scientists finally detect a form of energy they have never seen, they will open a new era in astronomy

By **ARTHUR FISHER**

In the vast reaches of the cosmos, cataclysms are a commonplace: Something momentous is always happening. Perhaps the blazing death of an exhausted sun, or the collision of two black holes, or a warble deep inside a neutron star. Such an event spews out a torrent of radiation bearing huge amounts of energy. The energy rushes through space, blankets our solar system, sweeps through the Earth . . . and no one notices.

But there is a small band of experimenters, perhaps 20 groups worldwide, scattered from California to Canton, determined that some day they *will* notice. Pushed to the edge of contemporary technology and beyond, battling the apparent limits of natural law itself, they are developing what will be the most sensitive antennas ever built. And eventually, they are sure, they will detect these maddeningly intangible phenomena—gravity waves.

Even though gravity waves (more formally called gravitational radiation) have never been directly detected, virtually the entire scientific community is convinced they exist. This assurance stems, in part, from the bedrock on which gravity-wave notions are founded: Albert Einstein's theory of general relativity, which, though still being tested, remains untoppled [PS, Dec. '79]. Says Caltech astrophysicist Kip Thorne, "I don't know of any respectable expert in gravitational theory who has any doubt that gravity waves exist. The only way we could be mistaken would be if Einstein's general relativity theory were wrong and if all the competing theories were also wrong, because they also predict gravity waves."

In 1916, Einstein predicted that when matter accelerated in a suitable way, the moving mass would launch ripples in the invisible mesh of space-time, tugging momentarily at each point in the universal sea as they passed by. The ripples—gravity waves—would carry energy and travel at the speed of light.

In many ways, this prediction was analogous to one made by James Clerk Maxwell, the brilliant British physicist who died in the year of Einstein's birth—1879. Maxwell stated that the acceleration of an electric charge would produce electromagnetic radiation—a whole gamut of waves, including light, that would all travel at the same

constant velocity. His ideas were ridiculed by many of his contemporaries. But a mere decade after his death, he was vindicated when Heinrich Hertz both generated and detected radio waves in the laboratory.

Why, then, more than 60 years after Einstein's bold forecast, has no one seen a gravity wave? Why, despite incredible obstacles, are physicists still seeking them in a kind of modern quest for the Holy Grail, one of the most exciting in the whole history of science?

To find out, I visited experimenters who are building gravity-wave detectors and theoreticians whose esoteric calculations guide them. In the process, I learned about the problems, and how the attempts to solve them are already producing useful spinoffs. And I learned about the ultimate payoff if the quest is successful: a new and potent tool for penetrating, for the first time, what one physicist has called "the most overwhelming events in the universe."

## A kiss blown across the Pacific

The fundamental problem in gravity-wave detection is that gravity as a force is feeble in the extreme, some 40 orders of magnitude weaker than the electromagnetic force. (That's  $10^{40}$ , or a 1 followed by 40 zeros.)

Partly for this reason, and partly because of other properties of gravity waves, they interact with matter very weakly, making their passage almost imperceptible. And unlike the dipole radiation of electromagnetism, gravitational radiation is quadrupole (see drawings, p. 92).

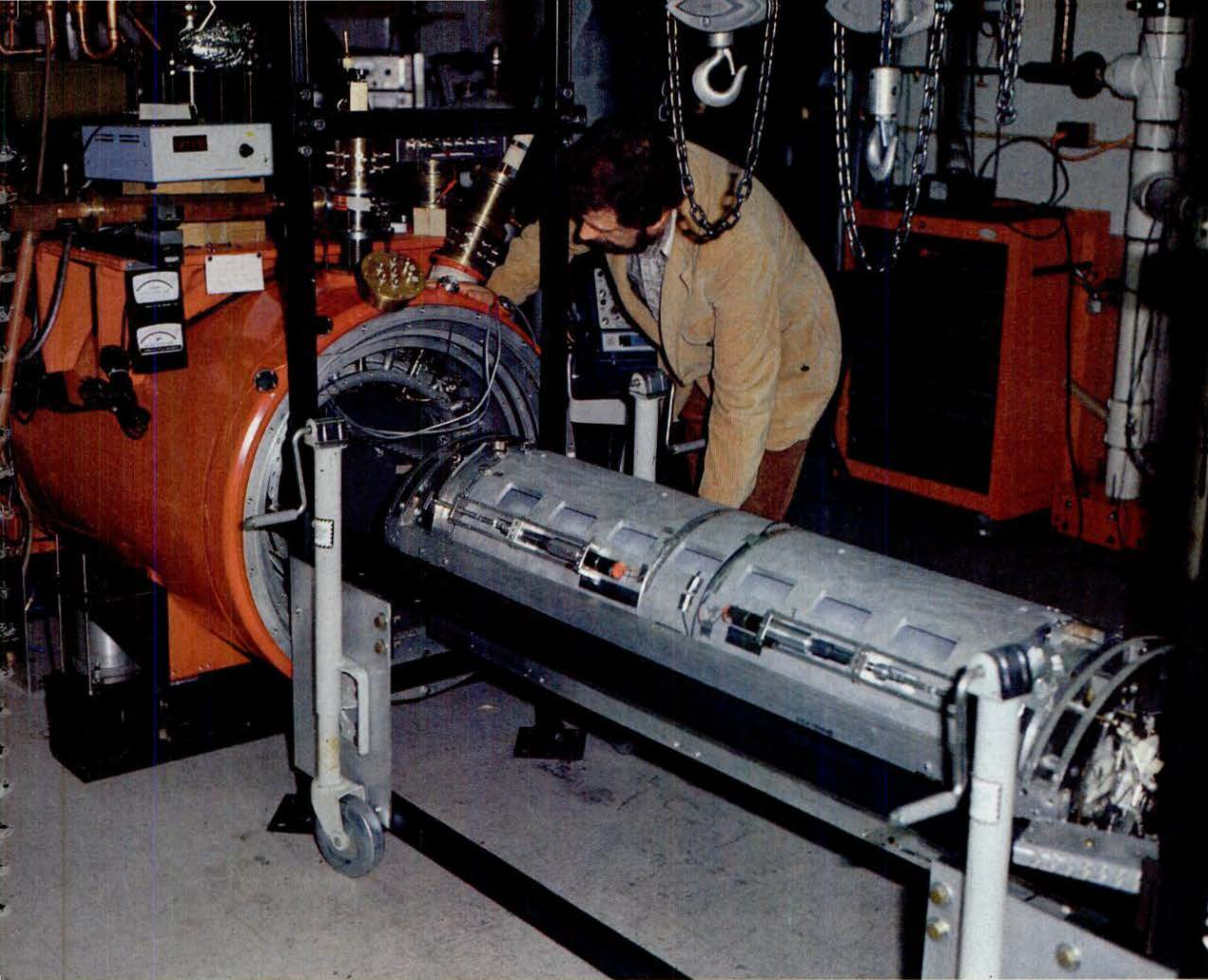
If a gravity wave generated, for example, by a supernova in our galaxy passed through the page you are now reading, the quadrupole effect would first make the length expand and the width contract (or vice versa), and then the reverse. But the amount of energy deposited in the page would be so infinitesimal that the change in dimension would be less than the diameter of a proton. Trying to detect a gravity wave, then, is like standing in the surf at Big Sur and listening for a kiss blown across the Pacific.

As for generating detectable waves on Earth, à la Hertz, theoreticians long ago dismissed the possibility. "Sure, you make gravity waves every time you wave your fist," says Rainer Weiss, a professor of physics at MIT. "But anything you will ever be able to detect must be made by massive bodies moving very fast. That means events in space."

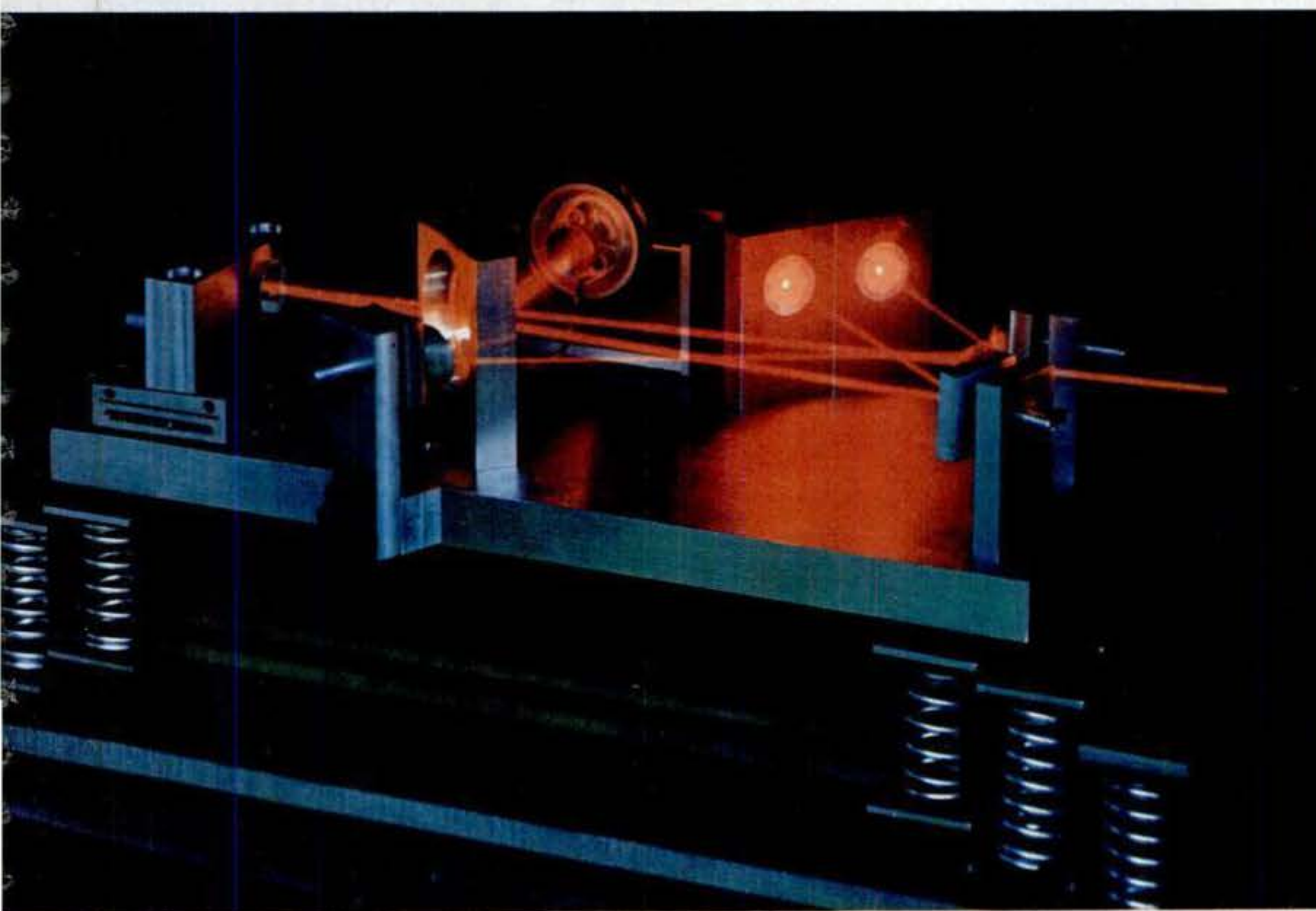
Astrophysicists have worked up whole catalogs of such events, each associated with gravity waves of different energy, different characteristic frequencies, and different probabilities of occurrence. They include the supposed con-

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ALAN J. KNAPP

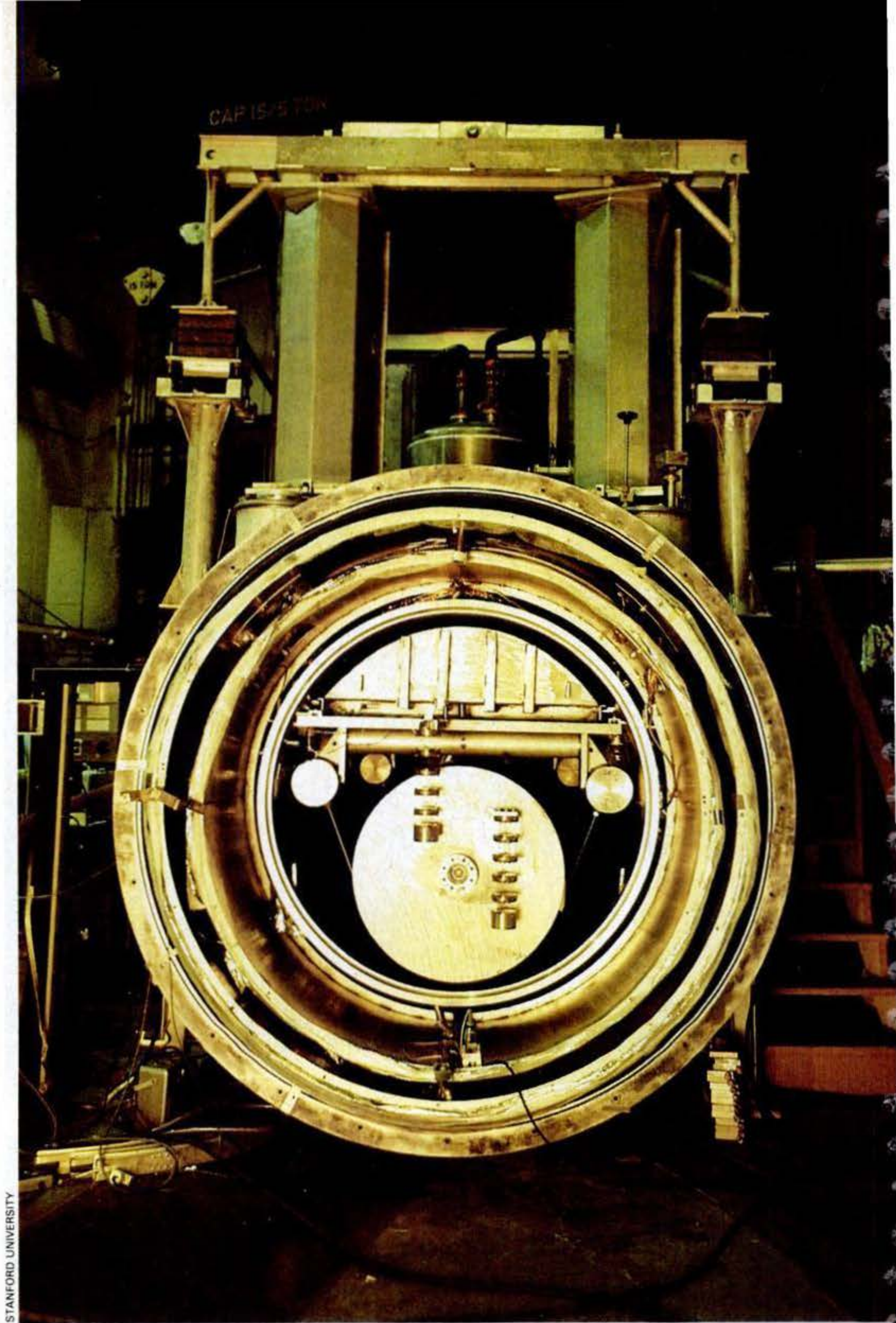


**Cryogenic bar detector** (above) gets check by Prof. David Douglass at University of Rochester. Aluminum cylinder, inside windowed shield, has been rolled out of red cryostat, which cools system to a few degrees above absolute zero. If a gravity wave passes through the bar, its length will change by a minute amount, a change that will be detected by superconducting devices at each end of the bar.

**Early test-bed**, left, for a low-noise laser interferometer detector was built by Robert L. Forward, Gaylord E. Moss, and Larry Miller at Hughes Research Labs. First such antenna, built in 1972, had an effective length of eight meters. There are now plans to build laser detectors more than a kilometer long.

CLIFF OLSON

DAVID K. LYNCH



STANFORD UNIVERSITY

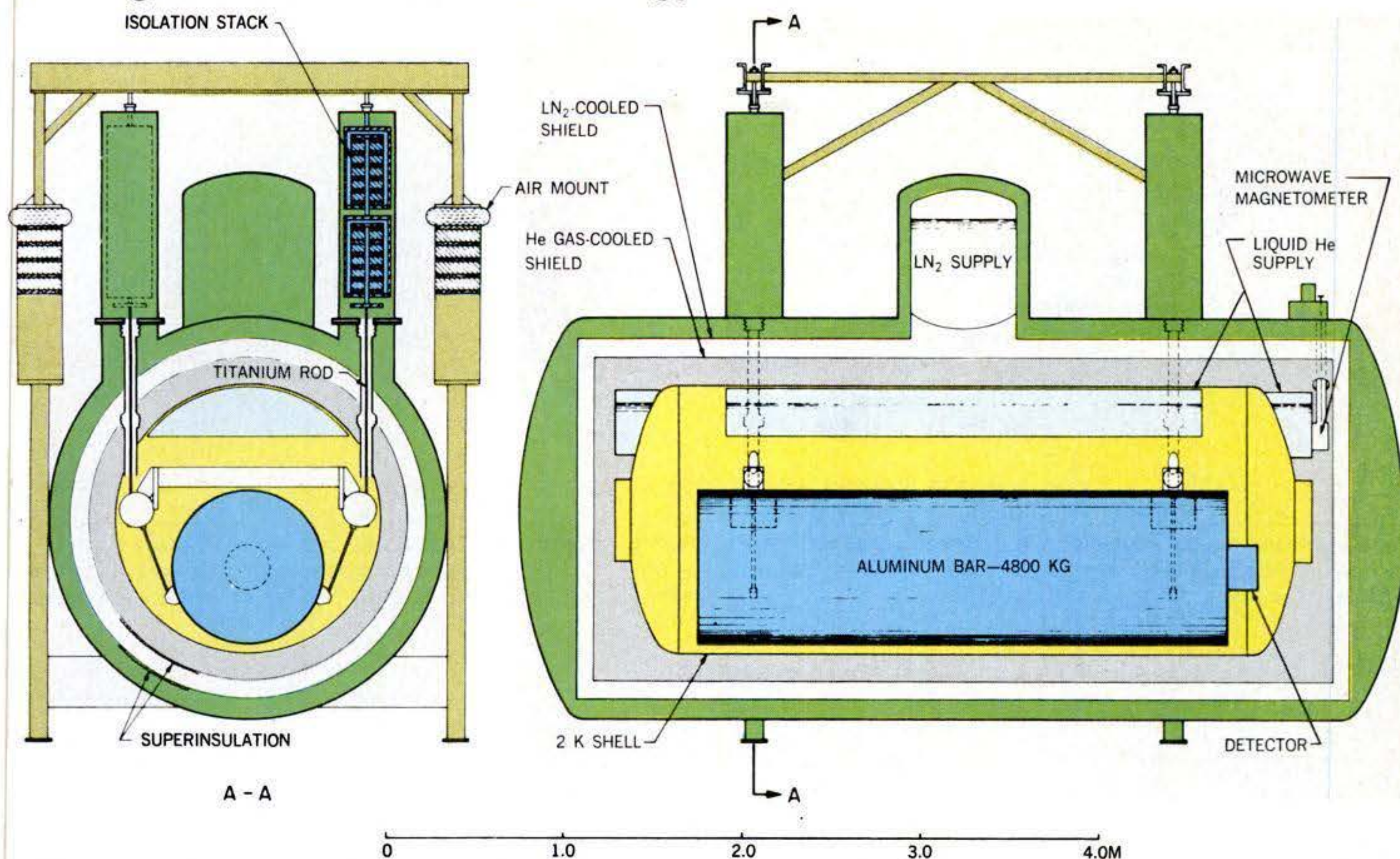
BILL BOURNE

**First bar-type gravity-wave detector** (above), developed by Joseph Weber at the University of Maryland, appears at Einstein exhibit in Smithsonian Institution. Robert Forward's proposed **free-space laser antenna** to detect gravity waves from the Crab Nebula is shown in artist's rendition, right. Central satellite of three has laser and beam splitter. Two outer spacecraft have reflectors.

**Massive cryogenic aluminum-bar** detector now operating at Stanford University (above, at right) was built by team headed by William Fairbank. Photo shows large cryostat with end removed, giving view of five-ton bar within, with instrumentation and suspension. (Details and dimensions are given in drawings, opposite page.) Use of liquid nitrogen and liquid helium cools detector.



## Battling the limits of modern technology



State-of-the-art aluminum-bar detector at Stanford University is isolated from all external noise by special mechanical filters.

tinuous background gravitational radiation of the "big bang" that began the universe [PS, Dec. '80], and periodic events like the regular pulses of radiation emitted by pulsars and binary systems consisting of superdense objects. And then there are the singular events: the births of black holes in globular clusters, galactic nuclei, and quasars; neutron-star quakes; and supernovas.

Probably the prime candidate for detection is what William Fairbank, professor of physics at Stanford University, calls "the most dramatic event in the history of the universe"—a supernova. As a star such as our sun ages, it converts parts of its mass into nuclear energy, perhaps one percent in five billion years. "The only reason a large star like the sun doesn't collapse," explains Fairbank, "is because the very high temperature in its core generates enough pressure to withstand gravitational forces. But as it cools from burning its fuel, the gravitational forces begin to overcome the electrical forces that keep its particles apart. It collapses faster and faster, and if it's a supernova, the star's outer shell blasts off. In the last thousandth of a second, it collapses to a neutron star, and if the original star exceeded three solar masses, maybe to a black hole."

One way of characterizing the energy of a gravity wave is the *strain* it induces in any matter it impinges on. If the mass has a dimension of a given length, then the strain equals the change in that length (produced by the gravity wave) divided by the length. Gravity waves have very, very tiny strains. A supernova occurring in our galaxy might produce a strain on Earth that would shrink or elongate a 100-cm-long detector only one one-hundredth the diameter of an atomic nucleus. (That is  $10^{-15}$  cm, and physicists would label the strain as  $10^{-17}$ .) To the credit of tireless experimenters, there are detectors capable of sensing that iota of a minim of a scruple.

But there is a catch: Based on observations of other galaxies, a supernova can be expected to occur in the dense

center of any given galaxy roughly about once in 30 years. That is a depressingly long interval. Over and over again, the scientists I spoke to despaired of doing meaningful work if it had to depend on such a *rara avis*. Professor David Douglass of the University of Rochester told me: "To build an experiment to detect an event once every 30 years—maybe—is not a very satisfying occupation. It's hardly a very good Ph.D. project for a graduate assistant; it's not even a good career project—you might be unlucky."

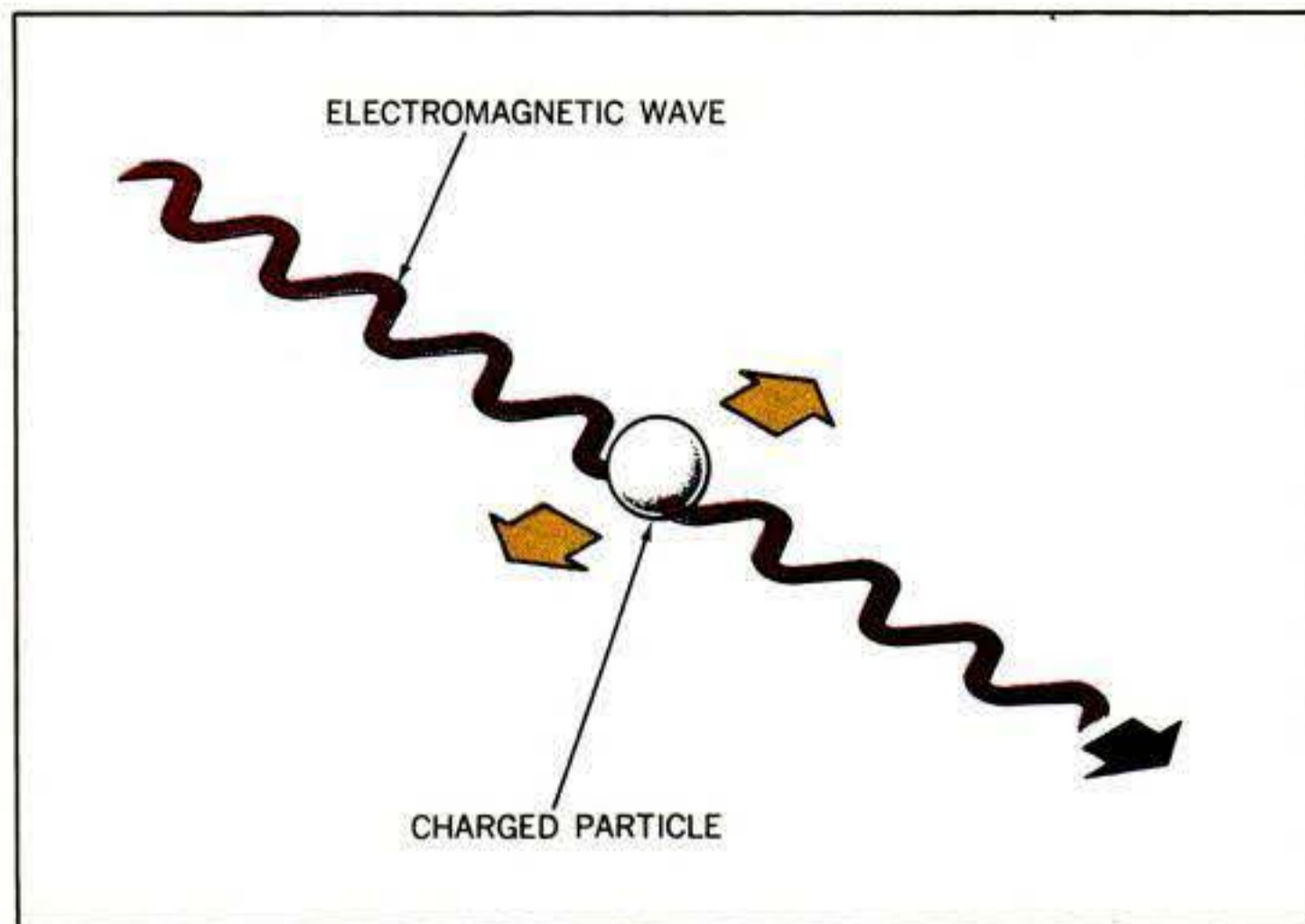
### Gravity waves: powerful astronomical tools?

What if we don't confine ourselves to events in our own galaxy, but look farther afield? Instead of the "hopelessly rare" (in the words of one researcher) supernova in our galaxy, what if we looked for them in a really large arena—the Virgo cluster, which has some 2,500 galaxies, where supernovas ought to be popping from once every few days to once a month or so? That's *Catch-22*<sup>2</sup>. The Virgo cluster is about 1,000 times farther away than the center of our own galaxy. So a supernova event from the cluster would dispatch gravity waves whose effect on Earth would be some million times weaker (1,000 times 1,000, according to the inverse-square law governing all radiative energy). And that means building a detector a million times more sensitive. "There is no field of science," says Ronald Drever of Caltech and the University of Glasgow, Scotland, "where such enormous increases in sensitivity are needed as they are here, in gravity-wave detection." Trying to detect a supernova in a distant galaxy means having to measure a displacement *one-millionth the size of an atomic nucleus*.

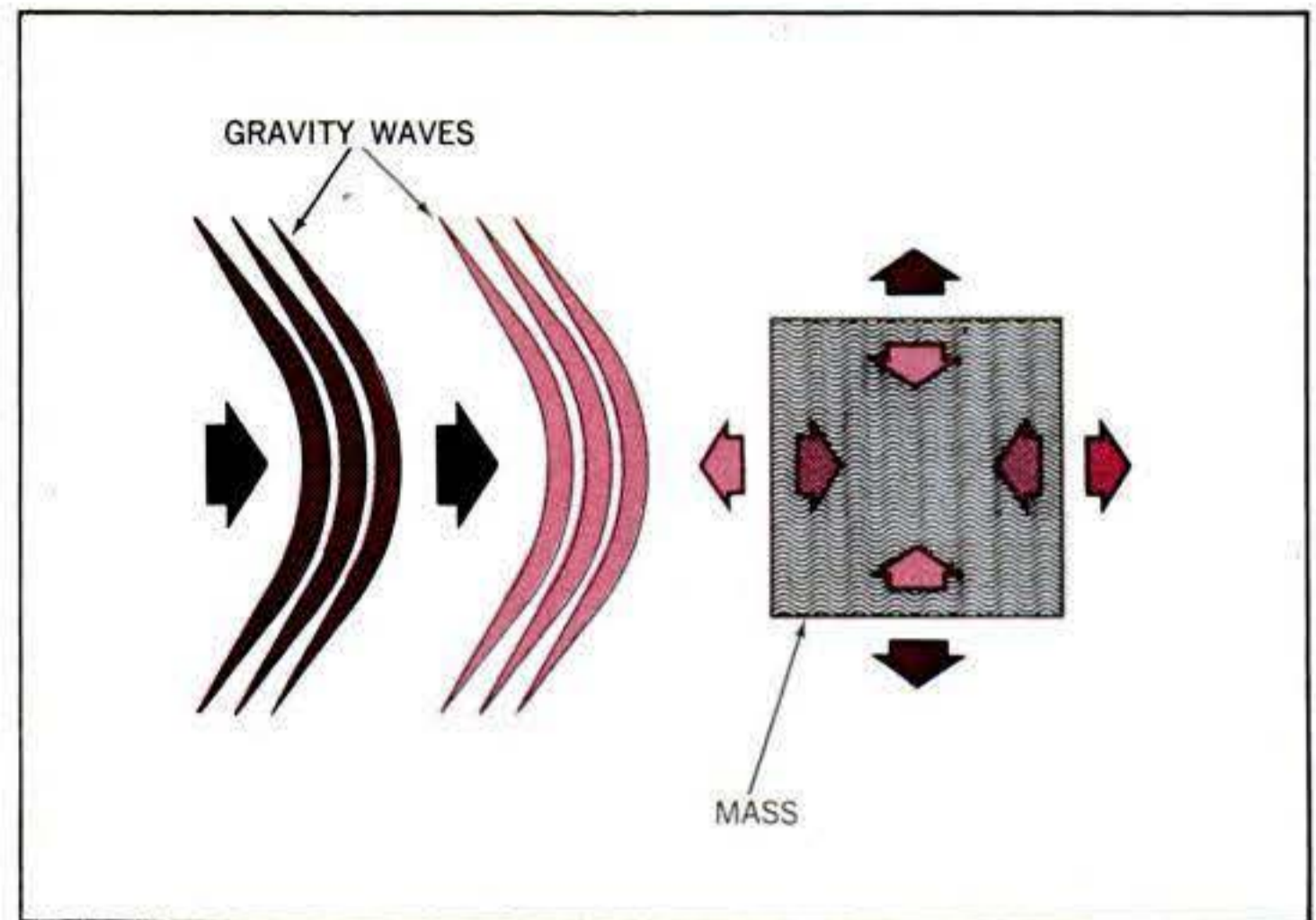
Paradoxically, it is this very quality that gives gravity waves the ability to be, as Kip Thorne says, "a very powerful tool for astronomy. True, they go through a gravity-wave detector with impunity. But that means the gravity waves generated during the birth of a black hole can also get away

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## Dipole electromagnetic waves and quadrupole gravity waves

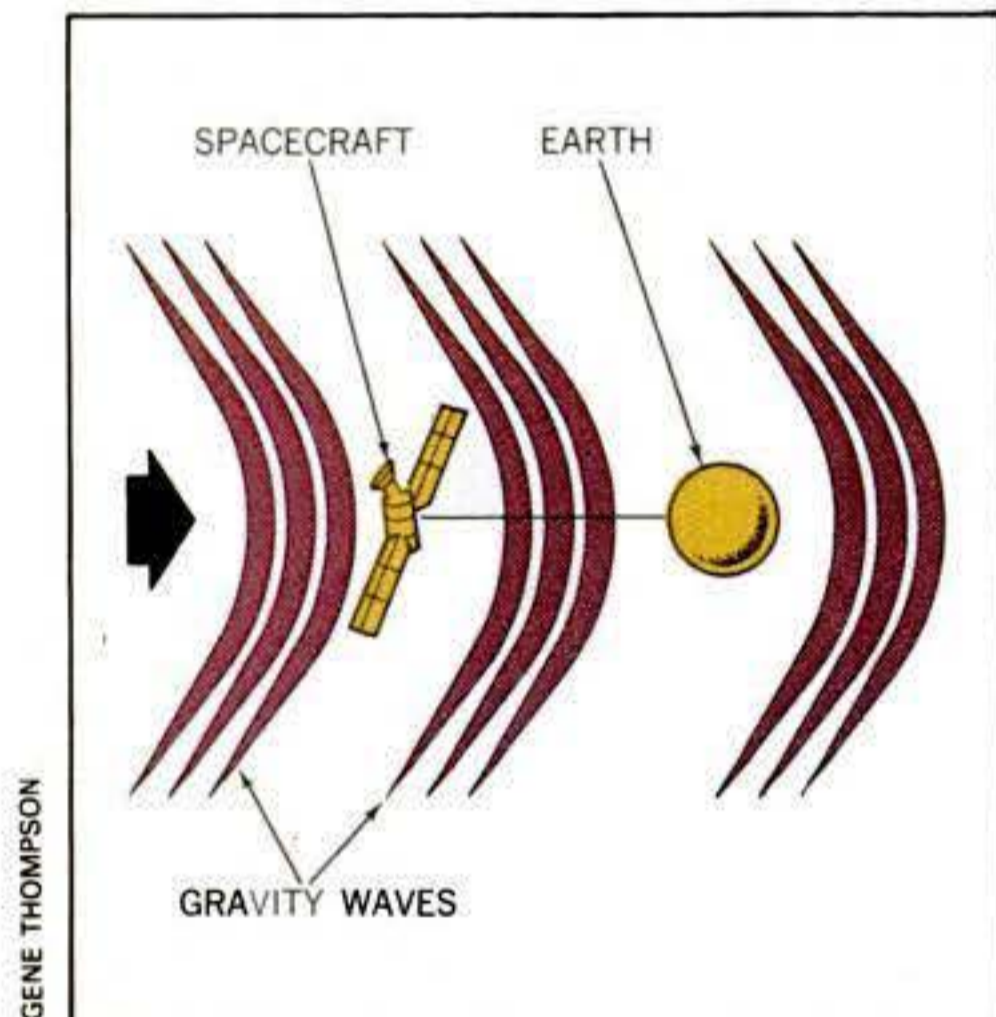


When electromagnetic wave (light, etc.) strikes a charged particle, the particle oscillates in a simple, back-and-forth dipole mode, perpendicular to the direction of the wave.

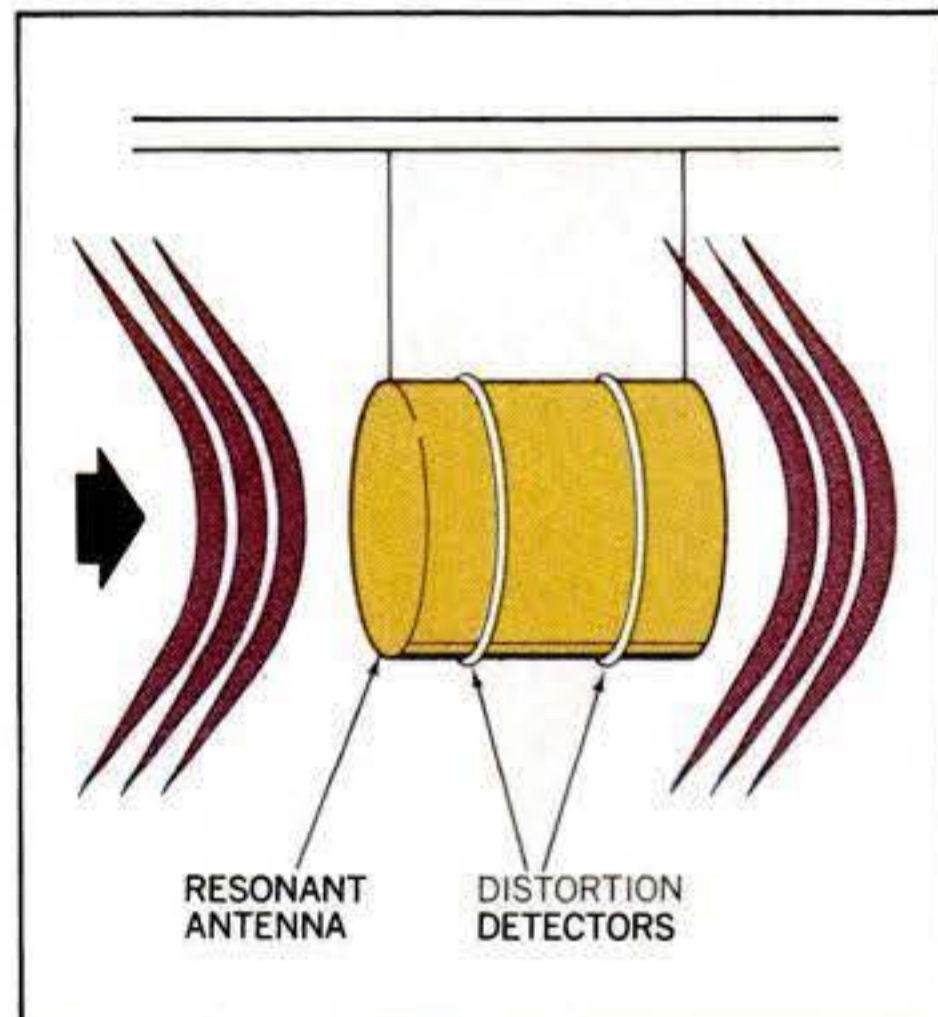


When gravity wave strikes mass, one dimension will contract, the other expand, in a plane perpendicular to direction of the wave. These quadrupole motions reverse on next half-cycle.

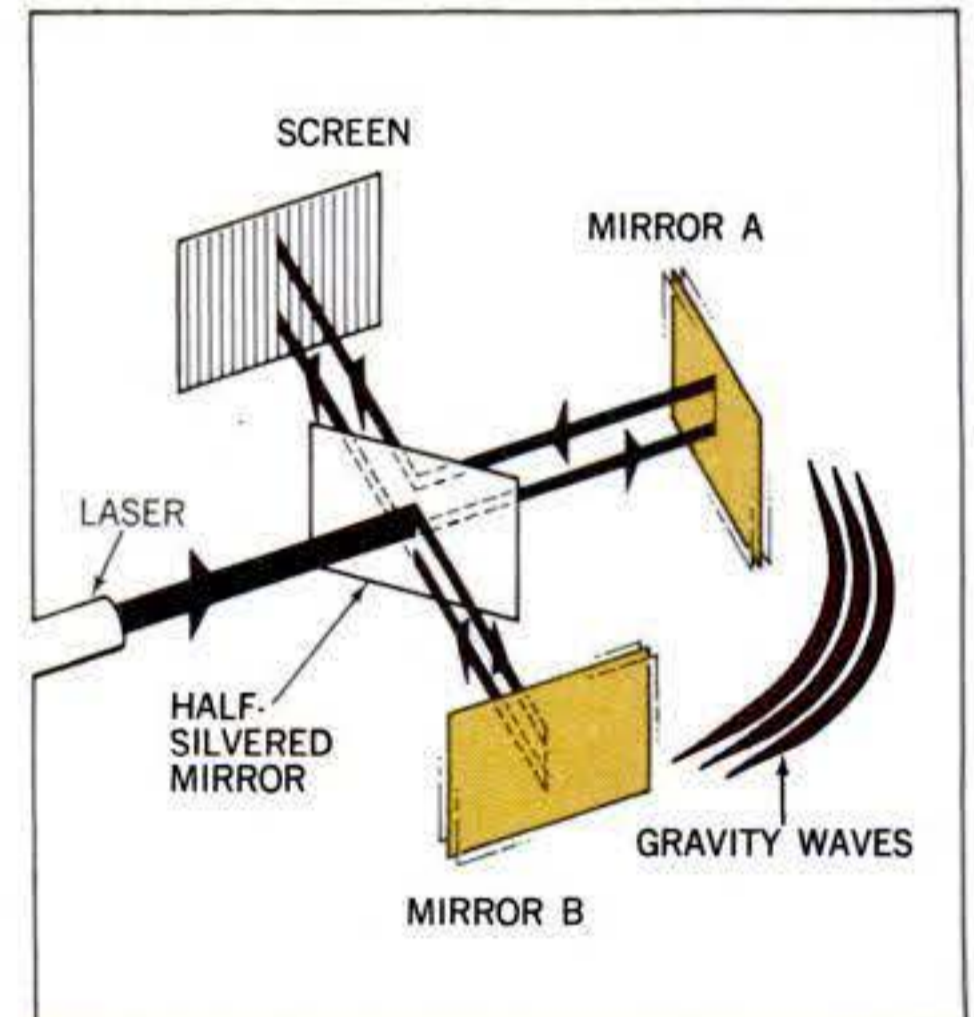
## Three kinds of gravity-wave detectors



**Doppler tracking** uses radio signal between spacecraft and Earth. When gravity wave passes, distance between them changes, introducing Doppler shift.



**Bar detector** changes length when gravity wave passes. Ultrasensitive transducers along or at ends of bar translate minute motion to electrical signals.



**Laser interferometer** bounces light beam between mirrors mounted on masses. Gravity wave changes distance between mirrors, producing interference pattern.

through all the surrounding matter with impunity." And neither light, nor gamma rays, nor radio waves can. During a supernova we can see the exploding shell via showers of electromagnetic radiation, but only hours or days after the initial massive implosion—the gravitational collapse. During the collapse, while a neutron star or black hole is being formed, nothing but gravity waves (and, theoretically, neutrinos) can escape.

"We've opened, at least partially, all the electromagnetic windows onto the universe," says Thorne. "With gravity-wave astronomy, we will open a unique new window onto fascinating, explosive events that cannot be well studied any other way—births and collisions of black holes, star quakes, collapses to neutron stars. This is the real bread and butter of modern high-energy astrophysics."

But first, as the cookbooks say, you must catch your gravity wave. Until the 1950's, no one presumed that the task was even feasible. Then Joseph Weber, a physicist at the University of Maryland, began to ponder the problem of building a gravity-wave detector, and proceeded to do so. It is no exaggeration to say that he fathered the entire field. By 1967, he and his assistants had built the first operating

gravity-wave detector—a massive aluminum bar, isolated as well as possible from external vibrations and girdled by piezoelectric crystal sensors, which translated changes in the bar's dimensions into electrical signals. Weber reported a number of events recorded on this and a twin detector at Argonne that he concluded were gravity waves [PS, May '72]. His report stimulated a host of other experimenters to build their own detectors. Designed by such investigators as J. A. Tyson at Bell Labs and David Douglass at Rochester, the detectors followed the same principles as Weber's pioneering bar detector, but with greater sensitivity. These and subsequent experimenters were unable to confirm Weber's findings; in fact, at the level Weber's bar was capable of, theoreticians believe it was impossible to have detected gravity waves. "Either Joe Weber was wrong," one told me, "or the whole universe is cockeyed."

Today, three basic kinds of gravity-wave detectors are being developed. One is basically a Weber resonant-bar antenna, much refined; the second is the laser interferometer; and the third is a space-based system called Doppler tracking. Each has its advantages, and each its own devilish engineering problems.

Farthest along is the resonant bar, mostly because it has been in the works longest. The more massive such a bar is, the better (because it will respond to a gravity wave better). And its worth depends on the quality of resonating, or "ringing," for a time after it has been struck by the wave. The longer it rings, the better an experimenter is able to pick out the effect of the wave. That quality is measured by the value called "Q"—the higher the Q, the better. For a while David Douglass and others, including Soviet scientists, have been seeking to make detectors out of such very-high-Q materials as sapphire-crystal balls. But Douglass, for one, has returned to aluminum. The reasons: New alloys of aluminum have been found with very high Q's; sapphire can't be fabricated in massive chunks (one of his detectors has a six-ton aluminum bar); and expense: "A 60-pound pure sapphire crystal," he told me, "would cost about \$50,000."

Like virtually everyone else developing bar antennas, Douglass has abandoned room-temperature detectors and turned to cryogenic detectors, cooled down as close to absolute zero as possible. That includes groups at Perth, Australia, Tokyo, Moscow, Louisiana State University, Rome, Weber himself at the University of Maryland, and William Fairbank and colleagues at Stanford University.

Fairbank told me why the low-temperature route was essential: "At room temperature, the random thermal motion of the atoms in a bar is 300 times as big as the displacement we're trying to detect. The only way to approach the sensitivities we're after is to get rid of that thermal noise by cooling the bar."

When I visited the Stanford campus, the detector's five-ton aluminum bar was sealed inside its cryostat, a kind of oversized Thermos bottle. The whole assembly looked like

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**“In about fifteen years, we will want big, space-based laser systems, using, say, a 10-kilometer frame”**

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something you could use if you wanted to freeze Frankenstein's monster for a few centuries. And the environment was suitable, too: a vast, drafty, concrete building that could have been an abandoned zeppelin hangar.

This antenna, and others like it, is designed to respond to gravity waves with a frequency of about 1,000 Hz, characteristic of supernova radiation. Obviously the antenna must be isolated as far as possible from any external vibration at or around that frequency. This the Stanford group does by suspending the cylinder with special springs, consisting of alternating iron and rubber bars in what is called an isolation stack (see drawings, p. 91). "Otherwise, with our sensitivity," Fairbank says, "this detector would make a dandy seismograph—just what we don't want in California." The Stanford suspension system attenuates outside noise by a factor of  $10^{30}$ , enough so that you could drop a safe in its vicinity without disturbing the detector.

At LSU, William Hamilton, who is building an antenna very similar to Stanford's (eventually it will become part of a Rome-Perth-Baton Rouge-Stanford axis looking for gravity-wave coincidences), takes another route toward seismic isolation. The very low temperature of the device allows him to levitate the bar magnetically; it is coated with a thin film of niobium-tin alloy, a material that becomes super-

conducting near absolute zero. If electromagnets are placed under the bar, the persistent currents running through its coating will interact with the magnetic field so that the bar literally floats in air.

Superconductivity is also the key to one of the most perplexing of all engineering problems: designing a transducer capable of sensing the tiny displacements of these antennas and converting them to a useful voltage that can be amplified and measured. "You can't buy such things," says David Douglass, "you have to make them, and go beyond the state of the art." Both Douglass and Fairbank use superconducting devices whose elegant design makes them exquisitely sensitive—orders of magnitude more than the piezoelectric crystals originally used—although their approaches differ in details.

Superconducting devices may also one day—a day far in the future—allow gravity-wave astronomers to perform a feat of legerdemain called "quantum non-demolition." To oversimplify, this means evading a fundamental limit for all resonant detectors, one that is imposed by the laws of quantum mechanics as the displacements become ever smaller. That problem will have to be faced if bar antennas are ever to be sensitive enough to detect gravity waves from supernovas in the Virgo cluster.

### **An alternative: laser interferometers**

"One of the reasons we're turning to laser detectors," says Ronald Drever, "is to avoid the quantum-limit problem. Because we can make measurements over a much larger region of space, we effectively see a much larger signal. We don't have to look for such minute changes as in a bar antenna."

Laser interferometers bounce an argon-ion laser beam back and forth many times between two mirrors. (A generalized approach to the scheme appears in the drawing on page 92.) As a gravity wave ripples between the mirrors, the length of the light path changes, resulting in a change in the interference patterns that appear in photodetectors. Numbers of such detectors are in the planning and building stages, including ones at MIT, designed by Rainer Weiss, a pioneer in the field; at the Max Planck Institute of Astrophysics in Germany; at the University of Glasgow; and at Caltech.

"The one in Glasgow has 10-meter arms," Drever told me, "and is working now. The one we're working on at Caltech also has 10-meter arms, but will be stretched to 40 meters as soon as a building for it is ready. This will serve as a prototype for a much larger version—a kilometer to several kilometers long."

Of course, laser interferometers have engineering problems, too, problems that become exacerbated as they grow larger. The laser beams must travel through vacuum pipes, and isolating pipes a kilometer long will not be simple. But Drever is convinced it can be done. "Maybe we'll put it in a mine, or in the desert," he says. This device may be ready by 1986, and has, Drever thinks, a chance of eventually detecting supernovas in the Virgo cluster.

One additional advantage of such laser detectors is that they are not restricted to a narrow frequency range, as are the resonant antennas, but would be sensitive to a broad band of frequencies from a few hertz to a few thousand hertz. They could therefore detect some massive black-hole events, which have lower frequencies than gravity waves from supernovas. To detect gravity waves with much lower frequencies, such as those from binary systems, you need very long baselines. "In about 15 years," says Rainer Weiss, "we will want big, space-based laser systems, using, say, a 10-kilometer frame in space. That way we could

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## Two indirect proofs for the existence of gravity waves

The first evidence of any kind for the existence of gravity waves comes not from sensing them directly but from observing their effect on the behavior of a bizarre astronomical object called a binary pulsar. A pulsar, believed to be a rapidly spinning neutron star, emits strong radio signals in periodic beeps. But pulsar PSR 1913+16, discovered by a team of University of Massachusetts astronomers in 1974 with the world's largest radio telescope (at Arecibo, P.R.), is unique. Its beeps decelerate and accelerate in a regular sequence lasting about eight hours. From this, the astronomers, led by Joseph Taylor, deduced that the pulsar was rapidly orbiting around another very massive object—perhaps another neutron star.

Einstein's theory of general relativity predicts that this binary system should produce a considerable quantity of gravity waves, and that the energy radiated should be slowly extracted from the orbit of the system, gradually decreasing its period as the superdense stars spiral closer to one another. Einstein's equations predict a decrease of one ten-thousandth of a second per year for a pulsar like PSR 1913+16. And after four years of observations Taylor's team announced, in late 1978, that ultraprecise measurements of the radio signals gave a value almost exactly that amount. The closeness of the match not only provides good—even though indirect—evidence of the existence of gravity waves, but also further bolsters Einstein's theory of gravity against some competing theories.

As Taylor said of what he called "an accidental discovery originally," the astronomers had an ideal situation for testing the relativity theory—a moving clock (the pulsar) with a very precise rate of ticking and a high velocity—some 300 kilometers per second. "It's almost as if we had designed the system ourselves and put it out there just to do this measurement."

Another indirect indication that gravity

waves do indeed exist came more recently, and more dramatically. It stemmed from an event that still has astronomers reeling. At exactly 15 hours, 52 minutes, five seconds, Greenwich time on March 5, 1979, a gamma-ray burst of unparalleled intensity flashed through our solar system from somewhere in space. It triggered monstrous blips on detectors aboard a motley collection of nine different spacecraft throughout the solar system, which form, in effect, an international network maintained by the U.S., France, West Germany, and the Soviet Union.

### Once-in-a-lifetime event

"This March 5 gamma-ray event was extraordinary," says Thomas Cline of NASA Goddard Space Flight Center, who, with his colleague Reuven Ramaty and other U.S., French, and Russian astrophysicists, has been analyzing it ever since. "It was not like the gamma-ray bursts that have been seen a hundred times in the last decade. It's a first and only, like something that's seen once in a scientific lifetime."

Because the surge of gamma rays was detected by so many satellites separated in space, astronomers were able to triangulate the position of its source and identify it with a visible object—the first time for such a feat. The object was a supernova remnant dubbed N49 in the Large Magellanic Cloud (LMC), a neighboring galaxy roughly 150,000 light-years away.

Ramaty, Cline, and colleagues posit that the genesis of the gamma-ray burst was a quivering neutron star—the ultradense, ultracompact object that many theorists believe is left over from a supernova explosion. "We believe," Cline told me, "that a neutron star can undergo a transformation analogous to an avalanche. Snow falls on a mountain until there's a slide. Similarly, dust and other material collect on a neutron star until it can't stand being as heavy as it is. Then there's a star

quake, either in the crust or in the core, and the star shakes itself at a frequency of about 3,000 Hz, a note you could hear if you were listening to it in an atmosphere. The surface of the star—only five to 10 miles in diameter—is heaving up and down several feet, thousands of times a second. Its magnetosphere is shaken, and that's what produces, indirectly, the gamma rays. But that's secondary, in our model, to the gravitational waves caused by the oscillation of the neutron star.

"Could we detect these? The answer is no. After all, this is only a kind of after-gurgle, thousands of years after the star's original collapse—the supernova. It's like a tremor after a major earthquake, maybe only one percent as big."

Nevertheless, Cline called all the U.S. gravity-wave experimenters who could have been "on-line" during the gamma-ray burst to learn whether they had seen anything. Of them all, only Joseph Weber had an antenna working that March day, and he had observed nothing.

The gamma-ray detectors aboard the satellites were not capable of sensing the 3,000-Hz frequency predicted by the star-quake model. If they had, says Cline, it would have been "a very direct link" to the existence of gravitational radiation.

But the star-quake model makes another prediction: The gravity waves generated should carry off an enormous amount of energy, far more than that in the gamma rays, and thus snuff out the star's vibration very quickly. "The nice thing," says Goddard's Reuven Ramaty, "is that the damping time predicted for gravity waves in this event exactly corresponds to what we observed: The main part of the burst lasted just 15 hundredths of a second, and that's what we calculate from our model. So we now have for the second time indirect evidence of the existence of gravity waves. But both have problems, as do all indirect checks. They won't replace *direct* evidence."—A. F.

avoid all seismic noise." (One early proposal for a laser system in space is illustrated on page 90.)

The third kind of gravity-wave detector already exists in space, after a fashion. It has been used for spacecraft navigation for 20 years. It is called Doppler tracking, and is very simple—in theory. Here's how it's described by Richard Davies, program leader for space physics and astrophysics at Jet Propulsion Laboratory in Pasadena, Calif.: "You send a radio signal from Earth to a spacecraft, and a transponder aboard the craft sends the signal back to you. If a gravity wave passes through the solar system, it alters the distance between the two, and when you compare the frequency of the signal you sent out to the one you get back, you see that they are different—the Doppler shift. However, the contribution of the gravity wave to this shift is minute compared to that of the spacecraft's own velocity.

"We want to detect gravity waves with very low frequencies, maybe a thousandth of a hertz, using interplanetary spacecraft and the Deep Space Net that is used to track them. Such waves could be emitted from a collapsing system with a mass of a million to ten million suns, or from double stars that orbit each other in hours."

A gravity-wave experiment had been planned for the

International Solar Polar Mission. But, according to MIT's Irwin Shapiro, who chaired the Committee on Gravitational Physics of the National Academy of Science's Space Science Board, the experiment was dropped by NASA because of budget cuts.

Which of these methods will yield the first direct evidence of gravity waves? And when will that first contact come? No one really knows, and the gravity-wave seekers themselves are extremely diffident about making claims and predictions. But some time within the decade seems at least plausible.

In the meantime, gravity-wave research is paying unexpected dividends. "It has opened up," says Kip Thorne, "a modest new chapter in quantum electronics. Because it is pushing so hard against the bounds of modern technology, it is inventing new techniques that will have fallout elsewhere; for example, a new way to make laser frequencies more stable than ever. This will be useful in both physics and chemistry research."

In the long run, however, the search for gravity waves is propelled by the basic drive of all scientists, and all mankind: to see a little farther, to understand a little more than we have ever done before.

# Versatool

turns your chain saw  
into a workshop

Mount an adapter, and  
your chain saw  
does eight other jobs

By A. J. HAND

PHOTOS BY THE AUTHOR

Why pay for another gas engine every time you buy a new piece of power equipment? Now your chain saw's engine can power them all. The Versatool system turns your chain saw into a power source to run shop and yard power tools, plus two pumps, a portable generator, and a lightweight outboard motor.

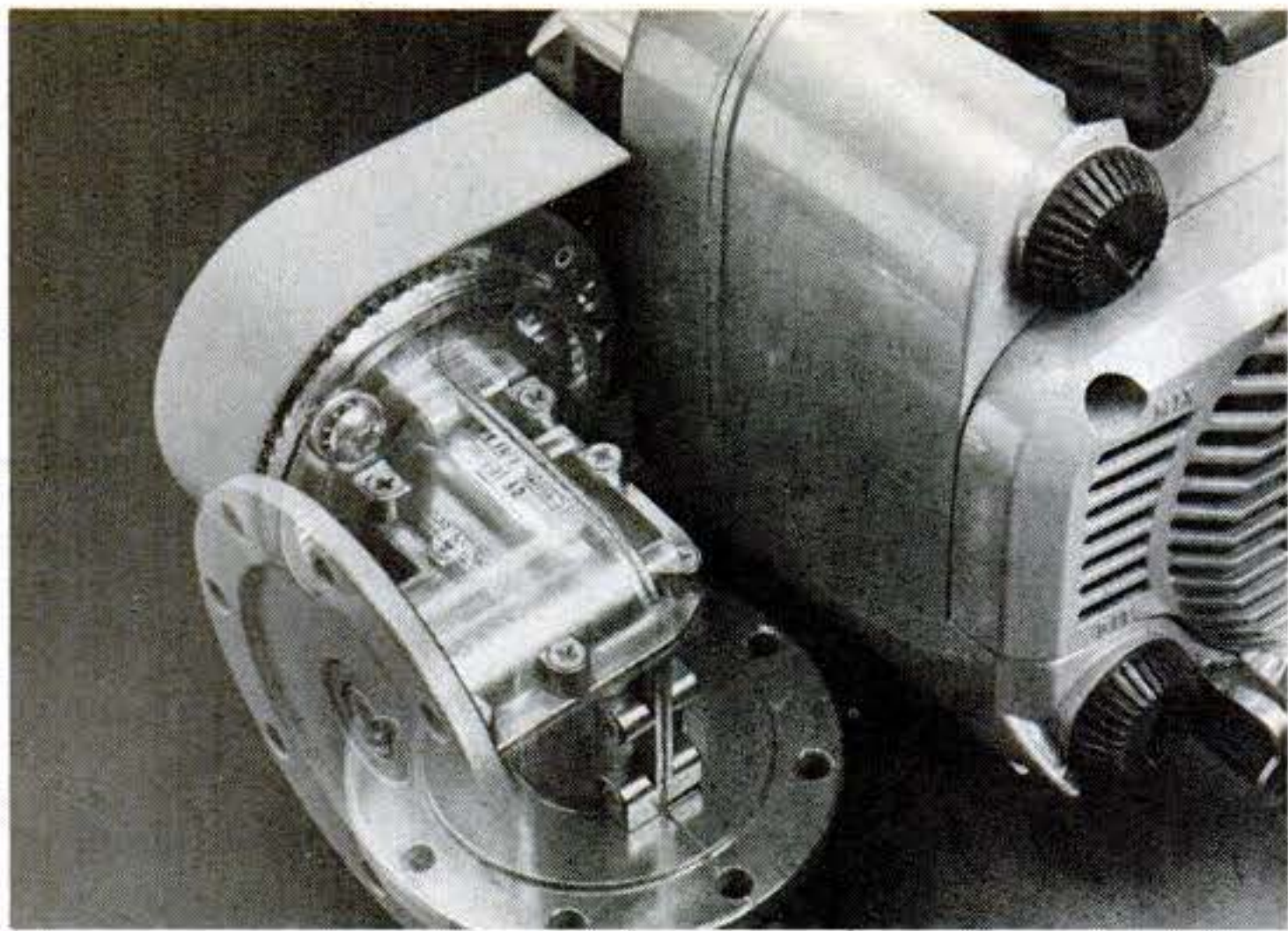
The heart of the system is the Versatool adapter, which bolts to your saw in place of the cutting bar to provide the mount for the other attachments. It fits a wide variety of small homeowner saws with  $\frac{3}{8}$ - and  $\frac{1}{4}$ -in.-pitch chains. Even a small saw provides plenty of power.

I recently put the system through its paces around my home. Overall, it performs quite well. Changeover from one tool to another takes only a minute or two, though mounting the adapter takes longer because you must adjust tension on the cutting and drive chains and drain the oil if your saw has automatic chain oiling. Piece by piece, here's what I found:

**Adapter** (\$19). Since this will receive the most wear of any part in the system, I took it apart to see how well it's made. Inside the heavy cast-aluminum housing is a right-angle drive with well-cut bevel gears. Both shafts ride in twin ball bearings, and the gears are packed with grease. The adapter should give good service. One complaint: Though the instructions call for the use of lock washers with the wing nuts that hold the attach-

*Continued*

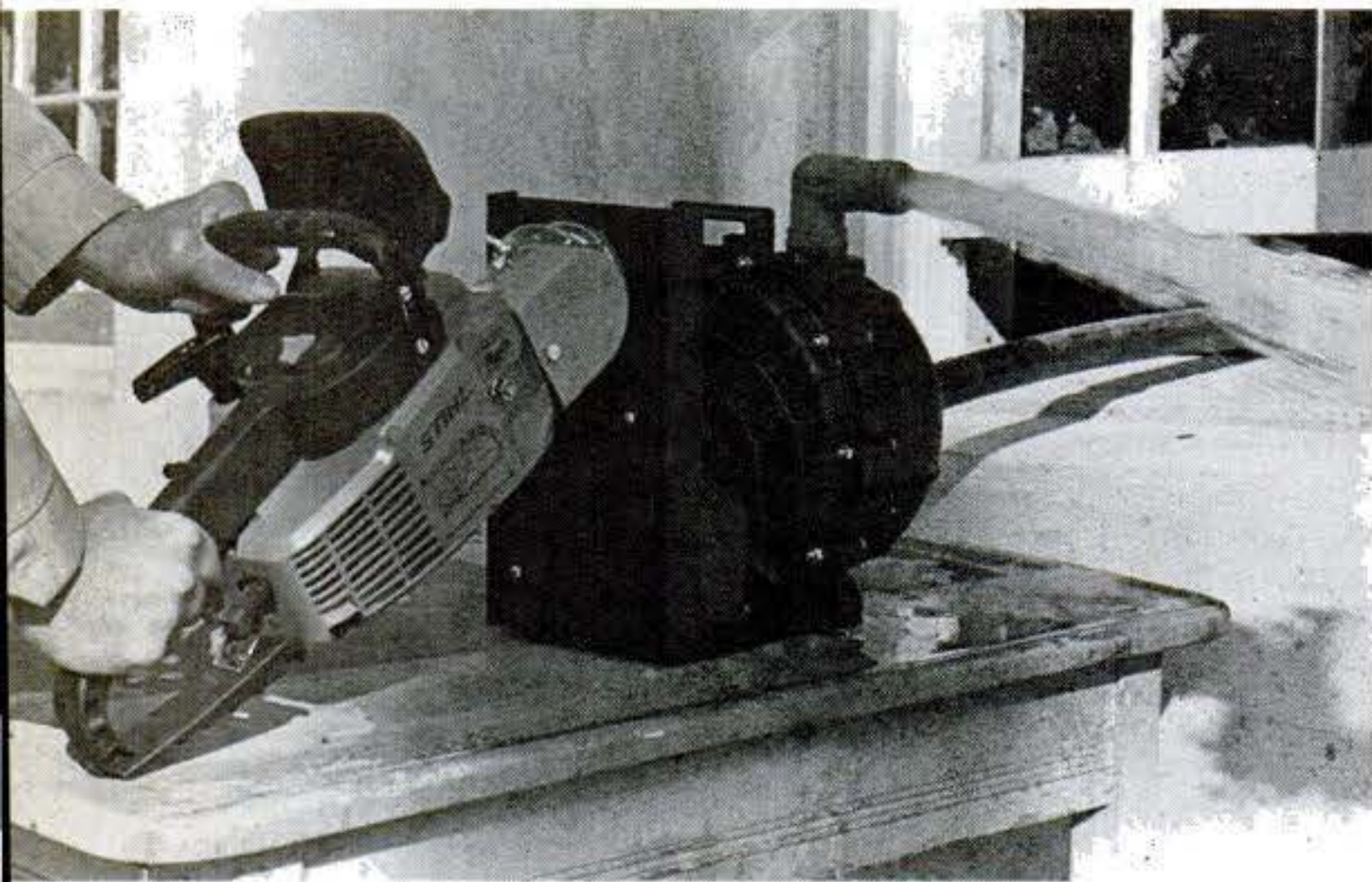




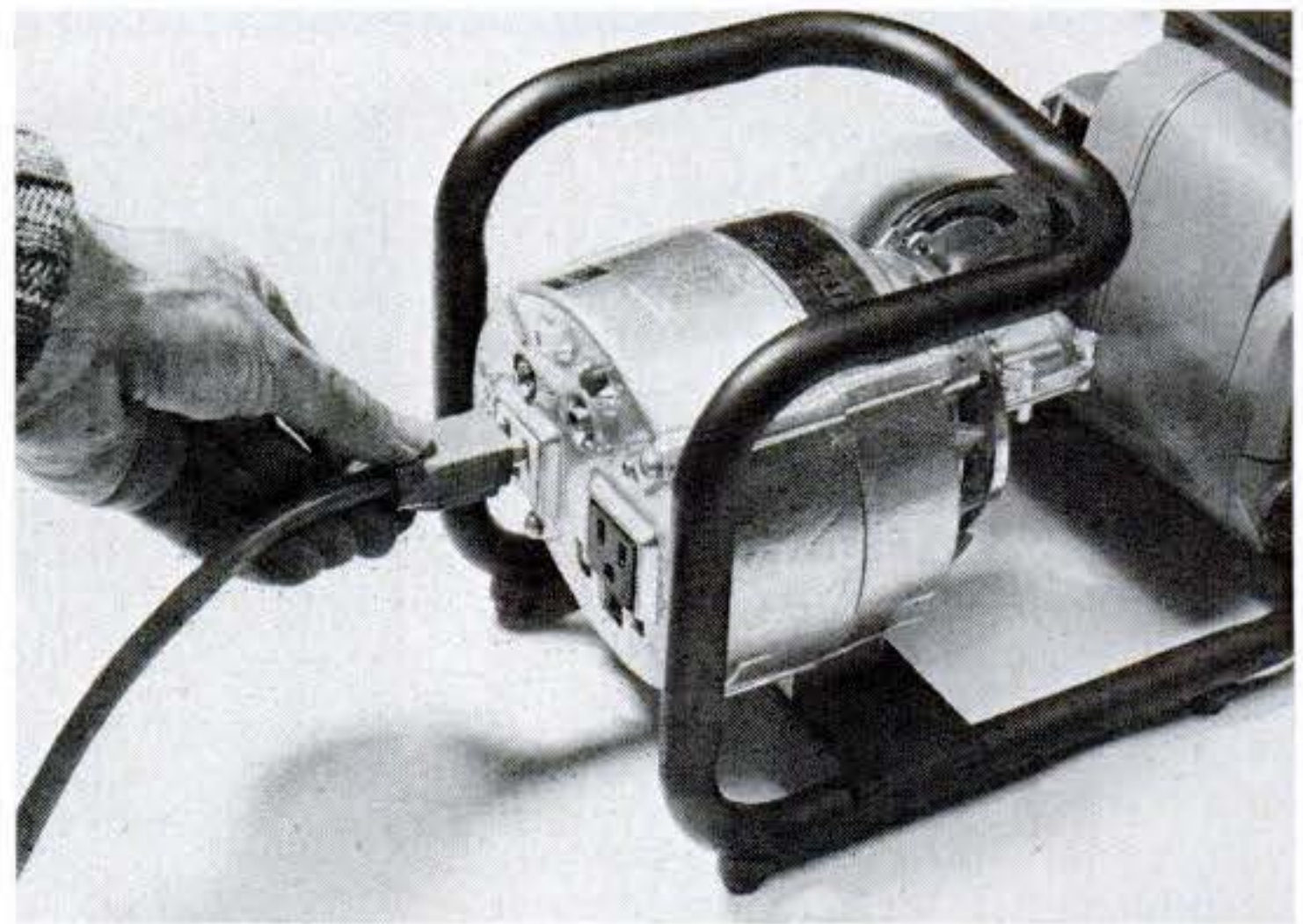
**Adapter bolts to your saw** in place of cutter bar. It swivels to suit various attachments, as shown in this double exposure.



**Hedge trimmer** has extra-long, 30-inch chrome-steel blades. Chain-saw engine has ample power to handle dense hedges.



**Eighty-gallon-per-minute pump** can quickly drain flooded basements if power shortage knocks out electric sump pumps.



**Generator delivers 500 watts**, has outlets for 115-volt AC and DC, as well as 12-volt jack and cables for charging car batteries.

ments to the adapter, flat washers were supplied in the parts bag.

**Drill** (\$69). Bolt this attachment to the adapter and you own a husky drill with a 1/2-in. chuck and the power to bore large holes in wood, steel, or concrete. Used on a Stihl 010AV, it performed flawlessly. Balance was good, drill speed was just right, and the chuck ran true.

**Weed trimmer** (\$69). This tool's Duraflex cutting head will handle everything from grass to light brush with ease. It uses pivoting plastic blades, which handle heavier work and provide better wear than string blades do. I've tested weed trimmers for PS in the past, and for cutting performance this one matches the best of them. Vibration is a problem, though. After only a minute or so of use, my hand holding the lower grip began to itch and sting.

**Hedge trimmer** (\$99). A chain saw's power is more than adequate to send this tool's chrome-steel blade zipping effortlessly through a thick hedge. One small problem: The nuts connecting the reciprocating blades must not

be overtightened or the blades bind, but if undertightened they fall off. A drop of liquid thread-locking compound solved the problem.

**Pumps** (\$35 and \$130). Two are offered: a little six-gallon-per-minute model with inlet and outlet fittings sized for a garden hose, and a large one that takes 1 1/2-in. pipe and can move a whopping 80 gpm. The small one, which is self-priming and will pull fluid eight to 10 feet vertically (once pumping, it can pull it 20 feet), is handy for use at a wilderness cabin, filling gravity-feed water tanks, watering the garden, and so on. The big one, ideal for serious pumping situations, is equipped with synthetic rubber parts so it can also be used for pumping kerosene, fuel oil, and diesel oil. Both pumps performed well for me, although the large one came with undersize mounting bolts. I had to replace them before I could mount the pump onto the adapter.

**Outboard** (\$99). While this little rig will certainly move a canoe or light rowboat around on the water, it has drawbacks: no tiller handle, no hands-

off open-throttle position, and it's noisy. I'd rate the outboard functional but not fun.

**Generator** (\$175). I couldn't test this attachment, said to put out 500 watts of AC or DC power, because the drive shaft on the one I received was too big to fit the female drive receptacle in the adapter.

**Reciprocating saw** (\$79). This tool wasn't ready for testing at the time we went to press but should be available by the time you read this.

The problems I found—oversize shaft on the generator, undersize bolts on the pump, and lack of lock washers for the adapter wing nuts—have since been corrected, says Abe Doctolero, Versatool's plant manager.

How much can you save by using Versatools instead of single-purpose power tools? You'll have to compare the cost of any single-purpose tool you're considering against the cost of the equivalent Versatool. Versatools, manufactured by Versatool Inc. (7420 San Fernando Rd., Sun Valley, Calif. 91350), are sold through hardware and power-equipment outlets. **PS**



# Car Care News

Popular Science



## SPECIAL SECTION

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Does your car really need those new SF oils?

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Squeeze-and-spray car care

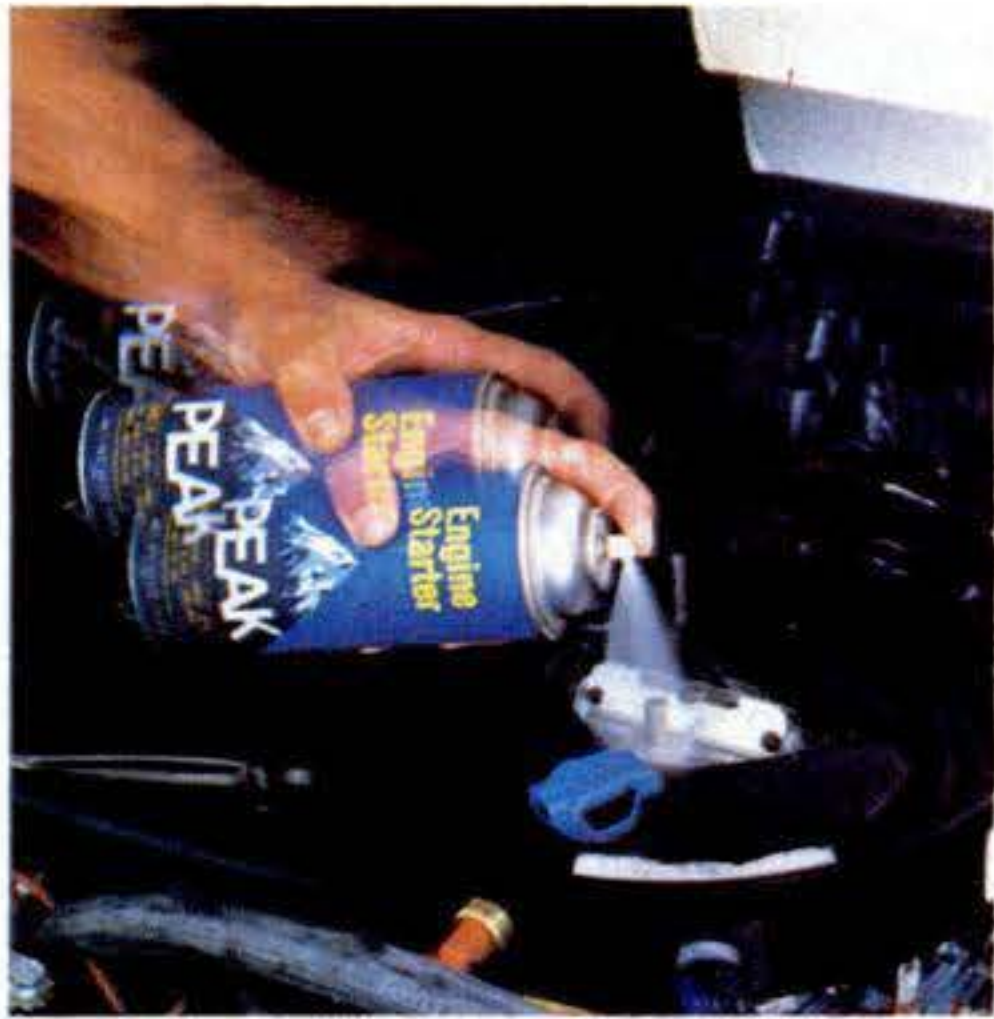
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Rating radials for tread life, traction, and speed

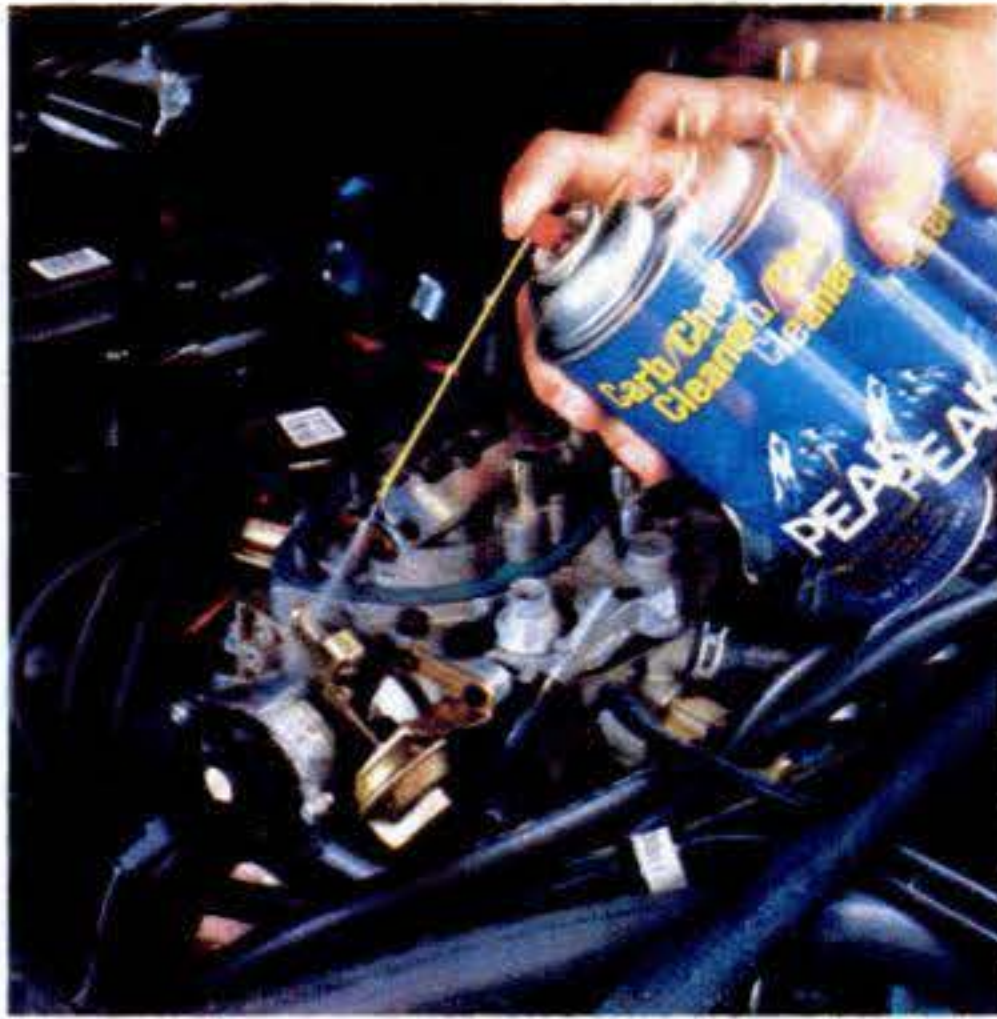


# PEAK lets you do it yourself

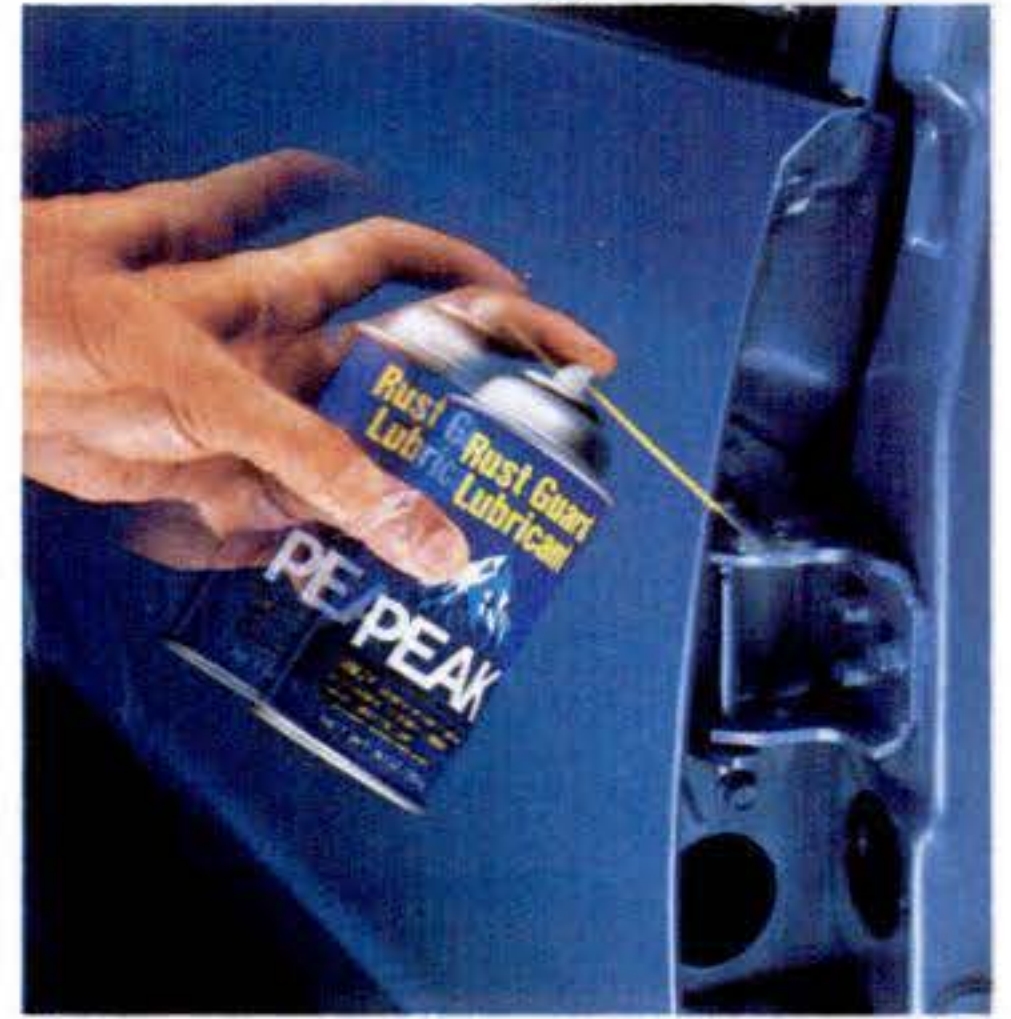
to carburetors



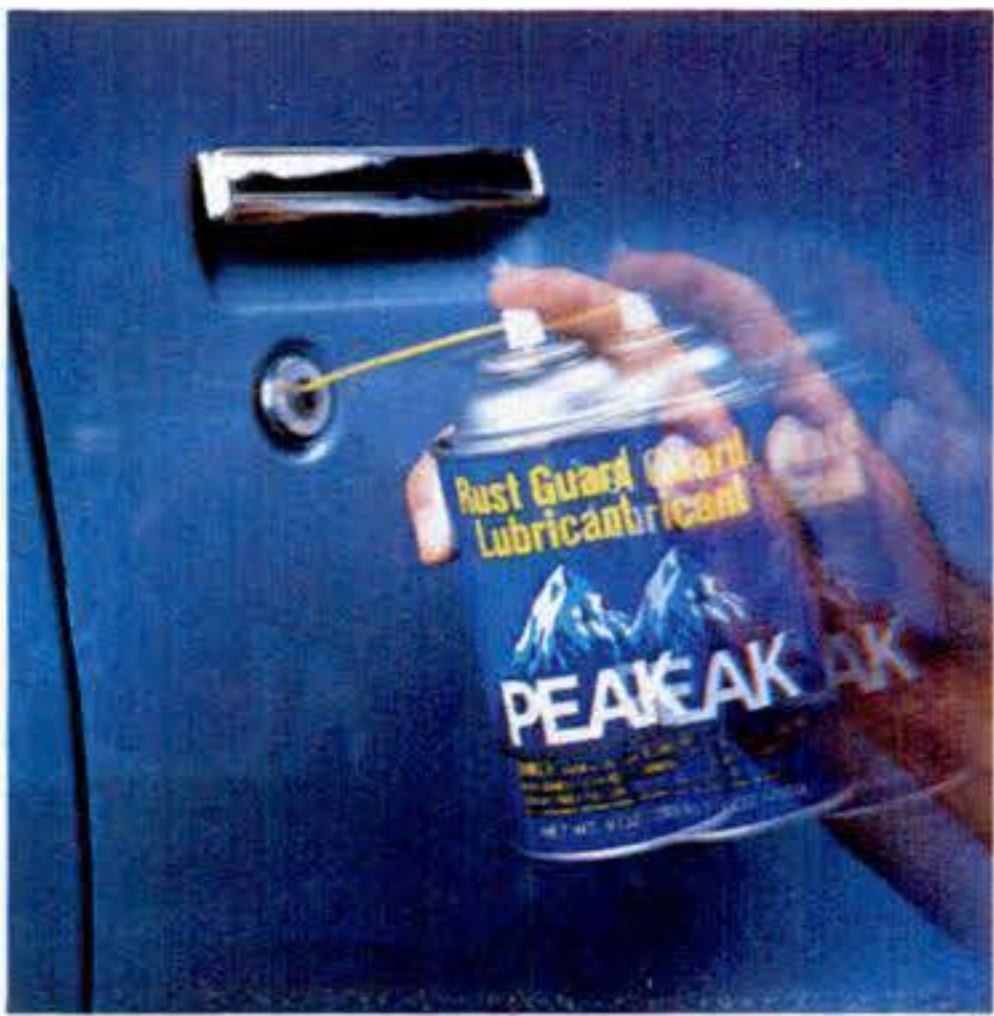
to chokes



to hinges



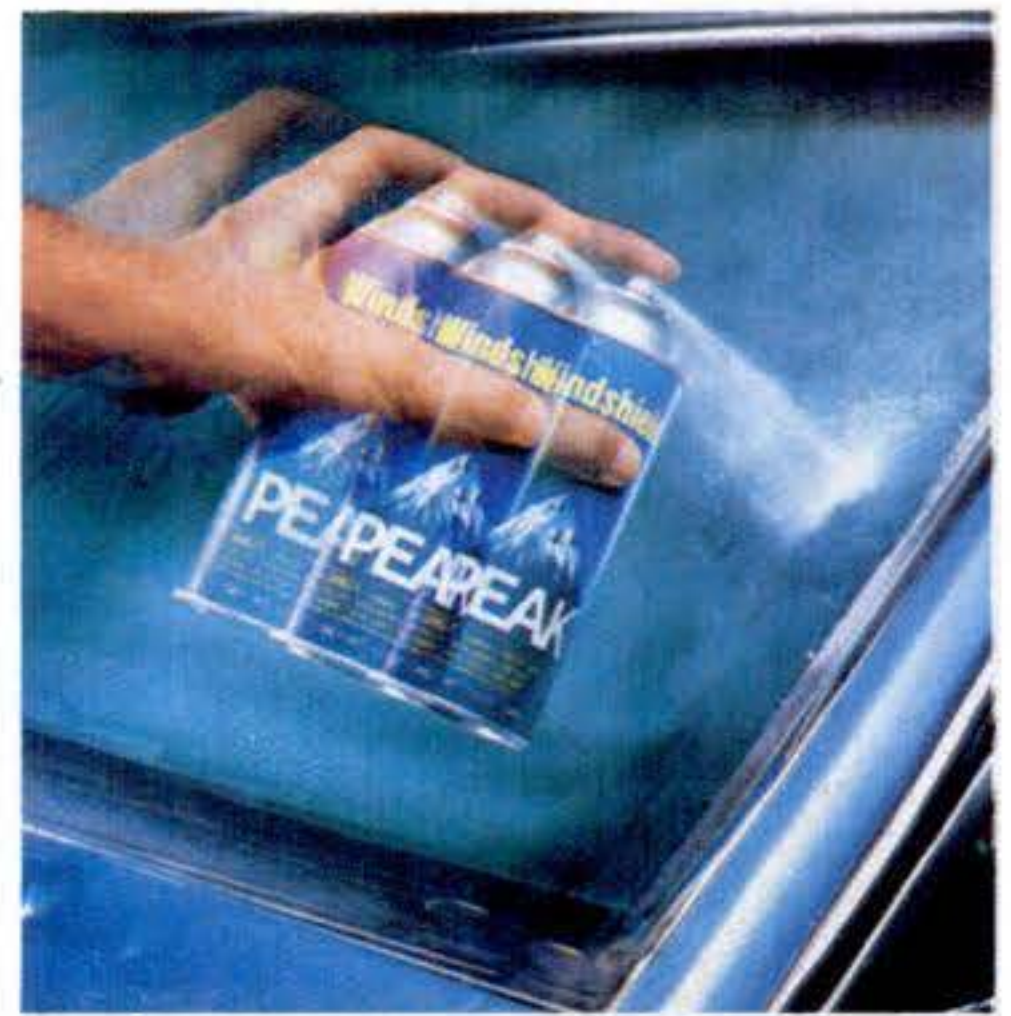
to locks



to fuel systems



to windshields



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Now there's a full line of do-it-yourself products from the makers of famous PEAK® antifreeze & coolant. Everything from carb/choke cleaner to diesel fuel treatment.

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 Northern Petrochemical Company

# For the '81 breed of cars, tough new **SF oils**

Today's high-revving little engines need a new, hard-working oil

By E. F. LINDSLEY

Unless you've changed the oil in your car recently, you may not have noticed that top-grade motor oils are now marked "SF" rather than "SE." That seemingly tiny change hides sizable differences.

It also prompts many questions: Why the change? What do the letter designations signify, anyhow? Are the new SF oils really improved? Are they important only for '81 cars, or will they also help older cars? And, turning to a different but related subject, do those so-called fuel-saving oils really save gas?

To get the answers to these questions, I talked to engineers at testing laboratories, car makers, and the triumvirate that sets standards for oils: the Society of Automotive Engineers (SAE), the American Society for Testing Materials (ASTM), and the American Petroleum Institute (API). From them I learned that the new standards were developed to keep pace with the increasingly rugged demands placed on oils by contemporary engines, and that while the new oils are superior to the older SE-type oils, they have not been able to deliver all of what was first hoped for.

If you're not sure what those cryptic letters on the top of an oil can mean, you're not alone. Actually, the letters SF aren't abbreviations or acronyms for anything. They simply indicate that a lubricant has passed a rigorous sequence of carefully conducted tests for corrosion protection, deposit formation, viscosity stability, and anti-

wear characteristics in meticulously monitored laboratory engines.

The old SE standards were established in 1972, at just about the zenith of big cars, big engines, and high-speed turnpike driving. In those cars, the engines were so big and underworked, with such enormous power reserves, that they could tolerate abuse, poor maintenance, high usage, and maybe even marginal lubrication with little or no damage.

Today's engines are smaller, lighter, higher-revving, harder-working, and vastly more sophisticated. They have catalytic converters, exhaust-gas recirculation, and computer-directed fuel-economy and emissions-control systems. On top of that, leaded fuel has been phased out. All of these factors influence wear, scuffing, deposits, and oil life.

Because of the changes in engines and fuels, SE oils caused problems in newer-type engines. So a tougher-rated oil was needed, which led to SF oil.

## Passing the test

As with SE-rated oils, tests for qualification as an SF-rated oil are incredibly complex. Briefly, test engines standardized to the last detail are run in precisely timed and varied load cycles on calibrated dynamometers for specified periods. Hundreds of pages of instructions detail everything—right down to cleaning solvents, wiping rags, and gasket sealers—to give the absolute control and elimination of variables.

Three sequence tests are used to qualify an oil as SF-rated, and they are run under controlled conditions designed to accelerate service troubles that might ordinarily develop over long periods.

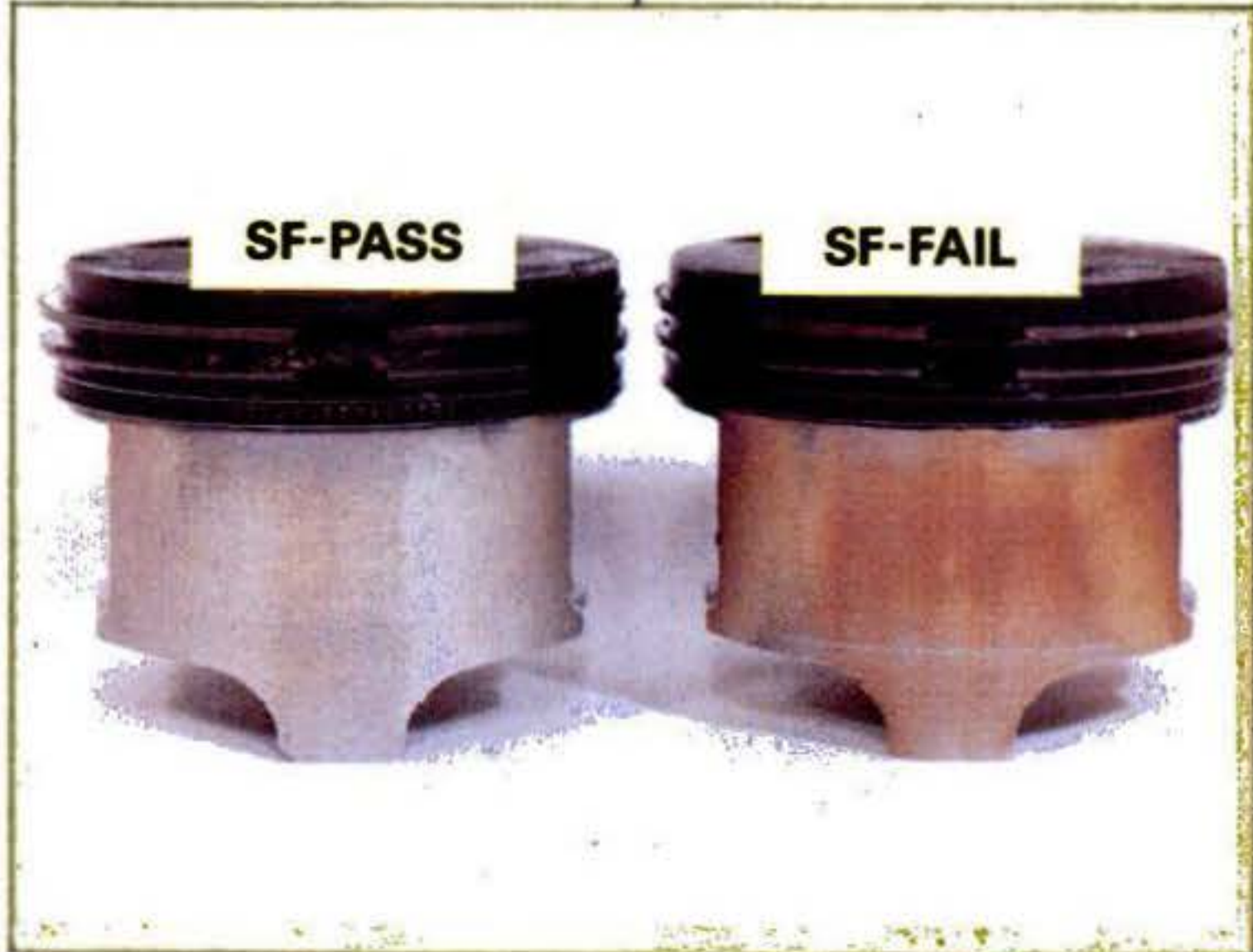
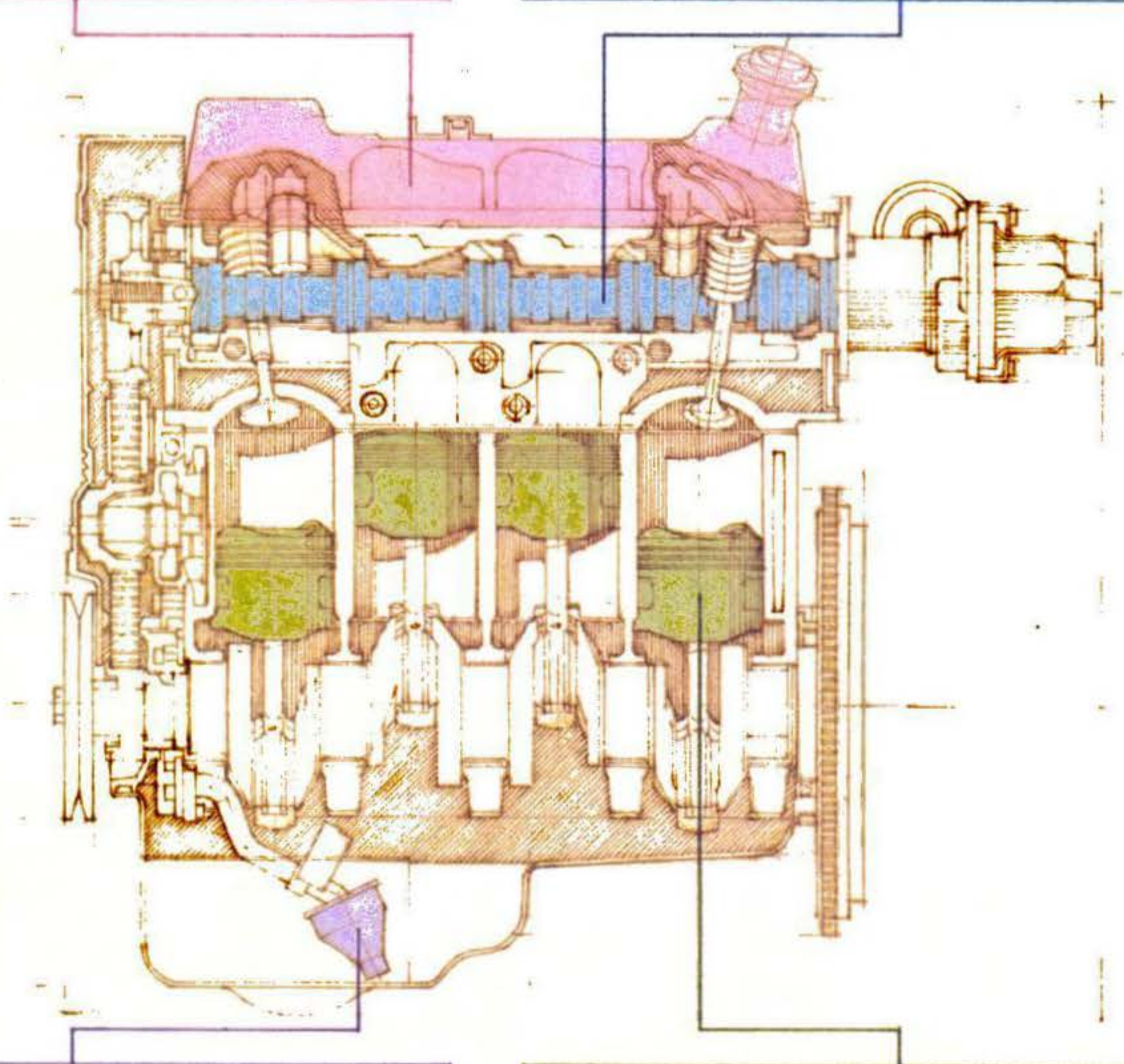
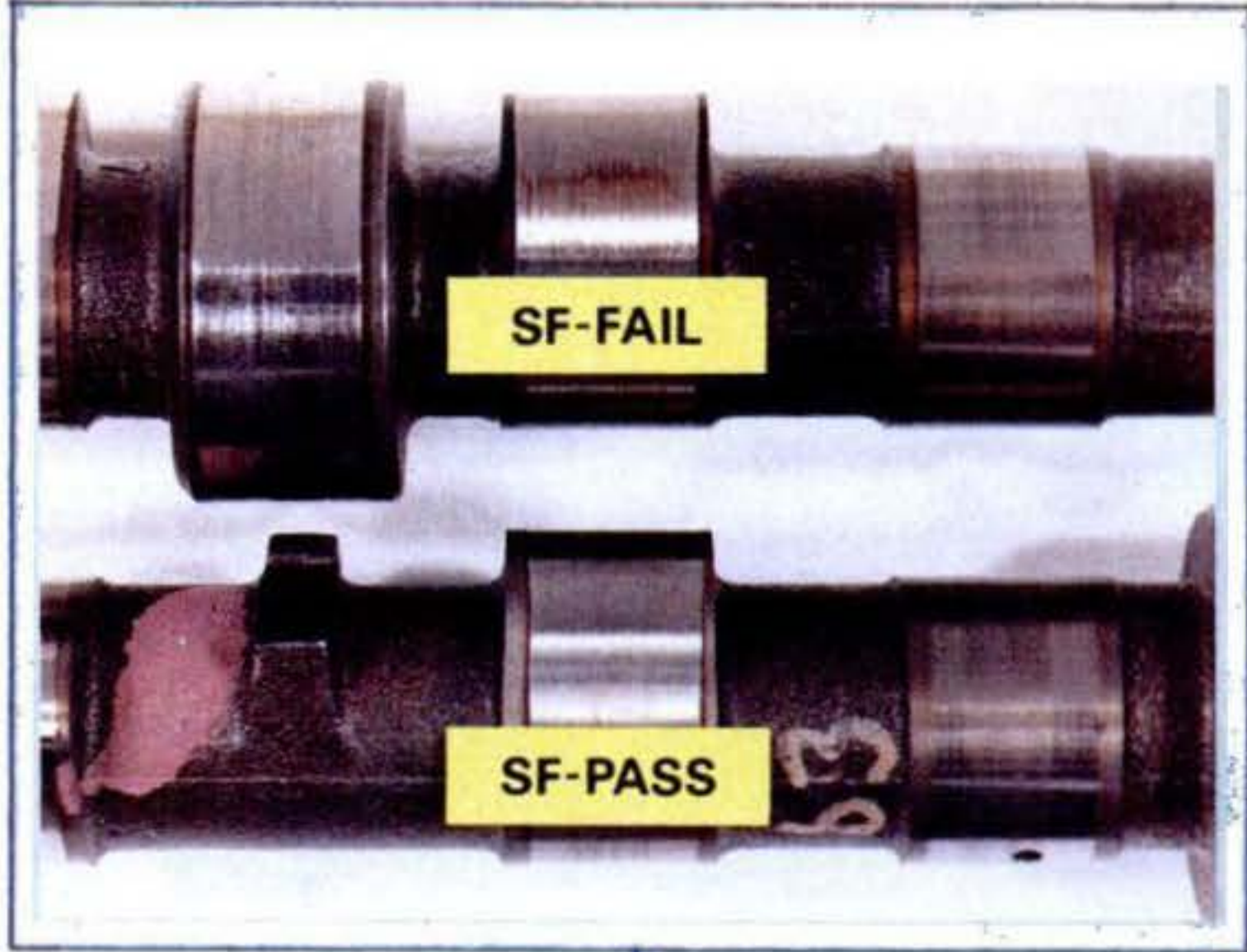
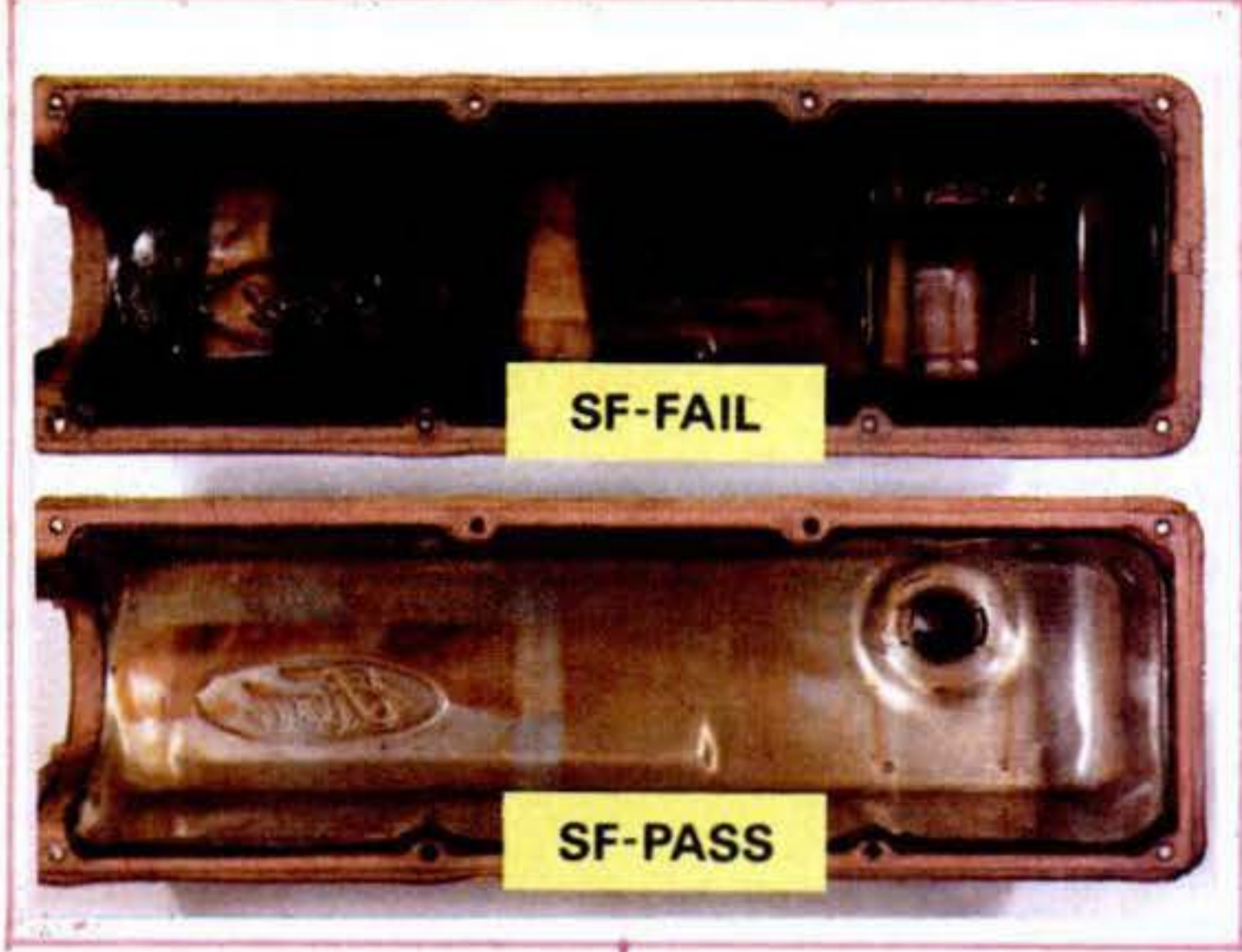
*Sequence II-D* evaluates the rust- and corrosion-inhibiting characteris-

tics of the test oil. If you drive short trips during winter in the upper Midwest, this test was designed for you. Its combination of temperatures, humidities, engine loads, and warmup and cooling conditions effectively simulates starting your car on a cold, damp morning and driving to the station or taking the kids to school. The standard engine is a 5.7-liter (350 cu. in.) Oldsmobile V8. It is run on leaded gasoline, because leaded gasoline presents more severe rust and corrosion potential and because there are still many V8 engines using it.

*Sequence III-D* checks high-temperature oil thickening, sludge and varnish deposits, and engine wear. It is intended to relate to turnpike driving in hot weather, as in the South and Southwest. The standard engine is again the Olds 5.7, run on leaded fuel. The former SE specification allowed a certain acceptable viscosity increase after 40 hours. The new SF standard sets the same limit, but extends the running time to 64 hours, a much more severe demand. So an SF oil is more likely to hold an acceptable viscosity between changes. That, according to one engineer, means that the new oils should save you some fuel just by holding down the friction increase.

*Sequence V-D* is most changed, now being run on a more representative engine, Ford's 2.3-liter four, which is fueled on unleaded gasoline. This is the part most important to you if you own a car with a smaller engine, since it is aimed right at your engine's special problems. The test checks primarily for protection against the formation of sludge and varnish, as well as valve-train wear. It also investigates the plugging of PCV valves, sticking and clogging of critical parts, intake-

*Continued*



valve deposits, and piston-ring and bearing wear.

What does all this mean to you? First, since SF oils are thoroughly tested in V8 engines running on leaded fuel, they are perfectly suited to your older car. (The SF designation, however, may have to appear in conjunction with a suffix like CC or CD. Check your owner's manual.)

Second, if you have a new car with a smaller engine and also have some SE oil on hand, it might be a good idea to give away the SE and buy some SF-rated oil. (The same qualification standards apply to synthetic oils as to conventional mineral types.)

### No promises

Despite the superiority of SF oils over SE types, you won't be seeing car makers lengthen oil-change intervals dramatically. "The inadequacy of the V-D test rules that out," I was told by Dick Cable of General Motors Research. He feels that the standard needs more development in that area. So, while you can buy lubricants that claim to be safe for extended periods, remember that there are no official qualification tests to back them up.

Procedures are being formulated to rate oils according to their ability to reduce friction and thereby save fuel. While there is no question that certain modified oils can show a fuel-economy improvement (although not all the time or under all conditions), there are no officially recognized standards to define the mpg gains. That leads to considerable pressure from the auto makers, who want to use the oils in developing their EPA economy ratings. But the government has tak-

**Today's smaller, higher-revving engines**—such as Ford's all-new 1.6-liter CVH—plus lead-free gasoline combine to tax oils beyond what was required of them just a few years ago. Tough new lubricants had to be developed to deal with these special problems. Rigorous testing is required for an oil to attain the new SF rating, and careful examination of test engines is an important part of the qualification. Sludge buildup in the rocker-arm cover (top left) is obvious, and is a quick disqualifier. Wear on critical parts, such as the camshaft (top right), isn't necessarily as easy to spot, so precise measurements are taken to obtain accurate evaluations. Damage to such important parts could cause expensive repairs or even a complete engine replacement. Sludge buildup on the oil-pump inlet screen (bottom left) can have the same results. Pistons (bottom right) are examined for varnish deposits, ring freedom, gap increase, clogging of the oil-ring slot, and scuffing.

en the stand that until such firm definitions and performance criteria are established, economy figures must be based solely on tests run with conventional oils.

Developing these tests isn't as easy as it might seem, however. To understand how oils can be modified to reduce friction, you have to look at the types of friction within an engine. Rubbing friction is the actual contact between high points or rough areas, such as piston rings on cylinder walls or rocker arms on valves. It is also called boundary friction, and occurs when the oil film is extremely thin.

**Despite the superiority of SF oils, you won't see car makers lengthen oil-change intervals**

Viscous friction comes from the oil film's resistance to shearing force while it prevents metal-to-metal contact. This would occur in crankshaft bearings, for instance.

One countermeasure to these two friction sources is lower-viscosity oil. It gets moving faster when the engine starts up and is more easily sheared in a well-lubricated bearing.

This thinner-oil approach has been tried—often to help cold-weather starting, as well as economy—but the results aren't all desirable. Among the problems are increased engine wear, oil leaks, high oil consumption, carryover of phosphorous additives that can ruin catalytic converters, and the vaporization of the thinner components of the oil blend, which causes such problems as viscosity change and oil loss.

To avert these problems, low-viscosity synthetic oils have been blended with mineral oils, and show worthwhile friction reductions. Even more improvement has been shown by adding friction modifiers such as graphite and molybdenum disulfide to these blends.

Some challenges still remain, however, almost as with a new medical discovery. Certain side effects and incompatibilities show up when the new additives, detergents, or modifiers are blended in.

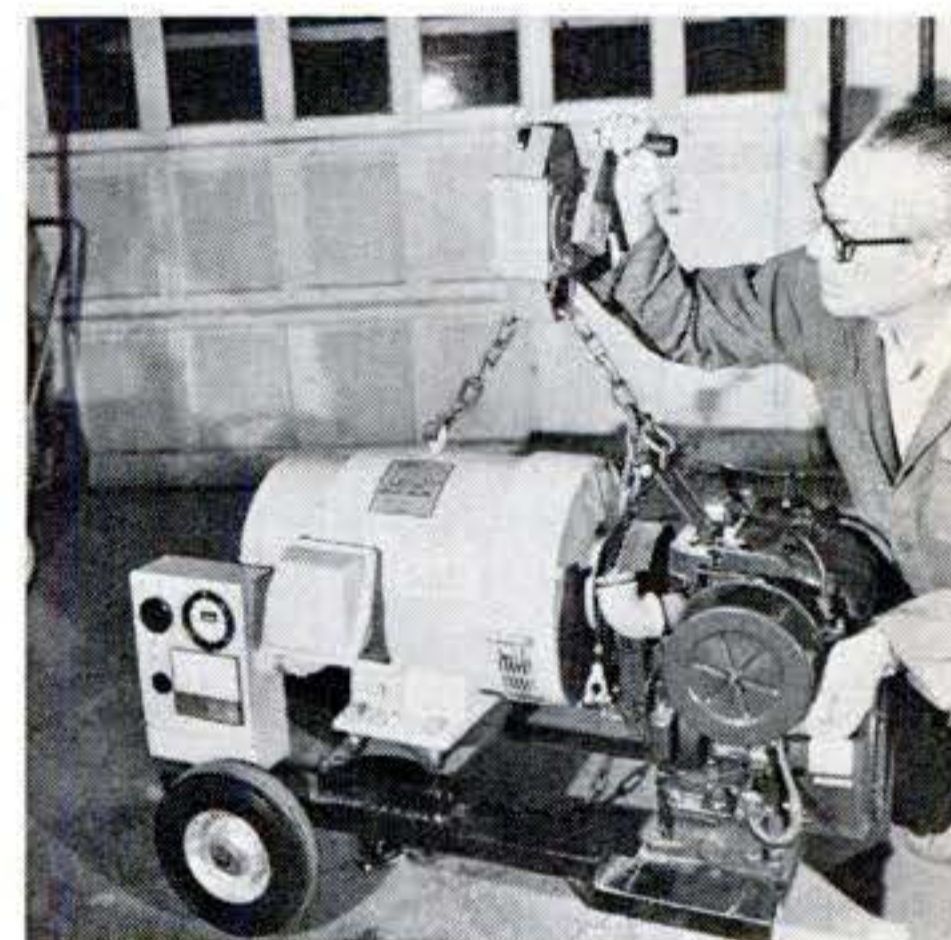
The trade-offs and occasional surprises definitely justify the extensive testing before you can feel safe about putting any and all oils labeled "energy-saving" in your car. **PS**

## Plastic winch is an easy lifter

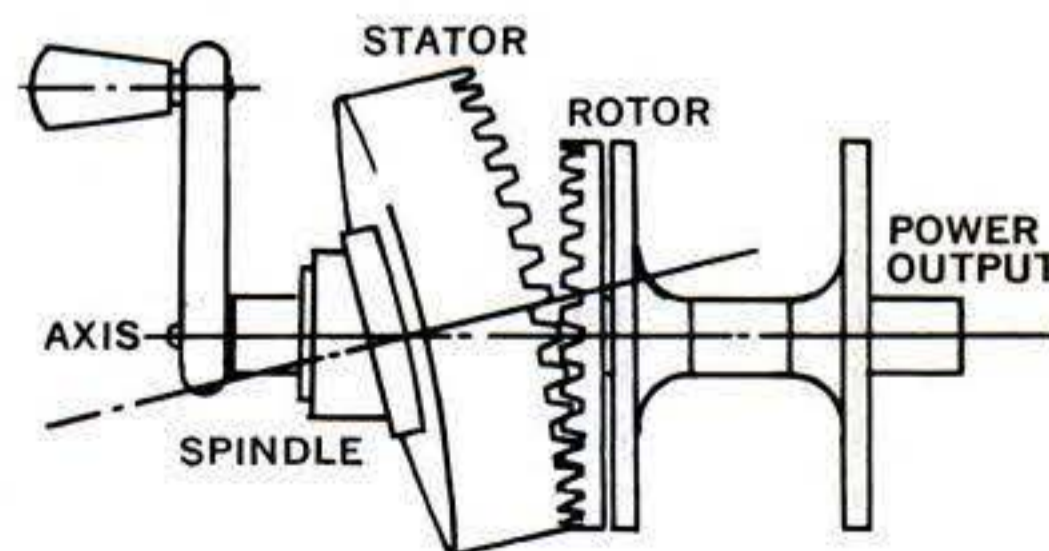
I had doubts when I looked at the Easy Tugger. Its plastic case weighs about five pounds, yet the winch is rated at 1,000 pounds, the same as my heavy chain hoist. A brochure from the manufacturer showed it being used to hoist a car engine and load a boat on a trailer—but I decided on a more cautious trial.

I latched the husky hook overhead and ran a chain sling through the open eye at the winch's other end and around my test load—a 450-pound generator. Next I flipped the winch's control lever from 1:1 back to 42:1, gave the handle a tentative turn, and heard the high-ratio drive drop in. Cranking took so little effort that at first I thought nothing was happening. Then I discovered that the heavy generator was already an inch off the floor.

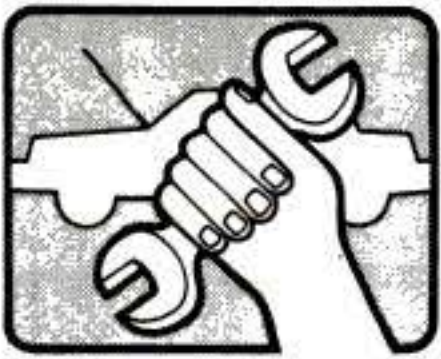
Easy Tuggers come in half-ton (\$82.50) and one-ton (\$99.95) versions with a variety of accessories. Tool Master, Box 2190, Boulder, Colo. 83036.—*E. F. Lindsley*



**Upside-down winch** works fine—unlike many chain-type hoists. There are no chains to tangle or gears to pinch—case encloses all moving parts.



**Novel wobbling gear** gives giant torque increase. For teeth to mesh, stator must be driven at an angle. Thus, when crank turns, the larger gear does not turn on its vertical axis. Instead, it wobbles around the rotor, which revolves around stator.



AUTO  
MAINTENANCE

# Squeeze- and-spray car care

It takes more than tools for good car care. You need tubes and cans, too

By **RAY HILL**

DRAWINGS BY RAY PIOCH

When should you use a gasket sealer? If a belt is properly tensioned but still squeals, how can you eliminate the noise? What's an easy way to remove stubborn carbon deposits from a cylinder head? How do you stop disc brakes from chattering?

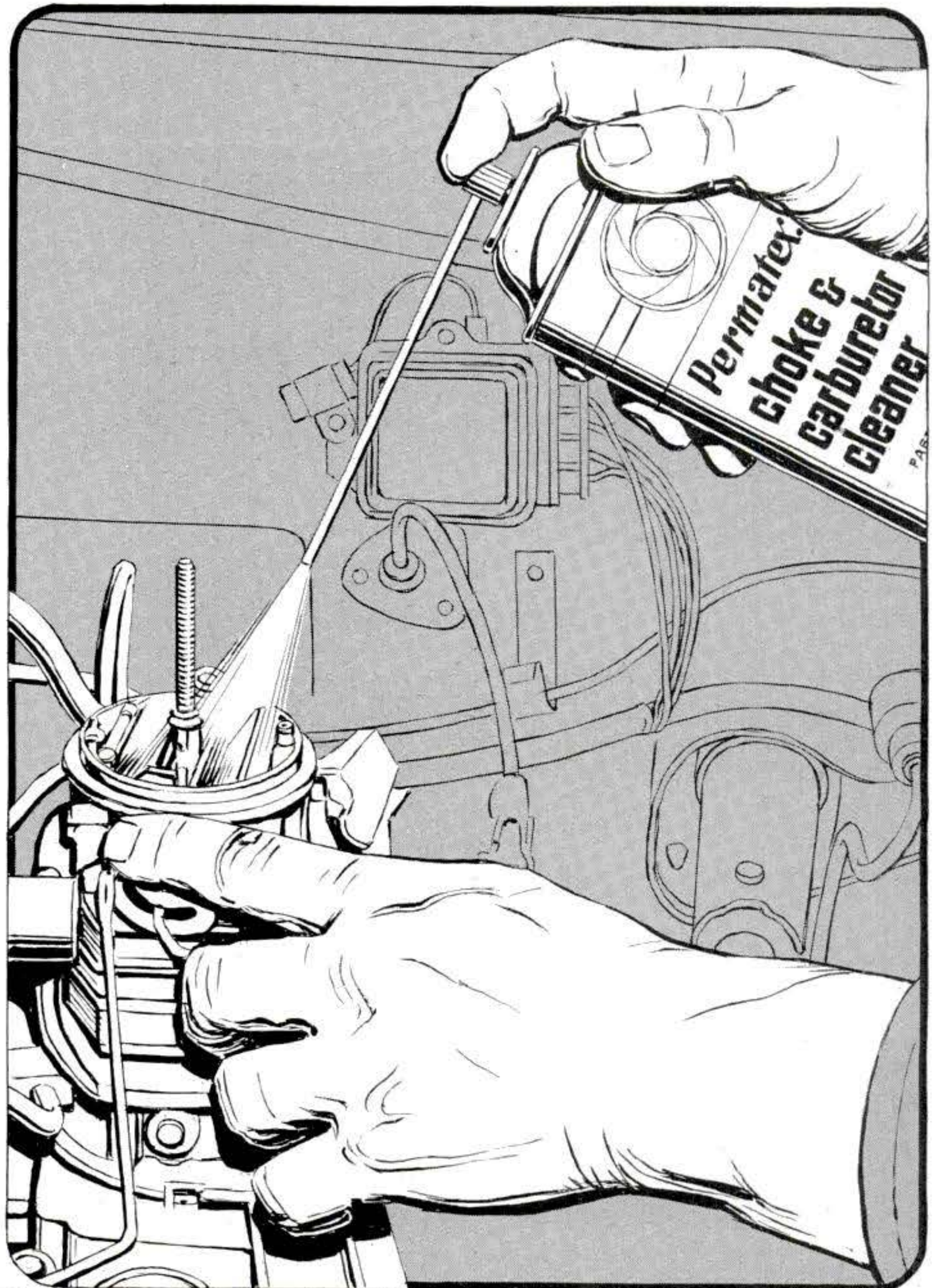
The answers to these and other tough questions are resting silently on shelves in your local auto-parts supply store—in tubes and cans that contain gasket sealers, adhesives, lubricants, cleaners, and other compounds. Getting to know them can greatly improve the quality of your auto maintenance and repairs. Let's take a closer look.

## Products for gaskets

An auto engine has many gaskets. When any item with a gasket is replaced, a new gasket is needed.

Removing the old gasket may or may not be easy. Gaskets that don't use a sealer, such as the carburetor gasket, may lift off in one piece. Others may stick to the metal as if they're part of it. With these, a gasket remover can be a tremendous help. Spray it liberally on the gasket and let it set for five minutes or so. Then scrape off the gasket.

Permatex gasket remover can be used to remove carbon deposits. Say you're cleaning a cylinder head in preparation for a valve job. Spray the stuff liberally on the carbon, let it set, and scrape off the deposits (which should now have turned into slush).



**Nozzle tube** on choke-and-carb cleaner lets you direct spray accurately. Spray is also useful for jobs such as removing dirt and grime when you're searching for a fluid leak where two parts join. It can be useful for cleaning small parts, too.



For a new gasket to seal properly, both surfaces that it will mate with must be scrupulously clean. Not even a speck of old gasket material should remain. With the surfaces clean, the next step is to use a gasket sealer, if needed. Some gaskets come with instructions that tell you whether a sealer is required. No instructions? Then ask the salesman who sold you the gasket. The sealer, if needed, is usually applied to both sides of the gasket. Two major exceptions are the valve-cover and timing-chain-cover gaskets. They require a sealer only on the sheet-metal cover side.

Never use a gasket sealer on a carburetor gasket or on an automatic-transmission pan. (Sealer that accidentally gets inside the transmission can cause expensive damage.)

Professional mechanics generally use two types of gasket sealers—a non-hardening all-purpose sealer (Permatex No. 3 is an old standby with many pros) and a high-tack type (when the sealer must hold the gasket in place while a component is installed, as with a valve cover).

For the do-it-yourselfer, a good choice is a new gasket sealer recently introduced by Permatex. It is both a high-tack material and a nonhardening sealer similar to No. 3. It's called Tack & Seal, and its part-number designation is 9A.

It has a couple of advantages over No. 3, too. It's white (No. 3 is dark brown), so it's easier to see where you're putting the sealer and how much you've applied. And it can be removed from your hands with soap and water. No. 3 is difficult to get off your skin.

If you don't need a high-tack sealer to hold a gasket in place during installation, a spray gasket sealer is handy.

**Handy helpers** like these should be in every well-stocked do-it-yourselfer's supply cabinet. They'll enable you to do a variety of jobs, from keeping your car's gas line from icing up to removing carbon deposits from a cylinder head.

For head gaskets and other metal-faced gaskets, 3M's Super Head Gasket Adhesive works well. There are similar aerosol gasket sealers for other types of gaskets available at auto-parts stores.

#### When no gaskets are used

Some late-model cars don't have gaskets in places where gaskets are traditionally used: the oil pan and valve cover, for example. In these cases, use a rubber-based adhesive sealant such as Permatex Form-A-Gasket. Follow the directions on the tube.

#### Cleaners

Choke-and-carb cleaner, engine degreaser, and brake cleaner are the three most common cleaning solvents you'll need.

**Choke cleaner.** For binding choke or carburetor linkage, spray a liberal dose of cleaner on each pivot point and work the linkage back and forth with your hand. Never use motor oil or other petroleum-based lubricants in place of carb spray. Oil can collect dust and dirt and eventually make the problem worse than before.

**Brake cleaner.** Spray liberally to clean brake parts and brake pads or shoes that have grease or other foreign matter on them.

**Engine degreaser.** There are various brands available. A good one I've tried is made by 3M. Spray it on dirty engine parts, wait a few minutes for it to penetrate, then flush away the dissolved deposits with water.



**Disc-Brake Quiet** comes in a handy applicator. You squeeze it out and use the flat end of the tube to spread it evenly on the metal on the back of the brake pad. It should be used only on the outboard pad, not on the piston pad.

#### Eliminating noises

Squeaking belts, chattering disc brakes, and squeaking hinges are three common and troublesome noises.

**Chattering brakes.** Permatex Disc-Brake Quiet, or a similar product, will often cure this problem. Remove the brake pads from the calipers and clean the back side of each pad with brake-cleaning spray. Then apply an even layer of Disc-Brake Quiet to the back side of the outboard brake pad. Let the pad air-dry a few minutes before reinstalling it.

**Squealing belts.** If a belt is properly

*Continued*



**Dirty hands** from using these tubes? Not if you use the tube at top center. Rub Pro-Tek on your hands before starting a dirty

job. When you're done, the dirt and grease will wash off merely using soap and warm water.



**Thread-locking adhesive** goes on easily and sets up quickly. Threads must be clean for it to work. If they're dirty, clean

them with carb-and-choke cleaner. The adhesive will not prevent easy removal of the fastener with a wrench.

tensioned yet still squeals, apply spray belt dressing to the belt according to instructions on the can.

Belt dressing should not be thought of as a belt-life extender, though. Belts should still be replaced every two years. If this is done, it's unlikely you'll ever be the victim of a broken belt (assuming you keep the belts properly tensioned).

**Squeaking hinges.** Door, trunk, and hood hinges often develop squeaks. Silicone spray lubricant will quiet these hinges and make them operate freely.

### Adhesives

**Thread-locking adhesives.** On nuts or bolts that have a tendency to vibrate loose, Loctite Lock N' Seal or a

similar thread-locking adhesive is the solution. Threads must be clean and dry before it's applied. Squirt some of the liquid adhesive on the threads, then tighten the fastener.

**Weatherstrip adhesive.** Loose weatherstripping can quickly be made tight again with a glue such as 3M's Super Weatherstrip & Gasket Adhesive. It sets up quickly and holds the weatherstripping securely.

**Rear-view-mirror adhesive.** This is the best stuff for reattaching a rear-view mirror to a windshield. A good one is made by Loctite; follow the instructions on the package.

### Stopping leaks

**Gas tank.** For sealing small leaks in a gas tank, Loctite's Instant Gas Tank Repair works well. It seals immediately and doesn't require removal or draining of the tank. First, clean the area around the leak. Tear off the amount of patching material needed, knead it with your fingers until it becomes a uniform gray color, and push it in and around the hole, following the instructions on the patching kit. It sticks to metal wet with gas.

**Leaks around windshield and through body cracks.** A clear sealer that's thin enough to get into small crevices and then harden is the ideal solution here. A product like 3M's clear sealer will do the job. First be sure the crack and the surrounding area are clean and dry. Then flow or brush the sealer along the crack.

### Other useful items

- **Cooling-system cleaner**—helps get rid of corrosion when the cooling system is flushed. The system should be flushed each time you change coolant. (A good rule of thumb for replacing coolant is to drain and flush every two years. Install new hoses every two years, as well.)

- **Anti-rust and water-pump lube**—helps fight corrosion and keeps the water-pump seal from hardening, decreasing the likelihood of a water-pump leak.

- **Starting fluid**—highly volatile, should be used with caution, following directions on can. Useful for getting a cold engine started when ambient temperature is low.

- **Penetrating oil**—great for loosening frozen nuts and bolts.

- **Anti-seize compound**—designed to eliminate galling and seizing where metal fasteners are exposed to extreme heat or corrosion.

- **Gasoline antifreeze**—keeps fuel lines from icing up in cold weather.

- **Graphite lock fluid**—frees up sticking car locks, helps guard against rust and wear.





## A little something to help blow away inflation.

It'll take more than Gabriel blasting 40% off Red Ryder prices to blow away inflation. Even so, it's a healthy puff in the right direction.

Now you can save \$9.98 off\* Gabriel's \$24.95 regular suggested retail price—on each Red Ryder shock absorber you buy.

If you were to buy all four Red Ryders, you'd stash away close to \$40. Besides giving your car Gabriel's best-selling shock absorbers.

Not only are Red Ryders heavy duty all

the way, they're now *computer tuned* all the way. To your tires. To the road. And to your car. For better control at higher speeds, greater comfort at lower speeds.

So here's to the 40% Off Sale. May it explode the myth that you can't give inflation a good shock.

**Gabriel**<sup>®</sup>  
On the road ahead.

Offer expires in a flash May 31, 1981.

Gabriel Shocks & Struts are products of Maremont Corporation.

\*Based on Gabriel's suggested retail sale price of \$14.97 and the regular suggested retail price of \$24.95. Installation not included. Prices may vary at participating dealers.

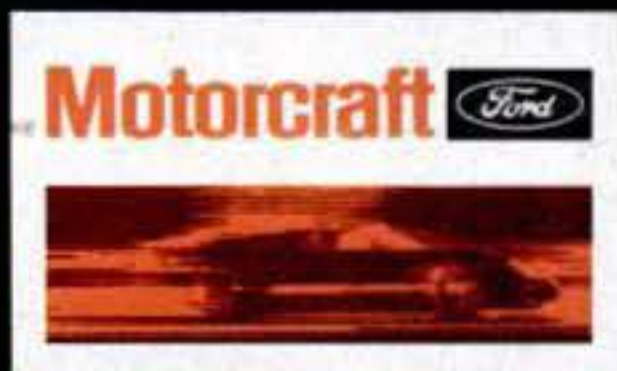
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**HOW TO BURN AWAY THE CARBON  
THAT CAN WASTE YOUR GAS.**

Sooty carbon. It's the enemy of your spark plug. It robs gas mileage.

Motorcraft Spark Plugs fight the enemy. In fact, with Motorcraft's extended tip design, carbon is actually



burned away as you drive. So, in normal driving with a properly tuned engine, you'll get improved mileage.

Motorcraft Spark Plugs. For the future of your car. For sure.

...FOR SURE

# MOTORCRAFT

# Rating radials

for tread life,  
traction, and speed



New U.S. quality scores  
may help you get the most  
for your tire dollars

By HERBERT SHULDINER

Government shoppers recently bought eight radial tires in Washington, D.C. The most expensive in the group, Michelin X, had the lowest tread-wear score in the federal uniform tire-quality-grading ratings. In fact, the ratings reveal many surprises. "Some tires may vary in price by as much as \$30 apiece yet offer the same performance as measured by the tire-grading system," a government spokesman said.

The relatively new ratings—molded into the side of every tire—are designed to give buyers a reliable measuring stick when shopping. The ratings reveal tread life, wet-traction capability, and high-temperature resistance—the latter indicating high-speed capability. Tread-wear ratings are scored on an open-ended scale ranging upward from 10 in increments of 10. Each 10 points means 3,000 miles in tread life, as measured on a government test course. Traction-rating and temperature-resistance scores are A, B, and C ["Grading Tire Quality," PS, April '80].

Recently Uniroyal became the first major tire company to advertise grades. Uniroyal's competitors have still not joined in, but there are indications that tire grades may soon become as important in selling tires as EPA mpg figures have in selling cars. On the following pages, PS lists all radial passenger-car tire ratings.

*Continued*

# Federal quality grades for radial passenger-car tires

Brand	Model and diameter*	Tread life	Traction	Temperature resistance	Mfr. code**	Brand	Model and diameter*	Tread life	Traction	Temperature resistance	Mfr. code**	Brand	Model and diameter*	Tread life	Traction	Temperature resistance	Mfr. code**
Acme	All Season, 13"	140	B	C	D071	Big O	Big Steel II Metric R Type	160	A	C	D171	Concorde	GTX 700 Metric 70, 13"	200	B	C	D119
Acme	All Season, 14"-15"	170	B	C	D071	Big O	Big Steel III Alpha Series	220	B	C	D171	Concorde	GTX 700 Metric 70, 14"	220	B	C	D119
Acme	Metric	170	B	C	D071	Big O	Big Sur P Metric, 13"	150	B	C	D036	Concorde	LTR Total Performance, 15"	180	B	C	D119
Acme	Special, all dia.	150	B	C	D071	Big O	Big Sur P Metric, 14"	170	B	C	D036	Concorde	Trac-Action 60, 13"	190	B	C	D119
Acme	Steel Belted, all dia.	170	B	C	D071	Big O	Big Sur P Metric, 15"	180	B	C	D036	Concorde	Trac-Action 60, 14"-15"	220	B	C	D119
Acme	Steel	160	B	C	D071	Bridgestone	Steel Belted 106V HR	140	A	A	F241	Concorde	Trac-Action 70, 13"	200	B	C	D119
All American	Custom H/E	170	B	C	D109	Bridgestone	Steel Belted 106V SR	140	A	B	F241	Concorde	Trac-Action 70, 14"-15"	220	B	C	D119
All American	SBR-4, 13"	130	B	C	D109	Bridgestone	Steel Belted 108V & 111V	200	A	B	F241	Concorde	Ultra Flex II Steel Belted, 13"	130	B	C	D119
All American	SBR-4, 14"-15"	170	B	C	D109	Bridgestone	Steel Belted 112V	220	A	B	F241	Concorde	Ultra Flex II Steel Belted, 14"-15"	180	B	C	D119
All American	Sport Custom H/E	100	B	C	D109	Bridgestone	Steel Belted 113V 82-70 Series	190	B	B	F241	Continental	/60 Series, 14"-15"	160	B	C	F261
All American	Steel Belted, 13"	130	B	C	D109	Bridgestone	Steel Belted 170 V2 70 Series & 82 Series	190	A	B	F241	Continental	/60 Series HR 14"-15"	160	A	A	F261
All American	Steel Belted, 14"-15"	170	B	C	D109	Bridgestone	Steel Belted 203V	140	A	A	F241	Continental	/60 Series VR 14"-15"	160	A	A	F261
All American	Supershield, 13"	180	B	C	D109	Bridgestone	Steel Belted 207V	220	A	A	F241	Continental	/70 Series HR 13"-14"	140	A	A	F261
All American	Supershield, 14"-15"	210	B	C	D109	Bridgestone	Texile Belted D102	100	A	A	F241	Continental	/70 Series SR 13"-14"	200	A	B	F261
All American	Supershield, 14"-15"	210	B	C	D109	Bridgestone	Texile Belted D105, D105A & D201	100	A	B	F241	Continental	145 - 155SR 13"-14"	160	A	B	F261
Alliance	Rayon Belted, all dia.	080	B	C	F221	Brigadier	Glass Belted	150	B	C	D071	Continental	155R 15"	160	A	B	F261
Alliance	Steel Belted 118, 13"	180	A	B	F221	Brigadier	Steel Belted	170	B	C	D071	Continental	165-175-185SR 13"-14"-15"	180	A	B	F261
Alliance	Steel Belted 118, 14"-15"	200	A	B	F221	Brunswick	All Season Steel Belted	160	B	C	D081	Cooper	Lifeline Glass, 13"	160	B	C	D021
Alliance	Steel Belted 120, 13"	180	A	B	F221	Brunswick	Mach Sixty & Seventy	180	B	C	D081	Cooper	Lifeline Glass, 14"	180	B	C	D021
Alliance	Steel Belted 120, 14"-15"	200	A	B	F221	Brunswick	Steel Belted	170	B	C	D081	Cooper	Lifeline Glass, 15"	200	B	C	D021
Alliance	Steel Belted 127, 13"	140	B	C	F221	Brunswick	Sun-N-Snow	160	B	C	D081	Cooper	Lifeline Steel P80 P75, 13"	160	A	C	D021
Alliance	Steel Belted 127, 14"-15"	160	B	B	F221	Brunswick	Twin Steel Belted LRR	160	B	C	D081	Cooper	Lifeline Steel P80 P75, 14"	180	A	C	D021
Alliance	Steel Belted 129, 13"	160	A	B	F221	Carlton	Accu-Trac 60	220	A	C	D011	Cooper	Lifeline Steel P80 P75, 15"	200	A	C	D021
Alliance	Steel Belted 129, 14"-15"	180	A	B	F221	Carlton	Accu-Trac 70, 13"	180	B	C	D011	Cooper	Malwear Glass	130	B	C	D021
Amoco	CXV	150	B	C	D071	Carlton	Accu-Trac 70, 14"-15"	220	B	C	D011	Cooper	Malwear Steel	130	A	C	D021
Armor	365 Steel Belted	200	B	C	D171	Carlton	Zodiac	130	B	C	D011	Cooper	Pro 60 Malwear	130	A	C	D021
Armstrong	Custom Sport	120	B	C	D011	Carnegie	Fulda All Seasons, 13"	120	B	C	D119	Cooper	Pro 60 P60 Series, 13"	170	A	C	D021
Armstrong	Maxi-Weather All Season, 13"	150	B	C	D011	Carnegie	Fulda All Seasons, 14"-15"	180	B	C	D119	Cooper	Pro 60 P60 Series, 14"-15"	180	A	C	D021
Armstrong	Maxi-Weather All Season, 14"-15"	200	B	C	D011	Carnegie	Fulda Metric 70 All Seasons, 13"	200	B	C	D119	Cooper	Pro 70 Malwear	130	A	C	D021
Armstrong	Tru-Trac 70 Series, 13"	180	B	C	D011	Carnegie	Fulda Metric 70 All Seasons, 14"	220	B	C	D119	Cooper	Sportsmaster R Type, 15"	180	B	C	D021
Armstrong	Tru-Trac 70 Series, 14"-15"	220	B	C	D011	Carnegie	Fulda XJ40	120	B	C	D119	Cooper	Sportsmaster Malwear	130	B	C	D021
Armstrong	Tru-Trac 60 Series	220	A	C	D011	Carnegie	Mark VII All Season, 13"	120	B	C	D119	Cooper	Trendsetter Malwear	080	A	C	D021
Atlas	Amigo All Season, 13"	140	B	C	D071	Carnegie	Mark VII All Season, 14"-15"	180	B	C	D119	Cooper	Trendsetter P75, 13"	090	A	C	D021
Atlas	Amigo All Season, 14"-15"	170	B	C	D071	Carnegie	XLD Steel Belted, 13"	170	B	C	D036	Cooper	Trendsetter P75, 14"-15"	120	A	C	D021
Atlas	Goldenaire II	180	B	C	D061	Carnegie	XLD Steel Belted, 14"	190	B	C	D036	Cordovan	All Season Premier IV, 13"	120	B	C	D109
Atlas	Goldenaire II GR70-15	200	A	C	D071	Carnegie	XLD Steel Belted, 15"	200	B	C	D036	Cordovan	All Season Premier IV, 14"	170	B	C	D109
Atlas	RRS All Season, 13"	120	B	C	D061	Cavalier	All Season Steel Belted	160	B	C	D081	Cordovan	All Season Premier IV, 15"	170	B	C	D109
Atlas	RRS All Season, 14"-15"	170	B	C	D061	Cavalier	Mach Sixty & Seventy	180	B	C	D081	Cordovan	CR-10	150	B	C	D109
Atlas	Silveraire	150	B	C	D061	Cavalier	Steel Belted	170	B	C	D081	Cordovan	CR-10	150	B	C	D061
Atlas	Silveraire	150	B	C	D071	Cavalier	Sun-N-Snow	160	B	C	D081	Cordovan	Hi-Speed	200	B	B	D109
Atlas	Silveraire, all dia.	150	B	C	D109	Cavalier	Twin Steel Belted LRR	160	B	C	D081	Cordovan	Hi-Speed, HR70-15	200	B	B	D109
Aurora	R737, 155SR13-15	120	A	B	F432	CBI	Heritage	180	B	C	D061	Cordovan	Premium RS, 13"	130	B	C	D109
Aurora	R737, 165SR13-14-15	120	A	B	F432	CBI	Heritage, 13"	160	A	C	D021	Cordovan	Premium RS, 14"-15"	170	B	C	D109
Aurora	R737, 175SR13-14	120	A	B	F432	CBI	Heritage, 14"	180	A	C	D021	Cordovan	G/T	200	B	C	D109
Aurora	R737, 185SR13-14	120	A	B	F432	CBI	Heritage, 15"	200	A	C	D021	Cordovan	Sovereign, all dia.	220	B	C	D109
Aurora	SR800, 155SR13-15	150	A	B	F432	CBI	13"	150	B	C	D011	Cornell (Pep Boys)	All Season P Metric, 13"	140	B	C	D119
Aurora	SR800, 165SR13-15	150	A	B	F432	CBI	14"-15"	170	A	C	D011	Cornell (Pep Boys)	All Season P Metric, 14"	150	B	C	D119
Aurora	SR800, 175SR13-14	150	A	B	F432	CBI	S/B, 13"	150	B	C	D011	Cornell (Pep Boys)	All Season P Metric, 15"	180	B	C	D119
Aurora	SR800, 185SR13-14	150	A	B	F432	CBI	S/B, 14"-15"	170	B	C	D011	Cornell (Pep Boys)	800 P Metric, 13"	170	B	C	D119
Aurora	SR807, 175/70SR13	180	A	C	F432	CBI	Starfire All Season, 13"	130	B	C	D021	Cornell (Pep Boys)	800 P Metric, 14"	190	B	C	D119
Aurora	SR807, 185/70SR13-14	180	A	C	F432	CBI	Starfire All Season, 14"	160	B	C	D021	Cornell (Pep Boys)	800 P Metric, 15"	200	B	C	D119
Aurora	SR807, 205/70SR14	180	A	C	F432	CBI	Starfire All Season, 15"	180	B	C	D021	Coronet	All Season, 13"	150	B	C	D011
Aurora	SR807, FR78-14-15	180	A	C	F432	CBI	Starfire Sport	180	B	C	D021	Coronet	All Season, 14"-15"	200	B	C	D011
Aurora	SR807, GR78-14	180	A	C	F432	CBI	Styleline, 13"	160	B	C	D021	Coronet	XA	140	B	C	D011
Aurora	SR807, HR78-14	180	A	C	F432	CBI	Styleline, 14"	180	B	C	D021	Coronet	XL	130	B	C	D011
Auto Club	All Season Steel Belted	160	B	C	D081	CBI	Styleline, 15"	200	B	C	D021	Coronet	X40, 13"	150	B	C	D011
Auto Club	Mach Sixty & Seventy	180	B	C	D081	CBI	Styleline 60, 13"	170	A	C	D021	Coronet	X40, 14"-15"	170	B	C	D011
Auto Club	Steel Belted	170	B	C	D081	CBI	Styleline 60, 14"-15"	180	A	C	D021	Coronet	X40 M, 75-80 Series	120	B	C	D011
Auto Club	Sun-N-Snow LRR	160	B	C	D081	CBI	Styleline 70, 15"	180	A	C	D021	Custom	XT	130	B	C	D011
Auto Club	Twin Steel Belted	160	B	C	D081	CBI	Styleline 60 Series	190	B	C	D061	Custom	440 Z, 13"	150	B	C	D011
Avalon	All Season, 13"	120	B	C	D119	CBI	Styleline 70	240	B	C	D061	Dayton	440 Z, 14"-15"	170	B	C	D011
Avalon	All Season, 14"-15"	180	B	C	D119	Ceazan	Riken Black Belt 70 Series Steel Belted	170	A	B	F421	Dayton	Blue Ribbon 78 Steel Belted, 13"	170	B	C	D036
Avalon	Fulda All Seasons, 13"	120	B	C	D119	Ceazan	Riken Black Belt 82 Series	170	A	B	F421	Dayton	Blue Ribbon 78 Steel Belted, 14"	190	B	C	D036
Avalon	Fulda All Seasons, 14"-15"	180	B	C	D119	Ceazan	Riken Professor Ace 70 Series	230	A	A	F421	Dayton	Blue Ribbon 78 Steel Belted, 15"	200	B	C	D036
Avalon	Fulda Metric 70 All Seasons, 13"	200	B	C	D119	Ceazan	Riken Professor Ace 82 Series	200	A	B	F421	Dayton	Daytona Alpha 60 Series	200	B	C	D036
Avalon	Fulda Metric 70 All Seasons, 14"	220	B	C	D119	Centennial	Mill	140	B	C	D051	Dayton	Daytona Alpha 70 Series	190	B	C	D036
Avalon	Fulda XJ40	120	B	C	D119	Centennial	60	200	A	B	D051	Dayton	Daytona Grande R Type, 13"	180	B	C	D036
Avalon	GTX 700 Metric 70, 13"	200	B	C	D119	Centennial	70	210	A	B	D051	Dayton	Daytona Grande R Type, 14"-15"	190	B	C	D036
Avalon	GTX 700 Metric 70, 14"	220	B	C	D119	Centennial	78	190	A	C	D051	Dayton	Daytona Q/T, 15"	180	B	C	D036
Avalon	LTR Total Performance, 15"	180	B	C	D119	Centennial	Steel Belted	130	A	C	D051	Dayton	Daytona S/P P Metric 70 Series, all dia.	270	B	C	D036
Avalon	Road Runner E/T 60, 13"	190	B	C	D119	Centennial	Tradition 70 All Season	210	A	B	D051	Dayton	Daytona XSH, 15"	180	B	C	D036
Avalon	Road Runner E/T 60, 14"	220	B	C	D119	Century	Made in Canada	170	B	C	D071	Dayton	Quadra, 13"	140	B	C	D036
Avalon	Road Runner E/T 60, 15"	220	B	C	D119	Co-op	All Seasons, 13"	180	B	C	D171	Dayton	Quadra, 14"	150	B	C	D036
Avalon	Road Runner E/T 70, 13"	200	B	C	D119	Co-op	All Seasons, 14"-15"	200	B	C	D171	Dayton	Quadra, 15"	180	B	C	D036

# STP OIL TREATMENT ADDS AN ANTI-WEAR AGENT AND VISCOSITY IMPROVERS TO YOUR OIL.

## IMPROVED VISCOSITY MEANS IMPROVED LUBRICATING QUALITIES.

Today's multi-grade oils begin to lose their effectiveness as you drive. STP Oil Treatment, the world's best selling oil treatment, is an exclusive formula which contains temperature-activated long-chain polymers. In Winter or Summer, as engine temperatures rise, these temperature-activated polymers "uncurl" to actually improve your oil's viscosity and therefore its lubricating qualities. Plus it contains ZDDP (zinc dialkyl dithiophosphate), an anti-friction, anti-wear, anti-oxidant agent. This special formula:

- Increases viscosity and anti-wear properties
- Promotes lubricating qualities
- Reduces oil consumption in many cars

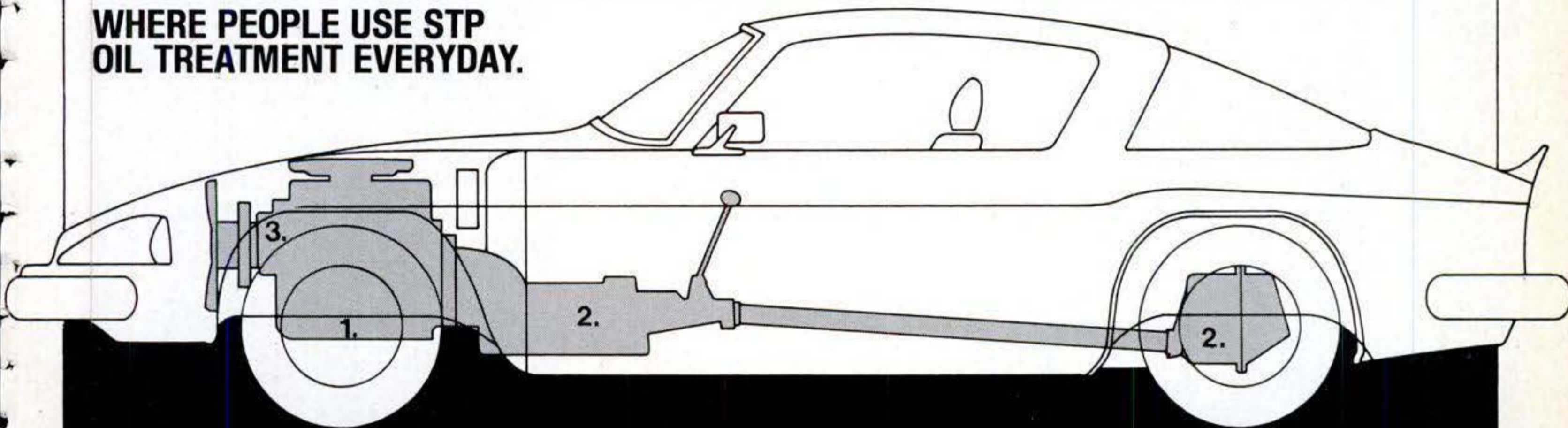


## WHEN TO USE STP OIL TREATMENT.

Use STP Oil Treatment year 'round. Always change your oil at manufacturers' recommended intervals.

The first time you need oil and every time you change oil add STP Oil Treatment. It blends with all petroleum base, graphite and synthetic oils or greases.

## WHERE PEOPLE USE STP OIL TREATMENT EVERYDAY.



**1. Your engine's crankcase.** The first time you need oil and every time you change oil add STP Oil Treatment when the engine is running and warmed up. Use one can of STP Oil Treatment to 4 or 5 quarts of oil. Maintain 10% by volume.

**2. Manual transmission, gear boxes and differentials.** Add one part STP Oil Treatment to 10 parts regular lubricant. For trucks and tractors, add up to 1 part STP Oil Treatment to 6 parts of lubricant. (Not recommended for use in friction drives and wet clutches.)

**3. Power Steering.** Use 1 part STP Oil Treatment to 10 parts power steering fluid.

**Engine assemblies.** If you work on your engine, coat all moving engine parts prior to assembly with a mixture of 1 part STP Oil Treatment and 1 part motor oil.

**Extra uses:** Two cycle engines, motorcycles, outboards and lawn mowers. Add 1 part STP Oil Treatment to 10 parts recommended oil and then add to fuel as directed.

**General Shop Use Lubrication.** Mix 1 part STP Oil Treatment with 4 parts general all-purpose oil.



**SATISFACTION GUARANTEED OR YOUR MONEY BACK FROM STP.**

STP Corporation, an ESMARK Company  
Ft. Lauderdale, FL 33310  
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**AROUND THE TRACK, AROUND THE WORLD...  
STP OIL TREATMENT IS NUMBER ONE.**

# Federal quality grades for radial passenger-car tires

Brand	Model and diameter*	Tread life	Traction	Temperature resistance	Mfr. code**	Brand	Model and diameter*	Tread life	Traction	Temperature resistance	Mfr. code**	Brand	Model and diameter*	Tread life	Traction	Temperature resistance	Mfr. code**
Dean	Skyark Glass Belt P Metric, 14"	120	A	C	D021	El Dorado	Import Metric, 15"	180	B	C	D021	Formula	Road & Track 50 Series, 13"	190	A	C	D011
Dean	Skyark Glass Belt P Metric, 15"	140	A	C	D021	El Dorado	Seville Dual Malwear	080	A	C	D021	Formula	Road & Track 50 Series, 14"-15"	220	A	C	D011
Delta	All Season, 13"	110	B	C	D061	El Dorado	Seville Dual, 13"	090	A	C	D021	Formula	Road & Track 60 Series	220	A	C	D011
Delta	All Season, 14"	130	B	C	D061	El Dorado	Seville Dual, 14"	120	A	C	D021	Formula	Road & Track 70 Series, 13"	180	B	C	D011
Delta	Durasteel, all dia.	230	B	C	D171	El Dorado	Seville Dual, 15"	140	A	C	D021	Formula	Road & Track 70 Series, 14"-15"	220	B	C	D011
Delta	Eurosport, all dia.	160	A	C	D171	El Dorado	Supreme Dual, 13"	160	B	C	D021	Fulda	All Seasons, 13"	120	B	C	D119
Delta	II, all dia.	220	B	C	D171	El Dorado	Supreme Dual, 14"	180	B	C	D021	Fulda	All Seasons, 14"-15"	180	B	C	D119
Delta	II 70, all dia.	230	B	C	D171	El Dorado	Supreme Dual, 15"	200	B	C	D021	Fulda	Diadem Stahl Sr Series	200	B	C	F433
Delta	Road Max 60, all dia.	190	B	C	D061	El Dorado	Supreme Dual, Malwear	130	B	C	D021	Fulda	Metric 70 All Seasons, 13"	200	B	C	D119
Delta	Road Max 70, all dia.	240	B	C	D061	El Dorado	Supreme Steel, 13"	160	A	C	D021	Fulda	Metric 70 All Seasons, 14"	220	B	C	D119
Delta	RSB, all dia.	180	B	C	D061	El Dorado	Supreme Steel, 14"	180	A	C	D021	Fulda	Rasant Steel HR Series	180	A	A	F433
Delta	Sierra GBR, all dia.	140	B	C	D011	El Dorado	Supreme Steel, 15"	200	A	C	D021	Fulda	Rasant Steel SR Series	170	B	B	F433
Detroit	Steel Belted	170	B	C	D081	Electra	Supreme Steel, Malwear	130	A	C	D021	Fulda	Rasant 411 HR+VR Series	150	A	A	F433
Detroit	Sun-N-Snow	160	B	C	D081	Electra	Made in Canada	170	B	C	D071	Fulda	XJ 40	120	B	C	D119
Detroit	Twin Steel Belted LRRAL	160	B	C	D081	Electra	P Metric, Made in Canada	180	B	C	D061	Fulda	Y2000 HR+VR Series	140	A	A	F433
Diamond	All-Season Steel Belted	160	B	C	D081	Empco	All Season, 13"	140	B	C	D071	General	Dual Steel III, all dia.	170	B	C	D071
Diamond	Mach Sixty & Seventy	180	B	C	D081	Empco	All Season, 14"-15"	170	B	C	D071	General	Dual Steel III, P155/80R13	140	B	C	D071
Diamond	Steel Belted	170	B	C	D081	Empco	Metric	170	B	C	D071	General	Dual Steel II	170	B	C	D071
Diamond	Sun-N-Snow	160	B	C	D081	Empco	Steel Belted	160	B	C	D071	General	Grabber R60, all dia.	200	B	C	D071
Diamond	Twin Steel Belted LRR	160	B	C	D081	Empco	Solar Steel Belted, 13"	130	B	C	D109	General	Jet, all dia.	150	B	C	D071
Discount	Arizona Steel Belted	160	B	C	D081	Empco	Solar Steel Belted, 14"-15"	170	B	C	D109	General	Jet, P155/80R13 only	120	B	C	D071
Discount	Mach Sixty & Seventy	180	B	C	D081	Empco	Special, all sizes	150	B	C	D071	General	Sprint Steel	170	B	C	D071
Discount	Steel Belted	170	B	C	D081	Empco	Special, P155/80R13	120	B	C	D071	General	Steel, all dia.	150	B	C	D071
Discount	Sun-N-Snow	160	B	C	D081	Empco	Steel, all dia.	160	B	C	D071	General	VSR, all dia.	110	B	C	D071
Discount	Twin Steel Belted LRR	160	B	C	D081	Empco	Super Cat 60, 13"	150	B	C	D109	General	VSR, P155/80R13 only	080	B	C	D071
Doral	Dazzler Dual Belted, 13"	130	B	C	D119	Empco	Super Cat 60, 14"-15"	190	B	C	D109	Gillette	Armor Belted, 3091/3147	220	B	C	D171
Doral	Dazzler Dual Belted, 14"-15"	180	B	C	D119	Empco	Super Cat 70, all dia.	200	B	C	D109	Gillette	Kodiak 70 Series, 3377	220	B	C	D171
Doral	Dura Season, 13"	120	B	C	D119	Emperor	Belted Malwear	130	B	C	D021	Gillette	Kodiak 78/75 Series, 3091/3147	220	B	C	D171
Doral	Dura Season, 14"-15"	180	B	C	D119	Emperor	Glass Belted P75, 13"	160	B	C	D021	Gillette	Sprint, 3477	160	A	C	D171
Doral	Dura Season, 15"	180	B	C	D119	Emperor	Glass Belted P75, 14"	180	B	C	D021	Gislaved	Speed 116 & 126/70	150	A	B	F271
Doral	Fulda All Seasons, 13"	120	B	C	D119	Emperor	Glass Belted P75, 15"	200	B	C	D021	Gislaved	Speed 216 & 226	160	A	B	F271
Doral	Fulda All Seasons, 14"-15"	180	B	C	D119	Emperor	Glass Belted P80, 13"	160	B	C	D021	Goodrich	GT-200, all sizes	180	A	C	D081
Doral	Fulda Metric 70 All Seasons, 13"	200	B	C	D119	Englebert	Steel Max I R Type	140	A	B	D171	Goodrich	GT-200 R Type	130	A	C	D081
Doral	Fulda Metric 70 All Seasons, 14"	220	B	C	D119	Englebert	70 Series Steel Max I	160	A	B	D171	Goodrich	Imported R Type 70 Series	160	A	B	D081
Doral	Fulda XI40	120	B	C	D119	Exxon	Steel Belted	180	B	C	D061	Goodrich	Lifesaver	220	B	B	D081
Doral	Sabre Metric, all dia.	120	B	C	D119	Falcon	All Season, 13"	110	B	C	D061	Goodrich	Lifesaver All Season	160	B	C	D081
Doral	Swinger GT 60, 13"	190	B	C	D119	Falcon	All Season, 14"	120	B	C	D061	Goodrich	Lifesaver XL III P Metric	150	B	C	D081
Doral	Swinger GT 60, 14"-15"	220	B	C	D119	Falcon	All Season, 15"	150	B	C	D061	Goodrich	Lifesaver XL-200, all sizes	140	B	C	D081
Doral	Swinger GT 70, 13"	200	B	C	D119	Falcon	Golden	140	B	C	D061	Goodrich	Lifesaver XLM, all sizes	170	B	C	D081
Doral	Swinger GT 70, 14"-15"	220	B	C	D119	Falcon	Golden Steel Belt	140	B	C	D061	Goodrich	Lifesaver 78 Steel-Belted	170	B	C	D081
Doral	Swinger GT 70, 15"	200	B	C	D119	Falcon	Radial II	180	B	C	D061	Goodrich	Pursuit Radial	220	B	B	D081
Doral	Swinger GT 70, 16"	220	B	C	D119	Falcon	SST	160	B	C	D061	Goodrich	T/A 50&60&70 Series	200	A	C	D081
Douglas	Mark III Dual Belted, 13"	130	B	C	D119	Falls	Roadmaster Malwear	080	A	C	D021	Goodrich	60	180	B	C	D081
Douglas	Mark III Dual Belted, 14"	180	B	C	D119	Falls	Roadmaster P75, 13"	090	A	C	D021	Goodrich	Sport GT	180	B	C	D081
Douglas	Mark III Dual Belted, 15"	180	B	C	D119	Falls	Roadmaster P75, 14"	120	A	C	D021	Goodrich	Technica (experimental)	050	B	C	D081
Douglas	Mark III Steel Belted, 13"	130	B	C	D119	Falls	Roadmaster P75, 15"	140	A	C	D021	Goodrich	The Advantage T/A	200	A	C	D081
Douglas	Mark III Steel Belted, 14"	180	B	C	D119	Falls	Roadmaster P80, 13"	090	A	C	D021	Goodrich	The Mark T/A, all sizes	200	A	C	D081
Douglas	Mark III Steel Belted, 15"	180	B	C	D119	Falls	Steel Belted Malwear	130	A	C	D021	Goodrich (imported)	/70 Series P Metric Y351	160	B	B	D081
Douglas	Track Master, 13"	190	B	C	D119	Falls	Steel Belted P75, 13"	160	A	C	D021	Goodrich (imported)	/70 Series P Metric Y882	160	A	B	D081
Douglas	Track Master, 14"-15"	220	B	C	D119	Falls	Steel Belted P75, 14"	180	A	C	D021	Goodrich (imported)	/70 Series Y883 Y351	160	B	B	D081
Douglas	Track Master 70, 13"	200	B	C	D119	Falls	Steel Belted P75, 15"	200	A	C	D021	Goodrich (imported)	/70 Series Y891	160	A	B	D081
Douglas	Track Master 70, 14"-15"	220	B	C	D119	Falls	Steel Belted P80, 13"	160	A	C	D021	Goodrich (imported)	/70 Series Y891 Y882	160	A	B	D081
Dunlop	Elite RS Patrol 70 Series	210	A	A	D051	Fidesta	All Season Fiberglass Belted, 13"	110	B	C	D061	Goodyear	American Eagle, P165/80 & P165/75	130	B	C	D091
Dunlop	Elite RS Patrol 78 Series	200	B	A	D051	Fidesta	All Season Fiberglass Belted, 14"	120	B	C	D061	Goodyear	American Eagle, 13"	170	B	C	D091
Dunlop	Elite Seventy All-Season	210	A	B	D051	Fidesta	All Season Fiberglass Belted, 15"	150	B	C	D061	Goodyear	American Eagle, 14"-15"	190	B	C	D091
Dunlop	Excel 70	160	A	B	D051	Fidesta	All Season Steel Belted, 13"	120	B	C	D061	Goodyear	Arriva, 13"	180	B	C	D091
Dunlop	Gold Cup	130	A	C	D051	Fidesta	All Season Steel Belted, 14"	170	B	C	D061	Goodyear	Arriva, 14"-15"	220	B	C	D091
Dunlop	Gold Seal	190	A	C	D051	Fidesta	All Season Steel Belted, 15"	190	B	C	D061	Goodyear	Arriva 65, 14"	180	B	C	D091
Dunlop	GS4 Fiberglass Belted	140	B	C	D051	Firestone	Cavallino, Made in USA	160	B	C	D061	Goodyear	Blue Streak Flexten, 14"-15"	130	B	B	D091
Dunlop	GT Qualifier 50 Series	180	B	B	D051	Firestone	Cavallino Sport HS-1 SR	170	B	B	D061	Goodyear	Blue Streak Rayon, 14"	210	B	B	D091
Dunlop	GT Qualifier 60 Series	200	A	B	D051	Firestone	Cavallino 155SR13, Made in Japan	160	B	B	D061	Goodyear	Blue Streak Rayon, 15"	190	B	B	D091
Dunlop	GT Qualifier 70 Series	210	A	B	D051	Firestone	Cavallino 165SR13, Made in Japan	160	A	B	D061	Goodyear	Corsair, 13"	160	B	C	D091
Dunlop	SP D-J 50/55 Series	150	A	A	D051	Firestone	Cavallino Steel Belted, Made in Japan	140	B	C	D061	Goodyear	Custom Polysteel, 13"	150	B	C	D091
Dunlop	SP D-1 60 Series	140	A	A	D051	Firestone	Cavallino Steel Belted, Made in USA	160	B	C	D061	Goodyear	Custom Polysteel, 14"-15"	170	B	C	D091
Dunlop	SP D-1 70 Series	120	A	A	D051	Firestone	Deluxe Champion, 13"-14"	140	B	C	D061	Goodyear	Custom Tread, 13"	120	B	C	D091
Dunlop	SP D-3 60/65 Series	150	A	A	D051	Firestone	Deluxe Champion, 15"	160	B	C	D061	Goodyear	Custom Tread, 14"	140	B	C	D091
Dunlop	SP D-6 60/70/80 Series	150	A	A	D051	Firestone	HPR	090	B	A	D061	Goodyear	Custom Tread, 15"	180	B	C	D091
Dunlop	SP D-7 70 Series	150	A	A	D051	Firestone	S/S 50 Series	210	B	C	D061	Goodyear	Customguard GT, 13"	160	B	B	D091
Dunlop	SP Steel Max	160	A	A	D051	Firestone	S/S 60 Series	190	B	C	D061	Goodyear	Customguard GT, 14"-15"	180	B	B	D091
Dunlop	SP4	160	A	B	D051	Firestone	S/S 70 Series	180	B	C	D061	Goodyear	Double Eagle, 15"	180	B	C	D091
Dunlop	SP4A, 155SR13	160	B	B	D051	Firestone	Steel Belted, 13"-14"	170	B	C	D061	Goodyear	Eagle GT, 15"	190	B	B	D091
Dunlop	SP4A, 175/70SR13	160	B	B	D051	Firestone	Steel Belted, 15"	200	B	C	D061	Goodyear	Eagle 390, 390 mm	240	B	B	D091
Dunlop	SP4A, 185/70SR14	160	A	B	D051	Firestone	Steel Belted 721, 13"-14"	170	B	C	D061	Goodyear	Imported Gran Prix E, SR	200	B	B	D091
Dunlop	SP4A, 185SR14	160	A	B	D051	Firestone	Steel Belted 721, 15" 80 Series	170	B	C	D061	Goodyear	Imported Gran Prix S, SR	200	A	B	D091
Dunlop	SP4A, 185SR14	160	B	B	D051	Firestone	Steel Belted 721, 15" 80 Series	200	B	C	D061	Goodyear	Imported Gran Prix 60 & 80, HR & VR sizes				

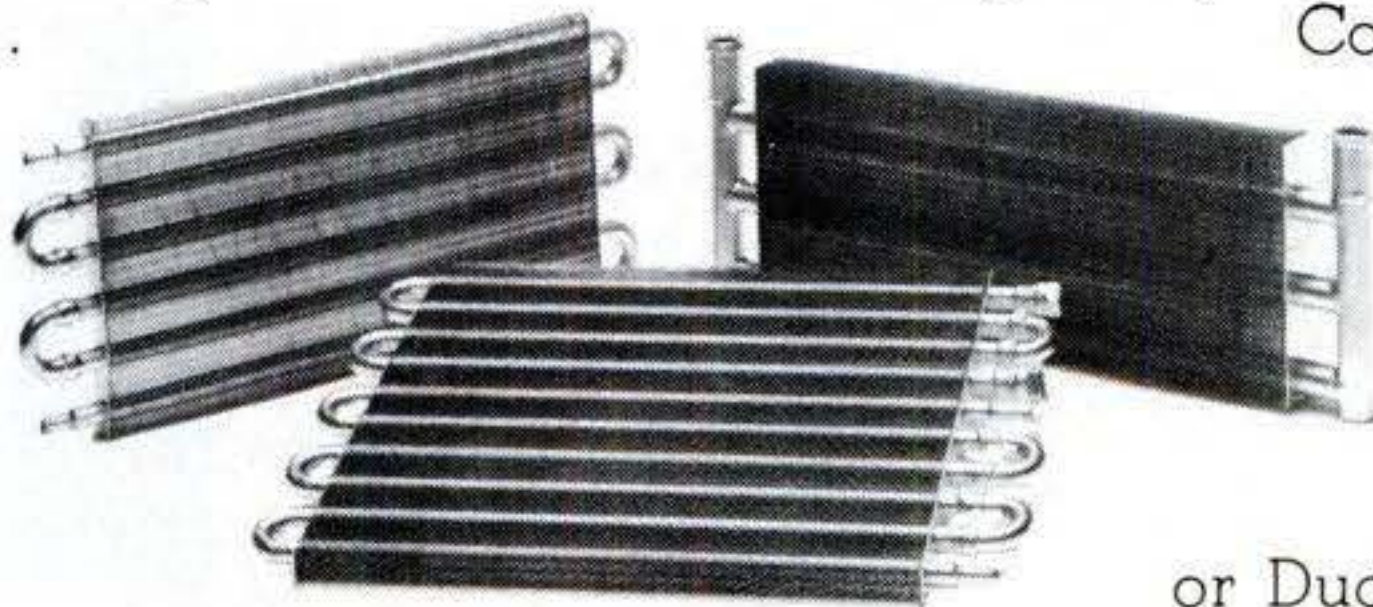
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# Federal quality grades for radial passenger-car tires

Brand	Model and diameter*	Tread life	Traction	Temperature resistance	Mfr. code**	Brand	Model and diameter*	Tread life	Traction	Temperature resistance	Mfr. code**	Brand	Model and diameter*	Tread life	Traction	Temperature resistance	Mfr. code**
Grand Prix	G/T 60, 13"	150	B	C	D109	Jetson	Sabre Metric, all dia.	120	B	C	D119	Michelin	XZX	140	A	B	D141
Grand Prix	G/T 60, 14"-15"	190	B	C	D109	Jetson	Steelshield III Steel Belted, 13"	130	B	C	D119	Michelin	ZX	140	A	B	D141
Grand Prix	G/T 70	200	B	C	D109	Jetson	Steelshield III Steel Belted, 14"-15"	180	B	C	D119	Miller	All Season Steel Belted	160	B	C	D081
Grande Marque	Grande Marque, 13"	150	B	C	D011							Miller	Mach Sixty & Seventy	180	B	C	D081
Grande Marque	Grande Marque, 14"-15"	170	A	C	D011							Miller	Steel Belted	170	B	C	D081
Griffin	Mach Sixty & Seventy	180	B	C	D081	K-Mart	Radial Plus	180	B	C	D151	Miller	Sun-N-Snow	160	B	C	D081
Griffin	Steel Belted	170	B	C	D081	K-Mart	Radial Plus	180	B	C	D061	Miller	Twin Steel Belted LRR	160	B	C	D081
Griffin	Sun-N-Snow	160	B	C	D081	K-Mart	Sport	140	B	C	D171						
Griffin	Twin Steel Belted LRR	160	B	C	D081	K-Mart	The Season Special	120	B	C	D151	Mobil Oil Corp.	Mini-Sport, all dia.	100	B	C	D109
Gulf Cruisemaste	Steel Belted 36 LRR	160	B	C	D081	K-Mart	The Season Special	120	B	C	D061	Mobil Oil Corp.	Premium I, all dia.	210	B	C	D109
Gulf Cruisemaste	Steel Belted 45, all sizes	170	B	C	D081	K-Mart	225	140	B	C	D151	Mobil Oil Corp.	Steel Belted Poly/steel, 13"	130	B	C	D109
Gulf Cruisemaste	Winter/Summer Steel Belted 36 LRR	160	B	C	D081	K-Mart	225, all dia.	140	B	C	D061	Mobil Oil Corp.	Steel Belted Poly/steel, 14"-15"	170	B	C	D109
Hallmark	AWR, 13"	120	B	C	D109	Kelly Springfield	Mark G/P	170	B	C	D109	Monarch	Fulda All Seasons, 13"	120	B	C	D119
Hallmark	AWR, 14"-15"	170	B	C	D109	Kelly Springfield	Navigator, 13"	120	B	C	D109	Monarch	Fulda All Seasons, 14"-15"	180	B	C	D119
Hallmark	AWR Ultimate G/P, P15580R13	120	B	C	D109	Kelly Springfield	Navigator, 14"-15"	170	B	C	D109	Monarch	Fulda Metric 70 All Seasons, 13"	200	B	C	D119
Hallmark	AWR Ultimate G/P	170	B	C	D109	Kelly Springfield	Pacemark, 13"	130	B	C	D109	Monarch	Fulda Metric 70 All Seasons, 14"	220	B	C	D119
Hallmark	PWR G/P III	170	B	C	D109	Kelly Springfield	Pacemark, 14"-15"	170	B	C	D109	Monarch	LTR Total Performance, 15"	180	B	C	D119
Hallmark	Sports Metric G/P	100	B	C	D109	Kelly Springfield	01	100	B	C	D109	Monarch	Metric	120	B	C	D119
Hallmark	Super G/T Sport 60, 13"	150	B	C	D109	Kelly Springfield	02	120	B	C	D109	Monarch	Metric 70, 13"	200	B	C	D119
Hallmark	Super G/T Sport 60, 14"-15"	190	B	C	D109	Kelly Springfield	03	130	B	C	D109	Monarch	Metric 70, 14"	220	B	C	D119
Hallmark	Super G/T Sport 70	200	B	C	D109	Kelly Springfield	04	140	B	C	D109	Monarch	Metro XS72, all dia.	120	B	C	D119
Hankook	R737 R Type	120	A	B	F432	Kelly Springfield	05	150	B	C	D109	Monarch	Road Hugger 60, 13"	190	B	C	D119
Hankook	SR800 R Type	150	A	B	F432	Kelly Springfield	06	160	B	C	D109	Monarch	Road Hugger 60, 14"-15"	220	B	C	D119
Heafner Tire Co.	Sunbelt Metric, all dia.	120	B	C	D119	Kelly Springfield	07	170	B	C	D109	Monarch	Road Hugger 70, 13"	200	B	C	D119
Hercules	Dual Belt II, 13"	090	A	C	D021	Kelly Springfield	08	180	B	C	D109	Monarch	Road Hugger 70, 14"-15"	220	B	C	D119
Hercules	Dual Belt II, 14"	120	A	C	D021	Kelly Springfield	09	190	B	C	D109	Monarch	Steel Belted, 13"	130	B	C	D119
Hercules	Dual Belt II, 15"	140	A	C	D021	Kelly Springfield	10 & 11	200	B	C	D109	Monarch	Steel Belted, 14"-15"	180	B	C	D119
Hercules	Glasspreme Malwear	130	B	C	D021	Kelly Springfield	12 & 13	220	B	C	D109	Monarch	Ultra IV All Season, 13"	120	B	C	D119
Hercules	Glasspreme, 13"	160	B	C	D021	Kelly Springfield	Sport Mark G/P	100	B	C	D109	Monarch	Ultra IV All Season, 14"-15"	180	B	C	D119
Hercules	Glasspreme, 14"	180	B	C	D021	Kelly Springfield	Supercharger 60, 13"	150	B	C	D109	Montgomery Ward	Gas Miser	180	B	C	D061
Hercules	Glasspreme, 15"	200	B	C	D021	Kelly Springfield	Supercharger 60, 14"-15"	190	B	C	D109	Montgomery Ward	Grappler All Season	190	B	C	D061
Hercules	Honcho 60, 13"	170	A	C	D021	Kelly Springfield	Supercharger 70	200	B	C	D109	Montgomery Ward	Grappler All Season	190	B	C	D109
Hercules	Honcho 60, 14"-15"	180	A	C	D021	Kelly Springfield	Supershield, 13"	180	B	C	D109	Montgomery Ward	Grappler Elite	200	B	C	D061
Hercules	Honcho 60-70 Malwear	130	A	C	D021	Kelly Springfield	Supershield, 14"-15"	210	B	C	D109	Montgomery Ward	Mini Metric	160	B	C	D061
Hercules	Honcho 70, 15"	180	A	C	D021	Kelly Springfield	Ultimate AWR, 13"	120	B	C	D109	Montgomery Ward	Primer	130	B	C	D061
Hercules	Sportpreme G/T Malwear	130	B	C	D021	Kelly Springfield	Ultimate AWR, 14"-15"	170	B	C	D109	Montgomery Ward	Rain Grappler	160	B	C	D061
Hercules	Sportpreme G/T, 15"	180	B	C	D021	Kelly Springfield	Voyager, 13"	180	B	C	D109	Montgomery Ward	Road Grappler	130	B	C	D061
Hercules	Steelpreme Malwear	130	A	C	D021	Kelly Springfield	Voyager, 14"-15"	220	B	C	D109	Montgomery Ward	Road Grappler, all dia.	130	B	C	D109
Hercules	Steelpreme, 13"	160	A	C	D021	Kleber	VTT M301 R Type	120	B	B	F281	Montgomery Ward	Road Tamer	190	B	C	D061
Hercules	Steelpreme, 14"	180	A	C	D021	Kleber	V106 Rayon R Type	070	A	B	F281	Montgomery Ward	Runabout	130	B	C	D061
Hercules	Steelpreme, 15"	200	A	C	D021	Kleber	V12 Steel R Type	130	A	B	F281	Montgomery Ward	Runabout All Season, 13"	120	B	C	D109
Hercules	Ultraseason, 13"	140	B	C	D021	Kleber	V15 GTS 70 Series Metric	130	A	A	F281	Montgomery Ward	Runabout All Season, 14"	130	B	C	D061
Hercules	Ultraseason, 14"	150	B	C	D021	Kleber	V15 TI 70 Series, 13"-14"	140	A	B	F281	Montgomery Ward	Runabout All Season, 15"	150	B	C	D061
Hercules	Ultraseason, 15"	180	B	C	D021	Laramie	Fulda All Seasons, 13"	120	B	C	D119	Montgomery Ward	Runabout All Season, 15"	150	B	C	D109
Holiday	All Season, 13"	140	B	C	D036	Laramie	Fulda All Seasons, 14"-15"	180	B	C	D119	Montgomery Ward	Wide-Trac 60, BR60, 13"	150	B	C	D109
Holiday	All Season, 14"	150	B	C	D036	Laramie	Fulda Metric 70 All Seasons, 13"	200	B	C	D119	Montgomery Ward	Wide-Trac 60, other sizes	190	B	C	D109
Holiday	All Season, 15"	180	B	C	D036	Laramie	Fulda Metric 70 All Seasons, 14"	220	B	C	D119	Montgomery Ward	Wide-Track 70	190	B	C	109
Hood	All Season Steel Belted	160	B	C	D081	Laramie	Fulda XJ40	120	B	C	D119	Multi-Mile	All Seasons, 13"	120	B	C	D109
Hood	Mach Sixty & Seventy	180	B	C	D081	Laramie	Glass Rider, 13"	130	B	C	D119	Multi-Mile	All Seasons, 14"-15"	170	B	C	D109
Hood	Steel Belted	170	B	C	D081	Laramie	Glass Rider, 14"-15"	180	B	C	D119	Multi-Mile	Classic RS, 13"	130	B	C	D109
Hood	Sun-N-Snow	160	B	C	D081	Laramie	Performer 60 GT, 13"	190	B	C	D119	Multi-Mile	Classic RS, 14"-15"	170	B	C	D109
Hood	Twin Steel Belted LRR	160	B	C	D081	Laramie	Performer 60 GT, 14"-15"	220	B	C	D119	Multi-Mile	Criterion	180	B	C	D061
India	All Season	200	B	C	D071	Laramie	Performer 70 GT, 13"	200	B	C	D119	Multi-Mile	Hi-Speed	200	B	C	D109
India	All Season, 13"	140	B	C	D071	Laramie	Performer 70 GT, 14"-15"	220	B	C	D119	Multi-Mile	Premium RS, 13"	130	B	C	D109
India	All Season, 14"-15"	170	B	C	D071	Laramie	Sabre Metric, all dia.	120	B	C	D119	Multi-Mile	Premium RS, 14"-15"	170	B	C	D109
India	Steel Belted PB128	170	B	C	D071	Laramie	Steel Rider, 13"	130	B	C	D119	Multi-Mile	G/T	200	B	C	D109
Interstate	All Season, 13"	120	B	C	D119	Laramie	Steel Rider, 14"-15"	180	B	C	D119	Multi-Mile	XL	150	B	C	D061
Interstate	All Season, 14"-15"	180	B	C	D119	Laramie	Tempra All Season, 13"	120	B	C	D119	Multi-Mile	Sigma	220	B	C	D109
Interstate	Drag Master 60, 13"	190	B	C	D119	Laramie	Tempra All Season, 14"-15"	180	B	C	D119	Multi-Mile	Supreme, 13"	120	B	C	D109
Interstate	Drag Master 60, 14"-15"	220	B	C	D119	Lee	All Weather, 13"	120	B	C	D119	Multi-Mile	Supreme, 14"-15"	170	B	C	D109
Interstate	Drag Master 70, 13"	200	B	C	D119	Lee	All Weather, 14"-15"	180	B	C	D119	National	GTX 700 Metric 70, 13"	200	B	C	D119
Interstate	Drag Master 70, 14"-15"	220	B	C	D119	Lee	Fulda All Seasons, 13"	120	B	C	D119	National	GTX 700 Metric 70, 14"	220	B	C	D119
Interstate	Fulda All Seasons, 13"	120	B	C	D119	Lee	Fulda All Seasons, 14"-15"	180	B	C	D119	National	LTR Total Performance, 15"	180	B	C	D119
Interstate	Fulda All Seasons, 14"-15"	180	B	C	D119	Lee	Fulda Metric 70 All Seasons, 13"	200	B	C	D119	Ohtsu	70 Series R720	180	B	B	F311
Interstate	Fulda Metric 70 All Seasons, 13"	200	B	C	D119	Lee	Fulda Metric 70 All Seasons, 14"	220	B	C	D119	Ohtsu	Alpha Series R460	180	B	B	F311
Interstate	Fulda XJ40	120	B	C	D119	Lee	GS Steel Belted, 13"	130	B	C	D119	Ohtsu	R-Type R520	170	B	B	F311
Interstate	GTX 700 Metric 70, 13"	200	B	C	D119	Lee	GS Steel Belted, 14"-15"	180	B	C	D119	Orban	R737, 155SR13-15	120	A	B	F432
Interstate	GTX 700 Metric 70, 14"	220	B	C	D119	Lee	LTR Total Performance, 15"	180	B	C	D119	Orban	R737, 165SR13-14-15	120	A	B	F432
Interstate	LTR Total Performance, 15"	180	B	C	D119	Lee	Manhandler 60, 13"	190	B	C	D119	Orban	R737, 175SR13-14	120	A	B	F432
Interstate	Steel Belted, 13"	130	B	C	D119	Lee	Manhandler 60, 14"-15"	220	B	C	D119	Orban	R737, 185SR13-14	120	A	B	F432
Interstate	Steel Belted, 14"-15"	180	B	C	D119	Lee	Manhandler 70, 13"	200	B	C	D119	Orban	SR800, 155SR13	150	A	B	F432
Ironsides	All Steel	200	A	C	D181	Lee	Manhandler 70, 14"-15"	220	B	C	D119	Orban	SR800, 165SR13	150	A	B	F432
Javelin	All Season Steel Belted, 13"	120	B	C	D109	Lee	Metric 70, 13"	200	B	C	D119	Orban	SR800, 175SR13-14	150	A	B	F432
Javelin	All Season Steel Belted, 14"-15"	170	B	C	D109	Lee	Metric 70, 14"	220	B	C	D119	Orban	SR800, 185SR13-14	150	A	B	F432
Javelin	GT	170	B	C	D109	Maxi Trac	60 Series	220	A	C	D011	Orban	SR807, 175/70SR13	180	A	C	F432
Javelin	Steel Belted, 13"	130	B	C	D109	Maxi Trac	70 Series, 13"	180	B	C							



A comparison of projections from manufacturers' treadwear ratings under the new government Uniform Tire Quality Grading System indicates that on a government-specified course:

# Uniroyal Steeler projected to last 15,000 more miles than comparable Goodyear or Goodrich tires.

Clip and take this to your Uniroyal dealer:

The U.S. Department of Transportation recently gave the public a standard yardstick to compare tires by.

Now, each tire company is required by law to grade its tires in three areas. Traction. Temperature resistance. And treadwear.

And then to emboss the resulting grades on the side of the tires.

When compared, most of the similarly priced steel-belted radials in the chart fared equally well in the traction test. Same for temperature resistance.

But one tire pulls ahead of the pack when it comes to the important grade that indicates the relative wear rate of your tire.

That tire: the Uniroyal Steeler.

In fact, when you translate its 220 rating into projected miles on the government-specified course, you see it was no photo finish.

On that course, the mileage projection for the Uniroyal Steeler is 66,000 miles.

That's 15,000 miles longer than the Goodyear, Goodrich, General and most Firestone ratings in the chart would project.

And 24,000 miles longer than Michelin's rating would project.

These mileage projections (including those in the chart) should be used for comparison only. You will probably not achieve these results. Actual treadlife will vary substantially due to your driving habits, condition of vehicle and, in many sections

of the country, road conditions and climate.

See your Uniroyal dealer for details.

MANUFACTURERS' RATINGS FOR U.S. GOVERNMENT QUALITY GRADING SYSTEM			PROJECTION OF MILEAGE ON GOVERNMENT-SPECIFIED TEST COURSE
Manufacturer/Tire:	Traction and Temperature Resistance	Treadwear	
UNIROYAL Steeler	B/C	220	66,000
GOODYEAR Custom Polysteel	B/C	170	51,000
FIRESTONE 721 (13" & 14" sizes)	B/C	170*	51,000
GENERAL Dual Steel II	B/C	170	51,000
B.F. GOODRICH Life Saver XLM	B/C	170	51,000
MICHELIN XWW	A/B	140	42,000

\*Most 15" Firestone 721 tires rated 200 which projects to 60,000 miles.

Source: U.S. D.O.T., 12/19/80.

For a free booklet on grade-labeling, please send your name and address to: Uniroyal, Inc., Tire Advertising Department, Middlebury, Connecticut 06749.

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**UNIROYAL**

# Federal quality grades for radial passenger-car tires

Brand	Model and diameter*	Tread life	Traction	Temperature resistance	Mfr. code**	Brand	Model and diameter*	Tread life	Traction	Temperature resistance	Mfr. code**	Brand	Model and diameter*	Tread life	Traction	Temperature resistance	Mfr. code**
Oxford	Invader 70, 13"	200	B	C	D119	Republic	Road Rebel 70, 13"	200	B	C	D119	Spartan	Sun-N-Snow	160	B	C	D081
Oxford	Invader 70, 14"-15"	220	B	C	D119	Republic	Road Rebel 70, 14"-15"	220	B	C	D119	Spartan	Twin Steel Belted LRR	160	B	C	D081
Oxford	LTR Total Performance, 15"	180	B	C	D119	Republic	Steel Belted, 13"	130	B	C	D119	Starfire	All Season Malwear	100	B	C	D021
Oxford	Steel Belted, 13"	130	B	C	D119	Republic	Steel Belted, 14"-15"	180	B	C	D119	Starfire	All Season P75, 14"	160	B	C	D021
Oxford	Steel Belted, 14"-15"	180	B	C	D119	Revere	Radial Plus	180	B	C	D171	Starfire	All Season P75, 15"	180	B	C	D021
Peerless	Permasteel 70 Series	220	B	C	D171	Revere	Special	120	B	C	D171	Starfire	All Season P80, 13"	130	B	C	D021
Peerless	Permasteel 78-75 Series	220	B	C	D171	Revere	200	100	B	C	D171	Starfire	Glass-Beltd Malwear	080	A	C	D021
Peerless	PTR 78	220	B	C	D171	Revere	225 70 Series & 78 Series	140	B	C	D171	Starfire	Impenal Glass P215/75R15	200	B	C	D021
Peerless	Sprint	160	A	C	D171	Reynolds	All Season, 13"	140	B	C	D071	Starfire	Glas-Beltd P75, 13"	090	A	C	D021
JCPenney	All Season II, except P185/80R13	110	B	C	D071	Reynolds	All Season, 14"-15"	170	B	C	D071	Starfire	Glas-Beltd P75, 14"-15"	140	A	C	D021
JCPenney	All Season II	110	B	C	D109	Reynolds	Metric	170	B	C	D071	Starfire	Glas-Beltd P80, 13"	090	A	C	D021
JCPenney	All Seasons, 13"	120	B	C	D036	Reynolds	Steel Beltd	170	B	C	D071	Starfire	Sport Malwear	130	B	C	D021
JCPenney	All Seasons, 14"-15"	170	B	C	D036	Reynolds	60, all dia.	200	B	C	D071	Starfire	Sport R Type, 15"	180	B	C	D021
JCPenney	Ground Gainer, 13"	130	B	C	D109	Road King	All Season, 13"	140	B	C	D036	Starfire	Super 60 Malwear	130	A	C	D021
JCPenney	Ground Gainer, 14"-15"	170	B	C	D109	Road King	All Season, 14"	150	B	C	D036	Starfire	Super 60 P60, 13"	170	A	C	D021
JCPenney	Ground Gainer, 13"	130	B	C	D036	Road King	All Season, 15"	180	B	C	D036	Starfire	Super 60 P60, 14"-15"	180	A	C	D021
JCPenney	Ground Gainer, 14"-15"	170	B	C	D036	Road King	ES 78 Steel Beltd JR78-15 & P205/75R15	200	B	C	D036	Starfire	Super 70 Malwear	130	A	C	D021
JCPenney	Mileagemaker XP	200	B	C	D071	Road King	ES 78 Steel Beltd, 13"	170	B	C	D036	Starfire	Super 70 P70, 15"	180	A	C	D021
JCPenney	Mileagemaker XP, all dia.	200	B	C	D036	Road King	ES 78 Steel Beltd, 14"	190	B	C	D036	Star Tires	All Season, P15580R13	120	B	C	D109
JCPenney	Reliant Sport	100	B	C	D036	Road King	ES 78 Steel Beltd, 15"	200	B	C	D036	Star Tires	All Season, all other dia.	170	B	C	D109
JCPenney	Reliant Sport, all dia.	100	B	C	D109	Road King	180/70 & 280/70	160	A	B	D171	Star Tires	Centurion, 13"	180	B	C	D109
JCPenney	Scat Trac 60	200	B	C	D036	Road King	240 R, 240/70 & 340/60	140	A	A	D171	Star Tires	Centurion, 14"-15"	210	B	C	D109
JCPenney	Scat Trac 70	190	B	C	D036	Road King	280 R Type	140	A	B	D171	Star Tires	Deluxe	170	B	C	D109
JCPenney	Survivor, 13"	120	B	C	D036	Safemark	All Season, 13"	140	B	C	D071	Star Tires	Quattro, 13"	120	B	C	D109
JCPenney	Survivor, 14"-15"	150	B	C	D036	Safemark	All Season, 14"-15"	170	B	C	D071	Star Tires	Quattro, 14"-15"	170	B	C	D109
JCPenney	Survivor Steel	170	B	C	D071	Safemark	Metric	170	B	C	D071	Star Tires	Sport Metric G/P	100	B	C	D109
JCPenney	Weather Tamer, 13"	120	B	C	D036	Safemark	Multi-Season P75, 13"	140	B	C	D071	Star Tires	Steel Beltd, 13"	130	B	C	D109
JCPenney	Weather Tamer, 14"-15"	140	B	C	D036	Safemark	Multi-Season P75, 14"-15"	170	B	C	D071	Star Tires	Steel Beltd, 14"-15"	170	B	C	D109
Pep Boys	Fulda All Seasons, 13"	120	B	C	D119	Safemark	Multi-Season P80, 13"	140	B	C	D071	Star Tires	Super G/T 70	200	B	C	D109
Pep Boys	Fulda All Seasons, 14"-15"	180	B	C	D119	Safemark	Sixty P Metric 60 Series	200	B	C	D071	Star Tires	Super GT Sport 60, 13"	150	B	C	D109
Pep Boys	Fulda Metric 70 All Seasons, 13"	200	B	C	D119	Safemark	Steel Beltd P Metric	170	B	C	D071	Star Tires	Super GT Sport 60, 14"-15"	190	B	C	D109
Pep Boys	Fulda Metric 70 All Seasons, 14"	220	B	C	D119	Saxon	All Trac All Season, 13"	120	B	C	D119	Star Tires	Super 70	200	B	C	D109
Phillips	All Season, 13"	140	B	C	D071	Saxon	All Trac All Season, 14"-15"	180	B	C	D119	Star Tires	Super Star, 13"	150	B	C	D109
Phillips	All Season, 14"-15"	170	B	C	D071	Saxon	Fulda All Seasons, 13"	120	B	C	D119	Star Tires	Super Star, 14"-15"	190	B	C	D109
Phillips	Metric	170	B	C	D071	Saxon	Fulda All Seasons, 14"-15"	180	B	C	D119	Star Tires	Super Star 70	200	B	C	D109
Phillips	II Alpha Series	150	B	C	D061	Saxon	Fulda All Seasons, 14"-15"	180	B	C	D119	Star Tires	Super Star 60, 13"	150	B	C	D109
Phillips	Steel Beltd	170	B	C	D071	Saxon	Fulda Metric 70 All Seasons, 13"	200	B	C	D119	Star Tires	Super Star 60, 14"-15"	190	B	C	D109
Phoenix	/70 Series HR14	160	A	A	F321	Saxon	Fulda Metric 70 All Seasons, 14"	220	B	C	D119	Stratton	All Season Steel Beltd	160	B	C	D081
Phoenix	3011	180	A	A	F321	Saxon	Fulda XJ40	120	B	C	D119	Stratton	Mach Sixty & Seventy	180	B	C	D081
Pirelli	P3, P3/70	150	A	B	F331	Saxon	SS Speed Track 60, 13"	190	B	C	D119	Stratton	Steel 78	170	B	C	D081
Pirelli	P76, P77, CN36, P5, P6, P7, CN12 & CN73	150	A	A	F331	Saxon	SS Speed Track 60, 14"-15"	220	B	C	D119	Stratton	Steel Beltd	170	B	C	D081
Pos-A-Traction	Twister 50 Series, 13"	190	A	C	D011	Saxon	SS Speed Track 70, 13"	200	B	C	D119	Stratton	Sun-N-Snow	160	B	C	D081
Pos-A-Traction	Twister 50 Series, 14"-15"	220	A	C	D011	Saxon	SS Speed Track 70, 14"-15"	220	B	C	D119	Stratton	Super Steel Beltd LRR	160	B	C	D081
Pos-A-Traction	Twister 60 Series	220	A	C	D011	Saxon	Steel Beltd, 13"	130	B	C	D119	Stratton	Twin Steel Beltd	160	B	C	D081
Power Cat	60 Series	200	B	C	D071	Saxon	Steel Beltd, 14"-15"	180	B	C	D119	Summit	Metric	170	B	C	D071
Power Custom	78, 13"	140	B	C	D036	Sears	Guardsman	130	B	C	D011	Summit	Trac 60	200	B	C	D071
Power Custom	78, 14"	160	B	C	D036	Sears	Roadhandler GT 60	220	A	C	D011	Summit	Siempre II All Season, 13"	140	B	C	D071
Power Custom	78, 15"	170	B	C	D036	Sears	Roadhandler GT 70	190	A	C	D011	Summit	Siempre II All Season, 14"	170	B	C	D071
Pro-Trac	R/P, 13"	150	B	C	D109	Sears	Roadhandler	140	A	B	D141	Summit	Siempre II All Season, 15"	170	B	C	D071
Pro-Trac	R/P, 14"-15"	190	B	C	D109	Sears	Roadhandler TR	140	A	A	D141	Summit	Steel Beltd	170	B	C	D071
Prowler	Cougar	130	B	C	D011	Sears	Silent Cushion	140	B	C	D011	Summit	Steel	160	B	C	D071
Ram	All Season, 13"	150	B	C	D011	Sears	Steel Beltd	140	A	B	D141	Sun Belt	Metric	120	B	C	D119
Ram	All Season, 14"-15"	200	A	C	D011	Sears	Superguard, 13"	120	B	C	D011	Telstar Corp.	Fulda All Seasons, 13"	120	B	C	D119
Ram	Big Horn	130	B	C	D011	Sears	Superguard, 14"-15"	150	B	C	D011	Telstar Corp.	Fulda All Seasons, 14"-15"	180	B	C	D119
Ram	Ram, 14"-15"	170	B	C	D011	Sears	Weatherhandler	130	B	C	D011	Telstar Corp.	Fulda Metric 70 All Seasons, 13"	200	B	C	D119
Ramus	Mach Sixty & Seventy	180	B	C	D081	Sears	Weatherwise	160	B	C	D011	Telstar Corp.	Fulda Metric 70 All Seasons, 14"	220	B	C	D119
Ramus	Steel Beltd	170	B	C	D081	Seiberling	Four Season, 13"	140	B	C	D036	Telstar Corp.	Fulda XJ40	120	B	C	D119
Ramus	Sun-N-Snow	160	B	C	D081	Seiberling	Four Season, 14"	150	B	C	D036	Telstar Corp.	Sabre Metric, all dia.	120	B	C	D119
Ramus	Twin Steel Beltd LRR	160	B	C	D081	Seiberling	Four Season, 15"	180	B	C	D036	Telstar Corp.	Streaker 60, 13"	190	B	C	D119
Regal	All Season Steel Beltd	160	B	C	D081	Seiberling	Le Mans S/R Alpha 60 Series	200	B	C	D036	Telstar Corp.	Streaker 60, 14"-15"	220	B	C	D119
Regal	Mach Sixty & Seventy	180	B	C	D081	Seiberling	Le Mans S/R Alpha 70 Series	170	B	C	D036	Telstar Corp.	Streaker 70, 13"	200	B	C	D119
Regal	Steel Beltd, all dia.	170	B	C	D081	Seiberling	Steel Beltd	170	B	C	D036	Telstar Corp.	Streaker 70, 14"-15"	220	B	C	D119
Regal	Sun-N-Snow, all dia.	160	B	C	D081	Semperit	SST M501 R Type /70 Series	150	A	B	F341	Telstar Corp.	Streaker 70, 15"	200	B	C	D119
Regal	Twin Steel Beltd LRR	160	B	C	D081	Semperit	SST M501 SR, 12"-13"-14"-15"	150	A	B	F341	Telstar Corp.	Triton II Dual Beltd, 13"	130	B	C	D119
Regal	XL 60, all dia.	180	B	C	D081	Semperit	SST M501 170SR, 13"-14"	150	A	B	F341	Telstar Corp.	Triton II Dual Beltd, 14"	180	B	C	D119
Regal	XL Steel Beltd LRR	160	B	C	D081	Semperit	VVT M301 R Type, 13"	130	B	B	F341	Telstar Corp.	Triton II Dual Beltd, 15"	180	B	C	D119
Remington	Cushion-Aire Metric	140	B	C	D051	Shell	VVT M301 R Type, 14"-15"	120	B	B	F341	Telstar Corp.	Triton II Steel Beltd, 13"	130	B	C	D119
Remington	Cushion-Aire	190	A	C	D051	Shell	GLS, all sizes	150	B	C	D071	Telstar Corp.	Triton II Steel Beltd, 14"	180	B	C	D119
Remington	Pioneer	130	A	C	D051	Shell	GLS, P155/80R13 only	120	B	C	D071	Telstar Corp.	Triton II Steel Beltd, 15"	180	B	C	D119
Remington	Society 70 All Season	210	A	B	D051	Shell	Metric	170	B	C	D071	Telstar Corp.	Triton II Steel Beltd, 15"	180	B	C	D119
Remington	XT120 60 Series	200	A	B	D051	Shell	All Season, 13"	140	B	C	D071	Telstar Corp.	Triton II Steel Beltd, 15"	180	B	C	D119
Remington	XT120 70 Series	210	A	B	D051	Shell	All Season, 13"	120	B	C	D109	Telstar Corp.	Triton II Steel Beltd, 15"	180	B	C	D119
Republic	All Season, 13"	120	B	C	D119	Shell	All Season, 14"-15"	170	B	C	D109	Telstar Corp.	Triton II Steel Beltd, 15"	180	B	C	D119
Republic	All Season, 14"-15"	180	B	C	D119	Shell	All Season, 14"-15"	170	B	C	D109	Telstar Corp.	Triton II Steel Beltd, 15"	180	B	C	D119
Republic	Fulda All Seasons, 13"	120	B	C	D119	Shell	All Season, 14"-15"	170	B	C	D109	Telstar Corp.	Triton II Steel Beltd,				

# Car transmitter sends digital data to speed servicing

Dread waiting in long lines of cars for maintenance at your local dealer? A miniature radio transmitter installed in your car and a computer at your dealer's service center may cut waiting time in the future. The transmitter-computer concept, besides helping you get to work on time, may also be used to help pinpoint problems in your car, operate ticketless parking systems, or alert police that a vehicle is stolen.

GM's service-development center has been testing small, fist-size electronic modules that would be installed by dealers. As a car approached the dealer's service entrance, the radio module would activate a computer at the dealership with a coded digital signal. By the time you drove in, the computer would have printed out your name, the vehicle identification number, a repair order, your car's repair history, a maintenance "menu," plus possible recall modifications needed. Instead of waiting for someone to look up all that information about your car and write out an order, you could be on your way in minutes.

"We're also working on a number of systems to improve a customer's ability to explain the symptoms his car is exhibiting so they can be properly diagnosed, as well as new equipment to help in the diagnosis," said S. Ted Parker, director of service research at the center.

One of these slightly more complex systems would tie the transmitter module into the C-4 microcomputer now standard on GM cars. Service personnel would then also have data on existing engine conditions, mileage, and emissions. The modules for the tests are built by Symtec, Inc. (Southfield, Mich.), and can be made "smarter" by altering their digital circuits.

Symtec believes its hardware would also work with ticketless parking systems. Instead of looking for a parking stub (which you might have misplaced), you would tap a confidential code into a keypad to raise the exit gate, thus preventing unauthorized persons from using your car. The system could provide automatic billing, too.

With the ignition on, your car would transmit its identification number constantly. If you reported your car stolen, sensors monitored by police could identify it.—John Free

Brand	Model and diameter*	Tread life	Traction	Temperature resistance	Mfr. code**
Toyo	Steel Belted Z702 HR	160	A	B	F401
Toyo	Steel Belted Z706/70 R14-R15	170	B	B	F401
Toyo	Steel Belted Z709/70 HR	160	A	A	F401
Toyo	Steel Belted Z711/70 SR13 & Z8-Z12-Z702 SR Z709SR	160	B	B	F401
Treasury	Mach Sixty & Seventy Steel Belted	180	B	C	D081
Treasury	Sun-N-Snow	170	B	C	D081
Treasury	Twin Steel Belted LRR	160	B	C	D081
Triumph	All Season, 13"	110	B	C	D061
Triumph	All Season, 14"	120	B	C	D061
Triumph	All Season, 15"	150	B	C	D061
Triumph	Steel Belted All Metric	190	B	C	D061
Triumph	Steel Belted P Metric	180	B	C	D061
TSC Industries	All Season Steel Belted, 13"	130	B	C	D109
TSC Industries	All Season Steel Belted, 14"-15"	180	B	C	D109
TSC Industries	440 II Steel Belted, 13"	140	B	C	D109
TSC Industries	440 II Steel Belted, 14"-15"	180	B	C	D109
Ultissimo	P Metric 75 Series, 14"-15"	130	B	C	D151
Ultissimo	SBR P Metric 75, 13"-14"	110	B	C	D151
Ultissimo	SBR P Metric 80, 13"	110	B	C	D151
Ultissimo	SR365, all sizes	120	B	C	D151
Union	Five Star Metric	150	B	C	D061
Union	Five Star Steelbelt, 13"	180	B	C	D061
Union	Five Star Steelbelt, 14"-15"	220	B	C	D061
Union	Four Star All Season, 13"	120	B	C	D061
Union	Four Star All Season, 14"	180	B	C	D061
Union	Four Star All Season, 15"	180	B	C	D061
Union	Four Star Steel Belted, 13"	130	B	C	D109
Union	Four Star Steel Belted, 14"-15"	170	B	C	D109
Union	Three Star, 13"	130	B	C	D061
Union	Three Star, 14"-15"	180	B	C	D061
Uniroyal	Fastrak Fiberglass Belted	180	B	C	D171
Uniroyal	Fiberglass Belted	180	B	C	D171
Uniroyal	Royal Seal Steel Belted	220	B	C	D171
Uniroyal	Steel Belted	200	B	C	D171
Uniroyal	Steel Belted	220	B	C	D171
Uniroyal	Steeler Steel Belted	220	B	C	D171
Uniroyal	Tiger Paw All Seasons, 13"	180	B	C	D171
Uniroyal	Tiger Paw All Seasons, all other sizes	200	B	C	D171
Uniroyal	Tiger Paw R-60	190	B	C	D171
Uniroyal	Tiger Paw Steel/Glass Belted	220	B	C	D171
Uniroyal	180, 165/70SR13	150	A	B	D171
Uniroyal	180, all other 70 series	160	A	B	D171
Uniroyal	240, 165HR13-14	130	A	A	D171
Uniroyal	175HR14	130	A	A	D171
Uniroyal	240, all other sizes	160	A	A	D171
Uniroyal	280, P155/80R13	170	B	C	D171
Uniroyal	280, 145SR13	130	A	C	D171
Uniroyal	280, 155SR13-15	150	A	B	D171
Uniroyal	280, all other sizes	160	A	B	D171
Vanguard	Mach Sixty & Seventy Steel Belted	180	B	C	D081
Vanguard	Steel Belted	170	B	C	D081
Vanguard	Sun-n-Snow	160	B	C	D081
Vanguard	Twin Steel Belted LRR	160	B	C	D081
Vanguard	XR Steel Belted LRR	160	B	C	D081
Veltro	Veltro, except 165SR14	150	A	B	F251
Vogue	Custom Built Aramid, P215/75 R15	220	B	C	D109
Vogue	Custom Built Aramid, P235/75 R15	180	B	C	D109
Vogue	Custom Built	220	B	C	D109
Vogue	Steel Belted all season, P235/75 R15	210	B	C	D109
Vogue	Twin LR78-15	170	B	C	D109
Vogue	Twin All Seasons, 13"	120	B	C	D109
Vogue	Twin All Seasons, 14"-15"	170	B	C	D109
Western Auto	American Spirit All Season P Metric	220	B	C	D109
Western Auto	LPS Steel Belted P Metric, 13"	150	B	C	D036
Western Auto	LPS Steel Belted P Metric, 14"	170	B	C	D036
Western Auto	LPS Steel Belted P Metric, 15"	180	B	C	D036
Western Auto	LPS Steel Belted R Type, 13"	180	B	C	D036
Western Auto	LPS Steel Belted R Type, 14"-15"	190	B	C	D036
Western Auto	Macho GT 60 Series Alpha	200	B	C	D036
Western Auto	Sentry P Metric, 13"	140	B	C	D036
Western Auto	Sentry P Metric, 14"	160	B	C	D036
Western Auto	Sentry P Metric, 15"	170	B	C	D036
Western Auto	Sentry 13 R	180	B	C	D036
Western Auto	Sentry 15 R	190	B	C	D036
White	Solution Steel Belted P75 JR78-15	200	B	C	D036

\*Diameter given where available  
\*\*See end of table for mfrs. names and addresses

Brand	Model and diameter*	Tread life	Traction	Temperature resistance	Mfr. code**
White	Solution Steel Belted P75, 13"	170	B	C	D036
White	Solution Steel Belted P75, 14"	190	B	C	D036
White	Solution Steel Belted P75, 15" & P235/75RI	200	B	C	D036
White	Whisper Jet II Belted, 13"	140	B	C	D036
White	Whisper Jet II Belted, 14"	160	B	C	D036
White	Whisper Jet II Belted, 15"	170	B	C	D036
Widetrack	Alpha 60 Series	200	B	C	D036
Widetrack	Alpha 70 Series	270	B	C	D036
Widetrack	Alpha 70 Series	190	B	C	D036
Winston	All Season, 13"	110	B	C	D061
Winston	All Season, 14"-15"	130	B	C	D061
Winston	All sizes except 165SR14 Californian	150	B	B	F251
Winston	160 B C	160	B	C	D081
Winston	Gas Stretcher	180	B	C	D061
Winston	Glass	150	B	C	D061
Winston	Metric Fabric R Type	130	B	B	F341
Winston	Metric Fabric 165R15	120	B	B	F341
Winston	Metric Fabric 175R14	120	B	B	F341
Winston	Metric Glass, all dia.	120	B	C	D119
Winston	Metric 80 Steel, all other R type	150	A	B	F251
Winston	Metric 80 Steel 165R14	150	B	B	F251
Winston	Metric 70 Steel 170 Series	150	A	B	F251
Winston	Metric 70 Steel 195/70 HR14	150	A	A	F251
Winston	185/70HR14, 195/70 R14	150	A	A	F251
Winston	60 Series R-R, all sizes	180	B	C	D119
Winston	60 Series Rayon-Rayon	180	B	C	D081
Winston	70 Series Polysteel	210	B	C	D081
Winston	70 Series Rowl Gran-Trak, 13"	200	B	C	D119
Winston	70 Series Rowl Gran-Trak, 14"-15"	220	B	C	D119
Yokohama	Alpha 60 Series, all dia.	220	A	B	F391
Yokohama	Alpha 78, 13"-14"	160	A	B	F391
Yokohama	Alpha 78, 14"-15"	180	A	C	F391
Yokohama	Metric 70 Series SR Y887, SR13"-14"	160	A	B	F391
Yokohama	R Type SR, all dia.	160	A	B	F391
Yokohama	Steel Belted 145SR13, 165/70SR13, 185/70SR13-14, 175SR14, 195/70SR14	160	B	B	F391
Yokohama	165/70SR13, 185/70SR13, 195/70SR14	160	A	B	F391
Yokohama	60 Series Y885 Alpha	180	A	B	F391
Yokohama	70 Series Y351 Y867	160	B	B	F391
Yokohama	70 Series Y882 Y885	160	B	B	F391
Yokohama	70 Series Y887	160	A	B	F391
Yokohama	75 Series Y858 P Metric	180	A	C	F391
Yokohama	78 Series Y850 Alpha	160	B	B	F391
Yokohama	78 Series Y858 Alpha	180	A	C	F391
Yokohama	82 Series Y865 Y867 Y350	160	B	B	F391
Yokohama	82 Series Y891	160	A	B	F391
Zenith	All Season, 13"	140	B	C	D036
Zenith	All Season, 14"	150	B	C	D036
Zenith	All Season, 15"	180	B	C	D036

## WHO MAKES THEM

**Domestic tire manufacturers by code (see table):**  
**D011 Armstrong**, New Haven CT 06507; **D021 Cooper**, Findlay OH 45840; **D036 Dayton**, Akron OH 44319; **D051 Dunlop**, Buffalo NY 14240; **D061 Firestone**, Akron OH 44317; **D071 General**, Akron OH 44329; **D081 B.F. Goodrich**, Akron OH 44318; **D091 Goodyear**, Akron OH 44316; **D109 Kelly Springfield**, Cumberland MD 21502; **D119 Lee**, 1100 E. Hector St., Conshohocken PA 19428; **D121 McCreary**, 1600 W. Washington St., Indiana PA 15701; **D141 Michelin**, Box 1007, New Hyde Park NY 11043; **D151 Mohawk**, Hudson OH 44236; **D171 Uniroyal**, 6600 E. Jefferson Ave., Detroit MI 48232; **D181 International Rubber Industries**, 2500 Grassland Dr., Louisville KY 40299.

**Foreign tire manufacturers and distributors:**  
**F211 Avon**, Peterson Associates, Inc., 587 Summit Dr., Orange CT 06477; **F221 Alliance**, Solcoor, Inc., 415 Madison Ave., New York NY 10017; **F231 Barum**, Bomon Automotive Ltd., 1855 Boul. Industriel, Chomedey, Laval, Quebec, Canada H7S 1P5; **F241 Bridgestone**, 2160 W. 190 St., Torrance CA 90504; **F251 Ceat**, S.p.A. Pneumatici, Casella Postale 509, 10100 Torino, Italy; **F261 Continental**, 1200 Wall St. W., Lyndhurst NJ 07071; **F271 Gislaved**, Products-From-Sweden, Inc., Rt. 22, Patterson NY 12563; **F281 Kleber**, The French Tire, 615 Franklin Turnpike, Ridgewood NJ 07450; **F311 Ohtsu**, 9-1 Kawaharacho, Izumi-Ohtsu Osaka, Japan; **F321 Phoenix**, Meon Inc., 221-26 Merrick Blvd., Jamaica NY 11413; **F331 Pirelli**, Six Ram Ridge Rd., Spring Valley NY 10977; **F341 Semperit**, 156 Ludlow Ave., Northvale NJ 07647; **F391 Yokohama**, 1530 Church Rd., Montebello CA 90640; **F401 Toyo**, 3136 E. Victoria St., Compton CA 90221; **F421 Okamoto Riken**, J. N. Ceazan Co., Carson CA 90749; **F432 Hankook**, Aurora Tires, Hyosung Inc., One Penn Plaza, New York NY 10001; **F433 Fulda**, 1100 E. Hector St., Conshohocken PA 19428.

# Heat-capturing house

has solar collectors built in

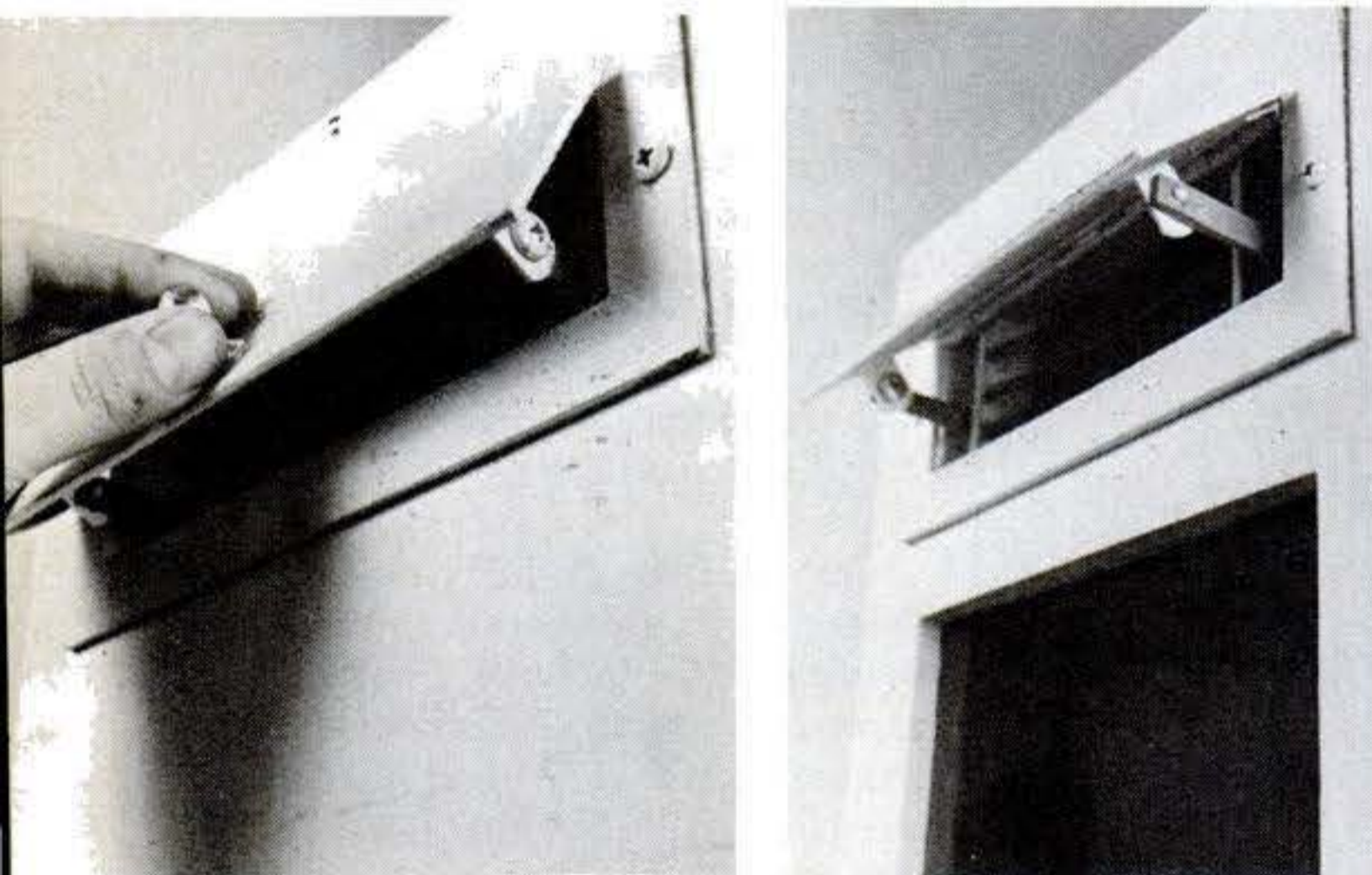
By AL LEES

The south wall of this snugly designed lodge that we commissioned from architect Samuel Paul is almost entirely glass, to capture solar heat: What isn't double-glazed window area is filled with a dozen homemade, built-in air collectors, set between the 2x6 studs. And when winter's past, the system isn't mothballed: through thermosiphoning action, it cools the house in hot weather.

But as a winter retreat this house is especially shrewd. Those big south-facing windows yield direct heat gain,

while the collector panels that flank them encourage circulation of sun-warmed air throughout the house. Windows are kept to a bare minimum in other walls, where the 2x6 framing (24" o.c.) allows for a full 5½" of fiberglass (R-19). Ceilings are insulated to R-30.

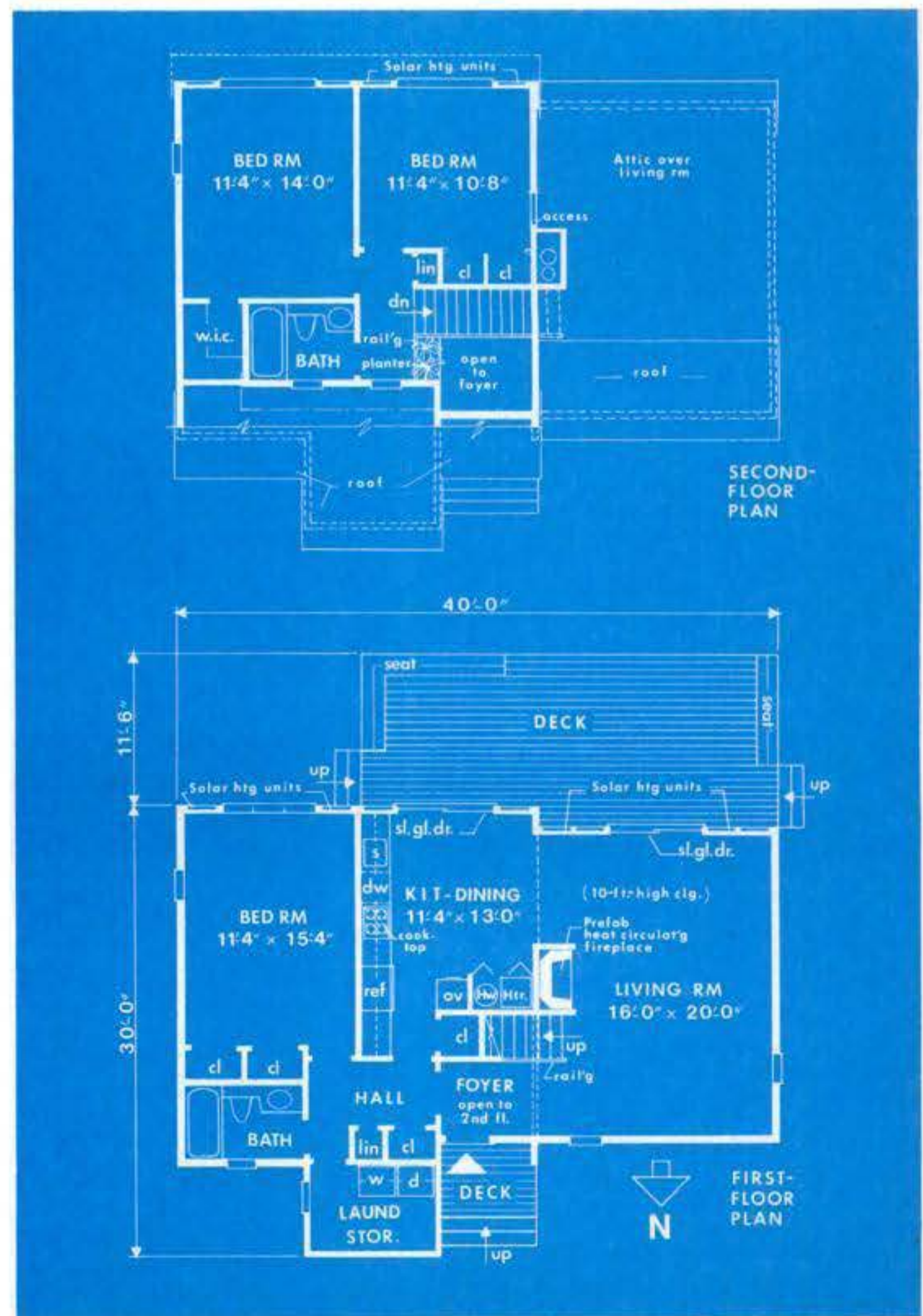
The wall collectors are easily made on the spot from ordinary building materials. Or you could prefab them in your home shop and truck them to your country site. Only the mechanically linked upper vents would have to be fabricated by a sheet-metal shop. The other components are stock items or easily made from the detailed plans. **EB**



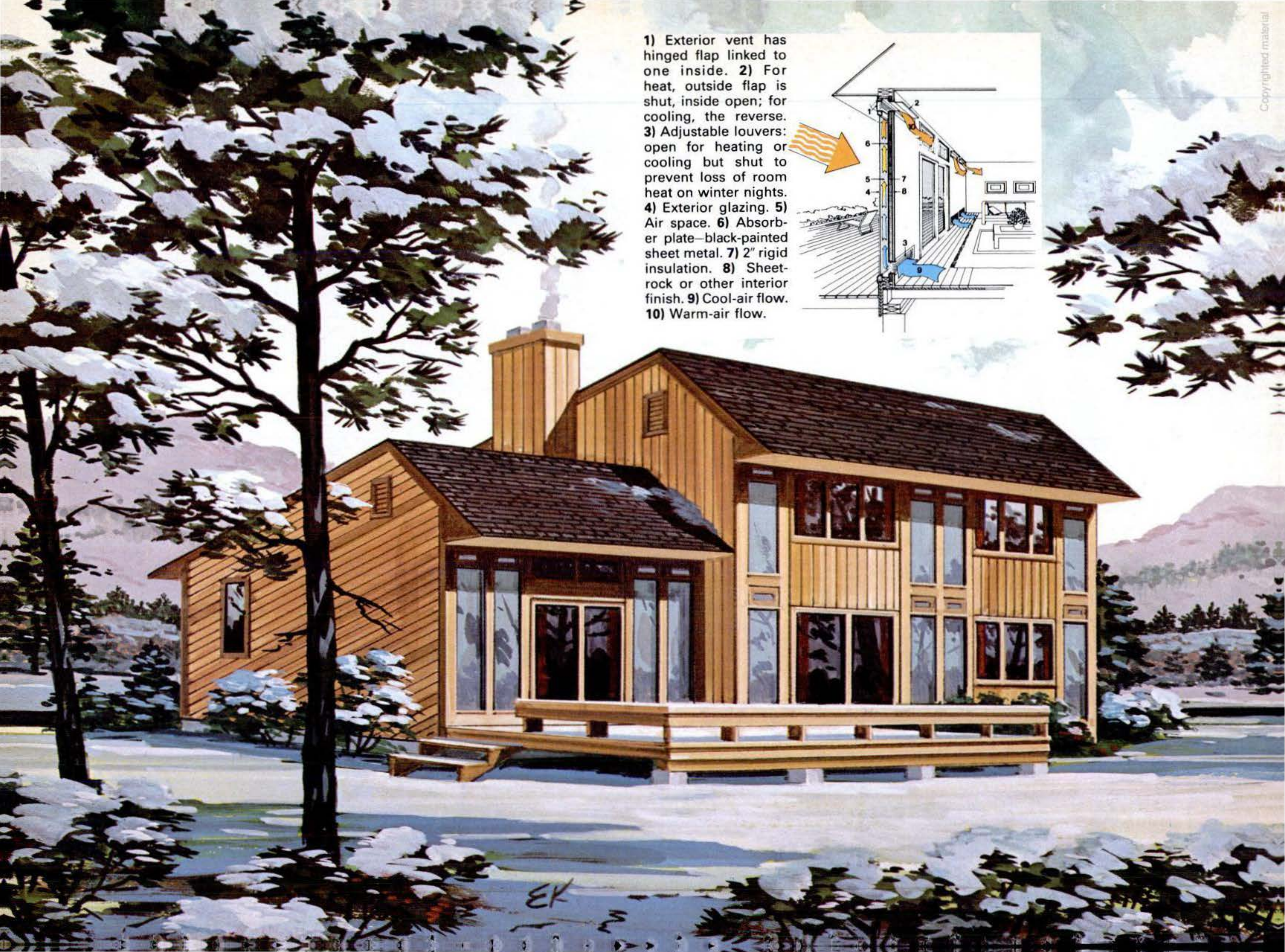
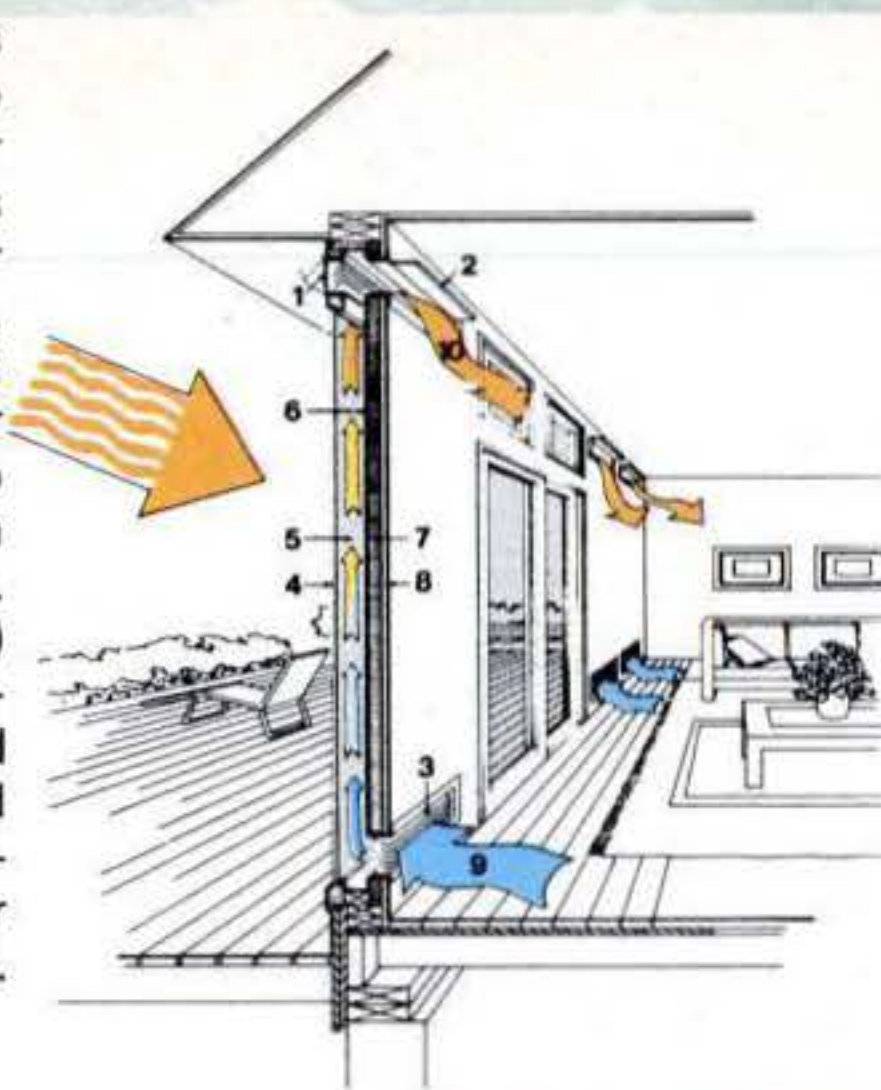
**Half-scale model** was built by architect to demonstrate the vent system: When room-side upper vent (above) is pushed shut, outside vent (top right) opens. Bottom vent (right) takes in room air near floor; its louvers are closed at night during the winter.

## How to order your plans

One set of detailed, professionally drawn blueprints for this house is \$85; five sets (for construction, financing, obtaining permits), \$115; materials list and specifications included at no extra cost. An additional mirror-reverse print can be ordered for \$10. Address orders or queries to Homes for Living, Inc. (specify Ridgewood Plan), 107-40 Queens Blvd., Forest Hills, N.Y. 11375. Add \$3 to all orders for postage and handling.

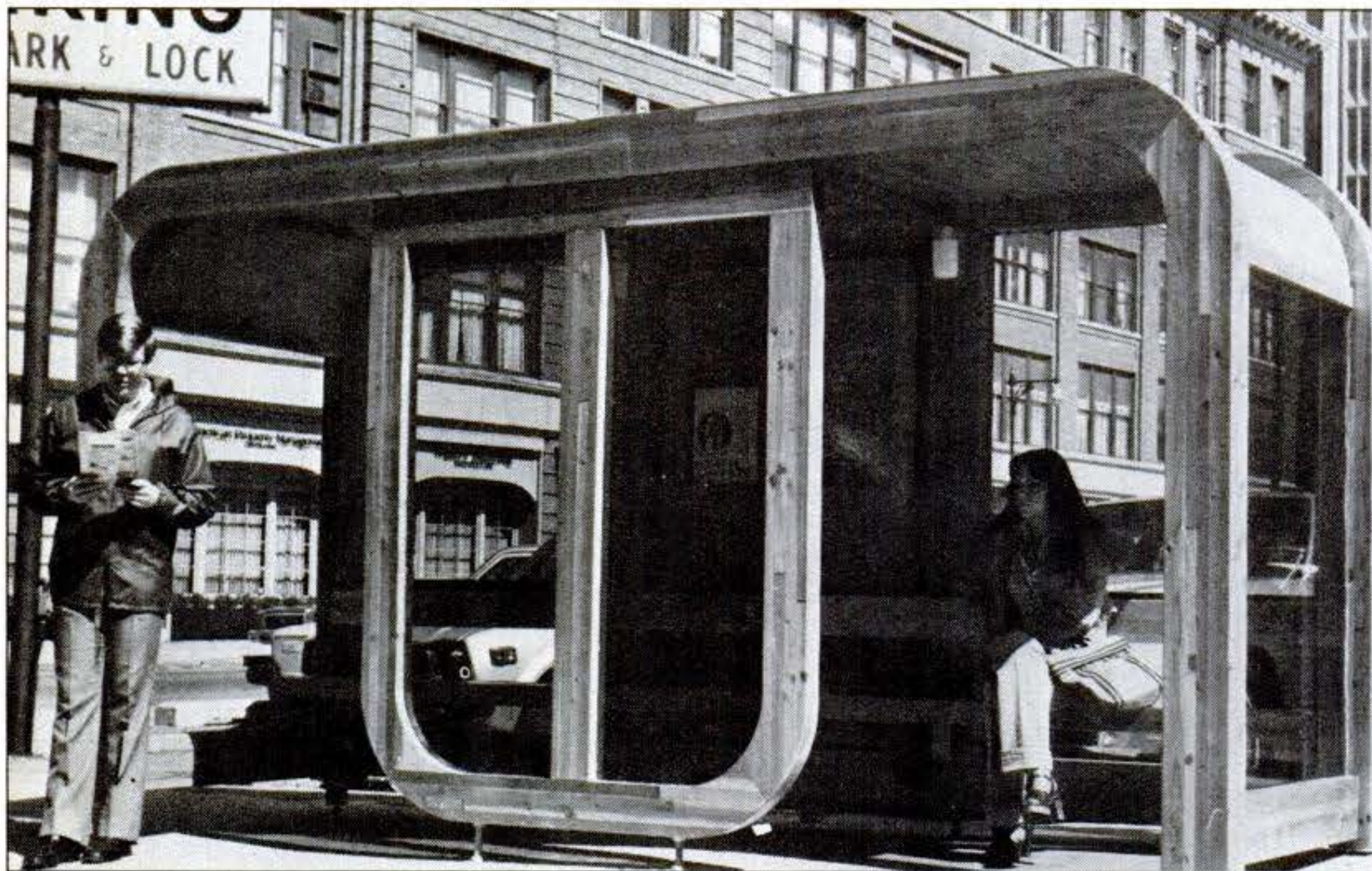


1) Exterior vent has hinged flap linked to one inside. 2) For heat, outside flap is shut, inside open; for cooling, the reverse. 3) Adjustable louvers: open for heating or cooling but shut to prevent loss of room heat on winter nights. 4) Exterior glazing. 5) Air space. 6) Absorbent plate—black-painted sheet metal. 7) 2" rigid insulation. 8) Sheet-rock or other interior finish. 9) Cool-air flow. 10) Warm-air flow.



# What's New

A PICTURE ROUNDUP OF NEW PRODUCTS AND DEVELOPMENTS



## Slick bus stop

Graffiti writers will find it hard to deface this modular bus shelter. The glazing is GE's Margard sheet, a super-hard plastic. With its new coating, the plastic has a glass-like finish that keeps stickers, paint, and other graffiti from permanently adhering to its surface.

## Bike hang-up

No place to park your bike? Put it on the wall—or on the ceiling. The 20-gauge-steel Bike-up rack is a simple channel with a special locking pin that holds the bike securely. Tires up to 1 3/4 in. wide fit in the \$17 rack. Lamaca Enterprises, 28 Roundhay Dr., Ottawa, Ont. K2G 1B5.



## World traveler

The aluminum coating on this laminated-nylon balloon reflects up to 80 percent of the sun's rays—important because overheating would endanger the 60-ft.-high, helium-filled balloon. The British craft is being readied for a nonstop, 20-day, globe-circling flight.



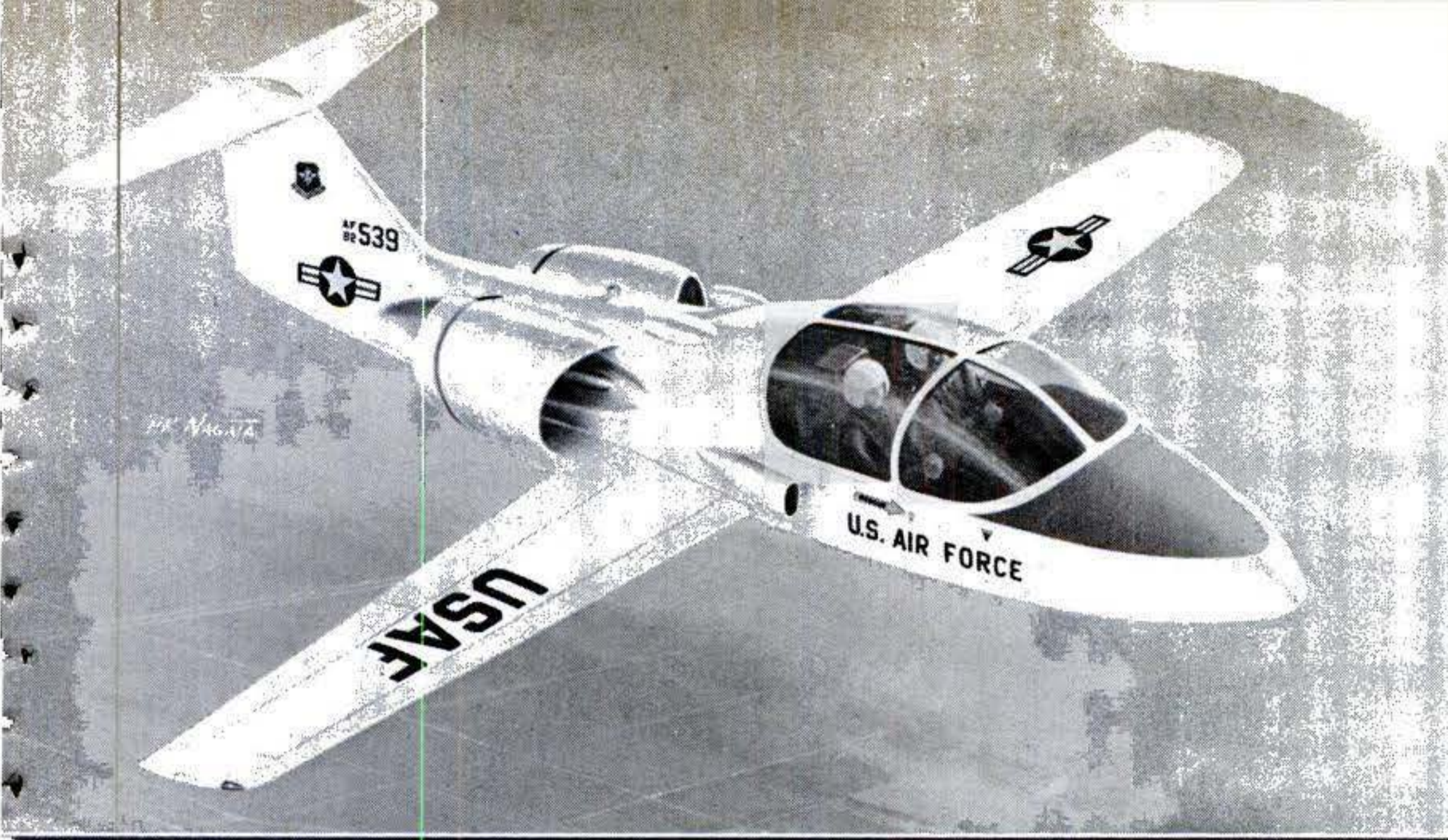
## Safety knife

Pressing a button releases this hunting knife from its safety sheath. The index finger slides easily into the button hole as the user withdraws the knife. The pistol-grip handle protects the hand and steadies the blade. Hanses, Borganasvagen 20, 781 00 Borlange, Sweden.

## Speedy tractor

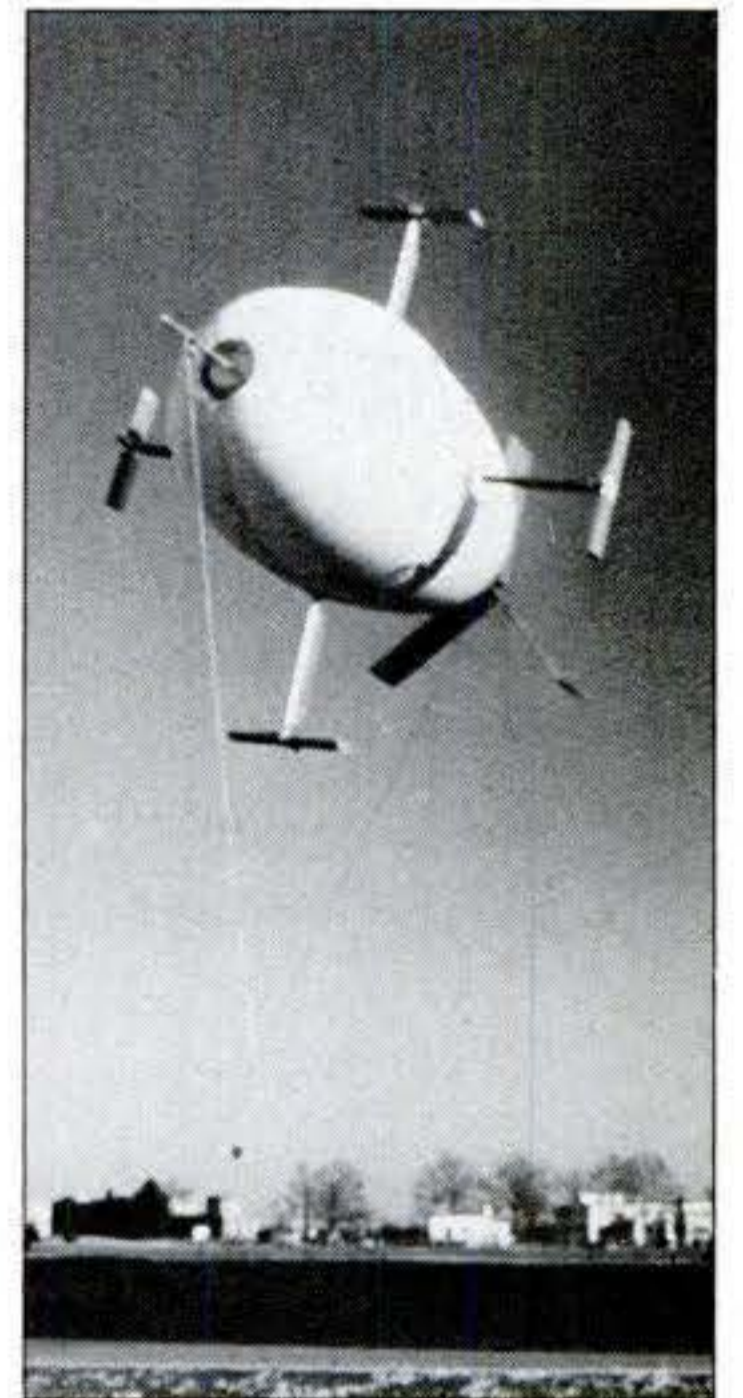
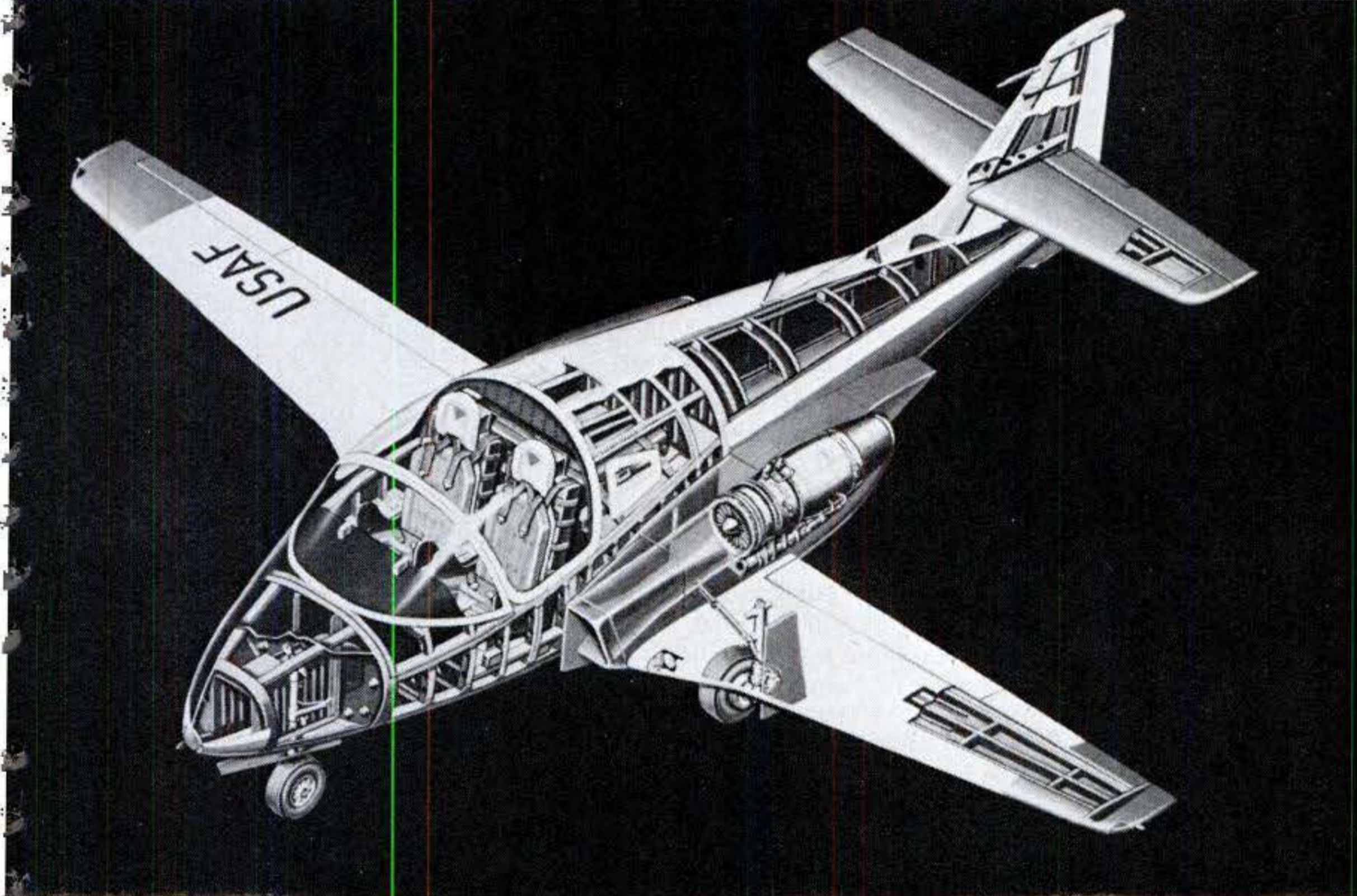
Trantor's newest dual-duty tractor not only hits 60 mph on the highway but can also haul a 12-ton trailer. An 80-hp Perkins diesel and a 10-speed transmission with auto torque-sensing differential lock make it possible. Trantor, Sandford Lane, Manchester M19 3FX, England.





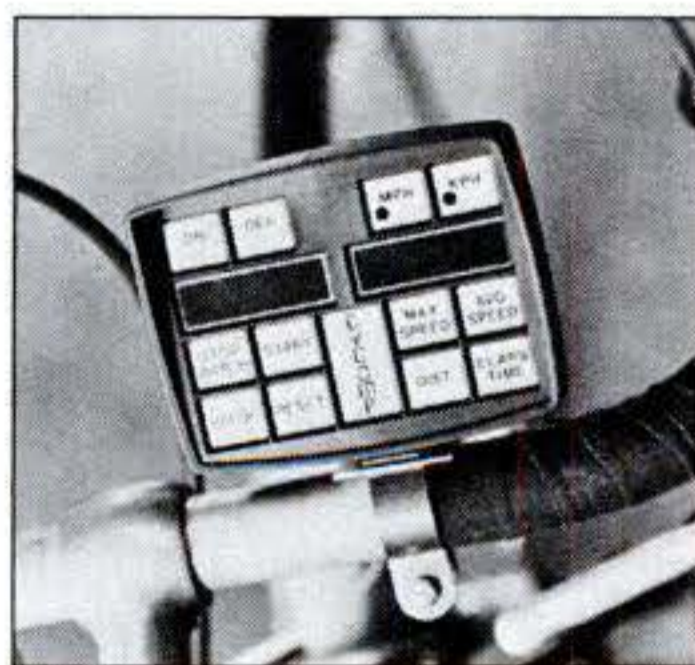
## Competing trainers

Twin turbine engines power these two planes, designed to replace the Air Force's aging Cessna T-37 jet trainer. The competing designs also have side-by-side seating for instructor and student. The Vought design (left) features a T-tail and has the distinctive ducted fans first used on Germany's VFW Fantrainer [PS, Mar. '77]. The ducted fans give fuel economy and reduce operating noise levels, says Vought. The Rockwell design (below, left) has a mid-mounted elevator and turbofan engines. Rockwell has conducted three wind-tunnel tests and built a full-scale, engineering mock-up of this design.



## Heat-loss meter

Using direct-contact instruments to measure heat losses from outside can be tricky. The R-value meter uses infrared energy for non-contact readings of surface temperatures, and converts the data to R-values. Barnes Engineering, 30 Commerce Rd., Stamford, Conn. 06904.

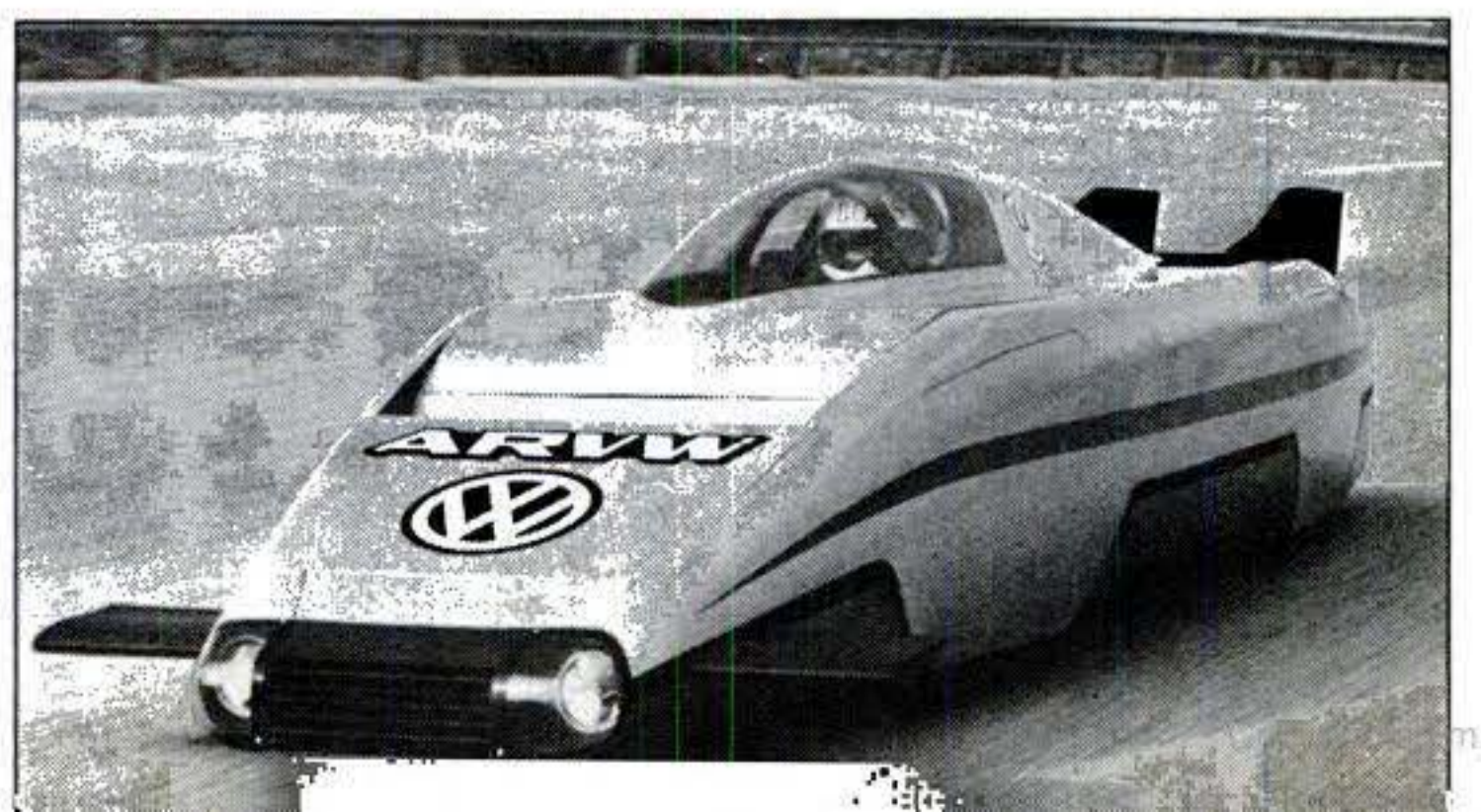


## Bike computer

The dual-display Cycomp gives bikers speed, distance, and time data. An electronic sensor clipped to the fork monitors two spoke-mounted magnets and feeds data to a microprocessor inside the unit. It's about \$60. Maker: Halfords Ltd., Redditch, Worcs. B98 ODE, England.

## 39 mpg at 155 mph

To shatter the diesel-car speed record, the Aerodynamic Research VW hit 215.4 mph—and it's been clocked at 225 mph. The car has retractable wings to balance high-speed lifting forces. The engine is a turbocharged 2.4-liter VW diesel. Mpg is 39 at 155-mph cruising speed.



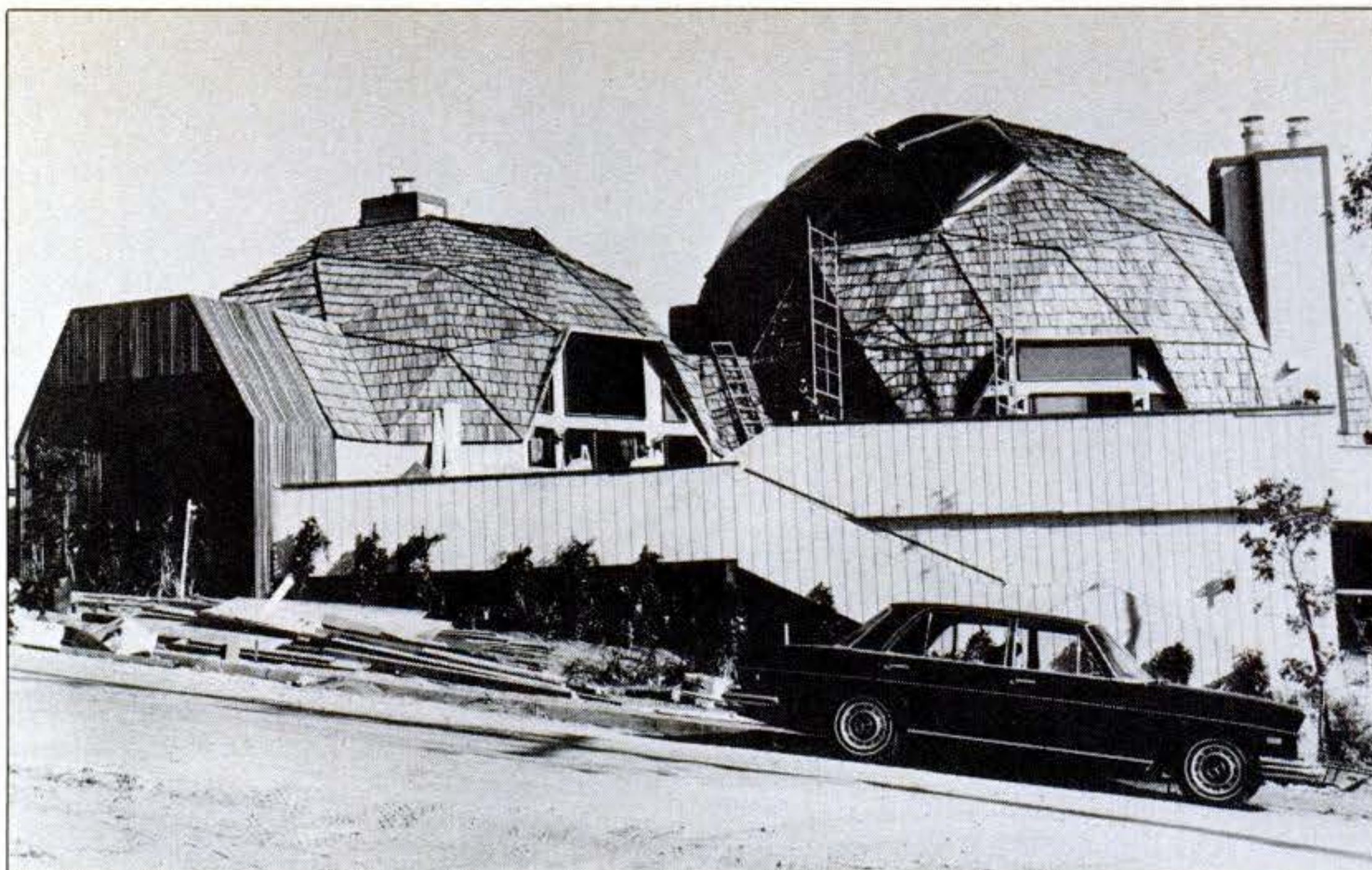
## Sky crane

The hybrid Cyclo-crane has a helium-supported body studded with T-shaped airfoil/rotor assemblies. The foils provide lift when hovering, then swivel to give forward thrust in flight. The craft lifts twice as much as a helicopter but is much cheaper, says DC Associates, Inc., Bozeman, Md.

# What's New

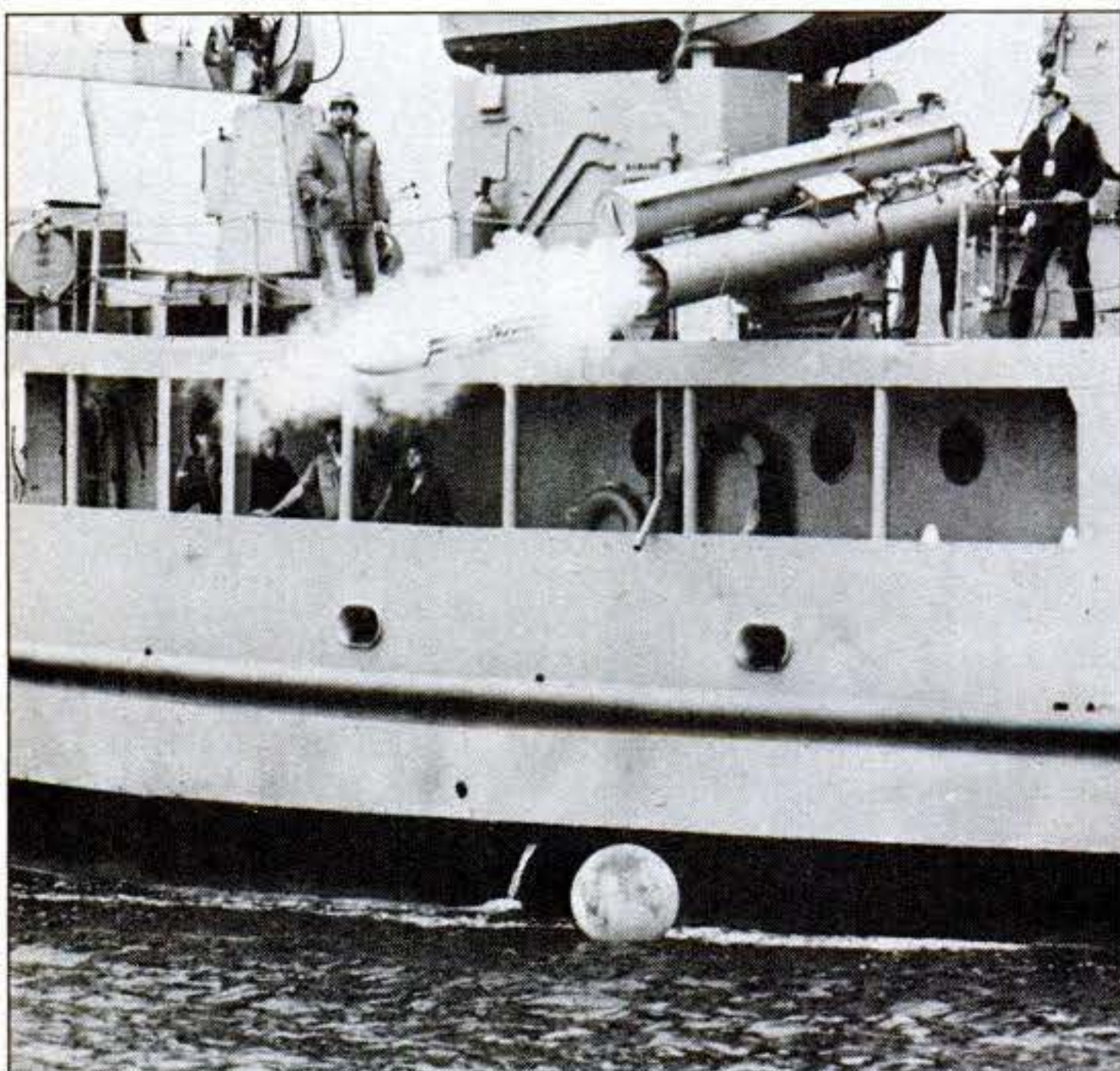
## Double dome

When completed, Monterey One will be the world's most energy-efficient home, claims Monterey Domes (Box 5621-A, Riverside, Calif. 92517). The double-dome house has advanced passive and active solar heating systems. Rigid foam insulation gives walls an R-value of 30.



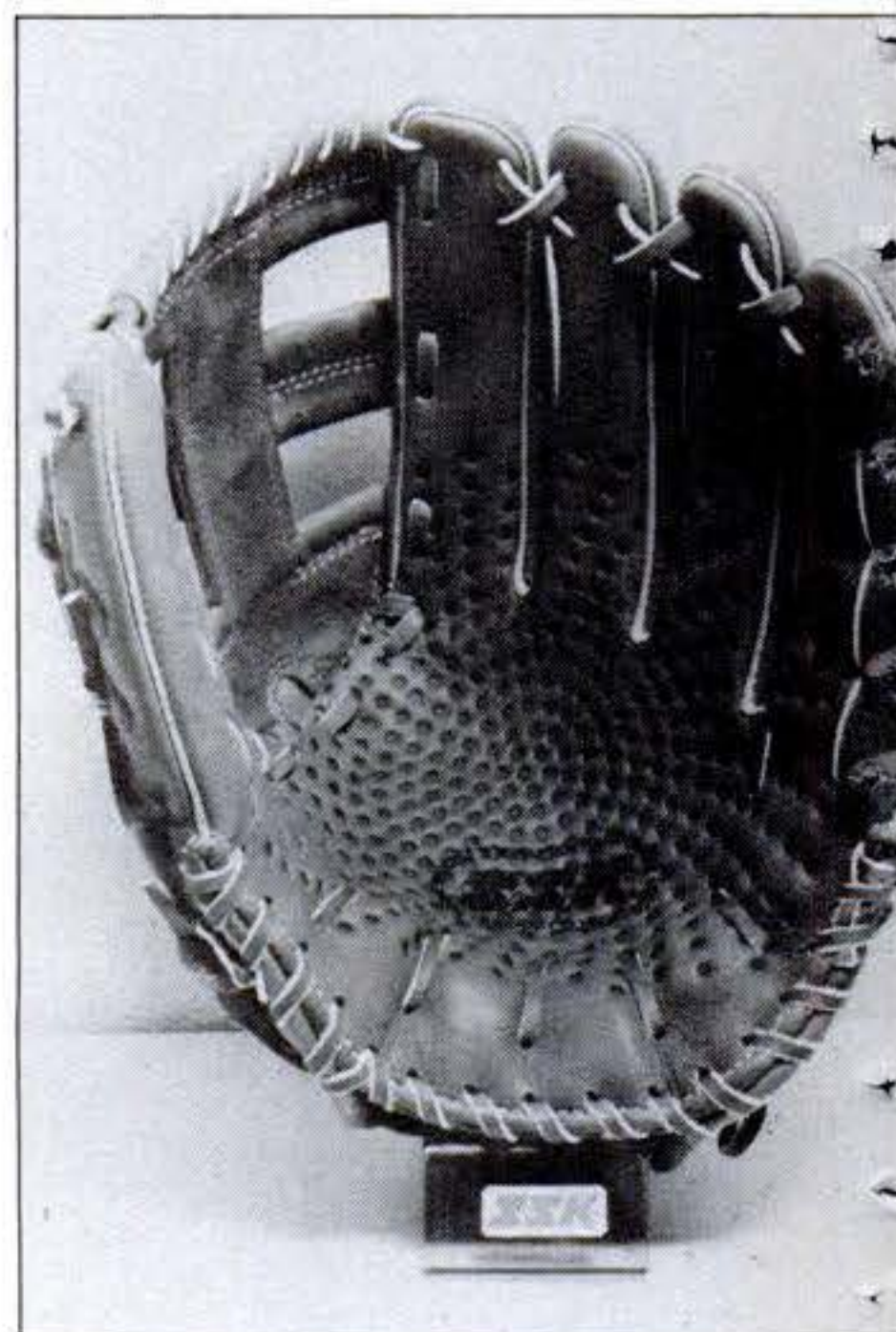
## Sub shooter

A new antisubmarine torpedo shoots out of the triple-tube launcher aboard a Navy torpedo test ship. The Advanced Lightweight Torpedo, made by McDonnell Douglas Co., can also be launched from helicopters and planes. The tests took place off Keyport, Wash.



## Pitted mitt

Hundreds of tiny pits in the palm of the Dimple Pocket Glove brake a spinning ball to a quick stop, says the maker. The dimples also make the glove more supple, so it conforms better to the hand. SSK America, 17101 S. Central Ave., Carson, Calif. 90746.



## Mini-planetarium

To chart the stars with the Bowl of Night, adjust inner and outer rims so your stargazing time matches the date. The inner bowl rotates, displaying the stars you should see. The 14-in.-dia. blue acrylic bowl costs \$63 from GL Ent., 185 Main St., Port Washington, N.Y. 11050.



## Electric doormat

Stride across this mat and moving belts of bristles brush dirt off your shoes—without tripping you. The belts are looped over separate pulleys alternately mounted on counterrotating drums on each side of the mat. A. Schmidt (2214 Hohenlockstedt, Postfach 40, Germany) developed it.



## Elegant electric

The sleek sports-car exterior hides a 19-hp electric motor and 24 six-volt lead-acid batteries. A microprocessor regulates power flow aboard the prototype Exar-1 car, which has a cruising range of 75 miles at 55 mph, says its maker, Amectran (900 Twin Towers S., Dallas, Tex. 75247).



# What's New IN BOATING

BY SUSAN RENNER-SMITH

## Comfy canoe

Want to explore wilderness waters in comfort? The Dolphin's concealed, foot-controlled electric motor scoots the craft along at a silent 10 mph. Swiveling bucket seats and wide sunshades help canoeists relax. \$995. Dolphin Products, Box 230, Wabasha, Minn. 55981.

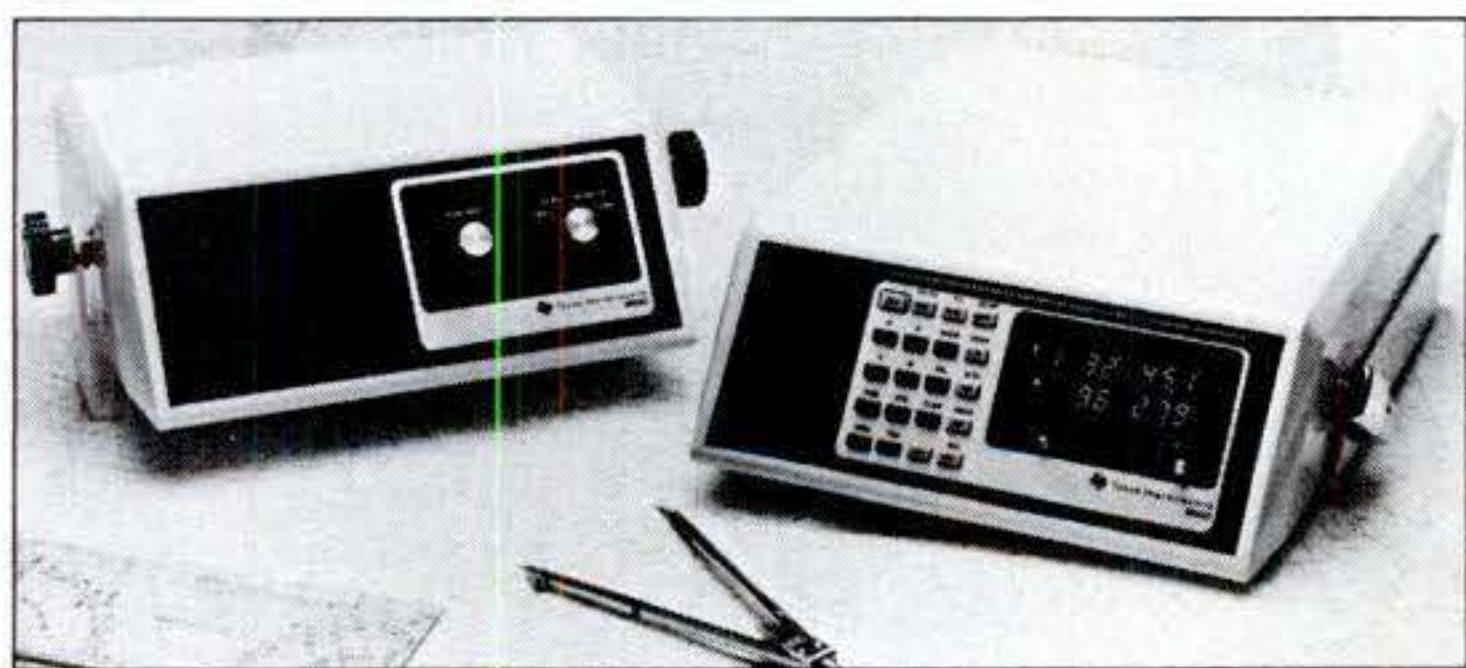


## Flying board

Engineered for racing, the Typhoon's unique, one-piece hull encloses a molded foam core. The combination gives the board minimum drag and maximum flotation, according to Surf-sailing International, 9 Davies Ave., Toronto, Ont. M4M 2A6. \$1,150.

## Practical dinghy

For extra stability, the new Harbormate dinghy has a tri-hull design with a flat aft section for easier towing. For safety, the eight-ft. fiberglass dinghy has more foam flotation than the Coast Guard requires. \$477. Howmar, 29 Mack Dr., Edison, N.J. 08817.



## Talking navigator

"Good morning, Captain," says a brisk male voice when you turn on Texas Instruments' Loran C 9900. Then, at preset intervals, the Loran announces its navigational readings. TI's add-on Speech Option module comes with speaker (left), costs \$695.

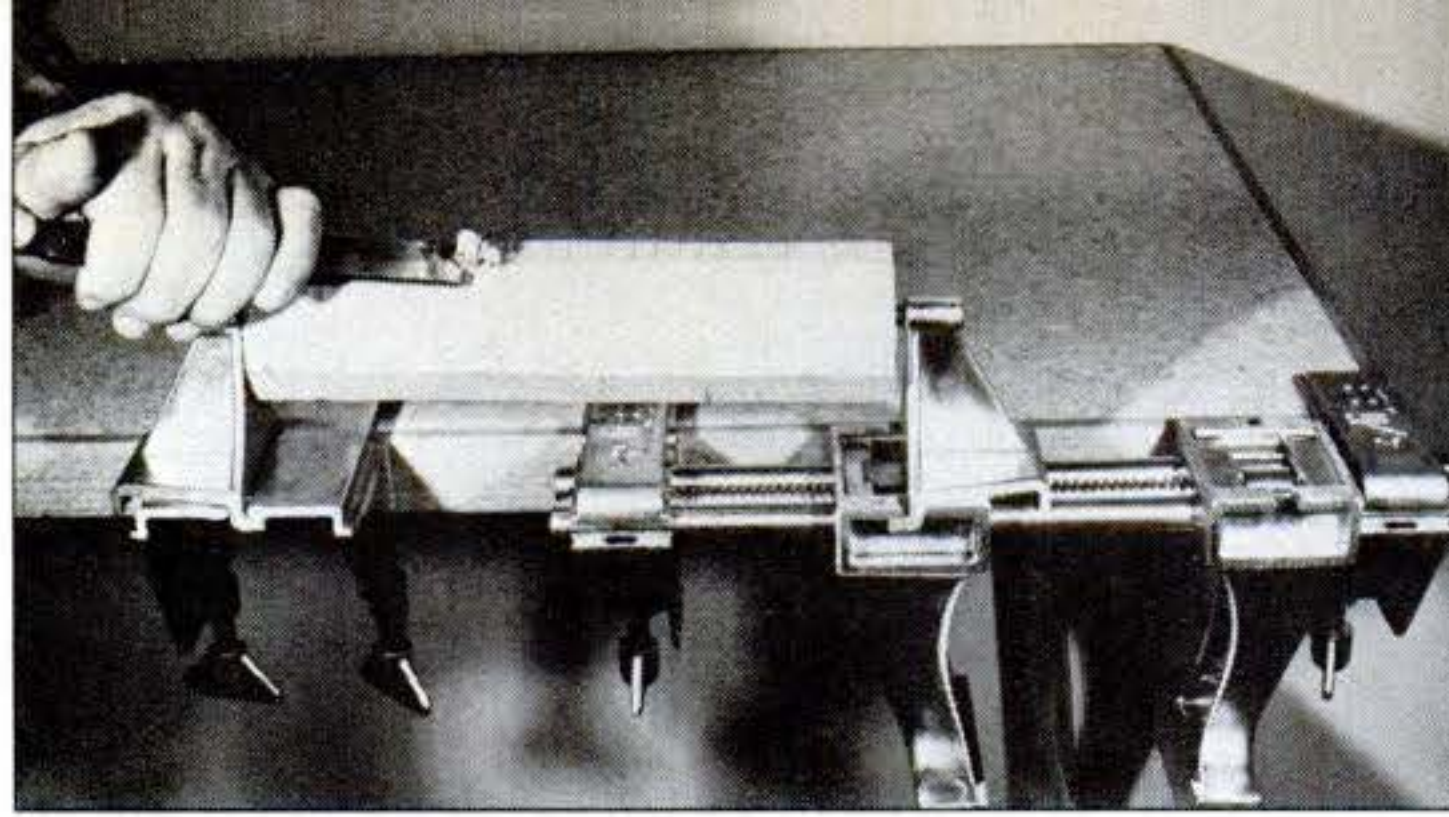
## Portable alarm

No wires or sensors needed—the M-300's transceiver generates microwaves to detect motion within a 15-ft.-wide area. Once tripped, the alarm sounds for four minutes, then resets itself. \$395. SDC, 33 Rustic Gate Lane, Dix Hills, N.Y. 11746.



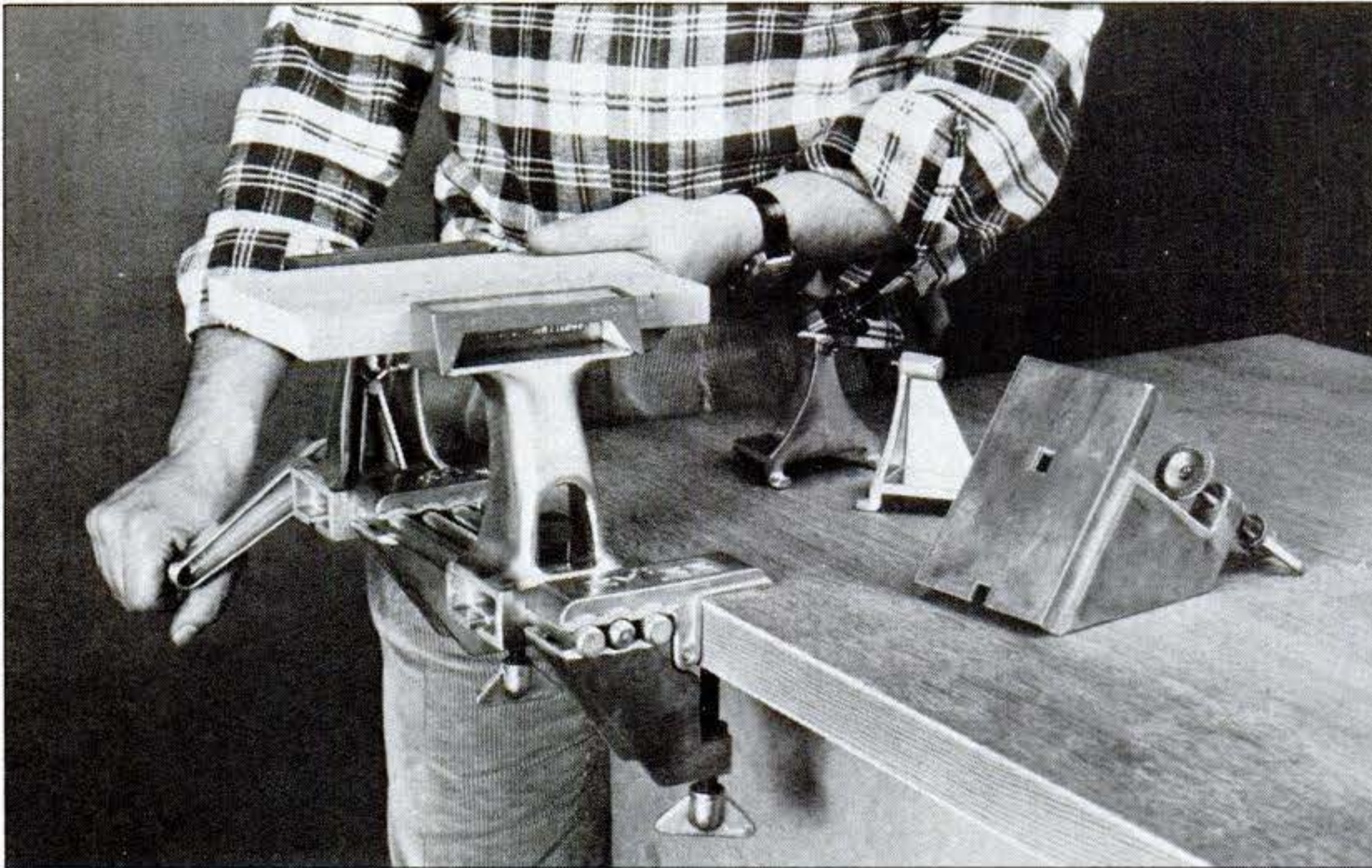
# What's New IN TOOLS

BY PAUL BOLON



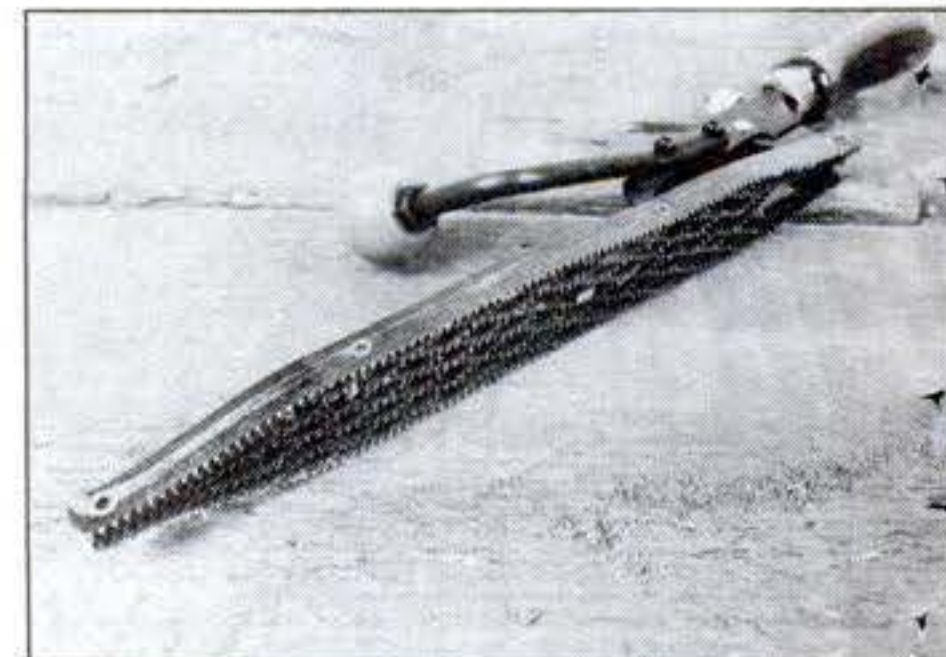
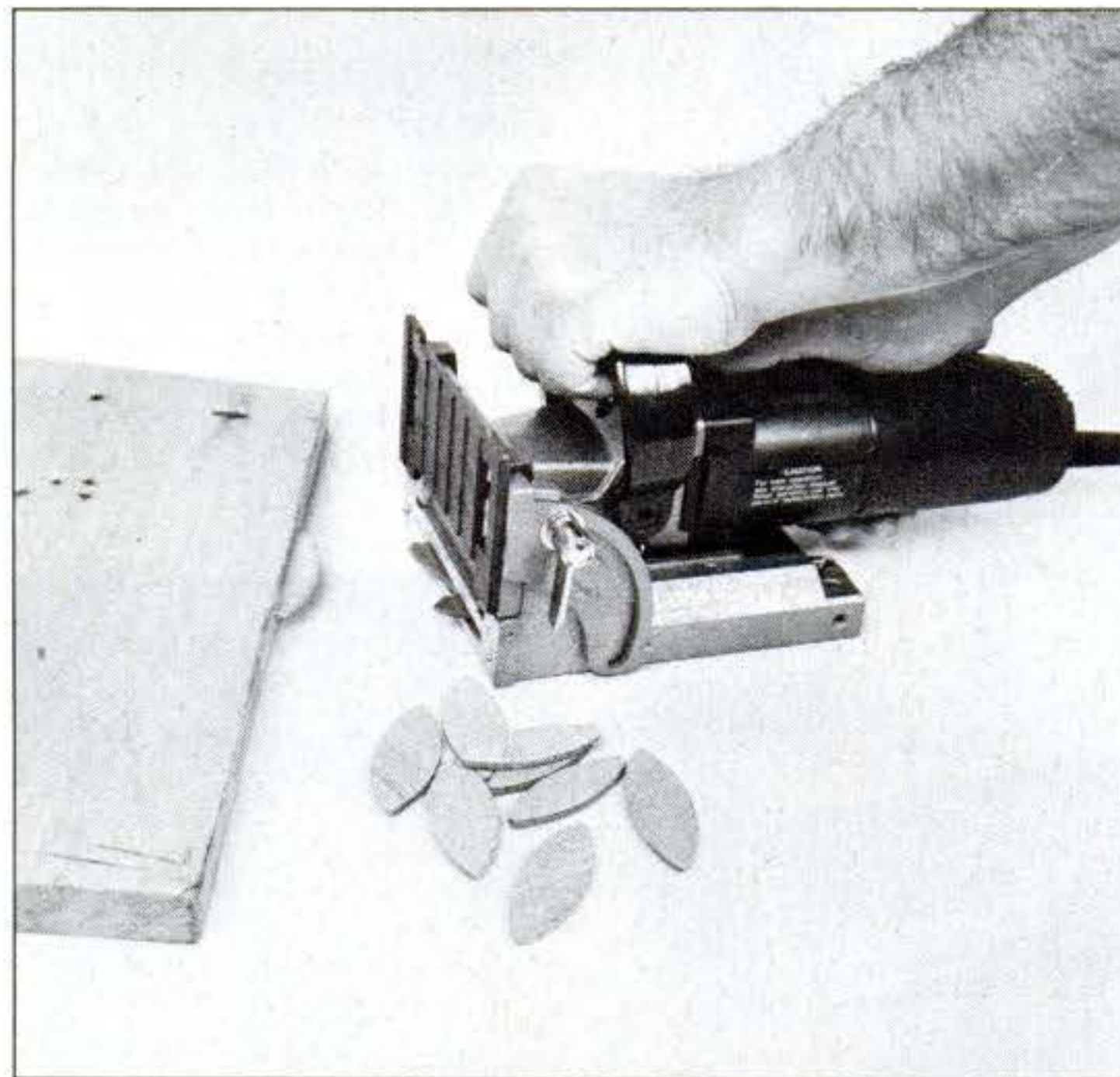
## Versatile vise

No room for a workbench or regular vises? The Zyliss vise (at left and above) could be just what you need. Weighing just 10 pounds, it's portable, stowable, and mounts quickly on most tables. With separate turning centers and an extra end stop, the Zyliss can hold long pieces for sawing, planing, or gluing. The basic vise can be used off the table like a C-clamp, or converted to a bar clamp, carving hold-down, or even a jack. The Swiss-made aluminum-alloy vise is unconditionally guaranteed by Clark Products (173 W. Arrow Highway, Glendora, Calif. 91740). Price: \$135.



## Spline cutter

Minilo's carbide-tip, four-inch blade accurately cuts sloped grooves for joining boards, cabinets, or furniture. Dried-beech, elliptical-shaped splines are sold in three sizes to match the depth of cut. Price of the cutter: \$580. Colonial Saw, 100 Pembroke, Kingston, Mass. 02364.



## Saw rasp

You can't clog this rasp, says Woodline (1004 Central, Alameda, Calif. 94501). The Japanese cutter, made of hacksaw blades, has two cutting sides, coarse and fine, that cut and clear debris from soft metals and plastics as well as wood. A locknut secures the handle to the rasp. It's \$10.95.

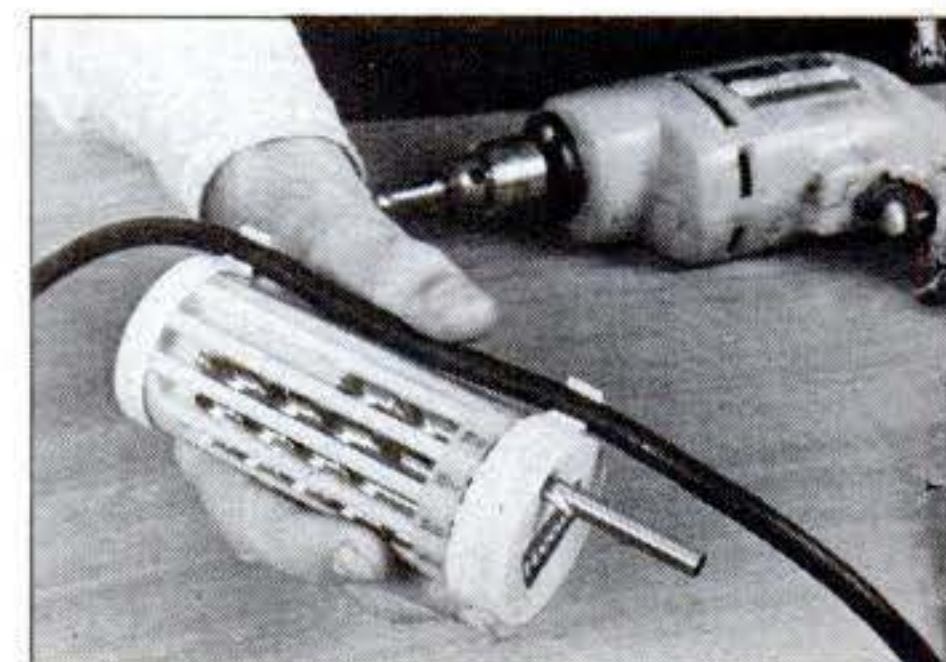


## Nose grinder

You can sand curves and hard-to-reach spots on cars, furniture, or castings with Makita's open-end sander. The double-insulated Model 9030 lists for \$120, including 10 1 1/8-by-21-inch abrasive belts in five grits. Makita, 650 Hadley Rd., So. Plainfield, N.J. 07080.

## Bit keeper

Drillminder clips onto your drill's cord to keep drill bits handy. To get a bit, you rotate the hole in the top to the desired size and tip the case. Bits range from 1/16 to 1/4 inch by 64ths. It's about \$17. Maker: Hanson Inc., 220 Brooks, Worcester, Mass. 01606.



# What's New

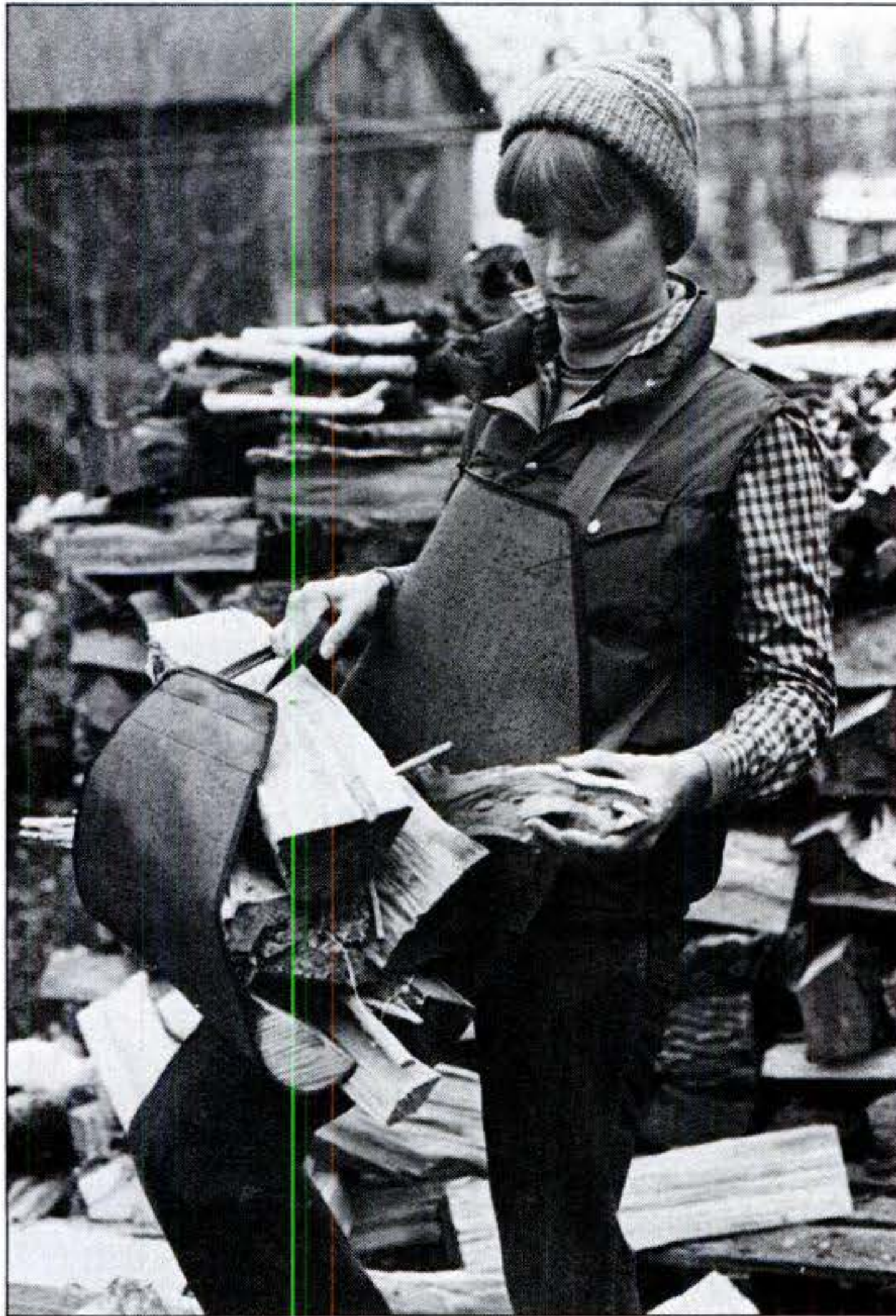
## IN HOME IMPROVEMENT

BY PAUL BOLON



### Reusable caulking

Dow's silicone sealants now come in resealable cartridges. For storage, the nozzle unscrews and is replaced by a threaded cap for a fresh, tight seal, Dow says. Sealant that remains in the nozzle is easily removed after it cures.



### Carrying apron

Save your arms for better things—the shoulder straps on this carrying apron from R&R Canvas (429 S. Wilbur, Syracuse, N.Y. 13204) transfer the weight of firewood or other bulky items to your body. The apron is heavy nylon duck with seat-belt webbing straps. It's \$10.95.

### Gazebo kit

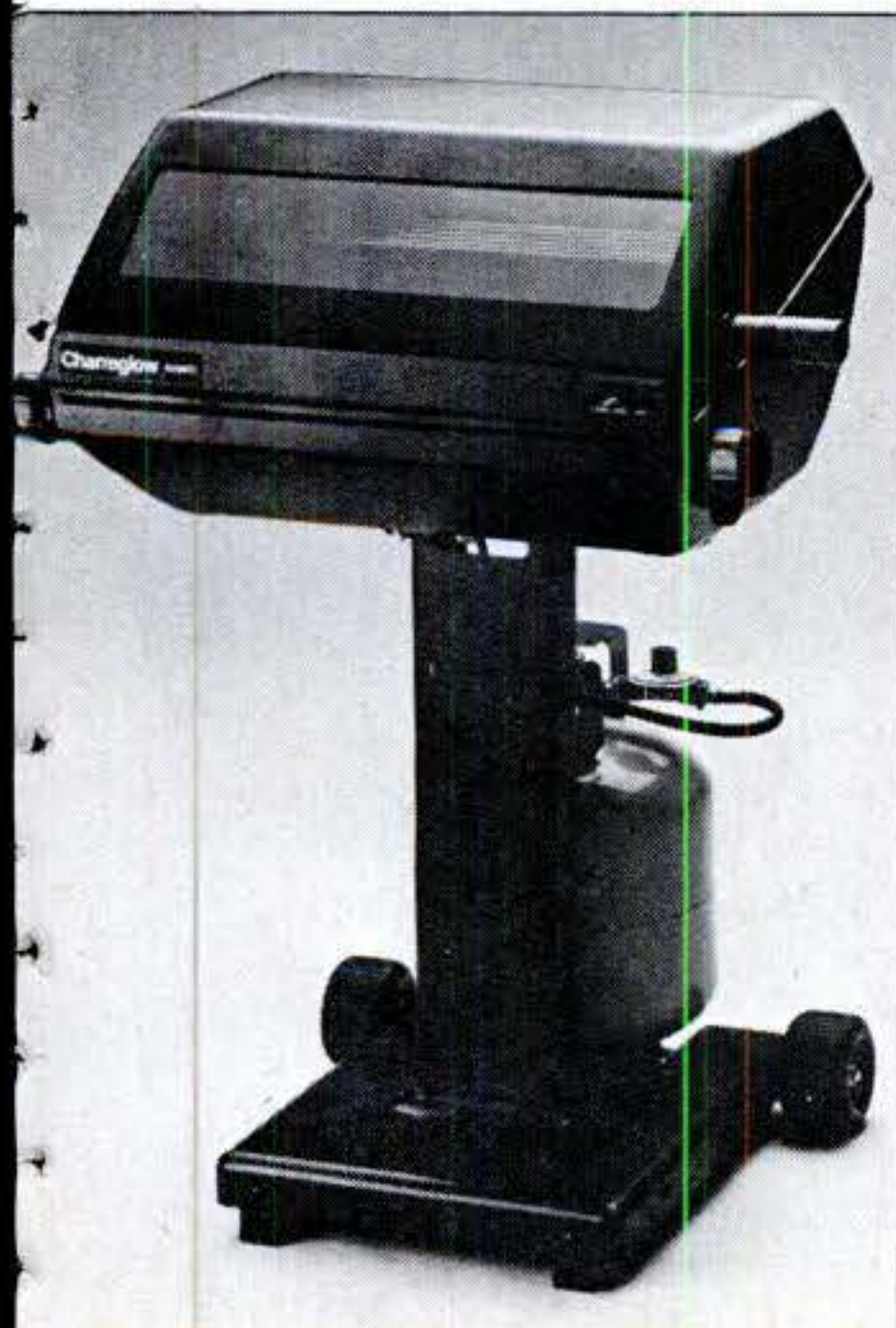
Two hours is all it takes to assemble a prefabricated redwood gazebo kit with screws or bolts, claims California Lattice Co. (616 N. Eckhoff, Orange, Calif. 92668). There are three styles to choose from in eight-, 11-, and 13-foot diameters. Price: about \$900 for an eight-foot model.

### Stylish barbecue

Watch your meat sizzle through the tempered-glass window on Charmglow's Avanti grill. The LP grill also has a heat indicator and a fuel gauge. Twin-burner Model 824E sells for \$400. Maker: Charmglow Products, Box 127, Bristol, Wis. 53104.

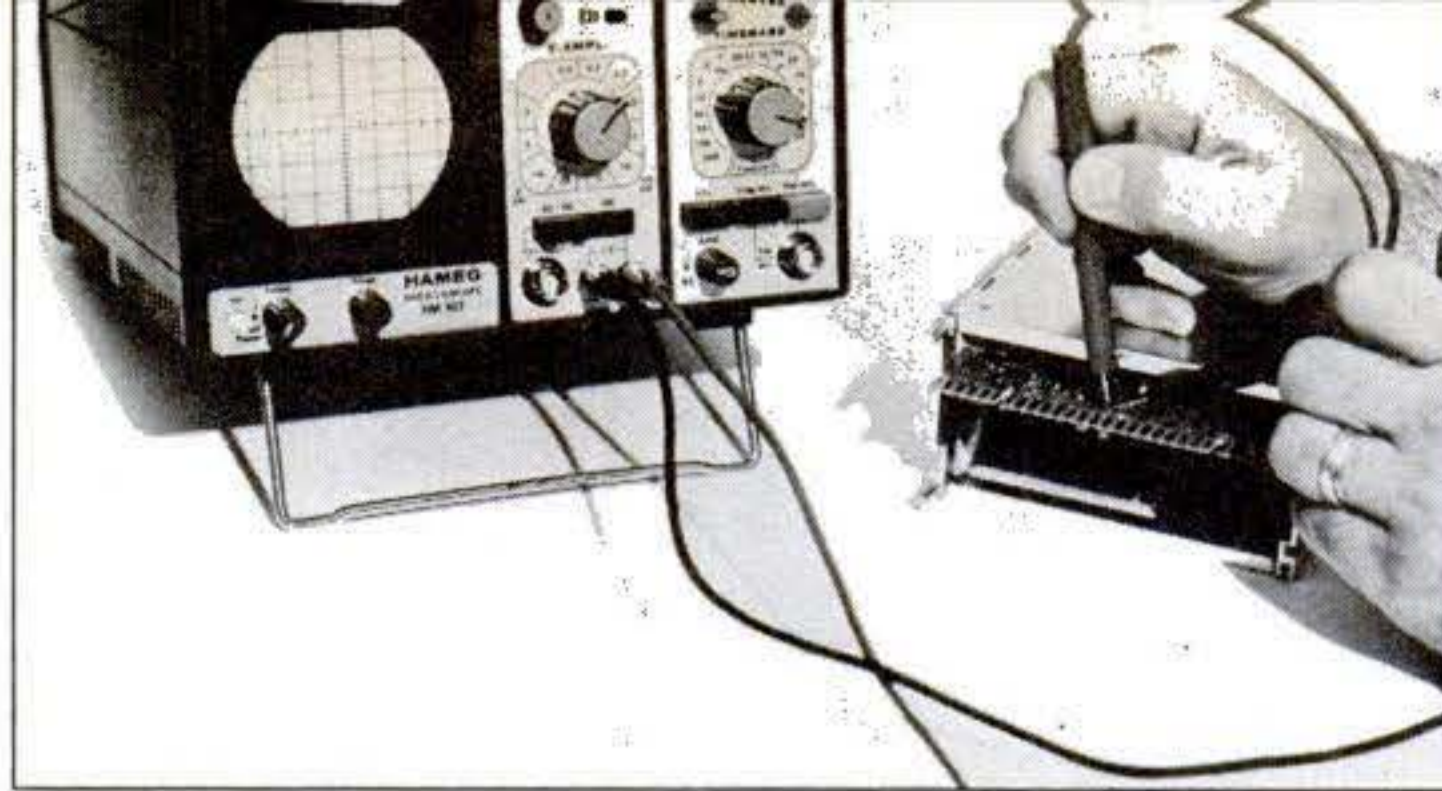
### Environment

Water jets sprinkle you, sun lamps tan you, and fans create warm breezes to dry you in Kohler's Habitat, one of its new enclosures [PS, May '77]. All weathers, plus stereo, are push-button controlled. It's \$5,285 without a steam option.



# What's New IN ELECTRONICS

BY WILLIAM J. HAWKINS



## Dual use

Push a button and this DC to 10-MHz triggered scope becomes an in-circuit component tester as well. It's good for bench work, but, at just 4.5 by eight by 12 inches, it's useful for field service too. And, at \$405, it might fit your budget. Hamamatsu, 88-90 Harbor Rd., Port Washington, N.Y.



## Easy writer

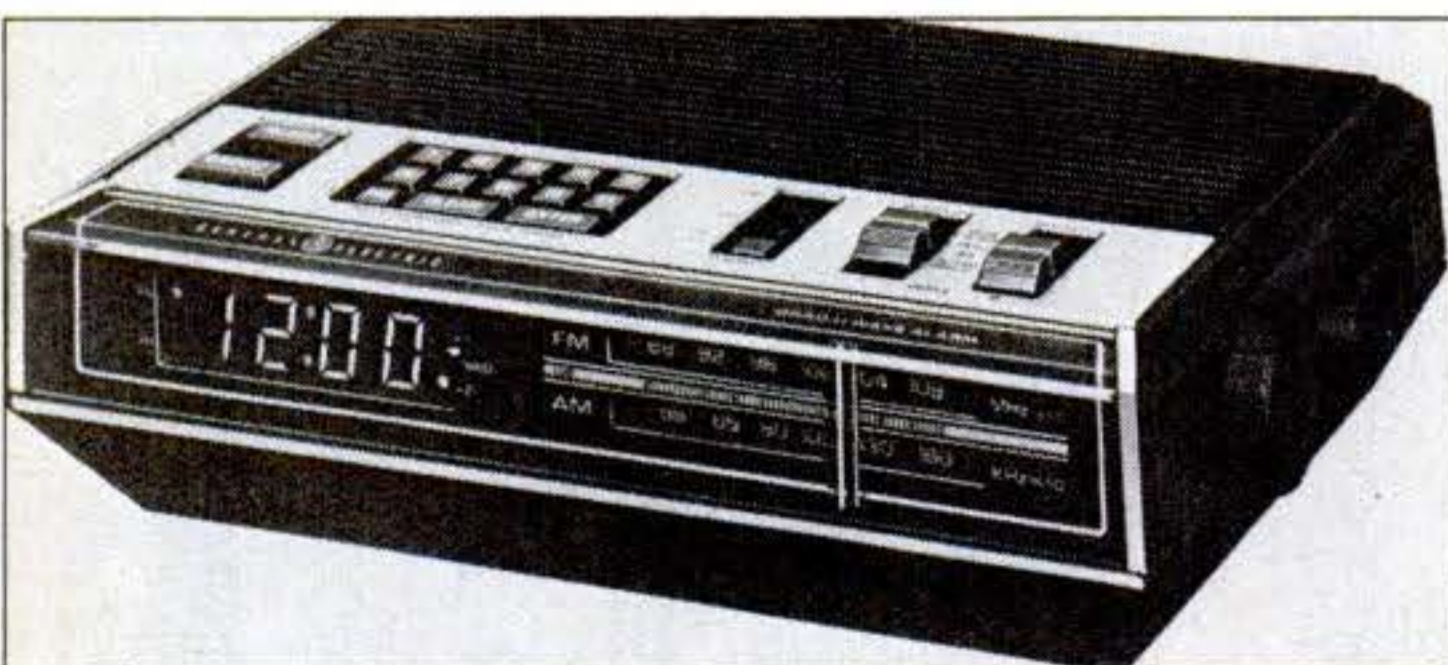
Just type. The Zenith word processor does the rest: Line centering, justification, and formatting are automatic; on-screen editing is simple. The final document can be saved on disk or put on paper with an optional printer. It's \$3,290.

## Auto deck

The microprocessor inside the Akai GX-F95 cassette deck makes it easy to use: Bias, equalization, and sensitivity levels are set automatically. And the unit will start at a preset time, rewind, and replay, without your help. All you do is select the music—and pay for it: \$1,195.

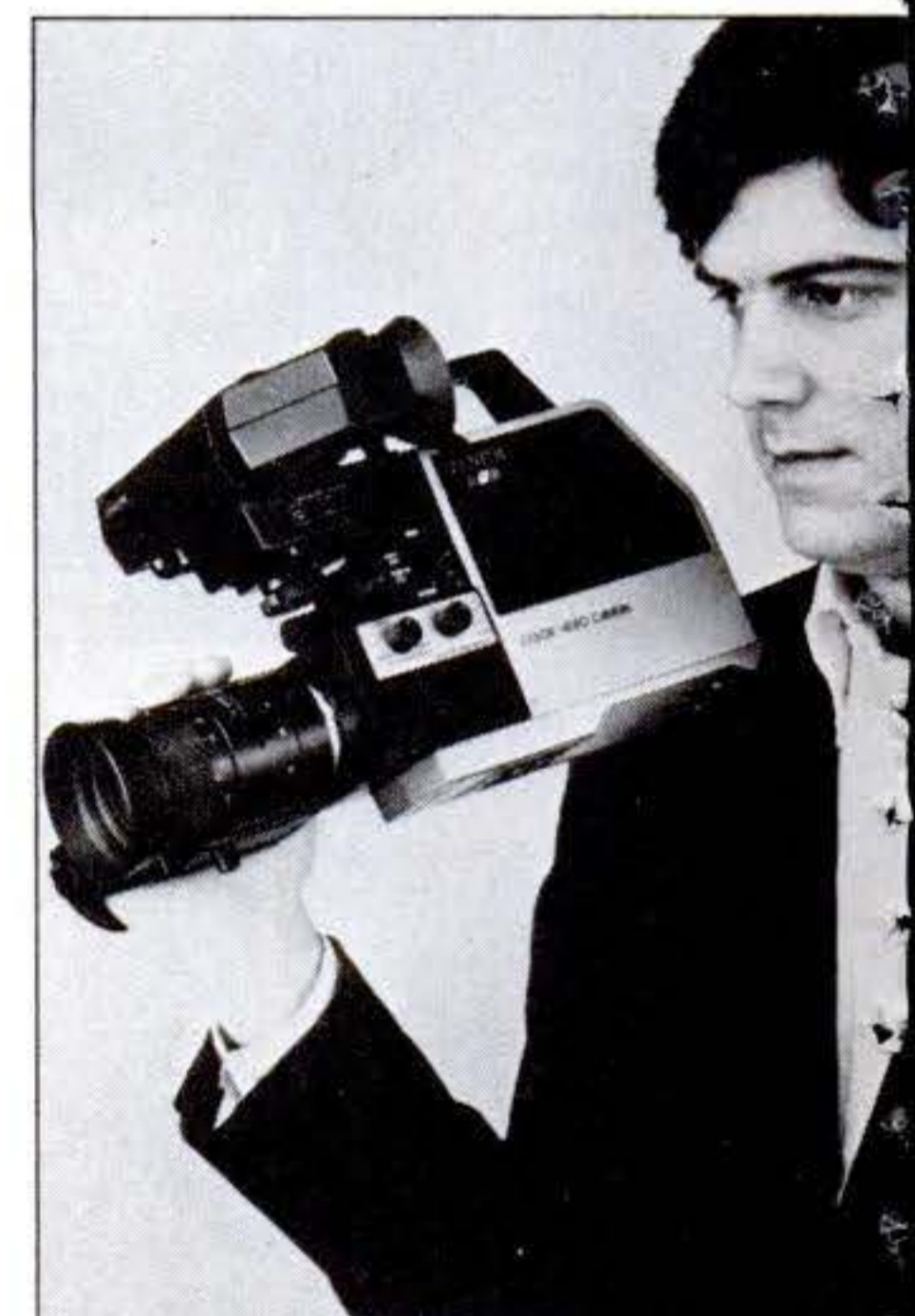
## Weather watcher

Forecast the weather wrong just once and you're considered an amateur weatherman. Do it all the time, and you're a meteorologist. To help you, here's the Heath digital barometer kit. The display shows pressure in inches or millibars and plots rate of change. It's \$240 from Heath, Benton Harbor, Mich.



## Gentle waker

At last, a clock radio with compassion: GE's Grad-U-Wake starts your day with music or an alarm, but softly, and slowly builds up to normal volume. The keyboard lets you program snooze times and a second alarm time for weekends when even *slow* is too fast. It's \$80.

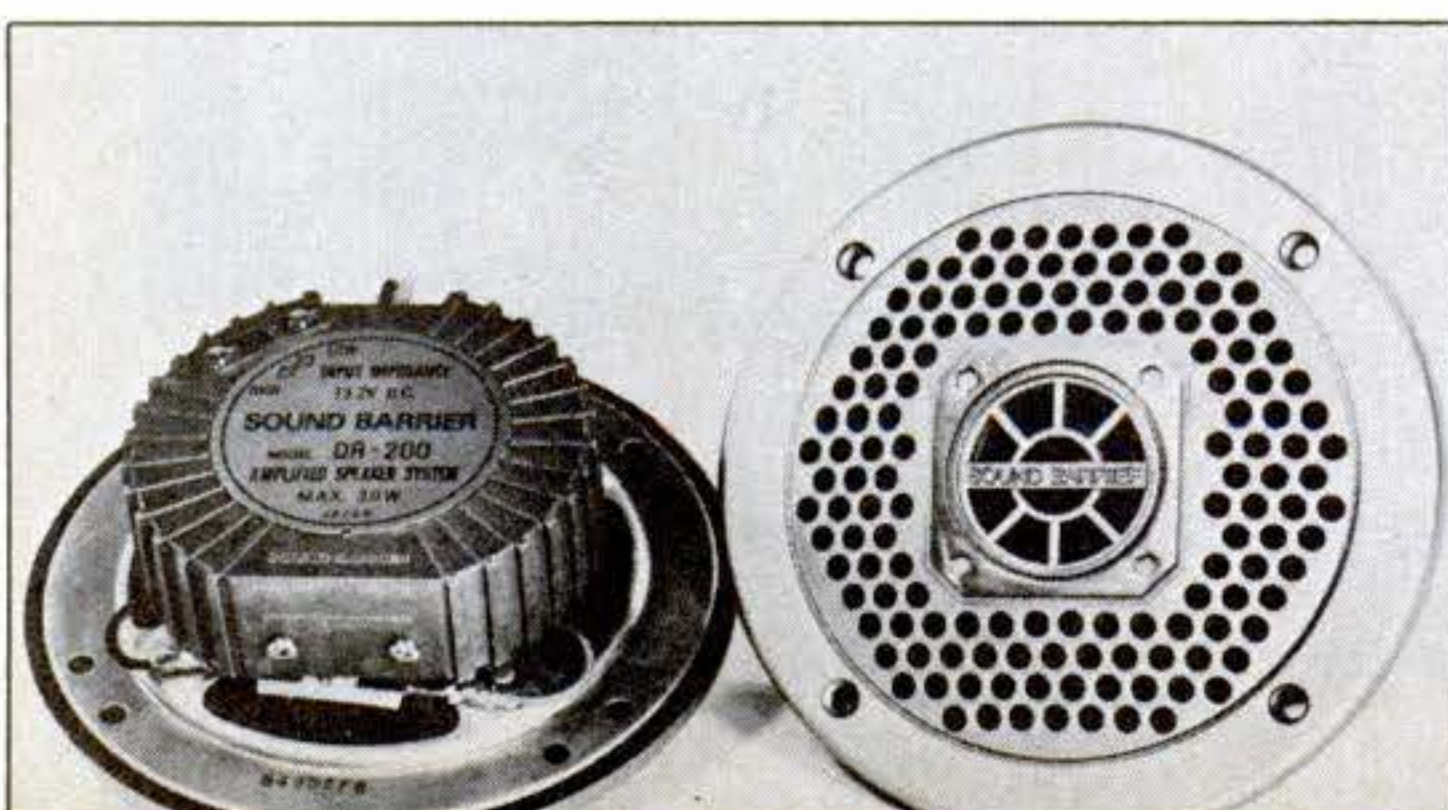


## Built-on amp

Mount this 1 3/4-inch-deep by 5 1/2-inch-dia. dual-cone speaker in your car door or kick panel and you won't need an amplifier to power it—a 30-watt amp is already attached. The two-speaker system costs \$138 from Sound Barrier, East Dominguez St., Carson, Calif. 90746.

## Two views

Look into the electronic viewfinder of the Zenith VC1600 video camera and you get the whole picture—and more. A CRT shows the scene and special waveforms, allowing you to precisely set light level and color. It comes with 6:1 macro-zoom lens, mike, and power supply. \$1,150.



# What's New FOR YOUR CAR

BY ED JACOBS



## Back supporter

The Mark-Fore Back-Aide seat is designed to counter lower back pain and fatigue caused by poorly designed automotive seats. It's adjustable for curvature, firmness, height, and tilt. Price: \$49.95. Nepsco, Inc., 53 Jeffrey Ave., Holliston, Mass. 01746.



## All-season tire

The unique "interior bloc" tread design is said to give the JCPenney Mileage-maker XP steel-belted radial extra performance in all kinds of weather. It comes in sizes to fit most domestic cars, plus many imports. Prices start at \$39.



## Jeep/Toyota top

Husky's Panorama Surveyor convertible tops for Jeep and Toyota 4WD vehicles have wrap-around windows, are mildew-resistant, and are available with a tinted sun-roof and windows. Prices start at \$325. Husky Products Co., Box 1119, Longmont, Colo. 80501.

## Shifty clock

You could have time in your hands with the Time O' Day gear-shift clock. Its hand-rubbed black walnut body incorporates a quartz clock with LCD display for time, date, and month. \$30. Creative Products, Inc., 1426-B Ritchey, Santa Ana, Calif. 92705.



## Mpg/fuel monitor

Maximiser observes road speed and fuel flow to give continuous readouts of mpg or fuel consumption for a complete trip or any portion of one. It automatically switches off in stop-and-go traffic so it won't distract you. Mobelec Ltd., Oxted, Surrey, England.



## Datsun cap

Ayr-Way's cap for long- or short-bed Datsun pickups has a fiberglass body and door, screened sliding windows, dome light, insulated roof, and molded-in rear spoiler. Price: \$642. Ayr-way Ind., Inc., Box 426, Kendallville, Ind. 46755.

# Solar wood dryer

quick-cures two cords

Sun-bake your logs for early-season fires

By JEFFREY MILSTEIN

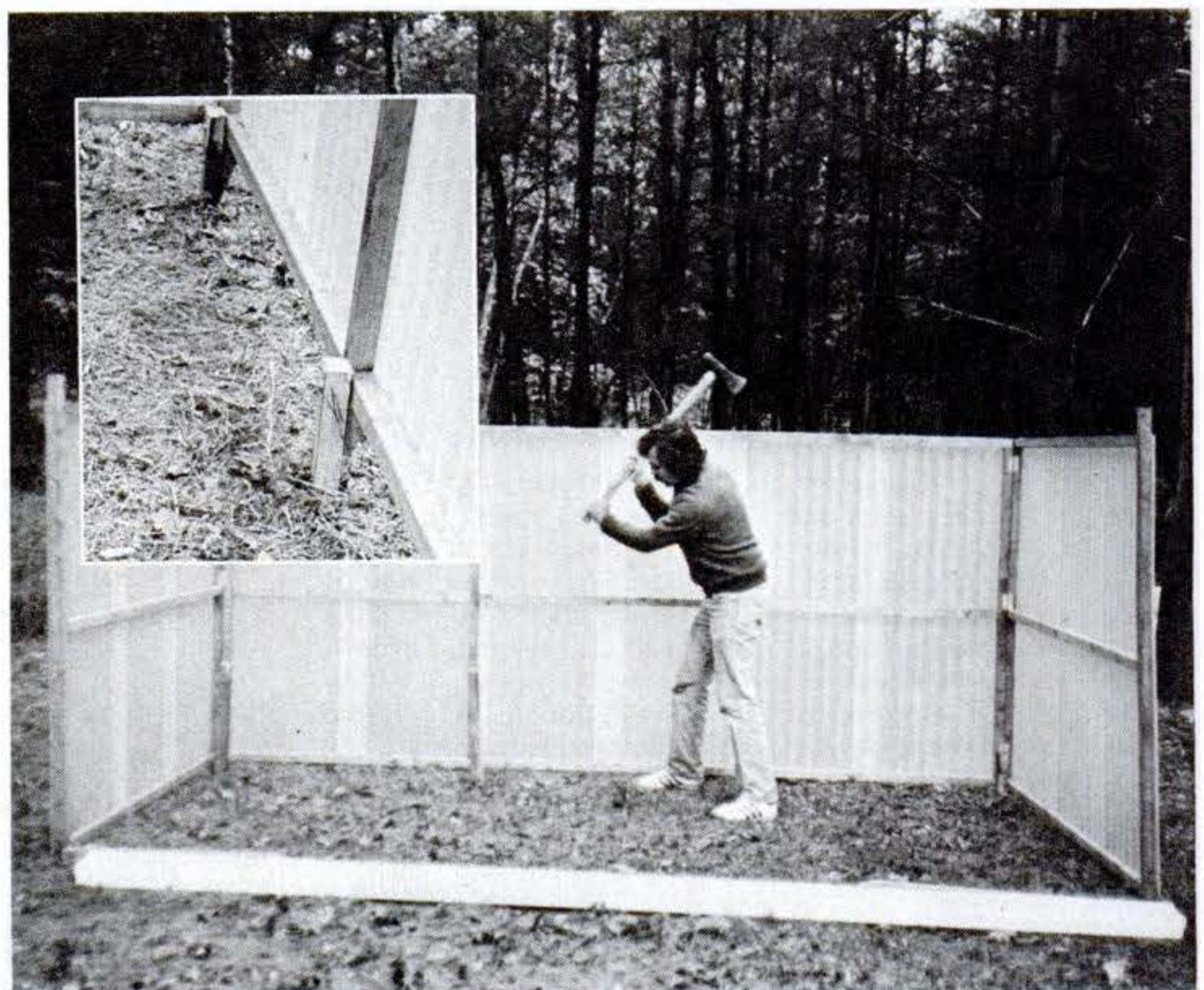
If you gather and split wood this spring, will it be dry enough for your stove or fireplace when the first cold snap hits? Probably not. Even short, split logs need up to six months to reach an acceptable moisture level (less than 25 percent).

But there's a way to accelerate the process: Put the sun to work by building a shed from clear FRP. A solar wood dryer can cut your drying time by 50 percent or more.

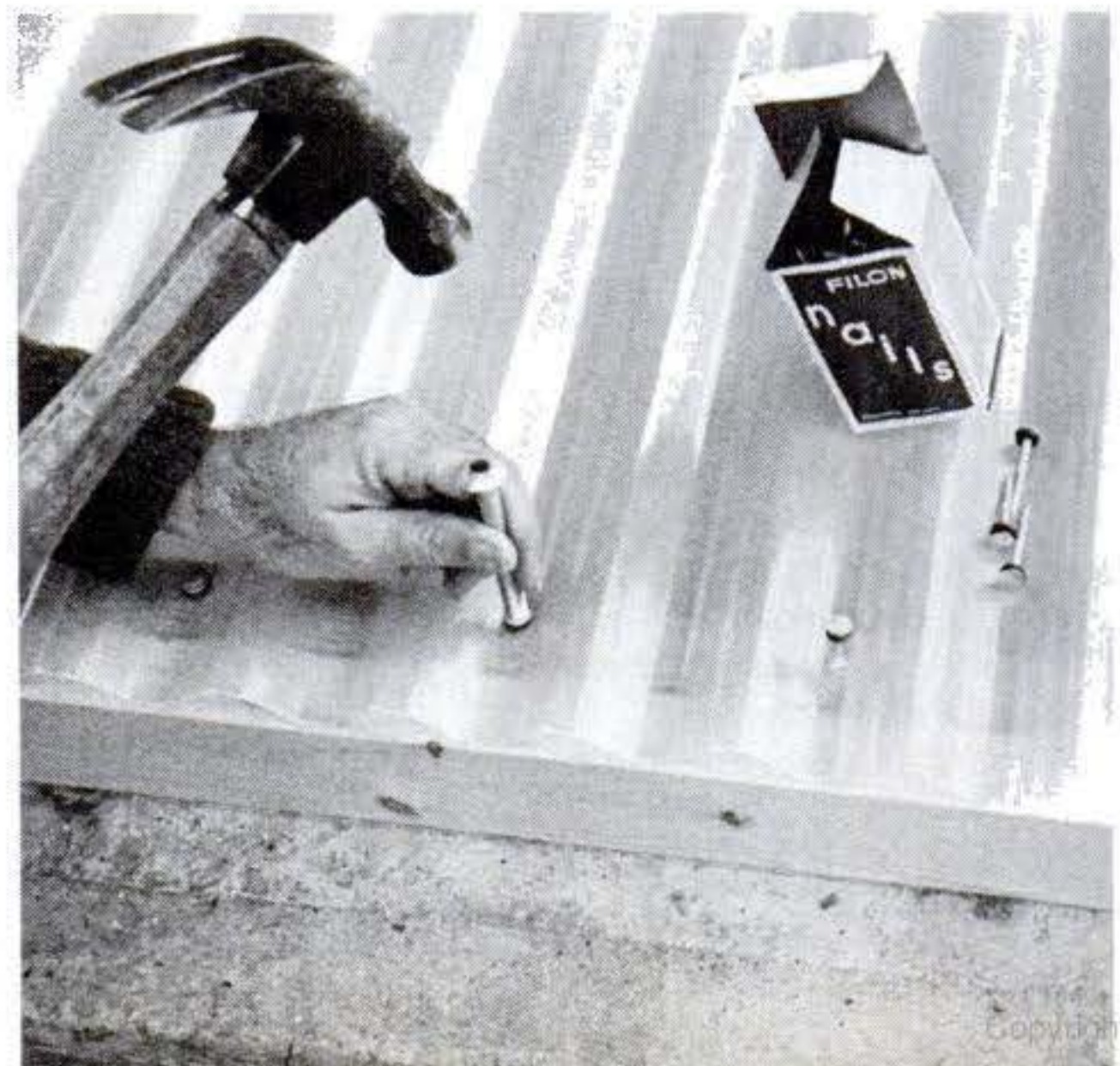
In my design, dry air enters the shed through the gap between the walls and ground, picks up heat and moisture as it circulates around two cords of sun-warmed logs, and exits as moist air through the top vents.

I used Filon's Type 416 Standard Clear corrugated panels in the six-oz.-per-sq.-ft. weight. You could use lighter material if snow loads aren't a problem; for very heavy loads, frame the roof with 2x4's. My panels cost about \$200, and I spent an additional \$125 on lumber and hardware.

The hinges on the walls let you fold the shed for storage or relocation. The two cross-buck doors hang from an aluminum track. Treat or paint all wood before attaching Filon. When fastening the panels, I didn't use the customary filler strips. This allows greater air circulation, but it means you must nail through the corrugation bottoms. Common nails are okay for walls, but on the roof use nails with neoprene washers to prevent leaks. Follow the panel overlap pattern (drawing) for a proper fit. ■



**Six stakes** hold dryer walls three to five inches above ground. After positioning them, move frame away so you can swing clear (above). To fasten panels (right), predrill holes at bottom of corrugations; carriage bolt makes good nailset. If you overdrive, Filon will craze, so practice on scrap. Space nails every other corrugation along edges, every third one across center. On verticals, nail every eight to 10 inches. For roof panels, use Filon nails with neoprene washer for a tight seal.







Now it's easier than ever to lay  
**sheet-vinyl  
flooring**

**Cut to fit precisely**, Armstrong's Villa Italia pattern vinyl flooring goes down without trauma. Perfect cut is due to the new Trim and Fit kit. It works with all Armstrong DIY flooring, including the Premier Sundial Solarian (about \$16.50 per square yard) shown here and Tredway (about \$10.25). Both flooring lines need fastening only at the edges. The \$6 kit is available from Armstrong dealers.

**Elegant Congoleum Contempora** flooring needs no tacking at the edges. The flexible, easily handled flooring is designed especially for do-it-yourself installation. Branham Crest (the pattern shown) comes in five colors, as do two other patterns: Emerald Glen, a natural stone look, and Legacy, a ceramic-tile-like design.





## Two major manufacturers offer a clever new kit and flexible flooring

By **SUSAN RENNER-SMITH**

A gleaming expanse of sheet vinyl can revitalize the appearance of a room. It can also unify two adjacent areas such as a kitchen and family room. Today's deep-cushioned, no-wax sheet floorings offer the added bonuses of comfort and easy maintenance. And installation no longer means wrestling with adhesive and trowel—many sheet-vinyl floors need cement (or staples) only on the perimeter to keep edges from rolling. (Seams, of course, must be cemented, too.)

With all these benefits, why have many homeowners chosen self-stick

vinyl tiles over the often more elegant and comfortable sheet-vinyl floors?

Fear of messing up—and of messes. Do-it-yourselfers dread the wrong cut, the slip of the knife that leaves a gap where vinyl is meant to flow smoothly around cabinet or stove. They're also fearful of a bungled cement job, or even of undertaking an arduous stapling job.

Now both Armstrong and Congoleum have introduced products that can help allay these fears—and make laying sheet-vinyl flooring easier even for the most timid among do-it-yourselfers.

Armstrong's Trim and Fit kit supplies a number of simple tools to solve some nagging installation problems. It can be surprisingly difficult, for example, to find or piece together enough paper to make a room-size pattern. Trying to tape wrapping paper or

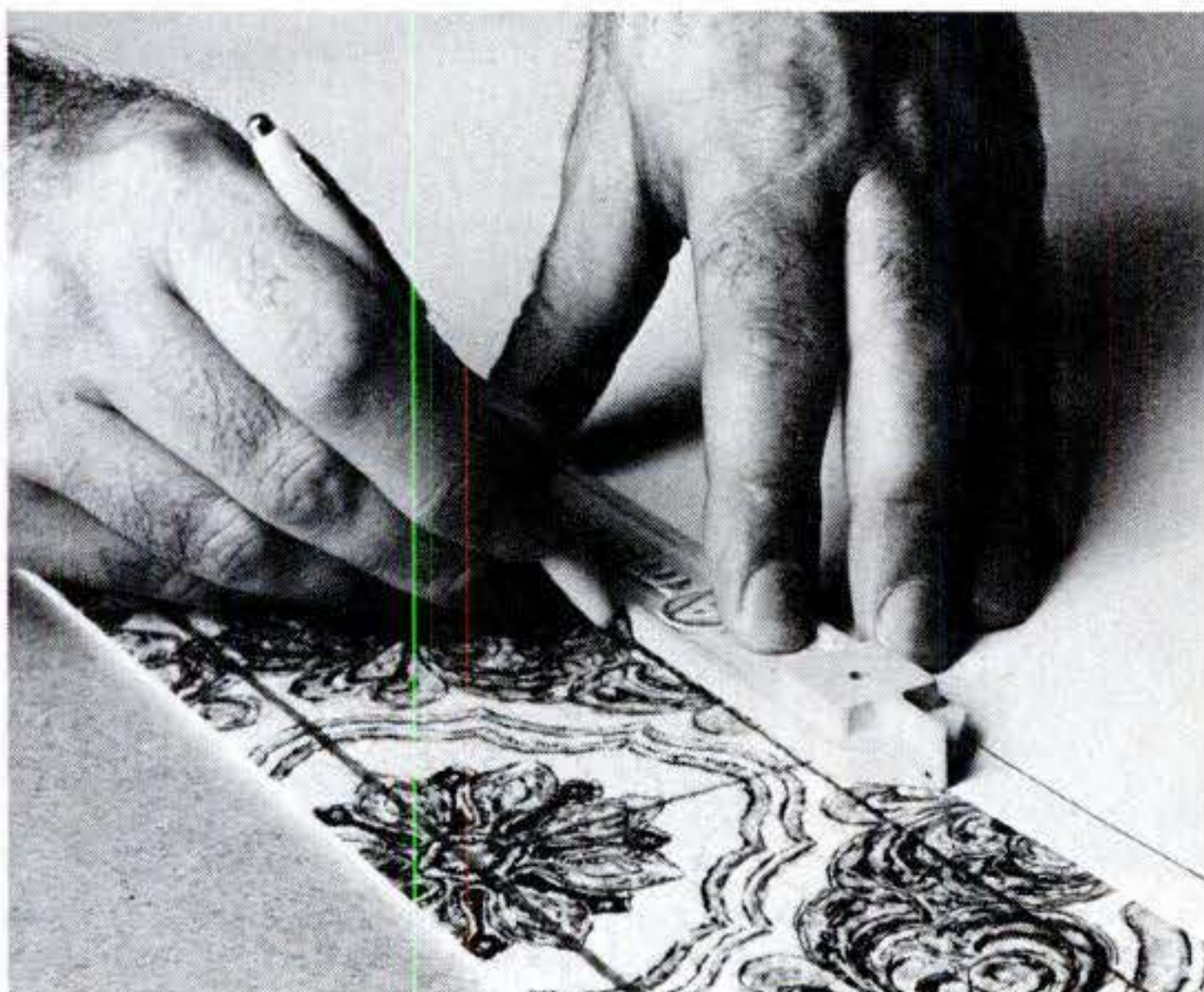
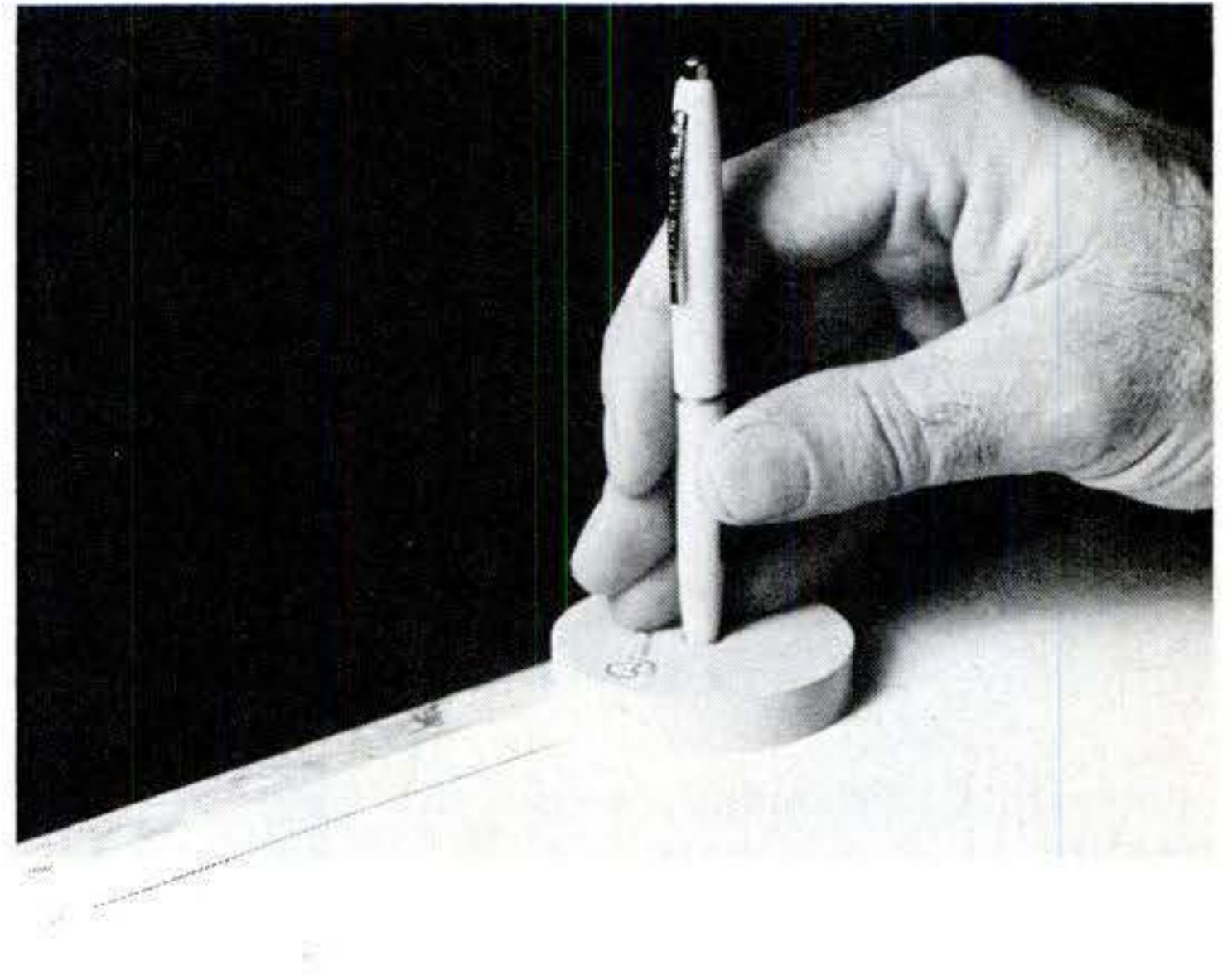
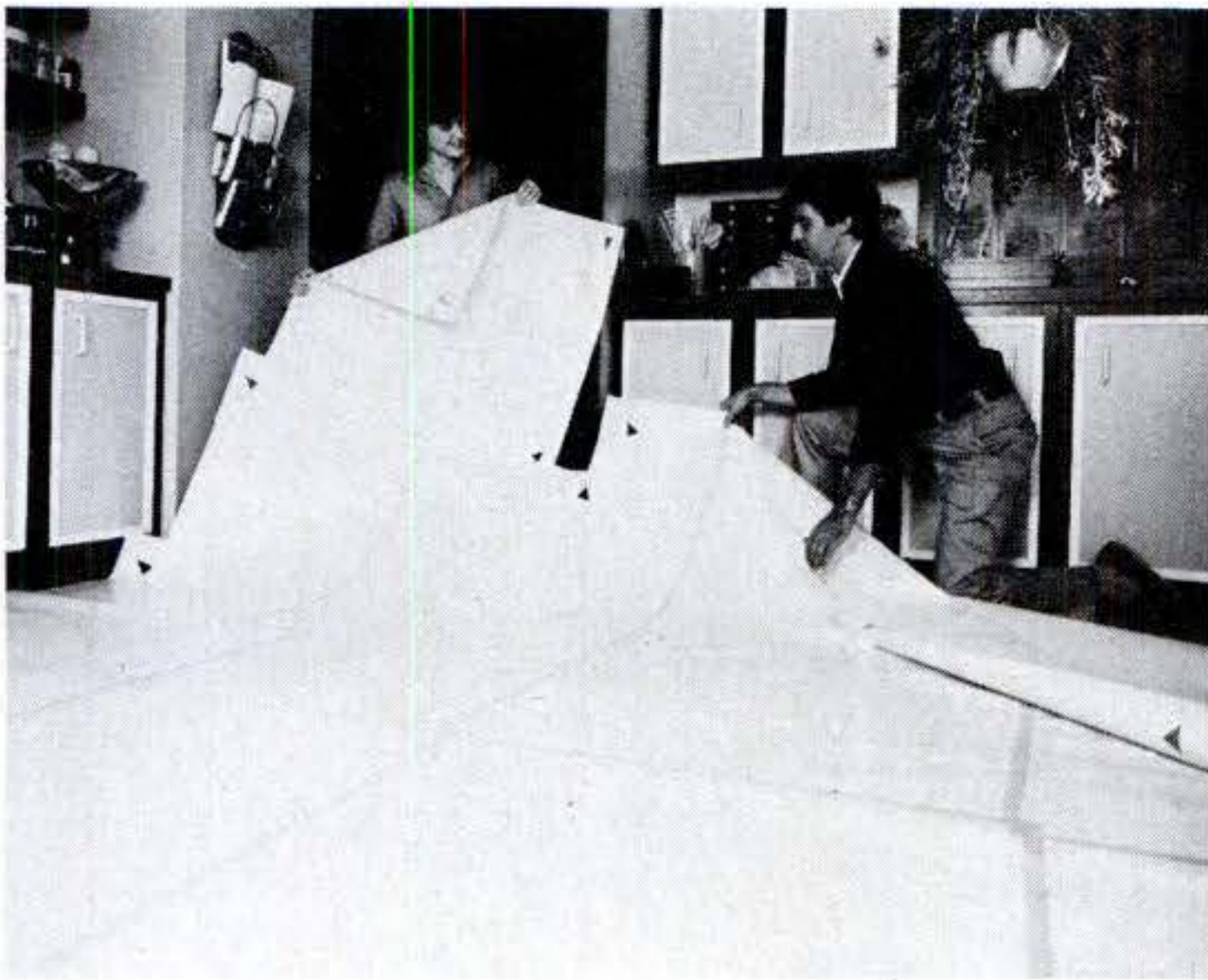
newspapers into a large enough piece is frustrating and almost ensures a sloppy pattern—and probably a cutting mistake. So one of the most important components of the Armstrong kit is a giant, 12-by-15-foot sheet of paper for pattern-making.

Both tracing and transfer tools also come with the kit. These unique tools make it easy to use the paper pattern as a guide for final cutting (see photos). The kit also includes a pen, a blade that converts the transfer tool to a utility knife, and instructions.

### Flexible flooring

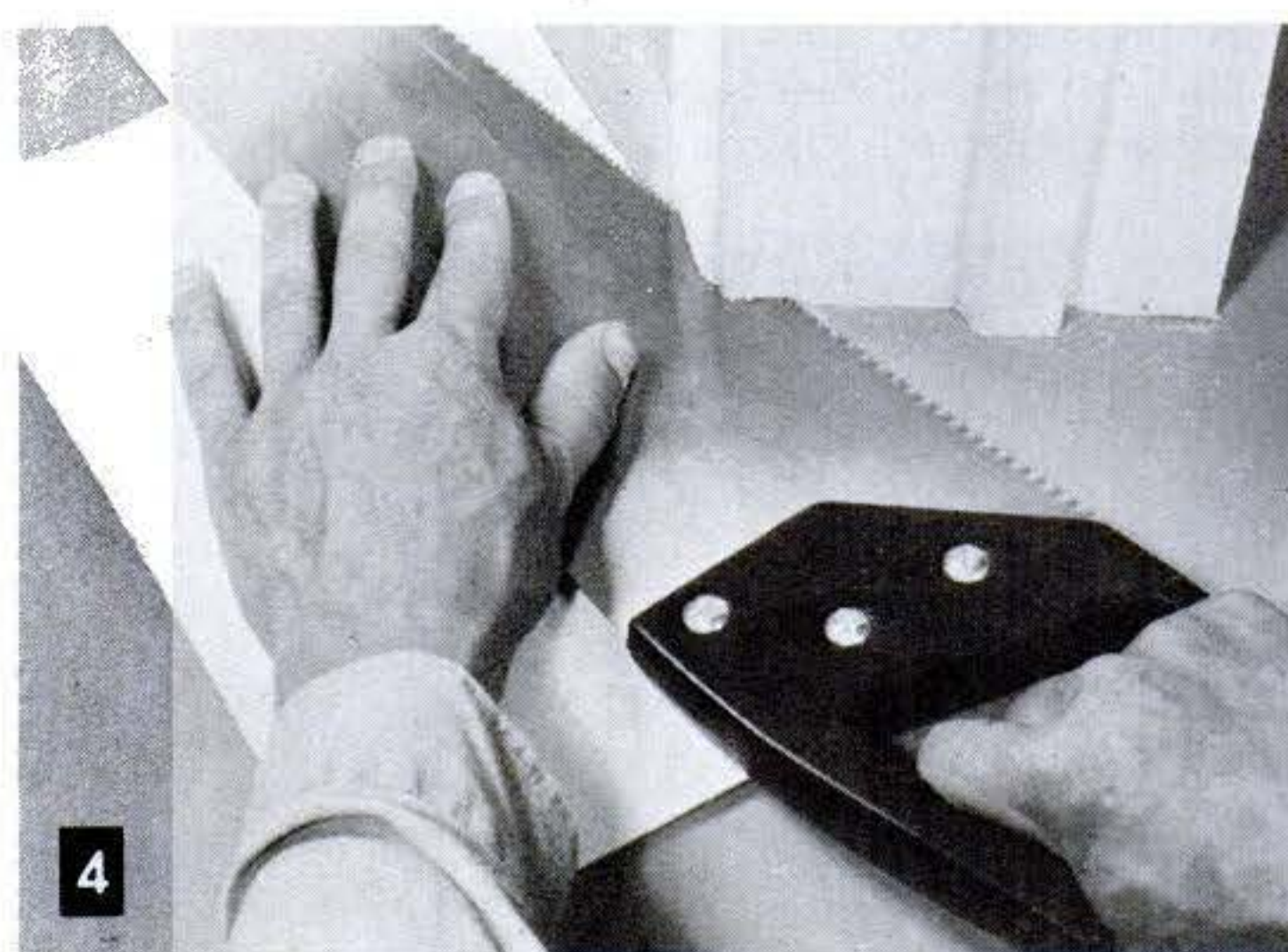
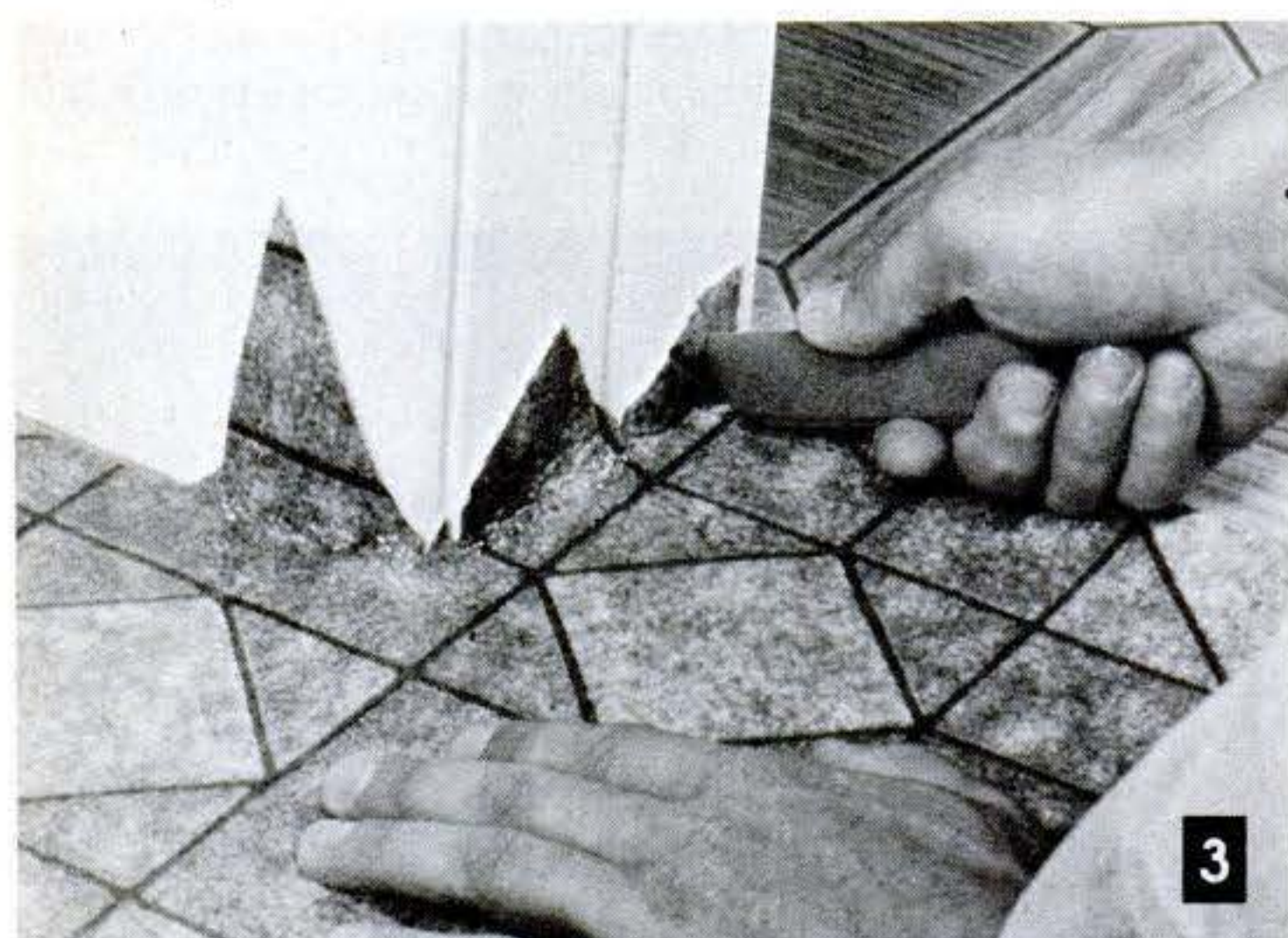
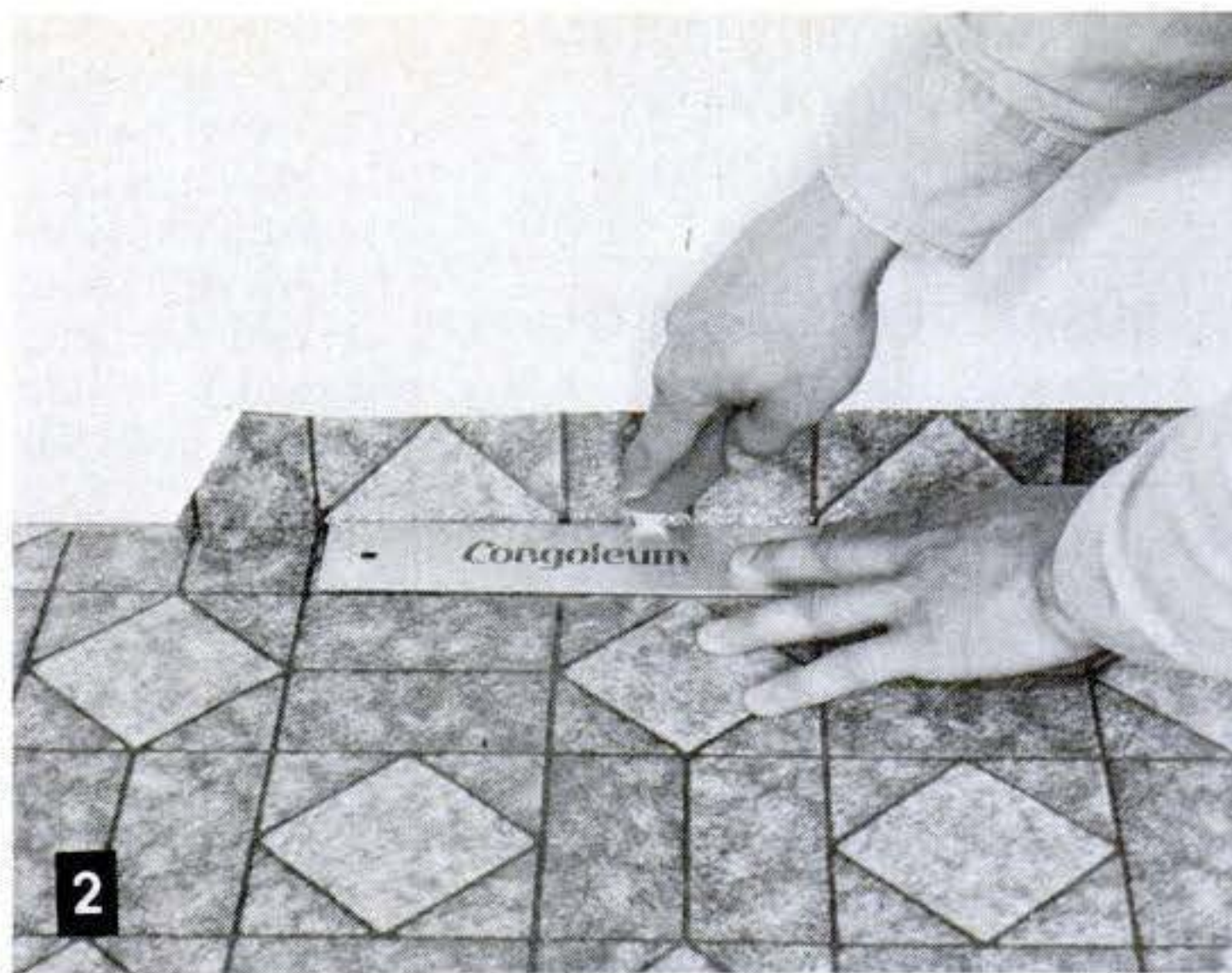
By eliminating even the steps needed to secure the edges, Congoleum has broken the last barrier to easy installation of sheet-vinyl flooring. Contemporaria, Congoleum's newest line of sheet vinyl, needs no edge-

*Continued*



Room-size paper pattern from Armstrong's kit (top left) need be cut only to within  $\frac{3}{4}$  in. from walls and protrusions. Running the tracing tool (top right) along the walls creates an exact outline of the room, minus one inch. With the pattern laid on top of the flooring, the inside edge of the transfer tool (above left) is then

lined up with the line marked on the paper. Tracing along the outer edge of the transfer tool makes up for the missing inch. Attaching its blade converts the tool to a knife designed especially for following the room outline drawn on the vinyl (above right). Once cut, it's a simple matter to lay the floor.



stapling or cementing (except at seams).

The new flooring, says Congoleum, lies flat without adhesive and neither curls at the edges nor shrinks after being laid. Its construction prevents cracks and ridges from showing through the vinyl and gives a smooth, flat fit that floats over most subfloor irregularities. For this reason, claims Congoleum, little or no preparation of the subfloor is needed—it simply must be dry and structurally sound. Suitable subfloors include all grades of concrete, and even cushioned vinyl floors.

Though strong and durable, the flooring is also flexible. Contempora can even be folded or bent for short periods of time without damage. This makes it easier to handle during installation. In fact, says Congoleum, you need not pre-cut Contempora—just lay it in a room and cut to fit (see photos on this page).

This convenience, of course, adds to the price. The new Contempora costs about \$18.95 per square yard—but you do save the price of cement and the time spent using it. 15



**To install Contempora**, simply lay the flooring down, allowing edges to lap up onto the walls (1). With a straightedge and utility knife, trim excess flooring one-quarter inch away from the wall to allow for subfloor expansion (2). (Cove molding can be added for a finished look.) At corners, make diagonal cuts until the flooring

slips down into place. At doors you can make a series of slits in the excess material, then press the vinyl flat against the floor and trim off at the crease (3). Or you can first undercut door trim with a hand saw (4). (A sheet of cardboard will protect flooring.) Then simply shove the rough-cut vinyl under the door trim (5).

# What Makes the Shopsmith MARK V a Better Buy for a Serious Craftsman than a Whole Workshop Full of Costly Single Purpose Tools?

Here are seven reasons that make the MARK V a better buy:

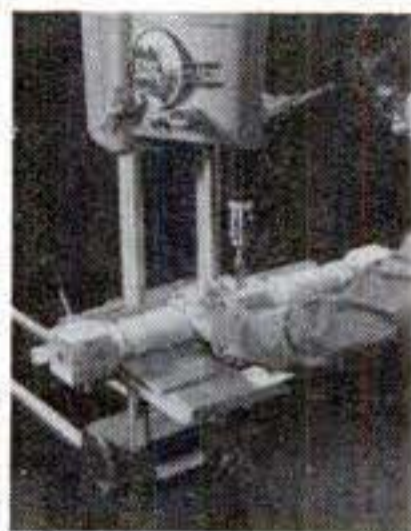
**REASON 1.** With the MARK V you can have the complete home shop to do accurate woodworking for considerably less than you would expect to pay for comparable single purpose tools. That's because it gives you the five most needed woodworking tools—a 10" table saw, a 16½" vertical drill press, a horizontal boring machine, a 34" lathe and a 12" disc sander—all in one compact unit.

**REASON 2.** You can do more with the MARK V than you can with single purpose tools. It lets you "share" features of one tool to enhance the capabilities of another. Because of this advantage, you can perform jobs with precision that's just not possible with individual tools.

**REASON 3.** The MARK V takes up far less room than individual tools. In fact, it takes up less space than a bike (2'x 6'). So you can have a lot of shop even if you don't have a lot of space.

**REASON 4.** The precision's built right into the MARK V. The control is built into your unit. So you make fewer mistakes. . . waste less materials. . . have more successful projects in less time.

**REASON 5.** Your MARK V workshop grows with you. As you learn more skills and develop more needs, you can add other Shopsmith tools and accessories to your system. . . and they all run off your MARK V motor. So they cost less than buying individual tools.



It's a vertical drill press.



It's a lathe.



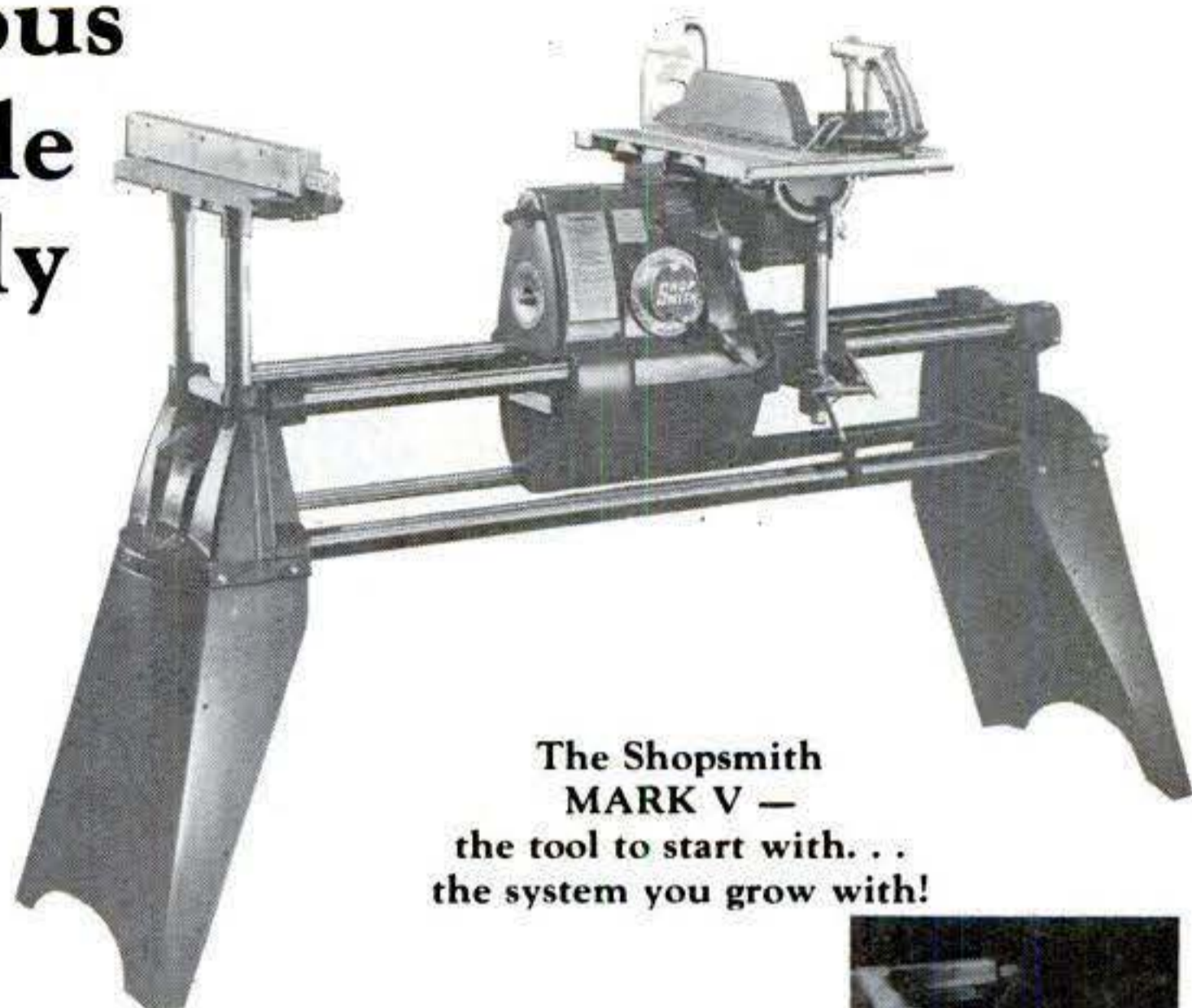
It's a disc sander.



It's a table saw.



It's a horizontal boring machine.



The Shopsmith MARK V —  
the tool to start with. . .  
the system you grow with!

**REASON 6.** The Shopsmith MARK V is easy to learn and convert. It comes with home study manual and text that makes it simple to use. . . even for a beginner. And after only an hour's practice you'll be able to change from function to function in only 30 to 90 seconds.

**REASON 7.** Over 250,000 MARK V's have been purchased since the machine was introduced. . . and nearly all are still in operation today.

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# Roof tile paves this **slate-tile patio**

Setting salvaged tile in a mortar bed produces a low-cost, one-step patio

By **ALDO P. BIAGIOTTI**

Like many homeowners, I had always wanted a patio. What better place to relax on summer evenings? Since I was afraid a mason would trowel my wallet as flat as the mortar, I decided to try the job myself.

I checked on the possibility of flagstone, and the price sent me scurrying for a reasonably priced substitute. An acquaintance had a stack of red slate roof tiles, eight by four by  $\frac{1}{4}$  inch thick, and suggested I use them. I did, and the results have proved practical and pleasing.

After determining the size and outline of the new patio, I removed soil behind the house so when the tiles were set in a three-inch mortar bed they would finish about even with the threshold of the cellar door. I dug out enough earth to ensure a pitch of about one inch across the patio's width to carry off the rain. I also dug a narrow trench about  $1\frac{1}{2}$  feet down at the outside edge of the patio to reach below the frost line.

Next I built a perimeter frame of  $2\times 4$ 's with another  $2\times 4$  down the middle to divide the frame, since I planned to lay only half of the patio in a day. I used a level to set the pitch of the frame and braced it with stakes. The frame and middle board would serve as a guide to keep the tiles straight on the pitch away from the house.

After the form was in place, I made the mortar by mixing Portland cement with sand, then adding water. I mixed 40 shovelfuls of sand with each 94-lb. bag of cement, a ratio of about two or three units of sand to one of cement. Mixing in a flat-bottom mortar tub was a little easier than in the wheelbarrow, which I used to move the fresh mix.

I dumped the first load of mortar in a lower corner and distributed it roughly with a shovel, tamping it firmly into the perimeter trench as well. Then I used a trowel to bring the mortar flush with a guide board laid across the frame. I set the first tile in the mortar, tapping with the trowel handle until it was settled firmly and flat under the guide board. I took advantage of the two holes in the tile to anchor it firmly with a couple of galvanized nails tapped into the mortar. If it was too difficult to settle a tile low enough, I picked it up and removed a little mortar; if the tile was too low, I added mortar. Another way to lay tile is to pour a concrete slab or lay a gravel bed first, and set slate, brick, or stone in a thinner bed of mortar on top. I decided to do the



**Smoothing the mortar between tiles with a jointing tool is author Biagiotti (above).** The finished patio can be seen on facing page. The red slate tiles used were salvaged from roofs of older homes in Ridgefield, Conn., where author lives. Salvaged tiles are often advertised in local weekly papers. Although the author did not use reinforcing wire (since his patio wouldn't carry heavy weight, as a driveway would), it's best to include six-by-six-in. wire mesh, or other reinforcement, in any mortar or concrete base to help prevent cracking and frost heaving.



job in one step, spreading my mortar directly over the scraped earth.

In areas that did not take a full tile, I made the tiles smaller by chipping away slowly and carefully with a mortar hammer. Whenever I tried to whack off a large chunk, the result was shattered, unusable fragments.

After laying several tiles, I used a jointing tool to smooth the mortar in the one-inch joints. After the tiles were laid on one side of the patio, I removed the 2x4's next to the house and filled the voids with mortar.

I allowed the first half to cure overnight, sprinkling it very lightly with water a few times to aid curing. The next day I filled the rest of the frame with tile. For an investment of \$50 for 12 bags of cement, I constructed a patio that will bring many years of enjoyment. **PS**

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

8 mg. 'tar,' 0.7 mg. nicotine av. per cigarette by FTC Method.

© Lorillard, U.S.A., 1980

A close-up photograph of a woman with voluminous, wavy blonde hair and blue eyes. She is looking directly at the camera with a slight, knowing smile. She is holding a lit cigarette between her fingers, with a small amount of smoke visible. She is wearing a dark, textured turtleneck sweater.

# Golden Lights.<sup>®</sup> You really know you're smoking.

Give up double digit tar. But don't give up the pleasure.

Kings and 100s.  
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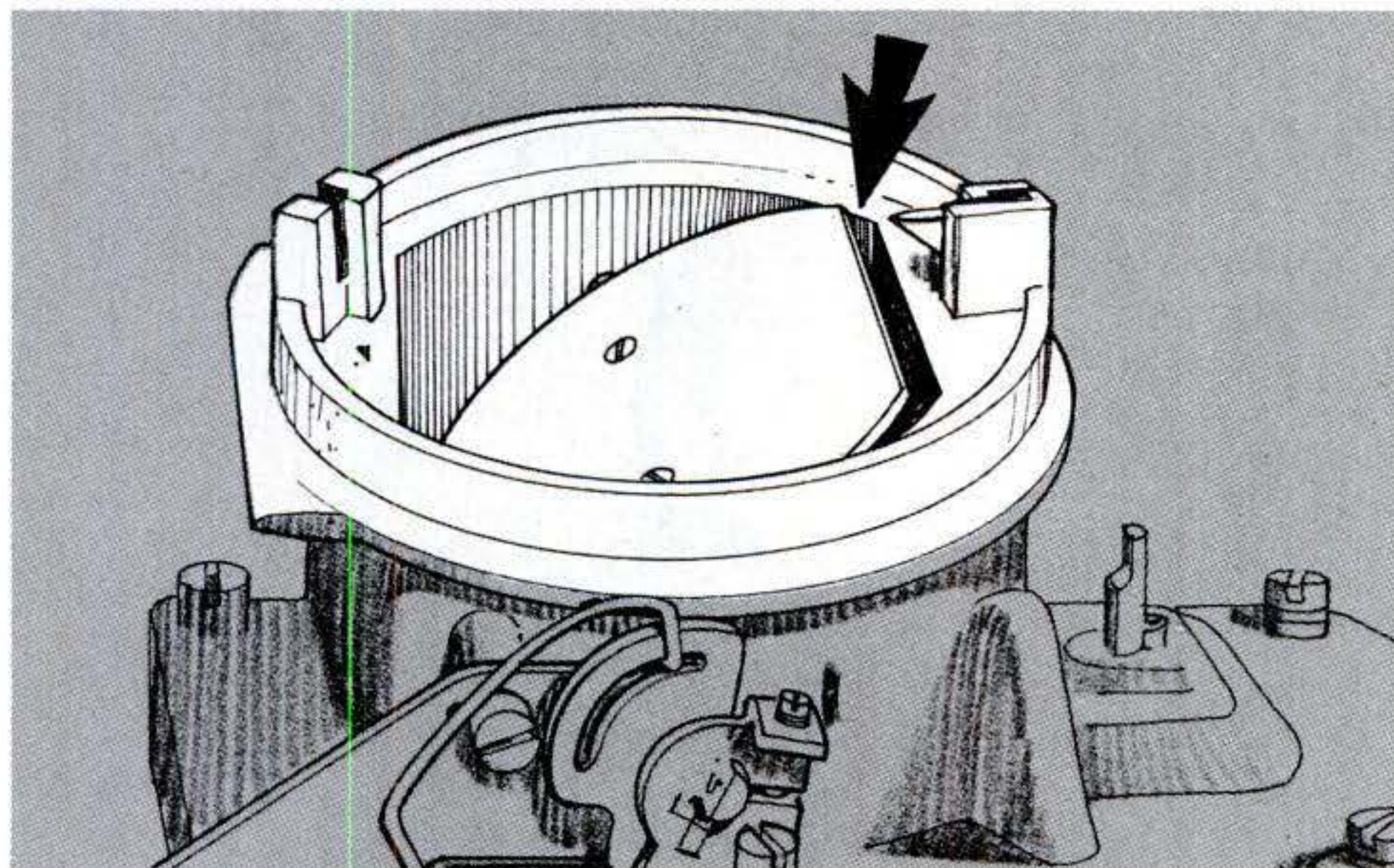
Two packs of Golden Lights cigarettes are shown at the bottom of the advertisement. The pack on the right is the primary focus, featuring a gold background with a blue and white vertical stripe on the left side. It has the Golden Lights logo (a crown) and the brand name in large, bold, white letters. The pack on the left is partially visible, showing a green and white stripe and the beginning of the brand name.

  
**Golden  
Lights**

# TAKING CARE OF YOUR CAR

Got a useful car tip? Send it (with Social Security No.) to Car Care, Popular Science, 380 Madison Ave., New York, N.Y. 10017. We'll pay you \$25 if we use it. If two or more readers send in the same usable tip, the one with the earliest postmark will be chosen. Sorry, but tips can't be returned.

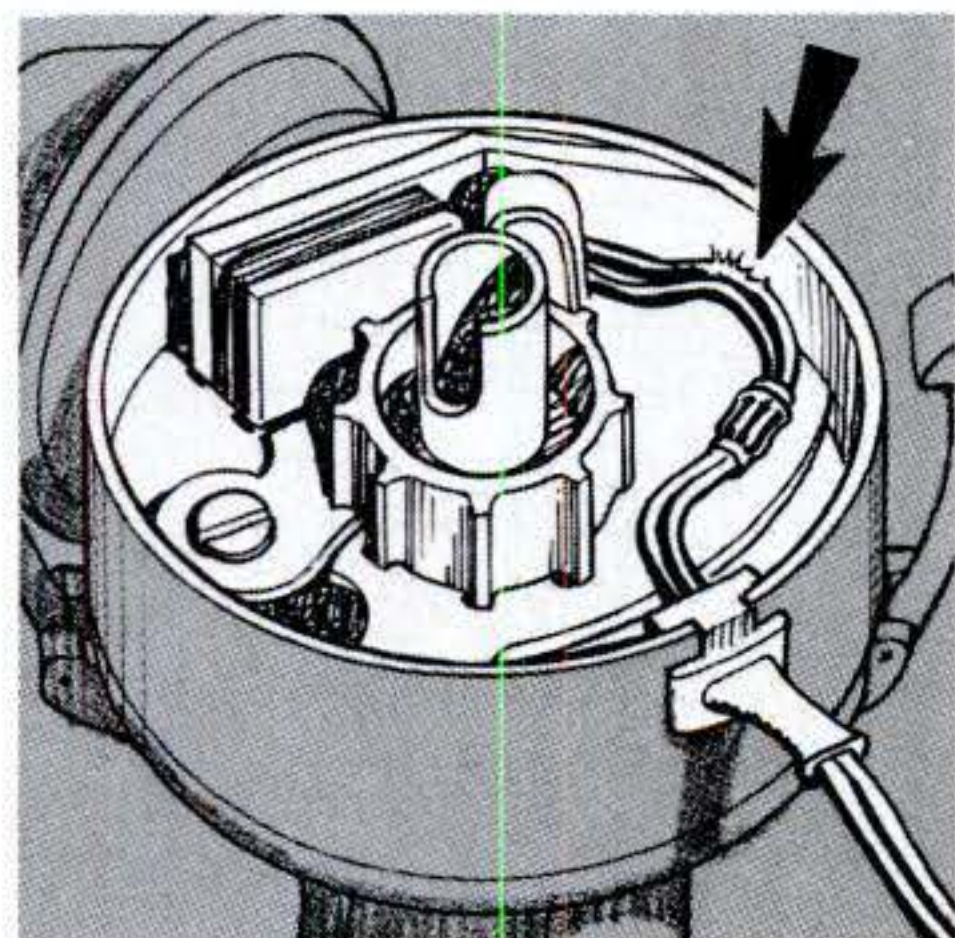
By RAY HILL



## Two likely causes of engine stalling when driving away

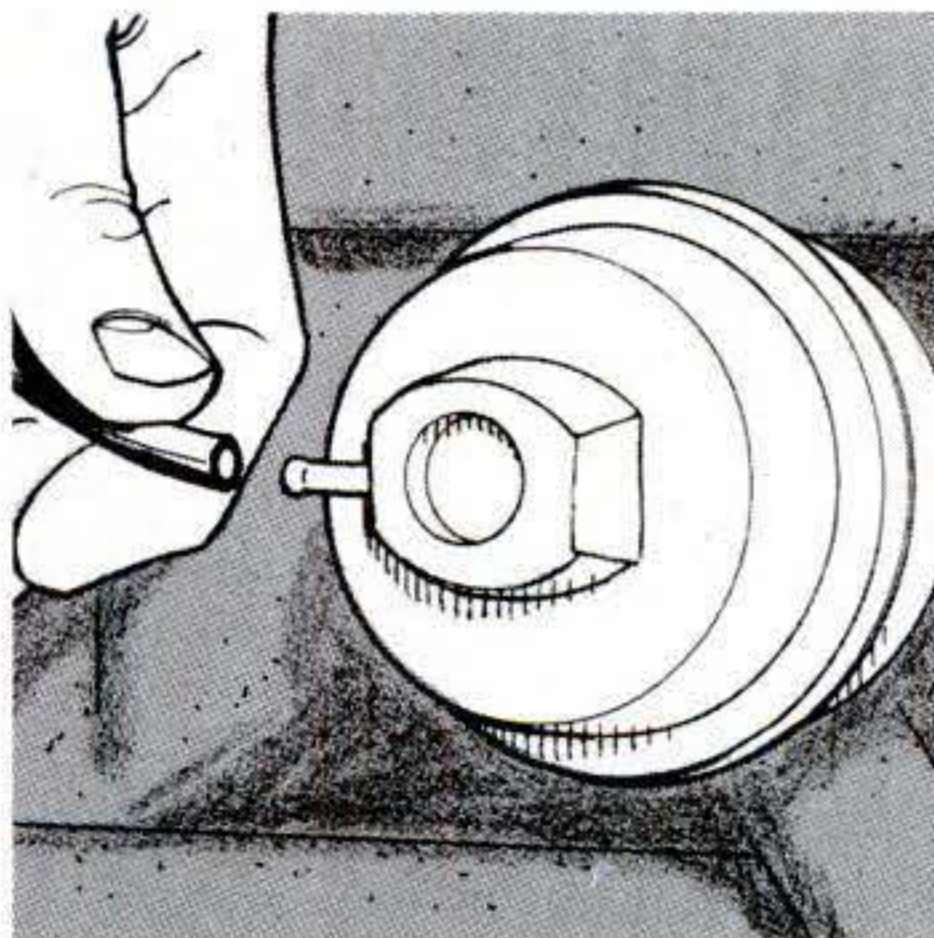
A cold engine that stalls when the automatic transmission is placed in gear may have a misadjusted or bad choke kickoff. Remove the air-cleaner top. Watch the choke plate when the cold engine starts. It should open slightly. If not, adjust the kickoff until it opens the plate the small amount specified in the shop manual. (Some cars have two kickoffs. One opens the choke at start-up; the other opens it a

little more, shortly thereafter.) If the kick-off linkage doesn't move and the kickoff is getting vacuum, the kickoff is bad. Replace it. If the choke is okay, check fast-idle speed with a tachometer. It may be too slow. Position the fast-idle cam as instructed in the shop manual, and note engine rpm. If you find that fast-idle speed is wrong, adjust it to the speed called for in the shop manual.



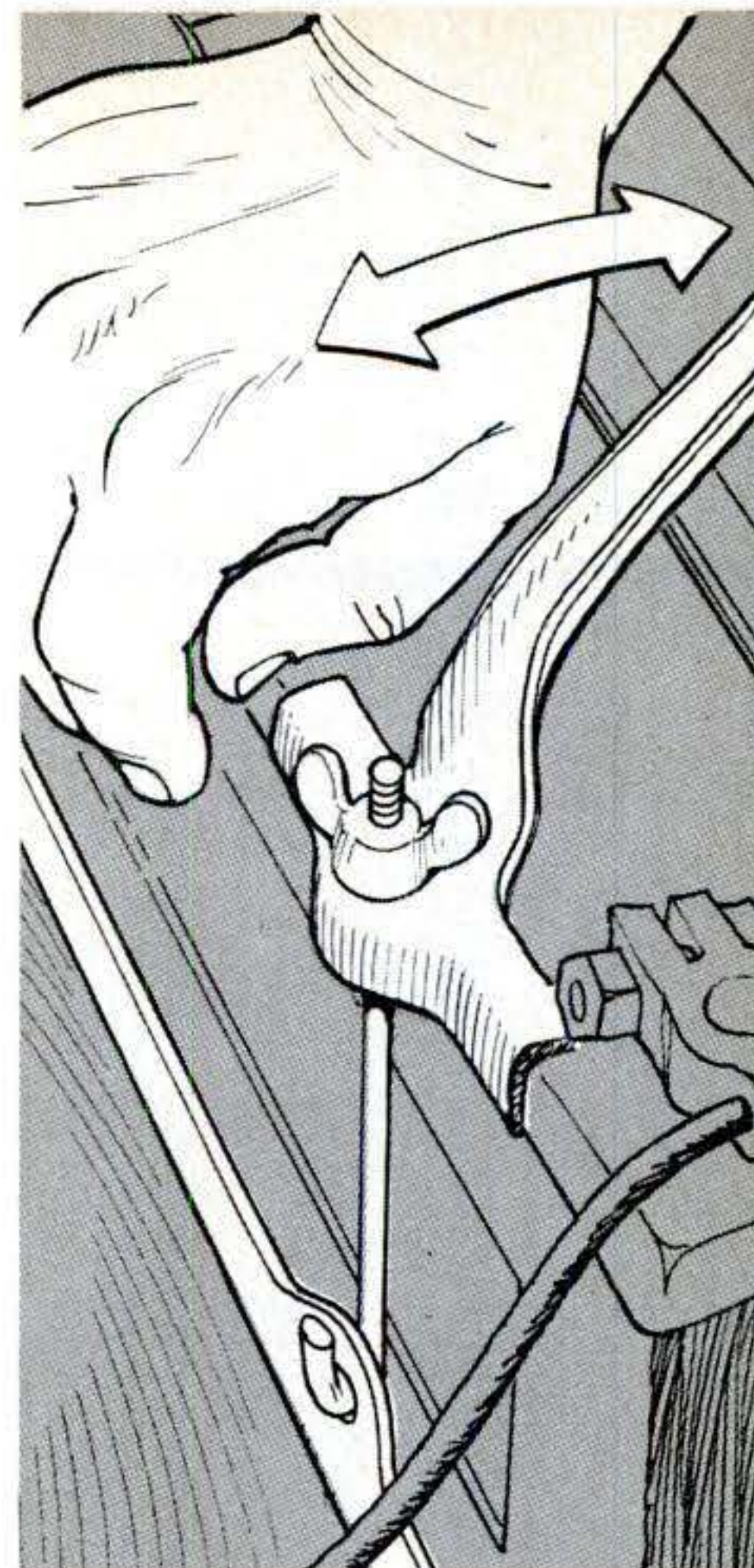
## Bad pickup leads

An engine that turns on and off during acceleration may be doing so because of a faulty pickup. On some cars, the pickup leads touch the distributor housing. Breaker-plate movement can eventually rub the insulation from the wires, allowing them to ground to the distributor housing. To check for a short, disconnect the distributor-advance vacuum line, then accelerate the engine. If the problem disappears, the leads are probably faulty.



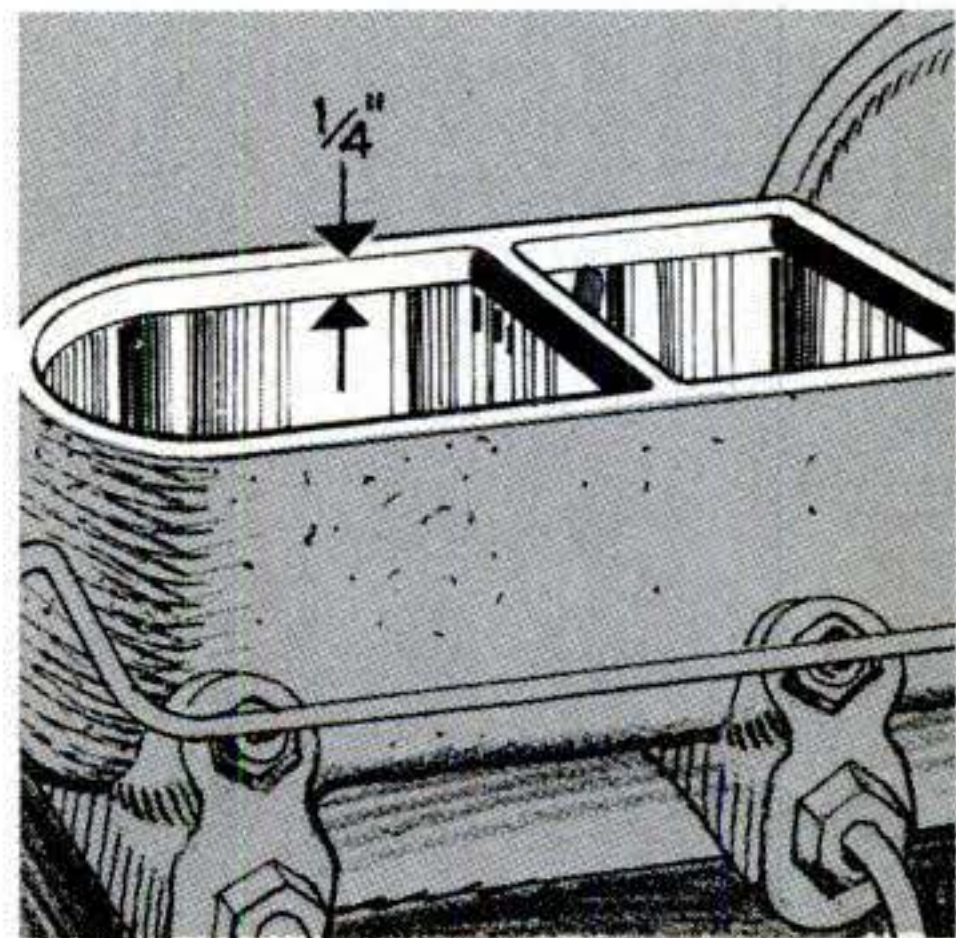
## Rough idle

A bad EGR valve can cause an engine to idle roughly. Disconnect the vacuum line to the EGR valve and see if the idle smooths out. If it does, the problem is in the vacuum system leading to the EGR valve. If the idle remains rough, shut off the engine and remove the EGR valve. Inspect it for carbon buildup, and be sure it seats properly. If the valve can't be cleaned and/or doesn't seat correctly, replace it. Be sure to use a new gasket.



## Check battery hold-down

An often-neglected item under the hood is the battery hold-down. If it's loose, the battery can bounce around excessively and its life may be shortened. Whenever you check the battery-fluid level, try to move the battery with your hand. If you can move it, tighten the hold-down until the battery is secure. If the hold-down is missing, as it sometimes is with used cars, install a new one.



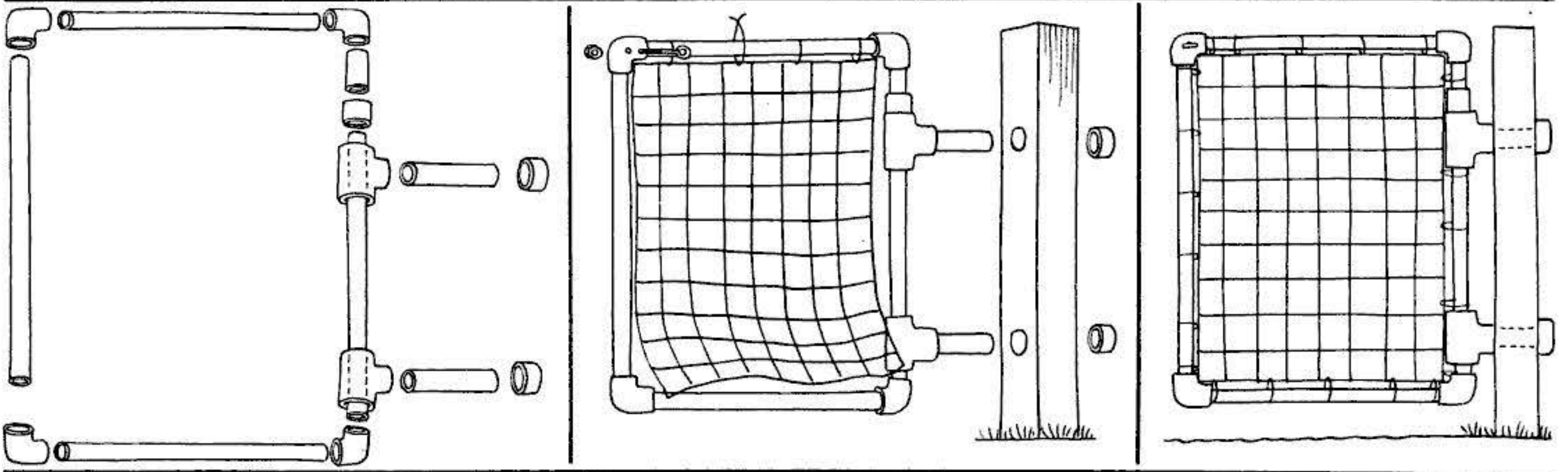
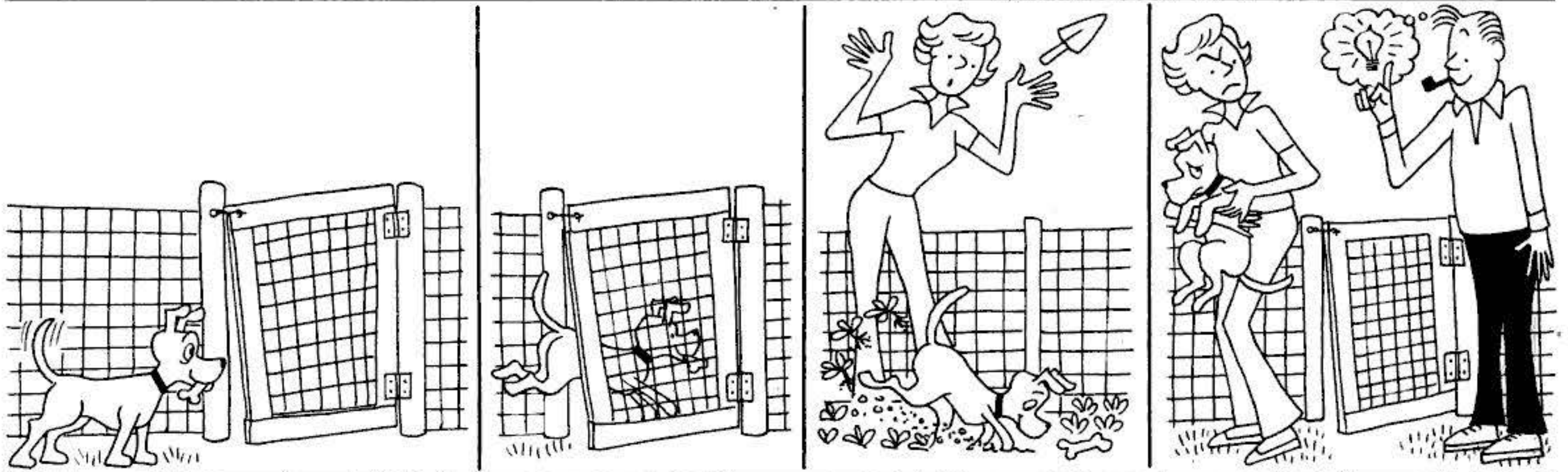
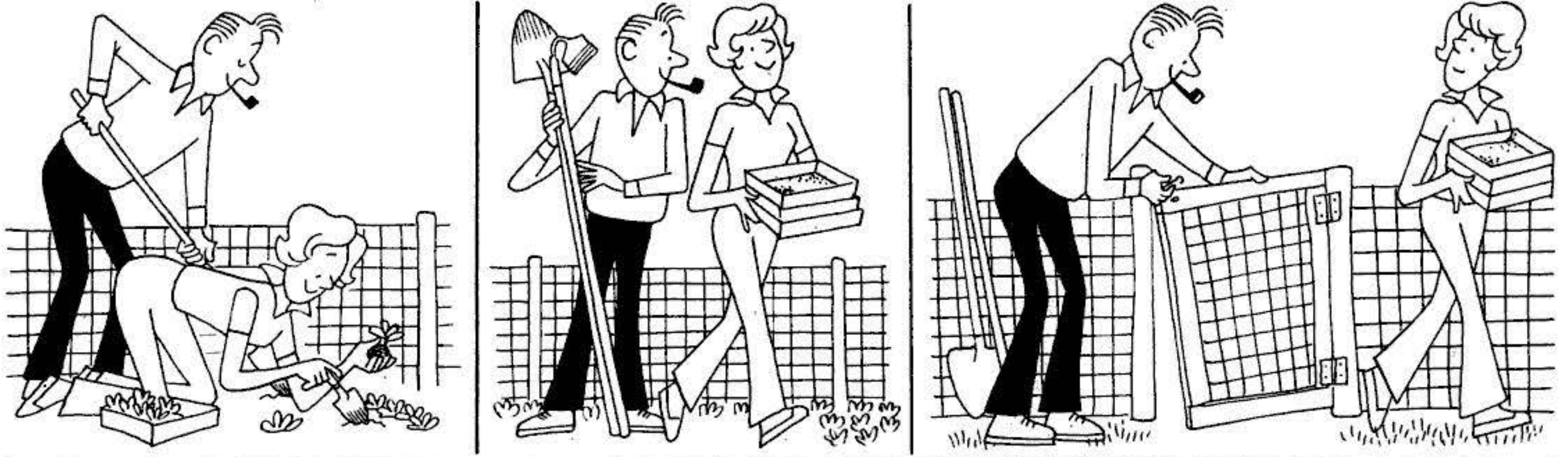
## Sinking brake pedal

Your car's brake pedal slowly goes to the floor while you're stopped at a light. Releasing the pedal and depressing it again results in the same thing. If this happens to you, an external leak or a bad master cylinder could be the cause. Check the brake-fluid level in the master cylinder. If the fluid level is okay and there are no external leaks (at hoses, wheel cylinders, etc.), the master cylinder is probably defective. Replace it.

# WORDLESS WORKSHOP

By ROY DOTY

\$50 to Allen Hancock of Portola Valley, Calif., for this idea. Send yours (with Social Security No.) to Wordless, POPULAR SCIENCE, 380 Madison Ave., New York, N.Y. 10017. Only purchased ideas will be acknowledged.





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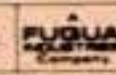
With a Zip Kit™, you can empty cuttings directly into plastic trash bags.

A Thatcherizer™ converts SNAPPER self-propelled models for removing thatch which prevents your lawn from getting the air, water and food it needs for healthy growth. Even more time-saving when used with a grass catcher.

You also have the choice of trimming closely with a large-capacity rear catcher; six forward speeds on rear-wheel-drive, self-propelled models; 19" or 21" cutting width; and, 3, 3½, 4 and 5 HP engines.

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# IF RISING FUEL COSTS MAKE YOU BLUE, THINK PINK.

Cheer up, things could get worse.

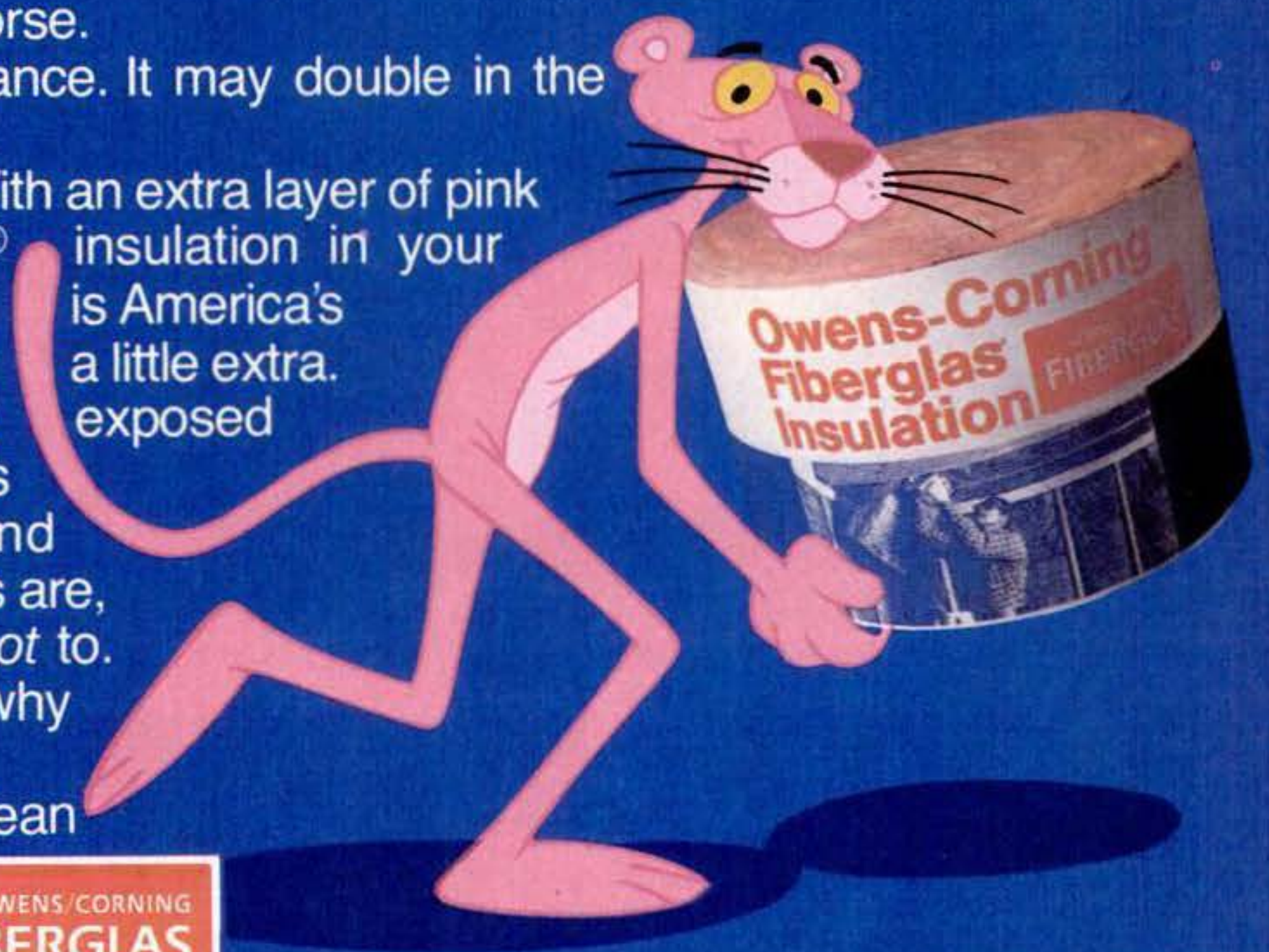
The cost of fuel, for instance. It may double in the next ten years.\*

But you can fight back. With an extra layer of pink Owens-Corning *Fiberglas*® insulation in your attic. Pink Owens-Corning best-selling insulation. Add a little extra.

Insulate your attic, walls to heat and cold, and floors over unheated garages and crawl spaces. The way things are, it could be more expensive *not* to.

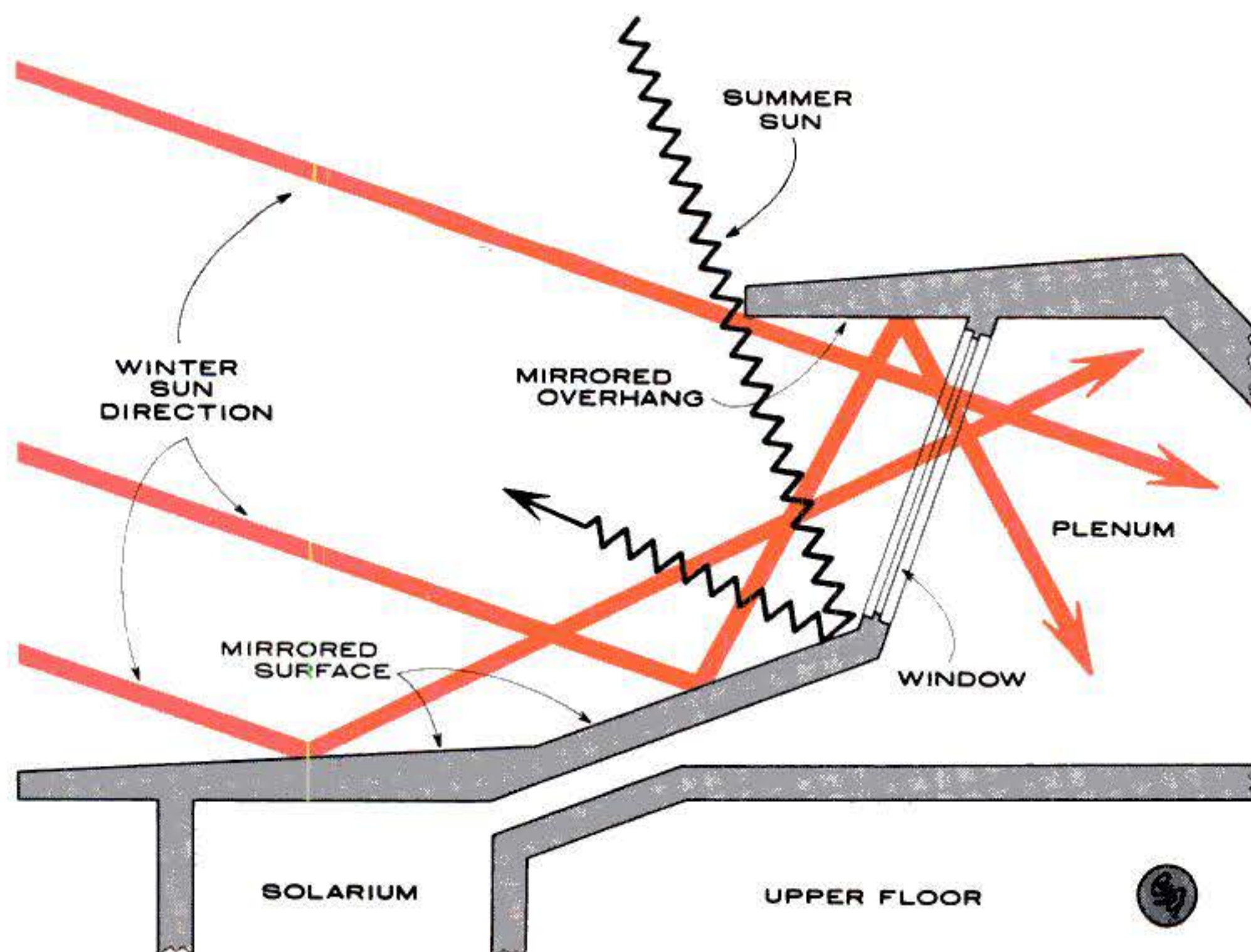
Savings vary. Find out why in the sellers fact sheet on R-values. Higher R-values mean greater insulating power.

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INSULATION



# SHOP TALK

By PAUL BOLON



## New wrinkle in loop houses

Passive-solar homes have always had one nagging limitation: Gathering more heat inside during the day requires increasing the area of glazing, which, in turn, results in increased nighttime heat loss since glass is a poor insulator. The SunScoop concept may be an answer to this dilemma. The SunScoop modifies the simple overhang, considerably increasing the "window" area of solar collection without increasing the area of glass.

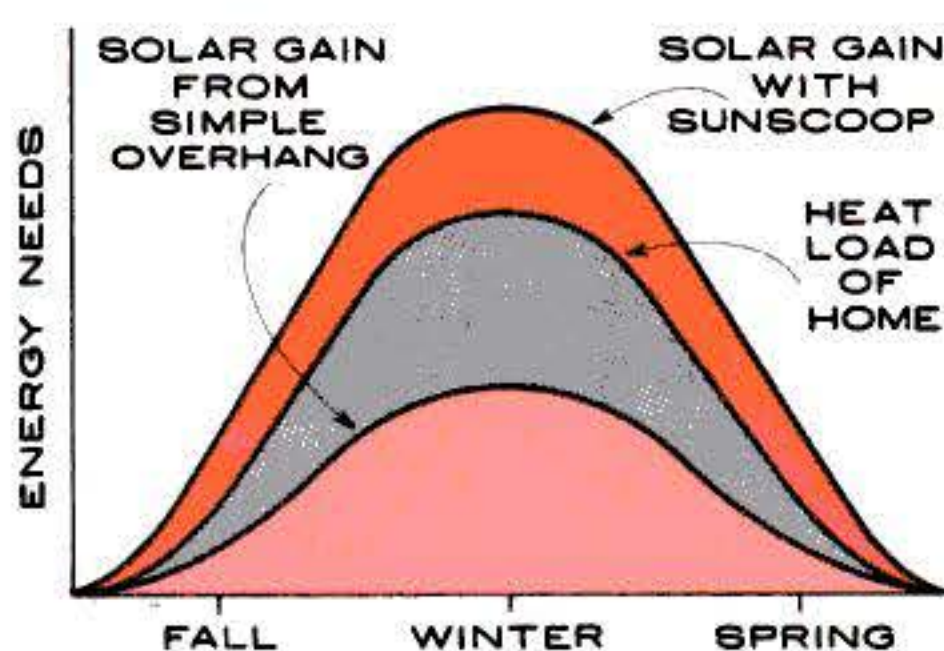
The SunScoop accomplishes this by adding low-angle mirrored surfaces in front of a window and making the underside of the overhang reflective, too (see drawing above). In winter, when the sun is low in the sky, the window receives direct light plus sunlight reflected from the surfaces in front of the window. The window and glass are also set at an angle to minimize reflective losses when the sun shines directly on it in winter.

If the mirrored surfaces are optimally aligned to the sun (a function of the latitude at the site), the SunScoop almost doubles the amount of solar energy that would normally enter the window, says Gerald Kitmann, president of Salgary Corp. and originator of the SunScoop idea. According to Kitmann, this extra energy gain is enough to meet the total heating needs of a home or other building throughout the entire year. As you can see in the graph (right) from Salgary Corp.,

the curve of the solar input from the SunScoop closely follows and exceeds the heating needs of a house, slowly turning off in warmer months.

Salgary Corp. has applied the SunScoop exclusively to double-shell, or loop, houses ["Double-Shell Solar House," PS, Dec. '79]. In these designs the SunScoop is in the top floor or attic along the entire length of the house and functions as a "solar amplifier," says Kitmann. Air heated by the sun behind an all-glass south wall (a solarium or greenhouse adjacent to the living space) rises up and over the inside shell. In the SunScoop design, this current of air draws even hotter air from the "solar amplifier" as it circulates down the north side of the house, through rock storage in the basement, and returns to the south wall.

The SunScoop's mirrored surfaces are produced by bonding 3M's reflecting film FEK-244 to a special grade of hardboard.



A metalized film, FEK-244 isn't degraded by long exposure to ultraviolet light—it's used extensively by the solar industry as a reflecting medium.

Salgary Corp. has completed design work for several different styles and sizes of homes and is presently building a house in New Paltz, N.Y. This will be a demonstration model open to the public. Construction of four homes is scheduled to begin soon, Kitmann reports. Salgary Corp. intends to control construction of houses and other buildings incorporating its concepts. For the present, use of these concepts will be restricted to franchised contractors chosen on the basis of experience and reliability in the solar field, the company says. Kitmann explained that proper quality control is essential in loop houses. Some builders may try to substitute for materials that are not available locally, and loop houses require rigorous adherence to design specifications and materials to ensure that the passive system will function as planned. For more information, write to Salgary Corp., 7 Innis, New Paltz, N.Y. 12561.

## Solar information

The answer to the often-heard question, "Where can I find information on solar energy?" is the 1980 *Solar Information Locator*. The 58-page book, published by the Solar Energy Research Institute (often recommended to PS readers), is a handy and complete reference to state energy agencies; private organizations with active research programs; federal agencies; regional and university centers of research and publication; and periodicals (like POPULAR SCIENCE) that regularly report on the solar field.

In all, the *Locator* lists over 300 organizations. A limited supply of copies of the 1980 *Locator* is available free from the SERI Document Center, 1617 Cole Blvd., Golden, Colo. 80401.

Once SERI's supply is exhausted, copies can be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. It helps to mention the book's catalog number, stock #061-000-00454-8. Copies are \$3.50.

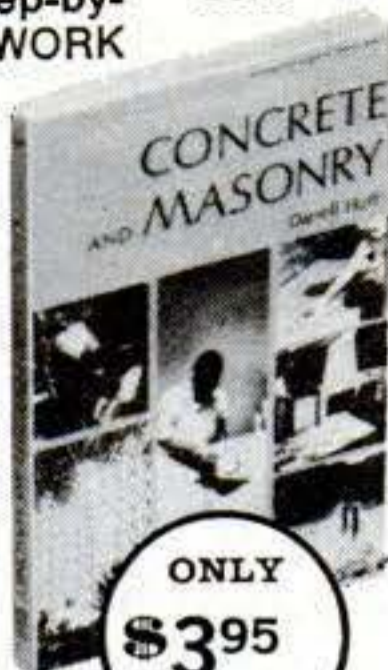
## Notes from underground

*Underground Plans Book-1* by architect Malcolm Wells and co-author (and son) Sam Glen-Wells is a follow-up to Wells' earlier *Underground Designs*. This new book is devoted to larger sketches and plans for underground homes with siting constraints (a north slope or a flat area, for example) and some new ideas (Truss Home, Terrasolarium). It also includes drawings of construction details common to mole-level homes and cursory discussions of such topics as room layout, landscaping, and waterproofing. The plans themselves are purposely incomplete—the authors are only "idea generators." So don't look for wiring details and other practical information you'll need to complete a house. The 44-page book is \$13 postpaid from Malcolm Wells, Box 1149, Brewster, Mass. 02631. [5]

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## "Say, Smokey—"

[Continued from page 70]

Look for coolant leaking under operating pressure. It doesn't take much of a leak to decrease the coolant supply enough to cause overheating.

The system should be liquid-tight to at least 15 psi. Also be sure when you fill the system that it is full. It's easy to have air pockets and think it is full.

Try drilling a 3/16-in. hole in the thermostat for a constant bypass.

## Is half a V8 good?

I've seen articles recently on how to change a V8 to a V4. It sounds attractive at first glance and I'm considering it. But I have several concerns. For example, wouldn't this put quite a strain on the head gaskets due to the temperature differences? What would happen to the unused cylinders, the distribution of oil, etc.? Is this conversion truly practical?

Steven C. Hayes, Greensboro, N.C.

Your concerns are valid. The real trouble, though, is in driving it up a hill on four cylinders. Yes, I know lots of folks say no sweat. If you think so, go ahead and try it. But be sure you leave the door open to come back.

In flat country, in no hurry, with no load, you can get by—but not very well. Here's where a cheap blower kit would really be great. But blower kits can't be cheap.

There's no magic. Weight and cu. in. have got to go down, but within reason. You have to keep a balance.

## White stuff in oil

I have a '78 Maverick with a 250 six-cylinder engine and about 57,000 miles on the meter. During the last several thousand miles I have noticed a whitish gel-like substance at the top inside of the oil dipstick tube. There are also little globs on the dipstick as well as on the underside of the valve cover.

I took a three-week vacation trip this past summer to Florida and then to Oklahoma before returning home, and never noticed this. There doesn't seem to be any problem with the cooling system leaking, nor is the car using any oil.

A. N. Geary, Taunton, Mass.

Sounds like water in the oil. Maybe not a leak, but condensation mixed into the oil. Perhaps the engine doesn't get hot enough to vaporize it. Take the oil out and heat it to about 200 degrees F with no open flame and no lid. I bet you go back to a normal oil color.

How do you stop it? Run the engine hard once in a while or add heat to the oil system.

## Water from tailpipe

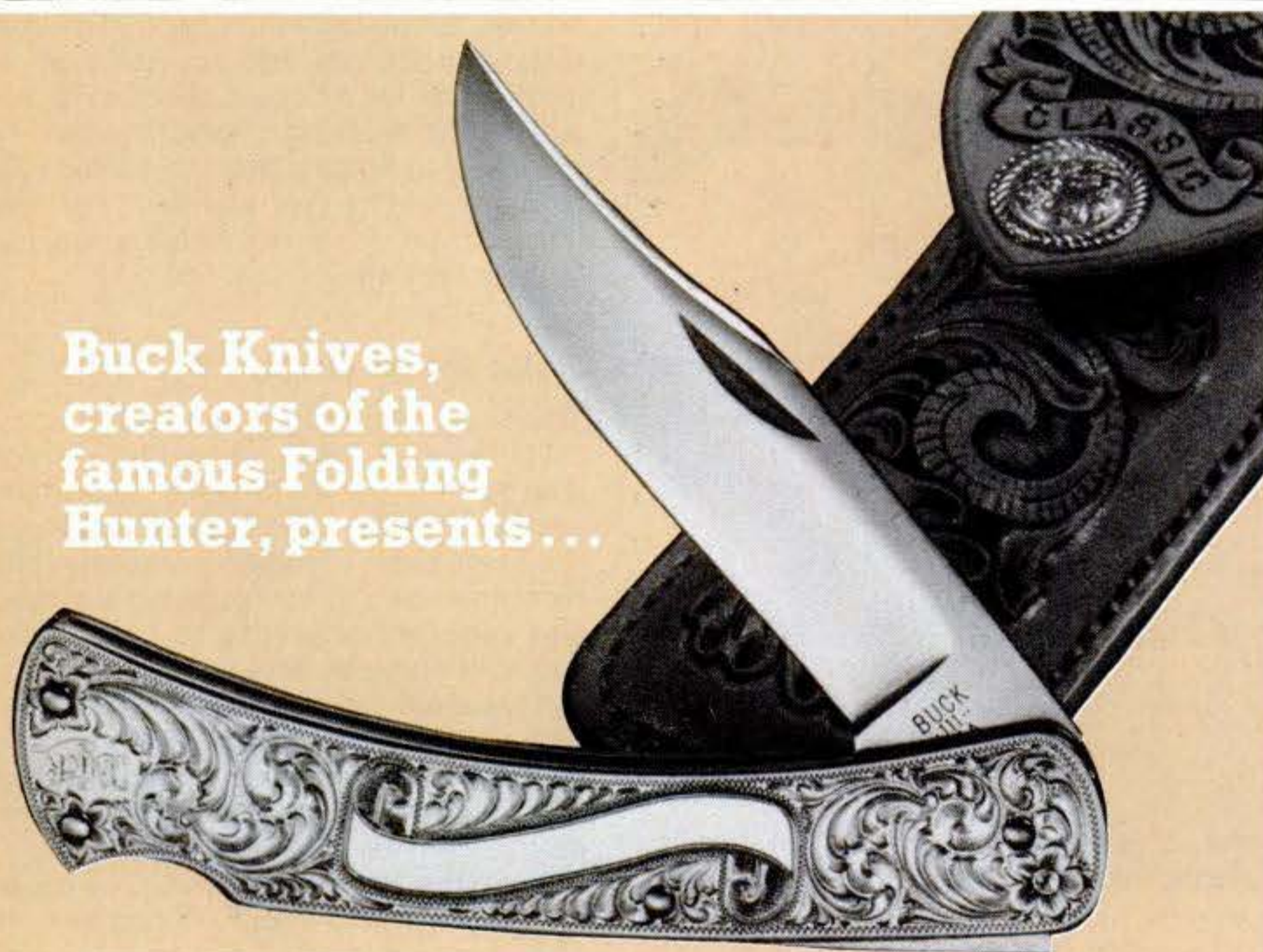
An excessive amount of water comes out of my car's exhaust pipe. It is a 1936 Cord. How can I find where it's coming from?

John McGowan, White Pigeon, Mich.

A cylinder-leakage test and dye in the coolant will show where the trouble is.

Continued

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## "Say, Smokey—"

[Continued]

### Bad steering pump

My 1977 Pontiac Catalina Safari station wagon has developed steering problems. The wheel binds only when turning to the right, usually only in tight areas such as when parking. The power-steering fluid level is normal, and the wheels have been realigned. My Pontiac serviceman says the problem may be in the spool valve. He has tested various elements, but has found no positive proof of what's causing the problem. At this point he is unwilling to take apart the steering box because it's a difficult and costly job.

What do you think?

Y. Azia, Hewlett, N.Y.

*I'd disassemble, examine, and repair as necessary. Sure, it can run into a few bucks, but compared to your hide, it's a bargain. I have seen the problem caused by busted-up bearings, which can be seriously hazardous.*

### Gasket keeps breaking

I have a 1977 Hornet wagon with a 258 engine. It has 45,800 miles on it. I've just replaced the gasket between the header pipe and the manifold for the third time. Can you tell me why the gaskets keep going bad? The exhaust hangers are all okay, but the exhaust does drag sometimes on bumps in parking lots. Could that be causing the breaks?

Also, we get an awful lot of heat in the car from the engine. I've had the solder melt out of two different fuses. The temperature gauge reads normal with just straight water in the cooling system. Add antifreeze, and it runs hotter. I have replaced the thermostat and am getting the same results.

Don Storey, Oxnard, Calif.

*How the exhaust is suspended from the vehicle is important. Stop the car from bottoming, and check for exhaust-system vibration when the engine is running. Sometimes a quick fix is to add a spring or two to dampen resonance. But this is not a job for the average do-it-yourselfer to tackle.*

*The fuse trouble could be fixed by changing to another brand of fuse, or by adding insulation in the fuse area.*

*As for the engine running hotter when you add antifreeze, this is unusual. It should run a bit cooler. Of course, all brands aren't the same. If you're under 205 degrees with water, I wouldn't worry. Still, for optimum cooling-system protection, you should have antifreeze in there, too.*

Each month in POPULAR SCIENCE Smokey Yunick answers questions on cars—family cars, high-performance jobs, hot rods, and racing cars—selected from those sent in by readers. Got a problem? Send it to: "Say Smokey—", Popular Science, 380 Madison Ave., New York, N.Y. 10017. Questions cannot be answered by mail.

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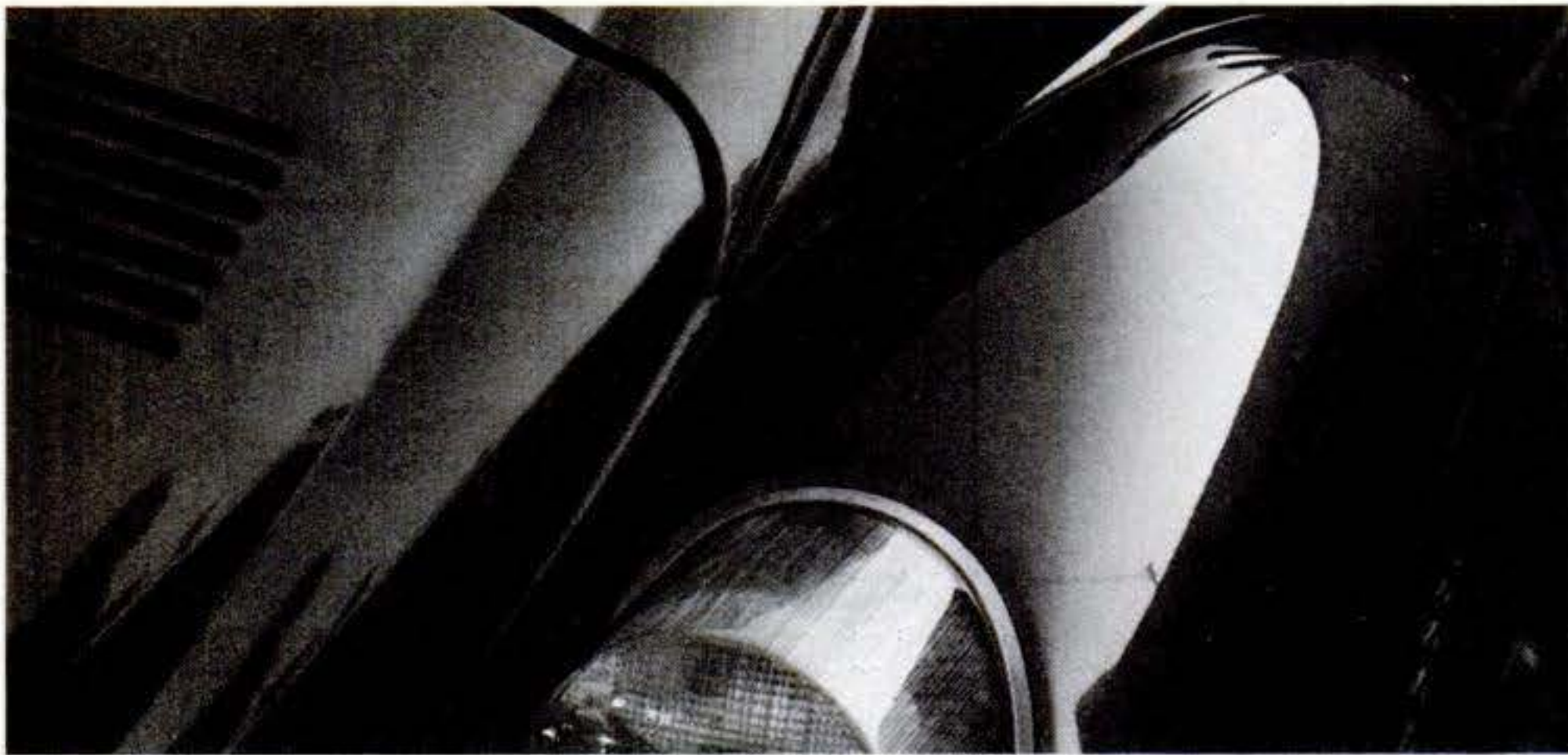
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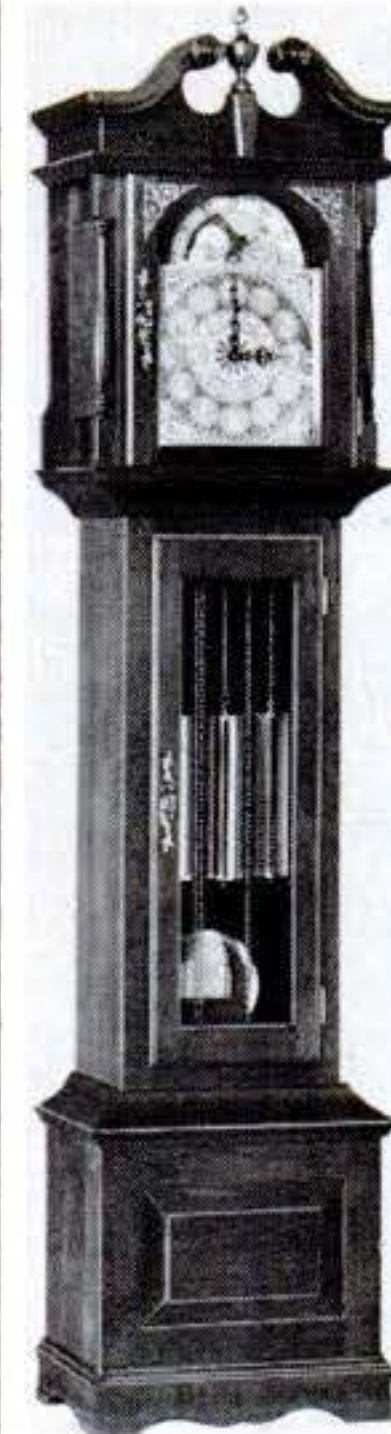
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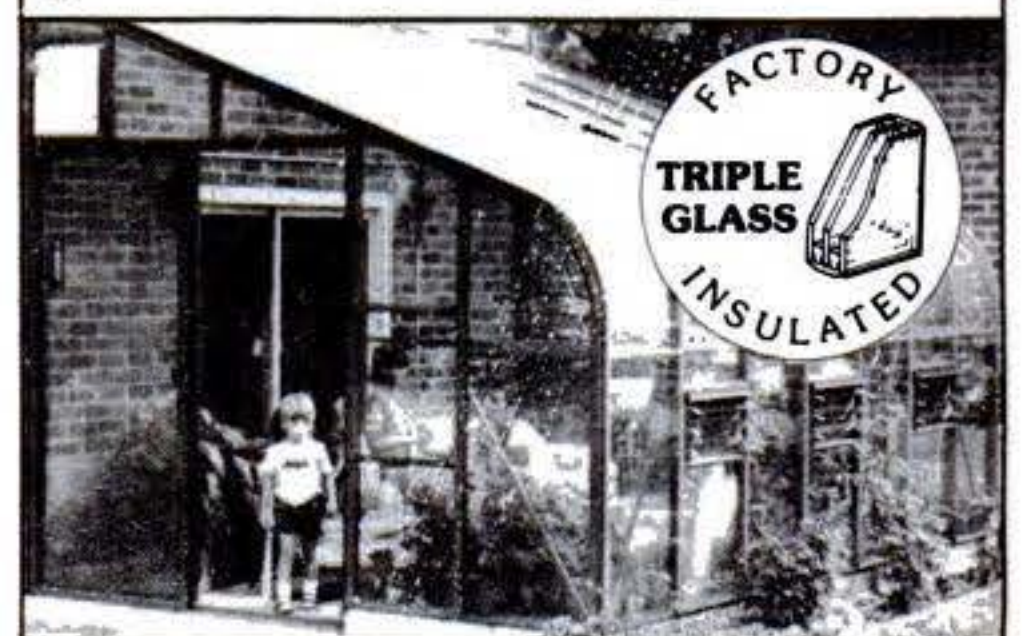
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## Best battery yet?

[Continued from page 83]

Hydrargillite is the feedstock of the aluminum industry, so the crystals—which look much like laundry powder—are washed, collected, and later removed to be recycled into new aluminum plates. After the hydrargillite is separated, more water is added to the electrolyte (to replace what stays in the residue) and it returns to the cell stack to repeat the process.

## Electricity powers cycle

Of course, the fuel cell is not a perpetual-motion machine: The tap water must be replenished regularly, and the hydrargillite doesn't produce aluminum for free—large amounts of electricity power the process. But the aluminum-air fuel cell is an extremely efficient system.

"With a stack of 60 cells weighing about 500 pounds," Cooper said, "we estimate that a vehicle the size of a VW Rabbit could travel about 3,000 miles. During the trip, the driver would refill the six-gallon water tank and remove the hydrargillite about every 250 miles.

"About three or four times a year, given normal driving, the aluminum plates would have to be replaced." And that should be no more difficult, and perhaps easier, than changing the oil in the car you drive today.

To date, the battery has not been tested in a car on the road, but lab-test results of the system are promising. "We estimate this power unit will be roughly equivalent in energy use and cost to engines using fuels derived from coal [synfuels]," Cooper said. In total cost per mile, the fuel cell would compete favorably against gasoline costing \$2 to \$3 a gallon, prices being paid today in Europe.

The aluminum-air battery won't be in the Sears catalog next Christmas. More development engineering is needed. Subcontractors are working on ideas to improve cathode durability under automotive conditions, develop aluminum-alloy/electrolyte combinations of higher efficiency and lower cost, adapt a continuous aluminum-casting process to produce the anode sheets, design the battery case for quick removal of many aluminum plates, and perfect the crystallizer hardware.

"We expect to have a working vehicular model toward the end of the decade," Cooper told me. If he's right, perhaps in 15 years we'll be pulling up to the filling station and saying, "Give me a tank of water and check the aluminum, please." E

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Department P

## HOUSEPOWER CLINIC

By EVAN POWELL



### New heat-pump water heater

Now a major heat-pump and air-conditioner manufacturer, the Fedders Corp., has begun marketing a heat-pump water heater, joining the ranks of the E-Tech Co., whose unit I installed and reported on in PS, April '80. You'll find a report on the new Fedders heater elsewhere in this issue.

The primary difference between the Fedders unit and E-Tech's is the temperature-sensing arrangement. At regular intervals the Fedders circulating pump turns on for 15 seconds and circulates the water from the storage tank past a temperature sensor in the heat pump. If the water is too cool, the compressor is energized. The E-Tech's temperature sensor is in the storage tank, an arrangement that requires additional wiring.

My first E-Tech unit, installed in mid-1979, is performing flawlessly. My monitoring indicates that it is delivering hot water at a cost 58 percent less than my previous electric water heater. The true saving is even more, since I no longer need a dehumidifier in the basement. Now I've installed a second unit at my new home on Chestnut Mountain and expect similar savings there. E-Tech reports that sales already number in the thousands. Considering the relatively high cost of the equipment (\$700-\$800), that's substantial.

A heat-pump water heater is well worth consideration by anyone who now uses an electric or oil-fired water heater and

lives in a moderate climate, or whose winter space heating is accomplished inexpensively (the heat source for a heat-pump water heater is the interior ambient air).

As originally designed, the E-Tech unit could not be placed where ambient temperatures fall below 45 degrees F. Now the company has introduced an optional transfer relay (\$40) that automatically shifts the water-heating duties back to the resistance element in the old water heater (which you otherwise use only as a storage tank) if the temperature falls below that. With this relay, the heat-pump water heater can be located any place that stays above 32 degrees (below that, the water lines would freeze). E-Tech models made before August 1980 must be modified with a conversion kit that includes a "45-degree switch" before the transfer relay can be used. Later models do not require the conversion kit. The components are available from E-Tech distributors or from the factory (3570 America Dr., Atlanta, Ga. 30341). E-Tech is also introducing a commercial version of the unit for restaurants and plants.

### Q&A Pellet test

I have a General Electric self-cleaning oven that remains soiled after a cleaning cycle. I suspect the temperature is not going high enough. How can I check this?

Fred Seger, Grand Rapids, Mich.

*Until recently a thermocouple-type temperature tester was required to verify that the temperature was going above the 800 degrees F required for pyrolytic cleaning. Now a temperature-sensing pellet has been developed that allows you to do this test easily. You can get it from a GE Parts Mart or through most appliance-parts distributors.*

*To use the pellet, fold a sheet of heavy-duty aluminum foil in squares until it is eight layers thick. Place the pellet on the foil and run the oven through a cleaning cycle. After the oven cools, examine the pellet. If it shows signs of melting or discoloration, the proper temperature is being reached. If it appears as it did before heating, the temperature is too low. Temperature can be adjusted by turning a screw located under the thermostat knob on models that use a dual-range thermostat or on a bias board on older models. Adjustments should be made in very small increments—1/8 of a turn makes a difference of approximately 25 degrees.*

## Rx for hand care

My answer to lowering the cost of operating a home has been to do all the tasks and projects myself, ranging from maintaining my car and appliances to building book shelves (thanks in large part to PS information). But this money-saving—and most enjoyable—hobby seems to be taking its toll on my hands, especially in cold weather. I've tried work gloves, but I can't handle small parts while wearing them. Do you have any remedy for this?

Paul Baker, Denver, Colo.

*My first advice would be to get a second opinion from your family doctor, but here's what I do. Like many people, I'm sensitive to certain liquids. In my case it's darkroom chemicals and petroleum-based products.*

*My solution: surgical gloves. They reduce your "feel" very little. You can obtain them from any hospital-supplies store. If you aren't sure where one is in your neighborhood, ask at your local hospital. Specify nonsterile gloves—they're much less expensive. I use the latex type for darkroom work, and the plastic type when working with petroleum products.*

## Fuse facts

I have an electric ceiling fan in my den. Lamp-cord-type wire runs 20 feet to a five-speed switch, then runs approximately five feet to a wall receptacle.

The fan takes approximately 75 watts. The fuse that protects the outlet is 30 amps. I can't seem to find any kind of five-amp fuse that I could plug in the wall outlet ahead of the fan. Do you know of any such device?

Marshall Van Winkle Jr.  
Palm Beach Shores, Fla.

*The wiring in your house that serves the receptacles and lighting circuits should be number 12- or 14-gauge, and it's that wiring that determines the proper fuse size. Number 12 is used on almost all receptacle circuits, although number 14 wire was once permitted by some codes. Your house wiring probably has nonmetallic sheathing. You can determine the size of the conductors by looking at the covering (wiring is often exposed in the basement or attic). The size will be embossed on the cable: 12/2 or 12/3 means that there are two or three number 12 conductors; 14/2 or 14/3 means that there are two or three number 14 conductors. Number 12 conductors should be protected by a 20-amp fuse, a number 14 by a 15-amp fuse.*

*Proper fusing is needed for protection in case of a short in an appliance. The length of lamp cord usually should not exceed six feet. Never extend the branch circuit by adding a receptacle and connecting it with lamp cord. Use nonmetallic sheathed cable instead.*

**Got a home-equipment problem?** Write to Evan Powell/Housepower, Chestnut Mountain, Route 1, Box 322A, Travelers Rest, S.C. 29690, giving appliance make and model number. Unpublished questions cannot be answered by mail.

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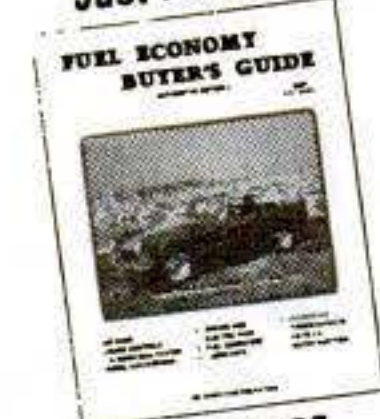
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## GM's J-cars [Continued from page 80]

does not move under high stress. Equally important, a center take-off for tie rods from the rack—instead of at each end—produces a longer tie rod. That means less reaction to the position of the front wheels in steering. The center take-off also results in a firmer anchor for the rack and less play in that part of the system.

Pontiac engineers coordinated the rear-suspension design. The cross-beam of the axle, which also acts as a stabilizer bar, has a trailing arm on each side, interconnected to the beam in a rigid manner. The axle is able to twist during roll functions. A conical, variable-rate coil-spring design allows each coil to compress inside the next one.

My first reaction sitting behind the wheel of a Cavalier (a full driving report will appear in the next issue) was that the engineers have succeeded in making an economy car sporty. The four-speed scoots from zero to 60 mph in just over 14 seconds, but with the initial-wheel-spin-then-lug-down that's common with under-size power plants. The gearshift lever is about six inches long, and that means short throws. The seats are set low in the body for a sports-car feel, and the steering-wheel position is nearly vertical, reminding me of the Chevrolet Monza.

### Cadillac firsts

Four J-car bodies will be built: a two-door fastback with hatch opening at the rear, two- and four-door sport sedans, and a four-door station wagon. All will be offered by Chevrolet and Pontiac. Cadillac will sell Cimarron in only one body style, the four-door sedan. Two transmissions will be available: the four-speed manual and a much slower three-speed automatic with lockup torque converter.

All three car lines will be built on the same assembly line, and for practical purposes will be the same vehicle except for grilles, taillights, and, especially in the Cadillac, amount and level of standard equipment.

Cadillac will use the same engine and transmission. Its use of the four marks the first time that type of engine has been installed in a Cadillac since 1914. The four-speed manual transmission is also noteworthy: Cadillac has never used one before.

Although prices have not been set, it is known that the Cavalier and J-2000 base price will be around \$7,000. The Cimarron will list above \$11,000.

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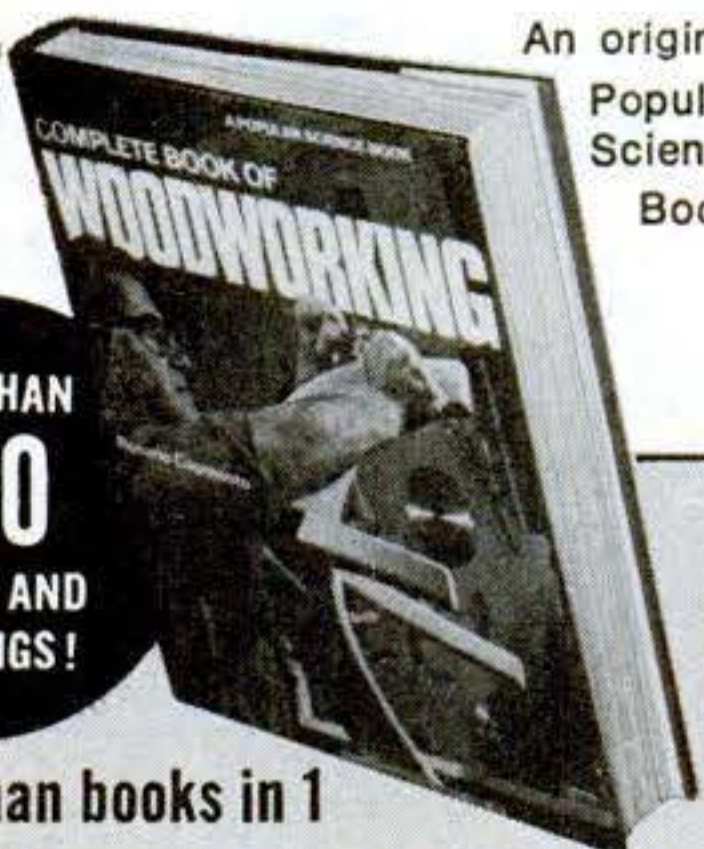
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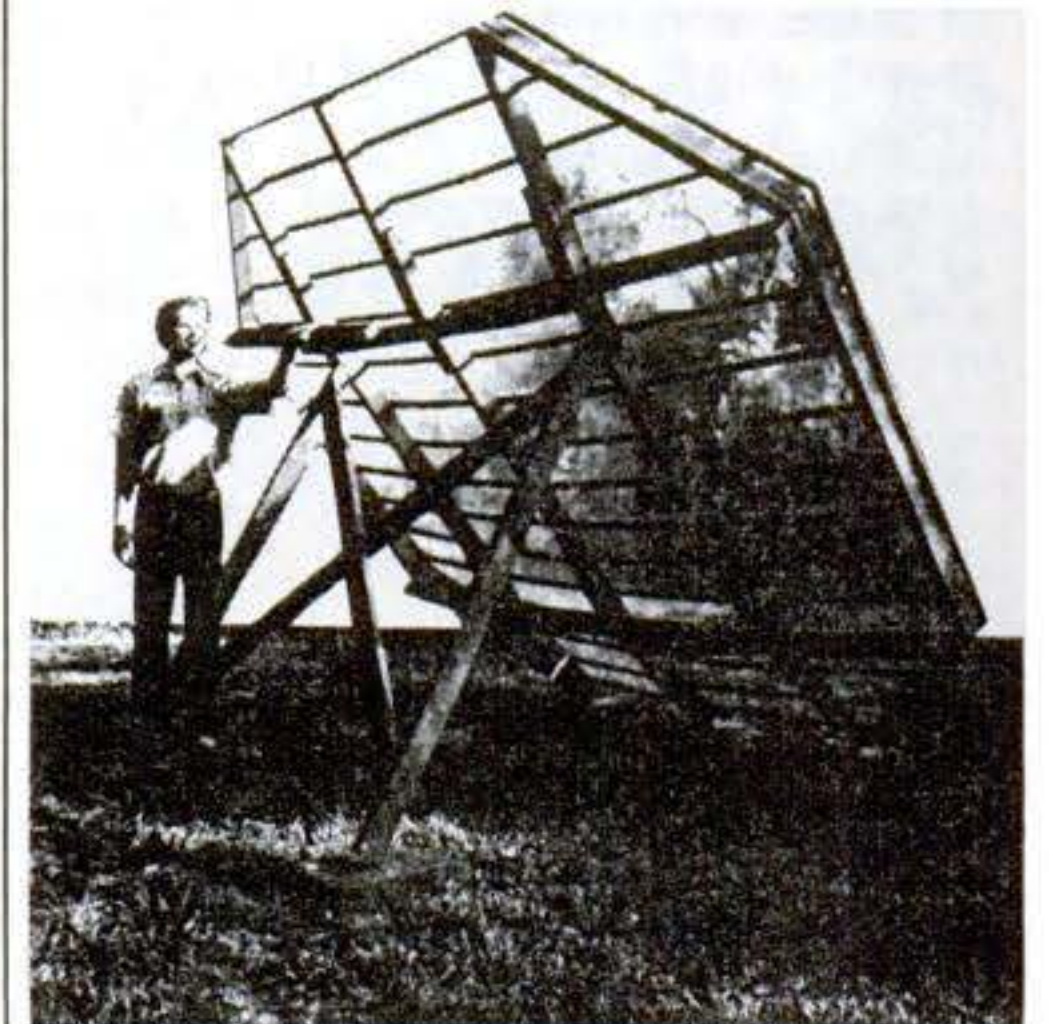
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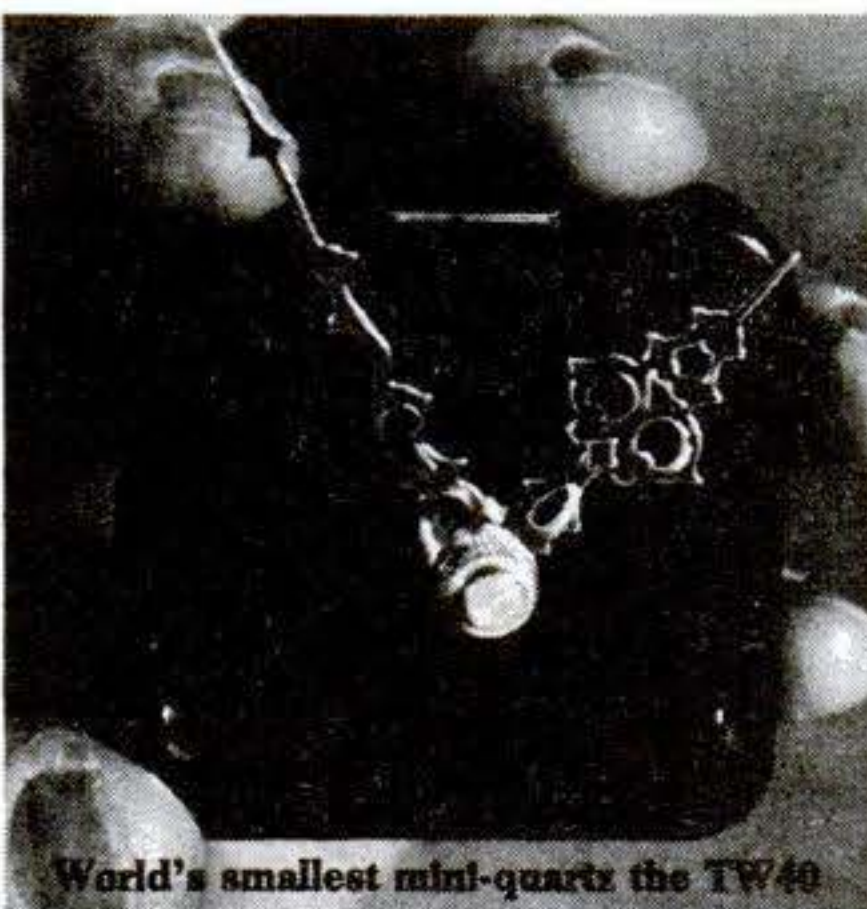
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It was tempting at the time to turn to "small" automotive alternators — which need several thousand rpm to generate the kind of voltage we wanted. They are large, heavy and also require an efficiency-killing step-up pulley to achieve the necessary rpm to generate power from a small water wheel or windmill.

Meanwhile, the price of oil and other fuels was just starting to skyrocket. Many energy-conscious people had made up their minds not to take these price hikes lying down. More and more people were thinking seriously of switching to free renewable energy sources — solar, wind, water — simply because it had begun to make good economic sense. Needing to produce exactly the right product for the growing boom in home-sized alternate energy products, Thermax engineers started from scratch to design the perfect small generator. It had to be inexpensive, light, and operate efficiently at low rpm (which no other small generator could do).

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At first, Thermax sales personnel were surprised that so many customers were attracted by the generator alone and didn't want to buy the whole windmill kit. Even without advertising, inquiries kept coming from do-it-yourself energy enthusiasts who really wanted to build their own power systems, not Thermax's or anyone else's.

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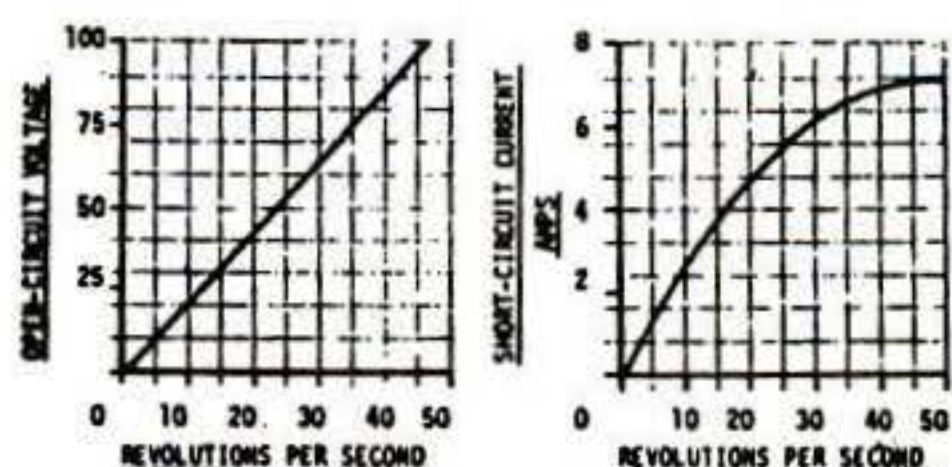
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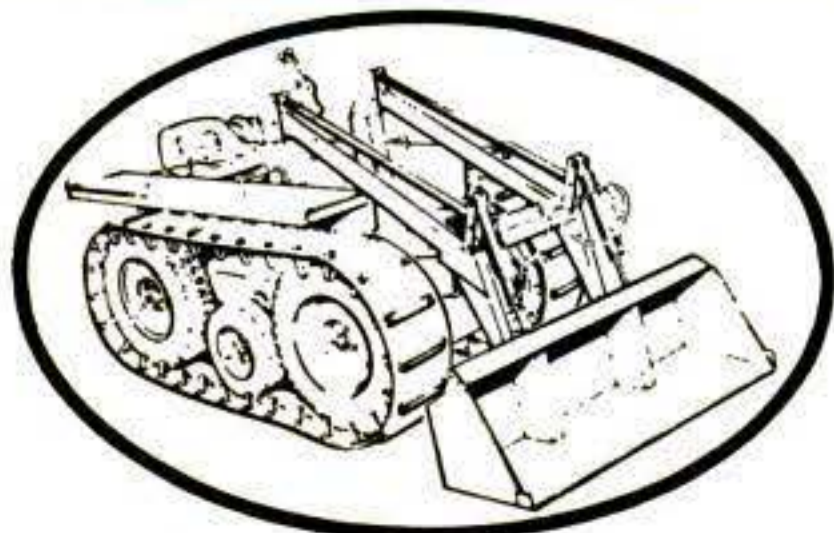


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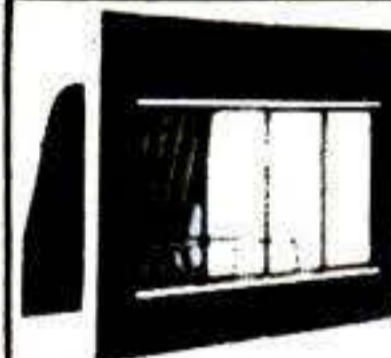
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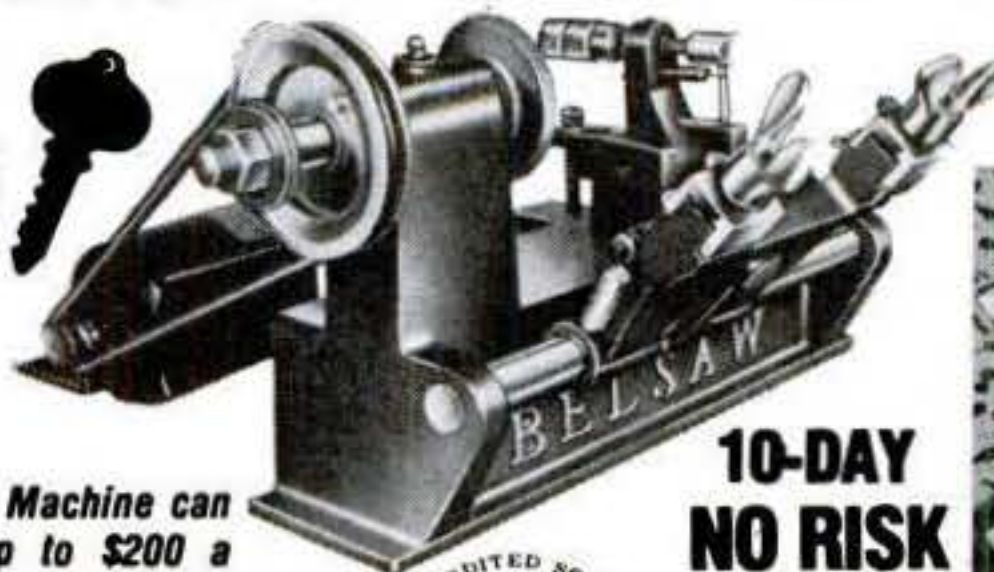
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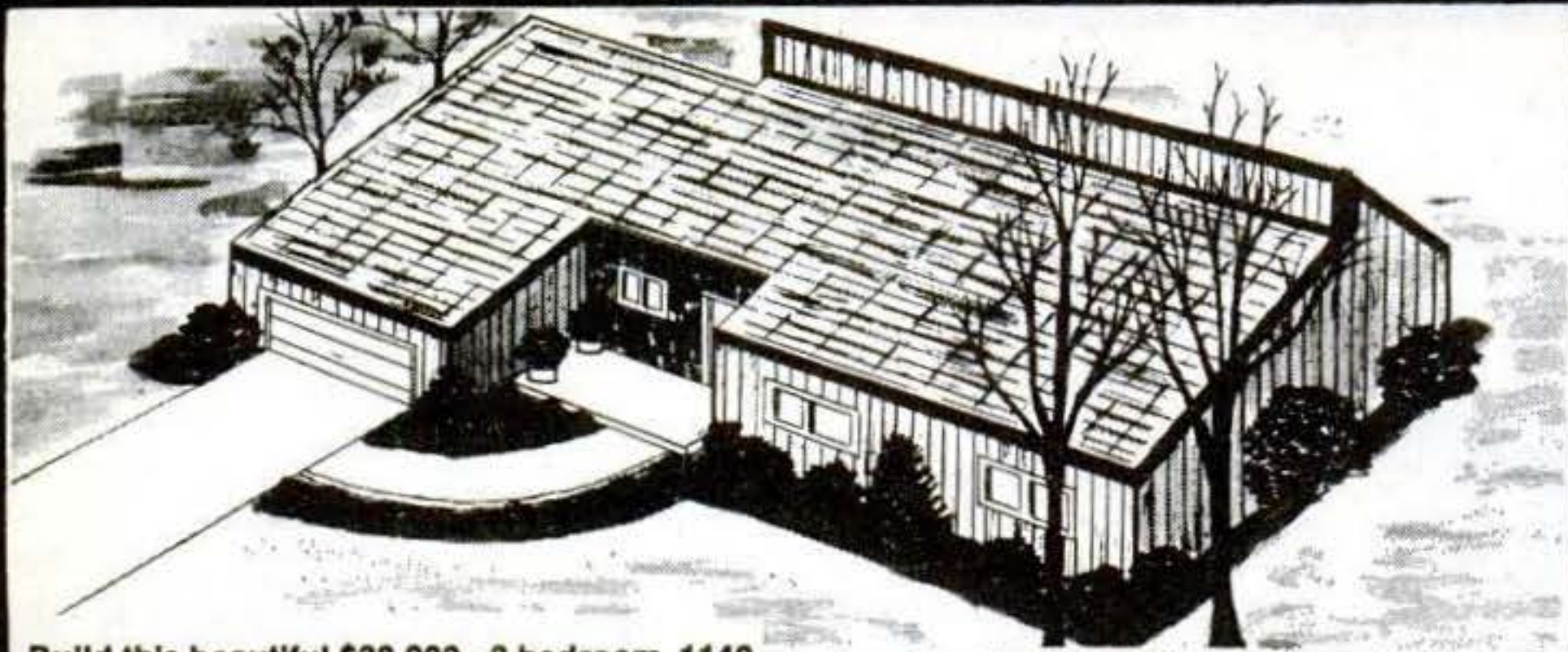
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# Golf Pros Banned From Using New "Hot" Ball; Flies Too Far

**Tests Confirm Extra Distance  
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NORWALK, CT—A small Connecticut company has fashioned a new golf ball that outflies 12 of the best balls on the market, but there's a catch: it's illegal—at least for pros.

That's too bad, because we could see some magnificent golf if pros were allowed to play with it. Tests prove it could give even a regular golfer as much as 22 more yards off the tee. A good pro could make a joke out of par.

To make sure that doesn't happen the U.S.G.A. imposes strict manufacturing standards on golf companies to insure they don't make golf balls that fly too far. Consequently, for nearly forty years golfers haven't had much to choose from when it comes to golf balls. All major brands are manufactured in a way that intentionally restricts their distance.

Now, a small company in New England is offering golfers—at least nonprofessional golfers—a ball that purposely disregards those restrictions, and the result is a ball that flies down the fairway like a Ferrari on the run. The company, H & L Labs, guarantees the new ball will outfly any legal ball on the market, regardless of price, and provides customers with a free sample to prove it.

The new ball looks, feels and sounds like a regular ball, so about the only way another player can tell he's playing against one is to keep a radar set in his bag.

Even the name of the ball won't tip him off. The company refuses to release it to anyone but a buyer. They simply call it THE HOT ONE. The real name is sealed inside the box, a secret between buyer and seller.

And while golf prides itself on being a gentleman's game,

it seems that more than 40,000 gentlemen—and ladies—are playing with these innocent-looking buzz bombs.

What's special about the illegal ball? John McGuire, the director of H & L Labs, told me this: "We've doctored up the ball's aerodynamics so that it has less drag and a greater concentration of power than conventional balls. You can tell the difference with your first drive. "What's more," our special construction could help keep tee and fairway shots down the middle... makes the ball 'bite and sit' with more authority... and putt with a steeper roll. The cover is virtually cutproof."

McGuire believes that more money is going to change hands with this little white bandit than all the tournament purses put together.

So far most pro shops don't dare carry THE HOT ONE, but if you want to "test drive" what could be the longest ball in the world, H & L will send you one FREE. Just order a dozen or more and they will send you an extra. They ask you to use the extra ball for a few holes. Independent tests show it should add as much as 22 yards to your tee shots, but if it doesn't, you can return the rest of your order for a prompt refund. The free ball is yours to keep in any case—for fun or profit.

And if you ever cut one of these super balls in normal play, H & L will replace it free. You pay only the return postage, about 25¢.

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Is the candle  
snuffed out?

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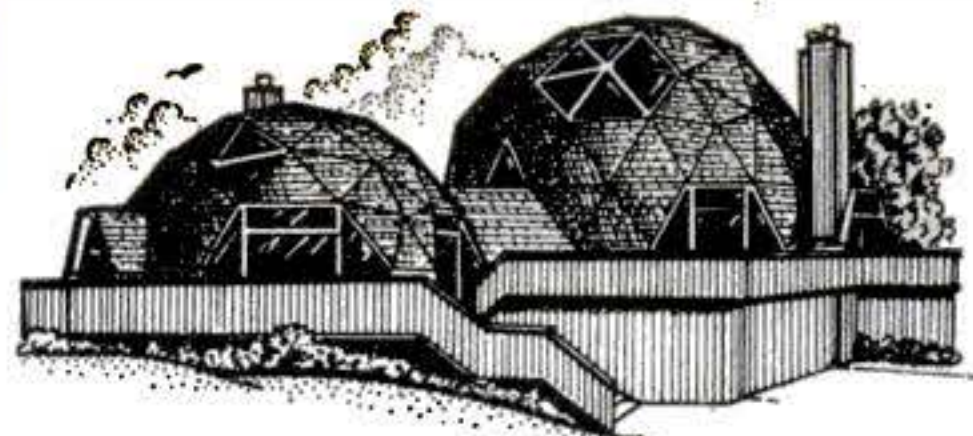
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1. Any retail magazine outlet which wishes to participate in this display allowance plan must enter into a Retail Display Agreement with TIMES MIRROR MAGAZINES, INC.  
2. The retailer will receive the display allowance indicated for each copy of the following titles sold by the retailer:

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3. The retailer must agree to maintain full-cover displays of the titles selected in a highly visible high traffic area during their entire sales period.

4. As of the above date, TIMES MIRROR MAGAZINES, INC. will assume the sole responsibility for the administration of the plan, such as, audits, payments, and acceptance and termination of the Retail Display Agreements.

5. Claims for display allowances must be submitted to TIMES MIRROR MAGAZINES, INC. within 60 days after the end of the calendar quarter in which the copies were sold by the retailer.

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7. This display allowance plan is subject to change or cancellation by TIMES MIRROR MAGAZINES, INC. at any time.

8. TIMES MIRROR MAGAZINES, INC. offers display allowances which are practically available on proportionately equal terms to all eligible retailers regardless of size.

9. For additional information and copies of the Retail Display Agreement, please write to:

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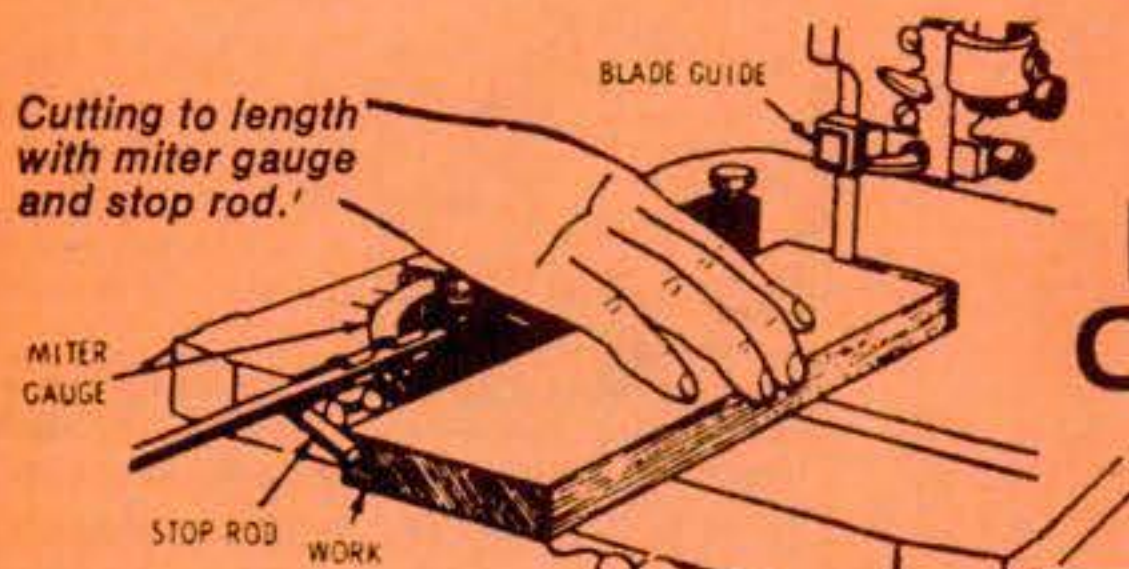
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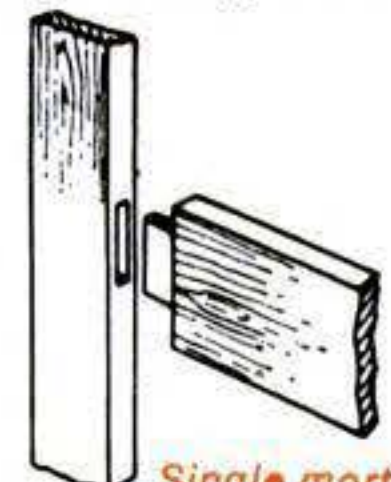
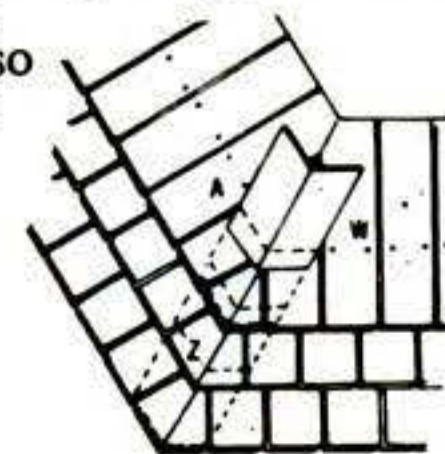
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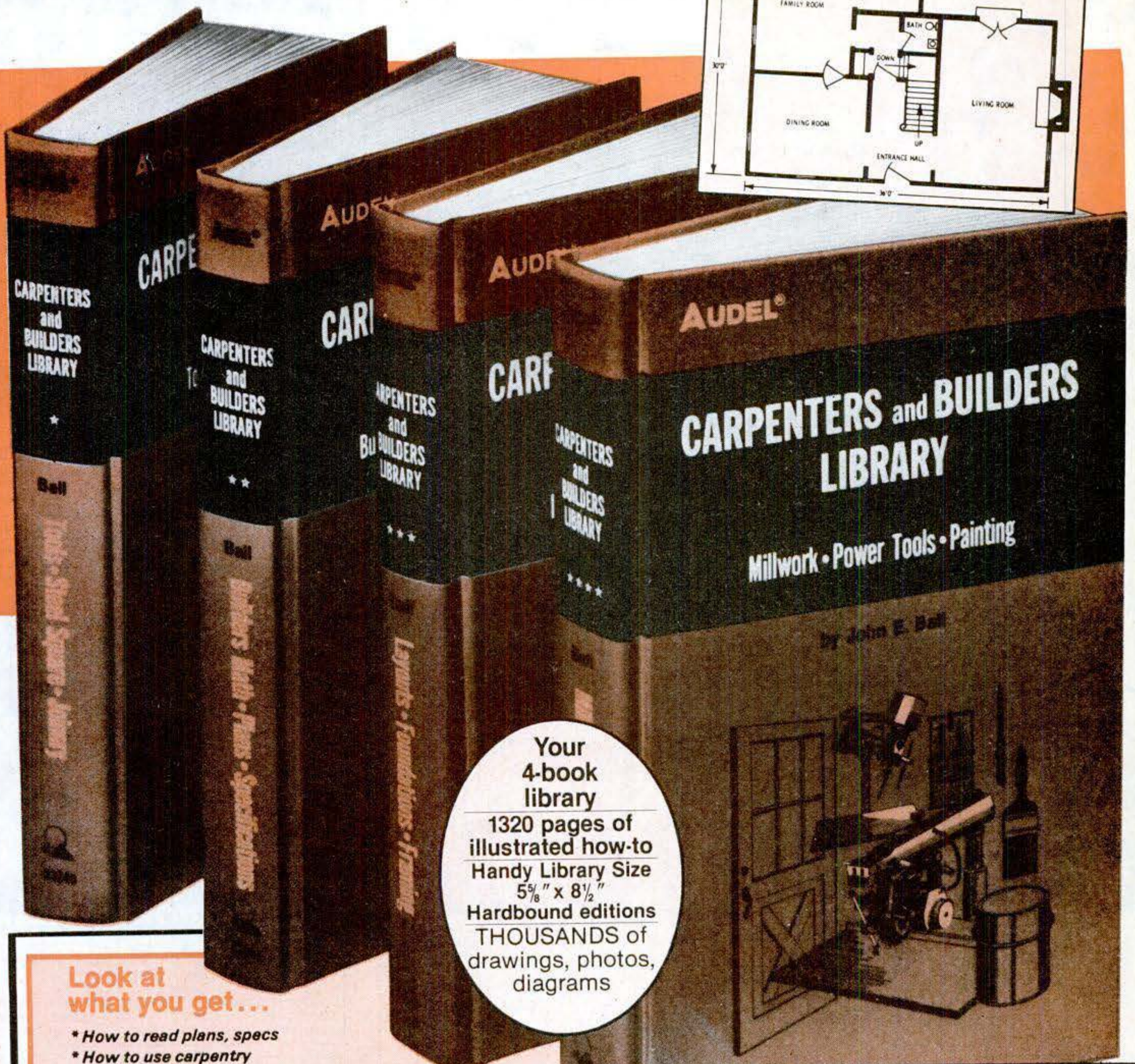
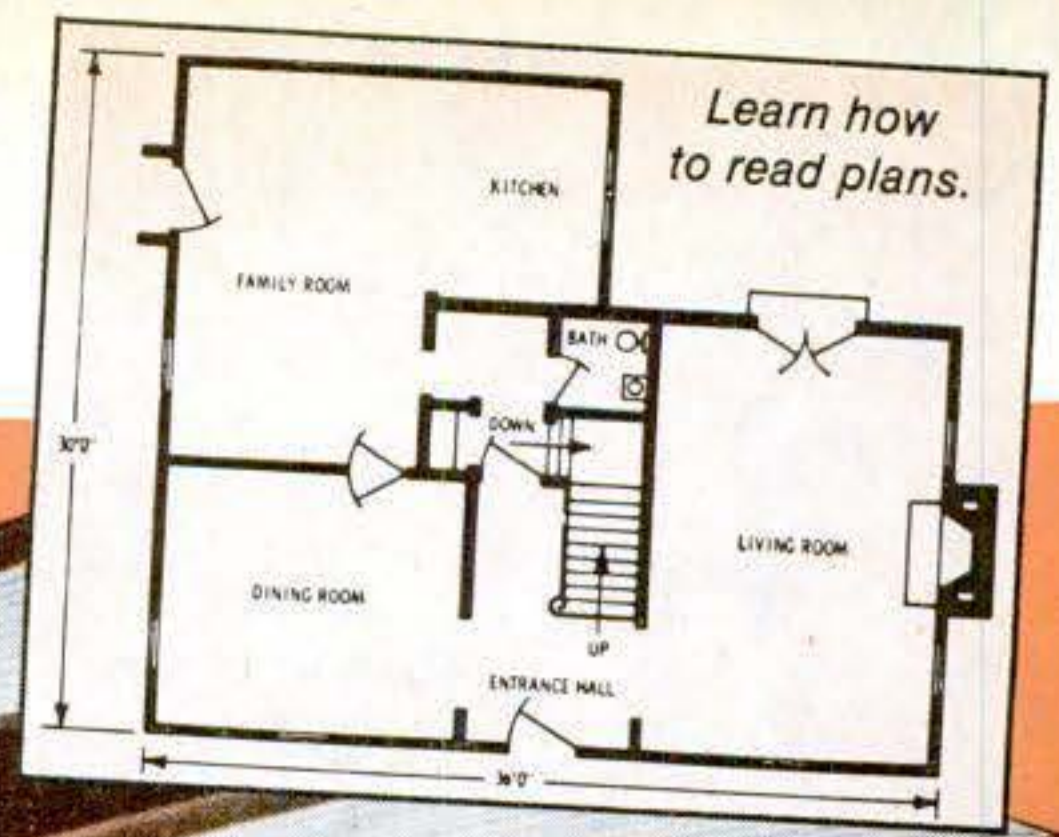
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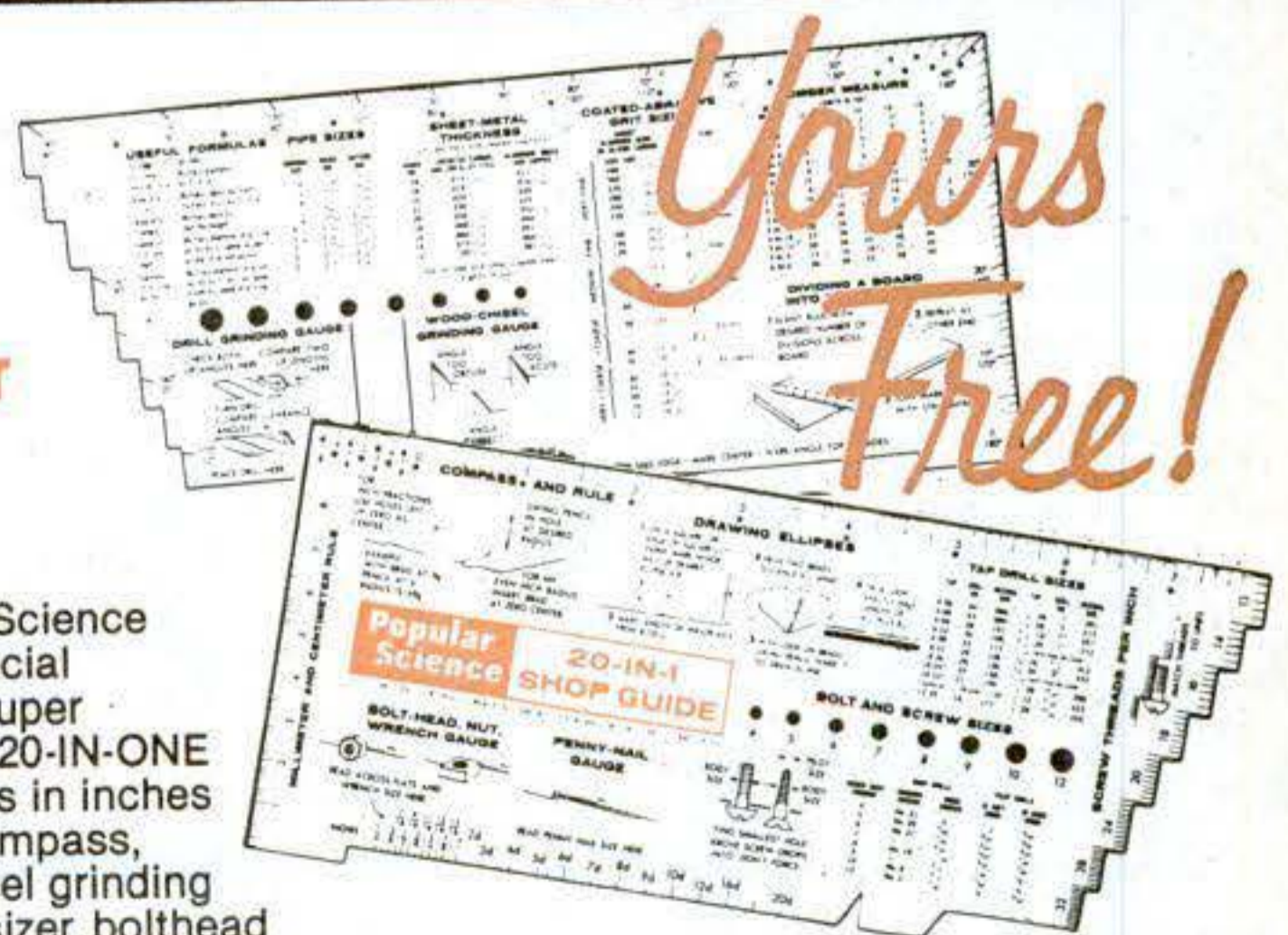
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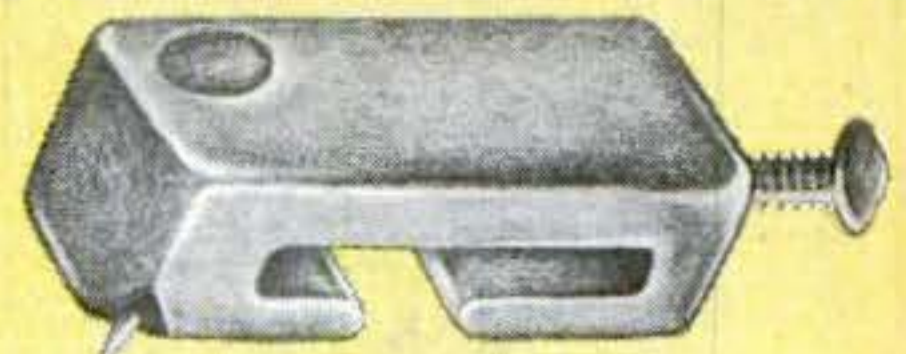
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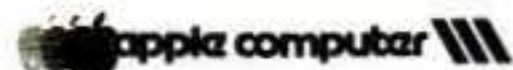
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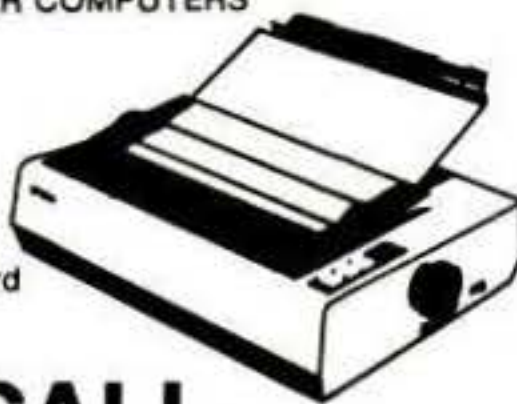
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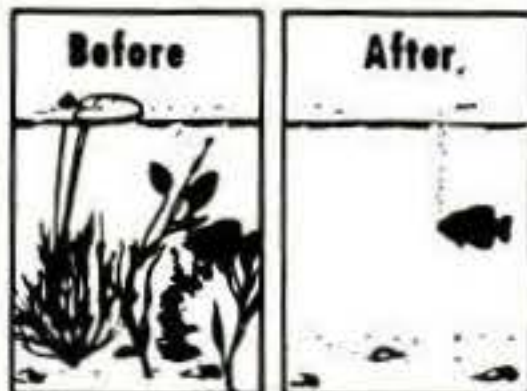
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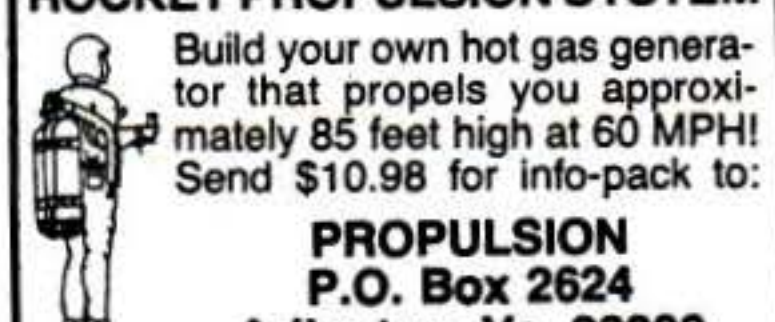
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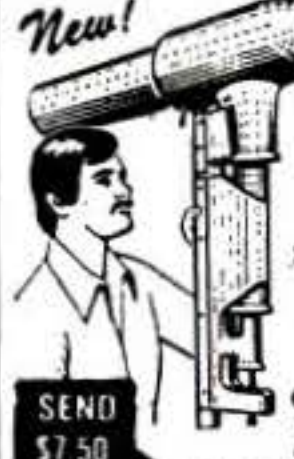
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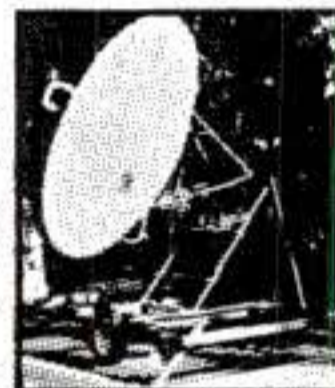
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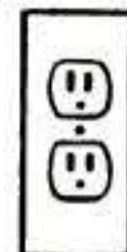
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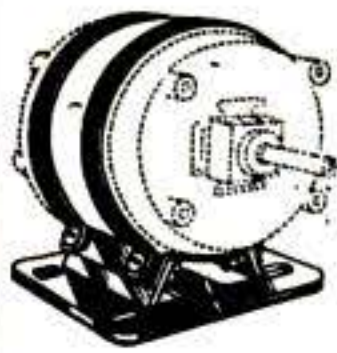
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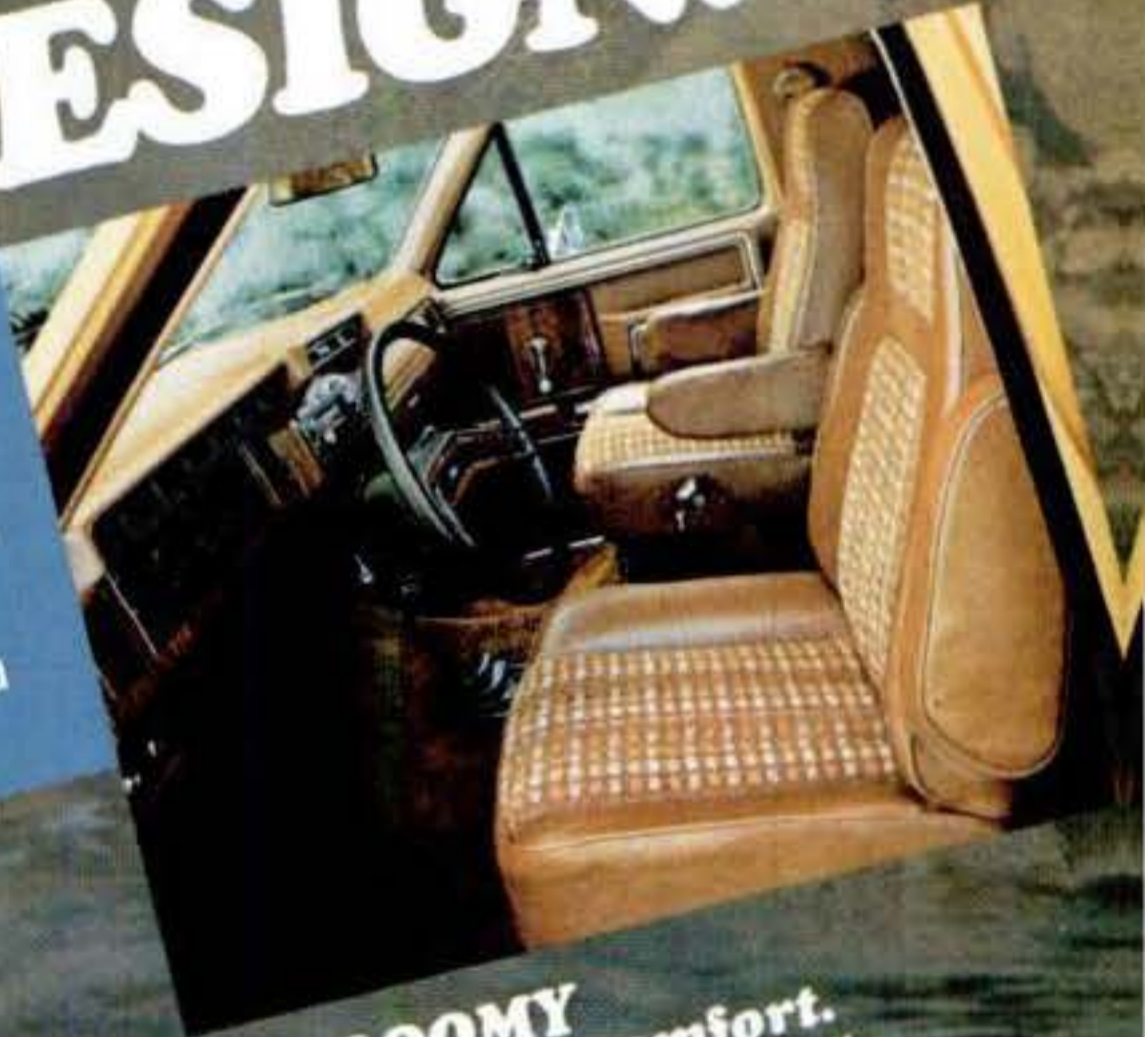
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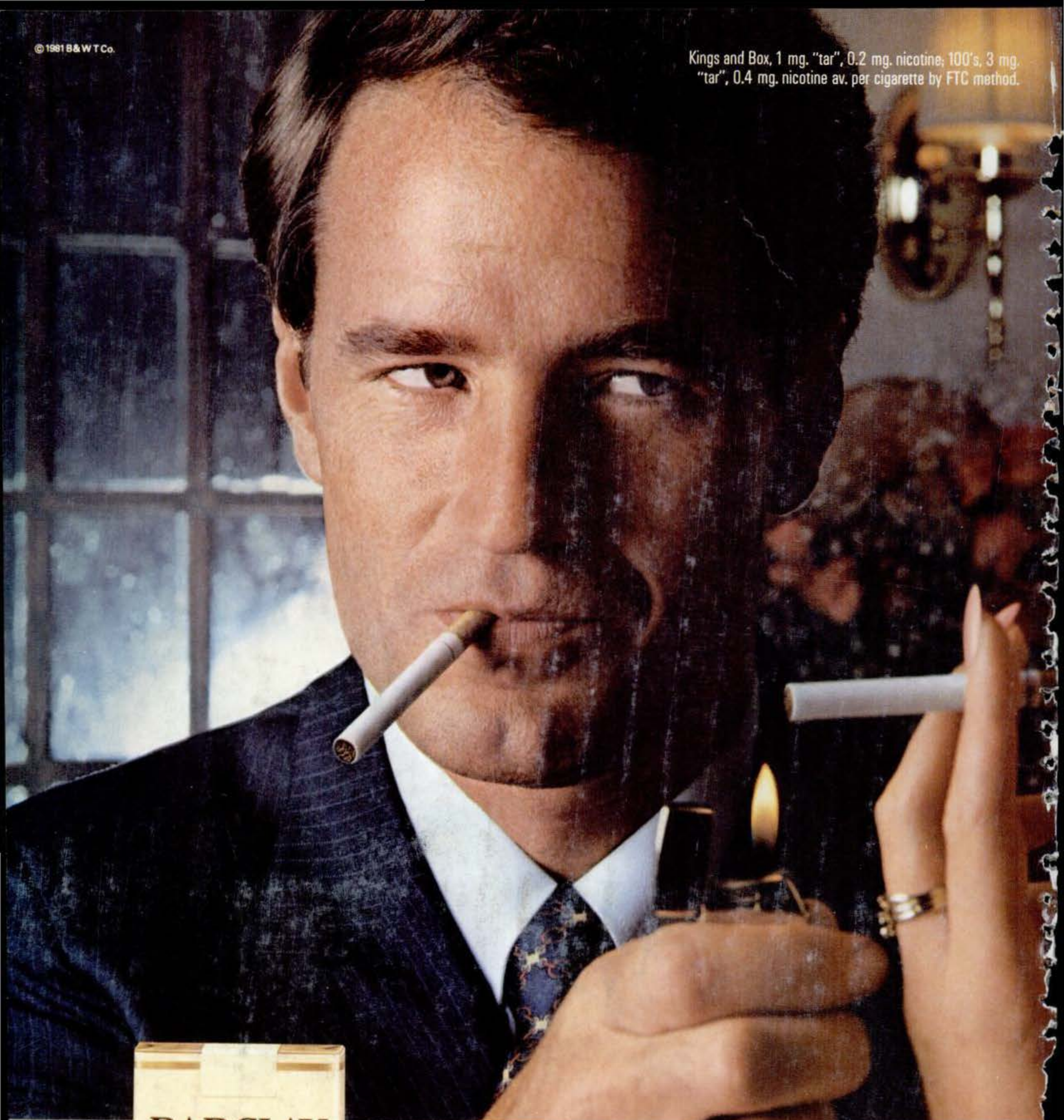
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