

The WHAT'S NEW magazine

APRIL 1984

\$4.75

# Popular Science®

Detroit's big switch to  
**TURBO  
POWER**



This tiny turbine can  
double engine power

Cosmic mystery:  
**Things that go faster than light?**





## OUR OUTDOOR LINE COMES IN SMALL, MEDIUM AND LARGE.

Honda can give you all the power you need for good times in the great outdoors. With a complete line of lightweight, portable generators from 500 to 800 watts. Each is really easy to operate. Just turn it on, pull the cord and you're off and running.

Honda generators are ideal for lighting up a campsite, charging the boat battery, powering

small appliances, or providing standby power.

Each one features a quiet, reliable Honda four-stroke engine. An advanced Oil Alert™ system that warns when the oil level gets too low.\*

# IT'S A HONDA

An Automatic Decompression system and CD Ignition for quick, easy starts. And a USDA approved spark arrestor muffler so it can even be used in National Parks.

So if you're looking for the best generator to fit your outdoor power needs, size up a Honda.

Check your Yellow Pages for the Honda Generator dealer nearest you today.

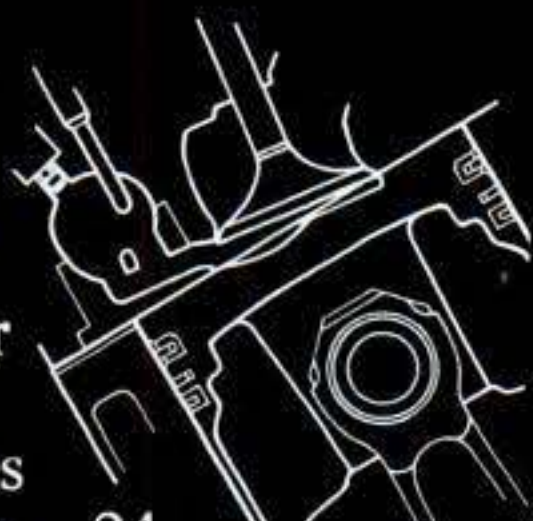


# The V6 diesel

## 4 million miles of testing made it right.

### Oldsmobile Cutlass Ciera makes it great!

In the lab and on the road—the most thoroughly tested engine ever offered by Oldsmobile. V6 engines were run non-stop... 24 hours a day... six days a week... for nearly two months. In all, over 1,000 hours of dynamometer testing of the V6 diesel. Additionally, six fleets of over 150 diesel V6 vehicles were tested over a 3-year period... on the road... coast to coast. In all, over 4.1 million miles of testing.



Venturi-shaped pre-combustion chamber for efficient, precise combustion.

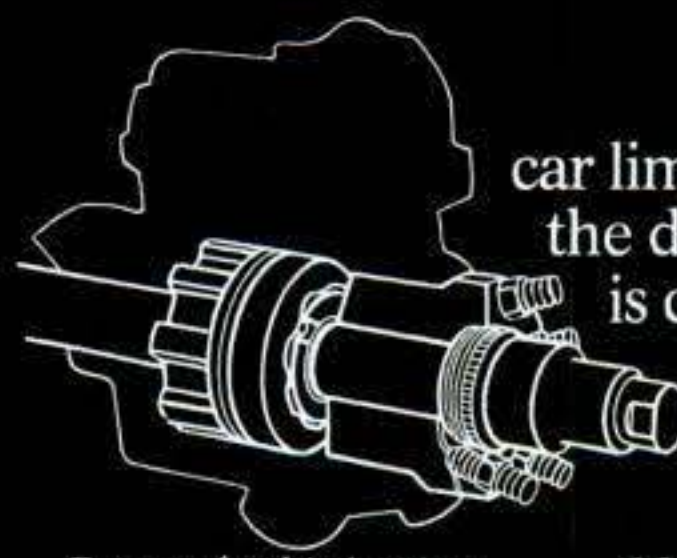
seconds and 0 to 50 in 11.7 seconds—in a V6 diesel Cutlass Ciera, according to test track data.

The fuel economy? Equally impressive at—43 estimated highway and 28 EPA estimated mpg\*.

Conclusion: with a high technology diesel Oldsmobile, you get both spirited performance and money-saving economy.

**Additional savings with Olds Diesel Traveling Package.** Now you can save \$300 compared to the Manufacturer's Suggested Retail Price of the same options purchased separately, on V6 Diesel Traveling Package equipped Olds Cutlass Ciera models with: AM/FM Stereo Radio, Wire Wheel Discs, Power Door Locks and Cruise Control or Rear Window Defogger. See your dealer for details.

**3-year/50,000-Mile Protection.** Another plus in the diesel Oldsmobile. As part of the Olds new



Rotary fuel injection pump precisely measures fuel for each cylinder.

car limited warranty the diesel engine is covered for 3 years or 50,000 miles, whichever comes first. Subject to a deductible after the first 12 months-12,000 miles.

Test-drive a V6 diesel Cutlass Ciera for 1984 at your Oldsmobile dealer. The way you'll feel behind the wheel will be the final and most convincing test of all.

There is a special feel in a diesel

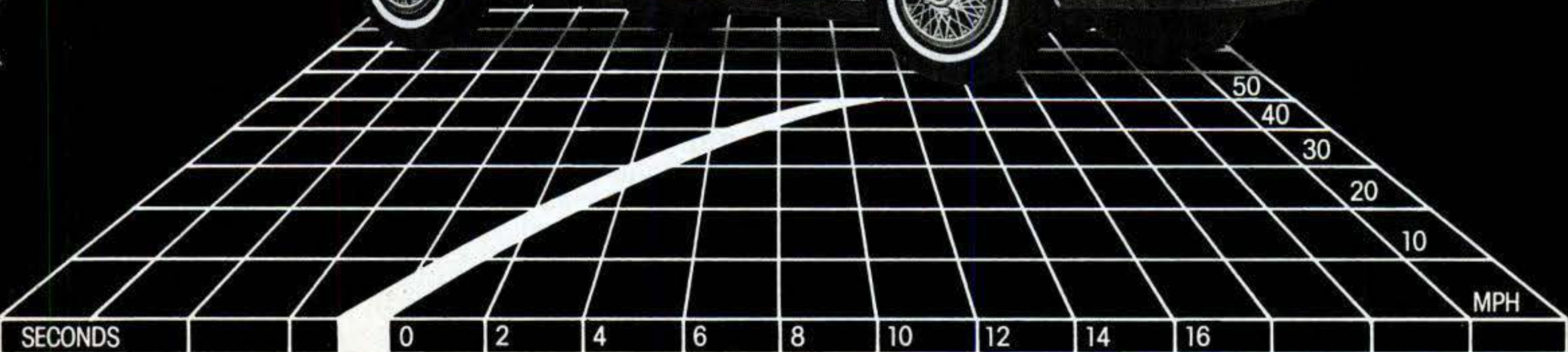


**Impressive performance and diesel efficiency through precision engineering.** The inherent advantages of a diesel were teamed with the balance and smoothness of the V-type engine configuration. The results: remarkable—0 to 30 in 5.2



Roller hydraulic lifters help quiet operation.

\*Use the estimated mpg for comparison. Your mileage may differ depending on speed, distance, weather. Actual highway mileage lower. Estimates lower in California. Some Oldsmobiles are equipped with engines produced by other GM divisions, subsidiaries or affiliated companies worldwide. See your dealer for details.



## Highlights of this issue

### *Detroit's big switch to turbo power*

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Cover photo by Greg Sharko

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**NEW TASTE TESTS PROVE IT.**

# **WINDSOR CANADIAN BEATS V.O.**

Two separate broad-scale taste tests were conducted in late 1983 among Canadian whisky drinkers. The results: Windsor's mild, smooth taste was chosen over the new 80-proof V.O. both times.

Try the taste of Windsor and find out for yourself why you can't beat its taste. And you certainly can't beat Windsor's price.

**WINDSOR**   
ONE CANADIAN STANDS ALONE

# Readers Talk Back

The WHAT'S NEW magazine  
**Popular  
Science**

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

## Another slant

I'm a 16-year-old high-school student and have chosen the controversy on slanted or vertical solar glazing [Aug. '83] as my topic for a science-fair project. I constructed two boxes of equal volume, each with a two-by-three-foot window. One window was set at a 60-degree angle; the other box had a vertical window. Both boxes were insulated with one inch of foam insulation. Data came from electronic thermometers and thermocouples secured behind aluminum plates (to keep the thermocouples out of direct sunlight). I measured temperatures during the months of November, December, and January. Solar heating was the only source of heat in these boxes, and the data cannot be directly compared with that from homes using supplementary heat sources.

I've found that a vertical window is more advantageous than a 60-degree window during the winter months. The 60-degree box accumulates snow (when such conditions are present), while the 90-degree box remains snow-free. Due to this, the 90-degree box obtained temperatures two to 100 degrees F higher than the 60-degree box.

Temperature readings (disregarding data when the 60-degree box was covered with snow) show that 57 percent of the time there was no difference in temperature between the 60-degree box and the 90-degree box. Twenty-eight percent of the time the 90-degree box's temperature was five to 34 degrees F higher than the 60-degree box's, and 14 percent of the time the temperature in the 60-degree box was three to 10 degrees F hotter than that in the 90-degree box. If the sun was bright enough to create a difference between the two boxes, the 90-degree box was more effective in collecting heat.

Nancy M. Fenn, Huron, Ohio

## Left in space

One might expect a better answer than you gave Joseph Hyde [RTB, Jan.] when he correctly pointed out your reversal of the astronaut picture in "Workhorse Shuttle" [Sept. '83]. Although vertical and horizontal have no meaning without a frame of refer-

ence, left and right certainly do. Unless the NASA shoulder-patch flag is unconventional, your picture was reversed as well as rotated.

Phil Eastman, Waterloo, Ont.

*Reader Eastman is correct. The picture was both rotated and reversed.*

## Geothermal tax

Please advise any of your readers who may be considering using geothermal heat to stop considering it. I have been notified by the Internal Revenue Service that my 1980 tax credit has been disallowed and assessed interest nearly equal to the amount of tax credit. The reason is that my ground-water temperature is not 122 degrees F. When drawing up the regulations for geothermal heat, the IRS stuck that little requirement in, and no one noticed. As a result, they are disallowing geothermal tax credits throughout the United States on that basis.

Ralph G. Rohner Jr.  
[no address given]

## Bronze mettle

In "Sticking Metal to Metal" [Nov. '83], there is the phrase: "a bronze (copper-zinc) rod."

It seems to me that if the material is copper-zinc alloy it must be brass, not bronze. Brass is also more in keeping with the origin of the word brazing.

George Williams, Naples, Fla.

*E. F. Lindsley replies: "Reader Williams revives an ancient conflict of terminology in the metal-joining trades so classic that it warranted a special footnote in Union Carbide's masterly book The Oxy-Acetylene Handbook. It says, 'Years ago, the process we now term "braze welding" was commonly known as "bronze welding." Traditionally, bronze was considered an alloy of copper and tin; brass, an alloy of copper and zinc. Today, while all alloys designated as brass contain a lot of zinc, several alloys commercially labeled bronze also contain zinc, and some contain no tin.' If you want to stick metal together, ask your supplier for either bronze or brass brazing rod, and you'll almost certainly get, according to the same reference, 'The filler*

*Continued*

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# WANT A GOOD REASON TO BUY A NEW MARINER? TAKE A LOOK AT AN OLD ONE.

Almost any outboard motor can look good in the showroom.

But a Mariner outboard still shines after the gloss wears off.

Mariners are built to run better, run longer and more efficiently than other outboards. And judging from the letters we get from owners each year, that's exactly what they do.

Our outboards have earned a reputation for reliability in some of the world's toughest waters. They've navigated ice flows along the bleak coast of Greenland and powered an expedition down the Amazon, Parana and Orinoco rivers.

In short, you can't buy a more reliable outboard.

Which is why every year you see more and more old Mariners still running strong. And more and more new ones being sold.

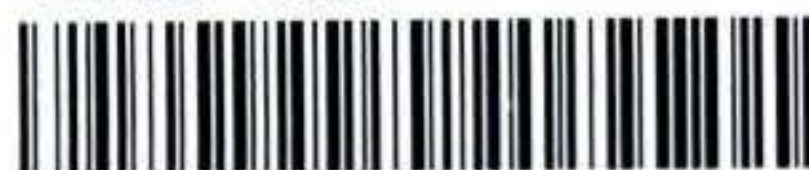
For a free catalog of Mariner Outboards from 2 to 200 horsepower, write Mariner, Dept. 84, 1939 Pioneer Road, Fond du Lac, WI 54935.



## BETTER IN THE LONG RUN.



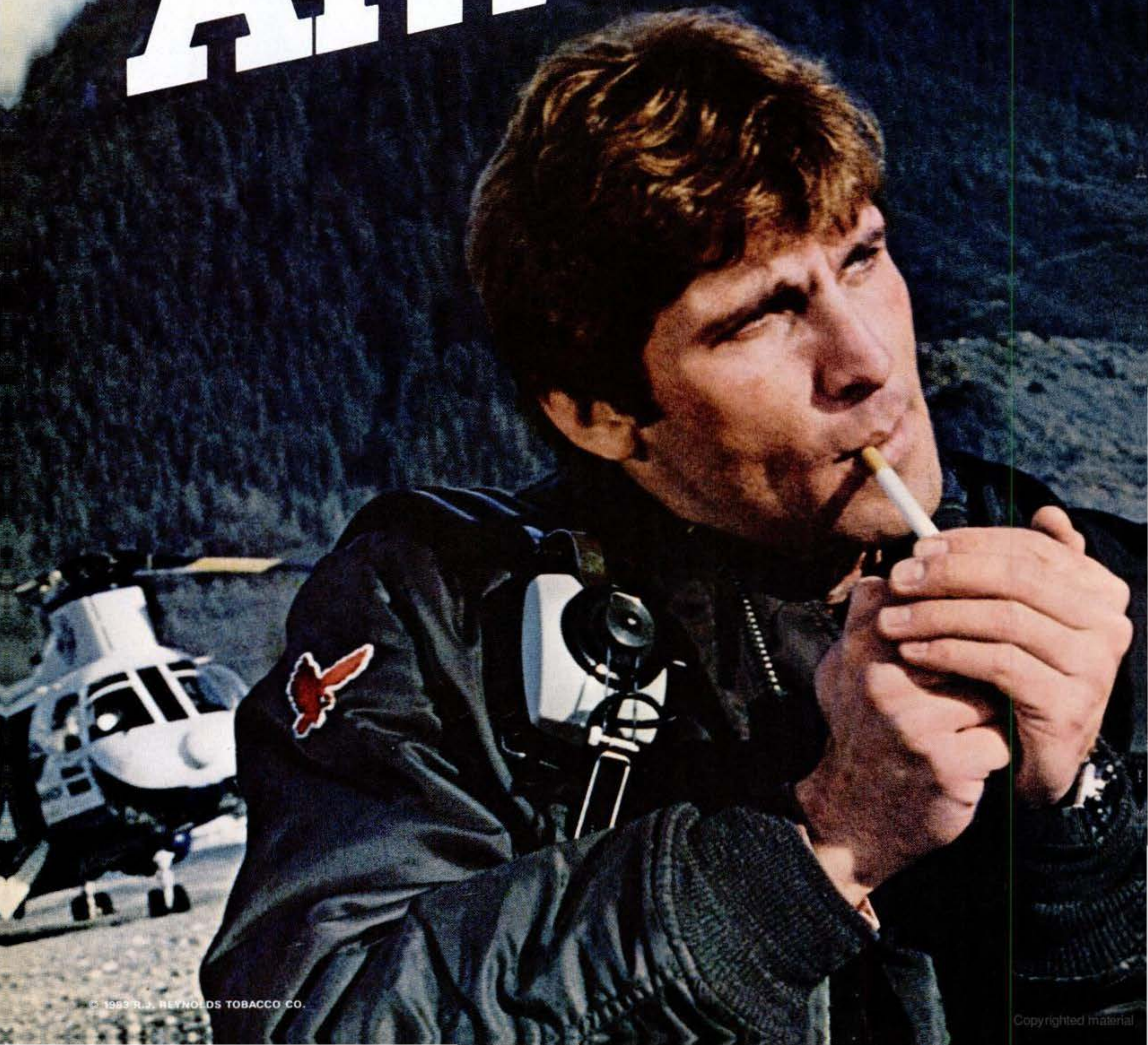
This one



3GQ6-0D8-NDSP

LIGHTS: 9 mg. "tar", 0.7 mg. nicotine, LIGHTS 100's: 12 mg.  
"tar", 1.0 mg. nicotine, av. per cigarette by FTC method.

# Winston. American.





# s Best



Join the first team.  
Reach for Winston.



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

# AT DODGE, WE ENGINEER THE PRICE AS CAREFULLY AS WE ENGINEER THE TRUCK.

**WE ARE DODGE. WITH THE LOWEST-PRICED FULL-SIZED TRUCK IN AMERICA. \$6,393\*.**

Pay more and get less. Or pay less and get more.

Because you can buy a full-sized Dodge D100 at a list price that's hundreds of dollars less than a compact Ford Ranger or Chevy S-10, when comparably equipped with six cylinder engines.

**BACKED BY AMERICA'S LONGEST RUST-THRU PROTECTION TRUCK WARRANTY. AT NO EXTRA COST.**

There's more rust-fighting galvanized steel in a Dodge D100 than any Ford or Chevy pickup, compact or full-sized.

One reason why we can give you the longest rust-through protection warranty.

## 1984 STANDARD FEATURES DODGE D-100 PICKUP

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- 225 CID SLANT SIX (3.7L) ENGINE
- 95 NET HP @ 3600 RPM
- 4-SPEED OVERDRIVE TRANSMISSION
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- POWER BRAKES
- 60-AMP ALTERNATOR
- 370-AMP MAINTENANCE-FREE BATTERY
- ELECTRONIC IGNITION

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- ALUMINUM GRILLE
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- BODYSIDE TAPE STRIPES

Dodge

Dodge Trucks

- BRIGHT WHEEL COVERS
- WOODTONE INSTRUMENT PANEL WITH BRIGHT TRIM
- COLOR-KEYED CARPETING
- 5/100 RUST PROTECTION WARRANTY

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- 2-SPEED WINDSHIELD WIPERS
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- IN-CAB HOOD RELEASE
- DUAL HORNS
- R&L HAND SIDE VISORS
- ROOMY GLOVE BOX WITH COIN HOLDER

### PAYLOAD

- 1395-LBS. PAYLOAD ALLOWANCE

**\$6,393.**

TOTAL\*

**5/100**  
YEARS / 100,000 MILES

ESTIMATED MPG FOR COMPARISONS

THE ESTIMATED MILEAGE FOR THIS MODEL, PLUS TO BE USED TO COMPARE TRUCKS OF THIS MODEL WITH OTHER TRUCKS. YOUR OWN MILEAGE MAY BE POORER DEPENDING UPON OPTIONS, DRIVING CONDITIONS, YOUR DRIVING HABITS, AND YOUR TRUCKS OPERATING CONDITION.

OTHER SIMILAR SIZED TRUCKS RANGE FROM 14.5 TO 18.5 MPG OF THE MODEL IS 15.5. ESTIMATED MPG OF THE MODEL IS 15.5. CONSULT THE MILEAGE GUIDE.

PER YEAR, \$1.65/GALLON

PLEASE USE THESE NUMBERS.

**IT'S A BIG TRUCK TO DRIVE. A SMALL PRICE TO PAY.**

With a standard full-sized six cylinder engine. Standard full-sized hauling capacity. And room enough for three full-sized adults.

**SAVE \$200 TO \$400 WITH PROSPECTOR EQUIPMENT DISCOUNTS.**

Actual savings depend on model and package. And are based on the list prices of package items if purchased separately. So see your Dodge Truck dealer for details.

## 5/100 RUST-THRU PROTECTION

Limited warranty covering outer body rust-through on new '84 full-sized pickups and Ramchargers at no extra cost for five years or 100,000 miles, whichever comes first. Ask dealer for details.

**QUALITY BACKED BY 5/100 PROTECTION.**



EPA EST 18 EST HWY 26  
MPG

Use EPA est. mpg to compare. Your mpg may vary with speed, distance, weather. Actual hwy. mpg & CA est. less. \*Base list price (taxes and destination charges extra) comparison. STANDARD EQUIPMENT LEVELS VARY.

BUCKLE UP FOR SAFETY

DODGE RAM D100



**RAM TOUGH**

Dodge Trucks



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**Readers Talk Back**

*metal used for most braze welding... a copper alloy containing roughly 60 percent copper, 40 percent zinc, and small amounts of tin, iron, manganese, and silicon."*

**Fire and foam**

Regarding "Foam Home" [Jan.], I wonder whether any of your research turned up the products of combustion of the foam and Insul/Crete materials. Is cyanide produced when that stuff scorches? Does the gas produced by combustion kill you?

David A. C. Rudloff, M.D.  
Melbourne, Fla.

*V. Elaine Smay replies: "According to Cubic Structures, the polystyrene foam used in the houses releases carbon dioxide and carbon monoxide if allowed to burn. The foam does not emit other objectionable agents, according to the company—based on intensive testing by the EPS industry and by Cubic Structures. Presumably cyanide would come under that category. In addition, the foam must be covered with the Insul/Crete or some other fire barrier to meet building codes; that, plus the solid construction of the walls, should keep most fires from spreading.*

*"For specific information about cyanide formation, contact John Lehman, Cubic Structures Inc., 4307 Triangle St., McFarland, Wis. 53558."*

**Burning woodshop scraps**

Your article describing new structural panels [Jan.] caused me to wonder about the toxic hazards of burning wood scraps in a fireplace or stove. A family in my town displayed symptoms of arsenic poisoning after burning firewood that was treated with chromate copper arsenate. In the past, I have burned scraps of plywood, waferboard, particleboard, treated lumber, and painted wood in my stove without realizing that this might cause toxic substances to be emitted. For the benefit of woodworking hobbyists, please tell me which of these wood products present a health hazard when burned.

Eldon Fick, Logansport, Ind.

*Al Lees replies: "Scraps of pressure-treated wood should never be burned in a fireplace or stove because chemicals are released into the air. The same is true, to some extent, of most reconstituted wood, such as particleboard and waferboard, because of the resins that bond the fragments. Plywood and painted lumber may also release toxic*

*substances, but scraps of hardboard and untreated wood may be safely burned."*

**Iowan and proud**

Reader Michael D. Gutter of Newburgh, N.Y. [RTB, Dec. '83], reminds me of one of his forerunners from the Catskills: Rip Van Winkle. He may know all about sports cars, but when he puts down the state of Iowa to make his point, he shows he's been asleep for the last 100 years.

Iowa produces more corn, soybeans, and hogs than any other state. Right here in Spud Knuckle (Ottumwa), John Deere has the largest tractor factory and the largest hay-harvesting-equipment factory in the world. We also have packing houses owned by Hormel, Wilson, Cuday, Rath, and Jimmy Dean. Other corporate citizens are Maytag, Quaker Oats, and Caterpillar.

I don't care if Mr. Gutter's sports car can outfly a cannonball. I just hope he wakes up and looks around the next time he flies through Iowa.

Dale R. Snyder, Ottumwa, Iowa

**Snow job?**

It always bothers me when a new idea in energy conservation states the yearly saving but not the return on investment. For instance, the investment for the Prudential ice pond ["Low-Tech Cooling," Sept. '83] includes land cost, excavation, and the snow guns, hoists, and other equipment. Furthermore, do the yearly savings quoted include the cost of personnel or energy for the snow guns?

Jeffrey A. Asher, Schenectady, N.Y.

*V. Elaine Smay replies: "System operating costs are included in the quoted annual saving. The Prudential project is an experiment; it will never pay back its cost. But it led the investigators to conclude that such a system could provide process cooling economically in colder climates because process cooling is needed year-round. And that led to the installation in New York. That system should have a payback of less than five years, they believe. There, the initial investment was much lower because, in that colder climate, they can make snow just by spraying water into the air. Furthermore, they do not attempt long-term storage of the snow (they supplement with conventional refrigeration). That saved the high cost of the insulated dome."*



ANNOUNCING  
A PROUD ADDITION  
TO YOUR FAMILY.

The next addition to your family could be the bright little newcomer in the growing family of IBM® personal computers.

Name: PCjr. Weight: 12 pounds.  
Heritage: more than 30 years of computer experience.

"Junior" is a powerful tool for modern times. Yet it's simple enough for a child to enjoy.

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## BRINGING HOME BABY

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It's a big day when PCjr comes home.



The surprises begin the moment you open the carton.

Surprise #1 is the IBM "Freeboard"—

a keyboard that doesn't need a connecting cord.

The Freeboard frees you to move around and relax.

Then there's the Keyboard Adventure—an instructional exercise for first-time users. It's built into the computer and explained step-by-step in the Guide to Operations. It will help anyone begin learning as soon as PCjr is hooked up to a TV set.

In systems equipped with a diskette drive, there's a program that lets you explore computer fundamentals at your own pace, with PCjr as your teacher.

And to get you off and running from the very first day, a sample diskette with eleven useful mini-programs (ranging from a spreadsheet for monthly expenses to a word game and a recipe file) is also included.

But there are still more surprises.



---

## FAMILY COMPUTING MADE EASY

---

Many IBM software programs written for other IBM personal computers will run on PCjr. And inexpensive new ones written especially for PCjr are being released.

An easy-to-use diskette word processing program, for example, uses pictures as well as words to guide you along. A comprehensive

IBM home budget program makes keeping track of money easier. There's also a selection of educational programs for children at home and at school.

And when the work is finished (or perhaps before), the fun can begin. Just slip in a game cartridge and stand back.

---

## GROWING UP WITH JUNIOR

---

Add a printer. A diskette drive. An internal modem for telecommunications. Increase user memory from 64KB to 128KB. With these and other add-it-yourself options, even the lowest-priced PCjr can grow up *real* fast.

PCjr is a powerful tool for home, school or college. With its optional carrying case, it's a powerful tool anywhere you care to take it.

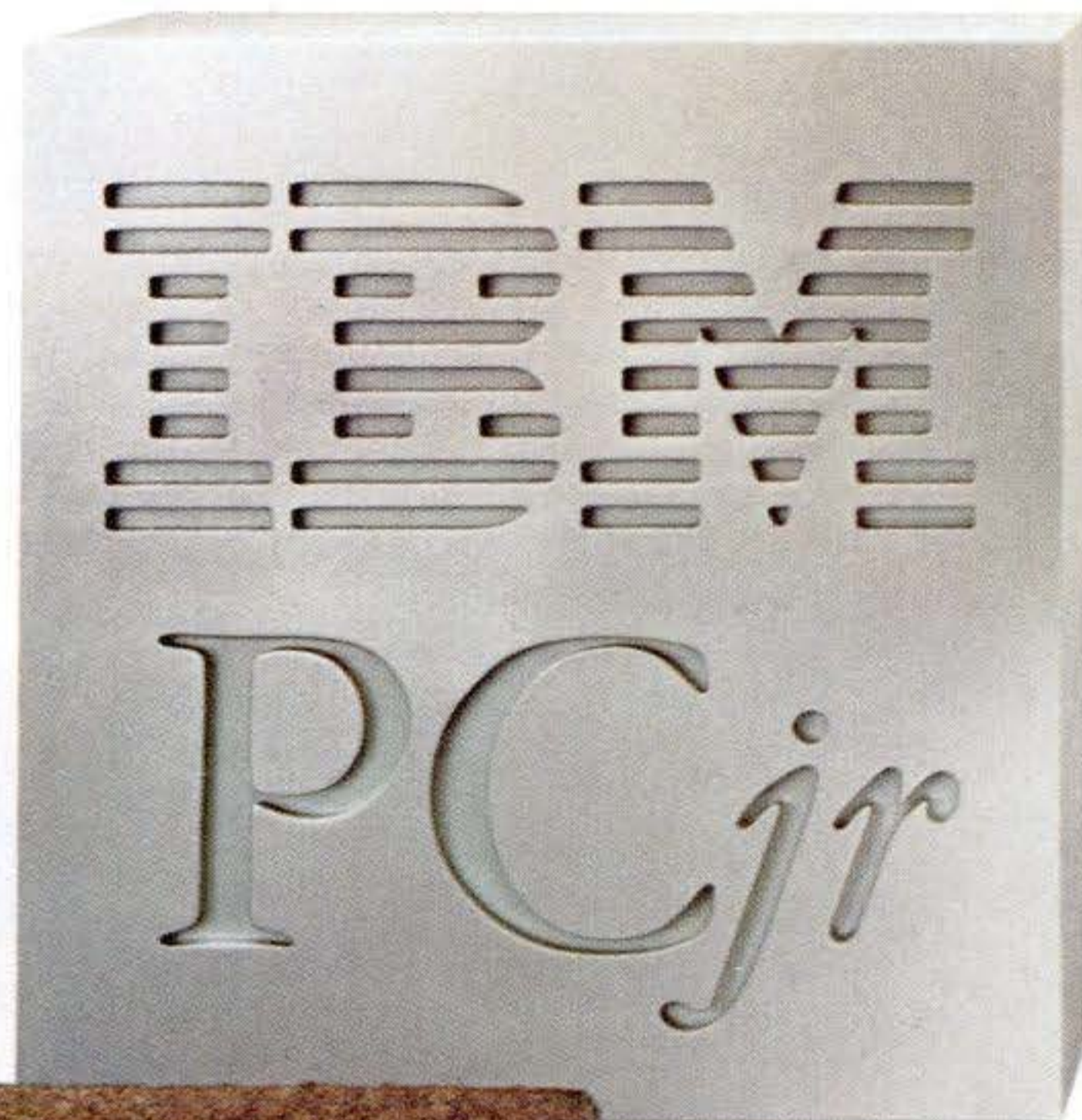
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## SEE JUNIOR RUN

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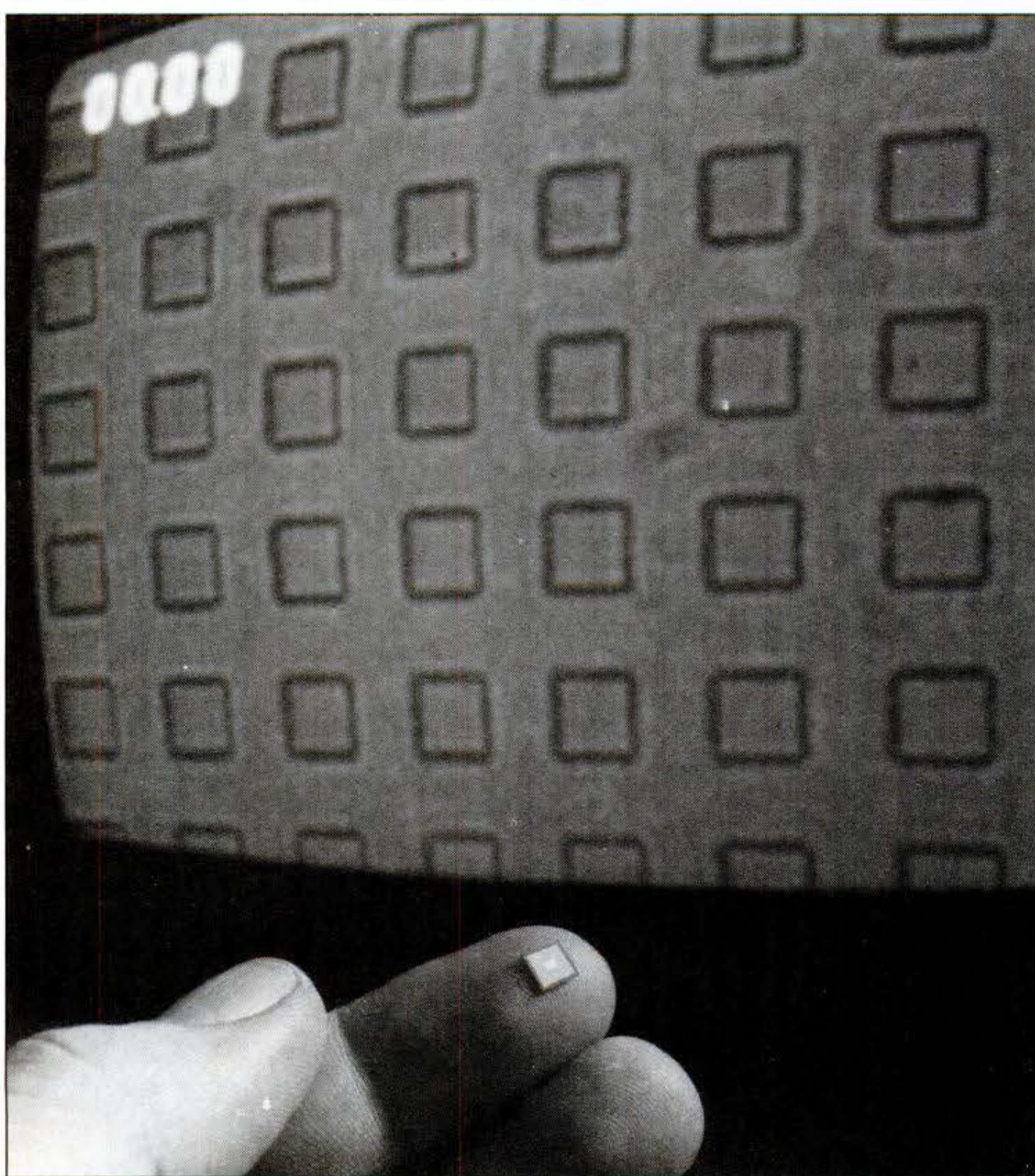
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# Science Newsfront

By ARTHUR FISHER



## High-power switch

The tiny chip seen on a finger tip in the top photo is a new semiconductor switch claimed to have the highest power-handling ability ever attained in a device of its kind. Developed by researchers at General Electric's Research and Development Center, it is a new member of GE's insulated-gate-transistor (IGT) family. It can handle more than 12,000 watts of power at switching rates of one million times a second. The switch is less than  $\frac{1}{4}$  inch square but holds 16,000 interconnected cells. Some of these cells, much magnified, appear on the TV monitor in the background.

The inventor of the IGT, Dr. B. Jayant Baliga, predicts that this second-generation switch will generate major cost savings when used in controls for energy-saving adjustable-speed motors and other electrical products.

## Antifouling compound

A chemical under study at the Naval Research Center has proved successful in tackling the normally frustrating problem of marine fouling by organisms such as barnacles and sea squirts. Six-and-a-half years ago, researchers there applied a protective coating of the Teflon-based substance to the hull of the Navy tug *Seamule*, based in Portsmouth, Va. Periodic inspections and cleanings show that the substance remains effective, as shown in the photo at the bottom of this page. The encrusted barnacles are literally being scooped up after the hull has been hosed down.

Traditionally, expensive and time-consuming sandblasting and repainting in dry dock have been needed to remove fouling organisms. A deposit of these creatures reduces a vessel's speed and increases fuel consumption.

The experimental coating consists of powdered polytetrafluoroethylene (Teflon) dispersed in NRL-developed fluorinated polymers. Unlike conventional antifouling paints, it is not toxic. Scientists at NRL believe that the effective life of the coating will be at least 10 years.

## Love bug's a no-no

Chagas' disease, a chronic, devastating, and often fatal affliction named after a Brazilian physician, is endemic in tropical America. It is caused by a parasite that is carried by a blood-sucking insect.

Now health experts are concerned that some villagers in Mexico have de-

veloped a new and highly effective way of contracting the disease. In the belief that the bugs are aphrodisiacal, some residents of the Mexican state of Nayarit are eating them.

### Microwave thermography

Yet another way to see inside the body has been developed by David Land, a physicist at the University of Glasgow, Scotland, seen in the photo below demonstrating his invention. It uses microwave thermography, or heat sensing, to aid in the diagnosis of cancers and inflammatory conditions. It is passive, painless, and non-invasive, relying solely on reading the microwaves generated naturally in varying amounts by different body tissues. The microwaves are sensed by a small antenna, about the size of a stethoscope head, that is moved over the skin above the region to be investigated and records temperatures of organs, joints, and muscle tissue.

Land claims that his device is less costly than X-ray machines and scanners and more precise than infrared



thermography, which only is capable of recording skin-surface temperatures. Prototypes of the device are undergoing clinical trials.

### False flippers

Lucky the loggerhead sea turtle was not so lucky. The hapless reptile's front flippers were lost to a hungry shark. Pity poor Lucky! But wait! Technology to the fore! Engineers at Good-year undertook to design replacements for Lucky's lost flippers. (The photo above shows a transparent study model of one possible design—a urethane prosthesis with steel reinforcements inside.) And on January 17 in Florida, history's first double-artificial-flipper-transplant was successfully performed.

### Earth flipping its field?

Geologists at the University of Minnesota have learned that the intensity

of Earth's magnetic field has declined more than 50 percent over the last 4,000 years, a possible harbinger, ultimately, of a complete reversal of the field's polarity.

Subir Banerjee and Donald Sprowl announced their findings at a meeting of the American Geophysical Union in San Francisco. Their evidence came from core samples, described as layered in a unique way so as to make them virtual magnetic calendars, from a Minnesota lake bottom. "The drop in intensity we found could be a temporary phenomenon. . . . But we could well be walking into the beginning of a reversal," said Banerjee. "We are overdue for a reversal."

Complete flips or reversals of the Earth's magnetic field (in which, for example, a compass needle would next point south instead of north) seem to occur every 200,000 to one million years, based on age-old rocks that have preserved the evidence. The last one was about 710,000 years ago. The reason for these reversals is unknown.

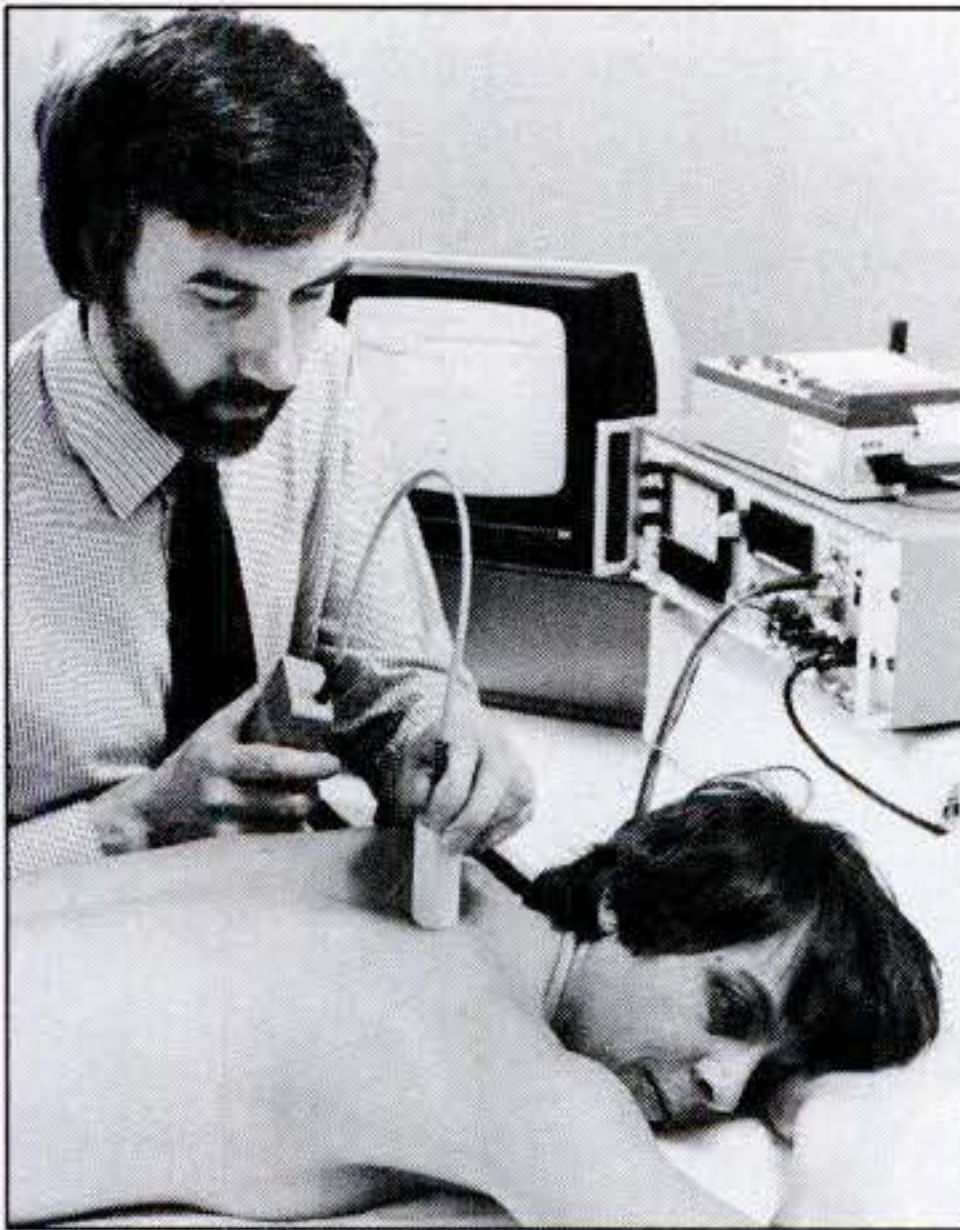
What is known, however, is that a reversal must produce profound changes on Earth. The magnetic field serves as a lifesaving shield, deflecting possibly lethal charged particles and radiation that originate in the sun. Some of these particles now filter through to the poles because the field is weakest there. But during a reversal they would bombard the atmosphere, causing climatic changes by creating more ice clouds and changing patterns of evolution more directly by extinguishing some species and causing mutations in others.

### Nissan AC electric car

Nissan Motor Company has designed a novel electric vehicle that uses an AC motor—Japan's first such car—rather than the more conventional DC motor. The innovation results in reduced need for maintenance and extended range from a single charge, according to Nissan engineers.

The experimental car, a modified Nissan March, appears in the bottom photo. Its transmission is an electromagnetic two-speed automatic—another first for a Japanese car. Its batteries are of the nickel-iron-alkali type. Nissan engineers developed a new transistorized inverter to change the direct current from the batteries to alternating current for the motor, and to serve as a speed controller. The car's maximum speed is 90 km/h (56 mph); its range is 160 km (99 miles) at a steady 40 km/h (25 mph) on a single charge.

PS



## Adventures in Alternate Energy

# Home-style heat pipes

An array of heat pipes—evacuated tubes that transfer heat from one end to the other as refrigerant inside vaporizes and condenses—is buried in a massive concrete wall in the center of this owner-designed house. The pipes move heat from a wood stove to be stored in the wall. Another heat-pipe array recovers energy from waste water. Refrigerant solar collectors and a ground-water heat pump are also employed in the unique system.

By DANIEL RUBY

**T**he centerpiece of John Rees's sun-, wood-, and ground-water-heated house outside Columbus, Ohio, is a massive, poured-concrete internal wall. "It amounts to a large, warm rock in the shape of a wall," the fire-department captain and energy innovator says.

But the 16-foot-eight-inch long, eight-foot-high, 8½-inch-thick wall is much more than the standard sort of "thermal flywheel" used in solar homes to smooth out temperature peaks and valleys.

Embedded inside are two arrays of

pipes that deliver and move energy efficiently between areas of the wall and to other radiant-heating zones in the house.

One piping circuit routes hot water from a solar system and coupled ground-water heat pump through the wall and then on to radiant pipes under the kitchen floor and in ceiling beams.

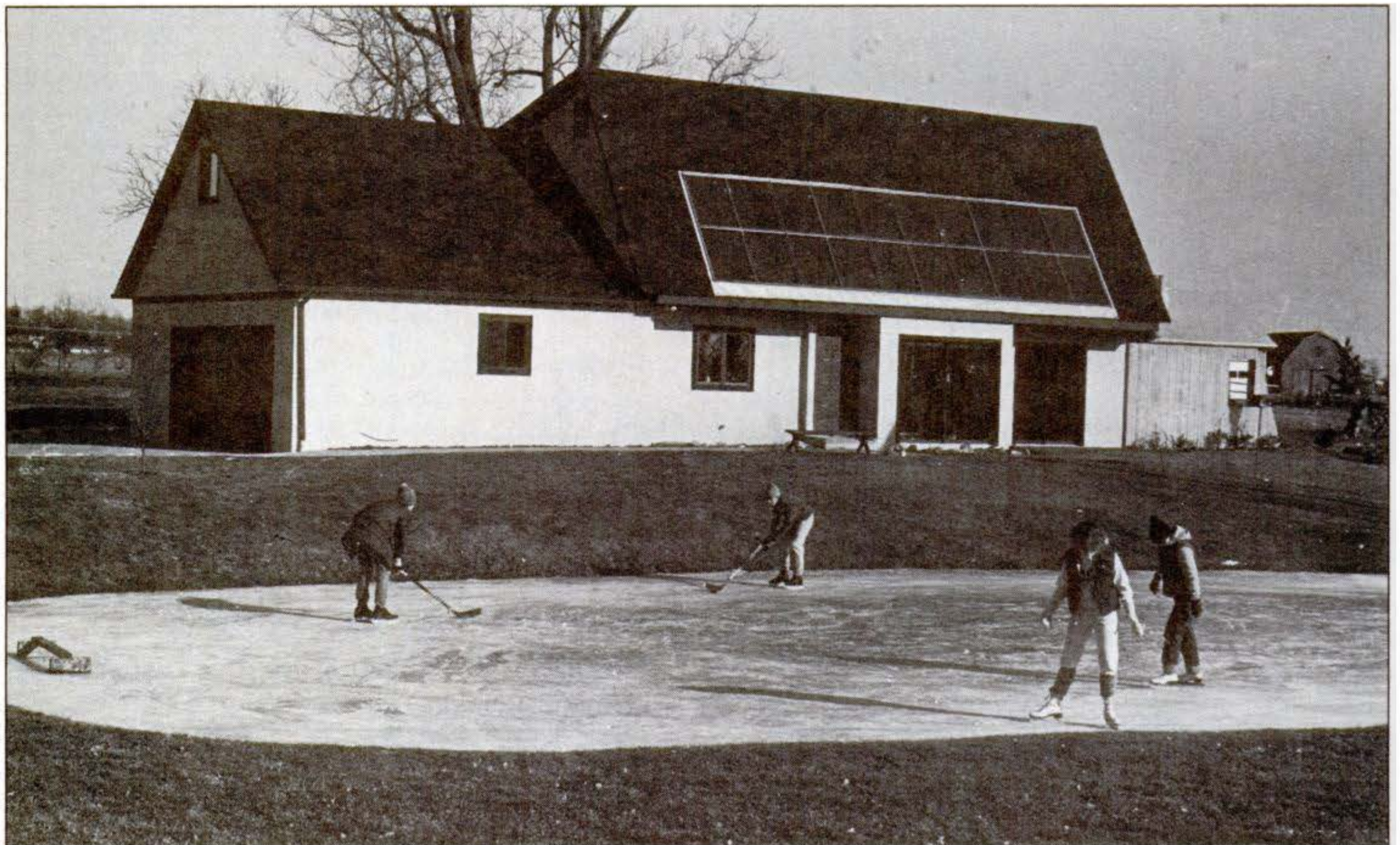
The second, more-unusual grid of pipes moves water vapor from a wood stove to deposit energy evenly throughout the wall. When the vapor in these homemade heat pipes gives off its energy and condenses, the water falls back to the bottom of the upright pipes under gravity return. (See PS,

June 1974 for information about commercial uses of heat pipes.)

"Heat pipes have to be the world's best-kept secret," Rees says. "They transfer heat without pumps, valves, thermostats, switches, or controls. Other than the phase change of the refrigerant, they have no moving parts of any kind—which eliminates almost all maintenance. After all, except for mechanical components, how often does a refrigerator need service?"

Surprisingly, Rees's heat pipes are charged with ordinary water instead of a fluorocarbon refrigerant. "Actually, water has an official refrigerant number—R-718," he points out. "I did

*Continued*



Owner-designed multi-energy house combines heating by sun, earth, and

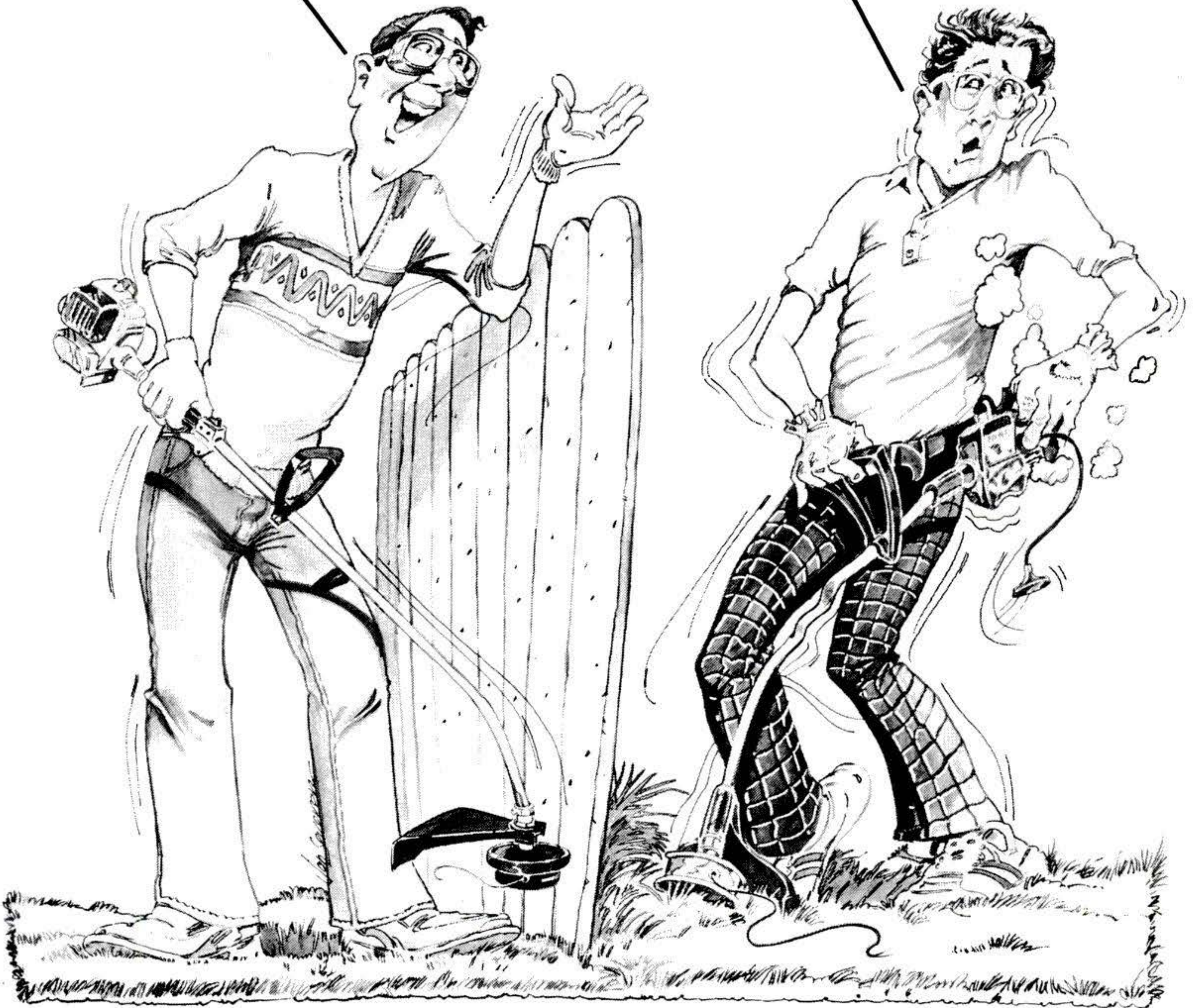
fire with passive-solar principles and extensive insulation. Six-foot-deep

pond was created when fill was needed for earth-berming house's north side.



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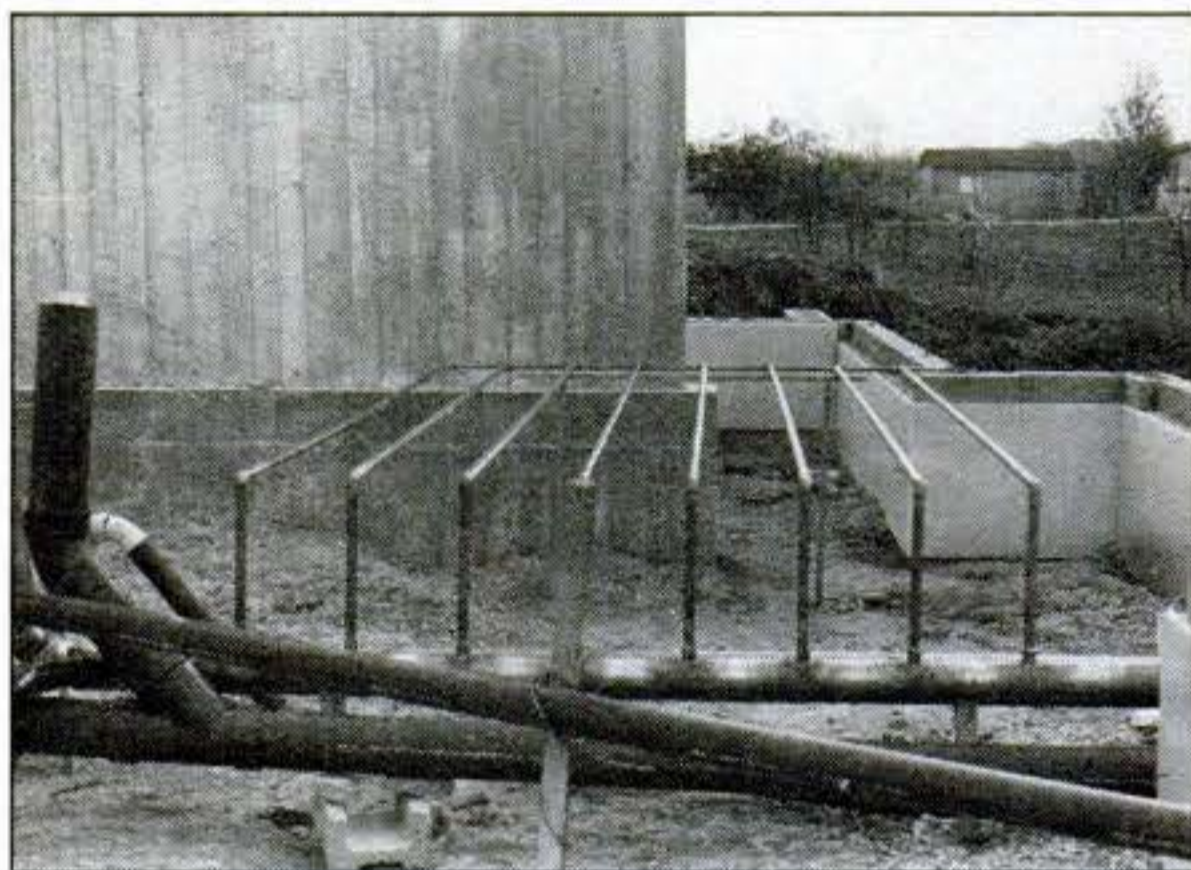
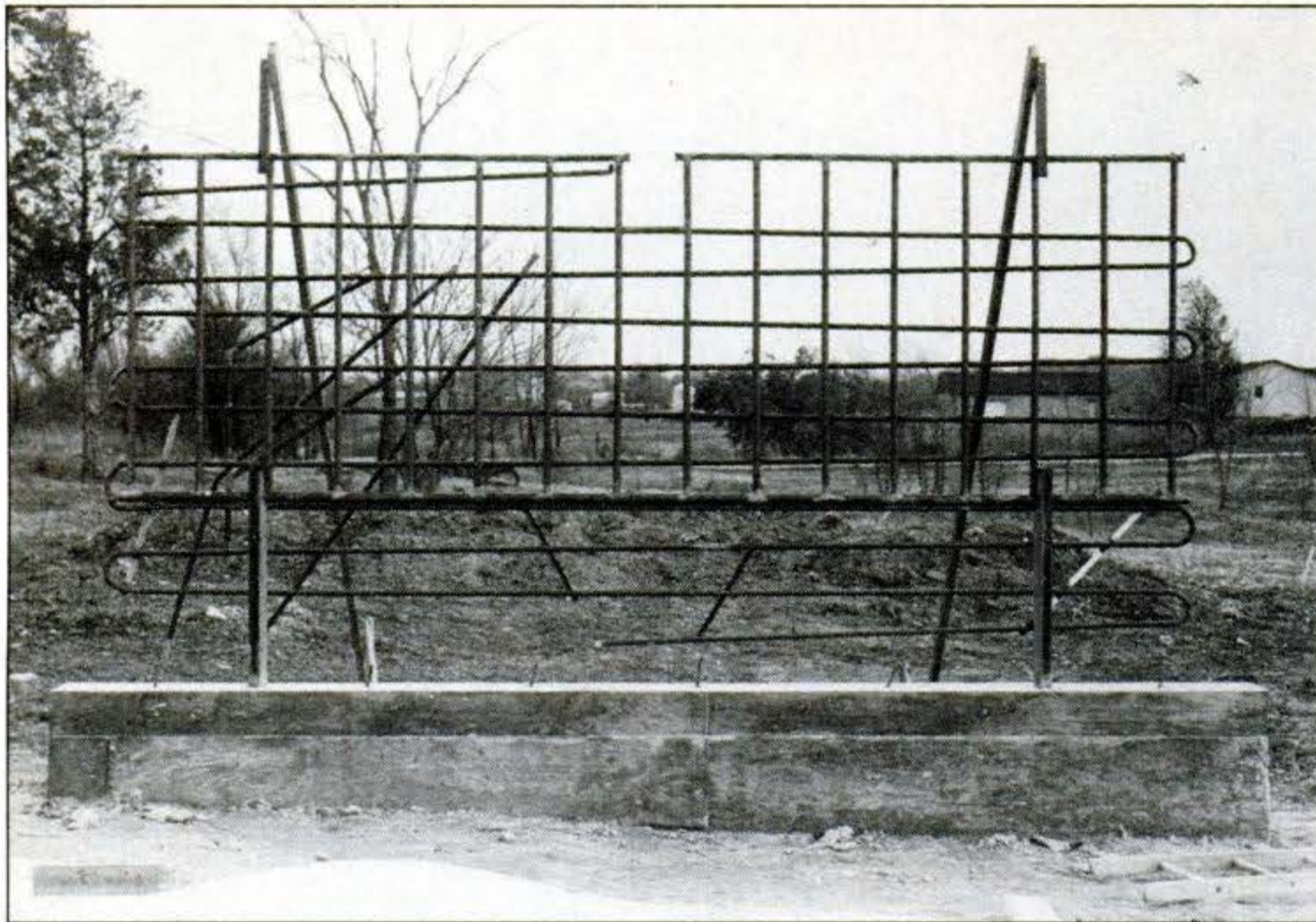
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## Home-style heat pipes



Vertical heat pipes overlap solar hot-water circuit inside thermal wall (top). Separate heat-pipe system recovers waste heat (above). Right: Rees feeds wood stove from pit in floor.

a great deal of experimenting before settling on the specifics of the design. I decided to use water because of its high latent heat and its ability to cycle limitlessly without degradation."

The heat-pipe wall is heated when Rees fires his Fisher wood stove on winter evenings. The two quarts of water in the evacuated pipes boils at 100 degrees F or less. This forces vapor through a bottom header to vertical sections of heat pipe, where the vapor gives off heat to the colder concrete and to water circulating in the adjacent loop of serpentine pipe. For each one-degree-F temperature rise of the massive wall, about 3,000 Btu is stored for later release. "The diode characteristics of heat pipes prevent a reverse heat flow," Rees says.

After a full evening's charge from the wood stove, the wall reaches a maximum temperature of about 95 degrees F, Rees says. In moderate winter weather, that's enough energy (with additional Btu absorbed in other concrete surfaces) so that the house temperature coasts at 70 degrees or better until the following evening. In colder weather, the heat pump kicks on to supplement the radiant system.

### Waste-not heat pipes

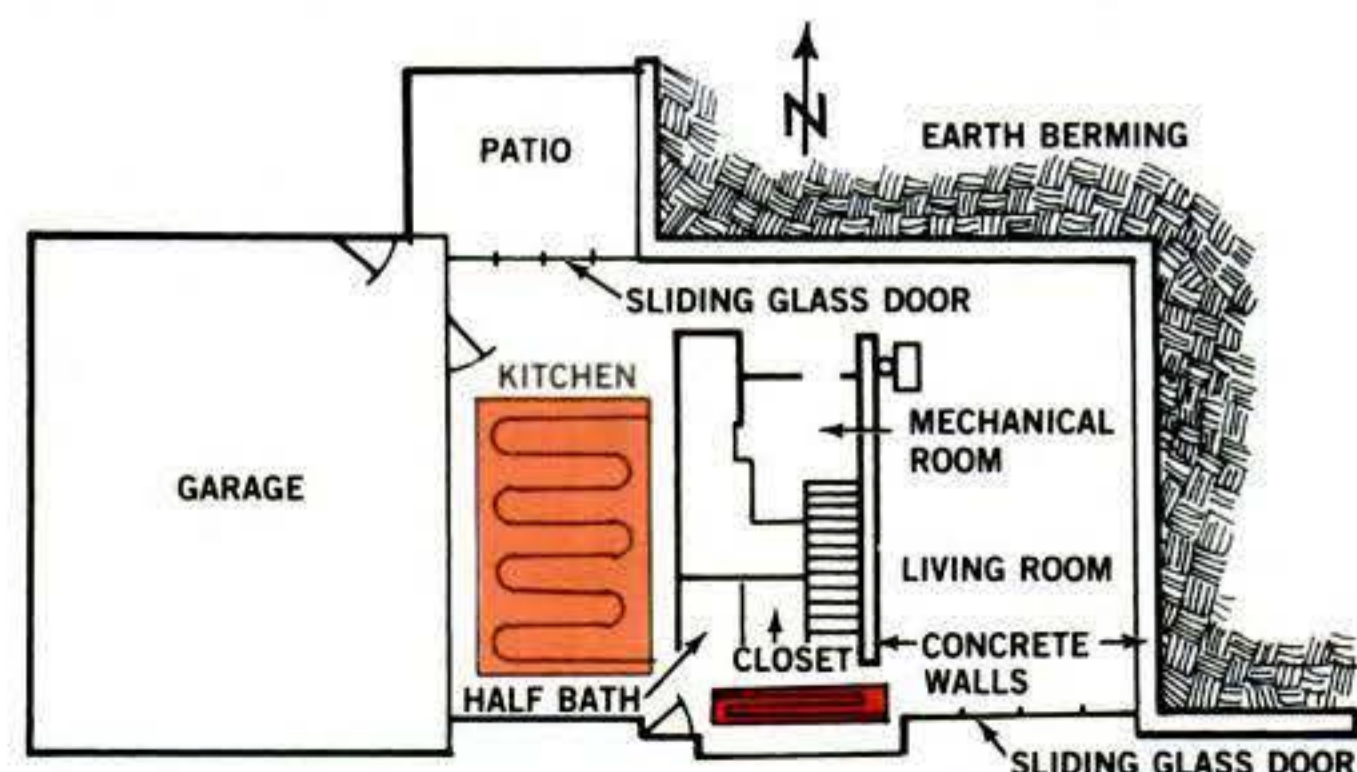
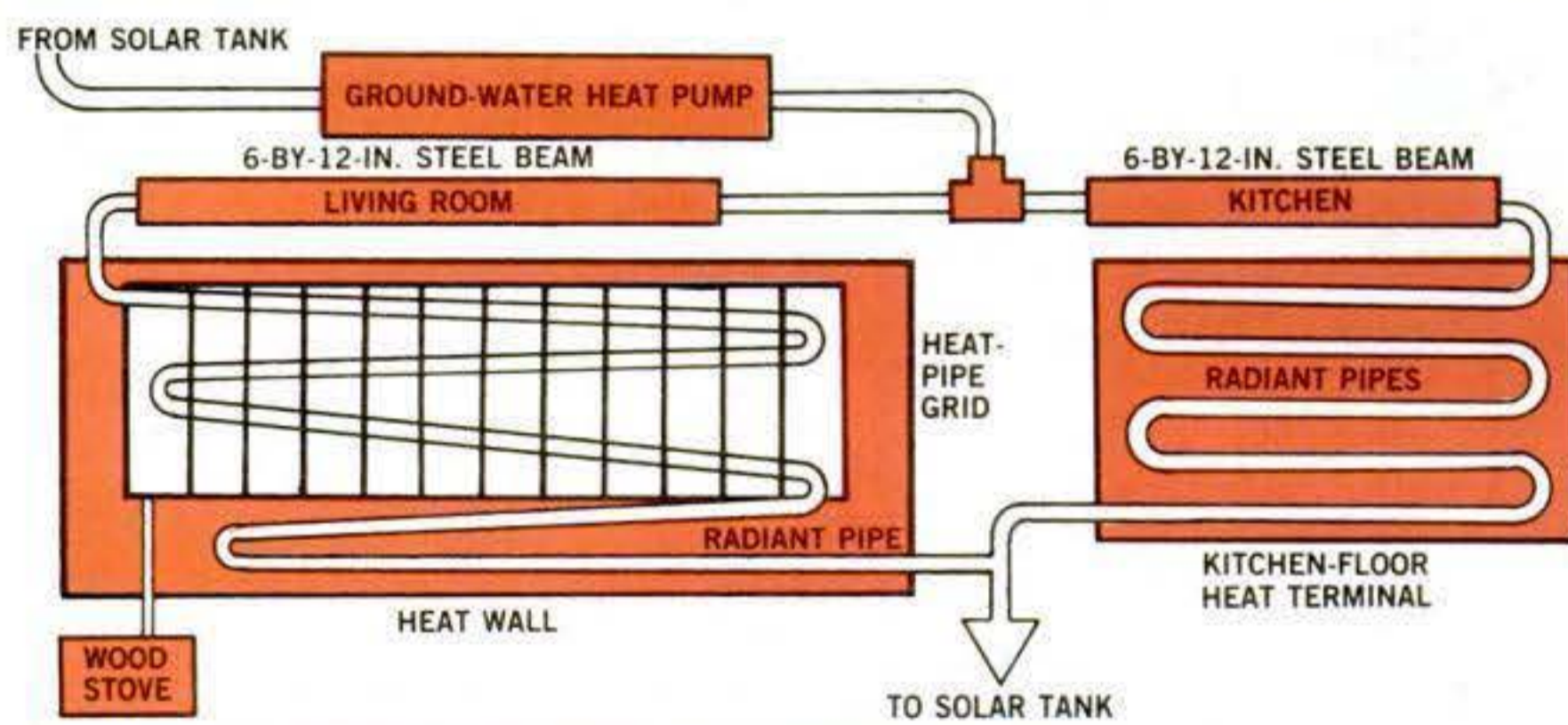
The heat pipes in the thermal wall are not the only ones in the house. A separate heat-pipe system (photo) is used to recover waste energy from the clothes dryer and gray water. A three-inch, R-12-charged copper pipe surrounds the two-inch gray-water pipe and abuts the dryer vent. The refrigerant boils and moves the recovered heat to the concrete floor in the home's entryway.

Rees does not have sophisticated monitoring equipment to prove the performance of his various systems. But fuel bills for the 1,900-square-foot house for the winter of 1982-'83 are impressive: \$112.50 for 1½ cords of firewood and \$35 for electricity to run the heat pump. Beyond that, his family swears by the comfort of radiant heat. "It's like summer all the time," Rees says. "My son runs around in shorts and bare feet year-round."

To ask a *specific* question about Rees's heat-pipe systems, send a stamped, self-addressed envelope to John Rees, 8278 Kennedy Rd., Blacklick, Ohio 43004. The systems don't, of course, adapt to retrofits. **PS**

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Coupled solar system and heat pump thermosiphon hot water for radiant heating to the ceiling beams, and to winding piping in kitchen floor and in thermal wall. Heat pipes charge wall by phase-change action of heated water.

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5. Winners will be notified by mail and may be required to sign an Affidavit of Eligibility and Release. All taxes are winners' responsibility. Only one Sweepstakes prize per family or household. For winners' names, send stamped, self-addressed envelope to: Lucky Strike Filters Winner, P.O. Box 10667, L.I.C., NY 11101.

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# Detroit Report

By JIM DUNNE



## Driven a Fordolet lately?

That could be Ford's slogan if prototypes of the 1986 full-size Fords go into production without major changes. Ford's latest prototypes are hybrid cars with Ford front ends and drive trains tacked onto Chevrolet Celebrity bodies. The grille, front fenders, and hood are new designs, much like the ones Ford will introduce in 1986. But to speed up drive-train testing, Ford engineers decided not to wait for complete new bodies. Instead, Celebrity bodies were chopped apart at the base of the windshield, and a new Ford front end was welded in place (see photo).

A Ford insider says that this is not that unusual. In fact, Ford engineers have found this trick easier to do on the new front-drive chassis. They simply put a 1986 power pack and suspension on the front of an existing body of approximately the same size as that of the new car, cover it with new sheet metal that fits the wheels and engine, and tie it into the production body with steering, brakes, lights, and accelerator. "We have a couple of different models running around with our front ends tacked onto both an Audi 5000 and a Celebrity," the insider revealed.

Of course, by the time the car is ready for production, the hybrids will be long gone, replaced by an all-Ford body and chassis. But for now, it's an easy and quick way to test parts of the new chassis without waiting for a complete new car to be assembled.

## Aero headlights

General Motors will use its own version of aerodynamic headlights on Buick's 1986 Regal coupe and a Skylark. Under the freedom granted by the government's new headlight rules, GM has come up with a lamp that is just 2½ inches high and seven inches wide. Insiders say that four of these will be used on the cars, two for brights and two for dims. Set side by side, the lights will stretch 28 inches across the front of the car. Dubbed "slit eyes" for their narrow appearance, the lights are designed to lower the frontal area and thereby reduce aerodynamic drag.

## Brick-lined engines

An Ohio firm says it can spray a brick-like material on the surfaces of engine combustion chambers. The purpose is to insulate and radiate heat so that engines will burn fuel more precisely. The material, described as "a refractory type of clay," is being tested on prototypes for durability. According to the maker, vibration, heat, and pressure are not a problem. "It will not crack, and it bonds mechanically," claims a spokesman for Bask Industries of Cincinnati. At high temperatures (about 1,200 degrees F), tendrils form on the metal surface and bond to the clay. The material is designed to tolerate higher temperatures in combustion chambers and exhaust systems. This will contribute toward more-efficient combustion. Formerly

used as insulation in buildings, the application will be only one mm (0.04 in.) thick when used on engines.

## More punch for Chrysler

The workhorse 2.2-liter (135-cu.-in.) four-cylinder engine will get an enlarged cousin in 18 months. That's when the company plans to introduce a 2.5-liter (153-cu.-in.) version to power its light trucks and high-performance cars.

Based on the 2.2, the new engine will have a number of unique features, including counterrotating balance shafts to reduce vibration for smoother running. The shafts are similar to those already used in the Mitsubishi-supplied 2.6-liter (159-cu.-in.) that Chrysler now uses as its premium engine. The new engine is to be built in the U.S. and may replace the imported 2.6 completely once production gets into high gear.

## Luxury line for AMC

American Motors plans to build a luxury sedan in the U.S. if marketing research points in that direction. The car will be an Americanized version of Renault's R25, a four-door sedan recently introduced in Europe. The engine lineup is impressive for this model in Europe, ranging from a 2.1-liter (128-cu.-in.) diesel on the low end up to a 2.7-liter (165-cu.-in.) aluminum V6 gas-burner. But if the vehicle is built here, it's expected that the engine line would be restricted to the big V6 and a turbocharged diesel. Bigger than the Alliance, the new model features impressive fuel economy. Much of the credit goes to its carefully designed body, which is claimed to be in the same aerodynamic class as Audi's new 5000 model.

## Shifting trends

Generally acknowledged as the leader in designing automatic transmissions, the U.S. fares poorly in comparison with the Europeans and some Japanese makers in building some manual types. This may soon change, however. Chevrolet is slated to build its own German-designed five-speed manual for small cars; it will be shared with the other GM divisions. Reports say that the gearbox will be installed in the Fiero. If true, this transmission would also be suitable for the X- and A-cars, which make up the bulk of GM sedans and station wagons. Introduction is set for shortly after the 1986 models hit the street. **PS**

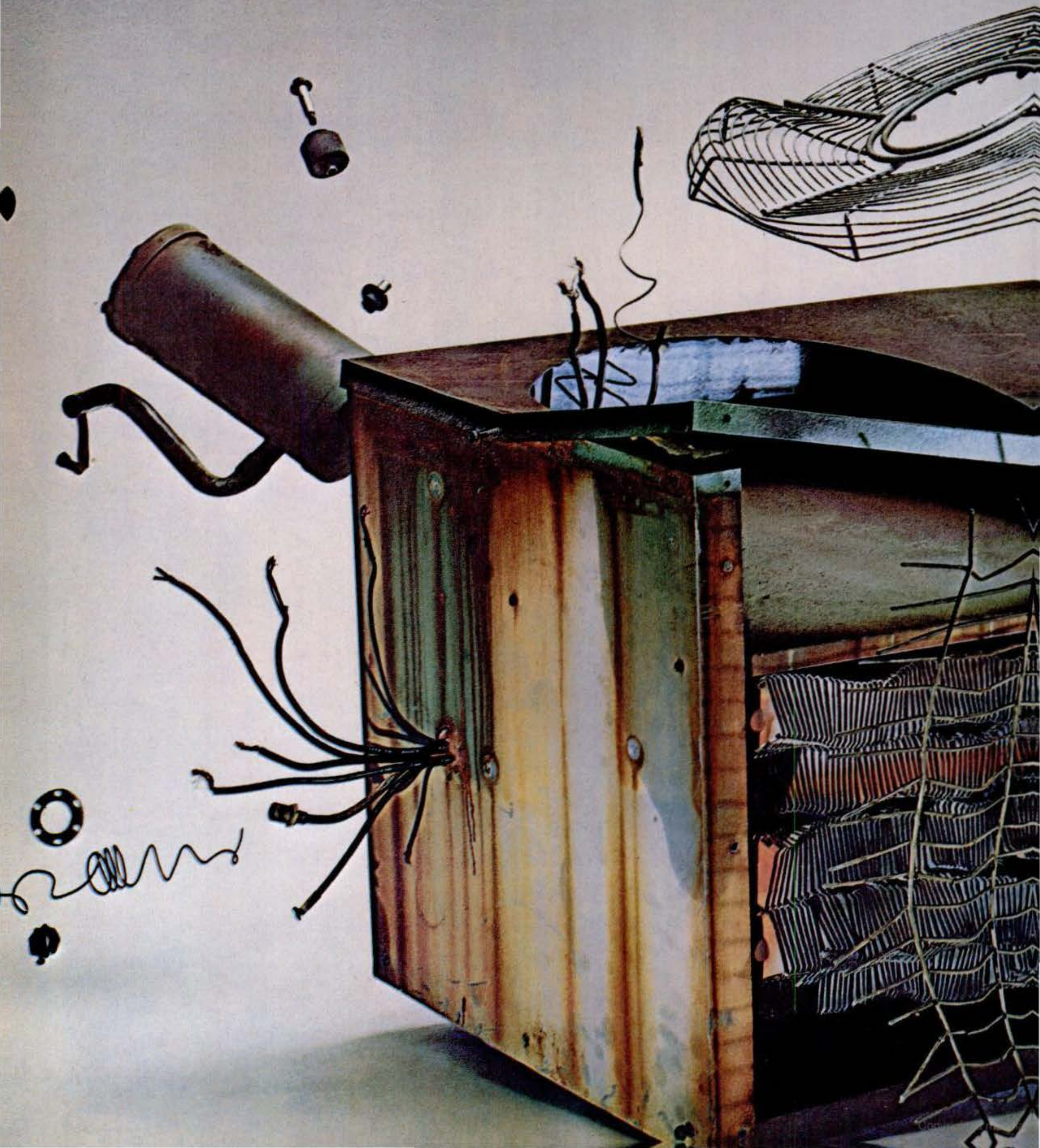
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# Turbo 4s vs. a hot V8

Can the Ford SVO Mustang and Chrysler Laser XE, with sophisticated turbocharged four-cylinder engines, outperform Chevrolet's 200-hp V8-engine Camaro Z28? To find out, PS assembled this trio for race-track testing.

By **JIM DUNNE**  
and **JACK KEEBLER**  
Photos by Greg Sharko

**V**8-powered cars are still kings of the American performance scene. But each time four-cylinder-turbo and V8 sedans tangle at Bridgehampton Race Circuit, the per-

formance gap shrinks. We found that a high-output V8 will still grab a strong lead from a standing start. But in just about any other type of driving, the turbos match or even beat the V8s.

We gathered three hot domestic competitors for a showdown: the Chevrolet Camaro Z28 with a high-output L69 V8 engine, Chrysler's turbocharged Laser XE, and Ford's state-of-the-art turbocharged SVO Mustang. All were

equipped with top-handling suspensions, the most advanced engines from their makers, quick steering, high-traction tires, and sports-car-like driving compartments.

But sportiness is expensive. Take a look at the prices in our specifications table. Are the cars worth the cost? A lot depends on what kind of driving you do. On twisting back roads, away from downtown tie-ups and boring interstate straightaways, each can be a source of rewarding driving pleasure. They answer the wheel with no-nonsense precise moves and accelerate with the best of the expensive, low-production imports, and most of their ailments can be handled by mechanics at local dealerships.

How do the performance approaches from each of the makers differ? The Z28's drive train is the most conventional. It's a high-output 305-cu.-in. V8 delivering power to the rear wheels through a five-speed manual transmission. Its 190-horsepower rating is the highest by a wide margin and explains why the Camaro is the fastest in zero-to-60-mph acceleration. We recorded a 9.2-second average time (a torrid pace when you consider the weight of the extra passenger we

*Continued*

Performance-bred sports coupes: Chevrolet Camaro Z28 (below right), Ford SVO Mustang (left), and Chrysler Laser XE (top).



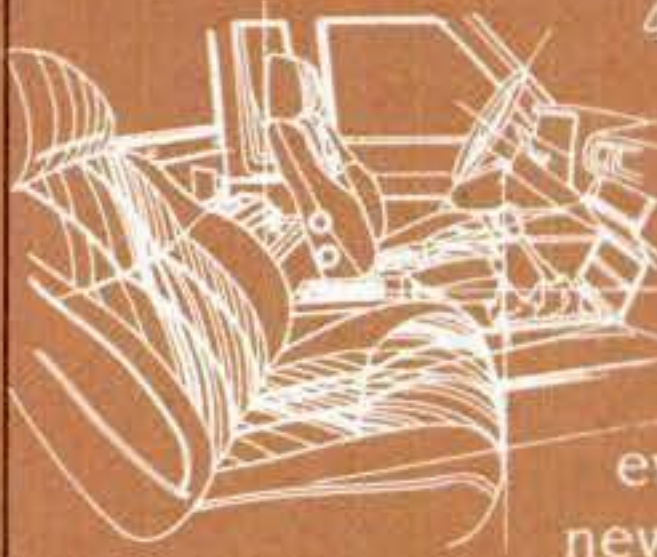


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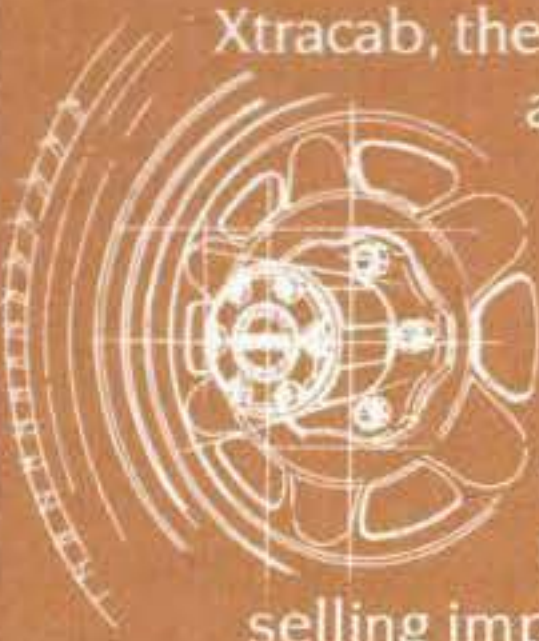
aerodynamics in the stylish new wedge-shaped front end with flared fender design and in the new flush surfaces on larger front and side windows. All the 4x4's have new improved rear suspension for more smoothness in the ride than you'd expect from a truck! More room and comfort too, more leg room, and standard on the SR5 4x4, AM/FM/MPX stereo and wall-to-wall carpeting. Most



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# MUSCLE!

## Turbo 4s vs. a hot V8

include and our 30 pounds of test equipment). Chevy chose a Rochester four-barrel carburetor instead of a fancy fuel-injection system. In addition, the car boasts a high-lift cam, special spark-control system (capable of producing 10 extra horses when premium fuel is used), and a less-restrictive (louder) exhaust system.

The Laser's front-drive configuration is fairly unusual for a sporting automobile, but it is gaining in popularity as the need for fuel-efficient engines continues. It uses the 2.2-liter (135-cu.-in.) four-cylinder that is standard fare on Chrysler K-cars. But there's a difference. A water-cooled turbocharger boosts the horsepower output of this engine to 142, and although that looks anemic compared with the Chevy V8, it's balanced against the light weight of the Laser body.

Ford's engine is a turbocharged version of the same 2.3-liter (140-cu.-in.) four first used in the Pinto. It's rated at 175 horsepower, which exceeds the Laser's 142 horsepower. There are two reasons for the Ford edge. First, Ford and Garrett AiResearch (the turbo maker) have been working on the turbo version of this engine since at least 1978. And second, the SVO boasts an intercooler, an air-cooled radiator installed between the turbocharger and the intake manifold. The intercooler's function is to cool the intake charge to prevent detonation and help increase the charge-air density for greater efficiency.

Although the SVO is currently the hottest Ford model in most driving modes, top honors in the zero-to-60 run are still held by the five-liter (302-cu.-in.) V8 Mustang GT and sister Mercury Capri RS [PS car test, May '83].

One drawback to the Laser and SVO turbo engines, and almost all turbo applications, is the lack of bottom-end power. The turbo boost does not pro-

## Performance comparison with selected models

	Mpg (city driving)	Acceleration 0-60 mph (sec.)	Brakes 60-0 mph (hot) (ft.)	Handling (mph)	Maneuverability (mph)	Noise @ 60 mph (dBA)
1983 Chevrolet Camaro Z28 V8	16	10.5	192	61.9	27.7	71
1983 Mercury Capri RS V8	15	8.2	178	59.0	26.5	74
1983 Pontiac Firebird Trans Am V8	16	10.1	200	61.5	27.6	72
1983 Mazda RX-7 rotary 2	19	12.8	186	61.8	28.5	76
1984 Pontiac Fiero 2M4 in-line 4	26	14.8	152	65.4	29.1	73

vide extra power until the engine is pulling a load and engine speed has reached a minimum of 1,500 rpm. Before this point, the output is similar to that of a non-turbo four-cylinder.

Here's how three of America's hottest sports coupes performed on our other checklists.

### Chevrolet Camaro Z28

With only two years on the road, the current Camaro is the oldest in this group. The engine is improved, but most other features, including the styling, remain the same.

A special disappointment is the ride. A drive along the broken pavement of New York's FDR Drive was a bumping, jolting, banging torture. Our photographer expressed serious concern about his delicate equipment stowed in the rear hatch. Even over reasonably smooth roads, rattles could be heard in different parts of the body. But this same ride stiffness enabled Camaro to garner top handling and maneuverability marks on the smooth surface at Bridgehampton Race Circuit.

Camaro's five-speed transmission is easy-shifting, and the handle moves through the gate with sureness and precision. The synchronizers usually handled fast snap shifts under a full load without protest, but occasionally we caught one napping.

Inside, Camaro's instrument panel begs for some sort of storage compartment. The driver has to be content

with the smallish covered pocket in the center console. But in the rear compartment, the hatch-door arrangement leaves plenty of space for carrying sports equipment in addition to a week's worth of luggage for a couple.

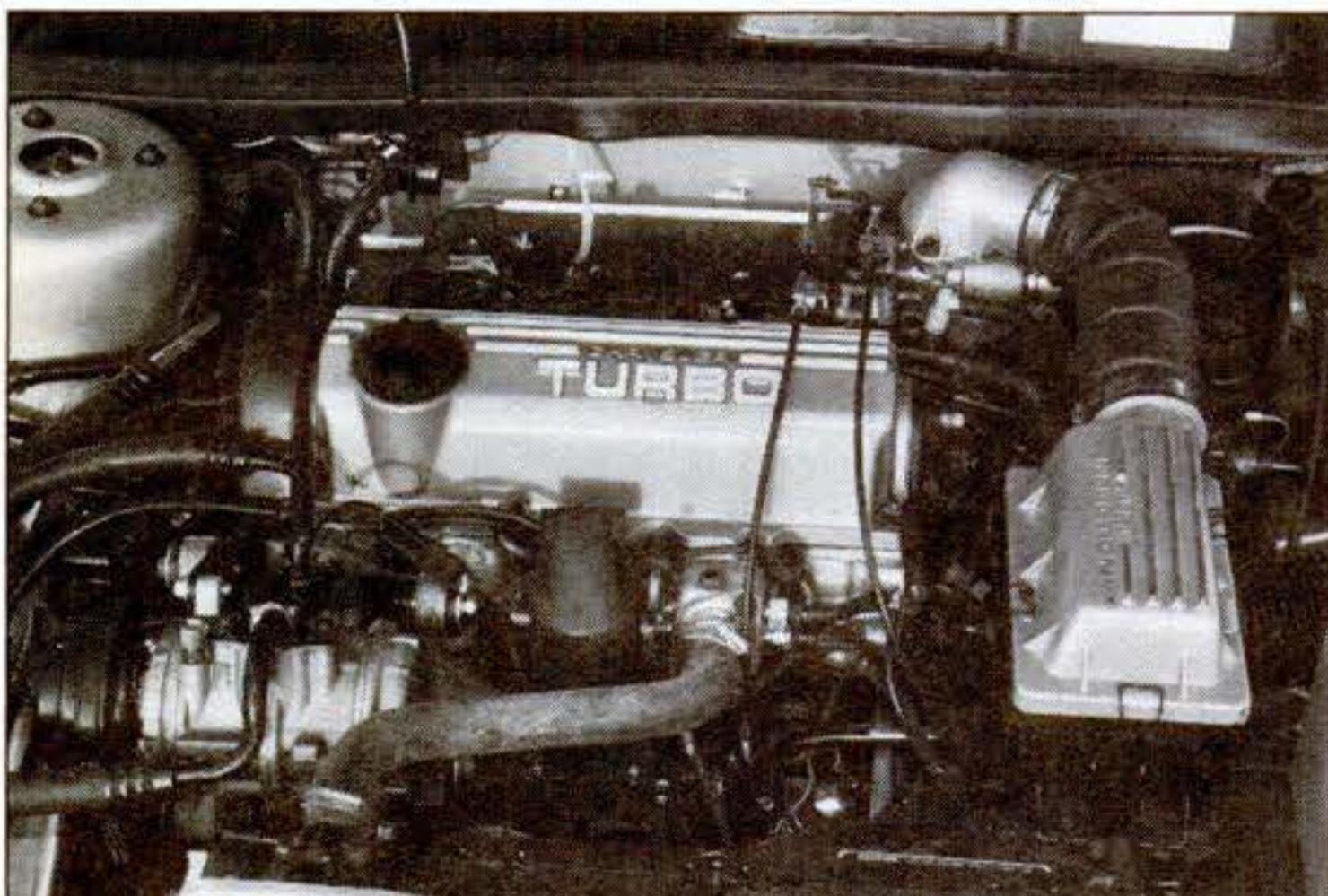
### Chrysler Laser XE turbo

Forget everything you might have heard about the Chrysler and its sister, Dodge Daytona, being K-car derivatives. Although mechanically related, the Laser has an entirely different feel, ride, and look. Apparent to everyone is the throaty exhaust note from the turbocharged Chrysler four. But what's not so apparent is the fine tuning that went into making this front-drive a precise-feeling, responsive automobile. In short, this car feels like no other Chrysler we've driven recently. It's solid, quick, and more nimble than the other front-drives.

Improvements in the cable shift linkage have eliminated many of the drawbacks we noted in earlier tests. The five-speed has a more-positive feel than the four-speed we tested last year. The driver gets reliable feedback as each gear falls into place. Quick shifts are easy.

Although the Camaro has a harsh ride and the SVO has a stiff ride, the Laser's ride is simultaneously compliant and firm. This makes the car a pleasant everyday cruiser capable of handling all-out-performance situa-

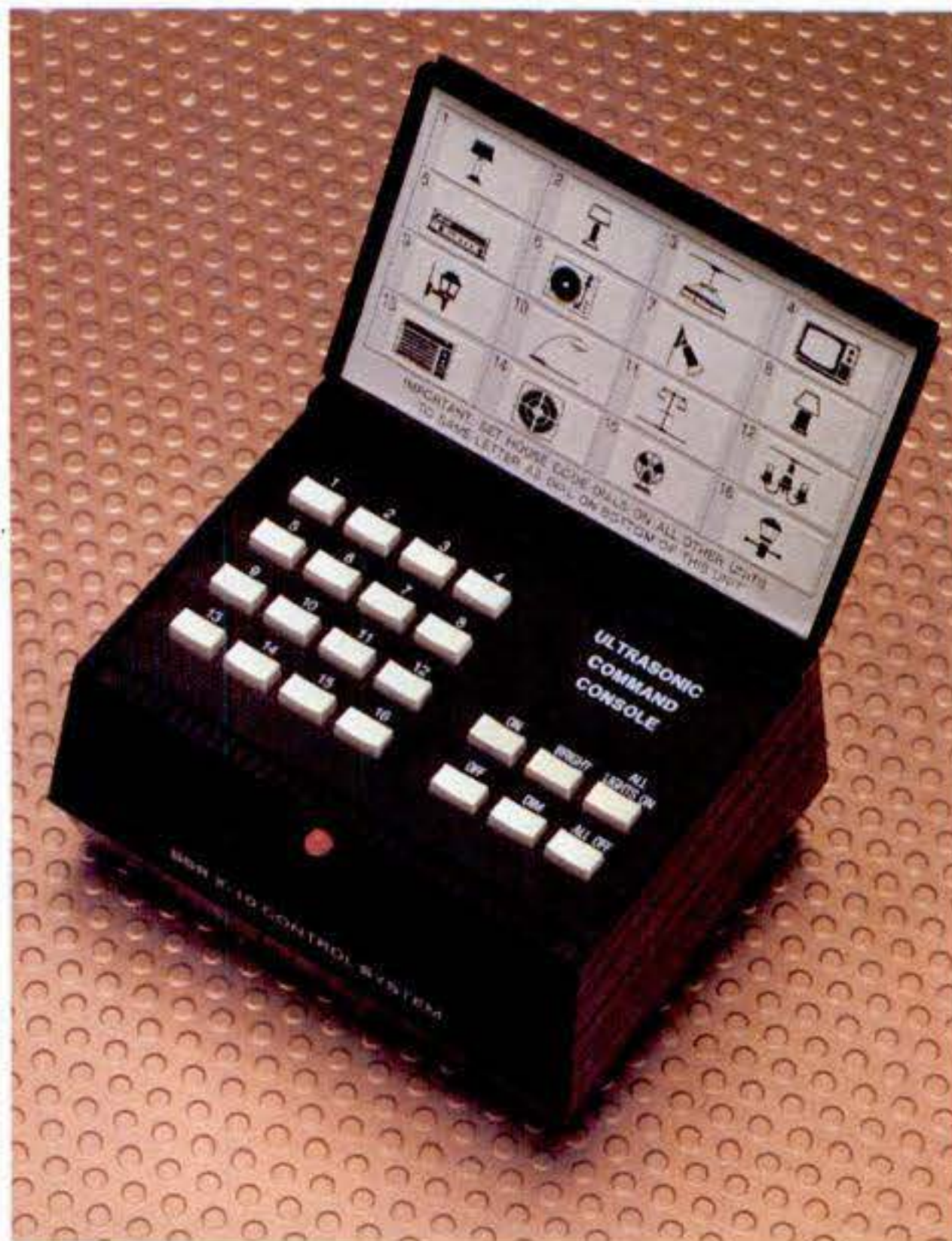
*Continued*



Chrysler Laser XE's turbocharged 2.2-liter four (above, left) is set transversely in the engine compartment. SVO Mus-



tang's striped intercooler, which cools the intake charge, is visible in the left-hand corner of the photo above.



# Remote Control Seduction

*It had to happen. Now you can do it from across the room or throughout the house. And best of all, you can do it without even leaving your bed.*

It's late at night. You're in bed. The lights are romantically low. The stereo playing in the background, as well as your lights, will be automatically turned off after you're asleep.

As you peacefully drift off, you'll be secure in the knowledge that to a burglar on the prowl, your family still appears to be moving about. Even your garage door will be electronically locked.

You'll sleep soundly while you save energy as your central heat is automatically set back for the night.

And if that's not enough, you'll awake in the morning to a warm home, freshly brewed coffee, and the sounds of your favorite cassette.

And look at this, even your electric blanket will be automatically shut off after you're up.

All of the above can be yours **right now**. And, wait till you see just what you can do when you're not in bed.

## CHEAP THRILLS

Romantic lighting, burglar deterrents and energy saving controls are just the beginning of this remarkable, installation free, remote control system from BSR, the mammoth electronics giant.

And speaking of remarkable, due to a DAK all cash buy, you can forget the retail price. In fact, you can even forget the wholesale dealer cost.

Now you can remotely turn on, off and dim your lights, thwart burglars, start your dinner while you're away and even turn the lights on or off in an unattached garage or barn for as much as 65% off the suggested retail price. Wow!

This instant remote control system simply plugs-in in seconds and consists of inexpensive space age control modules and command centers.

It actually uses your existing house or

office wiring. And if you can plug in a lamp, you have all the expertise you'll need to plug-in this system.

## \$16.50 STARTS IT ALL

Imagine that you're watching TV. You can dim the lights from your easy chair. If you hear a noise outside, touch a button and your outside flood lights jump to life. If you get warm or cold, just touch a button to activate your heat or air.

It's all easy when you have this top of the line Command Console, shown above, sitting next to you. It can let you control up to 16 different lights and appliances.

You can turn each on or off. You can dim or brighten lights. And look at this, you can turn all your lights on or off for instant security with the 'all on' and 'all off' buttons on the console. Plus, a red LED lights to acknowledge commands.

It's a \$49 retail value, but it's yours, only from DAK, for just \$16.50. You can keep the Console on your nightstand, by your easy chair, or in the kitchen.

You can even move it from room to room because its total installation consists of simply plugging it in. Or at DAK's super low price, you can put Command Consoles in as many rooms as you wish.

No matter where the Command Console is, you can control lights, fans, TVs, and stereos anywhere in or around your home.

**There's even a remote for your remote.** This top of the line Command Console has a built-in ultrasonic receiver so that you can add (they weren't sold as a set) an optional \$24.99 retail value wireless remote handset. DAK's price for the handset is just \$10.

Every control on the console is exactly duplicated on the handset. So you can roam up to 30 feet from your easy chair or your bed and still be in full control.

And, if you buy several consoles, the

handset will work with all of them. But beware, the handset only works with the top of the line \$49 consoles. If you already own a BSR X10 console it may not have the sophisticated circuitry to accept and act on the remote handset's signals.

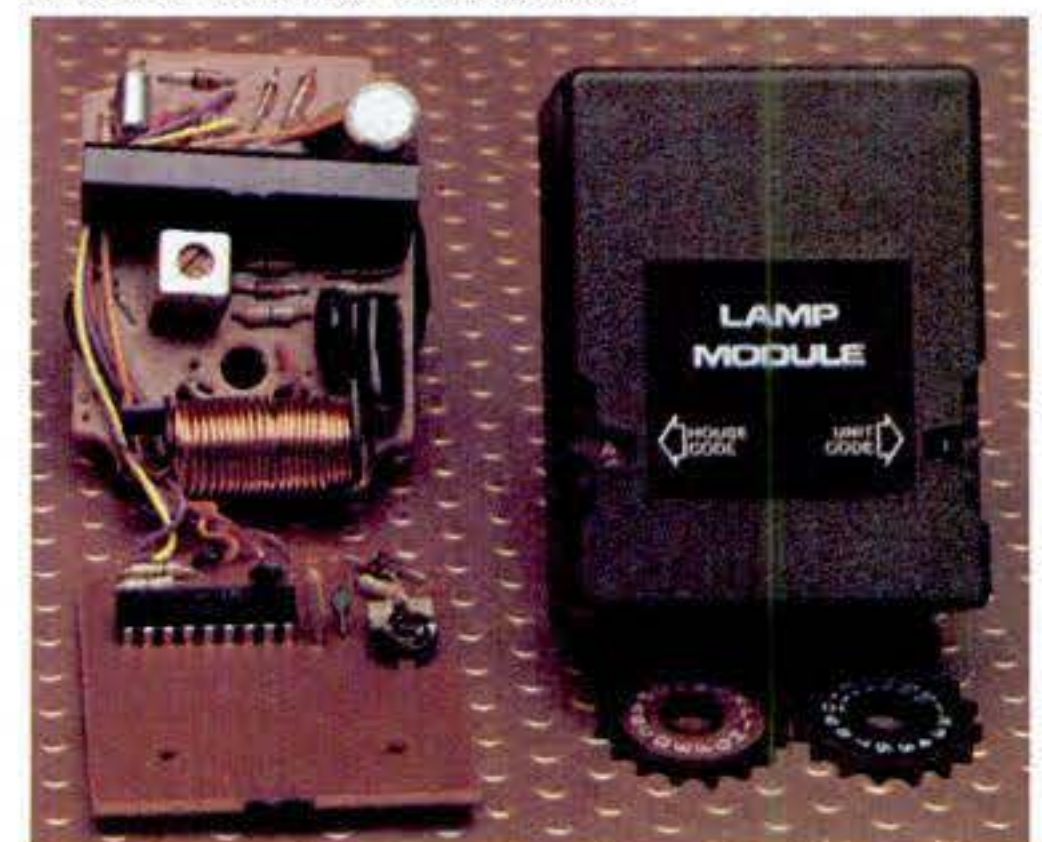
## HERE'S HOW IT WORKS

As you push each button on the command console, a powerful but silent, encoded signal is sent down its AC cord into your home or office wiring.

This safe, silent encoded signal travels in all directions throughout your electrical system. It won't disturb your TV or your FM, but it will instantly find its way to every inch of your system.

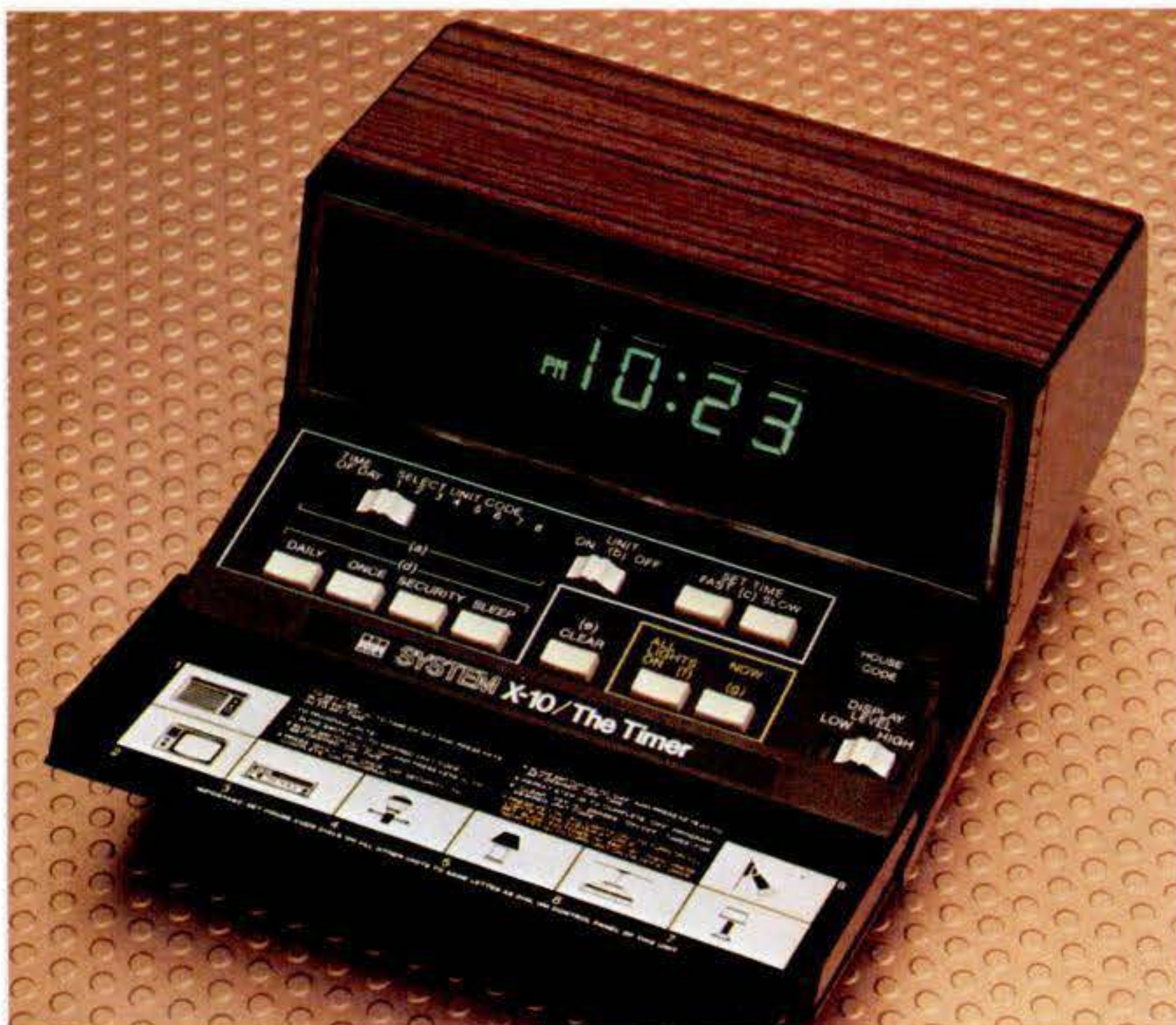
It can even reach your unattached garages, barns, sheds and even your pool light, porch lights and yard lights.

Wherever you want to control a light or appliance, all you have to do is plug-in one of the system's sophisticated special controller modules.



Each module has a rotary dial numbered from 1 to 16. Just dial in a number to match one of the 16 number buttons on the console.

Over Please. Copyrighted material



## Remote Control

(Continued from previous page)

Then, just plug the module into the wall and the lamp or appliance into the module for instant remote control.

A sophisticated Integrated Circuit in each module senses all signals and responds only when the button on the console that corresponds to the number shown on the module's dial is activated.

**Important note:** You still have local control of all your lights and appliances by just using their normal switches even though they are plugged into modules.

Each module actually senses when you turn the controlled unit's switch and automatically relinquishes control.

There are separate modules for lamps that have full range dimming capability from 0% to 100% and handle up to 300 watts (that's three 100 watt bulbs or 5 60 watt bulbs). There are appliance modules that have no dimming but can handle up to 500 watts, or 1/3hp motors.

And, there are even light switch modules that have both full dimming and 500 watt capability which you can install instead of your present wall switches.

You can move the modules from place to place or change their numbers in seconds. And of course, if you move, your system goes with you.

So all you have to do is dial in a number, plug in the module and plug in the controlled device. Now, you'll have instant remote control in your own home.

### SOME NEAT IDEAS

You'll find the system changes and bends to meet your exact needs. You can set several modules to the same number so that the front and rear lights can come on together.

Or, you can set all the lamps in a room to come on together. And, you can even dim them together.

If you don't set modules to the same number, you're still in control. If you want 5, 7, and 9 to come on, just punch the number keys and then on. With this intelligent system, there's no need to push on, off or dim after each number.

You're sure to want a module in your dining room. Eating by subdued light is a

real pleasure. And it's important to remember that not only do you get full remote control, you get 0% to 100% control of your lights.

It's like getting free dimmers thrown in with your remote control system. So, for bedside lamps, swag lamps, ceiling lights, track lights and garage lights, you'll be in full command.

And, you'll automate your fans, coffee-maker, de-humidifiers, crock-pots and even shut off your electric garage door opener when you're at home.

And, there's one last very important feature. In addition to the 16 electronic devices you can control, the entire system gives you a choice of 16 master system codes that you set yourself.

BSR calls them house codes and there's a second dial on all the modules and on the Command Base that lets you select a code from A to P. You don't need to use this code except that all your modules should be set to the same 'house code'.

But, look at this. If you'd like to run more than 16 devices, just add another Command Console set to another 'house code' and you can have a second, third or even a fourth totally separate system that won't interact with your first system in any way.

Of course, if you set a Command Console to the same 'house code', it will become part of the original system. And, there's no limit to the number of Command Consoles you can use in a system.

### THE TIMER

Now let's add remote control that doesn't even require you to be at home.

BSR calls it simply, 'The Timer'. But, it's so much more. This sophisticated electronic brain can perform 32 tasks. BSR's price list shows a suggested retail price of \$74.99 for the timer, but from DAK, it's yours for just \$37.50.

It installs just like the Command Console. Plug it in and you're in operation. But, wait till you see what it will do.

Just select the module number you want to control, then decide if you want the controlled device to come on or off.

Now the fun begins. This is more than

an on or off timer. You're in command. If you only want something to happen once, just push the 'Once' button.

This is great for starting dinner before you get home. Or, if your cassette deck is 'timer ready', now you can record a special AM or FM radio event that you'd miss because you were at work or asleep.

There is a 'Daily' button that lets what you've programmed occur every day, 7 days a week, 365 days a year.

This is great for set-back heating, night lighting and wake up functions. The daily function can be put 'on hold' any time you don't want an event to occur.

There's a 'Security' button. You can program lights and radios to give your house a lived-in look when you're away.

This button will cause whatever you've programmed to occur at random times, differing each day by as much as 30 minutes from the set time.

And, there's a 'Sleep' button. A single touch of this button will let you turn any controlled module on for an hour.

So, tonight you can listen to your stereo for an hour before auto-shut off and tomorrow you can go to sleep watching TV.

And, if you want more than an hour, just push the button twice for two hours, 3 times for three hours and so on.

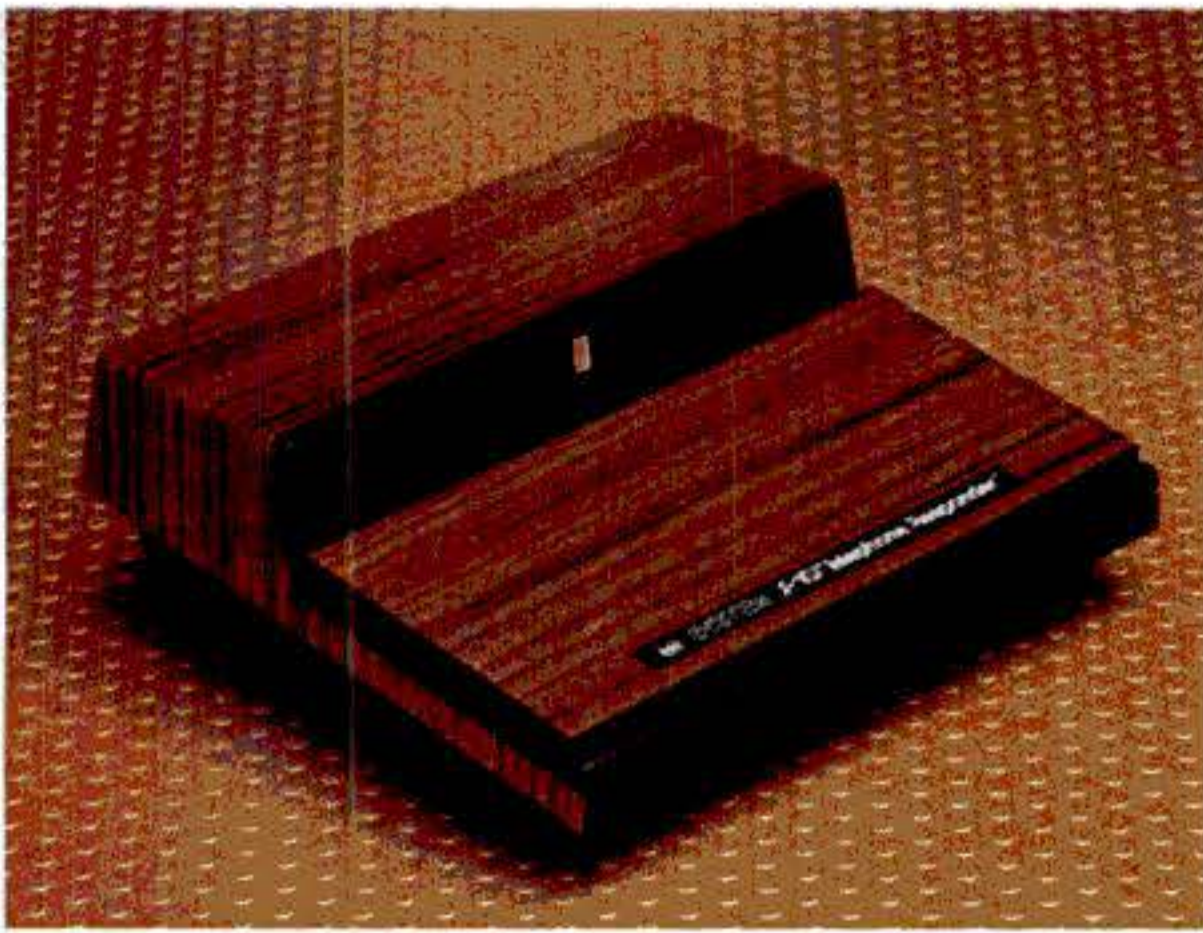
The Timer will allow you to program 8 modules of the 16 possible numbers. Each module can be turned both on and off twice a day to suit your needs.

Every command can be different. For example, you can have any module come on 'Once', go off 'Daily', come on for 'Security' and still program it for 'Sleep'.

And, The Timer can be used as a Command Console by selecting a module and pushing the 'Now' button for instant nontimed operation. There's also an 'All Lights On' security button.

With The Timer you can set either your central or window air conditioning to come on an hour before you return from work. You can have your porch lights come on so you'll never enter a dark house. And, you'll have complete control of all your electronic devices.

Over Please. . .



## Seduction

### TELEPHONE CONTROL TOO

And if this doesn't end all, now you can even call your home on the telephone and control anything you like.

The Telephone Responder is the most sophisticated option to the system. BSR's price list shows its suggested retail price to be \$149. But, you can control your home by telephone for just \$69.

The Telephone System is incredibly easy to use. Just plug it into both your AC line and any modular phone jack in your home or office.

Then just call your regular phone number, give it your 3 digit code that you set yourself, and start controlling.

You can call home and turn on your lights before you leave work or before you leave a midnight party. Call home and turn on your air conditioning or heat. Or, call home and start your tape deck.

Anything you can control from the regular Command Console, you can turn on or off by phone. If you have a summer or winter home, call it before you 'head out' so it will be ready when you arrive.

If you live in a brush fire area as I do, you can call and turn on your automatic roof sprinklers. If you have a mountain cabin, you can turn on your pipe heaters if there's an early snow.

The Telephone Responder lets you control 8 of your modules. You can turn them on or off. Plus there's an 'All Off' feature as well. The base can also operate as an on/off command console.

Although this whole system is obviously made for the very rich, you'll live like a king without paying a king's ransom.

### AND NOW THE SEDUCTION

Close your eyes and imagine the soft music, dimmed lights, the cocoon of safety and the remote temperature control. What a wonderful 'picture of seduction', right out of the movies this can be. And, it can be yours today.

### CHEAP, BUT WITH FULL WARRANTY

DAK has made an incredible all cash buy on a limited quantity of these BSR X10 components. BSR sold them to us for two reasons.

First, BSR made too many units with

the Leviton (the light switch manufacturer) brand name on their name plate, so BSR didn't know what to do with them. And second, BSR was supposed to have a joint venture with a computer company for an interface for this system. Unfortunately it hasn't worked out.

DAK already has these components at just pennies on the dollar. So, if you don't mind some of your modules or controllers saying Leviton X10 instead of BSR X10 (they look identical) and if you don't need to hook the system to your computer, you're going to save a bundle. Of course, the modules for the system are available almost anywhere.

And, even though you're only paying pennies on the dollar, it's backed by the full strength of BSR.

Every component you buy is backed by BSR's iron clad full one year limited warranty for your protection.

### TRY A REMOTE WONDER RISK FREE

Now you can experience the wonder of remote control. It's simply a thrill to use. And at DAK's price, it's a cheap thrill.

As you get into bed tonight, think about what you'd do if you heard a noise outside, downstairs or at the other end of the house. Now, just touch a button and your home will be bathed in light.

Think about how nice dimmed lights would be in your bedroom, den or living room. And, think about coming home to a piping hot meal. It's all possible with BSR's incredible remote system.

Try any part or all of it. If you're not 100% satisfied for any reason, simply return it to DAK within 30 days in its original box for a courteous refund.

Order any combination of Command Consoles and modules that you want. The choice is yours. There are no limitations except that sales are limited to stock on hand.

1)The Control Console-Lets you control up to 16 different modules. On/off/dim/all on/all off. Just \$16.50 plus \$2 P&H. Order No. 9775.

2)The Ultrasonic Remote-Lets you roam up to 30 feet from any Control Con-

sole and duplicates all functions. Just \$10 plus \$1 P&H. Order No. 9776.

3)32 Event Clock Timer-Lets you control 8 modules with up to 2 on and 2 off commands to each. Also acts as a command base plus sleep and security extras. Just \$37.50 plus \$2 P&H. Ord No. 9777.

4)Telephone Responder-Now you can just call your home, enter your code and control any 8 of your controlled devices. It's also a base. It's yours for just \$69 plus \$3 P&H. Order No. 9778.

5)Lamp Module-Controls/dims lamps up to 300 watts plugged into walls. Just \$12.50 plus \$1 P&H. Order No. 9779.

6)Wall Switch Module-Controls/dims lights now controlled by wall switches. 500 watt capacity. This is the only module that requires installation. Just replace your current wall switch with this automated module. Just \$12.75 plus \$1 P&H. Order No. 9780.

7)Appliance Module-Control stereos, TVs, or anything with motors. 15 amps, 500 watts, 1/3hp rating. Just \$13 plus \$1 P&H. Order No. 9781.

8)Thermostat Controller-You don't touch your own thermostat. This device sticks just below your thermostat and 'fools' it into doing what you want by heating it 5, 10 or 15 degrees. It works for both air conditioning or heating, and it works perfectly. Use it to set back your heat at night, or turn your air on before you come home. Just \$69 plus \$3 P&H Order No. 9782.

You'll thrill in the automation of your whole house, not only at a fraction of the original price, but in ways that were never possible before at any price.



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## Turbo 4s vs. a hot V8

### 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.

	Chevrolet Camaro Z28	Chrysler Laser XE turbo	Ford SVO Mustang
Acceleration	5	5	5
Braking	2	2	2
Handling	5	5	5
Maneuverability	5	5	5
Quietness	2	1	1
Roominess	3	3	3
Vision	3	4	4
Entry/exit ease	3	2	3
EPA economy	2	4	4
Ride comfort*	2	3	2

\*Authors' opinion



SVO Mustang's wide Goodyear Eagle GT P225/50VR16 tires and suspension tuning put the modified model within 8/10 mph of the top-handling Camaro Z28.



Camaro Z28's high spring rates, sticky rubber, and trigger-quick engine response all combined to make it the maneuverability champion of the test trio.

Chrysler Laser XE, shod with narrow P185/70R14 tires, managed top handling and maneuverability grade but posted the longest hot stop.

tions without punishing its occupants.

Inside, this first-year car easily matches the comfort of its competitors. There is good front-seat room, and the hatch and folding rear seat offer the same loading ease as in the SVO and Z28. But as in the Camaro, rear-seat room is poor, with head room the most obvious inadequacy.

The Laser's simple, functional instrument panel features a large, round speedometer and tachometer set side by side directly in front of the driver. On both sides of this group are smaller gauges for temperature, oil pressure, battery charge, and fuel.

### Ford SVO Mustang

"We believe that the small engine is the wave of the future for performance cars," explains a Ford executive.

We won't debate that point after driving the SVO Mustang. Its performance is a strong argument, indeed. But there are still some rough edges. First, there's little performance available at lower engine revs, and clutch action is heavy. This makes the car extremely awkward to drive in stop-and-go traffic. Second, despite having the power of a small eight, the four is not nearly as smooth running as an even-firing V6.

Because the SVO uses the standard Mustang body shell, rear-seat room is the best of the three sportsters tested. And the rear seat back folds down in two separate sections.

The layout of the SVO's instrumentation is similar to that of the Laser. But two of its outermost gauges—turbo boost and oil pressure—are partially hidden by the steering-wheel rim. Although most controls are located in logical positions, visual and manual access to them is uneven.

*Continued*



The sleek handset can be placed up or down.

# Bedside Big Mouth

**Now you can reach out to the world from the comfort of your bed with this elegant new electronic clock radio, telephone and speaker phone.**

You're lying in bed. And, you are discussing the day's events with your mate. The lights are out, you're relaxed and your hands are at your sides.

**So what's so new?** Well for one thing, your mate is out of town and the two of you are talking on the latest in hands free speaker phones. What's more, if the two of you were in bed together, you both (or your whole family for that matter) could talk to anyone on the phone simultaneously.

Of course you can pick up the decorator designed phone handset with its long coiled cord, and talk or make calls as you would with your regular telephone. But with this new phone, you'll have all the new telephone advances rolled into one.

And best of all, you won't have to pay the phone company's monthly rental charges for their dumb phones ever again. Just plug in the standard modular plug and the AC line cord and you're ready to go.

You'll have universal push button dialing that gives you the convenience of push buttons anywhere and works on your current phone line and your own number.

A last number redial key redials busy numbers with the touch of a button. And, you'll really enjoy the delightful chirping electronic ring that won't send you into shock if it sounds when you are asleep.

If you want momentary privacy from the person you're talking to, a mute key lets you have it. It's like electronically putting your hand over the mouthpiece.

The sound quality is nothing short of incredible. An electret condenser mike lets you be heard loud and clear at the other end, whether you're using the handset or the hands free speaker phone.

When you use the handset, you hear the other person through a high quality transducer like you'd find in fine headphones. With the speaker phone, you'll hear fab-

ulous sound through the Hi Fidelity speaker used for the AM/FM radio.

## AND WHAT A CLOCK RADIO

If you're impressed with this telephone system (I hope you are) wait till you find out about the timing conveniences and sound quality of this electronic clock radio.

First the controls. The large green LED display with high/low brightness switch, is extremely easy to read. You won't have to worry about losing the time if there's a power failure once you install the standard 9V battery (included) for protection.

You'll have fast and slow set for both the regular and alarm times. And, once you've set the alarm, you can choose to be awakened by your favorite radio station or an electronic chirp alarm. If you aren't quite ready to get up, just tap the handy snooze button for a few minutes of extra sleep.

And since getting up is no fun, this radio will also help put you to sleep. A touch of the sleep button will give you up to an hour of your favorite radio station to relax you. The radio will then shut itself off and wait to perform its next programmed task.

## GREAT SOUND SAYS IT ALL

It doesn't take many features to beat the phone company's phones. But, there are lots of regular clock radios.

Once you hear the sound of these fine sensitive radio receivers, you'll be sold on the sound as well as the phones.

This FM radio really pulls in the stations. And the full range speaker has a very pleasing and full rich sound.

Of course, with the touch of a switch you can also tune in your favorite AM stations too. You can keep up with the latest news or your choice of music on AM.

This all new electronic clock radio telephone brings a really elegant look to your bedroom, office, den or kitchen. What you can't see in our pictures is the elegant

sound you'll enjoy for years to come.

## TRY THE BEDSIDE BIG MOUTH RISK FREE

Be prepared for a shock. If you haven't tried any of the new electronic phones you're in for a pleasant surprise. And, for that matter if you haven't bought a new clock radio for a few years you're going to be pleasantly surprised too.

Try this all new Electronic Clock Radio Telephone risk free in your own bedroom. If you aren't 100% satisfied, simply return it to DAK within 30 days for a refund.

To order your all new ~~Unitech~~ Bedside Big Mouth (our name for it), Electronic AM/FM Digital Clock Radio Telephone, with both handset and speaker phones risk free with your credit card, call toll free.

Or send your check not for the up to \$129 to \$159 price tag we've seen on other telephone clock radios without the speaker phone, but send the incredibly ~~low price of just \$68 (\$5.50 P&H) Order No. 9807. CA res add 6% tax.~~

## \*\*NOTE\*\*NOTE\*\*NOTE\*\*

We've sold more than 10,000 Bigmouths for \$68 each. But, now because of a direct cash purchase from our supplier's supplier, we can slash the price on just the units we have in stock.

Our original supplier was Unitech, their supplier was Fortronics. Unitech said Ok, so we bought them all. They're yours for just \$39 plus the same \$5.50 for postage and handling. Use Order No. 9800.

You'll still have a full limited warranty. Every part and every feature is the same.



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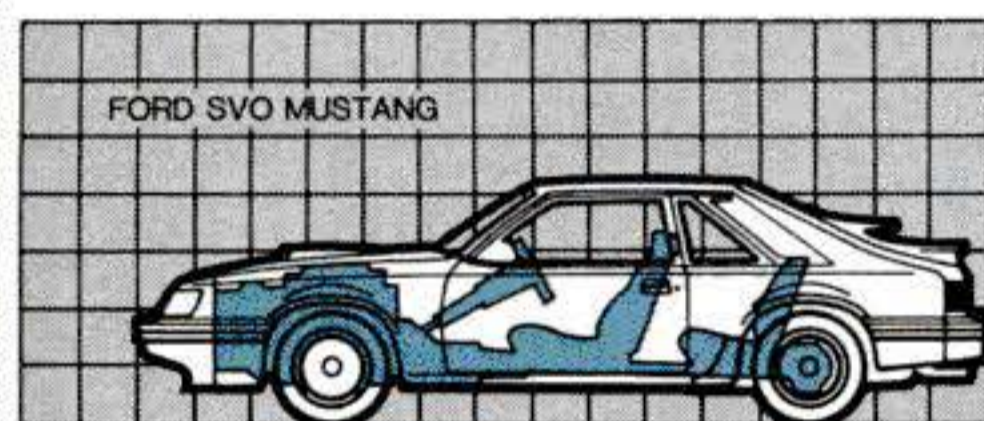
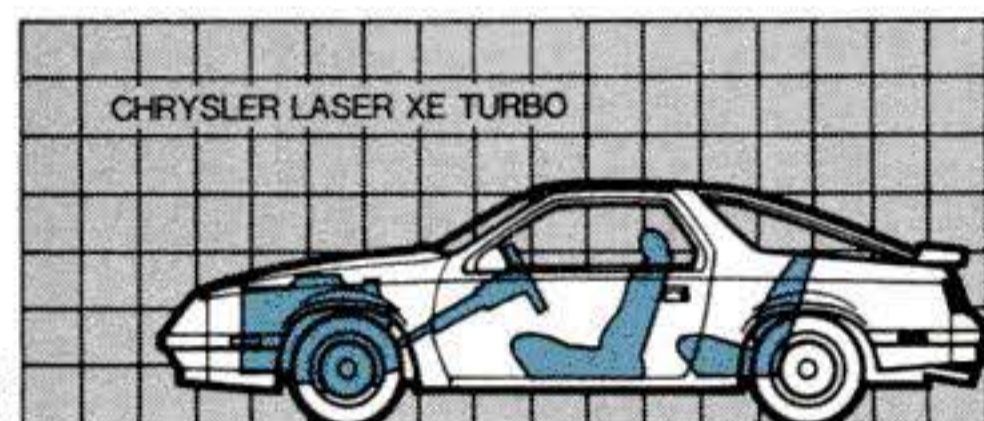
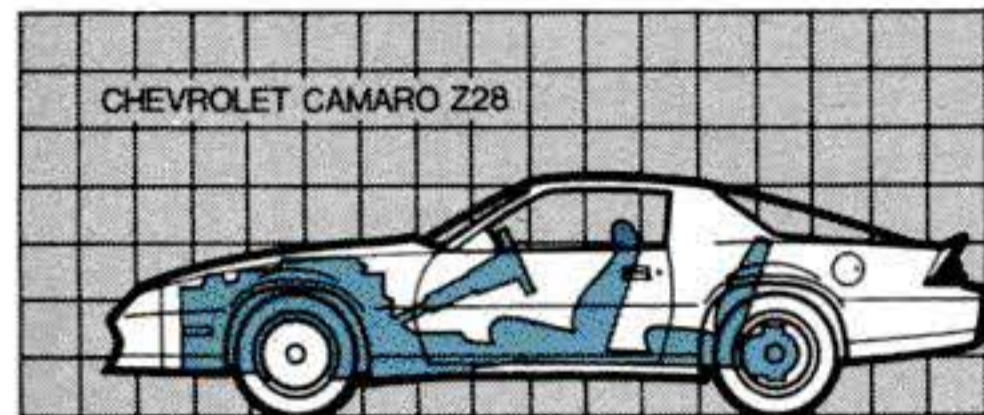
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## Turbo 4s vs. a hot V8

### Our picks

Laser's got what it takes: good performance, precise shifting, and handsome looks.—J. D.

I want to say Camaro Z28, but the ride was brutally hard. Frankly, I'm intimidated by the complication under the SVO's hood, but park one in my driveway and I'll happily spend the time to get to know it.—J. K. **PS**



DRAWINGS 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.

	Camaro Z28	Laser XE turbo	SVO Mustang
<b>Checking fluid levels</b>			
Battery	4	5	5
Master cylinder	5	3	3
Windshield washer	5	5	5
Engine oil	3	5	4
Coolant	5	5	5
<b>Checking the engine</b>			
Spark plugs	2	5	1
Distributor	1	3	3
Carb adjustment	1	F.I.	F.I.
Oil filter	2	4	4
Oil fill	3	4	5
<b>Replacing hoses</b>			
Upper radiator hose	3	5	5
Lower radiator hose	1	3	3
Heater hoses	3	3	3
<b>Changing bulbs</b>			
Headlights	4	4	4
Taillights	2	3	3
Front running lights	3	4	3
Front parking lights	3	4	3
Front directionals	3	4	3
Rear directionals	2	3	3
Rear running lights	1	3	3
<b>Checking fuses</b>	3	3	3
<b>Spare-tire accessibility</b>	4	3	3
<b>Changing belts</b>	2	3	4

## Test results, dimensions, and specs

	Chevrolet Camaro Z28	Chrysler Laser XE turbo	Ford SVO Mustang
<b>TEST RESULTS</b>			
Acceleration (sec.)			
0-60 mph	9.2	11.7	11.2
Brake test (cool) 60-0 mph			
Stopping distance (ft.)	181	170	158
Pedal pressure (lbs.)	160	100	160
Brake test (hot) 60-0 mph			
Stopping distance (ft.)	182	189	186
Pedal pressure (lbs.)	120	130	160
Interior noise (at 60 mph (dBA))	73	72	72
Handling test (mph)	66.8	65.3	66.0
Maneuverability test (mph)	32.0	29.0	29.4
<b>EPA FUEL MILEAGE (mpg)</b>			
Highway	28	38	33
City	16	22	21
Calif. city	16	22	21
<b>PS FUEL-MILEAGE TESTS (steady-state mpg)</b>			
35 mph	25.2	38.2	*
55 mph	22.8	32.4	*

**TEST CONDITIONS** Ambient temperature, 74° F; relative humidity, 80 percent; barometric pressure, 29.9 inches Hg  
\*Due to the extremely high fuel pressures generated by this system, we were unable to complete our regular fuel-economy tests.

<b>DIMENSIONS (inches)</b>			
Wheelbase	101.0	97.1	100.5
Overall length	187.8	175.0	181.0
Overall height	49.8	50.3	51.9
Overall width	72.0	69.3	69.1
Track, F/R	60.7/61.6	57.6/57.2	57.8/58.3
Ground clearance	4.8	5.7	6.2
Front head room	37.0	37.1	37.2
Front hip room	56.3	54.4	56.1
Front leg room	28.6	30.1	30.7
Rear head room	36.1	34.3	35.6
Rear hip room	42.8	47.9	47.1
Rear leg room (min.)	28.6	30.1	30.7
Rear knee room (min.)	-0.6	-3.2	-1.2
Couple distance	26.3	26.7	27.6

<b>SPECIFICATIONS</b>			
Engine type	V8	In-line turbo 4	In-line turbo 4
Displacement (cu. in./L)	305/5	135/2.2	140/2.3
Compression ratio	9.5:1	8.1:1	8.0:1
Carburetion	4-bbl.	F.I.	F.I.
Net hp @ rpm	190 @ 4,800	142 @ 5,600	175 @ 4,400
Net torque (ft.-lbs.) @ rpm	240 @ 3,200	160 @ 3,600	210 @ 3,000
Transmission	5-speed manual	5-speed manual	5-speed manual
Axle ratio	3.73:1	3.56:1	3.45:1
Tire make	Goodyear	Goodyear	Goodyear
Tire type	Eagle GT	Eagle GT	Eagle GT
Tire size	P215/65R15	P185/70R14	P225/50VR16
Steering	Power, recirculating ball	Power, rack & pinion	Power, rack & pinion
Overall steering ratio	14.0:1	14.2:1	20.0:1
Turns, lock to lock	2.5	2.5	3.05
Turn diameter (ft.)	36.9	33.5	37.4
Front suspension	Independent, modified MacPherson struts, coil springs	Independent, dual-path iso-struts, coil springs	Independent, modified MacPherson struts, coil springs on lower arm
Rear suspension	Salisbury axle, torque arm, coil springs	Trailing arm, beam axle, coil springs	Four-bar link, rigid axle, coil springs
Front stabilizer-bar diameter (in.)	1.2	1.06	1.2
Rear stabilizer-bar diameter (in.)	0.8	1.0	0.87
Brakes	Power, disc-drum	Power, disc-drum	Power, disc-disc
Brake swept area (sq. in.)	307.7	283.0	432.0
Fuel tank (gal.)	16.1	14.0	15.4
Trunk space (cu. ft.)	31.2*	48.7*	30.0*
Liftover height (in.)	34.7	32.0	29.8
Curb weight (lbs.)	3,179	2,651	2,987
F/R weight distribution (%)	58/42	62/38	57/43
Basic price	\$10,336	\$10,546	\$15,596
Price as tested	\$14,038 <sup>1</sup>	\$14,498 <sup>2</sup>	\$16,711 <sup>3</sup>
Major options (over \$100) on test car			

<sup>1</sup>Tilt wheel \$105, tinted glass \$105, power locks \$120, rear defogger \$135, luggage-compartment trim \$164, speed control \$170, power windows \$180, custom seats \$227, HO V8 \$450, AM-FM-cassette stereo \$520, A/C \$725; <sup>2</sup>handling suspension \$102, rear wiper \$120, speaker system \$126, special tires \$148, power windows \$185, power driver's seat \$215, AM-FM-cassette stereo \$299, turbo package \$872, basic group: A/C, tinted glass, speed control, rear defogger \$1,194 <sup>3</sup>power locks \$174, power windows \$198, A/C \$743

\*With rear seat folded



# Pall Mall A Step Ahead

*Step up in taste,  
step down in tar*



9mg. tar  
0.8mg. nic.

9 mg. "tar", 0.8 mg. nicotine av. per cigarette, FTC Report Mar. '83.

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

# Computer program "talks" plain English

You've dialed your personal computer into a news-data service such as Dow Jones News/Retrieval. But now it's time to talk to a distant computer with commands such as "\$BA/P" or ";BS 82 Q." If you get the punctuation right or have the patience to locate the right

codes in your Dow Jones manual, you're all set. The data-base computer will churn out the latest price-volume information for Boeing or Bethlehem Steel's stock prices for each quarter in 1982 (the codes above).

Recently, I sat before a Texas Instru-

ments Professional-model computer programmed with a form of artificial-intelligence language that lets you use plain English instead of computer-like codes to communicate with Dow Jones. TI calls its new \$150 software package, which includes a Dow Jones subscription and an hour of data-base time, NaturalLink.

NaturalLink divides the high-resolution screen on TI's computer into a number of "windows," each with a menu or series of short statements. You compose requests for data-base information by scrolling a cursor over the appropriate statements, then pushing the "Return" key. Because little typing is required, human error is reduced. These, for example are among the 10 commands in one of the windows: "is the current quote for" and "are the estimated earnings for." As you select options, NaturalLink forms them into simple statements at the top of the screen, indicating the final query to Dow Jones.

Naturally, the options change in the windows, depending on the selections



you make. That means it's not possible to make illogical choices, and your personal computer doesn't reply with a statement saying how dumb you are or, even more irritating, return stubbornly to some preprogrammed "entry-not-possible" statement.

The computer program, written in the "C" language, lets you create a personalized stock portfolio of several hundred companies on a disk and then quickly access data on each one. A series of questions can be prepared before you dial onto Dow Jones and then transmitted in a batch to save on-line time and money.

NaturalLink requires 256K of memory, two disk drives, and a telephone modem. Developed at TI's computer-science laboratory, it's likely to be only the first in a series of programs.—John Free

Our Work Horse GT-1100 8-speed lawn and garden tractor is designed to do more than just cut grass. It will till, and move snow or dirt, for years to come. We invite you to compare. You won't find a better value this spring on a full-capability lawn and garden tractor.

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by  **Wheel Horse**

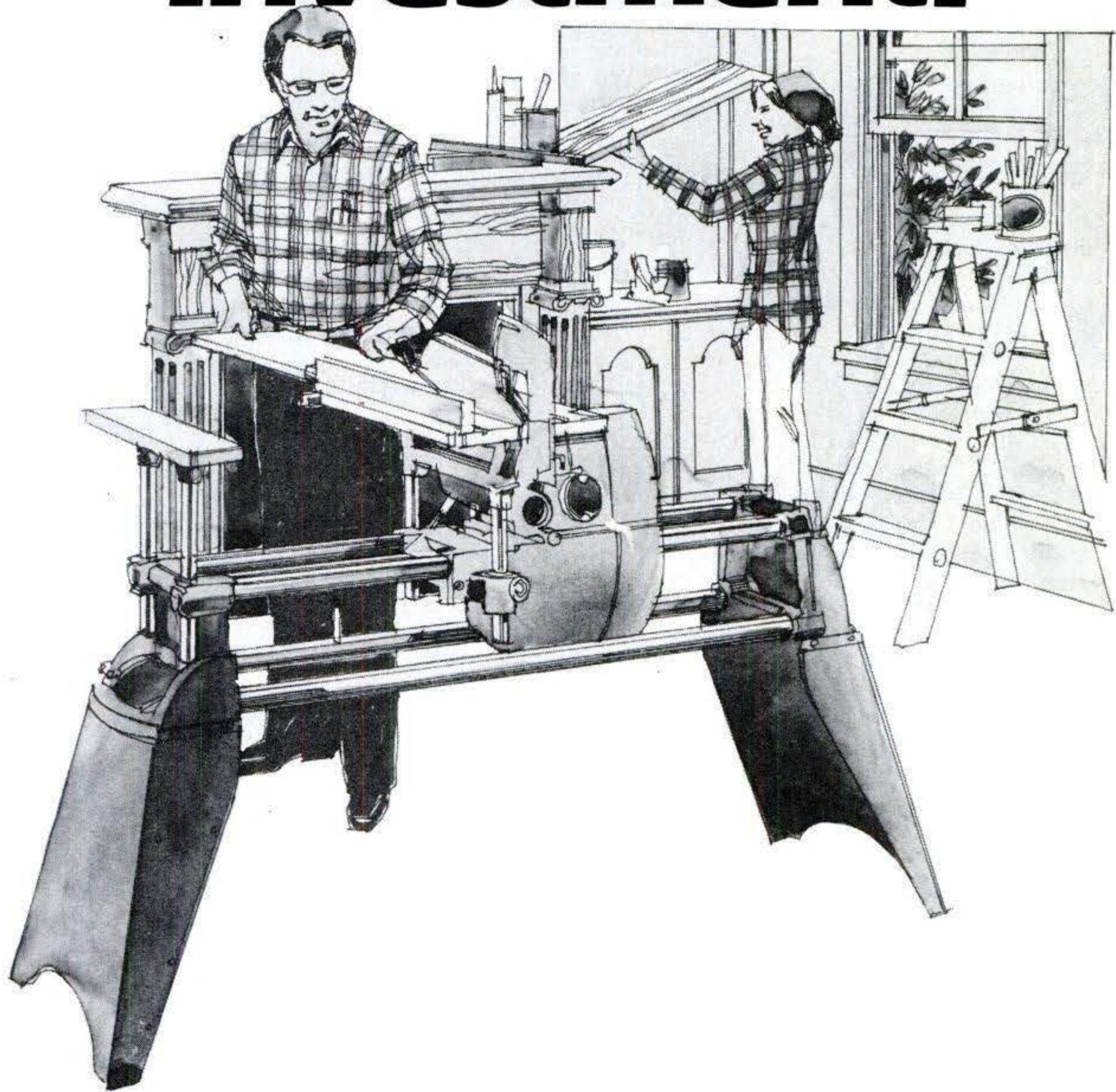
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\*Base price for tractor only. Mowers and other attachments optional — available at participating Wheel Horse dealers only. Freight, dealer prep, delivery, state and local tax not included.

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# Fast-lane diesel

Sure, fuel-stretching diesels work, but who wants to drive in the slow lane forever? Not Oldsmobile. General Motors' leading diesel-engine division has plans to build some excitement into its V6 diesel engine that should dispel the old idea that diesels are steady and economical but slow. At the same time, Olds is hoping to improve its diesel-engine sales, which have been in the doldrums ever since Americans got used to \$1.25-a-gallon gasoline and turned their attention to higher-performing, less-fuel-efficient cars.

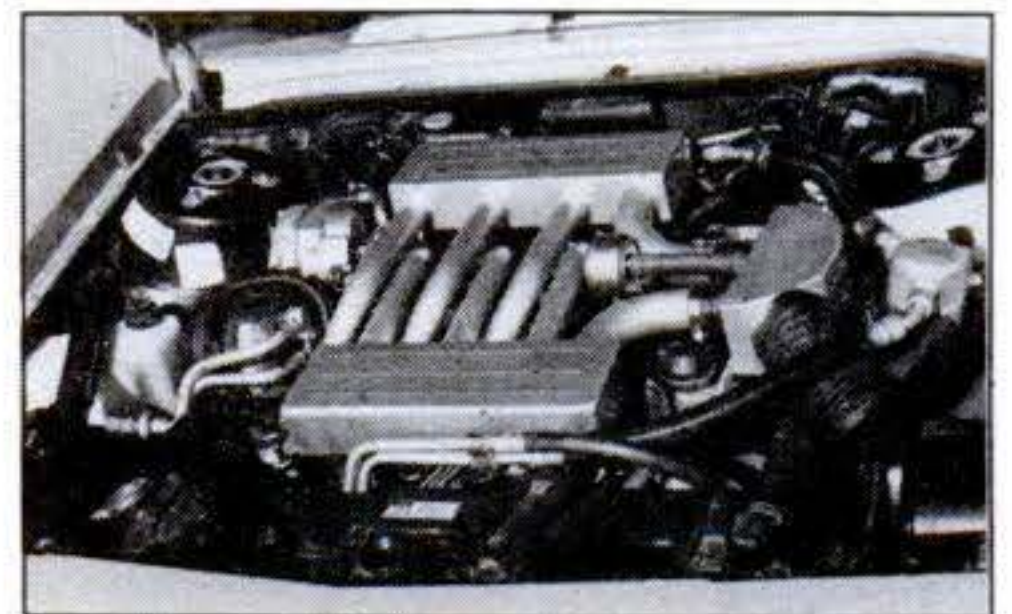
A peek at what Olds has in store is seen in the Tuned Induction Diesel Ciera, a one-of-a-kind experimental model that contains surprisingly simple cures for the diesel's low-power ills. Powered by a specially tuned 263-cu.-in. V6, the diesel Ciera will outrun many sporty cars. Olds claims a zero-to-60 time of 10.3 seconds with a full tank of fuel and just the driver aboard.



I posted an 11.1-second run, according to my hand-held stopwatch. If Olds is bragging, it's sticking reasonably close to the truth.

"We built it as a concept car," says Dave Pruehs, the Olds engineer in charge of the project. "The basic idea is that any time you get more air into and out of the engine, you get more power."

Another important difference in the prototype is a four-speed manual transmission taken from the Omega (X-car). A-cars, like the Ciera, are available only with an automatic.



Tuned-intake runners boost the power.

All in all, it's a highly refined prototype easily translated into a production design.—*Jim Dunne*

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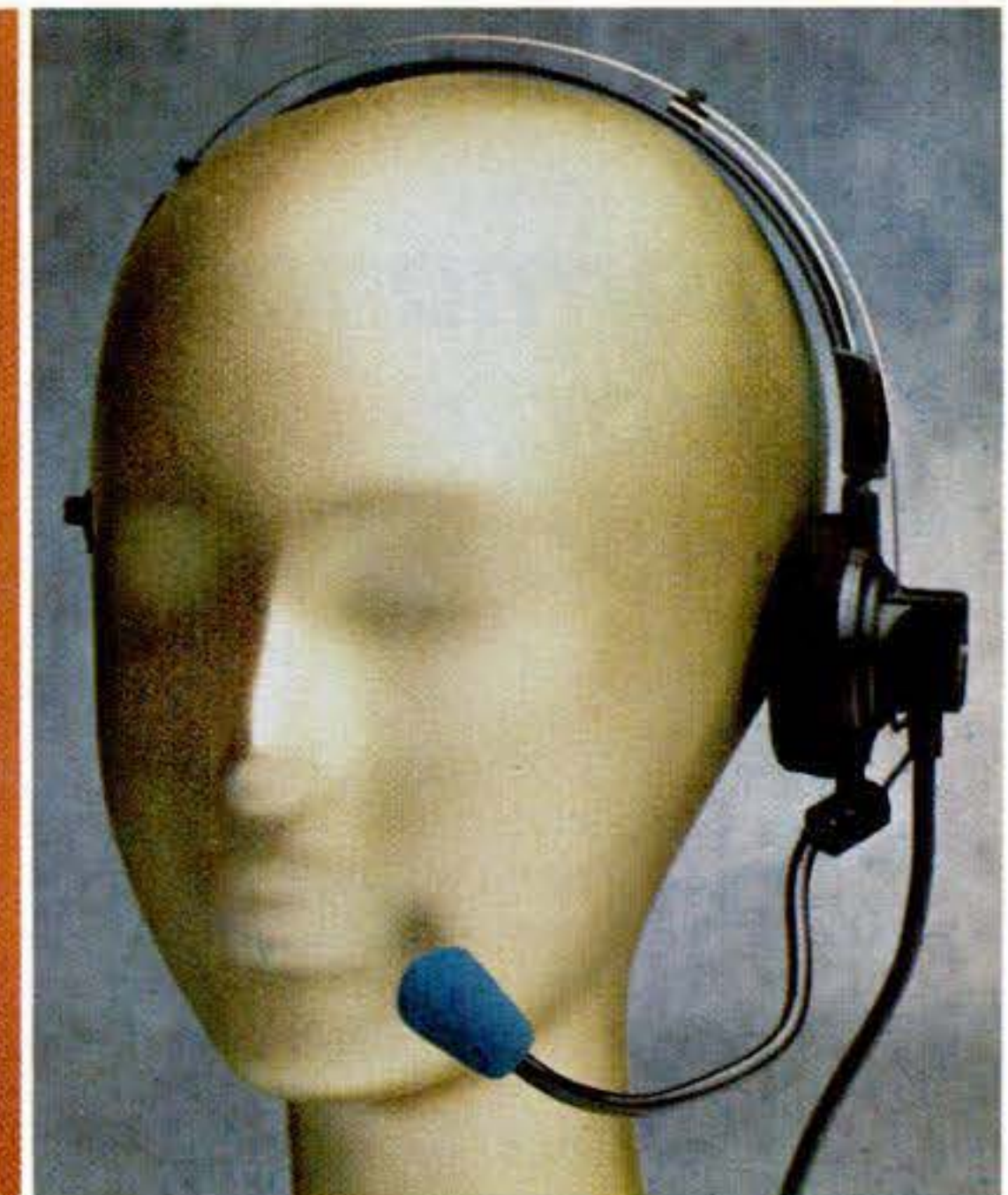
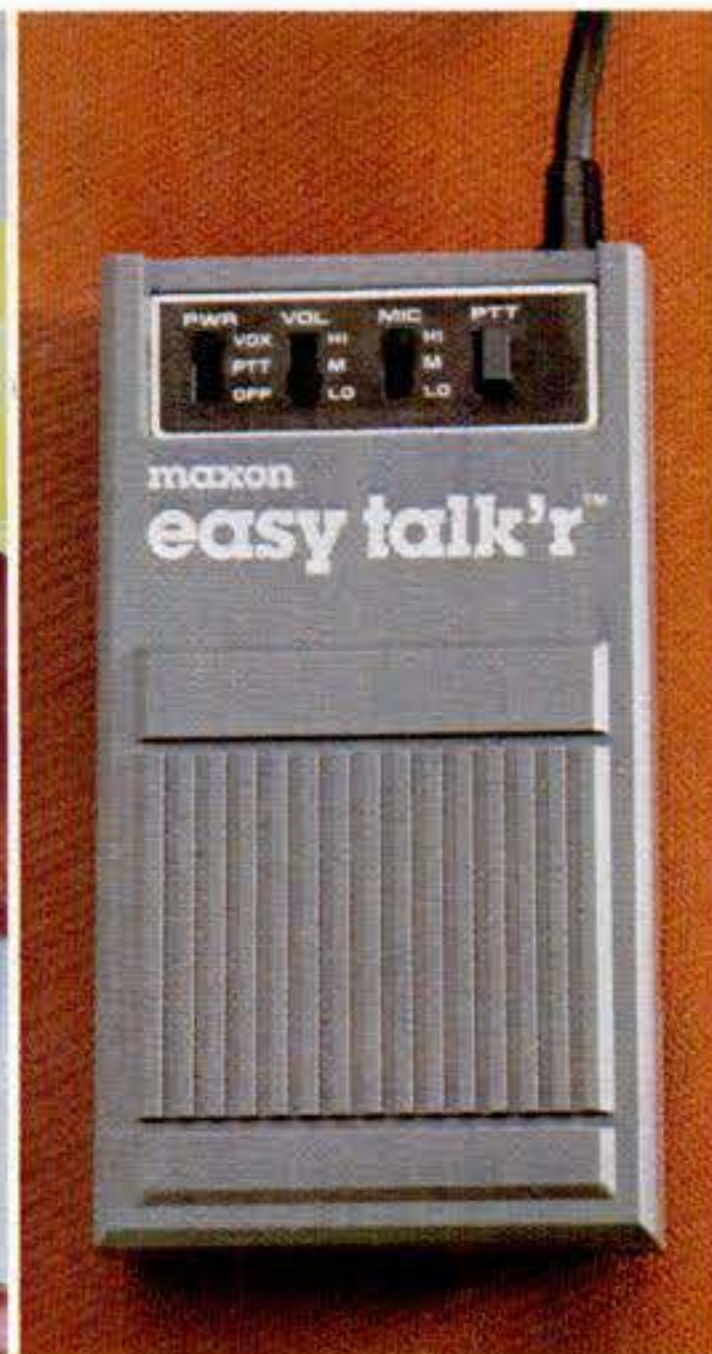
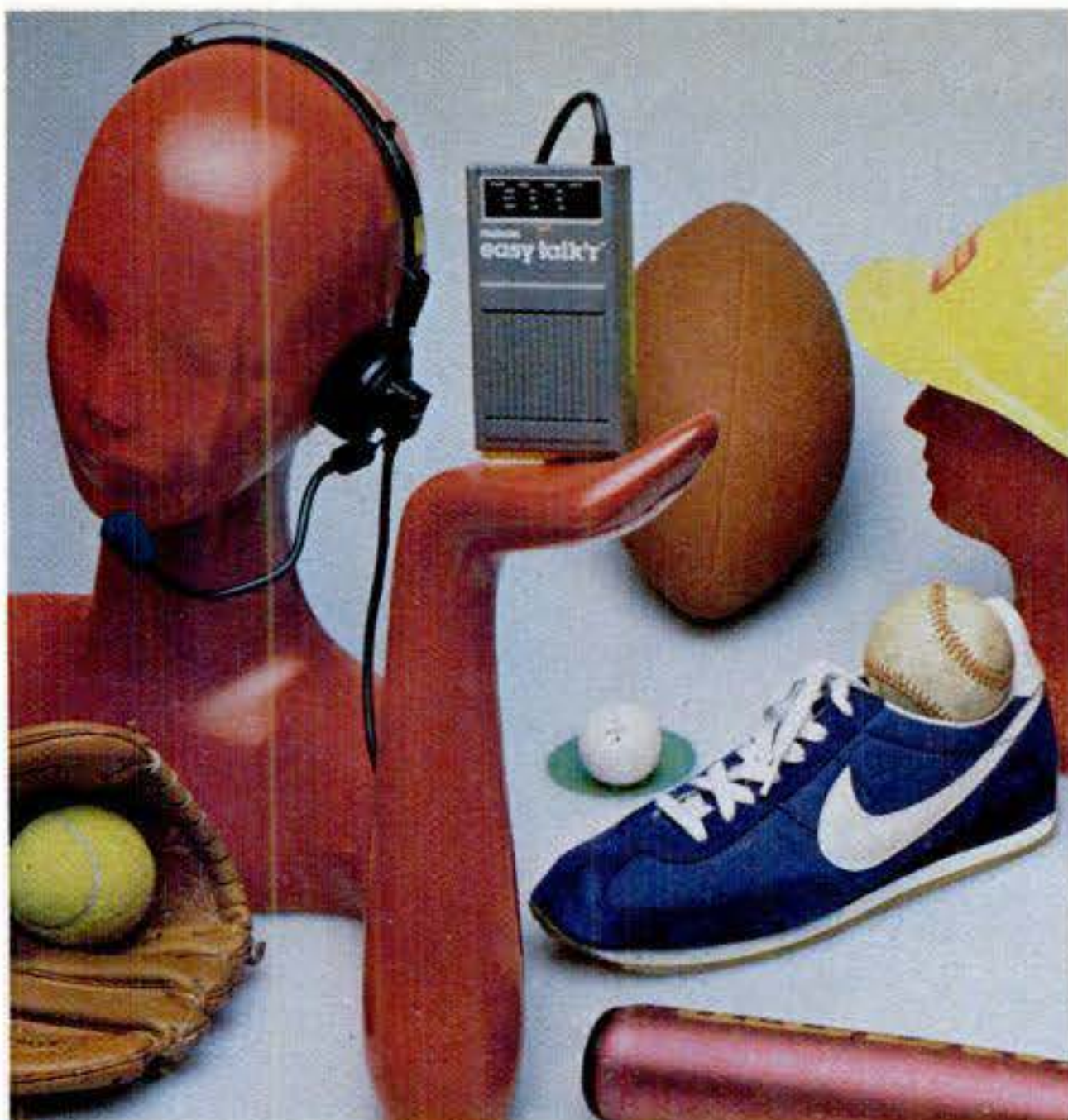
Open it up and this little portable air compressor'll do just about anything one of those tank-mounted monsters'll do.

**SUPER PAL™ THE TANKLESS AIR COMPRESSOR THAT WORKS LIKE A TANK.**  
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# Think Speak

***On the job, on the field, or on the road. Now you can talk and listen hands free at a new breakthrough price.***

SWAT teams use them. So do quarterbacks and firemen. Now you too can talk and listen to people near and far totally hands free while you are jogging, riding a bike, or hiking.

Both at work and at home this unique communications system with a range up to 1/2 mile will let you keep in touch.

You'll keep in close contact with your hunting partners when you hunt, and you'll communicate for ease and safety on construction sites.

Plus, you can effortlessly perform tasks like fine tuning your TV antenna when you need to communicate with someone on the ground or out of sight.

## NOT A WALKIE TALKIE

This is no toy. The Think Speak is totally automated. When you speak, a special voice activated circuit (VOX) automatically engages the transmitter so you are broadcasting. When you stop speaking, it automatically returns to 'stand by' to await a reply.

It is virtually noise free because it uses a quartz crystal locked dual conversion superheterodyne communication circuit that operates on an FM band.

So, your communication won't sound like a CB or an AM radio. You'll speak and hear with the full power and clarity you'd expect from an FM radio station.

## HERE'S WHAT IT IS

You wear the Think Speak just like a personal stereo. There is an adjustable headphone that you wear on either your right or left ear. The other ear is clear to hear the outside world for safety.

A flexible boom microphone lets you speak normally while you transmit. The entire shaft of the boom mike is adjustable and will retain any position you set.

All of the electronics are contained in a small 6½ oz. case that easily clips to your belt or with its removable clip fits

into your pocket. And, what controls.

The voice activation circuit has a 3 level sensitivity switch. If you're riding a motorcycle or breathing hard while you jog, you can set the sensitivity to low so that you won't transmit in error.

If you are hunting or fishing and you can't talk much over a whisper, you can set the sensitivity to high. Plus the headphone has a 3 level volume control too.

In addition to the VOX voice operated circuit, you have 'PTT' which means Push to Talk. When you want to talk, you just push the PTT button.

This is a really great feature when you want to whisper very quietly below the threshold of even the high sensitivity setting of the Voice Operated Circuit. You may be into surveillance or photographing wildlife. When you can only whisper, you'll especially appreciate the super quiet FM reception of this system.

## SOME SPECIFICS

You can expect long battery life from a standard 9V battery (not included). In the 'stand by' mode, the Think Speak only consumes 13.5 milliamps of power while it's ready to transmit or receive.

The antenna is conveniently clipped to the headband for normal use. For full range use, the antenna pops up.

The system operates on the 49 mhz band using FM so you shouldn't be bothered by any other radio transmissions as you are with CBs and Walkie Talkies.

There are 5 channels (A-E) allotted to the Think Speak to further prevent interference. We will ship all units ordered on each order with the same channel.

The transmission output is a full RF of 10,000uV/m @ 3 meters max. No FCC license is required. And, the FM hum and noise is almost good enough for a high fidelity system at 40db min. The case is 4-9/16" x 2¼" x 15/16".

## PERSONAL OR GROUP

You can talk to 1 or even 10 people with Think Speaks. So, if you're the head of a Search and Rescue team you can talk to everyone at once and get responses from one at a time.

The Think Speak is great if you're skiing with a friend, using two boats on a lake or at sea, hiking in the mountains or just jogging around the block.

If you're a pitcher you can talk to your catcher or the coach. If you're on a loading dock, you can talk to the man in the truck or on the forklift. If you're a security guard, you'll never be alone.

The Think Speak is manufactured and backed by a limited warranty from Maxxon Electronics, the two way specialists.

## TRY A THINK SPEAK

### RISK FREE

Walk around the block. Take a bike ride and really test the range of this breakthrough in personal communication. If you aren't 100% satisfied with the incredible sound quality or the range, return it in its original box within 30 days for a courteous refund.

To order your Think Speak risk free with your credit card, call the DAK toll free hotline or send your check for the incredible breakthrough price of only **\$49.95** each (minimum of 2 required). Plus **\$2.50** each for postage and handling. Order Number 9415. CA res. please add 6% sales tax.

When you think out loud, people will listen. Try a Think Speak risk free today.



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# High-performance Jaguar rag-top

COVENTRY, ENGLAND

The XJ-SC Cabriolet, the latest big cat to roll off Jaguar's Castle Bromwich production line, marks the English car maker's return to open-air motoring after the end of E-type production in 1974.

Park Sheet Metal Co., in Coventry, is chopping the top, and Aston Martin Tickford of Bedworth is installing the convertible roof. At Park Sheet Metal, the rear pillars are removed, the underbody and trunk are reinforced, a new windshield header is installed, and twin roll bars are welded into the roof line's panels.

Jaguar seems to have licked many of the problems inherent in converting convertibles. I had a chance to drive the XJ-SC on an extended road trip in England. Although I noticed



some wind noise at above-legal speeds, the chassis seemed extremely rigid and completely devoid of the Flexible-Flyer ride and handling characteristics of most convertible conversions. All XJ-SCs will come with twin interlocking targa roof panels and a removable rear "half-hardtop."

But fresh air still seems to exact a price: This cabriolet was designed as

a strict two-seater. Unlike the XJ coupes, the rear seats have been replaced by twin lockable boxes under a luggage platform.

At the heart of the soft-top is an all-new aluminum 3.6-liter (219-cu.-in.) engine—only the third Jaguar engine introduced since the end of World War II, following the XK six-cylinder in 1948 and the V12 in 1971. The inline six is lighter than Jag's older XK six—430 versus 560 pounds.

In European trim, the engine produces 225 hp at 5,300 rpm with digital electronic fuel injection. Why did Jaguar choose the added complexity and expense of a cross-flow, four-valve cylinder head? The excellent high-rpm breathing characteristic of this type of cylinder head is probably the reason. The valves are operated by twin overhead camshafts driven by a two-stage duplex chain.

Additional intake efficiency is realized through the use of six 17-inch ram pipes. Unlike many recent aluminum engines in which pistons slide against high-silicon-content aluminum walls, Jaguar's pistons ride inside cast-iron thin-wall dry cylinder liners. As in earlier six-cylinder Jag engines, the crank spins in seven large thin-wall bearings. This engine will also be available in the XJ-S coupe. Standard equipment in both models is a five-speed Getrag transmission.

Jaguar claims the new beast will lunge to 60 mph in 7.6 seconds. For those brave enough, top speed is 145 mph, and safe, powerful braking is ensured by four-wheel discs.

The English car maker hopes that the combination of a 24-valve six-cylinder and a five-speed transmission will appeal to the same type of owner who once purchased the sporting E-Types.

—W. David Houser



—Mrs. T. Bufford, comfortable camper.

A tent made with Evolution<sup>®</sup> 3 fabric is great for camping even when the weather's not.

That's because Evolution 3 fabric lets your family handle a rain delay in dry comfort. It's highly water repellent to keep the rain out. And it's breathable, for through-the-fabric air circulation, to keep fresh-



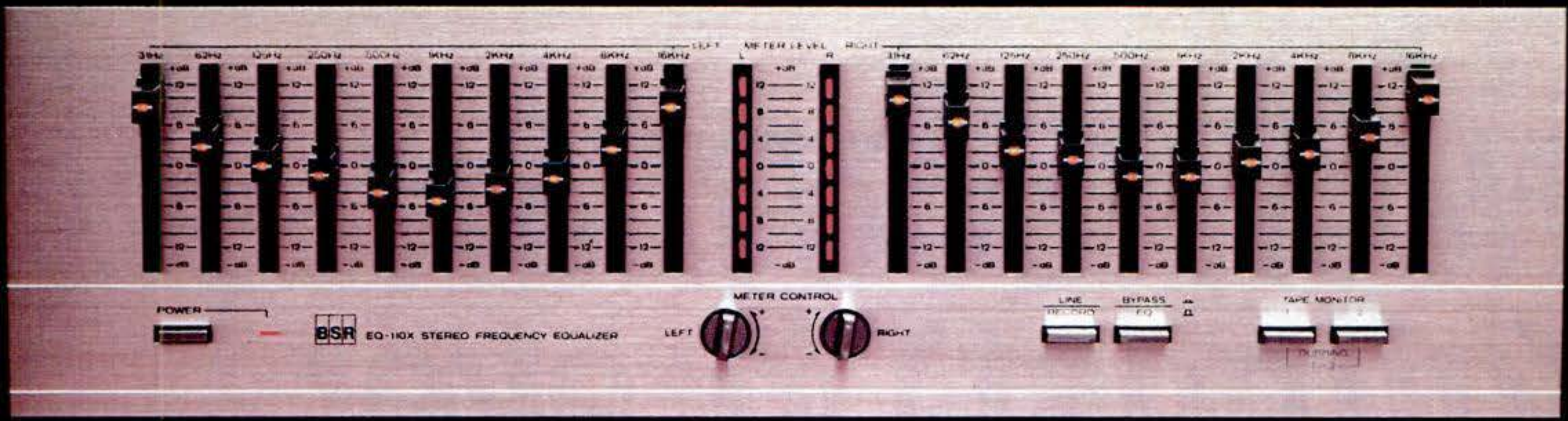
air comfort in.

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**\$89 CLOSE-OUT**



# Sound Detonator Plus

**Make your stereo system's sound explode with life. Improve the sound quality by 30 to 50%. Plus, you'll add tape dubbing too with this limited BSR \$89 close-out.**

It's like night and day. Crashing cymbals, the depth of a string bass, more trumpets or more voice will come bursting forth from your stereo at your command.

You'll make your music so vibrant that it will virtually knock your socks off when you use this professional quality 10 band stereo Sound Detonator Plus Equalizer.

It has a frequency response from 5hz to 100,000hz  $\pm$  1 db. BSR, the ADC equalizer people, make this super equalizer and back it with a 2 year limited warranty. Our \$89 close-out price is just a fraction of its true \$249 retail value.

## CAN YOUR STEREO SOUND BETTER?

Incredibly better. Equalizers are different from regular bass and treble controls. And, 10 band EQs are the best.

Bass controls turn up the entire low end as well as the low mid-range, making the sound muddy and heavy. With an equalizer, you simply pick the exact frequencies you want to enhance.

You can boost the low-bass at 31 hz, 62hz and/or 125hz, and the mid-bass at 250hz and 500hz to animate specific areas of the musical spectrum.

And, when you boost the part of the bass you like, you don't disturb the mid-range frequencies and make your favorite singer sound like he has a sore throat.

The high frequencies really determine the clarity and brilliance of your music.

You can boost the mid-range and highs at 1,000hz, 2,000hz, 4,000hz, 8,000hz and 16,000hz. So, you can bring crashing cymbals to life at 16,000hz while at the same time you cut tape hiss or annoying record scratches at 8000hz.

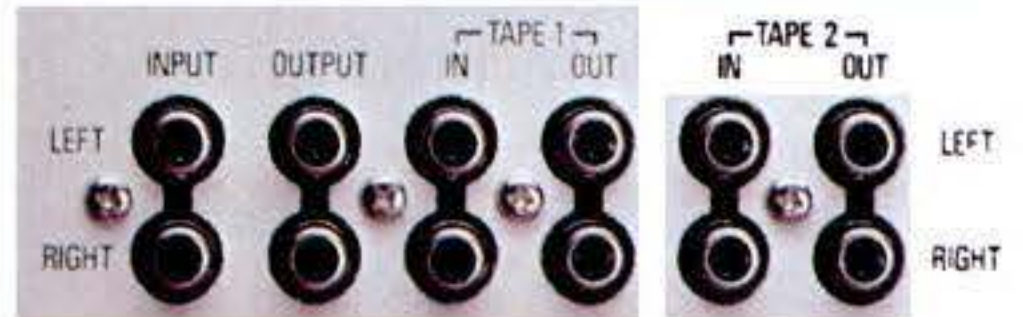
You can also boost or cut specific mid-range frequency areas to add or subtract vocal, trumpets, guitars or whatever instrument ranges you prefer.

## GREAT FOR 2 TAPE DECKS

You can push a button and transfer all the equalization power to the inputs of two tape decks. So, if you have a cassette deck in your car or a personal stereo that you wear, now you can pre-equalize your cassettes as you record them.

Now you can get all the dramatically enhanced sound wherever you are. This

is an especially great feature for bass starved portables and high-end starved car stereos to make them come alive.



And, look at this. There are two tape inputs and outputs, so you can dub from tape deck A to B, or make two tapes at once with or without equalization.

## EASY HOOK UP

Use your tape monitor circuit, but don't lose it. Now your one tape monitor circuit lets you connect two tape decks.

Just plug the equalizer into the tape 'in' and 'out' jacks on your receiver. We even supply the cables.

As you listen to your records, FM or 'aux', any time you push the tape monitor switch on your receiver you'll hear your music jump to life.

The output from your receiver is always fed directly to your tape decks for recording, and with the touch of a button, you can choose to send equalized or non-equalized signal to your recorders.

When you want to listen to a tape deck, just press a tape monitor button on the equalizer and your tape deck will work exactly as it did before. Except, that now you can choose to listen with or without equalization and you can dub.

You won't be listening to any distortion or hum. The Sound Detonator Plus has a 95db signal to noise ratio and total harmonic distortion of just 0.018%

Once you've set your equalizer controls, switch it in and out of the system. You'll hear such an explosive improvement in sound, you'll think you've added thousands of dollars of new equipment.

## WHY A CLOSE-OUT?

Last year DAK closed out over 18,000 of BSR's 7 band equalizers because BSR had decided to only sell equalizers under their ADC name and they still had some left with the BSR name on them.

Well, as Detroit comes out with new cars each year, ADC comes out with new equalizers. We got them to supply us

with just 15,000 of last year's model before they shut down for the new one.

They had already paid for all the tooling, all the research and design, so we were able to buy these for less than half the normal price, for cold hard cash.

So, you can go to any HiFi store and buy this year's design in an ADC equalizer made by the parent company BSR, or you can get this \$249 value BSR equalizer while our limited supply lasts, for \$89.

## THE FINAL FACTS

There are 20 slide controls, each with a bright LED to clearly show its position. Each control will add or subtract up to 12db. (That's a 24db range!)

There are separate sound detonation slide controls for each channel at 31 hz, 62hz, 125hz, 250hz, 500hz, 1,000hz, 2,000hz, 4,000hz, 8,000hz, and 16,000hz.

LED VU meters with  $\pm$ 0.5db accuracy show levels for each channel. It is 17" wide, 6 1/2" deep and 4 1/2" tall.

## PUT LIFE INTO YOUR MUSIC RISK FREE

Prepare for a shock the first time you switch in this equalizer. Instruments you never heard in your music will emerge and bring a lifelike sound that will envelop you and revolutionize your stereo system.

If your system doesn't spring to life, simply return the equalizer within 30 days in its original box for a refund.

To order your Sound Detonator Plus Tape Dubbing BSR 110X 10 Band Stereo Frequency Equalizer risk free with your credit card, call toll free or send your check not for ADC's \$249 value, but for only \$89 plus \$7 for postage and handling. Order No. 9724. CA res add 6% tax.

Wake up the sound in your stereo. Your sound will explode with life as you detonate each frequency band with new musical life. And now you'll be in control of two tape decks as an added plus.



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# Now: food that lasts (almost) forever

—irradiation keeps it fresh

Gamma rays and electron beams can pasteurize or sterilize food to extend its shelf life or prepare it for indefinite storage. Proponents say that an FDA go-ahead for food irradiation could prevent staggering losses from food spoilage. However, opponents say that not enough is known about new substances that form in food after it has been irradiated.

By **DICK YOST**

**T**he contents of the silver-foil pouches in my hand were good enough for Bob Crippen, John Young, Sally Ride, and other astronauts. So why should I be nervous?

Despite excellent reviews from dozens of astronauts and an assortment of nuclear, nutritional, and medical scientists, though, I was a little uneasy. I slipped the package contents—juicy pieces of chicken, succulent beef, and lean pork—into a skillet.

The packaged meat smelled fine. But it had been sitting on a storeroom shelf for six years—without refrigeration. Taste? The meats all had a “processed” flavor not present in fresh meat, and the texture was somewhat grainy. But it wasn’t bad.

The meat represented 30 years of research into food irradiation. This preservation process beams radiation into food products. Depending on the radiation dose, microorganisms or insects that spoil food are partially or totally destroyed. The result is storage life extended by days or years. Experts say its widespread use could halt billions of tons—and dollars—in food spoilage and become an important weapon in the war against world hunger.

Irradiation can also serve as a substitute for chemical food additives, for insect control, and to delay fruit ripening or inhibit vegetable sprouting.

In the United States, irradiation of supermarket foods has been blocked more by legal than technical problems.

But it is finally clearing the last hurdles preventing its use here.

Although food processors have traditionally relied on radioactive isotopes as a source of radiation, newer and faster methods, employing powerful electron beams, are also available. Opponents, however, believe that regardless of the radiation source, not enough is known about chemical changes that take place in irradiated food to put it on supermarket shelves.

## Radiation ruling

World War II stimulated the U.S. military into finding better ways of feeding its troops. Just after the war, the Army began studying food processing with irradiation at its Natick, Mass., research lab. By the 1950s, a major food-irradiation program was under way. Then, in 1958, the Food and Drug Administration (FDA) decided that radiation must be considered an additive to food. That ruling sharply restricted irradiation of supermarket products. (Each item would have to be exhaustively tested.)

Still, irradiation research continued. People dining in space benefited, and 22 other countries accepted the process as safe and began using it on dozens of foods. In 1980, the Natick research was transferred to the U.S. Department of Agriculture (USDA).

Early attempts to irradiate meat were not all successful. “When we first started our research in the late 1950s, our irradiated meat was described as tasting something like a wet dog,” said Edward Josephson, a food scien-

tist at the Massachusetts Institute of Technology and past director of the National Food Irradiation Program. “While I have to admit I’ve never eaten a wet dog, I will say the meat did *smell* like a wet dog.”

“But the technology is much different now than in 1950. Radiation sources that give much more accurate and uniform doses have been developed. The importance of pre-irradiation food quality, freezing, and vacuum packaging has also been realized. Irradiated foods today have good flavor and texture, and they are nutritious,” Josephson said.

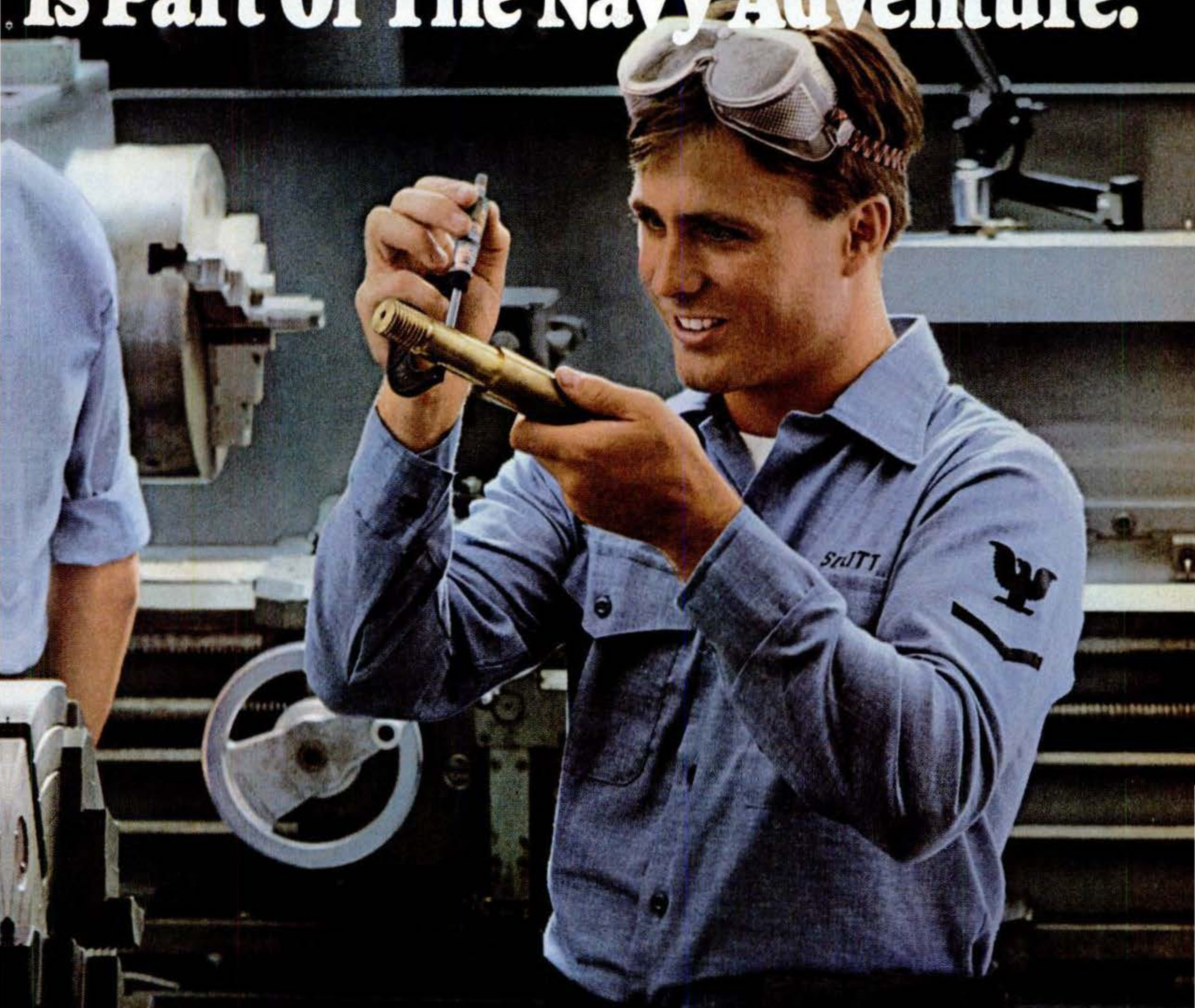
At one irradiation center, Radiation Technology, Inc. (Rockaway, N.J.), meat is first prepared in multilayered plastic-foil pouches or cans. A large vacuum machine removes air from the containers. Then the meat is lowered into liquid nitrogen, a process that produces thick white clouds of vapor. These steps—removing oxygen from the meat and freezing it—reduce loss of color, flavor, texture, and nutrients during the next step.

Flowing along conveyor belts, similar to most food-processing operations, the meat disappears into a massive blockhouse with six-foot-thick walls. Inside, bundles of 18-inch-long, ½-inch-diameter stainless-steel pipes await in a 20-foot-deep pool of water. A characteristic blue glow in the water is produced by gamma rays—a form of ionizing radiation more energetic than X-rays—emitted by cobalt-60 or cesium-137 isotopes in the pipes.

*Continued*



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As the meat approaches, the rods emerge from their watery radiation shield. The meat travels up and back past both sides of the rods. Cobalt rods, Radiation Technology has found, have better "processing power."

"Cobalt and cesium both give off gamma rays," said Radiation Technology's Martin Welt. "But cobalt gives off two gamma rays per disintegration [atomic decay], while cesium only gives off one. We've found that it takes about four times more cesium than cobalt to accomplish the same amount of processing."

The radiation has a devastating effect on living organisms that cause food spoilage. At the molecular level, the gamma rays knock electrons off atoms and molecules—water, for example, breaks down into ions and free radicals. As a result, newly formed chemicals react with proteins and other components in bacteria, mold, and insect larvae. This either kills an organism or reduces its rate of growth.

Irradiation not only sharply reduces the number of bacteria that cause spoilage; it also eradicates deadly botulism pathogens and bacteria such as salmonella, which causes intestinal illness and alone runs up a U.S. medical bill of \$1.2 billion.

With some FDA restrictions now eased, a more-efficient irradiation process, based on machine-made electron beams, is evolving. The advantage: Electron beams can deliver tremendously higher radiation doses in far less time than cobalt-60. (Radiation is measured in units called grays, equal to 100 rads. A rad is the dosage of absorbed radiation equal to the absorption of 100 ergs [dyne centimeters] of energy per gram of material.) Several hours of cobalt-60 radiation are needed to deliver the same 100-kilogray dose completed in a few seconds with an electron accelerator.

But there is a problem: Electrons have limited penetrating power. It takes electrons accelerated by about a million volts to penetrate  $\frac{1}{8}$  inch of water or its equivalent. Such meager penetrating power limits electron-beam processing to thin sandwich meats, bacon, and other processed meats.

"Nevertheless, machine-produced irradiation can in seconds treat meat, fruits, and vegetables that would take minutes or even hours with cobalt or cesium," said Dr. Marshall Cleland, director of technology development at High Voltage Engineering, a Burlington, Mass., firm that makes electron accelerators.

"A 10-million-volt accelerator, which would have a total penetration power of three to four inches by treating a

product on both sides, would cover most store-bought meats.

"Electron beams are now used most often for curing plastics and rubber," Cleland said, "but now that the FDA is opening the door to food irradiation, I think shifting this type of irradiation over to the food sector will be fairly simple."

### Longer shelf life

Since the beginning of radiation processing almost four decades ago, the goal has always been the same: to use the technique to delay spoilage of meats, fruits, and vegetables. Expose chicken, fish, or other meats to two kilograys of radiation—enough to destroy many microorganisms, but not all of them, for sterilization—and shelf life is extended from two or three days to two or three weeks. Estimated savings in meat spoilage alone run in the billions of dollars. Strawberries and other berries and fruits begin to mold within a week of harvest. With a radiation dose they remain fresh and tasty for three to four weeks.

"Not only will radiation save tremendous amounts of food," said Dr. Eugen Wierbicki, chief researcher at the USDA's Eastern Regional Research Center, "it will also mean that consumers in the Midwest, for example, will be able to buy fresh fish shipped in from the East or West Coast. The season for fresh fruits and berries will be extended considerably."

**“I expect that within two years we will have approval for the irradiation of all foods”**

In addition to extending shelf life, irradiation can also sterilize meat—destroying all microorganisms that can cause spoilage. "You don't see much canned meat in the supermarket because it has to be heated to such high temperatures for sterilization," Josephson pointed out. "Sure, we have canned tuna, salmon, and fruits such as peaches, but they don't taste anything like the real thing. Meats sterilized by irradiation, however, have much the same flavor, texture, color, and nutritional value as their fresh counterparts."

Consumer and professional taste panels back up Josephson's claim that irradiated meats nearly rival the fresh, plastic-wrapped meats at the supermarket. (The samples I tried, which had been sterilized rather than

just treated with enough radiation to extend shelf life, were prepared years earlier; preparation techniques have improved since then.)

Although irradiated food isn't going to show up at your favorite restaurant, meats such as the ones I sampled were outstanding when compared with the dehydrated and heat-treated fare that campers, hikers, and soldiers have had to stomach over the years.

"With the availability of readily accessible fresh meats in the United States, I doubt that sterilized meat will become a large part of the food-irradiation industry in this country," Wierbicki said. "But there is terrific potential in Third World countries where refrigeration and modern transportation systems are lacking."

Wierbicki, Welt, Josephson, and Cleland say that public acceptance of irradiated foods is uncertain. But there's a consensus that, with education, these foods will be accepted.

Opposition to food irradiation has been based on the possible creation of dangerous substances—so-called unique radiolytic products—following the process. Also, there's the idea that radioactivity could be induced in food or containers.

Irradiation opponents, such as Robert Rodale, chairman of Rodale Press, stress that researchers can't definitely say that radiolytic products have no effect on humans. "Not all the unique radiolytic products have been identified yet," Rodale explained.

### Gathering evidence

Changes in federal rules on food irradiation have been delayed pending firm evidence that the chemical compounds of unique radiolytic products are not toxic or carcinogenic.

Although tests show that irradiation causes fewer of these unique products than heat treatment, the FDA has been very cautious; it would rather not have to reverse any of its decisions. "The FDA is a conservative organization," said one FDA official. "What we decide ultimately affects more than 250 million Americans. We can't afford to take any unnecessary risks."

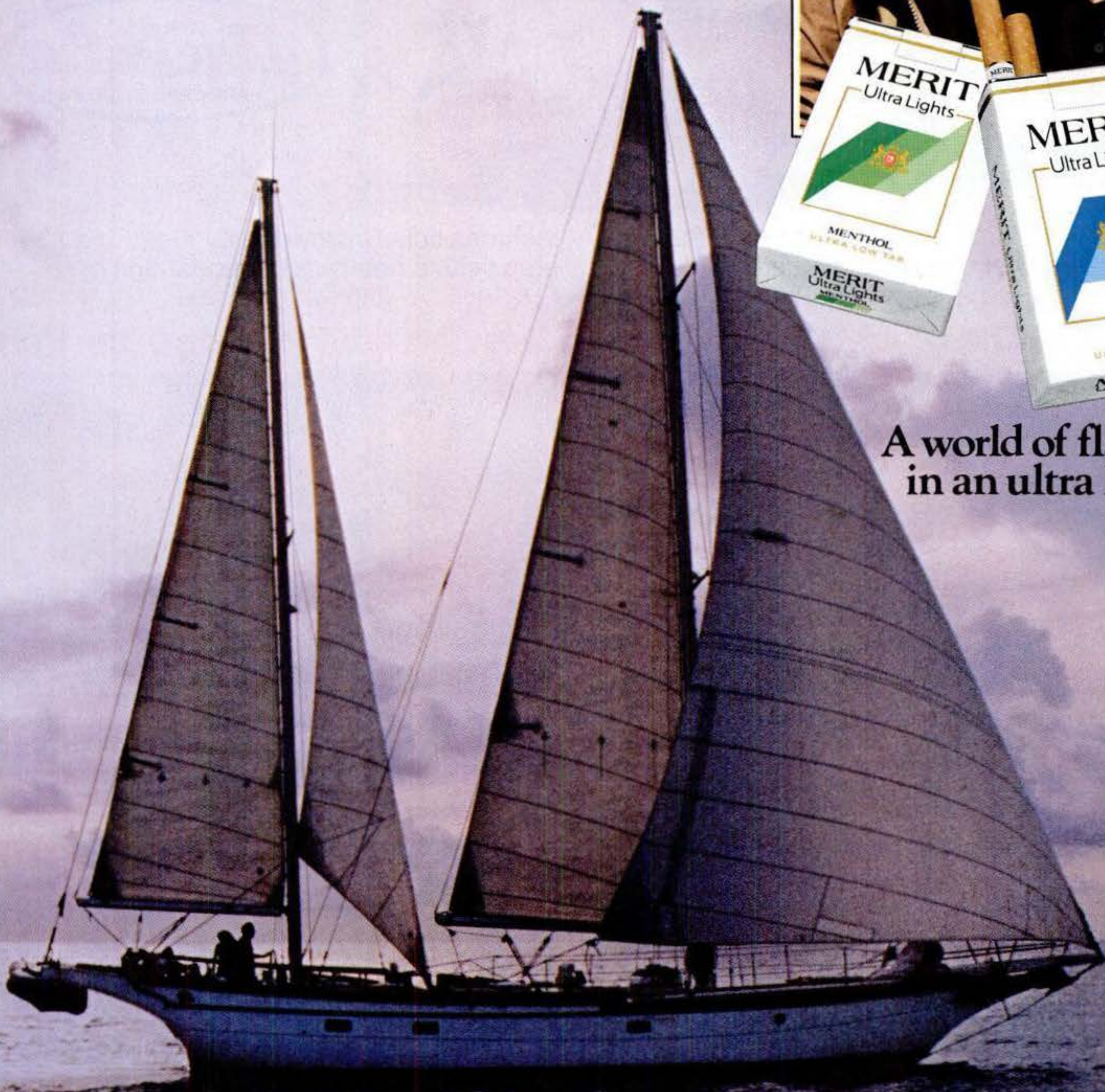
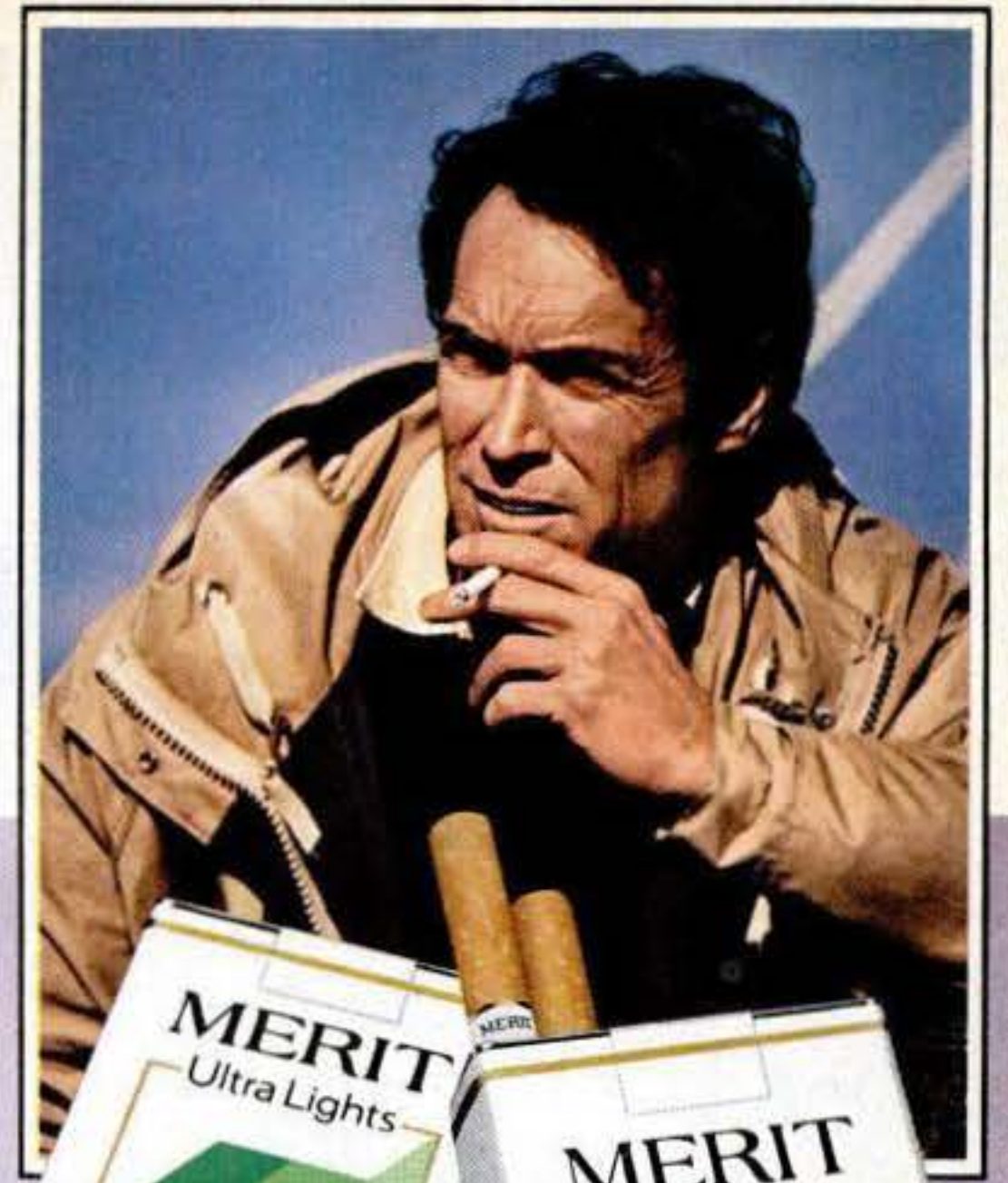
What about induced radiation? "It must be emphasized that there is absolutely no way that irradiated food can become radioactive," Wierbicki said. "Just as an X-ray table doesn't become radioactive with repeated use, neither will food become radioactive. It's much like shining a flashlight onto the product. Once the rays are turned off, nothing remains."

Technically, induced radiation is possible, but only at radiation levels far in excess of cobalt-60's level, which is

*Continued*

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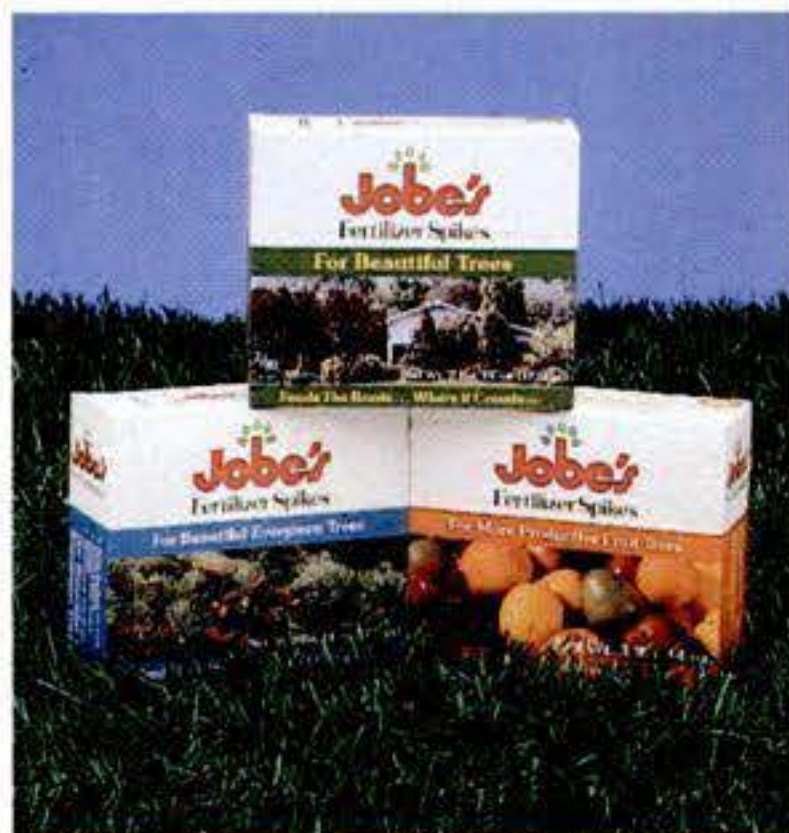
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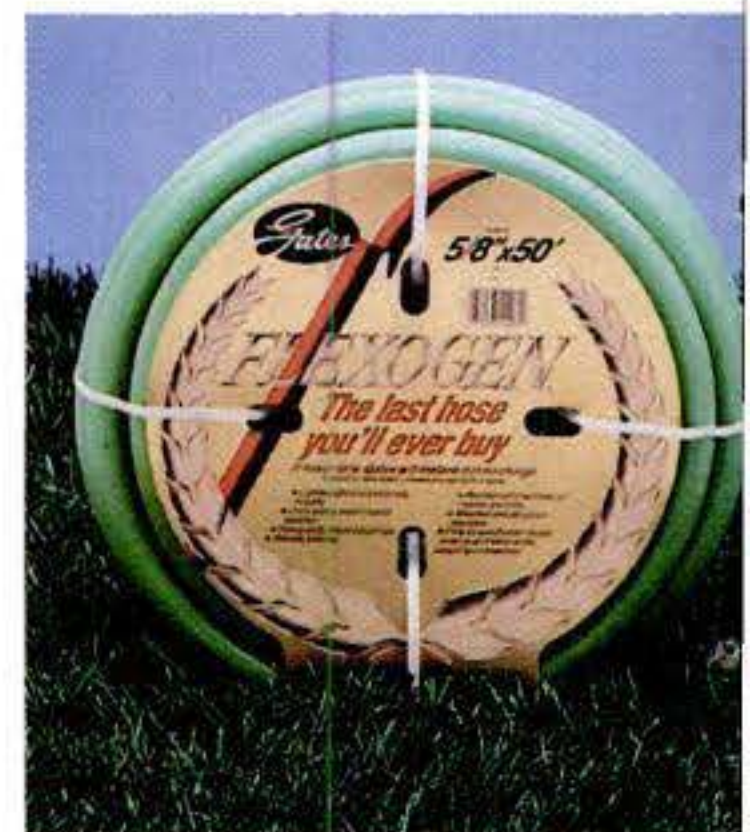
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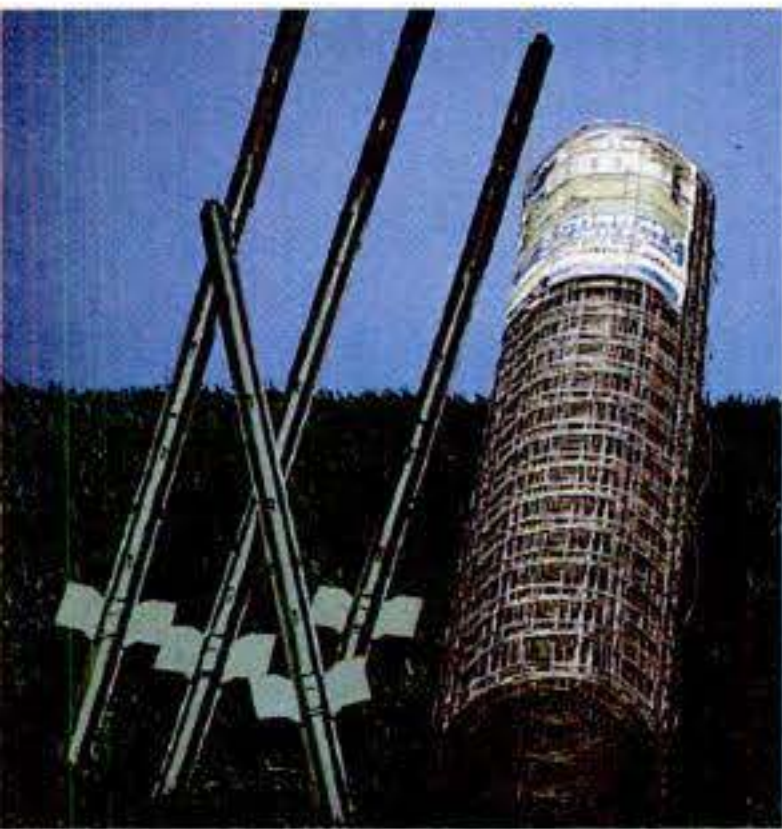
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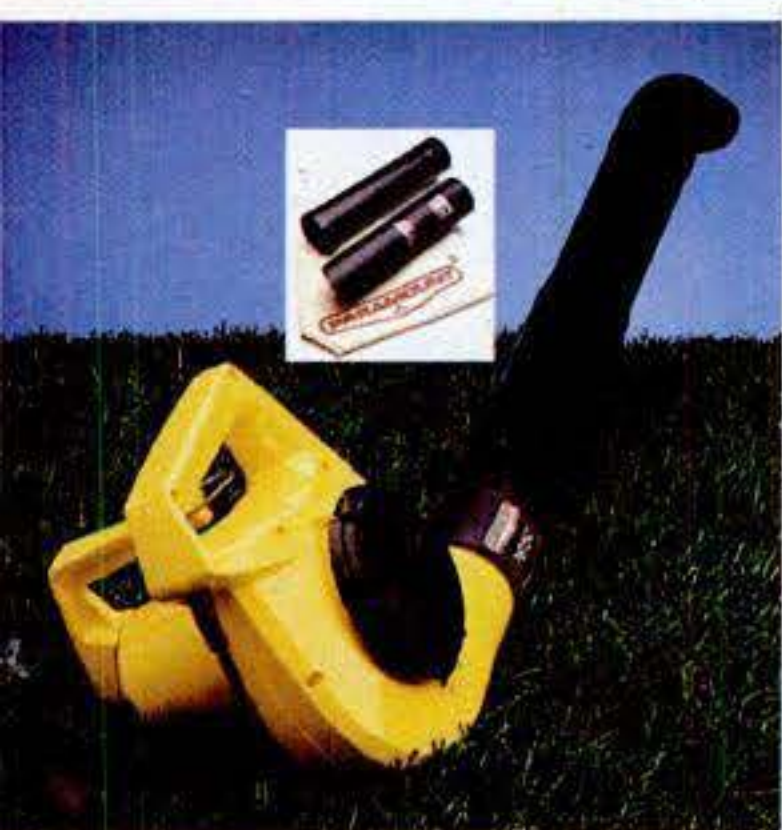
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less than 1.3 million electron volts (MeV). Induced radiation is negligible and very short-lived below 16-MeV energy levels. National and international committees have recommended maximum energy levels of 10 MeV for electrons and five MeV for gamma rays to avoid any possibility of induced radiation.

### Spicy irradiation

Despite the glacial pace, changes finally have begun. Last summer, for the first time in 19 years, the FDA amended its rulings to allow irradiation for disinfection of spices. About three years ago, 117 nations accepted the World Health Organization's clearance of the process. Although the new amendment only applies to about 400 million pounds of food annually, it opens the door to irradiation pasteurization and sterilization of many foods on supermarket shelves.

"I expect that within two years we will have FDA approval for the irradiation of all foods," said Radiation Technology's Welt. His is the only commercial food-irradiation firm in the U.S. "We currently irradiate hundreds of thousands of pounds of frozen shrimp, frog legs, and refrigerated fish fillets for shipment to Europe. But

we're set up so that when we're finished with one product we can easily switch to another, whether it's spices, turkeys, or medical supplies.

"Each of our pallets can carry 2,500 pounds, or 80 to 90 cubic feet, of product," Welt pointed out. "For example, we can irradiate a pallet of 2,500 pounds of grapefruit in a minute, disinfecting the fruit of any insects or insect larvae."

The change to radiation disinfection could solve another sticky problem. Chemicals are now used for fruit and grain disinfection in the U.S. Ethylene dibromide, a carcinogen and mutagen used to fumigate citrus fruits and grain, was detected in some products by health officials in several states. After the products were ordered removed from stores by state agencies, the Environmental Protection Agency ordered suspension of the use of ethylene dibromide on grain products and announced maximum safe levels for products and grain already in the food pipeline.

Removing ethylene dibromide from the market for fruit and grain preservation will mean substantial losses of both products through spoilage. But irradiation plants built to disinfect fruit and grain will have to prove


themselves by providing a more-efficient means of preservation.

Irradiation may also reduce the use of other questionable chemicals in foods. "Nitrites [and nitrates] have for some time been used to enhance the flavor and color in bacon, ham, and other cured meats," Josephson said. "And more importantly the chemical destroys botulinus [a toxin-producing bacterium]. But nitrites and nitrosamines formed by residual nitrites are also suspected of being carcinogenic."

Because irradiation can destroy botulism spores, the quantity of nitrites and nitrates in meat can be reduced by up to 80 percent. Only a small quantity of the chemicals would be used to enhance color and flavor.

Still, no one in the food-processing industry is predicting that there will soon be an irradiated ham in every pantry. Noted former AEC commissioner and Nobel laureate Willard Libby: "The success of these [irradiation] processes will depend ultimately upon their costs, consumer acceptance, and labeling requirements, as well as evaluating whether the technology fulfills a perceived consumer need. Wasteful as man has been in the past, he can no longer afford to waste time, technology, and food." P 5

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The Anova combines every desired electronic telephone feature with every desired answering feature and puts them together with beauty and class. True it's not cheap. But compare the total number of features and only then will you realize its great value.

Let's start with the built-in telephone. It has a sixteen-number dialer capable of both pulse and tone dialing. It features one of the best built-in hands-free speakerphones with excellent voice quality that reduces the echo effect common to other units. And its display shows you the number you dialed and the length of your call in minutes and seconds. There is also a hold button that blocks your voice, but lets you hear the other party.

We particularly liked the hands-free speakerphone. It is one of the few full duplex systems which means that both parties can talk at the same time without the annoying voice clipping found in other units. And then there's the shape and feel of the phone—a sculptured piece of art that sounds as good as it looks and feels. If we're a little too enthusiastic, we plead guilty. The Anova is an incredible telephone—but wait.

The Anova is also a telephone answering unit that will not only work at home but in your office. The mini cassette system holds up to seven different outgoing messages. At the office you can record a message for use during lunch, while in a meeting or away on a rip. At home, you can record one message or when you're walking the dog and one for when you're out for the evening. One message can announce that your tape is full.

The unit uses controlled VOX which means that a caller can leave a message from 30 seconds to a controlled limit of 3 minutes or as long as you want. And the heavy-duty tape transport system is so well designed that its recordings sound great, and the system will accept up to 30 minutes of messages per side without having to change your tape.

You can retrieve your calls with a remote pager from any telephone in the world. That's no big deal. But with the Anova, if there are no messages waiting for you, your unit will

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At home the time and date of each call received by your answerer is recorded and displayed on the screen as you replay your messages. This saves time because you never have to ask the caller to leave the time or date. You won't realize how nice this feature is until you use it. You can also record conversations, and your unit can automatically redial busy numbers at intervals until you reach your party.

We enthusiastically feel that this telephone and answering system is the most advanced and yet the greatest value of any unit we've examined. But there's even more. The Anova can be attached to a security system console that can turn lights on and off and sense intrusion or fire—and then dial out for emergencies. We'll send you more details of this expansion capability—but the point is simply this. The Anova phone answerer is only one building block of an exciting phone communications and security system that is years ahead of anything we've ever seen.

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# Soft-ride bicycle

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One way to get to know a road—especially its lumps and potholes—is to ride a bicycle over it. On the new unisex Alex Moulton bike, however, you may find your knowledge of roads you ride

less intimate than usual. Invented and marketed by a Briton of the same name, the Alex Moulton's front and rear wheels are both sprung. Result: a soft ride, even with the tires inflated to a hard 90 psi (for low rolling resistance).

The "advanced-engineering bicycle," as the designer calls it, weighs only 24 pounds and has small, 17-inch wheels and a unique thin-wall, multi-tube space-frame body that has a 41.5-inch wheelbase.

Furthermore, the bicycle splits in two for convenient stowage in a clos-

et, car trunk, or boat. Front and rear sections are joined by a central kingpin with a captive knurled bolt.

A simple hook-joint strut below provides vertical strength, and the X-frame assembly has massive lateral and torsional stiffness, according to designer Moulton.

The front suspension of the bike consists of a special fork that acts against a long coil spring that is housed in the steering column. Damping (by polyurethane friction pads) is adjustable, as is the suspension height, which can be varied according to the rider's weight.

At the bicycle's rear, a triangulated fork pivots at the bottom, while the top compresses a bonded-rubber cone. This arrangement permits considerable wheel travel, which isolates road shocks without interfering with pedaling. The height of the saddle can be adjusted over a nine-inch range to suit different leg lengths.

There are two versions of the Alex Moulton bicycle. The AM7 Country model, with drop handlebars, has a seven-speed derailleur with an ingenious method of detaching both the gear control and rear-brake-caliper cables when the frame is split.

On the AM2 Town model, with straight handlebars, there's a two-speed flip-flop rear hub with a coaster brake on the rear wheel and a caliper brake in front. Moulton has started production at his small Wiltshire factory (Alex Moulton Ltd., Bradford on Avon, Wiltshire BA15 1AH, England), and he's keeping a beady eye on the U.S. market.

British prices for the AM7 Country and the AM2 Town models are around \$750 and \$610, respectively. Front and rear luggage carriers and a carrier bag for the two-section bicycle are available as extra-cost options.  
—David Scott



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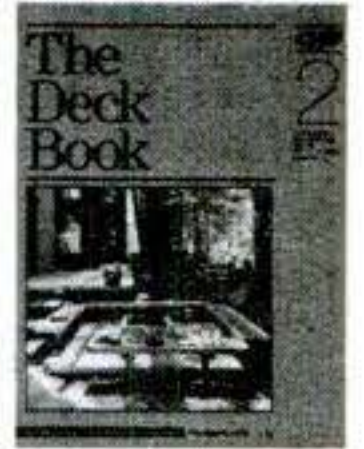
We're Georgia-Pacific. And this year we'll be helping millions of Americans with more deck plans, room additions and home remodeling projects than ever before.

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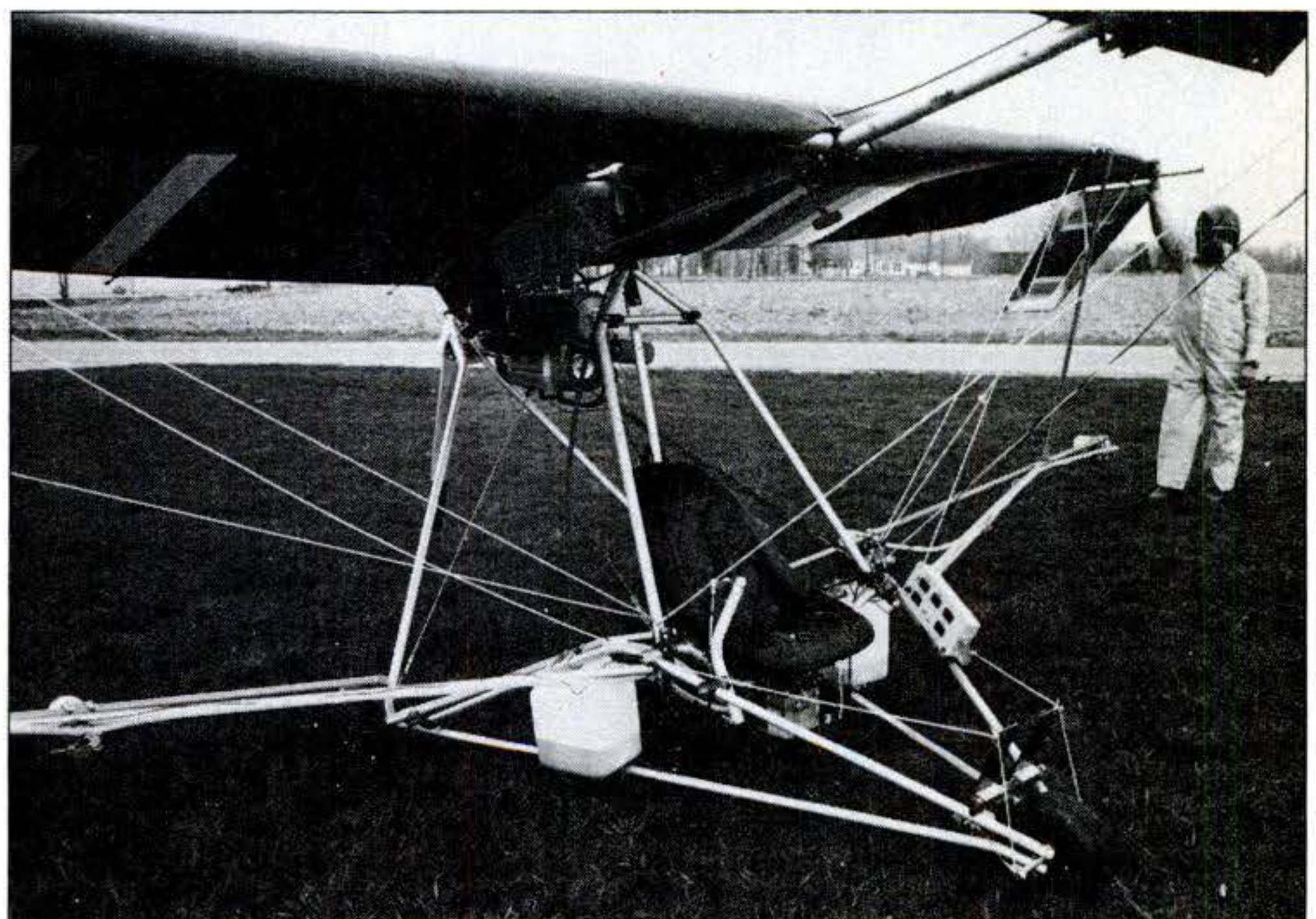
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## Ultralight crop sprayer

Flying 12 to 15 feet above a field at 40 mph, an ultralight aircraft can direct crop sprays with precision and use less chemical than a conventional craft. "It's a lot cheaper, too," says John Moody, founder of Ultralight Flying Machines of Wisconsin (Box 248, Kansasville, Wis. 53139).

When Moody first combined a small engine and a hang glider to make an ultralight plane, he was thinking in terms of sport. Now, his company is promoting the ultralight as a workhorse as well.

The advantages of slow-speed spraying are economy and better droplet distribution. The chemical is delivered by electrically driven spray heads that spin to atomize the liquid evenly. The droplets are micron-size (a millionth of a meter). And, says Micro-Ag Systems of Lake Geneva, Wis., maker of the spraying equipment, "an amazing thing happens when we slow down aerial application." Precise droplet control, the company claims, cuts by 90 percent the amount of water used and



Extended booms support spray heads, seen midwing and at the tip. Plastic

jugs hold liquid chemical. A battery under the pilot's seat powers the system.

the weight the plane must carry. With four spray heads, the entire system weighs only 26 pounds empty.

In addition to saving fuel, low-speed, low-altitude spraying protects the environment by reducing overspray and runoff. The equipment, adaptable to many makes of ultralights, holds eight

gallons—enough to spray 32 acres.

Because an ultralight itself requires no license and can be flown by unlicensed pilots, many agricultural-spray jobs now can be done by the landowner for much lower cost than would be charged by commercial crop sprayers.

—E. F. Lindsley

# Ford's aero van

The sleek, aerodynamic Aerostar concept vehicle is a sneak preview of Ford's new mini-van, due out in 1985. The rear-drive van seats seven and has a one-ton payload. Ford predicts EPA mileage of up to 40 mpg, highway. Production Aerostar vans will closely resemble the concept vehicle, but they will differ in details such as grille and headlights.



By **JIM DUNNE**

**F**ord gave mini-van watchers a glimpse of the small van it plans for 1985 introduction when it unveiled the Aerostar concept vehicle recently. The company confirmed that the new van will be smaller, lighter, more aerodynamic, and more fuel efficient than Ford's present full-size van. Two versions will be offered: a commercial van and a station-wagon type that seats seven in a two-two-three arrangement.

One of the more interesting chassis details is a rear-drive axle, which is contrary to the way Chrysler and some imports build their small vans. "Front-wheel drive has some drawbacks we wanted to avoid in our small van," says Phil Benton, Ford sales vice-president. "Aerostar is rated to carry a 2,000-pound load inside or to pull a

trailer up to 5,000 pounds in weight."

Benton also points out the benefits to the driver of having the engine in front (in contrast to some imports): "We think some van buyers like the idea of having an engine ahead of them if there is an accident. Also, the driver and front-seat passenger do not have to climb over the front wheel wells to get into the cab, as in mid-engine [Toyota] and rear-engine [Volkswagen] vans."

Three engines will be offered: 2.3-liter (140-cu.-in.) four-cylinder and 2.6-liter (159-cu.-in.) V6 gasoline types and a turbo-diesel four. With a five-speed manual transmission, the four-cylinder gas engine is expected to deliver EPA fuel economy of 30 mpg in the city and 40 mpg on the highway. A four-speed automatic imported from Germany will be optional.

Aerostar is 174.9 inches long, with a 119-inch wheelbase. The long wheel-

base is important for ride; it prevents the pitching that occurs when a stiff suspension is set in a short span. That's why Aerostar's rear wheels are set so near the rear of the body.

Aerodynamics is stressed in the body shape, though the production Aerostar will be less dramatic in appearance than the concept vehicle. Also, the production vehicle's windows will be recessed slightly and not be completely flush as shown on the concept vehicle.

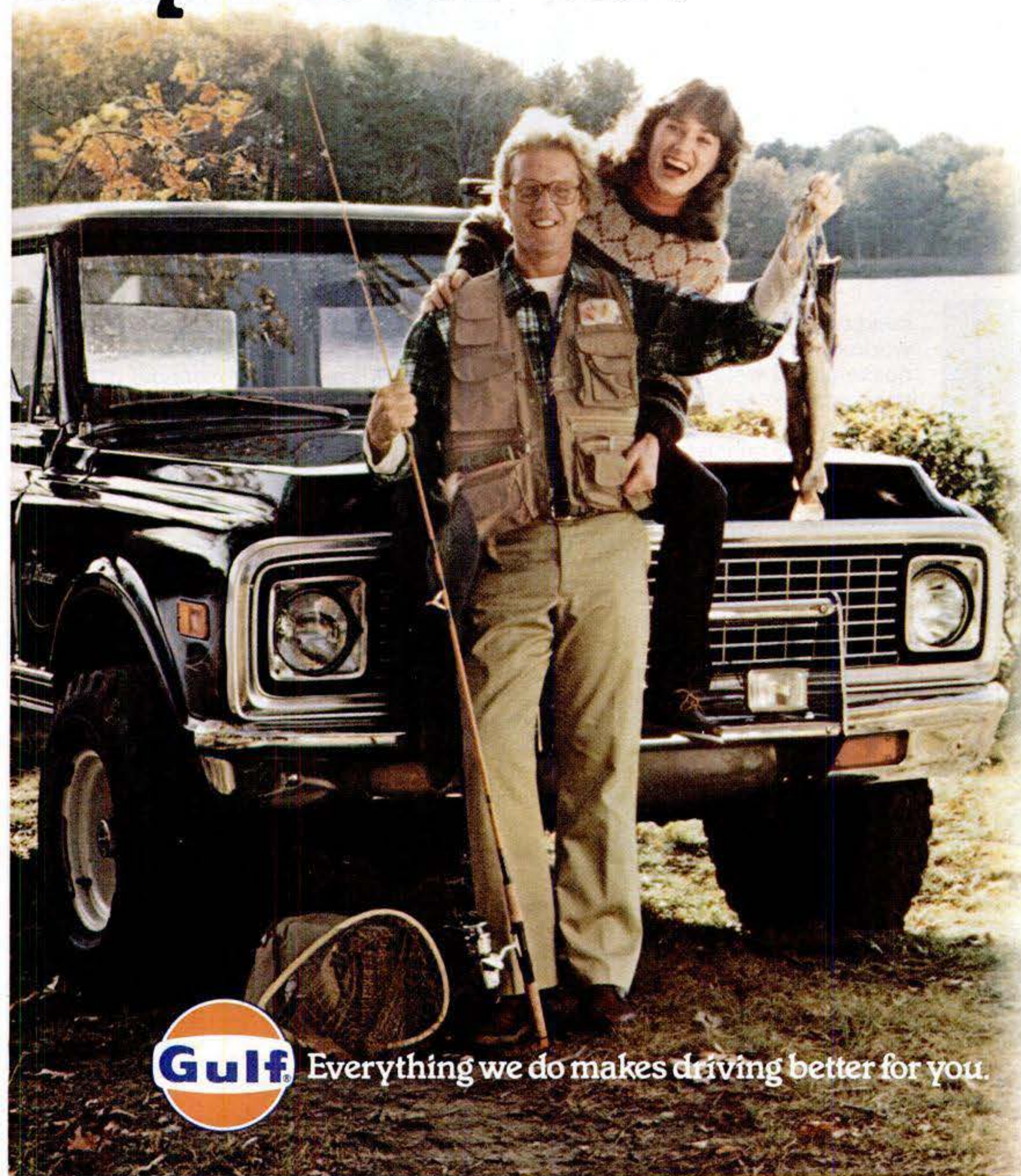
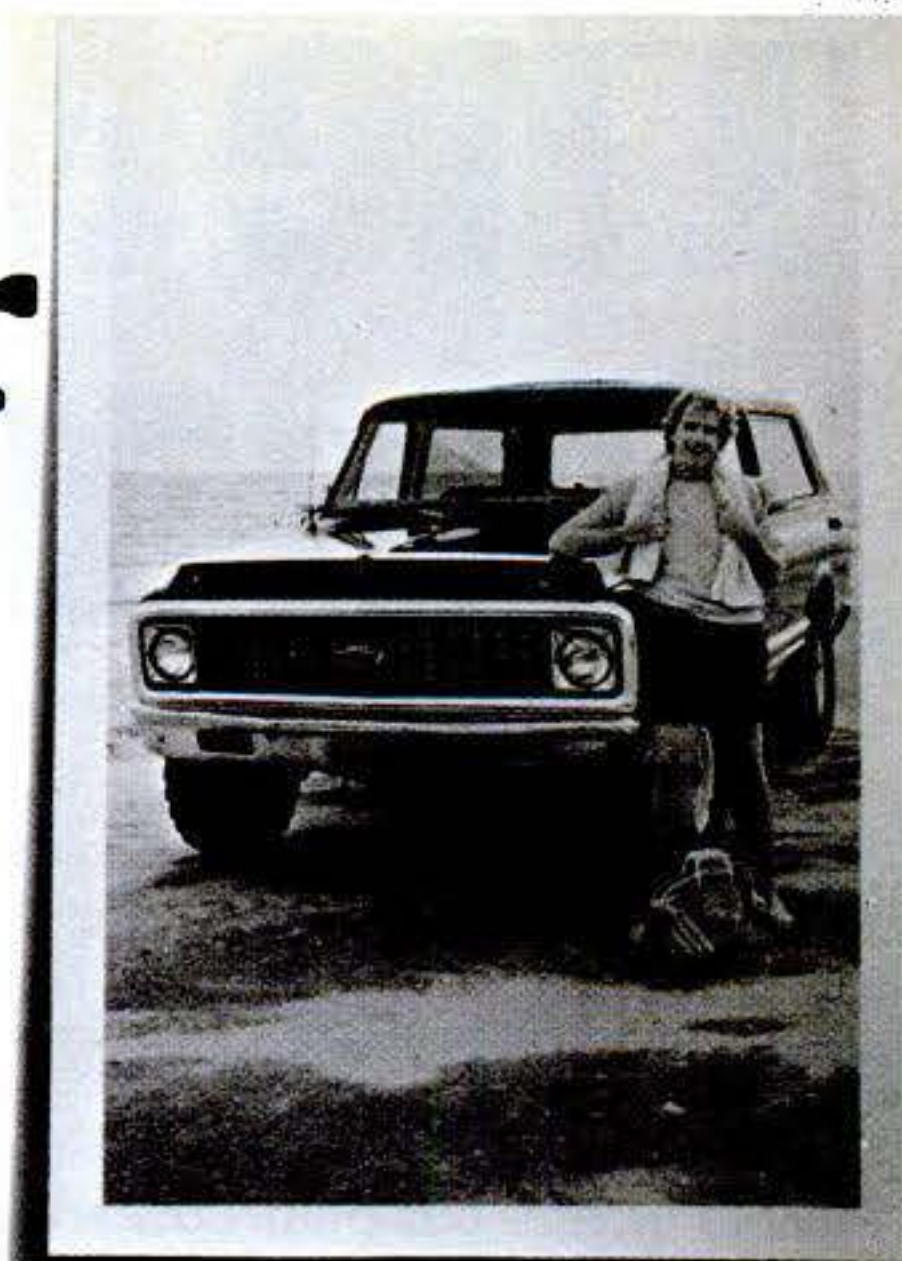
The shaped lens for the headlights will be foregone in favor of conventional rectangular lamps with almost flat lenses. And look for the production grille to be more open for better engine cooling.

Ford will continue to produce its full-size van and sell it alongside the Aerostar. With that arrangement, the new van is expected to be priced below the full-size model. **PS**

# In '72, I drove this car to Lauderdale for Spring Break.

# The girl I caught staring at it married me the next year.

# Do you think I'd use just any motor oil?



A '72 Blazer, raised on Gulfpride®

To this day, my wife swears she married me for it. So you could say I have a stake in keeping it running right.

Which is why there was Gulfpride in the crankcase back then. And why it's still there now.

Of course, after 11 years, you can bet this car has had its share of dents and dings. What 4x4 hasn't? But for all the rough road work I've put it through, the engine still purrs like a kitten.

So I'll keep changing the oil every couple of months. And I'll keep right on using Gulfpride.

After all, my wife says she'd leave me if it weren't for this car.

I know she's kidding. But still, I'm not taking any chances.



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Get a \$2.00 rebate when you buy 5 quarts of any grade of Gulfpride oil. For details, look for Gulfpride displays at participating retailers.



Everything we do makes driving better for you.

# The Nautilus legend to save your back.

At this moment, 75 million Americans suffer with chronic back problems. Assuming present trends continue, by tomorrow morning 20,000 new victims will be hurting along with them.

Whether or not you become a prisoner of your back too, could depend on a pleasant, pain-free exercise requiring less than a half hour of your time a week. On an extraordinary new invention from Nautilus®—the company that revolutionized the science of exercising.

Without question, this new Lower Back Machine is the single most important piece of exercise equipment ever invented for home use. Here's why:

## Exercise for an exercise-starved muscle.

While the specific causes of back pain vary greatly, it is estimated that as much as 90% of back problems can be traced to weak muscles.

Exercise specialists at Nautilus created this new machine solely to work your *erector spinae*—the critical muscle mass in your lower back that

helps support your spine. It will strengthen it, increase its flexibility and help reverse the ill effects of bad posture, tension, gravity's constant compression of the spine—including the general weakening of this major muscle from a life of inactivity. Being a chair-sitting executive may be a necessity for your career, but it's bad for your back.

## The fast road to progress.

The Lower Back Machine gives you the same proven, high-efficiency method of muscle conditioning as the most expensive Nautilus commercial machines. An ingenious arrangement of precision cams provides *variable resistance*—to match the strength curve of a specific muscle through its entire movement. (At a point where the muscle is weaker, your Nautilus eases the weight; where the muscle is stronger, the machine increases the load.)

This revolutionary approach to conditioning allows a muscle to be worked far more efficiently than with conventional weight lifting or calisthenics. You get remarkably fast results—safely and without straining. In as little as 10 minutes a day, three times a week.

## A stronger back two ways.

The procedure is as simple as reclining in an easy chair. You sit on the inclined seat, lean back against the firmly padded cushion and slowly push the movement arm back as far as possible—through a 70° range of motion. Producing a pleasant, invigorating warmth in your lower back as you exert these neglected muscles. Then—

slowly—you come forward, releasing yet still pressing against the machine's resistance. The Nautilus cam strengthens your muscles on both the back and forward stroke. This positive/negative resistance method is essential to balanced muscle development.

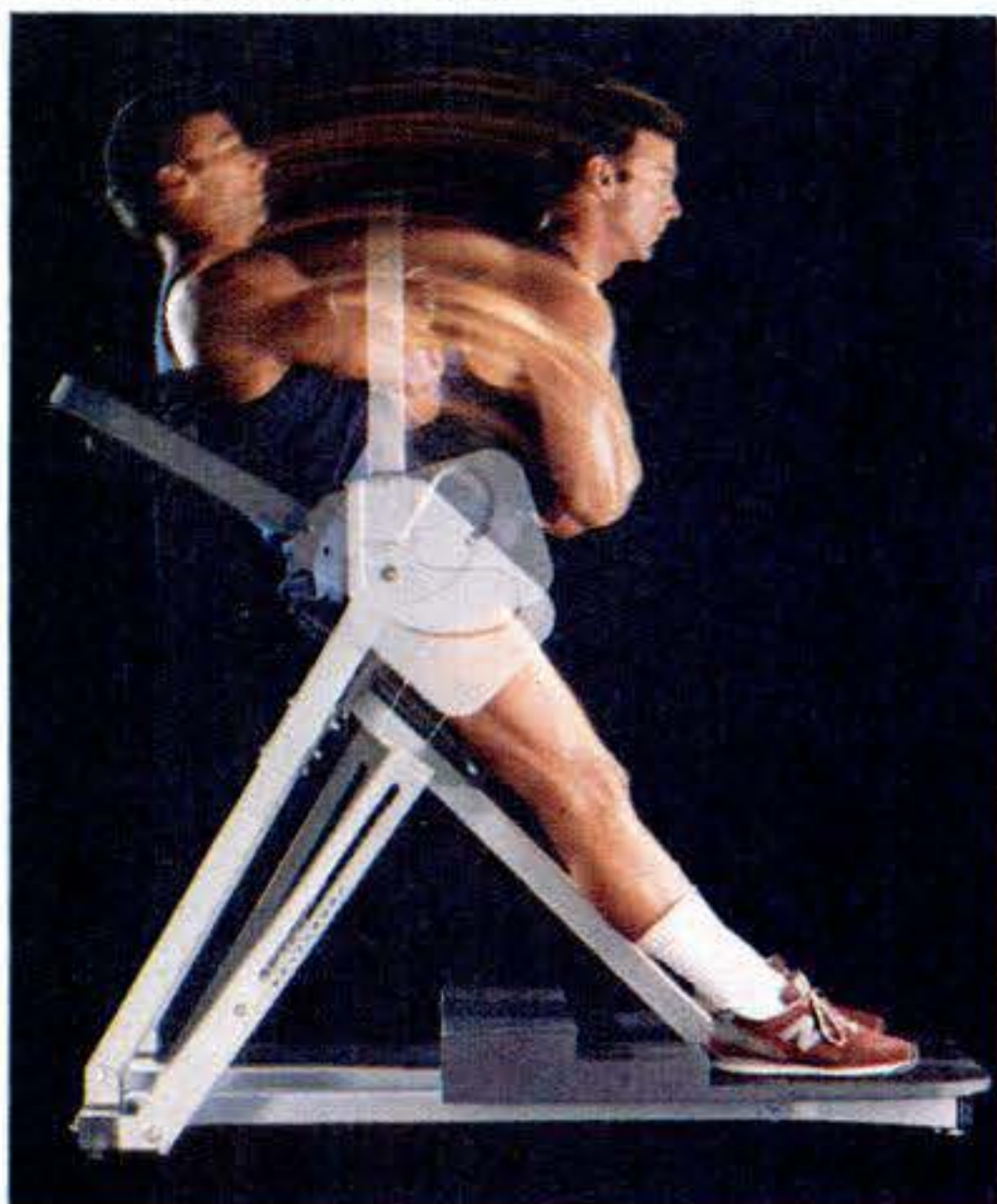
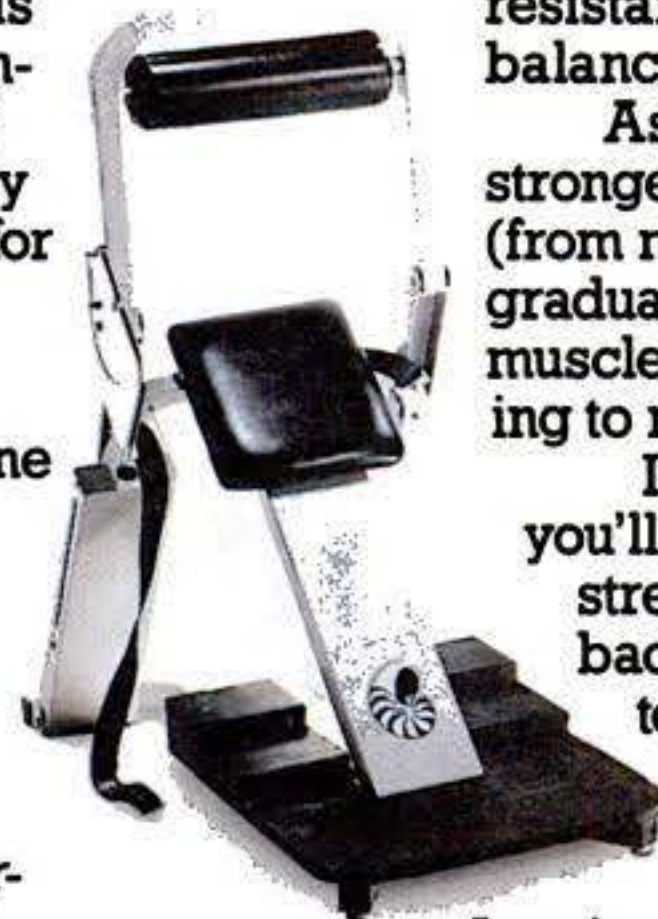
As your back grows stronger, nine tension settings (from mild to strenuous) let you gradually increase the load. A muscle needs constant challenging to remain vigorous.

In only a week or two, you'll notice a new feeling of strength and power in your back. Your posture is better, you're standing taller.

## Nautilus succeeds where ordinary exercise fails.

Jogging, tennis and cycling are great stamina builders, but do practically nothing to strengthen your back muscles. Ordinary back exercises such as extensions (raising and lowering your torso, on your stomach), and "dead lifts" (hoisting weights from the floor with knees locked) can lead to muscle strains and dangerous compression of the vertebrae.

This is the only machine in the world designed specifically



While you exercise, the machine's resistance is always perpendicular to your spine. As you travel through the range of motion, the vector of resistance moves with you—forces are never pressing down on you.



# comes home

to strengthen the lower back. No other exercise device or program even comes close.

### **A friend for life.**

In building their first home machine, Nautilus sacrificed none of their legendary quality. The

heavy tubular steel frame will stand up to years of use.

Tough, double gauge Naugahyde over high density foam covers all body contact surfaces. Assembly takes less than 20 minutes (only 8 bolts to tighten and you're finished). Requires just a common screwdriver and wrench.

Measures 54 x 51 x 35", weighs 150 lbs. Disassembles

easily into compact sections for quick storage.

And you don't even have to move a muscle to own it. The Lower Back Machine is available to you by mail with a free phone call to The Sharper Image. Comes with full instructions, exercise program and 90 day warranty.

### **A better back or your money back.**

In the past 12 years, Nautilus has changed the way the world exercises. Every day, 3½ million Americans improve their physical fitness on Nautilus equipment—in countless gyms, health clubs and professional sports facilities. Nautilus now brings that wealth of experience to your home.

The Nautilus Home Lower Back Machine will soon be selling for \$485. To introduce this unique home Nautilus, orders placed before the end of April will be processed at the special price of \$435, plus delivery.

When your machine comes, try it for 30 days without risk. You must notice a dramatic improvement in your back strength, posture and sense of well-being or return it for a full refund (including the delivery charges).

Call or write today. And start now to build a strong, healthy back.

## **ORDER TOLL FREE**

For fastest delivery, credit card holders please call toll free. Order product #MNT100 for the Nautilus Lower Back Machine. Or send a check for \$435 (before April 30) plus 55.00 delivery. CA residents add 6% tax.

**800-344-4444**

Overseas/Canada (415) 344-4444

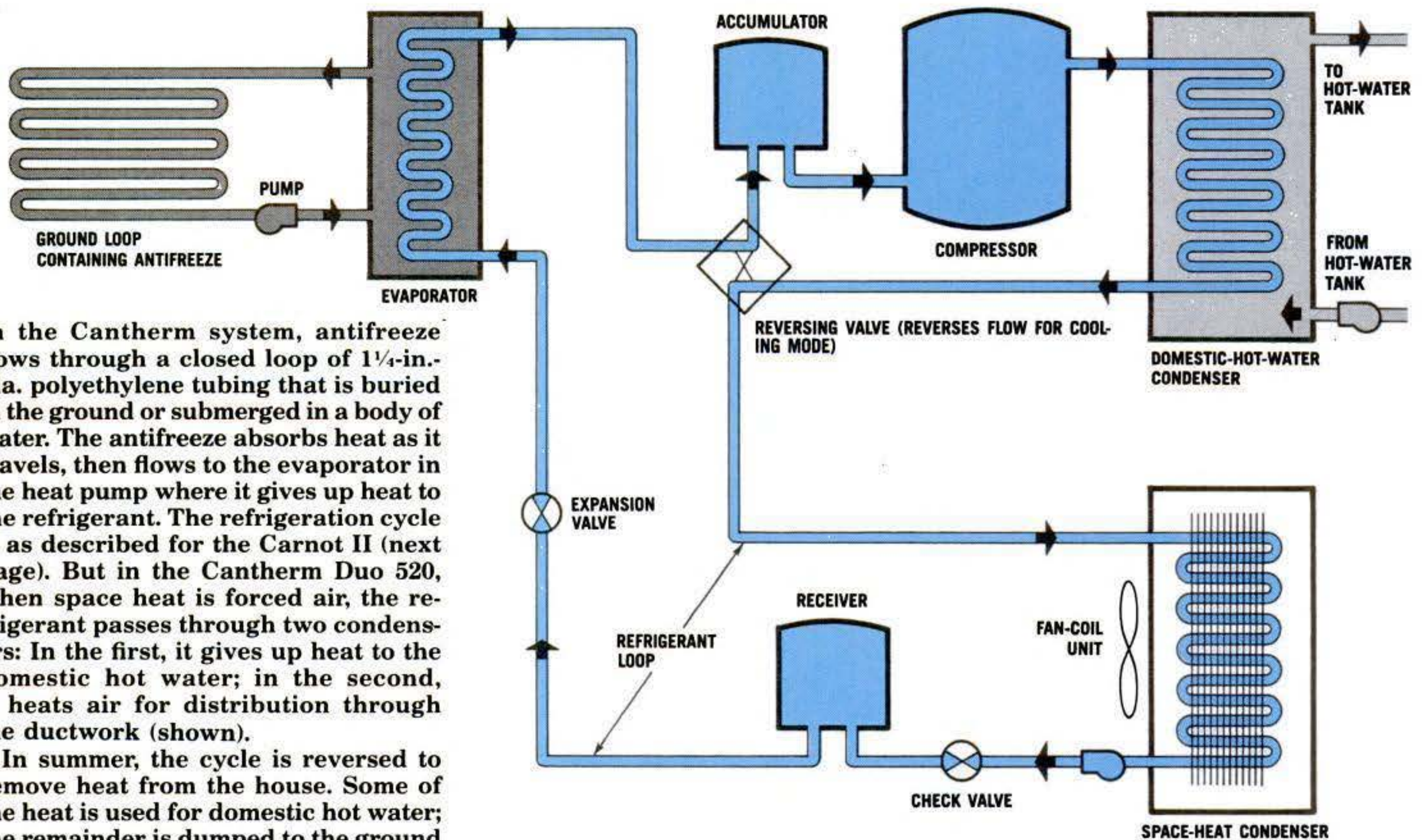
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# Multi-source heat pumps

Two new heat pumps offer a choice of heat sources: One gets a solar boost and can use ground water or city water as a backup source; the other absorbs heat through a closed loop that can be buried underground or submerged in a lake, pond, or river.



In the Cantherm system, antifreeze flows through a closed loop of 1/4-in.-dia. polyethylene tubing that is buried in the ground or submerged in a body of water. The antifreeze absorbs heat as it travels, then flows to the evaporator in the heat pump where it gives up heat to the refrigerant. The refrigeration cycle is as described for the Carnot II (next page). But in the Cantherm Duo 520, when space heat is forced air, the refrigerant passes through two condensers: In the first, it gives up heat to the domestic hot water; in the second, it heats air for distribution through the ductwork (shown).

In summer, the cycle is reversed to remove heat from the house. Some of the heat is used for domestic hot water; the remainder is dumped to the ground (or water) via the antifreeze loop.

By V. ELAINE SMAY

Drawings by Eugene Thompson

A heat pump is an efficient machine for converting electricity to heat because it uses energy to move and amplify heat, not simply to produce it, as electric-resistance elements do. Air-to-air heat pumps [PS, July '78], move heat from the outside air into the house. Ground-water heat pumps [PS, Feb. '78] absorb heat from well water. Ground-coupled heat pumps [PS, Oct. '83] tap the heat of the earth. And solar-assisted heat pumps [PS, May '78] use a solar-heated fluid.

Two recently introduced heat pumps give you a choice

of heat sources. The Cantherm, developed by a Swedish company, can be ground or water coupled: It can draw heat from the earth via a glycol antifreeze solution that circulates through 1,200 feet (or more) of buried polyethylene tubing, or the antifreeze loop can be submerged in a body of water. The Carnot II Vapor/Compression Furnace from Fedders can be a solar-assisted, ground-water, or ground-coupled heat pump. For maximum efficiency it is rigged as a solar-assisted heat pump with ground water, city water, or a ground-coupled loop as the backup source.

Both of these heat pumps provide heating, cooling, and domestic hot water efficiently. Both cost a hefty sum to

Continued



# "We just bought our 4-year old an American Eagle."



"It was the only logical choice, really. Because Eagle does certain things no ordinary automobile could begin to do, *some* of which the little guy appreciates a *lot*.

Like Eagle's ability to switch from 2-wheel drive into 4-wheel drive to take him places other cars just couldn't go. His favorite campsite on Squirrel Lake, for example.

Of course, we happen to be impressed with Eagle's 4-wheel drive traction for other reasons, as

well. Especially for the feeling of confidence it gives us when the weather is stormy... when the roads are wet or icy... and *he's* with us.

Frankly, he doesn't really care much that Eagle switches back into 2-wheel drive for excellent gas mileage.\* (Some day he'll appreciate the value of a dollar!) But it's something that meant a lot to us.

He also *claims* to be indifferent to Eagle's luxurious amenities. ("What's an amenity, Mom?") But

you should have seen the look on him when he saw the optional leather seats, stereo tape deck and power windows!

Why'd we buy him an Eagle instead of an ordinary car? Purely selfish reasons. After all, he lets us use it, too!"



Now available for purchase or lease at participating dealers.

## THE 2-WHEEL/4-WHEEL DRIVE



\* (24) EPA EST MPG, 30 HWY EST. 4-cylinder/4-speed. Use these figures for comparison. Your results may differ due to driving speed, weather conditions and trip length. Actual highway figures are probably lower.

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9 mg. "tar", 0.7 mg. nicotine av. per cigarette, FTC Report MAR. '83.

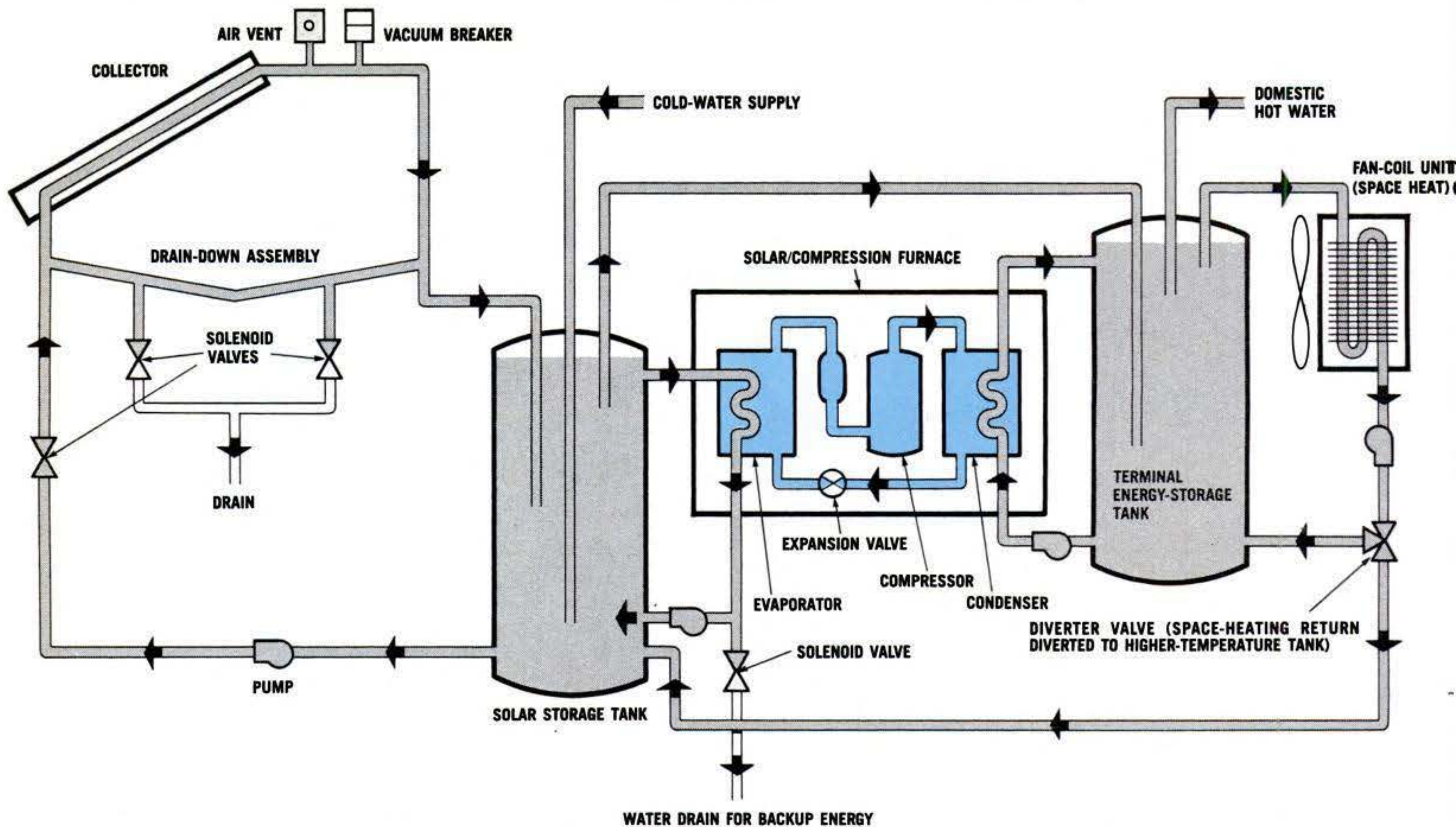
# THE TASTE OF SUCCESS



# VANTAGE

Great Taste with Low Tar.  
That's Success!

## Multi-source heat pumps



In its ultimate configuration, the Fedders Carnot II is a solar-assisted heat pump that uses ground water, city water, or a ground-coupled loop as the backup heat source. Fedders calls this the Sweetwater system. Here's how it works: In heating mode, water from the solar tank circulates through the evaporator, where it gives up heat to the refrigerant, a fluid selected for its low boiling point. The refrigerant boils and goes to the rotary compressor, where its pressure and temperature are increased. From there, the hot gas travels to the condenser, where it gives up

heat to the water circulating from the terminal energy-storage tank. In the process the refrigerant gas condenses, passes through an expansion valve into a low-pressure area, and returns to the evaporator to repeat the cycle. Water from the top of the terminal energy tank is drawn off for domestic needs and pumped through radiators or to a fan-coil unit (as shown) for space heat.

When water in the solar tank falls below 47 deg. F, the control system activates the drain-down valve to drain the collectors. Then the backup system comes on: Under pressure of a pump

or city water main, water flows into the solar tank and from there to the evaporator, where it gives up heat to the refrigerant. The source water then drains into an injection well or city sewer. (With a ground-coupled system the water is recirculated through the loop.)

For air conditioning, water chilled in the evaporator is routed to the terminal energy tank and fan-coil unit (lines not indicated). Water heated in the condenser is stored in the solar tank for domestic needs. Any unneeded heat is discharged to the ground water or outdoors through a fan coil.

install, but both companies claim a reasonably short payback in many installations.

Engineers determine the heating efficiency of a heat pump by dividing energy output by input to come up with a ratio called the coefficient of performance (COP). With ground water entering the Carnot II at 55 degrees F and the water for space heat leaving at 120 degrees, the heat pump's COP would be 3.29 (at a 19-gallon-per-minute flow rate). Electric-resistance heat operates at a COP of one.

With an entering water temperature of 90 degrees F, as it often would be from a solar collector, the COP of the Carnot II would be an even more impressive 4.09. This heat pump, which uses a rotary compressor, can operate with entering water temperature as low as 47 degrees and as high as 120. "But at 120 degrees the solar-heated water would go directly to heat the house," says Sal Giordano, assistant to the director of sales at Fedders.

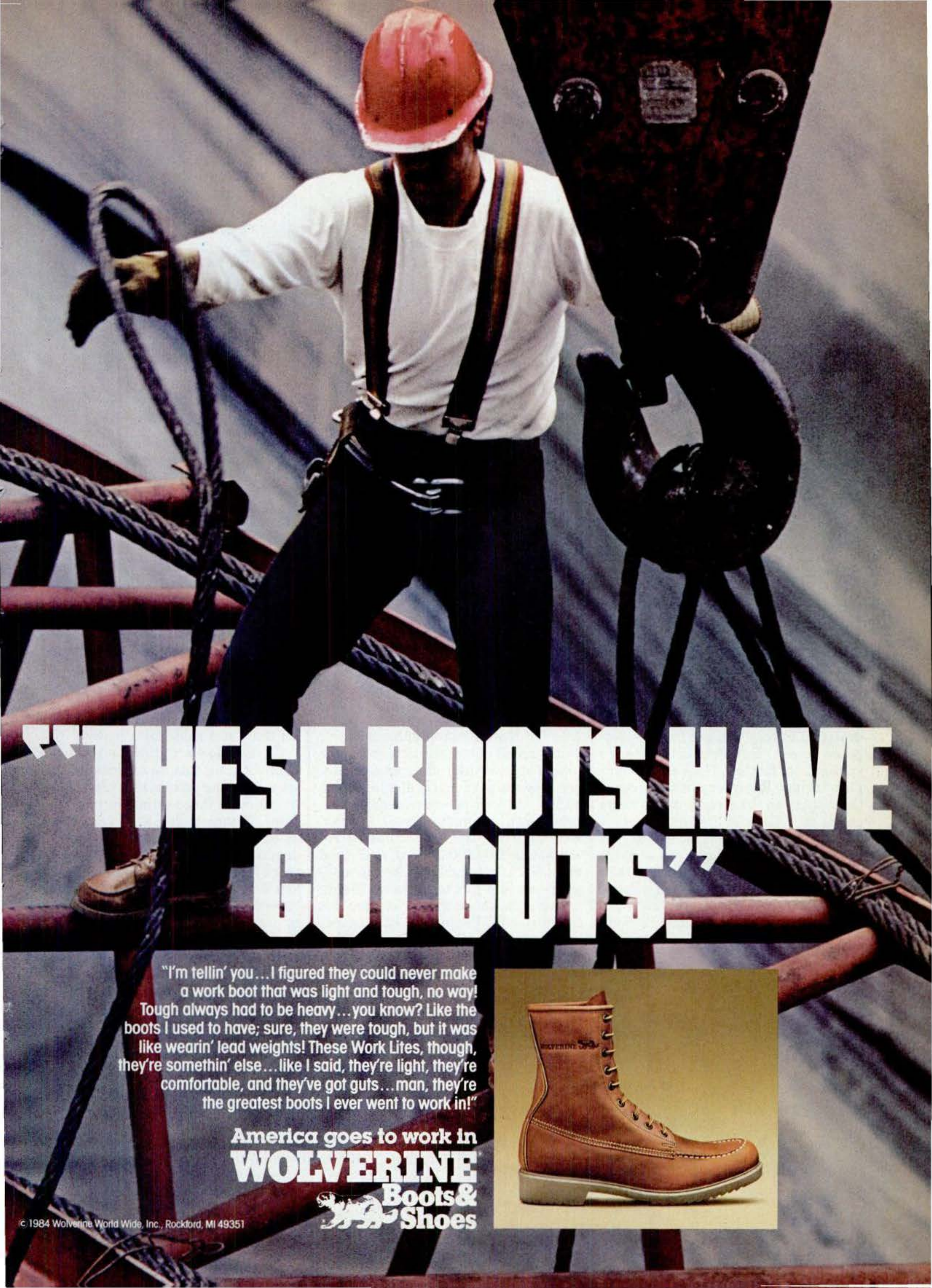
Likewise, the efficiency of the Cantherm depends on the temperature of the antifreeze as it enters from the ground- or water-coupled loop. When the temperature is 32 degrees F, a typical system might perform at a steady-state COP of 2.8, according to the company. With an entering temperature of 50 degrees, the COP climbs to three. "We claim a seasonal COP of three, including parasitic losses,"

says Reginald Gignoux, Cantherm's director of marketing.

A heat pump's (and air conditioner's) cooling efficiency is stated as another ratio, called the energy-efficiency ratio (EER). The Carnot II can perform with an EER of up to 15. "The best air conditioners today rate an EER of around 12," says Giordano, "and we consider anything above 7.5 a high-efficiency model." The Cantherm works at an EER of 11 (assuming antifreeze is at 50 degrees F).

The cost to install either system would likely range from \$7,500 to \$10,000. Both companies use computer simulations to determine how long it would take for an installation to pay for itself through energy savings. In many examples, a payback of five years or even less is predicted. But only by using numbers relevant to a given situation can the makers estimate a payback for a site.

The Carnot II, from Fedders Solar Products (Edison, N.J. 08817), comes in 20,000-, 40,000-, and 60,000-Btu/h capacities, and can provide either hydronic or forced-air heat. The Cantherm Duo 510 heat pump provides forced-air heat and air conditioning; the Duo 520 can provide forced-air or hydronic heat, air conditioning, and domestic hot water. Heating capacity ranges from 40,000 to 57,000 Btu/h. Cantherm (1475 Shelburne Rd., S. Burlington, Vt. 05401) offers an information packet for \$1.



# "THESE BOOTS HAVE GOT GUTS."

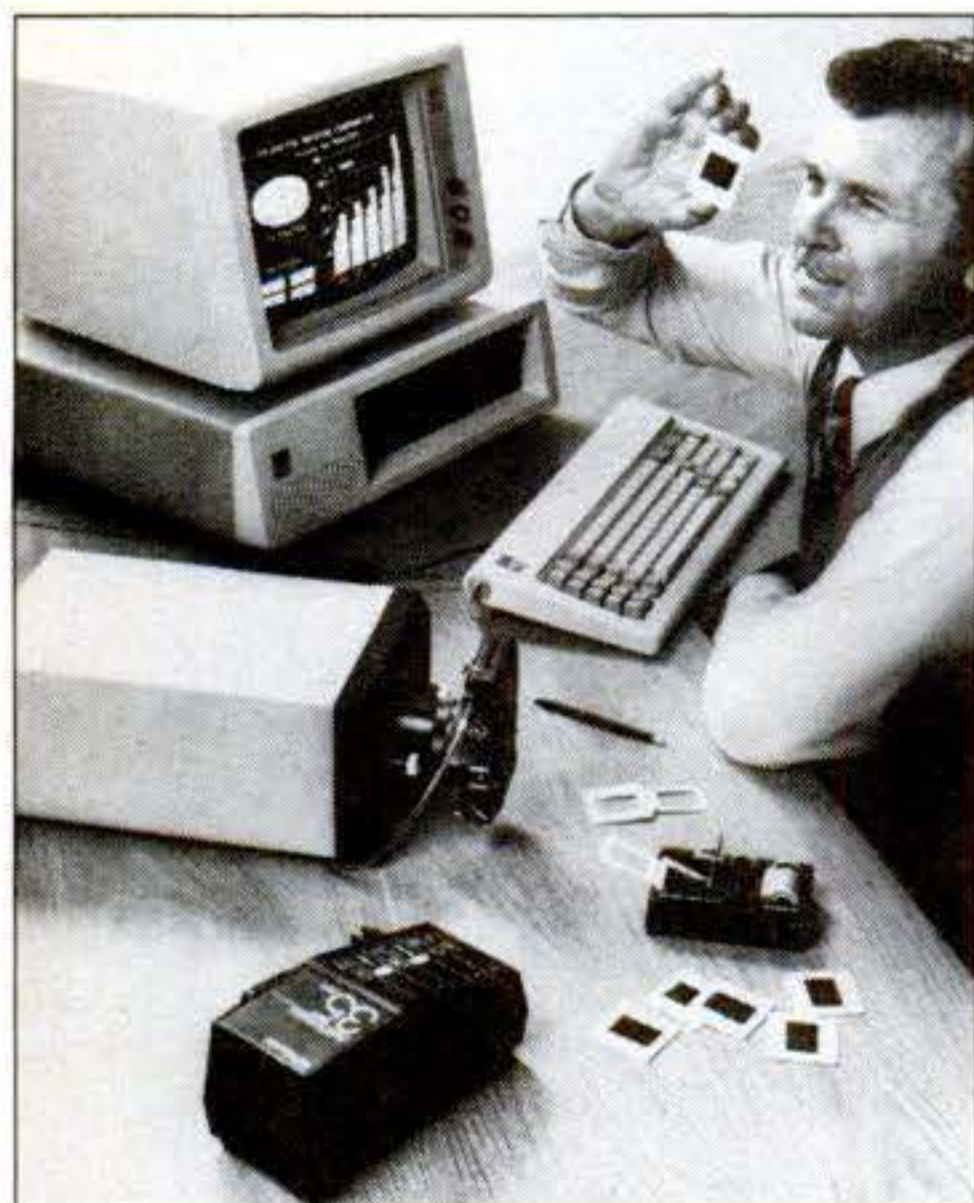
"I'm tellin' you... I figured they could never make a work boot that was light and tough, no way! Tough always had to be heavy... you know? Like the boots I used to have; sure, they were tough, but it was like wearin' lead weights! These Work Lites, though, they're somethin' else... like I said, they're light, they're comfortable, and they've got guts... man, they're the greatest boots I ever went to work in!"

America goes to work in  
**WOLVERINE**  
Boots & Shoes



# Through the Viewfinder

By EVERETT H. ORTNER



## Computer pictures

It's hard to tell where photography begins and electronics ends anymore. Take the new Polaroid Palette Computer Image Recorder, for instance. Is it a photographic system or a computer peripheral? Like the Kodak Instagraphic Imaging Outfit introduced several months ago [PS, Dec. '83], it's designed to copy images from a computer screen. But Polaroid takes its system a lot further: The Palette Computer Image Recorder not only copies the display on the screen, it also helps create it.

There are two parts to the \$1,499 Palette system: the photographic hardware and the computer peripherals. The photo hardware consists of a Polaroid pack camera back for 3¼-by-4¼ instant prints, an SLR-camera body

(Minolta XG-A) with autowinder, and the necessary equipment to process Polaroid Autoprocess (instant) 35-mm slides.

On the computer side, you get a diskette that programs the Palette system, cable connections to your computer (IBM PC, Apple IIe, and Apple II Plus now; DEC Rainbow-100 coming), and, most important, an Image Recorder (middle left in the first photo). It contains what Polaroid calls an "exposure unit"—a small CRT with a color filter wheel. That's an ingenious device that enables you to add color to an image, even when you have only a black-and-white computer monitor. Using the Palette program with your computer, you control the red, green, and blue filter wheel in the Image Recorder to change the colors in any area of a graph. The result is a photographic image with virtually double the resolution of the video image, says Polaroid—and, of course, via Polaroid magic, in eye-catching instant slides or prints.

## Economy route

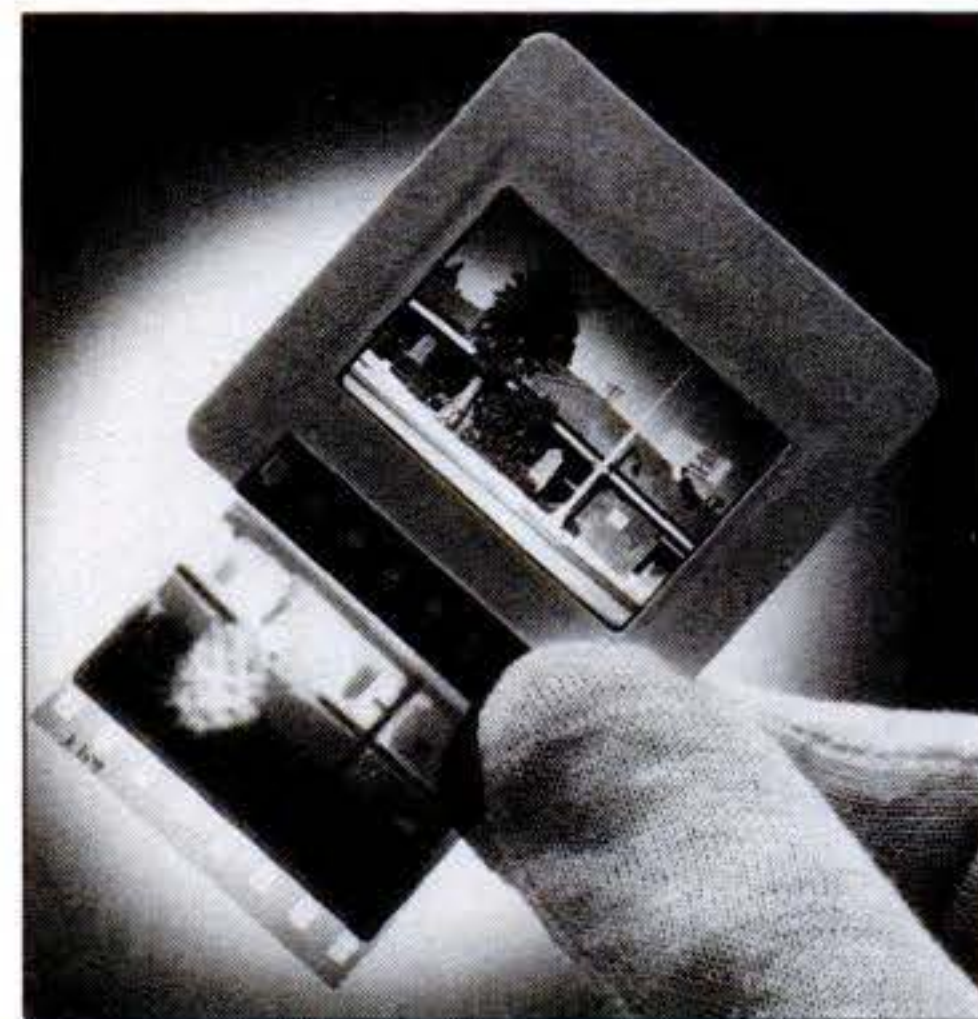
Like the Kodak Instagraphic Imaging Outfit noted above, the Screenshooter (photo at lower left) offers an economical way to turn CRT displays into slides and prints—provided you already own a computer and an SLR camera. The \$169 kit includes a Polaroid OneStep 600 camera, CRT hood and hood adapter, diopter lens to mate your camera to the system, 35-mm camera bracket, and carrying case. It's made by NPC Photo Div., 1238 Chestnut Street, Newton Upper Falls, Mass. 02164.

## Masked marvels

The big problem with making a print from a slide is contrast. (Subtle pictures lose their subtlety. Dark tones get darker. Middle tones fade out.) Or rather, it's a big problem with ordinary mass-pro-

duction prints. With money, the problem disappears. Order a custom print from an expensive color lab, and it's likely the lab will make a mask that will reduce the contrast and give you a print that almost exactly reproduces your original slide.

What's a mask? It's a negative image of the slide that the lab binds in con-



tact with the slide in making a print. By neutralizing some of the extreme tones of the slide, the mask reduces the contrast range of the slide to a point at which it can be reproduced in the more limited contrast range of color paper. Highlight and shadow areas particularly benefit. The mask need not be in color; in fact, a black-and-white mask can lower contrast without changing color saturation. But all that, as I said, costs money.

Or did. Now a California processor claims that it has an automated contrast-masking process that can be used to produce large volumes of prints from 35-mm slides at a reasonable price. The technique, says Marc Madow, director of research and development for Solarcolor (7310 Laurel Canyon Blvd., N. Hollywood, Calif. 91605), "speeds the process of making masks to over 100 times faster than conventional methods."

The 35-mm masks are produced by an optical method without removing the slides from their mounts. After the mask is processed, it is put into register with the slide—again without removing the mount—by a proprietary device.

The prints I have seen—made on Cibacrome—are handsome indeed. Solarcolor has been test-marketing the system in the Los Angeles area for some time and is planning to sell the system to processors nationally. Four sizes of prints are available: 2R (2½ by 3½ inches) for 85 cents, 3R (3½ by five) for \$1.75, five by seven for \$5, and eight by 12 for \$12.50. **PS**





## Engineering innovation. Just for the fun of it.

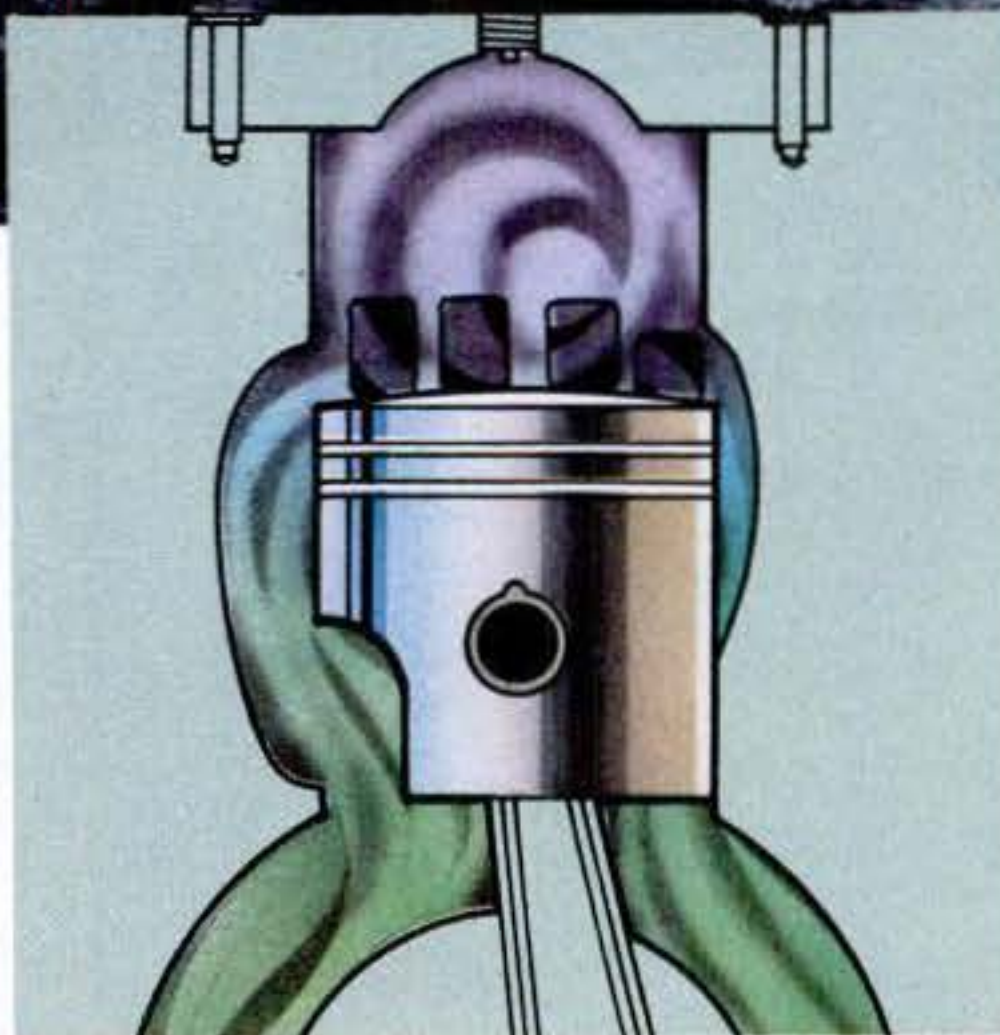
Your satisfaction is the bottom line.

That's why Johnson's engineering leadership is dedicated to making dependable outboards that start quicker, run faster and last longer. With fuel efficiency.

It's all part of the reason why, throughout the world, more boaters run Johnson® outboards than any other brand.

Johnson, for example, pioneered Loop-Charged cylinders in American outboards years ago. It's now featured in mid-power models from 50 to 75 hp.

But we've added this cylinder design carefully and selectively. Because Loop-Charging maximizes power and efficiency only when it's part of a total and unique engineering package. At Johnson, innovative tuned exhaust, electronic ignition and cooling systems — and other custom components —



have been integrated in these engines.

It's the precise compatibility of all these elements, not just Loop-Charging, which results in outboards that start so easily, pop up skiers so powerfully and run so far on so little fuel.

You might expect the worldwide leader to have the corner on technology. But, most importantly to you, we know when and where to apply it.

Johnson outboards are sold and serviced by a nationwide network of top dealers. For the name of the one nearest you call 800-447-2882.

**Powerful technology from the world leader.**

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**OUTBOARDS**

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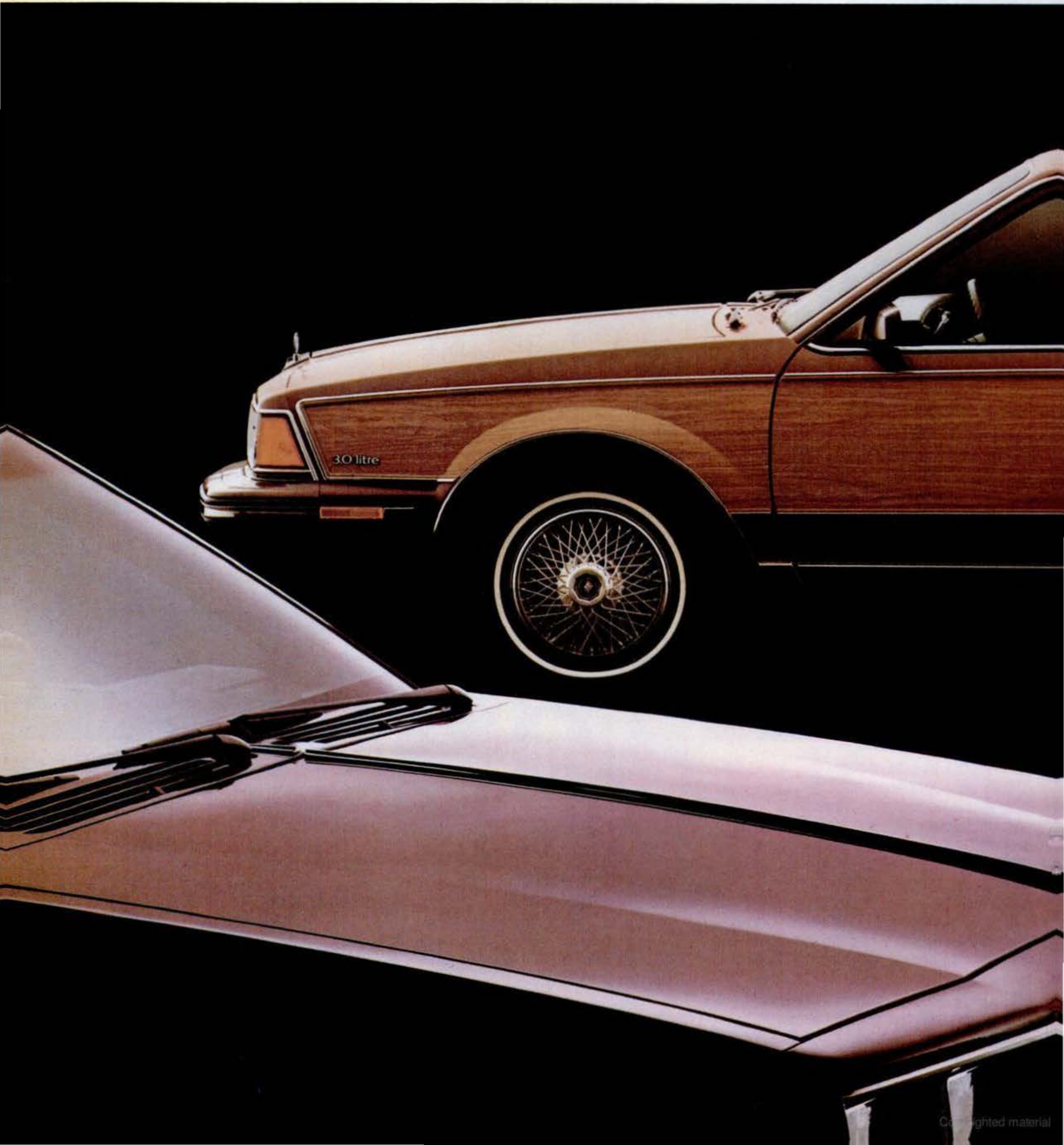
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# A logical extension of the Buick philosophy.

Introducing the Buick Century Estate Wagon. What makes it exceptional is that, in addition to the spaciousness and convenience of a traditional station wagon, it also offers you all

the advantages of a very advanced Buick.

It has the tight, firm control of front-wheel drive. The confident, dependable performance of a computer-controlled V-6 engine. And the





smooth, quiet ride provided by its computer-  
ned suspension system.

Beyond these highly advanced characteris-  
s, you will also appreciate the careful  
attention to workmanship that goes into the  
new Century Wagon—and into all new Buicks.

Of course, you will also discover the plush,  
comfortable, convenient interior that discrimi-  
nating car owners have come to expect in  
Buicks.

If you're looking for a wagon that offers  
more than just extra space,  
visit your Buick dealer and  
buckle yourself into the  
Century Estate Wagon.

Not only is it logical.  
It's also very, very  
comforting.

Official Car of the XXIIIrd Olympiad  
Los Angeles 1984



**Wouldn't you really rather have a Buick?**



Some Buicks are equipped with engines produced by  
other GM divisions, subsidiaries or affiliated companies worldwide.  
See your Buick dealer for details.





# Come to Marlboro Country.



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

17 mg "tar," 1.1 mg nicotine av. per cigarette, FTC Report Mar.'83

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

## What's News

Why should an engineering innovation that flopped dismally in the 1960s become a hot item in the car world of the 1980s? That's a question Jim Dunne, POPULAR SCIENCE senior automotive editor, set out to answer for this month's cover article. "There wasn't much incentive 20 years ago for car makers to bother with complex hang-on systems designed to boost power output from engines," Dunne says. "It was easier to simply build them bigger." During the horsepower race of the '60s and early '70s, engines got so big that some cars had V8s displacing as much as 500 cubic inches.

The first oil embargo in the early '70s changed all that. Mileage was suddenly on everyone's mind as the price of gasoline and diesel fuel skyrocketed. But even \$1.35 per gallon of fuel hasn't snuffed out all interest in the performance big engines can give. Auto makers, however, can't go that route today. Big engines would wreck the CAFE (corporate average fuel economy) figures for most car companies and bring on the levying of federal fines for gas-guzzler models. The way out of this dilemma? The turbocharger—the same device that flopped in the '60s. To find out what was behind this revival, Dunne interviewed domestic car makers, importers, and Garrett, which pioneered automotive-turbocharger engineering. His illuminating report appears in this issue. Staff photographer Greg Sharko took the cover photo of a Garrett turbine.

### Passive restraints

Another automotive-engineering issue that's stirring up controversy these days is the question of passive restraints for car occupants ["Belts vs. Bags," PS, Oct. '78]. Some cars already offer passive belt systems; these aren't controversial. But bring up the subject of air bags, and the debate heats up. Most auto makers strongly oppose installing air bags; only Mercedes currently offers one.

I recently got "air bagged" in a

Mercedes 300 SD. (This was only a demonstration; I didn't have to crash the car to make the air bag deploy.) It was a breathtaking experience. While a Mercedes engineer counted down, I gripped the car's steering wheel, anticipating impact. But the air-filled pillow deployed and deflated before I heard the countdown end. Immediately afterward, my nose and cheek were numb. A Mercedes engineer speculated that the air bag had smacked my left hand into my face when I apparently raised it to protect myself.

Although the experience was less than pleasant for me, Robert LaRoche has an entirely different perspective on the matter. LaRoche and his wife were driving on a country road near Amarillo, Texas. They were not wearing seat belts when an oncoming car forced LaRoche's Mercedes 500 SEL off the road. The car flew some 40 feet into a ravine.

"My wife was bloody," LaRoche later told a Department of Transportation hearing on passive restraints. "I didn't have a scratch," he testified. Why? LaRoche's Mercedes had a driver-side air-bag system. LaRoche told the government hearing that he'd now like to have a car with two air bags.

But LaRoche and anyone else who desires such a system will have to wait until at least next fall to get one. That's when BMW will begin importing cars with optional front air bags.

Meanwhile, the only air bags available on production cars are those you can order on Mercedes S models. The Mercedes air bags cost \$880, regardless of what model you buy. The company expects to sell about 4,000 air-bag-equipped cars this year.

### Air bags for domestics?

During congressional hearings late last year, Ford urged the government to start a new air-bag field test that would require auto manufacturers to equip five percent of their cars with passive restraints "to allow the nation to finally determine how effective and

how acceptable passive-restraint technology really is."

Helen O. Petrauskas, Ford's vice-president of environmental and safety engineering, who made the proposal, told the hearing that "before the American public invests billions of dollars in new technology, we must be certain of the effectiveness of air bags and passive belts."

But General Motors already has a huge amount of experience with air bags. Between 1973 and '76, GM put air bags into 11,281 cars. The National Highway Traffic Safety Administration has kept close watch on what has happened to those cars. Through last January 1, there have been 274 air-bag deployments in accidents involving these cars. Only 13 persons were killed in the crashes—most of which were severe impacts with high closing speeds. According to William Scott, director of NHTSA's National Center for Statistics and Analysis, the experience with the air-bag-equipped cars has been "very positive."

Despite this, many still oppose installation of air bags in all cars. Critics are concerned about both the expense and reliability of air bags. There seems to be no clear-cut answer to what air bags need to cost. We do know what Mercedes charges, however. Also, there has been no evidence that an air bag failed to deploy in an accident in which the 12-mph threshold speed had been reached. And while there have been 15 air-bag deployments in cars that haven't crashed, none caused a loss of vehicle control or an accident, the NHTSA claims.

Do air bags work? Perhaps it's time to let the marketplace decide whether they are viable safety products. It would be useful to see other manufacturers do what Mercedes and BMW are doing—give consumers a choice.

*Herbert Shulman*  
Executive Editor

# Faster than light?

To the already inexplicable behavior of those bizarre astronomical objects called quasars, add one more baffling phenomenon: They seem to expel jets of matter at speeds faster than light. Astrophysicists think they have explanations for this paradox. But one would entail rewriting the laws of physics.

By EDWARD EDELSON

**N**ow this one was taken in February 1982," said astrophysicist Stephen Unwin. I peered over his shoulder at a greenish image on the screen of a computer terminal in a basement room at the California Institute of Technology. "You can see the difference from the other one, which was taken in February 1981."

To the untrained eye—like mine—neither of the images that Unwin was showing me seemed impressive. Each showed a couple of blobs sprawled side by side on the screen. If I didn't know better, I would have guessed that they were computer-drawn contour maps of two not-very-interesting islands. But I understood just enough to know that I was getting the most detailed view possible of one of the most fascinating mysteries in astronomy today.

Indeed, I was seeing a mystery inside a mystery. What Unwin was showing me was the central core of a quasar, one of those incredibly distant and powerful objects that astrophysicists are still struggling to understand after two decades of study. Quasars (short for "quasi-stellar objects") are believed to perch at the rim of the visible universe, pouring out vast amounts of radiation—equivalent to converting millions of stars into pure energy. Most astronomers believe that the engine powering a quasar must be that weird super-collapsed, ultra-dense object called a black hole, but no final model of that engine has yet emerged.

The detailed picture of the quasar's core that I was seeing posed an even weirder puzzle. The two images, made a year apart, showed that the blobs were separating. If you took the generally accepted estimate of the quasar's distance from Earth, you could see that the blobs were moving apart at a speed far greater than that at

which light can travel—anywhere from five to 10 times the speed of light.

Everyone knows that such things can't happen. One of the rocks on which modern physics is built is the belief that the speed of light in a vacuum is a constant that cannot be transcended. That's a fundamental part of Einstein's theory of general relativity. Yet measurements made over the past decade, using some of the most ingenious astronomical techniques and mathematical analyses available, have confirmed the existence of this "superluminal expansion," as astrophysicists call it, in at least seven quasars. Is the impossible then real?

A few—a very few—astronomers say that the discovery of superluminal expansion means that we have to start rewriting some of the basic laws of physics. But the majority view is that this mystery can be explained without throwing the theory of relativity out the window. What we're seeing, the astrophysicists say, is an illusion, not really something moving faster than light. Theorists are reasonably well along in explaining how the illusion is produced. The most widely accepted explanation, picturesquely labeled the "relativistic cannonball," seems to fit most of the observations. More about that later.

Understanding the phenomenon of superluminal expansion could do more than resolve a paradox; it could bring astronomers a long stride closer to a complete solution of the quasar problem. Because of superluminal expansion, several astrophysicists have developed a unified theory to explain the variety of quasars that have been observed. Others use superluminal expansion to draw pictures of the energy at the heart of quasars.

The first thing to understand about superluminal expansion is that it isn't visible to the unaided eye. The objects that appear to be moving faster than

light are emitting radio waves, not visible light. Astrophysicists gather those radio waves in a special way and then process them in an even more special way to produce images.

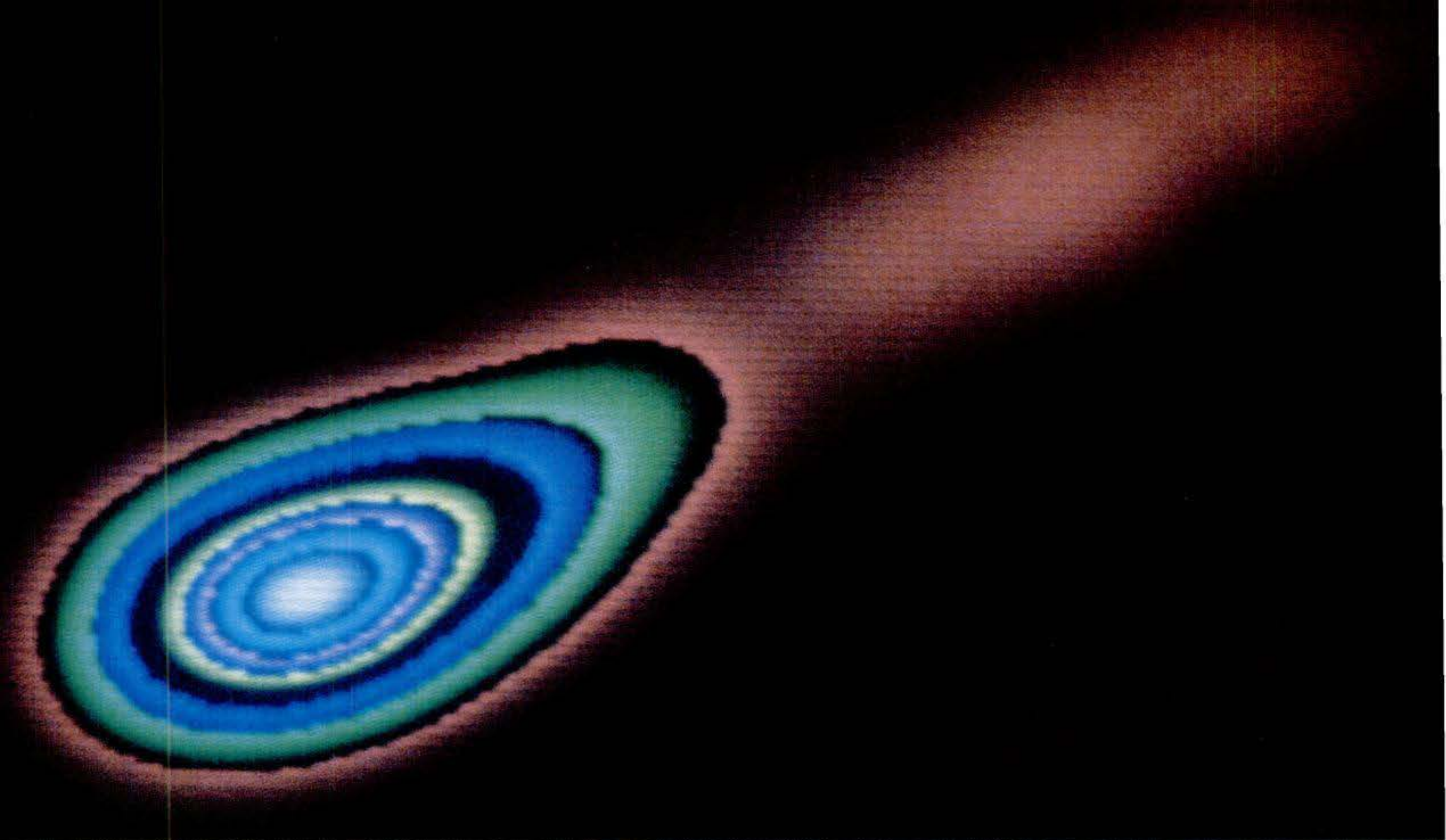
The images I was seeing on the Caltech computer screen were made by a battery of radio telescopes pointing at a quasar called 3C 273. They showed a huge jet of radiation that had been spurting out from the quasar's heart for several years. It's just such jets that appear to be moving away from quasar cores at superluminal speeds.

## A chance discovery

As it happens, the very first report of superluminal expansion was an accidental byproduct of an observation of 3C 273. In October 1970, radio astronomer Irwin I. Shapiro of the Massachusetts Institute of Technology made some observations of another quasar, 3C 279, to measure how its radio waves were deflected by the sun's gravitational field—a test of relativity theory. Shapiro also observed emissions from 3C 273 as a control because they were not affected by the sun.

Shapiro was using a technique called very-long-baseline interferometry (VLBI), which gives unparalleled resolution of the relatively small cores of the quasars. Resolution—the size of the smallest feature that can be seen—depends upon the wavelength of the radiation being observed and the size (or aperture) of the telescope. Visible-light wavelengths are measured in millionths of an inch, and astronomers get good resolution with optical telescopes, whose size is measured in inches or feet. But radio waves are measured in inches. To get good resolution, radio astronomers need telescopes measured in miles.

VLBI achieves such resolution by combining the signals received by two or more radio telescopes that are far



Galaxy NGC 6251, with a remarkable jet five times the diameter of our own galaxy, appears in a Caltech computer image.

apart. Shapiro was using dishes at the Goldstone Deep Space Station in California and the Haystack Observatory in Massachusetts, which gave him an effective aperture of more than 2,500 miles. He got an unprecedentedly clear look at the detailed structure of quasar cores.

For the first time, those cores could be seen to consist of several components. As observations were made over several months, it became apparent that the components were moving. Early in 1971, in a paper reporting on his observations, Shapiro added one of those dry little notes that make other scientists sit bolt upright. "The separation of the components of 3C 279 appears to have increased by about 10 percent in four months," the note said. An astronomer who factored in the generally accepted distance of 3C 279 from Earth, about 1.5 billion light-years, could calculate that the components were moving apart at 10 times the speed of light.

By the time that note appeared, astrophysicists at Caltech were in hot pursuit of more examples of superluminal expansion. A few months earlier, Shapiro had mentioned his observations to Caltech's Marshall I. Cohen, one of the developers of VLBI, who immediately began making his own observations.

### A physical impossibility?

One of the first theories out of the gate was this: Suppose observers weren't really seeing superluminal be-

havior at all because quasars weren't really as distant as they thought. The distance to a quasar such as 3C 279 is pivotal in calculating superluminal expansion. The farther away you assume it is, the greater the distance its jet seems to travel for a given angular displacement across the sky. (The moon travels much farther in traversing half the vault of the sky than does a 747 covering the same apparent distance.) So if 3C 279 were really a lot closer than conventional theory says it is, the motion of the quasar's components would be much smaller than calculated, and their velocity would *not* be faster than the speed of light.

That's exactly it, according to astronomer Halton Arp, who has been arguing for years that the quasars are really much closer than the vast distances they seem to be from Earth. But that, in turn, means that one of the astrophysicist's basic measuring rods—something called the "red shift"—doesn't work the way it was originally thought. And that, in turn, would mean having to rewrite some of the basic laws of nature.

What is the red shift? Astronomers know that the universe is expanding. Stars, galaxies, and quasars are believed to be moving away at velocities that are directly proportional to their distance from us. When an object is moving away from an observer, its light waves are shifted toward the red end of the spectrum—the Doppler effect. Astronomers thus can measure

distance from Earth by measuring the red shift of objects. Quasars are generally believed to be the most distant objects in the universe because they have the largest known red shifts.

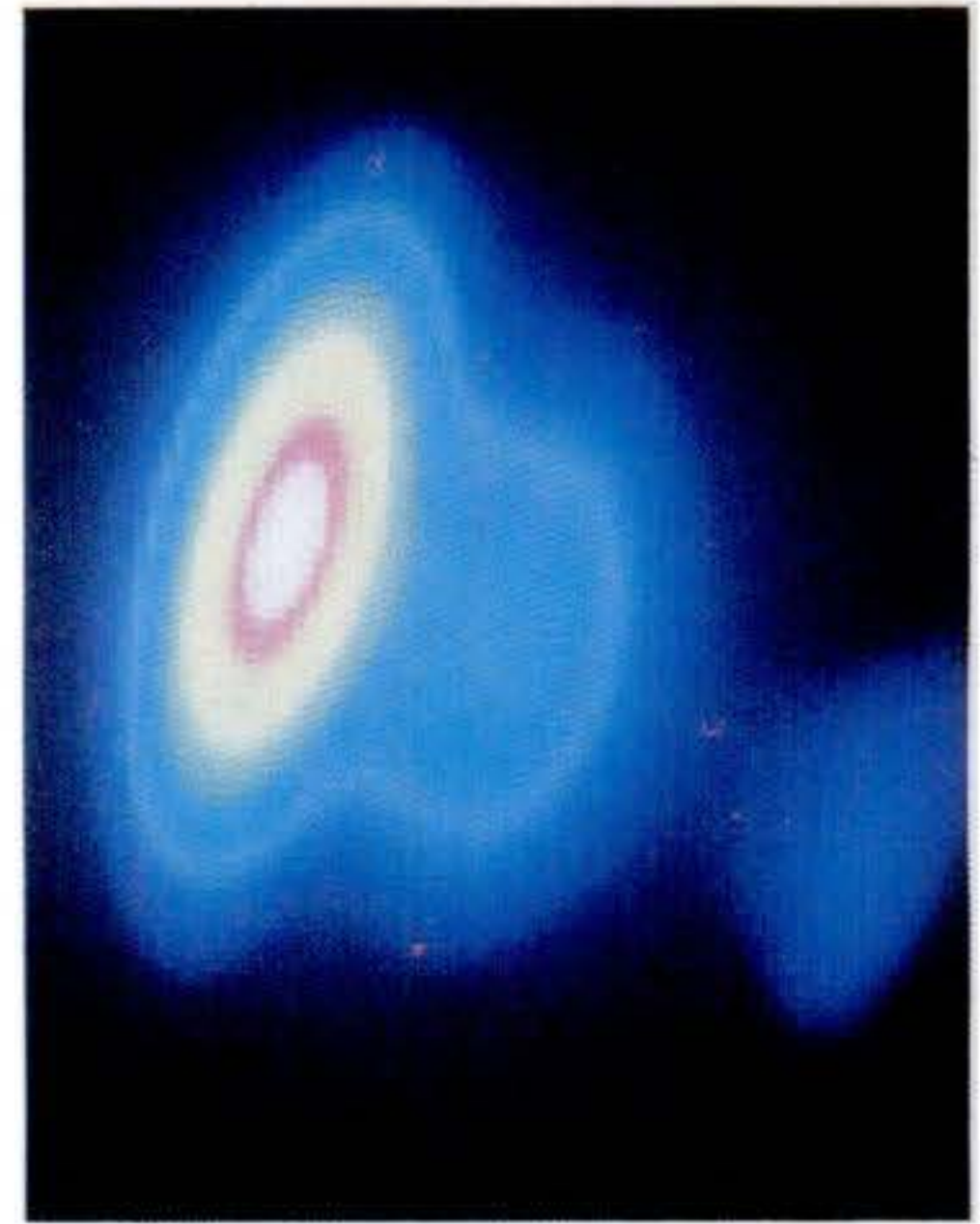
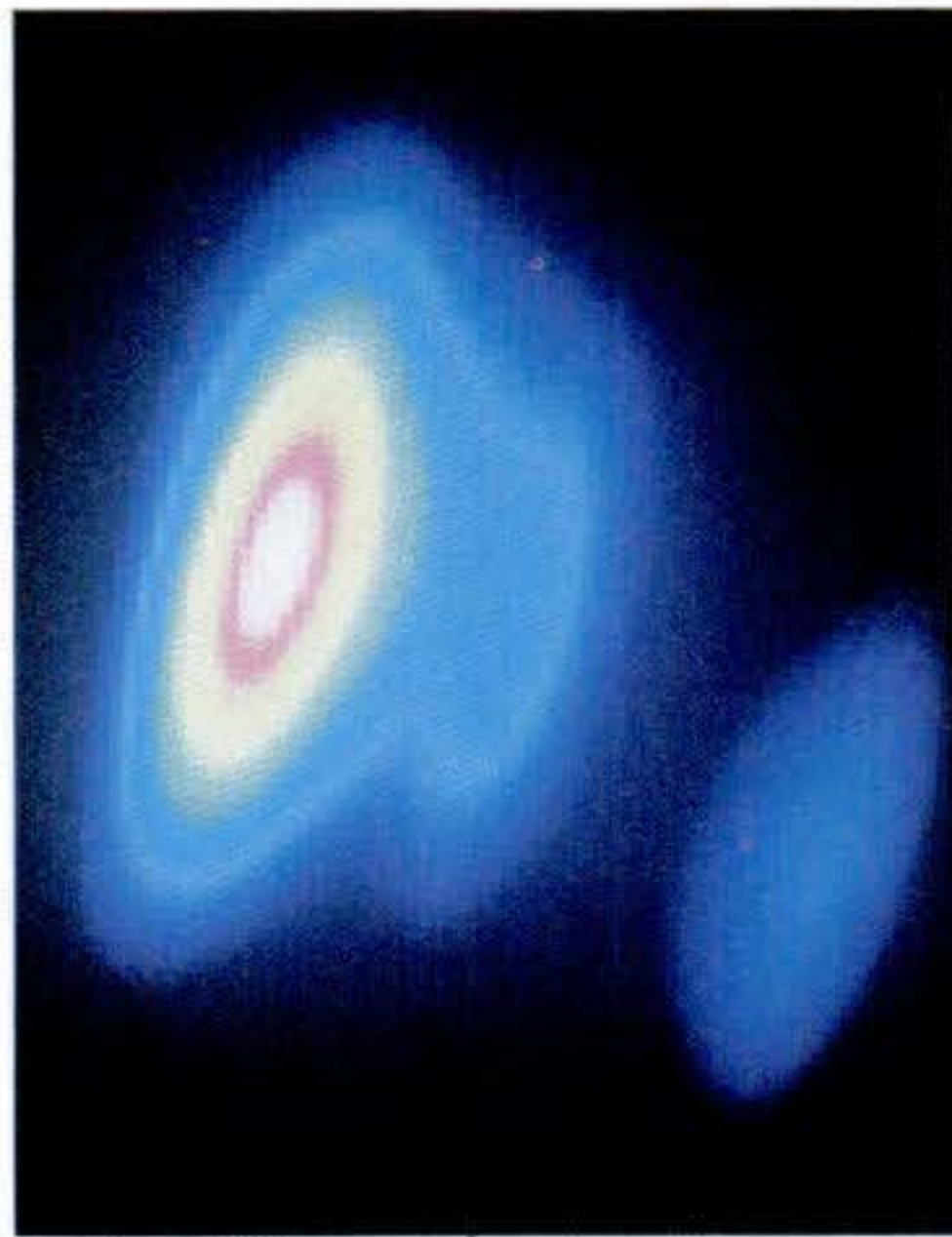
But Arp argues that something unexplainable in a quasar produces a very large red shift in an object that actually is rather close to Earth. To support that argument, he has made an extensive collection of pictures that show quasars that have large red shifts and are connected by one bridge or another with objects that have much smaller red shifts.

If Arp is right, his theory solves not only the problem of superluminal expansion but also the mystery of the immense energy output of quasars. If their red shifts lie, then the quasars aren't really turning millions of solar masses into pure energy.

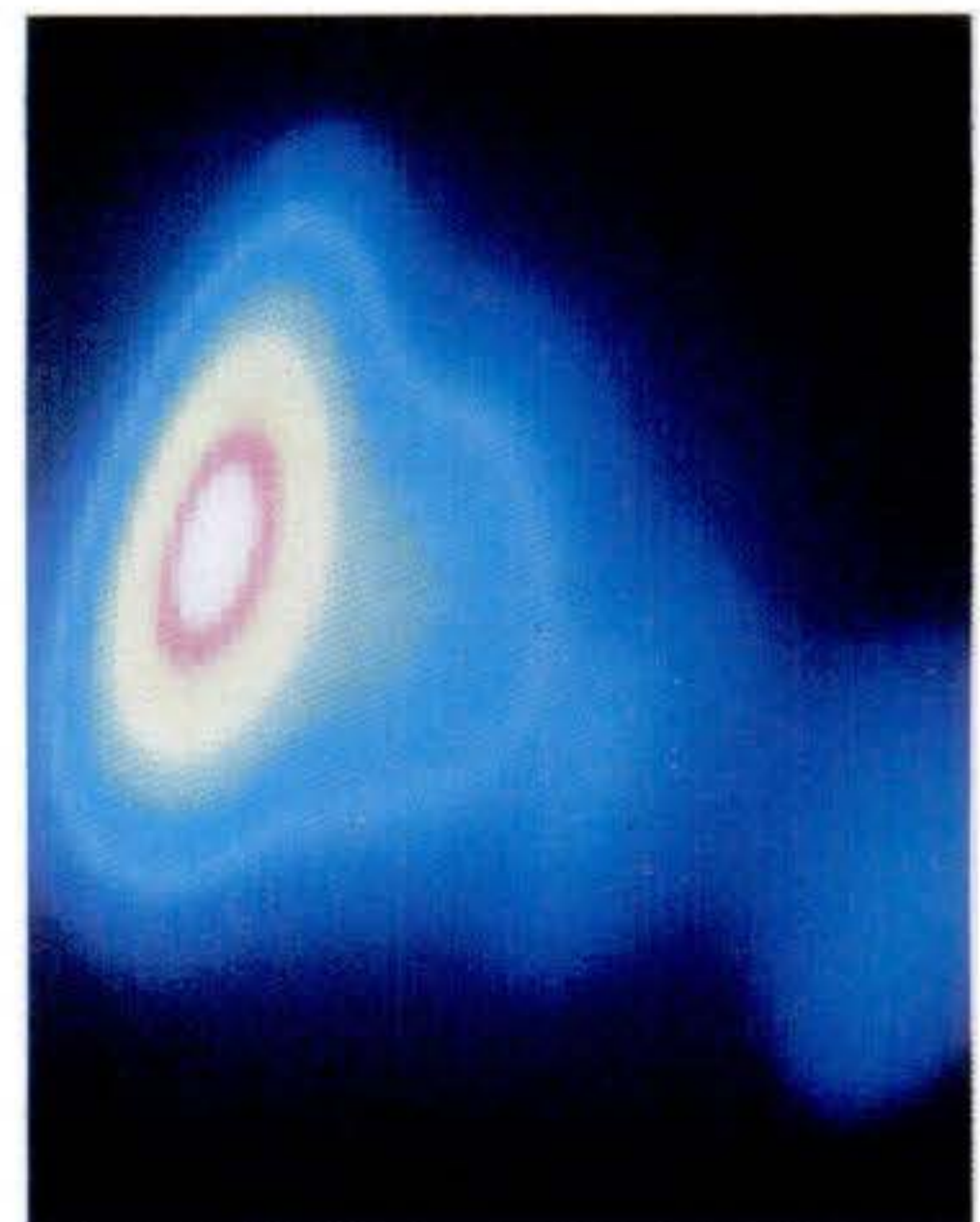
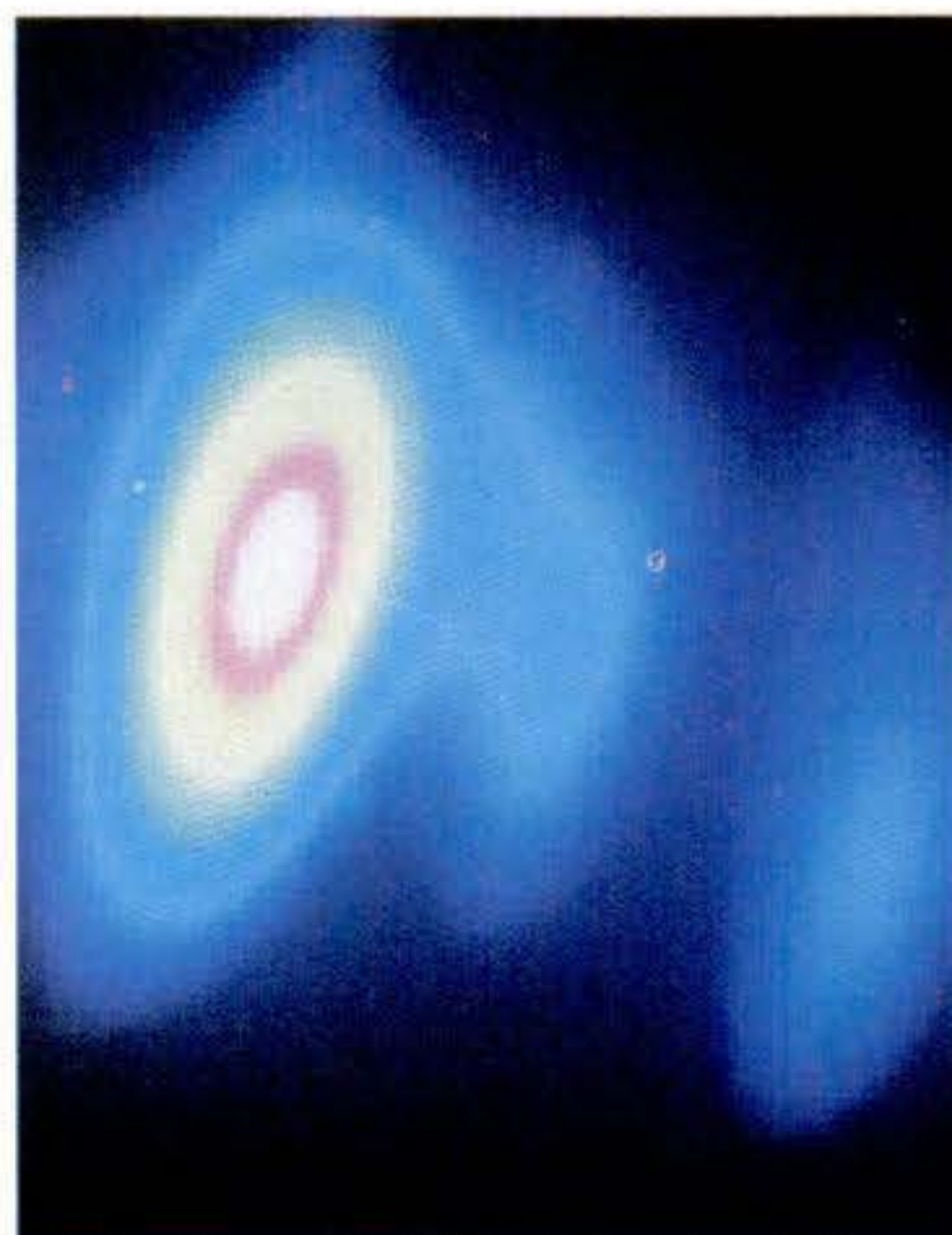
That might seem like an easy way out of two problems, but most astronomers say that Arp's proposal causes more problems than it solves. It's much more logical, they say, *not* to rewrite the laws of physics as we seek to explain superluminal expansion and other queer goings-on in quasars. They argue that the apparent bridges on Arp's pictures are not real, that the quasars really are far behind the other objects, and that the connections would disappear if we only could look from another angle.

Superluminal expansion isn't as queer as it seems, those astrophysicists say. In fact, it was predicted in

*Continued*



Superluminal expansion is captured in this sequence of radio images of quasar 3C 273, obtained via VLBI (very-long-baseline interferometry). The first image dates from July 1977, the last from April 1981. During this almost four-year interval, a blob-like component of the quasar seems to have moved away from the core a distance of 36 light-years. (This is based on the assumed distance of the quasar from Earth—2.6 billion light-years—calculated from its red shift.) Therefore the blob has traveled at 9.9 times the speed of light. These computer-derived images were made at Caltech by Anthony Readhead, Stephen Unwin, and colleagues from observations taken at five separate radio-telescope sites.



1966, well before the first observation was made, by Martin J. Rees, director of the Institute of Astronomy in Cambridge, England.

Let's assume that some quasars emit jets at speeds close to the velocity of light—"relativistic speed," in the language of astronomy. According to Rees, if such a jet is aimed almost directly at Earth, it will appear to be moving away from its source at superluminal speeds. That's your relativistic cannonball.

### Cannonball run

Anthony Readhead of Caltech, one of the leading experts on superluminal expansion, explained the relativistic-cannonball theory to me like this:

Suppose one of the components is being ejected almost, but not quite, straight at us at a speed more than 99 percent that of light. (Here Readhead drew a long, skinny triangle with its vertex at the point where the quasar and its component start to diverge.) After a certain time, we ob-

serve that the blob, or jet, has moved a certain distance away from the quasar. Let's assume that 300 years after we first observed its position, it has moved away from the quasar a distance of 25 light-years—the base of the skinny triangle. But because it is moving almost directly toward us at nearly the speed of light, it has actually moved 297 light-years closer to our radio telescopes. So the radiation from its new position reaches us only three years (300 - 297) after our first observation, not 300 years later. This creates the illusion that the object has traveled its 25 light-years in a mere three years—more than eight times the speed of light—rather than the actual 300 years.

"There's another useful way to look at it," said Readhead, "as simply a Doppler effect. Suppose there was a car moving almost directly toward you but at a slight angle, and it was tooting its horn once a second. And suppose you were calculating the sideways speed of the car by measuring its posi-

tion and counting the beeps. Because of the Doppler shift caused by the motion of the car toward you, you would perceive the beeps as occurring more than once a second, and you would calculate the speed as higher than it actually is."

For the superluminal phenomenon to occur, the moving object must be heading in almost a straight line toward observers on Earth. If a quasar jet, for example, were moving at right angles to our line of sight to the quasar, there would be no Doppler effect, no "foreshortening." Radiation from the object as it passed through different positions would take essentially the same time to reach us. If it took 300 years to move out from the quasar a distance of 25 light-years, it would take 300 years for us to "see" the points 25 light-years apart.

There were some arguments about this picture early on. Critics pointed out that no astronomical jet moving at nearly the speed of light had ever been directly observed. If there were

such a jet, they added, it would be a remarkable coincidence to find that it pointed almost directly at Earth.

Most of those objections have been answered over the years. One key event was the discovery in 1978 that SS 433, a previously unremarkable star in our galaxy, emits some light that is red-shifted and some that is blue-shifted. Further observations showed that SS 433 is emitting two narrow jets, one pointed toward Earth and the other pointed away, both moving at about a quarter of the speed of light. That speed is significant, according to Cohen. If such a commonplace object as SS 433 can emit jets at relatively high speed, he says, it's probable that quasars, impressively larger and more energetic, can emit relativistic jets.

Meanwhile, the detection of superluminal motion in a quasar designated NRAO 140 by astronomers Alan Marscher, now of Boston University, and John J. Broderick of Virginia Polytechnic Institute was answering the other major objection to Rees's theory. NRAO 140 was first detected as an X-ray source by the orbiting Einstein X-ray Observatory. Astrophysicists can estimate the X-ray output of such objects because they know how the X-rays are produced: Photons are boosted to X-ray energies when they collide with electrons. Marscher and Broderick made estimates based on the theory that NRAO 140 was emitting the same amount of energy in all directions. The actual X-ray emissions proved to be about 1,000 times less. Therefore, NRAO 140 had to be emitting its relativistic jet in a narrow beam that was pointed toward Earth.

The same kinds of measurements have been made on other quasars, with encouraging results. There are now seven objects in which we have found evidence for motion near the speed of light toward us.

Roger Blandford, a theorist at Caltech, told me that "the cannonballs may be too simplistic." Blandford is interested in the jets that produce the illusion of superluminal motion. If astrophysicists can understand how quasars produce such jets, says Blandford, they will be much closer to understanding exactly what quasars are.

### Probing the black hole

The general belief is that the energy source of a quasar is a spinning black hole, a super-massive object that has collapsed of its own weight. A black hole has a gravitational field so strong that not even light can escape. But it can turn matter into energy with extraordinary efficiency as it sucks surrounding material toward oblivion. (Caltech astrophysicists be-

lieve that a black hole is also at the core of a huge elliptical galaxy known as NGC 6251, pictured in this article.)

Blandford is trying to understand how such black holes can emit energy in narrowly focused jets. Gas flowing into a black hole could be focused by its intense magnetic field, according to Blandford. "Wrapping a magnetic field around the gas gives us a nice way to confine it," he said. Or gas could accumulate in a doughnut-shaped cloud that would focus the emitted energy.

The fascination of superluminal expansion, Blandford explained, is that "the jets have transferred the location of the action to smaller and smaller radii," so that astrophysicists are getting closer—literally—to the core of the quasar mystery.

There are actually two kinds of quasars, Readhead pointed out. One group has two large lobes that emit radio waves on either side of a compact core. The other group consists of small cores without the lobes on either side. The kind of VLBI observations that showed superluminal motion are leading toward "a simple unified theory" of quasars, Readhead said.

Those observations are showing that many, if not all, of the compact quasars emit jets that are aimed toward observers on Earth, says Readhead. Let's assume for a moment that the same kind of jets are being emitted in the opposite direction, away from Earth—a logical assumption because quasars are symmetrical objects. If we're looking from the side, those relativistic jets could be too thin to be visible to our radio telescopes. The jets make themselves evident when they hit intergalactic gas and suddenly are slowed to one-thirtieth the speed of light. The energy produced by those collisions produced the large lobes that radio telescopes detect.

But suppose we're looking at the jets nearly head-on. In that case, their energy is so focused that they are visible to radio telescopes. But the energy produced by their impact with the intergalactic gas is too diffuse to be detected. The orientation of the jets thus would account for both types of observed quasars.

That's probably too simple a picture to explain all the quasars, but, says Readhead, at least it's a start. What astronomers need now are observations that will either support or disprove the theory that quasars emit jets in both directions.

To make such observations, astronomers need a more-advanced VLBI system. Until now, observations have been made with radio telescopes that were not designed specifically for

VLBI. Most of the observations have been made at wavelengths of about three centimeters (1.2 inches). The real action is at much-shorter wavelengths, down to a few millimeters, says Readhead. A network of radio telescopes designed to work at those wavelengths and dedicated to VLBI alone is at the top of his wish list.

It's also at the head of the list prepared by the Astronomy Survey Committee, chaired by George Field of Harvard, which recently laid out a coordinated plan for astronomy in the 1980s. The Field committee came up with two top choices: a new X-ray satellite costing \$500 million, and a VLBI network costing \$50 million. Planning money for the VLBI project is in the budget for fiscal 1984.

### Radio-telescope network

Tentative plans are for one radio telescope in Hawaii, one in Puerto Rico, one in New England, and "most of the remainder in the Southwest," said Kenneth I. Kellerman of the National Radio Astronomy Observatory. The Southwest location would give double value for the money because it would increase the capabilities of the Very Large Array (VLA), a radio-telescope observatory that covers a 20-mile range in New Mexico [PS, March '77]. One of the new VLBI antennas would be 50 miles away from the VLA, the next would be 100 miles away, and so on in a staged array that would make the VLA better than ever, says Kellerman.

The VLA has a resolution of a few tenths of a second of arc but covers a large area of the sky. The VLBI array would have 10 times the resolution but would have a much narrower field of view. "Various combinations of the VLA and the VLBI array could fill in more detail," Kellerman pointed out.

If all goes well, the new VLBI array could be in operation by the end of the decade. Already, NASA is looking at the next logical step: an orbiting VLBI antenna. NASA has a technical working group headed by Bernard Burke, an MIT astronomer.

"We're looking at a number of possibilities," Burke said. "We have concepts that could either fly on the space shuttle or could fly freely in space. We're hoping for a launch sometime in the 1990s. We're by no means on NASA's launch schedule, but it's a reasonable possibility."

The orbiting antenna would extend the effective VLBI aperture out to one or two Earth diameters, Burke explained. That would give astrophysicists the kind of detailed look that could help them solve the quasar mystery once and for all. [S]

# The house that

It's prefabricated, shippable, modular, expandable, energy efficient, and low in cost. Microprocessors control its environment and appliances, and robots do the housework. Designed with the aid of computers by a team at Illinois Institute of Technology's Institute of Design, this "House of the Future" could be built with existing or near-term technology.

By **RICHARD STEPLER**

**C**HICAGO  
Imagine a prefabricated home that adapts to any site or climate, expands or contracts to suit your family's needs for space, has interior partitions that can be moved or modified to provide for growing children, has computerized environmental controls, and includes robots that cook your food, wash your clothes, and vacuum your floors. Best of all, it costs less than the price of a conventionally built home. Sound impossible? Or a dream of the distant future?

Not so, says Professor Charles Owen. He and a team of students and faculty at IIT's Institute of Design in Chicago used powerful minicomputers to design this "House of the Future." Although the house exists only in plans and scale models—and in the memory of the team's DEC and Hewlett-Packard computers—Owen says it could be built by the 1990s, using existing or near-term technology.

What the IIT team has developed is not merely one house of the future but a versatile system of building components that can be used for high-rise apartments, two- or three-story townhouses, and single-family homes. "The system's interior components could even be used to renovate older buildings," says Owen.

The project encompasses virtually every function or activity that occurs in a home. Examples: climate control, ventilation, fire protection, security, cleaning, food preparation, storage, hygiene, exercise, entertainment, communication, education, and child care.

Key to the cost-saving in the IIT design, like other manufactured-housing projects of the past, is industrial production and prefabrication of its components. And therein lies a hindrance. Owen points out that unless federal legislation mandates a national building code and banks and unions change outdated practices, IIT's design for mass-produced housing—or

any other design using advanced technology, for that matter—isn't going to happen. More about that later.

The IIT team used computers extensively, both to help organize their research and identify and "cluster" problem areas, as well as to design the project's components. In fact, computers were essential to efficiently manage a complex project created by a large team: 24 students and five faculty from the product-design, architecture, planning, and engineering programs at IIT. "Whenever you get into a problem that's complicated," says Owen, "you need a way to handle information with sophistication. That's why we use the computer."

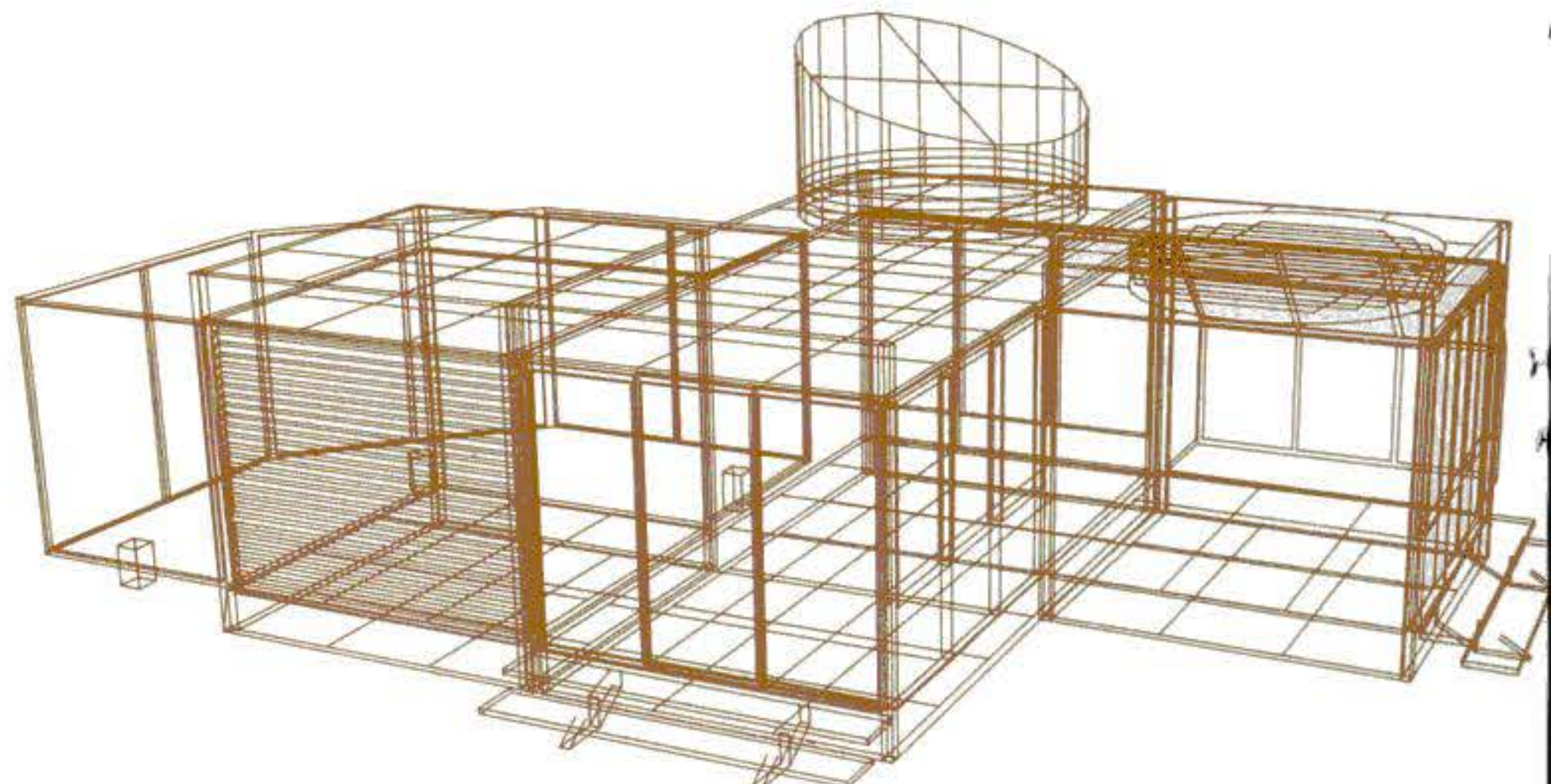
Computers also helped speed the work. The entire project, from basic research through detailed concepts and models, took just 24 weeks.

The final design, detailed in a 30,000-word poster series, shows meticulous attention to detail and ingenious solutions to household problems. The structural system is a steel post-and-beam frame based on a 1.2-by-1.2-meter (3.9-by-3.9-ft.) grid. A basic module is 3.6 meters (11.8 ft.) long, but variations

are possible in 1.2-meter increments to permit modules up to 7.2 meters (23.6 ft.) long. The prefabricated frames can be stacked up to three or four stories high. (Higher structures would require extra supporting frames.) Deep floors (or ceilings), prefabricated in 3.6-meter square modules, come with flexible systems of electric wiring, plumbing, and ductwork for heating, cooling, and ventilation already in place. Removable panels allow easy access to utilities.

Exterior enclosure components permit a variety of architectural styles: Bay windows or greenhouses, gabled or flat roofs, and decks or porches are all possible. Theoretically, you could build a saltbox for New England or an adobe-style house for the Southwest. "Finish materials can be anything," says Owen. "You could use stucco in Florida or cedar shakes where that was popular. More likely, you would go to completely modern materials: interior foams and aluminum skins with vinyl over that for a really low-maintenance house."

All components are designed to be  
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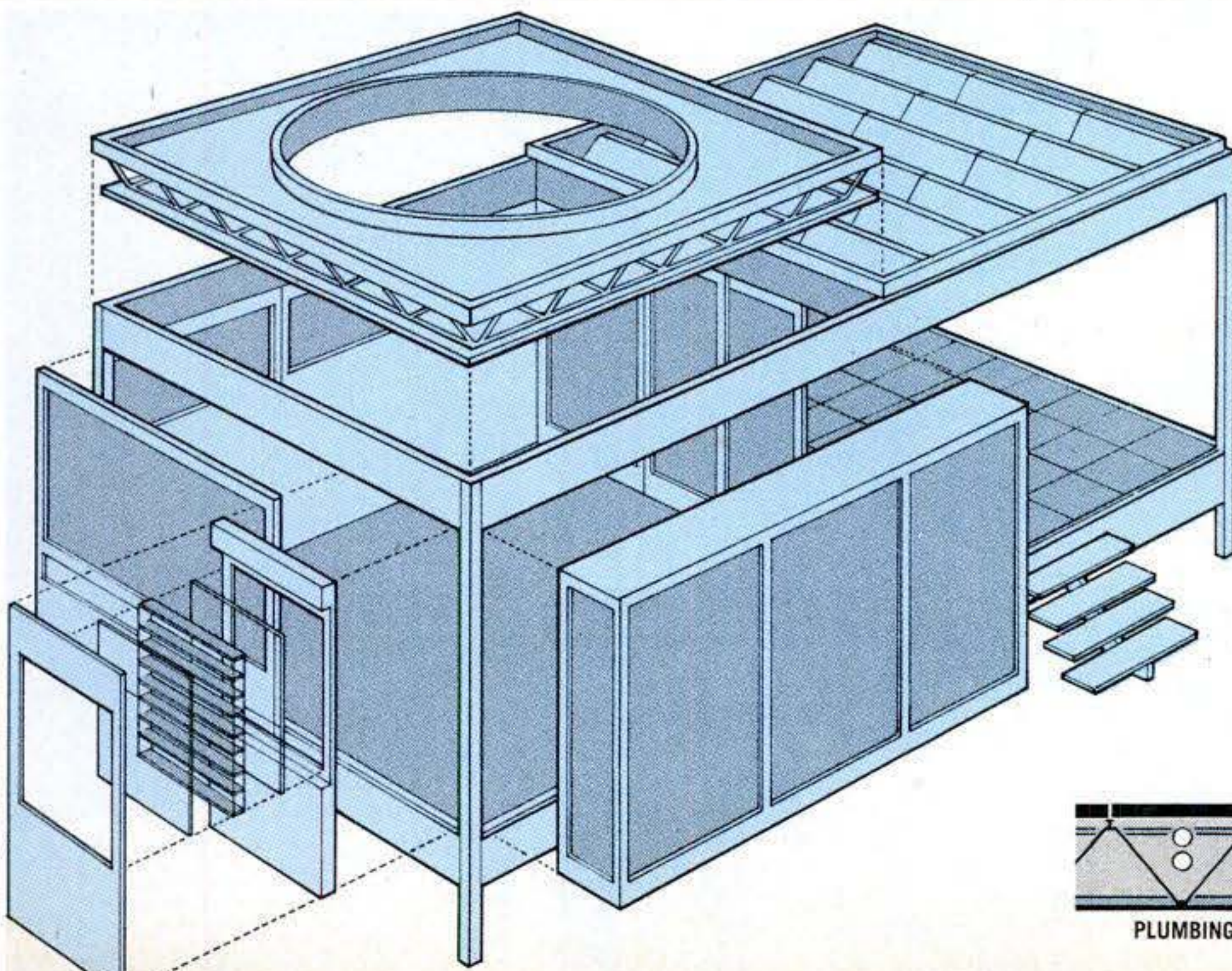
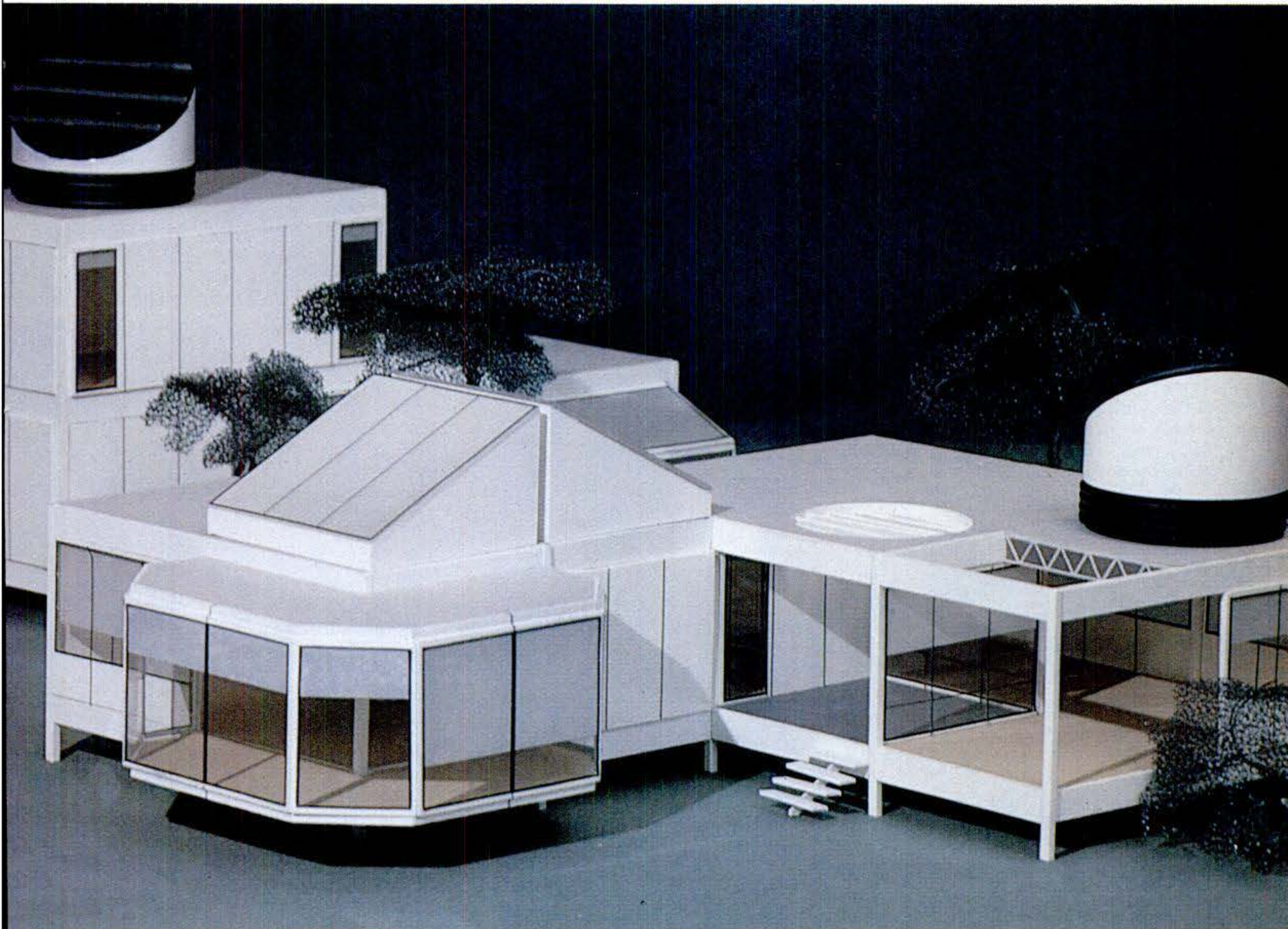


Computer-generated drawing shows one possible configuration of IIT's innovative House of the Future. The project

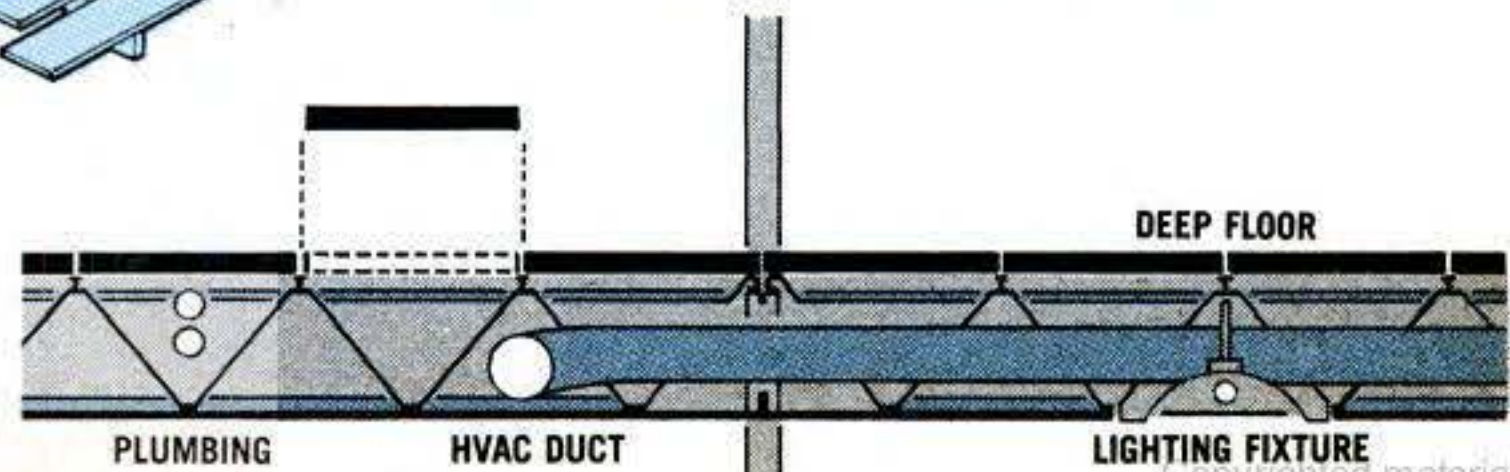
won the 10-million-yen grand prize in Japan's First International Design Competition, held in Osaka in 1983.



# computers built

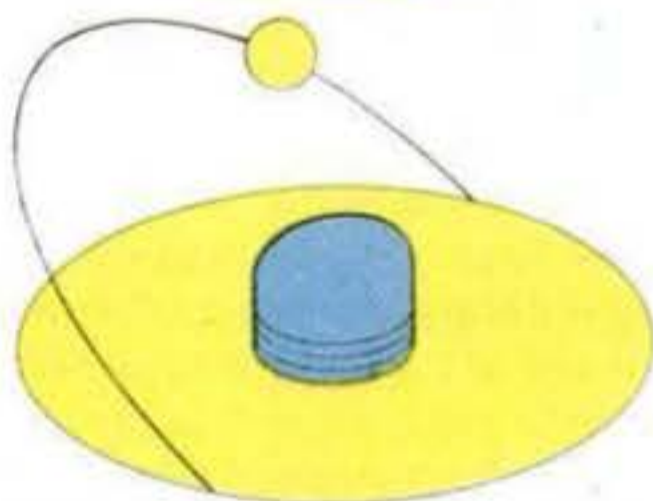
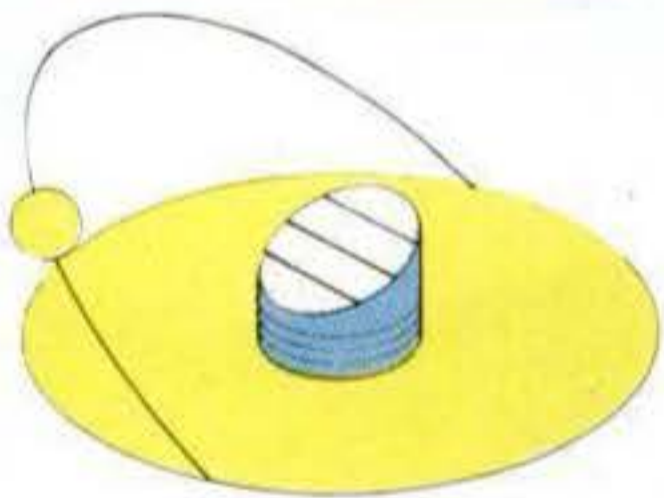
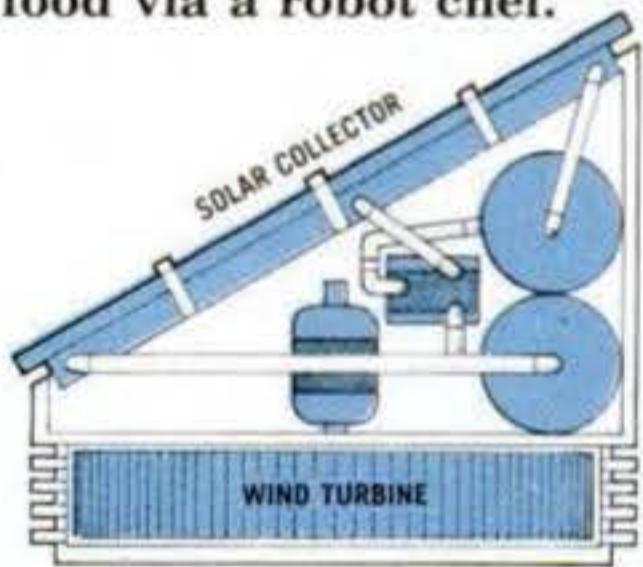


A large house with both single and two-story elements is depicted in the model above. Circular structures on roof are solar-hydrogen-wind-turbine modules. Based on a 1.2-by-1.2-m modular grid, the house's steel post-and-beam frame is designed to permit many variations and architectural styles (left). Roofs can be flat or pitched, with openings for skylights and solar collectors. Wall options include bay windows and greenhouses. Double-glazed windows sandwich blinds that are automatically controlled to admit or reflect sunlight. A deep floor (or ceiling) holds plumbing, electrical, communications, and climate-control systems. Components are preassembled for on-site connection.

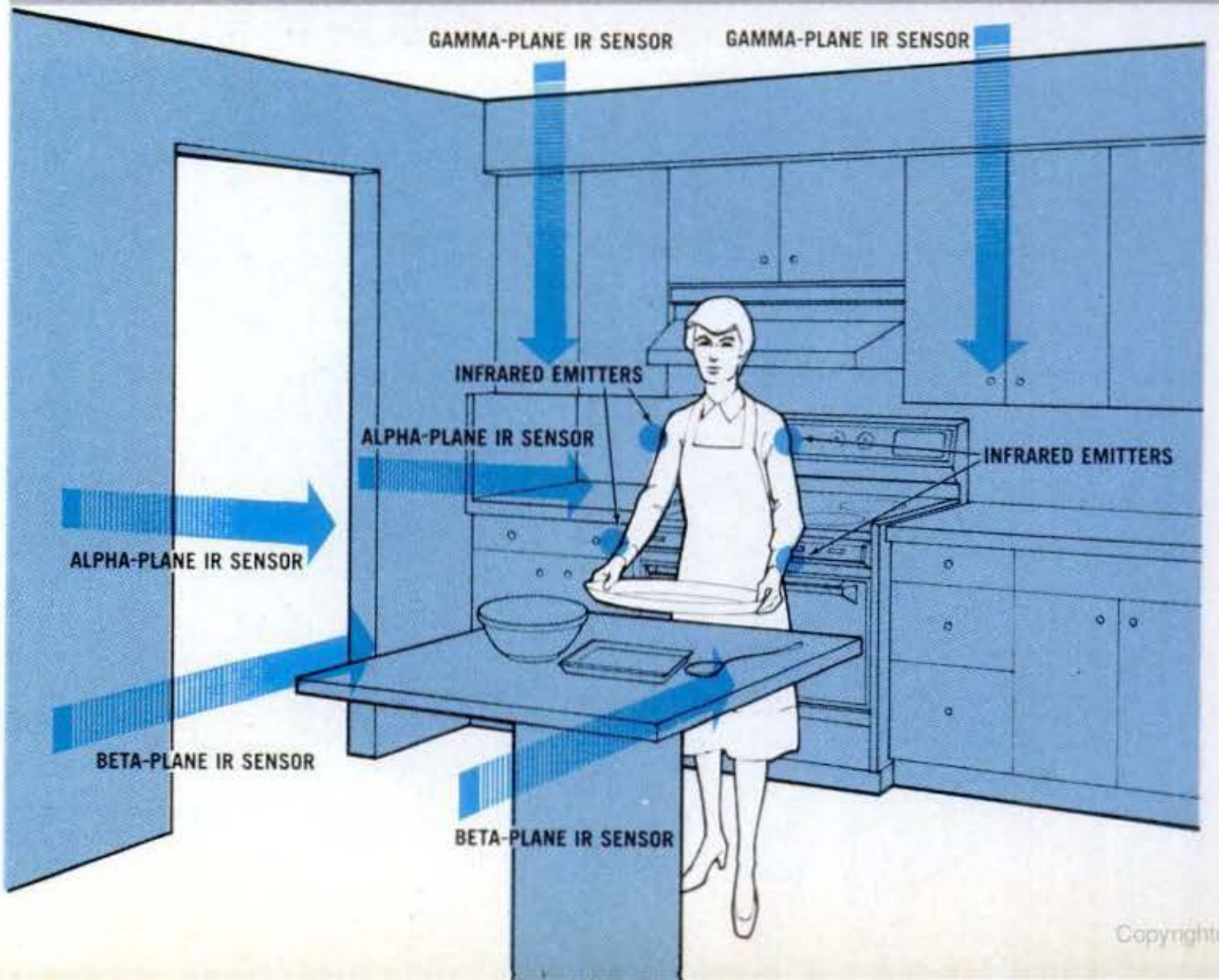




Entertainment center (above) includes a holographic TV set, admittedly the only technology in the scheme that's not "near term." Mobile service unit (above, right) sorts the laundry; it vacuums, too. The kitchen (right) has a "food wall" that stores, prepares, and cooks food via a robot chef.



Solar-wind module (above) tracks the sun; solar heat breaks down hydrogen bromide into hydrogen and bromine. These are recombined as needed to produce electricity. Wind turbine provides additional power. The home's robot can be programmed to perform a variety of household tasks using MIMIC (right). To set a table, for example, you'd first instruct the computer by voice command to go into MIMIC mode. Then, after placing IR or radio emitters on your hands and arms, you'd perform the task you wanted the robot to mimic. Sensors would note position, speed, and direction of movement; with this in its memory, the robot could perform the task on command.



easy to install and remove. As a result, you could start with a small house and then add to it if your need for space increased. Interior partitions also contribute to the houses' flexibility: All of them are movable. You can even relocate kitchen and baths.

### Computer controls

The home's control system is a distributed computer network, with a powerful central microprocessor monitoring the performance of household functions such as environmental control, fire detection, food preparation, and security. These functions are, in turn, controlled by their own microprocessors.

A predictive climate-control system coordinates the operation of equipment such as heat pumps, humidifiers/dehumidifiers, and solar collectors. Indoor and outdoor sensors, including temperature, humidity, barometric pressure, and wind speed and direction, provide some of the inputs to help the system maintain a comfortable interior climate.

Independent energy sources supplement power drawn from the utility grid. These include:

- Solar-hydrogen-and-wind-turbine modules (see drawing): These produce electricity by using solar heat to break

**Bath (right):** Open spa allows space for exercise. Wash basin, toilet, bidet, shower, and tub can stand alone or be enclosed for privacy. For sleeping, studying, etc., spaces can be enclosed by folding walls (shown open, below).

down an electrolytic solution of hydrogen bromide. The wind turbine generates electricity directly.

- Biomass system: Bath and kitchen waste fed to a biomass tank produces methane gas, which is compressed and stored for later use.

- Thermal-energy-storage system: This includes six components: gas furnace fired with gas from the biomass system, auxiliary electric furnace, heat-storage pile, an air-conditioning unit, and, of course, a microprocessor for control.

The climate-control system coordinates the operation of all of these systems, using the most economical

source (or combination) to heat and cool the home. For example, if the system determines that wind speed is more than sufficient to meet the home's power needs, it sends surplus power back to the utility grid, reducing the electric bill.

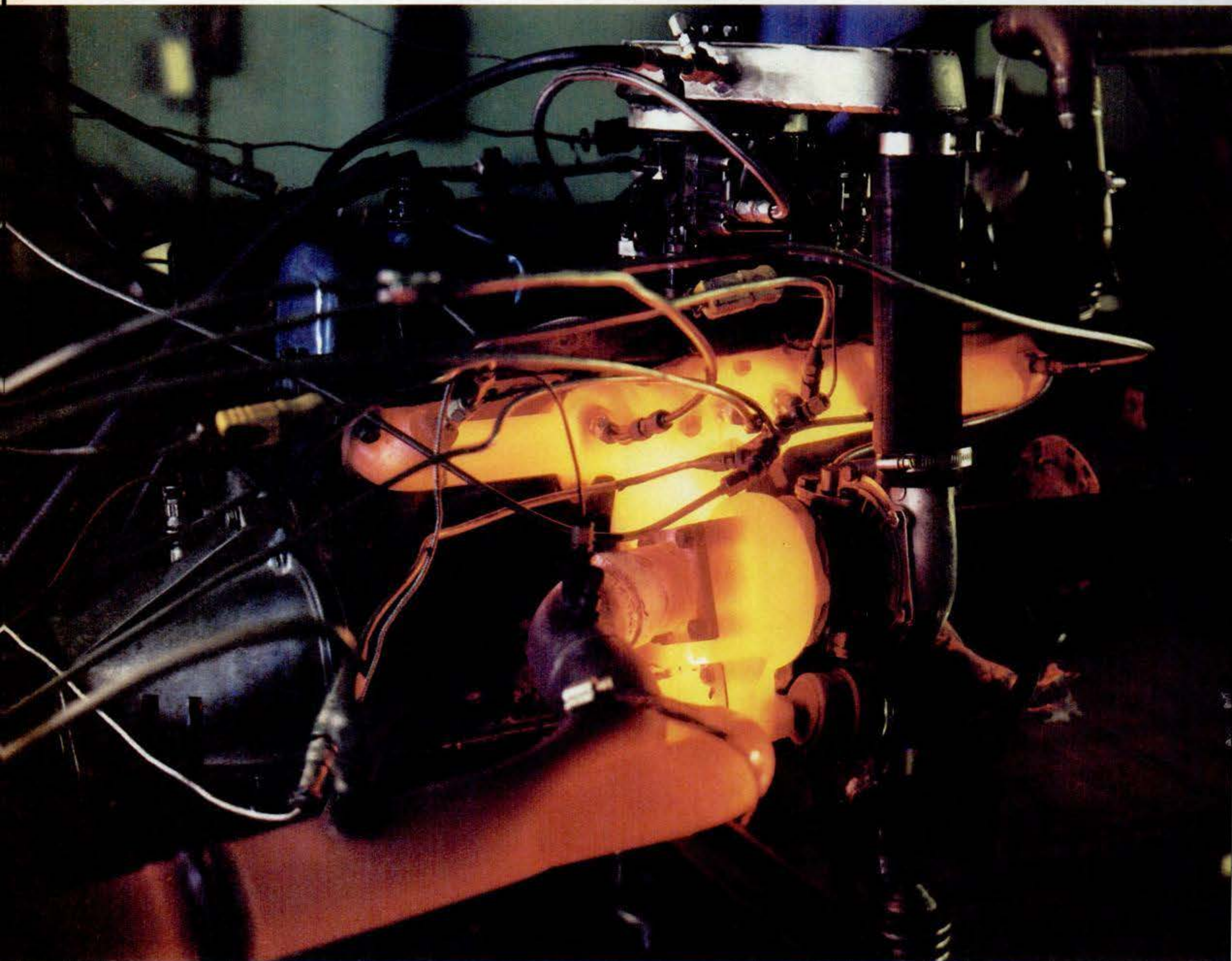
Fire protection is handled by ceiling-mounted, heat-seeking extinguishing systems. If the home control system detects a fire (using sensors in the air ducts), pop-down nozzles in the area scan it with infrared sensors. If a fire is located, the nozzles spray it with Halon gas, smothering the fire without damaging property. While fighting the

*[Continued on page 160]*



# *Detroit's big switch to* **TURBO POWER**

Driven by 1,742-degree-F exhaust gases, a turbocharger spins at up to 250,000 rpm to force-feed air in a small engine. This gives big-engine performance when needed yet preserves small-engine economy the rest of the time. The turbo could breathe new life into fuel-efficient but formerly performance-poor cars. But skeptics remain.



Red glow is produced by 1,600- to 1,800-degree-F temperatures generated in exhaust manifold and turbine side of

turbocharger housing. But compressor side of housing remains relatively cool to maintain volumetric efficiency.

By JIM DUNNE

**T**wo cars, bodies rocking from side to side, strain at the starting line. One is a traditional muscle car with a massive 300-plus-cu.-in. V8. Its rival, with a tiny 140-cu.-in. four, seems overmatched, clearly out of its class. On signal, they should screech away to a predictable finish.

But wait! The graphic on the underdog reads "TURBO." That makes a difference. Chances are the two will finish even, or perhaps the smaller-engine vehicle will win.

What's the advantage of a small turbocharged engine over a large engine? Part-throttle efficiency. When the turbocharger is not working, which is most of the time, the engine has the fuel efficiency and performance of a small non-turbo engine; the turbine-wheel restriction in the exhaust flow causes only a small loss of efficiency. But stamp down on the accelerator, and the turbo rams air—lots of it—into the combustion chamber at greater-than-atmospheric pressure. Because it can then effectively burn more fuel and develop more power, the small turbo engine takes on the power characteristics of a bigger engine.

I spoke with engine experts at General Motors, Ford, Chrysler, import-car companies, and turbocharger manufacturers to find who's using them, what early problems gave them a poor reputation for durability, and what's been done to improve their performance and reliability.

### Who uses turbos

At one time, when a car manufacturer needed more power in a model, it simply installed an engine with a larger displacement. Of course, the bigger engine used more fuel, and the additional weight adversely affected the handling. But fuel was inexpensive, and other than a small group of sports-car enthusiasts, few understood what good handling was. Turbocharging was too complicated and expensive for high-volume production. Today, with new-engine development costs in the millions, the expense of fuel, and a growing public awareness of handling as an important vehicle attribute, turbocharging has been rediscovered.

Chrysler's workhorse 2.2-liter (135-cu.-in.) four is a domesticated type that produces an adequate 99 horsepower to serve the firm's many K-car variations. But Chrysler lacked the V8 or even V6 engines to provide its sports models with exciting performance. To the rescue: turbocharging. This year, a Garrett AiResearch turbo and fuel injection will pump the four's power up to 142 horsepower.

At GM, Buick's 231-cu.-in. V6 delivers 110 horsepower in base form. Add a turbo and fuel injection, and the output jumps to an amazing 200 horsepower. This engine is offered in the Regal T Type coupes, which sometimes carry a "We brake for Corvettes" bumper sticker.

Like Chrysler, Ford embraces the turbo as a wonder cure for small, low-power engines. Its turbo applications range from the \$6,000 Escort to the \$20,000 Mark VII. At Ford, the turbo is seen as part of "the engine of the future." That's why the all-out-performance SVO Mustang has a turbo four instead of Ford's equally sensational high-output 302-cu.-in. V8. The tiny 140-cu.-in. turbocharged four in the SVO jumps from 88 to 175 horsepower.

"In the long run, we believe small-displacement engines with turbos will be the only performance engines," said Ford's marketing manager, Dave Hall. "We foresee the time when we will no longer offer a V8 as a performance engine."

In Europe, faced with traditionally expensive fuel, heavy taxes on large-displacement engines, and limited amounts of development funds for a wide range of power plants, car makers recognized the turbocharger's potential early.

Saab's first production turbo model was unveiled in 1976 and was offered to the public the next year. Late last year, Saab built its 100,000th turbo model.

"We're totally committed to turbocharging. In fact, 46 percent of the 23,000 Saabs sold in the States last year were turbos," pointed out Steve Rossi, Saab's product-development and compliance manager.

In 1978, Mercedes was faced with a gas-guzzler tag for its big gasoline-powered cars. So its engineers installed a turbocharger on the innovative five-cylinder diesel. Not only did the turbo-diesel easily meet U.S. CAFE (emissions) standards, it also provided acceptable performance for Mercedes' picky luxury customers.

Porsche-Audi was also an early advocate of turbos. Porsche introduced a high-performance turbocharged model called the 930 in 1976. Later, the company sold one of the first turbocharged four-door sedans, the Audi 5000.

### Early problems

Everyone dislikes talking about former problems or failures. The auto companies are no exception. So to roll back the clock a bit on early turbocharger applications, I spoke first to Smokey Yunick, one of the country's most respected auto consultants. Then I questioned representatives at some of the car companies that have seemed reluctant about turbocharging.

"First, in the early attempts, they sized the turbos so that the only time you got anything out of them was when the pedal was on the floor," Smokey explained. "What many of them were trying to do was bring the turbo in at engine speeds above the speeds at which the emissions tests

**“ In the long run, small-displacement engines with turbochargers will be the only performance engines ”**

were made. They didn't seem to know how to pass the tests with the blower working.

"Second, they had a lot of oil problems. They'd fry the oil. Mineral oil just won't stand more than 320-degree-C [608-F] temperatures for 20 minutes. That center-bearing section of the turbine housing would cause two things to happen: First, it would burn the oil. Then, it would sometimes further refine [the oil] into a coke that would plug the oil supply to the turbine-shaft bearing. Turbos were failing because of a lack of lubrication.

"Finally, if you let one of the turbocharged engines get lean, it sneezes. It backfires. That's a fairly common problem if you don't get enough fuel. It's then possible to blow the blades off the compressor. If you blow the blades off the compressor on a pull-through [turbo downstream from carburetor], you send that material down into the valve gear. You can also get burnt pistons because of poor carburetor metering.

"Of course, there's no reason why turbo engines can't be as durable as non-turbo engines. Industrial engines—bulldozers, drag lines, trains, ships, stationary engines—have been using turbochargers for 30 years. They run for 25,000 hours—that's nearly three years, 24 hours a day—without failures."

Another skeptic is Bob Templin, Cadillac's canny chief engineer. "I'd like to see all our competitors get turbos in their cars, with us the only holdouts," he said. "Then we'd see who'd come out on top."

Another GM critic objected to the high cost of the turbo.

*Continued*

"It costs us \$250 to get a turbo in a car. It's easier and cheaper to put in more cubic inches. We already have the bigger engines if we want to use them, so the need for a turbo is not so great."

That \$250 figure includes the cost of the turbo, special ignition controls, and related equipment. Given the traditional 1:5 industry cost-to-retail-price ratio, the turbo runs the customer an additional \$1,250. An Oldsmobile source said that a bigger engine costs the customer a third of that or less.

And that will buy you a lot of gasoline, he concluded, resolving the problem of the higher fuel consumption of the bigger engines. But Olds is not as strongly against the turbo as Cadillac. Bob Dorshimer, Olds' chief engineer, hinted that a turbo may show up in a future Olds model.

"The secret to more power is getting more air inside the engine," Dorshimer said. "Whether it takes a turbo to do the job or intake tuning makes little difference."

Chevrolet hasn't a single turbocharged model. "We have a position on turbocharging based on what people expect from Chevy products," a Chevrolet insider pointed out. "It has to do with the cost of production and how people tend to treat Chevrolets. We did turbos in the Corvair, and we think we know as much about them as anybody else. At this time, we know enough to stay away from them."

### Later solutions

To answer the charges brought against the turbocharger, I spoke with the turbocharger manufacturers and auto makers who use the device.

Garrett AiResearch is generally acknowledged as the current auto-turbocharger leader. Between 1977 and late 1982, a million Garrett turbos were installed on new cars in the U.S., Japan, and Europe. In 1983 alone, worldwide auto-industry use approached one million. Besides Garrett, major producers are Kuehule, Kapp, and Kausch AG (KKK) in Germany, and Hitachi and Mitsubishi in Japan. A strong newcomer in the U.S. is Warner-Ishi.

What did experts say to Smokey's observations on improper sizing in early turbocharging applications?

"We make two basic sizes of turbos," said Mike Dyer, sales manager of Garrett's passenger turbos. "The bigger one, the T-3, will take a gasoline engine up to 300 horsepower. The lighter one, the T-2, is rated at a 165-horsepower limit." Another Garrett spokesman described the situation this way: "We give advice, but in the end, we deliver what the manufacturer needs."

Warner-Ishi's sales manager, Bruce Renton, had more to say about sizing. "Turbochargers, like camshafts, are tuned for a limited rpm range. You have to decide what you want. If you want the horsepower in early, that would predicate a relatively small turbine size. If you want top-end horsepower, you'd put on a larger turbine housing."

Recent U.S. turbocharged cars, especially Buick's 231-cu.-in. Regal T Type tested at Bridgehampton Race Circuit by POPULAR SCIENCE [PS, March], surprised the test crew with low-end torque and zero-to-60-mph elapsed times close to those of high-output V8-engine autos. These performances seem to show a great concern for turbo sizing.

What about the problem of oxidation and the coking of oil in the center-bearing housing? Temperatures on the turbine wheel reach 1,600 to 1,850 degrees F, and can go even higher. I spoke with Buick about this high-temperature gremlin.

"We had a coking problem early on, and we spent many hours here at Buick and at GM Research to eliminate the

problem," said Ron Yuille, Buick's assistant staff engineer of the turbo group. "What we did was add cooling fins to our center rotating assembly. We also added an extra cooling hole in the oil gallery of the turbocharger itself. We went into production with that in 1982 with about 1,000 units—and all of 1983's production. We're happy to report that not a single turbocharger since that change has been returned for any signs of coking."

Chrysler keeps coking problems in check with a clever water-cooled center-bearing housing—one of the first in the auto industry.

Another problem for early carbureted turbocharger applications was keeping the fuel-to-air mixture properly balanced. "One thing that fuel injection allows us to do is tune the intake manifold, which really helps the low-end performance and enhances the ability to build boost fast," said Yuille. "You also eliminate the heat crossovers running under the manifold to keep the fuel properly vaporized and suspended in the intake charge, which increases the volumetric efficiency. A carburetor would have puddled the fuel in the low spots in our specially tuned manifold."

The final question posed to these experts concerned the high cost of turbocharging relative to a large engine with an equal amount of power.

"If you already have the tooling for a big engine, the big engine might be cheaper," admitted Renton.

Porsche-Audi spokesman Fred Heyler agreed that turbo engines are more costly. "With two engines of nearly equal power, a turbocharged engine is more expensive, but you're not going to get the part-throttle efficiency in the bigger engine that you would in the smaller turbo engine."

Countered Yuille: "It depends upon what kind of tooling you have in place in your plant. If you have to build a whole new engine, turbocharging is a lot cheaper. But if you've already got the tooling in place, a big engine is less costly." PS

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### How turbos work

The amount of power an engine can produce is directly proportional to the mass of air it can inhale. When the throttle is wide open, the engine will pull in only as much air as atmospheric pressure will allow. But by compressing the air, the horsepower of the engine can be effectively increased.

A turbocharger is by far the most efficient means of pressurizing the intake charge. It uses the energy remaining in the exhaust gas to rotate the turbine wheel and shaft. The exhaust temperature drops 150 to 300 degrees F, and gas pressure falls from 14.7 psi to approximately two to five psi as it passes through the turbine housing. The compressor wheel at the other end of the shaft spins at the same speed as the turbine wheel and packs the compressed air into the intake manifold.

With the increased temperatures and pressures, there is a greater predisposition for combustion-chamber or piston damage due to detonation. One way to control this is through an intercooler (air radiator) installed between the compressor and the intake manifold; it reduces the temperature of the intake charge.

There are at least three different methods of controlling abnormal combustion within the engine. The simplest method is to lower the compression ratio. This is usually accomplished with flattop or dished pistons. The second method is to inject water or alcohol during boost. The third method involves a waste gate—simply an exhaust-gas valve built into the turbo housing to bypass exhaust gases around the turbine wheel to prevent overboost. Most modern applications use a microprocessor linked to the combustion chamber by a detonation sensor. The microprocessor either opens the waste gate to reduce boost or retards the ignition timing to control detonation. The amount of turbo boost is controlled by the waste gate.



# Amazing hardening fluid

*opens a new world of hydraulic devices*

Chemists at England's Sheffield University have perfected a suspension of polymer solids in heavy oil that has the strange and wonderful property of changing from liquid to solid when a voltage is applied. The electro-rheological fluid could find broad use in a variety of hydraulic mechanisms, including automotive clutches and hydraulic valves.

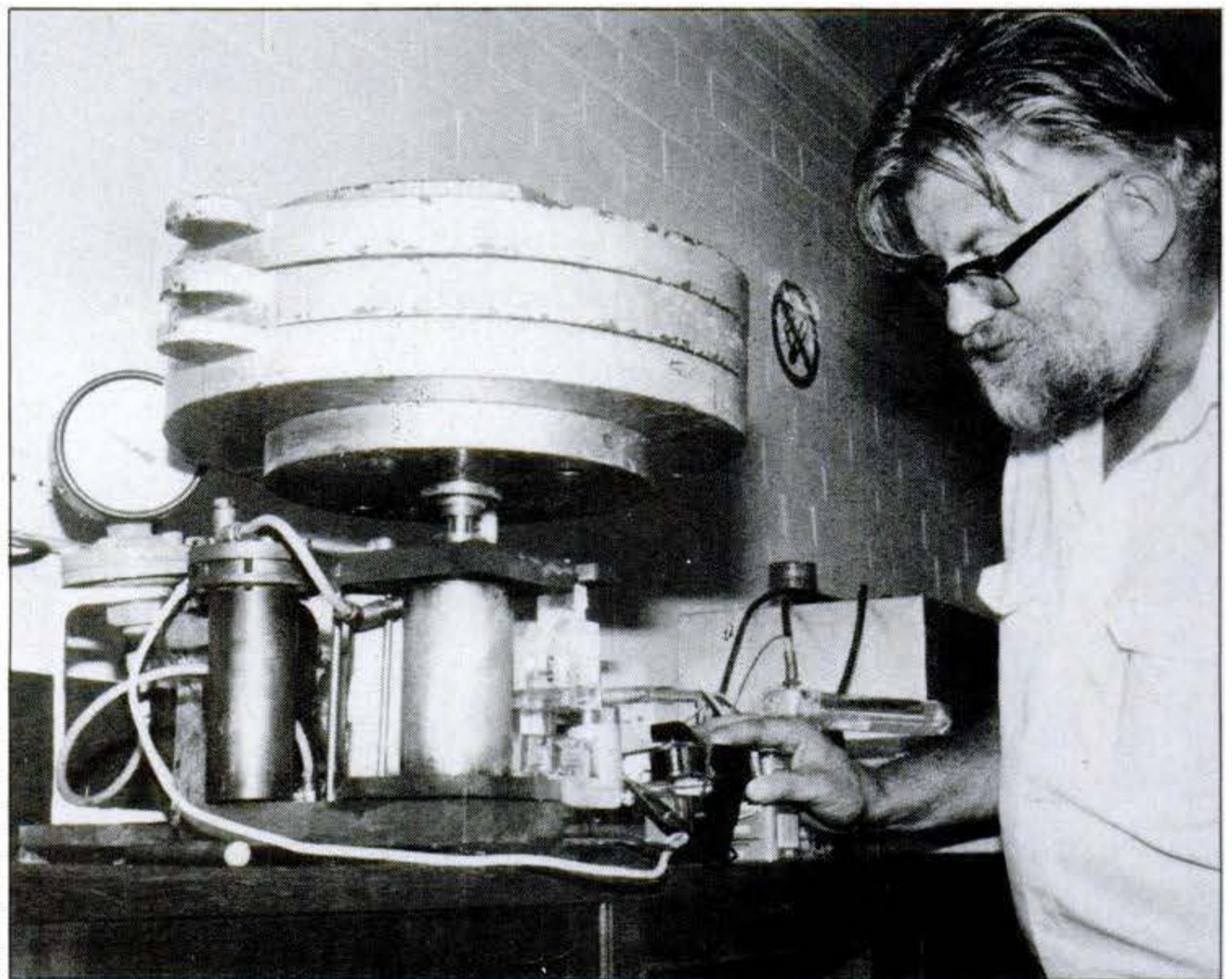
By DAVID SCOTT

SHEFFIELD, ENGLAND  
"Watch this," said Dr. Jim Stangroom as he dipped a pair of tweezer-like metal strips into a glass jar containing a milky liquid. The strips were fixed to the jar cap and wired to a small power pack on the laboratory bench.

The bearded, jovial chemist flipped a switch on the battery, lifted out the strips, and held them up for my inspection: A glob of the white stuff clung to their splayed tips. I poked the putty-like lump with a pencil. "Now watch again," he told me, switching off the current. Instantly, the glob dissolved and dribbled back into the jar.

Stangroom grinned at my amazement. "This is electro-rheological fluid," he said, "a very special mixture of oil, water, and minute solid particles that has the unique property of changing from liquid to solid when a high voltage is applied across it. Because the reaction occurs very quickly and can be controlled very precisely, the fluid can be used in any type of machine in which electrical signals govern mechanical motion." Enthusiastically, he ticked off some examples: "Automotive clutches, robotics, artificial human limbs—we're coming up with new applications for this stuff every week."

Stangroom heads a project team at Sheffield University's Department of Mechanical Engineering that has been



Hydraulic jack lifts weights when ER fluid pumped around loop circuit is diverted to an upright cylinder (center)

by a cylindrical ER valve (left). Dr. Jim Stangroom varies voltage from the power supply to control jack's lift.

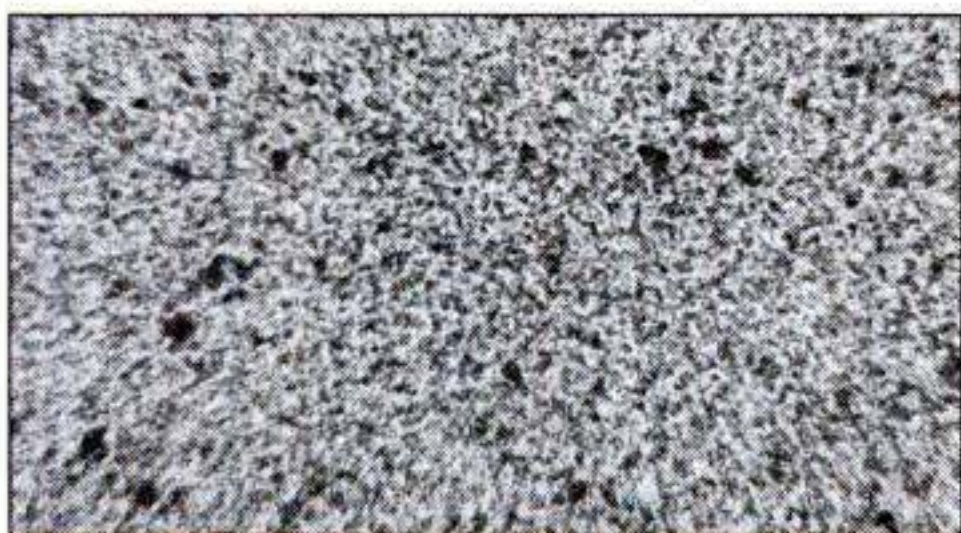
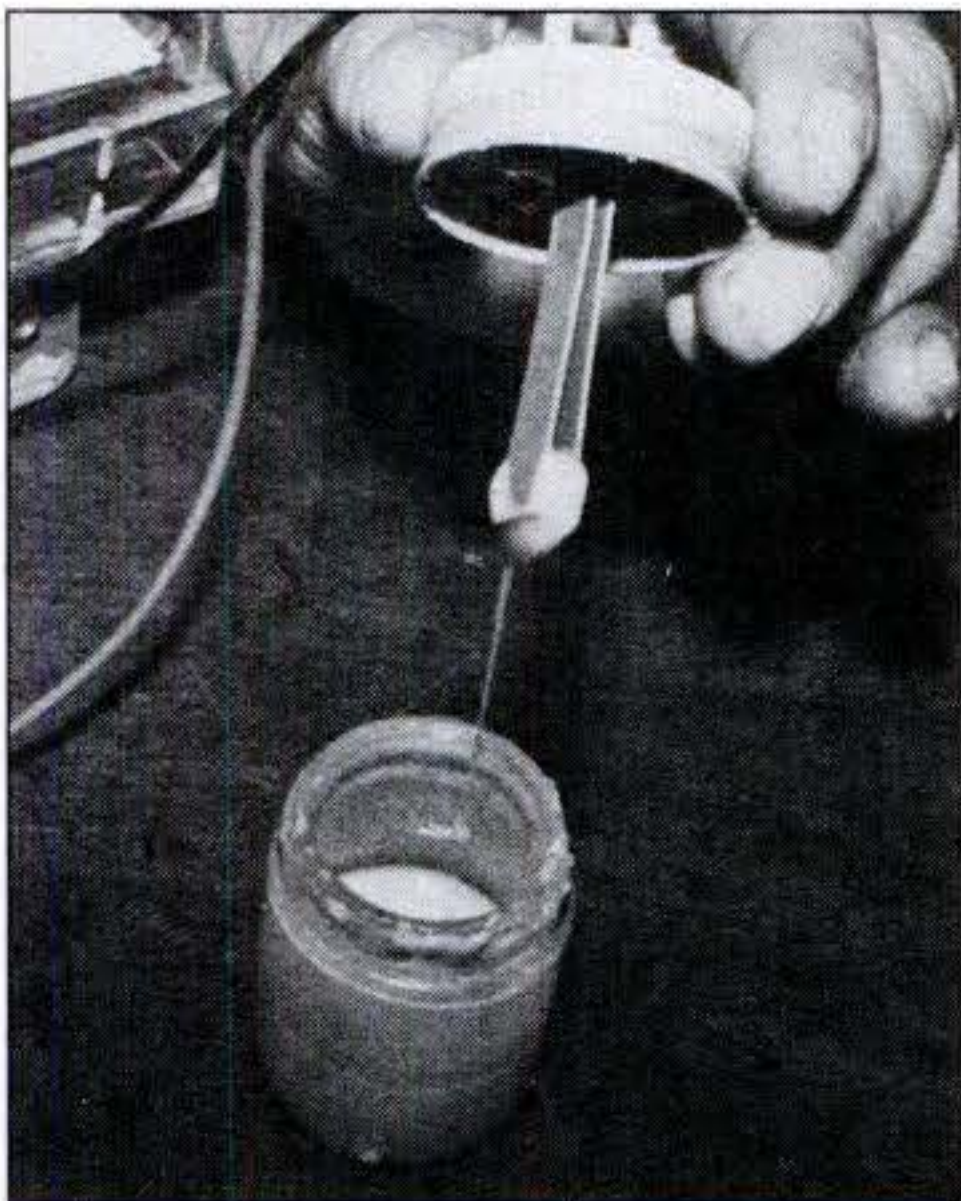
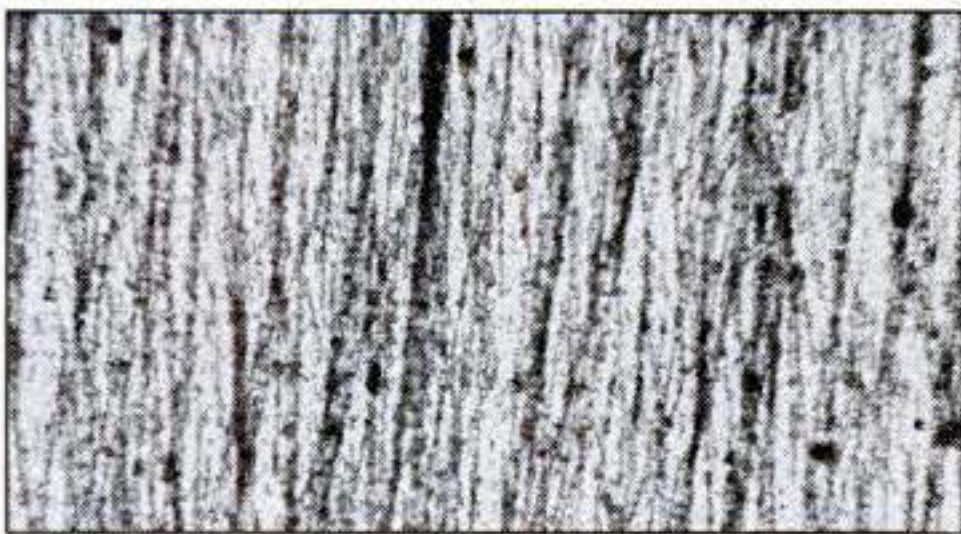
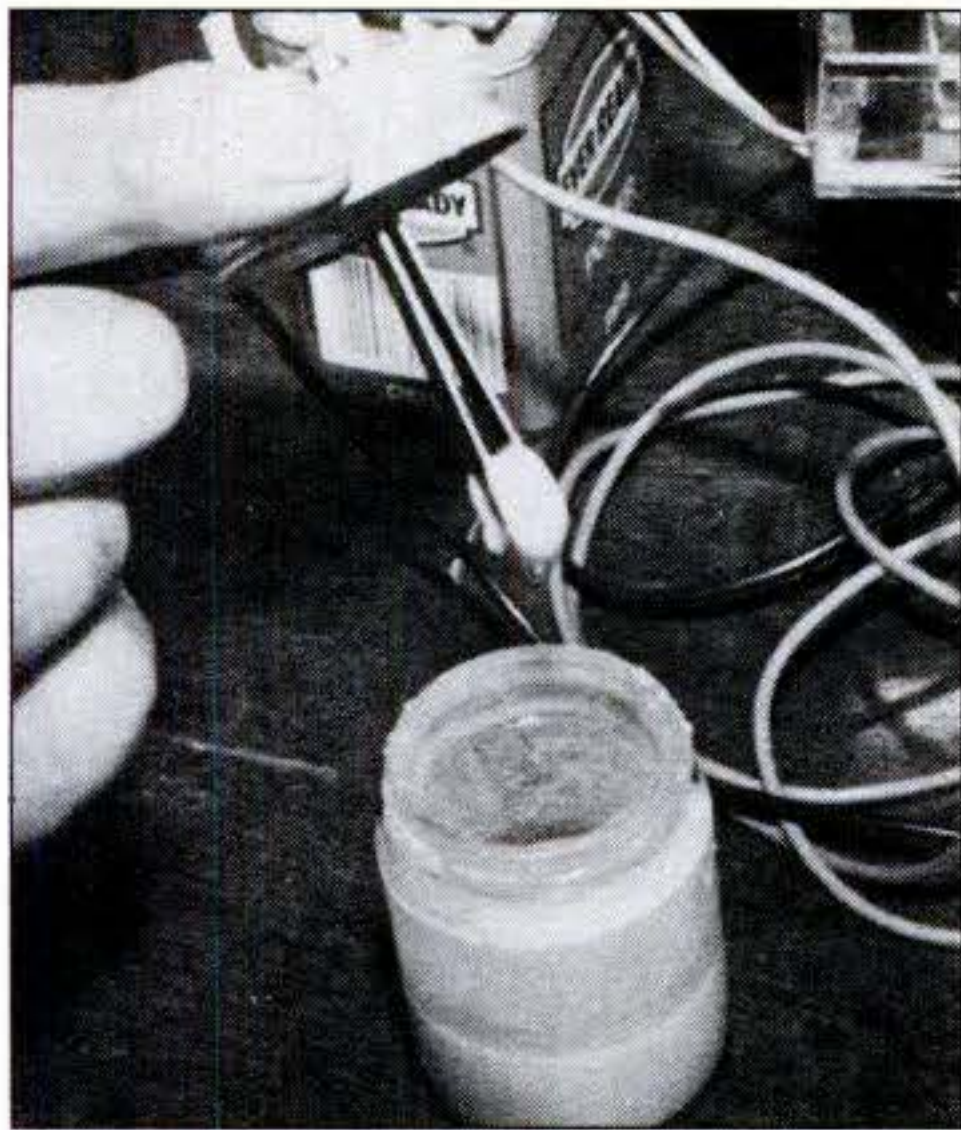
investigating the possibilities of electro-rheology (ER) for the past 10 years under a contract from the British Ministry of Defense. Only now have the tight security wraps been lifted, and Stangroom delighted in his new-found freedom to tell me the details.

Rheology is the science of the flow of matter. The idea of controlling flow

by the application of electricity—electro-rheology—dates back to the 1940s, when William M. Winslow of Wheatridge, Colo., experimented with a mixture of transformer oil and silica-gel particles. In its normal state, the mixture behaved as a viscous liquid; but when a voltage was applied, it turned to a solid mass.



## How ER fluids work



Electro-rheological fluids are a special mixture of oil and solid polymer particles containing water. The microscopic solids, comprising about 40 percent of the volume, are tangled chains built of negative and positive ions. The negative ions are the chain's links; the positive ions float free. Water molecules, which overall have no charge but do have north and south poles, cluster into "balls" around the free ions.

When a DC field is applied across the fluid, the positive ions move toward the negative plate, taking the water in tow. Thus, the chains line up like filings in a magnetic field: The positive, wet ends align head to tail with the negative, dry ends. Surface tension binds them. By varying the voltage it is possible to control the percentage of particles adhering to each other and thus the relative solidity of the fluid.

The photos demonstrate the process. With voltage applied between the splayed electrodes (top), the fluid congeals into a hardened lump. The photomicrograph (magnified 100 times) shows that the solid particles in the fluid form chains along the path of the current flow. When the current is switched off (below), the material liquefies and dribbles back into the jar. In the uncharged state, the particles are unconnected.

"It's a bit like mixing flour and water to make dough," says Jim Stangroom, head of the Sheffield University team that is developing ER fluids for industrial applications. "With flour, the separating lubricant between dry, solid particles is air instead of oil, and the water is introduced externally instead of from within the particles. But the particles stiffen to form a solid. If too much water is poured into the bowl the congealed mixture becomes more liquid. The same diluting effect occurs with ER fluid when the voltage is too high. Too much water is drawn from the particles, reducing their adhesion."

Even more so than with bread-making, the requirements for making ER fluid are exacting. Stangroom enumerates some of the particulars: "The mixture of oil, water, and particles must be chemically stable over a wide temperature range. It must be nonabrasive and have good lubricating properties. It's essential that the oil and particles have the same density so the particles don't settle. And the oil must be a good insulator that strongly repels water, while the particles must be porous with a sponge-like attraction for water."

It did for brief periods, anyway. After a time, the widely differing densities of the oil and silica in Winslow's fluid caused the particles to settle out and stop the ER effect. The fluid was also highly abrasive, causing abnormal pump wear and electrical shorts. These snags dampened the early enthusiasm of several American com-

panies, and the project was shelved.

Its revival at Sheffield points to the great potential for ER devices but not to any sudden easing of the technical hurdles. Progress has been laborious, requiring parallel developments in polymer chemistry, organic chemistry, mechanical engineering, rheology, and electronics.

But now Stangroom's team has moved beyond the laboratory stage and has created a London company, ER Fluid Developments, to exploit the electro-rheology concept commercially. Already it is negotiating licensing deals with several private firms, including a British automobile manufacturer with American connections.

## Weird concoction

When I visited Stangroom's lab at Sheffield University, prototypes and test rigs of various ER devices were scattered on bench tops. But first he showed me the chemistry lab in which experimental quantities of the special fluids are made.

In a room filled with the familiar glass and rubber plumbing of any chemistry lab, Stangroom led me to a stand of glass vessels, tubing, and hoses at the far end. This, he explained, was where the fine plastic particles were formulated from polymethacrylic acid, the same monomer used in the manufacture of Lucite. The liquid is mixed with water and grown into a tangle of long-chain polymers—"like three-dimensional wire netting in a liquid solution," Stangroom said. He pointed to some white goo in a glass beaker. "It has the stiff consistency of animal gristle."

Next, the material is pressed and dried so that it resembles coarse sand, with voids, or pores, throughout the entire structure. Finally, it is ground in a vibrating-ball mill to a state something like talcum powder. The result, Stangroom told me, is dry particles about 10 microns (millionths of a meter) across having a specific gravity of 1.4.

That's much heavier than water. Oil, in which the particles are suspended, is normally lighter than water. The trickiest part of the process is increasing the specific gravity of oil from 0.8 to 1.4, which is necessary to produce a stable suspension.

"We make the oil heavier by replacing some of its light hydrogen atoms with heavy bromide ones," Stangroom explained. "Generally when you make things heavier, they become more solid. In this case, though, the differing molecular shapes don't fit together neatly to form a solid, so instead of freezing, the substance remains a liquid to quite low temperatures. It's a chemical oddity."

This unnatural stuff is produced from synthetic oil in a molecular still. The complex distillation process, which takes place in a vacuum frozen to -196 degrees C (-320 F) to prevent vapor contamination, restructures and purifies the oil. When the plastic par-

*Continued*

# *“A voltage supply the size of a flash*

ticles are added to the oil, they remain in suspension indefinitely. The only drawback to the ER fluid is its cost. In the laboratory, it costs about \$450 a liter to produce. Stangroom thinks that, in bulk production, the cost might be only one-tenth of that amount, however.

But even at the fluid's present high cost, Stangroom believes that ER technology is viable for automotive clutches because only a small volume of fluid would be needed. To demonstrate his point, he showed me a laboratory model of a cylindrical clutch. (This and the other devices described in the article are shown in the drawings.)

A small motor with a tubular foot-long shaft sat on a bench top. The tube, sealed at the end, enclosed a rod with a pulley on its outer end. A cord wound round the pulley was tied to a weight resting on the lab floor. The tube, Stangroom explained, was filled with ER fluid.

## **On again, off again**

Stangroom flipped a switch on a power pack to start the motor and tube running, but the rod inside the tube stayed still. Then he flipped a second switch, applying a voltage between the tube and rod; instantly, the rod started turning and hoisted the weight off the floor. The fluid had solidified, locking the two parts together.

“I can alter the degree of clutch engagement with controlled slip by varying the voltage,” Stangroom said as he turned a knob. The pulley slowed and barely inched the weight upward, although the tube speed was constant.

“For cars, you could have a disc clutch working on the same principle,” Stangroom continued. “Such a plate coupling would have opposed discs enclosed and sealed in a similar way. To meet torque requirements it could be a multi-disc device. Alternate elements are connected in parallel as interleaved electrode arrays, rather like a radio variable condenser with circular plates.”

Stangroom believes that ER clutches are especially promising for automatic transmissions because they give positive drive when fully energized: The hydraulic losses of a conventional torque converter are eliminated, as is the need for any auxiliary lockup (to prevent slip) or for an oil cooler. During disengagement, the slight viscous drag of the fluid is unlikely to cause creep, and controlled slip can be electronically regulated by a slow voltage rise. Battery drain during engage-

ment periods is negligible, he says.

On one occasion, the clutch grabbed too well. “We got one batch of rather active fluid,” Stangroom told me with a slight smile. “We piled on the volts too fast and destroyed the test equipment. Working backward, we figured out that the rig was giving the power of a small car.”

ER clutches could have other automotive uses outside the drive train. Two possibilities are couplings for air-conditioning compressors and thermostatically controlled cooling fans.

“Now have a look at some valves,” Stangroom said as he hustled me across the room. He picked up a stack of metal plates that looked like a block of multilayer cake. “Put some volts across this, and it can reduce or completely stop the fluid flow. Such a valve would have extremely fast on-off action and very accurate flow control. It would also be inexpensive to produce. On vehicles, it could be used for hydraulic power steering with electronic command signals, ride control to vary shock-absorber damping, and anti-skid brake systems, in which rapid response to modulate brake-fluid pressure is essential.”

To demonstrate how the device would work, Stangroom led me to a strange-looking hydraulic jack, where a 120-pound weight sat on top of an upright cylinder. Fluid is normally pumped directly from a supply tank to the cylinder, he explained, but when an ER valve in a bypass circuit is opened, flow to the cylinder is stopped.

Stangroom then switched on the voltage to block the return flow, and the weight slowly rose as the fluid built up under the cylinder. A gauge recording the fluid pressure rose steadily to a mighty 300 psi. “I can regulate the lift by lowering the voltage,” he hollered over the pump noise as he twisted a knob. The gauge needle trembled back to around 100 psi, and the weight barely moved.

“That rig's powerful enough to just about lift me,” Stangroom chuckled.

Valves can also be cylindrical. Stangroom showed me one made up of a number of coaxial elements supported by radial insulating spacers. This type has a larger electrode surface for a given frontal area and can handle a greater flow. It also avoids the “dead” edges of plates and is easier to make.

Four valves—either multi-plate or cylindrical—can be combined in a novel fluid equivalent of an electric Wheatstone bridge for precise control of a double-acting hydraulic cylinder.

Piston movement in either direction is regulated merely by applying voltage to two valves on opposite sides of the diamond-shape bridge. Switch over the voltage, and the piston slides the other way.

“We also have a fluid piston that's really crafty,” Stangroom told me. “A multi-cylinder ER valve can actually work as a hydraulic piston, eliminating external control valves entirely. It slides inside a conventional outer cylinder, and a wire threaded through the hollow piston rod takes the control voltage to the piston's alternate ‘hot’ rings.”

Hydraulic fluid is pumped at a constant rate through the outer cylinder in a loop circuit. With the current off, it passes freely between the piston elements, so there is no movement. When voltage is on, the piston becomes blocked up, so it's moved by the fluid pressure. The degree of solidity and, therefore, movement is determined by the voltage. Two such cylinders, connected back-to-back and operated out of phase with each other, would give bidirectional travel.

## **Late developments**

The concept behind ER devices is startlingly simple; turning the concept into real machinery involves dozens of thorny problems, however. One is developing techniques to reduce the cost of the ER fluid.

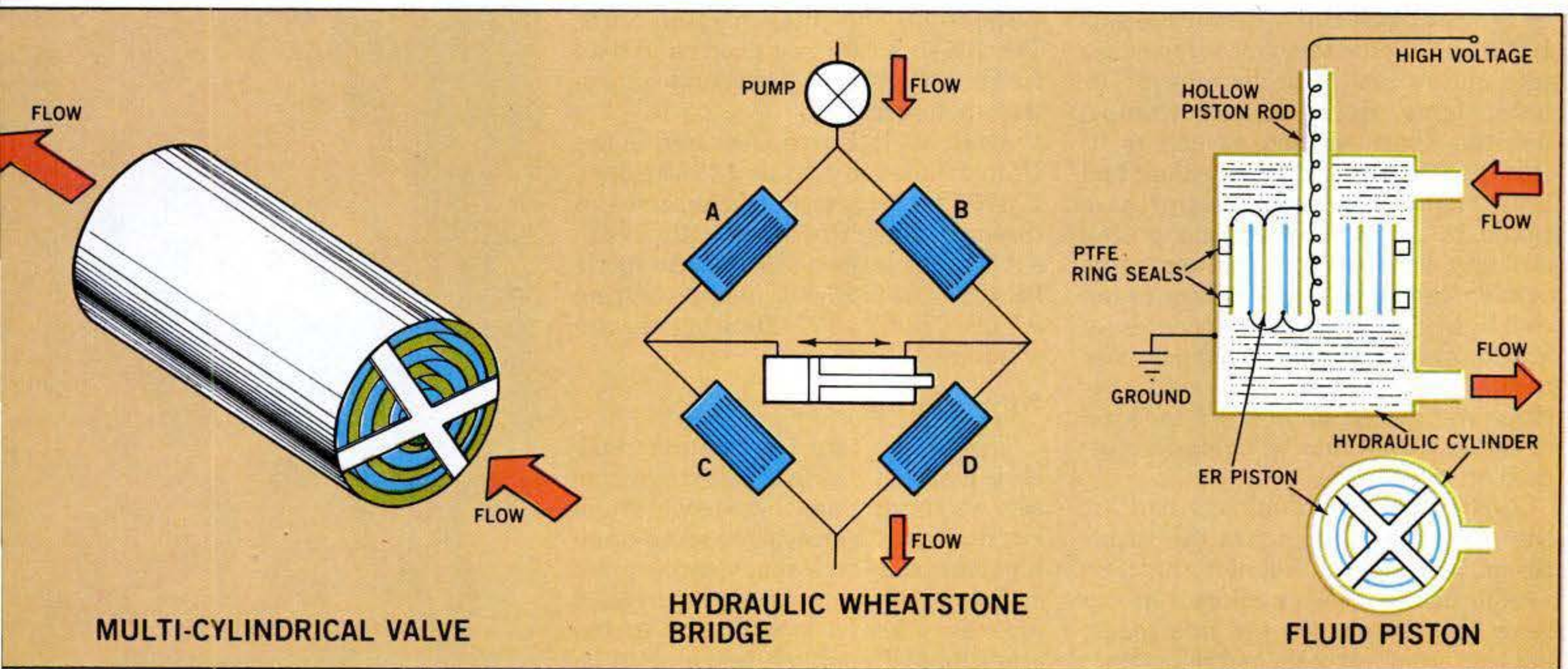
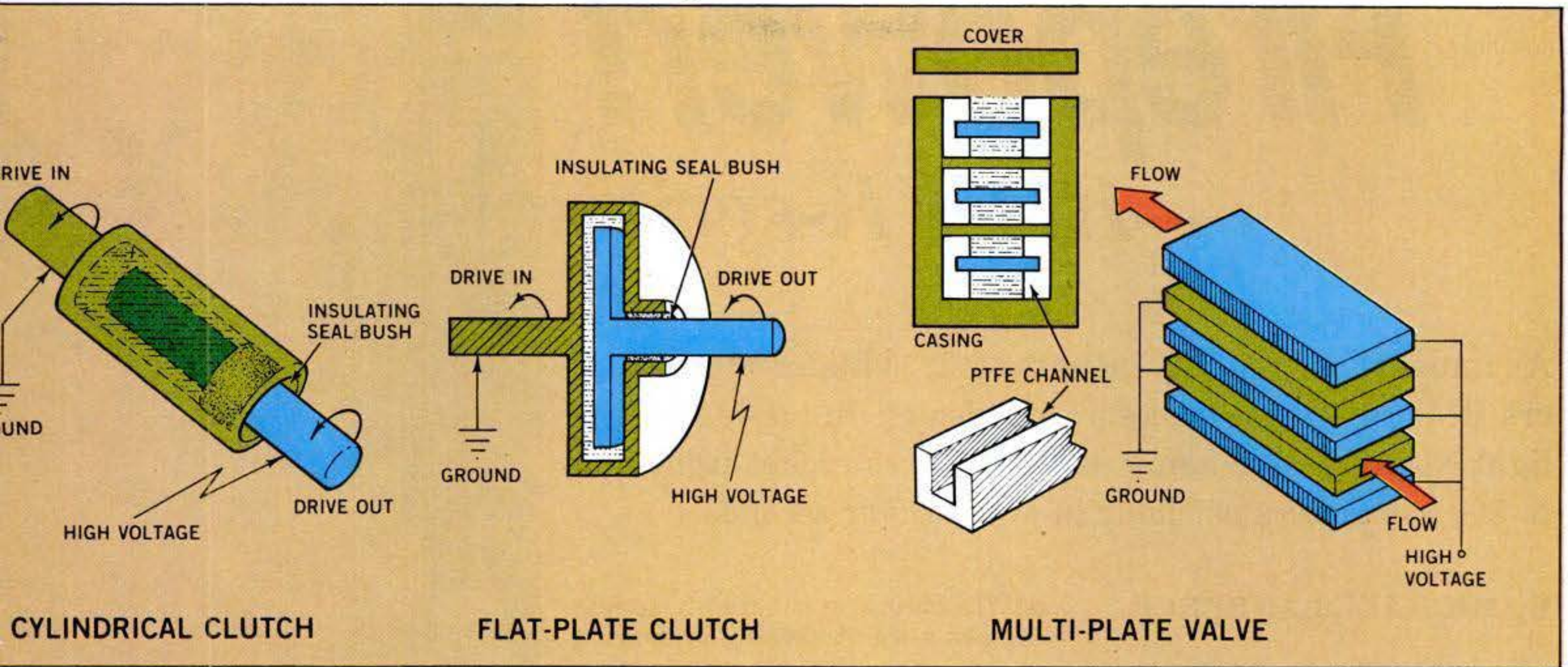
Another problem has been building precise, reliable power supplies. The amount of power needed is very small. Stangroom pointed at the electronic flash gun attached to my camera. “A voltage supply no bigger than that could operate a clutch or valve.” But to take full advantage of the fluid's extraordinary speed of response, it is necessary to vary the applied voltage at the same rate—and precisely. Electronic research scientists on Stangroom's team at the university are working to perfect the power supplies.

A third problem is possible contamination of the fluid by mechanical wear. Exhaustive tests at Sheffield have shown that the fluid itself is not abrasive because the particles in it are soft plastic. However, ordinary pump wear could deposit metal slivers in the fluid that could cause electrical arcing or even a short in the ER device.

Ordinary fine-mesh filters can't be used to prevent this, as they would also remove the ER solids. Magnetic plugs to trap any metal worn from mechanical parts are seen as the answer.

Stangroom is confident that the re-

# gun's could run a clutch or valve'



ER clutches, valves, and pistons all have similar construction. The mechanical elements are in a sealed housing filled with the special fluid. When a voltage, typically two to six kilovolts

per millimeter, is applied across them, the fluid congeals to a solid mass in a few milliseconds. Current drain is tiny, far less than for a miniature flashlight bulb. In all of these devices, the work-

ing parts are spaced a half-millimeter or more apart. Such wide clearances eliminate the need for close production tolerances. (See text for description of the workings of these six devices.)

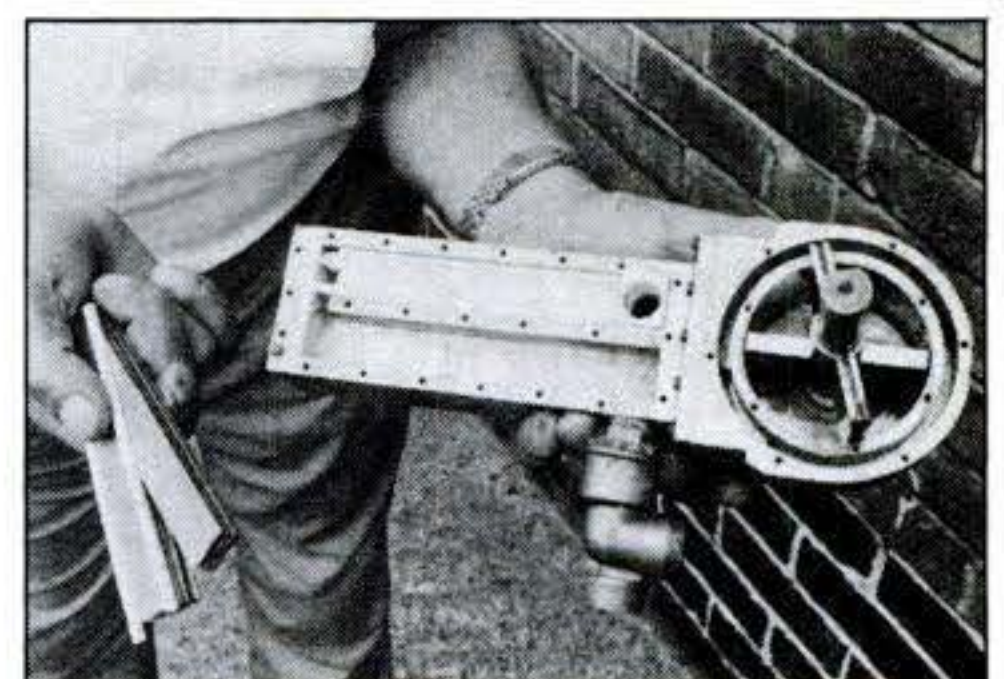
maintaining technical problems will be overcome. Whether economic obstacles will fall as easily is not certain.

"It's a chicken-and-egg situation," Stangroom said. "Potential manufacturers of ER equipment are hesitating because there's no commercial supply of ER fluid. And chemical manufacturers are reluctant to make the fluid because there's no commercial market for it yet.

"But we're getting more and more inquiries about it. I'm confident that ER is going to take off." PS



Cylindrical valve has concentric elements supported by plastic spacers. DC voltage is applied to alternate rings.



Robotic joint rotates with flow of ER fluid to opposed chambers under control of ER valves (disassembled, left).

# Firepower!

## —BMW K-series

An unusual horizontally mounted four-cylinder engine powers BMW's first new motorcycle design in 60 years. The lightweight, aerodynamic K-series bikes rocket from zero to 100 kilometers per hour in a mere four seconds.

By **MICHAEL LAWRENCE**

**A**lpine passes are never easy, but the newest BMW motorcycle was carving the tortuous serpentines into child's play. Uphills, downhill, lefts, rights, rights, lefts, downhill, uphill—there seemed no end to it. But the BMW K 100 I was riding had been engineered with exactly these roads in mind. The engine pulled strongly, with its broad power curve cutting gear changes to a minimum; the light weight and low center of gravity made directional changes mere mentally inspired flicks; the riding position was perfect for hours of the kind of riding that would be tiring in minutes on most bikes.

Earlier, leaving Munich, I had hit the Autobahn and opened the throttle on a rampage that left the tach needle locked above redline—in top gear. The Autobahns are fine roads, but they aren't smooth, and they aren't at all straight. This was no simple top-speed run but a thorough workout of all parts of the motorcycle.

Whether leaned over at angles that

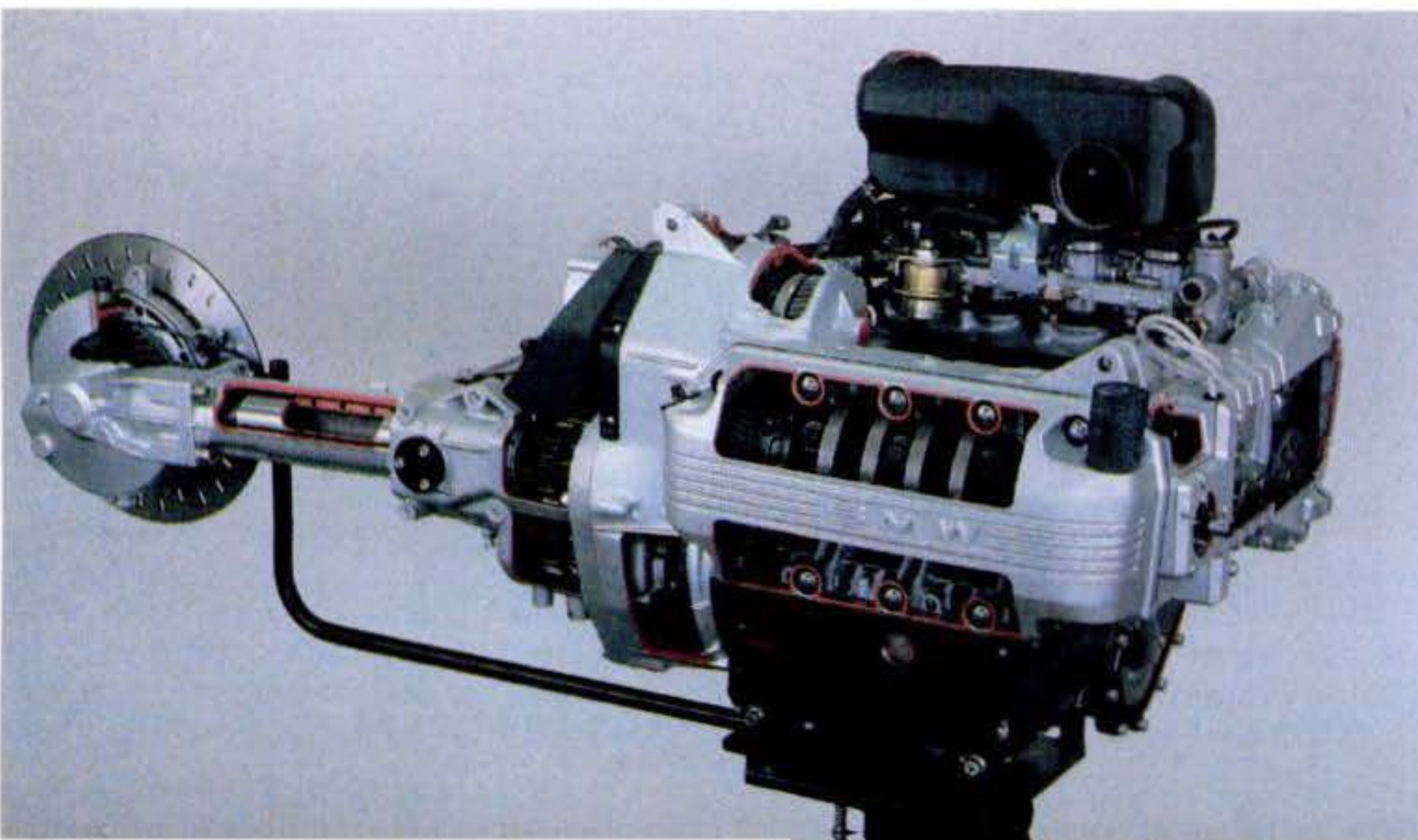
put the horizon at a crazy tilt, streaking along the Autobahn, or soaking up rough pavement with its long-travel suspension, one thing became clear: The BMW K 100 is a good candidate for the title "most all-around competent motorcycle."

Available in Europe now and in the United States in July as a 1985 model, BMW's K-series motorcycle comes in three versions: the base K 100 (without fairing) at about \$5,500, the sports RS at \$7,200 to \$7,500, and the touring RT at \$7,700 to \$7,800 (all prices are estimates).

### New engine

The power plant for all three models is a new in-line four-cylinder (photo below). The engine's forged-steel crank has five main bearings and seven counterweights; a large spur gear in place of the eighth counterweight drives a secondary shaft, located low in the crankcase. The clutch is mounted on this secondary shaft, as is a cushion drive, and the shaft's forward end extends to drive the oil and water pumps.

*[Continued on page 158]*



BMW K 100 RS (above) features a wind-tunnel-developed fairing that's claimed to provide stable high-speed riding with little wind pressure. Cutaway at left shows the heart of the K-series motor-



cycles: an in-line, liquid-cooled DOHC four-cylinder engine with bore and stroke of 67 by 70 mm (2.6 by 2.8 in.) that displaces 987 cc (60.2 cu. in.). The engine, fed by Bosch L Jetronic fuel

injection, is mounted longitudinally to eliminate a right-angle gear to a BMW tradition, the drive shaft. The twin cams are driven by roller chain and operate two valves per cylinder.

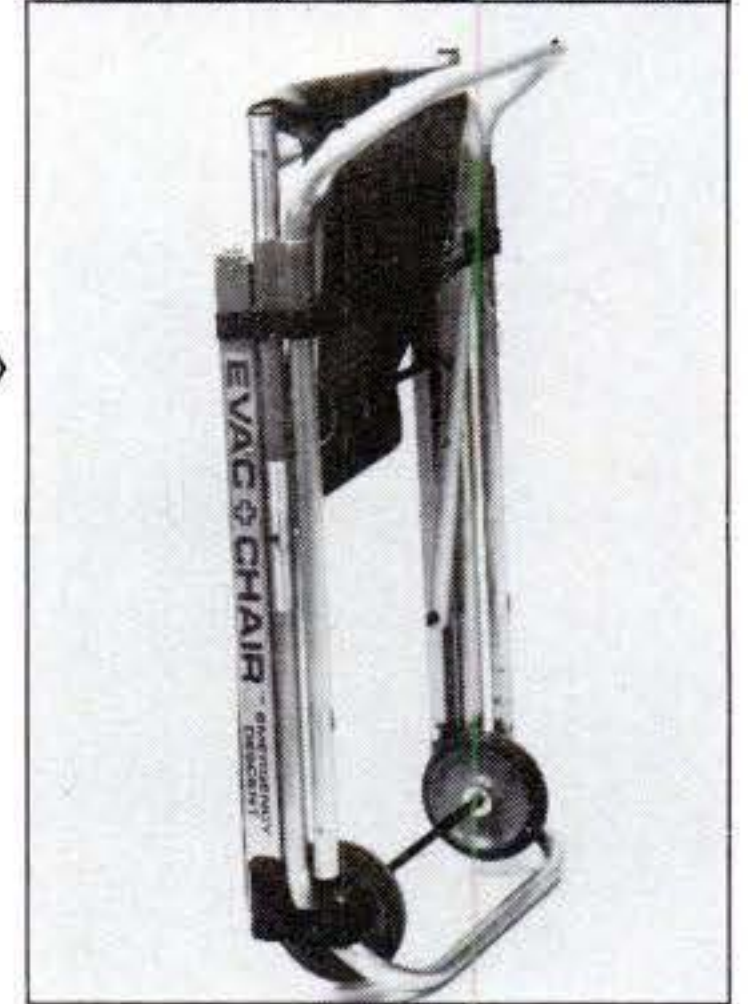
# What's New

*products/technology*



## ◇ Safety seat

Slam on the brakes, and a child is held fast by an inertia-actuated harness, says Nissan. The seat—for children from four months to four years old—is self-adjusting yet allows free movement. A padded breastplate and one-buckle fastener can be connected with one hand.



## ◇ Escape chair

When a fire, bomb threat, or power outage threatens handicapped persons in high-rises, the \$649 folding Evac + Chair simplifies evacuation, says the maker. Persons weighing up to 250 lbs. can be wheeled down steps. Egen Polymatic Corp., 17 E. 67th St., New York, N.Y. 10021.



## ◇ Fiber helmet

Super-tough carbon fibers keep its model 32 motorcycle helmet light (two lbs.) to reduce fatigue, says Simpson. "Slippery" shape cuts wind buffeting; vents aid cooling. Lexan shield easily snaps into place. Simpson, 22630 S. Normandie Ave., Torrance, Calif. 90502. \$270.

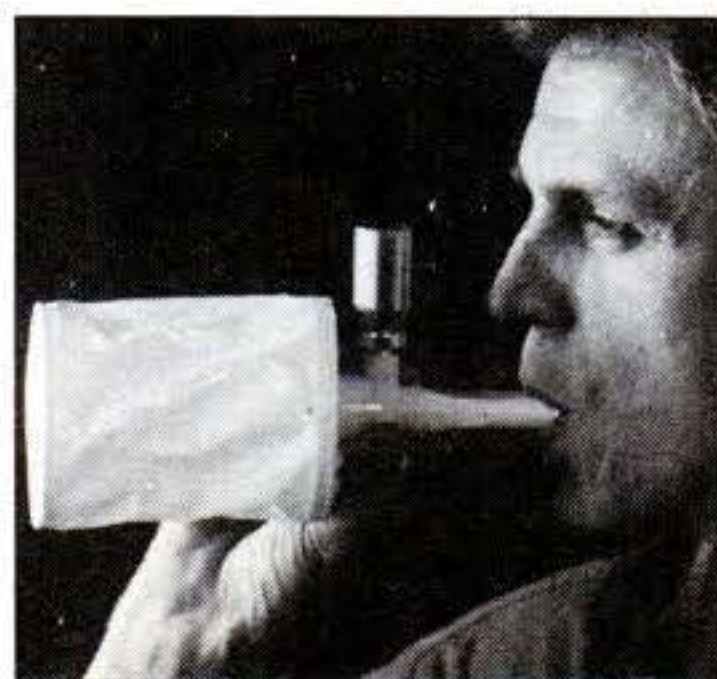
## ◇ Future cars

Toyota unveiled automobiles of tomorrow at a Tokyo car show. The FX-1 (top right) is a sporty design with advanced technologies, such as electronically controlled suspension and anti-skid braking, plus a color-CRT dashboard display. A six-cylinder, twin-turbocharged engine and 0.25-drag-coefficient body keep fuel consumption low. The SV-3 (middle) is a two-seat personal car with a midship-mounted four-cylinder engine for stable cornering and road holding. TAC3 (bottom) is a small, 4WD three-seater with an automatic transmission. Driver's centered seat pivots 45 degrees either way. Windshield and top come off.



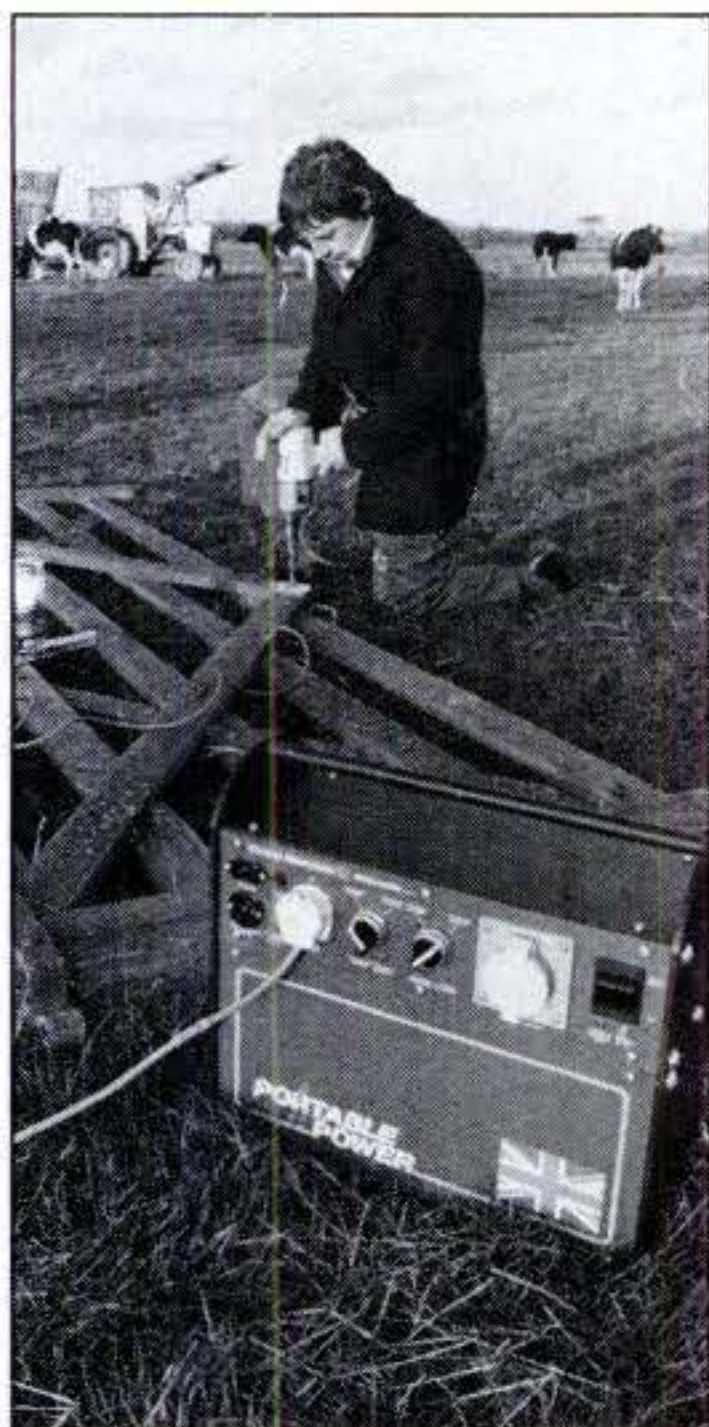
## ◇ Audible inhaler

InspirEase is the solution for patients frustrated at breathing fast puffs of medication from metered-dose inhalers, says Key Pharmaceuticals (Miami, Fla.). The \$9 prescription device has a reservoir bag for spray inhalers. A reed whistles when medication is inhaled too fast.



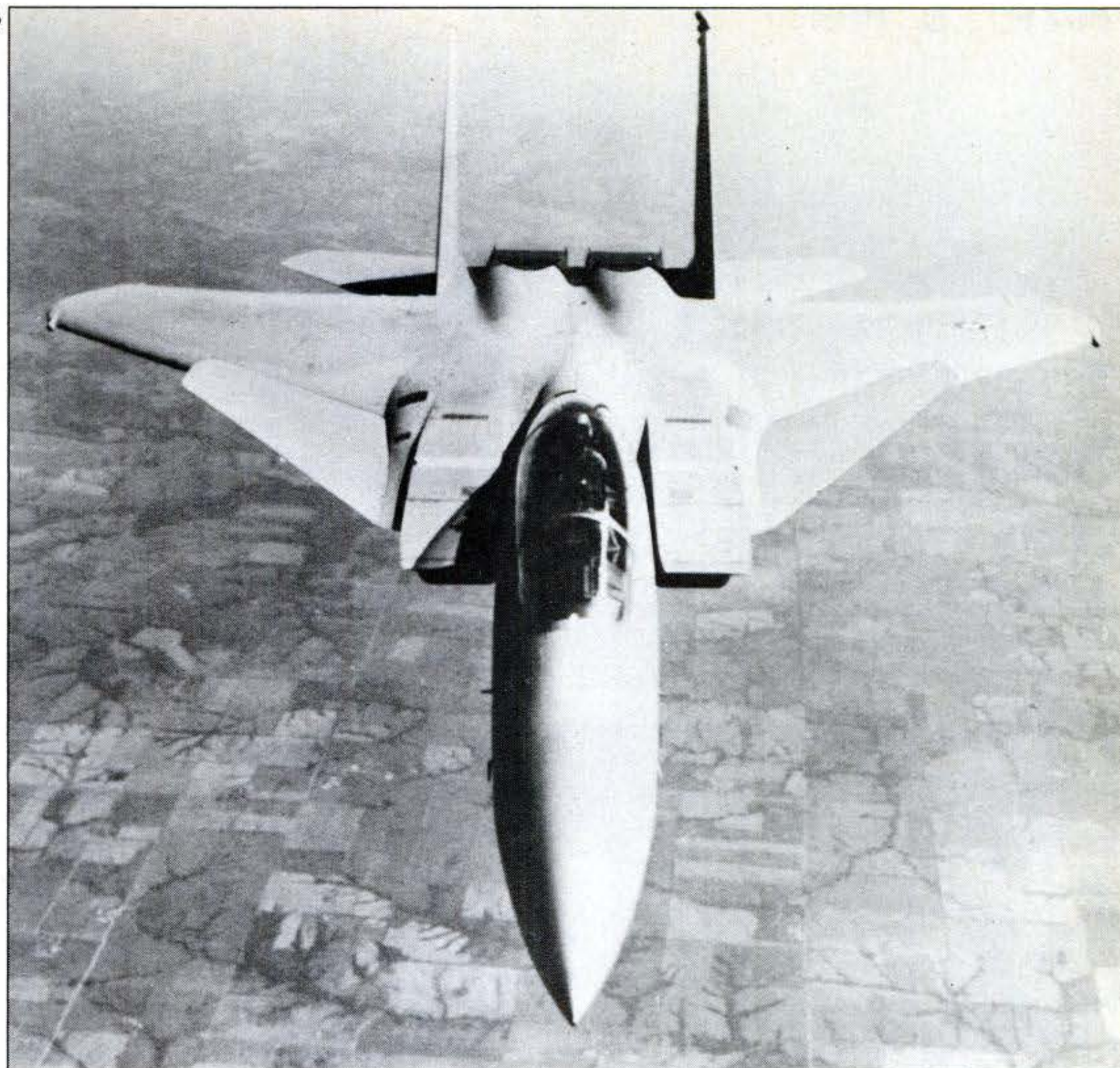
## STOL F-15

A design concept modifying its F-15—small canard wings and rectangular thrust-directing engine nozzles—could give it short takeoff-landing capabilities, says McDonnell Douglas. The craft could use short or bomb-damaged runways. Design also boosts maneuverability.



## Portable power

Powermate has two special batteries and an inverter to deliver 110 and 240 V (50 or 60 Hz) anywhere. The British power pack supplies up to 400 W for tools or emergency lighting. Furama Electronics, Athron Developments, Athron St., Holmes Market, Doncaster, England.

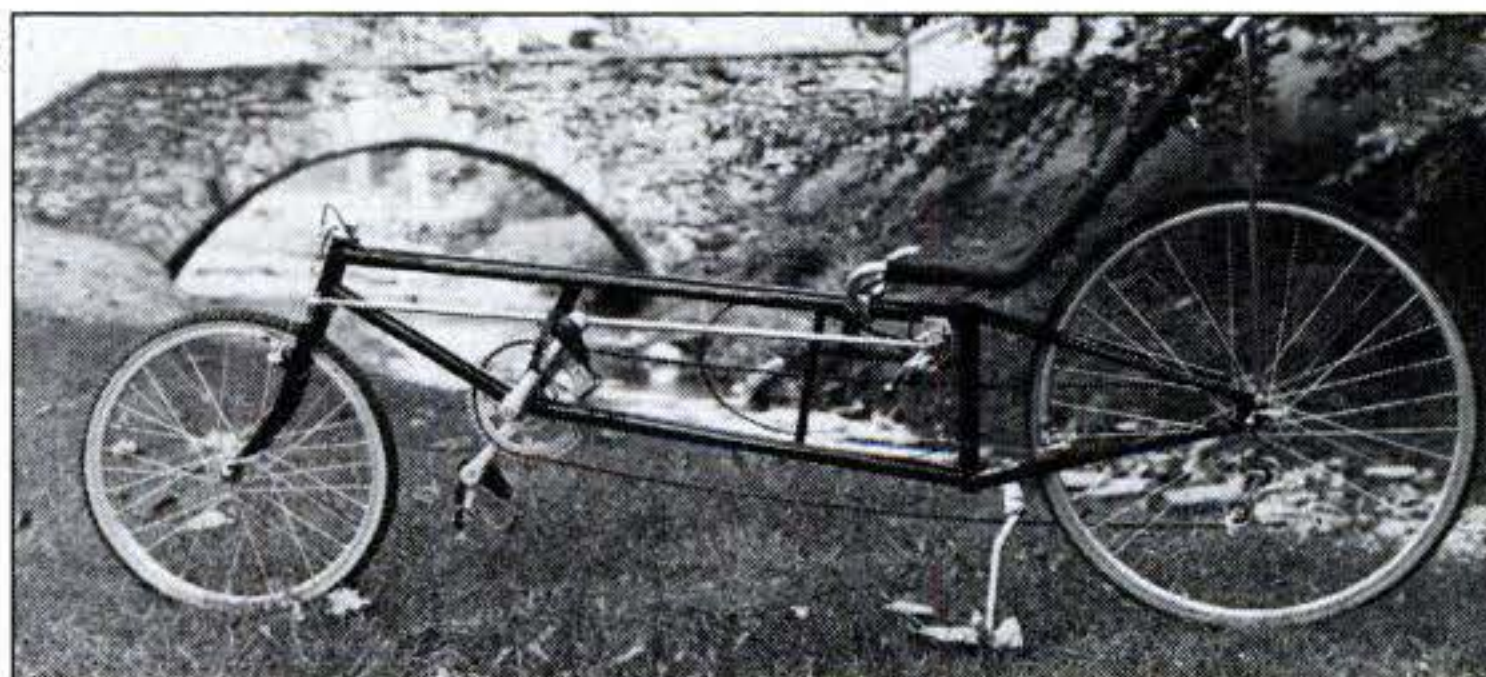


## Safety monitor

Homebound persons can press a beeper worn around their necks to activate Communi-Care's telephone intercom. A 24-hour nationwide service with computerized patient records can offer help within 90 seconds, says Staff Builders (122 E. 42nd St., New York, N.Y.).

## Recumbent bike

High quality at half the price of similar models—that's the claim for this recumbent bike. With 20 times the seat area of conventional bikes, it lets you lean back and cut wind resistance. DeFelice Recumbent Bicycle Co., Box 321, New Palestine, Ind. 46163. \$549 to \$600.



## Training plane

Learning to fly? The two-seat SAH1 trainer, a low-wing 118-hp monoplane, is stressed to six G, with good spin and recovery characteristics, according to the maker (Trago Mills Ltd., Aircraft Div., Treswithick Farm, Cardinham, Bodmin, Cornwall PL30 4BU, England).



## Halogen lamp

Its Watt-Miser tungsten-halogen lamp uses 600 W less electricity than the 1,500-W lamp it replaces, says General Electric. The lamp has a 2,000-hour average rated life and nearly the same initial light output. A coating reflects infrared onto the filament to help heat it.

# What's New



## Mammoth yacht

The 340-ft. *Sea Goddess*, a commercial cruise ship designed like a millionaire's yacht, has a fold-down dive platform for water sports. A waterfall flows down the ship's funnel, adding ambiance. Sea Goddess Cruises (5805 Blue Lagoon Dr., Miami, Fla. 33126) operates it.



## Concept car

At speeds below 40 km/h (25 mph), MX-02's rear wheels steer in opposite direction to the front. This unique, four-wheel steering system gives its concept car low-speed agility and high-speed stability, says Mazda. Vehicle has a "heads-up" windshield instrument display.

## Elegant wheelchair

Advanced composites make an elegant—and versatile—wheelchair. The spokeless wheels adjust for best hand grip, the armrests retract for side exit, and, cushions removed, the chair goes into the shower. Designer: Ronald H. Williams, 13564 Trinity, Detroit, Mich. 48223.



## Rail bus

A standard bus mounted on a railroad chassis is cheaper to build than conventional rail cars, says Britain's Leyland National. The two-car rail bus is now being tested on the rails. In future tests, the train will roll from the tracks onto the road to serve remote areas.

## Sailing tug

Under full sail, the 51-ft. *Norfolk Rebel* saves up to 50 percent of the fuel it would normally use, claims the designer, Captain Jesse A. Briggs (Rebel Marine Service, Norfolk, Va). The "tug-antine" is intended to serve as a sail-assisted fishing boat.





# What's New in Boating

BY SUSAN RENNER-SMITH

## Kayak stabilizer

Climbing back into a capsized kayak can be tricky and dangerous. The feat becomes simpler with the Paddle Float—a sturdy, inflatable pouch that converts the paddle to a stabilizing outrigger. Price: about \$25. Sea Trek, Schoonmaker Point, Sausalito, Calif. 94965.

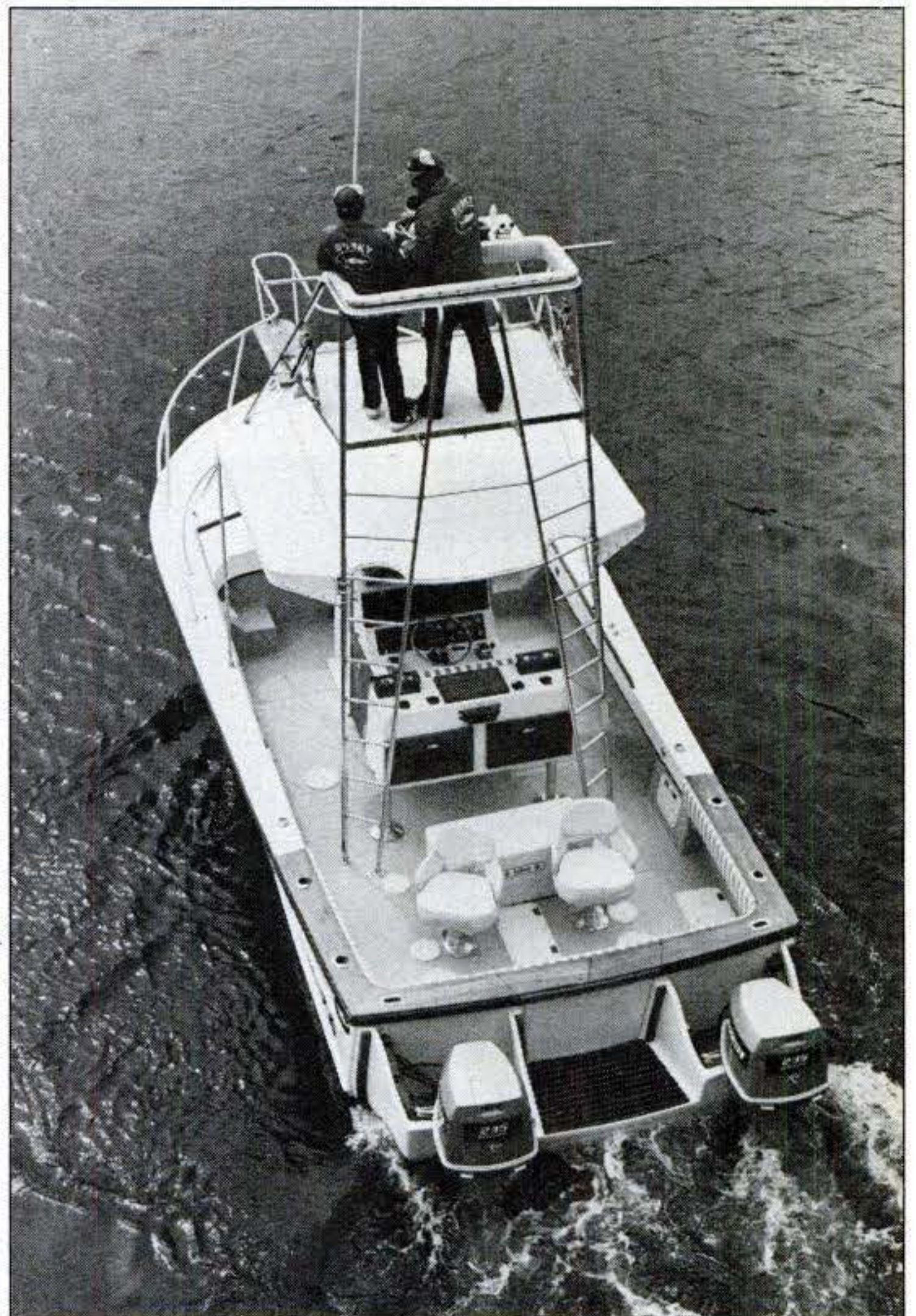


## Sail trainer

The three fiberglass hulls on Star Runner's aluminum frame offer extra stability for the novice sailor, says Northern Plastics (6733 Myers Rd., E. Syracuse, N.Y. 13057). The two-seater steers via a front foot bar, leaving hands free for sail tending. The \$1,995, 13¾-ft. craft weighs 170 lbs.

## Transom well

Twin outboards mounted in external fiberglass wells flank a dive platform on the Dusky 26-ft. sportfisherman. The wells, bolted and epoxied to the heavy-duty transom, free cockpit space. The system also improves handling, says Dusky (110 N. Bryan Rd., Dania, Fla. 33004).



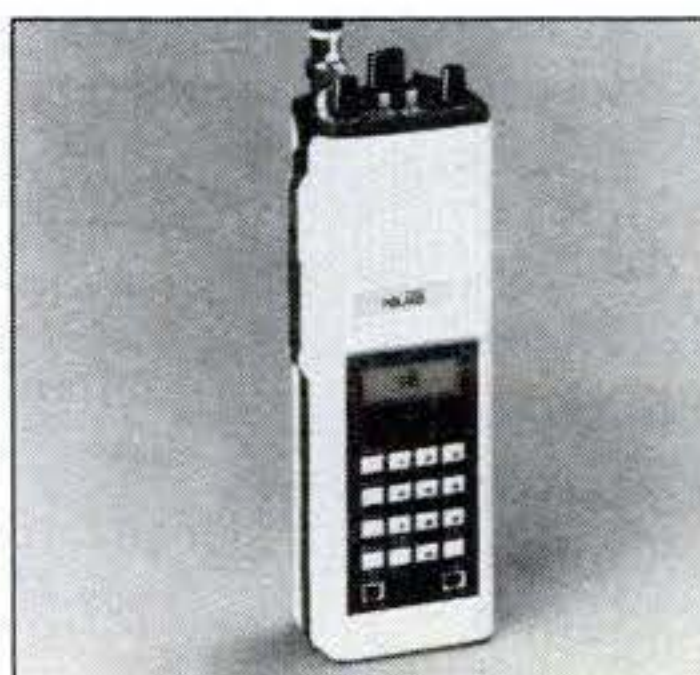
## Brainy tracker

The computerized Model 580 fish tracker monitors 10 depth ranges down to 200 ft. An alarm sounds if the anchor drags, if depth varies from the preset setting, or if fish swim within the set range. Ray Jefferson, Main and Cotton Sts., Philadelphia, Pa. 19127. \$350.



## Handy transceiver

With key-pad tuning of all marine channels and 10 weather channels, plus channel-scanning and call-waiting, the hand-held \$549 Polaris MT 1000 lacks only power. A \$219 option boosts power from three to 25 W. Regency, 7707 Records St., Indianapolis, Ind. 46226.

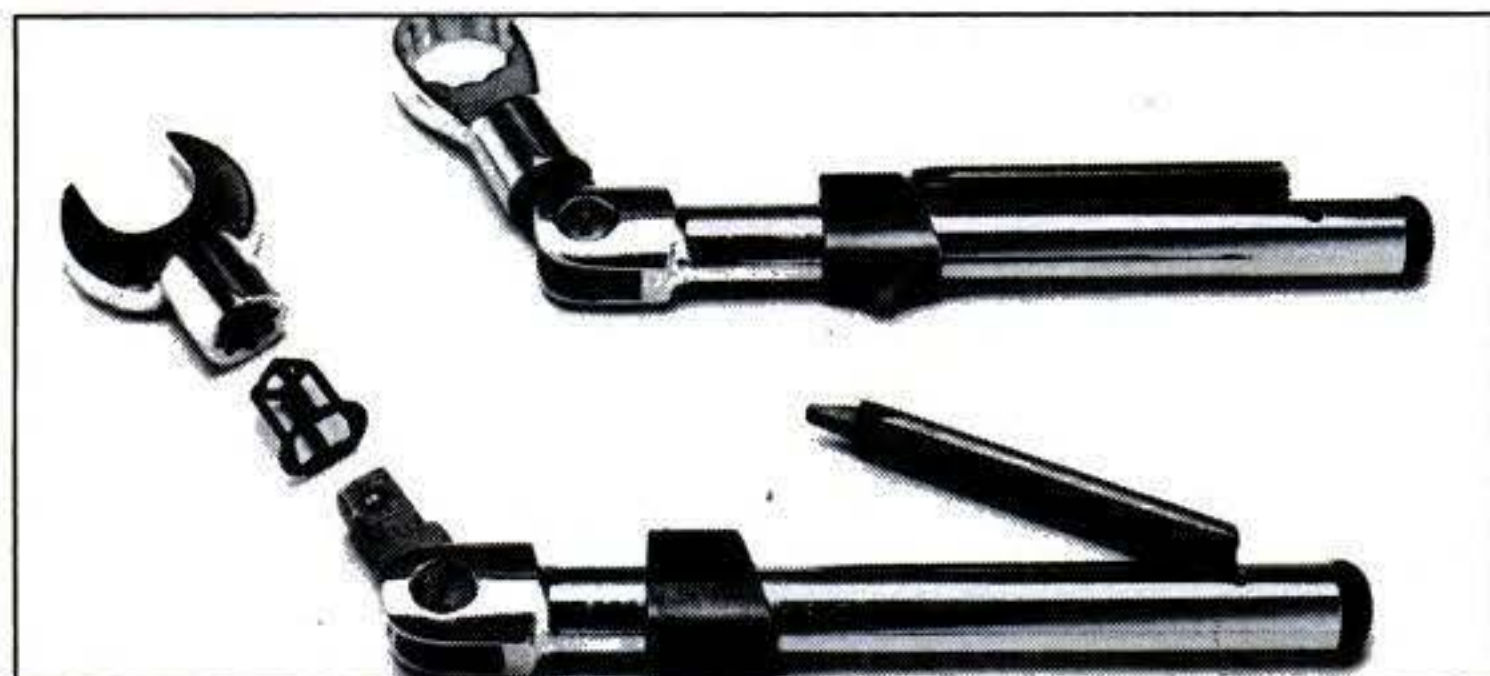
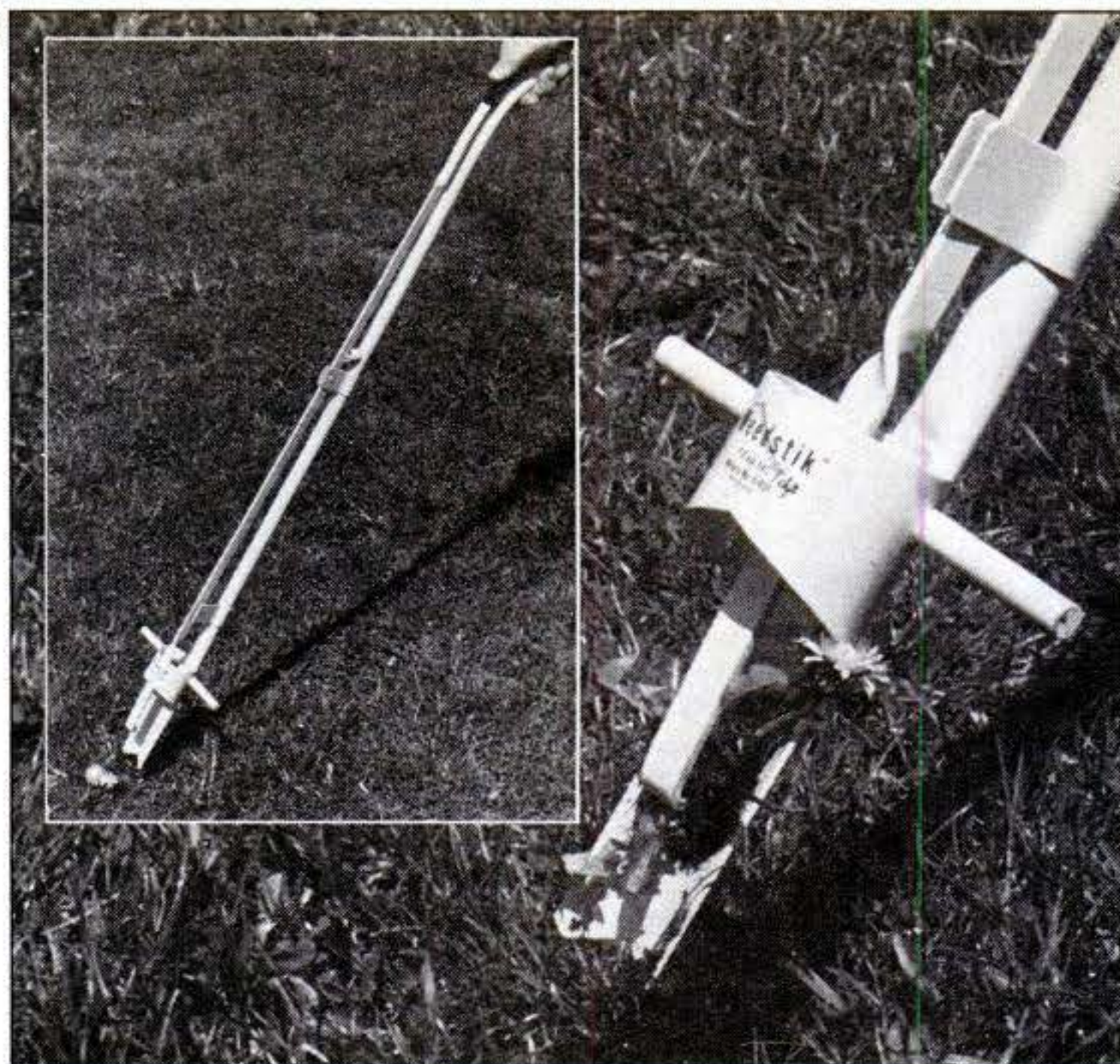


# What's New in Tools

BY V. ELAINE SMAY

## Stand-up weeder

Do weeds have you crawling on hands and knees? With Weedstik, you can weed standing up, says the maker. Push the tool's cutting head into the soil at the base of the weed (inset), then pull it out. A spring clamp grabs the weed. Weedstik (Box 543, Woburn, Mass. 01801) is \$20.

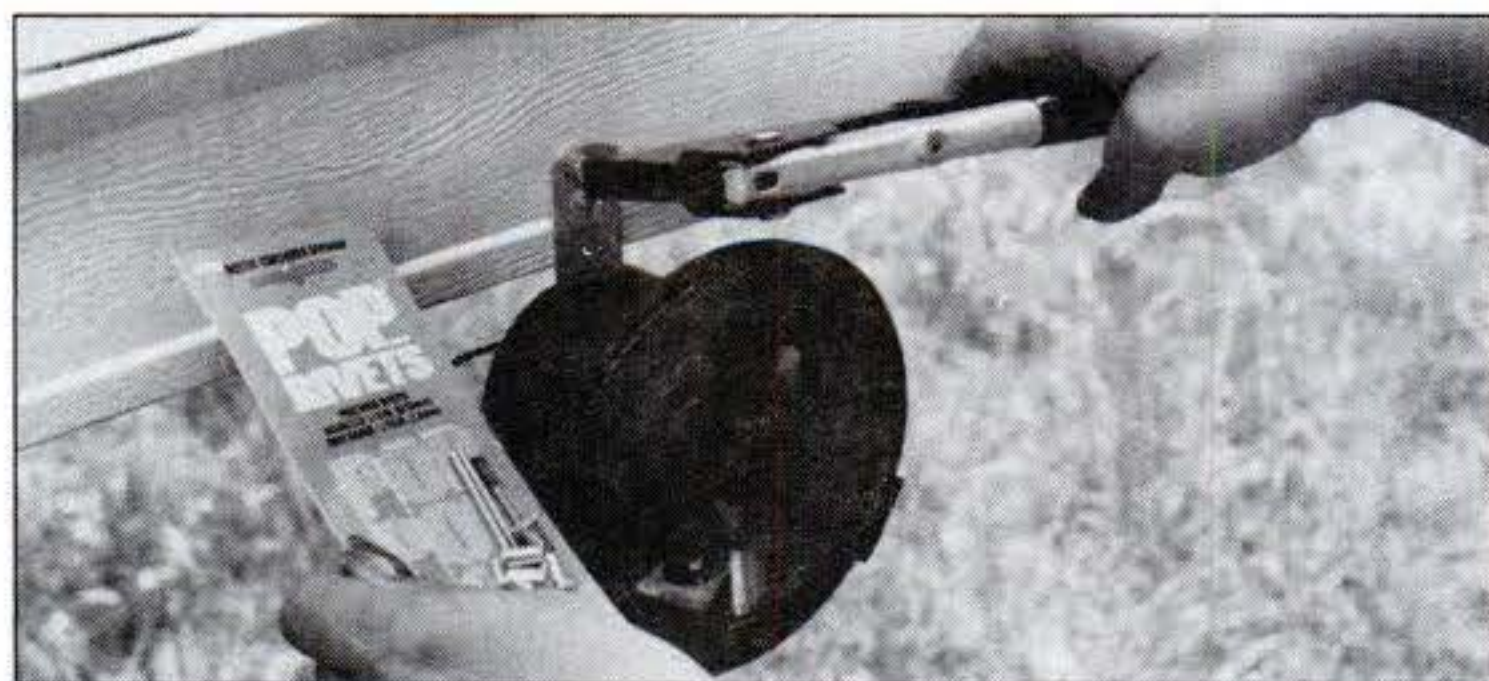
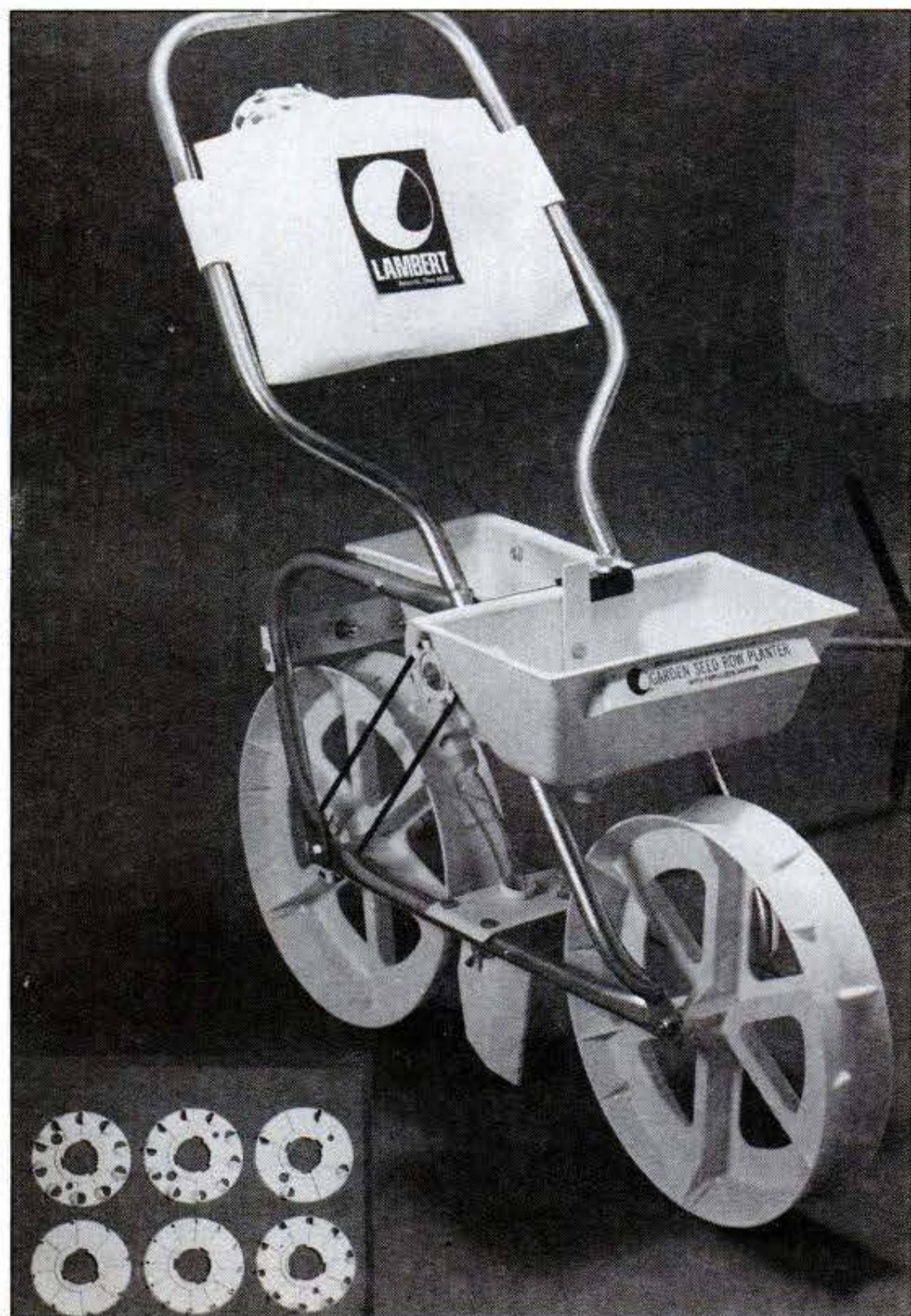


## English angler

Heads on Flexiwrench (11 Croston Rd., Garstang, Preston, Lancashire, England) can be angled in two planes: The shank pivots through 250 deg. and locks in 15 positions. It fits in bi-square sockets via a plastic sleeve that allows rotary positioning in 45-deg. increments.

## Cordless trimmer

For in-season trimming jobs, reach for Ready Trim, says Black & Decker. The shrub trimmer's four nicad batteries give 30 min. of running time, and its six-in. blades cut shrubs and bushes cleanly, according to B&D. Ready Trim (less than \$50) charges continuously in its base.



## One-pass planter

"This tool opens the soil, plants the seeds, applies fertilizer, closes the row, and marks it and the next one—all in a single pass," says Lambert Corp. (Box 66, Dayton, Ohio 45401). Six interchangeable plates (inset) accommodate 31 seed types. Garden Seeder-Feeder is \$60.

## Threaded rivets

Blind rivets are strong and permanent—too permanent for some jobs. Now Bostik has POP Rivets that make threaded holes for 8-32 screws. Drill a 1/4-in. hole, insert the rivet with a POP Rivetool, and attach the add-on item with the screw. Want to undo? Just unscrew.



## Midgets & monsters

Huge holes or tiny—you can drill them all with two bit sets from Sears. The 20-piece micro set covers sizes from 0.0135 up to 0.039 in.; the eight-piece, large-dia. set features 1/2-in. shanks and sizes from 1/16 up to a full inch. Prices: \$30 for the midgets, \$150 for the monsters.

# What's New in Home Improvement

BY SUSAN RENNER-SMITH

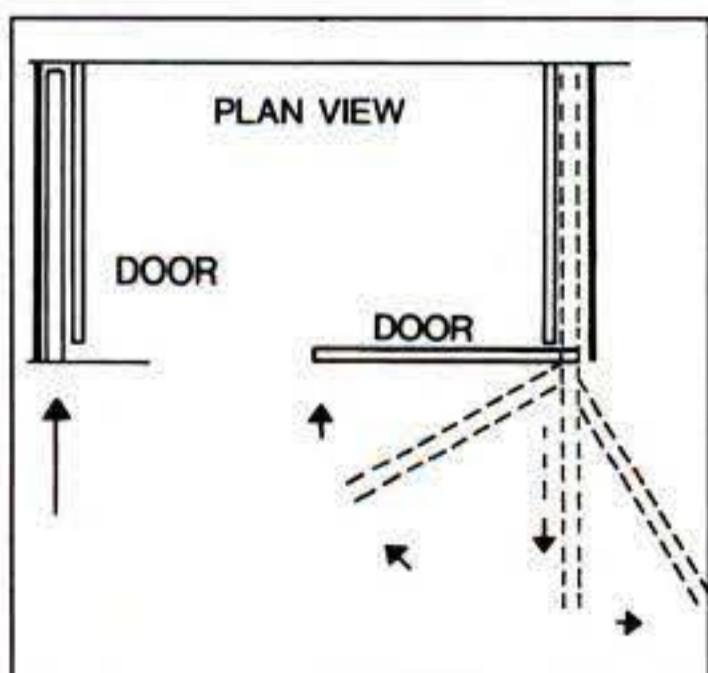
## Fire snuffer

Twin jets on the one-lb. Flam-X extinguisher shoot a stream of semi-liquid Halon 1211 that cools and smothers fires. The gas chemically disrupts combustion, making flashback unlikely, says Flam-X USA (1734 W. Pembroke Ave., Hampton, Va. 23661). Price: \$15.



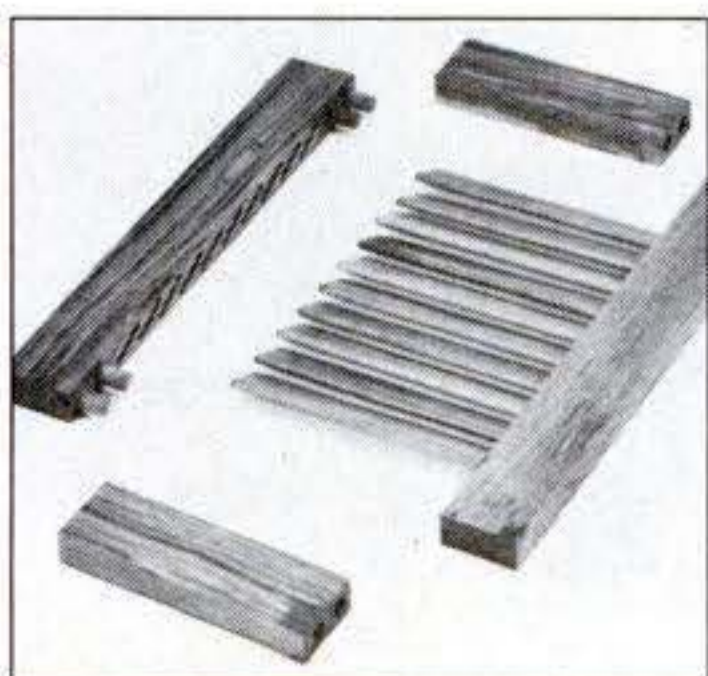
## Door-hiding hinge

Double doors slide into side "pockets" to give full access to this laundry closet. When the wash is done, the pull-out doors swing closed like any other door (diagram). Stor-A-Door hardware for most doors costs \$177.50 from J & J Peterson Co., Box 1661, Darien, Conn. 06820.



## Custom door

Snap louvers into side rail slots, and attach top and bottom stiles—you've got a louvered teak door for a cabinet or kitchen entry. Components for a four-ft.-square Seateak door cost about \$77. American Foreign Industries, 1085 Shary Circle, Concord, Calif. 94518.



## Bar sink

Like to whip up fancy mixed drinks for guests? The Elkay bar sink comes with a built-in Nu-Tone power unit and blender. The stainless-steel sink has straight sides and a flat bottom to protect fragile stemware. Maker: Elkay Mfg. Co., 2222 Camden Ct., Oak Brook, Ill. 60521.



## Well cleaner

To sterilize well water, Land-O-Matic feeds chlorine into the well when the pump comes on. There's no need to mix chemicals or handle gas tanks, says Autotrol Corp. (1701 W. Civic Dr., Milwaukee, Wis. 53209). All you do is keep the hopper filled with the dry pellets.

# What's New in Electronics

BY WILLIAM J. HAWKINS

## Postage saver

Drop a package on the Mail Scale, enter the zip code on an attached computer, and in seconds you'll know the best way to send it. The \$1,195 scale can save up to 35 percent of business postage costs, claims K-Tron (7955 E. Redfield Rd., Scottsdale, Ariz. 85260).



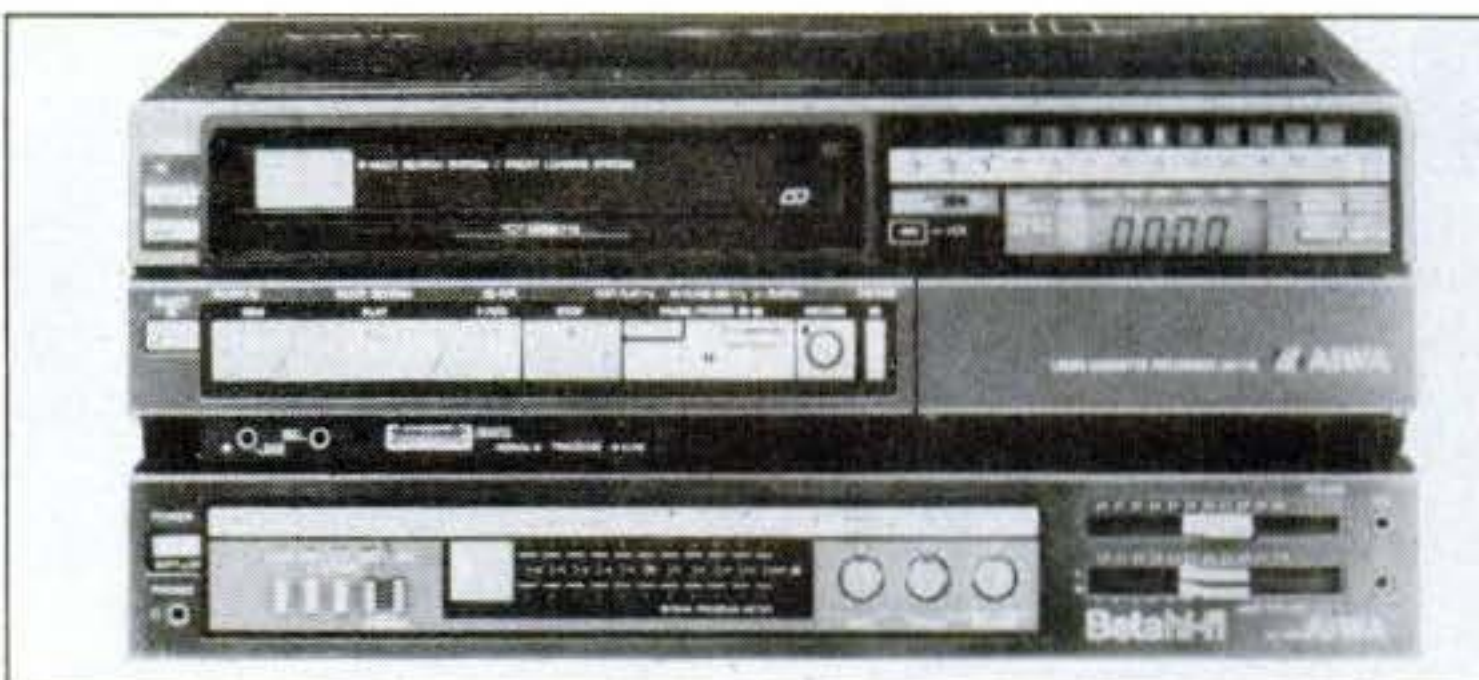
## Clock-phone

This AM-FM digital clock radio is also a speaker-phone telephone. Push buttons let you make outgoing calls; a "talk" button mutes the radio and lets you answer. The TT 202, made by Super Tel (4151 Beverly Blvd., Los Angeles, Calif. 90004), is \$100.



## Palm-sized video

The RCA "Small Wonder" video camera uses a solid-state MOS imager instead of the usual vidicon tube. Result: It fits in the palm of your hand and weighs just 35.2 oz. The unit has an f/1.2 lens with 6:1 zoom, electronic viewfinder, auto color, and auto iris. Price: \$995.

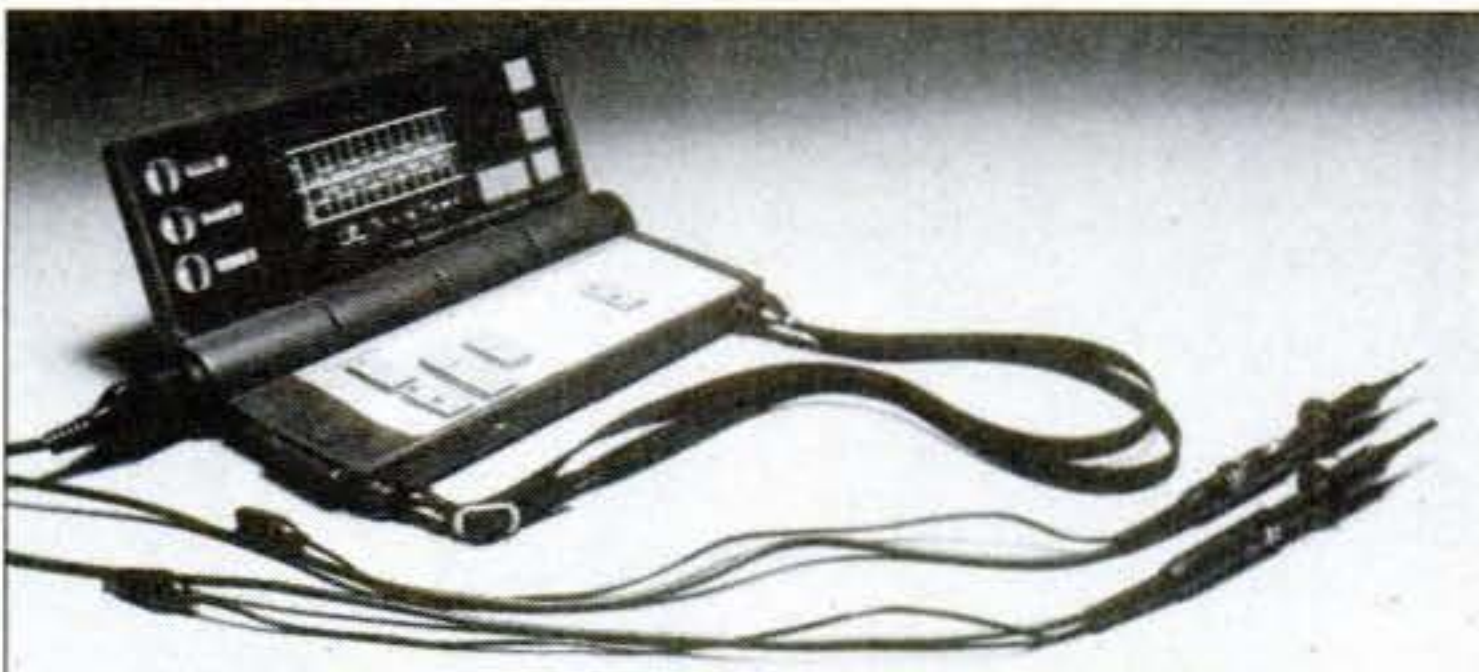


## Beta VCR

The top half is a 13.7-pound portable Beta VCR, complete with power supply and tuner. At home, plug it into the bottom adapter unit for Beta hi-fi stereo-sound reproduction. (A five-W amplifier is built in.) Made by Aiwa, the V-5 system is \$1,395, including remote control.

## Portable scope

It's a complete oscilloscope and logic analyzer, but the two-by-100-LED-array display makes it compact (eight by four in.), lightweight ( $\frac{1}{2}$  lb.), and portable. It's powered by a nine-V battery or AC. Logic/Scope 136 is \$495. Pocket Technology, Box 2459, Columbia, Md. 21405.



## Camera & recorder

Kodak's Kodavision is a video camera and recorder in one. It uses eight-mm cassettes (the size of audio tape) to record up to 90 min. of "movies." The camera slips inside its home unit (top) for recharging, recording off-air shows, and playing tape. Price: under \$2,000.



## Cassette holder

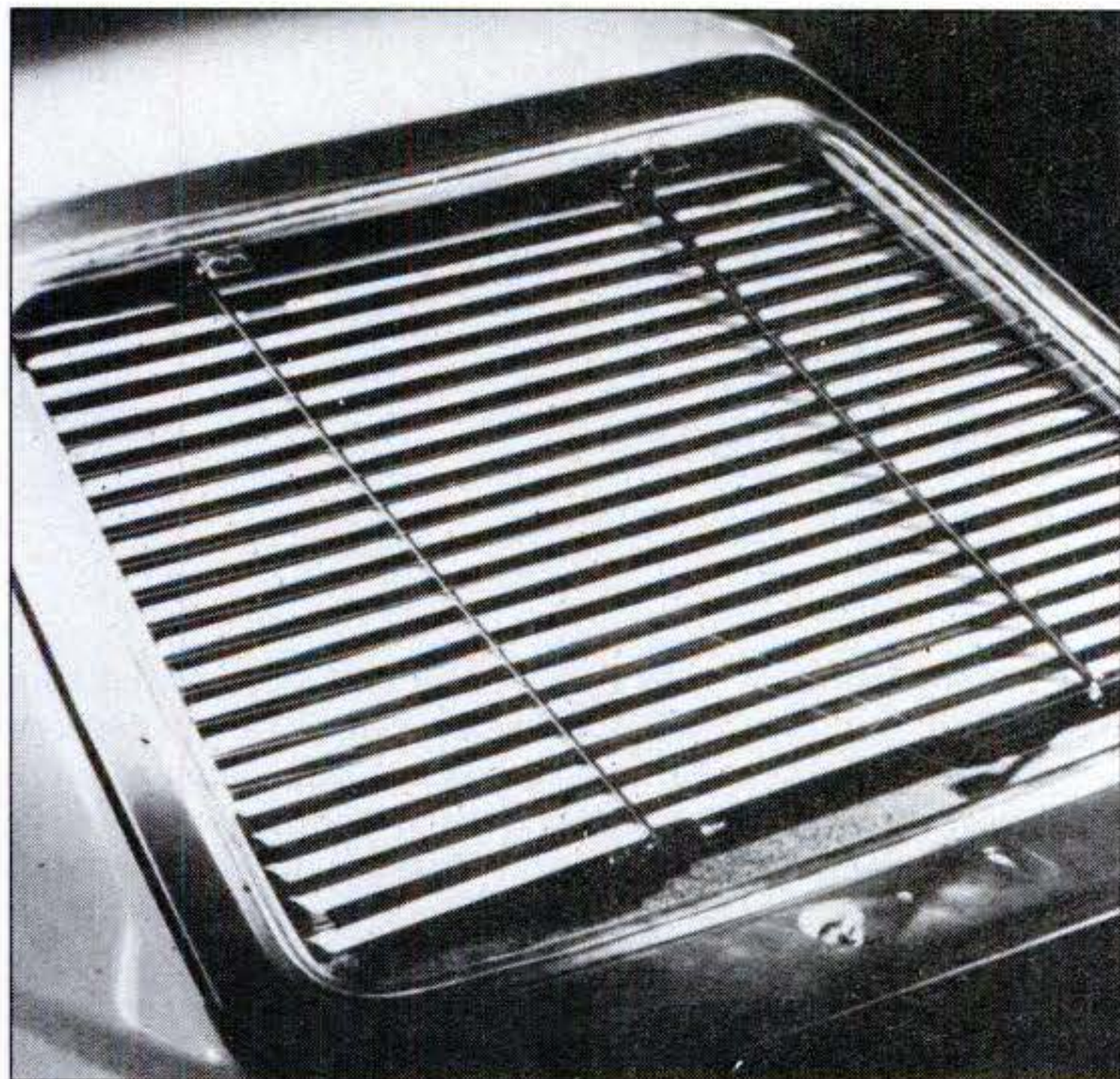
Accordion-pleated cassette case folds compactly for storage then stretches flat for a full view of up to 20 titles. A Velcro strap holds it together or sticks it to a car seat for traveling. It's made by Orbit Enterprises, 30 Ross Way, Northwood, Middlesex HA6 3HU, England.

# What's New for Your Car

BY JACK KEEBLER

## Little lift

Powered by a car's 12-V battery, this hydraulic lift provides up to three ft. of stable underside access and tilts forward or back to 25 deg. Ringparts Ltd. (358 Whitehall Rd., Leeds, West Yorkshire LS12 5PS, England) says Mighty Mite will heft vehicles of up to two tons.



## Electronic blind

A dashboard-mounted switch adjusts the Elixir louvers to any intermediate position. Attached to the glass with adhesive clips, the assembly removes easily for cleaning, claims Elixir Industries (17809 S. Broadway, Gardena, Calif. 90248). The price ranges from \$50 to \$75.



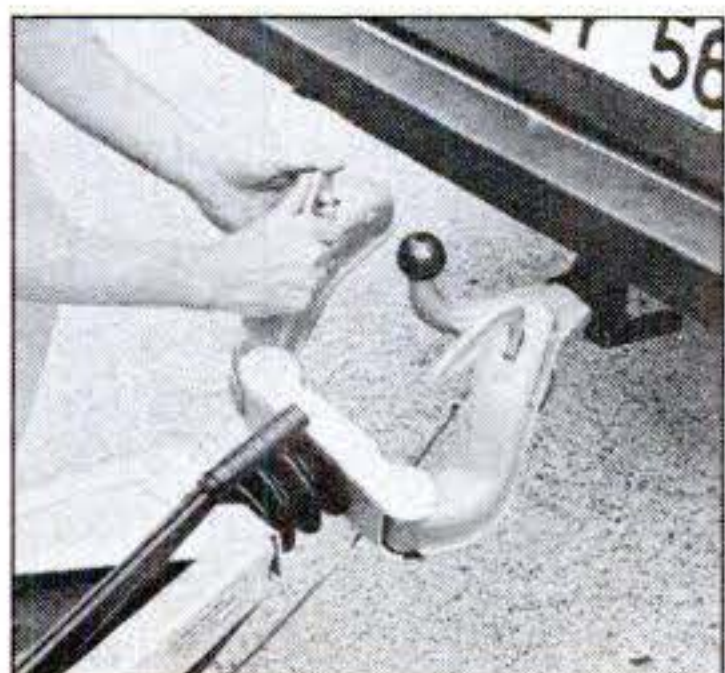
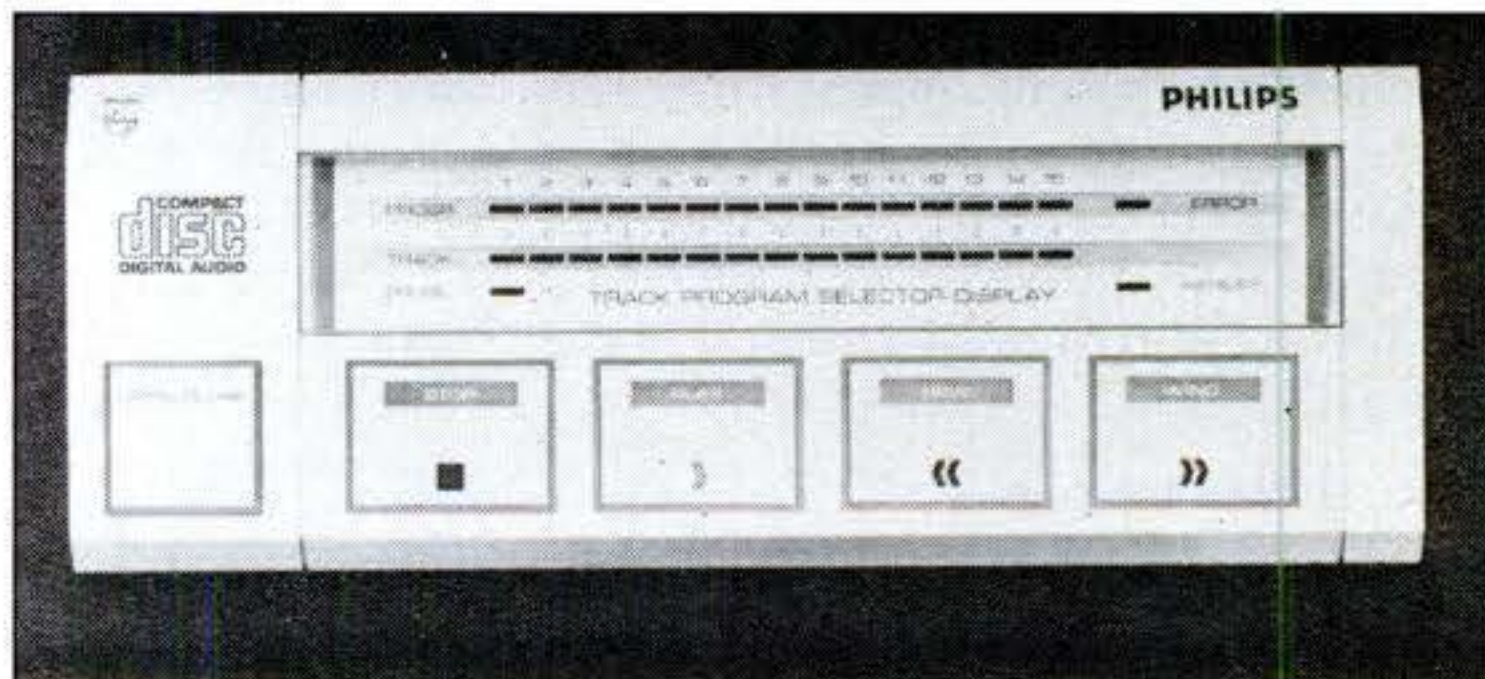
## Powerful flasher

Small enough to fit in a purse or pocket, this xenon discharge-tube flasher is visible up to three miles away, according to A-Tech (6265 Little Applegate Rd., Jacksonville, Ore. 97530). Two AA batteries power it for up to 3½ hours. It sells for \$15.95.



## Monitored battery

Sears Incredicell battery features a dash-mounted monitor that indicates over- or under-charge and even alerts the driver to lights left on. The battery is said to provide up to 650 cold-cranking amps for hot- or cold-day starts. Price: \$100.



## Twin-ball hitch

Pivoted swing-links on the AL-KO tow bar mate with twin balls on the car hitch. The geometric coupling improves towing stability, claims AL-KO Overseas (8871 Kotz 2, W. Germany). Developed in cooperation with Daimler-Benz, it will be on the market next year.

## CD for cars

A compact-disc player for cars? Yes, says Philips. The company hopes to further reduce the size of the player and improve the disc-loading system before the final production version is reached. The prototype model shown above uses standard 12-cm laser-read discs.

# PS drives GM's '85 luxury cars

GM's all-new luxury sedans—Cadillac de Ville/Fleetwood, Olds 98, and Buick Electra—sport front-wheel drive, unit-body construction, and independent rear suspension. The sedans are shorter, lighter, and more fuel efficient than those they replace.

By JIM DUNNE

Following a predictable pattern established a decade ago by higher gas prices, General Motors is introducing new models in its luxury lines that are smaller, lighter, and more fuel efficient. The 1985 Buick Electra, Oldsmobile 98, and Cadillac de Ville and Fleetwood—GM's C-car line—are completely new in appearance and radically different from 1984 models in mechanical design. They are also different on the road. I found ride, steering, performance, and interior roominess to be noticeably different—even though key dimensions inside are nearly identical to those of 1984 models.

Most traditional big-car buyers will not be disappointed. These two- and four-door sedans, which sell in the \$14,000-to-low-\$20,000 range, still have much of the same appeal that has made them best sellers in the top end of the market for more than 40 years. Some buyers, however, may object to the feeling of reduced space and to the new ride.

## The differences

I recently had a chance to drive two Olds 98 prototypes—one equipped with a 3.8-liter (232-cu.-in.) fuel-injection V6 gasoline engine, the other with a 4.3-liter (262-cu.-in.) diesel V6—and found a number of important differences between the old and new models. The new cars have:

- Front-wheel drive, with a newly developed four-speed transmission.
- Unit-body construction.
- A 600-pound-lighter curb weight.
- Better fuel economy: 22 mpg city for gasoline engines, 28 for diesels.

- An independent rear suspension.
- Rack-and-pinion steering.
- Up to two-foot-shorter length.

In addition, GM claims performance improvements in all of the models.

The key to all of the differences is the switch to front-wheel drive. Transverse engines and compact transmissions perform the same magic on the big-car lines that GM worked on its smaller cars, such as the X, J, and A.

A big problem was keeping the big-car ride and feel in a smaller, lighter package. Says Oldsmobile chassis engineer Tom Rasmussen: "Strut suspension systems in front and rear, with each wheel fully independent, helped us keep the road-isolation characteristics of the older models. The new body has less roll in turns—that's more comfortable. And the automatic level control on the rear wheels allows us to use softer springs and permits full wheel travel in the suspension no matter how the passenger load is distributed."

Rasmussen also points out the advantages of the rack-and-pinion steering that replaces the recirculating-ball system. In the 98, typical of the C-line, the steering gear is connected directly to the wheels by tie rods, eliminating one extra connection. The rack is attached to the front suspension cradle, so body lean does not affect steering, as is the case with some body-mounted racks.

"What you get is stiffer steering—a more direct connection between the steering wheel and the wheels on the road," says Rasmussen. "The car goes just where you steer it. There is no need for a second adjustment in the steering wheel when taking a sharp turn."

As I drove the new 98, I noted that it had a firmer ride. The suspension seemed to control the chassis more precisely. Steering differences were just as Rasmussen described them—direct, obedient, and precise, with little need for correction when passing through a tight curve at moderate or high speed. Combined with the shorter overall length, the steering makes the new 98 more nimble in traffic and gives a greater sense of participation at the wheel, less of a feeling of sitting back and guiding the car.

Oldsmobile supplies the V6 diesel power plant that all three cars offer as an option. Its fuel-economy advantage over gasoline engines is an impressive six mpg in the city, according to EPA estimates.

## Buick's engines

One of Buick's major contributions to the C-line is the improved 3.8-liter gasoline engine.

"We boosted horsepower to 125 from the 110 of the base 3.8-liter engine," says Stan Fowler, Buick's Electra project engineer. "Part of that is due to a stainless-steel exhaust manifold that is tuned for better engine breathing, and part is due to the fuel-injection system."

Both the diesel and 3.8-liter gasoline engines I drove felt faster than the V6 and V8 engines in the 1984 C-cars. The diesel is especially impressive. It is smooth running and probably as quiet—at all speeds—as any diesel in the world. That's a big improvement over the V8 diesel sold in '84 and earlier models.

At Cadillac, the most important goal for the designers of the new de

*Continued*



**Buick Electra's hood has an aerodynamic flow-over shape that covers the fender line as well as the engine compartment.**

**The cutaway below reveals the front drive line of the C-body chassis. Note the flat floor in the passenger compartment.**





Three versions of GM's new C-cars: the Buick Electra T Type (top), Oldsmobile 98 (middle), and Cadillac Fleetwood

(bottom). Key interior dimensions are almost identical to those in the big 1984 models (see table at right).

Ville and Fleetwood was to maintain the image of GM's plushiest sedans while cutting size and weight.

"That's one reason we stuck with the V8," says Bob Templin, Cadillac's chief engineer, explaining why his division offers the only C-car V8, at 4.1 liters (250 cu. in.). "We introduced V8s in 1914 and haven't found anything since that offers their virtues of balance, high-speed smoothness, and quiet operation."

### V8 squeeze

Squeezing a V8 crosswise between the frame rails in the de Ville was not a simple task, however. Templin's job was to take three inches off the length of the engine without significantly changing the block or head.

"All the shortening came out of the accessories at the front of the engine," Templin says. "We took on a serpentine belt to run the accessories, which helped. But the biggest saving was in a new water pump that we squeezed down to a 1/4-inch width and set off to the side of the block."

A second Cadillac exclusive is a viscous clutch that softens the transmission lockup. The device uses a liquid coupling between the engine and transmission when the drive line locks up to its most efficient setting. The clutch does away with any nudge, bump, and shudder at low-speed lockups.

Measure basic dimensions such as head room and leg room, and the new cars are virtually identical to their predecessors (see below). But I found the feeling inside different. Windshields are closer to the passengers, as is the side glass. Seats are thinner, so although the numbers say the interiors are as roomy, the impression when sitting inside is one of less space and less stretch-out room. The cars' relatively flat floors compensate for some of this, however. **PS**

### Old versus new

Specifications <sup>1</sup>	1984	1985
Wheelbase (in.)	119.0	110.8
Length (in.)	221.1	196.1
Width (in.)	76.3	71.4
Height (in.)	57.2	55.0
Curb weight (lbs.)	3,884	3,298
Engines <sup>2</sup>		
Gas	V6 4.1-liter V8 5.0-liter	V6 3.0-liter V6 3.8-liter
Diesel	V8 5.7-liter	V6 4.3-liter
EPA city economy (mpg)		
Gas	17	22 (est.)
Diesel	23	28 (est.)
Front interior dimensions (in.)		
Shoulder room	59.6	59.1
Head room	39.5	39.3
Leg room	42.2	42.4
Rear interior dimensions (in.)		
Shoulder room	59.8	58.8
Head room	38.1	38.1
Leg room	41.7	40.9
Trunk (cu. ft.)	20.5	16.7

<sup>1</sup>Specifications based on Olds 98 sedan; <sup>2</sup>Cadillac uses 4.1-liter V8 gasoline engine.



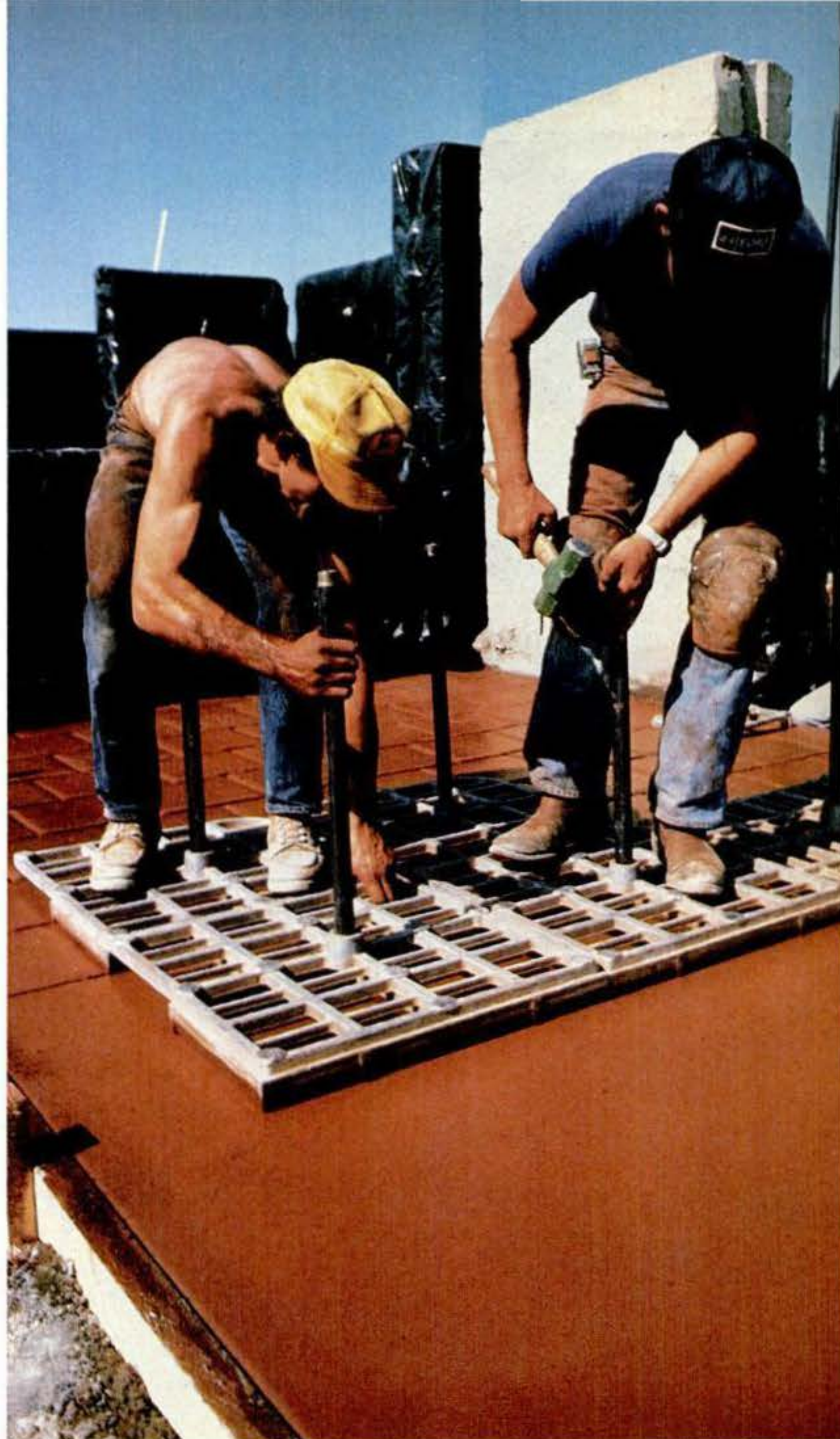
# Cookie-cutter concrete

Instead of laying plain gray slabs, create concrete pavings with the look of expensive tile, brick, or cobblestone. The pattern-stamping technique used by professional cement finishers can be performed by homeowners using new plastic pattern stamps. The author stamped a 450-square-foot patio to resemble clay tiles. His tips will ease the task for other first-time pattern stampers.

By RICHARD DAY

I won't say it was easy. But pattern-stamping a concrete patio at my son's home was no tougher than it would have been to hand-trowel a slab to a super-smooth finish. And for only \$150 more than we'd have spent on that plain-Jane slab, Doug and his wife, Leanna, have a colored, grooved patio that looks as if it's laid with expensive clay tiles. And I ended up with a pair of pattern-stamping pads that can be used again and again.

*Continued*



Large working surface of aluminum stamping pads (above) allows professional crew to complete large job before concrete stiffens. Vertical pipes act as handles for moving pads. Patio stamped by the author (left) and jigsaw-like surface at San Diego mall (below) suggest the range of patterns.





Slab to be stamped is prepared in usual way. Bull-float immediately after strike-off to maximize stamping time.



Author's crew tried two stamping methods. Here, stamper positions one pad while standing on another.



Working from knee board permitted greater care in positioning pads, but area under board needed extra float.

You can do pattern-stamping, too. What used to be a pro-only job can now be tackled by do-it-yourselfers using new plastic stamping pads available in a variety of designs (see box). These outsize cookie cutters create concrete sidewalks, driveways, and patios that appear to be paved with tile, brick, or stone. They can also be used indoors for house, basement, and garage floors. When done well, only an expert can tell that grouted, pattern-stamped concrete isn't the real thing.

For the most part, a pattern-stamped slab is prepared in the same way as a plain one. The usual needs of concrete slabs—such as uniform support, proper jointing, careful edging, and complete curing—all apply. The thickness of the slab is no different than for plain slabs.

There are some differences, however. For one, the forms should be laid out in multiples of the size of the stamping pads (allowing an extra  $\frac{1}{16}$  inch per foot for float, or movement of the pads as they are impressed in the soft concrete). Thus, the inside measurement between the forms of a 12-foot-wide patio slab should be 12 feet  $\frac{3}{4}$  inch.

### Smoother mix

A pattern-stamped slab requires a somewhat-different kind of mix than a plain slab. Because large stones might get in the way of the stamping pad's blades, a cement-rich, small-aggregate mix is used. It should be made with a maximum coarse-aggregate size of  $\frac{1}{4}$  inch. If you order ready-mix, tell your dealer that you are planning to pattern-stamp. Also say that you want the mix to contain enough fines and an aggregate gradation to make a workable, easily finishable slab. The dealer likely will increase the normal cement content.

Air entrainment is important to prevent water from separating and weakening the concrete. Specify 7½-percent air entrainment, plus or minus one percent. For a protected slab or one built in a mild climate, specify three-percent air entrainment.

Although it is usually best not to use additives in concrete, you may need the additional finishing time that one or two additives can provide. Normal concrete begins to set 1½ hours after mixing—faster on a hot, dry day. (Don't try pattern-stamping in that kind of weather. Wait for a cool day, or work early in the morning.) To take some of the pressure off the stamping operation, you may want your dealer to add a water-reducing retarder to the mix along with a small amount of superplasticizer. This combination gives a high-slump condition that remains workable for two to three hours.

Expect to pay a little more than you would for a standard mix. For his 4¾ cubic yards of mix, Doug paid \$303. The concrete pump and operator to place the mix between our forms cost an additional \$65, which was definitely worthwhile considering the time it saved.

Because you are trying to obtain a match with natural paving materials, you will be coloring the slab. The best approach is to use two applications of dust-on coloring ["Concrete Facings," Aug. '78]. Any color that would look natural in real paving material may be chosen for pattern-stamped paving. We used a brick-red oxide coloring pigment in our dust-on mix.

You should get started on the coloring as early in the life of the slab as possible. This means dusting it on *before* bull-floating (smoothing the surface with a long-handled float immediately after strike-off). The air entrainment in the mix will help prevent water from bleeding to the surface and getting in the way of your early finishing.

Ordinarily you'd apply the first coat of color *after* bull-floating, but we saved a whole floating by doing it first. Then came the second dust-on application, which we troweled using a magnesium float.

As soon as the concrete has cured enough so that impressions do not fill in, you can begin stamping. In our case, the concrete was ready by the time we'd finished the coloring and floating. To make impressions, you position the pad and then pound it with a dead-blow hammer (Stanley Tools makes several sizes; see box) to set the blades about 1/2 inch in the concrete. To minimize movement of the pad, pound first in the center and then around the edges. Avoid pounding over an unsupported corner, though; that could break the plastic. Because the concrete will be setting while you work, making impressions will require somewhat more pounding as the day progresses.

Around the edges of the slab there will be places where the pads won't fit. There, it is necessary to hand-tool the grooves using chisel-like grooving tools that come with the pads. If done correctly, there is no visible difference between the tool-stamped and pad-stamped grooves.

Because the color layer is quite thin, the stamp-pad blades may punch through it in places, exposing gray concrete at the bottom of the grooves. You can remedy this by dabbing a slurry of water and dust-on coloring into the grooves with a paintbrush. You do this the following day, after the slab is strong enough to hold your weight. You should also apply a color wax sealer the next day to enhance the color and assist curing. We used Kemiko Col-R-Tone II (Kemiko, Inc., 4343 Temple City Blvd., Temple City, Calif. 91780). It comes in eight colors.

## Two stamping techniques

Our pattern-stamping crew—Doug; Leanna's father, Bob Hunt; and I (Leanna hand-tooled while we pounded)—tried two methods of working with the stamp pads (see photos). Bob preferred working from knee boards as he stamped.

The results he achieved commend this technique, but because the area under the boards required a quick once-over with the magnesium float, he worked more slowly than Doug and I did. Our technique was to stand on one pad while pounding another. Our portions showed a few misalignments that Bob's did not, though.

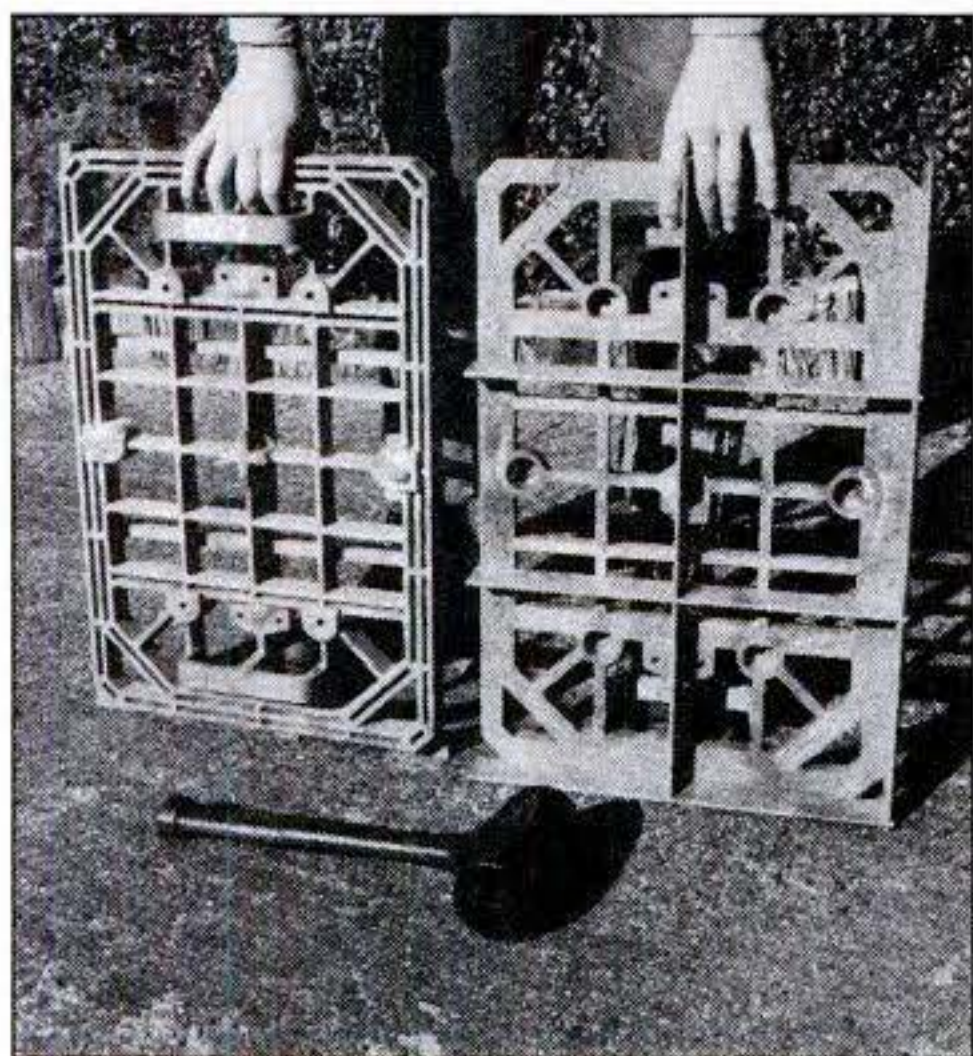
Either way you work, if you get the first pad correctly aligned with the house or other master line, the others will pretty well follow suit. The second stamp pad is set against the one already in place and lowered with its edges aligned. To disguise slight irregularities, try to arrange the pattern so that long lines run across the line of sight.

A good rule of thumb for how much area of slab to tackle in one day is 100 square feet per worker. This rule worked for us. We began pumping at 10:30 a.m. and finally put our tools away at 5:30 p.m., tired. Without the additives, our patio would have gone partly unstamped. Next time, I'd make the 450-square-foot area a two-weekend project and forgo the retarding additives.

One reason for that became obvious the next morning. A normal mix would have set hard enough to walk on by nightfall, but our slab stayed slightly tacky. During the night several dogs dropped by to investigate and left paw prints all over the rear portion of the patio. By morning the concrete had hardened, preserving the prints like dinosaur tracks. Fortunately, we were able to hide them by brushing on a slurry made from leftover dust-on coloring.

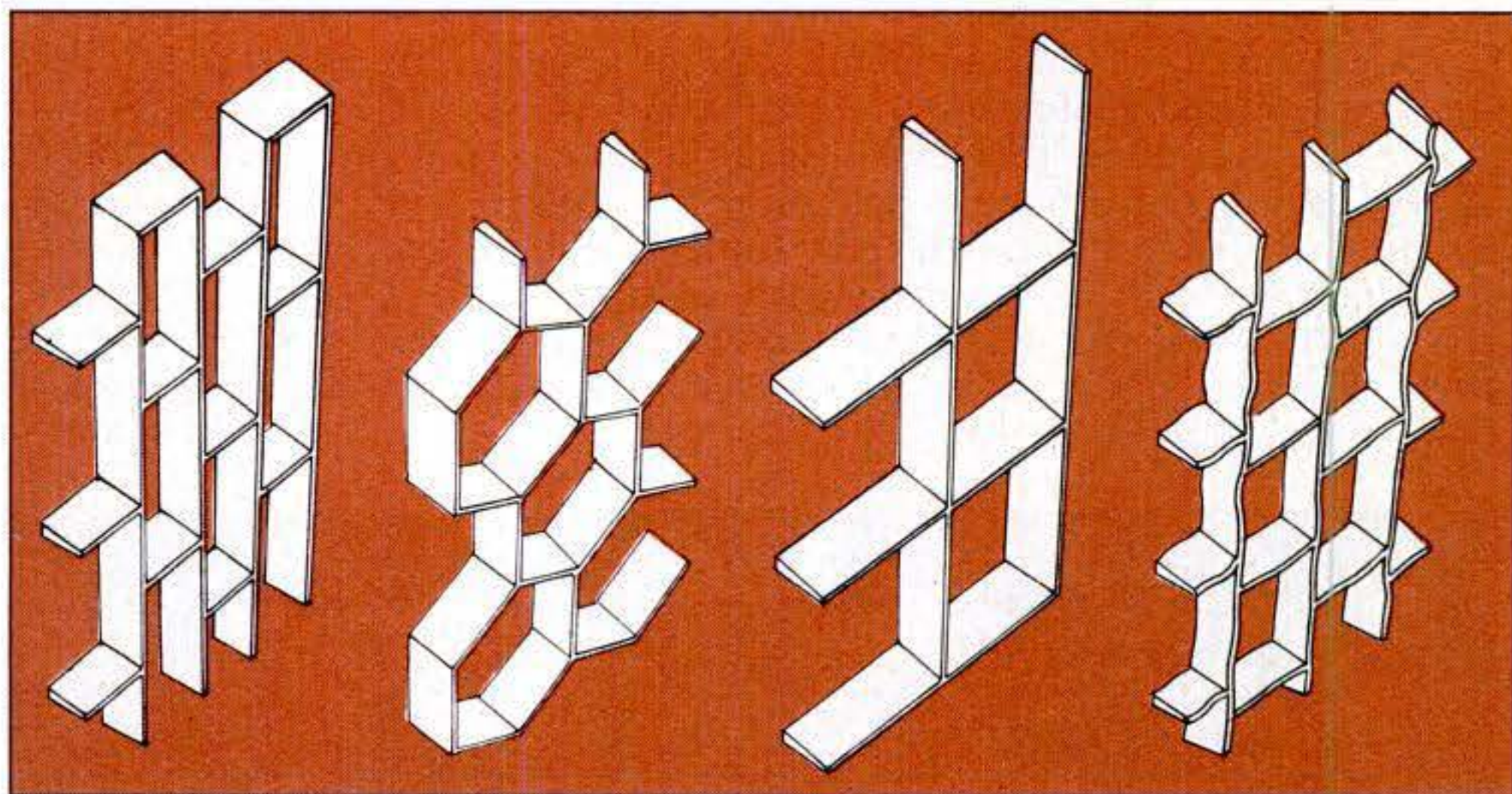
Despite such problems and the hard work of pattern-stamping, I'd gladly do the job again. Tired or not, the beauty you build in as you work provides a satisfaction that inspires you until the last portion has been stamped. Doug and Leanna love the rustic, handmade look of their patio. So does everyone else who sees it. **ES**

## Pads for pattern-stamping concrete



Pattern-stamping pads are available in either aluminum or plastic. Professionals use aluminum pads, but at \$225 apiece (at least two are needed) these are too costly for most do-it-yourself projects. It may be possible to rent a set of aluminum pads, but they are not readily found at rental yards. Plastic pads cost about \$50 each, including a pair of hand tools for completing the pattern in spots where the full pad can't fit. Properly handled, the plastic pads should last through a number of projects, longer if you're careful not to pound on them too hard.

We used Brickform plastic stamping pads (above, left) for our project. They are foam-injected to be rigid and stress-free yet resilient. They weigh just seven pounds each—considerably less than metal pads.



The blades on the stamp pads make one-inch-deep impressions when the pad is fully pounded down. (We found it difficult to get a full-depth impression, however, and settled for half-depth grooves.) All four sides of the pads are made to match up with another pad, so you can move in any direction no matter where you start. For convenience, the pads have molded-in grab handles and optional mounts for easier-working extension handles. Or they can be ganged by fastening them to a optional gang module. This minimizes float and misalignments.

Brickform stamping pads are available from many concrete-products suppliers in brick, hexagon-tile, square-paver, and cobblestone

patterns (drawings, left to right). Or you can order them by mail from Goldblatt Tool Co., 511 Osage, Kansas City, Kan. 66110. For pounding, use only a three- or four-pound dead-blow hammer, not a regular hammer. The Stanley Compo-Cast Soft Face hammer (\$25) is an example of the proper tool.

Instructions with the stamp pads show them used with polyethylene sheeting over the concrete to produce a pillowed effect. While we liked the looks of the rounded edges, we decided that spreading poly sheeting evenly over the fresh slab would be too difficult and thus stamped it bare. Some pillowing resulted anyway. Perhaps it would be easier to use poly on a narrower, more-accessible slab such as a sidewalk or narrow driveway.—R. D.

# Story-and-a-half solar

Both upper and lower floors benefit from solar gain in this clever design. And with dual indoor access, the sunspace is likely to be the most popular area in this home.

By AL LEES

Architect: Samuel Paul

Renderings by Edward Kelbish

**W**ith this house specially designed around it, the passive sunspace dominates both the exterior and interior—but it isn't the only solar device incorporated into the plan. A pair of bubble skylights contributes light and heat to the living-dining area, and roof-mounted collector plates provide the hot water.

Any home with passive-solar elements must be well insulated, so all exterior walls are framed with 2×6s to provide a thicker cavity for insulation. The ceilings are insulated to a minimum of nine inches. Both double glazing and thorough weatherstripping contribute still more toward saving energy.

A circulating fireplace helps heat the house on chilly evenings and winter weekends. A fan in the space above the second-floor bedrooms siphons off hot summer air through louvered gable vents.

But the solarium is this home's major feature, and it's easily erected from a commercial kit. With easy access to it from the outside and from both the country kitchen and the dining area inside, it's destined to be the most-used space in the house. It can also, of course, serve the conventional function of a greenhouse, keeping vegetables and flowers growing year-round.

Adjacent to this sunspace is a large deck for alfresco activities, from sunbathing to dining. Should an unexpected storm arise during dinner, it's not much trouble to move the table into the sunspace.

The street entrance has its own deck, sheltered by a second-floor projection. Inside, the foyer stair leads up to a balcony that overlooks the dramatic, sloped-ceiling living-dining area. The opposite wall consists of three pairs of sliding glass doors that frame the view and grant access to deck and sunspace.

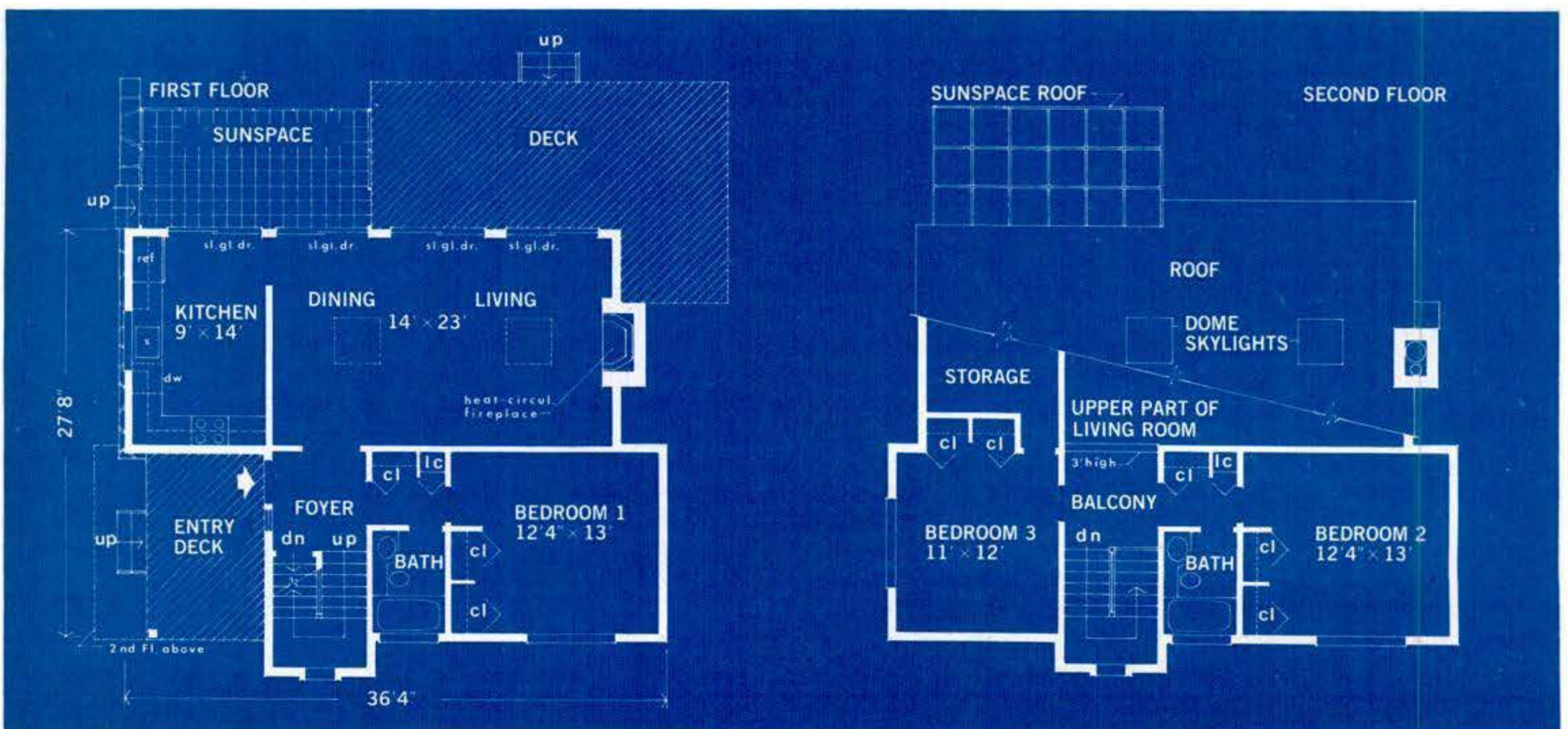
The exterior is finished in plank siding, applied vertically except on the accent wall of the sheltered entry. The whole house celebrates simplicity of design and construction, which makes it economical to build, even with the full basement shown in the section.

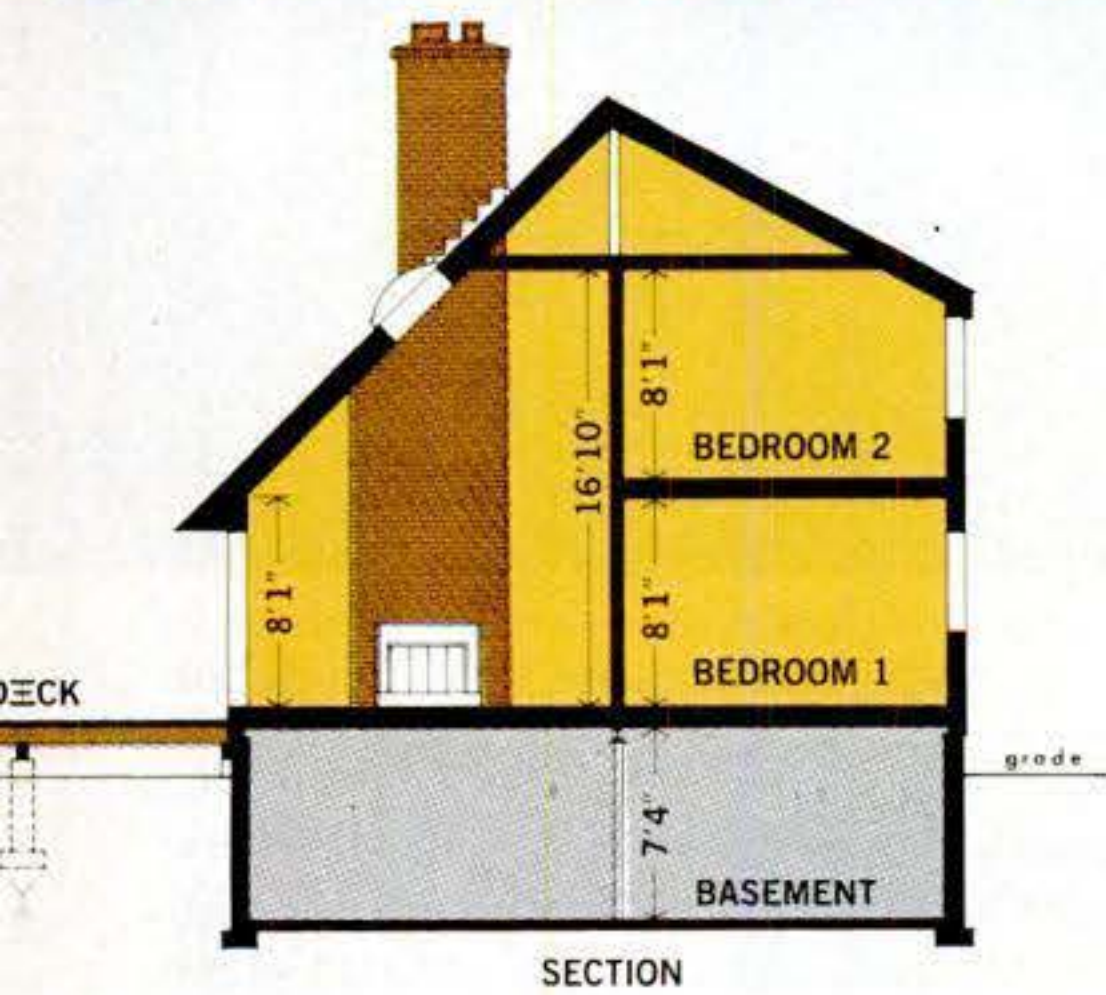
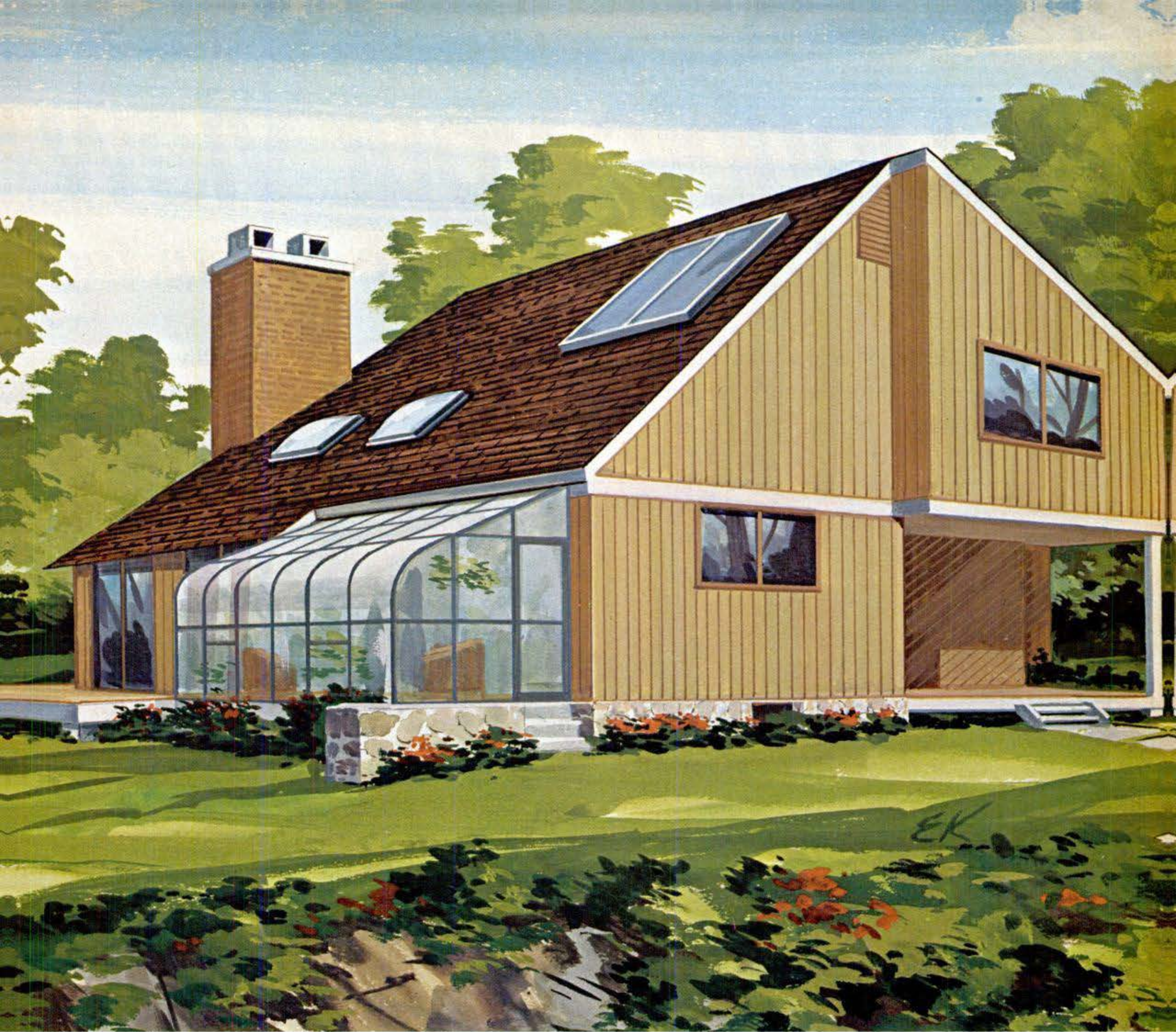
If you are planning to build a leisure home this summer and would like to consider a broad range of designs before you commit yourself to the purchase of a specific plan, a selection of 56 of the best plans from the first 10 years of our Leisure Home series—including eight more by this month's architect, Samuel Paul—has been collected in book form under the title *Popular Science Leisure Homes*. For a copy, send your check for \$18.95 to Popular Science Books, Dept. P43P, Box 2018, Latham, N.Y. 12111.

You may also want to consider the option we'll present in this space next month: the packaged home. We'll show two examples of attractive new homes designed for the owner-builder.

You either do all the assembly work yourself or have the house erected as an unfinished shell for you to finish inside. The packaged or pre-cut home may be the route to take if you want a house to enjoy *this* summer because erecting a stick-built home from scratch is a slow process—especially when your work time is limited to weekends and vacations.

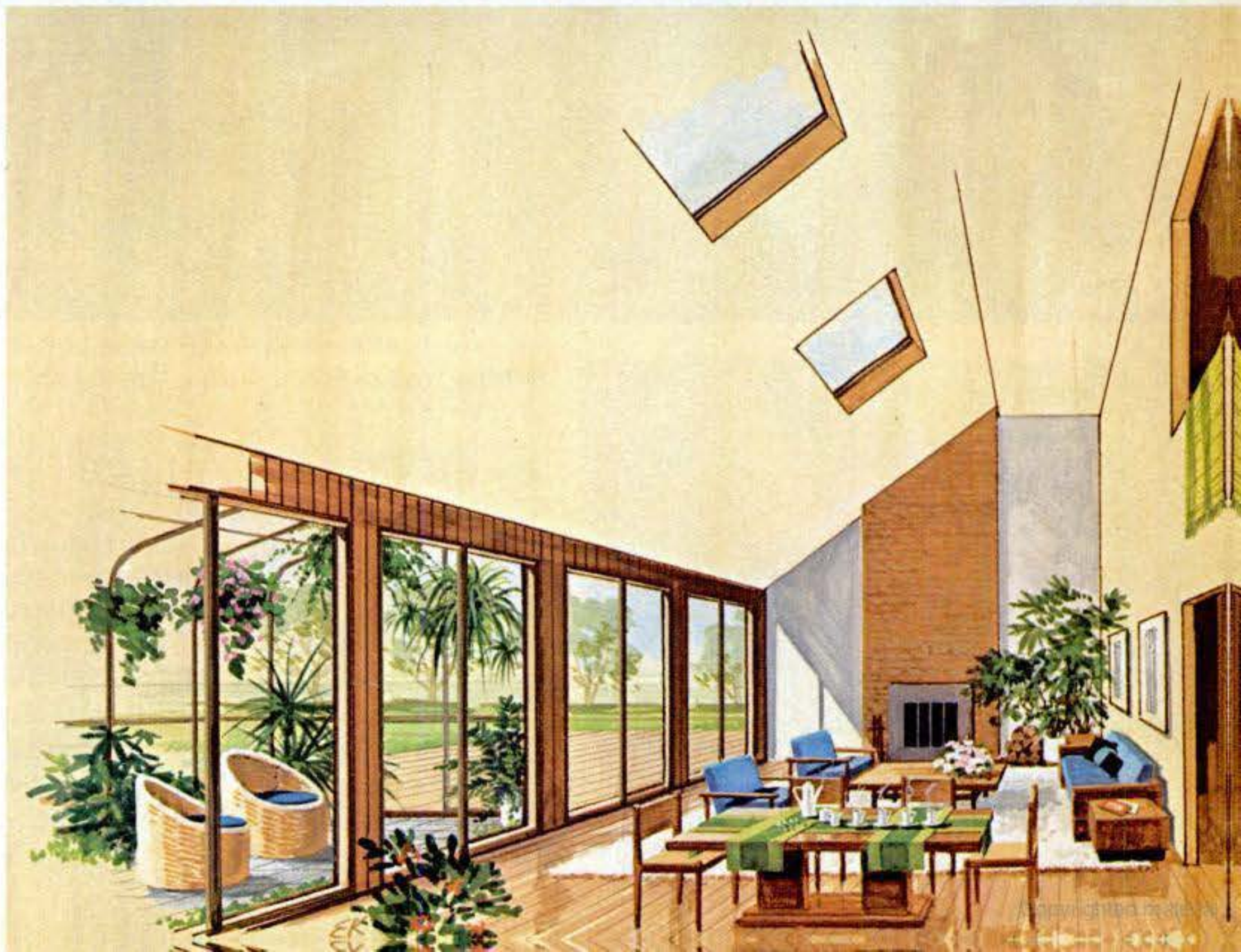
PS





### How to order your plans

One set of detailed blueprints is \$95; five sets (for construction, financing, obtaining permits) are \$135. An additional mirror-reverse print costs \$15, and a materials list is \$20. Address orders or queries (specify Sequoia plan) to Homes for Living, Inc., 107-40 Queens Blvd., Forest Hills, N.Y. 11375. Add \$5 to all orders to cover postage and handling.



# Double your view

## and save energy, too

With a single window, this homeowner had only a cramped view of his backyard, and a low level of daylight. The solution? An attractive double unit that, thanks to an energy-efficient design, also helped lower his fuel bills.



Dramatic change in small room at left, which was saddled with a tiny double-

hung window, came about thanks to new six-ft. window and updated decor.

By CHARLES A. MILLER

**A**spectacular view was being wasted. The backyard stretched all the way to the Delaware Water Gap, but from the existing window it was all but invisible. And the double-hung window itself was old (photo at left) and leaked heat badly.

The owner of the house in rural New Jersey remedied both drawbacks in one move—he installed a double

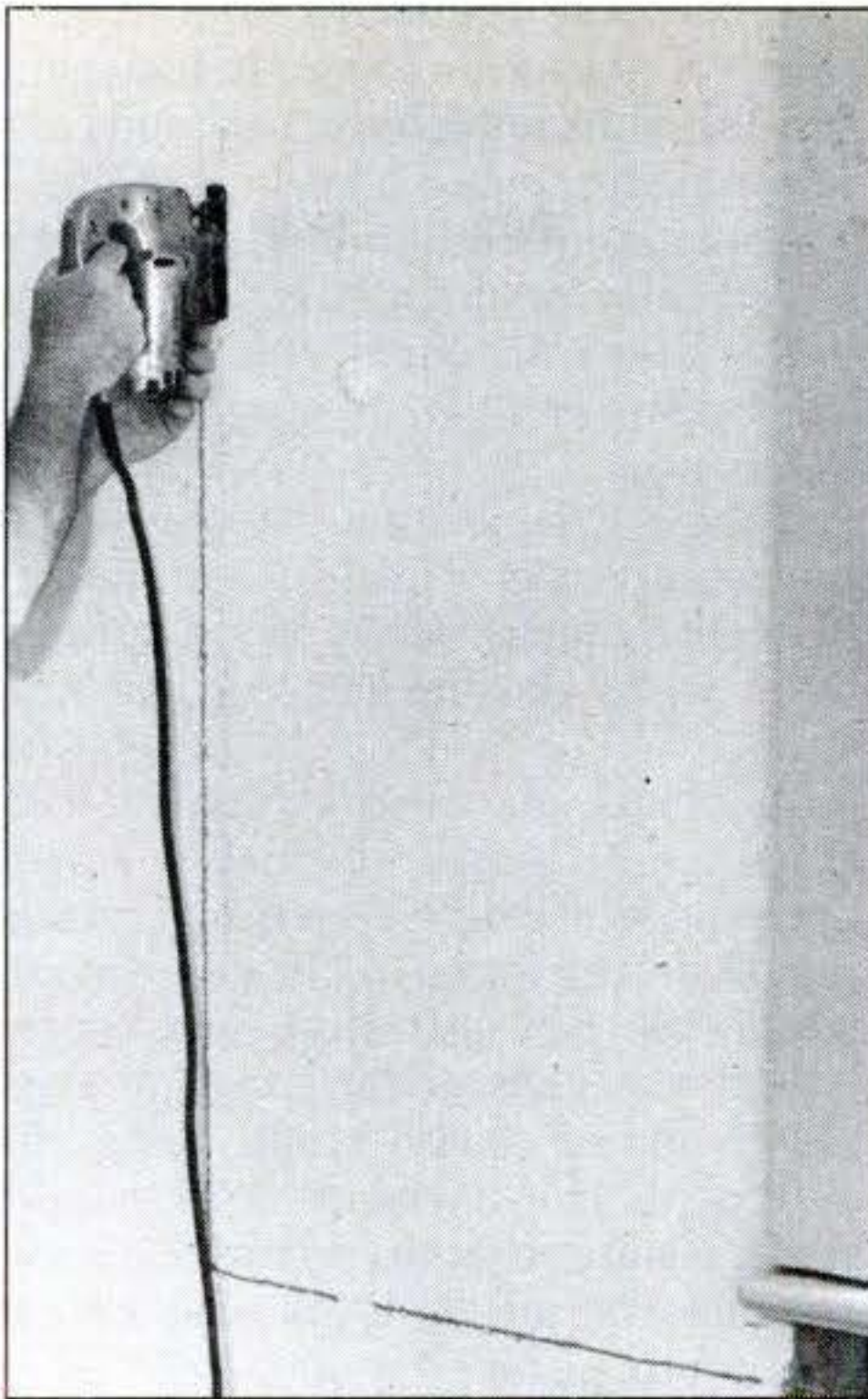
wood-frame insulated-glass window that was equipped with efficient, tight-fitting jam liners. The result? Both his room and his energy outlook brightened.

You can double a small window, too. Here are suggestions for doing the job from the National Woodwork Manufacturers Assn., sponsor of the New Jersey project. The room shown has a sheathed wood-frame wall covered with conventional siding and an interior

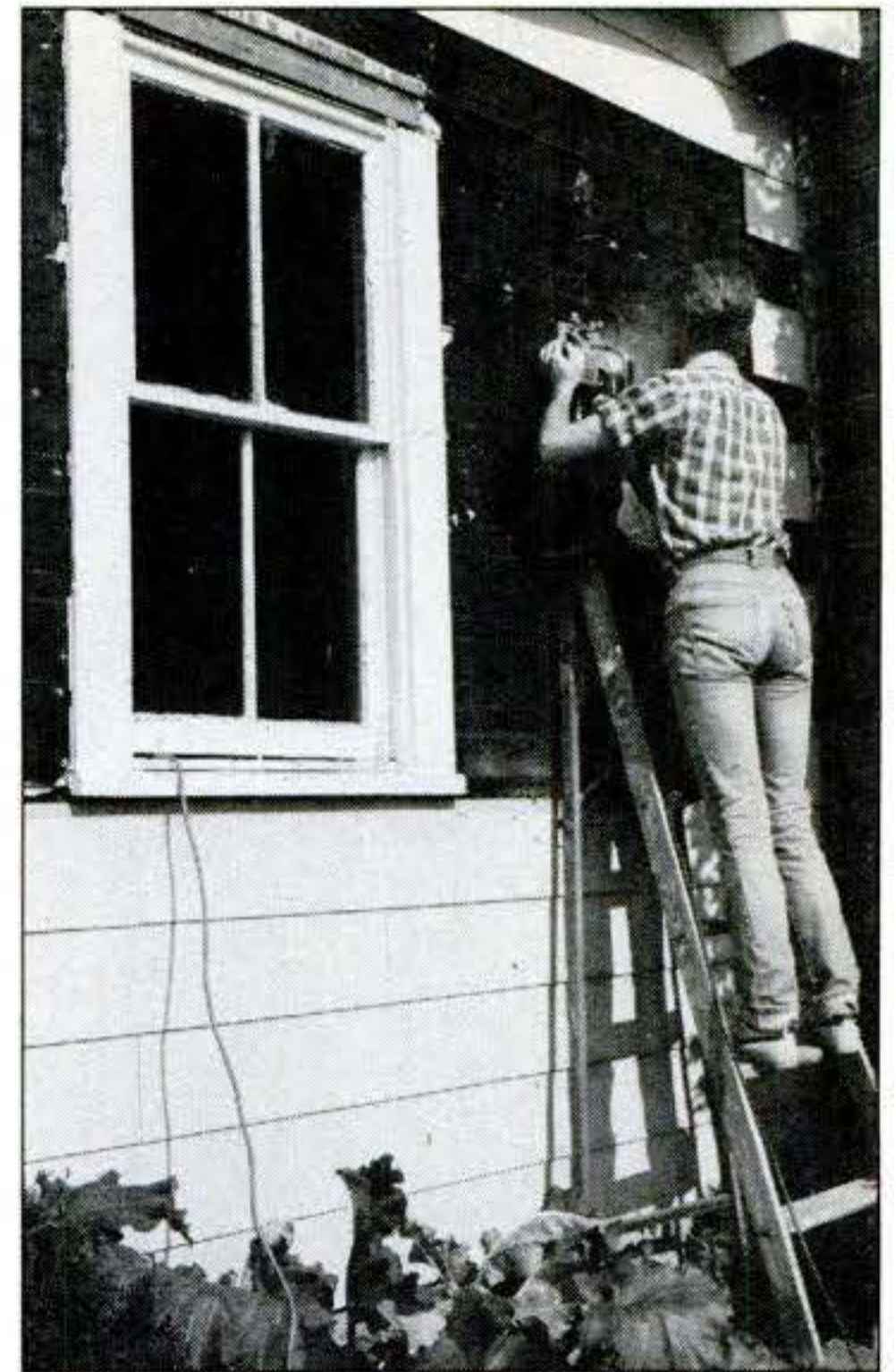




Replacement of old window starts with removal of interior casing to expose the wall. Height matches the sliding door.



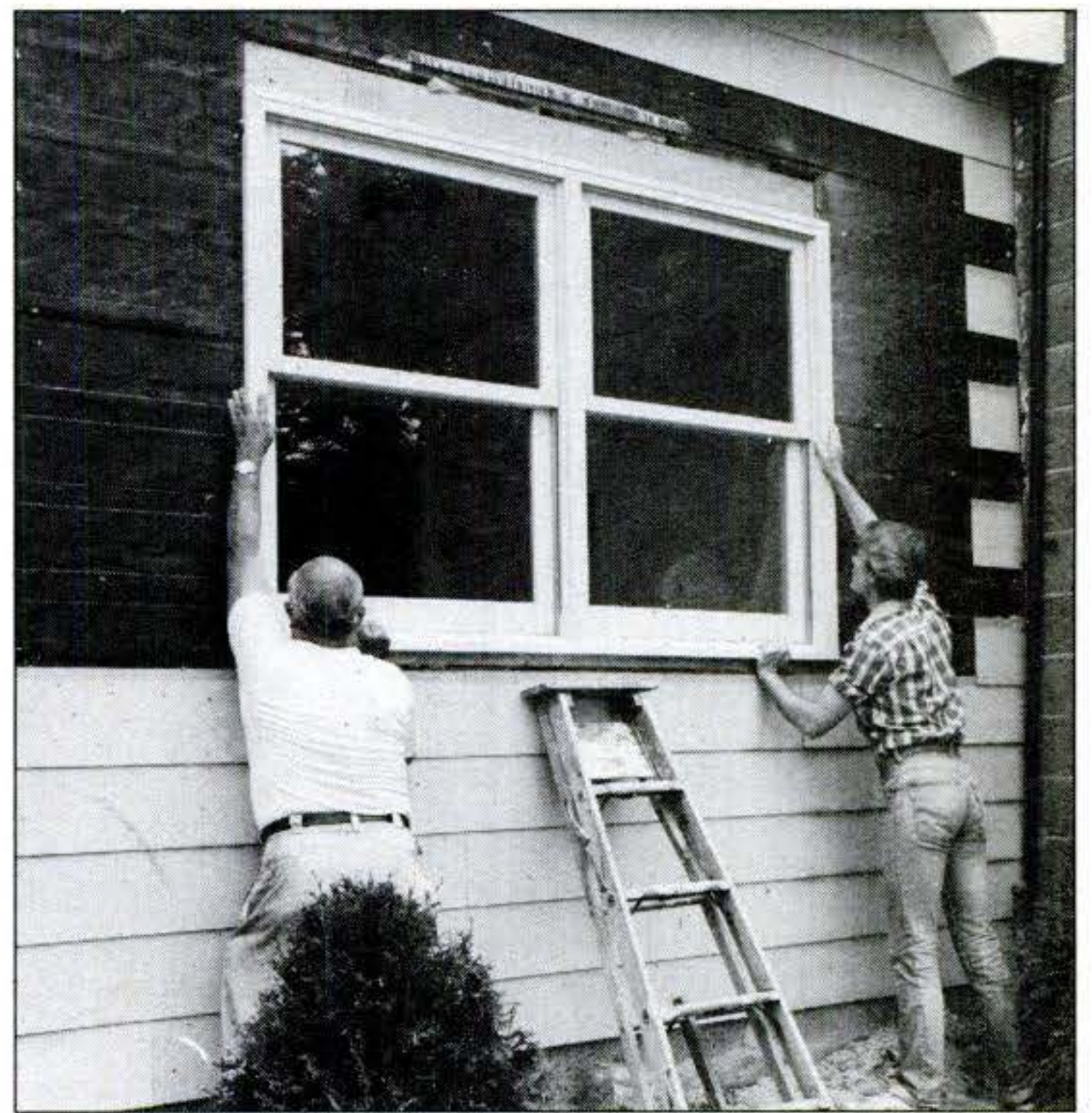
A jigsaw is used to cut the rough opening in interior wall. Cut wallboard through on all sides, bypassing studs.



A circular saw is used for the outside cuts. The saw cuts partway through the studs so less hand-cutting is required.



Wall section, complete with old window, is lifted out and lowered to the ground. It can easily be dismantled.



Using a ladder for support, raise window into position—ease it up one step at a time. Once it's in place, check for level.

finished with wallboard. The replacement window is a preassembled unit.

Your first task is to locate the wall studs at either side of the planned opening. Measure the width of the opening, and mark cutting lines on either side—but be sure that the cuts will be at least 1½ inches away from existing studs. Use a level so that the lines are perfectly vertical.

Measure down from the ceiling to establish the new window height.

To make room for a new header and longer sill, add six inches to the measurement at the window top and 1½ inches to the bottom. With a level, mark the horizontal cuts at top and bottom. Be sure there are no wires or plumbing runs in the way—relocate them if necessary.

To indicate the outside cut, drill a ¼-inch hole through the wall at each corner of the box you've drawn inside. Go outside and remove the shingles

or siding to expose the sheathing in the area to be cut, and draw cutting lines from hole to hole.

Now return to the inside. Use a portable jigsaw to cut the opening in the wallboard (if the windowsill or casing at the top interferes with the rough opening cuts, remove it before cutting). When making the horizontal cuts, skip over the studs—you can cut them later with a handsaw.

*Continued*



Interior trim is nailed in place after sanding the wall smooth. Wood can be painted or stained to match decor.

Remove the wallboard carefully and save the pieces for reuse. Remove any insulation from between the studs and set it aside, too.

Now go outside and, with a portable circular saw, cut the rough opening in the wall sheathing, following the lines carefully. Again, skip over the studs.

If the ceiling joists are supported by the wall you're working on, support the ceiling temporarily by propping it with 2x4s—before cutting the wall studs.

To install the new structural sill, cut a 2x4 at least six inches longer than the width of the opening (assuming that the existing studs do not frame the new opening), and center it over the ends of the existing cripple (trimmed short) studs along the bottom of the opening. Add cripple studs, if necessary, to support the ends. Be sure the sill is level, and nail it into place.

To form a header, cut two 2x6s to the required length, sandwich a piece of 1/2-inch plywood between them as a spacer, and nail them together. Hold the header in place so that it bears against the cripple studs at the top of the opening, and measure down to the sill to determine the length of the trimmer studs you'll need on either side. Cut the trimmer studs to the proper length.

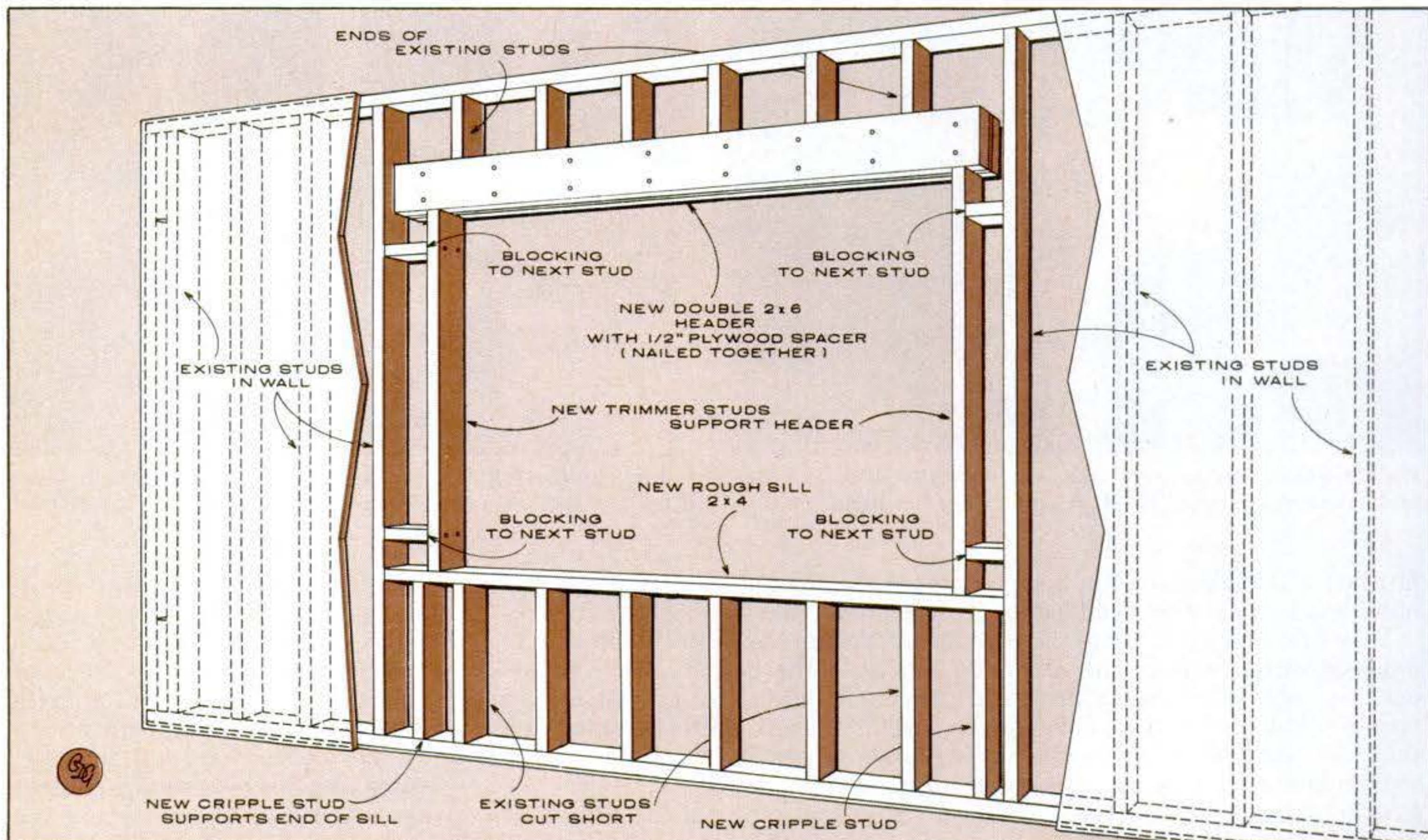
If, as is likely, the window does not

fit directly between the existing studs, measure for new trimmer studs at the sides of the rough opening. After the rough opening has been cut, measure the distance to the nearest existing wall studs at either side, deduct 1/2 inch, and cut blocks of 2x4s to this length. Nail these blocks to one side of the trimmer studs. The blocks will bear against the existing studs when the trimmer studs are set into the wall. Push the header into position at the top of the opening, and tap the trimmer studs into position—stuff insulation into the wall space behind them. Toenail the trimmer studs to the sill and header, and nail sheathing to the sides of the new frame.

With a helper, lift the new window unit into the opening from the outside. Make sure the unit is plumb, level, and square. Use shims if necessary, then nail it into position with three-inch galvanized finishing nails. Put a drip cap over the top of the window to keep rain out. Now sheathe the wall at the top and bottom of the window, and put on the siding. Caulk around the entire unit.

Stuff insulation into any gaps from the inside, then cut pieces of wallboard to cover the header and sill, and nail into place.

Now trim, add a windowsill if desired, and paint or stain to suit. You're now ready to step back and enjoy your doubled view. **PS**



Replacing an old window with a larger unit means that you have to cut a new

rough opening in the existing wall. The diagram above is for the wall pictured

on the preceding pages—that is, one without heavy ceiling and roof loads.



# Custom-make your own *tambour doors*

By R. J. DeCRISTOFORO

They're turning up again in today's furniture—those elegant, practical closure panels that take their cue from the roll-top desk. Slats are mounted on a flexible backing so they can bend around curves—and you can assemble such doors from ready-made materials to avoid making all the slats.

**T**hey're sliders, but unlike conventional bypass doors, tambours disappear into the cabinet to expose the entire contents. Construction isn't complicated, but you must take care if the doors are to function efficiently. Two vital factors: The case must be square, and—because the doors are guided by grooves or tracks in opposite panels—the guides must match.

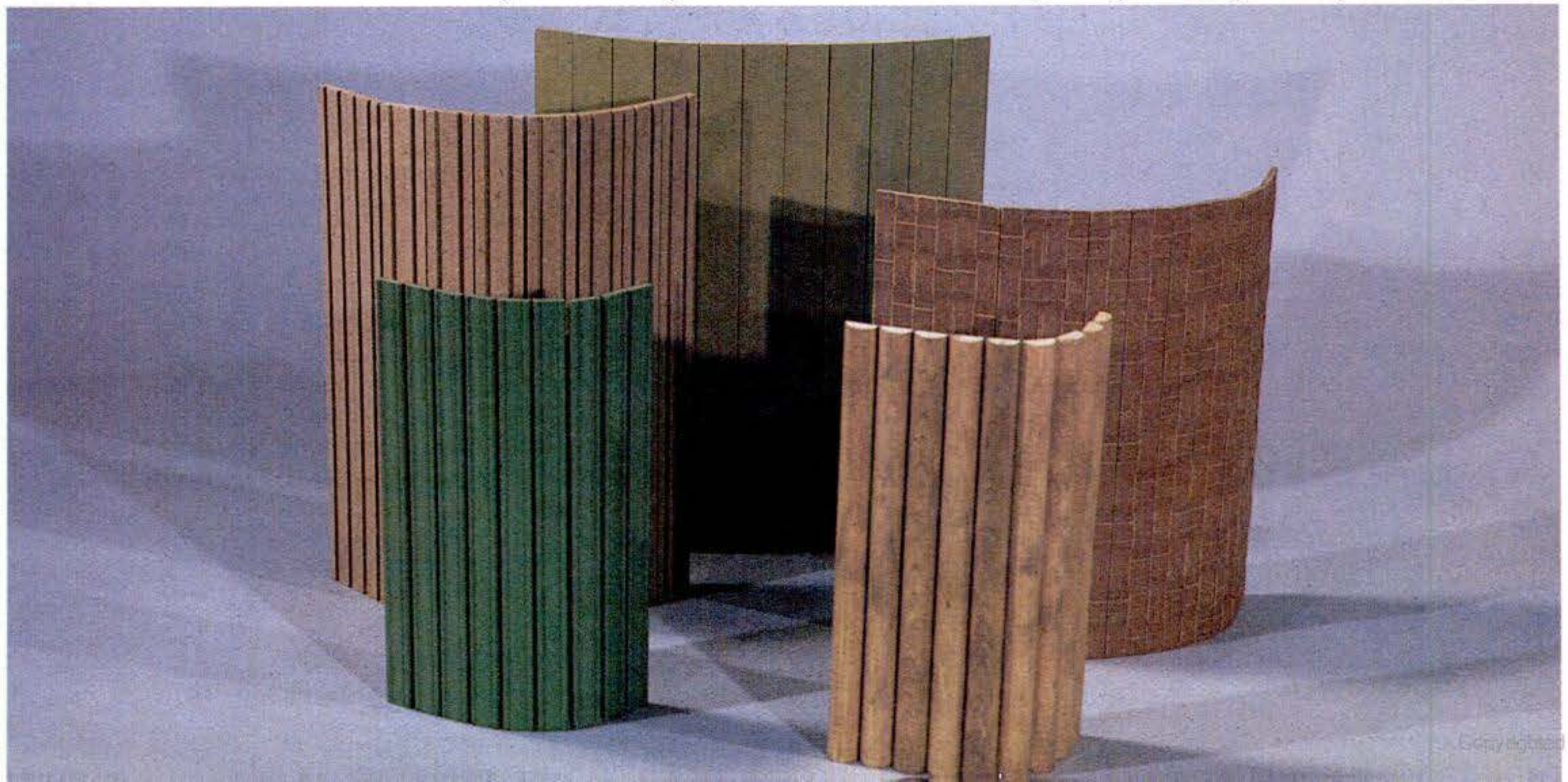
You can buy the slats or make them. Suitable ready-mades include the moldings sketched on the next page. The problem lies in finding moldings

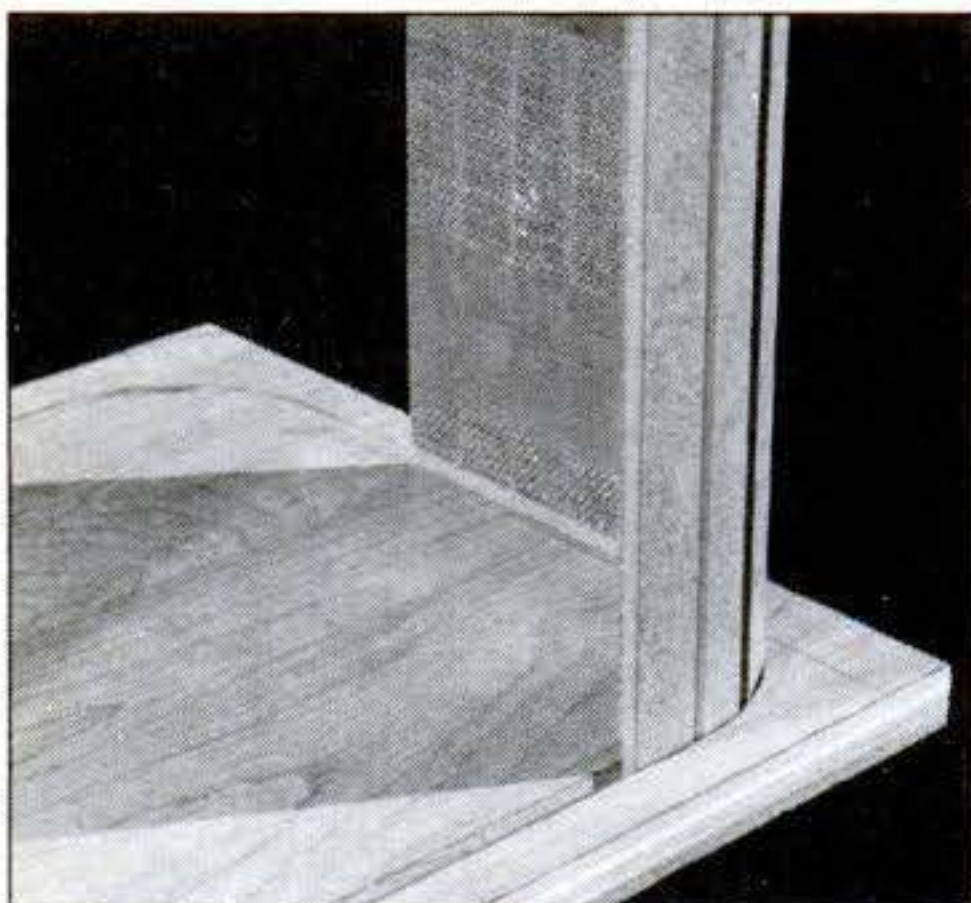
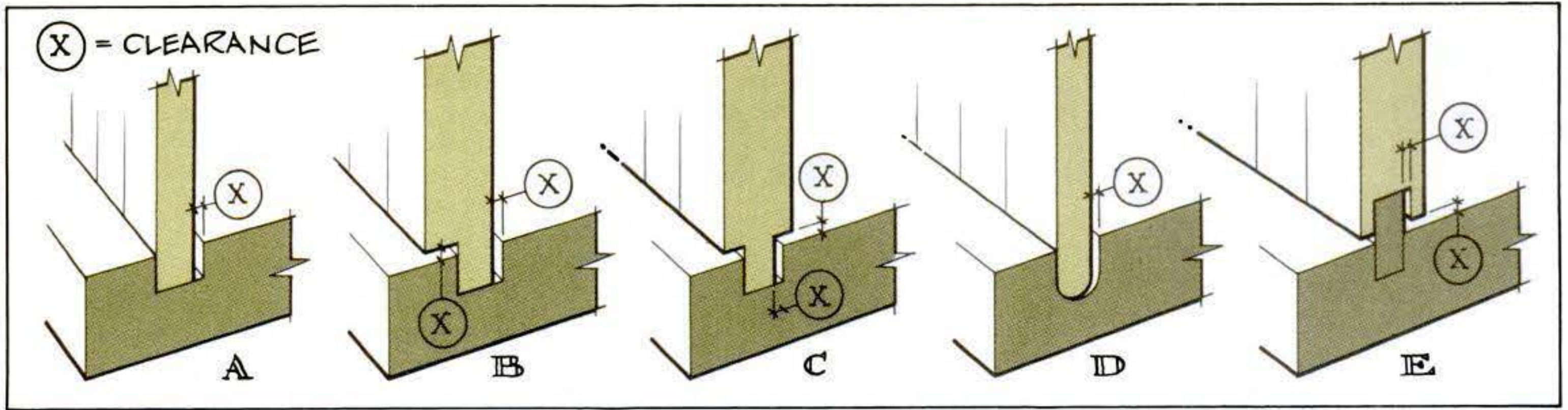
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Now you don't see it (above), now you do (right). Tambour doors are especially appropriate for masking equipment that should be heard and not seen. A pair of sliding doors

on this cabinet would only let you open half at a time, and hinged panels need swing space. You get a variety of textures (below) by using molding or strips of hardboard.





Take your pick of track techniques: First photo and sketch show full-width slats riding in groove; second

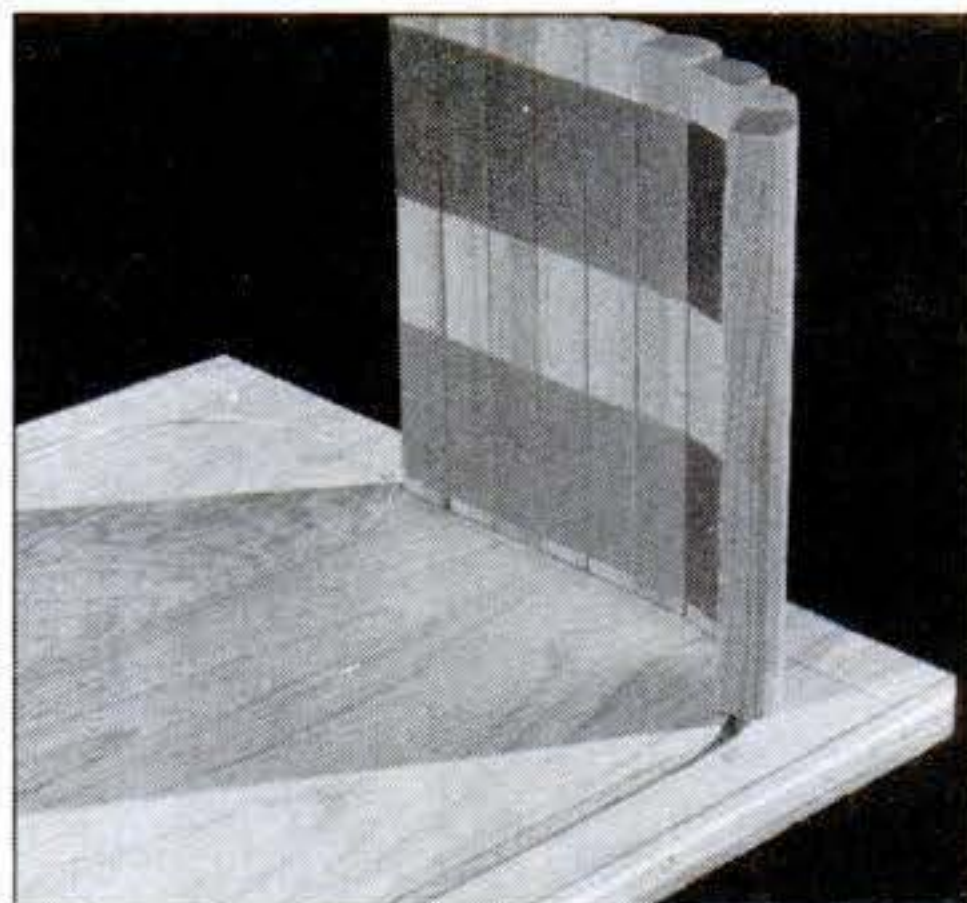
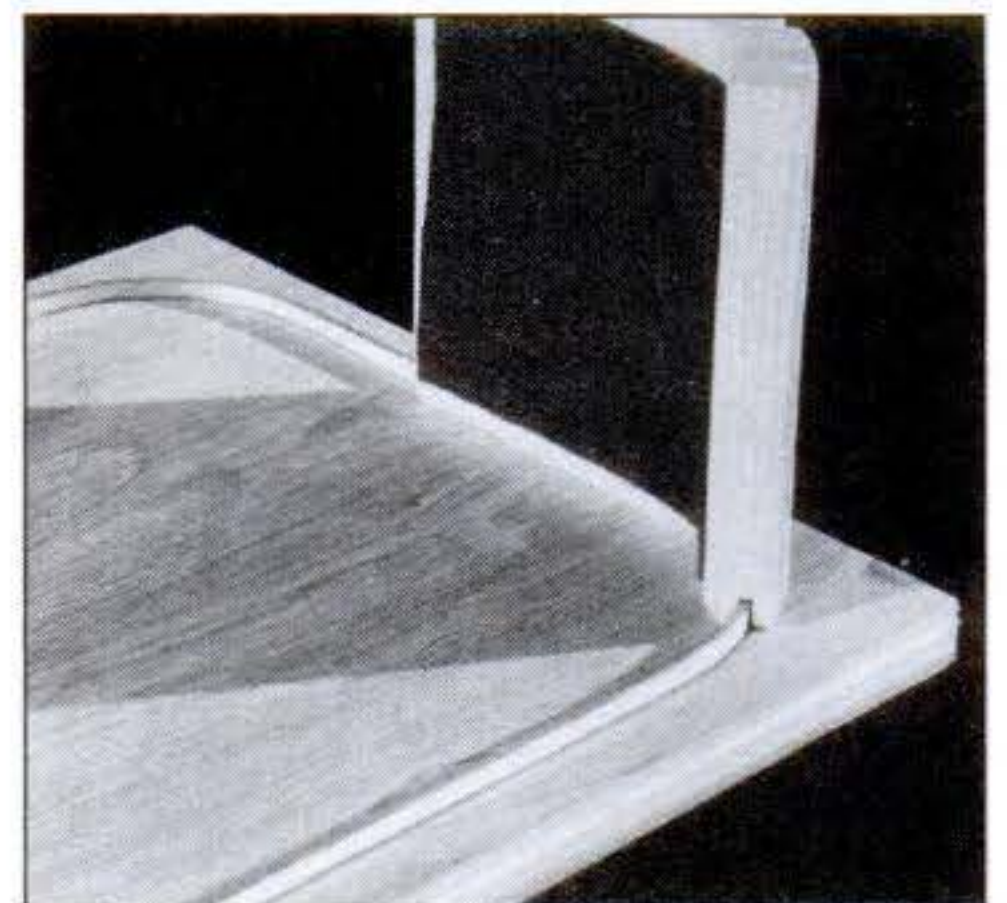
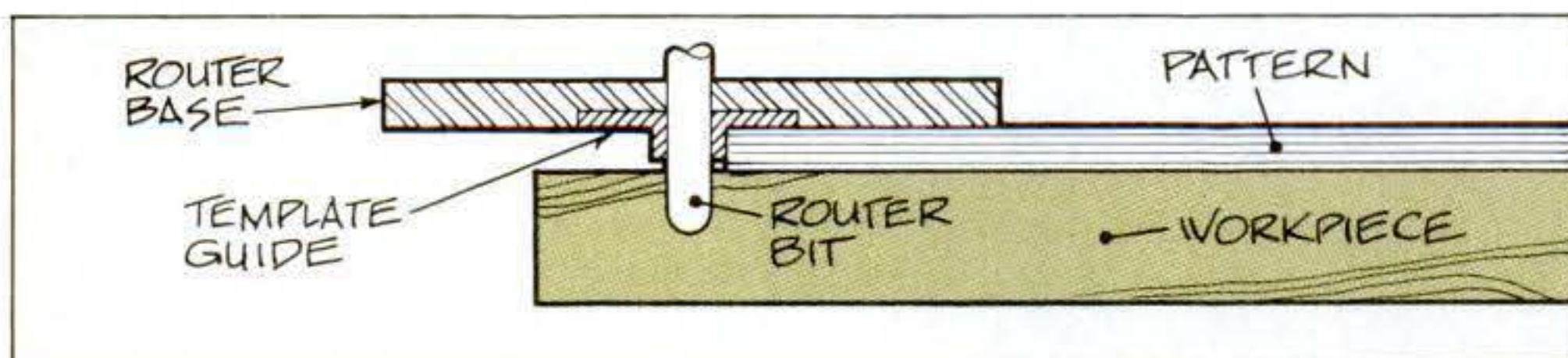
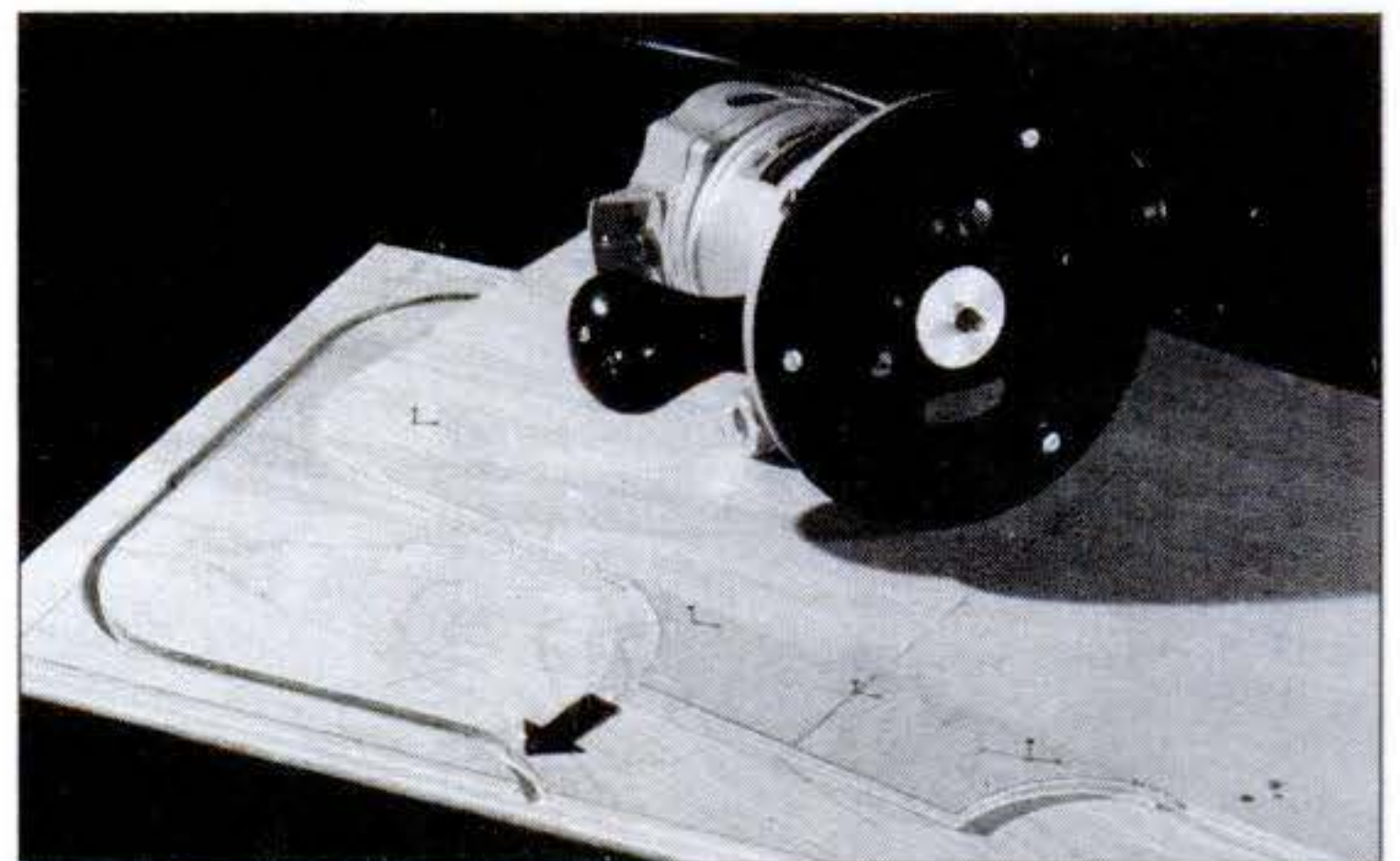
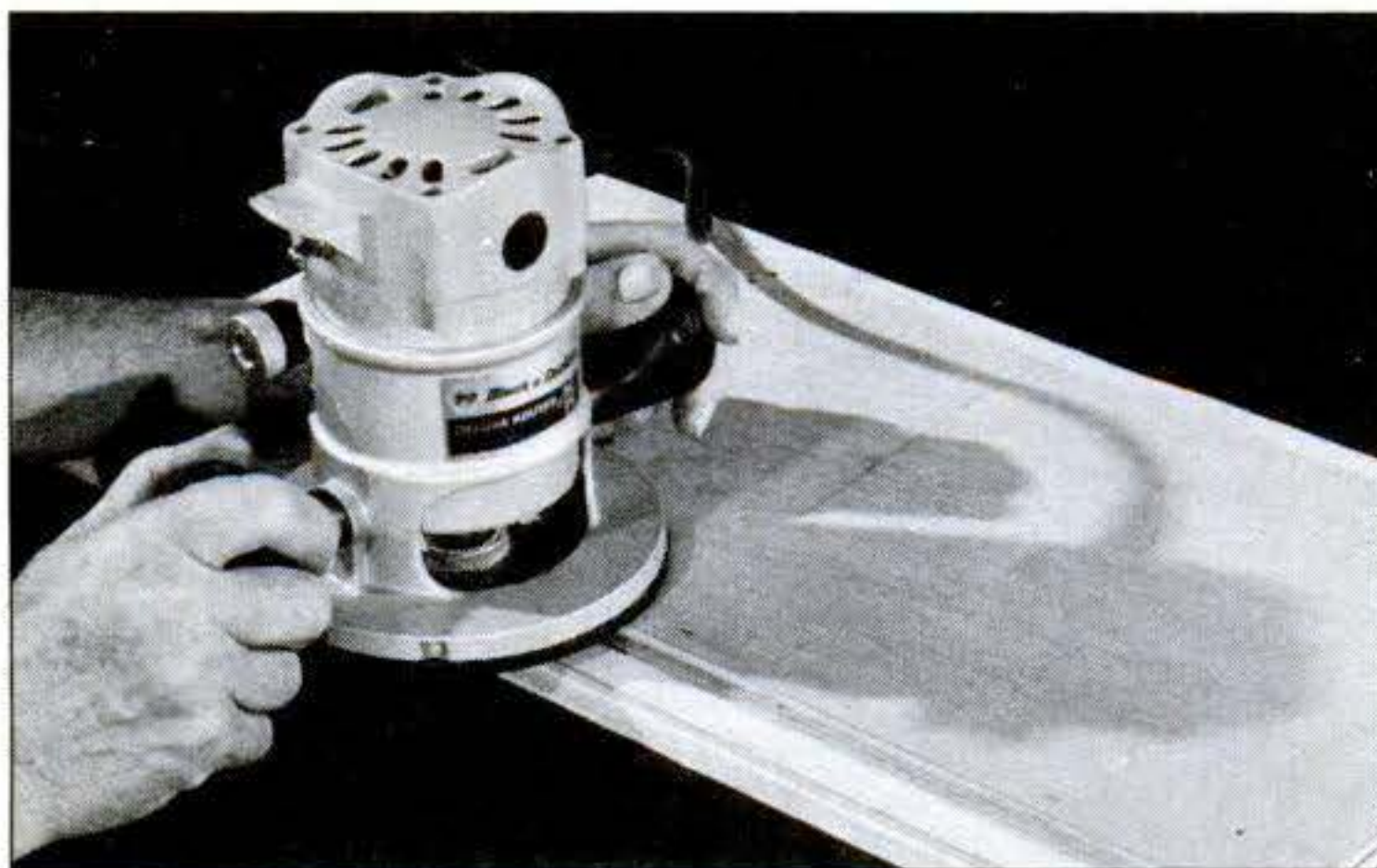


photo shows 3/4-in.-thick slats rabbeted to form tongue for narrower groove (sketches B and C). Track can also



be round-bottom groove (sketch D) or spline-like projection of 1/8-in.-thick plywood (third photo, sketch E).



To rout the grooves, tack an accurate pattern to surface (left photo). Fit the router with a template guide that bears on edge of the pattern, as shown in the diagram. If you want to be able to insert tambours from the rear (before the back of the case is attached), make a pattern with run-out (arrow).

to match the lumber you use for the case (unless you plan to paint the project). It's hard to find moldings in fancy hardwood such as teak.

Making flat slats is easy—rip as many as you need from wide boards, then pass them between a fence and drum sander (sketch, next page).

To create molded slats, you'll need a shaper or drill-press accessories. Don't attempt to shape slats after they've been cut. Instead, shape the edge of a wide board, then rip off the

edge to the thickness you need. Shape the newly sawed edge, and repeat the process until you've cut all the strips you need. When one board becomes too narrow for safety, start another.

Slat thicknesses and widths are variable—thin and narrow for delicacy, wider and thicker for a substantial appearance. As a guide, figure that slat width can range from 1/4 to one inch; slat thickness from 3/16 to 3/4.

Thin slats can ride directly in the grooves. For slats thicker than 1/4 inch,

each end should be rabbeted on one or both faces to form tongues; you won't want grooves much more than 1/4 inch wide. If you're cutting slats from a wide board, shape the tongue before doing the ripping; if you're using ready-mades, secure the slats to a flat surface with several battens and do the forming with a portable router.

To cut the grooves, fit your router with a template guide and tack a pattern panel to the face of the board. Work with a 1/4-inch bit, and make the

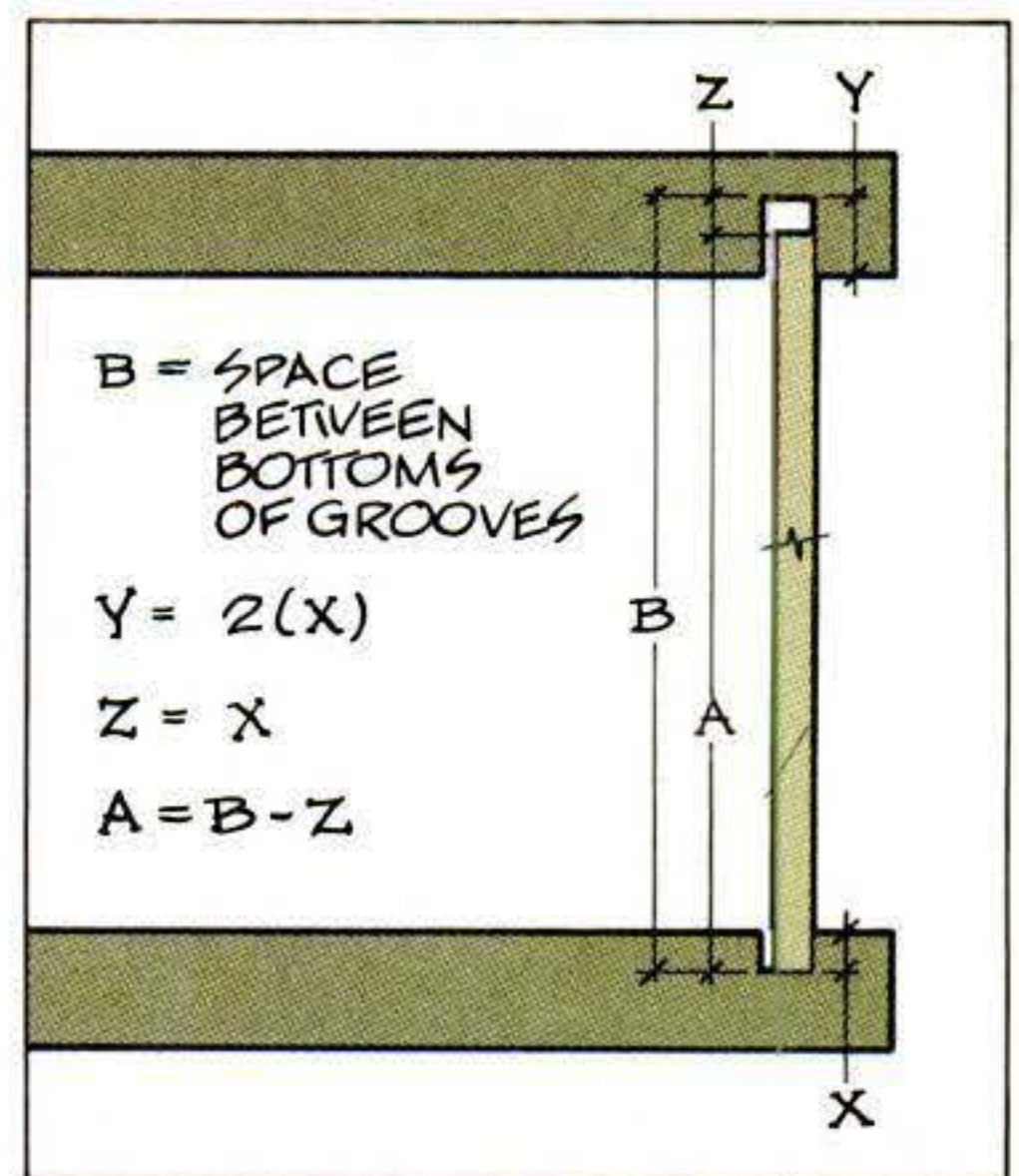
groove about 1/4 inch deep. The radius of the corner curves will depend on the width of the slats. As slats make the turn, they run tangent to the curve, so the narrower the slats, the smaller the radius can be. A radius of 1 1/2 to two inches is fine for slats up to about 3/4 inch wide.

Tambour doors are usually assembled by coating the backs of slats with glue before laying a sheet of light canvas across them. This is time-consuming and can be sloppy—and the right canvas isn't always easy to find (check the Yellow Pages). It may be simpler to work with one of the many self-adhesive materials available. I've tried such unorthodox backings as self-adhesive felt, plastic-coated or flocked wallpapers, and shelf liners—even

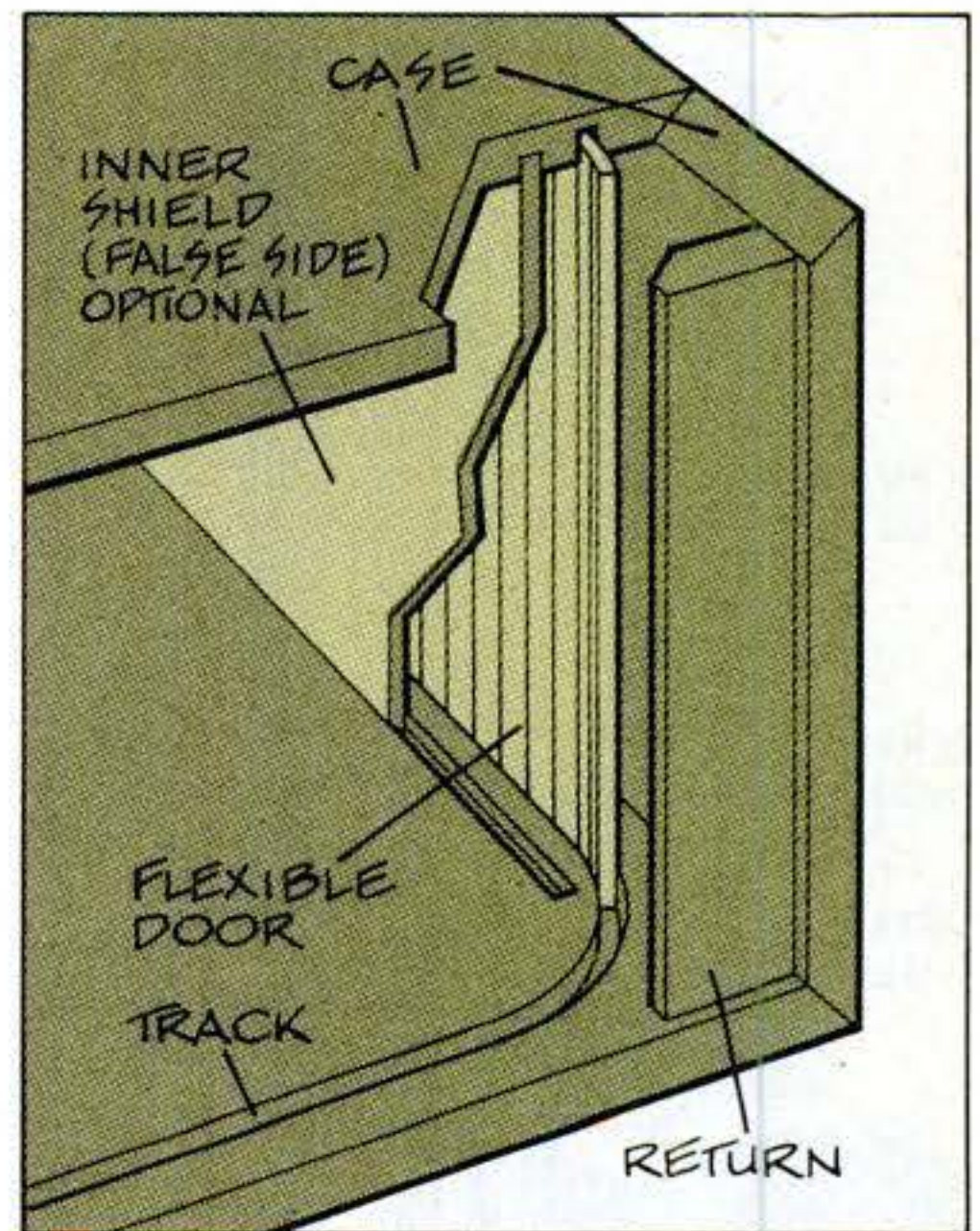
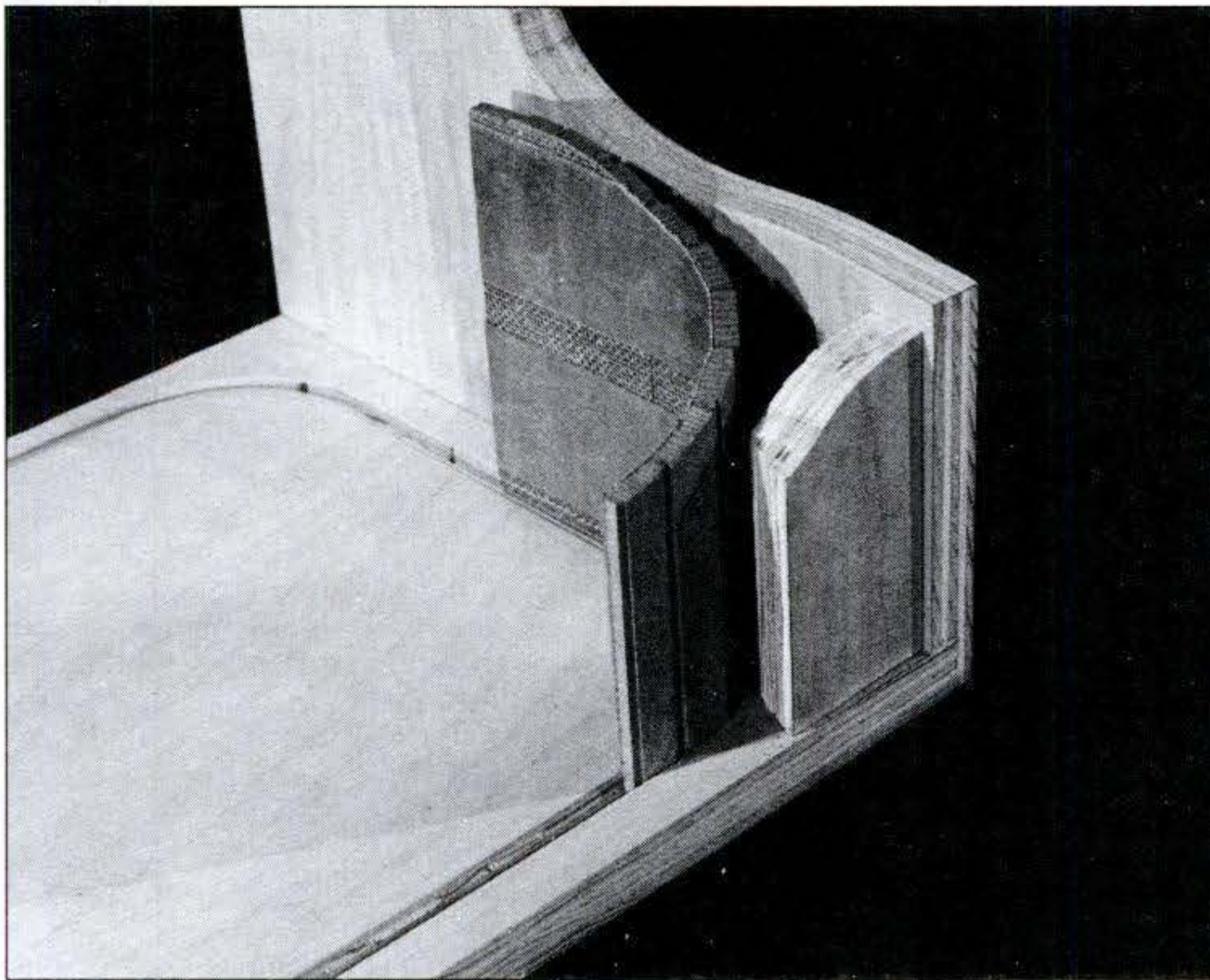
duct tape. They can be applied in strips or as overall backings. Keep all slats square as you apply the backing. Use a carpenter's square as a jig.

To insert the finished doors in their grooves, the least convenient way is to hold them in place as you assemble the case. It's better to run out the guide grooves at the rear of the case.

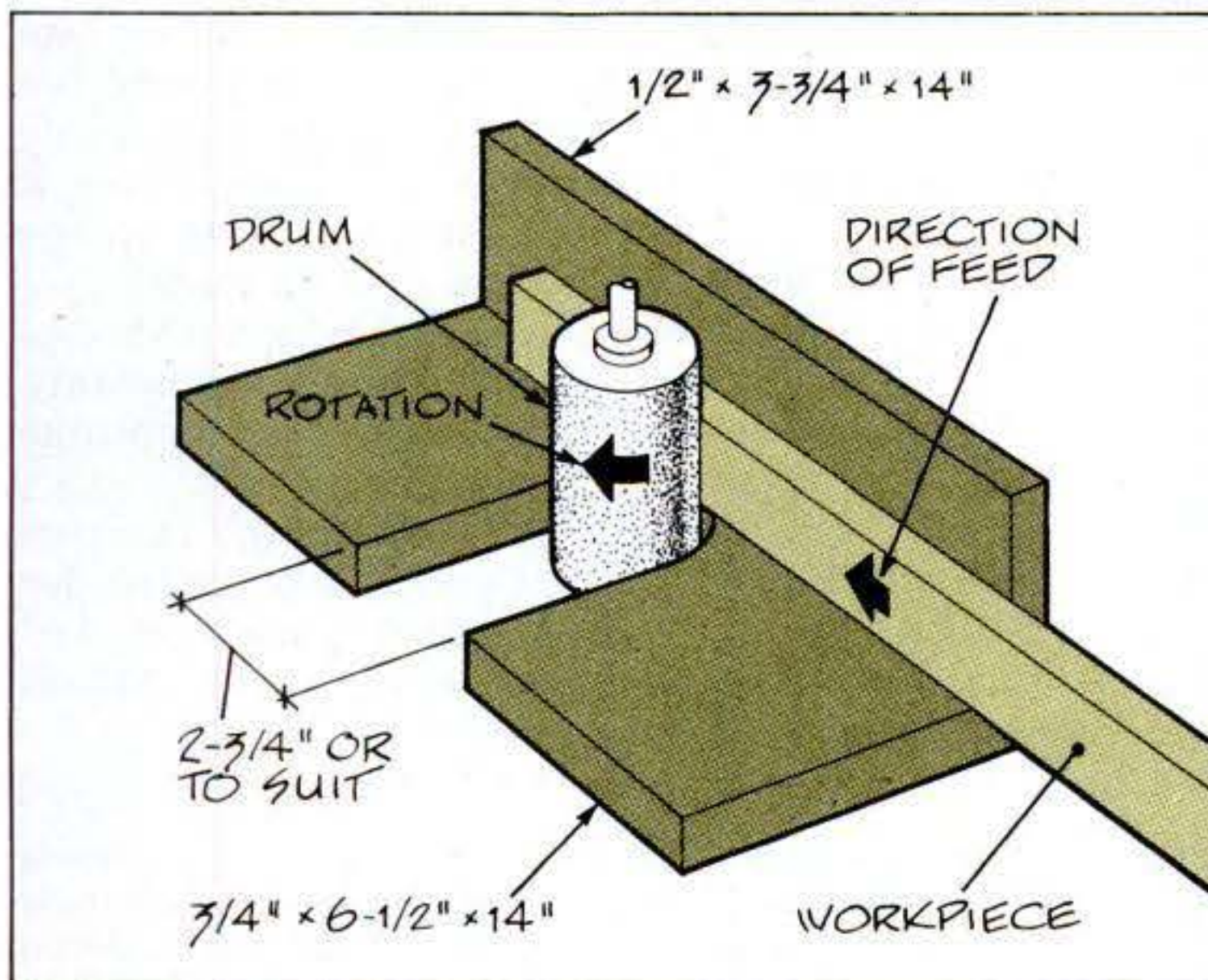
A third method is possible if the width of the opening is more than the length of the door—the same method you'd use for conventional sliding panels: You cut the top groove enough deeper than the bottom one to let you push the panel up and tilt back the bottom so it falls into the bottom groove (see sketch). With these last two methods, you can finish the doors before putting them in place. **PS**



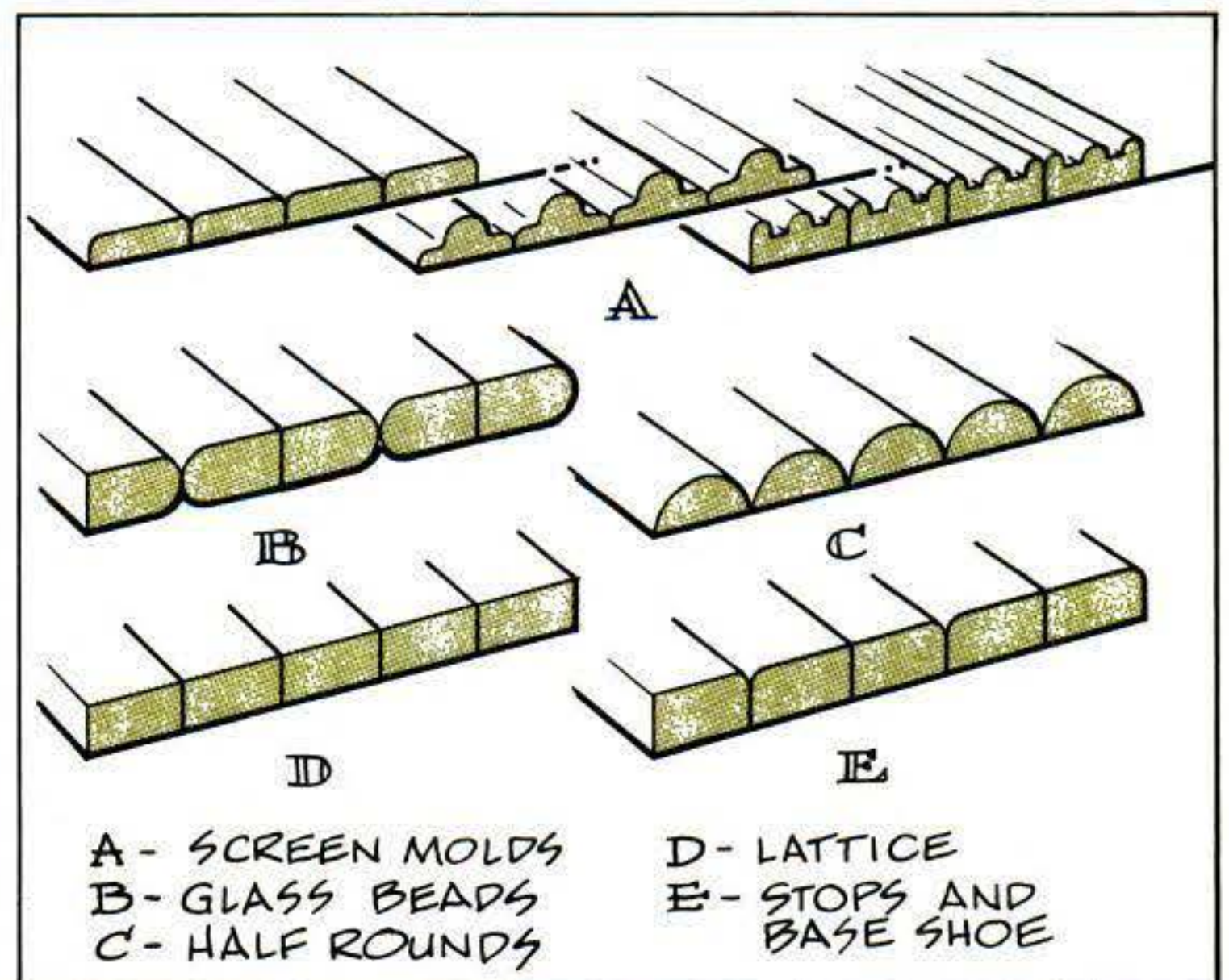
You can design your cabinet with an extra-deep top groove so door panels can be inserted after case assembly.



"Returns" are masking blocks glued inside cabinet corners to conceal door mechanics. As shown in the cutaway photo, a bevel on the leading edge helps clearance. If stored items might clog the track, add a shield (above).



Jig for use with drum sander in a drill press helps you smooth door slats and bring them to uniform thickness.



Ready-made moldings can give a variety of patterns to tambour doors. They're all attached to backing in same way.

Special section:  
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# Why the boom

Today's smaller auto engines run cooler than the old V8s at low speeds but hotter at highway speeds. To cope with these extremes, engineers redesigned the spark plug: The insulator nose is longer to reduce fouling at low speeds, and the center electrode contains copper, which dissipates heat better at high speeds. All the major suppliers have copper-core plugs on the market, and they are original equipment in many new cars.

By **FRANK LEWIS**

*Drawings by Russell von Sauers*

**T**he silver Mercedes sedan rolling up to the shop was stumbling and gasping like a beginning jogger. Puffs of black smoke surrounded the tailpipe as the driver shut it down. The driver came inside and explained to the service manager that she had been running errands all morning and the car seemed to be steadily losing power, rocking and shaking in the process. Since the car had been tuned the previous week, what could be wrong?

Bud Robinson, the service manager, soon had the car running on the electronic engine analyzer. The diagnosis took only minutes: The spark plugs were misfiring, wasting fuel and cutting down on the power output of the engine. When he removed a plug, I could see that the business end was covered with shiny, black soot.

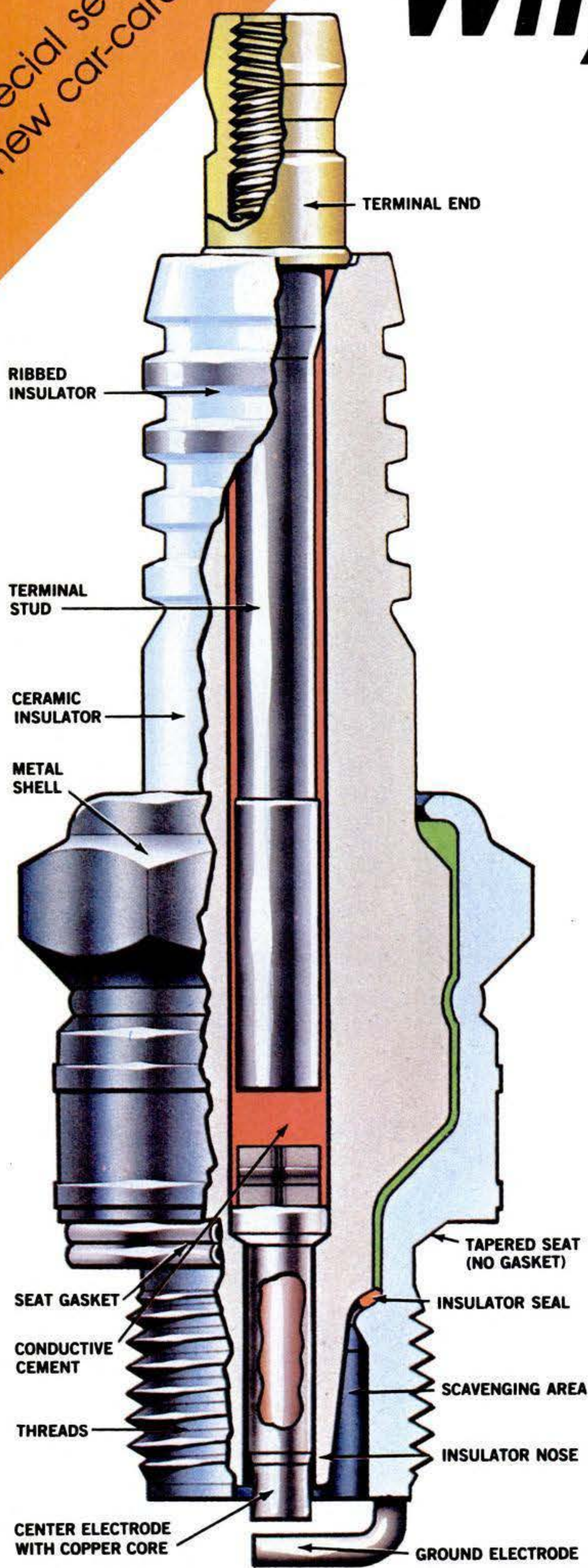
"The plugs have been replaced recently," Robinson observed. "Here's a clear case of carbon fouling, though. The question is, why?"

The next step in the diagnosis was to see if the right plugs had been installed. "The plugs are correct for the model, all right," Robinson said with a nod as he consulted the plug-manufacturer's catalog, "but maybe not for the type of driving you do. Has the car been used only for short trips since the tuneup?" he asked the owner. It had. One final question: "Is the car ever driven on the interstate?" Sure—generally several times a month.

He then suggested a new type of spark plug with a copper core. A half-hour later the car was running smoothly, without any exhaust smoke. Furthermore, it will continue running that way for a good, long time.

A new type of spark plug? The spark plug's function hasn't changed since the original patent was applied for in the 19th century. Why should it need a redesign? And why are the new copper-core plugs so promising that all the plug makers now offer them?

**Simplified cross section of an automotive spark plug shows its main elements. Latest development in its evolution is the addition of a copper core to the center electrode. Some plugs have a gasket around the seat, as shown on left side of diagram; others have a tapered seat with no gasket, as shown on right. (See sidebar for installation tips for each.)**



# in copper-core plugs?

I asked these questions of engineers from car makers and spark-plug suppliers, as well as professional mechanics who install plugs every day. It turns out that because cars have changed, there have been some design changes in spark plugs. "You can't see the major changes we've made in our plugs in the last two years," says David L. Walker, Champion's director of technical services. "You can't see the copper; it's sealed within the center electrode. The insulator nose is longer, too, but you won't notice that unless you look carefully. The plug we have today looks identical to the one of 10 years ago, but it's not."

The copper core, longer nose, and other modifications broaden what is called the heat range of the plug. That can be critical to the efficient operation of newer, smaller engines. It can make some older cars run better, too, though it probably won't benefit a V8 engine.

## Cars of the '80s

Copper-core spark plugs have been used in aviation engines since the 1930s. But they didn't find their way into auto engines until recently. "As we've gone toward fuel economy and brought engine power down with respect to car weight, the engine runs faster," explains Bob Miller, staff engineer for the AC Spark Plug Division of General Motors. "A four-cylinder engine runs at higher rpm than a V8 and, consequently, runs hotter."

But that's only part of the story. "Four-cylinder and some V6 engines operate over a much wider rpm range—600 to 6,000—than the older V8 engines, which rarely got above 3,000 rpm," adds Dave Bowman, technical communications manager for Fram/Autolite. "At idle, a four-cylinder engine runs fairly cool; at freeway speeds, it runs hot." And that creates special problems for the spark plugs.

Before I tell you why, you need to know some spark-plug basics. Simply stated, a spark plug is an insulated conductor that transports electrical energy provided by

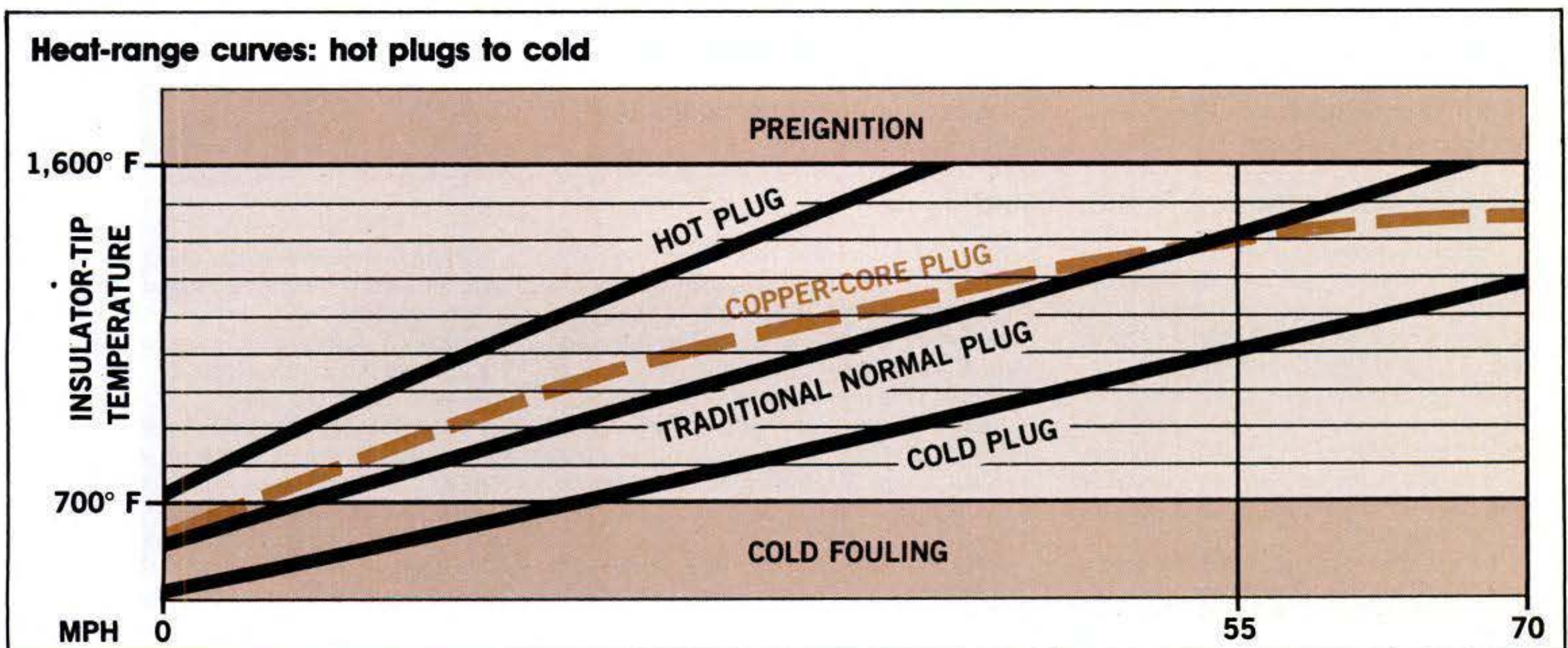
the ignition system across a gap between two electrodes located inside the combustion chamber. The spark that's produced as the electricity jumps the gap—typically about 30,000 volts in a GM four-cylinder engine—starts the burning of the fuel-air mixture in the combustion chamber. The expanding gases produced by the explosion act on the piston and provide the engine's mechanical energy.

A spark plug operates under extreme conditions. The terminal end, outside the combustion chamber, may be freezing, while the firing tip is exposed to flame temperatures as high as 3,000 degrees F. The tip of the plug must be kept hot enough so the wet fuel mixture burns off without leaving carbon deposits. If deposits cover the tip and the insulator, the plug fouls and the electrical energy is shunted to ground without jumping the gap. A loss of power results because the mixture isn't completely burned. The black exhaust smoke of the Mercedes was caused by fouled plugs. In extreme cases a complete loss of ignition can occur, and the car will fail to start or will even stop running, especially in cold weather.

Keeping the tip above the fouling temperature—usually about 700 degrees F—is an important design criterion, but it's not the only one. Preignition can arise if the tip becomes *too* hot. An overheated spark-plug tip will remain hot enough after the fuel explosion to ignite the incoming mixture in the next cycle before the timed spark jumps the gap. Engine knocking or pinging is the audible result. The tip of the spark plug and its insulator inside the combustion chamber must therefore be kept below preignition temperature, about 1,600 degrees F on current engines.

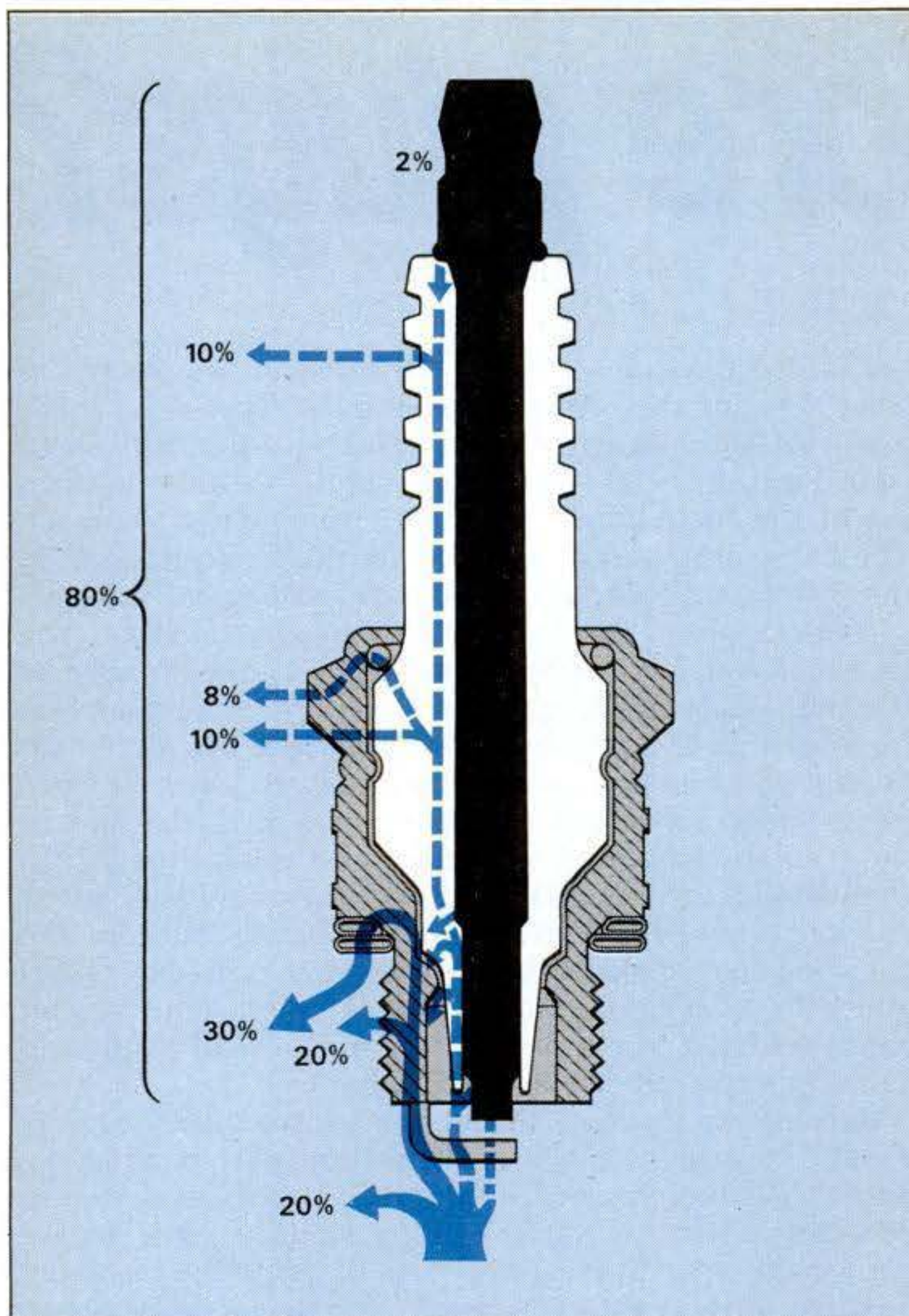
To provide the most efficient combustion, a plug must operate between these two temperatures at all times: warm enough to prevent cold fouling, cool enough to prevent preignition. The heat-range number is an index that represents the ability of a plug to transfer heat from its tip

*Continued*



Insulator tips of spark plugs must operate above 700 deg. F to avoid cold fouling and below 1,600 deg. to avoid preignition (both numbers are approximate and depend on plug

design and engine). Operating-temperature range is called heat range. Copper-core plugs run hotter than traditional plugs at low speeds yet run cooler at highway speeds.



**Heat-flow paths show how spark plug transfers heat out of the combustion chamber. These numbers include only that portion of the heat that is dissipated through the plugs, though this is only a fraction of the total heat.**

inside the combustion chamber to the insulator, to the shell, and then to the engine block or outside air.

Engineers talk about colder spark plugs and hotter ones: A colder plug transfers heat more rapidly than a hotter one, thus its tip runs cooler. In traditional spark-plug design, a colder plug has a shorter insulator nose; it transfers heat faster simply because of the shorter pathway the heat must travel before it is dissipated.

"Smaller engines need a colder plug because they reach higher temperatures, but the colder plug leads to fouling

during short-trip driving," says Bowman. Witness the sputtering Mercedes (an actual—though extreme—example).

This is where the copper-core spark plug comes in. By putting copper inside the center electrode, it's possible to broaden the heat range because copper dissipates heat faster than the traditional nickel-alloy electrode. Consequently, engineers can make the insulator nose longer—in some cases twice as long—without overheating the tip. The longer nose, in turn, provides a longer fouling path, delaying the onset of carbon fouling when the engine is cold. This buys time for the spark plug during short-trip, stop-and-go driving until the engine warms and burns off the carbon. The longer nose also makes the plug run a little hotter at low speeds than the traditional normal-heat-range passenger-car plug, but because of the copper it runs cooler at high speeds (see graph). Other design modifications—using adhesives that conduct heat better and widening the base where the porcelain insulator meets the shell, for example—have also contributed to the broader heat range.

An added bonus of the expanded heat range is that fewer plug models are needed to fit many more engines. For that reason, experts predict that copper-core spark plugs will eventually be used across the board. All the major suppliers—AC, Autolite, Bosch, Champion, and Motorcraft—now market them. NGK makes nothing else for cars.

The car makers are tagging closely behind. GM started the trend in 1982 by putting copper-core plugs in the two-liter, four-cylinder engines used in some J-cars. Now they are original equipment in many four- and even six-cylinder engines in both foreign and domestic cars. Ford will be using copper-core plugs on some cars by mid-year and expects to use them on its entire 1986 car line.

Bowman cautions that these plugs will not solve all plug problems. Aside from its better heat-transfer characteristics, the copper-core plug performs about the same as the last generation of plugs.

The replacement interval is unchanged for the moment, and it will continue to be specified by car makers. GM and Ford are recommending a 30,000-mile change interval. Champion thinks that an annual replacement should be considered. Professional mechanics say cars with electronic ignition that run on unleaded fuel may easily reach 30,000 miles with the same spark plugs. In fact, many mechanics feel that car makers are too conservative when setting change intervals. They are probably right. Jack Obermeyer, manager of ignition components, engine engineering at Ford, predicts that the copper-core Motorcraft spark plugs that will be used on 1985 and '86 Fords will have a 60,000-mile change interval. **PS**

### Changing plugs: more to it than you'd think

First, use the spark-plug maker's latest catalog and buy what is specified for the make and model of your car and the engine in it. Never use a cross-reference chart to choose a plug. These charts purport to equate the plugs of one maker with those of another according to part number. But spark-plug makers do not always agree on a specific application, and plug design can vary between brands, so a cross-referenced plug may be wrong for your car.

Before you change plugs, allow the engine to cool. Mark all the ignition-wire positions before removing them, or remove only one at a time. To remove the wire, twist the boot back and forth until it turns on the plug, then pull off the boot—never grip the wire itself.

Next, back the plug loose from the cylinder head. Professionals often do this by hitting the end of a ratchet wrench with the palm of the hand. Loosen the plugs two turns and stop. Clean any dirt away from the base of the plugs. (The easiest way is with compressed air, but a length of windshield-washer hose and a good set of lungs will do.) If the plug feels tight, use penetrating oil and patience. Turn the plug back and forth and slowly work it loose.

Once the plugs are out, look at them. If your car runs on unleaded fuel, the color of the firing-end insulator should be tan to chocolate brown. Black indicates oil fouling or a rich fuel mixture. Burned electrodes or a cracked insulator indicate an ignition-timing problem.

Before installing the new plugs, check the gap; the factory setting isn't always right. Use a gap tool that bends the ground electrode and doesn't damage the insulator tip. Never try to move the center electrode; this breaks the seals inside the plug.

Install the new plugs finger-tight. If they have a gasket around the seat, continue to tighten one-quarter turn. You should feel the gasket collapse. Tapered-seat plugs (ones without a gasket—see cutaway drawing) only require one-sixteenth turn after hand-tightening. Since the seat is tapered, there is no definite stop; be careful not to over-tighten. Before you reconnect the wires, inspect the boots; if they're burned or cracked, the wires should be replaced.

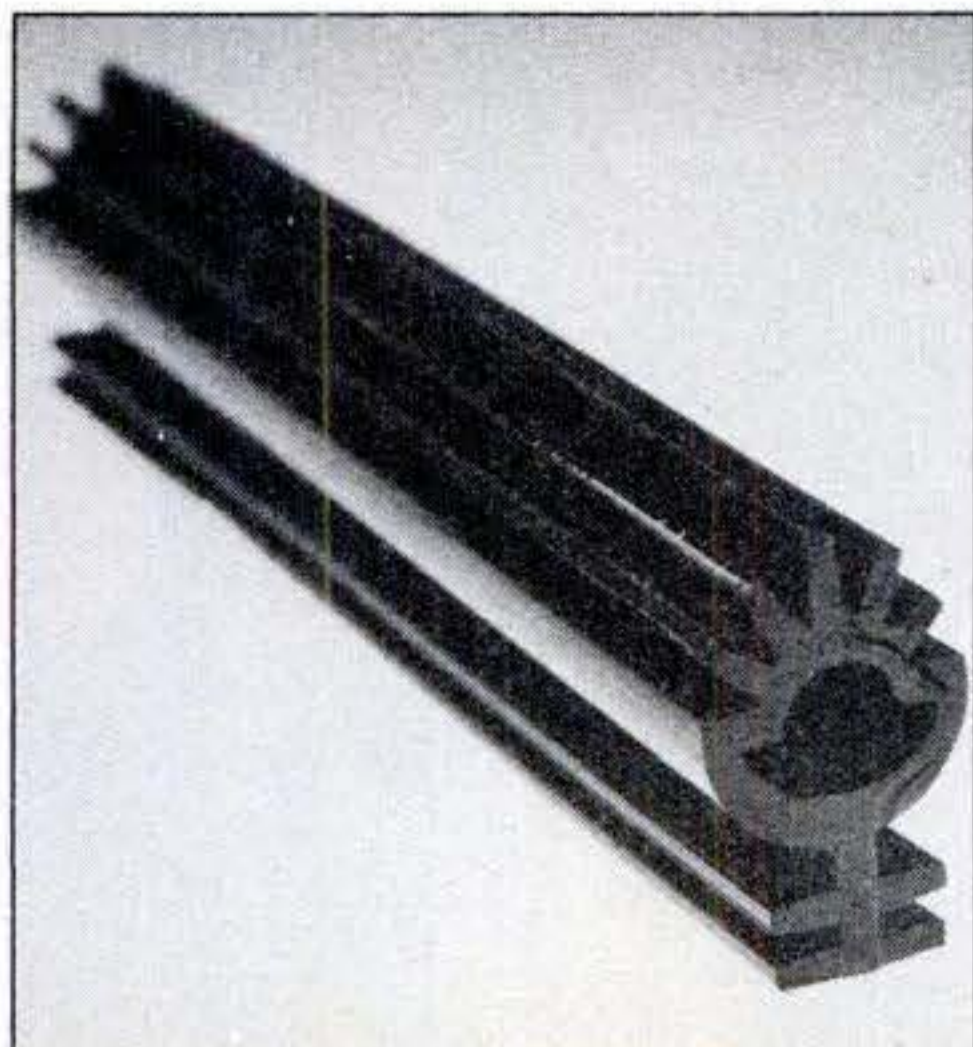
## Multi-ribbed windshield wiper

Charles Fritz has never been happy with car windshield wipers. The 60-year-old Delaware man grumbled about "being able to go to the moon" but not being able to stop windshield streaks and smears when it rained. Two years ago, when the blades on his new car failed, he began searching for the cause and a cure.

"Conventional wiper blades wear out too fast because the single-edge blade sticks to the windshield during hot spells and gets frozen to it during cold winter weather," says Fritz. "When the wipers are turned on, minute particles are ripped off the edge, leaving a streak in its path."

So the former vending-machine operator turned inventor. His idea: Start with a different blade material—a synthetic, non-rubber material that doesn't wear so quickly. Instead of a one-edge blade, put five ridges on a rounded wiper so that it works like a multi-bladed razor: As the wiper sweeps one way, the first rib removes most snow or rain. The second rib starts to dry the glass. And the third (middle) rib squeezes the windshield dry. On the return sweep, the two remaining ribs plus the longer squeegee rib go into action.

Major blade manufacturers told Fritz that such a wiper was impossible to make. But a knowledgeable neighbor, Du Pont Co., thought that its elastomer Nordel could do the job. Last year, with help from Wilmington's Harvard Business Services, Fritz formed Smear Clear Wiper Corp. and tested several dozen blade designs. The resulting blade can be made with simple extrusion equipment. Best of all, the new blade lasts three to four times longer than ordinary blades, says Fritz. The clip-on wipers will soon be on the market.—*John Free*



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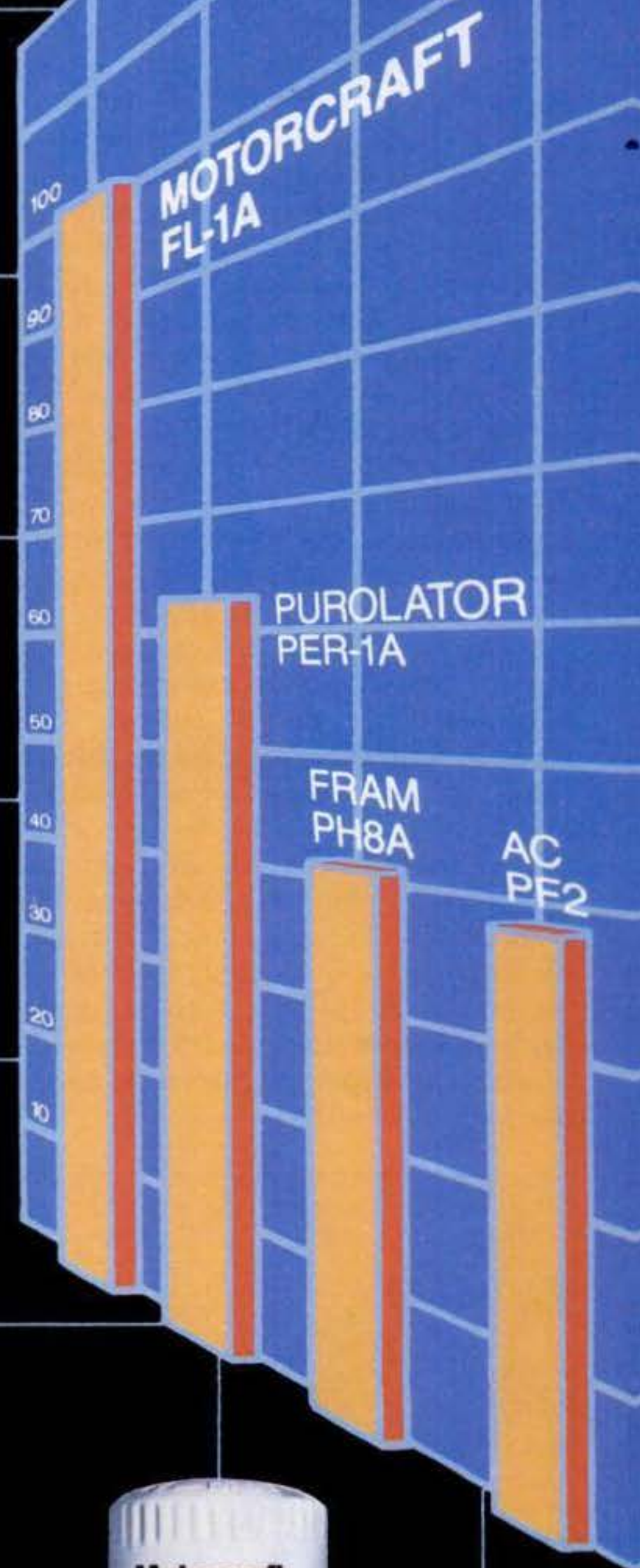
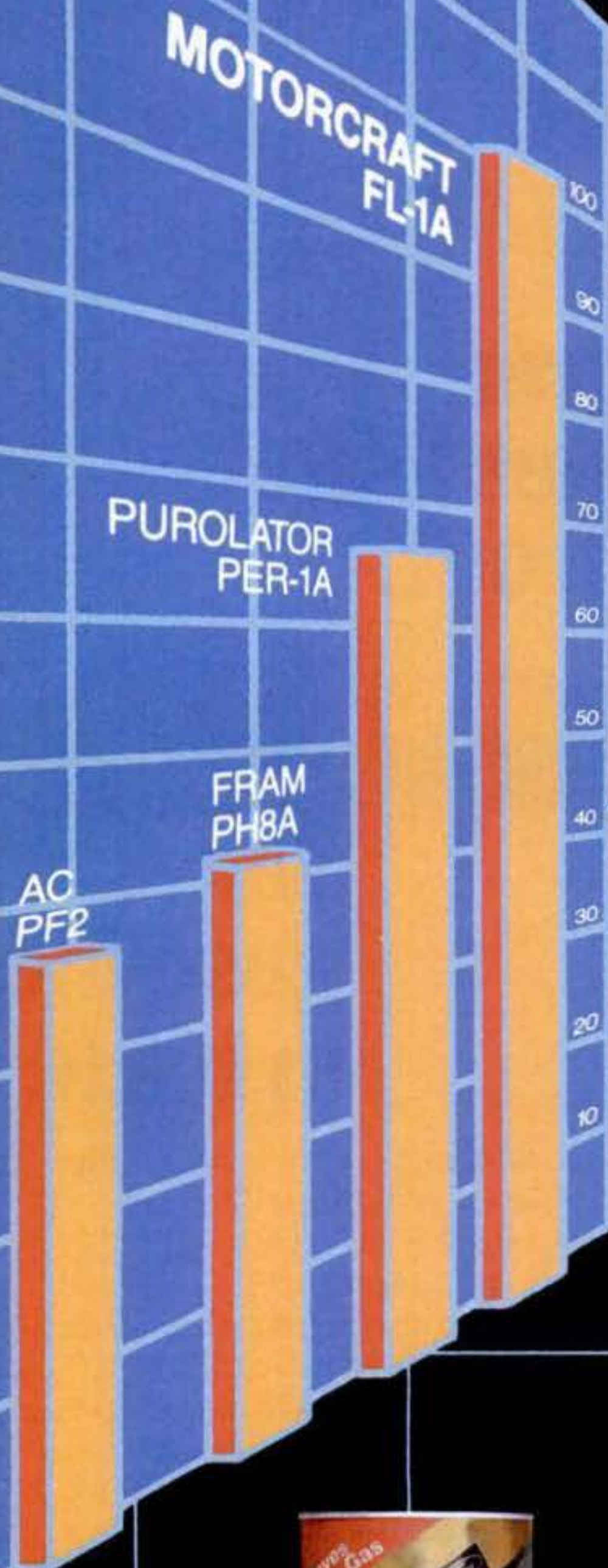
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EXCEEDS THE NEED





By JIM DUNNE

**E**very time I cross the railroad tracks in the morning, the CHECK ENGINE light goes on," the owner of a new Buick told his dealer's service manager. "It runs fine otherwise, but I'm worried."

Like many such intermittent problems, the symptom didn't show itself when mechanics checked out the car. Nor could they find any underlying problem with the engine. So the service manager called in Buick's new checkout tool, the Diagnostic Data Recorder, to ferret out the problem.

The electronic detective was installed on the car, and the next day it recorded a complete magnetic-tape log of 26 engine functions as the car went through its daily routine. Sure enough, just after the railroad tracks, the CHECK ENGINE light flashed on for a few seconds.

At the end of the day, the service manager removed the recorder from the car, hooked it up to a phone connected to Buick's service headquarters in Flint, Mich., and reran the tape. Before long, engineers in Flint had traced the problem to a faulty on-board computer chip and relayed the remedy to the dealer. With a new chip, the phantom fault disappeared.

The story illustrates how the newest diagnostic tool in motordom solves those on-again, off-again engine problems. "A service technician at any Buick dealer in the country can receive an immediate display of engine performance," says Buick general manager Lloyd Reuss. "If the technician finds a problem he can't decipher, the data can be transmitted to our service engineers at Buick for assistance."

The Diagnostic Data Recorder works instantaneously as well as by data tape to put the resources of the Buick engineering department in contact with problem cars in dealership bays. "We can trace things such as engine temperature, O<sub>2</sub> sensor, timing, and air-fuel-mixture control," says Tom Roberts, manager of Buick's Technical Assistance Center. "The computer prints a stream of numbers on the CRT screen, and we match those numbers against a normal pattern."

Buick is the only auto company with an on-line diagnostic system. At present, the system is limited to just one recorder for each of Buick's 26 zones. But if the demand for the service grows, the company says it will expand the system so that eventually every dealer will have a recorder.

"We're doing this for customer satisfaction," says Roberts. "He'll tell his friends. We make the dealer the hero." P S

# On-line auto repair

Intermittent and recurring engine malfunctions are easier to find and fix with Buick's new computerized diagnostic tool. If a problem defies solution at the dealer level, the portable data recorder connects 1981 and later-model Buicks to computers at the company's Michigan headquarters.



Car's diagnostic connector plugs into portable data recorder, which links to remote computer over phone line. Tape allows delayed data transmission.

# For 1984, add a 1985 third brake light



The third brake light on the author's car took 45 minutes to install. It flashes simultaneously with the hazard lights.

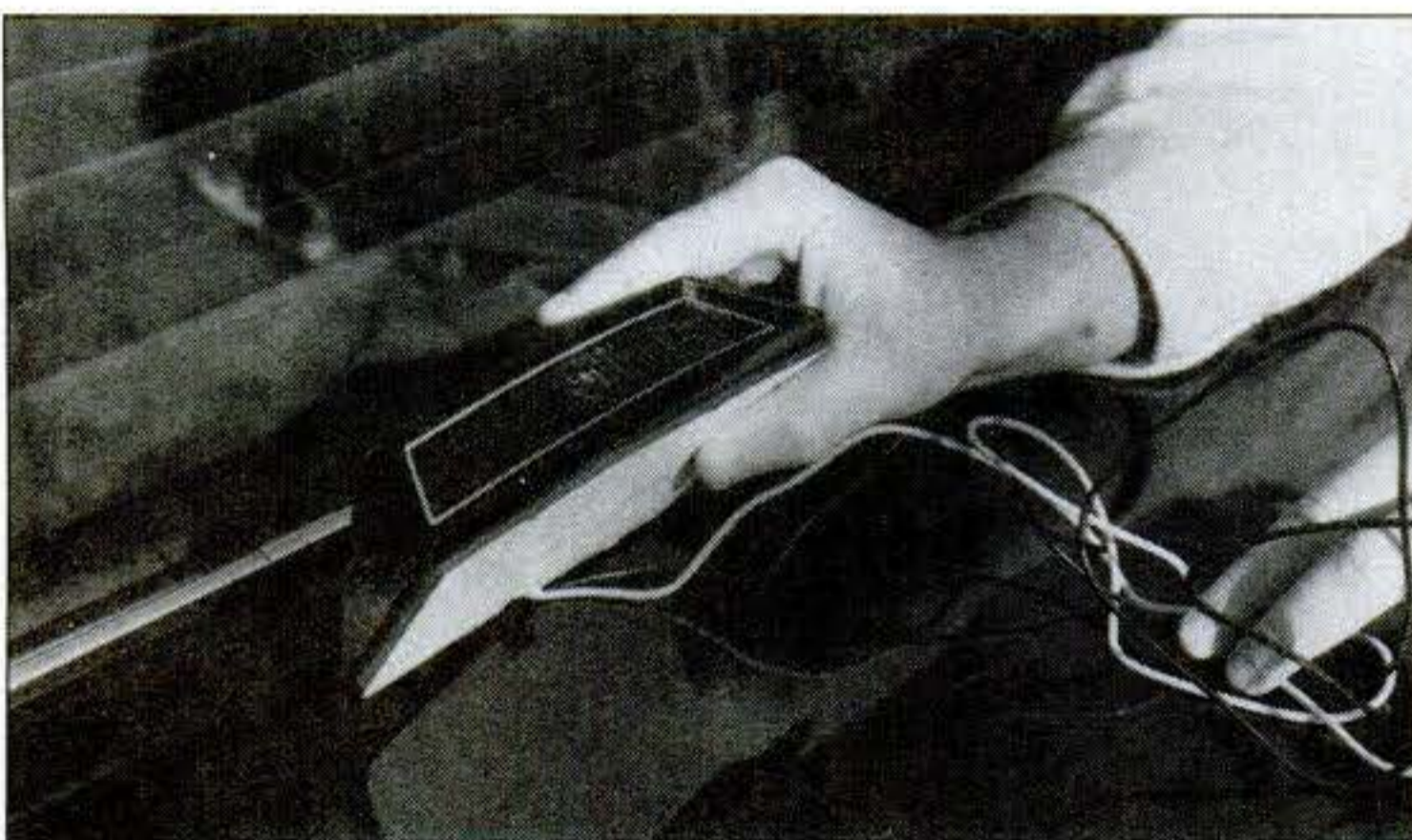
By **GEORGE SEARS**  
*Photos by the author*

If your car had a third brake light mounted behind the rear window, your chance of being rear-ended would be reduced by more than 50 percent. So say studies made by the U.S. Department of Transportation and the Insurance Institute for Highway Safety.

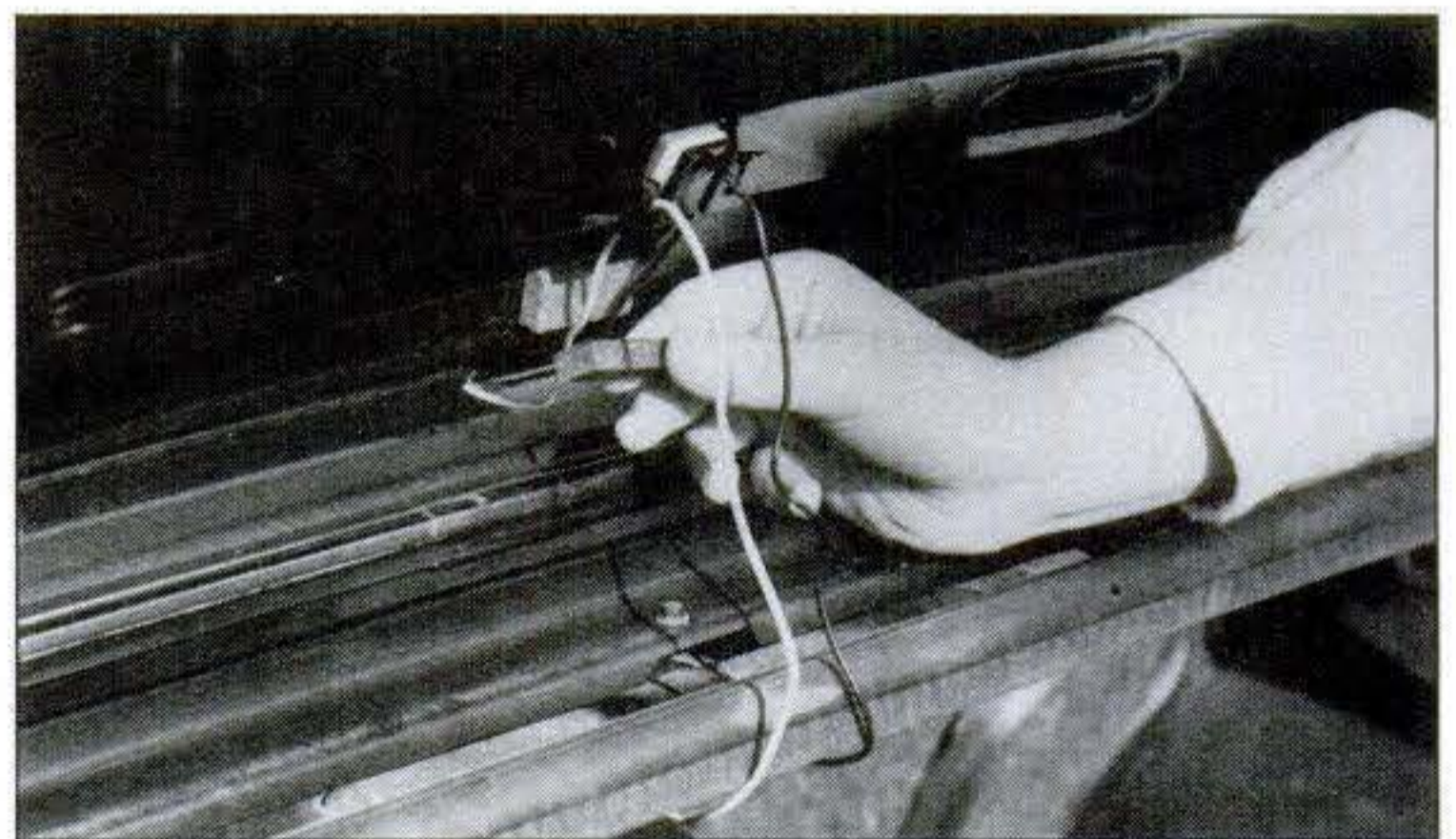
This finding is the basis for a new federal regulation requiring a third brake light on cars manufactured after August 31, 1985. But you don't have to wait until then. You can add a third brake light now using a new kit.

The kit, called the Hi-Lite Collision Avoidance Light, is made by Laser Corp. (2121 Cloverfield Blvd., Santa Monica, Calif. 90404). It has a suggested retail price of \$19.95.

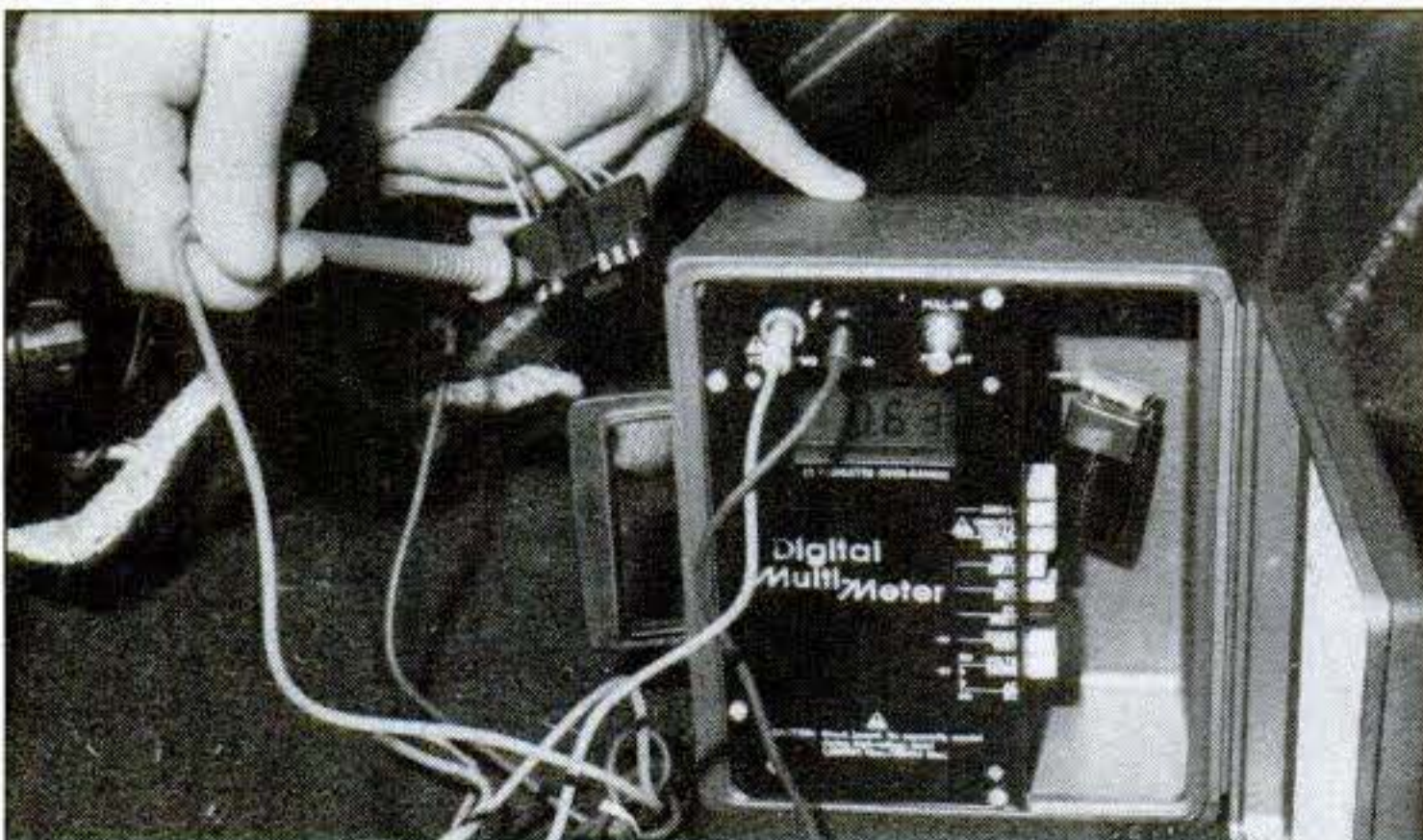
I put one on my car, and it works well. In fact, I've noticed that drivers behind me keep their distance when



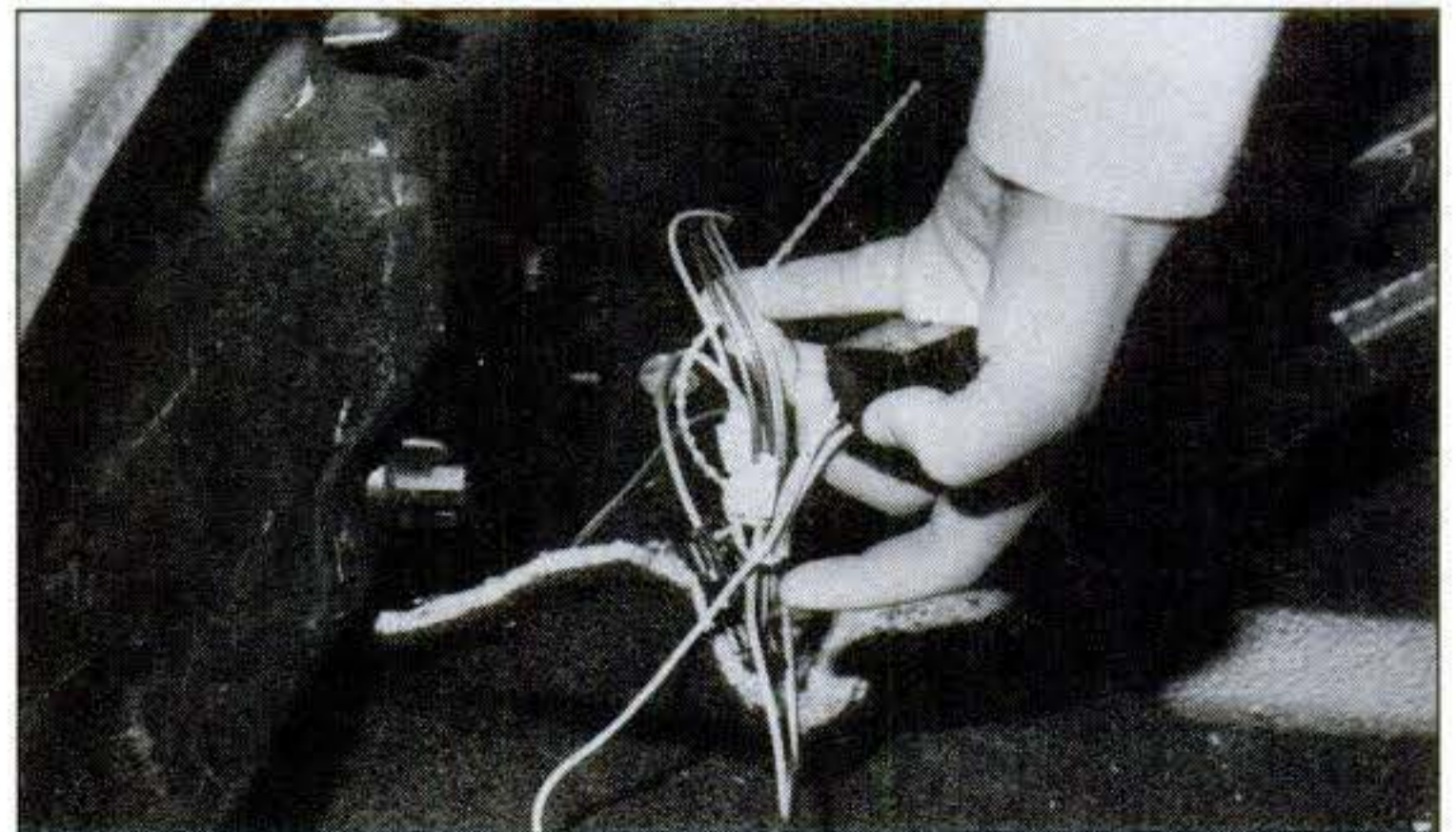
Place the third brake light on the trunk lid. Wash the area to remove dirt and wax; otherwise the mounting pad may not adhere. The back of the light should overhang slightly.



Open the trunk lid, and pass the wires from the brake-light housing into the trunk. The kit's wire supports and foam gasket pads keep wires in place and prevent damage.



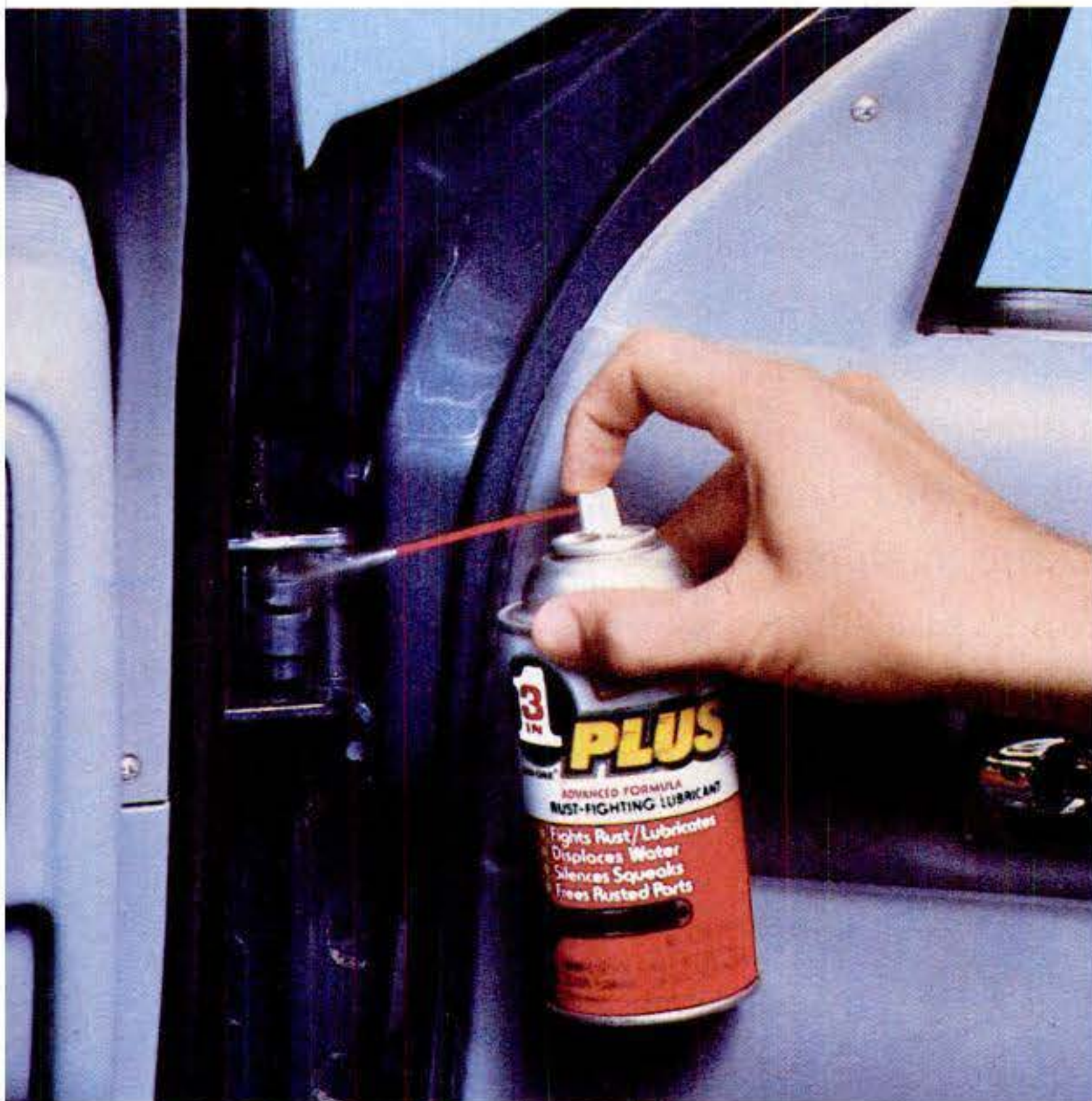
To identify turn-signal wires of a car with combination lights, pull apart connector and probe terminals as the signal flashes. Watch for pulses between zero and a low reading.



Use the self-splicing connectors provided in the kit. In a car that has separate turn signals and brake lights, wires from the circuit interrupter connect to brake-light wires.

**INTRODUCING**

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I brake, probably because the eye-level light catches their attention sooner than my conventional brake lights.

The kit is fairly easy to install on the trunk lid. (My car is a standard notchback sedan. The manufacturer has specific installation recommendations for wagons, hatchbacks, and cars with diagnostic-warning-light systems.)

First wash the mounting area with hot water and detergent. Find the best location for the light by aligning its center with the center of the rear window. Mark this position with masking tape.

Stick the kit's adhesive pad on the bottom of the light housing; then attach the light to the trunk lid, using the masking tape as a guide. Be sure the position is correct. You can't remove the pad without damaging the car's paint.

The third brake light has two wires. The black one is the ground wire; the yellow one is the hot wire. String the wires into the trunk through the back edge of the trunk lid and keep them in place by fastening them to the two wire supports and foam gasket pads provided in the kit. Connect the ground wire to a metal body screw.

The circuit interrupter, called a "logic circuit" by the manufacturer, serves two purposes. If the car's brake lights and turn signals use the same wiring and bulbs (as in most vehicles built in the U.S.), the device prevents the third brake light from flashing when turn signals are activated. If your car has separate wiring and bulbs for brake lights and turn signals, the device reduces current flow to the third brake light so it won't overheat.

The circuit interrupter has three wires. The yellow wire is connected to the yellow wire of the third brake light. The two green wires of the circuit interrupter are connected to the wires of the rear left- and right-turn signals in cars having combined brake lights and turn signals. In

cars with separate brake lights and turn signals, the green wires are connected to the brake-light wires.

You'll have to identify which of the car's wires you must connect to the circuit interrupter's green wires. In cars with combination brake lights and turn signals, you'll find a group of different-colored wires on one side of the trunk. These serve brake lights, taillights, turn signals, side-markers, and backup lights. You may also find a plastic connector where wires from the battery join wires coming from these lights. Pull this connector apart to uncover its metal terminals. Work with the connector that holds wires coming from the battery (if there is no connector, you can splice directly into the wires with no ill effect).

Connect a voltmeter's ground wire to the car, switch the ignition key on, and turn on either the left- or right-turn signal. Now probe each of the metal terminals of the connector until the voltmeter pulses. Mark the wire to identify it. Do the same with the other turn signal.

Finish installing the third brake light by mounting the circuit interrupter on the wiring harness near the connector. Use a wire tie (provided in the kit). Then splice the two green wires of the circuit interrupter to the car's turn-signal wires and splice the yellow wire of the circuit interrupter to the yellow wire of the third brake light.

In cars with separate brake lights and turn signals, there's no problem finding the brake-light wires because only one wire—usually brown—is connected to each brake-light socket. Connect one green wire of the circuit interrupter to one of the brake-light wires; then connect the other. Finally, connect the yellow wire of the circuit interrupter to the yellow wire of the new brake light.

Once you're finished, notify your insurance agent. The light may qualify you for a reduced premium. **PS**

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From 3-In-One®, makers of all-purpose lubricants for over 90 years, now comes new 3-In-One Plus™—the most advanced lubricant, rust fighter and water displacer we've ever formulated. Anyone who drives a car will find it indispensable. It silences those annoying squeaks in your car door hinges. Helps your doors open and close freely and smoothly. And next time you change a tire, loosening those lug bolts can be a struggle. But spray some 3-In-One Plus on them first, and see how much easier the job becomes.

And what an efficient water-displacer! If your car won't start or stalls due to wet ignition problems, simply spray 3-In-One Plus inside your distributor and on your ignition wires. Chances are you'll soon be on your way again. Always keep a light coating of 3-In-One Plus on ignition components to guard against starting failure due to condensation.

3-In-One Plus. The lubricant and moisture repeller no car owner should be without.

**A new addition to the 3-In-One family.**



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# Time-saving? Accurate? How good are those **CCC testers?**

All GM cars built after 1980 include a device called a Computer Command Control. It's used to control the air-fuel ratio and to report any malfunctions through a complicated series of tests and displays. Now special testers can interpret the CCC signals and diagnose trouble at the push of a button. All CCC testers can find basic problems, but some do more than others. That can make a difference in the time it takes to accurately trouble-shoot a problem.

By **BOB CERULLO**

In 1980, General Motors "computerized" its engines for better fuel economy and emissions control. Doing so meant adding a tiny micro-computer, called a Computer Command Control (CCC), under the hood, various sensors scattered around the car, and a new "idiot light" on the dash that flashes CHECK ENGINE when something goes wrong.

Check the engine for what? Good question. There are dozens of reasons why the CCC can signal a potential problem—from an incorrect carburetor-throttle position to the amount of oxygen in the exhaust. The CCC has a diagnostic mode to help you pinpoint the trouble (I'll tell you how it works later), but its self-test results can be confusing and time consuming and often require more test gear.

But now there are CCC testers: clever boxes that connect to the CCC to perform, in many cases, one-button checkouts and to provide instant failure reports. Well, at least that's what their makers claim.

Do these testers really save time? Are they accurate? And what are the differences among the four testers presently available? (POPULAR SCIENCE reported on the first of them, the OTC Monitor II, in the April 1983 issue.)

To find out, I tested each one on the same "patient": a 1981 Oldsmobile Delta 88 equipped with a 4.3-liter (262-cu.-in.) V8 engine—and a faulty oxygen sensor that caused the CHECK ENGINE light to go on after a few minutes of driving.

All the testers found the problem (or, rather, helped me find it), but each in a different way. And as a comparison, I first followed the prescribed shop-manual method of trouble-shooting.

## By the book

The main function of the CCC system is to maintain an air-fuel ratio of 14.7 parts of air to each part of fuel. This is the ideal, or stoichiometric, mixture at which the three-way catalytic converter keeps carbon monoxide, hydrocarbon, and oxide of nitrogen exhaust emissions at their lowest level and fuel economy at its highest.

To do it, the CCC system uses a GM-built microcomputer, called the Electronic Control Module (ECM), to

CCC testers intercept signals from the car's on-board computer, allowing you to request specific tests and see diagnostic results. Units shown are (clockwise from top): Brainmaster, Monitor II, Multi-Scanner, and Mini-scanner.





The hand-held OTC Monitor II uses a touch-pad keyboard to enter data and

interpret the signals it receives from a variety of sensors throughout the engine. The sensors monitor such things as the carburetor-throttle position, coolant temperature, manifold vacuum, barometric pressure, vehicle speed, and the amount of oxygen in the exhaust gases.

The system then uses the data to control the air-fuel ratio. That's done by adjusting the mixture-control solenoid used in feedback carburetors or by changing the amount of time the injectors stay open on engines with throttle-body fuel injection.

When something goes wrong, the CCC records the error (actually a number that represents the error) in its internal memory and illuminates the dash light. It's then your job to get the number out and determine the cause of the problem. Using the conventional shop-manual method without one of the CCC testers, here are the steps you take:

- Check the part number of the programmable read-only memory (PROM) inside the ECM. (There are different types, and each contains specific engine calibrations.) For this, you must remove some trim under the dash to locate the ECM and remove its access cover.

- Warm up the engine so the CCC system enters its "closed-loop" mode. This means the sensors are being used to maintain the proper air-fuel mixture. (When the engine is cold, an

test requests. The results are displayed on a nine-digit alphanumeric display.

"open-loop" mode fixes the values for a rich mixture to keep the engine running.) There is no indication as to when the system enters the closed-loop mode, so you simply run the engine for about 15 minutes.

- Trigger the CCC self-diagnostic mode. This is done by installing a jumper wire between a ground and a "test" terminal located on an underdash connector called the ALCL diagnostic connector. (ALCL stands for assembly-line computer link.) The jumper connection commands the ECM to display its trouble codes by flashing the CHECK ENGINE light on the dash in a particular sequence. The first sequence is a single flash of the light followed by two quick flashes: A code of "12," according to the manual, means the CCC self-diagnostic function is working.

- Interpret the codes. The next series of CHECK ENGINE light flashes indicates the trouble code. In this case, a code of "45" was displayed. The CCC system shop manual has a list of codes, and each has a corresponding trouble-code chart. According to the chart, code 45 indicates a rich exhaust and recommends another test using a dwell meter.

- Perform independent tests. The chart then directs you to connect a standard dwell meter across the carburetor-mixture-control solenoid. With the meter set on the six-cylinder

*Continued*

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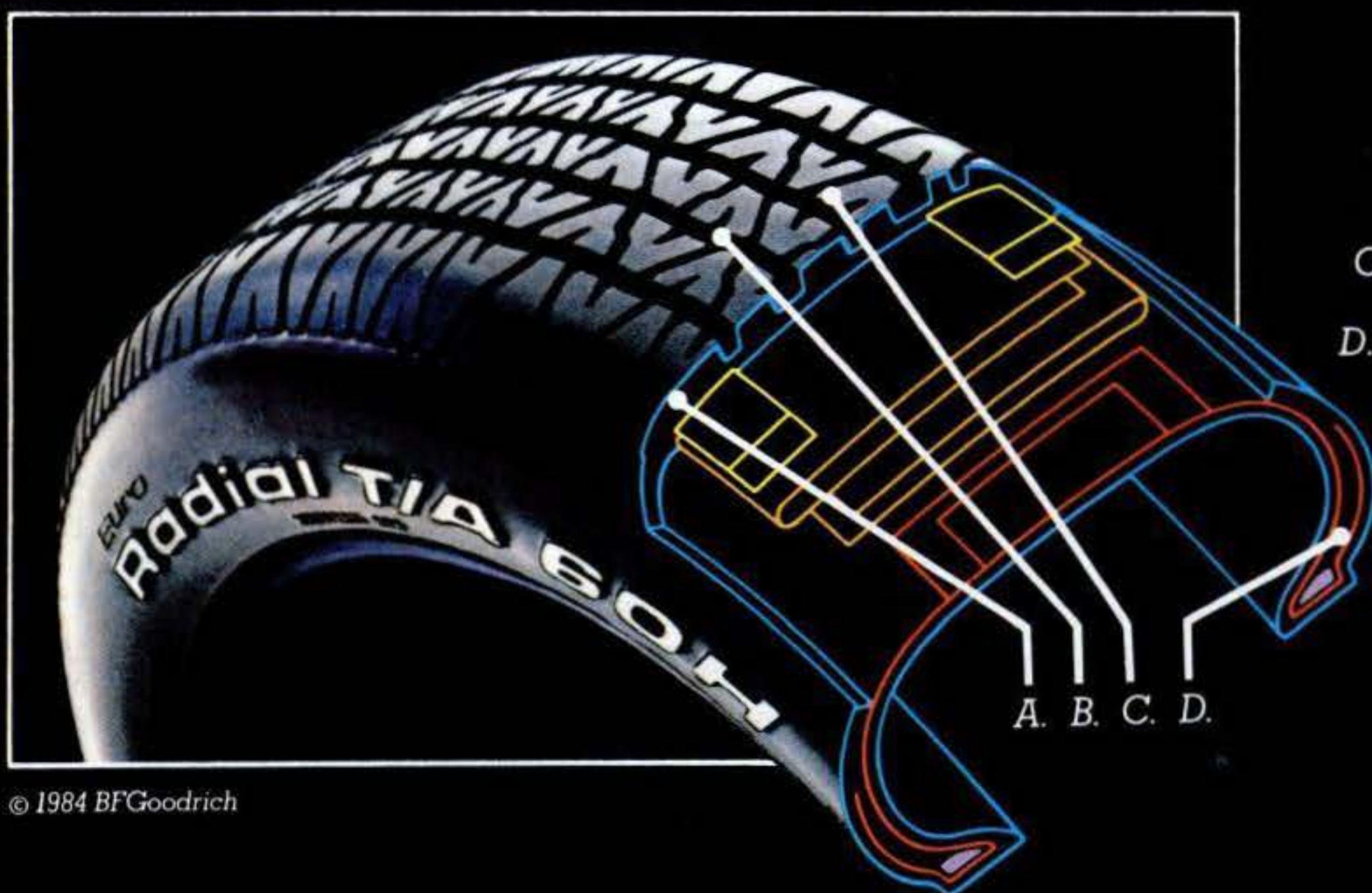
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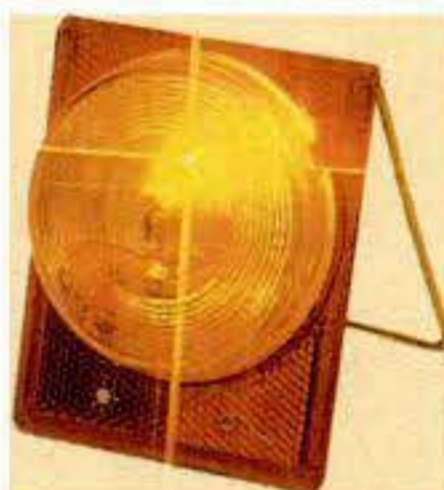
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scale and the engine running at 3,000 rpm, the reading should have been less than 50 degrees. The reading on the test Olds was more than 50 degrees. The next step on the chart directs you to remove a large vacuum hose to cause an air leak that will make the mixture leaner. That should cause a decrease in the dwell reading, indicating a carburetor problem or a disconnected wire at the mixture-control solenoid. But the dwell stood firm.

• Conduct the final test: The chart now says to disconnect the oxygen sensor and ground the connector terminal at the ECM. After doing so, the dwell dropped to below 10 degrees. Using a digital voltmeter, I checked the voltage on the lead from the ECM. It was less than 0.55 volts, indicating the trouble—at last—to be a faulty oxygen sensor.

### Again—with the Monitor II

The first tester I tried was the OTC Monitor II (model 3455) from the Owatonna Tool Co. The Monitor II is a rugged, hand-held tester with just two hookup leads: One plugs into the under-dash ALCL connector and the other into the cigarette-lighter socket for power.

When it's switched on, the tester

prompts you to SELECT C3 SYSTEM on its nine-digit fluorescent display. You use the key pad to enter the engine size and type of CCC system. The tester is then ready to accept your first entry.

Is the correct programmable read-only memory installed? I touched pad 2 on its membrane keyboard, and the correct part number was instantly displayed. There's no need to physically look at the PROM.

Is the system in its closed-loop mode? All it takes to find out is a press of touch-pad 3, and if it is, the tester displays the word CLOSED (something that I had to guess when using the shop-manual method).

Then I touched pad 1 for a look at the trouble codes. Code 45 displayed instantly without any of the bother of having to grope under the dash to jump the ALCL-connector test terminal.

Using the shop-manual method, trouble-code chart 45 calls for a test of the mixture control with a dwell meter. The dwell meter is not needed with this tester. Without moving from the driver's seat, you simply press mode 17. The tester then displays the engine rpm and the mixture-control dwell (in degrees).

Once again the dwell was over 50 degrees, and as before, I removed a large vacuum hose to cause an air leak. The Monitor II dwell-meter reading remained steady but dropped to less than 10 degrees with the ECM lead to the oxygen sensor disconnected and grounded.

The final step, as before, is to test the voltage at the disconnected ECM lead. I had hoped this would be just another press of a touch pad, but it's not. I had to use a digital voltmeter. Once again the reading was well below the minimum 0.55 volts, indicating the faulty oxygen sensor.

In all, the Monitor II has 23 modes that permit you to check some 47 parameters for five different CCC systems. At a touch, you can test such things as the coolant temperature, manifold pressure, carburetor throttle-position switch, air-divert doors, EGR and canister-purge solenoids, air-conditioner status, and a host of other more-complicated systems such as electronic fuel injection.

Without question, the tester cuts diagnostic time considerably, but its internal data must be updated to keep up with yearly changes in CCC systems. This means that the \$399 Monitor II must be modified at a cost of between \$129 and \$150 for it to accommodate the 1984 CCC systems. But by the time you read this, OTC promises a Monitor IV that will test everything, including all 1984 systems.

### Brainmaster

The Brainmaster model 3200, from Alltest Inc., is smaller in size and price than the Monitor II—it's \$250. The unit has two slide switches, a 10-position rotary switch, and a seven-position rotary switch to select the type of system and the specific test. Its three-digit LED display is larger and easier to read than the nine-digit display used on the Monitor II.

I found I needed more-frequent references to the operating instructions to use the Brainmaster. However, it's capable of easily displaying the trouble codes and performing basic functions such as checking the throttle-position-sensor voltage, the oxygen-sensor voltage, mixture-control dwell, rpm, and coolant temperature.

If you make a mistake in entering data, you see a puzzling three-dash (---) display. (Monitor II uses a more helpful ERROR display.) A lingering "888" means the tester is receiving a signal that doesn't compute.

The Brainmaster will not perform the more-exotic tasks such as displaying the PROM number, but it does the most important tests by checking 33 separate parameters.



Changes for 1984 model cars have also caught up with the Brainmaster; it will be updated in model 3210 to accommodate the newest systems. Older units can be modified at the factory. There is also an optional adapter to cover 1980½ cars.

### Multi-Scanner/Mini-scanner

Next I tried the \$399 Multi-Scanner model 3818 from Micro Processor Systems Inc. (also marketed by Kent Moore Corp.) This is not a hand-held model. Instead, it's mounted in an impact-resistant plastic carrying case that's about the size of an electric-drill case. The unit attaches to the car in the same way as the previous testers except that it has an extra extension cord. This allows you to place the unit on the fender with all the connections in place—a useful feature for tests requiring a lot of work under the hood.

It's the most elaborate of the testers. It will tap 47 operating parameters on GM systems through 1984, including the CCC systems on Isuzu trucks. In addition, it has an adapter kit (No. 2511) that makes it possible to use the unit on 1980½ vehicles equipped with the 1981 CCC system.

I found most of the Multi-Scanner's tests quite useful, but some of them you will likely never use—such as the third- and fourth-gear-switch tests, which only apply to cars with a standard transmission. And because of all that flexibility, I found it a bit more difficult to use.

As on the other testers, the Multi-Scanner has a backup mode for use on a fuel-injection system when the ECM has failed. The tester takes over the work of the ECM, providing injector pulses synchronously with the high-energy-ignition distributor reference signals as diagnostic tests are being done.

Micro Processor Systems also offers a hand-held CCC tester, the \$265 model 5247 Mini-scanner. It also has a backup mode and will test 1980½ vehicles with an optional adapter. It is, however, limited to just 32 operating parameters and will not display the PROM number.

The Mini-scanner covers 17 different computer systems that must be selected by properly setting four multi-position slide switches. Of the hand-held units, it is more complicated to operate than the Monitor II, but it's on a par with the Brainmaster. To test my 1981 Olds, for instance, no year selection is required. But to test a 1982 or newer car, you have to use the air-mode switch. Use of this meter requires particularly careful attention to the instruction manual.

### PS buyer's guide to computer command testers

Features	Brainmaster model 3200 \$250	Mini-scanner model 5247 \$265	Monitor II model 3455 \$399	Multi-Scanner model 3818 \$399
LED display	•	•		•
Fluorescent gas			•	
Trouble codes	•	•	•	•
Dwell	•	•	•	•
Hand-held	•	•	•	
Vehicle speed	•	•	•	•
Engine rpm	•	•	•	•
O <sub>2</sub> sensor	•	•	•	•
MAP/Baro.	•	•	•	•
Backup	•	•	•	•
PROM ID			•	•
Ignition switch			•	•
3rd- & 4th-gear switch			•	•
Throttle status	•	•	•	•
Loop status		•	•	•
Membrane touch pads			•	
Rotary switch	•			•
Slide switch	•	•		
Carrying case	•	Optional	•	Integral
1984 CCC		•		•
Parameters	33	32	47	47

There is no question that any of these testers is a tremendous improvement over the shop-manual method for diagnosing problems. For the serious do-it-yourselfer, I'd suggest either the Brainmaster or the Mini-scanner. For the professional, I would suggest a look at the Multi-Scanner or the Monitor II, with updates to handle the

newest systems. Any of the testers, however, will dramatically reduce the time and effort it takes to diagnose a CCC malfunction. **PS**

#### MANUFACTURERS OF CCC TESTERS

Alltest Inc., 715 S. Vermont, Palatine IL 60067; Micro Processor Systems Inc., 7641 19 Mile Rd., Sterling Heights MI 48078; OTC Tools and Equipment, Div. of Owatonna Tool Co., Eisenhower Dr., Owatonna MN 55060

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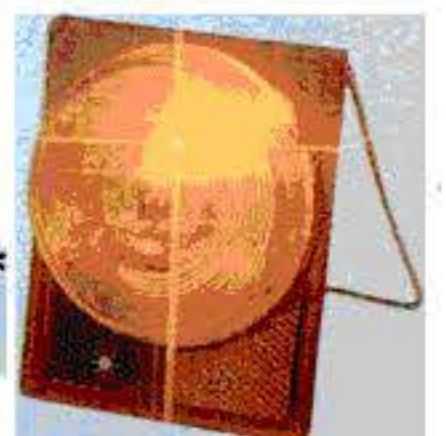
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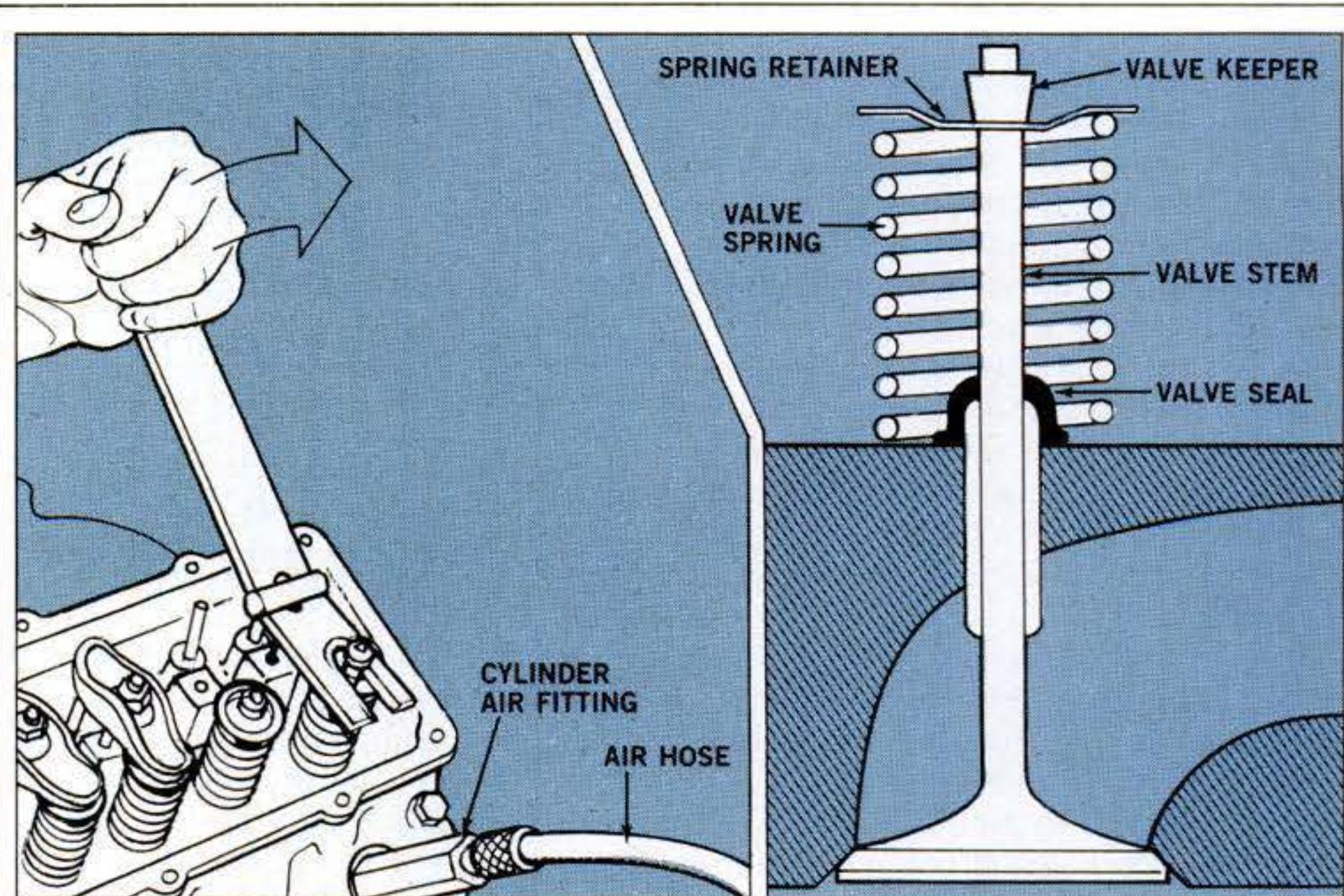
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# Taking Care of Your Car

By STEVE MERCALDO

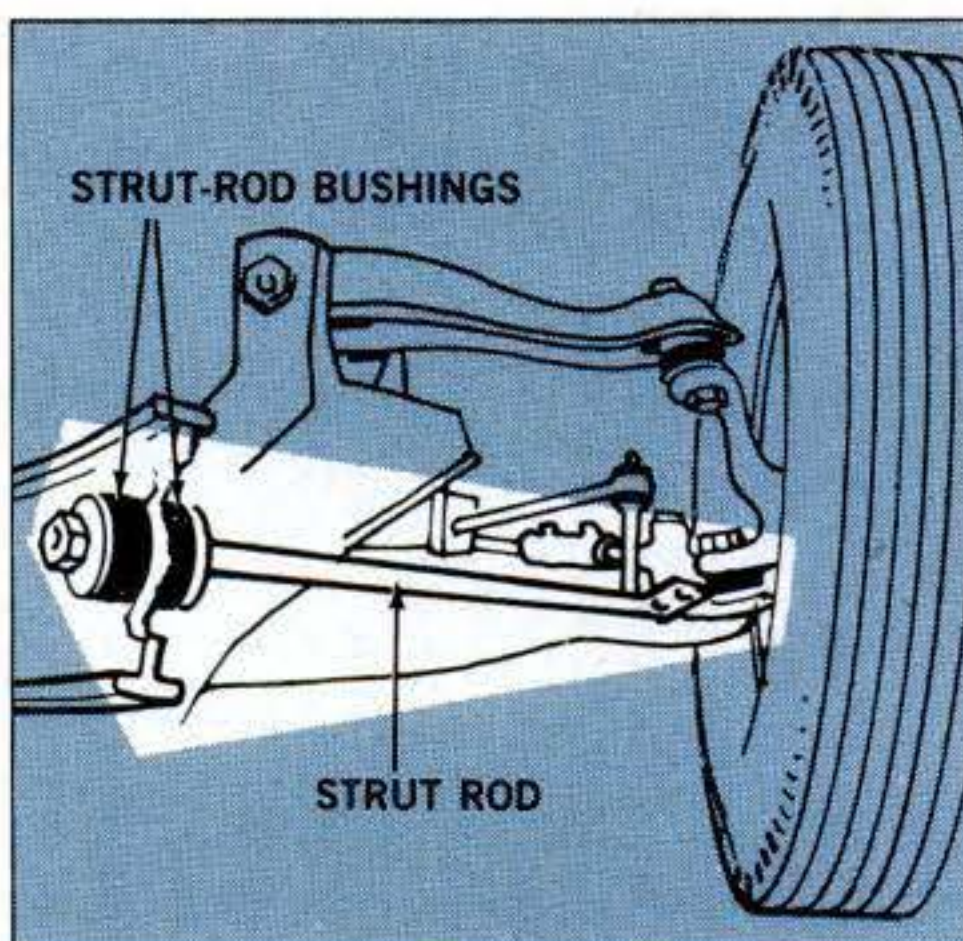
Got a useful car tip? Send it (with Social Security No.) to Car Care, POPULAR SCIENCE, 380 Madison Ave., New York, N.Y. 10017. We'll pay \$50 if we use it. If two or more readers send the same tip, payment goes to the one with earliest postmark. No tips can be returned.



## Valve-seal fix

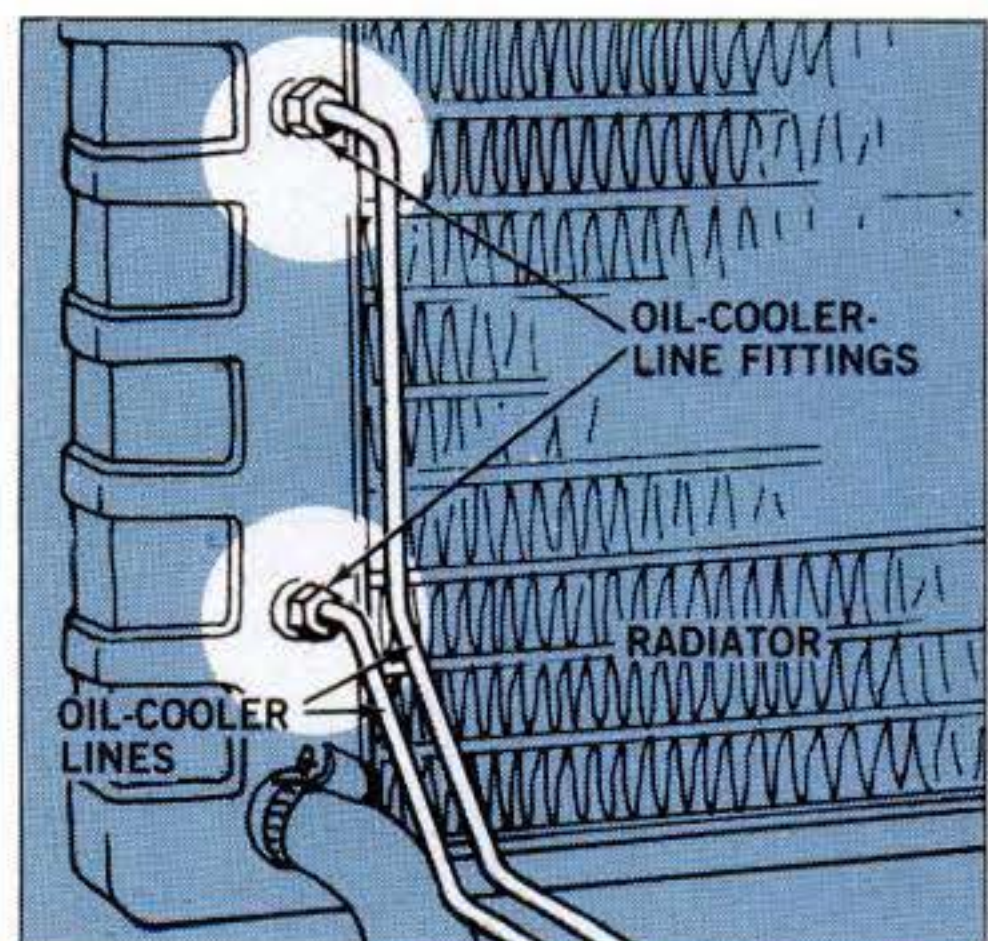
Worn engine valve seals can cause excessive oil consumption. But the repair procedure involves holding the valve in position while the spring and keepers are removed—tricky without the right tools. Try this: Screw a special air fitting (available at the local auto-parts store) into the spark-plug

hole before starting the repair. Crank the cylinder to top dead center. This will close both the exhaust and intake valves. Then couple the fitting to a compressor line carrying at least 20 psi. The air pressure will hold the valve in place during the fix. Then remove the keeper and retainer.



## Front-end noise

Banging or clunking in the front end—noticeable when braking or turning—is often caused by damaged strut-rod bushings. To check: Jack and support the vehicle or drive onto repair ramps, but do not let the wheels leave the ground. Inspect each strut-rod bushing. Replace worn or torn bushings that don't support the strut rod.



## Overfill cure

Adding too much automatic-transmission fluid can damage your transmission, but most automatics have no drain plug. The solution is simple: Loosen one of the oil-cooler lines at the radiator, and place a drain pan beneath it. Place the transmission in park, and start the engine. The fluid will leak from the loosened fitting.

*Continued*



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 CHECK BLOW-BY/COMPRESSION

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**TRANSMISSION REPORT**  
 TESTS INDICATE ABNORMAL UNIT WEAR  
 CLUTCH WEAR  
 OIL COOLER LEAKING  
 DRAIN OIL  
 INSPECT CLUTCHES  
 CHECK OIL COOLER  
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You take care of your car, change oil regularly, and have routine maintenance performed. You treat your vehicle like the fine machine it is. **Whether you do the repairs or pay for the work done, you need the least expensive and most efficient methods** used by large corporations and governmental agencies — having engine oil and transmission oil undergo spectroscopic analysis. Then you will know what should be done and can tell your mechanic what is needed. No more unnecessary, costly work!

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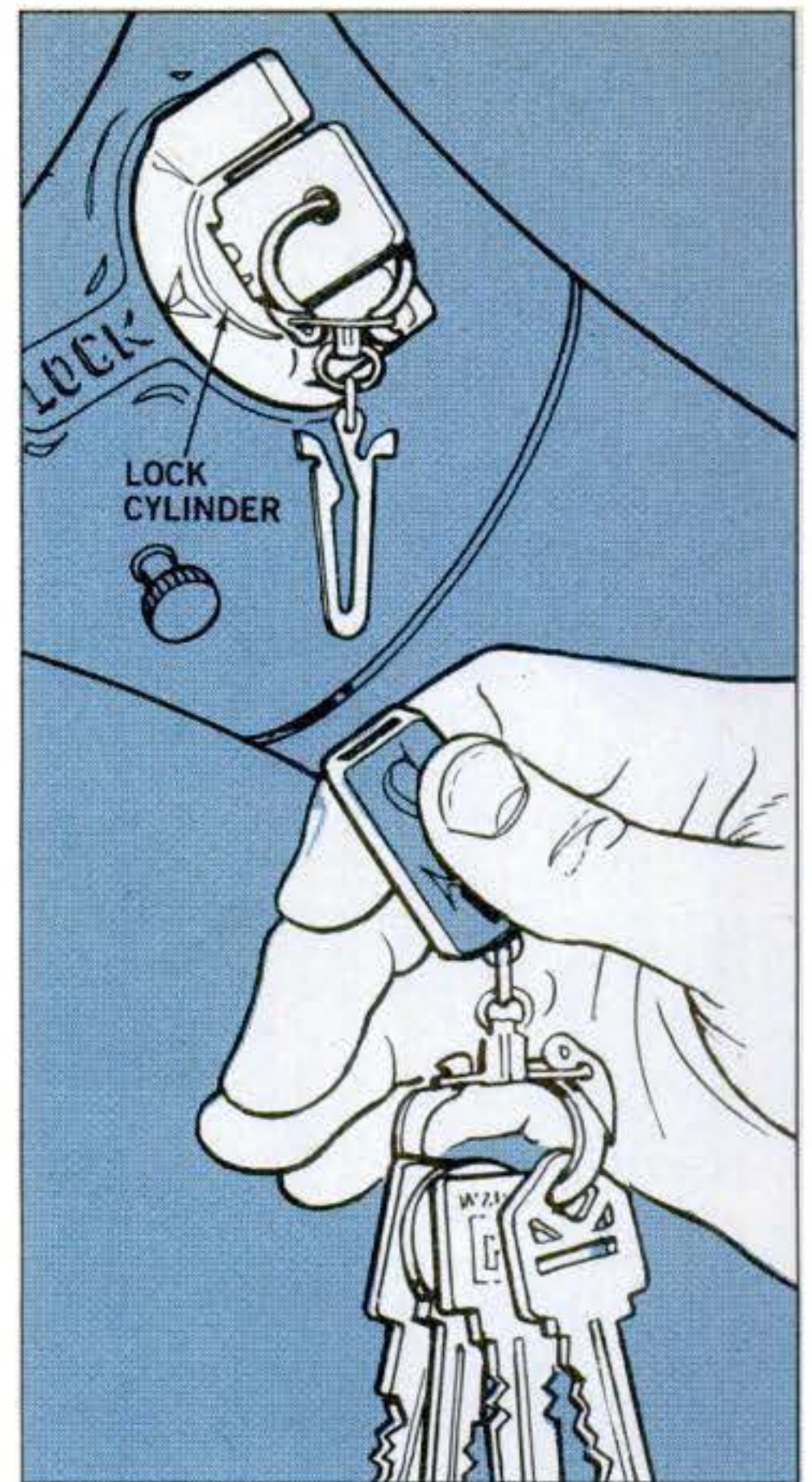
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Check No. of Kits Ordered	Price
<input type="checkbox"/> 1	\$18.95
<input type="checkbox"/> 2	\$35.00
<input type="checkbox"/> 3	\$51.00
<input type="checkbox"/> 4	\$67.00

Sub-total \$ \_\_\_\_\_  
 Add \$2<sup>00</sup> per kit for shipping & handling \$ \_\_\_\_\_  
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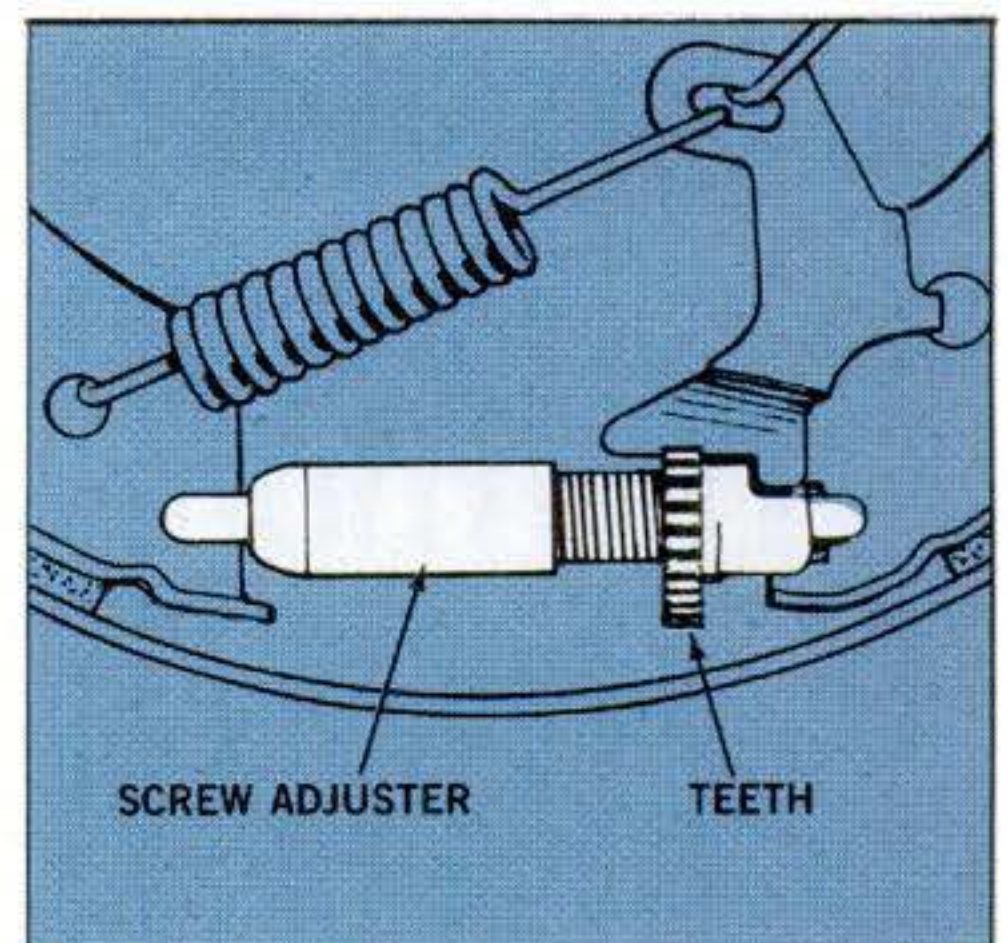
How many of the tests ordered are for aircraft? \_\_\_\_\_

**Taking Care of Your Car**



**Key trouble**

Does your ignition key hang on a heavy ring with lots of other keys? In time, the excess weight may damage the tumblers and ruin the lock cylinder. Here's good advice: Keep your ignition key on a separate, detachable ring to avoid this problem, which could eventually leave you stranded.

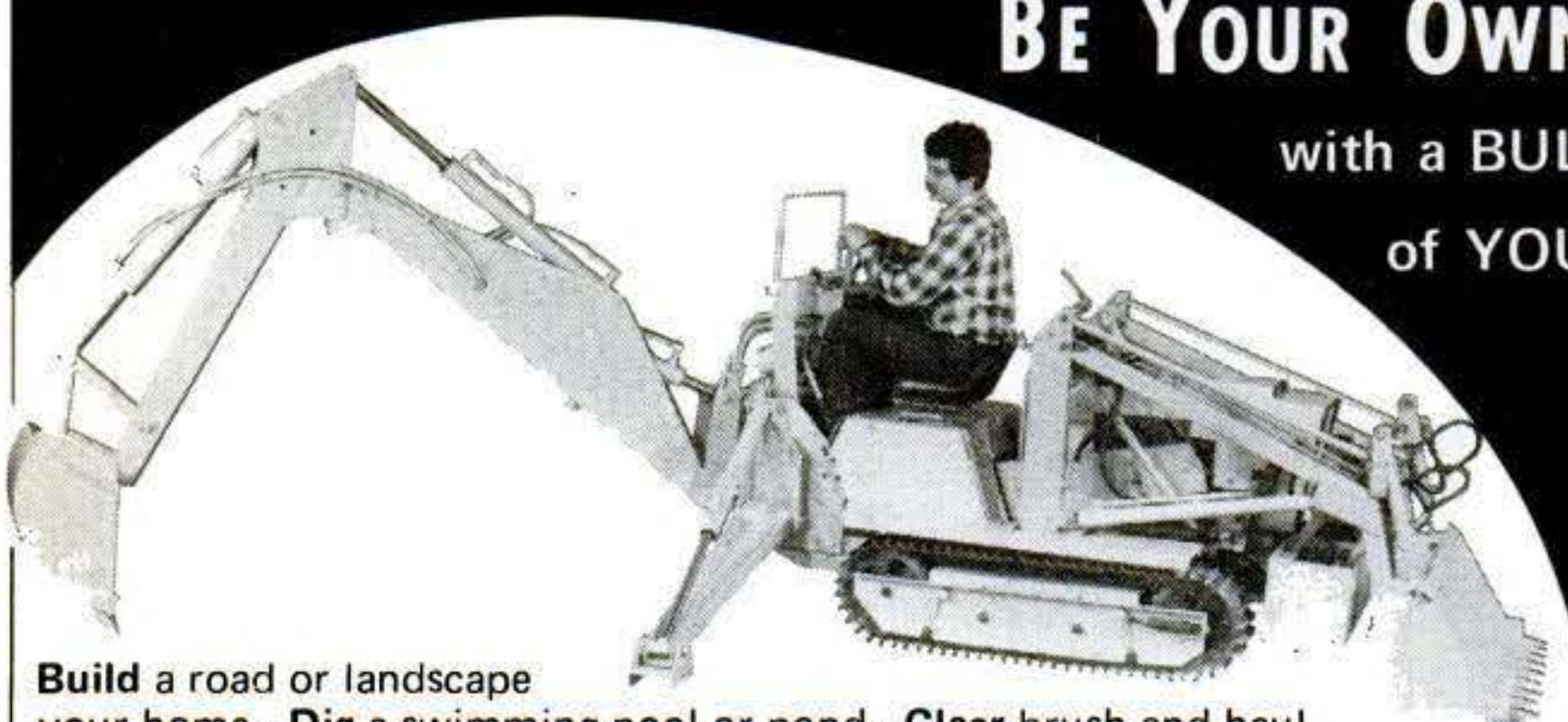


**Low brake pedal**

A low brake pedal on a vehicle with self-adjusting drum brakes can be caused by a star-wheel adjuster with worn or missing teeth. If you find a damaged adjuster, remember to ask at your local auto-parts store for a left adjuster for the driver's side and a right adjuster for the passenger side. They're stamped with an L or R.

**BE YOUR OWN BOSS**

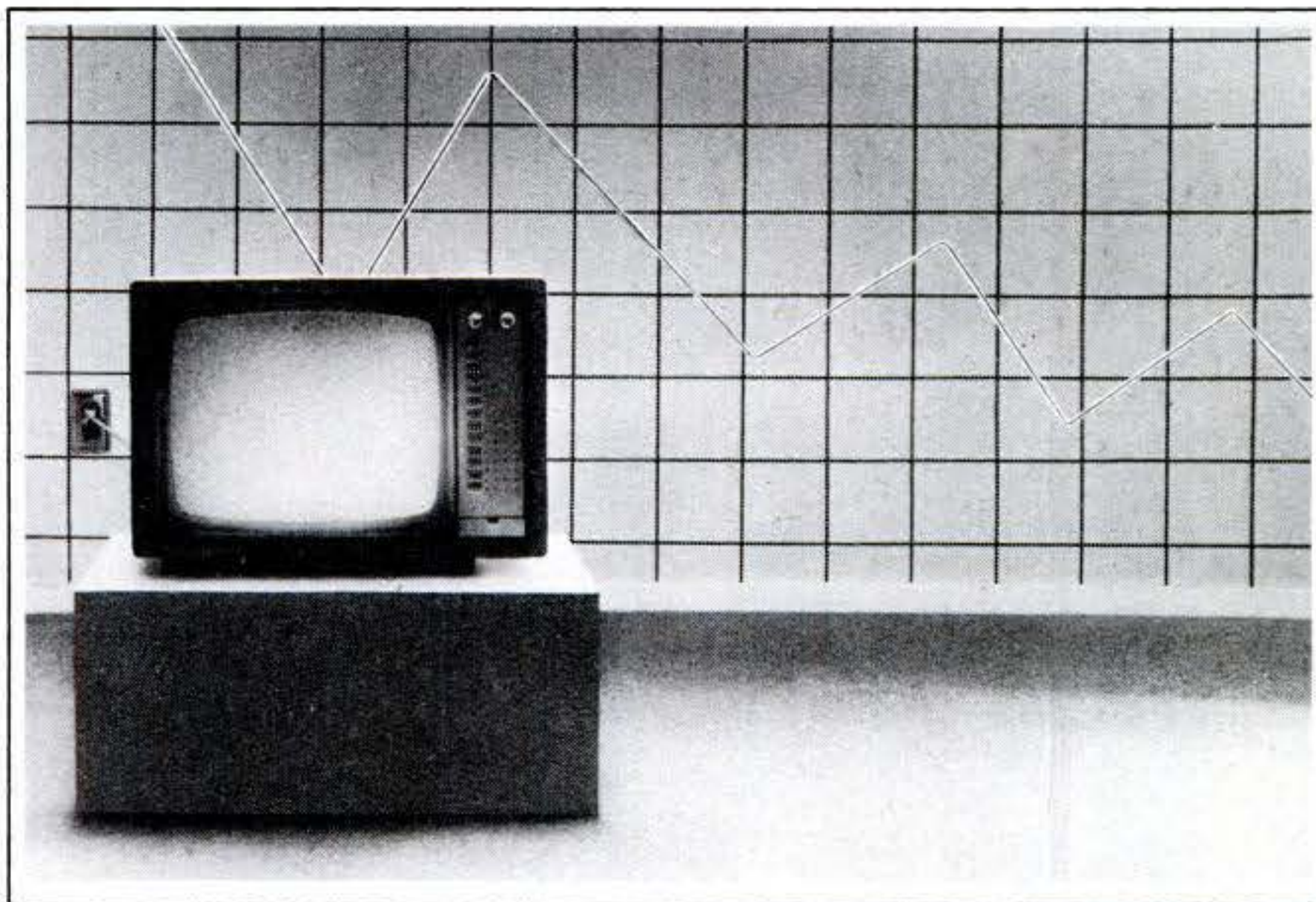
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Many advertisers are worried. They know that people who aren't watching network aren't watching the advertising either. They can't advertise to people watching most pay-cable stations. And they can't afford to lose this affluent group.

That's why many of them are realizing it pays to channel more money into magazines.

Magazines can reach people where networks fall short. In homes with VCR's. In homes with video games. And in homes with cable.

In fact, a recent survey points out that magazine readership is strongest in homes with 36-channel cable. These homes just happen to be the ones that watch network the least.

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SPRNG TQ 500  
3 ENTER  
09/14/8:  
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# A tune-up helps make sure they're split-second right.

As Mr. Goodwrench explains, "At 55 miles per hour, an 8 cylinder car or truck makes about 8,000 explosions per minute. And the more precise they are, the better performance you get.

"That's what a tune-up is about. Perfect timing. You see, for 8,000 explo-

sions, your engine needs 8,000 perfect gulps of air, 8,000 perfect sips of gas, and 8,000 perfect sparks of electricity less than a tenth of an inch long. One of each—per cylinder—per six-hundredths of a second. That splits it pretty fine. And everything has to happen at the exact split second it's needed.

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## The brake battle

I've performed three front-disc-brake repairs on my 1978 Subaru without success. The last time I had both rotors turned, and all three times the rotors were warped. I have attempted to avoid the problem by torquing the hub mounting bolts to only 25 ft.-lbs. Also, I've tried to reduce disc-brake squeal by smearing a thin layer of non-hardening gasket compound on the back of the brake pad. The man who machined the rotors told me to expect them to warp because they are too thin.

Jim Holmes, Jewett City, Conn.

*Brake rotors absorb energy, and if the rotor is too small and can't absorb the energy, it gets too hot. It is then possible that it could change dimensionally. Your rotors are too small, and hard driving will deform them. You're right about the wheel bolts; over-tightening is a big problem—watch it. As for brake squeal and its cures, be sure your cure can stand 700 degrees F because the brakes get that hot. The best defense against noise is good lining material, good rotor-surface condition, and holding the things involved tight enough to resist resonance—or damping to move the frequency out of range.*

## Gasohol—curse or blessing?

My mechanic does not recommend gasohol; he says that his association published data about possible carburetor contamination and corrosion because alcohol attracts water and forms acid. Can you enlighten me on this?

Walter W. Kunde, Quinlan, Texas

*Gasohol is a Band-Aid for detonation. I've been against it from the start and have caught hell about it. It oxidizes and attacks aluminum, steel, iron, and pot metal. It's going to cost this country a ton from now on, but for a real horror story, check with someone in Brazil, where they use straight alcohol. Gasohol also dilutes a car's oil and plugs all the small orifices.*

## Ping and its causes

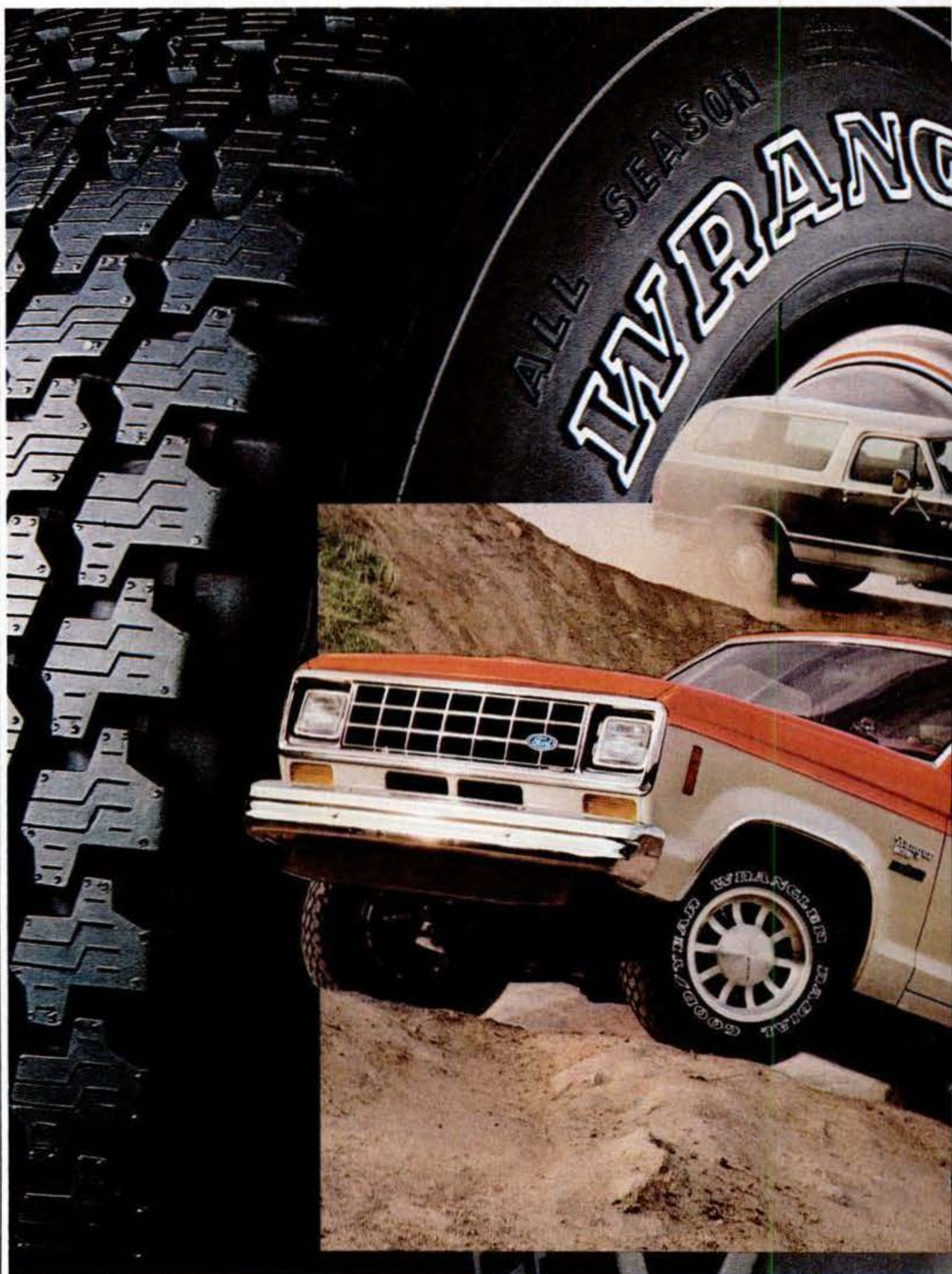
I first noticed pinging in my 1981 Honda Civic at about 5,000 miles, and

it persists now, at 18,000 miles. It's always present, even when the engine's warm and accelerating moderately. I've tried different brands of premium unleaded fuel, a tuneup and new plugs,

dealer engine analysis, timing setback, water-vapor injection, and a compression check, which showed 180 psi in all cylinders. Could it be caused by an air leak around the intake manifold? How could I find it? Could it be caused by the carburetor or valve adjustment?

Tim D. Eaton, Saginaw, Mich.

*In the Otto-cycle engine, preignition, ping, and detonation are all caused by the same thing—loss of control of the*



**WRANGLER RULES THE ROAD.**



burning reaction of liquid carbon and air. The causes vary, but here are some of the more-common ones: ignition timing too advanced, compression too high for the fuel, and carbon or a gasket or sharp-metal exposure in the combustion chamber that acts as a glow plug. Loss of control appears proportionate to air and fuel temperature and elevation. Leanness aggravates loss of control, and the octane rating is extremely important. I think your trouble is mostly incorrect ignition advance, not static

setting. I also believe you're running too lean. An air leak at the manifold can cause the lean condition—sometimes in one particular cylinder. Find it either by a manifold-pressure check or by an external addition of oil to the suspect area and watching for smoke coming out of the tailpipe. Valve adjustment can influence ping to a minor extent because it can vary valve timing and increase or decrease compression. Cars ping because today's engines need 105-octane fuel, although

the fuel's not available. Why are engines designed this way? Emissions and mileage are helped by lots of compression and timing advance. You're caught in the middle.

### Doesn't make the grade

At about 60 mph under full throttle—as when I go up a slight grade—my 1979 Chevette suddenly slows down, sputters, and misses. Three or four trips to the dealer, \$150 for a carburetor overhaul, and checking the timing, fuel pump, filters, and EGR haven't helped.

Marvin Schuldenfrei, Bethesda, Md.

*I'd suggest a check of the fuel-tank cap, canister, and venting. Look for a vacuum in the tank that's fighting the fuel pump. Do an eyeball examination of the tank's fuel-pickup filter, and check the metal fuel line leading to the fuel pump to see whether it's being heated by the exhaust system and building up vapor.*

### Power-steering dropout

My 1978 Plymouth Horizon with power steering frequently reverts to non-power steering during moderately sharp right and left turns. There's a slight improvement at higher temperatures, but a new power-steering pump hasn't helped.

Rosalie Oleson, Denver, Colo.

*Go back to the dealer. I suspect a small internal pressure leakage at the pinion-valve sealing rings. The temperature increase probably swells the seals and reduces leakage.*

### Pressure problems

My 1976 Chevrolet Suburban with a 350-cu.-in. engine has 47,000 miles on it and runs fine. But when the engine warms up, oil pressure drops to zero at idle speed. The gauge shows 30 to 35 pounds at higher speeds, and I've checked to make sure the gauge is OK. Also, I've changed the oil pump, cleaned the pan, and changed oil and filter. I'm wondering about the cam bearings, but short of disassembling the engine, what else should I look for?

Howard Miller, Alexandria, Va.

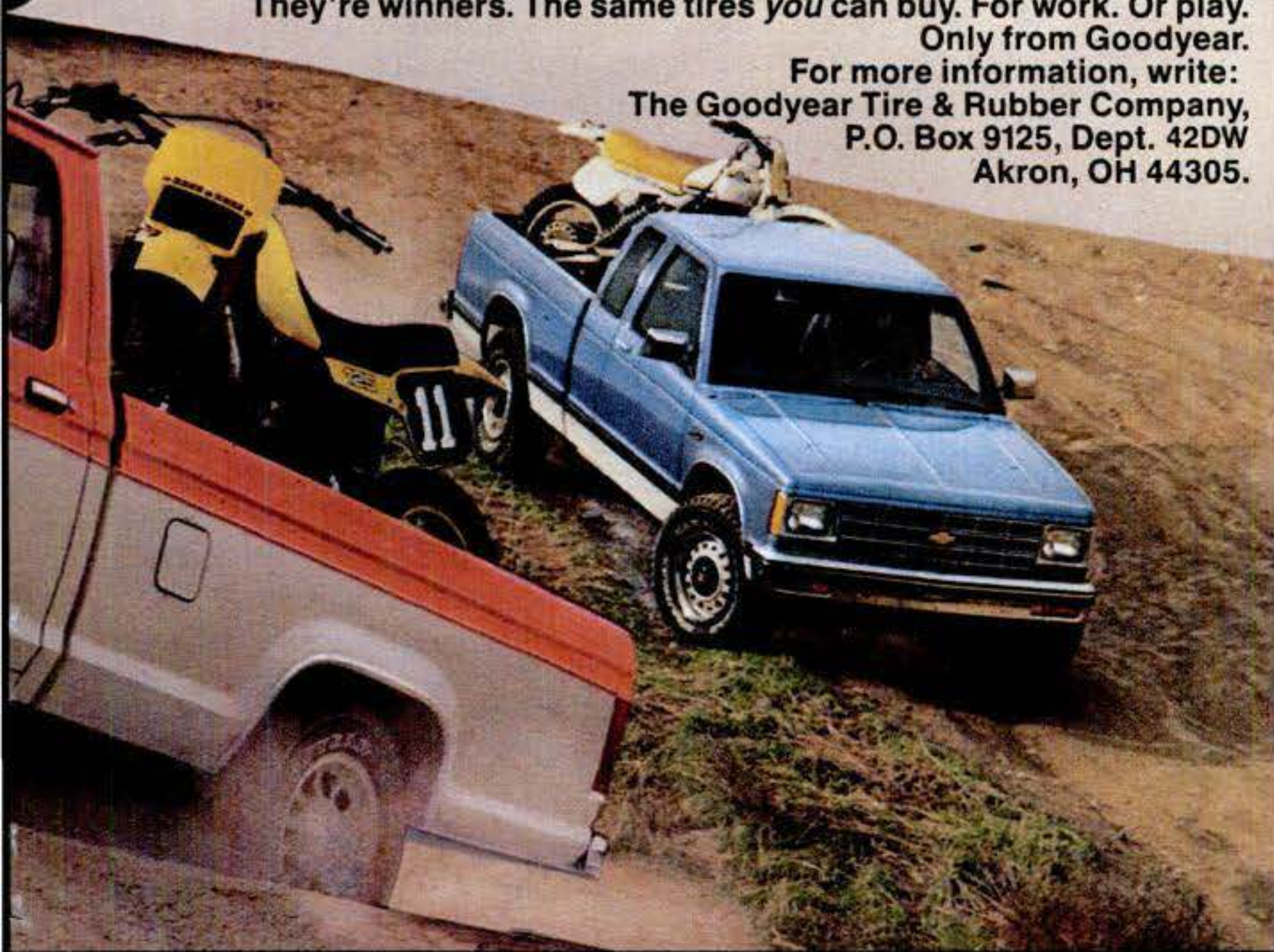
*I don't know of any easy way to look, but the rear cam bearing could be installed short of specs and be bleeding oil. The best check is to pull the pan and hook up an oil-pressure tank. Look for a big drain-off. There's a Welsh*

*Continued*

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## "Say, Smokey—"

*plug under the rear main-bearing cap that might have been left out in a previous repair. In any case, the pressure test should show any major leaks.*

### Noisy transmission

My 1983 Ford Escort has a built-in siren in its automatic transmission, especially when it downshifts to low gear. Also, the shifts themselves are not very smooth. Is this normal?

Woody Nadeau  
Hibbing, Minn.

*I'm afraid that you'll have to replace the planetary-gear set to get rid of the noise. The original gears probably have handling marks or a rough finish. The shifts should become smoother with an accurate adjustment of the throttle-valve linkage; the procedure must come by the numbers from the appropriate Ford service manual.*

### Add a vane blower?

I've been wondering about getting a vane-type supercharger blower. I've heard that they're popular in England. I've also heard that Bendix is going to market a supercharger of the vane-blower type. What's your opinion?

Ray Jackson, Marshfield, Mo.

*My preference, by far, would be a turbo-charger. Vane blowers are an attempt to remove lag and get an early entry of artificial aspiration, and they are complicated and space-consuming units. As I understand it, Bendix threw in the towel on its attempt.*

### Water on the engine

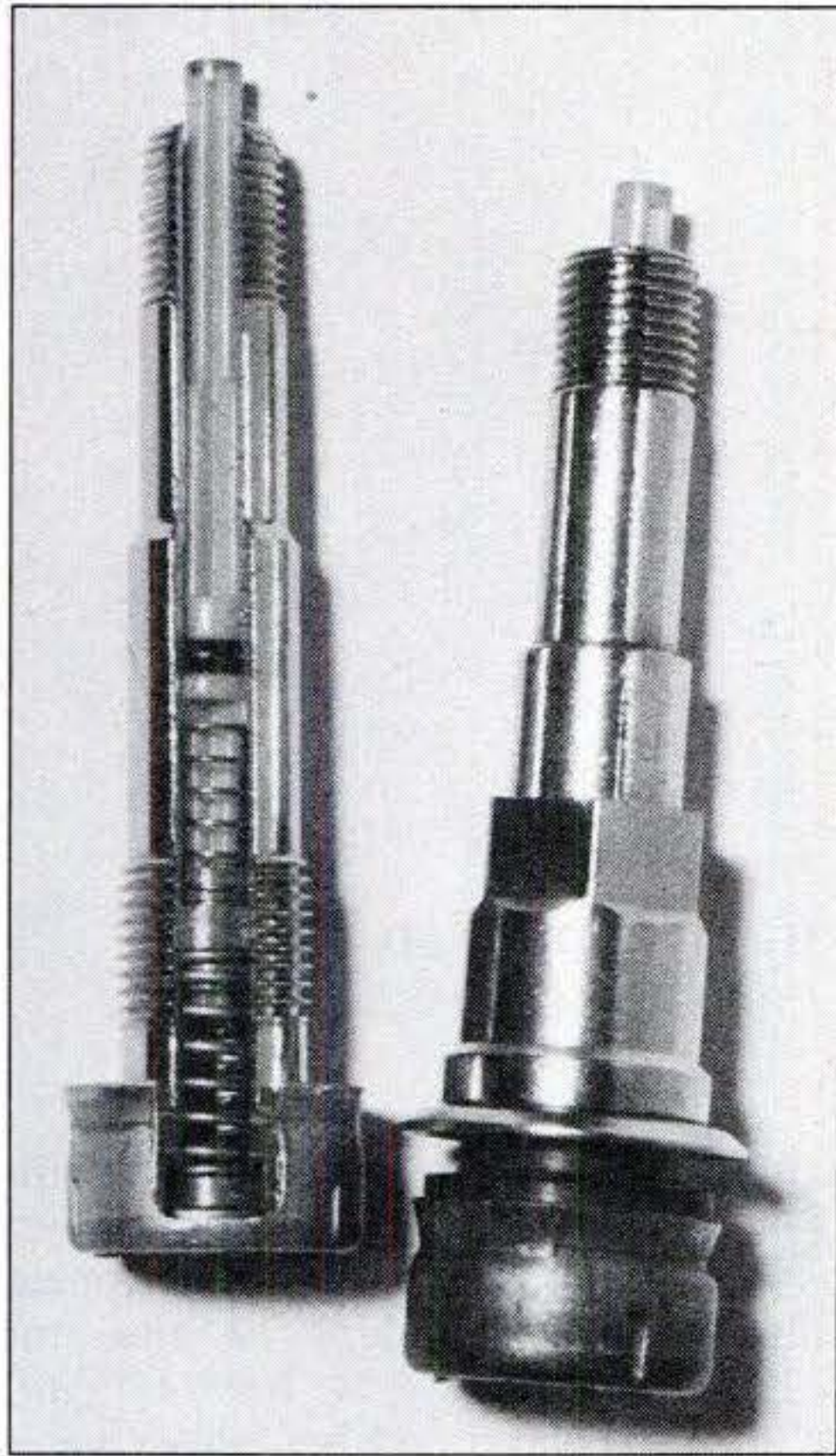
My 1966 Plymouth Sport Fury with a 318-cu.-in. engine is still in mint condition with 93,000 miles on the odometer. Lately, though, it's been developing moisture in the engine that condenses on the dipstick, PCV valve, and oil-fill cap. When I drain the oil, it doesn't appear to have water in it. A hot-cold pressure test shows no leak in the cooling system. Where does the moisture come from?

Shirley J. Howard  
Portland, Ore.

*Check the engine's crankcase-venting system. Too much or too little venting can cause a big moisture buildup.*

Got a car 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 not selected for publication.

## Tire-pressure tattletale



Ever inspect the squat-looking sidewall on a radial tire and try to decide whether the tire was under-inflated? Now a new tire valve developed by the Schrader Automotive Group (2000 Richard Jones Rd., Nashville, Tenn. 37215) makes it easy to spot a leaking tire.

Inside Red Alert is a bright-red pin. If pressure drops below 21 psi, the pin pops up inside the tire valve's clear plastic cap. You need only walk around the car and look for a tripped pin. You inflate or deflate the tire just as you would with a standard valve. Ford is offering it as an option on the new Lincoln Mark VII.

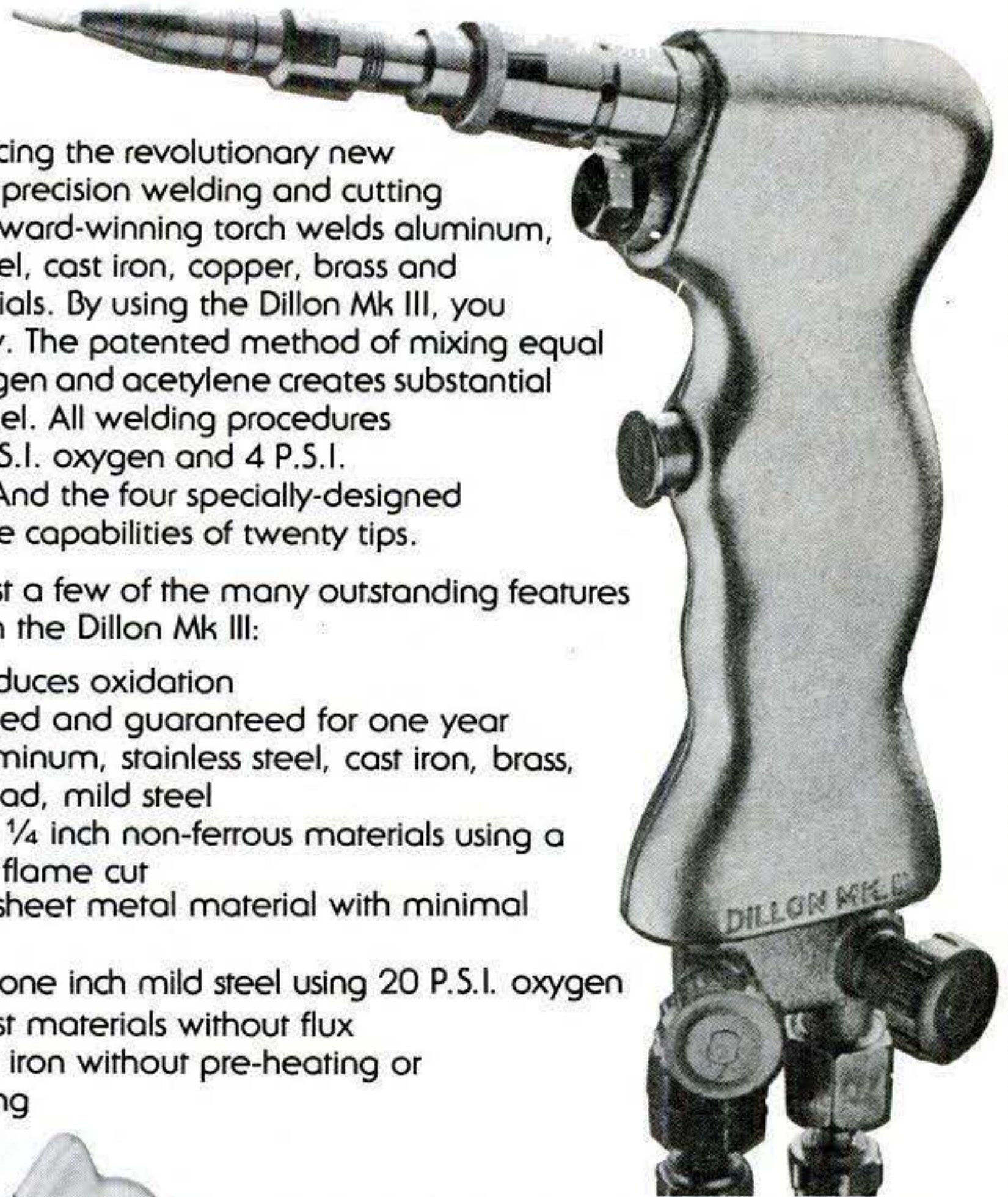
The valve comes in two sizes—two-inch (TR 414) for compacts and sub-compacts and 2½-inch (TR 418) for intermediate and full-size cars. According to Schrader, it incorporates the first basic change in the tire valve since 1896; it has no valve core. The primary sealing means is located inside the rim, not at the end of the valve stem. And there are only four moving parts. Because pressure is monitored within three psi, Red Alert can extend the life of radials and improve fuel mileage, says Schrader.—*Jack Keebler*

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# Cordless phones —portable, convenient, and now... reliable?

Millions of cordless phones now battle for the airwaves, and the resulting interference problems render many phones unusable. A new generation of improved portables, additional channels, a shift in operating frequency, and digital coding can protect your investment—and your privacy.



By **GORDON MC COMB**  
Photos by *Greg Sharko*

One month ago, Steve York could hardly wait to bring his newly purchased cordless phone home, plug it into his telephone line, and call around the world. Now, he can't wait to return it, get his money back, and forget the whole nightmare. "After trying three different models and wasting a lot of time," York confesses, "I have come to the conclusion that cordless phones aren't what they're hyped to be."

Does this mean you should forget the idea of owning a cordless phone? Not at all. It means that depending on where you live, you need to carefully consider the features included in the model you choose—features that are becoming more common, including digital coding to prevent unauthorized use, voice scrambling to add a measure of privacy, and user-switchable frequencies to prevent interference. What's more, the Federal Communications Commission (FCC) is ready to approve the use of five more channels for cordless phones—so the problem of channel interference in highly populated areas ought to be roughly halved.

When are these extra features necessary and how much should you expect to pay for them? How long will you have to wait before you can buy

*Continued*

**Tiny switches on AT&T Nomad 800 select a specific digital code for secure operation between phone and base.**



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You can fumigate them, poison them, trap them, etc. But what do you do with those dead and unsightly things? And those poisons can be harmful to humans and pets. And pests can become immune to them. Bentley's knows a better way! DECIMATE 500C (the biggest unit) delivers an ultrasonic sound that cannot be heard by humans and pets. It is completely harmless. But it is another story to all those pests and varmints. It drives them looney! DECIMATE causes them extreme discomfort and pain. Would you take this kind of treatment? Heck no. And neither will they. In just a few weeks all those pests and varmints just leave and never come back.

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There is no longer any question that ultrasonic sound at the right frequency range and appropriate decible output is the most effective way of ridding your home or plant of pests and varmints. The question is: how do you tell the best product from the rest? Check those other units for the following features and see if they measure up to Decimate 500C.

Decimate 500C has an EPA (Environmental Protection Agency) establishment number and is approved by City Building and Safety Departments. It is listed by Underwriter Laboratories (UL).

Decimate 500C has an ultrasonic intensity output of 152db. United States Testing Laboratories proved it thousands of times more powerful than the next leading competitor.

Decimate 500C sweeps two levels of frequency from 25,000 to 65,000 Hz in each cycle. (Beware of units of low intensity and constant frequency). The overall efficiency of the unit is greatly enhanced with the changing frequencies. Decimate 500C protects 3,500 ft.<sup>2</sup> (25,000 ft.<sup>3</sup>). Other units may cover as little as 1500 ft. or less.

If those other units do not have all these important features that DECIMATE 500C has than you should not buy them. Buy the best, Decimate 500C. This product should

last for 10 years or more so why not get the best and the most powerful unit. And now, Decimate 500C also generates sound in the "infrasound" range. This is sound below humans and pets range of hearing that will be bothersome to even more pests than before.

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Models such as (l. to r.) AT&T Nomad, Uniden EX-6000, GE Voyager, and Webcor 512 are for densely populated areas.

one of the new 10-channel phones? Or if you buy (or have bought) one of today's five-channel models, will it be obsolete in the next few months?

I talked with leading telephone manufacturers and others involved in cordless phones to get the answers. I was surprised to learn, for instance, that the additional channels allotted to cordless phones by the FCC are only a temporary measure—one that may last less than five years.

### Three million problems

There are an estimated nine million cordless-phone owners in the U.S. today; an average of one out of every three—that is, three million consumers—experiences some of the same problems as York did. At issue:

- **Crowded airwaves.** Cordless phones make up more than half the dollar amount of today's consumer-telephone sales, which means a lot of people are attracted to the convenience of no-cord phoning. But this popularity also means a heightened chance of others

in your neighborhood owning cordless phones. Though models are currently available in any of five discrete frequencies, interference of one form or another between units is common when your cordless-equipped neighbors are within range of your phone—typically 1,000 feet or less.

Says York: "I estimate there are at least two other cordless-phone owners in my immediate neighborhood. When they use their cordless units, all I get is a screeching hiss in mine."

- **Ghost ringing.** The popularity of cordless phones also means that calls meant for your neighbors can be picked up by your handset, and vice versa. "On many occasions," York laments, "I answered my phone, but the call was for my neighbor." There needn't be other cordless phones around for false rings, however. Because cordless units use the airwaves for communication, stray signals from just about any source (CB radios, fluorescent lights, etc.) can cause the unit to ring when no call is being made.

"The second phone I got rang and rang while it was still in its box," recalls York. "It was ringing without the base plugged into my phone line—something it wasn't supposed to do. I half expected E.T. on the other end. No one was there, of course, just a lot of static."

- **Theft of service.** The typical cordless phone lacks any kind of foolproof anti-piracy circuitry. The result: It is technically feasible for someone in your neighborhood with a cordless-phone handset to activate your base and call out through your telephone line. When the handset captures the dial tone, any phone in the world is fair game—on your bill, of course.

- **Loss of privacy.** Cordless phones use standard transmission and reception techniques, which means that nearly anyone with another cordless phone, an all-band radio receiver, or a VHF scanner (such as that used to receive police and fire calls) can tune into your conversations.

*Continued*

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# CHEVY TOUGH IS TAKING CHARGE

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## Cordless phones

Basically, as I found out, all these problems come down into one of three groups: illegal use and false ring, interference, and privacy.

### Free rides and false rings

Theft of service, also called a "free ride," is the bane of the cordless-phone industry. "If I can pick up a dial tone from your base with my handset," Mort David of Mura Corp. told me, "I can call anywhere I like—at your expense."

Free rides are uncommon, the experts say, but for several years manufacturers have been building security devices into their phones to prevent such trouble. The earliest method was a simple switch that deactivates the base station when the handset is returned to the cradle. This is still in use, but because the handset is usually returned for recharging only, nearly every phone maker has added another anti-piracy scheme to the works: guard tones.

Guard tones are medium-frequency audio signals, usually between 3,000 and 5,000 hertz, that are sent between the remote and the base unit before or during a call. The tones are outside the 300–3,000-Hz bandwidth of the base-to-handset communications link, so they cannot be heard.

There are four guard-tone sets, so the combination of five channels and four tones means that there is a one-in-20 chance of two handsets being able to use each other's base. And the tones also eliminate false rings (your phone ringing on my calls). But guard-tone circuits are susceptible to distortion by radio interference, so problems between cordless sets in highly populated areas are still a good possibility.

"The only real solution to the free-ride-false-ring problem is digital cod-

ing, as found in our model 800," says Mura's David. With digital coding, the handset and base communicate with one another only after they have received the proper code. Models with digital circuitry, such as the Phone-Mate IQ-4200 and AT&T's Nomad 800, simply cannot work unless the correct code is sent. There's no problem of poor discrimination between tones; the digital sequence is quite distinct.

The complexity of the code can vary, however. The simplest technique, such as on the Radio Shack model ET-330, has a coding sequence that consists of only 16 possible combinations. That's plenty for less-dense areas, but other units, such as the Webcor Zip 512, have a sequence eight binary digits long, which provides for 256 different codes—more than enough for most uses. Even more-elaborate models, such as Mura's MP-800, have 4,096 or more permutations.

"The user selects the code," says David, "most often by setting a bank of miniature switches [see lead photo]. Set the switches in the base and handset alike, and the two must receive the same digital code from each other before a call can be made or received." The Mura MP-800 and Radio Shack ET-330 differ in that they are set by entering the desired code with the dialing key pad.

### Running interference

Although a digital code will prevent a base from ringing a remote unit or a remote unit from accessing a base, with only five channels available there's a good chance that two or more phones in close proximity will share the same transmission and receiving frequencies. The resulting interference can be anything from an annoying buzz to

overhearing the conversations of your neighbors.

"The FCC is scheduled to allot five additional channels for cordless-phone use," says FCC engineer Julius Knapp. "The 10-channel system should reduce the bulk of the interference problems for the next two to five years. The plan is to phase in these new 10-channel systems and require that no five-channel model be allowed to be built after October 1, 1984."

Most current phones are available with only one preset channel out of the five available. If you find your neighbor has a cordless phone that operates on the same frequency as yours, take the unit back and exchange it for one that works on a different channel. A few current models, however, such as Phone-Mate's IQ-4200, are switchable between two built-in channels. With two channels, you can choose the less offensive one with a flick of a switch.

Similarly, when 10 channels are available, it's likely that the earliest models will have only one or two channels built in. "But by year's end," Mura's David claims, "or perhaps by spring of 1985, we'll see phones that have electronic tuning for instant selection of all 10 channels. And beyond that, the higher-end models will automatically search for the cleanest channel among the 10 before establishing the base-to-remote link."

Along with five new channels, the frequencies used by cordless phones will change to some extent, too. At present, cordless units use two frequency sets: The base transmits to the remote phone at 1.7 MHz and receives signals at 49 MHz.

"The new phones will keep the five channels in the 49-MHz range, and

*Continued*

## PS buyer's guide to full-featured cordless phones

Brand	Model	List price (\$)	Range (ft.)	Special features						Dial type		Security features			Comments	
				Inter-com	Remote charge	Call on hold	2-way page	Speaker	Multi-dial mem.	Tone	Pulse	Wall install	Mini/std.	Switch. channels		Digital coding
AT&T	700	169	50			X				X		S	—	X		Clock radio, code not selectable Pocket-sized, code not selectable Code-selectable Replaced Nomad 1000
	600	199	700	X		X	X			X		M	—	X		
	750	199	700	X		X	X	X		X	X	S	—	X		
Cobra	Nomad 800	319	700	X		X	X		X	X	X	S	—	X	X	Call-on-hold in base 49-49-MHz system
	CP-330	229	1,000	X	X	X	X			X	X	S	—	X		
Electra	4000	349	1,000						X	X	X	S	—	X		46-49-MHz system (tentative) 46-49-MHz system (tentative) 46-49-MHz system (tentative) 46-49-MHz system (tentative) 46-49-MHz system (tentative)
	750	139	1,000							X	X	S	—			
	1100	169	1,000				X			X	X	S	—			
	4000X	249	1,500			X			X	X	X	S	—	X		
	4500	319	1,500	X		X	X	X	X	X	X	S	2	X		
GE	5000	349	1,500	X		X	X	X	X	X	X	S	5	X		Replaceable nicad batts. in remote Base includes corded phone
	Voyager	199	1,000		X					X	X	S	2	X		
GTS	178	249	1,000	X	X	X	X	X	X	X	X	S	—	X		Base includes corded phone
Mura	MP-710/711	199	1,000	X	X	X	X	X	X	X	X	S	—	X		Base includes corded phone Same as 710, with voice synthesizer
	MP-800/801	249	1,000	X	X	X	X	X	X	X	X	S	—	X		
Phone-Mate	IQ-4200S	139	700		X					X	X	S	—	X		Remote-base pair Handset only Base only
	IQ-4220HS	99	1,000		X					X	X	S	5	X		
	IQ-4210T	90	1,000							X	X	S	5	X		
Radio Shack	ET-330	179	500	X			X		X	X	X	S	—	X		Tone warns at maximum range
Uniden	EX-2600	149	1,000			X	X			X	X	M	—	X		Flip-type remote Volume control for speaker on base
	EX-6000	269	1,000			X	X	X	X	X	X	S	—	X		
Webcor	512	289	1,000	X				X		X	X	M	—	X		Pocket-sized remote



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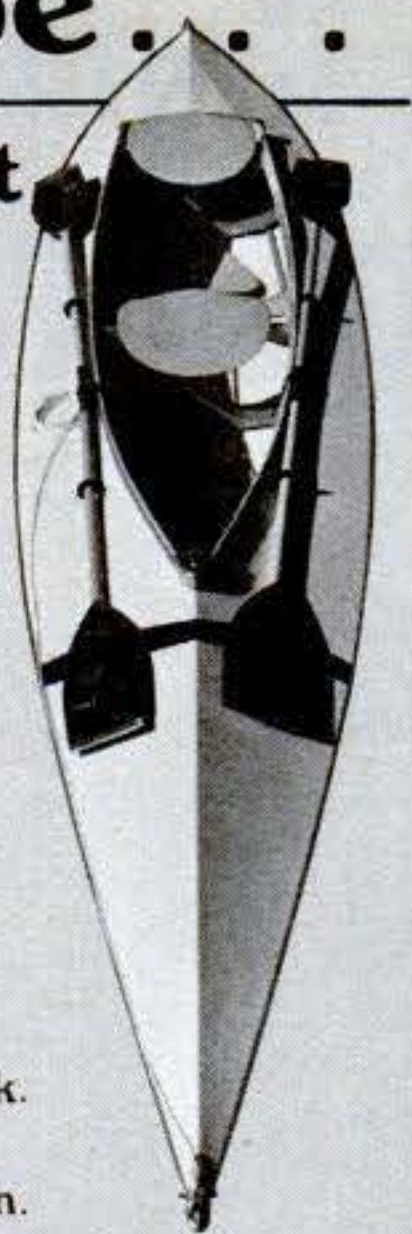
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## Cordless phones

five more will be added," Knapp says. "The 1.7-MHz frequencies will be dropped, however, and be replaced by 10 channels in the 46-MHz range."

The 46-49-MHz system has many advantages. Current phones with the 1.7-MHz channels use the AC wiring in a home or office for transmission. The range of a cordless phone is then limited to a great extent by the type of wiring and the materials used in the construction of the building.

"Wires encased in conduit or placed behind stucco and steel lath wreak havoc with cordless-phone transmissions," remarks Eric Schimmel of Electra. "The new 46-49-MHz system means that signals are transmitted and received by the base via a telescopic monopole antenna. No longer will the range claims of cordless phones be so dependent on wiring and building construction."

Schimmel believes that the move to paired 46-49-MHz frequencies also means better FM capture ratio, which further prevents phones from interfering with one another. Capture ratio is the ability of a radio receiver to distinguish the strongest signal from the weakest.

Suppose you and your neighbor both have one of the new 10-channel 46-49-MHz cordless models, says Schimmel, "but both operate on the same frequency. The FM circuitry in your phone will cancel any signals from his phone, because your neighbor is farther away and it's the weaker signal. The same holds true for his phone: The signal from your base and remote are weaker and are blocked out by his equipment."

Two phones, the AT&T Nomad 800 (and model 1000, which has been replaced by the 800) and the Electra model 4000, already bypass the 1.7-MHz problems by using two channels in the 49-MHz range. The 49-49-MHz multiplexed system used in these models enables them to have the same benefits as the planned 46-49-MHz phones. However, it's likely the FCC will mandate that they can no longer be manufactured once the new changes are in effect. You'll be able to use the telephone you may have already bought, though.

"We want to make it clear," says the FCC's Knapp, "that the old five-channel and 1.7-MHz phones will not become obsolete. They can't be sold after October 1 if the new regulations are accepted, but they can be used indefinitely thereafter."

## Legal phone tapping

"Always assume your cordless phone is being 'tapped,'" says Sam Simon, director of the Telecommunications

Research and Action Center in Washington, D.C. "Never use it for private conversations—family secrets included."

Cordless phones use standard radio transmissions that can be intercepted in a variety of ways: with another cordless phone, a conventional all-band radio, or a scanner.

For most of us, the threat of eavesdropping is moot: We have nothing to hide (well, almost nothing), and the people listening likely are strangers we'll never know or meet. But sensitive information, such as calling-card numbers and credit or bank accounts, and such personal data as health and accident information can be abused if they fall into the wrong hands.

As of now, the only cordless phone that scrambles the communications between the base and handset is the AT&T Nomad 800. (Naturally, AT&T won't say how it's done.)

"All of the major cordless-phone manufacturers are working on sophisticated voice-scrambling techniques, particularly those that use digital encryption," Mura's David says. "We have to make the design secure but not so costly that the phones become prohibitive to consumer use. But I predict voice scrambling will be common on high-end models within the next year or two."

A year or two? Does that mean many more changes are to come? You can bet on it.

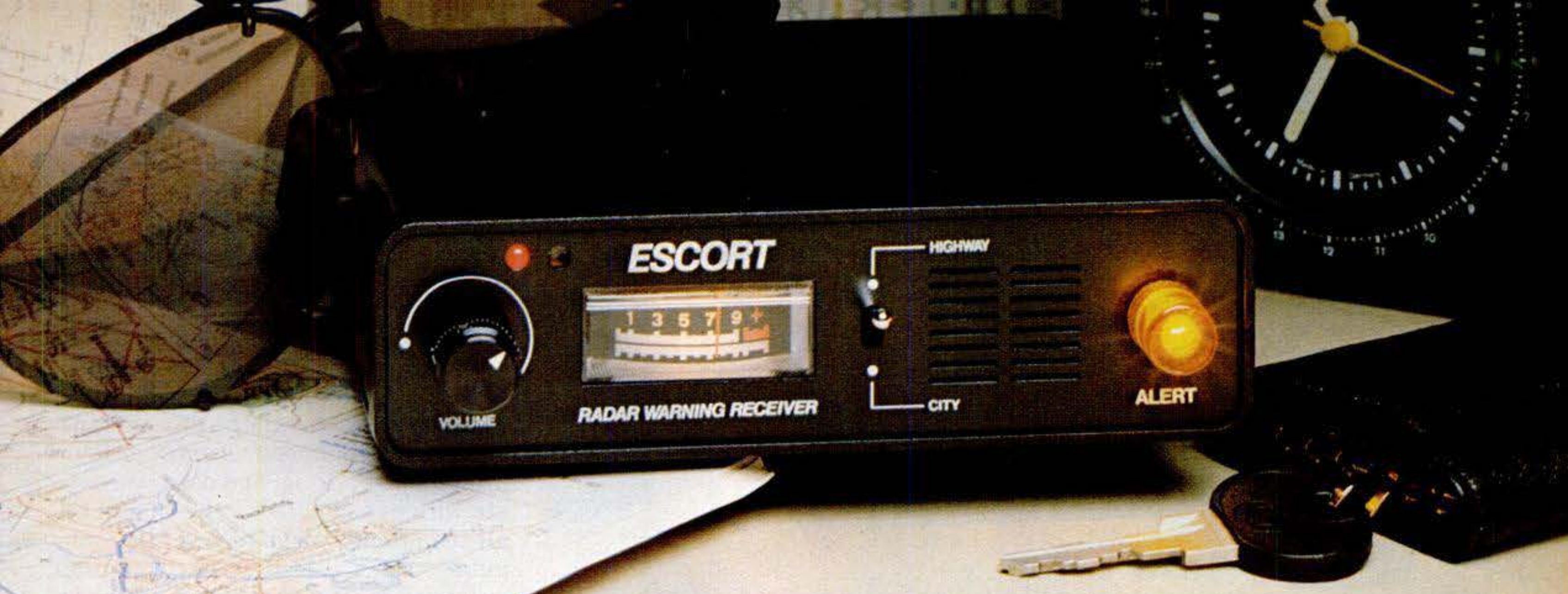
"The new cordless-phone frequencies are really being borrowed from a government band, and the FCC is calling this an 'interim allotment,'" says Electra's Eric Schimmel. "The FCC and the industry are talking about the allotment lasting five years."

"When the population of cordless phones gets to be about 30 million," adds Mura's David, "we'll likely have to move on to a totally new frequency band—perhaps up to 900 MHz."

The phone industry and the FCC agree: No matter what band is used, it, too, may only last a few years until a replacement is needed. Big trouble? I don't think so. After all, there are currently 80 million U.S. households equipped with a phone line, and all are potential customers for a cordless model. Those are a lot of reasons for more solutions. **PS**

## CORDLESS-PHONE MANUFACTURERS

AT&T Consumer Products, 5 Wood Hollow Rd., Parsippany NJ 07054; Cobra/Dynascan Corp., 6460 W. Cortland, Chicago IL 60635; Electra, 300 S. County Line Rd. E., Cumberland IN 46229; General Electric Audio Electronics Products, Electronics Park, Syracuse NY 13221; Mura Corp., 177 Cantiague Rock Rd., Westbury NY 11590; Phone-Mate, Inc., 325 S. Maple Ave., Torrance CA 90503; Radio Shack, One Tandy Center, Fort Worth TX 76102; Uniden Corp. of America, 6345 Castleway Dr., Indianapolis IN 46250; Webcor Electronics, Inc., 28 S. Terminal Dr., Plainview NY 11803



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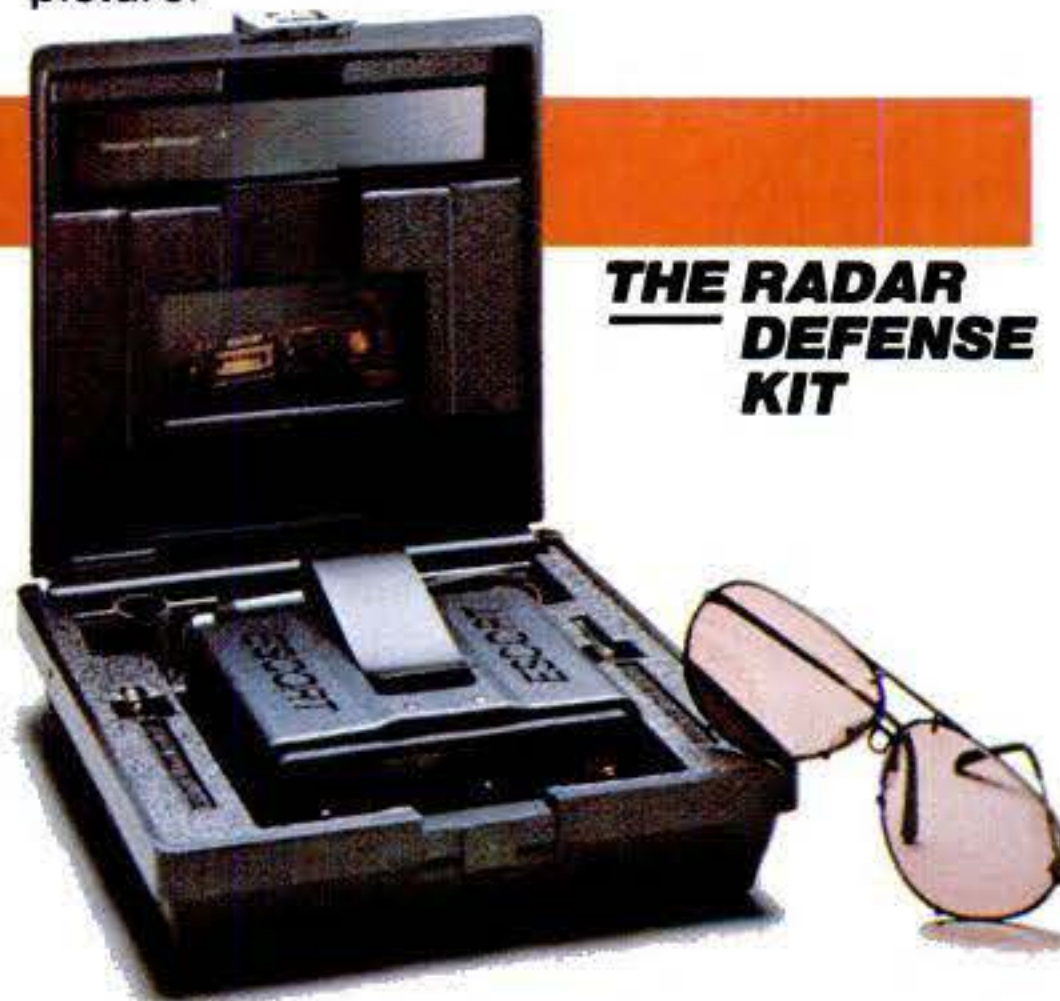
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To use the word-processing program, for example, I needed only to plug in the CapsuleWord module and begin tapping the keys. I could store my text permanently on disk, or even in the machine's RAM memory, because the memory is always supplied with power unless the rechargeable nickel-cadmium batteries are removed or are dead.

Gavilan's programs are designed to work with each other. You can instantly switch among as many as four programs at a time, and data you create with one module can be shared by all the others. What's more, the computer makes use of several pre-programmed function keys when running the integrated programs. Want help, for instance? Just press the HELP button. You're greeted with a series of questions you can ask the machine, such as "Where am I?" or "What just happened?"

Flanked by the function keys is a rectangular touch panel. The panel acts as a cursor-positioning mouse: When I moved my finger over it, the cursor moved in the same direction. The panel senses both direction and speed: As I moved my finger slowly to the right, the cursor slowly danced to the right, one character at a time. When I flashed my finger across the panel, the cursor zipped to the right, jumping words at a time.

Each side of the floppy microdisk used with the Gavilan holds up to 360 kilobytes of data. Flip the disk over, and you can store another 360K. The 3.5-inch size of the disk means lots of data are packed in a small area, and the plastic-outer-jacket design makes the microdisk nearly indestructible.

Gavilan's 64K of RAM is housed half inside the machine and half on a 32K memory-expansion capsule that fits into the same slots used by the integrated applications programs. (The Gavilan is advertised as having more RAM memory than 64K, but not all of it is available to the user.) For many programs, excluding the ones that come with the computer, you'll need more than 64K, however. Solution: Add three more 32K RAM packs—at \$350 apiece—for a total of 160K inside and out. Or you can add an optional external 3.5-inch drive (\$1,245) that contains another 128K of memory.

Other accessories include a 3.5-inch microdisk drive without memory (\$695), a 5¼-inch floppy drive that reads IBM PC-formatted disks (\$595), and a 50 character-per-second thermal printer (\$985). All three accessories attach to the rear of the computer and make automatic electrical contact. The computer also has a video output jack to connect a monitor that gives a 24-line display. **ES**

## COMPUTER REVIEW

# Lap-sized portable

Keyboard, display, disk drive, mouse, printer, and integrated software: They're all built into the fold-up Gavilan computer, which works for eight hours on a battery charge.

By GORDON MC COMB

**W**hen I first saw the Gavilan (rhymes with javelin) at last year's National Computer Conference, I wasn't impressed. Its 11-inch-square-by-three-inch-high body—no larger than a notebook—seemed much too small to contain a worthwhile business computer. I admit my error.

Packed into the nine-pound package from Gavilan Computer Corp. (240 Hacienda Ave., Campbell, Calif. 95008) is a complete, full-size typewriter-like keyboard with a numeric key pad, an 80-character-by-eight-line liquid-crystal display (LCD), a double-density microdisk drive, an 8088 microprocessor, 64K of user RAM, a built-in auto-answer/auto-dial modem, and a standard RS-232C serial interface. Oh yes, and enough battery power to keep it all working for up to eight hours without using the included

AC adapter. The unit's price: \$3,995.

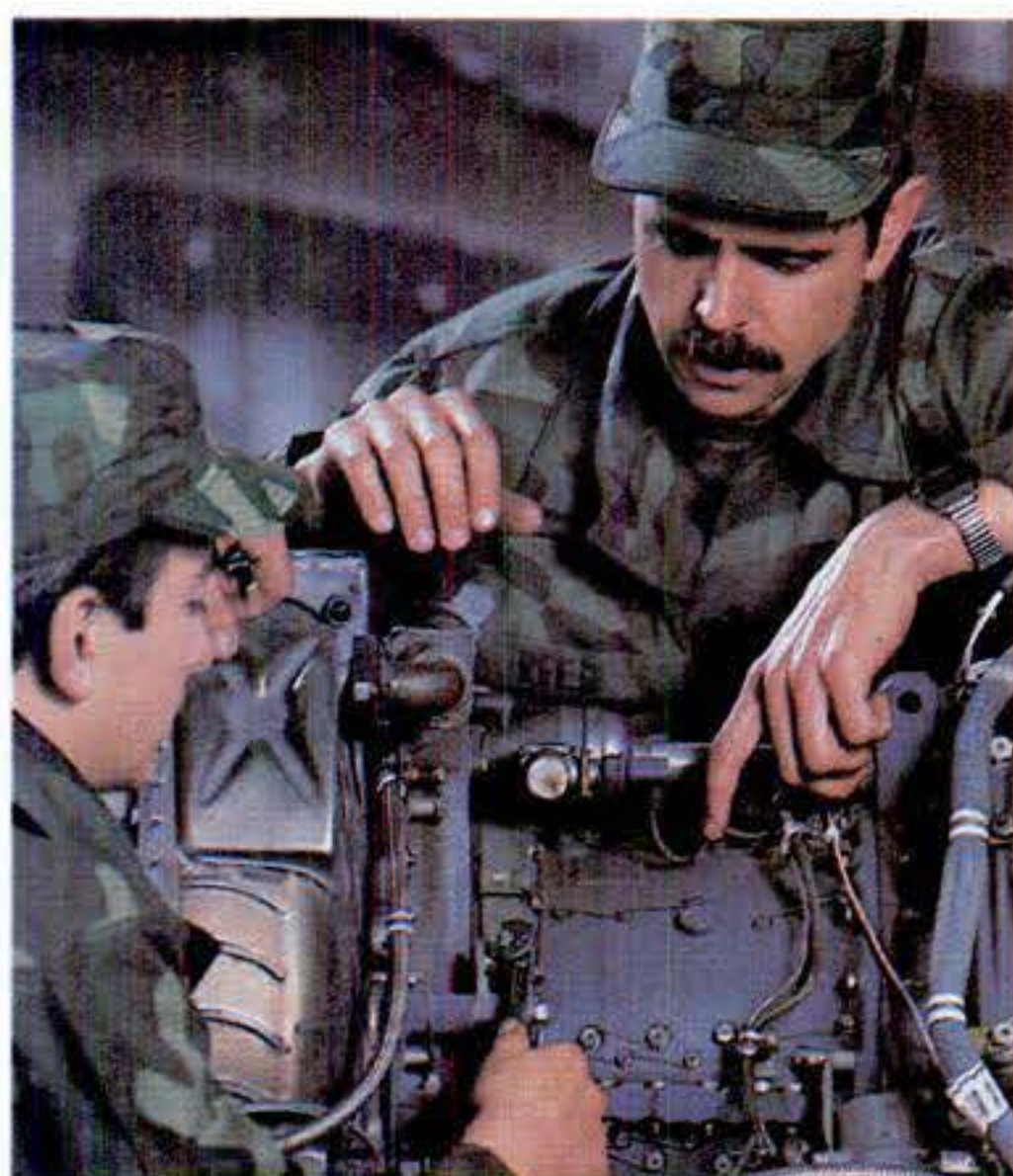
There is no power switch on the Gavilan; you simply pop the top cover to reveal the keyboard and display. After a few seconds, the computer beeps, and the LCD comes to life.

The Gavilan works under the MS-DOS operating system, allowing it to run many programs designed for the IBM PC, although some tailoring is required. (Gavilan sells special copies of WordStar and SuperCalc2, for instance, that have been rewritten to better fit the 80-by-eight display.)

Along with MS-DOS, the Gavilan comes with its own proprietary operating system and a set of five integrated, business-oriented applications programs: word processing, spreadsheet, data communications, portable secretary (appointment book), and forms processing (good for salesmen). Each program is contained in its own "capsule" that plugs into one of the four expansion slots located under a door on the top of the computer.



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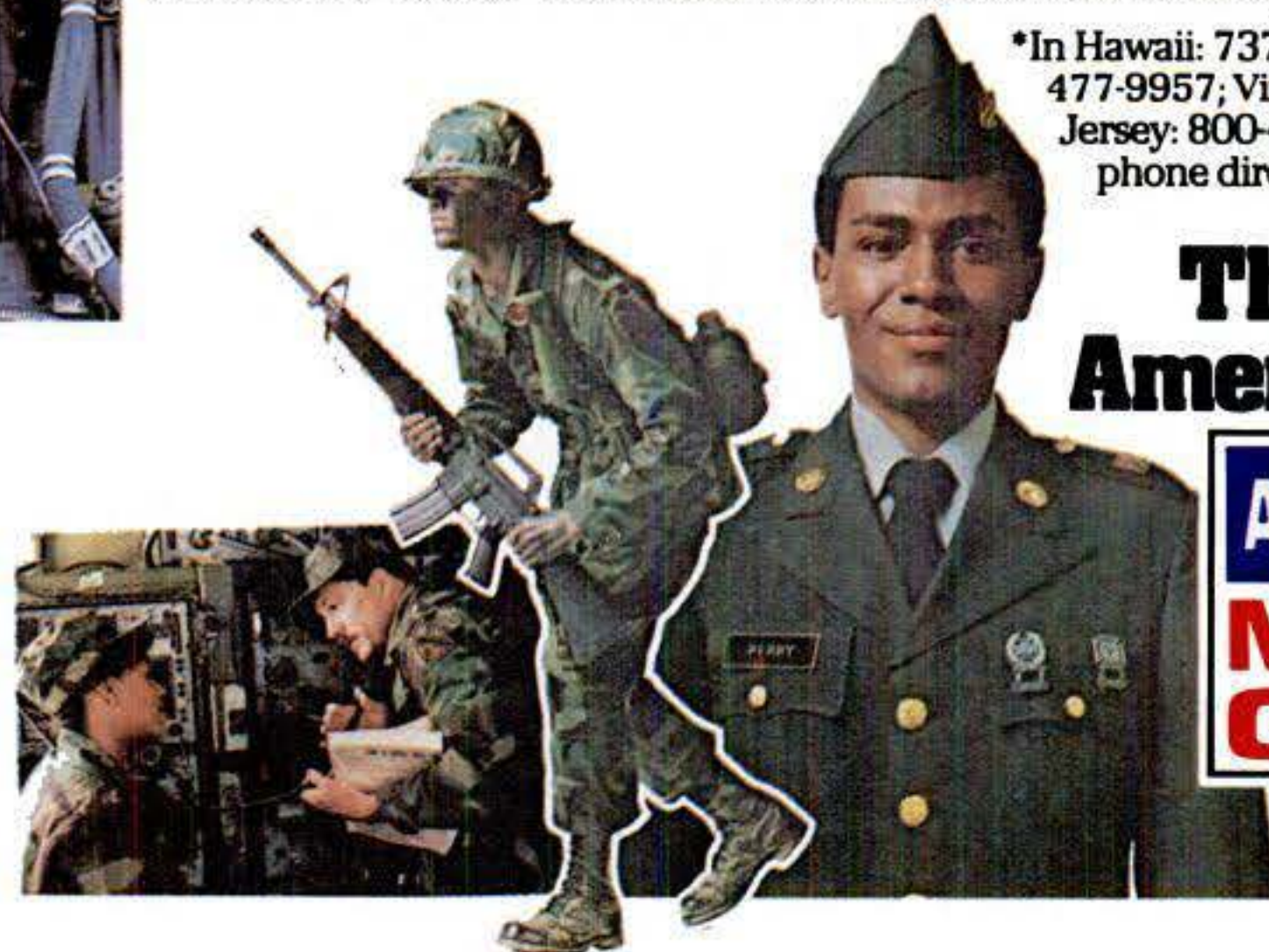
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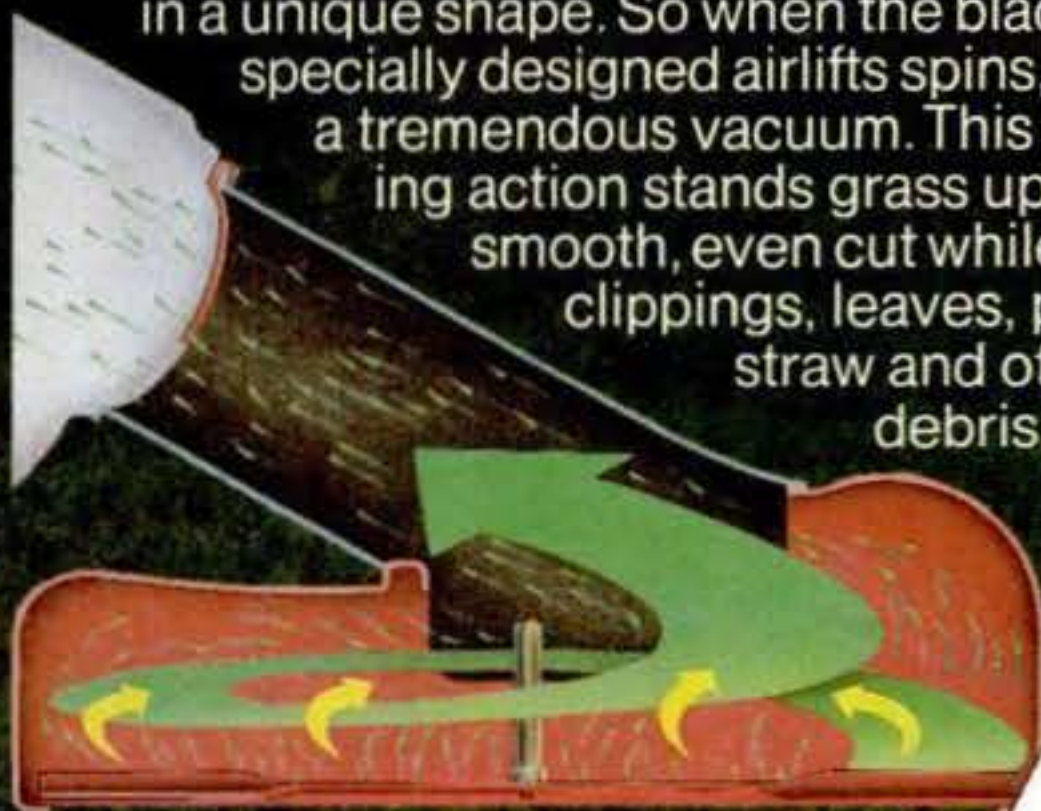
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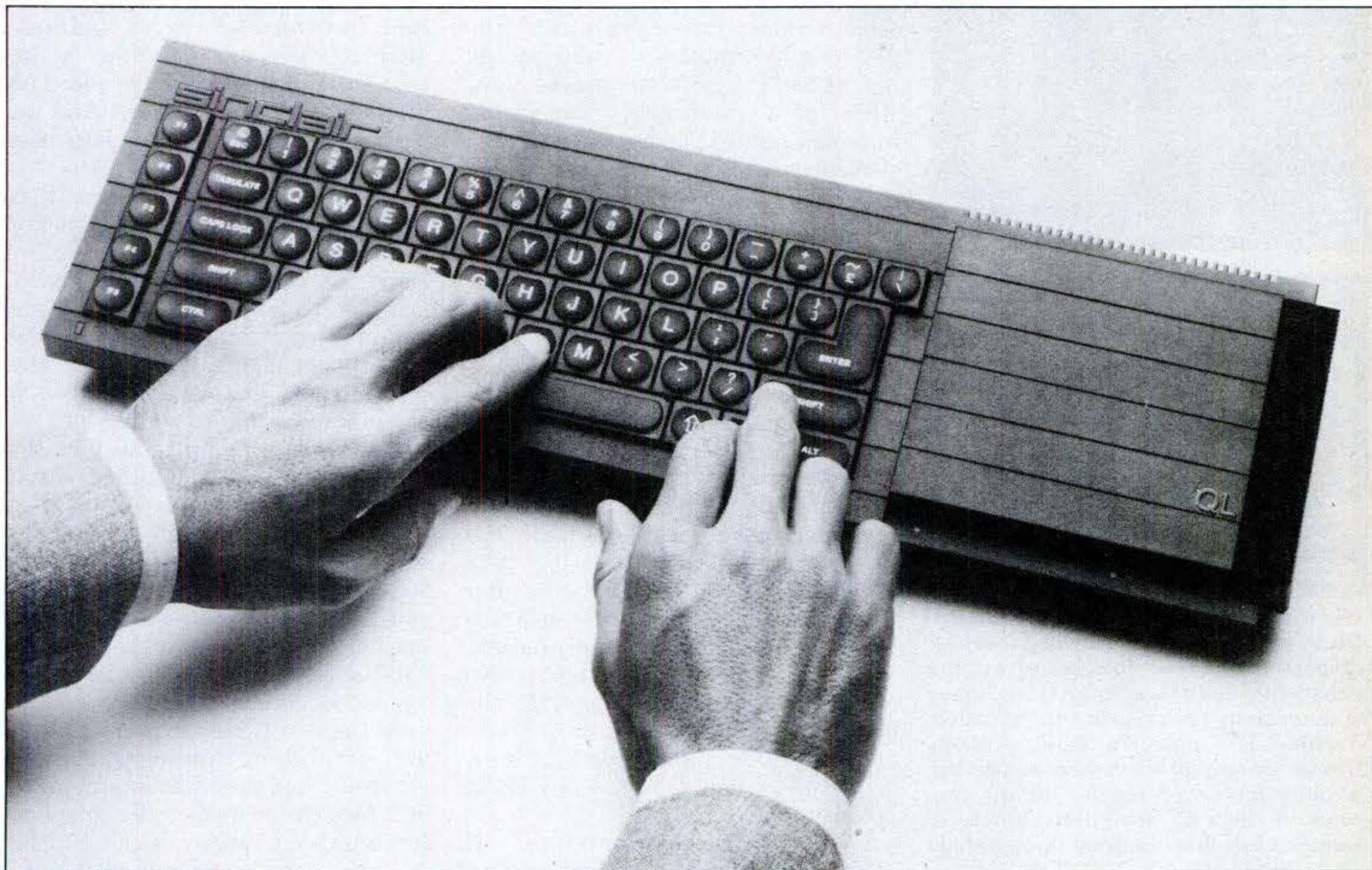
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# 32-bit business computer

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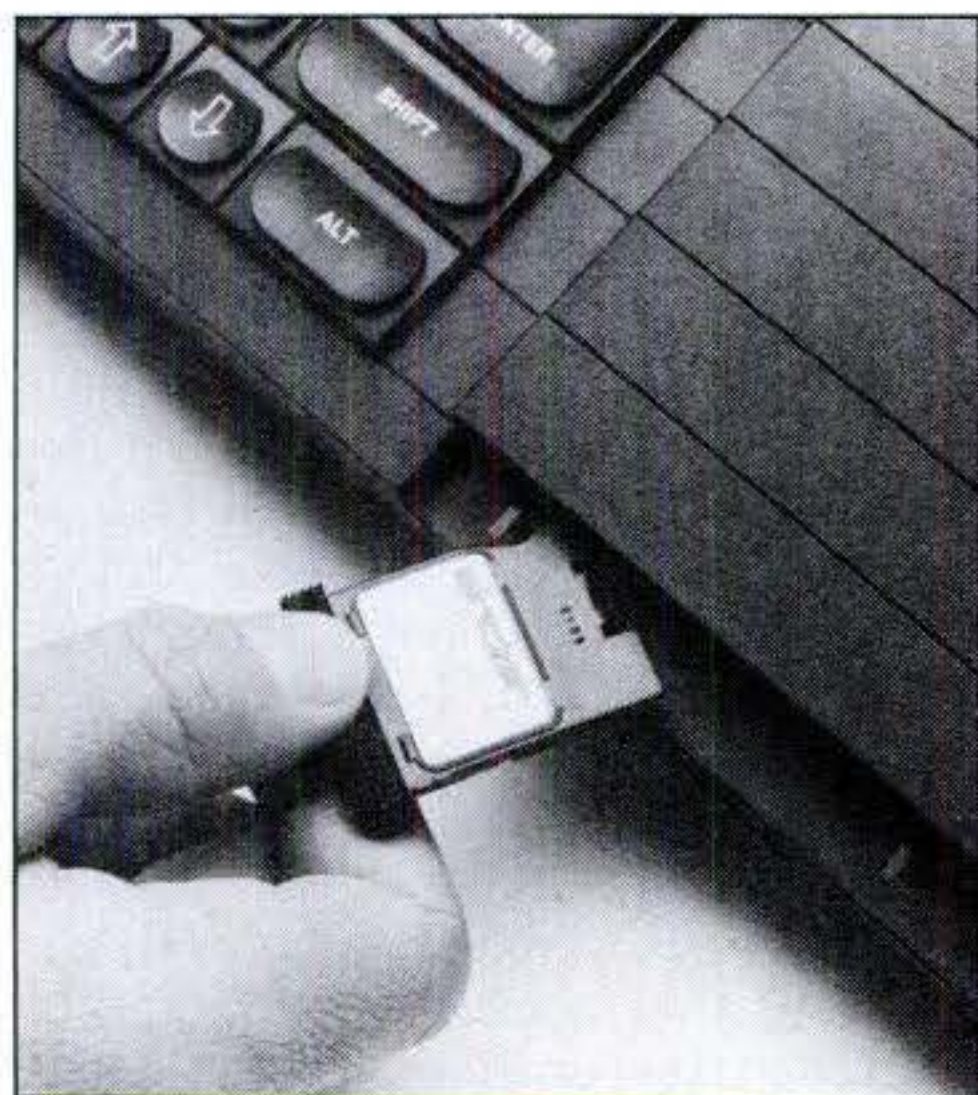
Sinclair's \$499 QL computer has lots of memory to run and display several programs at once. Tiny tape cartridges store data; you add a monitor or a TV. The included software handles word processing, spread sheets, data bases, and business graphics.



Sinclair QL has 65-key keyboard, two tape drives, 128K RAM, and 32-bit

microprocessor in 19-in.-long, under-three-lb. package. QL has 25-line, 85-

character display for monitors, or 40 to 60 for lower-resolution TVs.



Loading and access speeds of the cartridge drives are slower than with disks but faster than with ordinary tapes.



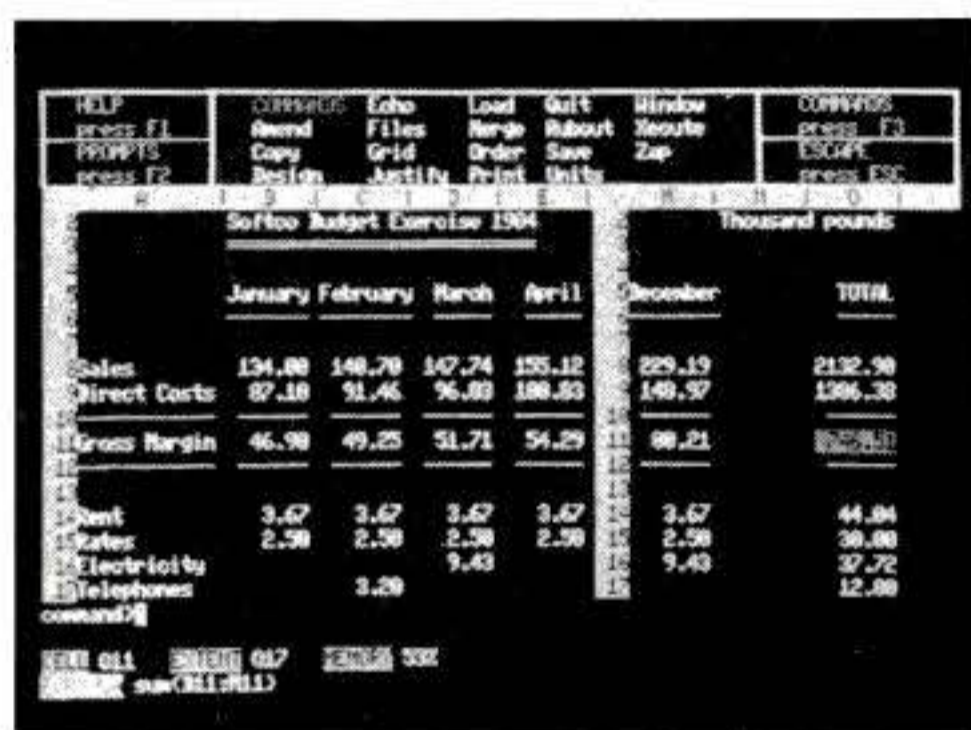
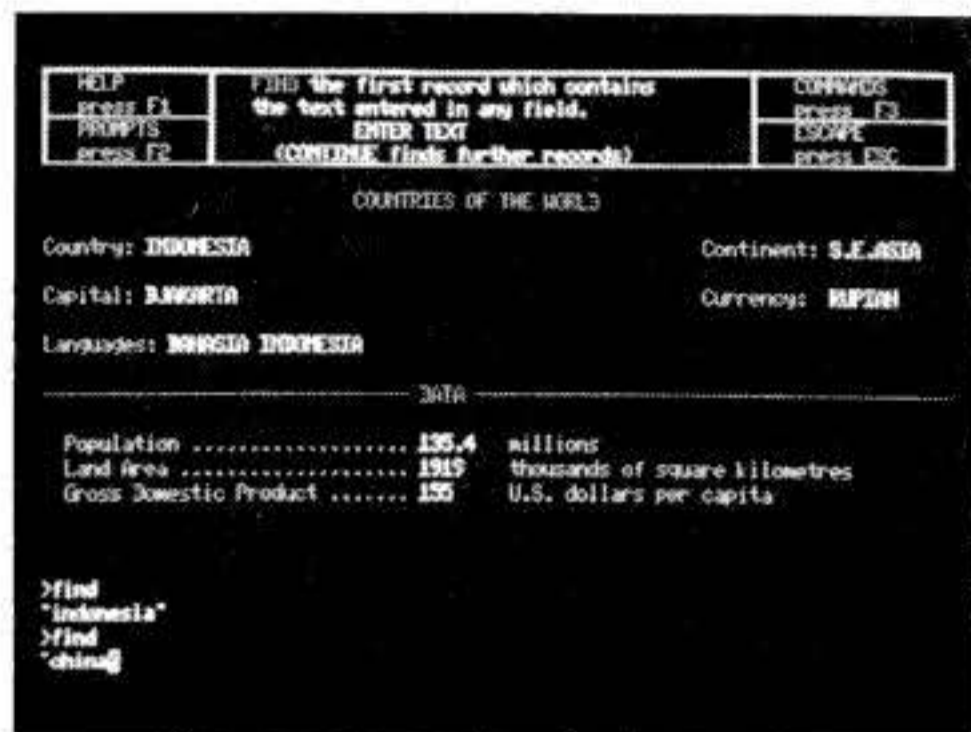
Plug-in 0.5-megabyte pack, under development, expands QL's built-in RAM to 640K—more than most micros.

By DAVID SCOTT

**A** color video monitor connected to a computer displayed this wintry scene: a cozy living room with snow falling outside French doors. On one wall in the scene, a framed picture duplicated the entire room—including moving snowflakes. And hanging on the wall inside that picture was yet another, still-smaller reproduction of the same scene.

At a London press demonstration, I was viewing the amazing graphics possible from a new bargain-basement British home computer, Sinclair's QL, for Quantum Leap. (Sinclair, of course, is the firm that launched the first

*Continued*



Word-processing package (top) for QL is easy to set up and use. Screen displays different fonts and actual subscript, boldface, etc. Data-base-management program (center), called Archive, is a powerful filing system. Electronic spread sheet (bottom), called Abacus, lets you refer to columns and rows of data by assigned names. A sample cash-flow analysis is included.

under-\$100 microcomputer [PS cover, Aug. '82].) The QL is a personal computer pitched at business users. But it's slated for sale in the U.S. this summer at \$499—half the cost of any comparable machine.

For that price you get a hefty 128K RAM, a 32-bit microprocessor, two built-in 100K miniature tape-cartridge drives for data storage, and sophisticated word processing, plus other software.

The QL has the ability to run several separate programs simultaneously—a technique called multi-tasking. The programs can be displayed in different sections, or windows, on the screen [see "Do-Everything Software," PS, Jan.], and they can be scrolled independently.

In the personal-desk-top arena, this 32-bit machine is matched in power

only by the Apple Macintosh [PS cover, March]—at about five times the cost. The QL's exceptional processing power is derived from the 68008 chip, one in a series developed by Motorola that crunches data internally in chunks 32 bits long.

Both the QL and Macintosh represent a significant change in personal-computer processing power. Most machines not marketed solely for business use, including the IBM PC and its imitators, use either 16-bit microprocessors or older eight-bit processors. In the QL, data are fed into the 68008 on eight parallel lines—the so-called data bus. By contrast, the 68000 microprocessor, used in the Macintosh, has a 16-bit-wide data bus. Although a wider data path can aid in processing data faster, other factors, such as the processor's operating speed (frequency) and the software itself, greatly affect overall speed.

### Understanding machine

The new Sinclair machine is designed to be used without prior training or computer knowledge, Sinclair claims. Hence its sales slogan: "The software understands the use rather than the user having to understand the software."

To simplify programming and making other entries into the QL, Sinclair has upgraded BASIC to what it calls SuperBASIC. This revised computer language has easy, make-sense key words and flexible procedures for use. The company also has created its own operating system to supervise the shuttling of data between tape drives and the 68008. Called QDOS, it's designed to exploit the QL's full 32-bit potential.

Four software programs are part of the QL package: word processing, business graphics, spread sheets, and data-base management. All are on individual tiny tape cartridges that plug into the front of the machine for loading.

With word processing, the screen shows exactly what you key in just as it will be printed (photos at left). "What you see is what you get," says Sir Clive Sinclair. There's no problem with formatting a page or learning coded embedded commands. From a plain-English option menu on the screen, you first specify requirements such as margins, line length, line spacing on a printer, or a form feed between pages.

Then, for typing, the screen splits into three horizontal sections. A "control" area along the top gives instructions and further options for editing, text layout, and presentation. A narrow "status" band at the bottom dis-

plays your document name, an ongoing word count, and the choice of typeface displayed on the CRT.

Your text appears in the central portion of the screen. A dotted ruler at the top marks character spaces and indicates exactly how far across the page you are with each line.

For graphics there's a similar easy-does-it approach with the QL Easel program. You go straight into high-resolution color graphs or charts (512 by 256 picture elements, eight colors) without having to construct a table of values or answer any questions. The program handles anything from lines, shaded curves, and histograms, to pie charts and overlapping or stacked bars. Text can be added and altered as simply as data. And preparing spread sheets and data bases is just as easy.

The tape cartridges storing these programs are an upgraded version of the units introduced last year for Sinclair's ZX Spectrum ["Bits & Bytes," PS, Dec. '83]. Each has a 200-inch loop of ultra-narrow (0.07-inch) video-quality tape in a matchbook-size plastic housing. The tape is driven by a pinch roller at 20 inches per second and contains up to 50 files that can be individually identified, sorted, displayed, and deleted. Two of these cartridges slip into the machine. Typical loading and access speed is 3.5 seconds. Another six 100K tape drives can be plugged into one end of the machine, providing a total of 800K non-volatile storage. RAM can be greatly expanded, too.

At the rear there are ports for local-area networking (linking QLs together), color and monochrome monitors or a TV, printer, modem (for telephone linkups), and two joy sticks. Sinclair says that the modem is still under development, as are a Winchester disk-drive interface, a terminal simulator, and other interfaces and utility software. There's also a connector for an add-on read-only-memory cartridge of up to 32K. The full-size typewriter-action keyboard has five special-function keys.

U.S. launch for the QL will initially be by mail order from Sinclair's Boston office (Sinclair Research Ltd., 50 Staniford St., Boston, Mass. 02114). Store sales will follow. Although outside software will have to be taped on those unique tapes, Sinclair has few doubts about the flood to come. Over 5,000 programs exist for its budget-priced Spectrum model, and sales of that computer are expected to reach two million by the end of this year. The company is banking on a repeat performance for the remarkable QL.





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This electronic wonder recalls phone numbers, credit card numbers, safe combinations and other tough-to-remember data. It makes forgetting a thing of the past.

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Calculator  
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00:00 00

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# Bits & Bytes

By JOHN FREE

## Macintosh software

A plump package from Apple Computer, Inc., arrived on my desk early this year, one day after Apple officially launched its impressive 32-bit Macintosh computer [PS cover, March]. A \$600,000 TV-ad campaign preceding the Macintosh unveiling suggests that Apple views its new personal computer as the 1984 alternative to Orwellian-like domination of the market by IBM.

The fat package made it obvious that Apple is avoiding the errors it made with its Lisa computer [PS, June '83]. (Lisa, based, as is the Macintosh, on Motorola's 16/32-bit 68000 microprocessor, premiered with a \$10,000 price tag and minimal software.) But the bundle of press releases from various software firms and delivered by Apple claims that some 500 programs for the \$2,495 Macintosh will be ready by 1985. Many of these programs are already available.

A year before the Macintosh introduction, Apple provided more than 100 software firms with a new computer plus technical and marketing help. To continue the flow of software, nationwide seminars and training sessions for developers are under way.

Programs offered on the Macintosh's shirt-pocket-size, 400-kilobyte, 3.5-inch disks ["War of the Microdisks," PS, Dec. '83] range from a dozen tailored for farmers and ranchers to a Lotus 1-2-3 ["Do-Everything Software," PS, Jan.], with a 2,048-row-by-256-column spread sheet. In addition, Apple

planned its Macintosh introduction so that other firms are already providing peripherals—five-to-32-megabyte hard disks, modems, and an attachable telephone, for example.

## Do-it-yourself scanner

A new hand-held optical character reader, developed by Britain's London-based Oberon Intl., is slated for sale soon. Character readers, which scan print, translate text into digital signals that computers can recognize and store. Readers eliminate time-consuming, error-prone typing from paper into computers.

But hardware to do the job, such as Toshiba's V100 page reader [B&B, PS, Feb. '83] is expensive. What makes the Oberon Omni-Reader special is its price, about \$500. The output of the new reader can be connected to most microcomputers. Oberon says its manually scanned character reader eliminates problems inherent in paper-transport mechanisms: jamming, text misalignment, and the scanning of nonrecognizable material such as company letterheads.

Omni-Reader looks like a large, thin book. A horizontal ruler and edge guide aid in moving the cigarette-pack-size reader head smoothly across and down a printed page. Oberon says the reader's microprocessor has been taught to recognize most fonts, but its software can learn new ones.

Several microcomputer accessories on the market ["Talking Appliances," PS, Sept. '82] that pronounce elements

of speech from characters typed on a keyboard might ensure (audibly) the accuracy of a page scan. They could also provide a reasonably priced reading system for visually impaired persons.

## Low-cost printers

Are you one of the millions who have  
*Continued*



# Everybody's making money selling microcomputers. Somebody's going to make money servicing them.

## Now NRI Trains You At Home To Make Money Servicing, Repairing, and Programming Personal and Small Business Computers

Seems like every time you turn around, somebody comes along with a new computer for home or business use. And what's made it all possible is the amazing micro-processor, the tiny little chip that's a computer in itself.

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## Growing Demand for Computer Technicians

This is only one of the growth factors influencing the increasing opportunities for qualified computer technicians. The U.S. Department of Labor projects over a 600% increase in job openings for the decade. Most of them are *new* jobs created by the expanding world of the computer.

## Learn At Home to Service Any Computer

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In addition to training in BASIC and advanced machine language, you gain hands-on experience in the operation and application of the latest computers for both business and personal jobs. You're trained to become the fully rounded, new breed of technician who can interface with the operational, programming, and service facets of all of today's computers. You're ready to take your place in the new electronic age.

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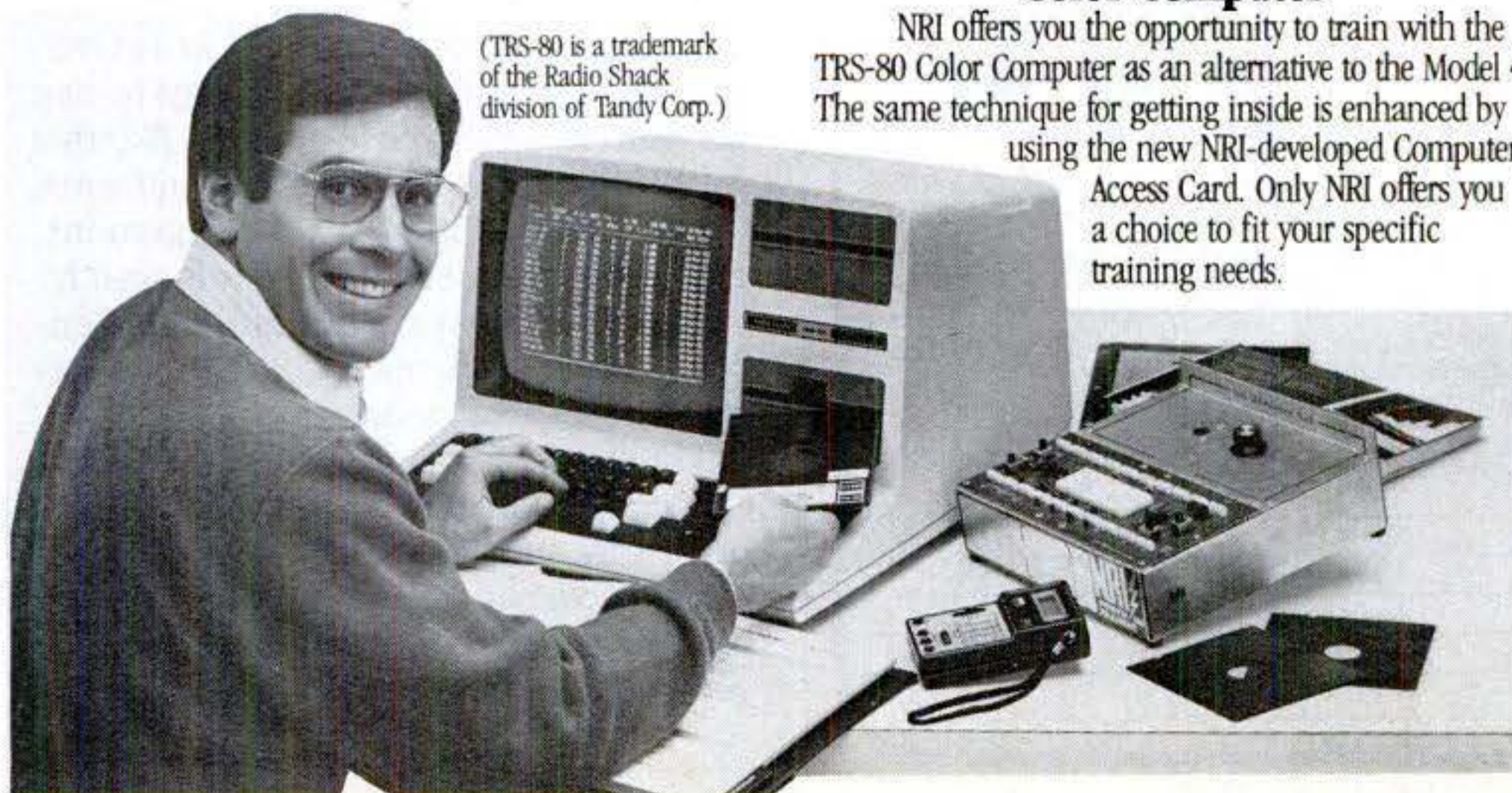
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advanced. You analyze and troubleshoot using the professional 4-function LCD digital multimeter you keep to use later in your work. Then you use the lab and meter to actually access the interior of your computer...build special circuits and write programs to control them. You "see" your computer at work and demonstrate its power.

## Same Training Available With Color Computer

NRI offers you the opportunity to train with the TRS-80 Color Computer as an alternative to the Model 4. The same technique for getting inside is enhanced by using the new NRI-developed Computer Access Card. Only NRI offers you a choice to fit your specific training needs.

(TRS-80 is a trademark of the Radio Shack division of Tandy Corp.)



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- Elliptical cone speaker for clear, natural sound of callers' voices. Suspended (cushioned) front mounting of speaker adds to greater clarity.
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- Main microprocessor chip is the culmination of 25 years of development.
- Fast forward and fast rewind. Quickly scan and locate any particular message desired.
- Instant rewind. No waiting for your announcement cassette to cycle back.
- Safety locking lever prevents the accidental erasure of your messages.
- Handsome, sturdy metal case is at least TEN times stronger than plastic used on competitive, cheaply made units.
- Metal case protects electronic components from bothersome outside RF interference.
- Red light goes on when first incoming call is received.
- You can limit callers to 45 sec. message OR allow them up to 30 min. total tape capacity.
- Record your "hello" message then flip lever to check instant replay of it.
- Safety locking lever prevents the accidental erasure of your messages.

## U.S. District Court

Jan. 1982 (Wash. DC) — As result of AT&T settlement with Justice Dept., Bell System companies will no longer be allowed to buy phone equipment for leasing to businesses. This prevents the Bell System from continuing their large scale purchase of Code-A-Phones.

## Public Notice

Aug. 1983 (Minneapolis, MN) — C.O.M.B. Co., Inc., the nation's largest liquidator is now authorized to liquidate Code-A-Phone commercial model phone answering systems to the public at far below AT&T's cost.

## Bits & Bytes

picked up a bargain-basement home computer recently? If you've spent less than \$100 or \$200 for a Texas Instruments, Timex Sinclair, Commodore, or other low-cost home computer, you're probably not in the market for a printer that costs several times as much as the computer.

Now there are several 40- and 80-column thermal printers priced for inexpensive computers. In fact, Alphacom (Campbell, Calif.) has models that make other low-cost printers [PS, Jan.] seem expensive. The \$170 Alphacom 81 (preceding page) prints 80 characters (one line) per second on thermal roll paper. And the 40-column Alphacom 42 costs less than \$100 (\$70 without an interface cable). Alphacom 81 models are packaged individually for various home computers.

Special interface cables, starting at \$45, print bit-mapped graphics—duplicating each TV-screen dot—for various computers. Other cables use Centronics and RS232 ports, common on costlier personal and small-business computers.

## Adam update

Production and other delays slowed the introduction of the all-in-one, under-\$700 Adam computer-game system [PS cover, Sept. '83] late last year. (Adam features a high-speed tape drive, keyboard, and daisy-wheel printer.) Coleco, its manufacturer, has set up a nationwide network of Adam service centers through Honeywell Information Systems.

Meanwhile, several Adam add-ons were unveiled at the Las Vegas show. Peripheral hardware includes a second tape drive, a 5 1/4-inch disk drive, a 300-1,200-baud modem for phone linkups, and a 64K memory expander (for 144K of RAM). For the Adam printer, there's also a tractor-feed accessory for fan-fold paper. Coleco says it will have a plug-in board for IBM PC compatibility, and the firm announced a package that links Adam with CompuServe, an interactive-videotex service. A new easy-to-use version of CP/M will expand Adam's software base, too. Some 170 software titles—education, home management, and entertainment—were released by Coleco, which says that many independent software firms are also marketing Adam programs.

There are also industry rumors that Coleco is talking with some manufacturers in the hopes of developing an interactive videodisc player that will plug into Adam and use specially developed software and discs.

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### Requires a lot of nerve

Making a fortune this way requires a lot of nerve, determination and the willingness to take chances—to start out with nothing more than guess-work and to try again if your financial guesswork turns sour.

But most people can't afford to take the chances necessary to gain that kind of practical, nuts and bolts financial knowledge. Very few are in a position to risk everything to acquire the skill that is essential to consistent financial success.

## METHOD #2

But now there is another way to acquire the skills and knowledge necessary to be successful in making your investment decisions. Now you don't have to risk everything you have in order to learn how to acquire wealth nor take a trial and error approach to investing. Now you can build your fortune surely, secure that each step you take will produce results.

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The program contains the input of such men as Dr. Morton Shulman, multi-millionaire in-

vestor and author of best-selling books on how to acquire wealth—and Andrew Sarlos, who built a multi-million dollar investment group.

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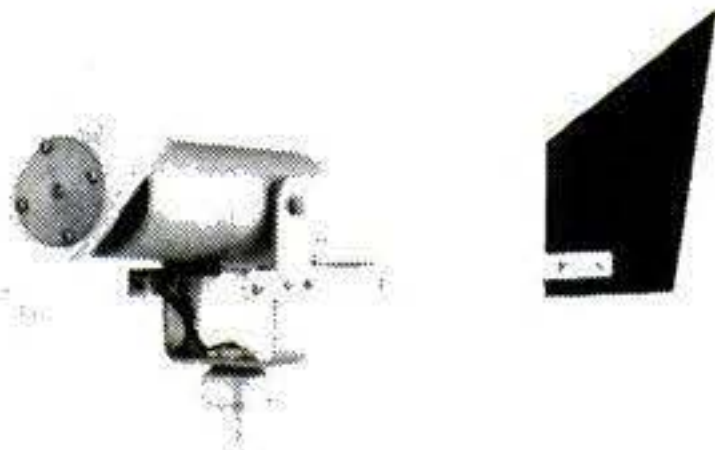
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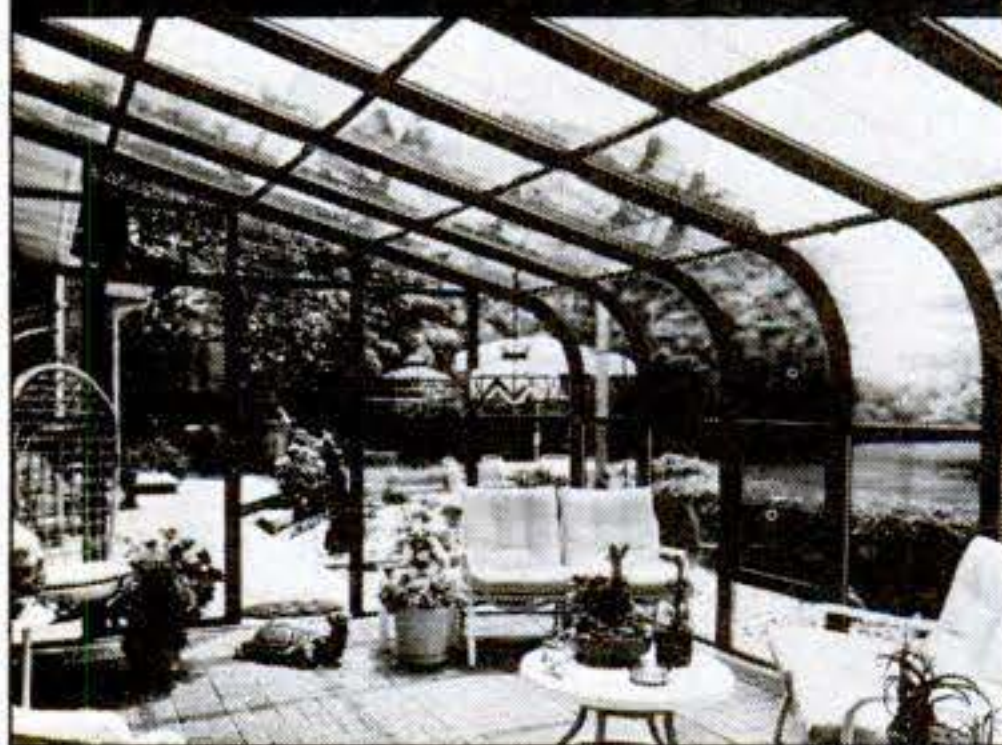


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Small but versatile Workslate computer has 60 keys and LC display. It's powered by four AA batteries. A variety of business software is available.

## COMPUTER REVIEW

# Briefcase computer

A new business-oriented personal computer—compact enough to fit inside your briefcase—has a built-in tape recorder for dictation or data storage of electronic spread sheets. A calendar reminds you of appointments, and a calculator speeds your math. You link the computer's modem to your telephone to dial and receive calls automatically.

By **JOHN FREE**

**W**hen I tapped Workslate's ON button, the readouts on its 46-character-by-16-line LC display immediately let me know that this lap-sized portable computer wasn't designed to play Dungeons and Dragons or crunch a very long program (no BASIC is included). The \$895 computer's electronic-spread-sheet-display format is familiar to many business people—the manufacturer's target buyers—who often must manipulate rows and columns of data.

Five keys just below the display—CALC, FINANCE, MEMO, PHONE, and TIME—tap the Workslate's pre-programmed functions and impressive capabilities. Everything is set up so

you don't have to remember complex computing sequences or codes. Press FINANCE, for example, and the 736-character display is formatted to solve pre-programmed appreciation, loan, and other problems. Prompts on the display call for data as needed. Entries are permanently stored in memory unless they are deleted or the backup batteries wear out.

There's a diamond-shape pointer key that moves horizontally or vertically from cell to cell in a spread sheet. Normally, an electronic spread sheet's rows and columns contain a few numbers at each cell (row-column intersection). But in the Workslate, a cell might contain a memo you've written or a list of telephone numbers. Instead of the familiar ENTER or RETURN key,

pushed after entering data on most computers, there's another key, labeled DO IT. Although the Workslate isn't designed for extensive word processing, its circular keys have a nice tactile resistance when pressed, letting you know contact has been made.

Press the MEMO key, and a beep from Workslate's speaker, plus a screen prompt, tells you to load a microcassette. Then (as with the other functions) temporary screen labels assign different tasks to the five function keys: RECORD, PLAY, STOP, etc., for example. One tape track records voice dictation (30-minute maximum); another saves data such as a typed memo or an electronic spread sheet—at a brisk 2,400-baud data-transfer rate.

The PHONE button—the telephone cable is included and plugs into a back-panel jack—lets you convert the Workslate into a sophisticated telephone. You can whisk the cursor to a number stored in a phone list and have it automatically dialed, or you can use the key pad of the built-in calculator for manual dialing. A phone amplifier eliminates the need for a handset, but a spare jack also lets you plug in a phone. The manufacturer (Convergent Technologies, Inc., 2441 Mission College Blvd., Santa Clara, Calif. 95050) will market an acoustic modem for locations where wall jacks aren't installed.

A 300-baud direct-connect modem in the Workslate also sends or receives data over telephone lines. And because the 8½-by-11¼-by-one-inch computer also has calendar and clock functions, you can automatically transmit or receive messages without being present. (It'll remind you of birthdays and anniversaries, too.) The computer can communicate with other Workslates, and a program is being readied that will send data to IBM personal computers. The sometimes-tedious procedure for logging into a data-base network such as CompuServe also can be automated after initial storage of the proper codes.

This means you could set up the Workslate to dial automatically a service offering stock quotations, then enter data for your portfolio into a spread sheet where you've stored formulas to compute buy-or-sell decisions.

There's an optional \$250 four-color printer-plotter that uses 4½-inch-wide roll paper. An optional interface will accept other printers.

The Workslate's LCD panel is susceptible to overhead glare, I found, although an adjustment knob makes readouts visible under most conditions. The computer's somewhat-limited 16K user memory can be expanded to 32K.

PS

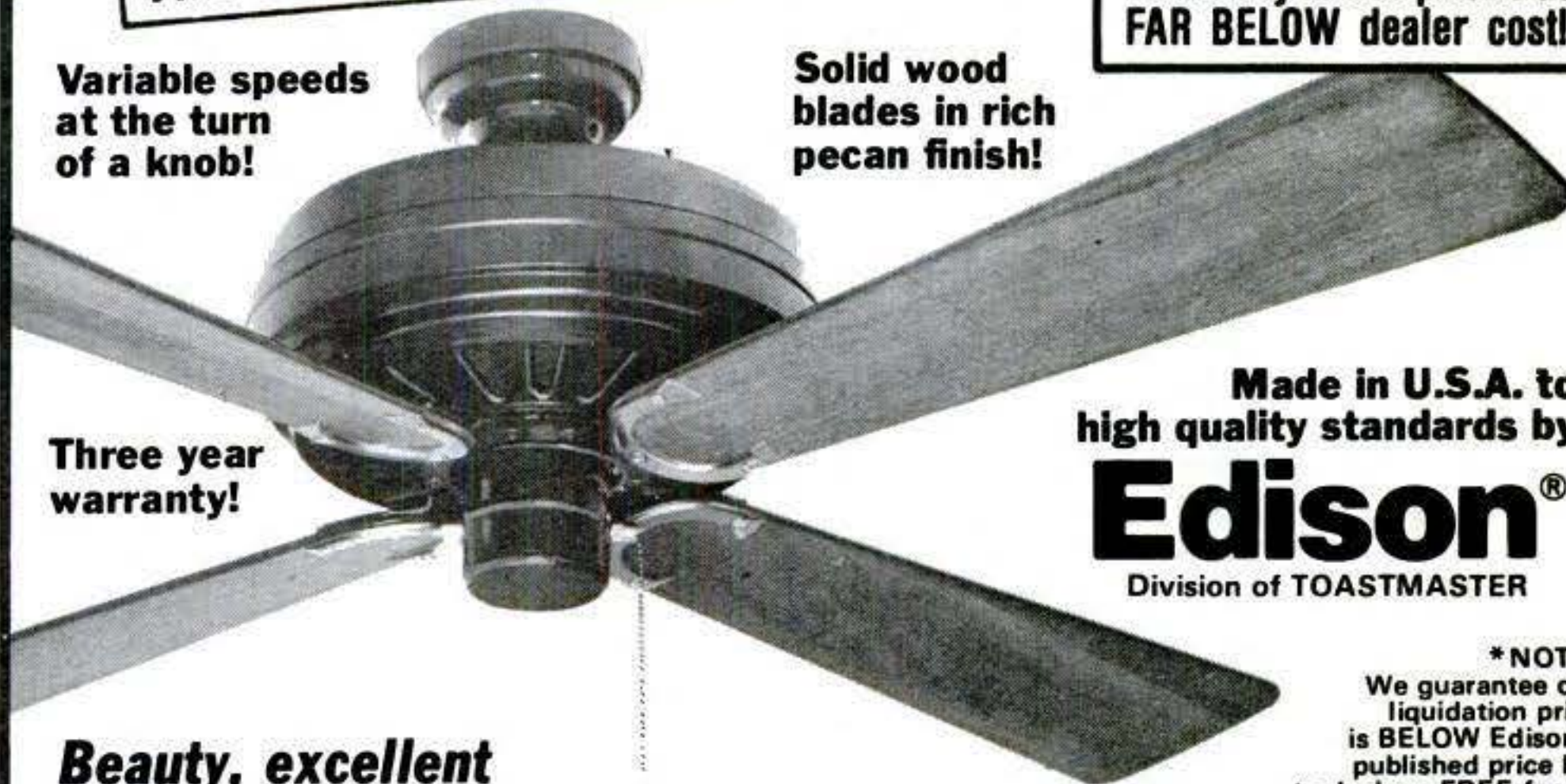
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Solid wood blades in rich pecan finish!

Three year warranty!

Made in U.S.A. to high quality standards by

**Edison<sup>®</sup>**  
Division of TOASTMASTER

\*NOTE:  
We guarantee our liquidation price is BELOW Edison's published price list to dealers. FREE fan to anyone who can prove differently.

**Beauty, excellent quality and smooth operation in an energy-saving fan that's easy to install.**

Ceiling fans have become so highly popular that competition is very intense among the many manufacturers. So intense that some of them have quit the business! The Edison division of the famous Toastmaster corporation was firmly committed to producing high quality fans. But that also meant high retail price tags . . . which cut down on sales volume. So Edison decided to stop making fans and to liquidate this remaining inventory at a drastic price reduction. Their loss is YOUR BIG GAIN! Now get a great bargain on excellent fans!

### Refreshingly cool in hot weather!

In summer, the cooling breezes created by these fans allow you to cut down on air conditioning. You'll enjoy substantial savings on energy costs! The large 52" diameter sweep of the blades provides movement of air for an entire room!

### Helps keep you warmer and comfortable in winter!

In winter, you can lower your thermostat and save on heating bills. And still stay warm and comfortable! As heated air rises to the ceiling, the slow-moving fan blades gently recirculate the warm air down again. This continuous mixing of air provides greater uniformity of warmth throughout the entire room . . . to help avoid cold areas by windows and doors.

This is a high quality fan, made to exacting specifications under strict U.S. quality control. The smooth running performance compares with the best on the market! The sturdy motor housing is in rich-looking chocolate brown. Antique brass blade brackets add accents of golden beauty! The dependable motor features all-metal construction with sealed, lubricated ball-bearings for smooth, quiet operation. And the motor is direct drive, with NO belts to wear out.

Overall vertical height is approx. 15". Convenient on/off pull chain. Pre-wired for easy installation of optional center light kit. (See order form for light kit.) Base is also pre-wired for easy installation. All hardware and instructions included. Supply of fans is very limited. Place your order promptly!

### Mfgs. 3 Year Limited Warranty!



Credit card customers can order by phone, 24 hours a day, 7 days a week.

**Toll-Free: 1-800-328-0609**

If busy signal, or if no answer, call:

**Toll-Free: 1-800-328-5727**

In Minnesota, call: **1-800-742-5685**

**C.O.M.B. Co.<sup>®</sup>**  
The Nation's LARGEST Liquidator!

14605 28th AVENUE NORTH  
MINNEAPOLIS, MINNESOTA 55441



**CENTER LIGHT KIT**

Add this decorative four-light Florentine fixture to your fan. Elegant tulip-shape shades are crafted of frosted white glass and are complemented by antique brass fixtures. Uses 4 standard light bulbs (NOT incl.). A pull chain controls lights or fan or lights AND fan. Pre-wired for easy installation.

Retail Value: **\$49.95**  
Liquidation Price . . . . **\$16<sup>50</sup>**

**Manufacturer's Suggested Retail**  
**\$149.95**

As per mfgs. Aug. '82 Price List  
**OUT THEY GO AT ONLY:**

**\$58**

Offer void outside original 48 states.

C.O.M.B. Co. / Liquidators Dept. F-479  
14605 28th Avenue North / Minneapolis, Minn. 55441

Item No. 6202-01 — Send \_\_\_\_\_ Ceiling Fan(s) at \$58 each plus \$10 each for shipping and handling.

Item No. 2299 - Send \_\_\_\_\_ Light Kit(s) at \$16.50 each plus \$4 each for shipping and handling.

(Minnesota residents add 6% state sales tax. Allow 3-4 weeks for delivery. Add 2-3 weeks extra if paid by check. Sorry, no C.O.D. orders.)

My check or money order is enclosed.

Charge:  MasterCard\*  VISA  Am. Exp.  Diners Club

Acct. No. \_\_\_\_\_ Exp. \_\_\_\_\_

PLEASE PRINT CLEARLY

Name \_\_\_\_\_

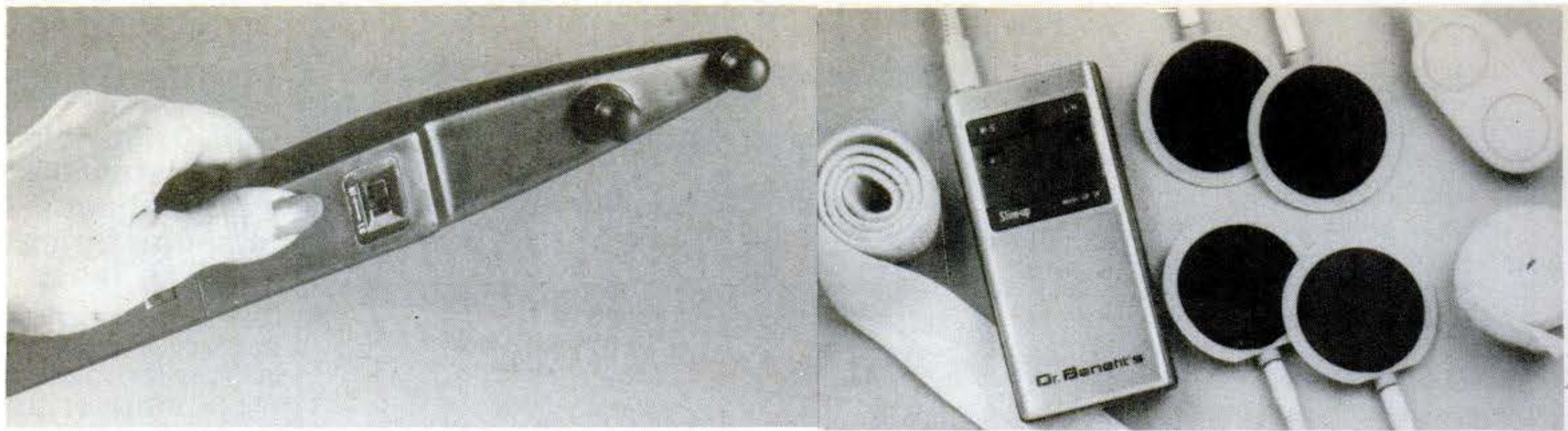
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City \_\_\_\_\_

State \_\_\_\_\_ ZIP \_\_\_\_\_

Phone \_\_\_\_\_

Signed \_\_\_\_\_



# WHY WE CAN'T TELL YOU THESE TWO AMAZING INSTRUMENTS ARE "AMAZING"

They aren't "scientifically" proved in the United States . . . but in Europe and the Orient, you'll find volumes of testimonials!

## THE DOCTRONIC ELECTRO-ACUPUNCTURE WAND

We make no medical claims for the DocTronic Wand. We can tell you that users say, in writing; It parallels the remarkable benefits of acupuncture.

### WHAT IT IS AND HOW IT WORKS

The DocTronic is battery-driven. It delivers a silent low-frequency vibration.

A switch moves from "high frequency" to "low frequency." If you have a headache, set it on "high" and touch it to your skin where the chart (included) indicates a "curing point"—not necessarily on your head.

If it works, we won't be surprised. If it doesn't send the DocTronic Wand back for a refund.

### THE ELECTRO-ACUPUNCTURE PRINCIPLE

Only now is acupuncture being accepted by medical authorities in the western hemisphere.

Acupuncture involves inserting thin needles under the skin, NOT at the point of pain, to get relief. Please note: **THE DOCTRONIC WAND HAS NO NEEDLES. IT SETS UP VIBRATIONS.** We'd never sell you something which if misused might cause physical harm. The Wand is absolutely and completely safe.

Does it work? We can't and won't say yes. Decide for yourself. To us it's an unbelievable electronic instrument, but that's our opinion, not a medical fact.



Try it. Use it for relief from some aches and pains. If you don't agree with us, we'll refund every penny you paid—and meanwhile you'll have had the fun of trying out the newest electronic wonder of our time.

- \*Uses ordinary 9-volt battery (not included)
  - \*Rests on skin—no puncturing
  - \*Special "curing point" chart included
  - \*Sturdy, trouble-free for years of use
- The DocTronic Wand . . . . . \$39.95  
Two for \$34.95 each.

## DR. BENEFIT'S SLIM-UP

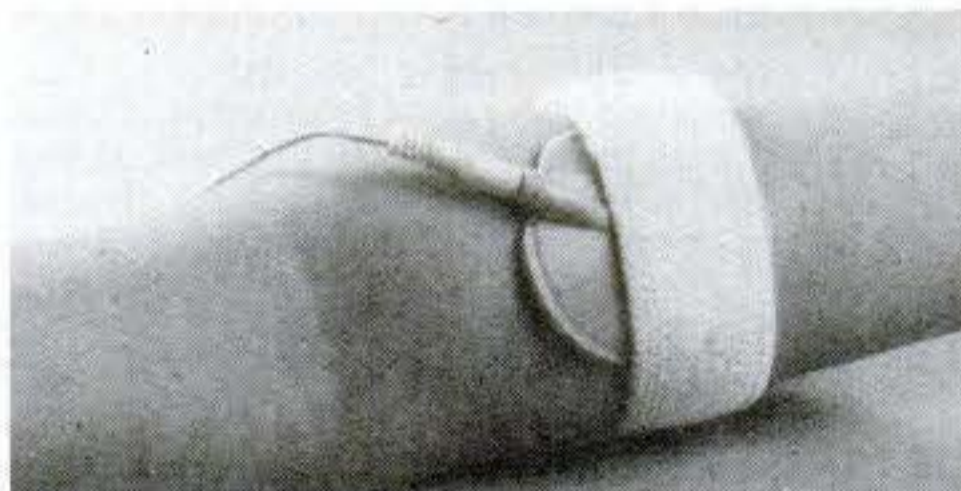
You could jog 5 1/2 miles every day or relax with this for 30 minutes and use as much body-energy!

Dr. Benefit emits electrical impulses from a single 9-volt battery (the same type you have in your transistor radio).

Unbelievable! You just relax. Dr. Benefit causes muscle contractions, **JUST LIKE NORMAL EXERCISE.** While you read a book, you're toning up your muscles.

### WHY IT'S WORTH TRYING

You should try Dr. Benefit, if for no other reason, because if it doesn't do exactly what we say it will, we'll refund every dime you paid for it. You can't lose.



A better reason is this: it comes from the Republic of China and is certified by the Taiwan Department of Health. This is no "gadget"—it's so good, so dependable and so effective at restoring your trimness, we're biting our tongues to be able to tell you what at this writing you'll have to find out for yourself.

Attach the weight-loss pads where you want them. Flabby thighs? Put them there. Thick waist? Put them there. Too-plump rear? Put them there.

(NOTE: Before you buy Dr. Benefit, you might want to discuss it with your doctor. NEW HORIZONS feels strongly that no weight loss program should begin without competent medical advice.

We're especially concerned because the FDA hasn't recognized such techniques except when used by a trained, licensed practitioner.)

### LASTS FOR YEARS!

Dr. Benefit should be available to every member of the family. Use it all day without damaging it. You may wonder why you waited so long when attractive slimness is so easy to have.

Dr. Benefit Slim-up . . . . . \$49.95  
Two for \$44.95 each

### WE ABSOLUTELY GUARANTEE!

Use the DocTronic Electro-Acupuncture Wand or the Dr. Benefit's Slim-up for 30 days. If either one doesn't please you, send it back undamaged for full refund.

### ORDER TOLL FREE

For fast delivery on credit card orders call toll-free 24 hours a day, 7 days a week:

**1-800-453-9600**

In Utah Call: 1-800-662-2500

For further information call: 201-370-1234

**Please ship at once, with 30 day money-back guarantee**

- DocTronic Electro-Acupuncture Wand . . . . . \$39.95
  - Two for \$34.95 each
  - Dr. Benefit's Slim-up . . . . \$49.95
  - Two for \$44.95 each
- Add \$2.50 per total order for shipping

Check Enclosed     Master Card     VISA

Card No. \_\_\_\_\_

Expires \_\_\_\_\_

Phone: (     ) \_\_\_\_\_

Name: \_\_\_\_\_

Address: \_\_\_\_\_

City: \_\_\_\_\_

State: \_\_\_\_\_ Zip \_\_\_\_\_

**NEW HORIZONS**

Dept. PS-4  
5-31 Fiftieth Avenue  
Long Island City, N.Y. 11101



# SOUND MASSAGER

## "Oscillates" The Tissues As Deep As 2 1/4" Below The Skin

European doctors and therapists use it to help blocked sinuses, muscle pains and poor circulation. But we can't make any claims for it.

But we make not one single claim for it. Why? Because it hasn't been "scientifically" proven in the United States.

### WHAT WE CAN DO.

No, we don't make any medical claims for the Sound Massager. But if it doesn't give you the same incredible FAST relief we'll describe to you in the next few paragraphs, send it back and we'll refund every cent you paid for it.

The F.D.A. has approved the Sound Massager for treatment for stress and strain due to overexertion, which means other approvals may be in sight soon. Meanwhile you can be the first to enjoy the benefits of the Sound Massager at the **NEW LOW PRICE!**  
**PRICE CUT IN HALF!**

In Europe, where medical approval is complete and until recently in this country—the Sound Massager has been priced at \$300. THOUSANDS of satisfied users bought it at that price.



Now, ONLY NEW HORIZONS CAN BRING YOU THE **SOUND MASSAGER** FOR HALF THE ORIGINAL PRICE: \$149.95!

### HOW THE SOUND MASSAGER WORKS

The Sound Massager produces oscillations in the 100 to 10,000 HZ range — some 600,000 oscillations per minute.

In one second, some users say, it gives more help than a standard massager can give in one minute. Unlike some hard-ended, bruising instruments, it can't damage delicate tissues.

### TRY IT FOR RELIEF FROM . . .

Aside from blocked sinuses, owners tell of quick relief from strains, blows, bruises (including those inflicted by other "massagers"), and sports injuries.

Older folks, with poor circulation, report it helps their hands and feet, which always feel cold. Still others use the Sound Massager for muscle spasms, nervous tension or just as an invigorating daily tone-up.

Arthritis? Try it. This is one of the uses we can't claim, but we wouldn't suggest you try it if we expected to have to refund your money.

### OTHER FEATURES

The Sound Massager has 2 massage heads. Plug it into any 120-volt outlet. You can adjust it through the Intensity Control as well as the on/off switch. The cord is expandable, coiled.

Warranty is for one year, but the Sound Massager is built to give you years and years of dependable use.

The Sound Massager . . . . . \$149.95

Two for \$139.95 each

(Add \$2.75 per total order for shipping)

### WE ABSOLUTELY GUARANTEE!

Use the Sound Massager or the Phoenix Pulse Watch for one full month. If either one doesn't please you, send it back undamaged for full refund.

### CALL TOLL FREE

For fast delivery on credit card orders call toll-free 24 hours a day, 7 days a week:

**1-800-453-9600**

In Utah call: 1-800-662-2500  
For information call: 201-370-1234

Or send check or money order.

### NEW HORIZONS

Dept. PS-4  
5-31 Fiftieth Avenue  
Long Island City, N.Y. 11101

## PHOENIX PULSE WATCH

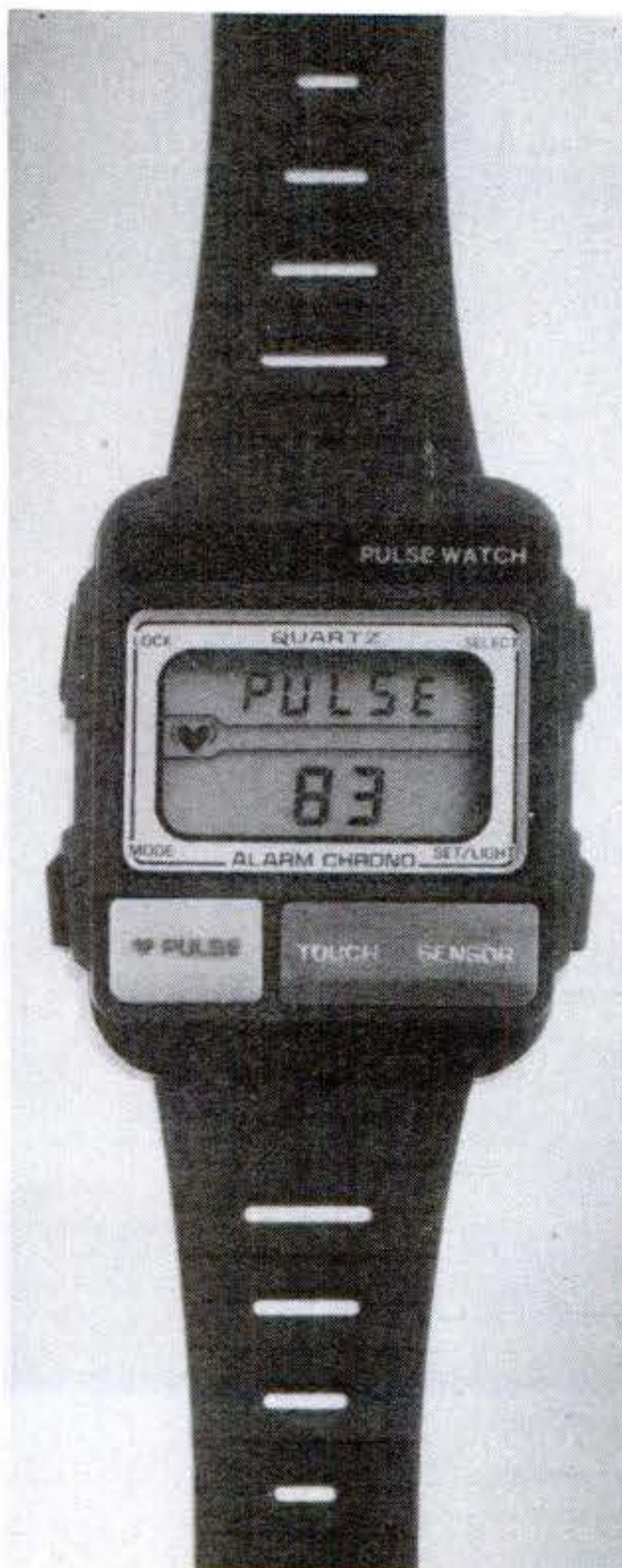
**Tells you, moment by moment, your exact pulse reading or, it's a time (12 or 24 hours)/day/date/alarm watch.**

The Phoenix is loaded with precision Seiko components. As an alarm-chronograph watch, it's precise to within five seconds a month.

It has a distinctive alarm, an hourly signal feature, a sophisticated stopwatch including lap-timers and continuous time measurement of TWO competitors—and that's just the beginning.

On your wrist, the Phoenix uses its contact with your skin to tell you, moment by moment, your exact pulse rate. Exercise and check your "recovery" rate against what the doctors say it should be. Put it on a patient's wrist and report the exact pulse-reading with hospital accuracy.

The Pulse Watch . . . . . \$49.94 each  
Two for \$44.95 each  
(Add \$1.75 per total order for shipping.)



# BANISH SMOKE POLLEN AND FUMES INSIDE CITY CARS

Imagine how much better and safer you and your family will feel while driving with the new ALPINE II from Zestron. Silicon Valley scientists have invented the newest and most powerful vehicle ionizer-air cleaner by recreating nature's own and best air cleaners—those amazing beneficial negative air ions you've read so much about. Many users report feelings of increased alertness, well-being, and reduced tension when driving with an ionizer. The all electronic ALPINE II, which fits in the palm of your hand, is made by Zestron, the world's leading ion generator manufacturer. It works in any 12 volt vehicle, or boat, or indoors with optional AC adapter while its super-



powered output silently removes smoke, fumes, pollen, dust and viruses without requiring expensive replaceable filters. Independent scientific tests prove that powerful ionizers like the ALPINE II are many times more effective than popular, inexpensive filter-fan air cleaners. Each ALPINE II comes with a FREE ion detector to verify and compare output.

**ORDER NOW! CALL TOLL FREE (800) 372-1200**  
Cal. (800) 392-1200, TWX 910 590 8032. (408) 371-1200. 30 DAY FREE TRIAL! ONE YEAR WARRANTY. Use credit card or send check to Zestron, Inc., Dept. P44, 1901 S. Bascom Ave., Campbell, CA 95008. Order one at ONLY \$79.95 or two at \$69.95 ea.! Add \$4.00 delivery per unit. AC adapter at \$7.95 ea. (Cal. res. add 6.5% tax.)  
CALL FOR DEALERSHIP INFORMATION

**ZESTRON** INC.

## Firepower!—BMW K-series

[Continued from page 86]

From the clutch, the drive goes to the gearbox input shaft (also equipped with cushion drive), to an intermediate shaft, to the output shaft, and then to the drive shaft—with a third cushion drive. As a result, the clutch, alternator, and drive shaft rotate counter to the engine crankshaft and therefore cancel its rotational torque. As you open and close the K 100's throttle, there is no accompanying side-to-side rocking of the motorcycle.

The liquid-cooled engine delivers 90 horsepower at 8,000 rpm—and does it solidly: The power curve is so flat that more than 85 percent of maximum torque is available from 3,000 rpm to the redline of 8,600, and above 5,000 rpm there is always at least 55 horsepower.

The drive line takes power to the rear wheel by BMW's Monolever system, which has been used before on the R80GS. Its beauty is that the rear wheel and tire can be changed about as easily as those on a car. The rear suspension is a single spring-shock unit with three pre-load settings.

### Bucking current trends

Front suspension is by conventional forks with progressive spring rates. Surprisingly, little of the suspension is adjustable. (Suspensions in current Japanese motorcycles may have literally tens of combinations.) BMW engineers trusted themselves to get it right the first time without the need for a lot of fiddling by the rider. In test rides, I found that the apparently simple springing and damping configurations proved their mettle—and the engineers' confidence.

Brakes are double discs in front and a single disc in the rear, with all rotors slotted. Everything is linked together with a stiff tubular space frame that utilizes the engine as a load-bearing component.

A major goal with the K-series was light weight, and here, too, the engineers succeeded. With fuel, the base K 100 weighs 526 pounds; the RS, 548 pounds; and the fully equipped RT, only 559. Owing to its lighter weight, the base version is credited with a 3.9-second acceleration for zero to 100 kilometers per hour (62 mph), compared with four seconds for the RS and 4.1 for the RT. But the superior aerodynamics of the RS comes into play at higher speeds: Its claimed acceleration for zero to 1,000 meters (0.62 mile) is 23.5 seconds, compared with 23.6 for the base model and 24.1 for the RT. The factory reports top speeds as 133 mph for the base model and RT and 136 mph for the RS. After riding the K 100, it appears to me that those numbers are conservative. **PS**

FACTORY DIRECT

## AIR BEDS FROM \$19.95



**IT'S TIME YOU TRIED SLEEPING ON AIR.** Your back & joints don't ache in the morning because of less pressure. You don't toss & turn as much and generally sleep deeper and more restfully because of less body movement. Air-cushioned comfort provides a better night's sleep as opposed to lying on a mattress of rigid metal springs.

**GENUINE AIR COIL CONSTRUCTION...** Herein lies the magic. Controlled Air Chambers are what support you when lying, sitting or lounging. You (and your sleeping partner) don't sink down in the middle. Instead you are both securely supported at all times in maximum comfort & stability. Also, a **Portable Spare Bed** inflating in minutes with an Air Bed Air Pump, vacuum or hair dryer. Rich camel color comes in Velveteen (suede-like finish

shown above) or vinyl. Inflates to 8" high. Dealer Inquiries Welcome.

**SHOP FASTER BY PHONE  
1-805-966-7187**

Or send a check or credit card # for Air Bed(s) below. Sorry no C.O.D. Add \$5.95 shipping per bed. (Canada add \$15.00.) CA res. 6% tax. If not satisfied return within 15 days from prompt refund (less shipping).

Bed Size	Vinyl	Velveteen
■ Singles (29" x 72")	■ \$19.95 (#600)	■ \$29.95 (#605)
■ Twin (39" x 75")	■ 29.95 (#601)	■ 39.95 (#606)
■ Full (54" x 75")	■ 39.95 (#602)	■ 49.95 (#607)
■ Queen (60" x 80")	■ 49.95 (#603)	■ 59.95 (#608)
■ King (76" x 80")	■ 59.95 (#604)	■ 69.95 (#609)
■ AIR PUMP (#669) - \$14.50 (plus \$2.00 shipping ea.)		

**STARSHINE OF SANTA BARBARA**  
816B State St., Dept. BD107,  
Santa Barbara, CA 93101

America's Premium Direct Mail House Now In Our 8th Year

# 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!

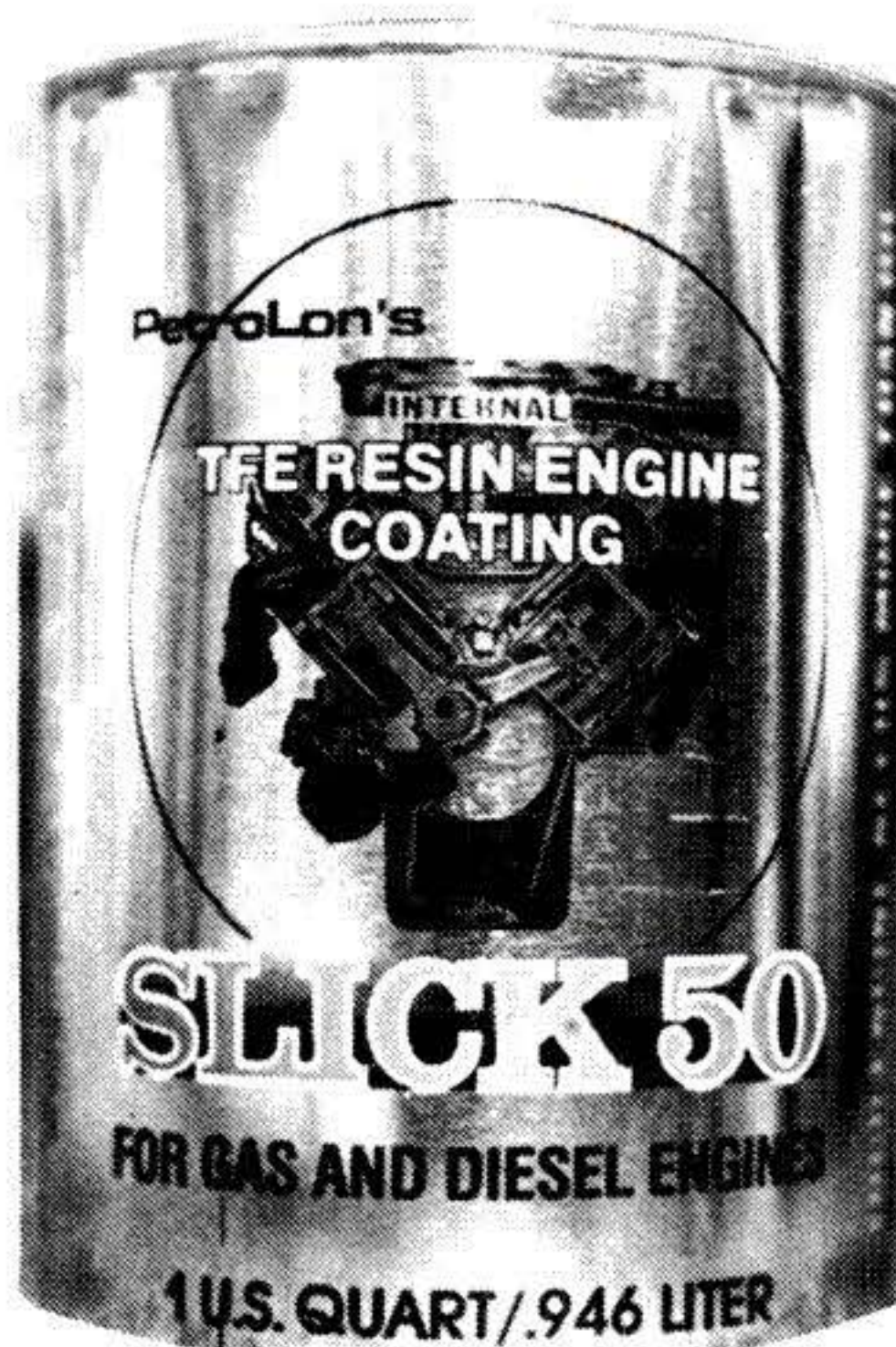
**WHAT IS POLY?** "Poly" is short for polytetrafluoroethylene (TFE). It is the slipperiest substance known to man (1981 Guinness Book of World Records, p. 188). The PetroLon Corporation, makers of Slick 50, has invented a way to permanently bind this slippery chemical to your engine with one treatment. 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 tankfulls of gas (\$34.95).

**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.

**Free engine flush sent with each order. Free shipping with orders of 2 or more.**

For purchase or further information, call toll free 1-800-228-6505, ext. 180 (in Nebraska call 1-800-642-9606) or send to: **FT. MORGAN SLICK 50, 15160 Hwy. 144, #7, Fort Morgan, CO 80701.**

-----PS4

I enclose \$34.95 + \$4.00 shipping and handling.

I want 2 or more (free shipping & handling).

Check       C.O.D.       Visa/MC

Card # \_\_\_\_\_ Exp. \_\_\_\_\_

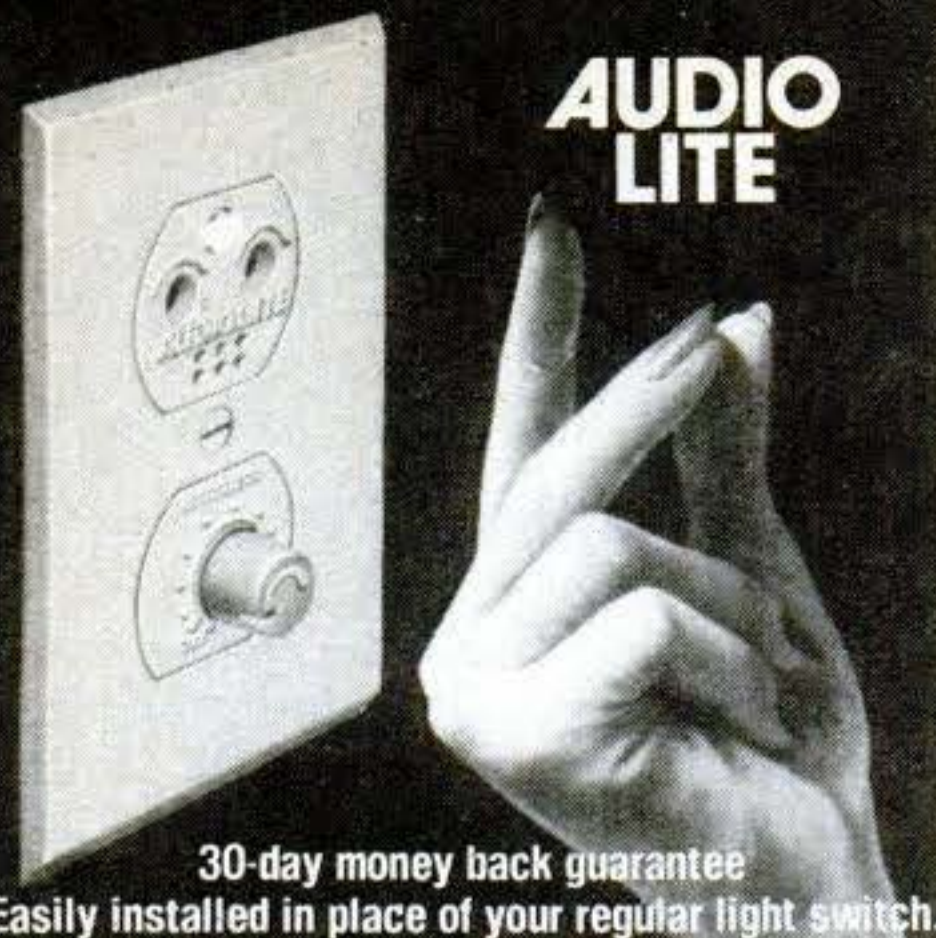
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Address \_\_\_\_\_  
(Give Street Address if possible for U.P.S. Delivery)

City \_\_\_\_\_

State \_\_\_\_\_ Zip \_\_\_\_\_

With a snap of the fingers, lights go on or off.



**Audiolite™!** The new way to turn your lights on and off without touching a switch. When the switch hears a sound, it turns on the lights and keeps them on as long as the sound persists. Actuating the switch starts a clock which works on a time control. Includes dimmer control and manual on/off positions. Installs in place of your light switch, and connects to the same 2 wires. Requires a standard 2-hole face plate, the same used on ordinary electric outlets. One Audiolite controls up to 300 watts. Audiolite has solid-state microcomputer circuitry to ensure years of trouble-free service. 1 year warranty. Incandescent models only.

Send check, money order or credit card number to:

**LS&S GROUP INC.**  
 P.O. Box 673, Northbrook, IL 60062

Send \_\_\_\_\_ AUDIOLITE(s) at \$32.00 each plus \$2.50 for postage and handling (for \$98.00 for 4 Audiolites, plus \$4.50 for postage and handling), within U.S.A. IL residents add 6% sales tax.

Name \_\_\_\_\_  
 Address \_\_\_\_\_  
 City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_  
 Allow 6 weeks for delivery. Add 2-3 weeks if paid by check.

Visa \_\_\_\_\_ MasterCard \_\_\_\_\_ Signature \_\_\_\_\_ (required on credit card purchase)

Credit card no. \_\_\_\_\_ Exp. Date \_\_\_\_\_  
**ORDER TOLL FREE 1-800/323-6556 Ext. R-23**  
 In Illinois, call 1-800/942-6345 Ext. R-23  
 (24 hours, including Saturdays and Sunday)

## The house that computers built

[Continued from page 77]

fire, the home control system also alerts occupants and the fire department.

The home control system also provides security:

- A perimeter "fence"—actually a buried cable—sets up an electromagnetic field that is monitored by sensors. The control system is alerted if someone passes through the field.

- Voice-activated locks in exterior sliding doors recognize only occupants of the house or those given temporary passes.

- Pressure-sensitive windows have sensors that alert the control system if broken.

- Heat-sensing detection is the final defense if an intruder gains entrance. Using the IR sensors of the fire-extinguishing nozzles, the control system can inform police of the intruder's location, alert occupants, or even attempt to frighten him.

### What can a robot do?

"Some people may actually still like to clean house," says Owen. He, however, is not one of them. The House of the Future uses "buffer zones" to prevent dirt from entering the house in the first place. (These are essentially mud rooms; some old ideas are still good ones.) The mobile service unit (see photo), a robot that moves on flat surfaces and communicates with the home control system, vacuums the floors and shampoos the rugs. (Yes, it does windows.)

"What can a robot do?" asks Owen. "Things that don't have to be terribly intelligent. You don't want a robot in a dangerous or expensive situation where it has to be right all of the time. For example, we don't think a robot ought to dust; who knows, maybe it's got a defective circuit and it wipes off a Ming vase."

But a robot can do vacuuming (you'd move furniture yourself for thorough cleanings), and it could wash clothes "if you help it out by clipping things you want cleaned on hangers," says Owen. "A bar code on a tag attached to an article of clothing could indicate how it's to be washed, and the robot could locate and sort the clothes by finding the clips."

In the kitchen, a robot could be taught to set the table using IIT's MIMIC programming system (see drawing). It could also serve food "in the sense of bringing in foods that are placed on a serving cart," says Owen. "You wouldn't want a robot to place food on your plate, however."

"In general, we don't think robots should be running around the house being involved in your life. A robot should not be seen and not be heard," advises Owen. Dish and clothes wash-

ing are done in a separate "service station"; other robot tasks can be done at night or when no one's home.

Nothing should ever get lost in the closets of the House of the Future. These are "storage cores"—dustproof enclosures with automated systems of rotating shelves or tracks with hangers for clothing (similar to those you see in dry cleaners' shops). If you want an item, you'd ask the home control system to find it for you. It would direct you to the appropriate storage core and rotate the shelf the item is on to the access door. In a child's room the door would be placed lower.

"We started out designing a number of special things for children," says Owen. "But it turned out that nearly everything is related to them. In fact, children know a house most intimately—every nook and cranny." Modular replaceable partitions allow interior spaces to change as children grow, and features such as wash basins that can be relocated closer to the floor via flexible plumbing solve problems of scale.

But to return to the problem mentioned earlier: Although the House of the Future could be built with near-term technology, it isn't practical with today's housing practices. "There are code problems," explains Owen. "In Chicago and other communities, for example, you still can't use plastic pipe or BX cable. We're told they're dangerous and a fire hazard. Well, it really doesn't have much to do with that. It has to do with the fact that it takes a union member longer to lay conduit and put screw threads on pipe." Flexible plumbing is another example of technology that can't be used in homes. "The problem is," says Owen, "we've got outdated union rules and local codes and bankers who won't give mortgages to anyone who's building anything unusual."

Still, Owen is optimistic. "The '80s could be different," he says. "Many people who put off having children now need housing and should be able to afford it, but can't. There could be a lot of political pressure from them to get affordable housing. The housing industry must go through the same painful rethinking and reorganization that the auto industry has gone through."

But what company could produce such an all-encompassing housing scheme? "A company like Sears," says Owen, "or another multi-service company that could supply all the internals, even the electronics. Or a consortium of companies could do it."

But whether or not IIT's House of the Future is ever built, it represents an impressive achievement. **PS**

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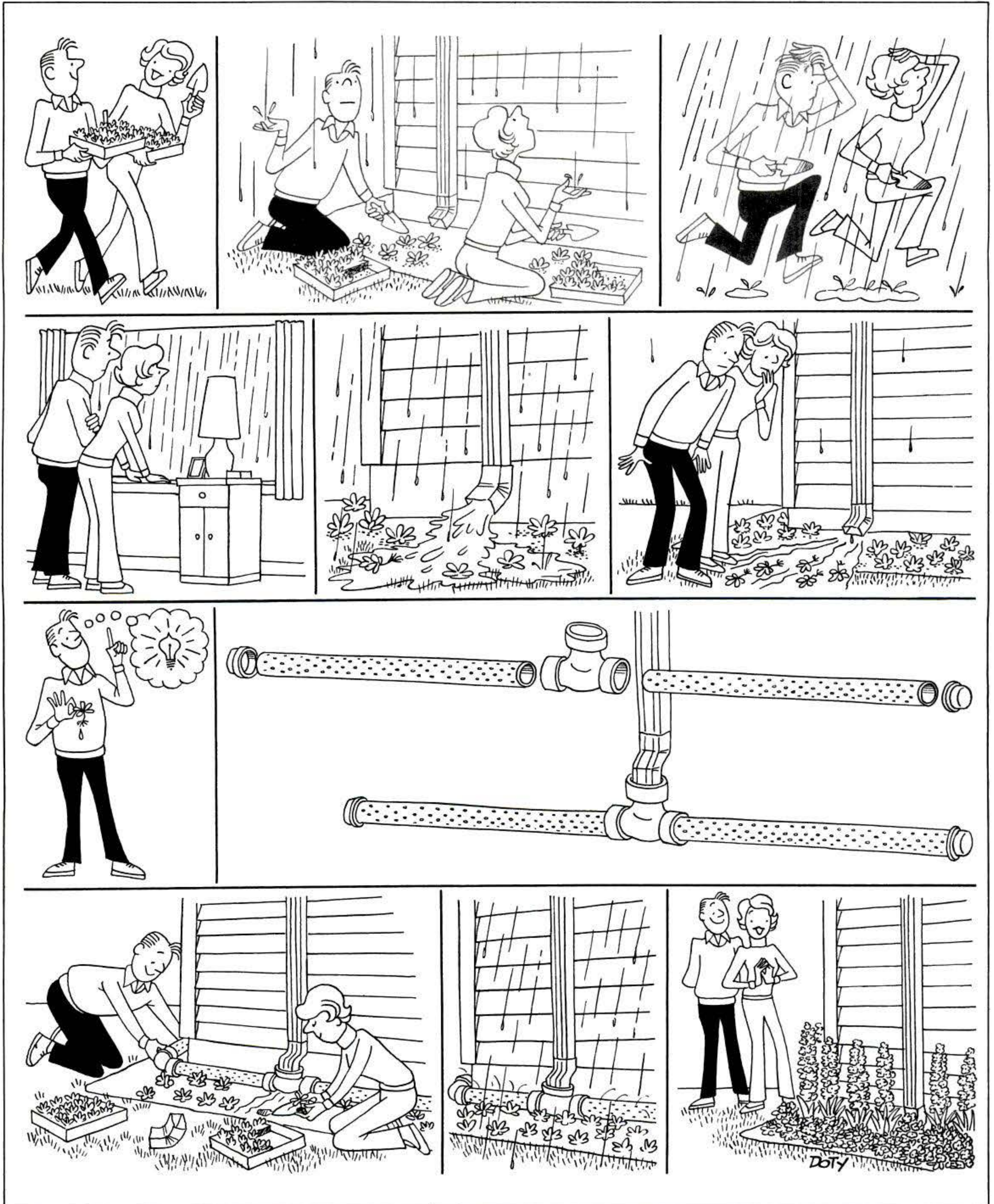
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# Wordless Workshop

By ROY DOTY

\$50 to John Weitendorf of Dallas, Texas, for this idea. Send yours (with Social Security No.) to Wordless, POPULAR SCIENCE, 380 Madison Ave., New York, N.Y. 10017. None can be returned.



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## 10-step tuneup for your outboard

The weather's balmy, the fish are running, and you can't wait to get out on the water. Still, an outboard-motor tuneup *now* will allow you to concentrate on the fish for the rest of the season. We asked the experts at the Outboard Marine Corp. for a simple program:

1. Start with your spark plugs. Clean them, and be sure they're gapped to specs. Also check that the terminal connections and wiring are clean, unfrayed, and snug fitting.

2. Check the lubrication level in the lower unit. If the motor looks as if it's been leaking, have a pro check it out. Leaks could mean seals and gaskets need replacing.

3. If you didn't drain the gear case in the fall, do it now. Refill it with the proper lubricant.

4. If your motor has a power-trim unit, check the fluid level in the system's reservoir. Fill with recommended fluid if needed.

5. When checking fluid levels, don't forget the battery—especially if you have an electric-start or remote-control system. Remove corrosion from terminals, and be sure the battery is fully charged.

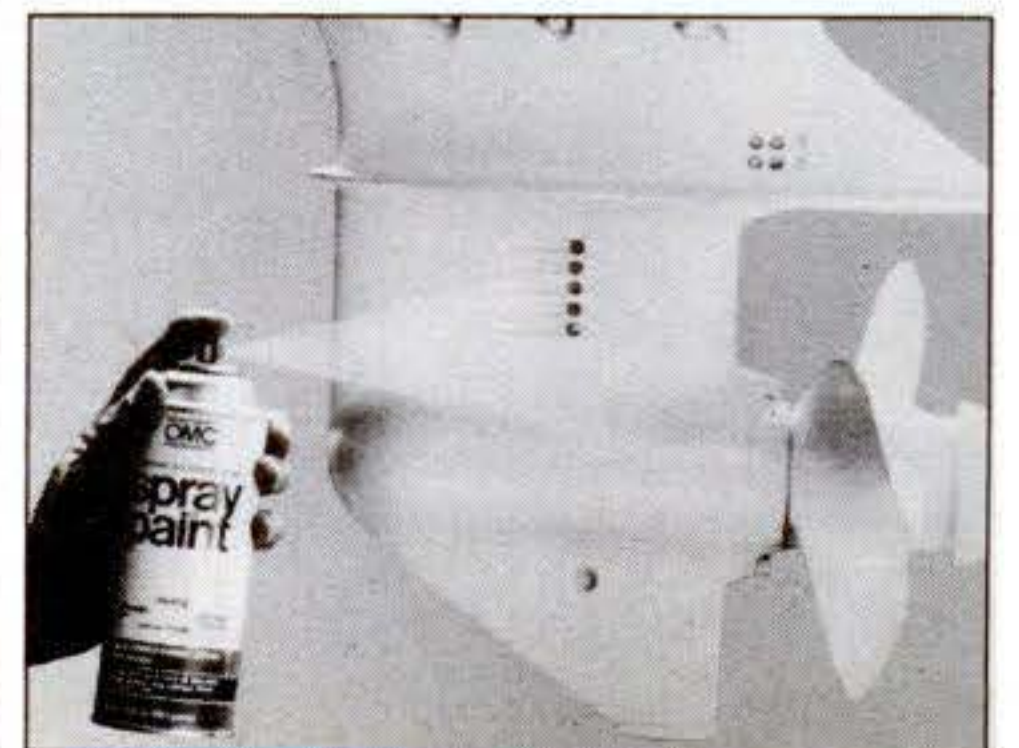
6. Drain old fuel from the tank, and clean the fuel-pump filter. Add new fuel, and check for leaks.

7. Examine the propeller for dents, gouges, and bends. Your finely tuned outboard will not deliver peak performance if there's even a small dent in the prop, says OMC. But a dealer can usually repair moderately beat-up units.

8. For efficient running, the boat's hull must be clean—so scrape off any barnacles and dried weeds.

9. Use an engine degreaser under the power hood and an all-purpose marine cleaner outside.

10. Touch up scratches with color-matched spray paint (photo) and apply auto wax.—Susan Renner-Smith



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If, for example, you have a lawn of a quarter-acre or less, and time isn't really an issue, your best bet is probably a walk-behind mower. There are several models available, including the 21-inch self-propelled version pictured above. It comes with a dependable 4-hp engine, a deep die-cast aluminum deck, and rear-wheel gear drive that provides excellent traction, even on hillsides. An optional rear grass bag enables you to trim on either side.

If you have a larger lawn and you'd rather spend less time mowing it and more time enjoying it, you may prefer one of the five new John Deere riding mowers. Even the 8-hp R70, the lowest-cost model, will mow a half-acre in just 30 to 45 minutes, depending on the amount of trimming to be done. In fact, when you consider the high-quality features and solid construction of the R70, you probably can't find a better rider for the money. It has a 30-inch mower, a full-length welded steel frame, a 5-speed shift-on-the-go gear-drive transmission, and an optional 6½-bushel rear grass bag.

Or, if you own an acre or more, and mowing's become a big production, a John Deere lawn tractor may be in order. The 116, for instance, with a 46-inch mower and 16-hp engine, will mow an acre of lawn in about 45 minutes. All seven John Deere lawn tractors provide added versatility with an optional front blade, snow thrower, dumpcart, lawn thatcher, and rear-mounted grass bagger (for 30- or 38-inch mowers).

So the choice is yours. From 4-hp walk-behind mowers to 16-hp lawn tractors. But regardless of how long it takes to do the job, you'll be doing it with the best.

*For more information or the name of the dealer nearest you, call 800-447-9126 toll free (Illinois, call 800-322-6796) or write John Deere, Dept. 62/59, Moline, IL 61265.*



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If you choose the rugged 6.2 liter V-8 diesel engine as an option, you'll have a practical pickup ideal for work situations involving stop and go driving.

The compact S-15 on the left is available with 4-cylinder or V-6 power. The 2.2 liter L4 diesel can haul up to 1,250 pounds, and the V-6 up to 1,625 pounds. Or when properly equipped, the S-15 can tow up to 5,000 pounds.

Full-size pickup cargo beds are available in 6½' and 8' lengths. The S-15 pickup has 6'1" or 7'5" cargo beds available.

Both versions feature tough, girder-beam, independent front suspension. You can get optional four-wheel drive. S-15's Insta-Trac system lets you shift from 2- to 4-wheel drive without stopping.

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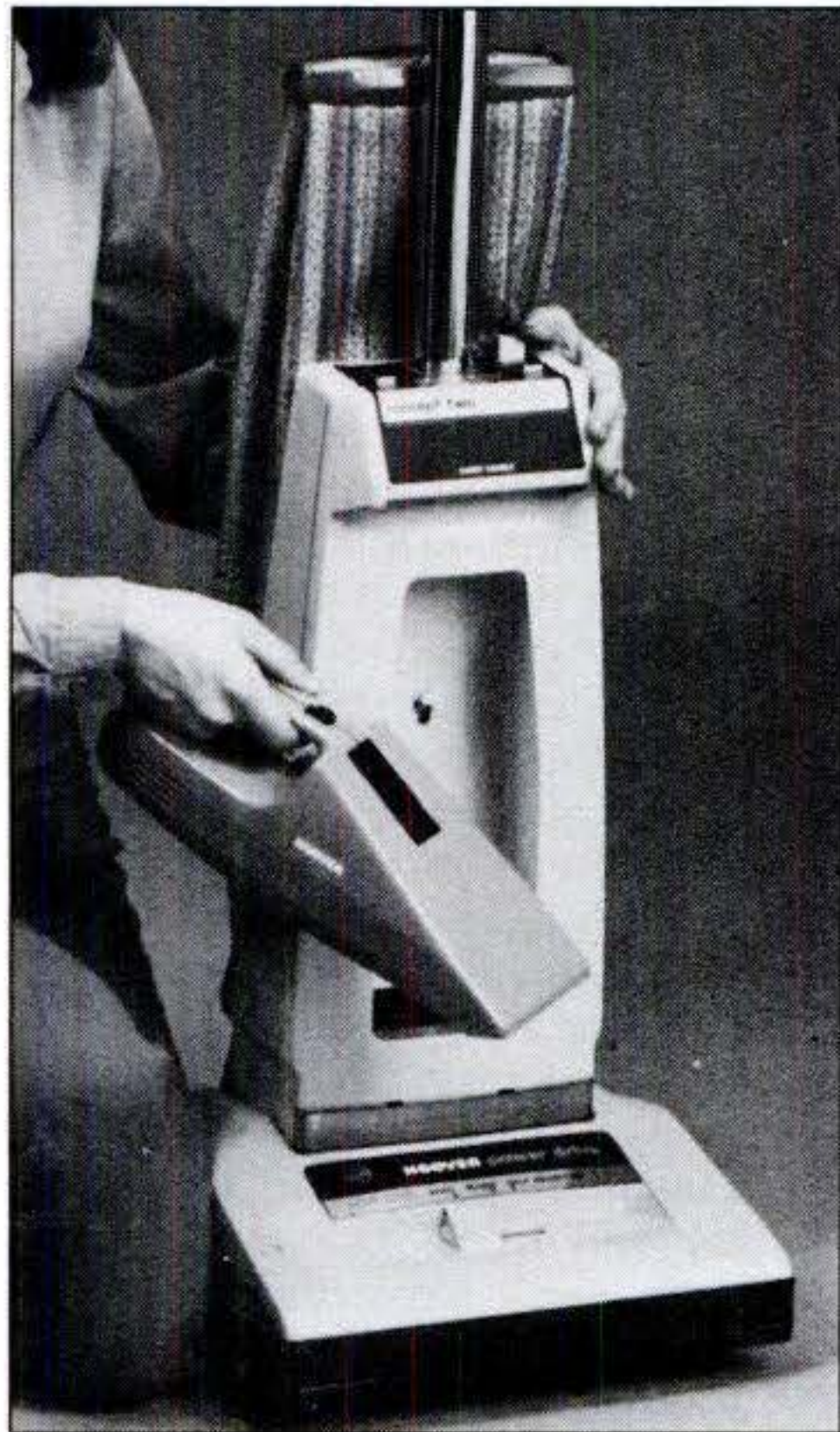
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# Housepower Clinic

By EVAN POWELL



## Improved appliance

If you've wrestled with upright-vacuum attachments that, at best, do a mediocre job of dusting and cleaning crevices, you'll welcome Hoover's new Concept Two cleaning system. It's an upright vacuum with a kangaroo-type caddy for a portable vacuum. Once the carpet is clean, you simply release the portable—called the Help-Mate—and attach the power cord, and you're ready for any hand touch-up. A brush and crevice tool for the Help-Mate are included. One drawback: The Help-Mate bag has to be emptied more frequently than the larger vacuum bags. I'm finding this piggyback to be one of the more powerful portable vacuums, especially handy for picking up sawdust after an on-site home-improvement project.

## Q&A Direct-drive blowers

I'm planning to have a new heating-cooling system installed in my house this summer, and I have been looking at new high-efficiency furnaces. I've been advised by friends (one of whom is in the heating business) that I should get a furnace with a belt-drive

blower. All of those that I've seen, though, have the motor attached directly to the fan. One dealer said he would check to see whether I could get the belt-drive blower as an extra-cost option. Would it be worth the \$85 difference?

Jim Garrison, Baltimore, Md.

*If you really enjoy adjusting the V-belt every season, replacing it every other season, and listening to it squeak and rattle in the meantime, buy a unit with a belt drive. I would choose a direct-drive blower without reservation. There once was some basis for the advice you received. When direct-drive blowers were first introduced, they were usually on small furnaces—some of the blowers were undersize. Many of them were also single-speed blowers, and you normally need at least two speeds when a furnace is used as the air handler for both an air-conditioning and heating system. These days, properly sized direct-drive blowers do the job well. They have few moving parts, and most of them offer up to seven different speed selections—you simply choose the proper taps on the motor terminal board.*

## Too cold to cool

When we operate our Westinghouse 12,000-Btu air conditioner in humid weather, water condenses on the fins of the coil. If we continue to run the machine, this condensed water turns into ice and frost, which blocks airflow. The unit becomes useless until shut down for defrosting. When we restart it, the same thing happens again. Apparently this is a common problem.

K. S. Goranson, Ancram, N.Y.

*Water running off the evaporator coil is normal—dehumidification aids comfort as much as cooling under humid conditions. But the coil temperature should not drop below freezing unless the surrounding air temperature drops very low. This could happen if the unit runs all night with the thermostat on a high setting.*

*Assuming that the unit is not being operated under these conditions, the cause of the low coil temperature might be restricted airflow across the coil. The most common cause is a dirty filter, which can also result in plugged*

*cooling fins. To remedy this, spray the coil with a commercial coil-cleaning solution or a heavy-duty household cleaning solution, allow it to stay on for 15 to 30 minutes, and finally flush with a spray of clear water.*

*If that doesn't do the trick, slide the chassis out of the cabinet to reach the fan motor (after first unplugging the unit, of course). Check to see that the fan blades are attached firmly to the motor shaft, that the motor is not binding, and that the bearings are well lubricated.*

*The thermostat can cause icing conditions if it's not calibrated properly or if it's not cycling the compressor off at the proper temperature. An improperly located thermostat sensing tube can contribute to this problem, too. Some sensing tubes are placed within a block of temperature-conducting material and are designed purposely to sense icing before it blocks the coil, allowing the compressor to shut down and the unit to defrost itself while still providing cooling. The unit then restarts automatically. If the sensing tube has pulled away from the clips that attach it to the evaporator coil, it could cause the problem you describe.*

*If nothing remedies the problem, you can buy a de-icer, at least for some older models. Check with a Westinghouse dealer.*

## Home-built air compressor

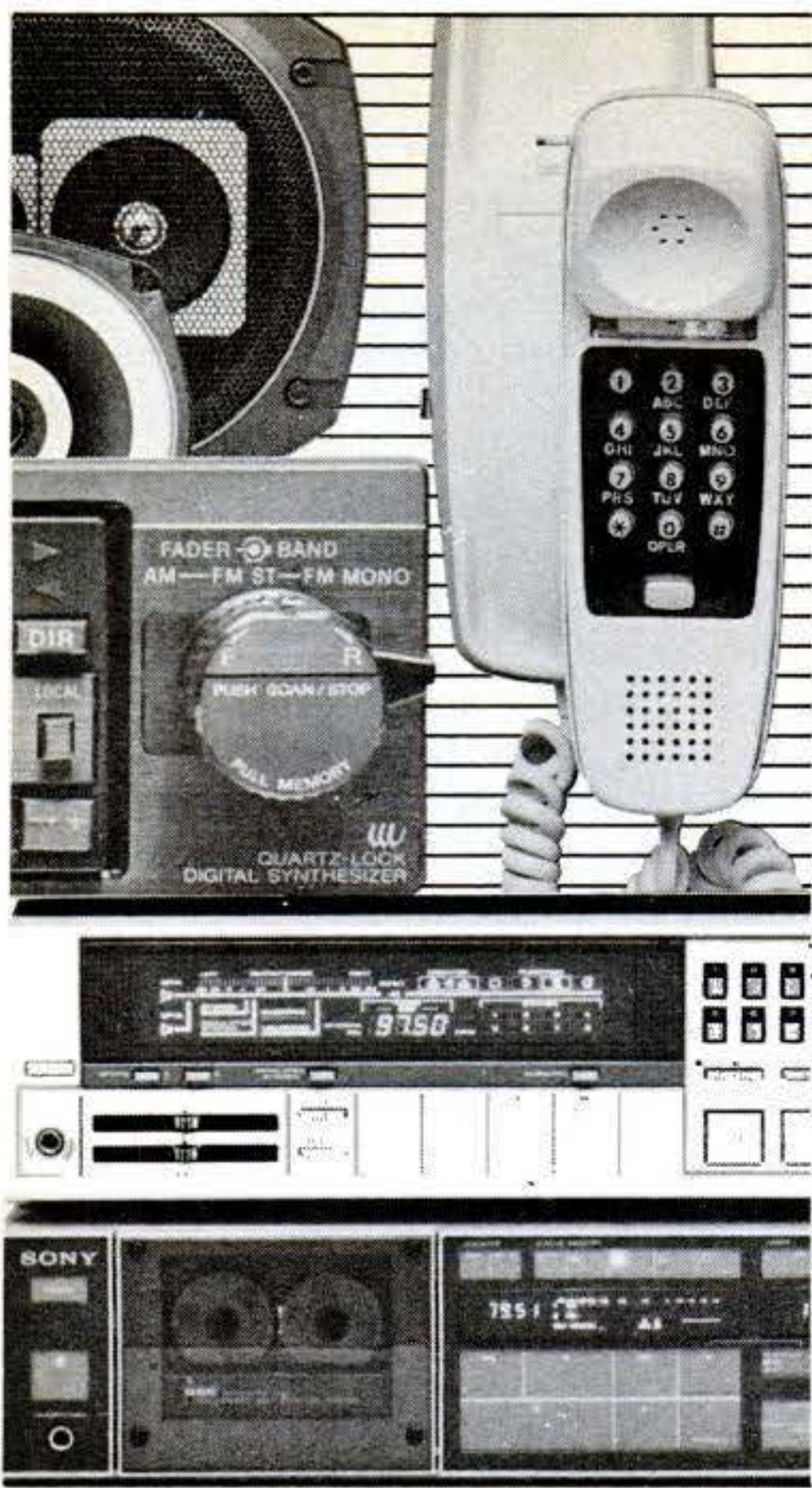
I need information on transforming a refrigerator-freezer compressor into an air compressor for my shop. My unit has a 110-volt ½-horsepower motor and a single-cylinder compressor.

Darwin Hendricks, Sellersville, Pa.

*What you propose can work, but the results are likely to be short-lived. I'd advise you to buy a used air compressor, for a number of reasons.*

*Refrigeration compressors are not the same as standard air compressors. Modern hermetic compressors are designed to recirculate some of the refrigeration oil through the system with the refrigerant. The vapor coming back into the head of the compressor both lubricates the compressor and bearing surfaces and cools the compressor windings. If a refrigerator compressor is used as an air compressor, even with a separate precooler circuit, that oil will soon be lost, and the lack of proper cooling will soon damage the motor windings.*

Got a home-equipment problem? Write to Evan Powell/Housepower Clinic, Chestnut Mountain, Rte. 1, Box 322A, Travelers Rest, S.C. 29690. Give appliance make and model number. Unpublished questions cannot be answered by mail.



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## CRUTCHFIELD

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# Shop Talk

By AL LEES

## Sample the future this summer

None of us should find leisure time hanging heavy this summer, what with the Los Angeles Olympics and two big political circuses (donkeys in San Francisco, elephants in Dallas) grabbing major TV time. Still, except for the few lucky attendees, these events offer only armchair participation, largely indoors. Between commitments to the tube, most of us will be seeking vacation destinations. So with the *POPULAR SCIENCE* reader's penchant for advanced technology in mind, I compiled this informal list of suggestions:

- The summer's other event that's bound to get national attention is the New Orleans fair—or, to be precise, the Louisiana World Exposition. With the verbose theme "The World of Rivers: Fresh Water as a Source of Life," it opens on May 12, to run through Nov. 11. The 82-acre site along the Mississippi River is getting spruced up as I write this. Like Knoxville two years ago, New Orleans is taking advantage of fairground preparations to upgrade a depressed area adjacent to downtown, with demolition of derelict buildings and reclamation of several old warehouses. Aside from a number of foreign pavilions, a major

exhibit will be a wholly new version of the Energy Saving House featured at Knoxville. All pavilions will be open from 10 a.m. to 10 p.m. daily. One-day gate fee is \$15.

- Speaking of Knoxville, if you are heading for New Orleans and your route takes you near that 1982 fair site, you can catch some of its energy exhibits at the American Museum of Science and Energy in Oak Ridge, Tenn.—the town that calls itself "The Frontier of the Nuclear Age." This major museum features its own energy-saving house, seen at far right in the upper photo below. (A typical exhibit, with hands-on electronics, is shown on the next page.) When the energy fair closed in the fall of '82, the museum bid for—and remounted—the best exhibits from several pavilions to add to its own extensive displays. It's open from 9 a.m. to 6 p.m. Monday through Friday and 12:30 p.m. to 6 p.m. on Sundays, and—a rarity in this age—it's free. Just follow the special signs for 15 miles off I-75.

- It was in our May '81 special section on high-tech houses that you first learned about a sprayed-foam, domed-and-turreted fancy called—after the Coleridge poem—Xanadu (bottom photo, left). This original version is in the Midwest resort town of Wisconsin

*Continued*



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- Hooked on Swing ..... 04722
- Statler Bros.: Today ..... 33753
- Stevie Nicks: Bella Donna ..... 43739
- J. Geils: Showtime ..... 13346
- Led Zeppelin: Coda ..... 33759
- Best Best Merle Haggard ..... 33505
- Chris Cross: Another Page ..... 34400
- Bob Seger: Night Moves ..... 43584
- Alabama: Feels So Right ..... 53632
- Hall & Oates: Private Eyes ..... 34524
- Joan Jett: I Love Rock ..... 43995
- Fleetwood Mac: Mirage ..... 04802

### Start Saving NOW!

Start Now with 3 Hit Albums for 1¢! Yes, pick any 3 records, or cassettes, or 8-track tapes...for just 1¢. Then agree to buy only 1 more hit at regular Club prices (usually \$8.98 to \$9.98) ...and take up to one full year to do it...with nothing more to buy ever! That's 4 smash hits for the price of one!

**No Further Obligation Whatsoever!** It's all up to you! You buy what you want...when you want to. This is one record and tape offer that really is different. And you pocket the savings!

**Exciting "Members-Only" Benefits.** Once you enroll, you'll receive your subscription to our exclusive music magazine, **MEDLEY**. Each issue is crammed with hundreds of hit tapes and records—many as low as \$2.98 to \$3.98—plus your featured "Selection of the Month" in your favorite category. In all, you'll have 19 convenient, shop-at-home opportunities a year.

**It's Easy to Get Your Favorite Hits!** If you want the "Selection of the Month," do nothing. It will be sent to you automatically. If you want other selections, or none: just indicate your preference on the card always provided...and mail it back to us by the date specified. You'll always have at least 10 days to decide. But if you don't, you may return your "Selection of the Month" at our expense for full credit. As a member in good standing, send no money when you order, we'll bill you later. A postage and handling charge is added to each shipment.

**FREE 10-Day No-Risk Offer!** Listen to your 3 big hits for a full 10 days. If not satisfied, return them for a prompt refund. You risk *nothing!* So don't delay. Pick your hits, write the code numbers in the boxes on the right, and mail today!



RCA Music Service, 6550 E. 30th St., Indianapolis, IN 46291

Send back this coupon...today!



**MAIL TO: RCA MUSIC SERVICE,  
P.O. BOX RCA 1  
INDIANAPOLIS, IN 46291**

I enclose 1¢. Please accept my trial membership in the RCA Music Service and send me the 3 hits I've indicated here under the terms outlined in this advertisement. I agree to buy just 1 more hit at regular Music Service prices in 1 year's time—after which I may cancel my membership. (A postage and handling charge is added to each shipment.)

**2 SEND MY SELECTIONS ON (check one only):**  
 Cassettes  Records  8-Track Tapes

**3 I am most interested in the following type of music—but I am always free to choose from every category (check one only):**

1  Easy Listening (Instrumental/Vocal Moods) 2  Country  
3  Hard Rock 4  Pop/Soft Rock 5  Classical

**4 RUSH ME THESE 3 SELECTIONS (indicate by number)**

\_\_\_\_\_

**5**  Mr.  
 Mrs.  
 Miss \_\_\_\_\_ (Please Print)

Address \_\_\_\_\_

City \_\_\_\_\_

State \_\_\_\_\_ Zip \_\_\_\_\_

Telephone (Area Code) \_\_\_\_\_

**6** Have you bought anything else by mail in  
 last 6 months  year  never  UAD  YV

RCA Music Service reserves the right to request additional information or reject any application. Limited to new members; continental U.S.A. only; one membership per family. Local taxes, if any, will be added.



# FRESH AIR BREAKTHROUGH!

THE COLLECTOR

SAVE 25%

NOW ONLY \$89.95

ORIGINALLY \$119.95

AMERICA'S PHENOMENAL ACCEPTANCE OF "THE COLLECTOR" RESULTS IN A NEW LOWER PRICE

IF YOU WANT CLEAN FRESH AIR OR YOU'VE UNPLUGGED YOUR POPULAR FILTER-FAN UNIT BECAUSE IT DOESN'T WORK THEN READ THIS...

Is your indoor air fresh, clean, and alive? Indoor air pollution is becoming a national health hazard. Energy efficient, airtight buildings are stifled with stale, polluted air which contains tobacco smoke, smoke and soot from fireplaces, heating systems, and cooking appliances; as well as dust, pollen, viruses, and bacteria. Most of these pollutants are so small (under 5 microns) that they are not effectively removed by common, small filter-fan units. Scientific tests show that these noisy, toy-like devices which emit chemical "citrus" odors are no match for The Collector, by Zestron, in thoroughly cleaning indoor air.

### ZESTRON BRINGS YOU NATURE'S ANSWER

You know how fresh and vibrant the air feels right after a rainstorm, in the mountains, or near a waterfall. That clean, alive, fresh air is rich in something important that is greatly depleted in our urban and indoor air. That missing element is negative ions, nature's own air cleaners. Many users experience great benefit from these amazing active ions, including feelings of aliveness, alertness and vitality similar to that experienced in the fresh mountain air. In addition, even hospitals use ionizers in some units.

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.

### THE ZESTRON BREAKTHROUGH!

Most ionizers clean your air but leave an untidy deposit of pollutants on room and furniture surfaces near the ionizer. The COLLECTOR takes ion technology a giant step forward by giving you superpowered ion output while depositing pollutants from your air on Zestron's exclusive easy to clean Collector Panel.

### AMAZING DEMONSTRATION!

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.

### THOUSANDS OF SATISFIED USERS

Don't you, your family and friends deserve the healthy, clean, fresh air that Zestron ionizers have brought to thousands of satisfied users? Users write: "I simply cannot believe how much better I feel" Dr. E. K. D. D. S. - MA. "I smoke heavily and it has cleared the air as advertised" G. P. - WA. "It has done everything you say. I'm amazed at the clean air, how it absorbs odors and collects dust" P. M. - K. Y.

When you use your COLLECTOR, you'll quickly feel the difference it makes and smell the freshness in your air. You'll actually see the elimination of smoke and dust in your air!

### SILICON VALLEY TECHNOLOGY

The COLLECTOR, incorporating years of high

reliability design experience, is built with quality parts in the heart of Silicon Valley, USA, to give you years of trouble free service.

The COLLECTOR operates anywhere in your home or office for pennies a month and has nothing to wear out or replace.

### SUPERPOWER OUTPUT

The COLLECTOR, by Zestron, is the only bipolar collecting ionizer with superpower output. The thoroughness and speed of air cleaning increases with more ion output, and Zestron ionizers give you the highest output (without detectable ozone). Don't be misled by low cost, low output units stating output at the emitter. Check the comparison chart below. Don't buy any ionizer not stating output using the industry standard of ions/cc/sec. at one meter.

IONIZER	ADVERTISED OUTPUT (1 m.) ions/cc/sec.	BIPOLARIZED
The COLLECTOR by Zestron	1,200,000	YES
JSA Bubble	not stated	YES
Orbit	not stated	YES
AirEase	not stated	YES
AirCarell	236,000	YES
Ion Fountain	540,000	NO
Modulian	75,000	NO

### FREE ION DETECTOR

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!

### SATISFACTION GUARANTEED

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.

### ADDITIONAL DEALERSHIPS AVAILABLE

Reorders are pouring in. Customers write: "We are enjoying the results of the first one and are ordering two more" Dr. J. B. M. C. - CA. "I'm a distributor for three other ion companies, and have to say I am extremely, extremely impressed" T. N. - CA.

ZESTRON, the leader in ion technology, has created a unique DEALERSHIP PROGRAM. Call or write for details on this RISK FREE OPPORTUNITY.

### TO ORDER—CALL TOLL FREE 800-372-1200.

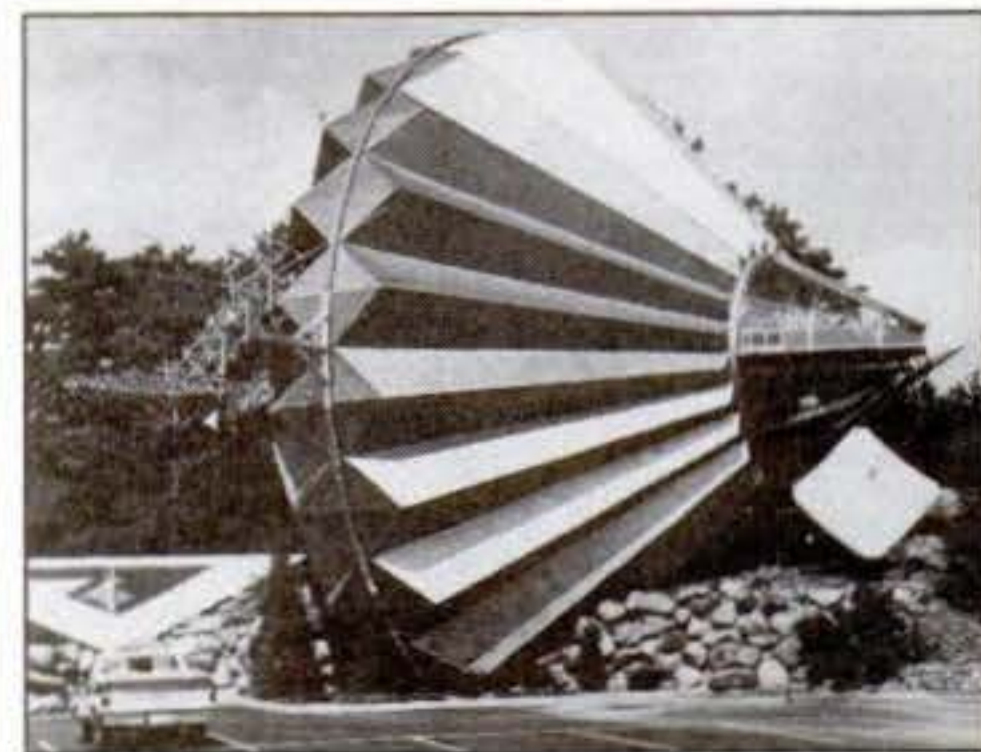
In Calif: 800-392-1200 or (408) 371-1200. TWX 910 590 8032. Use your credit card or send check or money order to Zestron, Inc., Dept. P 44, 1901 S. Bascom Ave., Campbell, CA 95008. Add \$4.00 shipping and handling per unit. (Calif. residents add 6.5% tax.) Orders outside U.S. add 15% to unit cost. Order one at \$89.95 or two at \$79.95 each. For additional quantity discounts, call Zestron, Inc.

## Shop Talk

Dells, Wis. Its success as a paid-tour attraction has caused near-replicas to spring up like mushrooms in other parts of the country. I've visited the original as well as its copy in the Great Smokies resort of Gatlinburg, Tenn. (something else you could catch on your way to New Orleans). But I've not toured the third version, just opened near Disney World in Orlando, Fla. All three are total-electronic demo homes and well worth a visit. Check hours and admissions with the Xanadu of your choice.

• Also nearby in Florida, of course, is Disney's latest wonder, EPCOT Center, where yet another technology pavilion—this one sponsored by General Electric—recently opened. There is no more-impressive demonstration of computer programming anywhere than the vast complex itself—every aspect of which is plugged into a giant control center.

• That pleated cone in the last photo houses another entertaining peek at the future in Wisconsin Dells. It's Tommy Bartlett's Robot World. The structure is as intriguing as the automated "home of tomorrow" it encloses: It's hung on tension cables stretched from a giant central hoop that's 215 feet in circumference. Every inch of the 115,000 cubic feet of space inside is ramped for fanciful displays of home robotics and computerized controls of home systems. Admission is \$4.95 for adults and \$3.50 for children 12 and under. April through June it's open from 10 a.m. to 8 p.m.; during the peak summer season, hours are 8 a.m. to midnight. P.S.

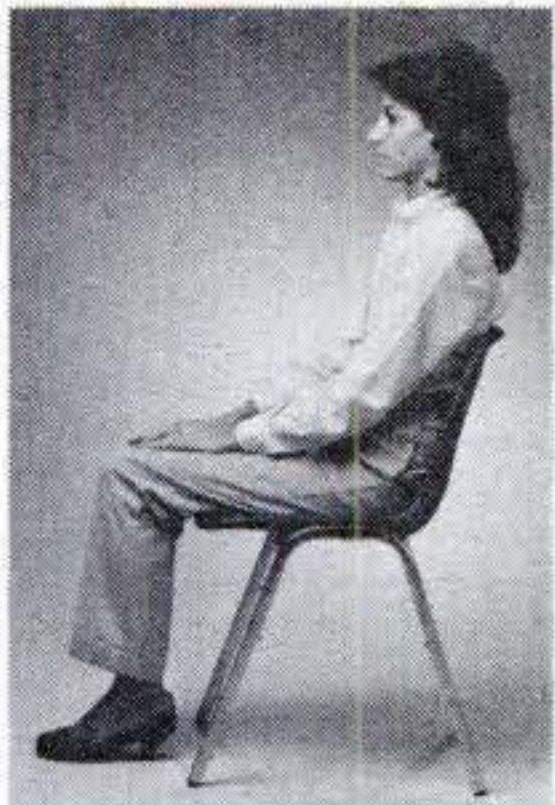


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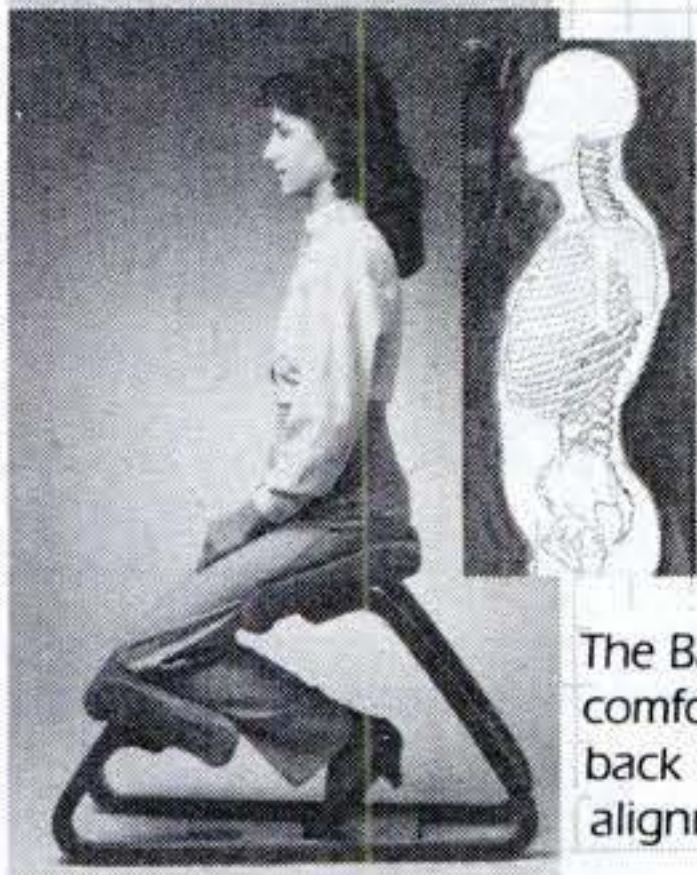


# A new concept in sitting.

## THE BACK CHAIR



**CONVENTIONAL CHAIR**  
Sitting in a conventional chair forces your lower back forward, creating excess stress on your spine & back muscles.



**THE BACK CHAIR**  
The Back Chair allows you to sit comfortably with your spine & back muscles in perfect alignment.



**ONLY \$89<sup>95</sup>**

Computer desk designed by  
Island Computer Desks, Santa Barbara, CA

### THE FIRST INTELLIGENT CHAIR

Consider the alternative — THE BACK CHAIR, the new chair designed with one goal in mind, the care of your back, spine, health & well-being.

### REDUCE THE EFFECT OF GRAVITY ON YOUR BACK

If you're sitting regularly in a conventional chair, your lower back is supporting the **total weight** of your body, plus additional weight due to the downward effect of gravity on your body. **No wonder millions of people complain about backaches every year!** Most doctors have long recognized that many back and neck problems are the result of improper posture when sitting. Unfortunately most chairs are designed for appearance, not for the health of your back. The BACK CHAIR'S therapeutic design was created by a team of designers collaborating with doctors and physical therapists.

### THE BACK CHAIR SOLUTION

**Sitting on the BACK CHAIR relieves your back from supporting the total weight of your body by distributing the weight between your lower back and legs.** The BACK CHAIR design is nothing more than simple common sense. Your legs support you when standing, your lower back supports you when sitting — combine them both in a comfortable sitting posture and you relieve the unnecessary stress on your back. When sitting on the BACK CHAIR you'll surprisingly feel much more relaxed, you'll

sit up absolutely and comfortably straight; and with the pressure off your lower back you'll breathe deeper with less effort. **At home or especially at work** the BACK CHAIR will help you in improving your posture and enhance your fitness and exercise program throughout the day. Made of multiple layers of hardwood with a final layer of oak, the BACK CHAIR assembles in 15 minutes with a screwdriver. Enjoy one for two weeks as our guest and see how intelligent chair design can soothe your aching back and greatly improve your sense of wellbeing throughout the day.

■■■■■■ MAIL COUPON WITH ORDER ■■■■■■  
**SHOP FASTER BY PHONE**  
**1 - 805 - 966 - 7187**

Or send a check or your credit card # (Diner's Club, VISA, MasterCard, American Express) for THE BACK CHAIR @ \$89.95 ea. plus \$9.95 shipping (Canadian orders \$13.00 shipping). CA residents add 6% sales tax. Sorry no C.O.D. If not satisfied return within 15 days for a refund (less shipping).

ITEM NO.	QUAN.	ITEM	PRICE EA.	SHIPPING	TOTAL
825		BACK CHAIR	\$89.95		

**STARSHINE OF SANTA BARBARA**  
816B State Street, Dept. BC-111, Santa Barbara, CA 93101





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**SPECIFICATIONS:**

- 5 HP
- 230 VOLT, 15 AMP
- TWIN CYLINDER
- 932 RPM
- AIR DELIVERY AFCM @ 40/90 PSI—11.8/9.4
- 125 # MAX PRESSURE
- ASME RATED 60 GAL. TANK (vert.)
- REGULATOR WITH GAUGE
- 15' HOSE
- METAL TIRE CHUCK
- 28 1/2" L x 23 1/2" W x 7 1/4" H
- SHIP. WT. 340 lbs.

5 H.P. MOTOR

MADE BY Famous CAMPBELL HAUSFELD

TWIN CYLINDER COMPRESSOR

PRESSURE SWITCH

ASME SAFETY VALVE

INSPECTION PORT

MODEL VT-5587 HEAVY DUTY COMMERCIAL 5 H.P. 60 GAL.

Made in U.S.A.

MOISTURE DRAIN

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Comes with 1 YEAR WARRANTY

**Perfect for:**

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- GAS STATIONS
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- SMALL FACTORIES
- MAINTENANCE OPERATIONS
- GARAGES

## ASME RATED TANK

Now YOU can buy the best selling 5 H.P. Air Compressor in the country at an incredibly low LIQUIDATION price!

This HEAVY DUTY workhorse of a compressor is perfect for running PAINT SPRAY GUNS, GREASE GUNS, POLISHERS, STAPLERS, SANDERS, IMPACT WRENCHES, AIR HAMMERS, DRILLS, TIRE CHANGERS or almost any labor saving pneumatic tool! And, because it was designed for COMMERCIAL applications, it has plenty of capacity to power many tools simultaneously. Depending, of course, on the air requirements of each tool.

Don't confuse this model with cheaply made imported or promotional compressors sold elsewhere! This is a TOP OF THE LINE compressor made in the U.S.A. by CAMPBELL HAUSFELD. They have been one of the WORLD'S LARGEST manufacturers of quality air compressors for over 43 years! Each unit comes with a manufacturer's 1 YEAR WARRANTY backed by over 300 SERVICE CENTERS NATIONWIDE!

Our buyers have been searching for a really good compressor liquidation for many years. Finally, after six months of negotiations we acquired this LIMITED QUANTITY of BRAND NEW CAMPBELL HAUSFELD compressors. Priced BELOW DEALER COST and at a savings of up to \$600.00, this is truly a rare bargain. Be sure and call or mail your order right away!

Compare up to \$1200.<sup>00</sup>

OUT THEY GO FOR ONLY

**\$599.**

Plus \$40.00 for Shipping & Handling

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COLLECT

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REMAINING INVENTORY AT BELOW DEALER COST 4250 WATT ELECTRIC START POWER GENERATORS!

Easy-spin RECOIL STARTER

ELECTRIC START push button

ALL COPPER WINDINGS

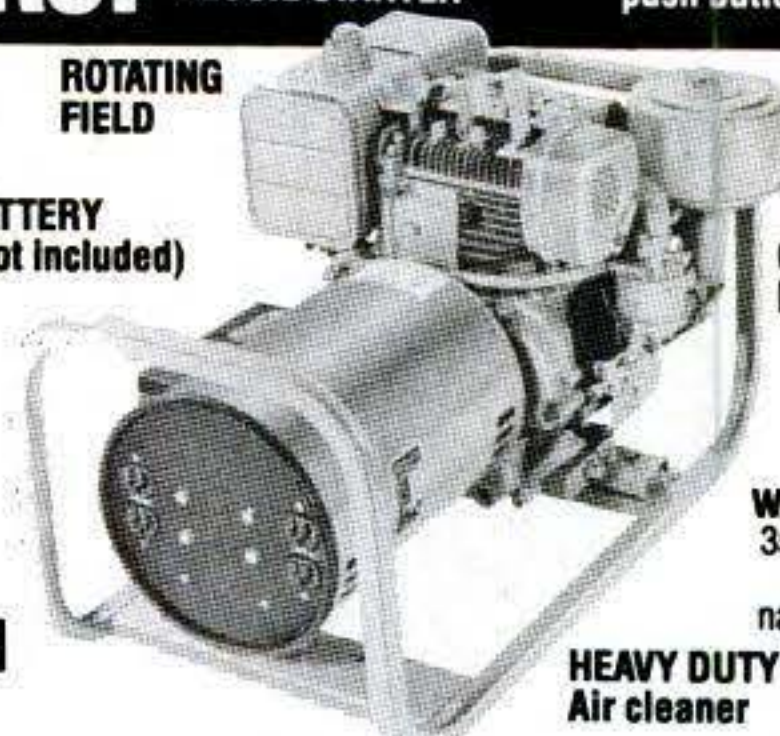
ROTATING FIELD

BATTERY (Not included)

QUIET MUFFLER

GASOLINE POWERED or can be factory converted to... GAS & NATURAL GAS or GAS & PROPANE!

8 H.P. BRIGGS & STRATTON 4-CYCLE ENGINE



1 YEAR WARRANTY 350 service centers nationwide.

HEAVY DUTY Air cleaner

2-240V & 2-120V RECEPTACLES 35.4/17.7 AMPS

## Protect your HOME or BUSINESS with "stand-by" ELECTRIC POWER!

A severe storm or utility power failure could leave you without electricity for hours, even days, shutting down ALL your home or business electrical equipment. Furnace motors would not run (pipes could freeze!)... refrigerators and freezers full of food could spoil... water pumps, sump pumps, lights, ranges and TVs would not operate. With blackouts, brownouts and severe storms becoming more frequent a STAND BY generator makes really good sense.

4250 WATT SURGE POWER or run all day at 3800 WATT continuous power



Keeps Electric blankets & furnace running during storms.



Runs appliances during power outage.



Runs electrical equipment anywhere.

## Use it ANYWHERE...ANYTIME to power tools & equipment!

This generator is COMPLETELY PORTABLE and incorporates the latest state of the art technology.

Don't confuse this ELECTRIC START POWER-RYTE generator with inferior imported or outdated models sold elsewhere! This is a BRAND NEW, TOP OF THE LINE, 1984 MODEL with a powerful 8 H.P. BRIGGS & STRATTON ENGINE. And, because this is a ROTATING FIELD unit, not rotating armature, the power is taken directly from the stator. This prevents heavy amperage wear points at the brushes and provides plenty of MOTOR STARTING SURGE POWER. (Extremely important feature when starting furnace, sump pump, air conditioner, etc. motors).

Made in the U.S.A., by a leading generator manufacturer, this POWER-RYTE comes with a 1 YEAR WARRANTY on electrical and 90 DAY WARRANTY on the engine.

Compare the features and price with ANY OTHER comparable model on the market today. You'll quickly realize what a great value this is. And (at a savings of up to \$700.00), these POWER-RYTE generators will sell out fast... so call or mail your order now!

Comparable Models prices at \$1200.00

OUT THEY GO AT ONLY

**\$499.**

- Motor starting capacity up to 1 1/4 H.P.
- NEMA standard receptacles meet OSHA and NEC regulations
- Heavy gauge carrying frame
- Size: 27 1/2" L x 19" H x 19" W
- Weight: 158 lbs.

Factory conversion to GAS & NATURAL GAS—\$150.00 ADDITIONAL GAS & PROPANE—\$150.00 ADDITIONAL

LIQUIDATION BUREAU, INC. 3602 N. 35th AVE., PHOENIX, AZ 85017

Dept. A25G-4

Send \_\_\_\_\_ 5 H.P. 60 GAL. COMPRESSOR(S) @ \$599.00 ea. plus \$40.00 ea. for shipping and handling. \_\_\_\_\_ 4250 WATT electric start GENERATOR(S) @ 499.00 ea.

Convert to  GAS & NATURAL GAS  GAS & PROPANE (Add \$150.00 each conversion). I will pay driver shipping charges upon delivery.

Enclosed is my money order or check. (AZ Res. add 6% Tax)

Charge my  VISA  MASTERCARD (Please PRINT clearly).

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Please no C.O.D.s • Orders accepted in Continental U.S. ONLY • Allow 4 to 5 weeks for delivery. If paid by personal check add 2 to 3 weeks.

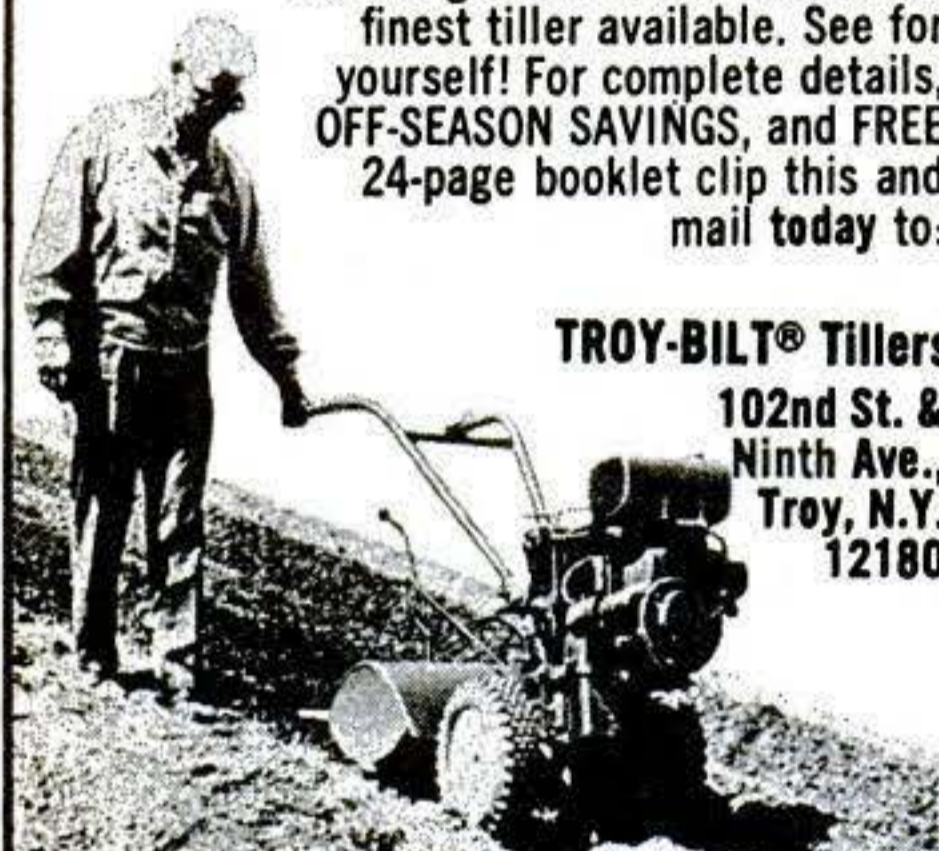
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Record telephone conversations in your office or home. Connects between any cassette or tape recorder and your telephone or telephone LINE. Starts automatically when phone is answered. Records both sides of phone conversation. Stops recorder when phone is hung up. This device is not an answering service.



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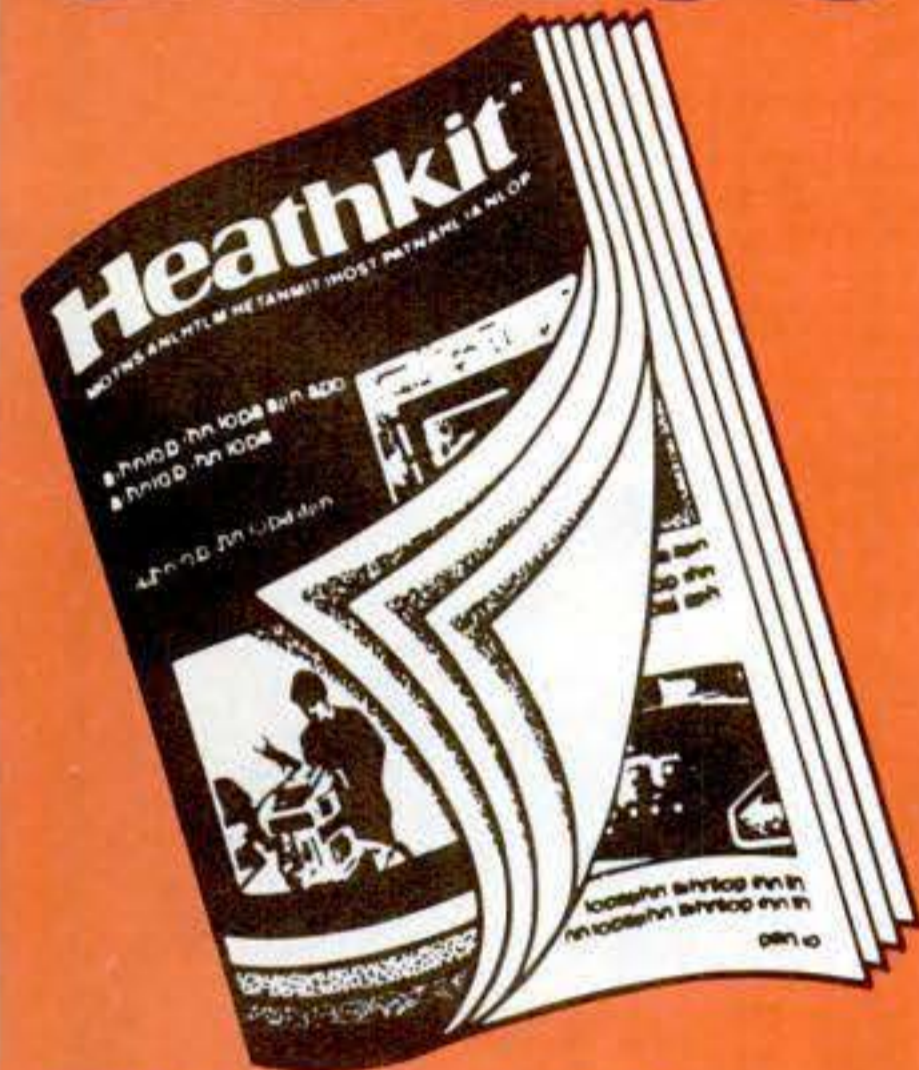
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It's a great way to relax in your spare time, resulting in beautiful things you'll be proud to have in your home. And it's easy. The famous Heathkit illustrated manuals make it easy for anyone to build reliable craftsman-like kits.

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It costs nothing to discover the complete line of Heath electronic kits. Don't miss it. Clip and mail the coupon now.

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MI 49022

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Benton Harbor, MI 49022

Send my free Heathkit Catalog now.  
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## Stop Unwanted Habits—Lose Weight Enjoy Success & Better Health

With SCWL® **Subliminal Techniques** you can go beyond your **greatest** expectations. Accomplish your most desired goals quickly and simply when you learn the truly remarkable principle of these new Behavioral Science Techniques. SCWL® has now become the choice of Doctors, Professional Athletes and men and women from all walks of life. Why? Because **positive results** can be achieved so easily and inexpensively by anyone.

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Explore your inner **creativity** that will spur exciting new thoughts, inventions and money making ideas. With SCWL® **Techniques** you'll discover new talents. Play music, develop skills, improve your athletic ability and **much, much more!**

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This SCWL® **Technique** alone could prove invaluable. Learn faster - Remember more. Like a computer, your mind stores everything you have ever experienced ready to be recalled at the **exact** moment you choose. Tell jokes, give speeches, read and comprehend information no matter how technical **without** any memory course of any kind.

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**Relieve Stress - Overcome Nervousness  
Become More Self-Confident**

Now you can eliminate fear, worry, anxieties and get more from everyday living. Understand your inner thoughts. Dictate total control over any situation, overcome nervousness, attract love and find **complete success** in everything you do. SCWL® **Techniques** work without exception "automatically". Because you already have the natural ability to make it happen.

### USE THE MOST POWERFUL SOURCE

Science has proven your only limitations are that of your conscious thought—self-imposed limitations that unconsciously determine your happiness, your personal well-being, success or failure. SCWL® **Techniques** simply **release** your mind's own **natural** abilities by reaching the most powerful source (your own subconscious mind). **With this there is no limit to what you can achieve.**

### THE MIND & THE SCWL® TECHNIQUE

Guaranteed to be one of the most enlightening dynamic cassette tapes you'll ever hear. Learn how you can possess absolute control over all conditions in your life with SCWL® **Techniques**. **Write Today** - it could be the most important step in your future.

## Midwest Research Inc.

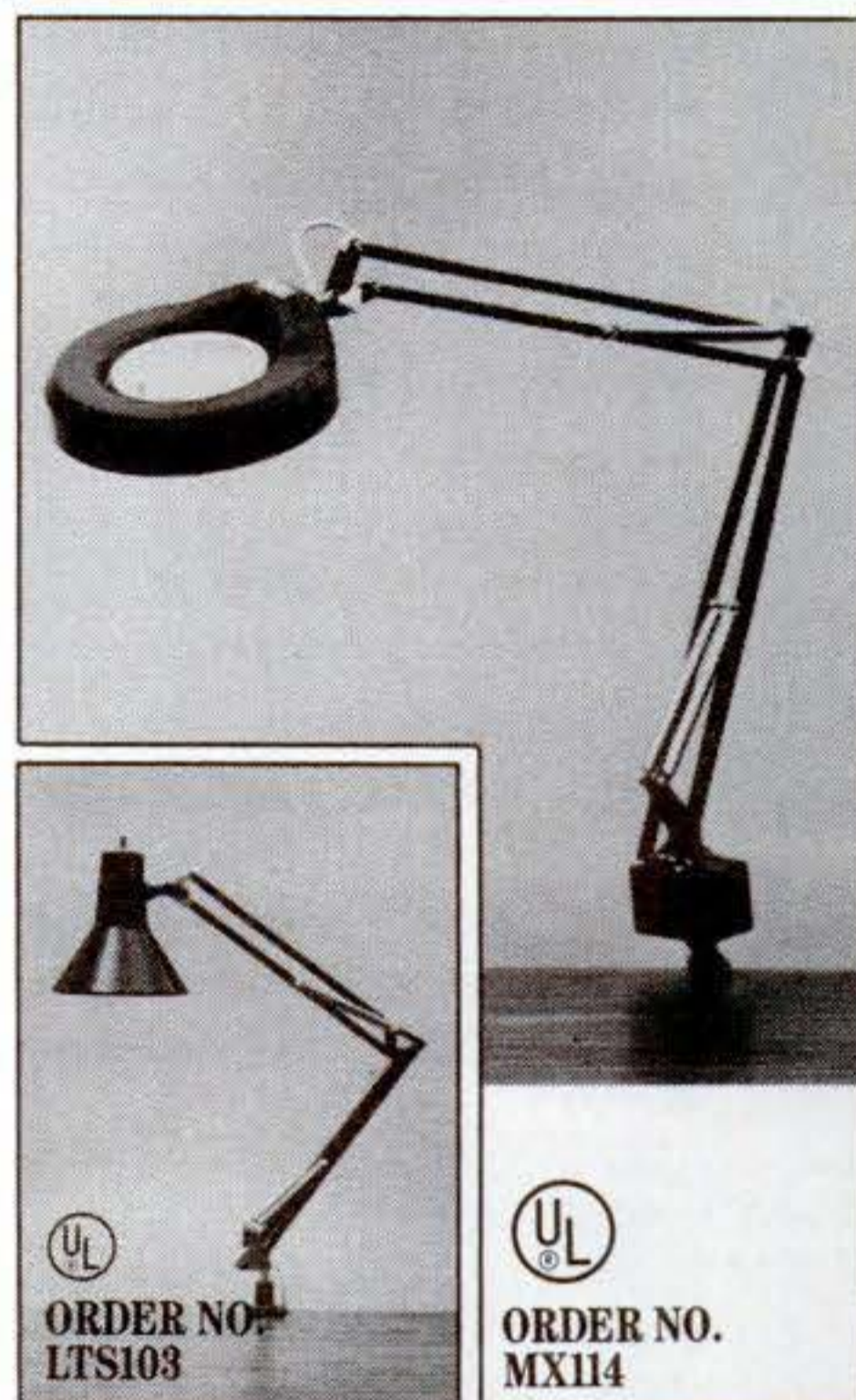
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Our literature is FREE.

- Please rush FREE literature.  
 I want to know even more about SCWL® Enclosed is \$3.00 for Introductory Cassette.

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# STUDIO SPEC™ MAGNIFIER LAMP AT \$59.95 YOU CAN'T AFFORD TO BE WITHOUT IT.



This quality all-metal construction UL recognized lamp uses a standard 22W fluorescent circline bulb (the bulb is included!). Features of this great buy include a polished, distortion-free glass magnifier (X3); a 4-way, all metal clamp bracket; a full 45" reach. The lamp is available in two colors; Ivory and chocolate brown.

You must agree, it's a steal at only \$59.95 each (plus shipping). If you buy 5 or more, it's only \$54.95 each (plus shipping). Order No. MX114.

Shipping is only \$5.00 each in the continental USA.

**SPECIAL BONUS!** If you buy one or more of the magnifier lamps, you can get our LTS103 bench lamp for only \$10.95 each (plus \$2.80 each shipping). The LTS103 is UL listed to 100 W, utilizes a porcelain socket, and includes mounting brackets.



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ELECTRONICS  
"OUR SERVICE MAKES THE DIFFERENCE"

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Northridge, CA 91325

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MasterCard and  
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**EXCLUSIVE  
ONE HOUR  
SHIPPING**

QTY	ORDER NO.	COLOR	PRICE	SHPG	EXT
—	80-MX114	—	\$59.95*	\$5.00	—
—	80-LTS103	—	\$10.95	\$2.80	—
—	80-MX115-FL	—	\$ 5.95	\$2.00	—

\*Only \$54.95 for 5 or more

**TOTAL** —

Credit Card# \_\_\_\_\_ Exp. Date \_\_\_\_\_

Name (please print) \_\_\_\_\_

Signature \_\_\_\_\_

THE FASTEST, EASIEST

\$100,000

You'll Ever Make in Your Life, Yours Now

WITHOUT A PENNY OF INVESTMENT

WITHOUT LEAVING YOUR HOME

WITHIN 90 DAYS

"WORKING" ABOUT ONE HOUR A DAY  
(OR EVENING)



There are all kinds of ways to make money. Good golly, really — if anyone knows that, I do! For the past 20+ years I've concentrated on finding, investigating, creating and specifically singling out only the very finest legal and ethical methods for carving out a mass of wealth in a hurry. But believe me, in all those years never have I experienced anything remotely as exciting as this one!

Recently, I came across a fairly new way to make big bucks, but after a thorough study I discarded it because it required too much investment of time, money and personal effort. But my study did serve as inspiration to develop yet another fantastic and unusual wallet-filler — something that until now has never been seen — yet fully complies with the tough set of standards I'm noted for demanding of any potential wealth-producing concept:

Must be able to be started with minimum investment

Must be possible to start at home and not interfere with family life.

Must be able to be started and run initially by one man or woman

Must require only a few hours of spare time per week

Must have realistic annual profit potential of \$40,000 or more

Well, this one goes way beyond my usual rigorous test. This: This extra-ordinary money-maker® allows you to:

Start at once — within 30 seconds of studying my report

Invest not a single cent

Accomplish everything without leaving your home — heck, you can do it from your favorite easy chair whilst eating pizza or petting the dog (or vicey versa!)

Have a potential net profit (not gross ... net!) of \$100,000.00 by the end of 90 days — tops. And that's cash, not theoretical or paper profits.

Usually, you're wondering what all this is — but I'm going to tell you here. No, it's going to cost you ten

For the past two decades Du Vall has captured the imagination of men and women the world over by providing solid, unique direction for their quest for financial freedom. His firm is headquartered in Michigan with international marketing offices in Hong Kong (known as DAX International, John W. Lane, President). In addition to producing some three dozen publications on money-making/self-improvement themes, DuVall is also the creator of the popular Derek Dax adventure/mystery/romance series and the author of the political intrigue novel, "The Big Dream" (published by Lyle Stuart, Inc., New York). Unlike most, he has never had to resort to outlandish money-back guarantees to attract only the finest DAX-DOERS worldwide and no such policy is expressed or implied.

His writings have been used in numerous style and content workshops and accredited courses at such institutions as California State University, UCLA, Fordham, University of Illinois and Worcester Polytechnic Institute.

smackers to find out. But I will tell you what it isn't so you'll not be off on some wild goose chase:

- ★ No sex or off-color stuff
- ★ No chain letter, pyramid or multi-level scam
- ★ No mail order, envelope stuffing or drop-shipping
- ★ No writing or self-publishing how-to stuff
- ★ No loan brokerage scheme
- ★ No stocks, commodities, real estate, etc.
- ★ No gambling, betting or wagering
- ★ No arts, crafts or special skills
- ★ No party-plan, door-to-door or phone selling
- ★ No catalogs, mailing lists, postage, etc.
- ★ No equipment to buy or rent
- ★ No bothering friends, relatives, etc.
- ★ Not anything you have ever seen advertised anywhere

### WHO CAN DO IT

Anyone with even a smidgen of ambition.

### WHAT IS REQUIRED

Other than my step-by-step detailed report ... nothing. I have thought long and hard about it; A person virtually without a shirt on their back or a pot to plant petunias in could do it. You will of course, have to put my plan into motion — but that's both fun and easy and totally accomplished from the comfort of your own home. (By the way, no one will be coming to your home, either.)

Finally, let me make this clear: Once you have my report, that is all you need to get going! I have nothing else to sell you for this deal. Your purchase of this extraordinary report is NOT a "foot in the door" to get you to buy some extra or expensive "course" or whatever ... this is all you need from me!

### WANT PROOF?

We have over 10,000 'tasty testimonials' from housewives, doctors, lawyers, layed-off factory workers—all sorts of good people. These excerpts sum up their feelings:

*"Thanks a million times . . . you have proved 100% accurate in what you said in your advertisement. Doing this work is so easy! I sometimes work while in bed. Should you come up with another ingenious thing, please let me know."*

Mohidin Mohammed, Sweden

*"We are so impressed . . . have our 13 and 16 year olds involved . . . thanks for giving our family new hope."*

MacClear Family, Indiana

*" . . . man in economically depressed area left \$35,000 secure job to put this method to work . . . made \$120,000. First man I've ever met who really made money on idea purchased through mail."*

David Roman, Editor, ROMAN REPORTS, Ohio

### WHAT TO DO NOW

You've got two choices:

1. Put this ad aside, wait 90 days or so and perhaps lose your chance at \$100,000.

### Nifty Bonus!

A few months back in our DAX MONEY-MAKER® CONFIDENTIAL NEWSLETTER, we reported on another business that can easily net \$1,000 a week for life. It's a bit more involved and does require getting out and about, but our readers were so delighted with it that I'm including it as an extra free bonus when you order our new special DAX report, "\$100,000 in 90 Days."

2. Do the only sensible thing. Send me the ten bucks and get started on wearing in that path to the bank.

P.S. One more thing (say, this Du Vall is a windy so and so, isn't he!). There are lots of people right now in bad financial straits. I hope you're not one of them, but if you are, having read this ad you now have absolutely no excuse for being broke, because as the saying goes, "This is it!" This could truly be the once-and-for-all solution to any money miseries you have. I guess you'll have to take my word for it until you receive these fabulous reports — but if it eases your mind any, over 1,000,000 men and women worldwide have been, over the years repeat buyers of my books, courses, reports, cassette tape programs and newsletters. There must be a reason . . .

— Dean F. V. Du Vall

Du Vall Press Financial Publications  
920 W. Grand River, Williamston, Michigan 48895

For same day DAX processing mail to: BOX 14-ND50 WILLIAMSTON, MI 48895

Dean — this sounds like just what I'm looking for — a chance to make mega-bux without any investment or having to leave the house. The same day you receive my order rush me your new DAX Special Report, "\$100,000 in 90 Days" plus the Free Bonus Report, "\$1,000 A Week for Life." Enclosed is ten dollars.



For Personal Success

Zip \_\_\_\_\_

Optional:  Add \$2 for individual handling/first class postage.

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## NOW! Get in on the PROFITS in SMALL ENGINE REPAIR

Work part time, full time — right at home — we help you every step of the way.

No doubt about it... as a small engine pro, you can cash in on the huge demand for qualified men in one of America's fastest growing industries. You'll be able to command top hourly rates of from \$10.00 to \$15.00 per hour — and that's just for labor.

Plenty of business waiting for qualified men. 65,000,000 Small Engines Are In Use Today!

That's the official count from the Engine Service Assn., and one-million new engines are being built each month. With Foley-Belsaw training, you can soon have the skill and knowledge to make top money servicing these engines.



Professional Tools and Equipment PLUS 4 hp Engine... All YOURS TO KEEP... All at No Extra Cost.

### NO EXPERIENCE NECESSARY!

You don't need to be a 'born mechanic' or have any prior experience. Lessons are fully illustrated... so clear you can't go wrong, and with our famous 'learn-by-doing' method you get practical 'hands-on' experience.

Foley-Belsaw Institute • 50457 Field Bldg. Kansas City, Mo. 64111

YES, please send me the FREE booklet that gives full details about starting my own business in Small Engine Repair. I understand there is No Obligation and that No Salesman will call on me.



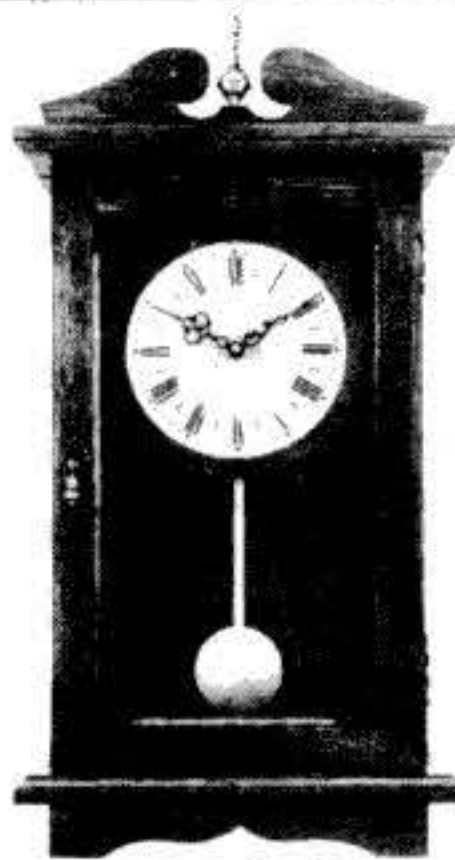
NAME \_\_\_\_\_  
 ADDRESS \_\_\_\_\_  
 CITY \_\_\_\_\_  
 STATE \_\_\_\_\_ ZIP \_\_\_\_\_

## Build This Clock

**\$59.95**

Including movement, dial and hardware.

- Do-it-yourself precut case kit
- Solid hardwood
- Battery quartz movement
- Money back guarantee
- Prompt shipment
- Quality for more than a lifetime



- Send my Early American Wall Clock (Please add \$3.00 to kit price to cover packaging and handling).
- Send my FREE copy of the 1984, 80 page Klockit Catalog.

Name \_\_\_\_\_

Address \_\_\_\_\_

City, State, Zip \_\_\_\_\_

Check Enclosed

Visa  Master Card Exp. Date \_\_\_\_\_

Card No. \_\_\_\_\_

Signature \_\_\_\_\_



Call (414) 248-1150



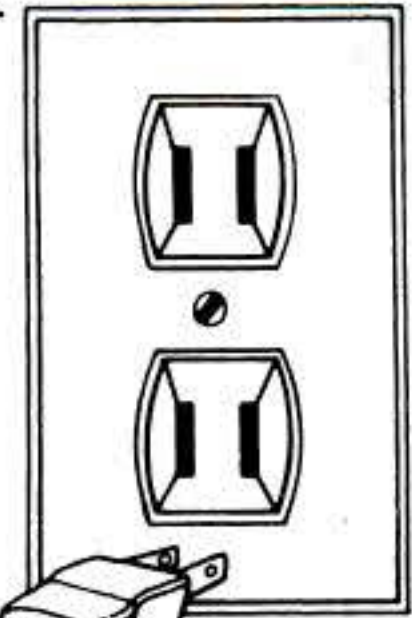
Or Write

**KLOCKIT** DEPT. PS44  
 P.O. BOX 629  
 LAKE GENEVA, WI 53147

**WARNING:  
 IF YOU THINK  
 THE POWER  
 IS OFF  
 WHEN THE SWITCH  
 IS OFF,  
 YOU'RE WRONG.**

### KEEP AWAY FROM WATER.

Everyone knows that electricity and water are a dangerous combination. But did you know that an electric appliance is still electrically alive even if the switch is off? If the plug is in, the power is on. So when you keep appliances near water, keep them unplugged.



**ALWAYS UNPLUG  
 SMALL APPLIANCES.**

Public Service ad from Association of Home Appliance Manufacturers and Underwriters Laboratories Inc.

## \$599.95 NEW Rear Tine TILLER

Powered by a 5 H.P. Briggs & Stratton engine with three forward gears (plus reverse) in an inline pattern, Groundhog II GH-5RT cuts a 26" swath, 14" deep. Big 16" lug tread tires, not tines, do the pulling so the manual effort needed by most front tine tillers is eliminated. Safety clutch is conveniently mounted on handlebar, not on a remote panel like the competition. Factory price saves you up to \$200 on competitive tillers.

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Engineered in kit form for the novice, first time builder. Ready to assemble with all parts precut, predrilled, color coded and lightweight.

Available in sizes from under 700 to over 3500 square feet with unlimited floor plan ideas. Prices start at \$3995.

Send today for Monterey Domes 100 page color Catalog & Plans Book of affordable kit homes. \$6.00.

- Yes, I want to begin my Monterey Domes experience. Please send my 100 page copy of Monterey Domes Catalog & Plans Book. Enclosed is \$6.00.
- Also, please send me the Monterey Domes Basic Home Assembly Manual for an additional \$5.00.

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Send to: **MONTEREY DOMES**  
 Dept. AR-4  
 1760 Chicago Ave.  
 Riverside, Calif. 92517

For Visa or MasterCard orders call 800-321-2244 (In Calif. call 800-336-4455)

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The kids of today are the doctors and nurses, the engineers and scientists, the teachers and journalists, the leaders of tomorrow.

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Please give to the college of your choice.

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## Discover the world's oldest hobby!

## Build this beautiful wooden ship model.

*Special offer for Those who have never built a ship before!*

Wouldn't you love to build this historic ship model? It's a true-to-scale, 21" replica of the 2-masted schooner *Swift*, a Virginia pilot boat of 1805. Well, now you can! And you don't have to be a skilled craftsman to do so.

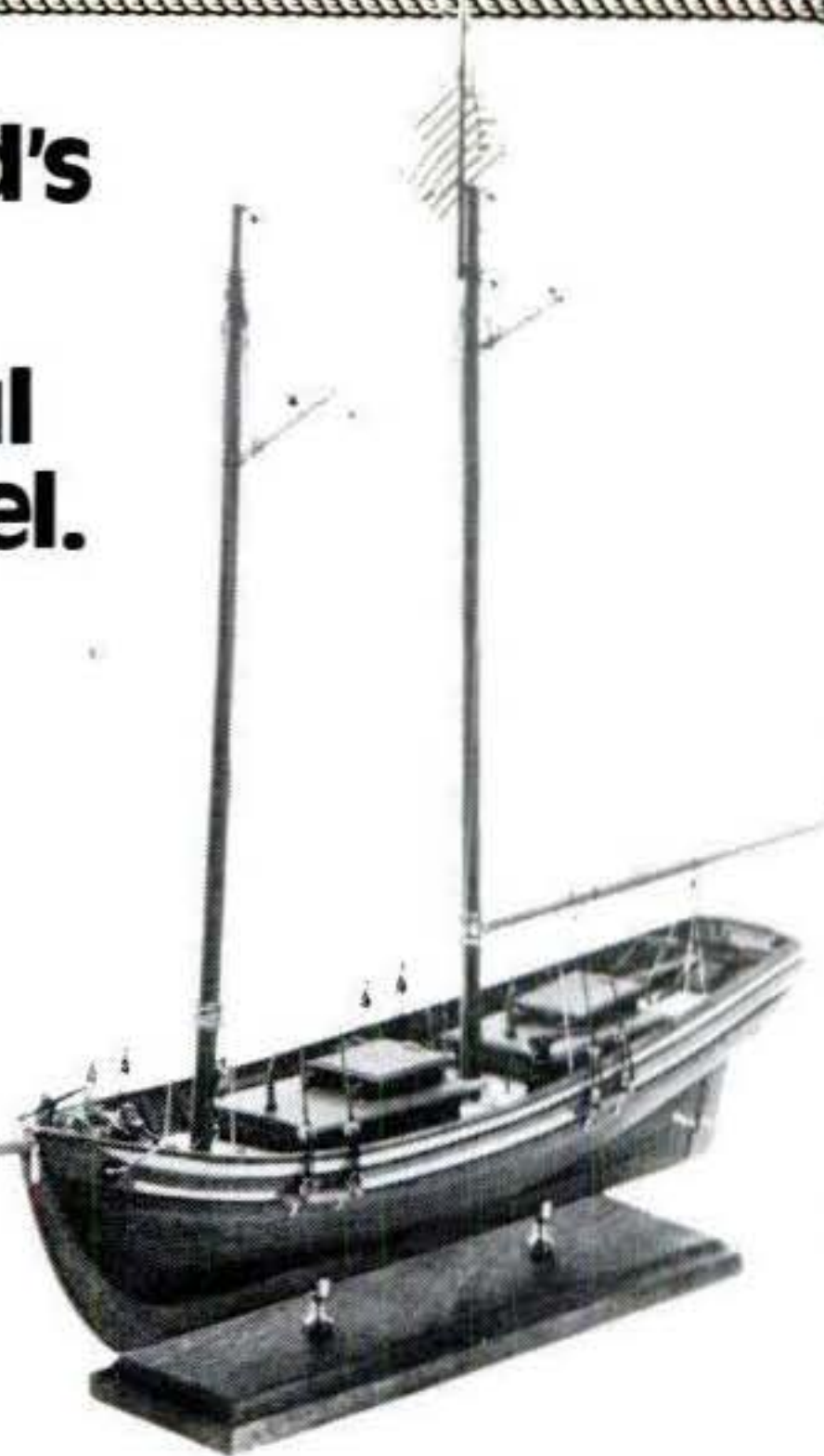
### It really isn't hard

Even if you've never built a model before, you can experience the relaxing pleasure and pride of accomplishment that is offered by this fascinating hobby. You can build the *Swift*. The secret's in our kit, designed especially for the first time modeler, with pre-cut parts that make assembly easy. Clear, large scale plans and instructions that virtually take you by the hand and guide you every step of the way through hours of the most relaxing fun you'll ever have. And when completed—a museum quality model you'll display with pride, with gleaming brass fittings, walnut planked hull, delicate rigging—lifelike in every detail.

### Quality you can see and feel

The materials in our kit may be better than those used in the original *Swift*. The keel section and frames are pre-cut plywood, ready for quick assembly. The *Swift's* hull is planked twice; once with thick, flexible limewood for strength, then overlaid with planks of African walnut for lasting beauty.

You won't have to make the fittings—we've done that for you. Our kit contains ready-to-use blocks and deadeyes of rare, yellow boxwood. We include eyelets, bracers and belaying pins—over 70 parts of solid brass! Even the cabin door hinges are brass, as are the 250 miniature nails you'll use to fasten the plank-



ing to the hull and deck. And, since the original wooden *Swift* had no plastic parts, our kit doesn't either—*anywhere!*

Creative? And how! Overwhelming? Not a bit! But be prepared for hours of the most challenging, engrossing, relaxing fun you've ever had.

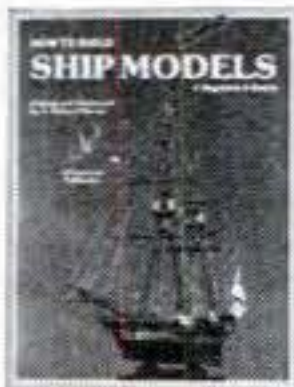
**An "everything you'll need" special offer, with free tools and handbook.**

We want to introduce you to this great hobby, now! So we've made it easy for you to get started.

Our special offer includes the *Swift* kit plus all the tools you'll need to build her: miniature pliers, hammer, knife, file, tweezers, sandpaper, glue, wood oil, and more. You'll also receive a free copy of Richard Mansir's "How to Build Ship Models," a 64-page beginner's guide. You don't have to buy anything else. The tools normally cost \$15; the book retails for \$7.95. But they're yours, FREE when you buy the *Swift* kit at its regular price of \$39.95 (plus \$4 handling and insured delivery).

**Credit card holders can order toll-free**

Call 800-228-2028, ext. 68, 24 hours/day. In Nebraska, call 800-642-8300. Or use coupon below to send check or money order.



72 page, full-color ship model catalog sent FREE with your order.

### Miniature Cannon Kit Bonus!

Set of two solid brass cannon on walnut carriages to be mounted amidship. \$4.00 value, sent FREE with your order.

**model expo, inc.**

23 Just Road  
Fairfield, N.J. 07007

### MODEL EXPO, INC.

23 Just Road, Fairfield, N.J. 07007

Please send me \_\_\_\_\_ kits of the *Swift* @ \$39.95 plus FREE tools, book, and cannons. Check or money order enclosed. (Add \$4 for handling and insured delivery. N.J. residents must add 6% sales tax.)

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## BIG...

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Power Feed  
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The Planer/Molder/Saw is a versatile piece of machinery. It turns out profitable precision molding, trim, flooring, furniture... in all popular patterns. Rips, planes, molds separately... or all at once. Used by individual home craftsman, cabinet and picture framing shops, lumber yards, contractors and carpenters.

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NO OBLIGATION—NO SALESMAN WILL CALL

**RUSH COUPON TODAY!**

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KANSAS CITY, MO. 64111



Foley-Belsaw Co.  
90465 Field Bldg.  
Kansas City, Mo. 64111



YES, please send me the FREE Booklet that gives me complete facts about your Planer-Molder-Saw and full details on how I can qualify for a 30-Day Free Trial right in my own shop. I understand there is No Obligation and that No Salesman will call.

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City \_\_\_\_\_

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**EARN UP TO  
\$12 AN HOUR**

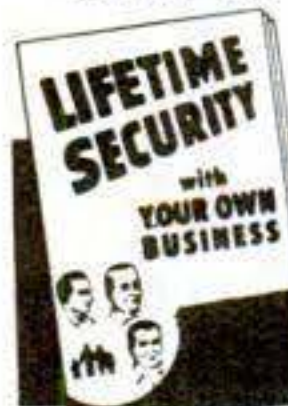
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SPARE  
TIME or  
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**SHARPENING BUSINESS!**



**ON OUR  
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Gives Full Details

Send for all the facts! Our free Book tells how to start a profitable, lifetime home sharpening business, how we help you grow, how we'll finance you.

Send for FREE details — mail coupon below or postcard TODAY!  
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please send me the **FREE BOOK** that gives full details.

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Cards; stationery; envelopes; advertising; labels; tickets; QSL cards; announcements; greeting, sympathy, prayer cards; tags, etc. Save money. **Own a Printing Business.** We supply everything direct from factory. Easy instructions. Also raised printing like engraving. Have home shop. Add to income.



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Enclose \$1.00 for our catalog.

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Career Opportunities**

**Get Your Associate Degree or Career Diploma at Home in Spare Time**

Now without attending school or college, without any previous experience, you can train for a money-making career...even get a 2-year Associate Degree or Career Diploma. Send for free facts about the exciting career program that interests you most. You will receive color brochure and information on employment opportunities in the field you choose. Mail coupon today and see how easy it is to train at home for a great new career or advancement on your present job.



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Please send me free facts, color brochure and full information on how I can study at home for the career I have chosen. I understand I am under no obligation and no salesman will call.

**CHECK ONE BOX ONLY!**

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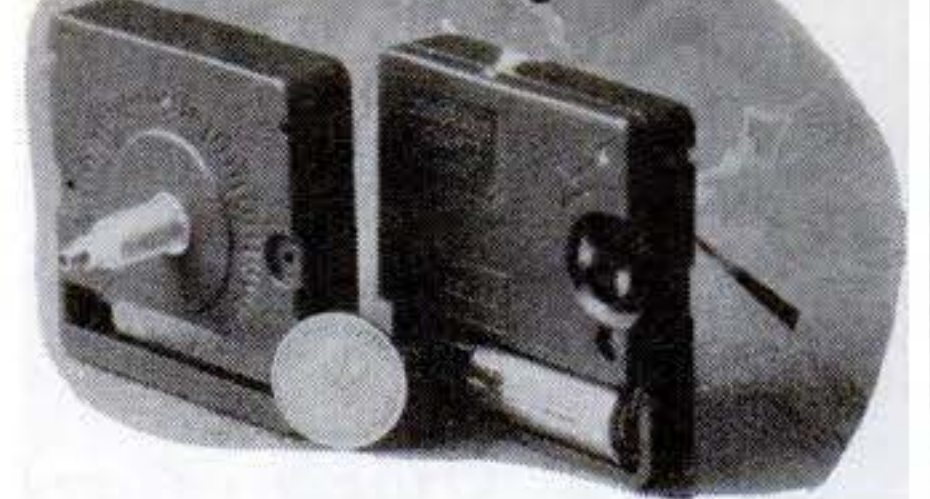
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- Computer Programming
- Gun Repair\*
- Computer Assisted Bookkeeping
- Electronics
- Microcomputer Repair

\*These courses are offered by North American Correspondence Schools. Both ICS and North American are Accredited Members of the National Home Study Council.

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**A small wonder  
at a low price.**



**SPECIAL OFFER, NOW ONLY \$3.95**

(limit of two, offer good thru June 15, 1984).

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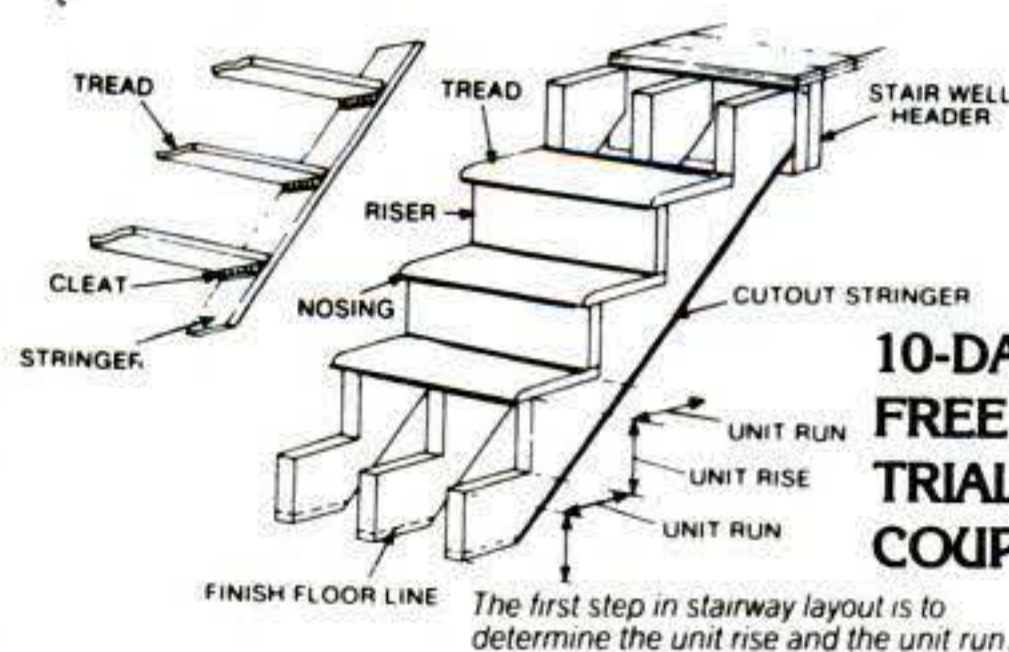
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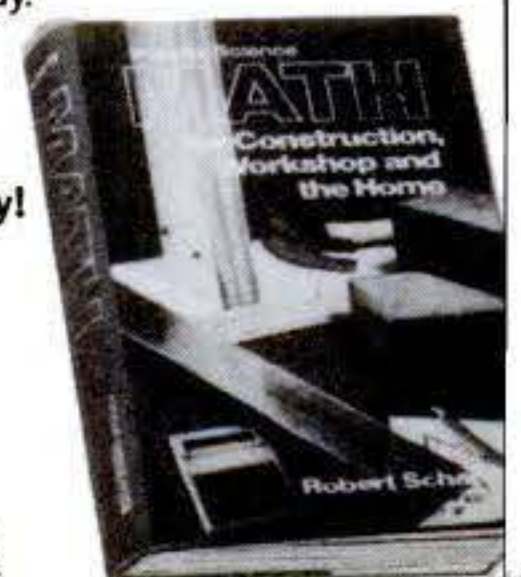
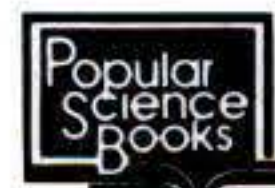
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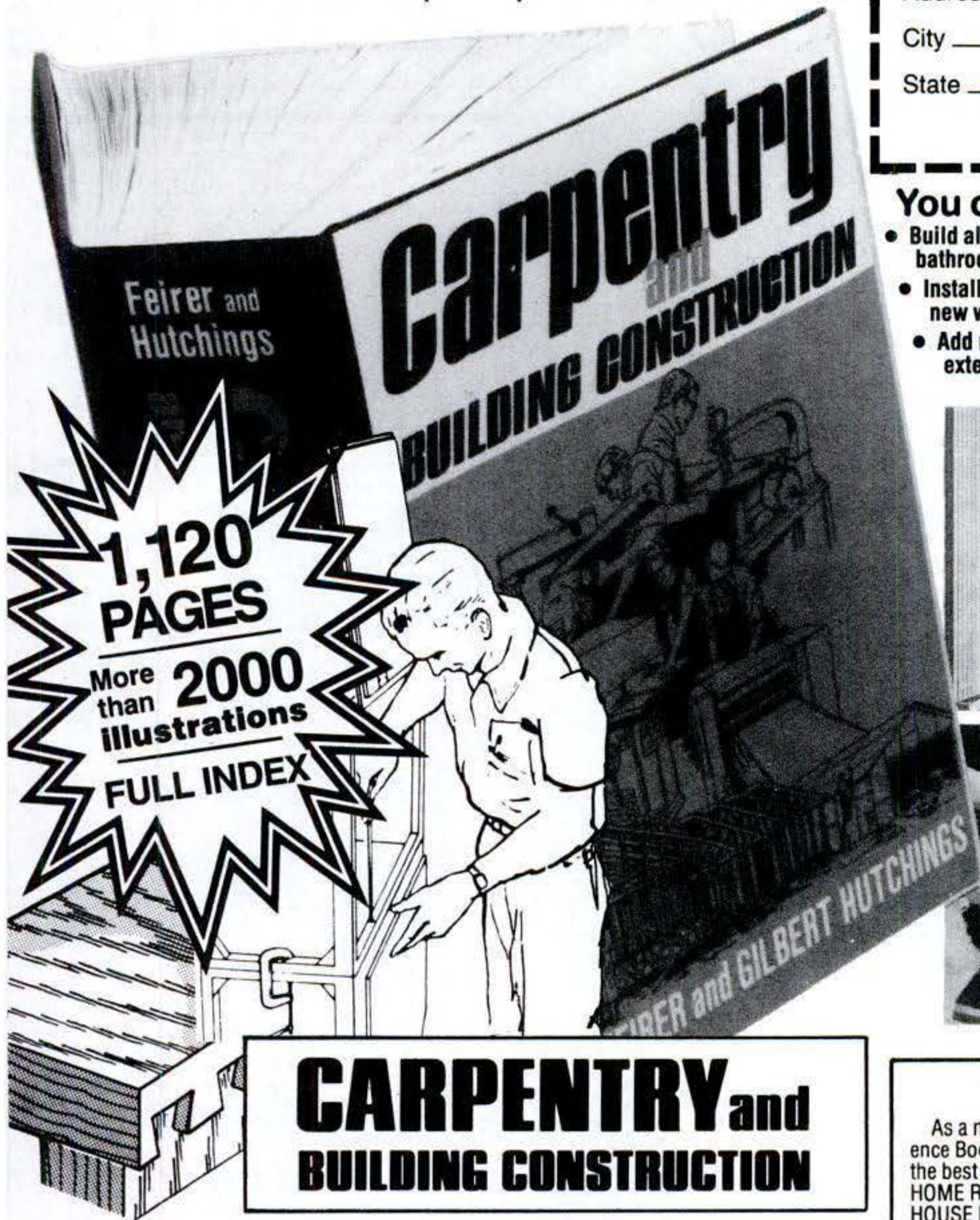
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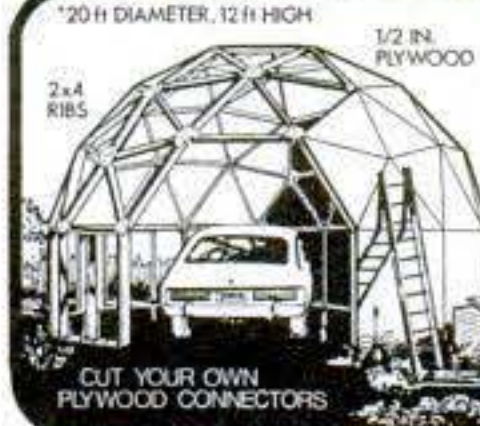
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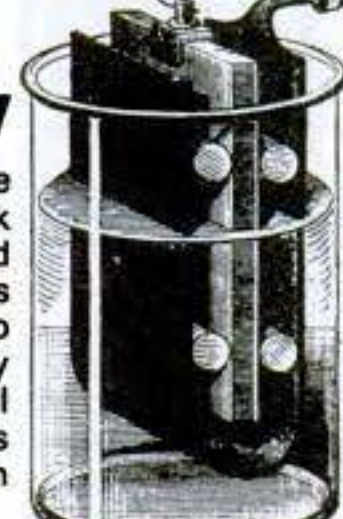
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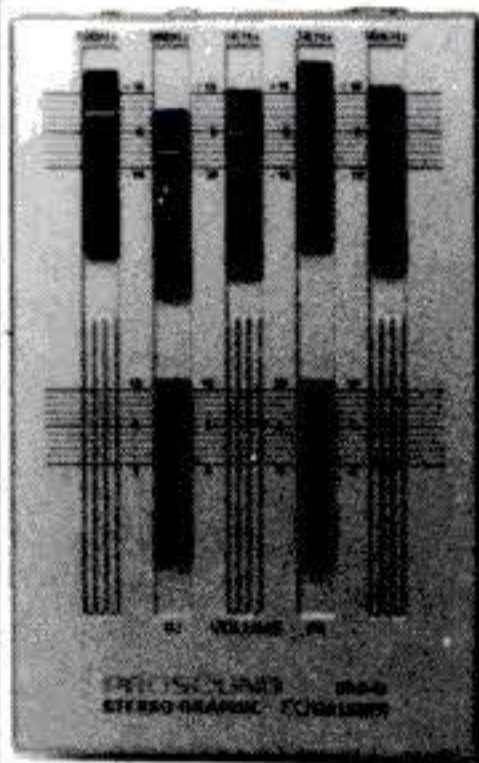
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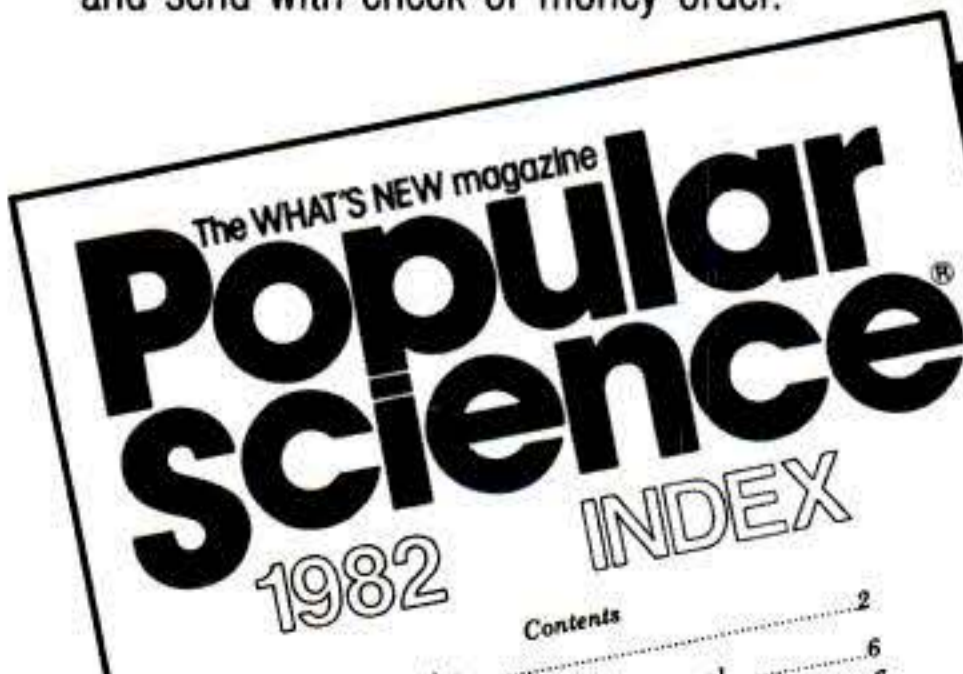
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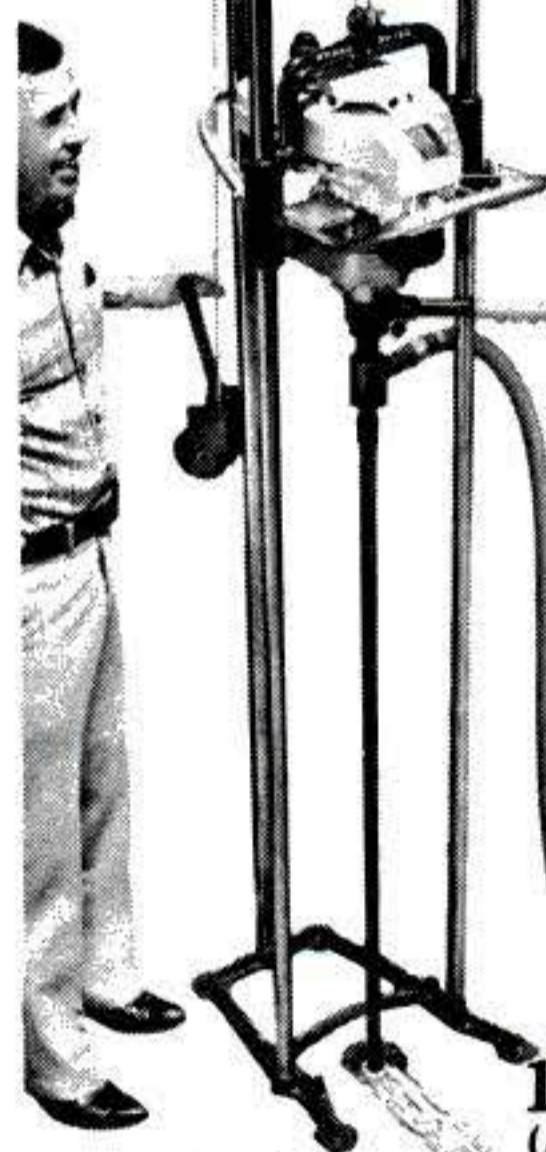
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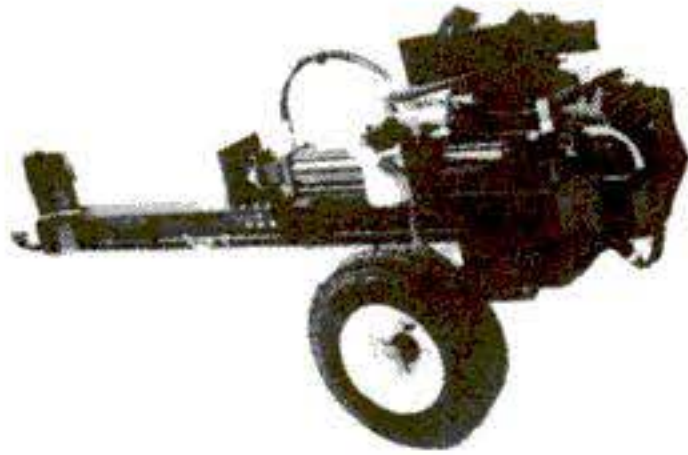
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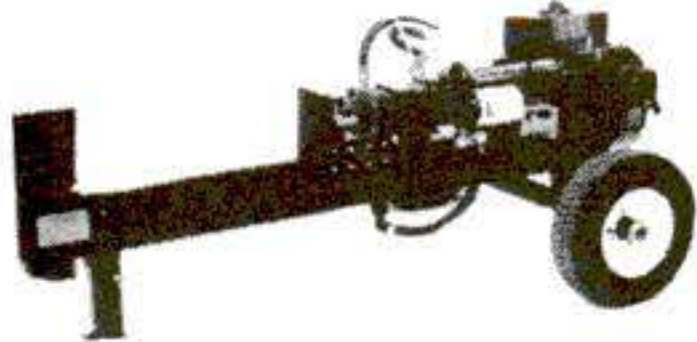
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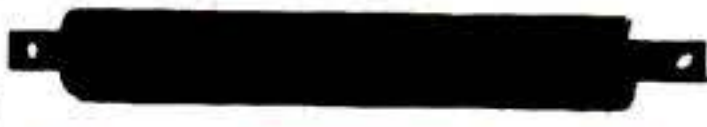
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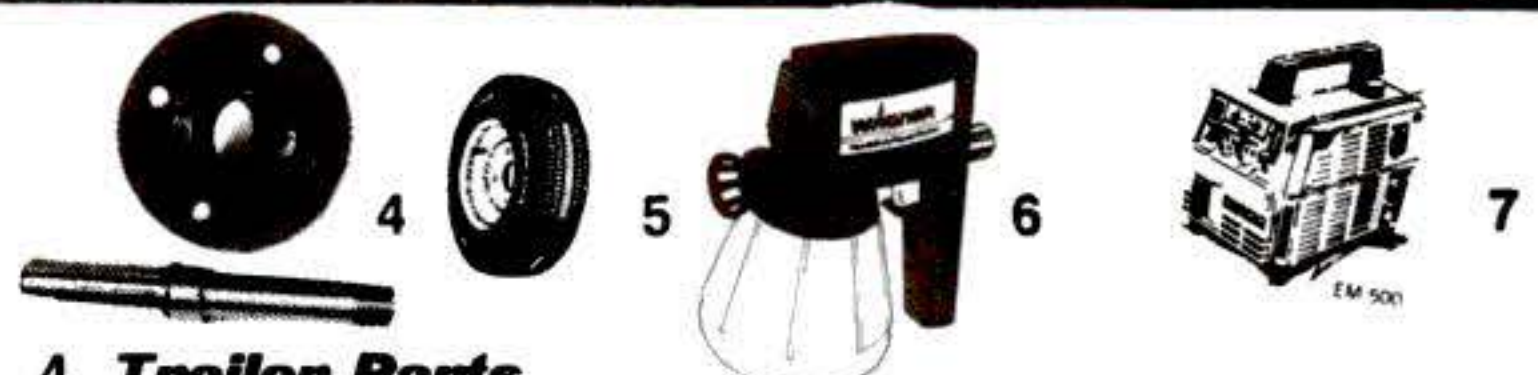


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**403 Wood Stoves** The Apache Stove color brochure includes wood-stove inserts for your fireplace, as well as free-standing stoves. The stoves' features include glowers, ash drawers, cool door handles, and solid or glass-panel cast-iron doors. Free

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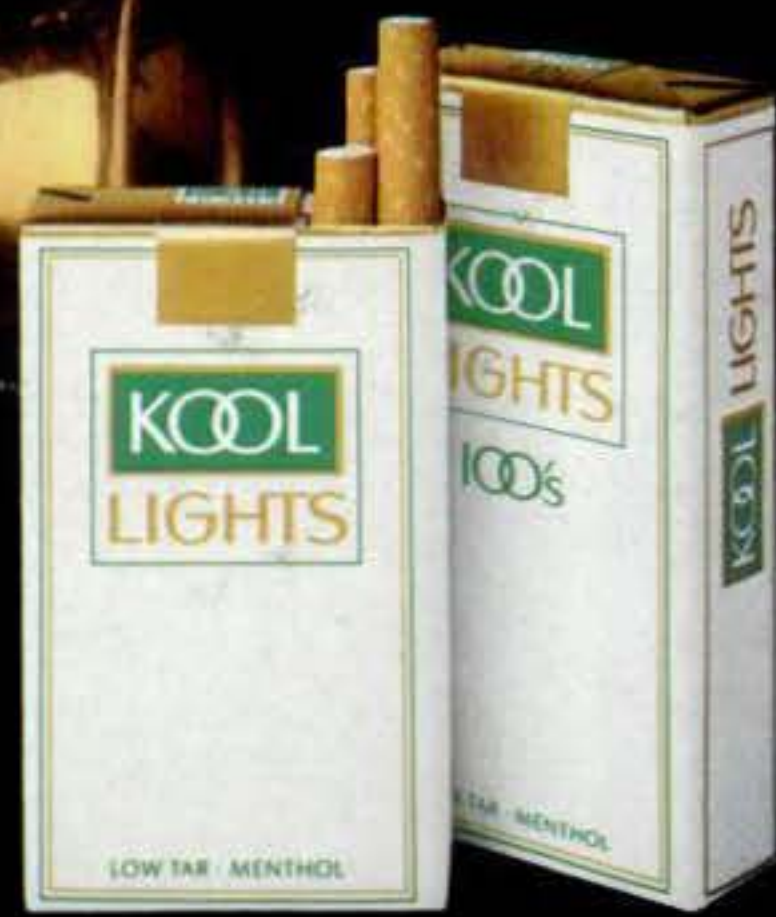
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