

Popular Science®

The **What's New** magazine

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1983

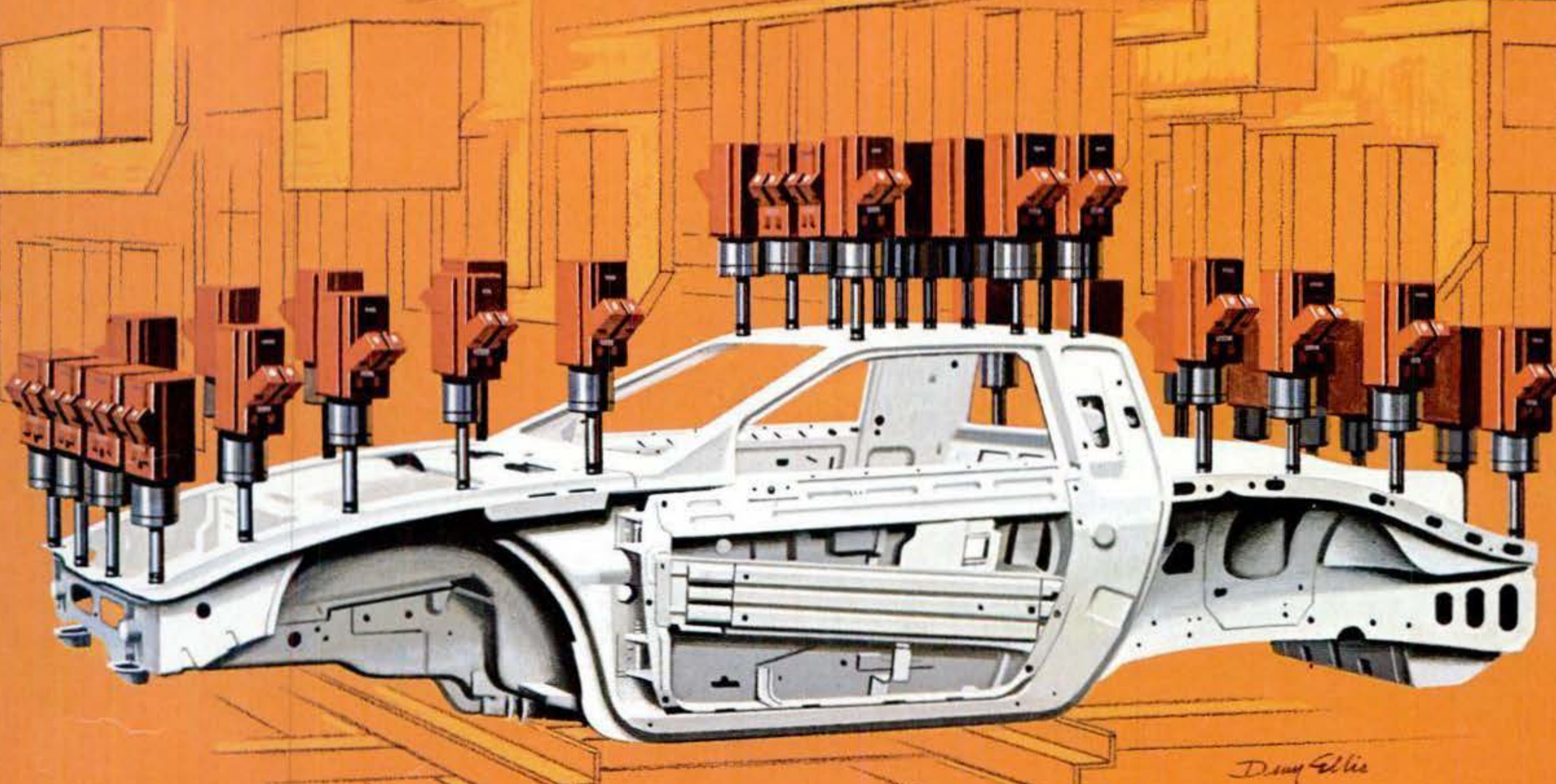
Secret science of
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WARFARE**

Coming:
**COMPUTERS
THAT LISTEN**

Revolution in car making

New GM machine gives:

- perfect body fit every time
- bolt-on, easy-to-replace body panels



- Car care: high-pressure high-temp cooling systems
- Analyze the stock market with new computer programs

- 3 projects of waterboard —amazing d.i.y. material
- 650-foot power tower





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New
Players Kings.
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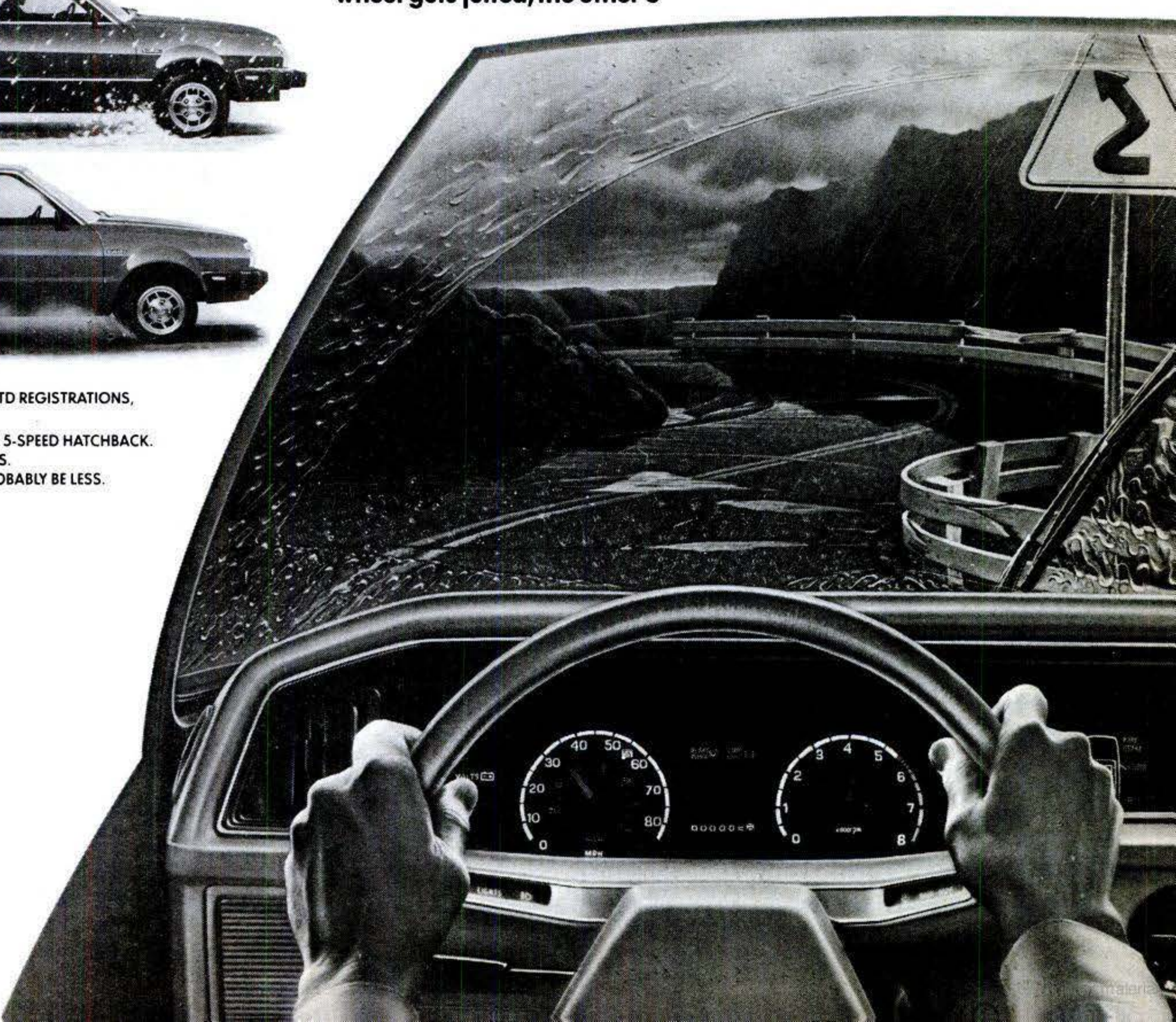
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**HIGHLIGHTS
OF
THIS
ISSUE**

Revolution in car making—precise fit with plastic panels

Can Detroit produce perfect body shells? Take a look at GM's attempt. **PAGE 58**

Challenger's engines—tracing the shuttle's fuel leaks

Come behind the scenes to see what delayed the second shuttle's launch. **PAGE 64**

Analyze the trends: computer stock-market programs

Here are 38 programs, costing \$30 to \$700, to help you chart the market. **PAGE 108**

Cram a walletful of information into a card with a brain

With a microchip buried in it, this credit card is a veritable computer. **PAGE 34**

New image for the K chassis: turbo sports cars

Chrysler wheels out the first U.S.-made front-drive high-performance cars. **PAGE 96**

Trouble-shooting high-pressure cooling systems

A top mechanic gives inside tips on keeping your car's temperature down. **PAGE 99**

COVER PAINTING BY DEAN ELLIS

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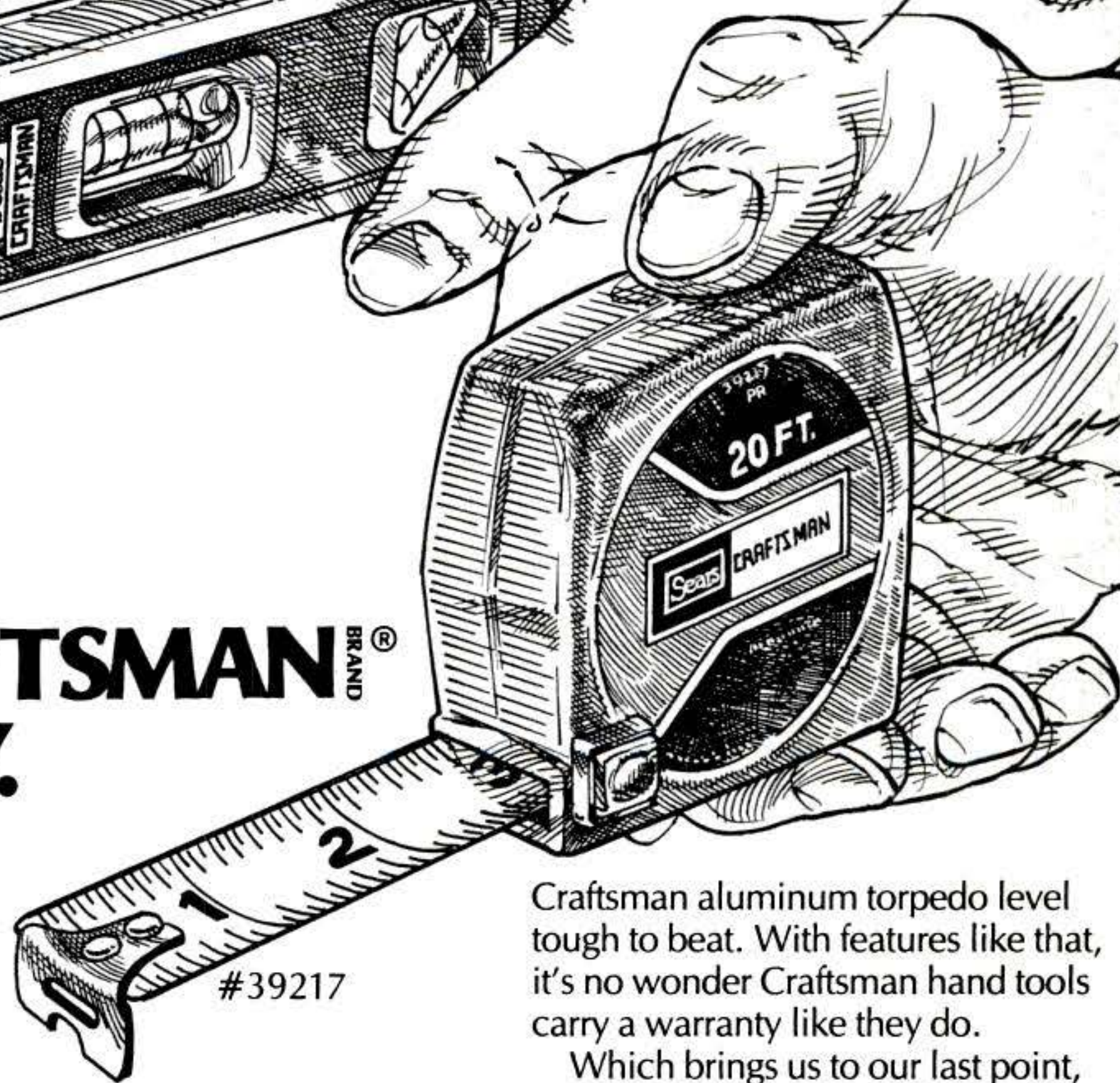
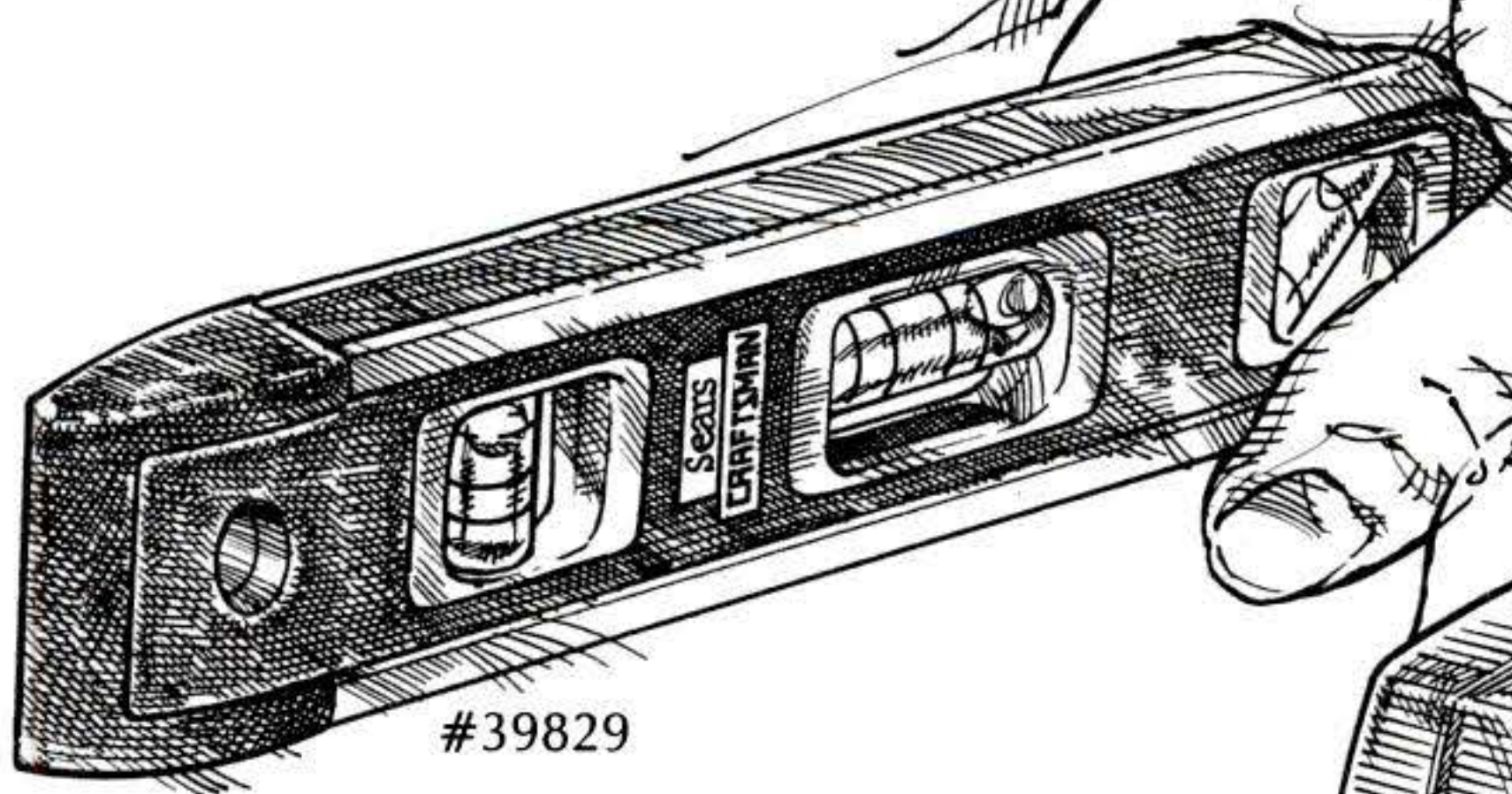
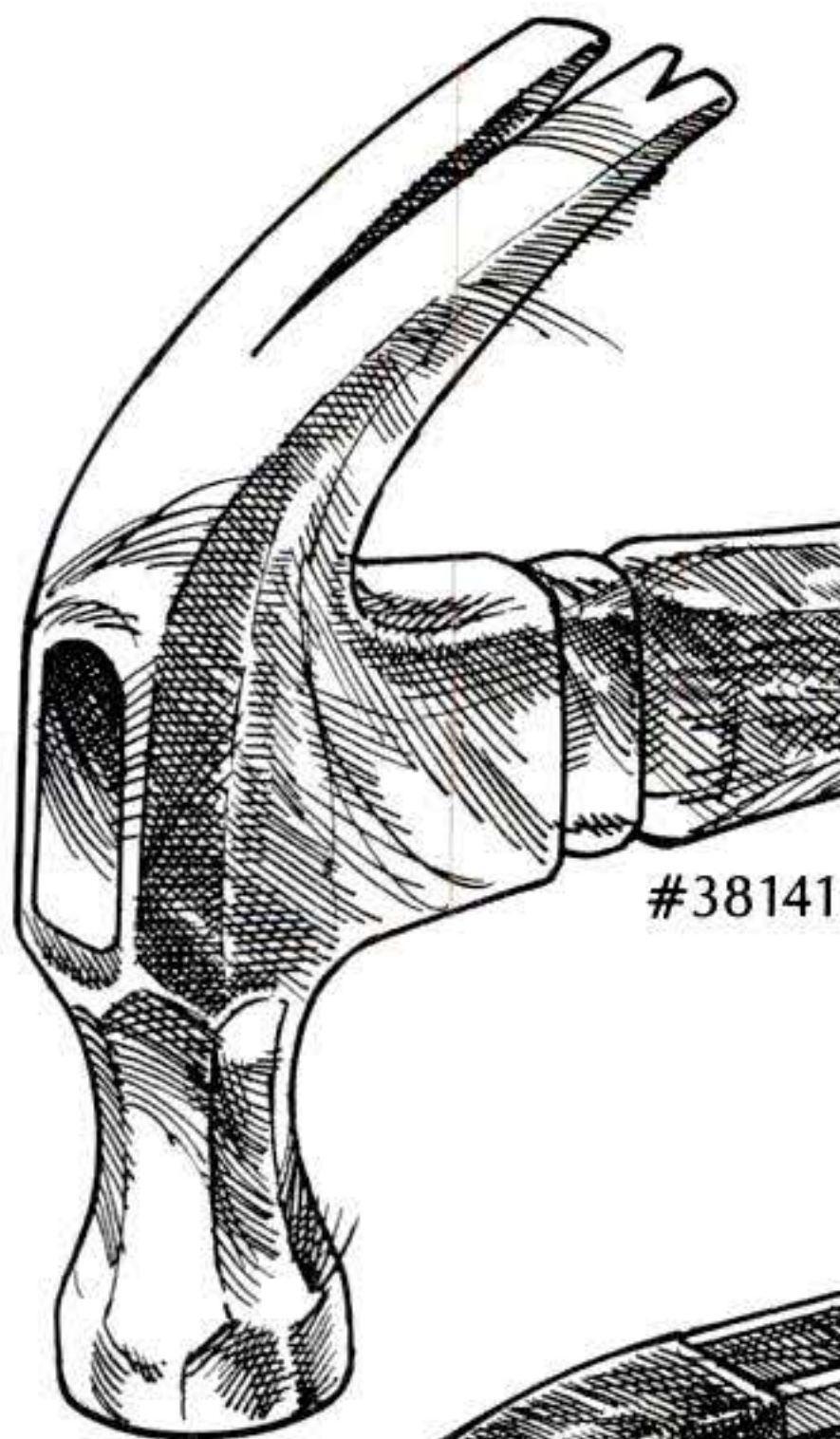
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Sears store throughout the U.S. and Sears will replace it, free of charge." No ifs, ands or buts about it. Now those are strong words, but Craftsman hand tools are strong tools.

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Craftsman aluminum torpedo level tough to beat. With features like that, it's no wonder Craftsman hand tools carry a warranty like they do.

Which brings us to our last point, now's the time to carry all three home. From July 3—16, they're the Craftsman Choice for just \$7.99 each—a 38% to 42% savings. A strong reason to visit the Sears retail store nearest you.

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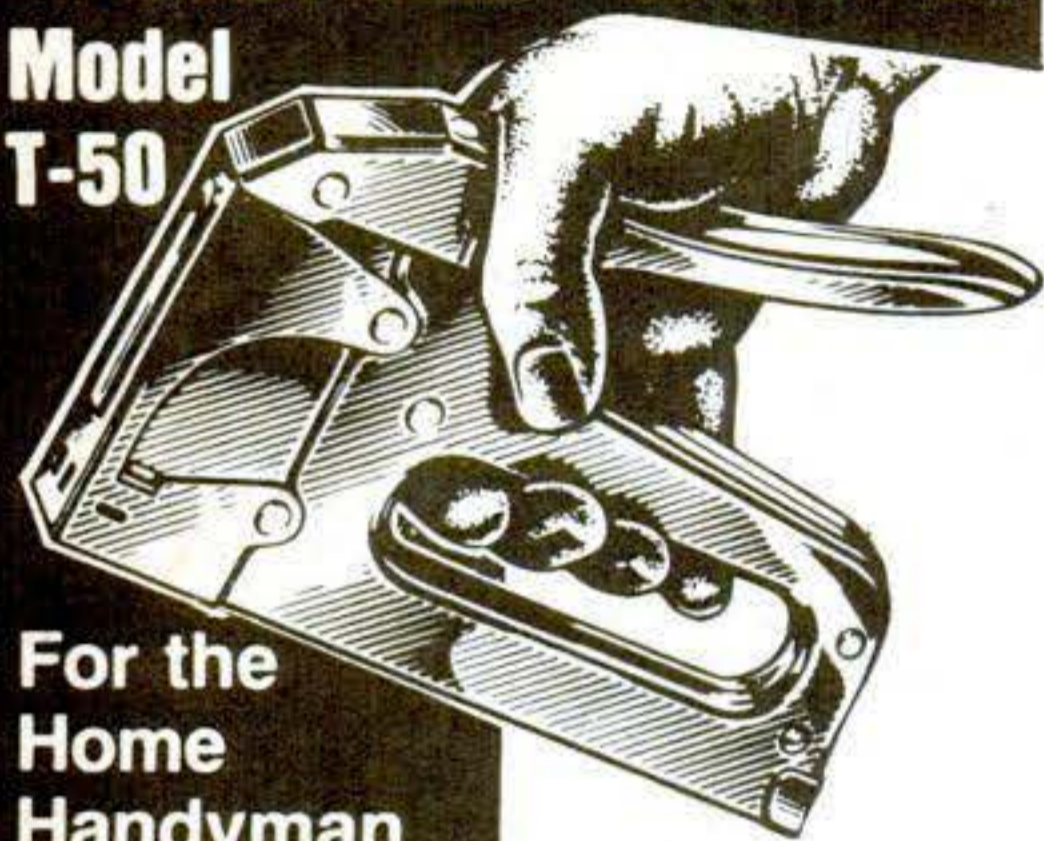
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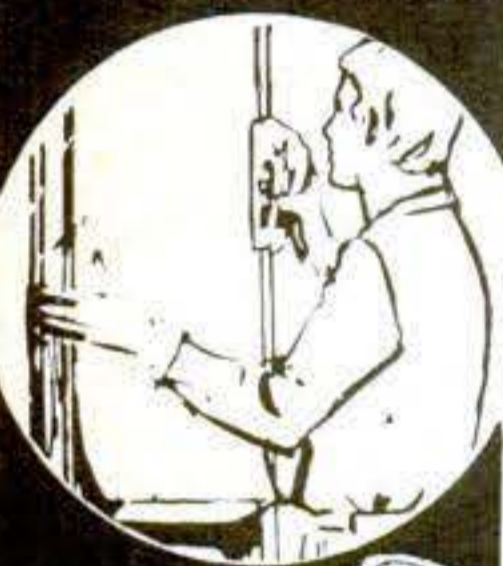
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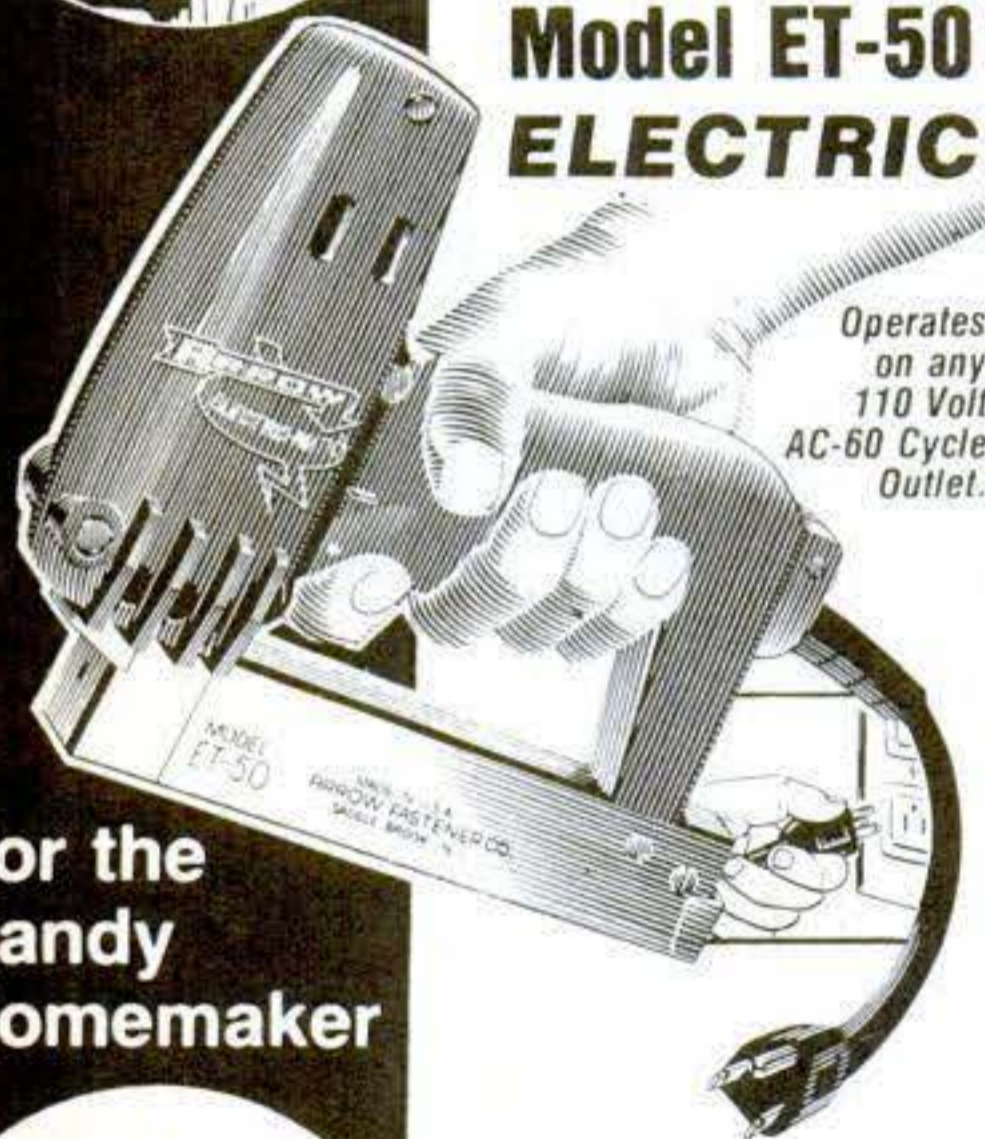


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PS READERS TALK BACK

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Smokey's engine

Smokey's adiabatic engine [PS, April] is a beautiful accomplishment. His gasifying process is a fundamental achievement because octane rating is effectively increased.

Henry North
Assoc. Prof. of Mechanical Engineering
Lakehead Univ., Thunder Bay, Ont.

If the claims for the engine are really true, I'm going to have to go back to school and forget about my three years of working on hot-rod engines. The engine defies not only commonly accepted thermodynamic laws but also much experimental evidence established by thousands of researchers worldwide. Besides the detonation problem mentioned in the article, higher intake-mixture temperatures will increase cylinder heat losses (and therefore fuel consumption) and reduce power output.

Christian Dupuis, Montreal, Que.

So Smokey has finally decided to stop fooling around and become an automotive giant. That's great. I hope he doesn't blow it on the Big Three. If his engine is as good as you say, he should get his own investors, buy one of the closed auto plants in California, and put his own name on the car.

Scott Broddy, Redlands, Calif.

Your article verifies the foresightedness of the Palm Beach Society of American Inventors in this year having named Henry "Smokey" Yunick its first Inventor of the Year for the state of Florida.

J. Merritt Jacobson, Palm Beach, Fla.

Heat-vent efficiency

I am planning to build a superinsulated home this year, so I was very interested in your article on air-to-air heat exchangers ["Heat-Saving Vents," PS, Jan.]. But the explanation of the efficiency of these units seems to be in error. Assuming equal inlet and outlet airflow rates, I do not see how it is possible to raise the temperature of the incoming air by more than half the inside-outside differential. This follows from the second law of thermodynamics, which says that energy cannot seek a higher state. Therefore, the best that could be achieved, if the flow rate were slowed almost to zero, would be equilibrium between the incoming and outgoing air.

Joseph V. Secen, Pittsburgh, Pa.

William Fisk, staff scientist for Lawrence Berkeley Laboratory's building-ventilation and indoor-air-quality program, replies: "For the case of a parallel-flow heat

exchanger, in which the airstreams flow parallel to each other and in the same direction, the reader is correct: Thermodynamics limits the effectiveness to 50 percent if the airstream-mass flow rates are equal. However, the effectiveness of cross-flow and counterflow heat exchangers can be much higher. This is possible because of the temperature profiles of the airstreams when they are actually flowing through the heat exchanger. For example, in a counterflow exchanger operating in winter, the supply air is already substantially warmed as it nears the exit of the exchanger. However, at this location it is in thermal contact with the warmest portion of the exhaust air and can still absorb heat from it. Thus the temperature of the supply air can approach the indoor temperature."

Mower blade brakes

The brake-clutch mechanism of new lawn mowers ["Blade Brakes," PS, March] requires a flywheel to take the place of the flywheel effect of the blade. This means that considerable weight will be added to the mower. On a self-propelled machine this is not too detrimental, but it would be undesirable on a push mower. On hand-pushed machines, extra weight pushes the wheels down into the grass. E. F. Lindsley may not have noticed this in his tests because he tried the machines out late in the year when the ground was firm and the grass sparse.

Alvin P. Fenton
Advanced Research Engineer
E & G Group Engineering, Kohler, Wis.

I can see it already. The engine-killing bail on the new blade-brake power mowers is going to be tied down with a piece of wire or duct tape before the new owner finishes mowing his lawn once.

Bruce Falk, Joliet, Ill.

E. F. Lindsley replies: "You're probably right. And I wouldn't be surprised if the people who do this used the seat belts from their cars for tie-downs."

Car of the future?

Does the experimental Ford Probe IV [PS, March] come equipped with dusting attachments? It should, because it looks like the business end of an upright vacuum cleaner.

When I think back to the artists' conceptions of how cars would look in the 1980s and '90s and then look at this rubber-coated roller skate, I could cry. What happened to the sleek lines, the gleaming chrome trim, the grace and elegance?

Continued

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PS readers talk back

What happened to the sex appeal in our cars?

Vehicles like the Probe IV may excite the car-as-appliance group, but it does absolutely nothing for my pulse rate.

Francis Pivar, New Kensington, Pa.

Cars of the past?

Will Detroit never learn? Several recent items in "Detroit Report" indicate that the temporary glut of petroleum products has caused the auto makers to rush back to producing big, inefficient cars. At the same time, Ford is closing its West Coast assembly plants because of "the boom in Japanese sales on the Coast" [PS, April].

The price of gasoline and other petroleum products will go up again due to its finite availability, but Americans, with the assistance of Detroit, will gleefully consume the last drop of gasoline as long as it's affordable. If Detroit insists on moving backward, we can expect another fall worse than the one the auto makers are just recovering from. Who is going to save the industry this time?

Carlton E. Salvagin, Hannibal, N.Y.

Computers in cars

Regarding Smokey Yunick's statement, "I reject computers for cars because we can't fix them" ["Say, Smokey—," PS, March], I believe a few comments are in order. The idea is to use the computing power and reliability of microelectronic devices for such demanding applications as engine fuel- and ignition-control systems. You don't fix an ignition coil or a burned valve; they are replaced. The computer microchip is no different.

Computer-based control systems are used in commercial airplanes and military vehicles where reliability, serviceability, and high performance are prime factors. Auto or other manufacturers who resist new high-technology products will not survive in the world marketplace.

Richard J. Valentine, Mesa, Ariz.

Forever foam

Your article "Cut Foundation-Wall Heat Loss" [PS, Feb.] performed a service in educating your readers about the concentrated heat-loss area of a foundation. And thank you for mentioning our firm as a manufacturer of a pre-coated insulating panel. I was surprised, however, that price was the only difference you noted between extruded and expanded polystyrene. The major difference between the two foams is not price or R-value; it is the retention of R-value after a few years of freeze-thaw cycling. ASTM tests have shown that after 400 cycles (about six years), expanded polystyrene retains 50 percent of its original R-value while extruded polystyrene retains 96 percent.

Christina M. Jones, President
Thermboard Manufacturing Co.
Albuquerque, N.M.

Security from within

Roy Bellon takes a dangerously limited view of national security when he argues

that the U.S. is safer buying MX missiles than adding insulation to buildings [RTB, PS, April].

Regarding the MX: The technology and deployment strategy (when finally selected) may not prove effective; deployment will invite a similar buildup by Russia; and construction of the missile could unleash runaway inflation in our economy by diverting work away from socially useful purposes. On the other hand, money invested in energy research and conservation provides the basis for noninflationary economic growth, fosters our competitive position in the world economy, and insulates us from the whims of erratic energy suppliers.

Unreliable weapons perched atop a faltering economy don't improve security.

William C. Mantis, St. Paul, Minn.

The bearing facts

It was interesting to see your photo and caption about the bearingless rotor system using composites instead of metals ["What's New," PS, Nov. '82]. We at Aerospatiale Helicopter Corporation have been using this type of system for more than a decade with over 2.5 million hours without a failure. What's exciting is that someone finally noticed.

Fred Salitore
Aerospatiale Helicopter Corp.
Grand Prairie, Texas

More on rammed earth

Thank you for including the work of the Center for Maximum Potential Building Systems in your coverage of rammed-earth construction [PS, Nov. '82]. However, a couple of errors crept in that could mislead people trying to use our techniques. Caliche and sulfur react poorly together, so the hot-iron method described can be used only with sulfur-sand block. A far better way to use sulfur is to spray it hot onto walls while mixing it with a fiber, à la fiber concrete. Also, sulfur's great compressive strength was overstated. Under ordinary conditions, it will take 6,500 psi. On another matter, the smallest amount of portland cement that we have been able to use with the very best caliches is five, not one, percent. And for future reference, although dictionaries might give a different spelling, the powdered rock used in cement is spelled *pozzolan* in the industry.

Pliny Fisk III, Director
Center for Maximum Potential
Building Systems, Austin, Texas

Corrections: We still have our wires crossed about polarization [RTB, PS, May, and "Polarization," Feb.]. The illustrations supplied by GE in both instances should have shown that a potential for shock existed if the neutral wire of a lamp is plugged into the "hot" side of an electrical outlet.

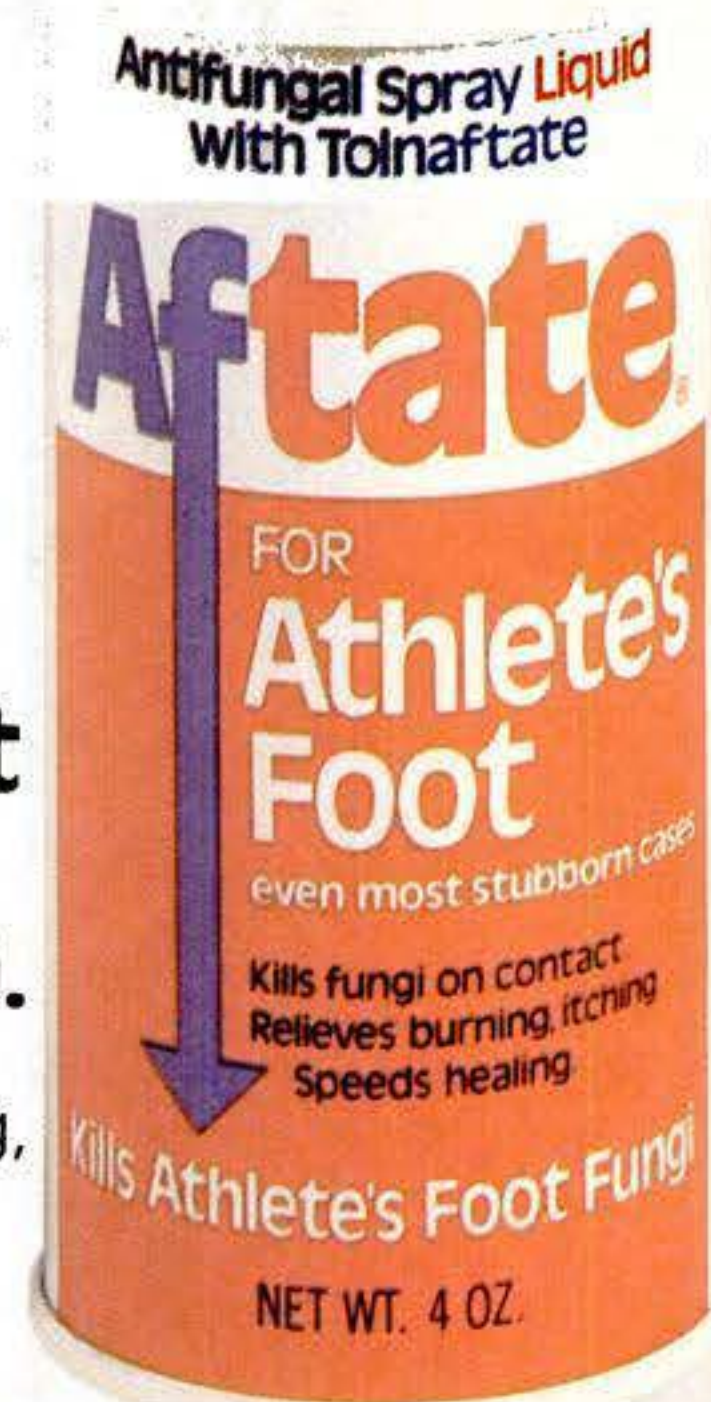
The input impedance of the digital voltmeter that must be used with the OTC diagnostic monitor ["Computer Analyzer," PS, April] should have been given as 10 megohms, not 10 ohms. [3]

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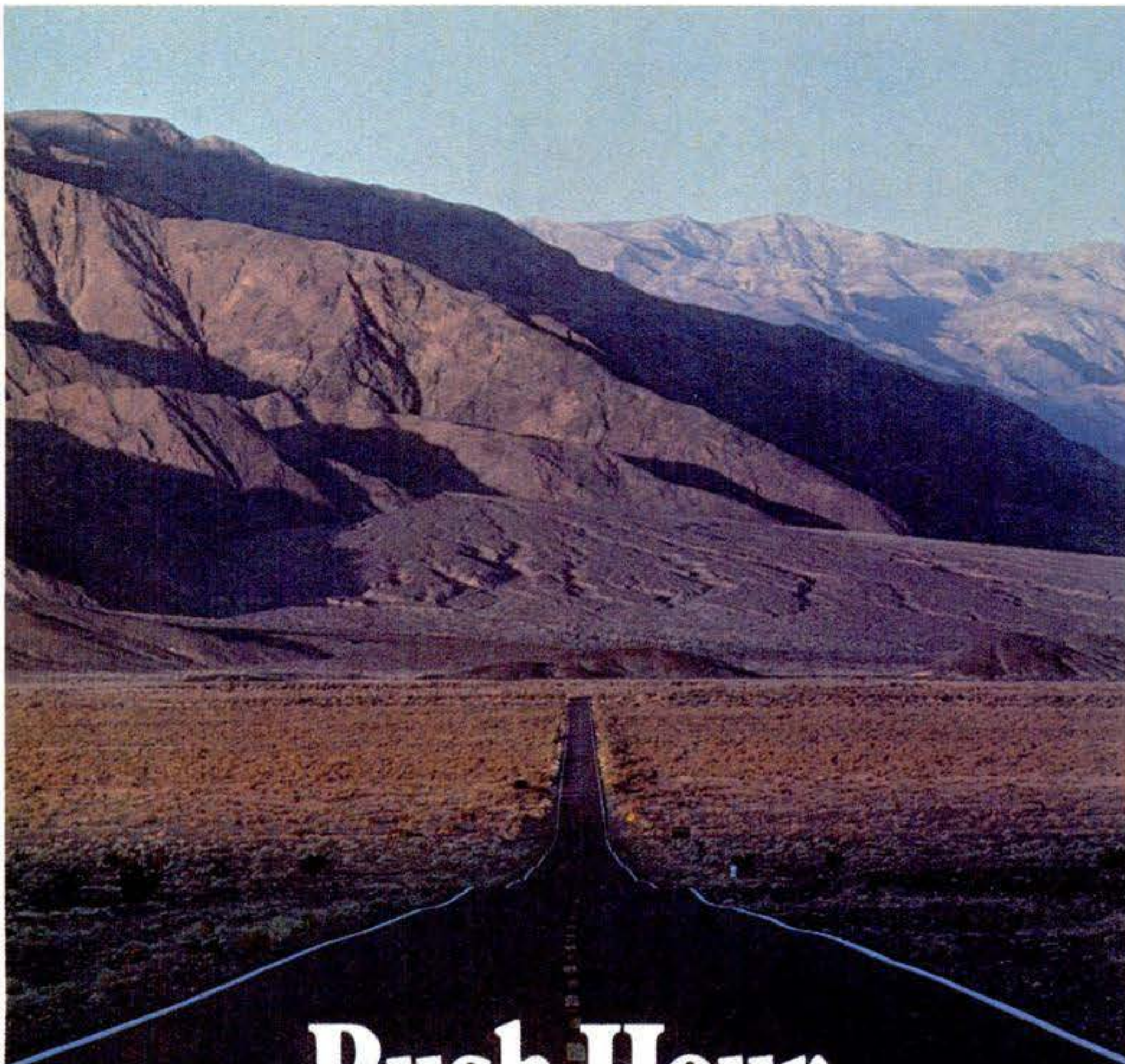
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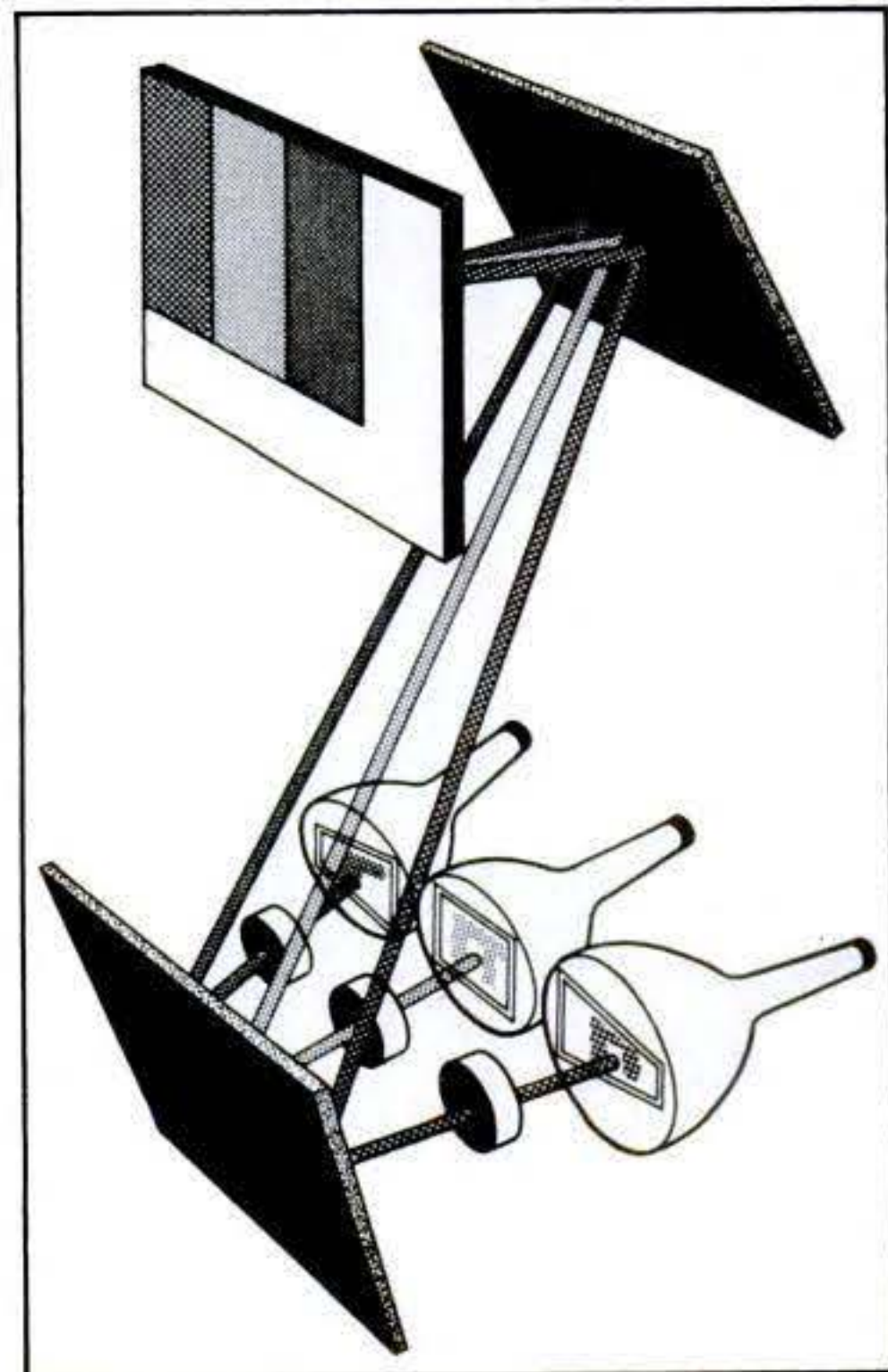
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Self-converging tubes sharpen projection TV

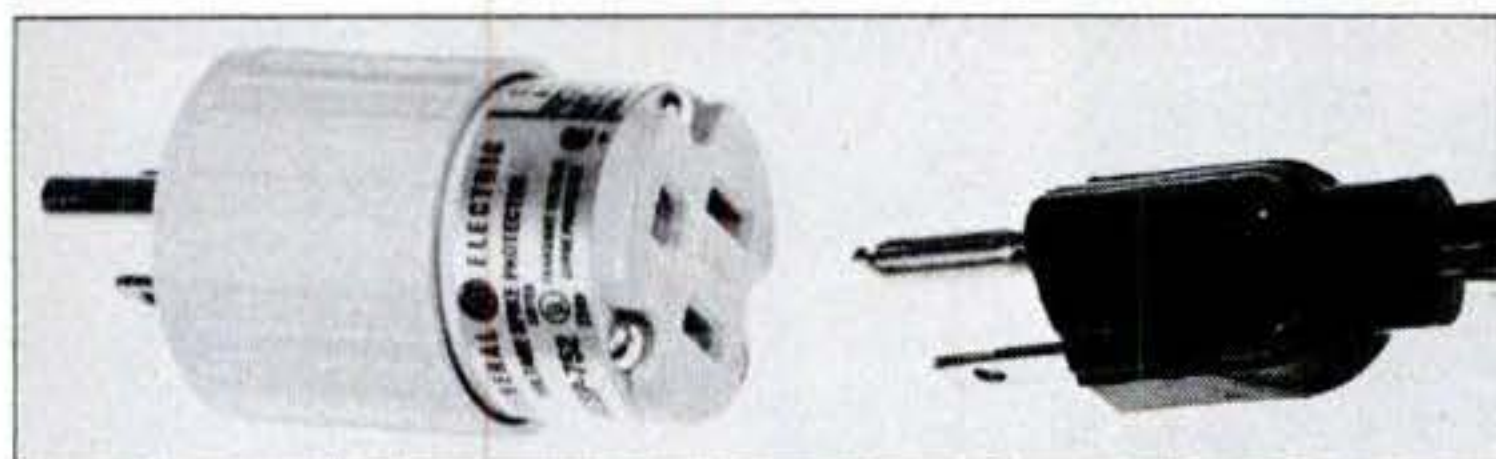
Most projection TVs with separate red, green, and blue tubes require special circuits to help converge images from each tube on a screen. I spent hours tweaking more than a dozen potentiometers inside my Advent when it was set up initially. The circuits and adjustments are needed to electronically "warp" signals so they appear normal when projected. Images are distorted because each tube is off-set from its neighbor. Also, trapezoid-shaped pictures result from off-axis projection onto screens.

For its 45-inch rear-screen models [PS, Aug. '81], Zenith's Rauland Division (Melrose Park, Ill.) came up with an optical fix for the problem that eliminates the need for correction circuits. Zenith's approach, tilted faceplates for each tube, saves on circuit components but doesn't perceptibly dent the \$2,700+ prices for its TVs.

Only the faceplates on outside red and blue tubes (diagram) are tilted less than five degrees. The tilt distorts the projected picture, canceling out the distortion caused by the projection angles to the screen. Self-converging tubes eliminate the usual beam-registration problems. For sharp pictures at high brightness levels, the tubes also have a unique new electron gun.—*John Free*



Spike protector blocks electrical transients



When Dr. Harold Miles, a physician in Naples, Fla., moved his stereo to change turntables, he found a blackened four-inch area around the electrical outlet. The cause: lots of potentially damaging voltage arcing around the plug. His stereo system, which still worked, had been connected to the outlet through a General Electric Voltage Spike Protector (VSP). This \$11 plug-in device protects solid-state appliance components from voltage spikes—sharp rises in AC-line voltage that may occur at split-second intervals during electrical storms.

Storms aren't the only cause of these voltage transients. They also occur when any motor-driven appliance, such as an air conditioner, furnace, washer, or dryer, is switched on or off. Transients under 600 volts pose little threat to most electronic equipment. Above 1,200 volts, however, even conventional insulation begins to melt. According to GE, household spikes as high as 2,500 volts have been recorded. At this voltage level there is a high risk of destroying unprotected solid-state components.

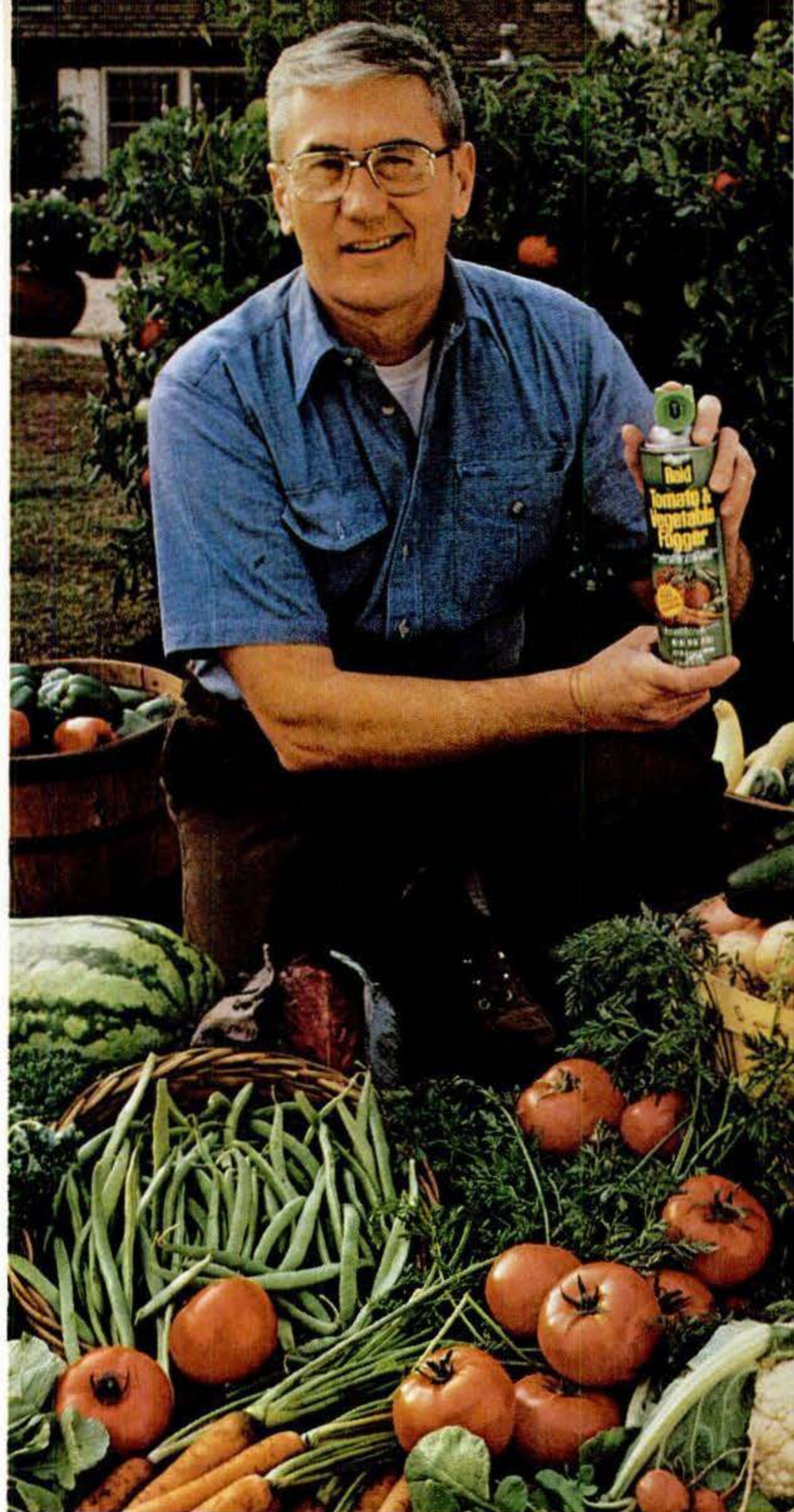
One-way flow

GE's VSP uses a voltage-dependent varistor—a nonlinear resistor that behaves electrically like back-to-back diodes. The varistor is analogous to a check valve in a water system, which allows water to flow in one direction but blocks it in the opposite direction. The VSP traps the voltage spike by allowing it to flow *into* the device—but not out. Spikes are absorbed before they can reach your equipment. Electrical conduction in the varistor occurs between zinc oxide grains distributed throughout its bulk; energy is absorbed uniformly in the VSP body, so heat is spread evenly throughout its volume. This allows the varistor to handle much more energy without damage than a typical solid-state component can.

Using the GE unit is simple: Just plug the protector into a receptacle, then plug the equipment into the protector (photo). Several types of low-power equipment—workshop tools, stereo and TV components, computer gear—can be plugged into a fused multi-outlet box, which in turn is plugged into a single spike protector. Some electronic equipment is protected internally by varistors, but it's usually difficult to tell whether your gear has this built-in spike protection. Double protection with a plug-in VSP is inexpensive compared with appliance damage.

Heavy-duty versions of the VSP are also available to fit home electrical-entrance panels. These should be installed by an electrician, since panel power must be shut off before installation. And you must be careful: These devices do not indicate whether they've been damaged during a storm, and special equipment is required to test them.

—Evan Powell



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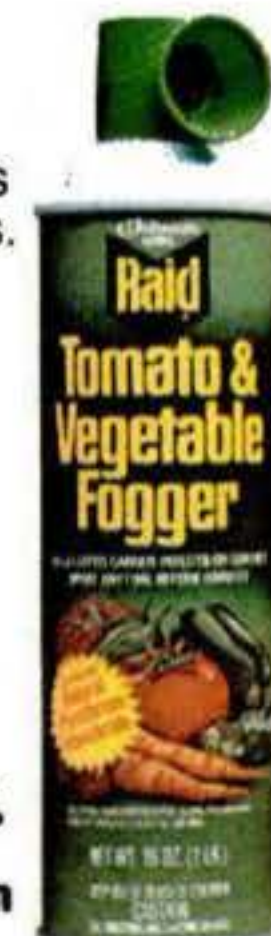
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DETROIT REPORT

By JIM DUNNE



Van plan

Ford and Chevrolet will each have a small van on the market within a year. However, they will be following Chrysler's lead ["Voyager/Caravan," this issue]. What they won't be following is Chrysler's novel approach to small-van design—front-wheel drive. Instead, they'll use a conventional rear-drive system. Result: The vans will weigh more, stand taller, and pull a bigger trailer than the Chrysler model.

Ford is currently testing a tiny prototype van (photo). Its styling features a protruding hood, only a slight overhang in the rear, and an extra-long 119-in. wheelbase. Four-cylinder engines and manual transmissions—if you want them—will make these new models at least 50 percent fuel stinger than the current V8-powered models.

Fear of 60

That's what Cadillac has. Sixty is the current average age of the de Ville buyer. And that age has been steadily climbing in recent years. Caddy fears that if the trend continues, it will run out of buyers for its biggest-selling line. "We figure a guy that age has two more new cars in his plans, and after that he's gone," one Cadillac official laments. The need to attract younger buyers has spawned such cars as Cimarron and sporty convertibles. Cadillac believes that more help is on the way in the form of the 1984 de Ville. Its smaller size, better styling, and improved performance will do the trick, or so goes Cadillac thinking.

Big-car backtrack

Pontiac has decided to backtrack to big cars. The GM division plans to return the full-size B-body to its lineup. Called the Parisienne (the same name it's sold under in Canada), the new model takes the place of the old Bonneville, which was dropped

two years ago when Pontiac set out on its own course, apart from the other GM divisions. Bonneville is now the name for the G-body sedan, a smaller car than the Parisienne. The move was made because Pontiac "is adapting to changing market conditions." Translated, that means Pontiac goofed. It's trying to get back into the big-car market, where Oldsmobile and Chevrolet are cleaning up. Two models will be offered: a station wagon and a four-door sedan. Standard engine is a 231-cu.-in. V6; a 305-cu.-in. V8 is the performance option.

Small but deadly

A study by the National Highway Traffic Safety Administration shows that small cars are more dangerous to pedestrians in an accident than larger types. Although a small car packs the same force when striking a pedestrian, the injuries tend to be more serious because there is a greater incidence of head impacts. That may be due to the shorter, lower hoods, which make striking the windshield and windshield posts more likely when a pedestrian is hit. Auto makers are being advised to take this finding into consideration when designing the fronts of new models, though no recommendation on what changes can be made is forthcoming.

Safer windshields

If an experiment by GM on 2,500 Chevy Cavaliers and Pontiac 2000 models works out, passengers in cars of the future will be protected from facial lacerations by a plastic liner on the inner glass of windshields. With government approval, the test cars will get a European-type windshield called Securiflex. An inner liner prevents broken glass from flying free inside the car. The extra layer will be in addition to the government-mandated glass-plastic-glass sandwich that's already used on

windshields. The new plastic liner is "self-healing," which means that it can be scratched but then covers over the damage through the natural action of the material. Vision is not impaired by the extra layer, and it is claimed to neither attract nor hold dirt. With the new design, facial lacerations could be drastically reduced from the estimated 400,000 cases that occur each year.

V6 equals V8

In the small cars of today, the performance engine has become the V6, just as the V8 was in the past. And you will see more V6s in the coming months, as the demand for fun in driving increases. Two examples: Cimarron will get a much-needed 2.8-liter (171 cu. in.) V6 in mid-1984, and Pontiac will have a 2.9-liter (177 cu. in.) aluminum V6 for the Fiero in late 1984. Pontiac expects zero-to-60-mph times in the eight-second range. The 2.9 V6 will have fuel injection to start, then a turbo will be added for even better performance.

Hot cars

The inside of a car can get hot in the summertime. You know that. Still, it's surprising to find that temperatures of 160 degrees F have been recorded at the same level as the driver's face. This testing was done in Phoenix with the windows closed in a parked car. Interior surfaces get even hotter. The seat can reach 200 degrees. A team from Sun Test Engineering found that the heat caused such problems as warping of trim panels, bleached seat covers, cracked electrical connectors, and collapsed vacuum lines.

Rebuilt cars

Would you buy a remanufactured car from that man? You may have the opportunity if a plan by Arrow Automotive Industries works out. Old automobiles would be repainted, interiors would be refurbished, and remanufactured mechanicals would be installed throughout. Some automobiles are already being remanufactured, though on a limited basis. Classics like the BMW 2002 are receiving total restorations. Auto engineers are being urged to build their cars with "sturdy and durable" parts that lend themselves to remanufacturing, according to Arrow's Harry A. Holzwasser.

Goodbye, Imperial

Say goodbye to Imperial, Chrysler's luxury coupe that never quite caught on after its introduction in 1981. The \$18,000 rear-drive flagship was planned as competition for the Lincoln Mark VI and Cadillac Eldorado. But the timing of its introduction put it in a market that was changing to smaller models. Chrysler expected to build as many as 20,000 Imperials a year but fell far short of that goal. It delivered only 6,400 in 1981, 2,800 in 1982, and an estimated 1,600 this year. Based on the Chrysler Cordoba chassis but with its own sheet metal, Imperial was also seen as a high-profit vehicle that could boost company earnings by more than \$100 million annually. **PS**

Montero

—rugged little 4x4
from Japan

Breakers pounded into white foam, and the soft, wet sand gave way as the wheels of Mitsubishi's new Montero dug in. There was only a moment's

hesitation before the high-riding little utility vehicle moved swiftly across the stormy beach. Debris was everywhere, but Montero rolled smoothly over it all as it made its way to the surf in four-wheel drive.

Introduced to the U.S. in April, Montero is boxy, roomy, and fun to drive. It's also the lowest-priced vehicle in its class, starting at \$9,250 and going to about \$11,500.

Montero has ample room inside for four passengers (or five tightly squeezed) plus modest cargo space. Its

2.6-liter (159 cu. in.), 105-hp engine develops plenty of power for hill-climbing and freeway cruising. Fuel economy with the standard five-speed manual overdrive transmission is adequate for a utility vehicle, about 21 mpg for combined city and highway driving. Free-running front hubs, which disengage the front-wheel-drive mechanism to reduce drag and improve fuel economy, are standard equipment.

The vehicle comes as a two-door only, and there's a high step up to the passenger compartment. Rear access is through a full-size gate door hinged on the right. It opens wide, eliminating any hindrance from a drop-type gate and making loading or unloading a simple matter. The spare tire is mounted externally on the door.

The fun of Montero is in the driving. Driver and passengers sit up high, with plenty of all-around vision. On the road, it handles lightly with little of the trucklike feel that's characteristic of this breed of vehicle. Off-road, with the four-wheel drive in high for normal use or low for extra-low-speed power, it's sure-footed and stable. The driver isn't bothered by bumps and road vibration. Sitting in the unique suspension seat that adjusts for both driver weight and terrain conditions is like sitting on an air pillow that inflates and deflates with the bumps.

If Montero has a flaw, it's in passenger comfort. Unfortunately, passengers bear the full brunt of jarring bumps. Mitsubishi is considering replacing the standard front passenger seat with the more comfortable suspension seat.

—Jim Schefter

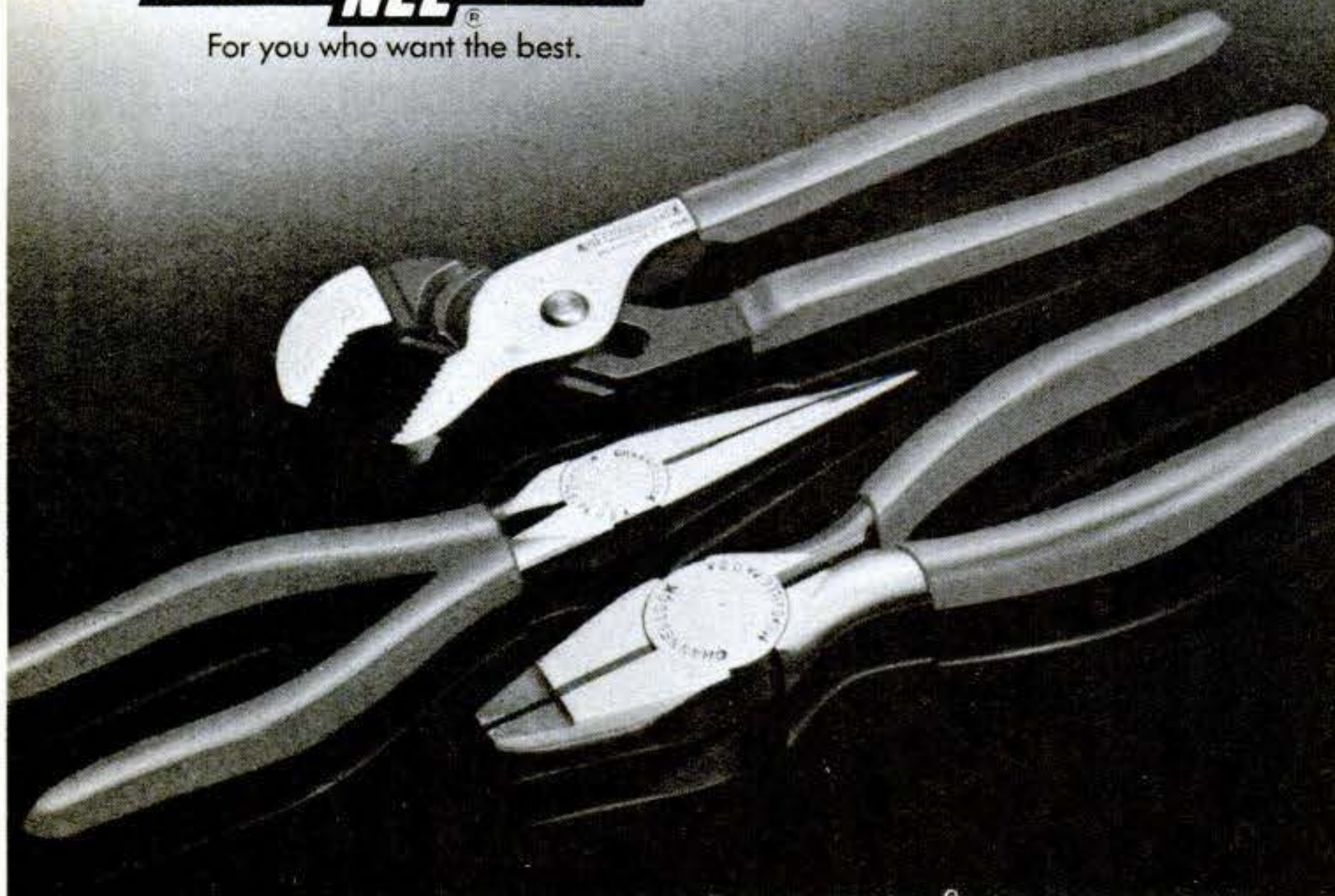
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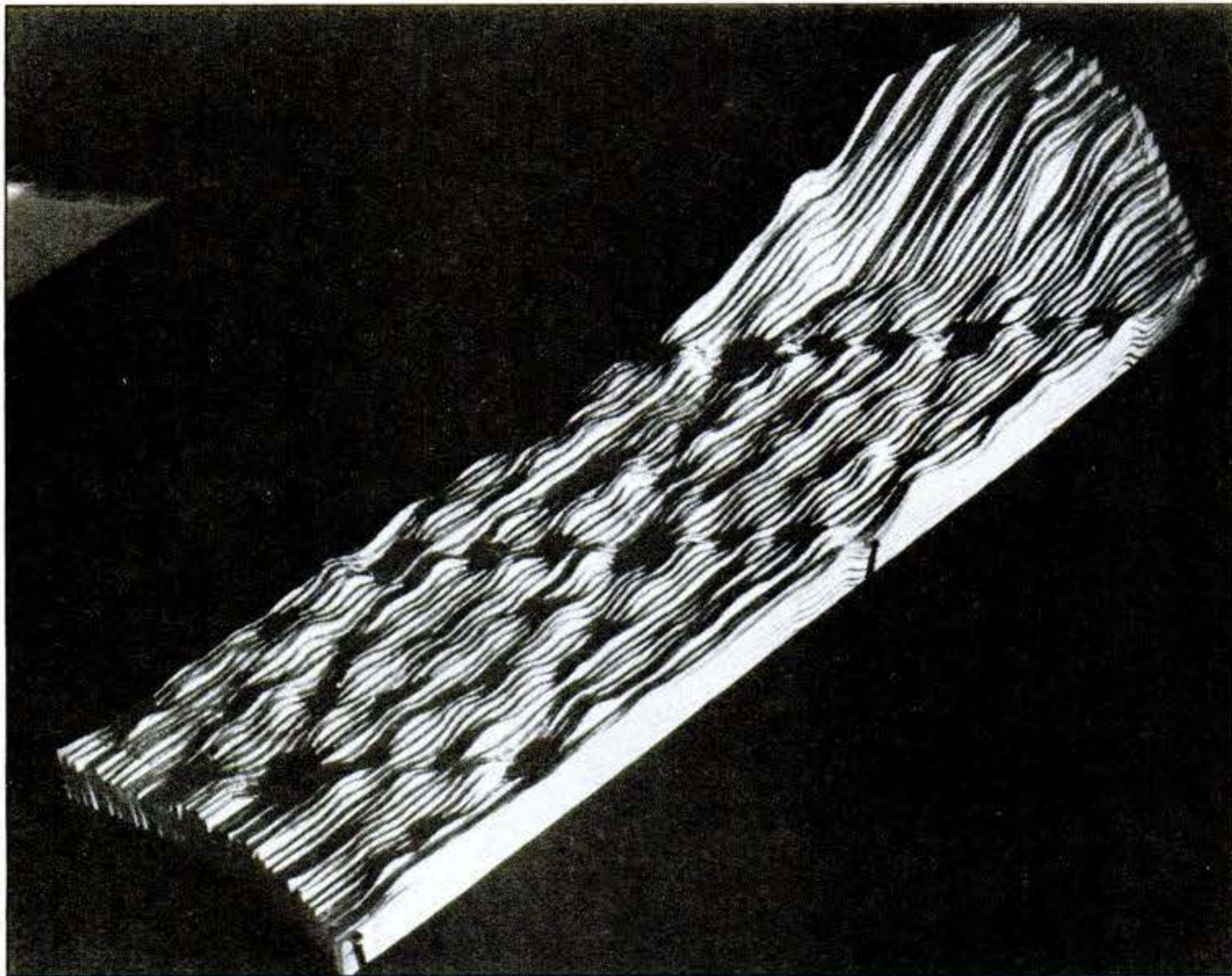
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SCIENCE NEWSFRONT

By ARTHUR FISHER



Getting down to atoms

The photo above is of an enlarged wooden model of a silicon surface. The amazing thing about it is that the bumps and valleys it shows are actually three-dimensional representations of details on the atomic level, shown with a vertical resolution as small as one-tenth of an angstrom (which is one-ten-billionth of a meter) and a horizontal resolution as small as six

angstroms. Thus the picture clearly shows two rhomboid-shaped unit cells, the basic, repeating crystallographic pattern of the silicon atoms. Within each cell you can see 12 bumps—features that have never been observed before. The bumps, whose exact nature is unknown, are only six angstroms apart.

This new technique for studying surfaces is called scanning tunneling microscopy, or STM, and was developed by sci-

entists at the IBM Zurich laboratory in Switzerland. It relies on the phenomenon called vacuum tunneling, in which electrons travel between two conducting or semiconducting solids separated by a vacuum. IBM physicists believe STM may have wide application in studying the electronic properties of surfaces and in imaging magnetic structures, among other uses.

NMR advances

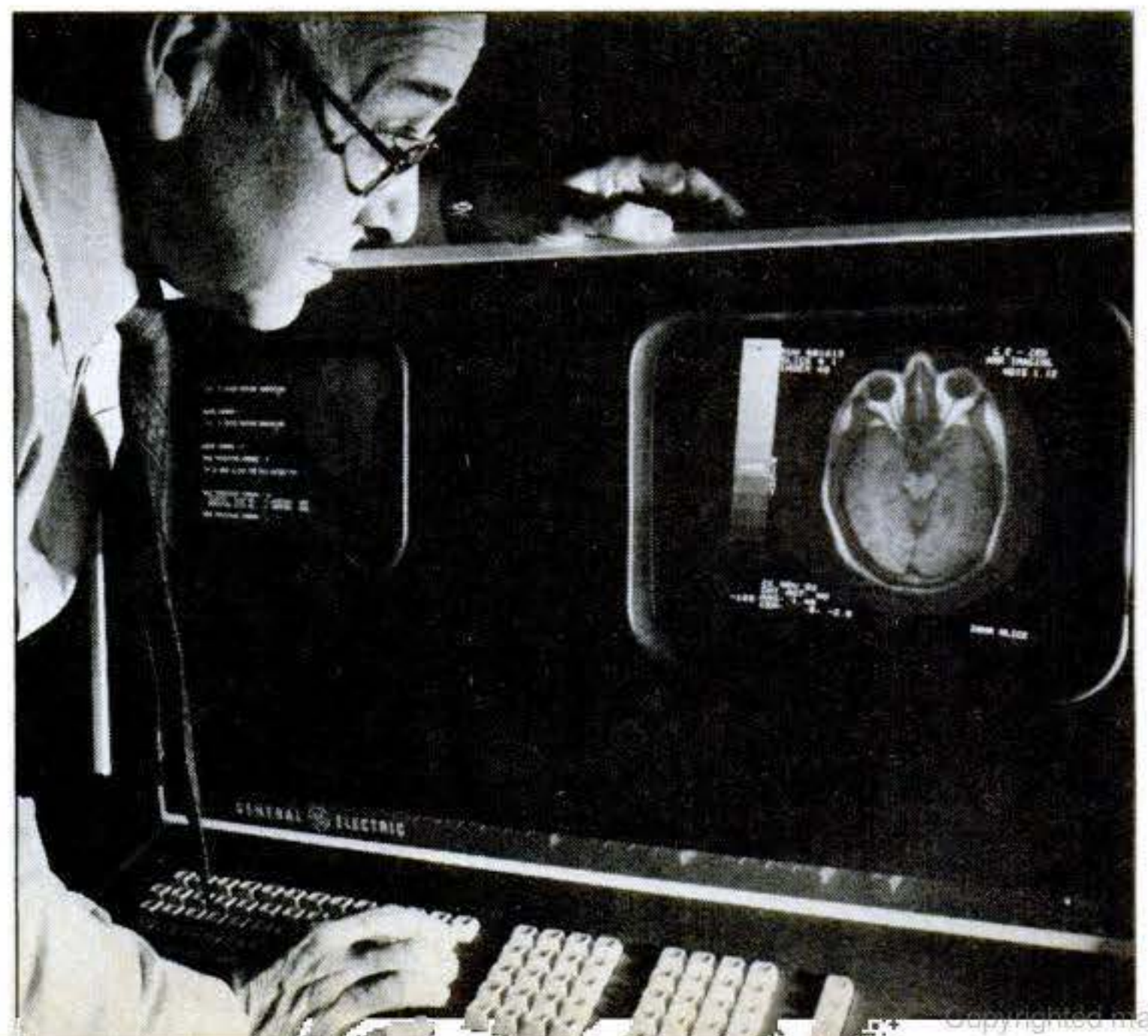
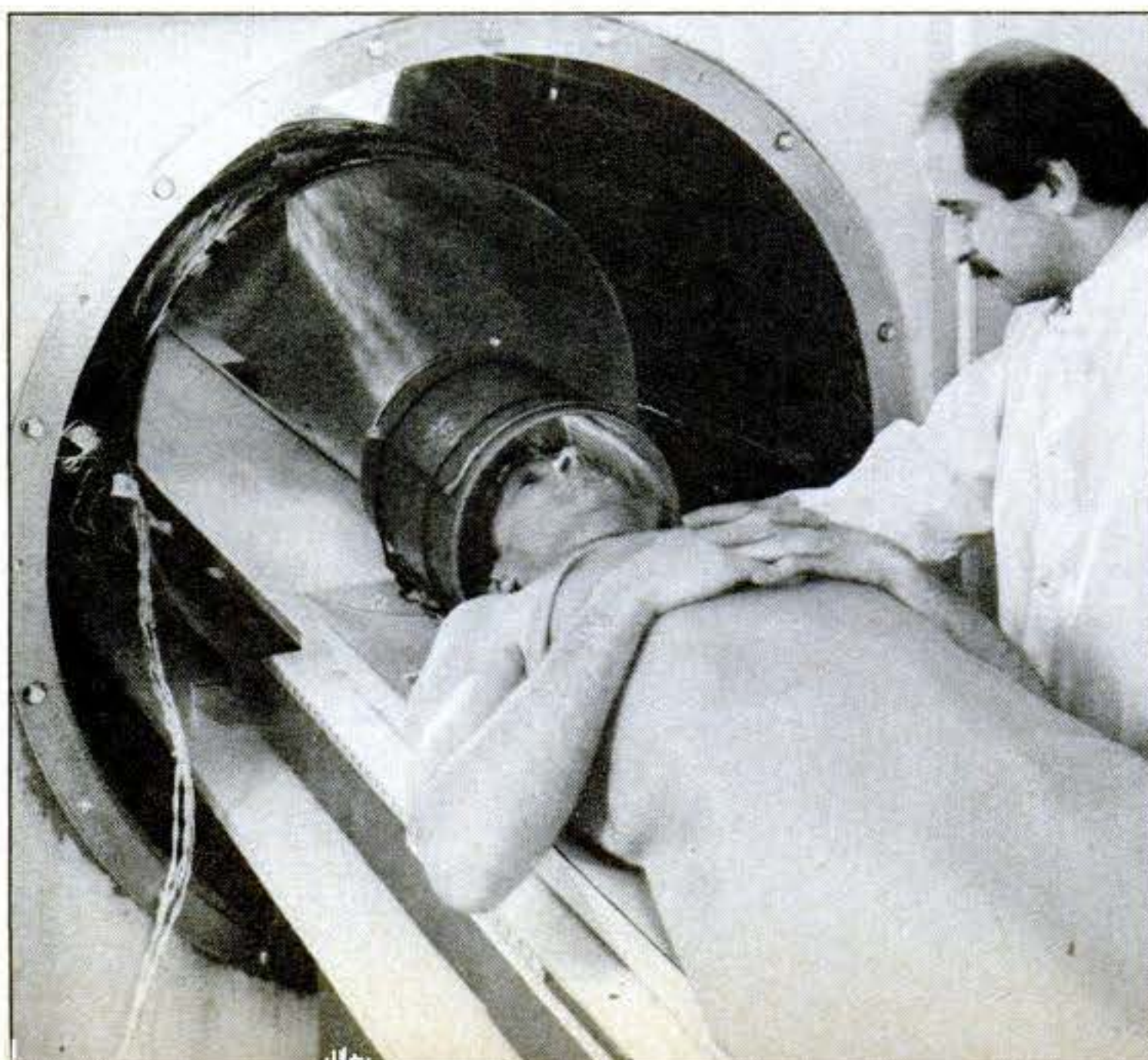
Nuclear magnetic resonance is a diagnostic tool for probing a living organism's chemical behavior. It is the subject of an intensifying, worldwide effort to make it applicable to human beings, with the eventual goal of enabling doctors to differentiate between cancers and benign tumors, to detect potentially lethal cardiovascular conditions, and to diagnose many other diseases.

Now scientists at the General Electric Research and Development Center in Schenectady, N.Y., say they have performed what they believe to be the world's first NMR analyses of the head and shoulders of a human subject. The patient lies on a movable cradle that is guided into the cylindrical bore of a massive superconducting magnet (photo below, left). The 15,000-gauss magnet creates a field some 20,000 times stronger than Earth's. Its three-foot-diameter bore is the first, according to GE, large enough to permit whole-body NMR studies.

Next, the patient is bombarded with high-frequency radio signals. The resulting information, corresponding to chemical changes within the body's tissues, is reconstructed via computer to give cross-sectional images similar to those from CAT scanners (photo below, right). The NMR system is now undergoing clinical trials at the Hospital of the University of Pennsylvania; another one will be installed at Duke University Medical Center this summer.

Torsatron fusion device

The Dept. of Energy has announced plans to build a new \$20 million fusion research



experiment at Oak Ridge National Laboratory within the next few years. It will replace the tokamak device called the ISX-B, which has been operating at ORNL since 1978. The new project, called the Advanced Toroidal Facility, or AFT-I, will help advance this country's magnetic fusion program.

The AFT-I will be a "torsatron," one species of the genus stellarator, in the overall family of toroidal (doughnut-shaped) fusion devices. The leading toroidal design in this country, and the world generally, is the tokamak. Stellarators, which have been around since the design was conceived at Princeton University in the 1950s, differ from tokamaks in the geometry of the electromagnetic fields used to confine the hot plasma that is the fusion fuel. Interest in stellarator designs has revived recently, partly because of promising experimental results. The torsatron concept has the potential for steady-state operation rather than the pulsed mode of the tokamak principle. The ultimate goal of magnetic-fusion research is to find a configuration that gives an optimal blend of advantages, so the AFT-I will probably serve a complementary role to the tokamak in a long-range program.

New kind of radioactive decay

A totally new kind of radioactive decay, which had been predicted theoretically but never observed experimentally, has been discovered by scientists at the Lawrence Berkeley Laboratory of the University of California. Called beta-delayed two-proton radioactivity, it is a form of decay in which a highly unstable nucleus disintegrates by first emitting a positron (a beta particle can be an electron or a positron) and then two protons. This unusual decay pattern has now been seen in the isotopes of two elements, aluminum-22 and phosphorus-26. According to Mike Cable, member of the LBL experiment team, "By measuring the properties of the two protons, such as the angle between them and their relative energies, we can learn something about how the strong nuclear force, which holds neutrons and protons together in the nucleus, affects this exotic decay."

Cannibal stars

The National Science Foundation reports that two astronomers, Dr. Albert D. Grauer, of the University of Arkansas at Little Rock, and Dr. Howard E. Bond, of Louisiana State University at Baton Rouge, have observed direct evidence that some stars can literally swallow others. This so-called "stellar cannibalism" leads to the formation of extremely close pairs of stars and to the expulsion of stellar material into space.

The two astronomers used a variety of optical telescopes in their work, including the 36-incher at Kitt Peak National Observatory near Tucson, Ariz. They found a number of cases in which two stars, revolving around each other in only a few hours, were at the center of some plane-

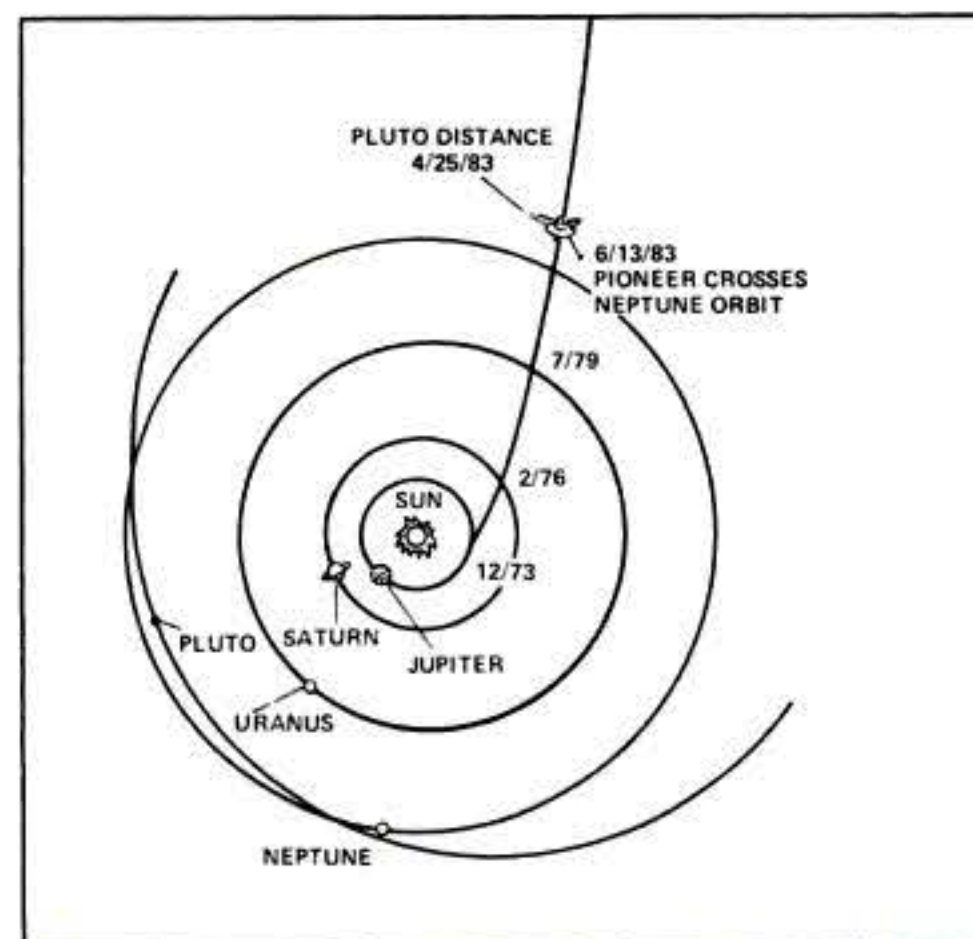
tary nebulae. Such nebulae are disc-shaped gas clouds that can somewhat resemble planets when viewed through a small telescope but are in fact far outside our solar system. The discoveries bolster the theory that the evolution of double stars actually involves the swallowing of one star by another.

Soundproofing board

A new noise-reducing board has been developed by Swedish Acoustic Products AB and will be marketed by Elof Hansson, both of Goteborg, Sweden. Called the M-board, it consists of two layers of a fiber-cement composite material sandwiched around a viscous-elastic layer. Its potential uses include the reduction of footstep noise and other sounds in apartment joist frames, in movable floors, and in noise-reducing inner walls.

Pioneer 10 makes an exit

There comes a time in human affairs when something really unprecedented occurs. June 13, 1983, marks such an event: the exit of an unmanned spacecraft, Pioneer 10, from our solar system. On that date, Pioneer will have crossed



the orbit of the planet Neptune, some 2.8 billion miles from the sun. (The outermost planet is normally Pluto, but for the next 17 years that strange body's orbit will lie inside that of Neptune, as the diagram above shows.)

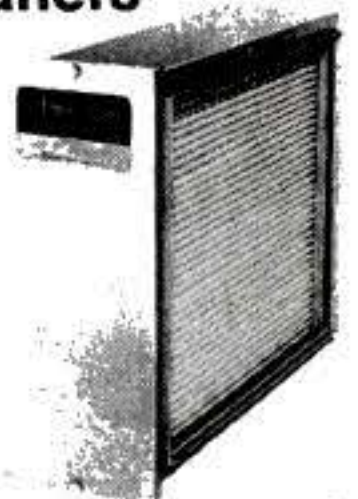
Pioneer 10 leaves our system with honor. Since its launch in 1972, the spacecraft became the first to encounter the giant planet Jupiter, surviving a traverse of the asteroid belt and Jupiter's own intense radiation belts in the process. It has carried out its varied missions almost without glitches. Beyond its Jovian discoveries—the first accurate measurements of the planet's moons and the first close-up pictures of the Great Red Spot, for example—Pioneer 10 is even now returning valuable data about the sun's sphere of influence, the heliosphere. NASA specialists will be able to track Pioneer out to about five billion miles. They are anticipating new findings "with intense excitement," according to James A. Van Allen, the renowned planetologist, "because we think the sun is typical of a majority of stars in the universe. It's the only star we can measure from 'close up.' "

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Computerized taxis dispatch without gab

If bursts of crackling voices in a radio-dispatched cab have ever jangled your nerves as a passenger, think of the driver, whose ear must be cocked for them all day or night. And have you ever phoned for a cab, then waited for what seemed like forever?

Now Volvo has a computerized taxi system that cuts out all of the irritating chatter and quickly dispatches the nearest cab. It's been adopted by Sweden's three largest taxi companies, in Stockholm, Göteborg, and Malmö.

Every cab has a radio transceiver, microcomputer, thermal printer, and push-button keyboard. The driver registers his general location with a central computer, which tacks an identity code onto every message.

All communication is in digital form. This is 10 times faster than voice exchanges, and it allows far greater use of existing radio channels. Best of all, the system is virtually silent.

When a customer phones the central office to order a cab, the operator keys the pickup address into the computer. The computer then scans its memory for the area code of the address and checks out available taxis in that area. A list of these cabs is now displayed on the terminal screen, and the operator tells the caller that a taxi is on the way.

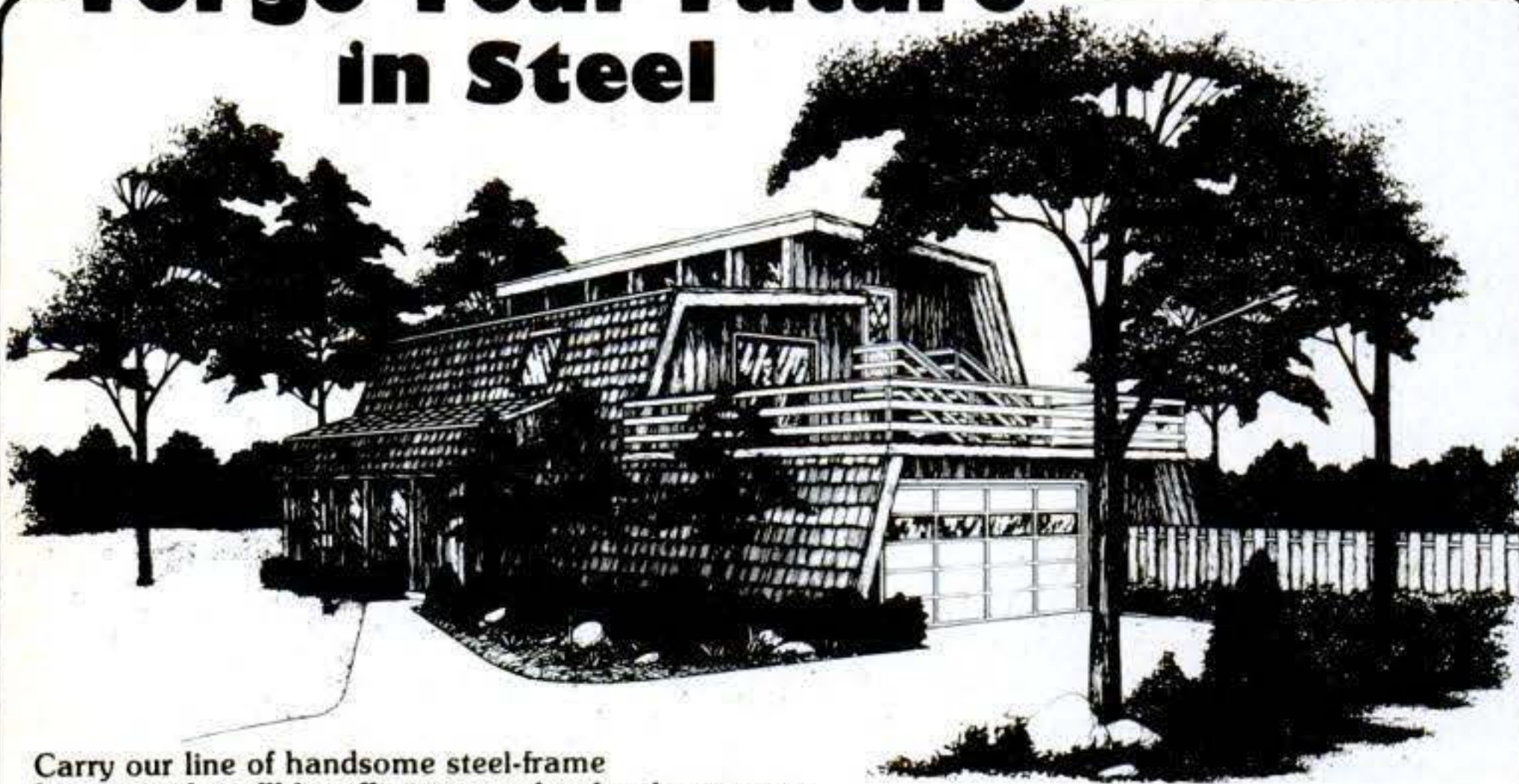
The operator assigns the order to the first cab on the list



via the computer, which transmits the address together with that cab's identity code. This comes out as hard copy from the driver's printer. The driver must confirm with a coded reply. If he doesn't accept the order within a short time, it automatically goes to the next car in line.

Using this system, cabs can be matched to fares in less than 30 seconds, Volvo says. Customers can even order a cab in advance. The dispatcher enters the required time, date, and address. Then just before pickup time, the computer goes through its car-selection routine and assigns the first available cab. The system can also transfer cars to high-demand areas and record statistical data on car use. If the system catches on, those endless waits could become a thing of the past.—David Scott

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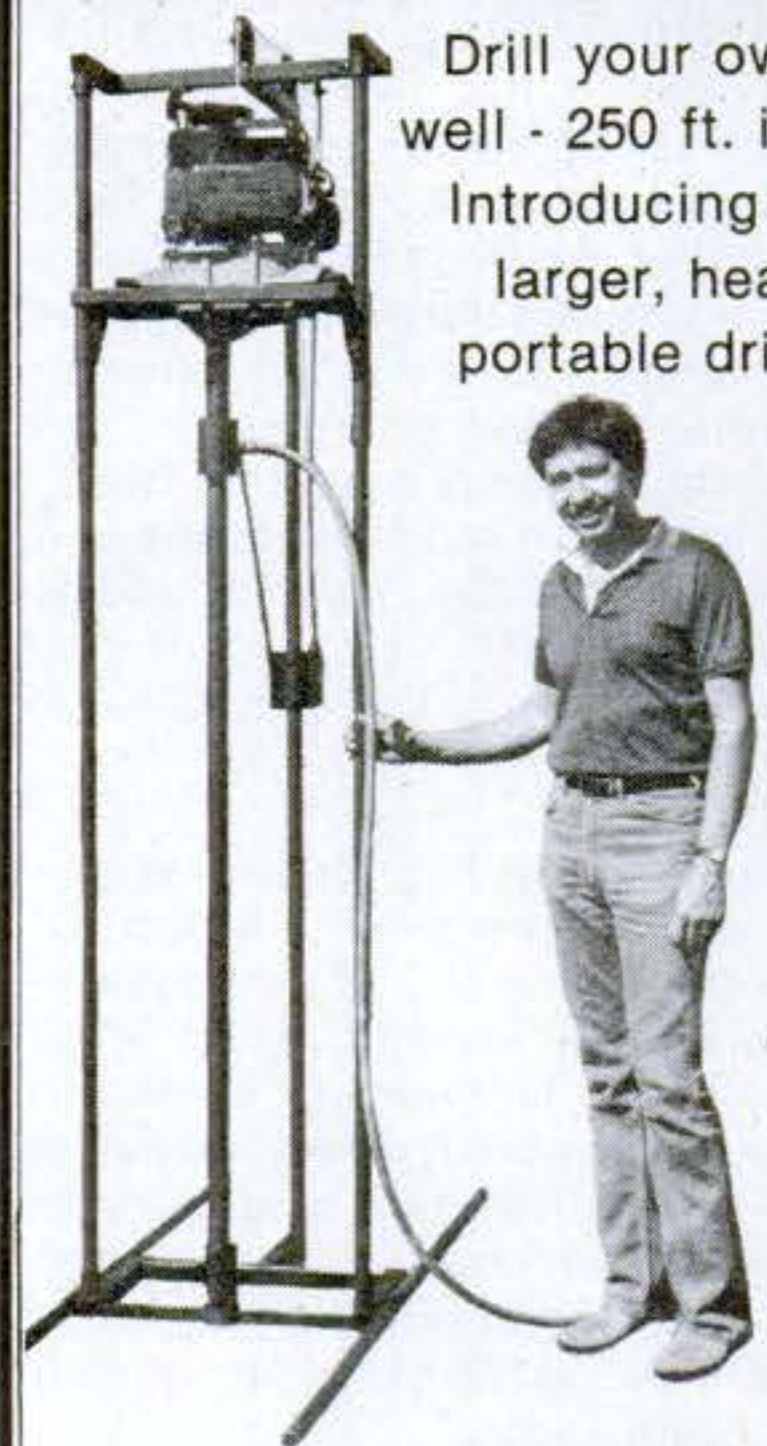
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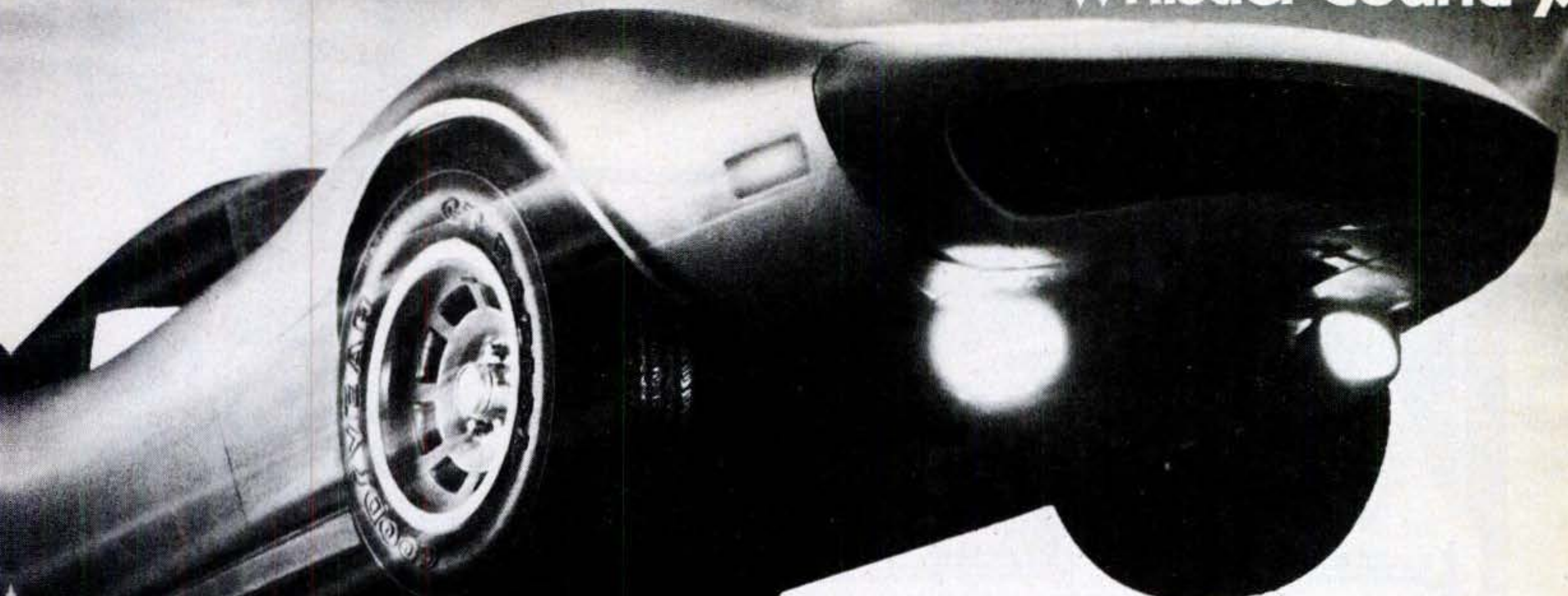
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RECREATION ROUNDUP

By HERBERT SHULDINER

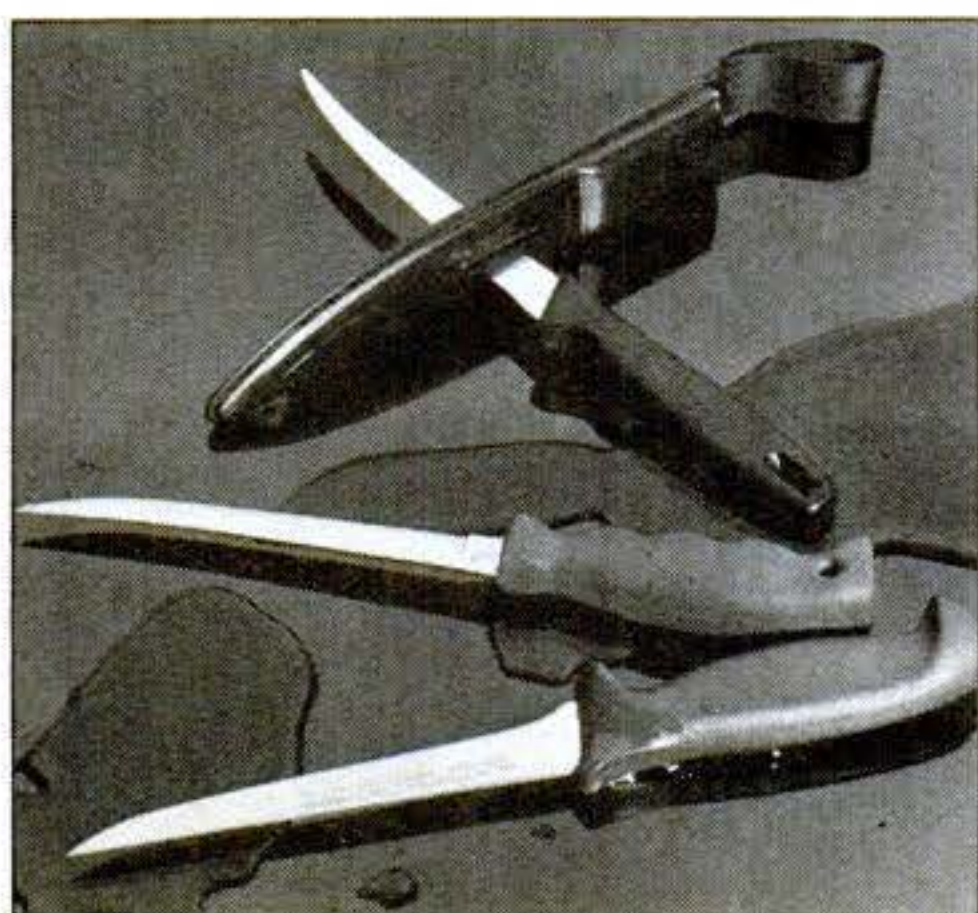


Camper pops its lid

The Sandtana Tilt-Top camper is built on either the Chevrolet S-10 (shown) or Toyota pickup chassis. It weighs only 3,470 pounds and gets over 20 mpg, according to Sandtana Industries, Inc. (425 S. Rancho, Colton, Calif. 92324). With the top down, the camper is garageable. With the top raised, interior headroom is six feet four inches. It sleeps up to six and costs from \$13,500 to \$16,500.

Outdoorsmen's knives

You won't ever have to work with dull edges with the knives shown below. They all feature long-lasting edges or are de-



signed to allow easy sharpening. The five-inch Frontier Lockback (top) comes with a lifetime sharpness guarantee. If the blade should ever get dull, you can mail it back to the factory for professional re-edging. There's a \$2 charge for postage and handling. The Lockback is made by Imperial Knife, 1776 Broadway, New York, N.Y. 10019. It's \$38.95.

The three fisherman's knives (bottom photo) also are designed to provide lasting edges—or in the case of one, to allow you to sharpen the edge instantly when necessary. The Fiskars fillet knife is shown with its sharpener built into the sheath. You merely insert the knife into the sharpening device and, while holding it at a 90-degree angle, pull the blade back and forth about a dozen strokes to sharpen. The Fiskars fillet knife is made by Fiskars Mfg. Corp. (10261 Yellow Circle Dr., Minnetonka, Minn. 55343) and costs \$17.95.

The LakeMate (center) is Buck's new fillet knife. The 6½-inch blade is made of high-carbon, high-chromium steel and comes in a handle made of Shell's Kraton plastic. The handle has a tacky feeling and is slip-resistant. Price: about \$22 (Buck Knives, Box 1267, El Cajon, Calif. 92022).

Imperial's Professional fillet knife (bottom) won't dull even after filleting 300 fish, the company claims. The six-inch blade, made of rust-resistant stainless, is double-ground and hand-honed. The handle is made of non-slip plastic. Price: \$14.95.

RV generators

Propane powers these motor-home generators from Onan Corp. (1400 73 Ave. N.E., Minneapolis, Minn. 55432). The 6.3 NHL (above, right) generates 6,300 watts. The 4.0 BGAL (top) turns out 4,000 watts. Propane fuel is commonly used in motor homes, so no extra fuel needs to be carried. Propane burns cleaner and inhibits lead

and carbon buildup while increasing engine life, Onan claims. Propane also costs about 30 percent less than gasoline in many parts of the country. Fuel consumption for the 4.0 is 1.3 gal./hr., and the 6.3 burns 1.7 gal./hr. at full load. Price of the 4.0 is \$2,100; the 6.3 is \$3,100.

Rental camping cabins

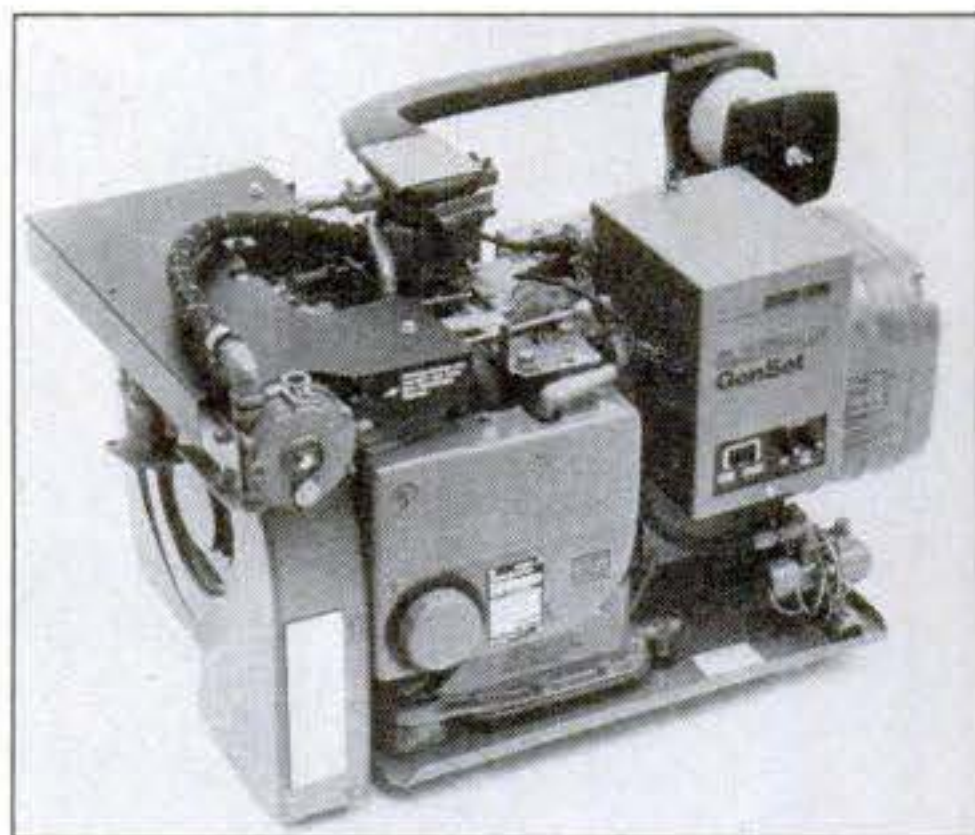
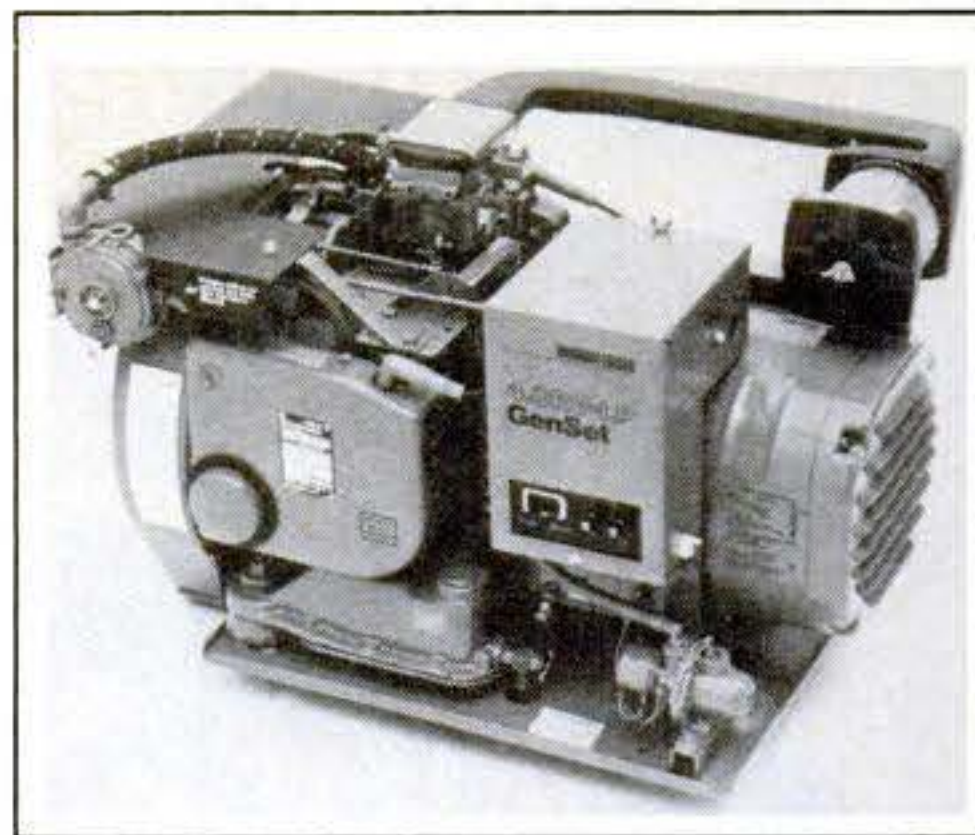
Kampgrounds of America now offers 18-by-12-foot cabins for overnight rentals in 68 sites in the U.S. The cabins have a 12-by-12-foot living area and contain a double bed and upper and lower bunk beds to sleep four. Price is \$18 per night. There are no plumbing facilities in the cabins, but campground toilets and showers are available. KOA says it added cabins to campgrounds because of the growing number of small-car and motorcycle owners whose vehicles can't tow trailers. The cabins allow these travelers to enjoy campground economy without the need to own an RV. KOA offers a money-back guarantee within an hour after check-in if you're not satisfied. For a directory of campgrounds offering the cabins, send \$1 to KOA, Box 30558, Billings, Mont. 59114. The directory is free at any KOA campground.

Outdoor trips

Adirondack Wilderness Tours, Inc. (Nick Stoner Trail, Arietta, Caroga Lake, N.Y. 12032), offers canoeing and backpacking in upstate New York through September.

Guided River Trips offers white-water raft trips in southern Pennsylvania through October. For more information, write Wilderness Voyageurs, Inc., Box 97, Ohiopyle, Pa. 15470.

Vermont Bicycle Touring (Box 711, Bristol, Vt. 05443), in its 12th season, offers 200 tours in Vermont and New Hampshire from \$64.50 to \$77.50 per day. **PS**



Thought Teleporter

Now your own brain waves (with a little help) can make lights turn on and off, stereos jump to life and TVs obey your command.

It's startling. You're sitting with friends. Suddenly lights jump to life, and your stereo system comes on.

Your friends look around in disbelief, as you quietly explain that you have discovered the secret of telekinetics. You patiently explain to them that telekinetics is the ability to make things happen with only the power of your brain waves.

And to prove your point, you close your eyes, grit your teeth and cause the lights and then your stereo to turn off.

MORE THAN A PARLOR TRICK

While you are sure to amaze your friends, be prepared to amaze yourself with an incredible step saving and maybe even life saving electronic device.

Just think of the security of never entering a dark room or a dark home.

Imagine the convenience of entering a room, touching a button on your watch and having the lights come on.

Then imagine touching another button and having your TV come on. And, let's not forget the sheer thrill of having America's first remote control watch.

HERE'S WHAT IT IS

Nestled within the circuitry of a high quality quartz alarm/chronograph watch is a super sophisticated, two channel infrared transmitter.

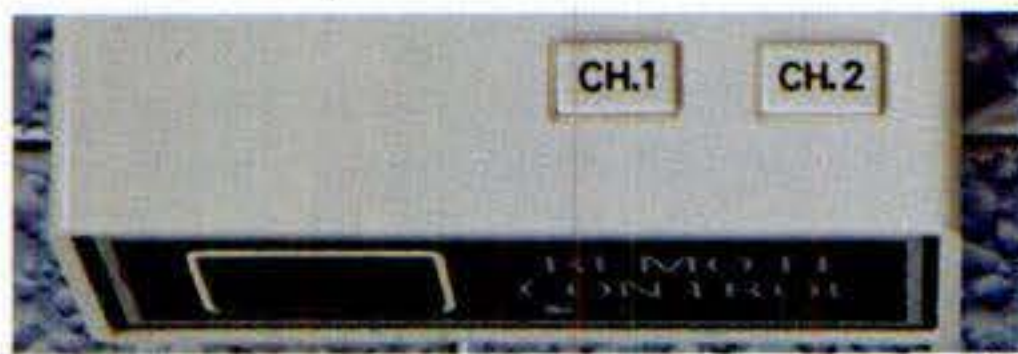
And, talk about sophisticated. When you push either transmit button, a Light Emitting Diode sends out a powerful beam of invisible pulsed infrared light.

Each channel has its own pulse code, but look at this. This system actually transmits 32,000 pulses per second.

The other half of this system is the infrared receiver (included). It has plugs for two 300 watt electronic devices. So, you can control even large lights, stereo equipment and even office equipment.

NO INSTALLATION

Just plug whatever you'd like to control into the two plugs on the receiver. There are even buttons on top of the receiver so you'll have local control.



The watch comes ready to use. It has a transmitting range of about 20 feet. But, it can work up to 40 feet, and it will transmit through glass, and even through a limited amount of water.

And speaking of water, the watch is guaranteed to a depth of 60 feet.

IS IT JUST FOR GADGET FREAKS?

There's no denying this watch will put any gadget freak in 7th heaven, especially me. I tested it in the bedroom, through windows, from the second story to the first and on and on. I had a ball.

My wife thought I was crazy. But everywhere I went, everything I tested jumped to life. About the only thing it wouldn't transmit through was a screen door.

HERE'S WHAT TO DO WITH IT

The system comes with the two channel watch and two channel receiver. But,



you can add as many receivers as you wish for your home and office.

For security. As you approach your home at night, just point the watch at a window and it will turn on your lights.

If you're in bed and you hear a sound, just touch a button and you can turn on a lamp at the far end of your bedroom.

Or stand at the top of the stairs and turn on lights below. All you need is 'line of sight' between the transmitter and receiver, and you'll be in control.

You can even plug in a siren or a sensor for your burglar alarm, and the watch will become a portable panic button.

For comfort. Now you can lie in bed at night and turn off the TV when you get tired. If you have a radio in your office, just a touch of the watch will turn it off whenever you get a phone call. In the kitchen, bedroom and living room, you'll have remote control luxury anywhere.

For fun. I have to admit it. It's just plain fun. You've got to see the expression on people's faces when they see this watch in action. If you're like me, you'll walk around the house for days, turning on and off your lights.

ALL THIS AND A WATCH TOO?

There's a 24 hour alarm, an hourly chime and a 12 hour stopwatch.

Innovative feels that this is a 'Sports watch', whatever that is. And, they deliver it with a black band.

I personally don't like black resin bands at all. So, I've gotten them to include a high fashion stainless bracelet too.

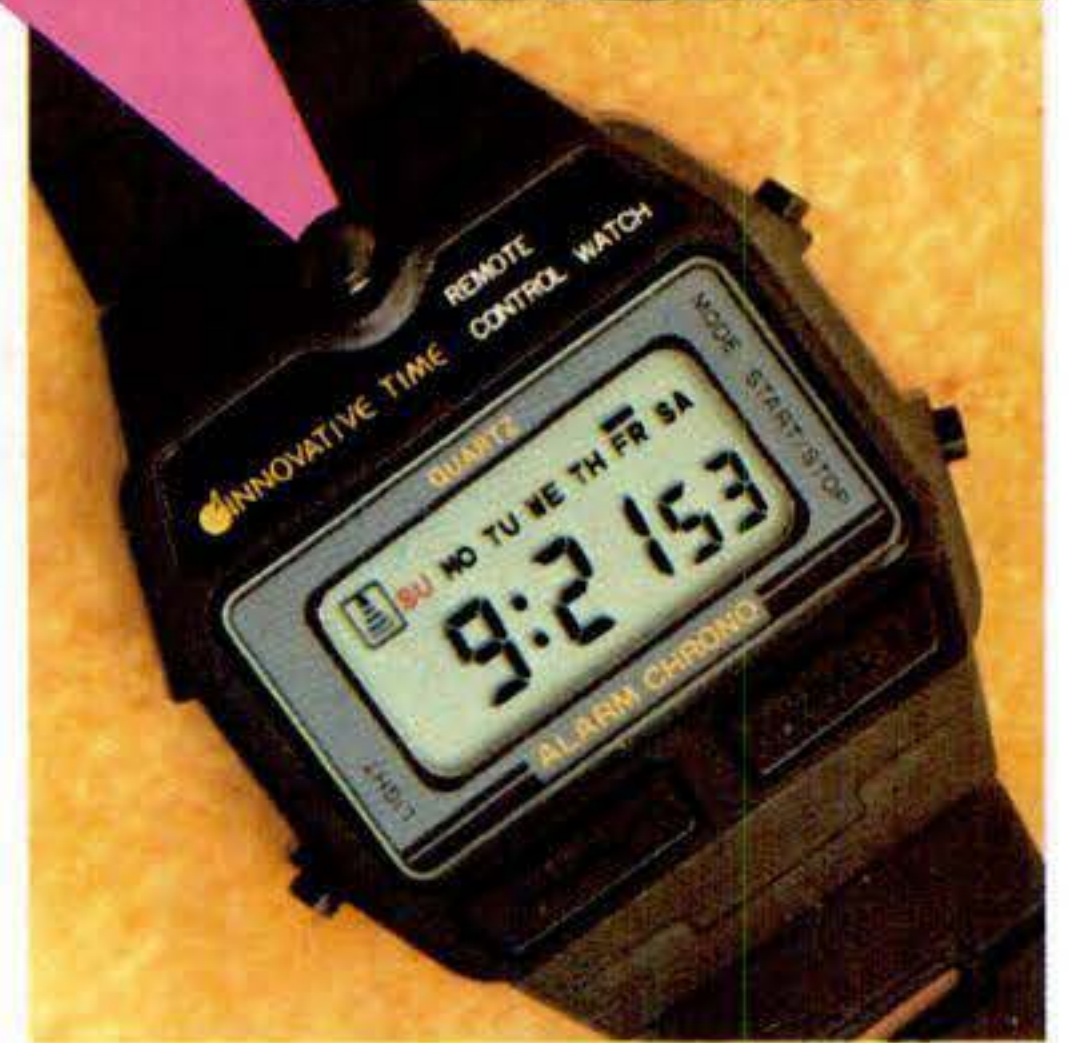


It's rendered in stainless and black and is a perfect high fashion choice. So, you'll get the watch with the black band on it and the high fashion band packed with it, compliments of Innovative's superb engineering and DAK's good taste.

The system is backed by Innovative's one year limited warranty.

TRY THE ULTIMATE REMOTE 'GADGET' RISK FREE

You're going to have a ball. You'll walk around pushing buttons on your



watch controlling everything for anyone who will watch, including yourself.

But, you'll also find that this 'gadget' is a neat and useful addition to your home and office.

If you aren't 100% satisfied, simply return the watch and receiver in their original box within 30 days for a refund.

To order your Innovative Time Infrared Remote Control watch with a 2 channel receiver risk free with your credit card, call toll free, or send your check for DAK's introductory price of just \$69 plus \$3 for postage and handling. Order Number 9685. CA res add 6% sales tax.

You may add as many receivers as you wish, using one per room. Each has two channels and is identical to the one that comes with the watch. They're just \$24 ea. (\$1.50 P&H) Order Number 9686.

This system will light both your lights and your imagination. It's almost unbelievable that so much can be squeezed into an absolutely normal size thin watch.



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Slim-profile drive

gives more speed for your fuel

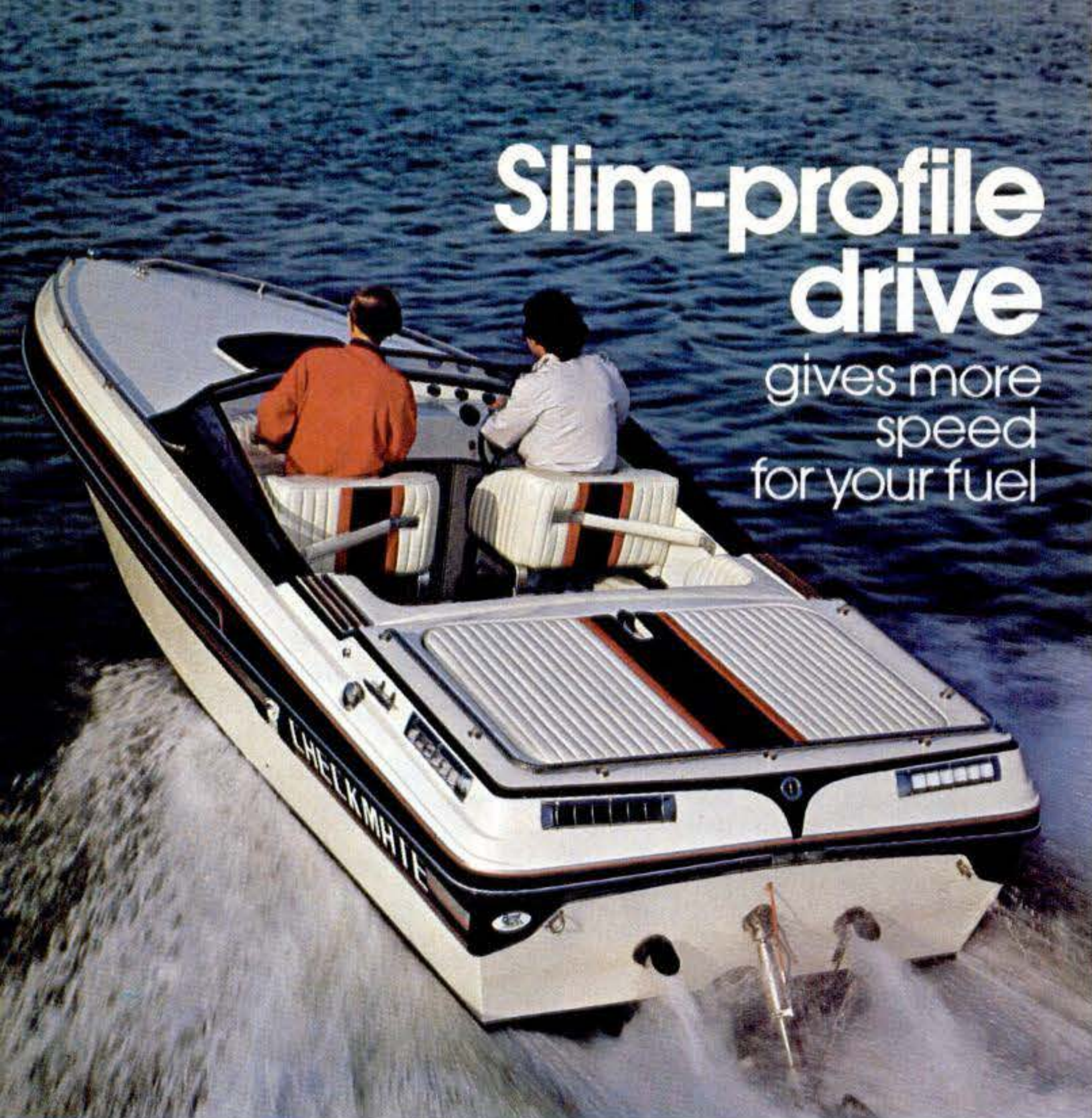
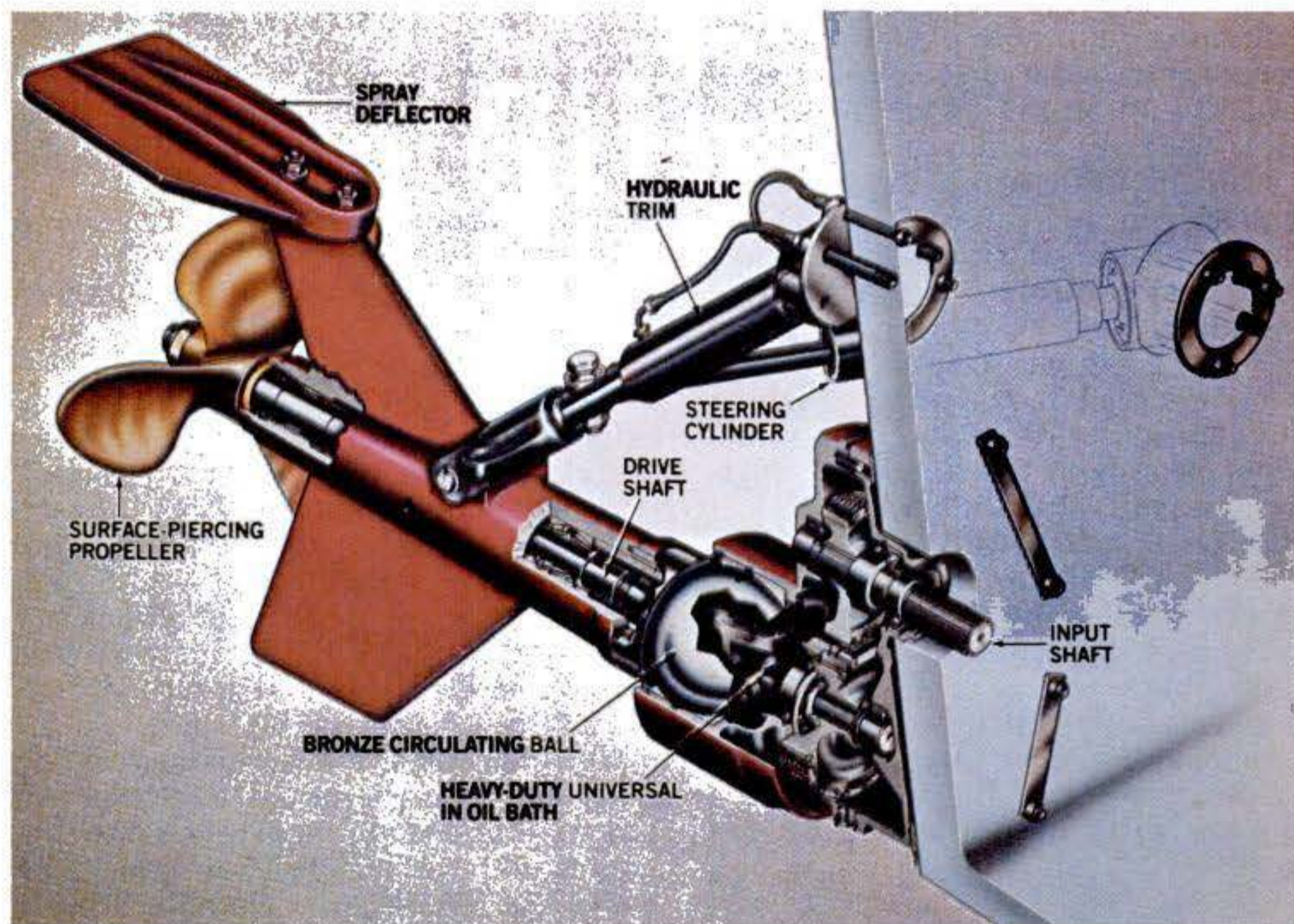


PHOTO BY JERRY IMBER

Propeller of Arneson drive pierces surface at planing speed, reducing drag in water—and kicking up a tail of spray. Author, at left, enjoyed its easy acceleration.



The new drive is lean and mechanically simple. Drop-center model, here, provides a six-in. external drop in drive shaft to allow engine to be installed close to transom. An in-line model suits bigger

boats with engine farther forward. Key to the design is a heavy-duty universal joint that allows steering of 23 degrees in both directions and movement through a 23-degree arc for trim.

Surface-piercing propeller and reduced drag make boat power more effective

By DAVID VIGREN

CYPRESS GARDENS, FLA. The takeoff was unusually smooth and prompt when I shoved the throttle forward. The Arneson drive moved the smart Checkmate 25 sports boat out without lunge and hesitation. It

felt as though friction had less claim on the boat.

As we reached top speed I was pleasantly aware of less vibration from the drive on the hull than I've learned to expect. When we were running flat out, I put it into the tightest turn I could handle without pitchpoling. It held without spinning out behind, and there was no cavitation and falling off plane, a common problem with other drives.

Invented by racing designer Howard Arneson and manufactured by Borg-Warner, the drive's design is uniquely simple and economical—in essence, a straight tube extending from the bottom of the transom, with running gear and spray deflector attached. This presents a small profile compared with the husky gear case of a conventional stern drive, where two sets of spiral bevel gears are needed to turn the drive line downward then rearward, and where clutches and oil pumps are incorporated.

While the slim new drive offers less drag, it also delivers more engine power to the propeller, since less is lost in transmission. This means more speed with the same engine and hull, and less fuel for the same speeds—a 10 percent advantage is claimed.

But experienced boat people think the greatest advance will be in the new drive's longer service life. "With a fraction of the number of moving parts in the Arneson drive compared with a stern drive," says Borg-Warner's Tom Huber, "it has the potential for less downtime, lower maintenance cost, and easier repair."

Another strong feature is its shallow-running characteristic. Installation is designed to put the propeller no lower than the bottom of the boat. This involves surface-piercing prop technology. Conventionally, the propeller itself is a drag force in power efficiency. On the Arneson drive, one or two blades do the work when the boat is on plane, while the remainder of the propeller is surrounded by vapor at the surface. It also produces an arched spume at top speed. To control it, the Arneson drive has a spray deflector that is effective at moderate speeds, and hydraulic trim can submerge more of the prop to eliminate the rooster tail for water skiing.

Most leading boat builders are testing the Arneson drive, according to Borg-Warner, and commercial fishermen in the Gulf and Pacific Northwest are showing keen interest because the shallow-running capability would allow taking nets close in to shore. And the promise of longer runs without time lost for repairs means money in the bank to them. **E**

The KLH Solo

Price Slashed

List Price \$199-Suggested Retail \$169

January 1983 Dealer Cost \$106

NOW \$68

It's been killing us. We bought these KLH stereos in April, but we agreed not to sell them till June. You see, the local KLH dealers still had lots of them in stock. Most were selling the Solo for \$169 (the very cheapest discount ad we've seen was \$129). And, the dealers had to have time to sell out their stock before our ads hit. So, we've been raring to go since April, while we've sat on DAK's best buy ever.

The KLH Solo was built to sell for \$169 to \$199 and to wholesale for \$106. It represents the very top end, state of the art in electronics. It's the audiophile's choice in personal stereos. But, unfortunately because of our last recession there just haven't been as many rich audiophiles around. So KLH ended up with 14,000 of these remarkable stereos.

DAK bought them all for cold hard cash. So if you're into absolutely the best sound in cassettes, complete with auto-reverse, dual flywheel anti-rolling design, and if you'd like incomparable FM reception from the included FM stereo tuner pack, the KLH Solo is for you.

And don't worry. All of our KLH Solos are brand new factory sealed direct from the manufacturer.

The KLH Solo will make the sound of your cassettes and FM stereo explode with life. It gives you auto-reverse. The sound is simply breathtaking, and so is the incredible \$68 price.

It's vibrant. And, the sound seems to be alive. The KLH Solo brings thunderingly powerful realism to personal stereo. And frankly for its \$169 price tag, it had better sound great.

In a market flooded with cheap Hong Kong imports, the KLH stands out as the Audiophile's choice. And even though DAK is able to offer the KLH Solo to you for just \$68 (a \$101 saving), let's look at what has made it worth \$169.



DEALER PRICE SCHEDULE

EFFECTIVE: JANUARY 1, 1983

Model	Description	Nationally Advertised Price	Suggested Retail Price	Now Dealer Cost
S-200	The Solo Auto Reverse - Includes FM Tuner Pack, Headset, Carrying Case, Accessory Case, Shoulder Strap, Hand Strap and Belt Clip	\$199.95	\$169.95	\$106.00

AUTO REVERSE

The anti-rolling transport of this deck is incredibly stable. It uses twin matched stabilization flywheels in conjunction with a specially designed motor to give you rock stable bi-directional play.

With auto reverse, your cassette need never stop. It just plays back and forth over and over again. It makes listening while you're on the run a real pleasure.

And, at home or in the office, with our optional home stereo cable you can plug this auto-reversing deck into any 'aux' jacks on your stereo system for an evening or a day of uninterrupted music.

Wait till you hear the quality of the sound from this audiophile cassette deck. And, while this deck is plugged into your stereo system, you can copy cassettes by playing them on the Solo and copying them on your home cassette deck.

FABULOUS FM STEREO TOO

Here's where you can really hear the difference. The Solo provides FM reception that is incredible. We think you'll get more and cleaner FM stations than with any other personal stereo.

But don't take our word for it. Test it yourself. Start at the bottom of the dial and compare station to station with any

other high end personal stereo.

Then, when you've left them in the dust, do the same test against the tuner in your own stereo system. You might just be in for a very big surprise.

The FM tuner pack simply fits into the Solo like a cassette. And retracting pins direct-connect it with the Solo.

The FM signal goes directly into the amplifier, not through the head and it works off the deck's power. It uses the headphone cable as a super antenna.

There's no tape/tuner switch because the KLH Solo is intelligent enough to know when its tuner pack is inserted.

But, all of the above wouldn't mean anything if it weren't for the incredibly sensitive FM tuner circuit. It utilizes a sophisticated 20 pin integrated circuit to produce dramatically alive FM sound.

ALL THE BELLS AND WHISTLES

The Solo comes with a heavy duty protective leatherette case, a matching case that holds 3 cassettes, a shoulder strap and a removable wrist strap.

You can attach the case to your belt or look at this, there's a 'screw-on' living hinge belt or waist band clip too.

So many features. There's a metal/normal equalization switch. The Solo reverses automatically plus even its reverse button is power assisted.

There are 2 LED arrows to show tape direction. And while we're on the subject of 2s, there are 2 headphone jacks and 2 volume controls.

Along with the 2 stability flywheels, there are 2 capstans. There's only one mute button. But, it cuts off the sound on 2 channels to hear the outside world.

The stereophones are the latest Samarium Cobalt mylar® diaphragm type that deliver earth shaking thunderous sound with such precise definition and detail, that music is almost three dimensional.

BUT IT'S THE SOUND

Take the KLH Solo to your local HiFi store. Compare its dramatic sound and



super stability with other top of the line stereos, then you'll really appreciate the achievement that the Solo represents.

The Solo is only 1/4" wider than a cassette box (4 1/2" X 3 1/2" X 1 1/2"). It operates on only two AA batteries (not included). And, it's backed by a limited 90 day warranty by KLH.

TRY THE KLH SOLO RISK FREE

Take the Solo on walks, as you commute to work, while you work or relax.

Don't put it away when you get home or to the office. With our optional cable, you can plug into your home or office stereo system for continuous nonstop play of your favorite cassettes. Here's a stereo you can use all the time.

If you aren't 100% satisfied, simply return it to DAK in its original box within 30 days for a courteous refund.

To order your KLH Solo with FM Tuner Pack risk free with your credit card, call toll free or send your check not for the the \$169 suggested retail price or even the \$103 Jan 1983 dealer cost. Send just \$68 plus \$3 for postage and handling. Order No. 9683. CA res add 6% tax.

And there's more. We have a bonus cable that you plug into an earphone jack on the Solo and into any stereo 'aux' inputs on your home stereo. Just add \$4 (\$1 P&H) Order No. 9200.

Never buy batteries bonus. We'll include a charger and 4 nicad batteries (that's two in and two charging) so you'll always have music. It's a \$24.65 retail value, but it's yours for just \$12.99 (\$1.50 P&H) Order Number 9206.



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Little 4x4s

—tough, fuel efficient,
and even stylish

By **JIM DUNNE**
and **JACK KEEBLER**
PHOTOGRAPHS BY GREG SHARKO

Four decades ago, millions of American GIs discovered a brand-new kind of motoring experience: the four-wheel-drive Jeep. Since then, millions of other Americans—driving improved vehicles with bodies that afford greater protection from the elements and larger, more powerful engines—have made four-wheeling a part of their everyday lives.

This year, the four-wheel-drive world takes another turn. Ford and General Motors have created new types of 4WD vehicles, Bronco II and Chevrolet S-10 Blazer. Slightly bigger, more powerful, and definitely cushier, Bronco and Blazer are a far cry from the Jeep of WWII. Yet they

offer the same kind of ruggedness and off-road agility. Against them, we positioned AMC's stalwart but dated Jeep CJ-7. But note: This test is not meant to compare the newer designs head-to-head with the Jeep, which is based on a much older chassis. We'll make that comparison next year when the all-new Jeep XJ is introduced. For now, the CJ-7 lets us take a balanced look at where four-wheeling has been and where it's headed.

Since these vehicles are built for the rough going of backwoods trails, a natural question is: How do they ride and handle on the street? The answer: much like the average sedan. The ride is slightly different—stiffer and a trifle bouncy—but not uncomfortable.

Off the road, the vehicles display a stubborn ability to stick to the ground at high speeds (30 to 40 mph), on

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 Bronco II	Chevrolet S-10 Blazer	AMC Jeep CJ-7
Acceleration	4	2	3
Braking	2	1	1
Handling	2	4	3
Maneuverability	4	5	5
Quietness	3	4	0
Roominess	3	3	3
Vision	4	5	2
Entry/exit ease	5	5	4
EPA economy	3	3	3
Ride comfort*	3	4	1

*Authors' opinion

trails, over steep inclines, or through deep ditches. The going is slower, but the power on all four wheels lets you drive in places where a sedan would surely bog down. On an excursion along a beach, our test four-wheelers plowed through deep sand for miles without getting stuck.

Bronco II and S-10 Blazer are smaller than their full-size brothers, Bronco and K-10 Blazer. That's because these are utility versions of the compact Ranger and S-10 pickups. They also cost about \$800 to \$1,000

Continued

Compact 4WD off-roaders (clockwise from left) Chevrolet S-10 Blazer, AMC Jeep CJ-7, and Ford Bronco II are ready for anything.



SLASHED TO \$39!



Computer Chess

PRICE SLASHED

Suggested Retail Price \$115, March 1983 Dealer Cost \$75, Now Cut to \$39.

Prepare yourself for the most aggressive attack and the most challenging game of your life. This chess computer has 7 levels of difficulty. Plus you'll save \$76.

It's you against the computer. Chess comes alive with this awesome space age computer opponent.

You'll be challenged by 7 levels of difficulty and a program that can actually analyze over 3,024,000 board positions. So, you had better come out fighting.

The only thing you won't have to fight about with this computer is the price. We've already chopped Fidelity's \$115 price down to just an incredible \$39.

March 1983 Dealer Price List

NAME	MODEL #	MASTER PACKAGE PRICE	NO UNIT VOLUME PRICE	SUGGESTED RETAIL PRICE
CHESS CHALLENGER	BCC	\$ 85	\$ 75	\$ 115

SIMPLE TO USE

Notice that I said, "Simple to use," not simple to beat. Using this computer is incredibly easy. You don't even have to tell the computer which piece to move.

Just tell the computer which square you want to move from and to. The computer knows the exact location of every piece on the board, so it automatically knows what piece you are moving.

When the computer wants to move, it shows you the square it wants to move from and the square it wants to move to, on its 'From/To' LED display.

It's simple. It's easy. And, best of all, it lets you concentrate on your game, not on how to use the computer.

OUTSMART THE COMPUTER

Even at level one you may need help beating this super smart computer.

There's help. Just touch a button, and the computer will join your team. He will pick your best possible move. A second button touch will send him back to his own side to pick his best response.

You can cheat. Let's say you make a really dumb move. After you see what

the computer does (horrors, he's taken your man), all is not lost.

If you're the type of person who says, "If I only had my Queen back, I could beat this thing," no problem. You can add back in any piece, anywhere.

And, that's not all. Not only can you add back in any piece you've lost, you can take any of the computer's away. So, you can get rid of a pesky Bishop, Knight or even a Queen.

But there are limits. This computer won't let you make an illegal move. And, it won't make any illegal moves itself.

There's more. The computer has a broad vocabulary of chess master book openings such as: Sicilian, Ruy Lopez, or Queen's Gambit Declined. Plus, you can set up any classic chess game in mid-play and see how you would do.

It does everything a real chess master would do. It castles, it has pawn promotion and en passant. So, best of luck.

I can't beat this computer at level 3 which it calls its 'advanced level'. And, I don't even want to talk about my games at its level 7 'tournament level'.

WOW, IT'S REAL CHESS

But, when all is said and done, playing chess is what it's all about. And this game is very smart, very tough, but incredibly easy to use.

It is full sized, measuring 12½" wide, 8" deep and 1" high. It comes complete with regulation Staunton design magnetized chess pieces. And, it simply plugs into any standard wall plug.

It's made in the United States (isn't that a change) by Fidelity Electronics. They are the largest and best known of the chess computer manufacturers. And, it's backed by their limited warranty.

SO WHY IS IT SO CHEAP?

Fidelity is in the forefront of new chess technology. Their new line has a new cosmetic look and a new way of entering 'your' moves into the computer called sensory (the computer moves are still the same, they're shown on a display or with lights).

The new system doesn't make the computer any smarter, but since this computer doesn't look like the rest of their line, they sold all 16,000 of these smart but nonmatching computers to DAK for cash. So, you'll save a bundle.

TRY TOUGH COMPUTER CHESS RISK FREE

If you like a challenge and your ego is strong enough to withstand losing to a computer, why not play just one game.

If you aren't 100% satisfied, you can return this computer within 30 days in its original box for a courteous refund.

To order your Fidelity Chess Challenger 7 Computer Chess, risk free with your credit card, call toll free or send your check not for the suggested retail price of \$115. Don't even send the dealer cost shown on the current March 1983 price list of \$75. Send just \$39 plus \$3.50 for postage and handling to DAK. Order No. 9682. CA res add 6% tax.

Whether you're a novice or a master, one of the 7 levels will keep you humble. Plus it's a fabulous \$115 value gift for someone really important, like yourself.



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PS car test & driving report



Bronco II revealed a strong tendency to under-steer when pushed hard through both high- and low-speed-handling tests.



Jeep CJ-7's lower weight should have given it a great stopping advantage, but the lightly loaded rear tires had no bite.



S-10 Blazer felt extremely stable during blacktop testing. Its surprising agility netted top honors in both handling tests.

less, on average. Old-time off-roaders will like the fuel-economy improvements over the full-size models, too. On the highway, it's a cinch to post a true 20 mpg or better.

Driving the 4WDs is as easy as driving your sedan. Just leave the transfer case in two-wheel drive when traveling on paved or hard-packed roads. In Bronco II and Blazer, you can shift into and out of 4WD high without coming to a stop. In CJ-7 you must stop the vehicle to make the shift. (All three vehicles require a dead stop for 4WD low.) There's a big advantage in nonstop shifting for off-road driving. Because you don't have to halt the vehicle when the trail becomes soft or muddy, you can maintain your momentum. Pull the shifter into 4WD and keep rolling.

Ford Bronco II

It has the same Twin-I-Beam front axle as the bigger Ford trucks, a source of pride for the company. But Bronco II recorded the slowest times in our two handling tests; it was the least controllable in the high-speed slalom. This, despite the fact that Bronco II had the swiftest acceleration time in our zero-to-60-mph run. Normally, that would have been an advantage in our handling tests.

Ford's top-hinged rear hatch is one of the best we've seen. It opens up the rear storage area across its entire height and width. That makes loading bulky or heavy objects easier—no leaning over a tailgate to reach inside. And the rear glass can be opened separately. One option that seems well worth its extra cost is the swing-away spare-tire rack mounted at the rear. It makes the spare easily accessible and opens up additional load space.

Except for the somewhat remote position of the shift lever, Bronco's controls are set within easy reach of the driver, with no awkward surprises.

Chevrolet S-10 Blazer

Our long-term driving experience [see PS 3,000-mile test, this issue] convinced us that the S-10 Blazer is

the most refined of the 4WD types, with the smoothest ride and quietest interior at all speeds. It's a utility vehicle that poses no problems for the first-time driver. Performance, handling, and braking are just like those of a modern sedan.

The V6 engine, combined with a four-speed automatic transmission, got the best fuel-economy results in our test group. But the price is performance. Blazer was the slowest in acceleration from a standing start. And during highway driving, the transmission downshifts from the tall fourth gear to third at the slightest upgrade. On the happy side, on long, 55-mph straightaways the overdrive fourth drops engine speed below 2,000 rpm. This makes a big difference in economy and interior noise levels.

AMC Jeep CJ-7

American Motors executives were reluctant to have this vehicle tested with the Bronco II and Blazer, and it's easy to understand why. Jeep's comfort level feels like a lawn tractor's in comparison with the other vehicles, especially the Blazer. But that may be acceptable to some, since the CJ-7 costs almost \$3,000 less than Bronco II or Blazer.

Comfort aside, CJ-7 is every bit the workhorse that the other 4WD types are. Its 258-cu.-in. in-line six—a proved AMC engine—is big enough to handle heavy-duty service. With the five-speed manual, fuel economy is just below that of the newer vehicles.

Posted on a sticker above the instrument panel, Jeeps carry a warning about unusual handling characteristics. Our experience showed that although the vehicle reacts almost too quickly to steering inputs, the chassis remains stable, even during high-speed testing on blacktop. In fact, Jeep got an excellent mark for low-speed maneuverability and a good mark for high-speed handling.

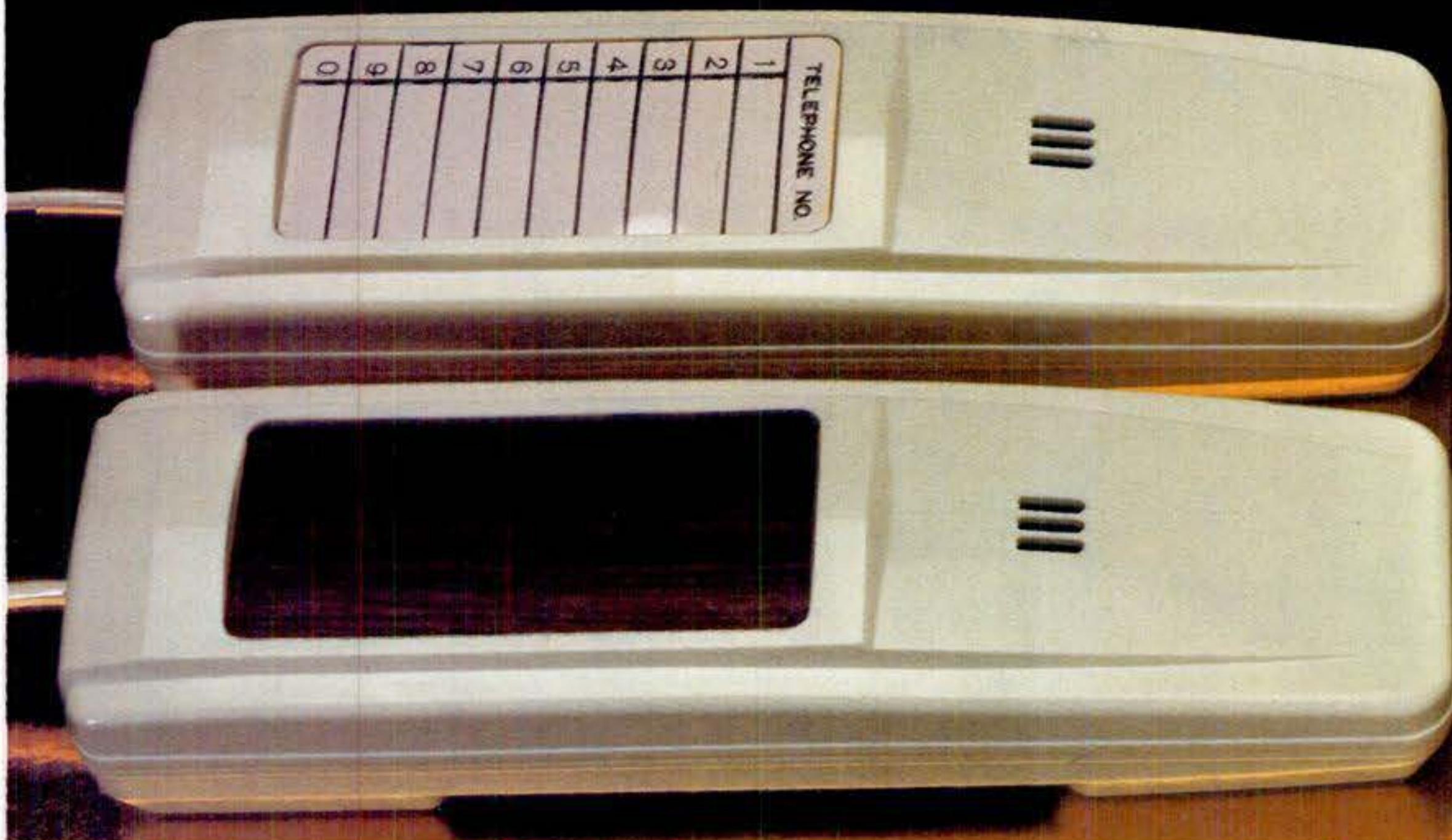
Our choices

There's no question that Blazer is the most refined of the current four-
Continued

Performance comparison with selected 1980 models

	Mpg (city driving)	Acceleration 0-60 mph (sec.)	Brakes 60-0 mph (hot) (ft.)	Handling (mph)	Maneuverability (mph)	Noise @ 60 mph (dBA)
1980 AMC Cherokee V8	11	15.8	124	58.2	26.8	71
1980 Chevrolet Blazer V8	13	14.1	171	56.3	26.4	70
1980 Dodge Ramcharger V8	13	18.6	155	53.0	24.6	72
1980 Ford Bronco V8	15	16.9	149	56.3	26.8	74

\$8 True Tone or 10 Memory Phone



It's up to you. Now you can have a push button phone with either True Tone or 10 Memories for just \$8. But, there's a catch.

Send back your dumb phones. Now instead of paying monthly service charges you can have push button dialing.

And, if that's not enough, you can choose either True Tone for use on Touch Tone® lines, or 10 Memory dialing.

You can forget big clunky phones. You can also forget dials. You can even forget cheap one piece phones.

Now you can have sophisticated True Tone or 10 Memory phones for just \$8. But, don't forget, there's a catch.

NOTHING TO INSTALL

Simply plug these sharp looking white phones with walnut accents into any modular phone jack and start talking.

If you don't already have jacks, call your phone company. Due to the Supreme Court, soon they'll probably be selling you your phones anyway.

HERE'S WHAT YOU GET

Both phones look the same. A quality condenser microphone lets the person you talk to hear you loud and clear.

And you hear them through a high quality speaker instead of the old diaphragm 'thing' that's been in phones for 20 years. Even the electronic ring is new. Plus you can shut it off.

The phone automatically hangs up when you set it down or put it in its included wall-mount holster (yes, it's a wall phone too). The phones come complete with a 10' cord, coiled at the phone end and a limited warranty from Unitech, the massive personal stereo company.

SO, WHICH ONE DO YOU WANT?

The 10 Memory Phone. This phone will remember 10 phone numbers including the last number dialed. And it's really easy to use.

To memorize a number, dial the number, push the * button twice and select any of the number buttons as the memory location. To dial a number from memory, touch the * key and a number button.

You can list the numbers on the back of the phone by turning over the decora-

tive walnut panel. Finally this phone features a mute button for privacy.

The True Tone Phone. If you have Touch Tone®, this phone will give you fast dialing, and access to all the discount services like MCI and Sprint.

The * and # buttons produce tones instead of last number redial and mute. These tones are used in some areas for call forwarding, and speed dialing. So, it works in even sophisticated areas.

Owning your own phones can save a lot of phone rental payments. But with these two phones, you'll enter the electronic communications age in style.



THE CATCH

Frankly, we are losing our shirts on these super phones, but we're looking for audiophiles who use cassettes.

If you buy top name TDK and Maxell cassettes, you probably pay \$3.50 to \$4.50 each for a 90 minute cassette.

We want you to try DAK's new Gold Label MLX ultra high energy, normal bias cassettes. Not at \$4.50 or even at \$3.50 each, but at a factory direct price of just \$2.49 for a 90 minute cassette.

We challenge you to compare the frequency response, dynamic range and signal to noise ratio of our new Gold Label MLX to Maxell UDXL or TDK SA.

If they win, we'll not only give you back your money, we'll give you a free gift for your trouble. DAK's come with a deluxe hard plastic box, an index insert card and a limited 1 year warranty.

WHY, YOU MAY BE ASKING?

You're very valuable to us in the form of future business. Over 280,000 customers have responded to bonuses like this. We find most of you keep buying once you've tried our cassettes and our prices; and that's a worthwhile gamble.

NOT A BAD CATCH

DAK manufactures a cassette with no problems and great sound. We've been hot on the heels of the frequency responses of Maxell and TDK. The tape we made last year had a great frequency response up to 14,000hz.

Now our new Gold Label MLX is second to none. We have a frequency response to 19,500hz and we'll go head to head against any tape on the market.

TRY NEW DAK MLX90 CASSETTES RISK FREE

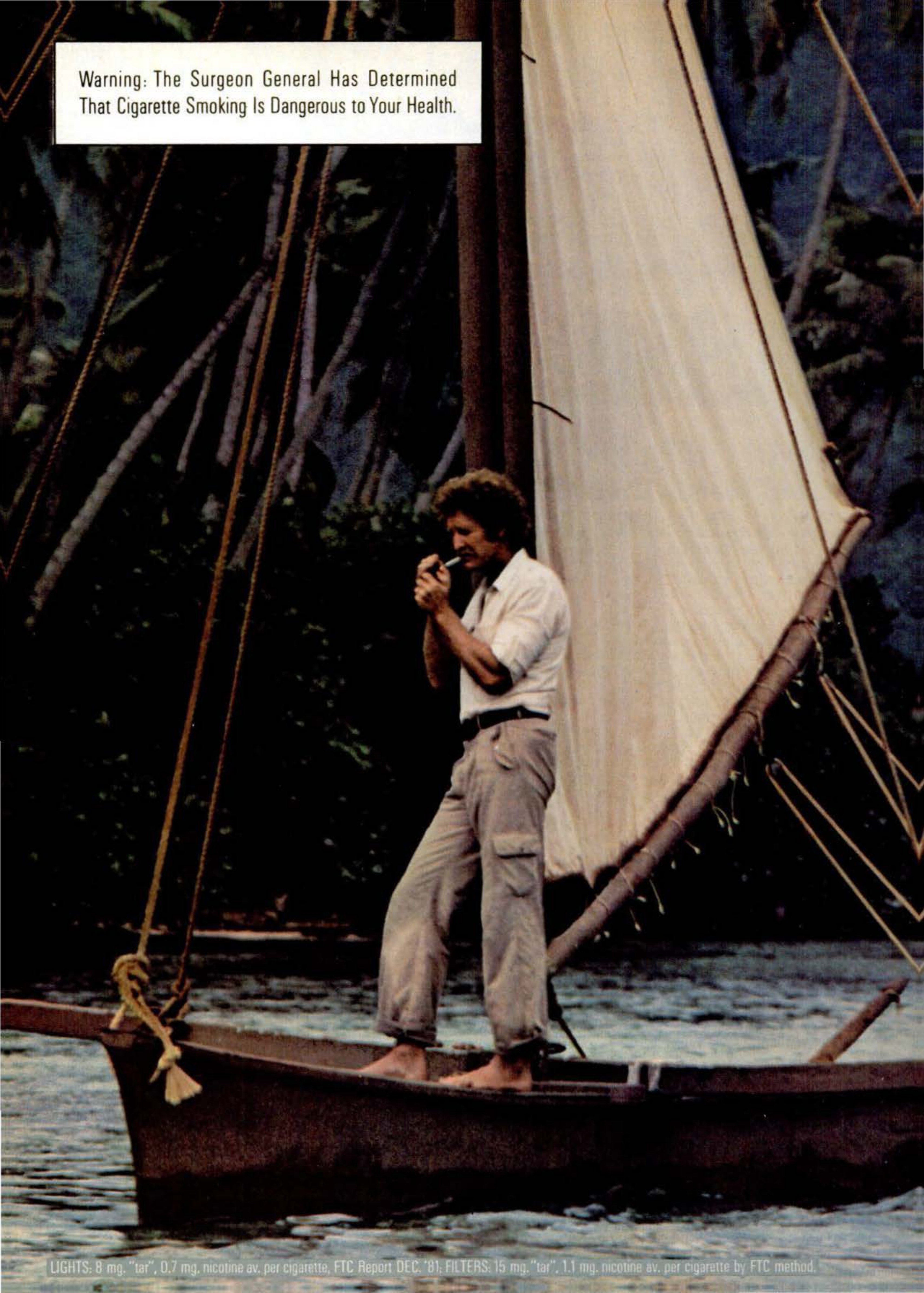
To get one of the phones for \$8, try 10 MLX high energy cassettes. If you aren't 100% satisfied, return only 9 of the 10 cassettes and the phone in its original box within 30 days for a refund. The 10th cassette is a gift for your time.

To order your 10 Gold Label DAK MLX 90 minute cassettes and get one of the phones for only \$8 with your credit card, call toll free or send your check for only \$24.90 for the tapes, plus \$8 for the phone and \$3 for post. and handling.

Use Order No. 9680 for the 10 Memory Phone, or Order No. 9681 for the True Tone Phone. CA res add 6% sales tax.

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Test results, dimensions, and specs

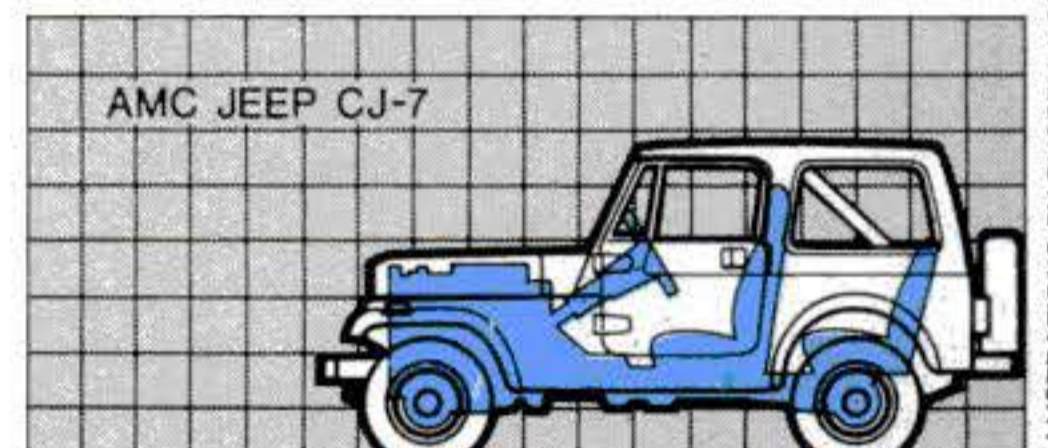
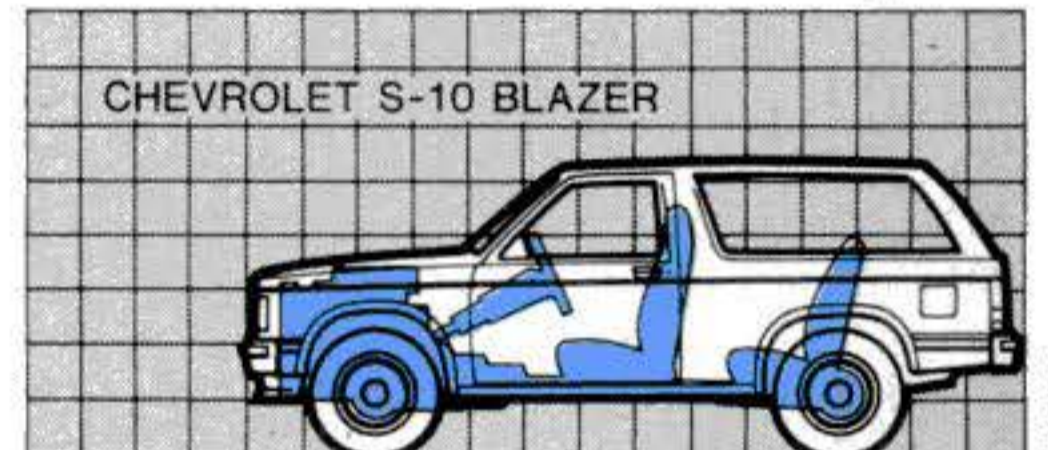
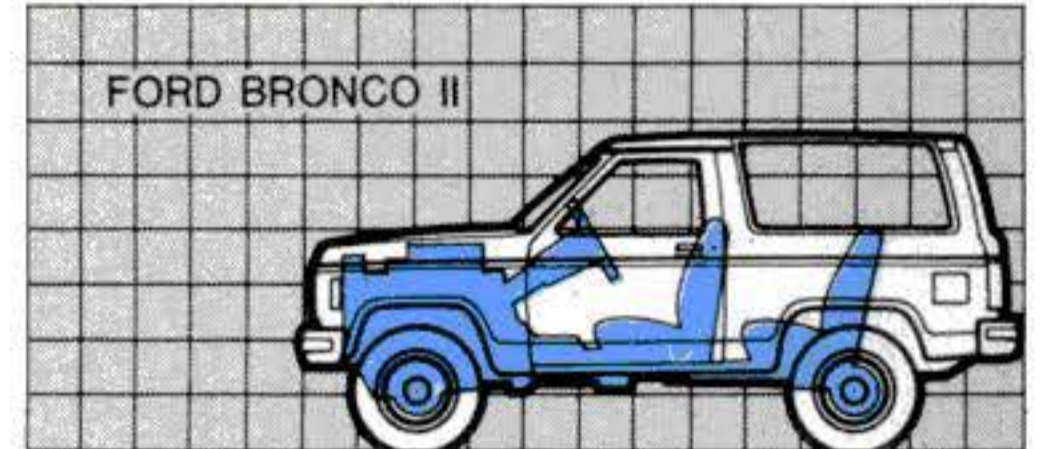
	Ford Bronco II	Chevrolet S-10 Blazer	AMC Jeep CJ-7
TEST RESULTS			
Acceleration (sec.)			
0-60 mph	15.4	18.9	17.7
Brake test (cool) 60-0 mph			
Stopping distance (ft.)	189	211	185
Pedal pressure (lbs.)	85	180	120
Brake test (hot) 60-0 mph			
Stopping distance (ft.)	184	199	195
Pedal pressure (lbs.)	90	140	85
Interior noise @ 60 mph (dBA)	70	68	76
Handling test (mph)	56.5	62.8	60.9
Maneuverability test (mph)	26.5	28.1	27.9
EPA FUEL MILEAGE (mpg)			
Highway	30	29	26
City	20	19	18
Calif. city	20	19	n.a.
PS FUEL-MILEAGE TESTS (steady-state mpg)			
35 mph	23.3	27.6	25.7
55 mph	18.5	23.3	19.7
TEST CONDITIONS: Ambient temperature, 55°F; relative humidity, 90 percent; barometric pressure, 28.7 inches Hg			

DIMENSIONS (inches)			
Wheelbase	94.0	100.5	93.4
Overall length	158.4	170.3	153.5
Overall height	69.0	64.2	69.3
Overall width	65.0	64.7	65.3
Track, F/R	56.5/56.5	54.2/54.2	57.3/56.6
Ground clearance	7.5	8.5	9.5
Front head room	37.5	38.6	39.9
Front hip room	41.0	40.0	53.6
Front leg room	43.0	37.6	39.5
Rear head room	35.0	37.0	40.7
Rear hip room	41.0	45.0	36.0
Rear leg room (min.)	35.0	37.0	31.0
Rear knee room (min.)	4.0	2.0	2.0
Couple distance	32.0	28.0	34.0
SPECIFICATIONS			
Engine type	V6	V6	In-line 6
Displacement (cu. in./L)	170/2.8	173/2.8	258/4.2
Compression ratio	8.7:1	8.5:1	9.1:1
Carburetion	2 bbl.	2 bbl.	2 bbl.
Net hp @ rpm	115 @ 4,600	110 @ 4,800	n.a.
Net torque (ft.-lbs.) @ rpm	150 @ 2,600	145 @ 2,100	210 @ 2,000
Transmission	3-speed automatic	4-speed automatic	5-speed manual
Axle ratio	3.45:1	3.73:1	3.31:1
Tire make	Goodyear	Uniroyal	Goodyear
Tire type	Wrangler Radial	Laredo Radial	Wrangler Radial
Tire size	75R15	75R15	75R15
Steering	Power, rack and pinion	Power, recirculating ball	Power, recirculating ball
Overall steering ratio	18.5:1	16.3:1	17.5:1
Turns, lock to lock	4.1	3.6	4.1
Turn diameter (ft.)	35.4	36.4	37.8
Front suspension	Twin-I-Beam, independent coil springs	Independent torsion bar	Solid axle, full-floating leaf springs
Rear suspension	Rigid axle, leaf springs	Salisbury axle, two-stage leaf springs	Solid axle, full-floating leaf springs
Front stabilizer-bar diameter (in.)	1.0	1.0	0.93
Rear stabilizer-bar diameter (in.)	0.75	None	None
Trailer towing (max. lbs.)	4,050	5,000	2,200
Trailer tongue weight (max. lbs.)	600	1,000	n.a.
Brakes	Disc/drum	Disc/drum	Disc/drum
Brake swept area (sq. in.)	n.a.	191.7	n.a.
Fuel tank (gal.)	23	13.2	20
Trunk space (cu. ft.)	63.8**	20	n.a.
Liftover height (in.)	26	27	24
Curb weight (lbs.)	3,239	3,115	2,916
F/R weight distribution (%)	52/48	53/47	49/51
Basic price	\$9,998	\$9,773	\$6,995
Price as tested	\$13,769 ¹	\$14,998 ²	\$11,014 ³
Major options (over \$100)	¹ AM-FM cassette \$100, tinted glass \$123, speed control \$185, floor console \$208, swing-away tire carrier \$213, cast-aluminum wheels \$219, limited-slip rear axle \$230, options package \$448, automatic transmission \$487, XL trim \$597, A/C \$693. ² Tilt wheel \$105, power windows \$175, speed control \$185, locking differential \$230, cast-aluminum wheels \$231, 2.8-liter engine \$243, power steering \$247, AM-FM stereo \$277, folding rear seat \$325, special tires \$364, automatic transmission \$650, A/C \$690, sport trim \$910. ³ Tilt wheel \$106, spare tire and wheel \$123, 258-cu.-in. engine \$200, 5-speed transmission \$225, power steering \$247, Laredo package \$2,935.		

*Measured at front differential
**With rear seat folded

wheelers—almost to a fault: It may be too pretty to take into the bush. But I'd still like to have it in my driveway. —J.D.

Blazer had a much smoother ride than Bronco or CJ, but the constant upshifting on rolling stretches of road was bothersome. Bronco II's top-hinged rear hatch is a big plus. It made loading heavy cargo easier. For now, the less refined but peppy Bronco II is my pick. —J.K.



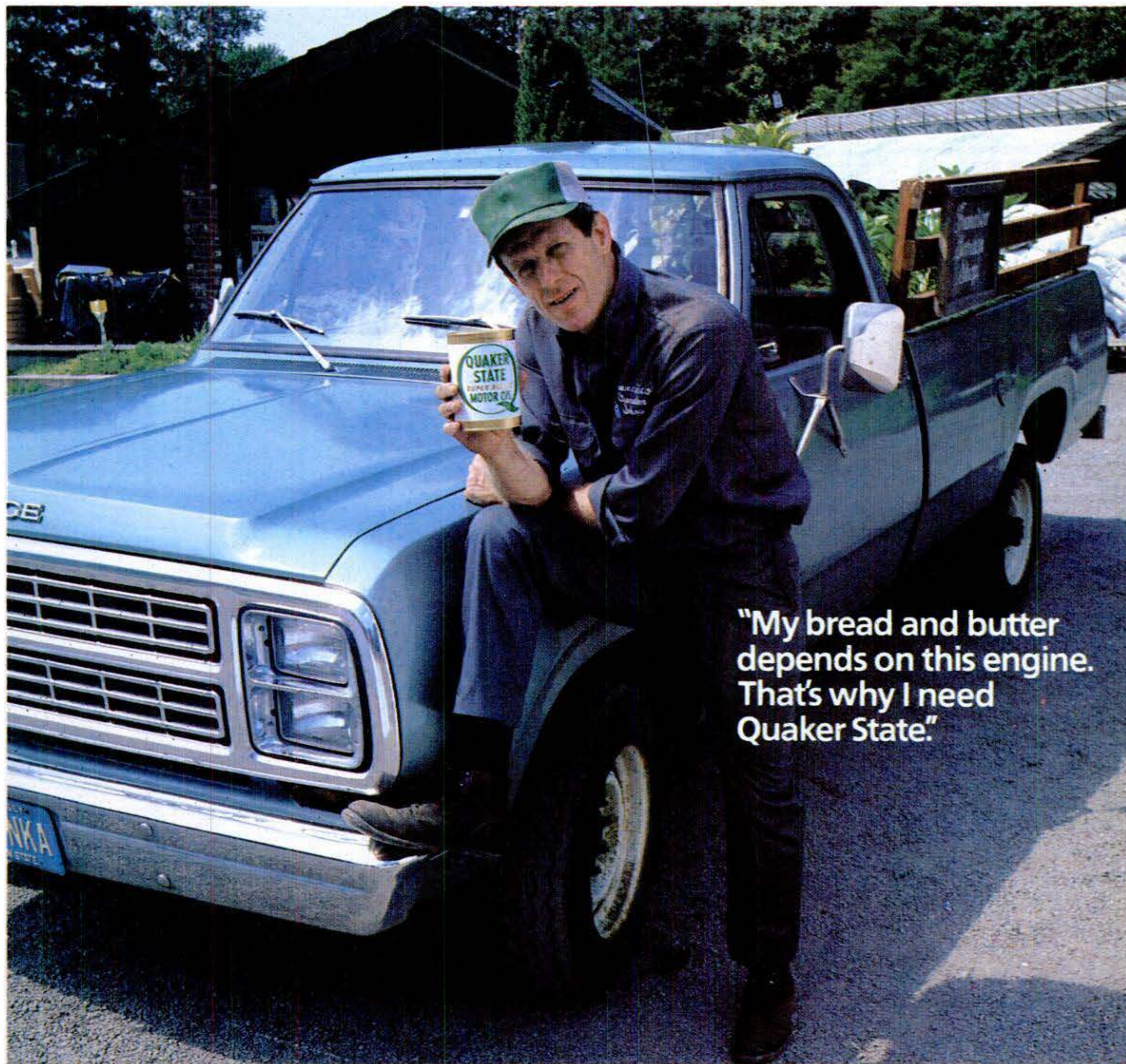
ILLUSTRATIONS BY RUSSELL VON SAUERS

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 Bronco II	Chevrolet S-10 Blazer	AMC Jeep CJ-7
Checking fluid levels			
Battery	5	5	5
Master cylinder	3	5	3
Windshield washer	5	5	5
Engine oil	3	3	5
Coolant	4	5	5
Checking the engine			
Spark plugs	3	2	5
Distributor	2	2	5
Oil filter	2	3	5
Oil fill	3	5	5
Replacing hoses			
Upper radiator hose	5	5	5
Lower radiator hose	3	3	4
Heater hoses	5	4	5
Changing bulbs			
Headlights	5	4	4
Taillights	3	2	3
Front running lights	3	3	3
Front parking lights	3	4	3
Front directionals	3	4	3
Rear directionals	3	2	3
Rear running lights	3	2	3
Checking fuses			
	3	4	3
Spare-tire accessibility			
	5	4	5
Changing belts			
	3	3	4

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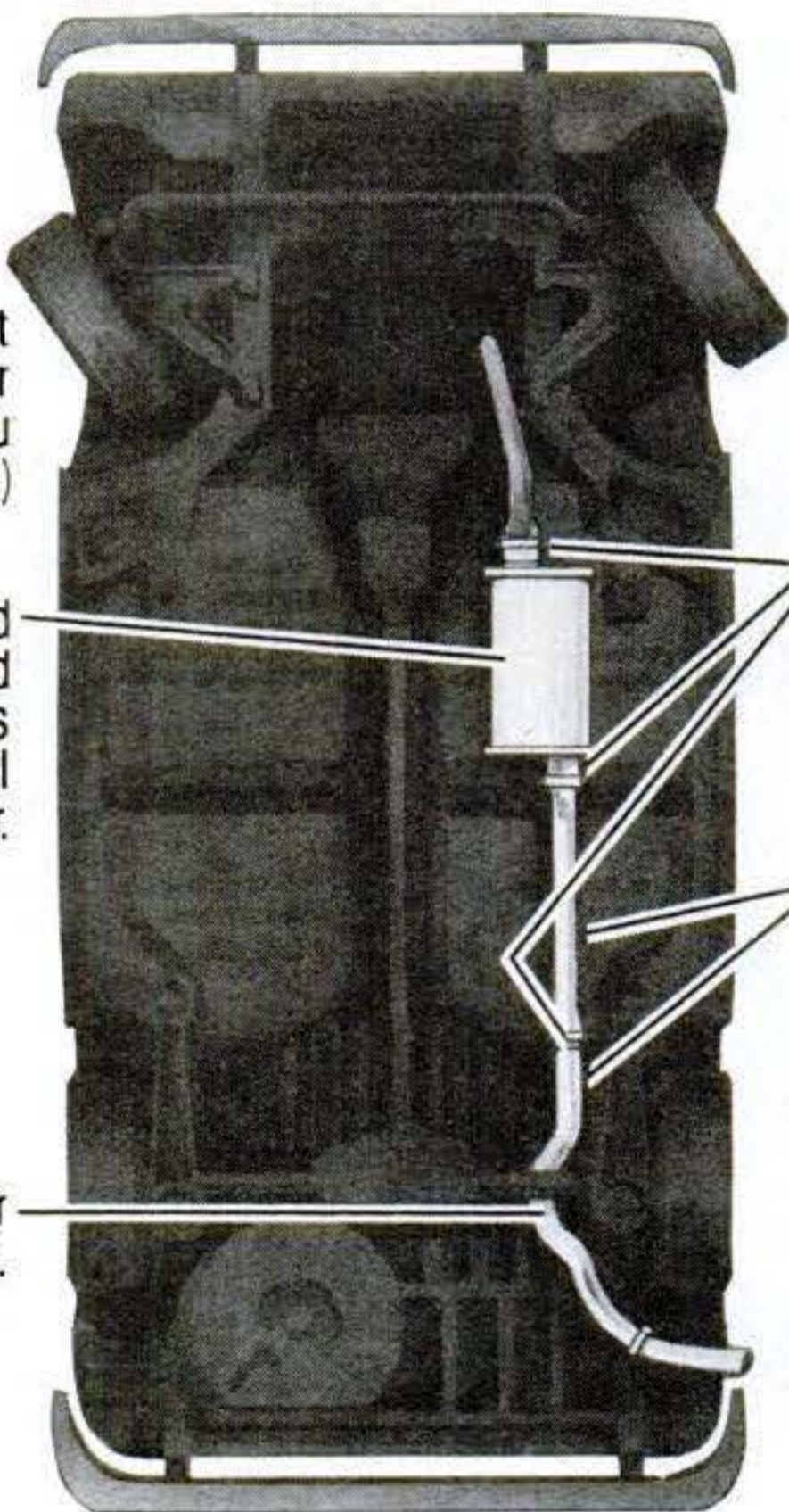
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Mufflow takes the fear out of replacing your muffler and tailpipe. (And saves you a bundle in the process.)

Heavy duty galvanized steel. Double wrapped construction meets or exceeds original equipment muffler.

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No special skills. No special tools. All hardware and easy instructions included.

Unique two piece Mufflow tailpipe also makes it easy to handle. Precision engineered so it's easy to install.

Fear not, Mufflow makes it easy.

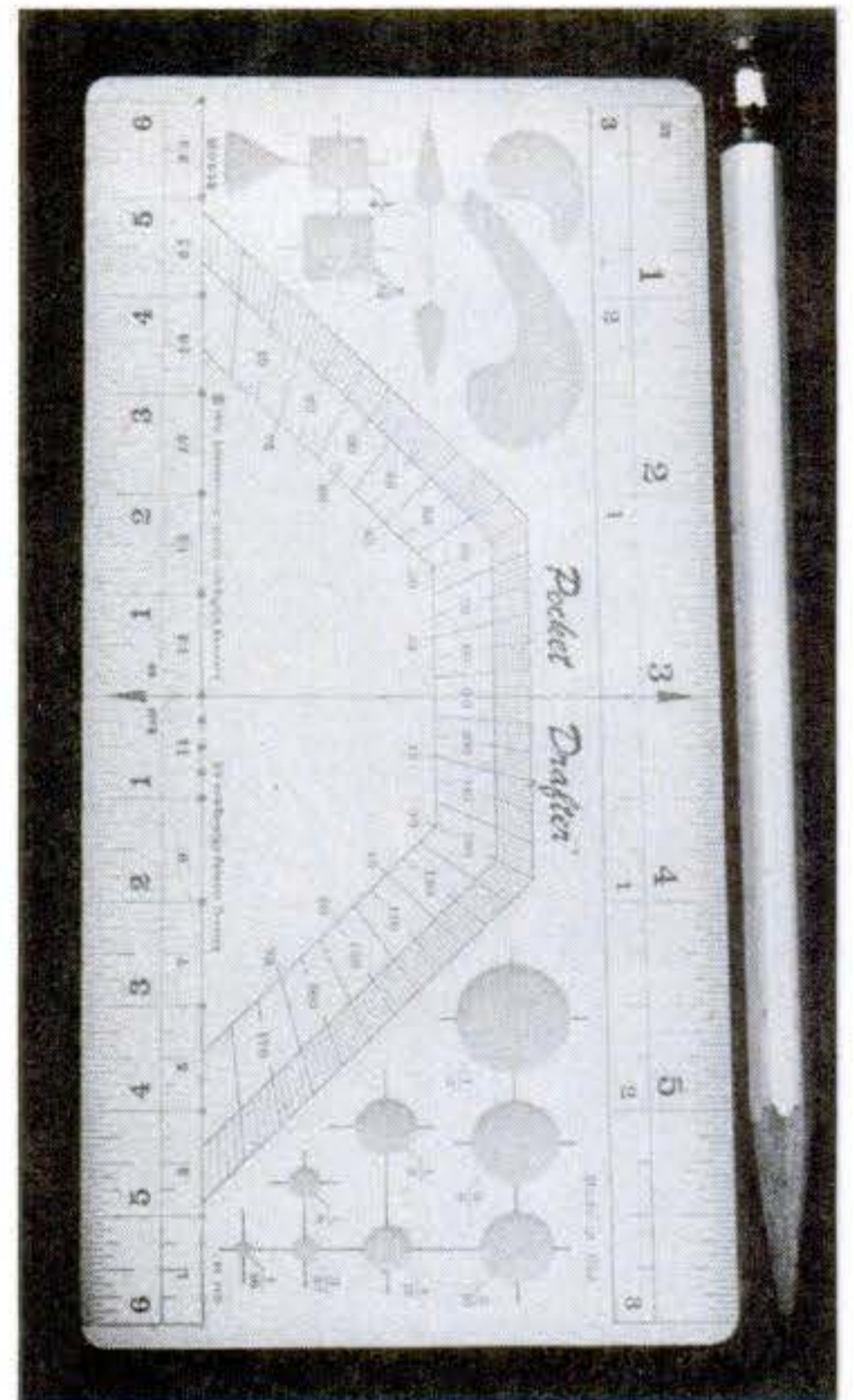


Thrush MUFFLOW

For information contact: Thrush Inc., Marketing Dept., 172 Bethridge Rd., Rexdale, Ontario. M9W 5E2

OVER 3,000,000 INSTALLED

Draw-it-all mini-drafter



"Once we got started, we just kept adding things to it," says John Pigman, co-inventor of the Pocket Drafter. The result, after 18 months of work, is a tool (photo) made for on-the-go designers: a strip of plastic that serves 14 drafting functions.

Along one edge is a six-inch ruler with $\frac{1}{32}$ -inch increments. Immediately below that there's a six-inch center-reading ruler. Etched in the middle: a protractor with beam compass, which measures from zero to 180 degrees. And you can use either side to measure 45-degree angles quickly.

On the opposite edge is a half-scale center-reading ruler for drawing in scale. Below that's a quarter-reduction scale that can be used for measuring in inches, feet, or miles.

The booklet that comes with the Pocket Drafter shows various ways to derive or bisect angles, draw 46 different circles up to 12 inches in diameter, plot points in Cartesian coordinates, and more. There are also templates for drawing small circles (eight—from $\frac{1}{16}$ to $\frac{1}{2}$ inch in diameter), French curves, and common drafting symbols.

Sold by International Design (4408 N. 12 St., Phoenix, Ariz. 85014), the drafting tool is \$4.95. Eleven versions will soon be available, including one in metric.—Jim Scheffer

If the way you read and the amount you read is holding you back in your work or social life...

Here's some powerful help in the form of a remarkable program that will give you the ability to learn fast from reading, plus the skill to remember . . . easily!

SUPER READING

How many times have you sat back in a meeting, afraid to make a suggestion that might have meant a personal triumph for you—simply because you weren't sure of your facts?

How many times have you hesitated to "speak up" at a gathering because you weren't as familiar as you should have been with the topic discussed?

How often do you feel frustrated because you're falling behind in your "must" reading or not keeping up with your daily workload?

If your slow reading skills and untrained memory power have put you in any of these situations, you're invited to take advantage of a remarkable system that has already helped hundreds of thousands of people to acquire one of the most rewarding gifts you can own . . . the ability to learn fast from reading while retaining and recalling key facts and information!

YEARS OF RESEARCH— THOUSANDS OF SATISFIED USERS

Dr. Russell G. Stauffer, originator and research director of this program, is unquestionably one of the country's leading experts on reading and learning. He is Professor Emeritus at the University of Delaware and founder of its internationally famous Reading Study Center.

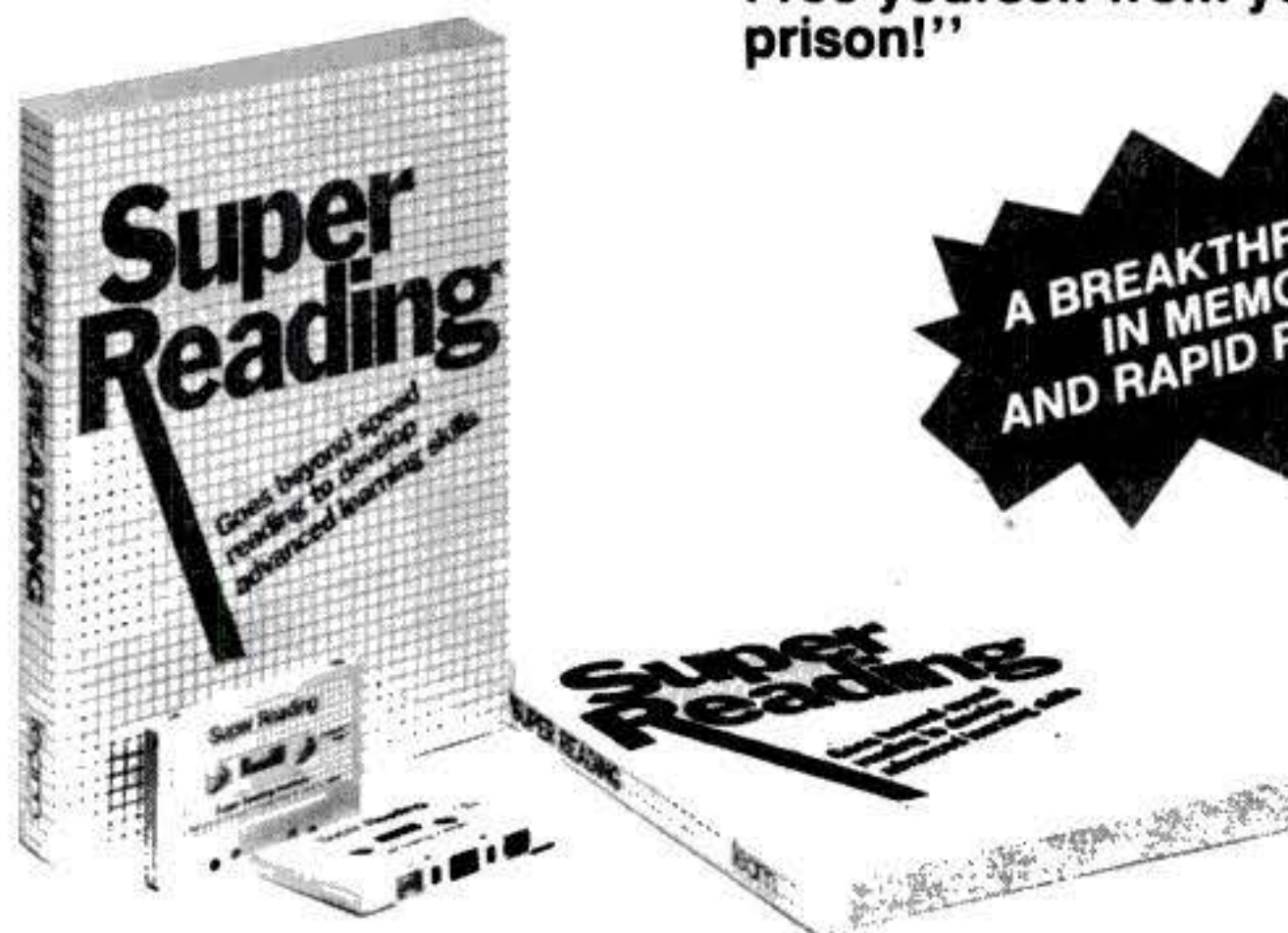
Now, after a lifetime of reading and learning research, he and his associates have developed a thorough, enjoyable program to help individuals break the "slow-reader-learner" habit.

As a Super Reader, you quickly begin to save valuable reading time each day . . . have a wider range of information at your beck and call . . . and become the well-informed person your associates and friends respect and admire. You express your ideas forcefully, without hesitation.

HOW DOES SUPER READING ACCOMPLISH THIS?

This proven system leads you step-by-step to increase your reading skill and speed quickly, so you understand more, remember more and use more of everything you read.

If you're like most people, you don't set a purpose for your reading. You're a "prisoner" of the printed word, going along word-by-word, hoping to eventually get to the point of it all. With Super



- Use your hidden memory power!
- Retain and recall facts when you need them!
- Read faster than you thought possible!
- Free yourself from your "paper prison!"

Reading you'll learn how to set a purpose for reading to quickly zero in on the information you need.

And there's more! Super Reading will teach you how to survey—helping you eliminate what you don't need, and making sure you read only what's pertinent. This skill alone can save as much as 30% of your valuable reading time.

You'll learn all seven of the Super Reading skills in the comfort of your own living room while your "teacher-on-cassettes" guides you, instructs, and explains material as you read. It's a remarkable way to learn . . . astonishing how easily you train your mind to efficiently go through the basic process behind efficient reading, understanding, and remembering.

And the printed material you receive is drawn from your everyday reading environment. Think how much more interesting and practical it will be to learn from articles just as they appear in your favorite magazines, newspapers, and books—and just as they appear in your more difficult reading including reports, journals, texts.

WHO CAN BENEFIT FROM SUPER READING?

People at all levels and walks of life can gain valuable skills of a lifetime with Super

Super Reading. Executives, students, professionals, men, women, managers, technicians . . . anyone who reads for career or pleasure. Anyone who wants to save time, gather and retain more information, understand and remember what they read. Anyone who wants to build their thinking power to new heights.

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You not only have the opportunity to purchase this remarkable program at a cost that's less than one-tenth the price of so-called "speed reading" classroom courses, you're invited to listen to the cassettes, review the text material, and then decide if this program can help you achieve your new goals: increase the speed at which you read and understand and remember more of what you read.

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I understand that I may examine the materials for 15 days at no obligation. If I am not delighted in every way I may return them in the condition I received them for a full refund or cancellation of my credit card charges.

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Address _____

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Signature _____

Outside USA add \$10 per item—Surface mail \$7—Airmail Extra

Cram a walletful of information into one card with a brain

With a computer in your hip pocket, you won't need cash, checks, or credit

By TIMOTHY O. BAKKE

In a jeweler's shop in Blois, France, a young man has just finished selecting some jewelry. Only 20 minutes before, he had picked someone's pocket and is now about to use that person's credit card. Smiling, he nods in agreement as he is asked to insert his card into a cash-register-like terminal. He doesn't realize that this is no ordinary charge plate but a so-called "smart card," with a microprocessor embedded in it.

Having inserted the card into the terminal, the young man is asked to key in his ID number. Timorously, he works the shielded key pad. Nothing. A second try yields the same result. For a third time, the pickpocket tries to get the numbers right. And on this wrong try, the terminal goes dead. The transaction has been terminated and the card's circuitry wiped out. The

Continued



Shown with contents of a wallet (above), smart card gives no hint of its computing potential. It is small enough to satisfy credit-card-size specs (ISO Standard 2894), but telltale gold disc in its upper-left-hand corner hides microprocessor (inset) capable of performing up to 200 transactions. Special prototype card (left) reveals road map of another processor's circuitry.

Power Ram 50



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\$5,665...That's the only thing you can call "small" about the '83 Dodge Ram 50. And this low price offers you all the big things that make this hard-working pickup a value standout in its class.

BIG 1630 LB. PAYLOAD. BIG ON PROTECTION.

■ The Ram 50 has a larger standard payload than any of the top-selling small pickups. Over 33% more than the base Ford Ranger ...63% more than the base Chevy S-10!

■ Dodge uses galvanized steel in critical areas to help protect your Ram 50 from corrosion. And loaded or empty, you can count on standard power front disc brakes to help make your stops smooth and sure.

riors and instrument panels. Adjustable steering column is a standard benefit—helps you get in and out easier and adjusts to suit your driving comfort.

BIG 2.0L ENGINE PERFORMANCE.

■ Ram 50's standard 2.0L powerplant has more horsepower than the base Ford Ranger and Chevy S-10. And neither the base Ranger nor S-10 can beat Ram 50's 27 EPA estimated MPG.†

BIG ON INTERIORS.

■ You'll like the room and common-sense layout of Ram 50 inte-

*Base list price. Title, taxes, and destination charges extra. Based on a comparison of base list prices. LEVELS OF STANDARD EQUIPMENT MAY VARY.
†Use for comparison. Your mileage may vary depending on speed, weather and trip length. Calif. est. lower.



ST/O/P

HOW IT WORKS



CHAPTER 1: "PASSIVE" TECHNOLOGY

The first radar detectors were of a very simple technology called "passive." These units had a very limited range, and weren't very selective about what signals they would detect, so they were only marginal even when police radar was unsophisticated. And after the advent of low power, instant-on, and pulsed radar, and the proliferation of the higher frequency K band, passive detectors became virtually useless.

CHAPTER 2: SUPERHETERODYNE TECHNOLOGY

In the late seventies, detector technology was advanced by a more sophisticated type of circuitry called superheterodyne (ESCORT was the first high performance superheterodyne radar detector). This "active" technology carries a much higher cost, but has many advantages.

Properly designed, it can amplify an incoming signal several hundred times (increasing the range of a detector significantly), as well as be very selective about which incoming signals are detected (by ignoring signals outside the police bands). Superheterodyne detectors were a remarkable advance over passive technology.

CHAPTER 3: ST/O/P DIGITAL PROCESSOR TECHNOLOGY

But today superheterodyne alone is not enough. A new type of imported radar detector flooding the highways transmits in the same bands as police radar, and sets off any other radar detector in the vicinity. Until now.

ESCORT's new ST/O/P circuitry does much more than superheterodyne can by itself. ST/O/P digitally analyzes signals and can eliminate those from "polluting detectors" — even though the "polluting" signals are in the police bands! Let's look at each type of signal and show how ST/O/P works.

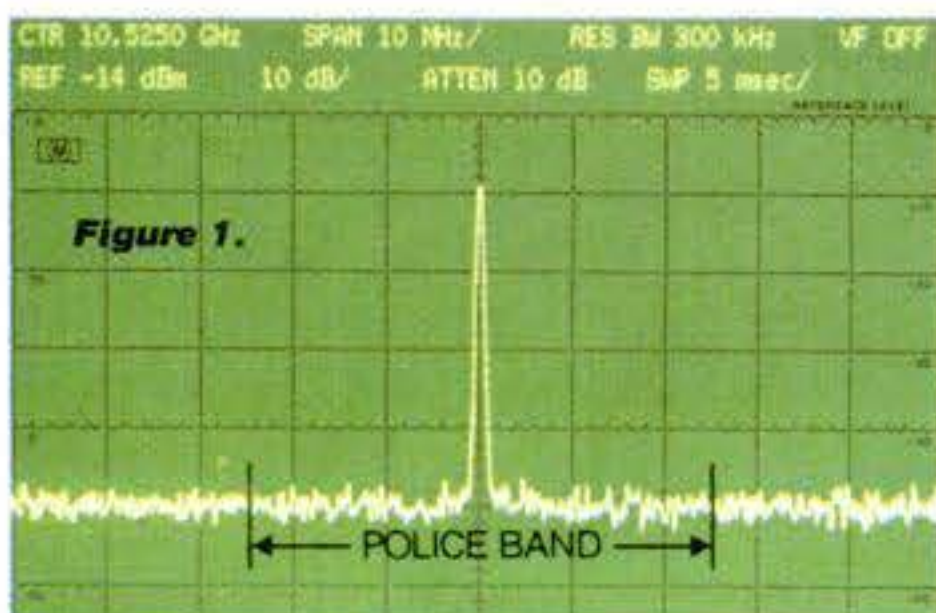


Figure 1 shows an X band police radar signal (displayed on a digital spectrum analyzer). The entire band allowed for X band police radar (10.500 to 10.550 GHz) is shown by the arrows below the illustration.

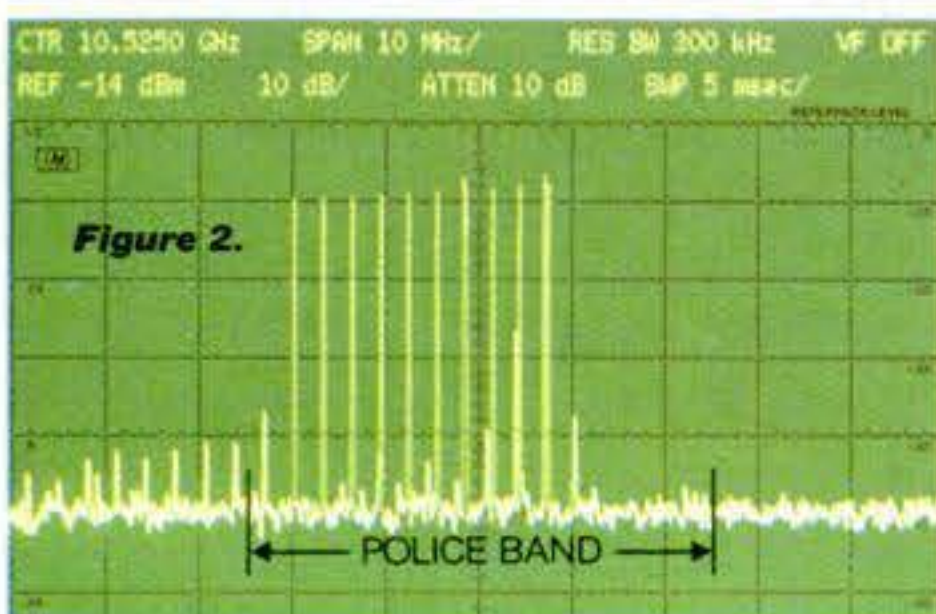


Figure 2 shows the X band signal that emits from a "polluting detector." ST/O/P digitally analyzes patterns in the frequency/amplitude/time characteristics of all signals and recognizes patterns exclusive to each, whether from a "polluting detector" or police radar. Other radar detectors without ESCORT's pattern recognition technology simply can't tell the difference.

With ST/O/P, ESCORT is redefining radar detection. **Again.**

ESCORT WINS AGAIN!

MAY 1983 CAR and DRIVER TEST

"The Escort looks so comfortable, contented, and familiar at the top of the heap that it's hard to see that something new and special has been added... live with a new Escort for a while and you'll realize it has advanced new circuitry that should go down as a genuine breakthrough."

ESCORT WINS

NOV 1982 CAR and DRIVER TEST

"The Escort, a perennial favorite of these black-box comparisons, is still the best radar detector money can buy. The Escort is a quality piece of hardware."

ESCORT WINS

DEC 1981 BMWCCA ROUNDEL TEST

"The Escort is a highly sophisticated and sensitive detector that has been steadily improved over the years... In terms of what all it does, nothing else comes close."

ESCORT WINS

SEPT 1980 CAR and DRIVER TEST

"Ranked according to performance, the Escort is first choice... The Escort boasts the most careful and clever planning, the most pleasing packaging, and the most solid construction of the lot."

ESCORT WINS

MAY 1980 BMWCCA ROUNDEL TEST

"This unit... constantly outperformed the other products and is the standard to which the others are compared. If you want the best, this is it. There is nothing else like it."

ESCORT WINS

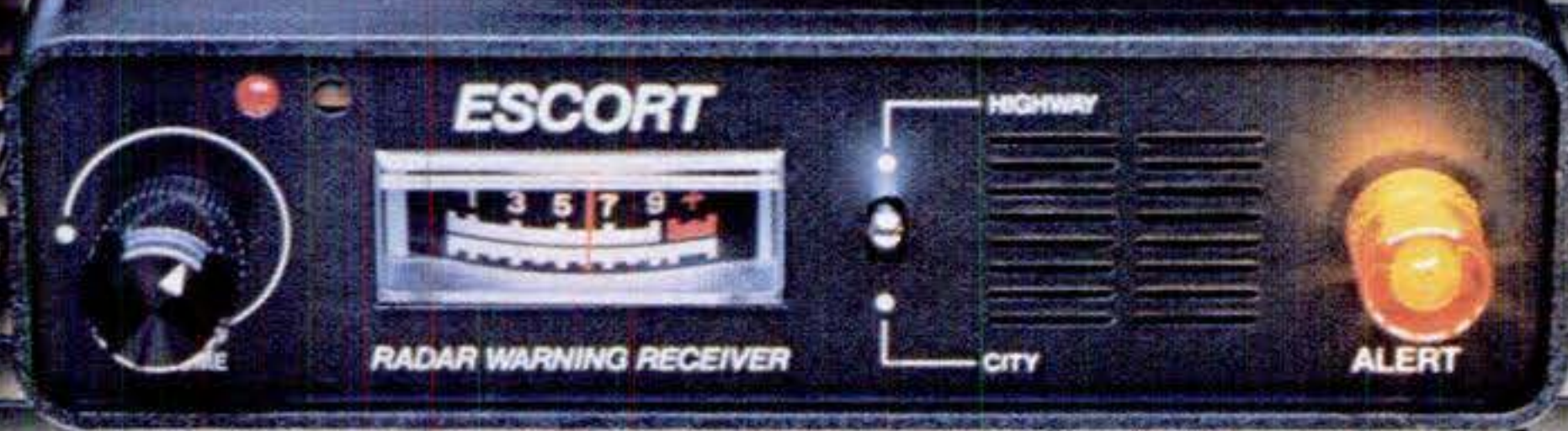
FEB 1979 CAR and DRIVER TEST

"Only one model, the Escort, truly stood out from the rest... once you try the Escort, all the rest seem a bit primitive. In no test did any of the other detectors even come close."

FOR ESCORT OWNERS ONLY:

As our ad above states, we've made another improvement. The new ST/O/P circuitry is a standard part of every ESCORT starting with serial number 400,000.

Is ST/O/P adaptable to your present ESCORT? Well, yes and no. At S.N. 200,000, there was an internal redesign of ESCORT



**ST/O/P:
THE
FIRST
RADAR
DETECTION
ADVANCE
SINCE
SUPERHETERODYNE**

ESCORT: "A GENUINE BREAKTHROUGH"

—CAR and DRIVER

If you keep up with magazine tests, you know that ESCORT does more than just outperform other radar detectors. In its most recent evaluation, Car and Driver concluded: "The Escort radar detector is clearly the leader in the field in value, customer service, and performance..." But performance, as measured by warning distance, is *not* the new breakthrough. After all, ESCORT has been beating all comers since its introduction in 1978.

Now There's More To It

While long detection range is obviously essential it does *nothing* to solve a problem that has cropped up in the last year. In fact, increasing range by itself just makes the problem worse. If you already have a good superheterodyne unit, you know what we mean. A new generation of imported detector *transmits* radar signals, and can set off your unit as far as a mile away. The longer the range of your unit, the farther away you find them. As Car and Driver pointed out last November: "Since there are far more detectors on the road than police radar units, interference... could become a genuine nuisance."

Low Level Contamination

At first it was just an irritation. At least ESCORT owners had a way of distinguishing the polluters from the real thing. Our unique audio warning differentiates between the two police radar bands: it "beeps" for X band and "braps" for K band. The polluters' trashy signals triggered both warnings at once, and made a new sound—different than the sounds for police radar. The rest of the industry didn't even know there was a new problem. Their detectors were making the same sounds as always, just more often.)

Radar Epidemic

As more and more of the "polluting detectors" hit the streets, the problem became more serious. If one of the "polluters" is approaching in an oncoming lane, the alarm from your detector is brief. But if it's traveling the same direction as you, your alarm can go on for miles. And the offending detector doesn't have to be in the car right next to yours. It can be ahead or behind, and up to a mile away. A very serious problem indeed.

Pollution Clean-Up

The problem required an entirely new approach. Examining the interference from these imports, our engineers discovered a subtle difference between their signals and those of police radar, even though they were on the same frequency. The solution, then, was to design new circuitry that would reject the pollution while—and this was the hard part—maintaining ESCORT's industry-leading response to pulsed and instant-on radar. We named it ST/O/P™ (STatistical Operations Processor), and it consists of a CMOS digital processor with built-in memory. ST/O/P is not simple, and it's not cheap. But it is, in our opinion, the most important breakthrough in radar detection since superheterodyne. Car and Driver would seem to agree: "Now, all the world's Radio Shack detectors can hum right by your car in full microwave broadcast mode and your Escort will sit on your dash as politely and silently as a canary-fed cat."



**THE RADAR
DEFENSE
KIT**

Peace of Mind

With ST/O/P, we've put the complications necessary to cope with today's radar problems inside—where they work automatically. Just install ESCORT, plug it into your cigar lighter, and turn it on. ESCORT does the rest. If you encounter a signal from a "polluting detector," ESCORT keeps quiet while maintaining its lookout for police radar. If the signal is the real thing, ESCORT immediately alerts you both audibly and visually. And, unlike other detectors that keep you guessing about the radar's location, ESCORT's signal-strength meter moves upscale as you approach and its variable-rate beeper/brapper pulses faster. You get the full story.

It's Simple

If you want the best, there's no reason to look anywhere else. But don't take our word for it. Try ESCORT *at no risk*. Open the box, install ESCORT on your dash or visor, and take 30 days to test it. If you're not absolutely satisfied, we'll refund your purchase *and* pay for the postage costs to return it. You can't lose. ESCORT is sold factory direct, so knowledgeable support and professional service are only a phone call or parcel delivery away. And we back ESCORT with a full one year limited warranty. Order today and let ESCORT change radar for you forever.

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It's easy to order an ESCORT, by mail or by phone.

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IN OHIO CALL 800-582-2696**

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incorporating custom integrated circuitry, a precision quartz timebase, and a new integrated microwave mixer/antenna/Gunn oscillator. The new ST/O/P technology builds on this by significantly expanding the digital logic and adding memory. As a result, older units (serial numbers less than 200,000) cannot be modified to incorporate ST/O/P technology.

For those of you with ESCORTs from S.N. 200,000 to 399,999 we are presently developing procedures and facilities to make adding the ST/O/P circuitry to your unit possible. The cost will be \$75, and details and special shipping instructions will be in our advertisement in the August '83 issue of this magazine. Sorry, but we won't be able to convert your unit until that announcement.



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you get a lot to like.**

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**Warning: The Surgeon General Has Determined
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**Kings: 16 mg "tar," 1.0 mg nicotine—100's: 16 mg "tar,"
1.1 mg nicotine av. per cigarette, FTC Report Dec '81**

Card with a brain

smart card has become a useless piece of plastic.

This imaginary but quite realistic incident illustrates the power of the ultimate in credit-card technology: the French-made *carte à mémoire*, or smart card—literally a computerized credit card.

Credit and banking cards have been getting smarter for some time. About seven years ago the magnetic stripe was chosen as the industry standard for storing account information on cards. You could charge an airline seat at a remote ticket machine in an airport or do your banking at an automatic teller—the card became, in effect, an electronic passkey. More recently, so-called laser cards have been getting attention. Reflective material on a plastic card can hold laser-encoded data.

But suppose you owned a tiny computer with the ability to store thousands of bits of information. And say it was embedded in a credit-card-size piece of plastic. And what if you could be assured that *no one* could have access to your private data but you? All the information in your wallet—represented by your credit and bank cards, Social Security card, medical-ID card, library card, etc.—could be stored in that one piece of plastic.

The *carte à mémoire*, invented by Roland Moreno, is such a card. The imaginary pickpocket discovered one of its more attractive features (to its owner): the security it provides. Another is its programmable memory, which makes it adaptable to many applications. Three variations of the smart card have been undergoing tests in France since July 1982. Although it will be some time before it becomes universal, the card could be used in retail point-of-sale and home-banking applications

soon. And the French aren't the only ones interested. Tests are also scheduled in the U.S.: one by a bank in Minneapolis (in conjunction with a videotex system) and another by the Department of Defense. The interest of the government may be crucial to the card's future here.

Computerized security

One of the microcircuit card's first uses was as part of a videotex system, the French-government-sponsored Telematique program. In such a system, sensitive data, such as customers' bank- and credit-account information, are transmitted over telephone or cable-TV lines. But that could be a problem because these lines are easily tapped. So both tight security and a method of recording transactions are needed.

Moreno fulfilled both requirements by burying a microprocessor chip in a plastic plate somewhat thicker than a credit card. The fleck of silicon in the card could be programmed with an access code; it could be instructed to encrypt and decrypt transmissions for security; and it could perform and record transactions. In 1974 Moreno, through Innovatron Corp., obtained a patent and soon thereafter licensed three French manufacturers to further develop the card: Cii Honeywell Bull, Philips Data Systems, and Flonic Schlumberger.

In 1980, Intelmatique, the international promotional branch of France's telecommunications administration, entered the game. Led by its English-born managing director, Roy Bright, Intelmatique brought the card to the Los Angeles Intelcom '80 trade show with the aim of showing that "the only features the magnetic-stripe card and the *carte à mémoire* have in common

are the plastic carrier, embossing, and some memory. In all other respects our card is in a different league."

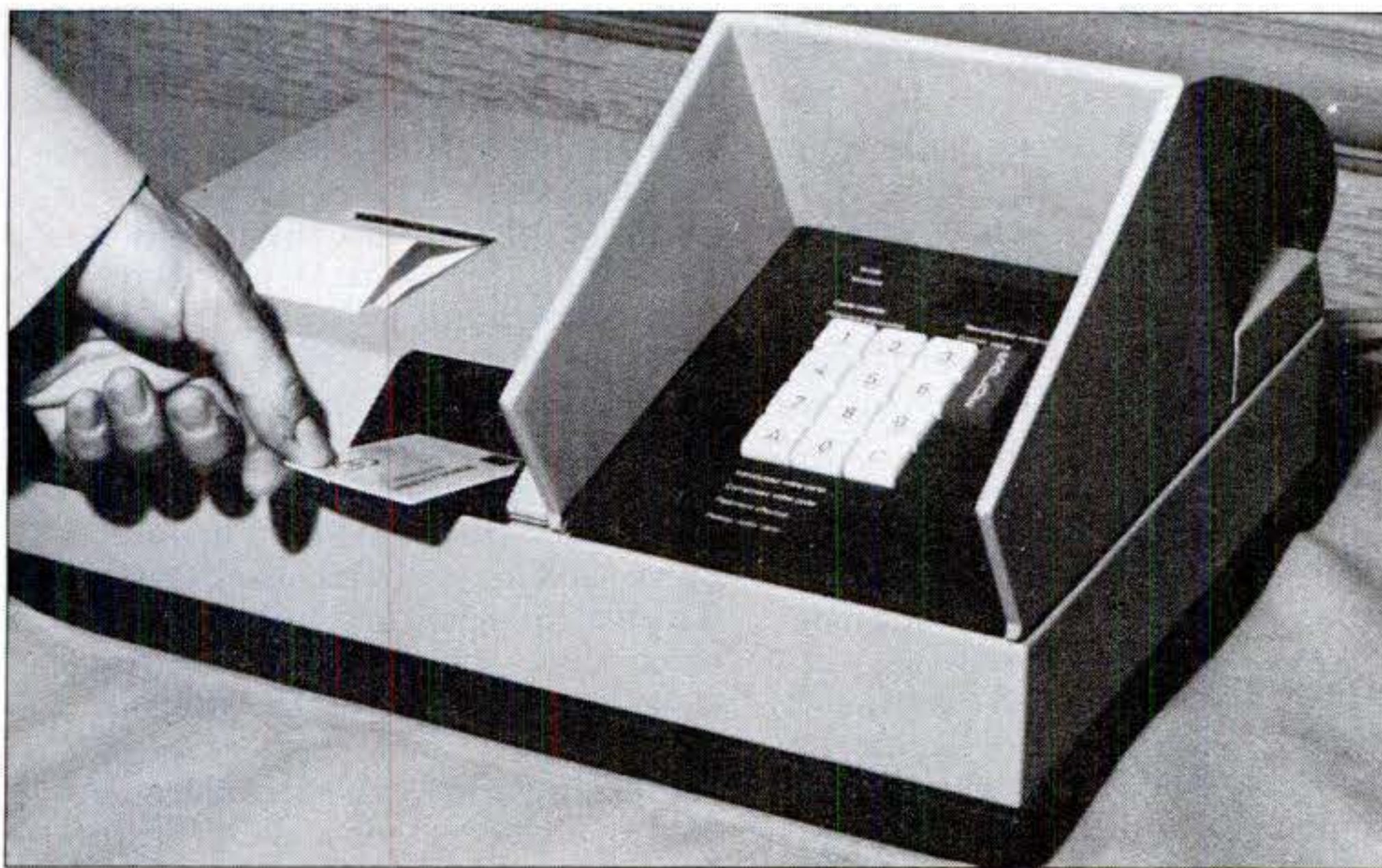
Bright hit the mark with Arlen Lessin, president of SmartCard International, a transactional-technology consulting company representing clients in the U.S. and overseas: "At Intelcom, I learned that these 'credit cards' were actually small computers that could be programmed to perform a variety of functions. It instantly hit me that here was something of great importance. In 24 hours I was invited to France to learn more about the technology; four weeks later to the day, I was made special consultant to Intelmatique."

Tests of the three smart-card varieties have been going on in selected French cities since early 1982. Twenty-thousand Honeywell cards and 200 point-of-sale card-reading terminals are in use in Blois, 50,000 Philips cards and 250 terminals in Caen, and 50,000 Flonic cards and 200 terminals in Lyons. Also, videotex tests using smart cards have been under way in three Paris suburbs for some time. About 450,000 cards have recently been ordered to expand these tests and participate in pay-telephone tests.

The cards all conform to the International Organization for Standardization's requirement for credit-card dimensions (85.7 by 54 by 0.8 mm, or 3.4 by 2.1 by 0.03 inches). The primary difference between them is in their circuitry. Both the Philips and Honeywell cards incorporate microprocessors: Philips uses an 8021 processor with 16K ROM, while Honeywell employs a Motorola 6805 8K microcomputer chip. Flonic's card has a simpler 4.6K chip that uses logic array to make calculations. Capacities range from 100 to 200 transactions, but larger memories able to store other kinds of information are promised as development continues. Overseeing this development is the International Assn. for Microcircuit Cards, based in Paris and consisting of banks from eight European countries and the U.S. In an effort to make smart cards multinational tools, the American National Standards Institute has established a committee to recommend international standards.

All the cards have nonerasable memory for security reasons, and the specialized procedures of each maker preclude the possibility of counterfeiting them. For further security, each card is programmed with a five-digit code, the customer's personal identification number (PIN). The holder must key this code into a terminal—power source for the card—before a transac-

Continued



Transaction begins when a customer inserts the smart card into a card-reading

terminal (card's power source) and punches his ID number into the shielded key pad.

Relive the golden age of the automobile with authentic metal replicas



Overall length, 5 3/8"

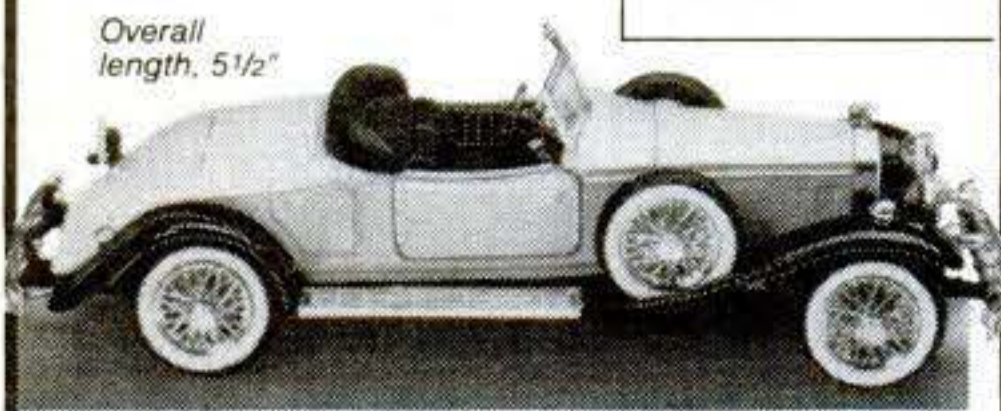
Rio scale model cars are not toys. They are carefully detailed automotive collectibles that faithfully replicate their originals. Each is imported from Italy where it is assembled by hand from over 70 component parts, and finished with a fine, oven-baked enamel. Many have doors, hoods, or trunks that open. They are rare tributes to the original automobiles that inspired them and are avidly sought by collectors everywhere.

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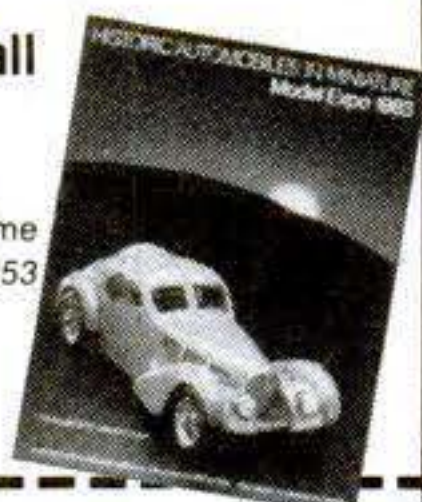
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Card with a brain

tion can take place. Enter a wrong code three times consecutively, as that pick-pocket did, and the circuitry fuses; the card is no longer operable. How secure are these features? Might a determined computer genius be able to break ID codes, for instance? Says Lessin, "It may be possible, but it would take millions of dollars in equipment and expert-personnel time, and the return wouldn't be worth the effort."

For the French point-of-sale tests, each card is assigned a monthly monetary limit. With every transaction the merchant first punches the purchase data into a terminal, then the customer inserts his card into the terminal and enters his PIN code. The reader terminal and smart card exchange secret protocols to ensure each is genuine. If all is well, the transaction is completed: The card subtracts the purchase amount from its memory, and the terminal records the exchange on a cassette and provides a paper receipt. At the end of the day the data on the cassette are transmitted to the bank.

Active versus passive

The smart card differs from other machine-readable cards in at least two important aspects: Its reader terminals are not connected to a central computer, and its memory can be divided into different levels of access.

Mag-stripe and laser cards are purely passive storage bins for data. Information can be magnetically encoded or, as with Drexler Technology's laser card, digitally etched onto reflective material. Both kinds provide access to on-line terminals (connected to a main-frame-computer system) and can record data. Smart cards actually perform functions. And although magnetic and laser cards are protected against unauthorized use by "password" codes, their security features aren't as intricate as the smart card's.

"In terms of accessibility of information," explains Lessin, "there are three zones in each chip card: a secret zone, inaccessible from outside and containing the maker's and issuer's codes; a confidential zone, in which information is available only to the card holder using the PIN code; and a free-access zone, usable without the code."

Why a free-access zone? "Say you fall down on the street and are taken unconscious to the hospital," says Lessin. "They don't know what's wrong with you, of course. But if you have this card and an emergency-room doctor can insert it in a reader and it tells him you have to have an insulin shot right now, he could save your life—without having to perform a series of tests to find out why you collapsed."

Of course, smart cards are expen-

sive—as much as \$20 each, though predictions say they'll quickly drop to \$5 in production runs. Mag-stripe types are only 60 cents apiece per million. But the smart-card system may be cheaper to install and operate than an on-line type because the terminals are cheaper and there need be no data-network costs. And therein lies a difficulty for smart cards.

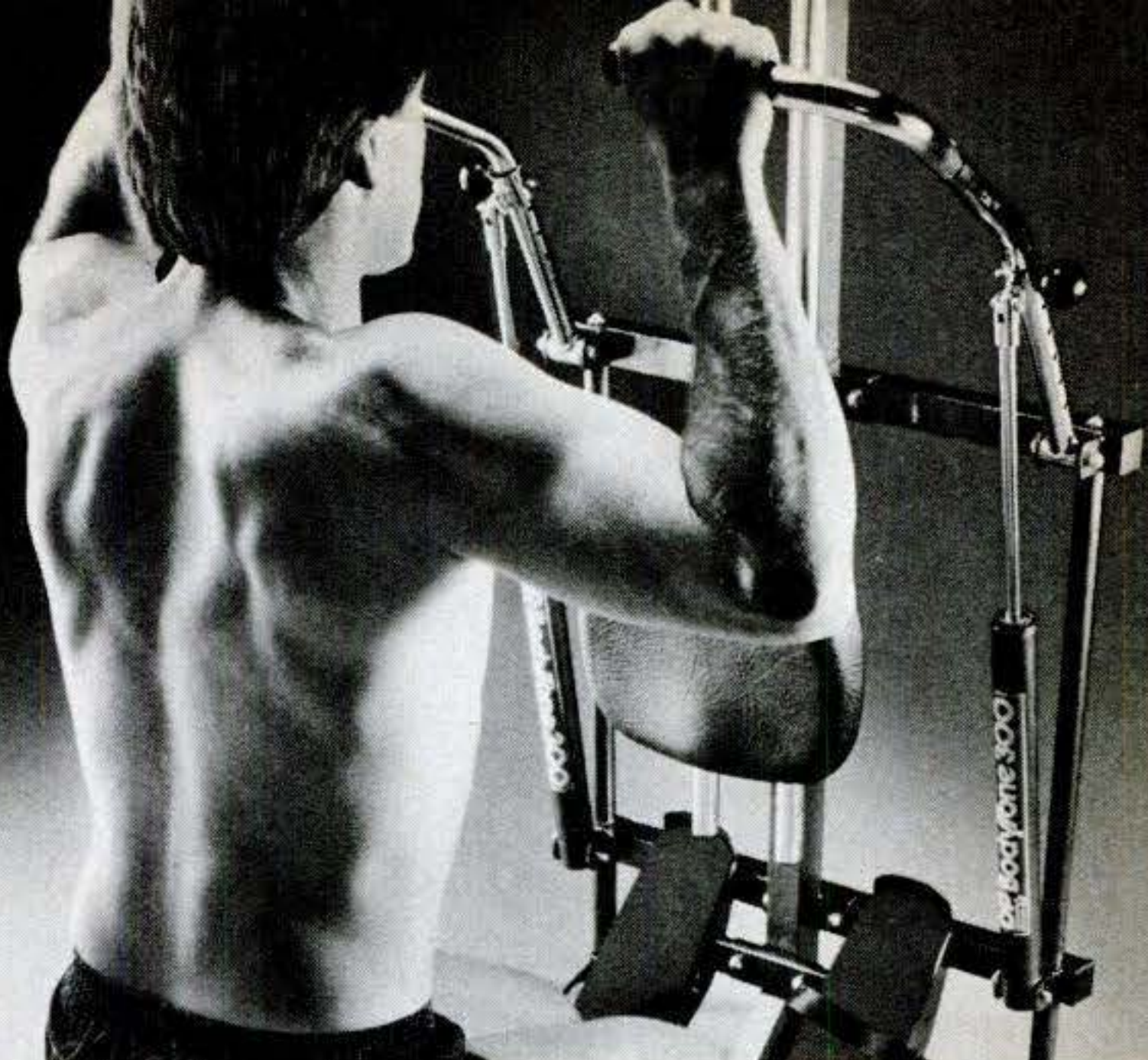
Most banking systems in Europe are off-line and check-based, and smart-card systems could cut down paper-shuffling costs. But banks in the U.S. may initially oppose using smart cards because they have massive investments in on-line systems. Consumers might also resist the new cards because they would lose the luxury of the "float" period between time of purchase and billing date.

Success of the smart card west of the Atlantic may depend on the outcome of U.S. tests like the one by First Bank Systems, Inc. (Minneapolis, Minn.). It has been under preparation for many months as part of a Teletel videotex home-banking trial [PS, Jan. '81]. Of the 300 videotex customers, "concern was expressed by a dozen farmers," says Roy Bright, "who objected to transmitting sensitive financial data. We'll provide smart cards and readers to ensure transmission security." According to Lessin, American Express and Chase Manhattan have also expressed interest in the smart card and are planning transactional and home-banking trials, respectively.

A test by the U.S. Department of Defense began this spring: The Philips card, various types of mag-stripe cards, and an infrared-scanning fingerprint-recognition system are taking part in a worldwide program called RAPIDS (real-time automated personnel ID system). About 3,000 smart cards have been distributed at Fort Lee (Petersburg, Va.) to be evaluated for use as both an ID card and PX point-of-sale payment vehicle. Success in this test would lead to an order for five to seven million cards in 1984, three million a year after that. The Department of Agriculture is also looking at the smart card—as a food-stamp replacement. At press time it was in the process of selecting a test site.

Despite the enthusiasm suggested by these tests, the smart card has yet to prove itself here. Critics have described it as technological overkill, a sophisticated solution seeking a problem, and it still must overcome the inertia of established systems.

But France has embraced the smart card and has great plans for its technological offspring. Extensive point-of-sale and telephone-toll-call tests there are barely the beginning. PS



The first home gym that builds more than half a body.

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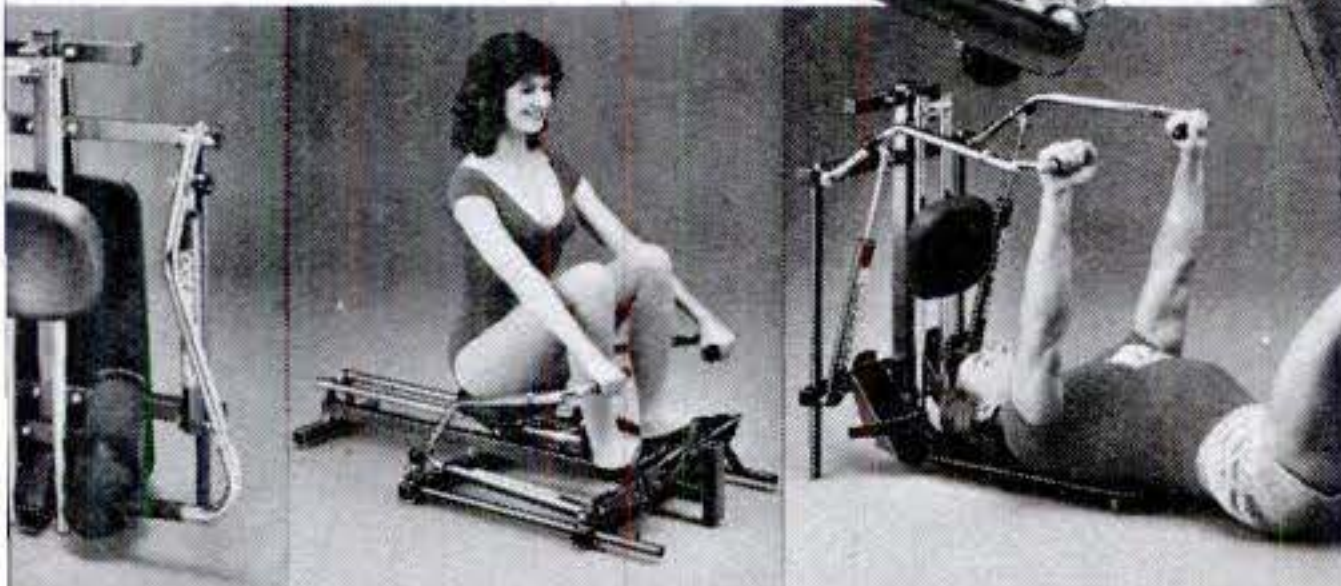
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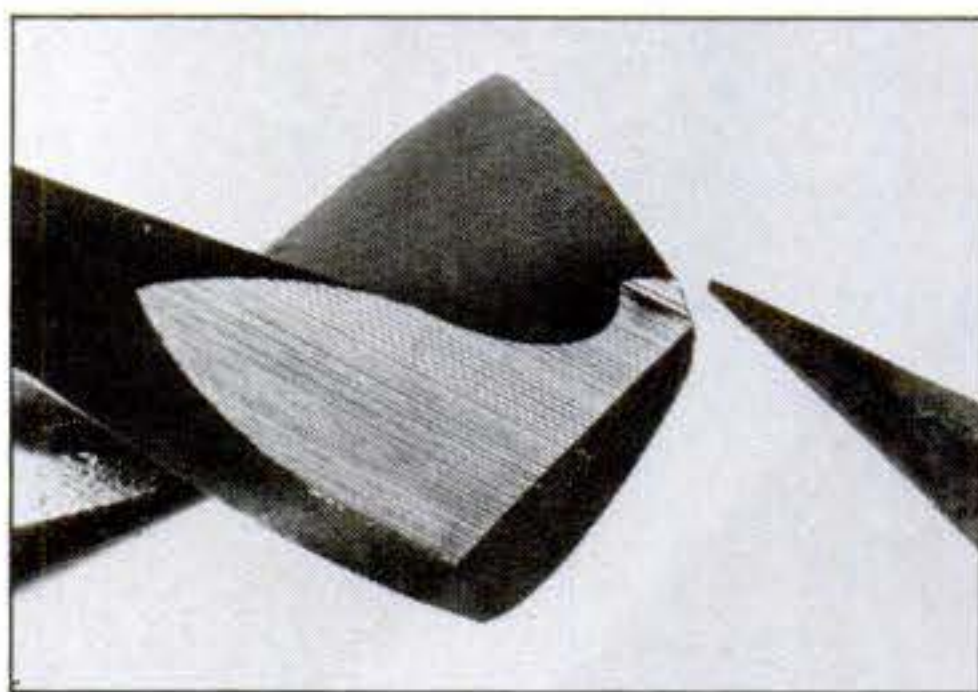
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Just when you think you know every imaginable type of bit, along comes another one. It's called the X-360 split-point bit. At first glance, it looks like an ordinary twist drill. But a closer look (photo) reveals an extremely steep secondary bevel behind the primary cutting bevel. This split point starts cutting immediately and prevents "wandering." You can start a hole without having to punch a starter hole, as I found by running the X-360s into oak, steel, and aluminum. Also, these bits chatter much less than ordinary twist drills, so they cut cleaner, rounder, more uniform holes than conventional twist drills.

The X-360s have "parabolic" flutes with extra-wide channels that clear chips much faster than other bits when drilling deep holes into hardwood. The maker claims they drill four times faster than twist drills, but I found they didn't do *that* well. Drawbacks? I'd hate to have to sharpen one.

The Credo Division of Omark Industries (2765 National Way, Woodburn, Ore. 97071) makes the X-360 in sizes from 1/16 inch (\$1.20 for two) up to 1/2 inch (\$5.95).—A. J. Hand

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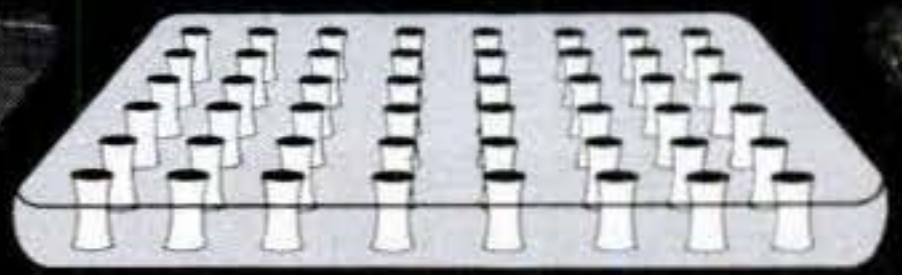
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LOOK AND LISTEN

By WILLIAM J. HAWKINS



While most recent advances in picture-tube design have concerned the screen, the COTY's secret is an overhaul of the electron gun—the component that creates and shoots the three electron beams that scan the screen to make an image. In a conventional gun (upper drawing, below left) each of the three beams passes through one hole. There, the beams are focused and bent by a magnetic field, as a lens would bend a beam of light, so they converge at precisely the same spot on the forward-mounted screen.

The closer together the beams are in the gun, the more precise the convergence. But the closer the beams, the smaller the electronic "lens," and any aberrations in the lens affect focus quality. In most present designs, the problem is controlled largely by giving each beam equal space within the tube neck.

In the COTY gun, however, the three beam holes are recessed about a half inch in a metal shroud that acts as another, larger lens (lower drawing). Now, aberrations in the smaller lenses are small in comparison with those in the main focusing lens. The three beams can be moved more closely together for better convergence with no loss in focus.

In numbers, beam spacing has been reduced by 23 percent, theoretically improving convergence by the same amount. But can you see the difference? In a recent demonstration, I could see a distinct improvement in picture sharpness in the COTY over a standard tube. In one scene, a truck license plate that was difficult to read on a standard screen was distinctly legible on the COTY. To me, that's the crucial test. But there's more.

The smaller beam spacing also means the yoke (a coil of wire around the neck of the tube that produces a magnetic field, which makes the electron beams scan the screen) needn't be as powerful. That means a reduction in the electronics required to control it. Result: higher reliability and lower cost—a saving of \$2 on a 19-inch set, nearly \$3 on a 25-inch.

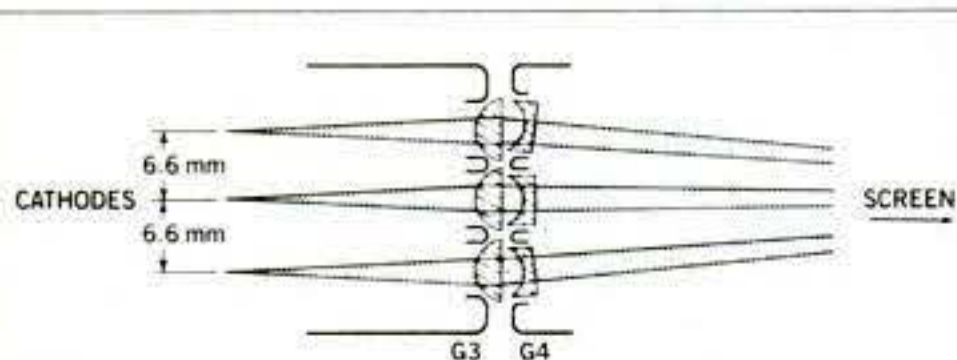
Jack Sauter, RCA Group vice-president, says the COTY tube "will soon be an industry standard." He's prejudiced, but considering that GE and Zenith have just bought the right to produce the tube, too, he's also probably right.

Sharper picture tubes

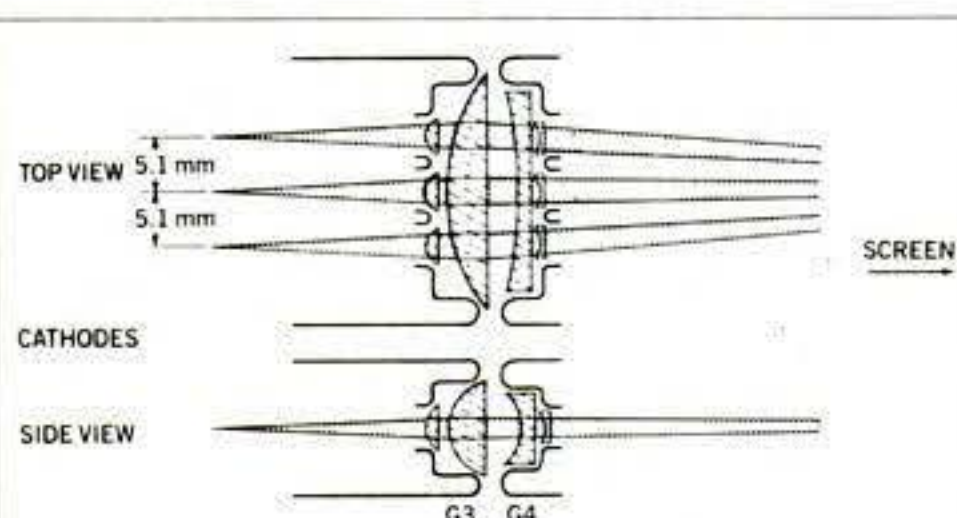
There have been many major changes in television design over the past years. We've come to expect solid-state-circuit integration that replaces hundreds of components, outlasts Johnny Carson, and gives us every convenience from instant channel selection to color lock.

Despite those marvels, the end result—a good picture—has still relied on the basic technology developed long ago: picture-tube design. That is, until now.

The picture tubes you see above will be included in some RCA TV sets for 1984. The color-tube design is called COTY-29, for Combined Optimum Tube and Yoke with a 29-mm-diameter (1.1 in.) neck. That's a mouthful, but it basically means these tubes produce a sharper picture, use less power, and are cheaper to produce than conventional picture tubes.



Optical analogy of main lens in present gun



Optical analogy of main lens in COTY-29 XL gun

Quick looks

Now that you may be watching TV on a new tube, what will you see on it? Here are some looks into the near future:

- The first *interactive* capacitance videodisc player will be available shortly from RCA.

- If you own a Channel Master backyard dish for satellite reception, now you can get stereo off the "bird" with the company's Stereo Processor box. It's \$359.

- Finally, if you feel like saving the world, you can prevent a nuclear catastrophe with Parker Brothers' new "Reactor" video-game cartridge. And if you still want to save your kids from video-game addiction, think again: According to an Atari survey, the typical video player is a well-adjusted male teen-ager who maintains at least a B school average. **15**

Grease-eating bacteria unclog sewers

Fast-food restaurants and many industries often create a special problem: grease. Grease buildup in sewer lines can be tough to clean. Maintenance workers can remove grease clogs with augers and caustic chemicals. But it's nasty, costly, sometimes hazardous work.

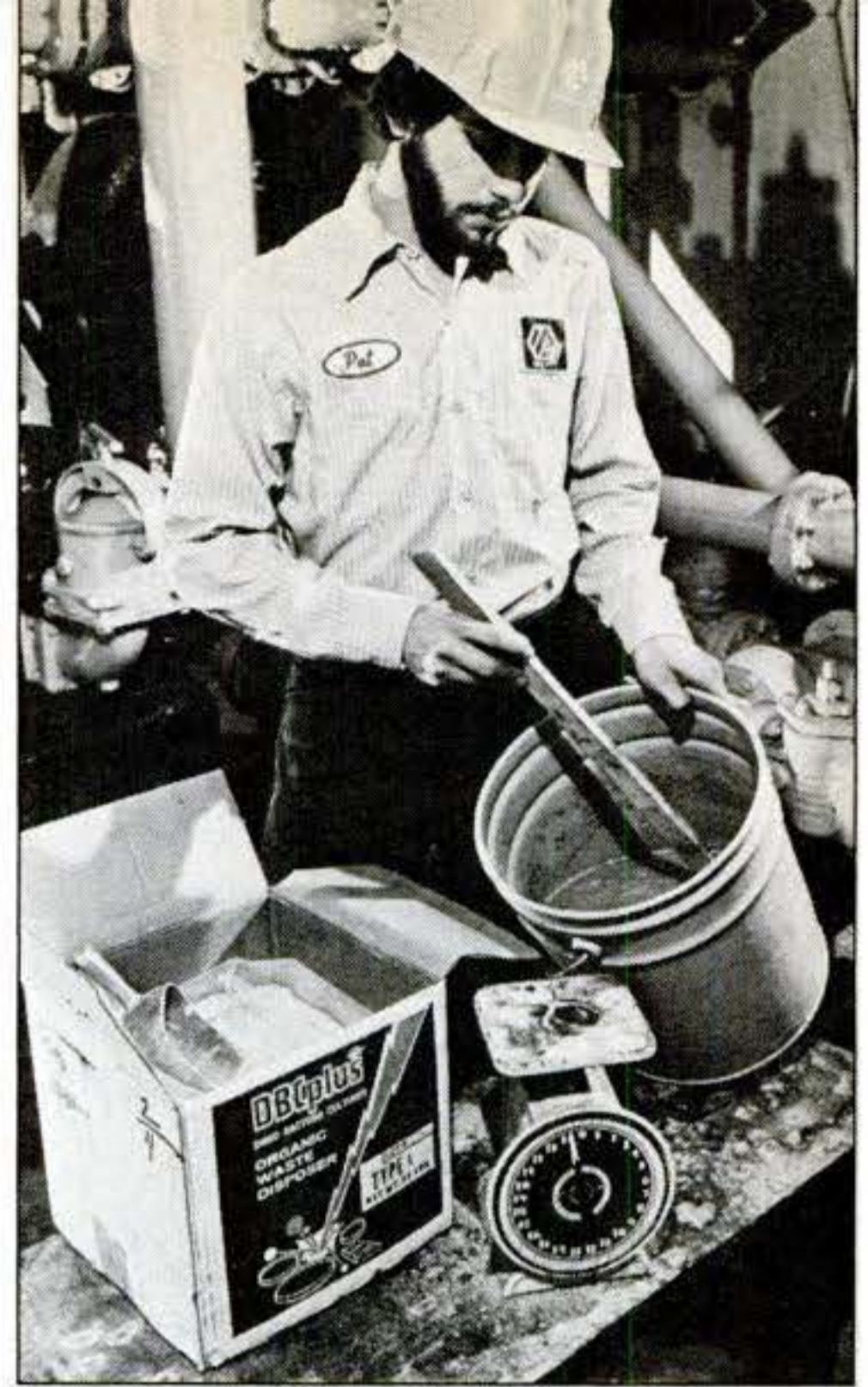
These days, sanitation engineers are turning to a simpler cleanup method: bacterial cultures that gob-

ble up grease. One firm, Flow Laboratories, Inc. (Inglewood, Calif. 90301), markets various types of bacteria spores in the form of a dried powder. (A one-pound package for home use costs \$12.)

The powder is mixed with warm water to form a slurry several hours before it's used. The liquid can then be added through a manhole cover upstream from the blockage. The bacteria consume enough grease to free the clog.

At one site in New York City, the auger method cost \$875 over a six-month period, compared with \$300 using bacteria at the same location.—*John Free*

Bacterial-spore powder is mixed with water and added to clogged sewer. Cold water in sewers slows unclogging.



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"SAY, SMOKEY—"

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

The seven-year match

I get only about 11 mpg locally and 14 mpg on the highway with my 1975 Chevy Blazer with a 250-cu.-in. engine and three-speed manual transmission. The 1982 EPA figure is 16 mpg. Is there any way I can upgrade my truck to match that? Is it worth the money to replace the carburetor with an economy type?

Ronald Nave, Horsham, Pa.

The carburetor change by itself won't get you the mileage you want. You'd need a new cam, manifold, and exhaust system—as well as an ignition-timing-curve change. Start with Crane's cam package (Crane Cams, Fentress Blvd. and Indigo Dr. N., Daytona Beach, Fla. 32014), and evaluate from there as to cost versus the gain in economy.

Old mechanic's tale?

I have heard that radial tires shouldn't be switched from one side of the car to the other because they will be damaged. No one has ever explained to me how this damages the tires. Is this true or is it just an old mechanic's tale?

Dave Frick, South Bend, Ind.

It's true. The reason is that the rubber pulls against the steel in one direction and gives slightly. When you switch the tires to the other side of the car and they are pulled in the opposite direction, the steel and rubber separate and get hot from friction when driven. This sets up a chain reaction that further loosens the steel belts from the rubber. The out-of-balance condition and heat buildup cause tire failure. It's also true that this isn't as bad now as it used to be.

Pay the price

My 1982 Subaru wagon knocks under load, and mileage has dropped from 37 to 30 mpg. I've checked all the usual items but found nothing. I've been told I should use premium unleaded gasoline. I hate to pay the extra cost unless I know it will help.

George Seifert, Cannon Falls, Minn.

It will help. This is another case of an engine built to the borderline in terms of octane requirements and available fuel. With its complex ignition and carburetor systems, only a genius can handle it—and then only down to about 89 or 90 octane.

Trailer limits

Car dealers tell me that no unit-body car should tow a trailer weighing more than 2,000 lbs. I've towed 1,500-to-2,000-lb.

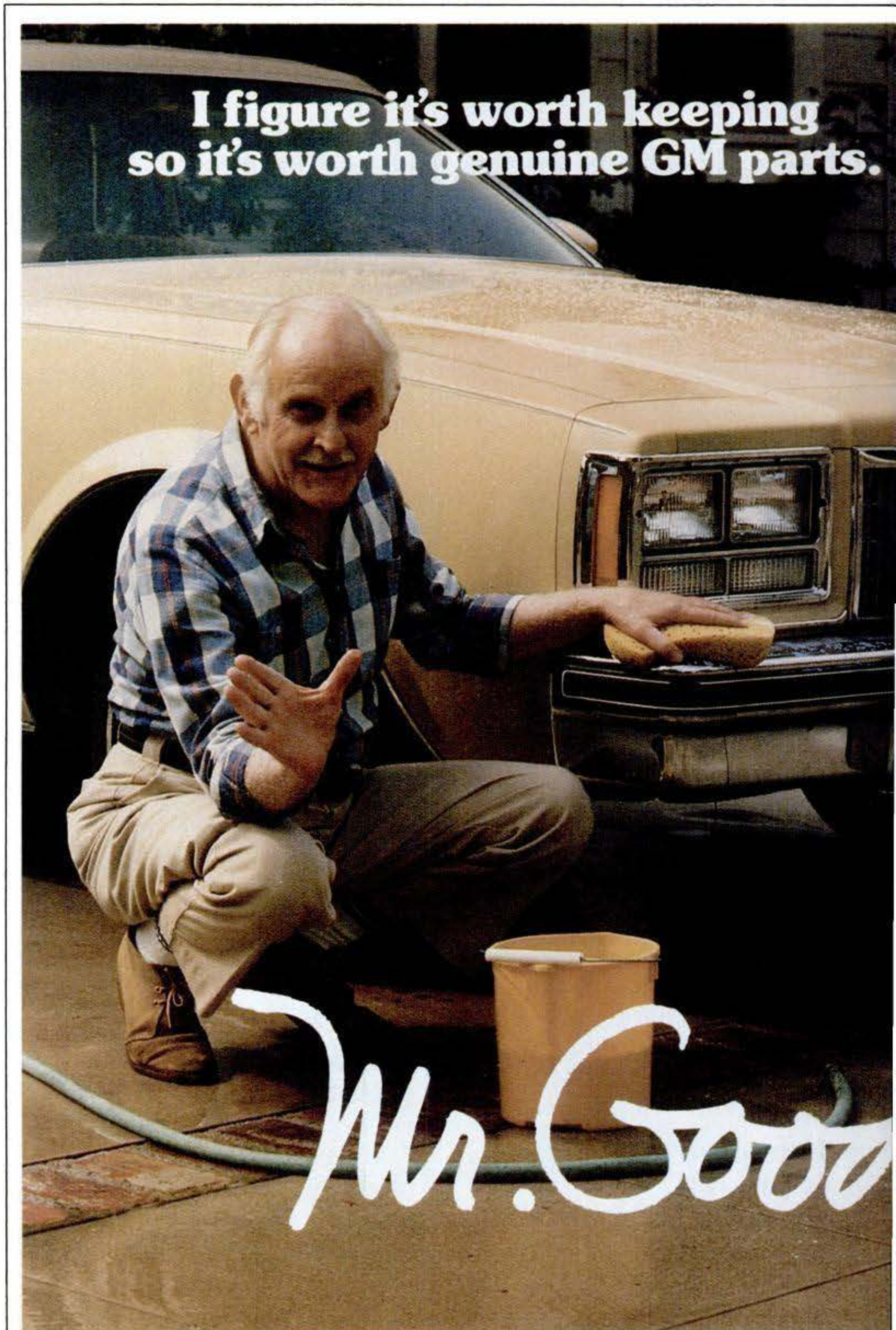
loads with my 1975 six-cylinder Granada, and I now want to buy a large sailboat with a trailer weight of about 2,500 lbs. If I get a 3,000-lb. load-carrying hitch, would it damage the unit body? If it's true that only body-frame cars can tow more than one ton, what does this mean?

John Martin, Des Moines, Iowa

For a 2,500-lb. tail I recommend at least a 3,500-lb. dog, and yours is smaller than that. Today's and tomorrow's cars will not double as trailer pullers. It appears that a special vehicle will be necessary. The unit body is strong, but there's no way to attach a pulling arrangement to spread the load. Big house trailers are already being sold by people who used to pull them with big cars, and heavy boats and mid-size trailers will be next. There are still a few choices left, and since everybody leases and rents everything these days, it might be cheaper and less trouble to do that than to drive our own hefty vehicles around.

Highway whiner

My four-cylinder, four-speed 1980 Chevy Citation sounds as if the engine has a high-speed whine at 55 mph. Fourth speed is a



0.81 overdrive with a 3.34:1 axle ratio. Is there an overdrive adapter for this car that I could install?

William Reepmeyer, Cohoes, N.Y.

Don't do anything. Check fourth gear with a tach, and you'll find the engine's not turning that fast. Larger tires would help, but you're going to lose performance.

Curing the shakes

As a certified mechanic at a large Honda dealership, I've learned of a couple of fixes that may cure Hondas of shake problems. We've found many wheels to be somewhat out of round; by mounting the high spots of tires and wheels opposite each other and spin balancing, we can correct the shake. Also, if the brakes pulsate so the steering wheel shakes, check the parallel-

ism of the front rotors. If necessary, regrind or machine with a rotor grinder that mounts on the car.

Daniel C. Brown, Oxford, Pa.

Thanks for your help. There seem to be an awful lot of people with these problems.

Mothball that idea

I've been told that in the 1920s and '30s some race drivers put mothballs in the gas tank for added zip. Would this work with today's unleaded gasoline and catalytic converters?

Hugh F. Foster
West Bloomfield, Mich.

Try it for a year and let me know how much it costs to clean up the system and straighten out the mess. The real answer is, don't do it. I'll get a bunch of letters from

old-timers saying it sure worked in the Model-A. But there was no fuel pump, the tank was above the carb, and the fuel line ran about two feet to a carburetor with about 10 parts.

It's not that simple

Ever since it was new, my 1976 Buick Regal V6 has sputtered, backfired, and sometimes died, occasionally at low speeds but mostly at highway speeds. When I start it up again, it's okay. They tell me that the fuel pump is fine, but there's a stoppage somewhere in the fuel system. No one can find it.

Robert Micals, Freehold, N.J.

When an engine is lean and lacks fuel, for whatever reason, it will spit through the carburetor and actually burn in the carb and air cleaner. Backfiring out the exhaust, as a rule, is either firing out of time or an open exhaust valve. The area to check for lean trouble is the pickup inside the tank and the tank venting. For firing out of time or intermittently, look for a cracked cap or rotor, coil trouble, moisture in the distributor, or incorrect voltage to the coil because of grounded wiring in the ignition's primary circuit. Some of the weird causes are a plugged or collapsed exhaust system, defective EGR that dumps in exhaust all the time, and an unvented distributor cap that allows oil or water film and ozone buildup, causing the spark to go everywhere. Sticky valves or bad hydraulic lifters can also cause it. The time to check is when the problem occurs.

The view from Daytona

I've run into two views on tire balancing. Some say static balancing is best; others say dynamic [spin balancing] is a must. What do you say?

John McKiernan
Chesapeake Beach, Md.

In my opinion, spin balancing on the car is best.

Converting the converter helps

I tolerated a year of poor performance from my 1981 229-cu.-in. V6 Monte Carlo and finally went in for what I thought was transmission trouble. The GM dealer knew immediately that the catalytic converter was bad and said they were changing from a two-layer to a one-layer type. Now, after the change, the car performs so well it's like a different automobile.

Lyle D. Haynes, Seattle, Wash.

Thanks for the report. I'd suggest to owners of GM cars with three-way converters who experience stalling and poor performance that there is a strong possibility their problems can be cured in the same way.

Got a problem? Send it to: "Say, Smokey—," POPULAR SCIENCE, 380 Madison Avenue, New York, N.Y. 10017. All letters are read, and those of widest interest are answered in this column. Due to the large volume of mail, Smokey cannot reply to letters that are not selected for publication.

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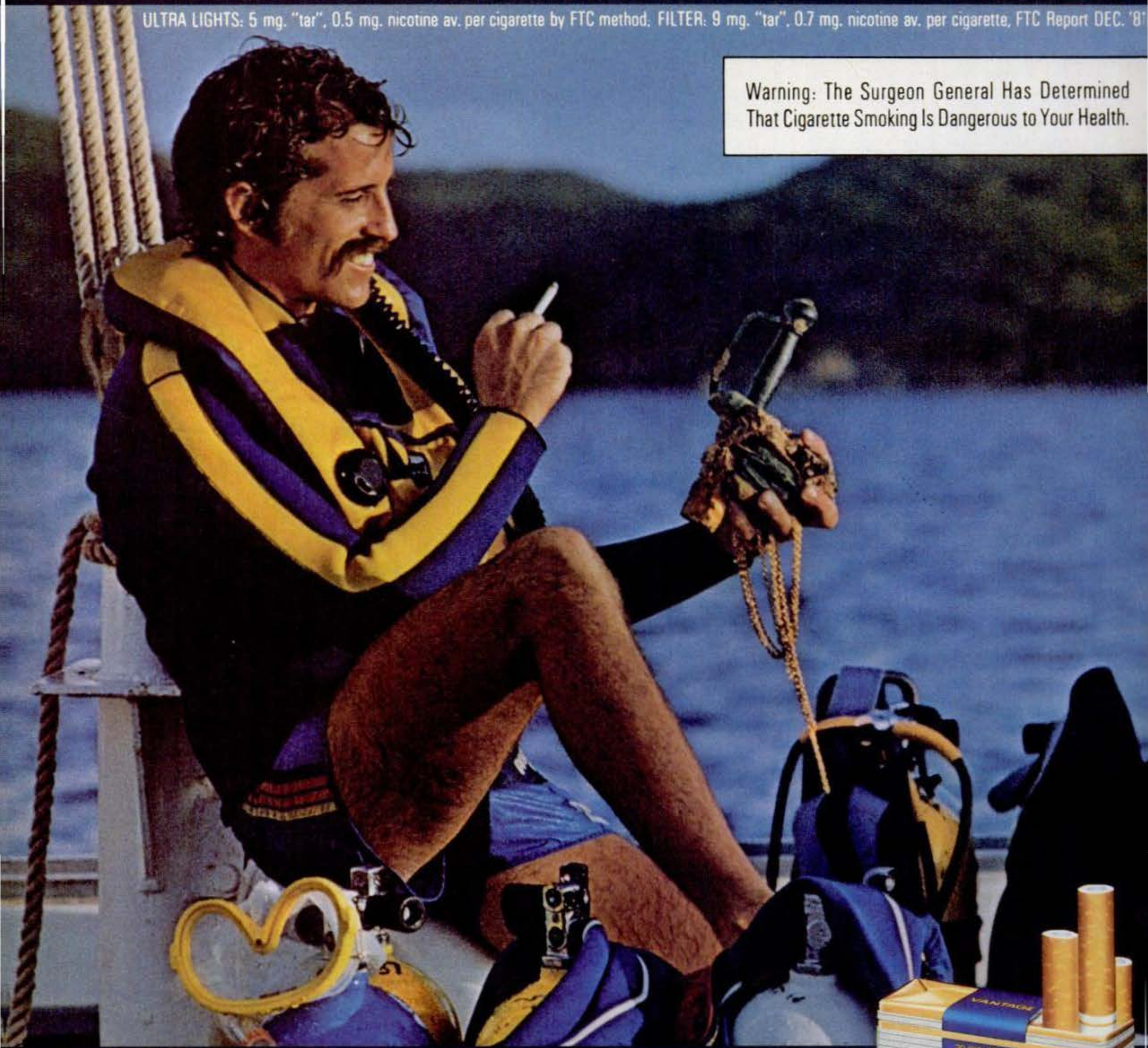
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SHOP TALK

By AL LEES

Living with waferboard

I'll bet a few eyebrows are raised over this month's color feature on waferboard as the workshop-project panel of the future. Most readers have probably encountered these panels only as boarding around construction sites, as sheathing on new homes, or as pre-cut parts for yard buildings like the storage-shed kit in the photo below. (It's from Handy Home Products, Box 548, Walled Lake, Mich. 48088.)

But for *indoor* projects? Especially one with which you'll be in close proximity, such as a headboard? Aren't manufactured panels involved in recent concerns over indoor pollution?

With the federal ban on urea-formaldehyde-foam insulation, many consumers became "sensitized" to outgassing from other products—as I predicted in my October 1982 "Shop Talk." And there *have* been cases (particularly within the tight confines of mobile homes) where outgassing from wall paneling and particleboard cabinets contributed to high formaldehyde levels. So how about this new waferboard?

I had a personal interest in researching this question: As this issue goes to press, I'm putting the finishing touches on a major PS home-improvement project constructed almost entirely of waferboard. It's a partition cabinet for a Murphy bed flanked with wardrobes (closed with accordion doors) and topped with storage compartments. The initial shopwork on it was handled by Ro Capotosto, four of whose step-by-step photos appear in this issue's feature, since they're of a general nature. We'll publish his project photos—plus complete plans—in an early-winter issue. Meanwhile, I'm sleeping in this alcove of waferboard every night. I wanted

to be able to assure PS readers that these panels presented absolutely no health hazard.

So when I found that a special sealer had been developed for particleboard, I tried to obtain some, assuming it would seal waferboard as well. But it turned out to be an industrial product, sold mainly in 55-gallon drums. I persisted, and was finally told by a distributor that he'd let me have a five-gallon pail if I made a 180-mile round trip to his warehouse to pick it up—with \$75 cash in hand. Anything for research! But when I arrived, the magic potion wasn't available.

The manufacturer, Degraeco Coatings, is a division of Valspar; I went to the top and was finally supplied two precious quarts of No. 50100 clear particleboard sealer. It turned out to be water-thin but white in the can. Using it is rather like brushing on skim milk—a feature that helps you check where you've already brushed. The white streaks begin to fade in seconds. The sealer dries in minutes (less in the more absorptive areas of the chips) to a low, uneven sheen.

If you're leaving your panels natural, you'll probably prefer the more even coating of a low-luster urethane varnish.

My final research (reflected in my article) indicates that special sealers aren't needed for waferboard, which is manufactured with *phenolic* resins instead of the urea-formaldehyde types used for particleboard. Ironically, particleboard, which is made only for indoor use, is the panel to be wary of if you are sensitive to formaldehyde. If you should *want* to seal uncoated particleboard and can locate a distributor who'll sell you a sensible quantity of Degraeco's 50100, I can tell you it's a water-base sealer that sets up as a rubbery membrane, cures ful-

ly in three days, and can then be coated with either oil- or water-base paint—or, of course, left natural (it comes in fruitwood and walnut tones as well as clear).

And speaking of natural finishes, I was surprised when I was shown (in Louisiana-Pacific's Portland, Ore., offices) that marble effect you'll see in my waferboard article. I've not had the patience to try this heavy-sanding trick; I've found the surfaces of waferboard panels resistant to sanding. Most finishes wouldn't really require any sanding, except that in the manufacturing process you often get spatters of wax burns on the good face, and these aren't easy to remove *without* power sanding. Then, on the back face, the manufacturing plant insists upon large brand stampings in ink. Again, power sanding is the only means of removal. I usually *paint* the back face—it's faster, even though the rough surface makes good coverage a rather tedious chore.

If you do want to try for that marble look, L-P tells me they sand away the sharp wafer outlines, then seal the surface with a lacquer-based sanding sealer to raise the wood fibers. A light sanding trims off this fuzz and makes the surface mirror-smooth for two coats of a good high-gloss urethane varnish.


The following items were contributed by other members of the PS staff, senior editors Elaine Smay and E. F. Lindsley, respectively.

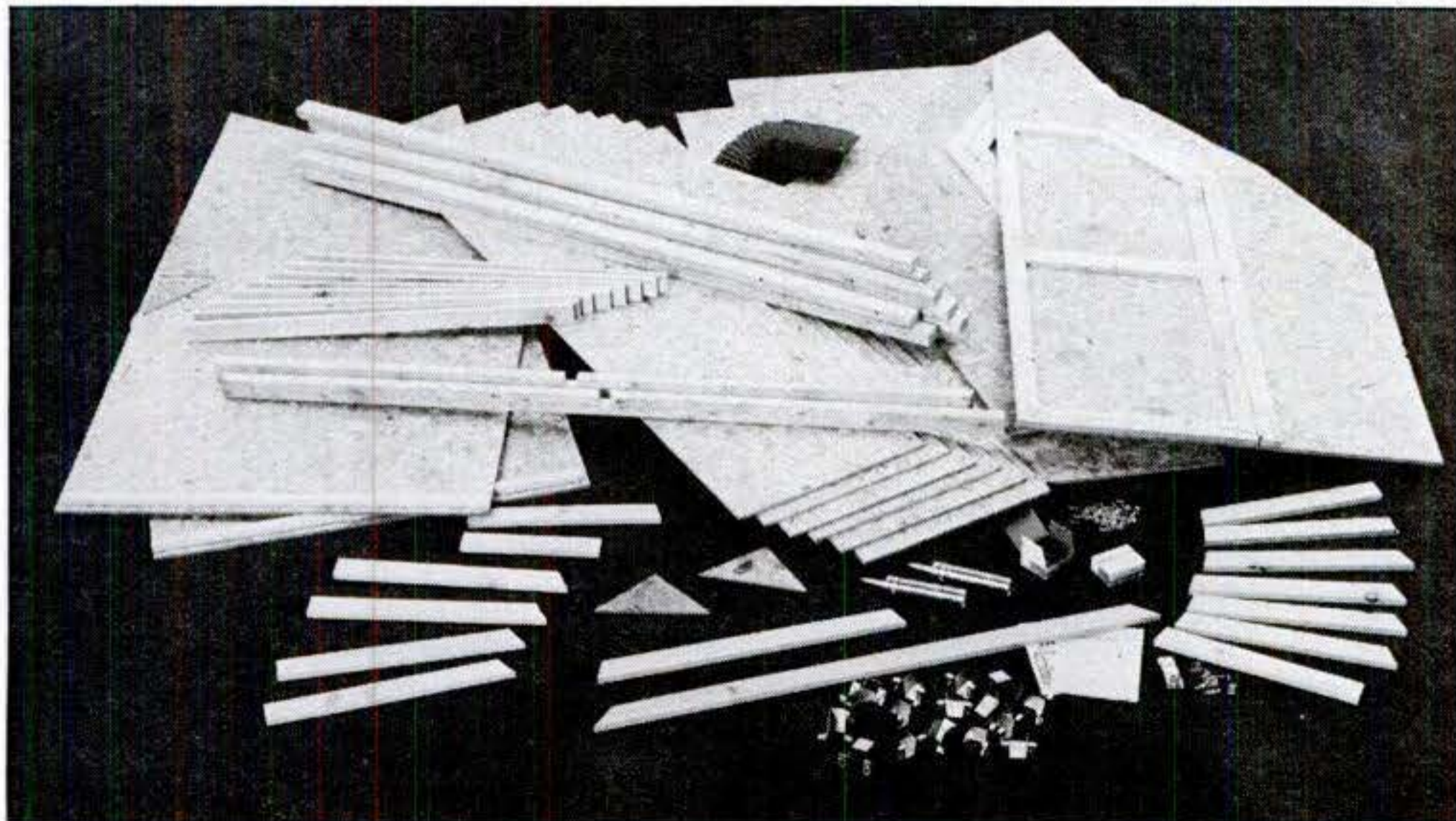
Reader's guide to solar

"If you're about to head for the library to research some aspect of solar, wind, or other form of alternate energy, you may want to start with the 'Solar Index.' It's a 78-page bibliography of articles on alternate-energy subjects printed during 1982 in 14 periodicals, including PS. Articles are listed under subject headings (more than 300) ranging from Absorber to Wyoming. This latest edition, compiled by architects Jerry Moore and Richard Heine-meyer, is the second in the series; the first lists 1981 articles. If you want your own copies, they're \$18 each from Solar Index, Inc., Box 6933, Denver, Colo. 80206."

Low-head hydro data

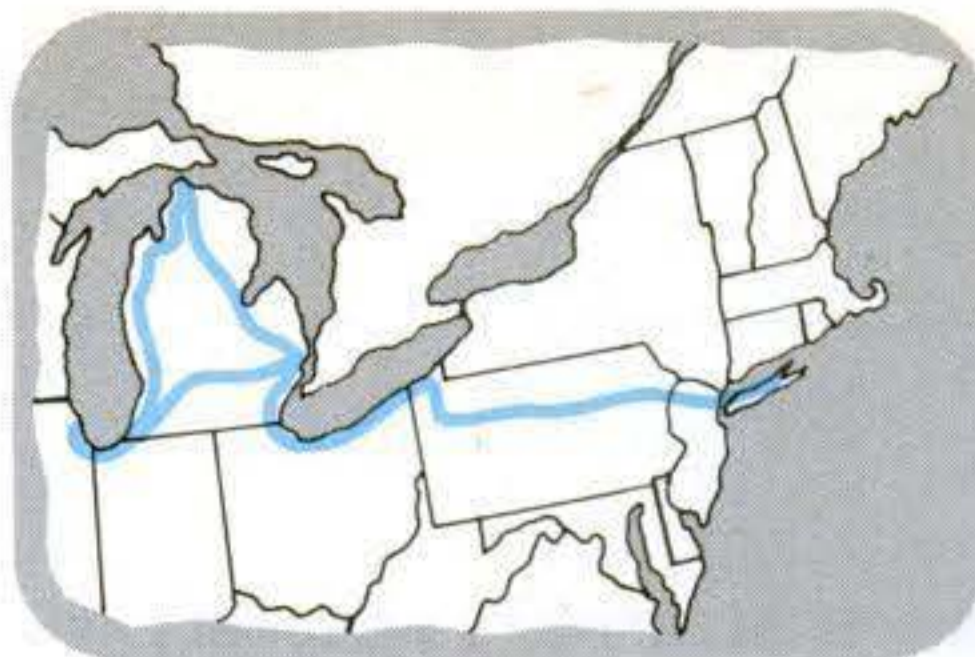
"Interest continues unabated in personal hydropower, judging by reader letters. The most common question: 'Where can I get information?' The information sought runs from how to evaluate a potential hydro site to what power can be expected from each type of equipment.

"Mike Johnson, of Little Spokane Hydroelectric, has been experimenting with, building equipment for, and installing hydro rigs for years. He's got it all for a high-head hydro site, but many hydro enthusiasts just don't have access to a mountain stream. Thus, his latest literature is especially interesting since he has had great success with sites having only 5.5 feet of head. This requires an entirely different turbine setup. An information package is available for \$3 (to cover printing and mailing) from Little Spokane Hydroelectric, Box 82, Chattaroy, Wash. 99003." 



PS 3,000-MILE TEST

CHEVROLET S-10 BLAZER



GM's baby 4×4 is compact, comfortable, and fuel efficient

By JIM DUNNE

Detroit's recent love affair with smaller, more-fuel-efficient vehicles is having an impact that extends into the small-truck field. But the benefits of the new designs extend beyond fuel economy. After 3,000 miles of driving a handsomely equipped \$15,000 S-10 Blazer on a variety of highways and off the road, I came away convinced that, whatever the original reason for bringing them to market, the smaller packages are much more desirable to drive than the full-size Blazers, Broncos, Jimmys, and Wagoneers. The compact body lines, big-truck drive trains, and full complement of convenience and comfort items match almost all the features of their bigger brothers. And they offer a bonus or two the big boys can't touch.

First: fuel economy. The four-wheel-drive baby Blazer I tested was equipped with the 173-cu.-in. V6 engine, four-speed automatic overdrive transmission, and over-wide 15-inch tires. The combination encompasses all the premium drive-train options that Chevy offers. At first check, I got just over 17 mpg. That was in mixed highway-and-city driving, with the emphasis on highway cruising. At 3,000 miles, though, economy im-



proved and settled near the 20-mpg level. Based on experience with the full-size V8 Blazer, the improvement is about five mpg, or 33 percent.

Don't expect the same kind of service from the V6 engine that the V8s provide in the bigger Blazer, however. Although the V6 is the biggest engine offered in the S-10, it lacks the muscle of a V8. Frequent downshifts are necessary because of the lack of power and the tall (0.7:1) overdrive gear in the transmission. This allows the engine to run at its best speed for fuel economy—a startlingly slow 1,700 rpm at 55 mph—but leaves no power reserve for high gear.

Off-road is another story. Just shift the transfer-case selector lever to four-wheel-drive low, and you get plenty of lugging power. A new transfer-case shift mechanism allows the driver to move from two- to four-wheel-high range without stopping the vehicle. However, to shift to the four-wheel-low range, you must stop.

The S-10 Blazer body has a split

rear gate—a swing-up window and swing-down door. The arrangement makes for more floor space for long loads. One major problem is the placement of the spare tire. On the test Blazer, the tire was too big to fit on one side in the rear compartment, so it was stored on the floor—smack in the center of the cargo space (see small photo). Check with aftermarket suppliers for an outside rack to solve this problem.

Another problem is rear-window dirt. Air currents pull road scum up onto the window in both wet and dry weather. Keep a glass squeegee handy and expect to use it often.

S-10's light weight can be a disadvantage for duties such as snow plowing or big-trailer towing. Its curb weight is in the 3,150-pound range, or about 1,200 pounds lighter than the full-size Blazer. The S-10 Blazer is rated to pull a 5,000-pound trailer or use a 6½-foot-wide snowplow; that's 1,000 pounds less and a foot narrower than its predecessor.

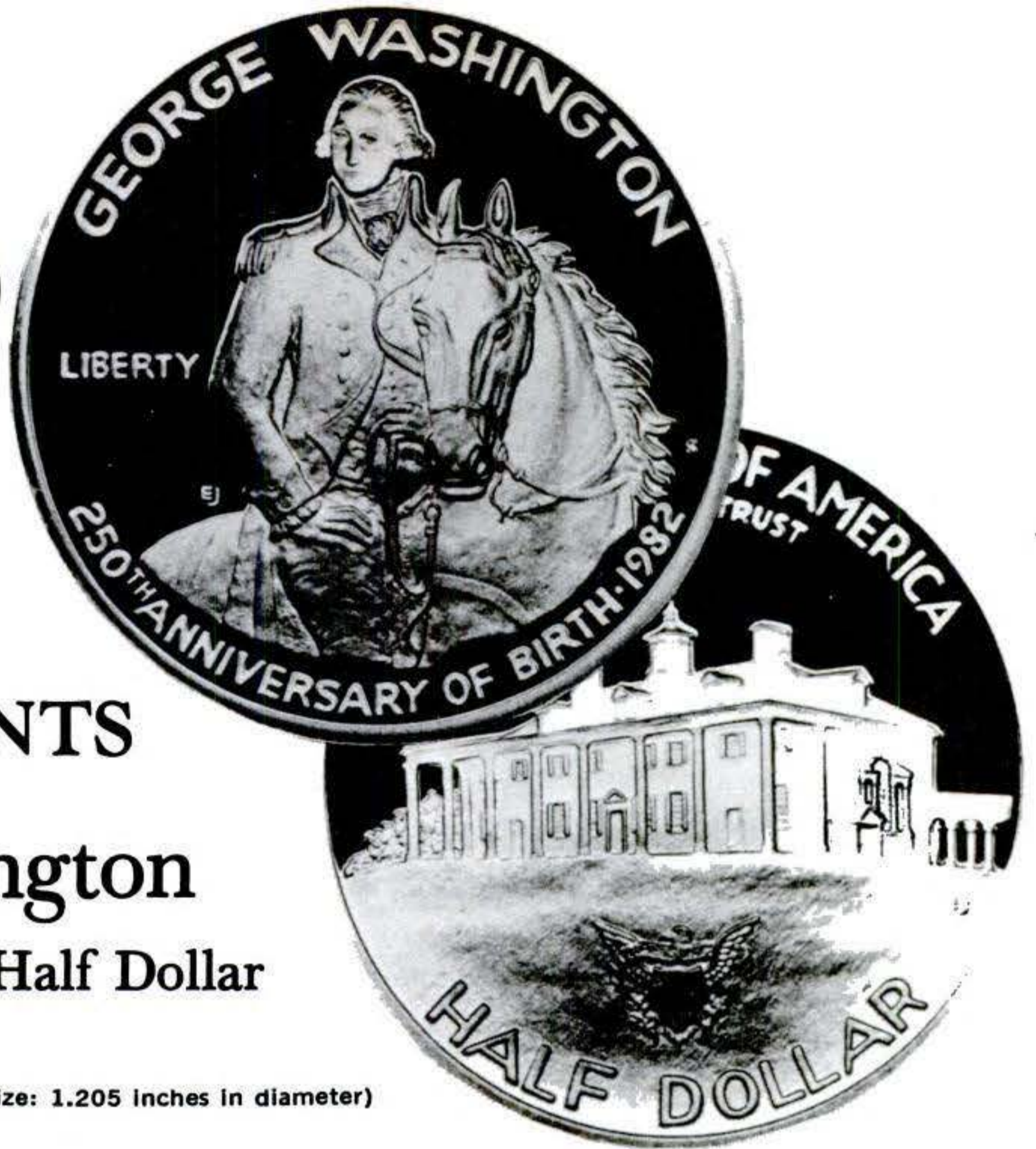
Blazer's designers apparently spent as much effort on passenger and driver comfort as on utility. Inside, there is generous seating room for four passengers; five can be squeezed in. Headroom is excellent for all passengers, and legroom is as good as you'll find in the largest sedans. A quiet interior, even at highway speeds, and a smooth, controlled ride on level roadways are comfort touches that are closer to those of a sedan than of a truck.

But on bumpy roads or over uneven pavement and rough trails, the body does a lot of fore-and-aft bouncing that can be uncomfortable. Chalk this up to the firm springs and short wheelbase. Overall, though, it's much better off-road than you'd expect from its civilized ride and appearance. It will tiptoe down steep slopes and scramble out of ditches with the agility of the best of the four-wheelers. Stop and shift it into four-wheel low when the going gets sticky: It takes on deep beach sand and loose gravel at a surer but only slightly slower pace.

S-10's small size has other bonuses that full-size 4×4 owners will like. The driver can reach across and unlock the right-side door or even adjust the right-side mirror without leaving his seat. Parking is easier. With a total length of 170.3 inches (a full 14 inches shorter, bumper to bumper, than the full-size model), the baby Blazer is as short as some of the smallest subcompact cars and will fit in just about any parking space. And with a six-inch-shorter wheelbase it turns around easily inside the curbs of most city streets. **5**

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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 University of Colorado.

Re-roofing for R-value

We will be re-roofing our existing, uninsulated, asphalt-shingled roof with cedar shakes. Is there a product we can use to lay over the existing roof that will increase the insulating value?

W. Meyer, Jerome, Mich.

Insulating a roof is a very effective method of reducing heating and cooling bills. However, it is not the simplest of energy-conservation retrofits. Here's one approach that will get you close to an R-30 roof:

Remove the old shingles and install a vapor barrier over the original sub-roof. Toenail or strap an on-edge grid of 2x4s onto the sub-roof. Then install 3/4-inch-thick polyisocyanurate foam, cut to fit tightly within the grid. Press the insulating board down firmly against the sub-roof, leaving a 1/4-inch air space above the board for ventilation. Next, nail new sub-roof (plywood, for example) to the 2x4 grid, and install the shakes and the special size of roofing felt used with shakes. Use new flashing as appropriate.

Make sure that the ventilation space above the insulation board is supplied with outdoor air via soffit vents, fascia vents, or a small air gap behind the gutters. The vent air will exhaust through a ridge vent (see article this issue) or fascia vent, depending on roof design.

Cooling a trailer

I live in north-central Florida in a 20-by-40-foot double-wide manufactured house. The manufacturer has placed very small louver vents near the roof. Would two wind turbines placed in the center of the roof help keep the inside cooler for air conditioning?

Lawrence Osgood, Ocala, Fla.

Wind turbines placed on the roof of your home will be counterproductive since conditioned air would be exhausted through the turbine. When air-conditioning a building, the minimum exchange of outdoor with indoor air should occur. However, when the air conditioner is not operating, wind turbines would help dissipate heat from the living space.

Condensation defenses

I recently had blown-in cellulose insulation placed between the studs of my brick-veneer frame home. The energy saving is already noticeable, but I'm worried about humidity and condensation. Will enamel paint or vinyl wallpaper help this situation?

Mike Barrett, Franklin, Ohio

I agree that you may have a problem with moisture. There are some vapor-barrier paints you can use. Two water-base ones are Glidden's Insul-Aid and Enterprise Companies' Thermo-Paint [PS, April]. Some other measures you can take are as follows: Control moisture sources by ducting the clothes dryer and kitchen and bath fans outside and by covering the crawl-space ground with a poly vapor barrier. You may even want to run a dehumidifier controlled by a humidistat. As a last resort, you could install a vapor barrier on the inner surface of your wall and then refinish. But this is not a trivial job.

Inside heat pump

Is it economical to use a self-contained heat pump (designed for inside installation) for domestic hot water? Several articles I have seen on such units tout the increased efficiency of the heat pump compared with resistive heating of water. I suspect that this is valid on a cost basis as long as the source of heat is "free" (such as outdoor air). I also suspect that if you put one in a basement where the heated air is not "free," there would be quite an increase in the household heating bill.

John Hohl, Binghamton, N.Y.

You are correct. Interior-type heat pumps used for water heating will increase the space-heating bill. However, if space heating is fueled by gas—which is usually less costly than electricity—this approach may still be economical.

Covering outside insulation

I have insulated my basement walls from the outside with Styrofoam and must now coat the insulation to protect it from the sun. I understand that there are trowel-on-type materials, but so far local lumberyards have been unable to help.

Paul Neuville, Sturgeon Bay, Wis.

I assume that you are speaking of an above-grade application. According to Publication 179-7403-82 from Dow Chemical Co., the manufacturer of Styrofoam, two mastic-type coverings can be used: latex-modified cement mortar and latex-modified stucco. Other coverings include pressure-treated wood, plywood, asbestos board, and rigid-vinyl sheet. With some of the above it is crucial to avoid ground contact with the covering ["Cut Foundation-Wall Heat Loss," PS, Feb.].

What size duct?

I read with interest the letter from Brian Laux regarding outside-air supply for a gas-fired forced-air furnace [AEA, PS,

Jan.]. What size should a retrofit outside-air duct be? Should all the return-air vents in the house be closed off?

Fred Spadafora, Staten Island, N.Y.

According to the Uniform Mechanical Code, use one square inch of net free-air-flow area for every 2,000 Btu/h of the input rating of the furnace. Add another 25 to 30 percent to the net area to account for the inlet-screen and other flow restrictions. For example, an 80,000 Btu/h-input furnace would require a 50-square-inch duct (about eight-inch dia.). The return-air vents have nothing to do with this question. Do not close them.

Wet metal

We have a metal utility building we use as a shop and laundry. On cold days we turn on an electric heater, which causes condensation on the inside of the metal deck. Would it be feasible to apply rigid insulation, such as Thermax or Styrofoam, to the baked-enamel metal?

Ardell Kisko, Ocala, Fla.

Electric heaters do not create humidity. It is produced by moisture sources such as clothes dryers, clothes washers, and people. To prevent condensation, you must insulate to such an extent that the inner surface of the building does not fall below the expected dew point of the inside air. In your area, the amount of insulation needed will be relatively small. Contact an insulation vendor or engineer for specific calculations.

Attic-vent formula

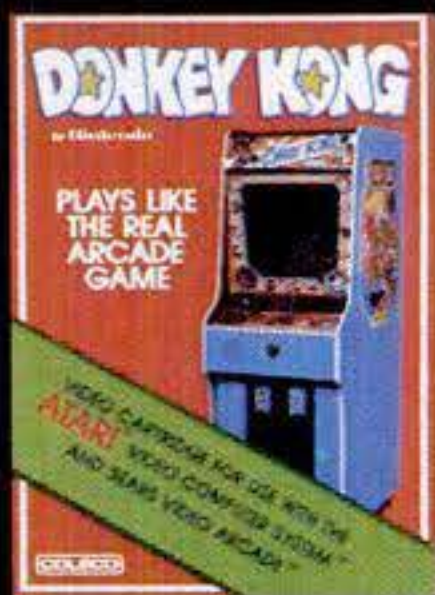
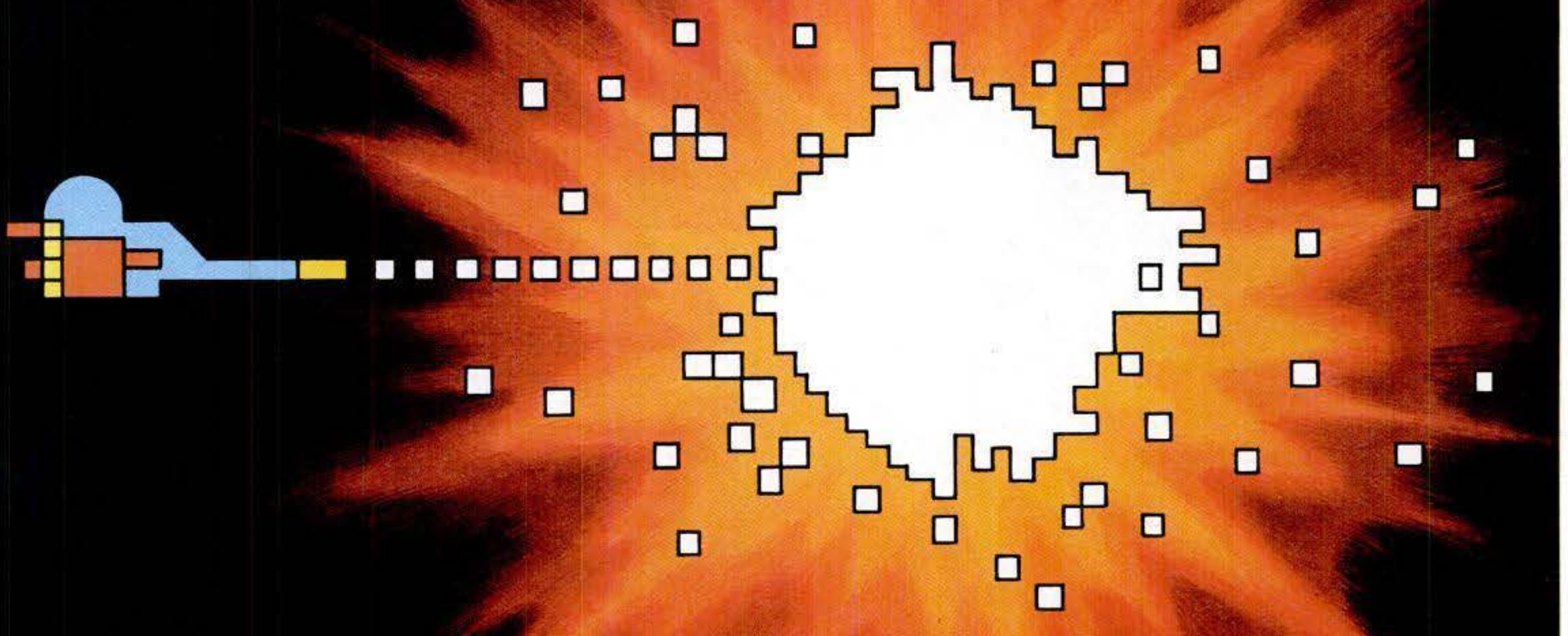
I am building a ranch-style house with a 20-foot cathedral ceiling and an eight-mil plastic vapor barrier. I plan to blow in roughly nine inches of cellulose insulation. What sort of ventilation do I need above the insulation?

Richard Schaeffer, Bethlehem, Pa.

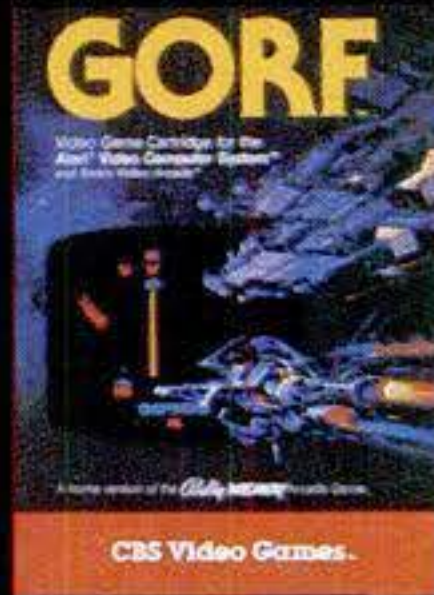
Within a well-insulated attic, temperatures drop to quite low levels in winter. If inadequately ventilated, water vapor will accumulate (even with a vapor barrier), condense, and even freeze on the rafters and roof sheathing. Moisture buildup can be avoided by using gable vents with a net area of 1/300 of the attic floor area (with vapor barrier). For example, a 2,000-square-foot attic needs a total net vent area of 6 2/3 square feet. If wood louvers and an 1/8-inch screen are used at the vents, the gross-to-net-area ratio is 2 1/4:1. For the example, two equal 7 1/2-square-foot (gross) gable vents are recommended. The gable-vent ratio can be cut to 1/300 if soffit vents of equal area are used.

Got a question on an alternate energy such as solar, wind, water, or wood? Wondering about energy-conservation techniques for home heating or cooling? Every other month, alternating with "Adventures in Alternate Energy," Jan Kreider answers selected questions from readers. Send yours to "Energy Questions," POPULAR SCIENCE, 380 Madison Ave., New York, N.Y. 10017. Individual queries can't be answered by mail.

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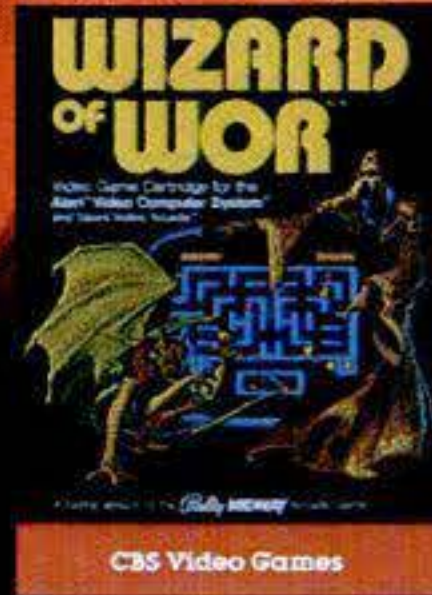
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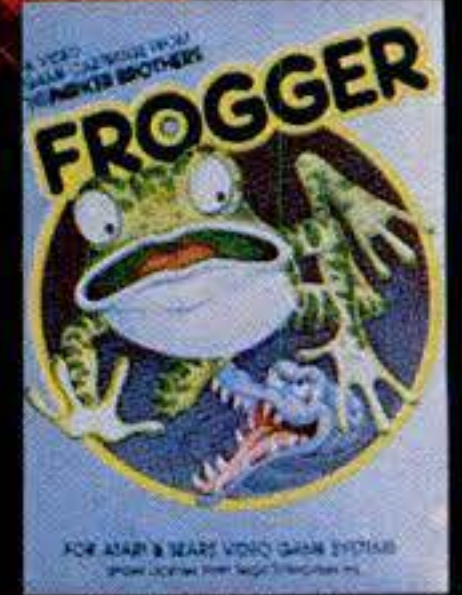
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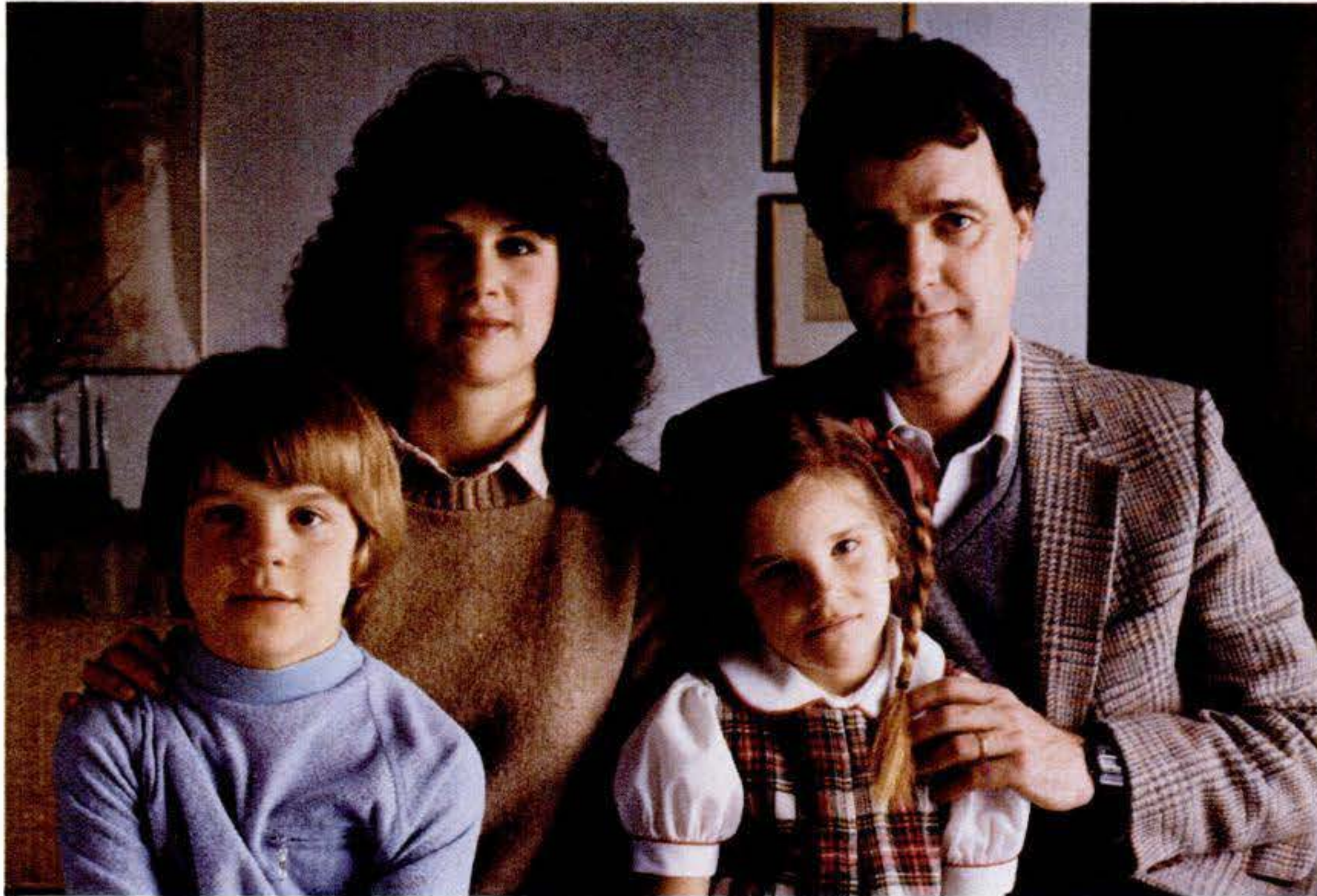
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The car that holds your family should also hold the road.



Ford LTD. Comfort plus capability.

A smooth-riding, comfortable family car has to face the same roads that are driven by everybody else. Roads that are bumpy, surprising, sometimes wet and always full of traffic.

That's why, when you look beyond the comfort of a 1983 Ford LTD, you will find a remarkably capable machine.

Case in point, the gas-pressurized shocks. As you drive, the first sensation they give you is smoothness. But then you'll notice how they keep the tires on the road over bumps. And as you turn, they help maintain control for better handling.

The steel-belted radial tires are also worthy

of note. The tread pattern wraps up around the sidewall. So in sharp turns, the tire rolls onto additional tread. Not smooth rubber.

Even the shape of the car is useful. It efficiently reduces gasoline-consuming drag (.37 Cd. for Ford LTD; .45 for Toyota Cressida or .46 for Saab 900), and reduces aerodynamic turbulence for less wind noise.

Speaking of efficiency, LTD offers a wide selection of powerplants. The standard engine is a crossflow head 2.3 liter four-cylinder engine with a four-speed manual transmission. You can also order a 3.3 liter in-line six-cylinder engine or a weight-saving 3.8 liter V-6.

Also available with the 3.8 liter V-6 is our four-speed Automatic Overdrive transmission. At highway speeds, this transmission reduces engine RPMs by nearly one-third for improved economy. The V-6 with Automatic Overdrive is rated at **20** EPA est. mpg, 32 estimated highway. The standard engine is rated at **26** EPA est. mpg, 40 estimated highway*.

Inside LTD, the comfort is obvious, with individually reclining front seats, soft cloth, cut-pile carpeting, plus handy bins and trays for all the stuff a family



collects. But here, too, you will feel the thinking of the designer.

The seats are designed to hold you comfortably, even for long drives. The steering wheel is located to put your arms in a natural, fatigue-free position. And most of the driving controls are mounted on the steering column, so your left hand can always stay close to the steering wheel.

Ford LTD is a name that has always meant room, ride and comfort. But now it also means impressive capability on the road. It's at your Ford Dealer, now.

*For comparison. Actual mileage may vary depending on speed, distance and weather. Actual highway mileage and California ratings lower.

Get it together — Buckle up.

Have you driven a Ford... lately?



They don't build cars the way they used to—they do it a lot better. Usually, changes are evolutionary. But now comes a big leap that will produce truly important benefits both for manufacturers and car owners. The innovation, pictured on this month's cover, is a giant drilling and machining tool aptly named the Gilman Drill and Mill. It will bring unprecedented accuracy to the car-manufacturing process, which makes for improved overall quality. It also opens up the possibility of do-it-yourself body-replacement panels. Crumple a fender, and you should be able to put on a new one in a few minutes using nothing more than a wrench.

The idea behind the machine is far from new. In fact, it's been used for years in making engines. In engine manufacture, a block is cast to approximate dimensions. Then it goes into a machine that holds it rigidly in position while all the necessary holes are drilled and surfaces machined flat where necessary. Since all of this drilling and machining is done by a series of tools held to extremely precise tolerances with regard to each other, the finished block is highly accurate on all working surfaces. Traditional methods of car *body* manufacturing have been completely different. As a body is put together, small individual inaccuracies can add up and become big overall inaccuracies. And that can ruin the fit of body parts.

The new machine, developed by General Motors, makes car bodies by using the engine-making technique. First, a basic frame is built. This frame is put into the machine, where it is held precisely in place. Then many drills and milling tools simultaneously drill and machine all attachment points around the body to exact tolerances. This level of accuracy means that body panels *fit*, and replacement parts will fit, too. Ultimately, this should reduce the cost of car manufacturing and raise the general level of quality associated with American cars.

One important aspect of the new technique: American manufacturers have been stung by the fact that most people think Japanese cars are put together better than American cars. They hope the new method will result in cars that not only *are* better but are *perceived* to be better by American car buyers. If so, the new move could have an important effect not only on the car companies but on the country's economy, as well.

How long before you can buy a car made this new, better way? Right now it is being used only on GM's P-cars, but look for the technique to spread. Just how far and how fast is a matter of economics. For the full details, turn to Jim Dunne's article.

Space Telescope—slow to orbit

Everyone agrees that its mirror is clearly the best ever built—accurate to within less than a millionth of a centimeter over its entire 2.4-meter surface. Its pointing mechanism will be by far the most accurate ever built, able to point the scope to within 0.007 seconds of arc for up to 24 hours. That kind of precise aiming would let a laser in Washington hit a dime in Boston dead center.

But while it's a technical triumph, the Space Telescope [PS, Oct. '81; "Science Newsfront," April '82] is in deep trouble. For starters, it now appears that it will cost somewhere between \$100 and \$250 million more than the original \$600 million estimate, and the original 1983 launch has now slipped to at least 1985. The problem, apparently, grew out of a clumsy dividing of responsibilities for the program. This was compounded by mismanagement by both NASA and some of its contractors and severe budget restrictions that made NASA try to save money by cutting back on such essential items as spare parts and test instruments. Since the program is crucial, it will go forward. But it seems clear that it will do so at the expense of other space-science projects.

Dim outlook for synfuels

On the plains surrounding Beulah, N.D., the world's largest synfuels plant is rising. It is designed to make natural gas out of coal—our most abundant fossil fuel. But now, with the \$6 million project half completed, it is doubtful that it will be able to operate successfully in the near future.

The problem is economic, not technical. Originally, when the five energy companies that banded together to build the plant started construction, oil prices were generally believed to be on a permanently rising curve. The owners had worked out a pricing structure with the federal government, pegging the price of the gas they would sell to the price of No. 2 fuel oil. It seemed that they would just about break even at first, and eventually they would

make money. But with the price of oil sharply down, the result would be economic catastrophe if the plant were to go into production now.

It's not a bright picture, and nobody quite knows what to do. Several other synfuels plants designed to convert coal to gas or shale to oil have been abandoned by those backing them. The owners of the Beulah plant are trying to get the Department of Energy to increase the payback period on a government loan or agree to an outright subsidy on the price of the gas manufactured. At the moment, the outcome is murky.

Technology gap

These depressing developments regarding the Space Telescope and synfuels may be scattered and unrelated symptoms of what some fear to be an accelerating trend. That trend: a general slowing of the pace of research and development in the United States. A blue-ribbon panel appointed by the National Research Council has just reported that preserving our national capacity to create and use advanced technologies must be "among the nation's highest priorities." To further this goal, the panel has recommended the establishment of a cabinet-level policy-making board to see to it that the U.S. maintains a competitive edge in world technology development. U.S. technology has traditionally been the world benchmark, the panel reported. But since World War II, its technological leadership has been progressively narrowing and other countries' strengths have grown.

Honors

Congratulations to POPULAR SCIENCE contributing editor Jim Scheffer. Jim has just won the 1982 National Journalism Award given by the Aviation and Space Writers Assn. for his piece in the July '82 issue of PS, "The Growing Peril of Space Debris." This is but the latest in a long series of awards won by Jim in his distinguished journalism career.



Editor-in-Chief

Revolution in car making

—precision body fit with
bolt-on plastic panels

**A unique building method
yields a rival for the
fit and finish of imports**

By JIM DUNNE

ILLUSTRATION BY JOE LAPINSKI

The giant machine crouches in the corner of the noisy assembly plant like some mammoth creature eyeing its quarry. A silvery car frame approaches. The machine lashes out with its metal tongue, noisily engorging its skeletal prey. It turns and tips and pushes the car into place, then clamps it hard. A cluster of tentacles descends from above and delicately chews through plastic and metal blocks on the frame—fashioning it in a way never before seen on an automobile assembly line.

This September, when GM's Pontiac division unveils its new P-car two-seater, Fiero, this scene will be repeated some 30 times an hour. Fiero's construction will mark a major change in the way a car is put together—a revolutionary departure. Where cars were once made with a body and chassis and later with a unit body, Fiero will be made with a space-frame chassis and a separate covering of body panels. And while American manufacturers are sometimes chastised for the poor fit and finish of their cars, GM designers can boast a match for the fit and finish of Japanese and German cars—and go them one better, building body quality and flexibility of design into a car from its initial stages of production.

With the new technique, tolerances of 0.005 inch will be commonplace.

What's more, the technology holds a promise of less-expensive body repairs for consumers. In many cases, body parts can be replaced with a few simple tools.

"Now we'll get body fits that can't be measured by the human eye," said Ernie Schaefer, manager of Pontiac's Plant 17 on the northern edge of Pontiac, Mich., where Fiero is to be built. "For instance, our critical door-to-front-fender seams will be held to tolerances that are closer than even skilled workers can gauge by sight."

What is this promising development? The key to the breakthrough is a huge machine tool called the Gilman Drill and Mill machine.

Ernie Schaefer recently escorted me on a tour of his plant, where I got a firsthand look at the machine and the line on which it plays a central role.



J. Lapinski

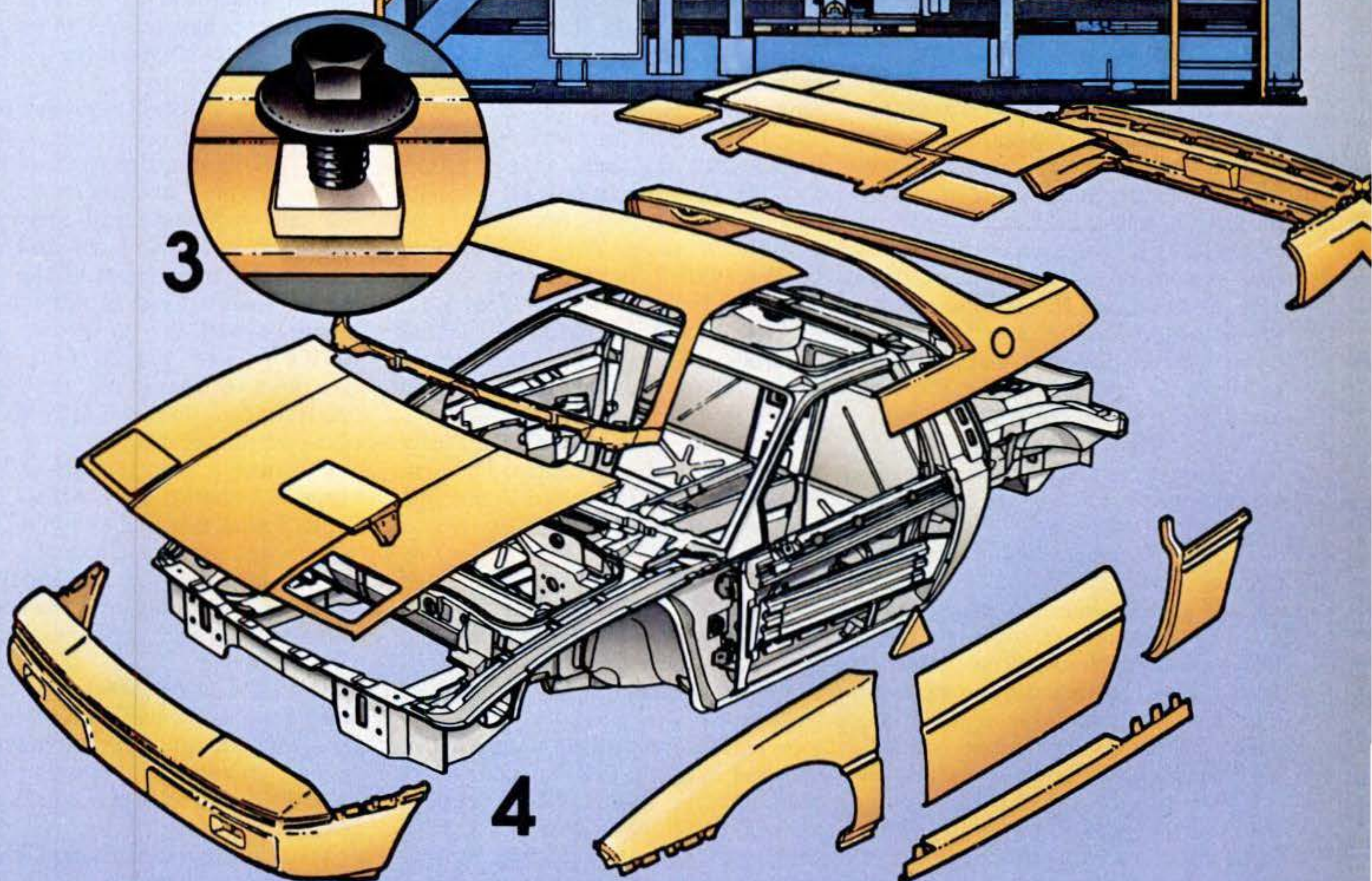
When I visited the plant, it was in a state of organized confusion, which is normal with plant changeover. A new assembly line was taking shape. Shiny new chains, coiled hoses, four-foot trenches, computers, and thick electrical cables filled the darkened interior, lighted only by workers' temporary fixtures. Unimates—robot welders, 22 of them—stood poised in flanks along one stretch of the line in the five-acre floor space. Welders, erectors, electricians—some with special skills that you can't find at your local plumbing and heating shop—hurried to get the plant ready.

Our tour took us to the far corner of the plant, to a bay five stories high, where Schaefer explained the operation of a mammoth drilling and milling machine. Made by Gilman, of Janesville, Wis., an old name in machine-tool builders, the 2½-story mechanical complex measures 20 by 30 feet at the base. It's anchored at a station in the assembly line just ahead of where Fiero's running gear is to be installed.

"For the first time we're building an automobile the same way we build an engine," Schaefer explained as we

Continued

Making Fiero body involves these phases: Space frame (1) has 39 body mounts to which plastic body panels will be bolted. Every 60 seconds Gilman machine (2) pulls a space frame in sideways, positions it, and drills and mills mounts. Space frame now moves along line to receive corrosion dip, then gets suspension and drive train before plastic body panels are attached. Inset (3) shows typical bolt that secures panel to space frame. Two types of plastic are used for bolt-on panels (4). If the same components were made of steel, they might weigh twice as much. If a body part is damaged during assembly, it can be replaced easily without welding or cutting metal. This means, too, that owners could be in for lower-cost body repair.





P-car frame goes into Gilman machine in demonstration. If a frame is out of toler-

ance, the machine lowers it back to the conveyor and signals operator.

stood before the monster. "We machine parts of the frame to ensure a near-perfect fit with the body, just as we machine an engine block so that the head fits properly." If the Gilman Drill and Mill machine does its job right, there is virtually no way the body panels can be misaligned, whether installed at the factory or replaced later when a body shop—or Fiero owner—bolts on a new part.

Think of it this way: Parts of cars made the old way were put together with certain tolerances. But mismatches could add up—metal that was not formed precisely could result in parts that would be farther apart or closer together than planned. But this new system puts the frame together first, then locates the critical mounting points, resulting in better fits. In other words, it doesn't matter if out-of-tolerance figures add up; the ultimate fit is close to perfect, anyway.

"What we get is precise body building," said Schaefer. "And there are other benefits, too."

Some of the benefits stem from a change in the sequence of putting a car together. The space frame and chassis go together first; body panels are added as one of the last operations. Because the work of installing the engine, transaxle, suspension, and electrical parts is done on the space frame, assembly-line workers can't scratch the body. This also allows ample access to the inside through the gaps of the frame, easing some of the more intricate jobs.

The frame forms a cage for the body. It is built in a traditional way with huge welding fixtures and those robotic welders. The shape of the cage

outlines the shape of the finished body, surrounding the passenger compartment and engine section (Fiero's engine is mid-mounted).

Drilling and milling

The Gilman pulls in the Fiero frame, positions it, and then drills and mills 39 body-mounting pads spaced along the top and sides—all in less than a minute. Eight clamps hold the frame. The door openings are sensed from three locations on each side of the frame, and an XYZ table (so-called after the three axes it aligns: fore-aft, up-down, side-side) positions the assembly. Then the drill heads bore the mounting pads, which are actually 3/4-inch hard-plastic inserts. The drill bits vary in size from 5.2 to 10 millimeters (0.2 to 0.4 inches) and cut at two speeds: rapidly through the plastic, then more slowly through the frame so as not to distort it.

On the necks of the drills are tungsten-tipped milling inserts. They run at a relatively slow speed to machine the mounting pad to the design height.

"All the drills and mills are self-monitoring," reports Jim Werner, project engineer for Gilman, the man who directed construction of the Drill and Mill machine. "A load cell on each drill unit senses when the drill is cutting plastic or metal, or when a drill is chipped, broken, or missing. The cell controls the speed of the drills. If there is a problem with the bits, a control board signals a factory maintenance man to come over and fix it."

After passing through the Gilman cycle, the Fiero frame moves down the assembly line to take on its running

gear and passenger-compartment dressing. Finally, the frame arrives near the end of the line, where body panels are attached. Workers use studs embedded in the plastic, or bolts that go through holes in the plastic, to hold the panels in place.

Two types of plastic are used for body parts: reinforced reaction injection molding (RRIM) for vertical surfaces such as fenders, and sheet-molded compound (SMC) for horizontal surfaces such as the roof. RRIM is reasonably stiff polyurethane, a "friendly" material that bends and snaps back after light impacts, cutting down on minor body damage. It's similar to the plastic used to cover modern bumpers. SMC is stiffer; it won't give as much when something is rested on its surface.

Ron Rogers, the engineer in charge of the Fiero car project, says the plastic is unlike any other used in automobiles. "We put this plastic side by side with metal body panels and asked engineers to see if they could detect the difference. None could. With a new glass-flake process developed by GM, we avoid the wavy surface you see in fiber-strand-reinforced plastic. It's smoother by a factor of three."

Each of the panels is painted with a primer coat over its natural yellow hue, then comes a layer of color, and it's topped off with a clear-coat finish layer.

Using plastic makes it easy to fashion in one piece a complex body part that would require a number of welded pieces if made of steel. Look at the rear roof section of Fiero in the drawing. It trails down and curves around the upper part of the engine compartment. That couldn't be done easily in steel.

"We'd need maybe four welded parts to do the same job," says Rogers. "And that would mean more cost with less certain accuracy."

Plastic is a boon to stylists, too. By simply changing body panels on the space frame, a stylist can give the car a fresh appearance. Changeover time in the factory to a new body style would be negligible, and the same assembly machinery could be used without alteration.

The fabrication technique can work with steel body panels as well as it does with plastic. That means it could be used in volume-production sedans, where steel has a cost advantage over plastic.

With widespread interest brewing, even among Japanese and German car makers, chances are that many of us may have a space-frame car in our garage before the decade is over. ■

The tantalizing quest for speech- recognition computers

Now that machines can decipher discrete words, how far off is the listening typewriter?

By MORT LA BRECQUE

It's a noisy party, with the hubbub of simultaneous conversations mixing with background music and tinkling glasses. On top of that, the man speaking to you has a thick foreign accent.

Politely, you concentrate and manage to pick up a word here, a phrase there. Then, performing a remarkable feat you take for granted, you combine those bits and pieces with the context of the situation and your knowledge of the language, and quickly decipher the man's meaning.

If machines could do that with anything approaching the ease with which humans do, we could dispense with the keyboards, switches, dials, and other mechanical devices used to operate them. Unfortunately, the machines that so far have been developed to recognize and understand speech are strictly limited. They have small vocabularies with restrictive rules for word arrangement, can recognize only one or a few speakers, and require that words be spoken with exaggerated pauses between them. These speaker-dependent word-recognition systems have been widely applied in industry ["Machines That Talk . . . and Listen," PS, Aug. '80], and they are now beginning to show up in consumer products and services. For example:

Bell Laboratories has demonstrated a speech-recognizing directory-assistance system and a voice-actuated automatic phone dialer. Toyota has developed speech controls for automobile air conditioners and radios. Threshold

Technology's speech-recognition chips will be used in arcade video games. And Hewlett-Packard is already offering speech-recognition capability for its personal computers.

That last application is undoubtedly one of the most fertile for this developing technology, but present systems are far from the point at which voice input can totally replace keyboards. That would require a system that could understand continuous speech from any speaker. Now, a group at IBM is actively working toward developing a device with that capability, a listening typewriter. I went to the company's Yorktown Heights, N.Y., research center to check the progress.

"Our goal," Bob Mercer, manager of real-time speech recognition at IBM, told me, "is to instantly recognize naturally occurring continuous speech composed of thousands of words, with no constraints on grammar and syntax, from just about anybody who comes along. We want to do everything."

That task is astonishingly difficult. Whereas isolated-word recognition is essentially an exercise in signal processing (see first caption), continuous-speech recognition requires knowledge of a large number of words, where one ends and another begins, and the grammatically permissible ways in which they can be arranged (see second caption). In short, the machine must know the speaker's language.

That is the heart of the problem. Little enough is known of the process by which people learn languages. Teaching English to machines clearly calls for approaches that go beyond the nuts and bolts of hard science and into the realm of psychology and linguistics. At present, there are only two groups working on the problem: one at IBM, the other at Carnegie-Mellon Univer-

sity in Pittsburgh (Bell's efforts are mostly confined to applications of word recognition).

Carnegie-Mellon's program, co-directed by Raj Reddy and Roberto Bisiani, uses the techniques of artificial intelligence to teach English to computers. Bisiani explains: "All sorts of knowledge—spelling, pronunciation, and grammar—is stored inside the machine. The computer searches this knowledge structure to find the best interpretation of speech input."

Sense from nonsense

The IBM group, led by Frederick Jelinek, uses a statistical technique known as information theory instead of artificial intelligence. Information theory, devised by Bell Labs mathematician Claude Shannon in 1948, gives a quantitative means of describing communication systems by treating bits of information as physical quantities.

Noise is the villain of information theory. Between source and destination, any information-carrying signal—a radio transmission, data in a computer, human speech, whatever—is garbled to some extent by outside interference. Shannon showed that messages can be retrieved from even badly garbled versions of themselves through probabilities. If the probability of various kinds of garbling is known, an estimate can be made of the original content of a garbled message.

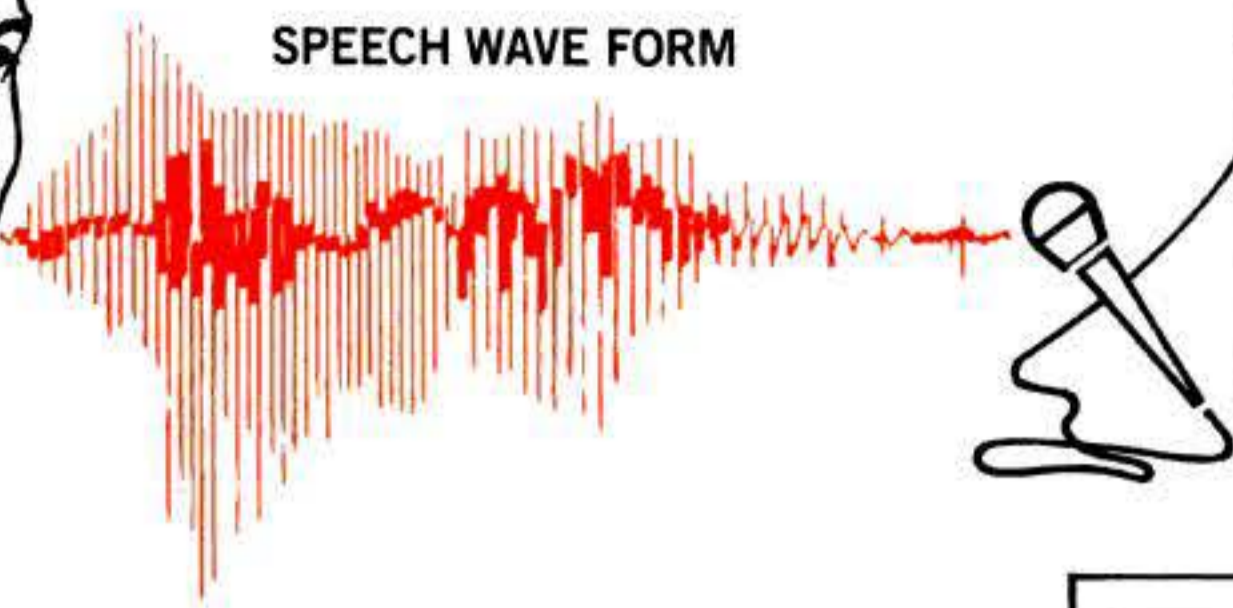
"We do various kinds of acoustic processing in the computer," Bob Mercer explained when I visited his lab, "to produce a string of labels that represents what the speaker said in a garbled form. Any number of sentences could have produced this garbled string, but each has a different proba-

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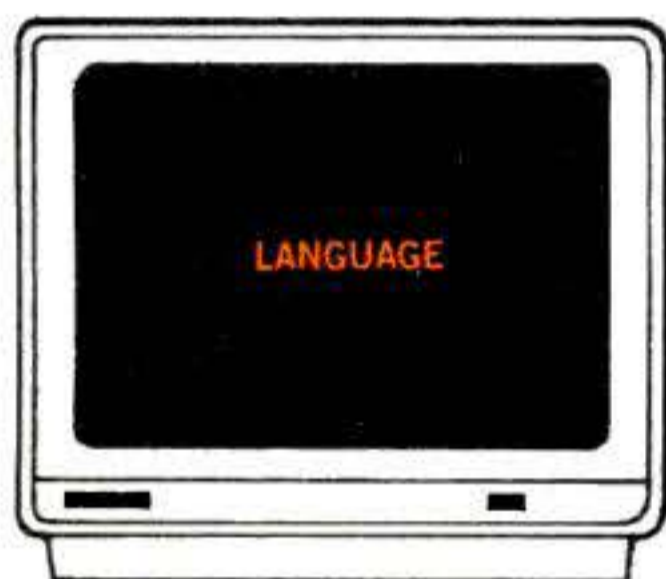
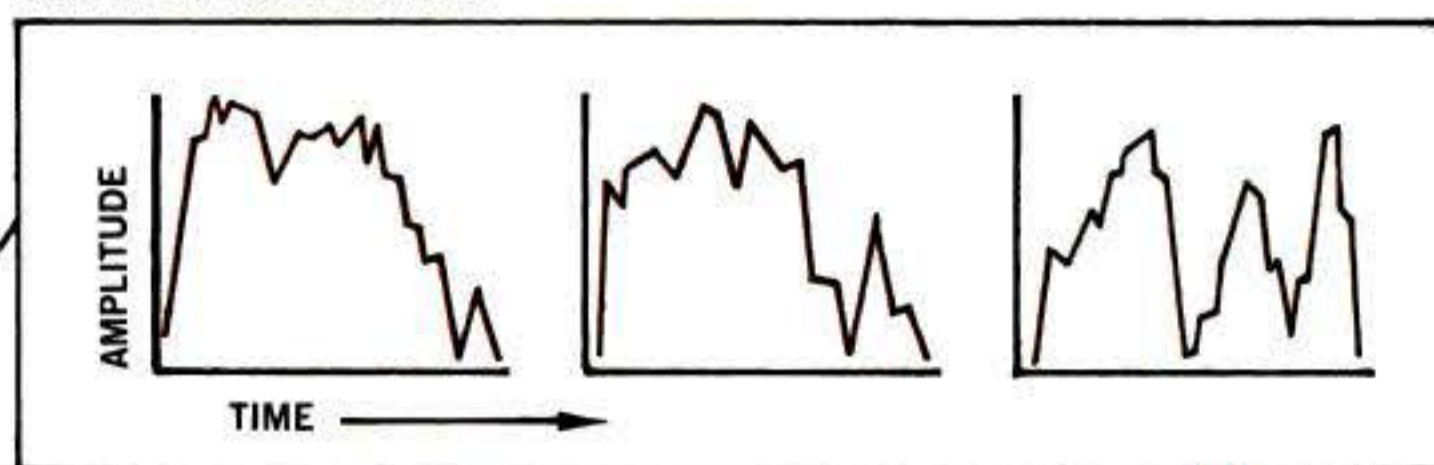
The easy part: matching templates



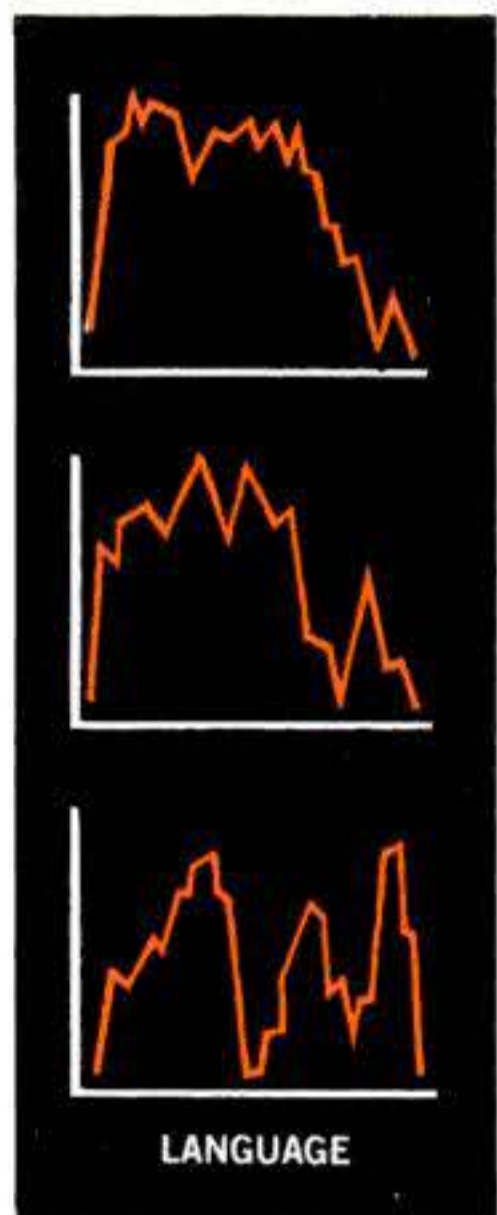
SPEECH WAVE FORM



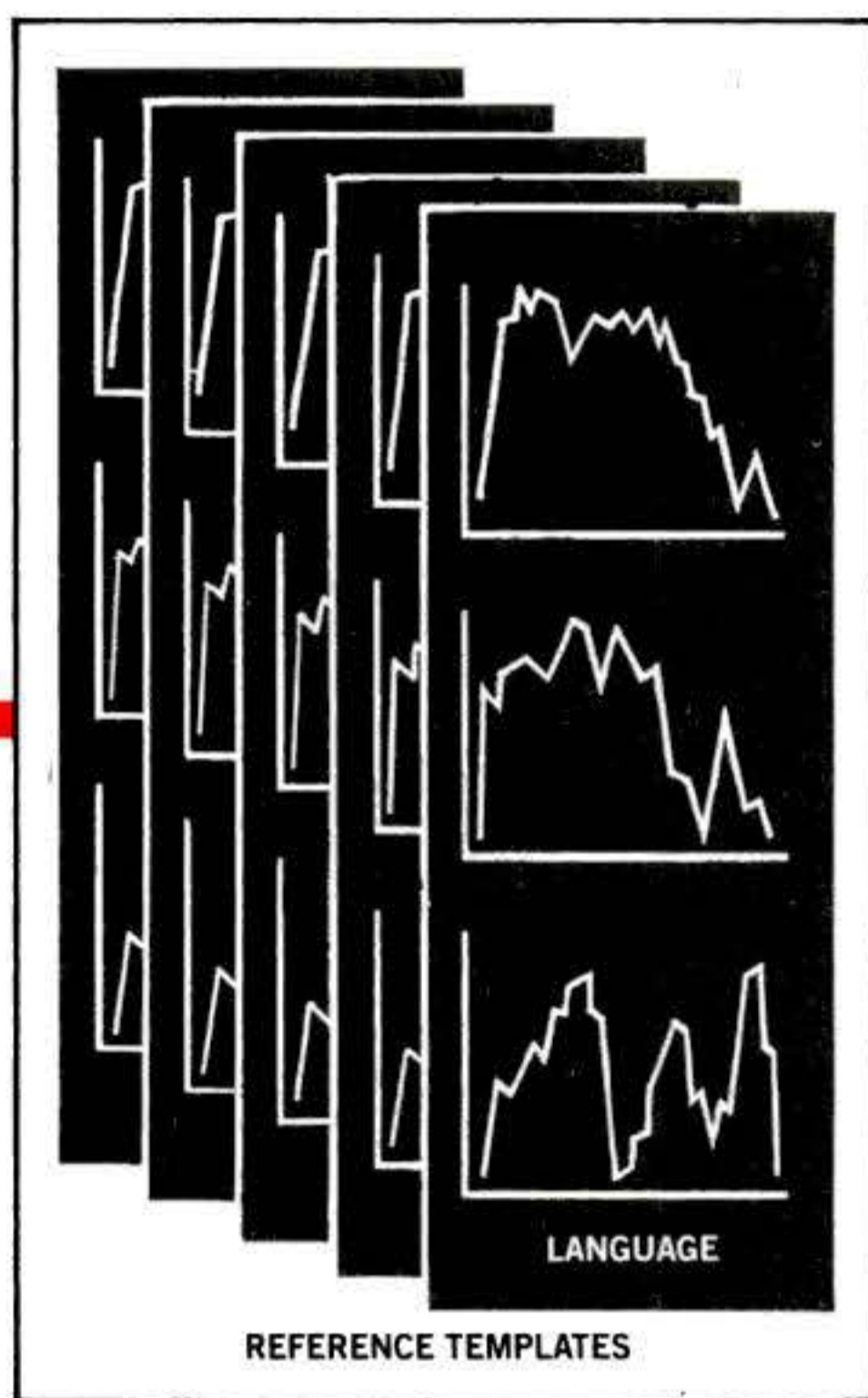
SIGNAL PROCESSING



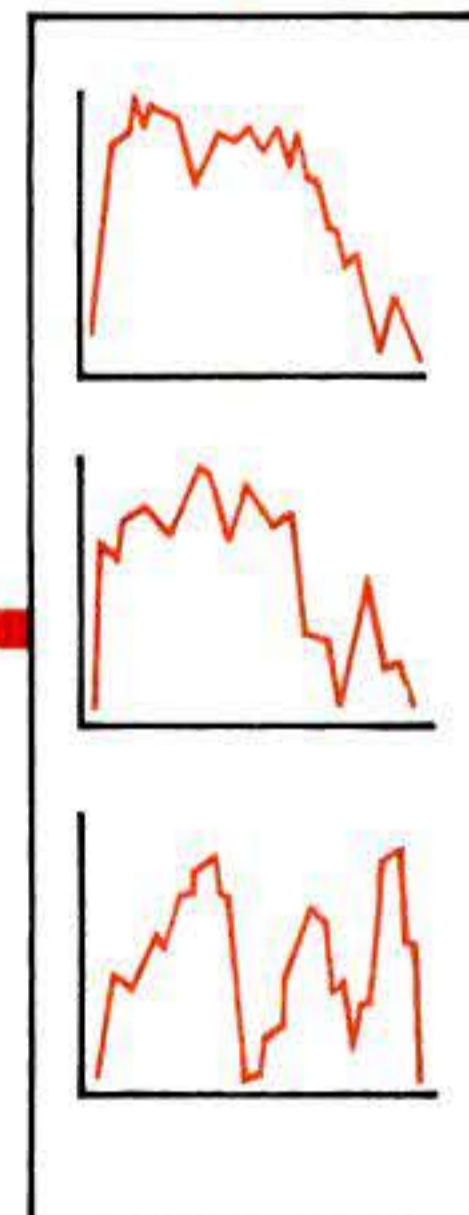
ANNOUNCEMENT



RECOGNITION DECISION



DISTANCE SCORING



TEST TEMPLATE

Isolated-word recognition works by matching the patterns of processed signals with patterns stored in computer memory. When the word "language" is spoken, the movement of the human vocal tract creates disturbances in the air. These sound waves are converted to an analog electrical signal when picked up by a microphone. The speech wave form consists of a complicated assembly of overlapping frequencies, with loudness at each moment varying during the time it takes to utter the word. To characterize the wave form, therefore, some method must be used to give a "two-dimensional" curve of a "three-dimensional" event. A mathematical technique called a fast Fourier

transform is often used to change the signal from the time domain to the frequency domain. But here, band-pass filters are used to divide the signal into three frequency bands (each an octave wide). The result is three curves that show loudness changing with time at three broad ranges. Taken together, the curves give a unique characterization of the utterance. In the computer's memory is a similar set of three curves, called a template, for each word with which the recognition system is programmed. These can be computer generated, but they are more often words previously recorded and processed. If recorded by the same speaker whose voice is to be recognized, the templates will match very

closely. If recorded by a different speaker (the case in a speaker-independent system), the templates could vary considerably. The computer compares the test template with the reference templates and assigns mathematical distance scores to quantify the similarity. The lowest-score template (or none if all scores are too high) is identified as the spoken word and is announced on the display screen or with a synthesized voice for verification. Continuous-speech-recognition systems may also use template matching as part of the process, but templates generally correspond to smaller units of sound than entire words. In English, about 40 linguistic sounds, called phonemes, make up all speech.

bility associated with it. By providing the probability distribution over garblings, we can decode the sentence most likely to have been spoken."

The probability distributions constitute the computer's knowledge base, equivalent to the language rules programmed into Carnegie-Mellon's computers. In this case, the information is partly drawn from extensive spoken recordings read into the computer.

Knowing that, I had expected to find

an elaborate recording studio when I visited the lab. Instead, I discovered Mercer using an ordinary office to make conventional analog recordings on a conventional cassette recorder. "Yes, when we began, we made direct-to-digital tapes in a soundproof room," Mercer recalled. "I did most of them and had to speak at a precise distance from the mike without breathing audibly between words."

In those early tests, Mercer spent

nearly two weeks speaking carefully into a microphone to produce two hours of speech acceptable to the computer. That was needed to form standards so the computer could recognize any sound he made. The computer program has been improved to the extent that now the computer needs just a half-hour of acceptable speech, and that is usually accomplished in two days. The researchers would like to cut this time still further so that new speak-

ers wouldn't need any training period at all.

This can be accomplished, they hope, by storing in the computer the speech of many people; taken together they would represent all possible speakers. Brief recordings of 200 IBM employees, made in their free time, are a step in this direction—and another reason for simplifying the recording system.

"Right now, each new talker is a surprise to us," said Mercer. "After we've digested all the data from the 200 employees, we expect to be less surprised."

The voice samples, when digitized and stored in a powerful IBM 3033 computer, serve as the data base for two computer programs that do the speech-recognition work. The first program, called the acoustic processor, slices up the samples into 1/100-second-long snippets. The spectrograms of each snippet are then compared with previously stored information from other speakers and assigned a label corresponding to a particular sound or combination of sounds. In the IBM program, there may be as many as 200 such distinct labels.

Slow but accurate

The second program, called the linguistic decoder, is much more complex. It takes these sound labels and begins to match them up into probable word sequences. After testing and evaluating all possibilities, the decoder eventually decides what it thinks the spoken sentence was and prints it out.

The best processing time so far is 100 seconds for one second of speech, and that's using a computer that executes up to seven million operations per second. It takes overnight for 10 or 20 sentences to be processed.

Speech recognition may be a slow process right now, but it isn't inaccurate. The first series of experiments, with Mercer reading sentences in a 250-word artificial grammar called New Raleigh, achieved perfect recognition.

The next, more-difficult series used a 1,000-word vocabulary drawn from the lengthy patent papers for a new kind of laser. Faced with a vocabulary four times as large as New Raleigh and no artificial restrictions on the way the words could be assembled into sentences, the computer correctly identified 93 percent of the words in spoken test sentences.

Of the errors, more than half were decidedly trivial, involving the substitution of one short word for another ("a" for "the," for example). Search disasters, so called because the computer makes an inadequate search of the possibilities, accounted for only one-sixth of the errors but were more serious. Such an error occurred in the

sentence "Not all of the light emitted by the gaseous discharge is available for pumping in the ruby rod." The computer failed to search hard enough for "available" and settled for the similar-sounding but absurd "of the tube will."

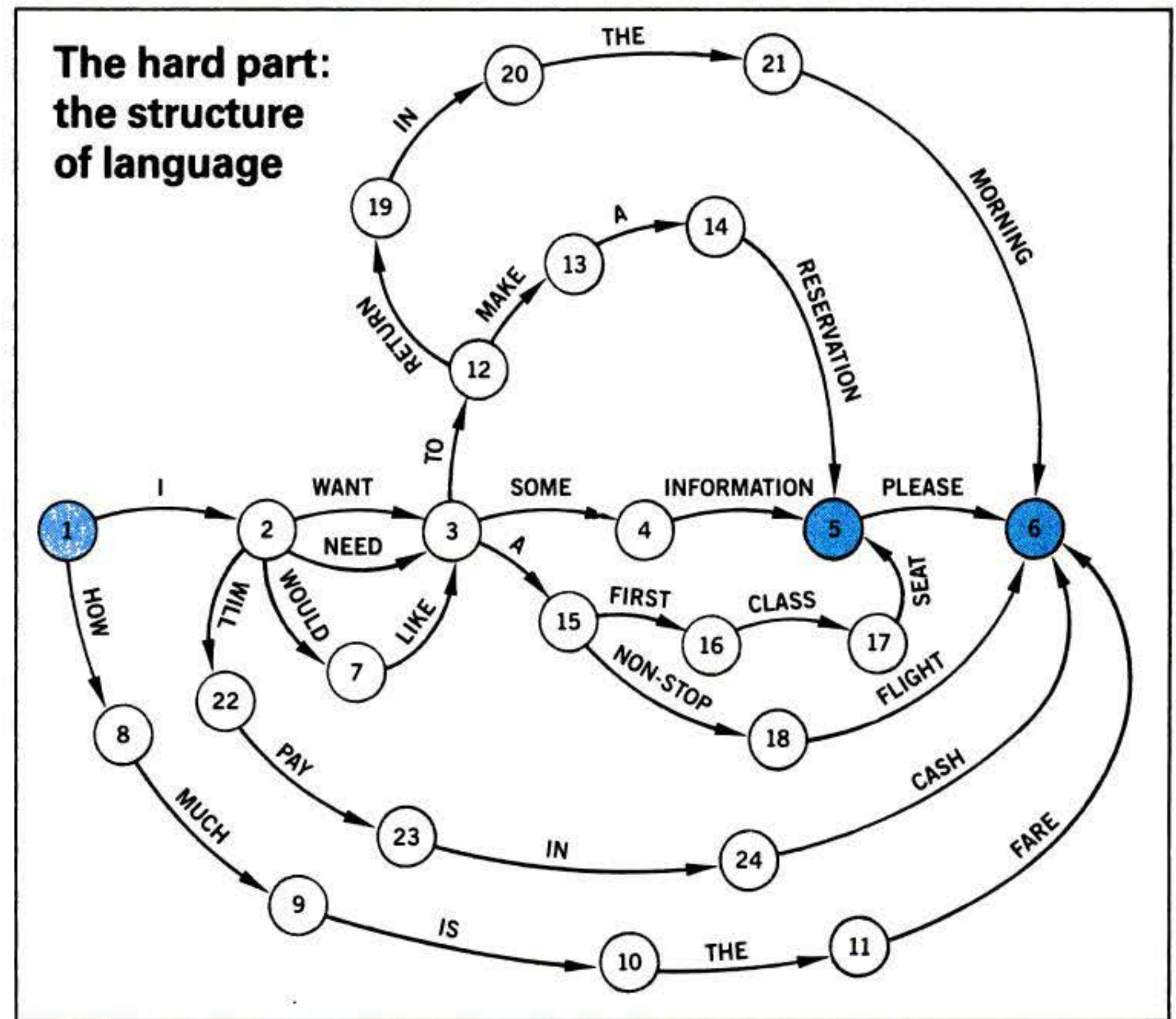
A more credible similar-sounding change cropped up in a sentence about the coatings used on a laser mirror, when the computer substituted "by electric coating" for "dielectric coatings." The missing "s" in that example is a more complicated error that shows the computer does more than merely match up sounds; it actually tries to understand sentences. In this case, it apparently read "coating" as a verb form instead of a noun, a reasonable mistake given the preceding error. In speech recognition, as in life, one error leads to another.

Likewise, one experiment leads to another. IBM's latest tests use a 5,000-word vocabulary drawn from internal company memoranda. As work contin-

ues, Mercer foresees these improvements: a vocabulary that can be expanded as the speaker introduces new words, real-time processing of isolated word speech, speaker independence and elimination of training time, and adaptive ability to allow improved recognition as the computer becomes familiar with a speaker.

As for the listening typewriter, a limited version that could produce first-draft-quality output within a constrained subject area could be a reality by the end of this decade. But the full-fledged model remains a distant—maybe an impossible—dream. "Things will go slowly," Mercer told me. "It's still a very tough problem."

The frustrating thing about speech-recognition research, as Carnegie-Mellon's Bisiani points out, is that the results must be compared with something. "You spend millions of dollars and work for years," he said, "and any human being does better." P S



Successful word-recognition systems are about 90 percent accurate. That may be adequate for single-word commands, but if the system must recognize a whole sentence of 10 words (disregarding the problem of words running together), correct identification would occur only 35 percent of the time. The example above shows how imposing a constrained syntax or grammar can improve performance, in this case for an airline-reservation speech-recognition system that Bell Labs researchers are developing. Beginning at the initial state, labeled "1," the computer would have to distinguish between two allowable starting words. If first word were "I," the com-

puter would know that only four possible words could follow. This would continue until a final state (dark color) was reached, at which point the computer would know that the sentence may end. The actual version of this program at Bell Labs allows 127 total words and a grammar that allows almost six billion different sentences (example: "I want one first-class seat on flight number three one to Denver on Sunday."). With the syntactical leverage, the computer correctly identifies whole sentences 95 percent of the time. IBM's New Raleigh experiment (see text) applies similar constraints, but researchers are aiming for totally unconstrained syntax.

Challenger's engines

—how high-tech detectives traced the shuttle's fuel leaks

Mysterious explosive gases delayed a critical launch as engineers scrambled to pinpoint the source

By JIM SCHEFTER

At the Kennedy Space Center last December, three 450,000-pound-thrust rocket engines in the new Challenger space shuttle belched brilliant plumes of flame. Inside the firing room at the launch-control center, technicians and engineers monitored banks of instruments. Abruptly, the muffled roar of the engines stopped. The 20-second flight-readiness firing of Challenger's engines was over.

But when a technician glanced at the digital readouts for the hazardous-gas-detection system on his console, he knew something was wrong. The panel indicated that the aft section of Challenger's fuselage contained 4,600 parts per million of hydrogen gas during the firing. "That's about double what you'd ever consider flying with," said Lee Solid, resident manager at Kennedy for Rockwell International's Rocketdyne division, the engine manufacturer. During the orbiter's ascent, hydrogen gas at such a high concentration might mix with oxygen and explode.

Over the Christmas and New Year holidays, a NASA-Rocketdyne team went into action, analyzing test data. Was there a leak somewhere in the engine system? Or had some hydrogen fuel, unburned just before ignition, simply filtered back into the spacecraft's aft section? They spread a liquid-soap solution over pressurized engine-plumbing joints to see if there were leaks. Nothing. They rechecked test data for clues. Again, nothing conclusive.

In late December, James Kingsbury, science and engineering director at NASA's Marshall Space Flight Center in Texas, announced publicly that Challenger should make its late-January launch schedule. But officials were concerned. Behind the scenes, a NASA-industry team launched a series of intensive investigations. Before they were through, they had found not one but three obscure engine flaws. There was a potential for disaster.

Now all the flaws have been repaired, both in Challenger and in other shuttles under construction. Future missions will be able to be flown safely. The lesson was not lost, however: The smallest error or design flaw, even in a part costing no more than a few dollars, could seriously damage a \$1 billion craft in the unforgiving arena of space.

Late last year, as most of the country celebrated the holi-

day season, the investigators began their search. The first step: find the source of excess hydrogen in Challenger's aft section.

"The leading theory around Christmas time," said Art White, Rocketdyne's managing engineer at Kennedy, "was that we were getting hydrogen from the outside." During the first few seconds of engine start-up, free hydrogen comes out the engine nozzles and is not burned off. "We postulated that some of that hydrogen managed to rise," he said.

"We are still a step away from knowing that we do not have a hazardous situation in there, although data point to an outside source," Air Force Lt. Gen. James Abrahamson, a NASA official and boss of the shuttle program, said at the time.

Preparing for a rerun

The investigators, however, were worried. They *had* to find the source of hydrogen before a launch could be risked. Reluctantly, officials ordered a second test firing of Challenger's engines—at a cost of \$1.5 million—to help solve the mystery. The additional firing would postpone the launch to late February. The test firing was slated for Jan. 25, and technicians swarmed over the engine area to prepare it. They added:

- Sample bottles—vacuum containers with valves that can be triggered to draw in gases for analysis.

- Sensors to back up those already on board for the hazardous-gas-detection system—a mass spectrometer in the mobile launch platform that vaporizes and analyzes gas fed from sensors throughout Challenger.

- Delta-P sensors, designed to detect differences in pressure, around the heat shield that separates the engines and the aft section. Readings would tell whether outside pressure was capable of forcing the gas upward through the shield.

The second test firing, held on schedule, narrowed the options. "We definitely proved that the hydrogen was not coming from the outside," said White. "And because of the location of the measurements, we theorized that the most logical place for the leak was around engine one and possibly around engine two."

To confirm their suspicions, the team turned to portable mass spectrometers—extremely sensitive devices that can detect minute concentrations of substances. They pressurized the engine plumbing with nonhazardous helium. Technicians then probed the complex plumbing with sensors attached to 25-foot-long hoses. A sharp deflection of the

spectrometer needle would mean the leak point for hydrogen had been found.

As technicians set up these “sniffers” on Jan. 29 to locate leaks, inspector Tom McLaughlin began moving his hand through the clutter of tubes and joints. He paused at one point on engine one. A rush of gas against his hand told the story: The leak had been found even before the high-tech test equipment was in use.

“It was a crack in the main combustion chamber’s manifold,” Erv Eberle, Rocketdyne combustion devices manager, told me at the firm’s Canoga Park site in California. “Liquid hydrogen flows through the combustion-chamber wall for cooling, then into the manifold,” he said.

At Rocketdyne, vice-president Dom Sanchini told Eberle to find the cause of the problem and fix it. By then, NASA had already ordered the defective engine, serial number 2011, pulled from Challenger. Tests began on replacement engine 2016 before installation in the orbiter.

Why had the manifold suddenly cracked? “That’s what we had to know,” Eberle said. “The first priority is always to find out whether the problem is generic to all engines or a one-of-a-kind problem.”

Shuttle-engine records are meticulous; more than 1.8 million pages are recorded on 1,500 microfilm reels. Each engine has over 70,000 parts, with individual serial numbers on 10,000 of them. Everything that has happened to each part is recorded; in fact, every part is documented back to the pot of metal it came from at the mill. When Eberle’s team in California pulled the record on engine 2011’s manifold, they quickly discovered what the cause of the cracking problem was.

In December 1981 at a Rocketdyne plant, workers used a vertical lathe to shave metal from a big hoop-shaped manifold welded to the main combustion chamber for an engine. But it didn’t stop when it was supposed to. Ignoring its cutoff switch, it tore through metal, ripping the L-shaped outlet neck from the manifold.

The fix: Cut the fractured manifold neck from the manifold, then weld in a replacement. But because the \$3 million component was already assembled, machine welding and heat treatment to lessen stress around a new weld weren’t possible. A less precise hand weld fixed the damaged section.

The manifold is made of Inconel 718, a lightweight alloy over five times stronger than stainless steel. Since 718 reacts with hydrogen at high temperatures, causing the metal to become brittle, a thin sheet of copper, less than 0.01 inch thick, is overlaid inside the manifold to protect the alloy. But on the rewelded neck, a microscopic tear developed in the copper.

“That was enough to let hydrogen in,” Eberle said. During each engine test, more hydrogen reacted with the Inconel. “We had hydrogen-enhanced cracking, and it finally grew to a through-crack,” he said. The manifold had a 3/4-inch crack.

An unsettling coincidence

While Eberle’s team in California discovered that the manifold break was a one-of-a-kind fluke, technicians at Kennedy made an alarming discovery: The replacement engine 2016, not yet installed, also leaked. Workers had pressurized 2016 with helium for routine leak tests after working near a critical engine component, a heat exchanger that converts liquid cryogenic oxygen into high-pressure, 390-degree-F gas. Mass-spectrometer readings near 2016 registered too much helium.

Technicians switched to portable spectrometers, moving wandlike probes carefully around the plumbing. Then a sensor held near the heat exchanger itself caused a sharp needle deflection on a spectrometer. Harmless helium gas

hissed from a tiny 0.2-inch-diameter tube in the exchanger. But oxygen leaking during a flight could have been catastrophic. Had the engine been installed on Challenger, “you would get oxygen coming out into a combustion environment—a blowtorch in a very critical area,” shuttle chief Abrahamson said later.

An inspector poked a fiber-optic borescope into the tube. He quickly spotted an incomplete weld—but no crack. Again that critical question: Was it generic to all engines or one-of-a-kind? This time, Rocketdyne engine-design manager Robert Crain investigated. “The only way to get to the tube was to cut out the entire part from the heat exchanger,” Crain said. “Once you do that, the game’s over for that engine. It’s a four-month job to repair and replace.”

The leaky part was flown from Kennedy back to Rocketdyne in California, followed later by the entire engine. On the pad in Florida, technicians set to work installing yet another engine, 2017, in its place. Alarm grew among the shuttle team. The launch date, now a month behind schedule, slipped to mid-March.

The heat-exchanger leak from 2016 proved elusive because of its size. “Once we got it in the lab,” Crain said, “it was easy. There was a 0.004-inch crack. You couldn’t see it with 50-power magnification.” But it was obvious that the leak resulted from incomplete fusion by an automatic welder (used by subcontractor Wintec Co., which made the part in 1977).

“We had to know why the manifold cracked. The first priority is always to find out whether the problem is generic to all engines or a one-of-a-kind problem.”

“We made it worse every time we tested it,” Crain said, “until it finally propagated through the tube wall.” Again, it was a one-of-a-kind error. Rocketdyne followed up by tightening inspection procedures at Wintec.

Meanwhile, concern over engine leaks grew at the launch pad. NASA had ordered exhaustive leak checks on all three engines. On Friday, Feb. 25, technicians set up portable spectrometers near the helium-pressurized number-two engine. Again, as an inspector passed his hand over the pipes in the area, he felt gas under pressure. Another leak. The mass spectrometer went off-scale.

At 7 a.m. that day, a telephone call from Florida alerted Glenn Coffey, Rocketdyne combustion-devices manager, at his California home. He ordered that a sketch of the leak area in engine two be drawn. By 9 a.m., the telefaxed drawing was on his desk at Canoga Park. Later that day, Coffey joined a large investigation team set up by Rocketdyne to solve this latest problem and find whether or not it was a dreaded generic fault.

The leak site: a hydrogen line feeding the engine’s augmented spark igniter (ASI). The ASI is the pilot light that ignites hydrogen and oxygen in the main combustion chamber to give the engines their thrust. The obvious first step was to find out why the line leaked: Did it have pinholes? Cracks? Faulty welds? No one knew yet. The ASI line is buried deep under other engine parts. On Saturday, technicians at Kennedy disconnected the lower portion of the line and ran a flexible borescope inside. What they saw was disheartening.

Directly behind a sleeve brazed to the line’s exterior were

Continued

two sharply defined cracks. They covered about 80 percent of the ½-inch line's inner circumference. A bright-orange substance filled the cracks. Engineer Don Mikuni, heading the investigative team at Canoga Park, received a new sketch of the problem. "We had the first clue," he said. "It gave us something to work on." Quality manager Bob Cole now had to trace the history of the cracked part. With the help of a computer, he pulled the records. Each team member studied material affecting his area. By Saturday afternoon they felt the problem was the brazed sleeve.

"We got the drawing on the ASI line and sleeve to see how it was made," explained William McFarlen, manager of design support. "It turned out to be a simple part. The chance of any defect in the tube itself was extremely remote, and the sleeve was of no great consequence."

"So that immediately pointed to the brazing under the sleeve," Mikuni said. "It was the only thing different from Columbia's engines," he explained, "and we'd been flying Columbia with no leaks at all." [Some shuttle experts believe tests used at the time simply were not able to detect leaks in the Columbia orbiter.]

The record told an intriguing story. The ASI lines, both hydrogen and oxygen, pass through opposite sides of the main injector. Since Challenger's engines are more powerful than Columbia's, the lines had raised concern. "The clearance through the wall was 0.04 inch," Mikuni said. "What if there were more vibration with these engines? Would the line chatter and chafe, maybe wear through?"

A Rocketdyne review board considered this possibility. It recommended brazing a small sleeve to the line where it passed through the wall to tighten the fit and prevent chafing. NASA concurred and ordered it done as new engines were manufactured. The brazing material selected had a distinct orange color.

“The only way to get to the tube was to cut out the entire part from the heat exchanger. Once you do that, the game's over for that engine”

The historical study continued long into Saturday night. Team member Al Hallden's structural and dynamics experts looked at the properties of the materials involved: stress levels, safety factors, loads, and test results. Nothing jumped out as the obvious culprit.

"About all we could think of were high-cycle fatigue or manufacturing defects," Hallden said. He requested computer support for Sunday, when Rockwell's main computer center is normally down for maintenance. He got it.

In the meantime, investigators tracked down other engines with the ASI line-sleeve modification. One was on a test stand at the National Space Technology Laboratories in Mississippi. A quick borescope inspection revealed identical cracks. (In the next few days, 12 modified engines were identified and inspected. Six had cracks in their hydrogen ASI line. Engine number three on Challenger was among those with cracked ASI lines.)

"By the end of the day, we were 99 percent certain that the brazing was our problem," Mikuni said. "But we had no proof. All we'd done was our homework; we wouldn't even get to look at the part itself for several more days."

Manufacturing director Glenn Burow left for Mississippi on Sunday, Feb. 27, with a crack-repair team. As the team flew east, Hallden's associates spent the day setting and

running 15 lengthy computer models to determine if vibrations or stress could have caused the cracks. He also studied field-repair tests and brazing techniques.

"These are the kinds of questions that come up as you're assessing the whole picture," Hallden said. "You have to check them." As engineers and technicians worked through the weekend testing, checking, and calculating, many discovered that they were on the wrong track; the problem was elsewhere. The computer runs ended by 7 p.m. They showed nothing.

By Monday morning, Mikuni's team in California homed in on the braze. Nothing else looked possible. "We decided that we had a 'liquid-metal embrittlement' problem," he said. "All we had to do was prove it."

Under pressure

Brazing compounds, explained design chief McFarlen, are heated to flow between two metal pieces. As the compound cools and hardens, the pieces are strongly bonded. But if one of the pieces is under stress, the brazing material can penetrate its crystalline structure and cause a crack.

But even then there is usually no problem. The liquid compound flows into the crack, fills it, and hardens. That would account for the bright-orange cracks seen inside the ASI line. But what stress would have caused the cracks? And why did the line leak?

After exiting the wall, the ASI line drops down to a flange and bracket that grips it tightly. Hallden set up a series of lab tests to see if the line was sensitive to motions at the flange. It wasn't. "But we wanted to make sure we had every little detail identified," he said.

At the same time, plans were under way for complete chemical and metallurgical analyses of the brazing alloy. Hallden also continued running computer checks on the ASI oxygen lines.

"There were identical brazes on those lines," Mikuni said. "We had to see if there might be more problems." (In the next few days, borescope inspections of ASI oxygen lines on every engine revealed no cracks.)

In Mississippi, Burow set to work on the hydrogen line of engine number 2014. Though the borescope showed cracks, it didn't leak. Technicians removed the line, and eight hours later it was at Canoga Park for 20 carefully planned steps of analyses.

The team photographed the line under magnification up to 20×, then X-rayed it to precisely locate cracks under the sleeve. Early on March 1, the tube went to a lab for spectrographic and hardness examinations to verify that tube and sleeve materials met specifications. Then they examined the tube under a microscope.

"We saw brazing alloy on the inner wall," McFarlen said. "At that point, we split the tube longitudinally to expose the interior, took more photos, then used a jeweler's saw to make very precise cuts until we could snap the wall open right along a crack."

Then, as a metallurgist studied it under a scanning-electron microscope, the crack underwent X-ray-fluorescence examination. Finally, they carefully cross-sectioned the crack to see if the brazing alloy completely filled it.

"There was no doubt," Mikuni grinned. "It was liquid-metal-embrittlement cracking. Right then, we knew for sure that it was a generic problem and that every engine had to be fixed."

The investigation team gathered to settle on techniques for welding in a new line without a sleeve. It was straightforward. "We had to decide what would be acceptable for a field repair," Hallden said. "The decision was to do nothing unusual—use only normal repair techniques."

By Wednesday, March 2, the investigation entered a new phase. The team ordered lab tests on braze-related cracking.

Technicians wired strain gauges to the engine to be fired Thursday at nearby Santa Susana to obtain additional data, and computer analysts finished their work.

In the lab, metallurgists hung weights from a sample ASI line to get known stresses. When they brazed it, cracks occurred. When they brazed the line with one end clamped tightly by a flange, the cracks developed again. "Now we knew what caused them," Mikuni said. "The hydrogen line cracked because it was held rigid during brazing. The oxygen lines hung free, so there were no stresses and no cracks. It was just a slight difference in manufacturing." (Mikuni also ordered a records search to identify every braze in the engine. His team counted 116 of them, none a problem.) But still, the cracks filled with brazing and shouldn't have leaked.

Early Thursday morning, Burow crawled under Challenger on the launch pad at Kennedy Space Center and carefully cut out the leaking line. The next day, at Canoga Park, the team began lab analysis of the line.

This time something was different. In the X-rays, brazed cracks show up as bright-white lines. In the tube removed from Challenger, one crack appeared black—an open channel with brazing clinging to its walls. It was the leak. The team carefully cut, sectioned, and examined the tube. By late afternoon on March 6, they knew the whole story.

The evidence, Mikuni explained, indicated the tube had been heated twice. In the first brazing, cracks developed and immediately filled with brazing alloy. But the braze wasn't perfect; the worker reheated it. In that instant, the cooled braze cracked open. But there was no molten brazing alloy above to fill it. The tiny crack, 0.021 inch wide, stayed open.

It might have been discovered before it left the plant, according to Mikuni. Dye-penetrant tests routinely conducted on such parts initially showed a pinhole leak. Such leaks usually mean there is a void in the braze, not a leak in the pipe. Filing the surface of this pipe did indeed reveal a small void. But another dye inspection came up negative.

“There was no doubt. It was liquid-metal-embrittlement cracking. We knew for sure that it was a generic problem and every engine had to be fixed.”

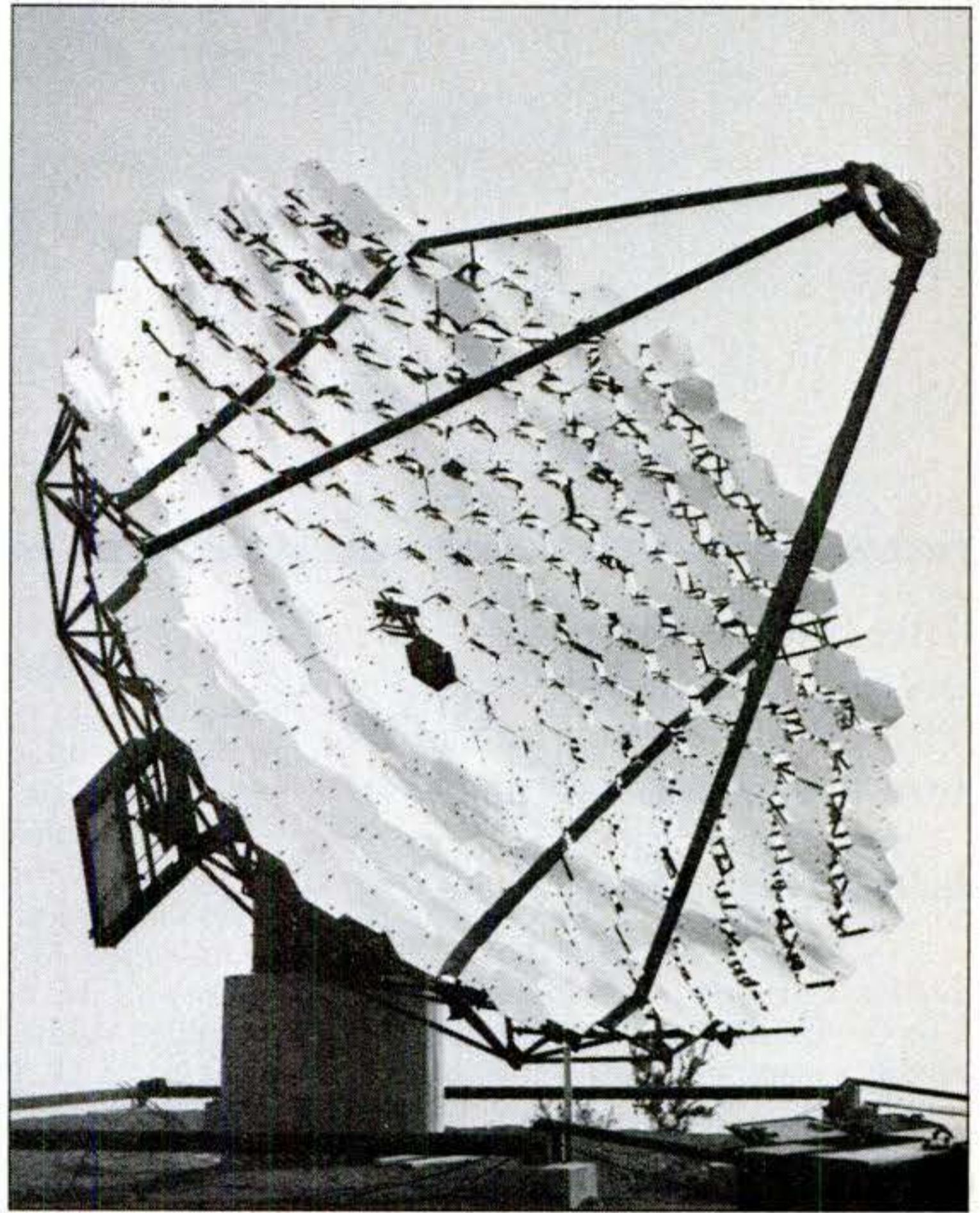
“The filing action smeared brazing material over the opening,” Mikuni said. “The crack didn’t reopen until the engine was fired.”

Even then, the leak was too small—just 27 cubic inches per minute—to be detected by normal means. Only the more extensive tests ordered on the launch pad uncovered the leak. “Without those earlier problems, this one might never have been discovered,” Mikuni said.

As word went out that the problem was solved, Burow completed installing a new hydrogen line in Challenger’s number-two engine. On Saturday, March 5, he and his men finished another installation. And on Sunday, they completed the retrofit of the third engine.

The hard part was over. Challenger was ready to fly. As the vehicle stood on the launch pad on March 27, a severe storm hit the Cape Canaveral area. Dust and sand blew into Challenger’s payload bay, contaminating the tracking satellite. Cleanup added another eight days to the delayed schedule. But on April 4, Challenger lifted smoothly from the launch pad into orbit. **ES**

Giant camera spots gamma rays



Pulsars, quasars, galactic nuclei, stars obscured by interstellar dust—some of the most tantalizing objects in astronomy are sources of gamma radiation. Yet until now, without a satellite or high-altitude balloon, cosmic gamma rays were invisible to ground-based observers because they are blocked by the atmosphere. The detection devices used were limited, too; they could be compared to a three-inch telescope in optical astronomy. Yet 28 sources of gamma radiation have been found in the plane of the Milky Way, and another has been associated with quasar 3C273. These results suggest an undiscovered territory awaiting a better way to detect its rays.

How do you use a ground-based instrument to detect and photograph something that never makes it to Earth’s surface? That was the question Trevor Weekes of Whipple Observatory and his colleagues David Fegan and Neil Porter of University College, Dublin, asked themselves. Gamma rays interact with Earth’s upper atmosphere to produce a signature—a shower of secondary particles and flashes of light known as Cerenkov radiation. And the flashes are extremely short, only billionths of a second in duration.

To take a picture of something that short-lived, Weekes and company used what’s called the Whipple Observatory Large Aperture Camera (photo). The camera has 248 mirrors that act together as a focusing lens, an aperture of 10 meters (33 feet), and an exposure time of one-hundred-millionths of a second. Its “photographic film” is an array of 37 phototubes; each one acts like a grain on a photographic emulsion. And the net effect is the ability to capture fleeting traces of activity in the universe.—K. Brown

On a plain in Spain: 650-foot power tower

This huge wind tower dwarfs its surroundings. The power company wants one four times as tall

By **BLAINE JUCHAU**

MANZANARES, SPAIN

Looming from the La Mancha plain like the lost lance of Don Quixote, the slender tower was an extraordinary sight on the horizon of this flat, dry land 100 miles south of Madrid. As I drove nearer, its startling size became apparent. The long, red-and-silver tube seemed to rise forever from a vast pool of plastic, which was carved into hundreds of neat square waves.

What at first looked like the creation of some big-thinking artist is actually an experimental power-generation facility now lighting a few homes in central Spain. The concept combines familiar principles of solar greenhouses, windmills, and chimneys in a novel but straightforward way. Air warmed by the sun under a greenhouse-like glazing is channeled to a tall central chimney, where a draft is induced as the lighter warm air inside is shoved up by cooler air outside. At the base of the chimney, a propeller-driven generator draws energy from the rising airstream.

Though the concept is simple, such a wind-power tower must be enormous in order to generate practical amounts of electricity. The test facility I visited seemed big: As I looked up inside the 650-foot-tall tower, the outlet, though 33 feet across, was a mere dot of sky in the distance. Under the 800-foot-diameter greenhouse there was plenty of room for four football fields. Still, this tower's peak output

is only 50 to 70 kilowatts of electricity—far below optimal size. A full-scale 400-megawatt version would require a 2,500-foot-tall chimney and a greenhouse nearly six miles wide.

This Spanish wind tower was conceived half a continent away by the German Ministry for Research and Technology. After extensive performance and cost analyses, the ministry concluded that a sun-driven wind tower could be the cheapest form of centralized solar power generation. And although initial plant costs would be higher than those of conventional coal or nuclear plants, the tower's simple construction would mean it could be built more quickly, the studies indicated. Once in operation, the tower's simplicity, lower operating temperatures, and free fuel would give it the economic edge, they concluded.

In late 1979, after three years of design and engineering work, the ministry contracted with the Stuttgart engineering firm of Schlaich and Partner to build a proof-of-concept tower. In 1980 the Manzanares site was selected, and the Spanish utility Union Electrica became a partner in the project. The Germans chose the La Mancha plain for its arid climate and flat terrain. Also, the strong winds there would be a critical test of the structure's durability. Construction began in the early months of 1981.

Chimney walls are made of 1.2-mm (0.05 in.) galvanized, ribbed-steel sheets. The builders rolled the sheets into cylinders, each 26 feet tall, and built the chimney from the ground up: Each section was put in place and jacked up, then another section was added below.

The greenhouse is made of a light steel framework divided into 20-foot squares and held aloft by thousands of

steel posts. Plastic glazing (three kinds are being tested) was draped over the framework and secured with cables.

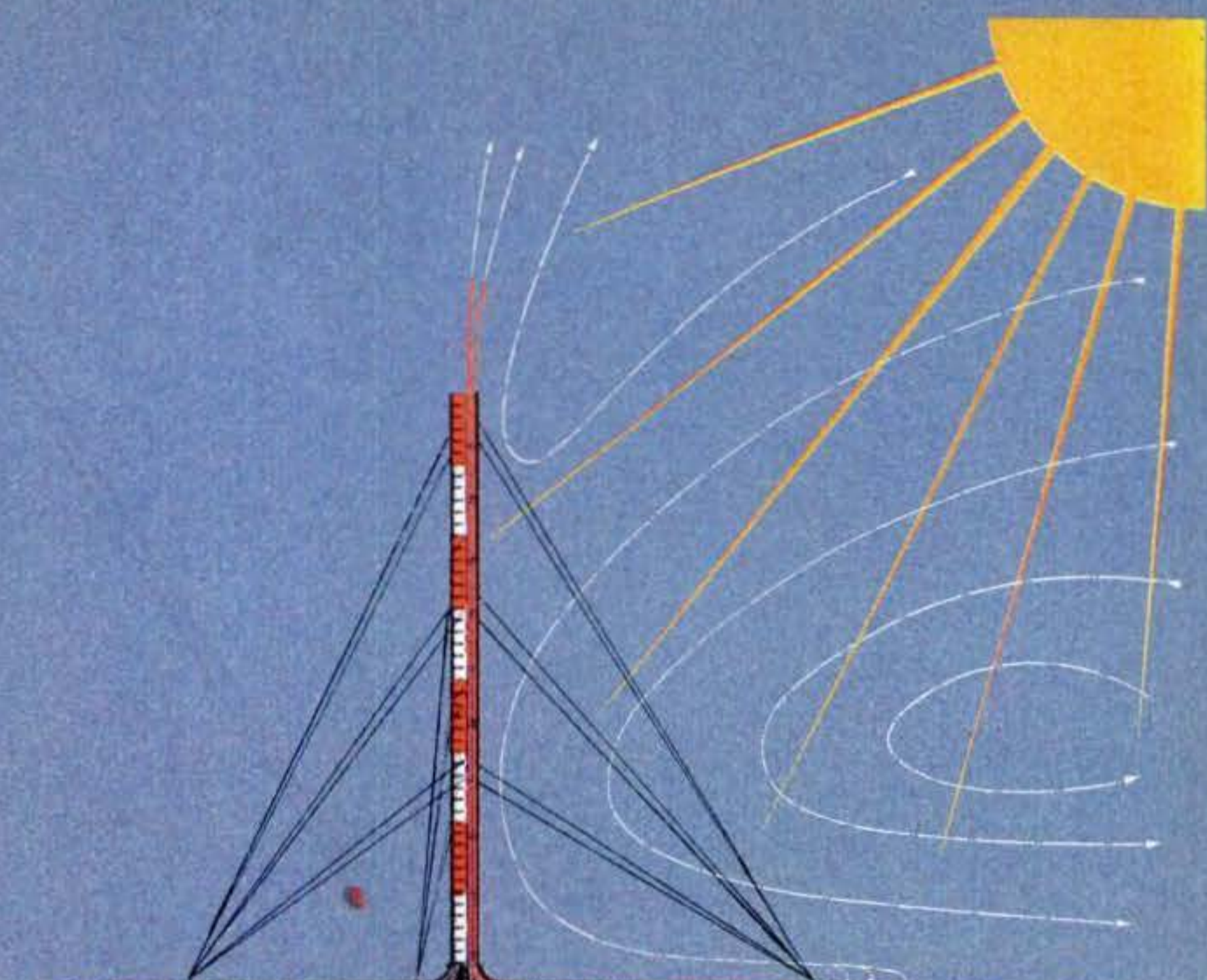
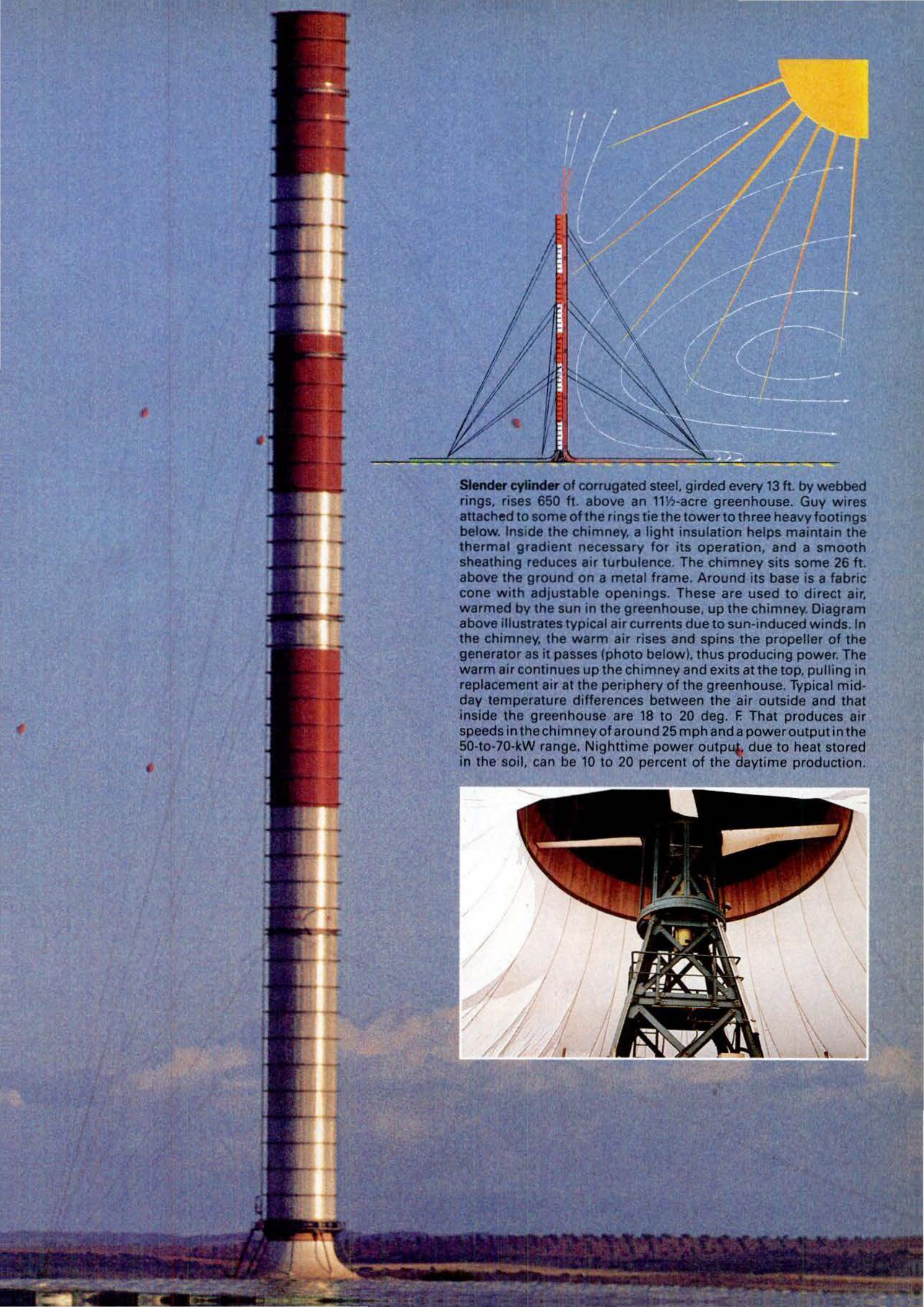
The greenhouse was severely tested even before it was finished. In late 1981, storms blasted Spain with winds up to 100 mph, tearing down power lines and stripping off roofs. In the wind shadow of the tower, where there was strong turbulence, some glazing panels ripped. (These were replaced with thicker materials.) But the rest survived unharmed.

Working parts

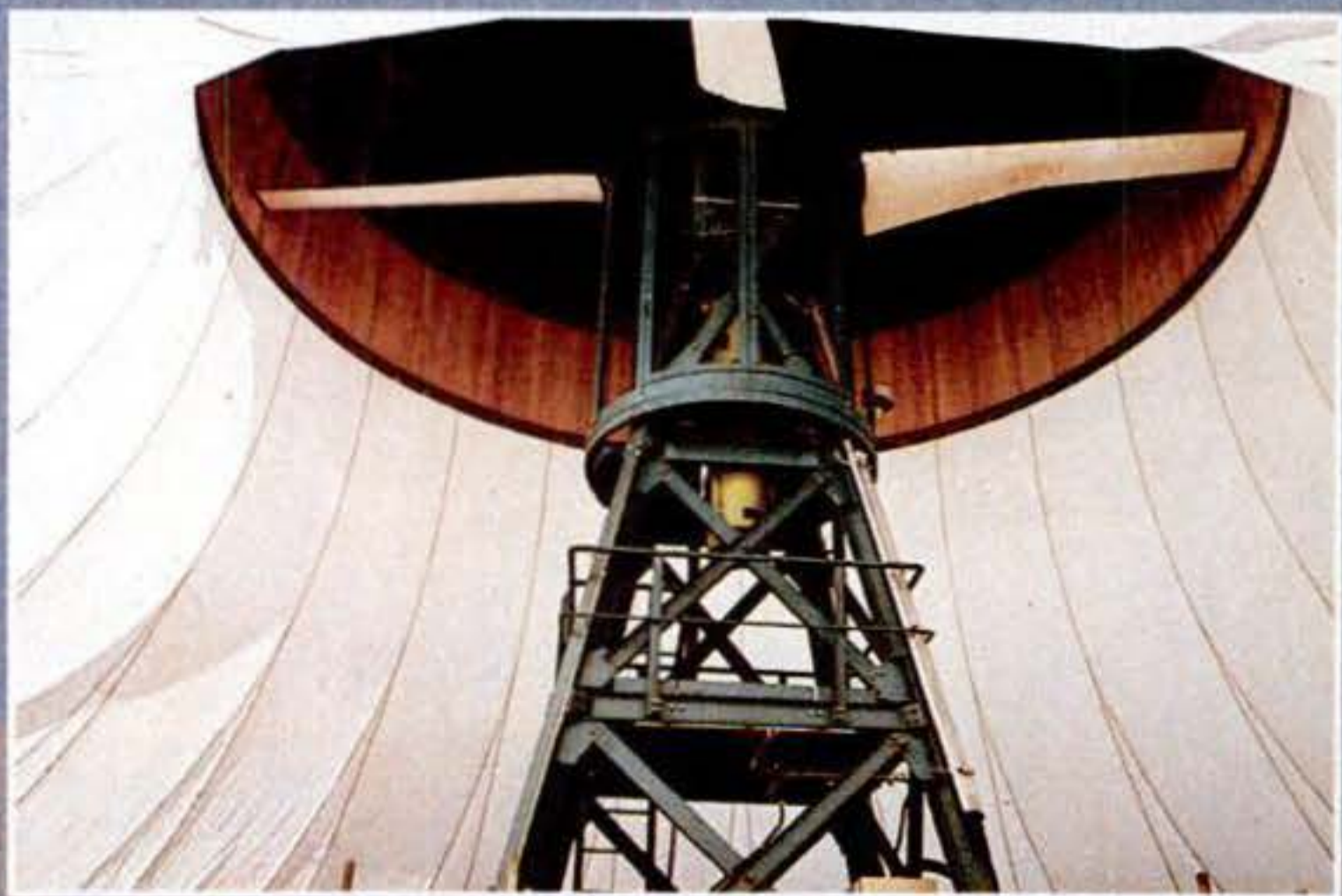
The plastic glazing hung like a giant translucent tent just above my head as I walked on splotchy, black-painted soil to the base of the chimney. The black paint makes the soil absorb solar heat better, my guide explained. At the chimney's base, a curving cone of white tarp swooped up to where the propeller of the generator spanned to within an inch of the chimney walls. The tarp's purpose: to direct the air from the greenhouse to the propeller. The generator, gearbox, and control system are all within the tarp.

The blades begin turning when the airflow reaches about 13 feet per second. To match the power grid's frequency (50 cycles per second in Europe), blade rotation is held constant at 150 rpm.

The Manzanares wind-power tower's performance has been constantly monitored, but results won't be available until the tower has operated for at least a year. Only then can the future of such facilities be assessed. Nonetheless, to someone standing in the rushing airstream, scarf aflutter, it's easy to see why engineers believe the risk is worth taking. ■



Slender cylinder of corrugated steel, girded every 13 ft. by webbed rings, rises 650 ft. above an 11½-acre greenhouse. Guy wires attached to some of the rings tie the tower to three heavy footings below. Inside the chimney, a light insulation helps maintain the thermal gradient necessary for its operation, and a smooth sheathing reduces air turbulence. The chimney sits some 26 ft. above the ground on a metal frame. Around its base is a fabric cone with adjustable openings. These are used to direct air, warmed by the sun in the greenhouse, up the chimney. Diagram above illustrates typical air currents due to sun-induced winds. In the chimney, the warm air rises and spins the propeller of the generator as it passes (photo below), thus producing power. The warm air continues up the chimney and exits at the top, pulling in replacement air at the periphery of the greenhouse. Typical mid-day temperature differences between the air outside and that inside the greenhouse are 18 to 20 deg. F. That produces air speeds in the chimney of around 25 mph and a power output in the 50-to-70-kW range. Nighttime power output, due to heat stored in the soil, can be 10 to 20 percent of the daytime production.





Ultralights to ultrajets
—a PS gallery of
**wild new
wings**



A twin-boom ultralight (above), Sadler Vampire has aluminum wings and fiberglass cockpit that look conventional. But the American Microflight craft weighs just 230 pounds. Quebec's Ultravia 210-pound Le Pelican kit-built plane (below) uses a reliable four-cycle engine. Left: Author Kocivar inspects British Vinten Wallis WA116 310-pound autogyro. It handles like a STOL.



Tomorrow's planes: novel designs plus new materials for spectacular performance

By **BEN KOCIVAR**

A veteran test pilot and observer for the National Aeronautic Assn., Alec Rankin, summed it up this way: "What's happening is that they're re-inventing the airplane."

The design revolution starts with this year's ultralights. These daring flying machines began as fabric-and-wire hang gliders propelled by tiny chain-saw engines. New ultralights, such as the Sadler Vampire, have enclosed cockpits and composite construction. More-reliable engines, such as Le Pelican's 18-hp, four-cycle power plant, are also available. Yet the craft still meet the FAA's unlicensed-flying weight (254 pounds) and speed (55 knots) limits.

Another trend: more-efficient commuter jetliners. These planes fly short hops and make frequent, fuel-gobbling takeoffs and landings. To cut costs, such new commuter planes as the Shorts 360 and British Aerospace BAe 146 have advanced, fuel-efficient engines as well as computer-designed

Continued



For aviation adventurers, the two-seat Eipper ultralight trainer (above) should also improve the sport's safety record. Aero

Gare Sea Hawk (below) has a 925-mile range. The composite amphibian comes as a kit with pre-molded pieces.





Four turbofans power British Aerospace BAe 146, a new 100-passenger commuter jet designed for flights as short as 150 miles.



Tomorrow's combat craft mate super-speeds with short-takeoff-and-landing capability. The General Dynamics F-16XL (left) has a graphite-composite wing with more than twice the wing area of the earlier F-16 Falcon. For added lift, the inboard leading edge of the "cranked-arrow" wing has more sweep than the outboard edge. The XL tops Mach 2 and uses shorter runways than the Falcon; research versions are already flying. Lockheed's proposed ultrajet (above) uses liquid-methane fuel. The hypersonic reconnaissance plane cruises at Mach 5 to altitudes of 100,000 feet. Four engines operate as turbojets at low speeds and ramjets at high speeds. The plane's outer edges are made of Inconel (a heat-

wings that give high lift at low speeds.

Digital avionics also boost efficiency. Instead of reading flight information from analog dials with oscillating needles, future commuter pilots will get detailed numerical readouts.

New military planes have more-advanced avionics—such as the video and infrared sensors that allow the Apache AH-64A helicopter to operate at night.

Since airports are prime battle targets, many new military craft will be capable of short takeoffs and vertical landings. For fast getaways the new planes have vectored thrust—exhaust systems that deflect some exhaust down, getting more lift from the same power.

New wings aid maneuverability. Many designs replace the tail elevator with a large canard that adds lift while providing attitude control. The new “cranked,” or double-delta, wing (see photos) also boosts agility. At low speeds, air swirling off the forward wing section spins like a mini-tornado back over the wing’s broad delta, improving lift.

Finally, the use of modern composites produces strong planes. Today’s advanced craft perform maneuvers that would make the wings fall off earlier, more fragile planes. **PS**



Attack copter from Hughes Helicopters fires video-aimed rockets at targets. Apache

AH-64A flies lower than treetop height and has special sensors for night flights.



resistant stainless steel), needed because at Mach 5 the jet’s leading edges reach 1,000 degrees F and glow red-hot. The Agile Combat Aircraft, shown in full-scale mock-up above, is a joint British-German-Italian project proposed for the 1990s. The fighter has a large canard and a double-delta main wing. This design, which uses carbon-fiber composites extensively, makes for exceptional maneuverability. Another canard design (lower right), the British P.103, has two rotating Rolls-Royce RB 199 turbofan engines that tilt for vertical takeoff. The British P.1214 (top right) has a forward-swept wing and vectored thrust for improved maneuverability at supersonic speeds.





The secret science of **undersea warfare**

The goal: Find the enemy,
but don't let him find you

By **CHARLES A. MILLER**

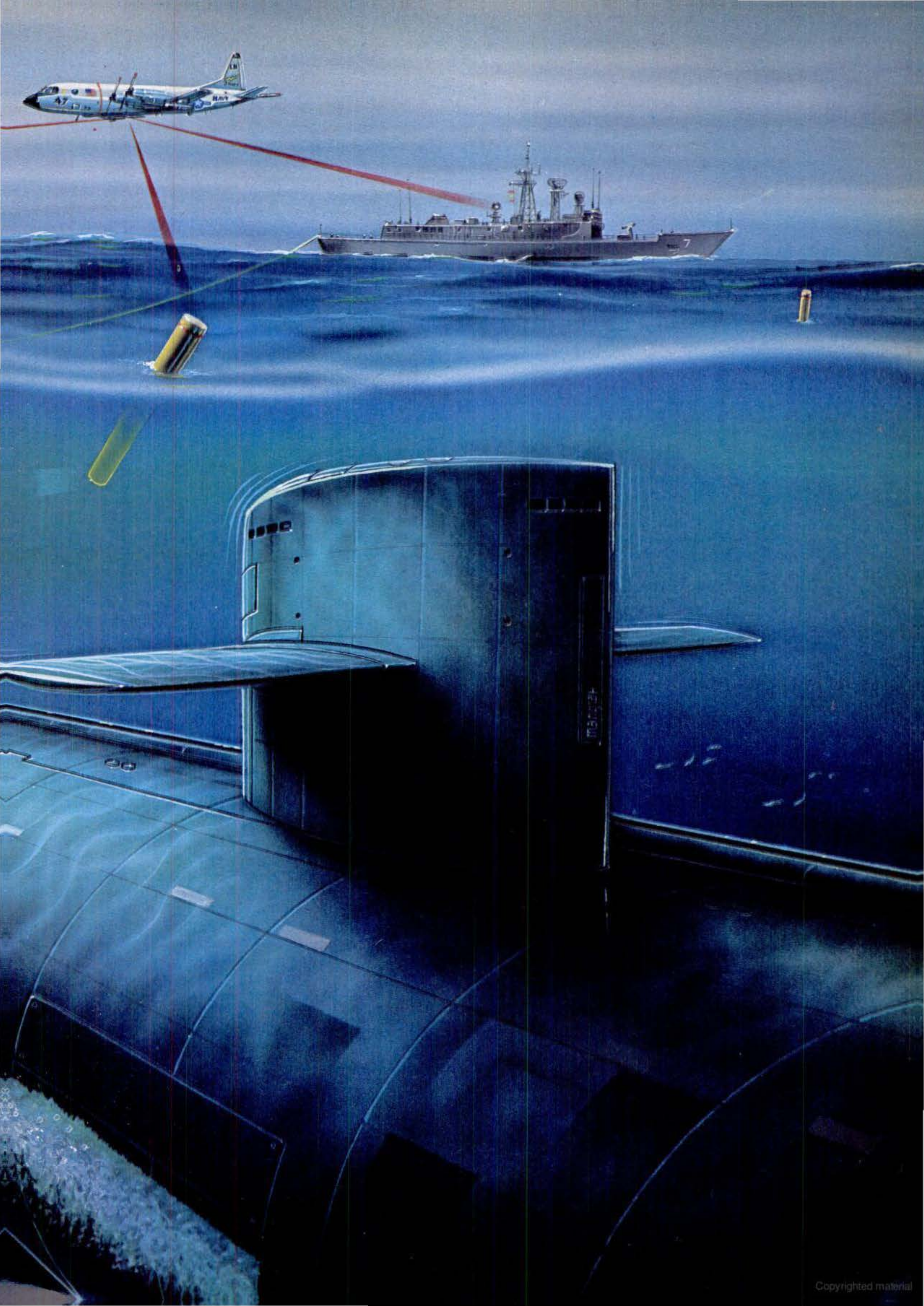
ILLUSTRATION BY JEFF MANGIAT

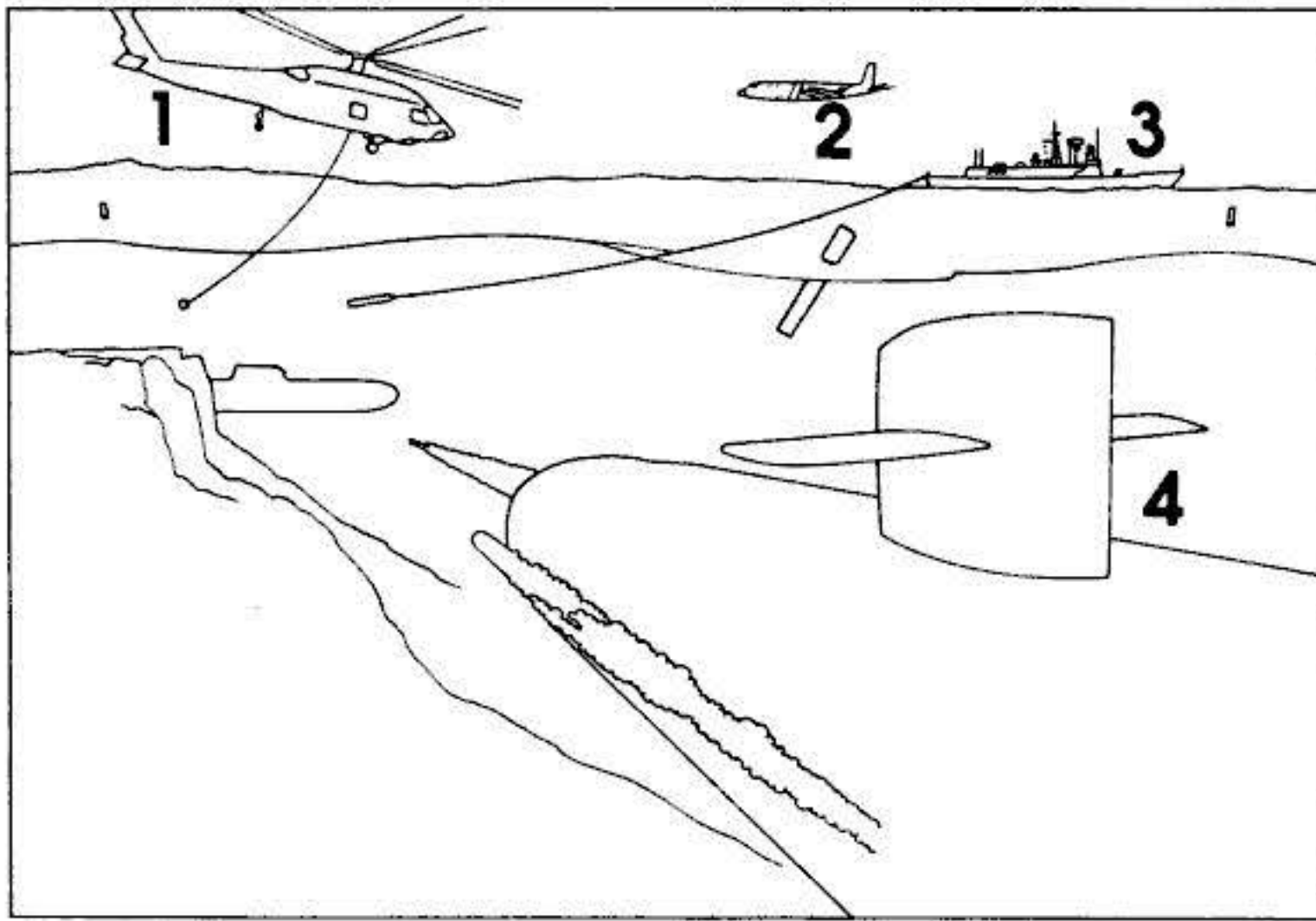
ABOARD THE USS ASPRO

It's moments before dawn. In the distance I can see the lights of Honolulu and Pearl Harbor. The starlit sky, dimly radiant in the predawn darkness, is starting to give way to a tropical glow of brilliant pink and gold, silhouetting the volcanoes arrayed a few miles before me.

The sleek black boat pushes ominously through the ocean calm. It's remarkably quiet; the diesel vibration you'd feel on a conventional vessel this size is missing. The only sounds are the wind, the slap of the waves against the conning tower, and the curl of the wake as the rounded bow moves swiftly forward.

Continued





Antisubmarine warfare over, on, and below the surface of the sea: (1) LAMPS MK III helicopter dips active sonar below the surface. (2) A P-3C Orion uses magnetic anomaly detection to pinpoint submarine's location. The plane also monitors sonobuoys that, upon striking the water, lower hydrophones to a predetermined depth and send back radio signals that are processed by linked computers. The P-3C carries a lightweight Mark 46 torpedo and will soon be fitted with a Harpoon air-to-surface missile. (3) Surface vessels tow hydrophone arrays, designed to limit hydrodynamic noise. The ships can drop nuclear depth charges (which descend slowly to allow the ship to retreat) or launch an ASROC missile that carries a nuclear-tipped torpedo or depth charge. (4) A fast attack nuclear sub launches a torpedo. Signals from sensors in the submarine's bow are computer-correlated with those from a towed array to pinpoint the target.

I'm aboard the USS *Aspro*, a fast attack nuclear submarine—one of the most lethal and fearsome instruments of war ever devised by man. This was the beginning of my final day aboard; we were heading home. I had been invited on a practice cruise to get a firsthand look at how the U.S. might conduct antisubmarine warfare (ASW) should the need ever arise.

ASW consumes a large part of the Navy's time and manpower, along with 15 percent of its budget. It involves super-sophisticated detection and fire-control systems, deadly weapons, and a highly synchronized fleet command. I saw up close how the Navy coordinates these to contend with the threat posed by hostile submarines. I saw especially the crucial role played by our submarines, whose most important mission is ASW—important primarily because the U.S.S.R. is rushing ahead with a buildup of its own submarine fleet, building more fast and quiet submarines than ever before (the Soviets now have some 365 submarines with 108 in reserve, compared with our 131).

What are the main elements of antisubmarine warfare? Before you can eliminate a submarine, you have to find it. The focus of ASW, then, is on *finding* submarines. In fact, the maxim goes, if a submarine can be detected, it can be destroyed.

"Battle stations!" The cry rang out over the PA system on my third day aboard. Instantly the boat came alive in a tumult of activity involving everyone. The already crowded control room, which is located just below the ship's conning tower, filled with people. I was sandwiched between two fire-control technicians, staring at an incredibly complex jumble of buttons, video monitors, knobs, and lights referred to as the Mark 117 fire-control system—a sophisticated computer system that locks onto a target and steers a torpedo to it. The captain of the *Aspro*—Fred Gustavson, a tall, cool professional—took the "approach," or control of the launch and firing systems. We were stalking an imaginary foe, actually a target beacon that showed on the Mark 117 as a blip with electronic vectors pointing to it. I

could see right away that, whatever it was, it didn't stand much of a chance.

The Mark 117 I saw in action is a remarkable system. It can follow several targets at once. It takes data from the ship's sonar computer and develops "solutions," as the technicians that operate the equipment put it, on what the target is doing (its bearing, heading, and speed).

Our shot was to be with a wire-guided practice torpedo. Earlier, the executive officer of the *Aspro*, Commander Tim Moore, a man as burly as he is affable, had taken me down to the torpedo room for a look. It was a long, narrow area, cavernous by submarine standards, jammed with between 15 and 20 green Mark 48 torpedoes, each some 20 feet long. As I stepped in, I was surprised that bunks were nestled in among the weapons. Most crew members sleep in three-tall berths up forward, but because space is at a premium on a submarine, some of the enlisted men share the skids with torpedoes. The specially built beds, which open into a locker underneath, looked comfortable enough, but personally, I'd find it hard to sleep with a nuclear weapon. Cmdr. Moore commented: "This is definitely not the preferred location to sleep, but if everyone wants his own rack, someone has to be here."

At the front of the room were four torpedo tubes, stacked two high on either side. The tubes are canted outward so that when the torpedoes are fired, they don't interfere with the sonar sensors behind the fiberglass nose of the ship.

A torpedo can be set to home in on the target, in which case the fire-control system provides data to it through the trailing wire. Once the target is in range, the torpedo breaks loose of the wire and finds it using its own sonar. The torpedo navigates to a position under the target's hull, where a proximity device sets it off. It doesn't actually strike the target—a much more damaging hole can be made if it goes off under the hull. (Of course, the damage question becomes academic with nuclear devices.)

Searching with sound

During the practice firing, stationed as I was between the two fire-control technicians, I got a feel for some of the target-tracking problems. Capt. Gustavson was shouting orders over the general din. He seemed uncannily aware of what everyone was doing and barked out objections when it seemed that the technicians were not correctly interpreting the target data. "That's not right," he said, pointing over the shoulder of an errant subordinate who seemed a bit behind in his calculation. "Get it right."

The captain had taken the time earlier to show me some of the most critical parts of the fire-control system, including its link to the ship's sonar. He had ushered me into a small, climate-controlled room amidships, through a door marked "authorized persons only." The room was dimly lit in red. One wall was filled with racks of electronic gear; on the opposite wall, amid banks of flashing indicators, was a series of monitors, which were manned by specialists hunched over the readouts looking for telltale shapes on the screens. These were the eyes of the ship.

I knew from previous interviews that there are two ways to search with sound. One is with active sonar, which, like radar, emits a signal that can be detected when it reflects from a target (though it is far less accurate than radar). The second is by passive sensors—just listening to sounds in the water. You can get a bearing by determining the direction of the sound, then figure the potential target's speed and distance by triangulating different readings. The preferred method is to search passively, without sending out a sonar signal; an active signal can give the searching submarine's position away.

To a sonar system, a target—especially a submarine—is the sum of its noises. When the propeller turns, it churns

water and creates a sound called cavitation noise. The flow of water rushing past the hull causes another characteristic noise, which increases as the submarine goes faster. Machines aboard the sub, too, can create a "sound signature" for the sonar's computer to analyze.

But sonar is not without its problems. It doesn't discriminate, for instance, between the torrent of stray sounds in the ocean, some of which are emitted by marine animals or seismic activity. Moreover, reflective and refractive distortions due to changes in the underwater speed of sound (caused by pressure, temperature, and salinity gradients) can be deceptive. They can mislead a sensor as to both the nature of a sound and its apparent direction (sound rarely travels in a straight line underwater).

The two primary sound-sensing systems aboard a modern submarine are located in the bow and in an array towed by the vessel while submerged. Towing an array aft helps the sonar equipment to distinguish between the low-frequency sound of the submarine towing it and that of a potential target.

The sonar computer assembles the signals from all of the sensors into a composite picture—literally. As we stood behind the technicians in the sonar room, Capt. Gustavson explained: "Sound is represented by time lines on the display. An operator can call up a combination of readouts to show 360 degrees of coverage on eight different elevation angles. When an operator discovers a contact, he assigns an automatic tracker to it, and, if there is enough sound from the contact [over the surrounding environment], the tracker stays on that target."

The contacts I saw on the screen looked like fuzzy isobars, similar to what you'd see on a weather map in the local paper except that they moved. One of the operators said that these were probably whales or other large marine life—"biologics" was the term he used. If the contact proved (through computer analysis) to be a submarine, however, it would be tracked and logged, including its evasive tactics should its captain realize he's being tracked.

Back in the control room at battle stations, our hunt was about to reach its climax. Once he was satisfied that the fire-control system had accurately determined speed, range, and bearing of the target, the captain ordered: "Shoot!"

I heard a tremendous clanking as the practice torpedo shot out. It can swim to its target at 63 mph and has a range of some 23 miles. Its miles of single-strand guiding wire—through which signals are multiplexed—are played out from a dispenser at its stern.

The torpedo was recovered later by a small surface vessel called, aptly, a torpedo retriever. I don't know whether it hit the target; Capt. Gustavson didn't find out himself until he was back on shore. After the shot, the crewmen were secured from battle stations and I went below to sample the fabled submarine food.

The fable, I can tell you, is true. As I sat down to a banquet of mashed potatoes, fried chicken, corn, salad, biscuits, and ice cream, I joined in the wardroom banter. The faces around the table were like those that might stare out of class pictures at any engineering school in America. Each officer, friendly and easygoing to a man, seemed cut from the technical mold. It wasn't difficult to imagine them two or three years back with a load of pens in their shirt-pocket protectors and a scientific calculator strapped to their belts.

The captain asked me if I would like to take a turn at the helm. "Me?" I thought. "Steer a multimillion-dollar ship through these shoals?" I told him I'd think about it. . . .

"Dive! Dive!" The warning for the dive was sounded. Even though I was aboard a modern nuclear submarine, the routine for the dive was right out of an old Clark Gable

movie. Two blasts of the Klaxon and down we went—with me at the controls. I had spent three or four apprehensive moments thinking over Capt. Gustavson's offer and then, without seeming too anxious (I hope), grabbed the chance to run the ship through its paces. The officer of the deck had me strapped in at the helm to take the ship down—but not without an able seaman standing by, just behind me, in case I veered toward a reef.

Then an announcement came over the public-address system: "The ship will be conducting test angles." Before I had a chance to figure out what that meant, I heard the order: "Take her down to [classified] feet, [classified] angle." I shoved the airplanelike yoke forward to the bulkhead, just as I had been briefed to do. As I did, though, I couldn't help but notice that maps, coffee containers, and clipboards crashed to the deck all around me. "So that was a test angle," I thought.

I had no sooner leveled the ship off at the ordered depth when I heard: "Take her up to 300 feet, [classified] angle." I immediately pulled back on the yoke, and the ship darted up. The depth indicator was spinning so fast that it looked as if it were about to lose some of its internal gearing. The charts that had just been retrieved fell back to the deck, and some of the crew struggled to get them before rolling down the sloping deck themselves. "Good thing I'm strapped in," I said to the fellow behind me, trying to act nonchalant.

A few test angles later, I figured I had had enough excitement to last me. I was about to relinquish my seat when I heard: "Take her down to [classified yet deeper] feet, [classified yet steeper] angle."

"He must be kidding," I thought as I shoved the yoke to the bulkhead, contemplating the loud popping I heard from the pressure hull and the tons of water it kept at bay. "That's only the sound of the deck on the struts," the dive officer assured me.

Finally, this exercise ended. The ship had performed beautifully; it was somewhat like being in the first car of a 5,000-ton roller coaster in the dark.

The endless watch

As you read this, many attack submarines such as the *Aspro* roam the oceans, endlessly repeating such training exercises as the ones I saw. They are part of a worldwide antisubmarine network. That network consists of submarines, planes, ships, and permanently located hydrophone nets such as those that make up the Sound Surveillance System, a series of acoustic sensors moored to the sea bottom off our coasts.

Any element in the chain might detect a suspicious sound. If so, it could relay the information to a P-3C airplane, which would search in the direction of the sound. It might use both acoustics (dropping sonobuoys) and magnetic anomaly detection, which works by detecting the changes in Earth's magnetic field caused by a submarine.

Once close, the P-3C would begin dropping passive or active sonobuoys, the signals from which would be picked up by the plane and processed on board or fed to computers aboard the command ship. If the submarine eluded this hunter, others would come to bear, notably fast attack subs such as the *Aspro*. And all of the searchers carry means to destroy a submarine.

Is all of this effort and expense justified? The Navy contends that it is and fears the ASW problem can only grow worse. Remember, the reason a submarine is so dangerous is because it can exploit the tactic of ambush so well. Or as the *Aspro's* Capt. Gustavson told me wryly: "What you don't do with a submarine is fight fair. If it looks as though it's going to be a fair fight, you leave—then come back later and pick up where you left off." [E]

What's New

A PICTURE ROUNDUP OF NEW PRODUCTS AND DEVELOPMENTS

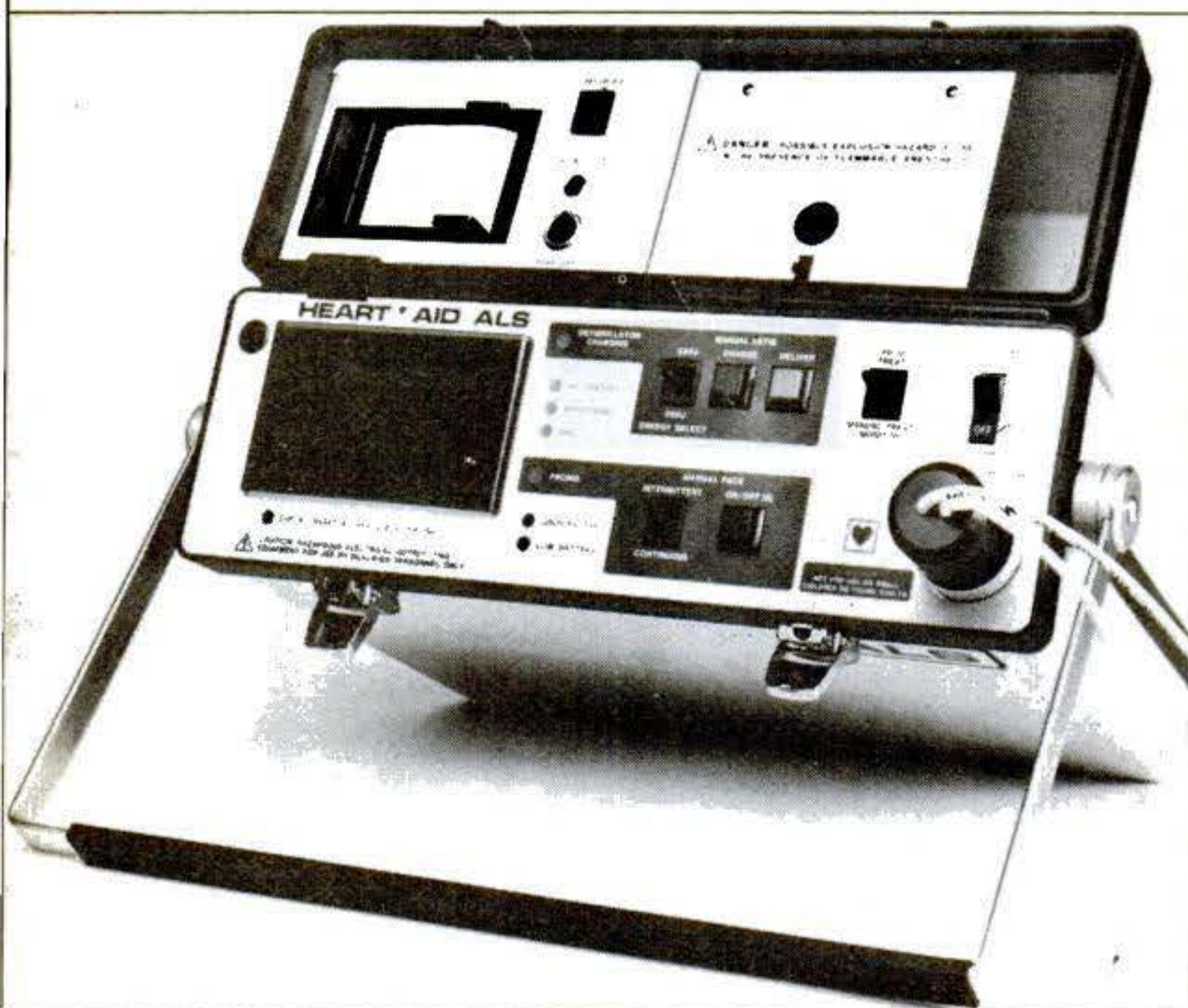


Compact telescope

A Schmidt-type corrector lens helps the Comet Catcher telescope deliver wide-field, razor-sharp images, says Celestron Intl. (Box 3578, 2835 Columbia St., Torrance, Calif. 90503). The \$350 telescope has a 5.5-in. mirror and can be mounted on a photographic tripod.

Heart shocker

Someone collapses nearby. Is he or she suffering from ventricular fibrillation—a deadly heart-rhythm disturbance? Now there's a compact device, suitable for big offices, sports centers, and factories, that can automatically diagnose this condition and deliver an electric shock to restore normal heart rhythm. Called Heart*Aid, the 22-lb. defibrillator-pace-maker is designed to be used with cardiopulmonary-resuscitation techniques—keeping oxygenated blood circulating to the victim's brain. The \$7,200 Heart*Aid can be purchased or leased through a doctor from Cardiac Resuscitator Corp. (Wilsonville, Ore. 97070).



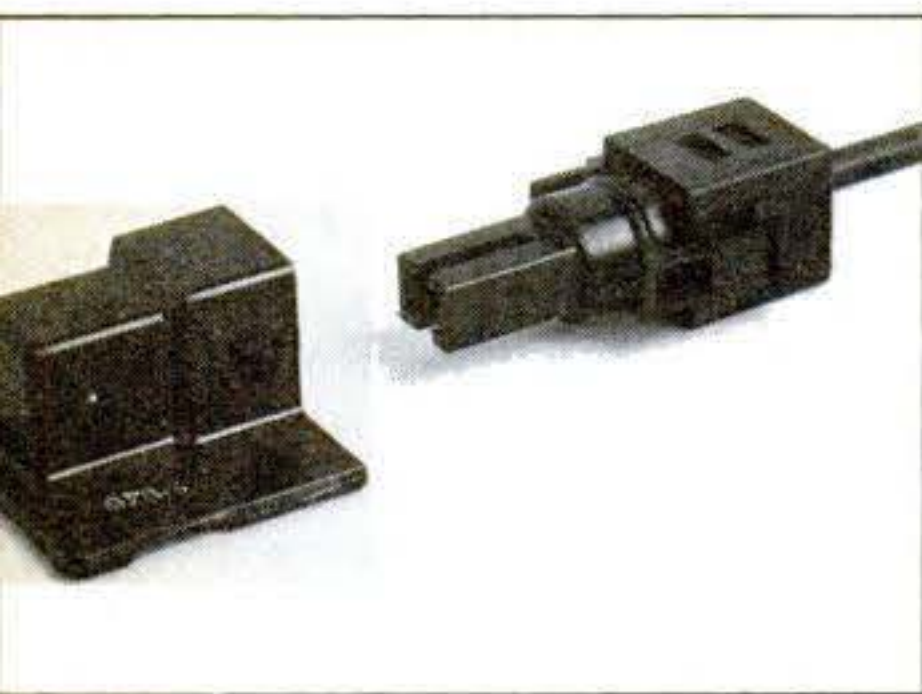
Radon detector

Put Track Etch detectors on the walls, and they'll record "hits" of radioactive radon-gas particles, which are sometimes concentrated in poorly ventilated energy-efficient buildings. Detectors are returned to Terradex Corp. (460 N. Wiget Lane, Walnut Creek, Calif. 94598) for processing.



Solar-panel plug

Solarloks make it easy to connect solar-cell modules into an array, says AMP Inc. (Harrisburg, Pa. 17105). The rain-tight plugs, designed for a 20-year life, minimize wiring errors and speed installation time, says AMP. A busbar housing (left) is bonded onto modules.



Modular locomotive

A new diesel-electric locomotive launched by British Rail in England can easily be adapted to rail systems throughout the world. The load-bearing underframe accepts a variety of bodies or wheelbases, and the superstructure is modular for easy parts replacement.

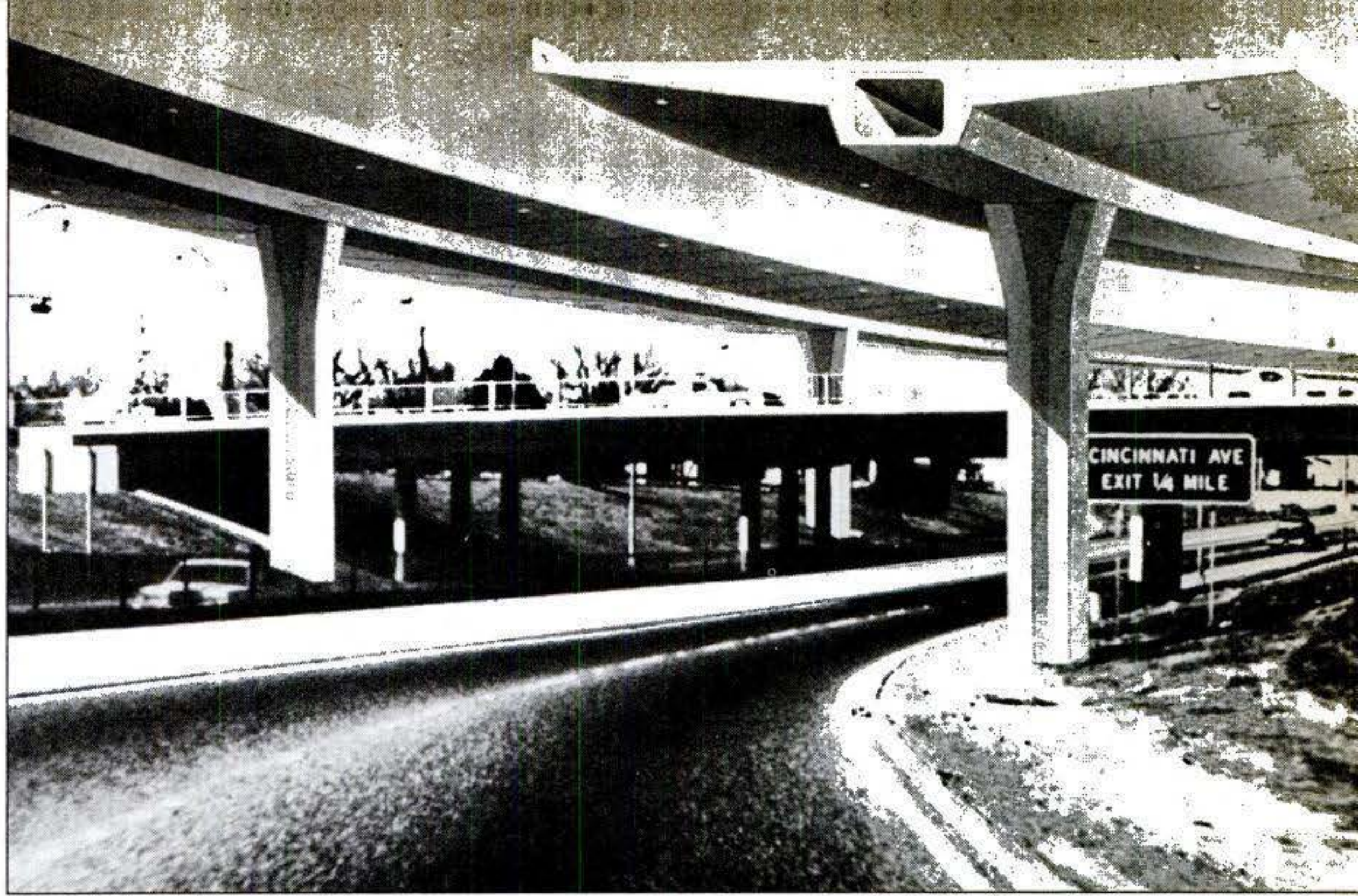
Tiny runabout

Ghia Trio is an eight-ft.-long, 743-lb. design car from Ford's styling studios in Turin, Italy. The three-seater has a honeycomb-sandwich floor of glass fiber and Kevlar. The runabout's 250-cc (15 cu. in.) rear engine gives 58 mpg at 50 mph with a belt-and-pulley transmission.



Winged highway

Elevated three-lane roadways on wing-girder spans will boost an interstate's traffic capacity in San Antonio, Texas. T. Y. Lin Intl., San Francisco, devised precast "wings" and a cast-in-place spine beam for the 40-ft.-high structures, which will span existing roads.



Safety packs

Blister packs for 40 analgesic tablets, plus a carton with glued end flaps, make this package tamper- and child-resistant, says Plough, Inc. (Memphis, Tenn.). St. Joseph Aspirin-Free Tablets for Adults packaging is virtually impossible to open without evidence of tampering.



Sleek hatchback

Comfort, compactness, and good mileage are the design goals Peugeot and Pininfarina set when they began work on the 205 six years ago. Engineers wanted plenty of room inside plus a sleek external shape. Wind-tunnel tests show a 0.35 drag coefficient. The 205 is not available in America.

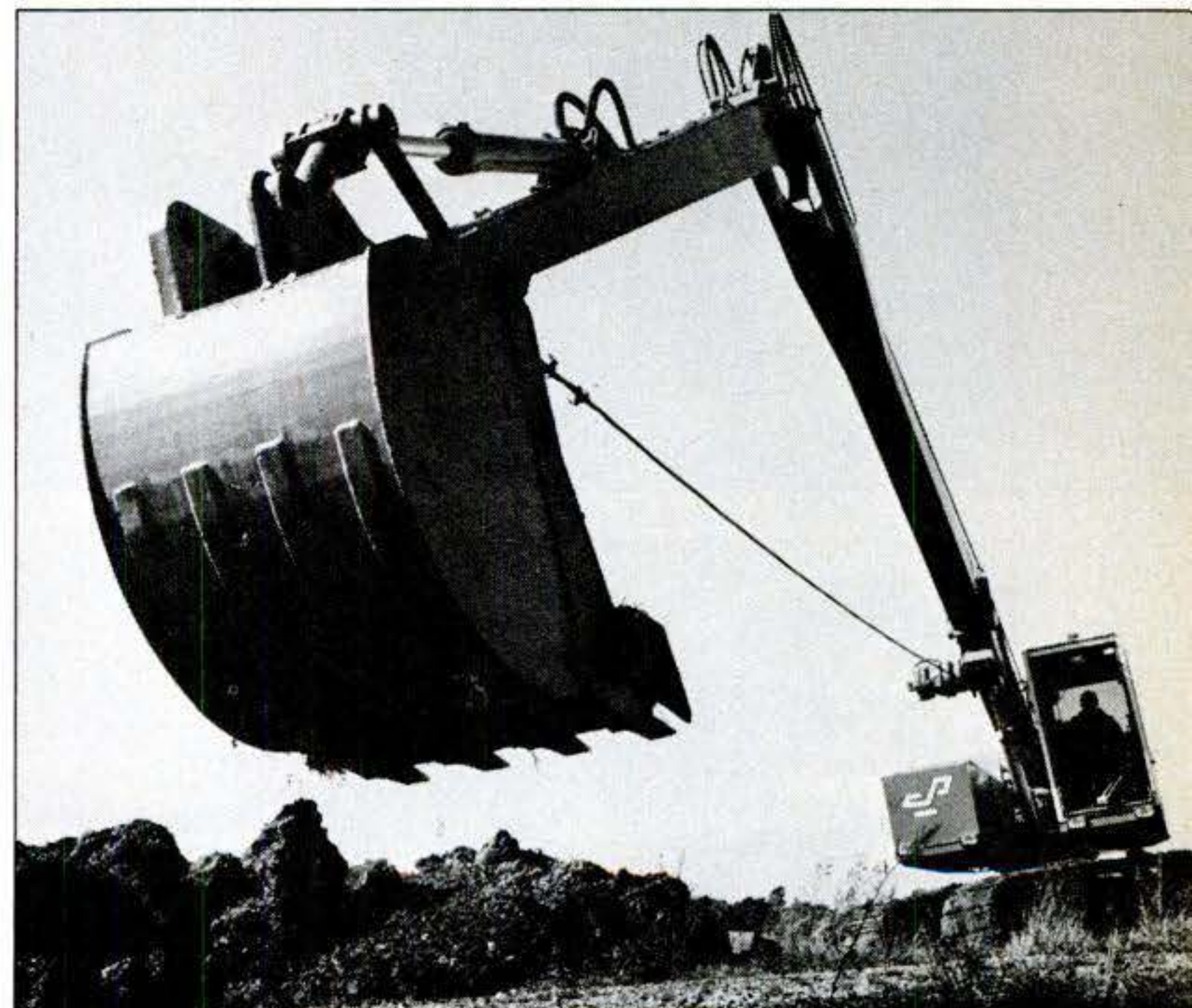
Restraint seat

Safe-T-Seat lets you restrain children on aircraft during take-offs and landings. Model 78 has been approved by the FAA, and it's suitable for car use, says Cosco/Peterson, Inc. (2525 State St., Columbus, Ind. 47201). Price: \$65.



Long arm

As its bucket moves out—up to 50 ft.—a counterweight on the VC15 excavator slides back to balance the load. That means the machine can handle 50 percent greater loads than many similar-size machines, says Priestman Bros. (Hedon Rd., Hull, N. Humberside, England).



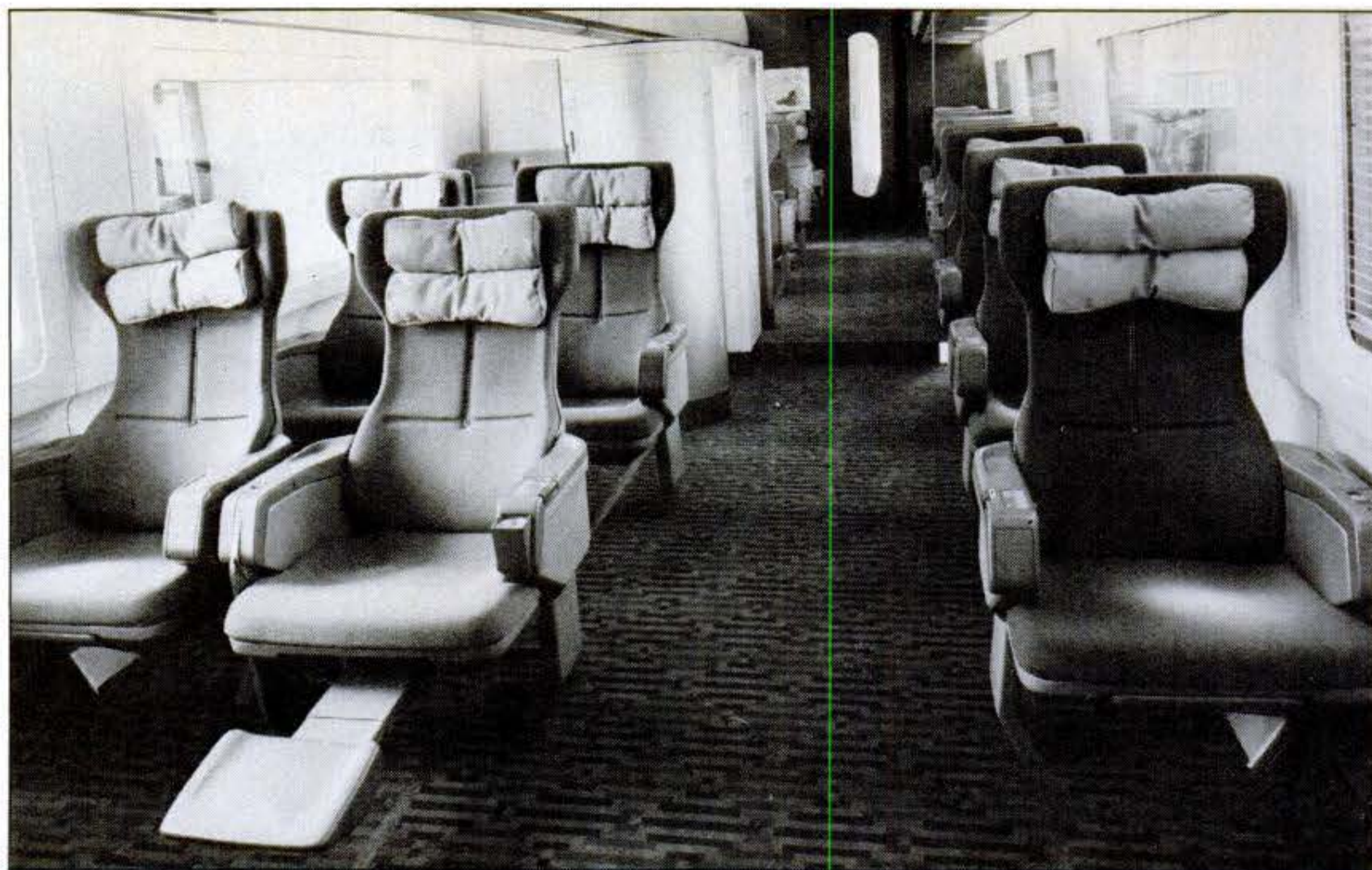
Propjet transport

Caravan is Cessna's newly designed 14-passenger propjet aircraft slated for 1985 production. A 600-hp turboprop enables the utility transport to cruise at 214 mph, with a 1,000-mile range. The plane can be fitted with floats and skis for various flying missions.

What's New

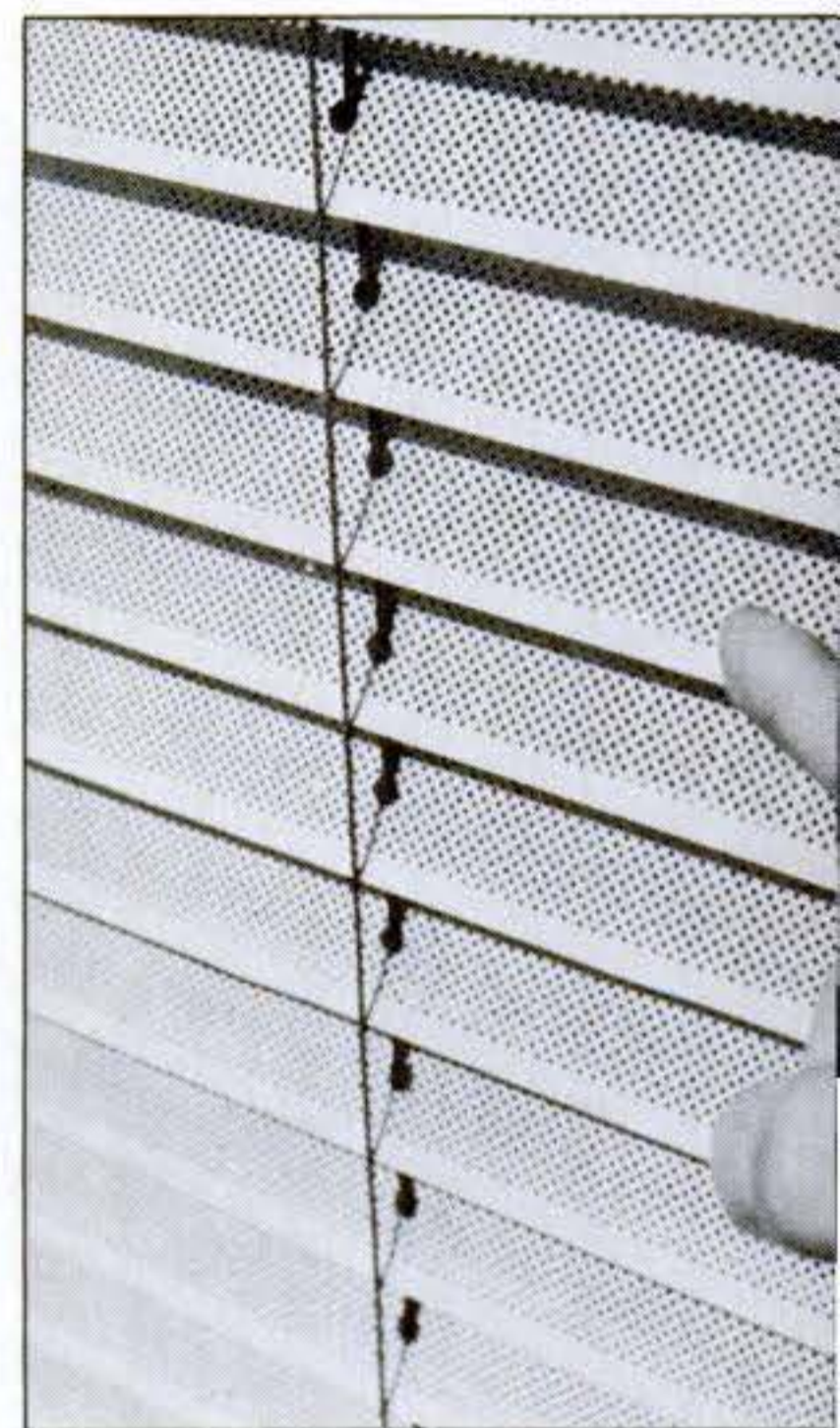
Super-train

This train looks like a plane—inside, at least. The prototype passenger car has aircraft-type seats, overhead lockers, and passenger-entertainment consoles. MBB, the German firm that makes the Airbus, built the car as part of a proposed 350-km/h (218 mph) intercity train.



Brick maker

No kiln needed—the Brepak hand-operated hydraulic press makes water-resistant building blocks from clay mixed with lime. The soil blocks cost half as much as concrete blocks, says their British developer, Welding Industries (Blackswarth Rd., Bristol BS5 8AX, England).



Venetian screen

Cable together perforated, plastic-coated aluminum slats. Result: a Venetian blind that performs like a window screen. The fully closed slats let light and air in while blocking out glare and insects. Maker: Jin Yang, 745-2KA Sung Su-Dong, Seoul, Korea.



Scout radar

From inside its small, streamlined pod suspended from the F-16's belly, Terrain-Following Radar scans details of the scene below. With this Texas Instruments system, fighter pilots can maneuver closer to the ground, avoiding obstacles and enemy jamming.

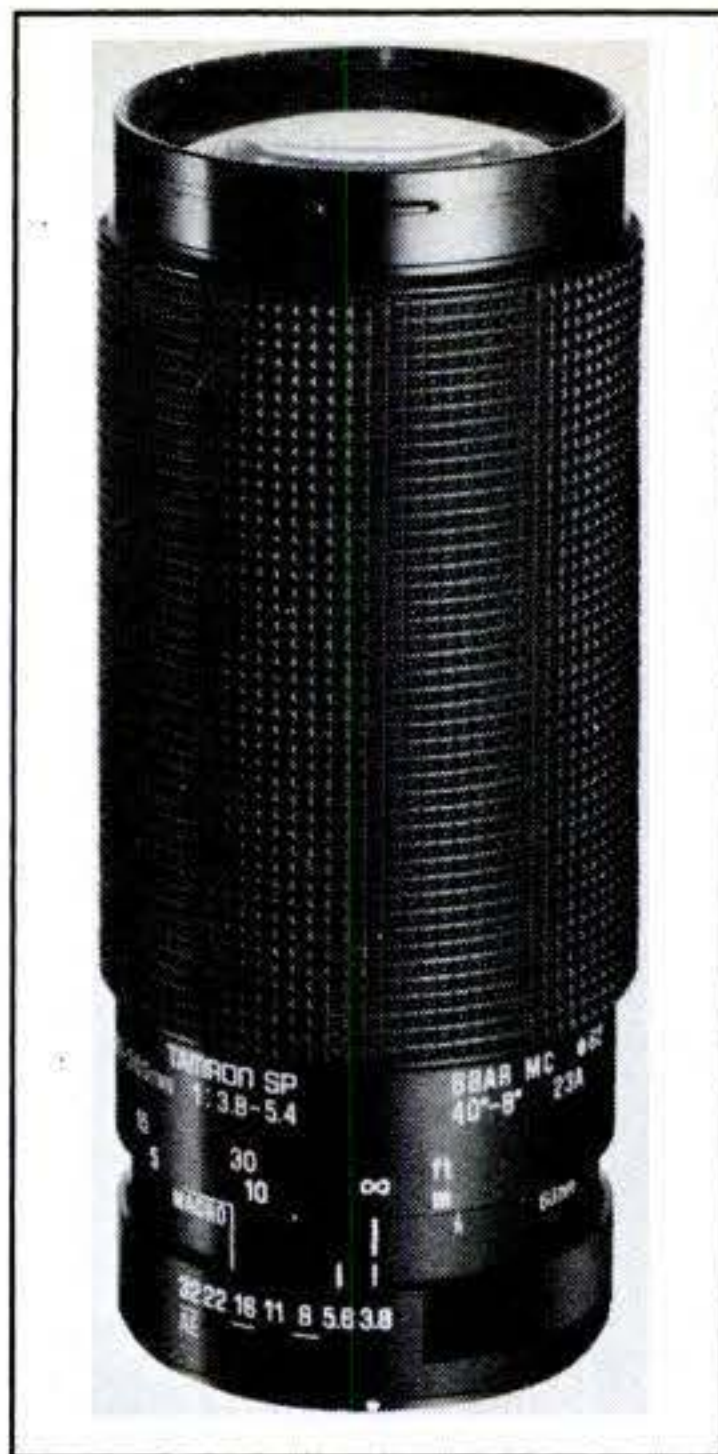
Family tent

A free-standing dome, the Odyssey tent sleeps four. The eight-by-10-ft. tent weighs 24 lbs. and has a six-ft.-high ridge, two windows, and a screened door. Its polypropylene laminate is strong and "breathable," says The Coleman Co. (Wichita, Kan. 67201). Price: \$216.



What's New IN PHOTOGRAPHY

BY E. H. ORTNER

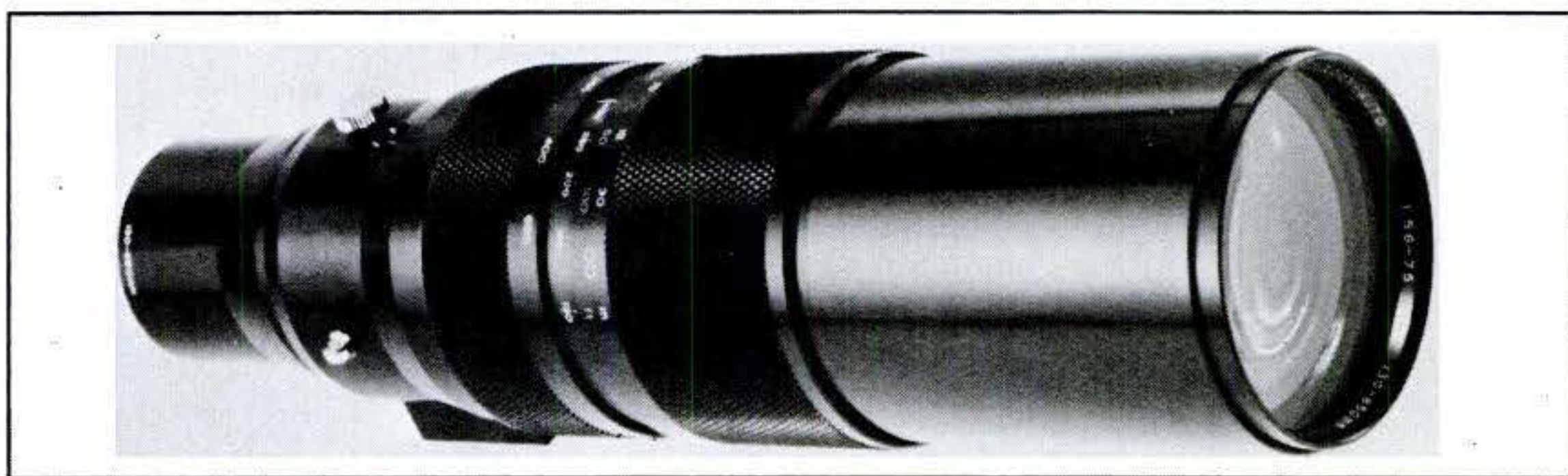
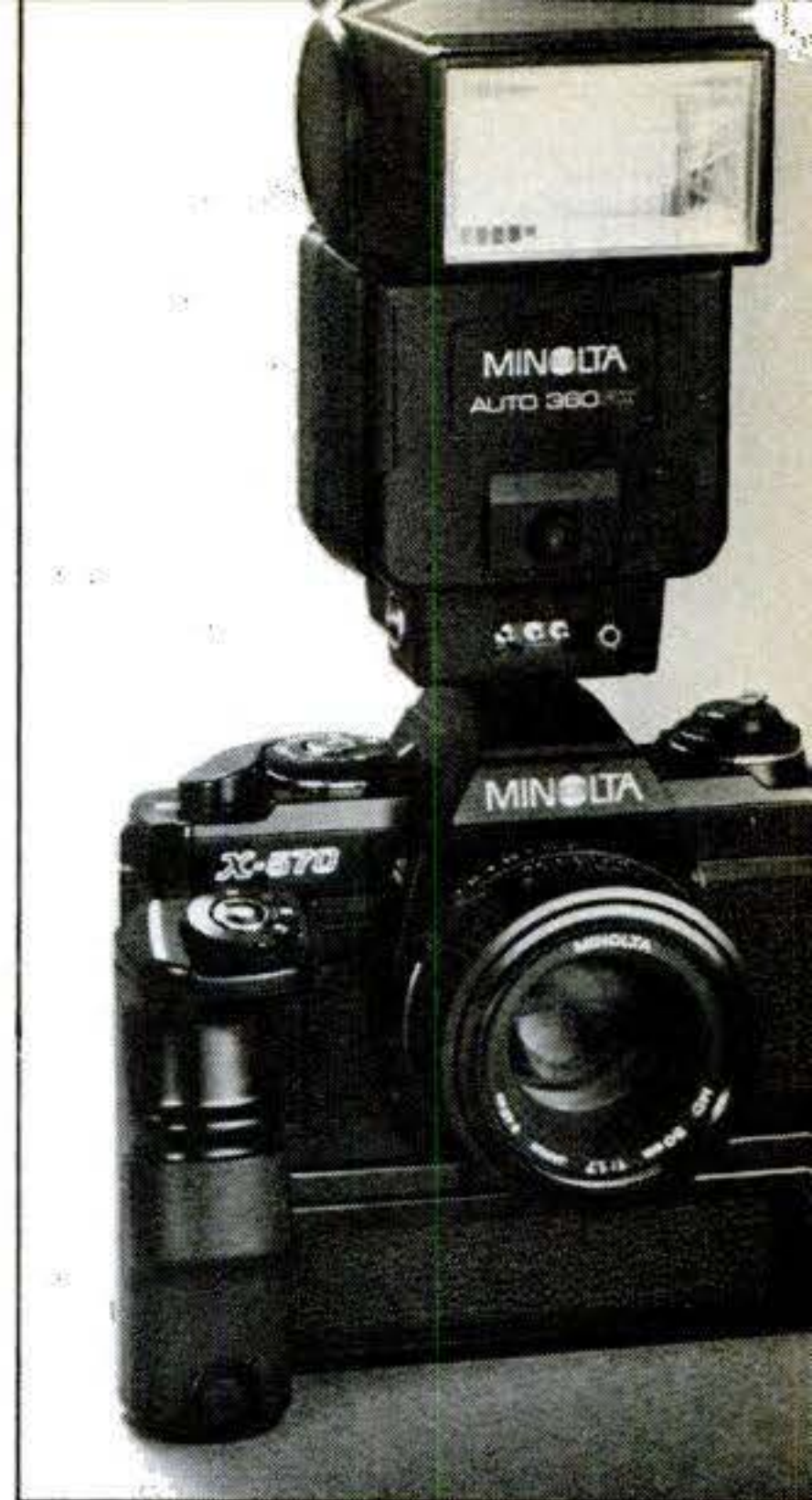


Ultra zoom

From 60 to 300 mm, this Tamron SP tele-zoom lens covers a 5× range of focal lengths from almost-normal to ultra telephoto. It offers one-touch zoom and focus control, is 6.5 in. long, and weighs 30.7 oz. List price of the f/3.8-5.4 varifocal lens: not set.

Flash-control SLR

You set the aperture; the Minolta X-570 sets the shutter speed—from four seconds to 1/1000. The aperture-priority camera also offers manual exposure control, plus film-plane flash metering. Price of the new automatic Minolta? Not yet set.



Compact zoom

It's only 4¼ in. long, but Tokina's prestige-line ATX lens takes in a big wide-angle-to-telephoto range of 28 to 135 mm, for a zoom ratio of almost 5:1 (6.9:1 in macro mode). Estimated list price of the f/4-4.6 varifocal lens is \$600.

Tele zoom

For nature or sports photography, it's hard to beat the Soligor C/D 130-650-mm f/5.6-7.5. It zooms from a mild telephoto angle of 18 deg. to a narrow three. The lens weighs 70 oz., is 14 in. long, focuses as close as 13 ft., comes with a seven-year warranty. With aluminum case, it lists for \$900.



Desk-top printer

Take your choice: The new Polaprinter can deliver either an eight-by-10 color print or transparency from your 35-mm slide. A built-in electronic flash exposes a Polaroid negative, which is removed and inserted with the positive material into a film processor. You peel 'em apart for the final product.

Spot-metering SLR

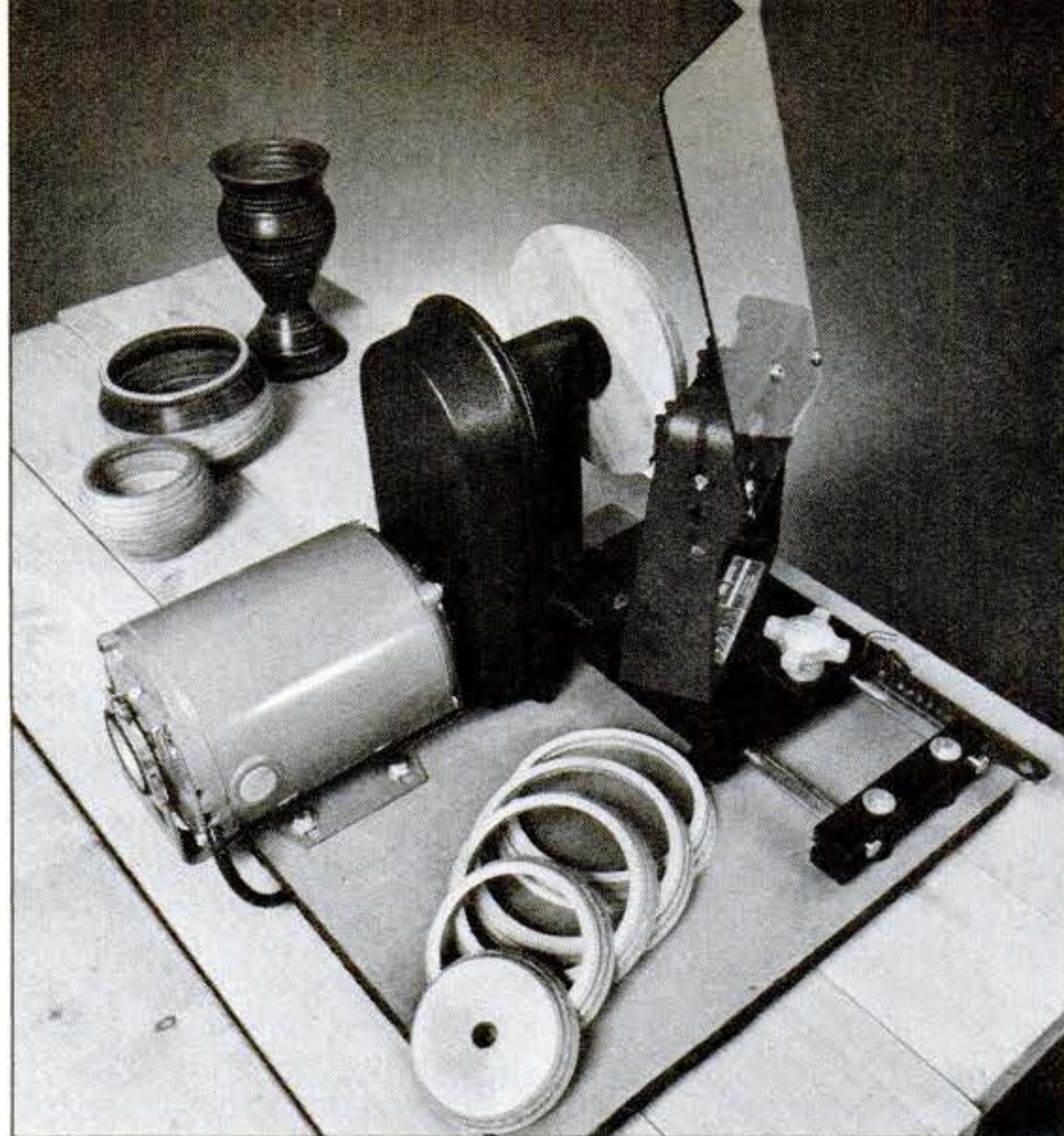
The Olympus OM-3 and OM-4 SLRs take spot readings at up to eight points in the subject area, then compute exposure. For a specific exposure to favor, say, highlight or shadow, or a center spot, just press a button. Both the auto-manual OM-4 and the manual OM-3 list for about \$600; f/1.8 lens: \$100.



What's New

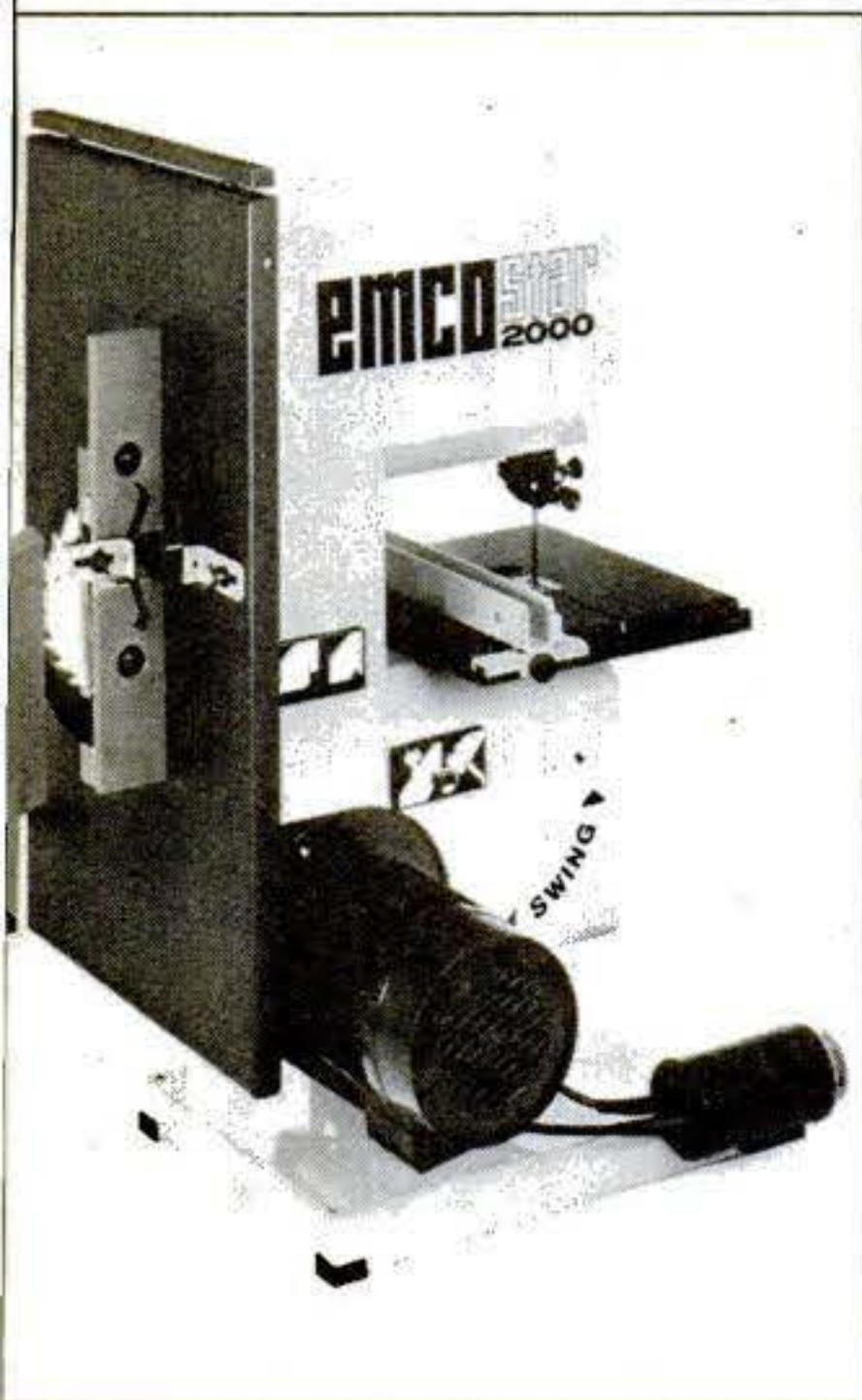
IN TOOLS

BY V. ELAINE SMAY



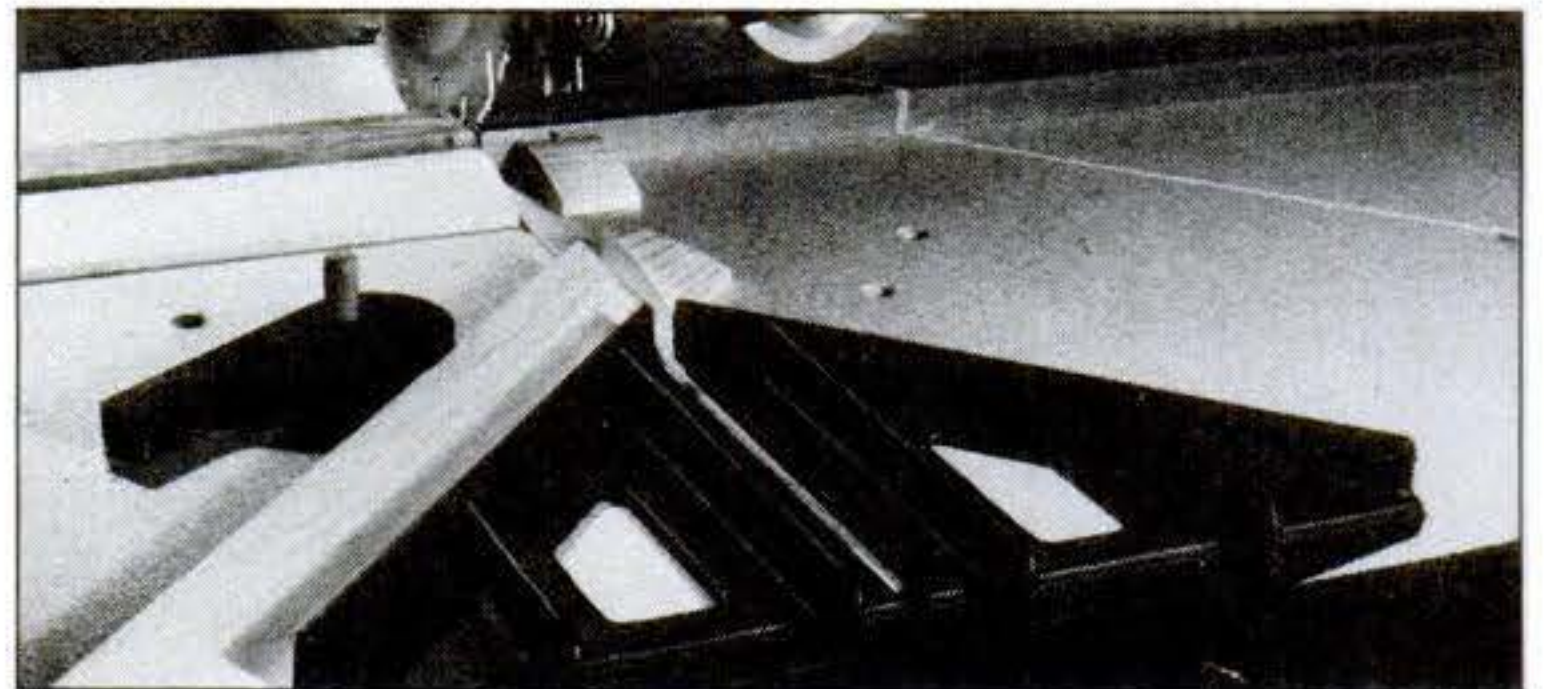
Ringer

You don't need a lathe to create wooden bowls, vases, and lamps, says Ring Master (Box 8527-A, Orlando, Fla. 32856). Blades (detail above) of this unique power tool cut concentric rings—straight or angled—from flat wood. You stack and glue the rings, then sand and finish. \$349.



One-piece shop

Emcostar 2000 is a band saw, as shown. But swing it 90 deg., and it's a table saw, molding machine, or disc sander—all powered by a 2.1-hp motor. Various accessories are available. Emco Maier Corp., 2050 Fairwood Ave., Columbus, Ohio 43207. \$895.

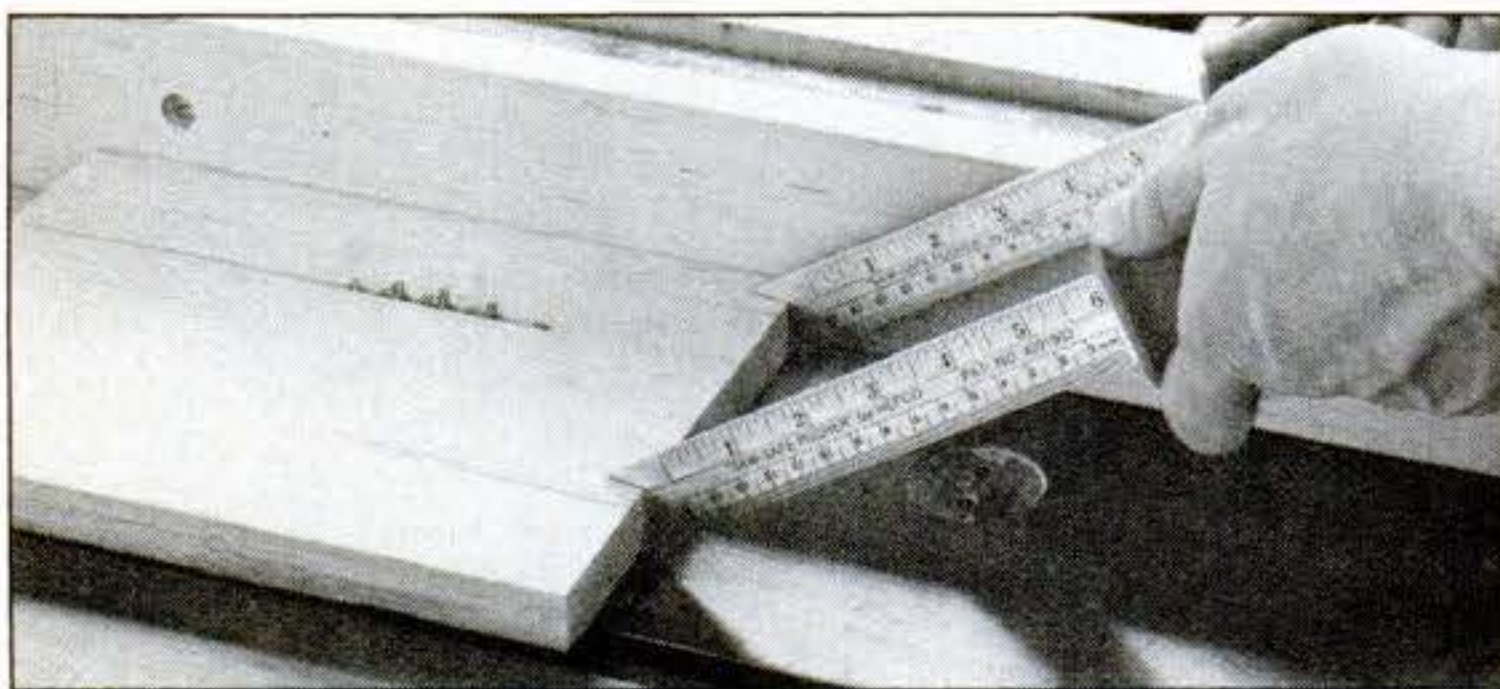


Good pusher

"Here's a pusher that'll keep you healthy," says Leichtung, Inc. (4944 Commerce Pkwy., Cleveland, Ohio 44128). The notched end will grip your workpiece so you can push it through a power saw, planer, or shaper—with your fingers safely above the action. Pair of pushers: \$9.95.

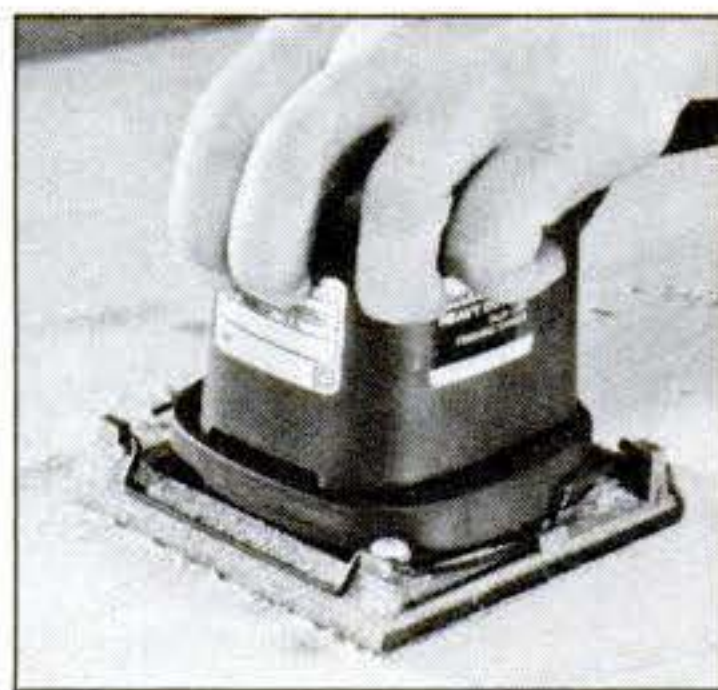
Miter maker

You can cut perfect miters for picture frames or moldings with your radial-arm saw—without changing its 90-deg. setting—when you attach the Radial-Miter (\$29.50), says Topper Mfg. Co. (1230 Racine St., Racine, Wis. 53403). Cam clamp (left in photo) holds work.



One-hand finisher

Lightweight (2 $\frac{5}{8}$ lbs.), heavy-duty Palm Grip Finishing Sander has a 1.5-amp motor that delivers 12,000 orbits per minute. It's from Black & Decker's Industrial/Construction Div., which just began selling its tools in consumer stores. Suggested price: \$73.



Aero-sander

You plug in this sander, but not to a wall outlet. Its air motor runs off a shop vacuum cleaner. And the vac sucks up the dust, says Central Quality Industries, Inc. (900 S. Division St., Polo, Ill. 61064). An optional kit converts the \$60 Dustless Sander to a polisher.

Kit crawler

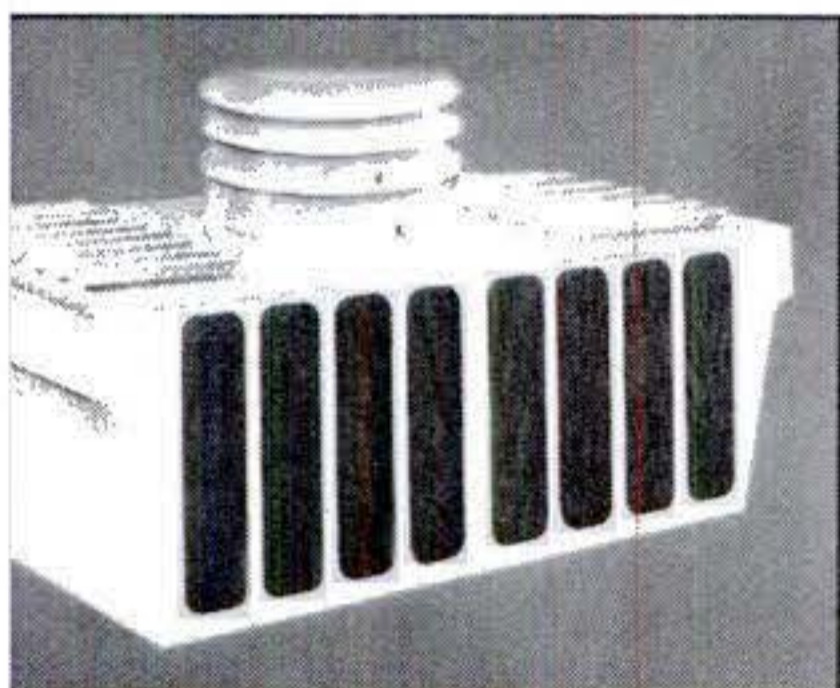
The Dahlco 3000 crawler tractor comes as a kit, which you can assemble in a weekend, says C.F. Struck Corp. (Box 307, Cedarburg, Wis. 53012). More than 30 attachments are available to adapt it for landscaping, gardening, or snow removal. It has an 18-hp engine, costs \$4,500.



What's New

IN HOME IMPROVEMENT

BY SUSAN RENNER-SMITH



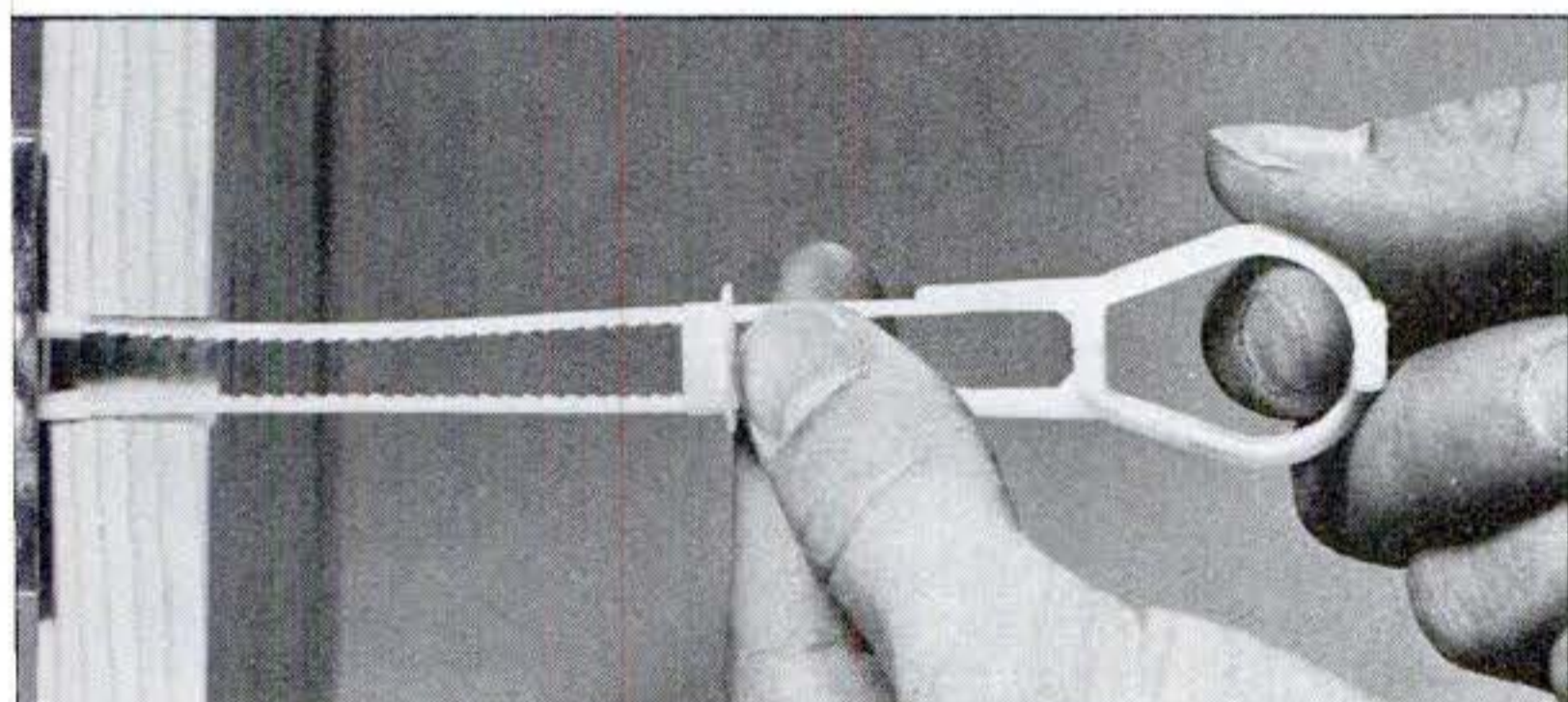
Lint catcher

Can't vent your dryer outdoors? The Lint Trap gives lint-laden dryer exhaust a bath. An interior baffle channels dryer exhaust through the water-filled unit and out fins at the top. Deflect-o (Box 50057, Indianapolis, Ind. 46250) makes it. It's about \$5.



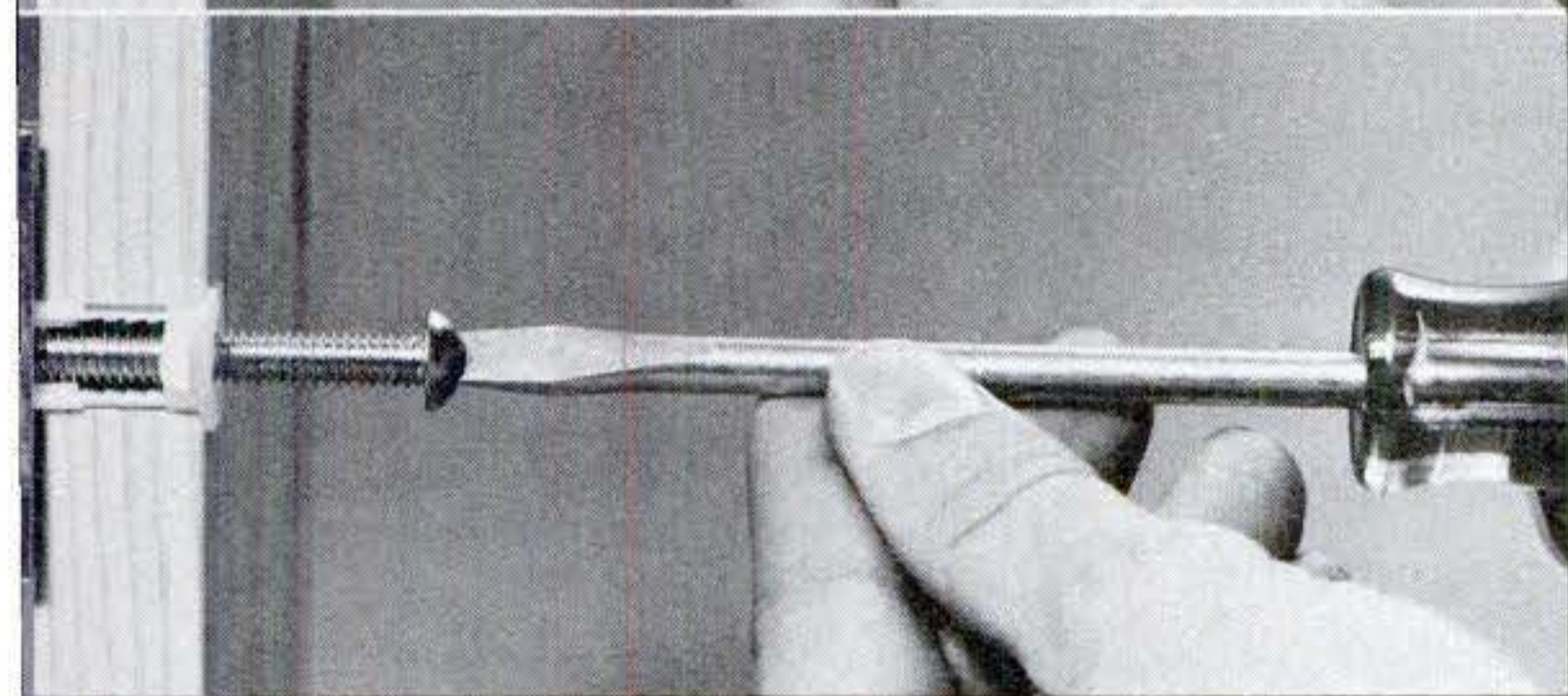
Smooth roller

Window shades seem designed to snap up and flap around. But shades raised with Rollease behave themselves, says General Clutch Corp. (425 Fairfield Ave., Stamford, Conn. 06902). The toothed pulley and cord are especially efficient on long shades, the maker notes.



Easy-mount anchor

The Toggler toggle bolt's metal channel pivots into place with a tug on the attached plastic ring (left). Ring snaps off once locking cap is pushed in place (lower left). Price: \$1.59 for two. Mechanical Plastics Corp., Box 328, Pleasantville, N.Y. 10570.

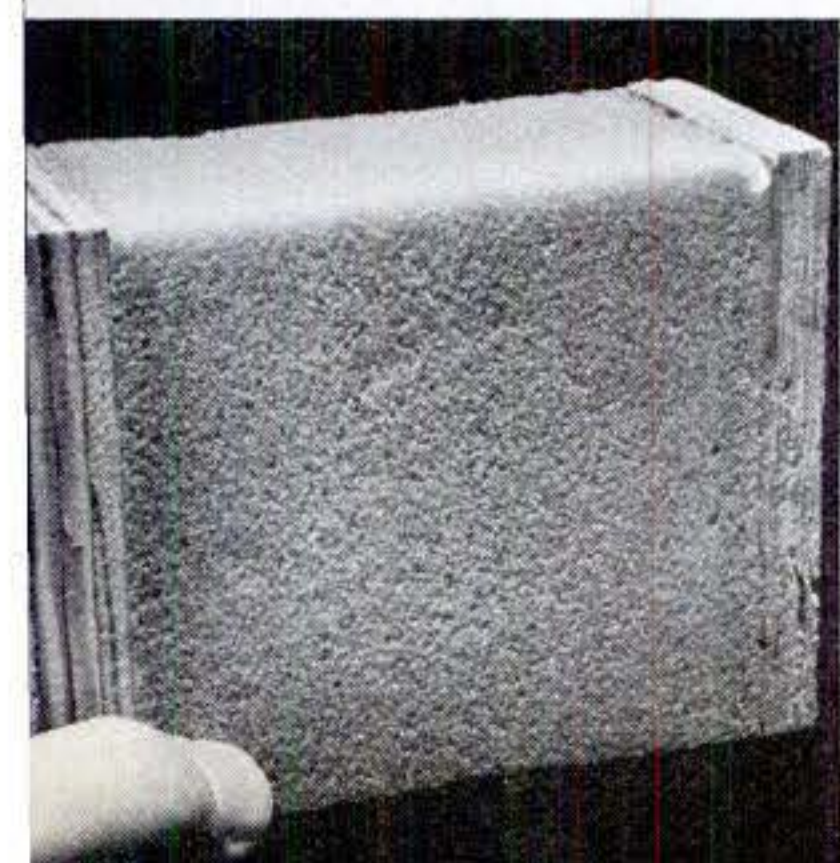
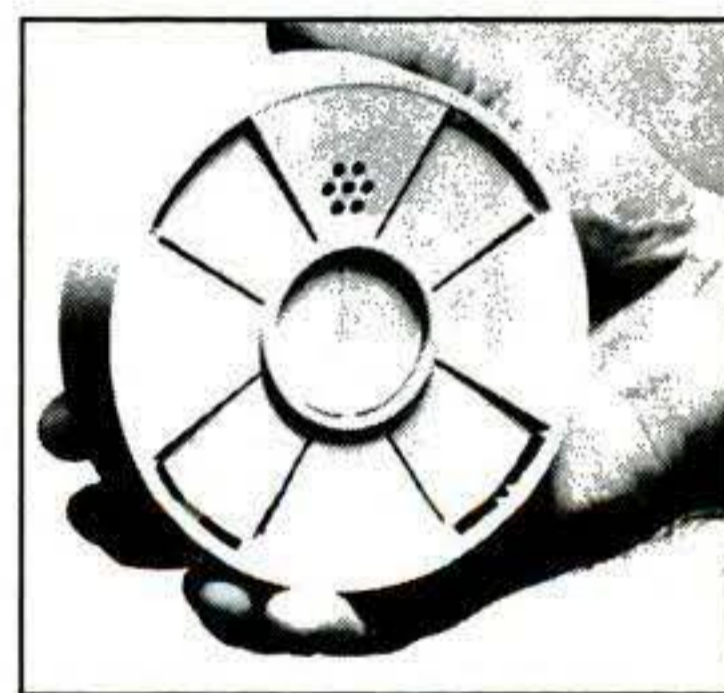


Heat blocker

A micro-thin sandwich of film and metal, Advanced Energy Technology Film blocks radiant heat but not light. First film of its type for DIY application, it costs \$24.17 for a 35-by-48-in. roll. Gila River Prod., 6615 W. Boston St., Chandler, Ariz. 85224.

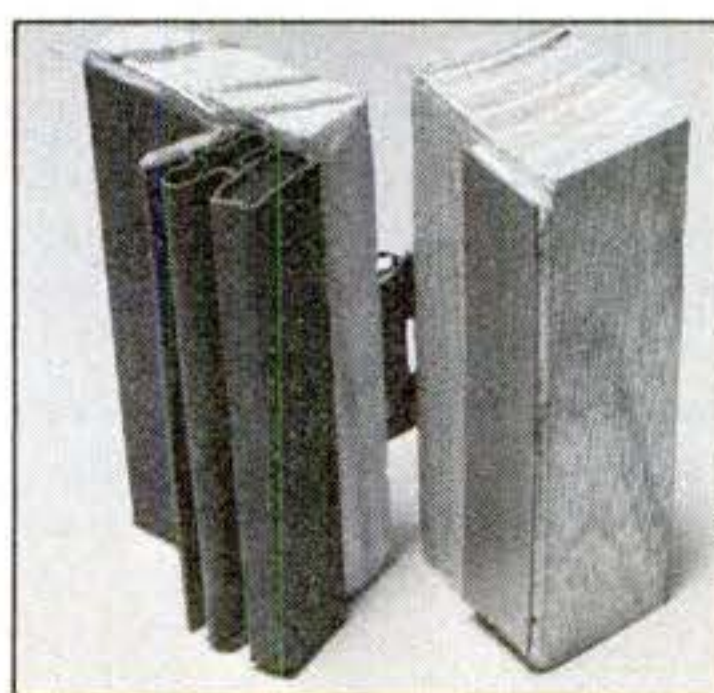
Screech stopper

Burning the bacon is bad enough without having to disable a screeching smoke alarm. The Lifesaver 0906 alarm has a "hush" button for false alarms. The midget alarm is as powerful as larger ones, says Fyrnetics (1021 Davis Rd., Elgin, Ill. 60120). \$23.



Foam wall

Five and a half inches of formaldehyde-free urethane foam molded between plywood facings give this building panel an R-45 rating, says Chase Panel Systems (16608 W. Rogers, New Berlin, Wis. 53151). Thermo-Panels join to form load-bearing walls.



Door seal

Like a refrigerator gasket, the A. T. Door Seal has a flexible plastic bellows to block air leaks. The self-adhesive, jamb-mounted seal adheres magnetically to a metal band fixed to the door. A 36-by-84-in. seal costs \$25. Tharwood Corp., Box 3078, Merced, Calif. 95344.

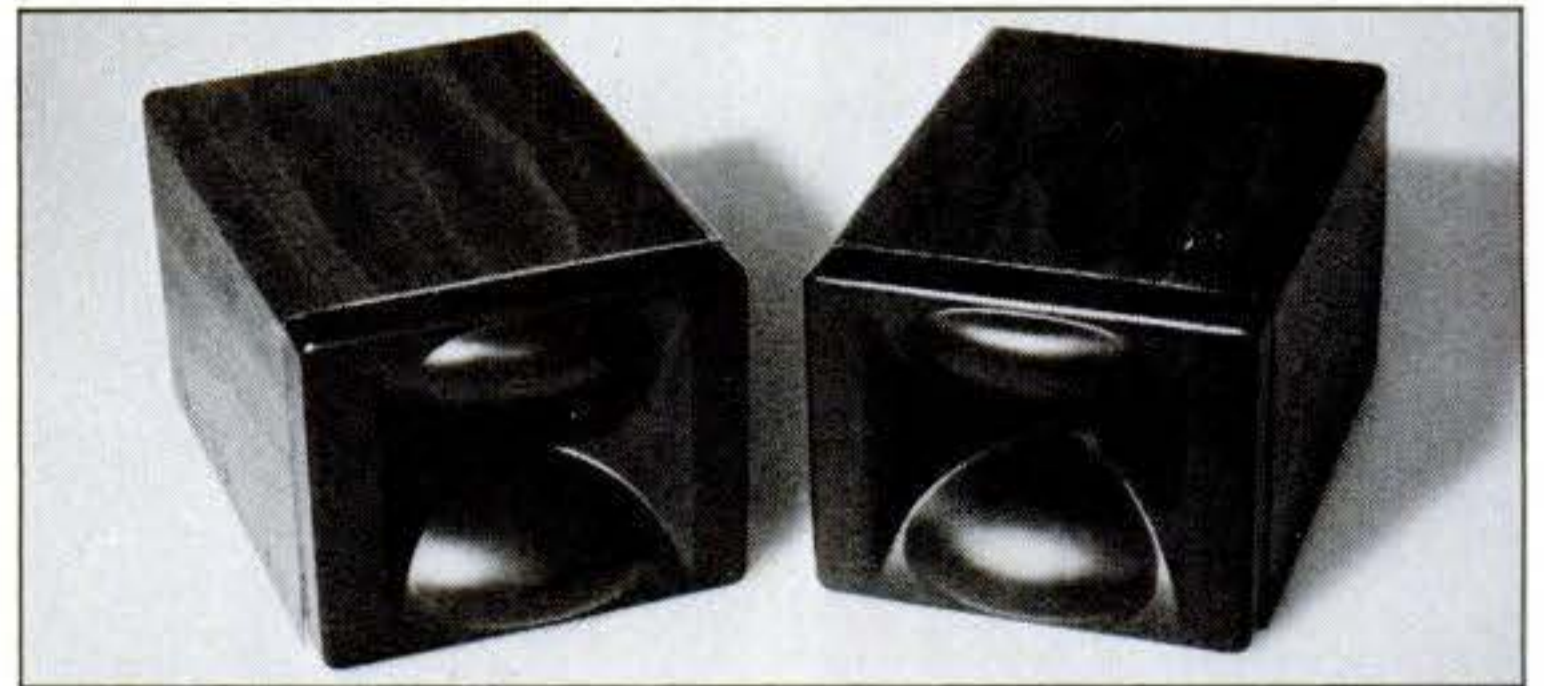
What's New IN ELECTRONICS

BY WILLIAM J. HAWKINS



Electronic reminder

It's a 10-digit desk-top calculator. It's a 12- or 24-hour clock. And the Sharp EL-6200 is also an appointment planner. Tap in your future schedule, and the clever box uses graphics—such as the display of a telephone—to remind you of a date for up to a month in advance. It's \$80.



Add-on discs

Pop the top of your Franklin (2138 Rte. 38, Cherry Hill, N.J.) ACE personal computer and replace it with the company's add-on floppy-disc-drive assembly. The box contains up to two drives and controller electronics, uses one internal peripheral slot. It's \$699 with one drive, \$1,098 with two.

Ribbon tweeter

The lower the mass, the faster a speaker cone can move and the higher the frequency response. That's why the Jumetite (1300 Richards St., Vancouver, B.C.) add-on tweeters use a "ribbon" cone—a 0.00025-in.-thick, 1/4000-oz. aluminum sheet—for a response to 35 kHz. \$350 each.



Hand-held tach

Touch this hand-held tachometer to any drive shaft, and the display shows speeds—from 0.0001 to 25,000—in 16 different units of measure. Built-in memory stores high, low, and four intermediate speeds for instant recall. Made by Graham (8800 W. Bradley Rd., Milwaukee, Wis.), it's \$189.



Kit orchestra

Want to put an orchestra together? No, don't start calling musicians—warm up the soldering iron. This electronic music maker comes in kit form and creates 13 instrument sounds—from bells to banjos. It's \$1,995 from Wersi, Inc. (Box 5318, Lancaster, Pa. 17601).

Credit-card calc

FlashCard gives new meaning to the term "credit-card" calculator. This one actually looks and feels like a plastic card—and is just about as thin. An embossed keyboard responds instantly to touch; photocells power it, eliminating the need for batteries. Made by Canon, it costs \$16 to \$20.

Clock-radio phone

GE's Call-Maker is a digital clock radio—and a bedside phone with memory for dialing up to 12 pre-programmed numbers at the push of a button. Three buttons are reserved for emergency calls—they're recessed to prevent accidental pressing. Price: \$116.



What's New FOR YOUR CAR

BY JACK KEEBLER



Easy-stow tow

Small enough to fit in your glove compartment, Stow-a-Tow's 14-ft. nylon-web tow line can lift nearly two tons, says Commercial Marketing Associates Inc. (7907 Yarnwood Ct., Springfield, Va. 22153). It retracts into its container when not in use. Price: \$24.95.



Stylish light

The black finish adds style, and a weatherproof urethane boot protects the halogen lamp's mounting pivot. KC HiLites, Inc. (Williams, Ariz. 86046), says the pair of competition lights produces 180,000 candlepower for visibility up to 1½ miles. A pair costs \$110.



Easy-load rack

Mount two tracks on the drip rails and a single track on your van's side. Then Trak-Rak's slide-mounted frame, rated at 150 lbs., tips down for easy loading and unloading. Pivot Mfg. Co. (12685 Stout Ave., Detroit, Mich. 48223) makes it. Price: \$450.

Ignition cutoff

If a thief tries to drive off with your car when this device is engaged, the engine stalls and can't be restarted.

Gard-a-Car's timed circuit breaker cuts off current to the distributor, says Martin & Martin Enterprises (3781 Bassett S., Detroit, Mich. 48217). It costs \$39.95.



Dual-scale tach

Flip a switch to check dwell angle or rpm. One scale on the add-on Tritach shows engine speed up to 7,000 rpm; the low 1,750-rpm scale is used for precise engine tuning. Gunson's Colorplugs Ltd., Agriold House, 40 Wharnton Rd., Stratford, London E15 2JU, England.

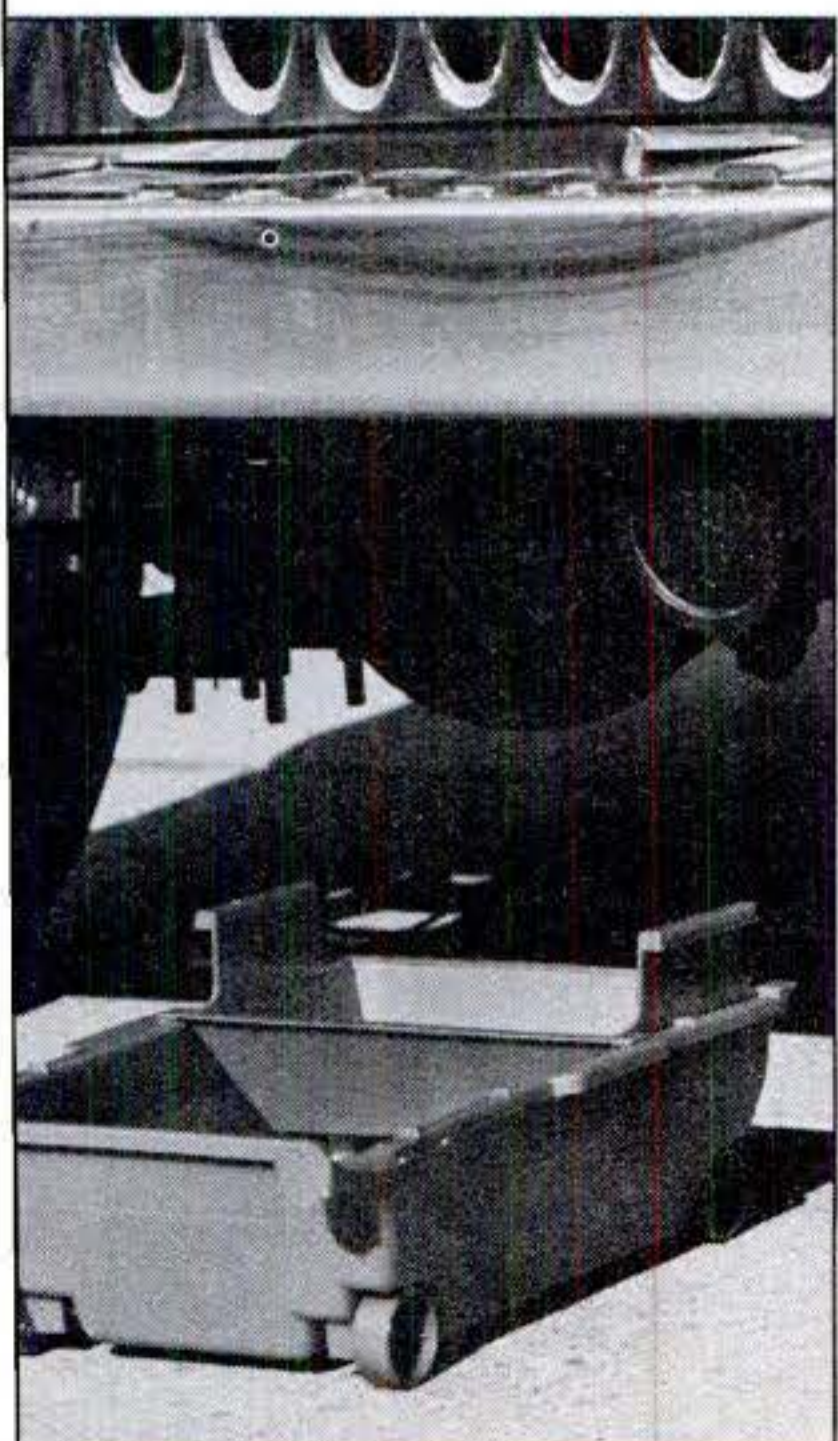


Wheeled oil pan

The Wheel Thing rolls under your car, and up to eight quarts of used oil and the old filter roll out, according to Sealbest Products, Inc. (Box 767444, Roswell, Ga. 30076). A basket catches the drain plug and filter for easy changes. Price: \$7.98.

Hitch rack

Bacrac attaches to your trailer hitch in less than five minutes. Made of zinc-plated steel, it weighs 20 lbs. and measures 20 by 30 in. Bac-Rac Products (Box 340014, Dallas, Texas 75234) says it holds up to the car's maximum trailer tongue weight. Price: \$89.



3 redwood gazebos

for your garden or poolside



Handsome designs offer shade, shelter, and privacy for summer outdoor living

By DANIEL RUBY

PHOTOS BY KARL RIEK
DRAWINGS BY EUGENE THOMPSON

Whether you use it as a place to entertain, as a garden shed or poolside cabana, or merely as a shady retreat from the summer sun, a backyard shelter makes an enticing addition to any home. An octagonal gazebo with latticework painted white is an American tradition, but these variations—designed and built by Homecrafters of California for homes in Fresno

Continued

Three inviting shelters are variations of basic post-and-beam design. Curved pool pavilion (left) has a flat slatted roof and airy crisscross latticework. A side door opens into the house. Classic garden gazebo (right) takes on a rustic look when built with garden-grade, knot-patterned redwood. Its shingled pyramid roof keeps out rain; lattice walls screen the sun. Angular pool shelter (below) has a shed-type slat roof that leaves part of the diagonal deck exposed to sun, part shaded.



—show how tradition can be updated.

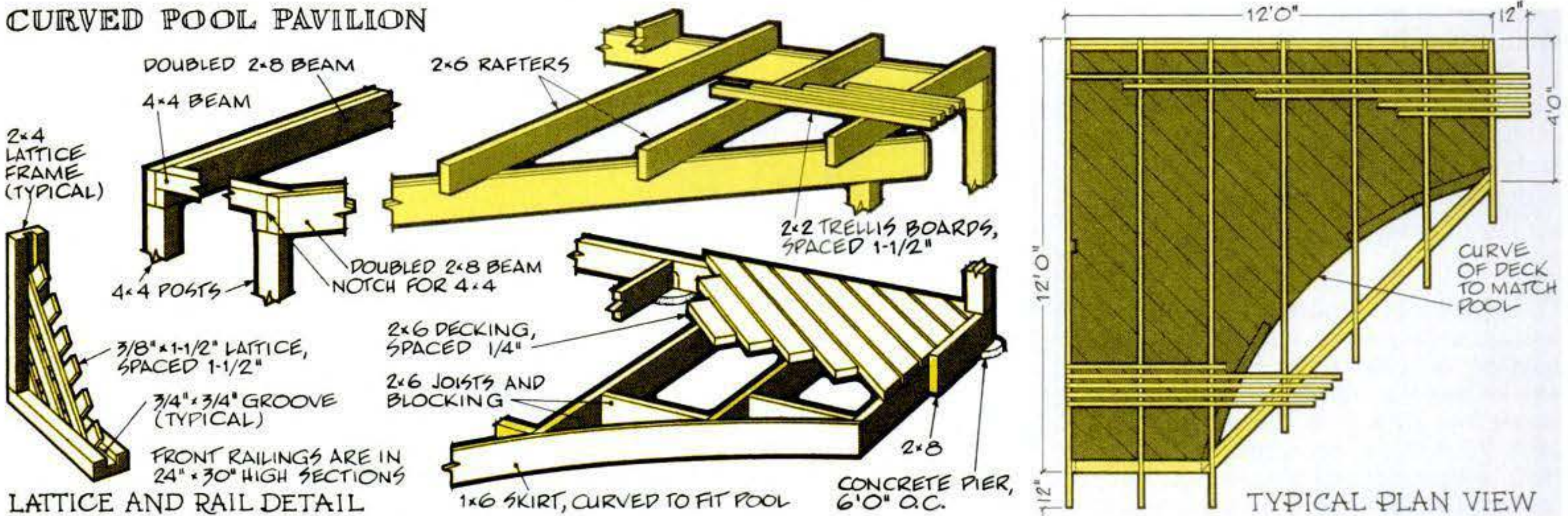
That customary white treatment must be renewed every few seasons to prevent decay. Today's chemically treated woods will stand up to outdoor conditions for many years. But garden-grade redwood is naturally resistant to insects and decay—and dimensionally stable. These qualities, combined with its warm and rustic visual appeal, make redwood a natural

choice for garden and poolside shelters.

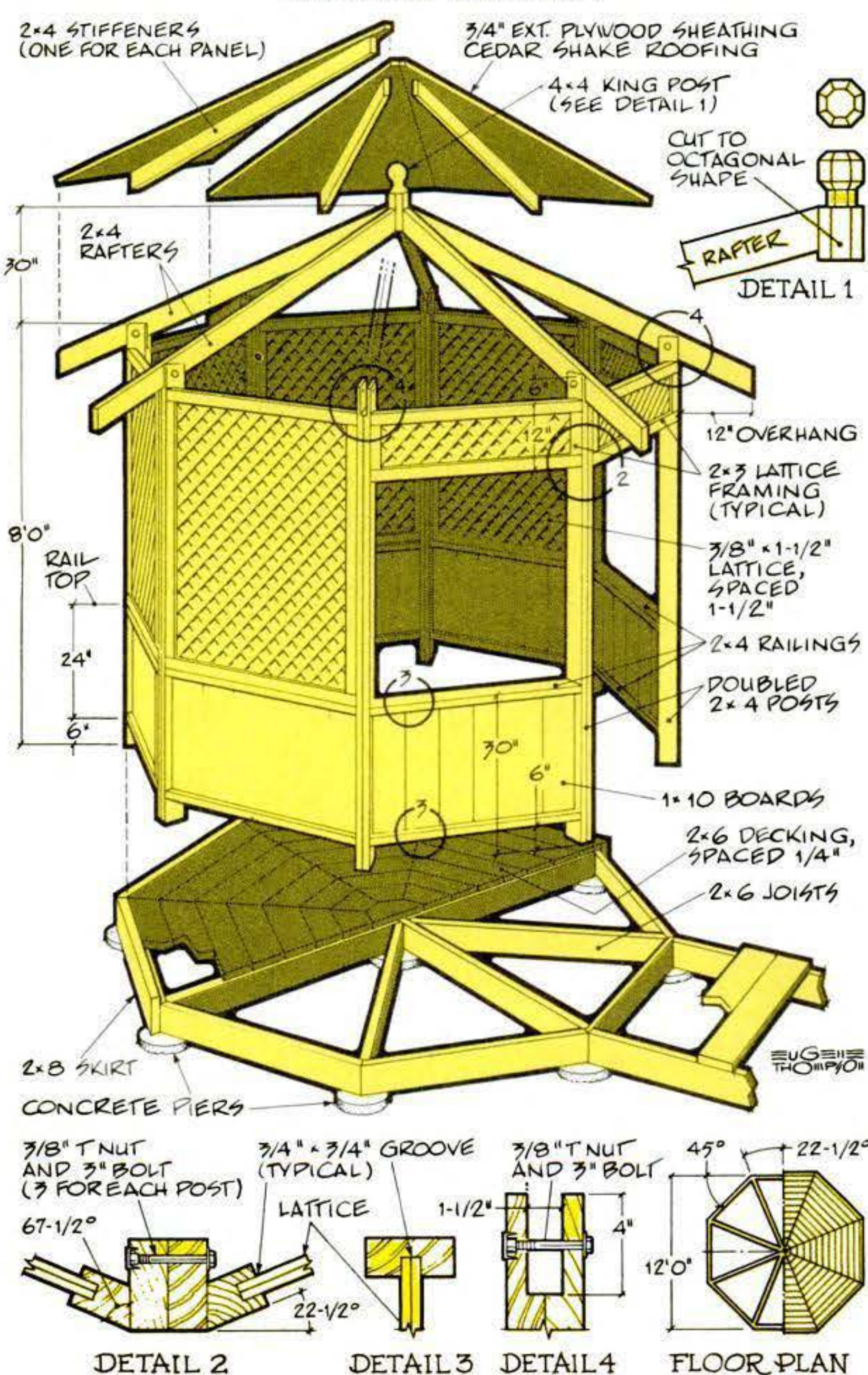
The California Redwood Assn. lists four garden grades of redwood; these are less expensive than the architectural grades but have knots and are not kiln-dried. Construction heart and merchantable heart grades contain no sapwood, and thus are recommended for structural members and for use in or near the ground. Construction common and merchantable

grades, which do have sapwood streaks, are good choices for decking, fencing, trellises, and similar uses. Merchantable grades contain larger knots than construction grades. The wood will weather differently depending on the finish. Unfinished, it will gradually turn gray; with a water repellent applied, the wood will stabilize at tan; to keep its red tone, you'd have to apply a deck stain. **15**

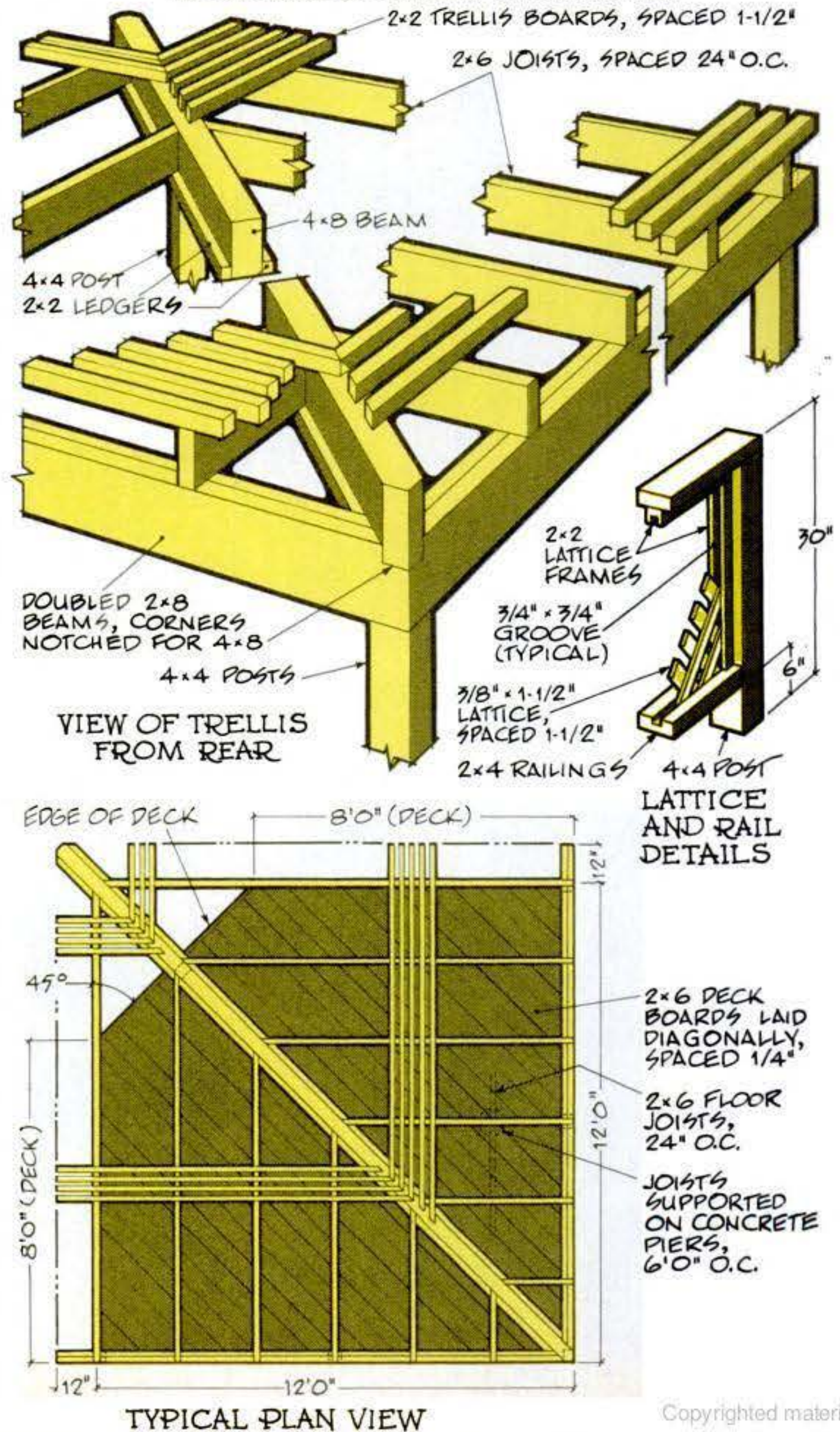
CURVED POOL PAVILION



GARDEN GAZEBO



ANGULAR POOL SHELTER



Island fireplace

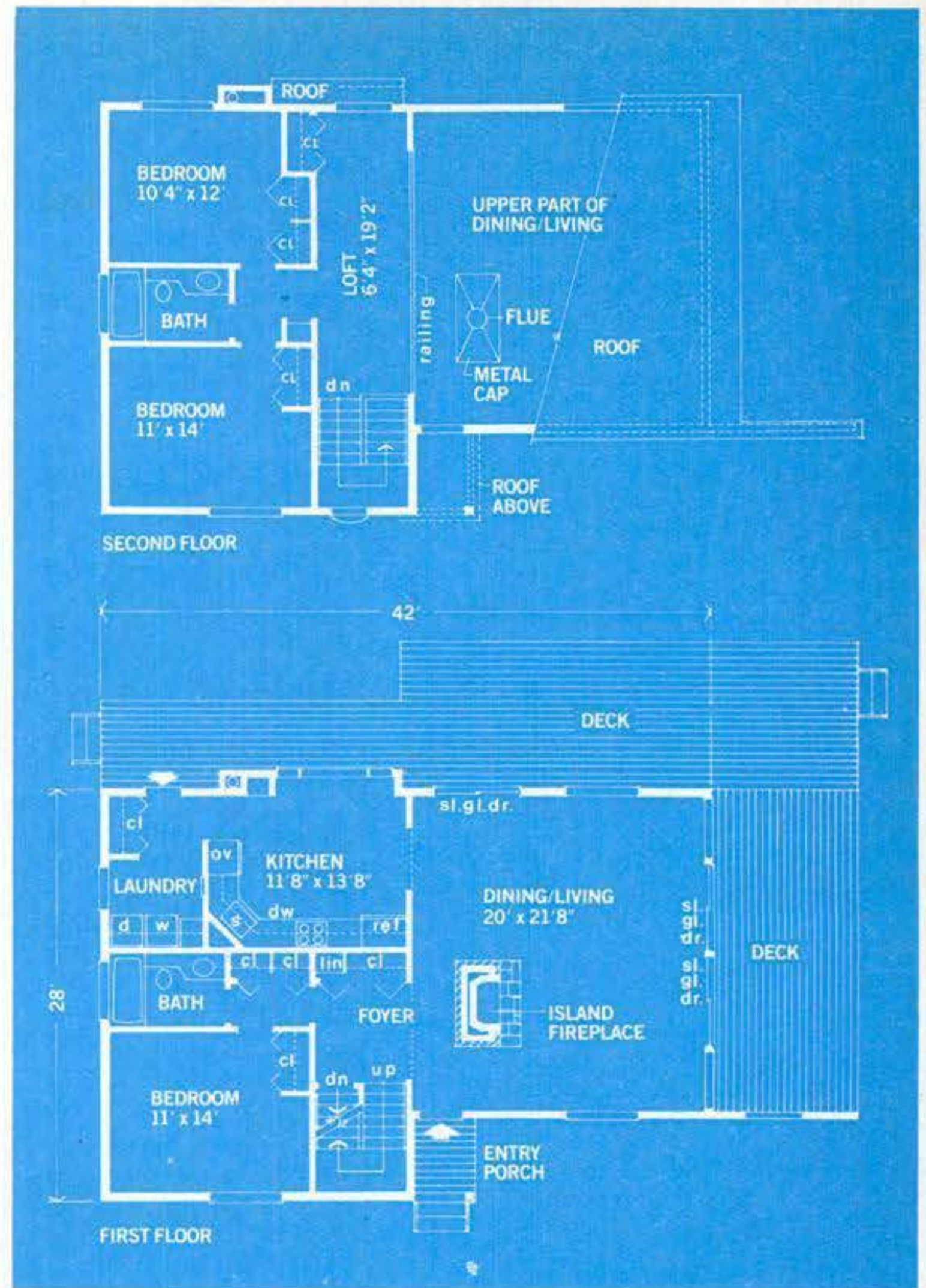
heats all rooms

By AL LEES

The dominant design element in this house is also its source of heat. Architect Samuel Paul wrapped the two-story open floor plan around a new-generation heat-circulating fireplace—such as Martin's Octa-Therm. Vents for outside combustion air run under the floor. The warmed-air jacket is vented directly into living space through pairs of grilled outlets at the top of both faces of the eight-foot-tall masonry island. Folding glass doors let you keep the fire burning when you retire. Solar panels on the roof heat your hot water on sunny days. **PS**

How to order your plans

One set of detailed, professionally drawn blueprints for this house is \$95; five sets (for construction, financing, obtaining permits), \$135. Specifications and energy-saving brochure are included at no extra cost. An additional mirror-reverse print can be ordered for \$15, materials list for \$20. Address orders or queries to Homes for Living, Inc. (specify Wildwood Plan), 107-40 Queens Blvd., Forest Hills, N.Y. 11375. Add \$5 to all orders for postage and handling; allow three weeks for delivery.

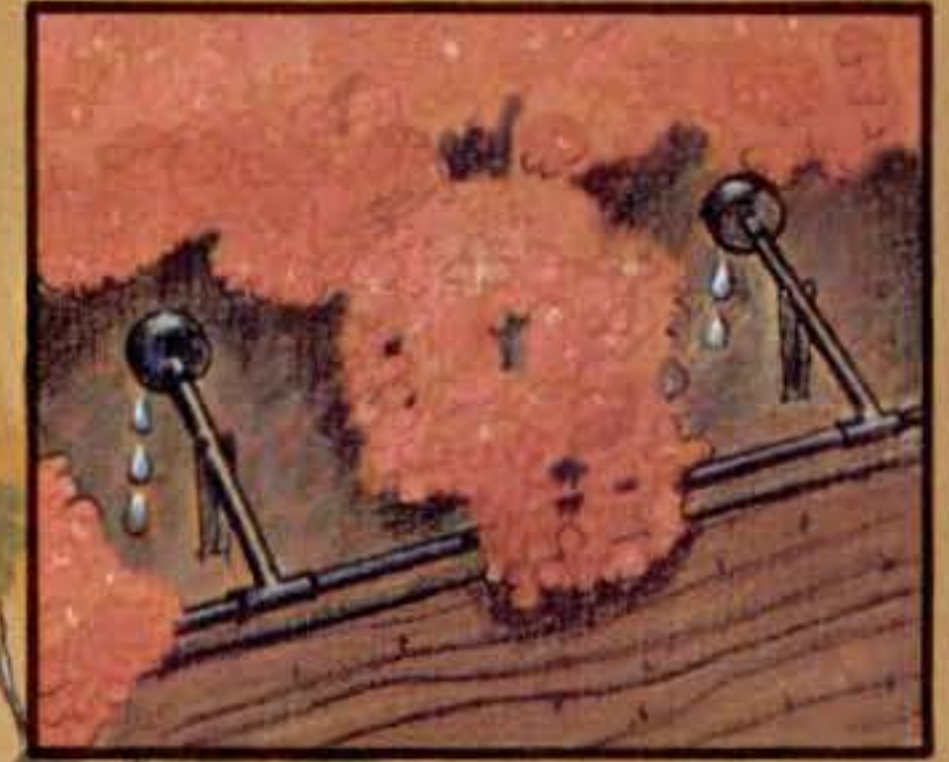


Drip irrigation

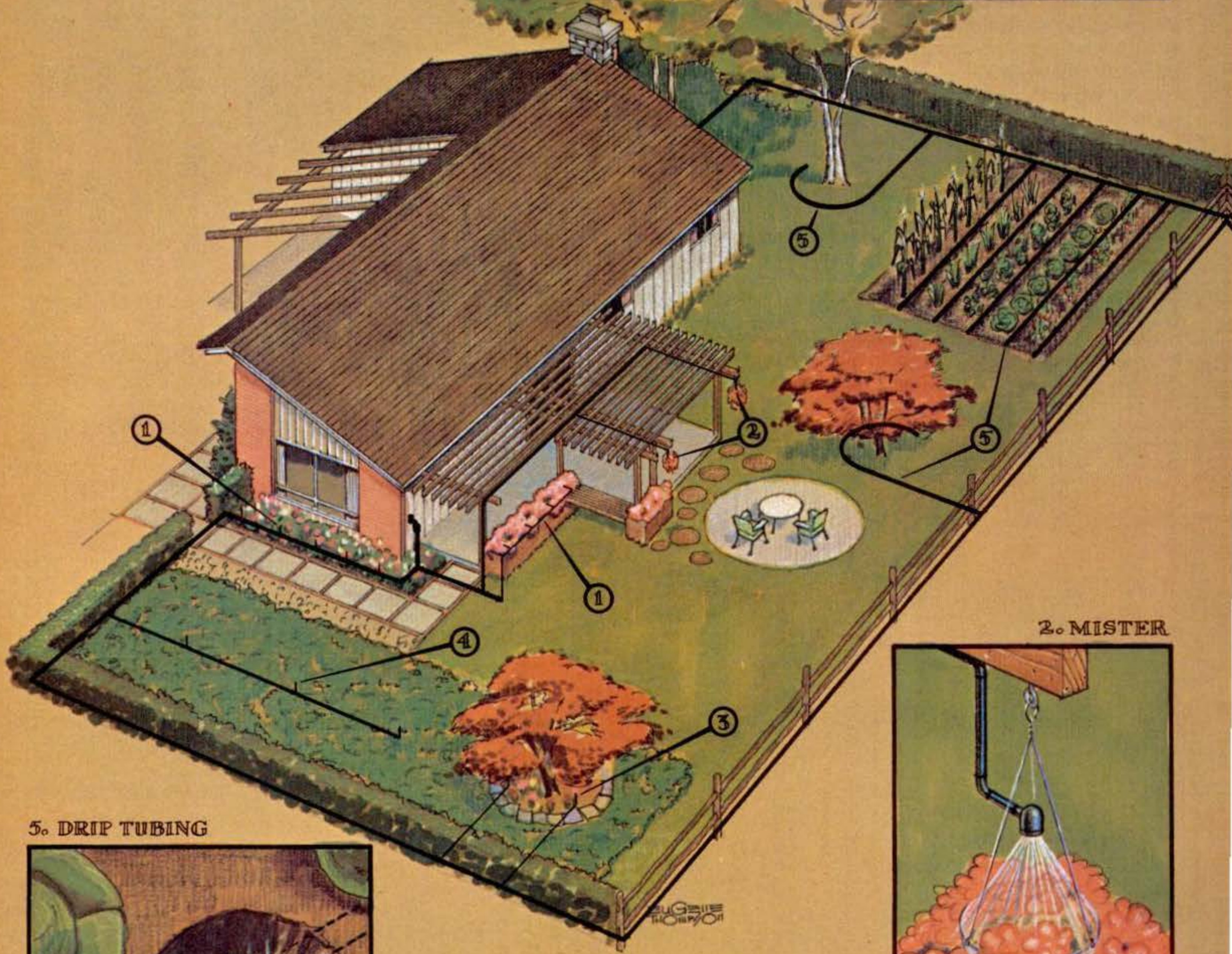
—no-waste route to automatic watering



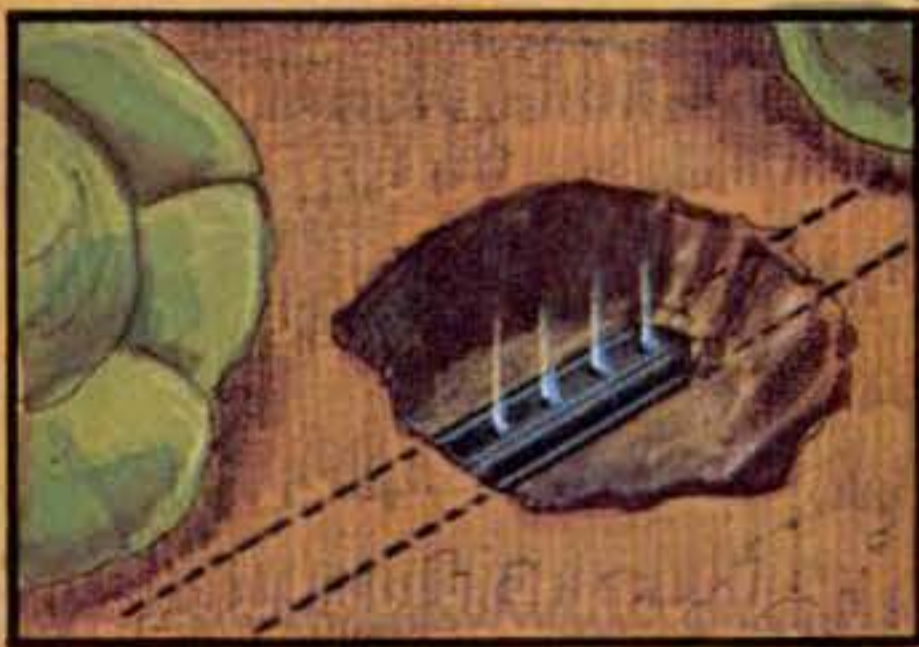
1. EMITTER



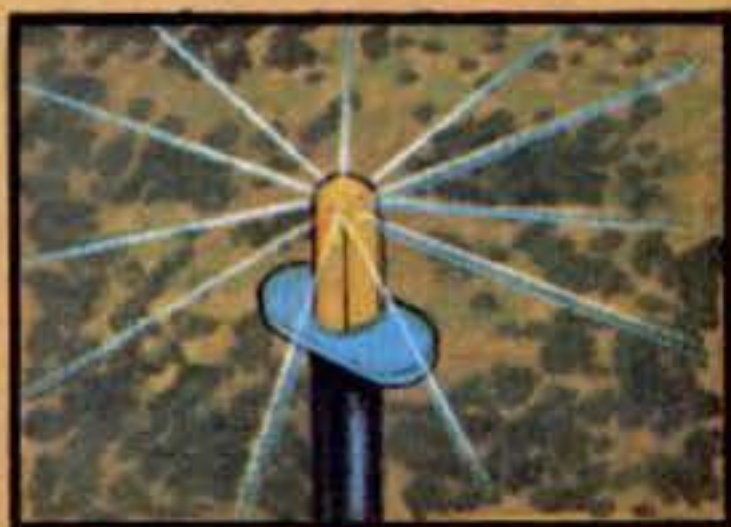
1. EMITTER



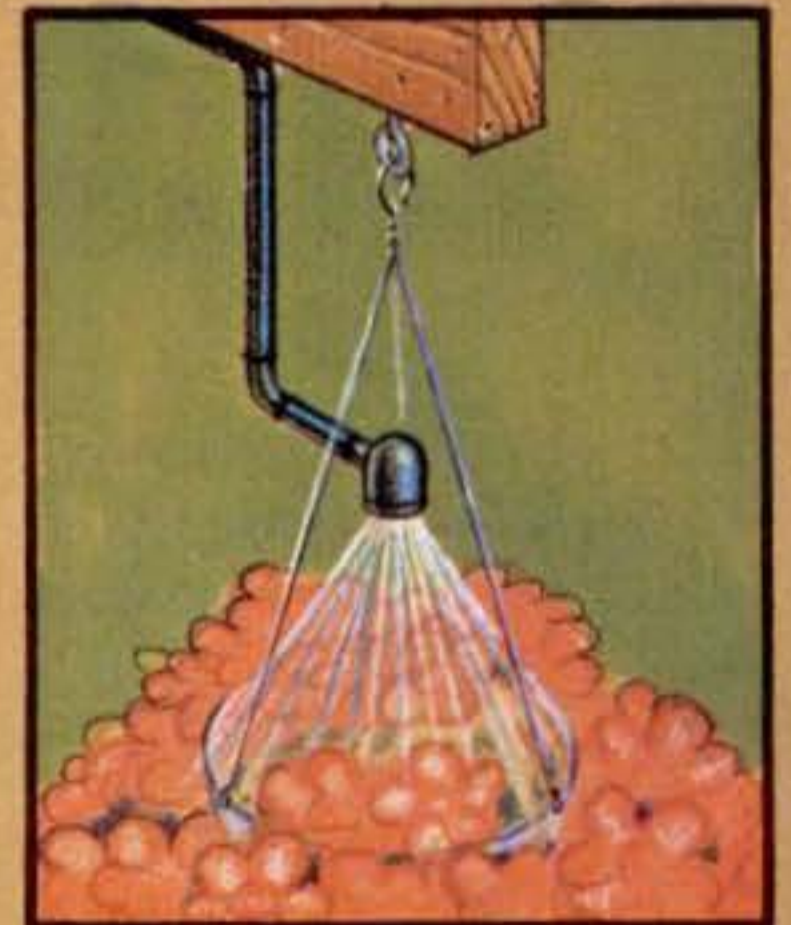
5. DRIP TUBING



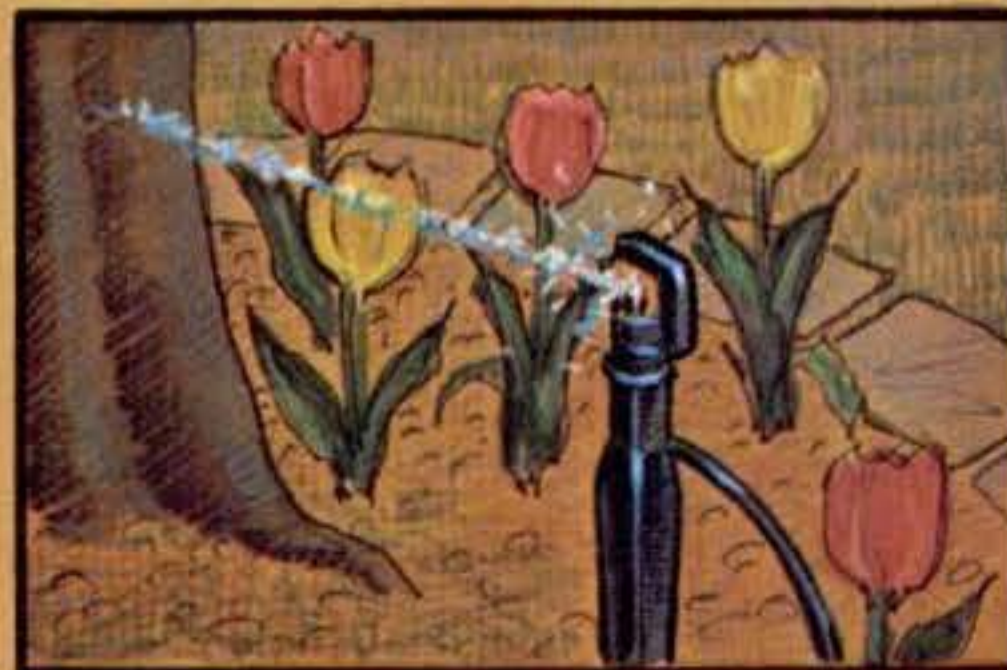
4. MINI SPRINKLER



2. MISTER



3. DIRECTIONAL JET



You can buy kits or parts to water a few plants—or a whole landscape and garden

By V. ELAINE SMAY

DRAWINGS BY EUGENE THOMPSON

One sunny day last July, Mike Nestor's neighbors in San Diego, Calif., might have noticed him in the yard, rolling out a coil of skinny black tubing. He started at the house, snaked the tubing along the hedge bordering the driveway, and rolled out more as he walked to his apricot tree, orange tree, and ornamental landscape area. Then he brought out a bag of small plastic parts, and at every plant knelt down, punched a hole in the skinny tubing, inserted a length of still skinnier black tubing, and pushed a piece from the parts bag into the other end. When he had visited every planting in this manner, he dug a trench about two inches deep and buried the larger black tubing, leaving the ends of the skinnier tubes above the ground.

What the neighbors *didn't* see after that was Nestor making his normal twice-weekly rounds with his old, green garden hose. Still, his plants thrived. During his hour-long ritual with the black tubing, Nestor had installed a drip-irrigation system.

Drip irrigation is a watering method that delivers water—slowly but frequently—directly to plants; there is little or no runoff, evaporation, or overshoot, as there is with conventional sprinklers. It has long been popular with commercial growers because it provides perhaps the best possible growing conditions for most plants and uses about the least amount of water.

A few years ago, scaled-down irrigation systems for home use began to appear in garden and home centers. Now, about three percent of single-family homes in the U.S. use them, says Nestor, who is manager of Cascade, one company that makes home

drip systems. Other major manufacturers include Care-free Irrigation Supplies (Drip Mist), Misti Maid, Raindrip, and Submatic. Home drip systems are easy to install and relatively inexpensive.

Components

The coil of skinny black tubing Nestor rolled out from plant to plant was the main delivery line of his system— $\frac{1}{2}$ -inch-diameter black polyethylene. Many companies also make $\frac{3}{8}$ -inch tubing. The skinnier tubing Nestor linked into the main line at each plant was $\frac{1}{4}$ -inch black polyethylene—called microtubing, spaghetti tubing, or transfer tubing. Most of the pieces he pushed into the other ends of the $\frac{1}{4}$ -inch tubing were emitters—simple mechanical devices that slow the flow of water and dispense it drop by drop to the soil. He also used some mini-sprinklers and directional jets. Drip-irrigation systems can also include misters and perforated tubing (shown at left, described below).

With the variety of components available, you can put together a drip system to water your shrubs, trees, flowers, potted plants, and vegetable garden. Some manufacturers (Submatic, for example) even suggest a drip system for lawn watering. Nestor advises caution, however. "The success of drip systems for lawn irrigation depends on soil type and the kind of grass you have," he says. "In some cases, you may not get enough lateral movement of the water, so your lawn could come out spotted or with zebra stripes." Drip-irrigation systems can work with a regular, high-volume sprinkler system, however. And Cascade will introduce low-volume, pop-up sprinklers next year.

Drip systems hook up like a garden hose to an outside faucet. Every other day, Nestor turns his tap about a quarter turn to water his plants, then turns it off again after a half-hour. But even that degree of personal attention isn't necessary. An inexpen-

Drip-irrigation system can water nearly all your plants (left) from a single tap. Water is dispensed by various devices: Emitters (1) may be linked to main water line with microtubing (as shown) or installed directly on or in the line. They come in about 50 different types with flow rates from $\frac{1}{2}$ to 15 gal./hr. Misters (2) are ideal for humidity-loving plants; directional jets (3) and mini-sprinklers (4) disperse water over wider areas for bedding plants, ground cover. Perforated tubing (5) waters row crops, trees. Components of a drip system snap together like Tinkertoys (right). To make a 90-deg. turn, cut the line and slip in elbow connector. Tee connectors let you add branch lines. To

insert an emitter or microtubing, make a hole in the line with the punch, then push in the barb or collar of emitter or connector. Goof plugs seal unwanted holes. End caps or clamps seal the end of every line. Simple screw-on adapter hooks system to outside faucet. A filter is essential. Simple filter shown must be disassembled for inspection, cleaning (Y-shape filter can be flushed with the push of a button). Anti-siphon valve must be used in some areas and is a good safety precaution anywhere, especially if you plan to fertilize through your system. Some drip systems use a flow-control washer or preset pressure regulator; others provide instructions on how to regulate the tap.

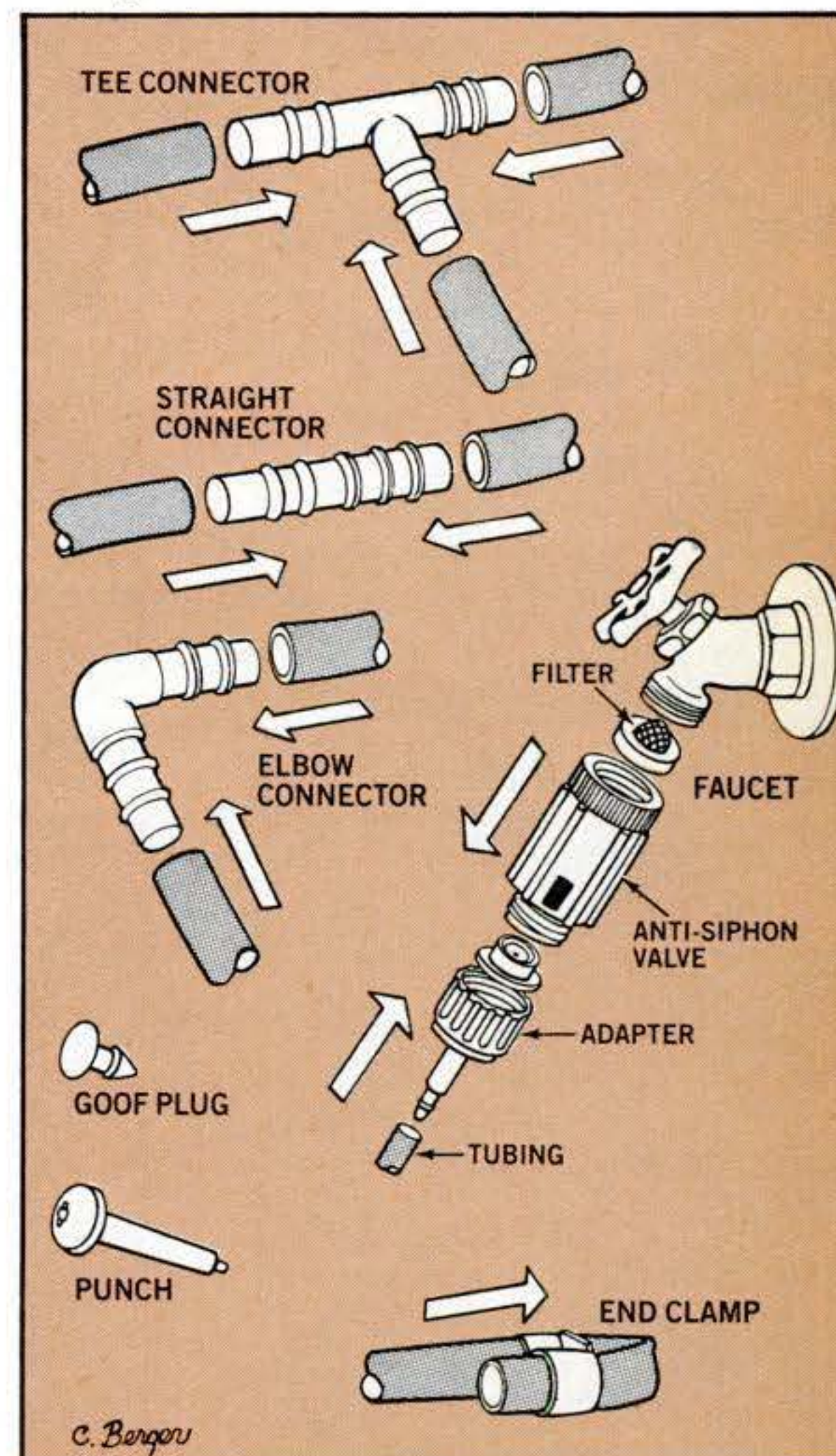
sive mechanical timer will turn off the water after a set interval, or a battery-powered or electric clock and valve can be hooked up to completely automate the system. One nice feature of all drip systems: They can be expanded easily. (Components from different manufacturers are not necessarily compatible, however.)

Maintenance is minimal. "If you use well or spring water, you should check the filter once a month and clean it if it's gunked up," says Nestor. "With city water, a check every other month should be enough." You should also check for plugged emitters; most can be taken apart and flushed. Most companies claim you can leave a drip system in place in winter, even in cold climates.

You can buy the components for a drip system separately or start with a kit. A small kit to take care of a few plants or containers costs less than \$10. Larger systems may cost up to \$150. Manufacturers claim that a drip system will use 30 to 60 percent less water than standard watering methods. At that, your system could pay for itself in short order. P 5

SOME MAKERS OF HOME SYSTEMS

Care-free Irrigation Supplies, Inc. (Drip Mist), Box 151, San Juan Capistrano CA 92693; Cascade, division of RIS Irrigation Systems, 1588 N. Marshall Ave., El Cajon CA 92022-2246; Misti Maid, Inc., 1808 Stierlin Rd., Mountain View CA 94040; Raindrip, Inc., 14675 Titus St., Panorama City CA 91402; Submatic Irrigation Systems, Box 246, Lubbock TX 79408.



To cool your attic:
install a
roof-ridge vent



Versatile, full-length vent adapts to any ridge type

By **ERIK H. ARCTANDER**

Why cool the attic? It'll make you miserable—or gobble energy dollars—if you don't (see box).

There are a number of ways to cool your attic ["Two Routes to Summer Cooling," PS, April '82]. But if you installed the Ridge Univent, you'd get as much free venting area as 11 roof vents, five turbines, or one heavy-duty power vent, claims the maker of the unit shown here (Air Vent Inc., 4801 Prospect Rd., Peoria Heights, Ill. 61614).

One reason for the vent's effectiveness: Its flashing doubles as a baffle, deflecting wind up and over it. This creates a venturi air-pump effect that helps draw warm attic air from the vent's underside.

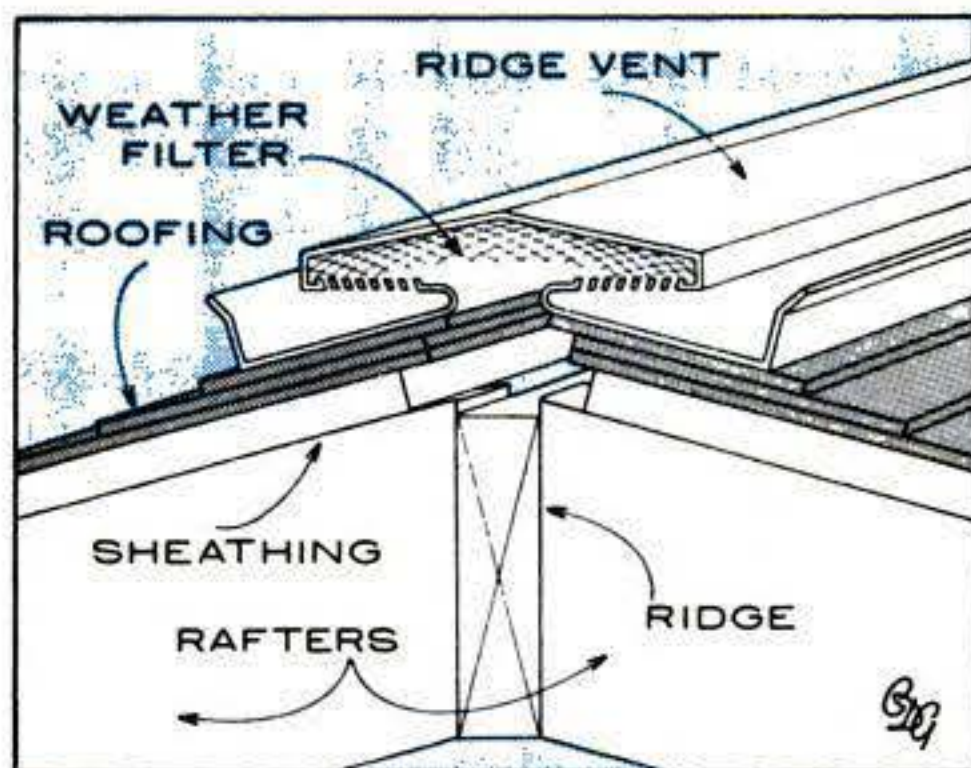
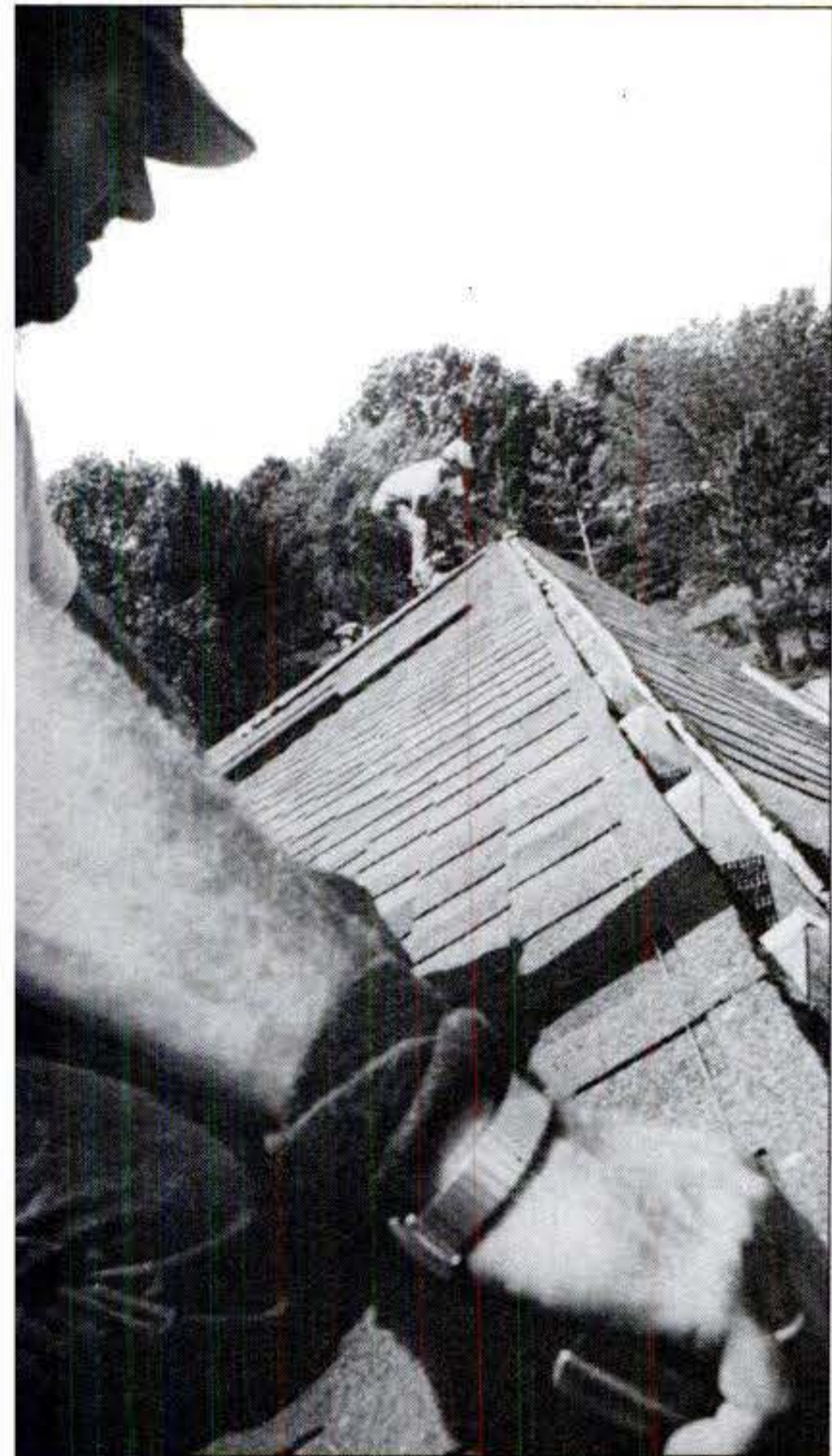
And since the vent covers the entire ridge, it provides a large volume of air flow for the full length of the roof.

Though no roofing job is without risk, installing the Ridge Univent is fairly simple. You first pry off the cap shingles, then cut through shingles and felt with a utility knife, switching to a power saw for the roof sheathing (see photos).

Next you position the 10-ft. aluminum sections over the slot you've cut, snap them together with press-in connector plugs, and nail them to the roof.

The vent works on most roof types and pitches and comes in several finishes. It costs about \$1.50 a foot. **PS**

Fastening connector straps over Ridge Univent joints is the final installation step. Holes are pre-punched, and aluminum nails are supplied with vent kit.



To make vent slot, cut through roof sheathing with a power saw (above), stopping four in. from end wall. Snap a chalk line (far left), then lay down vent, extending it beyond the slot to full length of ridge. Vent cap (sketch) has built-in filter that blocks rain while permitting air flow. Vertical flanges on the vent's built-in flashing double as wind deflectors (see text). On steeply pitched roofs, use wood strips to raise flashing to proper angle.

Computations for efficient cooling

A ridge vent will cool your attic most effectively if it's part of a comprehensive whole-house cooling plan. Whether you rely on central air conditioning, a whole-house fan, or passive cooling from attic vents, calculating your cooling needs will make your system more efficient.

Here are some tips from the experts on planning a new cooling system or re-vamping an older one.

Start with the attic. No amount of insulation can completely seal off the downstairs from attic heat. How much heat gets through? To calculate, first determine the heat-loss factor of the attic floor. It may vary between 0.15 and 0.05 Btu/h/sq. ft./deg. F, depending on the type and amount of insulation. Multiply this by the difference between attic and downstairs temperatures. Then multiply the product times attic-floor area.

Let's say your attic measures 30 by 40 ft. Attic temperatures often reach 130 deg. F, and you're maintaining at least 80 in the house below. In the worst case, you get a heat transfer of 9,000 Btu/h. In the best, 3,000 Btu/h move downstairs. It takes one ton of air conditioning to neutralize 12,000 Btu/h, so you'll need an extra ¾ ton in the worst case.

Of course, you can also install a venting system to rid the attic of excess heat. How much hot air will the vents have to exhaust? To calculate that, you halve the product of the width, the height, and the length of the attic. In an eight-ft.-high, 30-by-40-ft. attic, you've got 4,800 cu. ft. of hot air to exhaust. Depending

on climate, shade, and insulation, you should change that amount of air from every four minutes down to every 30 seconds. That means moving 1,200 to 9,600 cu. ft./minute (cfm), respectively.

But that's only the attic. To cool the whole house by ventilation, add 9,600 cu. ft. of volume for each floor (except the basement), minus 10 percent for closets.

Once you determine how much air must be moved, you can decide whether a passive vent, such as the Univent, will meet your needs or whether a powered vent, roof turbine, or whole-house fan will be necessary.

Now you need openings to pull in and exhaust the air. Power vents and turbines have exhaust ratings. But passive vents and attic-fan louvers aren't so easily sized to match air flow.

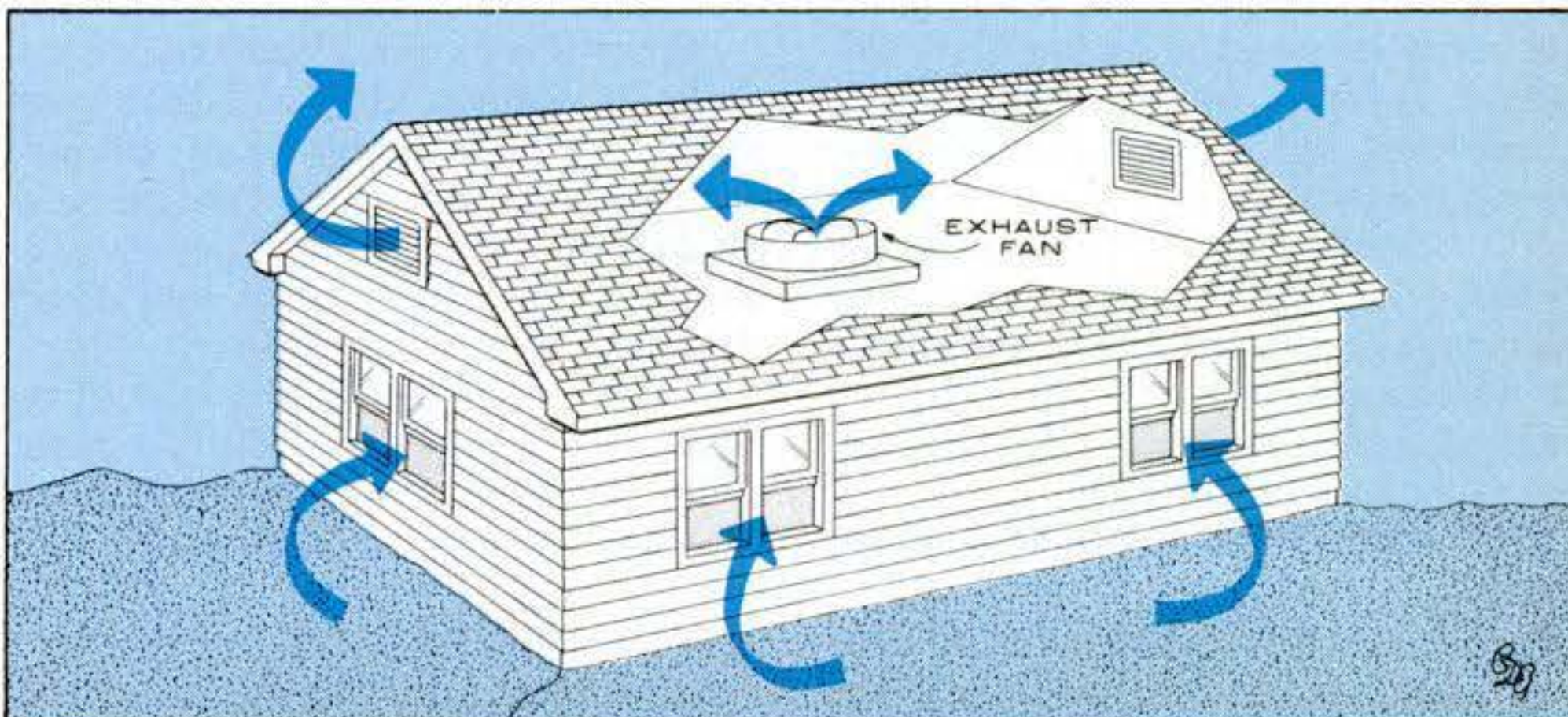
Figure that one sq. ft. of clear opening

will exhaust about 700 cfm of air. Add ½-inch mesh to bar squirrels and birds, and you'll need a 20 percent bigger opening. Add insect screens, and you'll need 50 percent more area.

Warning: If your house is often exposed to strong, gusty winds, be wary of ventilation systems that require vertical intake louvers. At exchange rates greater than 600 cfm, the louvers may pull in rain or snow along with the fresh air. A ridge vent may be more practical in such cases.

To calculate ridge-vent capacity, allow about 94 cfm per ft. with fan-forced ventilation, 54 cfm per ft. of vent without.

If you're ventilating the whole house, you can open windows and doors to pull air in (see diagram). Figure the area of openings needed as you would an attic louver.—E. H. A.



Quartz-halogen lamps for ultra-precise **focused beams**

**Dramatic lighting effects
come from tiny bulbs
that can last 3,000 hours**

By SUSAN RENNER-SMITH

"This lamp satisfies a need that no other light source can fill," said Frederick Bertolone, an independent lighting consultant. He was describing GE's new low-voltage, quartz-halogen lamp. The tiny, two-inch-wide lamp projects brilliant light.

"When I first saw it, I was amazed," said Mike Medwin of Neo-Ray Lighting. "It's so small—it's remarkable how much light it puts out."

Yet the new lamp uses less energy than standard spots and floods. "You can substitute a 20-watt Precise bulb for the 50-watt lamp you'd normally use to light a painting," said Henry Sciam of Roxter Mfg. Corp.

Neo-Ray and Roxter are two of the many manufacturers now introducing lighting fixtures for the Precise lamp. Why has the new lamp generated so much interest?

Consider two rooms. One is in a house set high on a cliff in Southern California. The spacious, 18-by-24-foot room houses the owner's art collection. Intense, narrow beams from 12 recessed ceiling fixtures light the room's treasures.

But the room's main attraction is a 15-foot-wide bank of windows facing the ocean. At dusk the family watches for whales through the black glass—without reflection from the Precise lamps focused on the art.

The second room is inside a pleasant house in suburban Cleveland. The cozy, 12-by-16-foot living room features a free-standing planter. Two wide-beam, 20-watt Precise bulbs in

recessed fixtures highlight the greenery—and light the entire room.

"The two lights enhance all the colors in the room—and give highly pleasant ambient lighting for conversation," owner Henry Burgess told me.

Burgess, a GE project manager, noted three reasons for the new lamp's effectiveness: It's a quartz-halogen bulb; it operates on low voltage; and it has a multifaceted reflector with a heat-reducing coating.

Halogen lamps produce a whiter, brighter light than standard incandescents of the same wattage. And the halogen self-cleaning cycle [PS, July '82] makes the bulbs stay bright longer.

The low-voltage advantage

Low voltage further boosts efficiency. "You get more lumens per watt with low voltage than you do with line voltage," said Max Arnold, a senior engineer at GE. One reason: Low voltage permits a thicker filament. "It can run hotter—brighter—for a given length of time," Arnold said.

Low-voltage filaments are also shorter—a 12-volt filament is one-tenth the length of a 120-volt filament for the same wattage lamp.

"Since it's so much shorter, we can make a compact little coil that operates very efficiently when coupled with a small reflector," Arnold said. "We can position the coil precisely at the reflector's focal point and direct the light where we want it."

The reflector also has a special reflective-emissive "dichroic" coating. This transmits infrared out the back and sides of the lamp, resulting in a cooler beam.

Frederick Bertolone, whose consulting firm, Luminae (San Gabriel, Calif.), designed the lighting for the

ocean-view room described above, has used the Precise lamp in many residential settings. "It's easily hidden," he said. "In my library, I have two concealed in bookcases and focused on a painting above the fireplace. The fixtures—free-standing tubes from Capri—are just two by 4½ inches."

Bertolone chose the Precise lamp because he didn't want light to be reflected off the picture-frame glass. But he discovered a bonus. "The painting alone is illuminated," he said. "No light spills around the edges, so it stands out from the wall."

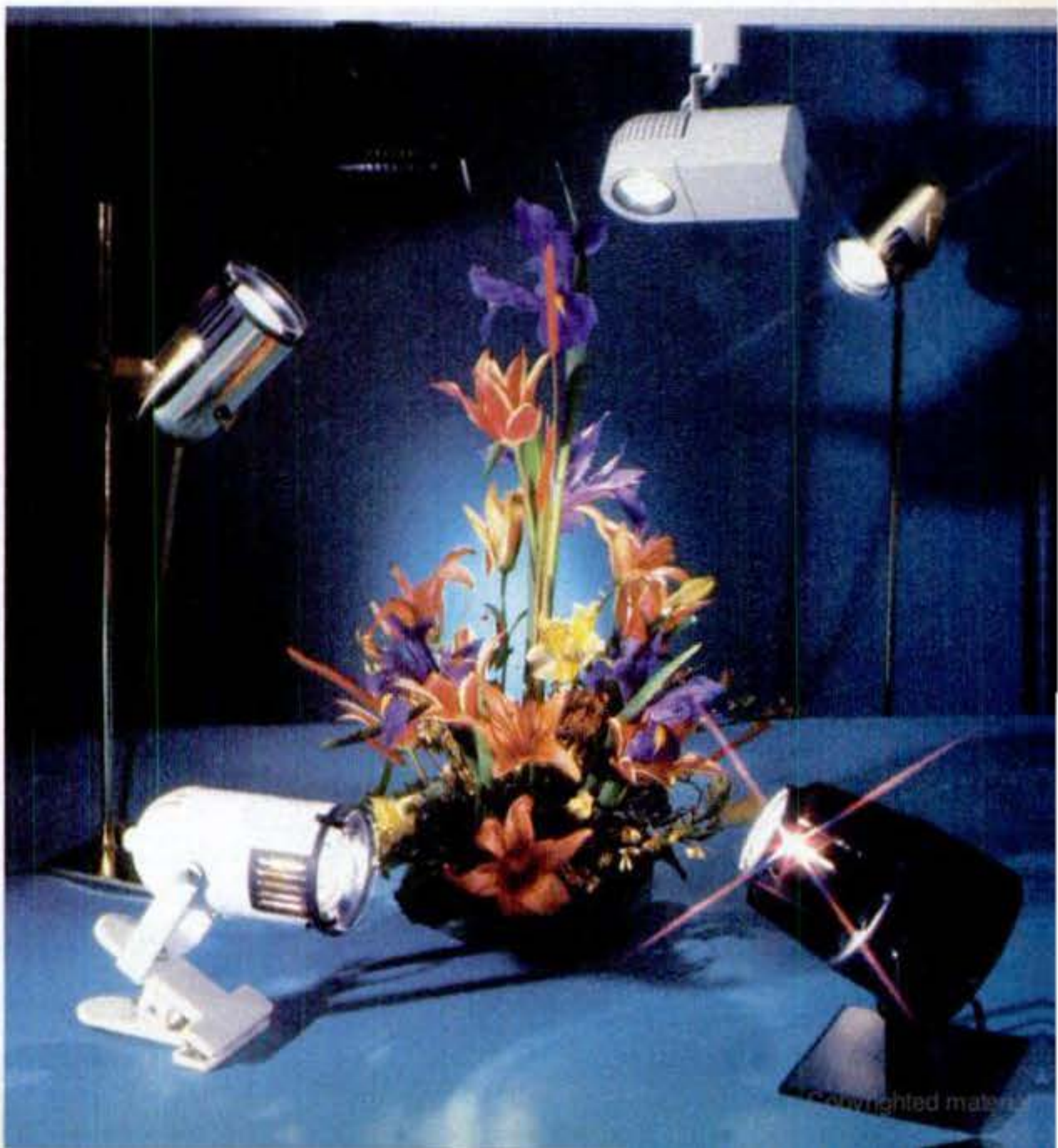
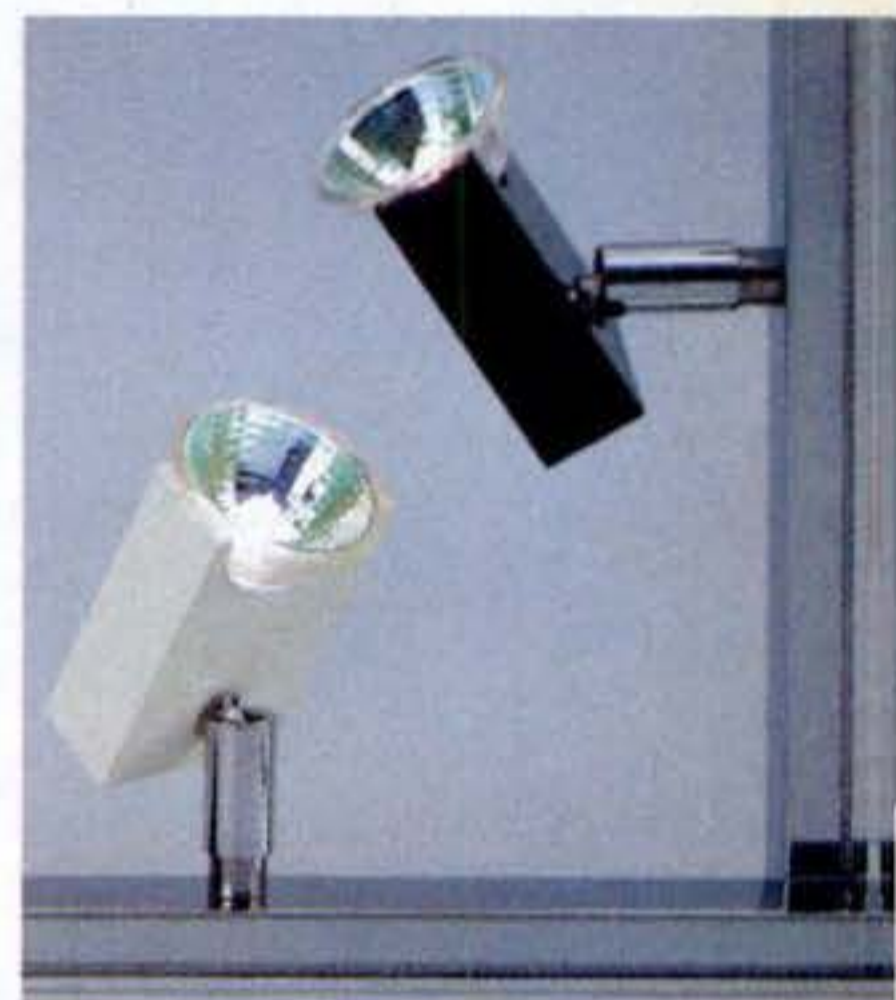
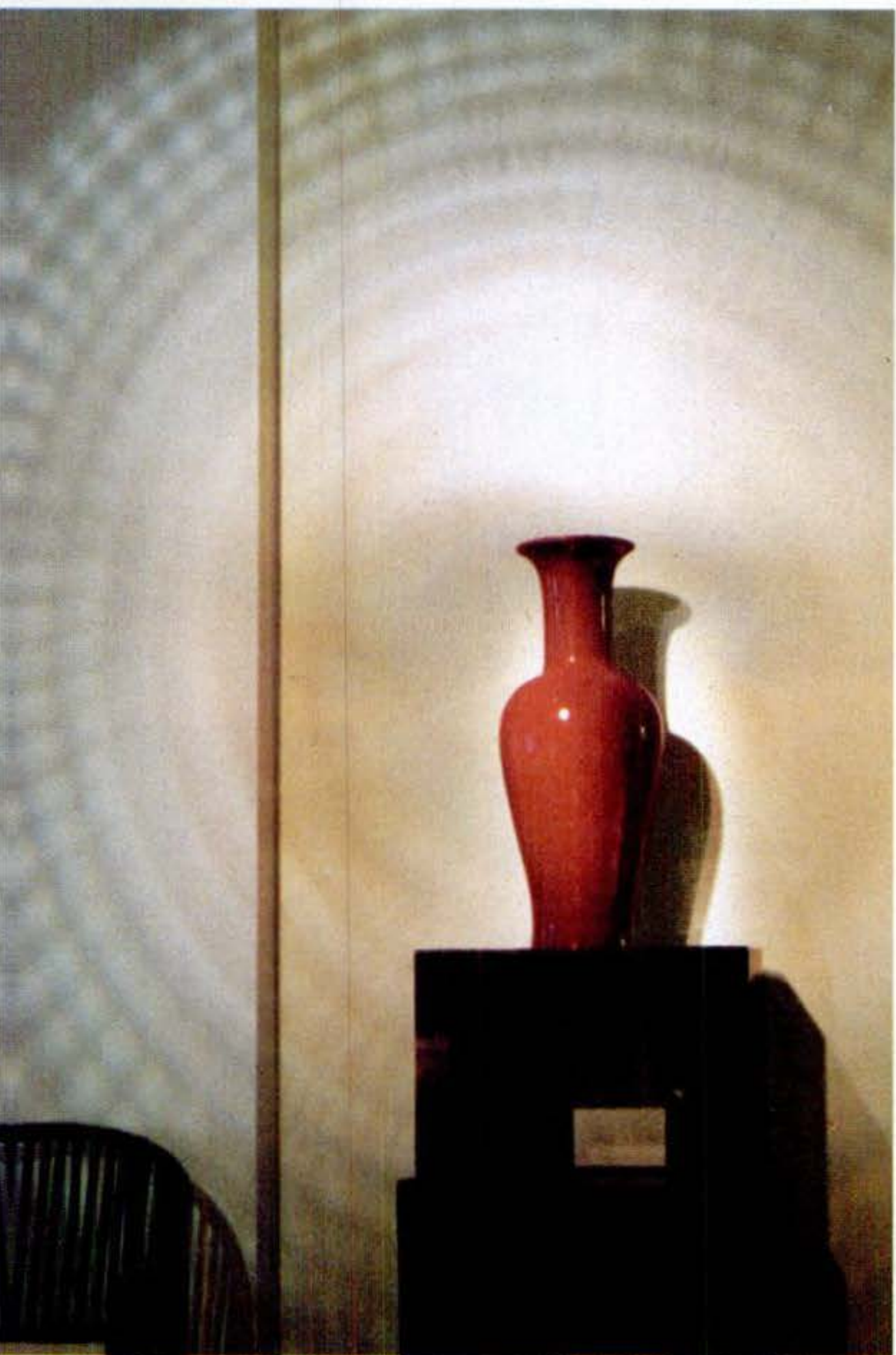
Bertolone recommends the lamps to homeowners, "provided," he said, "they install them with care." You should never touch the light element, he warns, because body oil can contaminate the quartz, shortening bulb life.

Even more important, these lamps become as hot as other bulbs of comparable wattage. "The lamps should never be placed in a planter, or anywhere without adequate cooling," Bertolone said.

GE prints similar cautions on the package, and recommends that the lamp be shielded by a lens or screen against the remote chance that the pressurized lamp will shatter.

Bertolone also noted that dimming the lamp can be tricky. An incandescent dimmer won't work because the halogen lamp is an inductive light source. "We've had problems with dimmers that were supposedly designed for these lamps," Bertolone said. "I suggest a fluorescent dimmer."

At \$15 to \$19, the 20-, 50-, and 75-watt lamps cost almost double the price of conventional "PAR" and "R" lamps. But the Precise lamps last twice as long—from 2,000 to 3,500 hours, depending on wattage. ■



An antique Chinese statue (top right) is framed by Precise lamp (center) concealed in a miniature fixture from Capri Lighting (Los Angeles, Calif.). A classic vase (above) stands centered in the reflector pattern. Coated reflector produces cool beam so flowers (right) don't wilt—even under intense beams from Halo (McGraw-Edison, Elk Grove Village, Ill.) track light and Roxter (Long Island City, N.Y.) lamps. All have built-in transformers, as do the track fixtures (top, left) from Progress Lighting (Kidde, Philadelphia, Pa.). For dramatic effect—and display only—the Neo-Ray (Brooklyn, N.Y.) fixtures (right, center) have no shield.

CHRYSLER '84
for '84

New image for the K chassis:

turbo sports cars



Chrysler Laser and Dodge Daytona rewrite performance-car theory

By JACK KEEBLER

MONTEREY, CALIF.

Chrysler confidently introduced the first American-built front-drive sports models at Laguna Seca Raceway recently, despite the general agreement among auto experts and designers that rear drive is best for high-performance automobiles. Still, the Chrysler Laser and Dodge Daytona are not alone. The class of front-drive sporting automobiles includes such cars as the Audi 5000, Saab Turbo, Renault Fuego Turbo, and Volkswagen Scirocco.

How good a job has the comeback company done? On the track, I experienced firsthand the cars' tuned suspension, turbocharged 142-horsepower four-cylinder engine, much-improved five-speed transmission, and braking system. My attempts to provoke typical front-drive understeer by driving hard into tight corners met with only limited success. In fact, because of their tendency toward neu-

All-new exterior sheet metal, which contributes to relatively slick 0.378 drag coefficient, is a feature of Chrysler Laser XE (left, top) and Dodge Daytona (left, bottom). Most of the chassis structure is new. Daytona has optional performance suspension and P195/60R Goodyear Eagle GT's on 15-by-seven-in. alloy rims.

tral handling, even at high speeds, I had to keep reminding myself that the cars were front-drives.

Chrysler engineers describe the front suspension as "dual-path-mount Iso struts" and the rear as a "trailing-arm beam axle with coil springs." These are basically upgraded versions of the systems on the K-car, but don't sell them short. They did a fine job of isolating road noise and provided a powerful grip on the smooth surface of the track during my test runs. Both the front strut cartridges and the rear shocks are gas-charged and seem to contribute to a well-controlled but not overly firm ride. An evaluation of how the chassis fares on rougher roads will have to wait until the new model is available for a PS road test.

The standard engine in the Laser, Laser XE, and Daytona models is a single-point-fuel-injection version of Chrysler's workhorse 2.2-liter (135 cu. in.) four. It's rated at 98 hp and 119 ft.-lbs. of torque. For those who are unsatisfied with a car that only *looks* fast, there is a multi-point-fuel-injection, turbocharged version of the 2.2. This feisty four pumps out 142 hp at 5,600 rpm and 160 ft.-lbs. of torque at 3,200 rpm.

The car's curb weight is approximately 2,650 pounds. That's nearly 680 pounds lighter than GM's 150-hp V8 Camaro and Firebird. Ford Mustang is almost 400 pounds heavier with its high-output, 175-hp V8.

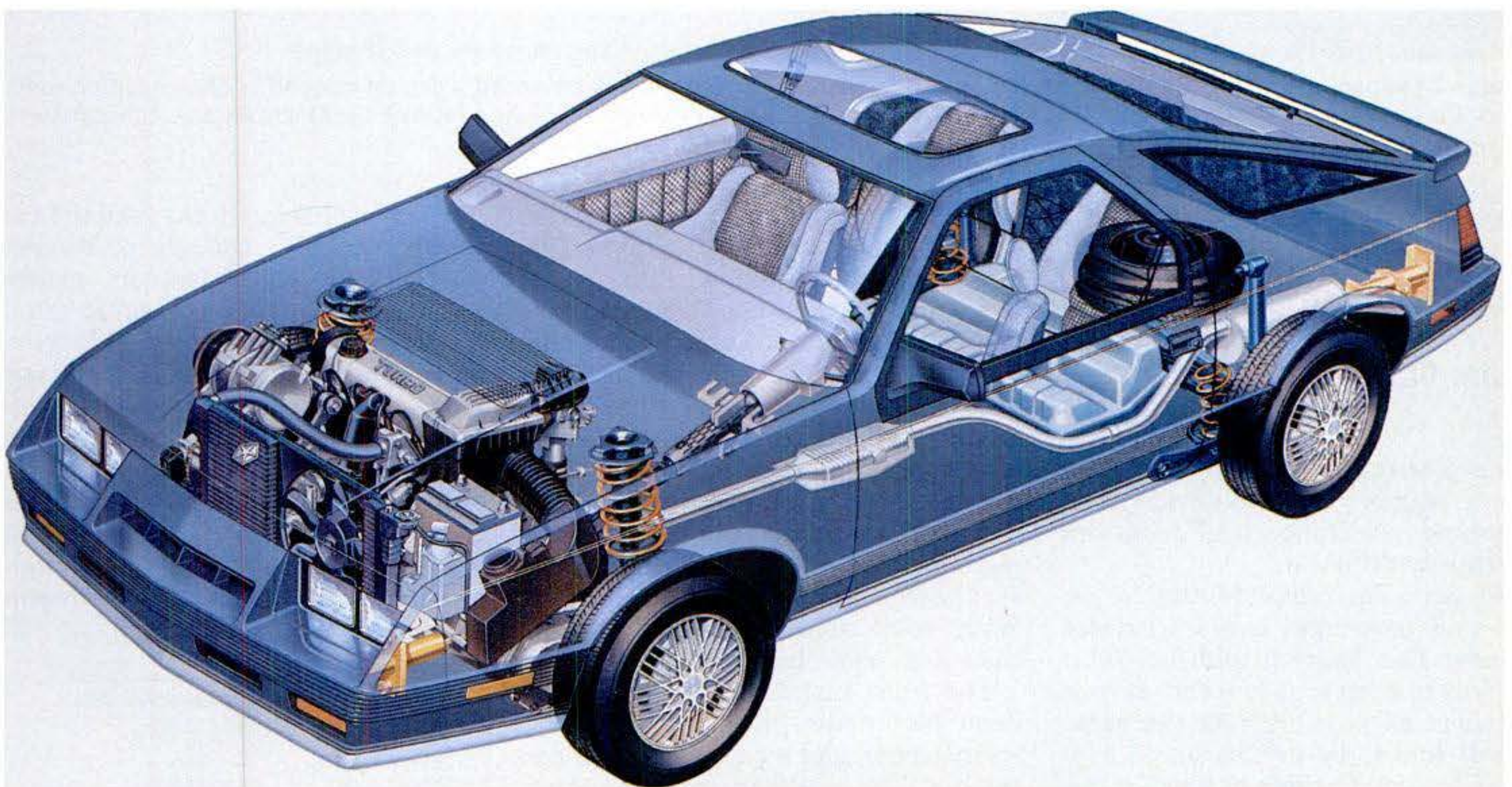
I thought the turbocharged engine felt quick and smooth, and the tach refused to stop climbing until the en-

gine ran into the rev limiter. Fuel economy is respectable: Even the hot version of the 2.2 has an EPA highway estimate of 38 mpg.

Although still not as smooth as some imports, the Chrysler five-speed transmission is a greatly improved design over that of the Dodge 600 ES recently tested by PS. The shifter detents are no longer vague, and shifting effort has been greatly reduced. Ratios are a close 3.29, 2.08, 1.54, and 1.04, with a tall 0.72 overdrive fifth gear. The axle ratio is 3.56:1 with the manual transmission. The standard clutch is a 215-mm (8.5 in.) unit. Turbocharged models have a heavier 230-mm (nine in.) disc to handle the increased output. A three-speed automatic is optional on both the standard and turbo versions.

Stepping on the standard power brakes made me glad my seat belt was tightly cinched. The 10.2-inch vented front discs and 8.7-inch rear drums did a fine job of slowing the car from 90-plus mph on the straights to 25 in some of the tight, nearly 90-degree turns. But I did notice the pedal going soft after about 15 laps. In fact, just before I pitted the car, the pedal could be pressed to the floor. Although I was still getting plenty of braking action, the performance was greatly reduced. Chrysler technicians later confided that air they bled from the brake lines afterward may have been the cause of the spongy pedal.

Price? Chrysler officials hinted at an approximate \$11,000 price tag for the premium turbocharged model. **ME**



Laser XE's die-cast-aluminum valve cover dresses up the car's under-hood appearance. Note the gas tank's protected position.

CHRYSLER
for '84

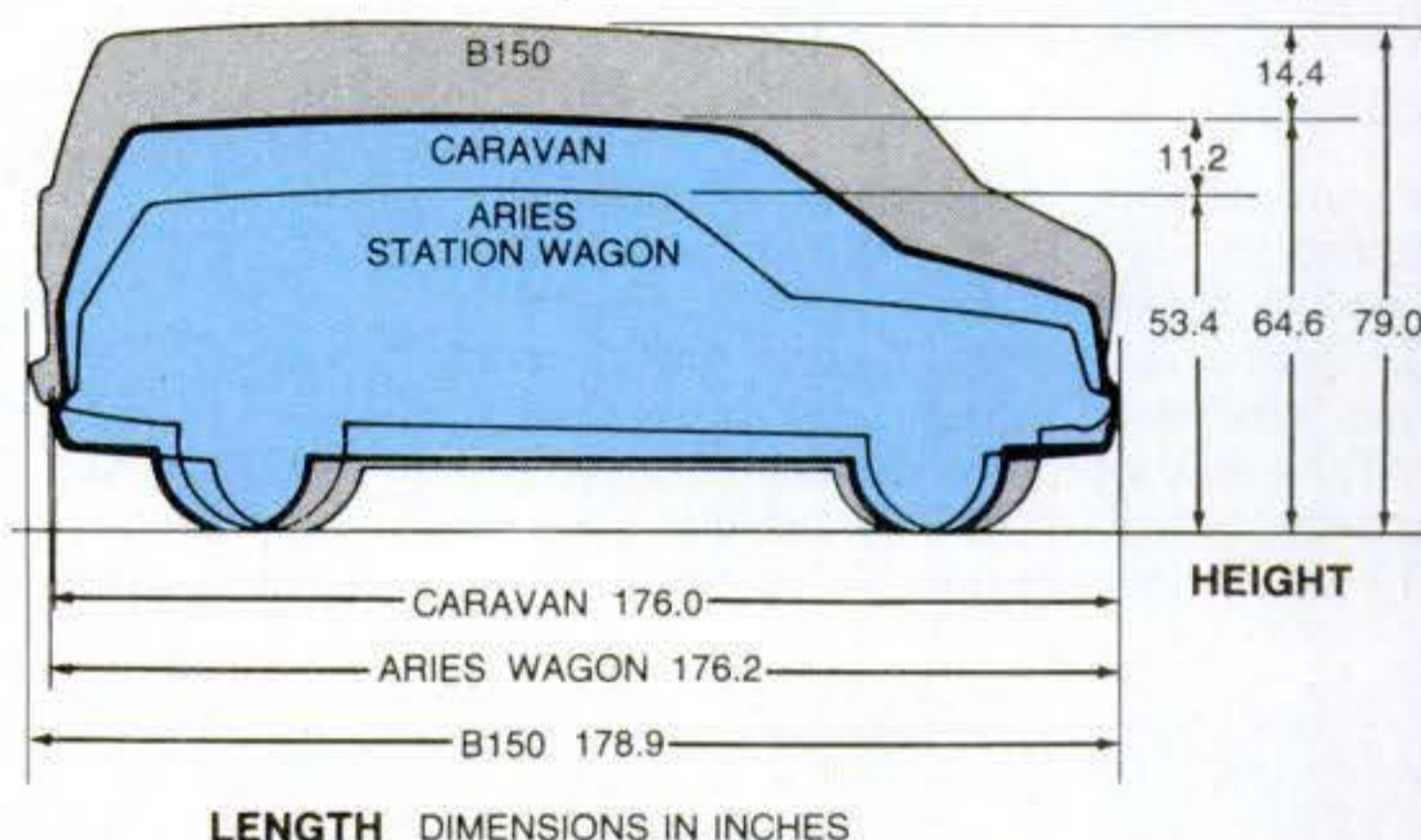


Voyager/Caravan

Chrysler's clever 39-mpg front-drive van



Chrysler T-Wagon comes in two versions: Plymouth Voyager (top) or Dodge Caravan (above left). Sliding door on the wagon's



side is so well balanced it can be opened or closed with one finger, PS found. Drawing (above right) shows size comparison.

Small enough to fit into a garage, big enough to carry seven passengers

By JIM SCHEFTER

It's not a maxi, not a mini, and not a station wagon. But whatever it is, Chrysler's new front-wheel-drive van is certainly different.

"It's an alternative to the larger vans and passenger cars," Chrysler engineer Don Ingram told me. "Our goal was to keep it as low and narrow and short as possible." At the same time, it had to be as functional as a van and as comfortable as a sedan. Although hybrid vehicles run the risk of too much compromise, leaving no one

satisfied, I found few shortcomings in the advance Voyager/Caravan T-Wagons made available to PS.

A steeply raked hood visually distinguishes the van from any other and gives it a carlike appearance. The hood is not only cosmetic: It puts the engine and other components forward of the passenger compartment. The result is a roomy interior with headroom and elbow room to spare. Front legroom is more than ample, but rear-seat passengers will be a bit squeezed. With rear seats removed, though, there's a seven-foot-long cargo area.

The front suspension has independent Iso struts, new springs and spring seats, and a one-piece strut assembly. The resulting ride eliminates the typical vibration of a van without sacrificing road feel or the capacity to

carry heavy loads. On the road the van handles crisply, though passengers will notice a bit of lean in corners.

A sharply angled 55-degree windshield and flush-mounted side glass contribute to the van's 0.43 coefficient of drag. Voyager/Caravan's base price will be under \$10,000, and the van will be offered with two engines: 2.2-liter (134 cu. in.) four-cylinder (manual or automatic) or 2.6-liter (175 cu. in.) four (automatic only). EPA highway rating is 39.2 mpg for the manual, 31.6 for the automatic. **PS**

CARAVAN/VOYAGER DIMENSIONS, SPECS

Wheelbase	112.0 in.
Overall length	176.0 in.
Overall height	64.6 in.
Overall width	68.9 in.
Curb weight	2,700 lbs.
GVW	3,900/4,400 lbs.
Payload	1,200/1,700 lbs.

By **BOB CERULLO**

ILLUSTRATIONS BY
RUSSELL VON SAUERS

Tips from a pro: trouble-shooting high-pressure, high-temperature cooling systems

What you can do

I didn't have to look hard at the Olds V8 brought into my diagnostic center to see that a great deal of work had already been done to solve a stubborn overheating problem. The water pump, radiator cap and core, thermostat, hoses, and cooling-fan clutch had been replaced. But even with all those new components, the temperature-gauge reading would begin to soar after an hour's highway cruising.

There were no external leaks, and the engine was properly tuned. Everything checked out okay, but the coolant was disappearing. It had to be going *somewhere*.

I had a hunch. I placed the probe end of an exhaust-gas analyzer near the uncapped radiator-filler neck, with the engine warm and idling. Normally, this device is used to test carburetor adjustment and emissions controls by monitoring the hydrocarbon and carbon monoxide levels at the exhaust pipe. In just a few seconds, the needle in the hydrocarbon gauge of the emissions analyzer started to bump and dance wildly.

I was looking at a serious problem. The analyzer was indicating the presence of exhaust gases in the radiator—a sure sign of a leaking cylinder-head gasket, a cracked head, or, even worse, a cracked engine block. I pulled the dipstick and examined the oil. It had a milky-white appearance, confirming the analyzer's diagnosis. It was time to pull the head.

Cooling-system leaks aren't usually this difficult to locate, nor does diagnosis require expensive equipment.

Most coolant leaks are the result of a ruptured hose, a punctured radiator, or failure of a water-pump seal. So I'll discuss how the cooling system works, how to diagnose some of the more unusual high-pressure cooling-system problems, and how to head off costly cooling-system repairs.

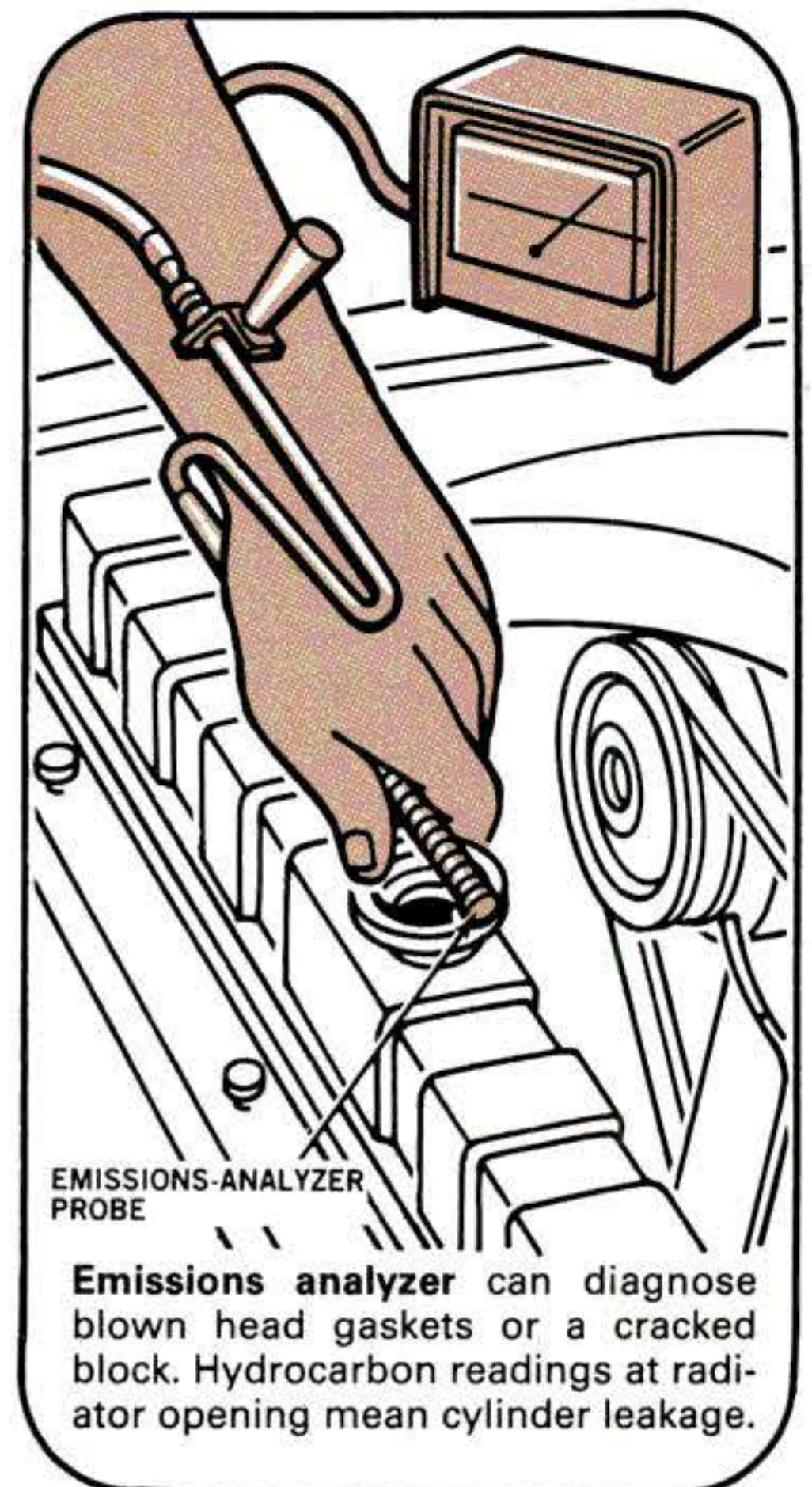
Components

The radiator cap is a pressure-relief valve designed to maintain a pressure of roughly 15 psi. The system is pressurized to raise the boiling temperature of the coolant. For each pound increase in pressure, the boiling temperature goes up by three degrees F.

The boiling point is raised further with ethylene glycol-base antifreeze in a 50-50 concentration. A concentration greater than 60 percent is not only uneconomical but reduces cooling-system efficiency, since water can absorb more heat per gallon than any other practical coolant. In fact, at the maximum concentration, the coolant will absorb only 85 percent as much heat as water. The pressurized system and a 50-50 concentration of antifreeze combine to bring the boiling point of the coolant to 265 degrees F.

Even with all this protection, systems sometimes overheat. And increased temperature causes increased pressure. This can force some coolant out through the overflow tube in the radiator-filler neck to a reservoir. As the system cools and the pressure is reduced, a vacuum is produced. This draws the vented coolant back into the system.

A small but important part of the cooling system is the thermostat. Its job is to get the engine warmed up as quickly as possible by restricting the flow of coolant until a preset temperature is reached.



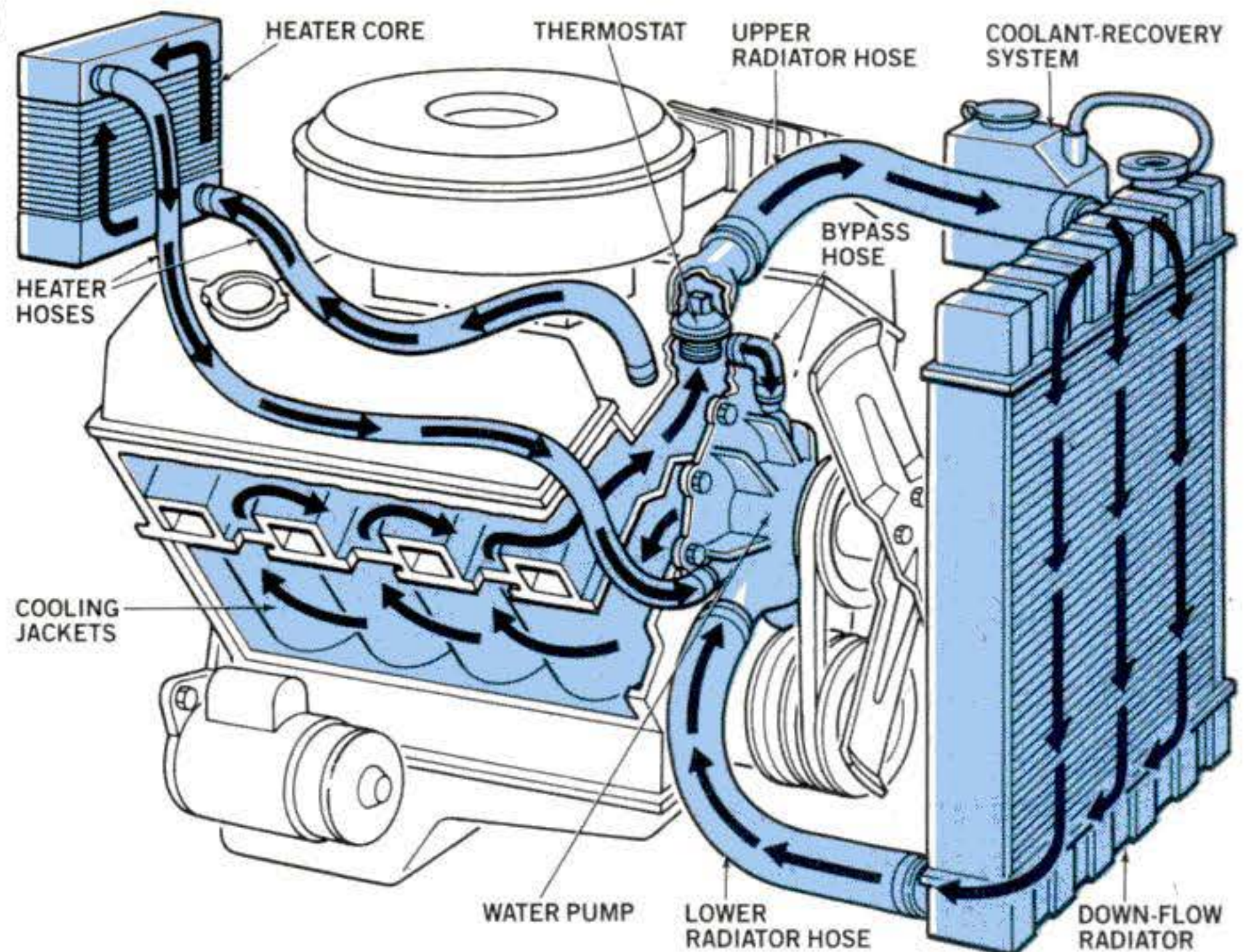
Although it's important to keep the engine from overheating, it is equally important to prevent over-cooling. Over-cooling encourages the formation of acids and sludge in the oil. It also tends to reduce combustion-chamber temperatures by quenching the flame front. This results in higher emissions and greatly reduced fuel efficiency, because much of the fuel remains unburned. That's why it is never a good idea to substitute a thermostat with a lower opening temperature than that of the one you are replacing.

After the thermostat opens, the

Continued

The COOLING System

Internal-combustion engines are unable to convert all the energy produced by their fuel into power. Roughly a third of the heat generated by an automobile's engine must be dissipated to the outside air. That is the job of the cooling system. To perform this essential function, the system must be clean and tight, and it must permit the free flow of coolant under specified temperature and pressure. The cooling system removes the heat from the engine by circulating coolant through passages surrounding the cylinders and combustion chamber. The heat is dissipated by circulating the heated coolant through the radiator, where the heat is transferred to the walls of the core tubes. The heat passes into the fins bonded to the tubes. Air passing over the fins, as well as convection, removes the heat from the system. There are basically two types of automotive-radiator designs: cross-flow and down-flow. In the down-flow design, heated coolant from the engine goes into an end tank on the top of the core and flows down through the core tubes into the lower tank. In the cross-flow type, hot coolant goes into a tank at one side of the core and flows across (horizontally) into another tank. One of the tanks has a filler neck with a pressure cap. A spring-loaded valve in the cap is set to open at a preset pressure. This prevents damage to the cooling system in case excessively high temperatures raise the system's internal pressure. The excess pressure generally forces some



coolant out of the system through a vent. A hose emptying into a plastic reservoir recovers the displaced coolant. Both system types use a coolant fan, which is normally attached to the water-pump shaft. The fan moves large volumes of air through the core at low road speeds when relatively little air is being forced through the core. The water pump circulates the coolant through the cooling jackets of the engine. The rate of flow is governed by three factors: the size of the pump pulley, the size of the

impeller, and engine speed. The heater core is an often overlooked part of the cooling system. Essentially, it's a smaller version of the radiator at the front of vehicle, but it's located in front of the passenger compartment. Engine coolant is pushed into the core, and an electric fan forces air through the heater core and into the passenger cabin to warm the vehicle. (Note: If your car overheats in traffic, you can sometimes increase engine-cooling capacity by turning on your heater.)

coolant circulates between engine and radiator, maintaining a temperature between 190 and 210 degrees F. It picks up a normal increase of 15 degrees as it passes through the water jacket surrounding the combustion chambers and cylinders.

The most easily recognized part of the cooling system is the radiator. Its job is to transfer heat from the coolant to the outside air. Most radiators are made of brass, copper, or aluminum because of the corrosion resistance and heat-transfer ability of these metals. The heat-transfer capacity is based on the number of fins per inch and the thickness, number, width, and height of the coolant-carrying tubes.

In a departure from convention, some companies have been making radiators with nylon end tanks and either an aluminum or copper-brass core. The tanks are attached to the core by header tabs bent over the edges of the tank—tabs similar to those used to seal the lids on pails of roofing tar.

The water pump is the heart of the cooling system. It will pump as much as 4,000 gallons per hour in a V8 engine to maintain the delicate balance between an over-cooled and an overheated engine. When it's cold outside, it must also push hot coolant through the heater core to provide a comfortably warm passenger compartment.

Diagnosis

Leaks are the most common form of cooling-system problem. The best time to catch one is just after you shut down the engine. While the engine is running, coolant temperature and pressure are kept below maximum by radiator cooling. But just after shutdown, the higher temperature and pressure are just the ticket for revealing hard-to-locate leaks.

The cooling-system-pressure tester is a special tool for finding elusive leaks. It looks like a small bicycle pump with a pressure gauge on the side, and it's installed on the radiator neck in place of the cap. You just pump up the system to the maximum

specified pressure on the cap, then look for leaks (see illustration).

A third method for finding external leakage is to apply low-pressure air to the cooling system through a drain cock or vent fitting in either the engine or radiator. (Note: Don't attempt this procedure without a pressure regulator and gauge or you might apply more than the recommended system pressure.)

The condition of the coolant can tell you a lot about your cooling system's health. A reddish foam in the radiator is a tip-off to a transmission-cooler leak that's allowing transmission fluid to enter the radiator.

Oil floating on top of the coolant is a sure sign of internal leakage. If oil is entering the radiator, coolant is probably leaking into the engine. If this is the case, you'll also probably spot steam escaping from your exhaust pipe.

If you suspect that exhaust gases may be entering the coolant but don't have access to an emissions analyzer as I did with the Olds, here's a simple

test you can do: Start by removing the fan belts, then remove the thermostat and reinstall the thermostat housing without the upper hose. Next, fill the thermostat housing with water until the water spills out. Start the engine and check the water in the thermostat housing for bubbles. Remember, you've removed the belts, so the water pump isn't turning; there's no flow of coolant. In a short time the engine will overheat. However, you'll have sufficient time to accelerate the engine six or eight times while watching the housing's outlet for bubbles, indicating combustion leakage into the cooling system.

A heavily rusted cooling system—one in which the coolant looks more like chocolate soda than radiator coolant—may be caused by the rapid deterioration of rust inhibitors. This often occurs when exhaust gases enter the cooling system.

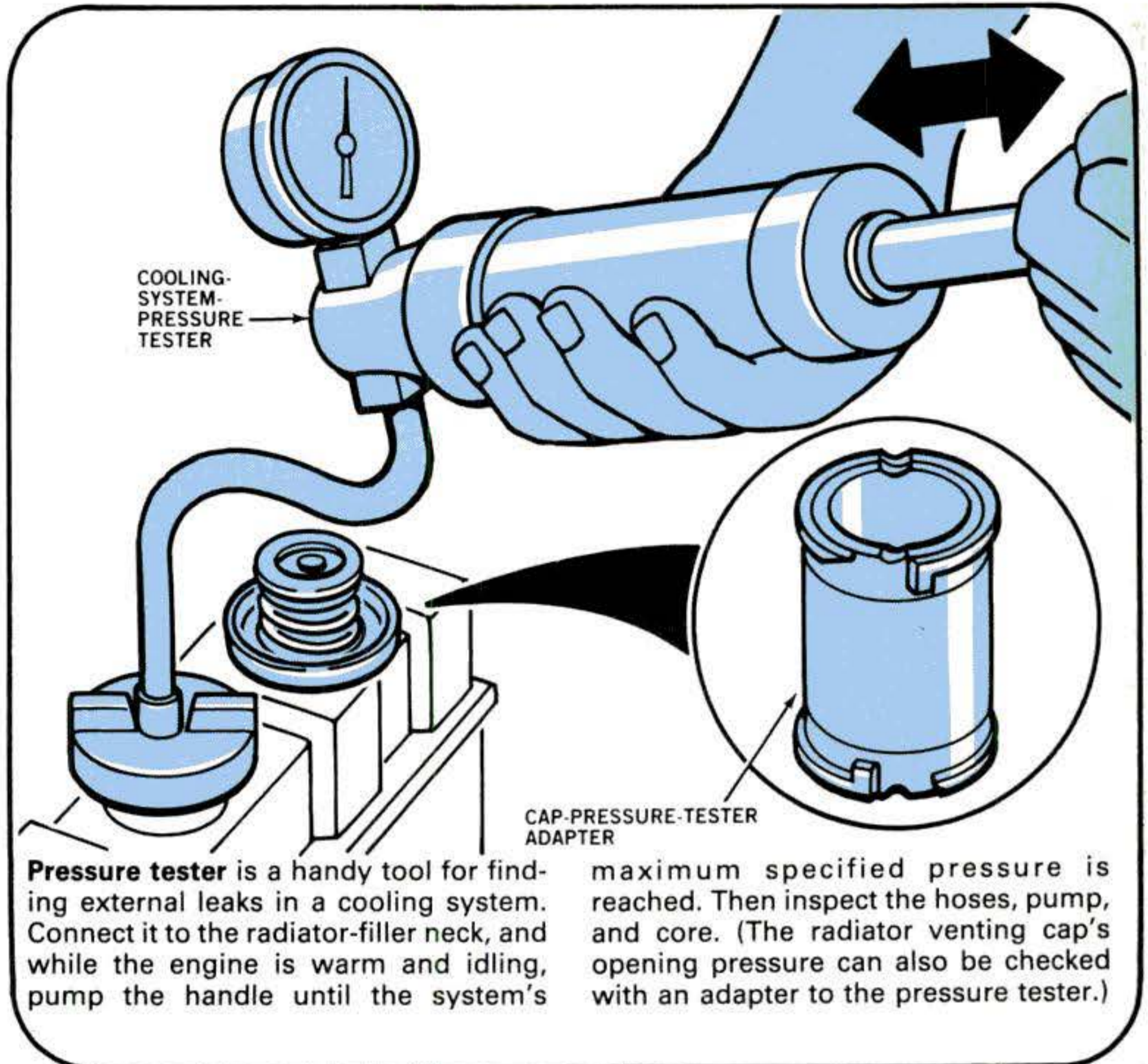
Reduced cooling-system efficiency may be as simple as a loose belt. Fan-belt checks are fairly easy to make, but be sure you twist the belt to view the underside, where cracks develop first.

What about hoses? Squeezing them may seem like a relatively accurate way to judge their condition, but since hoses wear from the inside out, it may not be your best bet. It's best to simply replace the hoses every few years. Certainly by the time you have 35,000 miles on your car all the hoses should have been replaced.

A bad thermostat, like a bad hose, is difficult to spot. If your engine is operating cold, the thermostat is probably stuck open and will have to be replaced. To check your thermostat, fill a container with water. Insert a feeler gauge into the thermostat's opening. Suspend the thermostat in the container by one end of the feeler gauge. Position a thermometer in the water bath and heat the container. The water bath is heated until the thermostat slips off the feeler gauge. The temperature recorded when the thermostat falls is the opening temperature. It should be within five degrees F above or below the temperature stamped on the thermostat's body.

Bearing and seal failures account for most water-pump problems. Bearings are easily diagnosed by applying hand pressure to the end of the pump shaft: There should be little or no side play in healthy bearings. Seal failures are even easier to spot. Simply look for any leakage at the pump's vent hole when the engine is running or stopped.

Now for the fan. Air is forced across the radiator core at low speeds by a



Pressure tester is a handy tool for finding external leaks in a cooling system. Connect it to the radiator-filler neck, and while the engine is warm and idling, pump the handle until the system's

maximum specified pressure is reached. Then inspect the hoses, pump, and core. (The radiator venting cap's opening pressure can also be checked with an adapter to the pressure tester.)

cooling fan. At high speeds air is pushed through the radiator by the forward motion of the car. For this reason, viscous fan drives were developed to reduce the speed of the fan at higher engine speeds. This both reduces fan noise and conserves energy. The clutch allows the fan to free-wheel when the engine is cool. A fan clutch must engage when the engine is hot. You can tell if it's doing its job by listening to the fan noise on a cold engine. As the engine warms up, you should hear a distinct roar when the fan clutch engages. If you don't hear anything, you may have a defective fan clutch.

Maintenance

Every cooling system should be pressure-tested at least once a year, using a cooling-system-pressure tester. After the first two years the cooling system should be flushed annually and a fresh fill of antifreeze installed. An effective way to do this is to install a special garden-hose adapter, available at any auto-parts store, in one of the heater hoses. With the heater controls in the "on" position, attach the garden hose to the adapter and remove the radiator cap. Run the water until the flow from the filler neck is clear.

Inspect the interior of the radiator's top tank through the filler neck for signs of scaling or excessive rusting. If the system has been neglected for a long period of time, you may want to

remove the coolant and fill the system with a flushing solution. Run the engine for at least 30 minutes, and drain the solution. Then add a neutralizer, fill the system with water, and run the engine for five minutes. Finally, drain the neutralizer solution completely and fill the system with fresh water. Run the engine for five minutes and drain. Refill with the proper antifreeze solution. (Note: Make sure the flushing solution is compatible with your car's radiator-core material.)

The volume of your cooling system is specified in the owner's manual. A chart, usually located on the antifreeze container, will tell you how much is needed for the cold-weather protection desired.

Belts have a habit of breaking at the wrong time. They stretch, wear, and crack. If a belt is loose, it may not drive the water pump properly. A belt-tension gauge is the only reliable method of checking belt tension. The best maintenance is to check belts frequently and to replace them at regular intervals. Throw the old belts in the trunk. They may serve well if one of the replacement belts gives up sooner than expected.

Most new-car water pumps don't require any maintenance or lubrication. However, the drive-belt tension should be checked carefully. Too little tension won't turn the pump, and too much will cause premature failure of the bearings.

Look what you can do with new waferboard panels

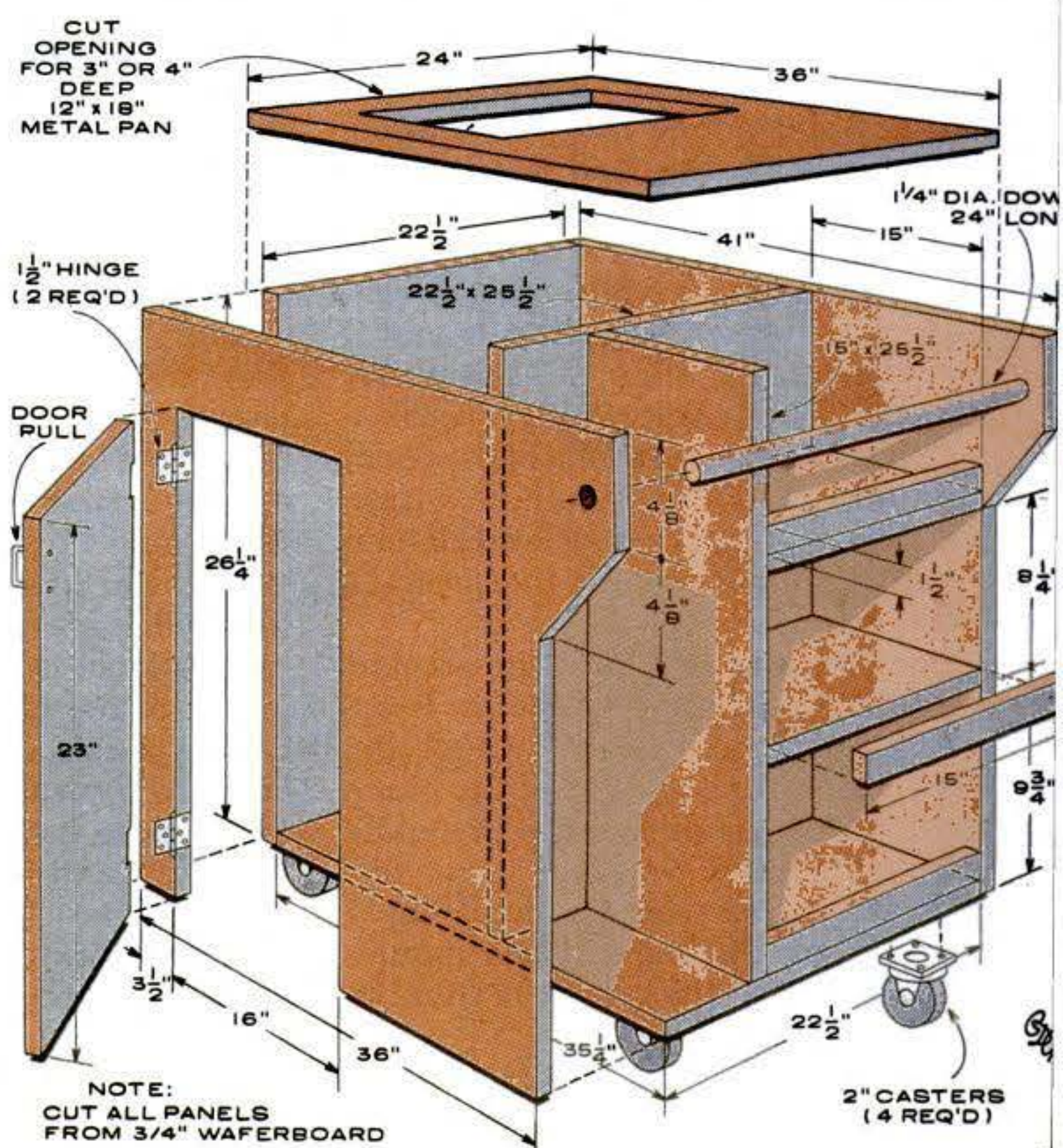
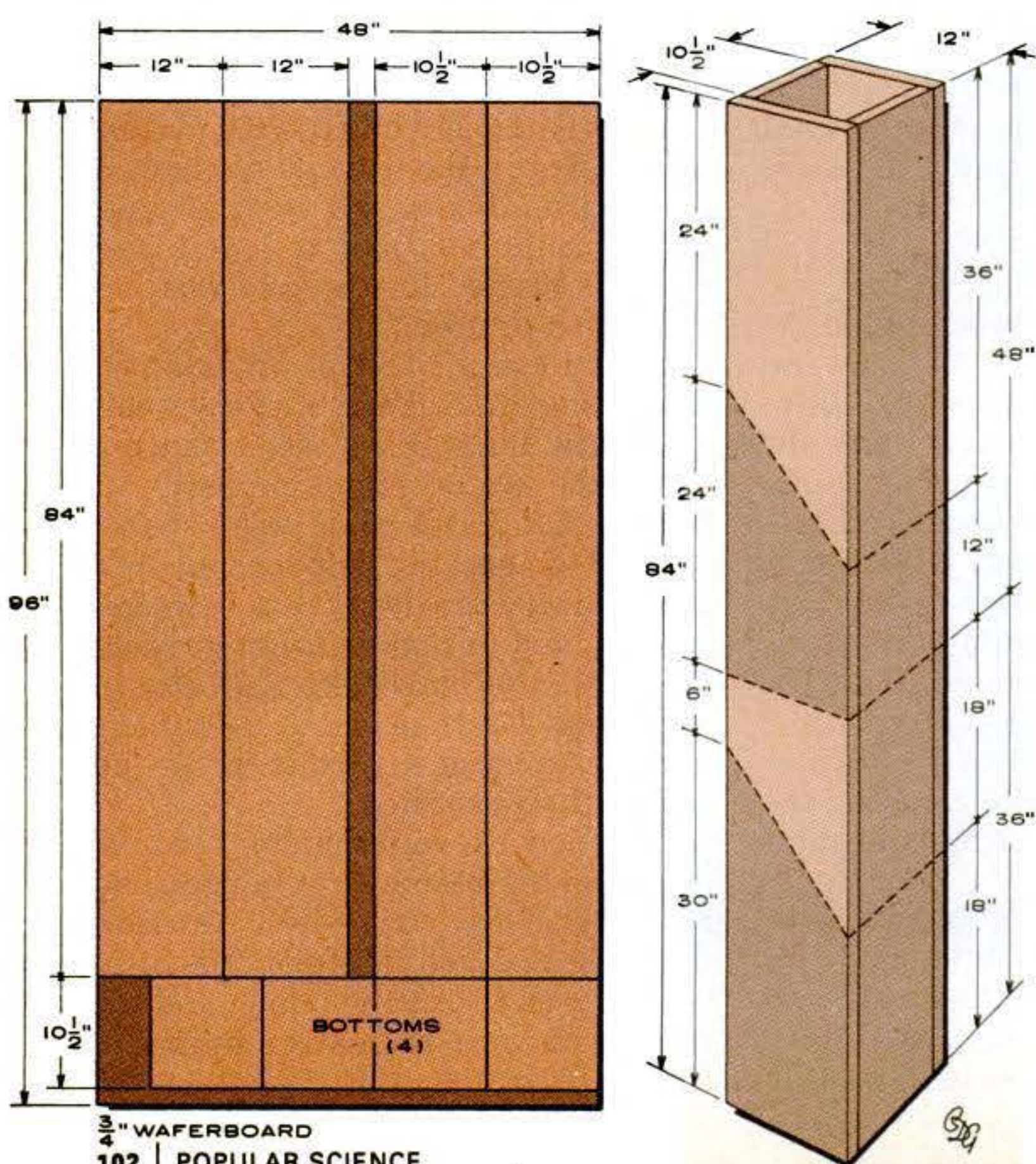
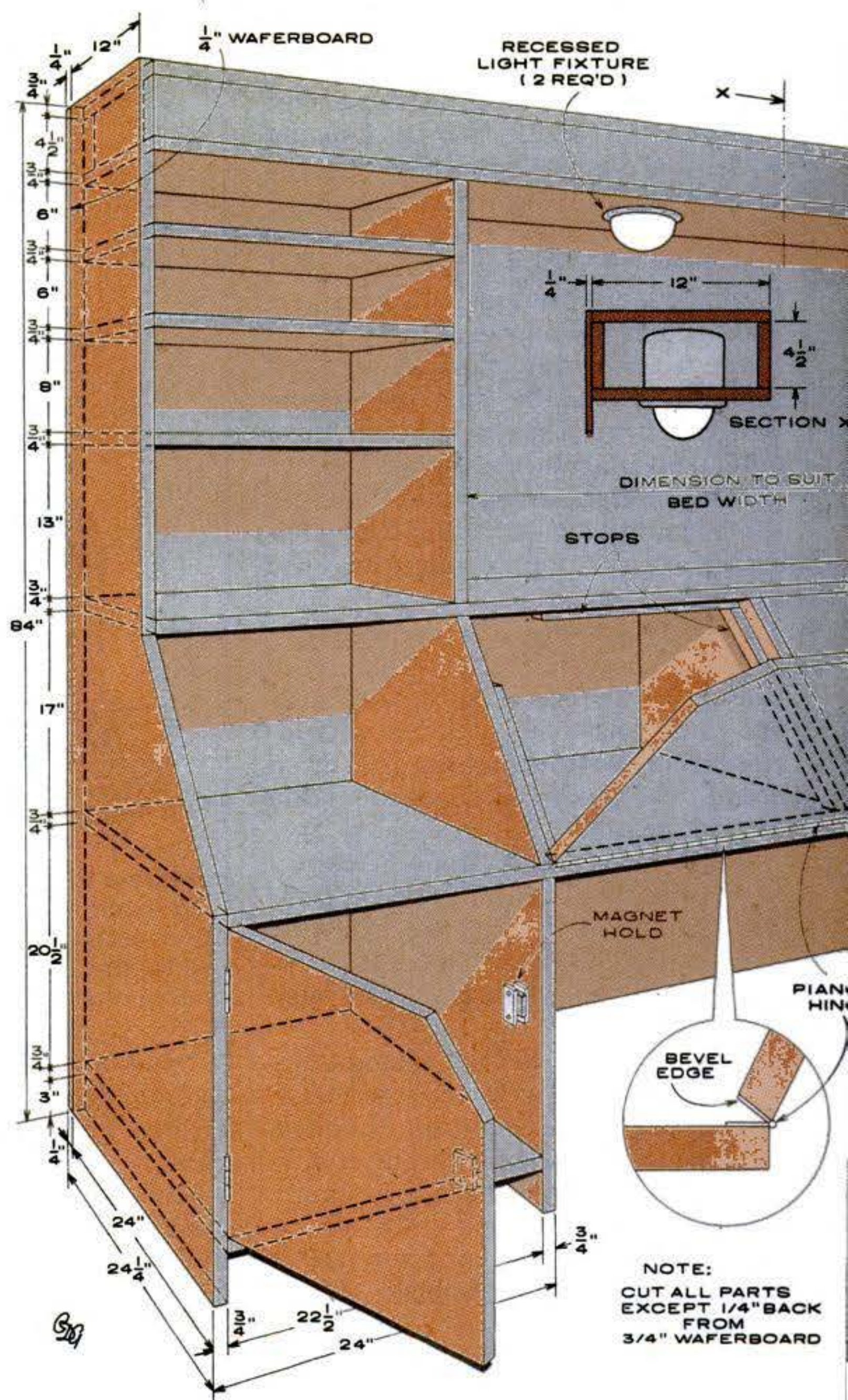
Now available nationwide: an alternative to plywood for home-improvement projects

By AL LEES

There's a new kid on the construction-panel block—and with his aggressive promotion and natural good looks he's offering quite a challenge to the long-established leadership of plywood and particleboard. The name's waferboard, and you'll be hearing it more and more.

PS has nodded to the product before. In a December '79 article, "New-Generation Particleboard," we mentioned that "large stands of previously unused trees make up the raw material for waferboard, the newest type of manufactured wood," and we ran a page of color photos showing

Continued





Storage headboard is made of $\frac{3}{4}$ -in. panels edged with lattice strips and backed with $\frac{1}{4}$ -in. waferboard—all finished with clear sealer. Projecting handles on compartment doors have been eliminated by cutting corners to serve as finger grips.

COLOR PHOTOS FROM LOUISIANA-PACIFIC



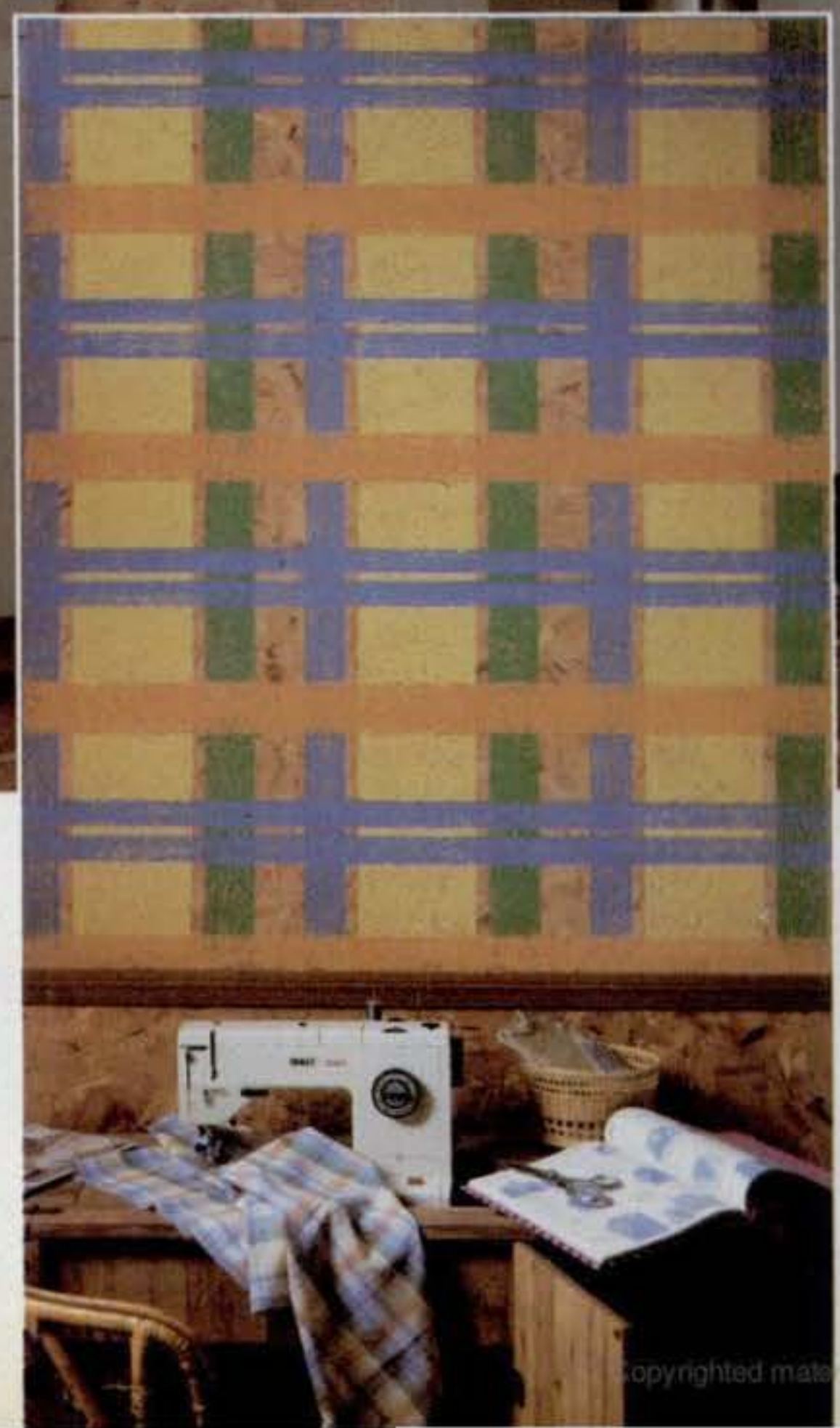
Organ-pipe planters, cut from single $\frac{3}{4}$ -in. column (as shown in sketch, far left), can be clustered in many arrangements. Planter faces are coated with an exterior sealer, then white enamel is applied to all exposed edges as an accent.



Barbecue cart is cut from $\frac{3}{4}$ -in.-thick waferboard and painted with exterior enamels. Rough surfaces give textured effect. Edges are painted in contrasting terra cotta, as are shelf lips and dowel handle; cart is mounted on casters.



Finishing treatments lend elegance to waferboard. Above, ½-in. panels used for cabinet doors and drawer fronts are framed in boards painted gray (before application). Sewing-center wall (inset) is given plaid fabric look with four colors applied with different-width rollers. Marble effect at right comes from power sanding until wafer edges round off and blend.



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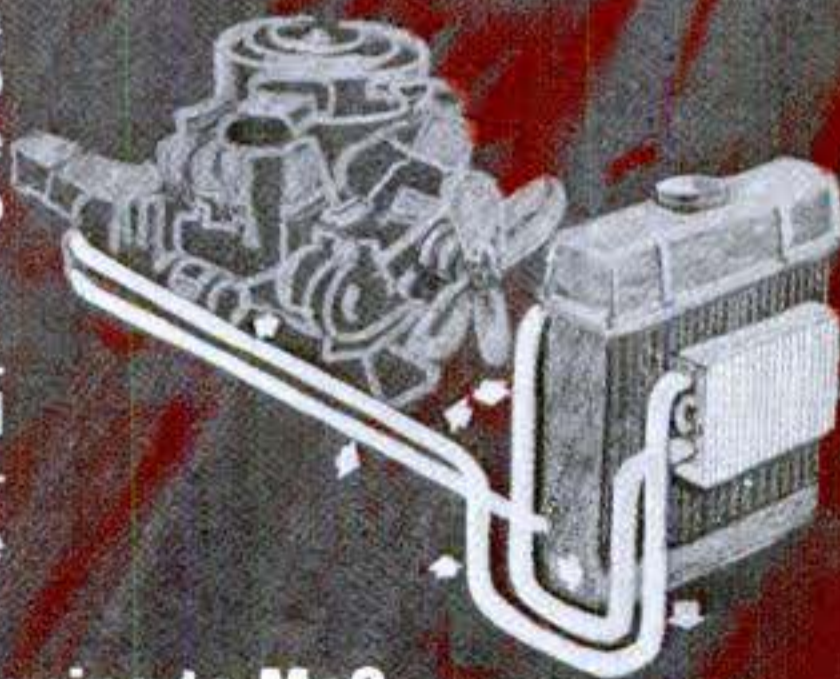
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*Courtesy ATRA (Automatic Transmission Rebuilders Association).



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waferboard used indoors and out. But this was a Canadian product, marketed under the names of Aspenite and Blandex, only then just beginning to appear in U.S. lumberyards. "Use of superior resins," we said back then, "was one of the research breakthroughs that made waferboard possible. Another was the decision to try fairly large chips instead of small particles."

Now all that resin and chip research has resulted in even-more-refined panels that are being pressed and baked in plants across the U.S. This latest waferboard is not particleboard or the old rough-faced chipboard, but a factory-sanded panel you can use anywhere you'd use plywood. It's formed of layers of wafers chipped from either hardwood or softwood logs (usually aspen or poplar—woods of little other commercial value). These wafers are coated with wax and waterproof resin, deposited in layers, and fused under heat and pressure into various thicknesses. As with plywood, these range from 1/4 to 3/4 inches. Panels are then factory-trimmed to four-by-eight-foot sizes.

Waferboard is easier to buy than plywood since you needn't fret about choosing the right grade for the job: All panels are made the same way, so, properly finished, they're all appropriate for both indoor and outdoor projects. (Particleboard is meant for indoor use only.)

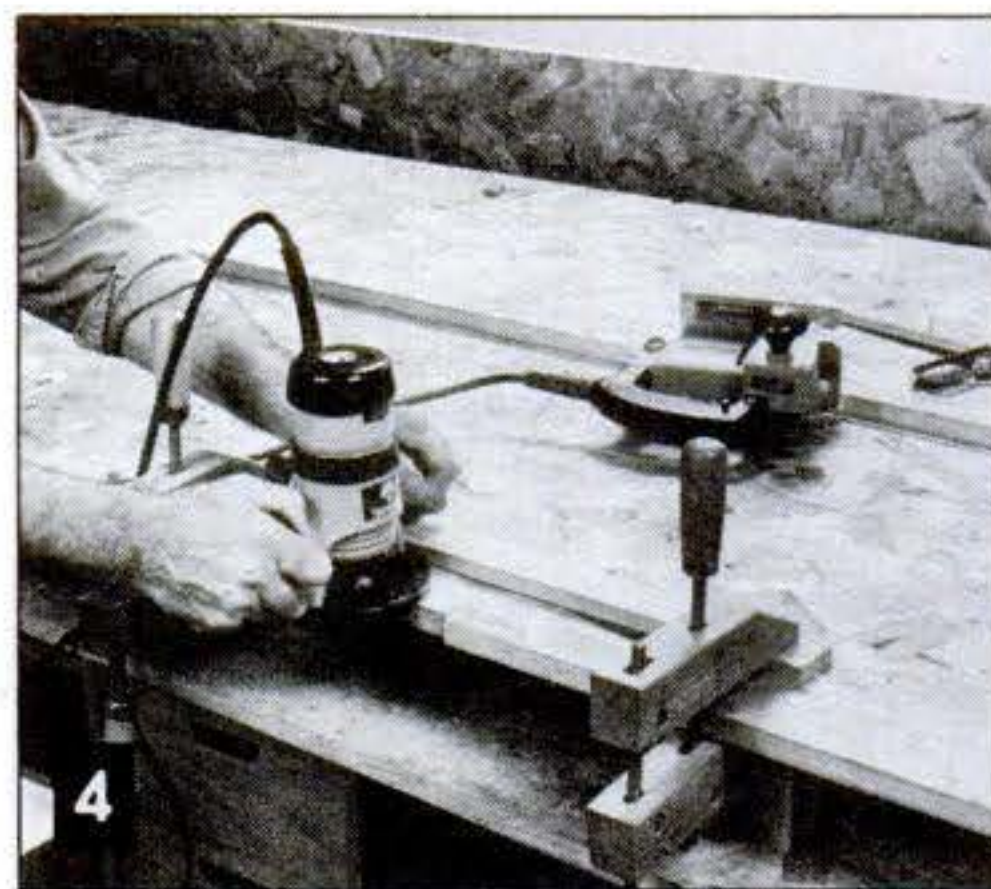
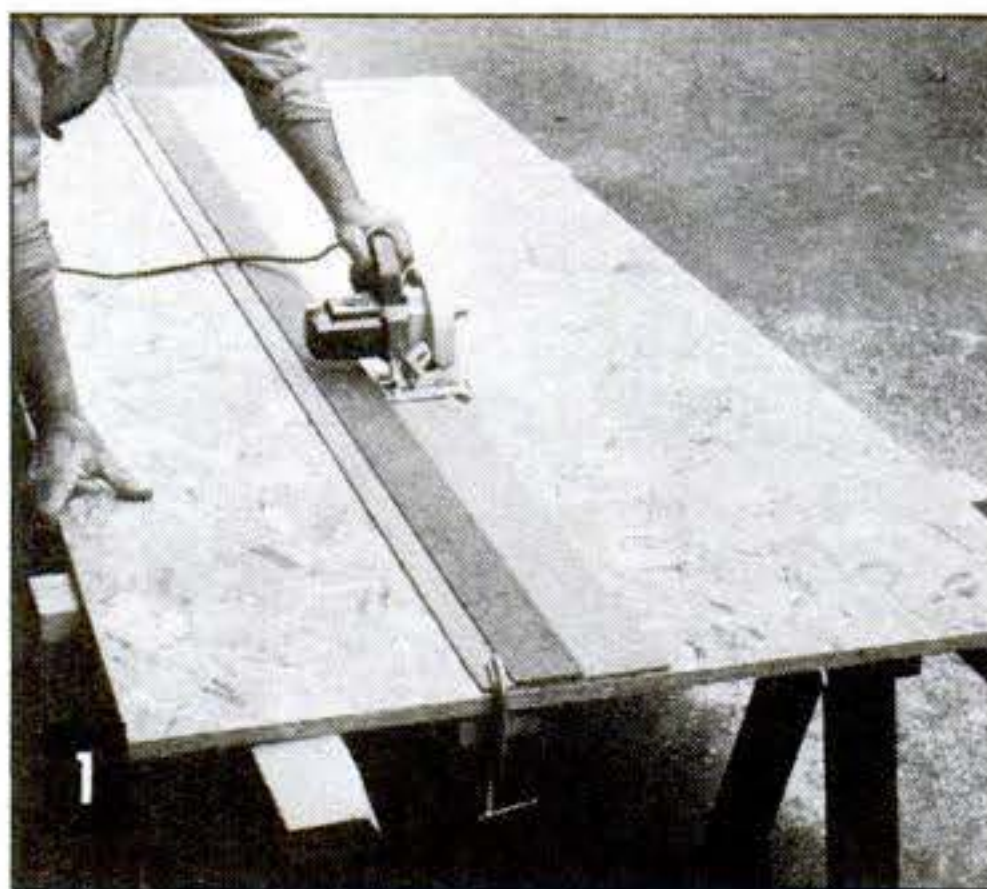
Unlike softwood plywood, whose wild surface grain must nearly always be tamed with pigmented sealer before you hide it under a coat of paint, a waferboard surface presents a mosaic of large hardwood chips that I find singularly attractive when varnished or shellacked.

You can, of course, get many special effects by letting a base-coat stain or paint dry thoroughly before brushing on a contrasting color and then wiping the surface, leaving the second coat only in the depressions. If you choose to enamel waferboard, you'll get a textured surface that suggests rough plaster.

Both treating edges and finishing exposed rear faces can be simpler than with most plywood. Since the panel is of the same layered-wafer structure throughout, you'll find no core voids or knotholes to fill.

I've worked with all standard panel materials, and I don't find waferboard any harder to handle than plywood or particleboard. Generally, it falls between those two in weight and workability, because it's between them in its wood-to-resin ratio. Since particleboard must use a lot of resin to bind its wood fragments, it's the heaviest

"The panels are easy to work," says Ro Capotosto



Pro woodworker Capotosto took these shots in his shop and offers these comments: (1) Face the "good" side down when cutting panels with portable circular or saber saw; clamp straightedge for best cut. (2) Cabinet scraper with

panel—and the one that dulls cutting tools fastest. (A panel of 3/4-inch waferboard weighs about 80 pounds.)

Use the same tools you'd choose for plywood. Waferboard saws, drills, and glues easily (its dense edge grain actually takes nails and screws better than plywood edges). A fine-toothed crosscut saw with little set will produce a smoother cut than a large-toothed rip blade with heavy set. A smooth-cutting carbide-tipped blade is best for circular saws. In my saber saw, an extra-fine woodcutting blade breezed through a 3/4-inch panel.

In using waferboard for indoor projects, should you fret about formaldehyde outgassing? No, say the makers: The phenolic resins used in waferboard don't have any significant formaldehyde emission levels (see this issue's "Shop Talk").

In laying out your projects on a waferboard panel, you can forget about grain direction. Since most panels are formed from a random placement of wafers, there's equal strength in all directions. Since waferboard is regularly used in home building—as sheathing, underlayment, and roof decking—its strength and stability are well documented.

One caution, though: Surface wa-

fered" edge does quick job of removing saw ripples. (3) Gang-sand exposed edges to save time; broad edge offers flat surface for belt sander. (4) Cut mortises with saber saw, then true cuts with router and flush-trimming bit.

fers at the edges can be torn loose with rough handling, so don't drag panels around before you've got a protective finish on them. If a wafer lifts in sawing, you can fasten it back with glue and masking tape.

The major U.S. manufacturer of these panels is Louisiana-Pacific, under the brand name Waferwood. We asked L-P to create projects for us that would demonstrate the versatility and natural beauty of Waferwood; then we asked them to send panels for us to work with in our own shop. Our experience has confirmed our initial impression: Waferboard is a fine new home-shop panel—at a cost well below that of plywood. We're so impressed with its potential that we're broadening our annual plywood design contest to include waferboard in '84. ■

FOR FURTHER DATA AND PLANS

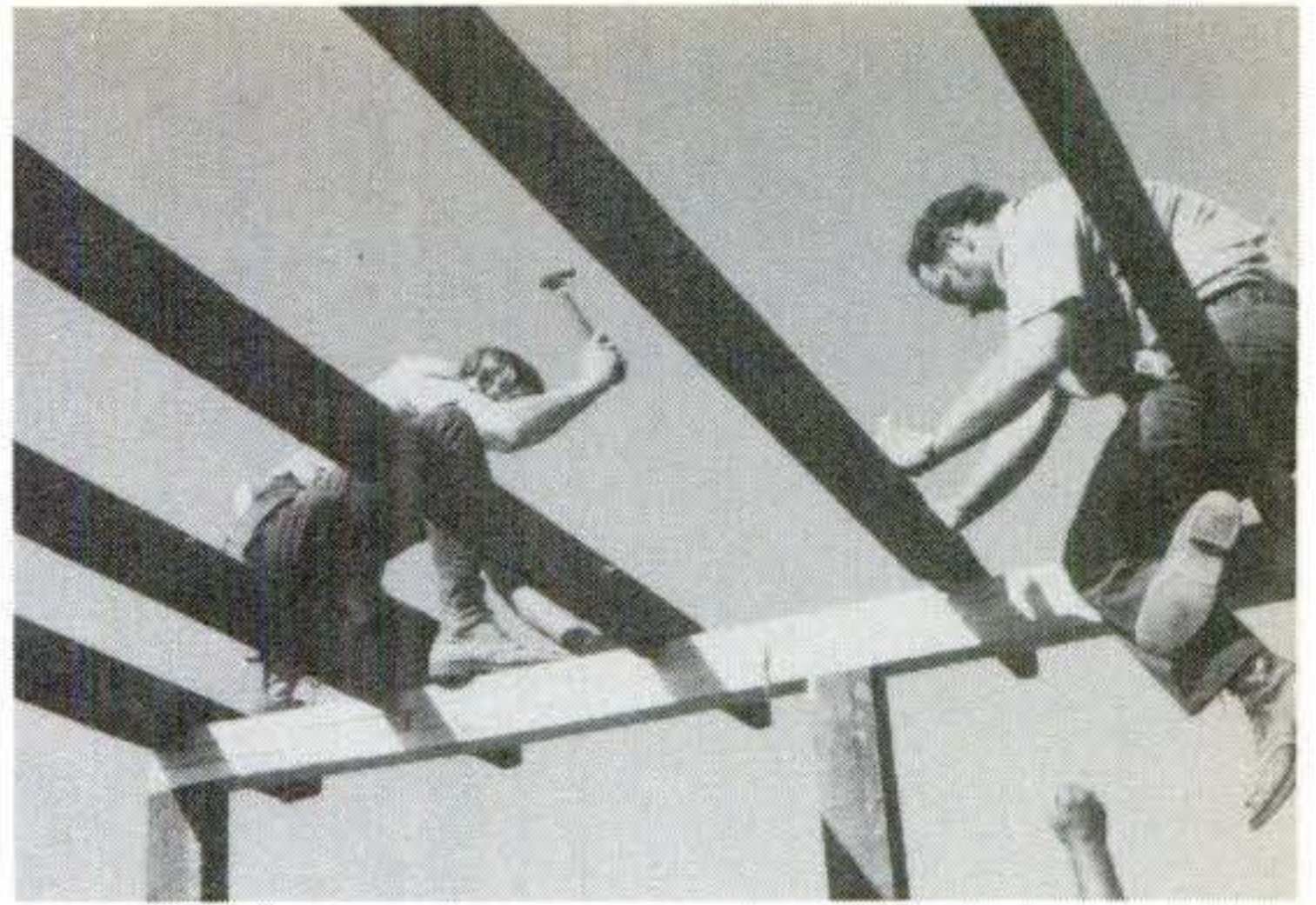
Louisiana-Pacific (1300 S.W. Fifth Ave., Portland OR 97201) offers the folder "How to Work Wonders with L-P Waferwood" plus idea booklets and project plans for a storage shed, doghouse, furniture, and toys. MacMillan Bloedel Ltd. (1075 W. Georgia St., Vancouver, B.C., Canada V6E 3R9) has idea booklets on using various Aspenite panels, including grooved versions called Aspenplank and Aspenstripe; also available are plans for an elaborate garden shed and several leisure homes. The Waferboard Assn. (Box 724533, Atlanta GA 30339) offers a booklet, "Waferboard in Residential Construction, 1983," and brochures on products of member mills (mostly Canadian). These include plan sheets for a tool shed and fences of Waferweld (by Weldwood of Canada) and a playhouse and utility shelf of Norbord (by Northwood Mills).

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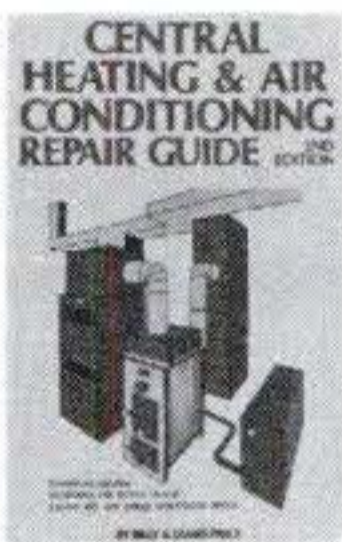
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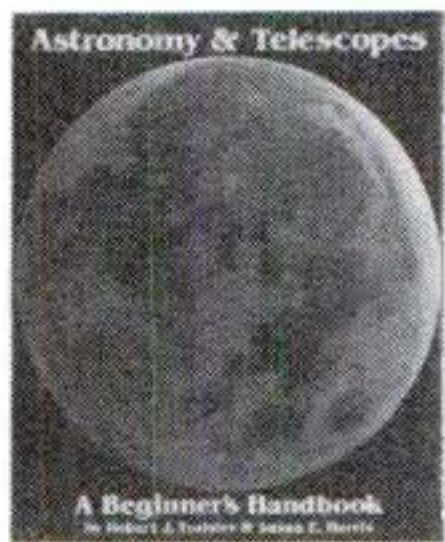
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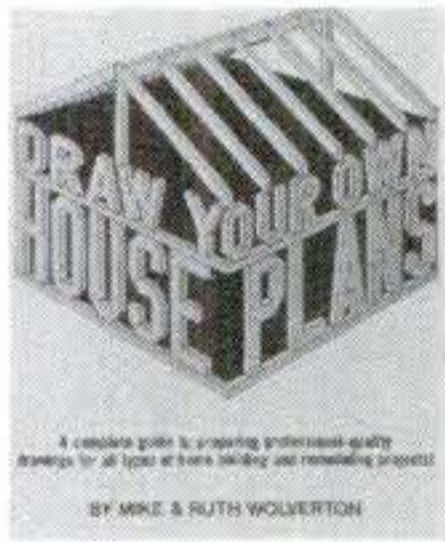
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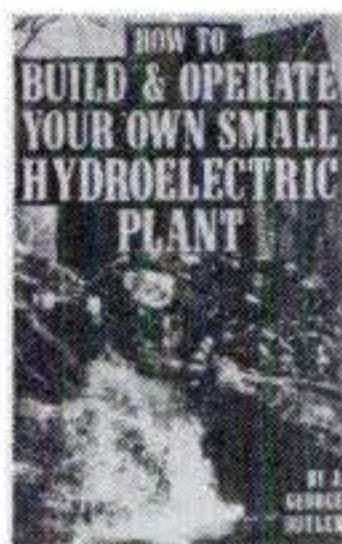
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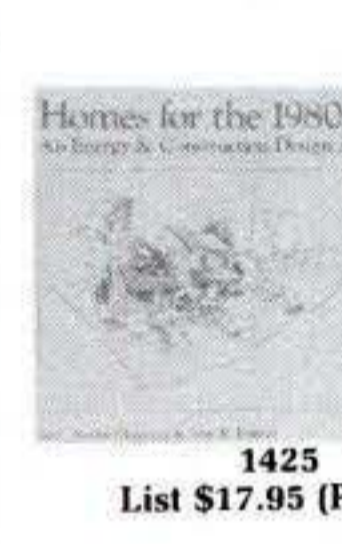
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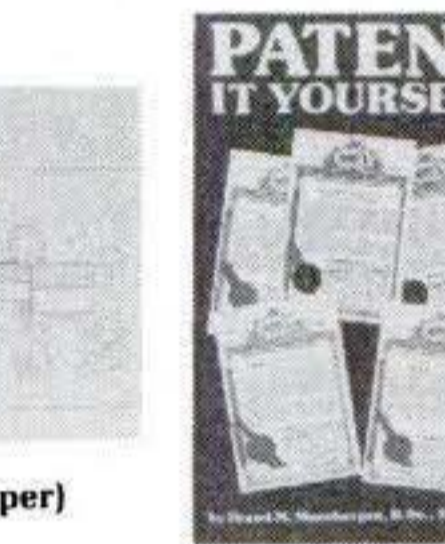
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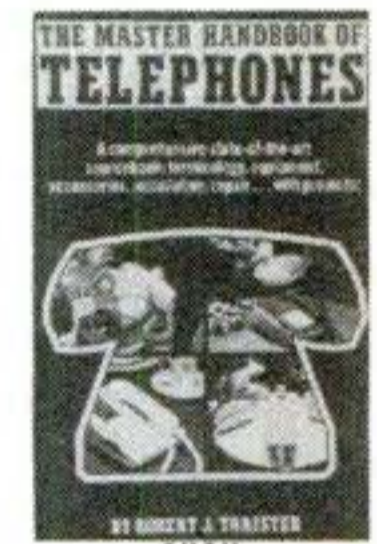
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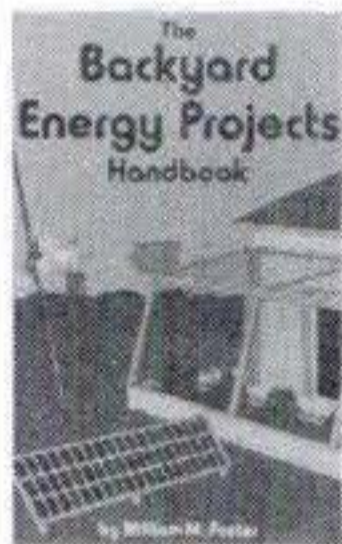
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Analyze the trends with computer stock-market programs

Chart the action on Wall Street, but don't expect instant riches

By GORDON MC COMB

For months I'd been following IBM, watching as its price rose steadily toward the top of my computer screen. Each evening, I would key into the computer the price and volume data from my afternoon newspaper for that and 19 other stocks, then sit back and watch as a series of full-color graphs came up on the display.

Moving up just below the price bars on the IBM display was a line that averaged the closing price for the previous 30 days, a so-called moving average. Then one evening, on a day that IBM had lost a point, the moving average surged past the current price. The next morning I called my broker and ordered 50 shares.

I am pleased to report that this simplistic system worked for me on this occasion. Two weeks later, when the current price climbed back well above the moving average, I sold out at a profit. But I'm not here to pitch a new beat-the-market scheme, just to review the great variety of stock-market software that's available for owners of personal computers.

The PS buyer's guide lists more than 40 such programs ranging in price from \$30 to \$700. (More-expensive programs were excluded because they are aimed primarily at professional traders and advisors.) With such a range available, how do you choose a program that's right for you? The programs can be categorized by their functions, the way data is entered, the kinds of graphics they display, their special features, and the

computers they will run on. In fact, the programs differ in so many ways that they really have only one thing in common: None, by itself, can make you rich.

The publishers of stock-market software are careful to make that point. "These programs work best when used as tools, not taken as gospel," says Clay Burch of RTR Software, publisher of the Dow Jones Market Analyzer and other programs. As tools, they are powerful: They can track a huge amount of information, retrieve historical data, compute commissions and capital gains, and generate graphics that organize the raw data into visual form. "But running the programs still requires a lot of effort on your part," says Jim Huebner of Investor's Software. "No stock-market program will tell you exactly when to buy and sell."

Nevertheless, buying and selling are what these programs are all about. If you don't make at least a couple of trades a year, stock-market programs can't do much for you. Conversely, heavy traders probably need something more comprehensive than the programs listed here.

Personal-computer stock-market software makes the most sense for light-to-moderate investors who have the interest but not the time or money to follow the market closely. For such investors, the programs can perform many of the functions their brokers do. They don't, of course, replace the broker's principal function of actually executing trades.

The software on the market can be sorted into three basic categories: portfolio management, technical analysis, and fundamental analysis. None of these, by the way, is in any way unique to personal computers.

The same functions have always been performed in more-ordinary ways. The news is that they are now available to home-computer owners.

Portfolio-management programs are really just electronic notebooks. They keep a complete record of the stocks you own and show how well you're doing at the game. They are especially useful at tax time: Their compilations of your losses, gains, dividends, brokerage commissions, and more, make it easy to account to Uncle Sam for your Wall Street activity.

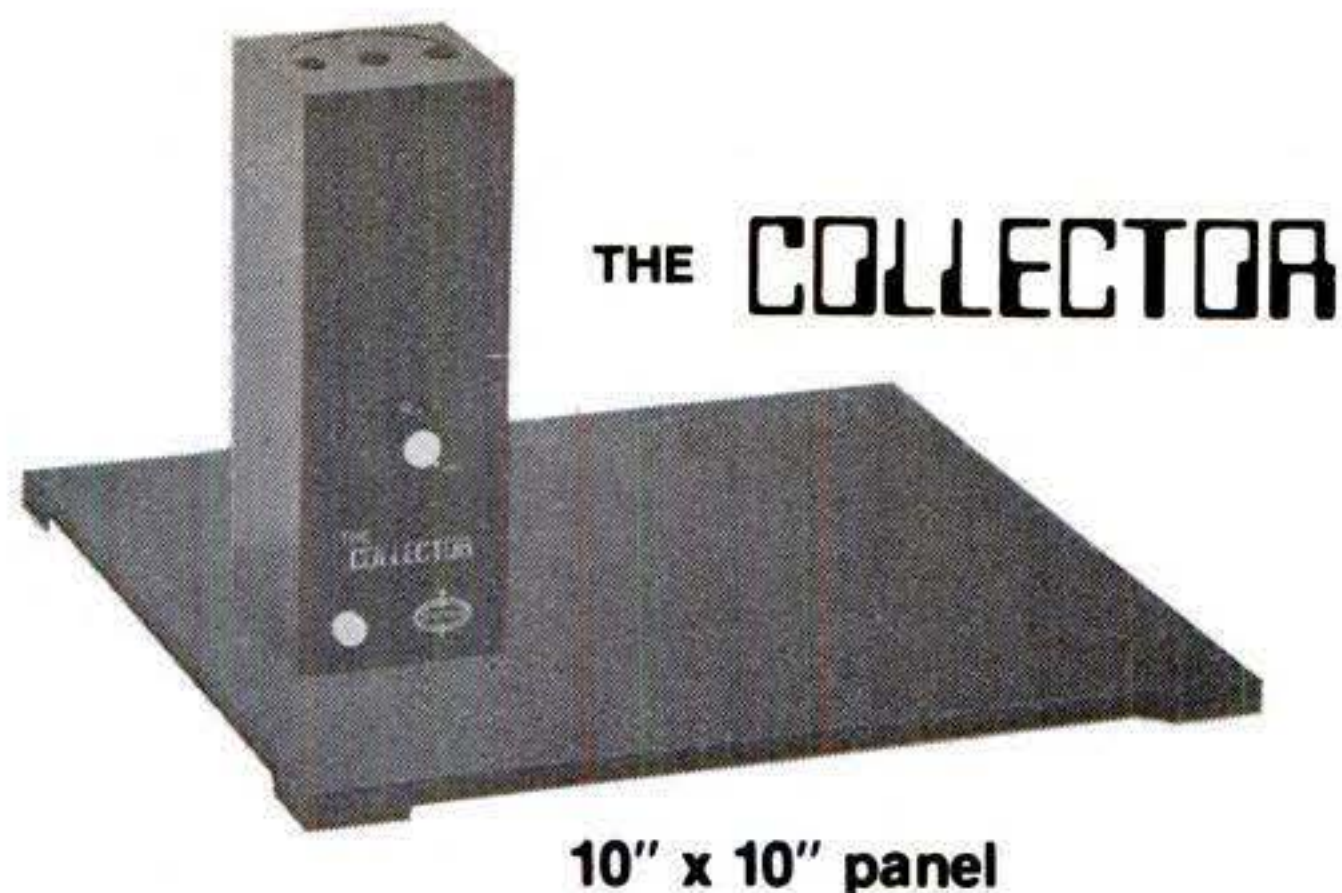
The other two types of programs, technical and fundamental analyses, go beyond mere record keeping and organize market and general financial information in ways that may help predict future activity. Although the end goal of both approaches is to outguess the market, they are based on wholly different assumptions.

Picking the winners

Fundamental analysis assumes that the price fluctuations of stocks are based on the basic financial health of the economy and the performance of the individual company. So fundamental analysts look at such factors as earnings, sales, assets, and liabilities. Then they use these to predict future price movements.

Nobody contends that such factors are unimportant, but technical analysts argue that they affect stock prices only over the long run. Short-term fluctuations, they say, are governed by psychological conditions in the market itself, not external factors. Therefore, they believe that studying the ways the market has behaved in the past can point the way to profits in the future. There are many different theories that promote various indica-

Continued



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Filter-fan units do not emit negative ions. The COLLECTOR, by Zestron, creates trillions of these beneficial ions every second, while giving you the best performance, value, and technology in air cleaning.

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Unplug your COLLECTOR, place the ionizer unit and an ashtray on top of the panel. Place a lit cigarette in the ashtray and watch the smoke rise into the air. Now plug it in, and amaze yourself and friends as the smoke barely rises above the ashtray and then nose-dives onto The COLLECTOR panel before it can enter the room air. This is accomplished entirely electronically with no moving parts. The COLLECTOR, by Zestron, is the only ionizer on the market that cleans the air powerfully enough to accomplish this test.

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The COLLECTOR by Zestron	1,200,000	YES
JSA Bubble	not stated	YES
Aspen	not stated	YES
Orbit	not stated	YES
AirEase	not stated	YES
AirCarell	236,000	YES
Ion Fountain	540,000	NO
Ion Cloud	350,000	NO
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Ion Breeze	not stated	NO

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A FREE remote ion detector comes with each COLLECTOR to verify and compare output. When you place the detector next to The COLLECTOR and a competitive unit, you will see greatly reduced or no output from the competitive unit!

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Order a COLLECTOR now and try it in your home or office risk free for 30 days. If for any reason you are not satisfied, return the unit for a full refund including return postage. The COLLECTOR has a full one year warranty on both parts and labor excluding abuse.

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PS buyer's guide to stock-market software

Program distributor	Program name	Price (\$)	For computer	Hardware requirements ¹	Memory requirements (K)	Disc/cass.	User category ²	Type of program ³	Graphics oriented?	Data-base mode ⁴	Auto. data retrieve ⁵	Disc-update frequency?	Printout capability?	Number of records stored ⁶	Comments
Ampero Software 5230 Clark Ave. Lakewood CA 90712	Portfolio Management Systems	60-150	TRS-80 I, II	B	32	D	I	PM	No	M	-	-	Yes	50	Optional modules available to perform Beta and group analyses
	Technical Analysis Package	60-150	IBM	A	64	D	I	PM	No	M	-	-	Yes	50	Same as above; program can also accept keyboard data
		60-150	TRS-80 I, II	B, D	32	D	I	TA	Yes	O	Yes	-	Yes	50	Same as above; program can also accept keyboard data
Centennial Software 410 17 St., Suite 1375 Denver CO 80202	Stock Focus	189	IBM, TRS-80 II	A	64	D	I	TA	No	M	-	-	Yes	-	Four-analysis program handles securities one at a time
		159	Apple II, TRS-80 I, III	A	48	D	I	TA	No	M	-	-	Yes	-	
Diamond Head Software 2937 Kalakaua Ave. Honolulu HI 96815	Stock Charting	49.95	IBM	A, C	64	D	I	TA	Yes	M	-	-	Yes	20	Alphabetizes stocks automatically
Dow Jones News/Retrieval Box 300 Princeton NJ 08540	Investment Evaluator	55	Atari 800	A, D	48	D	B	PM	No	O	Yes	-	Yes	400	Accepts keyboard entry; color graphics
	Market Microscope	700	Apple	A, D	48	D	A	FA	No	O	Yes	-	Yes	1,000	Ranks stocks by 68 financial indicators
	Portfolio Analyzer	350	Apple	A, D	48	D	B	TA, PM	Yes	O	Yes	-	Yes	100	Accepts keyboard entry; color graphics
	Portfolio Evaluator	50	Apple	A, D	32	D	B	PM	No	O	Yes	-	No	50	No manual keyboard entry
	Portfolio Management System	150	Commodore	B, D	48	D	I	PM	Yes	O	Yes	-	Yes	100	Auto-dial modem to call Dow Jones
Dynacomp 1427 Monroe Ave. Rochester NY 14618	NY Index	29.95	Atari	A	32	D	B	TA	Yes	D	-	Monthly, \$5/mo.	Yes	20	Program comes with last two years of stock data
	Stockard	29.95	Atari	A	32	D	I	TA	Yes	M	-	-	Yes	17	Trend lines can be superimposed on graph
	Stock Master/Stock Plot	59.95	Apple II	A	48	D	B	TA	Yes	M	-	-	Yes	30	Allows storage of 10 years of stock data
Financial Software 11401 Westridge Circle Chardon OH 44024	Market Maverick	175	Apple II	A, G	48	D	I	TA	Yes	D	-	Monthly, \$120/yr.	Yes	200	Automatically ranks stocks
Galaxy, Dept. LP5 Box 22072 San Diego CA 92122	ANA1	69.95	Apple II	A	48	D	I	TA	Yes	M	-	-	Yes	n.a.	Color graphics
H & H Trading Box 549 Clayton CA 94517	Market Tracker 2.1	225	TRS-80 I, II	B	48	D	I	TA	Yes	M	-	-	No	30	Requires optional Market Grapher module for hard copy
	Market Tracker 3.1	225	Apple I, II	B	48	D	I	TA	Yes	M	-	-	No	30	Same as above
	Stock Tracker 2.5	285	TRS-80 I, II	A	48	D	I	TA	Yes	M	-	-	Yes	30	Extensive tracking capability
	Stock Tracker 2.6	495	TRS-80 I, III	B, D	48	D	I	TA	Yes	O	Yes	-	Yes	30	Accepts keyboard entry
	Stock Tracker 3.5	285	Apple II, III	A	48	D	I	TA	Yes	M	-	-	Yes	30	
Intelligent Investor 810 Camelview Plaza 6900 E. Camelback Rd. Scottsdale AZ 85251	Series 0	75	Apple II, IBM, NEC PC8000	A	48	D	I	PM	Yes	M	-	-	Yes	4	Compares investment performances
	Series 1	75	Apple II, IBM, NEC PC8000	B	48	D	I	PM	Yes	M	-	-	No	16	
	Series 2	130	Apple II, IBM, NEC PC8000	B	48	D	I	PM	No	M	-	-	Yes	16	Calculates security performance
	Series 3	39.95	Apple II, IBM, NEC PC8000	B	48	D	I	PM	Yes	M	-	-	Yes	16	Develops projections
Investor's Software Box 2605 San Francisco CA 94126	Portfolio Master 3.1	195	Apple II	B, D	48	D	A	PM	No	O	Yes	-	Yes	100	Auto-dial modem to call Dow Jones
Kate's Computers Box 1675 Sausalito CA 94965	Advisor	600	Apple II, any CP/M computer	B, D, E, G	52	D	A	PM	Yes	O	Yes	-	Yes	30	Option modules available; multiple portfolios can be tracked
	Analyst	600	Apple II, any CP/M computer	B, D, E, G	52	D	A	TA	Yes	O	Yes	-	Yes	60	Option modules available
Omega Microware 222 S. Riverside Plaza Chicago IL 60606	Chart Trader	149	Apple II	A	48	D	I	TA	Yes	M	-	-	Yes	8	Modules available for easy expansion; can store 200 weeks' data
	Financial Trader	499	Apple II	A	48	D	A	TA	Yes	M	-	-	Yes	8	Modules available for expansion; calculates relative-strength index
	Market Analyst	249	Apple II	A	48	D	I	TA	Yes	M	-	-	Yes	8	Same as above
Options-80, Box 471 Concord MA 01742	Options-80	125	TRS-80 I, III, Apple II	A	32	D	A	TA	Yes	M	-	-	Yes	n.a.	Program specifically for options investing
PBL Corp. Box 559 Wayzata MN 55391	Personal Investor	145	IBM PC, Apple, TI Professional	D	48 or 128	D	I	PM	No	O	Yes	-	Yes	600+	Price includes sign-up with Dow Jones
Radio Shack 1300 One Tandy Center Fort Worth TX 76102	Cassette Portfolio	29.95	TRS-80 I, III	F	16	C	B	PM	No	M	-	-	No	45	Some analysis functions provided
	Standard & Poor's Stockpak	49.95	TRS-80 I, III	B	48	D	I	FA	No	D	-	Monthly, \$200/yr.	Yes	100	Extensive search-and-select feature of data-base disc
	Trendex	49.95	TRS-80 I, III	B or F	32	D or C	B	TA	Yes	M	-	-	Yes	50	Provides trend indications
Rainbow Marketware 3111 Berkshire Rd. Baltimore MD 21214	Trader DOC	39.95	Apple II	A	48	D	B	TA	Yes	M	-	-	No	20	Theoretical program
RTR Software 444 Executive Center Blvd. El Paso TX 79902	Market Analyzer	350	Apple II	A, D	48	D	I	TA	Yes	O	Yes	-	Yes	100	Color graphics, Dow Jones on-line service, keyboard entry possible
	Market Charter II	250	Apple II	A	48	D	I	TA	Yes	M	-	-	Yes	104	Optional data-base disc module
	Point & Figure Charting	125	Apple II	A, E	48	D	A	TA	Yes	M	-	-	Yes	50	Can use Market Analyzer data discs

¹Hardware requirements: A = one disc drive; B = two disc drives; C = color-graphics adapter (IBM only); D = modem; E = CP/M card and 80-column card (Apple only); F = cassette player; G = language card or 16K card (Apple only). ²User category: B = beginner; I = intermediate; A = advanced. ³Type of program: PM = portfolio management; TA = technical analysis; FA = fundamental analysis. ⁴Data-base mode: O = on-line; D = disc; M = manual. ⁵Auto. data retrieve: indicates if an on-line program can automatically update selected securities. ⁶Number of records stored: maximum or preferred number of securities handled at once.

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That's right! **Free** movies, sports, and special events, 24 hours a day and all commercial free. The Saturn-15 XHP super deep fringe microwave receiver can be used by homeowners outside the service area of local **over-the-air** pay TV stations (ex. HBO, Showtime). Yes, if the local pay TV station installs microwave receivers on homeowners TV mast, you too can receive those unscrambled signals free by installing the Saturn-15 XHP on your TV mast in minutes. A signal can be received up to 100 miles, depending on the height and power of the local transmitter, and the installed height of the Saturn-15 XHP. If you have waited to own a microwave receiver, or own a low power unit, call and order your Saturn-15 XHP and own the most powerful receiver available today. Free TV—yours for a call. Note: General microwave receivers cannot be used for receiving scrambled signals. Nor can they pick up from cable TV or their relay towers.

A Total Unit

The Saturn-15 XHP comes complete with a 30 inch precision tuned receiving dish, advance design downconverter, power tuner, 60 feet

coaxial cable, necessary adapters, mounting hardware, and installation instructions. A six month parts and service warranty covers the Saturn-15 XHP.

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By calling our **information number** (916) 454-2190 and talking to one of our trained technicians, we can help determine if the Saturn-15 XHP will work for you.

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As JDL Industries has and continues to provide the very best in products and customer service, we want everyone to be able to enjoy our new system, Saturn-15 XHP. The regular price for the Saturn-15 XHP is \$285.00. Order C.O.D., pay only \$260.00 and save \$25.00. Trade in your old unit, from any manufacturer or home built, working or not, with your order, pay only \$235.00—save \$50.00. Or if you own our original Saturn-5 and wish to upgrade to the Saturn-15 XHP, return your unit and pay only \$210.00—a savings of \$75.00. We also accept Visa and Mastercharge at the regular price, \$285.00. Sorry—no personal checks. Shipping (\$9.50) and 6% sales tax for Calif. residents not included. Trade-in units become the property of JDL Industries and **cannot** be returned under any circumstances.

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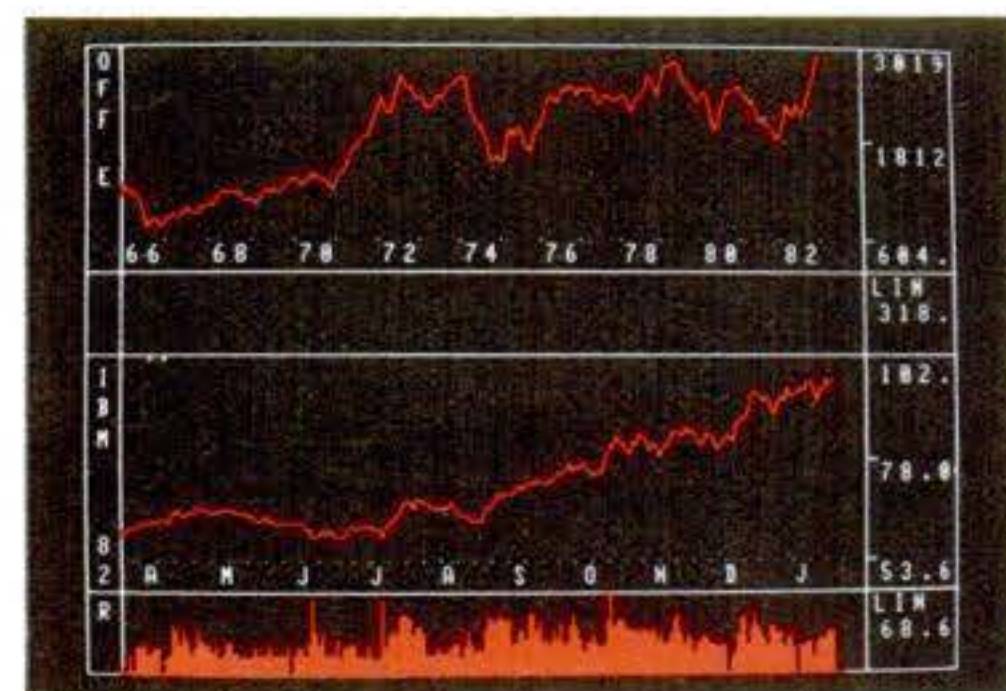
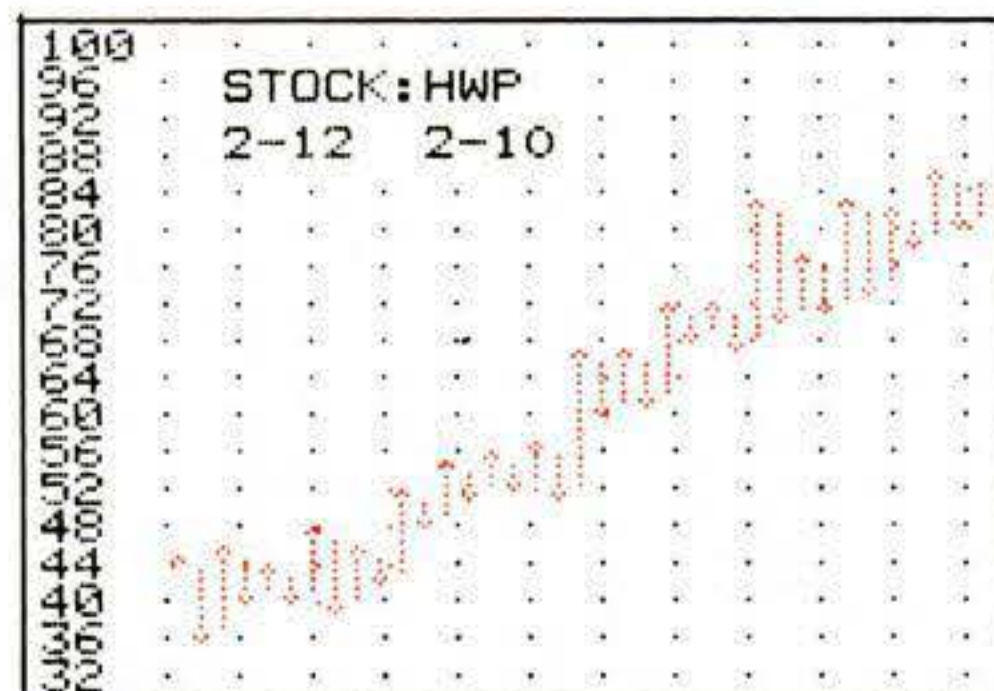
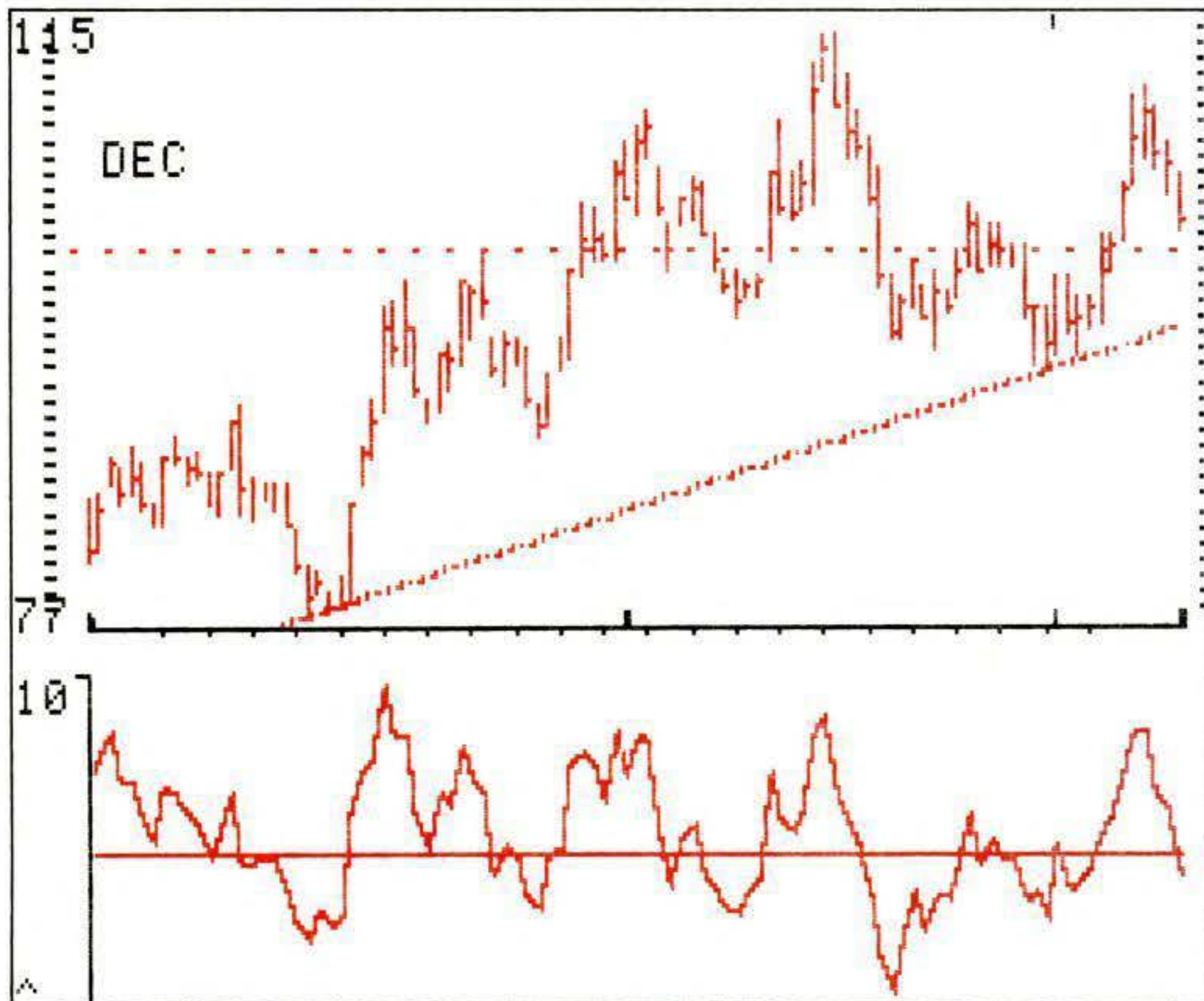
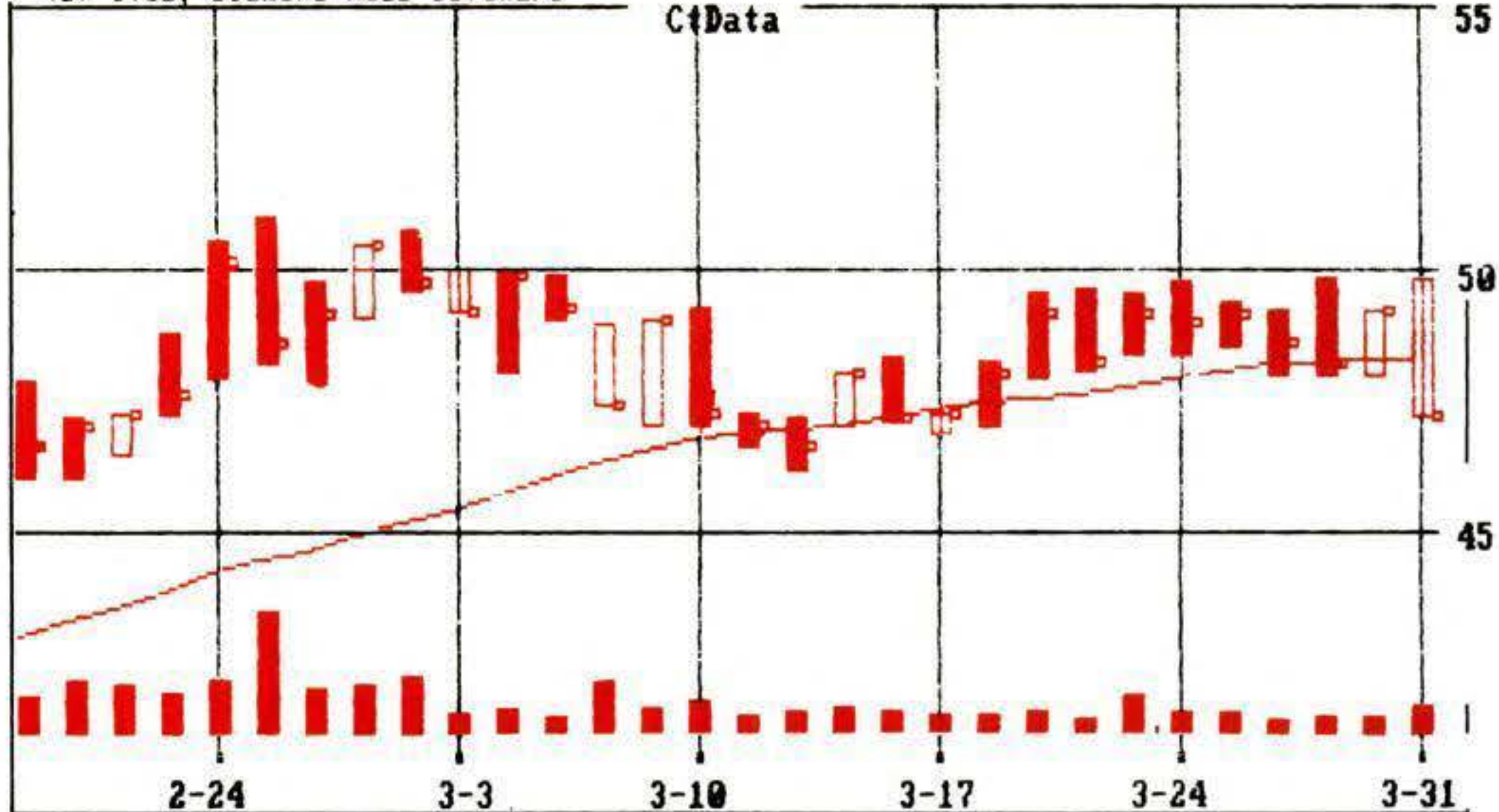
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Technical analysts use many different charting methods. Top: standard price-and-volume chart for Control Data stock by Diamond Head Software's Stock Charting program. Price bars at top show daily high and low; ticks indicate close. Line of 30-day moving average smooths short-term changes. Bars at bottom show relative volume. Middle: price bar chart for Digital Equipment stock by RTR Software's Dow Jones Market Analyzer. Added rising "trend line" and level "resis-

tance line" set thresholds analysts deem significant. "Oscillator" curve at bottom relates closing price to 12-day average price. Above left is point-and-figure chart for Hewlett-Packard stock by RTR's Point & Figure Charting. Some analysts believe such charts predict future price reversals. Above right: Split-screen chart by Kate's Computers' Analyst shows price and volume for IBM stock at bottom, performance of office-equipment group in general (including IBM) at top.

Stock-market programs

tors as the key to future price movement. Some of the major indicators are the relationship between price and volume, market averages, and new highs versus lows.

Both fundamental and technical analysis call for crunching endless supplies of numbers, so they are well suited for computers. But fundamental analysis considers such a diversity of information that it may be beyond the capability of most personal computers. In fact, of the analysis programs available, almost all do technical analysis. Only Standard and Poor's Stockpak and the Dow Jones Market Microscope use fundamental data. The latter works by sorting and ranking companies and industries according to 68 financial indicators.

The strength of technical-analysis programs is the charts they produce. A typical program generates a two-part chart, with price bars at the top and relative volume at the bottom. This basic display can often be augmented with various kinds of superimposed lines that help the analyst pick out underlying trends from short-term fluctuations. Many other kinds of charts are also possible (see the illustrations for some examples).

One of the ways in which the programs differ is the way you enter data. Most portfolio-management programs rely solely on information you feed into them—on a daily, weekly, or monthly basis, depending on the period you deem important. Usually this approach is adequate when you are following only a dozen or so stocks.

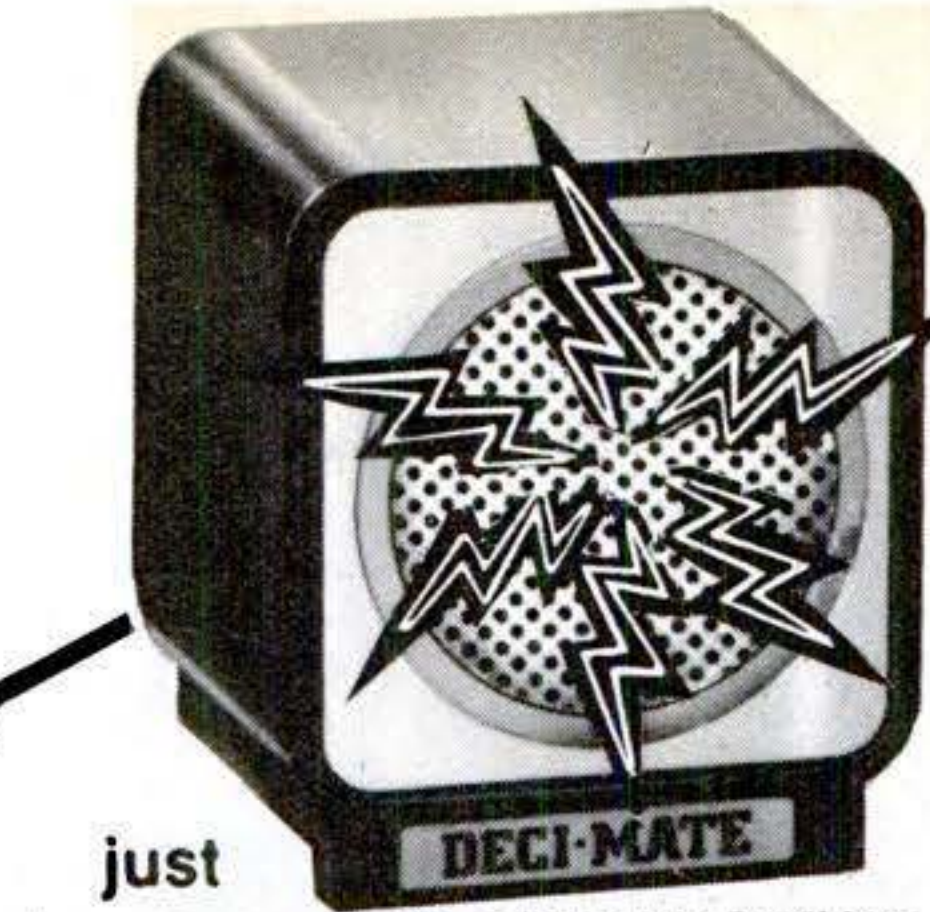
The Stock Charting program that led to my profit in IBM is a manual-entry type. To use it, I entered the high, low, close, and volume data for each of 20 stocks. That process took about 15 minutes every evening.

Manual entry is especially suited for portfolio-management programs, for which the total number of stocks followed and kinds of information called for are fairly small. But good technical-analysis programs commonly follow many more issues, and they call for historical data going as far back as possible. That makes hand entry unwieldy.

Some programs, such as RTR's Market Charter II, use diskettes to store previous months' data of selected stocks. You simply tell the computer which stocks you are interested in, and it calls up the information you want. Commonly, such a diskette would contain data on up to 1,000 issues going back several years. Monthly updated diskettes are sent to you on a subscription basis.

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This Air Cleaner uses only 14 watts of power. It's whisper-quiet. It's compact and attractive.

But under its good-looking exterior thrums a mighty, powerful, industrial-strength heart. As it gathers the dust and pollution in the room, it disinfects and cleans the air, actually replacing dirty air with ozone-clean fresh air.

Kills Air-Borne Germs and Mites

The CLEAN ACE Air Cleaner has a built-in ultraviolet light. This special lamp radiates on two separate wavelengths.

The first, lower wavelength converts the oxygen molecules in the air to ozone, destroying odors as though a hammer is smashing the offending molecules.

The second, high wavelength kills not only germs but also the tiny "mites" that can be so irritating (and socially unacceptable). You might notice an immediate **decrease** in the number of runny noses and colds. It's no accident.

Will you Actually Feel Better?

We think you'll feel better because the air will be so pleasant and refreshing to breathe. Many, many people report the disappearance of their tiredness and general irritation when the air is properly ionized.

An opinion is one thing; a fact is another. The ability of the CLEAN ACE to kill germs and airborne pests is a **fact**. The feeling of well-being you get from fresh ozone is a **fact**. The oxidizing effect ozone has on bad-smell molecules is a **fact**.

Of course the CLEAN ACE is absolutely safe. The special ultraviolet quartz-glass tube doesn't transmit the high-range rays that can redden the skin. The unit plugs into any wall outlet, and because it "creates" fresh air you don't have to open a window.

Unbelievable POWER

The home-size Model 8200 CLEAN ACE is 11" wide, 7½" high, 5" deep. It weighs only a couple of pounds. It makes no noise.



The home-size CLEAN ACE Model 8200 cleans the air in an average room in about 10 minutes.

Can you believe it will clean the air in an average room in about 10 minutes? Can you believe it works with every window shut and the heater or air conditioner on? Can you believe you'll be able to see the ugly black particles from your room the CLEAN ACE has trapped in its super-efficient filter?

You'd better believe it.

You don't assemble anything. We'll include a descriptive booklet, but there's nothing to learn: just press the "On" button and let it run.

END EMBARRASSMENT FOREVER!

If someone is bedridden, somehow odors start to accumulate. Never again!

If even two or three people smoke at a party, the air is blue with smoke. Never again!

If you have a meeting in your office or conference room, after a while the air is heavy, even foul. Never again!

If you're cooking, the aroma of fish, shrimp, lamb, and many vegetables seems to hang there forever, gradually changing from "aroma" to "smell." Never again!

Now—

A CLEAN ACE for Your Car!

The Model 1000 mounts under the dashboard or sits on the seat. Plug it into the cigarette lighter, and smog, pollution, grime, and stale air never will touch you.

What a difference clean air will make when you're driving around town or when you're stuck bumper-to-bumper in rush hour traffic, where normally you'd be inhaling the carbon monoxide from the exhaust of the car in front of you!

If someone is a smoker, instead of driving around with smarting, burning eyes, turn on your CLEAN ACE Model 1000 and forget that cigarette or cigar is lit.

COMFORT IS AS NEAR AS A PHONE CALL

We've seen old-fashioned air cleaners which lack the space-age technology of the CLEAN ACE, selling for up to \$245. New Horizons is a direct-factory source, and you'll be able to own this **high-powered** air cleaner for far less than you'd expect to pay in a store—if they had it.

Here's how to order:

The powerful home-size CLEAN ACE Model 8200 is yours for just **\$139.95**, plus \$4.50 for shipping.

The powerful automobile-size CLEAN ACE Model 1000 is yours for just **\$119.95**, plus \$4.50 for shipping.

Send check, money order, or credit card information (VISA or MasterCard) and we'll ship your CLEAN ACE Air Cleaner immediately.

We Absolutely Guarantee!

After you have your CLEAN ACE, plug it in and use it for up to a full month. If for any reason you don't want to keep it, send it back for a full refund, no questions asked.

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Model 1000 — **\$119.95**

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At Last—a Cordless Phone with TWICE the Range, Sound Fidelity to Rival Phones with Cords, and a Privacy Code System—All This in a Phone Less Than an Inch Thick!



The Super Fone is less than 1" thick. The base unit has a built-in speaker phone, a fully independent intercom and is 110 volt-220 volt switchable.

Until now, cordless phones have given you wonderful convenience. But they've had two problems:

1. The range is limited to 600 to 700 feet.
2. Some of them sound as though you're talking inside a barrel.

As cordless phones have become enormously popular, another problem has arisen: two people, living near each other, can have the same channel. Not only is there line confusion, but someone else can literally make a long distance call on your phone.

No more. Never again.

Range: 1500 Feet OR MORE!

The SuperFone 650 uses state-of-the-art electronics to bring you the ultimate cordless phone. Sound quality is superb — and it stays superb, 1500 feet or more from the base station. That's more than twice the distance of standard cordless phones.

Only SuperFone 650 has a secret code system to prevent interference and false operation of the phone. You choose from 512 possible "code" combinations. Both the base unit and the phone are locked onto that code, which you can change when you want to.

No other phone can interfere. No other unit can share the signal. No one else can hear or speak on your carrier-wave.

Enormous Range

We say the SuperFone 650 has a range of 1500 feet.

Notice we didn't say "up to" or "as far as" 1500 feet. There's no hedging, because this seems to be the minimum, not the maximum range.

Users report 1800 and 2000 feet. That's nearly half a mile. SuperFone 650 is a radiophone, not a toy, and that's why its signal doesn't break up or start hissing or crackling when you get half a block away.

You can tell when you heft it. It's a Little Giant. You can feel the power inside. What a marvel of electronic engineering it is! And it's tough, too. It fits into your shirt pocket, and you can bounce it around all day without damaging it.

Speakerphone, Intercom — Everything!

SuperFone 650 is The Everything Phone. Anything any phone can do, it can do.

First, the base station is a speaker phone. Touch a button and you can have a hands-free conference conversation in the room in which the base station sits.

Next, it's an intercom. You can page the handset from the base unit and have a private conversation. You have a true wireless intercom, not just a signal.

Third, you have a privacy button. Push that button and you'll still be able to hear anything the other party says, but he or she won't be able to hear you until you take the button off "hold."

Fourth, you have an automatic redial. Touch the key and the SuperFone will redial the last complete number.

What else? A security switch which makes it impossible for anyone to call out on the remote phone, without changing the ability to receive calls. A volume control for the speaker on the base unit. A call button to page the base from the cordless phone. THIS PHONE HAS EVERYTHING!

30-Second Installation

Plug your SuperFone 650 into any wall AC outlet. Push its standard modular terminal into the telephone plug. You're in business.

Every component is heavy-duty, from the built-in condenser microphone (with automatic gain control) to the LED indicator lights. This phone is designed for hard use.

The SuperFone 650 is yours for \$249.95. If you want the SuperAntenna with it, giving you a range of a mile — or even more — you can have both for \$319.95. (Or you can get the SuperAntenna alone for \$79.95.)

We Absolutely Guarantee!

Use the SuperFone 650 (or any electronic instrument you acquire from us) for up to 30 days. If for any reason you decide not to keep it, return it for a 100% refund.

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BOTH Phone and Antenna — \$319.95

Adapter for Multi-Line phone — \$39.95

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New!

MULTILINE ADAPTER FOR BUSINESS PHONES

If you have several lines, you can plug them into your SuperFone with this single adapter.

The adapter costs \$39.95. Nothing else is required to attach multi-line phones to one SuperFone 650.

TRIPLE THE RANGE OF ANY CORDLESS PHONE!

The SuperAntenna will give your cordless phone, regardless of make or model, three times the range it has now.

If the range is 700 feet, it'll leap to over 2,000. If it's 1500 feet, it could be as far as one mile!

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Stock-market programs

tion into stock-market programs is over the telephone. Various data-base services supply detailed financial information—both current and historical—which can be retrieved by any computer through a telephone modem. Programs that get data from a remote computer are termed "on-line."

On-line services have most, if not all, of the securities you are likely to be interested in. For example, The Source's new Media General service includes over 3,100 common stocks, with 55 items of data available for each. Included are all common stocks traded on the New York and American Stock Exchanges, as well as 840 over-the-counter issues. You don't get quotes instantly, however. All of the exchanges require a 15-to-20-minute delay. Nor do they come cheaply. Even at Dow Jones' evening rate of 15 cents a minute, you can easily run up a sizable bill.

Once you have entered all that data into the computer, the next thing to consider is what you will see on your screen and in hard-copy printouts. Since portfolio-management programs deal with numbers only, what you get on the screen is an unspectacular listing of numbers. On the other hand, most technical-analysis programs are capable of graphics. Although the displays will vary from program to program, the complexity of the graphics is more a restriction of the computer than of the software. An Apple or IBM PC, for instance, will have more-complex graphics than a TRS-80 or Atari. Some programs are capable of color (when used on a computer with color capability).

Once you have a marvelous display on your monitor, the next matter is reproducing a printed copy. Keep in mind that graphics printing is terribly slow; it can take several minutes to produce a simple line chart. In general, dot-matrix printers are better for this purpose than "formed character" types, whose limited character sets are not well suited for graphics.

Graphics or not? On-line, disc, or manual? Portfolio management, technical analysis, or fundamental analysis? These are the general questions to ask when choosing a stock-market program. As with any software, it is always best to actually work with the program before you buy. Then you won't be surprised to find that it can't do what you expected it to.

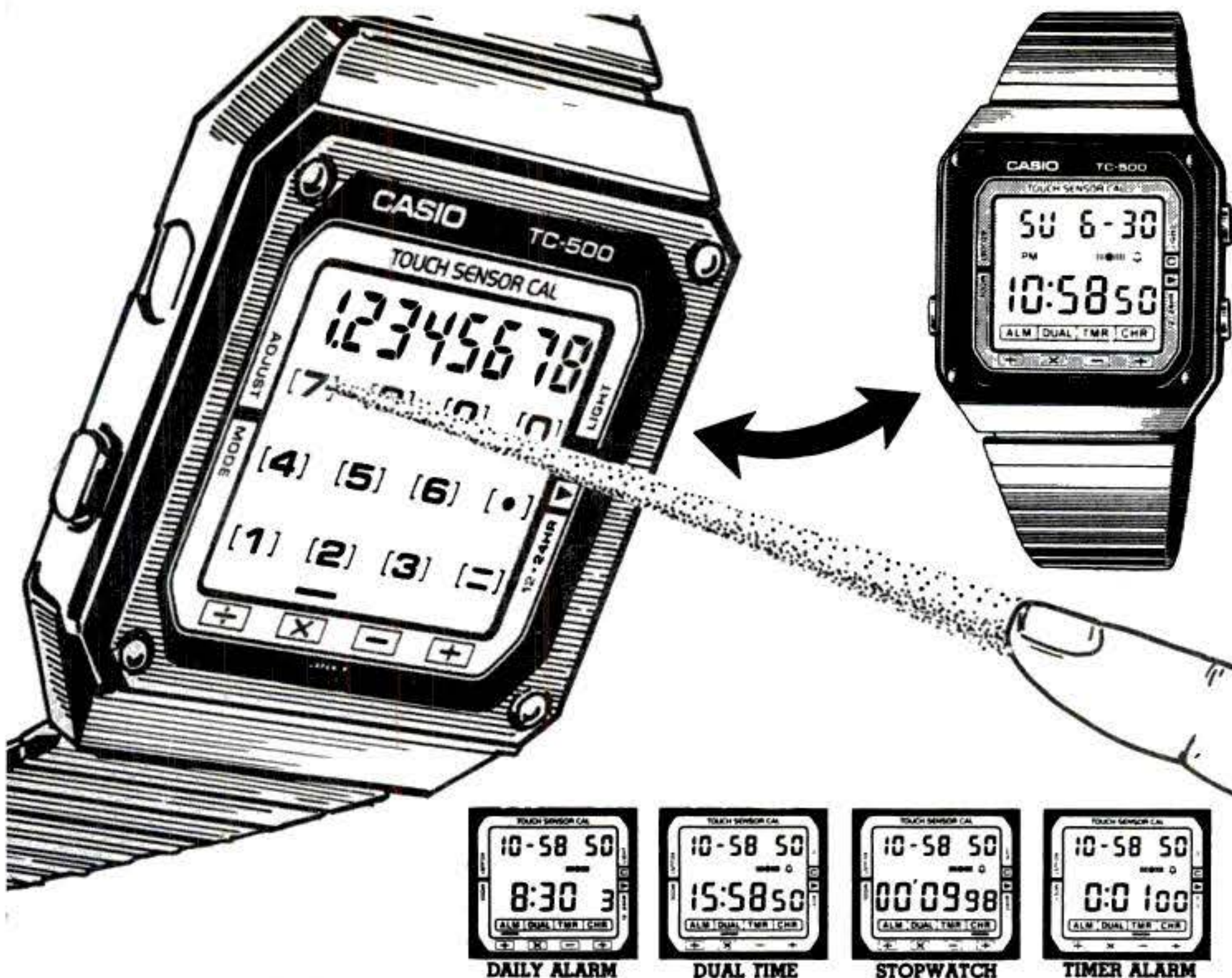
One expectation should be thoroughly deflated by now: Stock-market programs won't make you a millionaire overnight. All the same, if your computer does help you strike it rich, just remember where you got the hot tips. If not . . .

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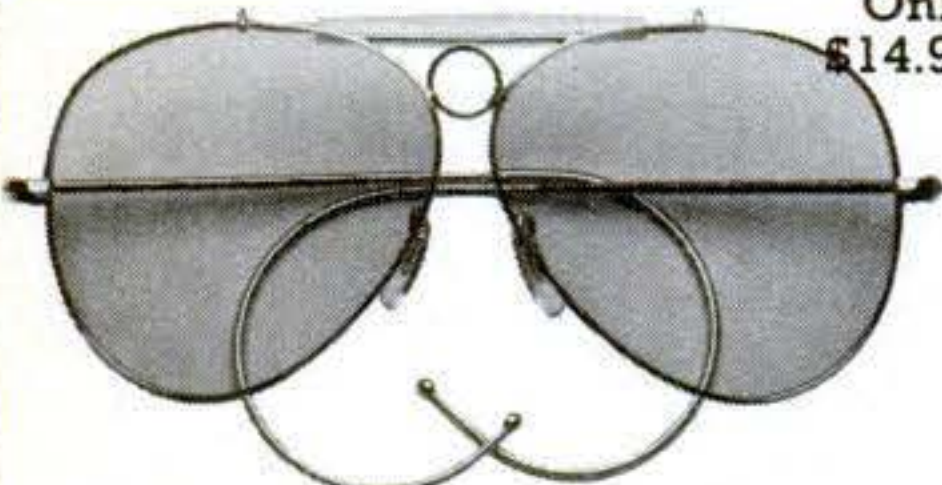
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BITS & BYTES

By WILLIAM J. HAWKINS



The new floppy standard?

We're running out of names. First there was the eight-inch-diameter floppy disc. Then came the mini-floppy at 5.25 inches. Now there's the micro-floppy. The newest disc drive you can add to your personal computer uses discs that are just 3.5 inches across and are capable of holding a whopping one megabyte (million bytes) of data. But hold on to your dust covers: If you buy one now, you could be making a mistake.

The problem is incompatibility. Being the first on your block with a new computer product is fun—but dangerous if nobody else joins in. The disc drive is the single most important way you can get data or programs into and out of your computer. If it's incompatible, you can forget about exchanging data with friends or buying the latest off-the-shelf program. To add to the uncertainty, the 3.5-inch micro is not the only new design available. There are also 3.25-, one other 3.5-, 3.8-

and four-inch versions in the works.

But wait. Now that I've warned you, let me add that disc drives like the one you see above stand a very good chance of becoming the new standard in computer media. In fact, it may not be long before your system is incompatible with others if you *don't* own one. Why?

The strongest reason for acceptance of this kind of drive is simply the number—and type—of manufacturers presently supporting it. Unlike many new computer ideas that have literally come from a garage, this system is designed by Sony (in accordance with standards that a committee of manufacturers has developed), the company that made Betamax and Walkman household words. And it's getting support from all the right places: Shugart, a major disc-drive maker; disc makers Memorex, Verbatim, and Wabash; and computer makers Atari and Hewlett-Packard (maker of the unit above).

Another reason is even more basic: Mi-
Continued

UNSER



THE RADAR DETECTOR GOOD ENOUGH FOR ONE OF THE WORLD'S FASTEST DRIVERS.

Bobby Unser. Three time Indy 500 winner. He's got enough races to have any radar detector. But he got the new Regency.

That's the reason? We didn't know. So we called Bobby Unser. And got the straight story. Here's what he said.

We tow race cars all over the country. Nearly all the time. It costs a lot of money. So we really don't appreciate those special tolls called speed traps. I needed a radar detector, and wanted the best. But I didn't know which one to buy.

So I checked with the guys at Regency. I've been using their two-way radios for years, and they work really well. It made sense that they'd know which radar detector to get.

Only I never expected the answer I got. They told me not to buy a radar detector. Seems I called at the wrong time. They were working on one and wanted me to wait. OK, I said, but why is yours better than that other brand everybody talks about? Well, they said that one I'd be paying too much and wouldn't get any more.

Why's that? Well a detector is basically a radio. The other guys were the first with a superheterodyne. And back then, they beat the pants off the older radar detectors. But really, superhet designs have been around in the radio business since the beginning. So there was no new magic. The guys at Regency said they knew how to make a good radio, and the same stuff makes a good radar detector.

The main trick is to get it real sensitive to what you want to hear, and reject what you don't want. I got that and found that the Regency did just exactly that. It picks up the speed traps over hills, around corners and far away. Yet it doesn't confuse you with any of the other microwave signals running around. And it does a super job on both X and K band from moving or stationary guns.

A couple of other features make my Regency radar detector special. It beeps and lights to let you know when a radar gun is around. When you're far away, it beeps slowly. The closer you get, the faster it flashes

and beeps. So it's like a distance meter, but easier to use. Plus you can set it for just the flasher, or just the beeper or both. It even tells you if there's radar coming up behind you, because the Regency is good enough to pick up deflected signals.



I like the fact that it has three types of mounting hardware. We Velcro® mount it to the seat. Use the bracket for the windshield of our pickup. Or we mount it on the sunvisor in the cars. It only takes a couple of seconds to put it on. So I just carry it with me, in my briefcase or my helmet bag, all the time.

Now I don't want you to get the idea I'm advocating speeding. I'm definitely not. A lot of people and cars just aren't good enough to be going fast. And those that are should be doing it on a race track. There are plenty, all over the country. But if those revenue speed traps where they write you for 56, 57 or 58 bother you like they do me, get the Regency radar detector. I know I definitely wouldn't be without mine."

Bobby Unser drives cars that cost \$300,000 and up. With engines that cost \$48,000 a crack. Which means he's a pretty good judge of equipment. So if he said the Regency radar detector was the one, it really meant something.

The other side of the equation was Regency. It turns out that they've been in the electronics business for over 35 years. And they sell nearly 100 million dollars worth of electronics equipment a year. Not bad. Must be doing something right.

So we had two sources. Both of them with good track records. And both of them saying that this new radar detector was something very special. That was all we needed. We got in touch with Regency and made a deal to handle only their new radar detector. Which puts us in a very unique position to make you a very unique deal.

Order the Regency RS Two and put it in your car or truck. There's even a hidden remote mount version if you're worried about the midnight auto supply. Then try out the Regency, just like Bobby Unser did.

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To order the Regency RS Two pictured above with your credit card, call toll free or send your check for just \$199.95 plus \$4.00 postage and handling. The hidden remote RS Three can be yours for only two hundred forty nine plus four dollars postage and handling.

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Bits & bytes

cro-discs are better than conventional floppies. Take the HP model 9121 add-on micro-disc system shown, for instance:

It's fast. It averages less than 1/2 second to find any data and can exchange it at 17.8 kilobytes per second. Give the command to load a large program such as the word processor WordStar, and it's up on the screen before you've thought of your first sentence.

It's reliable. The internal discs are sealed in a relatively hard jacket (about 1/8 inch thick), making them safer for shipping, storage, and long-term use. A sliding aluminum door opens to expose the disc surface when in use and closes to protect the disc when it's not. And there is a special "media monitor." Each time you use a disc, it's tested for wear. A light flashes when the disc's useful life is about over.

And, of course, it's small—discs are shirt-pocket sized. It's perfect for use with a portable computer [PS, March], and it makes it easier than ever to bring your work home with you.

Does all this mean the 3.5-inch micro-floppy will become the new standard for small computers? It's still too early to tell. But I'd hate to bet against it.

In case you're already sold, the HP dual-disc-drive system is \$1,775; a single micro with Winchester is \$4,975. Discs are about \$6 each. If you're not sold yet, keep checking PS—a feature story on the new micro-drives is planned.

Nibbles

● After 158 pages to prove a point, a study from International Resource Development Inc. (30 High St., Norwalk, Conn.) concludes that personal computers will make "human paper shufflers" obsolete. As one shuffler to another, here's what you can do about it: Enroll your kids in a computer training course. For \$95, they get a 15-hour, five-day course on computers. Then when they get home, they can teach you what they've learned. Computer camps have been available locally to kids before, but the new course, from the Computer Education Institute (Vernon, Conn.), is available nationally.

● The newer 16-bit personals with lots of memory can do much more than just run big programs at high speeds. They can also accept a multi-user operating system. That means more than one person can use the computer at the same time. UNIX (Bell Labs) and MP/M (Digital Research) are two well-known systems. Which one can run the most programs? Neither. That important advantage goes to OASIS (Phase One Systems), which, according to company president Howard Sidorsky, has more programs available than UNIX and MP/M combined.

● Matsushita has recently introduced an optical videodisc machine that can erase old discs and record new information on them. At present, that information can be up to 15,000 separate video pictures. But with a little imagination, it could also read or write computer data. The machine could replace discs and magnetic tape now in use—one videodisc could hold hundreds of millions of bits of data. [PS]

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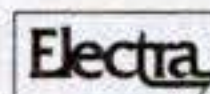
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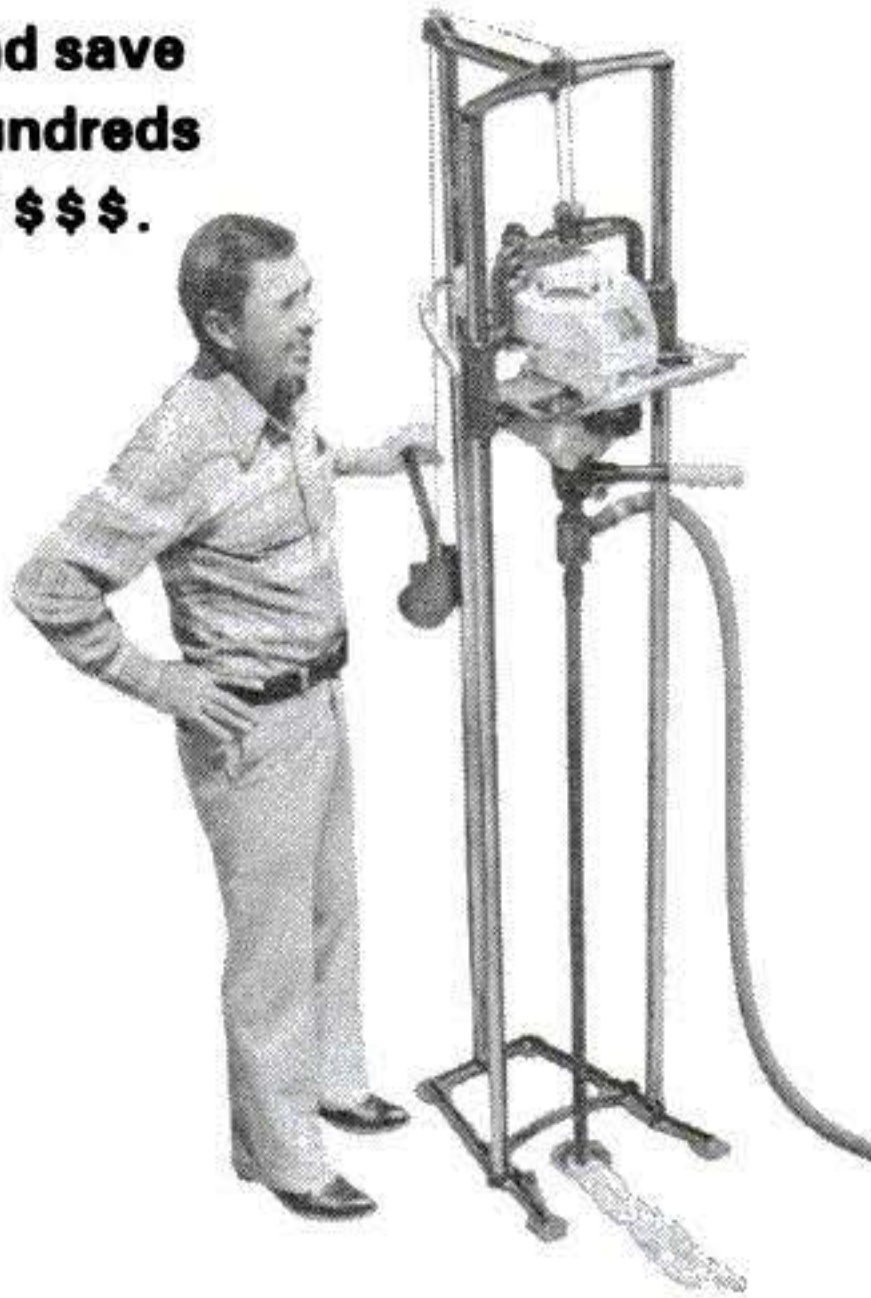
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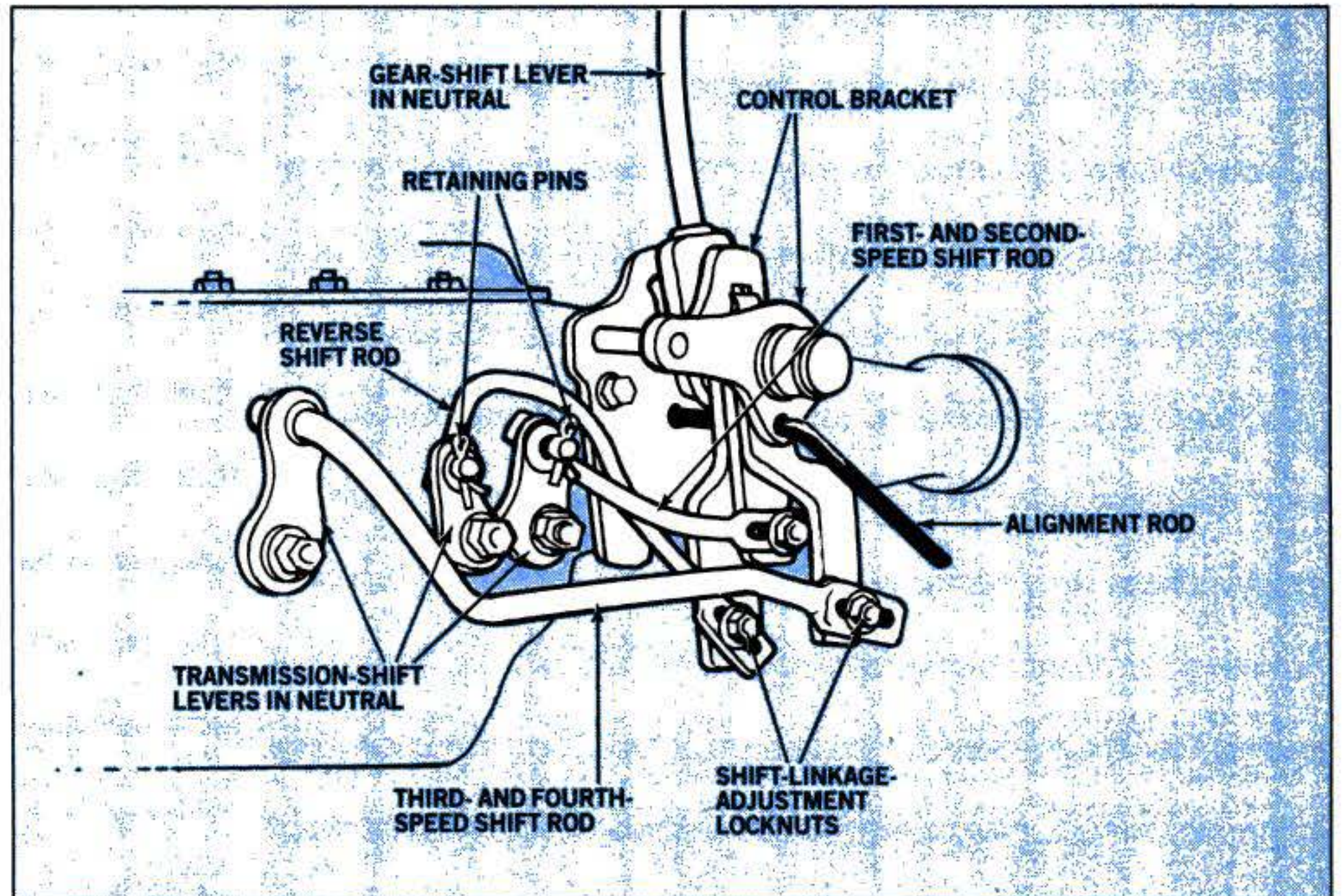
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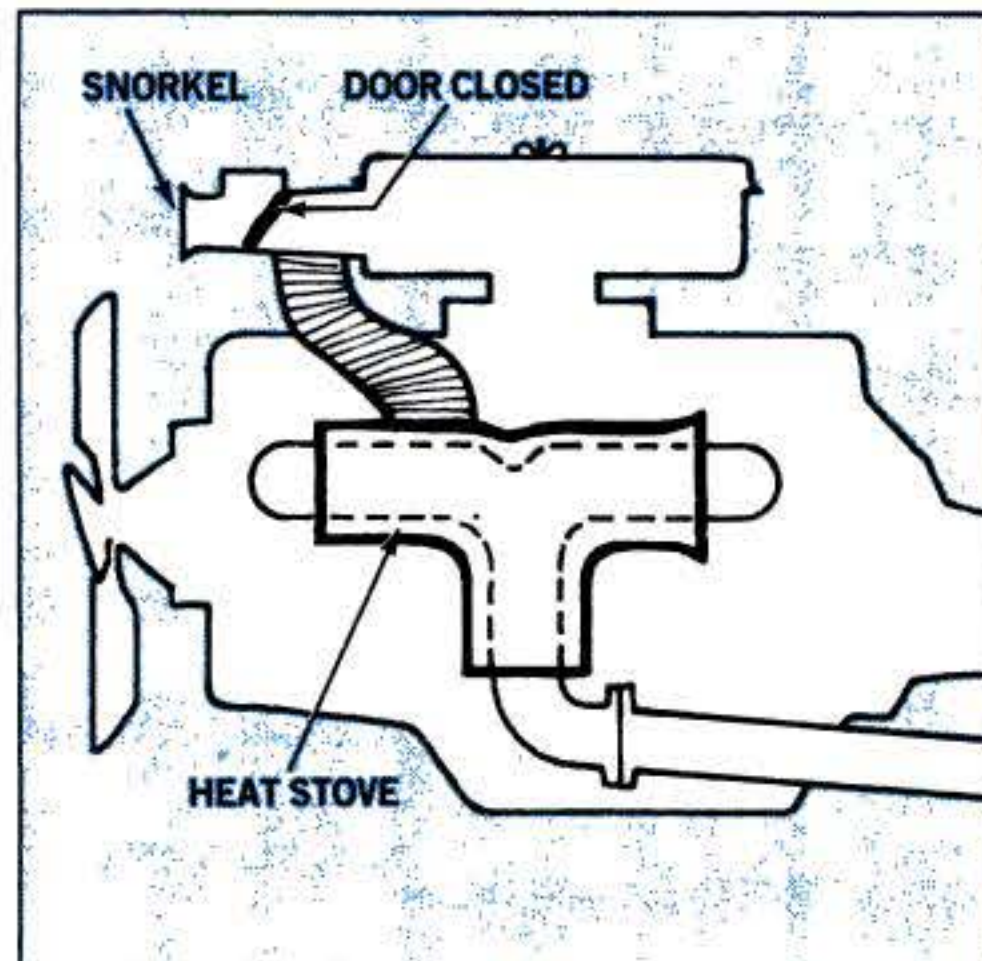
By STEVE MERCALDO



Smoother shifts

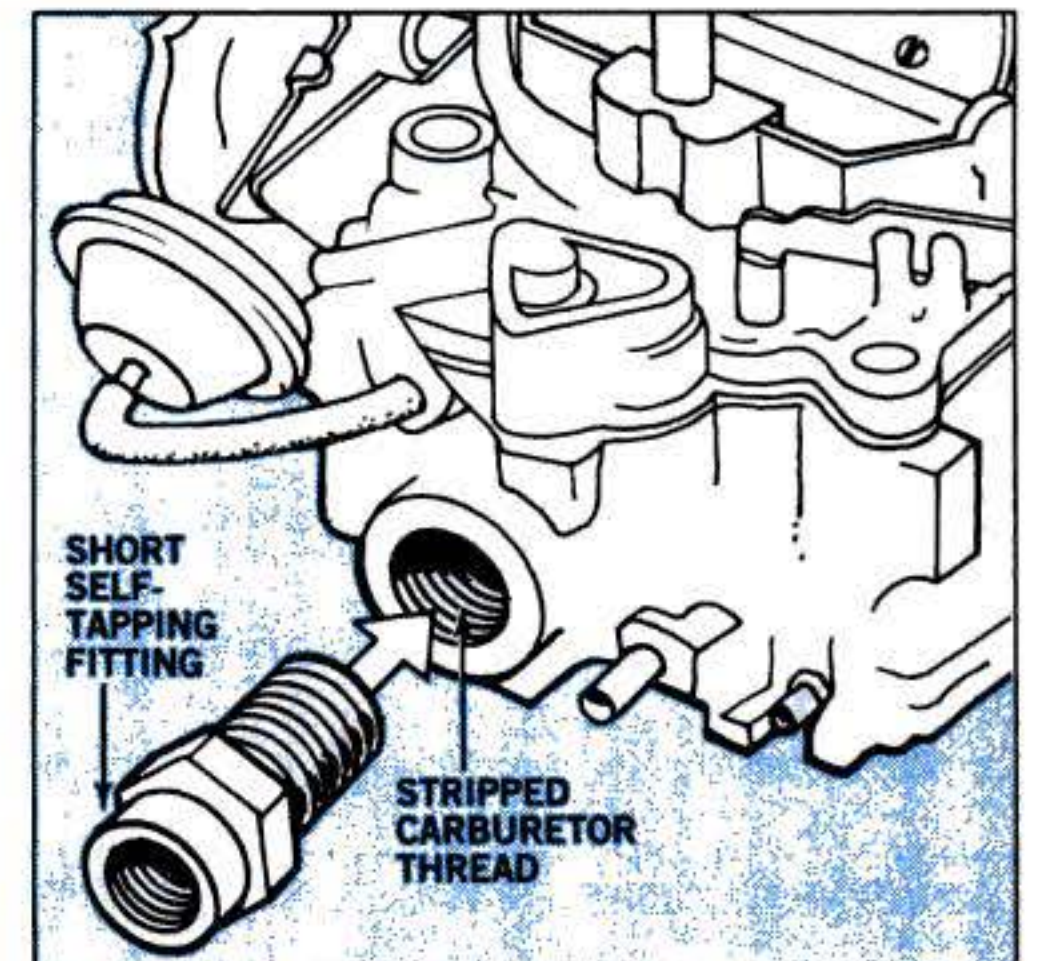
Do you have trouble shifting gears? If your vehicle has a floor shift with an external linkage, it may need adjustment. But before trying that fix, make sure the clutch-pedal free play is properly adjusted and the linkage isn't simply loose. The shift rods should fit tightly without any side play. To adjust: Raise the vehicle and

support it on jack stands. Put the gear shift in neutral. Loosen the shift-linkage-adjustment locknuts, and move the transmission-shift levers into neutral. Insert the L-shaped alignment rod through the shift assembly's alignment holes. Tighten the linkage-adjustment locknuts securely and remove the alignment rod.



Engine pinging

Does your car's engine ping after it's warmed up? When an engine is cold, heated air is delivered to the carburetor from an exhaust-manifold heat stove. Hot air helps a cold carburetor vaporize its fuel supply. However, the door in the air-cleaner snorkel should open to cold air after the engine reaches operating temperature. A binding door or faulty temperature sensor may be causing the ping.



Filter fix

Replacing the filter in a GM Rochester Quadrajel or Dualjet carburetor often results in stripped filter-body threads. To repair them, use a special hardened-steel self-tapping inlet nut. The nut will cut new threads in the carb body as it's screwed into place. You don't even have to remove the carburetor for the repair. When you buy the self-tapping nut, specify the fuel-line size and fuel-filter length.

Continued
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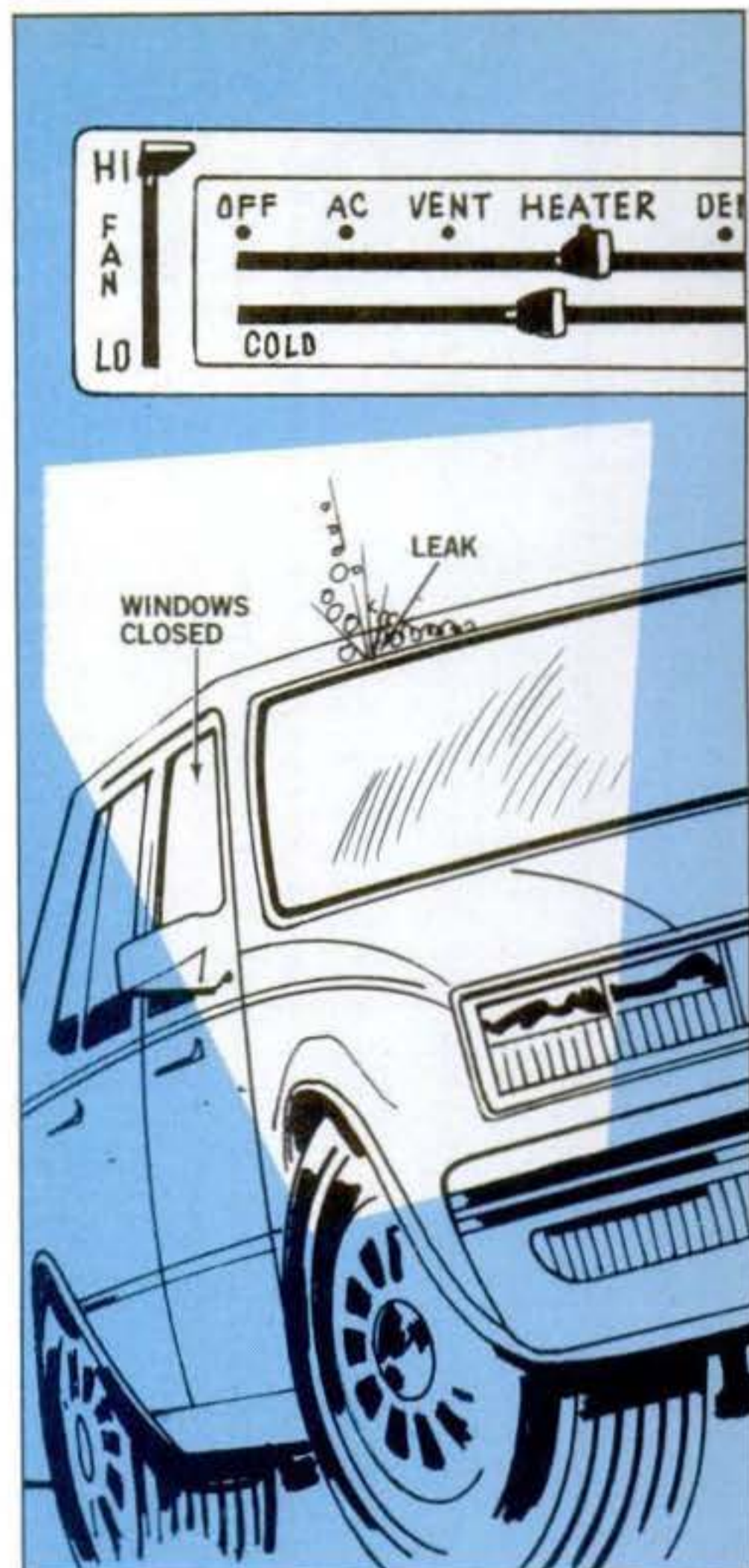
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*These courses are offered by North American Correspondence Schools which recently merged with ICS.

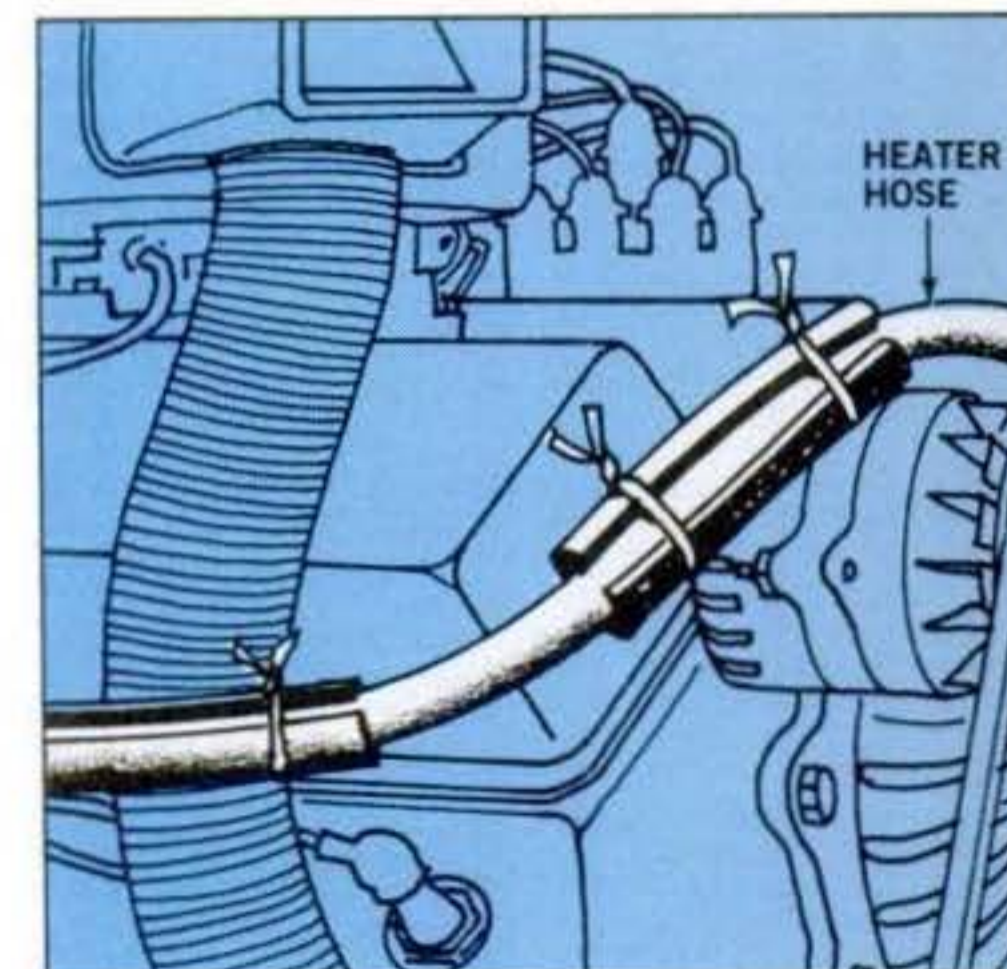
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Taking care of your car



Leak relief

To locate water leaks when it's not raining, turn your A/C or heater fan to "high." With the car doors closed, the blower fan will create a slight positive pressure, effectively pressurizing the interior. Air will be forced out of the leaks. A mix of water and liquid soap on the exterior seals should make them easy to spot.



Hose protection

As the outside of modern autos shrink, so does under-hood space. This provides a greater chance for heater-hose abrasion. Sometimes it's impossible to reroute the hose to avoid the interference. If the hose must come close to another hose or a component, position a section of old heater hose over the trouble area. Split the hose lengthwise, and secure it with either a plastic fastener or a trash-bag tie.

Only Way Left For Little Guy To Get Rich

Here Is the Uncensored Message My Wife Asked Me Not to Write

I love my wife. And I understand why she wants me to keep my mouth shut. She just wants to protect me from the IRS.

But I can't be quiet any longer. I'm angry. We are really getting jerked around. And I'm tired of it.

The government says one thing. Then does the opposite. Especially Reagan. And I even voted for him. One of my biggest mistakes.

First the feds talk tax cuts. Then they pass the biggest tax increase in history. Who are they kidding?

Average taxpayers, you and I, are getting screwed.

The new law doesn't bother the rich fat cats much. They still have loopholes galore. Let's face it. They always will.

But recently I ran across a workable angle. It's cheap. And it's legal. It's meant for the rich. But it's perfect for us little guys. You don't need any money. And we can get the same breaks the rich get.

I can hardly believe it. Catch this. I formed a corporation. Of my own. For peanuts.

It's my way of fighting back.

Now I have a small, one-man corporation. I operate out of my apartment. My work? I'm a commercial designer. Freelance. Brochures, fliers—stuff like that. On my income, I didn't think I could save much. But I'm paying almost zero taxes. And it's legit. Just like the fat cats do it. I have no guilt. Uncle Sam already gets plenty. Too much from all of us.

One thing the feds didn't bother much under the new tax laws—corporate tax goodies. Guess they figured right. Burden business too much. Result? No jobs for anybody. Including them. Not to worry. They know better.

From a buddy, I heard about this unusual book. It's called **How to Form Your Own Corporation Without a Lawyer for Under \$50**, by Ted Nicholas. Damnedest book I've seen. Has the forms right in it. Pages are perforated. You just fill in some blanks and rip 'em out and mail them in. A couple of days later you've got a corporation. No wonder it's a best seller. (They tell me over 650,000 copies have been sold.)

No need to bring in other people. You can be President, Vice President, Secretary, Treasurer all by yourself. Just like me.

You know, lawyers charge \$300 to \$2,500 for incorporation. Talk about rip offs! And their secretary fills in the form—a single page with two blanks. Now you don't need a lawyer. And there is no hassle at all. It's simple. No wonder lawyers like you to think everything is so complicated.

You don't have to employ anyone either. Just by your lonesome. And I always thought corporations had to have lots of employees.

Oh well. Now I know.

Let me tell you something. I'm a skeptic. I like to shop by mail. But I've been ripped off in mail order. So, before I sent my check, I checked out the company. Called the Better

Business Bureau. And the Chamber of Commerce. Found out publisher has a good record. And the book is guaranteed. So, what the hell. I spend that much on a few beers. That's how come I ordered it.

Damned if it didn't come in a couple of weeks.

I expected a shlocky-type mail order book. What a shock. Instead the book was typeset. Has a silver cover. And it's big. 8½ x 11.

I've had it for only three months. Already I've given myself all kinds of fringe benefits. Kind employer I am! Put in a medical reimbursement plan. A one-page form did it. Makes all my doctor, dentist and medical bills tax deductible—for me, my wife *and* my kids.

Now, my wife has been seeing a shrink. Guess living with me is no picnic. We deducted over \$600 in the last two months alone. Also just got myself new teeth. Caps, I should say. Cost me \$2,500. My son's braces figure to cost \$2,000 next year. I can deduct it. Right off the top. And my wife and I are into special vitamins. Heavy. Those pills cost over 400 bucks. Couldn't get into them before because of cost. Tax-deductible now. Imagine this too. Right off the top!

Savings have been scarce for me. I have a helluva time saving bread anyway. But, with this little corporation, I'm really socking it away. How? First, I tax deduct any cash I don't need. A corporation makes this easy to do. And then I invest it. Interest and dividends are completely tax-free. Until I retire. In the meantime, I can even borrow the money back. So I don't lose the use of it like in an IRA or Keogh. This gimmick is called a Pension/Profit Sharing Plan. Again, I just filled in a couple of blanks on a standard form.

Now, I'm no financial genius. But I'll tell you this. I'll be a fat cat myself soon at this rate. It may not be as bad as I thought. Incorporation

is the only way left. Now little guys like me have a shot at the big money.

This little corporation even covers my rear end. I could get sued. Everybody likes to sue these days. Something for nothing. And some judge might not like me. But you know what? The only thing anyone can get is what's in my little corporation. Big deal. A drafting table. A desk. And a little paper. Nobody can touch the real bucks. My home, cash, cars—even benefit plan monies are protected.

Maybe you've got some little business deal going. Or maybe you can get something started. Even a part-time business. This book can help. It can make the difference between just making it or operating just like the big boys. Even better, since you don't have their expenses.

For a real shot at big bucks, isn't it time you looked into incorporation?

It worked for me. So well that I wrote a fan letter to the company. They asked me to write this message. In my own words. But I did ask them not to print my name. Who knows? Maybe my wife is right. You can't be too careful. The IRS might want to hassle me. Even though everything is 100% legal. They may not like my message.

If you order now, the publisher will throw in a free bonus. A report called *The Income Plan*. Worth 10 bucks by itself. Shows you how to turn most jobs into a corporation. Outlines how to operate as an independent contractor instead of an employee. You can increase take home pay up to 40%. Taxes will no longer be withheld before you get your hands on the money.

Here is how to get your copy of **How to Form Your Own Corporation Without a Lawyer for Under \$50**. And remember. Get the book. Look it over for 30 days. It will give you ideas. Lots of them. If you don't want to keep it for any reason, return it for a full refund. And keep your bonus. No questions asked.

Please rush me a copy of **How to Form Your Own Corporation Without a Lawyer for Under \$50**, by Ted Nicholas, at \$14.95. I have up to 30 days to look it over. If, for any reason, I don't feel it's for me, I can return it for a fast refund. And the bonus *Income Plan* is mine to keep, regardless.

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The flying test bed has so far been limited to lifting 40-ton loads—five tons for each of its eight rotors. But its modular design gives it an added advantage. The metal frame unbolts to make four independent, twin-rotor helicopters, each having a 10-ton lift capacity. This lets the operator tailor the copter to the job at hand, saving fuel.—*S. Renner-Smith*

Save Gas, Save Engine with 'POLY'

The following introduces one of the most fully tested and credentialed gas saving, friction reducing engine treatments ever to reach the market!

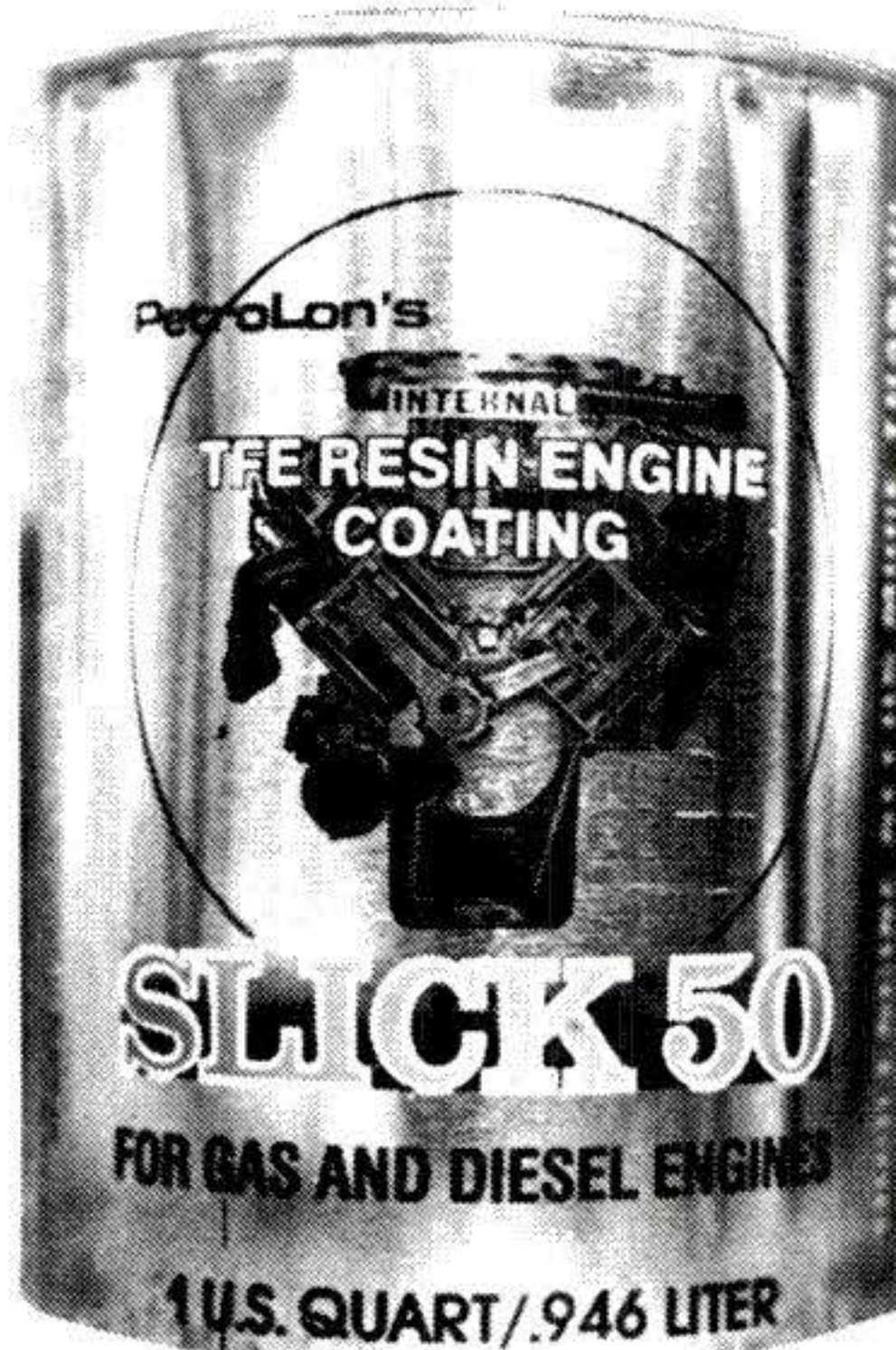
WHAT IS POLY? "Poly" is short for polytetrafluoroethylene (TFE). It is the slipperiest substance known to man (1981 Guinness Book of World Records, p. 188). The PetroLon Corporation, makers of Slick 50, has invented a way to permanently bind this slippery chemical to your engine with one treatment. All you do is add one quart of Slick 50 to your oil during oil and filter change. By reducing engine friction, Slick 50 increases gas mileage and horsepower and reduces engine operating temperature thus causing your oil and engine to last longer. Just as important, it reduces metal wear, defraying costly overhauls.

HOW DO I KNOW THIS ISN'T A FRAUD? Slick 50 has some very impressive credentials. The "Consumers Digest" magazine (March/April 1982, p. 35) states "Slick 50 does reduce engine heat and ordinary wear, and our informal tests indicate that it will improve gas mileage by about 2 or 3 miles per gallon." Researchers at the **Franklin Institute Research Laboratory**, after applying a powerful ultrasonic cleaning process to a Slick 50 treated engine part, were surprised at its permanence. They stated, "We actually expected the PetroLon Slick 50 TFE Resin coating to also be removed, but later found it was still there."

The **FAA (Federal Aviation Administration)** has fully accepted Slick 50 Aircraft Piston Engine Treatment (F.A.R. #33.49). An FAA test simulating 1400 hours of engine use (equivalent to about 70,000 miles on a car) showed almost zero engine wear!

Twenty-five hundred miles after removing Slick 50 from the crankcase, tests done at the **University of Utah Engineering Experiment Station** showed that the benefits of Slick 50 were still there. They reported a horsepower increase of 16.9% and 9.9% for light and heavy loading respectively. The senior engineering researcher at the **University of Southern California** in San Diego stated this, "Slick 50 does increase horsepower and decreases fuel consumption in tests done at the university." The **Space Shuttle Columbia** uses the chemical "poly" in its gears and bearings because it is the only chemical lubricant which can withstand the heat and corrosive elements of space.

Perhaps most dramatic of all is a torture-test overseen by the **Automotive Services Council for Pennsylvania** and



shown on television station WTVE. Three cars with between 75,000 and 129,000 miles on them were treated with Slick 50. Six months later the oil was drained from each vehicle and the cars were driven without the oil plugs for about a half hour. The water temperature never rose and the engines sustained no apparent damage. The Southwest Daily Times (Dec. 19, 1982, p. 6), reports that a man from Liberal, Kansas, flew his airplane without oil for 30 minutes. There are many more tests available. If you are still skeptical, send \$2.00 to defray printing and postage costs and we will send you additional, more detailed, test information, etc.

HOW DO YOU TREAT AN ENGINE? Very simply. A few minutes before oil and filter change add engine flush (sent free with each order) to clean out your engine. Let your engine idle for 5 minutes. Then drain your oil, change filters and add the proper amount of oil less one quart. Add one quart Slick 50, drive for 30 minutes, and leave it in the crankcase for 3,000 miles. As the engine operates, the oil carries the polytetrafluoroethylene between the parts where it is burnished into the pores of the metal. Once impregnated it is permanent, so you do it only once, not each time you change oil. One quart of Slick 50 will treat all standard 4, 6 and 8 cylinder gasoline and diesel engines.

WILL IT WORK WITH MOST OILS? Yes, Slick 50 will work with all petroleum based oils and all synthetics that are compatible with petroleum based oils. An exception is graphite oils. However, once an engine is treated, you can go back to a graphite type if de-

sired.

WHAT ARE THE BENEFITS OF SLICK 50? Your actual benefits in percentages may vary, depending on the kind of driving you do, vehicle condition, etc. By reducing friction, Slick 50 does all of the following: It increases gas mileage. It increases horsepower — small economy cars and large RV's really need this. It makes for easier starting. It reduces operating temperatures, thus increasing the lubrication and life of your oil and your engine. Last but not least, the drastic reduction in engine wear defrays or eliminates costly overhauls which can save you over \$1,000.00. Slick 50 eliminates the "lubrication starvation" that all cars experience when first started before the oil has a chance to circulate. Up to 90% of the wear on a car can be caused by this lubrication starvation. You receive all of these benefits for less than the cost of two tankfull of gas (\$33.95).

WILL SLICK 50 HARM MY ENGINE OR AFFECT MY WARRANTY? No! Slick 50 is suspended in an excellent grade of petroleum oil which meets or exceeds every manufacturers engine warranty requirements. In addition, Slick 50 carries an API (American Petroleum Institute) service classification SF-CC-CD. It also carries the military specifications MIL-L-21046 and MIL-L 46152-A.

DEALERSHIPS ARE AVAILABLE. **OTHER SLICK 50 PRODUCTS** available are Small Engine Treatment (for 2-cycle engines), Aircraft Engine Treatment, Gear Treatment (manual transmissions, etc.), Grease, Ultra 9 Oil, Fuel Conditioner, and Fabric Protector. Free information is sent upon request.

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----- PS7

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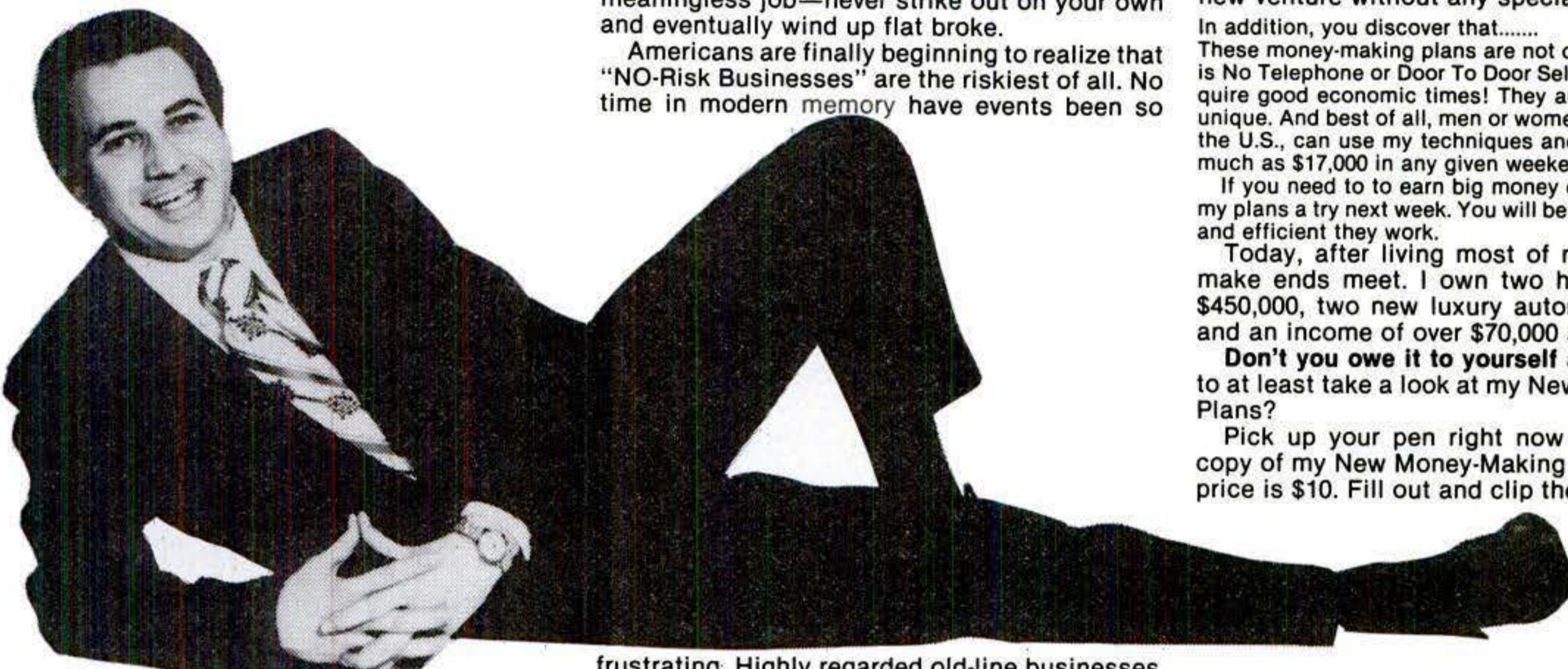
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I discovered years ago starting a venture and starting a profitable venture are two different principles at work. The problem in the U.S. today is the tendency to play it safe—get stuck in a meaningless job—never strike out on your own and eventually wind up flat broke.

Americans are finally beginning to realize that "NO-Risk Businesses" are the riskiest of all. No time in modern memory have events been so

frustrating. Highly regarded old-line businesses have been going belly up with depressing regularity, millions of people are unemployed, and whole families are being forced out of their homes. Yet there are still so-called friends that will tell you—NOT to start a new venture—NOT to begin to carve out your own destiny. What is the meaning behind their madness?

Or, Most Importantly, what will they be earning next year or the year after? \$100 a week? Or \$17,000 a week?

What will they be driving, an old chevy?

Or a new Cadillac?

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Or a \$500,000 home with a swimming pool?

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Do It Yourself People Are Making A Killing!

Some people in the coming months will score Big. Others will still be following the same, out of work, drummer.

I am not saying this to brag, but I would like to make this special point. I have found an easy way to earn a large income, and I would like to share the secret with you.

Fourteen months ago I put one of my new money-making plans into operation, and so far have deposited \$1 Million Dollars in my bank. *My business financial statement will verify this.*

Last month alone I deposited **\$71,264.03** and I could have easily made \$4,000 more if I hadn't taken a few days off.

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February	\$53,995.54
March	\$69,004.26
April	\$77,466.79
May	\$57,248.61
June	\$54,448.71
July	\$69,583.56
August	\$72,937.06
September	\$90,187.80
October	\$82,904.75
November	\$71,264.03

Was it A miracle? Or A lucky break? Not at all! These money-making plans are making this kind of money consistently and often.

If you or your family require a large injection of cash! I will show you the ultimate plan for

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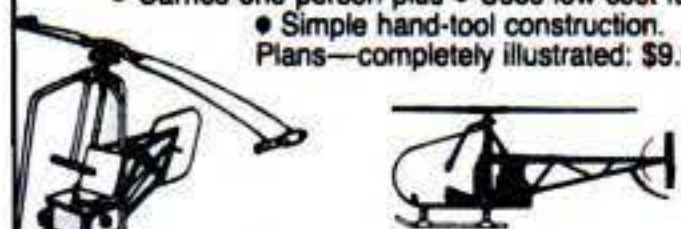
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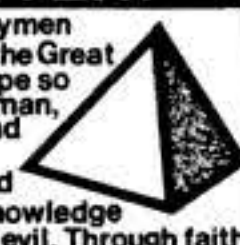
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