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for the mid-'80's

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Popular Science

JANUARY 1980
Founded in 1872/Vol. 216, No. 1

MONTHLY®

The **What's New** magazine

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The only one to own

Backgammon Panache



From Fidelity—king of the encounter games—comes the most challenging gammon computer you can own or give...and you can, for so very little.

There is something to be said for the universal popularity of Backgammon. Its origins have been traced back 3000 years before Rome.

For most of us, the sum total of this rich history amounts to hours of stimulating play. For the aficionado, it presents an encounter of skill and challenge enmeshed in strategies that have been polished to an art after centuries of practice.

It's no wonder, then, that some of America's finest electronic engineers have sought to put the magic of Backgammon onto a tiny, solid state computer chip. Until recently, the ability of capturing the mathematical complexity of the game, without it costing a small fortune, was near impossible. But, Fidelity engineers have finally done it.

Total Enjoyment

For every enthusiast who has ever moved a tile across a gammon board, the Fidelity Backgammon Challenger is the most exciting and complete electronic game imaginable. Apart from being an exceptional value—we planned it that way—its extraordinary microprocessor brain is pre-programmed with a phenomenal amount of gammon mastery and flexibility.

Play is Easy

Fidelity's success with its chess and bridge games is, in part, its ease of game control. You don't have to become an electronic genius to enjoy their units. In fact, common sense keyboard inscriptions put you in command in minutes.

The Backgammon Challenger is a fascinating teacher as well as an intriguing opponent. You are not restricted to a specific method of play. While some games dictate that the computer roll the dice, the Challenger gives you 3 options:

- You can roll a real pair of dice for yourself, while the computer rolls its own, "dice," for itself.
- Or, you can roll for yourself and the computer.
- Or, it can roll for you and itself.

This flexibility is not available on other, even costlier, games.

Of course, it can double

The doubling cube is very much a part of the Challenger's logic. If, during the action, it feels that it has the edge, it will double the stakes. If you have already done so, it knows to surrender or accept the cube. If it accepts, it quite naturally, can redouble at its own discretion. A tiny red lamp lights to indicate cube possession.

Position Verification

The PV key may be used anytime during the game to display the doubling cube's value. This key is also used to verify stone positions on the field.

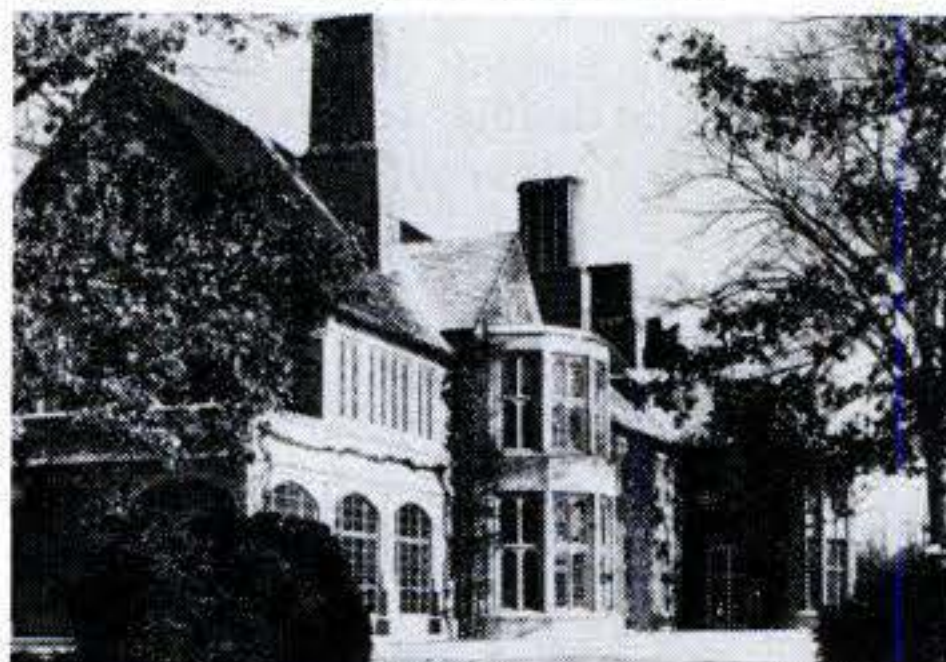
Scoring is shown at the end of a game. The Challenger automatically accumulates scores until it is turned off.

It knows the rules

The Fidelity game is exceptionally cunning. It plays a fine backgame and employs duplication and diversification strategies. Its blocking defenses, alone, present an invaluable education for any player. But, it won't permit wrong doing—on either your part or its own. Along with the vast libraries of knowledge that have been fed into its brain, are all the rules that govern regulation play.

Problem Solving

With the Challenger, you can set up specific encounters and then watch how the computer handles them. You can even switch places with it, mid-game, to see how it would carry on with your play.



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The Challenger is an unusually affordable, intelligent game. Its comfortable half inch square tiles are magnetized to stay where you place them on the scratch proof mylar table. This set is mounted in a simulated wood-grained housing which measures 12 1/8" x 8" x 1". It operates on 110V household current. Bright, half inch tall LED electronic digits provide unmistakably clear readout. It is backed by a 90-day manufacturer's limited parts and labor warranty.

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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.



Leisure home from PS plans

In March 1977, you carried plans for a "Skewed-Prow" two-story leisure home, which we have now built using plans we ordered from PS.

We are delighted with the outcome. We built the home in the Moonridge area of Big Bear Lake, Calif. It was built for us by a local contractor, Norm Reinik, and he did an outstanding job. The only modification we made was to eliminate the decking down the side of the house since our lot is only 40 feet wide. Here is a picture of the completed house.

Col. Roland B. Scott
Sherman Oaks, Calif.

Offspring of perpetual motion?

I read the article "Magnetic Wankel" in the June 1979 issue with great interest.

I have been a perpetual-motion nut for 37 of my 47 years. In 1965 I built another of my attempts at the evasive discovery. It is a circular array of bar magnets with like poles facing the same direction. The rotor is a steel spiral. If a full circle of magnets is in place, the rotor will not move due to equal forces. (Of course, continuous rotation was the intention.) Remove 90 degrees of magnets and the rotor will rotate 270 degrees and stop. It does not have enough momentum to break free from the last magnet, jump the gap, and start another cycle. A double-spiral rotor I made did not work, either.

An acquaintance suggested (in 1965) the possibility that an improved electric motor could be developed from my folly. I didn't pursue it; energy was cheap then.

I really wonder if the developers of the magnetic wankel started off with perpetual motion as their goal? Why else would they use a spiral gap between rotor and field?

Steve Witter, Branford, Conn.

Fireplace heat saver

I recently installed one of those fireplace devices that takes cold air into the bottom end of a series of pipes and delivers heated air from the top of the pipes into the room. We find it a great help in heating our room, even without the blower attachment. But it needed customizing to fit our fireplace.

The fireplace is very deep, so the pipes would not reach the face. Bringing the fire forward caused smoke to drift into the room. The problem was solved with downspout of the right size, cut to the needed lengths. I stretched each piece on one end and drove it over the ends of the pipes to extend their length. Black fire-resistant paint made it look like the other pipe.

Dr. L. G. Higgins, Scotts Valley, Calif.

More on the Nola controller

With regard to "Nola's Clever Motor Controller" [PS, July, '79] by E. F. Lindsley, I'm curious to know if there is any saving in equipment maintenance, replacement, or overall wear and tear due to reduced heat. Will the device reduce (or eliminate) the necessity for cooling fans?

Second, other "dimmer" devices don't really save electric energy since power diverted from the main load is dispersed as heat through a resistance, or is sent to ground, or both. What does this device do with the diverted power?

Joe Noecker, Portland, Ore.

E. F. Lindsley replies: "Mr. Noecker is right; Nola's power saver not only saves power but also extends motor life by reducing heat. Note, however, that most of the savings come at no load or moderate load. Hence, if there were times of sustained full load, the cooling fan would probably still be needed. It's an individual-application consideration. Unlike resistance-type devices, which simply divert

[Continued on page 152]

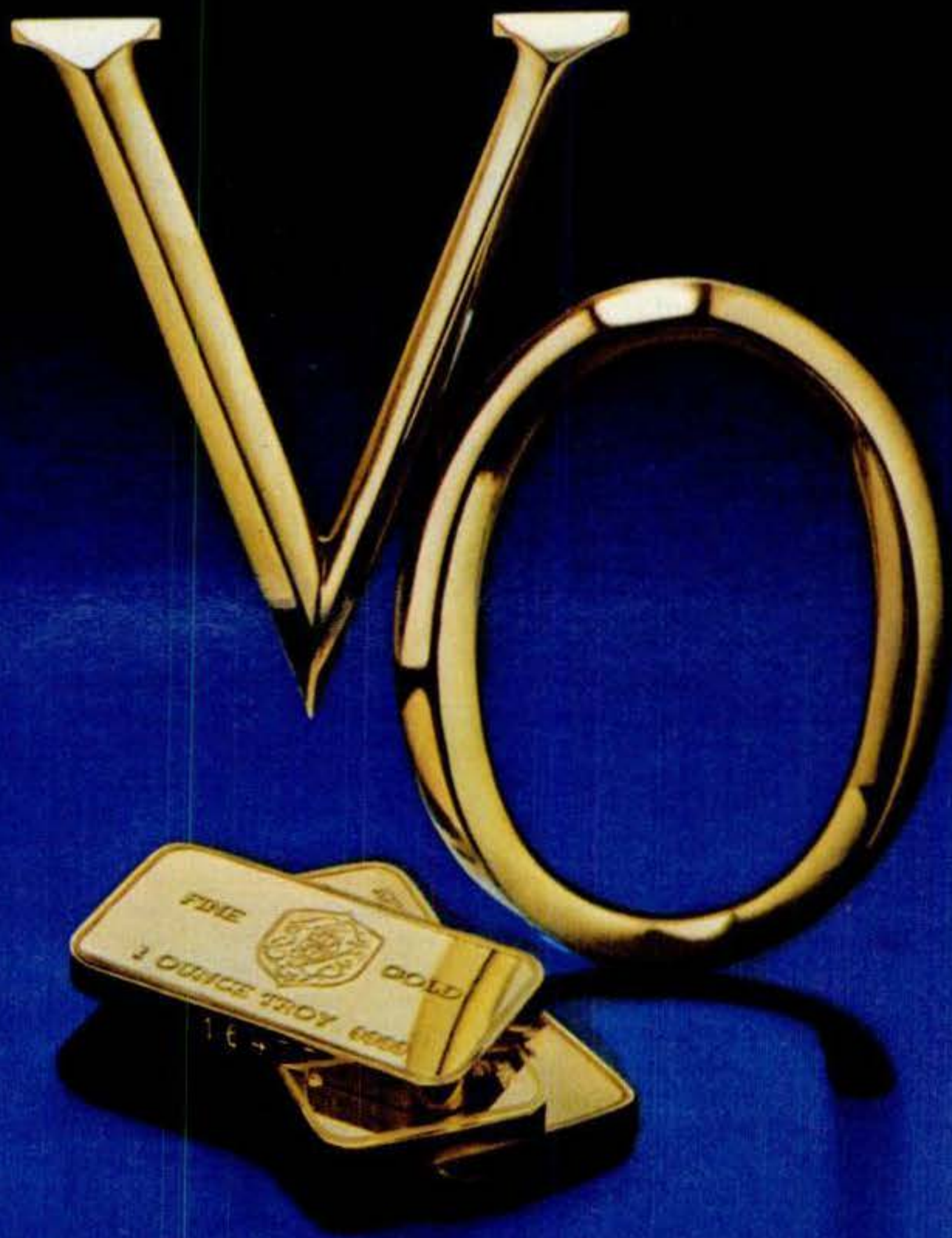
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CALCU-LETTER

By DARRELL HUFF News of pocket calculators—and how to have fun with them

Cube roots three ways

Aside from using pencil and paper, or slide rule, abacus, logarithms, or a fat book of tables, there are three ways to find cube roots—all by calculator. The easiest way is to own one of those rare calculators that have a key for just this purpose. One is the EL-5806 scientific; another is the PC-1201 programmable, shown below. Both are made by Sharp Electronics Corp., Paramus, N.J. 07652.



It's your money

Interest rates are very much in the news lately, mostly because they have been soaring—like nearly everything else except the prices of pocket calculators. So maybe it isn't coincidental that one day's mail brings a neatly matching pair of letters. Louis H. Eisen, Oceanside, Calif., suggests a simple method of figuring compound interest by calculator. And Bill Neef, Grass Lake, Mich., points to what he suspects is dirty work in this very area on the part of some banks.

In those dismal days before calculators came along, only a real punishment glutton would have tackled compound interest. Today it's not bad at all.

For the basic method, begin by dividing the stated rate by 100 to turn it into a decimal and then by the number of compounding periods in a year. Add 1. Then raise this result to a power equal to the number of periods the money stays invested. The result, multiplied by the number of dollars, will tell you how much the money will have grown to.

As a bonus, this procedure can give you a second piece of information. If you drop the 1 at the left and move the decimal two places to the right, you'll discover the annual yield as a percentage. This is the sec-

ond, and larger, of the two figures you read in newspaper ads of savings institutions. You find it in a form such as "7.75 percent annual rate produces 8.06 percent annual yield with daily compounding."

Try it on your own calculator. Note that when compounding is daily, the number you divide by is 365. If your calculation is for one year's interest, the power to use is also 365.

If you use the formula to check up on those banks that reader Neef's not happy about, you'll come up with figures much closer to his than to theirs.

A couple of Detroit banks, says he, have been offering 9.524 percent annual interest and claiming that their continuous compounding turns that into 10.138 effective annual yield. No, says Neef, it's only 9.99, which doesn't sound nearly so good. That's what my calculator says, and I think yours will, too, if you use daily compounding or even hourly.

But what about continuous compounding? In the November "Calcu-letter," I suggested a simple routine for computing continuous interest with a scientific calculator: Just enter the percentage rate in decimal form and press the e^x key (on some models, the $\ln x$ and $\ln x$ keys). This method tells you the annual yield at those Detroit banks is still 9.99 percent, al-

though some trailing decimals are a trifle higher.

Who was right?

In the November column, we tangled with the timely question of how much inflation of 0.9 percent in one month comes to on an annual basis. The White House had called it 11.4 percent and had been rebuked for bad arithmetic by a business magazine, which insisted that 10.8 percent was the proper figure. Our question was: Who's right?

Did you discover that, for once, the White House is not the goat? Simply multiplying by 12, as the business magazine had done, fails to take into account the effect of compounding.

Figure it this way. After one month the index will have gone from 1 to 1.009. The rise for the second month must be calculated on that new base. And so on. The problem comes down to 1.009 times itself 12 times. The twelfth power of 1.009 is 1.114, an increase over 1 of 11.4 percent—just what the White House said.

Cussed ladders

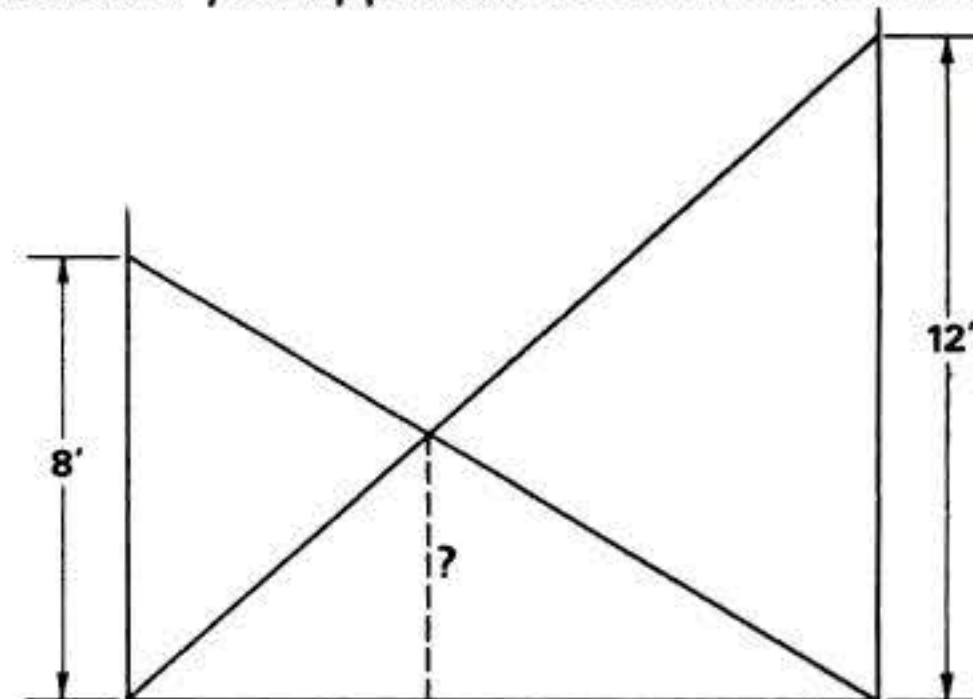
This is such a cussed puzzle that out of sheer compassion—as much for myself as for readers—I've been avoiding it for months. But several dozen demands that I publish it, coming from as far away as Hong Kong and Sarajevo, Yugoslavia, have been topped by a plea from Jim Russell of Wilton, Conn. Jim is 13, he says, and his granddad has inflicted it on him.

One reader recalls seeing some version of it in PS nearly 40 years ago, and has been haunted ever since. None of us wants such a fate to overtake Jim, so it appears that a mass attack on this classic is now in order.

It is a kind of brain-buster that, in all charity, warrants a warm-up. So, in that spirit, here is an easier variation of the puzzle, one that calls for only a small amount of simple algebra for solution.

In this version, all you're told is that the tops of two ladders crossing in an alley are eight and 12 feet above the ground. At what height do the ladders cross?

As I said, the math is simple. As for the puzzle as a whole... well, that depends on how you approach it. Solution to this



version, in the March issue, will be accompanied by a presentation of the tougher version for you to chew on.

PS calculator columnist Darrell Huff (P.O. Box AS, Carmel, Calif. 93921) is the author of *How to Lie with Statistics*, *How to Take a Chance*, and other works. He welcomes comments, solutions, and suggestions.

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ALTERNATE-ENERGY ANSWERS

By JAN F. KREIDER

Jan F. Kreider is a consulting engineer specializing in the design and economic analysis of solar-energy and energy-conservation systems. He is the author of several books on solar technology, and a lecturer at the Univ. of Colorado.

Underground reading list

I'm thinking of building an underground house with only the south side "open." The house will be solar heated. I would appreciate a few good references to read to acquaint me with the pros and cons of an underground house, and the solar aspect of heating it.

Horace Hensley, Camp Springs, Md.

You might start your reading by checking the April '77 issue of *POPULAR SCIENCE*. The cover story, "Underground Houses—Energy-Saving, Private, and Secure," gives a good overview on underground living. *Underground Designs*, an 88-page paperback by the well-known underground architect Malcolm Wells, includes a collection of plans and drawings, plus information on codes, financing, waterproofing, and insulation. It's \$6 from the architect, at Box 183, Cherry Hill, N.J. 08002. *Earth Sheltered Housing Design*, by the University of Minnesota's Underground Space Center, is probably the most comprehensive book on the subject. The 310-page paperback costs \$10 from the Underground Space Center, 11 Mines & Metallurgy Bldg., 221 Church St., Univ. of Minn., Minneapolis, Minn. 55455.

How much solar energy?

I have a question concerning solar-energy potential. Assuming all available area in the U.S. were used for solar panels (i.e., no area left to grow crops or woods) with a reasonable conversion efficiency, what would be the output in barrels of oil per year? By comparison, what is the total energy consumption of the U.S., including all users and all types of energy?

J.S. Sohre, P.E.

One difficulty in answering this question is the shortage of solar data for the U.S. If we assume that 450 langley's per day (about 1600 Btu/ft²) strike the U.S. on the average over a year, then 584,000 Btu strike each square foot per year. Since the area of the U.S. is 3,615,123 square miles, about 60,000 Q (a Q equals one quadrillion Btu) fall on the U.S. per year. In 1985 the U.S. may use between 90 and 100 Q. If solar conversion efficiency is 25 percent, 2/3 of one percent of the surface of the U.S. could provide all the U.S. needs for 1985. Of course, solar heat is not oil. Oil has uses other than heating—plastics, pharmaceuticals, etc.—and is a convenient form of energy for many purposes.

This answer to your question, though highly simplified, shows that solar availability is not the problem. Costs, reliability, consumer confidence, and lack of clear

government support are more serious difficulties.

Outside vent for fireplace

I plan to install an outside air vent in my fireplace. The front of the fireplace is used brick; the firebox is firebrick; the outside (chimney) is brick and stucco. In my opinion, the ideal location for the vent is in the rear of the fireplace, for several reasons: least distance to drill from inside to outside; outside air closest to fire; least noticeable in the firebox.

However, it would appear that since the location of the vent is in the rear of the firebox it would be difficult to insert a damper on the inside. I believe a damper would be needed to control air intake. I would appreciate your advice and recommendations.

W.J. Mentele, Wayne, Pa.

Indeed, providing a damper to control outside air intake is very important. By varying the opening you can control the fire's rate of combustion, very much as is done in "airtight" wood stoves, assuming your fireplace is fitted with glass doors. (If it's not, I'd strongly recommend installing them.) There are air-intake dampers commercially available. For an example, and to see how to provide the air ducts, see the "Heat-Circulating Brick Fireplace" article in this issue.

Solar maintenance tips

With the heating season near its peak, what maintenance items should be attended to on my solar heating system?

You don't state whether you have an air or liquid system. If you use a liquid-type collector and storage, check the specific gravity of the antifreeze to ensure that your freeze protection is adequate. Also check the pH of this fluid with a piece of litmus paper. The fluid must not be acidic or rapid corrosion will occur; a pH of 7.5 to 8.5 is best. Add buffers from the manufacturer to correct the problem. Operate your solar controller manually in all modes to check the operation of three-way valves, pumps, and heating circulators. If your pumps have inlet and outlet pressure gauges, check the pipe pressure rise against the as-installed numbers. Empty all filters and traps. Finally, inspect what piping is visible for leaks.

If you use an air system, perform the same items listed above except for fluid checks and leak inspection. Replace the filter, check the controller and dampers, and examine all ducts for leaks. Repair any collector-glass breakage.

Passive solar home

I plan to build a passive solar home featuring an atrium (greenhouse) centrally located with shutters to close off the windows located in the roof. The atrium would house an in-ground swimming pool to serve as heat storage. The atrium would be separated from the living area by cement-block walls and sliding glass doors.

I am told excessive humidity would be a serious problem. Do you agree? I want to avoid expensive exhaust-fan systems for humidity removal since I would also lose heat with the same. A friend suggested that a pool cover (plastic sheet) would probably contain humidity and therefore reduce heat loss by evaporation. Would you agree?

Clark S. Magness, Lincoln Park, N.J.

A centrally located atrium is not the best method of passive solar heating for your area for the simple reason that the only access for sunlight is through the top surface or roof. In winter, the sun is very low in the sky so the effective horizontal "solar window" does not intercept much sunlight. Second, at low sun angles the reflection losses will be high, unless the atrium has a special roof with a steep, south-facing glazing. A final problem is summer overheating, since the summer sun is at a high solar altitude and "sees" much more of the atrium than does the winter sun. Shutters will help, but some overheating will still occur since inside shutters absorb some sunlight. External shutters can block heat completely.

The plastic cover would serve very well to control evaporation from your pool.

Wood-stove heating

How efficient and expensive are wood stoves? If I begin heating my home with wood, will I run into problems?

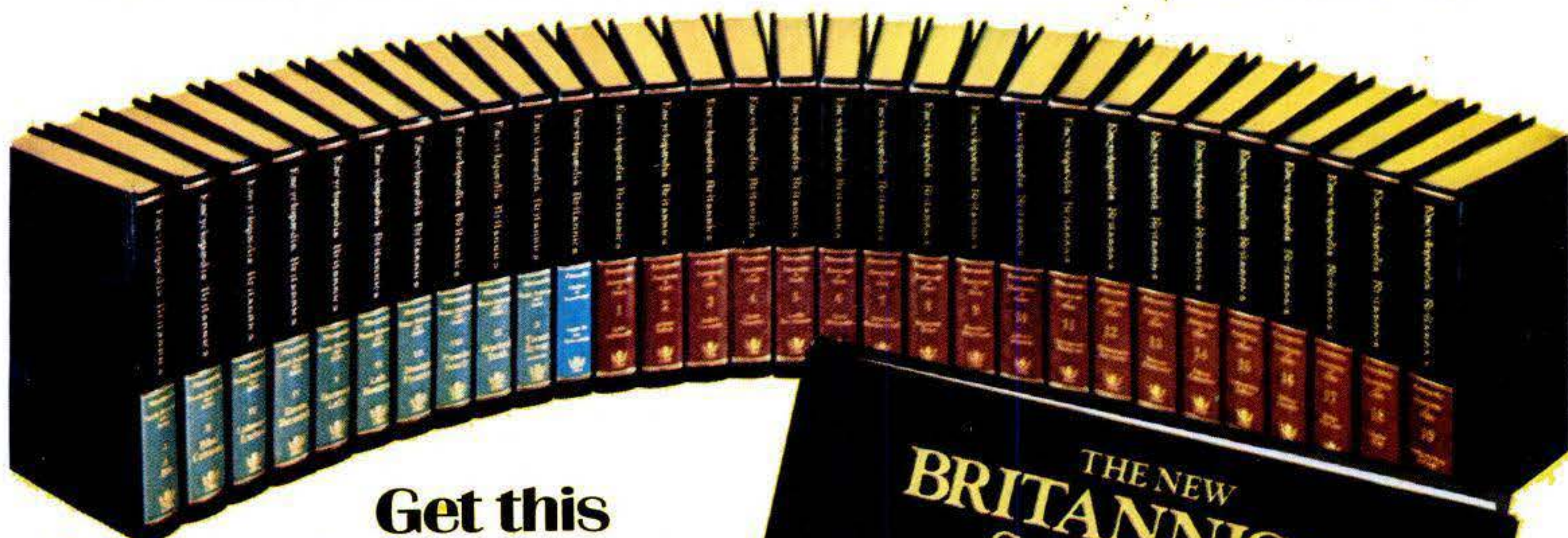
Free-standing wood stoves with good air control will deliver—at the most—when new, 75 percent of the heat energy stored in the wood. If the stove is well maintained, the efficiency should not drop appreciably over the years. Wood stoves will probably cost a minimum of \$150 uninstalled to \$800 installed. The median range for the heating value of wood is about 25 million Btu per cord. A well-insulated 2000-sq.-ft. home in a 6000-degree-day climate will require about 100 million Btu per heating season, or four cords per winter.

Practical matters involved with wood stoves are ash disposal, adequate heat distribution to all rooms in a home, and, in urban areas, particulate air pollution from wood smoke.

Got a question on an alternate energy such as solar, wind, water, or wood? Or on energy-conservation techniques that could reduce your home's heating and cooling costs? Every other month, alternating with "Adventures in Alternate Energy," Jan Kreider answers questions selected from those sent in by readers. Write to "Energy Questions," *POPULAR SCIENCE*, 380 Madison Ave., New York, N.Y. 10017. Queries can't be answered by mail.

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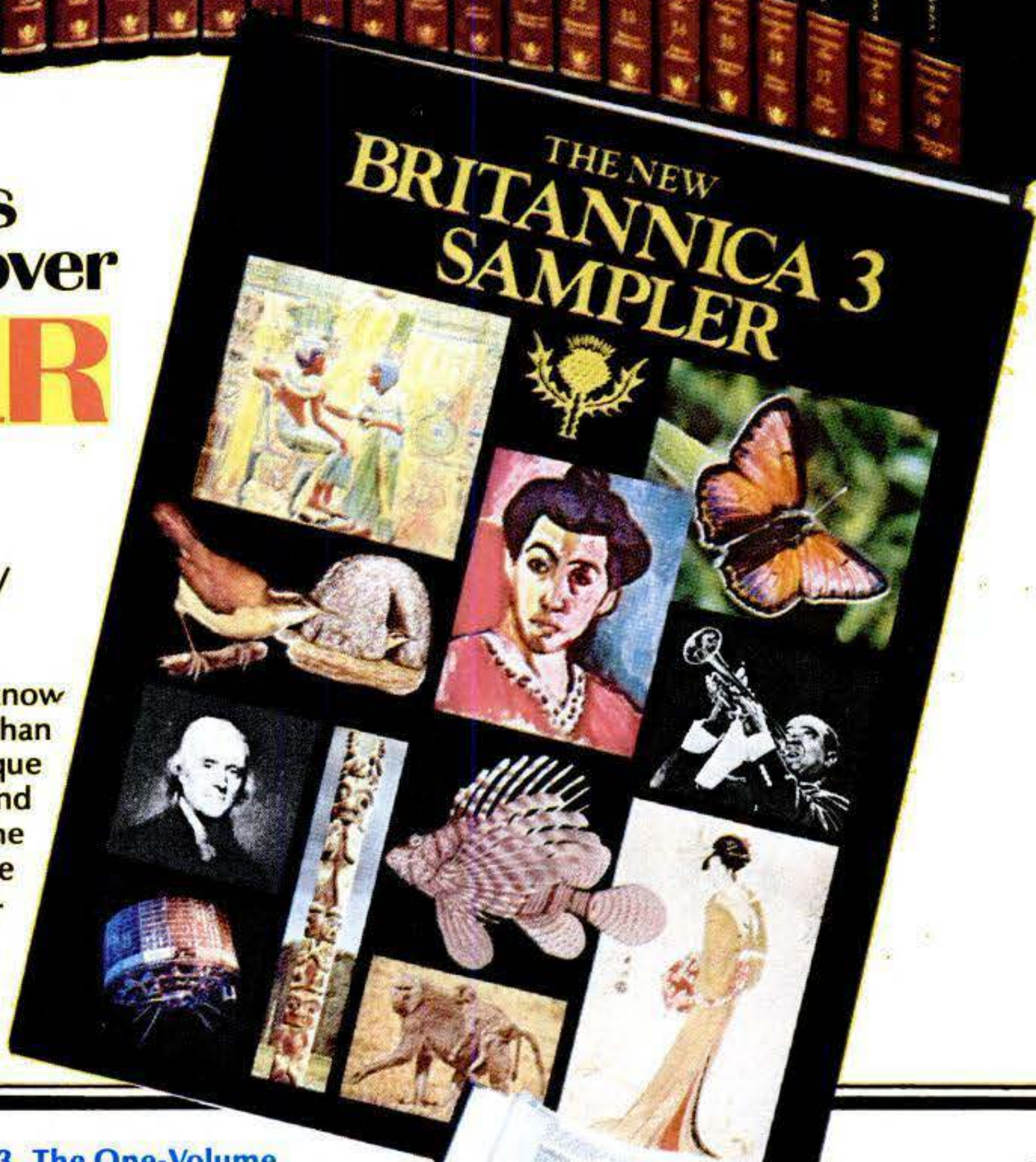


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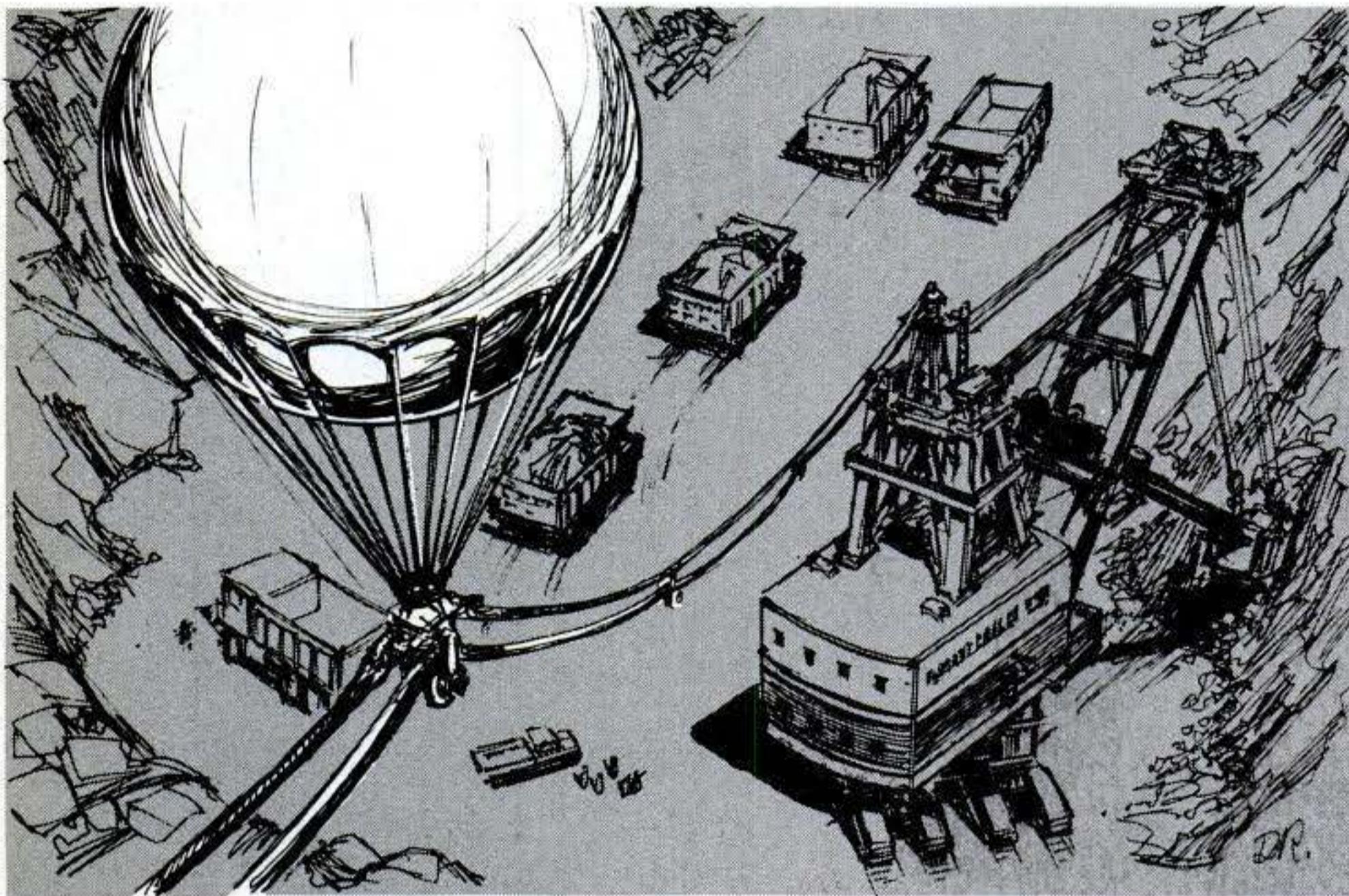
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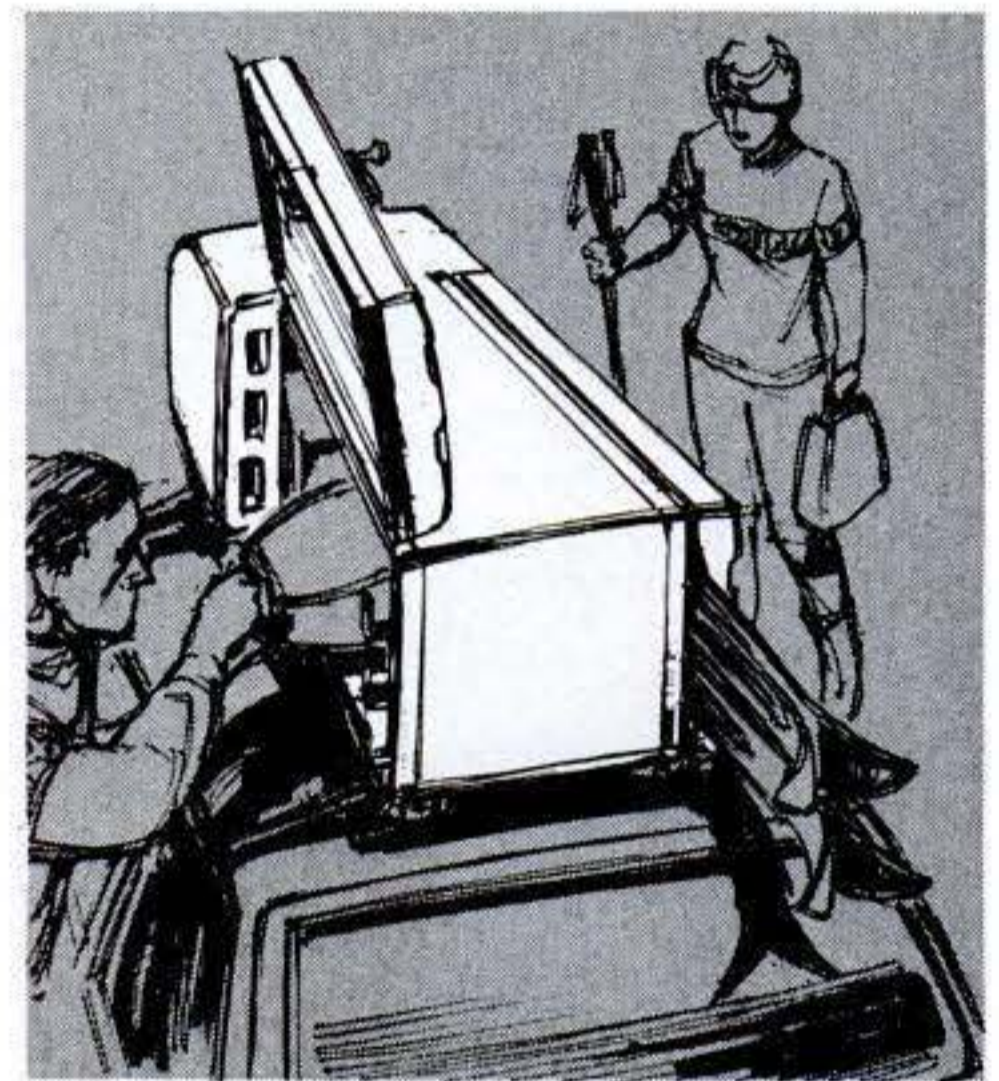
ILLUSTRATIONS BY DANA RASMUSSEN



Balloon carries power lines to open-pit mines

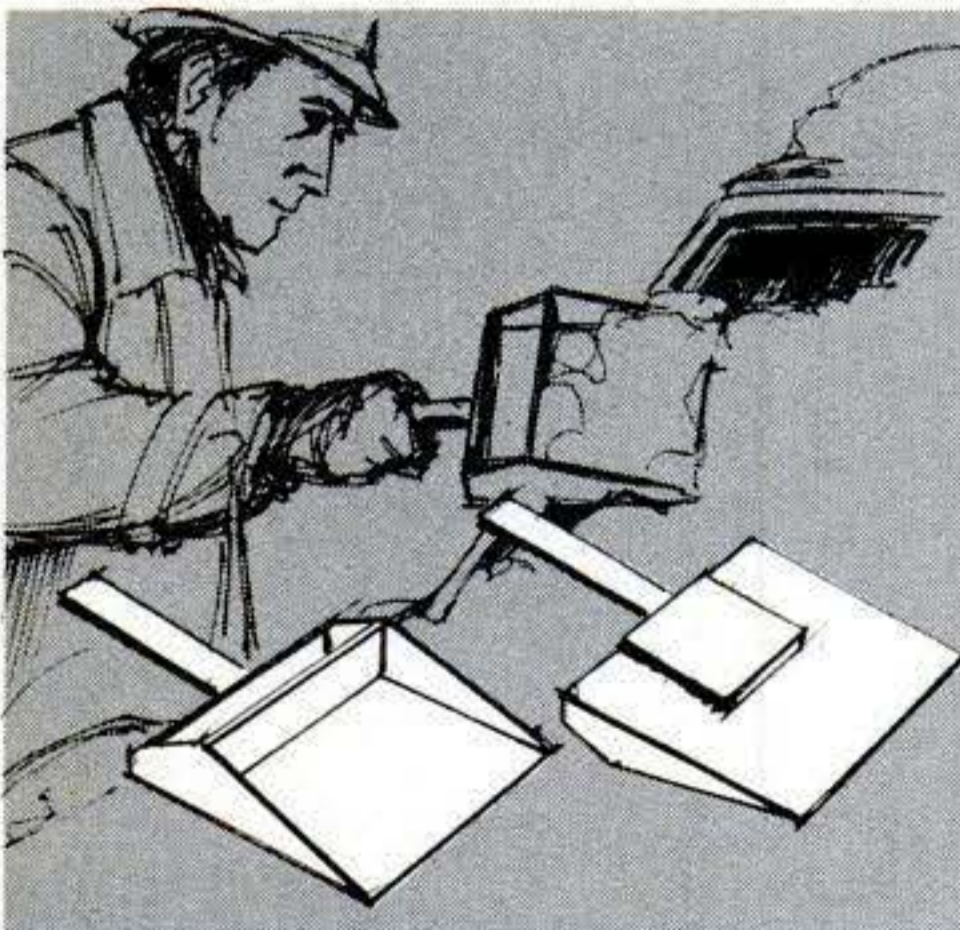
Electric-powered shovels and other tools might often be the equipment of choice for working open-pit mines and some construction jobs if power could be brought in safely and without obstructing the equipment itself. This tethered,

lighter-than-air balloon would keep cables in the clear. Connectors spaced along the pulleyed tether would provide convenient power taps while allowing the cable and the plugged-in rigs to move freely to and within the work surface.



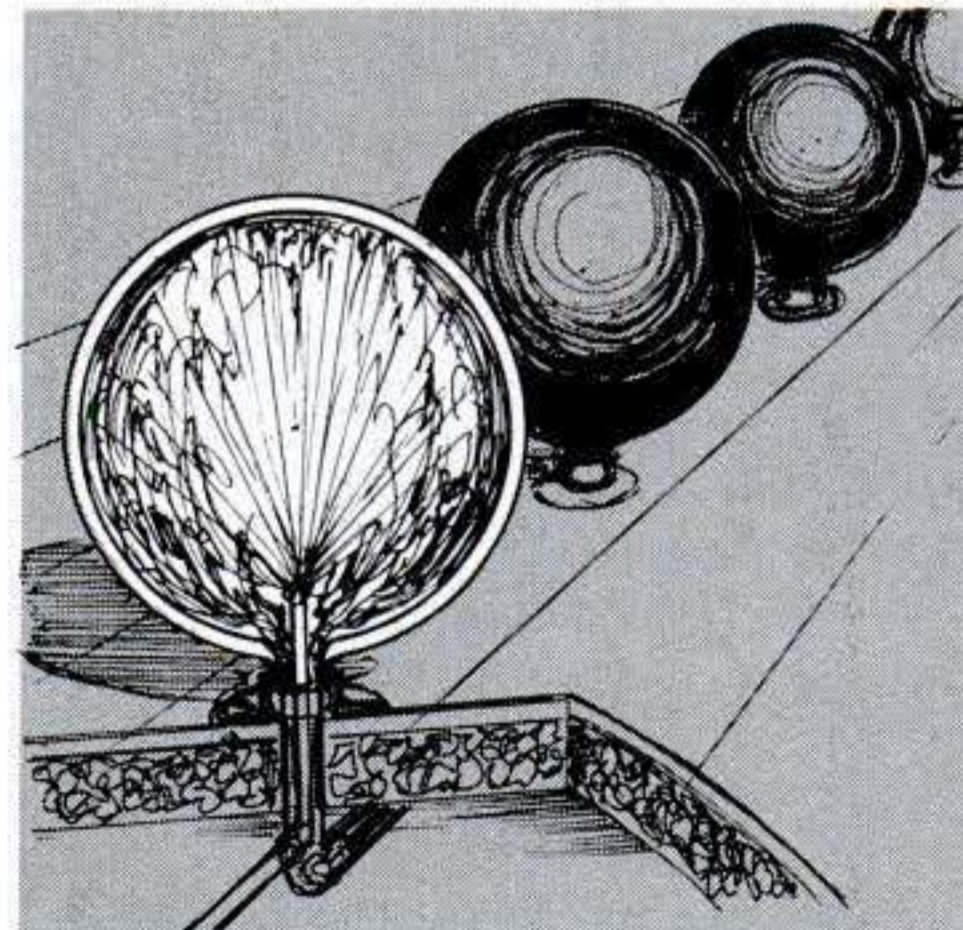
Ski carrier stows gear

A rigid center enclosure in this car-top carrier would stow luggage, boots, and other gear in the space between vertically arranged ski-holding slots. This would provide better protection for skis and bindings and use normally wasted space on the vehicle's roof. The luggage space would be reached through hinged doors on both sides that could be locked to secure the skis, as well as the other gear.



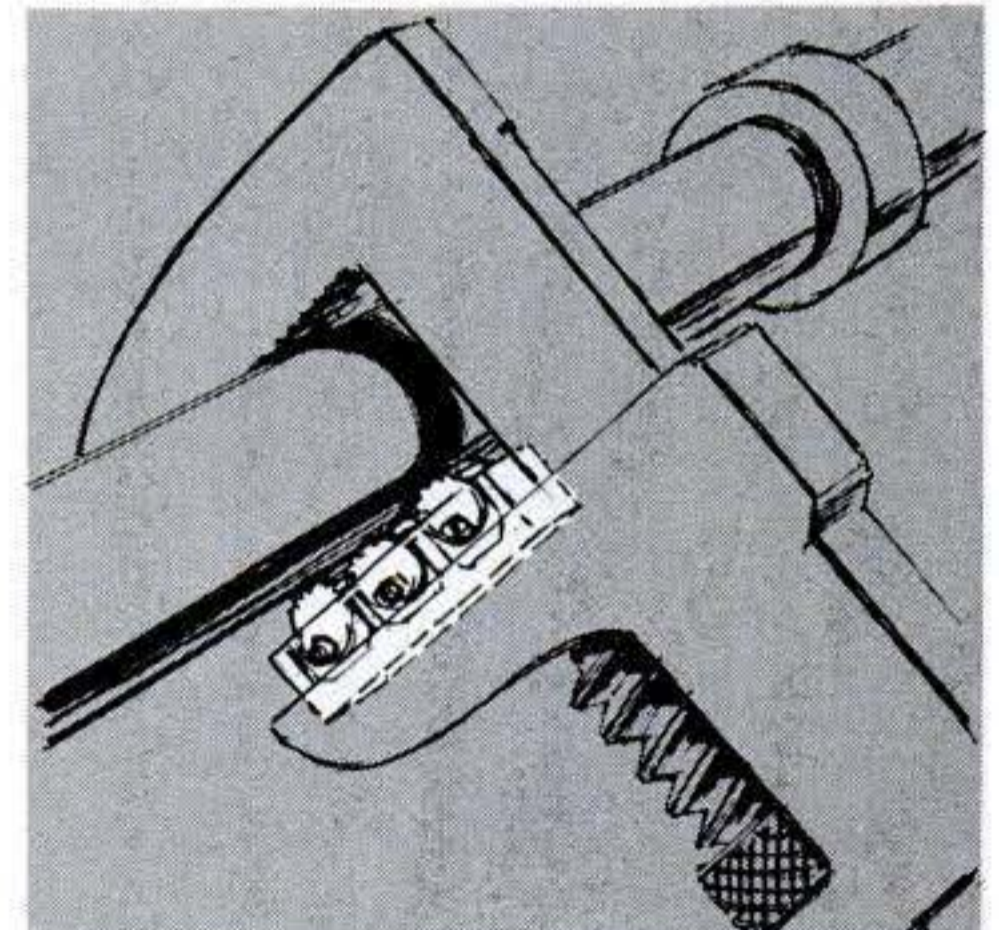
Flexed scraper for snow cleaning

Made of reinforced plastic, this dustpan-shaped scraper would flex along its leading edge to follow the contour of any flat or curved car surface. It would move stiffly forward, when you pushed it, to speed removal of deep or piled-up snow. A barrier at the rear would protect your hands; a scraper shoe underneath would chip and loosen harder snow or ice.



Bulbs collect solar heat

Spherical, double-walled bulbs might absorb heat efficiently over most daylight hours. This clear outer bulb would pass the sun's rays to sprayed-in fluid inside the dark-colored, heat-absorbing inner bulb. A vacuum between the globes would minimize heat loss. The heated fluid would flow through a pipeline along which the bulbs could be connected.



Rollers tighten wrench grip

Toothed rollers set into this wrench jaw would turn themselves for a secure grip on a pipe or similarly shaped workpiece. Rotating in an off-center arc, the grippers would take a firm hold when you moved the handle in one direction, slack off for a ratchetlike action in the other. The removable insert (or a set of them) would give you a faster bite, easier action.

The following patents have been issued on these inventions: **Balloon cable carrier**—No. 4,071,124 to Donald L. Price, Bend, Ore.; **Snow and ice scraper**—No. 4,067,107 to Philip Scafetta, Green Lane, Pa.; **Solar collecting bulbs**—No. 4,137,903 to Charles E. Annett II, Nokomis, Fla.; **Ski and luggage rack**—No. 4,071,176 to John Tuzee, Waukegan, Ill.; **Wrench-**

jaw rollers—No. 4,070,933 to Robert M. Macintosh, Melrose, Mass. Copies of patents may be ordered, by number, from the Commissioner of Patents and Trademarks, Washington, D.C. 20231, at 50 cents each. To write to an inventor, if address above is insufficient, address him by name and patent number in care of the commissioner.

NEW PRODUCT

Sports Radar^{T.M.}



Here's how an exciting new micro-electronic breakthrough will make your children heroes and improve your tennis game.

Just point the gun and read the results.

When Roger started pitching for his little league team, he was just another player. And his arm was no better than anybody else's.

Two months later a small miracle took place. Roger was the best pitcher on the team and had a fast ball that was the most powerful in his league—and all thanks to his father.

Roger's success came from a radar gun—the same type device used by police to catch speeding motorists.

SCRAMBLED EGGS

The minute Roger's father was able to clock his son's pitching speed, Roger was subconsciously given a daily challenge of pitching harder and faster to beat his previous speed. The more he practiced, the better he got.

Roger's father paid \$2,000 for the radar gun. But in his upper class neighborhood, it wasn't too unusual for a father to spend that kind of money to help his son.

SPEEDING CITATION

A large manufacturer of radar-type security devices saw what Roger's father had done and felt that there was a definite need to produce a low cost radar unit designed exclusively for the sports market.

The company, Solfan Systems, developed the Sports Radar gun—a major breakthrough in projectile speed detection as well as electronic radar circuitry.

Using the doppler effect of radar and phased-lock-loop circuits, Solfan has developed the Sports Radar gun that compares to even the most sophisticated of police radar units that cost \$2,000.

OVERLAND EXPRESS

The Sports Radar gun is held in your hand and pointed toward the pitcher. You turn it on, press the ready button, and point the gun. The gun will ignore the moving arm of the pitcher but will lock in on the moving ball. The radar unit would then follow the ball for approximately ten milliseconds and the built in computer measures and computes the speed and flashes the reading on the display. The gun registers the speed to the exact mileage within one-half miles per hour.

The gun can be mounted on a tripod so that the person taking the measurements can also catch the ball.

In tennis, the speed of the serve can be measured by aiming the gun at the person serving. You can also use the unit by yourself by setting the unit on a tripod and measuring the speed from behind.

WORKING AND PLAYING

Aside from its extreme accuracy and advanced electronics, the unit is priced to meet the budget of every sports-minded athlete or parent. It's only \$149.95 complete.

You can measure the speed of baseballs, soccer balls, tennis balls, golf balls, hockey pucks, downhill skiers, radio controlled model airplanes or anything that moves—even automobiles.



The speed is flashed on the large LED display and is shown in miles per hour.

The unit accepts two commercially available 6-volt lantern batteries which you can purchase locally or from JS&A for only \$2 each. The batteries will last for weeks with normal use.

SUCCESS AND GOOD THINGS

The unit comes in a sports blue color and weighs 38.4 ounces, exclusive of batteries. It's rugged, well built and designed to endure the typical use and abuse it would normally receive.

We urge you to test this exciting new product during our 30-day free trial. Order the Sports Radar gun. When you receive it, measure your child's pitching speed. Test it on your own tennis serve. See how knowing your speed will actually improve it as you try to outperform your previous record fast pitch or serve. Then decide if the Sports Radar gun doesn't make a very exciting addition to your sports equipment.

ONE FOR THE MONEY

If you are not convinced that the Sports Radar gun is something that you'll use constantly to help improve your game, return it for a prompt and courteous refund, including your \$3.50 postage and handling. You can't lose—and chances are your son will at least have the most popular new product in the neighborhood.

To order one for your test, simply send your check for \$149.95 plus \$3.50 for postage and handling to JS&A Group, Inc., at the address shown below. (Illinois residents please add 5% sales tax.) Credit card buyers may call our toll-free number below. If you wish to buy a set of two six-volt batteries, simply add \$4.00 to your order.

We'll then send your unit, the batteries (if you order them from us), a 90-day limited warranty and complete easy-to-understand instructions.

Radar electronics for the sports enthusiast is now a reality. Watch your game improve by ordering your Sports Radar gun at no obligation, today.

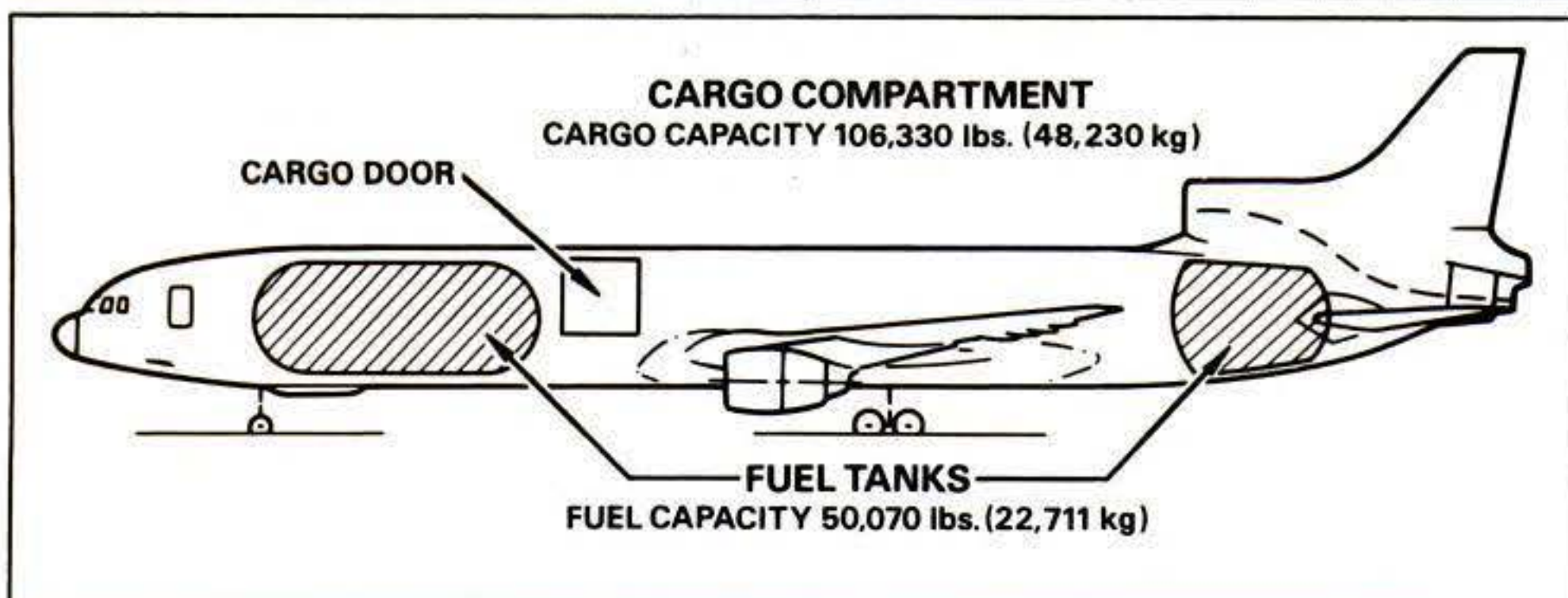
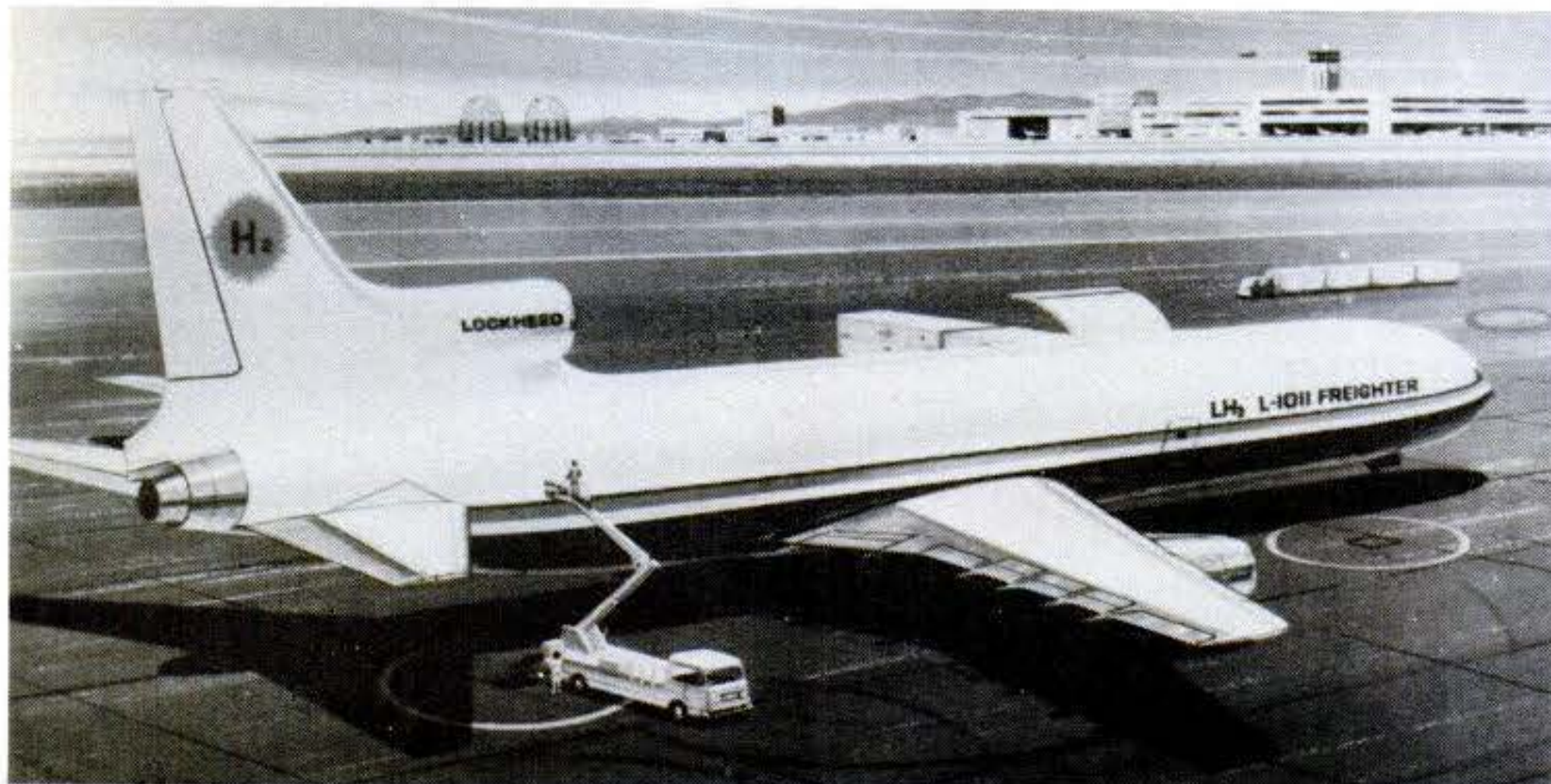
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SCIENCE NEWSFRONT

By ARTHUR FISHER



Hydrogen-powered air freighter

As airlines feel the ever more painful pinch of tight and expensive petroleum fuel supplies, the goal of powering aircraft with liquid-hydrogen fuel becomes ever more attractive. Now Lockheed Aircraft Co. has put forward a plan for a four-country fleet of modified L-1011 freighters to begin hauling cargo in 1987. The new craft, shown here in artist's concepts, would be 35 feet longer than present L-1011's. A large liquid-hydrogen (LH) fuel tank would be installed forward of the cargo hold, and a second, smaller LH tank aft, with a combined fuel capacity of 50,000 pounds. The plane could carry 106,000 pounds of cargo over a range of 3500 nautical miles.

Where would these large quantities of liquid hydrogen come from? Under the Lockheed plan, four nations—the United States, Great Britain, West Germany, and Saudi Arabia—would each build its own LH plant near a major airport. The fuel would be stored in underground reservoirs at the airfields (the painting above shows a worker connecting the craft's fuel tanks to the underground supply).

Development, production, and delivery of four aircraft, according to Lockheed, would cost about \$650 million. Throw in

the LH plants and the special airport facilities, and the total cost to be shared among the four participating governments is about \$1.38 billion. If the project began in 1980, the planes could be flying, Lockheed says, by 1987.

Hide-and-seek with the gluon

An international team of some 300 physicists, working at a high-energy accelerator in Germany, has found convincing evidence for the existence of a key fundamental particle—the hitherto-elusive gluon. The discovery is the capstone in a long series of experiments that support the theory called quantum chromodynamics, or QCD. That is the best theory that we have at this time to account for the structure and behavior of the atomic nucleus.

Modern physicists believe that all the matter and energy in the universe obey the mandates of four fundamental natural forces: the electromagnetic force, gravity, the weak nuclear force, and the strong nuclear force. They govern a firefly's flash, a planet's path, radium's glow, the H-bomb's awful power. And, according to this picture of the world, each of these four natural forces is passed to and fro among the basic particles of matter by

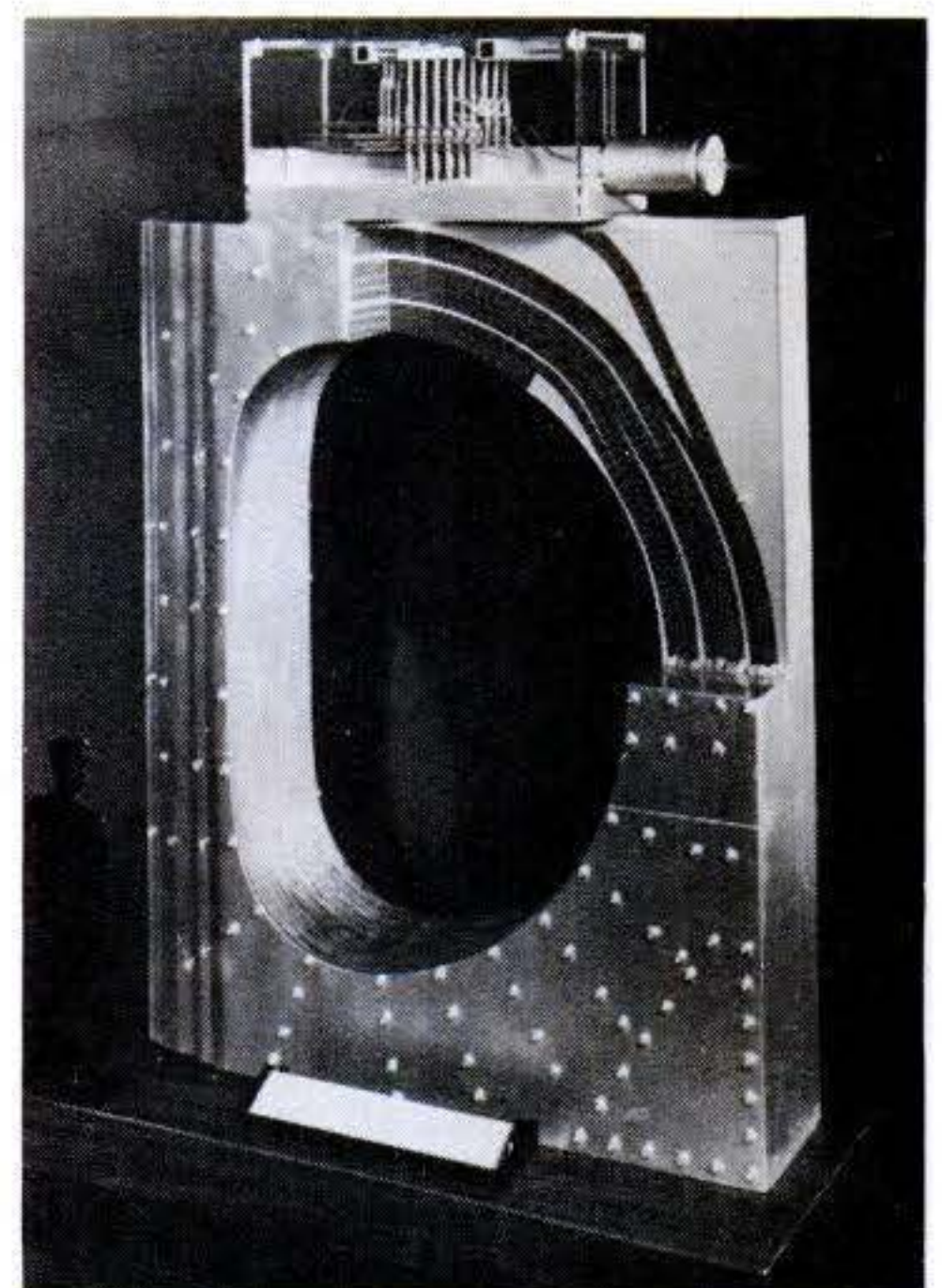
unique force-carrying particles. For example, the electromagnetic force is carried by the photon, the weak force by the intermediate vector boson, and gravity by the graviton (though the last two have not yet been experimentally confirmed).

The strong force binds the particles inside the nucleus together. The theory of the strong force, QCD, pictures the nucleus as consisting of protons and neutrons, which, in turn, are made up of basic particles called quarks. Nobody has ever "seen" a quark, and some physicists believe they can never be isolated. But there is general agreement that they do exist. To confirm the quark idea and QCD, physicists needed to stalk an equally mysterious theoretical particle that would bind together the quarks by carrying the strong force. This particle would, in effect, act as the glue that holds the nucleus together; it was gleefully dubbed the gluon.

Last year, at PETRA, a colliding-ring accelerator built by the West German government at the DESY complex in Hamburg, experimenters indirectly detected the gluon when it left its signature in the aftermath of very-high-energy collisions between electrons and positrons. The achievement is a tremendous mood lifter for all those physicists who have been working to shelter the four fundamental forces under one theoretical umbrella, the so-called grand unification theory. Said Dr. Leon Lederman, director of the U.S. Fermi National Accelerator Laboratory, "Physicists are ecstatic. We're beginning to understand how it's all put together."

Giant magnet

The photo below shows a cutaway model of what is to be one of a family of the world's largest magnets. It's an 18-ft.-tall, 32-ton superconducting electromagnet destined for use in this country's fusion-energy program. Magnetic fusion-power reactors of the future will require enor-



mous, highly concentrated magnetic fields.

This magnet, to be built by Westinghouse Electric Corp. for the Department of

Continued

The U.S. was founded by a group of individuals who rebelled against the oppressive policies of King George in England. Today, this same spirit of independence, a uniquely American phenomenon, underlies a growing displeasure with government tax and spending policies. This viewpoint is a healthy sign. Our society can remain the freest and most prosperous in the world if government power is held in check by us, the citizens who make up the country. Recent passage of laws (such as Proposition 13) are an indication of a growing wave of protest against wasted tax dollars. The effort is getting stronger and more vehement every day.

The largest tax each one of us pays is Federal Income Tax. Yet, the largest corporations and the wealthiest individuals often pay the least amount of tax. According to an article in a leading newsletter, 17 huge corporations paid no federal income tax in a recent year, although they had a world-wide income of \$2.5 billion. Numerous tax loopholes were used. The list includes United States Steel, Bethlehem Steel, Armco Steel, General Dynamics, Singer, Phelps Dodge, American Airlines, Philadelphia Electric and The Chase Manhattan Corporation. The burden caused by these non-taxpayers must be assumed by "somebody." "Somebody" is always the wage earner. There is, therefore, a major inequity under the law which favors the wealthy and, most especially, corporations. In America today we have what could be called a "Corporate Society."

Some individuals have become so upset with these startling inequities, they have stopped paying taxes and have in many cases even ceased to file tax returns. This approach, however, is fraught with danger and has resulted in stiff fines or prison sentences when the government locates and prosecutes the courageous individuals.

You Can Become Part of "The Corporate Society"

Rather than break the law and suffer serious consequences, there is a safer and more viable alternative. You can use the same type of smart thinking as those who own and control great wealth. The big corporations are not necessarily immoral. However, they do get the best advice available on tax matters.

You, as an individual, can now use all the tax loopholes for your own self interest. Thus, you legally gain the advantages yourself as do the huge corporations. Rather than break the law, you can use it to your advantage. Perhaps the best way to accomplish this, as well as reduce your tax burden is through incorporation, the legal form of tax rebellion.

Surprisingly enough, the government encourages incorporation with a number

Wage Your Own Personal Tax Revolt

Like the early pioneers who started this country, many people are rebelling against the near confiscatory taxation at all levels of government. The federal government consumes the taxpayer's cash at the rate of over \$800,000 per minute, and the amount that is wasted is scandalous. The citizens are mad as hell and they're not going to take it any more.

There is but one answer left!

of favorable laws, especially in the area of taxation. In fact, it is rare to find a successful individual who is not incorporated. Incorporation is favored by nearly all millionaires. It is one of the causes of wealth, not its effect. Think about it. Can you think of a single wealthy individual who doesn't own and control his own corporation? It is rare indeed. Let's face it, the first step toward achieving the American Dream in our corporate society is probably incorporation.

To add even more impetus to the idea of starting your own corporation, passage of the Revenue Act of 1978 makes incorporation the ultimate tax shelter. This act and the earlier ones close the door to practically all other tax shelters and loopholes. The tax rate on corporations (especially smaller ones) has been substantially reduced, to as low as 17%.

Favorable laws such as the investment tax credit are most helpful when buying equipment. Even if you incur losses in one year you can deduct those losses over several profitable years.

More Advantages. . .

You can set up a corporate medical plan wherein you deduct from your taxes every dollar spent on medical and dental care, drugs, and health insurance for yourself and your family. You can also get tax deductible group life insurance even if the "group" consists of only one person.

It is important to note that potential tax savings are not the only reason to incorporate. Another chief value is that it limits your liability to the assets of the corporation in the event of a lawsuit. If you do business as an individual or partnership, you can be sued personally,

"Over and over again courts have said that there is nothing sinister in so arranging one's affairs as to keep taxes as low as possible. Everybody does so, rich or poor; and all do right, for nobody owes any public duty to pay more than the law demands; taxes are enforced exactions, not voluntary contributions. To demand more in the name of morals is mere cant."

Judge Learned Hand

which could put your house and other assets in jeopardy

You can put more money (25% and more of income) into your corporation pension plan. This is more than a traditional "Keogh" plan which has a maximum contribution of \$7,500 a year, or even an I.R.A., where the maximum that can be sheltered under special circumstances is only \$1,750.

In these times of growing inflation and periodic ups and downs of the economy, your own corporation is probably the only way that you may maintain control over your economic destiny. And you can often benefit from incorporation without leaving your present job. More about that in a moment.

You Can Incorporate Simply, Easily and Inexpensively.

Up until now, throughout the majority of history, incorporation had one major drawback: high legal fees. Lawyers today charge stiff fees, up to \$2,500 for incorporation. The truth is that you can easily incorporate yourself for under \$50. A remarkably easy and inexpensive method of incorporating is contained in a book called *How To Form Your Own Corporation Without A Lawyer For Under \$50*. It comes complete with all the tear-out forms required to start your own corporation . . . minutes . . . bylaws . . . everything you will ever need. The author, Ted Nicholas, has helped thousands of people start their own corporations and has saved them millions of dollars in the process — and many millions more in taxes.

It is very easy, and we will show you how. We'd like to send you a copy of *How To Form Your Own Corporation Without A Lawyer For Under \$50* for a free thirty-day trial — without risk or obligation on your part. If, for any reason, you're dissatisfied, simply return it for a full refund of your purchase price. We'll also send you a free bonus: The Income Plan — an astounding report that tells you exactly how to turn your present career into a tax-sheltered corporation. The Income Plan — a \$9.95 value — is yours to keep *absolutely free*, even if you decide to return the incorporating system.

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Science newsfront

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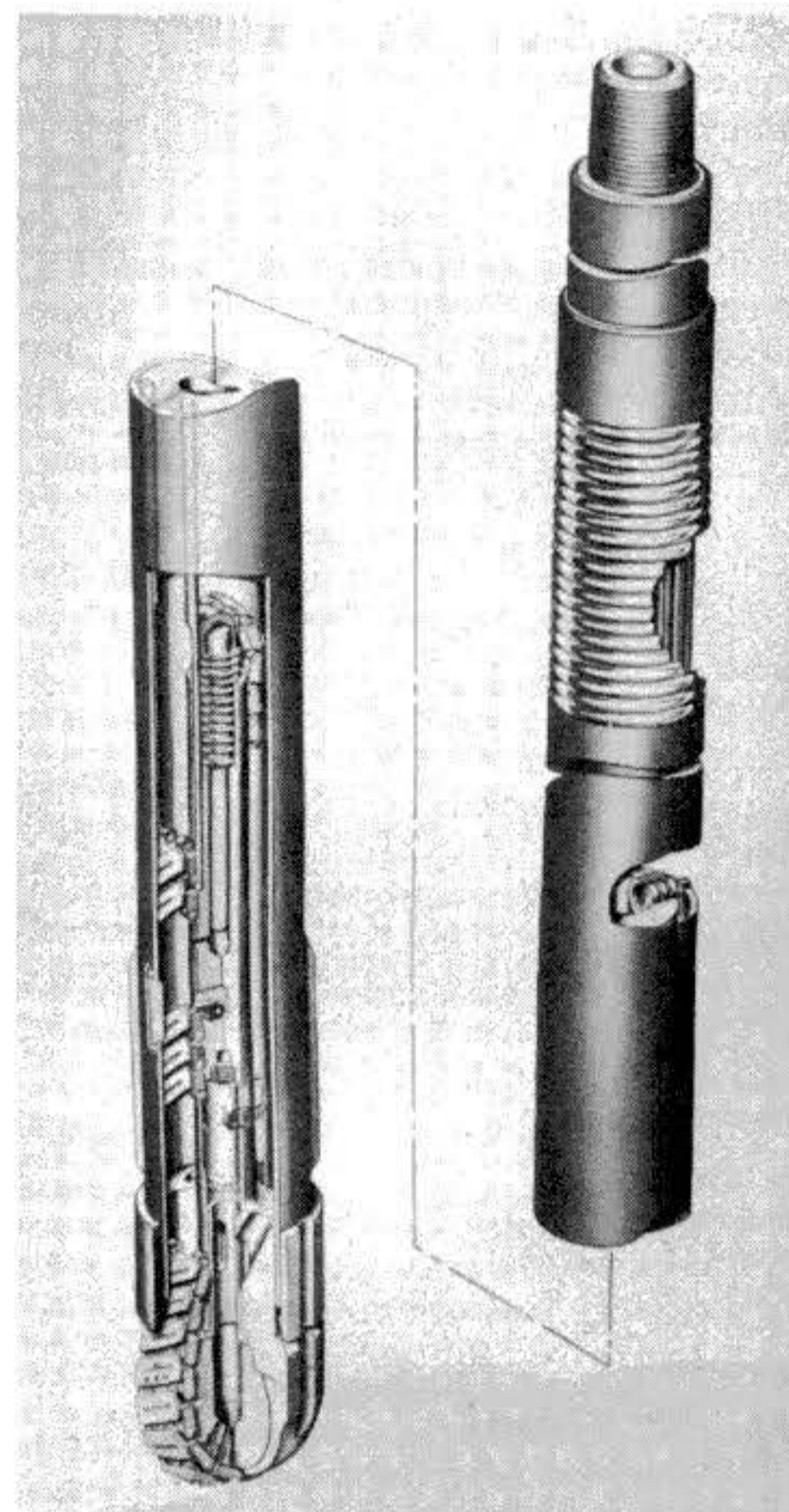
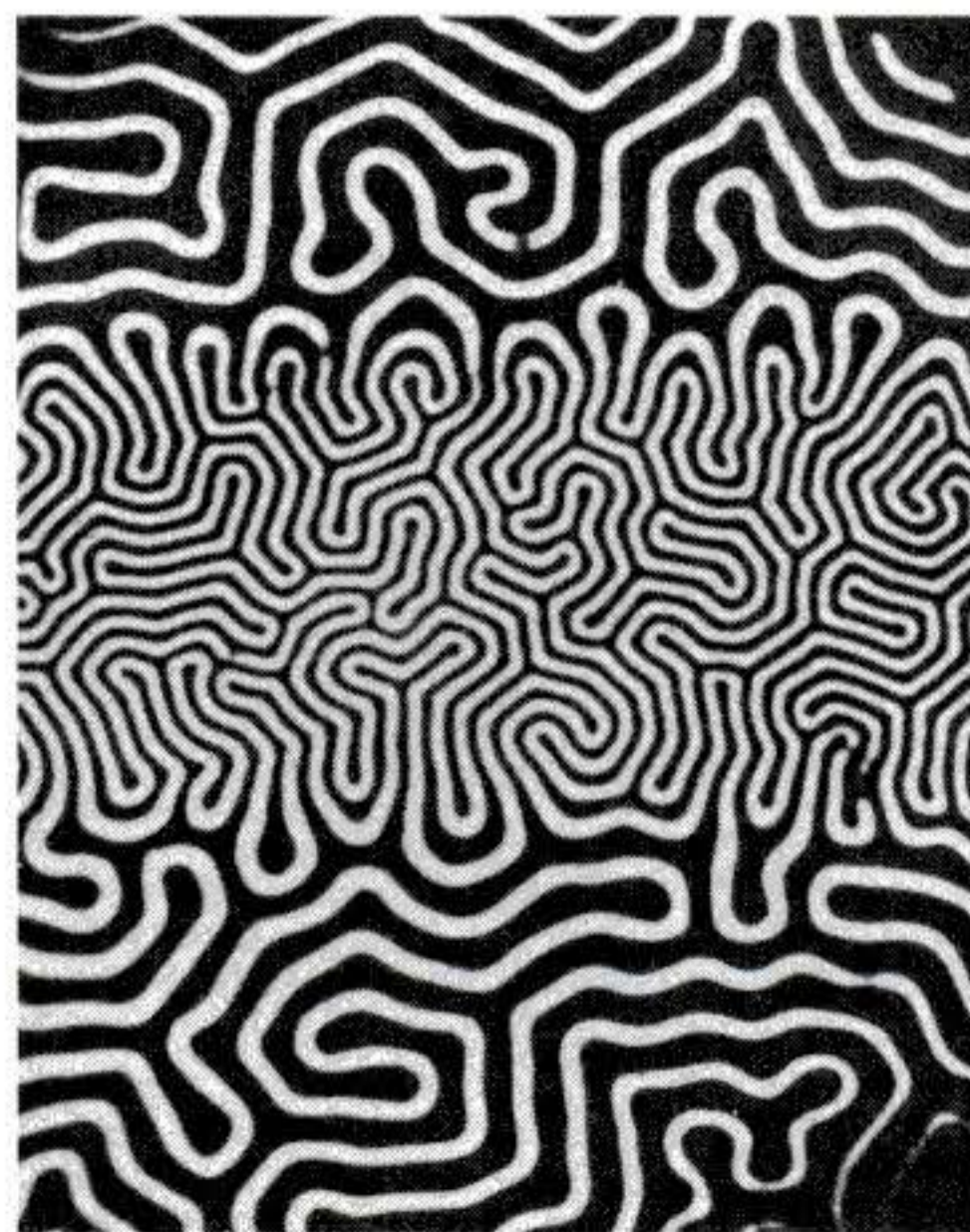
Energy's Oak Ridge National Laboratory, is one of six magnets of this size ordered, but is alone in using niobium-tin superconductor in the coil, rather than niobium-titanium superconducting alloy. The niobium-tin alloy is less tractable, but may produce higher field strengths. The Westinghouse coil should generate a magnetic field more than five times stronger than that inside today's largest electrical generators—about 150,000 times stronger than the Earth's magnetic field. The three miles of conductors in the coil, cooled by liquid helium to the near-absolute-zero temperature required for superconductivity, will circulate 17,600 amperes of current without electrical resistance. If they were of copper, which is not a superconductor, the resistance losses would eat up 30,000 kilowatts of power.

Insights into nearsightedness

Dr. Ben C. Lane, a researcher at New York University, reports some provocative findings on myopia—nearsightedness. For the first time, he claims, both chromium deficiency and too much protein in the diet have been linked to the development of myopia. His studies, which relied heavily on computerized analysis, also confirmed three other factors previously associated with an increase in myopia: excessive eye-focusing stress caused by long hours of reading or other close work; excessive consumption of sugar and other refined carbohydrates; and abnormal calcium metabolism or intake.

Smaller bubbles

Further progress in the pursuit of magnetic-bubble materials with ever-higher information density is reported from scientists at IBM's Research Division [PS, Oct. '79]. The photo below demonstrates the startling effect of laser annealing on the magnetic domains in a thin film of gallium-substituted garnet. Where the laser has swept across the central strip, the domain widths have shrunk from about 16 microns to about seven microns.



Nonstop chain drill bit

One of the peskiest problems in drilling boreholes through hard rock is the natural propensity of drill bits to wear out. When this happens, the entire string of pipe to which the bit is attached must be pulled out of the hole, the bit replaced, and the pipe lowered again all the way to the bottom. Of course, the deeper the hole, the more often this operation must be repeated: It could consume eight or 12 hours for a 10,000-foot-deep hole.

Now Sandia Laboratories has successfully field-tested a continuous chain drill bit, pictured here, that moves a new cutting surface into the business end when one wears out, without having to be withdrawn.

Each cutting surface in the Sandia bit consists of five adjacent chain links wrapped around a hemispherical bit head. When the five links are worn, the chain is advanced remotely, so that the next five links are moved into place. Each link, measuring 2 1/4 by 1 1/2 inches, is set with 100 diamonds—about 10 carats' worth.

The field-tested model had only 30 links—six cutting surfaces—and drilled 250 feet in granite. A commercial version would have a chain about 7 1/2 feet long, with 75 links. In a 4 3/4-inch "slimhole" model (primarily designed for exploratory drilling) it would probably cost about \$30,000, some 10 times the cost of a conventional diamond bit. But the new bit, with 15 cutting surfaces, could still reduce drilling costs 30–50 percent, depending on well depth, even if each surface lasted no longer than a conventional bit. **PS**

Portable refrigeration price breakthrough! Save \$25.00 off-season

Solid State Refrigeration makes portable coolers as obsolete as grandma's kitchen ice box.

The kindest thing you can say about ice boxes is they're better than nothing.

They fall down on the job in hot weather. They look more like swimming pools than refrigerators when the ice melts. And, every other day, you have to dig into your pocket to buy more ice. (If you can find it).

Koolatron's 12 volt portable refrigerators work on thermoelectrics, not ice. And maintain normal refrigeration temperatures.

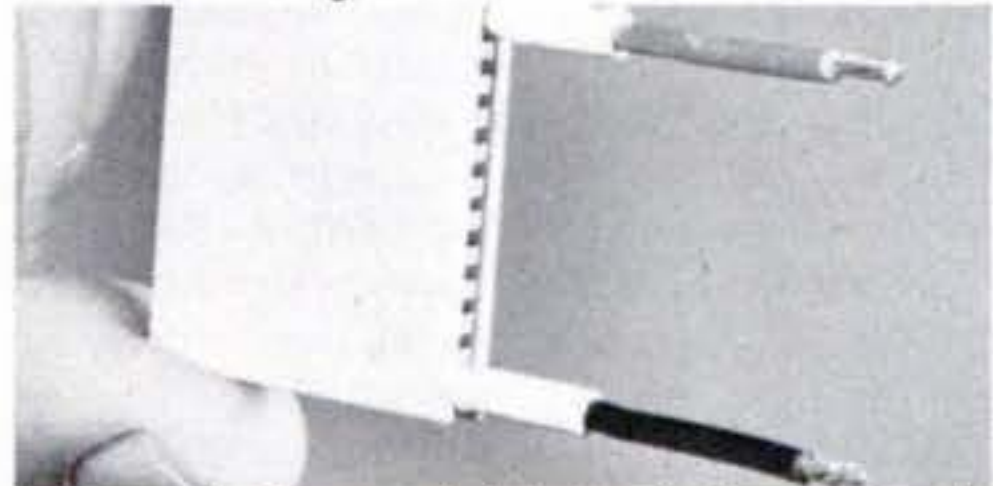
So taking the Koolatron on your trip is like taking a small version of your home refrigerator. Everything — and everybody — stays cool.

USES AEROSPACE REFRIGERATION MODULES

The Koolatron portable cools your food electronically with solid state thermoelectric refrigeration modules. These same powerful modules are used by military and aerospace scientists to cool critical components in rockets and satellites. They use thermoelectric cooling because of its *absolute reliability, insensitivity to motion or level, small size & weight and minimal battery drain.*

WHY IS THE KOOLATRON PORTABLE SO MUCH BETTER THAN AN ICE CHEST?

An ice chest maintains an air temperature of 50-60 deg. F. Meat and milk spoil rapidly at temperatures above 50 deg. F. which is why the top of your meat will go bad even when it is sitting on ice. Koolatron portables maintain normal home refrigeration temperatures of 40-45 deg. F. even in 95 deg. F. weather.



Two of these miniaturized thermoelectric modules replace all the bulky complex piping coils, compressors and motors in conventional portable refrigerators. The modules pump heat from your food into efficient heat sinks where it is dissipated by a quiet fan. They operate on a principal called the "Peltier Effect" — passing electricity through the junction of dissimilar metals causes heat to flow away from the junction.

BOATING, FISHING, CAMPING, HUNTING

Fits into virtually any boat, van or camper. Carry it on the back seat during car trips. Ideal for fishing and hunting — bring your catch back home fresh (a few loads of fish fillets could pay for your portable). Use it for grocery shopping, medicines, carrying film, salesmen's samples. Take it to the drive-in movies, auto races and other sporting events. With an inexpensive battery charger you can use your

Koolatron as a bar fridge all winter and a patio fridge in the summer. Run it in your motel room at night and enjoy a midnight snack whenever you feel like it. We have customers using our portables on construction sites, in workboats, laboratories and even in locker rooms for a "cold one" after the game.

THE ULTIMATE PORTABLE REFRIGERATOR

It weighs less than most coolers with a block of ice but holds over 40 lbs. of food or 48 pop cans in its large 36 qt. capacity. Plug it in a lighter socket in your car, boat or van or operate it from a 12 volt battery charger plugged into 110 volts. Cold contents will stay cold overnight with unit off. Draws a maximum of 4 amps., averages about 2 amps. at 70 deg. F. with the thermostat on. Keeps your food cold and dry. Exterior dimensions are 21"L x 16"W x 16"H. Interior dimensions are 16"L x 11-1/2"W x 12"H.

BUILT-IN QUALITY AND DURABILITY

The rugged "ABS" case is filled with the best insulation available — rigid urethane foam. It has a "150 lb. test" handle and non-rusting polypropylene hinge and latches, with stainless steel fasteners. Your portable comes with a 9 ft. detachable cord which plugs into your cigarette lighter. It also has terminals for attaching wires directly from a battery or fuse panel. The same terminals are used for your battery charger clips when operating from a charger. A reverse polarity warning light & buzzer are included. Because of Koolatron's solid state construction your unit should never require any servicing unless physically damaged. If service is ever required, it is available through our service depots in Batavia, NY, or Barrie, Ont., Canada.

GUARANTEE, 21-DAY MONEY-BACK TRIAL PERIOD

Your Koolatron comes with a written 1 year guarantee plus complete instructions and helpful information about batteries and chargers. If for any reason you are not totally satisfied, return it for a prompt refund in full.



PAYS FOR ITSELF

If you are regularly using ice, your Koolatron portable will pay for itself with the money you save on ice, spoiled food,



The Koolatron portable keeps over 40 lbs. of food at household refrigeration temperature but weighs only 15 lbs. Only 21" x 16" x 16" ext. Model F1A shown.

restaurant bills and the gasoline used looking for ice.

SPECIAL OFF-SEASON DISCOUNT!

The Koolatron F1 has regularly been selling at \$159. (\$179 in Canada.) By ordering off-season you can save a full \$25 off these prices. You save! We keep our plant at an efficient operating level off-season! But you must order now.

ADJUSTABLE THERMOSTAT OPTION

For an additional \$10.00 you can order the Koolatron portable with an adjustable thermostat in place of the standard fixed temperature thermostat — order Model F1A.

OPTIONAL 110 VOLT ADAPTOR

This custom-made adaptor allows you to operate anywhere on 110 volt power... home, cottage, hotel, patio, pool, ... \$29.95 (\$34.95 in Canada) plus \$3 shipping. Special price if ordered with main unit only \$25.00 (\$30.00 in Canada). No shipping charges — save \$7.95.

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Phone your order in collect to

705-737-0842

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Canada: 230 Bayview Drive, Barrie,

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Dept. 995

Send me ___ Koolatron F1 @ \$134.00

(\$154.00 in Canada) + \$7.00 each for handling and delivery in USA or Canada (N.Y., Ont. and Que. residents add sales tax.)

___ I want model F1A and have added \$10.00.

___ I also want the power adaptor and have added \$25.00 (\$30.00 in Canada) shipping included. If I order separately it will be \$29.95 (\$34.95 in Canada) plus \$3 for shipping.

I understand that I may return either item undamaged within 21 days and get a full refund if I am not satisfied. I enclose my cheque

money order for \$___ or, please charge my Visa Mastercharge American Express.

Acct. No. _____

Expiry Date _____ Send brochure only

Signature _____ (necessary to ship merchandise)

Name _____

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City _____

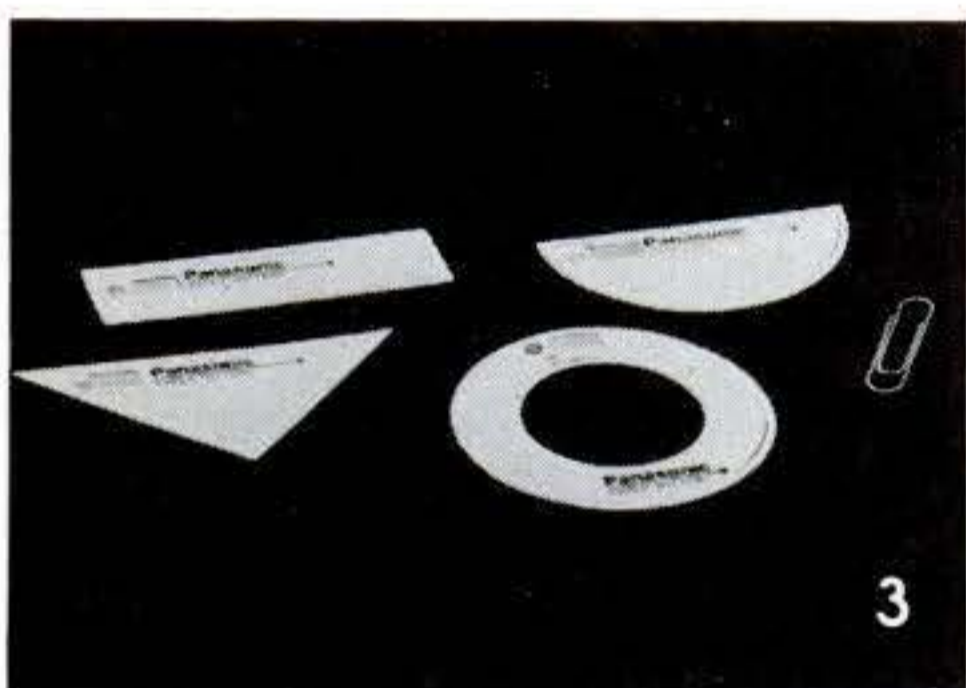
State _____

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P534

LOOK AND LISTEN

By WILLIAM J. HAWKINS



New audio/video gear

Every so often there is not one but a variety of new audio/video devices that are particularly ingenious or useful, or appear to be the start of a new trend. Here are some items that fall into that category.

The Technics direct-drive turntable (1), for example, is just slightly larger and thicker than an LP record jacket. There's no conventional tone arm; it uses a linear tracking system that sweeps the cartridge horizontally across the record. This eliminates tracking-error distortion on the inner grooves, since the cartridge is always perpendicular to the groove. Also, no anti-skating device is necessary.

Once a record is placed on the table, the top shell locks over the bottom, holding the disc in place. An optoelectronic detector (photocell device) automatically searches and cues the record for you. You can then turn the player upright and stow the system in a conventional record rack or shelf. The \$600 player also runs on 12 VDC, so you can use it in a mobile system.

Moving from turntables to turning the tables on boring commercials, there's The Killer (2). It's a black box that connects to your video tape recorder and kills commercials whenever you're taping one of those old black-and-white late-night movies. The clever box, plugged into the video output and remote jack of the recorder,

detects color (chroma) information from the video signal. When Bogart's on, there is no color info and The Killer allows the recorder to run. But let a color commercial muscle in on the movie, and The Killer spots the color signal within two milliseconds and stops the tape. After the color disappears (or after a time delay to prevent the recorder from damaging the tape), the recorder again starts.

Video Services (80 Rock Ridge Rd., Fairfield, Conn. 06430) makes it. Price: \$95 for Beta or VHS model.

Sure calculators are getting smaller and more pocketable than ever. But how about one that fits in your billfold? That—and a lot more—may now be possible with a new battery (3) by Panasonic. It's paper thin, and can be made in almost any shape. The secret: a stainless-steel plate that replaces the conventional thick carbon rod or sheet. A "chewing gum" size rates at 1.5 volts with a discharge capacity of 27 mAh—plenty for cameras, calcs, and watches.

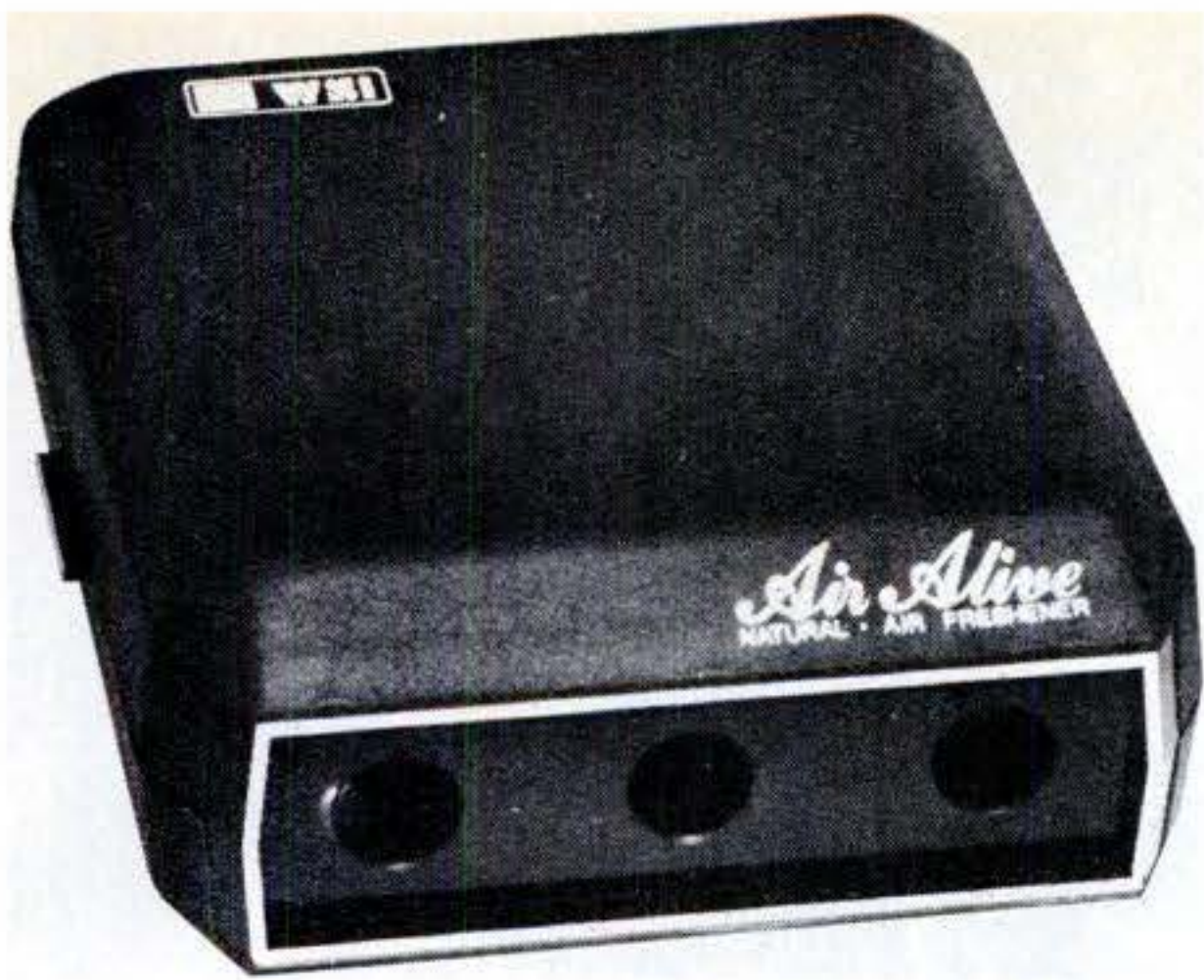
Demagnetizing made easy

Forgetting to demagnetize your tape-recorder heads can only result in noise and poor frequency response if it's neglected too long. Doing it isn't difficult, just inconvenient when using the standard units. The WhistleStop (4) from Robins, however, makes it easy and quick enough to do every 15 to 20 hours, as recommended by most deck makers. It's a cassette shell that contains an electronic demagnetization circuit with battery. When you insert it in your machine and press the play button, you hear an audible whistle through the amp. When that stops, the operation is complete and the heads are demagnetized. Price: \$26.50.

I find it hard to justify the average \$60 bill for a prerecorded video cassette of a movie I'll probably tire of after the second play. But the cassettes (5) from AstroVideo (90 Golden Gate Ave., San Francisco, Calif. 94102) are an exception and an exceptional buy at \$39.95. There are 25 tapes available covering NASA space developments. They contain over 60 NASA films including the lunar landing. They are basically a science series, but they could be the first electronic heirlooms. (Meanwhile, you can legally tape programs off the air for noncommercial use, ruled a Los Angeles judge. Three years ago MCA and Disney sought an injunction to stop Sony Betamax VCR sales. The two movie makers may appeal this ruling.)

Phonograph that plays books

Finally, if Microsonics has its way, I may have to clear my throat before writing future "Look and Listen" columns. That hand-held device (6) is a miniature record player that gets up to 90 seconds of audio off a special transparent record glued to the page of a book. When used with educational books, for example, a student could hear the actual speech given by a politician, or learn how to speak in a foreign language. The Microphonograph, from Microsonics (2049 Century Park E., Los Angeles, Calif. 90067), could be the start of an entirely new way to learn. **PS**



Attractive Air Alive unit measures only 4 1/2" x 4" x 1 3/4" and cleans a 20' x 15' x 8' room in up to 15 minutes.

AIR ALIVE

Uses "Nature's Air Cleaners" to electronically destroy odor, smoke, dust, and pollen. Now research shows it may do more!

Little-understood particles, called negative ions, are said to be nature's best air cleaners. They attach themselves to dust, smoke, pollen or anything else floating in the air, and cause it to fall harmlessly to the ground. Now there is growing proof that negative ions may affect your moods, health and sense of well being.

THE ION CONTROVERSY

For the past 20 years, scientists and scholars-world wide have been studying the effects of electronically charged particles in the air called negative ions.

Russian scientists have recently proven that the presence of ions in the air is essential to animal life. Research conducted at the University of California has shown that plant growth is stunted when the ion content in the air is decreased.

Some researchers claim there's evidence that negative ions can relieve allergic ailments and headaches, help control virus, retard the growth of bacteria, increase mental alertness and energy, reduce pain, tension, fatigue and depression and produce sound sleep.

Interestingly, while the number of those who believe that negative ions do, in fact, produce these benefits, has grown, the number of doubters has decreased over the years.

THE ION IMBALANCE

The air is made up of molecules that contain either a majority of electrons, making them negative particles, or a majority of protons, making them positive particles.

Although nature produces a nearly equal number of positive and negative ions, there are a number of reasons why we are surrounded by an over abundance of protons: air pollution depletes the number of negative ions in the air, the static charge from synthetic fibers produces positive ions and natural earth radiation, that would normally produce negative ions, is retarded by concrete and asphalt covering the land.

In effect, we are breathing air that nature never intended us to breathe ... air that has been depleted of negative ions. What is needed is a way to correct this ion imbalance.

NATURE'S AIR CLEANERS

There is almost no disagreement among scientists that negative ions are unmatched in their ability to cleanse the air of impurities. This is how they do it: negative ions attach themselves to dust, smoke and pollen, neutralize them and cause

them to fall harmlessly from the air.

Engineers and doctors have recently recognized this benefit and have begun to take advantage of it. Many now use commercial units that emit negative ions and effectively destroy odors and pollutants in the air.

It has only been during the last year that technology has developed an affordable consumer model. These units were first introduced in Europe where there is a high level of interest in the benefits of negative ions.

Now we are introducing one of the first consumer units to be sold in this country!

ONE OF THE FIRST UNITS UNDER \$100

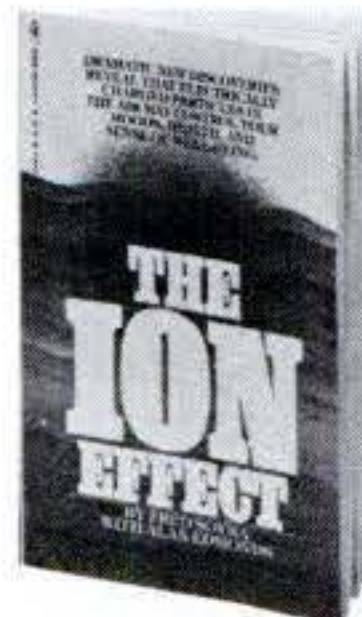
When we were offered the opportunity to introduce Air Alive to the American market, we jumped at the chance! Why? Because it's one of the first consumer models in this country to be sold for under \$100. And because it's manufactured by Western Systems, Inc., a pioneer in the ion generation field.

MOST COMPACT UNIT ON THE MARKET TODAY

Air Alive measures only 4 1/2" x 4" x 1 3/4" and puts out 3 trillion negative ions per second per cubic centimeter. That's as many or more than larger, more expensive units now on the market. It is so powerful that it cleans a 15' x 20' x 8' room in up to 15 minutes. Air Alive brings you more cleansing power in its compact size.

WARRANTED FOR TWO FULL YEARS

Air Alive is an all solid state unit ... it has no moving parts. The unit is so trouble free that it is warranted by Western Systems, Inc. for two full years, in the unlikely event that anything should go wrong.



FREE BOOK JUST FOR TRYING AIR ALIVE

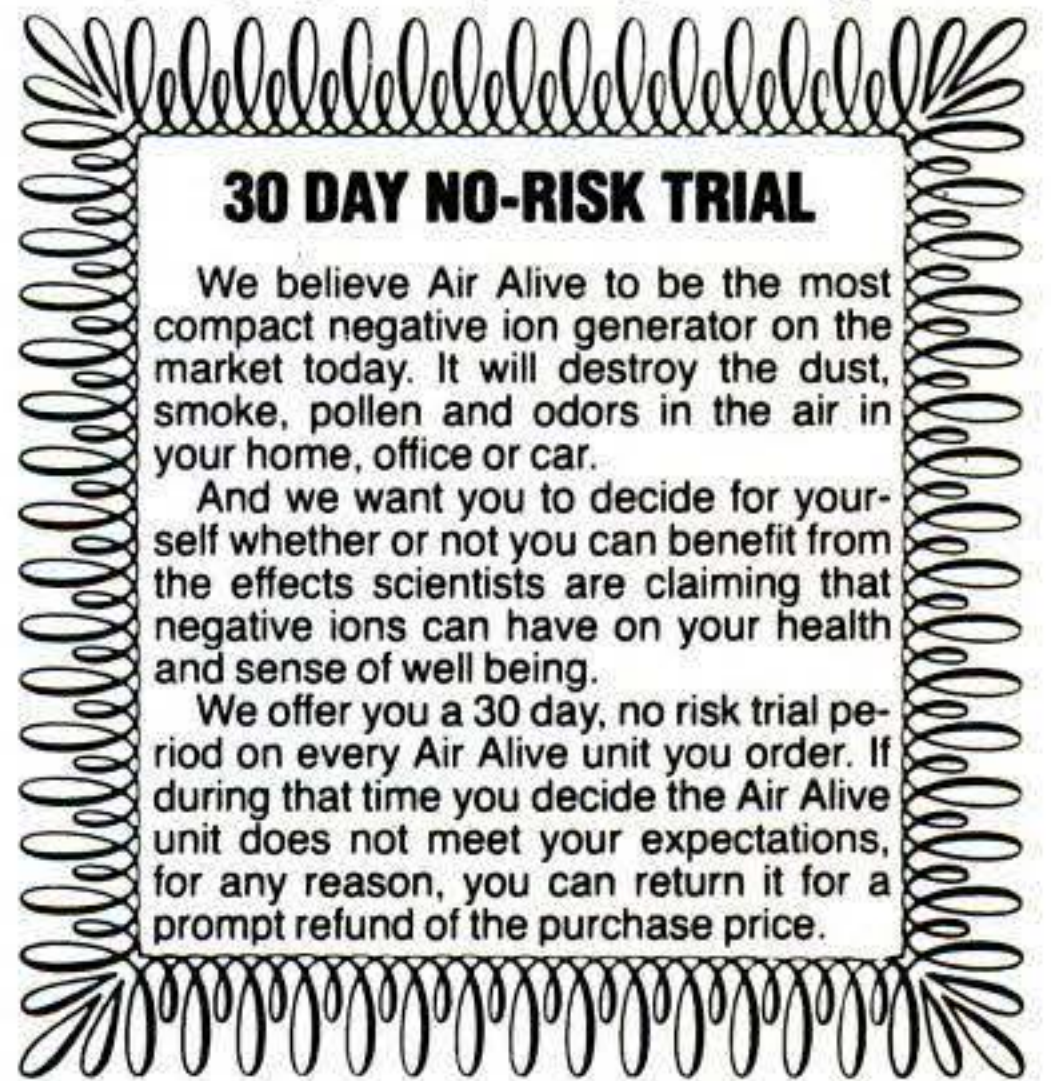
Just for trying the Air Alive unit, we are offering a 160 page book entitled "The Ion Effect".

Absolutely Free!

It is yours at no additional charge. It's yours to keep even if you should return the Air Alive unit during our 30 day trial period. "The Ion Effect" traces one man's 10 year effort to discover the truth about the effects of ions. Judge for yourself the benefits of negative ions.

OPTIONAL AUTO ADAPTER

Now Western Systems, Inc. brings something new to the American market that Europeans have used for years ... an optional auto adapter that allows you to use your Air Alive home model in your car, truck, van or RV. Hardware included for mounting under your dashboard and adapter plugs into your cigarette lighter.



30 DAY NO-RISK TRIAL

We believe Air Alive to be the most compact negative ion generator on the market today. It will destroy the dust, smoke, pollen and odors in the air in your home, office or car.

And we want you to decide for yourself whether or not you can benefit from the effects scientists are claiming that negative ions can have on your health and sense of well being.

We offer you a 30 day, no risk trial period on every Air Alive unit you order. If during that time you decide the Air Alive unit does not meet your expectations, for any reason, you can return it for a prompt refund of the purchase price.

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PS-1

Opel Kadett

— front-drive successor to Chevette?

By DAVID SCOTT

MAINZ, W. GERMANY

The probable front-drive successor to the present Chevette (due for replacement in 1982) should be a real Rabbit-chaser. That's my conclusion after testing the new, transverse-engine Opel made by GM in Germany. It's the likely replacement for the U.S. sub-compact. Kadett won't be sold in the U.S. as such, but it's a fair guess that it will ultimately be built and sold there as a Chevrolet by General Motors, Opel's parent company.

Opel describes the Kadett as a "big step into the future" and a second-generation "world car." The first car given that label was the Chevette, which was produced in various near-identical guises in seven countries, including the U.S. and Germany.

Opel's latest baby is cast in a hatchback mold like the Rabbit's, but has more generous passenger and luggage space because of a longer wheelbase and body. The Kadett layout is essentially a scaled-down edition of the GM X-cars, where the transverse drive-line gives maximum interior room for a given body length. Unlike the VW and present Chevy, there are six models, including two- and four-door hatchbacks, fastback sedans, and station wagons. The increased overall dimensions of Kadett (see table) give substantially more back-seat leg and hip room than the Chevy, despite the shorter body (which yields easier parking and maneuvering). The wagon provides a 64-inch cargo platform with the back seat folded, and a maximum cargo volume of 50 cubic feet. Vehicle weights range from 55 to 221 pounds lighter than the Chevette.

There are two engines for Europe, but the one more likely for U.S. use is the 1.3-liter, 75-hp cam-in-head unit with hydraulic tappets. It's very similar to the 1.6-liter power plant in the current Chevette, which, in fact, was designed in Germany by Opel.

I tested a 1.3-liter hatchback on a 110-mile trip near Mainz. In city traffic, it was surprisingly zippy, with



Spirited and easy to maneuver, says European Editor Scott of the 1.3-liter Kadett.

brisk getaway. Crisp shifting and a feather-light clutch encouraged the fullest sporty use of the gearbox. Ultra-light steering took the effort out of parking and K-type turnarounds on narrow roads.

Tough tests

On a long stretch of the unrestricted Autobahn, I startled a couple of Mercedes and BMW's by passing them at 85 mph, eventually winding up to an indicated 97 mph. Even at that speed, there was little wind noise or road

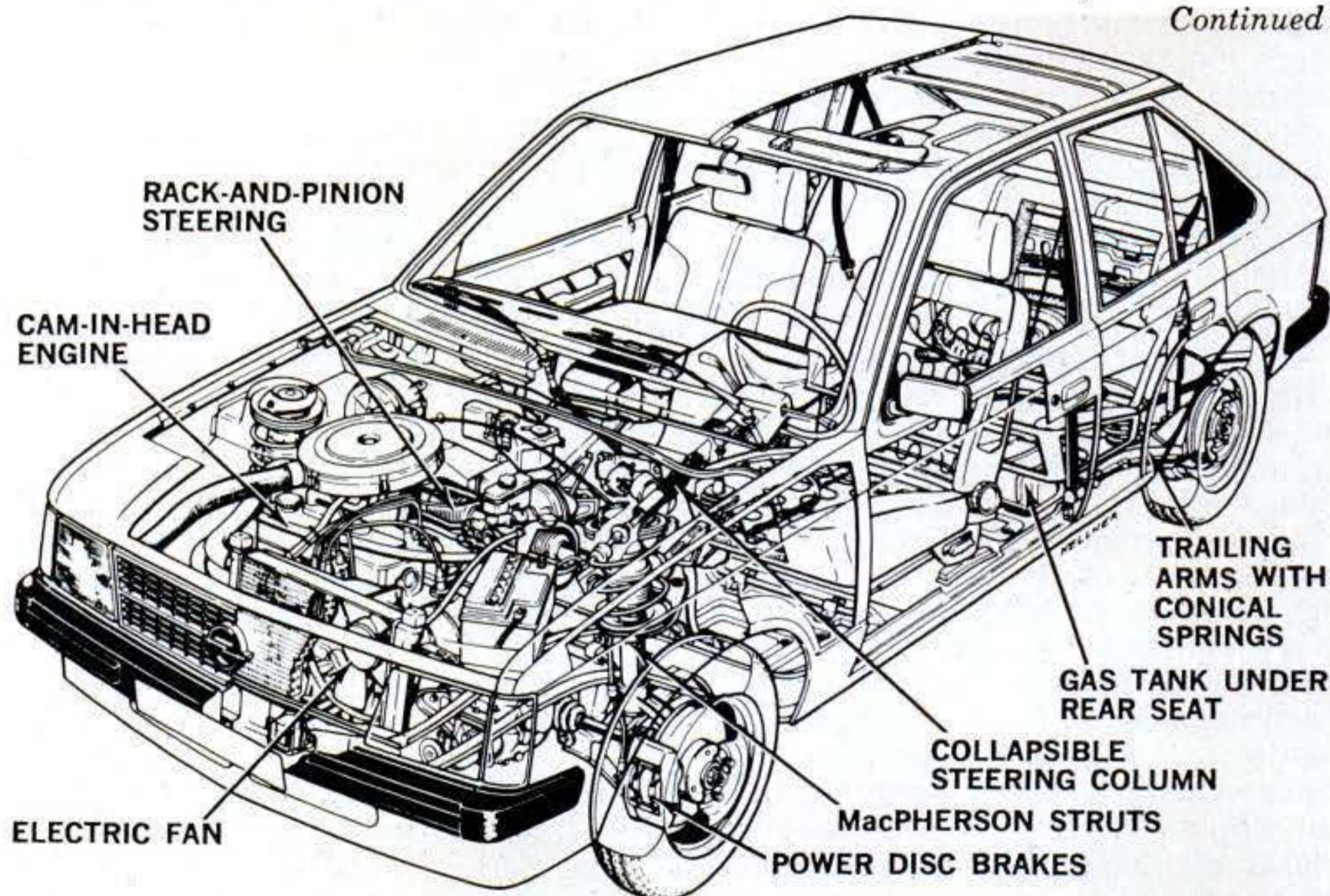
The nearly square headlights and clear protective covers are illegal here.

rumble, although there was plenty of thrash from the high-revving engine. Dropping back to a sedate, U.S.-style 55 mph, I heard no more than a muffled background hum.

On a twisty country road through the Taunus mountains, I charged around a few hairpin bends to check adhesion. While the tires squealed in agony, they didn't lose their grip, and there was only slight body roll. The suspension also showed that same stability during fast lane changes.

Acceleration to 60 mph took a com-

Continued



Cutaway of Kadett reveals many design similarities to GM X-bodies, especially in rear suspension, where a torsion beam and sway bar are built one inside the other. Conical rear springs reduce cargo-area intrusion.

How Kadett compares with Chevette and Rabbit

	Kadett four-door, hatchback, sedan	Chevette four-door	Rabbit four-door (European)
Wheelbase (in.)	99.0	97.3	94.5
Length (in.)	157.5	162.6	150.2
Width (in.)	64.5	61.8	63.4
Height (in.)	54.5	52.3	55.5
Track, front/rear (in.)	55.1/55.3	51.2/51.2	54.7/53.5
Luggage space (cu. ft.)	14.0	8.4	11.3
Base engine (liters/hp)	1.2/53	1.6/70	1.1/52
Optional engine (liters/hp)	1.3/75	1.6/74	1.5/70
Curb weight (lbs.)	1885	2106	1859

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

10 mg. "tar", 0.8 mg. nicotine av. per cigarette, FTC Report MAY '78.



This boy of mine's going to get my John Deere Chain Saw when he's grown. If he behaves himself.

My daddy. He got his ax about the same time old Eddie Dunk's barn burned down. Now that was an ax. It was my job to keep it all sharpened up.

Now when I turned 18, why, my daddy gave me all his bottom land, a handshake and that ax.

I remember the handshake. I still farm the bottom land. But the ax fell out of the pick-up on Route 7. Went back. Never found it. So I got this John Deere Chain Saw.

Truth is, I prefer it over that ax. Cuts easier. Doesn't get hung up. Even in dry oak.

I let the boy here keep it sharp. He takes it serious. Just like I used to with that ax. Oh, he doesn't know it yet, but he's sure to get that bottom land and the handshake.

And if he'll just stop baiting his sister Emily all the time, he'll get the chain saw, too.



Nothing Runs Like a Deere.®

For a free folder, write John Deere, Dept. 52, Moline, IL 61265

Opel Kadett

[Continued]

mendable 13.9 seconds, which matched Opel's claim. Fuel economy is claimed to be 24 mpg for a European urban-driving cycle, and 35.6 mpg at a steady 55 mph, although I had no chance to check this. The transverse gearbox has an overdrive fourth-gear ratio that boosts both fuel economy and top speed. There's no automatic yet, but a special one designed and built by GM in the U.S. (a big clue that Kadett will succeed Chevette) will soon be available.

Design features

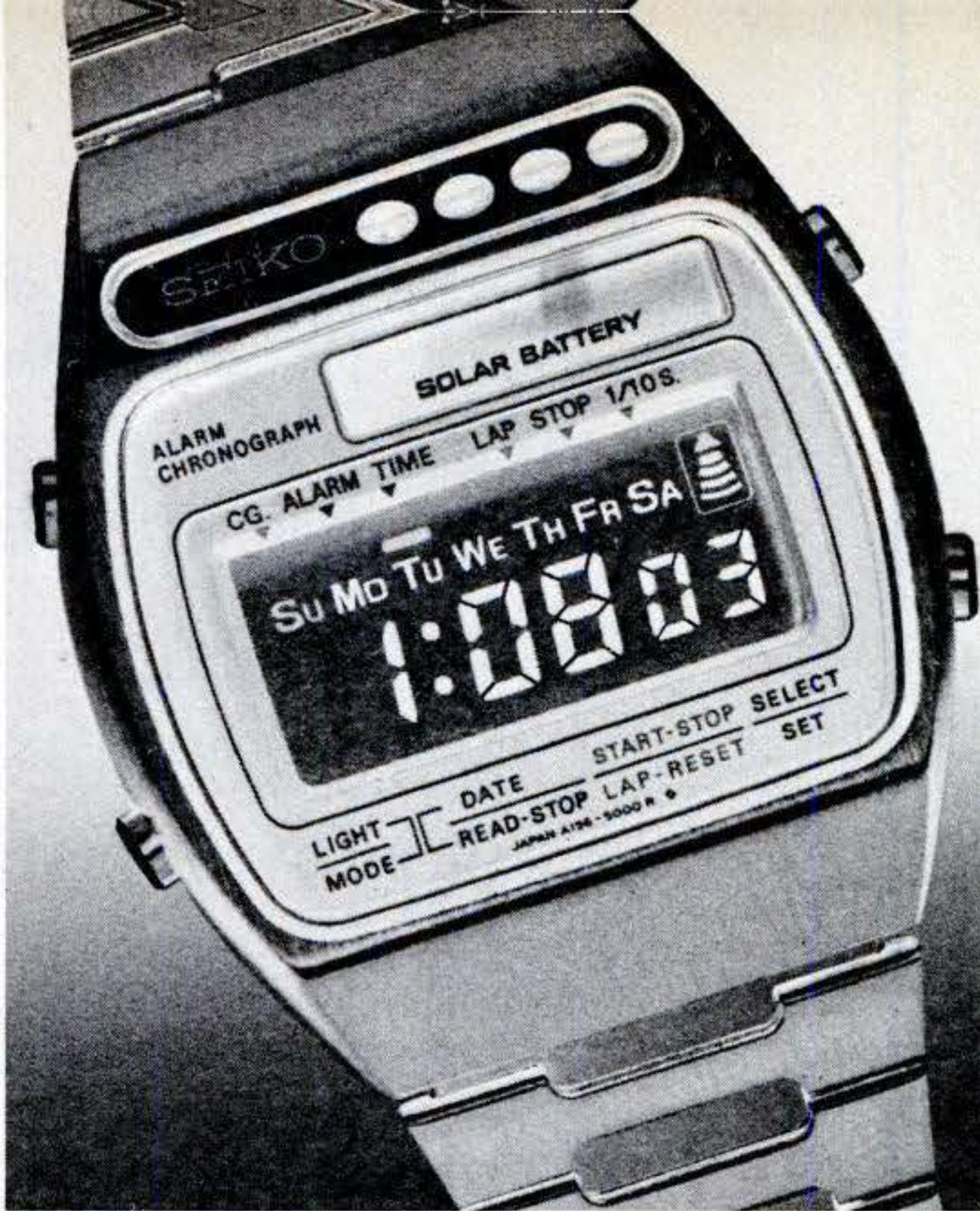
The MacPherson-strut front suspension uses "negative scrub radius" geometry so it won't pull to one side when a front tire is soft or flat. Rack-and-pinion steering is mounted high on the firewall for collision safety. Long, equal-length tie-rod arms connect it to steering arms high on the back of the struts.

The independent rear suspension has crank-type trailing arms joined by a flexible U-beam crossmember enclosing an anti-roll bar. (A similar crossmember-and-sway-bar arrangement is used on the X cars.) The rear springs are conical "mini-block" coils, shaped like bed springs. They can compress into a flat spiral at full wheel deflection, so suspension height can be lowered for less intrusion into luggage space. An extra-wide track adds to stability and ride comfort.

The body shape was developed in wind-tunnel tests, and is claimed to have a 15 percent lower coefficient of drag than the previous model. Passenger protection also got special attention. For instance, the 11-gallon gas tank is placed under the rear seat—well ahead of the rear axle, and well-protected from crash damage.

Routine maintenance on the Kadett should be simple. Spark plugs, dipstick, and distributor are all on the front or top of the engine, and easily accessible. Unlike most other cross-drive cars, the clutch can be changed without removing the engine and takes only about 65 minutes, Opel says.

Right now, Opel is mainly concerned with outclassing the Volkswagen Golf (European Rabbit), and company officials are pretty cagey about saying whether Kadett will replace Chevette—despite very strong rumors on both sides of the Atlantic. However, it seems mighty unlikely that GM could tolerate being upstaged by the Ford Erica, a smack-on rival due to replace the Pinto and Bobcat in America a year earlier, as a 1981 model. PS



provided by a prompt U.S. service-by-mail facility. About all you'll be giving up is the convenience of walk-in warranty repairs at Seiko service centers during the first year. Of course, repairs are rarely needed, ever. The solid state components never need service, and after twelve months, you can use any Seiko service facility.

Please order now.

This watch is so new most stores don't have it yet. And quite frankly, our supply is very limited. By ordering today, without obligation, you'll be

Imagine you've just flown into Japan's Tokyo Airport. You head for the Duty Free shop, hoping to pick up a Seiko alarm chronograph at substantial savings. Approaching the showcase, you realize the model shown is one you've never seen. It's the new Solar alarm chronograph, just released and not yet available in the States. And because the shop is duty free, the \$295 gold model is marked down to only \$220. The \$250 stainless model is only \$190.

THE NEW SOLAR SEIKO™ AT A DUTY FREE PRICE.

Smiling at your good fortune, you charge one to your credit card. It's a handsome, useful addition to your life. And at that price, an excellent investment.

Batteries never lasted this long.

It's got the latest solar cell battery, which gives you up to ten years of battery life. Even the nightlight battery gets up to 5 years without a change. The alarm is a handy wake-up or appointment reminder. The stopwatch times up to 12 hours to 1/10 second, and gives splits, 1-2 finishes, and time-outs. The day of the week is always displayed, and date and month appear on command. Unusually well finished in solid stainless steel case and band, it features a hard mineral glass face crystal. The distinctive front-

mounted speaker grills are a Seiko exclusive, making it immediately recognizable.

Stay home, and still save.

Rather than flying to Japan, pick up your phone and dial toll-free to The Sharper Image. You'll be able to order the new Seiko Solar (list \$295) at the same low price, only \$220 in gold, or \$190 in stainless. You'll save about \$75 either way. You can't get a better price, even at the shop in the Tokyo Airport. Not only will you save a tidy sum, you'll be among the first to own a timepiece that's guaranteed to start conversations.

One small snag.

Even at this low price, you'll get a full year of limited parts and labor warranty coverage. This coverage is

sure of receiving the newest Seiko at an unusually low price. If it's not everything you expected, you are welcome to send it back within 2 weeks of receipt for a prompt and courteous refund.



Get ten years from a battery. Save \$75 with a phone call.

But please order now to avoid disappointment.

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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.

	Ford Thunderbird	Chrysler Cordoba	Dodge Mirada	Pontiac Grand Prix	Chevrolet Monte Carlo
Fuel economy	2	2	2	2	2
Acceleration	5	4	3	4	5
Braking	3	3	0	3	4
Handling	4	2	4	2	3
Maneuverability	5	4	5	4	5
Ride comfort	3	4	4	4	4
Quietness	1	2	2	3	3
Roominess	4	4	4	4	4
Visibility	2	3	3	2	2
Entry/exit ease	4	3	3	4	4

By **JIM DUNNE** and **ED JACOBS**
PHOTOGRAPHS BY GREG SHARKO

This year things are going to be even livelier than last year in the already popular personal-luxury-car field. This specialty class has gotten a heavy dose of engineering for 1980. There are a number of fresh, resized body styles, big weight reductions and

fuel-economy improvements, significant new power-train developments and options, plus some clever electronic innovations. All of this promises to stir up intense competition among the personal-luxury cars, five of which we've checked out for this month's report.

Ford's Thunderbird has a new body
Continued

Redesigned for 1980 (clockwise from front): Chevy Monte Carlo, Dodge Mirada, Ford T-Bird, Chrysler Cordoba, Pontiac Grand Prix.



What will you do with your \$700,000?

Millions of people will "blow" the \$700,000 they'll earn. Will you?

IF A MAN or woman averages just \$15,000 a year, he or she will make about \$700,000 during the usual 45 years of employment. And, at average earnings of a little over \$20,000 a year, the total earning figure is an incredible one *million* dollars!

Yet, U.S. Dept. of Commerce figures show that millions of people end up with an income of only a few hundred dollars a month after they've retired—and that includes their monthly income from Social Security!

A few hundred dollars a month! That's hardly enough money to enjoy all the good times we promise ourselves after we stop working. In fact, at today's prices, it's barely enough to survive on.

Why do most folks end up with so little money to show for nearly a half-century of work? Usually, it's because they didn't bother to take care of themselves first! They pay the butcher and the baker and the gas station owner and the banker—and never seem to have money left over to provide for their own future happiness and security.

Yet, many experts have noted that people who have a definite "plan of action" for retirement—an absorbing hobby or sport, travel, etc.—seem to enjoy better health and longevity compared to those who are forced to sit around bored, lonely and frustrated because they don't have the money to travel, to enjoy hobbies, to entertain friends, to be "on the go."

Is it too late to start doing something about this? Not at all! In fact by paying yourself *first* with what can amount to small change, you can assure yourself a good added monthly income that you can never outlive, no



matter how old you become—or that can even help you retire early if you want to.

Now you can send for an informative free "Money Book" by return mail, that tells how simple it can be to use the assured monthly income benefits of cash-value life insurance protection to help provide yourself the added money you'll need and want for your future pleasure and security—over

and above what you collect from Social Security!

For your free copy of the "Money Book", simply mail the postage-free card next to this page. It will be mailed to your home by Bankers Life and Casualty Co. of Chicago, which now protects millions of people coast to coast. There's no cost or obligation for this important service.

NY, NJ, and CA residents, see card.

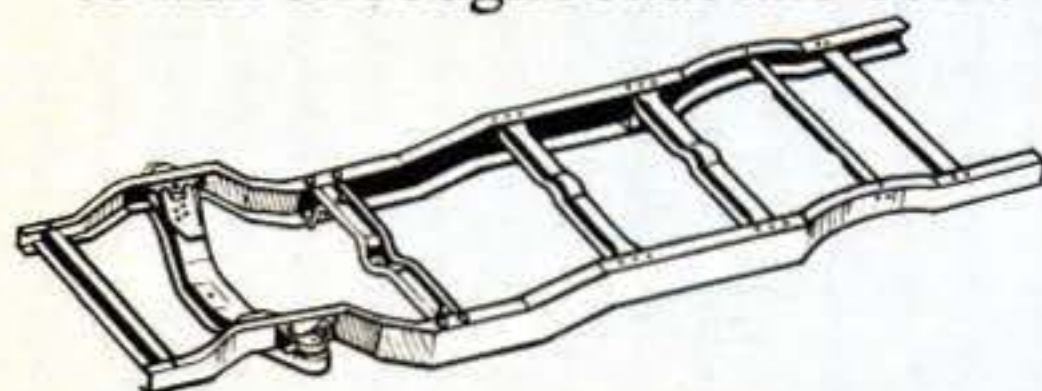
RAM TOUGH

FOR 1980, DODGE PICKUPS

Ram Tough means carbon steel frames with 7 crossmembers.

More than Ford or Chevy.

Our frames are tough enough to flex on rough roads and come



The Ram Tough Dodge frame: 7 carbon-steel crossmembers. More than Ford or Chevy.

back for more. We use 7 carbon steel crossmembers for extra lateral, vertical and torsional strength. Compare that to Ford's 6 and Chevy's 5.

Ram Tough means galvanized steel for critical area rust protection.

More than Ford or Chevy.

Every 8-ft. Sweptline Dodge Pickup has 160 sq. ft. of galvanized steel—plus lavish amounts of zinc-rich primers, vinyl sealers and road-tough

enamel. And unlike Ford or Chevy, we *weld* our Sweptline boxes to cross sill brackets. Result? No rust-prone bolt holes.

Ram Tough means bigger maximum payloads.

More than Ford or Chevy.

By design, Dodge Pickups have low curb weight and high Gross Vehicle Weight. That means more useful load-carrying capabilities than Ford or Chevy.

What's more, Dodge 8-foot boxes have more load *area* than Ford or Chevy, to carry bulkier cargo.

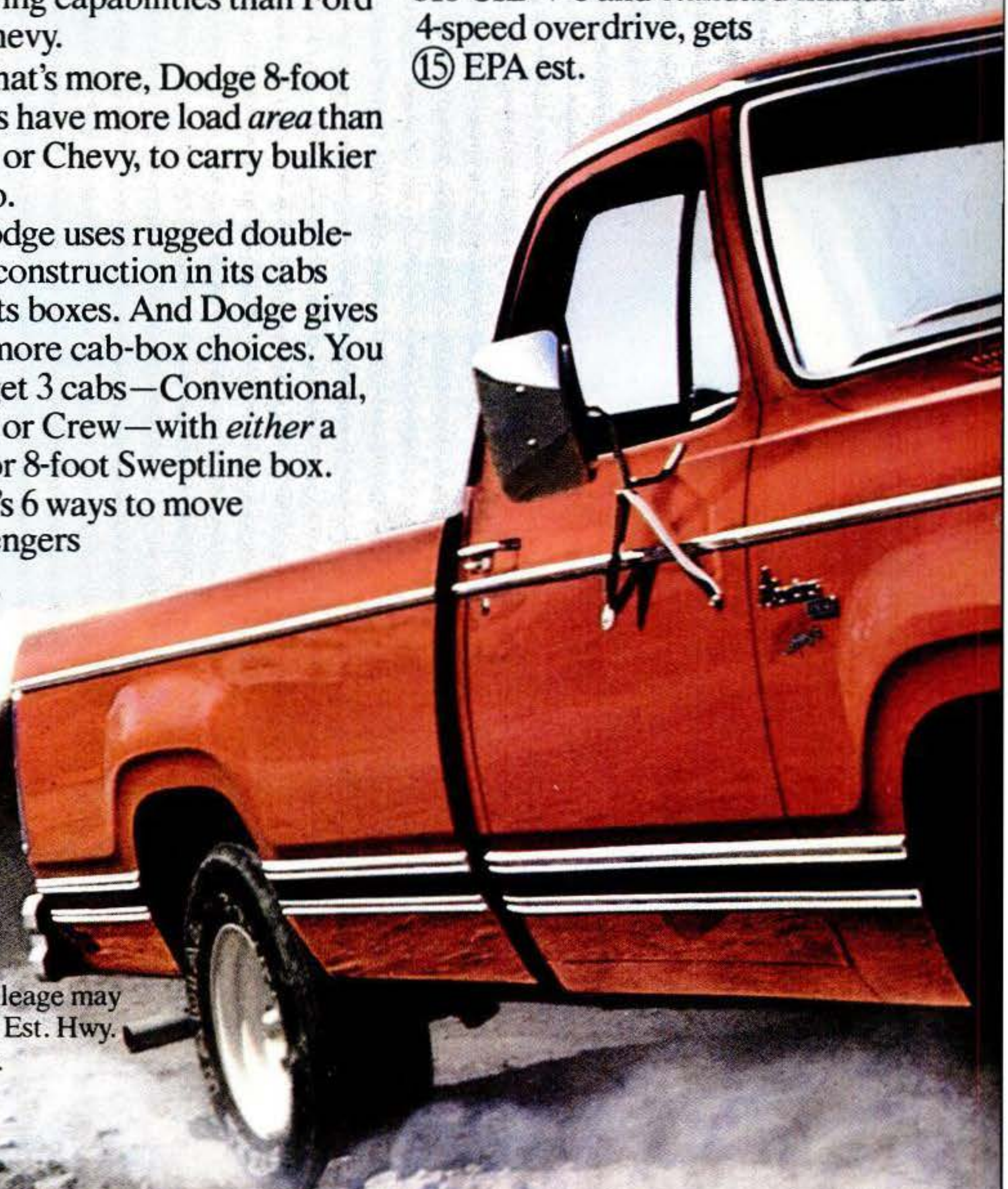
Dodge uses rugged double-wall construction in its cabs *and* its boxes. And Dodge gives you more cab-box choices. You can get 3 cabs—Conventional, Club or Crew—with *either* a 6½- or 8-foot Sweptline box. That's 6 ways to move passengers



The Ram Tough Dodge payload payoff: up to 5575 lbs. max. payload. More than Ford or Chevy.

and cargo. Ford and Chevy only give you 4 each.

Even with these advantages, Dodge Pickups have competitive mileage ratings. The D 150, with 318 CID V-8 and standard manual 4-speed overdrive, gets 15 EPA est.



*Use EPA mpg number for comparisons. Your mileage may vary depending on speed, distance and weather. Est. Hwy. will probably be less. California estimates lower.

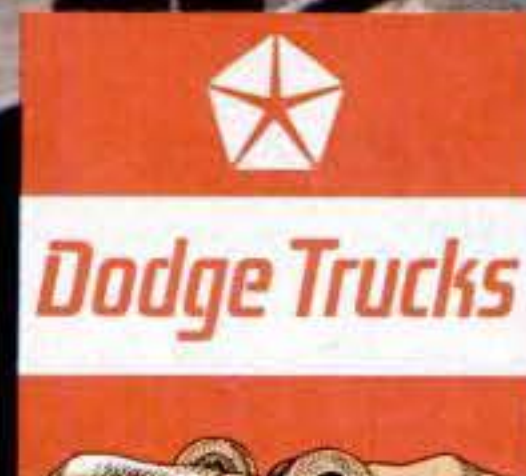
WHY DODGE

GO BEYOND "TOUGH."

mpg; 22 est. Hwy. mpg*

If you want automatic, only Dodge has a proven 3-speed with lock-up torque converter that's remarkably fuel-efficient at highway speeds.

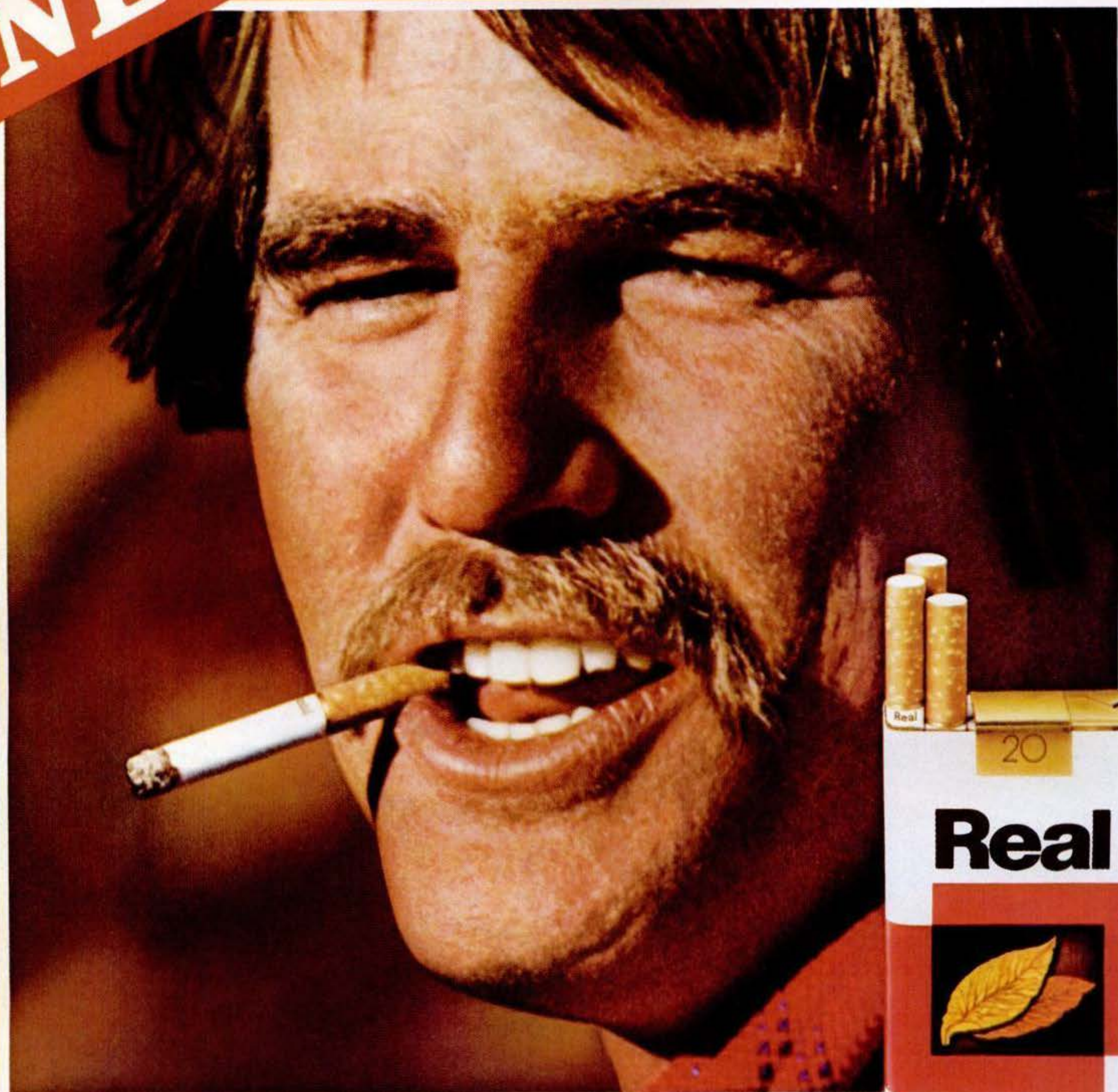
The 1980 Dodge Pickups. Engineered by Chrysler to go beyond what others call "tough." Engineered to be Ram Tough.



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

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



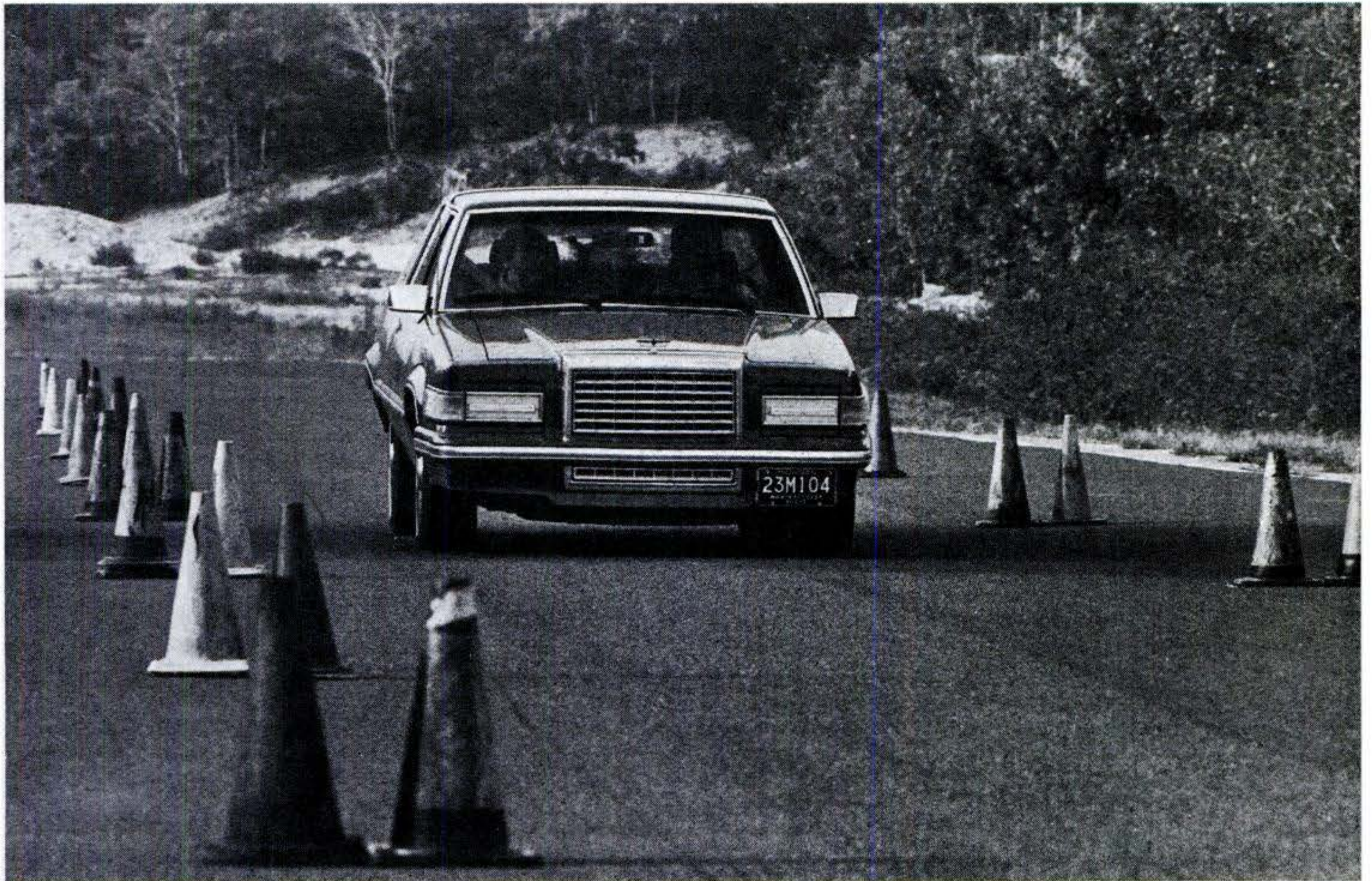
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Richer...mellower than before"***

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

The smoking man's low tar

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Thunderbird's 60-mph panic stops were perfectly straight, with no brake lockup, but it was second best in cold and hot stops.

(shared with Cougar XR-7) and the company's optional, trend-setting four-speed automatic overdrive transmission, plus electronic and graphic-display innovations. The Chrysler Cordoba and Dodge Mirada (a new name for the Magnum) also have a new body and a performance-improving, optional automatic transmission—this one a wide-ratio three-speed. General Motors has added a turbocharged V6 to the Chevrolet Monte Carlo and refined the popular Pontiac Grand Prix.

Thunderbird

You can't miss the smaller size. The new Thunderbird is 15 inches shorter, and almost 900 pounds lighter. Inside, however, passenger room is better than in the 1979 model. The biggest difference is 3.8 inches more rear-seat legroom.

Despite those added inches, the 1980 Thunderbird somehow feels slightly smaller inside. The front seat seems cramped, due to the extra-wide transmission tunnel, low head clearance, and the closer position of the windshield. The rear seat, however, is more spacious than in the 1979 version.

Ford's innovative four-speed automatic transmission lived up to all of its performance claims. In fact, with

the 302 V8, it made the Thunderbird the quickest of the five cars tested. The overdrive gear dropped smoothly into place during our track testing, but on extended highway driving, that was not always the case; and while the smooth-road handling was reasonably good, our test car's rough-road manners were less than perfect. There's more detail about the handling problem in the 5000-mile test report (elsewhere in this issue), but a brief sketch is in order here, as well.

Despite the special TRX handling package, the front suspension was so soft that the nose easily bottomed on bumps, as well as doing a lot of bobbing and weaving. Compounding matters, the stiff rear suspension would dance on washboard and occasionally try to lead.

A digital speedometer in the optional electronic-display instrument panel on our test T-Bird is probably the forerunner of future developments. The digits are large, bright, easy to read at a glance, and very easy to get used to. The novel graphic fuel gauge uses horizontal vacuum-fluorescent bars to indicate the fuel supply. It, too, is interesting and easy to read.

The pushbutton combination lock on the door is simple, seems dependable, and is a big convenience. It eliminates the bother of pulling a key from

your pocket or handbag when you're loaded down or in a hurry.

The Thunderbird is no longer the sort of car old-time T-Bird buyers are accustomed to. Fuel economy, smooth-road handling, and ease of driving have been improved. Overall, however, the car doesn't handle as it should, and isn't as quiet as its predecessors. We think a better job could have been done in both areas.

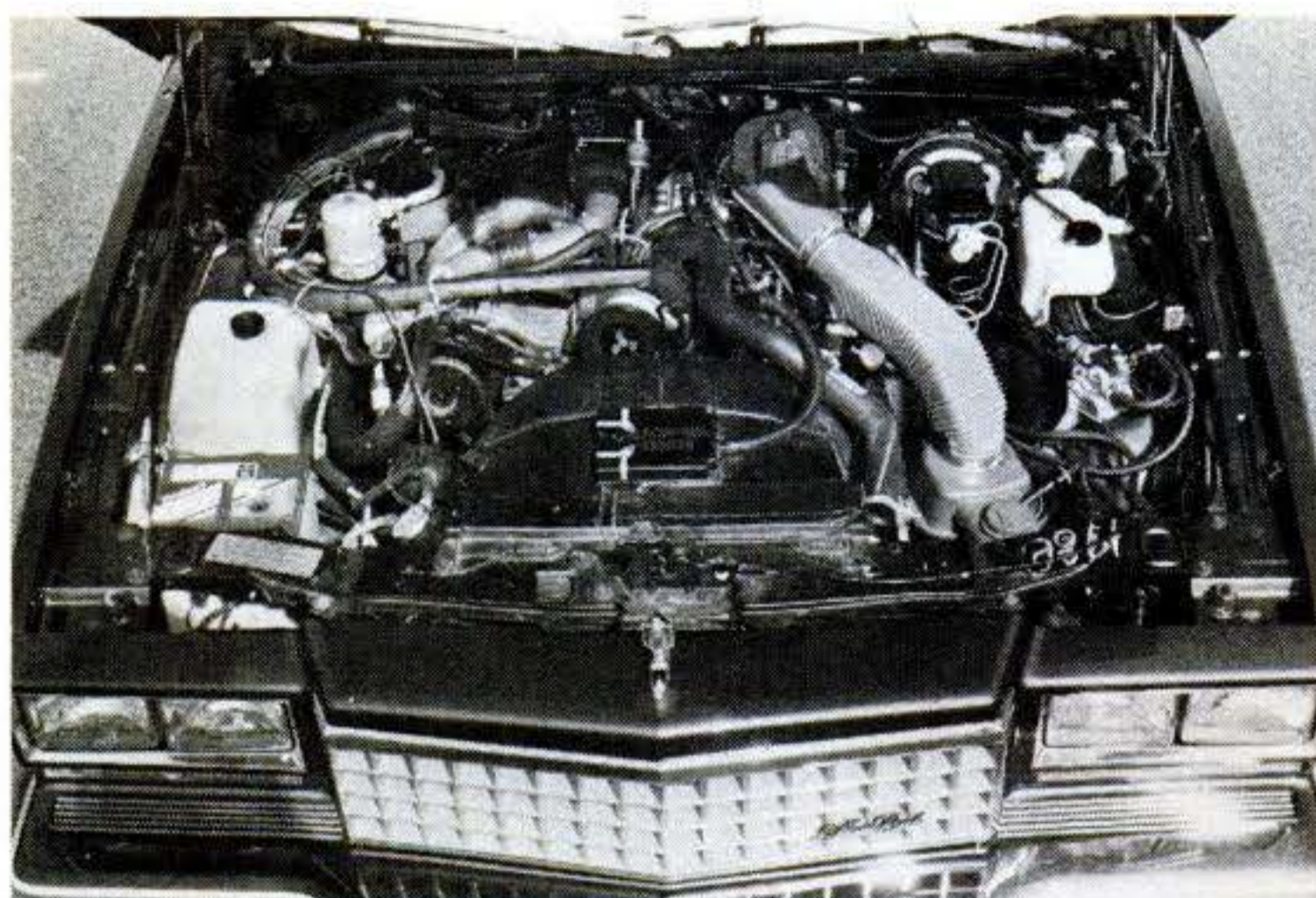
Chrysler Cordoba

Chrysler has changed the 1980 Cordoba in many of the same ways Ford revised the Thunderbird. It's smaller, slightly more fuel efficient, and easier to maneuver. But, like the Thunderbird, ride smoothness and interior noise are not as good as before.

This car appears new inside and out, but the basic chassis is the same one used by the Chrysler LeBaron/Dodge Diplomat last year. The drive train is also a duplicate.

Our car had Chrysler's workhorse 225-cu.-in. Slant Six, the firm's top-economy power plant. It was coupled to the new wide-ratio automatic transmission, which is intended to make the six perform like a V8 around town, while giving six-cylinder economy on the highway. It does this fairly well. The combination is rated two

Continued



Underhood nightmare of plumbing, belts, and accessories confronts the do-it-yourselfer working on a turbo Monte Carlo.



Unusual stagger of inside, outside door edges narrows rear-seat access on Cordoba (shown) and Mirada.

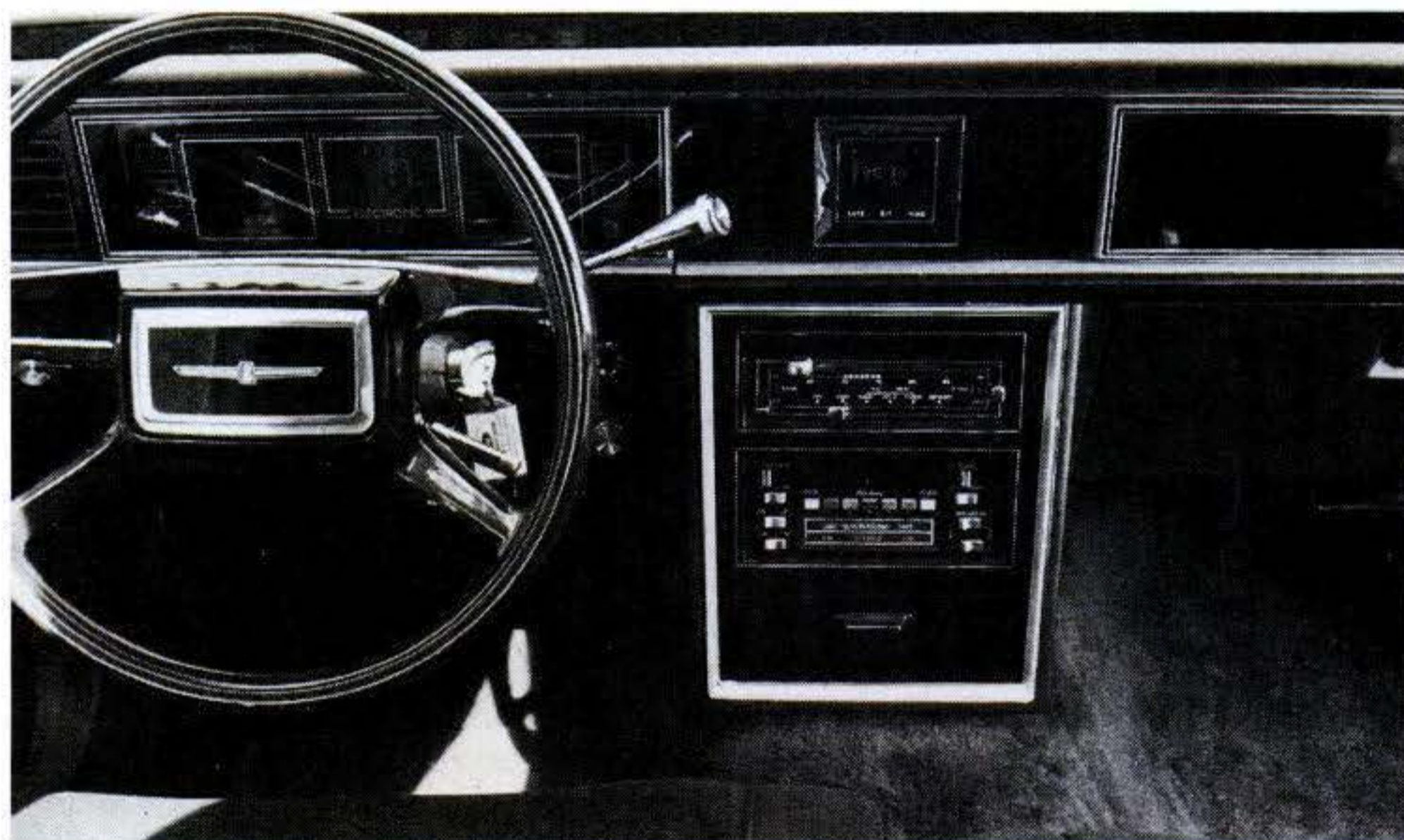


Mirada's electronically tuned radio proved easy to use, but speakers made dash vibrate, ruining sound quality.

mpg better than the 318-cu.-in. V8 with the conventional three-speed automatic. For that increase, you get slightly less performance, with a little more noise. The six is a more-than-adequate engine for most driving needs, though.

The shape of the dash adversely affects the legibility of the instruments. Speedometer and gauges are deeply recessed and, in some lighting conditions, are difficult to read at a glance. Two other complaints: The smooth-faced controls on the lower end of the dash reflect light and make labels difficult to read. Second, the side-hinged hood-release lever appears ill-fitting and fragile, and proved cantankerous on both Chrysler products.

On the plus side, both of the Chrysler cars have large expanses of glass in the greenhouse area, giving good visibility all around. In that respect, they are vastly superior to the T-Bird, which has only small opera windows



Pronounced reflections of steering column and front seat are visible in Thunderbird's glossy instrument panel and dash.

in the massive rear pillar, severely restricting visibility to the rear quarters.

Cordoba's fresh-looking exterior and spacious interior blend into a pleasant, airy design. Although the new car isn't quite as luxurious as its predecessors, it's still a nice package.

Dodge Mirada

Dodge's twin for Cordoba is the Mirada, successor to the Magnum. Mirada shares most of the advantages and disadvantages of its Chrysler sister. Instead of a luxury car, Dodge sells Mirada as a sporty model. Its sloped, slotted nose and better aerodynamics should soon be seen in competition on stock-car superspeedways.

The prime difference between the Mirada and Cordoba we tested was the 318 V8 in the Mirada, which made it a bit faster from zero-60 mph, but there were few other differences that you'd notice. The two-mpg fuel-economy penalty of the V8 for both city and

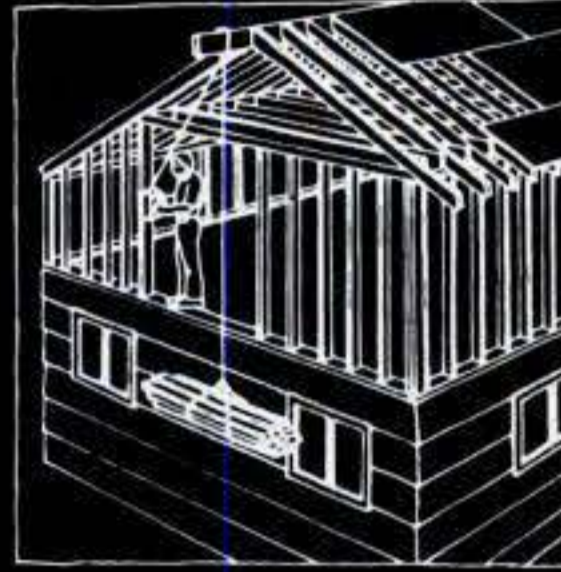
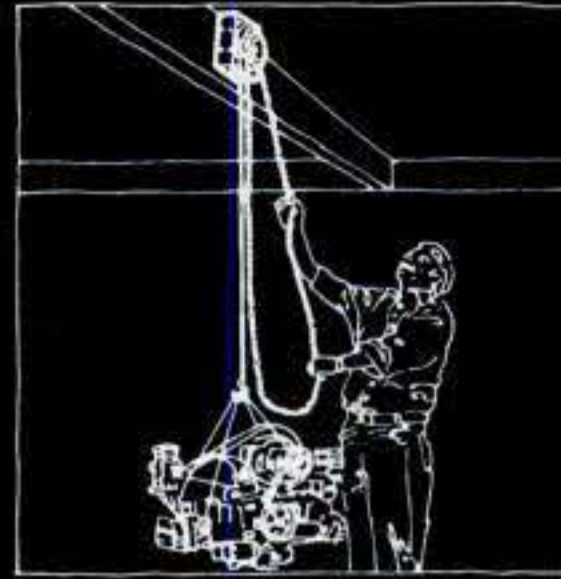
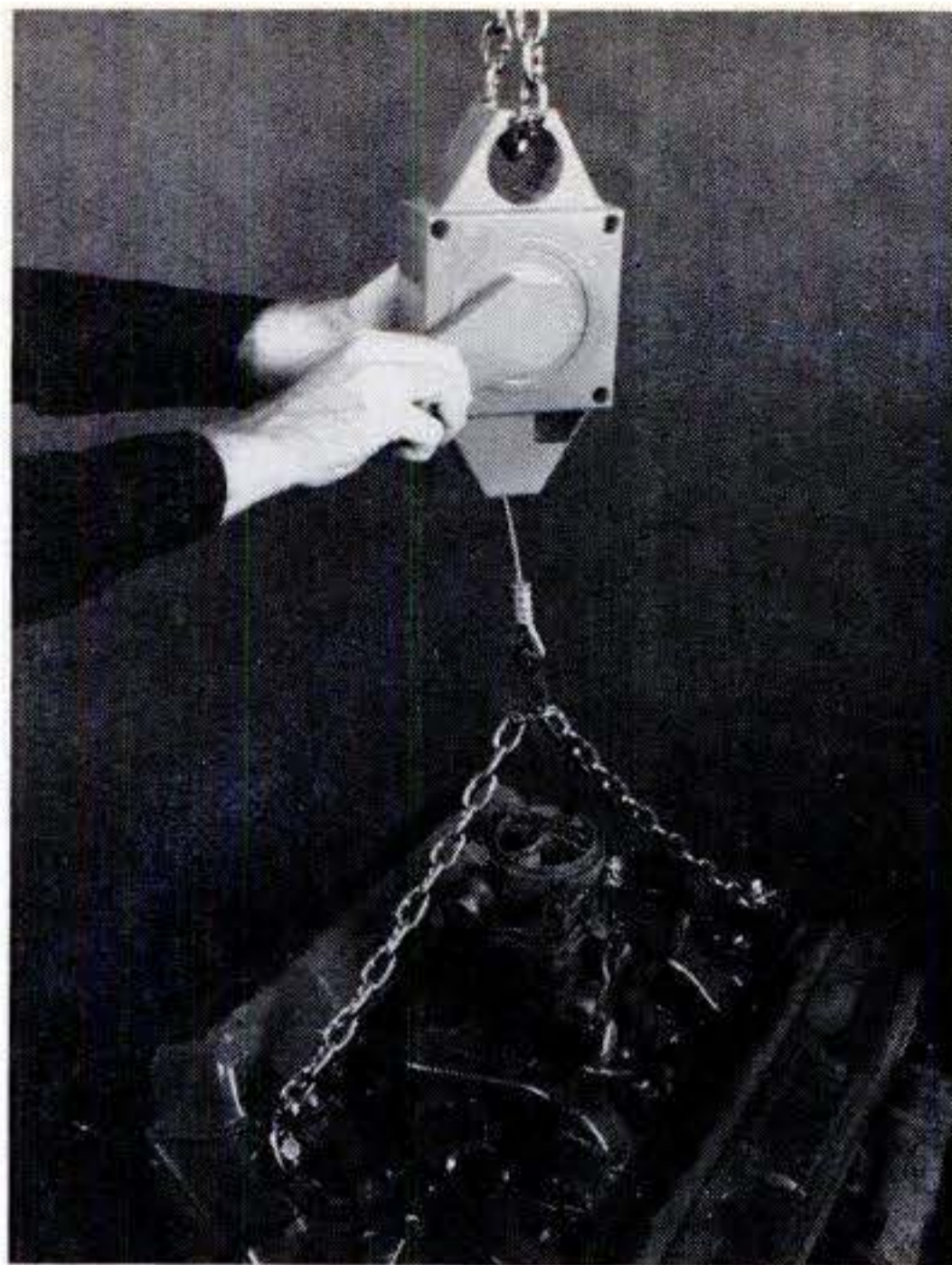
highway driving could be the deciding factor in favor of the six.

The two cars showed striking differences during our brake testing. From 60 mph, the Cordoba stopped in 150 feet with hot brakes, whereas the Mirada traveled 230 feet. Aside from the nearly negligible engine-weight variation, the only difference between the two cars was in the tires. Apparently it was substantial.

While Mirada's rakish plastic nose section may catch your eye, what you can't see is that there is no metal bumper behind it, as there is behind everyone else's. Instead, a big plastic-foam "bun" absorbs impacts, and seems to do so very well. When the Mirada gently "kissed" the Thunderbird at a peculiarly shaped intersection, the driver of the Mirada felt nothing, while the driver of the Thunderbird was clearly aware of the contact. Since the all-plastic front end will undoubtedly become common in the near future, our unofficial little "test" would seem to indicate it's a good idea.

Pontiac Grand Prix

The tamest version of Pontiac's per-



Gear breakthrough replaces ratchet catches.

Use it as a winch.

Use it as a hoist.

Use it with your electric drill or socket wrench.

With the Universal Mount, one winch does the job of many.

Automatic two-speed transmission.

Totally rustproof.

Saves time and money.

The Easy Tugger™ Load Handler

Up to the minute technology, Down to earth dependability for \$29.50

With an Easy Tugger™ handling any heavy load is no more trouble than rolling your car window up or down. The safety, convenience, and low price of the Easy Tugger™ is made possible by a revolutionary new breakthrough in gears and power transmission protected by a variety of U.S. and international patents including U. S. Patent No. 3,895,540. This new technology puts the old-fashioned winch and hoist in a class with the dinosaur—clumsy, unsafe, heavy, out-of-date.

Safest

Easy Tuggers™ are much safer than ordinary winches and hoists. A case protects fingers and knuckles. A replaceable shear ring prevents accidental lifting of oversize loads that might break the cable. There is at least a 400% over-design on all parts. And our **Load Handling Handbook**, included free with each Easy Tugger™, will make you a pro at pulling and lifting.

Strongest

Tool Master's Easy Tugger™ has the highest strength-to-weight ratio of any winch. The Easy Tugger™ body is designed to take an 8,000 pound load, and its cable has a safety factor of four times its advertised rating, and it has a totally rustproof case and drive unit.

Saves You Money

The Easy Tugger™ costs less and does more than the old-fashioned winch or hoist. Use an Easy Tugger™ to help on those jobs which would ordinarily require expensive extra labor, or a serviceman, jobs like repairing your own car or moving things around the house. Carry one next to your spare tire to pull your car out of a ditch or to use as an emergency tow cable. The Universal Mount, available separately, allows one Easy Tugger™ to be moved easily and quickly from one job to another.

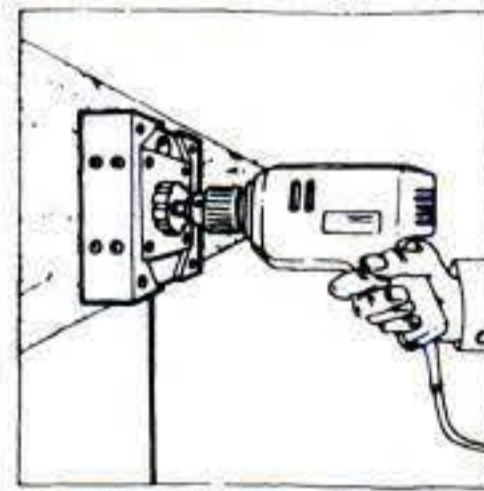
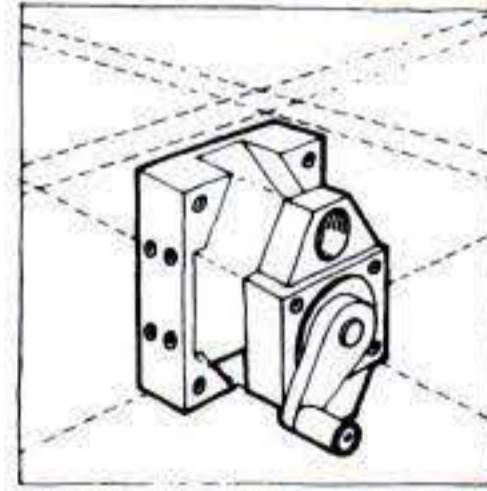
The Easiest to Use

The hand cranked Easy Tugger™ can be driven by an electric drill or socket wrench and will adapt to virtually any load handling problem. The cable automatically locks in

position with no ratchet catches. The Easy Tugger™ has an automatic two-speed transmission which gives maximum efficiency in handling light or heavy loads. You never waste time winding in the cable and the Easy Tugger™ is instantly ready to lift a heavy load.

Use it Everywhere

The Easy Tugger™ can be mounted vertically or horizontally, on just about anything; it can be attached with bolts, a chain, a hook, rope, stake, or trailer hitch. This load handler is a boat winch, a utility winch, a chain hoist, a ratchet hoist, a load binder, all in one. You can take the motor out of your car with the same Easy Tugger™ you use on your boat trailer.



If you use tools, you need the Easy Tugger™. The Easy Tuggers™ come in five models for every application—hand powered in ½ and 1 ton models, 1 ton "endless chain" powered, and 1½ ton 110V AC electric "Home and Shop Model," and 1½ ton 12V DC electric "Outdoor Recreation Model." Many optional features are available, including the Universal Mounting bracket; 70 ft., ⅛ inch, 2000 lb.-breaking-strength cable; drill adapters; "endless chain" kit and more. Even if you already own a winch, you should order a copy of our **Load Handling Handbook**, for \$3.50 just to find new ways to use it.

No Risk Guarantee

Too good to be true? Try an Easy Tugger™ for thirty days without obligation. If you're not satisfied, just return it and your money will be refunded.

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_____ ½ ton Hand Powered Easy Tuggers™ with 12' cable @ \$29.50 _____

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_____ 1 ton Deluxe "Endless Chain" Easy Tuggers™ with 30' cable @ \$54.50 _____

_____ 1½ ton 12V DC Electric Easy Tuggers™ @ \$99.50 _____

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Shipping and handling
Add \$2.50 for each Easy Tugger™ _____

_____ Universal Mounts @ \$5.00 each _____

_____ Load Handling Handbook @ \$3.50 _____

Colorado residents add 3% sales tax _____

Total Price _____

EPA fuel mileage (mpg)

	Ford Thunderbird	Chrysler Cordoba	Dodge Mirada	Pontiac Grand Prix	Chevrolet Monte Carlo
Highway	29	25	23	27	25
City	17	17	15	20	18
Calif. city	17	16*	16*	15	15**

*318 V8 4-bbl., only engine for California
 **305 V8, only engine for California

sonal-luxury car comes with the 231-cu.-in. V6 engine supplied by Buick. The V6 may not be the best size for the Grand Prix, but it provides marginally good performance—15.7 seconds for zero–60 mph. It's also quiet and smooth running, for the most part.

The 1980 model isn't the Grand Prix of pre-1978 years, but it's a standout nonetheless, due to careful selection of trim materials and attention to detail.

The instrument panel of the GP is the most imposing of all, though its needle-type gauges may appear slightly dated in comparison to the electronic readouts found on the Thunderbird. It's far better, however, to have the older-looking needle-type gauges than the "idiot" lights found on most cars.

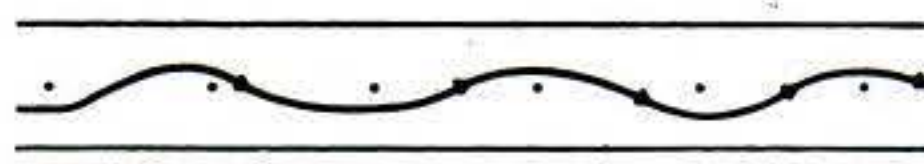
Pontiac knows what the personal-luxury car is all about, and continues to impress us with its high-quality interiors. The LJ option on Grand Prix, for example, includes pillow-styled leather seats and a separate instrument panel with six gauges, plus a console with a large storage bin that completes the look of luxury inside.

The rear seat is comfortable, with visibility that is among the best in the personal-luxury class. The attractive metal pull handles on the doors, however, are a mistake. Those hard, unyielding surfaces sticking out of the door panels look hazardous to us.

Monte Carlo

Chevrolet has added the turbocharged Buick 231-cu.-in. V6 to the Monte Carlo this year. Although it's a performance engine (the turbo boosts power to the level of a V8), it gives almost the same fuel economy as the base V6. Our zero–60-mph acceleration tests showed the turbo Monte Carlo a full three seconds faster than its Pontiac twin, the Grand Prix—a similar car equipped with a non-turbo V6. The engine, however, is shoe-horned under the Monte Carlo's hood, making servicing—especially the right-side spark plugs—all but impossible without special tools.

Except for the front end, which now has dual rectangular headlights, the exterior and interior of the 1980 mod-



Grand Prix negotiates slalom course. With smallest front antisway bar, and none in the rear, its handling and maneuverability weren't quite up to others'.

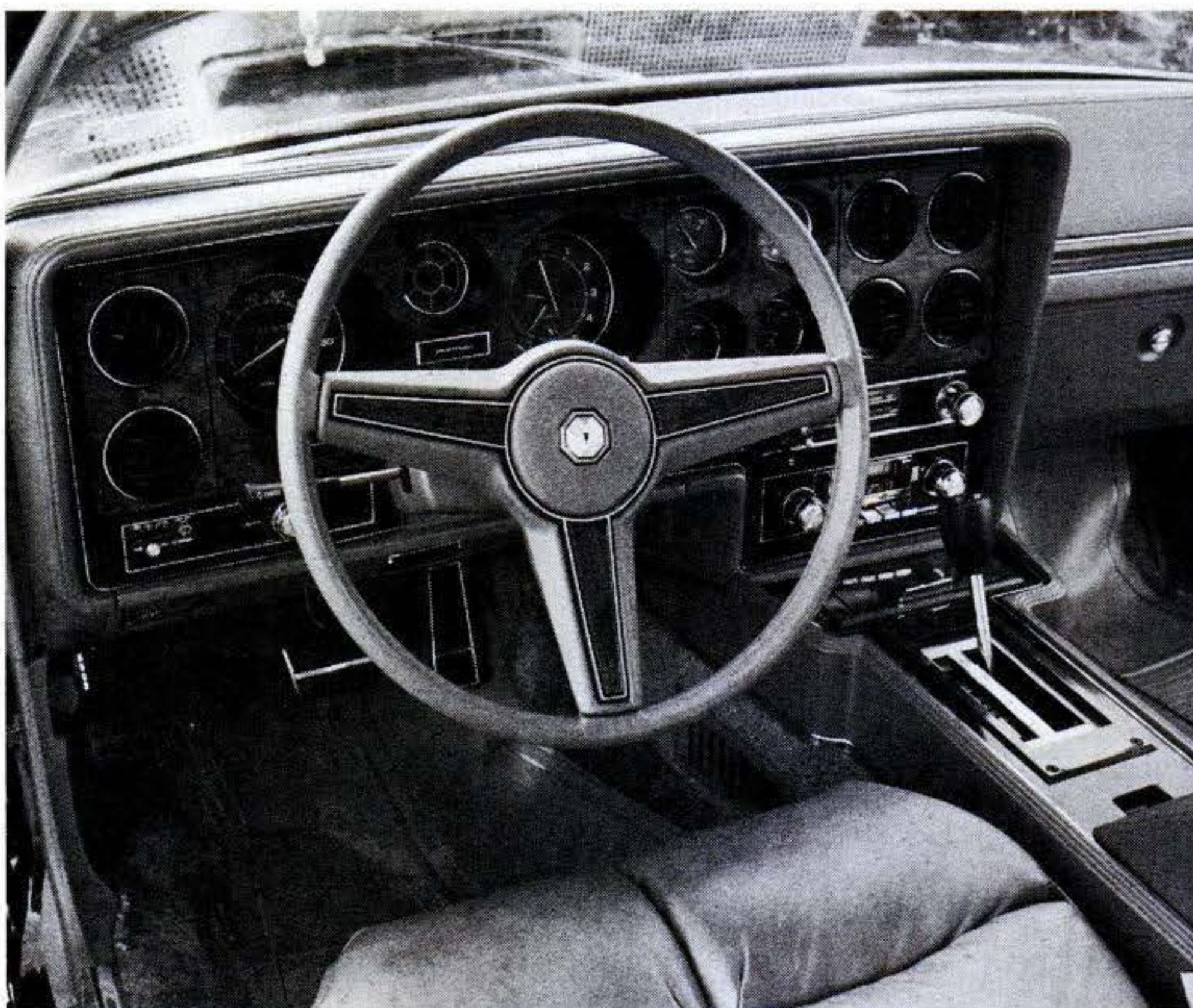
el are reruns of the '79. Only the TURBO legend on the instrument panel and hood bulge separate this model from the standard Monte Carlo.

The engine is improved over the Buick turbos we've tested recently. Only a trace of knock was heard, and then only at full throttle. Also, the whistling sound of the turbo is gone, so it's a real challenge to tell the difference between this engine and a V8 without first looking under the hood.

Although their designs are begin-

ning to look a bit dated, this is a year of refinement for Monte Carlo and Grand Prix, so most of the improvements are small. The cars are, however, the quietest riding, and evidently the most carefully assembled, in this group. They're more like the personal-luxury models of the past than the newly designed cars from Ford and Chrysler, which seem to have lost some of their luxury, quietness, and sparkle—not forever, we trust. **PS**

For specs and tests results, turn page



Grand Prix LJ's instrument panel contains several useful gauges. Unfortunately,

they aren't aimed at the driver, making them less than convenient to read.

Read this Ad next time you're drowsy and dragged out at three in the afternoon.

More and more research shows ion-deficient air is a major cause of drowsiness

That invigorating feeling you get from a walk in the mountains is the work of electrically charged air particles called negative ions.

Negative ions are nature's air cleaners, removing polluted particles from the atmosphere.

In the city - and in offices, homes and cars, the natural negative/positive ion balance breaks down, leaving you with far too many energy-sapping positive ions to breathe.

The resulting drowsiness causes reduced productivity in your home or office. And, in your car, where ion deficiency is even greater, it is not exaggerating to say that the atmosphere can be downright dangerous.

How ion deficiency affects you

While we don't yet know all we want to about the effects of ions, we do know this much.

Air conditioning, central heating and pollution strip beneficial negative ions from the atmosphere. This helps to explain why so many office workers and housewives complain of the blahs in mid afternoon. Breathing bad air is bad news.

The same thing applies to your car. Only more so. Compare your car's ion balance (about 80 to 100 negative ions per cubic centimeter) to that of fresh mountain air (1,000 to 5,000 negative ions per cubic centimeter.)

No wonder drivers become sluggish and irritable. This atmosphere is not only unhealthy. It's dangerous. Especially when you consider that ion-deficient air slows reflexes by as much as 20%.

More negative ions mean more energy and alertness

Wherever ionizers have been tried, they have changed things for the better.

People have reported greater energy, better health and increased productivity.

An ionizer replaces the negative ions killed by metals, man-made materials, air conditioning and central heating. It restores the natural balance of the air, making it fresh and easy to breathe. At the same time, an ionizer radically reduces airborne dust, pollution, bacteria and pollen. And almost completely eliminates stale odors like tobacco smoke. Naturally.

You feel better and more alert. So think what it can do for you if you have allergies.

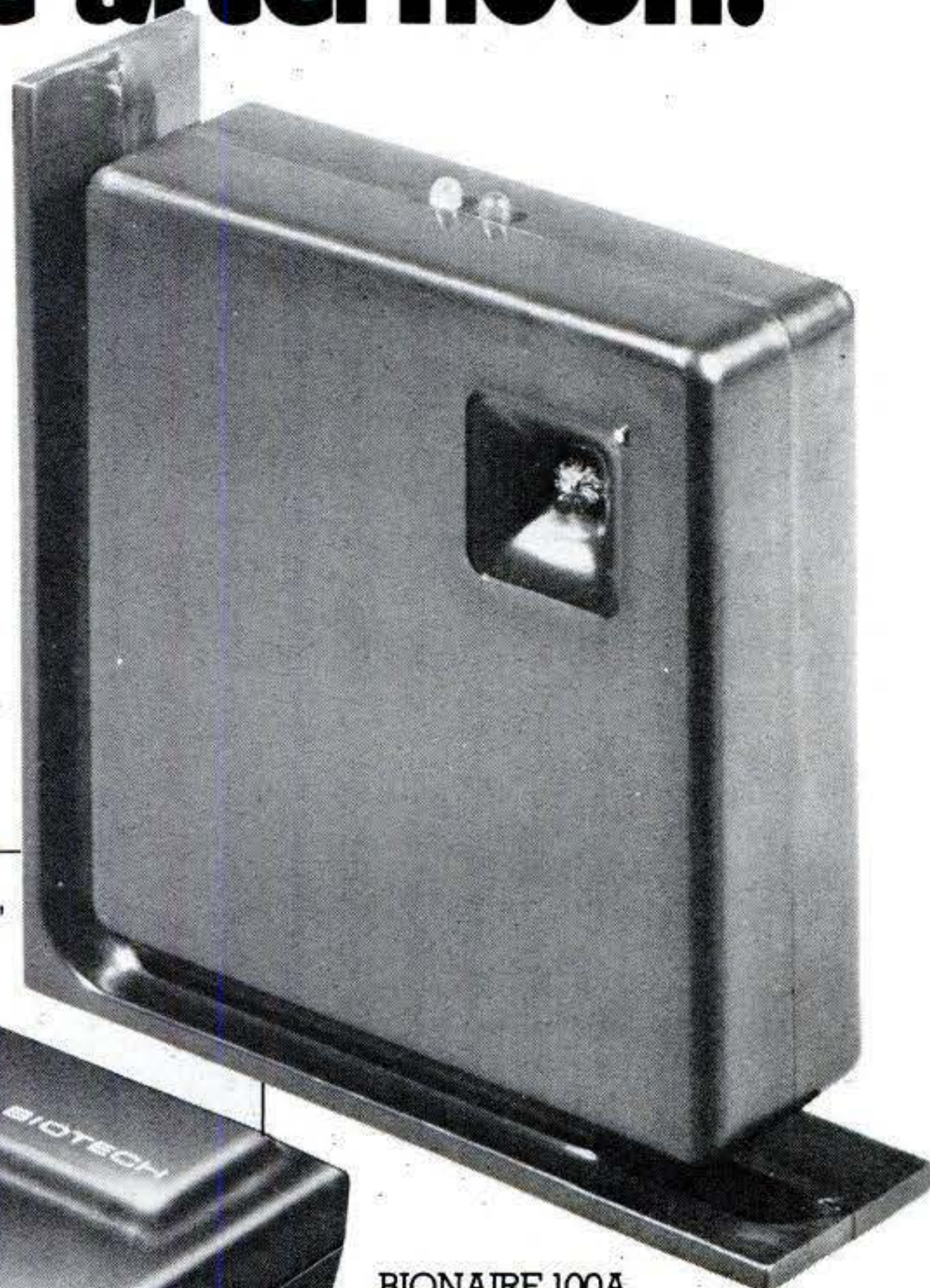
Why you should choose Bionaire ionizers over any other models

Many ionizers on the market emit ozone or other harmful gases. With Bionaire, all you get is a pure, invigorating stream of negative ions.

Another frequent problem is TV, CB and radio interference. You'll get no static with a Bionaire unit. It just quietly does its job.

The Bionaire 100A for your office or home

This unobtrusive, decorator-designed unit ionizes an area of approximately 250 sq. ft.



BIONAIRE 100A
HOME/OFFICE UNIT 2-1/2" x 6" x 6"



BIONAIRE 300
CAR UNIT 1" x 4" x 3-1/2"

It comes complete with unique output monitor indicators, omnidirectional emission, and a full one-year warranty.

The Bionaire 300. Consider it a safety device for your car

As mentioned, ion-deficient air slows reflexes by as much as 20%.

This can mean all the difference between avoiding a dangerous situation, and running right into it.

The compact Bionaire 300, (1" x 4" x 3-1/2") weighs only 4 ozs., sits on the dash without obstructing your view, and will keep you calm and alert through those endless rush-hour drives.

It's easy to install, has a multi-point ion source, and emits the highest ion output of any self-contained unit of its size. It also has a full one-year warranty.

Each Bionaire unit keeps the air in an 8 ft. radius around it charged with at least 10,000 negative ions per cubic centimeter.

Would you like to know more?

If you'd like to read the latest scientific facts about ions, and learn more about these exceptional Bionaire units, we'll be

glad to send you some very interesting literature including an article from P.379, December Playboy. Just mail us the coupon below.

Or do you know enough already?

Credit card holders: If you're convinced of the benefits Bionaire can bring you, order your home or car unit by calling 416-363-8704 collect.

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At no obligation, please send me free, the full scientific facts on:

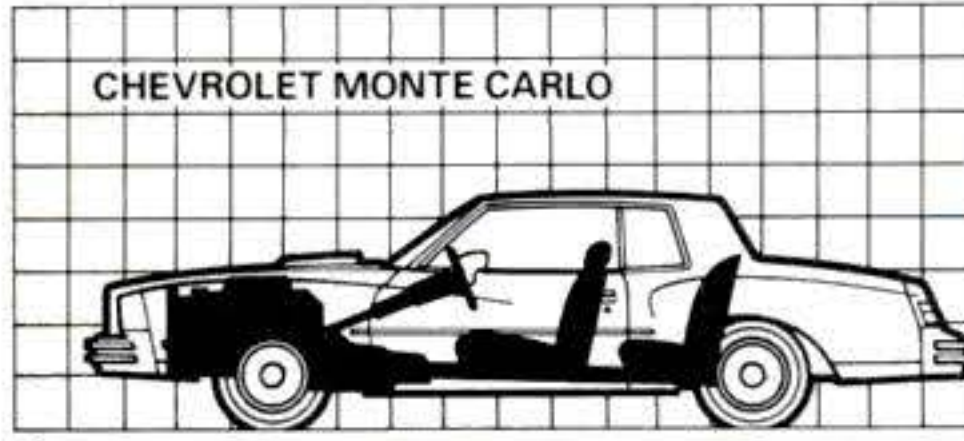
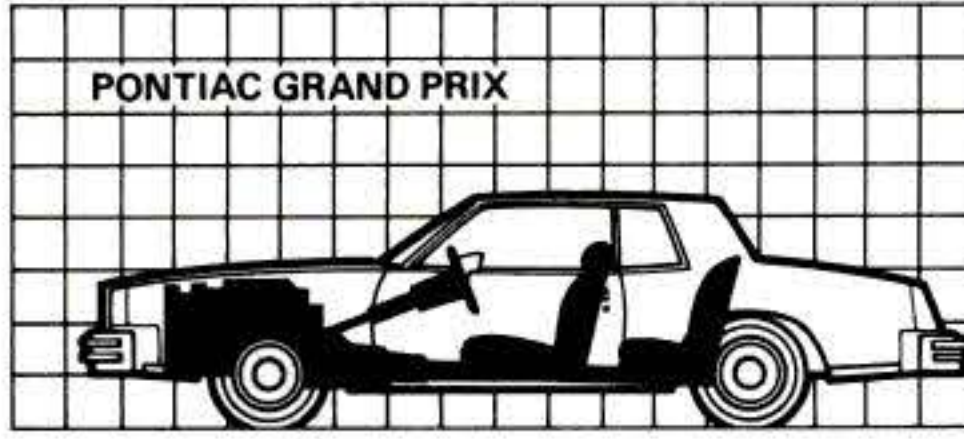
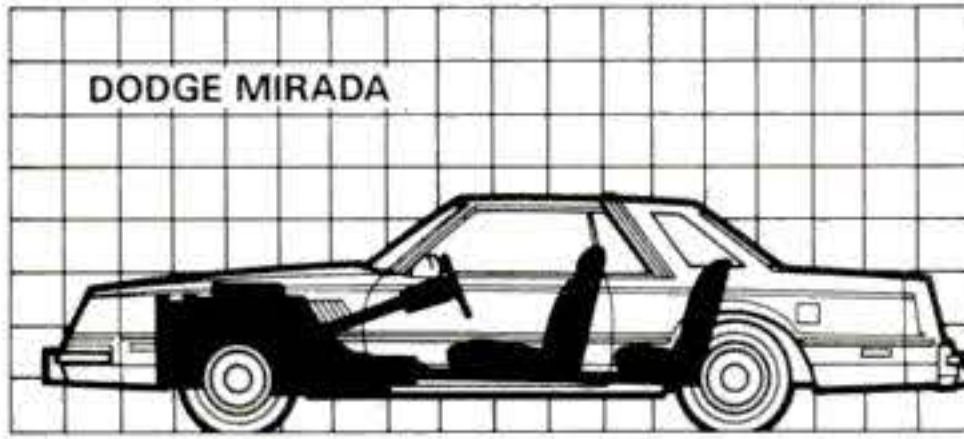
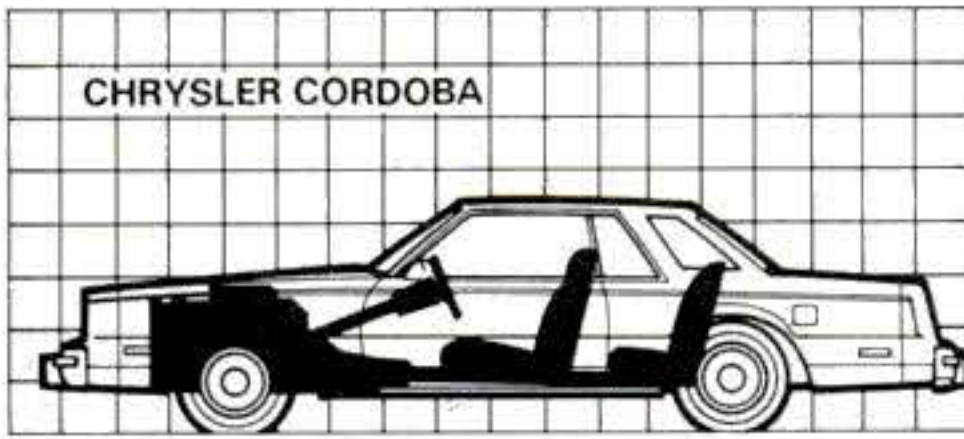
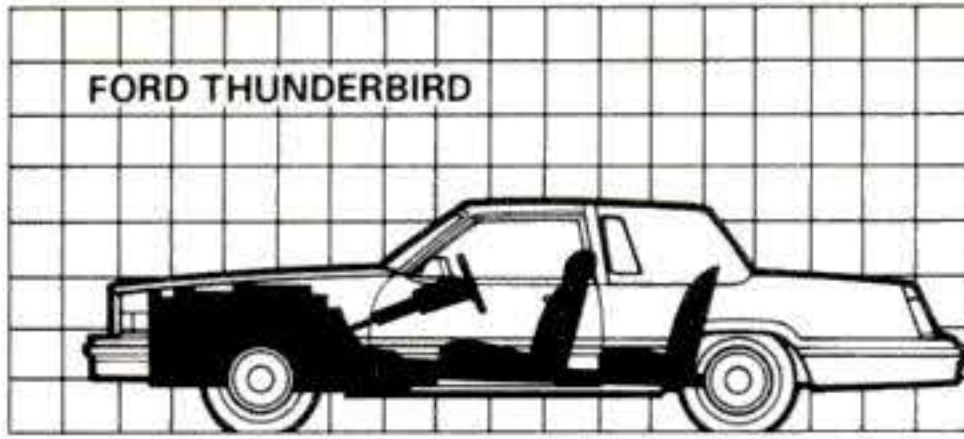
- Bionaire 300 (Car unit)
 Bionaire 100A (Home/office unit.)

NAME _____

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CITY _____

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Ford Thunderbird, Chrysler Cordoba, Dodge Mirada, Pontiac Grand Prix, and Chevrolet Monte Carlo—dimensions, specs, and test results

	Ford Thunderbird	Chrysler Cordoba	Dodge Mirada	Pontiac Grand Prix	Chevrolet Monte Carlo
DIMENSIONS (inches)					
Wheelbase	108.4	112.7	112.7	108.1	108.1
Overall length	200.4	209.8	209.5	201.4	200.4
Overall height	53.0	53.1	53.1	53.9	53.9
Overall width	74.1	72.7	72.7	72.7	71.5
Track, F/R	58.4/57.2	60.0/59.5	60.0/59.5	58.5/57.8	58.5/57.8
Ground clearance	6.3	7.6	7.6	6.7	6.7
Front head room	37.1	37.4	37.4	37.6	37.6
Front hip room	55.9	54.8	54.8	51.6	51.6
Front leg room	41.6	43.3	43.6	42.8	42.8
Rear head room	36.3	36.5	36.5	37.8	37.8
Rear hip room	52.0	57.2	57.2	54.9	54.9
Rear leg room (min.)	36.4	34.9	35.1	36.3	36.3
Rear knee room (min.)	1.8	0.6	0.6	2.1	2.1
Coupe distance	33.8	32.0	32.0	32.1	32.1
SPECIFICATIONS					
Engine type	V8	Inline 6	V8	V6	Turbocharged V6
Displacement (cu. in./L)	302/5.0	225/3.7	318/5.2	231/3.8	231/3.8
Compression ratio	8.4:1	8.4:1	8.5:1	8.0:1	8.0:1
Carburetion	2-bbl.	1-bbl.	2-bbl.	2-bbl.	4-bbl.
Net hp @ rpm	133 @ 3400	90 @ 3600	120 @ 3600	115 @ 3800	170 @ 4000
Net torque @ rpm	245 @ 1600	160 @ 1600	245 @ 1600	188 @ 2000	265 @ 2400
Transmission	4-speed automatic, overdrive	3-speed automatic	3-speed automatic	3-speed automatic	3-speed automatic
Axle ratio	3.08:1	2.76:1	2.47:1	2.41:1	2.73:1
Tire make	Michelin	Goodyear	Goodyear	Goodyear	Goodyear
Tire type	TRX, steel-belted radial	Viva radial	Polysteel radial	Steel-belted radial	Steel-belted radial
Tire size	220/55R390	P195/75R15	P205/75R15	205/75R14	205/75R14
Steering	Rack-and-pinion, power	Recirculating ball, power	Recirculating ball, power	Recirculating ball, power	Recirculating ball, power
Overall steering ratio	Variable, 20.7-17.9:1	18.7:1	18.7:1	Variable, 16.4-14.2:1	Variable, 16.4-14.2:1
Turns, lock to lock	3.4	3.5	3.5	3.3	3.3
Turn diameter (ft.)	40.7	40.7	40.7	38.2	38.2
Front suspension	Independent, Hybrid MacPherson strut, with coil spring on lower control arm	Independent, non-parallel control arms with transverse torsion bars	Independent, non-parallel control arms with transverse torsion bars	Independent, SLA type with coil springs	Independent, SLA type with coil springs
Rear suspension	Four control arms, coil springs	Hotchkiss drive, semi-elliptical leaf springs	Hotchkiss drive, semi-elliptical leaf springs	Four control arms, coil springs	Four control arms, coil springs
Front stabilizer-bar diameter (in.)	1.13	1.0	1.0	0.86	1.06
Rear stabilizer-bar diameter (in.)	0.52	None	None	None	0.63
Trailer towing (max. lbs.)	2000	2000	2000	4000	3235
Trailer tongue weight (max. lbs.)	200-300	200	200	480	600
Brakes	Disc/drum, power	Disc/drum, power	Disc/drum, power	Disc/drum, power	Disc/drum, power
Brake swept area (sq. in.)	275.0	375.3	375.3	307.8	307.8
Fuel tank (gal.)	17.5	18.0	18.0	18.1	18.1
Trunk space (cu. ft.)	17.7	16.7	16.7	16.1	16.1
Liftover height (in.)	28.5	30.0	30.0	31.0	29.6
Curb weight (lbs.)	3128	3280	3443	3383	3235
F/R weight distribution (%)	57/43	59/41	59/41	56/44	56/44
Basic price	\$10,036	\$6601	\$6346	\$7295	\$6162
Price as tested	\$11,381	\$8006	\$9730	\$10,174	\$9242
Major options on test car	Keyless entry system \$106, premium sound system \$150, 302 V8 \$150, 4-speed automatic transmission \$138, aluminum wheels with TR tires \$528, rear defroster \$101	AM/FM stereo \$101, light package \$104, sport appearance group \$191, rear defroster \$106, wire wheel covers \$170	Leather interior \$550, light package \$104, CMX package \$685, 318 V8 \$230, rear defroster \$106, cruise control \$116, power left seat \$179, power windows \$148, AM/FM stereo/search \$227	Leather seats \$426, A/C \$600, cruise control \$112, rear defroster \$107, power seat \$175, power windows \$143, AM/FM stereo \$285, wire wheels \$495	Special upholstery \$366, power windows \$143, rear defroster \$107, A/C \$601, cruise control \$112, gauges \$109, AM/FM stereo/CB \$525, turbo V6 \$500, appearance package \$120
TEST RESULTS					
Acceleration (sec.)					
0-60 mph	11.9	16.5	17.1	15.7	12.7
25-70 mph	13.7	19.0	17.9	19.3	14.2
Brake test (cool) 60-0 mph					
Stopping distance (ft.)	149	124	170	149	160
Pedal pressure (lbs.)	58	45	115	82	65
Disc temperature (°F)	214	156	283	201	185
Brake test (hot) 60-0 mph					
Stopping distance (ft.)	147	150	230	162	128
Pedal pressure (lbs.)	150	65	130	175	72
Disc temperature (°F)	794	447	665	546	484
Interior noise @ 60 mph (dBA)	69	68	68	67	65
Handling test (mph)	62.4	58.2	62.4	58.2	60.0
Maneuverability test (mph)	29.1	27.2	29.6	26.4	28.6
TEST CONDITIONS: Ambient temperature 72° F; relative humidity 65 percent; barometric pressure 29.6 inches Hg					

PS serviceability ratings

How easy is it to service these cars? To give you an approximation of how difficult it is for a typical person to perform various service operations, we examine each test vehicle. The numbers mean: 1, very difficult; 2, difficult; 3, average degree of difficulty; 4, easy; 5, very easy.

	Ford Thunderbird	Chrysler Cordoba	Dodge Mirada	Pontiac Grand Prix	Chevrolet Monte Carlo
Checking fluid levels:					
Battery	4	5	5	5	5
Master cylinder	3	3	3	5	5
Windshield washer	5	5	5	5	5
Engine oil	3	4	5	4	3
Coolant	5	5	5	5	5
Checking the engine:					
Spark plugs	2	4	4	2	1
Distributor	3	2	3	2	2
Carb adjustment	3	3	3	3	3
Oil filter	2	3	3	3	3
Oil fill	3	4	2	3	3
Replacing hoses:					
Upper radiator hose	3	5	5	2	1
Lower radiator hose	2	3	4	3	3
Heater hoses	3	3	3	3	2
Changing bulbs:					
Headlights	4	3	3	3	3
Taillights	3	3	2	3	2
Front running lights	3	3	3	3	3
Front parking lights	1	3	3	3	3
Front directionals	1	3	3	3	3
Rear directionals	3	3	2	3	2
Rear running lights	3	3	3	3	2
Checking fuses					
	2	4	4	4	4
Spare-tire accessibility					
	5	5	5	5	5
Changing belts					
	3	3	2	3	2

*Mixture adjustment sealed

Performance comparison with selected 1979 and earlier models

	Mpg (city driving)	Acceleration 0-60 mph (sec.)	Brakes 60-0 mph (ft.)	Handling (mph)	Maneuverability (mph)	Noise @ 60 mph (dBA)
1979 Dodge Magnum V8	14	15.1	193	58.2	25.7	69
1979 Buick Riviera V6 Turbo	16	14.1	140	62.4	28.1	63
1978 Ford Thunderbird V8	14	14.9	141	60.0	25.0	68
1978 Buick Regal V6	17	11.2	138	62.4	29.6	68
1978 Pontiac Grand Prix V8	17	12.2	142	67.1	28.1	68
1975 Ford Thunderbird V8	10	12.8	174	51.3	22.4	63
1975 Pontiac Grand Prix V8	11	12.0	158	58.2	25.0	64
1978 Dodge Diplomat V8	15	14.4	182	62.4	25.0	66

**US PATENT
No. 3,151,613**

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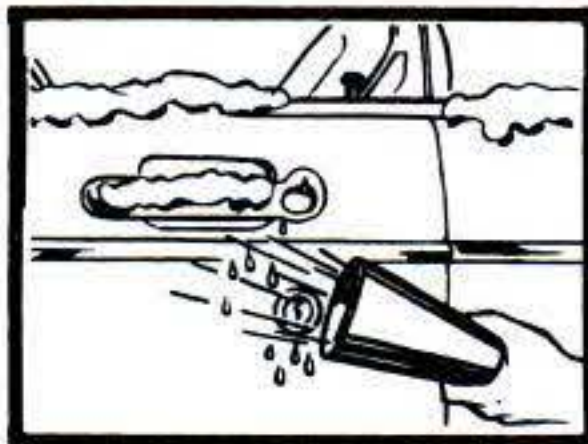
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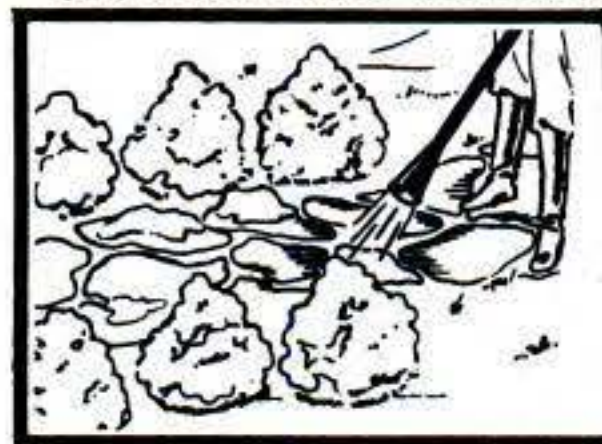
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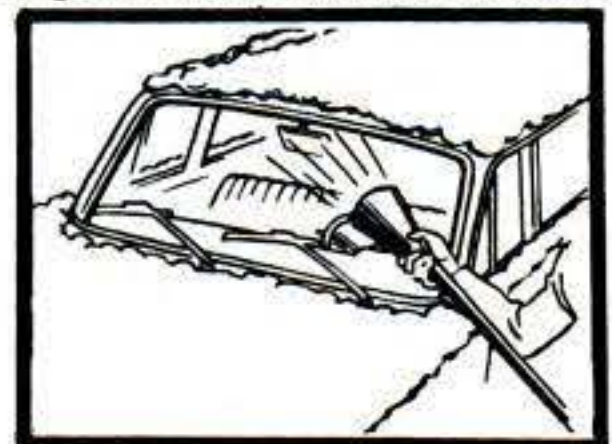
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Fireplace- efficiency boosters

— How do they rate?

A physicist experiments with accessories to find out how well they perform

By **JAMES TREFIL**

The author, a professor of physics at the University of Virginia, Charlottesville, writes regularly about energy conservation.

Books on wood heating aren't kind to fireplaces, branding them as wasteful and inefficient. I suspect they'd be banned completely if wood-stove partisans had their way. But there's no denying that people enjoy fireplaces, efficient or not, and will continue using them.

Over the last decade many accessories have been introduced to upgrade fireplaces as a home-energy component. These range from simple metal gadgets you can set in place in seconds to more complex devices that essentially turn your fireplace into a wood-burning stove. Costs range from tens of dollars to well over \$500.

Last fall I realized that the double fireplaces in my home made it possible to test how effective these accessories can be. The back-to-back fireplaces share a common double-flue chimney. Each fireplace heats about 700 square feet of floor space, and the two separate areas can be isolated from each other by closing doors. By monitoring the heat delivered by each fireplace, I could estimate how much an accessory-equipped fireplace increased in efficiency over the fireplace without an accessory.

My tests at home couldn't provide the precise measurements of flue-gas chemicals, wood water content, or other data possible in a lab. But the advantage is that my tests closely matched how an accessory would function in a real-life setting.

Efficiency boosters

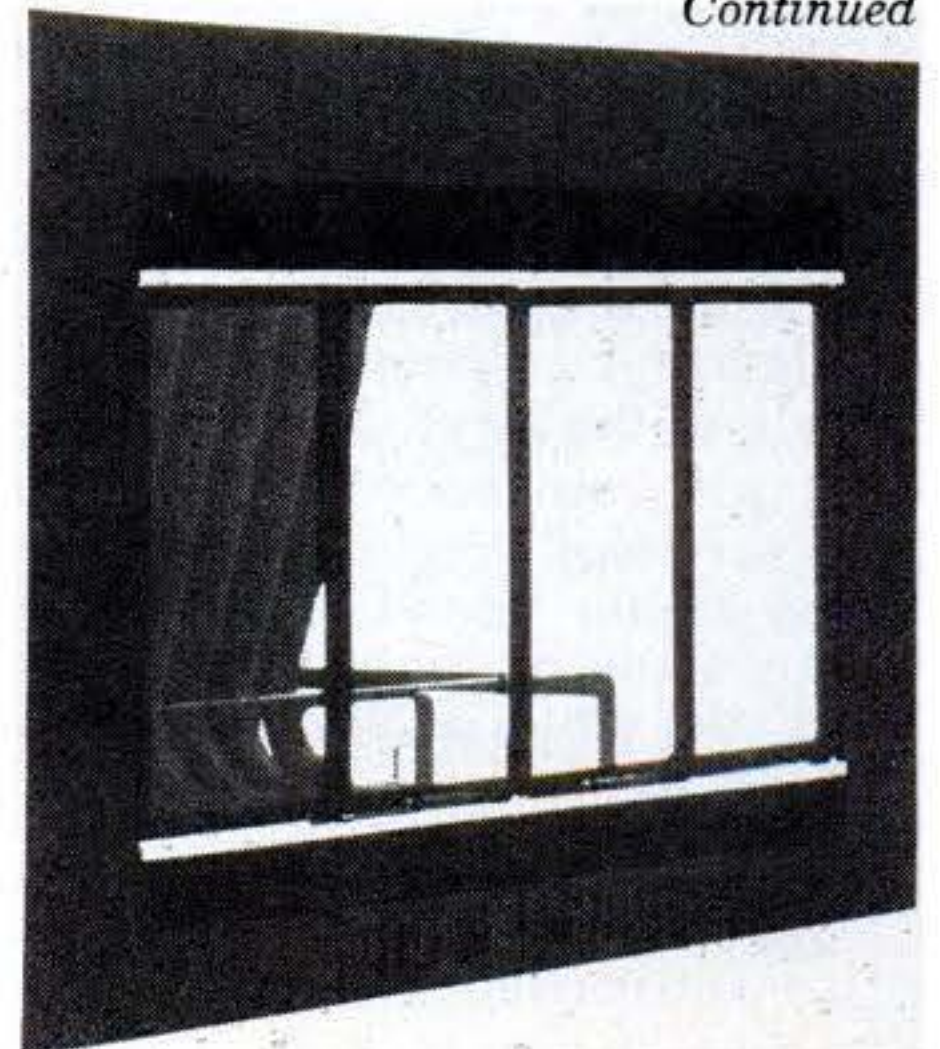
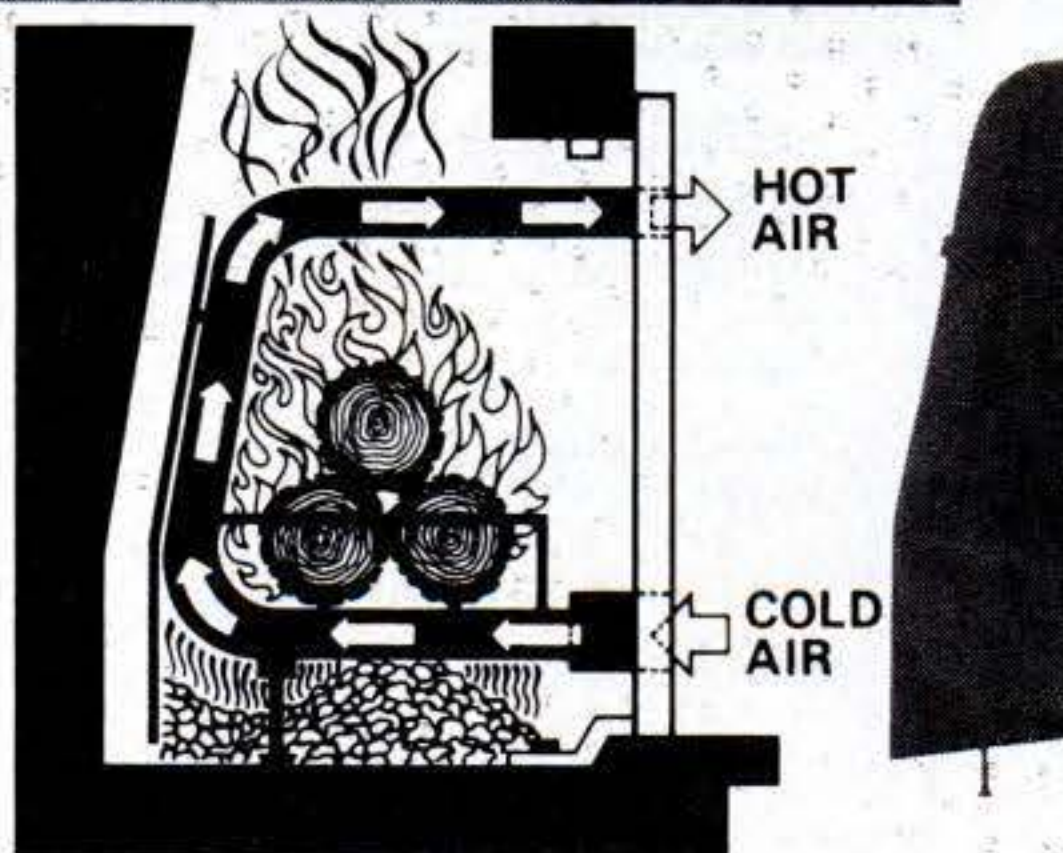
I selected, arbitrarily, accessories for tests that were practical for my own situation. They are not representative of the entire accessory field, but all of these can be installed without

Continued



Metal reflector shield from Kronos converts a straight-back, brick-lined fireplace into slant-back metal installation. Overlapping panels adjust for width.

Fireplace-furnace concept draws in cool air through pipes, heats it, and expels hot air into the room. Thermograte's glass windows let you control air intake.



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

Also available in 100's.

KING: 16 mg. "tar", 1.1 mg. nicotine, BOX: 18 mg. "tar", 1.2 mg. nicotine,
100's: 19 mg. "tar", 1.3 mg. nicotine, av. per cigarette, FTC Report MAY '78.

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

Fireplace-efficiency boosters

[Continued]

the need for elaborate retrofitting.

Each of the accessories is designed to overcome one or more of the defects that reduce fireplace efficiency. Efficiency boosters can be classified as:

- **Radiation enhancers.** Hot coals are often shielded from the room by logs. These accessories are designed to increase the amount of heat radiated into the room. They may rearrange the fire or the fireplace structure.

- **Alternate-air suppliers.** Normally, there's no precise control of air coming into a fireplace. These devices bring combustion air into the fireplace from an outside source.

- **Convectors.** Unlike stoves that heat by radiation and convection, fireplaces heat only by radiation. These accessories augment normal radiation by circulating air around the fire in pipes and forcing it back into the room.

- **Fireplace stoves.** These accessories are more complicated (and expensive), but they turn your fireplace into the equivalent of a high-efficiency wood stove.

Accessories I tested or used are shown in photos and drawings on these pages. Two of the three radiation enhancers, the Texas Fireframe grate and Kermco Heat Booster, function by rearranging the fire. The Kronos Reflector modifies the fireplace. The curved Kronos reflector converts a vertical brick-lined fireplace into a metal-backed arrangement. Since I started with a slant-back, metal-lined fireplace, little efficiency increase could be expected from the Kronos, and it is not included in the test results.

The Jai Ram Air Iron drew combustion air from a crawl space in my home when it was placed over the ashpit opening. The cold outside air was fed into the front of the fire. Morton's Hearth furnace and the Thermograte fireplace stove are both convectors. The Thermograte device can be operated with or without its electric fan. Also, its airtight glass door allows you to control air intake.

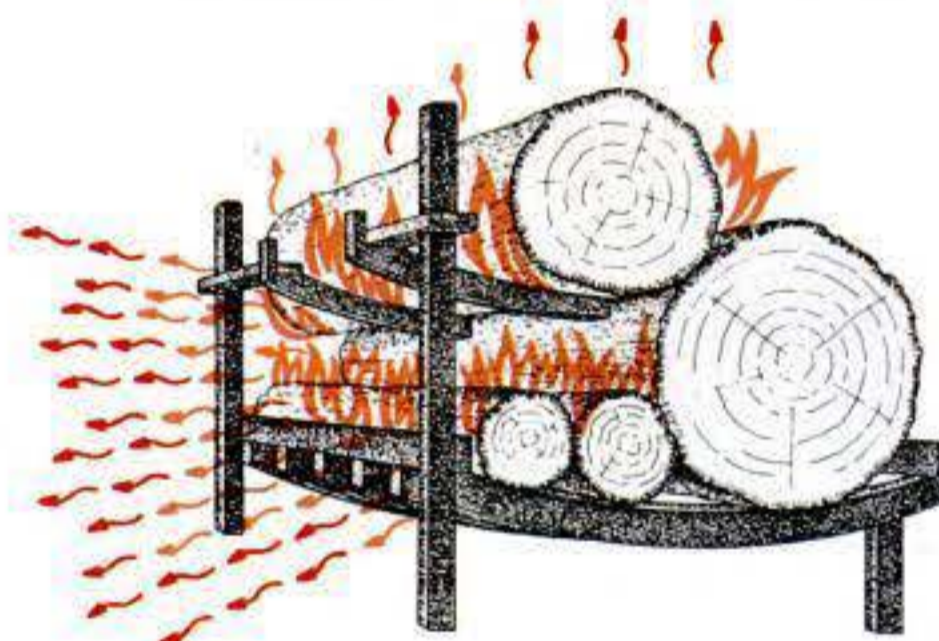
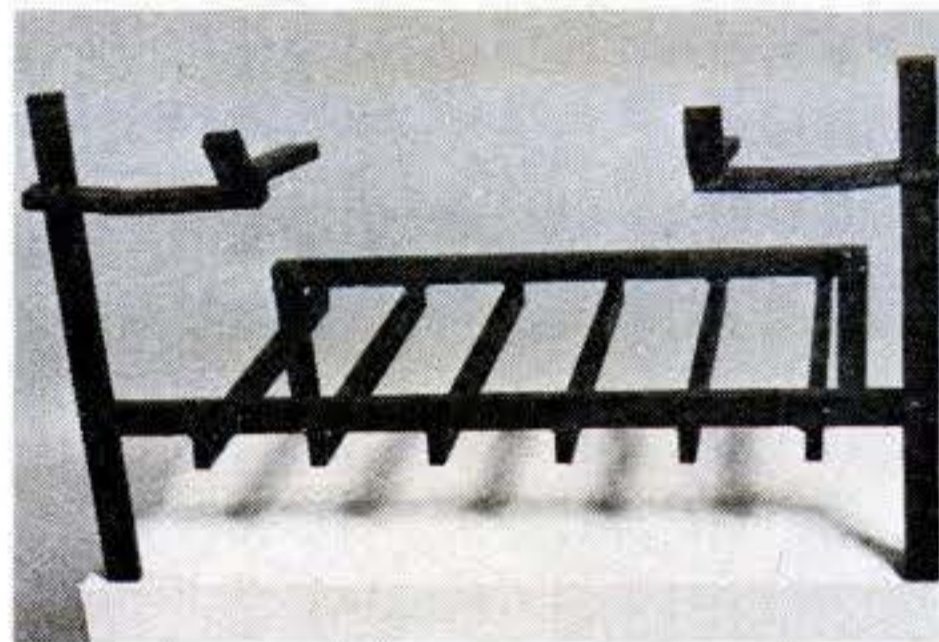
Test formulas

Heat loss through the walls and roof of your home depends on its insulation, number of windows, and type of construction. It is this heat that must be made up by the fireplace [see "Woodburner Efficiency," PS, Jan. '79]. The major influence on heat loss is the temperature difference between your living space and outside air. This can be expressed as

$$Q = K(T_{in} - T_{out}),$$



Combustion air drawn through the floor or ashpit and supplied to fire can prevent heated room air from being drawn up the flue. Jai Ram makes the Air Iron.



Radiant-heating improvement is claimed for the Texas Fireframe, which arranges logs to create a slot-shaped opening. Arrangement also controls log burning.

where Q is the fireplace heat, T_{in} is inside temperature, and T_{out} the outside temperature. K is a number that depends on the built-in insulation factors mentioned above.

In my setup, two fireplaces each heat a different space. These heat sources can be written as

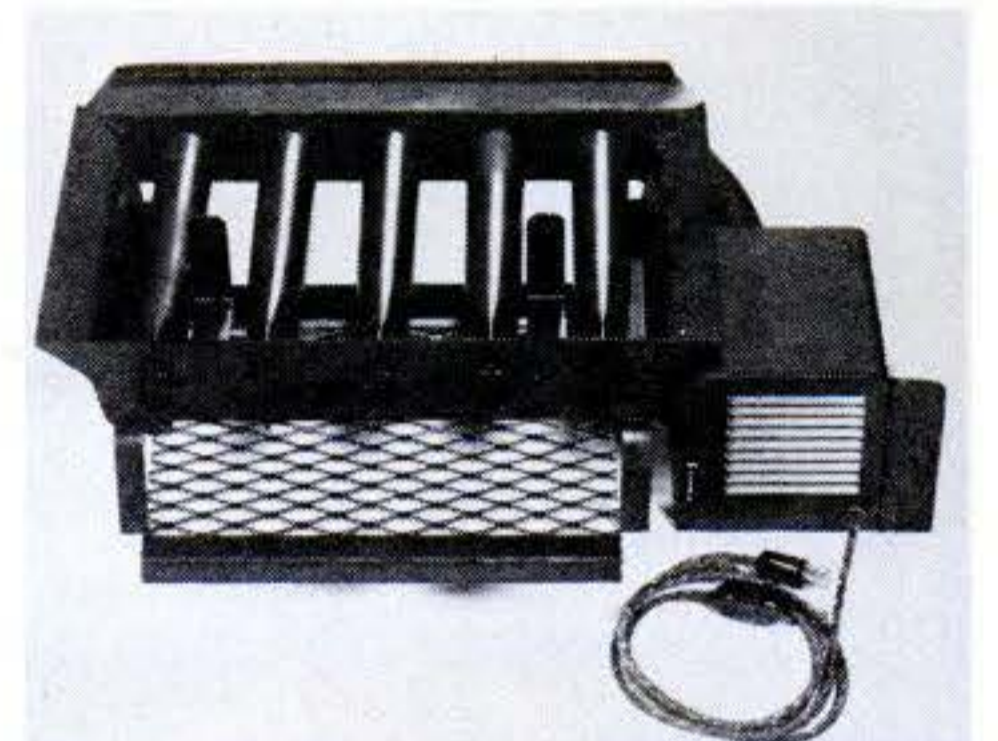
$$Q_1 = K_1(T_{in} - T_{out})$$

and

$$Q_2 = K_2(T_{in} - T_{out}),$$

where Q_1 refers to heat delivered by the first fireplace and Q_2 is heat from the second.

The spaces being heated aren't exactly identical. One fireplace room has a stairwell, while the other side has ceiling grates. The south side has more windows than the north side.



Hollow steel tubes in the Morton Hearth furnace support the fire. An electric blower draws air through the pipes, augmenting heating from direct radiation.



Angling logs toward you provides more radiant heat in the room and less up the chimney, according to Kermco. Its Heat Booster goes on a grate or floor.

Heat from a stove, refrigerator, and water heater is added to one side.

To account for these differences, I first made what's called a normalization run. Equal amounts of wood were burned in both fireplaces so they could deliver the same amount of heat to their respective areas. Monitoring the temperature in each space (and outside) enabled me to determine how construction differences influenced heating the two areas. For example, if it takes 10 pounds of wood to keep one area at 65 degrees, but only nine pounds for the other, you can say

$$Q_1/Q_2 = K_1/K_2 = 10/9 = 1.11.$$

The normalization run, then, tells how differences between the two heat-

Continued

HOW MUCH FISHING CAN HOMER CIRCLE DO WITH EVINRUDE'S NEW 7½ AND 5 GALLONS OF FUEL?

NOTE FROM EVINRUDE: Miles per gallon and gallons per hour figures are fine for boat testers and engineers. But they don't mean much to ordinary troll-and-search, stop-and-cast fishermen. So we invited noted fishing writer Homer Circle, Angling Editor of Sports Afield, to run the 7½ for a week — doing what he would typically do fishing an unfamiliar lake — and report on what he did and how much fuel he used.* His report follows:

“It takes a heap of running to find fish during dog-day doldrums. And this was the challenge we faced when invited to “wring out” Evinrude’s new 7½ hp outboard.

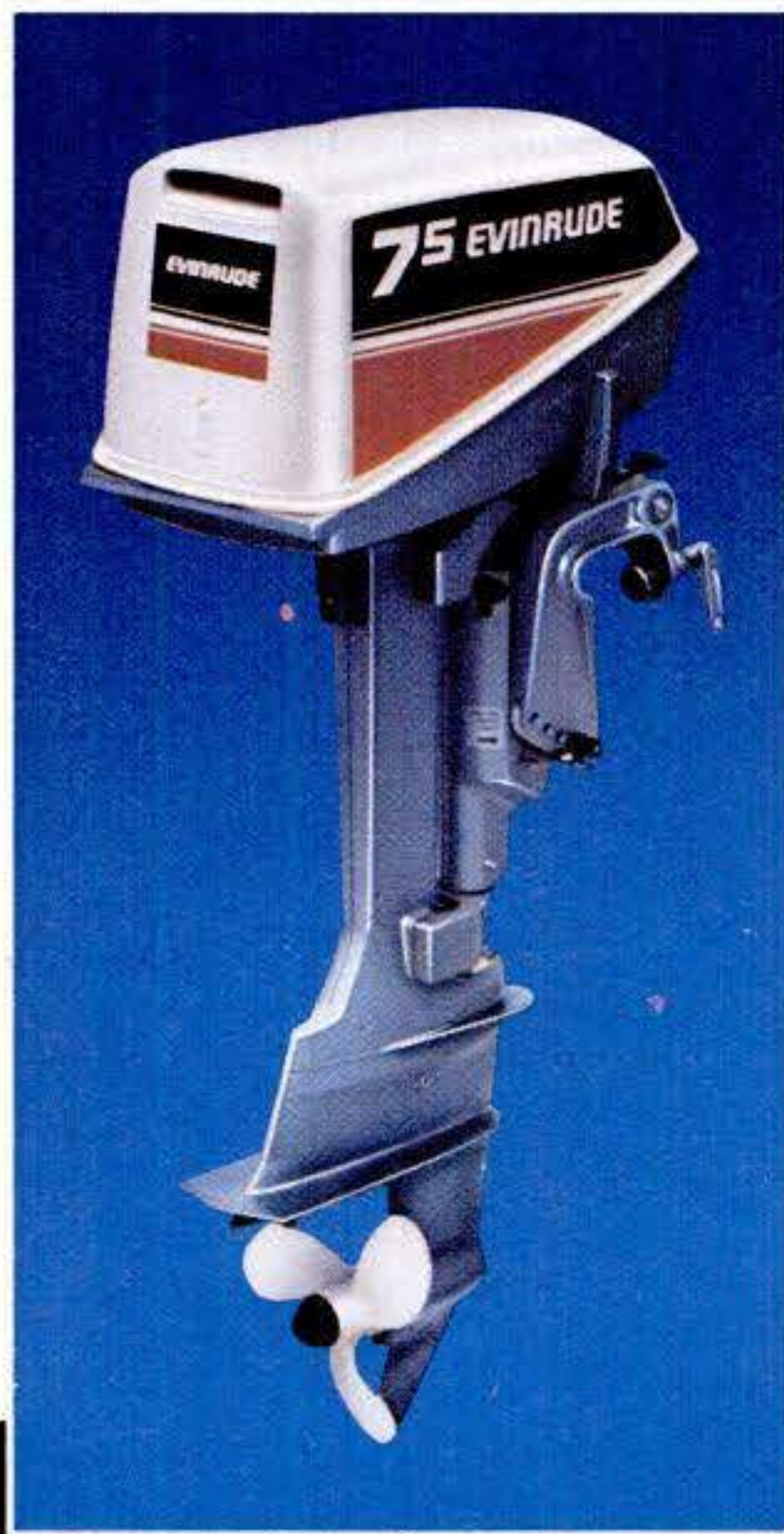
“A week’s fishing on less than a gallon of fuel a day? The way I fish, without the help of an electric motor? Frankly, I doubted it. maybe four, but surely not six days.

“Gayle, my ‘childbride’ of 42 years, and I have fished together over three continents, and rarely have we found the fishing tougher.

“Using a topographic map of Wisconsin’s Namekagon Lake, we systematically sought out bottom structures using a sonar flasher. We did not skimp on fuel but probed as we normally would under such conditions.

“We fished as we did 25 years BE, before electrics. We either let a friendly breeze waft us along an area, or anchored to fish out select spots, or trolled from one point to another.

“To catch enough fish to eat, we had to hit it hard to ferret out four holding areas from one to four miles from the dock. Then, putting aside



thoughts of fuel frugality, we deep-trolled during midday hours seeking a suspended lunker.

“Not only did we use just 5 gallons of gas during the week, we experienced the flawless performance of a thoroughbred. It powered our 14-foot Alumacraft from flat to scat in seconds.

“I found especially handy two features at the tip of the control handle: a kill button, and a knurled ring to fine-tune idling.

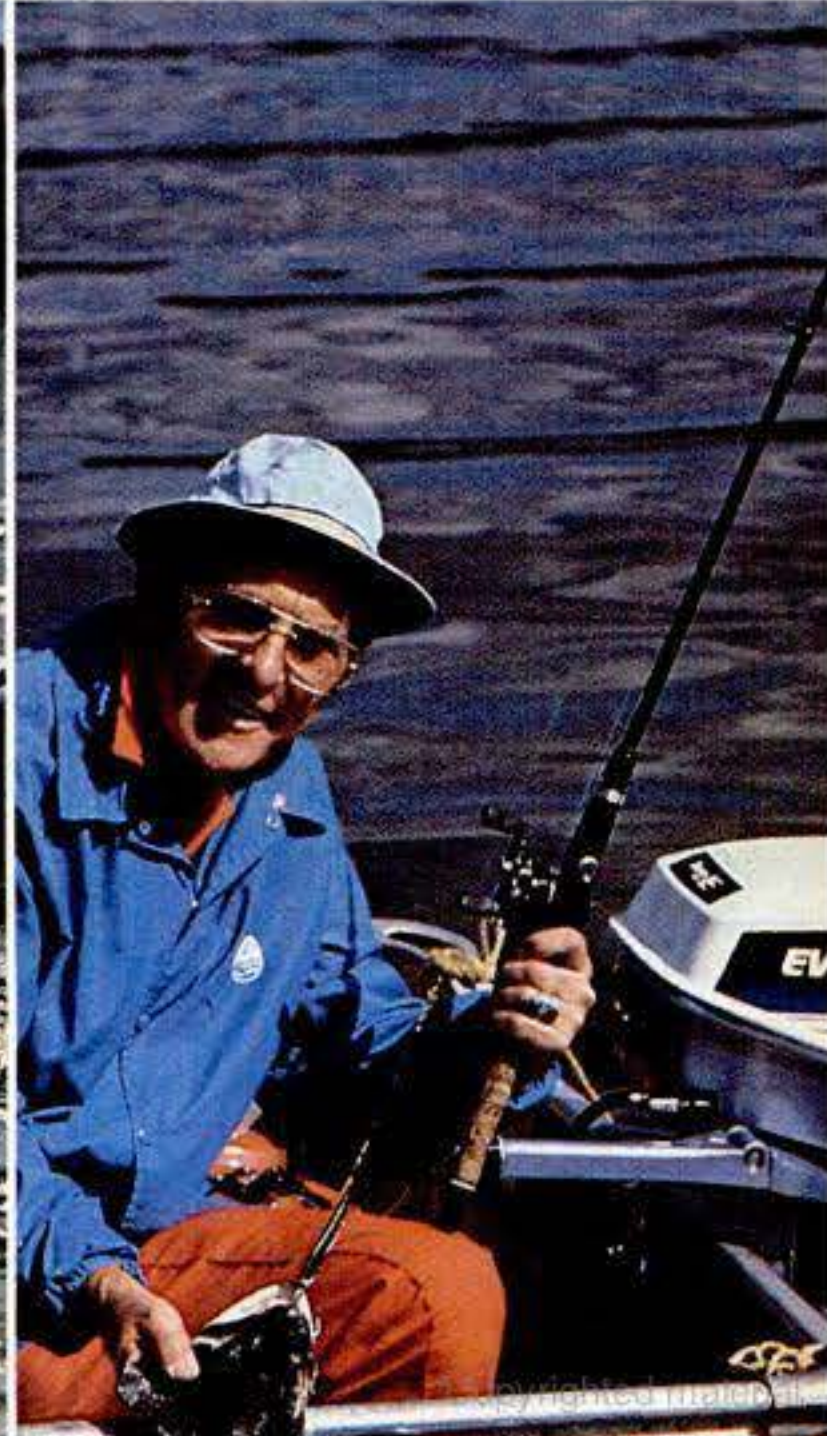
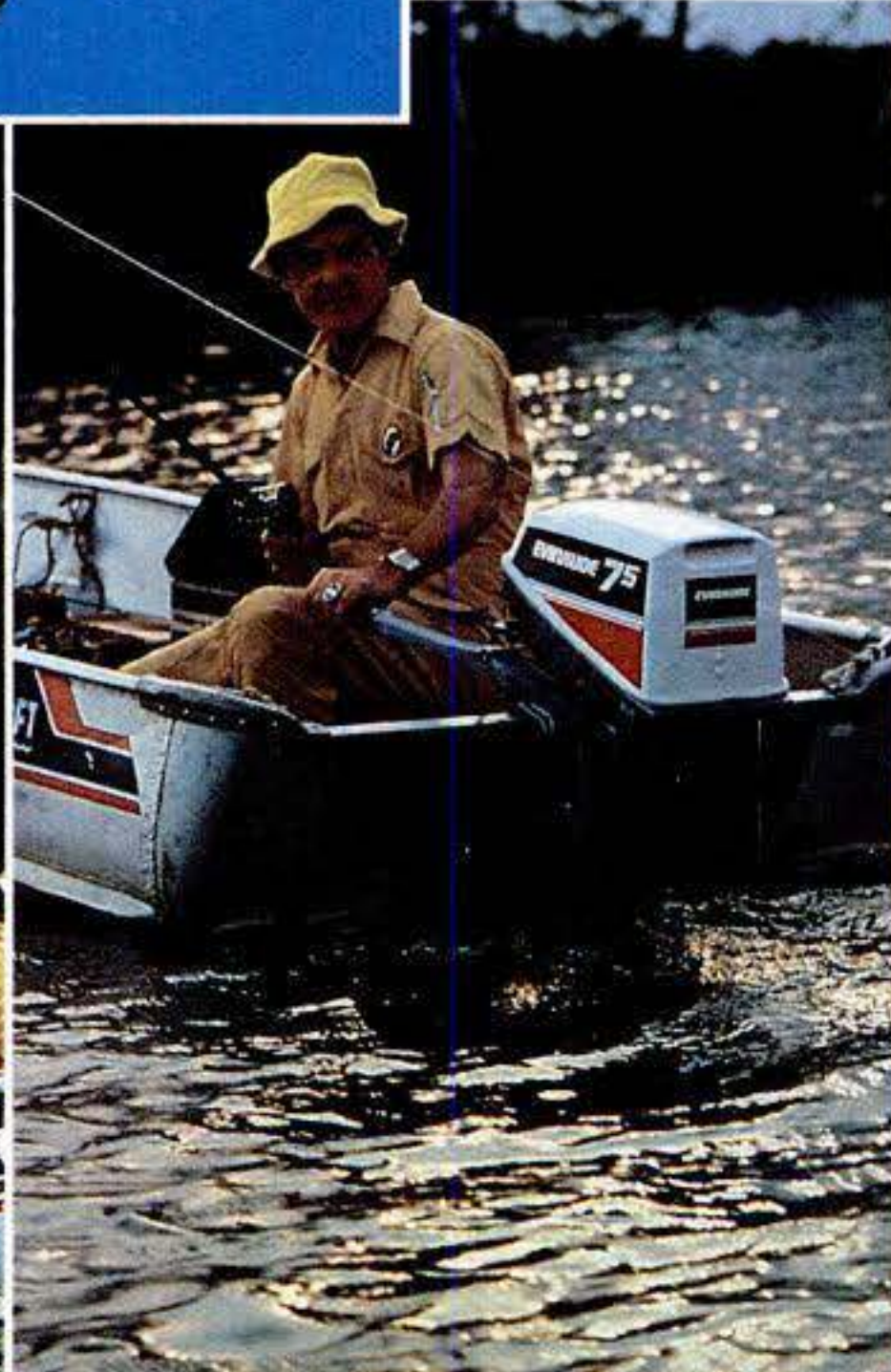
“Only on three occasions did this motor fail to start on the first pull. All were my fault for forgetting to put the handle control on ‘start.’ I liked the dock manager’s comment: ‘Sounds like my mother’s sewing machine.’

“Summarizing: we put Evinrude’s new baby to the test and found it totally adequate to all our fishing needs. In short: it’s a gas-hoarding honey!”

**Of course, your fuel consumption will depend on conditions and your use of the outboard.*

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- Submitting Your Invention Before Patenting

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Fireplace-efficiency boosters

[Continued]

ed areas influence their thermal performance. This measurement also tells when an accessory improves fireplace efficiency. In the example above, the fireplace plus an accessory in area two must burn less than nine pounds of wood for an efficiency improvement—even though the fireplace without an accessory burned 10 pounds. After several runs, the result for my home, K_1/K_2 , was 1.2.

With the preliminaries settled, I could begin the main testing program. Let's run through a one-hour test so you can see how the whole process works. Suppose fireplace one with an accessory burns seven pounds of wood in one hour, while fireplace two burns 10. Say that during this hour the outside temperature is 30 degrees, the temperature in area one is 65 degrees, and it's 62 degrees in area two.

This means that during the hour an amount of heat $Q_1 = K_1(65 - 30) = 35K_1$ was delivered to area one. Also, heat equal to $Q_2 = K_2(62 - 30) = 32K_2$ was delivered to area two.

Now the amount of heat a wood-burner delivers is equal to its efficiency times the amount of wood burned. In area one (accessory fireplace),

$$E_1 \times 7 \text{ pounds} = Q_1 = 35K_1,$$

while the efficiency of area two (fireplace only) is

$$E_2 \times 10 \text{ pounds} = Q_2 = 32K_2.$$

Thus the relative increase in efficiency in this hypothetical case is

$$\frac{E_1}{E_2} = \frac{K_1}{K_2} \times \frac{35}{32} \times \frac{10}{7} = 1.875,$$

where the result of the normalization run is used to set $K_1/K_2 = 1.2$. The conclusion is that the added accessory produced an 87½ percent increase in efficiency at converting firewood into heat. Efficiency for a nonaccessory fireplace is 1.0 (see table).

Tests on the accessories ran for five or six hours instead of one. The first two columns of the table show test results for two cases. Column one indicates efficiency increases over a standard fireplace, obtained by closing off the air ducts on my circulating fireplaces (not recommended normally, since uncooled metal can overheat). In the second column are efficiency increases over a circulating fireplace.

All these numbers represent *relative* efficiencies—that is, efficiencies of the fireplace and accessories relative to the fireplace alone. Another relevant number is absolute efficiency, in the third column. In an earlier article [PS, Oct. '78], I described how a simple experiment indicated the efficiency of my circulating fireplaces was about 30 percent. This figure was used to es-

timate the absolute efficiencies of the accessories. Unlike the results of the first two columns, these estimates aren't something I've measured directly.

Two radiation enhancers, the Texas Fireframe and Kermco Booster, provided noticeable "beamed" heat. But keeping the fire arranged properly was something of a chore. I used the Kronos reflector shield as extra protection against burnout—gradual oxidation of metal contacting hot coals—of my metal fireplace core. It's far easier to replace a \$30 reflector than a built-in core.

Burnout shouldn't be a problem with the heavy-gauge steel in the Morton and Thermograte accessories. Air flowing through the pipes should minimize overheating. But budget "wraparound" grates of thin metal probably couldn't survive one winter of moderate use. Jai Ram's Air Iron is installed with a very effective layer of wood-ash heat insulation.

After a winter of messing around with fireplace add-ons, I've concluded:

- Accessories can boost fireplace efficiency into the 20–30 percent range—efficiency matched with that of cheap wood stoves.

- Costlier fan-driven accessories can push efficiency still higher.

- Add-ons like the Thermograte can convert a fireplace into a stove at a cost comparable to that of expensive wood stoves.

- Devices like the Jai Ram Air Iron produce the highest boost in efficiency for lowest cost, minimizing heated living-space air going up the flue.

Since I dislike the noise of motor-driven fans, and prefer throwing a log on the fire without worrying about its arrangement, my choice for the current heating season was a Jai Ram Air Iron. PS

Comparison of booster efficiencies			
	Efficiency relative to an ordinary fireplace	Efficiency relative to a circulating fireplace	Estimate of absolute efficiency
Ordinary fireplace	1.0	0.37	0.11
Circulating fireplace	2.7	1.0	0.30
Texas Fireframe	2.6	0.96	0.29
Kermco Heat Booster	2.7	0.99	0.30
Jai Ram Air Iron	3.2	1.2	0.36
Morton Hearth	4.3	1.6	0.48
Thermograte	5.1	1.9	0.57

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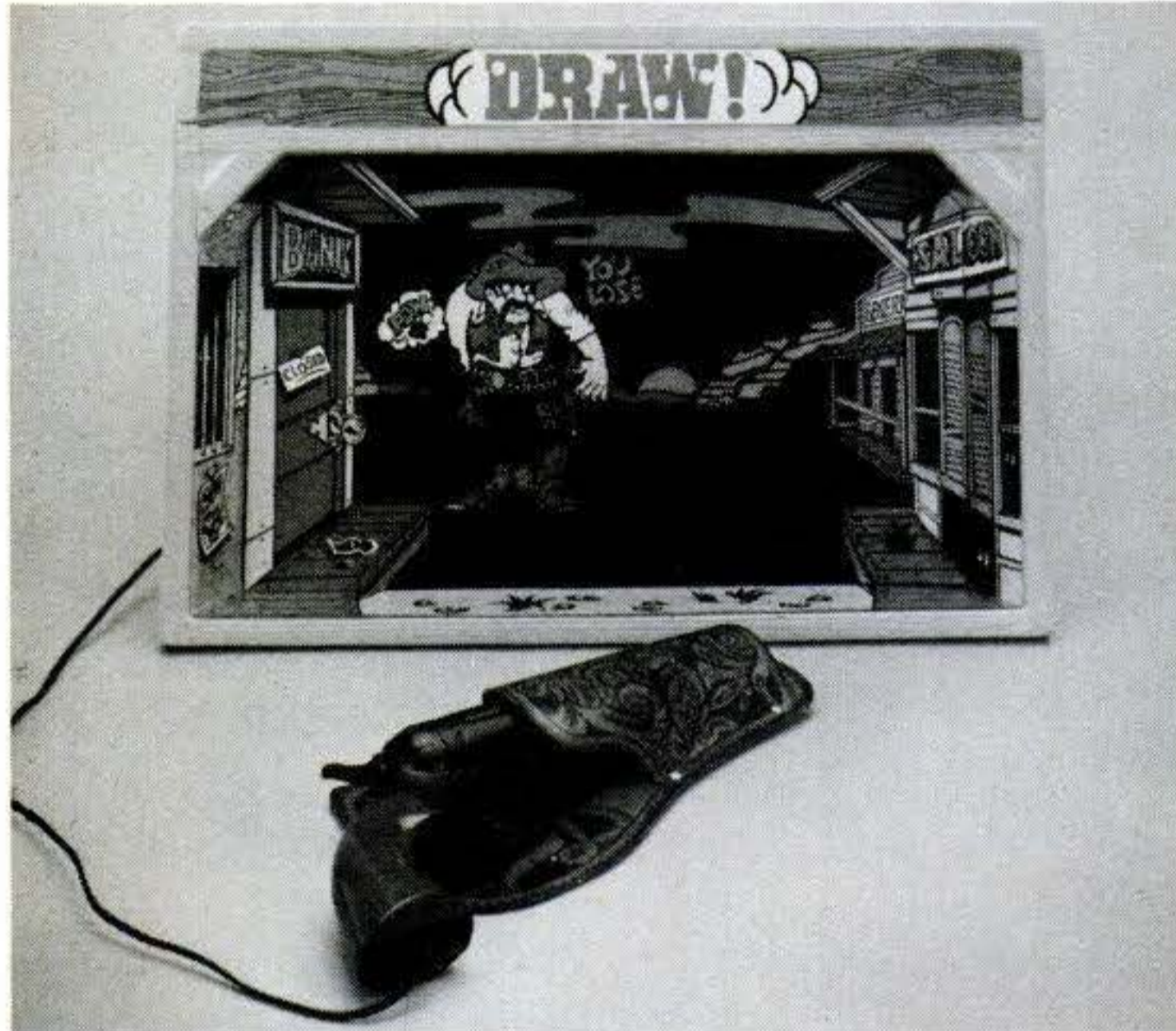


Private First Class Lee Thompson, 841st Engineer Bn. USAR, Miami, Florida.

MEET TODAY'S ARMY RESERVE.

ON TARGET

By PAUL WAHL



When the outlaw begins to draw (his gun light moves), you pull your revolver and shoot. Realistic light and sound effects simulate the exchange of gunfire. Outdraw the badman and he falls to the music of one of six programmed dirges. Miss by shooting too soon or too late and you get an electronic Bronx cheer while the YOU LOSE sign flashes. After six tries, beeps sound out the number of hits you scored.

Fast-gun fun

Microprocessor technology has made possible the fascinating new shooting game "Draw!" Your computerized opponent, an evil-looking desperado, faces you from an illuminated screen. The idea is to beat him to the draw.

Electronic six-shooter holstered on your hip, you press a button and cock the handgun's hammer to start the action.

The time it takes the outlaw to make his move is varied randomly. Should you prove more than a match for his gunslinging, you can make the game more challenging by switching from the BEGINNER to the PRO setting, thus speeding up his draw.

Playing gunfighter with "Draw!" is great fun. I think that this product of Coleco Industries, Inc. (945 Asylum Ave., Hartford, Conn. 06105) is well worth its under-\$35 price.

New woods rifle

Marlin's lever-action repeaters have been favorites of American hunters since 1893 and the rifles of today retain the superior design features, as well as the classic Western look, of the originals. Latest in this series is Model 375, a fast-handling carbine chambered for the powerful 375 Winchester cartridge ["On Target," Nov., '78]. It's just the ticket for deer hunting in heavy woods.

Weighing about 6¾ pounds, the Model

375 has a 20-in. barrel and its half magazine tube holds five cartridges. The two-piece stock is American black walnut with fluted comb, full pistol grip, rubber butt plate, quick-detachable swivels, and leather carrying strap. Standard sights are semi-buckhorn rear and hooded ramp front. But for best results, I recommend equipping the Model 375 with a suitable scope sight in 2½X or 3X, ample magnification for brush-country hunting. Marlin's solid-top, side-ejection receiver permits low, centered scope mounting. And to facilitate cocking the scope-equipped rifle, Marlin provides an offset hammer spur. Adaptable for right or left handers.

A product of the Marlin Firearms Company (100 Ken-na Dr., North Haven, Conn. 06473), the Model 375 carbine costs \$210.45.

the enjoyment of other outdoor activities, too. Recently, I tried out a new Nikon Featherweight Roof Prism 7x20 binocular. It weighs about 7½ ounces and, at only four inches wide and four inches long, can be carried conveniently in the pocket of a hunting shirt.

Ultralight compact binoculars

If you like to travel light, conventional binoculars often seem too big and heavy to take along. Yet good binoculars really are a must for every hunter and add a lot to



Field of view for this 7x20 binocular is 122 meters at 1000 meters. Brightness index is 8.2. It costs \$250 in a choice of satin black or silver finish, including a zippered soft-leather carrying case. Also available are 6x20 at \$231.50 and 8x20 at \$268.50. These binoculars are distributed in the U.S. by Nikon Inc., 623 Stewart Ave., Garden City, N.Y. 11530.

Designed to be the outdoorsman's constant companion afield, A. G. Russell's compact Sting and the BenchMark Natchez and Ninja, designed by Blackie Collins, are prime examples of the popular new general-purpose knives.

Utility knives

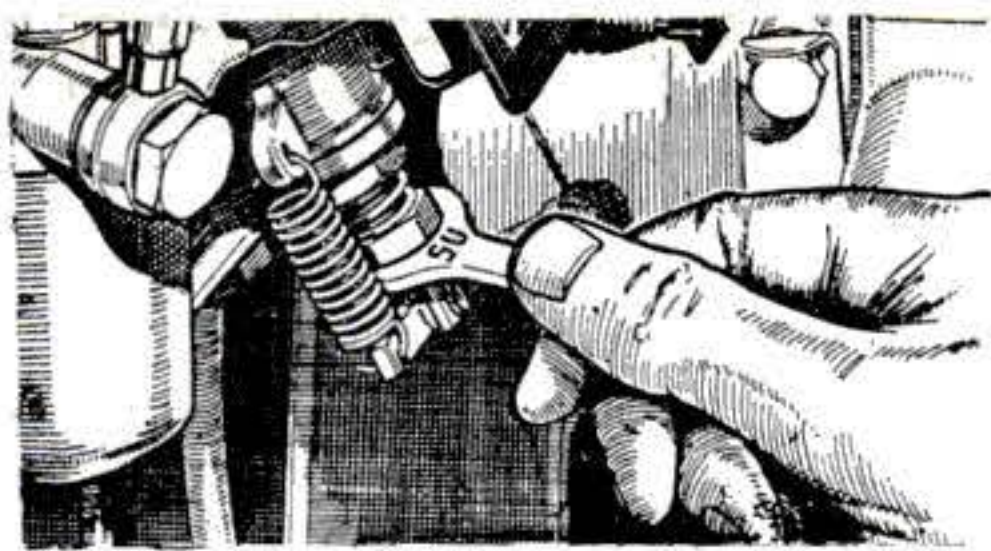
Only 6½ in. long and weighing about three ounces, the handsome little Sting is one piece of stainless steel, drop-forged, with integral hilt and butt. Its 3⅞-in. double-edge blade has a bright mirror finish. Depending on your choice of handle, the Sting costs \$45-\$85, leather sheath with clip included. It's made in Solingen, Germany, for A. G. Russell Co., 1705 Hwy. 71 No., Springdale, Ark. 72764.

Striking good looks and fine design characterize the Natchez. With overall length of 8⅝ in. and weight of about six ounces, it has a four-inch stainless-steel blade with a long false edge and a double guard of brass or stainless with matching handle rivets and lanyard hole liner. With a lined Micarta handle and brass guard, the Natchez sells for \$68.50.

"Businesslike" best describes the Ninja with its rugged, black Lexan handle. This tough, lightweight (four ounce) knife is eight inches long; the four-inch hollow-ground stainless-steel blade has a short false edge. The Ninja is secured in its leather sheath by a locking stud that engages the lower hole in the handle. This allows the knife to be worn upside down. Easily one of the better survival-knife designs, the Ninja is priced at \$54. Both the Natchez and the Ninja are made by BenchMark Knives, Box 998, Gastonia, N.C. 28052.

PS





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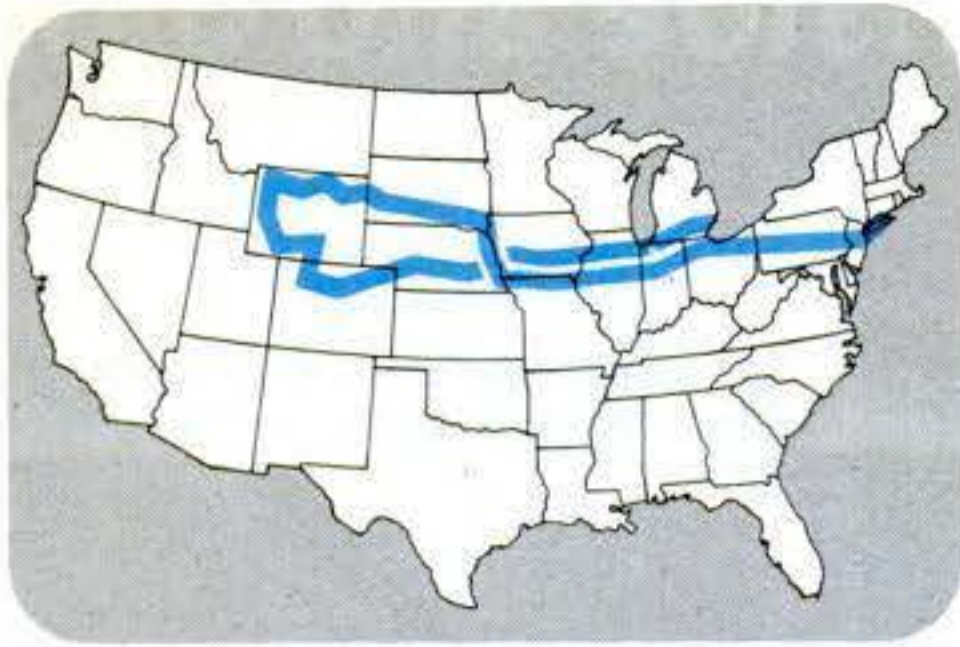
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PS 5000-MILE TEST

FORD THUNDERBIRD



Even at 14,260 ft. the Thunderbird had some power in reserve. Mt. Evans is about

150 ft. higher than Pikes Peak, its more famous cousin to the south.

By ED JACOBS

As we climbed through 14,000 feet, Merle Zimmer turned to me and said, "It's hard to believe, but there's still some power left. I've never seen that this high."

No, we weren't testing a new private aircraft. Merle is a section foreman with Colorado's highway department, and he was driving Ford's resized, new Thunderbird—climbing the last couple of hundred feet to the summit of Mt. Evans, on the highest paved passenger-car road in the world. And the Thunderbird was performing impressively, despite being tuned for sea-level driving.

I'd returned to the Rockies (and Mt. Evans, specifically) because I wanted to push the Thunderbird hard, and because our LTD test last year [PS, Jan. '79] had convinced me that Colorado and Wyoming are ideal test areas. They offer the diverse and punishing extremes of road surface, altitude variation, and weather conditions that tell you a lot about a car in a hurry. Also, by retracing large sections of the LTD's route, I had bench marks against which to measure things like ride quality, noise levels, fuel economy, and handling.

What I found was that the new Thunderbird delivers very good fuel economy, with sure-footed *smooth-road* handling and impressive power

for a contemporary car. Complementing that are some interesting and useful new electronic-display innovations. On the negative side, the car suffers from poor rear-quarter visibility, and poor rough-road handling.

On last year's test of the smaller LTD I reached only 13,000 feet on Mt. Evans, because the road was closed for the winter. This year, Merle was my escort to the summit, and I had him drive to get his reactions. We'd hardly left his office in Idaho Springs (8500 feet) when he said in amazement, "This car outperforms my 302 Granada that's lighter and tuned for this altitude." (We didn't get much farther before he was equally impressed with the straight, sure braking that is so important in the Rockies.)

Economical 302 V8

Where the '79 LTD averaged just over 15 mpg on roughly the same route last year, the T-Bird easily bettered 19 mpg. Although they are in different size classes, that's not really an apples-to-oranges comparison. Their ratios of torque and horsepower to weight and frontal area aren't all that different.

Best economy was 24.34 mpg on one westbound leg, but that was approached several times. Since the engine never even hinted at pinging, the ignition timing could probably have been advanced considerably in order

to get a significant economy jump.

Much of the credit for the economy increase must go to Ford's new four-speed automatic overdrive transmission. Even though it has a rather long-legged, mileage-boosting 0.67:1 fourth-gear ratio, that doesn't seem to limit flexibility or performance. Our transmission occasionally shifted a little slowly and a bit harshly, but not to the point of being a problem.

Our car had the 302 V8, the biggest engine available. It's well suited to the car, especially when coupled to the four-speed automatic. Power and acceleration are both surprisingly good. Our only complaint was some stumbling when the engine was cold.

Poor handling on bumpy roads

The new Thunderbird does tend to wander a bit on the highway. It also rides a little harsher and is noisier over tar strips and road irregularities. That was to be expected, though, because we ordered the stiffer, optional TRX handling package.

Right after picking up the car, I noticed it displayed a fair amount of bobbing and weaving when it passed over moderate dips in the road. We'd inadvertently gotten a Ford engineering-department training car, and it wasn't until I got off smooth, interstate-type highways, however, that I found out what was really going on.

Hustling along a mountain road, I became aware that I was working hard to maintain speeds that the LTD had easily cruised at. Then I encountered some routine bumps on a long, sweeping, downhill left-hander.

Where the LTD had swept neatly over them the year before, the Thunderbird suddenly tried to swap ends. I corrected quickly and, fortunately, caught the slide. That's the kind of correction I make dozens of times each month in our track testing, so I'm used to it. But there was a 1000-foot drop-off on the other side, and the average driver might not have fared as well.

The soft front suspension had "mushed in," while the much-stiffer rear had begun to dance. The condition recurred numerous times after that, and proved to be surface-related rather than speed-related. It was kicked off by a particular (but varying) frequency and amplitude of bumps, sometimes as slow as 15 mph on dirt and 40 mph on pavement—in places where you'd normally drive at those speeds.

Subsequent checks revealed that a Ford parking-lot error had netted us the wrong car. (That couldn't happen to you.) Ford said it had the wrong springs and shocks (which *could* happen—with any manufacturer), and felt that had caused the handling dif-

Continued

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Ford Thunderbird

[Continued]

difficulties on bumpy road surfaces.

When the necessary changes were made, the ride and handling were improved, but not greatly. The easy front-end bottoming was gone, but there was still a lot of pitching. The T-Bird still skittered over bumpy sections, and rode too hard.

Interior problems

The high driving position offers a commanding view of the road, but wide rear pillars block vision to both corners. They make risky business of crossing angled intersections and backing out of angled parking.

While the seats are plush and reasonably comfortable for short periods, they're lacking in lumbar support. If you do a lot of distance driving, investigate the optional Recaro seats.

Ford's new digital speedometer is a significant improvement in instrumentation. The big, bright numerals are extremely easy to read at a glance, and aren't distracting at night. The vacuum-fluorescent graphic fuel gauge is also very nice, although ours didn't always return to the proper reading after hilly sections.

Unfortunately, in daylight driving, reflections on the instrument panel made even the brilliant displays hard to see. Also, I couldn't see the LOW FUEL light even when I knew it was on. At night, the large high-beam indicator light was completely obscured by the steering wheel.

It was also surprising to find that the defroster wasn't particularly effective, especially at the top center of the windshield. The powerful-sounding fan moves relatively little air, either for defrost or ventilation.

On the plus side, the back seat is roomy and comfortable—four inches more knee room. Trunk capacity is also very good, and the space is quite usable. There's a deep well in the center, where grocery bags, suitcases, and large parcels will fit vertically.

Overall, I have very mixed feelings about the new Thunderbird, regardless of all of the problems caused by the incorrect components in the suspension. The concept of a smaller, roomier, more fuel-efficient car is, of course, faultless. But transferring that concept to metal, glass, and fabric has left a number of areas seemingly overlooked. Great potential does exist, however, and I'm certain Ford is working hard to develop it. In the meantime, though, the new Thunderbird isn't as plush, stylish, comfortable, or quiet as it once was. Though it's no longer a class leader, it's still a nice car.



Sometimes It Pays To Have Nosey Friends

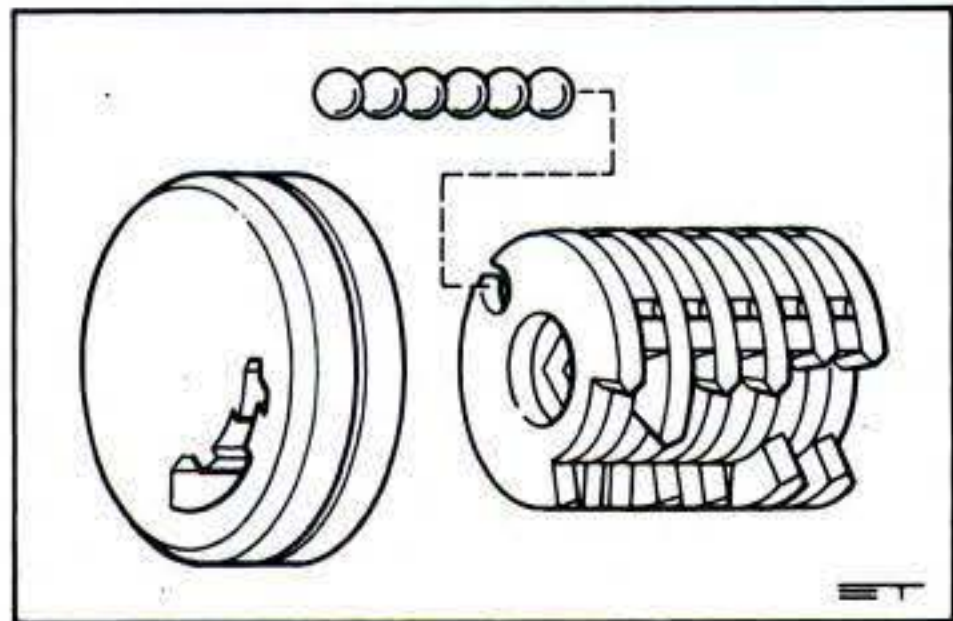
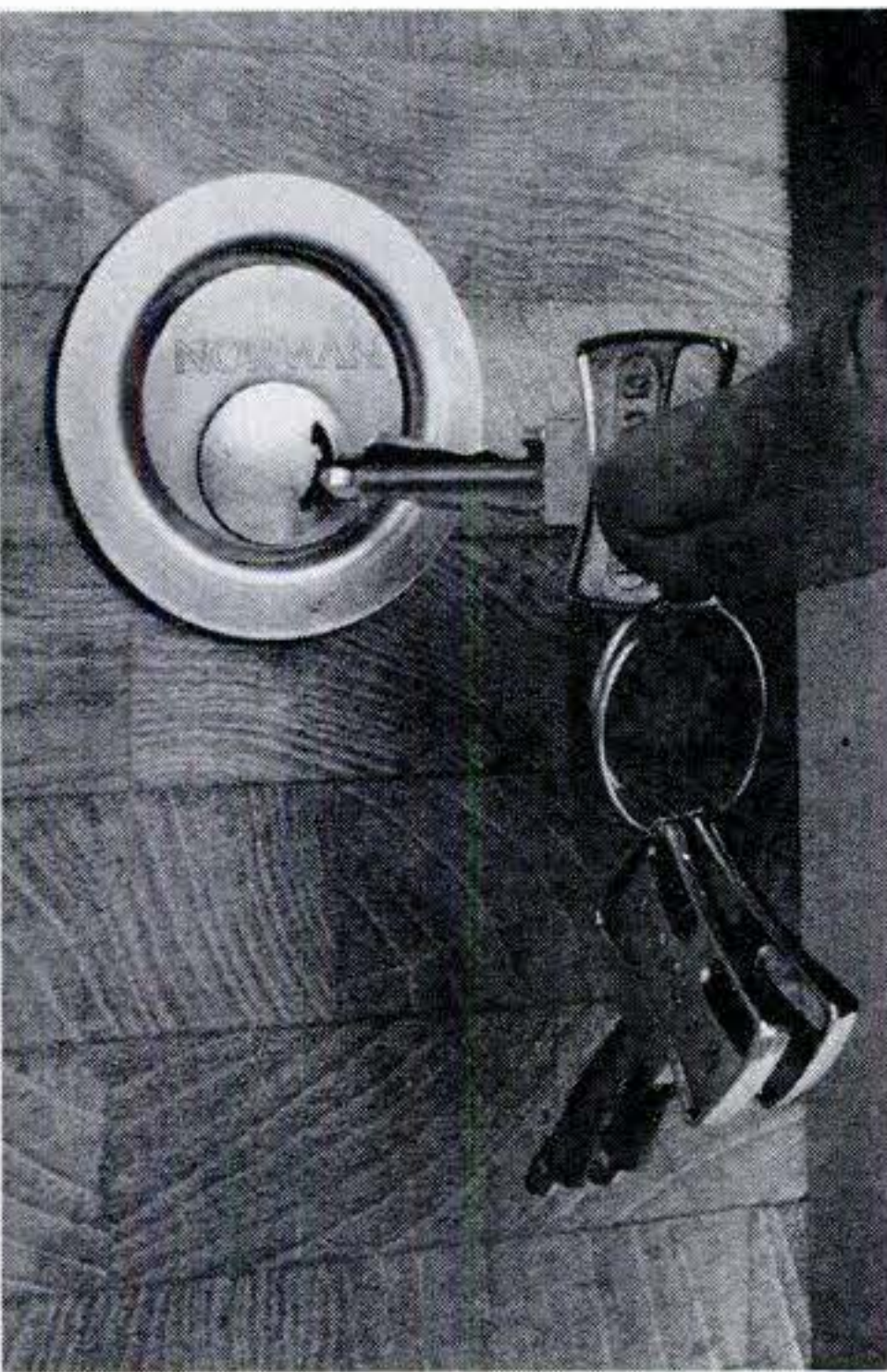
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It looked simple, but a group of professional locksmiths were unable to pick their way into a small compartment that held \$1000 in prize money for anyone who could succeed.

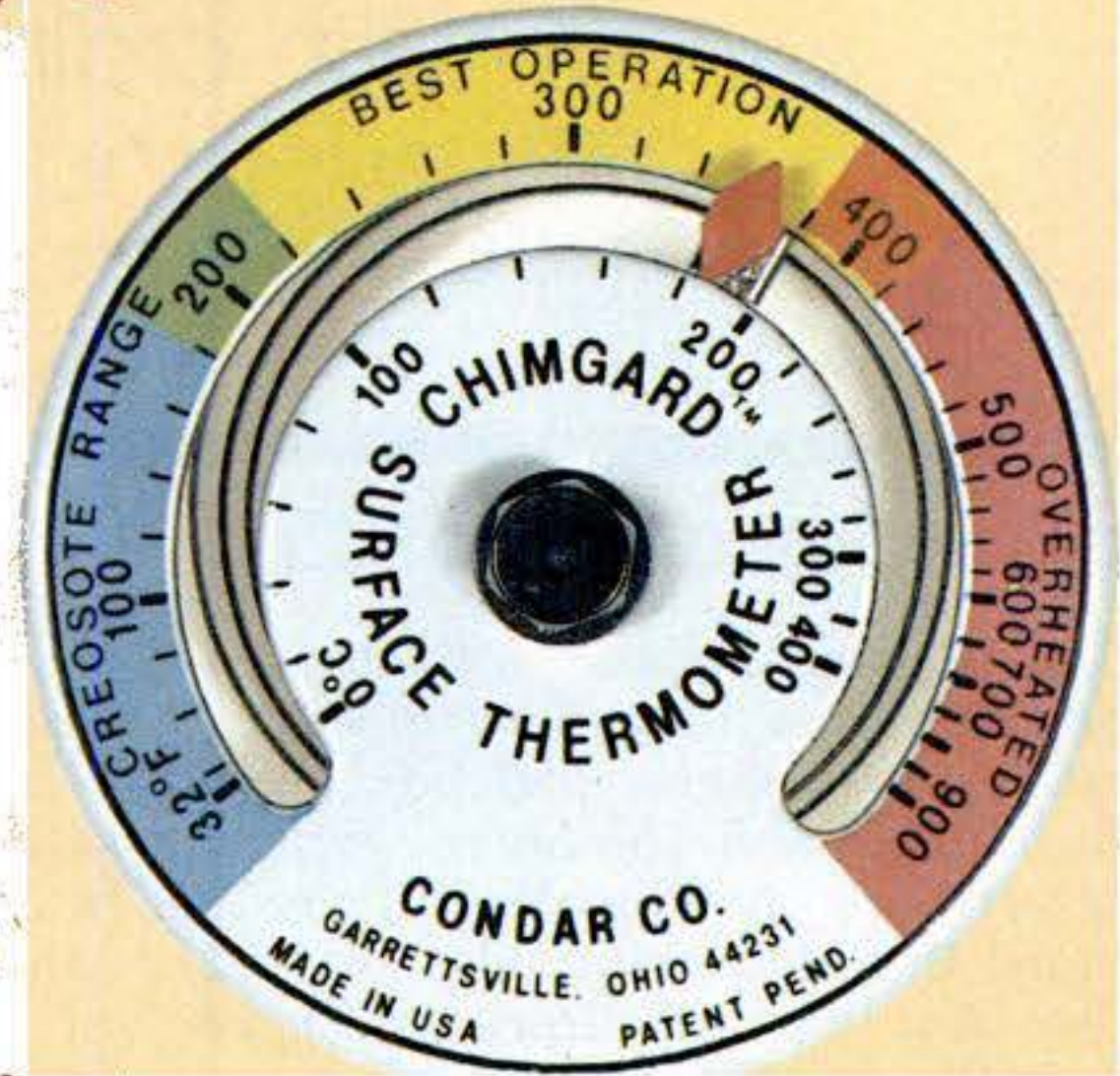
The thing that stymied them was a unique lock cylinder that has a curved keyhole, with computer-designed keys available only from the factory. An extra push is required to insert the key completely and simultaneously align the unlocking elements—balls instead of pins. This foils picklocks, who work by aligning elements one at a time.

The designer of the Norman High Security Lock Cylinder, Norman Epstein, is an escape artist who says he can pick most locks—but not his own. The cylinders will be sold (for about \$35) for rim or mortise locks. Maker: Pragmatic Mfg. Corp., Rte. 301, Carmel, N.Y. 10512.—*Sandi Doughton*

A Thermometer for Woodstoves?

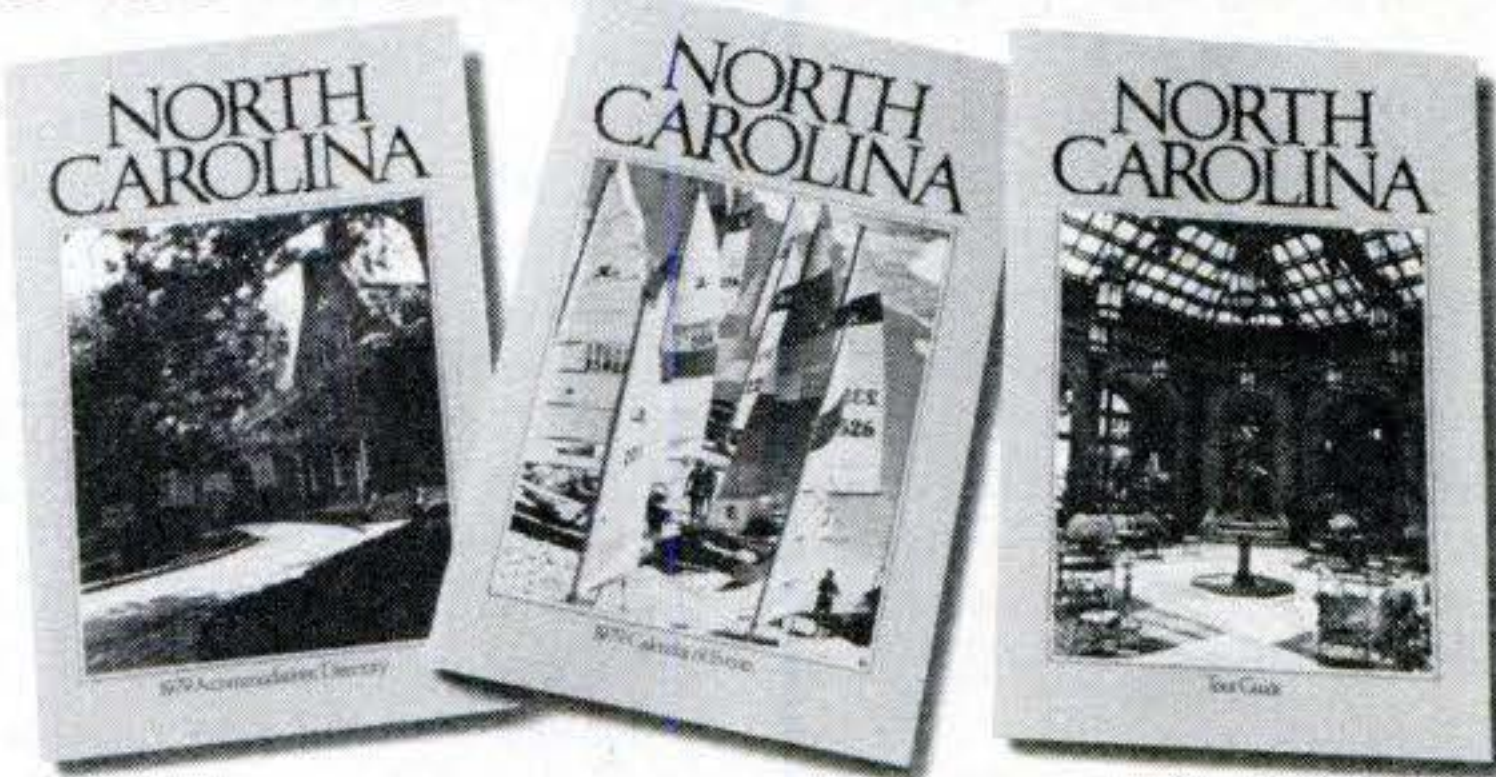
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Save energy

with ordinary roller shades

By PAUL BOLON

Simple roller shades may be the easiest and most cost-effective way to reduce your winter fuel bill. David Buchanan and Maureen Grasso, researchers at Cornell University, found that ordinary shades cut window heat loss by a surprising 30 percent. Shades with an aluminized surface that reflects radiant heat back inside the house conserve 45 percent of the normal heat loss.

There is only one secret to getting this kind of performance from shades: They have to fit snugly in the window. Shades must be mounted inside the window frame and hang an inch or less out from the bottom sash, with only 1/4-in. clearance on each side. When unrolled, they must touch the sill and leave less than an inch gap above the roller. A shade installed more than an inch from a window or that does not close the air gaps is dramatically less effective.

Buchanan and Grasso achieved their results testing off-the-shelf, vinyl-coated products. They made their own reflective shades by adding Du Pont's Mylar film to a regular shade.

How important are windows in conserving heat? And how do shades compare in cost and savings with other heat-saving solutions for windows? In a house with 5 1/2 in. of fiberglass insulation in the ceiling and 3 1/2 in. in the walls, about 25 percent of the total heat loss is through the windows. Only attics and ceilings lose more. Glass is such a good conductor of heat that even small windows create strong convection currents when it's cold outside. These air currents increase the chilling effect of glass by bringing more air into contact with the window and circulating the cold air throughout the room. Close-fitting shades isolate this circulation from the room and minimize the volume of air that the window cools.

To test the effect of completely blocking the windows (for best possi-

ble heat savings), Buchanan and Grasso added simple wood channels on the sides and sealed the air flow above the roller with denim. This arrangement increased the heat savings with regular shades to 40 percent and with Mylar shades to 55 percent—which about equals the performance of storm windows. Using channels also counteracts the tendency of shade edges to curl.

Compare the alternatives

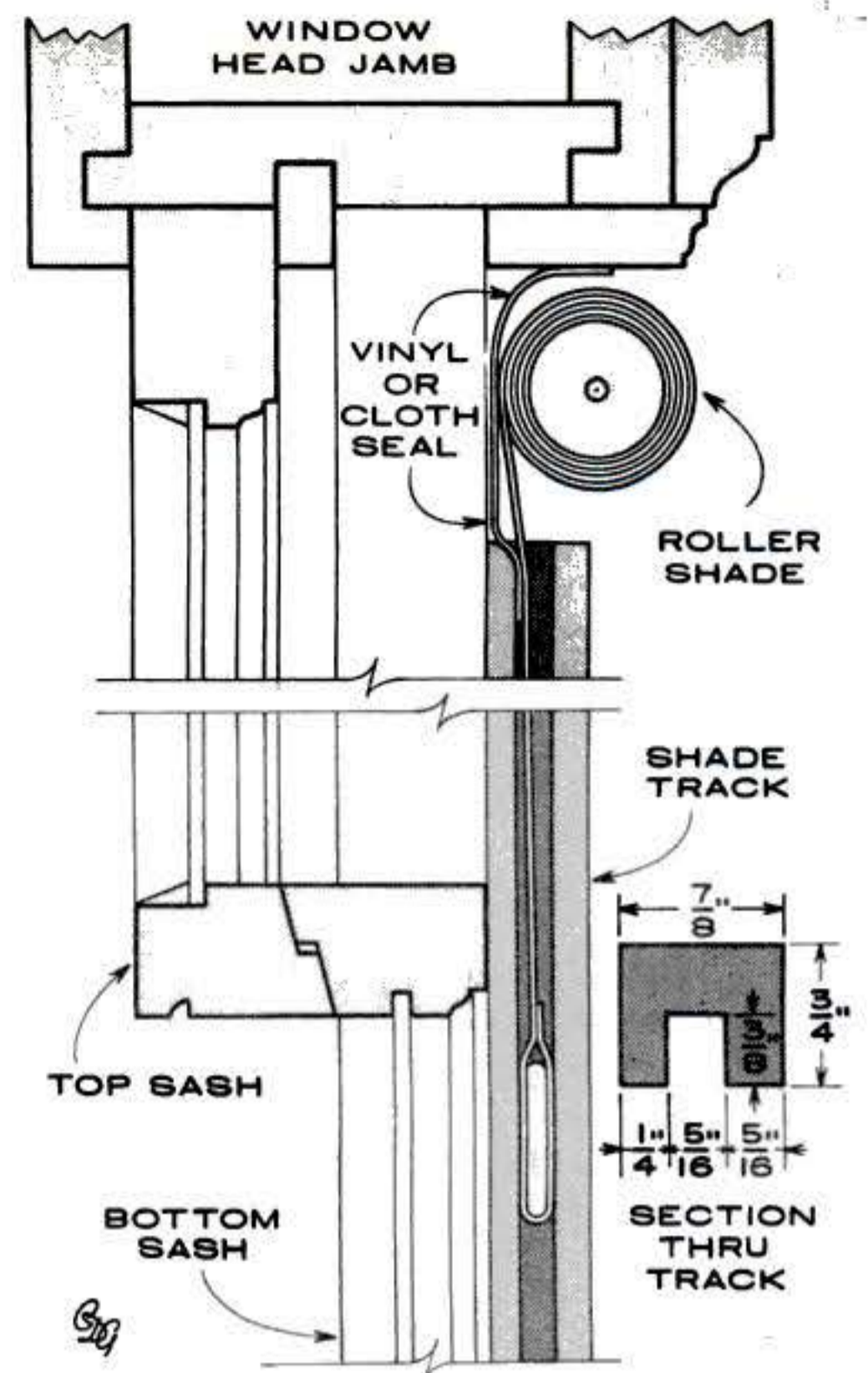
- Storm windows reduce heat loss through windows by about half. They are a long-lasting investment and are relatively expensive. Their payback period in fuel savings will be at least three years—more likely four or five.

- Fabric does a wonderful job of keeping your body warm, but when used for curtains it does almost nothing to insulate windows. If curtains are lined with a vinyl or other impermeable liner, they partially reduce the flow of air. But conventional installations do not effectively seal air flow around a cold window.

- Venetian blinds also have little value as a barrier to the cold.

- PS reported on insulating shades [Jan. and Oct. '79] that have several layers of film and Mylar running in channels two to four inches wide in the window frame. These may require considerable modification of the window frame to install, and they are relatively expensive. Also, they are best suited for large areas of glass, such as picture windows and sliding patio doors, which are commonly of single-pane construction.

Roller shades are cheap (\$6-\$10), install easily, and have a payback period of one or two years, even without channels. They are ideal for cutting heat loss in little-used rooms. Drawbacks are the occasionally balky roller springs in older shades and the need to adjust shades manually. If you have shades already mounted on the window casing, it's easy to cut them down yourself to fit the inside dimension.



How to construct side tracks

To make side tracks or channels for a shade, first examine your windows. If the window stop, or guide, is less than an inch wide, simply add a small piece of wood—about 3/8 by 3/8 in. will do—and use the stop as one of the tracks. Leave about 5/16 in. between the stop and the wood for the shade to run in. If the stop is wider than one inch, you can mount the shade brackets on it and use two small pieces of wood, or a single piece of wood with a groove, for the channels, as shown in the figure. You can also replace the stop with a track arrangement. The track should extend from two inches below the roller to the sill. The top seal is tacked or stapled above the roller, and can be almost any flexible material: extra shade stock, plastic, or heavy cloth. It must be heavy enough not to be affected by rolling the shade. The shade may be closer than an inch from the window—just so it doesn't touch the glass. Measure for shades after you've made the channels, making certain to leave 1/4-in. clearance on both sides. For a perfectly fitted shade, screw in the first bracket, unroll the shade in the window, then mark the placement for the second bracket, and screw it in.

Shades will save about the same percentage of heat loss if you already have storm windows, but they will be less cost-effective because the storm windows will have already halved the loss. If, for instance, storm windows and tracked Mylar shades are both installed, 75 percent of the heat lost through single-pane windows will be saved.

During the day, you can gain heat by raising the shades in sunny windows. And if you air-condition your home, opaque white shades will save more on your energy bills in summer than in winter. E3

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RECREATION ROUNDUP

By HERBERT SHULDINER

Snowmobile mecca

For the past 15 winters, I've traveled all over the North American snowbelt on snowmobile trips. I've driven the perky little ski-scooters in the high Rockies, the level forests of the upper Midwest, and the scenic hills of New England and Quebec. In the process, I've become acquainted with many of the "snowmobile capitals of the world": Rhinelander, Wis.; Brainerd, Minn.; West Yellowstone, Mont.; and numerous other small towns where snowmobiling is a consuming passion.

Surprisingly, though, I had never been to Old Forge, N.Y., in the Adirondacks, even though it's only about a five-hour drive from my home north of New York City. I decided to remedy this late last winter and packed my family and duffel bags full of warm clothing into a Ford van to head for this snowmobilers' magnet.

Even though there was barely any snow alongside the New York Thruway, which takes you within an hour of Old Forge, there was plenty of the white stuff in the Adirondack town. Even more important, there was still plenty of snow on the trails that radiate all through the area. That report came from Doug Bennett, owner of the Big Moose Inn, where my family and I stayed.

Bennett specializes in accommodating snowmobilers every winter, often acting as tour guide to groups of guests who want to do more than routine trail riding. Some trips have been to places as distant as Lake Placid, about 100 miles away. You can actually snowmobile all the way to Canada from Old Forge by tying into other trail networks.

500 miles of trails

My trip started about midday Saturday with Bennett leading the way. Besides the five in my family, there was Bruce Nash, owner of the local Ski-Doo dealership, who provided the snowmobiles for our group, and Dick La Beau, a district manager for the Ski-Doo distributor in New York.

Getting onto the Old Forge trail network is easy. There are numerous entrances leading from many hotels, winter campgrounds, restaurants, and other popular spots in town. We started out from right in back of Bruce Nash's showroom, hooking up with an incredible array of marked trails—about 500 miles of them mapped and maintained by the Town of Webb, N.Y., which encompasses Old Forge and five other hamlets (Eagle Bay, Beaver River, Stillwater, Big Moose, and Thendara).

Virtually all of the trails are on private lands and snowmobile clubs in the area pay to obtain rights of way from the individuals and companies who own them. The trails are carefully laid out for two-way traffic and are exceptionally well marked. There are heated restrooms at frequent intervals, and the routes pass many good eating places where you can warm up and rest.

The traffic was fairly light on this day, probably because it was late in the season and the trails were not in prime condition.

That wasn't the fault of the town, however, but of the fairly warm (mid to high 20's) temperature. When the snow softens, trails tend to develop more moguls than usual. Even frequent grooming can't keep trail surfaces from developing a washboard look—and feel.

3000 machines in a weekend

Early in our ride, we encountered one of three machines the town uses to groom the trails. It was operated by Frank de Camp, one of six who man the machines on two shifts during weekends. De Camp was running a \$37,000 Bombardier Ski-Dozer 252, but took a break to fill me in on the trail-grooming program.

"We go where the traffic is," de Camp told me. "Trail 5, one of our busiest, gets hit three times a day. Other busy trails are groomed once a day, and all of the 300 miles we maintain are tackled at least every other day."

Why did they need so much attention, I wondered. The amazing number of snowmobiles on the trails is the reason, de Camp says. "I've spotted as many as 350 snowmobiles in a half hour," he says. "And about 3000 snowmobiles use the Old Forge trails in a good weekend."

Snowmobilers come from all over the northeastern U.S. and southern Canada to use the trail network. Sometimes a half-dozen clubs will descend on Old Forge for a weekend, coming from Ohio, Pennsylvania, New England, and Quebec. Virtually all visitors trailer their own snowmobiles. There aren't too many rental machines available, but there are plenty of guides who will take groups out for trips. Some guides charge only \$30 per day.

12,000 permits every year

The Town of Webb sells about 12,000 trail permits a year for \$15 each. (Not having a permit can result in a \$25 fine.) This goes to pay for trail grooming and for acquiring rights of way and the printing of maps, which are extremely well done.

On weekends, there are two patrol sleds on the trails, manned by local police who check on registrations. "As long as your snowmobile is registered someplace, you're welcome here," says Bennett. Of course, you also need the special town sticker which the police also check for. In addition, a game warden patrols the trails.

Neither the police nor the game warden has very much to do, Bennett claims. The coy dogs (a cross between a coyote and a dog) in the area are about the only things that bother deer in winter. There have been a few cases of snowmobilers chasing wildlife in recent years, but they are infrequent occurrences, Bennett claims. And there aren't many cabin break-ins, either. Snowmobiles can reach remote cottages and cabins, but few use the machines for this purpose, Bennett says. "We do have a snowmobile stolen once in a while," he told me. This is a growing problem in all snowmobile areas.

After a ride that lasted most of the day, we emerged from the trails at the local airport. Not surprisingly, it gets taken over by snowmobilers during the winter. And it is a fairly wild drag strip. The long runway allows drivers of hot snowmobiles to speed at full throttle, something that's almost impossible to do on the twisting trails. The strip keeps hot rodders off the regular roads where they might attempt to hold impromptu races.

It seems to me that this town, with only about 2000 year-round residents, has really put it all together for snowmobilers. It's been a profitable thing for owners of resorts and other tourist attractions, too. Bennett says most resorts couldn't exist without the revenue snowmobilers bring in, despite the fact that Old Forge is a popular summer vacation area, drawing over 25,000 warm-weather visitors.

Snowstorms don't stop traffic

During the last 10 winters, average annual snowfall in Old Forge has been 280 inches, and temperatures often plunge to -40°. Does this make it tough to get in and out of town? Roads are constantly plowed, Bennett says, and it's a very rare occurrence when guests aren't able to depart on schedule.

I was also quite impressed with the way the town has solved most of the problems snowmobiling has caused in other places. Attracting machines to an area that's prepared to handle them is a big help. With trails created on private lands, snowmobilers aren't tempted to take their machines into the nearby Adirondack Park, where they're banned. This prevents any potential damage to park lands or wildlife. Most snowmobilers, however, dispute allegations that snowmobilers' use of the park would damage either wooded areas or wildlife. Having the alternate area, though, makes the argument academic. The only penalty to snowmobilers is that they have to pay for land use now. Being able to use park lands would save a lot of money.

If you'd like to visit Old Forge, you can get additional information from the Tourist Information Center, Old Forge, N.Y. 13420. 5

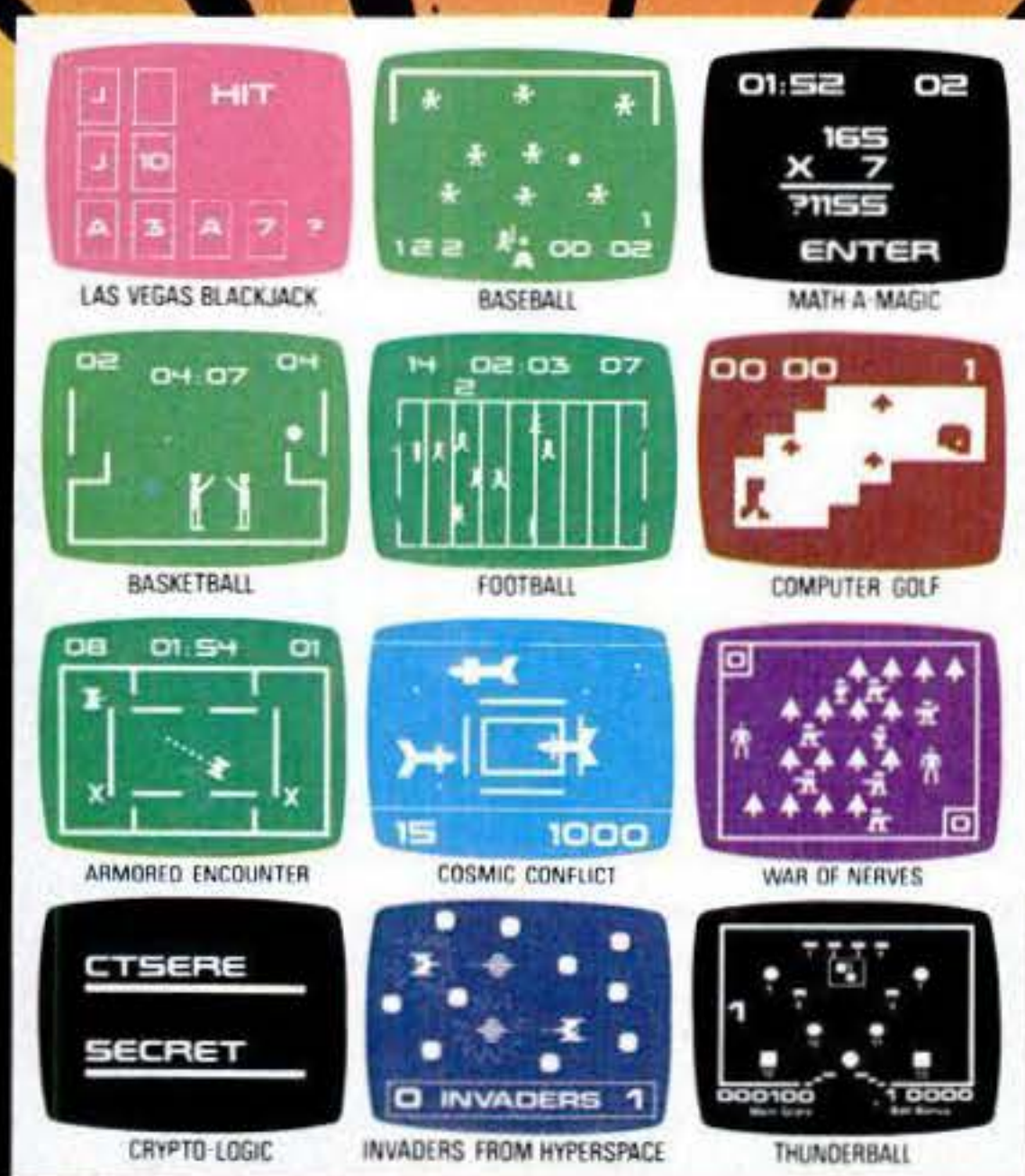


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A man with dark hair, wearing a bright yellow raincoat, is shown in profile from the chest up. He is holding a lit cigarette in his right hand and looking out over a dark blue sea under a bright blue sky with scattered white clouds. The background shows the railing and part of the boat's structure.

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DETROIT REPORT

By JIM DUNNE

PROCO report

Ford's programmed-combustion engine, now in development and set for 1983 introduction, requires such precise construction that one insider says, "We don't know if we can build it." A PROCO-powered fleet is now in operation as a final test of durability and reliability, but noise and vibration are still problems. That's because PROCO (called the gasoline diesel) has a rather high compression ratio for a gasoline engine, and the increased combustion pressures are heard and felt inside the car. The engine uses two special spark plugs per cylinder to promote complete combustion. Says one Ford man, "It looks odd with all the spark-plug wires hanging out, but it may be the savior of our V8-engine lines." Only Ford is so optimistic about the V8's future.

Ford's diesel

Despite reports from Ford brass that the company is depending on its PROCO engine exclusively, a diesel engine is now in the running for its big-car power plant of the future. Last summer, Ford hired Cummins to design a six-cylinder, 3.2-liter (195-cu.-in.) diesel. At first, Ford executives claimed that the Cummins deal was a backup to PROCO, that the engine would not be produced unless PROCO struck out. However, Ford has changed its mind, prodded by GM's success with the Oldsmobile diesel. The Ford diesel will go into production just as soon as it's ready—which could be within two years. Cummins is designing the comparatively small diesel with a turbocharger to boost power, making it suitable for all Ford models bigger than the Pinto/Bobcat, which is due for replacement in 1981.

Chrysler's diesel

Chrysler, too, has a diesel—a revised version of the 225-cu.-in. Slant Six. There are two versions on the shelf, waiting for the money to put them into production. One is a normally aspirated engine, the other turbocharged. The basic design has pre-chambers and uses a beefed-up gasoline-engine block. Horsepower is very close to that of the gasoline six—95 vs. 100—but fuel economy is 25–30 percent better, according to Chrysler reports. The turbocharged version puts out 135 horsepower, yet delivers an average city/highway 21 mpg in a full-size St. Regis. Chrysler will first concentrate on producing its 2.2-liter, four-cylinder gasoline engine for the new line of compact cars due next year, then turn its attention to the diesel.

Chrysler's K-car

The front-drive replacements for Volare and Aspen are set for introduction next fall as 1981 models. They will be built in two- and four-door notchback and station-wagon models. Insiders say they resemble the new Buick Skylark most of all. They also point out that the use of a notchback body in the sedans will help separate the new cars from the Omni/Horizon. The wheelbase of the new compacts will be 100 inches, versus 112.7 for the current Aspen/Volare—within an inch of the Omni/Horizon. Look for the new models to have a much bigger body and wider track, to help distinguish them from subcompacts.

High-performance Chrysler

A special, high-performance version of the 2.2-liter, four-cylinder engine Chrysler is preparing for its 1981 small cars will be offered in two-door models. The revised engine is being developed in Italy by de Tomaso, and uses a turbocharger. This engine will be offered in both the new compacts and in a supersport version of the Horizon TC3 and Omni 024.

Future electric vehicles

Look for electric power to be used first in vans and delivery vehicles, despite General Motors president E. M. Estes's recent statement that no decision has yet been made. The inside word, from both GM and Ford, is that the van—not the commuter car—will be the first choice for electric power. There are several reasons: The batteries can be carried and maintained more easily; delivery vans spend much of their time at idle; recharging time can easily be scheduled overnight; the low speeds and short city routes are ideal for the types of electric power plants now being developed. Commuter cars have disadvantages, including long trips and/or high speeds, when power would quickly be drained from batteries.

Another small pickup

Volkswagen's compact pickup is already on the road, but GM is not far behind. An American version of the Japanese-built LUV half-ton pickup is in development, and should make its debut before the end of 1980. The new Chevy will be slightly bigger than the LUV. It will feature softer styling and a Styleside-like cargo box, and will have the proportions of a Japanese import. Chevy plans to use GM's own four-cylinder engines and transmissions

for the new pickup. Prototype vehicles have been seen undergoing pre-production testing.

Japan going front drive

Look for the Japanese to quickly change their high-volume small cars over to front-wheel drive. The success of General Motors' X-cars, and the superiority of the Volkswagen Rabbit and Chrysler's Omni/Horizon have not escaped the Japanese producers. Even though some have already changed, the Japanese lag behind most European and some American producers. Toyota, Datsun, and Mazda will move quickly to bring out new lines of front-drive cars in the next two years. By that time, GM, Ford, and Chrysler will all have new front-drive small cars of their own. Eventually the changeover will stretch virtually across the entire small-car spectrum; the packaging benefits are too great to ignore.

Chrysler will still buy from VW

When the current agreement to buy 1.7-liter VW engines runs out at the end of 1980, Chrysler will renew its contract with the German auto maker, but on a different basis. Instead of buying 300,000 1.7-liter gasoline engines per year, Chrysler will use its new-for-1981, 2.2-liter four, and ask VW to supply diesel and turbocharged engines. Eventually, Chrysler plans to build all its own engines. For now, though, the additional supply from VW will fill special engine needs.

Chrysler's explanation

Chrysler says its financial troubles are caused, in part, by safety and emissions laws that penalize it more than GM or Ford. It costs Chrysler "almost twice as much as it will cost GM" to meet these regulations on an individual, car-for-car basis, according to a Chrysler report. Since all companies have to develop engines and exhaust systems to meet the same regulations, GM's higher sales volume cuts its cost per car substantially. The Chrysler line does make sense—until you compare costs for foreign car makers. Their volume is tiny in comparison to Chrysler's, yet they continue to operate at a profit.

GM's two-seat commuter cars

GM has two prototypes for two-seater economy cars running around its Milford, Mich., proving grounds. One is a shortened Plymouth Horizon with two bucket seats, plus a large storage area replacing the rear seats. Except for the shortened profile, some fender bulges, and a Chevy "bow tie" emblem on the grille, its appearance is little different from the production Horizon used as a base. The second car is quite different in appearance. Its front end looks like a Monza, while the rear is like a Chevette. A large hatch window wraps up into the roof at the rear. Both cars are prototypes for GM's economy commuter cars of the 1980's, but don't look for their public unveiling until 1982, at the earliest. P 5

People write to



Have a question about motor oil? Lubricants? Engines? Ask the Pennzoil experts...

Change You Must. I have an inboard engine boat that is used very infrequently. I use a 30-weight motor oil in this boat engine, and change the oil and oil filter every year. Is this really necessary since the oil is never dirty when I do change it? Does the oil lose any of its protective properties over the course of a year?

D.A.C., Atlanta, Georgia

Although you do not put many hours of operation on your boat engine, we still recommend that you change the oil and filter every year. Oil which sits for a long period of time in an engine may be subject to deterioration from moisture in the atmosphere. Oil loses its protective properties from the contamination of the fuel being burned by the engine. Contaminants such as soot, acid, water, varnish and dirt are held in suspension by engine oil additives. Eventually these materials will cause the oil to lose its lubricating properties. It is for your own safety and protection that you should continue your present practice of annual oil changes.



Whistle While You Work. My 1968 automobile constantly whistles upon start-up and idling. The noise leaves when speed is accelerating. My mechanic has lubed the fan and power steering belts, but that has not helped. What would you suggest?

C.R.M., Lyndhurst, Ohio

Since the noise does not appear to be coming from any of the belts on the car, we suggest you check the exhaust system. Any area of the exhaust which is not properly sealed may make a whistling noise. The noise you described may be coming from your car's exhaust manifold. You should have all the connections from the header pipe back to the tail pipe checked. If the exhaust

system is not the problem, have your alternator checked. A bad bearing in the alternator could also be the cause of engine noise.



Cold Shift. During the cold weather I have been experiencing shifting problems in my '74 wagon. Once the car warms up, the shifting is easier. Any suggestions for easier shifting?

R.L.W., Canton, Ohio

It is not unusual for hard shifting to occur in an automobile in cold weather. The problem you have encountered may not be abnormal. We would suggest, however, that you change the transmission and differential fluids. We recommend Pennzoil 4096 80W-90 Gear Lubricant for both applications. It's possible that your present gear oil is too heavy or contains dirt which would contribute to your shifting problems.

Keep The Lead In! I have been using premium leaded gasoline in my 1968 Oldsmobile. What adjustments would have to be made in order to use unleaded fuel in this car?

R.G., Rockford, Illinois

You will have to continue using leaded gasoline for the life of your 1968 Oldsmobile unless you have the valve train completely overhauled and new heads and valves installed. Older engines require lead to help protect the valve seats. Therefore, if you don't overhaul your valve system, the use of unleaded fuel might very well ruin your valves.

Take A Brake. I've recently been advised that a car with high mileage should have its brake fluid changed. My car has 74,000 miles on it, and I have never changed the brake fluid. What would you recommend?

P.J., San Antonio, TX

Condensation and rust do develop in

the brake cylinders. Brake fluid eventually becomes contaminated with moisture; therefore it should eventually be changed. A safe practice to follow is to install new brake cylinders and change brake fluid when brake linings are replaced. Remember that brake cylinders should be completely honed out to remove rust when new brake linings are installed.

Carbon Complaint. What could cause excess carbon to build up on my air filter? I had my carburetor tuned up, but one week later the filter was clogged up again. When I start my car in the morning, carbon comes out of my exhaust pipe. What do you suggest?

C.T., Staten Island, N.Y.

Excessive carbon deposits are usually the result of improper air-fuel mixture. Since you are getting excess carbon build-up on the air filter, it appears that there is some blockage in the crankcase ventilation system. You should have all your hoses checked to make sure they are not plugged and be sure the PCV valve is not sticking. Also check the choke for proper operation, especially while the engine is cold. If the car is backfiring, this would indicate improper timing which would also provide excess deposits on the air filter.

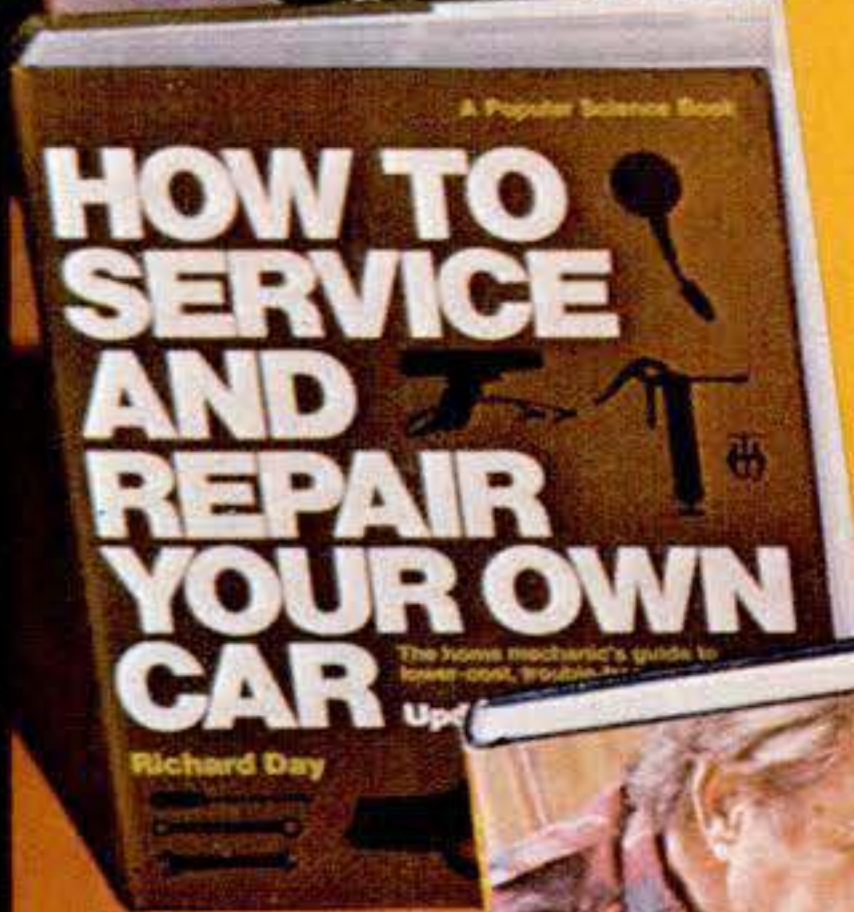
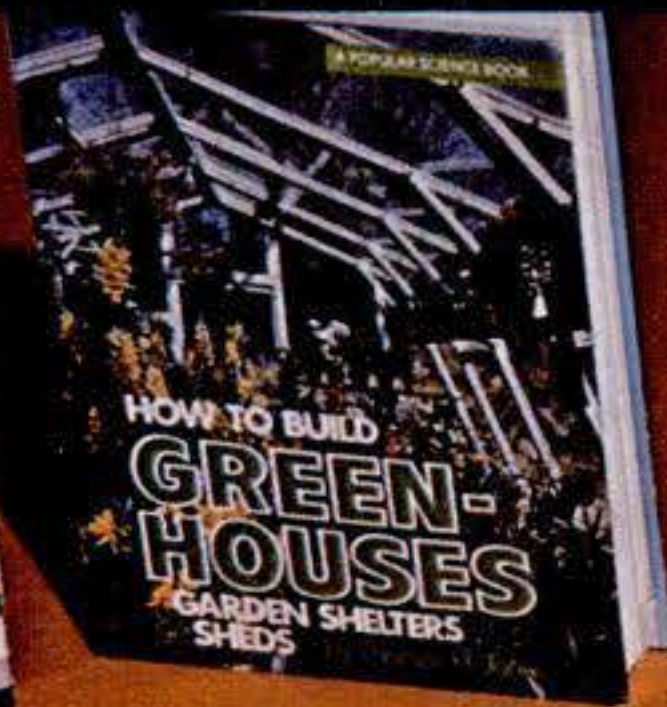
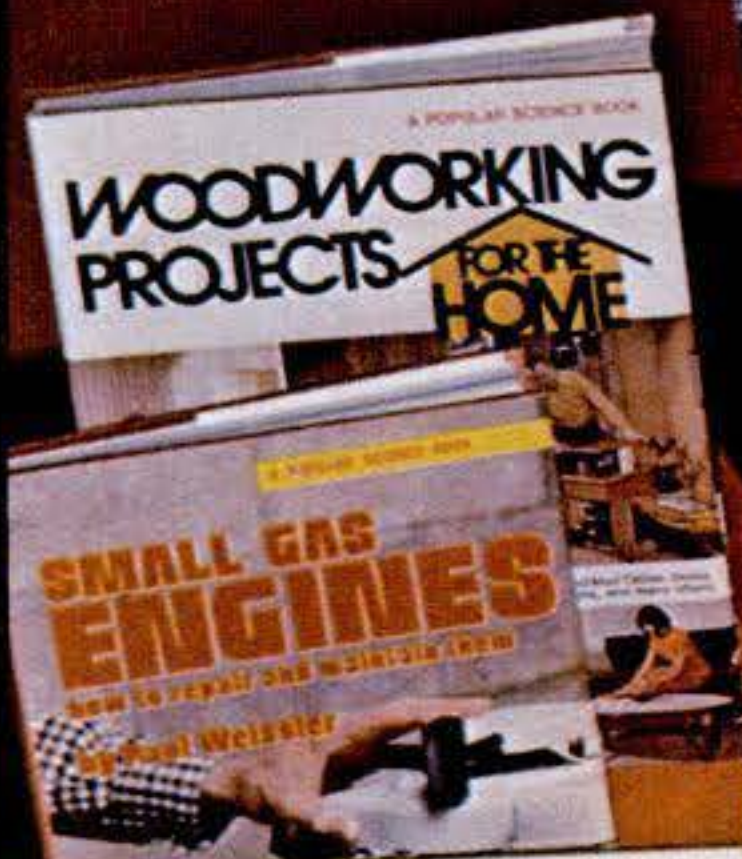
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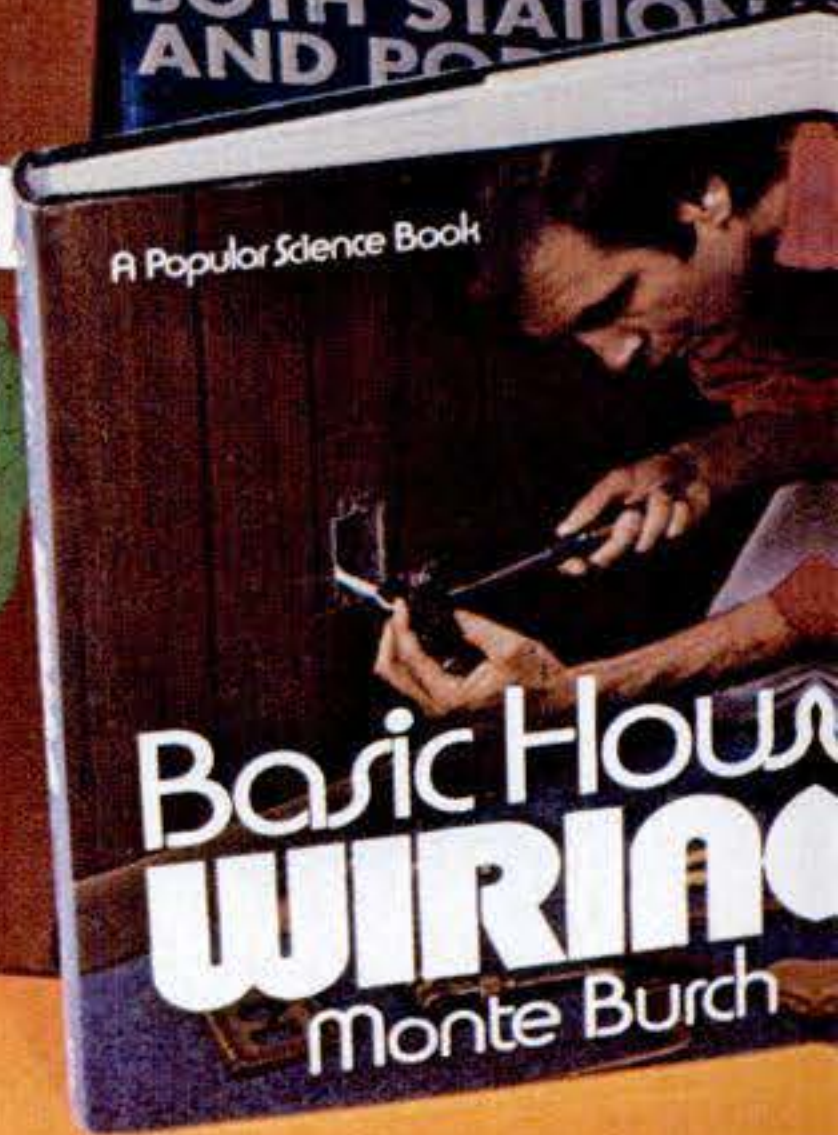
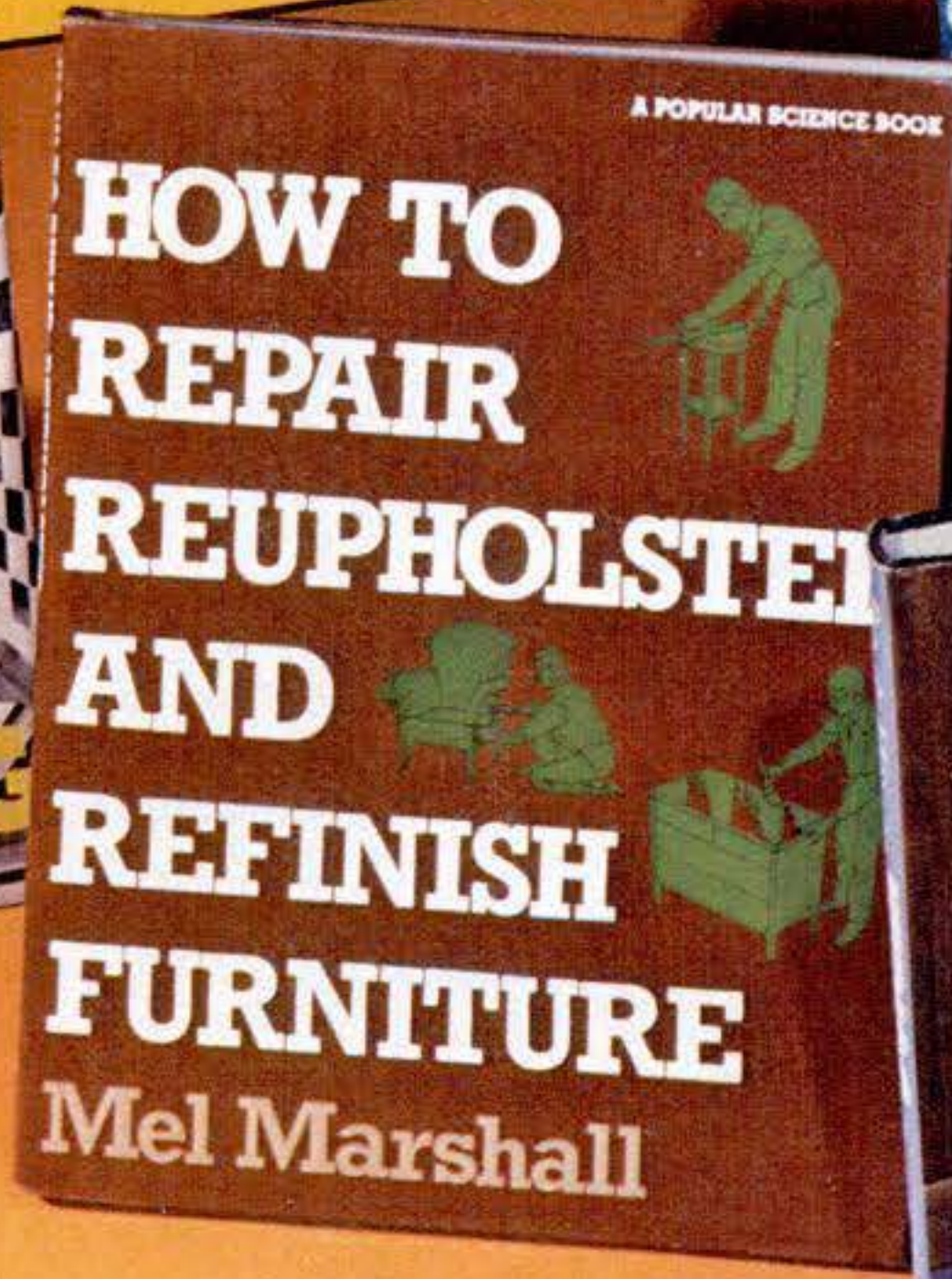
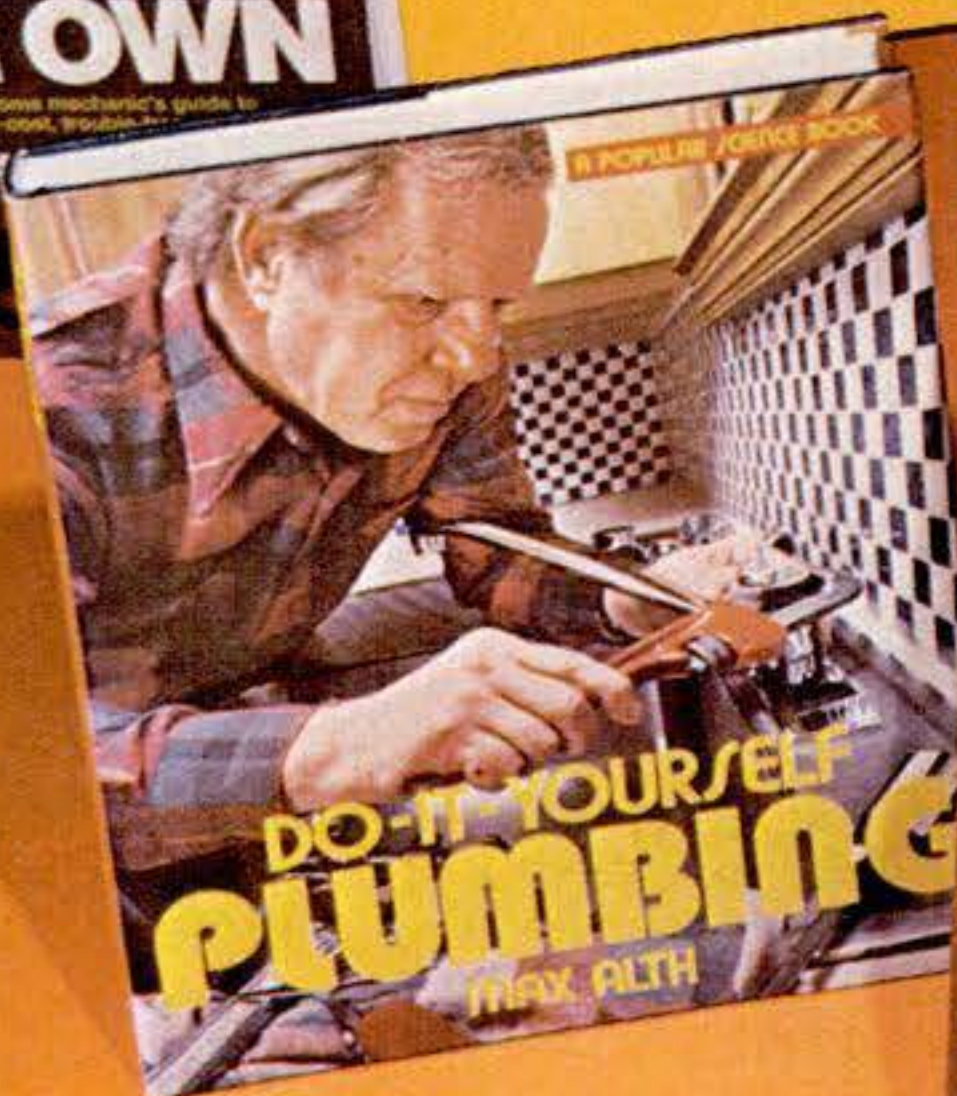
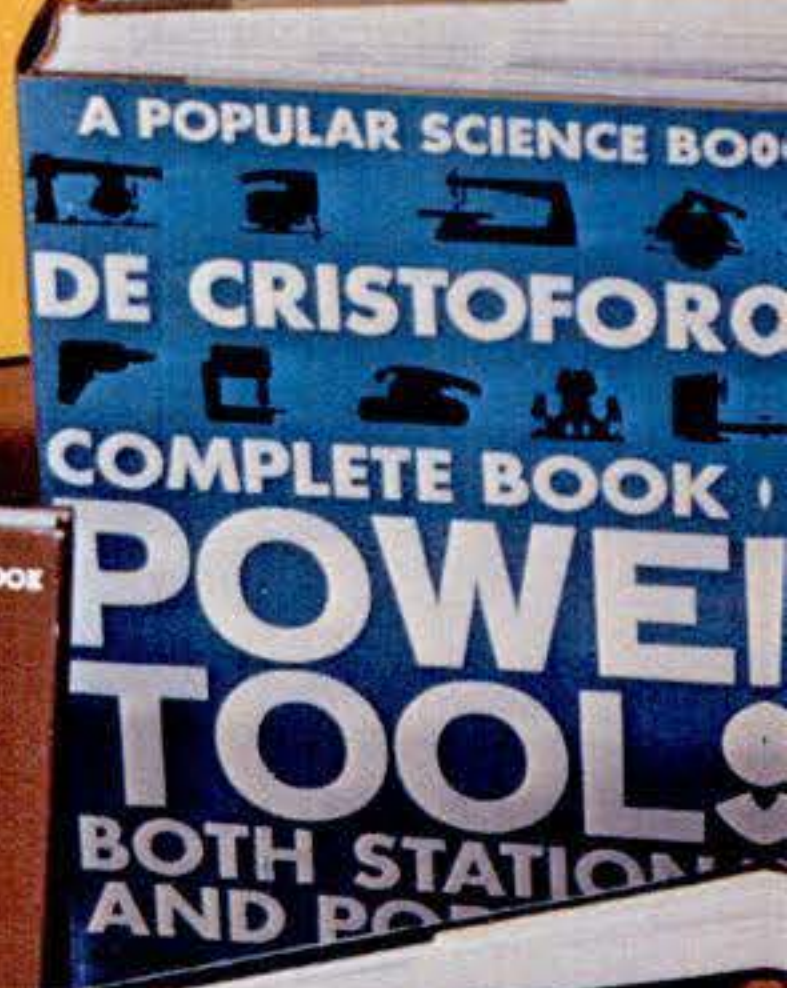


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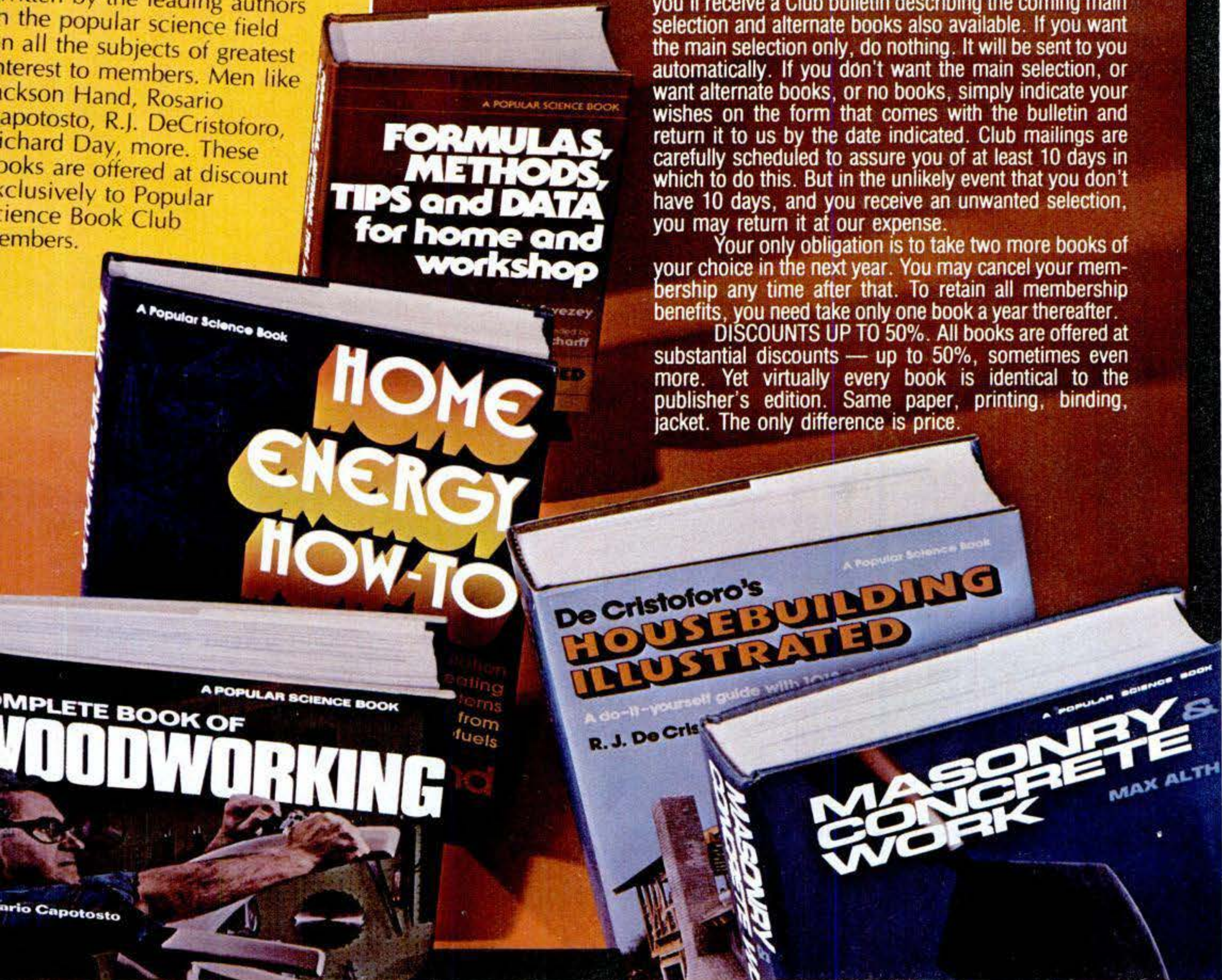
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Railroad safety

—tough new tests
help prevent disasters

Research is reducing the risks of transporting hazardous material by rail

By WILLIAM H. MCKENZIE

On a barren plain near Pueblo, Colo., there's a strange 75-car train that runs throughout the night but goes nowhere. Hopper cars creak with heavy rock loads; water sloshes in metal tank cars as the train maneuvers around curves; truck trailers atop flat cars sway in the moonlight. Five nights each week, beneath distant Pikes Peak, the train continuously circles a 4.8-mile track loop.

"It's boring," says Ernie Register, former locomotive engineer for the train. "You think about going fishing, something at home—anything to occupy your mind. You can't go to sleep." On Feb. 27, 1979, crew-member boredom was forgotten when 24 cars in the middle of the train derailed with

a screeching crash on a broken rail.

But the train and crew had done their job, pinpointing a weak link in the system, although this mishap was unexpected.

The looped track is called FAST—the Facility for Accelerated Service Testing. "We see the FAST program as a giant wear test," said Pete Cramer, FAST operations manager. This one test track in less than three years has carried over 400 million gross tons—as much freight as a busy railroad would have in seven to 10 years. FAST is part of the Department of Transportation's test center in Pueblo.

Elsewhere across the sprawling test center are the Rail Dynamics Laboratory that tests train performance under varying conditions, sidings that contain experimental sensors to detect problems *before* they cause accidents, and other test facilities.

The mission of the center is to try to

reduce the growing number of train derailments and accidents that have plagued the nation's railways, and to minimize the impact when accidents do happen.

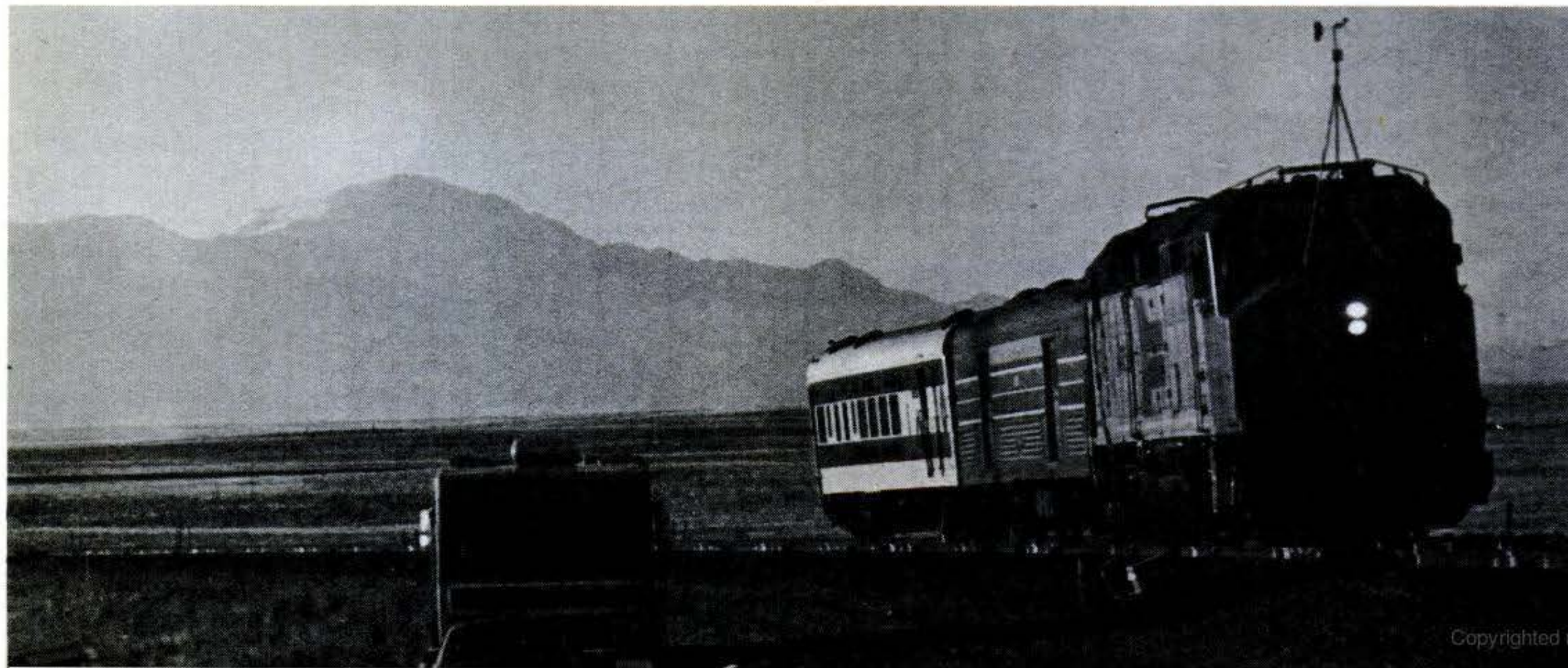
Deadly cargo

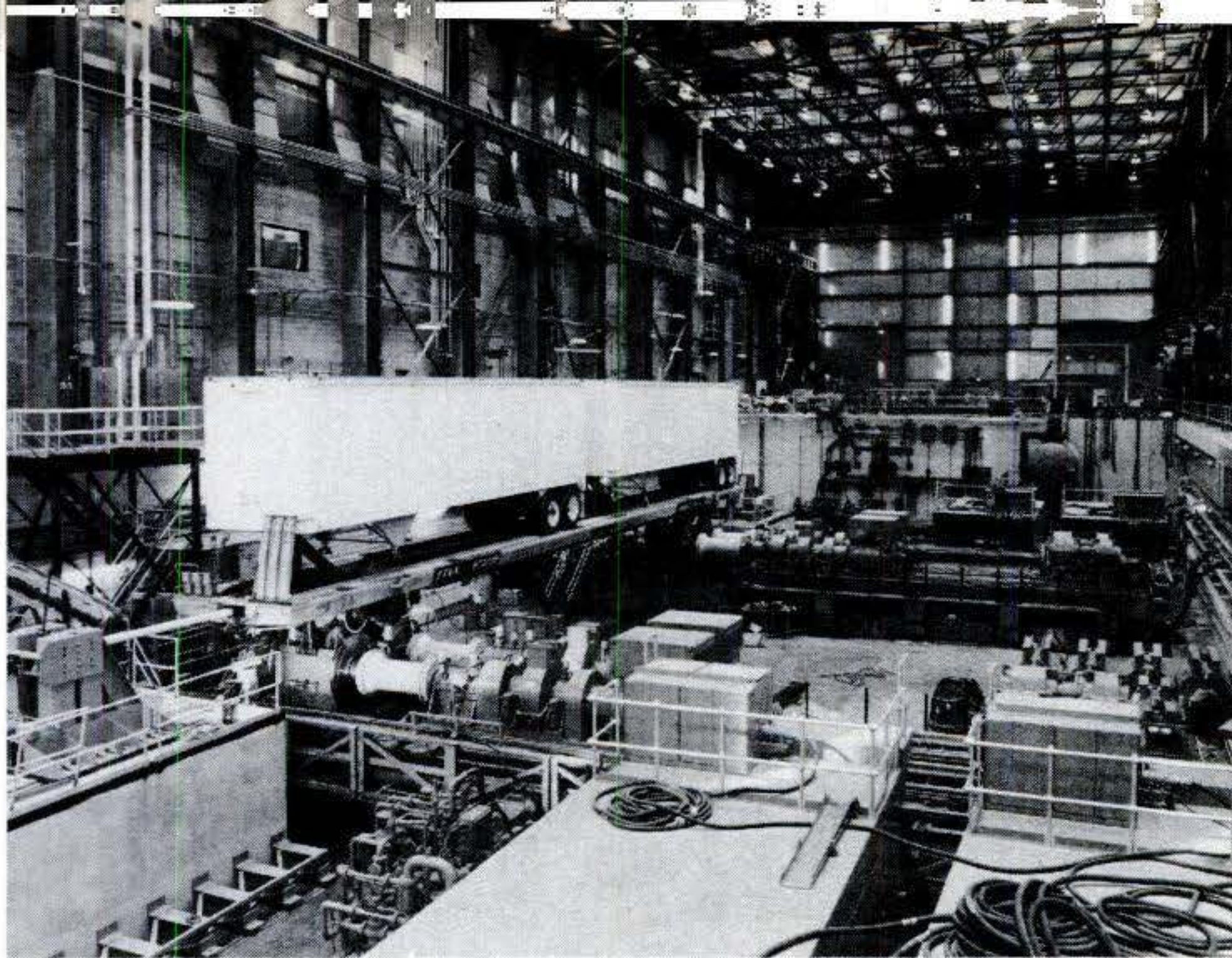
The need for such work is clear. The Federal Railroad Administration reports that there were 7858 derailments in 1977, 500 of them involving hazardous materials.

In Waverly, Tenn., for example, a tank car carrying liquid propane gas exploded in 1978, destroying 14 buildings, killing a dozen people, and injuring 50 others. Just two days later, another train derailed near Youngstown, Fla., and a ruptured tank car of chlorine spread a deadly blanket of yellowish-green fog over a wide area. Automobiles nearby stalled for lack of oxygen, their occupants gasping and spitting blood as the gas seared their lungs. Eight died and 67 were injured.

Warped track at government test center near Pueblo, Colo., is designed to stress Amtrak locomotive and two cars it's pulling.

Track sensors feed data into the trailer. Assembly on the locomotive's nose measures wind speed and direction.





Track movement is simulated for 89-foot trailer on flatcar (left) at the Transporta-

tion Test Center lab. The setup recreates track movement by rolling cars in place.

Can the test center help reduce the likelihood of such accidents? One of the main causes of derailments, the experts agree, is roadbed maintenance. Of those 7858 derailments in 1977, some 4360 of them were caused by maintenance problems. "The railroad system does not generate enough income to sustain itself," said Raymond James, chief counsel for the FRA Safety Office. "What gives first is maintenance—and it's getting worse."

Work at the Transportation Test Center (TTC) in Colorado can't contribute directly to railroad income for track maintenance, of course, but the application of technology can minimize the impact of reduced maintenance. For example, TTC tests established that premium rails—specially heat-treated or made with chrome or molybdenum alloys—were cost-effective on track curves because they last longer.

Also, all the various types of wooden and concrete ties tested proved durable. Only steel ties failed, developing fatigue cracks under the rail base after 26 million gross tons of use. Other experiments have improved the fastener systems for joining rails to ties, rubber tie pads, tie plates, concrete tie anchors, and more.

Rock and roll

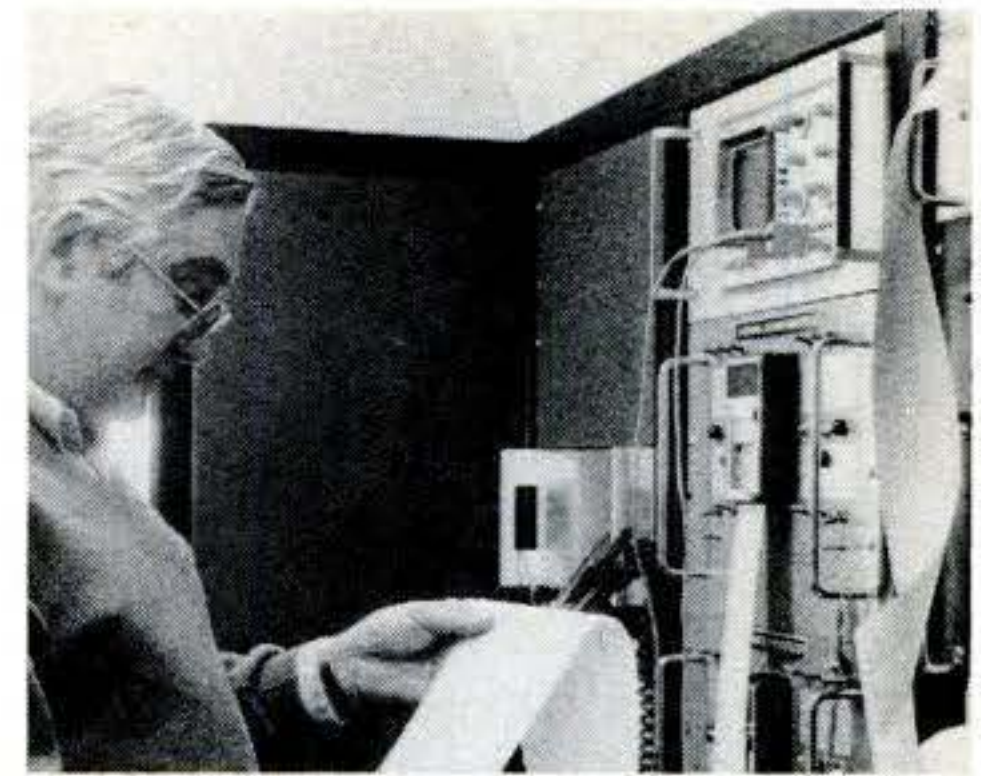
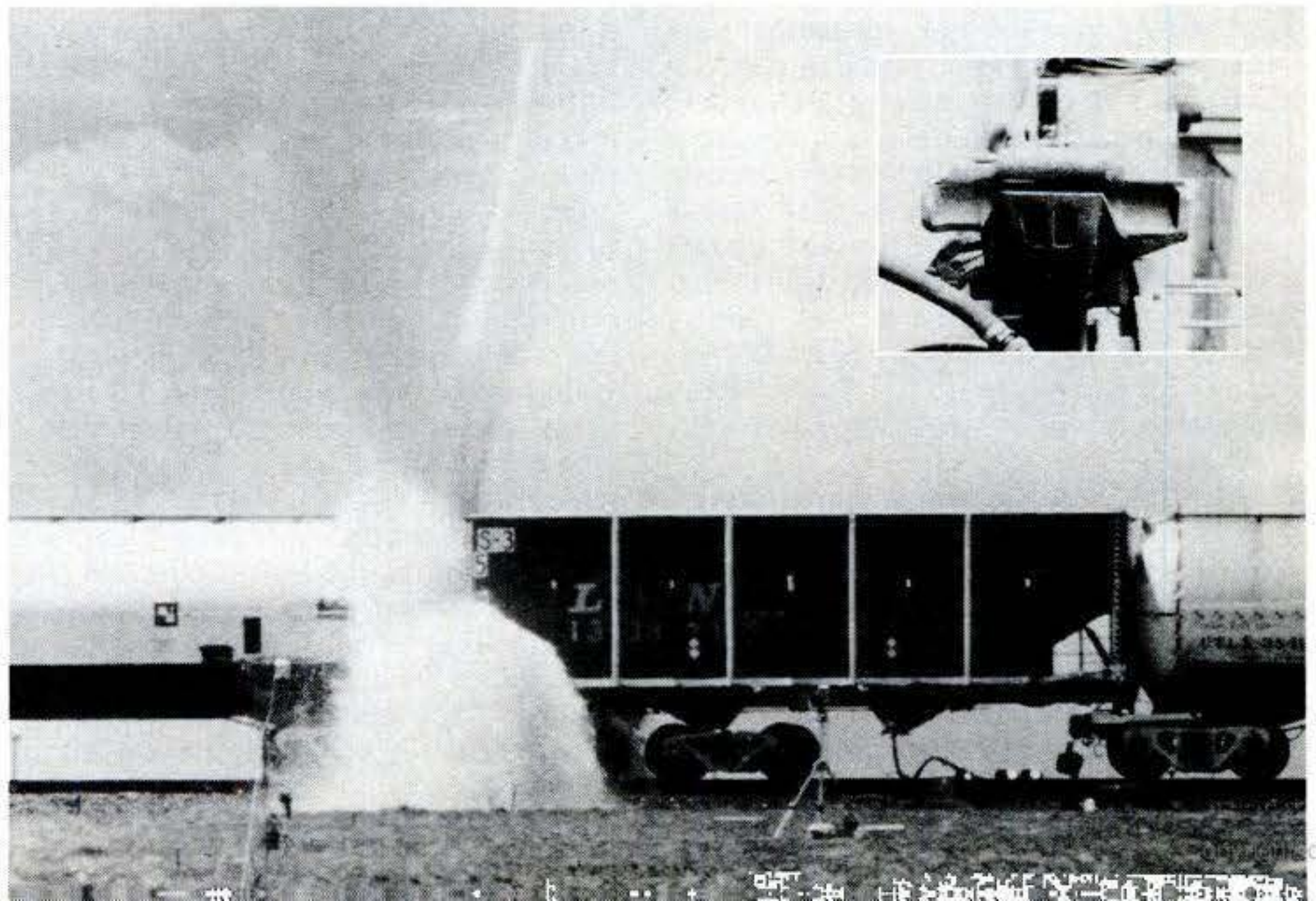
TTC's \$19 million Rail Dynamics Laboratory may become as important to train technology as the wind tunnel is to aircraft. "We're breaking new ground in test equipment," said Jim Densford, project manager, test design and analysis, who explained that the lab has one-of-a-kind machines.

A Roll Dynamics Unit simulates rail motion for freight or passenger

cars and locomotives. Vehicle wheels rest on spinning rollers to simulate near-perfect track and speeds up to 144 mph. This machine evaluates wheel performance in acceleration, adhesion, and braking. The Vibration Test Unit applies vertical and lateral vibrations to vehicle wheels. It simulates imperfect track, and enables researchers to study suspensions, ride comfort, and the reasons why vehicles tend to roll and rock. When I visited the dynamics lab, engineers were correcting operating problems with these unique new test machines. But on a track siding not far away, a battery of sensors was working perfectly.

"Come ahead at five miles an hour," said engineer Paul Mathieu into a walkie-talkie linked to a train crew and railside research van. A bright red Alco diesel locomotive belched

Water cascades from 33,000-gallon tank car when it smashes into a standing hopper car at 17 mph. Tests helped develop a



Strip-chart recorder at test center captures readings on all cars tested. A separate computer terminal only displays data about wheels on defective cars.

black smoke and began pulling four decrepit boxcars and a tank car forward. The car wheels, riddled with known defects, approached a detector using a series of 124 metal fingers near the rail.

"The wheels play these keys like a piano," Mathieu explained. Normal wheels strike an insulated wear plate on each finger and depress it. But wheels with a broken flange, mounted on a bent axle, or set out of gauge touch the wrong part of a metal finger, complete a circuit, and trigger an alarm.

Cracked wheels, warped track

Another sensor at the TTC's Wayside Detection Research Facility uses ultrasonic signals to check wheel treads for cracks (see box). Only three of these sensors exist. "It cost \$150,000 for this system," Mathieu said. "But if it prevents one derailment, it has paid for itself."

Infrared sensors detect train "hot-boxes"—overheated journal bearings where the wheel joins the axle—that

Continued

new car coupler (inset) with elongated knuckles to prevent couplers from penetrating gas-filled tank cars.

Railroad safety

[Continued]

can break an axle and derail a train. Other devices are used to sense any dragging equipment, such as dangling brake shoes that can wedge in a switch and cause a derailment.

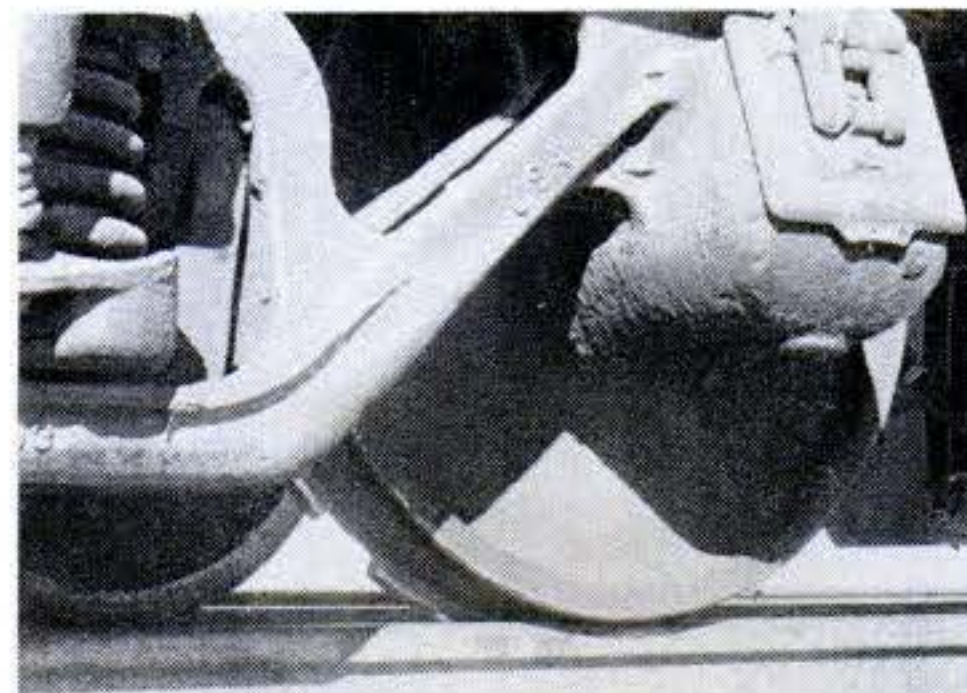
TTC specialists sometimes deliberately misbuild a test track to detect problems. A quarter-mile section of its two-mile Train Dynamics Track was prepared with heavy rails and top-quality ties. But the rails were of uneven height. A track curve had a kink in it. Technicians also greased the rails.

An Amtrak passenger locomotive was to travel this track nightmare. Sister locomotives with a similar six-wheel truck had been involved in several bad derailments, sending passen-

gers to hospitals. The problem was to determine whether the truck design was faulty, or if poorly maintained tracks were responsible for the accidents.

Late one winter afternoon, a silver locomotive with a six-wheel truck roared toward the warped section of track. The locomotive, pulling a baggage car and passenger coach, had instruments and strain gauges mounted on its axles and wheel sets.

A 3000-hp diesel accelerated the train to 55 mph—15 mph over the limit set for curves by railroads following the rash of derailments. But when the train hit the kink in the curved track, it rocked and wobbled, then continued on without mishap.



Wheel-flange gap (lower left) was cut into car used at Transportation Test Center. Gap fails to depress mechanical detector fingers, and triggers an alarm.

“Our preliminary conclusion is that there is no problem with this particular truck,” said test manager Bob Moll, adding that test data wasn’t fully analyzed. Moll said the train was manned at speeds up to 75 mph. “It gave us a rough ride, but we felt it was safe,” he said.

Tougher tanks

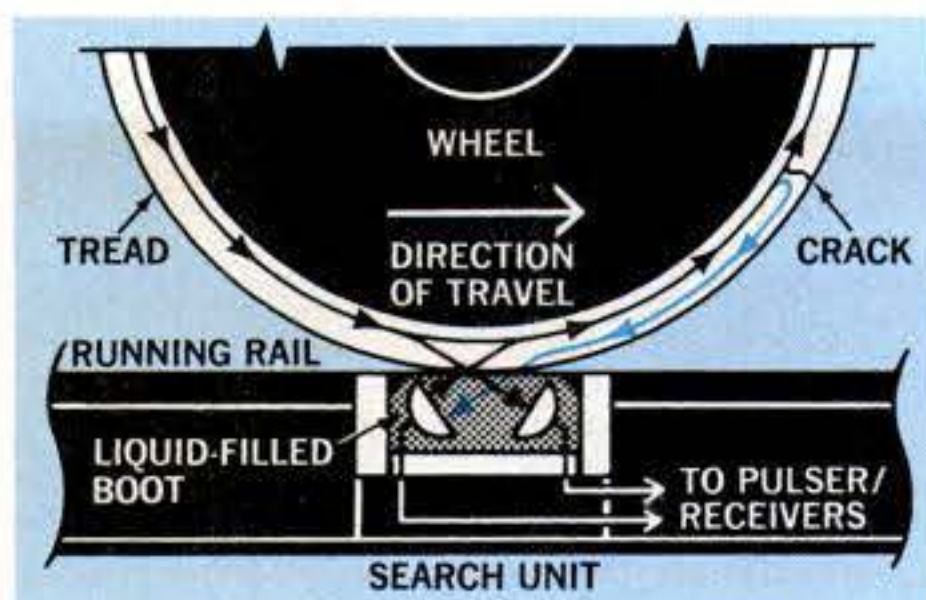
Beginning in 1976, technicians at the TTC staged tank-car collisions and filmed them with high-speed cameras. The tests were used to validate an experimental coupler designed to prevent couplers from disengaging during a collision and piercing adjoining tank cars like a spear. Crashes like this can occur even in railroad switchyards, exploding pressurized liquefied gas. These new couplers are now required on tank cars carrying hazardous materials.

A second safety device is a 700-pound head shield, a metal plate attached to each end of the tank car. It offers further protection against couplers or other parts of colliding rail cars.

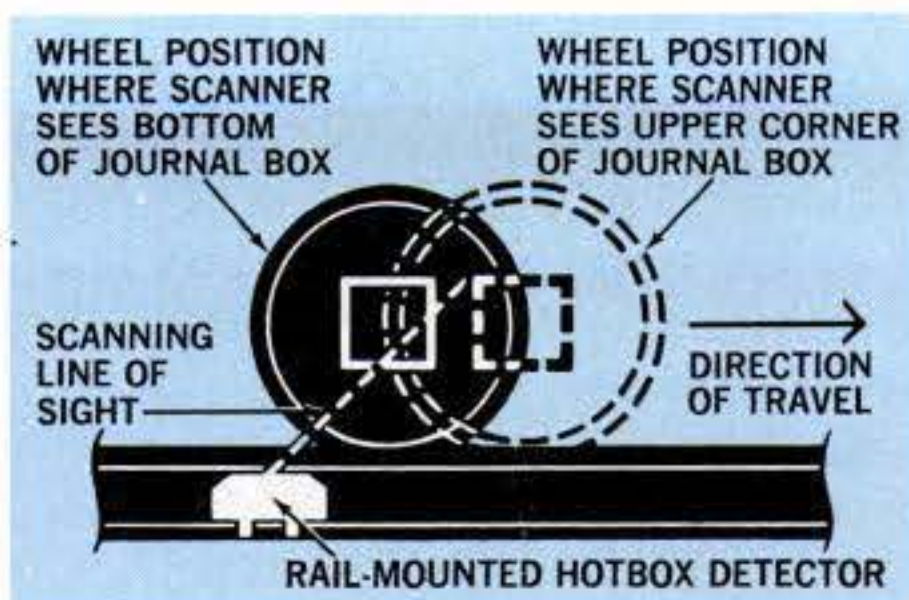
Torch testing of many types of insulation is also conducted at the TTC. Plastic-like substances can be sprayed onto the metal shell like paint; insulated blankets held in place by steel jackets can also cover tank cars. TTC technicians burned liquid-propane tanks and found that insulation enables fuel inside a car to vent off and burn over a longer period, lessening the severity of an explosion. Pressurized tank cars must be retrofitted with head shields or thermal coating by 1981.

The test center is also working with manufacturers to test vehicles before they’re manufactured. Experiments on new mass-transit passenger cars and work with linear-induction motors is pioneering the way for safer and more efficient railroads in the 21st century. P 5

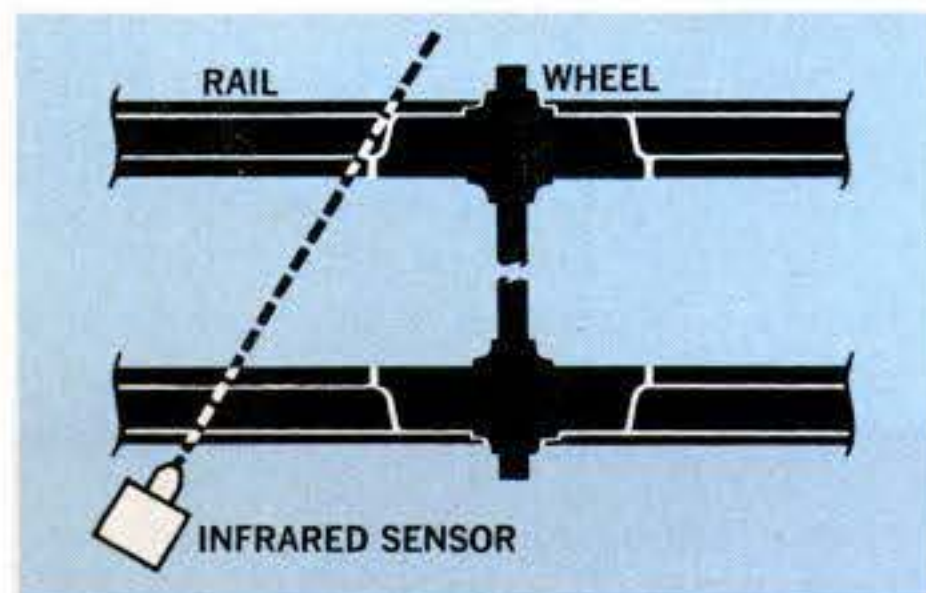
How train-safety sensor systems work



Cracked-wheel-tread detector



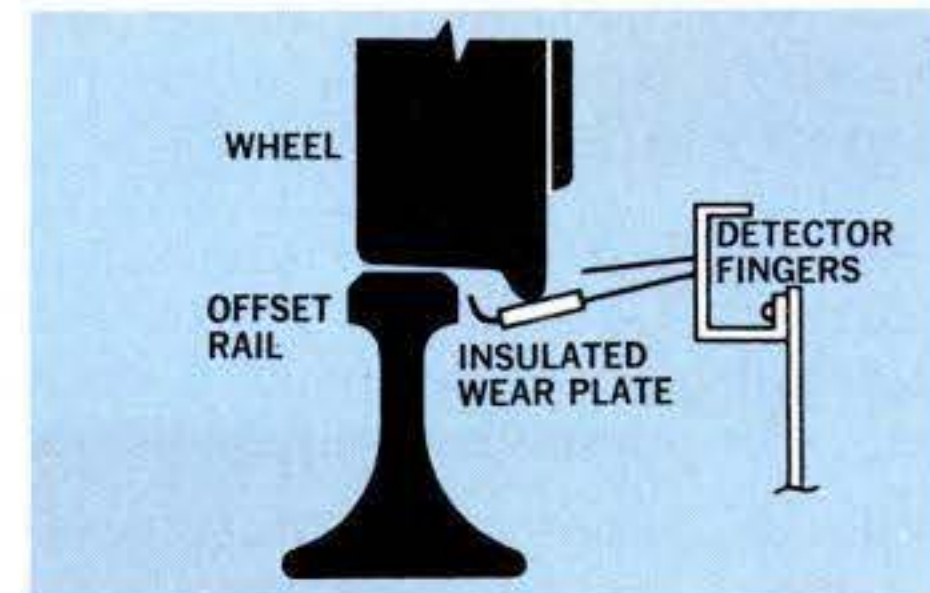
Hotbox detector



Hot-wheel detector

Cracked-wheel-tread detector: By beaming an ultrasonic signal around the surface of a moving train wheel, cracks in the metal can be detected. An ultrasonic transducer sealed in a measurement rail injects a signal that travels around the wheel rim as the train passes over the detector. A second transducer detects the signal. But a crack reflects part or all of the signal back to the first transducer. The strength of the reflected signal determines how serious the crack is.

Hotbox and hot-wheel detectors: A rail-mounted infrared sensor scans the journal box of a passing train, triggering an alarm if the bearing temperature exceeds a predetermined level. The sensor system is “smart” enough to distinguish the heat radiation from journal bearings and the uniform distribution of normally hot roller bearings. Another in-



Loose-wheel, broken-flange detector

frared sensor mounted next to the tracks scans diagonally across the railhead. Both wheels on every axle are scanned, and an alarm is sounded when a wheel temperature is too high.

Loose-wheel and broken-flange detector: A row of 124 electromechanical detector fingers is next to a test rail. The outer flange of a normal wheel passing over the fingers depresses the insulated wear plate on the lower finger. This prevents electrical contact between the wheel and the fingers. But a broken wheel flange will not depress the bottom finger enough to prevent contact between the tip of the finger and the metal wheel. An electrical path through the wheel and rail actuates an alarm. The row of sensors can also detect improperly mounted wheels, bent axles, and other defects that put wheels out of alignment.

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The Environ-air unit's patented process electrostatically creates these same negatively-charged oxygen molecules that permeate any enclosed space and attract odor molecules like a magnet until they're totally "neutralized."

BEFORE ENVIRON-AIRE

There were two ways to control odors: *Dilute*—constantly recycle fresh air to dilute odor molecules or *deodorize*—constantly mask odor with a heavy perfumy scent. Now, with Environ-air, there's a third, more effective and highly scientific way. And that's to *destroy* all organic odor molecules electronically.

WHAT THE ENVIRON-AIRE IS NOT

It's not a one-shot cover-up. It doesn't mask odors—it destroys them electronically. And it kills tough odors *continuously*—not temporarily like sprays, wicks, stick-ons, etc. There are never any chemicals to buy, bulbs to burn out or filters to replace. The unit uses only as much electricity as a 25-watt light bulb.

WHAT IT IS

The Environ-air is a *continuous* air-cleansing process so unique it's patented. It uses the latest in space-age electronic technology to create the first energy and cost-efficient air purification system for the home. Even in a

smoke-filled room, you will be breathing only clean, fresh air all day long.

FORCED AIR—THE MOST IMPORTANT NEW FEATURE INNOVATION

One of the secrets of this new system is that it keeps the ionized air in *constant motion*. The Environ-air is the *only* electronic air freshener that *continuously* "pumps out" ionized oxygen molecules into the air, permeating every square inch of space—ready to attack and deactivate any odor-causing molecules instantaneously. Keeping the ionized air circulating is such an important factor that so-called "space age" air fresheners without it are truly outdated. Without it, odor-killing molecules simply fall to the ground near the unit, rendering them useless against odors.

A DUST-FREE ENVIRONMENT: AN UNEXPECTED BONUS

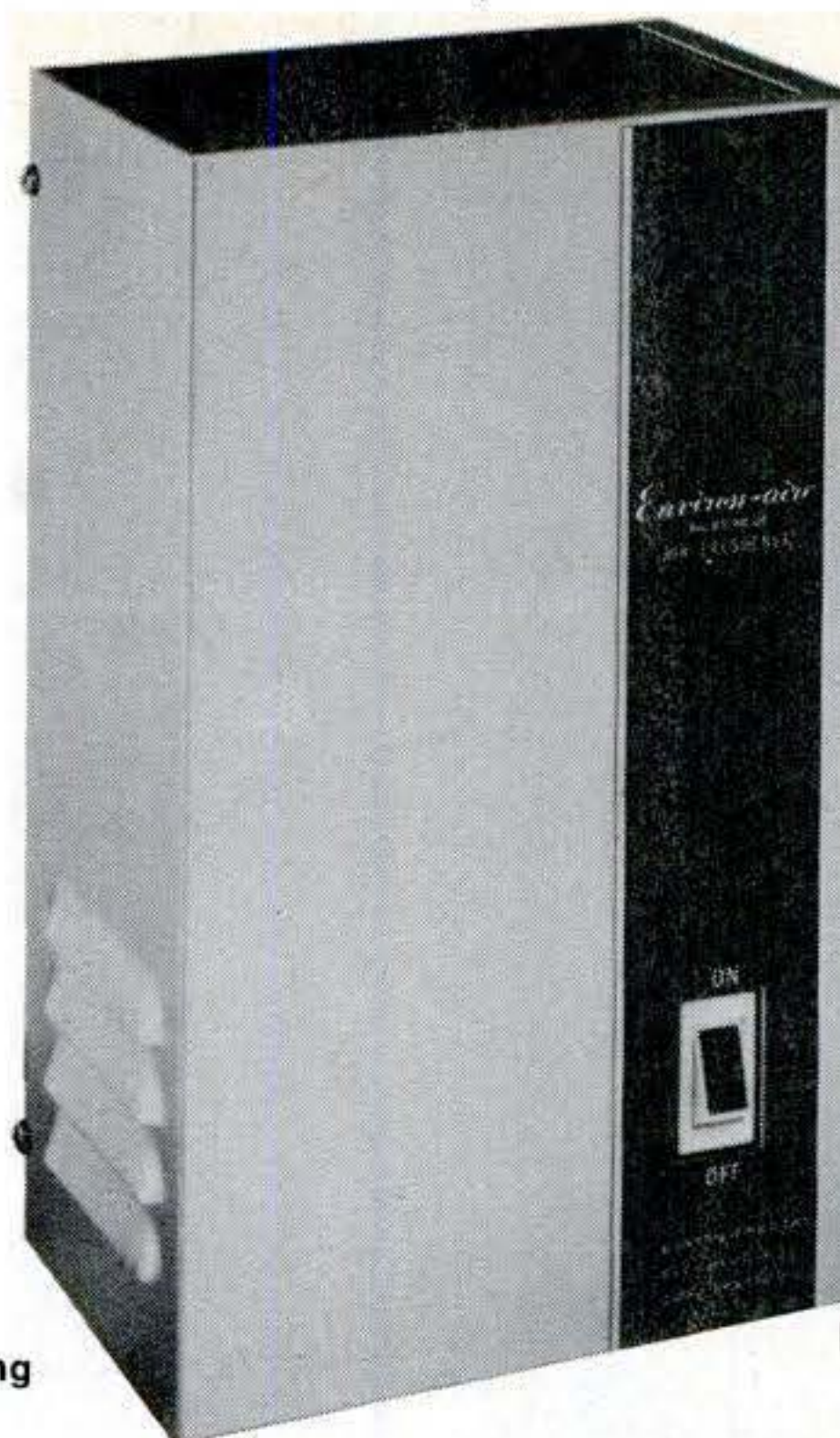
The Environ-air also de-activates dust particles suspended in the air. The ionized oxygen pumped into your room will attach itself to any impurities in the air, causing them to fall to the ground. Ahhhh... what's left is pure, clean air.

PROVEN EFFECTIVE IN HOSPITALS, FISH MARKETS, PET SHOPS & MORE

Prior to this special introduction to consumers, hundreds of Environ-air units were used by businesses with their own peculiar odor problems. After using it for over 8 months they found it to be the only answer to annoying, persistent odors. Why? Because it outperforms other systems in what it does and how it does it.

TO USE IT IS TO LOVE IT

You will feel the difference immediately. The Environ-air will cleanse any 20' x 20' room of odor-causing molecules within just 5 minutes!



listed by



U.S. Government Patent No. 3,925,673

Imagine how exhilarated you'll feel with a fresh supply of ionized oxygen surrounding you day and night!

CLEAR THE AIR ONCE AND FOR ALL

In the kitchen... bathroom... basement... nursery... pet areas... smoke-filled offices. Use it anywhere stale, musty, offensive or pungent odors are a problem. The attractive wood-grain unit is compact—10' x 6" x 4" deep—and lightweight—only 8 pounds. It can be wall mounted as an inconspicuous permanent fixture where annoying odors tend to accumulate. Or, it can be moved from place to place as needed, taking up little space on a shelf or floor. And installing it is simple—just plug it in. It uses regular household current.

LET YOUR NOSE PROVE ITS EFFECTIVENESS IN YOUR HOME OR OFFICE

The Environ-air may sound too good to be true. That's why we offer a 30-day trial period and ask you to really give it a workout. For starters, simply turn the unit on, then cut up a big, juicy onion. No tears. No smell.

SOLIDLY BACKED

If anything goes wrong with your unit during the first year Environmental Electronics Corporation will repair it—without charge. Although the Environ-air is built to last and be virtually maintenance free, it's still nice to know the manufacturer is service conscious.

SPECIAL INTRODUCTORY PRICE

The Environ-air is manufactured for Cambridge International by EEC. We are offering this exciting new product directly to our customers exclusively through the mail for only \$119.95 during our national introduction. Order one at no obligation today.

CAMBRIDGE INTERNATIONAL, Inc.

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4. Excellent enough to earn government approvals or UL listings (when applicable)
5. Developed from the most advanced technology available

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Cambridge International, Inc. Dept. P1
8700 Waukegan Rd., Morton Grove, Ill. 60053

Please rush me _____ Environ-air unit(s) at just \$119.95 each plus \$6.95 shipping & handling. (Ill. residents add 5% tax.) I understand that if I am not absolutely satisfied with my purchase, I may return it within 30 days for a prompt and courteous refund.

Check or MO enclosed. Charge to: Visa Master Charge
 American Express

Account# _____ Exp. Date _____

Name _____

Address _____

City _____ State _____ Zip _____

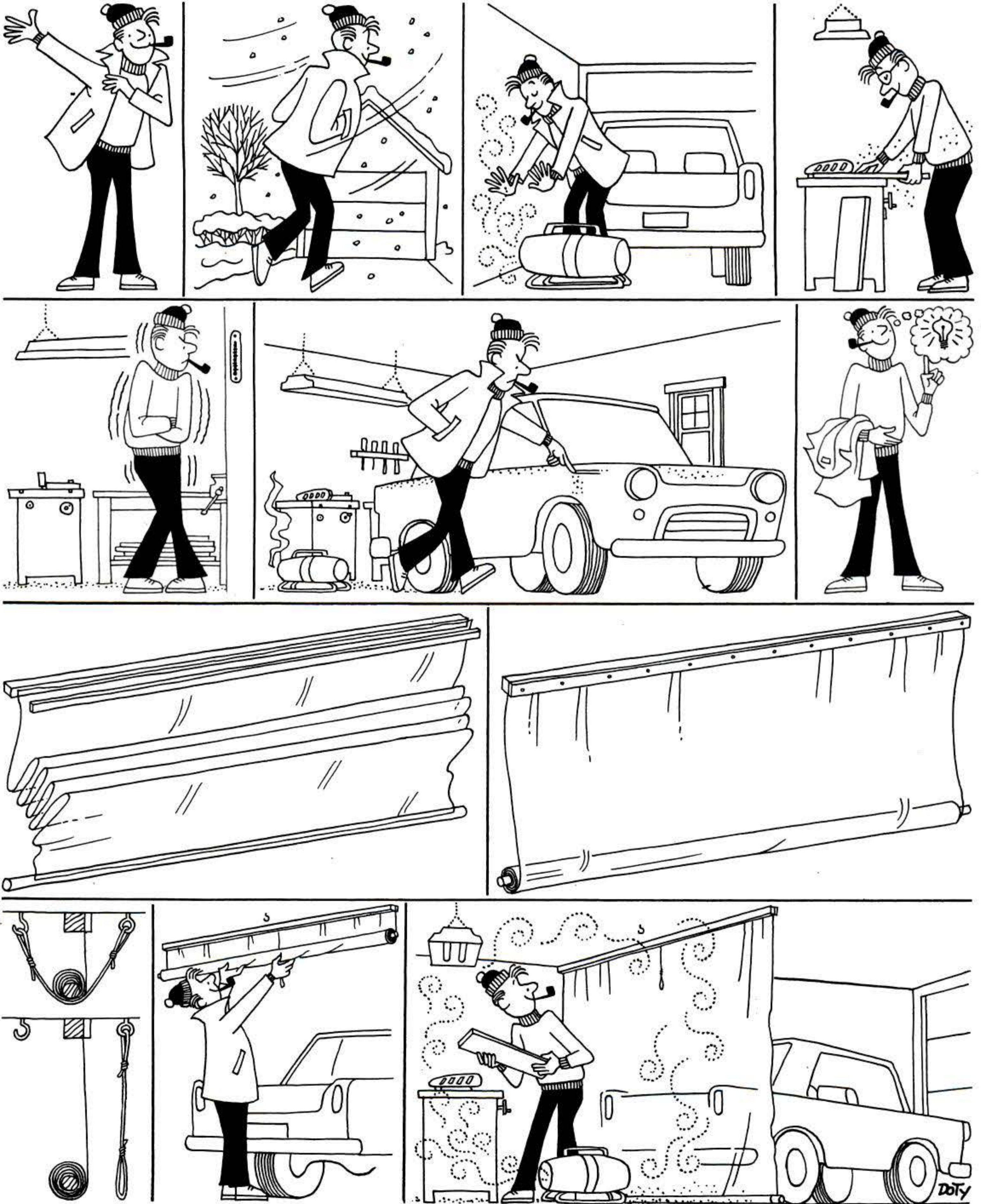
Signature _____

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WORDLESS WORKSHOP

By ROY DOTY

\$50 to Steve Poland of Richmond, Ind., for this idea. Send yours (with Social Security No.) to Wordless, POPULAR SCIENCE, 380 Madison Ave., New York, N.Y. 10017. Only purchased ideas acknowledged.





INTRODUCING 1980 FORD BRONCO

A new advance in family 4-wheelers.

Exciting news for 1980: Bronco introduces Twin-Traction Beam, the only truck in its class with independent front suspension. Feel the difference on the road. And off.

Ford's new design Bronco gives you the best estimated mpg of any V-8 4-wheeler. Trim new size outside for easy maneuvering. All-new interior with more front leg room, improved climate control, new anti-theft features.

Bronco's built tough on a truck chassis, tested tough at Ford's Arizona Proving Ground. Test it at your Ford Dealer. Ask about Ford's corrosion perforation warranty. It's a no-cost 36-month limited warranty that excludes exhaust system components. And ask about Ford's Extended Service Plan, too.



Roomy interior has all-new styling, options like tilt steering wheel, reclining Captain's Chairs up front, AM/FM stereo with cassette or 8-track tape player.



New Bronco choices include six roof colors. Above: Landau Tu-Tone with accent tape stripe. At top: Free Wheeling Bronco shown with optional tri-color tape stripe, styled steel wheels, RWL tires, and more.



Independent front suspension eases wheels over bumps separately to give a better ride than last year. Helps off-road control.

**BEST V-8
ESTIMATED MPG**

15 mpg
EPA EST.*

Optional 5.0L (302 CID)
V-8 with automatic transmission.

*Compare this estimate with others. Your mileage may differ depending on speed, distance and weather. California excluded.



FORD

FORD DIVISION





**Come to where the flavor is.
Come to Marlboro Country.**



**Marlboro Red or Longhorn 100's —
you get a lot to like.**

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

Kings: 17 mg "tar," 1.0 mg nicotine —
100's: 18 mg "tar," 1.1 mg nicotine av. per cigarette, FTC Report May '78

PS | What's News

Most of the automotive engineering developments you read about in PS originate in the research-and-development departments of the car companies and their suppliers. They've got the money, the market incentive, and the expert work force required for this kind of expensive research. But the federal government doesn't agree that they can come up with all the answers for the kind of car we must have on the road before the end of this decade. There is a need, the reasoning goes, for highly innovative research that is not inhibited by the need to show a profit on it next year or the next. Over \$20 million of federal money has been spent so far with non-automotive companies to develop the high-technology vehicles shown on our cover and described in Group Editor Herb Shuldiner's article starting on page 86. Some of the most interesting and far-reaching work, Shuldiner found, is happening at electronics and computer firms. As the cars of the future become more and more dependent on electronics [PS, Aug. '79], maybe this is an area in which outsiders can most usefully put the spur to Detroit efforts. I sat at the same table at a luncheon recently with General Motors president E.M. Estes. I tuned in on the last half of his reply to a question about electronics in automobiles and heard him say with a laugh, "I'm just a sophisticated blacksmith; electronics is beyond my expertise." Although this kind of modesty is in the tradition of Dr. von Braun's oft-repeated claim that he was "just a plumber," my observation over the years is that most senior auto engineers in Detroit look on electronic solutions to automobile engineering problems with more than a little skepticism.

Bigger wind turbines

A cluster of three giant wind turbines with an electrical output rated at 2.5 megawatts each is to be erected on a site along the Columbia River Gorge in southern Washington. With 300-foot-diameter blades, they will be the largest such machines ever built. The project also will be the first test using a grouping of wind turbines to generate electricity for a utility grid. Power from the turbines will be fed into the Bonneville Power Administration's electric distribution system beginning in late 1980. The turbines, designated MOD-2, are the latest and the largest of

a series developed by NASA [PS, Mar. '76]. They will be prototypes of the first large wind turbines designed for the commercial power-generation market. If manufactured in quantity, these machines would cost utilities about \$2 million each, according to projections made for DOE by the Boeing Company. At that price, they would come close to competing with other sources of power in some regions. They differ from their predecessors in several ways as a result of experience with the earlier DOE-sponsored turbines and design studies by the Boeing Engineering and Construction Company. Energy costs should decrease as the size of the turbine increases. The technical hurdle is making bigger and bigger blades that will withstand the loads. The MOD-2 turbine's blade will be constructed as a single span with rotational speed regulated by pitch control of the blade tips. Previous models adjusted the pitch of the entire blade for control. The hub on which the blade is mounted teeters to help absorb unequal wind loads resulting from variations in wind speed as the blade sweeps through its 300-foot span. To avoid the vibrations caused by wind shadow that were experienced by earlier downwind designs, MOD-2 will have its single-span blade positioned upwind of the tower. With more efficient operation at lower wind speeds, the MOD-2 will generate about twice as much total electrical energy in a year's operation as the earlier MOD-1 2000-kilowatt turbine now operating at Boone, N.C. The two machines weigh about the same, and weight is an approximate guide for relative production costs. According to estimates, commercially manufactured MOD-2 turbines would generate electricity at an approximate cost to the utility of less than four cents per kilowatt hour in a moderate wind region. DOE assumes that large wind turbines would be installed by utility companies in clusters of 25 or more, with a half mile separation.

Diesel taxis get better mpg

Diesel-powered taxis in New York City got 50 percent better mileage in a three-year test sponsored by the city's Transportation Department. The study began in May 1976, with 66 gasoline and 66 diesel-powered 1976 Dodge Coronets, identically equipped except for the engines. The diesels averaged 14.7 mpg, while the gaso-

line-powered taxicabs got 9.7 mpg. The Transportation Department reports also that the diesel exhaust emissions are much lower than those of the gasoline engine in hydrocarbons, carbon monoxide, and nitrogen oxides.

Electric car in the mid-80's?

It accelerates with a humming low-grade whine, smoothly pulling away from the corner and reaching 30 mph in about nine seconds. It's comfortable inside, aerodynamically smooth outside, and visibly different from other cars in only a few important details. There's no engine front or rear, and the transmission is replaced by three buttons on the dash board: FORWARD, NEUTRAL, and REVERSE.

This is the latest electric car, a stylish, technologically advanced four-seater called the Electric Test Vehicle-One (ETV-1). It is an experiment managed by JPL in Pasadena, Calif., and funded by DOE. Early results are encouraging.

The car has a stop-and-go city driving range of about 75 miles, with cruise at 55 mph for freeway driving, and top speed of more than 70 mph. At a steady 45 mph, its battery charge will be good for 90 or more miles.

More important, ETV-1 is not a laboratory freak. It was designed from the ground up as an electric car that could go into early production. It would sell for about \$6400, based on building 100,000 units.

And most important of all, ETV-1's efficiency is not the result of major breakthroughs in battery life. Rather, it stems from microprocessor-controlled electronics packages and a new 20-horsepower DC motor, both developed for the car by General Electric, and from weight-saving frame and body design by Chrysler Corp. ETV-1's curb weight is just 3320 pounds, including 1080 pounds of batteries.

Electronic advances that conserve battery power include a controller that prevents drivers from making jack-rabbit starts and a regenerative braking system that turns the motor into a battery-charging generator when the brakes are applied or when the car coasts downhill.



Editor-in-Chief

Energy storage: search for the perfect flywheel

Bold new designs and advanced materials produce ultrafast, energy-packing flywheels

By **SUSAN RENNER-SMITH**

ILLUSTRATION BY GENE THOMPSON

"When you set a world record, here's what you get," David Rabenhorst said, bounding up from his desk and reaching into a cabinet. "Catch."

I caught a large, limp mass of tangled blond fibers. Soft and floppy, about a foot wide, it reminded me of a giant Dolly Parton wig.

"That's a filament-wound flywheel made of Kevlar," Rabenhorst said. "It failed at about 30,000 rpm—a world record at the time."

On his way back to the desk, Rabenhorst flicked a spoked wire sculpture I had noticed upon entering his office at Johns Hopkins Applied Physics Lab (APL). The "sculpture" began to spin soundlessly—and fast.

"An early design for a superflywheel," he said. "Never got built. The technology moved too fast."

A stocky, energetic man who likes his early-morning tennis game, Rabenhorst is in his mid-50's—hardly old enough to be the "grand old man" of a major new technology. But that's how he's regarded in flywheel circles.

Over a decade ago, Rabenhorst dreamed up the "superflywheel." Made of new, superstrong fiber materials, the superflywheel would be an amazing energy-storage machine. It could spin at fantastic speeds—up to 50,000 rpm—without breaking. If it did break, it wouldn't hurt anyone—it would just disintegrate into shreds.

Rabenhorst's vision [PS, Aug. '70] captured the imagination of engineers



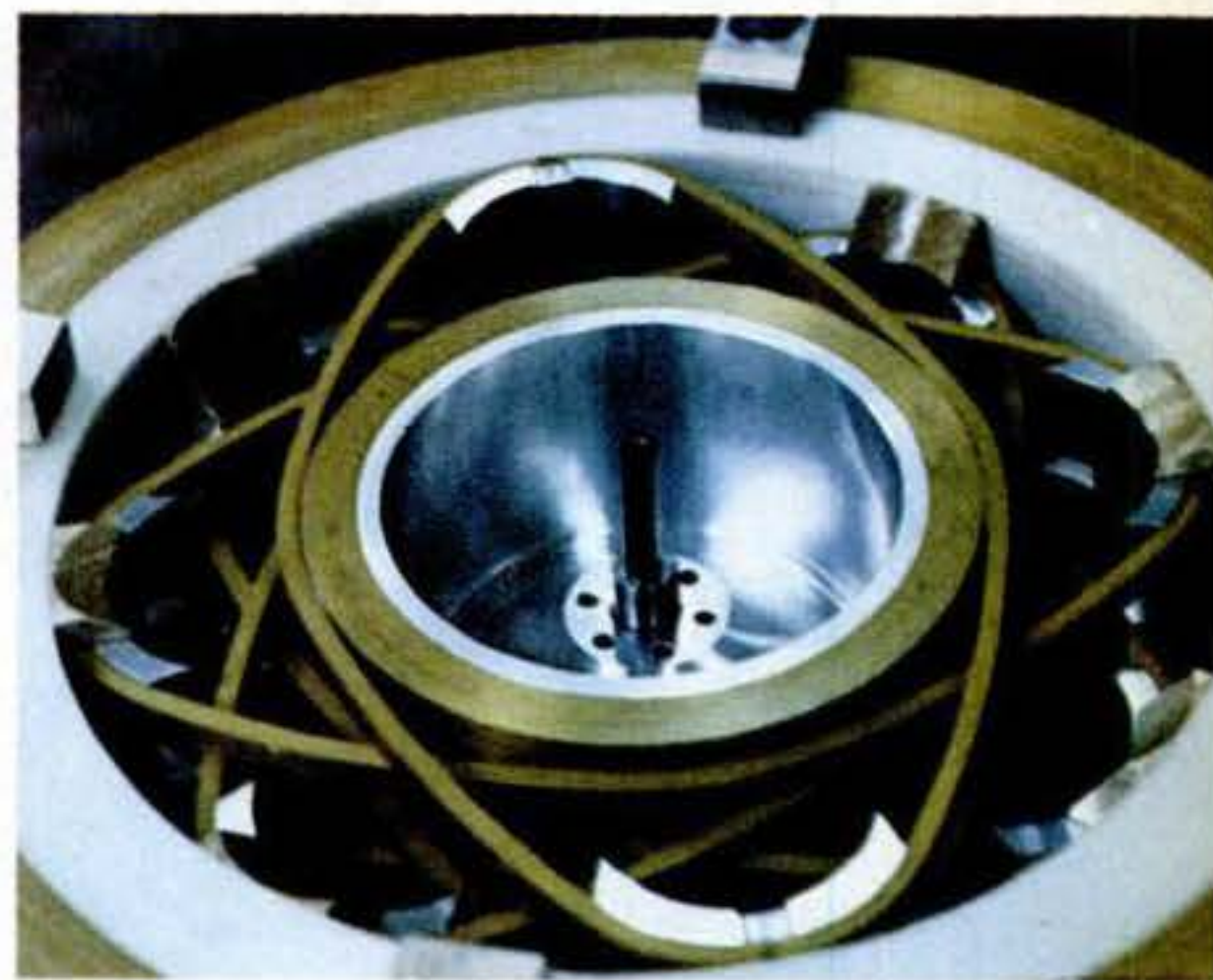
Bare-filament flywheel is explained to author (center) by David Rabenhorst and associate Tom Small. Made of radial-tire wire wound on a tapered hub, this is a

around the nation, and a number of researchers began designing their versions of the ultimate flywheel. But the job was a lot more complicated than anyone thought. Any number of perfect—on paper—designs failed miserably. Only now, fully 10 years later, does the elusive, ideal flywheel seem close to reality.

low-cost APL design. At 14,500 rpm, the wheel stores about 14 Wh/lb—competitive with a solid-steel flywheel, but not as likely to fly apart.

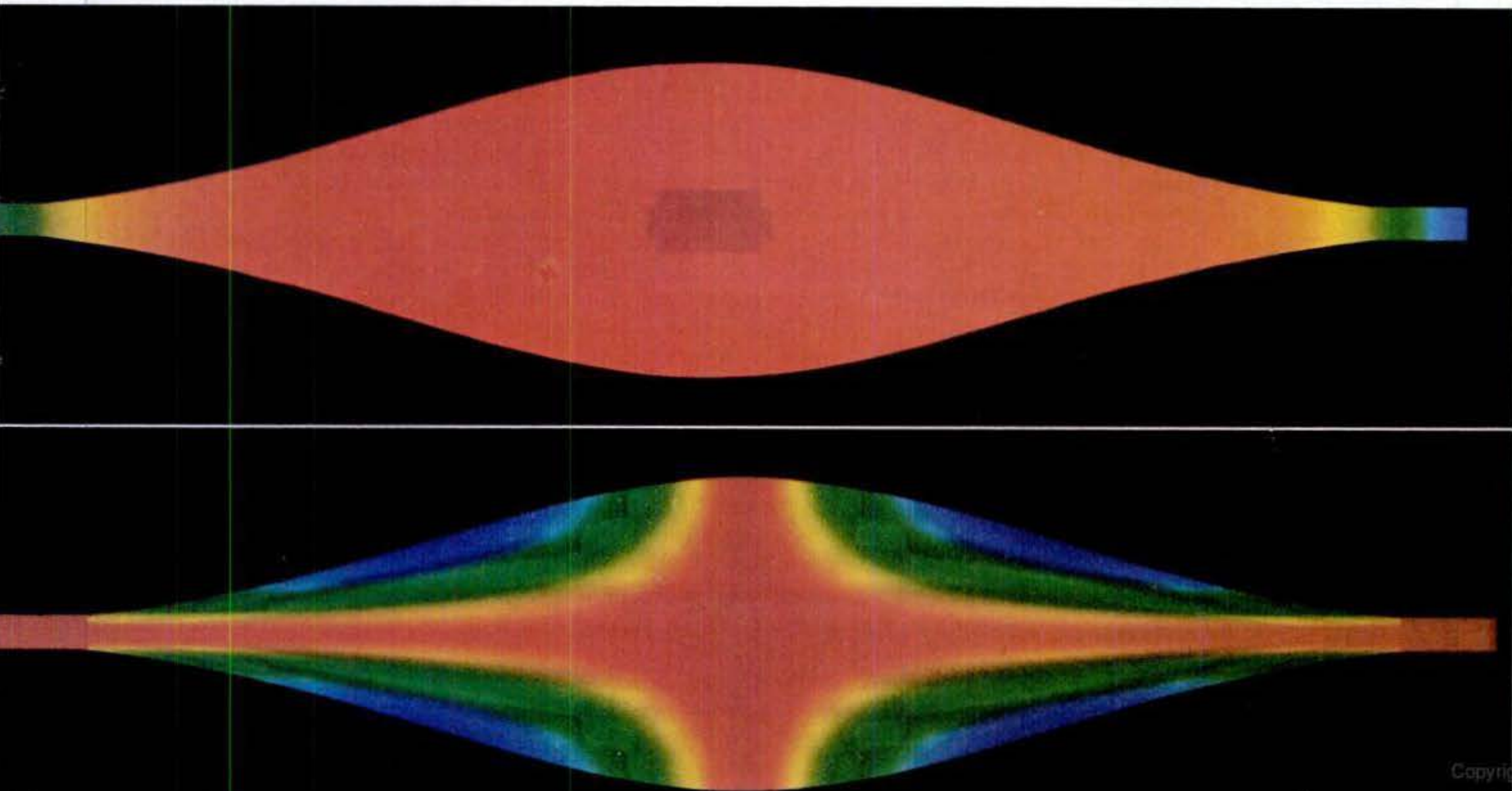
Why the perfect flywheel?

Because, as the energy shortage worsens, we need better systems for conserving energy. Today, batteries are about the best practical means we have for storing energy in compact systems. But batteries are heavy; they need to be watered and vented; they



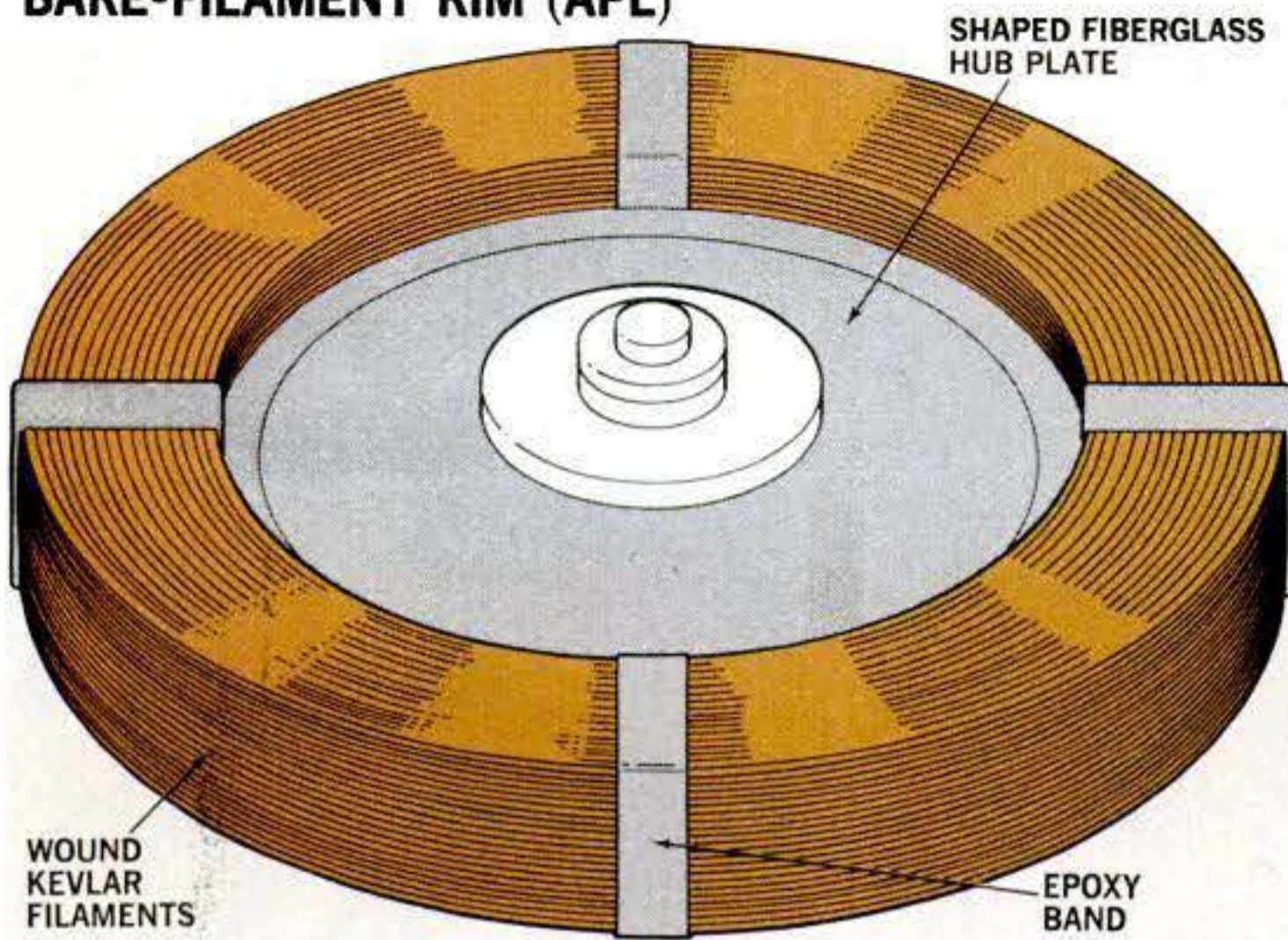
Curved Kevlar spokes are tension-balanced to resist forces acting on the flywheel and to transmit the high torques needed to accelerate the rim to 36,000 rpm. The 23.5-in.-dia. wheel, made by Wm. Brobeck, should store 40 Wh/lb.

Rings of light (left) reflect off edges of 160 graphite layers laminated at different angles to even out stresses in LLL-designed flywheel. Computer photo (below) shows how design equalizes radial stresses ranging from 570 psi (blue) at tips to 115,400 (red). Shear stresses, sliding forces that can separate the laminated layers, are not as evenly distributed (lower photo). When spin-tested, this disc failed at 36,000 rpm with an energy-density level of 29 Wh/lb. Stronger versions could hit 50,000 rpm and store 55 Wh/lb.

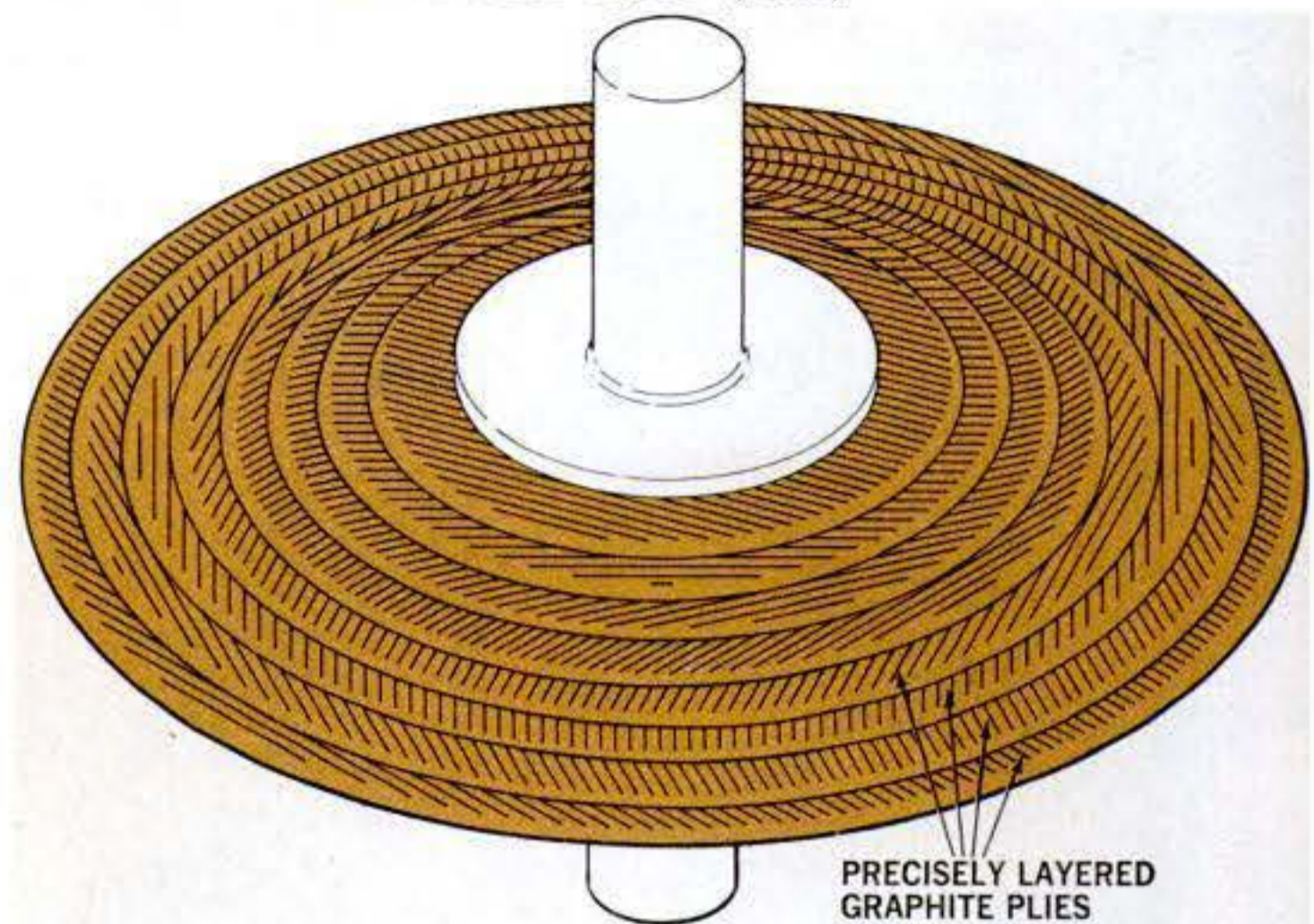


Tomorrow's high-speed flywheels, made of super-strong fiber composites,

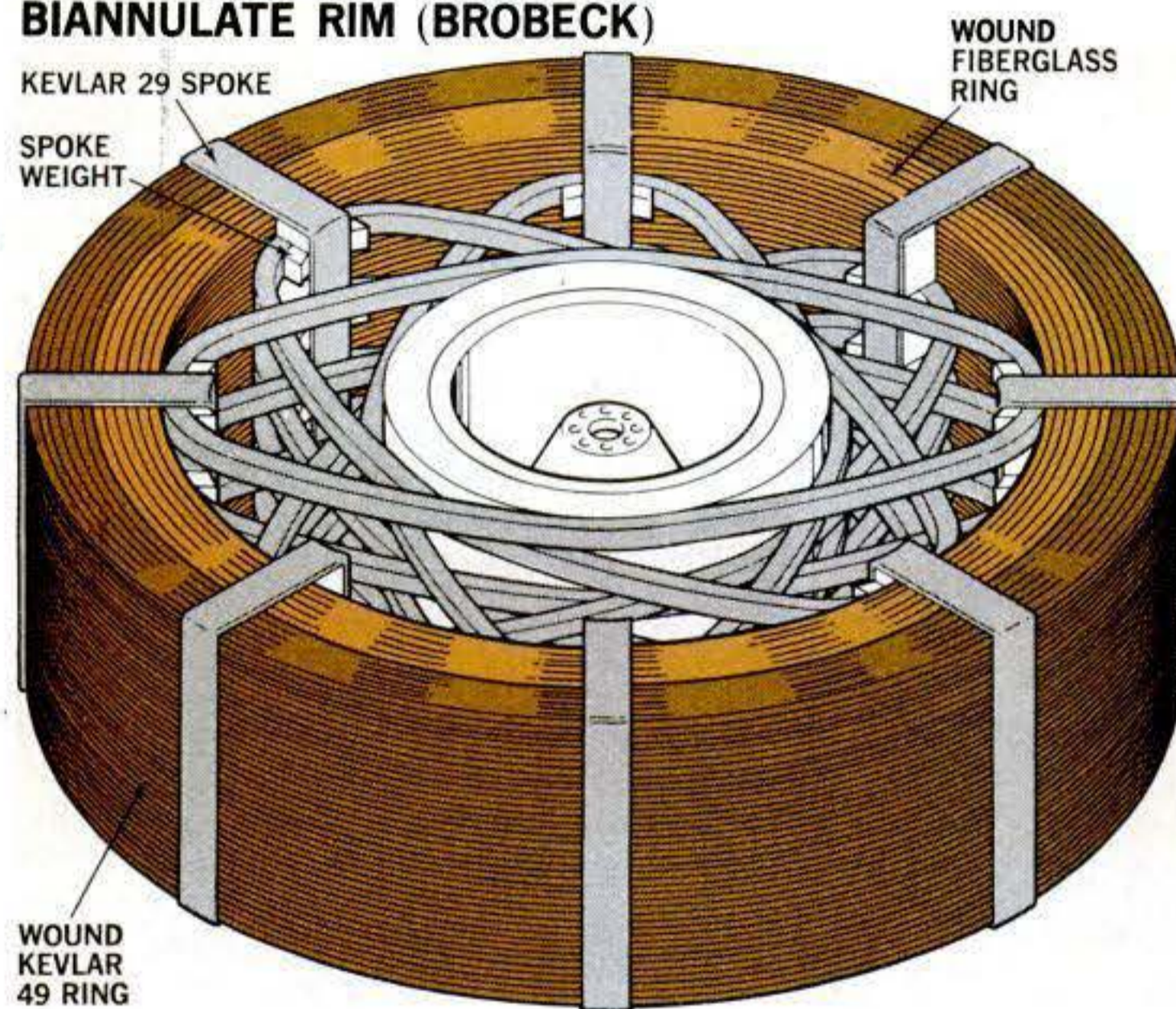
BARE-FILAMENT RIM (APL)



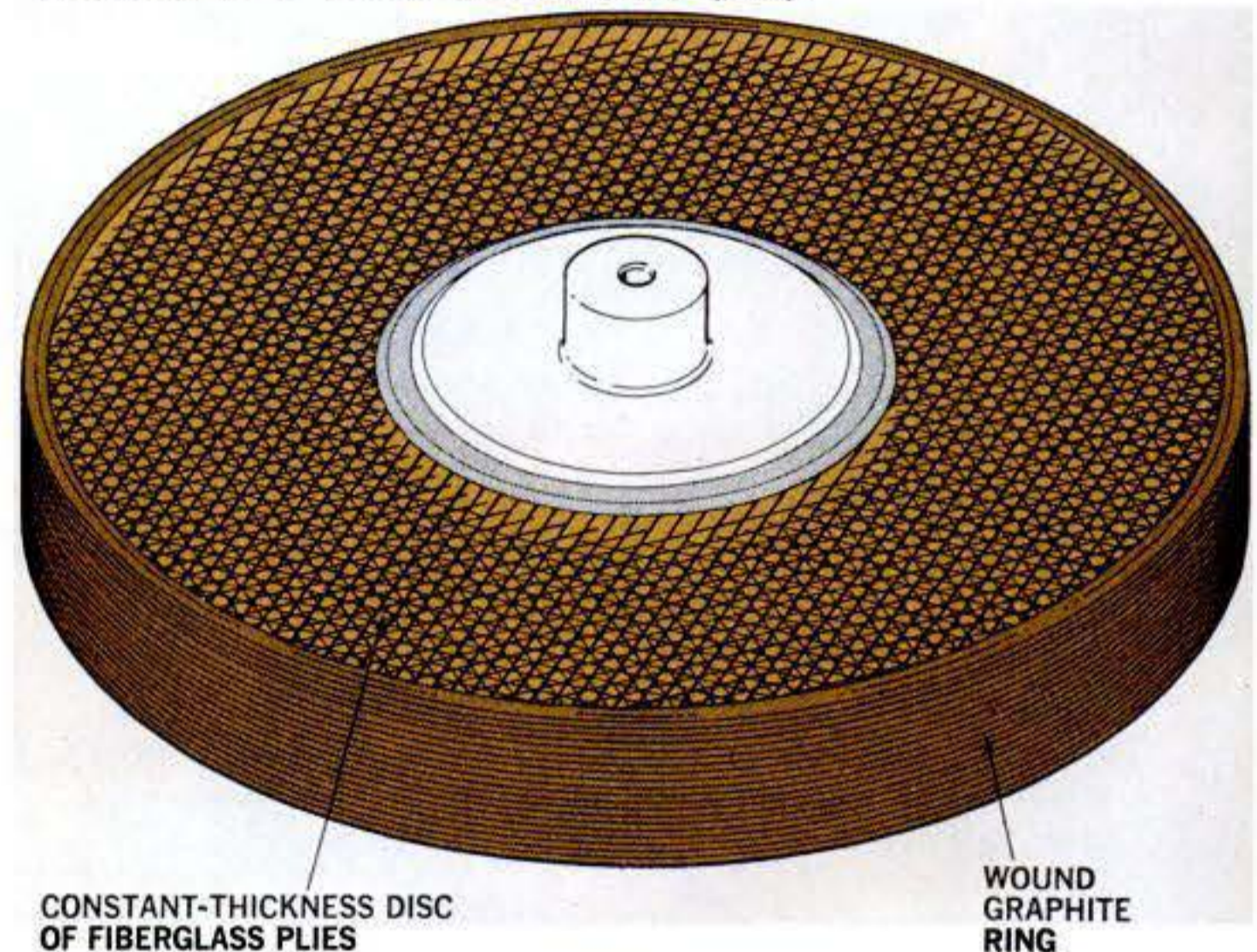
TAPERED LAMINATED DISC (LLL)



BIANNULATE RIM (BROBECK)



LAMINATED DISC WITH RIM (GE)



can discharge dangerous gases—and they wear out too fast.

The *perfect* flywheel is compact, pollution-free, quiet, long-lived, and, theoretically, can store as much energy as advanced batteries—about 40 Wh/lb (watt hours per pound).

An advanced flywheel would do a different job than today's low-speed units. Familiar flywheels basically smooth the transmission of intermittent power pulses—from auto engine to transmission, for example.

But a high-speed flywheel could substitute for batteries in an electric car, thus solving the weight problem that retards their development [PS, Aug. '70]. Advanced flywheels could also power urban subways and buses [PS, Feb. '74]. Mated with the transmission of an internal-combustion engine, advanced flywheels would allow the engine to operate at peak efficiency for improved gas mileage [PS, Aug. '73]. Finally, flywheels could even be used for stationary energy storage—to store energy generated by sun or wind

or even a utility's off-peak production ["Basement Flywheel," PS, Oct. '79].

Fibers for flywheels

Why can't ordinary flywheels be used for energy storage? In theory, they can. In practice, there are difficulties. To store useful amounts of energy in a relatively small space, a flywheel must turn at high speeds. The faster it goes, the more energy it can store for each pound of its mass. The problem with regular steel flywheels is that you can't spin them fast enough to store a useful amount of energy; they come apart first.

New superflywheels may solve that problem. The superflywheel idea was sparked by the emergence of the super fibers Kevlar and graphite. First developed for the aerospace industry, these fibers, Rabenhorst realized, were suited for advanced flywheels.

"Composite materials have many times the strength-to-density ratio of the best steel," Rabenhorst said. A composite flywheel can theoretically

store as much energy as a steel flywheel twice its weight.

"Also," Rabenhorst added, "you can see from that batch of limp Kevlar you're holding that a composite flywheel doesn't fail as catastrophically as a steel one. A high-speed steel flywheel wants to break into three chunks—each traveling at about Mach 3.

"When that Kevlar flywheel broke, it just spun around for a while going bobbety, bobbety, until it stopped. And we let it. There was no danger."

"So, since composite flywheels are safer, you can spin them faster to store more energy," I summarized.

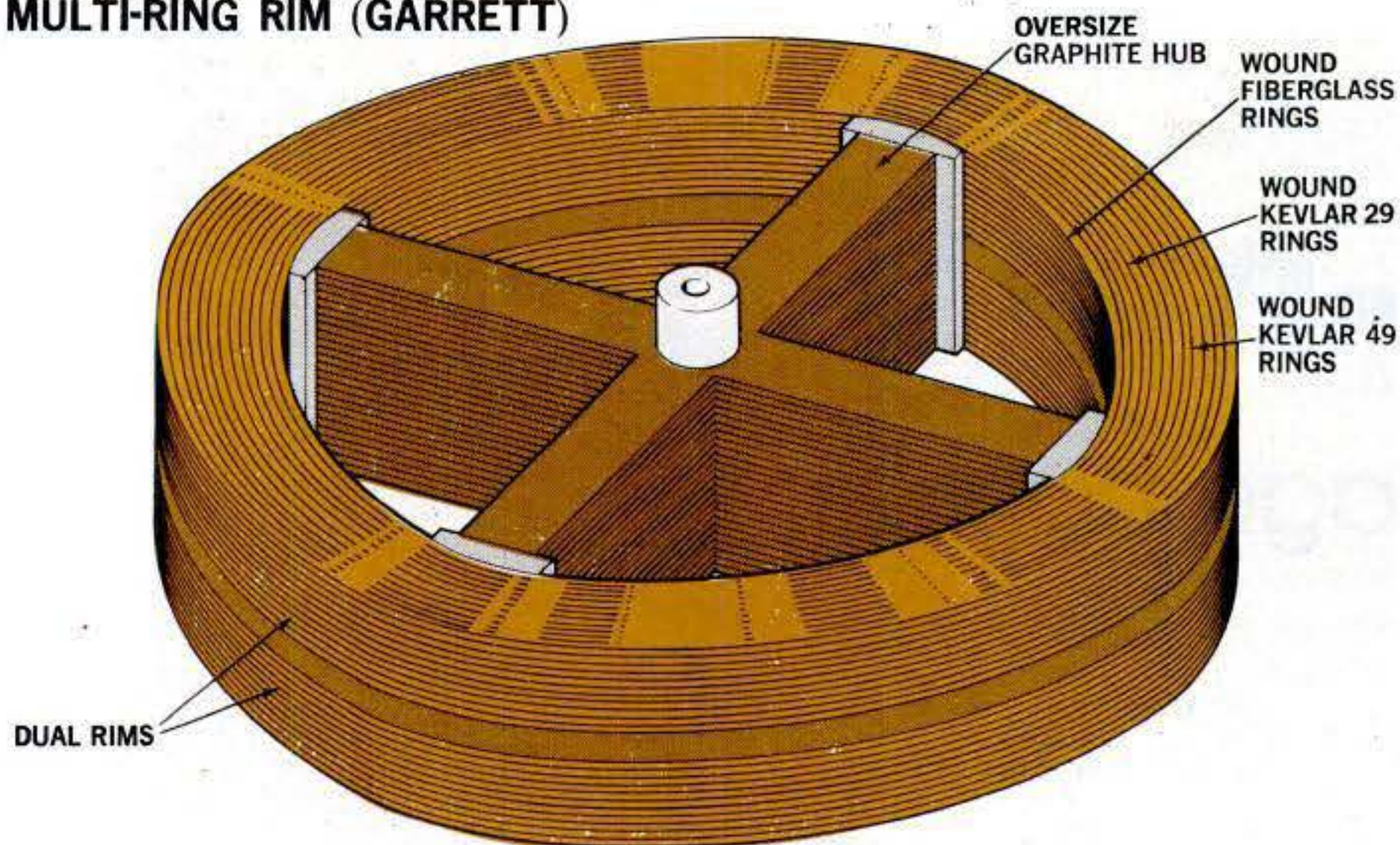
"Yes," he said, "but in flywheel jargon, rotational speed alone doesn't define the case. Let's review basics."

Flywheel primer

Up from his desk again, he pivoted to a large, wall-mounted blackboard behind him. A selection of colored chalks, each in its own holder, was neatly arrayed along the edge.

store as much energy as batteries

MULTI-RING RIM (GARRETT)



Dramatically different flywheels, each is designed to resist radial stresses created by centrifugal force at high speeds. The bare Kevlar filaments of the **APL** flywheel, wound into a slightly subcircular rim, are bonded together at only four points. Each winding can act as a separate ring, stretching freely outward as centrifugal forces pull the rim into the optimum hoop shape. The graphite fibers in the **LLL** disc are all bound with epoxy resin, as are the fibers in the remaining flywheels. The laminated construction of multi-angled plies makes the disc equally stiff in all directions. It is also tapered, getting fatter toward the hub, where stresses are greatest. The dual rims of the **Garrett** flywheel are force-fitted onto an oversize hub, giving the rims a squarish shape. Spring forces trying to pull them back into a circle mechanically bond the rims to the hub. The rims consist of a number of thin (0.2 in.) rings made from composites of varying stiffness. The outer group of Kevlar 49, stiffest of all, presses in against the others as they expand during rotation. On the **Brobeck** flywheel, a stiffer, thick outer ring of Kevlar 49 is wound onto a fiberglass one, setting up compressive forces between them that resist radial stress. The curved spokes are weighted so they'll stretch outward with the rim. The fiberglass plies of the **GE** flywheel are laid down in a different angular pattern than the **LLL** version. A thin wound ring of graphite, shrink-fitted to the disc, acts as a safety measure. The graphite ring also stores a great deal of energy for its weight, allowing the disc to be made of cheaper fiberglass.

"You know the formula: E equals I omega squared over two." Rabenhorst chalked it on the board. " E is energy, of course, omega the rotational speed, and I the moment of inertia. But I equals mass times the radius squared. You have to think about the diameter."

Chalking briskly away, Rabenhorst reviewed how both mass and diameter affect a flywheel's storage potential.

A flywheel stores energy as speed. A heavier flywheel stores more energy at a given speed. But there's a catch: The faster a flywheel whirls, the stronger the centrifugal forces trying to pull it apart. The only thing that resists the stresses caused by these forces is the tensile strength of the flywheel's materials. (Think of a weight tied to a string. Whirl it around your head. What keeps it from sailing off is the tensile strength of the string.)

And the farther out from the center the flywheel mass is, the greater the forces pulling on it. "The amount of energy you can store is a function of

the radial stress," Rabenhorst concluded, "and the stress is a function of both rotational speed and diameter."

So even though a heavy-rimmed flywheel can theoretically store the most energy, in the real world it would be pulled apart before it stored a fraction of its hypothetical energy.

At least that's what would happen to a heavy-rimmed steel flywheel, one equally strong in all directions. Flywheel researchers figured they could break the rules with the new materials. Since the new fibers are superstrong, winding them all in the same direction would create a superstrong hoop—one that would resist radial stress from centrifugal forces.

But they forgot about the epoxy. If the superfibers are to be laid out in the same direction, they can't be woven together as usual. The fibers must be held in place by some kind of glue or matrix—usually an epoxy resin. And the epoxy isn't as strong as the fibers.

"The basic, inescapable problem with any wound flywheel," said Ra-

benhorst, gesturing with his chalk, "is that the outside wants to stretch fully eight times as much as a point halfway between the rim and hub. No resin is capable of allowing that."

So the flywheel delaminates. Tiny cracks appear in the resin. They spread, and the fibers work loose from the matrix. The flywheel breaks.

It breaks nicely. The excess energy forms new surfaces—fuzz and hair—on the fibers. But however nicely, the flywheel still breaks too soon.

"So, we worked on other ways to use filamentary materials," Rabenhorst told me. "You can arrange the filaments in a radial direction—have the spokes without the rim." He waved at the model of the early superflywheel he'd spun up before. "But that radial design doesn't store enough energy for the volume of space it occupies. It has to be made too big for useful storage.

"There's another way to use these materials. It's obvious now, but it took us a lot of computer work to get it."

He slashed a crosshatch design on the board. "This is a laminated disc made of flat layers arranged at different angles, like a piece of plywood."

"A plywheel?" I suggested.

"Yeah." He grinned. "But we call it a pseudo-isotropic disc. It acts like steel, an isotropic material—it behaves the same in all directions. It can resist the forces exerted on it when it's spun, so it doesn't stretch and crack the resin."

And the laminated disc has an added advantage, he said. Since it fills all of the volume swept out by its ends as it rotates, it can store more energy than the same-size hoop-type flywheel.

"But there's a major disadvantage," he said. "I'll show you when we get down to the test labs."

These were set into a little hollow some distance from the sprawling main complex. "It feels like a bunker," I said to Rabenhorst as he led me down a narrow walkway lined with 10-ft.-high concrete embankments.

"It was formerly an explosives test facility," he explained. "These are 18-in.-thick reinforced-concrete walls. We want to be careful when we spin these high-energy flywheels to destruction."

Apparently, they had done that to many flywheels. Twisted masses of shimmering fiber slumped against the concrete walls. Inside the main test lab, more dead flywheels lay in the corners. Others were tossed in a bin, their histories marked on their hubs. "Failed at 20,000 rpm," read one; "spun to 30,000 rpm," another; "failed at 36,000 rpm," a third.

"It's a veritable flywheel museum,"

[Continued on page 150]

1403-mpg car

wins mileage contest

By DAVID SCOTT

MALLORY PARK, LEICS., U.K.

Rolling torpedoes, cigar tubes, deck chairs, and mattresses were the order of the day for the 1979 Shell Motor Mileage Marathon at this English track. More than 40 weird little cars built by schools, apprentice training groups, technical colleges, and scientists competed to beat last year's 1369-mpg (in U.S. gallons) record, itself a big advance on the winner's 914 mpg earlier test [PS, Dec. '77].

This time they had to average at least 15 mph for 10 laps around the race circuit for a 9.5-mile course, instead of 10 mph as before. The higher speed added interest, and was also a greater challenge in an economy run. Yet the record was broken by a wide margin.

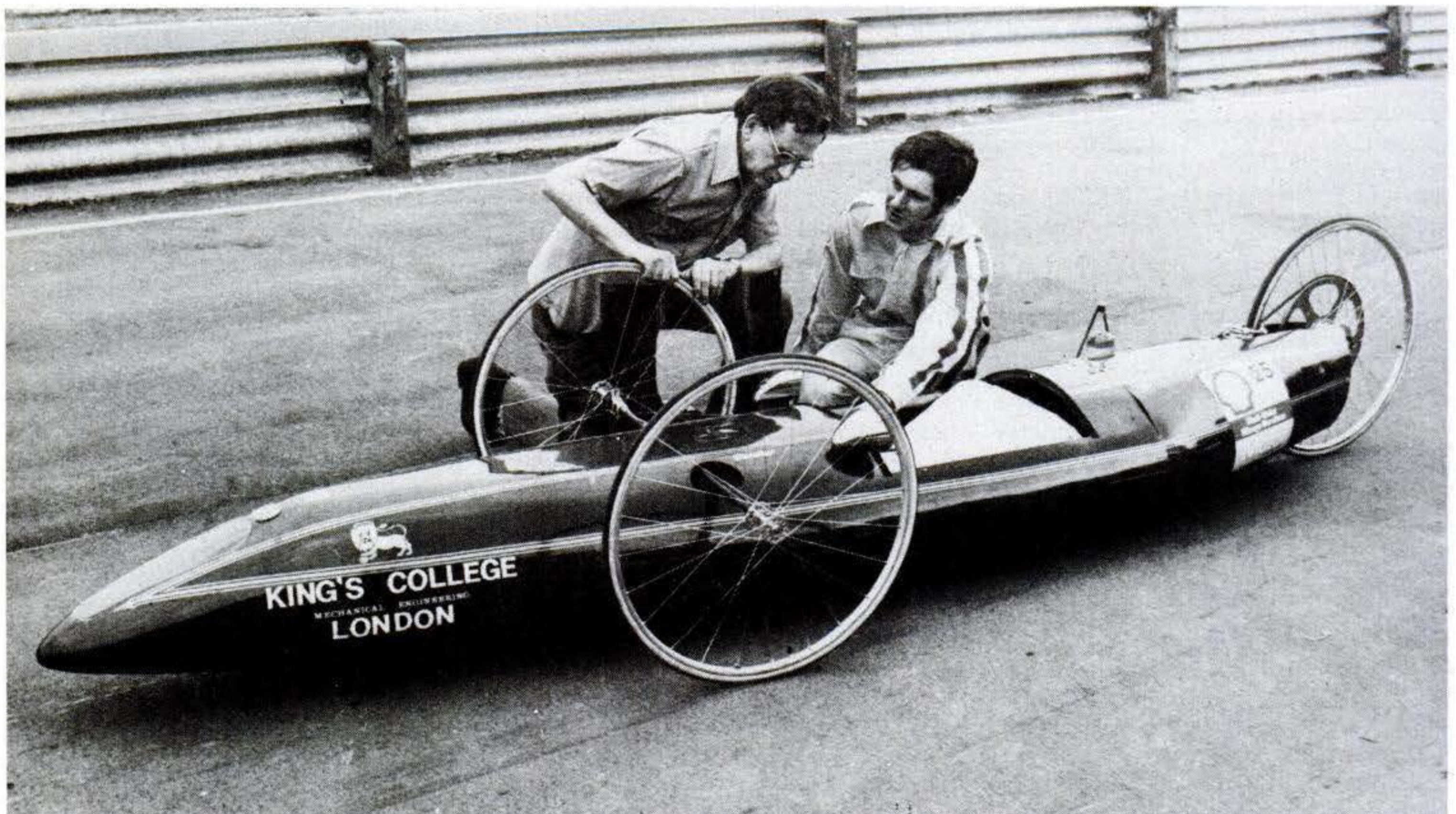
The ingenious one-of-a-kind cars differed enormously in design and performance, though most had three bicycle wheels and air-cooled Honda 50-cc moped engines. All the engines were heavily insulated to improve combustion efficiency and reduce heat

loss during coasting periods in the gearless vehicles.

To save fuel, drivers circled the track with short bursts of power. They would accelerate slowly to about 22 mph, then shut off the engine until the speed dropped to five mph, running it for only perhaps a sixth of the distance. Every car was checked for compliance with construction rules by contest examiners, who also carefully filled each tiny gas tank before and after a run to determine fuel consumption.

Next time—2000 mpg?

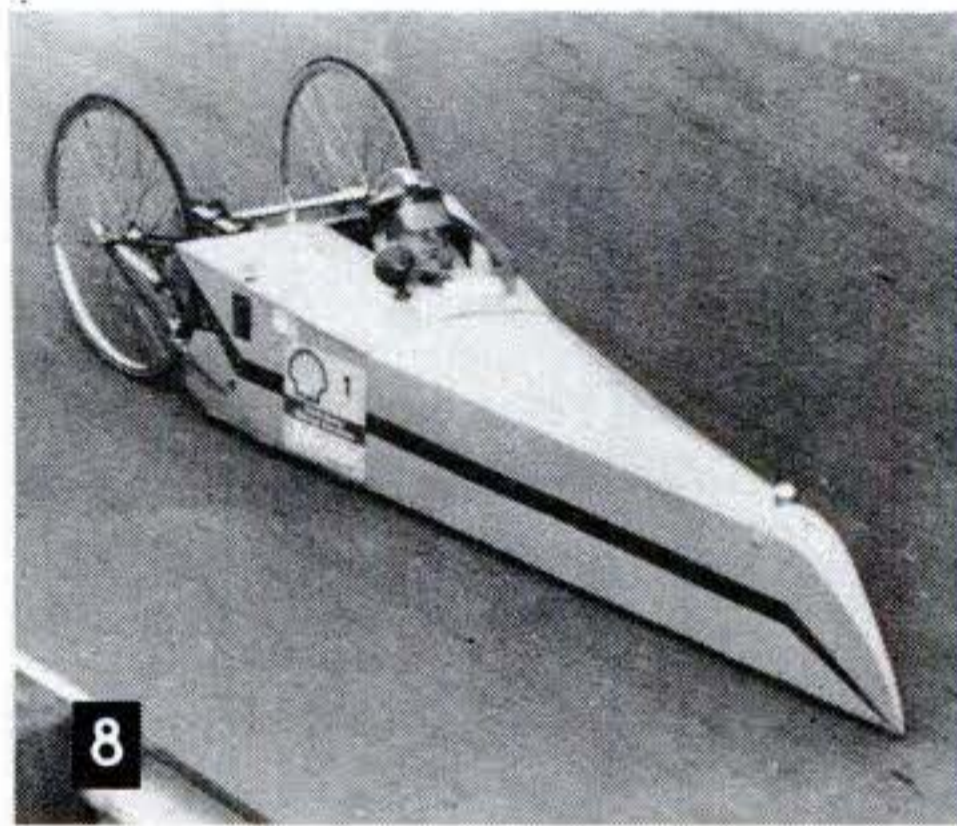
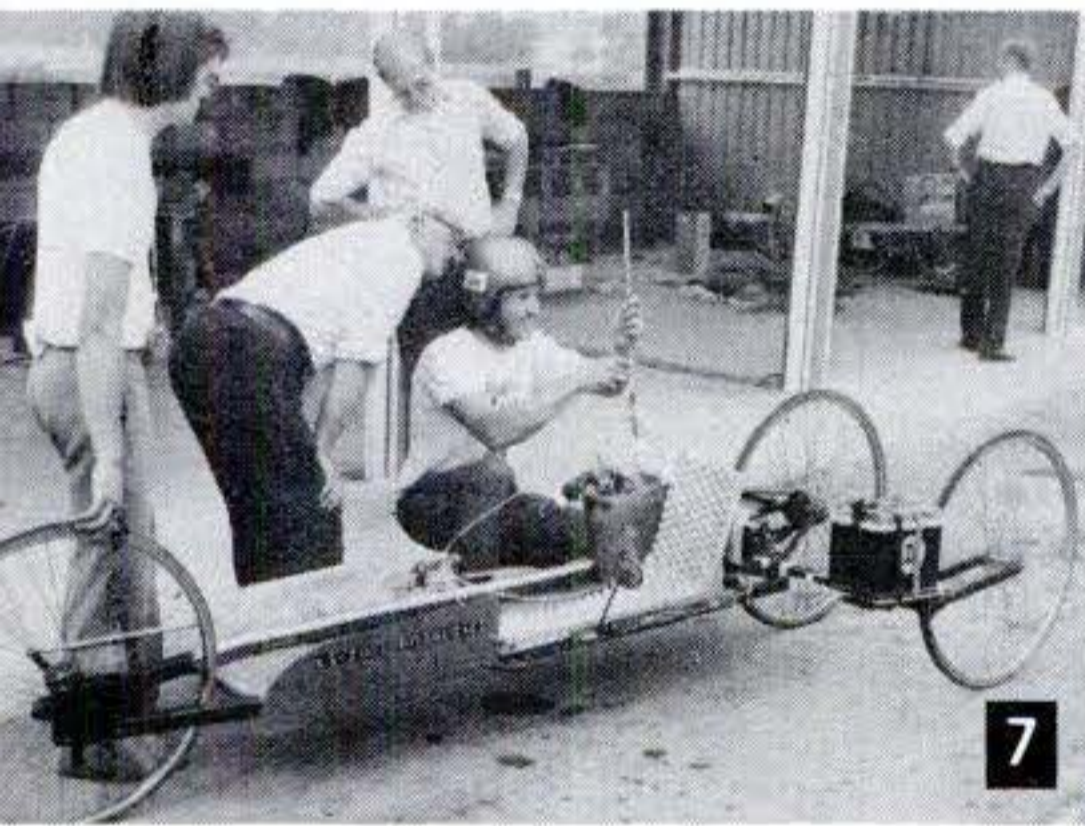
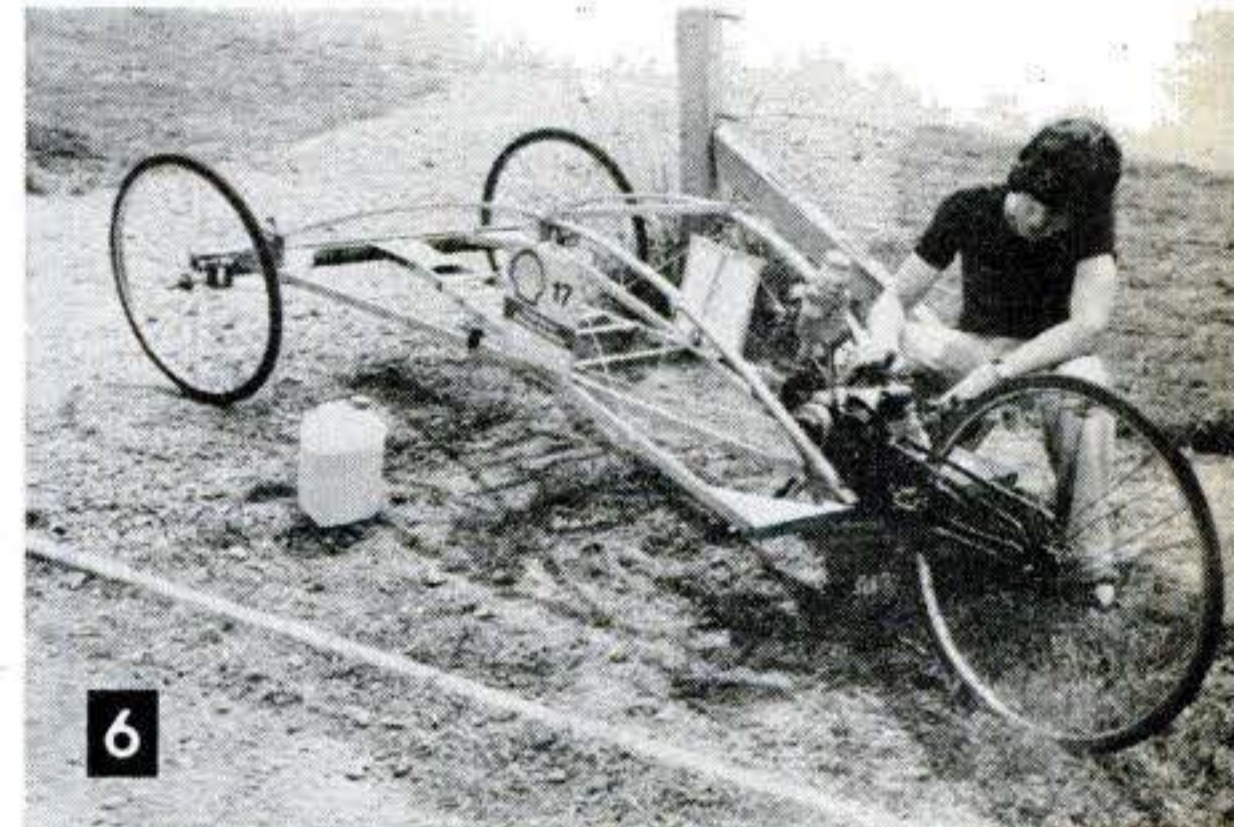
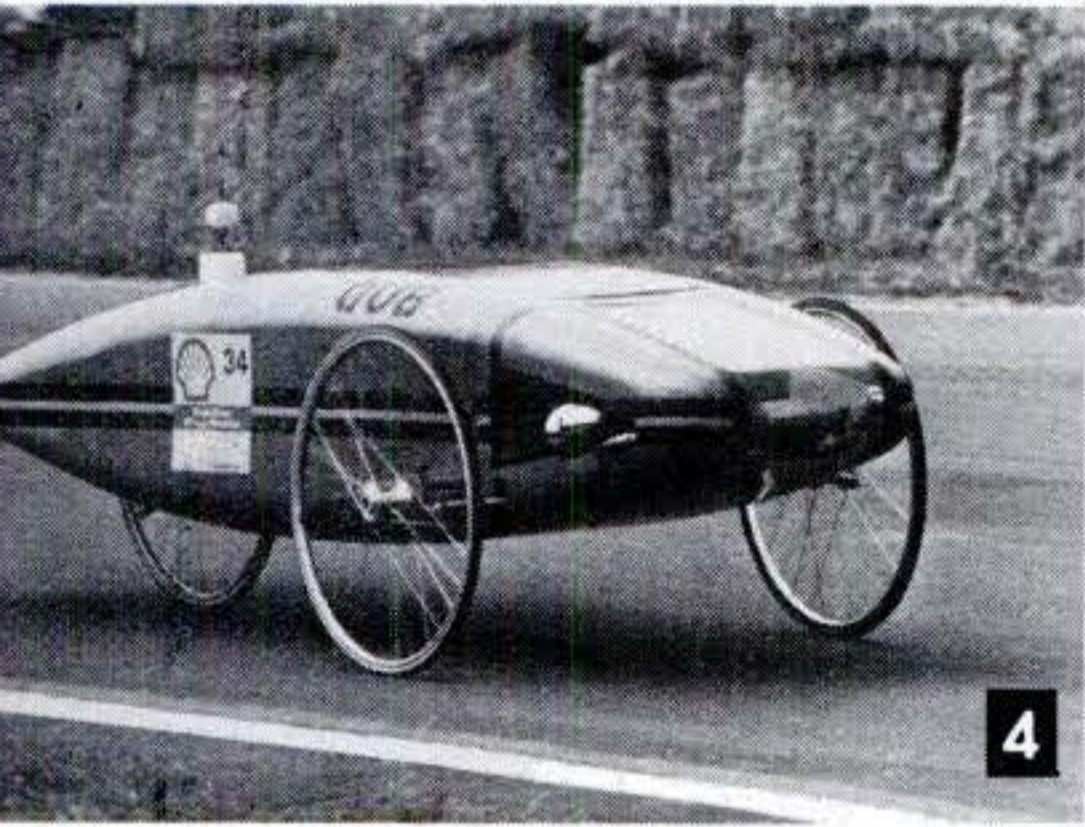
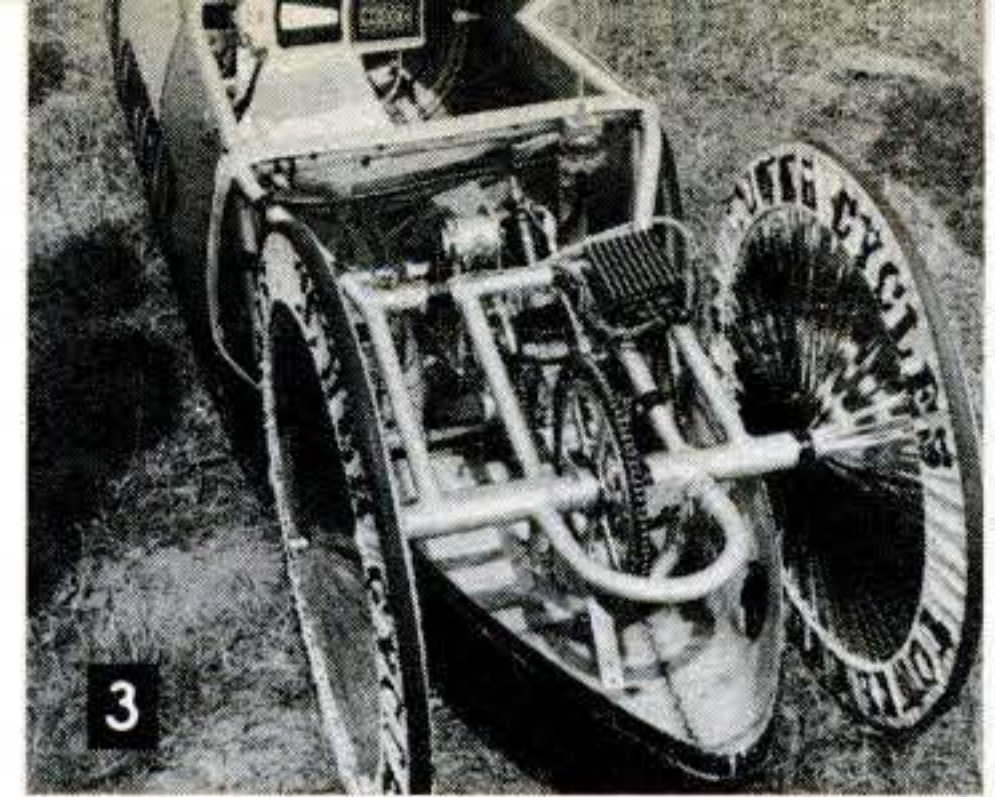
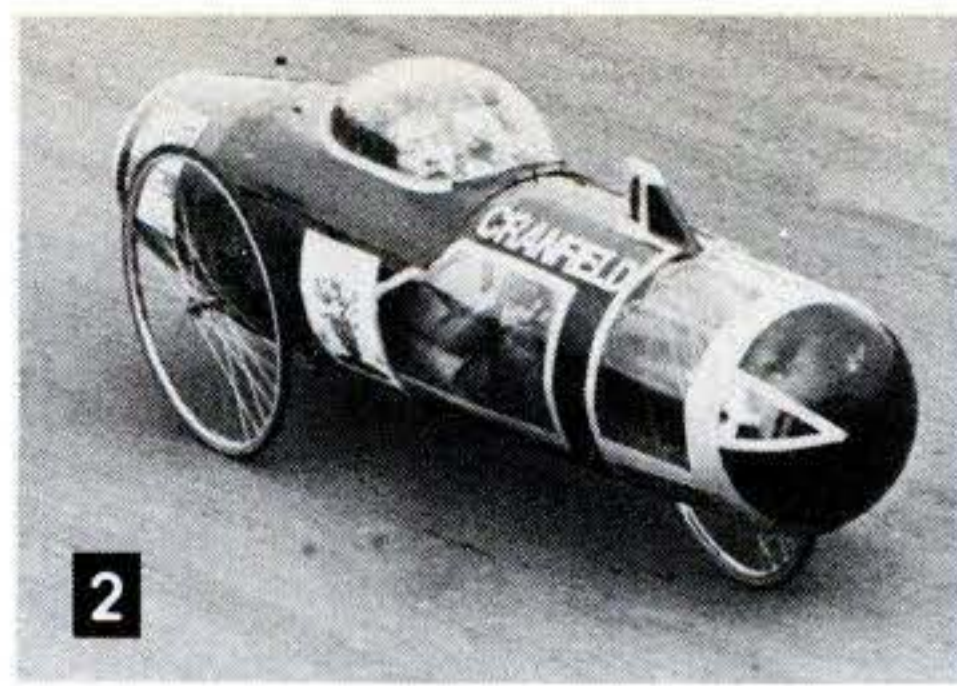
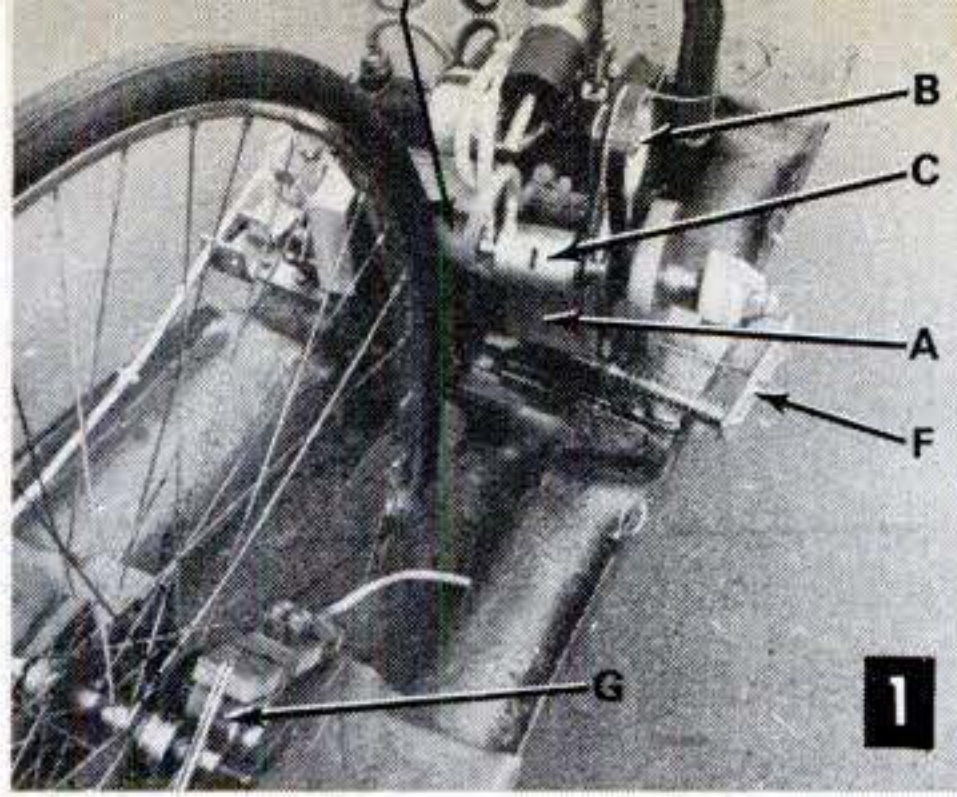
PS



The winner, at 1403 mpg, was this sleek torpedo from Kings College. Low-slung monocoque body has a light tubular frame bolted to the rear, supporting the

engine and drive wheel. Special 24-spoke front wheels cut wind drag, and the axle is centrally pivoted for simple farm-cart steering. The 50-cc Honda engine is stan-

dard except for modified camshaft and an electronic distributor. All gears are removed. Drive to the rear wheel is by a slender chain to a large sprocket.



1 Top award for technical merit went to G. R. Seyfang's private entry, which, sadly, conked out on the tenth lap, so didn't qualify in the mileage contest. Featherweight engine (A) is a tiny 15-cc, 1/3-hp unit built by a retired toolmaker. It has a belt-driven overhead camshaft (B), and is water-cooled by pump (C) and tubular radiator (D). Friction cone (E) drives the rear tire, giving infinitely variable ratio changes. Entire engine assembly is angled to parallel the cone surface, and slides transversely for stepless "shifts" controlled by lever (F) and a fist-grip cable. The assembly also pivots to disengage the cone from the tie, so it doubles as a clutch. This is used for bump-starts, eliminating a heavy motor and battery. Electric motor (G) driven by wheel hub operates speedometer.

2 Cranfield Institute of Technology tallied 1036 mph in a fiberglass tube enclosing sophisticated technology. All but one piston ring is removed to cut friction. Air flows through an exhaust heat exchanger for improved combustion. There's electronic fuel injection, with gas in an auxiliary chamber initially pressurized by an air-filled aerosol can (rules forbid pressurized main tanks). Pressure was maintained during the run by a tiny air compressor driven off the front tire.

3 Chrysler UK's machine didn't last the course, but packed a lot of clever gadget-

ry. The Honda engine with electronic ignition has compression ratio upped to 12.5:1, and drives one wheel by means of chains. Rear-wheel spokes are covered with aluminum foil to cut wind drag, and protected by slip-on covers off the track. Slick racing tires run at a rock-hard 160 psi. A car-type trip computer shows average speed, average mpg, and other read-outs to help the driver.

4 A high-rise car would cut ground drag, figured its builders from Queens University of Belfast. But it got only 607 mpg. Body fully enclosed a cocooned Honda engine with the cylinder head running at 225 degrees C instead of the normal 140.

5 C. H. May's rolling boat, made of plywood and sheet aluminum, weighs 29.5 pounds, has a truly midget engine. The 2.3-cc model-aircraft unit (at left of cockpit) is converted from diesel to gasoline operation and spark ignition required by the rules. It friction-drives one front wheel, and is pull-started. Pivoted rear wheel is steered by a cable and lever. The car couldn't finish the course in the maximum time of 38 minutes allowed.

6 Wooden suspension-bridge car has laterally stiff X-braced frame hung from arched strips by string tensioners. The driver lies head first on hammock straps, steers knuckle-joint front wheels with a crossbar. The car was an engineering project for teenage students at Hayes

School. It didn't make the running at Mallory Park only because the drive chain kept falling off the sprocket.

7 Cyclone Hovercraft got 1116 mpg in a homemade machine built by the 1977 winner. The Honda engine has a May-type Fireball combustion chamber, and special ultra-lean carb with electric valve to cut off gas flow when coasting. Rear wheels on linked trailing arms are rubber-sprung on a central hinge. Front axle pivots for steering. Designer Nigel Beale checks fuel consumption after practice run.

8 A track-hugging wedge, only 3/4-inch off the ground, this Shell Research-Engine Fuels No. 1 got 1025 mpg. Engine has one variable-venturi carburetor for starting and warm-up, and a separate cruise carb with no throttle for full-power spurts around the circuit. It chain-drives one rear wheel through a derailleur gear for ratio changes. Tires are inflated to 100 psi. Front wheel has tiller steering.

9 Half-round design from British Aerospace Dynamics got a healthy 1124 mpg. The sophisticated machine can do 40 mph with only a 50-cc engine. Packed with electronics, it has a digital speedometer and tach, solid-state ignition with variable timing. Engine power is boosted by steam injection, using water boiled by exhaust heat. The transmission is stripped down to only one gear, and drive is through a freewheel to maximize coasting.

BRESLIN

—the home computer that runs my house

He's a butler, babysitter, companion—and sometimes a nuisance

By **BILL HAWKINS**
DRAWING BY ROY DOTY

Okay, so he's got flashing lights and a TV readout, and is plugged into a wall socket—Breslin is still one of the family. He teases the dog, talks to our kids, call my wife "Mom," and is charged with some of the more difficult tasks around the house—like getting me up in the morning. The idea was simple: let my home computer take over the time-consuming, tedious jobs around the house. Much of my house was already electronically controlled [PS, Sept. '75]—all it needed was a "brain" to take over completely.

Breslin is not your normal "print-it-out-only" computer, although he does print up monthly bank balances and take care of addressing our Christmas cards. He not only talks over the house intercom system, but listens (to take verbal commands) and can remotely control everything from the garage door, to TV cameras, to nearly every light in the house. He knows the time, predicts the weather, and can communicate (in his native digital tongue) with other computers to get the latest news headline or to retrieve personal data, such as the babysitter's phone number or what to do if I lose a credit card.

Sound good? It is, and if you decide to adopt a home computer as I did, I offer my programming attempts for your use. But let me warn you: There are some pitfalls. I tried to make Breslin as "human" as possible—a trait which, when combined with the tire-

less rapidity of a computer, could help you toward your first ulcer. Sure, I've yelled at machines before, but they never yelled back. But before telling you what could go wrong, let me explain what's supposed to happen when things go right.

A time for all reasons

Breslin normally follows one of four standard schedules (unless you've told him to do otherwise). The one he chooses depends upon the day of the week, whether it's a holiday, and whether or not someone is home. He usually begins at dawn. That's when various lights that he switched on earlier for night lights around the house are turned off, the burglar alarm is silenced, the heat is turned up in winter, and the garage door is unlocked. And, just before getting us up, he starts the coffee in the kitchen.

Although some things, like the burglar alarm, are wired directly to Breslin, almost everything else is controlled remotely by a BSR X-10 wireless remote-control system. Normally, to use the BSR system, you push buttons on a transmitter box, which then sends a digital code over the house wiring. Plug-in modules, at each light and appliance, decode the signal and turn the correct appliance on or off.

The BSR transmitter box, however, can also be controlled with an optional hand-held ultrasonic unit—and that's how Breslin takes control. He's programmed to mimic the ultrasonic tones normally produced by one of these hand-held units. The transmitter box, placed near Breslin, picks up the tones and sends out a corresponding digital code over the house wiring controlling the appliance.

During the week, when it's time for me to get up for work, Breslin is pro-

grammed to start my day at 6:30. He begins with soft, gentle tones over the intercom, followed by "Good morning, this is Breslin." He then gives the time, notes any appointments logged in his memory for the day, tells the temperature and barometer readings, and predicts the weather. Finally, he turns on an FM tuner for the news.

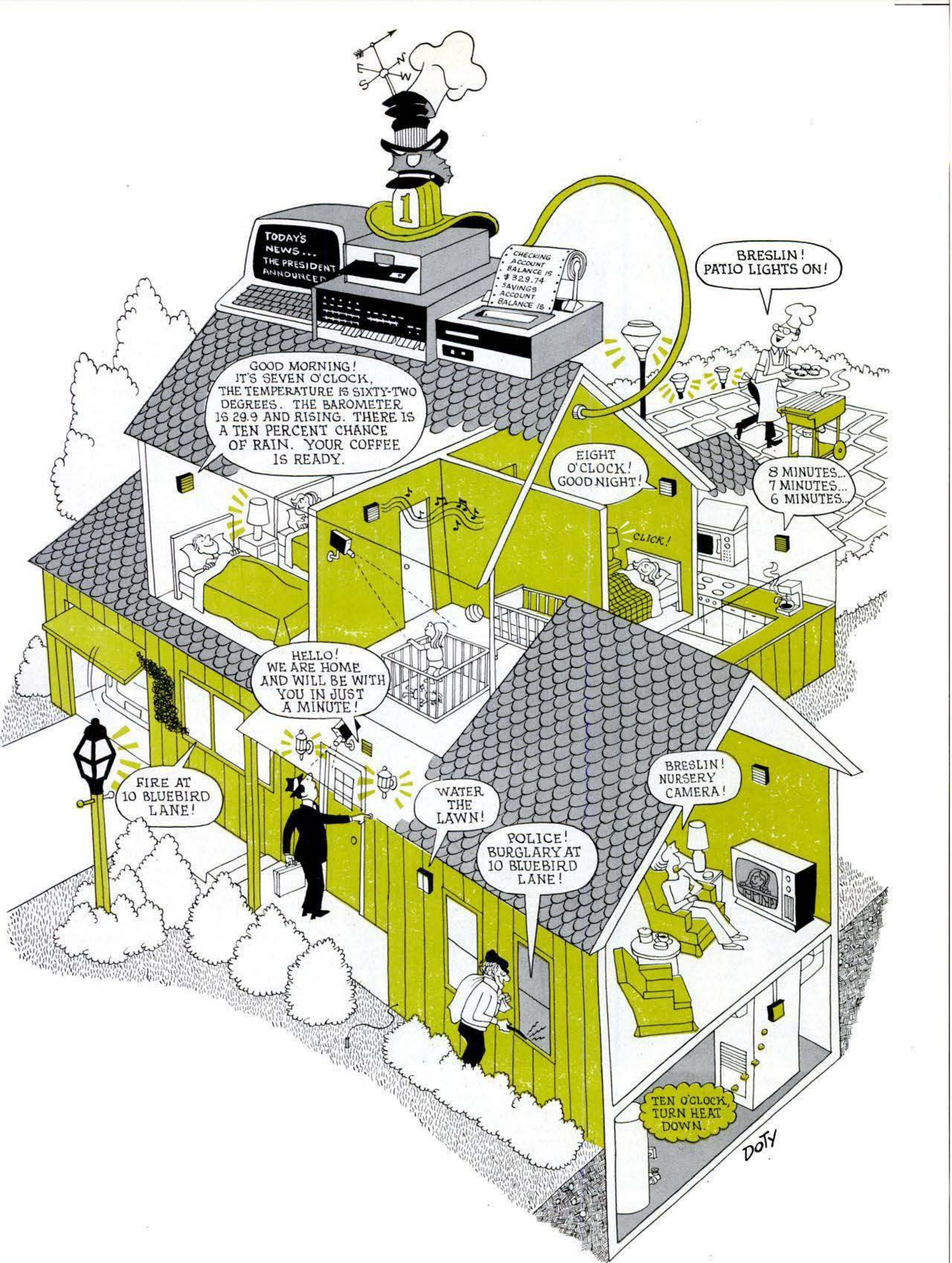
To predict the weather, Breslin is attached to a Heathkit digital weather station. He is constantly checking temperature and plots barometric changes per hour in his memory. The resulting numbers (deltas) are assigned weather predictions: rain, snow, clearing, etc. How good is he? He's been about as accurate as our local weatherman. (I told you he wasn't perfect.)

During the day, Breslin spends most of his time checking his internal clock against scheduled events and sampling the status of various sensors around the house. He does it so often, however—10 times a second—that it leads to some early troubles.

I spent my last summer vacation with a paintbrush. But I'm not the kind of house painter you see in TV commercials—my shirt sleeves are smudged and my shoes, socks, and pants are wet with drippings and splatters. When I had finished for the day, my wife sensibly suggested I strip in our attached garage before coming inside. No problem. It was dark, the door was closed, lights were off, and it would just take a minute.

Breslin was faster. He noted a momentary "glitch" in one of the heat sensors (an appliance turning on could have caused it). Conclusion: The house was on fire. I think you can guess the rest. The house and garage lit up like a parking lot, alarms

Continued



GOOD MORNING!
IT'S SEVEN O'CLOCK,
THE TEMPERATURE IS SIXTY-TWO
DEGREES. THE BAROMETER
IS 29.9 AND RISING. THERE IS
A TEN PERCENT CHANCE
OF RAIN. YOUR COFFEE
IS READY.

EIGHT
O'CLOCK!
GOOD NIGHT!

BRESLIN!
PATIO LIGHTS ON!

8 MINUTES...
7 MINUTES...
6 MINUTES...

HELLO!
WE ARE HOME
AND WILL BE WITH
YOU IN JUST
A MINUTE!

FIRE AT
10 BLUEBIRD
LANE!

WATER
THE
LAWN!

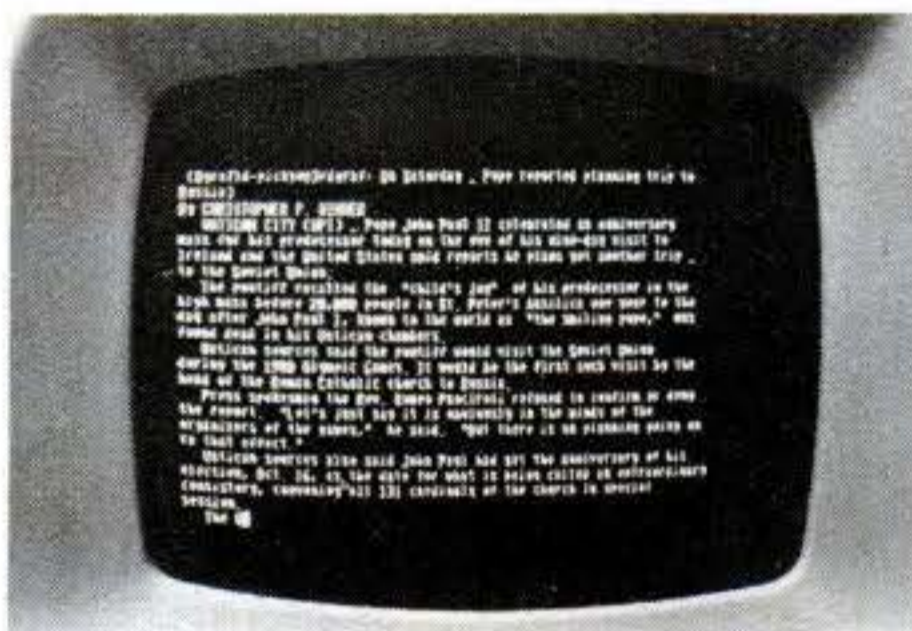
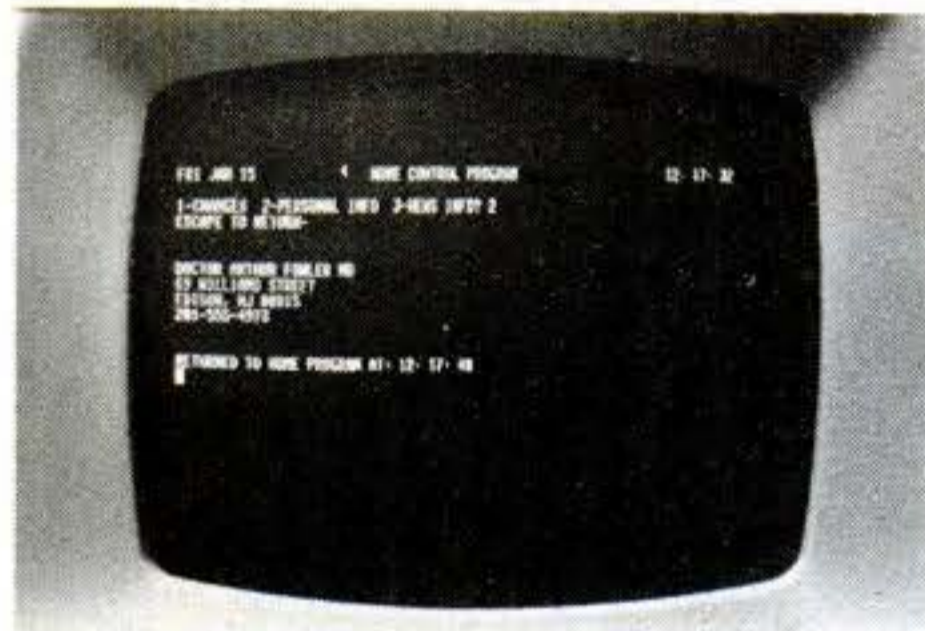
POLICE!
BURGLARY AT
10 BLUEBIRD
LANE!

BRESLIN!
NURSERY
CAMERA!

TEN O'CLOCK,
TURN HEAT
DOWN.

DoTy

Additional info from Breslin



FRI JAN 15		HOME CONTROL PROGRAM		12: 50: 18
DEVICE	ON TIME	OFF TIME	STATUS	
1 - FR/PORCH	2325	2330	OFF	<div style="border: 1px solid black; padding: 5px;"> <p>Additional Information</p> <p>SCHEDULE: WEEKDAY</p> <p>EMRGY PH: 555-5478</p> <p>ALARM PH: 555-5415</p> <p>IN TEMP: 67</p> <p>OUT TEMP: 45</p> <p>BAROMETER: 33</p> <p>SPK INTVL: 30</p> <p>MESSAGES--</p> <p>1 CALL ARTHUR</p> <p>2 DOCTOR APPOINTMENT</p> <p>3</p> </div>
2 - FOYER	2330	530	OFF	
3 - LD/YARD	0	0	---	
4 - HI/YARD	2325	2330	OFF	
5 - LIV/RM	0	0	---	
6 - STEREO	0	0	---	
7 - FAN/RM	1915	2330	OFF	
8 - EMPTY	0	0	---	
9 - FR/BDRM	0	530	OFF	
10 - HEAT/AIR	600	2330	ON	
11 - BK/BDRM	1945	530	OFF	
12 - CAMERA	0	0	---	
13 - MSTR/BDRM	2330	2340	OFF	
14 - COFFEE	620	1000	OFF	
15 - GARAGE/LK	530	2330	ON	
16 - ALARM	2315	600	OFF	
17 - SPEAK	630	2300	ON	
18 - MUSIC	630	0	ON	
19 - EMPTY	0	0	---	
20 - EMPTY	0	0	---	

Breslin is an IMSAI 8080 computer equipped with a Computalker speech board for talking, an SSM board for music and tones, and a Heuristics Speechlab board for understanding verbal commands. The "Home" program is 52 kilobytes (52,000 bytes) long and loads into the computer in a few seconds from a North Star disk system. The Lear Siegler terminal allows us to enter and receive data through the system. Depending on what you want, the program allows the

IMSAI to talk to a small Pertec (MITS) 680b computer for personal info such as credit-card numbers, or through a phone-line modem box to Telecomputing's "Source" system. That data bank will give you everything from airline schedules to the latest news. Other monitors and TV sets installed around the house can instantly show the present schedule being used or display a closed-circuit camera for the baby's room or the front door.—W.J.H.

screamed inside and out, and the automatic garage door opened wide to the neighborhood for a fast emergency exit. It was a mad scurry in my skivvies for the family-room door. Needless to say, he's been reprogrammed to "look again" before taking action.

Although correcting problems in a computer is usually easy, *finding* them could make you want to trade the box in on a new toaster.

For example, when you look at a clock and the minute hand is passing the 12, you know the next minute is coming up. But what if it's exactly on the 12? Logically, is it the end of the last minute or the beginning of the next? To us humans, this is minor; to Breslin, routinely checking his internal electronic clock, it meant total confusion whenever it happened. Until found, it happened often enough to make me expect an occasional blinking light by day or a "good night" message at three in the morning.

Speak to me

Normally, however, Breslin does quite well. As he gathers data, such as the soil moisture content, he saves it for use when he speaks—routinely on the hour or half-hour, and randomly at various times throughout the day with additional "personal" messages.

The messages are made up from vocabulary words he can combine. (It's structured so that the combination of words always forms a complete sentence.) He may say, "I love you, Kristen," to my daughter or start calling our dog, Skip, in an attempt to lure him off his guard duty (asleep). The sentence is random except on special occasions, such as the kids' birthdays, when he'll also add in a few bars of "Happy Birthday to You."

But Breslin doesn't confine his conversations to the inside of the house. When you ring the doorbell, for example, he first turns on the porch light if it's dark, plays a few synthesized tones through an outside speaker to get your attention, and verbally asks you to wait a moment or politely apologizes that no one is home (he knows that from the schedule he's on). In the back yard, he's especially useful when I'm barbecuing—if everything goes right.

Not only can Breslin speak through these outside speakers, but he can receive orders as well. He's programmed to accept specific words spoken by either me or my wife. The main word he knows is his name, "Breslin," which is used as a key to get me into his programming. He responds with "yes," to let me know he's listening, and I can then proceed to have him turn on the overhead patio lights, actuate a

[Continued on page 154]

A new family of penetrating finishes



New EnviroSol coatings perform like oil-base products, but contain 60 percent less petroleum solvent—so they don't pollute.

They soak deep into wood, coat smoothly on metal, and clean up with water

By **DAN RUBY**

For years, paint-industry chemists have sought to develop products that would join the performance advantages of oil-base coatings with the convenience and easy cleanup of water-base ones. But, though advances in latex coatings have been rapid, none were produced that had the hiding power, tough finish, and ability to work in temperature extremes of standard oil paints and varnishes.

Now the Flecto Co., maker of coatings for the do-it-yourself market, claims to have done it with a whole new family of coatings under the EnviroSol trademark. Key to its success, says Flecto, is its new Envirolite resin, developed after an eight-year development program involving chemists at six labs in the U.S. and Canada. The resin is a condensation polymer with unique qualities that enable the coating to penetrate deeply into wood to provide exceptional dimensional stability and prevent corrosion on metal without a primer coat. Best of all, the EnviroSol products clean up easily with water.

By happy coincidence, Flecto's new coatings reached the market at the

same time that California was placing strict limits on the sale of most oil-base coatings because of their environmental impact. According to a spokesman for the California Air Resources Board, evaporating solvents in architectural coatings contribute 100 tons of hydrocarbon emissions per day to Southern California's smog-fouled air, roughly seven percent of the total. Flecto's EnviroSol products, which contain 60 percent less solvent than traditional oil-base coatings, comply with the new regulation. If the federal EPA issues similar guidelines to the other 49 states, as it is considering doing, Flecto will have a huge head start over its competition.

The EnviroSol family includes 15 colors of brush- and spray-on paints called Le Spray and Le Brush, Varathane clear gloss and satin finishes (also available in spray cans), and Varapel exterior wood sealer and preservative with mildew and fire retardants.

With formulation patents pending on the Envirolite resins, Flecto is unwilling to divulge the details of their makeup, but so far its claims have proved out in testing. Harlan Associates, a San Francisco lab specializing in paint, ran a series of tests of the paints applied to metal. In the accelerated-weather and hardness tests, the EnviroSol products performed better than nine competitors, while they

were comparable in salt-spray and corrosion-resistance tests.

Flecto vice-president for research, Dr. Ramesh Vasishth, is happy to explain how the resins work. "They all have two properties in common: low average molecular weight and lots of reactive groups."

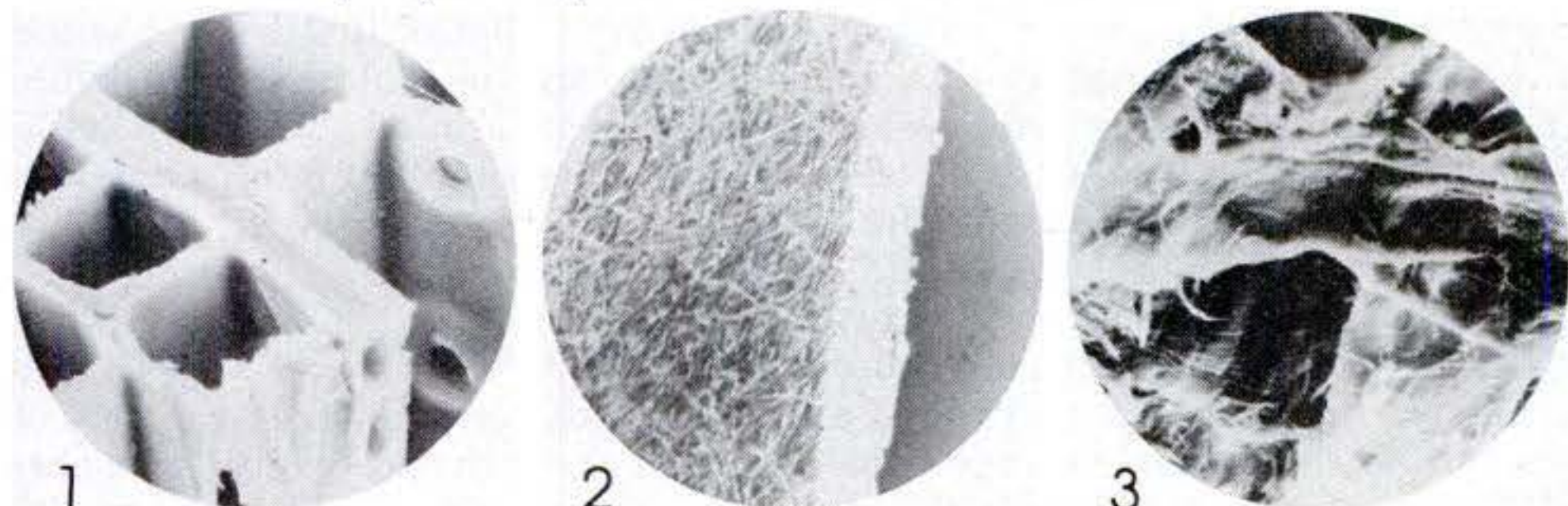
The small size of the polymers (50 percent of them under molecular weight 1000) is what enables the products to penetrate deeply into the cellular structure of wood, and therefore prevent warping, checking, and cracking. Also, the polymer can be modified to carry other chemicals such as mildew and flame retardants with it. So, for the first time, exterior woods need not be heat- or pressure-treated to get such preservatives in.

The reactive groups are what give the paints such good adhesion on unprimed metal. They create an electron polarity that causes the pigment molecules to attach to each other end to end to give a smooth, continuous film on such hard-to-cover materials as galvanized steel, aluminum, Formica, and PVC. This, along with an electrochemical current generated by the polymer itself, also contributes to corrosion resistance.

The idea of penetrating resins is not really new. Linseed oil has small molecular size, but it is carried by an organic solvent that is blocked by the

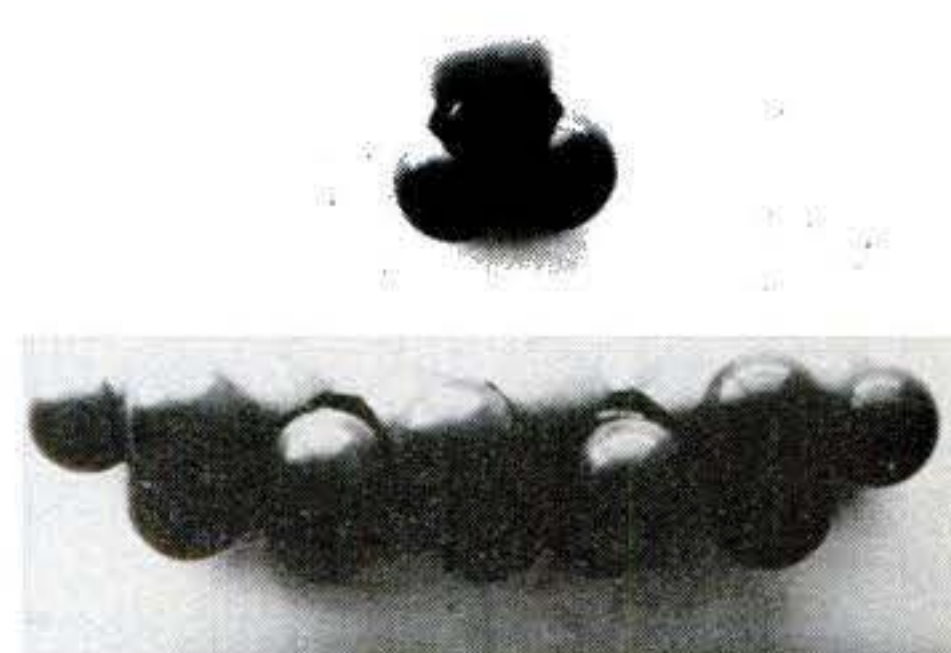
[\[Continued on page 158\]](#)

How the new polymers penetrate wood-cell walls



Increasing magnification of scanning electron microscope shows fine structure of wood. The hollow tubes, or lumen (1), are the pipelines by which a living tree

routes water and nutrients. The cell walls (2) consist of chains of cellulose fibers. Magnified a million times (3)—the same scale as the simulated molecules at right—



it is apparent that the gaps between fibers are large enough to be penetrated by the Envirolite resin (top), but not by a typical latex polymer (bottom).

High-tech cars for the mid-'80's

- radar-controlled cruising, braking
- computerized manual transmission
- safety in 50-mph crashes

By HERBERT SHULDINER

Since last March, a sleek, futuristic car with gull-wing doors has been visiting cities from coast to coast and getting enthusiastic responses from safety experts, government officials, and the general public. A "clone" of that car is now nearing completion and the National Highway Traffic Safety Administration, which paid to have it built, says it is the first high-technology car that features engineering and electronic innovations designed for autos of the mid-1980's.

A different advanced vehicle, built by Chrysler under a contract from Calspan Corp. of Buffalo, N.Y., which designed it, has also been on a national tour and has been receiving a lot of acclaim from safety experts. On the outside it looks like many of today's production cars. Under the skin, however, it also is highly innovative.

These vehicles, financed by NHTSA, have been built primarily to perfect occupant-protection technology—to develop cars that keep people alive in serious crashes. But these high-technology cars also contain advanced engineering and electronic innovations that make them the forerunners of the autos you'll be driving in the years ahead. Among the advanced features are bumpers that aren't damaged in collisions up to eight miles an hour, run-flat tires, replaceable bolt-on nose sections, and the most advanced active and passive restraint systems yet devised—offering survivability in crashes up to 50 mph.

Although the cars, reflecting their original purpose, are called research safety vehicles (RSV's), there's a lot more to them than just safety engineering. The increasingly stringent

requirements for better fuel economy and cleaner exhaust have led to the introduction of other advanced engineering systems.

Most advanced of the RSV's is the one now under construction by Minicars, Inc., of Goleta, Calif. Its outstanding features will include these innovations:

- Radar-controlled brakes.
- Radar-guided cruise control.
- Computerized manual transmission that does the shifting and clutching for you automatically.

High safety standards

"Minicars designed a vehicle as no one had ever done before," says William A. Boehly, chief of NHTSA's integrated-vehicle research division. Instead of starting out with a standard frame and then designing a body to go around it, "they took a sheet-metal design and enclosed sections filled with polyurethane foam. This gives you very light weight because you can use light-gauge sheet steel, yet achieve a very strong capability to absorb crash forces." For further protection, the Minicars RSV has air bags for driver and front-seat passenger; three-point belts secure rear-seat riders.

The result, Boehly claims, is unparalleled crashworthiness. About 15,000 lives now lost in traffic accidents annually could be saved if every car on the road were built to the Minicars RSV standards, he says.

The latest version of the Minicars RSV also has a radar system designed to prevent or reduce the severity of a crash. It consists of a microwave-guided cruise control that maintains headway intervals automatically, warning drivers if they get too close to the rear of another car. The radar will also trigger the RSV's brakes if a high-

speed collision becomes inevitable.

I recently visited RCA's David Sarnoff Research Center in Princeton, N.J., where the radar system is being built, to get a preview of how it will work.

"If you're a normal driver, you should never know the radar-controlled brakes are in the car," says Dr. Ervin F. Belohoubek, head of microwave-circuits technology at the RCA laboratory. "It should work only if something goes wrong, like when a driver falls asleep at the wheel."

It's not designed to prevent a crash, Dr. Belohoubek stresses, but to slow the car down to about 30 mph (remember, the car is designed for survivability in crashes up to 50 mph) before a collision actually takes place. This reduces the damage to the car and decreases the severity of injuries to occupants. But the brakes are not designed to come on early enough to actually prevent a collision. "We can't use a detection area that's more than 30 meters in front of the car because of the great risk of false alarms," says Dr. Belohoubek.

In addition, he says, if you're 40–50 meters away from a potential collision, you can still make an evasive maneuver. "If a skilled driver has the brakes come on automatically while he's steering around a vehicle, it could prevent his completing the maneuver and avoiding an accident," Dr. Belohoubek explains.

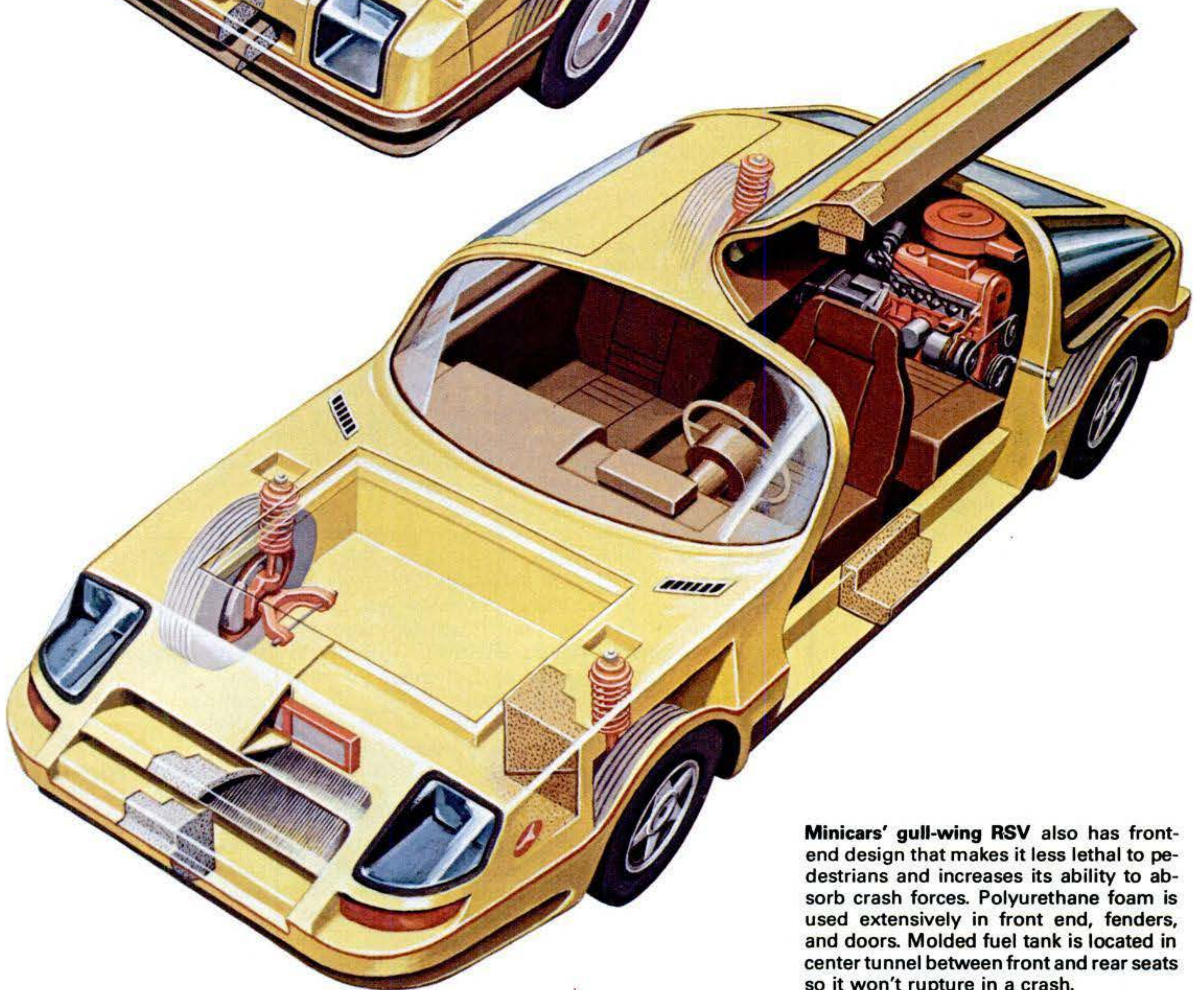
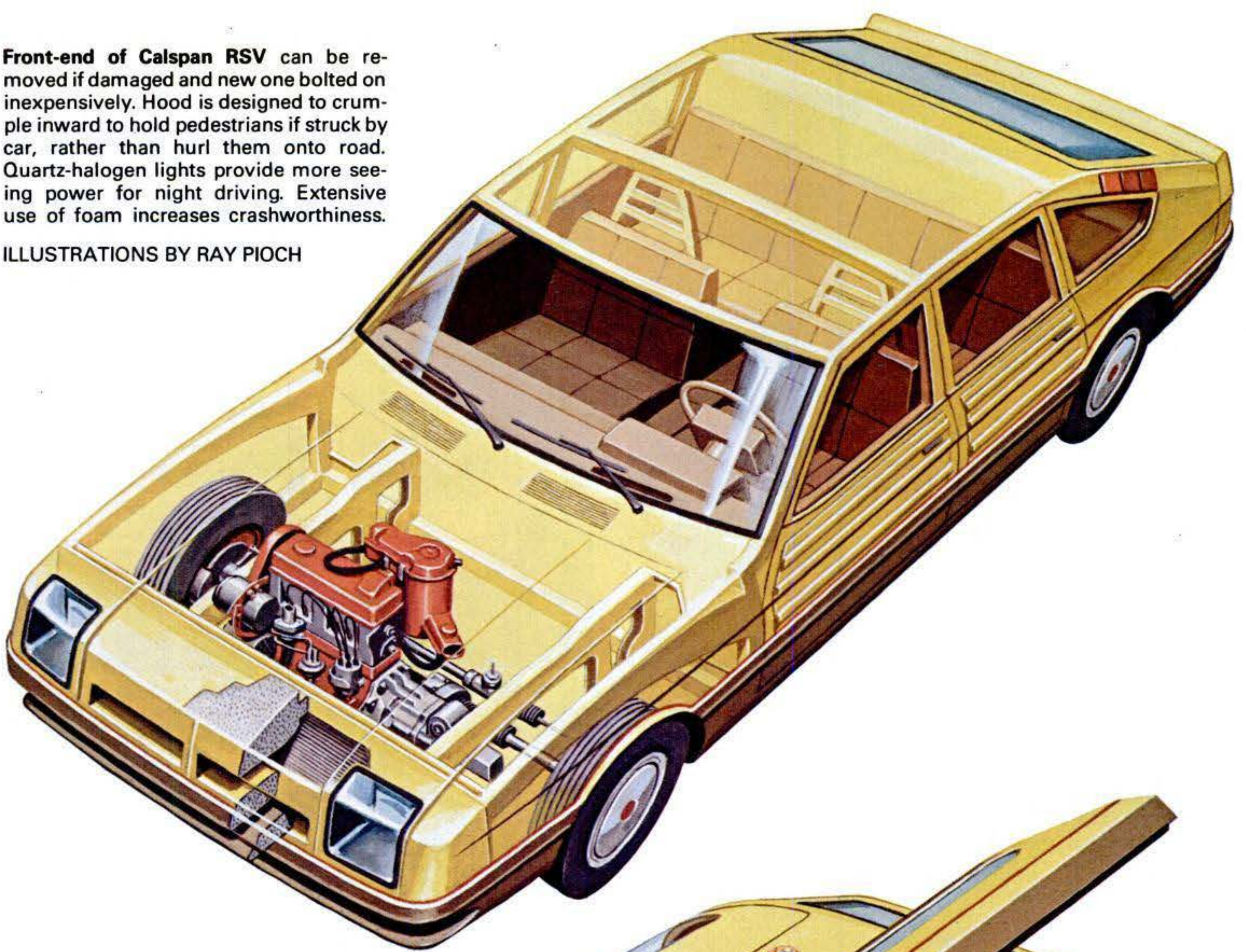
No false alarms

The radar antenna is in the nose of the car under the hood. It beams a narrow (three degree), low-energy (20 mW) microwave signal on the 17.5 GHz frequency. It's a different wavelength than the radar frequencies

Continued

Front-end of Calspan RSV can be removed if damaged and new one bolted on inexpensively. Hood is designed to crumple inward to hold pedestrians if struck by car, rather than hurl them onto road. Quartz-halogen lights provide more seeing power for night driving. Extensive use of foam increases crashworthiness.

ILLUSTRATIONS BY RAY PIOCH



Minicars' gull-wing RSV also has front-end design that makes it less lethal to pedestrians and increases its ability to absorb crash forces. Polyurethane foam is used extensively in front end, fenders, and doors. Molded fuel tank is located in center tunnel between front and rear seats so it won't rupture in a crash.



Calspan RSV doesn't look any different than most cars on the road now. It's actually a modified Simca 1308 with Omni/Horizon engine and drive trains. This RSV weighs 2675 pounds.



High-technology Minicars RSV has modified rear end in this version. Spoiler has been added to improve aerodynamics. It's a rear-engine, rear-drive car, and weighs about 2500 pounds.

used by police and airports. So if you're driving past an airport, or a police radar unit, your brakes won't be triggered inadvertently. Nor will rain or other weather conditions affect the system, it's claimed.

If the microprocessor that controls an RSV's radar senses a closing velocity that it determines means an inevitable collision, it actuates a Bendix antiskid braking system—and it will slow your car down even if you keep your foot on the accelerator. The microprocessor cycles the brakes on and off. Thus it won't lock the wheels and throw you into a skid. But it stays just short of lockup, so you have maximum braking without losing control.

The collision-mitigation system won't actuate in all collisions. It doesn't come on at all when the vehicle's speed is under 30 mph. And it shuts off when the car speeds around sharp turns. That's to prevent false alarms, Dr. Belohoubek says.

Keeps proper spacing

The radar is also used in the RSV's automatic headway-control system. For this, it's programmed to "see" 40–50 meters ahead. "If you approach a car going slower than yours," Dr. Belohoubek says, "it will settle behind the other car at a distance safe for your particular speed, and it will keep that distance as long as you drive behind that car." It keeps working even when you slow down to a virtual crawl.

If you move into another lane or the car in front turns off or speeds up, you go back to the speed you originally set.

The cruise control doesn't actuate the brakes. It slows you down by disengaging the throttle. This generally works well enough to maintain desired distances on level roads, but you have to do some manual braking to maintain proper intervals when driving down steep hills. Tests have confirmed that the automatic headway-control system can keep proper spacing between cars better than human drivers can, RCA claims.

The cruise-control system was also designed to increase the RSV's fuel economy. Surprisingly, though, extensive tests run by RCA have failed to establish any fuel saving for cars using the microwave-guided cruise control over vehicles operated by average drivers. "We have established, however, that the cruise control does better than a bad driver who's always speeding up and slowing down," Dr. Belohoubek says.

The Minicars RSV should get better fuel economy from a novel computerized manual transmission. It starts with a standard Honda Civic five-speed manual transmission. But the standard stick shift and clutch pedal have been eliminated. Instead, there's a lever and PRND indicator similar to ones used in center consoles of some sporty cars with automatic transmission.

Why then didn't Minicars just use an automatic? "There are several reasons," says Donald Friedman, the company's president. First, the torque converter in an automatic wastes power. And, second, it does not always select the right engine speed/trans-

mission ratio for maximum fuel economy. But the computer in the new transmission, says Friedman, "selects the optimum gear at the optimum speed range for the speed of the car. We actually throw the clutch out and throw the clutch back in—and the computer does more shifting than you normally do," Friedman explains.

The increased shifting is not a problem to the driver, Friedman says—he's not even aware of it. And it's no problem for the computer.

Smooth shifts

The five-speed transmission was chosen to give the control setup the option of operating at its optimum speed under a wide range of conditions. The difference such a computerized manual transmission makes, Friedman claims, can be demonstrated when you drive the combined EPA city and highway fuel-economy test cycles. Where there might be 50 shifts with a standard manual-transmission car, there might be 100 with the computerized version, he says.

The automatic shifting and clutching is accomplished with three sensors and actuators on the shift rods. The sensors tell an Intel 8080 microprocessor what gear you're in. The microprocessor compares this with engine and car speed, and controls pneumatic actuators—small 3/4-by-three-in. cylinders—that actually do the clutching and shifting.

There is no balking, Friedman claims. "It's the kind of smooth gear changing an experienced manual-

transmission driver would produce." And it all happens automatically. There are provisions for manual override, however, to rock the car out of mud or snow, or to park.

The microprocessor also aids knock control of the turbocharged four-cylinder Honda CCVC engine by limiting the amount of supercharging. Turbocharging the engine is expected to increase maximum power output from the standard 68 to 110 hp, Minicars says.

Borrowed chassis design

Unlike the Minicars RSV, which is new from the ground up, the Chrysler front-wheel-drive, four-door hatchback is based on a 1976 Simca 1308 chassis. The drive train and 1716-cc engine, however, are from the Omni/Horizon. Calspan chose a current design for its RSV so that if the government decided to use the car's innovations as a basis for new mid-1980's standards, the existing production techniques could be used. That would give car companies sufficient lead time to get into production.

The Chrysler/Calspan RSV exterior, forward of the windshield, differs markedly, however, from the Simca 1308. Its wheelbase is almost three inches longer, and it has a new rear bumper and hatch. Wind-tunnel testing produced the rounded front, and also makes the car less likely to injure pedestrians seriously if it strikes any. Lower front air dams, front wheel flares, smooth wheel covers, and a rear hatch-lid spoiler also improve the car's aerodynamic performance, Calspan says.

Inside, the superficial resemblance to the Simca remains. But there are important differences. Thicker door-trim pads, enclosing energy-absorbing aluminum honeycomb material, provide greater protection to occupants in a side collision. Aluminum honeycomb in the lower instrument panel reduces potential damage to knees in a frontal crash. Another innovation is see-through headrests that add to the feeling of roominess inside the car.

Several Calspan and Minicars

RSV's have been crash-tested at research facilities in the U.S., Europe, and Japan. The Minicars RSV passed a 50-mph barrier crash; the Calspan vehicle, a 40-mph barrier crash. Passing means that accelerometers in dummies inside crashed vehicles recorded G-forces that indicate people would have survived.

NHTSA officials hail this achievement and call for manufacturers to bring production vehicles up to these standards. But are the RSV's practical and can they be built to sell at affordable prices?

There's little question that the Calspan vehicle, since it's basically a production car, could be built. The special safety innovations would add \$1795 to the price of the basic Simca, the company says. It estimates that total price would be about \$5800.

Donald Friedman says his company has no plans to build the gull-wing car "at this time." What would it cost if it were mass-produced? It would sell for less than \$10,000 without the high-technology features. RCA says the electronics could be fabricated for about \$170 in production runs of at least 100,000 units. The retail cost, however, would be somewhere between \$500 and \$1000, RCA told me. And that's not taking into account what inflation might do to costs by the mid-1980's.

GM's reaction

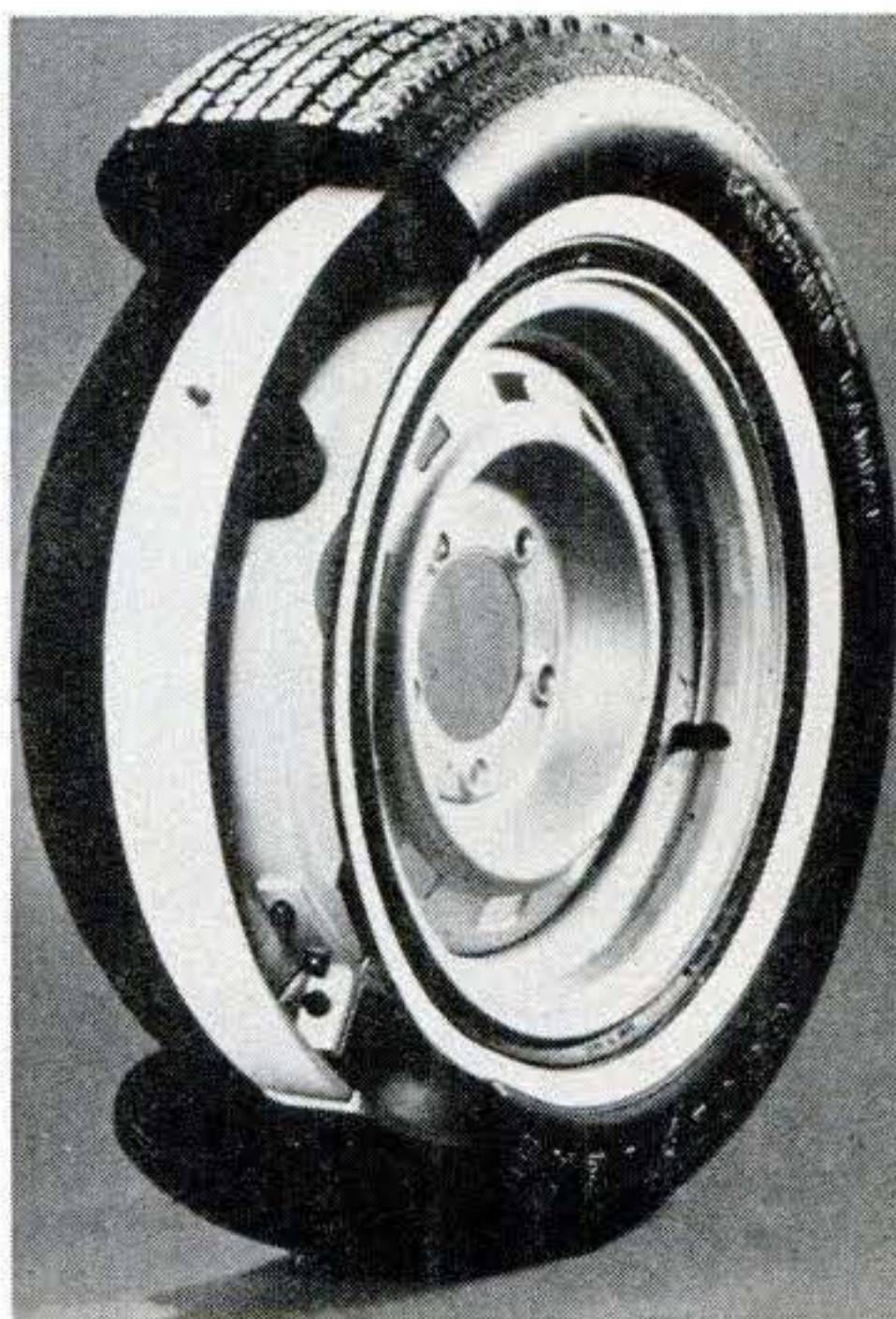
What do car makers think of the RSV project, and do they consider it practical to incorporate the innovations into their cars? POPULAR SCIENCE didn't survey all auto manufacturers, but we did put the question to General Motors president E. M. Estes, whose company makes more than half the cars produced in the U.S.

"We just don't get anything out of the sort of vehicles they build," Estes told me recently. "We've done more on our own."

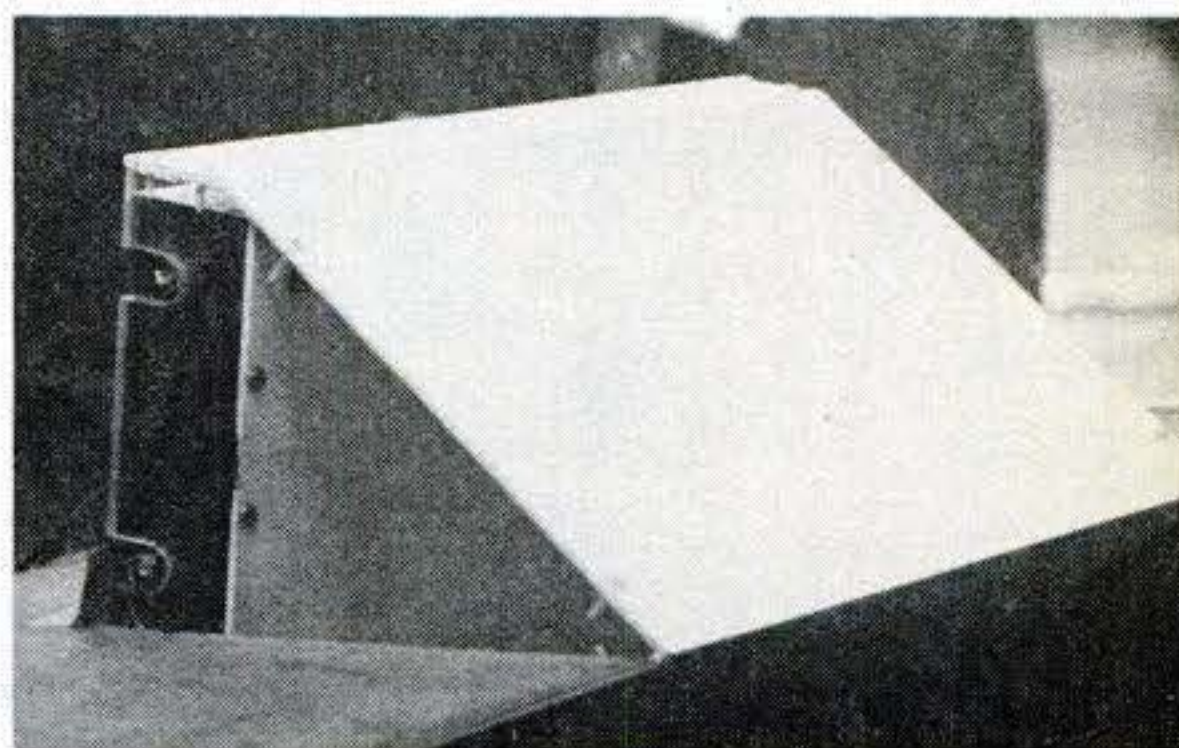
In fact, Estes claims that the GM X-body car, which weighs almost exactly the same as the Minicars RSV and about 175 pounds less than the Calspan vehicle, just about equals the experimental cars in crashworthiness.

Estes says NHTSA told him it had crashed some X-bodies recently to confirm this. Estes admits, however, that the RSV's pass the NHTSA test without the need for passengers to buckle up, while X-body occupants must be restrained with standard belts. Only about 14 percent of all car occupants buckle up, according to NHTSA.

As much as he opposes the construction of RSV's, Estes says the radar tests could offer fundamental information to help determine the feasibility of building such sophisticated systems into production cars. "I don't think they could be installed in mid-1980's cars, however, unless NHTSA makes it mandatory to do so," Estes says. P 5

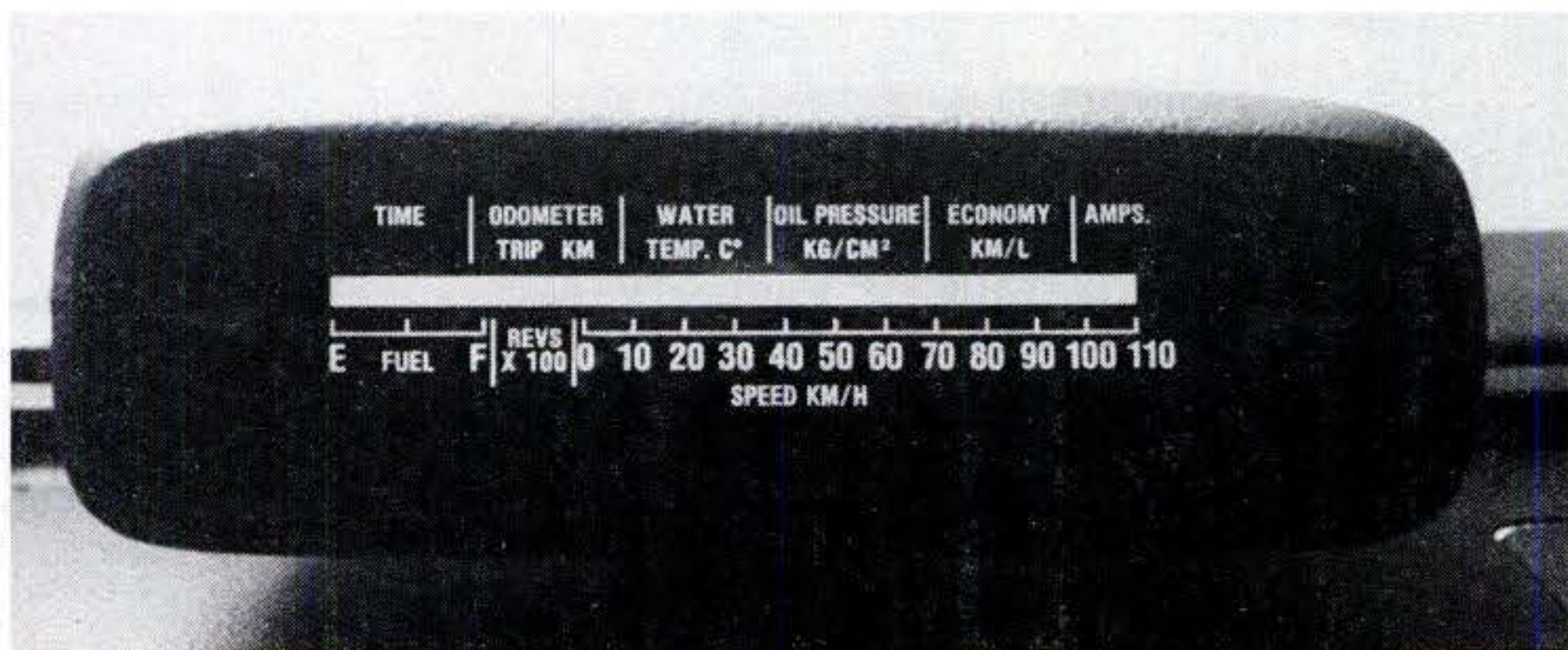


Flatproof tires are used on Calspan RSV to eliminate dangerous tire changes along freeways. They also eliminate the need to carry heavy spare wheel and tire.



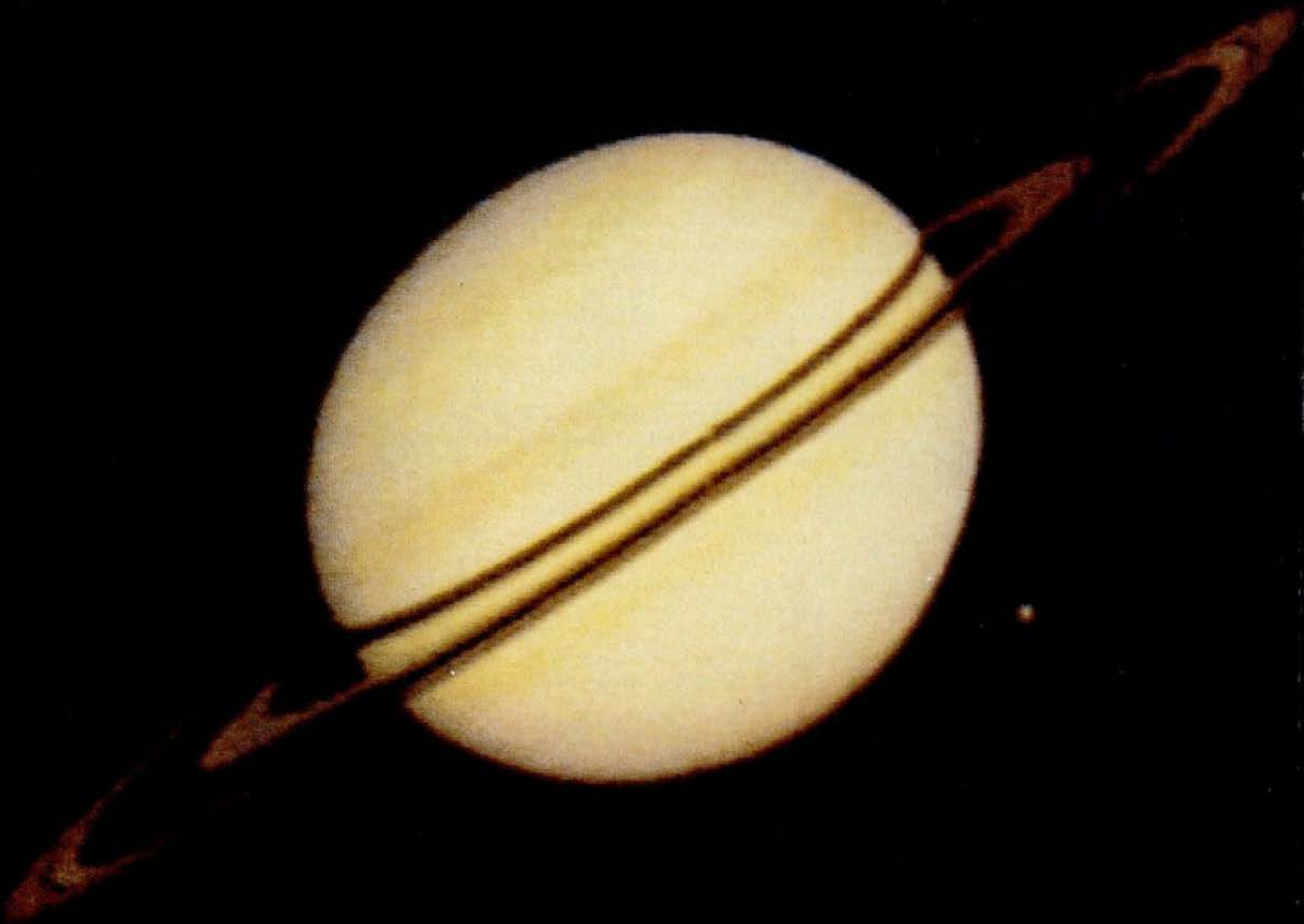
Radar antenna for Minicars RSV is mounted in nose, just under the hood. It sends out a narrow, low-energy beam to maintain safe headway for the RSV.

Electronics display on Minicars RSV dash gives standard readings, but also flashes warnings, such as ANTISKID SYSTEM INOPERATIVE and DOOR OPEN, when necessary.



SATURN!

Pioneer makes
first encounter



Against formidable odds, an aging spacecraft returns the first close-ups of the ringed planet

By **JIM SCHEFTER**

ILLUSTRATION BY RAY PIOCH

The planet ahead is different. Its giant face is banded with clouds, much like Jupiter, but with colors softer and muted. Its moons are mysterious, difficult to find, and little understood. Its magnetic field is weak and pure.

And those rings! What are they? Can they be traversed, or will they destroy the approaching craft?

Out of the void of interplanetary vacuum and into the maelstrom of debris surrounding Saturn it sails—a tiny, obsolete, space-battered Earthship. A storm of solar particles has scrambled its radio. Yet chattering its reports in a dead language of electronic bits, Pioneer 11 accelerates toward the next plateau on a voyage that had begun more than six years earlier.

That plateau would occur in a fraction of a second on September 1 when Pioneer II passed through the plane of Saturn's rings. If that region contained a heavy population of particles—and many scientists thought that it did—the little ship would be destroyed.

We all know that the tough little craft did make it through the rings, but the outcome was not so certain last August. The last week was one of increasing tension at NASA's Ames Research Center in Mountain View, Calif., where I waited with dozens of scientists and writers for the Saturn encounter.

"I rate its chance of survival at 50-50," project scientist Dr. John Wolfe told me.

Odds like that are unheard of in space exploration, where 0.999 is the normal chance of success. But Pioneer was sailing into an uncharted region, where guesswork was standard and facts were few. Though the results of its voyage are not so dramatic as the findings from the recent Jupiter encounters, the dogged Pioneer spacecraft managed to greatly expand our understanding of Saturn and its mysterious rings.

Saturn's ring system was not well mapped before Pioneer's visit. At about one billion miles from Earth, the planet is simply too far away for

accurate study with telescopes. Four rings, labeled A, B, C, and D from the outermost ring in, and an open space between A and B called the Cassini Division had been identified. The visible rings A, B, and C reflect sunlight with varying degrees of brightness. Ring D and the Cassini Division are dark.

Beyond that, almost nothing was known about Saturn's rings. Speculation on their content ranged from mammoth blocks of rocky debris, to bergs of ammonia or water ice, to bands of dust specks glistening in the pale sunlight.

A fifth ring, far from the planet and tentatively called the E Ring (see diagram, page 92), was surmised after radar data indicated a faint band of invisible matter out there. Pioneer was targeted to penetrate the E Ring, if indeed it existed.

It all made for the most "iffy" mission in NASA's 21-year history.

The biggest "if" was survival. Rushing inbound under the pull of Saturnian gravity, Pioneer's speed would be nearly 14 miles per second when it reached the E Ring. An eye-

“At that speed, even a dust mote would rip right through the spacecraft”

blink later, it would be out the bottom and sweeping even faster in toward Saturn. But would it still be transmitting, or would it be a riddled hulk of scrap? It would take 86 minutes, the transit time of radio from Saturn to Earth, before we'd know.

One after another, voices in the small NASA control center, the corridors and halls, and the cramped newsroom fell silent. Though suffering from the incredibly coincidental interference from two massive solar storms, Pioneer's static-laden radio continued to chirp.

"We're losing up to 25 percent of our data at times," bemoaned project manager Charles Hall, and he ordered the transmission rate cut in half from 1024 bits per second to 512 bps.

Later he would cut it again, to 256 bps, in a valiant attempt to filter out the static and salvage crucial information from Saturn. With each reduction, the amount of data coming back to Earth was reduced and the field of view of instruments, including the imaging polarimeter that was sending

home pictures of the trip, was narrowed.

There was frustration for everybody, and a touch of sadness mixed in with the drama being played out nearly one billion miles away. Pioneer was clearly out of its league, a Model T spacecraft called out of semi-retirement for one last crack at the big time.

Meteoroid strikes

If the material in the E Ring was chunky, Wolfe had told me, Pioneer should survive. The pieces would be too far apart for much danger. "But dust grains will kill it," he'd said. The tiny particles would pepper Pioneer at velocities more than 200 times as fast as rifle bullets. At that speed, even a tiny dust mote would rip right through the spacecraft.

Just 10 minutes before E Ring penetration, Pioneer's meteoroid detector recorded a strike. A minute later, there was another. The timing was significant. It had been months since the detector, designed to measure the flux of material in interplanetary space, had been hit.

But now, because of the instrument's design, it turned itself off. No matter how many more times it might be hit it could record nothing for 78 minutes.

The instrument contained 234 gas-filled, steel-covered cells, and just two data channels. About half of the cells had been punctured in the six years since launch, 10 or 11 when Pioneer passed Jupiter in 1974. Each data channel switched itself off after a strike and stayed that way until all the gas in the punctured cell escaped.

"We didn't design it for rings," Dr. Donald Humes of Goddard Space Flight Center told me. "It's for interplanetary space where we only get a hit every month or two."

So Pioneer plunged toward the E Ring with its meteoroid detector disabled, but almost everything else turned on. The static-filled telemetry flowed toward Earth. The moment of ring crossing came and went—hardly time to exhale—and the quiet continued. Then a short cheer, a louder cheer, sounded from the control center.

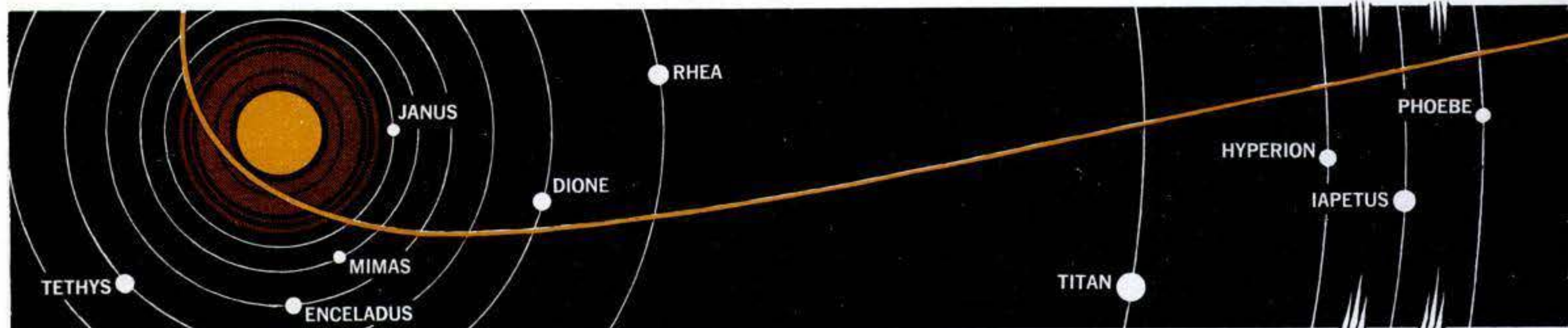
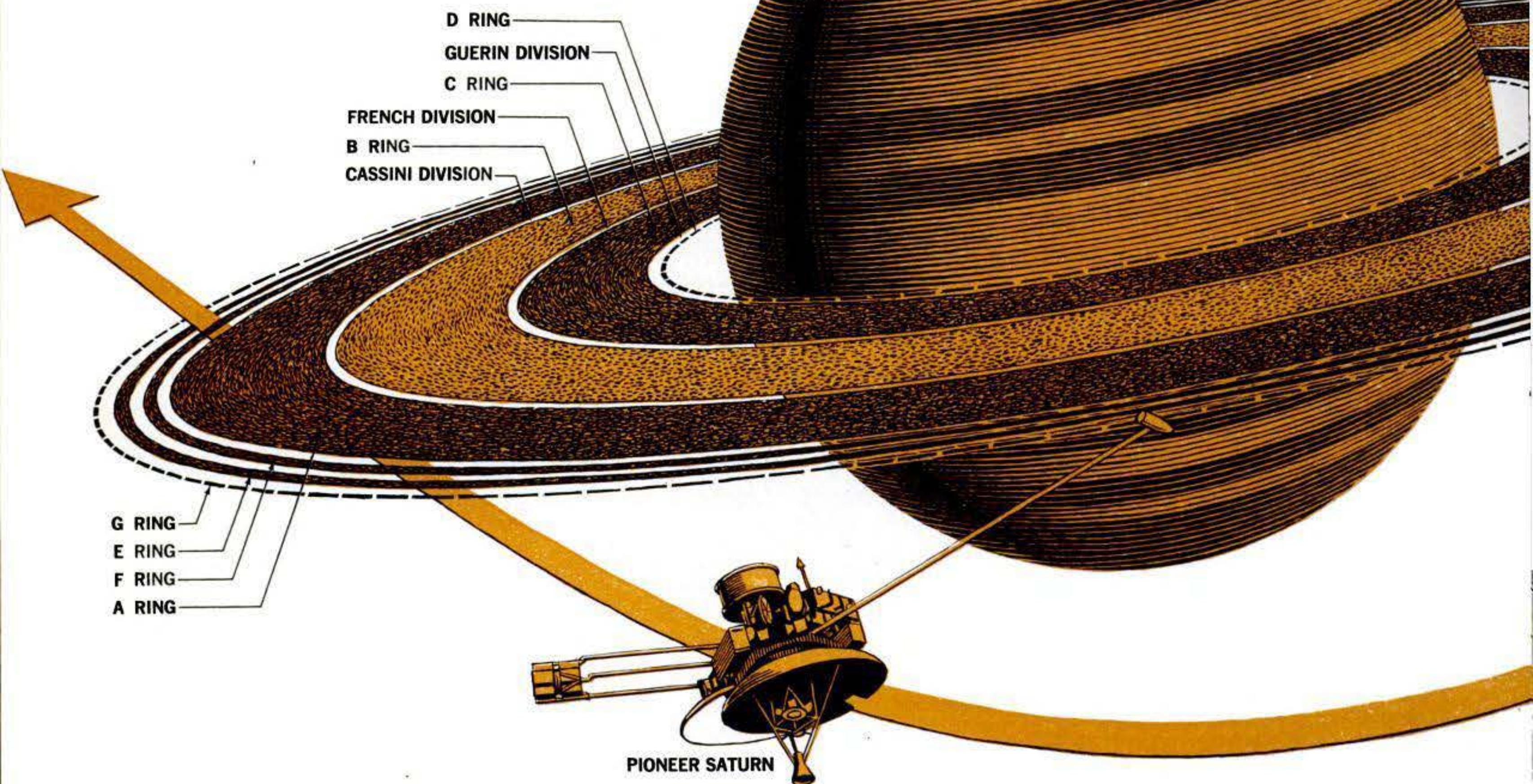
"The Pioneer 11 spacecraft has survived its crossing of the ring," reported NASA commentator Larry King. "We have a mission. It's an absolutely healthy spacecraft in every respect."

It almost wasn't. That fact wasn't known for several days, until scientists examined the rough early data, then checked and rechecked their findings in disbelief. But it was true:

Continued

Shimmering rings of ice frame Saturn's banded face. Planet's sixth moon, Rhea, is at lower right. Pioneer was about 1.5 million miles from Saturn when recording data for computer-enhanced photo.

A new moon, more rings and gaps— Pioneer leads the way



Pioneer had nearly hit a moon. Dr. Tom Gehrels of the University of Arizona and principal investigator for the imaging photopolarimeter (IPP) had first spotted the unknown moon a few days earlier. It appeared as a faint and fuzzy blur in an image showing the outer region of the rings. The fuzziness was due to the limitations of Pioneer's imaging system. It is far less sophisticated than the high-quality television of Viking or Voyager, partly because it came from an earlier time and partly because it was never intended to produce pictures in the first place.

Blurred moon image

The IPP records the intensity of light in a target region called a pixel, for "picture element." The light intensities are what concern scientists most, because these data are used in

measuring such things as cloud formations and composition, atmospheric motions, and reflectivity of solids. These pixels can be put together by computer, one by one, back on Earth to form an image.

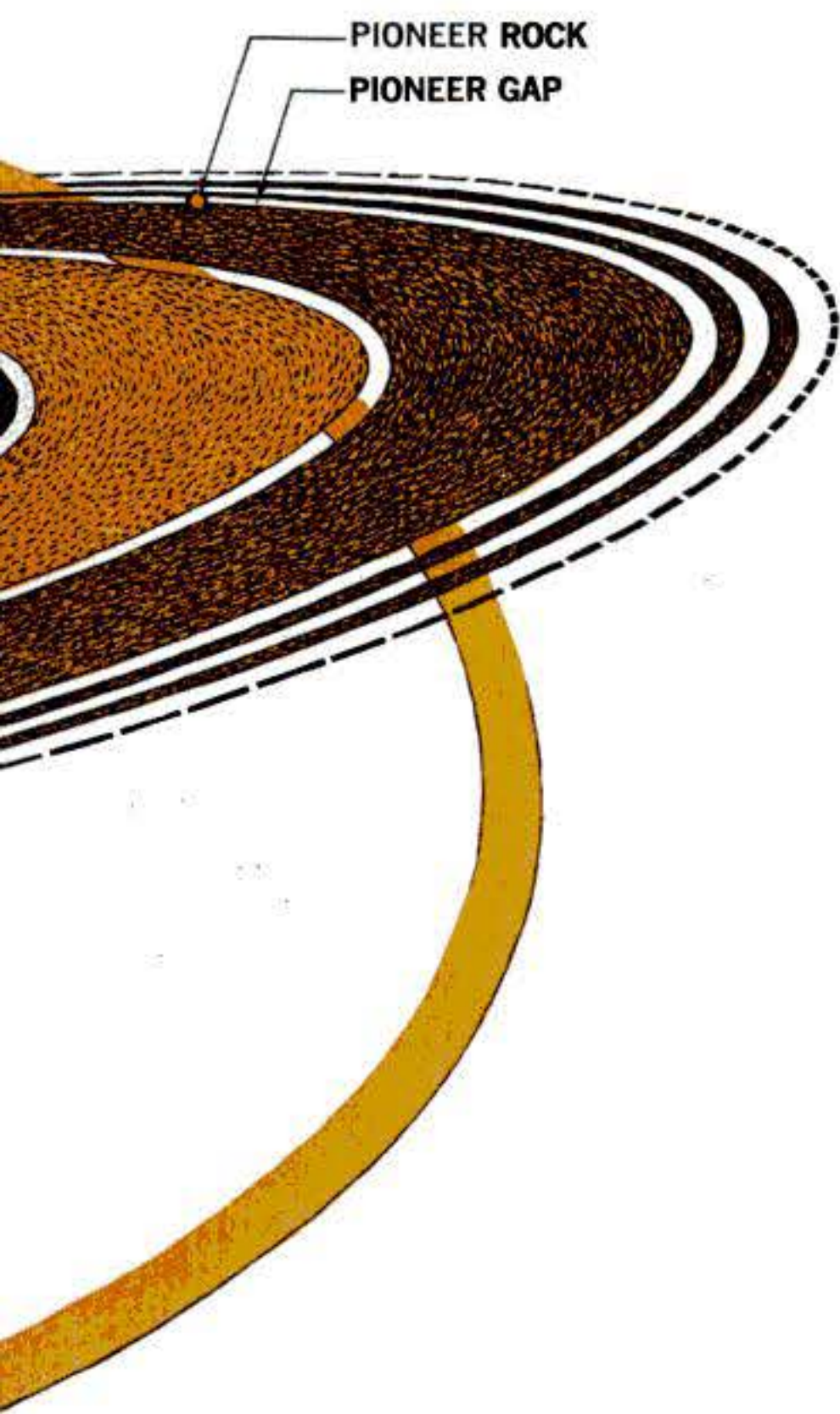
To complicate imaging even further, Pioneer is a spin-stabilized spacecraft. It was designed to spin at five rpm to keep its antenna pointed at Earth as it moves through space. The spin has gradually increased over the years to 7.5 rpm. The IPP pixels are now elongated, requiring added computer work to form images. And because of the spin, the IPP views its target for only a few seconds of each revolution.

Though the Pioneer images are less sharp and detailed than we've become accustomed to, they are still many times better than any Saturn views ever seen with a telescope.

But when Gehrels spotted the fuzzy "moon" image, caution ran rampant. No one was willing, or able, to confirm that it was a moon. Most of Saturn's 10 known moons are too small for accurate orbital tracking from Earth. Another possible new moon, dubbed S-11, had appeared faintly in a single observatory photo in 1978. It had not been seen since. Was the Gehrels moon actually the missing S-11? Was it tiny Janus, the closest moon to Saturn officially discovered? Or was it something else?

Whatever it was, one blurred image didn't give experts the chance to compute its orbit. So it was promptly forgotten in the mounting drama. Until, just 23 minutes after ring-crossing, some of Pioneer's instruments went funny.

"The first thing we saw was a data drop," said Dr. Edward Smith of the



Shooting through Saturn's rings, Pioneer narrowly missed smashing into an uncharted moon, passing within a scant—for space missions—930 miles of "Pioneer Rock." The craft then swooped down to 12,560 miles above Saturn's cloud tops, headed back up through the rings, and out past the moons (lower left). Charged particles from two giant solar flares shrouded the craft just as it passed the giant cloud-covered moon, Titan. The resulting static drowned out most of the much-anticipated data. All Saturn's moons, except the newly discovered "Rock," lie outside the rings. At 2.2 million miles out, Iapetus is well over twice as far from Saturn as Titan, while tiny Phoebe is eight times as far away (and follows a reverse orbit).

Jet Propulsion Laboratory, whose magnetometer readings then began to oscillate.

The charged-particle detector being monitored by the University of Chicago's Dr. John Simpson virtually went dead. High-energy electrons in the surrounding space disappeared, then resumed.

The scientists dutifully reported the phenomena before spending several days puzzling out what had happened.

"We detected the presence of a massive object by particle physics," Simpson then said. "The object was very close to us."

Temporarily called "Pioneer Rock," it was the same object seen earlier by Gehrels. "The Rock blocks out a cone of particles as it moves," Smith said. "We presume it lies in or near the ring plane."

Thus Pioneer flew directly through the "shadow" the Rock casts as it obscures the high-energy flow of particles. It lies just outside the big A Ring and could be either ice or metal, Simpson said. Its precise identity still isn't known. That will take more study.

Radiation-free zone

Pioneer provided more surprises. After its narrow brush with Pioneer Rock, the ship passed under the sparkling rings. And there it entered the purest vacuum yet found in the solar system.

Beneath Saturn's rings, all the high-energy particles typically found in space were absent.

"They're gone when you get inside the rings," Wolfe said. "They're just chopped off."

Apparently the rings absorb gamma rays, X-rays, electron and proton flows, and even interplanetary plasma. They act as both a filter and a shield. The result, Wolfe said, is a boon for scientists studying Saturn's magnetic field.

That field had not been observed from Earth, but was finally found by Pioneer. It was, as would be expected, a field much stronger than Earth's, but still far weaker than had been predicted.

Because of the radiation-free zone beneath the rings, the magnetic-field data is pristine. "Saturn is now simple to study," Wolfe said. "We'll finally get a good understanding of magnetic fields in general."

Once under the rings, Pioneer rushed past Saturn. The craft's velocity zoomed up to more than 71,000 mph as it skimmed past Saturn and back up through the rings.

In between, its meteoroid detector noted three more hits. But with the prolonged "off" cycle in effect, there was no chance to record impacts at the second crossing.

There was a slight possibility that the detector could have been saturated, but Wolfe thought not. Later, he even discounted the existence of the E Ring.

"There was definitely material there, but it's hard to prove," he said. "I think we can throw out the E Ring and substitute F and G."

Those two rings were positively discovered by Pioneer and will appear on future Saturn charts. The F Ring is a narrow band of visible particles clearly seen on some Pioneer photos. It lies just outside the large A Ring, separated by a dark zone the scientists were quick to call the "Pioneer Gap."

The G Ring lies still farther out and was detected by Pioneer's various particle and radiation instruments rath-

er than by photos. It is invisible to the eye, Wolfe said, but is definitely there.

So is yet another gap in the rings. This one occurs between the inner C and D Rings and showed up on several photos. The gap had been reported decades ago by French astronomers, but no one else had seen it. Now Pioneer proved the French were right. In their honor, scientists named it the "French Division."

With Saturn shrinking behind, Pioneer completed one final task in its amazing mission. Its instruments were trained on Titan, a moon larger than the planet Mercury and having an atmosphere of its own. Because of a variety of factors, including the radio static, reduced data flow, and an extremely narrow viewing angle, results were thin.

Scientists had hoped for detailed infrared measurements that might tell whether or not Titan had a greenhouse effect. The real question was whether or not Titan could be warm enough for its methane atmosphere to produce amino acids or other pre-life forms.

But with all the problems, they were limited to a quick reading of Titan's cloud-top temperature and found it to be a deadly -328 degrees F. The planetoid showed little likelihood of being warmer below. Since amino acids need liquid water to form, the outlook was dim.

"We're not throwing out all possibility for life on Titan, but it just isn't very likely," Wolfe commented.

The fuzzy image of Titan, relayed over nearly a billion miles of static, showed no features at all. "We're just very disappointed," Wolfe said.

Rings of hailstones

Even so, Pioneer's visit to Saturn was a success. Infrared measurements proved that the rings are not made of rock or dust, but of ice chunks.

"If the rings were dust, they'd cool off very fast in Saturn's shadow," Wolfe said. "But they're centimeter size and larger—hailstones of water or ammonia ice.

"They could even be basketball size. We've collected more details on the rings than we ever expected. Now it's up to the theorists and dynamicists to make it work."

NASA is preparing now for another look at Saturn and beyond. The first of two Voyagers arrives late this year; the second reaches Saturn in early 1981, and could be sent on to yet another outer planet.

"We've proved that you can get by Saturn safely," Wolfe said. "That's as good as a guarantee that Voyager 2 will go on to Uranus." E3

What's New

A PICTURE ROUNDUP OF NEW PRODUCTS AND DEVELOPMENTS



All-purpose engine

Mowers, tillers, snow blowers—you could find this new two-cycle, 5.5-cu.-in. gasoline engine on lots of new equipment. It's smaller than any other similar engine, says Textron's Homelite. An all-position carburetor permits horizontal or vertical shaft applications.

Sleek 757

A rounded nose is part of the new look on Boeing's redesigned 757 twin-jet airliner, slated for use in 1983. The up-front aerodynamic changes smooth air flow, cut noise, let pilots see more. Improved fanjet engines will burn 20–35 percent less fuel per seat than today's planes.



Five-door Le Car

Now there's a flip-up back door, plus rear doors, on Renault's latest Le Car. The dash has been tidied up and an easy-drain system for engine oil added. The French 5 GTL version has a special low-thirst, 45-hp engine that gives 42 mpg at a steady 56 mph.

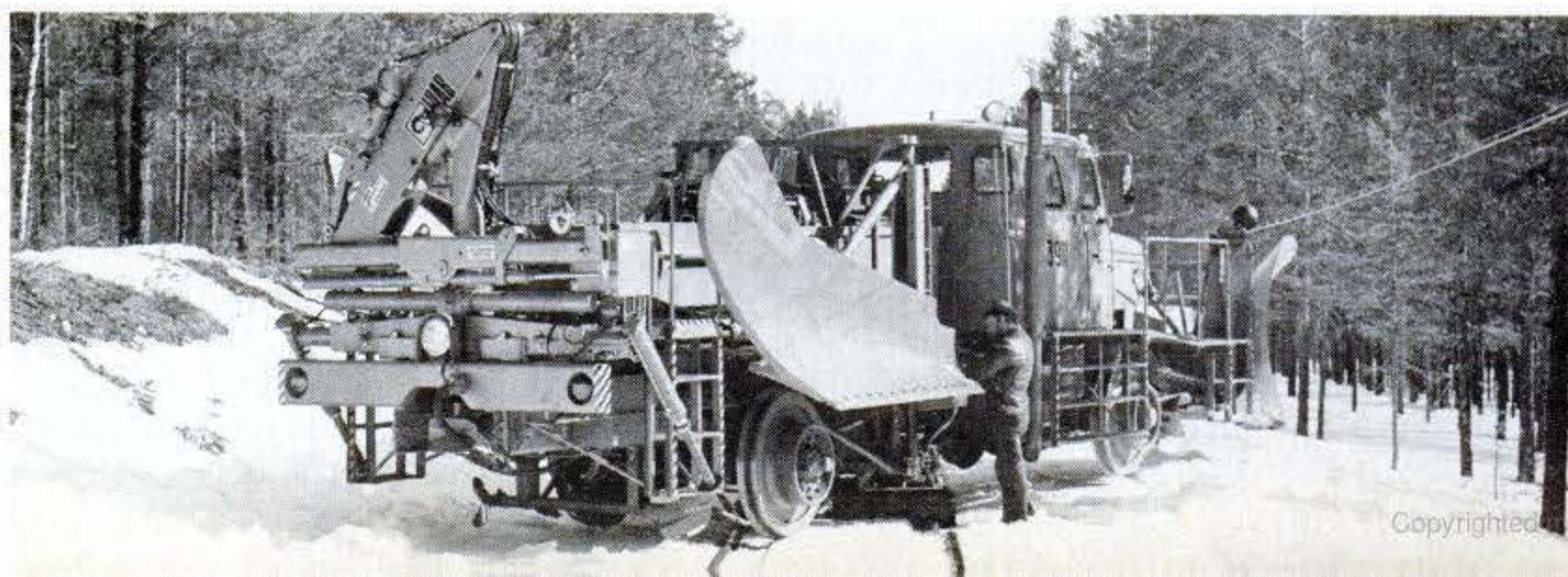
2282-mpg diesel

A world fuel-economy record—equivalent to 2281.9 mpg—was set by this 108-lb., three-wheel vehicle. The 10-ft.-long, fiberglass-and-aluminum machine, built by a Mercedes-Benz team, used under 1/2 oz. of fuel in its 1/2-hp diesel engine to cover an 8.9-mile German course.



Two-way plow

Four hydraulic jacks lift this railroad snowplow so operators can push it around a central pivot and reverse direction. The 20-ton machine is based on a 275-hp diesel truck with flanged wheels. A V-blade spans the track; outer blades clear the edges. The maker is Sweden's Saab-Scania.





Four-blade 412

Double the blades, less noise—two ways that the twin-turbine Bell 412 chopper differs from its predecessor, says Bell Helicopter. New 46-ft.-dia. fiberglass rotors have lower tip speeds and make less noise than the Bell 212's twin blades.



Refractor scope

Compact 60-mm refractor telescope weighs less than seven pounds. It's rugged enough to be used on nature walks without elaborate setting up, maker claims. It can also be used with any standard tripod. Price: \$299.95, from Edmund Scientific, 7782 Edscorp Bldg., Barrington, N.J. 08007.

Articulated bus

Twin-deck articulated touring coach is 58.5 feet long and carries 65 passengers. A 400-hp diesel powers the German Neoplan N 121 Spaceliner. The bus has a lounge, galley, bar, and toilet. Both sections have huge luggage bins. Driver's cockpit has a panoramic glass enclosure.



Double-deck truck

After the upper floor on this double-deck German truck is lowered and filled, it's hydraulically raised and locked into position. Then the bottom floor is filled with cargo. Each floor holds 10 tons, and total volume is 3200 cu. ft. The truck speeds chain-store deliveries.

Solar lens

Pump water, heat/cool buildings, make electricity—the linear Fresnel lens on its solar-energy system makes it all possible, says E-Systems, Inc. (Box 226030, Dallas, Tex.). The tracking collector's covering lens is made from plastic containing a multitude of tiny prisms.



What's New IN PHOTOGRAPHY

BY E. H. ORTNER

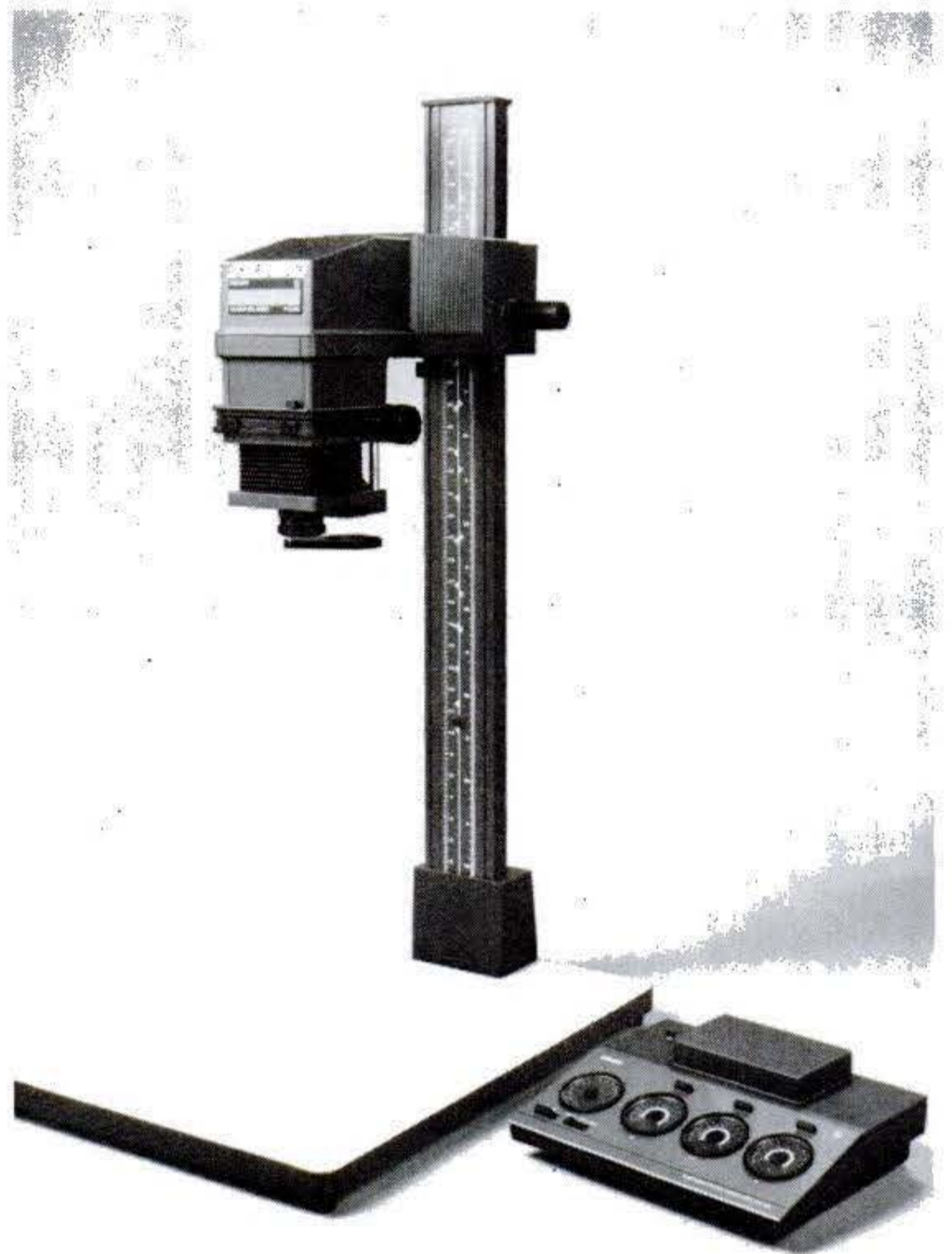


Dual-use extender

Remove the center lens cell of the Sigma 2X Tele/Macro extender, and the outer cylinder becomes an automatic extension tube for near-life-size (1:1) images. Put the lens cell back, and the tele-extender doubles the focal length of your camera's lens. Price: \$134.

System flash

First compact flash with full system versatility, claims Vivitar for its thyristorized automatic Model 2500. The flash head zooms in and out to match the beam to lens focal lengths from 35 mm to 105, tilts for bounce, has a guide number of 40 with ASA 25 film. List price: \$99.95.



Compact SLR

A 16-LED display in the viewfinder indicates shutter speed and exposure (over/under) in the compact Vivitar XV-3. It's aperture-priority (you set the aperture, it sets the shutter speed, from 1/1000 to eight sec). With f/1.7 lens, it's \$400. A wind-up is \$135.

Tilting tripod

Close-ups, copying, you name it, the Velbon VS-3 tilts to almost any angle for the job. It'll even extend horizontally and hold up to three cameras. The three-section tripod opens to 61 in., contracts to 25. It's \$64. Maker: Velbon, 2433 Moreton St., Torrance, Calif. 90505.

Bayonet SLR

Now Fuji has a bayonet-mount SLR, too. The Fujica STX-1 replaces the screw-mount Fujica ST605N (but takes Fujinon screw-mount lenses with an adapter). The exposure meter uses blue cells for light sensing; shutter speeds are 1/2-1/1700 sec. With f/2.2 lens, the STX-1 is \$250.



Electronic darkroom system

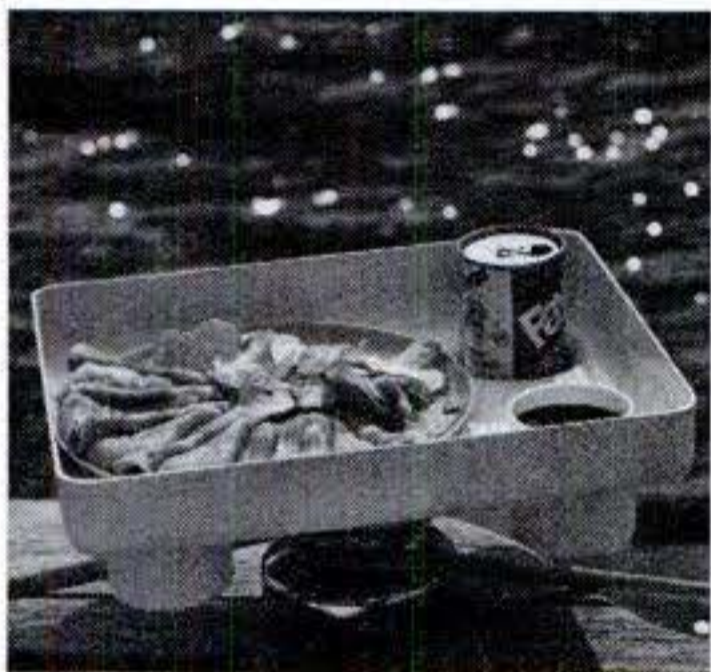
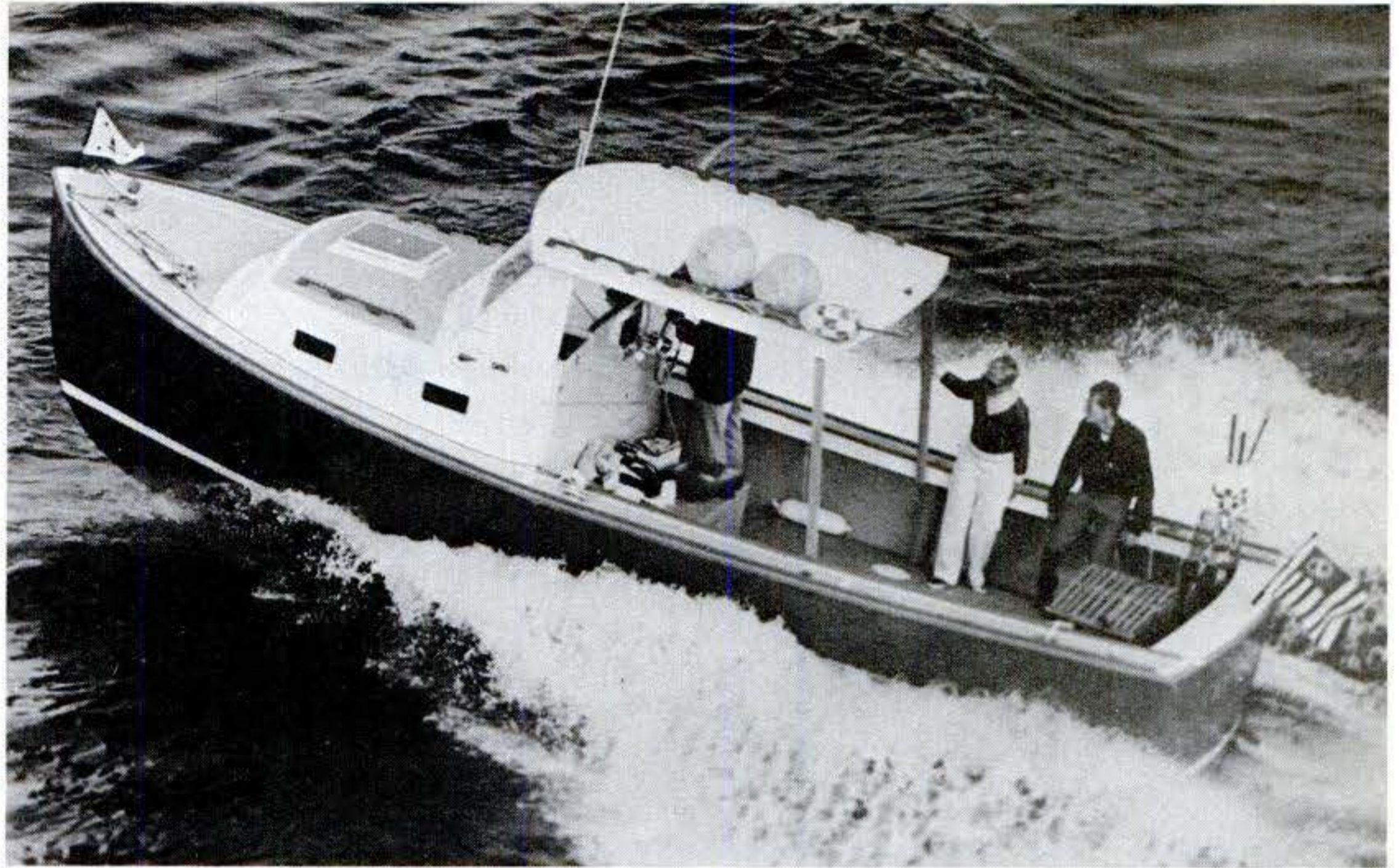
ETC—Electronic Tri-One Color system—Philips calls its new system: a basic enlarger for films from 110 size to 2 1/4 by 2 3/4; a three-lamp light source composed of 35-watt, 14-volt lamps with narrow-band red, green, and blue dichroic filters; and an electronic timer/color control unit. For b&w variable-contrast papers, the unit offers 0-5 grade control. The PCS 130 enlarger, with 150-watt lamp, is \$315. The ETC light source and control unit are \$560. U.S. distributor is Hindaphoto, 446 Sunrise Hwy., Rockville Centre, N.Y. 11570.

What's New IN BOATING

BY SUSAN RENNER-SMITH

Fisherman

Slicing cleanly through a chop, the Sisu 26's semidisplacement hull mates speed with fuel efficiency, says Sisu Boat, Inc. (Industrial Park, Dover, N.H. 03820). The 25.5-ft. inboard-powered craft sports a fishing-boat-type canopy. Lowest price: \$17,935.



Serving tray

Serve lunch or snacks on deck—but don't plan to come about during the meal. The Captain's Table mounts atop any winch that uses international winch handles. The sturdy plastic tray can also be rail-mounted. Nautical Engineering, Box 5252, Northville, Mich. 48167. \$20.



Plastic dinghy for easy toting

This portable dinghy doesn't deflate—it rolls up! Packed into an elongated duffel bag (inset), the boat with all its parts weighs only 55 lbs. The 8'3" craft is assembled from a flat, polypropylene rectangle that's prescored like a cardboard box. Bow and stern are simply pulled up, folded and bolted to wooden seats. A spray dodger and gunwales with integral oarlocks snap into place. With a 3.5-hp motor, the sturdy plastic craft planes at 15 knots in calm water. The folding dinghy is made by Gault Boats, 28 Baker St., London W1M 1DF, England.



Battery booster

Deck-mounted for efficiency, these rugged solar photovoltaic cells can be scuffed and splashed. In sunshine, the 100-milliamp, 14V array trickle-charges the battery, extending its life. Kit price: \$100. Chesapeake Solar Systems, 10750 Columbia Pike, Silver Spring, Md. 20901.

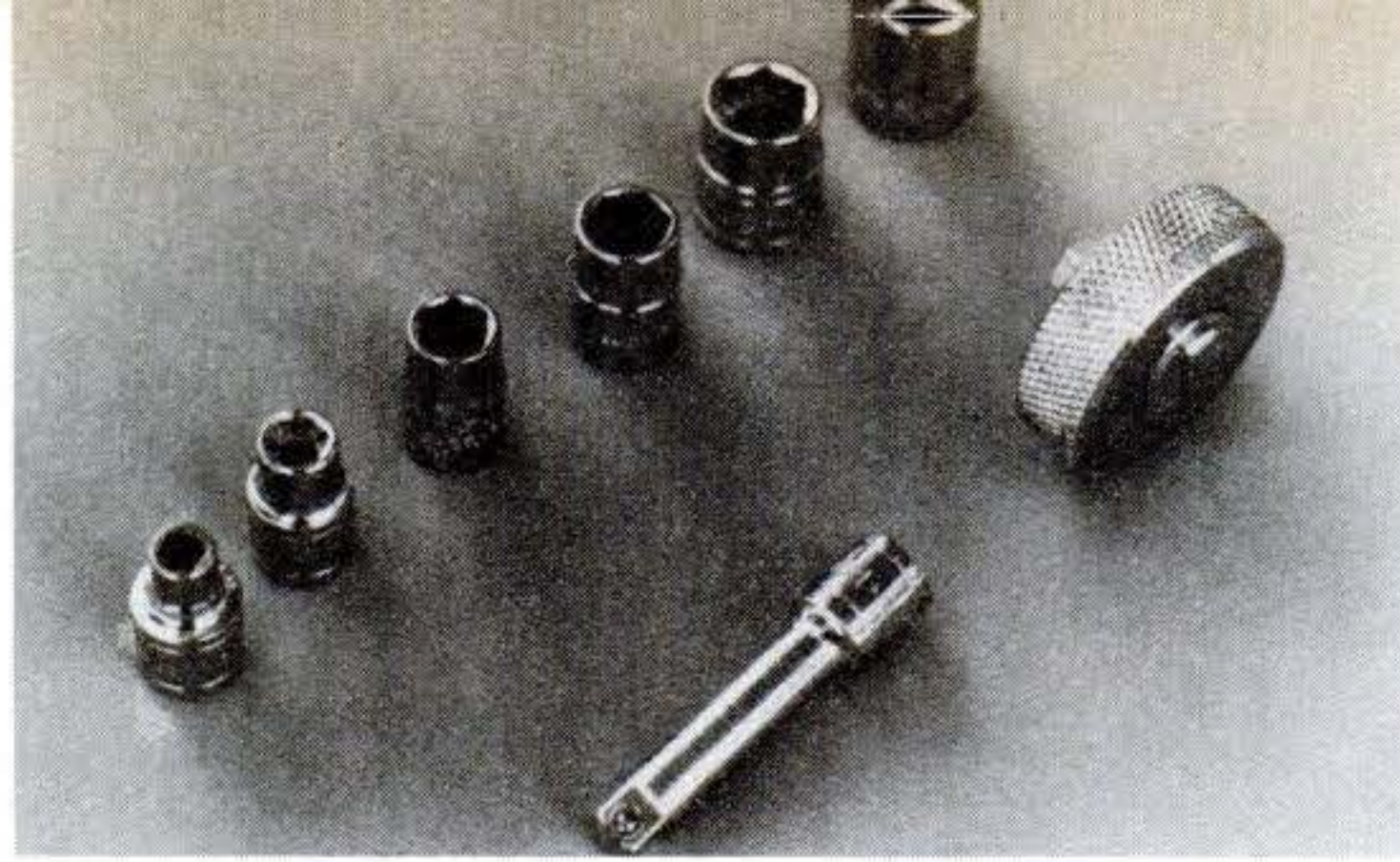
Steering system

A no-fuss replacement for corrosion-prone cables, this hydraulic steering system is easy to install and maintain, says Hi Drive Engineering (8-12 Glen Roy St., Athol Park, S.A. 5012, Australia). The unit's piston pump is self-locking, allowing "hands-off" steering.



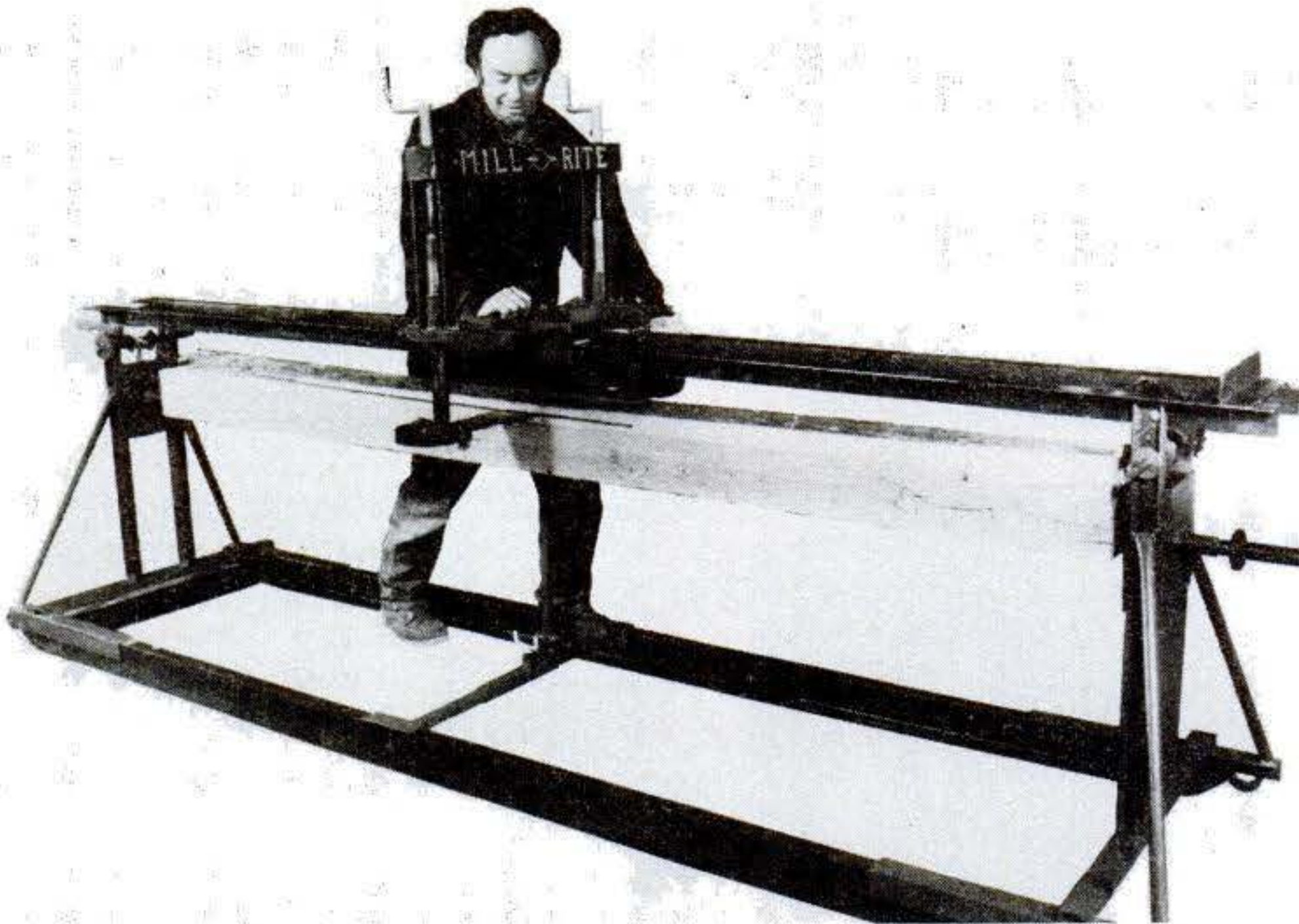
What's New IN TOOLS

BY R. L. STEPLER



Little ratchet

A thumbwheel drive on this ratchet set lets you get into tight spots. Set includes 1 1/2" dia. thumbwheel ratchet with 1/4" drive, 2" extension, and six sockets: 3/16", 1/4", 5/16", 3/8", 7/16", and 1/2". It's \$15.95 from Howard Products, Box 57246, Dallas, Tex. 75207.



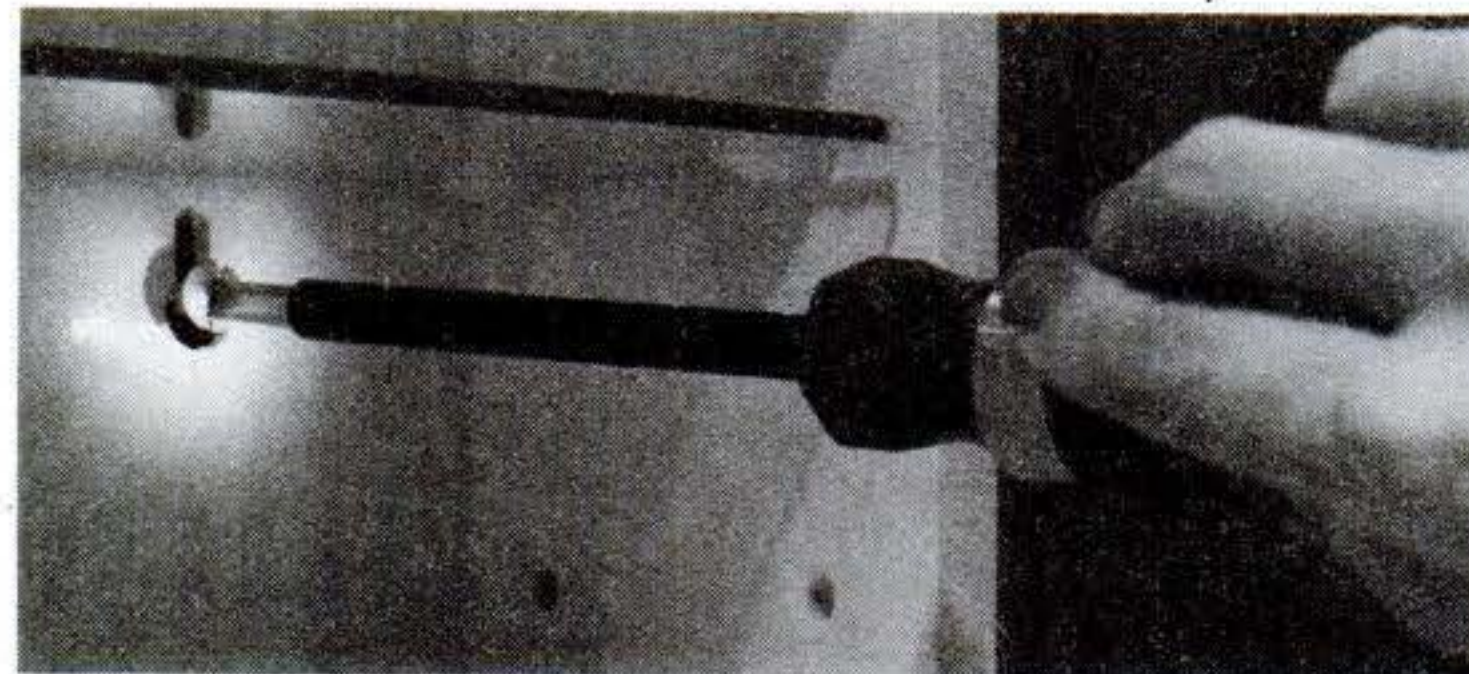
Sawmill

Own a chain saw with 24-in. bar and 4.5-cu.-in. (or larger) engine? Fit it to a Mill-Rite portable sawmill and you can saw boards, timbers, clapboards, shingles, and posts, says The Old Metal Shop, Box 21, Dover-Foxcroft, Me. 04426. Two models saw eight- and 12-ft. logs.



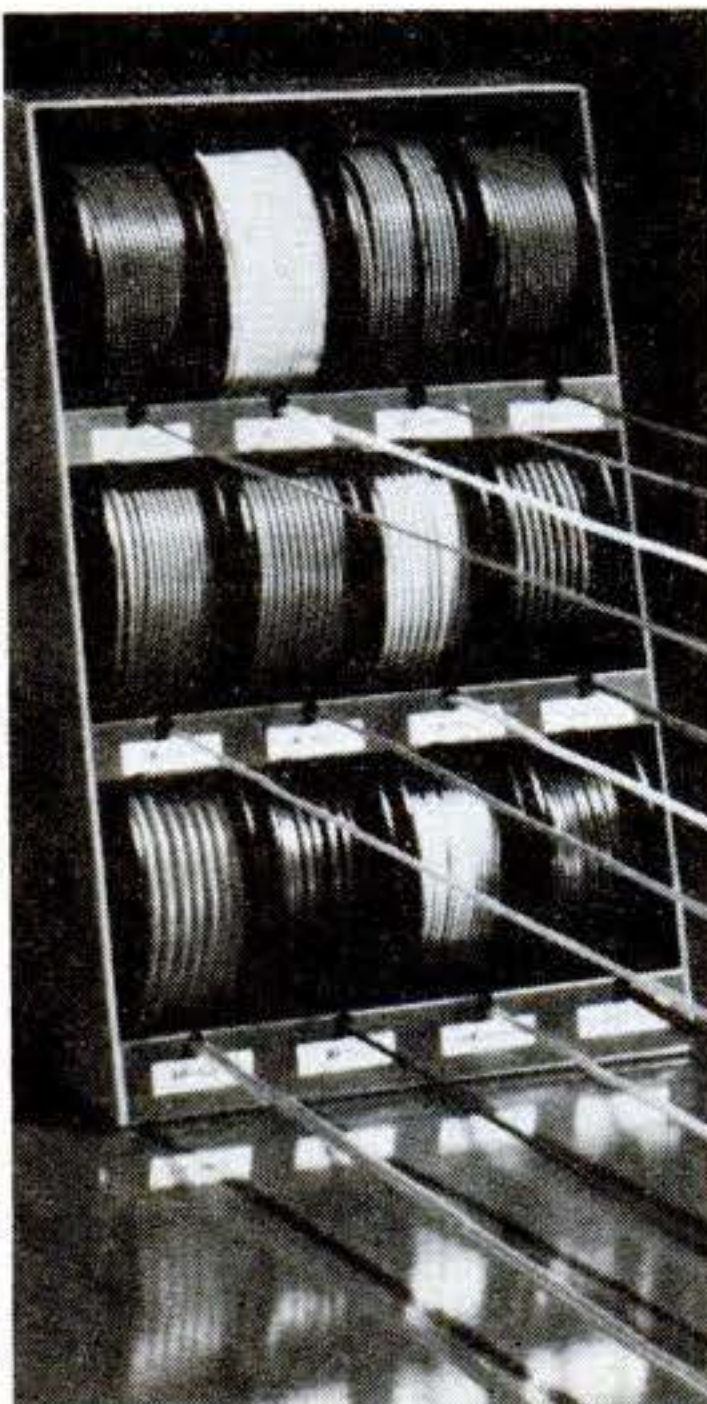
Pro router

Rockwell's model 675 router features a 1/4-hp motor, plus a D-handle and trigger power control for improved maneuverability and safer operation, according to the maker. Price of the professional heavy-duty tool: \$119.50.



Screwdriver

Optical fibers illuminate this British-made screwdriver's blade, aiming light right at the work. Batteries and flashlight bulb are in the handle. The driver is 264 mm long, has a seven-mm blade, weighs 160 grams. Arrowlite Tool Corp., 717 W. Robertson St., Brandon, Fla. 33511.

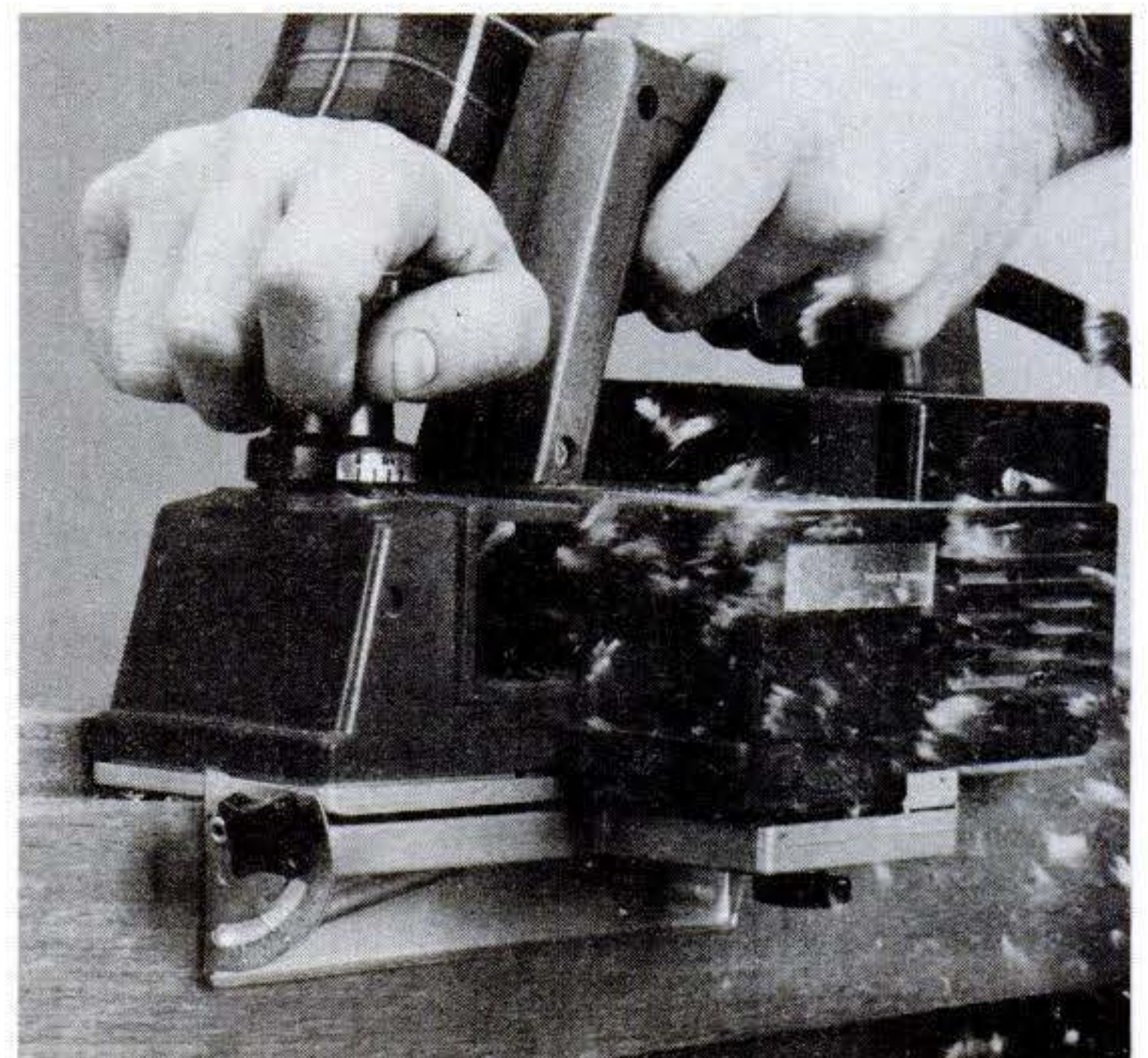


Electrical wiring

You'll have just the right wire for electrical repairs and projects with the Wire Shop. The metal case holds 12 spools of 10-22 gauge single-conductor wire, plus zip, speaker, and bell wire. It's \$33.85 from D.R.I. Industries, 6868 Washington Ave. S., Eden Prairie, Minn. 55344.

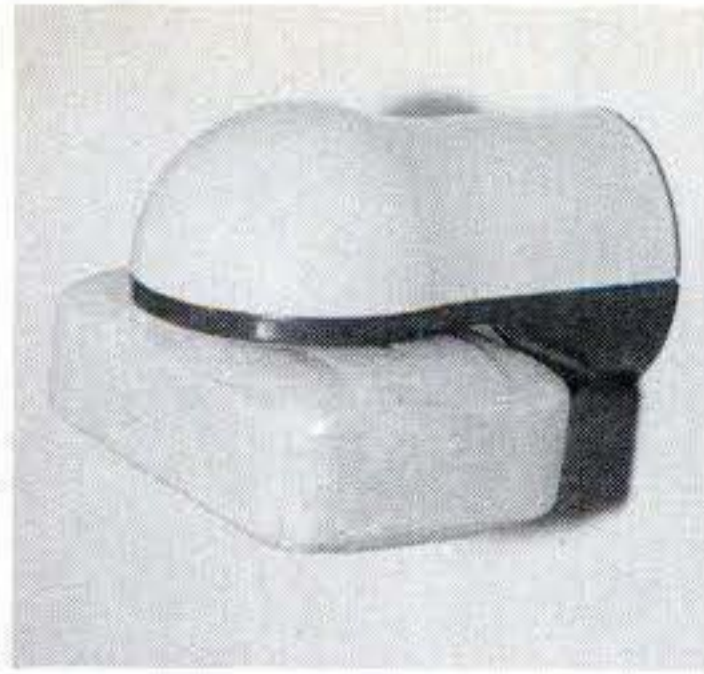
Power plane

Skil 98H plane for edging, surfacing, and rabbeting allows a preset depth of cut up to 2.5 mm. Bevel guide sets up to 45 deg. Rabbeting capacity: 20 mm deep, 75 mm wide. Cutting speed: 12,500 rpm. Made by Skil Nederland B.V., Konijnberg 60, 4825 BD Breda, Holland.



What's New IN HOME IMPROVEMENT

BY R. L. STEPLER



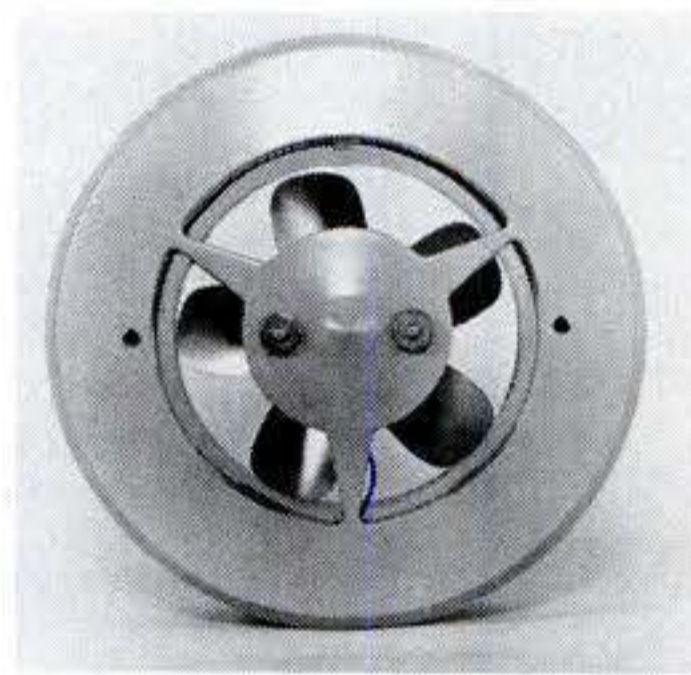
Soap holder

Get a grip on slippery soap with a magnetic soap holder. A magnet imbedded in the bar of soap keeps it suspended high and dry. Price: \$4.50. Tiger Home Products, Inc., 2000 Spruce St., Trenton, N.J. 08638.



Water filter

Peerless home water filter has an easy-to-remove five-stage disposable cartridge (inset) with a membrane originally developed for use in hospitals. It removes unpleasant tastes and odors, plus rust and sediment, claims Peerless Faucet Co., Box 40980, Indianapolis, Ind. 46240.



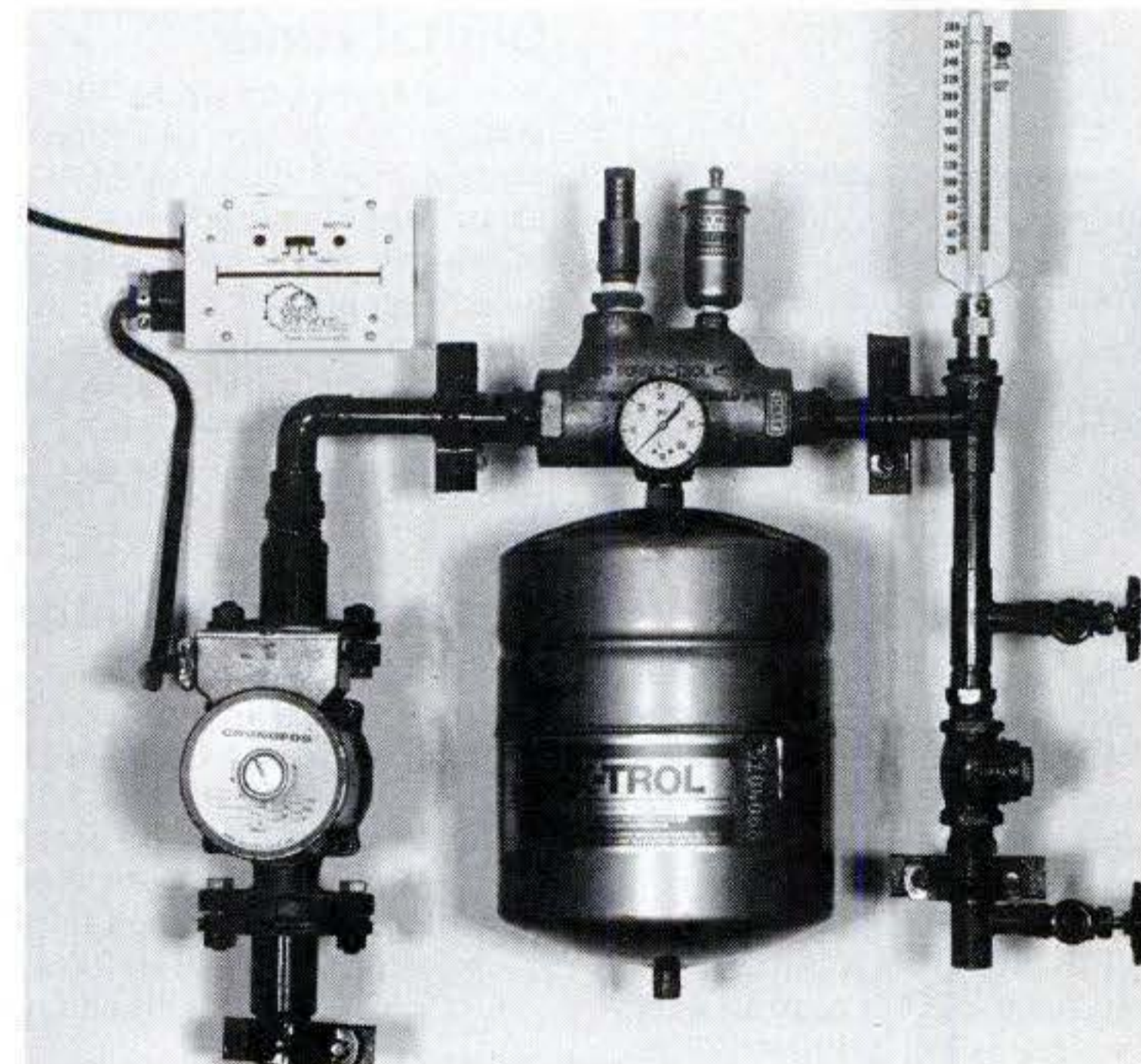
Wall fan

Preway's Transaire fan installs in interior walls to move air heated by a wood stove or other space heater from room to room. Housing adapts to fit walls from 2 1/4 to 5 1/2 inches thick. Price: \$80.95. Preway, Inc., Wisconsin Rapids, Wis. 54494.



Ceramic fireplace

Kiln-fired silicon-carbide clay Firepots radiate heat long after the fire is out, says The Abercrombie Shop (Box 432, Oxford, Md. 21654). Loki (shown) is 43 in. high, 23 in. in diameter; it costs \$625. Two other models cost \$450 and \$575.



Storm window

Double-glazed plastic storm window kit installs from inside with double-faced adhesive tape. Durethene kits fit small windows, plus picture windows and patio doors. They're made by Arco Polymers, Inc., 7001 W. 60 St., Chicago, Ill. 60638.

Solar plumbing

A one-piece, preassembled module handles control, pumping, air elimination, fill/drain, and monitoring functions for solar water-heating systems, says Earth Services, Inc. (Box 99, Pawlet, Vt. 05761). Components include 1/20-hp pump, thermostat, expansion tank. It's \$325.

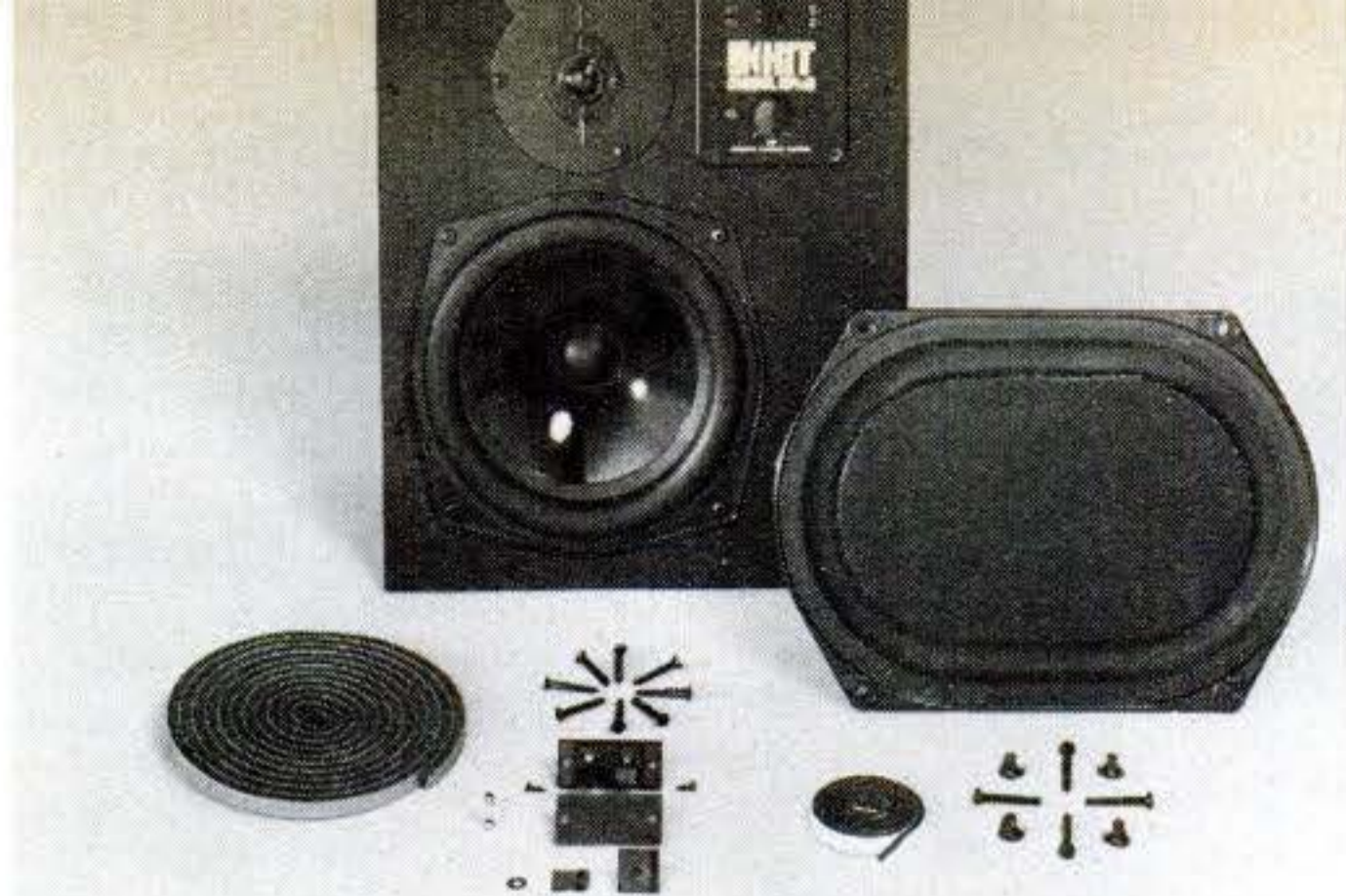


Whirlpool

Sears' Whirlpool Bath installs in the same space as a standard five-foot tub. Acrylic unit features four fingertip-controlled nozzles, 3/4-hp pump, orthopedically designed contour and armrest. Luxuriate in the soothing water after you've paid the \$1200-plus-installation price.

What's New IN ELECTRONICS

BY WILLIAM J. HAWKINS



Speaker you build

One way to cut the cost of a stereo system is to build the speakers yourself. You can, with a kit from Intratec (Box 17414, Washington, D.C. 20041). At \$250 a pair, each model 104aB is good to 100 watts (eight ohms) using a midbass driver and tweeter.



Computer with muscle

Computers are normally used to increase our "brain power." But Data General's Eclipse S/250 is being used by the U.S. Olympic Committee to develop physical power. Scenes from a high-speed film of an athlete in action (in this case, a discus thrower) are entered into the computer by tracing them off the screen with a light pen. The computer then creates a stick figure of the body movement, calculating velocity, acceleration, direction, and force. Using that to make changes, such as shifting a foot slightly or releasing the ball earlier, could (and did, in earlier trials) result in dramatic improvement.



Digital tuner

You can program up to 15 stations for instant selection on the Revox digital AM/FM tuner. And when you hear the music, that's *all* you hear; exceptional specs virtually eliminate noise, distortion, and alternate channel interference . . . and your cash. It's \$1779 with Dolby.

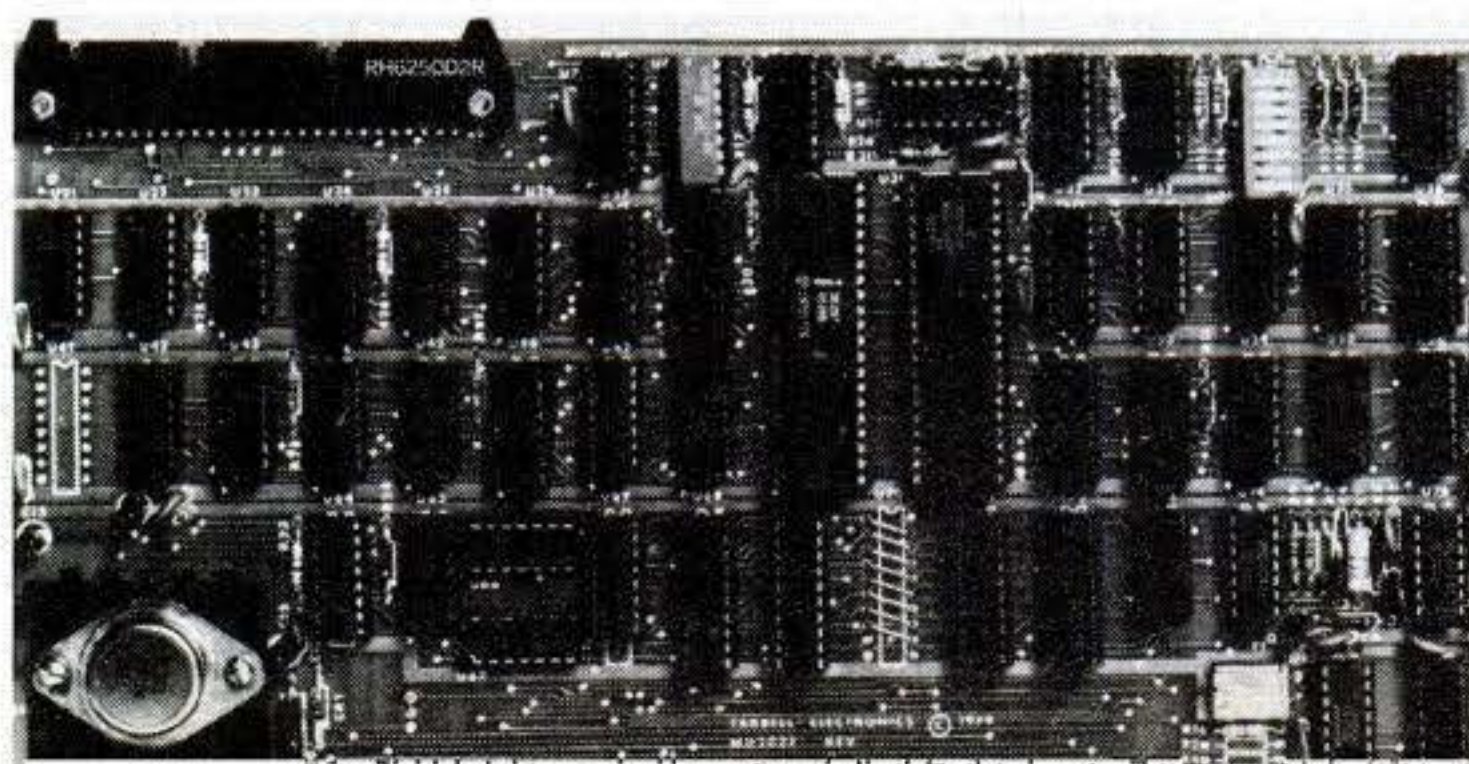
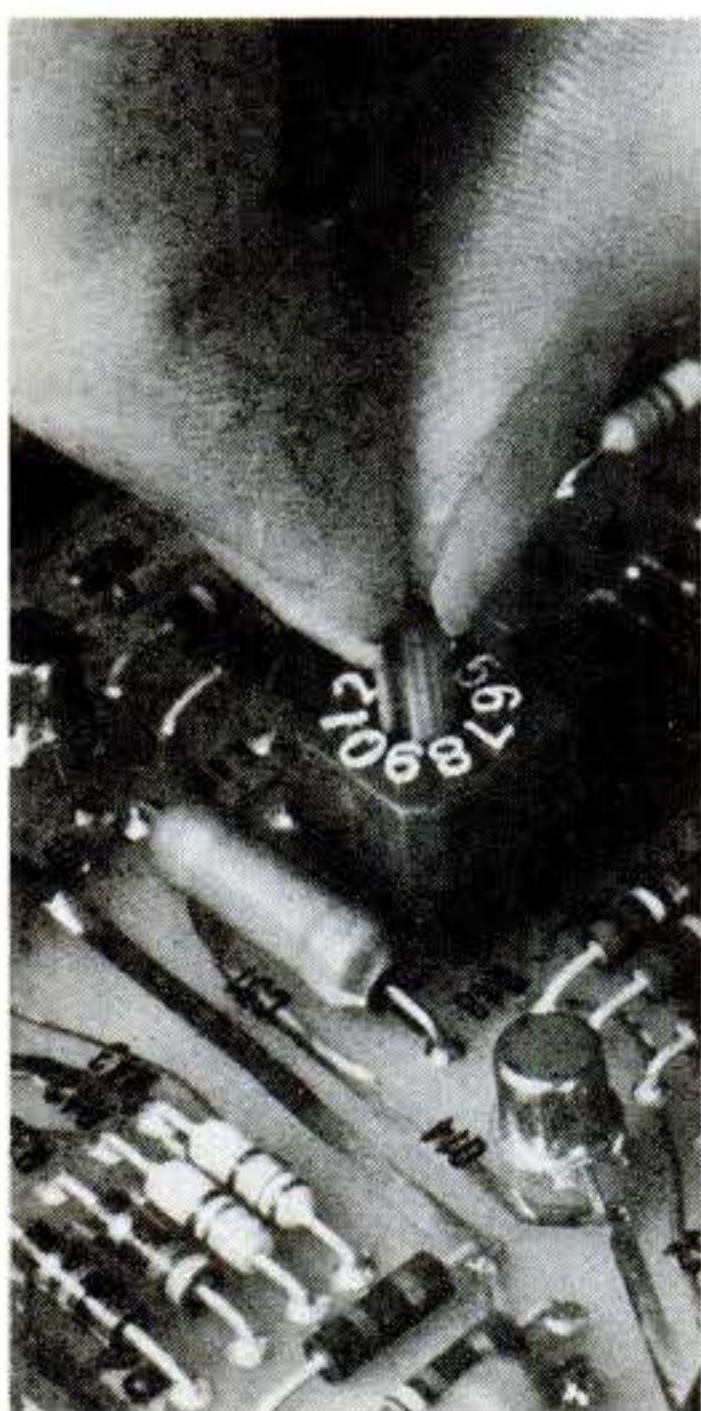


BCD DIP switch

Replace conventional rocker-type DIP switches with a rotary type on your printed circuit boards, and the coding is done for you. This Micro-Dip switch from EECO (1601 E. Chestnut Ave., Santa Ana, Calif. 92701) is internally coded for a BCD output on each of 10 positions. Price: \$2.35.

Timing calculator

It's still called a pocket calculator, but the type of pocket it fits in makes Sharp's 8061E different—a vest pocket. And there's room to spare since you won't need your vest watch; the calc keeps time on a 24- or 48-hour cycle. It's \$40 with chain.

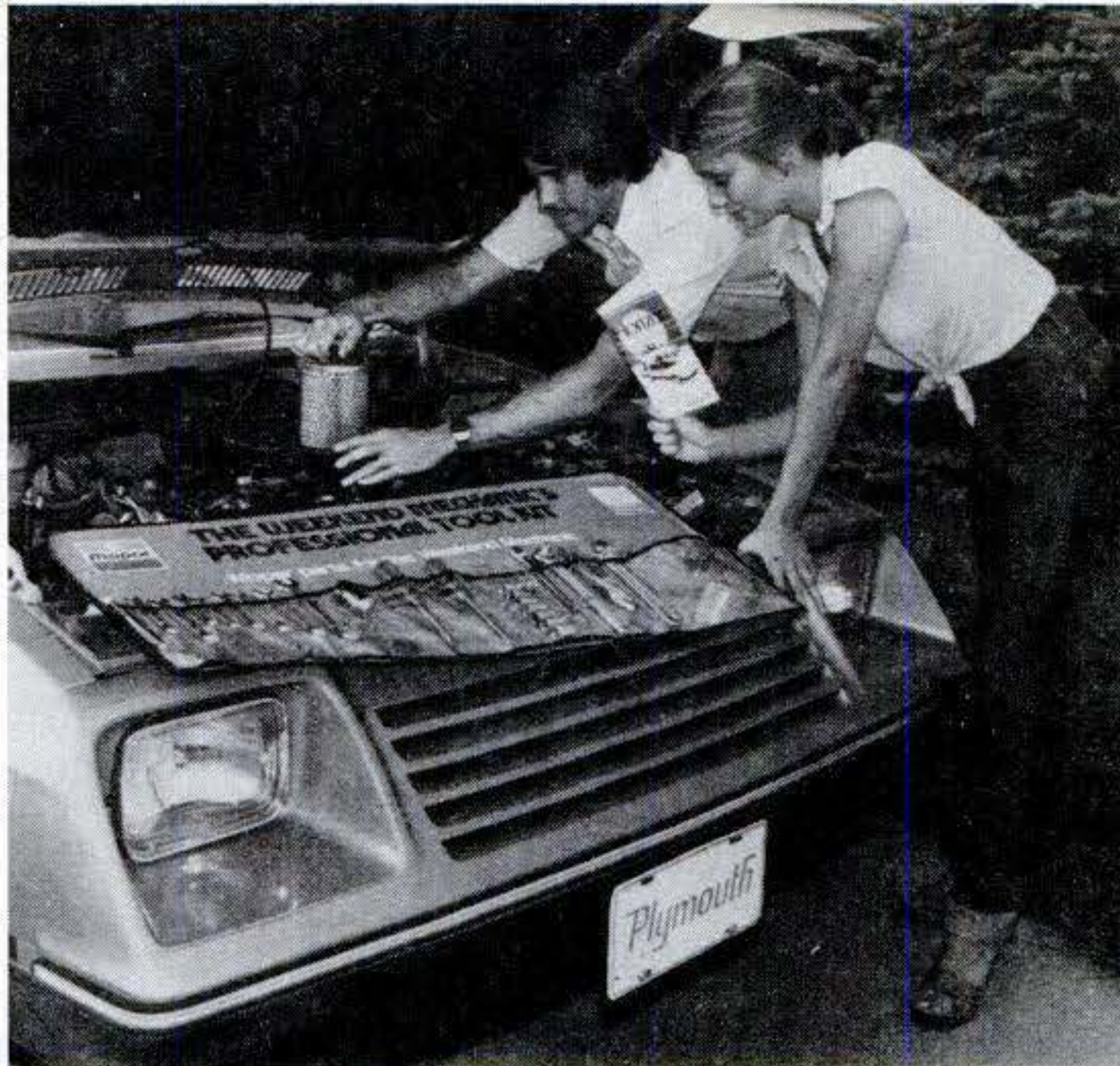


Double dense

A disk controller board for S-100 computers permits double-density recording to store twice the normal amount of info on a disk. Phantom bootstrap PROM will automatically bring up CP/M without affecting memory. It's \$425, from Tarbell, 950 Dovlen Pl., Carson, Calif. 90746.

What's New FOR YOUR CAR

BY ED JACOBS



DIY tool kit

The Professional Tool Kit for weekend mechanics contains 25 basic tools in a pocketed vinyl pouch, including spark-plug and tire gauges, oil-filter wrench, sockets, and ratchet. It's primarily for Omni and Horizon owners, and costs \$39.95. Truecraft Tool, Box 94009, Chicago, Ill. 60690.

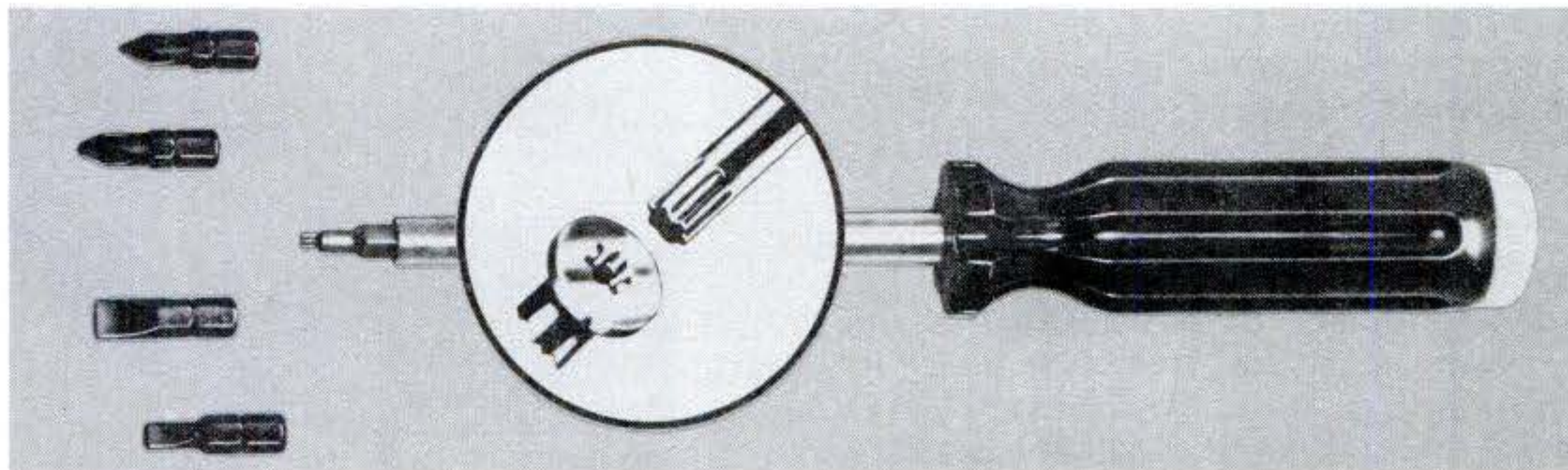


Battery drill

Versadrill is a quarter-inch drill that runs off the 12-volt battery in your car, truck, or RV. Two-stage reduction gearing is said to give sufficient power for sanding, polishing, or grinding, in addition to drilling. Varsity Accessories, 2a South Parade, Oxford OX2 7YB, England.

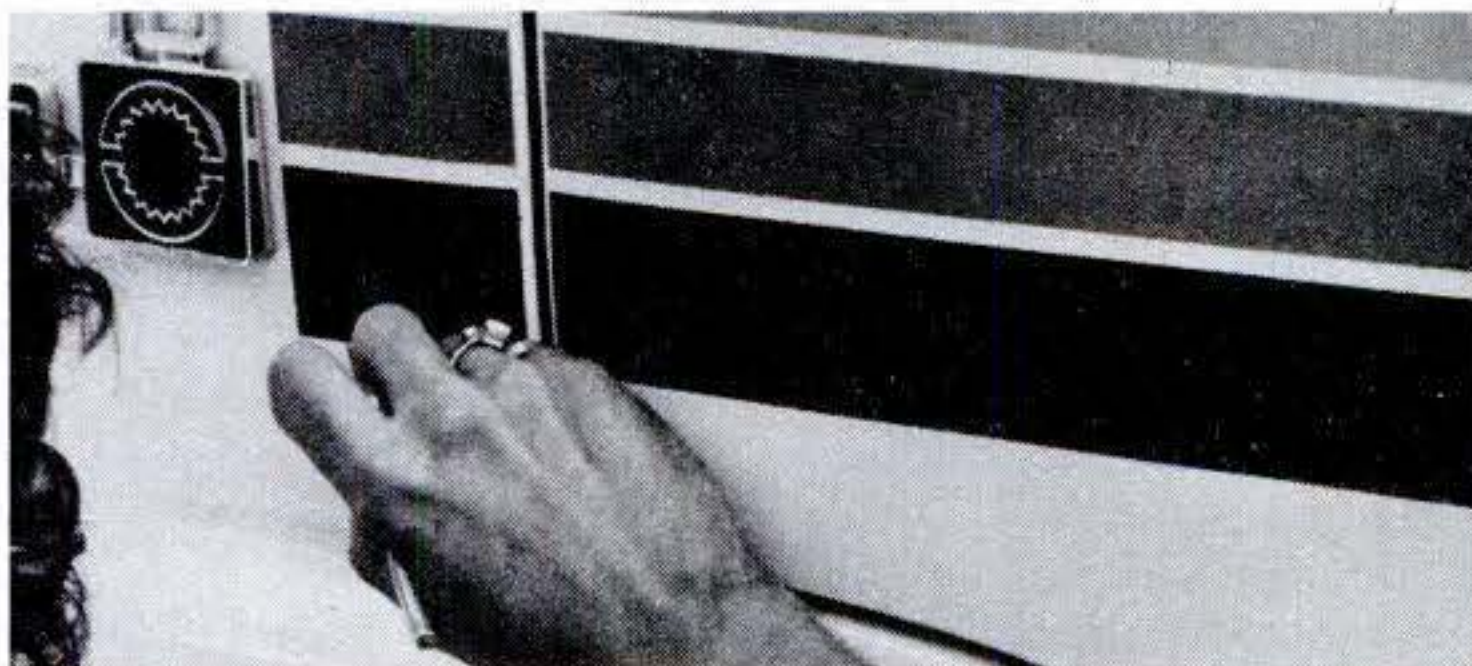
Traction booster

By slipping one Traction Aid under each driving wheel and slowly driving onto them, you can free a stuck vehicle in as little as 10 seconds, according to Six Wheel Drive, Box 273, Derry, N.H. 03038. They're all-welded steel, cost \$20.95 per pair for cars, ppd.; \$45, trucks or RV's.



5-in-1 screwdriver

A magnet in the shank of this Vaco 5-in-1 screwdriver holds the interchangeable bits in place. The five bits include common and Phillips types, plus the new "Torx" drive (inset) used on most U.S.-built cars. The hollow plastic handle stores unused bits. \$6.40 at local stores.

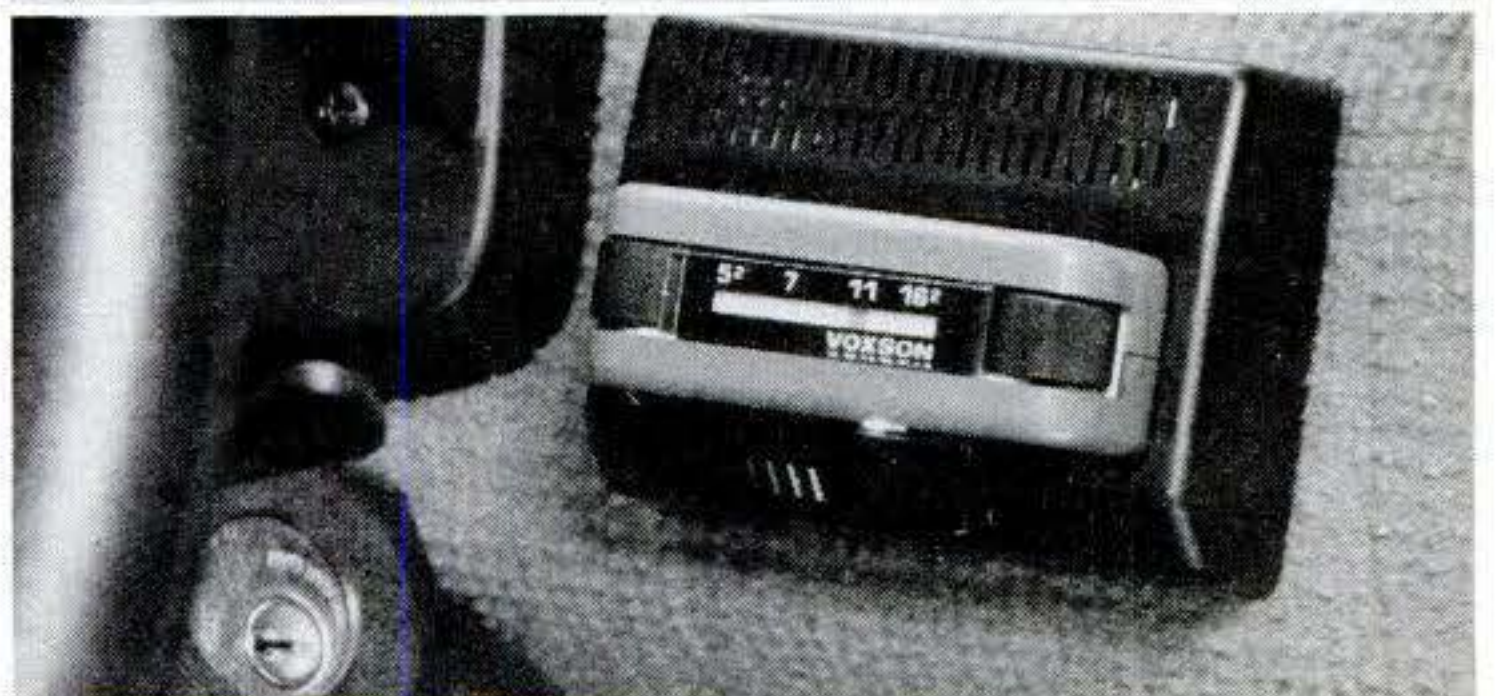


Striping kit

Add decorative striping to your car, van, or truck with Trimprite's Unistripe III kits. They're available in either black, silver, and white or dark blue, medium blue, and light blue combinations. The bands are five inches wide, 22 feet long, and cost \$10.79 at auto-parts stores.

Plug-in radio

Tanga is a tiny, three-inch-wide radio that you can unplug from your dash for theft protection, then plug into a console with its own speaker for home or office use. It has a six-watt output, and is available for FM, MW, and LW bands. Voxson S.p.A., Via di Tor Cervara 286, 00155 Rome, Italy.



Micro components

— big performance
from small packages

By C. P. GILMORE

PHOTOS BY JOHN KEATING

The age of miniaturization has finally hit hi-fi. About time.

We're all impressed by quartz watches, pocket tape recorders, microprocessors that cram millions of parts on a chip the size of your fingernail. Then why in the hi-fi field do we think that bigger equals better?

Whatever the reason, it's time to put the myth to rest. The new generation of components you see on the facing page gives superb performance from half-size packages.

The micro world

Some manufacturers call the new units minis, some micros. (We've included in this article only units whose largest dimension is less than one foot.) But whatever you call them, they're packed with outstanding engineering features. For example:

- The Mitsubishi M-T01 tape deck has dual-capstan drive and logic-operated solenoid control. You can jump from rewind to play instantly without the danger of snarling the tape. The M-F01 tuner uses quartz-crystal-controlled phase-locked-loop synthesized tuning—the most advanced technique available.

- The Toshiba F15 gives digitally synthesized tuning, automatic or manual. It will scan up and down the band, locking on stations it finds. Preset buttons bring in 10 different stations instantly. Or the frequency of a station can be punched in directly on numbered buttons. "No tuner of any size or price does what this tuner does," says Peter Dyke of Toshiba.

- LED displays are everywhere. Technics and Mitsubishi use them on the tuning indicator. Aiwa uses LED's

to indicate power levels; Mitsubishi, to indicate signal strength and the settings of the tone-control circuits.

- Technics uses gold-plated back-panel contacts for sure, noise-free connection, and supplies similarly gold-plated cables.

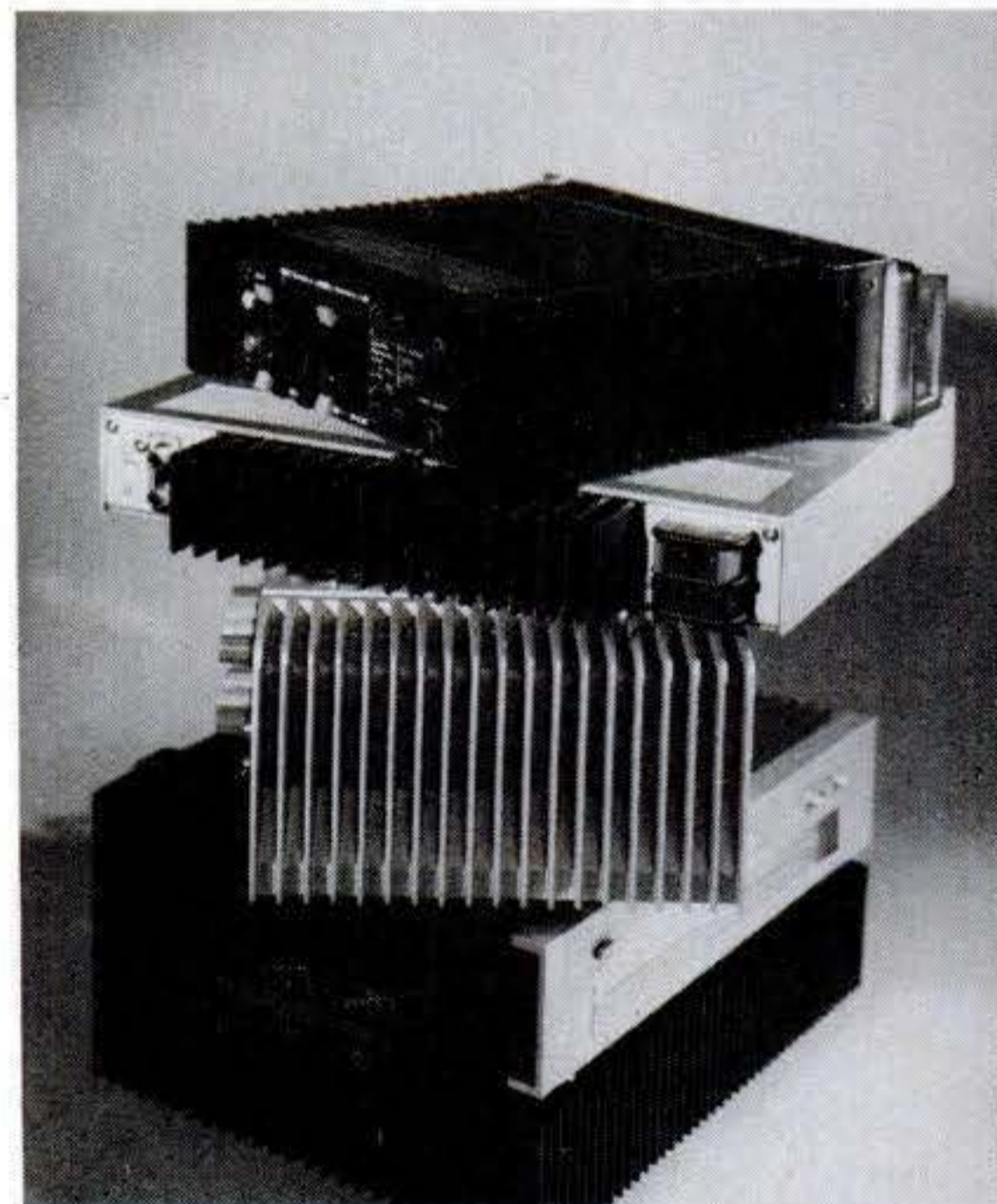
Making them little

"There were a number of advances that had to be dealt with from an engineering point of view," says Fred Hartfelder of Mitsubishi. "A lot of them will later be used in our bigger components."

The most significant had to do with the power amplifier. In general, the size of the power supply in a power amplifier is proportional to the output power. So power supplies had to be squeezed. Mitsubishi, which produces a powerful 70-watt-per-channel unit, chose what is called a cut-core transformer. "It's 47 percent smaller than an equivalent conventional transformer," says Leo Delaney.

Toshiba, with a 40-watt-per-channel power amplifier, solves the same problem with a torroidal-core device. And Technics, also with a 40-watt-per-channel amplifier, has gone to a special technique called a switching power supply. The 60-Hz line power is transformed into a 20,000-Hz square wave, which is then used to generate the voltages necessary to run the amplifier. But the higher frequencies mean that the power transformer and capacitors can be considerably smaller than conventional ones.

Tuner, preamplifier, and tape-deck design were easier. The main problem: Magnetic fields of close-packed parts tend to couple unwanted signals from one circuit into another. Careful placement and shielding can overcome such problems.

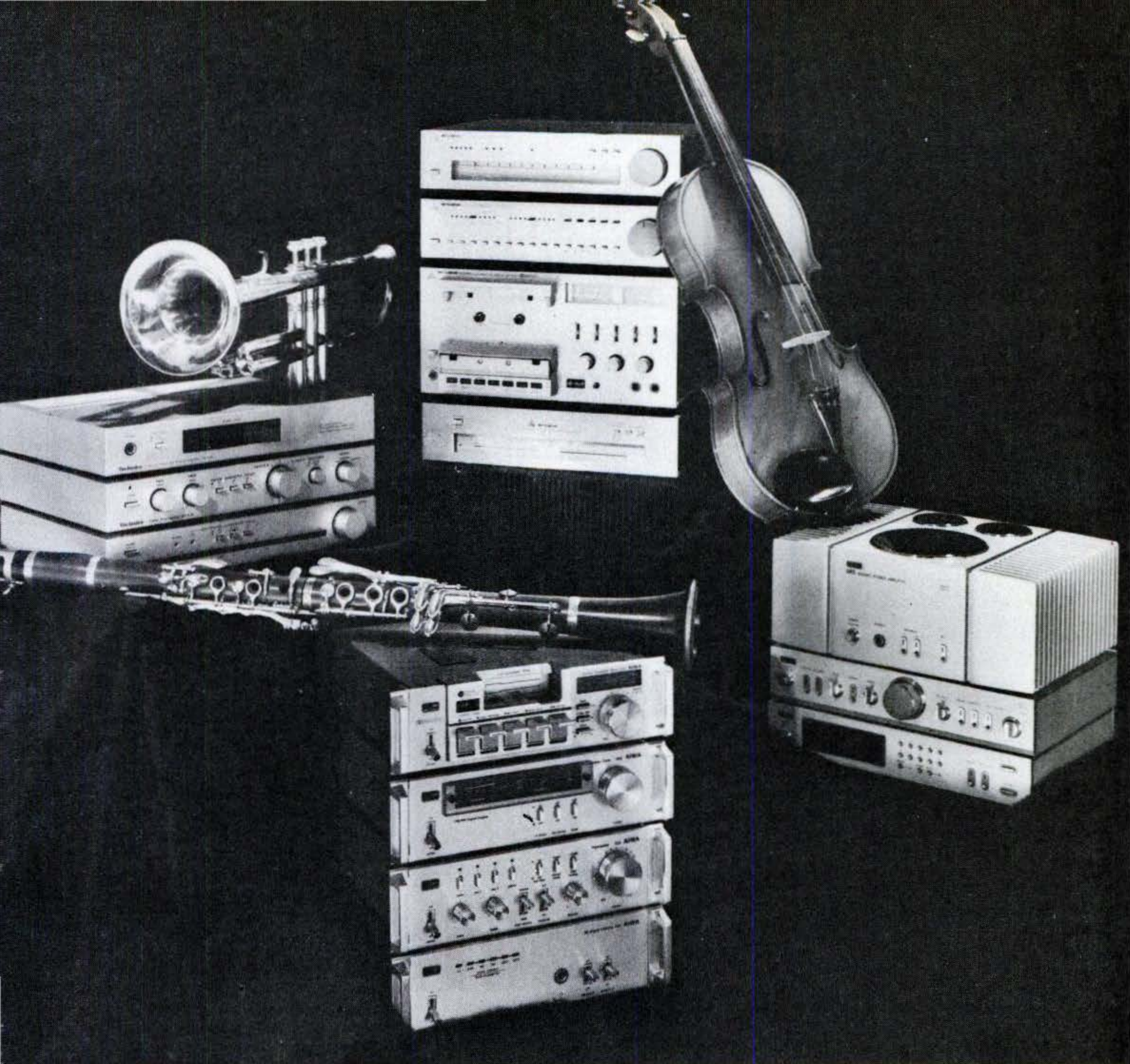


Massive heat sinks demonstrate micros' big problem: getting rid of heat. Small units generate normal amount of heat but have smaller surface for heat radiation.

In the marketplace

Micro components, despite their virtues, have not been selling well. "Dealers still feel that Americans equate bigger with better," says Peter Dyke. "There's a certain status element involving customers that's always there," says Jim Parks of Technics. "Take a receiver. The more bells and whistles it has on it, the more attractive it is to the consumer at the point of sale."

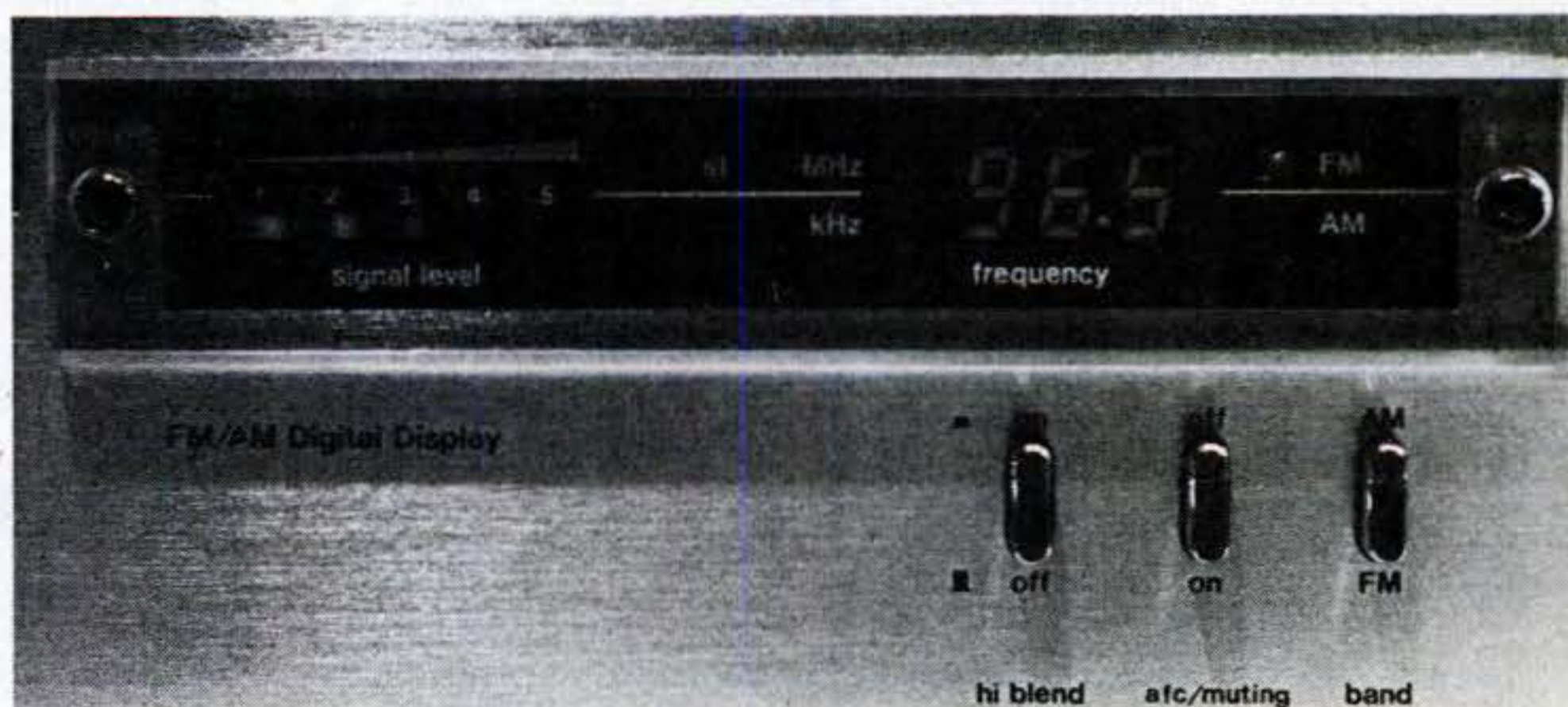
In fact, micro components have been thought of primarily as being designed for people with limited space. But as the specs show, these units have the same kind of performance as full-size components in the same price range. The four minis shown fall roughly into three price and perfor-



Tiny, jewel-like exteriors conceal no-compromise, state-of-the-art circuitry. New-generation micros show that big doesn't necessarily mean better.

performance ranges. Aiwa has gone for the lowest-price market with power output of 30 watts per channel, and other specifications somewhat below those of the more expensive units. Technics and Toshiba each produce a clean 40 watts per channel without even breathing hard, and have superb high-fidelity specifications in all departments. Mitsubishi produces an astonishing 70 watts per channel and has truly superior specifications. Here are unit-by-unit details:

	Tuner	Pre-tuner	Pre-amp
Aiwa	ST-R22 (FM/AM) \$200	SA-C22 \$140	SA-P22 \$210
Technics	ST-C01 (FM/AM) \$260	SU-C01 \$260	SE-C01 \$360
Toshiba	F15 (FM) \$360	C15 \$300	M15 \$340
Mitsubishi	M-F01 (FM) \$340	M-P01 \$370	M-A01 \$500



Advanced features such as digital frequency display and LED signal-level indicator appear on Aiwa ST-R22 tuner, least

Three makers offer tape decks to go with the micro series: the Aiwa SD-L22 at \$260, the Toshiba D-15 at \$550, and the Mitsubishi M-T01 at \$560.

At such prices, micros aren't cheap.

expensive line of true micros. Other makes offer digital synthesizer tuning, dual-capstan-drive tape decks, and more.

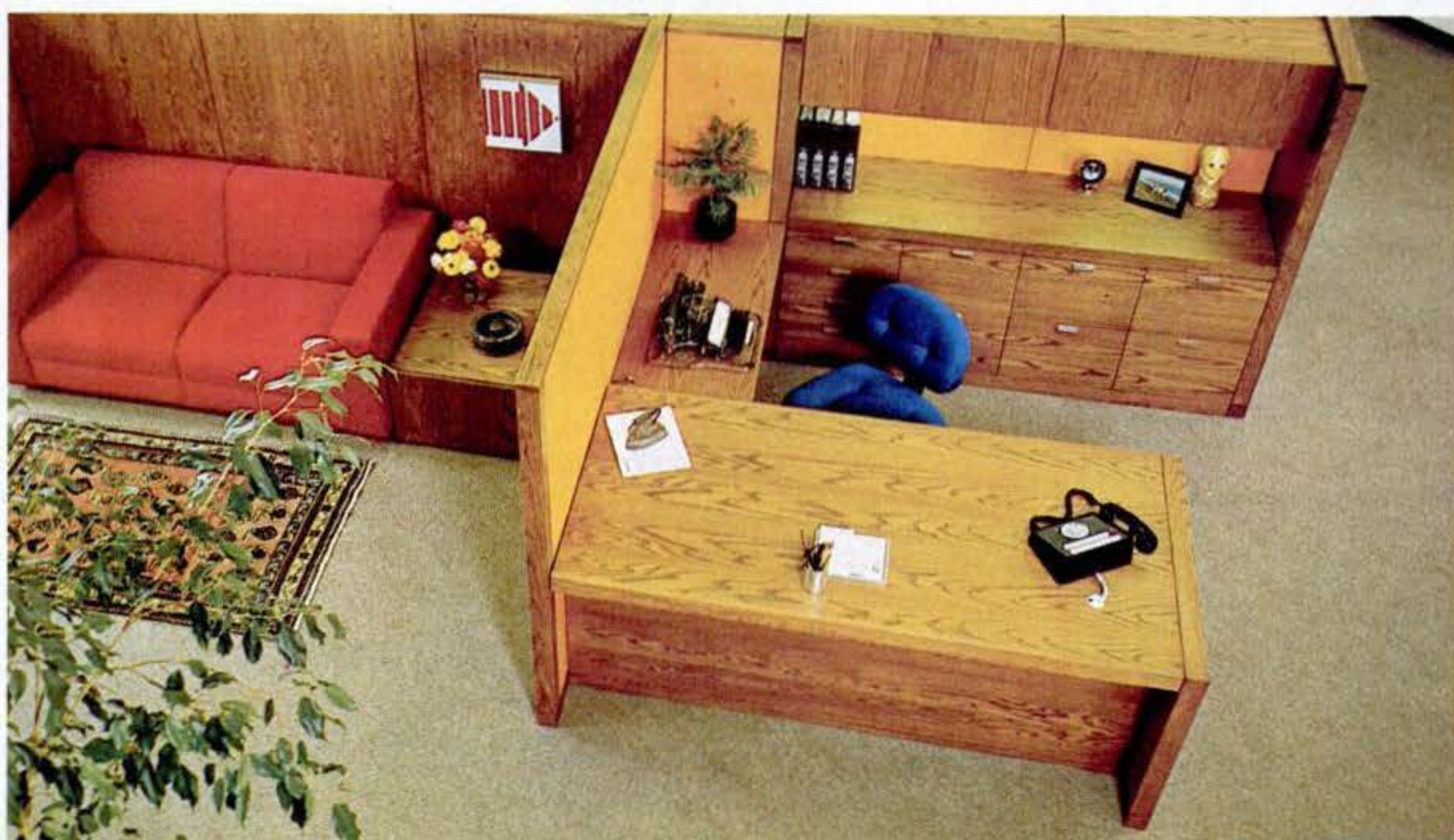
So why should you buy a little one if you can get a big one for the same money? In a world of shrinking resources, I'd put the question the other way: If you can buy a good little one, why buy a big one? **ES**



No space for
a home office?
Create a
**room within
a room**

Diagonal corner increases work space, puts everything within easy reach in Westinghouse ASD module. Integral lighting is mounted above work space. Shallow drawers, shelves are ideal for paper storage.

Desk, typing surface, and storage unit form compact U-shape; tall partition wall isolates office from rest of room in this setup from Hiebert. Such a nook is elegant enough to fit into any room of the home.



Integrated modular furniture, seen in today's best-dressed offices, can fit in at home, too

By ROBERT GORMAN

For those of us who live in an ordinary-size house or apartment, one of the frequently missing marks of gracious, spacious living is a personal den or study, a place to get away from family clatter. A private area where we can do our own work, think our own thoughts; where papers can be kept—undisturbed.

A separate room could solve the problem nicely. But what if you don't have an extra room for every family member who would like one? For an alternative solution, you might take a closer look at today's modular office furniture.

An unlikely place to look? Not when you consider that much of today's office furniture is designed for modularity, flexibility, and better space utilization. These office "systems," as they're called, integrate walls, furniture, accessories—often even lighting—to create handy, handsome private work areas within a larger room. Such an approach could be as useful at home as it is on the job.

The partition walls that are the basic element in these space-thrifty systems link together in modular widths, heights, and depths. Storage enclosures and other accessories, all adjustable and changeable, usually attach to special tracks or slots built into the walls. Desks and other work surfaces may hang on the walls or be supported on pedestals. Most can be outfitted with rails to hold drawers (of various

Continued



Two-sided desk with partition between creates separate work spaces for husband and wife or for a couple of kids. Surround-

ing screens cut noise transmissions and adjust for more or less isolation from room. Herman Miller makes this system.



Slender L-shape partition walls hold work surfaces, cabinets, shelves—some with integral task lighting—in this Herman Miller assemblage. Hang-on accessories can be raised or lowered. Fabric panels can coordinate office nook with rest of room.



Short dividing walls give office occupant visual contact with room, but hide desk top from view. This module from Alma is assembled from panels and corner posts; accessories hang on chrome standards. Panels come in oak veneer, fabric, or vinyl.



Light fixture (top), concealed in cabinet when doors are closed, aims ambient light toward ceiling; task lighting illumi-

nates desk. Eppinger system is in Manchester, N.H., federal building as part of HUD test on energy-saving office lighting.



sizes) below. Joining and supporting methods permit quick assembly and knockdown without special tools. The partitions usually incorporate acoustical material to reduce noise.

Most desks and other hang-on accessories can be adjusted up or down along the tracks in the walls, so an office system could grow with a growing child or be refitted for a new occupant. And if you move, your mini-office can move with you.

Lighting designed in

Many of these systems integrate clever combinations of general (ambient) lighting and work-focused (task) lighting, in the form of hang-on lights, free-standing towers, or concealed shelf fixtures. These go a long way toward eliminating glare and shadows, and veiling reflections.

In some offices such carefully planned integral lighting schemes have reduced lighting requirements from a traditional level of about five watts per square foot to as little as 1.5 watts for equally comfortable illumination. Tests have shown that the energy saving (in reduced air-conditioning load as well as lighting energy) can amount to about 30 percent.

Along with integral lighting, most of these systems have built-in wiring channels. This banishes the rat's nest of lamp cords, phone connections, antenna lead-ins, and loudspeaker hook-ups from your office setup.

Designers of systems furniture have shown considerable ingenuity in adapting and combining new and traditional material—solid and veneered woods, metals, plastics, fabrics, and others—to fit different tastes and budgets. But none of these systems is cheap. And some may be hard to come by because many manufacturers and distributors aim primarily (or exclusively) at the commercial market. The field, however, is growing rapidly, and you shouldn't have trouble finding a system that meets your needs. Or you might adapt the idea for a do-it-yourself room within a room. 5

MAJOR SOURCES OF OFFICE SYSTEMS

Alma Desk Co., Box 2250, High Point NC 27261; **American Seating Co.**, 901 Broadway N.W., Grand Rapids MI 49504; **Atelier International, Ltd.**, 595 Madison Ave., New York NY 10022; **Eppinger Furniture Inc.**, Fairview Park, Elmsford NY 10523; **Giltspur Expo Industries, Inc.**, 3225 S. Western Ave., Chicago IL 60608; **Herman Miller, Inc.**, 457 W. Washington, Zeeland MI 49464; **Hiebert, Inc.**, 23605 Telo Ave., Torrance CA 90505; **JG Furniture**, 121 Park Ave., Quakertown PA 18951; **Knoll International**, 745 Fifth Ave., New York NY 10022; **Myrtle Desk Co.**, High Point NC 27261; **Steelcase, Inc.**, 1120 36th St., Grand Rapids MI 49501; **Stow/Davis Furniture Co.**, 25 Summer Ave. N.W., Grand Rapids MI 49504; **Westinghouse ASD Group**, 4300 36th St. S.E., Grand Rapids MI 49508.

Carrels for everyone could be created in a small space at home, as well as in an office. These systems from JG Furniture combine task and ambient lighting in the same integral fixture. Deep drawers attach under desks to hold files.



Need a home for your home computer?
This office setup from Steelcase could in-

spire your imagination. Storage accessories, light fixtures shown are only a few of

many options. Panels that form partition walls come in many heights and widths.



Bookcase doubles as dividing wall in Myrtle Desk Co.'s Environmental Module System. Tambour door on cabinet saves space. EMS line includes a variety of filing cabinets, bookcases, drawer units, and divided storage. Bookcase has integral lighting.



Surround yourself with a U-shape wall topped by a low counter. Long desk inside provides large work space. Shelf, cabinet, and drawer space are all within easy reach. This system, from Herman Miller, isolates office, but not user, from the room.

Anti-theft devices

that scream, lock, or stop your car dead

Most are easy to install. Any of them could save your car, truck, or van

By **ROBERT GORMAN**

"You can't stop a determined thief from stealing your car." That's what I've been told by cops, government and insurance specialists, locksmiths, even auto thieves themselves. You can't stop them, but you can sure slow 'em down—and that may be just enough to save your wheels.

The trick: Add one of the new anti-theft devices now available for your car, truck, or van. The devices buy you time: All are designed to make it harder for a thief to enter, start, or drive your vehicle away safely and quietly.

Just how that's accomplished—and how well each device works—depends on the system. More money generally buys better protection, but how you use it is equally important. Knowing what these new silent sentries will do for you and how well they will fit in with your driving habits is the real key to good auto security. And, depending on the type, they might even save you some insurance money as a bonus.

The anti-theft systems fall into one of four categories:

- Door and parts locks, to discourage looters and strippers as well as drive-away thieves.

- Reinforcers for ignition locks, which also disable steering, transmission, or both.

- Car stoppers, which kill the ignition or block the fuel line either before or after a thief hot-wires your car or starts it with a duplicate key.

- Alarms that are triggered in var-

ious ways: unauthorized entry, wheel jacking, or a towing attempt.

Singly, or in combination, these devices can provide reasonable protection against the majority of rip-off attempts. Here are some you can install—or have installed—and what they cost.

Door and parts locks

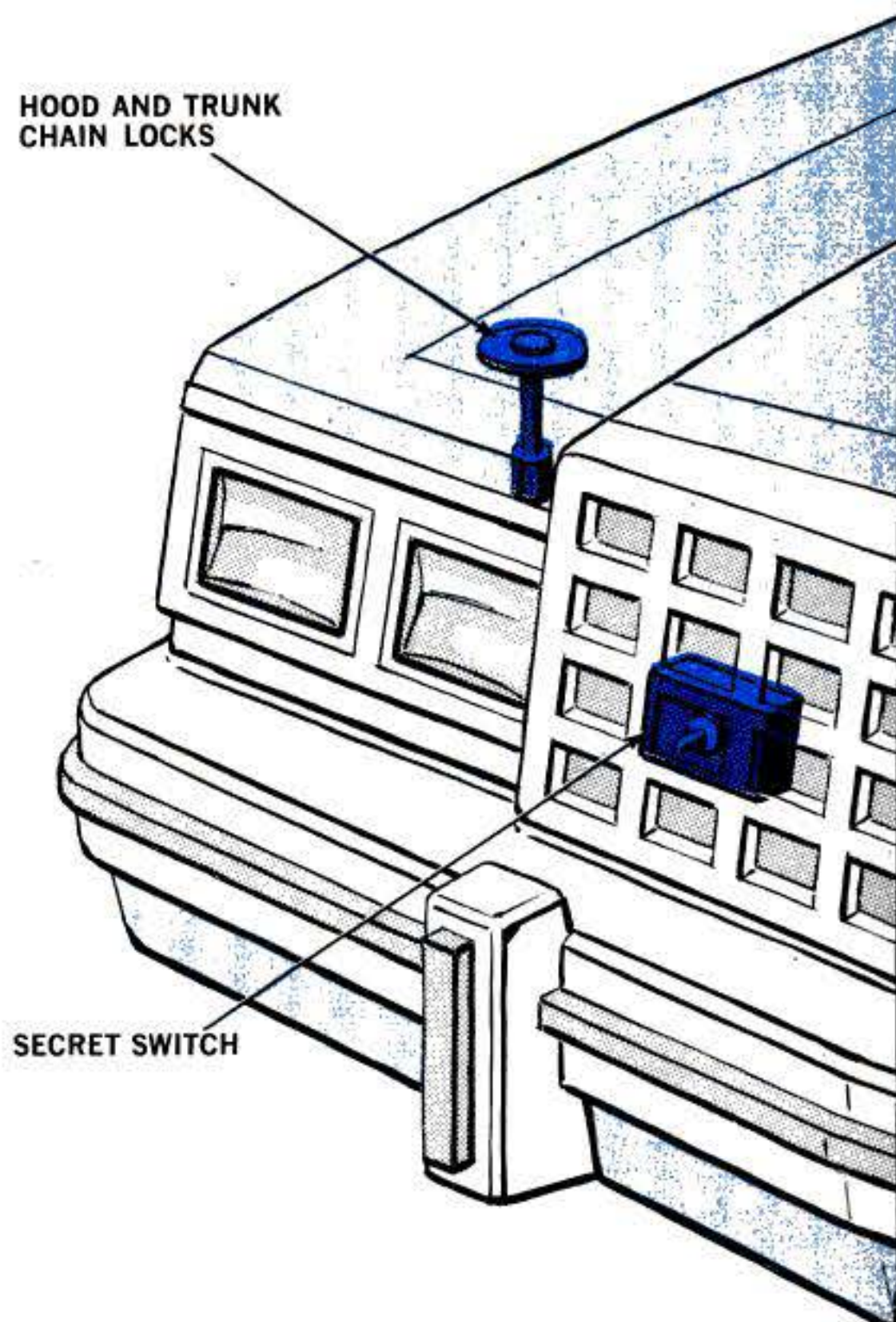
Police records show that up to 70 percent of all stolen cars are taken by small-time, relatively unskilled operators or youthful joyriders, many of whom seem to prefer older cars.

To make a quick score, this class of thief will first usually look for an unlocked car, or risk a quick, furtive knob-pull with a bent coat-hanger. You can help protect against this just by locking your door. Don't laugh. The insurance-sponsored National Automobile Theft Bureau says eight out of 10 stolen cars were left unlocked; one out of five had keys in the ignition.

And you can stop the coat-hanger user by replacing mushroom-cap door-lock buttons with inexpensive straight or tapered shaft buttons. Or look for a new type recently introduced by EMT Enterprises; it uses an anti-pull collar and sells for under \$4 a pair through new-car dealers.

On the well-supported assumption that many quick-score thieves are more interested in your car's contents and parts—tires, batteries, air conditioners, and the like—it could pay to look at other auxiliary locking devices. These include bolt-on trunk and hood chain locks, locking wheel lugs, and hardened-steel trunk-lock cover plates that you attach with one-way screws. They're fairly inexpensive and a cinch to install.

Unfortunately, pull-proof door-lock buttons don't keep out the determined



thief. And once inside, he can defeat most steering-column locks in a couple of ways. One professional group works with sets of master or duplicate keys (sometimes obtained from impressions made by parking attendants). Others use brute-force tools to twist or break the lock cylinder or to yank it out so the mechanism can be worked with a pick or screwdriver.

Yanking is commonly done with a wrench or with tools designed to bang out the cylinder. Some government experts have been urging Detroit to counter this with a lock cylinder that breaks apart when a strong twisting or pulling force is applied. Ford adopted this type of cylinder a couple of years ago. In Massachusetts, where

new Ford products had been running four to 12 times ahead of other American makes in the rip-off sweepstakes, it quickly fell into a tie with its competitors.

Ignition-lock "hardeners"

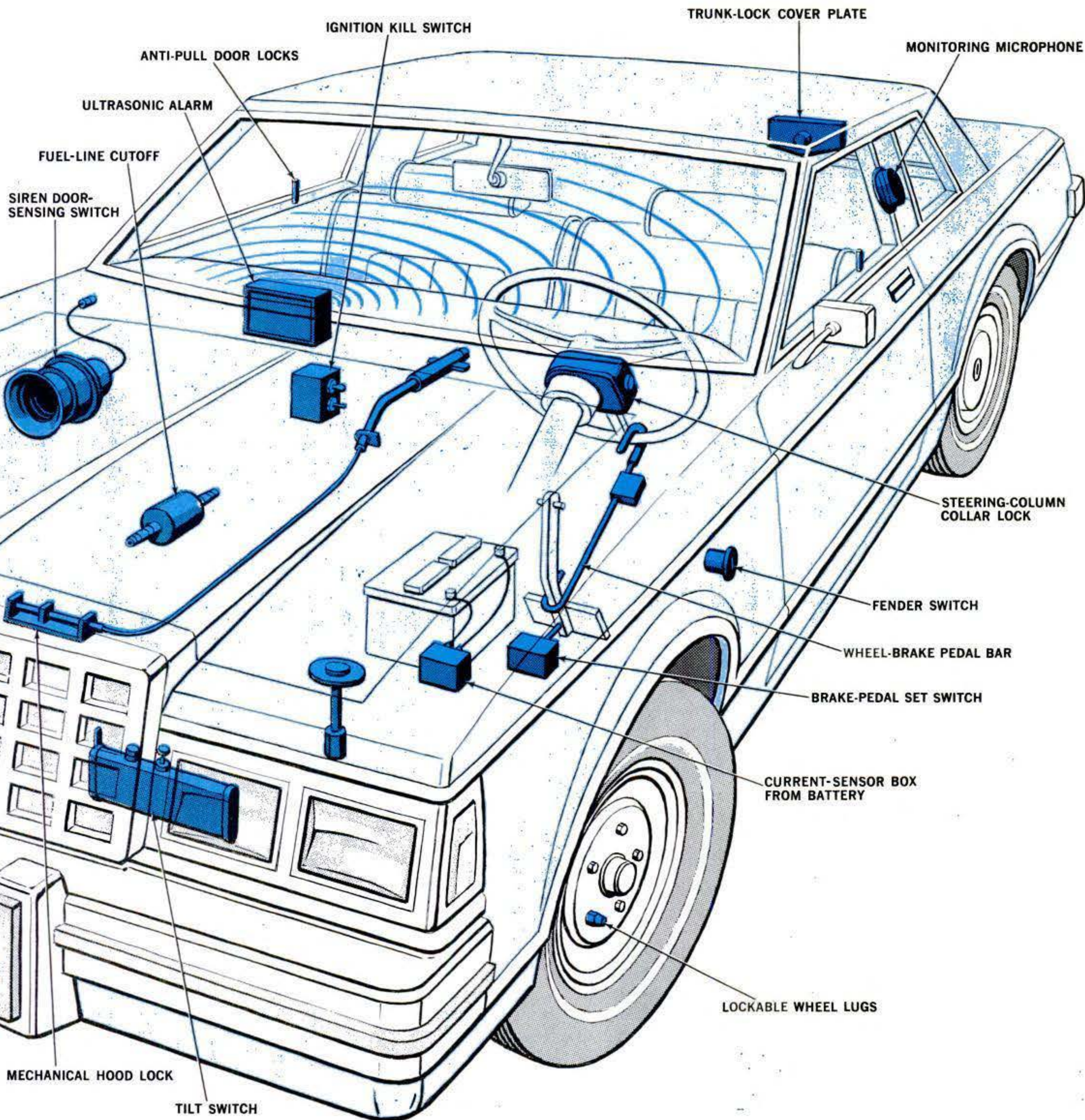
You can make it tough for a duplicate-key or brute-force thief by clamping a steel collar around the steering column and ignition lock. An effective collar costs about \$35.

You can get similar protection for even less money with a pair of steel rods bent at opposite ends and joined through a sliding lock. You hook one end through the steering wheel and the other around the brake pedal, then lock the rods to jam them both.

Most mechanical reinforcers like these use nonstandard, pick-resistant locks with keys a master-key thief isn't likely to have. But they have some drawbacks: You must remember—and take the time—to apply them each time you leave your car, and you must find a place to keep them while you drive. That could make them almost as inconvenient for you as for a thief.

A neater approach that appears to be quite effective is Lock Technology Corporation's "Hi Security" steering-column lock. It simply replaces the original lock (in GM, AMC, and Chrysler tilt-wheel models) with a pick-resistant Medeco cylinder. It has

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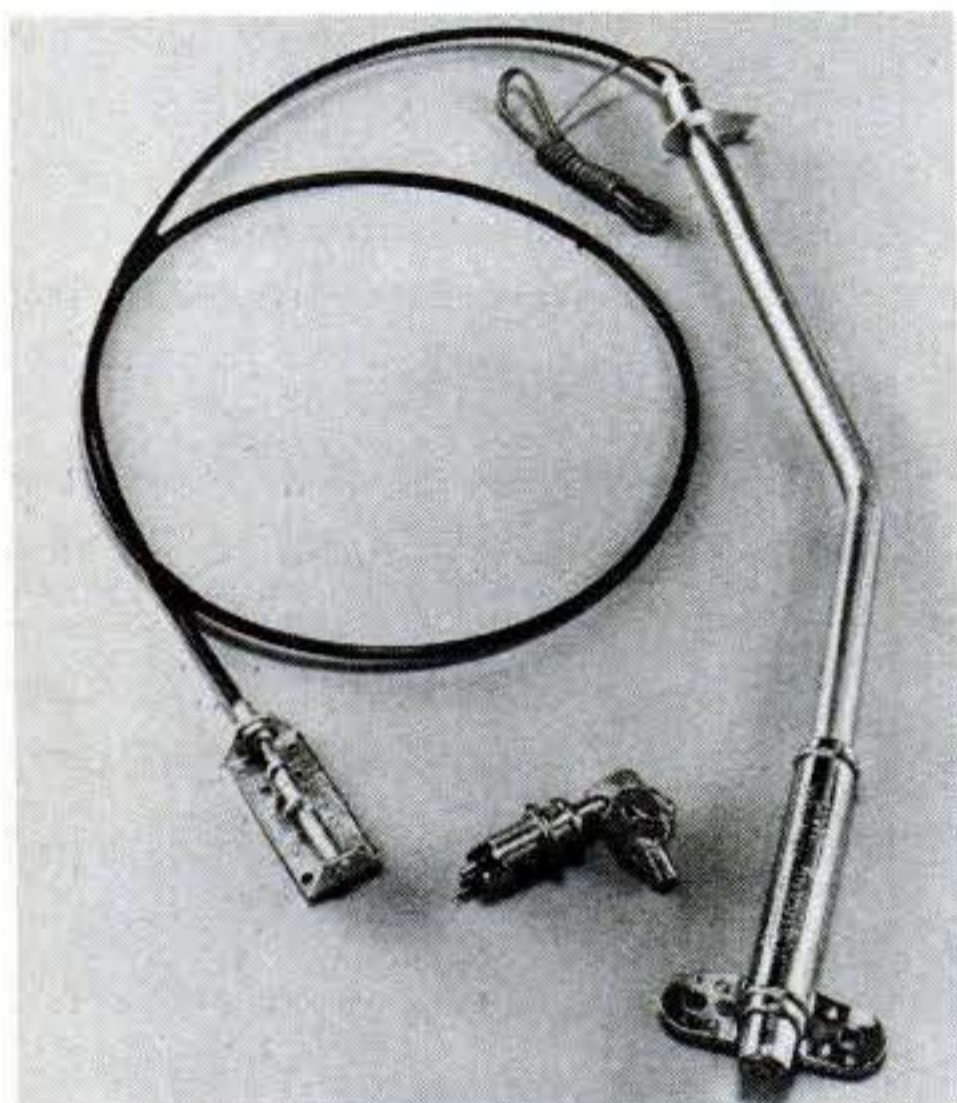




Ungo Box uses a digital circuit to thwart car thieves. System will deactivate only when correct code is entered.



Sonic Sentry box uses ultrasonic sound waves to detect an intruder. Delay allows you to enter without sounding alarm.



Chapman lock mounts under dash and extends through firewall. Mechanism locks hood and cuts power to coil on engine.

a key-slotted but free-turning hardened-steel facing that's immune to twisting force and can put up a good fight against most brute-force pullers. The lock assembly, with two keys, lists for \$39.95; installation by a qualified locksmith could easily double that cost.

Car stoppers

One way to beat a thief is to throw him a curve—with a system that's harder to overcome because he doesn't know it's there.

Ignition-kill switches are both simple and effective. You can install one yourself for the cost of an adequately rated toggle or button switch and a couple of feet of wire. Hide the switch where you can reach—but not see—it, and wire it to chassis ground to short the points.

More sophisticated kits, such as the \$19.95 Gard-A-Car, have built-in delays that let a thief start a car—and then stall it eight or 10 seconds later unless the hidden switch is properly thrown. The claimed advantage of the delay is that since he's already into traffic a thief won't take the time to hunt for the switch or figure out a way to overcome it.

Fuel-line cutoffs are even more likely to feature such delays. Among the newer models is a Swiss-made electrically operated valve package distrib-



Theft Alert system transmits silent alarm to the pocket pager that you carry. Once notified, you then call the police.

uted in the U.S. by Stanton Corporation for \$39.95. It arms itself automatically when you kill the ignition; to start your car you must key to "on," then press the hidden button. If you don't, you (or a thief) will run out of gas in a block or two.

Auto-squad cops I talked to seemed to favor delayed-action disabling devices of this kind. So do insurance companies, many of which have lately been offering up to 15 percent discount on your comprehensive premium for a properly installed system. Their enthusiasm, however, wasn't shared by any of the security-system installers with whom I talked. Installers—who must also listen to kickbacks from their customers—say they've had complaints from drivers who have stalled out in awkward, sometimes dangerous, places.

That doesn't mean professional security people are against ignition-kill outfits. Virtually all I spoke to say that car safety ought to start with the long-familiar Chapman hood lock or some equivalent. The Chapman uses a hard-to-pick round-key lock that extends through the firewall. When you engage it (by pressing the lock button), it disables the ignition at the coil, making it impossible to start the engine even with a duplicate or master key. And to frustrate under-the-hood hot-wiring, the system me-

chanically locks the hood. The Chapman hood lock lists at \$125.

Alarms

You may get a lot of arguments about what kind—or even whether—alarm systems make it harder for a thief to steal your car. All present types are supposed to sound off before a crook can enter your car or get under the hood to disable the alarm. They do this with various degrees of electric or electronic sophistication, and range from the cheapest to the most expensive security items you can buy.

Although many shrilling alarms often go unheeded by neighbors or the police, even a pro feels uneasy about the noisy attention. "Maybe neighbors don't react to alarms in some neighborhoods," said one experienced auto-squad cop, "but crooks do."

In residential neighborhoods, though, it's not uncommon for crooks to deliberately set off alarms two or three times a night until, in disgust, you silence the system and allow him to take your car in undisturbed quiet.

Still, if you can match his patience or endurance, an alarm could tilt the odds in your favor. Most systems are triggered in one of two ways when the hood, trunk, or door is opened. One method simply uses separate switches you must install at each opening. The other senses current changes that occur when an opened door turns on a courtesy light, for example, or when the ignition is switched on. Both types

should—and nearly all do—provide re-set mechanisms that silence the alarm after a few minutes to save the battery.

Current-change systems are the easiest to install, since most of the needed wiring is already in place. However, they're said to be prone to false alarms.

Installation of direct-wired systems needn't be much more difficult, since you can usually hook onto existing door switches. But additional switches, plus new wiring, would be needed for either system to protect unswitched openings.

The controls on all wired systems and on most current-change types allow you to extend your protection by adding mercury, swing-arm, and other types of vibration and tilt switches. Probably the most sophisticated—and costly—outfit to build in this type of sensor is the Techné Electronics' Ungo Box (\$329 plus installation). Its motion detector is hooked to an electronic memory that remembers the car's last attitude, whether on a hill or level ground. Any change caused by coasting, drive-away motion, or an attempt to jack or tow your car triggers the alarm.

Similar protection is claimed for the Vibra-Larm (Adalarm Co., \$74.95 list), which is said to detect any movement caused by opening the trunk, hood, or any door; removing a wheel; or tampering with an attached item, such as a trailer. Depending upon the sensitivity, however, all can cause havoc on a windy day.

Another new type of sensor, which doesn't depend on door switches, is an ultrasonic motion detector that's similar to the residential units. Delta Products' Sonic Sentry reacts to the physical movement of an intruder in a closed car.

Other types of car-alarm sensors include tiny glue-on microphones that

listen for the sounds of forced entry. They're part of Page Alert Systems' Silent Alarm, which includes an in-car radio transmitter and a pocket beeper that you carry with you. A \$99 half-watt outfit has a claimed half-mile range; a one-watt transmitter, said to have a one-mile range, lists for \$149.95. The distinctive feature of a silent alarm is that it alerts you without scaring off the thief.

Active or passive?

However they're triggered and wherever they sound, car alarms are armed in a number of ways from inside or outside the car. Passive alarms set themselves automatically when you key to "off," then allow you from about 40 seconds to two minutes to step out and lock up. Opening any door except the driver's should sound the alarm instantly. Driver-door switches are programmed to give you from about seven to 20 seconds to cut off the noisemaker when you enter. Passive alarms are now being offered by General Automotive Electronics, Monroe Timer, and Landia, Inc. Landia's Bearcat model is triggered by motion as well as by door switches. All these alarms run about \$150, installed.

Many insurance companies will now give you a break on your premium if you install completely passive security devices. The discount is usually five percent for an ignition-kill or fuel-line cutoff. As defined by insurance companies, these devices must set themselves without requiring any additional action on your part.

If you don't want to let this possible discount determine your choice, you might look at some alternate arming systems that are pretty hard to neglect. Among these are the Ungo Box's beep that reminds you to dial in your unique security code. Or there's the new, so-called "keyless" alarms (made

by Universal Security and others) that you engage just by tapping the brake pedal before you get out.

There's also much to be said for the less expensive, more familiar externally keyed alarms. These start at about \$50 and can give you protection as good as any—provided you train yourself to use them.

Most of the lower-cost keyed outfits require you to mount a switch in the fender or another handy place. But this job—and the rest of the installation—is well within the scope of most do-it-yourselfers. Many people believe that the visible alarm key is, in itself, a deterrent to carjacking.

Advocates of externally keyed alarms are also prone to take potshots at passive and inside-keyed systems on other grounds. Most of them don't give you much protection against crooked parking attendants. And their brief exit delays could put a rush on back-seat passengers.

Should you decide on a fender-keyed system, however, keep one possible problem in mind: Many exposed key switches are subject to false-alarming and other malfunctions, especially in wet or cold weather or when passing through car washes. Look for one of the newer lock switches that use a clipped-on mercury capsule to make or break contact; they're more reliable.

Perhaps most important, don't count on any single type of security device to protect you against the infinitely varied dangers posed by joy riders, quick-hit vandals and strippers, or professional steal-to-order thieves. But if you decide that your car and your peace of mind are worth it, today's hardware should persuade even the best of the bad guys to leave your car alone. P 5

MANUFACTURERS

The numbers in parentheses signify the type(s) of security system(s) available from each manufacturer or distributor: (1) mechanical locking and anti-stripping hardware, including ignition switch, trunk, hood, wheel protectors, chains, special lugs; (2) active (key- or switch-operated) fuel or ignition cutoff; (3) passive cutoffs; (4) active alarms; (5) passive alarms; (6) remote or silent alarms; (7) tilt, motion, or vibration sensors.

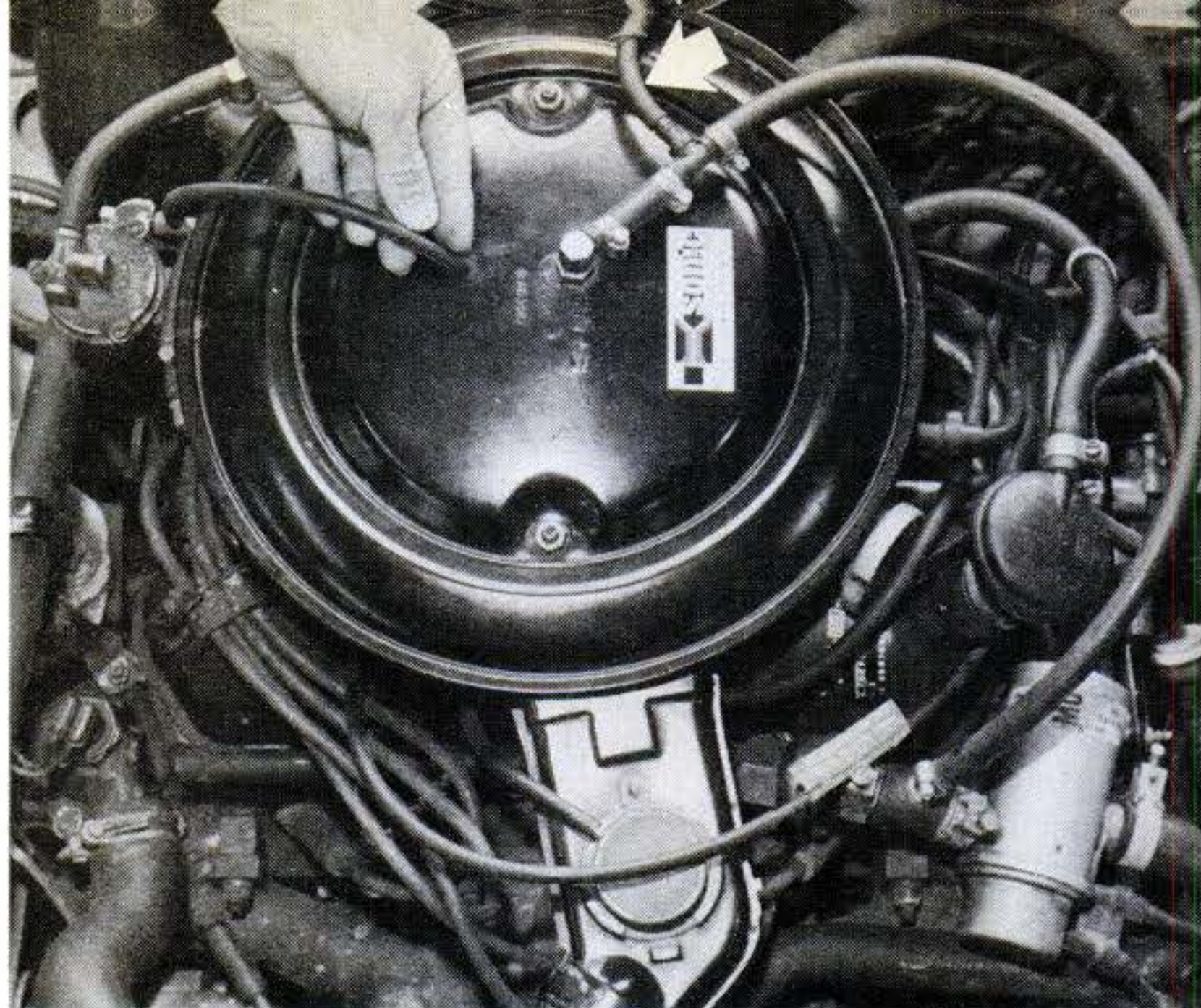
Adalarm Co., 323 W. Collins Ave., Orange CA 92667 (4, 7); **Babaco Alarm Systems**, 508 Hudson St., Hackensack NJ 07601 (1, 2, 4, 7); **Chapman Industries**, 2638 United Lane, Elk Grove IL 60007 (1, 2, 4, 7); **Delta Products, Inc.**, Box 1147, Grand Junction CO 81510 (4, 7); **EMT Enterprises**, Box 435, St. Louis MO. 63166 (1); **Gard-A-Car, Inc.**, 8110 Macomb, Grosse Ile MI 48138 (2); **General Automotive Electronics**, 462 Barell Ave., Carlstadt NJ 07072 (3, 5); **Ideal Security Hardware**, 215 E. 9th St., St. Paul MN 55101 (1); **Landia, Inc.**, 450 3rd St., Excelsior MN 55331 (5, 7); **Lock Technology Corp.**, 685 Main St., New Rochelle NY 10801 (1); **Monroe Timer Co.**, 3044 Westchester Ave., Bronx NY 10461 (1, 2, 4, 5, 7); **On-Guard Corp.**, 350 Gotham Pkwy., Carlstadt NJ 07072 (1, 4, 8); **Page Alert Systems**, 23900 Hawthorne Blvd., Torrance CA 90505 (6); **Stanton Corp.**, 841 Bishop St., Honolulu HA 96813 (3, 4, 7); **Techné Electronics, Ltd.**, Box 5760, San Jose CA 95150 (4, 7); **Universal Security Instruments**, 10324 S. Dolfield Rd., Owings Mills MD 21117 (4, 7, 8); **Wolo Mfg. Corp.**, 46 Cain Dr., Plainview NY 11803 (1, 2, 4, 7).

Conventional but reliable is the siren with door-entry switches such as this system from Radio Shack.



Water injection

improves small car's performance and mpg



Engine compartment looks normal except for extra plumbing. Hose held by hand is water hose to nozzle. Hose (arrow) goes to pressure gauge on the dash. Other hose is from AIR pump.

By RAY HILL

With rapidly rising gas costs, fuel shortages, and inflation nibbling at our heels, fuel-efficient engines are becoming increasingly important. Not only are the auto makers saddled with the task of making their cars get better mileage, they must also meet increasingly demanding emissions requirements.

As a result, many engines today knock, performance is a shadow of what it was a few years ago, and, if you've got an older car with a high-compression engine, you may not be able to run it because you can't find gas with a high enough octane rating.

Water injection is a solution for these problems. It lets you run a high-compression engine with lower-octane fuel, resulting in improved performance and mileage. So claims Pat Goodman, president of Goodman Engines in Winchester, Va.

Goodman backs his claim with a Ford Fiesta he has modified. It has a 13:1 compression ratio; water injection to prevent detonation; a reworked head and different pistons to induce more turbulence of the fuel-air mix, for more efficient burning; and a slightly different camshaft (changed partly to prevent the valves from hitting the pistons at TDC, and also for a slight performance gain). Body, drive train, and wheels are stock.

The Fiesta was tested at Transportation Research Center (TRC) in East Liberty, Ohio. TRC is the largest independent vehicle-testing facility in the U.S. Owned by the state of Ohio, the huge 8100-acre test center does everything from crash-simulation testing to fuel-economy testing for the transportation industry.

Goodman's Fiesta was first tested in stock form at TRC. Then the engine was modified and TRC tested it again. Mileage improved, performance increased, and emissions tests were passed with a comfortable margin.

When I first heard all this, I was naturally curious to learn more. So I arranged to drive the car, and to take the engine apart and photograph it.

The drive was intriguing. We topped off the gas tank at a local gas station in Winchester, and then I drove the car 81 miles and topped it off again. The tank took an even two gallons. That averages to 40.5 mpg. Much of the drive was over crooked mountain roads. And I made no attempt at fuel economy, letting my heavy foot have its way.

Performance is snappy. I jabbed the accelerator several times in low and second gears and the tires spun immediately. TRC testing bears this out. Pat Goodman showed me the test data sheets. With the car stock and a 430-pound payload (including the driver), zero-60 mph was 17.3 seconds. With the modified engine, zero-60 time was a livelier 15 seconds (again with a 430-pound payload).

Mileage also improved between testing sessions at TRC. Mileage was measured in two ways: on a chassis dyno and on the track. Dyno procedure was identical to the EPA city-driving schedule, which also measures emissions. In stock condition, the Fiesta got 30.17 mpg. Modified, it got 34.05 mpg. Both times it passed emissions requirements easily.

Track testing, which is closer to real-world use, but is not used by the EPA, was the SAE J-1082 fuel-economy test procedure. This consists of three modes of driving, supposedly simulating urban, suburban, and in-

terstate driving conditions. Basically, the urban cycle consists of a lot of stop-and-go driving with speeds up to 30 mph. The suburban cycle has fewer stops with speeds up to 60 mph. And the interstate cycle has no stops, and an average speed of 55 mph.

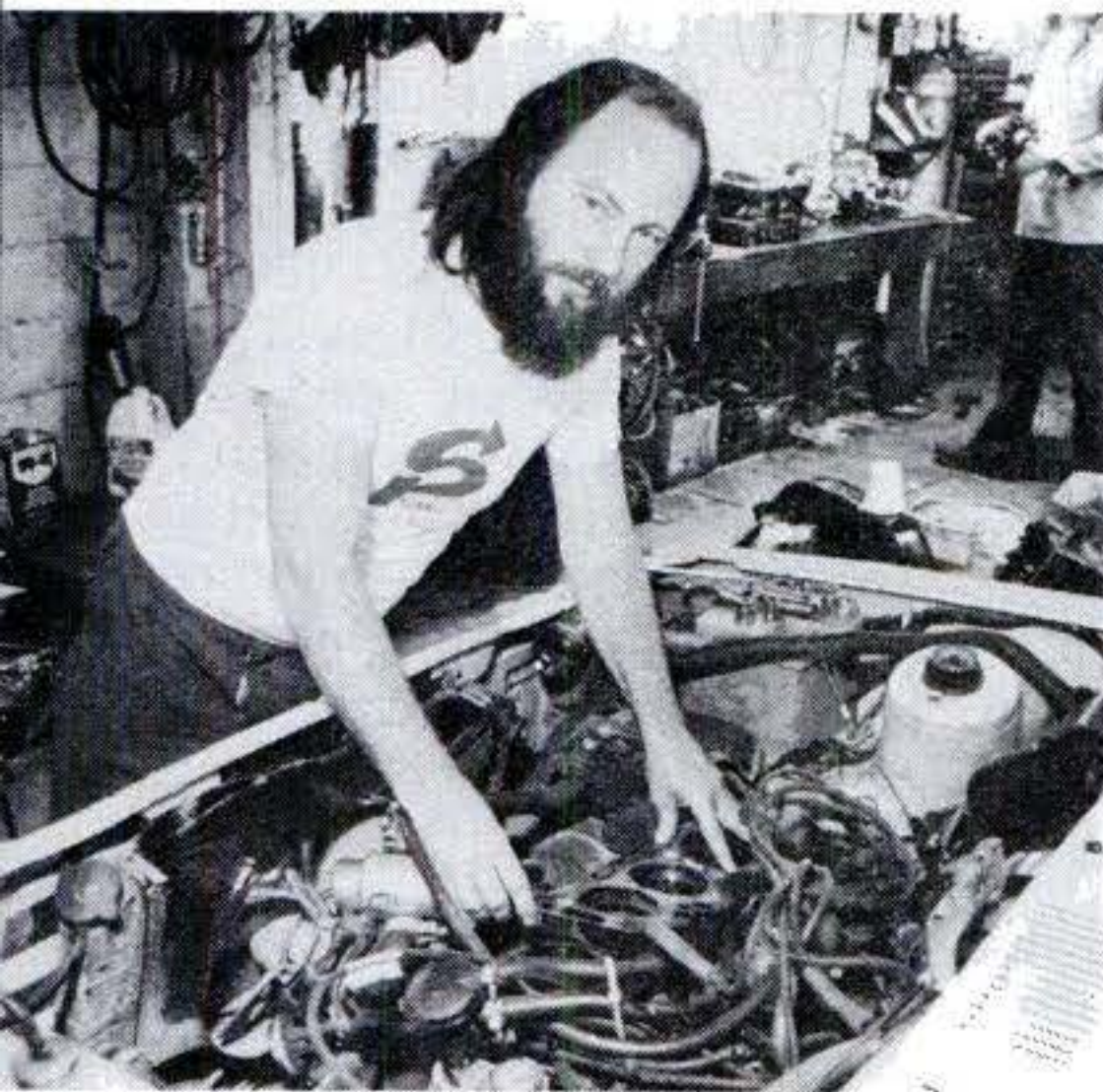
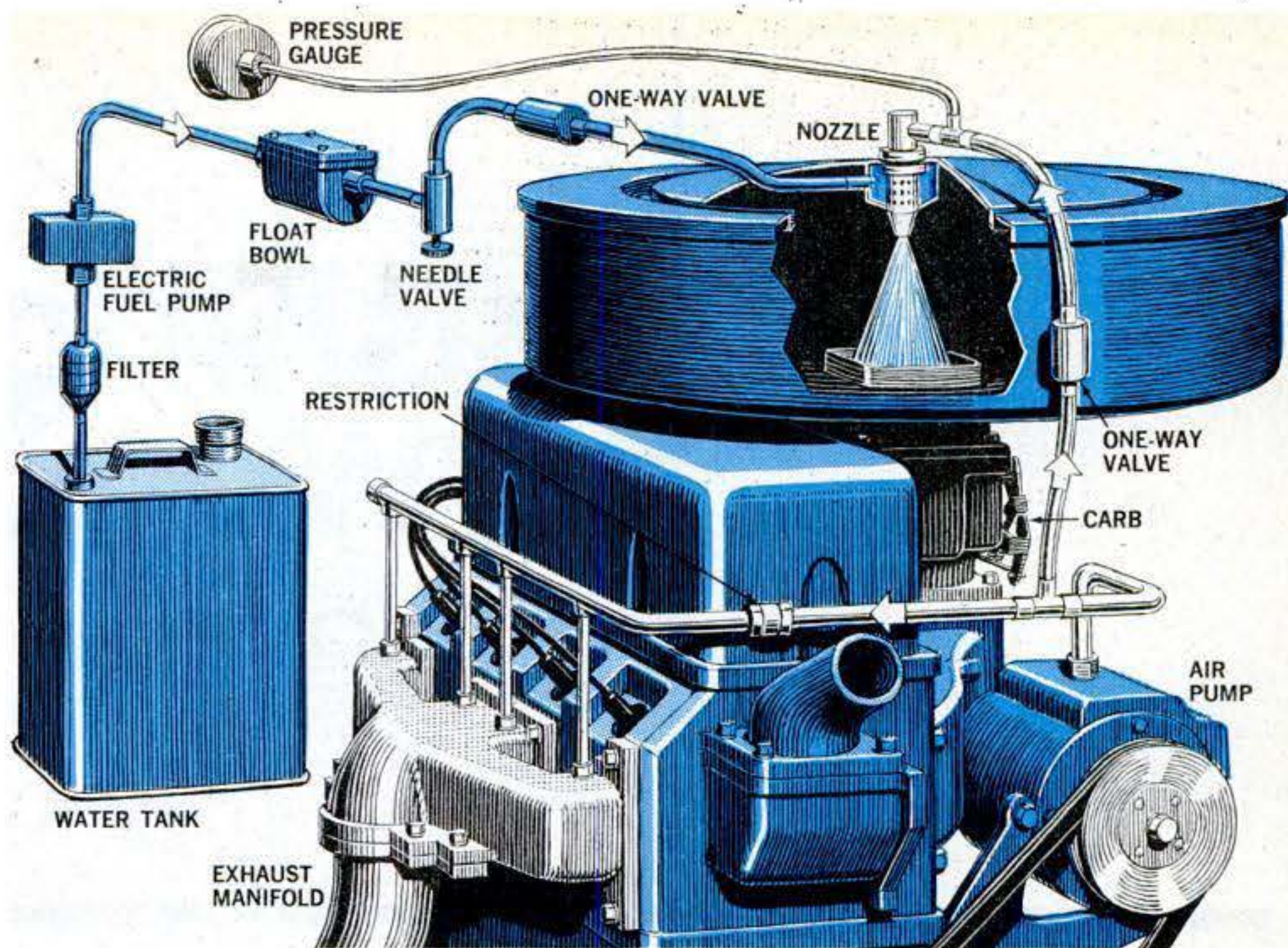
Before modification, the Fiesta got 21.97 mpg, urban; 36.80, suburban; and 37.04, interstate. After modification the figures were 25.27, 36.66, and 39.70. The reason for the lack of improvement in the suburban cycle, says Goodman, was that water vapor going over the brass throttle shaft in the carb cooled the shaft, which in turn cooled the electric choke, causing it to close partially—and at those speeds there was not enough engine heat to overcome the cooling effect of the water on the shaft.

"This happens only between 20 and 50 mph under mild acceleration," Goodman says. "We had not encountered this particular combination of temperature and driving conditions before, so we didn't realize it could happen. It could easily be cured, though, with the addition of a hot-water line running to the choke element."

How the system works

Basically what happens in the engine is that an ultra-fine water mist is sprayed through a special nozzle mounted above the carburetor throat, where it is sucked down into the rejected carb and into the combustion chambers, along with the fuel-air mixture. As the water-mist turns to steam in the combustion chamber, it lowers the peak combustion pressure and extends the pressure time toward the bottom of the stroke, which also keeps the nitrogen oxides down (see drawing).

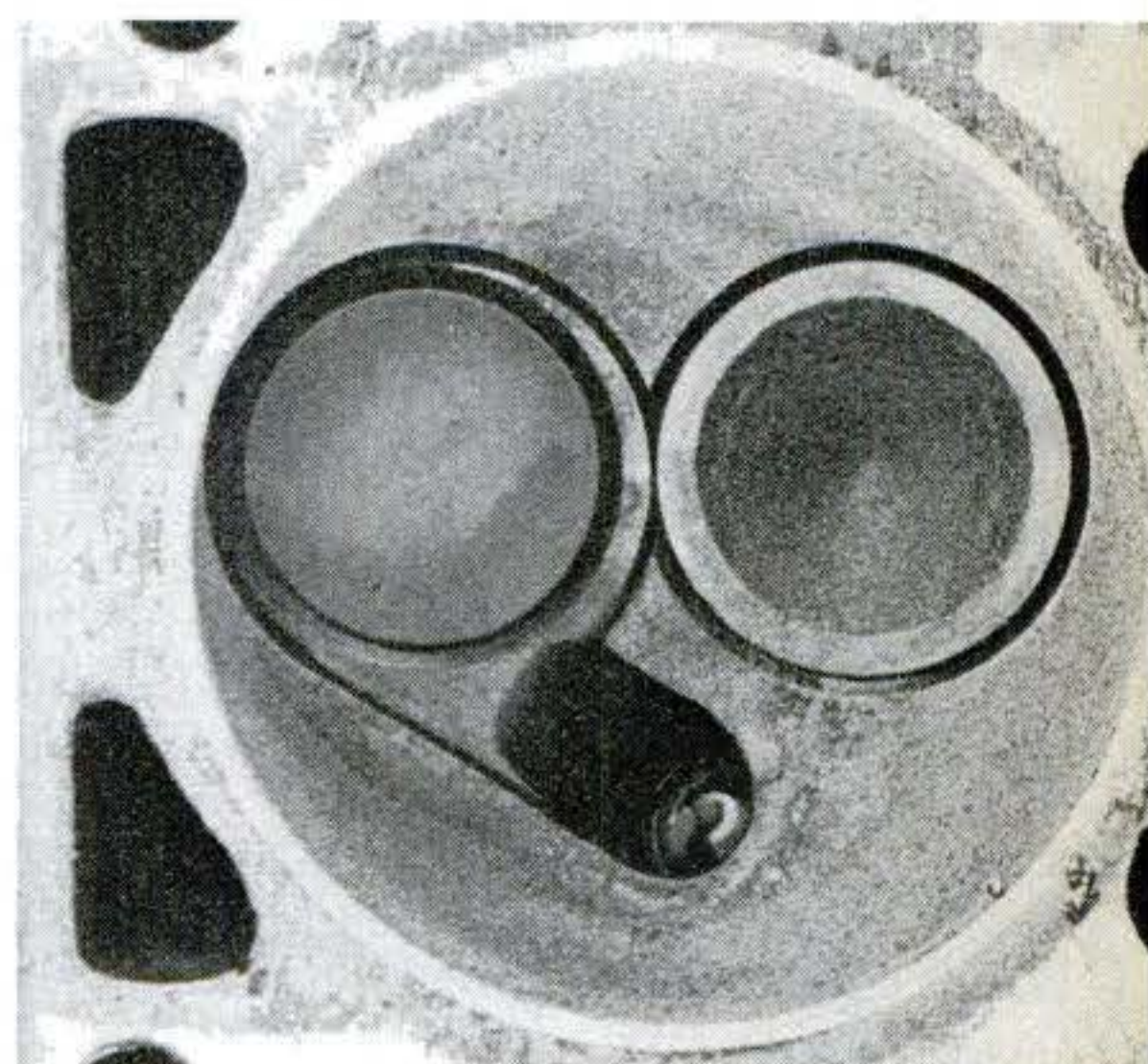
How the water-injection system works: Electric fuel pump pushes water into float bowl, then through adjustable needle valve (from a model-airplane engine) and a one-way valve (which keeps line to nozzle full at all times). Air Injection Reaction (AIR) pump still pumps air into exhaust manifold, but a restriction has been added to reduce the amount of air to the exhaust manifold. The lower volume of air needed is due to the lower temperature of the gases entering the manifold. AIR pump also pumps air into the atomizing nozzle through a one-way valve. Without a valve, at trailing throttle and high rpm, vacuum in the exhaust manifold could suck in water. One-way valve here is from oxy-acetylene welder. Air pumped through nozzle draws water through nozzle's many tiny orifices. The amount of water spray increases in proportion to the rate of air flow through nozzle. Manifold vacuum draws the spray through the carb and into the cylinders.



Modified Fiesta engine's head gasket is removed by Pat Goodman. His shop, Goodman Engines, builds racing engines and does automotive machine work.



With top off air cleaner and a shop air hose connected to the special nozzle, a fine mist is produced by nozzle. In car, nozzle pressure ranges from 2½-10 psi.



Top half of combustion chamber is in cylinder head (recessed area around exhaust valve and spark plug). Top of flat piston has matching recession.

An air-injection pump (standard on the Fiesta and many other cars) is used to control the amount of water spray leaving the nozzle above the carb. Because the pump normally supplies more air pressure as engine load increases (also the condition in which more water is needed to prevent detonation), it's an ideal device for controlling the volume of water spray.

The combustion chamber has been designed to increase turbulence and therefore provide better fuel-air mixing. The chamber is comprised of matching depressions in the piston and cylinder almost entirely under the exhaust valve (see photo).

Goodman says the car can be provoked to detonate, if you run it at full throttle for a long while and get the pistons really hot. "But that's a developmental problem," he says. "If I had oil spray on the piston, as Mercedes does in its turbocharged diesel, or a

spark sensor like the one on the Buick Regal, I wouldn't have it."

Advantages of the system

Increased performance, better mileage, and the ability to burn low-octane fuels without knocking are the benefits of this system, Goodman claims. "What you're doing," he says, "is using water as a replacement for lead. Lead will give you the power, because it will let you run a higher compression ratio, thereby increasing the engine's efficiency. But lead is a harmful pollutant, and the higher temperatures produce nitrogen oxides, another no-no. Water not only takes the place of lead; it also serves the function of EGR (exhaust gas recirculation), which is disconnected on Goodman's Fiesta. The result is more fuel economy: Running at a higher compression ratio, the engine uses less gas to do the same amount of work."

"Thermal efficiency in modern engines is almost nothing," he continues. "If car makers raised compression and used water injection, they could use a smaller engine, increase engine efficiency, and at the same time enjoy the benefits of a smaller, lighter car. Less weight not only translates into more mileage; it means that producing the cars would use less energy."

Why has water injection, which has been tried many times before, not been widely adopted?

The main problem, Goodman believes, has been finding a way to meter the water properly. "At 60 mph," he says, "this engine burns five or six quarts of gas and six ounces of water in one hour. It's hard enough to make the carburetor meter five quarts of gas in an hour, without trying to make it meter five or six ounces of water."

His two key solutions: the special
[\[Continued on page 159\]](#)

Finishing plywood

like the pros

Careful preparation and the right ply for the job spell success

By PAUL BOLON

Many home craftsmen have buried a perfectly constructed project under a poor finish. A professional cabinetmaker devotes as much attention to finishing as to construction. In fact, because the type of finish will influence the choice of materials and construction details, it's usually included in the first stages of planning.

Planning the finish is particularly important when you're working with fir plywood, where wild grain and exposed edge plies can create special problems. And a bonus comes with any good finish on plywood: It not only enhances the appearance of your project, but with properly sealed and protected panels, the finish will extend the project's life. (A fine finish will also impress the judges of PS's annual plywood contest. For rules and entry coupon, see PS, Nov. '79. They will be reprinted in next month's issue. Deadline for entering the contest is March 1.)

Where do home craftsmen slip up in finishing? Most often either the wood is not thoroughly prepared for the finish or the choice of finish is wrong. To complicate matters, there seems to be a limitless variety of finishing products, and the manufacturers' labels indicate that most of the products are okay for almost every job. But by observing some simple steps in preparing plywood and using specifically recommended finish products, you can follow a foolproof route to obtaining a great finish.

To minimize work, bring home the

best possible sheet of plywood from the lumber yard and handle it carefully throughout construction. At the lumber yard, give the faces and edges of each piece a quick examination before accepting. It makes no sense to buy extra work repairing damage from handling.

If you're buying plywood for a furniture project and planning a natural, or clear, finish, you'll want a sheet with an attractive, close grain pattern. Fir plywood's grain pattern is too wild to be attractive with a clear or stained finish, except in special applications.

Overlaid, or resin-coated, plywood will save labor if you plan to paint your project. Overlaid plywood is ready for painting and requires no sanding or other surface preparation. Textured plywood (board-and-batten or rough-sawn, for example) also needs no surface preparation, whether stained or, for an unusual effect, painted.

Care and preparation

If you must store plywood before using it, avoid exposure damage by putting it in a cool, dry place away from sunlight and weather. But get that first finishing coat on as soon as possible after your project is built; there's a definite relationship between the performance of the finish and the time the raw wood has been exposed.

The American Plywood Assn. recommends that all edges of plywood be sealed to minimize warping. Edge grain of plywood is the same as the end grain of lumber: It absorbs and loses moisture faster than the surface. (To seal wood means to cover or fill the pores and surface, creating a coating impermeable both to humidity and to the oils and chemicals of the wood.

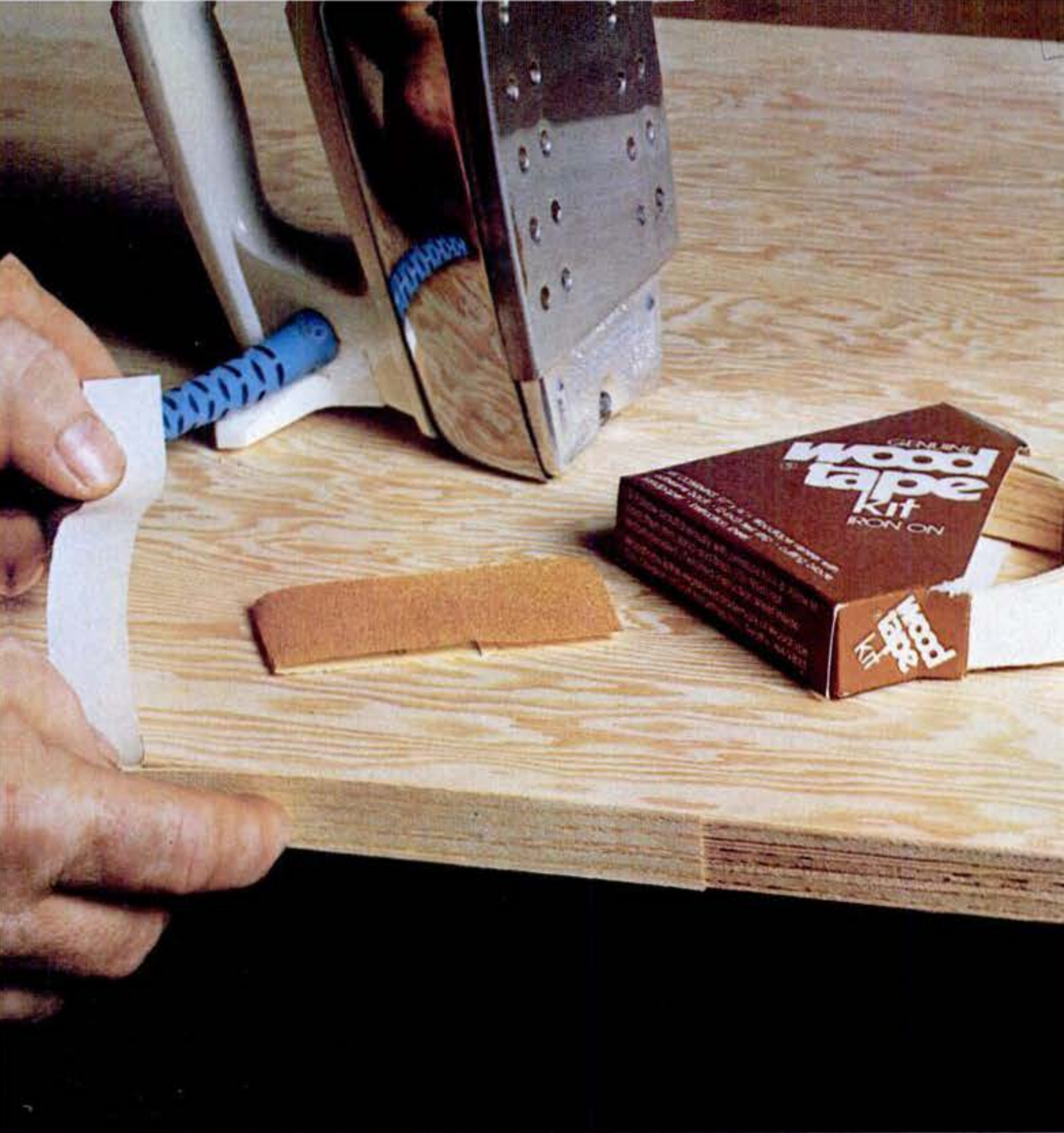
These oils might otherwise dissolve through a finish coat and discolor it. Commercial sealers are clear, fast-drying products. Urethane varnish and oil-base paints are also effective sealers.) To seal the blind edges of plywood before construction, stack the plywood pieces together with the ends flush and apply sealer to them all at once. If your interior joints and blind edges are glued as well as fastened with nails or screws, the glue will seal the edges. The exposed edges can be sealed when the rest of the product is finished.

Exposed edges can also be covered with strips of veneer, which come in rolls available at lumberyards and hardware stores. The veneer is usually glued to the plywood with contact cement. But you can also buy rolls of veneer with preapplied adhesive backing. Wood moldings are available in several woods and many decorative designs to accent edges. Moldings are usually glued and nailed on.

After your project is assembled, all dents, countersunk nail and screw holes, and voids in the edge grain should be filled with wood putty. Also, fill all knots, pitch streaks, and sap pockets, and apply a coat of sealer over the area. If you plan a clear finish, use a putty that matches the color of the wood. Plaster spackling works well for indoor projects that are to be painted. The surface must be completely smooth before applying any finish.

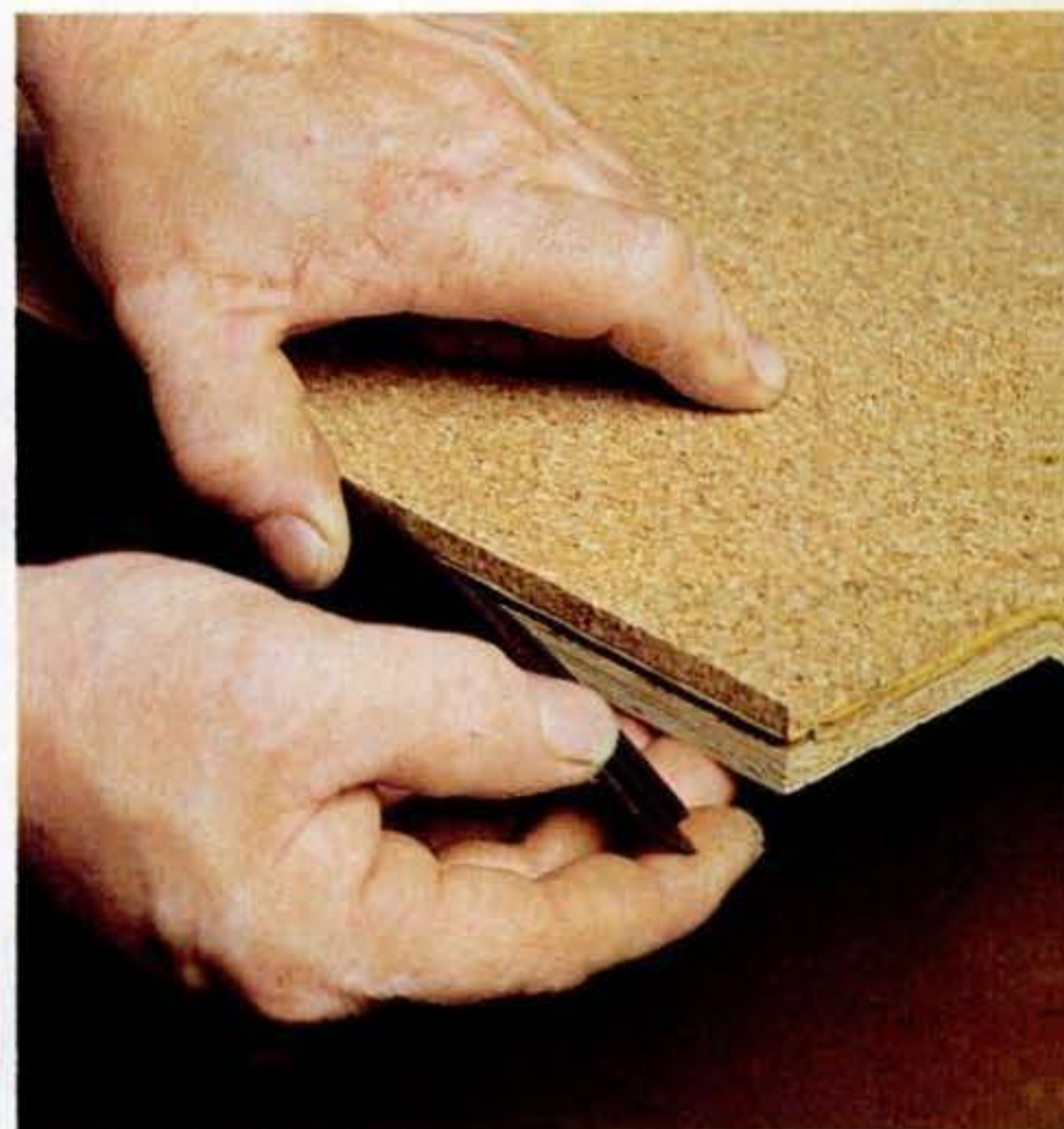
For handsome and long-lasting results, immediately prior to brushing on any liquid finish, plywood should be sanded lightly with 180- or 220-grit finishing sandpaper and the dust cleaned off. Putty repairs can first be sanded with 150-grit sandpaper.

Continued



T-molding fits neatly into a saw kerf cut in the edge for well-anchored edging.

Adhesive-backed, peel-and-stick wood veneer is the easiest method to use for finishing plywood edges.



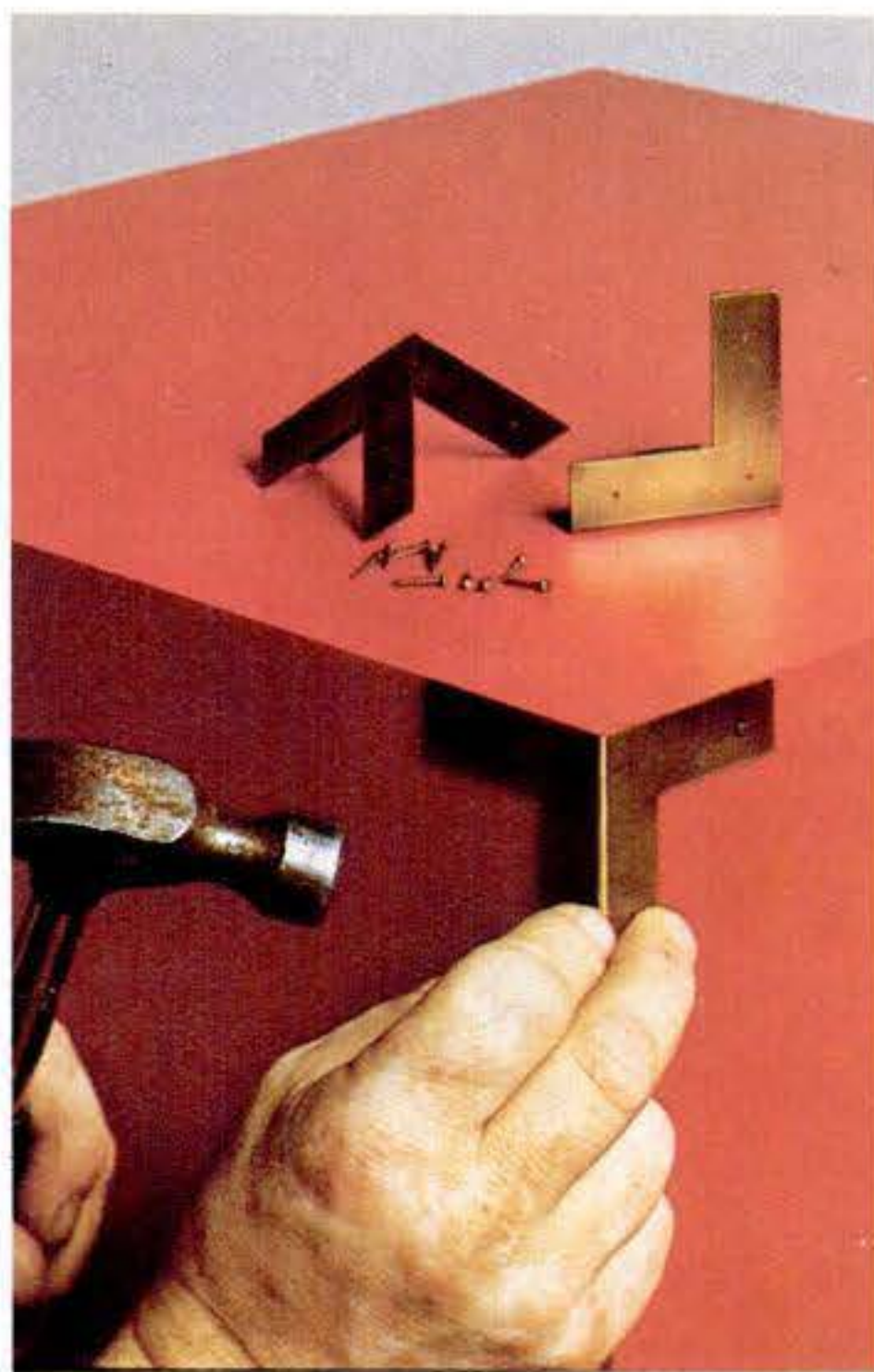
Cork is functional option as surface treatment for plywood. To mask the exposed edges of the sandwich, decorative T-molding is pressed and glued into a saw kerf (see above).

Plastic laminate as plywood surface treatment should be aligned, using dowels as spacers after contact cement has set.

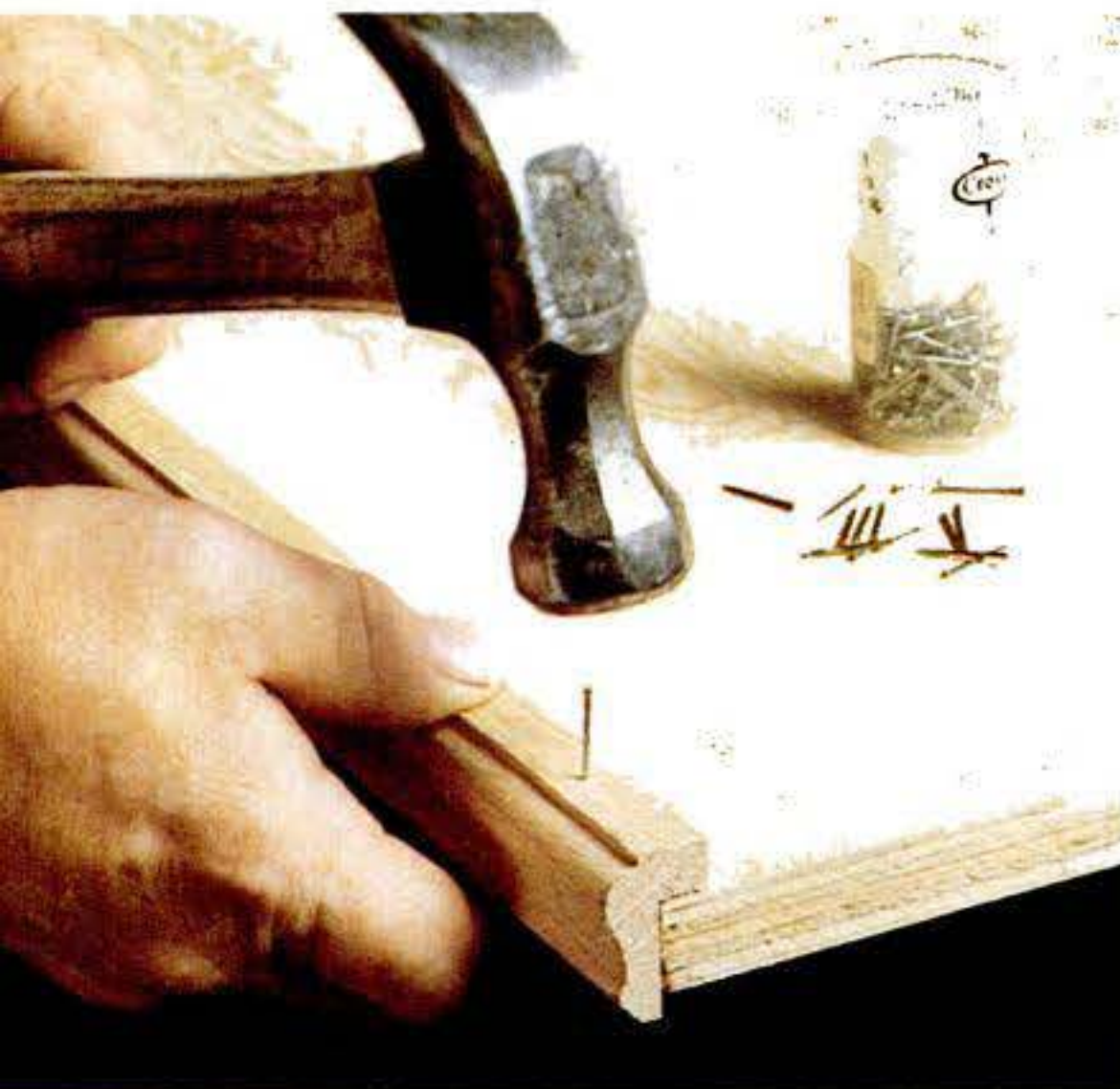




Sturdy brass-plated corners or double-L's are ideal for sprucing up a finished project



like this toy box. They protect plywood corners from chipping, too.



Panel molding glued and nailed on an exposed edge provides an attractive lip.



Decorative molding can be stained to match the surface, for a carved effect.

If you plan a natural finish and there are scratches that require heavier sanding, you can begin with a coarser paper, say 100 grit. Once the mars are smoothed by the coarse paper, resand with finer grits in steps not exceeding two grit sizes per step. For instance, if you began with 100 grit, successive sandings with 120 and 140 are required before that final light sanding that precedes the finish. Edges require block sanding, beginning usually with an 80- or 100-grit paper. Be sure to sand off glue spots around joints.

Interior finishing

Two coats of most finishes are adequate, three are better. Any exposed edge grain should be given an extra first coat. Between finish coats, touch-sand with 220 sandpaper. Interior and

hidden surfaces should have a single coat of finish to seal them.

Oil-base paint is recommended for interior projects. Not only does it produce a durable and easily washed surface, but most oil-base paints are self-priming, which saves buying two products. Two coats of paint required can be brushed, sprayed, or rolled on. For most projects you will want the shiny finish of a semigloss or high-gloss enamel paint.

Some high-gloss enamels are relatively thin-bodied. These need a heavier-bodied priming coat that will produce a smooth surface with a single application. This avoids repeated coatings of the thinner enamel. Textured plywood may be finished with latex paint for indoor projects.

Frequently, spots that need additional filling or spackling appear after

the first coat of paint is applied. Fill them, sand, and cover only the repair with one or two coats of paint prior to the project's final coat. For the most natural-looking finish on regular or textured plywood, apply two coats of clear sealer. Sealer comes in a range of flat to high-gloss finishes. And bear in mind: Exposed, well-sanded edge grain or quality plywood can look fine with just a clear sealer, if this effect is compatible with the design of the project.

If your project has repairs or grain not attractive enough for a clear finish, but you wish to have some kind of natural finish, there are two solutions: The easiest method is to darken the wood with a mixture of companion stain and a clear, nonpenetrating sealer. Practice on scrap to get the desired amount of color in the sealer, and then mix enough for one coat. Final coats should be clear sealer.

Another way to mellow the grain requires whitening the wood with pigmented resin sealer. The longer this sealer is left on the wood, the whiter and more opaque it will finally be. For even coverage, wipe all excess off while it's still wet. After it's dry, apply clear sealer and finish off the work with a coat of satin varnish or brushing lacquer.

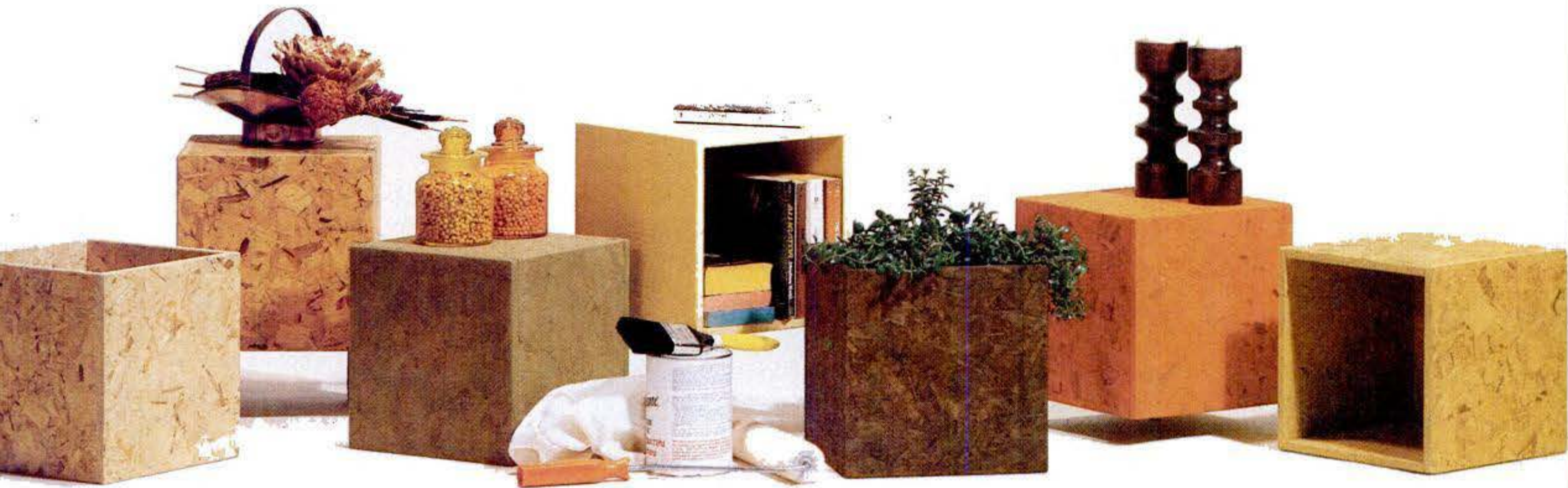
Stain alone is rarely the way to finish an indoor project. It often does not obscure a wild grain at all (it may even accent it), and it has a dull surface. Changing fir to mahogany is a kind of alchemist's trick, and the results look like colored fir rather than mahogany.

Exterior finishing

For textured plywood siding you may want to try an exterior semi-transparent (often called penetrating) stain. It will penetrate the surface but allow the desirable grain and texture to show through. Oil-base stains are recommended. If you prefer to emphasize the texture alone, use an opaque stain that will obscure both knots and repairs. Use a brush to work the stain into the wood. Properly applied, both semi-transparent and opaque stain produce a surface that will weather and refinish without preparation. There are also clear sealers for outside projects.

To paint your exterior project, select an acrylic-latex exterior house paint with companion primer. This minimum two-coat system (one coat primer, one top coat) is essential. The primer is always the most important of the two. To avoid later difficulties, a stain-resistant primer is a must. Two top coats will give significant improvement to the life and performance of the finish. P 5

How to make the most of new-generation particleboard



Dramatically textured waferboard has a variety of looks, depending on the finish. The panels come lightly sanded or unsanded.

It's great stuff—if you handle it right. Second of two parts

By FRANKLYNN PETERSON and JUDI R. KESSELMAN

As the price of lumber soars, more home carpenters are turning to the new particleboards. And lower cost isn't their only attraction. As PS reported last month, lab research has developed some exciting new products, including the handsomely textured waferboard shown here. And old standbys such as hardboard and the original pressed-sawdust type of particleboard are being used in a variety of new ways.

In today's construction industry, there are several well-defined areas where manufactured woods—hardboard, particleboard, and waferboard—are used. But there's a problem. Do-it-yourselfers who grew up knowing instinctively how to work with pine boards and plywood don't always know how to use the newer manufactured boards. Since the professional construction market consumes almost all of their existing output, particleboard manufacturers

(with the exception of the Masonite company) have not yet concentrated on supplying do-it-yourselfers with detailed information. So we've surveyed manufacturers and large users of particleboards and combined their advice with our own experience in using these products.

We've extracted guidelines from industry literature and cross-checked them against building codes. The prices quoted are for four-by-eight-ft. sheets as listed in the catalog of a large Midwestern building-supply dealer. Mills generally manufacture a wider variety of sizes, but these usually require a special order.

Versatile hardboard

Often known as Masonite, one of its trade names, hardboard is a tough, economical, and easy-to-finish product. It's used for drawer bottoms and separators, cabinet backs, sliding cabinet doors, underlayment for rough but structurally sound floors, and wherever a relatively flexible material is called for. Tempered hardboard is suitable for exterior applications such as fences, windbreaks, and soffits.

Some hardboard siding panels are rated by local building codes for nailing directly to studs without any addi-

tional sheathing. And the familiar prefinished wall panels are often adequately fire-rated and strong enough to use instead of plaster or gypsum board.

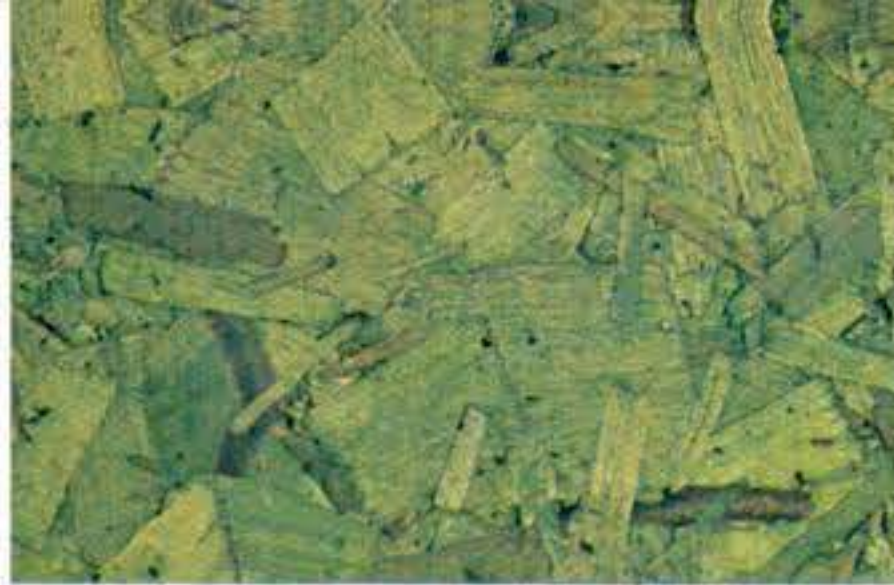
A 1/8-in.-thick sheet of hardboard costs about \$4.50; a 1/4-in. sheet, \$6.25. Also available are four-by-four-ft., 1/4-in.-thick pieces for underlayment for about \$2.80.

Economical particleboard

A medium-strength, very inexpensive building material, the original type of particleboard is used almost exclusively in interior applications. The mobile-home industry uses it extensively for floors and other structural units, though home craftsmen have used it only for underlayment until recently. But, now, many have discovered its value for shelves, cabinets, desks, and counter tops [PS, Dec. '72]. Because of its bland tan appearance, most people either paint it or cover it with Formica, vinyl, or wood veneers.

A 1/2-in.-thick interior-grade sheet of particleboard costs about \$10.50. It's \$13 for a 5/8-in. sheet, and \$14.50 for a 3/4-in. one. For about \$16 you can get 3/4-in. sheets graded for exterior

Continued



1 Green resin stain



2 Orange wiped finish



3 Purple two-tone



4 "Hot pink" two-tone



5 White antique two-tone



6 Deep red two-tone



Unusual wall units, made from waferboard panels, are finished with a thinned

wood-tone enamel, wiped down to highlight the chips. (See directions below.)



Waferboard panels transform ordinary doors into a dramatic entrance. A subtle wiped finish enhances textured panels.

Dazzling spectrum of finishes (left) shows only a sample of waferboard possibilities. For the first finish, apply one coat stain, and wipe down with a clean rag to even out color. Next finish takes a coat of thinned orange enamel (two parts to one part thinner). Wipe till wafers show plainly. For two-tone effects, base coat must dry for three days before wipe coat is applied. The purple two-tone takes one coat of thinned (3:1) purple enamel and a wipe coat of purple paint thinned to same proportions. Hot pink requires one coat of 3:1 thinned violet enamel, and a similarly thinned coat of vermilion paint. For the antique-white finish, apply two coats of interior, low-luster white enamel. The wipe coat is a mix of one ounce raw umber and one pint slightly thinned white paint. The red two-tone takes one heavy coat of high-gloss red enamel and a wipe coat of black enamel mixed with equal parts thinner. All finishes are for interior use. The most protective exterior finish is a good-quality exterior paint.

use. Particleboard also comes precut in useful sizes and as shelves (\$2.50 per 3/4-in.-by-12-in.-by-eight-ft. piece) and stair treads (50¢ per linear foot).

Intriguing waferboard

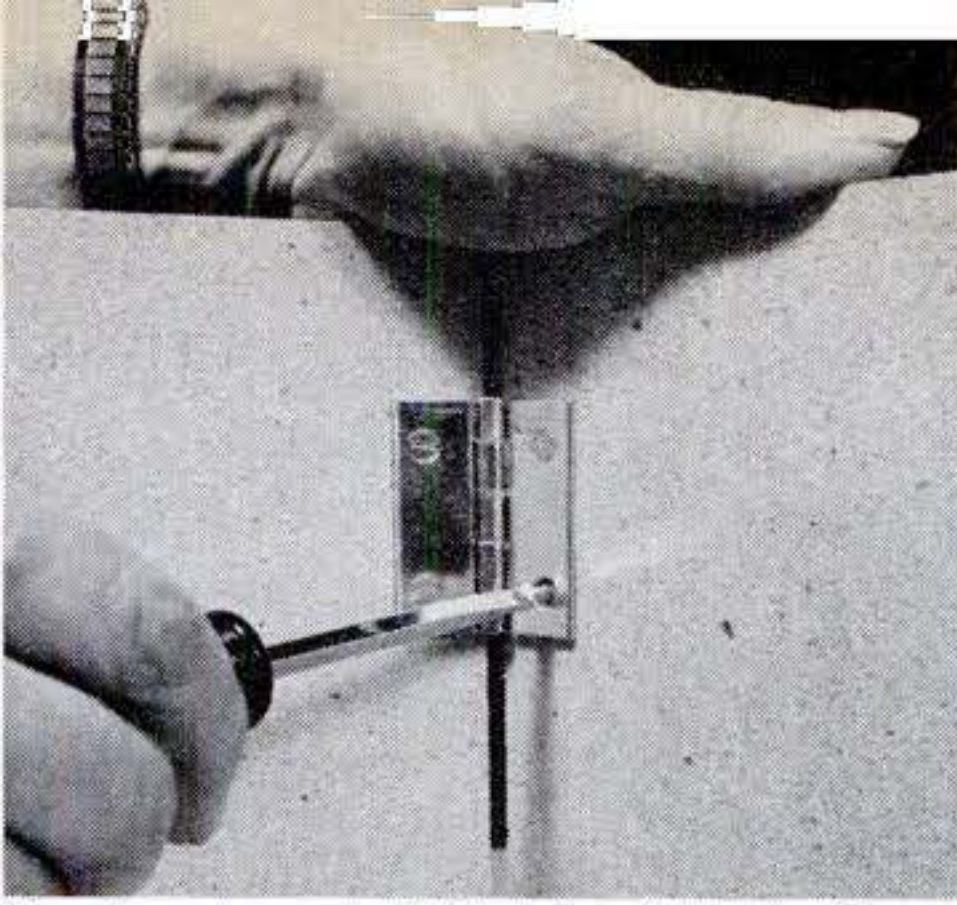
The wild, though tamable, pattern of wood chips is not waferboard's only attraction. It's much less expensive than interior AD plywood and competitive with most exterior siding and interior wall paneling.

Most building codes have accepted waferboard as a substitute for plywood sheathing on roofs and walls. The price is steadier than that of always fluctuating plywood, which means waferboard is sometimes a dollar or two cheaper than CD-X plywood, sometimes a bit more expensive. But it's always free of knots, edge gaps, and other imperfections found in CD-X plywood.

So far, waferboard is available under two trade names, Blandex and Aspenite, although other brands may soon appear. It comes in 1/4-in. (\$5.25), 3/8-in. (\$7.75), and 7/16-in. (\$8.50) exterior-grade sheets. In some areas, Aspenite is also available with a lightly sanded surface, for a softer look. There are also two specialty products available: Aspenstripe (\$3.80), a panel grooved every eight inches, and Aspenplank (\$3.80), one that's grooved in reverse board-and-batten style. Both panels have exterior ratings but they are often used for dramatic interiors.

Working with particleboards

Ordinary saws, routers, sanders, and similar tools work well on all particleboards, but for extensive cutting or shaping, carbide-tipped tools are definitely a better choice. The gritty



For the strongest joints in all types of particleboard, use sheet-metal screws (above). Boards can be cut or sanded,



or routed like any other wood. Carbide tools will keep an edge longer; Surform tools and sanders also work well.

insides of particleboard can be murdered on non-carbide-tipped tools. (The grits are equally hazardous to your eyes. Wear goggles.)

With power saws, it's important to expose only enough of the blade to penetrate the thickness of the board. Otherwise, you risk chipping the board's underside and could ruin your project. Use a combination-type blade on your power saw. If you're working with prefinished products, saw from the *back side* with a power saw, but from the front by hand.

Before using waferboard structurally, check to make sure your locality has accepted the national building-code approval of waferboard. For roof or wall applications, some codes require that waferboard be $\frac{1}{16}$ in. thicker than the required thickness for plywood sheathing. The Department of Housing and Urban Development (HUD) allows $\frac{3}{8}$ -in. Blandex on studs at 16 in. on center or 24 in. on center. For roof sheathing, $\frac{3}{8}$ in. is accepted at 16 in. on center, but $\frac{7}{16}$ -in. Blandex is required for 24-in.-on-center spacing.

Assembly

Common nails are fine for waferboard construction, but don't use finishing nails—their heads pop through too easily. When using waferboard for cabinets or wall panels where the nails may show, use ring-shank nails coated in a color that will camouflage the nails among the flakes.

Both hardboard and particleboard have limited nail-holding powers and require ring-shank nails for most building construction. The best way to install hardboard or particleboard is to apply construction cement or a white glue (such as Elmer's) to the wooden supports before hammering in the nails. To assemble particleboard pieces into shelving and furniture, you can simply glue the pieces together after sandpapering edges to remove chemical impurities left over from pressing. Since the glue is doing most of the work, you can, in this case, hold the glued parts together with finishing nails. Set them slightly and fill the holes with a neutral wood paste.

Another way to assemble particleboard parts is with sheet-metal screws. Choose a size narrower but longer than you'd use on natural wood or plywood. You can countersink their heads, but only slightly. Unless you really need a knockdown capability, glue is really the best choice for assembly.

You can use almost all of the traditional cabinetmaker's joints for particleboard construction, but the brittleness of the material may make you wish you'd never tried. Be sure to test out your favorite rabbets, tenons, and mortises on pieces of scrap before cutting into your good materials. Technical Bulletin #8 from the National Particleboard Assn. (see "For Further Reading") puts almost all classic joints out of the do-it-yourselfer's league, except for the simple mitered joint—and even there the association recommends that you beef up the joint with a spline.

Another in the same series of bulletins should help prevent a lot of headaches. Bulletin #4 has a series of graphs to help you calculate how thick your particleboard must be, and how close together to place the supports. The graphs take into account the kind of loads the shelves will carry, and indicate the acceptable amounts of deflection for varying shelf lengths and thicknesses. The bulletin even notes how shelf finishes affect deflection. Self-stick vinyl, for example, won't alter the figures, but a Formica-type laminate will add a degree of stiffness.

Finishing the boards

Particleboard edges require some puttying, but aside from that, finishing manufactured boards can be a joy. Most of them, in fact, require less sanding than pine, hardwood, or plywood.

Use a paste wood filler and a putty knife to plug any spongy-looking edges you've left exposed in your project. Then sandpaper the edge, making sure not to sand away too much of the filling. Now you can finish the edge along with the other sur-

faces. Another option: You can stick a strip of veneer or vinyl to the exposed edges.

Clear varnishes will leave particleboard still tan-colored but with a bit more character, since the finish will penetrate more deeply into more porous areas. You can stain the project, too, before applying a clear finish. Stains penetrate deeper and faster into particleboard than into most wood, so always test your stain on scrap.

For best results with enamels, coat the whole surface with a wood filler first. Otherwise, you won't get the high sheen most people prefer in enameled finishes.

Hardboard requires a sealer for both clear and pigmented finishes, and clear finishes often work best after you use a filler as well. You can experiment with stains on hardboard, too, if you're looking for rich and unusual tones.

When you're working with free-standing pieces of hardboard or particleboard—such as doors, fences, and dividers—you have to apply the same finish to *both sides*, even if one side won't normally be seen. Otherwise, one side may absorb more moisture than the other and become warped.

There are three basic types of painted finishes for waferboard. For a solid-color finish, you can apply a good-quality paint according to directions. The result will be a slightly textured, matte look. Or you can do a wiped finish, with a single color paint or resin. Finally, you can produce a handsome two-tone finish by wiping on a second color that lodges between flakes to give an exotic shaded effect. Several combinations are especially handsome (see samples and directions on preceding page), but there are probably many more effects waiting to be discovered. [3]

FOR FURTHER READING

American Hardboard Assn., 20 N. Wacker Dr., Chicago IL 60606: "Today's Hardboard . . . Building Better than Ever."

Building Products Information Department, **Georgia-Pacific Corp.**, 900 S.W. Fifth Ave., Portland OR 97204: "Help with Hardboard and Particleboard"; "Georgia-Pacific Particleboard Shelving."

Corporate Communications, **MacMillan Bloedel Ltd.**, 1075 W. Georgia St., Vancouver, B.C., Can. V6E 3R9: "12 Fences You Can Build with Aspenite Panels"; "Easy to Build Garage or Carport"; "Truck Canopy"; "Aspen-grove Cottage Plan"; "Garden Shed and Snowmobile Shelter"; "How to Build Your Own Contemporary Aspenite Leisure Home."

Masonite Corp., 29 N. Wacker Dr., Chicago IL 60606: "Re-siding Styling Guide."

National Particleboard Assn., 2306 Perkins Pl., Silver Spring MD 20910: Bulletin #4—"Particleboard Shelving Design" (50¢); Bulletin #5—"Edge Filling of Particleboard" (20¢); Bulletin #6—"Sawing Particleboard" (20¢); Bulletin #7—"Edgebanding and Veneering of Particleboard" (20¢); Bulletin #8—"Joints Used with Particleboard" (20¢); Bulletin #12—"Sanding Particleboard" (20¢); "Painting Particleboard" (20¢); "How to Install Particleboard Floor Underlayment" (20¢); "Story of Particleboard" (40¢); "28 Ways to Use Particleboard" (40¢); "References to Particleboard by Building Codes Regulatory Agencies" (\$2); BB-1—"Particleboard/MDF Shelf Systems" (5¢); BB-2—"Particleboard for Stepping" (5¢); UM-70—"Particleboard Interior Stair Treads" (HUD) (20¢).

Solid-fuel alternatives

— besides wood,
what else can you burn
in your wood stove?

Compressed-wood logs and pellets, lignite briquettes, and coal could replace costly firewood

By **JASON SCHNEIDER**
PHOTO BY ORLANDO GUERRA

With wood-burning stoves now replacing swimming pools as suburban status symbols, the time has come to look at some of the alternatives in solid-fuel heating. For despite its many advantages, wood is not without its drawbacks as a fuel.

Besides its inconvenience compared with oil and natural gas, the price of firewood has increased dramatically in recent years. Prices for cords of seasoned hardwood from dealers now typically range from \$75 to \$150. And as more wood burners have joined the ranks, demand has outstripped supply in some areas.

State and privately owned forest lands might provide some relief, but, since wood is a low-density energy source, it seldom makes sense to transport it over great distances.

In short, while wood remains a viable heating fuel for many Americans, the rest of us should consider some of the alternatives. Granted, the fuels I'll talk about cost money—more money than fueling and servicing a chain saw and gassing up the pickup. But at least they're available. And several of them promise to be available at reasonable cost in the future as the oil crunch and the wood squeeze continue.

Specifically, solid-fuel alternatives range from new waste-wood products, including compressed-wood logs and the somewhat exotic Woodex and Coalex pellets, all the way down to the coal we thought we'd never heat

homes with again—and to coal/wood combinations. While few of these fuels (except coal) can presently compete with firewood on a dollars-per-Btu basis, all offer convenience advantages and are suitable as an emergency fuel for wood-stove owners. And all of them can be burned in most existing wood or coal/wood stoves. (If you're only now considering the purchase of a wood stove, don't despair: Consider a unit that will burn both wood and coal. A buyer's guide follows this article.)

Woodex and Coalex

Woodex is the trademark for a pelletized fuel created from "fibrous organic material" that has been compressed at high pressure (about 18,000 lbs/sq. in.) and relatively high temperature (400–500 degrees F). Individual pellets (see photo) are ¼ in. dia., about ¾ in. long, and can be produced from virtually any organic vegetable material rich in cellulose: Wood chips, sawdust, bagasse (sugarcane residue), and corn husks are a few examples. Woodex pellets have even been successfully made from organic garbage. A pound of Woodex yields approximately 9000 Btu—about halfway between seasoned hardwood at 6800 Btu per pound (net) and high-grade anthracite at around 14,000 Btu per pound. And significant quantities can be manufactured by using only a fraction of the estimated 150 billion tons of fibrous waste generated worldwide each year. It is hardly surprising that its creator, Bio-Solar Research & Development Corp., claims that Woodex could go a long way toward replacing fossil fuels as energy.

In the actual manufacture of Woodex, fibrous organic material is first pulverized to about the consistency of

face powder, moisture is reduced to approximately 12 percent (this can be varied to suit the burning condition), and the dried particulates are forced through a standard pelletizing mill. This patented process, combining high pressure, relatively high temperature, and the presence of moisture, "shifts the molecular structure of the biomass, making all the natural carbon more available for combustion," according to Bio-Solar chemists.

The wood-based pellets I examined are dark brown and smooth and shiny on the outside because, according to Bio-Solar, "the waxes and lignites have been driven to the outside of the pellet and the cellulose in the wood partially broken down so that heat energy can be released more readily." Other advantages of this manufactured fuel include low particulate emissions, very low or no sulfur content, low ash (approximately three percent) which, like wood ash, can be used as a soil conditioner, and suitability for use in existing industrial furnaces and boilers.

But can Woodex be burned in residential stoves and central heating systems? Yes, but with some important qualifications. First, since Woodex pellets burn at around 1500–1800 degrees F, it can only be burned in stoves with insulated linings (such as firebricks) or well-made "airtight" cast-iron units. And while Woodex can be used alone, the results of my tests suggest that it is easier to maintain a steady heat output if Woodex is burned together with wood or coal—particularly when it's used in a manually controlled "airtight" stove.

Crushed newspaper or kindling can be used for ignition, and once Woodex is burning it will continue to burn until the fuel is consumed. Since the pellets are quite small, a grate adapter



Fuel for thought: CoalLog compressed-wood cylinder holds seven lbs. of bituminous coal. Each log contains 90,000 Btu, costs \$2.49. Ucofo Fire-Bricks are compressed lignite; 16-brick package delivers 164,000 Btu, costs \$3.50. Woodex (light-color pellets in foreground) is compressed organic waste such as Douglas fir

(light-color pile at right). It contains 9000 Btu/lb., costs \$40–\$50 a ton. Coalex (two piles of dark pellets) combines pulverized coal (dark piles) and wood waste, contains 10,000–12,000 Btu/lb. Compressed-wood Aglo Firelogs give 8500 Btu/lb. A 12-lb. package with starter stick costs \$1.50–\$3.50.

(or finer grate) is necessary when burning Woodex in a wood/coal or coal stove. Otherwise, the burning pellets will drop through the grate and burn in the ash pit or ash drawer.

With a projected at-plant price of \$40 to \$50 per ton, it appears that, in terms of economics and pollution, Woodex has a bright and glowing future. However, it is doubtful that it will attain its full potential as a home-heating fuel until units specifically designed to burn it are readily available and/or it is marketed in larger sizes for more convenient loading.

Add pulverized coal to pulverized biomass such as wood waste, mix it together and process it in the same manner as Woodex, and what have you got? Coalex. This fuel contains 10,000 to 12,000 Btu per pound, but what about pollution? According to

preliminary tests conducted by Bio-Solar, this mixture burns with the same low particulate emissions as Woodex, and sulfur contained in the coal component tends to remain in the ash rather than being released up the chimney. According to Bio-Solar, Coalex emissions are well within EPA guidelines. But it's still in the development stage, says Bio-Solar, and is not yet commercially available.

Compressed-wood logs

As the name suggests, these are produced by compressing or "densifying" under high pressure wood waste such as logged wood, wood chips, or (less commonly) coarse sawdust. Such cylindrical logs differ markedly from what are known in the trade as "cosmetic" fireplace logs in which fine sawdust and waste paper are molded

into a loglike form by adding combustible binders such as waxes and various chemicals such as copper sulfate to provide colorful flames. While cosmetic logs may burn for a few hours at a time and often produce a satisfying visual display, they must never be burned in closed stoves of any kind (makers' directions are universally specific on this point). So they cannot be regarded as a serious source of heat, despite their often high heat value (15,000 Btu per pound).

The original compressed-wood log on the U.S. market was the Prestolog, produced in the U.S. since the '20's by several manufacturers. A more recent development in compressed-wood logs that is also intended as an economically viable heating fuel is the Aglo Firelog manufactured by Agnew En-

Continued

Coals with one-half percent of sulfur or less

State	Bed or field	Sulfur content (%)	Ash content (%)	Btu/lb.
Alabama	Helena	0.4	7.4	13,660
Colorado	Keystone	0.3-0.4	5.4-9.2	13,120
Colorado	Campbell & Seymour	0.2-0.4	3.9-7.8	10,080
Montana	Canyon	0.3	4.6	9,088
New Mexico	Standing Rock	0.5	5.2	11,050
Oklahoma	Croweburg	0.4	4.7	12,556
Pennsylvania	Ashland/Mammoth	0.5	6.9	13,540
Utah	Soldier Canyon	0.5	7.5	13,158
Virginia	Tiller	0.5	5.0	14,200
Washington	Springbrook	0.4	5.6	11,060
West Virginia	Pocahontas #4	0.5	5.0	14,600
Wyoming	Dietz #3	0.5	4.4	9,710

Note: This is a sampling, not complete list. Coal varies within a seam.

vironmental Products, Inc. (see photo). These 10-in.-long, three-in.-diameter logs come in four-log, 12-lb. packages along with a six-in.-long wax-impregnated "starter stick." Using Douglas fir as the base, Firelogs produce about 8500 Btu per pound.

I can confirm the manufacturer's assertions that Aglo Firelogs burn with little or no visible smoke, kindle easily in the normal manner when the starter stick is used, are capable of long (eight to 12 hour) burns in a variety of conventional wood stoves when two or more logs are used, and leave a very low amount of ash residue. Retail prices of Aglo Firelogs vary greatly around the country: \$1.50 to \$3.50 for a four-log package.

Coal

Low-sulfur anthracite coal is, in many ways, a more convenient fuel than wood, and, if burned properly in the appropriate appliance, it compares quite favorably with oil in economic terms and in terms of pollution, too.

The ideal stove or furnace coal should be of a uniform size recommended by the heater manufacturer; it should have an ash content of 10 percent or less; and it should have a high ash-fusion temperature (preferably above 2500 degrees F) to prevent clinkers (fused ash or metallic slag)

How fuels compare

Use this chart to compare the heat content of various fuels. Check fuel prices in your area for cost comparison. Each quantity shown contains 140,000 Btu.

No. 2 heating oil	1 gal.
Natural gas	140 cu. ft.
LP gas	1.5 gal.
Electricity	41 kWh
Coalex	11.6-14 lbs.
Anthracite coal	12.7 lbs.
Woodex	15.5 lbs.
Lignite briquettes	15.5 lbs.
Compressed fuel logs	16.4 lbs.
Seasoned hardwood (20% moisture)	24.1 lbs.

from forming too readily at high heat-output settings, thus blocking the grate. The greatest advantage of anthracite coal over wood is that it is a much more compact energy source, yielding almost twice as many Btu per pound as seasoned hardwood (see table below).

The oldest and most common form of packaged coal product is bagged anthracite or bituminous coal. It's offered in 50- and 100-lb. reinforced-plastic or canvas bags at hardware stores. The primary advantages of bagged coal are that it's easy to carry and convenient to store. But these conveniences don't come cheaply: Bagged coal generally costs between \$4 and \$5 per 50-lb. bag, or \$160 to \$200 per ton.

Another variation on the packaged-coal theme is the CoalLog, a 17-in.-long, 5½-in.-dia. cylinder (see photo) made of compressed-wood chips and containing seven pounds of high grade, low-sulfur (one percent), bituminous coal. Each log contains approximately 90,000 Btu of potential heat energy, and is designed to burn three to five hours in an open fireplace.

I tried burning a few CoalLogs in a cast-iron wood/coal stove with a cast-iron shaker grate and updraft combustion pattern. Under these conditions, the logs ignited easily and burned for six to seven hours, delivering a steady heat output. My sole reservation is that during the first half hour after ignition I could smell a moderately strong coal odor outdoors. Since bituminous coals have a higher volatile (combustible gas) content than the anthracites, I recommend burning them only in stoves or heaters with efficient, well-articulated secondary combustion systems. With a suggested retail price of \$2.49 each, CoalLogs are considerably more expensive than bagged or bulk coal.

Lignite briquettes

Lignite is sub-bituminous coal yielding about 8000 Btu of heat en-

ergy per pound. Ucofo Fire-Bricks (see photo) are brown lignite dried and compressed into brick form, which increases their Btu-per-pound content to about 9000. Individual 18-oz. bricks measure about six in. long, 2¼ in. deep, and 1⅞ in. high. These West German-made bricks are available in packages of 16 bricks (18¼ lbs.) and 44 bricks (55 lbs.) for "household convenience and easy storage."

Perhaps the most significant advantage of this particular type of lignite briquette is its extremely low sulfur content—0.12 percent, according to Pasvalco, the U.S. importer. This would place it well below domestic anthracite and bituminous coals in what is regarded as the most ecologically damaging of chemical pollutants. In addition, lignite briquettes are definitely less dirty and dusty to handle than coal; clinkers and slag are virtually nonexistent; and ash is minimal—about five percent by weight. One of the few negative points of these European fuel bricks is their relatively high cost: \$3.50 for 16 bricks and \$9 for 44.

Although lignite briquettes were originally designed as a low-pollution "smokeless fuel" for coal stoves, they can also be burned readily in most grateless wood stoves, provided they're placed atop a reasonably lively bed of coals. And unlike coal, which often gives off a slight to moderate odor when an area heater is freshly stoked, lignite briquettes are virtually odorless.

Coalwood bricks

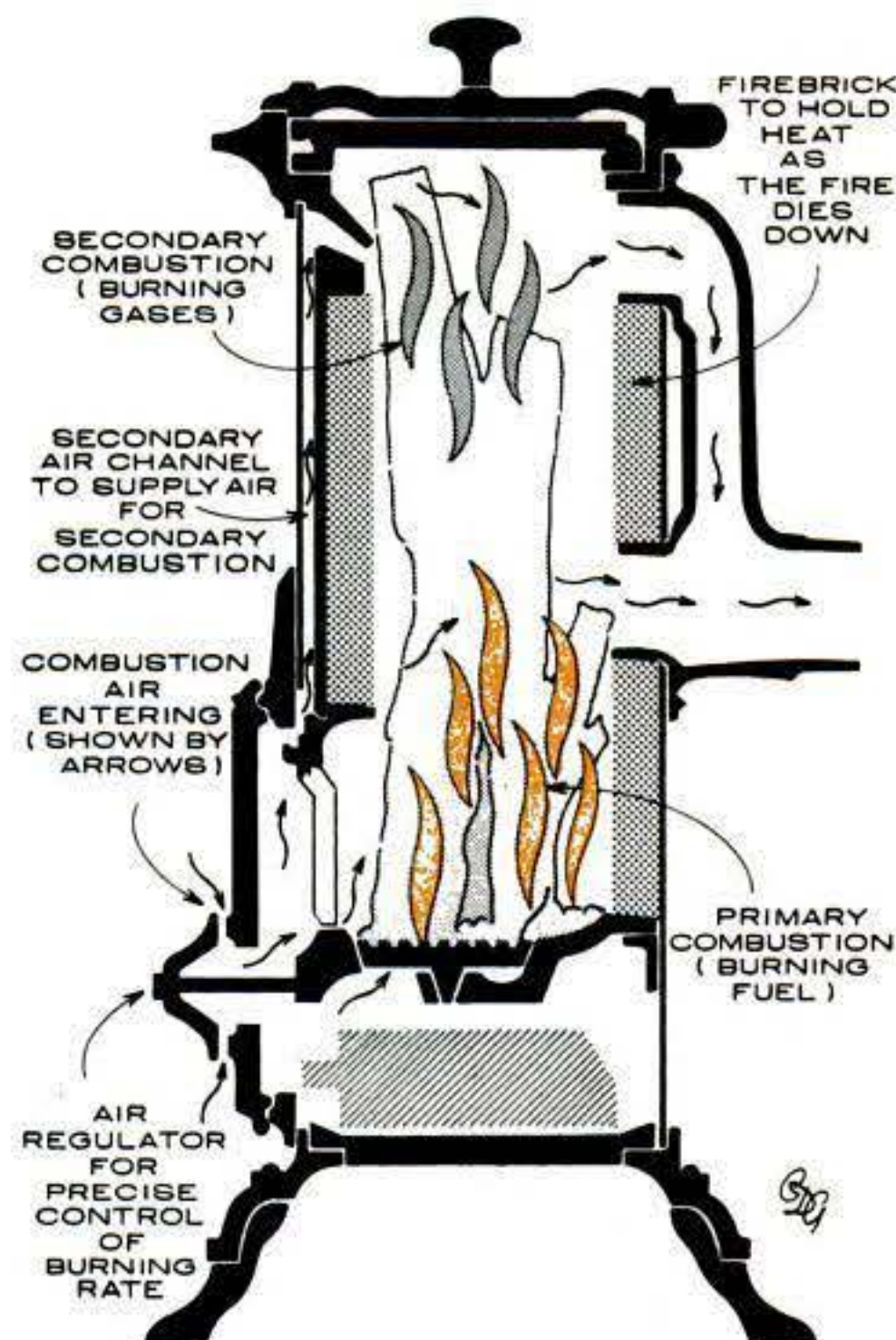
Coalwood "fireplace and stove fuel" is a combination of ¼-in. by ¾-in. hardwood chips and low-sulfur bituminous coal chunks of approximately the same size. The chips and chunks are held together by an "organic resin" binder and cold-molded directly into a four-brick box. Each three-by-three-by-six-inch brick contains about 25,600 Btu, and the four-packs will sell for about \$1 each, according to National Coalwood Products Co. Since the coal component contains only about 0.6 percent sulfur (well under EPA limits), pollution should be minimal. The shiny black bricks are clean to the touch and provide a good "flame effect"—important to owners of stoves with fire-viewing windows. The manufacturer says that the bricks will be offered in larger "economy packs" in the future. P 5

FOR MORE INFORMATION

Aglo Firelogs: Agnew Environmental Products, Inc., Box 1168, Grants Pass OR 97526. **CoalLog:** St. Bernard Coal Co., Louisville KY 40204. **Coalwood:** National Coalwood Products Co., 2170 Alum Creek Dr., Columbus OH 43213. **Ucofo Fire-Bricks:** Pasvalco, 400 Demarest Ave., Closter NJ 07624. **Woodex and Coalex:** Bio-Solar Research and Development Corp., 1500 Valley River Dr., Eugene OR 97401.

Buyers guide to coal/wood stoves

Most wood stoves are capable of burning compressed-wood logs and Wood-ex pellets quite efficiently, particularly if the latter are used along with firewood. And though compressed-lignite briquettes are technically a variety of coal, these too will burn readily in most grateless heating units. But the most flexible approach to heating with solid fuel, especially in regions where firewood is expensive or in short supply, is to opt for a stove or furnace capable of burning coal as well as wood. While some are equally suited to burning both fuels, most dual-fuel units are primarily designed for one or the other, while providing adequate but less efficient and/or convenient service with the alternate fuel. But happily there are wood/coal stoves on the market capable of burning either fuel efficiently without frequent tending. Nine are described here.—*J.S.*



Cylindrical, top-loading Petit Godin No. 3721 coal/wood stove has been manufactured virtually unchanged in France for more than 90 years. Like most stoves of this type, it is a base burner with an updraft combustion pattern (cutaway). The stove accepts logs up to 20 in. long. Claimed heating capacity is 10,000 cu. ft. with wood, and 14,000 cu. ft. with coal, with 24- to 30-hour burns when loaded to its 60-lb. capacity. Bow and Arrow Stove Co., 14 Arrow, Cambridge, Mass. 02138.

Multi-fuel boiler

Riteway's brand-new model RB-75 boiler is designed to burn coal or wood in a gigantic 11.7-cu.-ft. combustion chamber, and oil, natural gas, or propane (depending on burner fitted) in a separate chamber. The RB-75 is rated at 75,000 Btu/hr., making it suitable for average-size homes. It accepts logs up to 28 in. long through its large 14-by-14-in. loading door—an advantage for those who cut their own wood. Riteway Mfg. Co., Box 153, Harrisonburg, Va. 22801.

Wood/coal stove with "industrial look"

Riteway's model 37 is a large wood/coal stove with a heavy sheet-metal body. Those who choose this stove for its virtues—magnetic damper that provides controlled temperature regulation via an on-off cycle, underfire draft and secondary combustion flue supplied with preheated air, and huge 7½-cu.-ft. firebox capacity—are likely to forgive its industrial appearance. The No. 37 accepts 24-in.-long logs, and is rated at 73,000 Btu/hr.

Coal stove with automatic hopper

The Belgian-made Surdiac model MCK 516 is capable of burning wood, but it is intended primarily for burning high-quality anthracite. The stove features a gravity-feed hopper adjustable for sizes of coal loosely described as "pea to nut." Capable of 24- to 36-hour burns, the Surdiac's heating output ranges between 38,000 and 60,000 Btu/hr., depending on the size of coal used. Southport Stoves (228½ Farmington Ave., New Britain, Conn. 06053) imports this unit.

Coal/wood-fired cookstove for central heating

The Tirolia 7ZH cookstove is said to be capable of supplying all of the domestic hot water and up to 75 percent of the space-heating needs when connected to the existing hydronic (hot water) heating system in an average-size home. The Austrian-made stove's firebox is surrounded on three sides by a water jacket and can accommodate 16-18-in.-long logs. Tirolia of America (Dunning Rd., Middletown, N.Y.) imports it.

Wood/coal furnace

Designed as a primary heat source or as an add-on for an existing oil or gas furnace, the Shenandoah model F-77 is a forced-air unit with a heavy-gauge, firebrick-lined firebox. Heat-output control is via bimetallic thermostat in the air inlet box in the bottom of the large loading door, and an automatic 900-cfm blower is located behind a detachable rear panel. Shenandoah Mfg. Co., Box 839, Harrisonburg, Va. 22801, makes this furnace.

Wood/coal heater

This firebrick-lined, front-loading "vertical barrel" stove is also made by Shenandoah (address above). The model R-65C's heat output is controlled by a bimetallic thermostat and features a cast-iron shaker grate with a dished circular outer grate ring for efficient coal burning. It's constructed of heavy-gauge steel and will accommodate 18-in.-long logs for "all-night heating."

Tile-clad wood/coal stove

The German-made Weso features a tempered-glass fire-viewing window in its nine-by-12-in. gasketed loading door. Though primarily a circulating or "convection" stove, this efficiently baffled, updraft-combustion-pattern unit also puts out significant quantities of radiant heat when its tiles get warm. Claimed heat output is 30,000 Btu/hr. Ceramic Radiant Heat (Pleasant Dr., Lochmere, N. H. 03252) imports this stove.

Coal stove with wood-burning capability

While the Warm Morning model 400 coal heater is not promoted as a dual-fuel stove, it is an efficient and relatively convenient wood burner capable of accepting logs 20 in. long. Its most distinctive feature is an almost cube-shape, firebrick-lined firebox with a small firebrick "mini flue" in each of its corners. The model 400 can burn virtually any size or grade of coal suitable for stoves, and its 100-lb. fuel capacity allows 24-hr. burns with coal at low output settings. It's made by the Locke Stove Co., 114 W. 11 St., Kansas City, Mo. 64105.

1980 outboards

- new small engines
- record horsepower
- better fuel economy



Testing Johnson's new 115-hp model, author Bob Stearns runs a fuel-economy check. New primer system allows easy rope starting in $\frac{1}{3}$ flywheel revolution.

By **BOB STEARNS**

The outboard horsepower race has hit a new high with Mercury's introduction of a jumbo 300-hp motor, eclipsing its own newly introduced 225 and Evinrude's and Johnson's 235-hp models.

Also new for 1980 are several small and midrange kickers, ranging from simple economy models like Mercury's basic economy 3.6 to surprisingly sophisticated portables like the 7.5 models from Evinrude and Johnson that have most of the features of larger outboards.

The new models, both foreign and domestic, are lighter, smaller, and loaded with engineering innovations. And my tests show that some of the new engines are more fuel-efficient than comparable '79 models I tested.

A good example of innovative engineering is the Merc 300. "It's lighter than any marine-drive power plant of 300 hp and gives better fuel economy," says Edward J. Morgan, Mercury vice-president of engineering. In fact,

the 300 has better fuel economy than Mercury's 200-hp model, Morgan says. An inboard in this power class would weigh about 1100 pounds. The Merc V-300 weighs 565 pounds. That's about 700 pounds less than a 300-hp stern drive.

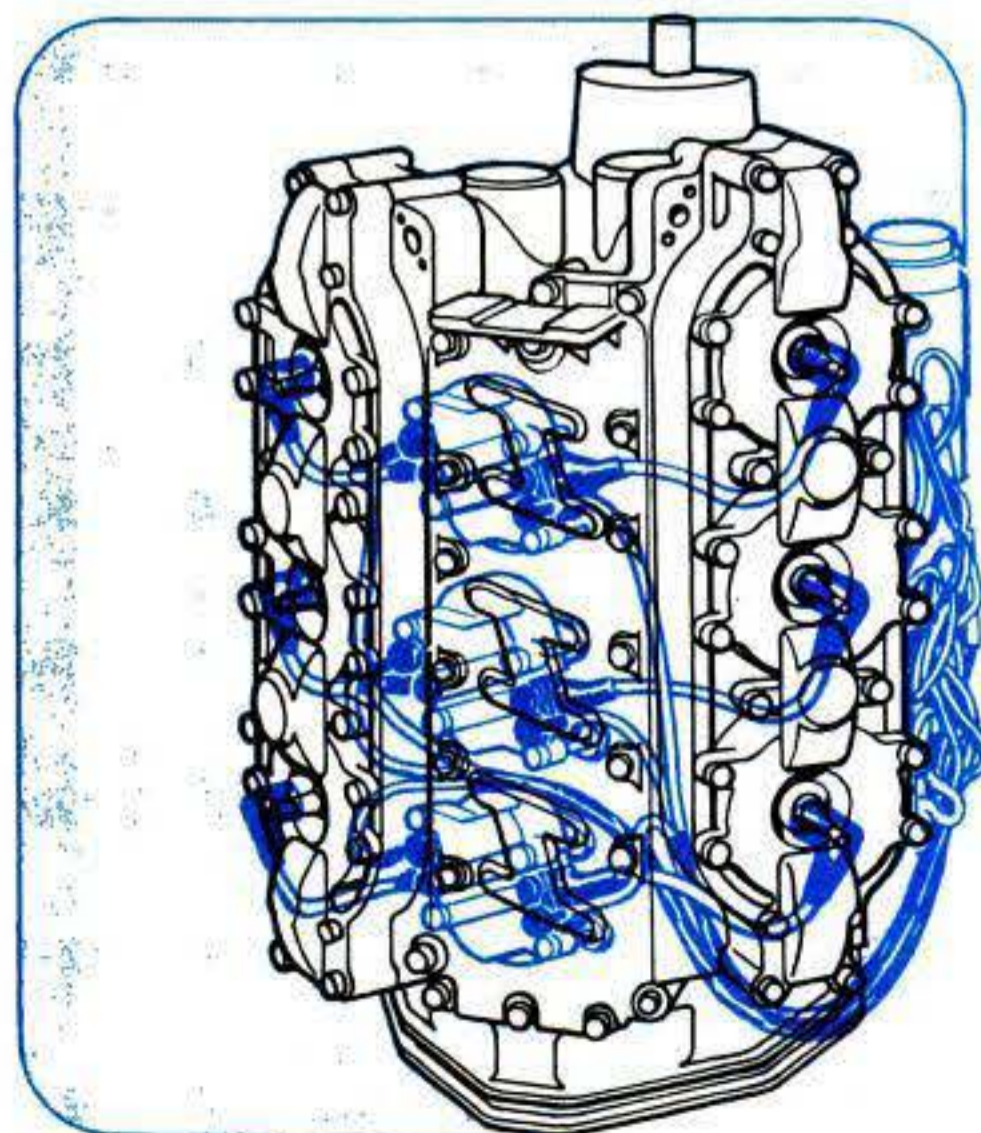
The six-cylinder 300 has a 207-cu.-in. displacement. Bore and stroke are 3.74 and 3.15, respectively. Six single-barrel carburetors are used in the motor. And it is the first outboard sold with power steering as standard.

Smaller outboards are also studded with engineering innovations this year. I had an opportunity to test some of these engines and found many interesting features.

Evinrude's 7.5 is identical in size and appearance to the 4.5 introduced in 1979. In fact, if it had not been for the horsepower label and the absence of the gas cap for the integral tank that's standard on the 4.5, I could have mistaken the 7.5 for that engine—it's that compact. It weighs only 56 pounds (four pounds heavier than the 4.5). But it is not a souped-up 4.5.

New champ in horsepower race is Mercury's 300-hp outboard. Drawing (left)

shows a rear view of 74° V design. CDI system with six individual coils is visible.

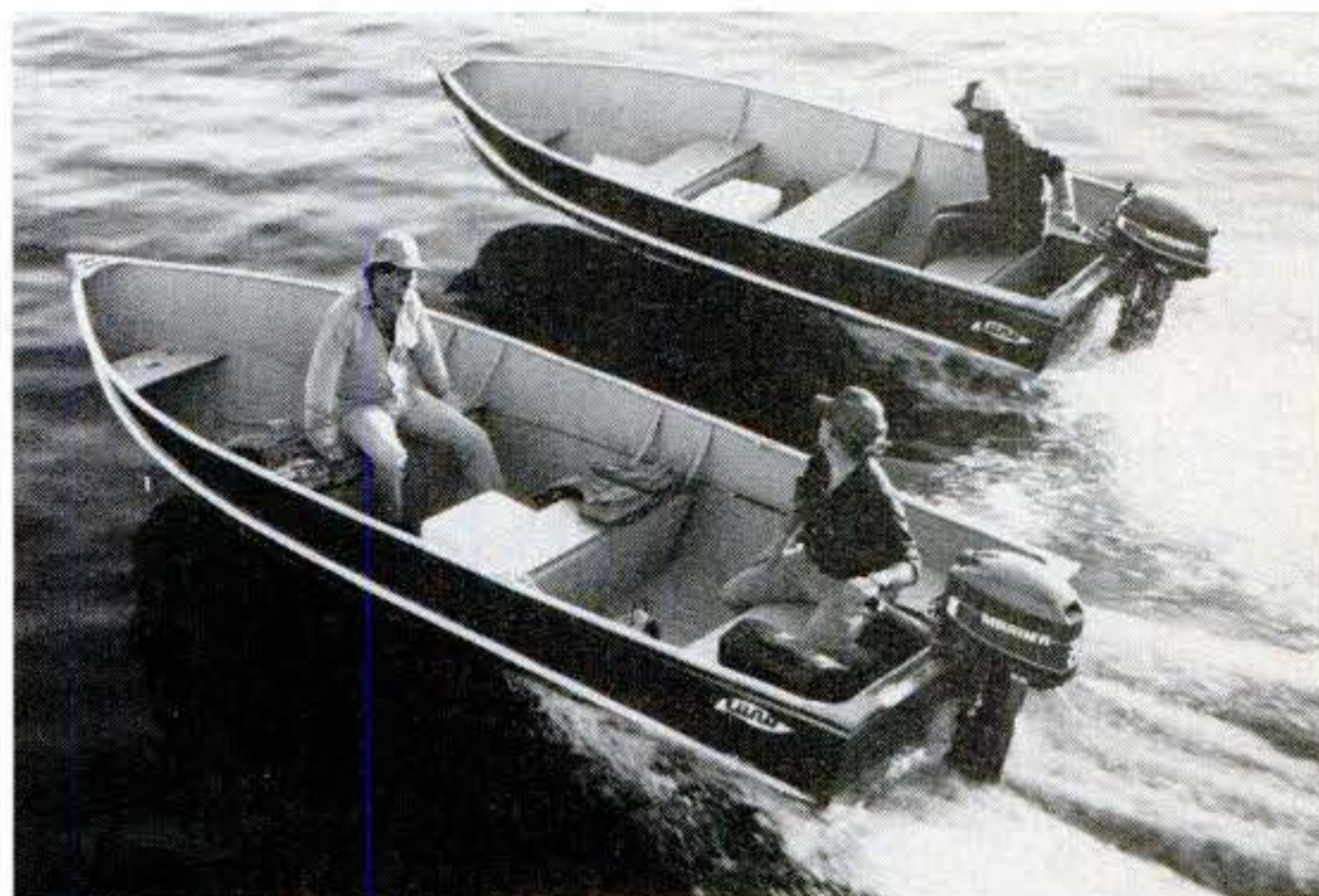




New Evinrude 60 has 11 percent more power at the top than last year's 55—and no increase in fuel consumption over '79.



Johnson 60-hp model has same displacement (44.99 cu. in.) as last year's 55-hp model. The new design, with closer piston fit and better shaping of ports, boosts horsepower.



New two-cylinder 25- (top) and 30-hp models join '80 Mariner lineup. The 25 has magneto ignition and 30 uses CDI. Both of these models come in either manual or electric versions.

Or even a souped-up version of last year's six hp, which it replaces. It's entirely new, from skeg to powerhead, using a block with 10-cu.-in. displacement.

I tested the 7.5 mounted on a 14-ft. semi-V-bottom aluminum hull, with two adults and a full load of test equipment. The 7.5 hit a top speed of 14.15 mph, easily planing the boat. Fuel consumption was miserly: 0.23 gph at 25 percent throttle (a good trolling speed), 0.44 gph at 50 percent, 0.80 gph at 75 percent throttle—with the boat almost on plane at about 10 mph—and 1.35 gph at full throttle. At 80 percent throttle on a boat of this size, the efficient little engine would have a cruising range of close to 50 miles with a six-gallon tank.

OMC's chief outboard engineer, Don Kueny, says, "We're using a new casting method for the cylinder block that allows closer piston fits, better proportioning and shaping of ports. With the 60 this has given us as much as 20 percent more horsepower in the low and midrange, and about 11 per-

cent more at the top over '79's 55."

Johnson's new primer

Included in the 1980 lineup of gasoline outboards from Johnson is a new primer system that will be standard on all V4 and V6 engines (85–235 hp). It replaces the old system in which a solenoid-controlled butterfly valve in the throat of the carburetor was closed during the choking process to force a richer gasoline mixture out of the carb and into the intake manifold. There's also much faster priming, and much faster starting for both cold and warm engines.

Mounted on a 17½-ft. Glastron SSV 176, the 115 (with two adults and a full load of test equipment) yielded a top speed of 42.36 mph at full-throttle fuel consumption of 10.23 gph. The overall improvement in fuel economy is obvious when you consider that just a few years ago this same engine burned 11.5 gph at full throttle.

As in the past, the most economical operating range for this engine was 3000–4000 rpm, burning 4.4–6.5 gph

and, in spite of a heavy boat, getting almost five mpg.

Mercury innovations

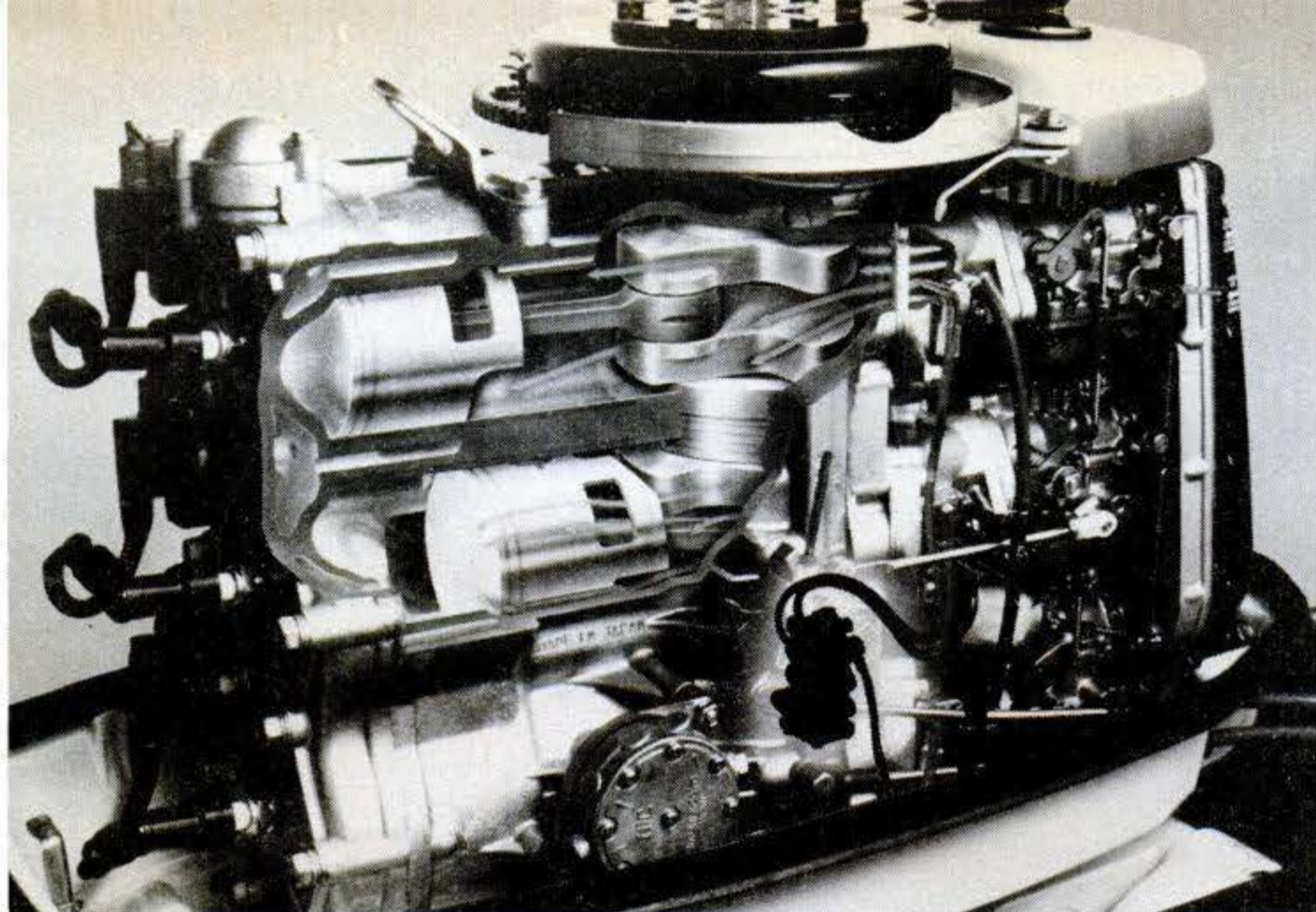
When I visited Mercury Marine's test facility to try the new 3.5- and 225-hp models, I found features that I felt would contribute significantly to their effectiveness on the water.

Compared to other similar-size outboards I've tested recently, the Merc 3.6 isn't pretty. It has no gearshift, no twist-grip throttle control. But it's also light: only 36 pounds. It has an integral two-quart gas tank and a "wraparound" carrying handle.

The two-quart tank provides almost an hour of full-throttle operation, and almost three hours at a very slow troll. Even with only one cylinder, the 3.6 idles smoothly at surprisingly low speeds. In addition, the owner's manual features detailed engine diagrams for the do-it-yourselfer, part of an across-the-board trend for Mercury to make owner servicing easier.

Next to the top end of 19 different

Continued



Engine cutaway shows first oil-injection outboard introduced by Suzuki/Spirit. The 85-hp model automatically mixes oil and

horsepower sizes for 1980 is Mercury's new V6 225-hp model.

"We've increased the reed-valve area by 40 percent, raised the exhaust ports, increased the compression ratio, redesigned the cylinder heads, increased the number of roller bearings, and beefed up the pistons," Mercury

gas. Mix is 100:1 at full throttle, 50:1 at idle. This means less plug fouling at idle speeds. Piston wear is also reduced.

engineers Keith Gagnier and Ralph Anderson told me.

With three adults and a full load of test equipment in the lightweight 20½-ft. Challenger hull, the 225 was able to push it to a top speed of 60 mph. According to my test equipment, at full throttle the 225 burned 18.75

gph (Mercury's showed 18.23 gph). Regardless of whose figures you prefer, that still puts the fuel efficiency of the 225 somewhere near or above 12 hp per gallon of gas per hour at full throttle. Compared to the 200, which I tested two years ago and got 11.5 hp/gal./hr., the 225 is more fuel efficient.

Mariner will have five new engines in its 1980 outboard lineup, ranging from a V6 200-hp model, a V6 150, a twin-cylinder 30, a twin 25, and a tiny recoil-start two. Both of the V6's are built in the U.S. and are similar in design to the Mercury V6's of the same horsepower.

Spirit and Suzuki have added a new three-cylinder 85 to the top of their lines. Standard features for this engine include built-in power trim and tilt, plus an 80-watt alternator. They have also added a new, lighter 3.5 hp.

Chrysler has five new models for 1980: a four-cylinder 100-hp Charger, three-cylinder 85 Charger "Special Edition," three-cylinder 75 Skier, and two new Hi-Thrust auxiliary sailboat motors—six and 9.9 hp. Chrysler claims new engineering innovations have improved fuel economy throughout its lineup. [5]

1980 GASOLINE OUTBOARDS

Manufacturer	Hp	Max. rpm	Cylinders	Displ. (cu. in.)	Gear shift	Weight (lbs.)
Aqua Bug Intl. 100 Merrick Rd. Rockville Centre NY 11570	1.2	7200	1	1.34	No	11
	3	6000	1	3.05	F-PR*	21
Chrysler Corp. Box 2641 Detroit MI 48288	4	5250	1	5.00	F-N	35
	6	4750	2	10.0	F-N-R	52
	6	4750	2	10.0	F-N-R	60
	6	4750	2	10.0	F-N-R	61
	7.5	4750	2	10.0	F-N-R	53
	9.9	4750	2	13.15	F-N-R	79
	9.9	4750	2	13.15	F-N-R	80
	9.9	4750	2	13.15	F-N-R	58
	15	5100	2	15.41	F-N-R	58
	20	4750	2	28.57	F-N-R	113
	30	4750	2	34.1	F-N-R	120
	45	5000	2	42.18	F-N-R	148
	45	5000	2	42.18	F-N-R	152
	55	5000	2	49.9	F-N-R	183
	75	4750	3	72.39	F-N-R	224
	75	4750	3	72.39	F-N-R	224
	85	5000	3	72.39	F-N-R	245
	85	5000	3	69.81	F-N-R	245
100	5000	4	96.55	F-N-R	251	
100	5000	4	96.55	F-N-R	258	
115	5000	4	99.9	F-N-R	253	
115	5000	4	99.9	F-N-R	260	
140	5250	4	103	F-N-R	253	
140	5250	4	103	F-N-R	260	
Clinton Engines Maquoketa IA 52060	2	3800	1	5.76	No	33
	3.5	4600	1	7.2	No	45
	5.5	5600	1	8.3	No	48
	5.5	5600	1	8.3	F-N	62
	7.5	6000	1	9.2	F-N	50
	7.5	6000	1	9.2	F-N-R	75
Evinrude Motors Box 663 Milwaukee WI 53216 and Johnson Outboards Waukegan IL 60085	2	4500	1	2.64	No	24
	4	4500	2	5.28	No	38
	4.5	5000	2	5.28	F-N-R	52-54
	7.5	5000	2	10	F-N-R	56-58
	9.9	5000	2	13.20	F-N-R	72-82
	15	6000	2	13.20	F-N-R	72-82
	25	5000	2	31.80	F-N-R	101-106
	35	5500	2	31.80	F-N-R	114-121
	55	5500	2	44.99	F-N-R	195-202
	60	5500	2	44.99	F-N-R	180-187
	70	5000	3	49.70	F-N-R	230
	75	5500	3	49.70	F-N-R	198-230
	85	5000	V4	99.60	F-N-R	288-306
	100	5000	V4	99.60	F-N-R	288-306
115	5000	V4	99.60	F-N-R	288-306	
140	5000	V4	99.60	F-N-R	293-315	
150	5000	V6	149.40	F-N-R	381-386	
175	5000	V6	149.40	F-N-R	381-386	
200	5250	V6	149.40	F-N-R	381-386	
235	5500	V6	149.40	F-N-R	396-401	
American Honda 3435 Wilshire Blvd. Los Angeles CA 90010	7.5	5200	2	12.2	F-N-R	75
	7.5	5200	2	12.2	F-N-R	77
	9.9	5700	2	12.2	F-N-R	75
	9.9	5700	2	12.2	F-N-R	77
Mariner Outboards 1939 Pioneer Rd. Fond du Lac WI 54935	25	5500	2	26.2	F-N-R	97
	30	5500	2	30.3	F-N-R	107
	70	5800	3	49.8	F-N-R	190
	150	5500	V6	121.9	F-N-R	378
	200	5800	V6	142.2	F-N-R	357
	Mercury Marine 1939 Pioneer Rd. Fond du Lac WI 54935	3.6	5000	1	5.5	PR
4		4700	2	5.5	N-PR	36
4.5		5500	1	5.5	F-N-R	53
7.5		5500	2	10.9	F-N-R	64
9.8		5500	2	10.9	F-N-R	64
18		6000	2	24.4	F-N-R	94
20		5500	2	21.9	F-N-R	94
25		6000	2	24.4	F-N-R	94
40		5500	2	33.3	F-N-R	152
50		5500	4	43.8	F-N-R	176
70		5500	3	49.8	F-N-R	190
80		5500	4	66.6	F-N-R	244
90		5500	6	99.8	F-N-R	290
115		5500	6	99.8	F-N-R	290
140	5800	6	99.8	F-N-R	290	
150	5500	V6	121.9	F-N-R	349	
175	5800	V6	121.9	F-N-R	349	
200	5800	V6	142.2	F-N-R	331	
225	5800	V6	142.2	F-N-R	360	
Sea King Montgomery Ward Montgomery Ward Plaza Chicago IL 60671	2	3800	1	5.76	F-PR	23
	3.5	4600	1	7.2	F-PR	32
	4	5750	1	5	F-N-PR	37
	5	5600	1	8.3	F-N-PR	36
	7.5	6000	1	9.2	F-N-PR	37
	7.5	5250	2	10	F-N-R	55
Sears, Roebuck & Co. Sears Tower Dept. 703 40 16 Chicago IL 60684	9	6000	1	10.14	F-N-R	49
	15	5600	2	15.41	F-N-PR	58
	1.2	6500	1	1.39	PR	13½
	3.5	4250	1	5.2	PR	36½
	5	5500	1	6	PR	37
	5	5500	1	6	PR	39
British Seagull Intra Corp. 151 Mystic Ave. Medford MA 02155	7.5	5650	1	8.17	F-N	40
	7.5	5650	1	8.17	F-N	44
	9.9	4750	2	15	F-N-R	59
	15	5500	2	15	F-N-R	60
	2	4000	1	3.81	No	32
	3	4000	1	3.81	F-N	37
Spirit Marine Div. Arctic Enterprises Box 635 Thief River Falls MN 56701 and Suzuki Intl. 13767 Freeway Dr. Santa Fe Springs CA 90670	4.5	4000	1	6.1	F-N	44
	5.5	4000	1	6.1	F-N-R	52
	2	4800	1	49.9	No	24
	3.5	4800	1	69.8	F-N	42
	5	5800	2	113	F-N-R	50.5
	8	5800	2	164	F-N-R	62
Suzuki Intl. 13767 Freeway Dr. Santa Fe Springs CA 90670	9.9	5500	2	256	F-N-R	77
	16	5800	2	284	F-N-R	77
	20	5700	2	396	F-N-R	100
	25	5700	2	447	F-N-R	100
	40	5800	2	37.65	F-N-R	150
	50	5500	2	723	F-N-R	178
	65	5500	2	798	F-N-R	183
	85	5300	3	1197	F-N-R	233

*Note: PR stands for pivot reverse

Tips from the pros on using a dial indicator

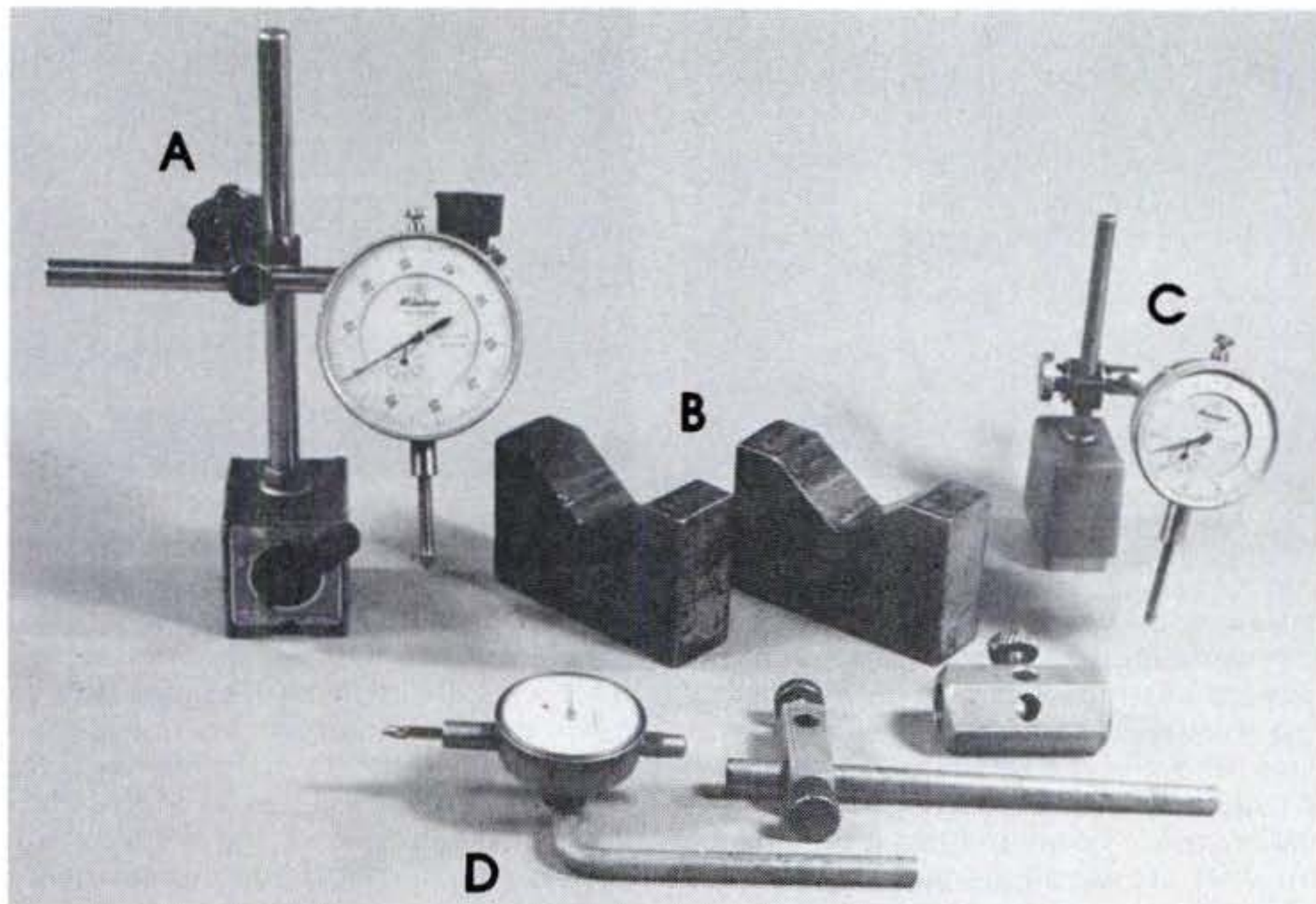
By RAY HILL

You've just had a new set of tires put on your car. They were precisely balanced, but you notice a roughness transmitted through the steering wheel. Even on smooth roads it feels almost as if you were driving on gravel.

The cause may be excessive tire runout. It can be easily checked with a dial indicator.

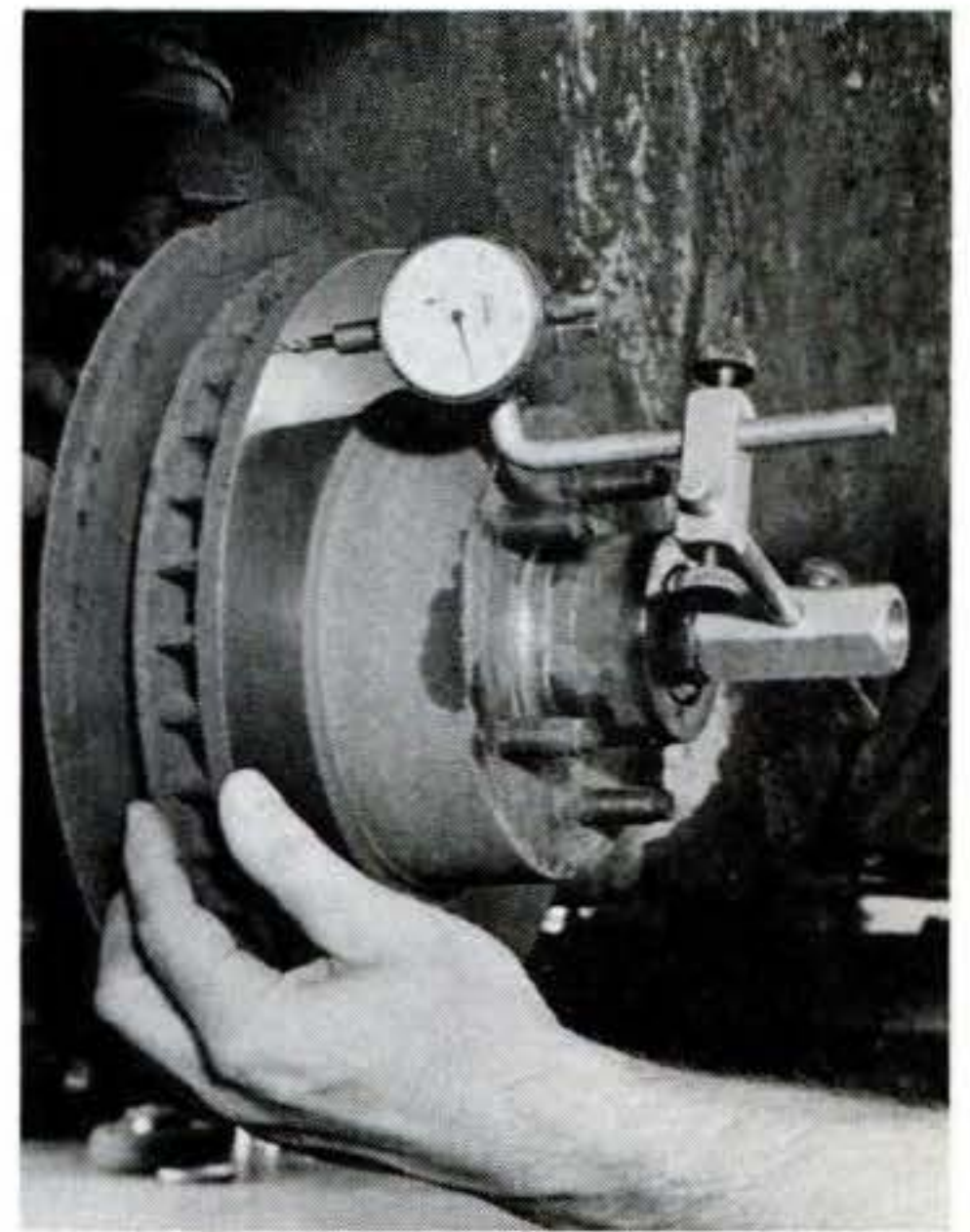
The dial indicator is useful for checking a lot of other items on your car, too: valve-guide clearance, brake-rotor runout, camshaft lift—to name a few. If you're a mechanic or a serious

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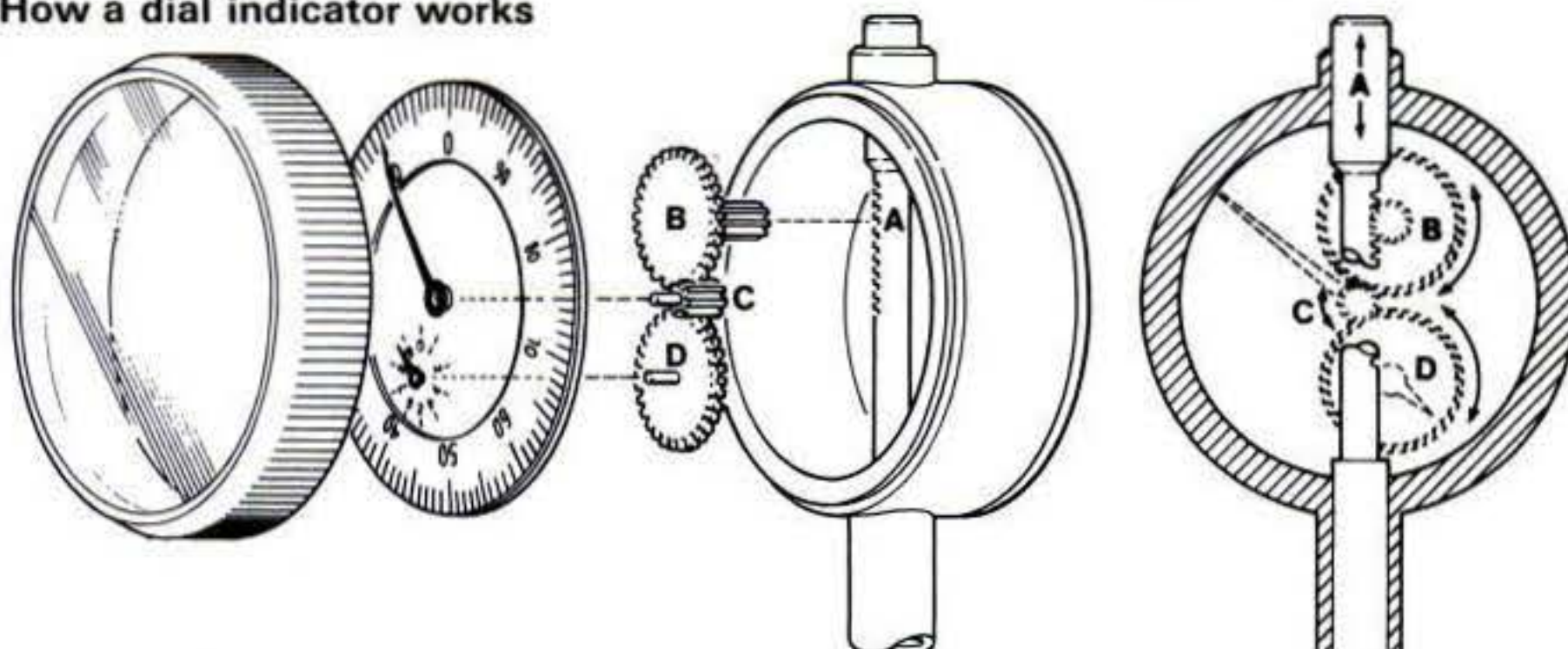
Dial indicators and attachments: (A) Dial indicator is mounted on magnetic base. The base is adjustable so that tip of indicator may be positioned precisely against item to be measured, in either vertical or horizontal position. (B) V-blocks are used when checking a crankshaft or camshaft for out-of-round. (C) A smaller, less expensive magnetic base attached to a dial indicator: Magnetic base allows dial indicator to be attached to any flat piece of ferrous metal. Several other types of

bases are available, some that clamp to an object, and others that screw into spark-plug holes. (D) Dial indicator and three attaching parts allow it to be attached to a wheel to measure disc-brake-rotor runout. Dial indicator and attachments can be purchased from Sears, jobbers who handle precision-measuring instruments, or some stores that sell automotive parts. A dial indicator should be treated like any other precision measuring tool—keep it clean, dry, and don't drop it.

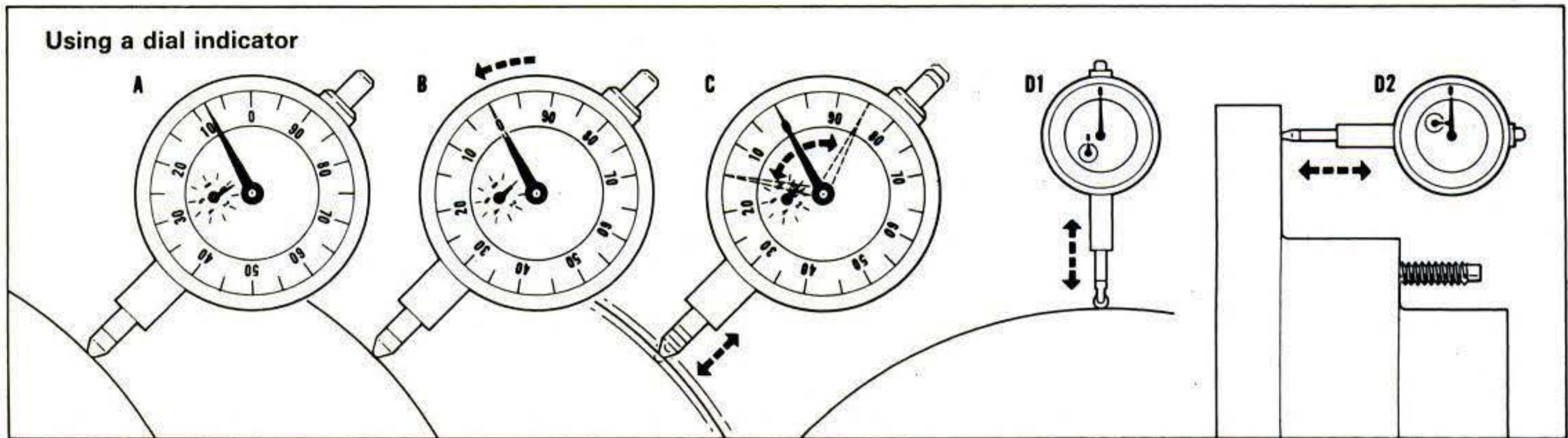


Brake-rotor runout should be between 0.002 and 0.005 in. Excessive runout will cause the brake pedal to pulsate when it is applied. To check rotor runout, first spread the brake pads so they don't contact the rotor. A heavy screwdriver, if handled carefully, can be used to spread the pads apart. Insert its tip between the top of the rotor and the ear on the brake pad (the metal part of the pad that the braking material is attached to) and pry the pad $\frac{1}{8}$ in., say, away from the rotor. Then stick the screwdriver tip between the top of the rotor and the brake-pad ear on the other side, and pry this pad about $\frac{1}{16}$ in. away from the rotor, and you can check to see if you have zero clearance at the wheel bearing. If you don't have zero clearance, you'll get an erroneous reading when checking rotor runout. To check for zero clearance, mount dial indicator as shown and rock rotor back and forth. If there is play in the wheel bearing, tighten the wheel-bearing nut until the play is removed. To check rotor runout, with dial indicator mounted as shown, slowly rotate rotor by hand at least one full turn, and observe how much the large needle on the dial indicator moves back and forth as the rotor turns. If runout exceeds specs, rotor must be turned at an automotive machine shop to be returned to specs. All brake specs are given in shop manual for your car.

How a dial indicator works



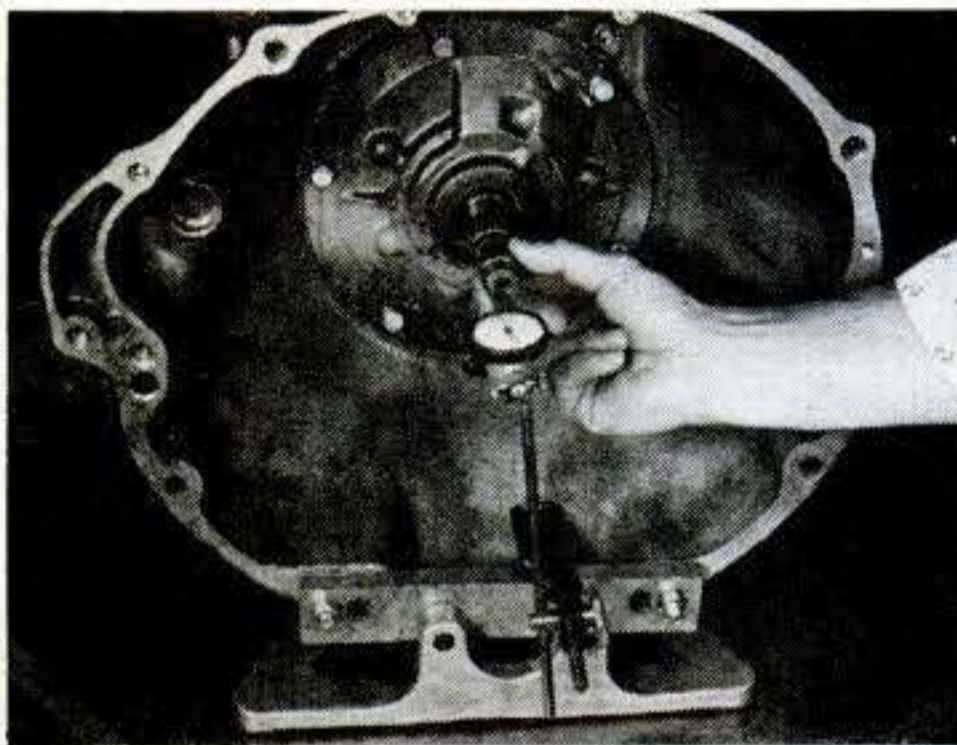
Dial indicator measures deflection. As shaft moves, precision gearing transmits that movement to needle on dial face.



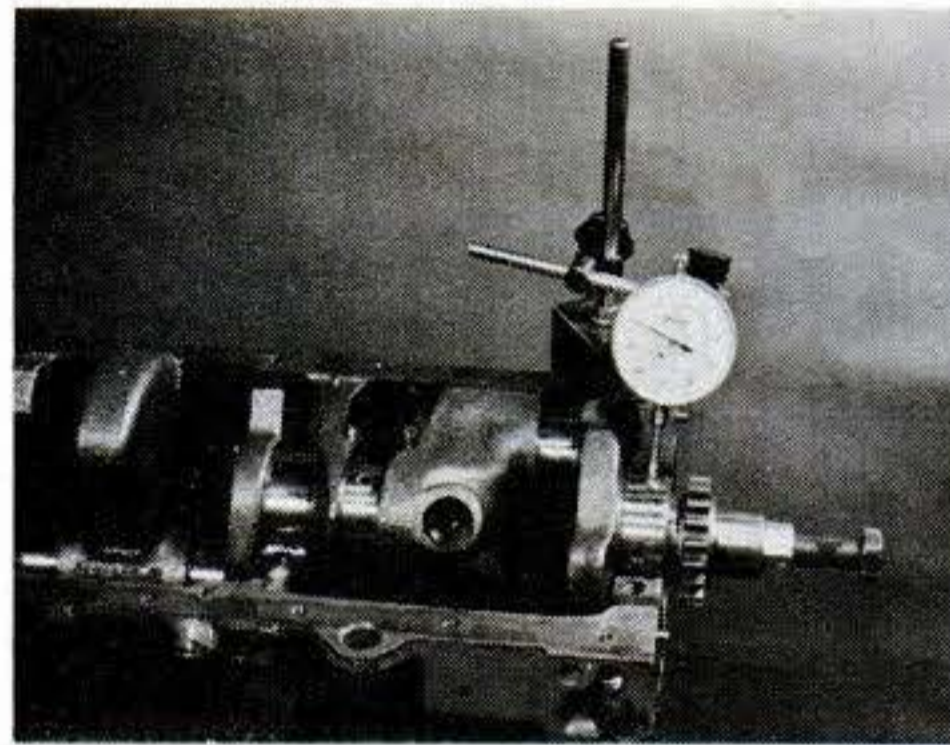
Tip of dial indicator is positioned so that it touches object that is being checked (A). Movable face of dial indicator is rotated until the tip of the needle points to zero

(B). Now, when the object moves, the amount of deflection from zero can be observed by watching the needle movement (C). When measuring up-and-down

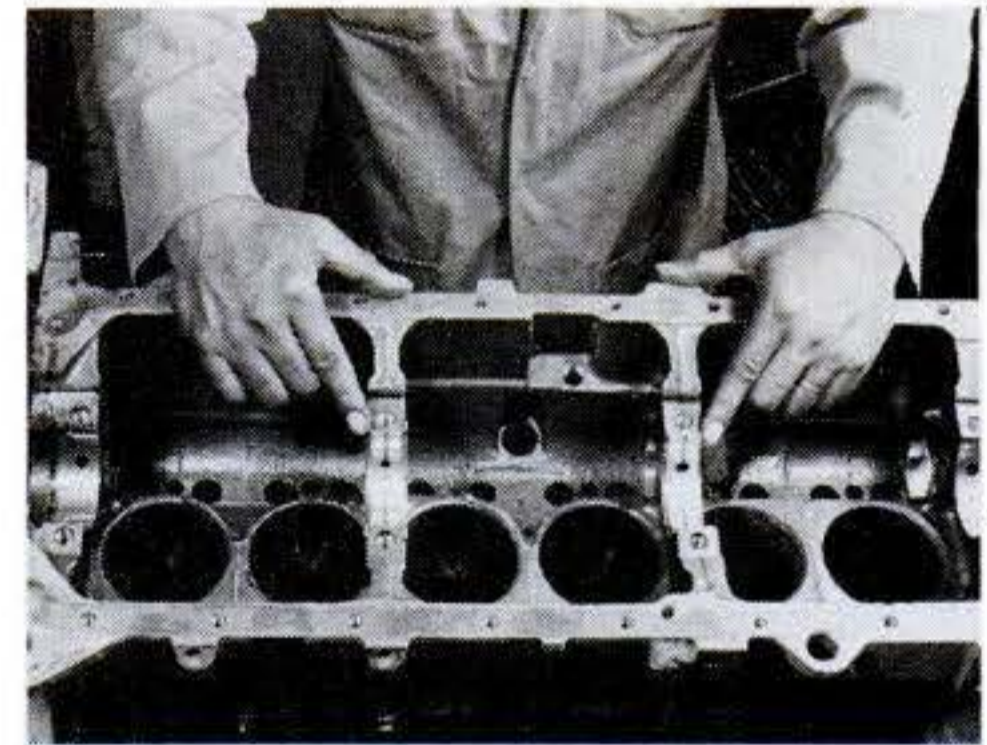
movement, the dial indicator must be positioned so that the tip is in a vertical plane (D1). When measuring side-to-side movement, tip must be horizontal (D2).



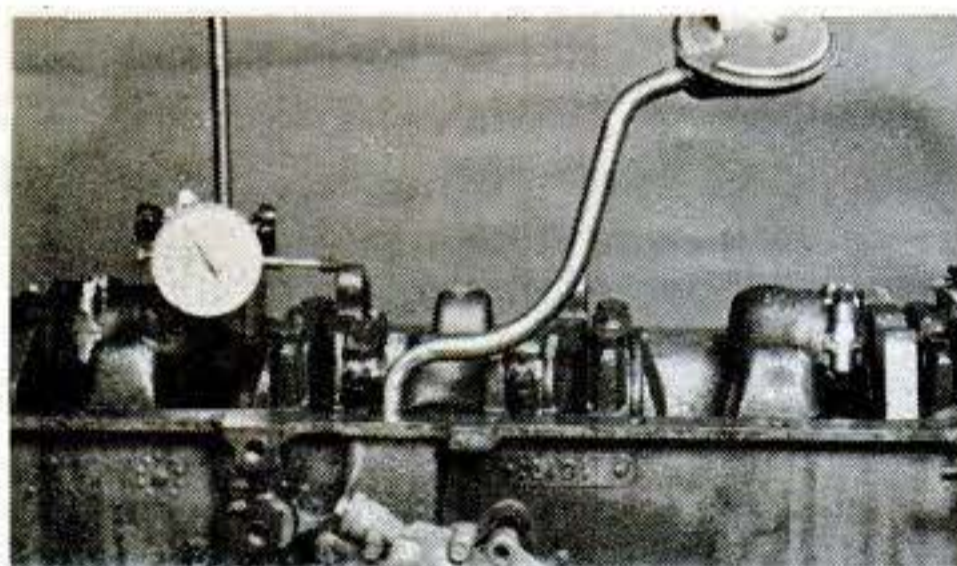
Input-shaft end play is an important indicator of an automatic transmission's condition. If you're buying a replacement transmission at a salvage yard and want to check it to see if it's worth buying, or want to check the unit in your own car, here's how. Mount the dial indicator as shown, so that the tip of the indicator touches the end of the input shaft. Move the shaft back and forth as far as it will go. End play should be within the specs given in the shop manual for your automobile. Specs vary for different transmissions.



Crankshaft runout should be checked any time you overhaul an engine. Too much runout can shorten the life of main bearings and rod bearings. In extreme cases it can cause engine vibration, and even spin a main bearing in its mount. Because of the massive size of a crankshaft, excessive runout isn't a common problem, but it should be checked. To do it, turn engine block upside down and rest it on a bench or other steady support. Remove crankshaft and two end main bearings, as in right photo. But leave the two middle bearings in place (bearing being pointed to by right hand also doubles as thrust bearing—note that it has a flange on either side to keep crankshaft end play within



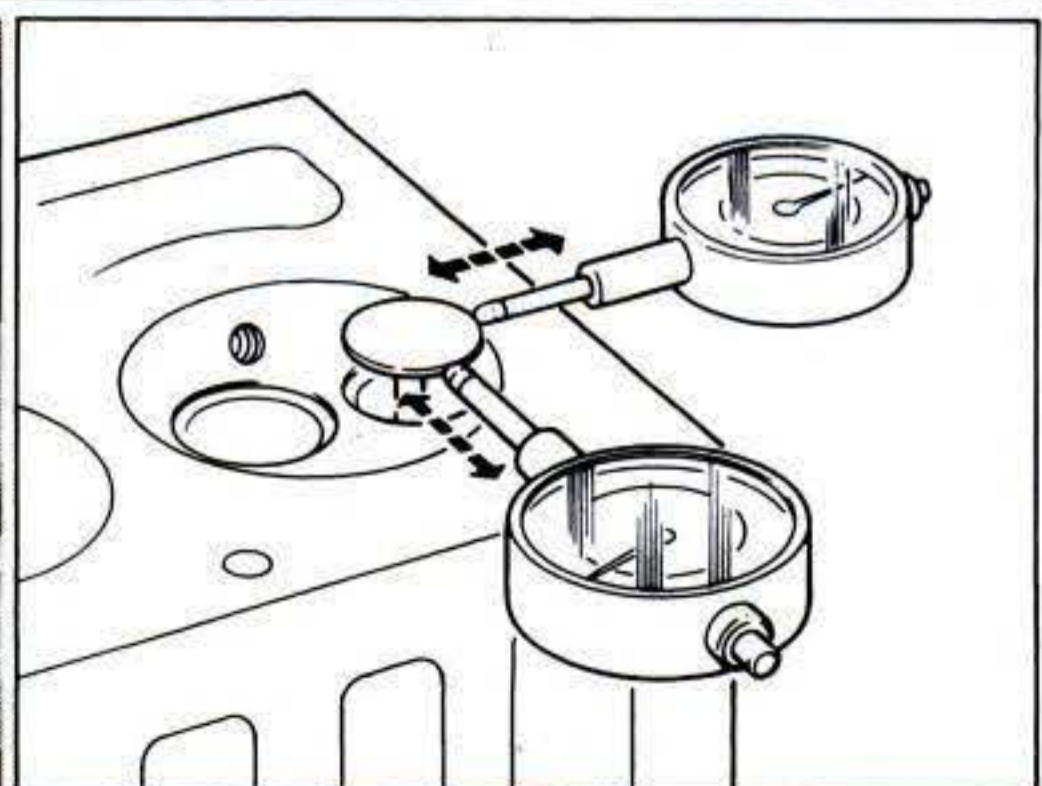
specs). Now place crankshaft back in the engine. It will rest on the two center main bearings. Place dial indicator, as shown in left photo, on each of the end journals of the crankshaft and rotate the crankshaft at least one full turn. Note readings. Now remove the crankshaft and lay it aside. Remove the two inside main bearings and replace the two end main bearings. Place the crankshaft back in the engine. Now position the dial indicator to measure the two inner bearing journals on the crank, just as you did with the outer journals. Runout of any unsupported bearing journal on the crank should not exceed 0.001 in. If it does, have the crank replaced or straightened until it's within specs.



Crankshaft end play is checked automatically during an engine overhaul. Check before removing crankshaft from the engine, and check again after it's been reinstalled with new bearings. To check, position the tip of the dial indicator against a crankshaft weight, as shown. Then move the crankshaft back and forth, noting the reading on the dial indicator. Crankshaft end play should be 0.001–0.006 in. If after reinstalling the crank with fresh bearings there is no end play, you've probably installed the wrong bearings. Remove the crank, and make sure all the bearings, including the thrust bearing (which determines crankshaft end play) are the correct ones. If, after installing new bearings, end play is excessive, you need a new or rebuilt crankshaft. To move crank, use a pry bar between block and a crank throw.



Valve-guide clearance should be checked any time you do a valve job. It is also checked when you are having valve problems (such as valves not seating). Excessive clearance between the valve stem and valve guide can contribute to oil burning, noisy valves, burning valves, and valves not seating properly. To check valve-guide clearance with a dial indicator, remove the valve spring and valve-spring retainer so that the valve can be removed from the valve guide. Position



the dial indicator as shown and lift the valve up so that the margin (that part of the valve between the valve face and the top of the valve head) is against the tip of the dial indicator. Now move the valve back and forth, observing the amount of movement shown by the dial indicator. Maximum movement on the dial indicator should be 0.015 in. If it's more than this, a new valve guide is needed. Check valve-guide clearance with the dial indicator in two positions, as shown in drawing.

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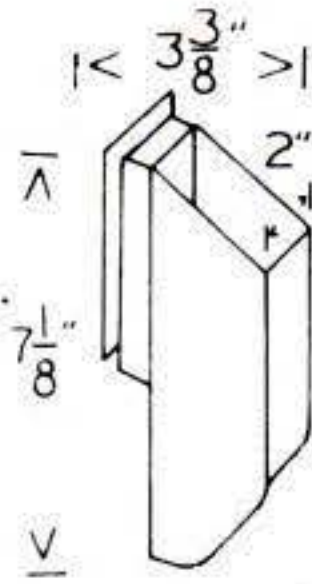
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WALL-IT can be installed easily in most walls in less than 15 minutes with the complete installation kit and detailed instructions included. (Kit includes a template, switch plate, even a saw.)

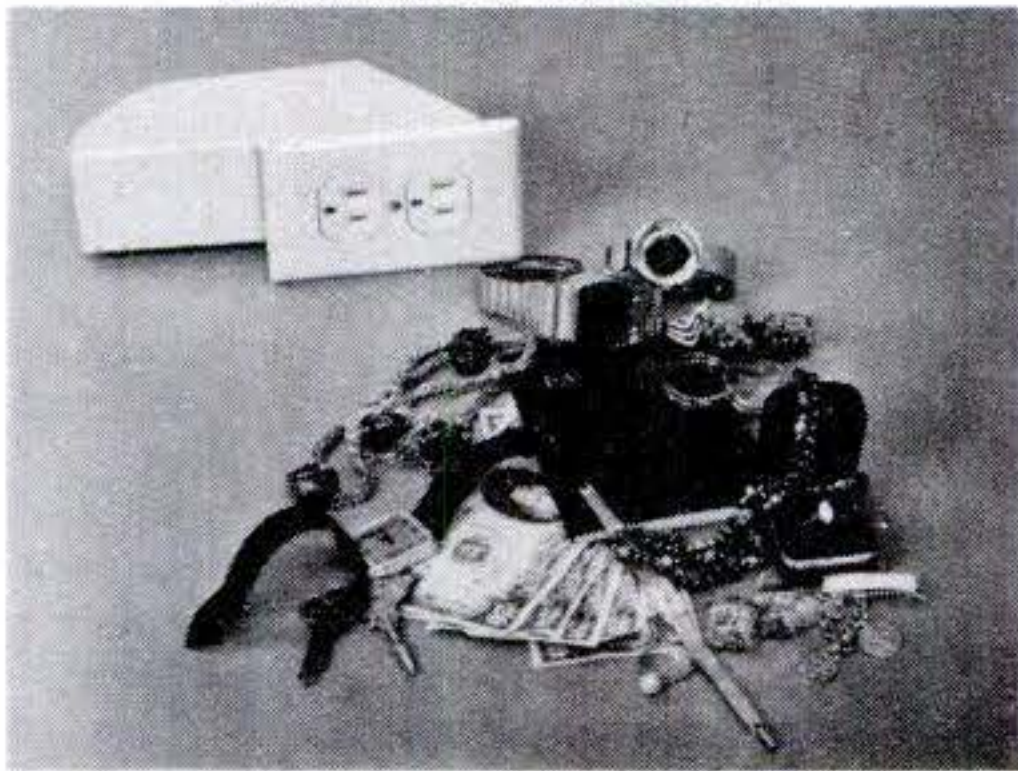
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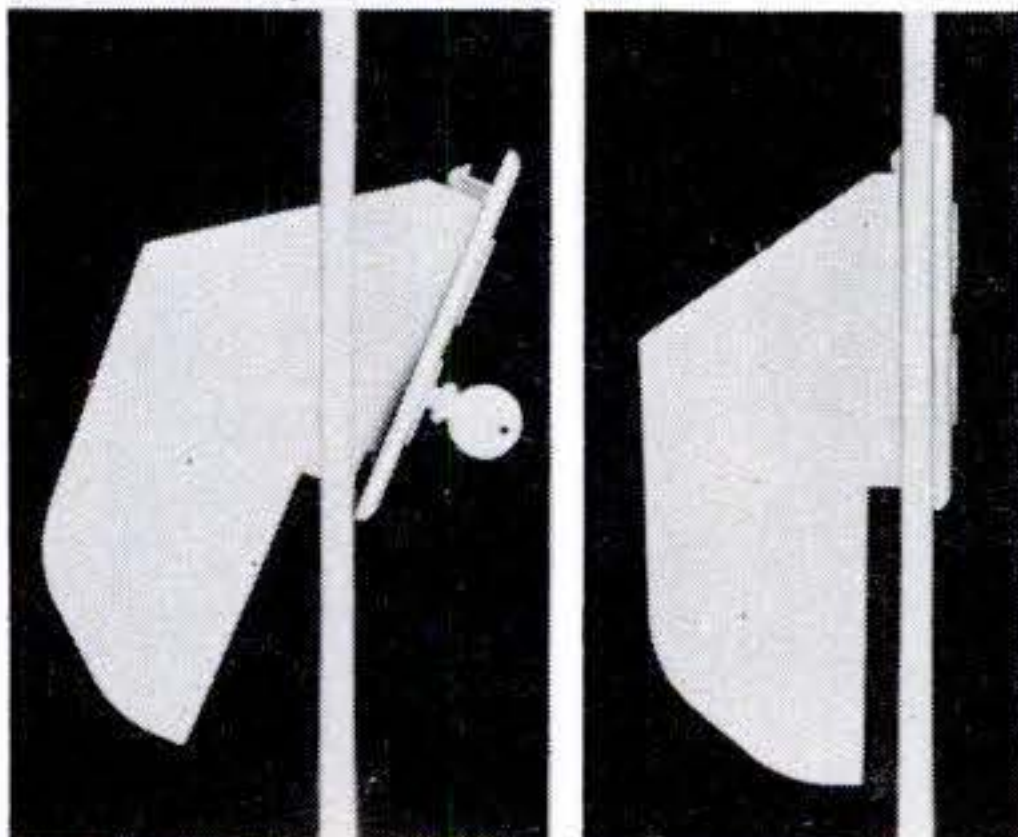
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Actual photo of WALL-IT in wall



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Signature _____

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Using a dial indicator

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do-it-yourselfer, it's a tool you must have and know how to use.

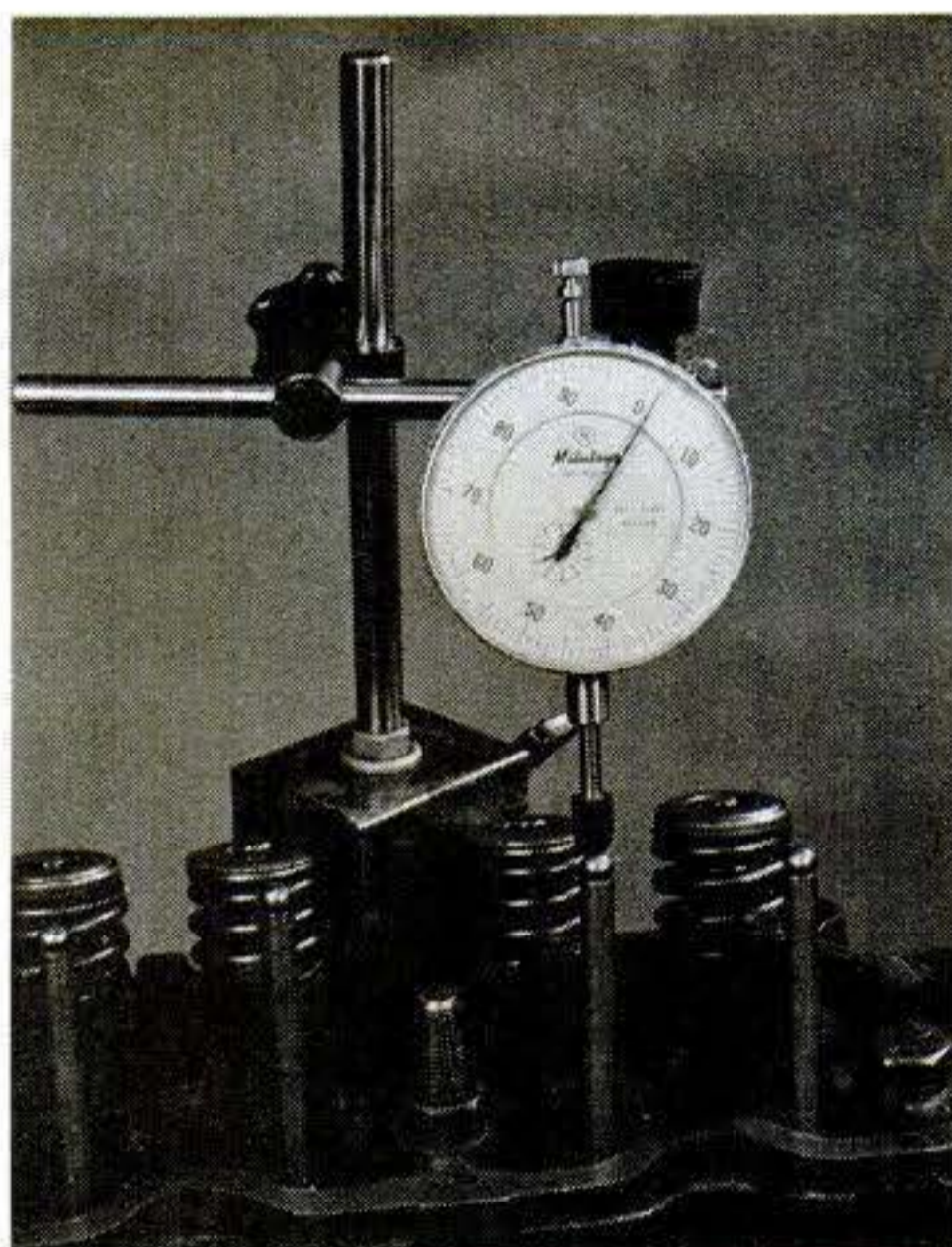
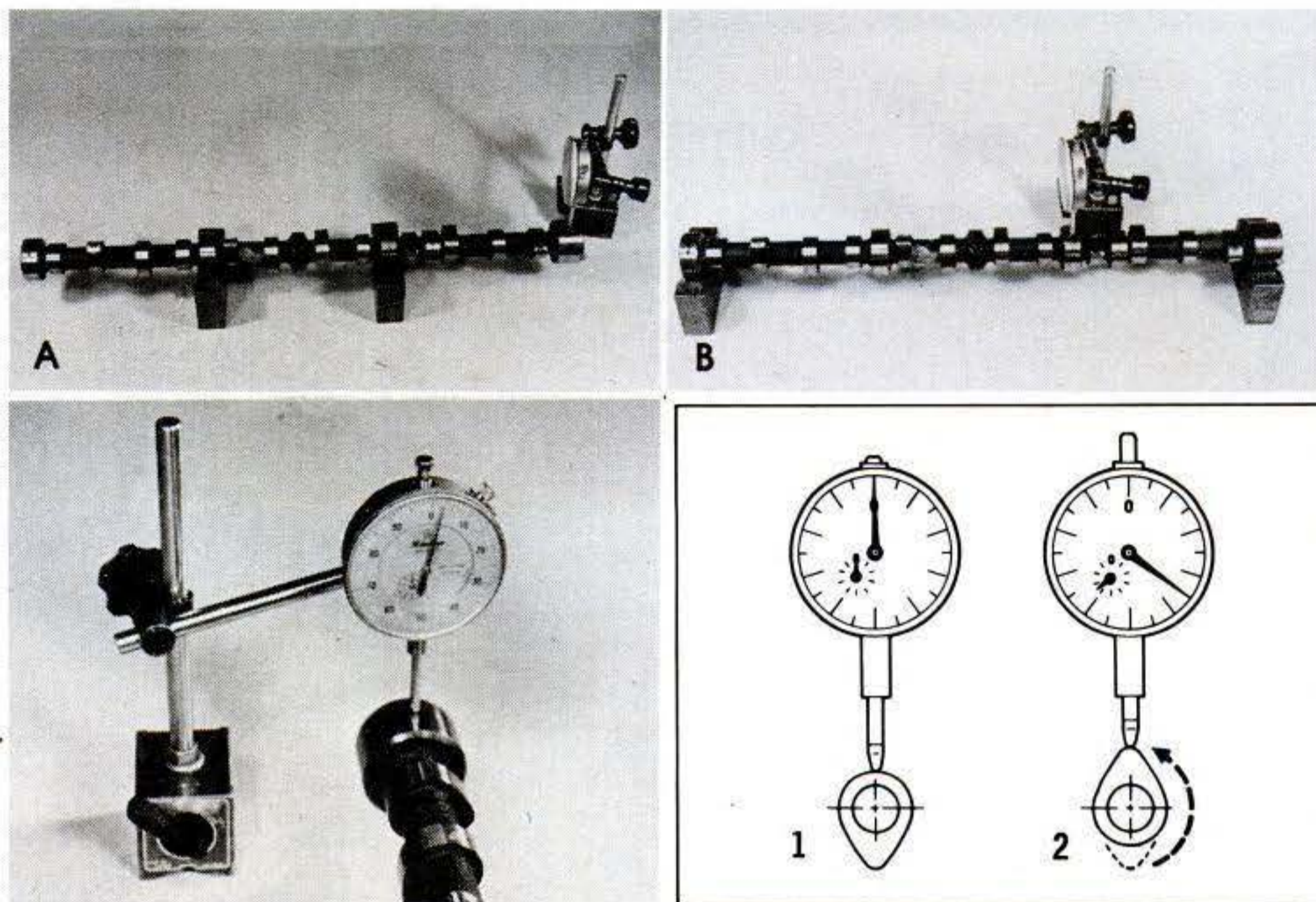
To learn how to use a dial indicator properly I visited the pros at Motech in Livonia, Mich. Motech is a training institute where students study all

Camshaft runout should be within 0.006 in. Ordinarily, excessive camshaft runout isn't a problem, but it should be checked at every engine overhaul. V-blocks are necessary to do the job. Middle two camshaft journals are placed in V-blocks, and camshaft is rotated at least one full turn by hand. Runout is measured by the dial indicator on the bearing journals at each end of the camshaft (A). Then the V-blocks are placed under the bearing journals at each end of the camshaft, and runout of the inner two bearing journals is measured (B). If runout is excessive, a new camshaft is needed. While camshaft is resting in V-blocks, cam-lobe lift can be measured if desired. Position dial indicator so tip is on bottom of lobe (1), then rotate cam until maximum reading on the dial indicator is achieved (2), and note reading (maximum reading on the dial indicator indicates maximum lift height). Cam-lobe lift (valve lift) specs can be found in the shop manual for your car.

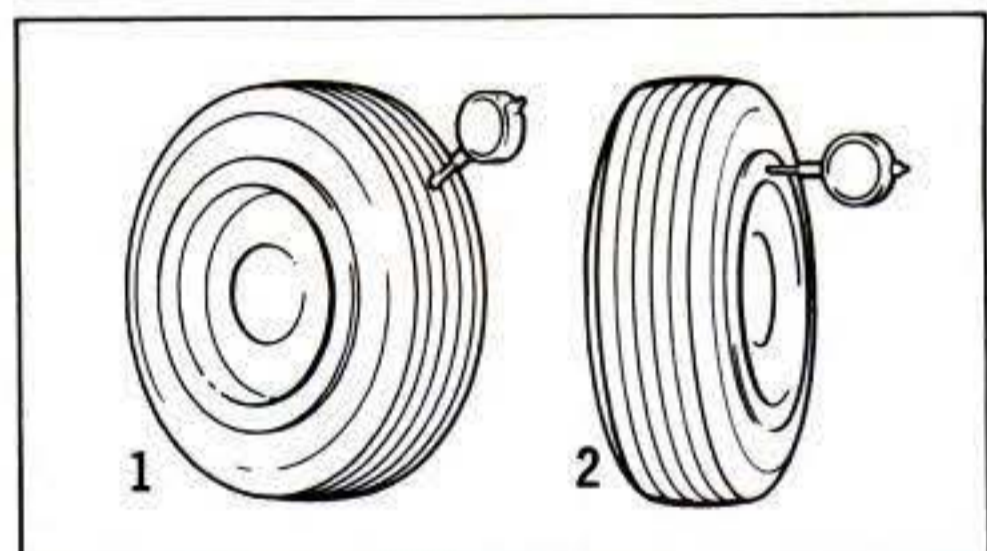
phases of automotive mechanics during a one-year course. Operated by Chrysler, the nonprofit training center covers all makes of U.S. cars. GM, Ford, and AMC provide the school with technical information about

their own cars and offer other assistance.

The pictures shown here were shot in Motech classrooms. The procedures are those used and recommended by Motech instructors. PS



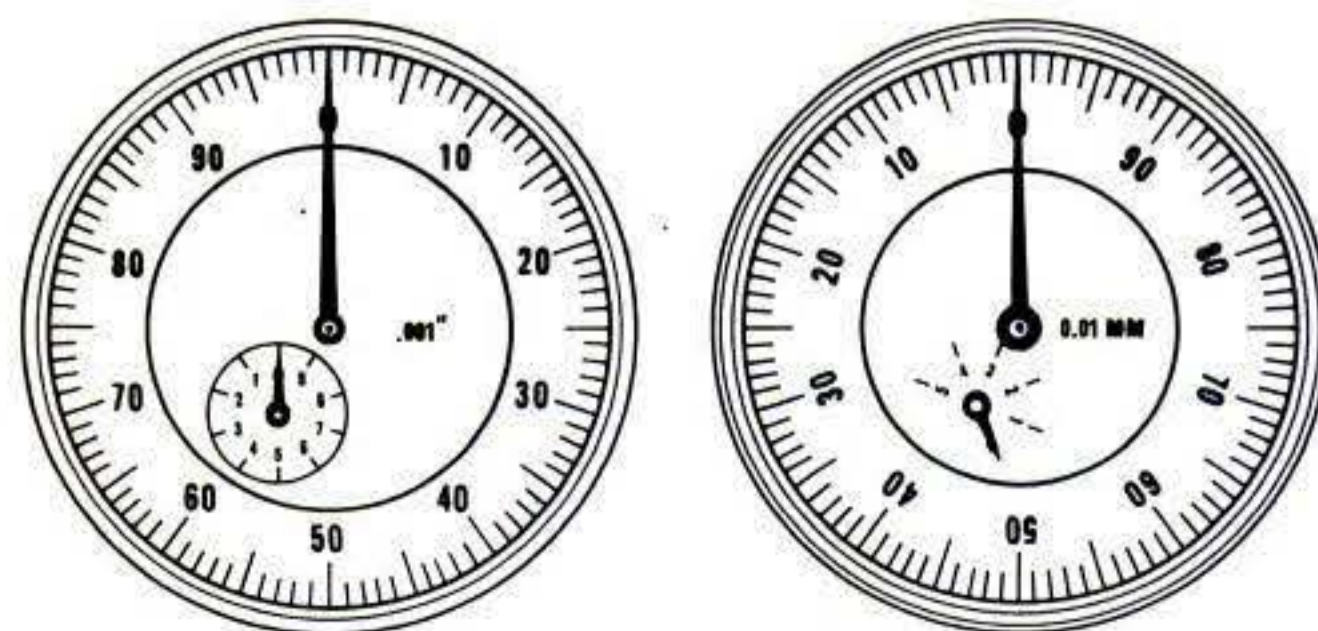
Cam-lobe lift is checked during an engine overhaul, or if you're having lifter or valve problems. However, to check it precisely requires removing the camshaft from the engine. Another common way of measuring cam-lobe lift (used by mechanics in the field), without removing the head and camshaft, is to remove the rocker arms and place the dial indicator, as shown at left, on the tip of a pushrod. Rotate the engine by hand and observe the dial indicator. If the pushrod doesn't move up to within 0.006 in. of the specified cam lift, the camshaft is probably bad and will require replacement. This procedure works with both hydraulic and solid lifters. To rotate the engine by hand you can use a breaker bar and socket on the nut at the end of the damper pulley. Best procedure for the do-it-yourselfer is to have a friend rotate the engine slowly while you observe the dial indicator. Rotate until maximum reading is seen on indicator.



Excessive tire runout or wheel runout can cause a rough feel in the steering wheel. To check tire runout, dial indicator (with a roller tip) is positioned so that it measures up-and-down movement of tire as wheel is rotated (1). Excessive side-to-side runout may be caused by a bent or out-of-round rim. To measure it, position dial indicator as shown (2), and rotate wheel. An out-of-spec rim must be replaced. It cannot be repaired. Consult your shop manual for specs and exact checking procedures for tires and rims.

Standard dial indicator for automotive use measures in the thousandths of an inch. One revolution of the large needle, from zero to zero, indicates 0.100 in. Ten revolutions would be one inch. The small needle indicates the number of revolutions made by the large needle. For example, if the large needle has made three revolutions (0.300 in.), the small needle would point to the number three. Each increment on the scale for the large needle represents 0.001 in. If the needle moved from, say, zero to 20, that would indicate 0.020 in. A metric dial indicator for automotive use measures in hundredths of a millimeter (a millimeter is 0.0394 in.). One revolution of the large needle, from zero to zero, indicates one millimeter. The small needle indicates the number of revolutions made by the large needle. Five revolutions of the large needle would put the small needle at five mm. If the large needle moved from zero to 20, that would indicate 0.20 millimeters. Shop manuals for most U.S. cars give specs in thousandths of an inch. Many foreign car manuals give metric specs.

Reading a dial indicator



Innovations

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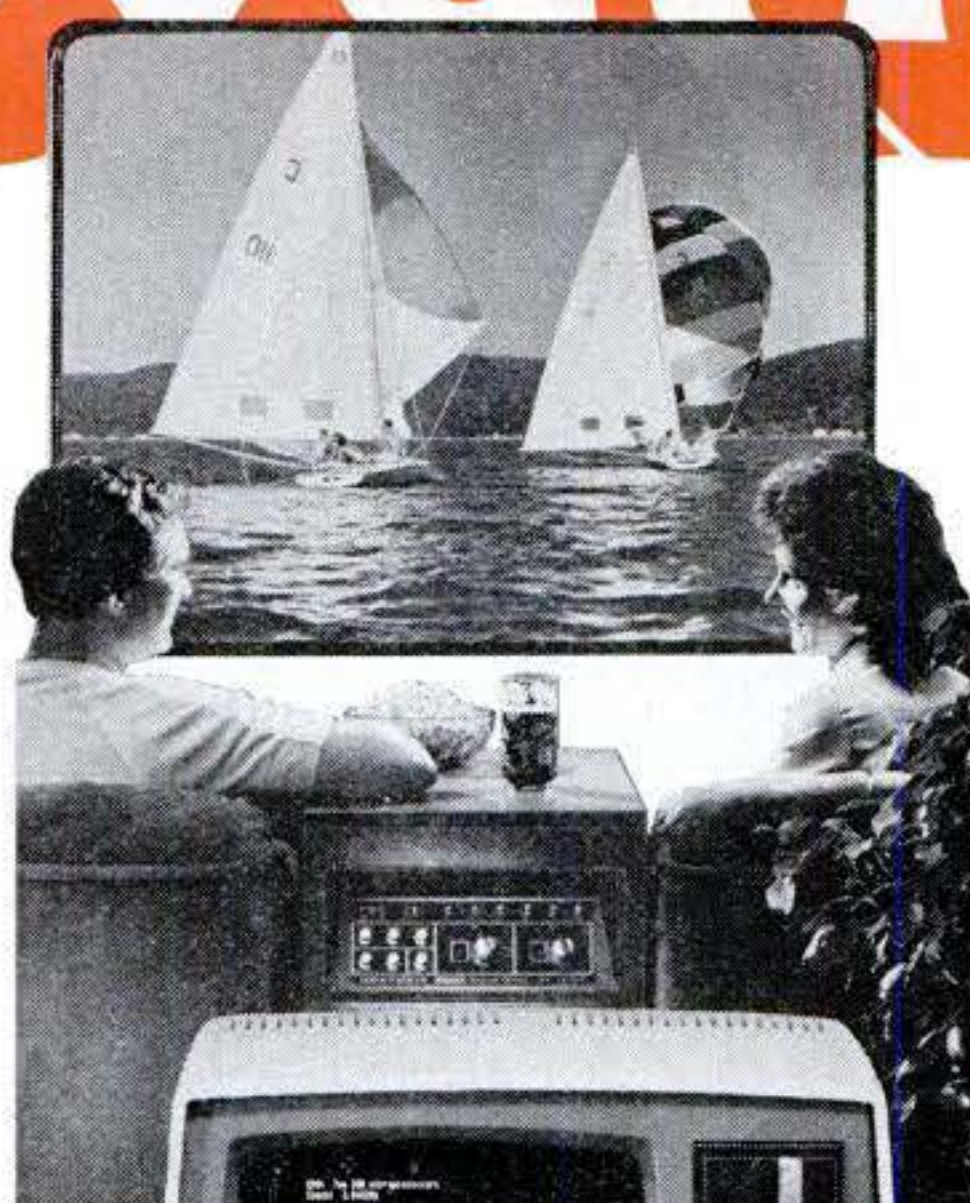
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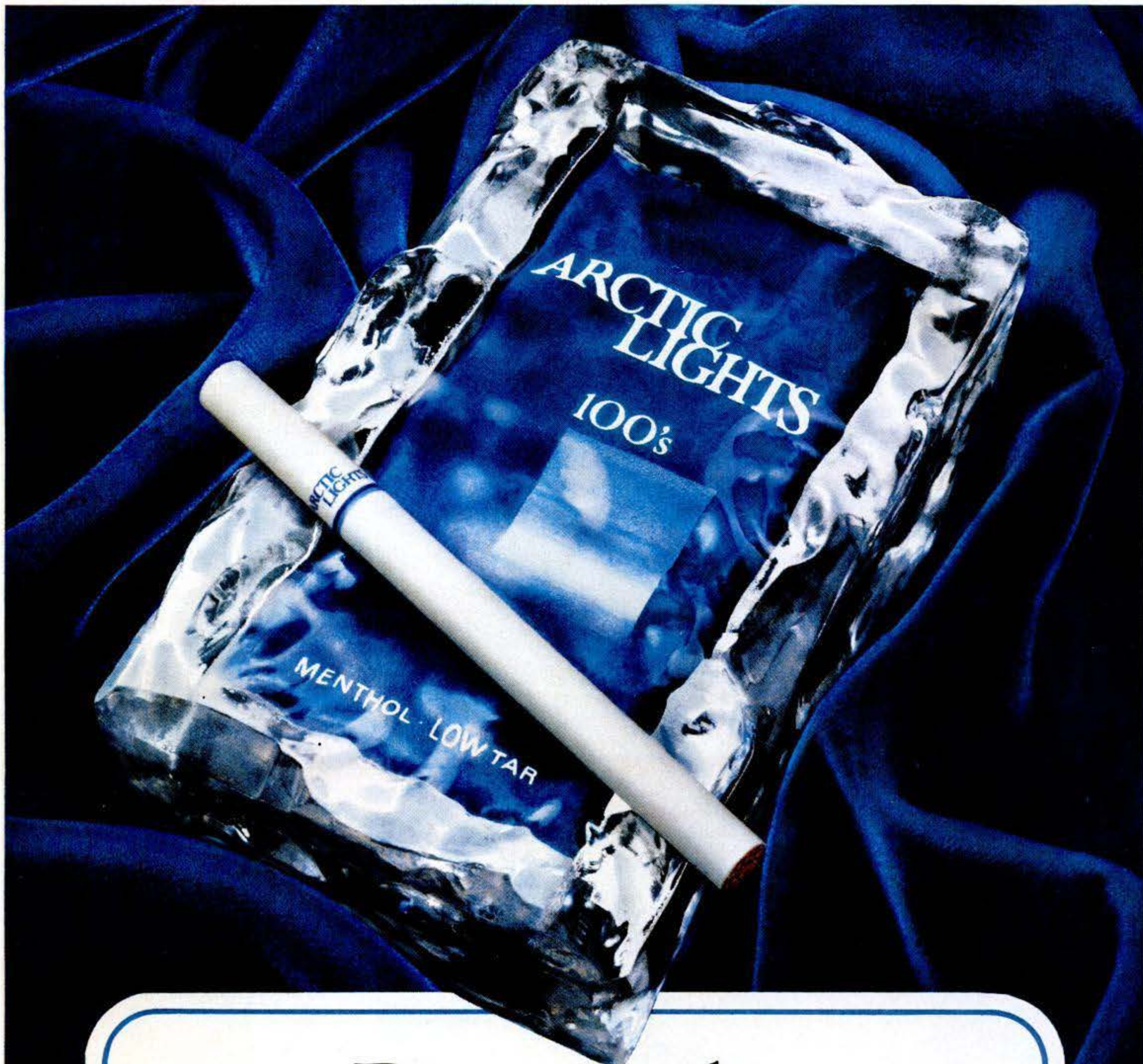
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Rid your glass doors of between- panes fogging



Unightly condensate between the panes of double-glazed patio doors can usually be cured with a low-cost home remedy.

By **THOMAS A. GAULDIN**

Double-glazed patio doors are certainly more energy-efficient than the single-pane variety, but they are subject to an annoying problem: condensate between the panes. The most common type of door (see diagram) has two panes of glass separated by a hollow aluminum mullion. The mullion is filled with silica-gel granules to dry the air between the panes continually. This sandwich is sealed with a vinyl gasket and caulking.

Eventually, the seal can break, however, and the silica gel become saturated with moisture. That's when condensate begins to form. But with a little work, you can cure the problem. You'll need to take apart the whole assemblage, dry out the silica granules, and put the sandwich back together with new sealant. Here's the step-by-step procedure.

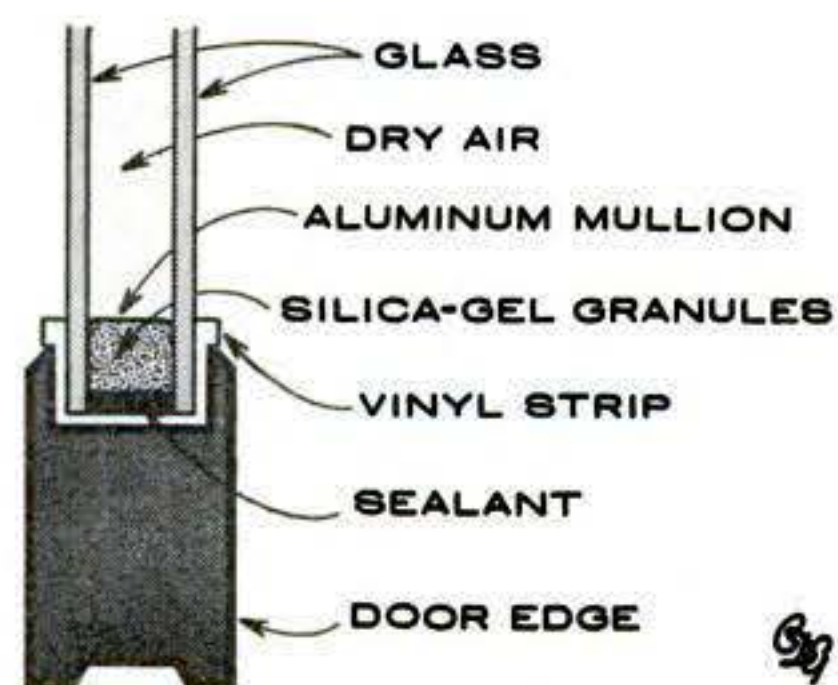
Begin by removing the screen; turn the screws at the bottom to relieve the tension on the rollers. Loosen the sliding section of the glass door in the same way. To remove it from the track, use a flat pry bar with a block of wood as a fulcrum. You'll need a helper; these panels are heavy and cum-

bersome. If the fixed door section is fogged, remove the clamps on the jamb side, force the door away from the jamb with a screwdriver, and then slide it far enough to expose and remove the two small blocks at the top of the frame. Use your pry bar and fulcrum to take out the door. Place it on sawhorses or on the ground. If sawhorses are used, make sure the metal edges, not the glass, rest on the supports.

Remove the edges; then pull the vinyl gasket gently away from the glass (see photo). Insert a thin, razor-type knife between the top glass and the mullion, and run it around the perimeter to cut through the old sealant. Remove the top glass. Next, cut loose and remove the mullion, pry it apart at the corners, remove the end caps, and pour the silica gel that's inside into a baking dish (avoid skin contact with the silica). Bake in a 400-degree oven for at least three hours to drive off the moisture and restore its desiccative abilities.

Clean and reassemble

Remove all traces of the old sealant from both glass and mullion with a razor blade and a rag saturated with lacquer thinner. (Wear goggles and do



Most common type of double-glazed patio door looks like this in cross section. This type can be disassembled and rejuvenated if moisture gets in. A more expensive type, however, uses glass that is sealed by fusing together the edges of the two panes at high temperatures with additional molten glass. Such glazing seldom loses its seal, but if it does, nothing can be done to dry it. An inspection will tell you which type you have.

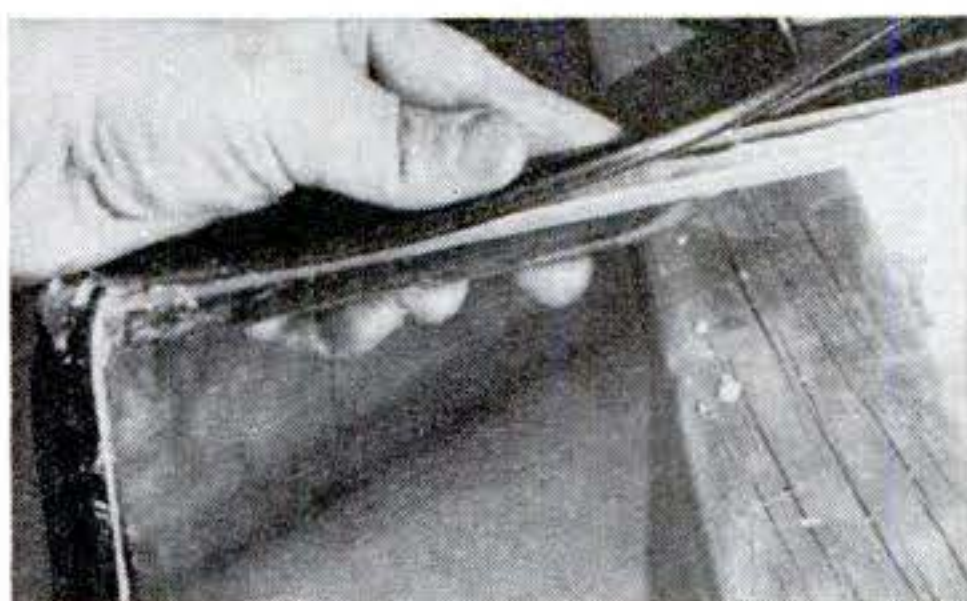
not smoke.) Finally, wash the glass with a solution of one-half cup ammonia per gallon of water; polish with crumpled newspaper.

When the silica is baked and cool, pour it back into the mullions. Reassemble the mullion with the perforations facing inward. With a caulking gun, place a $\frac{3}{16}$ -in. bead of silicone sealant around the inside edge of the bottom sheet of glass. With a helper, carefully lower the mullion onto the sealant and press lightly. Then run a bead of sealant on top of the mullion and lower the top sheet of glass onto it. Check position with a small square. Run a larger bead of sealant around the edge and replace the vinyl gasket, pressing it gently into the fresh sealant (see photo); the splice in the gasket should be at the top. Next replace the metal edges of the door and put it back into the frame.

How much did you save? A tube of sealant costs about \$4; a new six-foot door assembly costs about \$300. **ES**



Remove metal edging—sides first, then top and bottom. You may need to tap them gently with a mallet and wood block. Peel off the gasket and keep for reuse.



Bond gasket to glass with new sealant. With fingers, work sealant into space between glass and mullion and $\frac{1}{4}$ in. over edges. Remove excess after 24 hours.

SHOP TALK

By RICHARD STEPLER



That's packaging

The next time you go to the hardware store to buy a box of screws, nails, or other fasteners, you may see one of the systems shown above instead of the familiar array of blister packages. Each package of hardware is actually a drawer that slips into a plastic storage cabinet sold as part of the system. At present, there are two versions:

- Stanley calls its entry the Assembly Line (top photo). It includes 280 items in two sizes of clearly labeled drawers, each with a transparent lid. A storage cabinet (the Organizer) holds 15 drawers, costs \$1.79 (empty). Prices of the drawers of fasteners: 59, 69, and 79 cents. Drawbacks: There's wasted space because the drawers don't entirely fill the cabinet. And you must remove the lids before you slide the drawers in. I'd prefer to leave 'em on so I'd have spillproof containers to carry to the job.

- The Drawer'N Store system (bottom photo) is imported from Germany by Suki International (8000 Cooper Ave., Glendale, N.Y. 11227). It's a bit more elaborate than Stanley's, with two sizes of interlocking cabinets and six sizes of drawers. Suki's cabinets cost \$1.99 (empty), and drawers of fasteners range from 49¢ to \$1.19. You can leave the lids on the drawers in this system, and the drawers slide into the cabinet with no wasted space. Either system is a great improvement over a tumble of baby-food jars.

A new name

You'll be seeing a new brand of abrasives and related products in hardware stores and home-improvement centers soon. The Norton Co., which has been in the industrial-abrasives business for more than 90 years, is now offering its products to consumers. Norton's line includes sand-



paper, grinding wheels, cutoff blades, sharpening stones, adhesive-backed sanding discs, plus safety goggles, respirators, and dust masks.

Wood-stove safety

As more homeowners install wood stoves, more home fires are being attributed to these appliances. The Consumer Products Safety Commission says that improper installation and misuse of the stoves is responsible for the growing problem. (POPULAR SCIENCE has regularly alerted its readers to wood-stove dangers, most recently in PS, Nov. '77, Oct. '78, and Oct. '79.)

Insurance companies, needless to say, are also concerned; the Insurance Information Institute offers these rules for the safe use of wood stoves:

- Provide proper clearance between the stove and *any* combustible material.

- Place the stove on a fireproof base.
- Make sure the stove is made of a sturdy material such as cast iron or steel.

A pamphlet with more tips is free from the Institute (110 William St., New York, N.Y. 10038). Include a self-addressed, stamped envelope.

Gripping gloves

Cling Grip gloves have a rubber-polymer textured, nonslip surface that should



be great for handling brick, concrete block, lumber, or any other rough surface. They also keep broom and rake handles from slipping and causing blisters. A dozen pairs cost \$21 from Advance Glove Mfg. Co., 901 W. Lafayette Blvd., Detroit, Mich. 48226.

That's packaging II

This new packaging for sandpaper falls in the same category as the Stanley and Suki



fastener systems—the "give 'em something to keep it in" school of useful products packaging. (This looks like a promising trend.) Howard Hardware Products' contribution is a 25-sheet package of sandpaper that hangs on the perfbord in your workshop or stores flat on a shelf. A self-dispensing opening in the top lets you remove individual sheets. An open window in the pack lets you feel the finish of the sandpaper, and the packs are color-coded for "instant recognition." You've a choice of aluminum oxide, garnet, wet or dry, and no-load, in nine-by-11-in. sheets, discs, or orbital sanding sheets. **PS**

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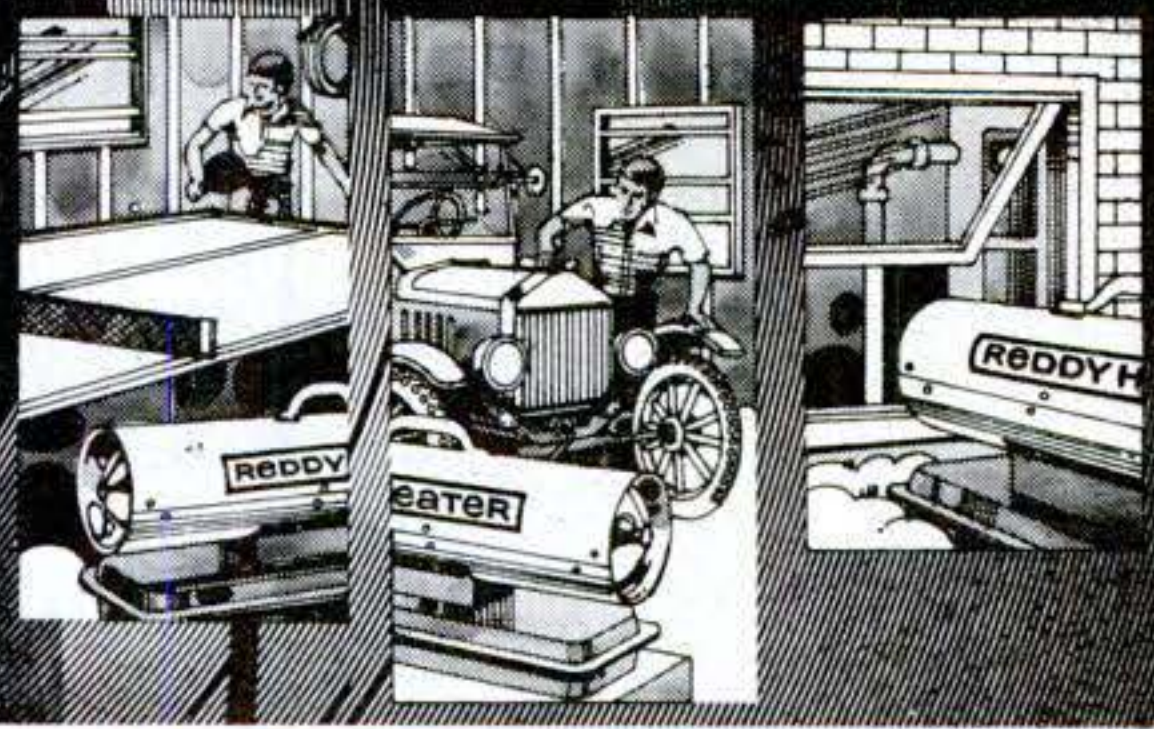
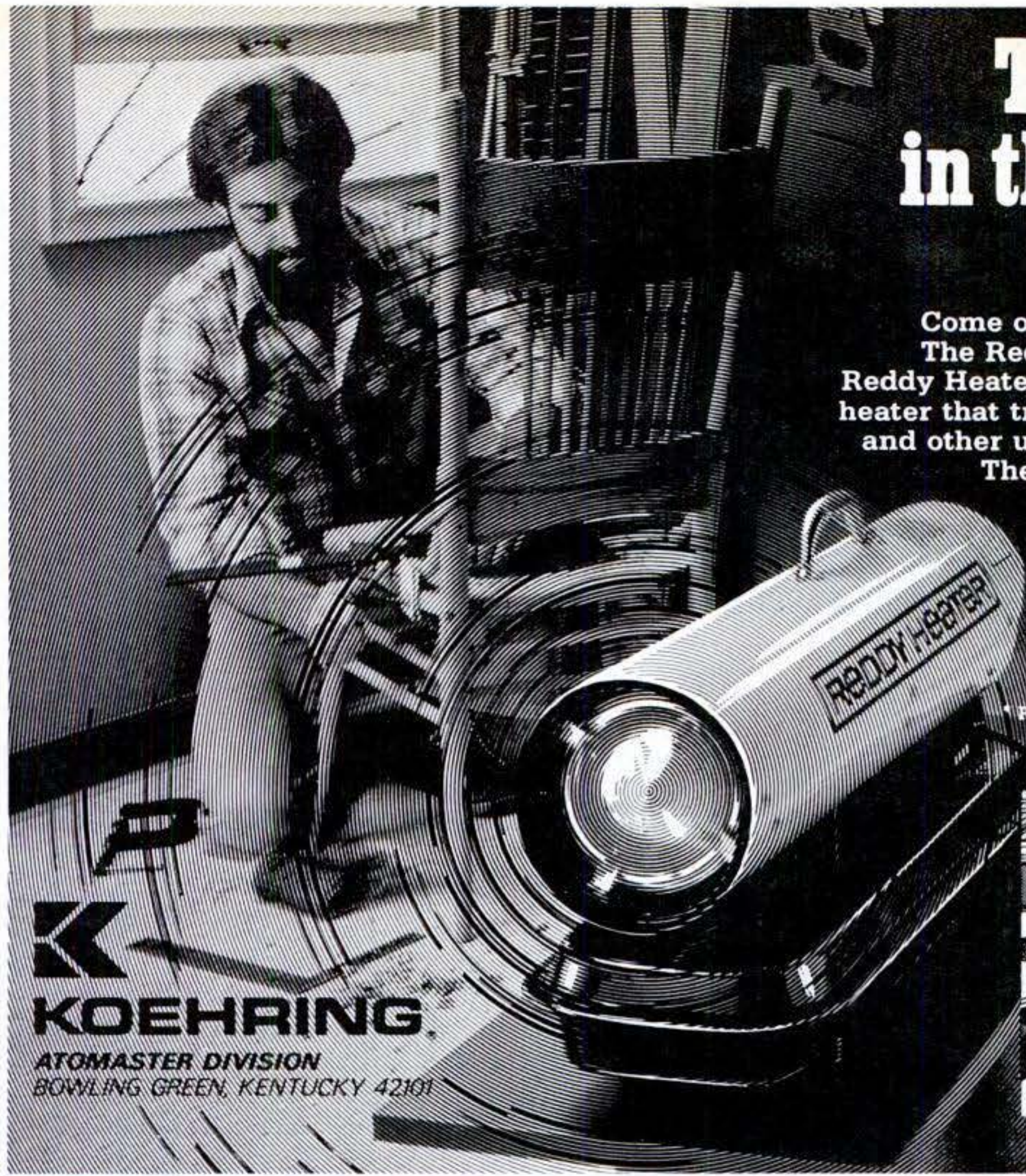
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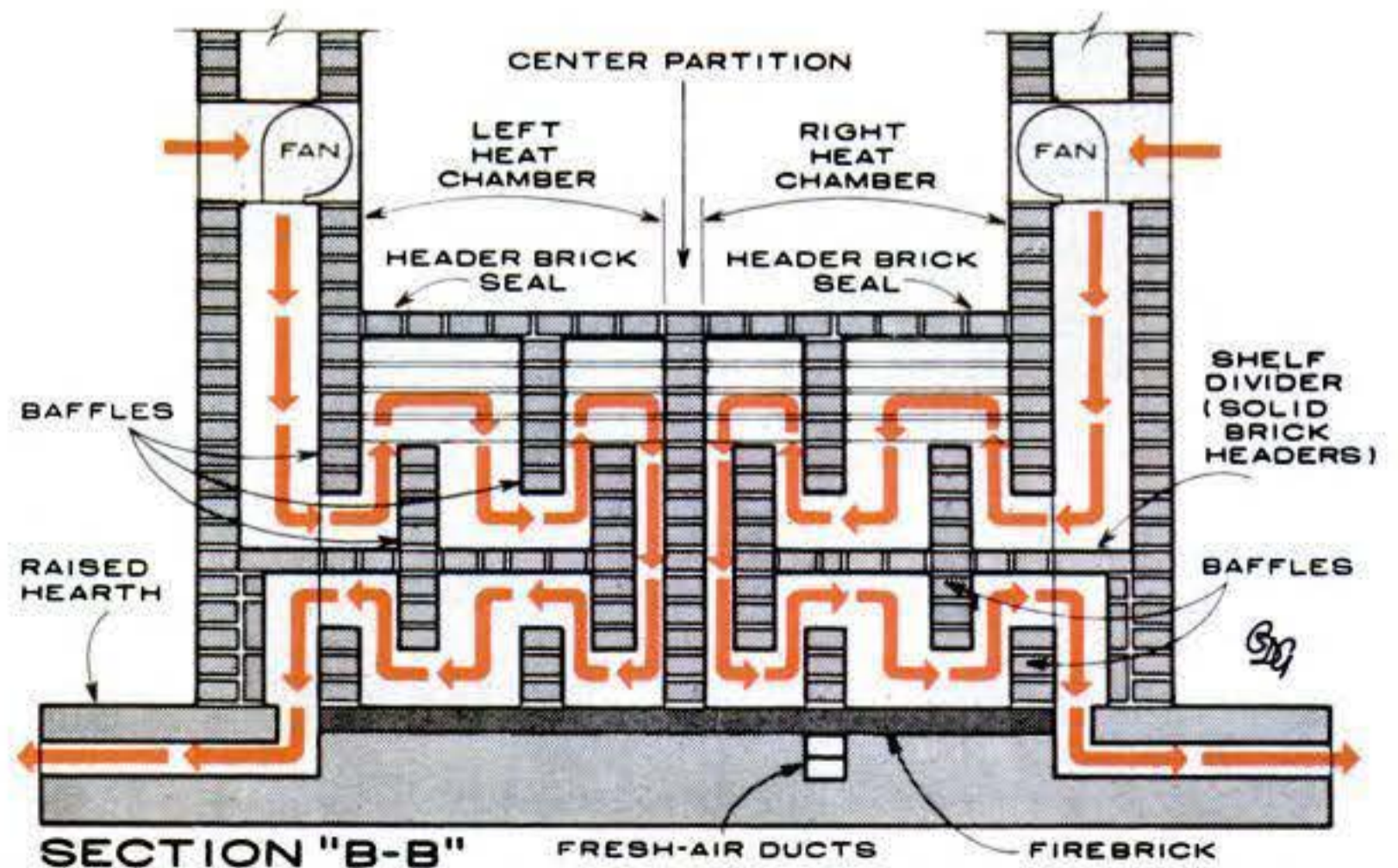
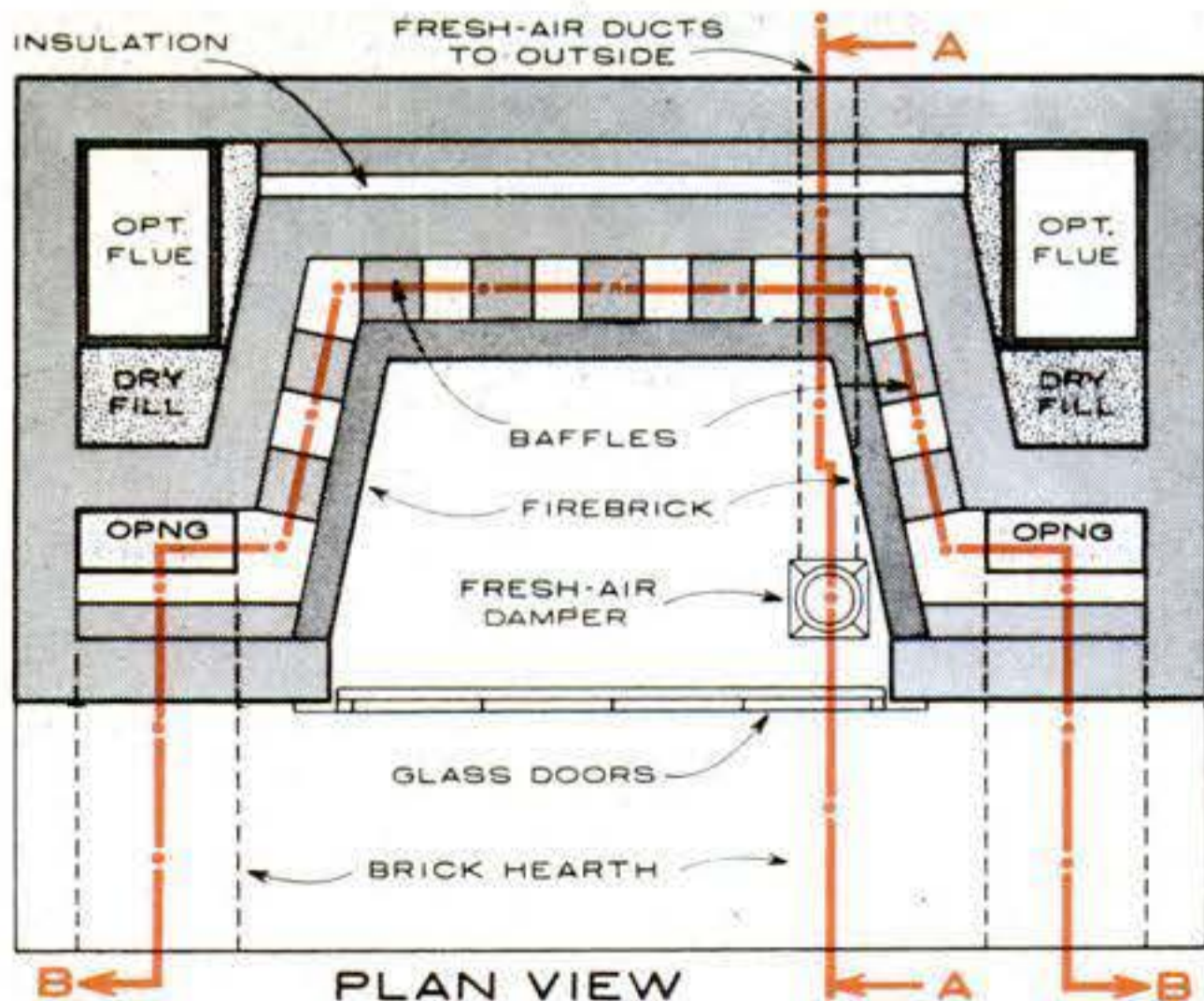
Heat-circulating brick fireplace

By RICHARD STEPLER



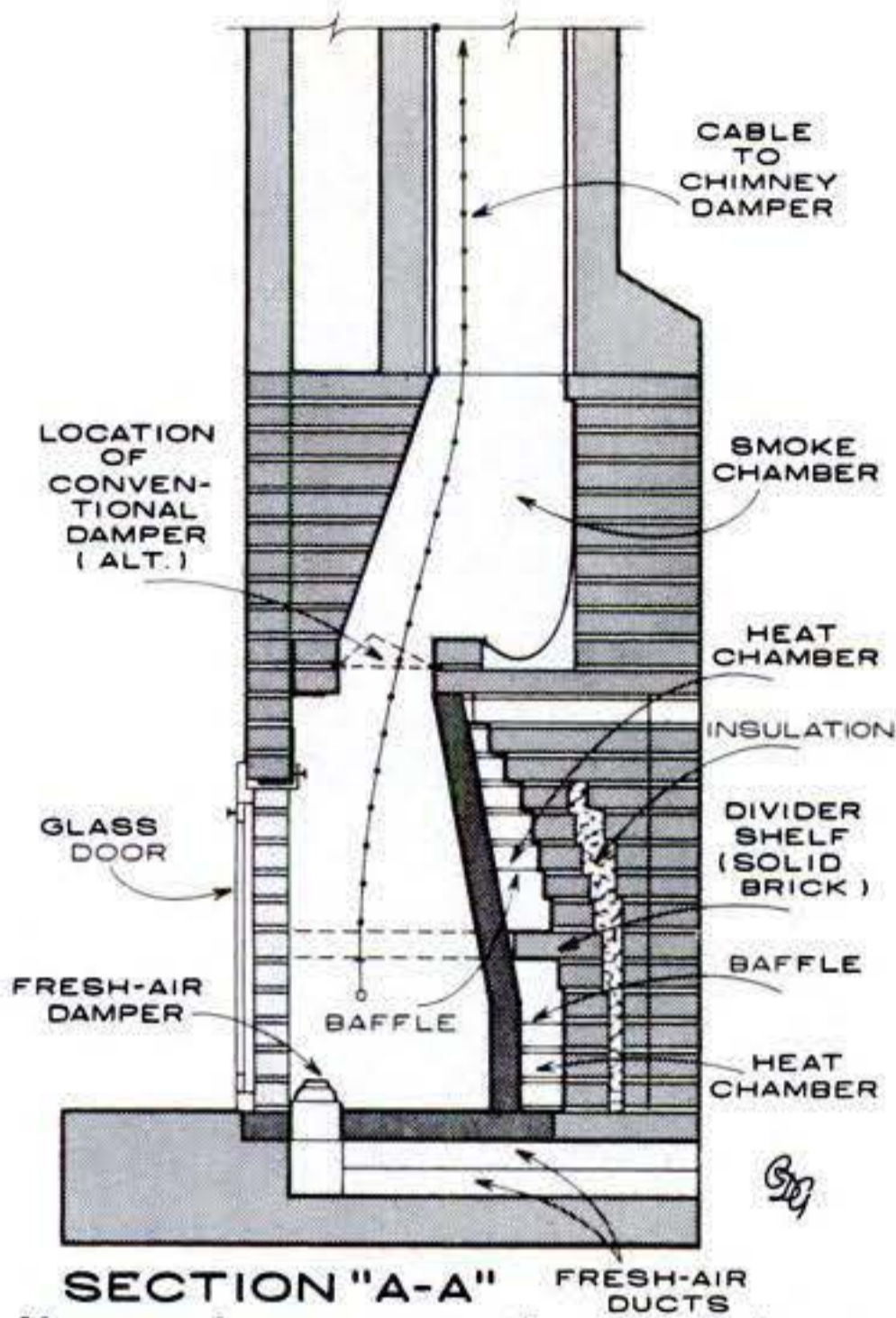
It looks like any other brick fireplace. Only four grilles (visible above the mantel and at the base of the hearth in the photograph) hint at what lies inside this energy-saving version: Double-wall construction sandwiches a series of baffles that provide a serpentine path for room air to follow and pick up heat held in the fireplace's brickwork. Other energy-saving features of the fireplace:

- Ducts bring combustion air directly from outside the house. This eliminates drafts and keeps the fire from being "starved" in a tightly sealed, well-insulated house.
- Glass doors prevent heated room air from escaping up the flue. You can close them when you retire without fear of sparks jumping from the dying fire.
- Two thermostatically controlled blowers inside the brickwork force room air through the fireplace and out into the room. In fact, heated air could



Spotlights accentuate brick's warmth (photo). Behind heat-circulating Brick-O-Lator fireplace's face, there's a serpentine series

of baffles (drawings) to heat room air efficiently. Two blowers, also inside fireplace, circulate heated air.



SECTION "A-A" FRESH-AIR DUCTS
 You can choose conventional or chain-operated flue-top damper for Brick-O-Lator.

be sent to another room via insulated ductwork.

Dubbed the Brick-O-Lator by the Brick Assn. of North Carolina (Box 6305, Greensboro, N.C. 27405), the fireplace can be built from plans available at your local brick manufacturer or from the association.

How it works

The fire, blazing behind glass doors, heats the firebrick and the system of baffles. The blowers, controlled by thermostat, draw room air through the upper grilles, force it through the series of baffles, and out into the room through the lower grilles. The fresh-air vent, located on the floor of the firebox, is adjustable so you can regulate the fire's intensity and slow down the burning rate.

Construction begins with the base, which includes three ducts: outside combustion air duct (two short lengths of steel downspouts); and two warm-air exhaust ducts (openings may be to the front or sides of fireplace). The firebrick floor and walls are laid using full mortar joints that are as thin as possible. The heat chambers, with their baffles, are laid directly behind the firebox. The balance of the brickwork is as shown in the drawings. PS

LIST OF MATERIALS

3350 bricks, including 310 face brick for profile (brick quantity for fireplace and hearth is figured from floor line to ceiling only). (1) 36" damper (or Lyemance chimney-top damper). (1) metal lintel 1/4" by 3" by 5" by 50" long. (1) metal lintel 1/4" x 3" by 5" by 44" long. (2) galvanized metal downspouts 3" by 4" by 32" long (for outside combustion air ducts). (1) glass fireplace door for 30" by 36" opening. Special equipment kit (available from brick manufacturer or from IXL, Inc., Box 21605, Greensboro, N.C. 27420) includes: (2) blower boxes with 265-cfm fans; (2) grilles with on/off switches; (1) wall-mounted thermostat; (2) warm-air registers; (1) fresh-air damper; (1) set of plans.

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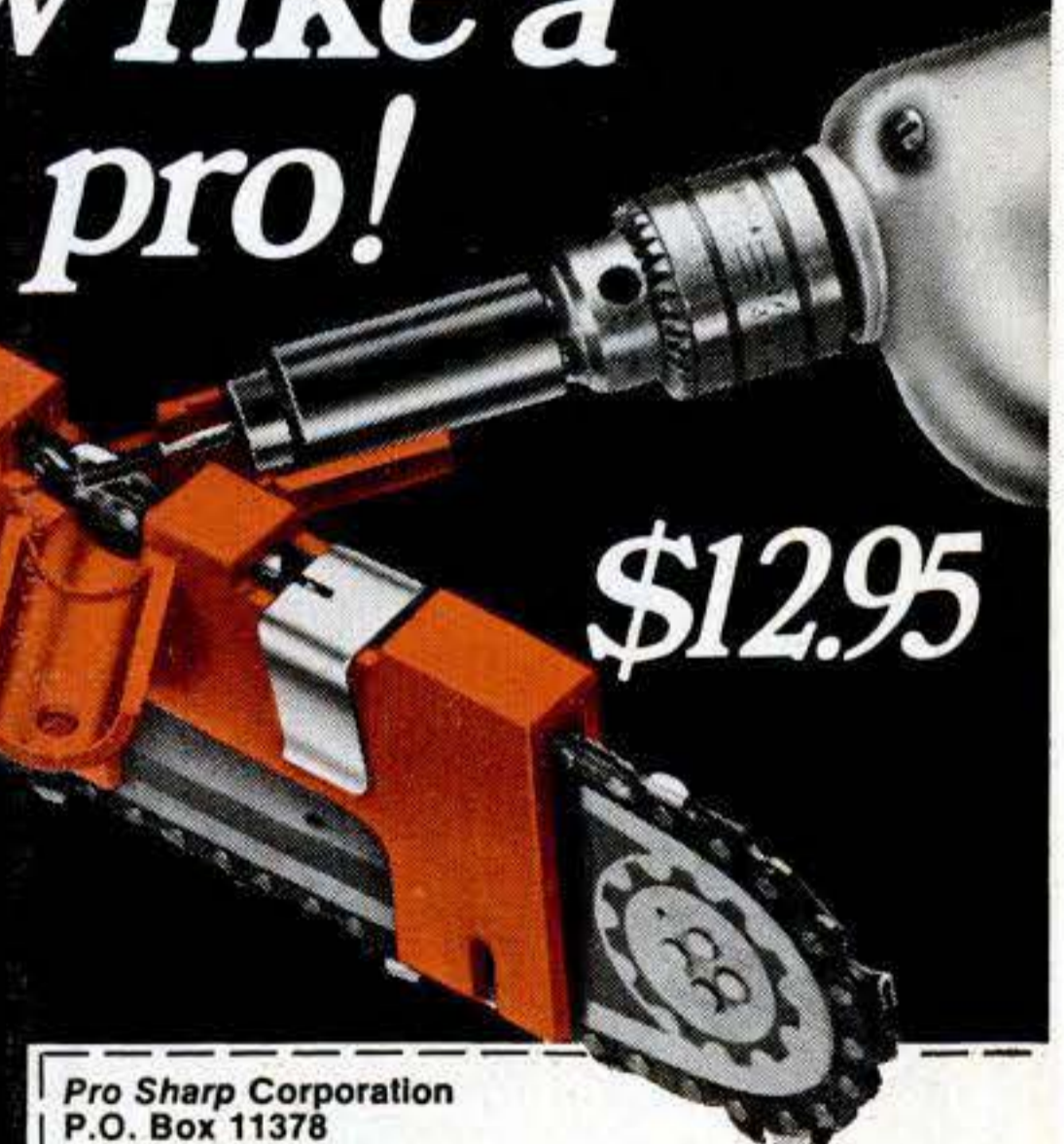


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Two-faced closets

you can add to your home

Running out of storage space? Double the utility of add-ons by putting doors on both sides

By **JOHN FREE**

DRAWINGS BY CARL DeGROOTE
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Do you find yourself going in circles in your house to locate or store something in a closet? Are you greeted with

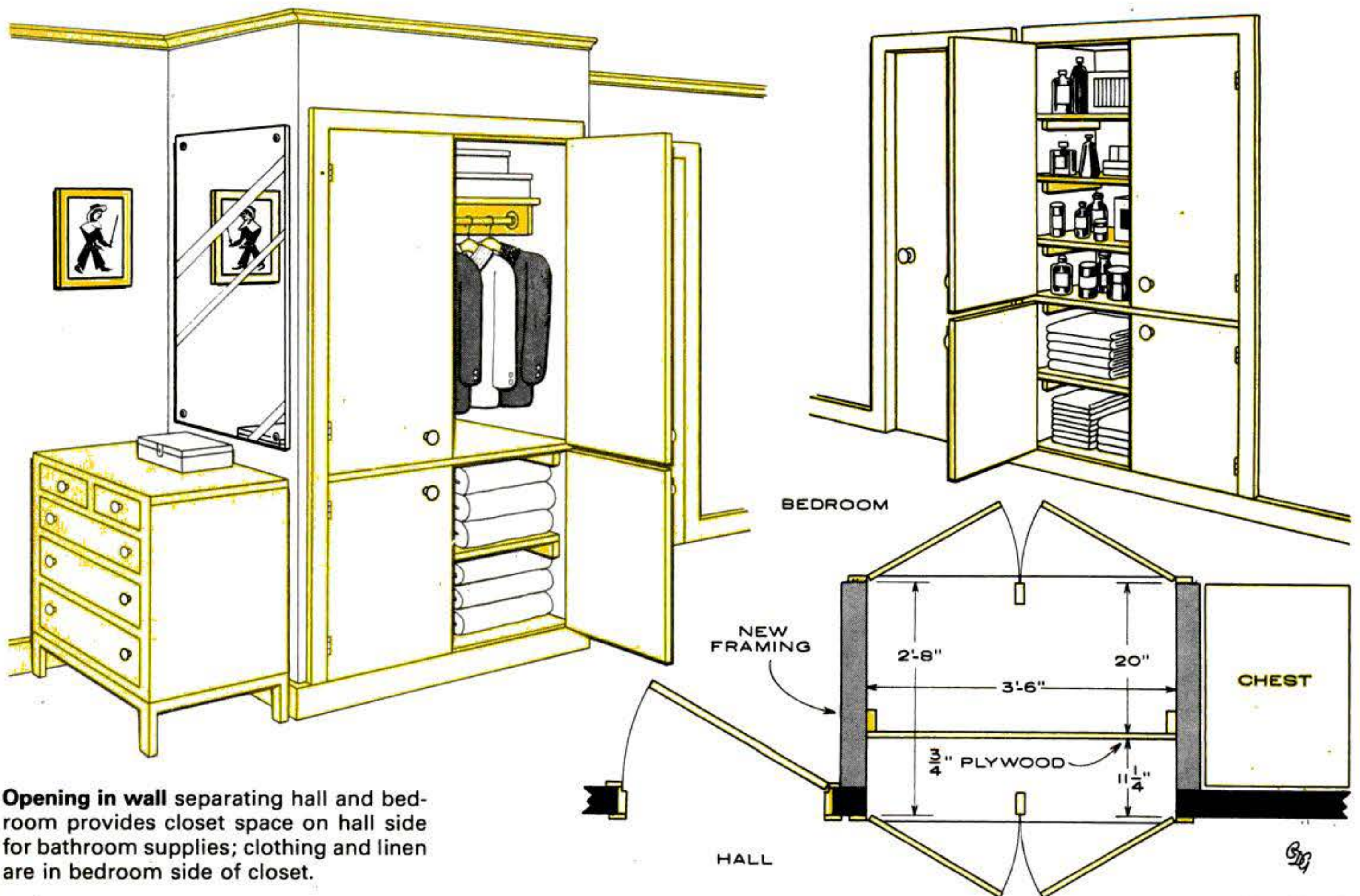
an avalanche of suitcases, cardboard boxes, sporting equipment, and mop handles when you open a closet door? Then you know it's time to add extra storage space.

But before you break out your power tools, look over Carl Sigman's designs on these pages, and figure out how to make your add-on closets doubly useful. If you plan to cut through a partition wall to provide room for a closet, why not install closet doors and shelves on both sides of the wall?

With this technique, for example, if

you cut through a partition between a bedroom and hallway, one side of the closet can store bathroom supplies and towels, while the bedroom side can hold blankets, sheets, and clothing. Such a design, shown below, requires some advanced planning to allocate space according to expected use. In this case, the bathroom-supply section has less than a foot of shelf depth, while the bedroom-closet shelves and the garment section are 20 inches deep.

If you can remove a section of parti-

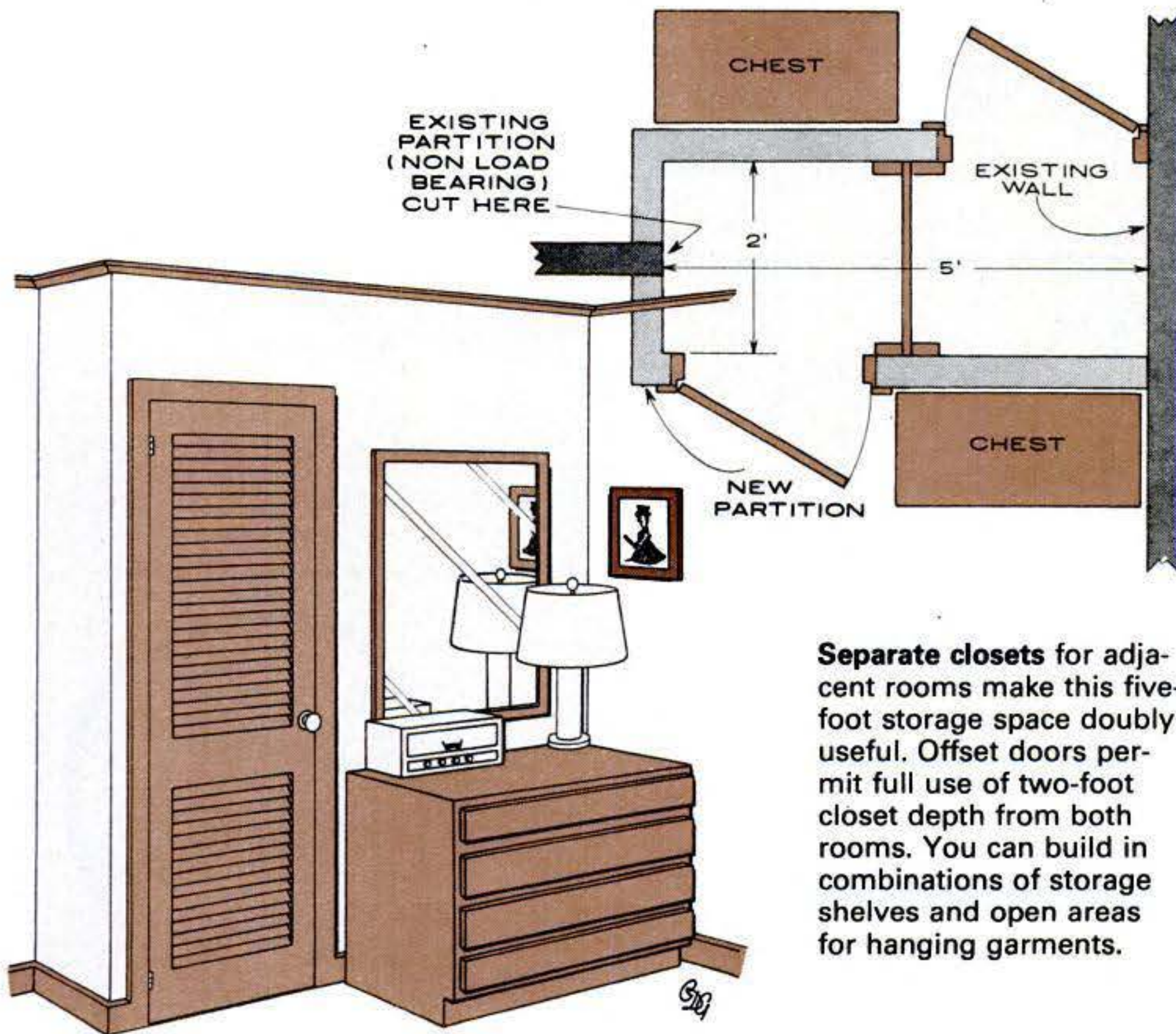


Opening in wall separating hall and bedroom provides closet space on hall side for bathroom supplies; clothing and linen are in bedroom side of closet.

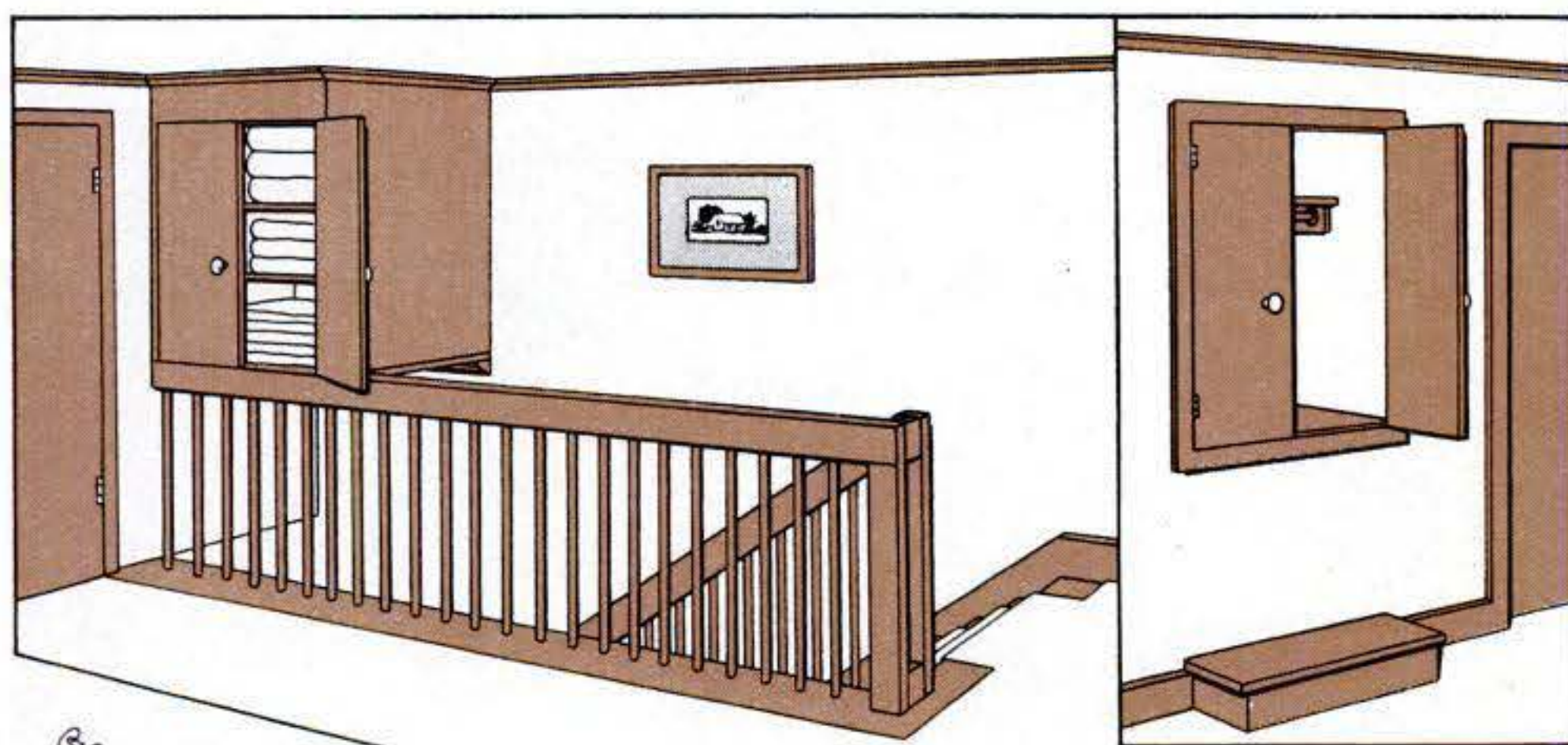
Two-faced closets

tion up to about 12 feet, a variation of the adjacent-room closets sketched below might involve separating the closets with a dressing table and mirror in one of the rooms. Finally, to

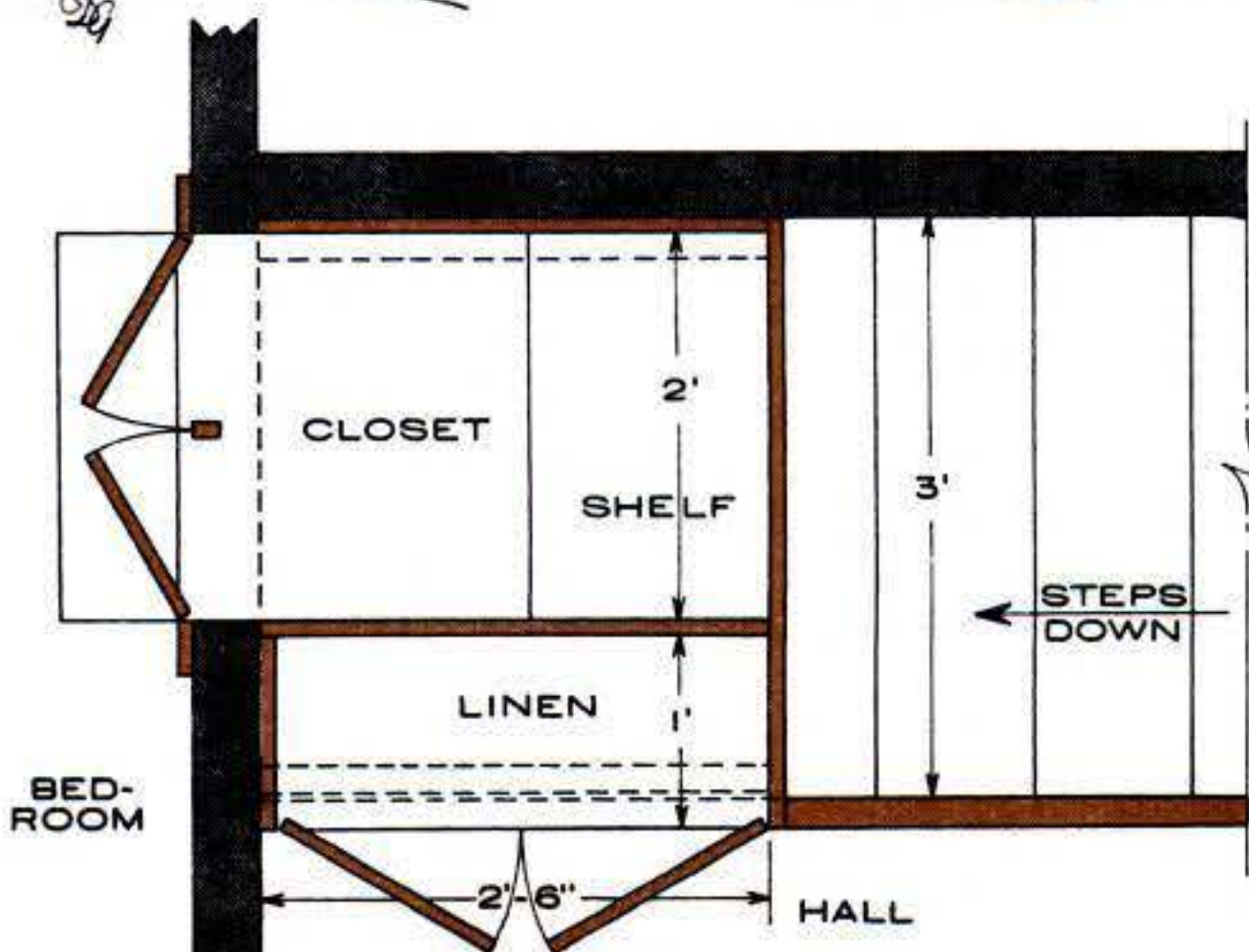
keep partition trimming to a minimum, the overstairs design shown here may help solve your storage problems. It makes clever use of space that ordinarily goes unnoticed. **E**



Separate closets for adjacent rooms make this five-foot storage space doubly useful. Offset doors permit full use of two-foot closet depth from both rooms. You can build in combinations of storage shelves and open areas for hanging garments.



Overstairs closet puts inaccessible space to use. This two-face approach provides storage space in a hallway for linen, and access to separate shelves from another room. Add-on minimizes partition removal, since cuts for closet doors within room are the only modifications needed.



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Trouble-shooting with an ohmmeter

By **RAY HILL**
 and **STEVE MERCALDO**
 SKETCHES BY GENE THOMPSON

An ohmmeter is a valuable tool for electrical trouble-shooting. It can be used to check spark-plug cables, ignition coils, the pick-up coil in an electronic-ignition distributor, radio antennas, and many other items.

An ohmmeter puts to work Ohm's law, which states that current flow in a circuit is proportional to voltage and inversely proportional to resistance. A current in the circuit under test is induced by a small battery of known voltage. Thus, the less current flowing in the circuit, the higher resistance, and the ohmmeter's scale can be calibrated directly in ohms.

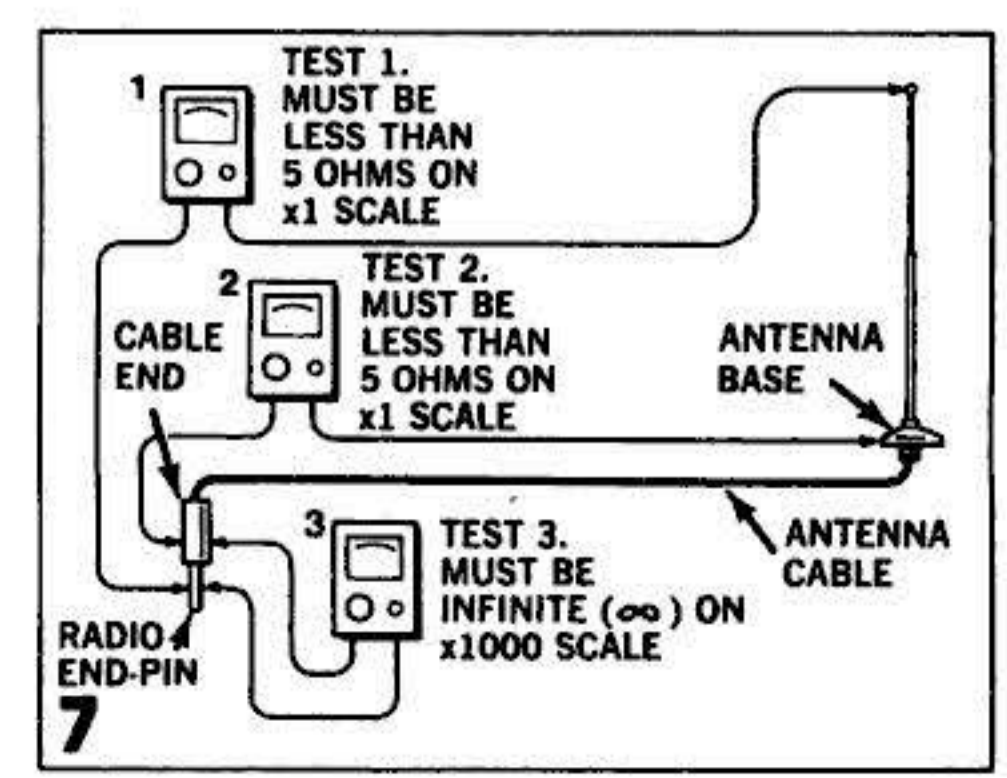
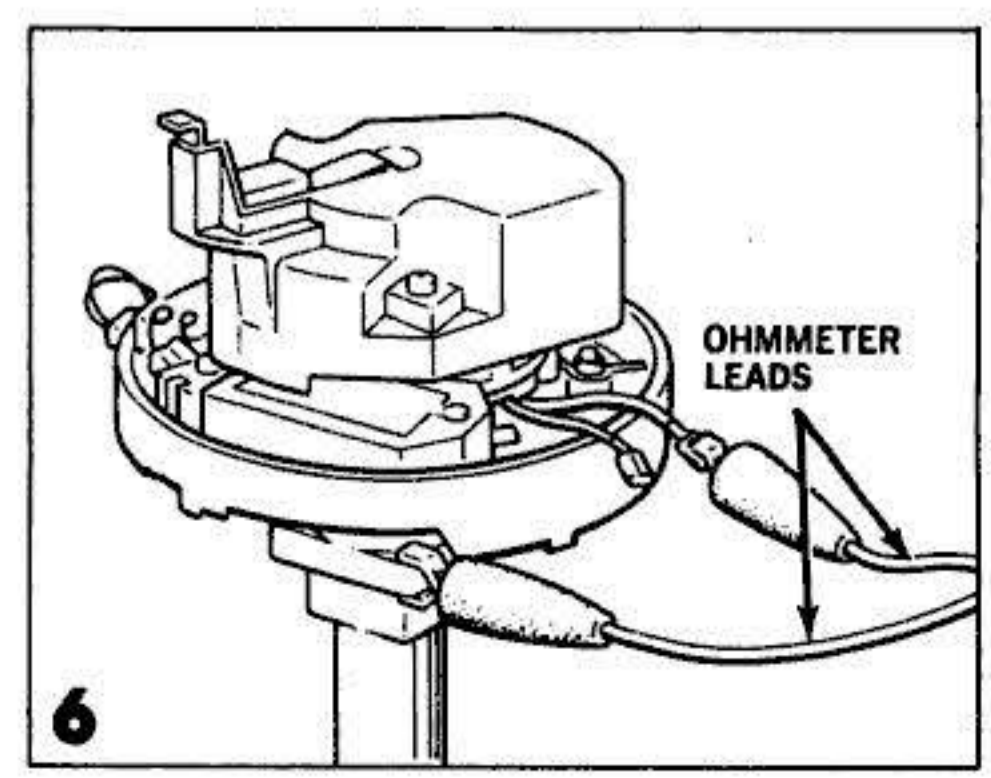
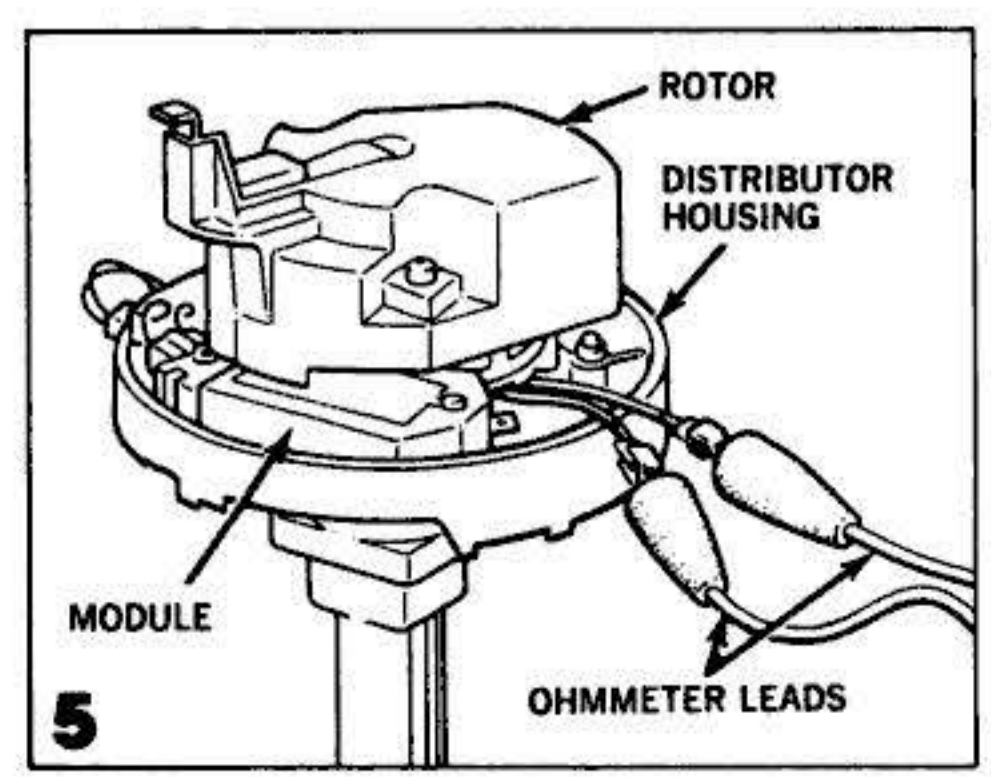
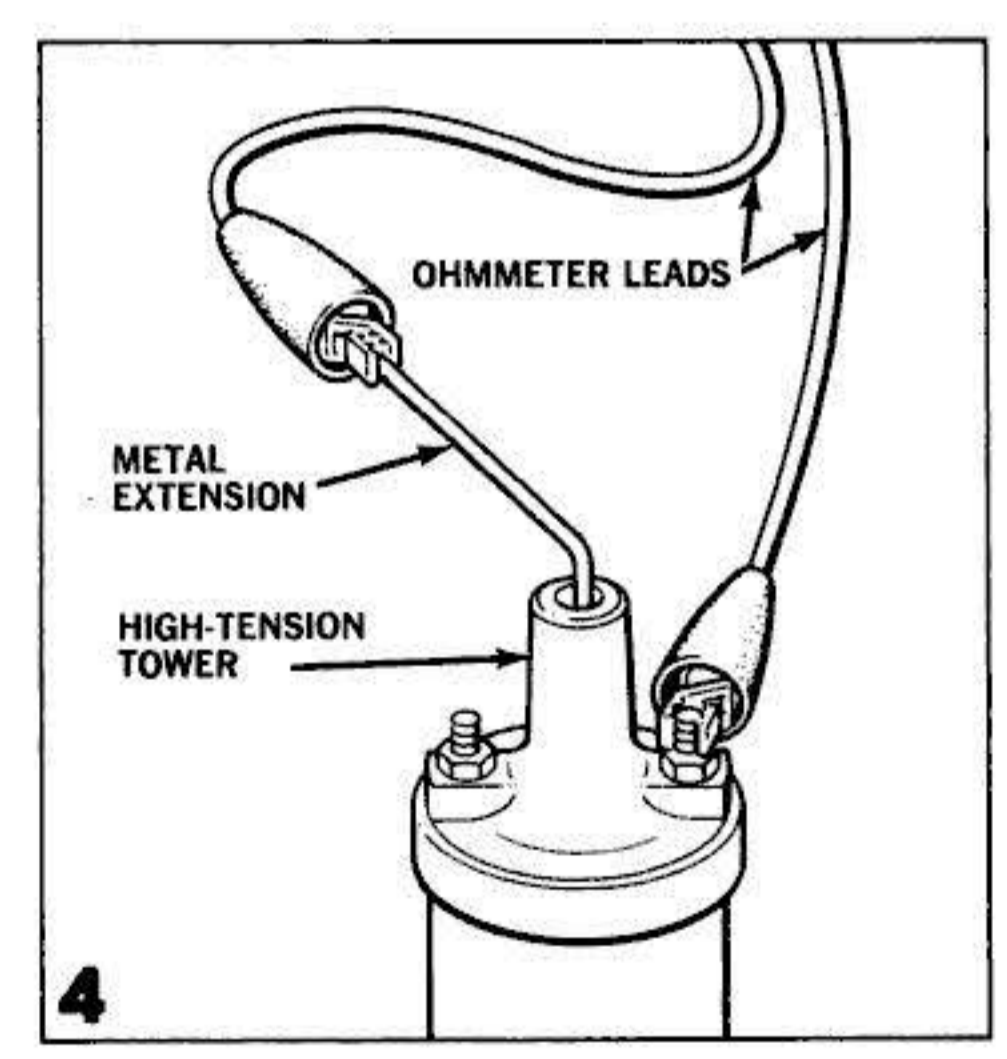
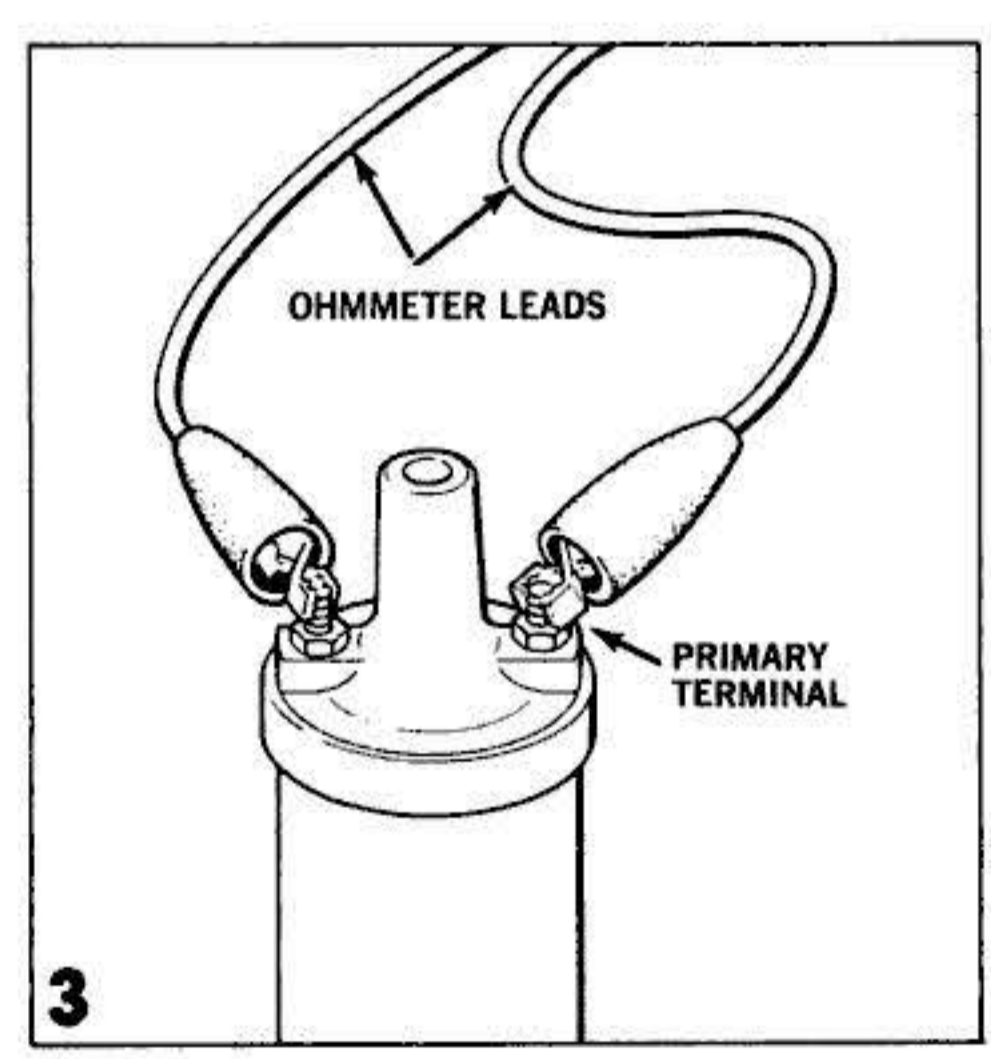
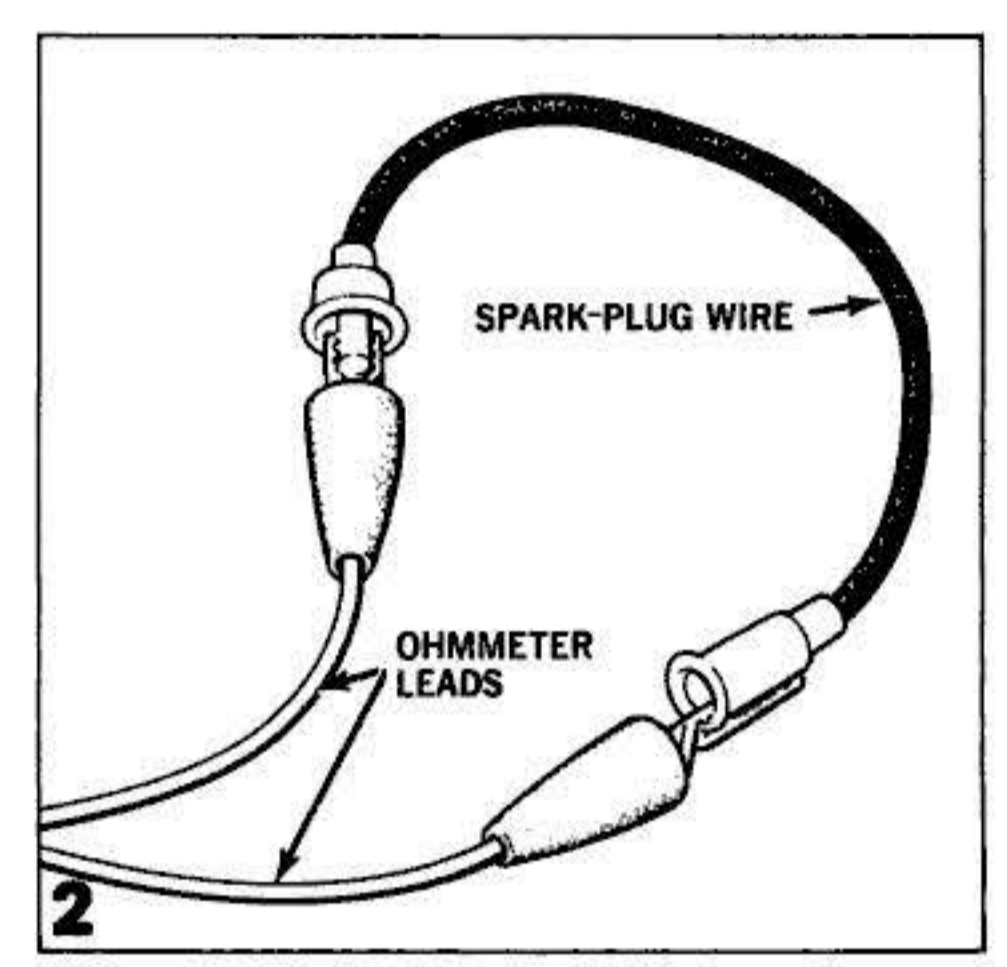
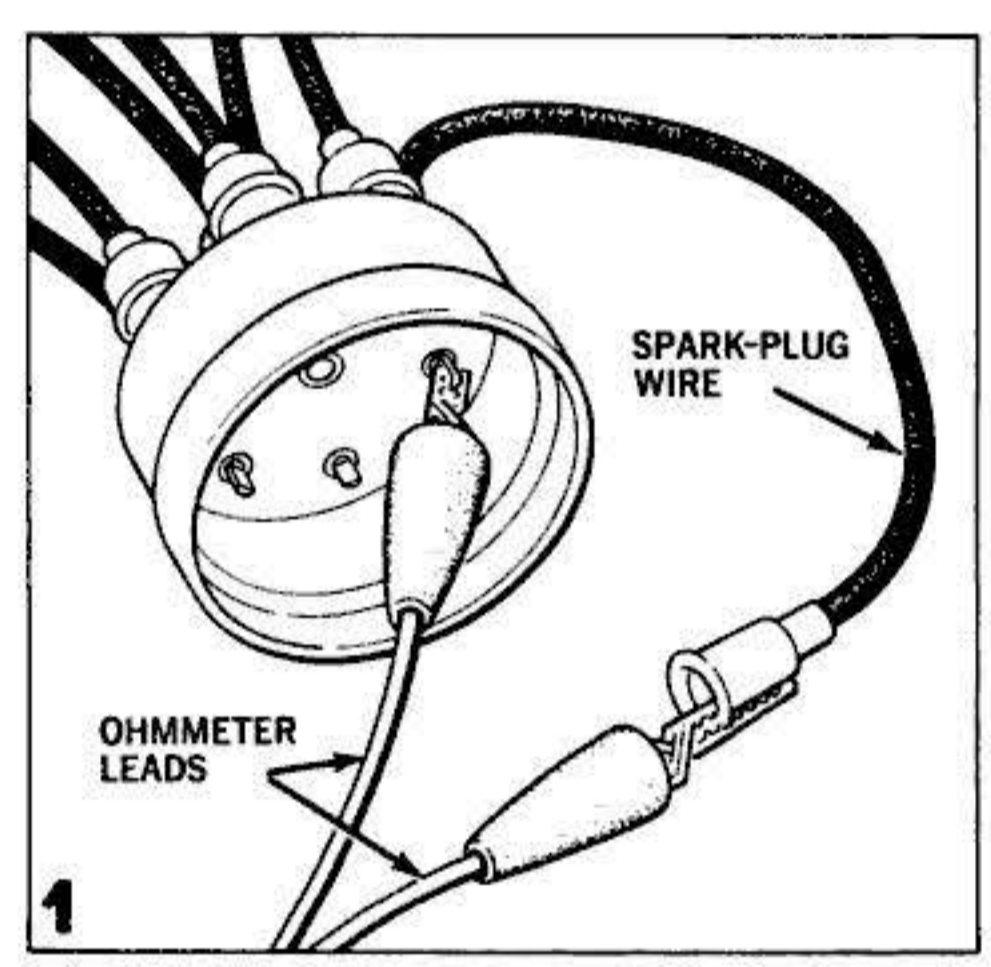
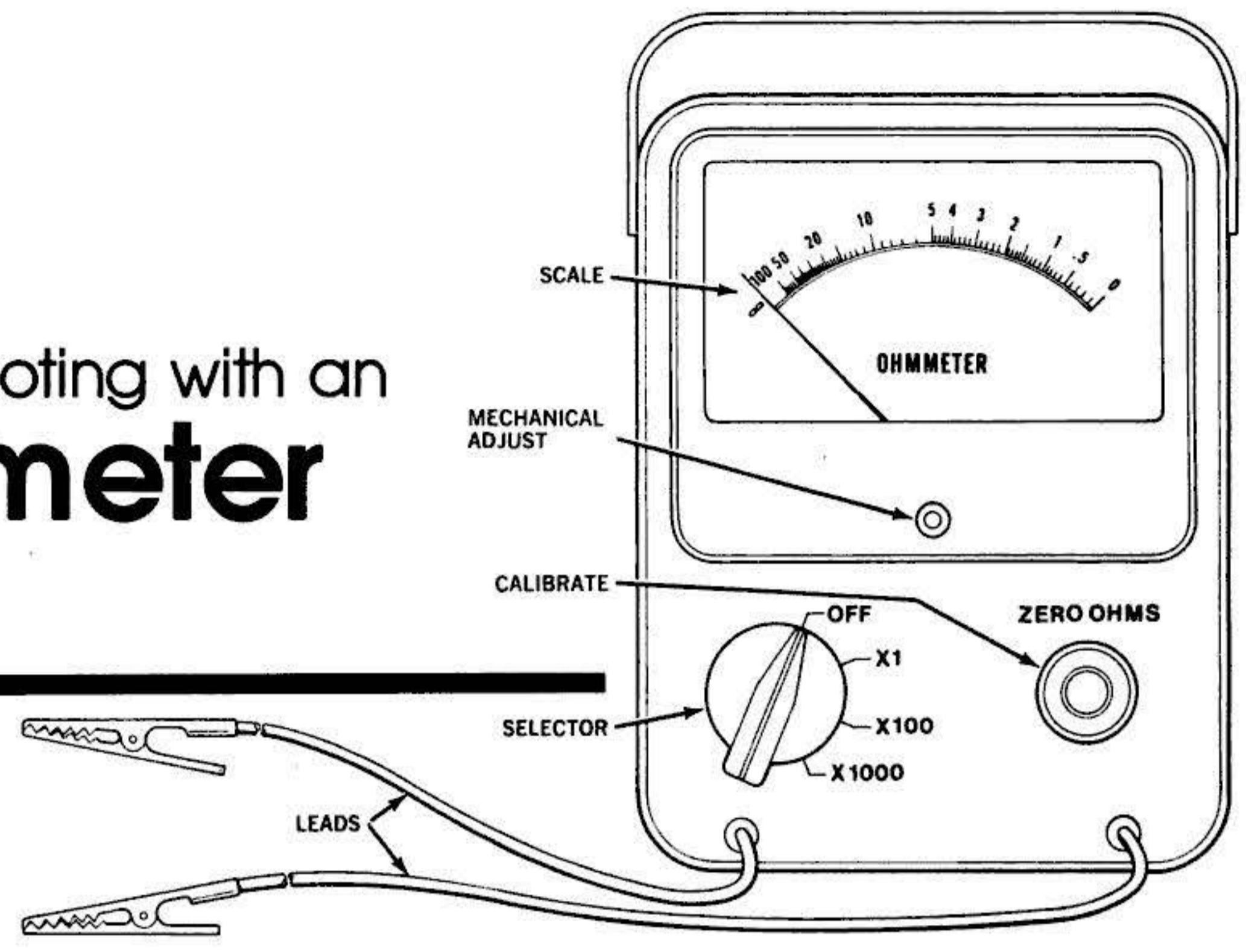
Problems begin in an automotive electrical circuit when resistance is too high (preventing adequate current flow) or too low (allowing too much current flow).

An ohmmeter should never be connected to a live circuit. This can cause an incorrect reading or even damage the meter. For accurate, safe test readings the wire or part of the circuit being tested must be electrically isolated from all other parts of the circuit. The easiest way to accomplish this is to disconnect all wires to the part or wire being tested.

Begin any test procedure by looking up in the car's shop manual the resistance of the part being tested. Next, select the correct ohmmeter range. The meter depicted here has three ranges: In range X1, the scale reads directly. In X100 you multiply the reading on the scale by 100, and in X1000 by 1000.

For example, a reading of 10 on the X1 scale indicates 10 ohms. On X1000, a read-

Continued



TEST 1. MUST BE LESS THAN 5 OHMS ON x1 SCALE

TEST 2. MUST BE LESS THAN 5 OHMS ON x1 SCALE

TEST 3. MUST BE INFINITE (∞) ON x1000 SCALE

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Ohmmeter

[Continued]

ing of 10 represents 10,000 ohms. Select a range that gives a reading as near the center of the scale as possible since that's where readings are most accurate. If you were checking, say, a ballast resistor that was supposed to have a resistance of five ohms, then you would set the meter on the X1 scale, which indicates resistance from zero-100 ohms.

After you have chosen the scale, turn the meter on and connect the two leads. Adjust the calibration knob until the needle reads zero. If you're unable to get a zero reading, check the battery. Also recalibrate when changing scales, unless the manufacturer of the meter directs otherwise.

Now you're ready to begin testing.

Checking spark-plug wires

Check your car's service manual for the spark-plug wires' resistance specs. Let's say it calls for 50,000 ohms. You would set the meter on the X1000 scale.

Remove the distributor cap from the distributor, but leave the plug wires attached. Remove a spark-plug wire from a spark plug and connect one lead to the spark-plug end of the wire and the other lead to the terminal inside the distributor cap that is connected to the wire being tested (see drawing 1).

Read the meter and compare with shop-manual specs. If the resistance of the wire exceeds 50,000 ohms, check to see if the wire is pushed all the way down in the distributor tower. Sometimes it's not, and pushing it in all the way can eliminate excessive resistance.

If the resistance is still too high, remove the wire from the distributor cap and measure the resistance of the wire alone—by attaching the two leads to either end of the wire (2). If the resistance remains too high, the wire is bad and you'll have to replace it.

If the resistance drops to normal, check for corrosion inside the distributor tower. A brush for cleaning the towers in the distributor and ignition coil is available at auto-parts stores. Also, inspect the inside of the distributor cap for corrosion and for cracks. If the distributor cap cannot be brought back to specs by cleaning, or if it is cracked, replace it.

Checking an ignition coil

Coil resistance that is higher or lower than specified can affect ignition-system performance. Look up the specs in your shop manual. Let's say they call for a primary resistance of 1.40-1.80 ohms and a secondary resistance of 7200-9400 ohms at an ambient temperature of 70 degrees F.

Remove the primary and secondary wires, but leave the coil in its mounting bracket in the engine compartment. Set the meter selector switch to the X1 range. Then connect the meter leads to the primary terminals (3) and compare the reading with specs.

To check the resistance in the secondary windings of the coil, set the selector switch in the X1000 position. Connect one lead to a primary terminal and the other into the coil's high-tension tower (4). You may need

a small metal extension to make electrical contact in the tower. If either reading is not within the range specified, the coil should be replaced.

To be absolutely sure a coil is okay, you should have a coil-output test made. This checks the ability of the coil to put out high voltage. A garage can make this test for you.

Checking magnetic pickup coil

Check your shop manual for the exact recommended procedure. But to give you an idea of the general procedure, here is how to check the pickup coil in a General Motors High-Energy Ignition System.

Remove the distributor cap. Disconnect the green and white pickup coil wires from the electronic-ignition-module terminals.

Set the ohmmeter to the X100 range. Connect the ohmmeter leads to the disconnected pickup coil leads (5). Observe the ohmmeter reading: It should be between 500-1500 ohms.

It's a good idea to apply zero-20 inches of vacuum to the vacuum advance unit while observing the meter. Readings throughout the vacuum range should remain unchanged.

Now, disconnect one ohmmeter lead (it doesn't matter which one) and connect it to the distributor housing (6). Set the ohmmeter on its highest range. The meter should read infinity, indicating no electrical connection between the pickup coil and ground. Apply vacuum to the vacuum advance while making this check, too. This way you make sure things don't change as the vacuum advance mechanism moves through its range of motion.

These tests check for broken leads or bad connections which can cause problems in the ignition system.

Checking the radio antenna

If excessive static, intermittent reception, or no reception is a problem with your radio, the antenna could be the culprit. Disconnect the antenna cable from the radio (7).

Test 1. Connect one lead to the top of the antenna, and the other to the radio pin. The radio pin is the piece at the end of the antenna cable that slips into the radio. The reading should be low, usually under five ohms. A low reading indicates a good connection between the tip of the antenna and the radio pin.

Test 2. Connect one lead to the cable end, and the other to the antenna base. A reading below five ohms indicates a good ground connection.

Test 3. Set the meter to the X1000 range. Connect one lead to the cable end and the other to the radio pin. The meter should read infinite resistance, indicating no electrical connection between the radio pin and ground.

When making these three checks, wiggle the antenna. Readings should remain the same when the antenna is wiggled. A changing reading indicates an intermittent connection or short.

If the antenna fails any of these tests, replace it.

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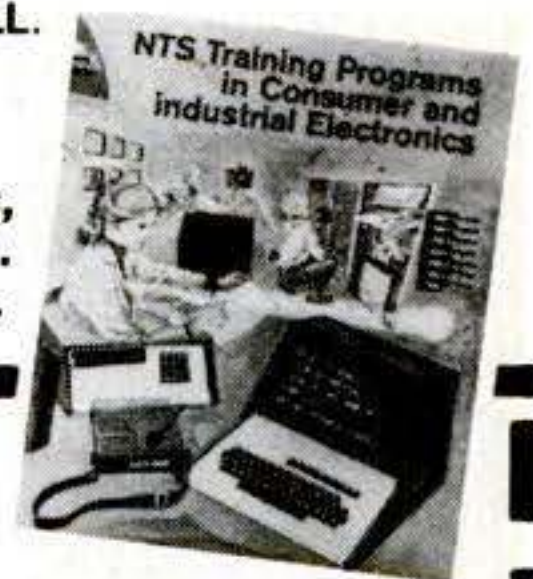
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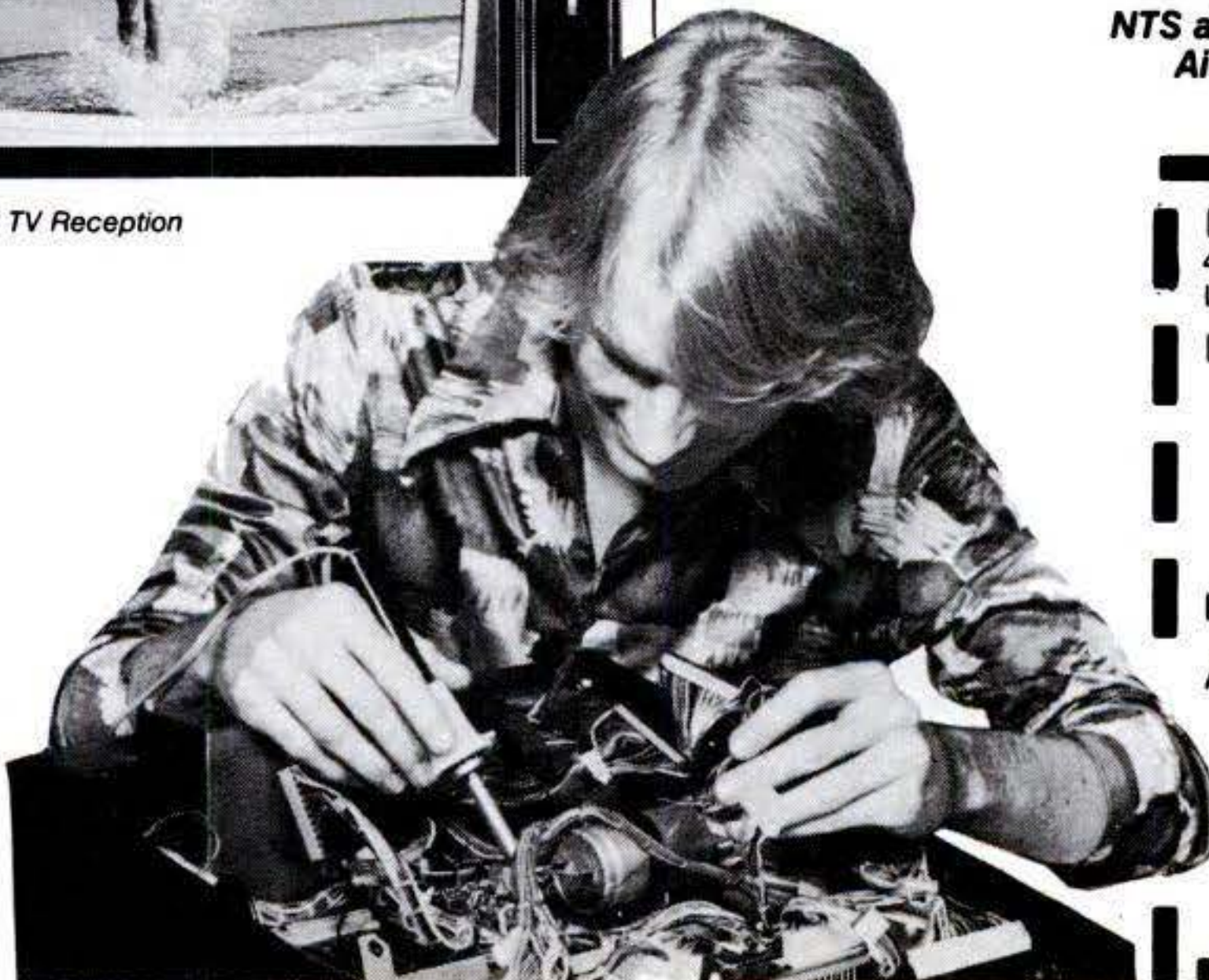
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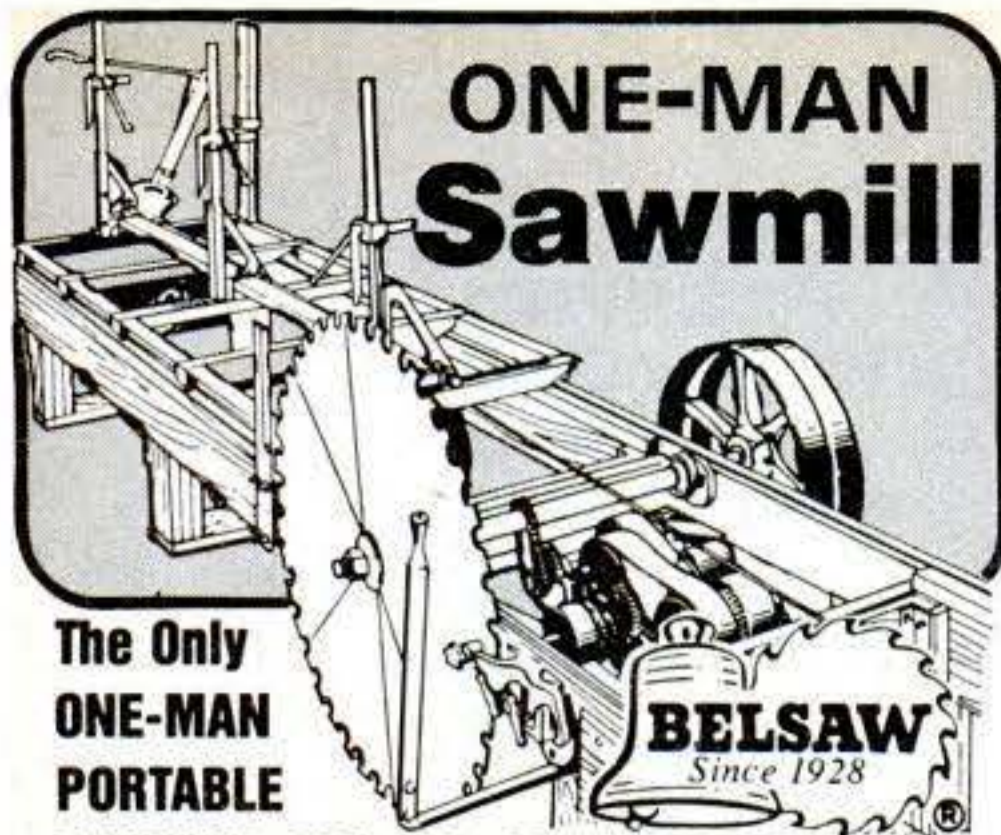
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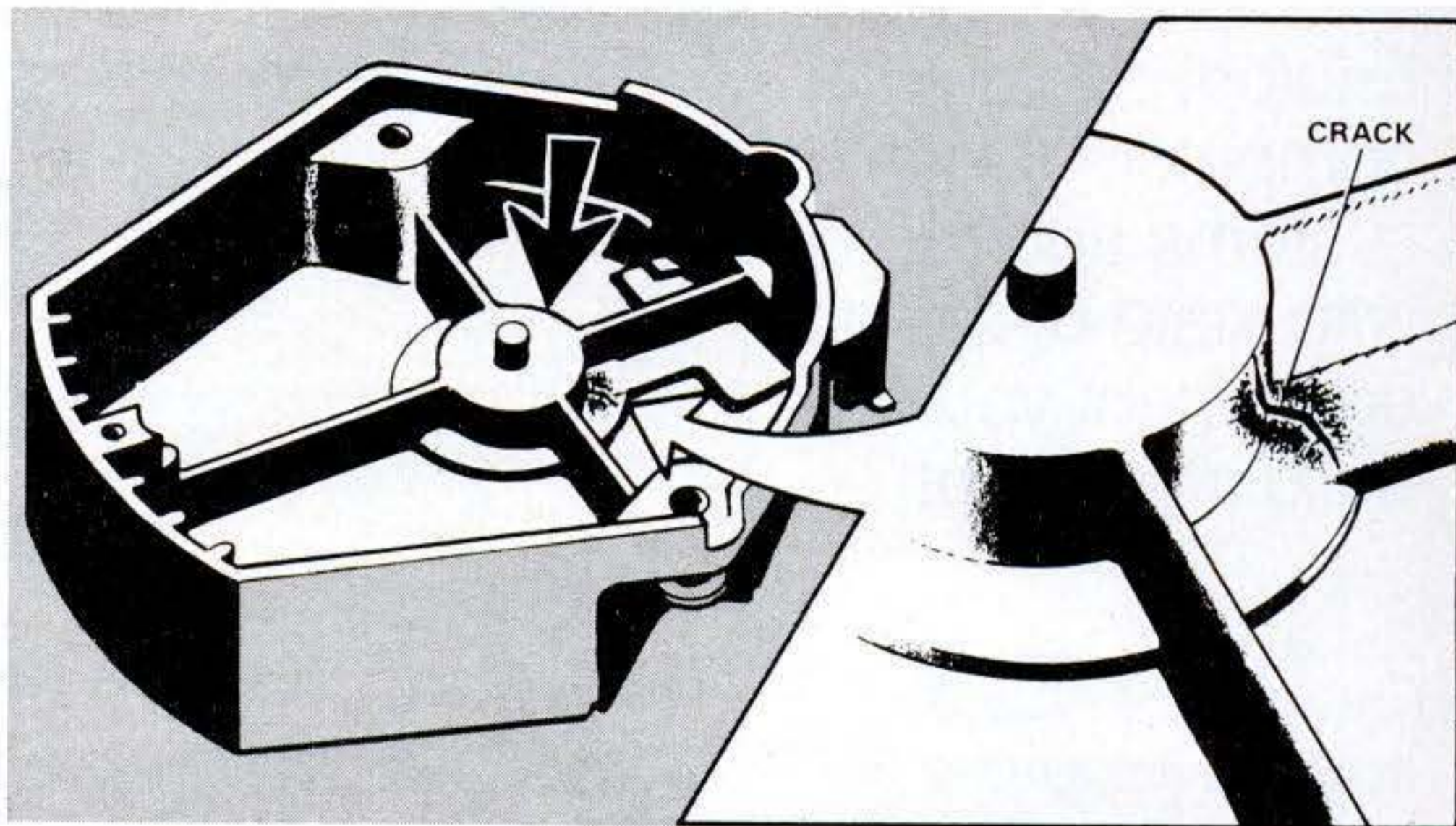
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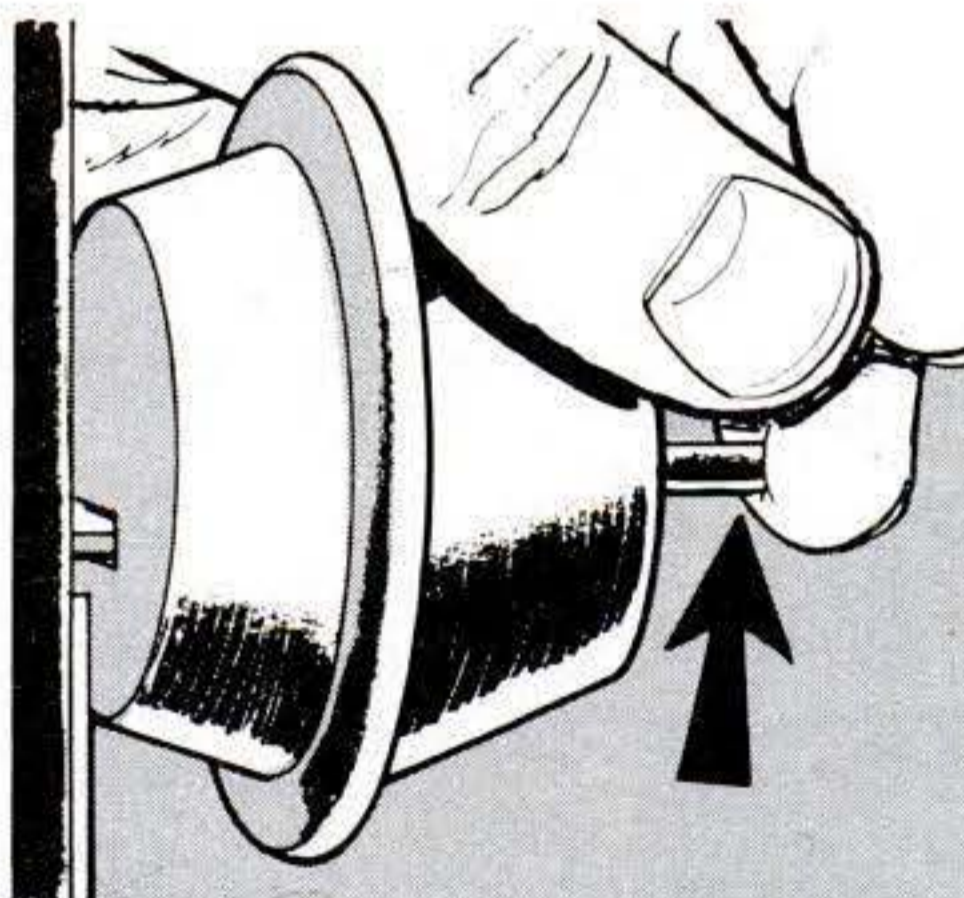
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Checking the rotor on GM HEI ignition systems

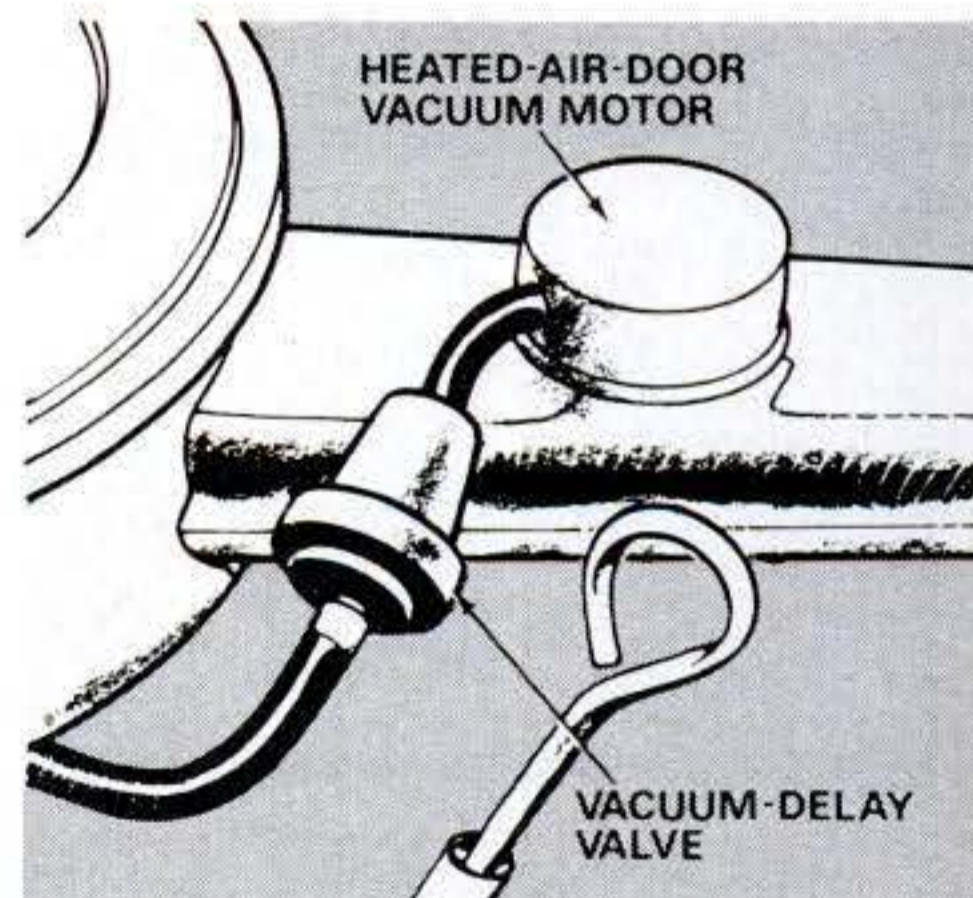
Electricity takes the path of least resistance. Sometimes, in an HEI ignition system, that path is through the plastic part of the rotor to the metal shaft it's attached to. The result? Decreased ignition performance. At every tuneup the rotor should be removed and inspected for cracks and burns—clues that indicate current is arcing through the rotor to the distributor shaft. If you find any cracks or burns, re-

place the rotor. At this time, also, inspect the distributor cap for cracks or burns, and replace it if any are present. Another thing worth remembering about the HEI system: Some tachometers and other electronic diagnostic equipment may not be compatible with it. If in doubt about your equipment's compatibility, check with the maker, whose name and address should be stamped somewhere on it.



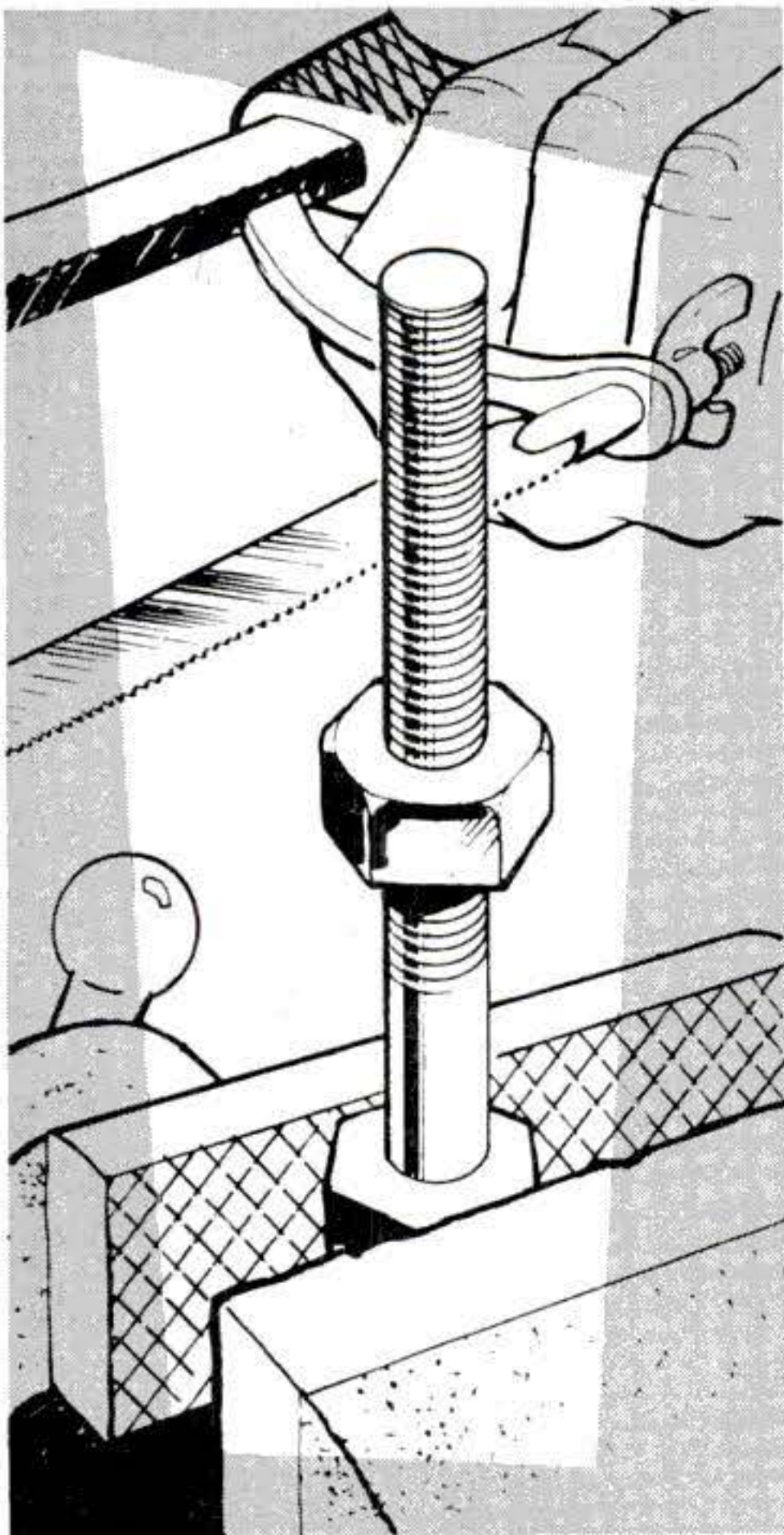
Checking vacuum advance

Here's a quick way to check the distributor's vacuum advance if you don't have a vacuum pump handy: Remove the vacuum line from the diaphragm housing. Rotate the breaker plate until it reaches its full travel in the spark-advance position. Place a moistened fingertip firmly over the hole where the vacuum hose connects. Release the breaker plate. If the diaphragm is good, the breaker plate will move slightly until it takes up the slack in the linkage and diaphragm. Then it will stay in the advanced position until you remove your fingertip.



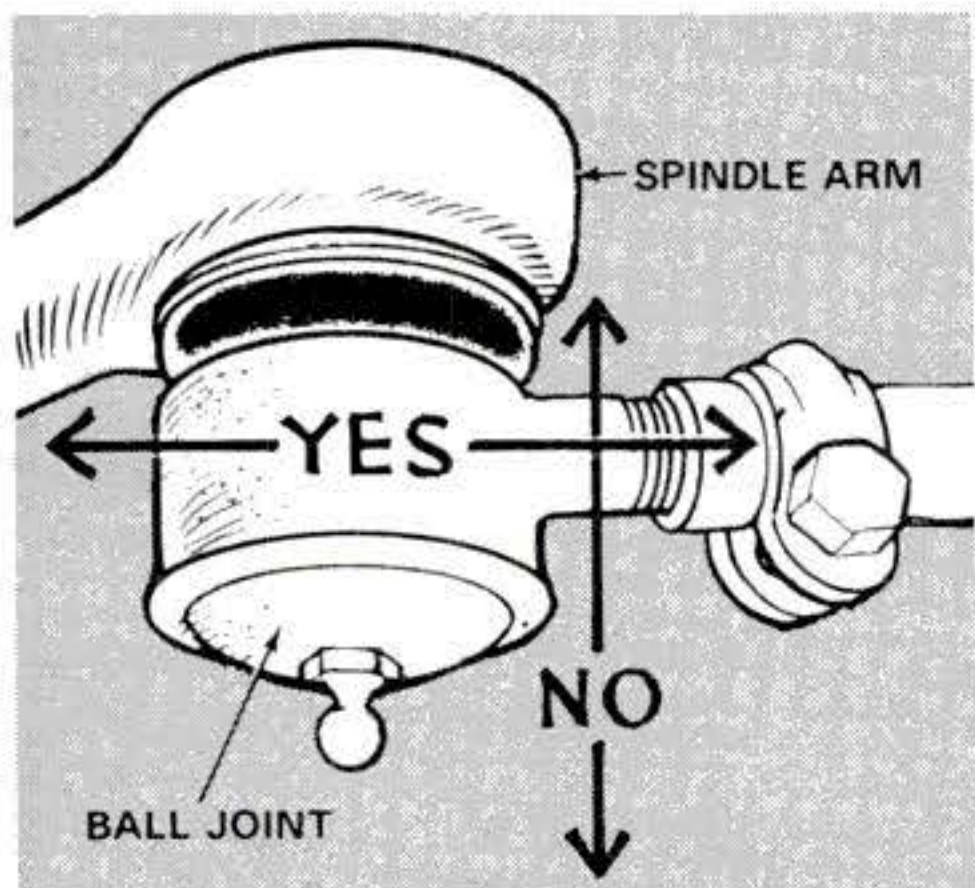
Poor drivability

Got a Chrysler car or truck with a 198 or 225 six-cylinder engine or V8 made during 1974-78, or an Omni or Horizon, with a drivability problem during warmup? This fix may help. Install a vacuum-delay valve in the vacuum line between the heated intake-air temperature sensor and the vacuum motor for the heated-air door. Part number of the valve is 4104371. On sixes and V8's, place it midway between temperature sensor and vacuum motor; on Omni/Horizons, install it four inches from vacuum motor. Smallest valve end should face vacuum motor.



Bolt too long

Shortening a bolt with a hacksaw? Screw the nut on past the point where you'll cut the bolt. Put the bolt in a vise and saw the excess off. Then smooth any sharp edges on the end of the bolt with a file and unscrew the nut. If the sawing operation caused minor thread damage, the nut will clean up the threads as it is removed. Now the nut will go back on easily. Double-check the length before sawing.



Checking steering linkage

If your car has a lot of play in the steering wheel, it may be caused by loose steering linkage. To check, with the car on the ground, eyeball the linkage from the side of the car. Now have a friend jerk the steering wheel back and forth (with power steering, the engine must be running, transmission in park, parking brake on). Look at the ball joints. They should not move up and down as the steering linkage moves side to side. Nor should they be loose at the joints. If you see any up-and-down movement or looseness, you should have the ball joints replaced.

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Perfect flywheel

[Continued from page 79]

Rabenhorst said. "We've spin-tested about 250 fiber flywheels of every design. We keep them around to learn from our mistakes."

He gestured at a table. On it was a large dented and twisted steel ring, about 13 in. across and ¼ in. thick. It encircled a heap of jagged metal fragments.

"That's a containment ring of cold-rolled steel," he said. For tests of dangerous, high-energy flywheels, he explained, APL technicians enclose the wheel within three rings to absorb any impact.

The large, dented ring on display had been the second one enclosing a graphite-composite laminated disc that APL spin-tested. "The garbage inside was the inner ring," Rabenhorst said. "The laminated disc blew that cold-rolled steel to smithereens," he added with awe. "It never happened before. The wound flywheels we tested just polished the inner ring a bit when they failed."

The constant-stress "plywheel" design that solved the delamination problem thus created another researchers hadn't anticipated. Since all the fibers are under equal stress, when the flywheel fails, all the fibers break at once—with great force.

"It's not a fragment failure as with steel," Rabenhorst said. "No single piece of filament is going to pierce its way through anything."

"But the momentum is still there—the blast energy. That's what we didn't realize."

I asked why the same thing didn't happen with the earlier, wound-type wheels.

"Because all the fibers don't break at once. Look." Rabenhorst seized a busted flywheel. I could see that at least half of the fibers, maybe more, still made a complete circle.

"The beauty of this wound wheel is that the very thing that held up its development—stress varies with the square of the radius—is its greatest advantage," he said. "Each fiber is under a different stress, so it's impossible to fail them all at once."

Because of the safety problems with the laminated disc, Rabenhorst and many other researchers returned full circle to the wound, rim-type flywheel. But the ones they are testing now are generations removed from the earlier models.

Battling radial stresses

During the past several years, flywheel researchers have developed several promising strategies for preventing wound-fiber flywheels from

stretching and breaking under stress.

- Using thin rings. A thin ring doesn't expose much area to radial stresses. A concentric array of thin rings rotating together can store as much energy as one thick ring.

- Varying the stiffness of the materials. A stiff outer ring can compress looser inner rings to even out the stress.

- Prestressing the wound fibers, mechanically or chemically. Either way, the fibers have a built-in tension that prevents excess stretching.

- Improving the matrix that bonds the fibers—or eliminating it.

- Contouring the wound surface so it's thickest where stresses are great.

Most of today's advanced composite flywheels use a mix of the above strategies (see illustration)—with one major exception. GE and Lawrence Livermore Labs, working together, are still trying to perfect the laminated disc.

Tom Barlow is project leader of the DOE's flywheel-development program at Lawrence Livermore. I asked Barlow why the laminated disc is still being developed, given the safety problem and the fact that the wound ring, with all the weight out in the rim, was a more efficient design.

Barlow gave me a four-part answer. First, he reminded me that this is still a developing technology. "It's too early yet to eliminate any good options," he said emphatically. "We still have a lot of work to do."

Next Barlow noted that GE has come up with a hybrid design mating the laminated disc with the wound ring (see diagram). "We can design a failure mode that's less explosive," he said. "We can make that outer ring break at any time we want to, and it will fail like any other wound flywheel."

He went on to point out that a disc flywheel can store more energy per unit volume than a rim-type wheel—and thus the disc might be needed where size is crucial.

Barlow saved the most interesting reason for last. "Besides," he said, "we're looking at ways to mold these tapered discs instead of hand-laying-up the laminates. If we can get good performance out of molded rotors, we'll have gone a long way toward mass-producing these things."

Lawrence Livermore has been working with Owens-Corning on beefing up the fiber content of structural sheet-molding compounds used by the auto industry. Made of extra-strong chopped fiberglass, the compounds

are not as strong as continuous fibers, but they are low cost.

"A fiber ring around the molded disc will boost performance and safety of these low-cost rotors," Lawrence Livermore's Dr. Satish Kulkarni said.

Others are working on lowering flywheel cost. Rabenhorst's team at APL, for example, has successfully completed a DOE contract to develop a low-cost flywheel. "Our design could be mass-produced for \$50 per kWh," he said.

And cost is the key. Only when advanced flywheels can be mass-produced will they have any impact on the real world.

How long a wait?

Nobody would give me a timetable for the basement flywheel—though all agreed it is technically possible.

"I think it will happen along with the development of solar photovoltaic systems," Dr. Phil Thompson of DOE told me. "But flywheel systems have to get a lot cheaper first."

Hybrid flywheel-powered vehicles are much closer to reality. "We could see flywheels commercially available in vehicles in five to 10 years—maybe closer to five years," Thompson said.

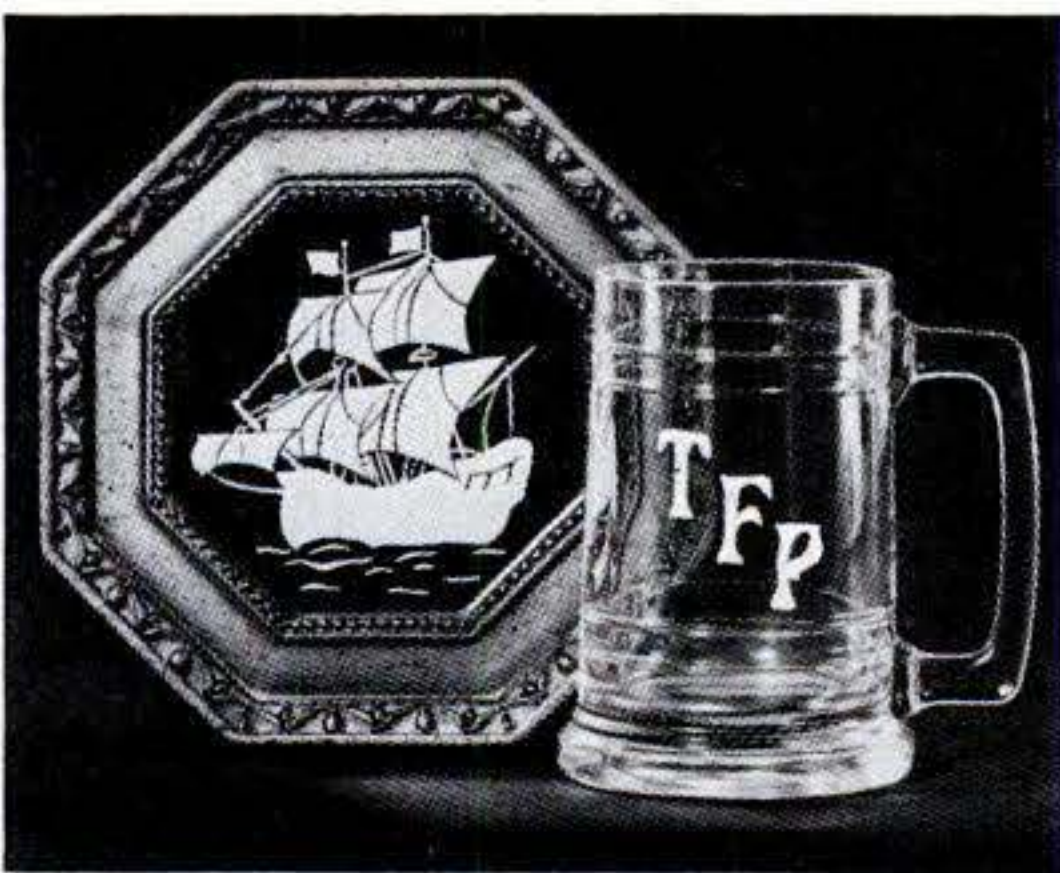
Garrett Corp. has just delivered to DOE a prototype electric car equipped with a flywheel. The flywheel, a composite rim on an aluminum hub, boosts acceleration by using energy stored during braking.

GE is now building a full-size electric urban-transit bus for DOE. Fully loaded, it will have a range of 3½ miles in stop-and-go traffic before making a 90-second stop to respin the flywheel to its operating speed—10,000 rpm. (An earlier, European flywheel-powered bus needed a two-minute recharge stop every half mile.)

Although a 3000-lb. advanced steel flywheel will power the prototype bus, GE hopes to later use a composite flywheel now being developed (see illustration).

Although the perfect flywheel is not yet a reality, a decade of experiments has brought the new flywheel technology close to fulfilling its promise. In fact, at least one researcher, Francis Younger of Wm. Brobeck and Assoc., thinks we're closer than we realize.

"I think we're already at the point where we can build a composite flywheel for practical applications," he told me. "We should continue basic research on the ultimate flywheel. We'll need that in the future. But we've got safe, 20-Wh/lb flywheels that we can count on now. I think we should get them out in the field." E5



Steuben?

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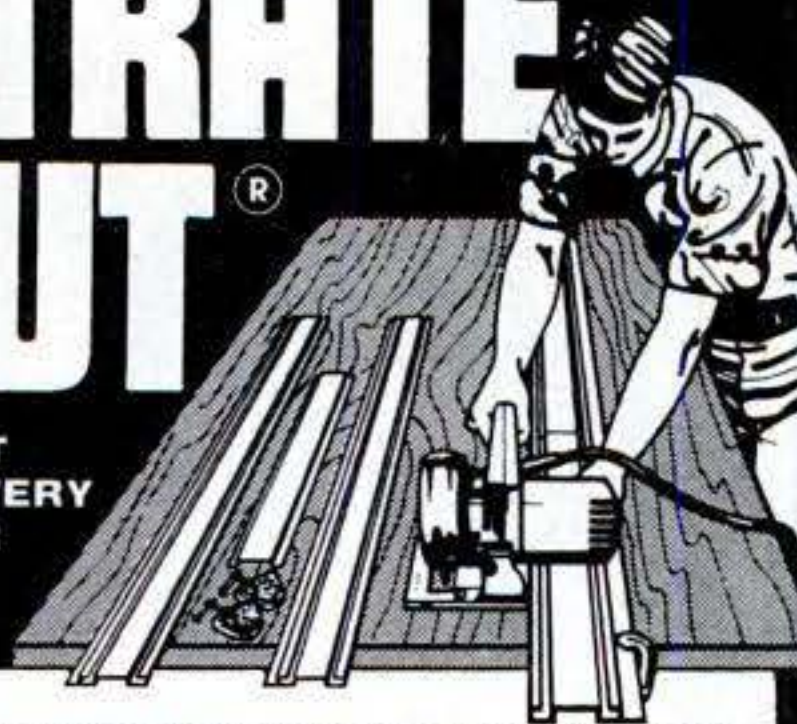
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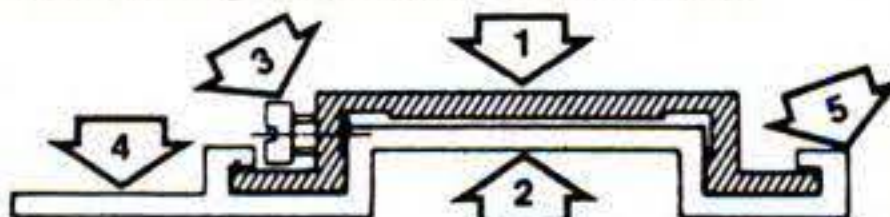
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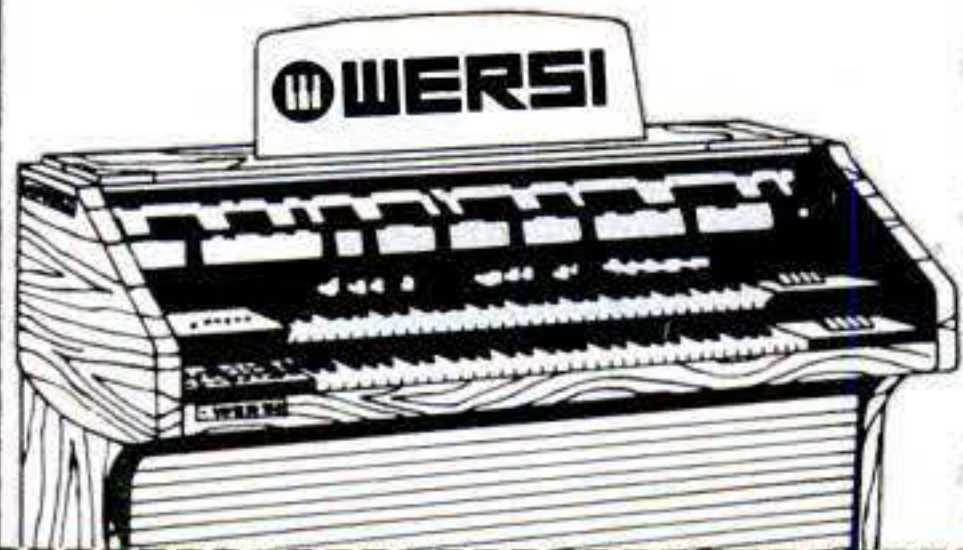


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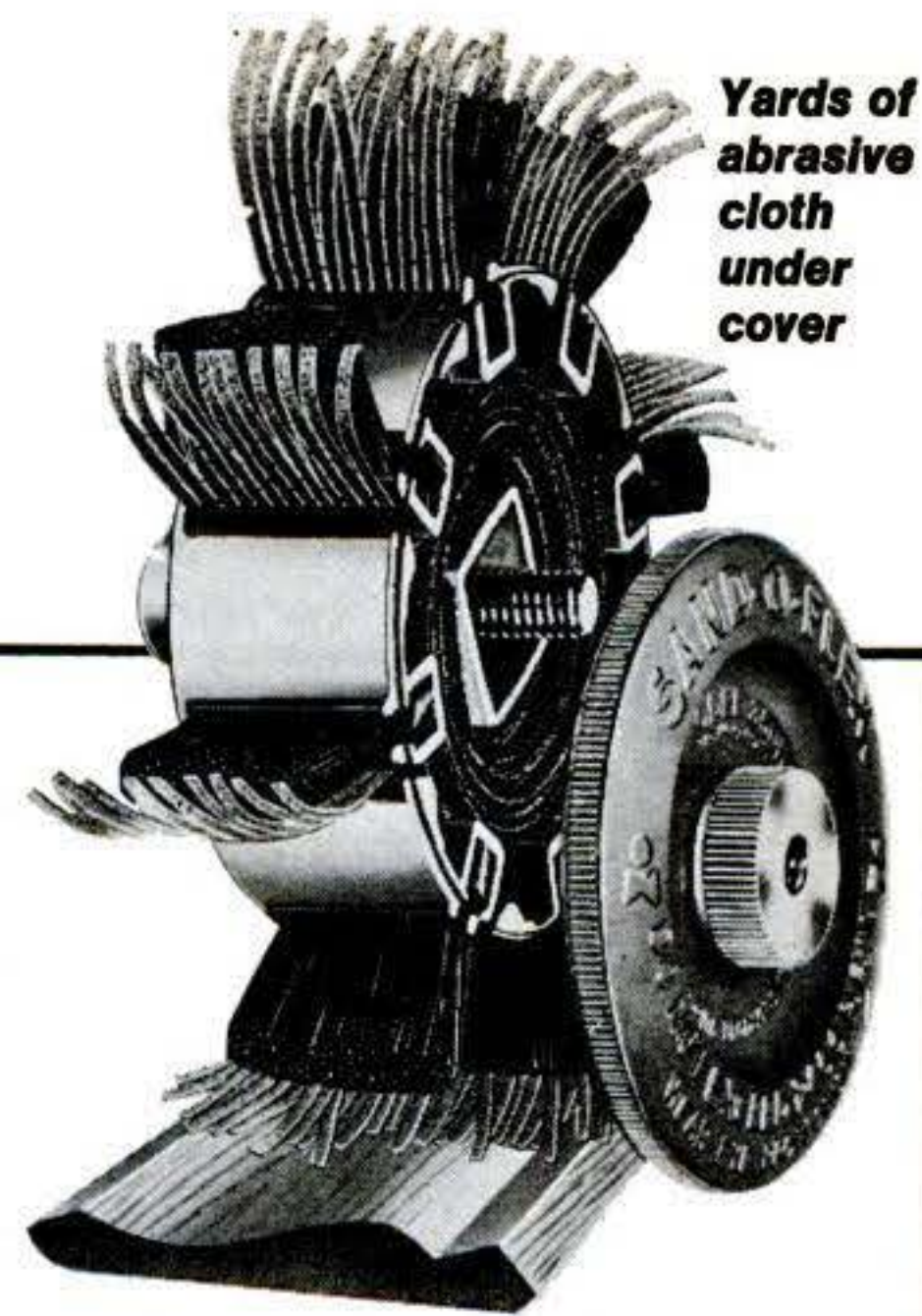
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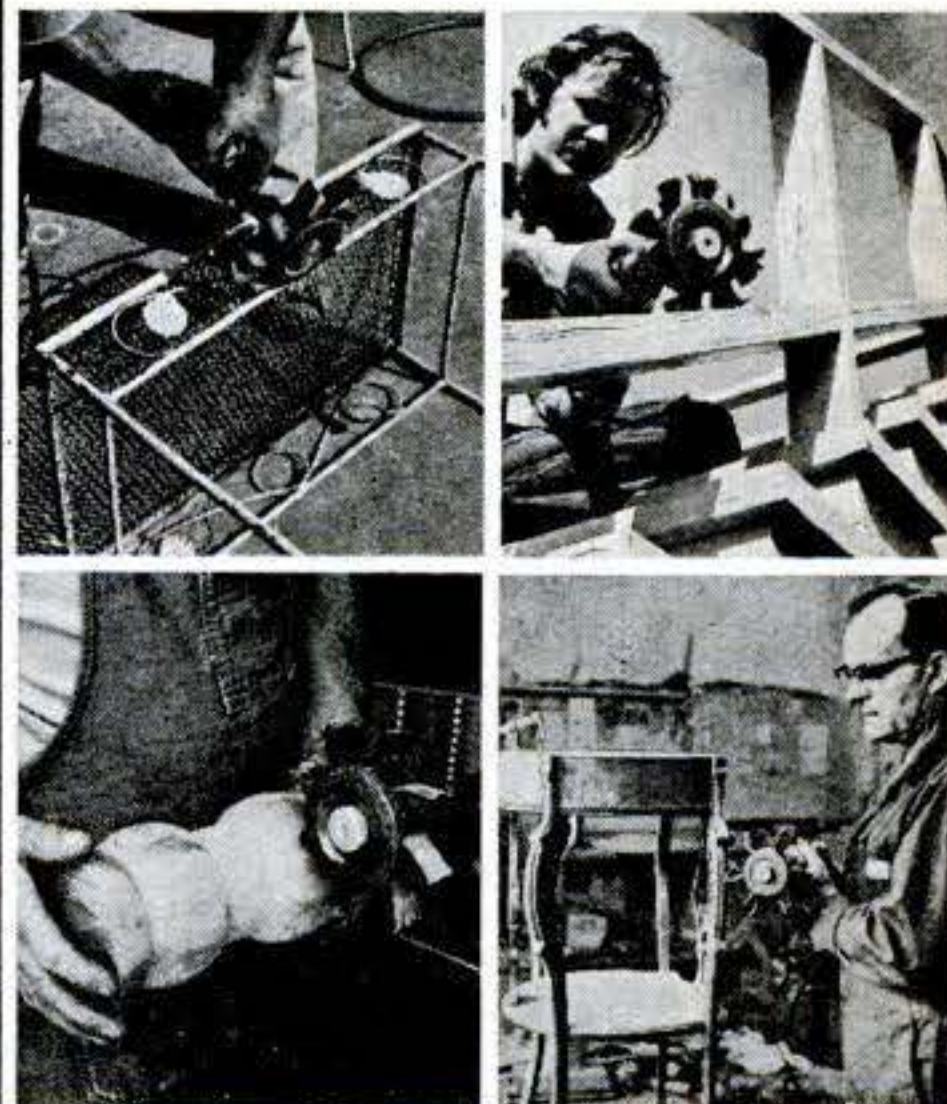
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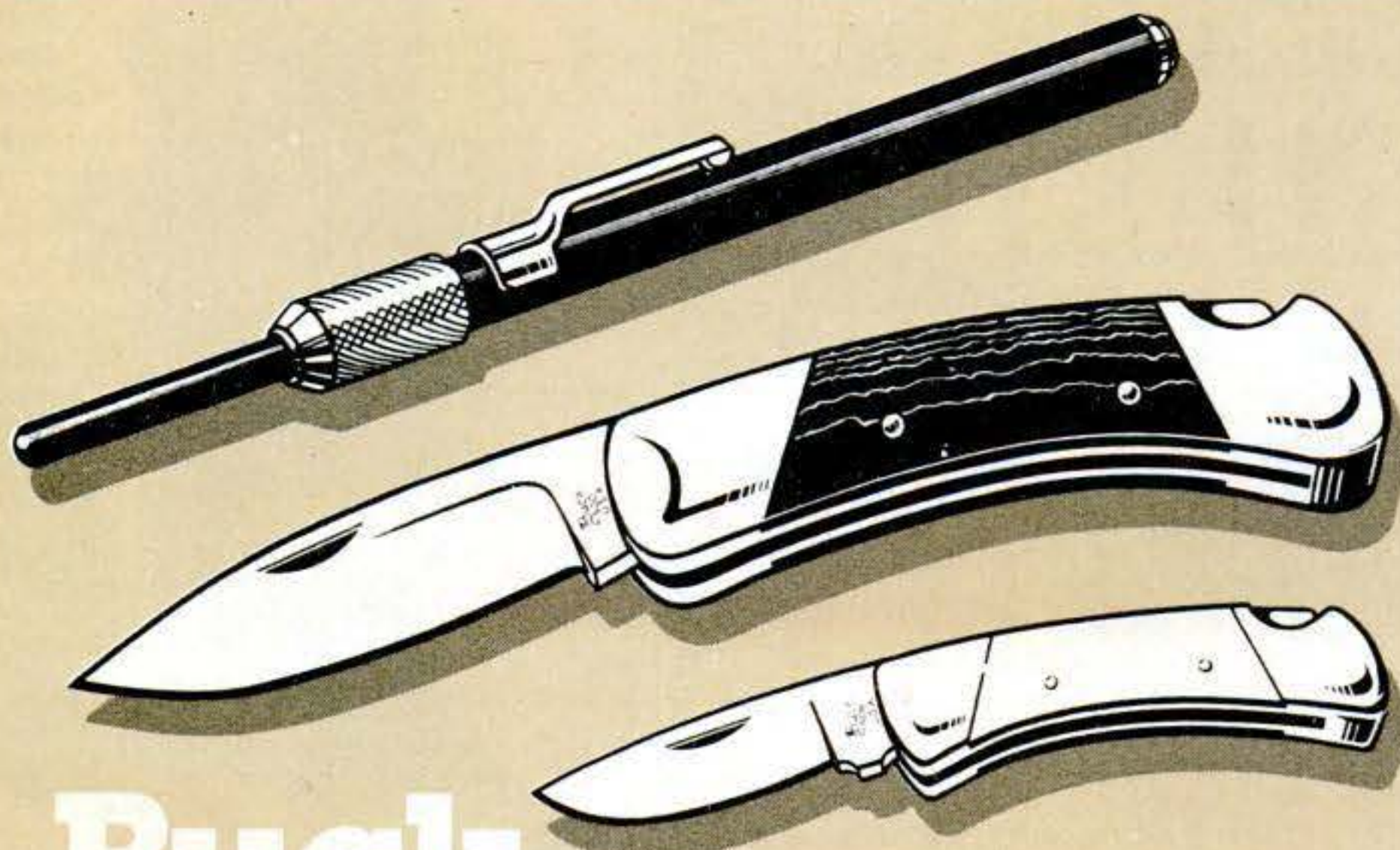
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The Lady Buck is a new drop-point folding lock-blade created with women in mind. It has beautiful ivory-colored Buckarta handle inlays. But beneath its stylish exterior is the traditional Buck engineering quality, including the hollow-ground,

high-chrome, high-carbon steel 2 $\frac{3}{4}$ " blade.

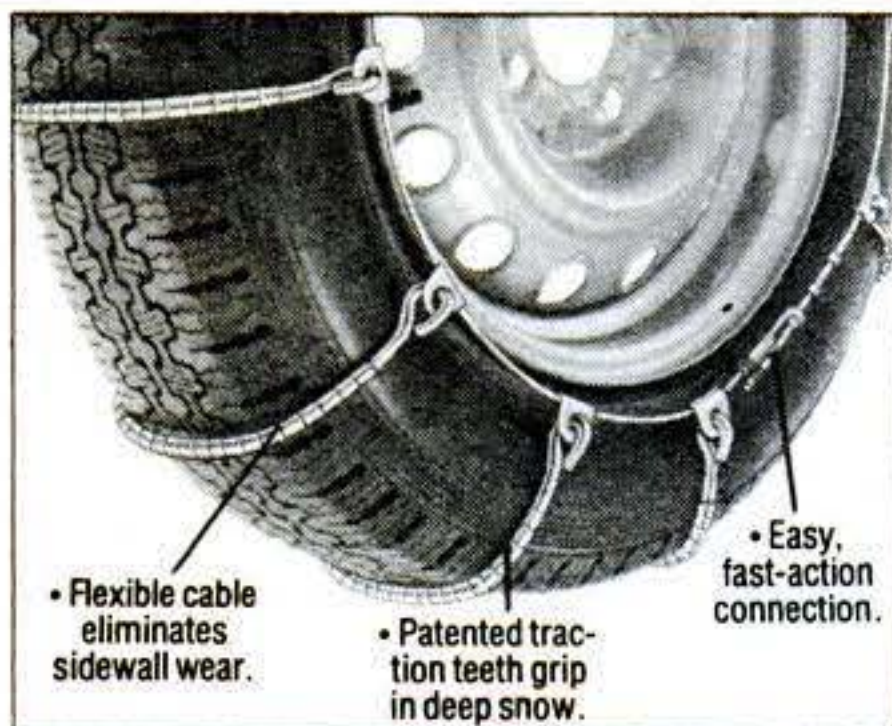
The Duke, largest of the slim-line lock-blades (4 $\frac{1}{2}$ inches), has burgundy Buckarata handle inlays. Specially engineered pivot rivet keeps blade locked in place, wobble-free. Comes in a pouch-type sheath.

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PS readers talk back

[Continued from page 4]

power into wasted heat, Nola's device reduces voltage to no more than needed by switching power on and off with the triac. Power is not 'diverted'; it's just never taken from the supply line."

I am curious if "Nola's Clever Motor Controller" uses the same technology as the controller Exxon Corp. has recently announced. Exxon is so enthused about this controller that it wants to buy Reliance Electric Co. Does Electronic Relays, Inc., see any patent infringement by either company?

W. R. Hudson, Rio de Janeiro, Brazil

Joseph E. Pascente, Electronic Relays, replies: "The Exxon controller is an inverter system in which the AC is converted to DC and then back to AC, where the speed of the motor is frequency-dependent. The Nola system is a voltage-reducing system, proportionate to the motor power factor. As a result, no patent infringement would result."

Which will sacrifice?

The article "Dockside Corrosion," by Bob Stearns [Aug.], contains a serious error that could lead to the destruction of aluminum boats and power units. The article lists a "galvanic series" that places aluminum below zinc and states that "zinc is a more active giver than aluminum." Actually, the opposite is the truth.

I invite you to examine any reputable chemistry reference book, such as Chemical Rubber Publishing Company's *Handbook of Chemistry and Physics*. You will find that the electromotive (galvanic) series tables list aluminum above zinc. This means that aluminum will sacrifice to zinc. Thus, anyone attempting to protect aluminum with a zinc sacrificial anode will have the opposite happen: The aluminum will be destroyed, the zinc protected.

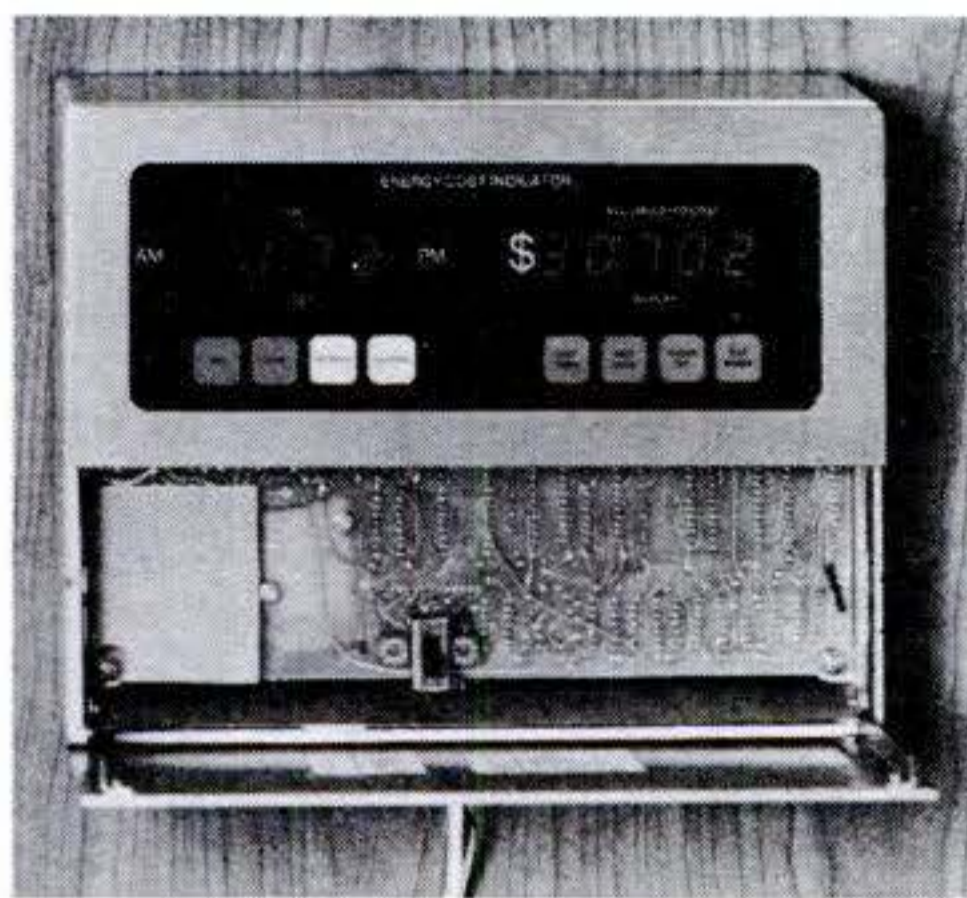
Zinc will sacrificially protect only those elements or alloys located below it in the electromotive series. To protect aluminum, one must use an element above aluminum, such as magnesium, as the sacrificial anode.

William M. Shanklin Jr., P.E.
Las Vegas, Nev.

Bob Stearns replies: "Your reference to the electromotive series in the Handbook of Chemistry and Physics is correct. However, that series deals with zinc and aluminum in elemental form. Aluminum, as used in the construction of boats, is an alloy, usually a 3000 series or higher. The galvanic table listed in my article refers only to the reactions of those metals in the marine environment. My reference, in that case, is Safety Standards for Small Craft, published by the American Boat and Yacht Council.

"My own experience, based on a lifetime on salt water, is that this galvanic series does work. The sacrificial zinc anode I place on the aluminum lower unit of my outboard motor wastes away at a rate that requires yearly replacement, while no corrosion takes place on the engine itself."

Energy-cost indicator previews utility bills



If you could see your utility bills tick upward, penny by penny, as you turned on the dishwasher or revved up the heater, would you work harder to conserve energy—and save yourself money? The Department of Energy thinks so and, to test that hypothesis, is placing Energy Cost Indicators (ECI's) in 600 homes.

An ECI keeps track of the gas and electricity coming into a house, and, based on average costs per kWh and therm, its computer brain calculates the dollars-and-cents costs. For an estimate of his day's utility costs—and maybe a shock—a homeowner has only to glance at the digital display of the wall-mounted unit (shown above with case opened to reveal circuitry). At the touch of a finger, he can also find out yesterday's bill, costs for the month, and what the cost for the next hour will be if he doesn't turn any appliances off or on. With all this data, says DOE's John Millhone, families can decide if they want to cut back their energy consumption, and how best to do it.

"By comparing costs for one 24-hour period when a major appliance, such as an air conditioner, is turned on with another 24-hour period when it is off, the family can figure out approximately how much it costs to run that appliance."

The test will go on for about a year in six American and Canadian cities (the Canadian government is picking up part of the tab). Participating families were chosen partly because they'd like to buy an ECI if it were affordable. The test ECI is only a prototype designed by Honeywell for the DOE experiment, and the other few models now on the market are a bit steep—in the \$300 range. DOE hopes its tests will spur development of a \$50-\$100 ECI.—*Sandi Doughton*

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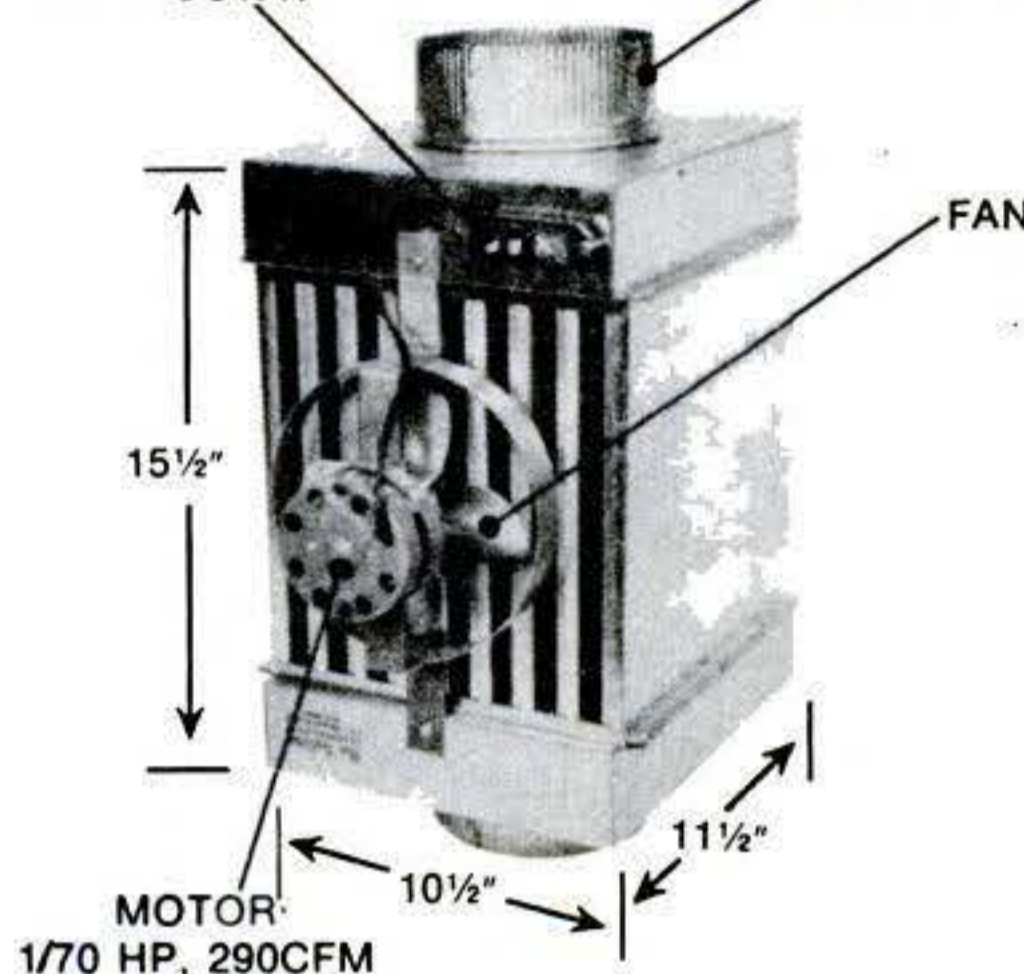
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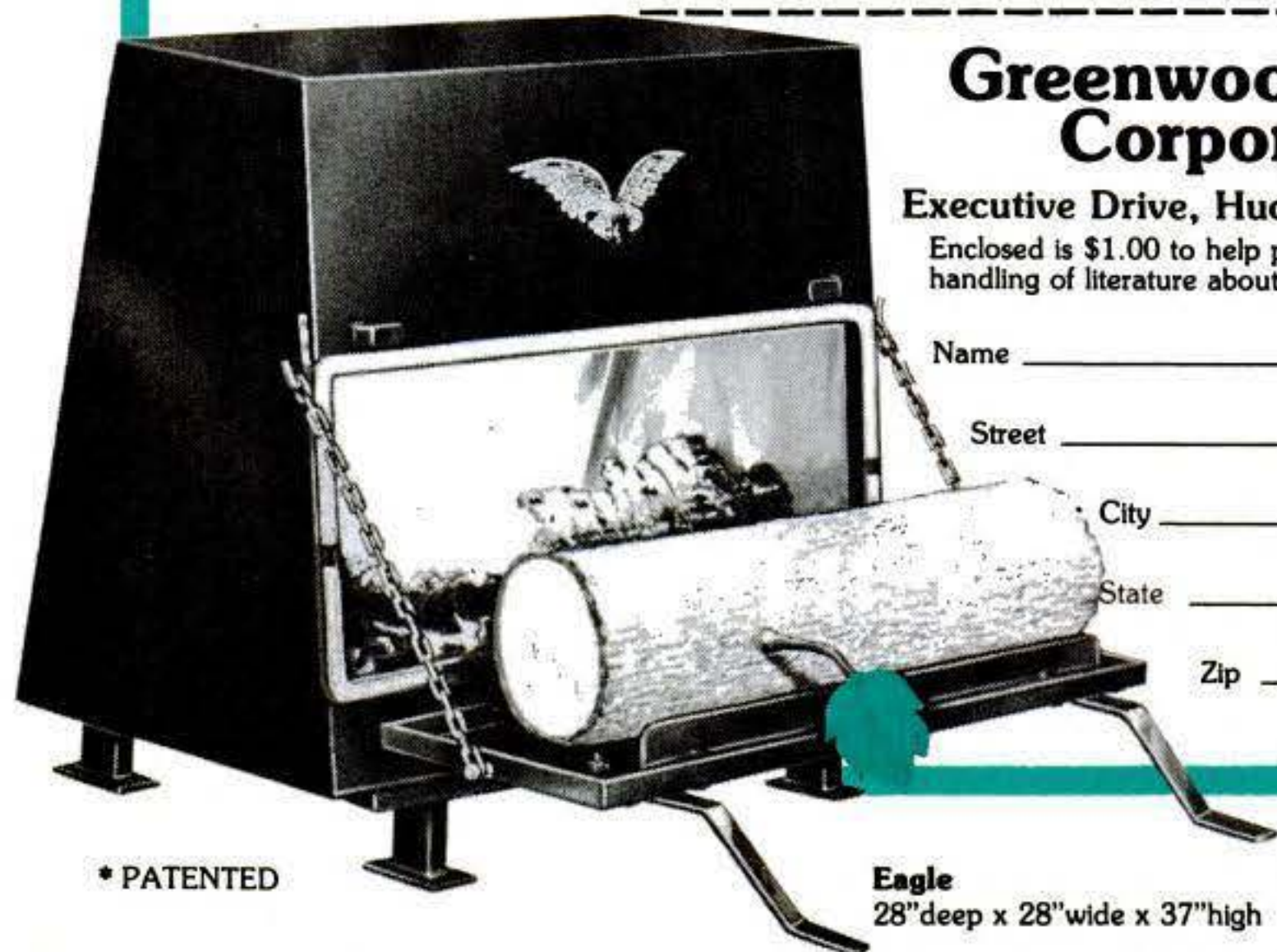
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Breslin

[Continued from page 84]

closed-circuit camera system, speak the time or weather, turn the alarm on or off, or begin a timer (which my wife uses for timing things in the kitchen, as well). The timer mode simply makes Breslin count off the minutes from when you told him to begin. When he hits "twenty," and the chicken's done, for example, you push the intercom "talk" button again to shut him up. All that's very nice and convenient, but, unfortunately, voice-recognition systems are always subject to potential errors.

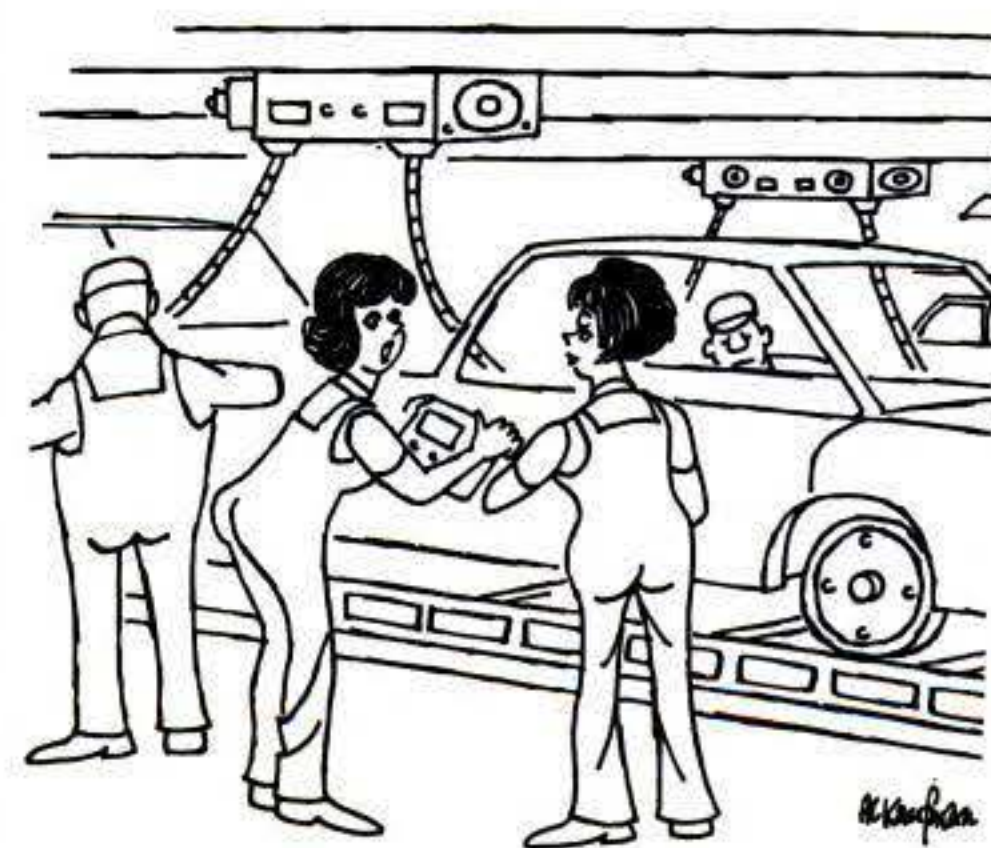
I was making hamburgers. The patio lights were already on and, as I placed the last patty on the grill, I hit the intercom button and said, "Breslin." "Yes," was his response, and I commanded, "Timer." I got weather.

"Timer," I again said calmly. "Alarm is set," the mechanized voice replied, and a little red light by the back door lit, indicating he had set the burglar alarm, locking me out of the house.

I tried to correct the damage: "Alarm off," I said into the speaker, which I was, by this time, clutching as if it were someone's (or something's) throat. Result: The patio lights went off leaving me in near total darkness. It would have been totally dark—if not for the burning hamburgers.

Now if all this seems as hard to swallow as our dinner that night, I do have someone who will back me up. Not once, but twice, I've received phone calls from my concerned father who lives about 15 miles away. "Bill, is that you?" he first asked, questioning the male voice that answered the phone. "Did you know your computer just called me and your mother and told us your house had just been robbed?"

It couldn't have been me, I thought. I was locked in the back yard making hamburgers. PS



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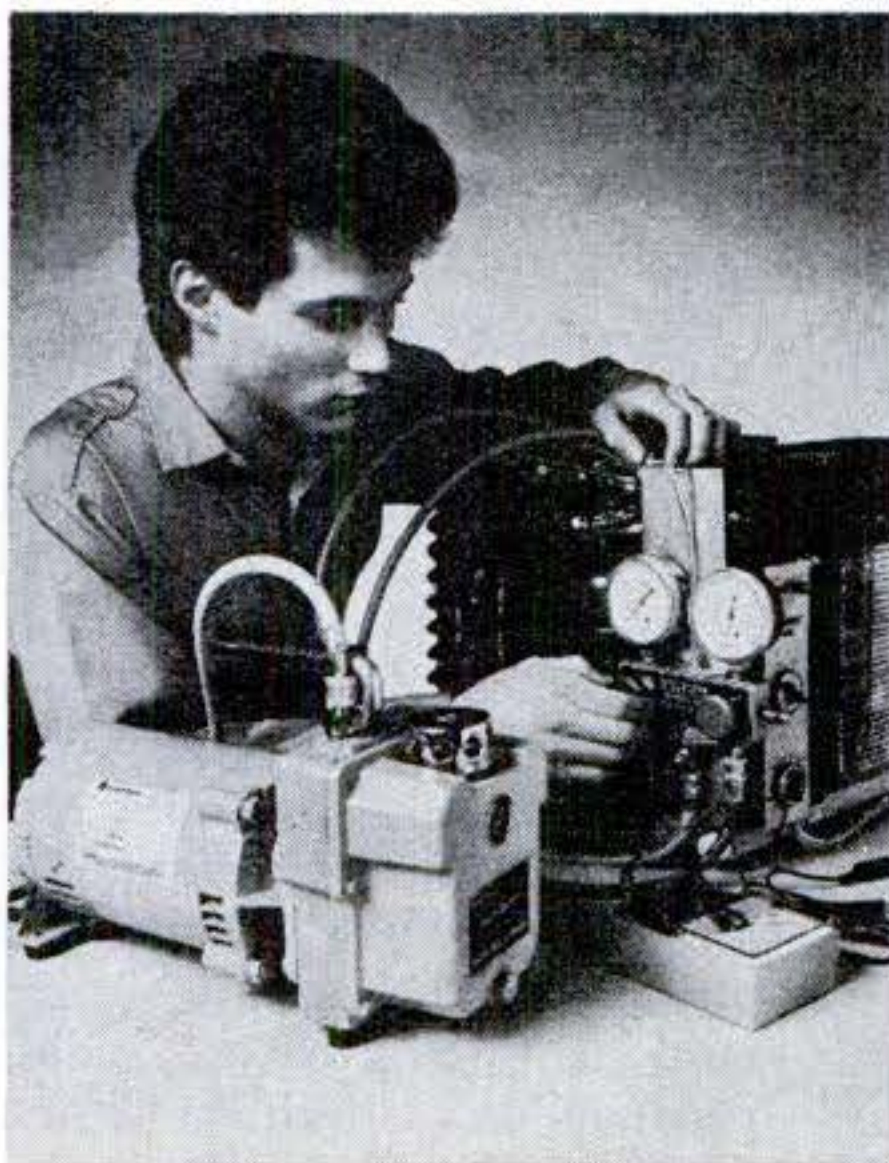
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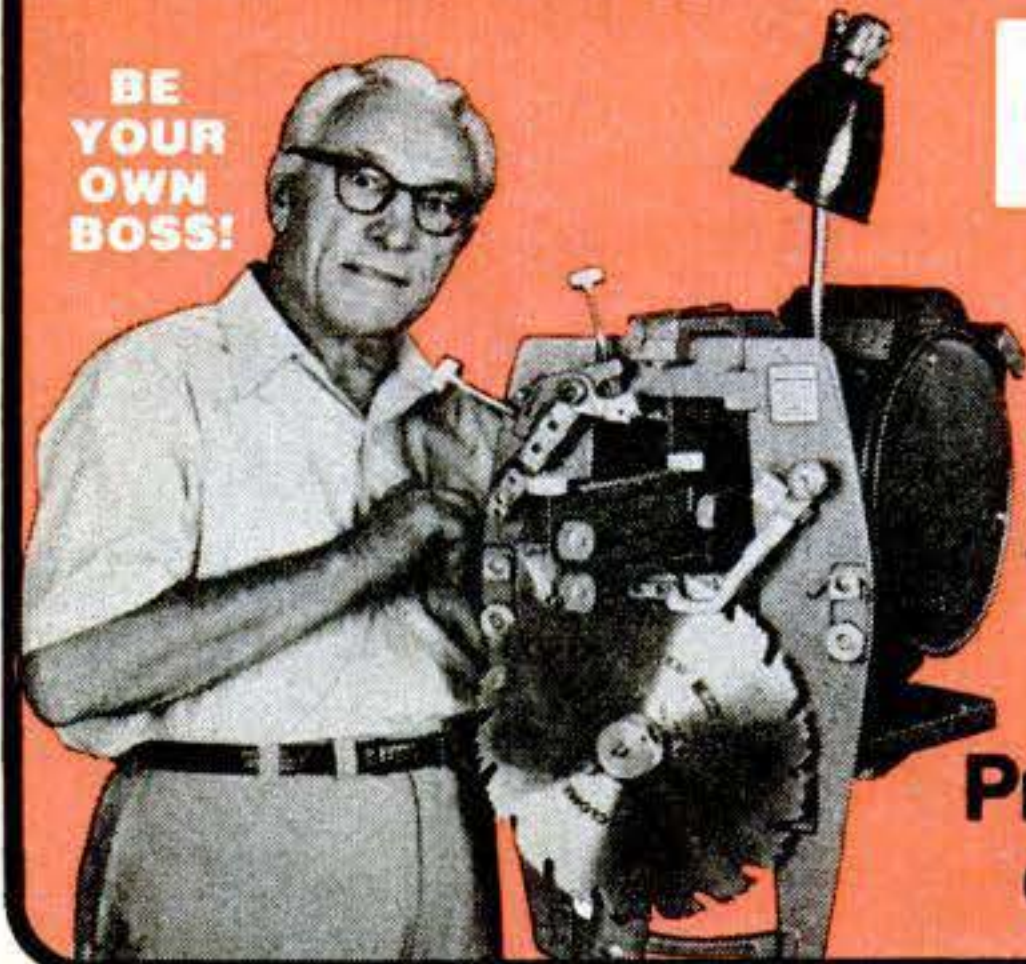
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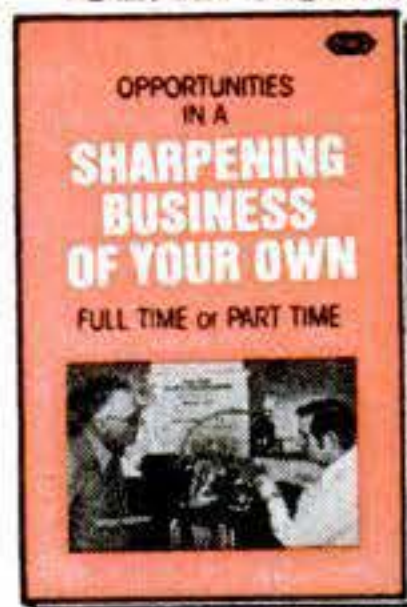
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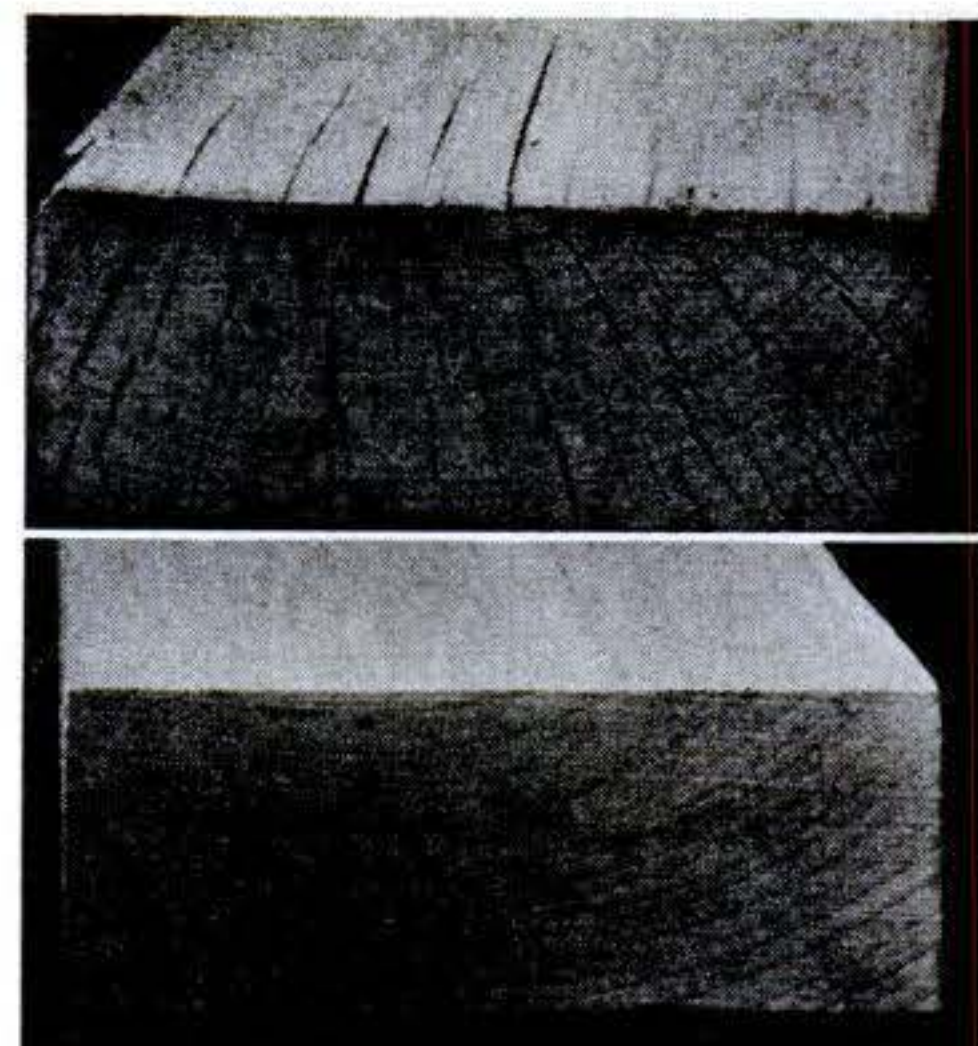
Penetrating finishes

[Continued from page 85]

wood cells, so only about five percent of the resin penetrates. Dr. Vasishth found that a water-carried resin was far more effective, because water makes the wood cells swell. When the water evaporates, the wood returns to its previous dimensions, leaving up to 25 percent of the resin inside.

Using water also allowed Flecto's chemists to grow the polymers using a condensation process instead of chain polymerization common in latex emulsions. With condensation, it was easier to adjust the polymer size.

However, water tends to raise the grain of wood, and it can leach out of the coated finish. The second problem was solved by engineering the polymer to act like lead in old-style oil



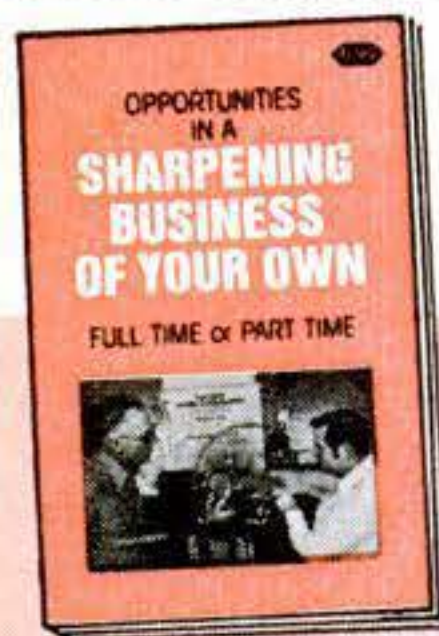
In accelerated-aging test—water-soaking followed by oven-drying—the Envirolite-treated block suffered none of the warping and checking of untreated block.

paints; it stops movement of water into or out of the wood. "As for the grain-rise problem," claims Dr. Vasishth, "it is overrated."

Of course, using water as a base also meant that brushes and spills could be cleaned up with water—a quality most attractive to consumers. The small amount of solvent still used is water-miscible, so it doesn't complicate cleanup. It's there to cut into undercoats, so that sanding between coats is unnecessary.

At their introduction, the price of the Envirosol products averaged 30 percent above traditional coatings. Since they contain less petroleum solvent, though, Flecto expects to see its prices become more competitive as oil prices rise.

And as the first commercial formulations sell, they will be replaced by new ones that contain even less solvent. It is Flecto's eventual goal to produce high-performance coatings with no solvent at all. [E]



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Water injection

[Continued from page 113]

nozzle, and using the air-injection system to draw the water through the nozzle. "The nozzle does a super-fine job of atomizing. In a test by AiResearch a few years ago, a similar nozzle was used to atomize unfiltered crude oil to run a turbojet engine on a test stand. The nozzle will atomize practically anything," he says.

The beauty of the system, Goodman claims, is that not only could car makers easily incorporate it into original engine designs, but that someone with a high-compression engine could also adapt the system to use the lower-octane fuels available today, without engine knock.

He says that modifying the combustion chambers for more turbulence isn't necessary for retrofit purposes. All that's needed is the nozzle, an air-injection pump (many cars have one as standard equipment), and the plumbing to hook up the system.

All the necessary items are readily available (at auto-parts stores, junkyards, hardware stores, etc.). And the average do-it-yourselfer can make the hookup, he says. The only item not readily available is the patented nozzle.

If you want to try this system on your own older high-compression engine, Goodman will sell you the nozzle for \$25. At press time he was preparing detailed plans that outline the parts you need, where to get them, and how to hook them up. He intends to sell the plans for \$8.50. Also, by the time this issue is printed, he may have available a kit with all the parts needed to make the installation. For information, write Goodman Engines, 685 N. Loudoun St., Winchester, Va.

What does the future hold for this method of water injection?

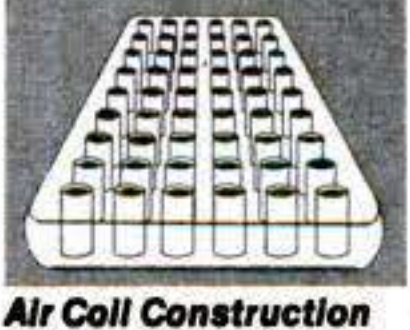
At this point it's impossible to say. Perhaps its most likely use is to enable older higher-compression cars that have a knocking problem to run on today's lower-octane gas. While in theory it should do this, at press time no retrofit on an older high-compression engine had been made. And, though it does seem to work satisfactorily on the Fiesta, that engine also has modified pistons, head, and a different cam.

Still, the system does seem worth investigating at the OEM level for small cars. Whether it can compete favorably with developments like the Texaco engine and others on the combustion horizon remains to be seen.

It certainly is an interesting technical exercise. Will it become more than an exercise? At this point, that's anybody's guess.

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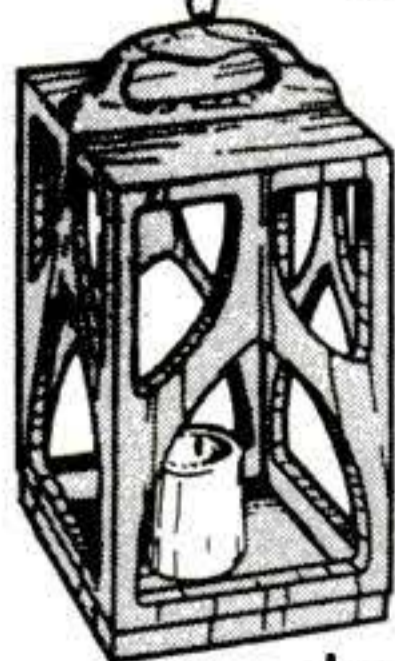
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100,000-mile Vega

My 1974 Vega reached 100,000 miles without an engine repair—yes, the troublesome aluminum four-cylinder OHC engine. My engine's only problem is the slowly increasing oil consumption, down to 300+ miles per quart of 10W50 oil and much worse if it uses 10W40 or 30W oil.

Should I rebuild the engine now, or should I wait until it stops from plug fouling?

I think the oil is being pumped down the valve guides and the head only needs rebuilding. What are your thoughts? Should I repair now or hold off?

Rich Dutch, Houston, Tex.

If you do anything, do it all at once. Don't patch it—100,000 is very good. Rebuild or replace whatever you can afford. I believe a new short block and a rebuilt head are the best options.

Broken distributor shaft

What would cause the distributor shaft to break at the gear on my 1978 Chevrolet Caprice Classic 305? The car has 23,000 miles on it.

To make matters worse, the gas station could not buy just a shaft, so I had to pay \$219, plus labor, for a new distributor. Nothing else was wrong with the engine.

Thomas Stylski, Redford, Mich.

The distributor drive shaft drives both the oil pump and distributor. Turning the distributor guts is very easy, but the oil pump is tough. I hope you haven't broken another shaft by now. Look for a problem with the oil pump.

If the distributor bearings, upper or lower, had a lube problem and seized, that could also break a shaft.

Dasher/Scirocco paint problem?

What have you heard from readers who have had problems with the silver paint jobs on Dashers and Sciroccos?

Charles Roda, Mt. Vernon, N.Y.

I have heard all bad. 'Course, nobody writes to tell me the good stuff.

Mustang engine switch

I just bought a very clean 1971 Mustang with a 351-cu.-in. engine in it. Since the engine is ready for a rebuild, I am thinking it might be a good time to go to a smaller power plant for the gas savings. I have in mind the six, of course. However, I understand that this is not a simple switch.

Will any Ford six work? Any frame reworking? I don't have access to welding

equipment, so I am hoping it is a matter of "bolt-ons."

Mike Dixon, Honolulu, Hawaii

I believe you'd be as well off going to a 302 V8. That six isn't a real mileage king. The 302 would be easy. Put a low-rpm, high-torque cam in it. Up the gearing and take it easy.

Wants to remove converter

I plan to remove the catalytic converter from my 1979 Jeep CJ7 (304-cu.-in. V8) in order to be able to use regular gasoline.

I understand the air blower is required only because of the catalytic converter, so I plan to remove it, also.

Will any engine adjustments be required after I've removed these two parts? Also, can I expect better engine performance and improved gas mileage?

Paul D. Folse, Tampa, Fla.

In our tests here with late-model engines (1978-79), we gained no power or economy with the removal of the converter. Nor did a loss occur. I don't recommend it.

Aftermarket turbocharger

With today's big engines and the goal for cleaner air and better gas mileage, larger cars and trucks seem to have less oomph. I've got a 1979 one-ton Ford van with a 351 Cleveland and a two-barrel carb, and I'm looking for a turbocharger. Who sells them?

Alex Hudak, Boseman, Mont.

There are many aftermarket turbo kits. The two biggest that enjoy some good comments are Turbo-Sonic by Roto Master (7101 Fair Ave., N. Hollywood, Calif. 91605) and one made by Spearco Performance Prod. Co., Inc. (10936 S. La-Cienega Blvd., Inglewood, Calif. 90304).

Mysterious missing

I have a 1974 Volvo 145, standard transmission, 68,000 miles, new plugs and points. After I accelerate hard in third or fourth gear, the engine starts missing badly. After a few miles, the miss mysteriously disappears. I have tried a two-hour cool-down while it was missing, but the miss continued upon re cranking, then disappeared two miles later. Could it be in the fuel-injection system?

Gene Lueg, Ruston, La.

Missing on acceleration as a rule is ignition trouble. But a lean fuel-air mixture can also cause it, and is more likely to show up with fuel injection than with a carb.

Sometimes a miss like this can come

from a dirty or wet spark plug that clears up after it gets hot. Or from an air leak on the inlet side that quits when the heat causes things to tighten up.

Burns oil

I have a 1973 Vega with the 140-c.i.d. aluminum-block engine. It now has 65,000 miles on it and is beginning to use excessive oil. The engine has never been overhauled or run at over 65 mph, and I consider that it has given good service. The body and running gear are in excellent shape, and I want to keep the car.

What has been the most successful fix for this engine? I have heard of boring and sleeving or boring and oversize pistons. Also, it is rumored that later models had an engine block made of different material. If the car belonged to you, what would you do to the engine to get additional good service?

W. W. Calhoun, Roswell, Ga.

Just bore it to first oversize, rebuild it as it is. Keep costs to a minimum. Drive as you have and get another 70,000 miles.

Lowering compression

My 1969 Chevy Corvette 350-hp, 350-cu.-in. engine has an 11:1 compression ratio. I'm having trouble with spark knock due to the premium-gas octane rating getting lower, and also hard to get. I'm due for an overhaul. Should I use flat pistons?

Is there an additive that I can economically use?

George Shipman, Houston, Tex.

I know it's not gonna be an answer you'll like, but as long as you're ready for an engine overhaul, drop it back to 8:1 or no more than 8.3:1 compression ratio. Octane additives are a long story that gets you nowhere. Your Chevy dealer has pistons for you. Yup, they are flat.

Dropped a valve

My 1973 Toyota pickup had a valve job done by an excellent mechanic and part-time racing-engine builder. About 550 miles later, the exhaust valve in the number-four cylinder got overly intimate with the number-four piston. The valve was bent and the piston crown was dinged. This happened at 50 mph in fourth gear, on regular (leaded) gas. The valves were unadjusted since the valve job, and were within adjustment specifications after the fun. What happened?

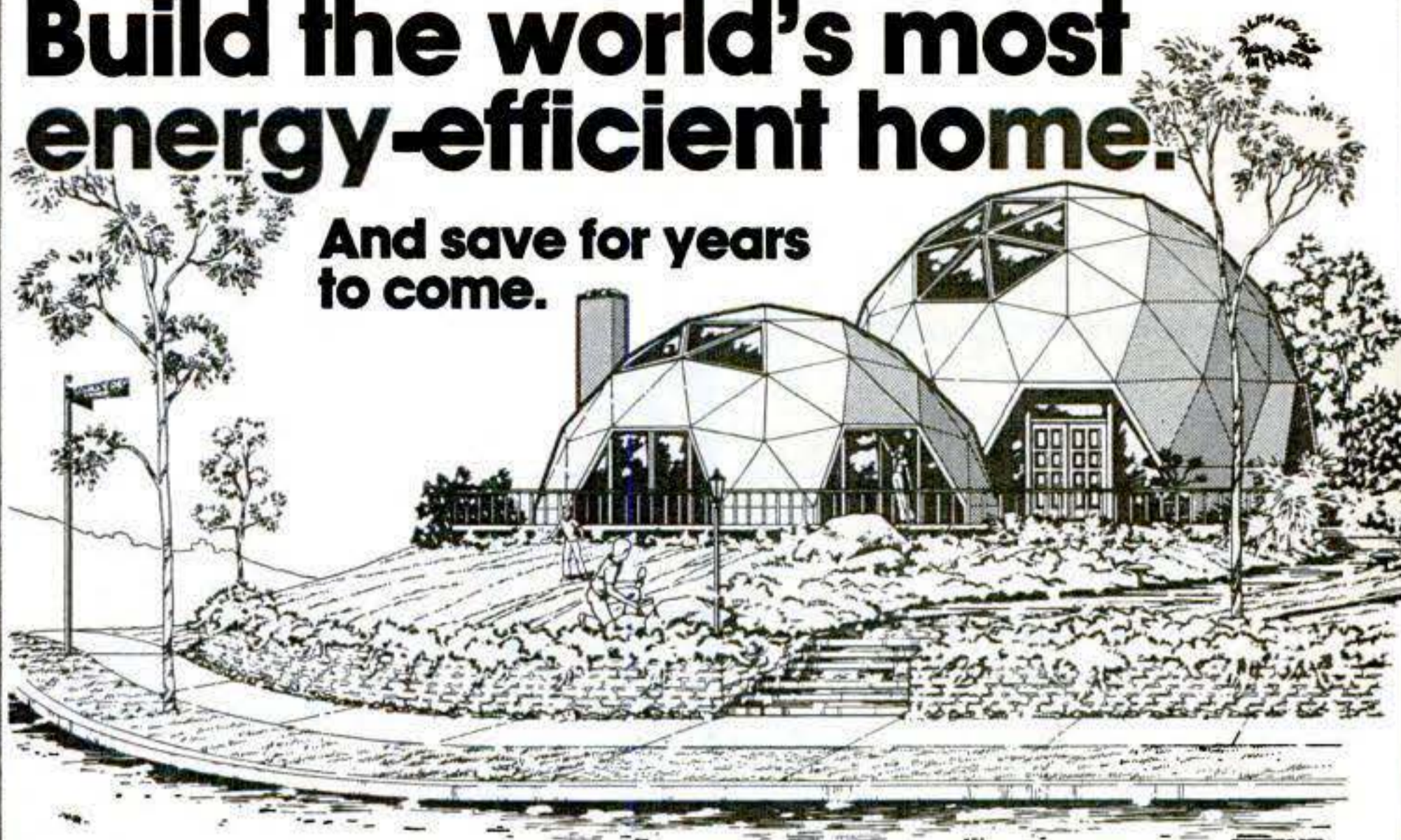
Donald C. Koury, Post Mills, Vt.

I'd say it was either a sticking valve, a weak or broken valve spring, or the engine was overrevved. You didn't mention springs, so I'd guess either sticky valves or overrevving.

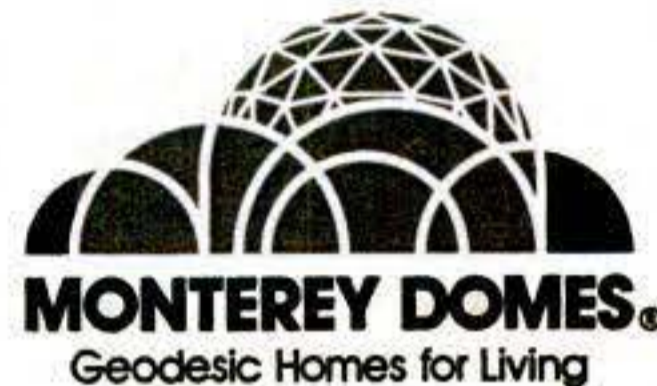
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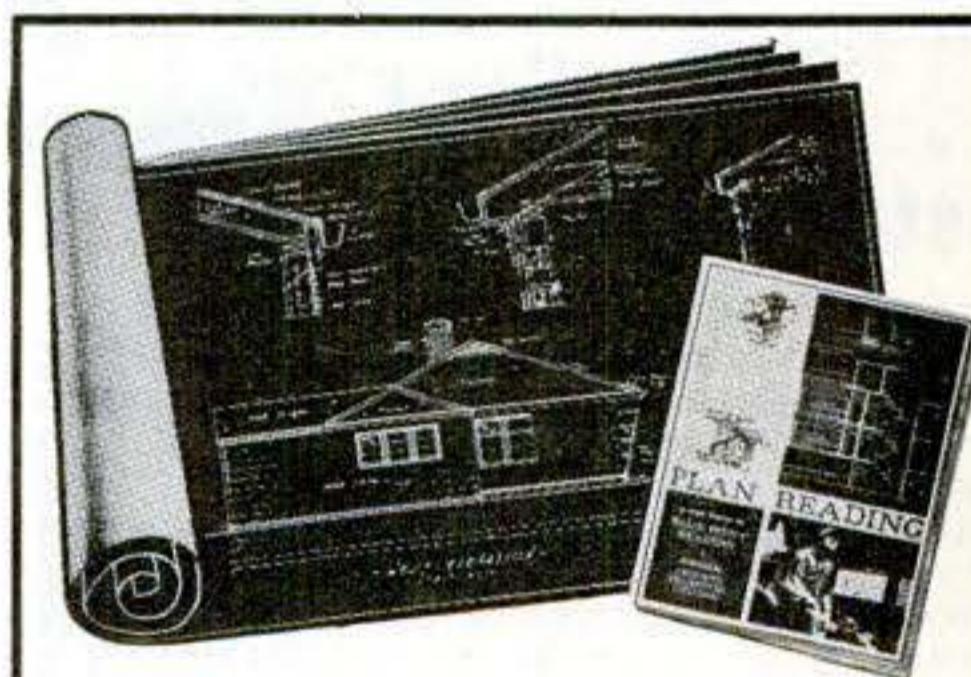
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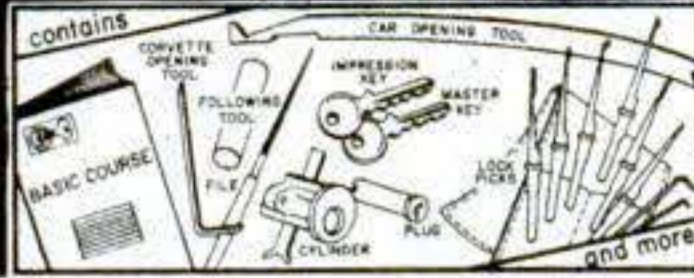
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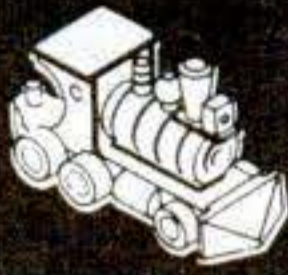
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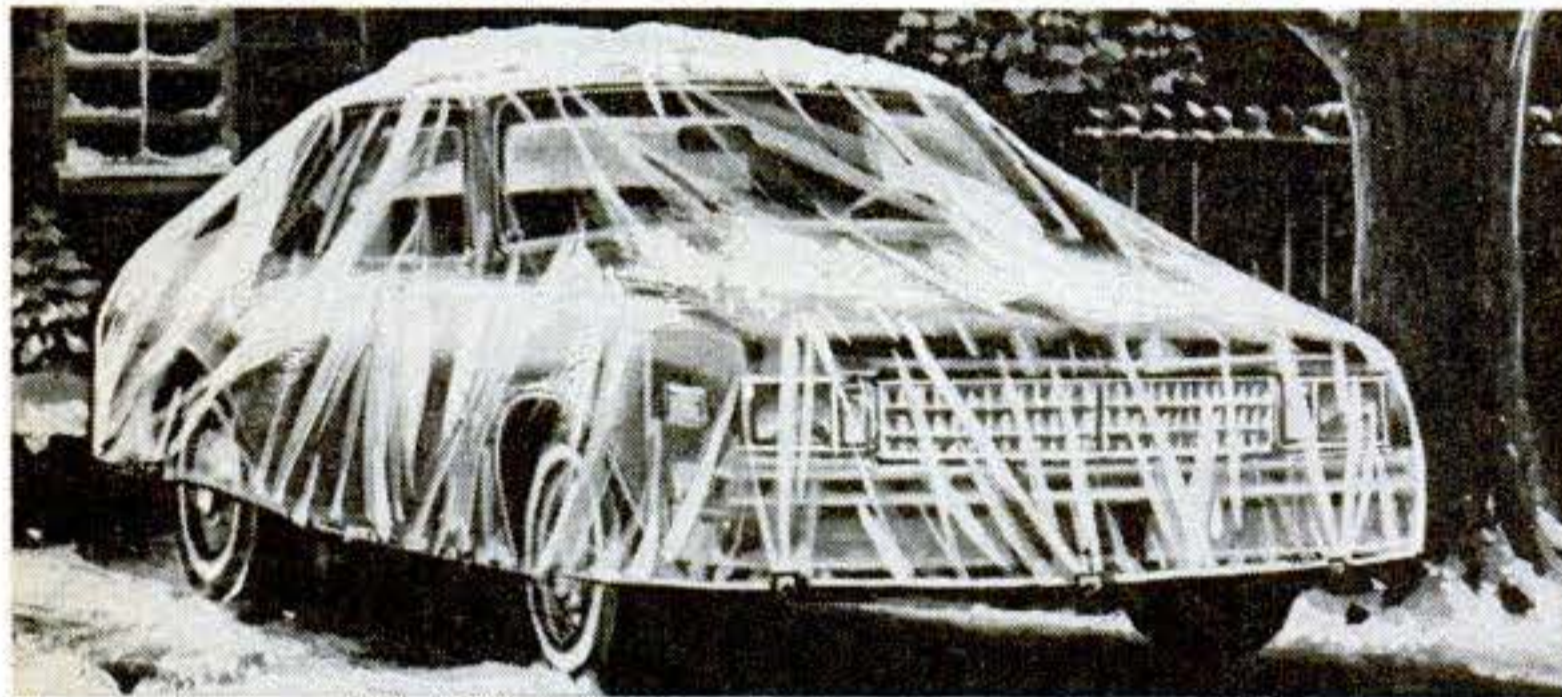
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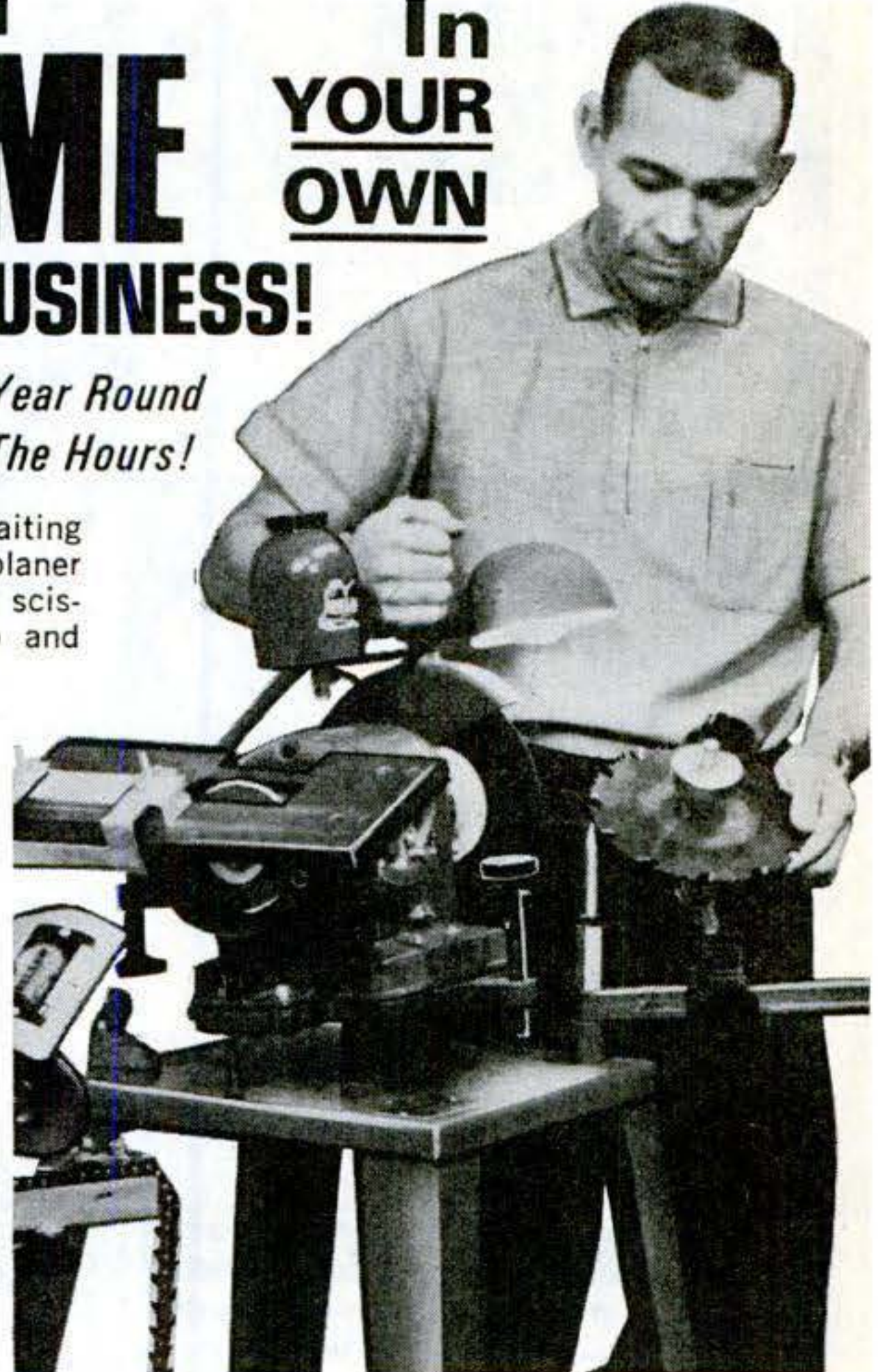
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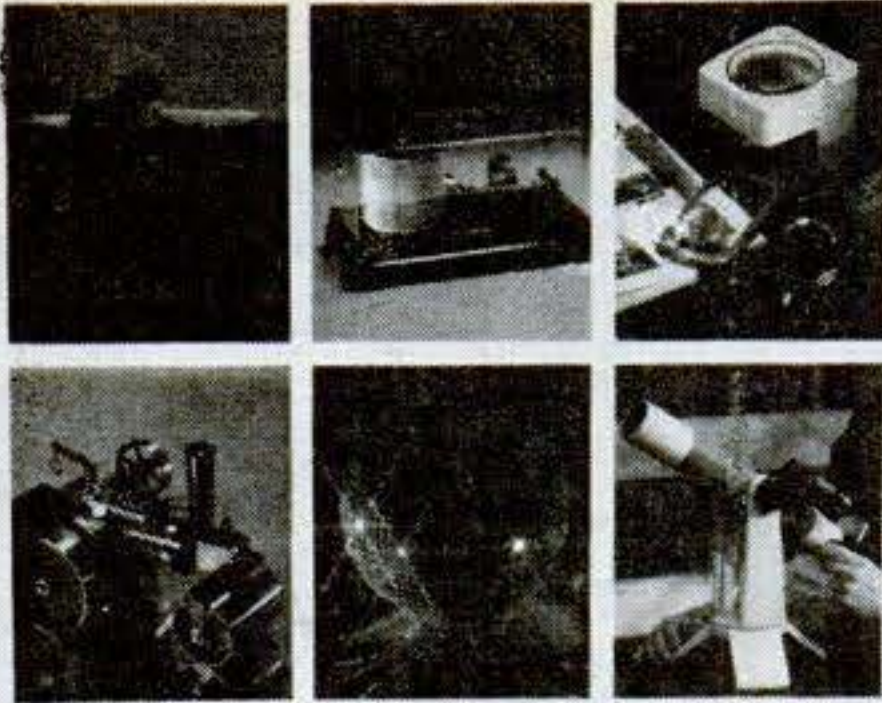
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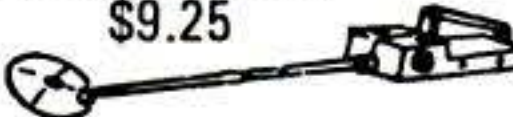
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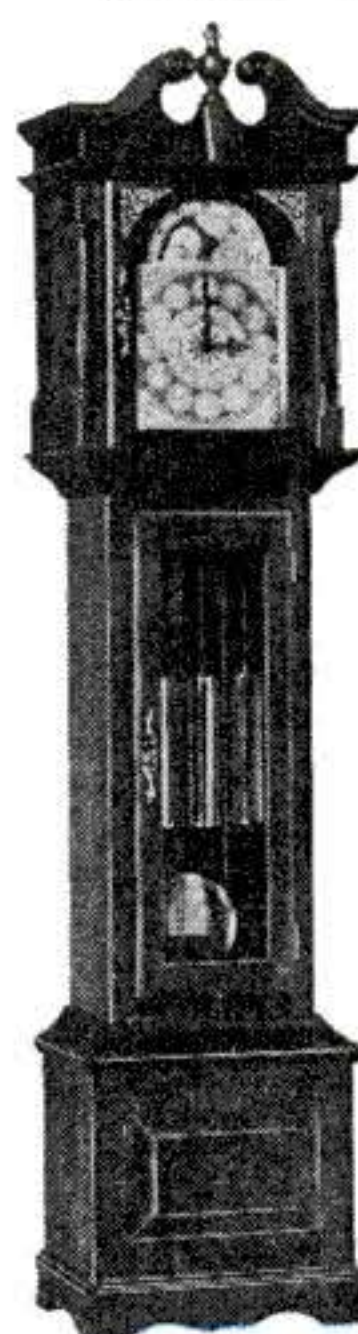
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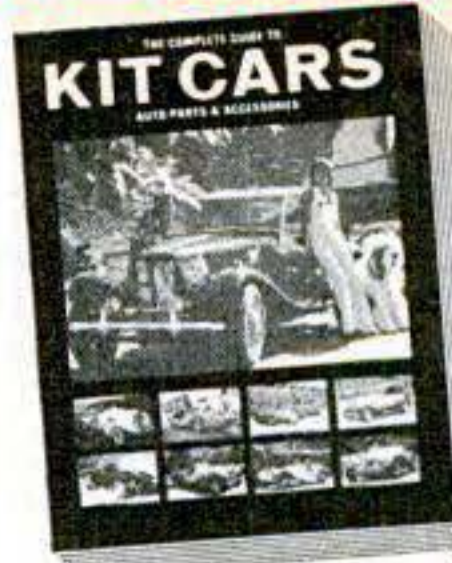
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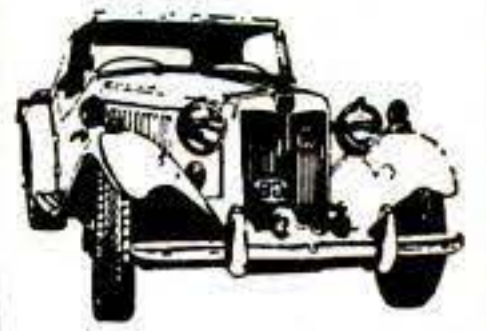
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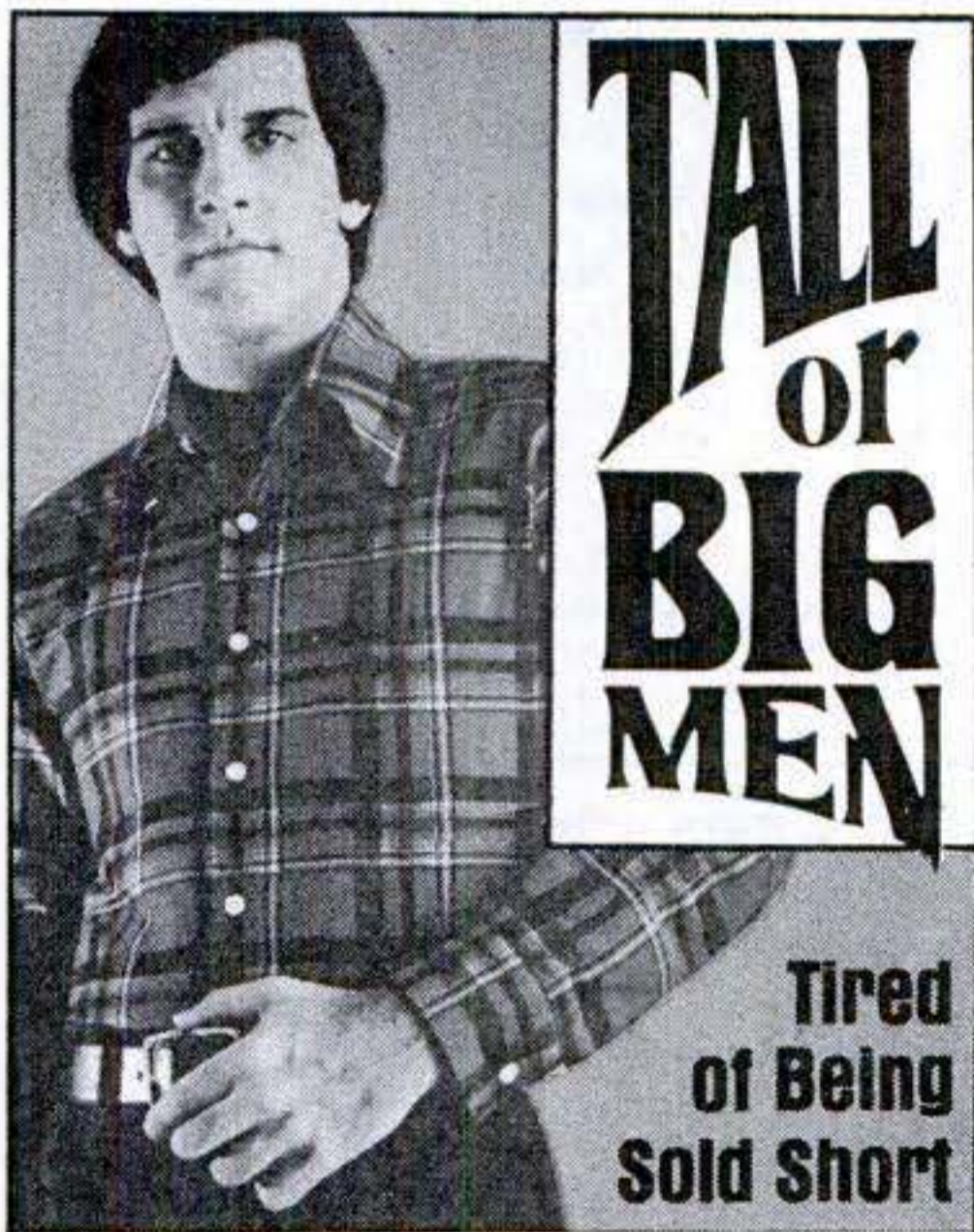
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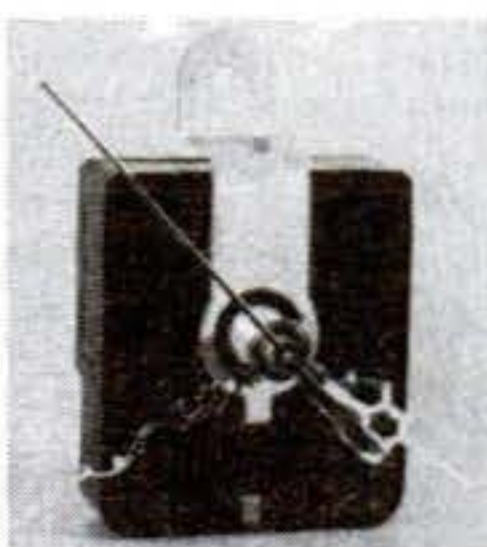


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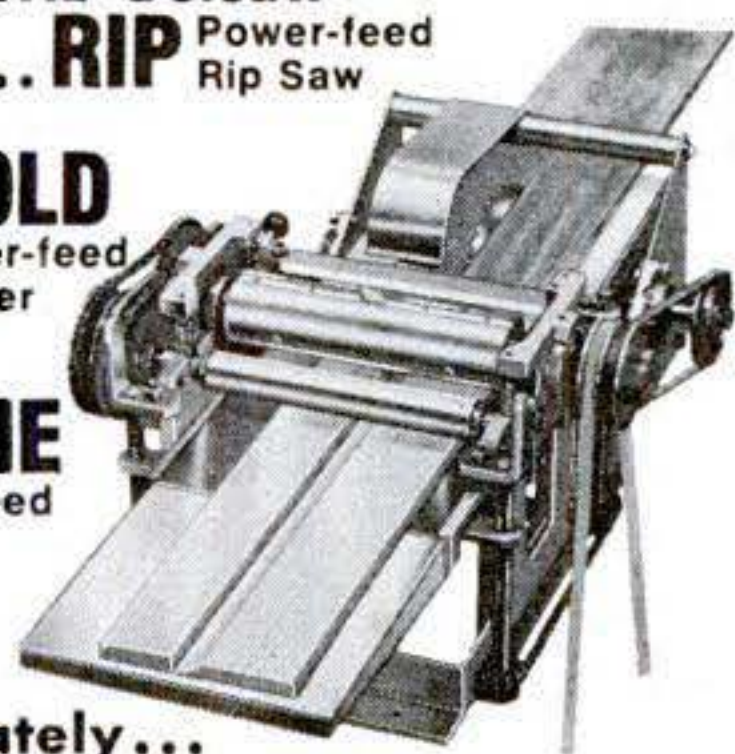
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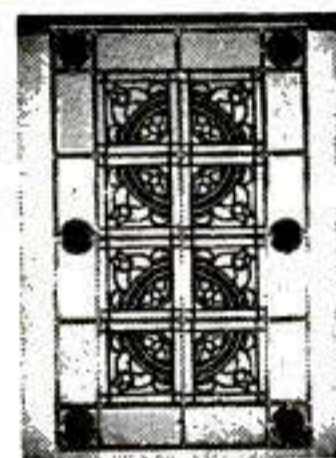
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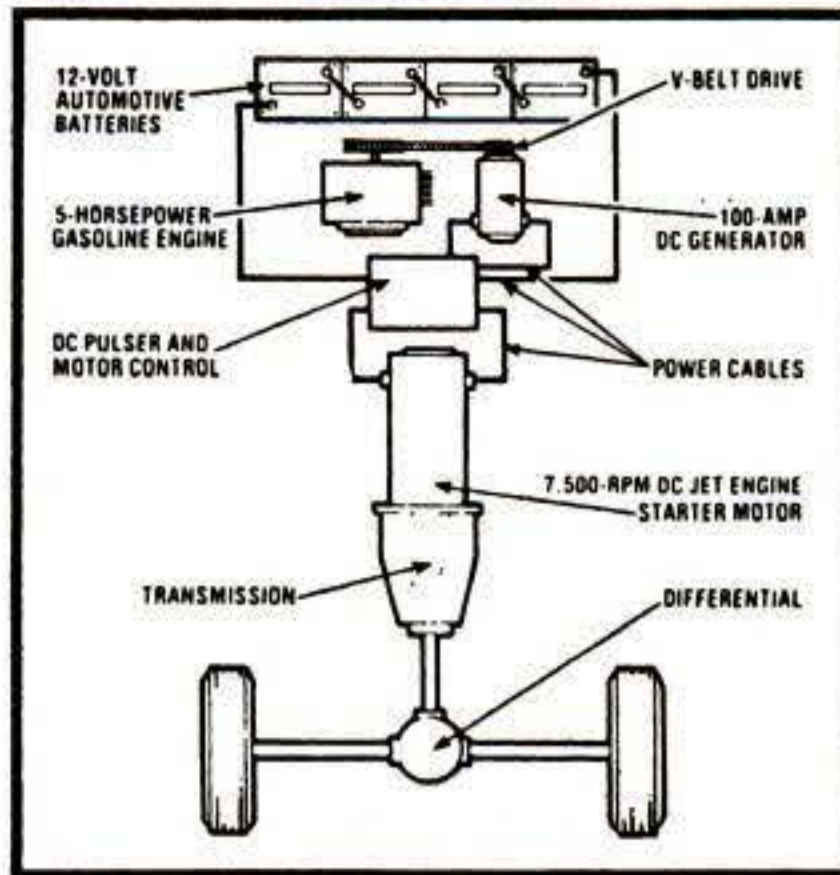
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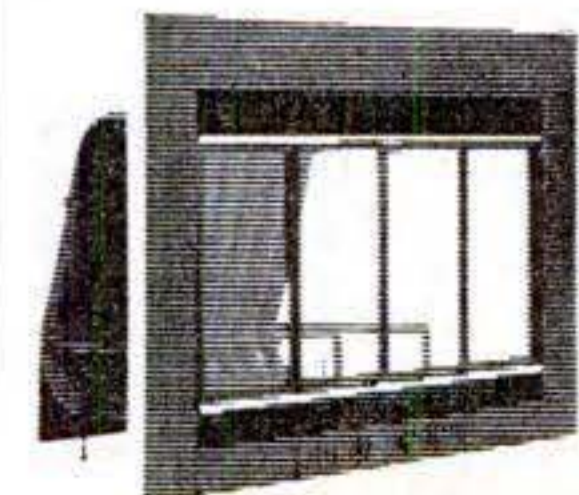
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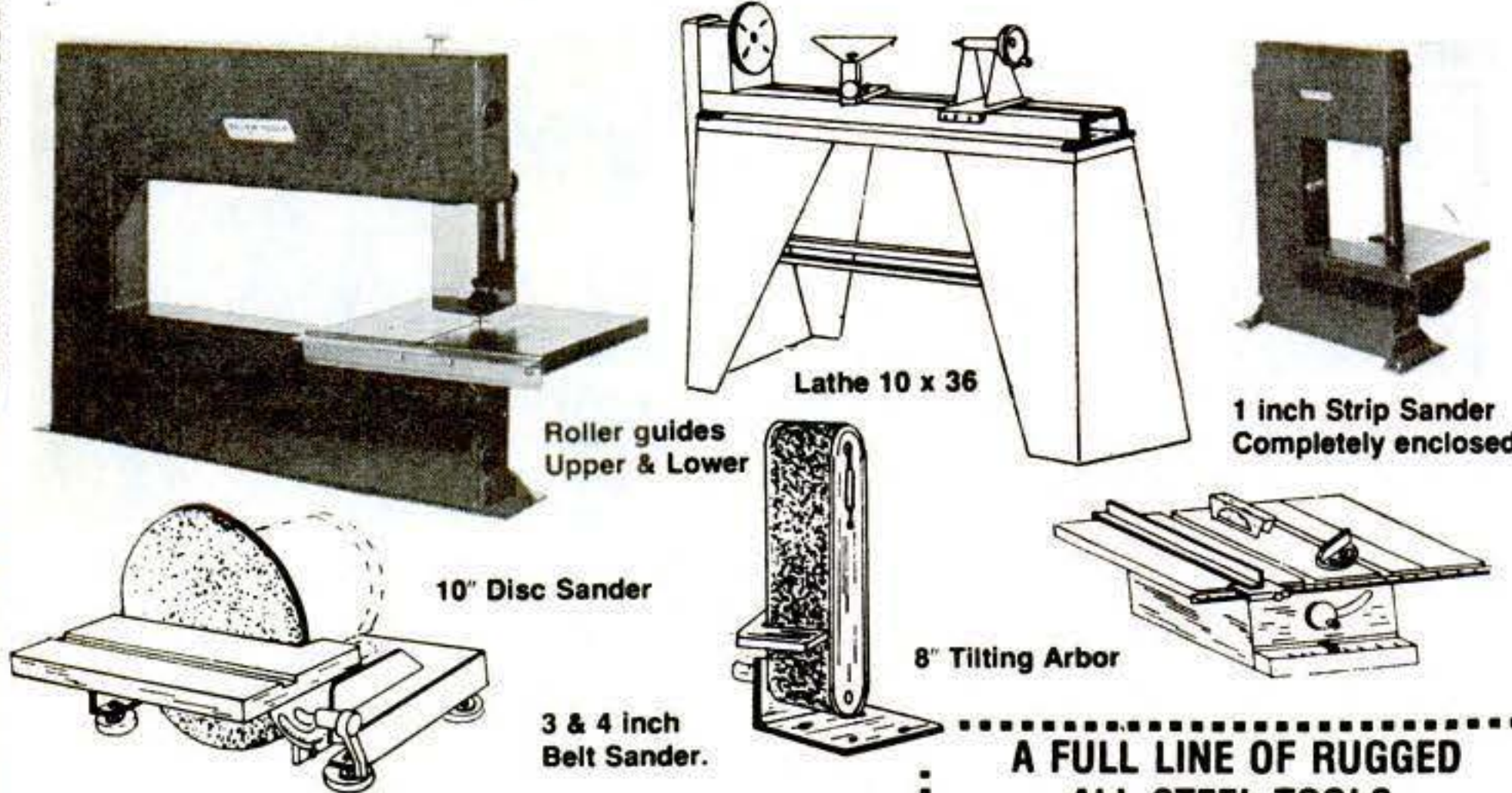
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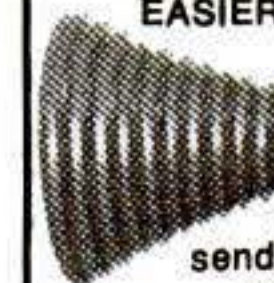


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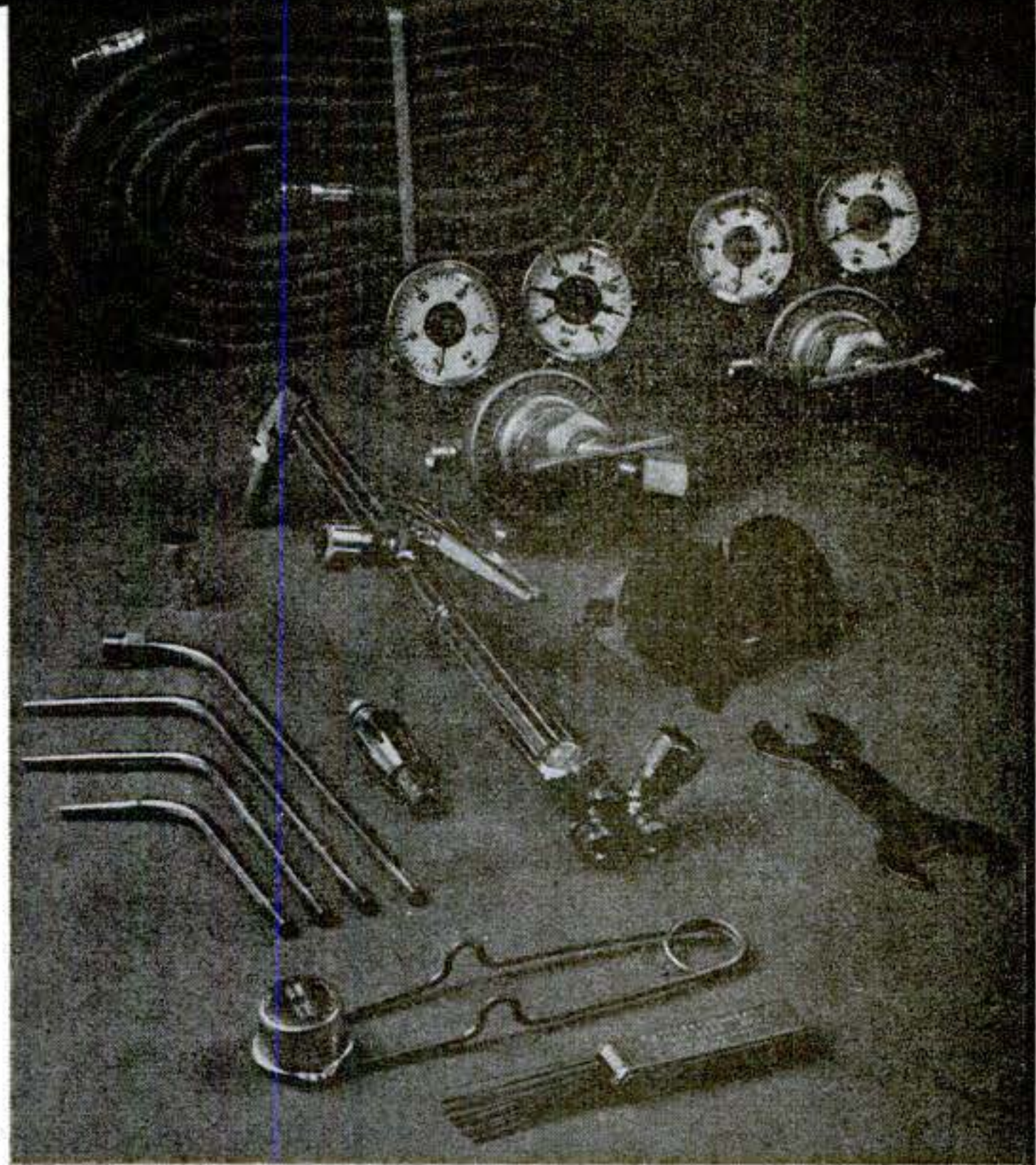
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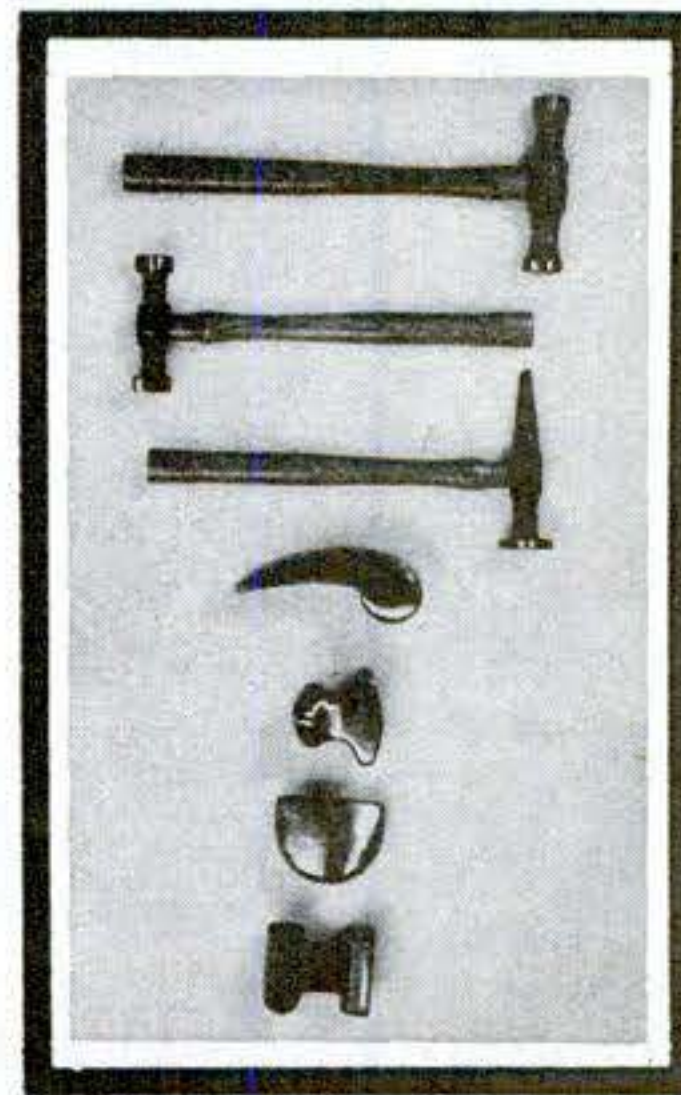
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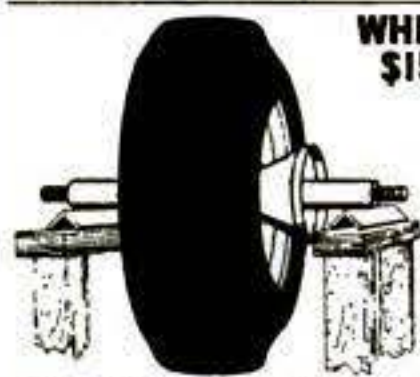
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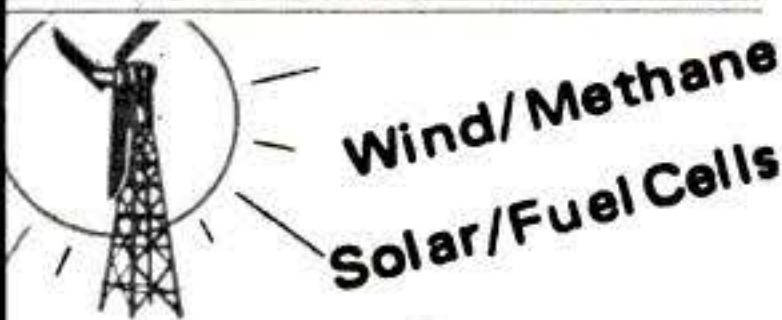
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