

Popular Science®

The **What's New** magazine

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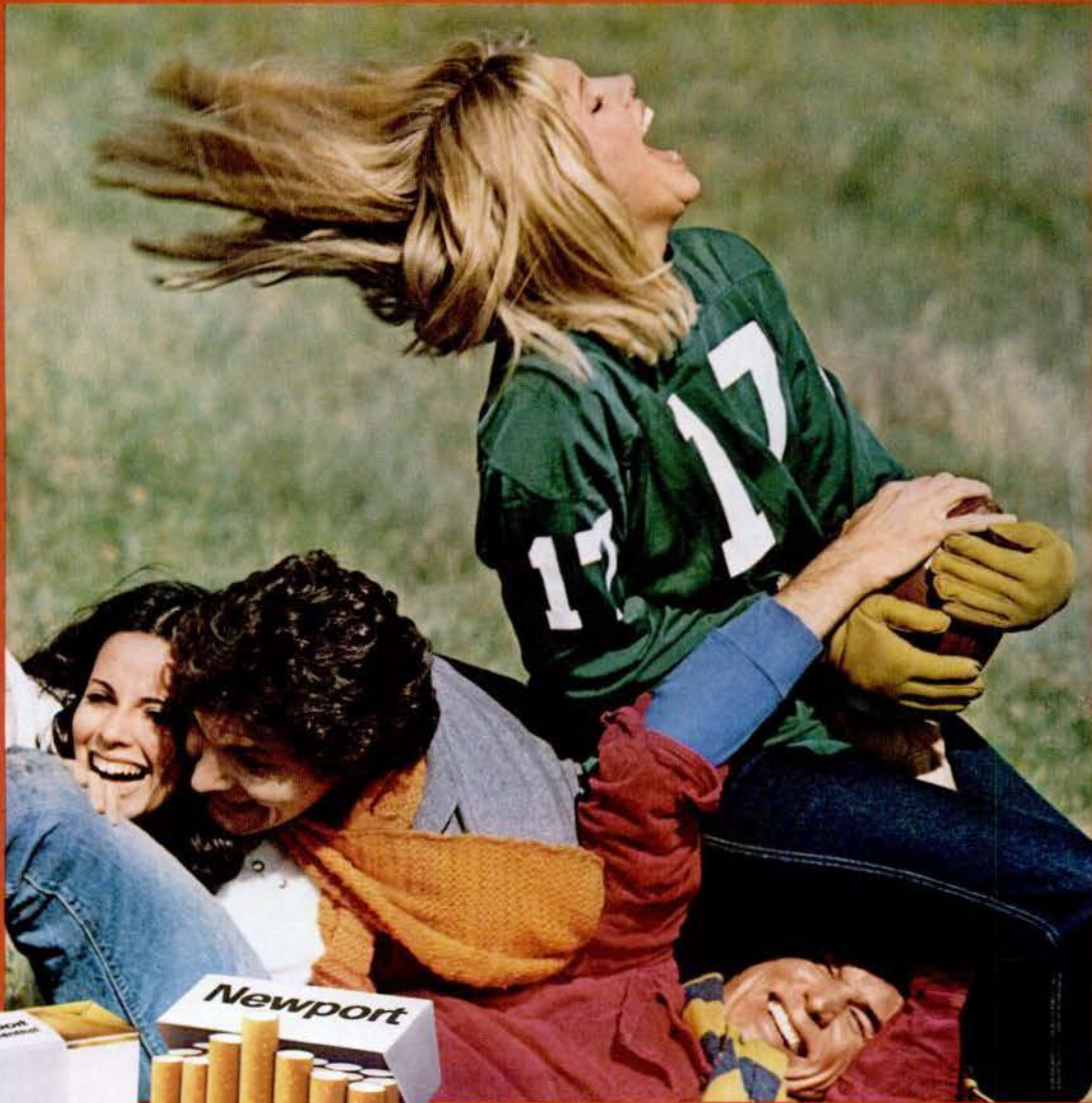
The missile killers—
top-secret race
to develop
**BEAM
WEAPONS**

New personal computers

First look at
models from
IBM, Xerox,
others



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The **What's New** magazine

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- New personal computers—now the big guns have arrived**
IBM, Xerox, and others may at last detonate the small-computer explosion. PAGE 93
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PS READERS TALK BACK

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Diesel pro and con

E. F. Lindsley's article "Diesel Troubles" [PS, Aug.] casts doubt on Oldsmobile's engine, but as the owner of the small 4.3-liter Cutlass I think a little boost is in order. After two years and 30,000 miles, I've spent just \$36 on repairs (for a fuel-line air leak that caused rough idle). I average 25 mpg in hour after hour of 75-mph desert driving with the air conditioning on. I've never added water or even seen the heat light come on. Acceleration has been fine since I broke in the engine; I find gasoline fours and sixes to be sluggish in comparison. Altitude is my only problem: At 5,000 feet it gives marginal response, and at 8,000 feet on a six-percent grade I have to shift down the automatic. A four-speed automatic would make it a great car.

Harvey DeGering, Pasadena, Calif.

Thank you for the informative article on diesels. I could have written a far longer one on my personal experience with the Olds engine (as I'm sure many of your readers could). Many of us who bought this engine thinking it would be dependable and economical have instead been plagued with endless troubles, poor economy, and high repair bills (for work that never seems to improve performance or economy). To top it off, we get no satisfaction from anyone in authority at the zone or dealer level. I hope the article makes others think twice and investigate thoroughly before buying this product. It is too late for us.

William B. R. Agnew
Yucca Valley, Calif.

Fuel and food

It's a mistake to place too much emphasis on the economics of gasohol ["The Great Gasohol Debate," PS, July]. We've put 60 years of intensive research into petroleum products but only five or so into alcohol fuels. It would be wrong to expect that alcohol technologies are much out of the cave yet.

Dave Gower, Ottawa, Ont.

The author is wrong about soybeans

putting nitrogen into the ground. On the contrary, if you let them mature, all the nitrogen leaves the ground and goes into the bean. If you want nitrogen left in the ground, you should cut the soybeans for hay or silage when the pods first form.

Norman L. Ivins
Wrightstown, N.J.

For safer swimming

The drop-leaf swim deck for power boats [PS, July] presents a potential safety hazard. If someone were to use the seat while the engine was running, he could get his feet caught in the prop. I suggest adding a safety screen under the drop leaf so that when the deck is down, the safety screen automatically drops into place.

Norm Shegitz, Lubbock, Tex.

Collector caution

Mr. Kirkewoog's collector certainly shows a great deal of inventive thought ["Ferrocement Solar Collectors," PS, June]. However, I would recommend—based on my six years of experience in solar research and development—that he re-evaluate some of the materials used. The high temperatures that occur inside a collector may not be compatible with the foam insulation. The wood spacers could also be a problem, both because they raise the possibility of fire and because high heat will cause outgassing of resins and vapors that will condense on the glazing undersurface. Similarly, the fiberglass insulation may outgas its binders and the silicone caulk used as flashing sealant could release gases that would fog the cover plate.

John G. Meeker
Lakewood, Colo.

Slipperier models

The "Low-Drag Cars" article [PS, Sept.] is guilty of an important omission: Our Mercedes-Benz 300SD and 380SEL models have drag coefficients of 0.36, making them the most aerodynamic four-door

[Continued on page 134]

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Remembering numbers is genie work.

BUSY Buttons

Turn those innocent little buttons on your telephone into Busy Buttons and release the genie from its little black box.

A fairy tale? The story you are about to read may be true or it may be false.

If the story is false, we've wasted a lot of your time. If the story is true, well...you might just make a lucky discovery. Here's why.

Your push button telephone has a bunch of buttons that make beeping sounds when you press them. The beeping sounds send signals or actually 'talk' to your phone company and its computerized switching system. That's how calls are made.

Now think of it. What if your phone was first connected to your own telephone computer. And what if in your own telephone computer you had a real genie that actually took your command and performed electronic magic on your phone lines. Far fetched? Read on.

WHAT KIND OF MAGIC

What if the system proved to be the fastest and most positive way to reach another person at another phone regardless of whether the phone is busy or whether that person is even near a phone. Enter Busy Buttons.

Busy Buttons is a miniature computer in a small black box. The box is nothing much to look at, measures only 1½" x 5" x 5¾" and in fact most people would probably hide it. The box plugs into the back of any telephone in your house or any multi-line telephone in your office. That's right, just plug it in. No installation, no wires to connect. Just plug it in.

HERE IT COMES

Now here comes the fairytale part. In that black box is indeed a real genie—a small creature so smart that it will understand every command you give it from your telephone's push buttons. No foolin'.

If you dial a number and that number is busy, you tell the genie you're upset by pressing the 'frustration' button—that's the button with a star on it. The genie will first redial that same number ten consecutive times the first minute and then once every two minutes thereafter until it reaches your party. When the call does go through, your genie will then signal you to

pick up the phone. And you can still make calls and receive calls in between those times your genie is trying to reach the other party.

But what if there's no answer? After you let your phone ring for awhile, press the 'disappointment' button. The genie will then dial your number every ten minutes for up to ten hours and then signal you when somebody answers.

GENIES NEVER FORGET

"But what if the genie forgets the number it was dialing?" you might ask. The answer is quite logical. Genies never forget. In fact, you can own a genie so smart it will remember up to 176 numbers each up to 32 digits so you can not only dial long distance, you can use your genie to dial the entire 23 digit MCI or Sprint numbers in seconds. Your genie will recognize the tones, the pauses and faithfully dial your number accurately each time saving you tons of money on long distance charges.

"Too complicated," you might say. For your genie it might be but not for you. Remember, you use your own push button phone. There's no other attachment other than that dumb black box where your genie lives. And when you want to dial a number, you dial PAUL to reach Paul, MOM to reach your mom or HAIR to call your hair stylist. Remembering names is easy, remembering numbers is genie work.

THE REAL SHOCK

Ready for a real shock? You only need one genie to cover every telephone in your house or office. That's right. Unlike other auto dialers, one genie is all you need to turn every phone into this fully automatic system. But wait, there's more.

Genies talk differently. The American genie talks very rapidly in tones like most push button phones. There is even a Japanese genie that talks slowly and methodically in a pulsating sound similar to a rotary dial telephone. This means you can use Busy Buttons on push button or rotary dial telephones.

The Busy Button system is quite inexpensive. Genies you see have no minimum wage,

are exempt from EEOC, EPA, OSHA, FDA and HEW regulations and don't mind putting in overtime or washing windows.

DIFFERENT VERSIONS

A 176 number Busy Buttons costs only \$200—the 93 number version costs \$180. If you want the Japanese Genie, you can have either model for \$20 cheaper. And you can order Busy Buttons using your credit card by calling our toll-free number below. (Illinois residents add 6% sales tax.) Or send your check for the amounts listed above plus \$4.00 for postage and handling to the address below.

When you receive your Busy Buttons computer just plug it in. That's right, plug it in. Then see how easy it is to program, how easy it is to redial a number either yourself or automatically. If you're not happy with the convenience of the Busy Buttons or the time and money you save from the day you install it, return it anytime within 30 days for a prompt and courteous refund including your \$4.00 postage and handling charge. It won't cost you a penny and you won't insult the genie.

At the beginning of this advertisement we told you that the above story may be true or it may be false. Well it's true. There really is a genie in every Busy Buttons. And if you believe that, wait till you hear about our new computerized burglar alarm with its own built-in SWAT team. Order your Busy Buttons at no obligation, today.

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THAT THINK

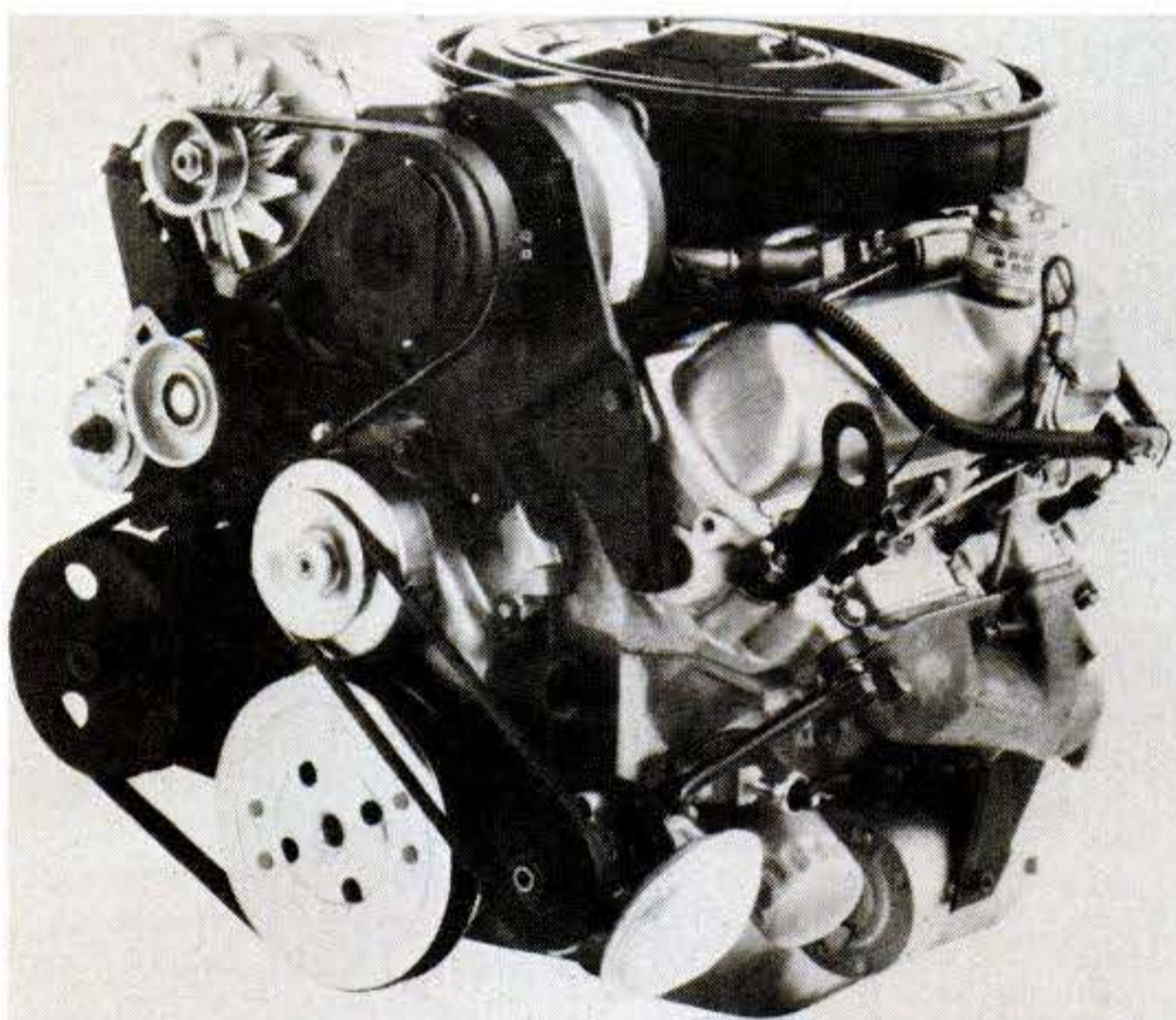
This one



QKFX-LXJ-6SUA

40-mpg diesel

for GM's mid-size cars



New V6 is lighter, cleaner-running, and satisfying to drive

By JIM DUNNE

Four years after introducing America's first mass-production diesel passenger cars, General Motors has developed another diesel engine, a 4.3-liter V6. Benefiting from the experience with its V8 cousin, the V6 will be cleaner-running and more efficient, and will be built with an interesting technological twist.

Like the 5.7-liter V8 (and its short-lived 4.3-liter V8 variant), the new diesel has been developed by Oldsmobile. It will be an extra-cost, economy-boosting option in all of GM's 1982 mid-size cars: Chevrolet Malibu, Celebrity, and Monte Carlo; Pontiac Bonneville, 6000, and Grand Prix; Buick Century and Regal; and Oldsmobile Cutlass Supreme and Ciera.

Two versions of the V6 are being built, one for front-drive, one for rear-drive cars. They are basically the

same except that the front-drive version will have aluminum cylinder heads for maximum weight saving. At 36 lbs. per pair, they're 44 lbs. lighter than the rear-drive's cast-iron heads. Another four lbs. saved through lighter parts makes the front-drive engine a total of 48 lbs. lighter.

The engine is a 90-degree design so it can be built with much of the same machinery as the V8's, with which it shares bore, stroke, cylinder spacing, and many other dimensions. To gain the smooth firing pulses of a 60-degree (ideal) V6, crankpins are offset 30 degrees.

I found that driving the V6 is virtually the same as driving a gasoline engine, except at low speeds, when diesel noise can clearly be heard. Engine balance is also remarkable; shake just isn't the problem that you'd expect.

The engine idles at 650 rpm instead of 800, to eliminate creeping and reduce wheel-spin on ice. Yet this doesn't cause any undue shake. A heavier flywheel and special rubber inserts in the pulleys help soak up vibration.

The "lost foam" technique used to produce the engine's aluminum cylinder heads is a twist on the old lost-wax process, which has been used for thousands of years for precision castings ranging from sculptures to intricate engine parts.

Instead of wax, Styrofoam is molded into the complex shape of the cylinder head. Then it's encased in a box of casting sand and molten aluminum is poured in, vaporizing the foam and taking its place. The process is more accurate, readily adaptable to automation, and more energy-efficient than conventional sand-casting techniques.

Economy is a diesel's strong point, of course. While final EPA test results aren't yet available, Oldsmobile's experts are expecting ratings for the new front-drive cars of about 28 mpg in the city and 40 mpg on the highway. That would put them among the most economical mid-size cars available, regardless of origin.

Performance has always been a diesel shortcoming, but the V6 Ciera I drove wasn't as slow as many other diesels I've tested. It averaged just over 16 seconds to accelerate to 60 mph—better than average for economy cars. And this is despite a 2.93:1 "economy" final-drive ratio.

Longevity and reliability will benefit from refinements and hard-learned lessons from the V8's. Quick-acting glow plugs (six seconds to start at zero degrees F), roller hydraulic valve lifters, a large water-separation system, and an extensive fuel-filtering system are major features.

A development affecting both the V6 and V8 is a venturi in the pre-chamber passage. Research had shown that the flame from the old passage left a pocket of unburned fuel-air mixture in the combustion chamber. The result was lower fuel economy and more exhaust smoke. The venturi design makes major improvements in both areas.

Other changes include a serpentine fan belt that does the work of three and a weight-saving switch to a single battery in the front-drives.

"We also made some changes in the piston rings and the piston shape," said Oldsmobile assistant chief engineer Frank Ball. "That reduces blow-by of combustion residue, cuts down on particulate emissions, and helps keep oil changes at only every 5,000 miles."

The first version of the new diesel will become available with GM's rear-drive 1982 mid-size cars. The other version will follow when the new front-wheel-drives are introduced in early 1982. **ES**



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THE BRAIN VS. THE BURGLAR

Perim-A-Tron's™ central console, or "BRAIN", employs a microprocessor, making it the most advanced security system available for consumer use. With Perim-A-Tron™ on duty, small sensors monitor doors and windows ready to signal the "Brain" from as far as 250 feet, in the event of a break-in attempt. The "Brain" processes each signal instantaneously and sounds not only a self-contained 85db internal alarm, but also a second 95db remote siren to augment the inside alarm or for placement outside to alert neighbors and police.

The Perim-A-Tron™ is so easy to live with that pets can come and go through partly-open windows or sliding glass doors without triggering it, yet so vigilant that an intruder will set it off before he can enter.

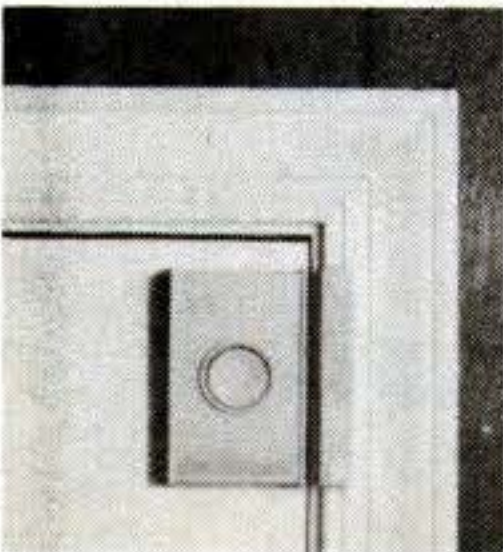
THOUSANDS OF OPTIONS

Perim-A-Tron's™ micro-computer lets you choose from thousands of three digit disarm codes. Only you know your code. But if your son's friend receives a "demonstration", you can easily change the code again...and again. You need no specially coded key which can be lost, misplaced, or stolen. The system even has two separate channels, each with its own distinct alarm sound. This feature allows you to zone your system. For example: Channel 1—house, Channel 2—garage, or Channel 1—doors, Channel 2—windows.

HOW IT WORKS

Operating the system is simplicity itself. When leaving, a light on the console tells you that you've armed the system properly, and have from 5 to 45 seconds to leave the house. This variable delay feature, not found on some expensive commercial systems, is selective so that it can apply only to frequently used doors. All other openings would be set for instant alarm. Upon returning home, you have ample time to turn the system off, thereby avoiding a false alarm.

If a break-in attempt occurs while you're away, an alarm memory light on the console tells you so. What's more, after sounding for



This photo shows a transmitter & magnet installed. If a break-in attempt occurs, the transmitter and magnet become separated triggering a wireless radio signal which activates the alarm. Installation takes only a few minutes and doesn't even require a screwdriver.



Perim-A-Tron's™ 20 button keyboard gives you protection a \$2,000 commercially installed system can't beat. Includes powerful remote horn.

10 minutes and scaring away the intruder, the system shuts off automatically and resets itself.

A CONSTANT GUARDIAN

Leave Perim-A-Tron™ in Test Mode during the day and it will signal when anyone leaves or enters. This thoughtful signal will not operate the remote horn but gives a 2½ second warning on the internal speaker only.

If power fails (or is cut-off), the console has a battery back-up. And each battery powered transmitter/sensor will signal at the console if the battery runs low.

The Perim-A-Tron™ system is highly resistant to false alarms because it is not sensitive to motion or sound. Pets can roam at will, curtains can blow in a breeze, you or your children can visit the kitchen for a midnight snack—all without setting off an alarm.

COMING HOME SAFELY

There is nothing more frightening than finding a prowler lurking near your house when you arrive home at night. Our system's EXTRA PROTECTION DESIGN lets you carry a transmitter in your pocket, purse or glove compartment (it's about the size of a cigarette pack). With simple modification, it serves as a PANIC device and will set off the alarm at the press of a button.

COMPARE IT

Hard-wired "commercial" burglar alarms can cost \$2,000 PLUS a monthly fee (and you still never own it). Motion and sound detectors cost up to \$200 per unit and cover only limited areas. Your home may require two or three of these units and, in most cases, no alarm will sound until AFTER a prowler is inside for 30 seconds or more. Perim-A-Tron™ combines pre-entry protection with micro-electronic circuitry to provide the most protection at the lowest cost.

U.L. LISTED

The Perim-A-Tron™ Home Security System is listed by Underwriters Laboratories as a burglary protection device, a rating which goes beyond electrical safety. To earn this listing our alarm was thoroughly tested for critical burglary protection functions such as transmitter range, sound volume, battery back-up, keyboard component life, battery failure warning, and test function. This tough-to-get U.L. listing resulted from the exacting standards engineered into the Perim-A-Tron™.

YOU BE THE JUDGE

We urge you to order just the basic Perim-A-Tron™ system (pictured above) for a 30-day trial period. Use it to protect your family while you sleep and to protect your home while you're away. Then if you're not convinced that the Perim-A-Tron™ is the most advanced, efficient security system available today, return it undamaged for a complete, no-quibble refund—including return postage. You are protected by a 90 day manufacturer's warranty as well as Shelburne's 25 year reputation for satisfied customers.

HERE'S HOW TO ORDER

To order simply send your check for \$199.95 plus \$5.65 for shipping and handling to the address below. Credit card holders can speed delivery of their system by using our toll-free number listed below. We will then promptly ship your Perim-A-Tron™ unit complete with easy-to-understand instructions and decals warning that the premises are protected. Additional transmitters are available for \$29.95 each, but one is not required for every door and window. Instead, magnetic contacts can be purchased and easily connected to the transmitter, allowing you to cover additional openings for as little as \$5 each. The instruction booklet is quite useful in helping you determine the correct combinations to protect your home or office at the lowest possible cost.

Give yourself some peace of mind—order a Perim-A-Tron™ today at no obligation.

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Double duty from a dual cassette



You put the original tape cassette in the left compartment; a blank cassette goes in the right. Push a button, and both tapes begin to move simultaneously. A half hour to 45 minutes later, you've made a duplicate tape—with near-duplicate performance specs.

That's Optonica's dual-cassette deck. It's actually two units in one package: a playback deck for playing an original tape, a record deck for making a copy. Each side uses heads and electronics optimized for its particular purpose, which accounts for the deck's frequency response: 20 to 21,000 Hz using metal tape.

Solenoid-driven controls make normal operation fast and tape cuing for editing tight. A program-search system automatically finds blank spaces on tape (between cuts) and readies songs for you. A peak-level display helps prevent distortion. And separate bias, equalization, and Dolby controls allow you to dub from any type of tape to any other type—ferric, chrome, or metal.

The RT-6605 is an excellent deck, but it's not without flaws. One is small, but most annoying: There is only one footage counter (mechanical), and it is tied directly to the record deck. But in use you'd normally need to know the position of the *playback* deck, since this is the source for the raw material. The most unfortunate part of this deck is that Optonica did not take full advantage of this capability: There's no way to change the original recording—you can only make exact copies. Faders, mixers (mike and line), echo, perhaps even a speed-change button for quick copying (voice material, for example), would have made the deck much more flexible, in my opinion.

Made by Optonica High Fidelity Products, 10 Keystone Pl., Paramus, N.J. 07652, it's \$550.—*W. J. Hawkins*

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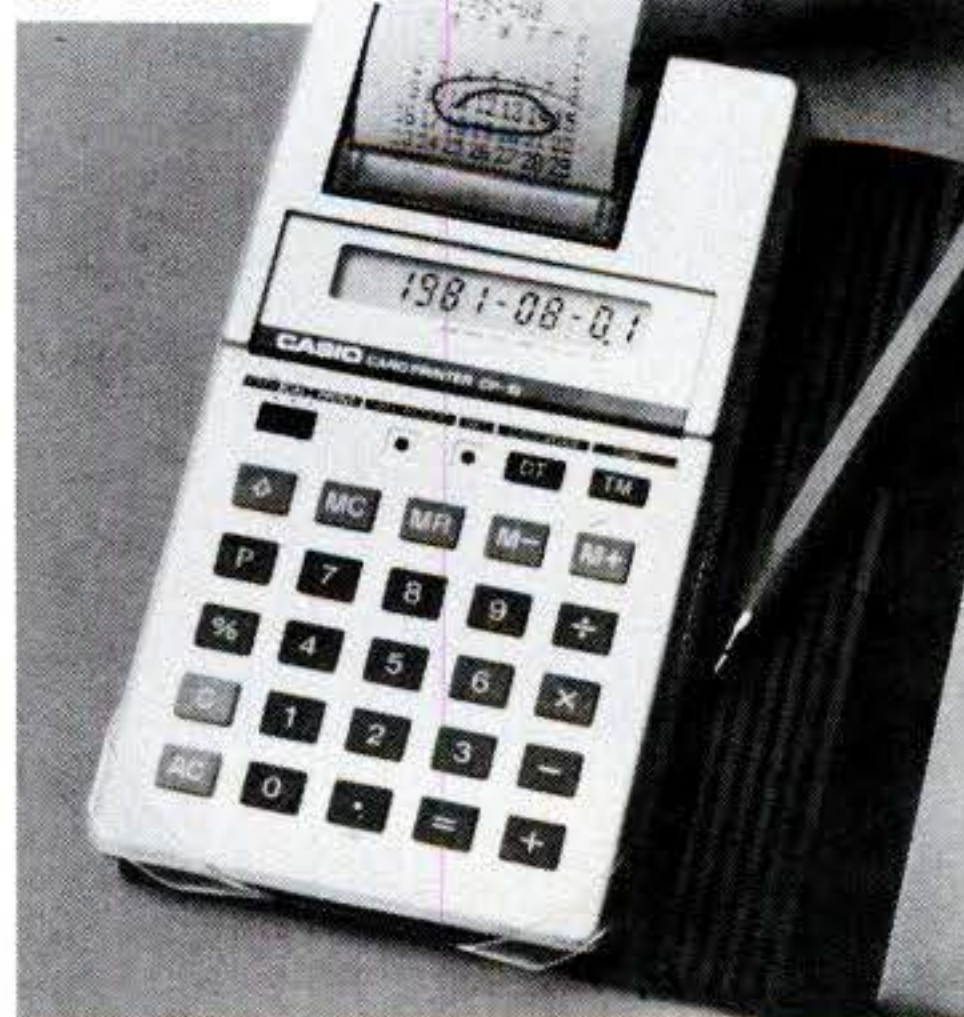
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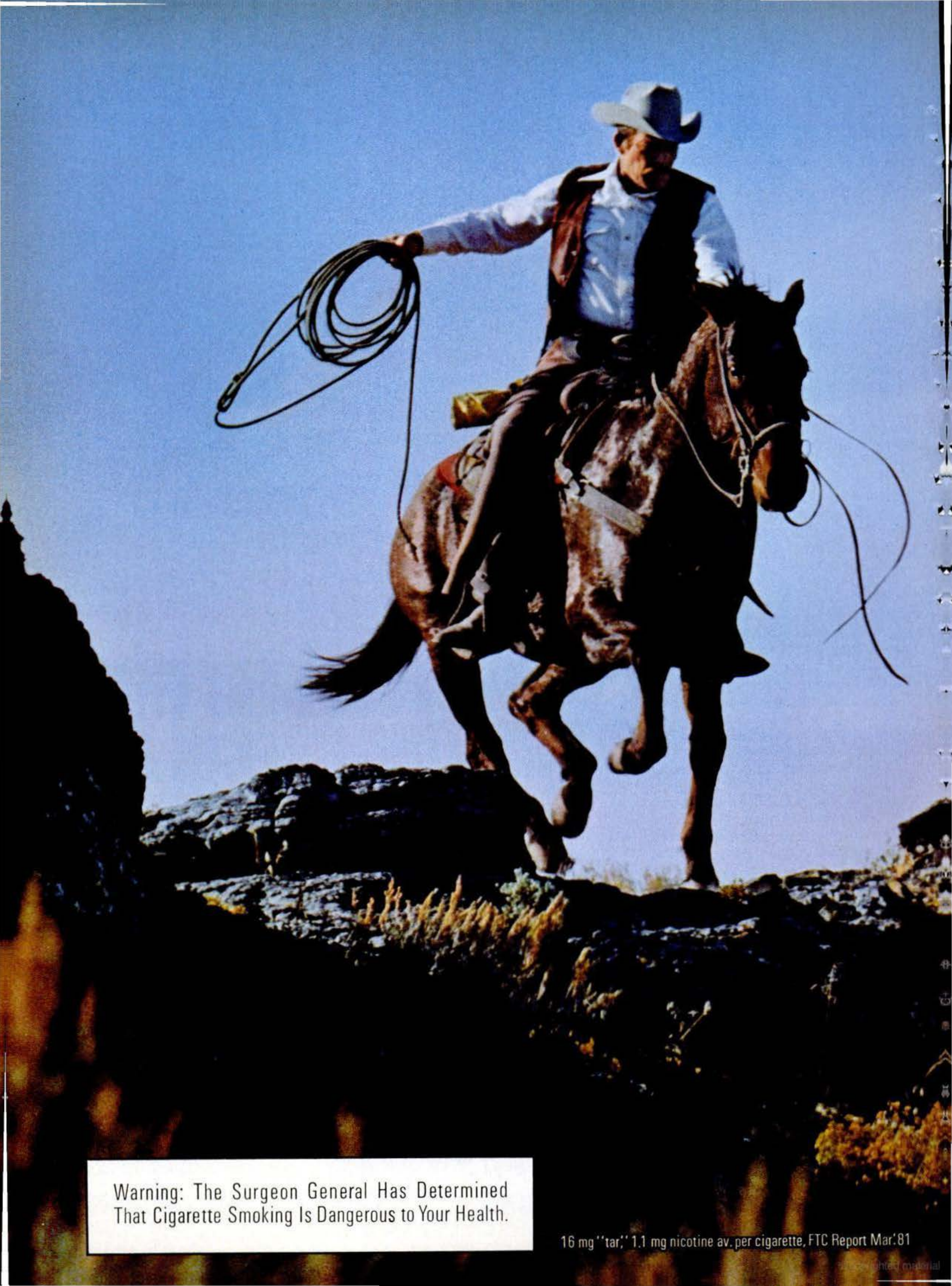
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ALTERNATE-ENERGY ANSWERS

By JAN F. KREIDER

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

Too much fan

We have a two-stage thermostat that first calls on our air-type solar system to provide heat before going to the conventional gas burner. This arrangement runs the furnace fan considerably more than the gas system by itself, and the air being circulated is often below the current room temperature. Is there something we can do to improve the situation?

Larry L. Schreiber, Westmont, Ill.

If your system indeed does deliver air below room temperature, it is far out of calibration, and the installer must adjust the controls. However, many air systems deliver air below body temperature but above room temperature. Such air will heat a building but cause uncomfortable drafts. The minimum-temperature air delivered by air solar systems is usually controlled by a sensor near the outlet end of the rock box. The cutoff point of this thermistor can be adjusted, but it's a job for the installer.

Cool air rising

The temperature in my basement is usually four to five degrees cooler than the upstairs in the warmer months. How can I effectively pull this cool air upstairs and prevent having to run the air conditioner? There is only one small cold-air intake in the basement, and it is located in an ineffective place.

H. S. Brooks, Roswell, Ga.

A good way to get cool air is through your gas furnace. Many older gas furnaces had a large panel that could be removed to introduce air into the furnace inlet plenum. If yours doesn't have one, you can certainly make one yourself—the bigger the better. But be aware that this air is unfiltered and may cause your house to be a bit dusty.

Heat-loss formula

How can I calculate heat loss through a wall knowing the surface area, thickness, temperature on each side, and R-value? Would you shed some light on how R-values relate to thermal conductivity?

Paul Johnson, Boca Raton, Fla.

The heat loss in Btu per hour is given by the product of the inside-to-outside temperature difference and the wall area divided by the R-value. Thickness does not enter into the calculation directly, but the R-value itself is the thickness divided by the thermal conductivity of the wall material. For example, the thermal conductivity of Styrofoam is 0.016 Btu

hr.-ft.². Therefore, the R-value of three inches (0.25 ft.) of Styrofoam is $0.25 \div 0.016$, or 15.625. There is also the effect of the inner- and outer-surface air film, but that value is small in well-insulated buildings.

Underground barn

I plan on finishing my basement with old barn boards on studs. With the wood

Infiltration-test follow-up

A number of readers have asked for more data on the water-evaporation method of measuring air infiltration ["Alternate-Energy Answers," PS, March]. The technique described there involved carefully measuring a quantity of evaporated water, but there are a number of other sources of humidity in a house that should also be taken into account in the equation offered in the earlier answer: water for plants (keep track of how much you add and when), water vapor from cooking (difficult to measure but can be estimated by measuring before and after cooking-water volumes), water vapor from people (0.25 lb. per person per hour). Other humidity sources, including water from baths and showers, are present but almost impossible to measure. The psychrometric chart referred to in that column is available from any air-conditioner supplier or manufacturer.

boards and an air space, would it be cost-effective to further insulate walls that are underground?

Jim Lord, Coxsackie, N.Y.

Wood and air don't insulate much. A vertical air layer $\frac{3}{4}$ in. thick has an R-value of less than one. The wood adds another R-value of one. If you use an inch of foam, however, the total R-value would be over seven and the heat loss reduced by more than 70 percent.

Variable tilt

Why should a collector for space heating require a different tilt than one used for water heating?

David Norsworthy, Bethany, Okla.

Solar-collector tilt angles vary with the application to favor the sun's location when peak demand for heat occurs. Since the sun is low in the sky in winter, solar-heating collectors are tilted more steeply than, for example, collectors used for solar cooling, which need solar heat most when the sun is high in the summer sky.

The tilt for solar collectors for domestic hot water is usually somewhere between these two.

Insulation board

I read that there is a form of rigid insulation board with an R-value of eight per inch. The material is identified as polyisocyanurate. Can you tell me who makes this product and what it's called?

Smiley K. Collins, Highland Park, Ill.

One manufacturer of this product is Celotex, whose name for it is Thermax. The R-value is 7.2 per inch.

Preheat tank I

The maker of my wood furnace sells a water heater (looking somewhat like a small car radiator) that installs between the outer insulated sheet-metal furnace jacket and the furnace itself. I am told I will need a hot-water holding tank. Other systems do not require an additional holding tank. Do I really need one?

Edward T. Cotter
New Fairfield, Conn.

A preheat tank (it can be another water heater without the heating element connected) is a good idea. It is connected upstream of your present water heater. This tank will store heat collected over many hours for use at the peak morning and evening periods. If you expect this kind of heat exchanger to provide 80 to 90 percent of your hot-water needs, the tank is required.

Preheat tank II

Last winter I used wood to preheat all my water. But at night when no water was being drawn off, the tank would get too hot and the pressure-relief valve would open. I would like to enlarge my storage capacity with another tank, but do not want to use a pump.

J. Ruberg, International Falls, Minn.

Place your new tank above the present one, and gravity flow will maintain them both at the same temperature. Your storage will be doubled. Use a large pipe from the top of your present tank to the bottom of the new tank. All piping must slope upward. No loops with downcomers can be used, since the natural flow would be blocked. US

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

In the "Alternate Energy Adventure" we present a project developed or reported on by PS readers, and pay \$200. Submit black-and-white glossies and a sketch to "Energy Adventure" at the address above.



How to pick a pocket.

To prove a point, we stitched together half a pair of the best-selling jeans and half a pair of JCPenney Plain Pockets.

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Energy roof for sunless climes

If the cold, cloudy weather where you live has made you reluctant to install a solar collector on your roof, think again.

A system designed and licensed by Austrian, German, and Swiss independent laboratories specifically for use in severe climates with long sun-

less periods is now being imported into the United States. The "energy roof," as it's called in Europe, is claimed to provide all your water- and space-heating needs—without relying on the weather. It's being distributed in New England by Northeast Polysolar (New Britain, Conn.).

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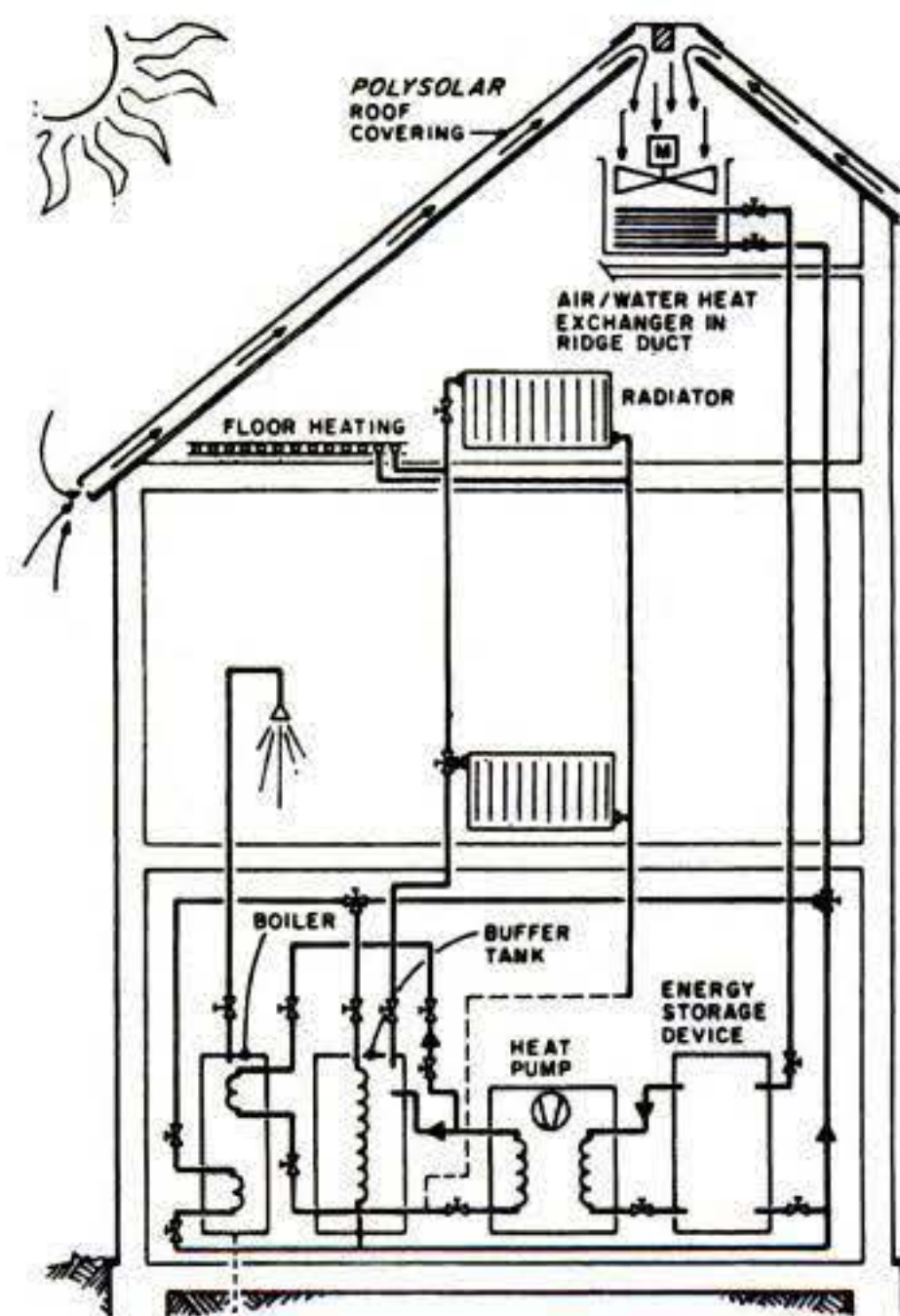
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The Polysolar system is an air collector that consists of double-walled PVC panels with clear-plastic glazing. The lightweight panels' tongue-and-groove joints connect to form the entire roof of your house; they're available in any specified length. To allow for expansion the panels are clipped loosely together.

Ambient air is pulled through the panels and enters a duct below the ridge of the roof, where an air-to-water heat exchanger is located (see drawing). It then passes through piping to a storage unit and to your home's domestic-water tank. In com-



bination with a Dando Energy Systems heat pump, the system is self-sustaining, claims Polysolar: No conventional furnace or other backup system is necessary. (For climates that are excessively cloudy a water-to-water heat pump can be added to draw energy from the already heated stored water.)

Dando is scheduled to manufacture the entire Polysolar system in the U.S. in the near future. Right now, the imported panels from Germany cost \$6 per square foot. The domestic cost is estimated to be \$3.75 per square foot.

Two brothers, Peter and Robert Knaus, began distributing the system almost two years ago. Polysolar's pilot installation on a duplex in Newington, Conn., produced combined winter bills for water and space heating of \$164, the company claims. A second installation, in Kensington, Conn., which uses more American-made components, is now being monitored, and a third is currently under construction.—Kathleen Murphy Lord



The new
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You've waited long enough to cut the cord.

These two cordless telephones bring you technical sophistication and convenience—at prices never before available. And you save money by replacing extension phones in your house, without monthly rental charges from the phone company. Now you'll have the freedom to take your phone anywhere (even to the backyard!) without extensions or phone jacks.

Both phones feature full duplex electronics (means both parties talking simultaneously can hear each other without pushing buttons), and quick plug-in installation at any modular jack. And with the latest technology, sound quality actually equals that of conventional wired phones.

But each design was created for slightly different needs. Which one is right for you?

The new medium range, compact Extend-A-Phone.

Bell Telephone made history when the first Trimline™ phone was introduced. Now Extend-A-Phone—the world's largest maker of cordless phones—introduces the first significant improvement to the Trimline phone in 10 years: Their new "trimline" style phone cuts the cord between the base and the handset.

You're free to walk around during calls without the annoying cord—up to 75 feet of tangle free communication from the base. An added plus is the total absence of any protruding antenna.

Equally important, you can receive calls at the hand set without hanging it up. Or, simply place it back in its base cradle for automatic recharging of its self contained permanent battery—for up to 6 hours of continuous conversation per charge.

Simply plug the base unit into any modular phone jack. To dial out, use the convenient Soft Touch Tone Pad. If a number is busy, touch the Redial button for an automatic redial of the number. There's also a Privacy switch that puts the outside party on 'hold'.

Extend-A-Phone can be used as a regular desk phone, or easily mounted on a wall. Comes in an attractive bone white color. This newest Extend-A-Phone takes you into the 21st century, at a price everyone can afford today: just \$129.

The long range Mura. On sale.

The 700-foot range Muraphone is selling nationally at \$199 to \$249. It's



worth every penny, setting new performance standards for the cordless telephone industry. And now, for a limited time, you can order it from The Sharper Image for just \$179.

The Muraphone is unique because its permanent built-in battery recharges anywhere, at any wall outlet. You can even place and receive calls while it's recharging. One charge gives four hours of continuous talking for weeks of operation.

The beige and brown Mura is also the only cordless to win design awards for its appearance. It has a small hideaway base unit, and a clean, futuristic design that's immensely functional: the angled tips make your phone conversations more comfortable, and the back mounted pushbutton panel lets you dial without lifting up the phone.

Also features automatic redialing of busy numbers, and a dial-out security switch. Plus the longest range of any popular priced cordless. Call anywhere in the world from up to 700 feet away from the base station. You'll receive clear, static-free phone transmission

on your back yard or porch. Thousands of Muraphone users testify this cordless is one of the most reliable ever made.

You choose the best phone for you.

Whichever you choose, both are unusually high quality, thoroughly tested FCC and UL approved products. They come with full instructions and 90 day limited warranties.

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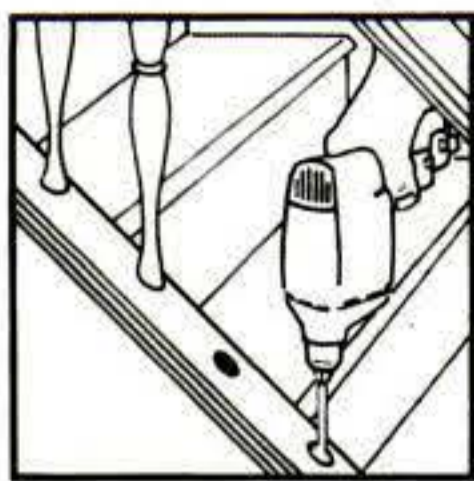
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SUPER DOERS QUIZ #4

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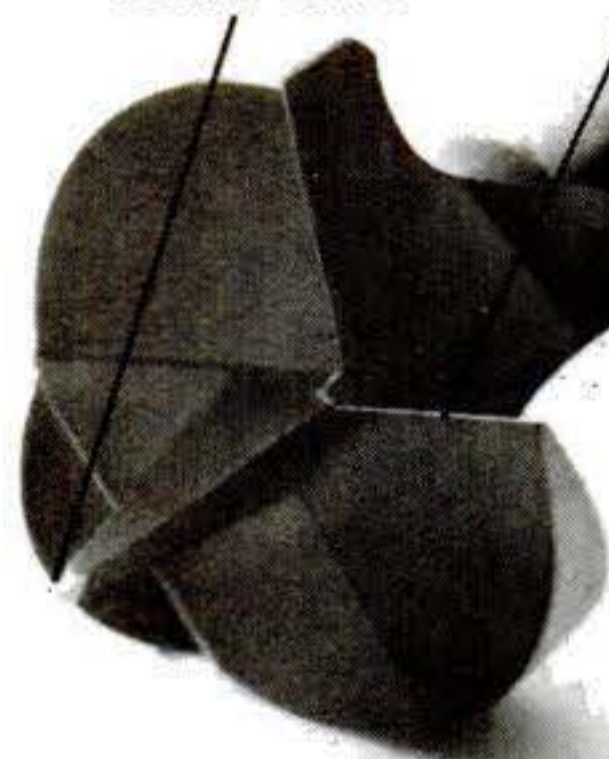


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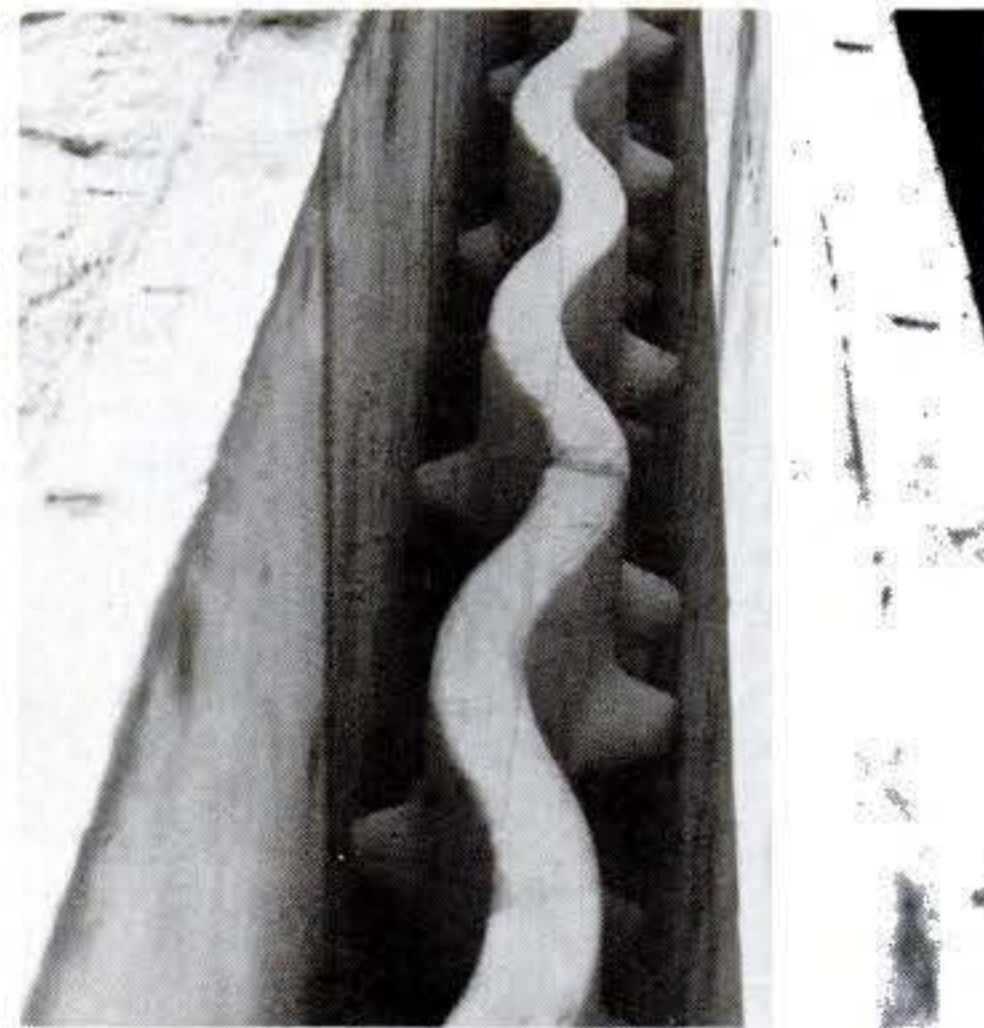
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Insulating core for concrete walls

Want to hold down construction costs and make your building more energy efficient? You can do both with these expanded polystyrene panels, claims Thoro System Products, 7800 NW 38th St., Miami, Fla. 33165.

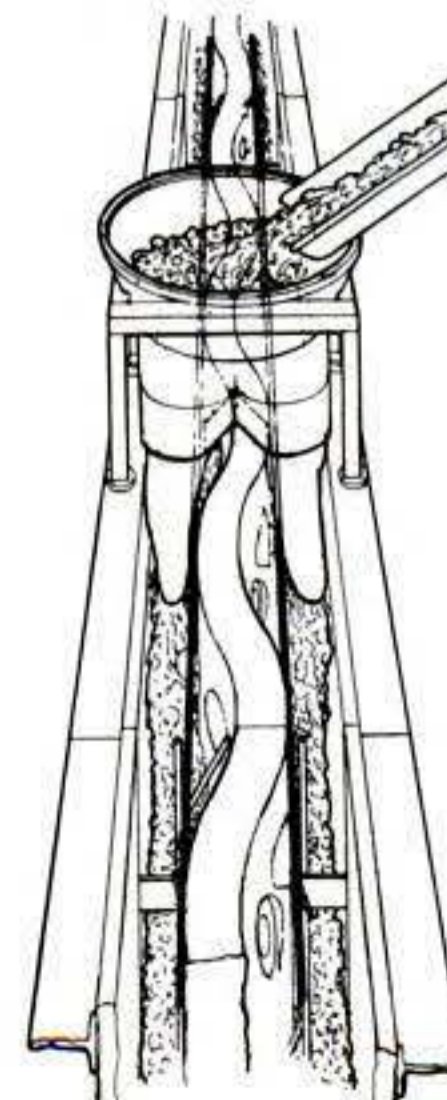
The panels, inside the concrete, can reduce heat loss by as much as 75 percent and cut the amount of concrete used by about 25 percent. They can be installed in a single pour without resetting or adjusting forms. There is no appreciable deflection of the panels during pouring.

In addition to its R-9 insulation value, Thermocurve has a low water-vapor transmission rate, won't rot, and is highly resistant to mildew, says the maker. It's available in three widths for all standard poured-in-place concrete walls and can be easily cut for custom sizing on the job. The panels cost about 80¢ per square foot.—Marita Begley



Thermocurve can be installed as the building's forms are set, or inserted afterward

by sliding the panels in from the top of the form (photo above). Concrete is evenly distributed on both sides of Thermocurve by using a splitter-type box such as the one shown in the drawing at left. Vertical reinforcing rods are used to retain structural strength and stability, which might be compromised because of the displacement of concrete by the insulating panels.



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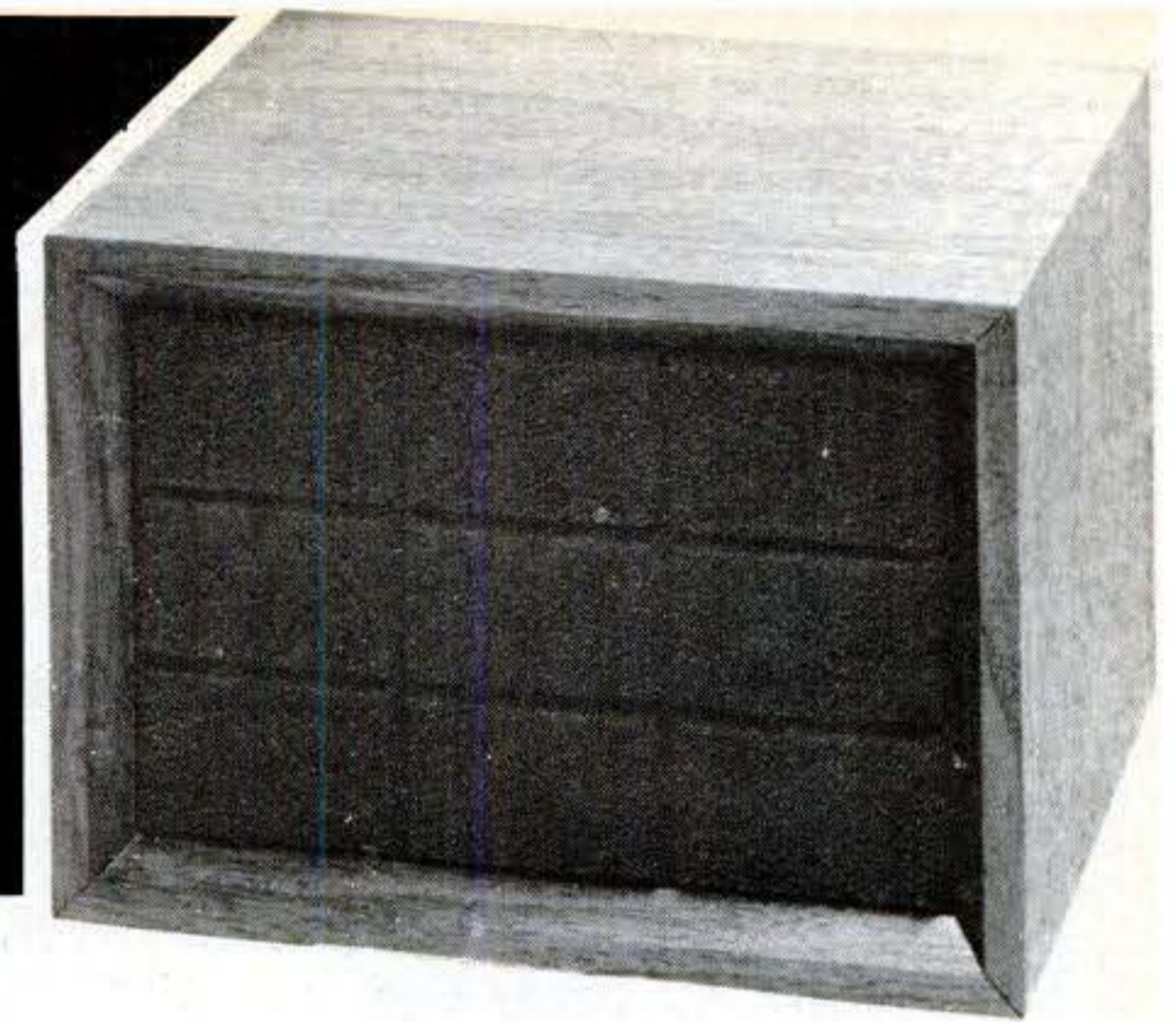
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Guardex 8000 Alarm System works on the principle of audio discrimination. This, put simply, is the process of electronically separating normal everyday sounds, such as voices, telephones, etc. from break-in type noises such as breaking glass, prying metal, or forcing a door open. The Guardex 8000 protects one story homes and offices up to 2000 square feet and open commercial buildings up to 10,000 square feet. The Guardex 9300 with wireless remote sensor capability is available for multi-story homes and offices or single story with more than 2000 square feet. Call the factory for more detailed information.

TURNS ON LIGHTS AUTOMATICALLY

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

POWERFUL ELECTRONIC SIREN

The Guardex 8000 alarm is equipped with a loud built-in siren. If during the five minute period the lights or other electronic equipment has been activated, a second break-in sound is detected, (it can be only a second or two after the first break-in sound) the built-in siren will start blasting for 90 seconds. At the end of approximately 90 seconds the siren will shut off and the alarm listens again. If another break-in sound is heard, the siren will come on for another 90 seconds. If no other break-in sound is detected, the siren will stay off and at the end of the five minute period the lights will shut off and the alarm instantly resets.



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

The Guardex 8000 Alarm System is walnut grained and disguised to look like a small stereo speaker (6³/₄" x 9³/₄" x 8") and weighs less than 6¹/₂ pounds.

EXIT AND ENTRY DELAY

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

BATTERY BACK-UP

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

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The F.B.I. statistics show that at the present rate, one out of every four Americans are going to be burglarized. That is not a very pleasant fact, but it is true. You have a greater chance of being burglarized than being a victim of a fire or automobile accident. The time is now to help protect yourself and your valuables with a Guardex 8000 alarm system.

WARRANTY

One year, 100% parts and labor when returned to factory post-paid. A five year extended warranty is available for a charge of \$25.00.

OUTSIDE SIREN

The Guardex 8000 alarm is equipped with a loud, built-in siren, but if you desire an additional siren to mount outside or in an area away from main alarm, they are available with 50 feet of wire for \$29.95. (Connecting terminals are provided on the back of the alarm).

30 DAY NO RISK TRIAL

This is your opportunity to purchase an alarm system directly from the factory for only \$239.95. Try it in your home or business for thirty days without risking one cent. Put our Guardex 8000 alarm to your own test. See for yourself! It will protect every window and door from break-in. If you are not completely satisfied, return the alarm within 30 days of receipt for a complete refund. To order your Guardex 8000 alarm, CALL TOLL FREE to charge your credit card or send your check to Guardian Electronics, Inc. in the amount of \$239.95 plus \$4.95 postage, handling and insurance. If you want the optional outside siren, add \$29.95. Optional outdoor 7" x 10" metal warning sign (stake not included) add \$9.95. (California residents add 6% sales tax.)

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DETROIT REPORT

By JIM DUNNE



Ford's propane cars

Ford will have 3,000 propane-powered cars on the road within the next 12 months, and will sell possibly 20,000 a year by 1985. But these cars are not designed for the average buyer. They are Granada/Monarch types (top photo) fitted with special propane tanks and induction systems. The first batch will be sold only in Canada, where there is a big surplus of LPG (liquid petroleum gas).

"We'll sell them to fleets first," says Ford's Don Van Kirk, the system designer, "where they will mean big fuel-cost savings in long-distance use." Part of the saving will come from the price of propane, which is usually just over half the price of gasoline. Additional savings will come from reduced maintenance. Propane burns cleaner, and that means fewer spark-plug changes, longer oil life, and so on. But the cars will cost \$600 to \$800

extra. Special parts such as 1/4-inch-thick steel fuel tanks, pressure regulators for the 160-psi system, and an air valve to replace the carburetor (lower photo) account for most of the extra charges. The prototype propane car I drove ran smoother, accelerated quicker, and started easier than its gasoline-fueled counterpart. All 1982 propane cars will use a Ford 2.3-liter, four-cylinder engine that has been modified for higher compression (10.5:1) and also less exhaust blowby.

Slant Six diesel sidetracked

Chrysler has a diesel version of its venerable 225-cu.-in. Slant Six engine ready to go into production but lacks the money to launch it. Even so, the six-cylinder diesel couldn't be used in the front-wheel-drive cars that make up the bulk of Chrysler's current and future sales plans. So Chrysler is talking with Perkins, the British engine company, about a joint project to produce a four-cylinder diesel version of the Slant Six. It's a complicated proposal, but it makes sense. The engines would be built in Canada, where government support money is available for new projects, and would help two of Canada's biggest industrial firms. If all went well, the engines would be built in both six- and four-cylinder versions (3.7 liter and 2.3 liter, respectively) and would be used in both Chrysler and Massey-Ferguson (Perkins) products. The inline six would power Chrysler's conventional pickups and vans, while the four would be for front-drive vehicles.

American/French look

Renault will take over most car-design work at American Motors in the coming years. The French auto maker, which now owns 46 percent of AMC, will begin alter-

ing its European models for U.S. tastes next summer. That doesn't mean that the new AMC's will have a totally European look. Detail-styling suggestions will continue to be made by American Motors but will be restricted to such things as grilles, headlight trim, and taillight shapes. Meanwhile, AMC will continue to design its Jeep lines without Renault involvement.

V8's: an endangered species

For the first time in 20 years, the V8 engine does not hold the number-one spot in U.S.-buyer demand. A survey of domestically produced 1980 cars showed that V8's made up only 30 percent of all sales. The remainder were fours and V6's in equal shares. The drop in V8 demand was sudden: In 1977, 76 percent were V8's. If you add imports to total U.S. sales, the share of fours zooms to a commanding lead, while V8's shrink to about 22 percent. Most insiders believe that the V8 will disappear from all but a few specialty cars by 1985, and will account for no more than five percent of the market at that time. Among those few cars that will have V8's will be the new F-bodies (Camaro and Firebird), which will be introduced in mid-January, and the Corvette (Y-body), which will also be completely restyled—but for the 1983 model year.

A rare change

Most cars are still made from metal—which is bent, shaved, cast, polished, and cut in much the same ways that it was a century ago. Changes in metalworking are rare, but a new type of metal-cutting coolant-lubricant is of intense interest to auto makers. It's a water-based synthetic that replaces a widely used mineral-oil cutting fluid. It reportedly lasts longer, is biodegradable, easy to store, and does a cleaner job than the natural fluid it replaces. Made by Pillsbury Chemical and Oil, Inc., the new coolant-lubricant will first be tested in machining difficult-to-shape aluminum parts. If it proves to be all that's claimed, it could replace natural oils in a wide variety of machining operations, ridding factories of the oil mist, dripping, and general dirtiness that accompany conventional oils.

GM likes arbitration

To settle customer complaints, GM is going more deeply into third-party arbitration. When regular customer-relations decisions are not satisfactory to the customer—usually in disputes over warranty coverage—the customer can ask for an outside arbitrator to decide. With increased expectations in recent years, customers have become more difficult to satisfy, so GM has agreed to the arbitration system as a final way to conclude repair disputes. The program started in Minnesota in 1979 and now extends to 20 cities. If you have a warranty problem with your GM car, check to see if an arbitrator is available in your area. His decision, which is binding, will at least let you know that you've gone as far as you can with the company. P 5

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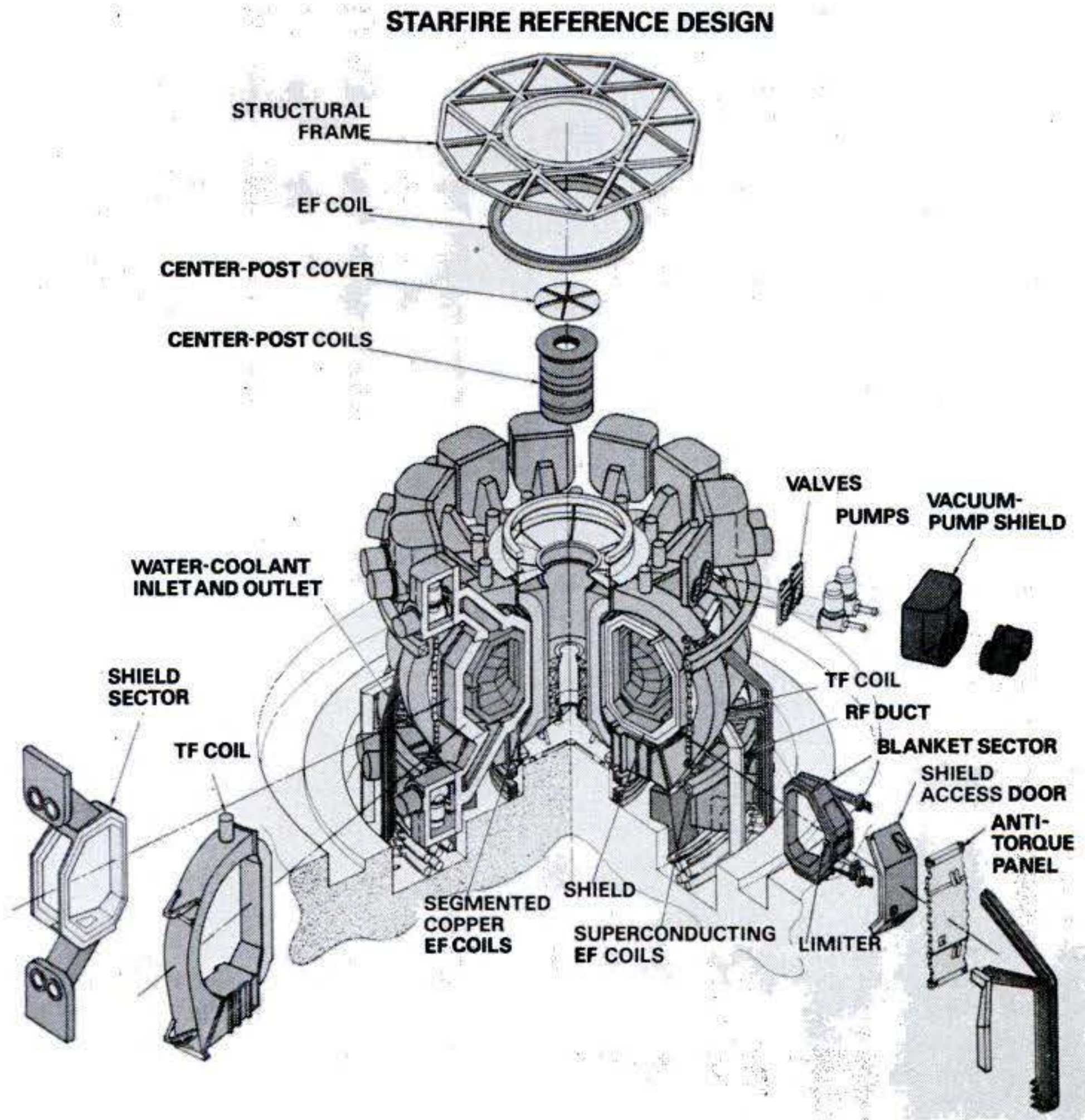
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Regular: 3 mg. "tar," 0.4 mg. nicotine av. per cigarette, FTC Report Jan. 1980.
Menthol: 3 mg. "tar," 0.4 mg. nicotine av. per cigarette by FTC Method.

SCIENCE NEWSFRONT

By ARTHUR FISHER



Starfire fusion reactor

You're looking at the most detailed design to date of a year-2000 commercial fusion power reactor. Dubbed Starfire, it is the result of a two-year, \$2 million study prepared for the Department of Energy by

Argonne National Laboratory, McDonnell Douglas Astronautics Co., and a variety of electric utilities and other private companies.

Fusion—the process of melding light elements, such as isotopes of hydrogen, to make heavier elements with an enor-

mous release of energy—is the most appealing route to energy independence. Physicists are certain that controlled fusion is scientifically feasible, but no one can be sure that complex and formidable engineering problems will yield enough to make such future plants economical. Design studies like this one are a preliminary step toward that determination.

The Starfire reactor shown here in cross section is based on the so-called tokamak design, one of the most promising yet tested experimentally [PS, Dec. '78]. To oversimplify, a tokamak is a doughnut-shaped chamber that confines a plasma of hot ionized gas, the thermonuclear fuel, until it can be heated to the extraordinary temperatures needed for fusion to occur. The Starfire design would generate electricity steadily, rather than in a pulsed mode typical of some other concepts. The DOE study suggests that the design could be cost-competitive with nuclear-fission plants and coal-fired electric power systems at the turn of the century.

Scissor-wing tested

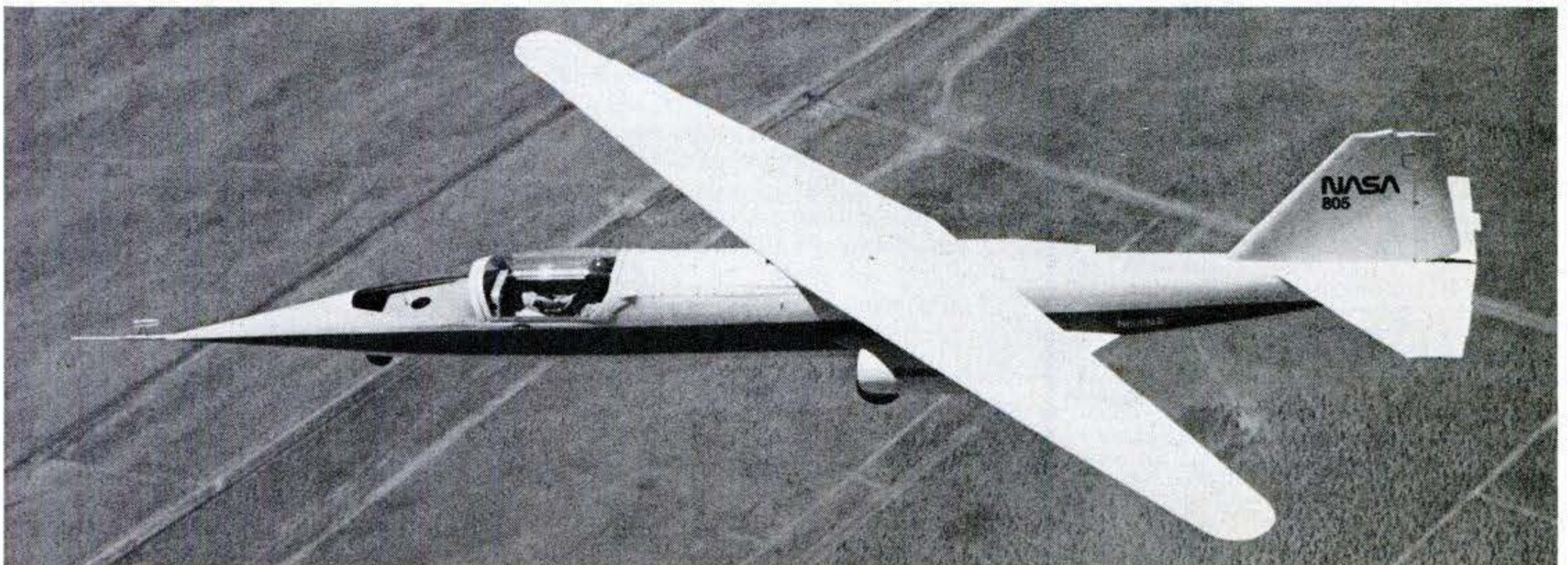
The latest step in the progress of the incredible AD-1 is pictured below. NASA's unique scissor-wing aircraft has flown successfully with its wing at the maximum, 60-degree oblique position. Flight tests at Dryden Flight Research Center by pilot Tom McMurty have shown the craft can skew its wing at angles ranging from 30 to 60 degrees and still perform the maneuvers required of it.

The object of the bizarre design is economy [PS, Oct. '78]. At low speeds and during takeoffs and landings, a scissor-wing transport of the future would fly with the wing perpendicular to the body, as in conventional aircraft. But by skewing the wing during transonic and supersonic flight, the plane would decrease aerodynamic drag and thus require less power—and less fuel.

Tennis turmoil

Four years ago I wrote about the introduction of the Prince tennis racket, a revolutionary design with an oversized head [PS, March '77]. Those who play tennis know that the Prince has been followed by a host of "big-head" competitors. In my sto-

Continued



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Science newsfront

[Continued]



ry, I said that there was really no limit to the size of such rackets, because the rules of the game specify many things about the court, the net, and the ball, but nothing about the racket. You are entitled, I wrote, to strike the ball with an "implement." And that might be, if you were so inclined, a pool cue, butterfly net, or the door off an old pickup.

Now, however, that's all changed. The International Tennis Federation, meeting in Switzerland, has finally set specifications for rackets, partly at the behest of players who believed the oversized rackets were somehow unfair. Overall length may not exceed 32 inches, and the strung surface (the head) may not be wider than 11½ inches or longer than 15½ inches. That's not terribly restrictive, however; the Prince falls well within those limits.

Fuel foiler

The long skinny object in the photo above is a railroad car, although hobo riders of the rails would be hard-pressed to recognize it. Developed by Santa Fe Railway in an attempt to conserve fuel through weight savings, the bare-bones container car is an articulated skeleton, consisting of I-beams down the center with cross pieces at both ends and the middle to support containers. (A container is being loaded in the picture.) The prototype car can carry 10 40-foot containers or 20 20-foot containers. Santa Fe executives expect the new cars will better the 15 percent fuel savings achieved with an earlier design.

Smoke gets in your wives

Last April I commented on a study that seemed to confirm the suspicions of many experts about so-called "second-hand smoke." Their contention was that nonsmokers can be physically damaged by tobacco smoke generated in their vicinity

by smokers. Epidemiologist Takeshi Hirayama of Japan's National Cancer Center reported the results of a 14-year survey of 265,000 Japanese men and women: Nonsmoking wives of heavy smokers were twice as likely to die of lung cancer as nonsmoking wives of nonsmokers.

The first challenge to this result came from the Tobacco Institute, an industry association. The Institute said that three U.S. statisticians had found a serious flaw in the Japanese study. One of them is Professor Nathan Mantel of the Biostatistics Center of George Washington University, who perfected a statistical procedure that was used in the Japanese survey. He says that while he has some questions about the study, he did not necessarily challenge its conclusions.

Perhaps more significant was the publication of an American epidemiological study of lung cancer by Lawrence Garfinkel of the American Cancer Society. The study followed 176,739 nonsmoking women and turned up no evidence that those married to smokers ran a greater risk of contracting lung cancer than those married to nonsmokers. But Garfinkel cautioned that neither his study nor Hirayama's provided definitive knowledge about second-hand smoke. It seems that we will have to wait till the smoke clears for unassailable conclusions.

Long-lived battery

Researchers at Sandia National Laboratories have developed a battery that can supply electricity uninterruptedly for as long as five years. They did it by modifying existing lithium/sulfur dioxide cells that were commercially available but had failed catastrophically after 12-18 months.

The new battery looks like an ordinary D cell, but provides current at three volts with a capacity of eight to nine ampere-hours, instead of the D cell's 1.5 volts at five to 10 percent of that capacity. It will deliver a base load of about 100 microamps over five years. The typical flashlight battery supplies 5,000 times that much current, but for only several hours. Even at the lower rate, it would last only a few months. The Sandia battery could eventually be used to power sensors used in safeguarding nuclear facilities and in remotely powered seismic devices planted on the sea floor.

No newts is good newts

Most people know that mixing alcohol with various drugs can be risky. But a 29-year-old Oregonian learned the hard way that it can be fatal to mix liquor and newts. After polishing off a half pint of whiskey, he swallowed an eight-inch newt on a dare. The salamander-like creature was a rough-skinned newt, *Taricha granulosa*, that is found in Oregon, California, and southern Alaska. It is also loaded with a neurotoxin that can cause respiratory paralysis. Within a few hours of his prank, reports the Journal of the American Medical Assn., the man was dead. P 3

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CALCU-LETTER

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

The tower and the trap

When faced with a hopelessly complex problem such as the one considered below, you can often solve it by cutting it down to manageable size and extracting a principle that can be applied to the larger question. Be careful, though, that the principle is truly universal—not simply a solution to a particular case. (That's where I went astray in my discussion of Reverse Polish Notation in the July "Calcu-letter." I'll take that up shortly.)

The ancient and honorable problem of the Tower of Hanoi involves a series of

three pegs. On one of them are stacked two dozen discs, each smaller than the one beneath it. You are to transfer the discs to either of the other pegs, moving one at a time and never placing a disc on one smaller than itself. How many moves will you need?

Reduce the problem to a single disc, then two, and so on. You'll find the number of moves needed forms a series: 1, 3, 7, 15, 31. . . . Since each element is twice the one before it plus one, you can extend the series until you note that it can also be generated by listing numbers that are one less than consecutive powers of two. For

CALCU-PUZZLES

September's solutions

The last "Calcu-letter" put you smack in the center of a one-acre circular field. You were asked to find (to the nearest square meter) the area of the triangle having these vertices: center of field; the point 28 meters due north of center; the point that is both due east of center and due south of a point on the circumference due east of the second point. First you had to perform a simple conversion to find that an acre contains about 4,047 square meters. Then you had to figure the lengths of the two unknown sides of the triangle. For many, this proves to be a sudden-insight problem. It turns from tough to easy as soon as you note that the hypotenuse of the triangle is the diagonal of a rectangle of which the other diagonal is a radius of the circle. Apply Pythagoras and the formula for the area of a triangle, and the answer falls out: 314 square meters.

Also suggested in September was the pursuit of what you probably recognized as the decimal part of the value of pi: 0.14159. . . . You were to get this into the display of a scientific calculator in the fewest steps without use of a pi or digit key. Probably the shortest route boils down to finding the arc-cosine of -1 radian, then dropping the integer part. If your method of entering -1 is by pressing cosine and change-sign keys, five steps does it. If your calculator happens to be preset for radians, as is possible with some Sharp models, steps dwindle to four. Also, with models having a sigma key that produces -1 in a single move, four is enough. If there's a calculator somewhere that has the sigma key and can also be preset for radians, three steps would do it. All this is strictly for fun and learning more about your calcu-

lator. But it would suddenly turn useful if your pi key broke down, wouldn't it?

How many spins?

If you enjoy this part of the column, you'll want to know about a bargain-priced collection of 100 puzzles ranging from tough to tougher. *Challenging Mathematical Teasers* by J.A.H. Hunter (\$2.75) is just one of a series of math-fun books from Dover Publications; write for a catalog (180 Varick St., New York, N.Y. 10014).

One of Hunter's horrible hundred has to do with a roulette wheel that has just produced the same number twice in a short series of spins. "Not too remarkable," says an observer. "The odds are only about three to one against it." The wheel has 36 numbers plus a single zero, as at Monte Carlo. How many spins were there?

Cussed ages

If that teaser whets your appetite, try this one of Hunter's. It's quite different, and you may find it totally mind-boggling unless you approach it right. Mark and Judy are one year apart in age. The difference between the cubes of their ages is one more than the square of Uncle John's age. How old is John? There are two solutions that yield realistic ages.

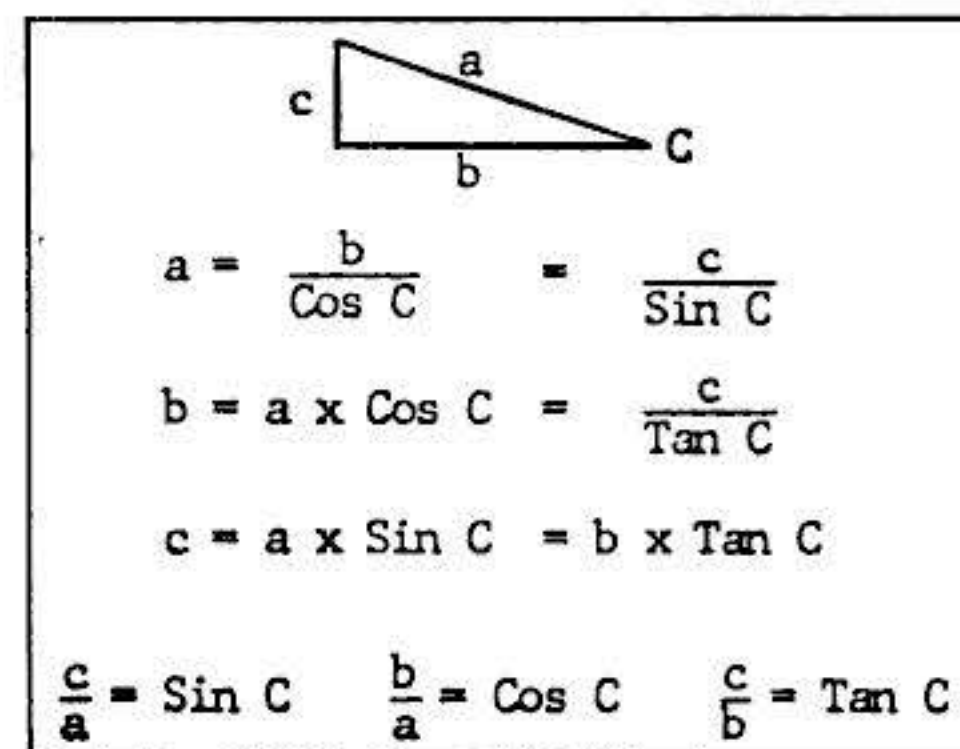
Here's a similar problem, but one that places an additional roadblock in your way. Three boys and two girls in a family are all of different ages. The boys' ages are spaced two years apart, and so are the ages of the girls. One of them, being of mathematical mind, discovers that the sum of the squares of the boy's ages totals exactly the difference between the cubes of the girls' ages. What are the ages?

any large number of discs, you'll find the answer quickly by raising two to that power and subtracting one. For 24 discs—allowing one second per move and never resting—the chore would take 164 days and a few hours.

Be forewarned, however, that testing a series of instances in this manner may suggest a solution but does not prove it right. Watch out for the simplistic trap that I fell into—and a fair-size horde of readers caught me on. It is true that if you enter 2, 3, and 4 into an RPN calculator you'll get the same answer whether you then press times and plus or plus and times. Analyze what's happening in the stack and you'll quickly see why that's true in this one case but not generally. Although $2+(3 \times 4)$ happens to equal $2(3+4)$, it doesn't follow that $a+bc=a(b+c)$.

Books and a shop tip

Differences between Reverse Polish and algebraic notations have led one publisher to offer a pair of paperback books that neatly divides the field. *Programmable Pocket Calculators* by Henry Mullish and Stephen Kochan is for users of RPN models, essentially Hewlett-Packard's 25, 25 C, 55, 65, 67, 19 C, 29 C, and 33 E with a Novus and a Sinclair thrown in. There's information on buying your first programmable, but the emphasis is on methods and applications. Price: \$10. Harold S. Englesohn, in *Programming Programmable Calculators*, contends that the fat manuals that come with most models are hard to understand because they weren't written with beginners in mind. He tries to make up for that deficiency in this supplementary book especially for owners of Texas Instruments' SR-52 and 56 and the newer TI 57-58-59 series. The book's strength is its sequences showing how



formulas or sets of data turn into programs. It's \$12. Both are from Hayden Book Co. (50 Essex St., Rochelle Park, N.J. 07662).

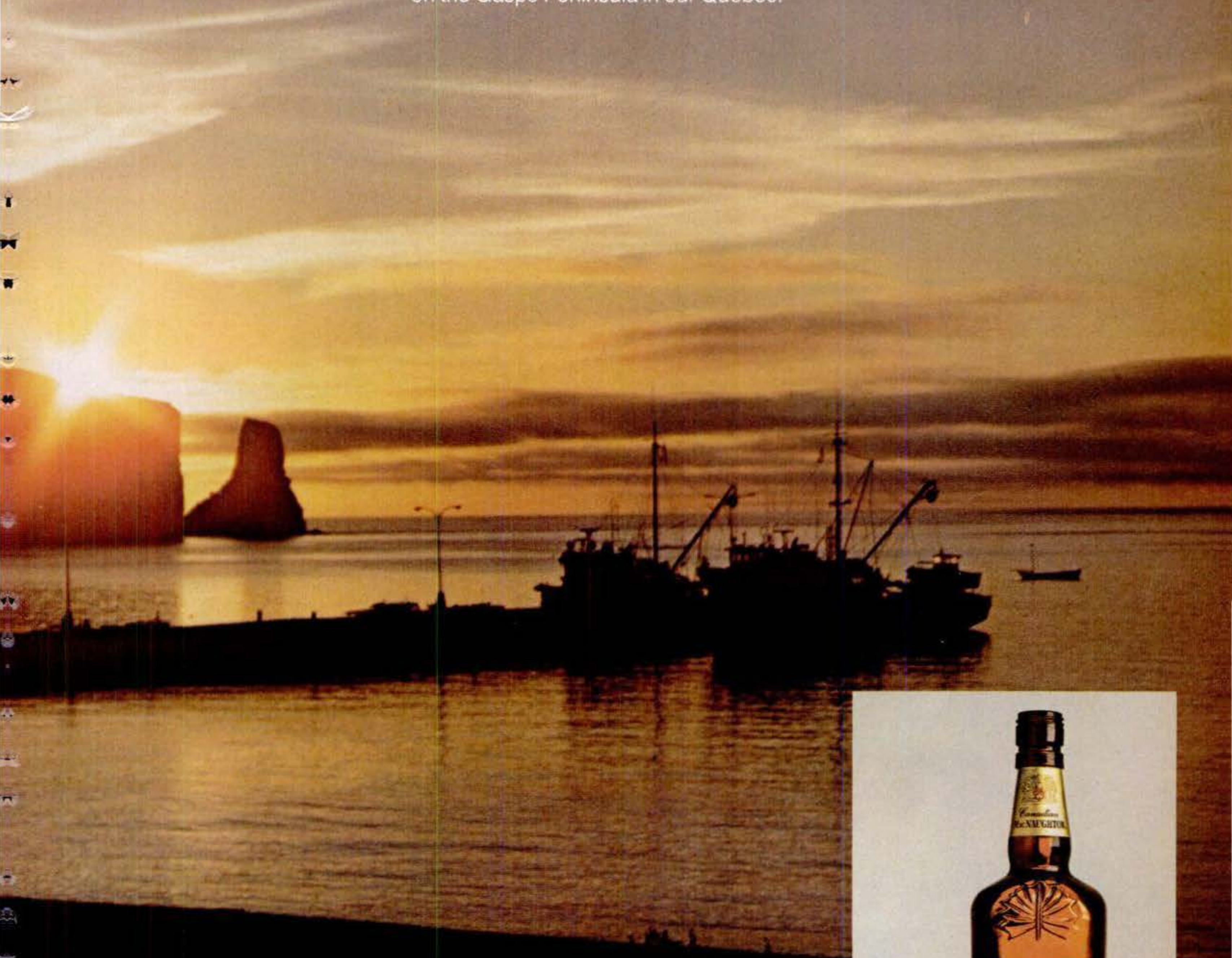
What you see reproduced above is a simple memory aid contributed by Ken Wisniewski of Mundelein, Ill. If you often need reminding about the basic trig relationships, you might want to clip this and tape it to the back of your calculator. Ken and others in his shop find it helpful in solving triangle problems. ■

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

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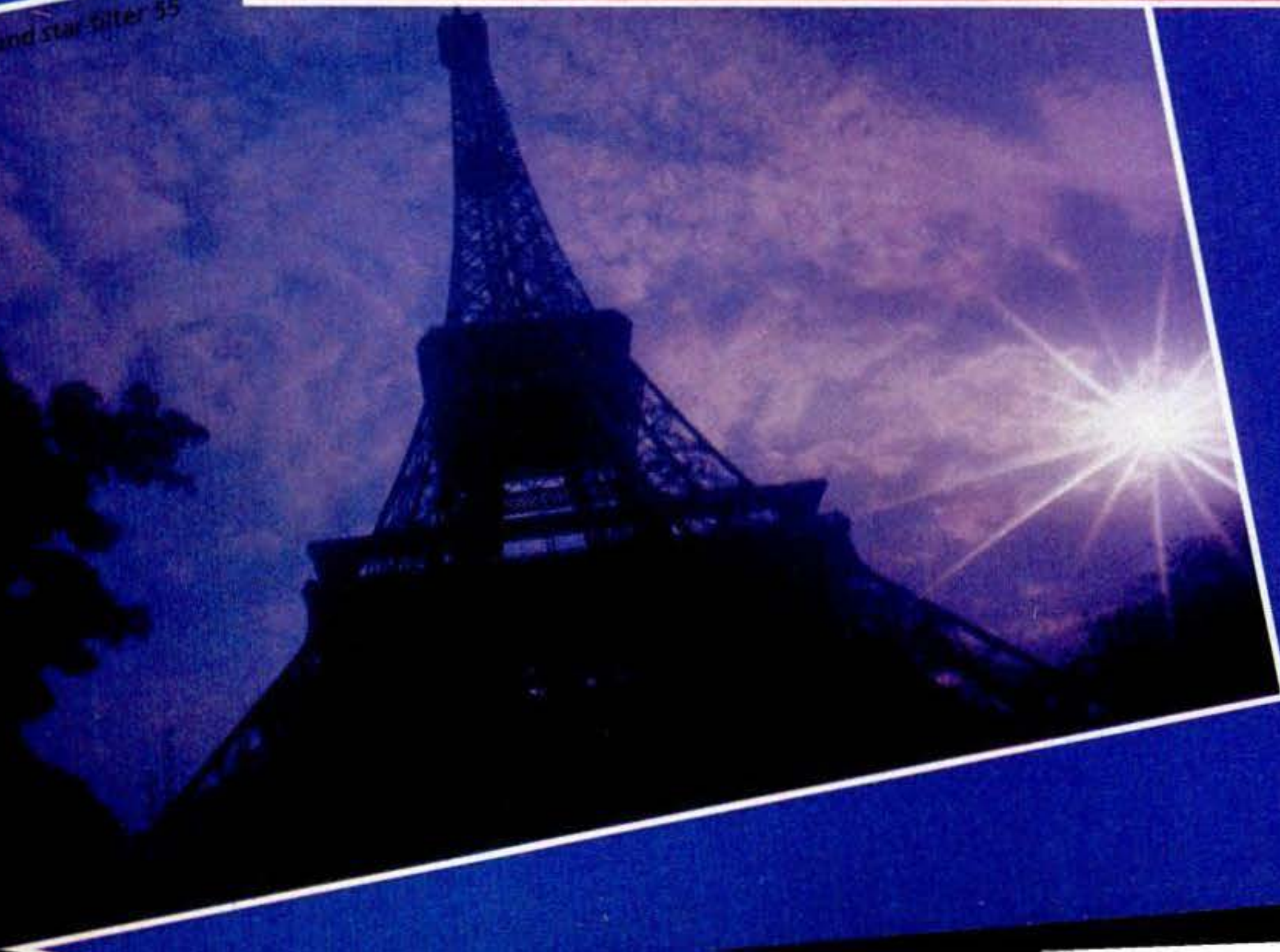
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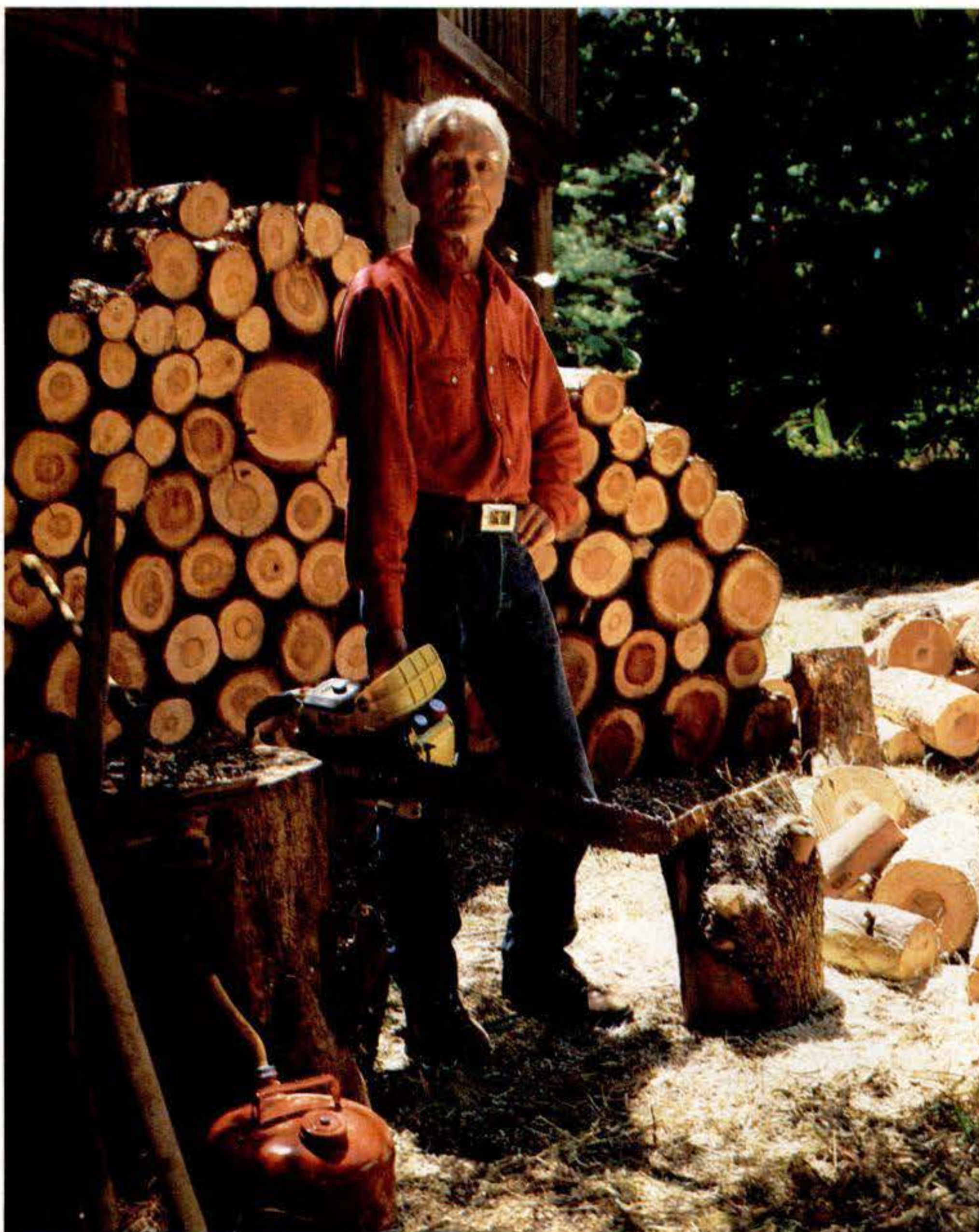
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Mercedes' steering-wheel air bag



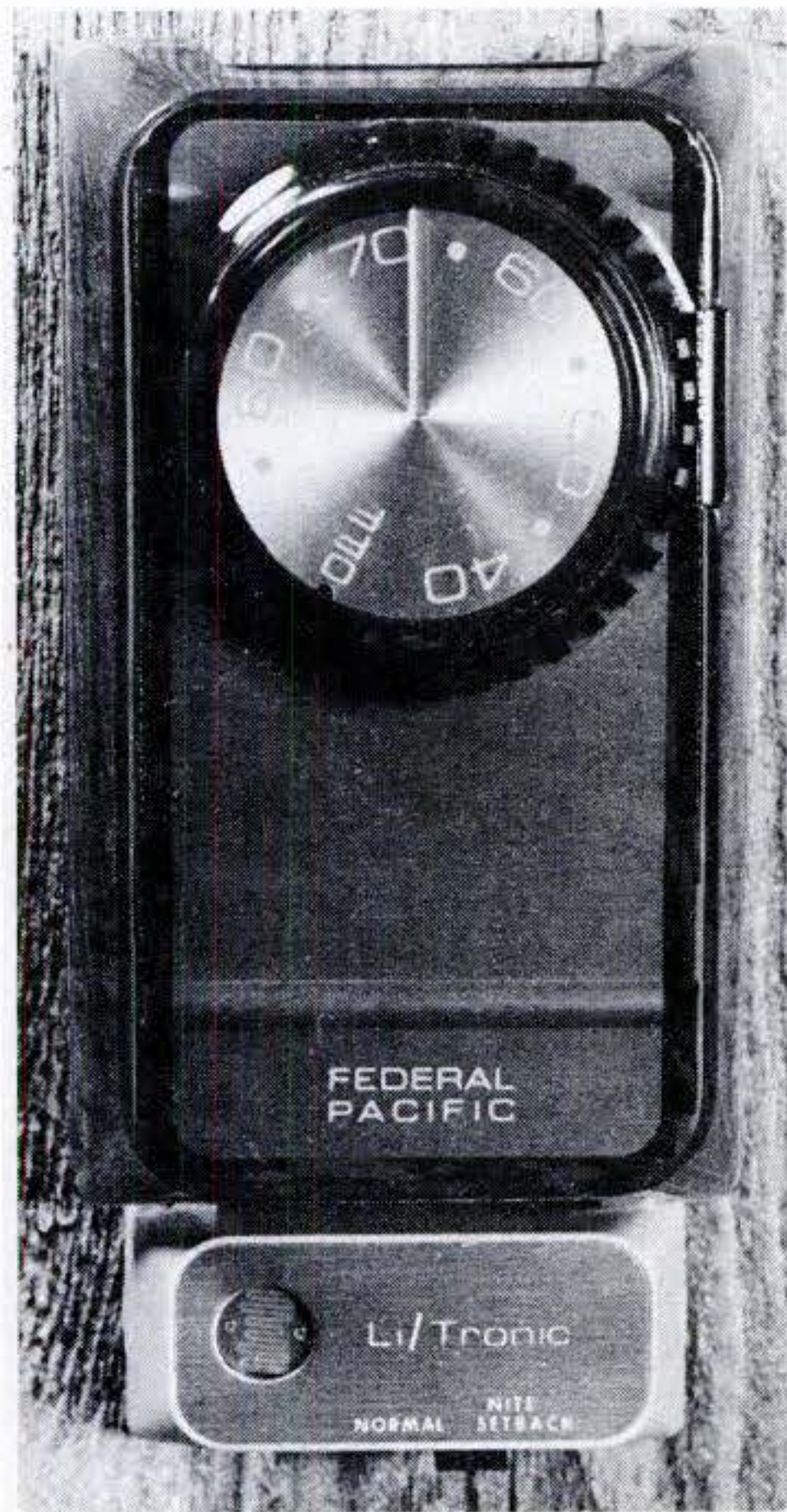
Chest-protecting air bag inflates from the steering wheel in $\frac{1}{30}$ of a second, preventing injury as the driver is thrown forward. After driver hits it, the bag deflates.

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Instead of an air bag, an inertial reel belt restrains the front passenger. The same sensor triggers gas from a separate capsule. The gas expands against a piston that forces fluid onto a miniature hydraulic-turbine wheel mounted on the belt reel. This tightens any belt slack in 12 milliseconds. When the ignition is switched on, a dashboard check light glows for a few seconds, indicating that the system is functioning properly. The safety package is available as an option only in Europe on Mercedes S-Class cars. Price: about \$620.—David Scott

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BMW	Falcon	Rabbit
Bobcat	Fiat excl 850, 124	Renault
Capri	Spyder, 500,	Saab
Celica	1100, 1200, 1500	Scirocco
Chevette	Convertible	Simca
Cobra	Fiesta	Skyhawk
Colt	Fox	Starfire
Corolla	Gremlin	Subaru
Corona	Hillman-Minx	Sunbeam
Cortina	Horizon	Sunbird
Corvair	Isetta	Tiger
Crocket	Jensen	Triumph exc
Crosley	Karmann Ghia	Spitfire, TR2,
Daimler	Lotus exc.	TR3, TR3A
Datsun 240Z, 260Z	Elan Elite to 1971	Vauxhall
Datsun 280Z, 280ZX	Mazda	Vega
	Morris-Minor	Volkswagen
	Mustang	Zephyr

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Avanti	Excalibur	Oldsmobile
Bentley	Fairlane	Omega
Bricklin	Ferrari	Packard
Buick	Firebird	Pantera
Cadillac	Ford	Peugeot
Camaro	Frazier	Pierce-Arrow
Checker	Granada	Plymouth
Chevette	Henry J	Rambler
Chevrolet	Hudson	Ranchero
Chrysler	Hupmobile	Rolls Royce
Citroen	Jaguar	Rover
Civic	Jensen Interceptor	Seville
Cord	Jeep*	Skylark
Cordoba	Kaiser	Studebaker
Corvette	Lamborghini	Thing
Cougar	Lancia	Thunderbird
Crown	Landcruiser	Torino
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Guide rail steers bus



Test track has a guide rail on each side, but the bus uses only one at a time (top). Roller (above), on a pivoted arm, is thrust against the rail by hydraulic pressure. When the bus starts deviating, the fluid volume in the cylinder changes. That varies the pressure applied to the bus's power-steering servo, which makes necessary corrections to the front wheels.

MUNICH, WEST GERMANY

At a test track near here I recently took a strange bus ride. The driver steered the bus onto the track and nudged a small, horizontal roller up against a lane-side rail. "Now we're locked on," said Michael Kruger, one of the development engineers for M.A.N. While the driver turned toward us grinning, his hands in the air, the bus wheeled smoothly around the twisty circuit, guided by the roller against the rail (see caption). His hands were folded as we shot through a long concrete tunnel barely larger than the bus. "The driver can override automatic guidance at any time," Kruger told me. "This gives greater maneuverability and safety." The driver demonstrated by swinging across to the next lane.

Precise automatic steering makes possible ultra-slim tunnels and elevated roadways at reduced construction costs. And the single rail would not interfere with other traffic, as dual rails would.

The German government covered half the cost of the \$2.5 million track, and also contributes heavily to vehicle development.—David Scott

YOUR PRESENT STORM WINDOWS ARE NOT ENOUGH!!!

TORLITE Can Double or Triple Insulate Windows

SAVE MONEY ON HEATING COSTS

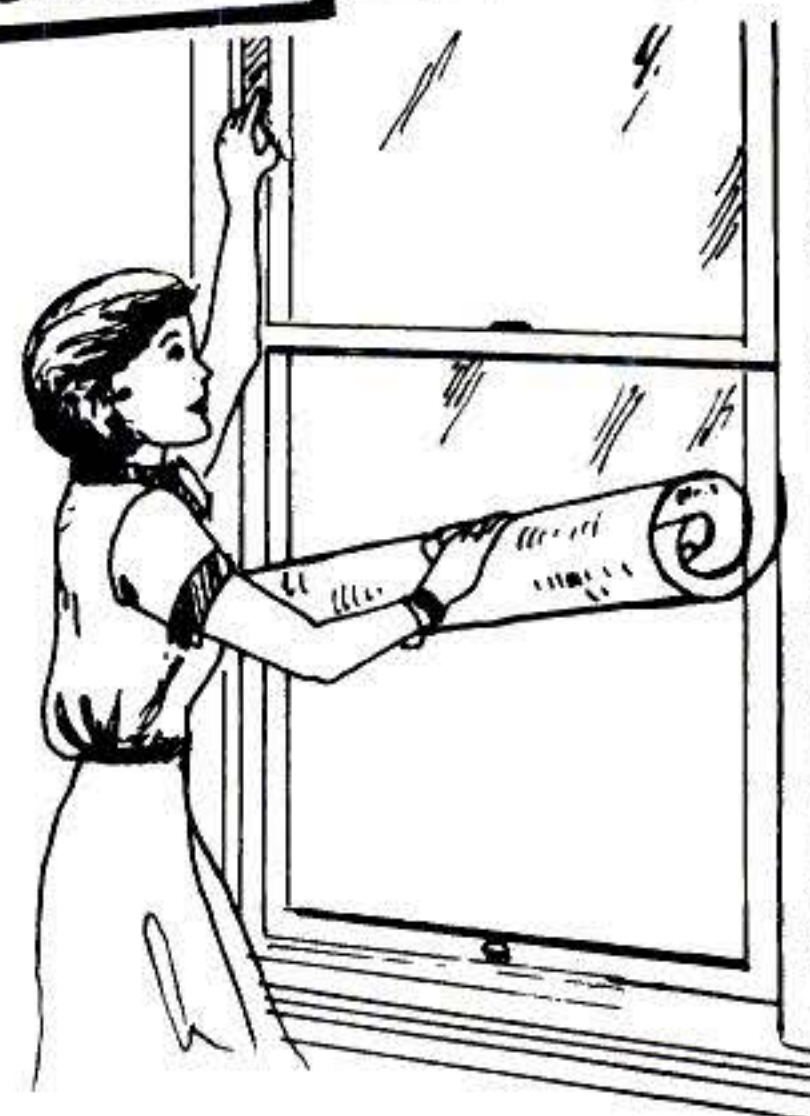
One **Torlite** kit can cover over 160 square feet of window area. This means you can stop **heat LOSS** and **PREVENT** cold air infiltration from **ten average size home windows**. With an energy savings that may equal **ten times** the cost of one kit.

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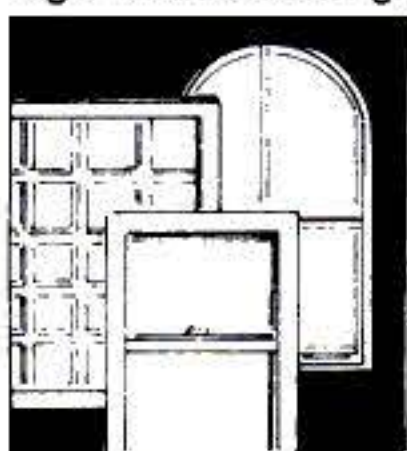
Even should you have storm windows, you can form another insulation barrier against **heat LOSS** and **SEAL OUT cold air infiltration**. The **Torlite** window system creates an **insulating pocket of air** inside your window area by keeping cold air **OUT** and keeping **IN** your heated room atmosphere.

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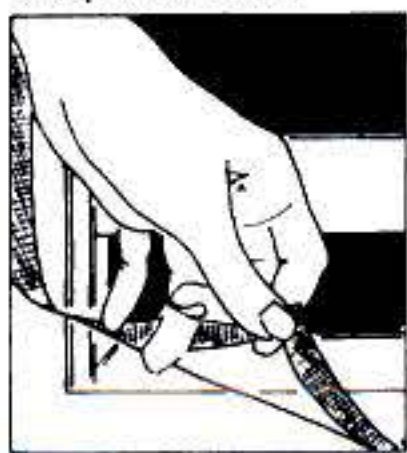
No other window kit available on the market today offers the amount of window coverage and **energy savings** of the **Torlite** system.



Durable, strong, high tensile strength



Fits any size, shape window



Easy as a zipper to open for access

- **Torlite** is 100% optically **CLEAR**. You don't even know it's on your window.
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- The sun's ultraviolet rays have a minimal effect on the **Torlite** film.
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This offer is made direct from the manufacturer. The **Torlite** material is not available to the public thru any retail outlet or store. We regret that we are unable to accept credit cards or telephone orders.

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Three little wagons for small families

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

The versatile station wagon, whose popularity evaporated at the onset of the fuel crisis, may be on the verge of a major resurgence. In 1973, one out of every eight cars sold in America was a station wagon. Today, only one in 11

is, because old-style station wagons suddenly became far too big and expensive to operate.

Now Detroit is responding with smaller, more fuel-efficient and space-saving designs. Among these new-wave wagons are Mercury Lynx, Pontiac J2000, and Dodge Aries K, listed

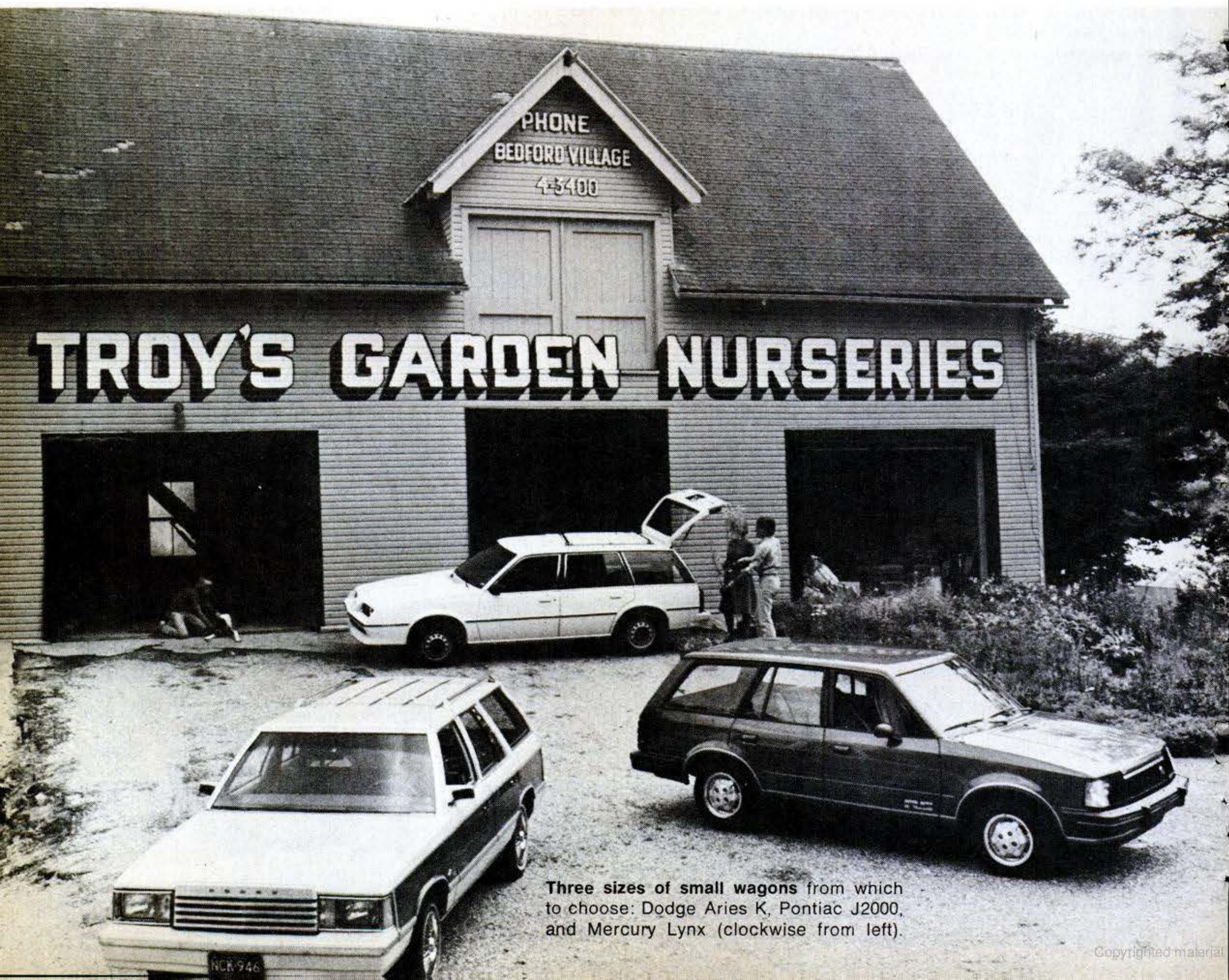
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PS ratings— test report in a nutshell

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

	Dodge Aries K	Mercury Lynx	Pontiac J2000
Acceleration	3	3	1
Braking	1	2	1
Handling	3	4	3
Maneuverability	5	5	5
Quietness	2	0	1
Roominess	4	3	3
Vision	4	5	5
Entry/exit ease	3	5	3
EPA economy	4	5	4
Ride comfort*	3	2	3

*Authors' opinion



Three sizes of small wagons from which to choose: Dodge Aries K, Pontiac J2000, and Mercury Lynx (clockwise from left).

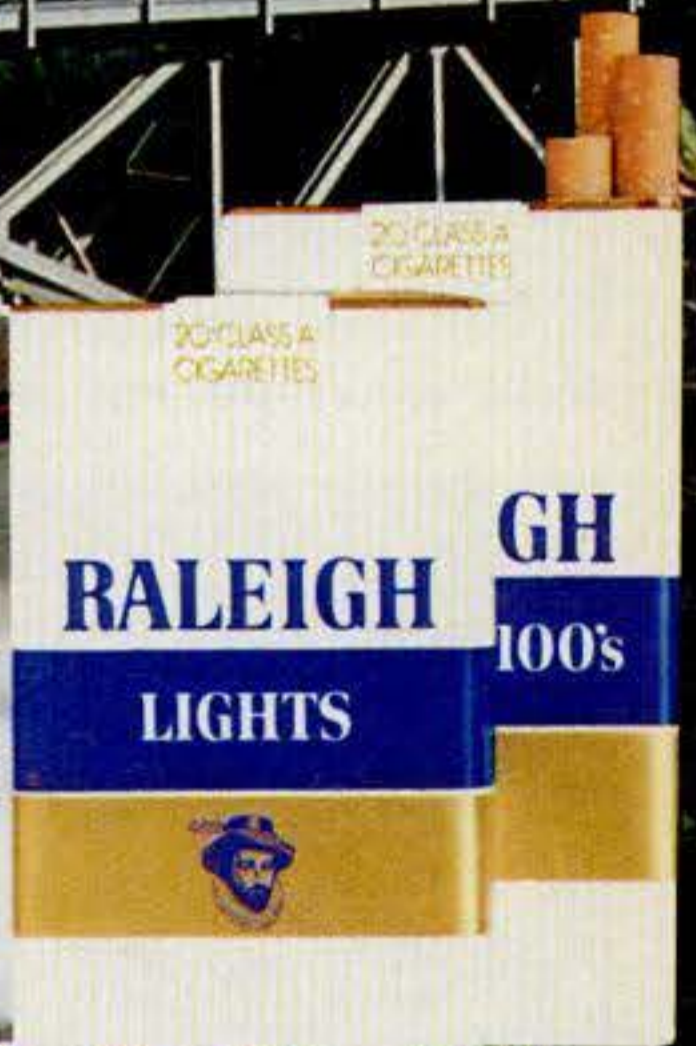
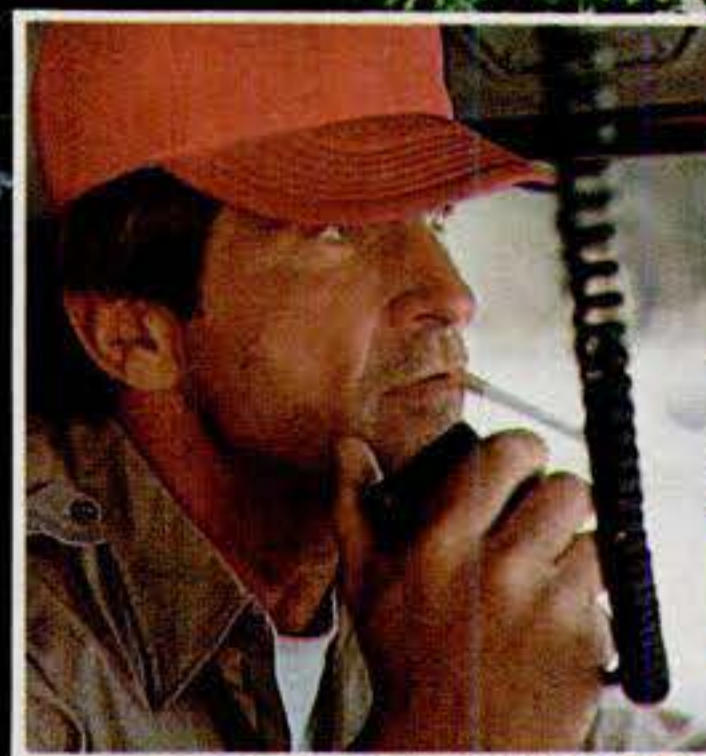
Warning: The Surgeon General Has Determined That Cigarette Smoking Is Dangerous to Your Health.

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Aries achieved a top rating in low-speed maneuverability, as did Lynx and J2000, but was slowest in the handling test.

in order of increasing size. Their size differences offer today's smaller families more of a choice.

We examined each closely and found that while a couple of important compromises were made—such as in seating comfort and cargo space—the basic do-anything versatility that made station wagons so popular hasn't been lost.

One standout impression is that the new wagons ride, drive, and feel the

same as small sedans. They are well-behaved on most highways, are comfortable to ride in (at least for front-seat passengers), and have much of the same nimbleness in traffic that makes quick converts of first-time small-car drivers.

Front-wheel drive works well with these cars. Wind wander at speed is minimal or nonexistent, which eliminates a major objection some people have to lightly loaded small cars. And

each is reasonably good over moderate bumps, although the Aries did tend to bounce on the worst roads, such as Manhattan's Henry Hudson Parkway.

Hatchback or wagon?

With the boom in hatchback sales, the need for small wagons is being questioned as never before. So what can a wagon give you that a hatchback can't? Well, it may be something as intangible as a more appealing look—not very useful, but still a big reason for some people picking one car over another.

On the practical side, a wagon provides much more cargo volume, as well as being far easier to load with bulky items. The higher roof line at the rear not only lets you load bigger objects, it also allows you to leave them at the rear. You don't have to wrestle them forward to close the tailgate, as you must with a hatchback's sloping roof.

When comparing cargo volumes, the jumps from hatchback to wagon are enormous for little cars. The three- and five-door Lynx hatchbacks, for instance, are rated at 25.5 cu. ft. with the rear seat folded down. The wagon can haul more than twice as much: 58.3 cu. ft. The same 2:1 ratio also

Continued



J2000 enters the test grid for a check of its 60-mph panic-stop characteristics.

EPA fuel mileage (mpg)

	Dodge Aries K	Mercury Lynx	Pontiac J2000
Highway	31	44	41
City	23	30	25
Calif. city	21	28	25

PS fuel-mileage tests (steady-state mpg)

	Dodge Aries K	Mercury Lynx	Pontiac J2000
35 mph	33.1	61.3	40.6
55 mph	25.5	37.5	29.3



Top-pivoted tailgates are designed to offer unrestricted cargo loading, as well as some shelter from poor weather.

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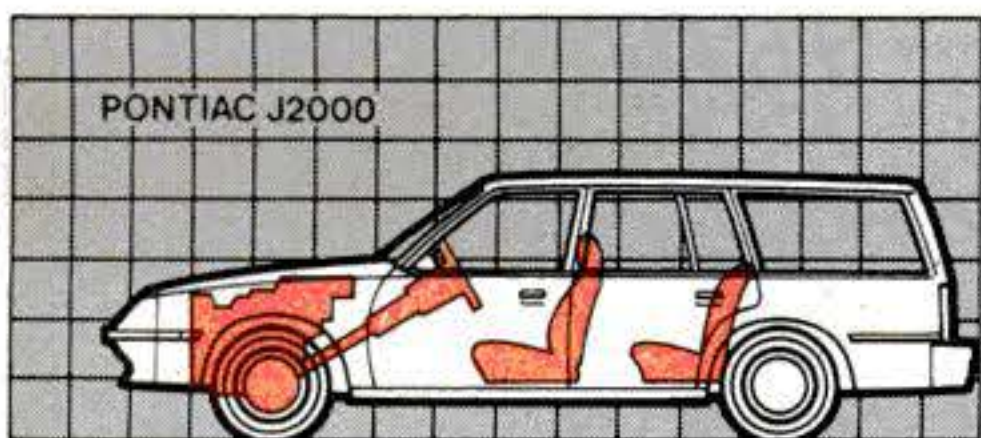
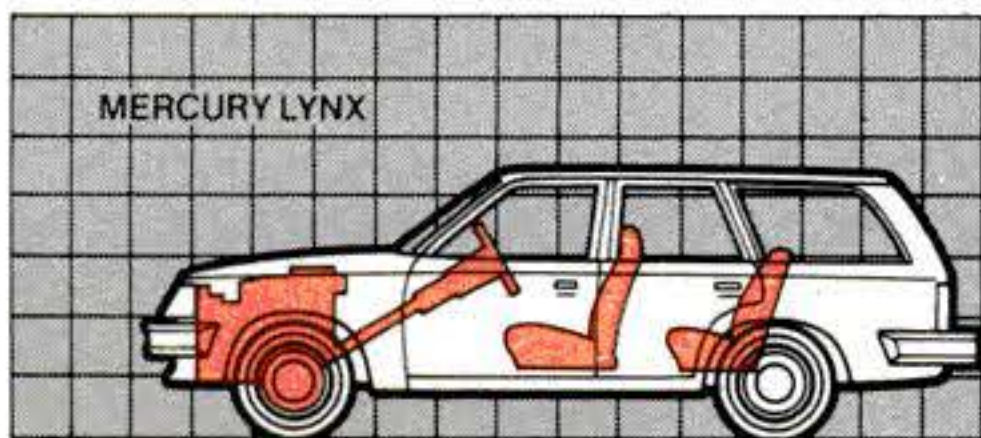
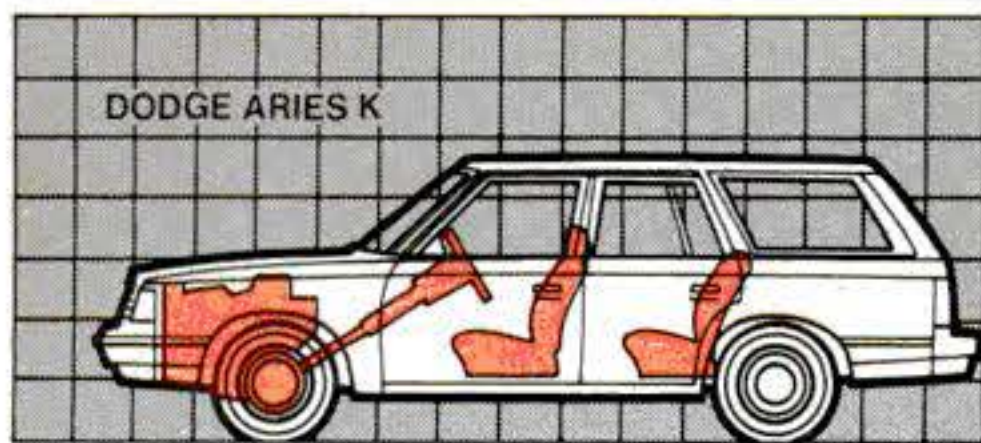
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Small wagons have carefully shaped exteriors for maximum fuel efficiency, and interiors carefully sculpted to maximize space. The greatest contributing factor to the impressive space efficiency is front-wheel drive. It makes few intrusions into passenger space; all components are forward of the front fire wall. Only a small tunnel down the car's spine is required for the exhaust system and chassis rigidity.

Dodge Aries K, Mercury Lynx, and Pontiac J2000—dimensions, specs, and test results

	Dodge Aries K	Mercury Lynx	Pontiac J2000
DIMENSIONS (inches)			
Wheelbase	99.6	94.2	101.2
Overall length	176.2	165.0	175.8
Overall height	52.8	53.5	53.9
Overall width	68.6	65.9	65.0
Track, F/R	57.6/57.0	54.7/56.0	55.4/55.2
Ground clearance	4.5	5.2	5.9
Front head room	38.6	38.0	38.3
Front hip room	56.3	52.0	48.9
Front leg room	42.2	41.5	42.1
Rear head room	38.1	38.2	38.7
Rear hip room	56.9	44.4	49.0
Rear leg room (min.)	34.9	35.4	33.1
Rear knee room (min.)	0.0	0.6	0.8
Couple distance	30.7	29.7	29.8
SPECIFICATIONS			
Engine type	In-line 4	In-line 4	In-line 4
Displacement (cu. in./L)	156/2.6	98/1.6	112/1.8
Compression ratio	8.2:1	8.8:1	9.0:1
Carburetion	2-bbl.	2-bbl.	2-bbl.
Net hp @ rpm	n.a.	65 @ 5,200	85 @ 5,000
Net torque @ rpm	n.a.	85 @ 3,000	100 @ 2,800
Transmission	Three-speed automatic	Four-speed manual	Three-speed automatic
Axle ratio	2.78:1	3.31:1	3.33:1
Tire make	Goodyear	Michelin	Firestone
Tire type	Arriva radial	XZX	Deluxe Champion radial
Tire size	P185/65R14	P165/80R13	P175/80R13
Steering	Rack and pinion, power	Rack and pinion, power	Rack and pinion, power
Overall steering ratio	18.0:1	21.3:1	16.0:1
Turns, lock to lock	3.2	3.5	2.9
Turn diameter (ft.)	34.3	35.1	34.7
Front suspension	Independent, MacPherson struts	Independent, MacPherson struts	Independent, MacPherson struts
Rear suspension	Semi-independent, trailing-arm twist axle, coil springs	Independent, MacPherson struts	Semi-independent, trailing-arm twist axle, coil springs
Front stabilizer-bar diameter (in.)	1.06	0.87	0.87
Rear stabilizer-bar diameter (in.)	1.00	None	None
Trailer towing (max. lbs.)	1,400	700	2,000
Trailer tongue weight (max. lbs.)	150	100	200
Brakes	Disc/drum	Disc/drum	Disc/drum
Brake swept area (sq. in.)	205.2	214.0	251.8
Fuel tank (gal.)	13.0	10.0	14.0
Trunk space (cu. ft.)	69.2*	58.3*	65.0*
Curb weight (lbs.)	2,488	2,122	2,484
F/R weight distribution (%)	61/39	60/40	62/38
Basic price	\$7,406	\$6,563	\$7,448
Price as tested	\$10,203	\$8,480	\$10,378
Major options on test car (over \$100)	A/C \$625, basic group \$566, power locks \$142, 2.6-liter engine \$159, whitewall radials \$142, rear defroster \$115, cruise control \$145, power seats \$183, AM/FM stereo \$100	A/C \$563, power steering \$176, AM/FM stereo-tape \$187, aluminum wheels \$183	A/C \$625, auto. trans. \$370, rear defroster \$115, power locks \$142, power steering \$180, power windows \$216, AM/FM stereo-tape \$217

PS serviceability ratings

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

	Dodge Aries K	Mercury Lynx	Pontiac J2000
Checking fluid levels			
Battery	5	5	5
Master cylinder	4	4	5
Windshield washer	5	5	5
Engine oil	4	2	4
Coolant	5	5	5
Checking the engine			
Spark plugs	4	4	3
Distributor	4	5	1
Carb adjustment	*	*	*
Oil filter	3	2	1
Oil fill	4	4	2
Replacing hoses			
Upper radiator hose	5	5	5
Lower radiator hose	3	4	3
Heater hoses	3	1	1
Changing bulbs			
Headlights	3	3	1
Taillights	2	3	2
Front running lights	3	3	2
Front parking lights	3	3	1
Front directionals	3	3	1
Rear directionals	2	3	2
Rear running lights	2	3	2
Checking fuses			
Spare-tire accessibility	3	4	4
Changing belts	4	4	4
	1	2	2

*Sealed

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)
1981 Dodge Aries K 4	24	18.1	175	63.5	27.6+	71
1981 Chevrolet Citation 4	22	15.9	163	60.2	27.6+	71
1981 Mercury Zephyr 6	20	16.8	168	60.3	27.6+	71
1981 Ford Escort 4	28	18.5	187	64.0	27.6+	73
1981 Plymouth Horizon 4	25	12.7	203	61.0	27.6+	72
1982 Pontiac J2000 4	25	18.9	193	62.2	27.6+	71
1981 Dodge Charger 2.2 4	25	11.7	178*	65.0+	27.6+	75
1982 Mercury LN7 4	29	18.0	199	65.0+	27.6+	78

*Measured manually

	Dodge Aries K	Mercury Lynx	Pontiac J2000
TEST RESULTS			
Acceleration (sec.)			
0-60 mph	16.9	17.3	21.2
25-70 mph	21.8	20.9	24.7
Brake test (cool) 60-0 mph			
Stopping distance (ft.)	200	168	191
Pedal pressure (lbs.)	40	50	140
Brake test (hot) 60-0 mph			
Stopping distance (ft.)	204	184	199
Pedal pressure (lbs.)	45	85	159
Interior noise @ 60 mph (dBA)	72	74	72
Handling test (mph)	59.0	62.1	61.2
Maneuverability test (mph)	27.6+	27.6+	27.6+

TEST CONDITIONS: Ambient temperature, 78°F; relative humidity, 65 percent; barometric pressure, 30.1 inches Hg
*Rear seat folded

AX-510



AX-1



AX-210

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This beauty does more and does it better than any other watch available in stores or in the mail.

DIGITAL/ANALOG AND TWO TIME ZONES

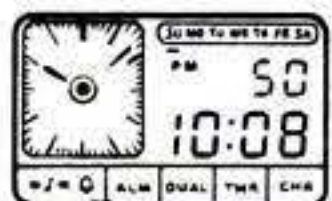
This multi-talented timepiece gives you the convenience of watch hands (analog) and the multi-function abilities of digital. Unlike Seiko or Citizen, these watch hands are **electronic** — no moving parts — giving you minimal maintenance and greater accuracy.

Is it Monday in New York? Or Tuesday in Hong Kong? You'll never have to ask that question again. This wonder allows you to view two time zones at one glance. And you can set the digital display for 12- or 24-hour time. The time to the second, the month, the date and the year are also clearly displayed.

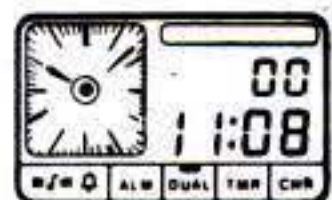
THREE MELODY ALARM SYSTEM

This unusual electronic watch/stopwatch features three computer synthesized melodies to help you cope with your busy personal schedule. The unique daily alarm system alerts you precisely on the chosen minute with a 20 second signal or your choice of melodies.

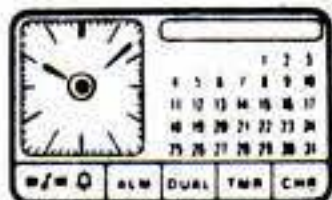
For example, you can wake up to *Dixie* and keep an appointment with the help of *Clementine* or *Greensleeves*. If you wish, this miniature orchestra can measure every hour with a 2-tone chime. And it reminds you of lunch time the way Big Ben would — by playing *Westminster Chimes* at 12 noon. Each and every note is a true reconstruction of actual musical pitch with vibrato and can be silenced with a touch of a button.



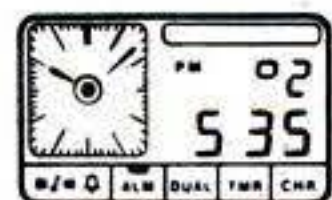
NORMAL TIME



DUAL TIME



CALENDAR



COUNTDOWN ALARM



STOPWATCH

COUNT UP, COUNT DOWN, COUNT AROUND

In addition to helping you organize your day, this gifted timepiece boasts some exceptional chronographic traits.

You get one of the most complete stopwatch and countdown capabilities we've seen. The graphic chronograph and countdown timer functions alert you by sight and sound when the preset time is up. LCD hands indicate the minute and second by one sweep per second (counterclockwise for countdown time).

The repeating countdown timer can be set in motion for any time between 1 second and 1 hour. Ideal for tallying cooking time, fuel management, flight approaches, minutes on your parking meter, or anything you like. Upon reaching zero, the timer alerts you with a pleasant chime. Then repeats — automatically.



3 different melodies plus "Big Ben" tune wakes you, reminds you and organizes your day. Each can be brought to life with a press of a button or silenced with a touch of another.

A press of a button sets into motion a full function stopwatch, featuring up to 1 hour of 1/100 second timing, laps, and 1-2 finishes. It even has a "beep" signal to confirm stops and starts. The perfect complement to the countdown timer.

THIS MONTH'S CALENDAR AND NEXT

Want to check a date on a calendar without fumbling for your checkbook? A press of a button brings forth a full calendar for the current month. Another press and you have next month's calendar. All in crystal LCD clarity.

This calendar system never has to be programmed. It's set until the year 2029. And the calendar display is in addition to the digital display of the day, date, and year which also automatically adjusts each month.

SPACE AGE POLYSULFONE, CHROME OR PRECIOUS PALLADIUM

This wizard is available in three good looking styles. The featherweight, high-impact black polysulfone **AX-1** is available for **\$49.00**. **Model AX-210** in chrome and stainless steel back and band is only **\$59.00**. And for **\$89.00**, you can own the luxurious **AX-510** with precious palladium-plated case (platinum group) and band.

Each watch has guaranteed quartz crystal

accuracy of ± 15 seconds per month (although many CASIO owners experience ± 5 seconds per month accuracy). Each watch is water resistant and comes with a long-life lithium battery in place (there's also a handy panel light for night viewing).

OUR DOUBLE GUARANTEE

First, the included CASIO factory warranty: one year parts and labor (in the rare event repair is needed, you'll find this service-by-mail feature very convenient).

Secondly, you'll also have the opportunity to decide if this CASIO is right for you. If not delighted, return it within 30 days for a prompt and courteous refund (including delivery charge). *You must be satisfied.*

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In Minnesota or if no answer, call 800-835-2246

On The Run

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applies to the J2000, which is rated at 65 cu. ft. There is no hatchback Aries to compare with, but this wagon's cargo volume is even bigger still: 69.2 cu. ft.

All cargo floors are flat and level, although the folded-down seat-back portions do tilt upward slightly. And all spare tires are stowed in wells under the rear of the cargo floors, where they're easy to get at, even when the cargo compartment is fully loaded.

From the back of the front seat to the rear bumper, there are many more similarities among these three wagons. The tailgates, for instance, are all top-pivoted and provide unobstructed, full-width, floor-to-roof openings for maximum loading convenience. Each uses gas-pressure struts.

These three also share surprising interior roominess for their compact exterior dimensions. Front-wheel drive is responsible, of course, and the result is an altogether more livable layout that sets this new breed of station wagons apart by a substantial margin.

Unfortunately, they are also set apart from their predecessors by slow-footed performance. Considerable care must be used in selecting drivetrain components, or you may choose a car that is unacceptably sluggish when fully loaded.

With the optional 2.6-liter engine and automatic transmission, Aries was the quickest, averaging 16.9 seconds to accelerate to 60 mph. Lynx, with the 1.6-liter four and a four-speed manual, was a couple of ticks slower, at 17.3 seconds. The J2000, however, with its 1.8-liter four and automatic transmission, crawled to a snail-like 21.2-second average. Remember, that's *lightly* loaded—just two people and approximately 30 pounds of test equipment.

Since hauling is one of the prime reasons for buying a station wagon, we strongly recommend manual transmission and the most powerful engine available. For Aries, that would be the 2.6-liter engine. For the J2000, it would be the optional 1.8-liter overhead-cam Opel engine that's coming soon. Lynx has only a 1.6-liter engine available, but its power output is being increased for the 1982 versions.

Strangely, our Lynx didn't behave like an '81; it felt considerably more like an '82 [see "Ford for '82," PS, Oct.]. Not only was it markedly quicker, it also handled differently. Emergency handling deficiencies that we faulted in the January Escort test seemed diminished, though there was still some tail sliding while braking in a turn. In any event, the changes are welcome—but there is still room for improvement.

All three wagons have good fuel economy. Not surprisingly, the manual-transmission Lynx was the least fuel thirsty, delivering 37.5 mpg at a steady 55 mph. Aries delivered 25.5 mpg, and the J2000, 29.3; but both were equipped with automatic transmission. We'd expect two or three miles per gallon more with a manual transmission.

Our picks

Aries is the closest to the big wagons in ride and interior space, but I'll take the J2000 for its handling, ride, and all-around good manners.—J. D.

The J2000 is comfortable and rides reasonably well, but it's decidedly under-powered for a gasoline-engine car—especially a wagon. I wouldn't consider it without the new engine and a manual transmission. Aries and Lynx (in the improved, '82 form only) are both good choices. Aries offers better carrying capacity, while Lynx offers high fuel economy.—E. J.

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Celica and Supra

Toyota restyles its sporty coupes for '82

FUJI INTERNATIONAL SPEEDWAY, JAPAN

Unfortunately, the rainy season and I both arrived in Japan on the same day. But the gloomy weather couldn't hide the new and distinctively different styling of Toyota's redesigned Celica (below, left) and Supra (below, right) here at Japan's grand prix race course, on the slopes of Mt. Fuji. Nor could the generally damp-to-wet track conditions mask the mechanical improvements to both cars.

For the first time, each car has its own styling, but the same body types are retained: two-door hatchback and notchback for Celica, two-door hatchback for Supra. Both

have substantially wider tracks front and rear, but the big suspension news is that Supra has four-wheel independent suspension for the first time.

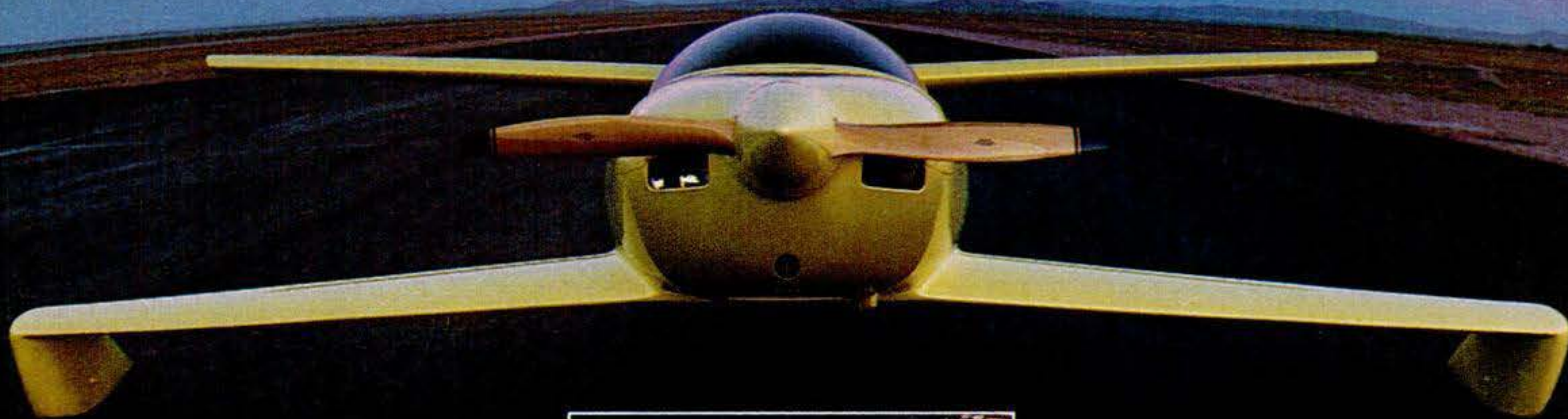
Under the hood, Celica will continue with the same 2.4-liter engine, but Supra will have an all-new 2.8-liter twin-cam engine with electronic fuel injection. It develops 29 hp more than the old 2.8 and is quite responsive.

There's more head and leg room up front in both cars, and almost anyone should be able to get comfortable. Optional (and expensive) sport seats may be the finest in the world. They have 16 adjustments, including three air bladders for fine-tuning lumbar support.

Allowing for the smooth and damp track, I found both cars well balanced and easy to drive, with only moderate understeer. With its added power and new suspension, the Supra was far more enjoyable—and impressive. Just how impressive? Well, comparing it with some of the cars I have tested recently, I'd say that in one giant leap Toyota has passed the Datsun 280-ZX and is knocking on the 280-ZX Turbo's door.—*Ed Jacobs*



Q2 • The World's Most Efficient Airplane



June 20, 1981 • Santa Rosa, Ca.
THE CAFE 250

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Scoring was based on a speed/payload/consumption formula. And when the skies over Santa Rosa had cleared, one ship stood out as the aerial econo-champ. Q2. The versatile new 2-seater from Quickie.

Q2's raw consumption score—42.36 mpg—was surpassed only by three other ships, all Quickie single seaters. And the aggregate scoring saw Q2 alone at the top. (The three smaller Quickies finished 2nd, 4th, and 12th.)

Not bad for an aircraft that's also capable of 180 mph, a fully loaded (525-pound useful load) climb rate of 800 fpm and a



minimum range (full load, maximum cruise) of 700 miles. The minimum operational ceiling is 15,000 feet.

All this in a trailerable ship that can be built in about 500 man hours. For about \$10,000. Complete. All you supply is paint, a battery and elbow grease.

Q2. The hot new 2-seater that puts flying back in the hands of mortals. Where does it say efficiency has to be boring?

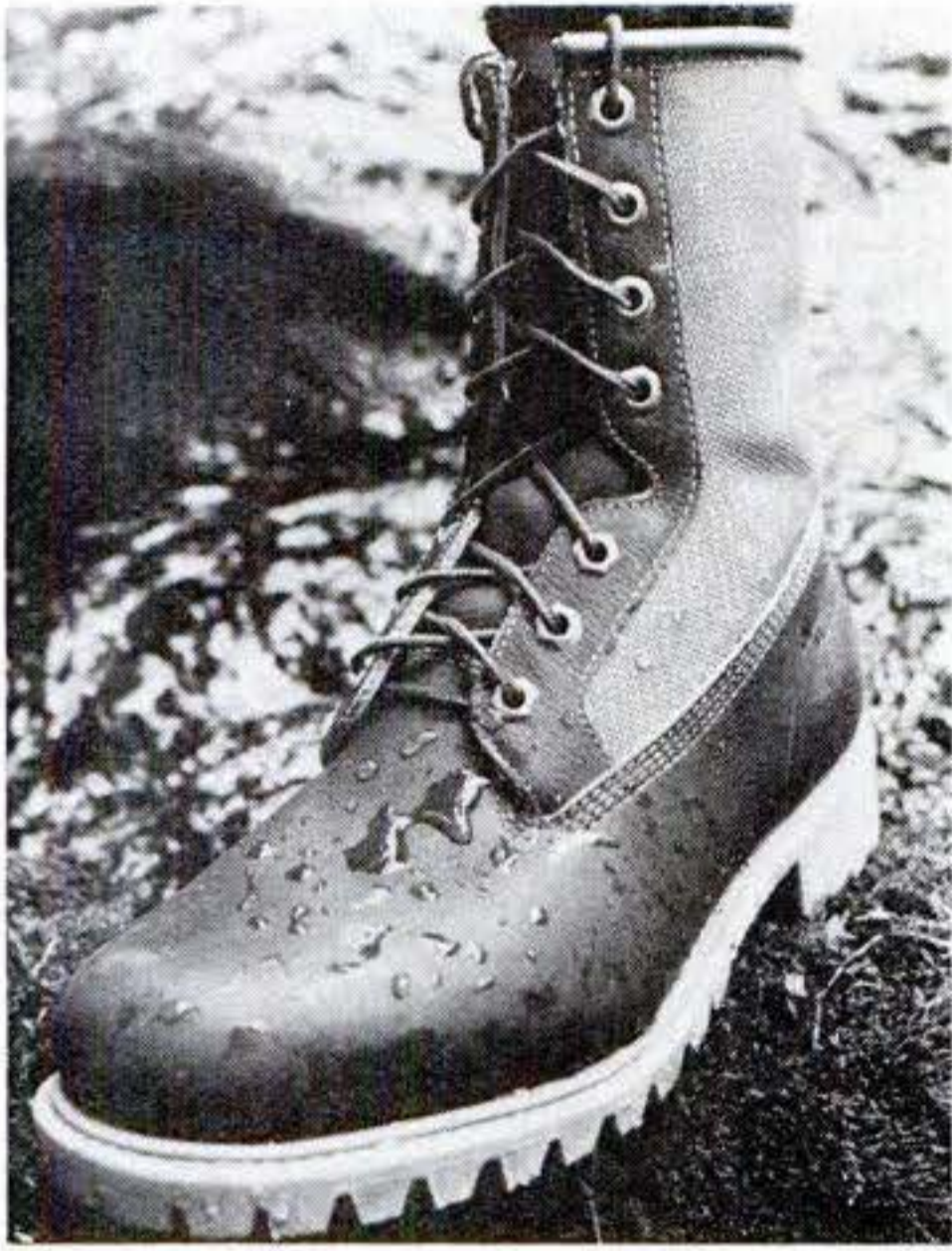
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Down-to-earth moon boots



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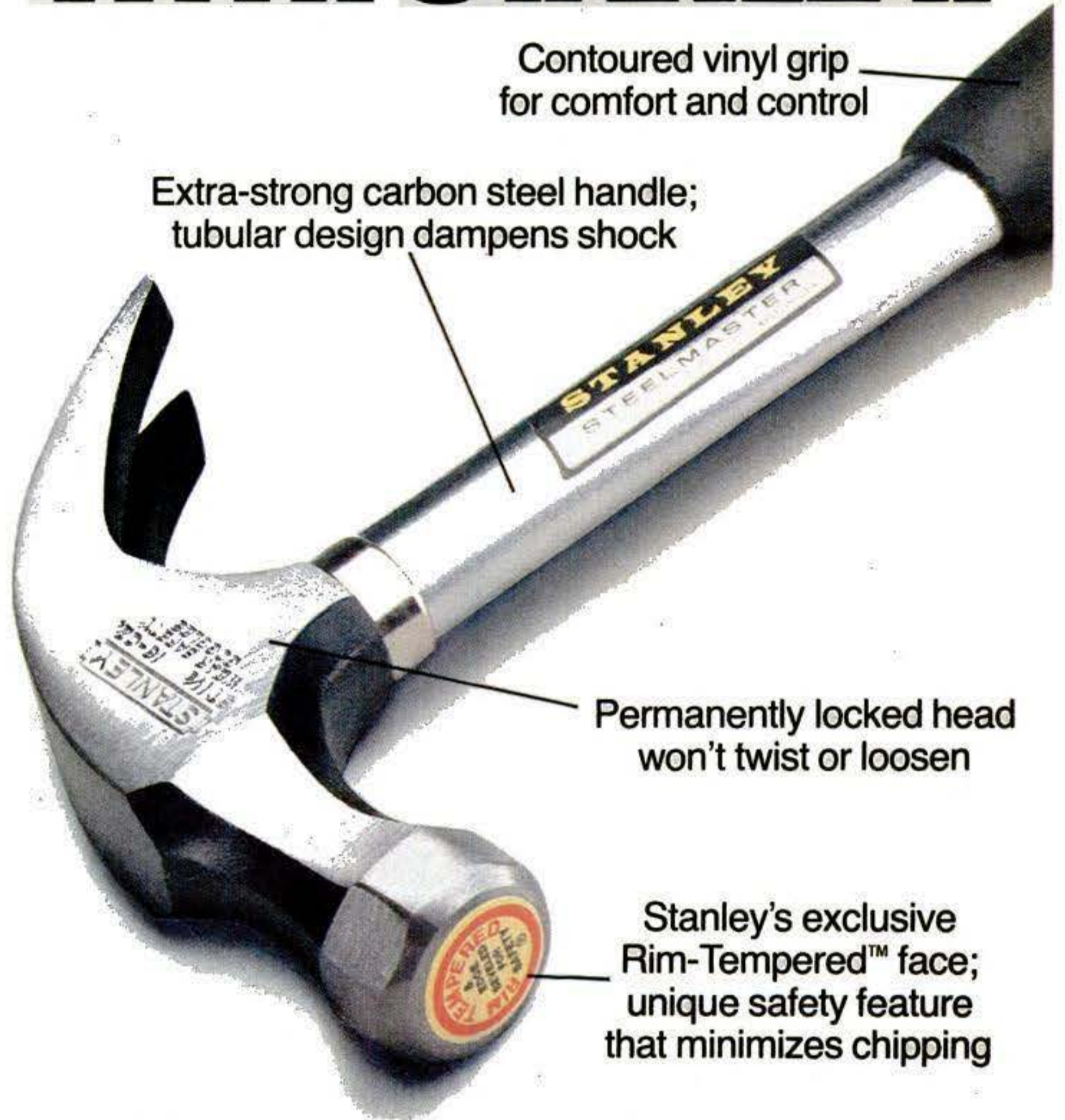
No, they won't look like the exotic boots worn by the astronauts; there's no need for anything that sophisticated for us earthlings. But we will get to share one of the moon boots' secrets: their special insulation.

Herman Shoe Co.'s Survivor line of boots now includes several new models that incorporate Herman's unique ThermaFlex K insulation. It consists of two flat woven-monofilament layers held together and supported by a third, corrugated, layer. Because it's virtually noncollapsible, ThermaFlex K maintains a constant dead-air space. Combined with the naturally low thermal conductivity of the monofilament, this yields what Herman claims is the most effective insulating material ever developed for outdoor footwear. It's also very thin, like sheet-type insulation.

ThermaFlex K allows air to flow around your feet and draw away the moisture that makes your feet feel clammy in summer and cold in winter. The bellows-like action of the boots as you walk pumps moisture-laden air through the insulation's passages and out the "chimnies"—special vents at the top of the tongues. The insulation's low thermal conductivity is said to retain the heat.

Herman has also combined a layer of the material with a new closed-cell foam to form what it calls the Orthoflex S foot bed for reduced shock loadings on foot-pressure points.—*Ed Jacobs*

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Warning - Protect your eyes
- Wear safety goggles
when using tools.



New diagnostic tool: nuclear magnetic resonance

A laboratory animal's heart, perfused by a special solution, is kept beating with the help of electrodes. The oxygen supply is then cut off to simulate a heart attack. Small, flat coils scan an area of the heart, and an oscilloscope records signals that will be used to interpret the metabolic behavior of the heart tissue.

Experiments like this are being conducted by Dr. Ray Nunnally, assistant professor of radiology at the University of Texas Southwestern Medical School, to analyze heart metabolism and determine when irreversible damage occurs. What's unusual about these experiments is that Dr. Nunnally is using nuclear magnetic resonance for his studies.

Long an analytical tool used in physics labs, nuclear magnetic resonance is a recent innovation in the area of medical research. Pioneered by Dr. Raymond Damadian for detecting cancerous tissue [PS, Dec. '77], it has

The first ultra Win Ult

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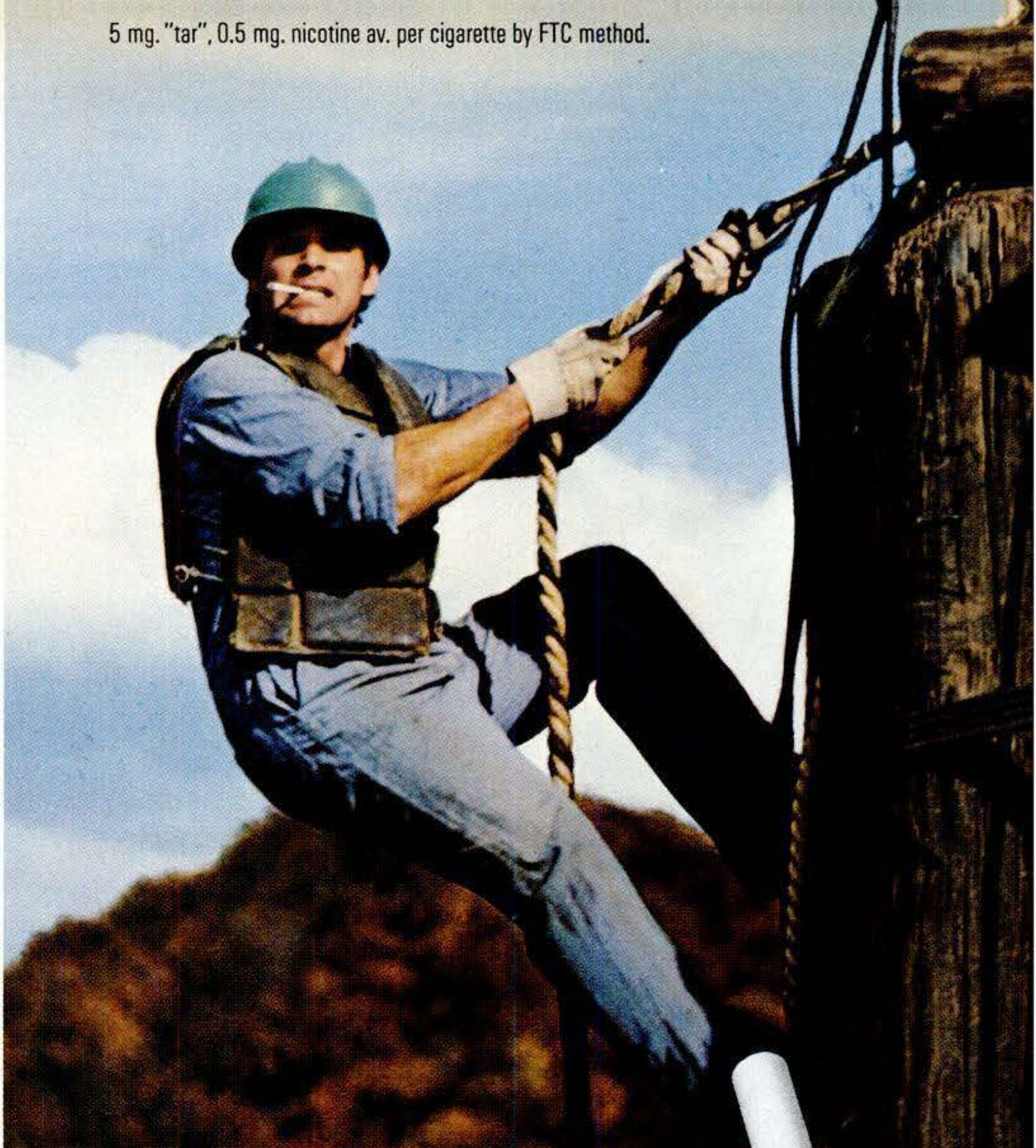
5 mg. "tar", 0.5 mg. nicotine av. per cigarette by FTC method.

just gone into clinical use with the purchase of the first of Damadian's scanners by Dr. Ronald Ross ["PS/What's News," Oct.] for his Cleveland clinic.

The principle of nuclear magnetic resonance is based on the effect powerful magnetic fields have on the properties of atoms. When exposed to superconducting magnets, atomic nuclei are aligned in the field. If a radio wave is beamed at these nuclei, each resonates at a specific energy level, allowing instruments to measure and display the resulting signals. The displays can take the form of a line graph or a kind of cross-sectional picture of a part of the body (without using X-rays). Result: a way of identifying metabolic activity inside living tissue without having to invade the body.

"We believe that nuclear magnetic resonance may eventually be used clinically to determine the location and size of an injury or abnormality, characterize the extent of deterioration, and monitor the effectiveness of drug treatment," says Dr. Nunnally.

There are less than a half-dozen labs in the world doing such studies, claims Dr. Nunnally, but the potential for medical use is impressive, and, what's more important, risk is negligible.—*Timothy O. Bakke*



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Can an aircraft maker design for groundlings?

Beechcraft's LNG car

Space-flight technology helps to bring natural-gas power to cars

By PETER BRITTON

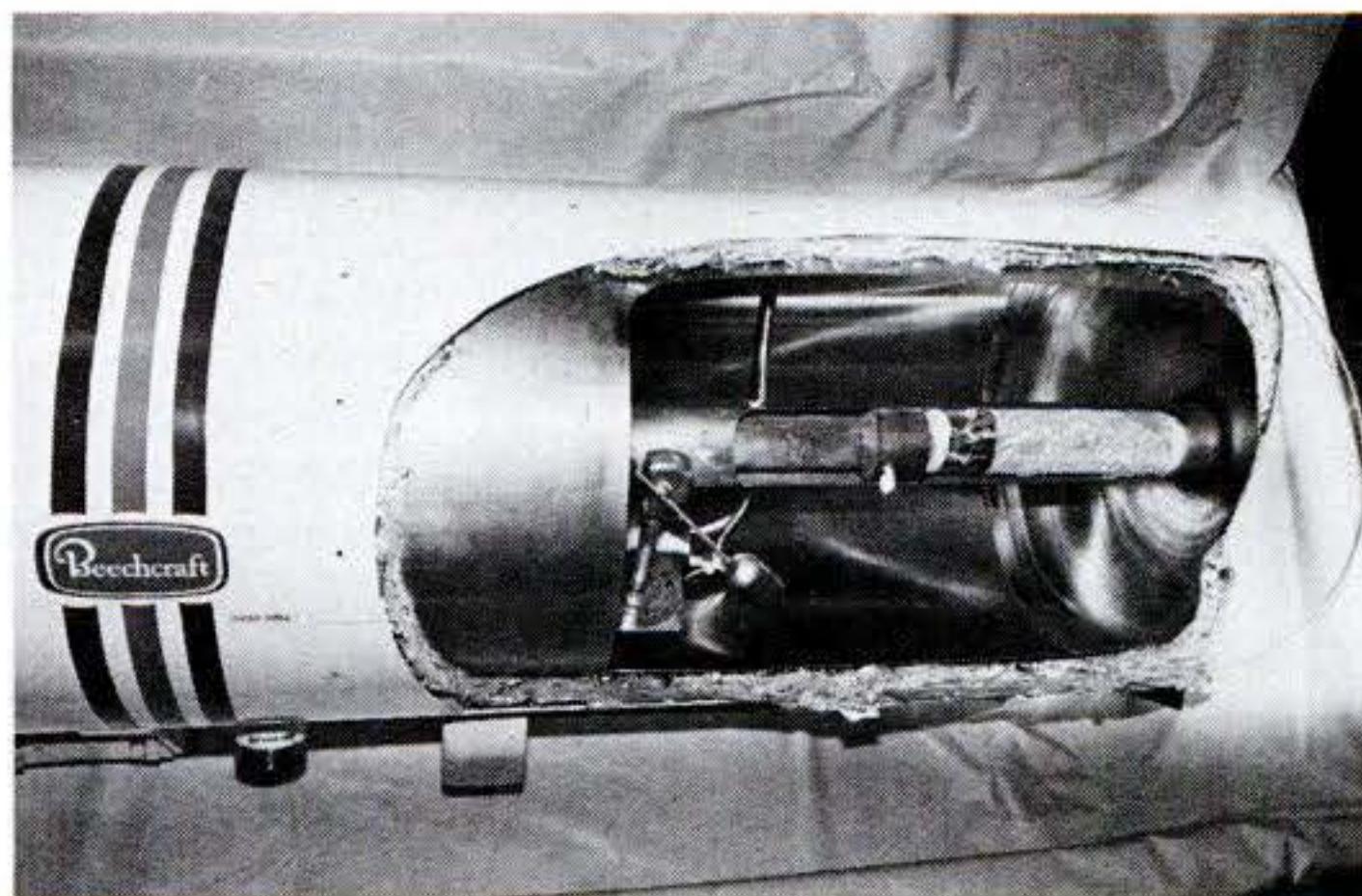
Soon, when you stop at a gas station it may really be a *gas* station. For natural gas is a fuel that may be as well suited to cars as to kitchen stoves. It would be carried in a super-efficient "thermos bottle" tucked into your trunk—at $\frac{1}{632}$ of its normal volume and -260 degrees F.

Natural gas—methane—lurks in

coal mines, gurgles up from fetid swamps, bursts from oil wells in prodigious quantities, can be produced from renewable sources, and isn't even new as a motor fuel. The Deutz Gas Engine Co. demonstrated a methane-fueled engine at the Paris International Exposition in 1867. Experts then conceded that methane was a fine fuel but felt it was unreliable and impractical, with major storage, handling, and safety problems. But interest continued, and today there are numerous methane-powered devices. The General Services Administration has run fleets of vehicles on liquefied



Modified cars, such as the Pontiac Phoenix above, are used to demonstrate the efficiency and operating characteristics of Beechcraft's LNG system. It uses the same carburetor as many propane conversions, but with slight recalibration. The cutaway storage tank at right reveals the inner works and heavy insulation.



methane, and the Department of Transportation has conducted crash-safety tests that established it as a safe fuel.

As a large-scale gasoline substitute, natural gas may be used in the form of LNG—liquefied natural gas. A 100+ octane fuel, it is cleaner-burning and easier on automotive engines than gasoline. According to GSA controlled-fleet testing performed in 1972, using methane as an automotive fuel doubles engine life and reduces maintenance by 40 percent.

I recently drove a 1980 Ford Granada fitted with a kit developed by Beech Aircraft Corp. Even in stop-and-go rush-hour traffic and a thunderstorm in high-humidity Houston, I couldn't spot any hesitation. Acceleration was quick and sure, with all the power of gasoline.

LNG is tasteless, odorless, colorless, nontoxic, noncorrosive, and lighter than air. Its ignition temperature is about 600 degrees higher than gasoline's; it is noncombustible when stored at -260 degrees F; and while conventional natural-gas domestic reserves are about 209 trillion cu. ft. (T.C.F.)—about a 12-year supply at current usage—leading government and industry estimates of unconventional reserves are well over 50,000 T.C.F.

To develop its LNG system, Beech drew on its experience with liquefied oxygen and hydrogen for NASA space flights, and also took advantage of advances in low-temperature technology (cryogenics), metallurgy, insulating materials, and manufacturing techniques. The result is a conversion kit that's now in production.

The car I drove was fitted with an 18-gallon tank (equivalent to about 1,500 cu. ft. of gaseous methane), which gave it a range of about 250 miles. There is also a 38-gallon size. Installation takes about eight hours. As a variation there is a dual-fuel system that allows either gasoline or diesel fuel to be used on long trips instead of LNG.

Beech wants first to equip car and truck fleets, claiming that LNG use by the country's 15,000,000 fleet-operated motor vehicles would reduce our import rate of 8.5 million barrels per day by about 296,000 barrels per day for each million vehicles converted.

The use of methane as an alternate fuel to gasoline was recently endorsed by the federal government with the enactment of the Methane Transportation Research, Development, and Demonstration Act of 1980. This act provides incentives and technology to operators of both government and privately owned fleets. E3

All-out energy audits

— how the pros spot heat leaks



Blower door mounts in any exterior door to depressurize the home and “amplify” infiltration. Here, Energy Clinic’s Bill Mun-

sell reads pressure differential between indoors and out to evaluate the effectiveness of his sealing efforts.

Leak-seeking instruments pinpoint exactly where you’re wasting energy

By A. J. HAND

I picked up the instrument and peered through its eyepiece at the room. What I saw looked like a bad TV picture—in black and red. Scanning the front door, I could see a band of black flowing in over the sill. I turned to a window. Black seemed to ooze from the glass and flow down the wall.

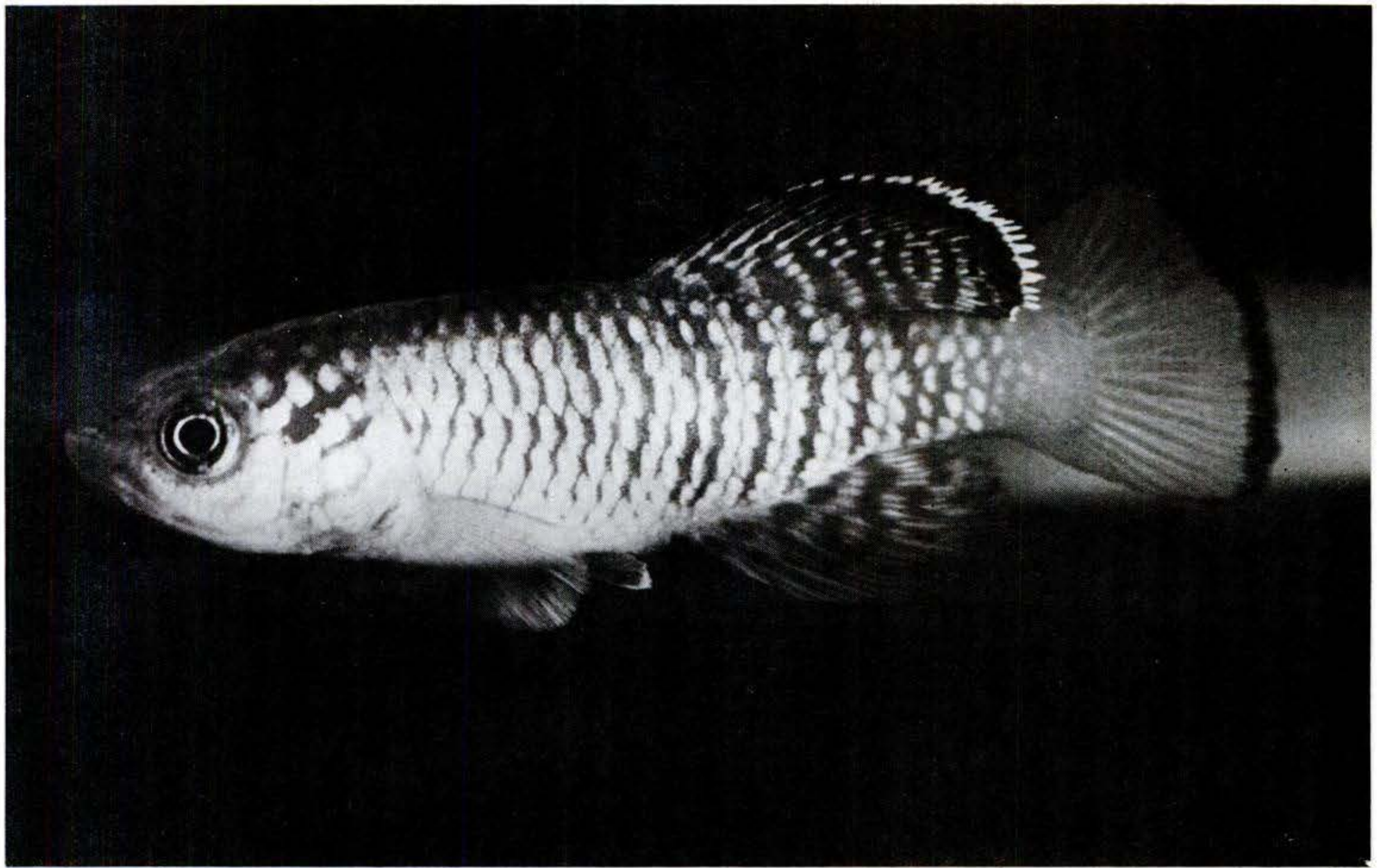
I was looking through an infrared scanner, a sophisticated tool designed to see heat [PS, Sept. '75]. Cold—such as the air slipping in under a front door or washing down a frigid window pane—shows up as black. Heat—in the form of long-wavelength infrared radiation—appears as red.

Such scanners are one of a number of scientific instruments that take the guesswork out of home-heat-loss calculations and point the way to cost-effective energy-saving measures. Along with blower-door depressurizers, smoke pencils, and furnace-testing equipment, they are the tools of a new but fast-growing trade—that of the home-energy auditor.

This kind of specialized contractor performs a unique service. The auditor comes into your home, makes exact measurements of its energy performance, and suggests ways you can improve it. In some cases, the auditor may actually undertake some of the recommended modifications.

A short time ago, the number of firms offering such a service—they are frequently called house doctors—could be counted on the fingers of one hand. Now they are popping up all over the

Continued



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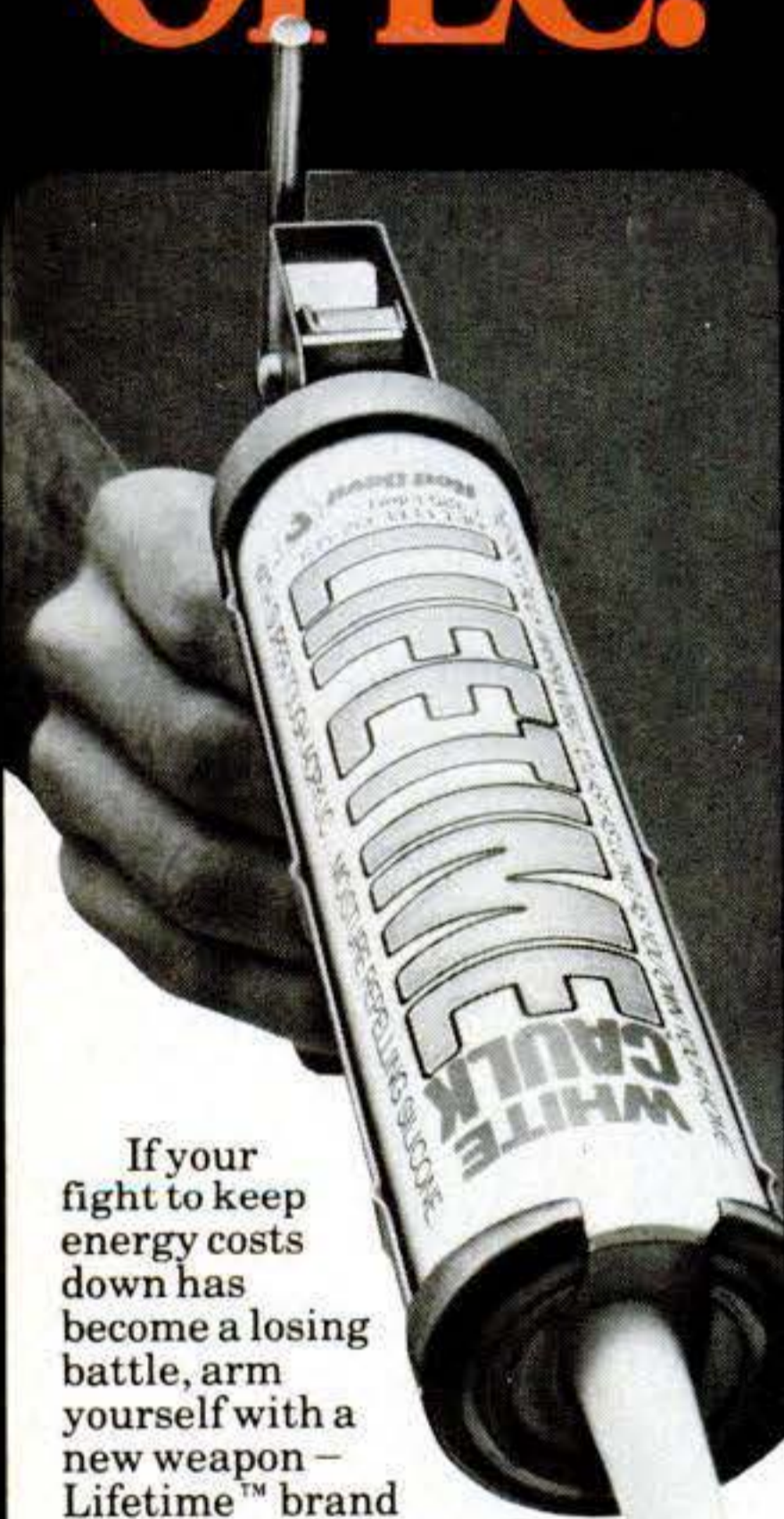
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WE'RE SOLD ON QUALITY.

All-out energy audits

[Continued]

country. Their services can cost the homeowner anywhere from \$100 to \$500 or more, depending on the sophistication of the analysis and whether or not the service includes any corrective measures. In general, house doctors will not perform complete retrofits; these can be done by the homeowner himself or by contractors at a cost of \$1,000 and up (see "Slash Fuel Bills," PS, Oct.).

Do you need a professional audit to pinpoint heat losses before commencing a retrofit? Not necessarily. Some kind of analysis is needed, but simply having lived in a house may tell you enough about where your leaks and drafts are. Or you could take advantage of the various free or almost-free audits that are offered. Project Conserve, developed by the Federal Energy Administration, is an example. You enter data about your home on a computerized questionnaire and mail it in for processing. In return, you get a computer printout listing possible ways to save energy and an estimate of costs and payback times. Finally, most utility companies now offer free walk-through audits. (In fact, the larger ones are required to in most states.)

All of these audits have merit, but at best they provide rough guidelines and estimates. "With instrumentation, you measure things instead of just assuming," says Princeton University's Ken Gadsby, who helped develop energy-audit procedures that have been adopted by some commercial auditing firms. "It's a systems analysis. Instead of having an insulation installer do one part, a storm-window salesman do another, and a furnace man another, a professional auditor does it all at once."

Pressure test

It's the instrumentation that really sets the pros apart from other audit services. The heart of the system is the infrared scanner and a device called a blower door, a high-powered fan that mounts in an exterior doorway to pull air out of a house. The scanner then detects cold outside air rushing into the depressurized house through leaks in the building skin.

Used alone, the scanner can't find as many leaks. "On the windward side of a building, the scanner by itself works fine," Gadsby explains. "But on the leeward side, it won't see anything. Yet what comes in must be going out. The blower makes all the leaks unidirectional. It amplifies everything and



Infrared scanner spots insulation bypasses and air-leakage sites better than any other tool. It requires temperature difference between indoors and out.

makes it much easier to do the job right."

The blower not only helps find leaks; it enables you to measure them and your success in eliminating them. "It gives an exact measurement of the pressure differential between indoors and outdoors," says Bill Munsell, an auditor for a house-doctor service, Energy Clinic, with branches in Connecticut and California. "After we do our sealing, we check the pressure difference again. With the right formula, we can tell just how much we've reduced the rate of air infiltration."

Energy Clinic's service generally cuts infiltration by 25 to 30 percent, but the improvement can go as high as 45 percent in a really leaky house.

Locating air leaks is only one aspect of a good audit. Just as important is finding what Gadsby calls "bypasses," routes by which escaping heat can get around your insulation. Bypasses are common in attics and basements, where insulation may be inadequate, poorly installed, or completely missing. They also typically occur around plumbing runs and electrical fixtures. Interior partitions are another problem area, since they're usually leakier than outside walls and they form a chase that runs from the attic to the basement.

Bypasses can also be more subtle.

Continued

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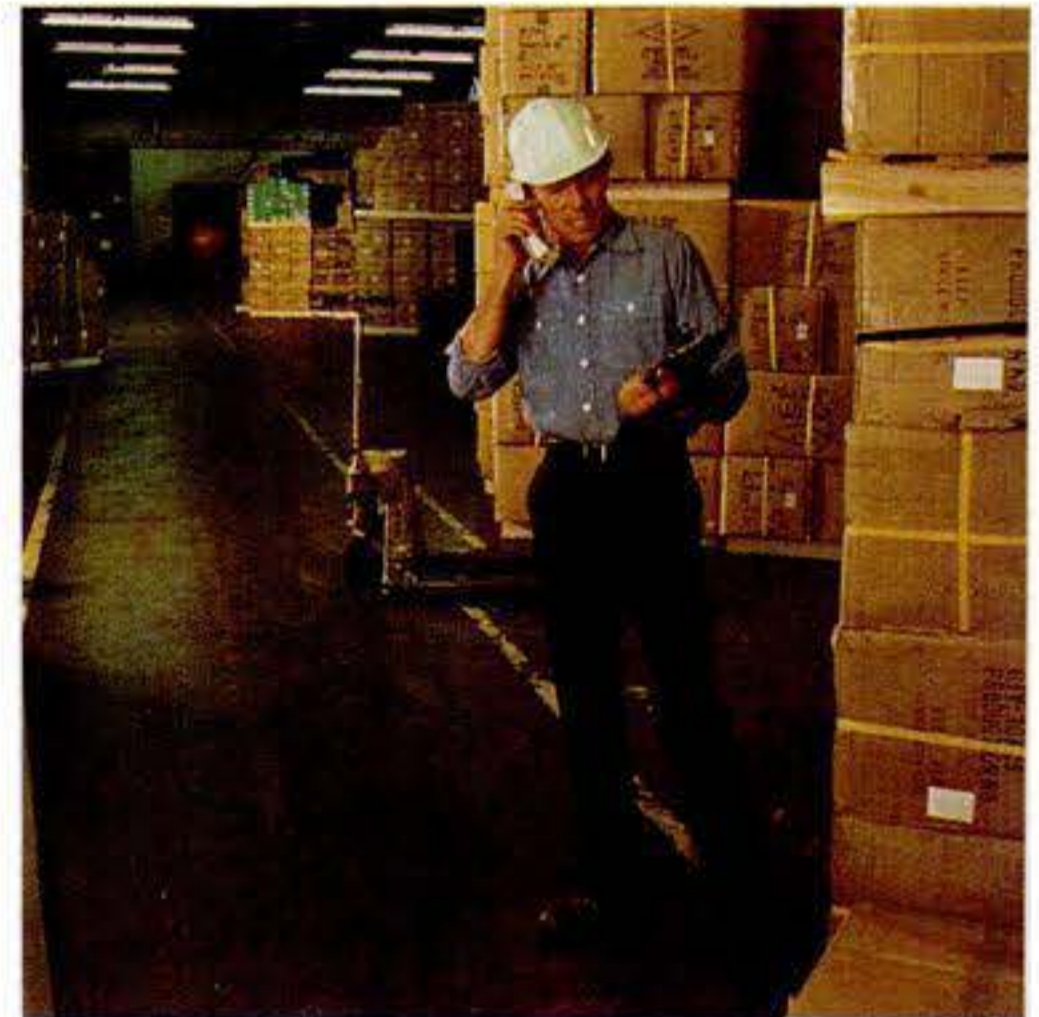
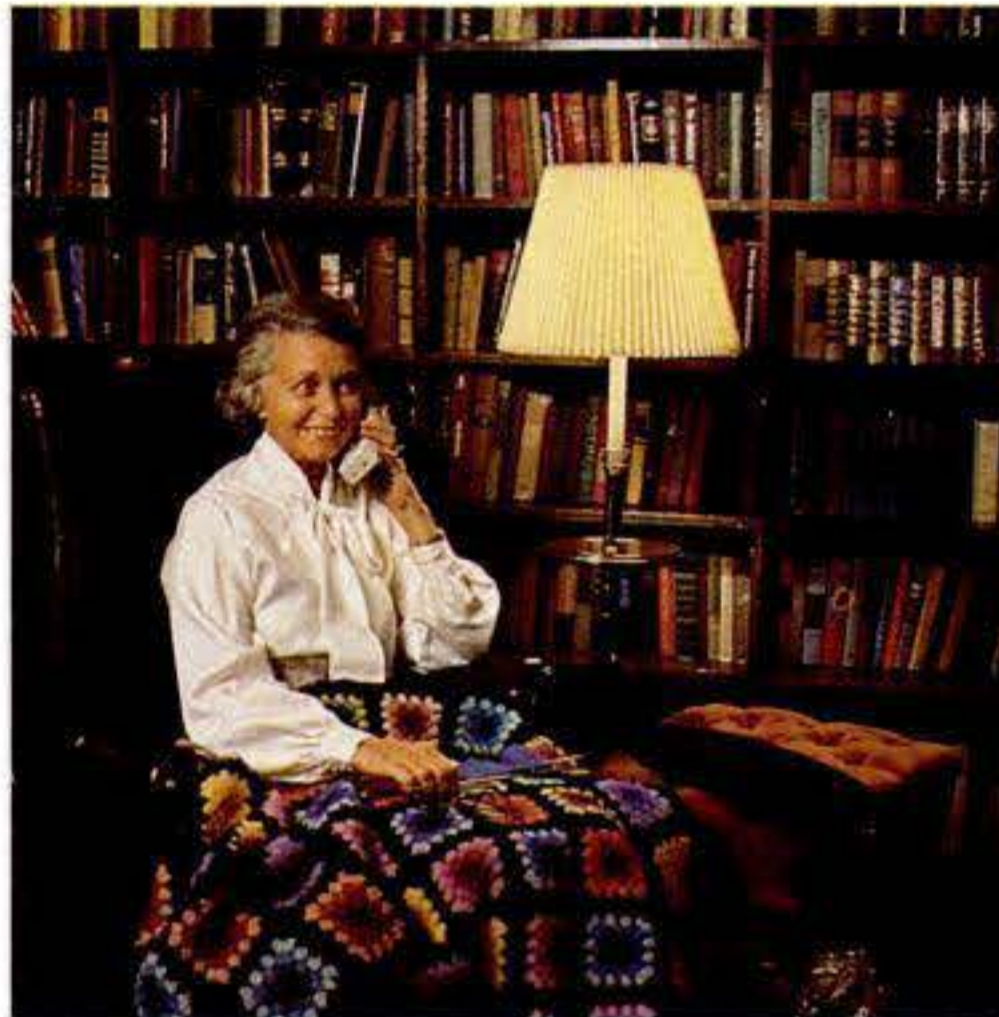
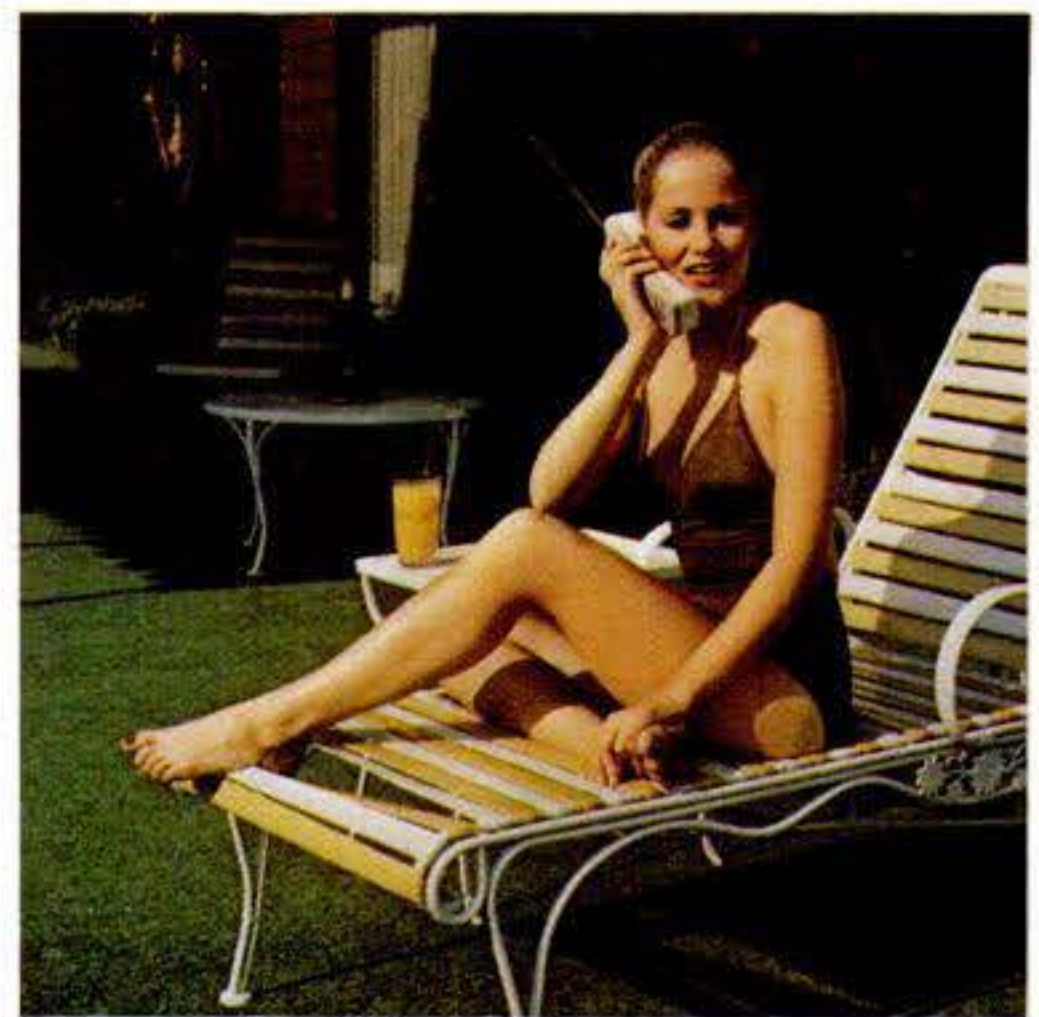
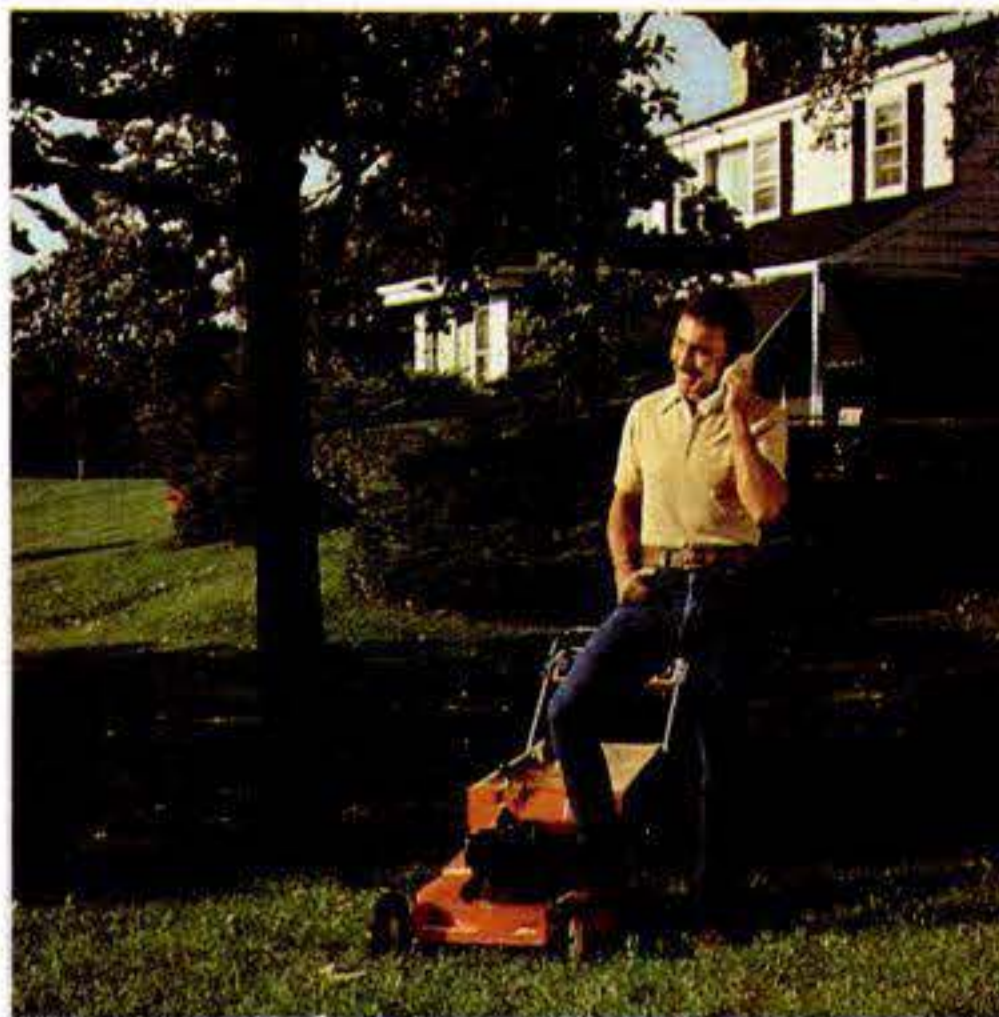
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All-out energy audits

[Continued]

Gadsby gave me an example: "Say you have a soffited ceiling over a shower. There is insulation over the top, but it is stapled at maybe 18-inch intervals, and there is a gap or 'fish mouth' between the staples. The air in the soffit, heated by room temperature, rises and goes out through the fish mouth, and cold air from the attic comes in the same way. You start a little pump going. It's not a direct air leak out of the building, but heat is still being lost."

Besides testing for infiltration and insulation bypasses, a complete energy audit also includes checks of furnace performance, water- and space-heating thermostat calibration, shower-head flow rates, hot-water-pipe and furnace-duct insulation, and more.

A furnace tuneup is particularly

important. With a half-hour adjustment, a professional house doctor can improve the efficiency of older furnaces by five to 10 percent. Thermostats are another common energy waster. In Gadsby's experience, it is not unusual to find thermostats that are off by as much as 15 degrees. Bad ones should be recalibrated or, better, replaced with setback types.

Taking action

Finding the problems is only part of a good audit. The second part is recommending the right ways to correct them. That's another area where the pro's experience can help. He'll provide you with a printout of suggested actions that take into account the likely cost-effectiveness of the various options. He will also have marked the

Continued

Here's what your house doctor is likely to prescribe

By itself, an energy audit won't save you any money. Once you get the auditor's recommendations, you must follow through, starting with those that are most cost-effective. Listed here are some of the commonly suggested jobs, though not all are necessarily appropriate for every house. Most of them can be tackled by the average homeowner. (For more details on proper procedures and available products, consult the PS bibliography at the end of this article.)

Caulk in places where leaks were found, usually at wall intersections, above moldings, and around window casings.

Weatherstrip around all doors and windows.

Install foam gaskets behind electric-box cover plates.

Seal around pipe and wiring runs.

Install plastic vapor barrier in dropped ceilings.

Weatherstrip and insulate attic hatch.

Seal gaps between foundation and sills.

Tune furnace (this calls for a pro).

Install storm windows or new multiple-glaze windows.

Insulate water heater and first 10 feet of hot-water pipe. Turn down thermostat to 120 degrees.

Install low-flow shower heads if rates exceed three gallons per minute.

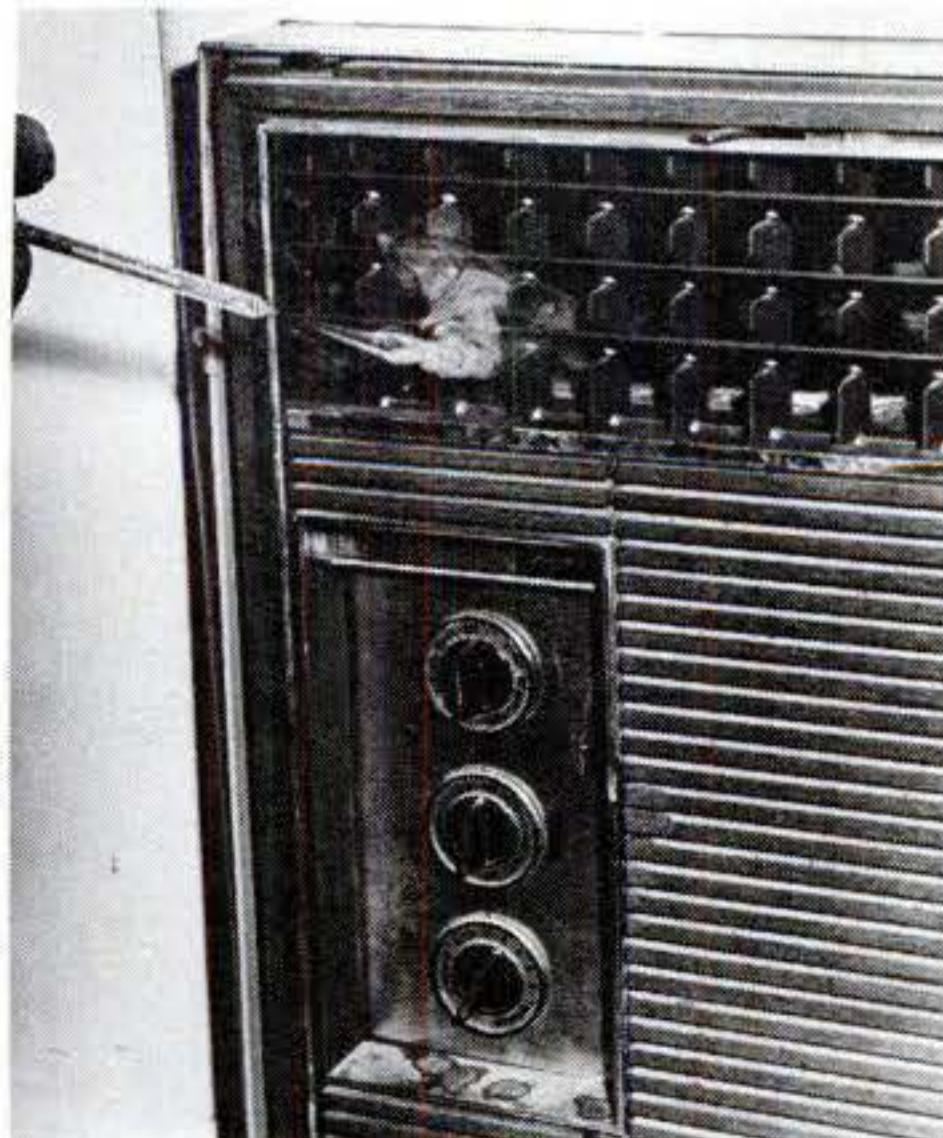
Upgrade your masonry fireplace with add-ons or convert to a wood stove.

Increase attic insulation.

Install insulating shades or thermal shutters.



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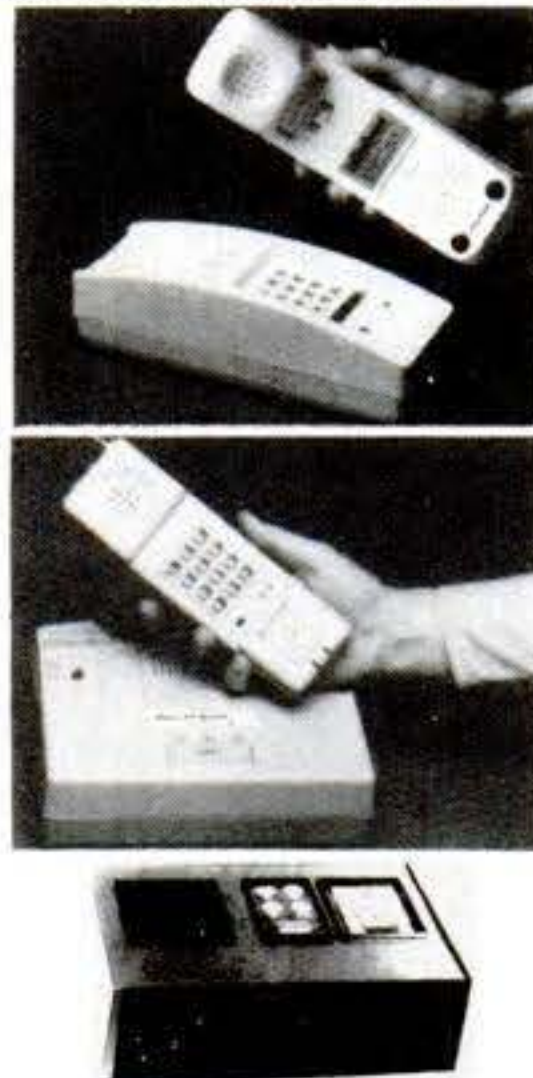
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All-out energy audits

[Continued]

leaky spots on the inside of the house (Energy Clinic marks them with pieces of tape) so you or your contractor can start right in with the retrofit work (see box for a list of common retrofit procedures).

Some auditors will even do some of the modifications for you. The Energy Clinic is typical. It performs a blower-door scan (leaving the treatment to you) for \$175. This is a good alternative if you have already made a lot of fuel-saving improvements or if you want to cut costs by using your own labor. Or you can choose the complete service for \$500. Then its auditors will actually plug infiltration sites, caulk and weatherstrip around doors and windows, tune your furnace, calibrate your thermostat, insulate water pipes, and install various energy-saving hardware.

The \$500 charge may sound high, but according to Energy Clinic's president Jackson Gouraud, "It doesn't even come close to covering our costs." He says the company offers the service as a loss leader, hoping it will stimulate sales of the wood and coal stoves, Blueray furnaces, and solar hardware that Energy Clinic sells. Besides, says Gouraud, energy audits qualify for the 15 percent federal tax credit, so the cost is really \$425. If the modifications save you 15 percent on your fuel bill, for example, the payback could be less than two years—depending, of course, on the price you pay for fuel.

Besides Energy Clinic, other energy-audit firms include The Energy Doctor in Lubbock, Tex.; Energy Detective in Philadelphia; Princeton Energy Partners in Princeton, N.J.; and Enercorp in Winnipeg, Manitoba. **P 5**

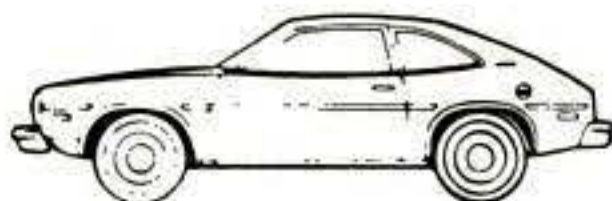
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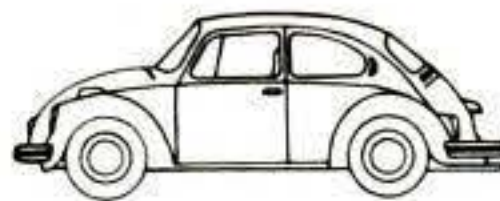
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A business revolution has occurred in recent years. Nearly half a million people have already been helped in forming small corporations with the aid of a remarkable book. It's called: *How To Form Your Own Corporation Without A Lawyer For Under \$50* by Ted Nicholas. It's now in its fully revised and updated 12th edition. And now you can get your own personal copy to examine—without risk—to learn how a corporation applies to you and how you can reap maximum benefits.

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Your own corporation can be used as a personal tool to gain all types of legitimate tax deductions. It will become *the ultimate tax shelter* for you. For example, a new car purchase or lease is tax deductible over the life of the car. So are gasoline expenses and repairs. The same goes for other equipment used in your business. There are *hundreds* of legal tax deductions.

If you have an office at home, you can pay rent to yourself and get tax deductions for doing so.

You may choose to set up a lucrative pension and profit-sharing plan with yourself as the main beneficiary. You can gain far greater benefits than unincorporated people do.

As an owner of a corporation, you'll have plenty of company. Over 30,000 new ones are formed each and every month. Ninety-eight per cent of them are small businesses, often just one individual working from home.

We live in a land wherein the corporation is king. Even the government recognizes this. To encourage small business expansion, the tax on small corporations was recently *reduced* to only 17% of up to the first \$25,000 in income. And this is *after* all the tax deductions have been taken.

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He wrote the book *How To Form Your Own Corporation Without A Lawyer For Under \$50* because he felt many more people could become corporate presidents of their own companies. The book has become the largest single source of new corporations in America.

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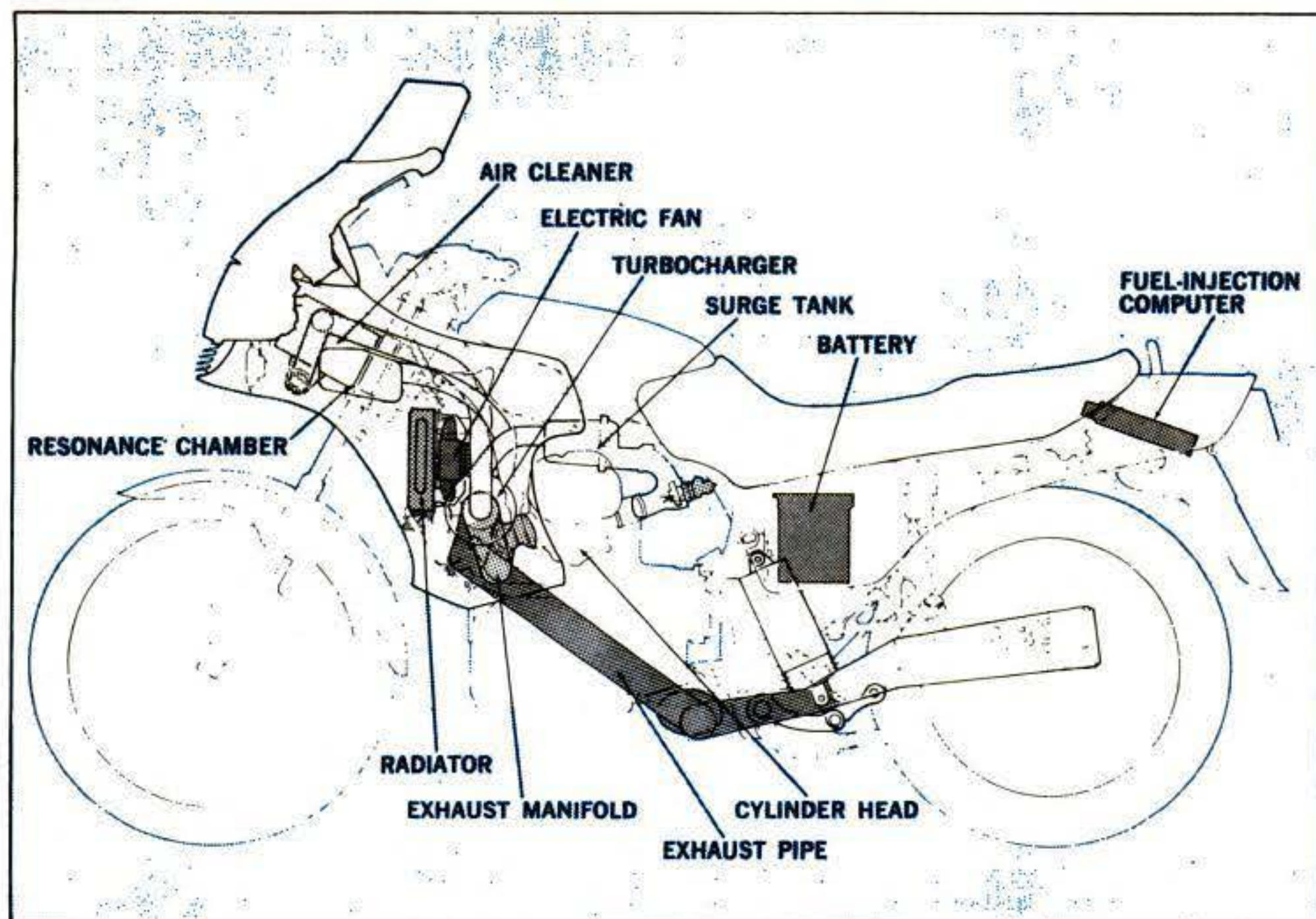
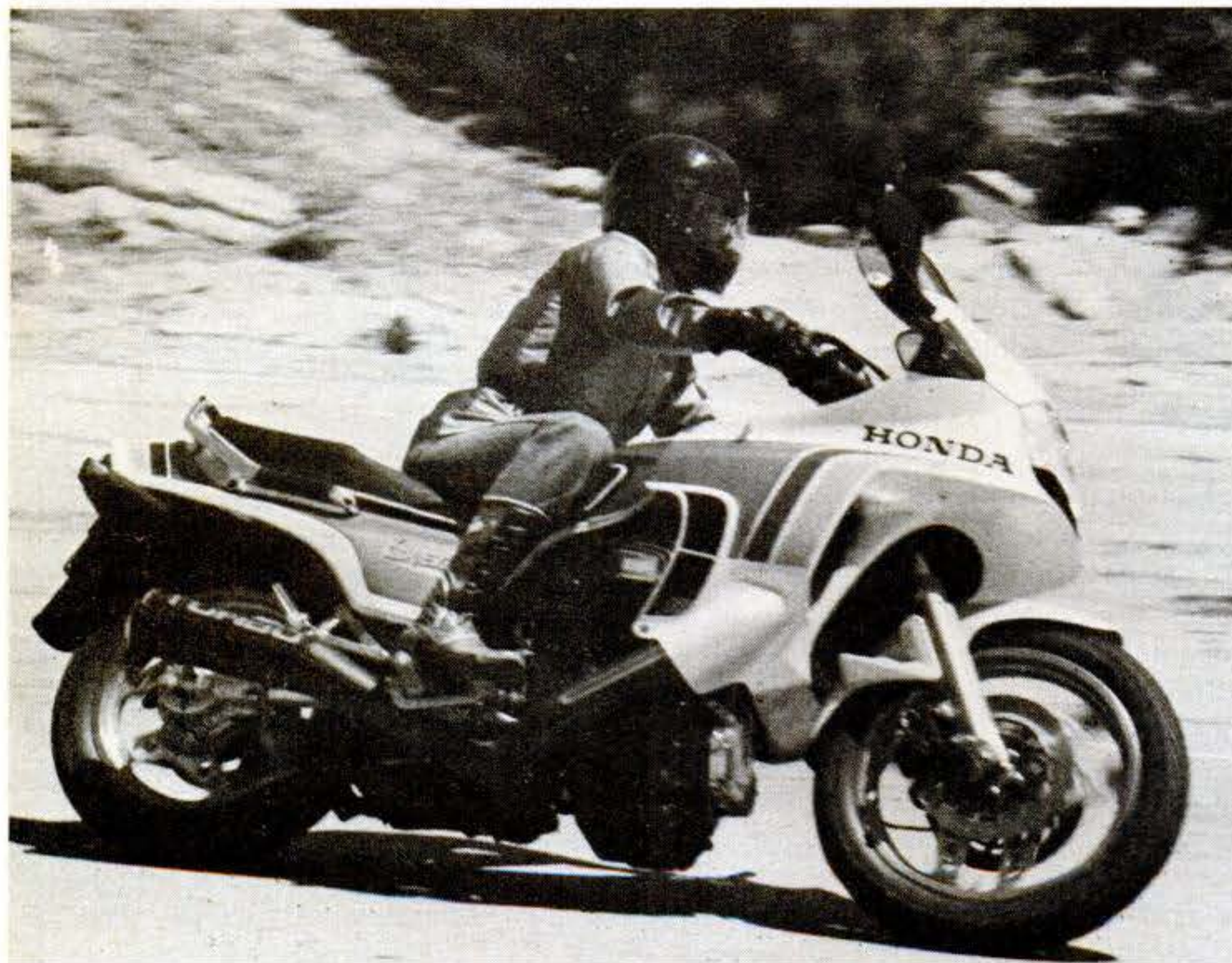
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Location of critical parts is shown in the drawing above. To understand how the

system works, see the schematic drawing and caption on following page.

Coming: world's smallest turbocharger in a state-of-the-art motorcycle

By RAY HILL

A glance at the speedometer showed the needle moving past the 110-mph mark. Just ahead, the course made a sharp right-hand bend. I squeezed the front-brake lever hard, pressed lightly on the rear-brake pedal, and the prototype Honda CX500T slowed rapidly as I leaned to the right. Accelerating out of the turn, I watched the tachometer needle streak to its 9,000-rpm red line. As I shot down a long straight-away, I marveled at the mechanical sophistication of the motorcycle I was riding.

Beneath me the world's smallest turbocharger was spinning smoothly at an incredible 180,000 rpm. At that speed the tiny compressor-impeller, only 1.9 inches in diameter, was producing 19 psi of boost in the intake manifold. This meant that each time an intake valve opened on the water-cooled V-twin engine, the air-fuel mixture was being rammed into the combustion chamber with a force of 19 psi. The result? A mid-size 500-cc motorcycle with the acceleration and top-speed capabilities of a 1,000-cc motorcycle. "Mileage, though," said John Row, Honda's senior research engineer, "is better than with our CX500 twin, which uses conventional aspiration." Honda says the standard 500 averages 49 mpg in combined city-highway driving. The Turbo averages 55.

The increased mileage is largely due to the way the turbo works. At legal cruising speeds the turbo is providing little or no boost, so not much fuel is being used. But when you open the throttle to pass another vehicle, the turbo forces much more air and fuel into the cylinders than the pistons alone could take in. The result is more power.

A digital computer mounted in the bike's tail section controls a sophisticated fuel-injection system. The computer also prevents the turbo from being destroyed. Although it has a 60,000-rpm safety margin built in (the turbo can spin up to 240,000 rpm without disintegrating), the computer senses if boost rises above 19 psi (which could happen if the waste gate failed to open) and reduces the amount of fuel injected. This prevents the engine from running so fast that the turbo provides excessive boost. "It acts like a fuel-controlled rpm limiter," Row says.

Continued



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Turbo cycle

[Continued]

The CX500T handles well considering its heft. At 547 lbs. with an empty gas tank, it's at least 100 lbs. heavier than most bikes in the 500-550-cc-displacement range. Kawasaki's KZ 550, for example, weighs 420 lbs.

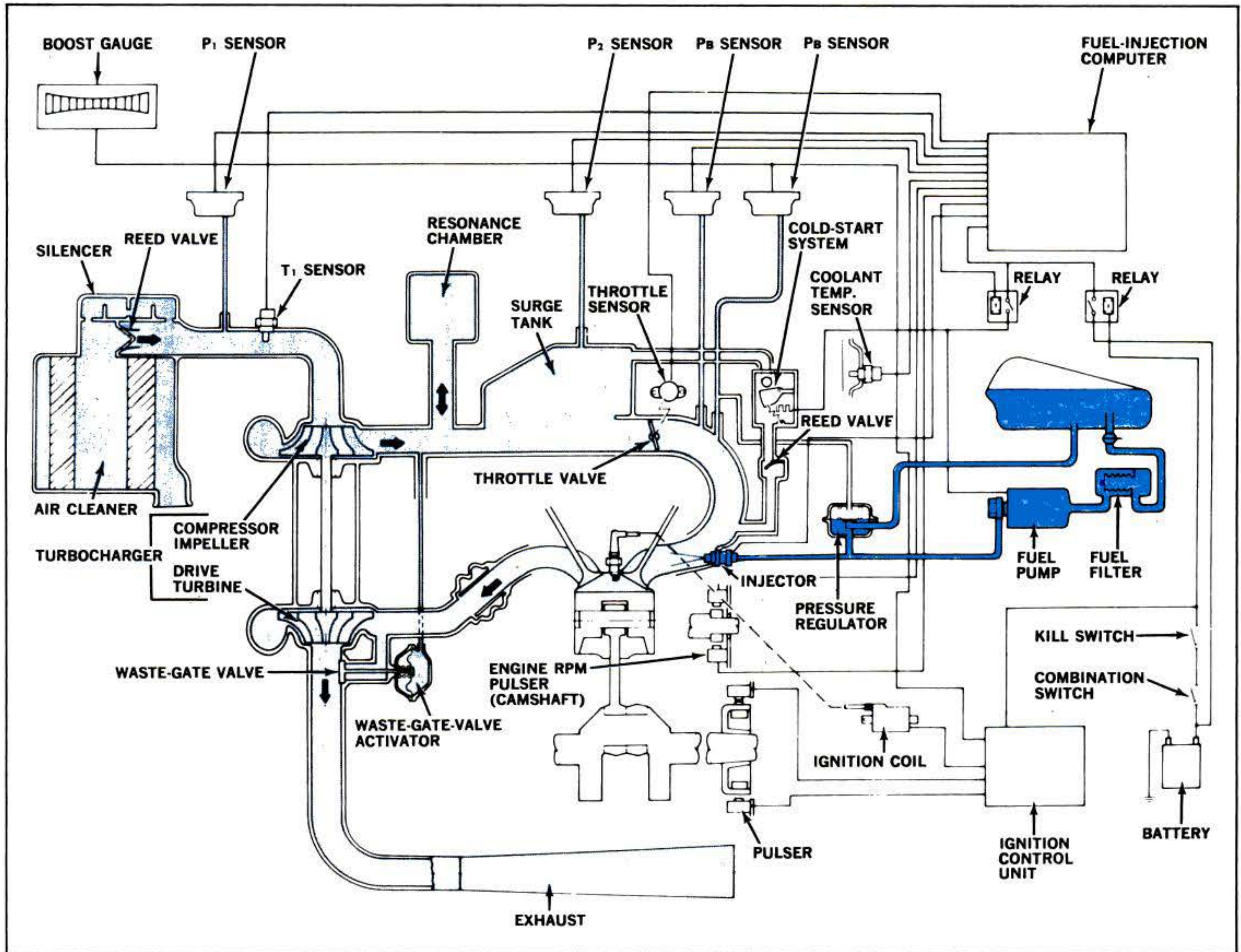
Brakes are excellent. And the fairing—the result of much wind-tunnel

work—directs hot air from the radiator out ducts at cruising speeds, instead of around your legs. Acceleration is rapid once the turbo kicks in. But there is a short lag after you twist the throttle before the turbo spins fast enough to provide noticeable boost.

The CX500T is scheduled to be on

showroom floors early next year. Price is expected to be in the \$5,000-\$6,000 range. This marks the first time a manufacturer has ever mass-produced a turbocharged motorcycle. With today's emphasis on making smaller engines more efficient, it's probably not the last. ■

How the turbocharger and fuel-injection system work



Exhaust gases spin the drive turbine, which in turn spins the compressor-impeller via a connecting shaft. When engine speed reaches 6,500 rpm, the turbo is spinning at 180,000 rpm, providing 19 psi of pressure (boost) in the intake system. At engine speeds above 6,500 rpm, a waste gate opens to let some exhaust gases bypass the drive turbine, holding the turbocharger to 180,000 rpm and boost to 19 psi. Forged pistons, stronger transmission gears, and a one-piece crankshaft enable the engine to handle increased power. A fuel-injection computer controls the amount of fuel injected in the two cylinders. It relies on information provided by various sensors: T_1 , which senses the temperature of incoming air, pressure sensors (P_1 , P_2 , P_B) that sense ambient-air pressure as well as pressure inside the

turbo system, and sensors that relay coolant temperature, engine rpm, and throttle-valve position. Because of the way it operates, it automatically compensates for variations in altitude.

A resonance chamber and surge tank ensure even flow of air. Without them, a long interval between intake-valve openings in the V-twin engine would result in erratic air flow. This is also the reason for the 19-psi boost, rather than the six to eight psi used in a turbocharged multi-cylinder engine. Because the multi-cylinder engine has more-frequent valve openings, flow in the intake manifold is smoother. The 19-psi boost pressure in the manifold of the V-twin engine actually results in a BMEP (brake mean-effective pressure) in the cylinder that's about the same as it would be in a four-cylinder

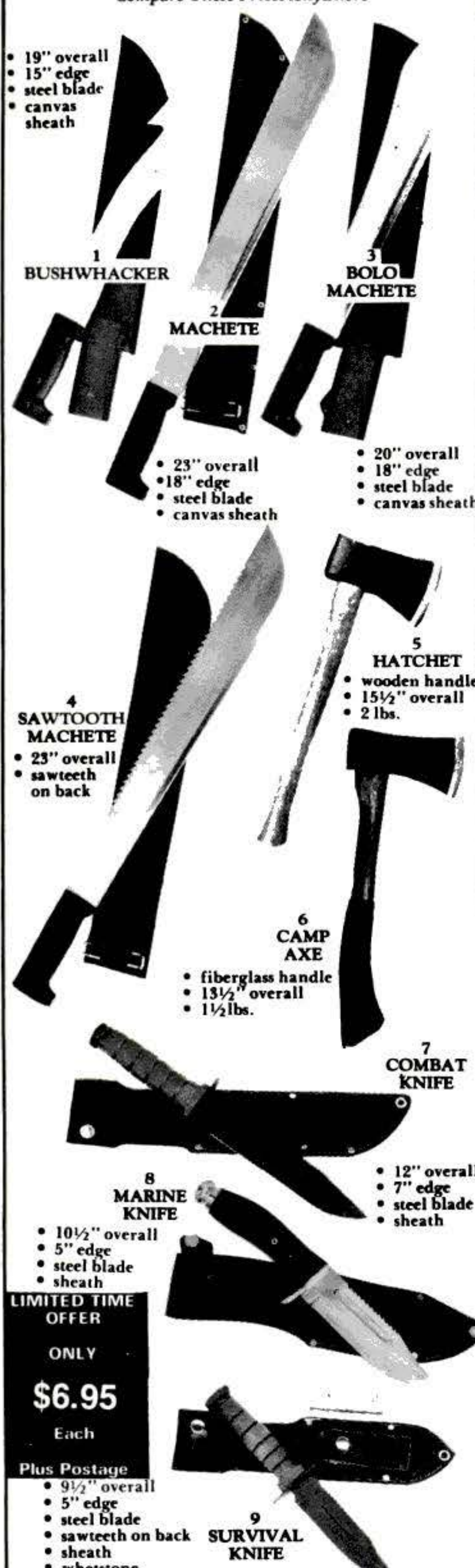
engine running with six to eight psi of boost.

A cold-start system ensures smooth running immediately after a cold engine is started. With throttle valve closed, the computer senses incoming-air temperature and engine-coolant temperature, then opens the air valve accordingly. The computer also injects the precise amount of fuel needed. A reed valve prevents air from being forced back through the cold-start system (which would otherwise occur because of valve overlap). The fuel-injection system uses a pressure regulator to ensure that pressure at each injector will be 25 psi more than the turbo's boost pressure. Excess fuel goes back to the tank through the return line. Ignition timing is controlled by the electronic ignition control unit.

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"SAY, SMOKEY—"

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Phooey on plastic parts

My '75 Rabbit has a plastic radiator that cracked where the pipe for the return hose fits to the top of the radiator. I don't want to spend over \$100 for a new radiator because of a small repair. I have tried an epoxy that works for a while. Has anyone found something better? Is this a common problem? For that matter, what business did VW have putting a plastic radiator in its cars?

Adam Burlock, Charlottesville, Va.

I don't think there's any way to fix it. Highways are covered with plastic parts falling off cars. They can't stand heat or age—and outgassings of many plastics may not be improving the national health. (Ever wonder where that film keeps coming from on the glass inside your car?)

Running too hot

I have a 1974 Olds 98 with 455 engine and a four-barrel carb. It has a 2.73 axle, dual-exhaust conversion with free-flow turbo mufflers, a combination engine-oil/transmission-oil cooler, and four-tube radiator. I use the car to tow a 1972 19-ft. Winnebago travel trailer.

I believe coolant temperatures when towing are too hot—about 250 deg. F (coolant) and 195 deg. F (transmission oil) on an 80-deg.-F Iowa day.

I've checked or repaired hoses, radiator cap, thermostat, fan unit, timing, carburetion, distributor, and gauge calibration. I also tried connecting the distributor directly to manifold vacuum and plugged the vacuum line to the EGR valve. None of this helped.

What can I do to bring down the temperature? This Olds replaced a 1969 Buick 350 that ran much cooler pulling the same trailer. My Winnebago dealer suggested I throw away the gauges!

Al Hays, Marshalltown, Iowa

Your 2.73 gear is lugging the engine. Go for a gear in the area of 3.25 to 3.50. Get an instant electric fan that will give maximum air flow at all speeds. Be sure air path in and out of radiator is unrestricted and shrouded. A lean fuel mixture or ignition timing that's too advanced or retarded will make it hot. A worn timing chain or cam can do same.

Rebuilt engine is dieseling

I have a 1972 Vega in which I just installed a rebuilt engine. The engine has a steel-sleeved block, with new pistons, rings and bearings. The head was rebuilt by a machine shop. The compression in each cylinder is high, at 173–175 psi.

The problem is that the car runs on after I have shut it off. The new engine has barely 100 miles on it. The engine temperature never exceeds 200 deg. F and usually runs at about 190 deg. F. I always use premium gasoline.

What could be causing the dieseling and what can I do about it?

Rick Hultz, Seattle, Wash.

Change fuel brands. Slow or speed up idle. And, most important, be sure the idle-stop solenoid is adjusted so that the throttle is completely closed when the ignition switch is turned off.

Unusual questions

As an ex-refrigeration technician and car lover, I have three questions to ask you.

Do you think that Mobil 1 is wax- and moisture-free and could be used in a sub-zero commercial freezing system?

Can the same oil do good duty in today's automatic transmissions?

What about nitrous oxide injection in a turbo-diesel?

Lynn Hinds, Ancienne Lorette Que., Canada

I believe in a pinch you could use oil for refrigeration and automatic transmission. But it's not a forever deal. I've used true synthetics for both, and both worked okay. Nitrous oxide is too expensive to consider as a steady additive and would require fuel-metering changes as well. You'd need more fuel with the addition of nitrous oxide.

Wants to modify

I have a '78 Jeep CJ7 309 and three-speed transmission. I'd like to get the best mileage I can without reducing the low-end torque. I have put headers on already. Would you recommend a carb, manifold, and cam combination? What do you think of Holley carbs?

Bruce Garner, Oak Park, Ill.

I'd look for a big four-barrel carb (800 cfm) and manifold. I prefer Holley for a carb. Cam will help but you'd need to upgear a tire size to capitalize on it. Look at Crane, etc., for high torque, low rpm.

Finding a V6 engine

You have mentioned a few times that a Buick V6 engine is a good replacement engine for a Vega. The problem is where to buy one. I have called a few Buick dealers in the New York metro area and they tell me that they do not sell engines.

I have a 1974 Vega GT with 40,000 miles

on it. The body is like new and the engine is still good, but I want to change it before it breaks down. Where can I buy the engine or have it changed?

Eddie Rivera, Orangeburg, N.Y.

Try junkyards; look for late-model wrecks. An even-firing engine would be a little better than the odd-firing model. Remember, though, engine swaps are usually a financial disaster. Of course, if you do it as a hobby, the money may not be important to you.

Gas vs. diesel fuel injection

I notice that in your answers on Rabbit diesels you say the fuel needs to be hospital-clean. Does this also apply to fuel-injection gas Rabbits?

Jacob P. York, Tipton, Iowa

Cleanliness is critical with fuel-injection gasoline engines, but it's even more important in diesel engines. Bacteria can develop in diesel fuel very easily, and that's bad news.

Rear-end problems

I am the original owner of a '66 Buick Sports Wagon with a rear-end axle/bearing problem. For 86,988 miles the car gave me excellent transportation, and except for normal maintenance there have been no outstanding expenditures. Currently my problem is that in the past 10,267 miles I have replaced: two used right-rear axles, three new right-rear axle

bearings and seals, and one new right-rear wheel cylinder; two left-rear bearings and seals, and one left-rear wheel cylinder. All new.

All the work has been performed by the same mechanic at the Buick dealer where the car was originally purchased.

I am a great believer in preventive maintenance, and the car is still serviced in accordance with the manual recommendations. The engine, with 98,000 miles, has never had any major repairs and, except for this problem, the car is in excellent condition. The Buick dealer cannot explain the continuous parts breakdown. In fact, the owner felt so bad about it that he did not charge me for the last bearing/seal repairs.

Samuel Weiss, Willingboro, N.J.

I think somehow the rear-axle housing has gotten out of alignment. Bent, probably, or maybe you increased your normal load to the straw that broke the camel's back.

Wants to halve his engine

After reading about your three-cylinder Buick [PS, Sept. '80], I wonder if I could get good results by removing the pistons, rocker arms, pushrods, etc., from one side of my 318-cu.-in. Plymouth engine, which is in a '69 Satellite. Or perhaps removing pistons two, three, five, and eight would result in a more balanced firing order. In order to maintain oil pressure, I would clamp two rod caps around each empty space on the crankshaft and leave the

valves to seal off the cylinders. What do you think? Would I just ruin a good engine, or could I improve gas mileage?

E. Bryant Davidson, Norman, Okla.

There's a lot involved in halving an engine. It would work, but the expense would not be justified unless it's a hobby or a means of continuing the life of a pet car. Professionally done, the job would run to several thousand dollars.

Using too much oil

Is it normal for a '79 Ford Pinto to require a quart of oil every 600 to 800 miles? If so, is it the same with all compact cars?

Richard W. Wolf
Richmond Hills, N.Y.

No. Most small car engines that use excessive amounts of oil seem to be doing so because: Oil is going down the valve guides because of poor sealing or loose or worn guides; excessive crankcase pressure; ring trouble; or a venting problem that increases pressure in the pan and blows oil through.

Each month, Smokey Yunick answers questions on cars—family cars, high-performance models, and racing vehicles. Got a problem? Send it to: "Say, Smokey—", Popular Science, 380 Madison Ave., New York, N.Y. 10017. Smokey reads all letters, answering those he feels are of widest interest. Due to the large volume of mail, Smokey cannot reply to letters that are not answered in his column.

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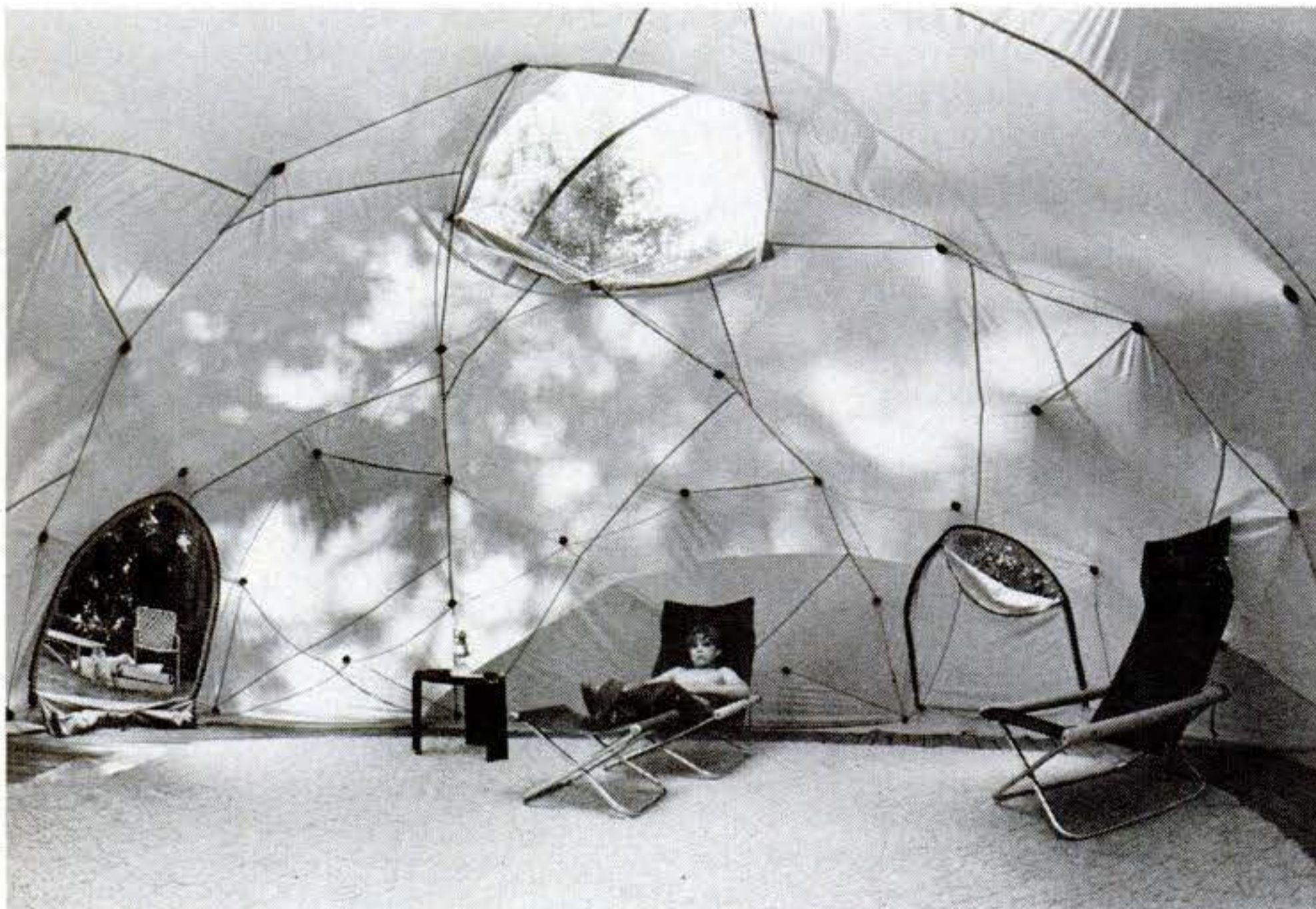
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RECREATION ROUNDUP

By HERBERT SHULDINER



Dome tent

The Soft House is a smart-looking, versatile dome shelter for outdoorsmen. It has 200 square feet of floor area, and the interior is totally unobstructed because the tent is suspended from an exterior fiberglass frame.

The tent fabric is attached to the frame by unique collar-and-button connectors. This system eliminates the need to puncture the fabric at the points where it attaches to the frame.

The interior view shows the apical skylight. It's made of 20-mil vinyl and has a high degree of optical clarity, the maker claims.

The Soft House has two doors, which are fastened by zippers. The structure is claimed to be stable in high winds.

Total weight of the dome is 38 pounds. It measures 16 feet in diameter and eight feet high in the center. The shelter comes apart quickly and can be carried in two stuff sacks.

It's made by Soft House, Box 21153, Eugene, Ore. 97402. An information pack-

et consisting of a brochure, fabric sample, and some hardware is available for \$2.

Telescoping pickup camper

Viking's new truck camper has a roof that you can lower 20 inches when the vehicle isn't used for camping. This cuts down wind resistance and makes the pickup camper more stable while driving. When you're parked at a campsite, the top goes up to provide stand-up head room.

The camper sleeps four persons and comes with a galley with a three-burner range and 75-pound icebox. A 2.5-cubic-foot refrigerator is an option.

The Vista SL-8 folding truck camper can



be installed on all standard-sized pickups. Prices range from \$2,600 to \$2,800. It's made by the Viking Division of Coachmen Industries, Inc., Box 725, Middlebury, Ind.

Tiny trailer

The small and sleek Sun Sleeper C-13 is a new trailer designed to be pulled by compacts and even some subcompacts, the maker says. The fiberglass recreational



vehicle has a clever rear door that doubles as an awning. There's also a second door to keep out bugs and weather.

Inside, a U-shaped dinette converts into a double bed. In addition, there's a sink and ice chest. A two-burner propane stove is an option. A manual water pump delivers 3½ gallons from a storage tank. There are also storage bins and cabinets.

The trailer is 13 feet long and weighs about 980 pounds. Tongue weight is only about 75 pounds, so you can easily lift it onto a receiver ball.

The Sun Sleeper is made by Chariot Manufacturing Co., 209 Pickney St., Oldsmar, Fla. 33557. Price is \$3,295. An 11-foot model, weighing only about 750 pounds, is available for \$2,695.

Backpacker's lantern

Now the famous Coleman lantern is available in a size that makes it feasible for back-country campers. The new Peak 1 lantern weighs only 30 ounces. It holds up to eight ounces of fuel that provide a burning time of at least 2½ hours. The lantern produces 125 candlepower, equivalent to a 75-watt electric bulb. And it's a lot quieter than standard-size lanterns. Price of the Peak 1 lantern is \$40. 15





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Popular Science readers have always been fascinated by the idea of home computers. Popular Science editors understand this fascination; they share it. A number of staff members operate personal computers; several own them.

Several months ago we noticed that many companies were bringing out new models. The companies involved were not only the traditional personal-computer companies, but industry giants such as IBM and Xerox. Clearly the industry is getting serious about these machines that cram so much computing power into such small packages.

Obviously this was news that would interest Popular Science readers. So Electronics Editor Bill Hawkins began gathering the new machines in our quickly overcrowded electronics test lab. Staff Photographer John Keating and Art Director Dave Houser began setting up the cover shot. At first, we went to a computer store nearby and shot it there. What we had in mind was a shot suggesting a supermarket, with an eager shopper loading his cart with computers and associated equipment. But if you've ever been in a computer store, you know that's not the way most of them are set up. In general, the computers are on round tables in the middle of the room, so that prospective customers can sit and operate them. There was just no way we could get the kind of shot we wanted.

Eventually, we hauled all of the computers back to Popular Science headquarters and found a temporarily vacant office. There we set up the scene you see on the cover. I don't suppose anybody will ever actually roll down the aisles of a computer store, loading goodies into the cart with such abandon. But it's a dream we can all identify with.

There is a personal note I'd like to add to this story. My own involvement with computers and computing began back in the mid-1960's. If you're a longtime reader, you may remember a piece we published in the May 1967 issue called "I Used a Real Computer at Home . . . and So Will You." I had a computer terminal in my home office, hooked up to a huge General Electric main-frame computer in a midtown Manhattan skyscraper. I learned the fundamentals of programming, and became fascinated with the hands-on computer experience.

Now the circle has been completed. Not

long ago, I decided that it was time for me to have a computer in my home office again. It had been needing remodeling for some time anyway, so I decided to build a new office/computer center. As we began putting this issue together, it occurred to several of us that many Popular Science readers are and will be facing a new problem: What to do with the computer that is or soon will be coming into their lives? My solution to this problem is shown on page 100. I hope it is helpful to you.

That troublesome telescope

In October, we reported on the new generation of giant telescopes now being built, and we mentioned in passing that the huge 236-inch Russian telescope—the world's largest—has never performed satisfactorily. I now have some additional information about the problems involved in operating that instrument.

The problem is that night temperatures at the Soviet observatory (as at almost every other place as well) change by as much as several degrees from one night to the next. But the huge mirror is so thick and heavy that it takes it up to three days to come into thermal equilibrium. Thus it is always either heating up or cooling down. And during such a period of adjustment, its surface is distorted and it is essentially useless as a telescope. Only when the outside temperature remains absolutely constant from night to night is the huge instrument operational.

The only solution, say Soviet scientists, is to scrap the huge pyrex mirror and replace it with one made of a zero-expansion-coefficient ceramic material. That's a dismal conclusion to be forced into after 15 years of planning and constructing what was to have been the world's mightiest celestial eye.

Sail ho!

One day a few months ago, the Charles Rowan arrived under sail power and with the help of a tug at the Leman Gas Field in the North Sea. Nothing unusual about that, except that the Charles Rowan is a huge floating oil rig. Susan Renner-Smith reported in her piece on the new generation of sailing ships [PS, Dec. '80] that a sail had been used to help an oil rig up the Atlantic coast. Now the technique seems likely to become common. The voyage of

the Charles Rowan, at a speed of five knots, took four days less than usual to get to its destination. A rig of this kind is worth \$50,000 a day. Since the mast and sail cost \$300,000, it will take only a few trips to pay for them and begin making a return. The company is now planning to use sail power to assist in the moving of all of its oil rigs.

And yet another item from the world of sail. Windship Development Corporation of Norwell, Mass., has just completed a year-long study of the feasibility of installing sails on cargo ships. The conclusion: It makes economic sense. The typical cargo ship of the future, says the report, will have a hull much like those of today. It will have somewhat smaller diesel engines, and it will have wing sails—much like those described in our recent article—to catch favorable winds. It will use from 18 to 25 percent less fuel, and sail on about the same schedules. It will use the engines exclusively during times of unfavorable winds and entering and leaving port. If half the world's cargo ships were so equipped, concluded the report, we'd save 70 million barrels of oil a year worth about \$2.3 billion.

Cheap solar cells

Stanford Ovshinsky, the controversial, self-taught engineer who developed the amorphous semiconductor [PS, April '78] has apparently scored another triumph. He has signed an agreement with the Standard Oil Company of California to enter a joint venture to develop his solar cell to the point where it could go into production. While it is still in a developmental stage, the new device nevertheless holds great promise. If it actually does convert sunlight into electricity as effectively as Ovshinsky predicts, it could slash the cost of solar cells dramatically and hasten the day of cheap, practical rooftop energy.



Editor-in-Chief

New age for airships?

Workhorse copter-blimp



Hybrid hoisters could lift up to 100 tons for remote logging or heavy construction

By TOM JOHNSON

ILLUSTRATION BY PAUL ALEXANDER

In the annals of aviation history, Lakehurst, N.J., is on a par with Kitty Hawk and Cape Canaveral. Since the 1920's, it had been the center of American lighter-than-air flight. The U.S. Navy blimps and dirigibles of World War II departed from Lakehurst on countless missions to patrol the Atlantic coast for submarines. After the war, the Navy continued to test the military applications of such craft there until 1961, when the airship program was discontinued.

Since then, gigantic Hangar No. 6 at the Naval Air Engineering Center in Lakehurst has been strangely silent, serving only as a catchall storage area strewn with old trucks, scaffolding, and empty cable spools. But last spring, a small crew from Piasecki Aircraft Corp. of Philadelphia set up shop beneath the 200-foot ceiling and filled Navy surplus gasbag ZPG2 for the first time in 20 years—inflating hopes among airship enthusiasts that a new age for lighter-than-air craft had finally arrived.

The silver-gray bag—343 feet long and 73 feet across—is one crucial element in a \$25 million plan to float a new kind of hovering aircraft that would be able to hoist and transport heavy objects over inaccessible terrain. The other elements are four old Sikorsky helicopters—also Navy surplus—that will be secured to a space truss of aluminum tubing lashed to the helium-filled bag. By this coming summer, the peculiar craft will be testing its rotors by hauling 25-ton loads of timber out of the remote forests of the Pacific Northwest.

Lifting limits

The hybrid copter-blimp, called a Heli-Stat, is the creation of Frank Piasecki, the maverick aerospace engineer and businessman who, in 1943, designed and flew the second successful helicopter in the U.S., the PV-2, and later built the first successful tandem transport helicopter. Piasecki patented his first yoked-helicopter-and-balloon unit in 1961, but, sidetracked by other vertical-flight projects, it wasn't until 1976 that he brought his Heli-Stat proposal to the attention of the federal funding agencies.

Piasecki was not alone in recognizing the need for an aircraft that married the buoyancy of a blimp to the vertical lifting power of a helicopter. Many large construction projects—oil rigs, bridges, power plants—need to move mammoth pieces of equipment, sometimes to remote locations without roads.

NASA did a study of the possibilities, and a number of aerospace companies, including Goodyear, submitted designs. Across the Atlantic and Pacific, English and Japanese engineers also pushed ahead with advanced airship concepts.

Present-day helicopters are limited to payloads of 20 tons or less. And, says Alan Faye, an engineer at NASA's Ames Research Center, "It doesn't look as if they will be able to do more than that for a while because of the investment required to develop heavy-duty helicopter transmissions. But if we could take existing heavy-lift helicopters—say, with 18-ton payload capacities—and mount four of them on a frame attached to an envelope of helium, we could actually lift close to 75 tons with very little advanced technology."

That potential is possible because

“It takes a heavy foot on the rudder pedal to turn a blimp in sharp winds. Once it starts turning, it's slow to stop.”

the blimp lifts practically all the weight of the helicopters. Consequently, the helicopters' lifting power can be entirely devoted to the payload instead of their own weight.

Piasecki's craft will probably be the first of the new ships to get into the sky, mainly because his design uses existing equipment and could be brought in quickly and relatively inexpensively. His proposal found an interested ear in the U.S. Forest Service, which, according to program liaison man James Beavers, was actively looking for alternative methods to economically log the nation's forests without ravaging the forest floor and destroying the watersheds.

"We've known since the early 1970's that we've reached the limit of logging with helicopters," says Beavers. A helicopter can economically remove timber from about 3,000 acres of forest surrounding a "deck," a site where logs are assembled to be trucked out of

the woods. Craft like the Heli-Stat are expected to "yard" trees from 63,000 acres. Lumber companies could harvest the now-ignored clumps of trees killed by insects or disease and salvage logs from remote, burned-over regions without need for new roads. In fact, one of the first tests scheduled for the Heli-Stat is on the 60–70-degree slopes of Mt. St. Helens, where the Forest Service hopes to remove at least 10 million board feet of Douglas fir downed by the volcano.

So the Forest Service helped shepherd the Heli-Stat proposal through the funding maze in Washington, and in early 1980 Piasecki got his money—\$11 million to design and construct the aerial behemoth. Another \$14 million was appropriated for three years of Forest Service testing at six sites in the Northwest. But of that \$25 million, "we expect to recover \$19.6 million by selling timber harvested during the tests," Beavers says.

Integrated controls

While the basic idea behind the Heli-Stat and similar craft is simple, building one involves some tough engineering problems. One major challenge is developing a system to simultaneously control the omnidirectional power of the four helicopters and the lumbering blimp. While the NASA researchers are working on a system to integrate the controls electronically—via a microcomputer—for one pilot, Piasecki will mechanically tie the controls of the four choppers together with a series of cables, all flowing to the command seat in the left-rear helicopter.

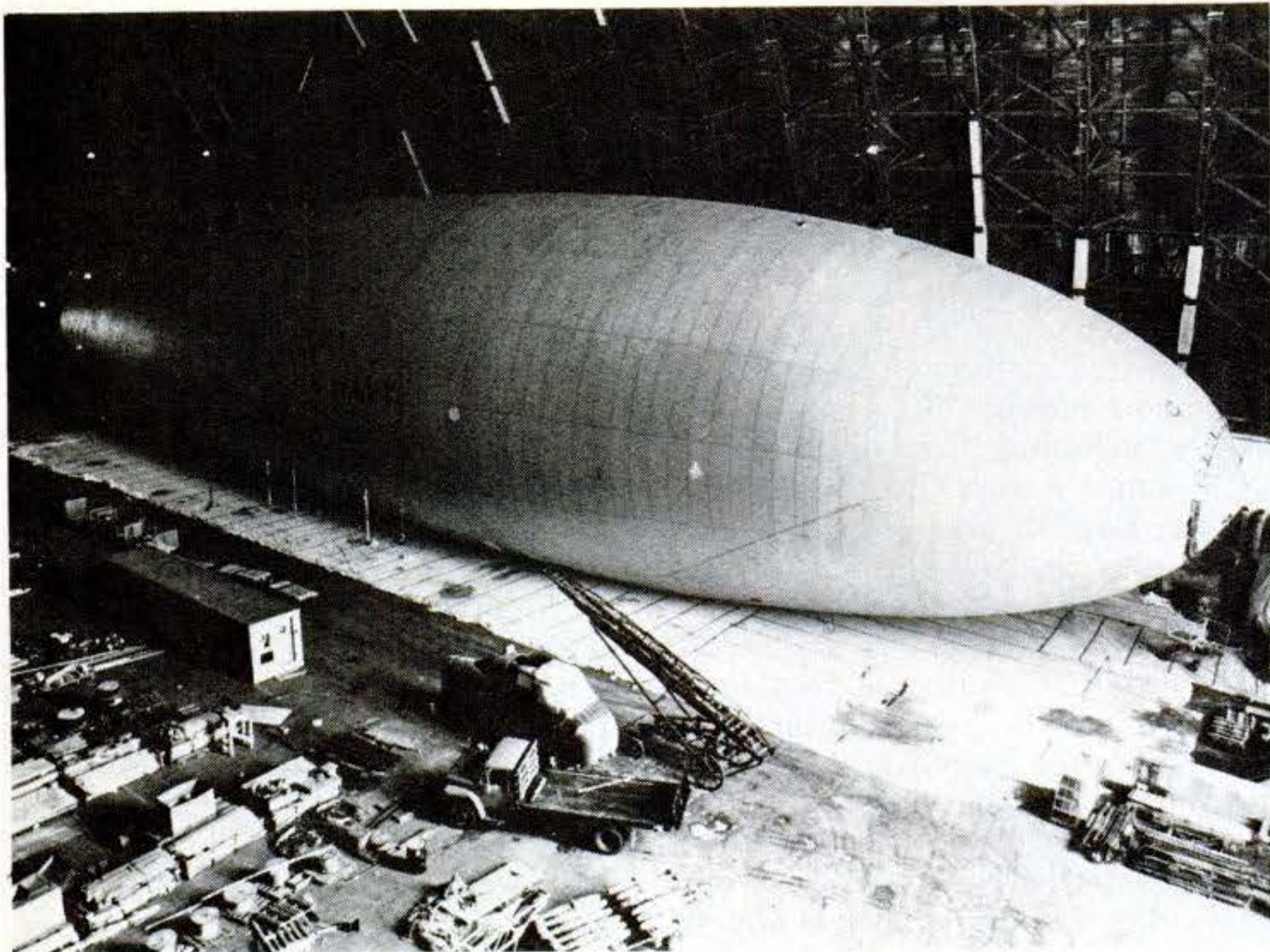
"The pilot—the guy in overall charge of flying the airship—will be sitting back there," Piasecki says. "There will also be flight engineers in each of the other three helicopters. They will be starting and stopping the engines and looking out for obstructions" as the giant ship maneuvers near tall trees and steep slopes.

Maneuverability remains the big unanswered question. Nobody knows if the hybrid ship will be sufficiently controllable to perform complex pick-up and delivery tasks, especially in windy conditions.

Helicopters by themselves are tricky beasts; they tend to bob and weave in gusting winds or from the ground effect of their own rotor downwash. Blimps, too, provide a special challenge for the pilot. Slow and sluggish, it takes a heavy foot on the rudder pedal and a lot of patience to get one turned in sharp winds. And once it starts turning, it is slow to stop.

Weather, especially winds, plays a

Continued



Gasbag ZPG2 came off the shelf for inflation tests in March 1981, ending 20 years of retirement. The million-cu.-ft. blimp will

be fitted with trusses to mate with four helicopters (disassembled in foreground) to test heavy-lifting-airship concept.

larger role in the flight of airships than any other type of powered aircraft.

"If you have a lot of wind you don't go anywhere," says Joel Chamberlain, pilot of Goodyear's airship *Columbia*. Pushed along by two 210-hp prop engines, *Columbia* has a top airspeed of 51 mph, with a cruising speed of 37 mph. "Once the winds get above 35 mph, you just look down at the same spot," says Chamberlain, who has logged 5,500 hours beneath the helium bag.

Ironically, one of the challenges for the Heli-Stat will be to stay in one spot. "No one has ever really hovered in a lighter-than-air ship," says NASA's Faye. "Airships have always had to fly in order to have controllability. Now the big question is, can you really hover the craft? And if you can do so in still air, can you hover it with any kind of wind blowing? And can you hover it precisely enough to pick up and deliver cargo from various altitudes?"

Hanging question

Piasecki thinks his ship might hover with greater precision than a helicopter. "It has a lot of inertia compared with any other aircraft," he recently told a convention of foresters, "and in a light-gust condition I think it will do better than a helicopter. In a steady, high wind . . ." He shrugged his shoulders and left the question hanging. Even with 40 years of design and engineering experience, he, too, will have to wait for the flight-test results.

Some experts are not convinced that the Heli-Stat will be able to handle fierce winds, and question the wisdom of its federal funding. The General Accounting Office, the investigative wing of Congress, charged in a recent report that development costs could run much higher than expected and that the payback in harvested timber depends on successful performance. The GAO also criticized the program for using surplus equipment in a design that may not be readily reproducible. The report suggested that it would have made more sense to design such a craft from scratch and develop a state-of-the-art machine.

The Forest Service contends that such an approach would have taken many millions of dollars more and years longer to accomplish, and that the goal of the program is only to test the concept, not to develop a state-of-the-art craft. "The ship isn't meant to be a production prototype," says Piasecki. "It's a developmental craft, designed to demonstrate that the concept will work."

Piasecki takes pride in the low-cost approach. "We're doing everything with 'GFE'—government-furnished equipment," he says. The surplus material includes eight Sikorsky H-34J helicopters, 16 R-1820 piston engines (the same radial engines used in the DC3 and DC4), and a stack of rotor blades. The rarest piece of surplus is surely the blimp envelope, which was fabricated by the General Development Corp. in 1960 but has sat on the shelf since its maiden flight. ("It passed all the pressure tests,

though, when we inflated it last spring," Beavers reports.) Even the timber used next year to test the logging capabilities of the airship will be "GFE," coming from the national forests.

While questions persist about the Heli-Stat program, there is widespread interest in some form of heavy-lifting aircraft. According to various studies by Congressional committees, NASA, and private designers and consultants, there are enough unusually heavy cargos to be hoisted to make development of such craft economically attractive. If they eventually approach the 70-to-100-ton lifting capacity or long-range, relatively high-speed cruising capability (100 to 125 mph), they could be used for constructing power plants and pipelines, transporting heavy oil-drilling rigs and transmission-line towers, and unloading cargo from ships.

If airships were available to help build an oil or gas pipeline across Arctic tundra, for example, it would eliminate—or at least greatly reduce—road-construction costs, which can run as high as \$150,000 per mile.

The Navy might use them for moving material (such as 60-ton tanks) from ships onto the beach. The Coast Guard also is interested, not for their lifting potential but for their low-altitude, high-fuel-efficiency cruising capabilities. "The Coast Guard used to have a 12-mile limit to patrol," Faye points out. "Now it has to cover a 200-mile limit with the old fuel allocation."

The next sunrise?

Engineers like Faye and Piasecki have been talking about such possibilities for, it seems, ages. Periodically, conferences are held around the world where a tireless group of men devoted to airships—some wags have labeled them "helium heads" and "balloonatics"—lay out studies and plans of seemingly irrefutable logic and practicality indicating that a new age for airships could and should begin with the next sunrise.

Are the current efforts just another pipe dream? Perhaps not. Aeronautical engineers today know far more about structural design than ever before. New materials have been developed that will make airships lighter, stronger, and faster. Engines today produce more horsepower per pound with greater fuel efficiency. Instrumentation can tell us more about weather conditions and navigation than was possible in the 1930's, the last great age of the airship. Perhaps now is the time for the helium heads' dreams to be realized. ■

The missile killers . . . top-secret race to develop beam weapons

Space-based lasers or particle-beam devices could kill enemy missiles almost instantaneously

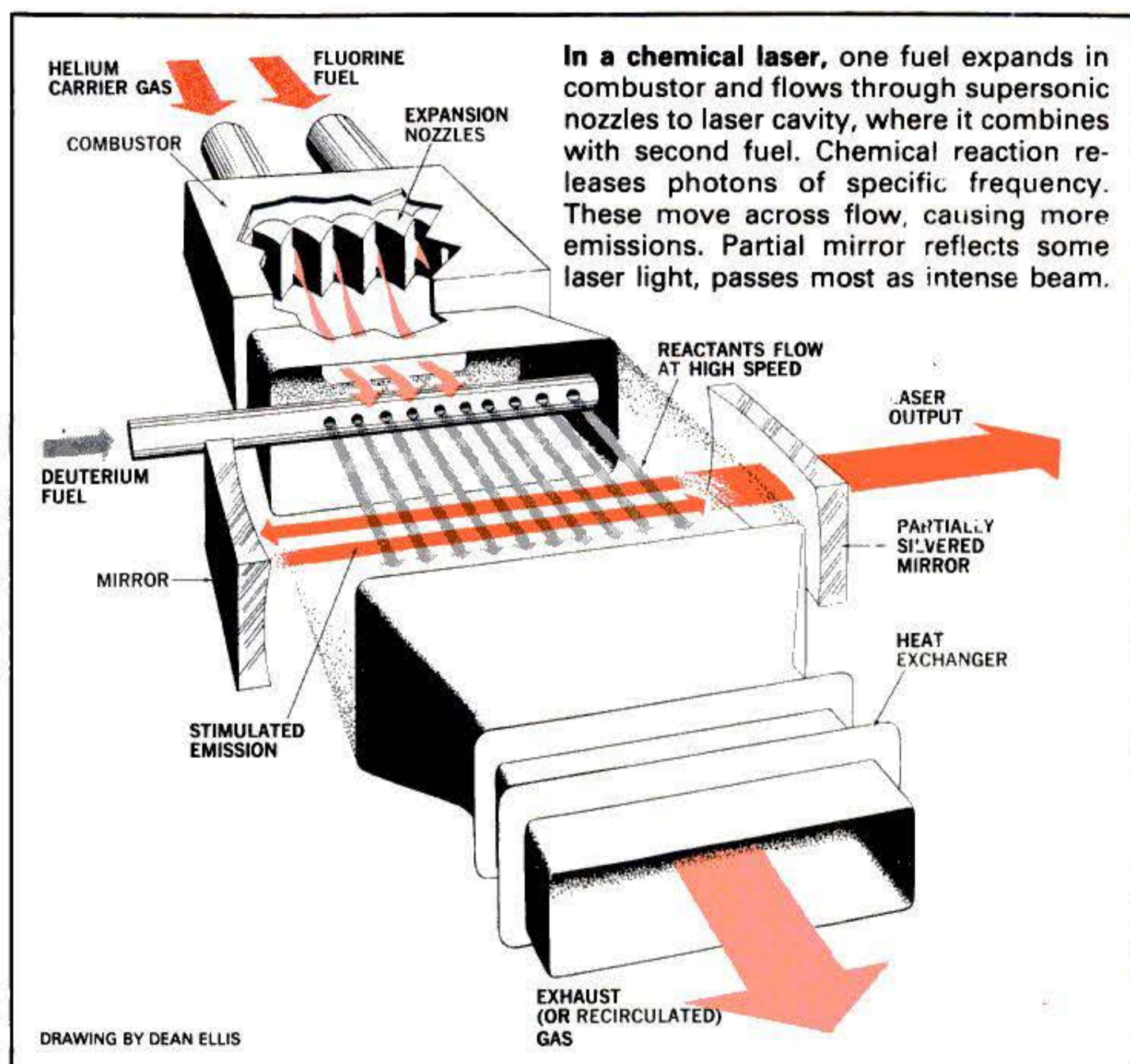
By JIM SCHEFTER

A speck in the vastness of space, the little 22-foot utility cruiser arced toward the next stop on its servicing run. In the tanks behind the lone pilot's cramped cockpit was a cargo of hydrogen and fluorine near absolute zero—replacement fuel for an awesome chemical weapon.

Ahead, something flashed in the sunlight, moving with dizzying speed across the patterns of ocean and clouds 800 miles below. The cruiser closed in for a rendezvous. Soon the pilot saw it clearly—a laser battle station, one of an orbiting picket line of laser weapons in space. At one end of the station's 65-foot cylinder a large parabolic mirror glistened. At the other, the massive bell of a dormant rocket engine protruded.

The station looked like any ordinary piece of space hardware. But the pilot knew otherwise. Let the automated battle station receive word from a tracking and command center on Earth that enemy nuclear missiles had been launched, and the huge mirror would spring into action: It would swivel toward a distant target and with uncanny accuracy unleash a finely focused beam of laser light. From up to 7,000 miles away, that beam would intercept a missile as it climbed above the atmosphere, burning through its aluminum skin in less than a second.

Whether the beam punctured the missile's fuel tanks, disrupted its electronics, or detonated its warheads



wouldn't matter. Within seconds, even as the battle station engaged a second and a third missile, the first target would cease to exist.

The pilot docked with the battle station and began refilling its laser-fuel tanks. They were low because the station had just blown an antique Titan II missile from the sky in a periodic test of the U.S. Air Force's orbiting picket line of space lasers.

A fanciful piece of fiction? No. But neither is it tomorrow's certainty. In a growing war of words among defense experts in the U.S., the one thing *not* in dispute is whether such battle sta-

tions—using either laser beams or streams of high-speed particles—are possible. Rather, opposing factions argue about how soon we can have them ready, how they should be deployed, and how much of a technology lead the Soviet Union has in developing them.

High and low hurdles

"Laser battle stations are not something out of 'Star Wars,'" Wyoming Senator Malcolm Wallop, who favors speedy development, recently told his colleagues. "Actual physical pieces of

Continued

the system already exist. Only the money and the will to put them together is lacking."

Wallop is convinced that the first pieces of an effective space-weapons system could be orbiting in five years. But others, including the Pentagon policy makers, prefer a slower approach. "The people closest to the program say we can't do it quickly," said Dr. George R. Millburn Jr., acting deputy undersecretary of defense for research.

Major technical hurdles remain in the development of the various systems needed for effective missile-zapping: the ultrahigh-power lasers and particle accelerators themselves; the complex optical elements that would focus the beams; the pinpoint-accurate aiming systems; and the sophisticated Earth tracking and command network.

Then there is the question of countermeasures. Some experts believe that relatively simple and inexpensive means are available to defeat space-based beam weapons, or indeed destroy them before they are operational. Others disagree. Finally, there are deployment decisions to be made: Laser or particle beams? Within the atmosphere or in space? High or low orbit?

For all these reasons, the Department of Defense has not made any commitment to put weapons in space, either during the 1980's or any time later. Nevertheless, it has spent an average of \$200 million a year for the past decade on high-energy-laser and particle-beam research. In 1981, Congress upped that budget by an additional \$50 million.

What is the potential for space weapons? In talking to the experts—scientists, military leaders, and politicians—I found that much of the research and development program is classified "top secret" and even higher. Still, many unclassified facts came out.

- Parallel research efforts are under way within several branches of the military and at government and industrial labs around the country. But most of the program is coordinated by the secrecy-shrouded Defense Advanced Research Projects Agency (DARPA), which is mandated to "examine the feasibility of high-risk, high-payoff technologies," but not actually to develop weapons.

- Space beam weapons are envisioned exclusively as anti-missile systems—the ultimate defense against nuclear attack. Offensive weapons against orbiting or ground targets can more easily be developed using established technologies.

- Several types of advanced chemical lasers are being developed. The Army, Navy, and Air Force have each tested versions by shooting down airborne targets. And other laser technologies show promise of ultimately surpassing chemical lasers in power. But no one is willing to pick out one system for all-out engineering and development because next year's breakthrough might be better.

- Two other elements of an effective space weapon—a high-quality optical system and a super-accurate pointing system—are also under development, but there is no plan now to combine the elements for even a single demonstration.

- Any picket line of orbiting battle stations must be served by an advanced, highly computerized command and control center on Earth. Not even preliminary work has begun in that area, according to Brig. Gen. Jake Jacobson, Air Force director of space systems command and control. However, a concept for a one-seat

“With no atmosphere to absorb laser light, the beams remain slim and destructive over vast distances”

“cruiser” that would service a fleet of space weapons has been prepared for the Pentagon by SRI International of Menlo Park, Calif. Up to three cruisers could be sent up in a Space Shuttle, then pick up fuel tanks and other equipment already in orbit to service the laser picket line.

- Advanced research is going on in particle-beam technology as well as in lasers. Particle-beam weapons would zap a target with either a charged stream of electrons or a neutral stream of hydrogen atoms. These would be generated the same way they are in the high-power particle accelerators physicists use in basic research, but the beams would have to travel through the atmosphere or through space. Test accelerators at Lawrence Livermore Laboratory in California and Los Alamos Scientific Laboratory in New Mexico are being used to investigate the propagation properties of charged and neutral beams. To date, the longest pulse achieved lasted only five billionths of a second. But planned second-generation machines will do better.

While particle-beam technology

remains in the lab, some laser weapons have already been built and tested. Last June, a carbon dioxide laser carried aboard the Air Force Airborne Laser Laboratory (a modified cargo plane) tracked and fired at Sidewinder missiles over the firing range at Kirtland Air Force Base in New Mexico. In two known tests, the laser scored one non-lethal hit and destroyed a second missile.

The Army's system, an electric-discharge laser fired from a mobile, tank-like vehicle, has destroyed helicopters and other drones in flight at Redstone Arsenal, Ala. And the Navy's TRW-developed deuterium fluoride laser has cut the wings from low-flying drones and destroyed antitank missiles at a secluded test site near San Juan Capistrano, Calif. The targets were often more than a mile away, sources said.

Of course, a mile is a far cry from the vast territory that a space-based laser would have to cover. And of the three systems tested, only the TRW laser has direct application to space. The electric-discharge laser, for example, is unsuitable because spacecraft could not carry the heavy external power supply that's needed.

But chemical lasers work well in space. In a simple chemical laser, heated fluorine and deuterium flow through nozzles into an optical chamber flanked by mirrors (see drawing). The flash chemical reaction between them causes light of a particular wavelength to be emitted. This light, trapped between mirrors, stimulates further emissions at that frequency. The energy ultimately emerges perpendicular to the gas flow as an intense, coherent beam that can be aimed at distant targets.

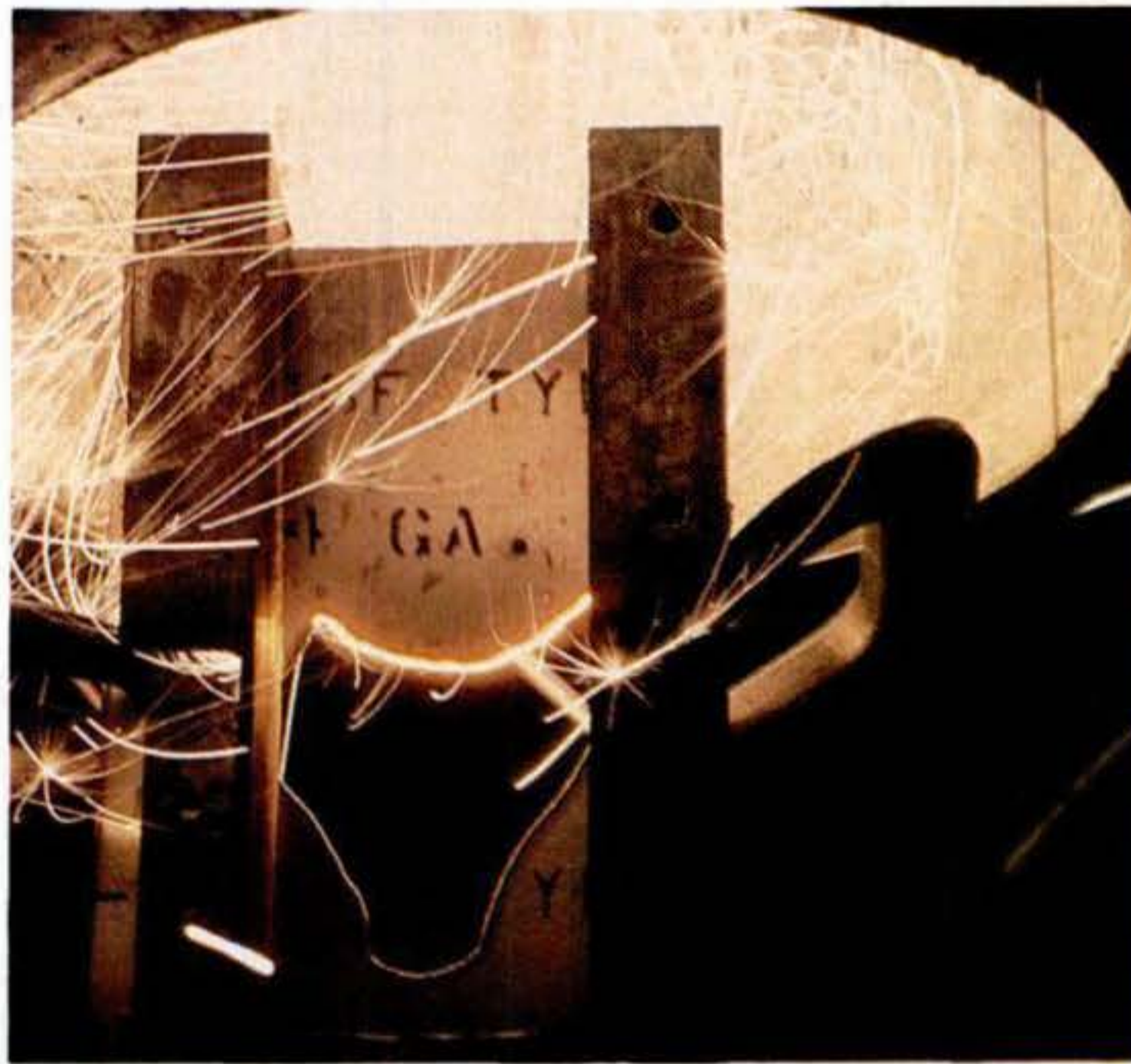
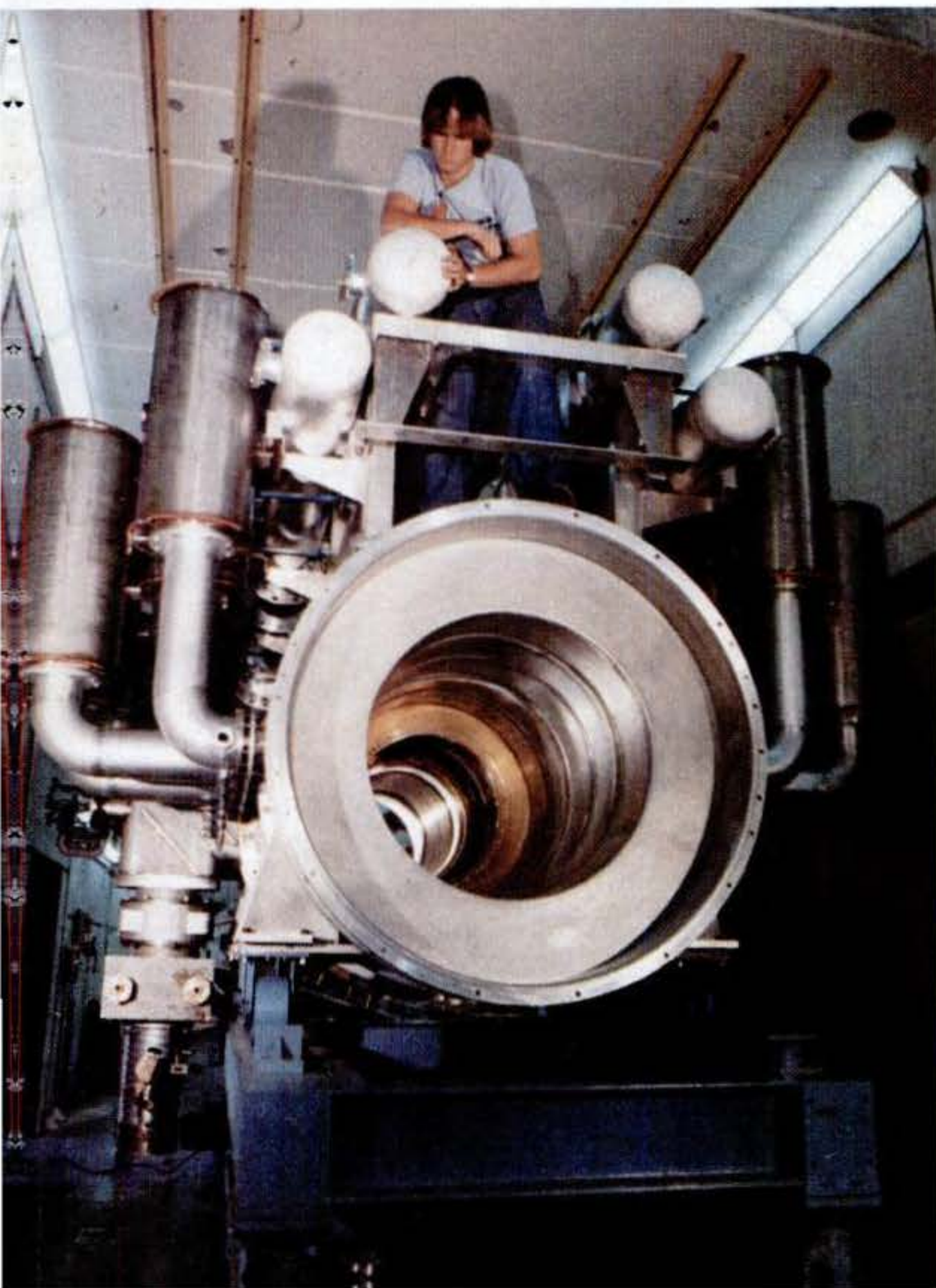
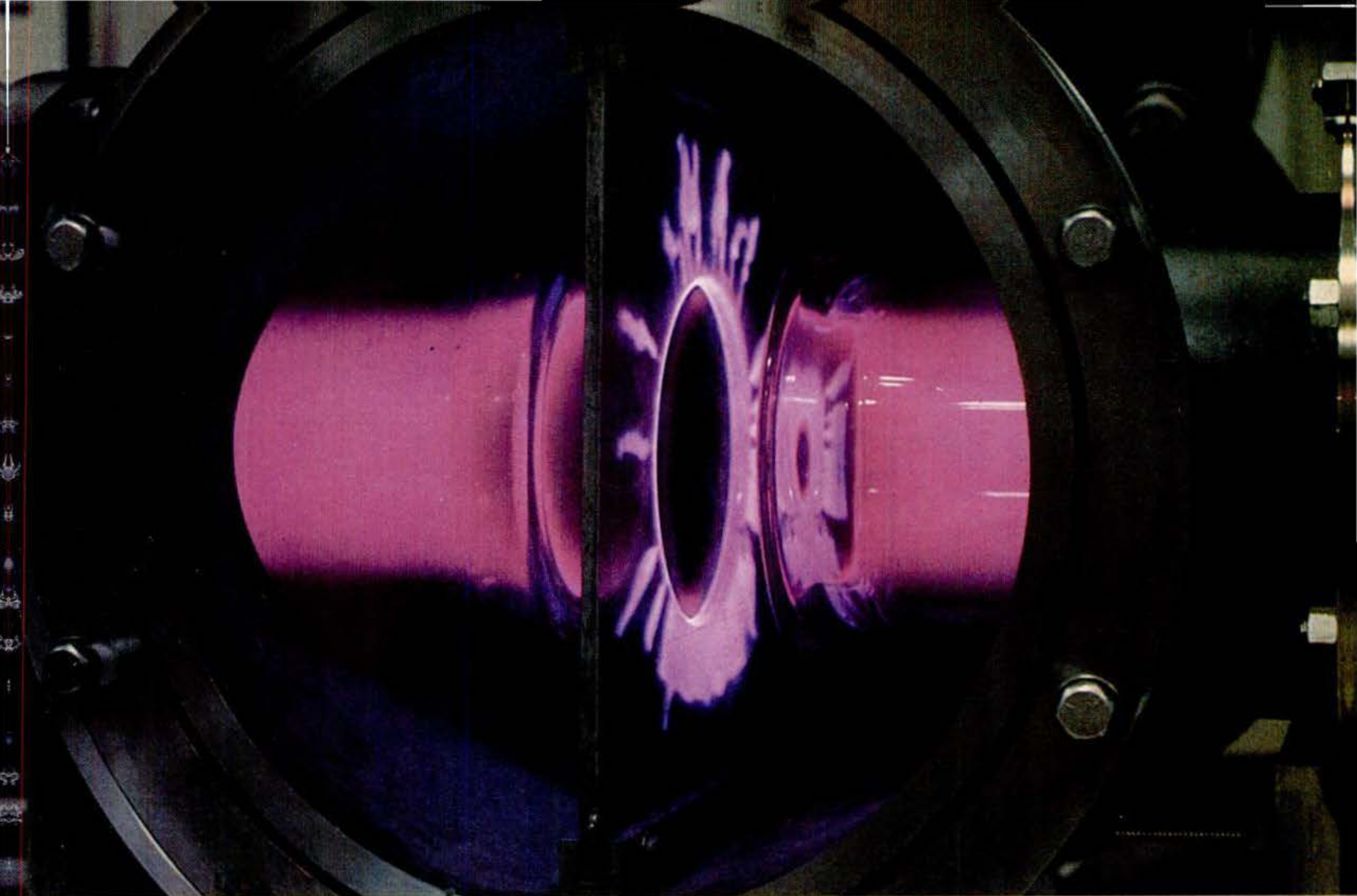
Perfect environment

With no atmosphere to attenuate or absorb the laser light, the beams can remain focused and destructive over long distances. Another advantage of space is that it provides a ready-made vacuum for the laser's reaction chamber. Finally, chemical lasers are well suited to space because they need no electrical hookups.

"Power source? What power source? That's the real beauty of it," a highly placed expert told me. "It's really a small rocket engine that provides the lasing medium," another source said. "It even smells like a rocket."

Because the beam results from chemistry, not from the sudden discharge of a capacitor-battery system, it can be fired in rapid, single-shot bursts, or be left on until its fuel is gone.

[Continued on page 138]



Ionized gases near cathode of electric-discharge laser at Air Force Weapons Lab, Kirtland AFB, N.M., luminesce as 20-kV current is discharged (top). In this laser, nitrogen, helium, and carbon dioxide are pumped into 10-ft.-long laser cavity (only viewing window is visible in close-up). When current is switched on, gas atoms jump to higher energy levels, then drop back and release coherent infrared light. Mirrors at ends of cavity produce 15-kW beam. Beam is used to test laser effects on target materials, such as titanium plate burning above (both photos: U.S. Air Force). Device at left is part of accelerating column of electron-beam generator at Lawrence Livermore Lab. The accelerator injects particle pulses into test chamber so researchers can study beam propagation in air.

Faster than bullets or rockets with new space-age slings: **electromagnetic launchers**

Out of sci-fi? Rail guns and mass drivers start new age of propulsion

By **DANIEL RUBY** and **DAVID LAMPE**
ILLUSTRATION BY WALTER HORTENS

It looks less like a gun than a cobbled-up collection of electrical leftovers. The device clamped to a bench top in Richard Marshall's lab at the University of Texas consists of bolted-together plastic slabs with a square, copper-walled bore. Large capacitors on the floor are wired to terminals on the device and a section of cotton-stuffed drainpipe dangles on wires a short distance ahead of the muzzle. Marshall loads a 1.5-cm plastic cube in the breech and a technician reads the countdown. At zero, there's a bang, a flare of light, and the drainpipe swings lazily back and forth. The embryonic rail gun has just fired a projectile faster than a conventional gun ever will.

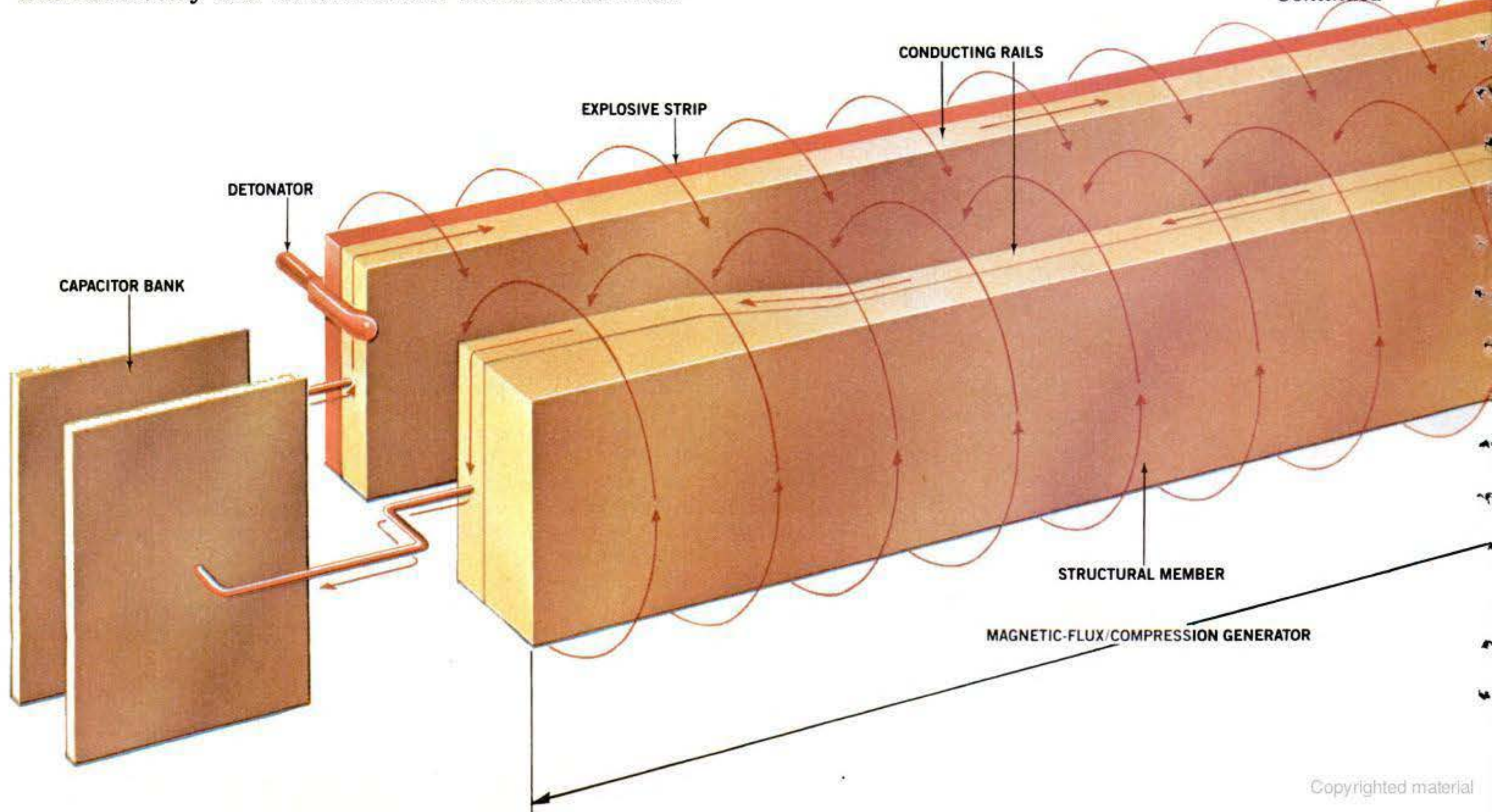
One state to the west, Max Fowler of Los Alamos Scientific Laboratory and Ronald Hawke of Lawrence Liver-

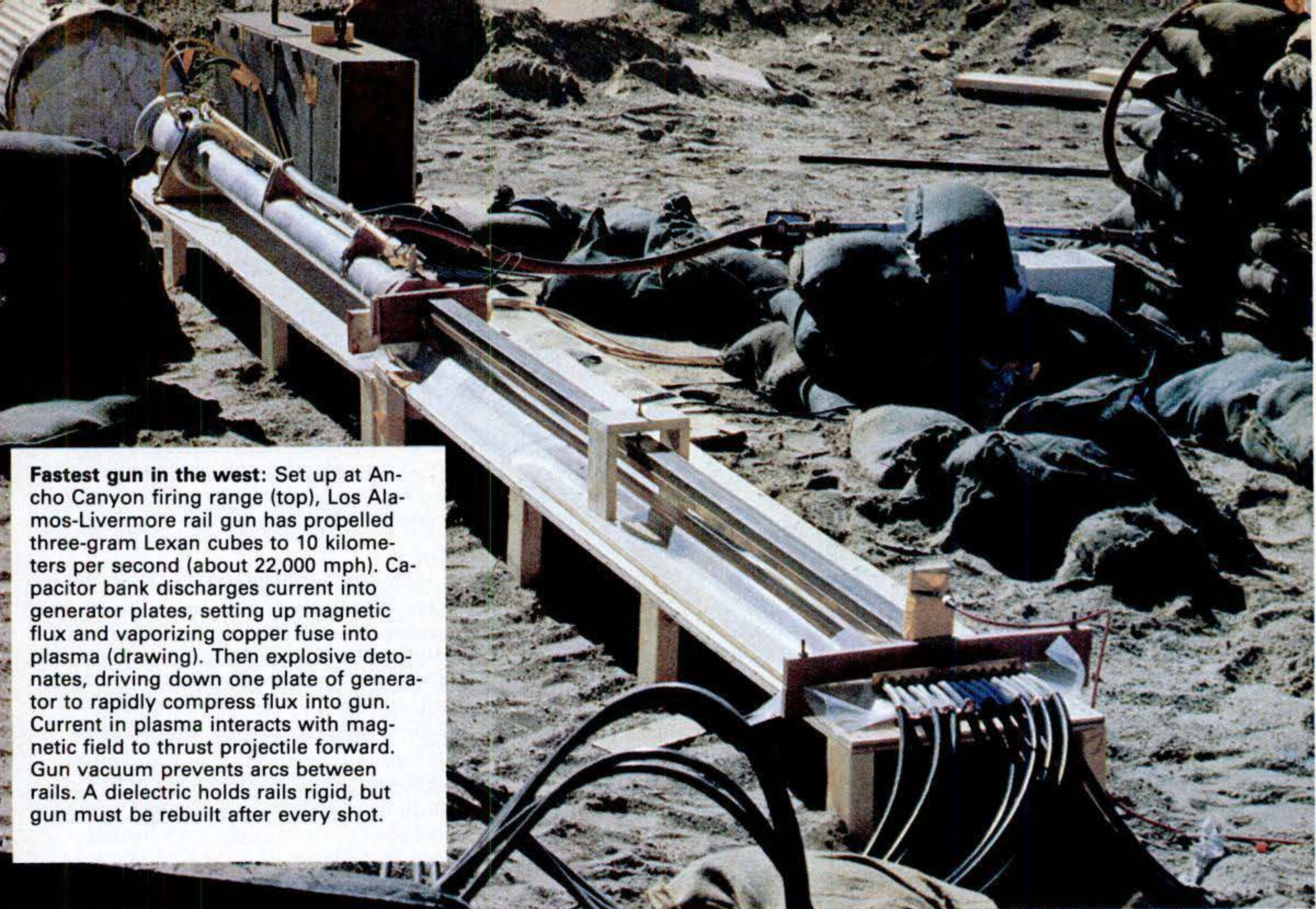
more Laboratory and their colleagues are set to test a similar electric gun. Their 1.8-meter-long device is set up among sandbags at the Ancho Canyon firing range because firing it involves an explosion that would be dangerous in a lab. As the explosive discharges, it squeezes a magnetic field behind a cubic three-gram plastic bullet and sends it speeding into a rag-filled garbage can at such acceleration that the cube breaks up into dozens of tiny pieces. Reconstructing the test, the scientists calculate that the projectile left the muzzle with almost the velocity needed to escape Earth's gravity.

In an exhibition hall at Princeton University, Henry Kolm and some graduate-student assistants are demonstrating a device they call Mass Driver I. A "bucket" consisting of superconducting coils is at rest at the left end of a 10-cm-dia. tube. When power is switched on, observers are amazed to see the bucket materialize at the right end before their eyes have seen it leave the left.

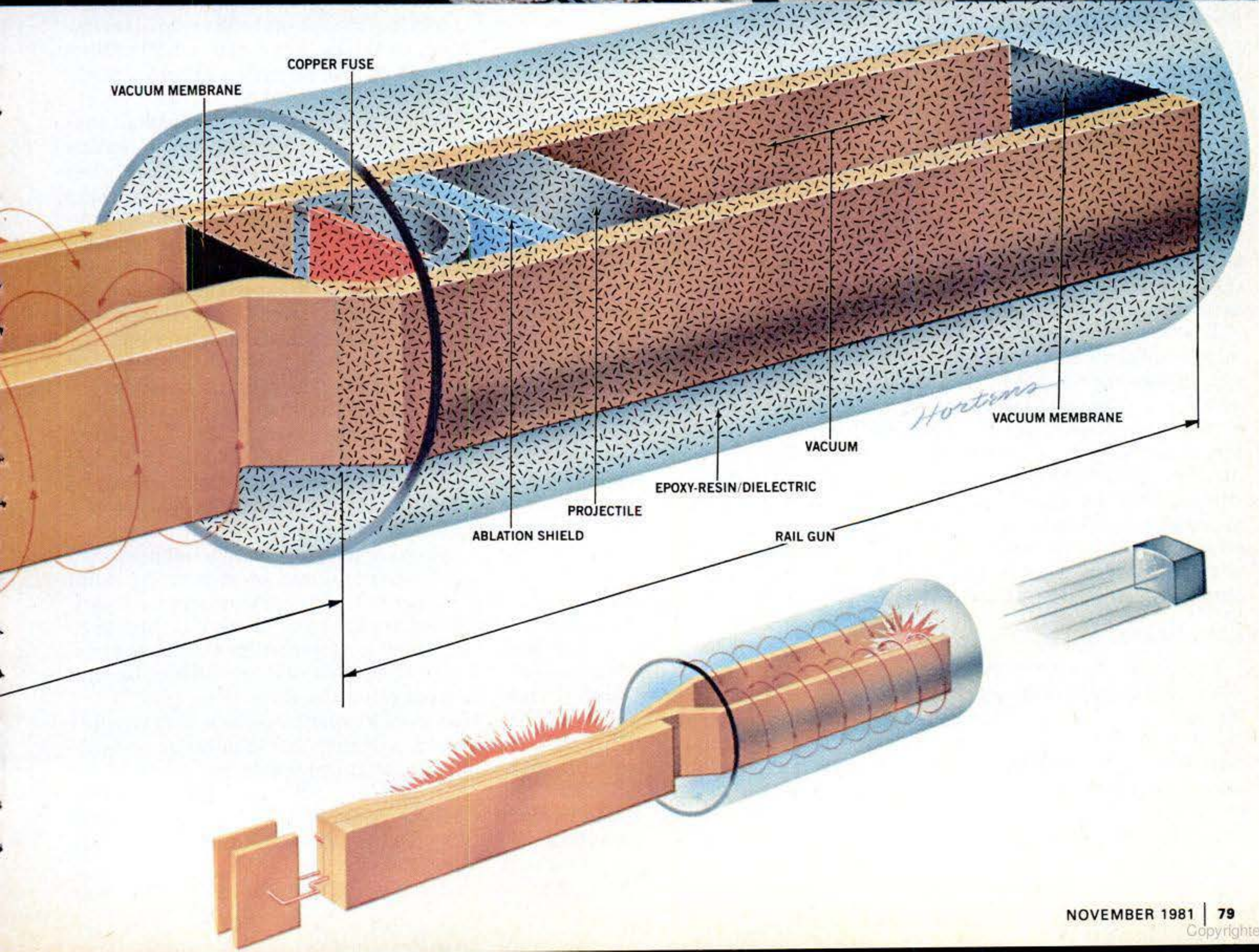
"A *Star Trek* experience," Kolm calls it—an apt description, because until recently such devices have been more at

Continued





Fastest gun in the west: Set up at Ancho Canyon firing range (top), Los Alamos-Livermore rail gun has propelled three-gram Lexan cubes to 10 kilometers per second (about 22,000 mph). Capacitor bank discharges current into generator plates, setting up magnetic flux and vaporizing copper fuse into plasma (drawing). Then explosive detonates, driving down one plate of generator to rapidly compress flux into gun. Current in plasma interacts with magnetic field to thrust projectile forward. Gun vacuum prevents arcs between rails. A dielectric holds rails rigid, but gun must be rebuilt after every shot.



home in science-fiction scenarios than in scientific laboratories. But now electromagnetic guns and launchers are getting serious academic, industrial, and military attention that could soon lead to important applications.

Two types of accelerating devices are under study: rail guns, in which a magnetic field generated between parallel conducting rails drives a projectile forward, and synchronous coaxial accelerators, which produce traveling magnetic waves that carry projectiles to great speeds. Among the fascinating possible applications for either type:

- Artillery or anti-aircraft weapons that could pierce armor that withstands ordinary projectiles.

- Space launchers that would operate at much lower cost than chemical-fuel rockets.

- Pellet accelerators that might pack enough punch to release nuclear-fusion energy.

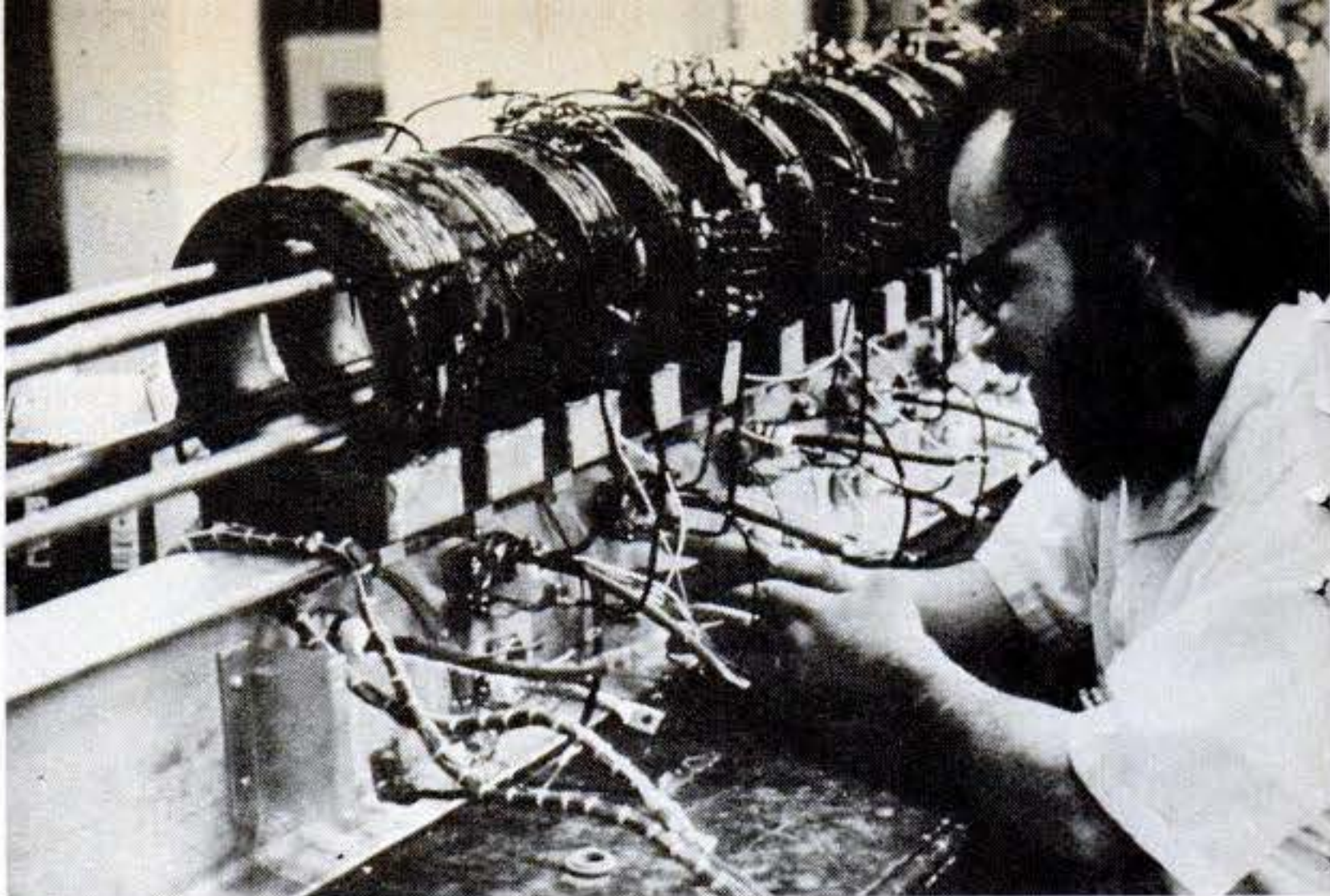
"Electromagnetic guns can propel things to much higher velocities than is possible with conventional guns, which are limited by the expansion rate of chemical gases," says Harry Fair, chief of propulsion technology for the Army's Large Caliber Laboratory in Dover, N.J., and principal advocate of electric launchers within the military. Researchers in this field refer to velocity in units of kilometers per second. For reference, Earth-escape velocity is about 11 kilometers per second; high-power rifles fire at about two kilometers per second. Rockets reach higher speeds, but only because they carry their fuel and engines on board; thus, the weight of useful payload on a rocket is a tiny fraction of the total. "With electric launchers," says Fair, "the only physical limit is the velocity of light. Of course, there are still engineering limitations."

The engineering problems have stymied potential developers for more than half a century. As far back as 1920 researchers realized that electric launchers could be built based on the Lorentz force—the force exerted on an object moving in an electromagnetic field that is the basis of any electric motor. The simplest such device would be a single-turn linear motor consisting of two parallel conductors joined by a sliding armature. When connected to a power source, the current would generate a magnetic field perpendicular to it. The interaction between that field and the current in the armature would drive the armature ahead. If a projectile were placed in front of the armature, it would accelerate at speeds proportional to the square of the current. Thus, in such a device the potential velocities would increase dramatically with modest increases in current.

That's the theory. In practice it has proved very difficult to provide the superpowerful but controlled surge of current necessary to power a practical gun. The earliest attempt may have been by Edwin Northrop, founder of the aerospace company, who built a primitive gun that lobbed projectiles across the Princeton University campus. During World War II the Germans worked on an electric missile launcher for a while and Westinghouse developed an aircraft launcher called Electropult that worked, but not as efficiently as conventional devices. All these attempts were premature, says Kolm, because the needed energy storage and switching technology was not yet developed.

Shot heard 'round the world

The birth of modern rail gunnery took place in 1968 when Richard Marshall and colleagues at the Australian National University in Canberra first coupled a device called a homopolar generator to an elementary rail gun in an early effort to develop an accelerator that might initiate a nuclear-fusion reaction. The homopolar generator is not new. First invented in 1821 by an obscure English mathematician, Peter Barlow, it consists of a conducting wheel rotating in a magnetic field with retractable brushes to pick off the current at the wheel's edge. They don't gener-



Mass Driver I's outer coils are wired to capacitors. Aluminum-coil "buckets" with auto-starter brushes accelerate along four copper tubes. Scaled-up version could put heavy payloads into space.

ate electricity but store energy fed from external sources over several minutes and release it in a powerful burst.

Using a large homopolar borrowed from a synchrotron, Marshall's group was able to accelerate gram-sized plastic cubes to velocities of six kilometers per second. Then, because the Australians decided on magnetic confinement as a more likely route to fusion, the program was killed.

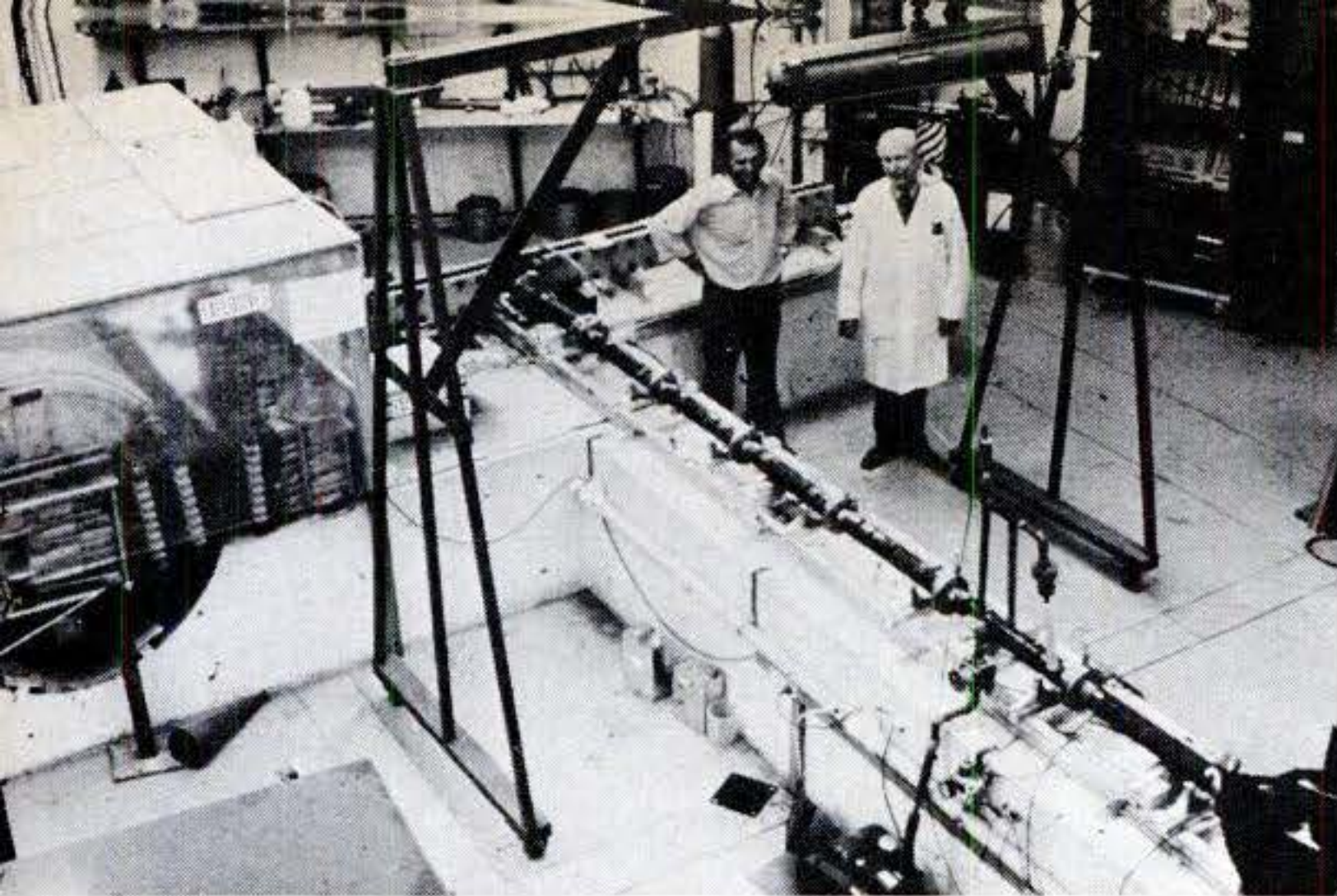
So Marshall took his rail-gun experience to the United States—first to Westinghouse, where he helped establish a rail-gun program, then to the University of Texas Center for Electromechanics, where he joined forces with its director, Bill Weldon. Weldon and Marshall went to work perfecting homopolar generators, beginning with monstrously huge machines and scaling down to a workable size. Their current version is a compact model—only 58 cm in diameter and a veritable feather at 550 kg. Yet it delivers 30 million joules of energy, enough to momentarily light up a medium-size city, in a fraction of a second.

While the power-supply work progressed, Marshall continued refining his gun. One improvement was to replace the sliding metal armature with a thin copper fuse that vaporizes when the current rushes through. This plasma carries the current as the metal contact does, but it eliminates friction with the rails. Another change involved what Marshall calls "distributed power supply." Instead of accelerating the projectile with one super-jolt, power units spaced out along the length of the barrel would increase its velocity stage by stage. "Make the barrel long enough, apply thousands of jabs of current," Marshall said, "and Earth-escape or impact-fusion velocities are possible."

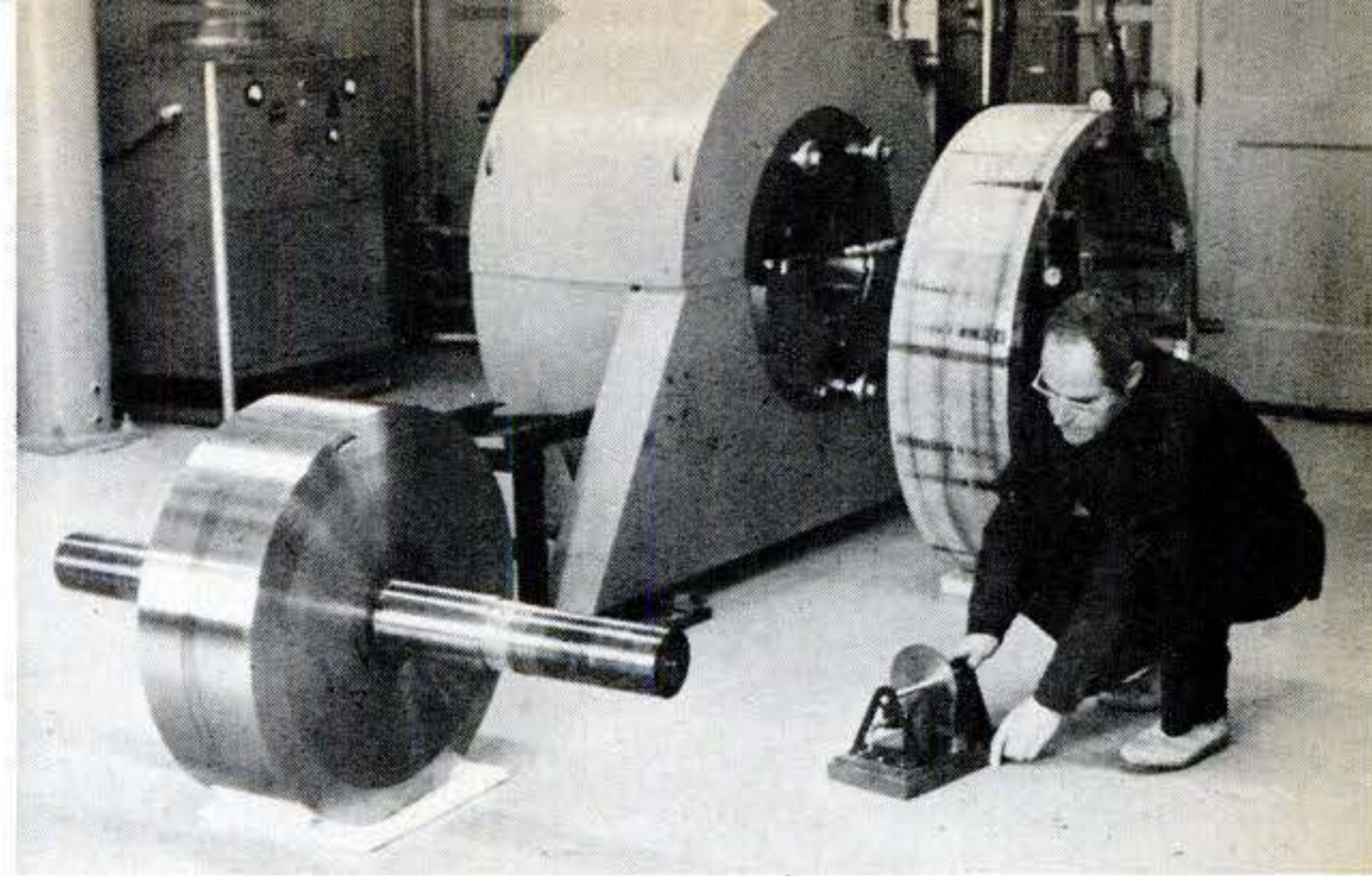
The gun that holds the current unofficial speed record—10 kilometers per second—is the one that Max Fowler and Ron Hawke are testing in the New Mexico desert. The Los Alamos-Livermore design duplicates many of the features of Marshall's gun, but instead of a homopolar generator, it is powered by a device called a magnetic-flux compression generator, which uses an explosive to rapidly compress and amplify a magnetic field introduced by a capacitor bank (see drawing). Fowler has built flux compressors for a variety of experimental devices for many years. For this application, he designed a very long generator that uses a relatively slow explosive to stretch out the time pulse and therefore ease the stresses on the projectile.

Even so, the pulse from Fowler's device is considerably shorter than one from a homopolar generator, so long-barrel launch applications are probably not possible. On the other hand, the currents are much higher, which accounts for the record velocities. There are problems, though—most notably that the gun rails and structure are destroyed with every shot.

"We think we can build the guns to include reusable



Australian rail gun (above), which fired projectiles up to four times rifle velocity, launched present excitement over electric guns. Homopolar generator (at left in photo) uses flywheel to



convert mechanical to electrical energy. Univ. of Texas' homopolar (disassembled at right) yields equal energy in a smaller package. Co-author Lampe views model of 1821 homopolar.

elements, but even then it will be a low-repetition-rate device," Fowler says. That's the reason that some others in the field are skeptical that the flux compressor will be a long-term answer to the power-supply problem. "Still," says Harry Fair, "the work is valuable in that it gives us high-velocity data early in the program."

Meanwhile, Fowler and Dennis Peterson of Los Alamos are working on new gun and generator designs that will achieve even higher velocities. One is an integral gun that would use the same rails for gun and flux compressor. Another is an "inside-out" generator that would have two compression spaces and the explosive in the middle, theoretically doubling the current. They are also developing circular-bore guns and metal-warhead projectiles.

"I would be disappointed if we didn't attain 20 kilometers per second within a year," Fowler says. That's still far short of fusion velocities (calculated at 100 to 200 kilometers per second) but more than fast enough to make advances in what physicists call equation-of-state experiments, in which materials are tested under very high pressure.

Pied piper's mass driver

The devices discussed so far represent only one way of propelling projectiles electrically. Another class of machines consists of synchronous co-axial accelerators—series of electrical coils within coils that generate a traveling magnetic wave that a projectile could ride like a surfer. Linear particle accelerators and magnetically levitated trains use this technology. In fact, one of the maglev pioneers, Henry Kolm of MIT, is the driving force behind this variety of electromagnetic launching. Kolm designed and built the Magneplane flying train in the early 1970's [PS, Dec. '73], and he is now collaborating with the space-colonization visionary Gerard O'Neill to develop what O'Neill calls the mass driver. A mass driver is a pulsed linear motor that accelerates a payload-carrying bucket to high velocities, releases the payload, then decelerates the bucket and reuses the energy. Its drive coils would be energized by tuned capacitors that would be continuously recharged by a primary power supply, probably a large inductor. But since the accelerating mechanism is much more efficient than a rail gun, gigantic power supplies are not needed.

"In a rail gun practically all of the energy is wasted in resistive heating of the rail," Kolm says. "With the mass driver, since the energy passes back and forth from coils to storage, you don't need a barrel filled with magnetic energy." He claims up to 90 percent efficiency for the mass driver, two of which have already been built.

O'Neill and Kolm are full of ideas for mass-driver applications. They have performed calculations and designs for moon-based launchers that would propel lunar minerals to

points in space where colonies and manufacturing plants would be located. Revised to work as a reaction engine by firing aluminum washers out the back, a mass driver could latch onto a metal-rich asteroid and tug it into Earth orbit. Most promising—and not at all pie in the sky, says Kolm: an Earth launcher to loft fuel and supplies into orbit.

"This is economically viable right now," Kolm says. "Our present idea is an electromagnetic launcher that would replace only the first stage of a standard rocket. It would accelerate the vehicle to two kilometers per second, putting it out of the atmosphere in about a second, after which the remaining rocket stages would take over. This would reduce the energy requirement to an amount that can be gotten almost on-line from a big power plant."

Kolm even has a site picked out. The launcher would be built on the west slope of one of the big mountains of the Sierra Nevadas, which are just a short distance away from a huge DC power line that runs the length of California. It would cost only about \$200 million, he says, and consume only 65 cents' worth of electricity per pound of payload.

Kolm is a man of many ideas—"a pied piper," Fair calls him, his enthusiasm is so infectious. In addition to space and military launchers, he is also working on a device that could send gliders carrying cargo or people into inaccessible terrain. "I've already built a glider that would be radio-controlled to deliver supplies to the front lines of a battlefield. It might also be used to fight forest fires, move material to off-road sites, or unload ships onto beaches."

Harry Fair agrees that none of this is impossible. Which applications get pursued is really a matter of funding and political interest. The Department of Defense is more than slightly interested, but it is too early for Fair to single out the military application to which electromagnetic launching is best suited. "Air-defense guns, anti-tank weapons, artillery pieces, aircraft launchers . . . it could be any of these. The one thing that is out of the question is an electric rifle, because the power supply could not be portable."

Now that the technology is nearing the application stage, private companies are getting involved. Fair ticks off the names: "General Dynamics, Litton, Vaught, Jaycor, and of course, Westinghouse."

Westinghouse is now finishing work on a large rail gun that will be powered by a homopolar generator and fire heavy projectiles ($\frac{1}{3}$ kilogram) to velocities of three kilometers per second. The device will be turned over to Fair's laboratory by the end of this year, where it will serve as a national user facility available to researchers from other companies, universities, and the armed forces. "It represents a major milestone," Fair says, "because unlike the university devices built, this may be the first gun that is not put together with baling wire and sealing wax." ■

Success at last for
this 40-year-old

stratified-charge engine?

Swirling turbulence, timed fuel injection, and special ignition enable it to run on any liquid fuel

By E. F. LINDSLEY

Early one morning last fall two dark brown, snub-nosed United Parcel Service vans, engines throbbing quietly, stood mysteriously poised at the end of a remote, unused airport runway in upstate New York. Testing was about to begin to prove that a long-ignored engine concept was valid after all.

The identical vans, typical of the 30,000 vehicles UPS calls "package cars," were both powered by proven but conventional 292-cu.-in. General Motors gasoline truck engines. One, however, was modified to use the Texaco Controlled-Combustion System (TCCS). [See PS, Sept. '79.]

First proposed nearly 40 years ago, the TCCS was an early stratified-charge engine—it uses directed, richer air-fuel mixtures to promote more complete combustion of weaker mixtures. Although it has offered considerable promise and certain distinct advantages, the engine has remained in limbo. Why? And why, after so many years, has a giant fleet operator like UPS suddenly taken up testing and development? Further, why weren't diesels or one of the newer stratified-charge engine types—such as Honda's successful CVCC or Ford's stillborn PROCOCO—of interest? To get the answers, I talked to the engineers and scientists inside the project, and even took a ride in the TCCS van.

As enlightening as the visit and ride were, the results of the airport testing had the most impact. There were no

tire-smoking starts or screaming curves—8,000-lb. vans carrying 4,000-lb. payloads don't exactly produce heart-pounding road tests. Instead, there was only day after day of a repetitious 56-step cycle of starts, stops, idling, and acceleration, with the drivers periodically changing seats. In the end, however, the Texaco engine had logged 35 percent better fuel economy than the standard GM engine.

Later, the same vans ran identical courses of city delivery and highway driving. Again, the mileage gains for the TCCS engine were startling. They ranged from a spectacular 142 percent at idle to 38.1 in delivery operation.

But that wasn't all. While the TCCS van ran most of the tests on gasoline, it also ran other tests—equally successfully—on diesel, JP-4 (jet fuel), and other unconventional fuels.

The story behind those snub-nosed trucks and their mission is really the story of two men, two companies, and combined engineering faith.

Bill Tierney, Texaco's dedicated and single-minded product manager for automotive developments, has preached for years that refining high-octane gasoline and high-cetane diesel fuel is just plain inefficient in terms of getting the greatest possible number of miles from each barrel of crude oil. While premium fuels do offer more miles per gallon of *refined* fuel, Tierney emphasizes that producing them wastes much precious refinery energy.

Even in the early 1940's he and Texaco felt that wasting fuel to pamper finicky gasoline and diesel engines was folly of the worst sort. So they began development of an engine with swirling turbulence, timed fuel injection, and their own special ignition system. That combination makes the

TCCS engine indifferent to octane or cetane ratings. In fact, it can burn fluids you'd never think of as fuels.

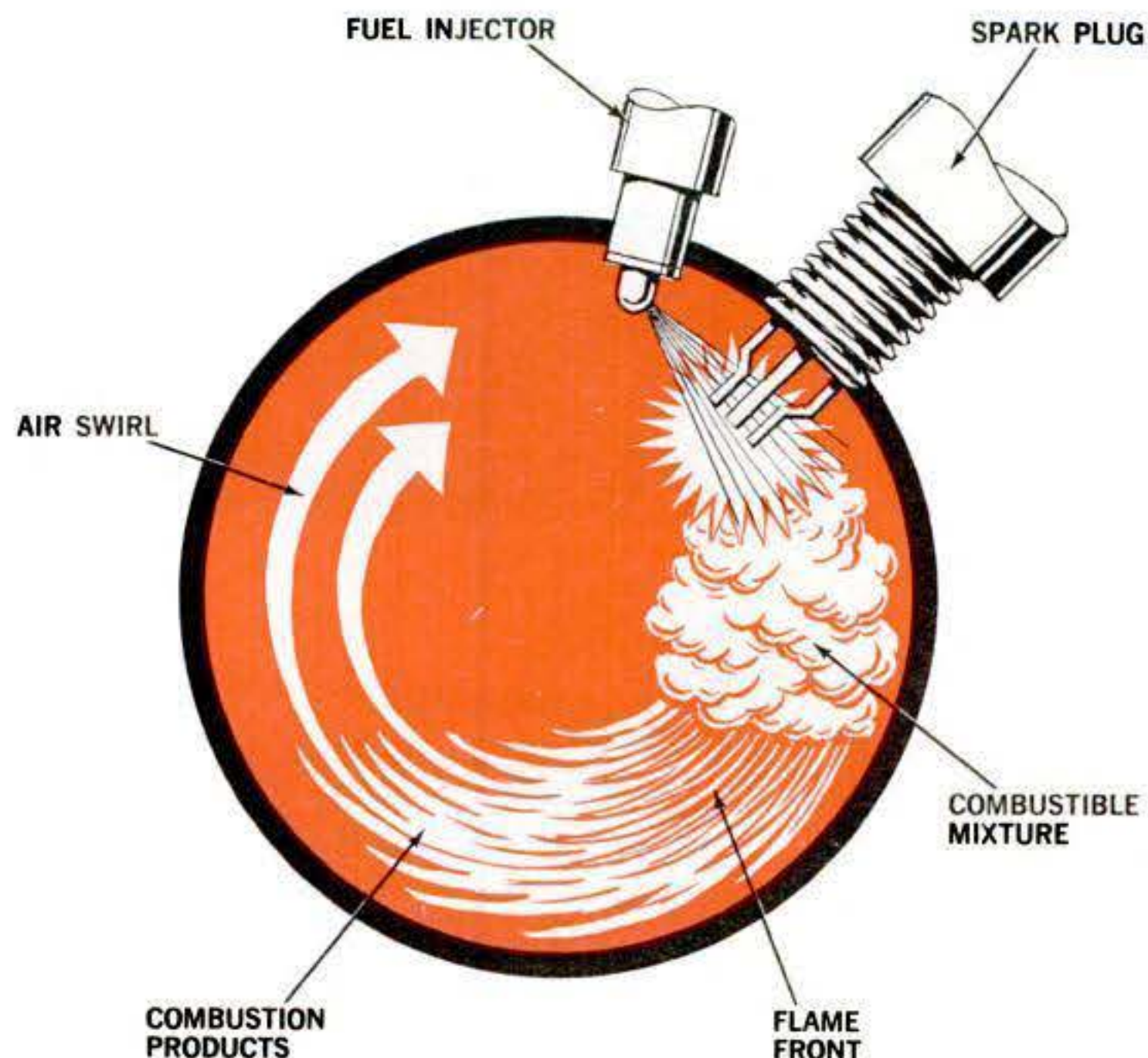
Yet, with the exception of some successful tests in Army jeeps (dropped when the Army decided to stick with diesel as its other primary fuel, since tanks require diesel fuel), the Texaco engine has never really had a good chance.

Tierney can quickly tick off the stumbling blocks that have arisen each time the TCCS seemed about to move into production. In recent years, these have been the various results of hasty scrambles by Detroit to cut emissions, improve fuel economy, or squeeze a few more years out of existing engines and tooling. Each situation demanded so much money and engineering time, pressed by such urgency, that manpower and lab facilities weren't available to seriously investigate yet another combustion system.

Detroit hasn't had its eyes closed, however. Chrysler began investigating the TCCS engine years ago, while engines with similar characteristics have been explored by both GM and Ford. Ford's PROCOCO system, unfortunately, was designed for the rapidly disappearing V8; its effects on the small fours and sixes are minimal, unlike Honda's successful—but different—stratified-charge technique.

Through a giant's eyes

When you're a giant like UPS and have struggled through two fuel shortages, you look ahead not only at the rising cost of gasoline but also at the very real prospect that future synthetic or shale-derived fuels will vary greatly in quality. So you'll need an engine that will run on whatever comes along, is inexpensive to main-



Closely spaced injector and spark plug create a flame front in the piston's dished area (above). Swirling air and continued fuel injection after spark termination feed the stationary flame front

(diagram above), burning the fuel at a controlled rate, and eliminating octane/cetane requirements. Top photo shows Bill Tierney (standing) and Jim Lewis with one of the UPS test vans.

tain, and can meet some special demands that diesels cannot.

"Detroit wasn't doing anything, so we had to," says Jim Lewis, UPS's automotive engineer. Fortunately, both he and Tierney felt that UPS's thousands of GM 292's could be converted to TCCS.

Although he is an optimistic man, Lewis had plenty of reason to worry. The company had made many conversions in the past, to diesels, and every time, the initial and maintenance costs had shot sky-high—although the engines themselves were reliable.

But the TCCS looked good on paper. Where a new diesel engine would cost \$4,000, plus a new transmission and many drive-train modifications, a new GM 292 short block (no cylinder head or accessories) would cost only \$450. Totally modified to TCCS, it would cost only \$2125. Better still, it wouldn't weigh significantly more and could be dropped right into the old bolt holes with only minor changes.

UPS contracted with the time-honored English firm of Ricardo Consulting Engineers to do the engineering. Finally, when two complete engines were assembled, one went onto Texaco's dynamometer, the other into a

truck. (As testimony to the engineering, the hood closed perfectly.)

Not everything *worked* perfectly ever after, however. One time when I called, Lewis said, "We just swallowed a valve." A cam lobe had worn, allowing the push rod and rocker assembly to bounce; so the valve retainers had worn, and suddenly the valve was pounding the top of the piston.

Then two things happened: The air shipment of new parts from England got lost, and GM came up with a new and tougher nodular-iron camshaft and roller valve lifters (the latter for its passenger-car diesels). Lewis says these seem to work just fine.

While the power characteristics for the original engines and the TCCS are almost identical, fuel consumption swings impressively in favor of the Texaco engine. In the field, Lewis says, performance is about equal. "We've had drag races, and the outcome depends on the guy driving."

The big advantage

Although the Texaco-engine marriage to the UPS truck appears a happy one, the engine's real future is in the widely varying fuels yet to come—fuels that contemporary stratified-

charge engines can't use. Tierney says that diverse, easier-to-refine fuels are perfectly suitable, especially JP-4. That opens the possibility of running on the interface fuels—"slops," he calls them—that result from mixing petroleum products end-to-end in pipelines. About all that can be done with such slops today is to sell them to a small refiner for reseparation.

Right now, whether the Cinderella switch from the mundane GM 292 to the exciting TCCS reverts from coach to pumpkin at the stroke of midnight seems to hinge mainly on government "tampering" regulations.

Tampering means that you've altered an approved engine, which automatically makes that engine illegal. So even though the TCCS engine has demonstrated remarkable fuel savings, and its emissions levels pass the requirements of all states that test for them, it is still technically in violation.

So far, under a hard-won two-year special exemption, four TCCS engines are being tested; 10 more are under construction; and 500 more are planned if all goes well. But whether the Texaco engine finally gets the green light after 40 years in limbo is still very much in question. E

What's New

A PICTURE ROUNDUP OF NEW PRODUCTS AND DEVELOPMENTS



Rugged bus

Modern styling, heavy-duty construction, standard parts—these features sold passengers and mechanics on Skillcraft Industries' (Venice, Fla.) new bus during tests in Florida's Sarasota County. So the county purchased a fleet of the low-floor, ramp-equipped buses.

Stretched VW

There's more room inside its new stretched Scirocco for '82, and much lower wind drag, says VW. The 2+2 hatch-coupe body is 6.5 in. longer, with luggage space up by 2.6 cu. ft. Better aerodynamics boosts speed and fuel economy, despite the extra size, says the maker.



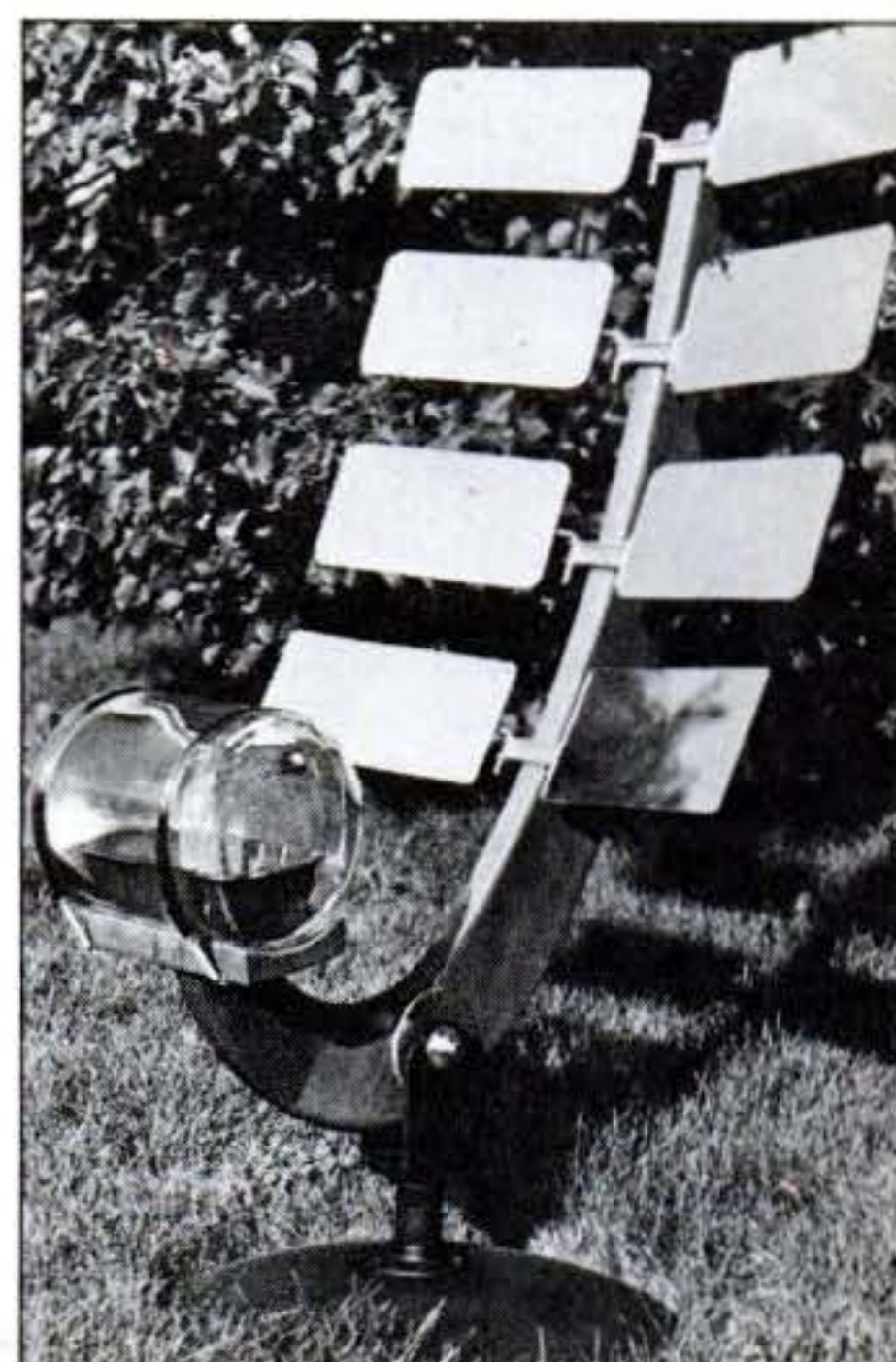
Hang-glider jet

Level ground and hang gliding go together—if you've got a 130-lb.-thrust, liquid-propane jet engine for takeoff. The engine (kit or assembled) has power for quick takeoffs and climbs, says EMG Engineering Co., 18518 S. Broadway, Gardena, Calif. 90248.



Solar oven

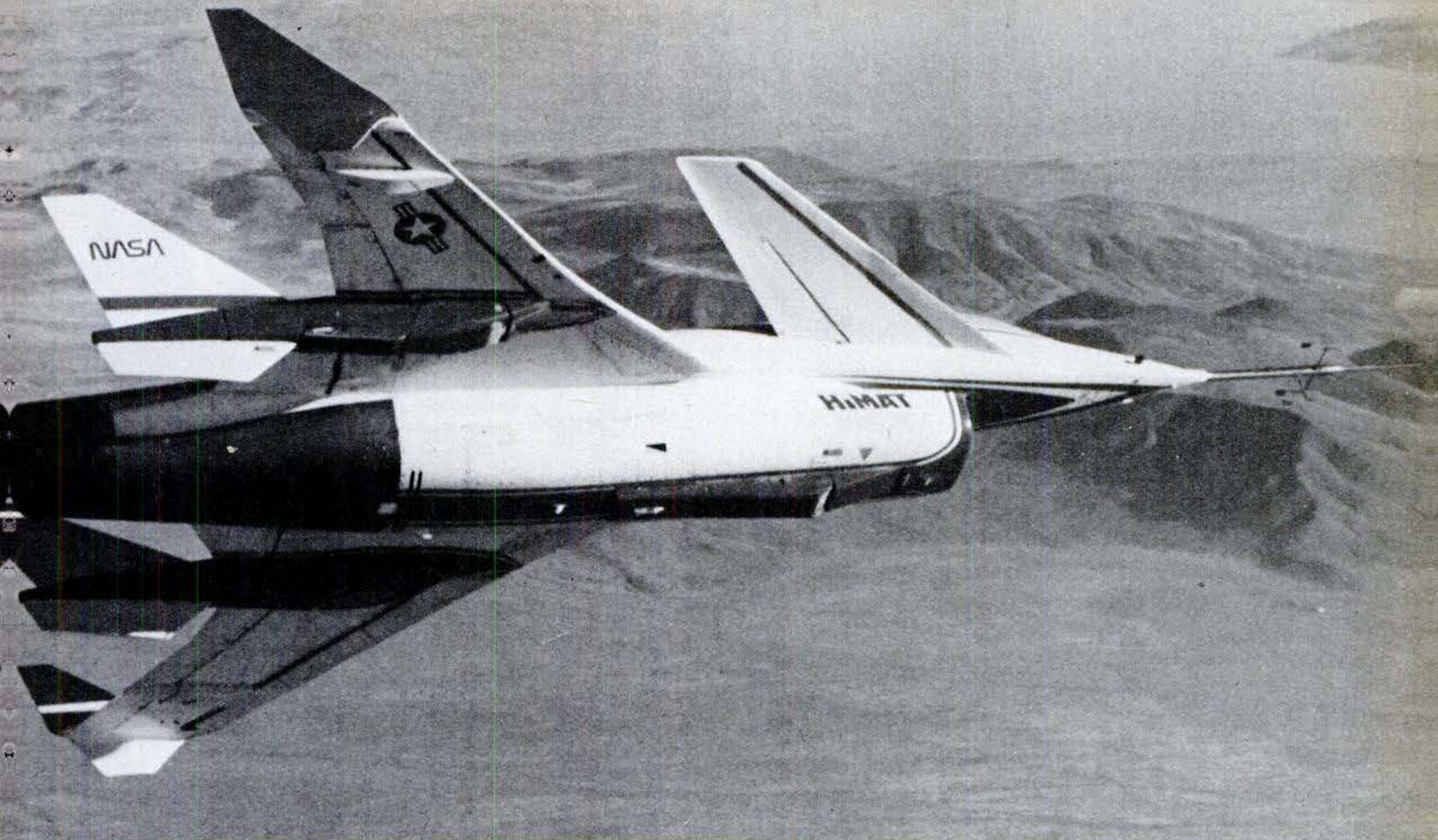
Family-size food portions cook in about one hour inside the Helioven's transparent enclosure, says Clevlab (Box 2647, Littleton, Colo. 80161). Eight mirrors concentrate the sun for oven temperatures above 375 degrees. Price: \$195.



Star scope

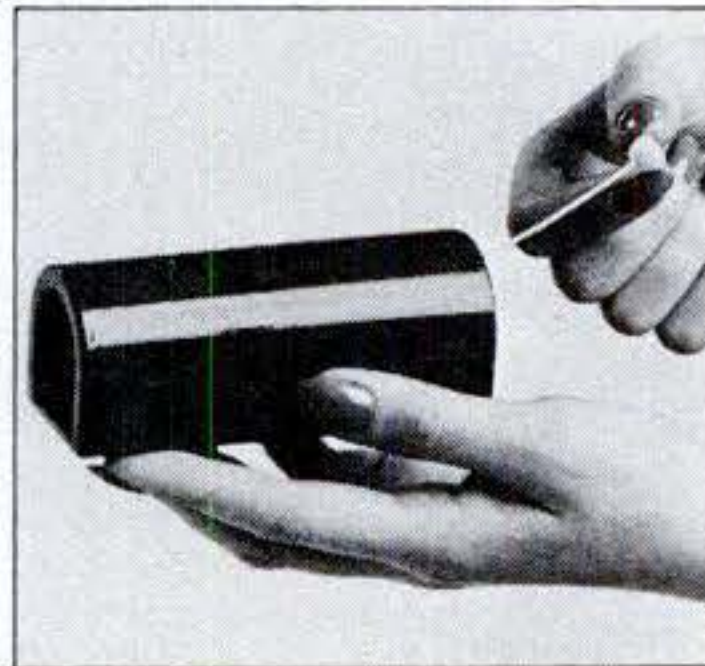
Telementor 2 has a 2.5-in. lens and equatorial mount for easy tracking of stars or planets. The German-built telescope comes with 21X and 34X eyepieces, tripod, and container. Price: \$650. Jena Scientific Instruments, Inc., 1211 Ave. of the Americas, New York, N.Y. 10036.





NASA RPV

How do you test an advanced design for future jet fighters? With NASA's remotely piloted HiMAT (highly maneuverable aircraft technology) vehicle. The 3,500-lb. RPV test platform is released at about 40,000 ft. from a B-52. A ground-station pilot guides it to a landing.



Easy-set mousetrap

Pull a knob and squeeze a bait capsule—that's all you do to set Clean-Kill mousetraps. A rodent nibbling the bait wick trips the spring. Pull the knob to empty. Two Kaiser Concepts (Milford, Mich.) traps with four bait capsules cost about \$3.50 in stores.

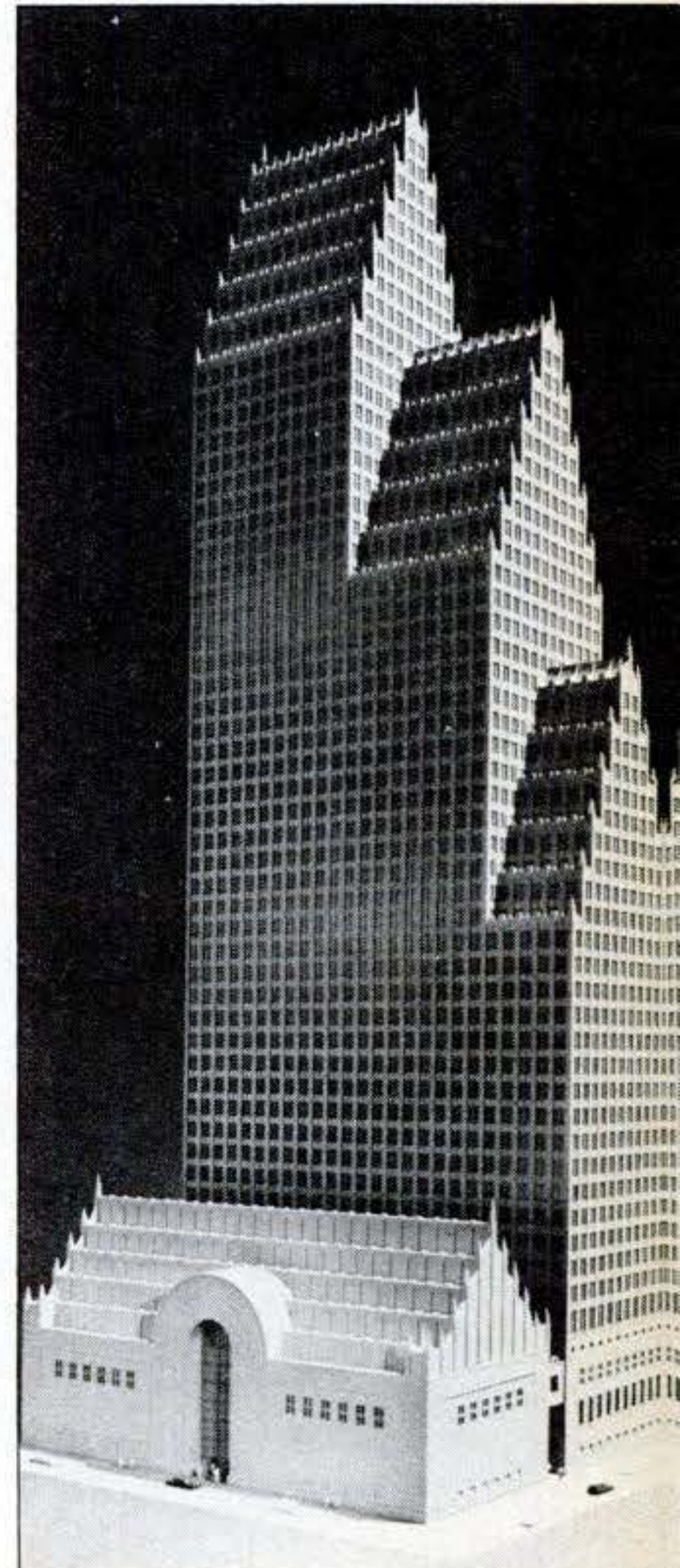


Kitchen controller

Plug an appliance into West Bend's Kitchen Controller and the built-in clock will turn it on and off. The \$80 device also has three timer/alarms, a metric and liquid/dry converter, and a calculator with floating or fixed decimal points. Two AA batteries power it.

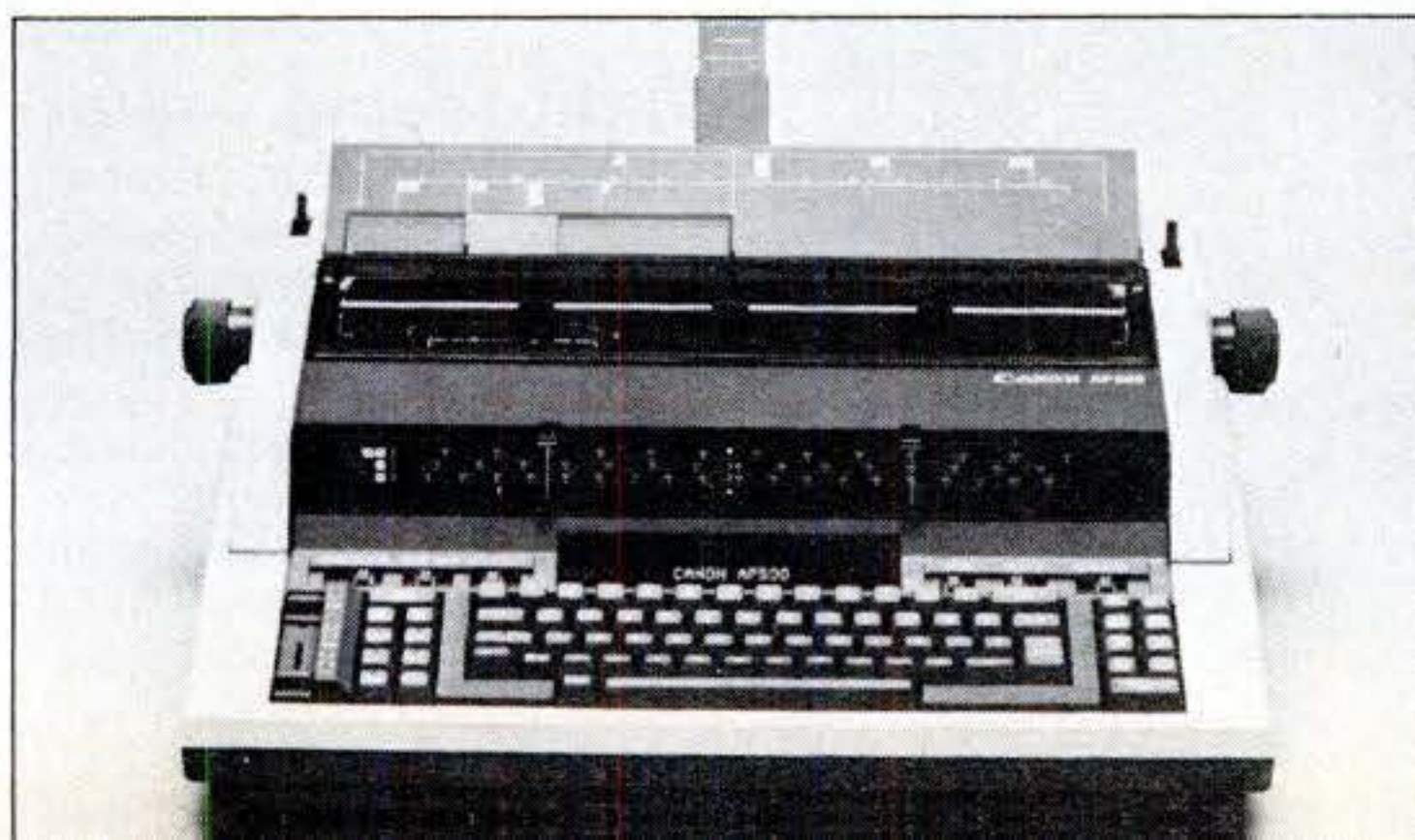
Gothic skyscraper

A touch of Gothic architecture—steep-pitched, jagged roof lines—will give a new 56-story Houston building a distinctive look. The Republic Bank Center's tallest section will have three types of internal structural support. A low section envelops an existing building.



Memory typewriter

Canon's new computerized typewriters have 96-character daisy print wheels. The \$2,000 AP500 has a 2,000-character memory (expandable to 32,000), with battery backup, plus a 20-character fluorescent display. The AP400 (about \$1,400) lacks the display and other features.





Passive prefab

It looks like a costly custom home. But this passive solar design is an Independence III kit house from Acorn (Box 250, Concord, Mass. 01742). Slab floors absorb heat collected by south-facing windows and a two-story solarium. Other windows are triple glazed. Cost: \$110,000 up.



Escape hood

Toxic fumes or thick smoke won't trap workers wearing a Scram hood. It gives at least 15 minutes of breathable air. The 3½-lb., Teflon-coated hood has a life-support pack that generates oxygen while "scrubbing" exhaled gases. Scott Aviation (Lancaster, N.Y. 14086) makes it for about \$215.

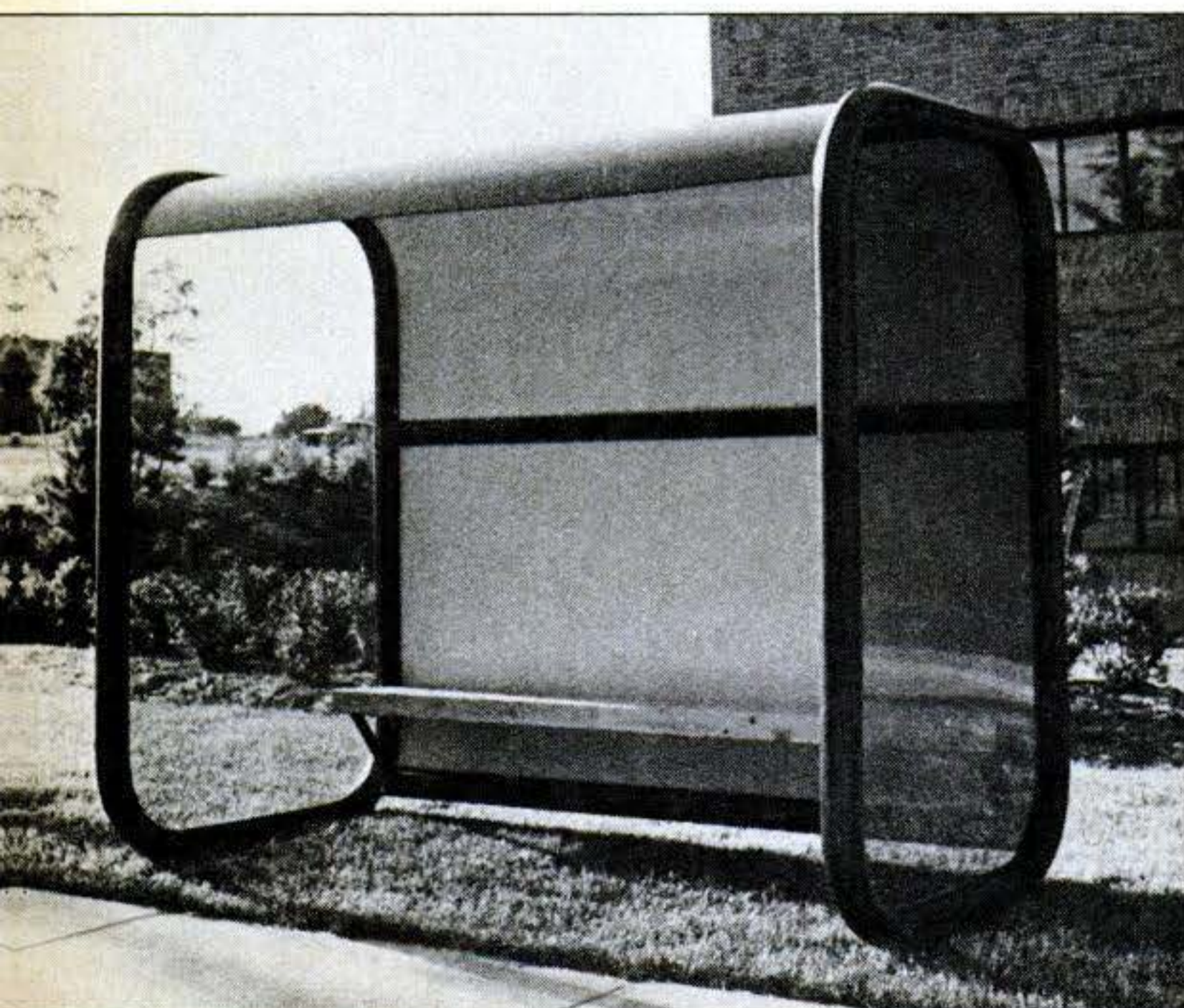
Versatile vehicle

High ground clearance mates with a low silhouette in AM General's new cross-country vehicle. Designed for a U.S. Army competition, the 1¼-ton prototype could serve as an anti-tank missile carrier, a fire-control vehicle, or even an ambulance, says the company.



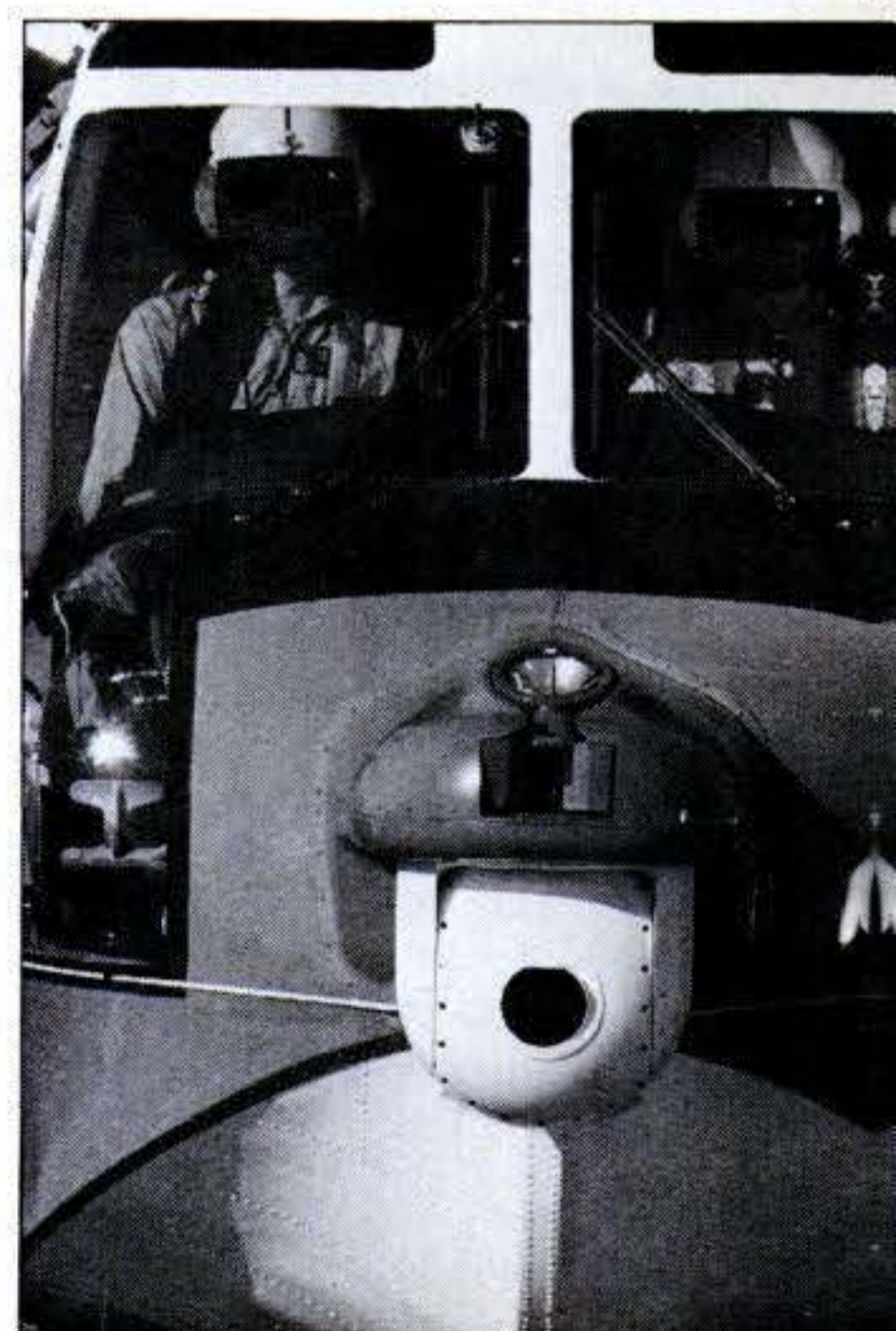
Sturdy bus stop

Sleek-looking shelter is not only handsome—it's vandal-resistant, says Scyma (3755 36 St. SE, Grand Rapids, Mich. 49508). Concealed connectors join the aluminum-alloy-tube frame, and an impact-resistant aluminum composite forms roof and back panels. Tamper-proof lighting is optional.



Night-seeing copter

An infrared "eye" at the nose of this Coast Guard helicopter lets rescue crews search the seas in any weather. The See Hawk infrared system functions despite darkness, high seas, or storms. Northrop Corp. developed it for the Coast Guard's new HH-65 Dolphin helicopters.



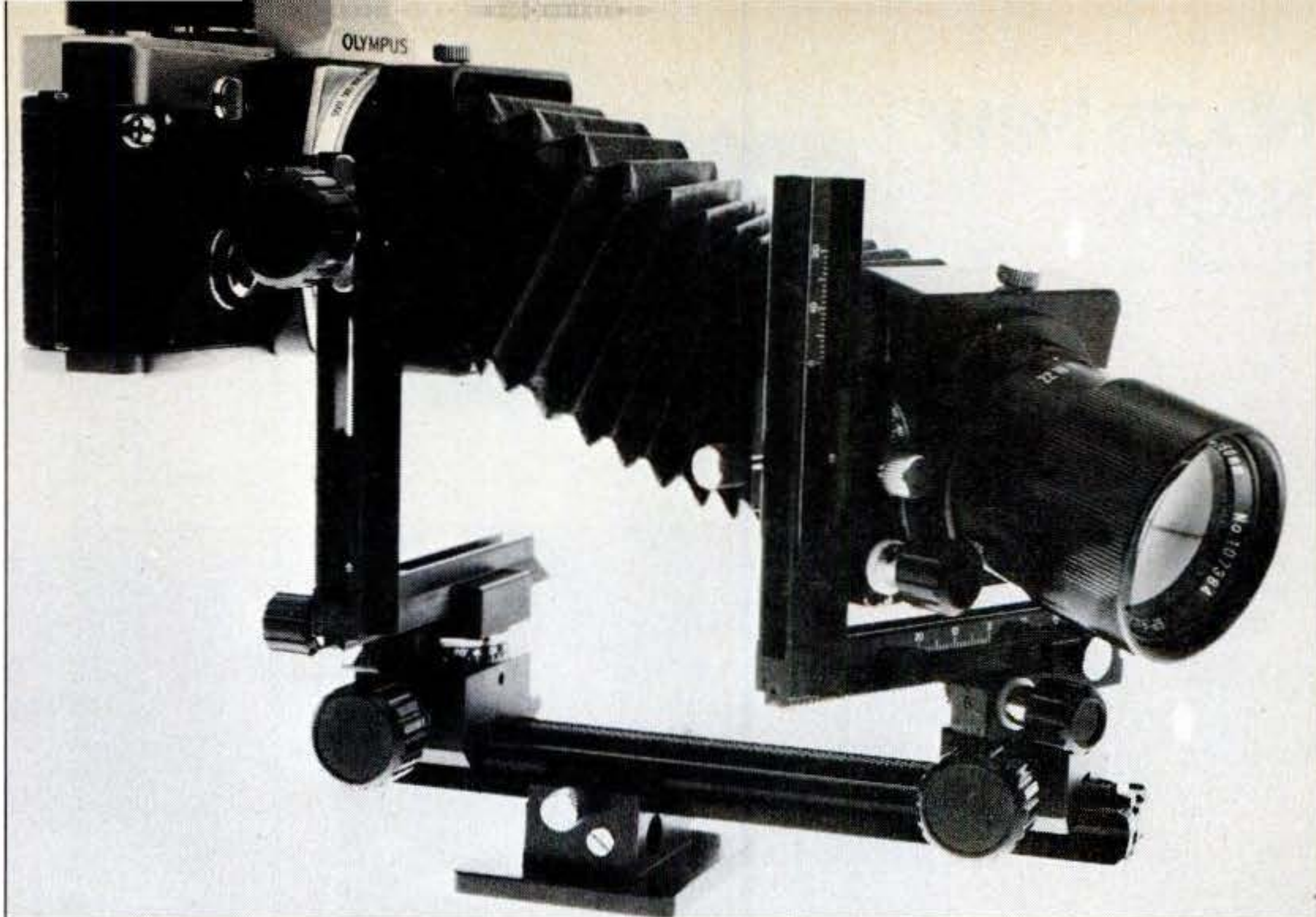
What's New IN PHOTOGRAPHY

BY E. H. ORTNER



All-auto 35

Name a function—Canon's new AF35ML Super Sure Shot does it automatically: focusing, film loading, film advance and rewind, flash, and exposure. It even beeps an alarm when you use up your film or need a tripod. It comes with a 40-mm f/1.9 lens. Price: about \$300.



Swinging 35

Turn your 35-mm SLR into a studio view camera? Just about, claims Spiratone, Inc. (135-06 Northern Blvd., Flushing, N.Y. 11354), with the Bellowmaster SST's swing, shift, and tilt movements. Front and rear standards move along a 6½-in. geared nylon track. \$189.95.



Bag watcher

Attach a Bag Alert to your camera bag, and any movement of the bag will cause the alarm to emit a loud screech. A switch provides either instant or 10-to-15-second delay, says Argraph Corp. (111 Asia Pl., Carlstadt, N.J. 07072). A special card arms the unit. It's \$29.95.



Flagship F-1

Now there's a new Canon F-1 to serve as flagship of the Canon system. A new electromechanical design enables it to shoot regardless of battery condition. A three-way metering system offers manual match-needle exposure, shutter-priority automation, or, with an accessory viewfinder, aperture-priority automation. Shutter speeds range from eight seconds to 1/2000. Available accessories include: 32 interchangeable focusing screens, five-frame-per-second motor drive, quartz-controlled interval timer. Price, without lens: about \$800.



Pointer

The Laser Pointer projects a visible bright red spot of light several hundred feet under normal lighting conditions—great for lecturers with slides. The \$800 helium-neon laser has an output of 0.5 mW—not enough to harm eyes or body, says RMF Products, Box 413, Batavia, Ill., 60510.

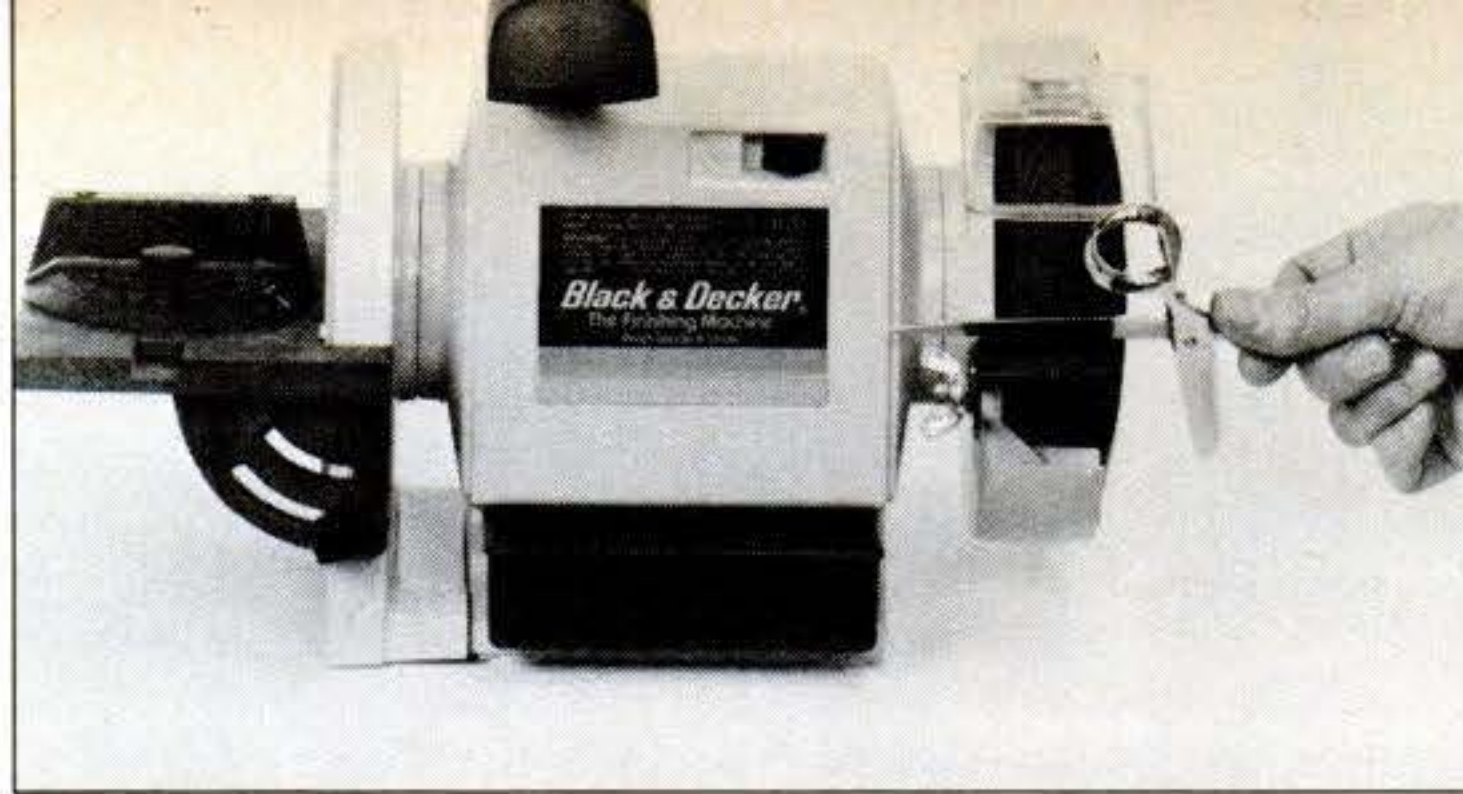


Totable tripod

It's only 15 in. high when extended fully, but what did you expect of a tripod that folds to 8½ in. and weighs 14½ oz.? Twist locks secure the legs. Price of Vivitar's Model 90: \$26.95.

What's New IN TOOLS

BY V. ELAINE SMAY



Dual tool

Grind, polish, sharpen—and sand with Black & Decker's Finishing Machine. The five-inch grinding wheel has an adjustable tool rest and a removable water tray. The six-inch sanding disc has an adjustable miter table and gauge for precision compound sanding. Price: \$79.99.



Log splitter

Give your ax the ax and turn trees to firewood the easy way. This hydraulic log splitter is chain-saw powered. It delivers 10 tons of splitting power but weighs only 125 pounds. Pow-R-Wedge is \$499.95 from Leeco Products, Box 331, Calimesa, Calif. 92320.



Cutups

Ultralight seven-inch Power Cutter snips cut through sheet metal, linoleum, vinyl tile, screening, carpeting, and wire, says the maker, Acme United Corp. (100 Hicks St., Bridgeport, Conn. 06609). Serrated stainless-steel blades never need sharpening. Snips sell in stores for \$4.95.

Small vise

Its self-centering head opens to nine inches or closes to hold tiny objects. Its base tilts, turns, and rotates. Six trays hold small parts. The Multi Purpose Work Center is \$44.95 from Panavise, 2850 E. 29th St., Long Beach, Calif. 90806.



Stand-up bagger

Rake 'em up, bag 'em, drag 'em to the dump—all without bending over. A patented locking system secures a standard plastic trash bag to the Leaf Bagger Tool's aluminum frame. Overholt Products Co. (220 Winding Way, Morrisville, Pa. 19067) sells the frame for \$12.95 ppd.

Angle drill

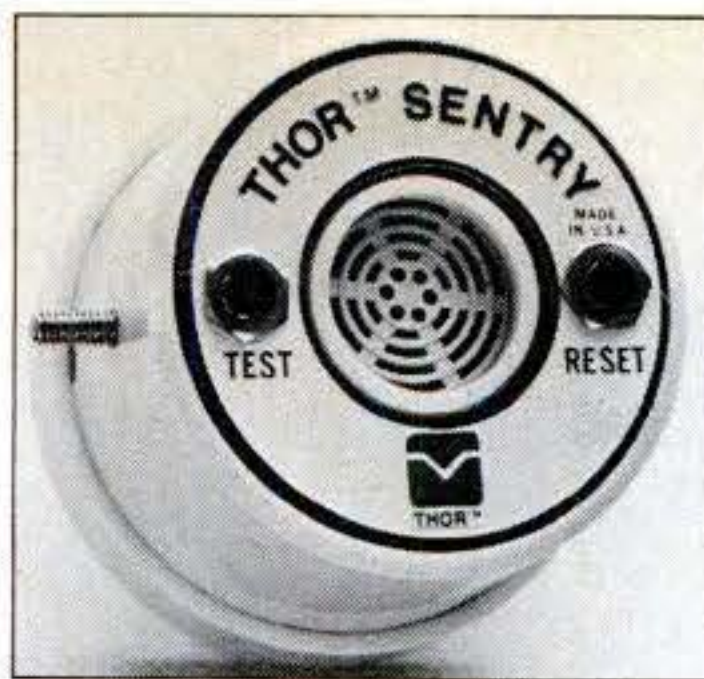
Flashlight-sized angle drill from Makita (650 Hadley Rd., S. Plainfield, N.J. 07080) fits in spaces far too tight for a conventional drill. A long paddle switch makes it easy to control the 1,400-rpm motor. The drill is \$147 in fine-tool stores.



What's New

IN HOME IMPROVEMENT

BY SUSAN RENNER-SMITH

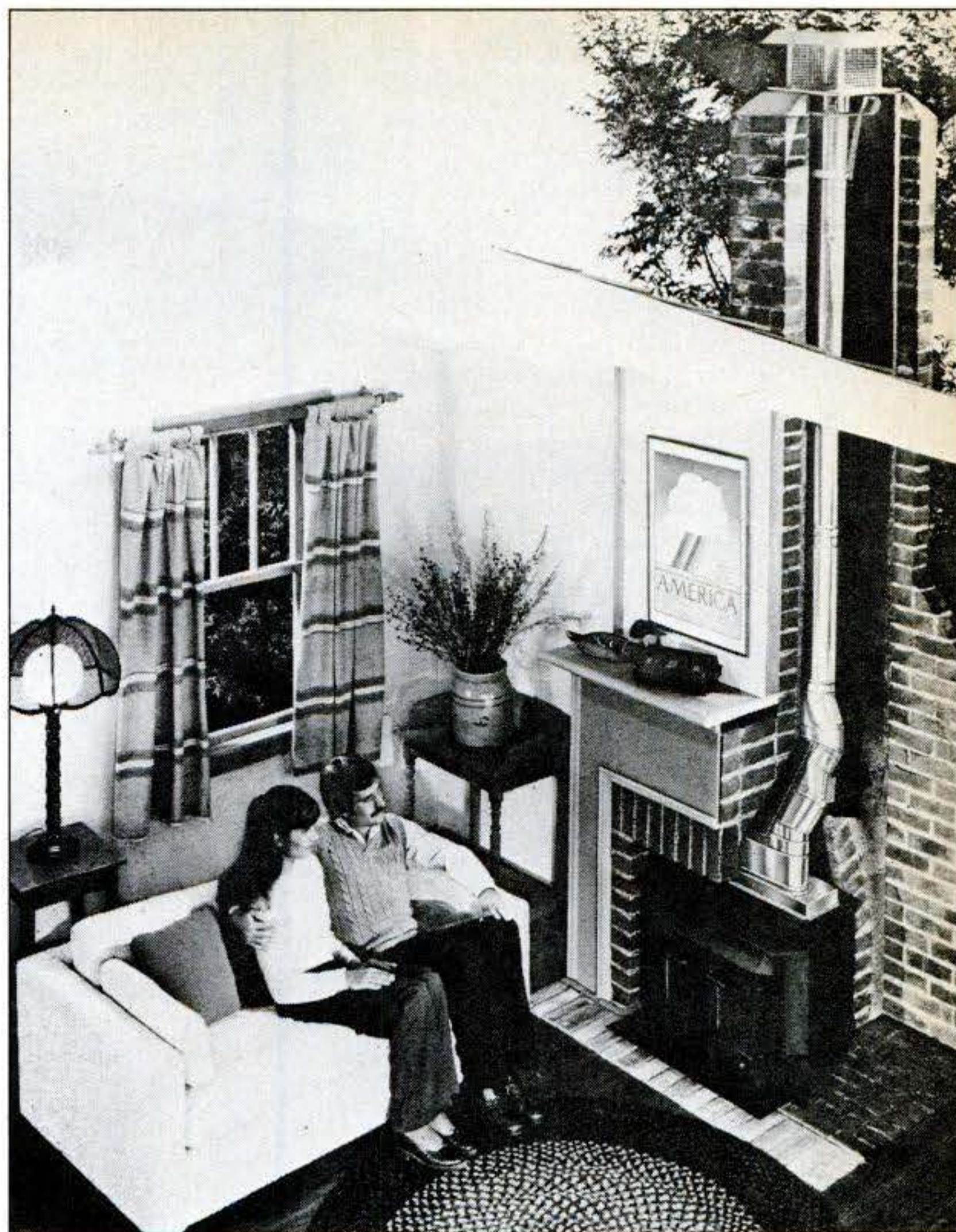


Stove watcher

If your wood stove runs dangerously hot, Thor Sentry shrills. The heat sensor sounds when air temperature near a stove hits 130 degrees F—not high enough to start a fire, but well above what a safe stove should generate. Thor Metal Works, Box 218, Eastwood Sta., Syracuse, N.Y. 13206. \$30.

Skinny insulator

Foil Ray fits in spots where you can't shove a batt. It's a 1/4-in.-thick air-trapping plastic honeycomb sandwiched between foil. For an R-value of 14, surround it with two inches of dead-air space. Price: About 28 cents a sq. ft. C-H Enterprises, Box 262, Westminster, Colo. 80030.



Custom air trap

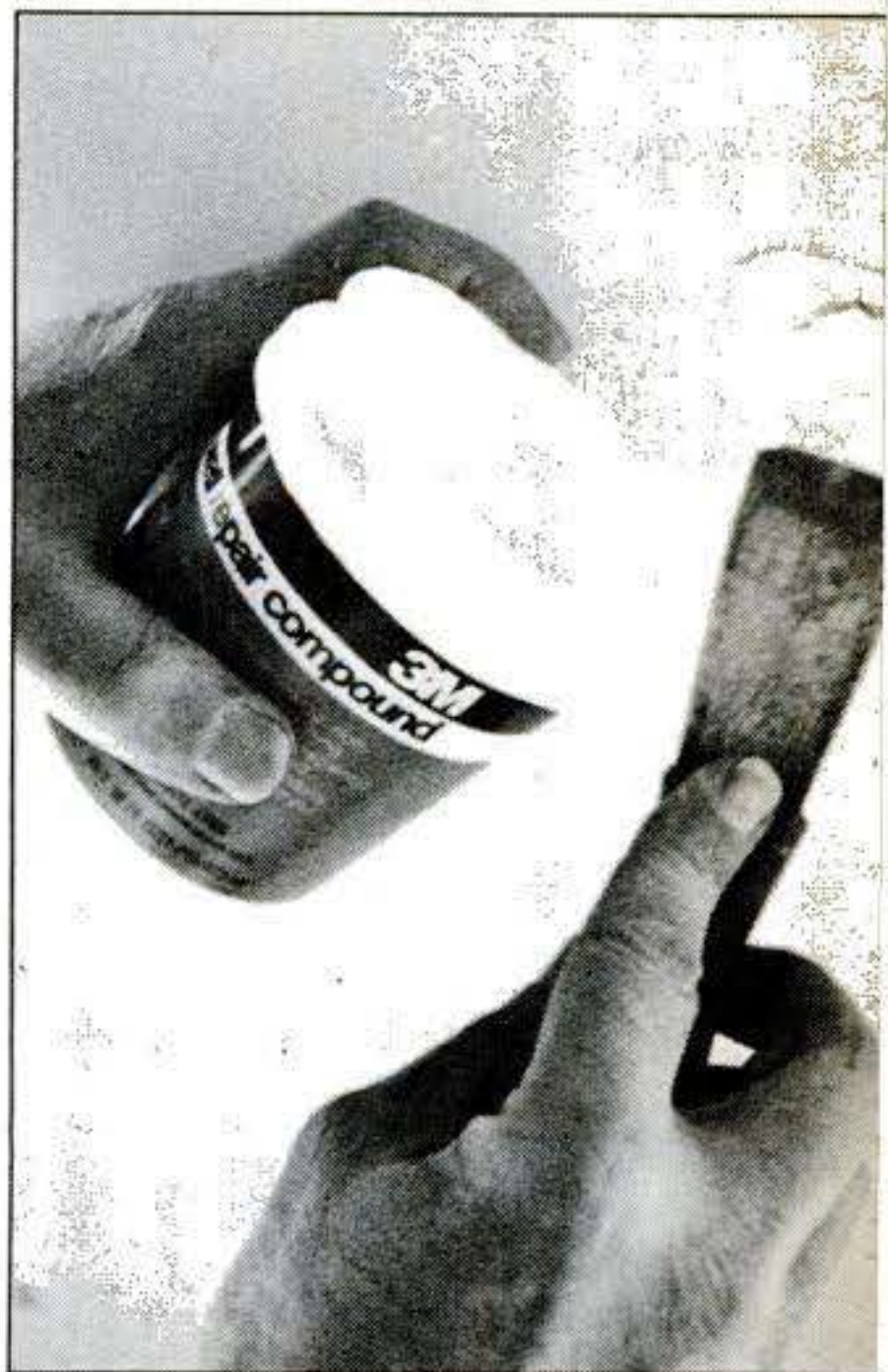
Handsome pleated shades you sew using your own fabric seal off a window's chill. The shades snap into glides mounted on window-framing PVC tracks. The Insul-trac system costs about \$2.79 per foot, including hardware. Plum Industries, Box 14, Delta, Ohio 43515.

Spark blocker

If your chimney liner is cracked, even one stray spark can cause a fire. Renew-a-flue makes old masonry chimneys safe, even when used with high-temperature fireplace inserts, says Dura-vent (Box 2249, Redwood City, Calif. 94064). The stainless-steel chimney-liner kits start at about \$295.

Speedy filler

Hole in the wall? Fill it with Wall Repair Compound and save time, says 3M. The new pre-mix neither shrinks nor sags, so one application is enough even for large holes, according to 3M. The compound also dries quickly so you can paint soon after use. A quart costs about \$4.75.



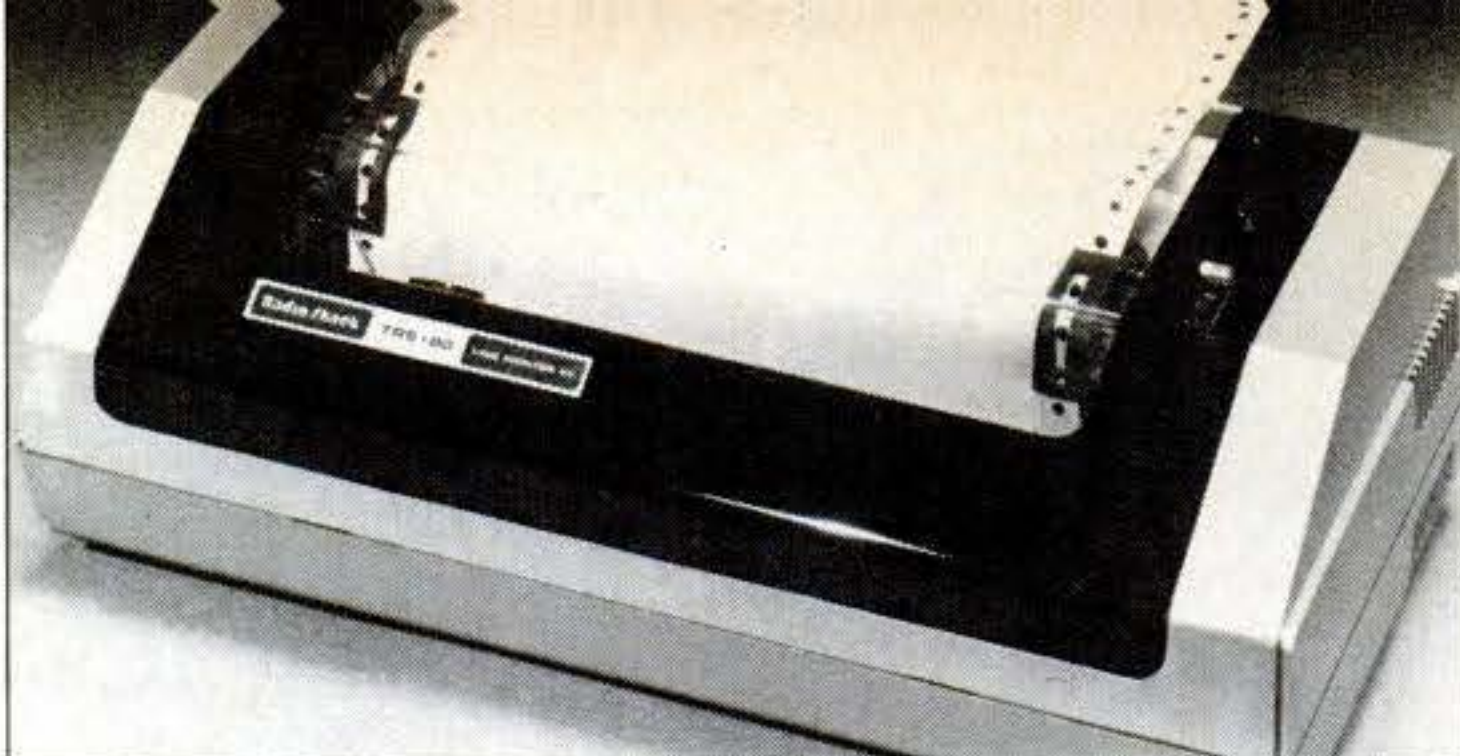
Stick-up nails

Want to panel your basement without drilling into concrete? A special adhesive clamps these plates with projecting nails to any wall, claims Miracle Adhesives (250 Pettit Ave., Bellmore, N.Y. 11710). They hold furring strips, shelves, even lawn tools. Price: about \$25 for 80 Stuk-ups, plus glue.



What's New IN ELECTRONICS

BY WILLIAM J. HAWKINS



Low-cost printer

Tractor paper feed, upper- and lower-case characters, high-density graphics, built-in serial and parallel (port) connections for attaching it to any personal computer—this LP VII from Radio Shack has everything you'd expect from a high-priced printer, except high price. It's \$399.



Hi-fi TV

That's not a TV set—that's a TV system. Just as audio components create high-quality sound, Sony's video components are designed to produce a "high fidelity" picture. The color monitor, tuner, control circuits, and audio are all separate. Prices have not yet been set.

Add-on printer

What every pocket computer needs: a pocket printer. The Sharp CE-122 printer connects to the company's PC-1211 computer for making a paper copy of programs or results. The unit also doubles as a cassette interface, allowing you to save info on magnetic tape. It's \$150.



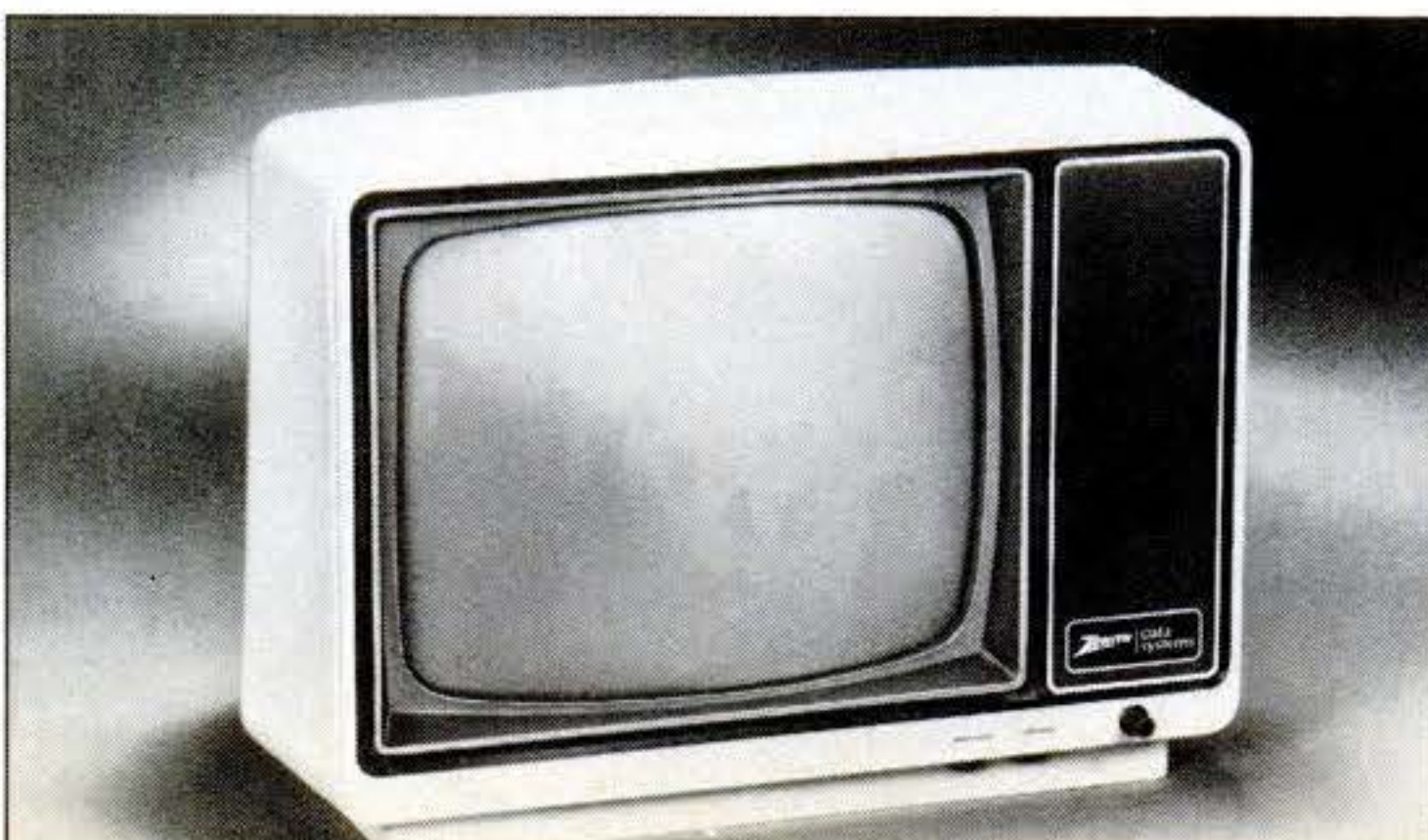
Weather plotter

Plot the barometric pressure and you can forecast the weather. To help you, there's this Heath (Benton Harbor, Mich. 49022) barograph kit. A seven-day chart recorder makes the results permanent; a digital display makes instant recall of highs and lows possible. It's \$295.95.



Toll stopper

The clever box is wired between your phone and phone outlet. Result: Without that small plastic key—which only you have—the phone cannot be used to make long-distance calls. The Toll Call Limiter is \$29.95 from Technidyne, 8556 Katy Freeway, Houston, Tex. 77024.



Hi-res TV

Zenith's high-resolution video monitor (17-mHz bandwidth) is specially designed for personal-computer use: It accepts a standard video input signal. The 12-inch, green-phosphor screen is easy on the eyes—the \$160 price tag is easy on the wallet.

What's New FOR YOUR CAR

BY ED JACOBS

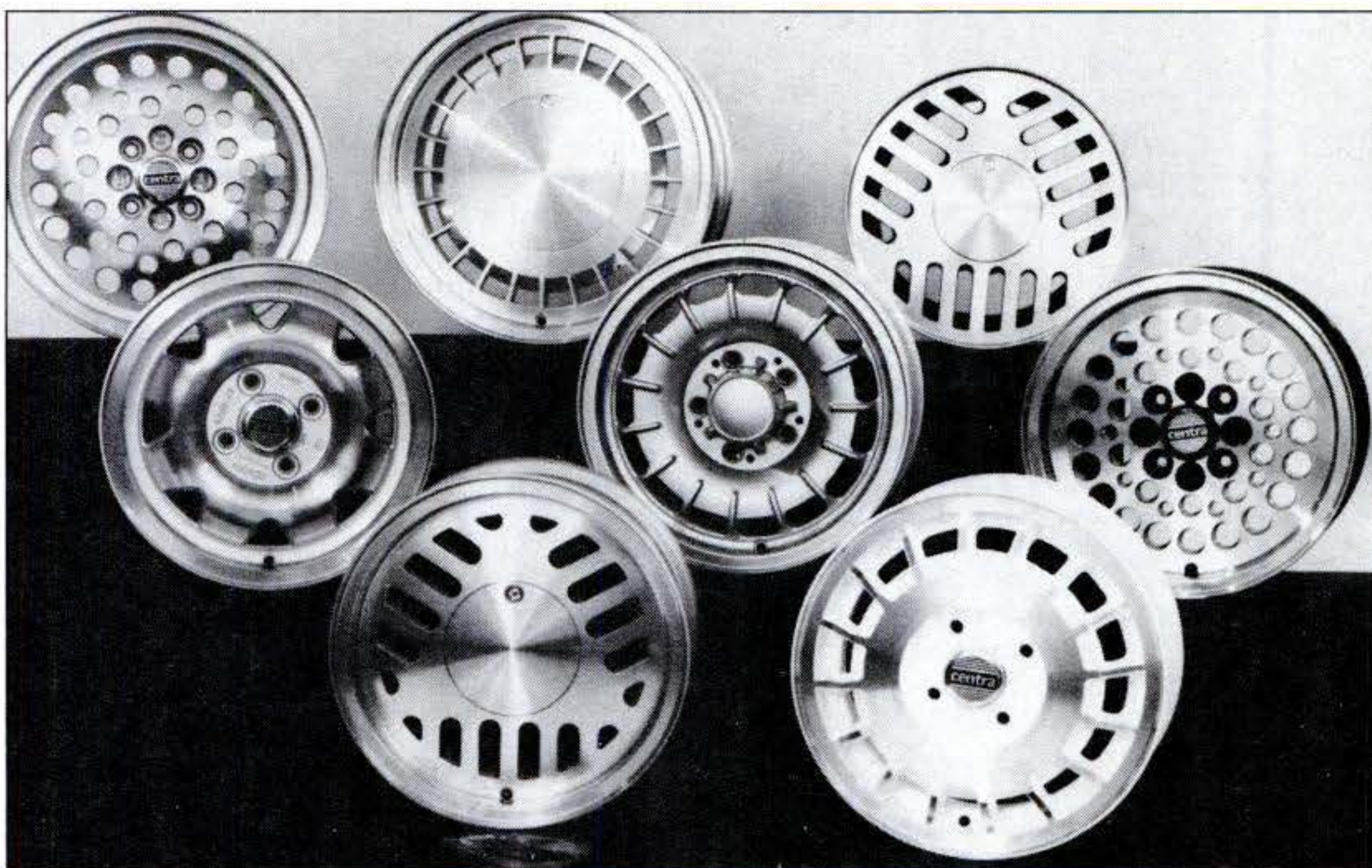
Double buffer

When one side of 3M's Superbuff is used up, an adapter kit lets you switch to the other. The six-inch, all-wool pad is washable, has a flexible edge to conform to contours, and fits either 1/4- or 3/8-in. drill chucks. It sells for \$6.75.



Coded gas cap

No keys are required to open this gas cap from Omniplast S.p.A. (Corso Francia 270/8, 10146 Turin, Italy). Its gripping surface remains free-spinning until the right code is selected from among hundreds of possible alphanumeric combinations.



Flashy wheels

Centra light-alloy wheels are available in eight styles, plus seven color-and-finish combinations. Many wheels are lockable, and there are sizes to fit most imports and some domestic cars, says CRP Industries, 1 Minue St., Carteret, N.J. 07008.

Powerful inflator

You can inflate tires, air mattresses, footballs, or almost any pneumatic device with Coleman's Deluxe Inflate-All 175. It's switch-controlled, has its own pressure gauge, delivers up to 175 psi, and comes with a carrying case and adapters. Price: \$41.26.



Ignition snooper

Only I.D. 80 can find the cause of intermittent ignition problems and predict potentially faulty system components, according to M-Ray International Corp. (1466 Pioneer Way, El Cajon, Calif. 92020). It costs \$776, including adapters for all domestic ignition systems.

Split-personality transmission

shifts like an automatic,
saves fuel like a manual

A British invention has car manufacturers around the world watching

By DAVID SCOTT

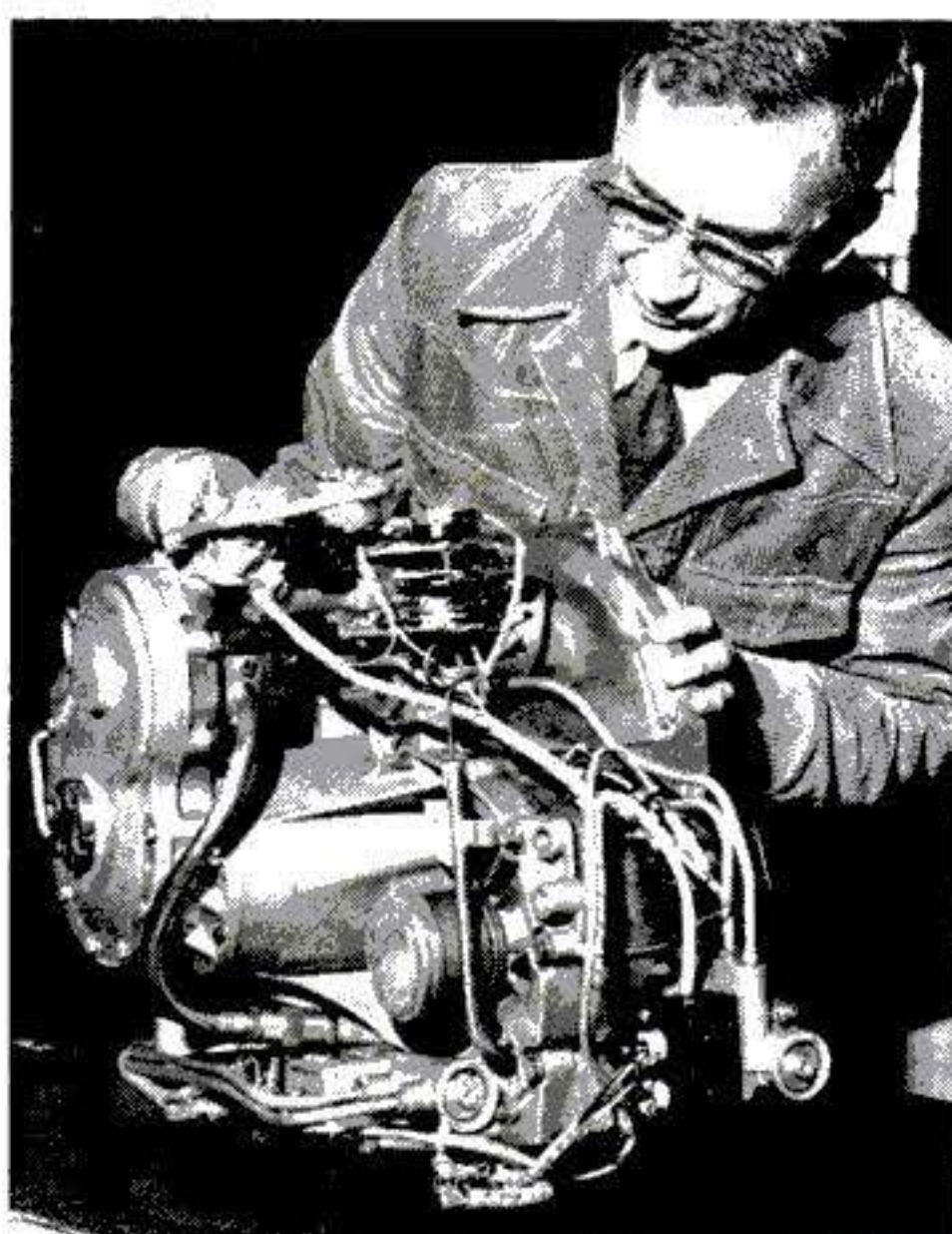
LEAMINGTON SPA, ENGLAND

I eased down the accelerator of the automatic-transmission Ford Fiesta and we glided off smoothly. Second gear came in with just a slight lurch, but the upshifts to third and fourth were silky. Everything seemed normal, except that there had never before been an automatic Fiesta—and here I was driving one with a tiny 1.1-liter, 55-hp European engine considered too puny for any conventional automatic.

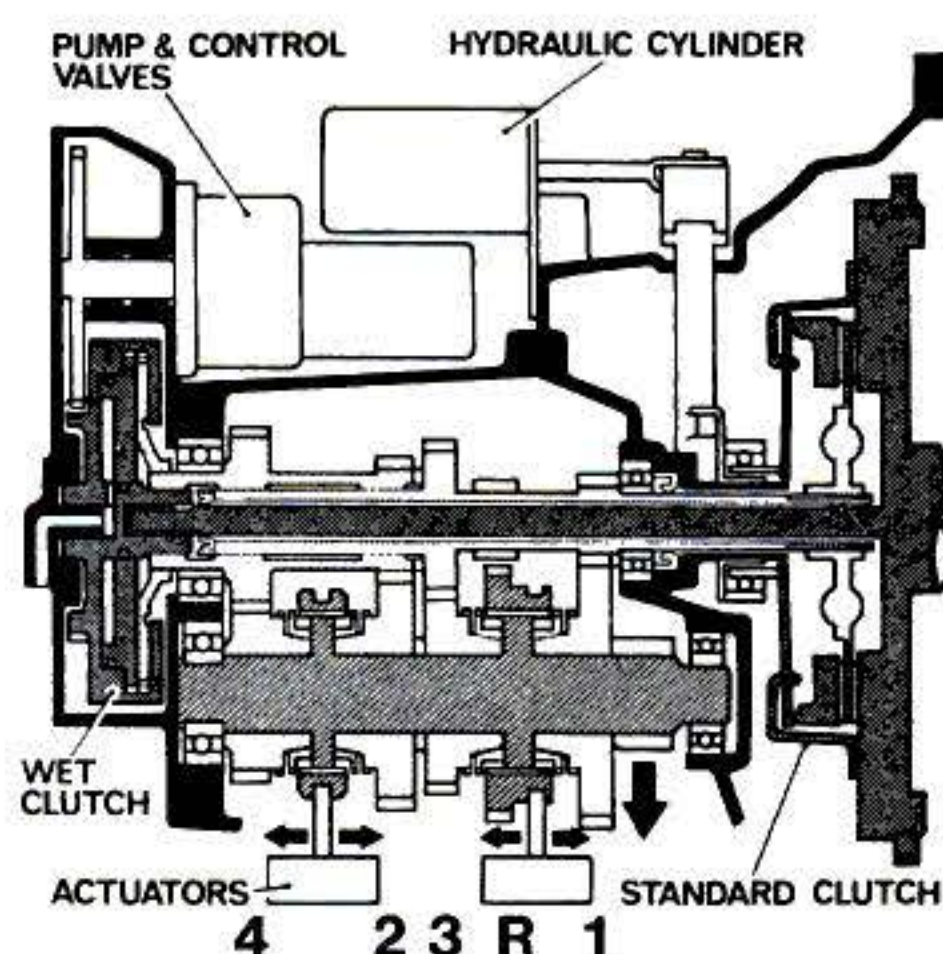
This new transmission has been developed by Britain's Automotive Products, Ltd., and is based on an ordinary synchromesh manual gearbox. It has the same high mechanical efficiency and fuel economy since there's no torque converter, and both hydraulic slip and creeping at red lights have been eliminated. Further, it's small enough to fit alongside the transverse engines in the smallest front-drive cars. That has some car makers around the world interested.

"It could be built on existing gearbox lines with only minor tooling changes," said Harry Webster, AP's engineering director. "Automatic and manual versions could come off the same line, with a big saving in production costs. All we've done is move two of the gear wheels around, add a second clutch, and fit some hydraulic actuators to handle the shifts."

Full manual override is a major feature, so I tried several manual shifts. Changes were instantaneous each time, owing to the electronic control system that also gives the shift lever a feather-light touch. "Remember that these are all 'hot' shifts," Webster pointed out, "just as in the automatic



Prototype of a four-speed unit (shown in cross section below) is examined by author Scott. Note extra wiring and hydraulic lines necessary for operation.



mode. There is no power interruption as there would be with the usual gearbox when you de-clutch. And with a microchip brain you can easily set the automatic-shift points to any speed you want. It only takes a few minutes using a screwdriver."

How does a constant-mesh four-speed transmission do such tricks? Starting with a conventional two-

shaft transmission, the idea is to rear-range and split the four pairs of meshed gears that give you forward movement so the odd- and even-numbered ones are on separate shaft sections. These sections are independently driven by the engine through two individual clutches. In this way, gear changes are made by disengaging one clutch as the other is simultaneously engaged. This flip-flop sequence gives a continuous power flow with the same fuel economy as a manual box.

Webster hasn't stopped there, though. For actual economy benefits with an automatic he's developed a six-speed version with twice the normal ratio spread of the four-speed: Fourth gear has a 1:1 ratio, fifth is a moderate overdrive, and sixth has a super-overdrive 0.5:1 ratio.

Such a high top gear means highway cruising at half the usual engine speed with a small throttle opening, which cuts gas consumption dramatically. In addition, the wide ratio spread allows you to keep engine speed fairly constant, which boosts thermal efficiency and fuel economy.

A microprocessor picks the optimal shift points according to load requirements at any given time, and the results approximate those of an ideal, continuously variable transmission. AP has tested a prototype six-speed in a two-liter car on a typical 115-mile road circuit and claims a 25 percent improvement in fuel consumption over that of the four-speed in the same car.

"The beauty of our design," says Webster, "is that six speeds can fit in the same width as four, since we have three shafts instead of two, and the meshing gears are redistributed on them in a vertical arrangement. That only makes the package deeper, so it's still suitable for transverse front-wheel drives."

AP has demonstrated the automatic to every major car manufacturer, and the interest and response have been tremendous, according to Webster. Right now he's preparing detail drawings and specifications for a number of front-drive cars.

The transmission's biggest appeal for the manufacturers is its use of standard parts already being made for existing manual transmissions. There are no unproved or exotic assemblies, such as the friction rollers or belt and pulleys of a continuously variable automatic. In addition, AP already makes some of the clutches and hydraulic actuators. So major tooling could be avoided and production could start quickly, at low cost. How soon? "Give it a couple of years," says Harry Webster. ■

Beginning here: PS special home-electronics section

PS SPECIAL **HOME
ELECTRONICS**

Home electronics? Just a few years ago, a section telling you about the latest developments in computers, digital audio technology, and satellite-TV antennas

would hardly be considered *home* electronics. But this year, all that and more is just part of what we have come to expect for our living rooms. In the next 16

pages of this special section, you'll see precisely what we mean: Never before has home electronics meant such a variety of new and exciting products and ideas.

New personal computers

— now the big
guns have arrived

IBM heads the list of new small-computer makers— and that means big changes to come

By WILLIAM J. HAWKINS

The room was jammed. I was lucky to be up front; before me sat the demonstrator. His hands stretched across the keyboard as characters streamed onto the CRT display. It was a computer, a personal model for use in home or office. But it wasn't just any new small computer—this was an IBM.

IBM entering the personal-computer business is like General Motors making motorized scooters—you could
Continued



The IBM personal computer (Box 1328, Boca Raton, Fla. 33432), can be made into a complete system by adding the disc drives

and printer as shown here. Other options, such as memory and graphics, are added with internal circuit boards.



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New personal computers

[Continued]



Lots of choices (clockwise from left): The PC-8001A is \$1,295 from NEC America (1401 Estes Ave., Elk Grove Village, Ill.

60007); the Osborne 1 (2650 Corporate Ave., Hayward, Calif. 94545) comes complete with software for \$1,795; the Xerox

820 (1341 W. Mockingbird Lane, Dallas, Tex. 75247) starts at \$2,995 for the basic system as shown here.

bet America's mode of transportation would be in for a radical change. This may be the beginning of the long-forecast personal-computer explosion.

"If you could choose one word to describe this system," said IBM vice-president C. B. Rogers at the machine's introduction, "it's 'quality.'" True. But that's also true of other new personal computers introduced by Xerox, NEC, and Casio. The target of these industrial giants is the present personal-computer establishment: companies such as Texas Instruments, APF, Commodore, and Osborne. These have responded with new, updated models in recent months. (Others, such as Radio Shack, Apple, Atari, and Ohio Scientific, have not, as of this writing, released new models.)

The result: a galaxy of new machines from which to choose. They're all good—as I found out in trying a number of them. Here are some of the highlights I found:

Newcomers

IBM. Saying "IBM" is about the same as saying "computer." IBM got that reputation through strong prod-

ucts and smart marketing. It will keep that reputation with this personal computer.

It's not cheap, but it's competitively priced. For \$1,565 you get a basic model. You supply the TV set for viewing data and a cassette recorder for saving it. IBM supplies the multi-function keyboard (63 standard character keys, 10 numeric-entry keys, 10 special-function keys) and a system box, which comprises the microprocessor, 16 K (kilobytes) of user RAM memory, and 40 K of permanent ROM memory containing a system monitor and the BASIC interpreter language it uses.

From there, the optional choices are yours: mini-disc drives (up to two) for saving 160 K per diskette; up to 256 K of internal add-on memory; graphics; bi-directional matrix printer; 11½-inch black-and-white CRT display; game paddles; and a serial out (port) connection for over-the-phone modem hookups with other computers.

The computer uses a 16-bit microprocessor (8088), as opposed to the smaller, eight-bit micros used in other machines. The result is compact programming and fast running speed.

Naturally, the more you'd like the

system to do, the more it costs. For all the IBM options you'd pay \$6,000—low by comparable standards; for a "typical" machine with small-business capabilities, about \$4,000.

Most surprisingly, IBM will initially be using outside sources of software and plans to accept programs from private individuals—a huge departure from past IBM practices. And the computer will be sold not only through IBM special outlets but through Sears business-machine stores and the Computerland chain.

NEC. Its system starts off simply: an all-in-one box with 32 K of internal memory and output connectors for cassette tape, printer, and video display. (There are two video-display connectors: one for black and white only, another for color.) An additional box, containing a dual mini-disc storage system, holds up to 286 K of information. And, with the drive options, the unit uses Microsoft's disc BASIC program—a version that's become so popular it's considered standard.

Speaking of standard, there's the Xerox model 820 system reviewed in *POPULAR SCIENCE* last month. Using a

Continued

Radio Shack's \$399 TRS-80 Color Computer— The Colorful Way to say "Merry Christmas"

Make this Christmas really memorable with a gift the whole family can enjoy—a Radio Shack TRS-80 Color Computer. It's the exciting way to enter the age of computers—because you can pop in a Program Pak™ for instant fun and games, or let the excellent 308-page manual teach you how to write your own programs.

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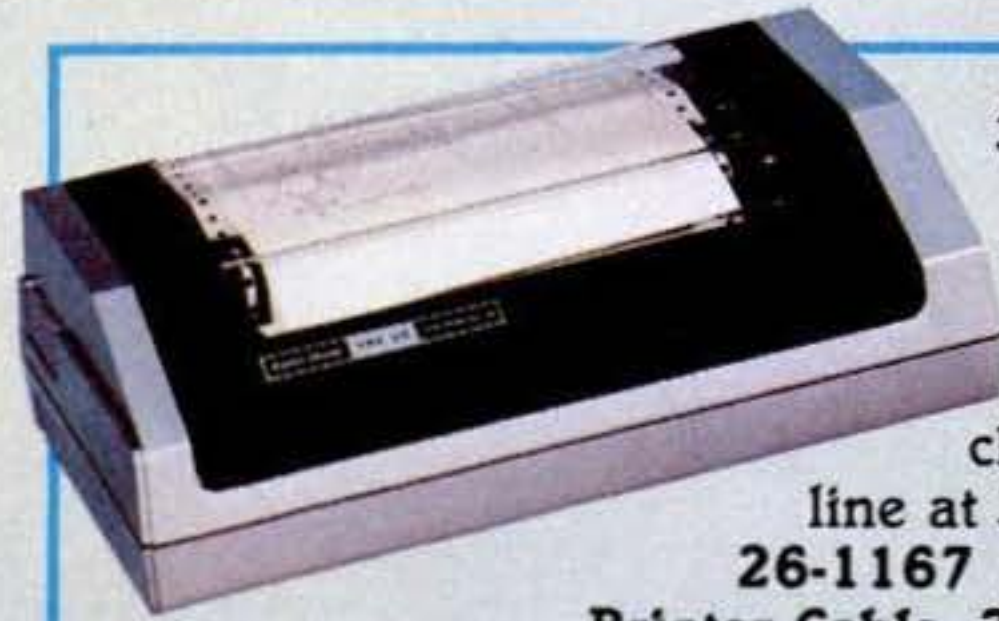
And since the Color Computer features brilliant color and sound, you can even compose music! There are also Program Paks to help you manage the family budget and tutor your youngsters in math.

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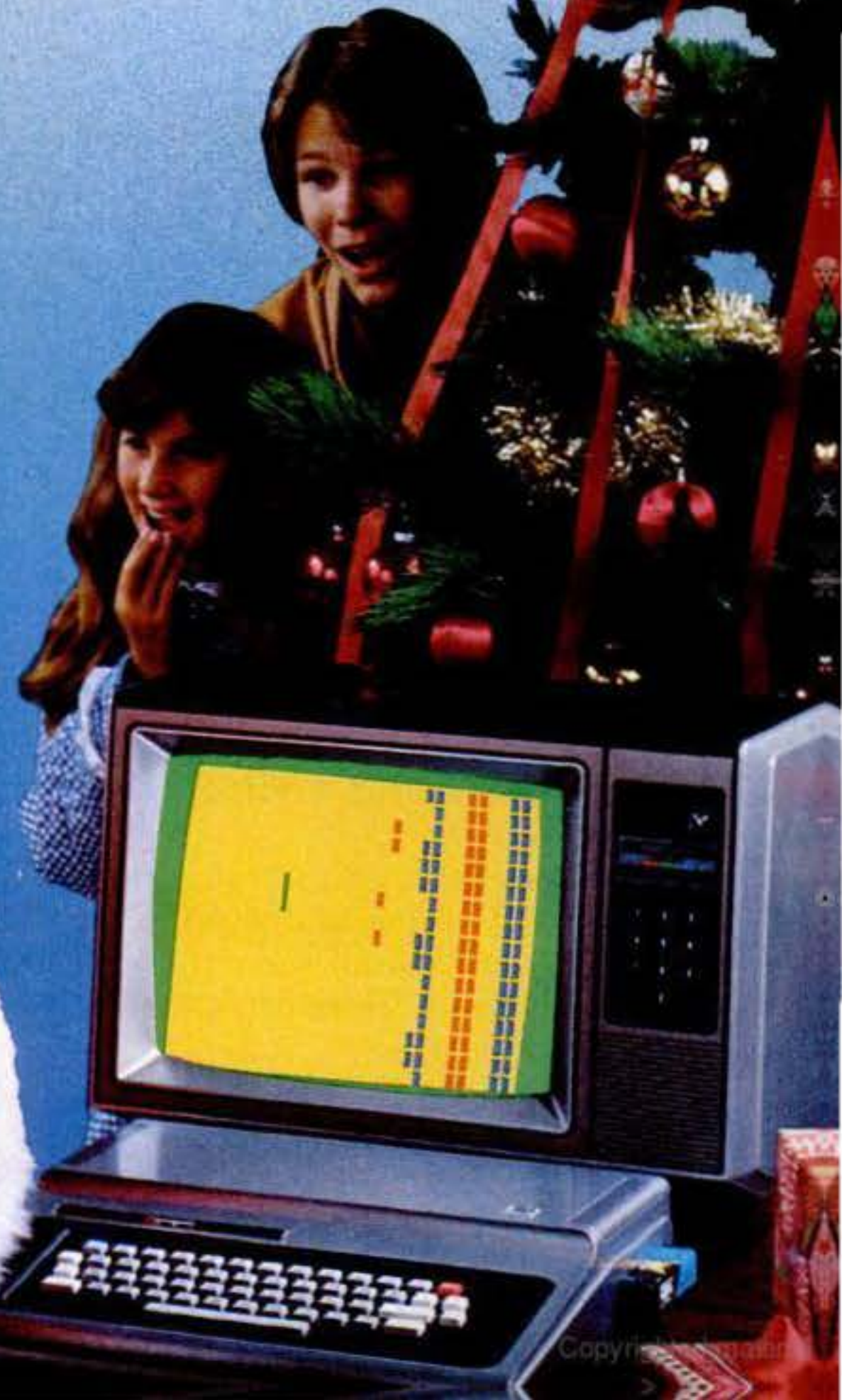
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Special order may be required.

Put a Color Computer Under Your Tree This Christmas!



These Cards Honored at Most Stores



New personal computers

[Continued]



Flip top allows you to add memory to Casio's \$1,199 FX-9000P, left (15 Garner Rd., Fairfield, N.J. 07006); Imagination

Machine (rear) is \$1,600 from APF (1501 Broadway, New York, N.Y. 10036); VIC 20, (middle) from Commodore (761 Fifth

Ave., King of Prussia, Pa. 19406), is \$299. Texas Instruments' 99/4A (Box 225012, Dallas, Tex. 75265) is \$525.

standard CP/M disc-operating system, it's compatible with some 2,000 personal and business programs.

The 820 looks and feels totally professional. The keyboard container is bigger than need be—depending on the size of your desk top. But the key placement and tactile response (feel) are excellent. The screen is large; characters are easy to read.

The basic system includes the keyboard, display, and mini-disc drives. A rear connection (serial port) lets you plug in the optional printer, included when you order the system as a word processor (\$5,895). There is also an optional eight-inch disc drive for large data storage.

Casio. This comes as a system, too—but a lot smaller. It's about the size of a portable typewriter but much lighter. It contains a keyboard, computer, and CRT display. Data are saved on an external cassette recorder. The right side pops open to expose circuit-board slots. Need more memory? (The computer will tell you.) Just add another circuit board.

For text editing the Casio would be limiting because of the cassette storage, small screen, and switch-type

keyboard. But for number manipulation—in engineering, the sciences, or accounting—it's in a class by itself.

Changes for the better

Upgrade Texas Instrument's 99/4 computer and you get the 99/4A. It's basically the same computer except for one important change: the keyboard. The new keyboard uses standard keys—not the buttons on the earlier design—and in a normal typewriter placement. Add to that some 2,000 software programs, and the TI 99/4A is a step above the earlier model.

APF's Imagination Machine has undergone similar modification. The first model APF offered was actually an enhanced video game. You bought the game and plugged it into the optional keyboard-computer to do work. That game has been removed and the Imagination Machine has instantly become a more professional machine. The resulting flat top is for the video display; a built-in cassette recorder can save programs and data. Add-ons, such as a disc system and printer, are attached through a rear connector unit.

Commodore made headlines—and

our cover in October 1977—by introducing the first home computer for under \$600. The company is known for breaking price barriers, and the VIC 20 is its newest ramrod. For its low price you get a lot of computer. It has a touch-typing-quality keyboard, built-in BASIC programming, and an external audio cassette for saving data or programs. Additional connections to the unit allow a printer or disc drive to be added. It also accepts pre-programmed cartridges.

The name Osborne is new to computer hardware, but well known for software—everything from programs to books on how to program. One idea of the Osborne computer is that you get everything you need in one package for one price: dual disc drives with the CP/M operating system and software, 64 K of internal RAM memory, keyboard, and CRT display. The other idea is that it's compact and portable. Put the keyboard-cover over the unit, and you walk away lifting the handle. Because of the compact design, however, that small screen is a disadvantage. But if you're looking for the most computer parts for your money, the Osborne may be it. **P 5**

For the '80's: a decade of wonders in **home electronics**

Look for 3-D TV, hand-held VCR-cameras, giant-screen TV, and noiseless discs

By **JOHN FREE**

Video. That word and its companion hardware dominated three home-electronics shows I attended this year. Exhibits brimmed with new videotape and videodisc machines, computerized TV games, accessories, mammoth earth-station antennas, an umbrella-size direct-broadcast-satellite antenna, and more.

Giant-screen TV, the most dramatic video eye-catcher, was everywhere, too, as the leaders in color TV finally entered the field: RCA showed its Hitachi-built front-projection console, and Zenith unveiled its pop-up screen, rear-projection console [PS, Aug.].

But significant new technology was also rolled out by Sylvania and Magnavox, both now owned by North American Philips. Sylvania's (1) and Magnavox's 50-inch rear-projection consoles have exclusive screens with narrow vertical black stripes on the front (see detail). The stripes absorb ambient light so you can have high-contrast pictures even in brightly illuminated rooms. Sylvania's 1981 SuperScreen model has a plump 41-inch-deep cabinet. But next year's model will be slimmer. A new mirror-lens system from U.S. Precision Lens positioned before each of the three projection tubes (diagram) will halve the cabinet depth.

Shrinking VCR's

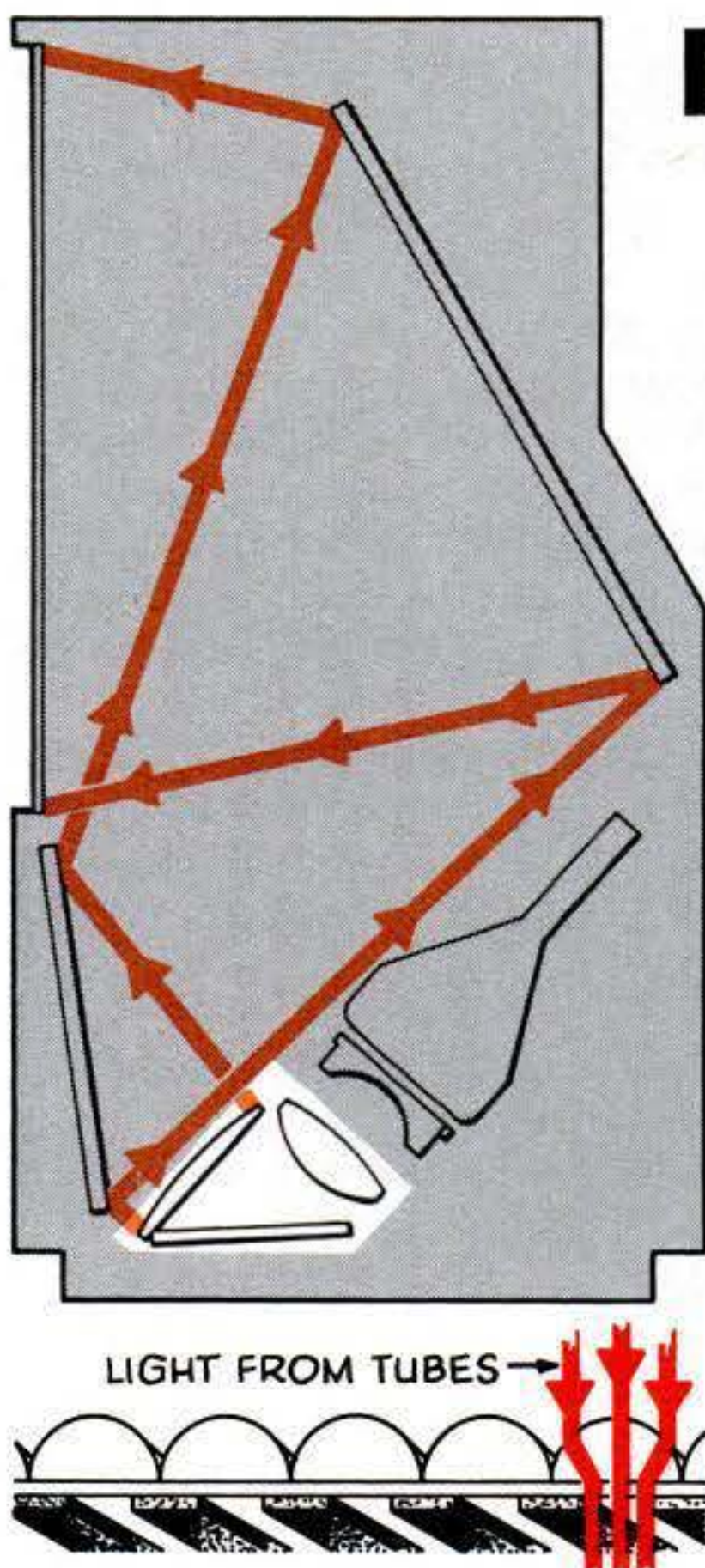
Beta-format video-cassette tapes are somewhat smaller than competing VHS-tape packages. Now, Sony and other Beta-format firms have exploit-

ed this by totally reengineering their decks. Sony's SL-2000 portable deck (2, left), for example, weighs just over nine pounds and measures 8½ by 3⅛ by 12 inches. It can record up to five hours on one tape (one hour per battery charge).

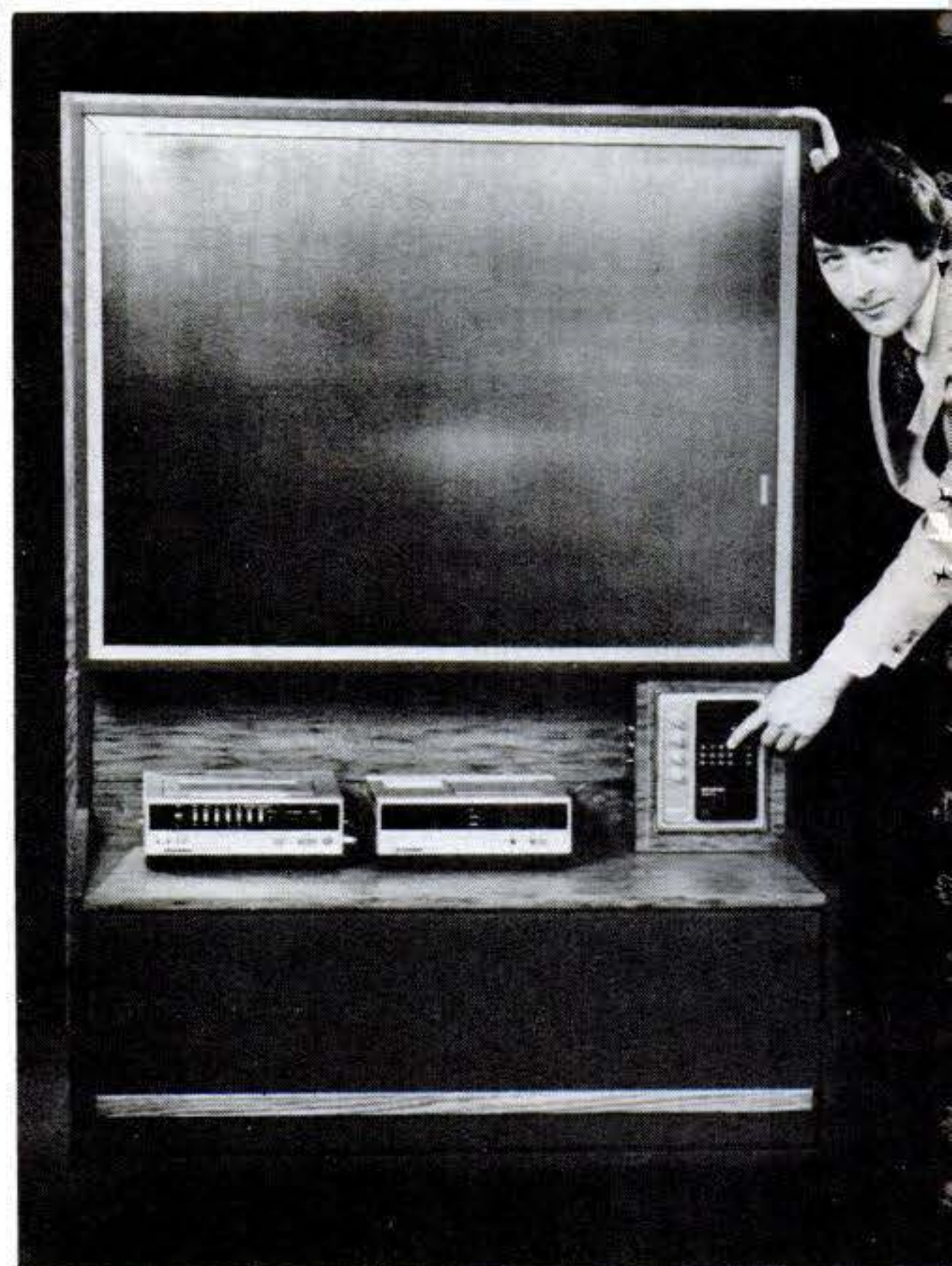
But JVC and other VHS-format companies are readying a counter-blow: a VHS mini-cassette a little larger than an audio cassette. Next year VHS firms will have portable decks weighing some 5.5 pounds. You'll be able to play one-hour VHS mini-cassettes back either with these compact portables or in standard VHS machines by slipping them into an adapt-

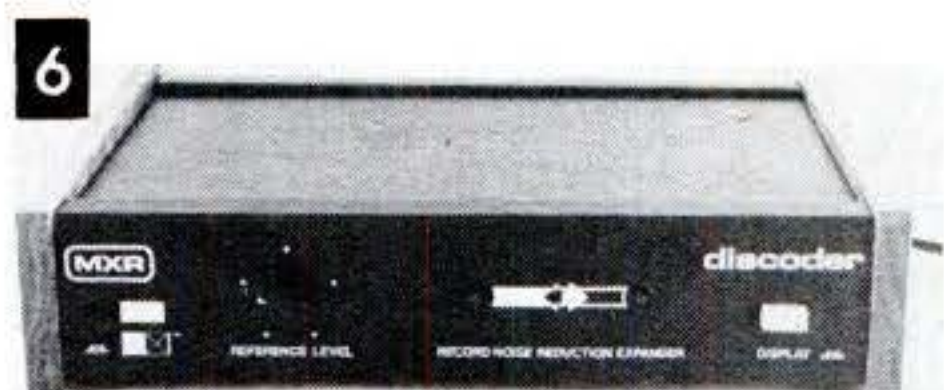
er the size of a standard VHS cassette.

Meanwhile, for the next jump in size reduction—combination VCR-camera units—Japanese firms are trying to settle on a single tape format. Matsushita was showing its design entry (2, right) at its advanced-technology show in Chicago. This model is slightly smaller than an earlier one ["Look and Listen," PS, July], since the camera has a solid-state image sensor instead of a ½-inch pickup tube. Matsushita's micro video system puts two hours on a cassette slightly smaller than a standard audio cassette by using metal-evaporated tape.



1





This high-density videotape is only 10 microns (millionths of a meter) thick—half that of VHS tape. These upcoming micro-videotapes are ¼ inch wide, compared with Beta's and VHS's ½-inch widths. One firm suggests a VCR-camera combo will be available as early as 1982. Next? How about still-smaller ⅛-inch tapes and hardware? Another Matsushita futuristic system at Chicago was a 3-D TV receiver (3) and a stereoscopic TV camera (4). The camera can record 3-D pictures on ordinary videotape machines and could be marketed soon.

The depth illusion is startlingly realistic. But you must wear special eyeglasses with photoelectric lens shutters synchronized to the images. There's some eye strain. Matsushita says the 3-D technique can be used with high-resolution TV [this issue], too. For 3-D TV in homes, though, many researchers are attempting to perfect a standard system that wouldn't require glasses.

Some audio components have a new look, too. Increasingly, you'll see turntables with nearly invisible tone arms—or arms mounted in "odd" positions. These are so-called linear-tracking models [PS, June '80]. They move the phono cartridge in a straight line across the disc—the way records

are cut—instead of in an arc. This improves playback fidelity. And it makes exceptionally small, low-mass arms feasible.

Southern Engineering Products (Canton, Mass.) has developed a linear-tracking mechanism (5) with an arm that weighs only 1.3 grams. The tiny arm glides along a track of glass rods, driven only by stylus force in record grooves. The mechanism, a \$500 turntable add-on, is said to have constant zero tracking error. By contrast, most linear-tracking turntables use electronic sensing techniques that continually play catch-up—adjusting tracking error back toward zero after it develops.

More low-noise LP's

CBS, the company that invented the 33⅓ LP disc, has introduced a new encoding scheme for records that sharply cuts surface noise and boosts dynamic range by 20 dB to about 85 dB. To achieve this, you need an add-on decoder like an MXR model I tried (6).

CBS calls its technique CX (compatible expansion). It's similar in principle to the dbx disc-encoding system [PS, March]. But unlike dbx discs, which sound very muffled if played without a dbx decoder, CBS's CX discs

sound normal on hi-fi systems without a decoder. You just don't benefit from reduced surface noise and expanded range. CBS notes, though, that CX is designed for "minimum audible pumping"—the "breathing" sound that has plagued some compression-expansion techniques such as this.

CBS has equipped all its mastering facilities with CX encoders. Also, RCA and the multi-label WEA group have adopted the process—with more disc firms expected to join. CBS is offering the technology on a royalty-free basis.

A listening test with a new release, Korngold's opera "Violanta" (CBS 35909), demonstrated the total lack of surface noise and dramatic music peaks typical of dbx discs. Yet with the MXR decoder switched out the discs sounded normal.

Unless you look closely at one of the newest hi-fi components starting to appear (7), you'll think it's just another cassette deck. Actually, it's a "casseiver"—a combination deck and hi-fi receiver. Several firms have introduced their own. This JVC \$650 model R-5000 includes two speakers. As microcircuits encompass more hi-fi functions, component integration like this becomes easier. You don't have to pay extra for separate chassis and power supplies. 15

Build a home computer center

It's simple to make,
puts everything you
need within reach

By C. P. GILMORE

If you're like me, you probably have a space set aside somewhere that you call your home office. And if your home office is anything like mine was until recently, it may be a table con-

taining heaps of papers, stapling machines, calculators, miscellaneous supplies, tools, and work in progress.

I've been meaning to build in a really efficient home office for years. And when I brought my new computer home recently, I decided the time had come. I wanted something handsome and useful. A place that would be pleasant to work in. A place in which everything I need—from the computer keyboard to a postage stamp—would

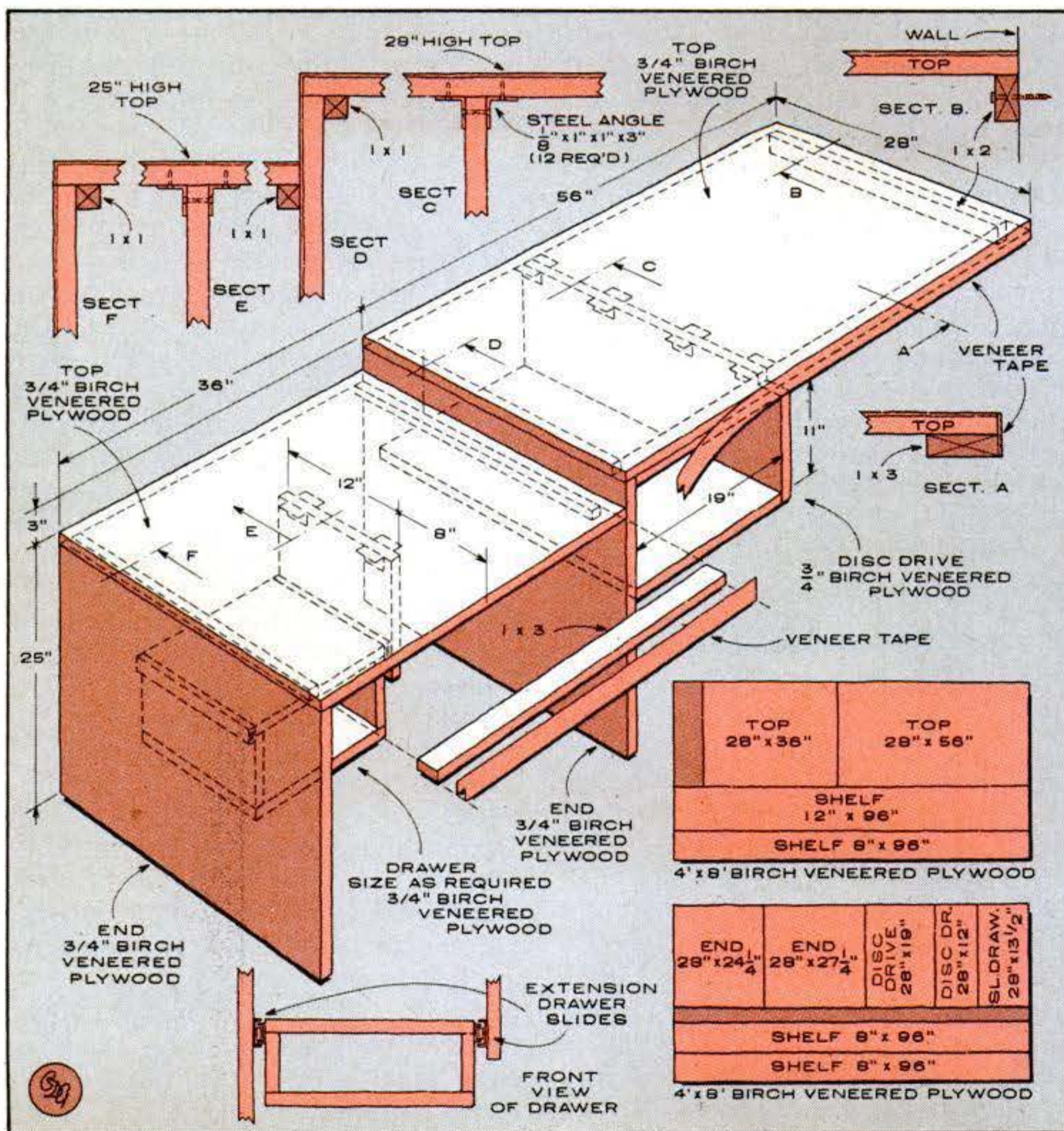
be instantly available and convenient. It was a simple project; a few weekends of work and it was completed. You can see the result on the opposite page.

The main features are evident. The computer console sits on a typing wing where it is easy to operate. Most standard typing tables are 26 or 27 inches tall. That's slightly higher than I like, so I built this computer surface 25 inches from the floor. The main desk surface is at 28 inches—again one to two inches below standard. Adjust these figures to whatever you find most comfortable.

Just to the left of the computer console is the printer. My Epsom MX-80 sits on top of a box open at front and back. A three-inch-thick supply of paper sits on the shelf below the printer. The box is mounted on standard nylon-roller drawer hardware, so the printer pulls out easily when needed, and disappears beneath the desk at other times.

The disc-drive mounting is straightforward. Disc drives are usually allowed to take up valuable desk-top space. But mounted under the table the unit is even more convenient.

Construction is simple throughout. The horizontal desk-top surfaces are butt-joined to the vertical supports at the ends. I didn't want to drive screws through the visible surfaces, so I installed a 1x1 where the two panels came together and used 1/4-inch flat-head screws and glue to make the joint secure. A 1x1 also serves as the shelf support at the right end of the typing wing. A 3/4-inch plywood desk top always looks skimpy to me, so I used screws and glue to attach a 1x3 to the underside of the front of each of the two desktop elements. Then I veneered the front edges, with one-inch





veneer on the vertical elements and two-inch on horizontal exposed edges. It doesn't show in the drawings, but I used $\frac{1}{4}$ -inch plywood gussets at the rear to stabilize the vertical members. The entire structure goes together easily and quickly with glue and screws.

Several problems remain unsolved. The principal one is disc storage. I was unprepared for the fact that I would generate a lot of discs as I put my computer to work as a word processor, bookkeeper, and list retriever. But the discs are piling up. I now keep them in boxes on the shelf just above the computer. But this means that I am always shuffling through boxes of discs. I hope to build a filing system of some sort, although I don't have the design worked out as yet. I suspect that it may be built of Plexiglas, a versatile material that comes in many

nice colors. And I think I'll design it to hang under the shelf behind or just to the left of the computer. It should let the discs slide out easily, and it should have some kind of tab identification system so that the desired disc can be located quickly and easily.

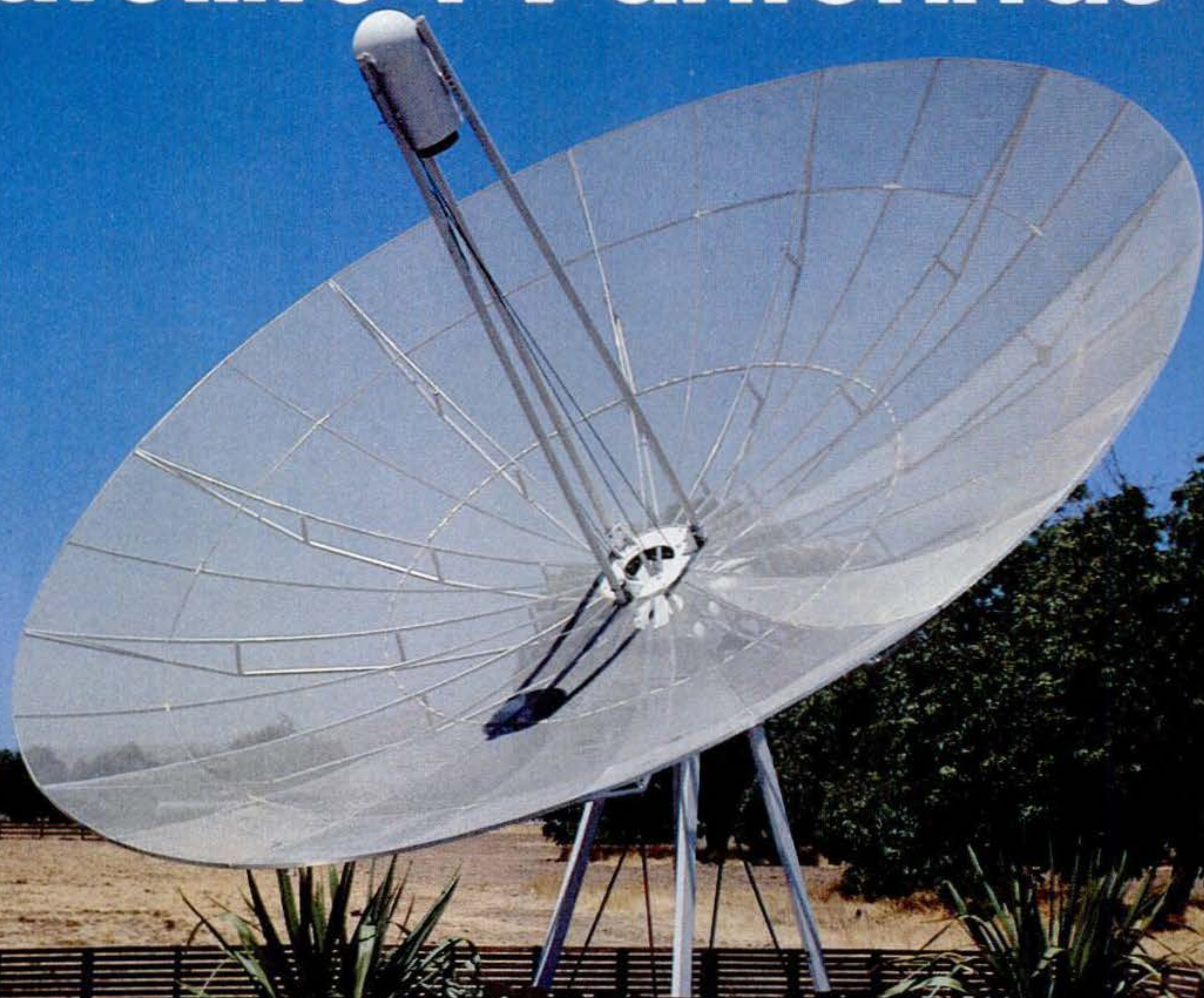
My other storage problems have been solved in a conventional manner. While I was building the desk/computer stand, I also put four shelves on the wall above and behind it. The bottom one is twelve inches wide, convenient for holding the stationery cabinet you see in the picture, large books, and other outsized items. The three top shelves are eight inches wide, suitable for all but the largest books. All shelves are mounted on conventional brackets and standards. Since I expected a heavy load of books, I mounted the standards on 20-inch centers and used heavy-duty brackets.

The two plastic six-drawer units you see on the desk surface to the right of the computer hold bills that need paying, stamps, address labels, letter openers, and a wide variety of other supplies.

I chose birch veneer with a tung-oil finish for the project because I like the color; the entire structure has a light, airy feeling. You can pick any material and finish, of course. Other furniture-grade plywood veneers would be handsome, as would a unit made of MDO and painted.

My computer wing is 36 inches long, fine for most home computers. If your printer is larger, you may want to make this surface longer to leave room for the printer and your legs underneath. My main desk top is 56 inches—again a convenient length. Adjust dimensions to your equipment and to the wall you want to fit. **E3**

Now, more channels, plummeting prices
for new backyard
satellite-TV antennas



Better quality, easier-to-use features,
and affordable do-it-yourself kits
make home Earth stations practical

PS SPECIAL **HOME
ELECTRONICS**

By **SUSAN RENNER-SMITH**

The view from my hotel room was so incongruous that I burst out laughing. A score of gleaming dish antennas squatted in the parking lot below me, facing the southern sky. It looked as if a giant mushroom crop had sprouted in the starlight. Then I saw the glowing TV set near one dish. People crouched around it watching, I knew, a program broadcast by some far-off satellite.

I'd come to Washington expecting to see some antennas—after all, I was attending a Satellite TV Technology conference (STT, Box G, Arcadia, Okla. 73007). But the antenna farm showed me how fast the field has grown since *POPULAR SCIENCE* first reported on backyard satellite-TV receivers [PS, March '80]. Once a toy of the super-rich—or the electronically gifted—satellite-TV terminals are becoming a middle-class luxury.

"No fewer than 1,500 terminals are installed each month," STT's Bob Cooper told me at the conference. Cooper started it all by installing—and publicizing—one of the first private satellite-TV receivers back in 1978.

What does this growth mean?

"Prices have come way down," said Cooper. "The equipment is easier to use. It's tremendously more reliable. And you have a wide variety of choices. The manufacturers are not just imitating each other—they're innovating."

Today nine domestic-communications satellites hover 22,300 miles over the equator, within "sight" of the U.S. Some have 24-channel capacity. And the FCC recently approved applications for 20 more satellites. By 1984, predicts Cooper, there will be about 500 channels available.

What's on the satellites? Cable channels like the all-sports ESPN and Spanish-language (SIN) networks; super-stations like New York's Channel 9; religious networks; and, of course, the paid-subscription, all-movie channels. High-powered transmitters on Earth beam this cornucopia of programs to the satellites, which re-transmit them to cable stations across the country. But anyone can pick up the broadcasts, as long as nothing blocks the view and there's no ground-based microwave interference.

What do you need? First, an antenna—10 or 15 feet in diameter—to gather and concentrate the microwave signals. Weakened by their long journey, the signals must be amplified, then converted from the very high frequencies the satellites use down to standard UHF frequencies. This job is done by electronic equipment—a low-noise amplifier and what the industry calls a down converter. Coaxial cable carries the signals inside to a receiver. It has no screen or speaker, but it may have a demodulator to convert the signals to frequencies your TV set can pick up.

The cost of all this has come down drastically. Commercial versions once cost hundreds of thousands of dollars. Two years ago you'd pay at least \$10,000 for a "turnkey" system, installed by the dealer, to pick up just one channel on one satellite. More versatile systems cost up to \$36,000.

At the STT show, I saw good basic systems that cost about \$5,000, installed. High-end systems with superior reception and convenience features go to \$16,000.

There's an even cheaper route. You can assemble your own antenna from a kit, pour the concrete footing, raise the antenna, and cable the electronics together. Many companies, such as Downlink (Putnam, Conn. 06260) and Global TV (Box 219, Maitland, Fla. 32751), sell all the components.

"If you know how to plug stereo components together,

you can assemble a satellite-TV system," Downlink's Wes Thomas told me. "The only complexity is building the antenna. You have to follow a manual carefully."

Downlink charges \$2,650 for a kit that includes the manual. With a preassembled 12-ft. antenna the price goes to \$3,595. Global offers a complete system for \$2,700.

For \$6,995, you can buy a bolt-together antenna and a semi-assembled receiver from the Heath Company. This kit rivals the \$16,000 systems in sophistication.

Two years ago you couldn't buy such systems. If you scrambled around, you could buy the components from several different manufacturers: Price? About \$7,000. "Today a smart shopper can do it for \$2,500," Cooper said.

Best of all, even the least expensive components have features you couldn't buy two years ago. You once had to tune in different channels with a screwdriver. Now you just flip a dial. To switch between satellites you had to go out and shove the antenna around to a new position. Now you sit inside and punch a few buttons.

New antenna technology also makes for cheaper systems. Using wire mesh instead of aluminum or fiberglass cuts costs. "The wind goes right through it," said Peter Dalton, president of KLM Electronics (Morgan Hill, Calif. 95037), maker of the Sky Eye shown at left. "You don't need the expensive braces used with solid aluminum."

You have to pay the piper

But is it legal to watch satellite TV at all? It's definitely legal to own a dish—the FCC lifted all licensing requirements back in 1979. But as the Heath Company notes, it's up to the customer to comply with all laws and pay fees if programmers charge them.

Some do. The all-sports ESPN network charges a \$100 lifetime fee. Some don't. Religious-program networks are delighted to have more viewers; they ask only a letter requesting permission. And some won't. HBO, Showtime, and some other all-movie channels won't even consider individual applications, citing copyright laws.

The satellite-TV industry is working, through an industry organization, to come to some agreement with the major program suppliers. Meanwhile, most satellite-TV viewers figure that they have a right to pull in signals raining down on their roofs.

Soon a different type of signal will be raining down on our roofs. RCA, CBS, Comsat, Western Union, and nine other firms recently applied to the FCC for permission to launch high-frequency direct-broadcast satellites. These will be more powerful than current satellites, so a smaller antenna could pick up their signals. Comsat, the first to apply, says its two-foot-diameter antenna will cost about \$100. The company plans to rent the electronics—including a descrambler—for about \$25 a month. For that fee the viewer will get three channels of entertainment.

Will today's backyard antennas be able to receive direct-broadcast programs? Bob Cooper says no.

"It's a totally different frequency band. All this equipment is frequency-conscious, except the antenna. If the surface is accurate enough it might be able to focus this higher frequency effectively," Cooper said. "Maybe two antennas in that parking lot can do it," he added.

So today's systems will be obsolete by 1983? "Not at all," said Cooper. "The choice will be to pay a one-time price of about \$2,500 for access to 500 different channels or pay monthly fees for three channels."

Cooper is betting that most people will choose big backyard dishes. By 1984 we should know if he's right. **ES**

The coming
record revolution.

digital discs

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TITLE
SONY DIGITAL AUDIO DISC SYSTEM
MICRO DISC



A laser "reads" the compact, no-wear disc to deliver superior hi-fi

By LEONARD FELDMAN

TOKYO, JAPAN

A Sony technician slipped a small disc into the slot of a player no larger than a portable cassette machine. I noticed the record's shiny surface broke light into rainbow colors. Seconds later I was bathed in rich, wide-ranging stereo music that sounded better than anything I'd ever heard from discs or tapes.

Sony Corporation's Dr. Toshi Doi, a leading digital-systems designer, explained that this was a true digital record: Information stored as number codes on its surface was being converted into music. Instead of grooves, this disc had an optical track "read" by a laser beam. I heard absolutely no surface noise or distortion and no pitch fluctuations from the spinning disc. Dynamic range, or the difference between the loudest and softest musical sounds, was awesome.

You can't buy such a digital audio disc (DAD) now at any price. But players and digital discs will be on the market in 1982-'83—sooner than anticipated. The new DAD technology merges hardware similar to that used for videodiscs [PS, July '80] with specially developed digital integrated circuits. Disc players, which can be plugged into any conventional hi-fi system, could cost from \$500 to \$1,000. Discs, initially, will cost about \$15. They have unique advantages—detailed shortly—compared with conventional LP records.

Setting standards

For more than three years representatives of companies participating in DAD technology have been trying to establish a disc standard. Audio firms want to avoid confusing consumers with incompatible discs and hardware.

But recently a council of 51 companies in the field ended its deliberations without establishing a definite DAD standard. Instead, the council leaned heavily toward the Compact Digital Disc system I had seen in Tokyo. This system was originally developed by Philips of Holland. Since its first showings [PS, Oct. '79], Sony and Philips have been working together to improve the system and convince others—quite successfully—that it should become a world standard.

While the Philips-Sony DAD system is based on optical laser technolo-

gy, Telefunken of West Germany has been demonstrating a different groove-type disc system. A mechanical pickup stylus traces digital information contained in the spiral groove. It now seems unlikely, however, that Telefunken's system will be accepted as a world standard, or even be offered to the public in the near future.

That leaves one other system, based on a grooveless disc that uses a pickup to sense minute changes in disc capacitance. This DAD was developed by JVC as a companion to its VHD (video high density) disc player for TV, slated for marketing early next year. JVC's audio-disc system uses the videodisc player with an extra plug-in adapter.

Music reproduction for these DAD's begins with a master tape using digital encoding (see box). Recording studios have been using this digital technology for several years. (Some conventional LP records are now called digital discs, but these are simply regular records made from digitally recorded master tapes.) Here's how this digital music information from a

“The sonic impact of music from a digital disc must be heard to be appreciated”

master tape is used for the Philips-Sony DAD.

The disc is only 4.75 inches in diameter, but it can store up to one hour of stereo on a single side. Four-channel recordings at reduced playing times are also possible. Digital audio information is stored in the form of microscopic pits in a thin metal layer beneath the clear plastic disc surface. The pits are only about 0.6 micron (millionth of a meter) in width and about 0.2 micron deep.

Digital signals from the master tape turn a laser on and off, creating a continuous spiral pattern of these pits for a master disc, which become projections rather than pits on production stamping discs. For an hour-long disc, the track of pits and flat, highly reflective area between them is some 2.5 miles long.

This track is made up of six billion bits—the ones and zeros of binary language. It is read from the disc by a laser beam focused many times finer than a human hair. The beam is produced by a tiny solid-state laser. Light reflected from the flat areas between

the pits is detected by a light-sensitive diode. Other circuits then convert these light flashes into music.

Since there's no physical contact between the laser beam and the disc surface, no matter how many times you play a disc there's no record wear. Also, the transparent plastic coating of the disc makes it immune to dust, most smudges, and rough handling. That's because the laser penetrates minor imperfections on the outer plastic coating.

Actually, each side of a Philips-Sony disc has a storage capacity of over eight billion bits. This is more capacity than 60 minutes of sound requires, so the added digital storage space offers fascinating new possibilities for hi-fi recordings. Some of the extra two-billion-odd bits, for example, can store detailed information about the music tracks—length, sequence, title, or perhaps the text of selections. This added information might be displayed on an alphanumeric display on the player, or other models could put it on a TV monitor.

Digital delights

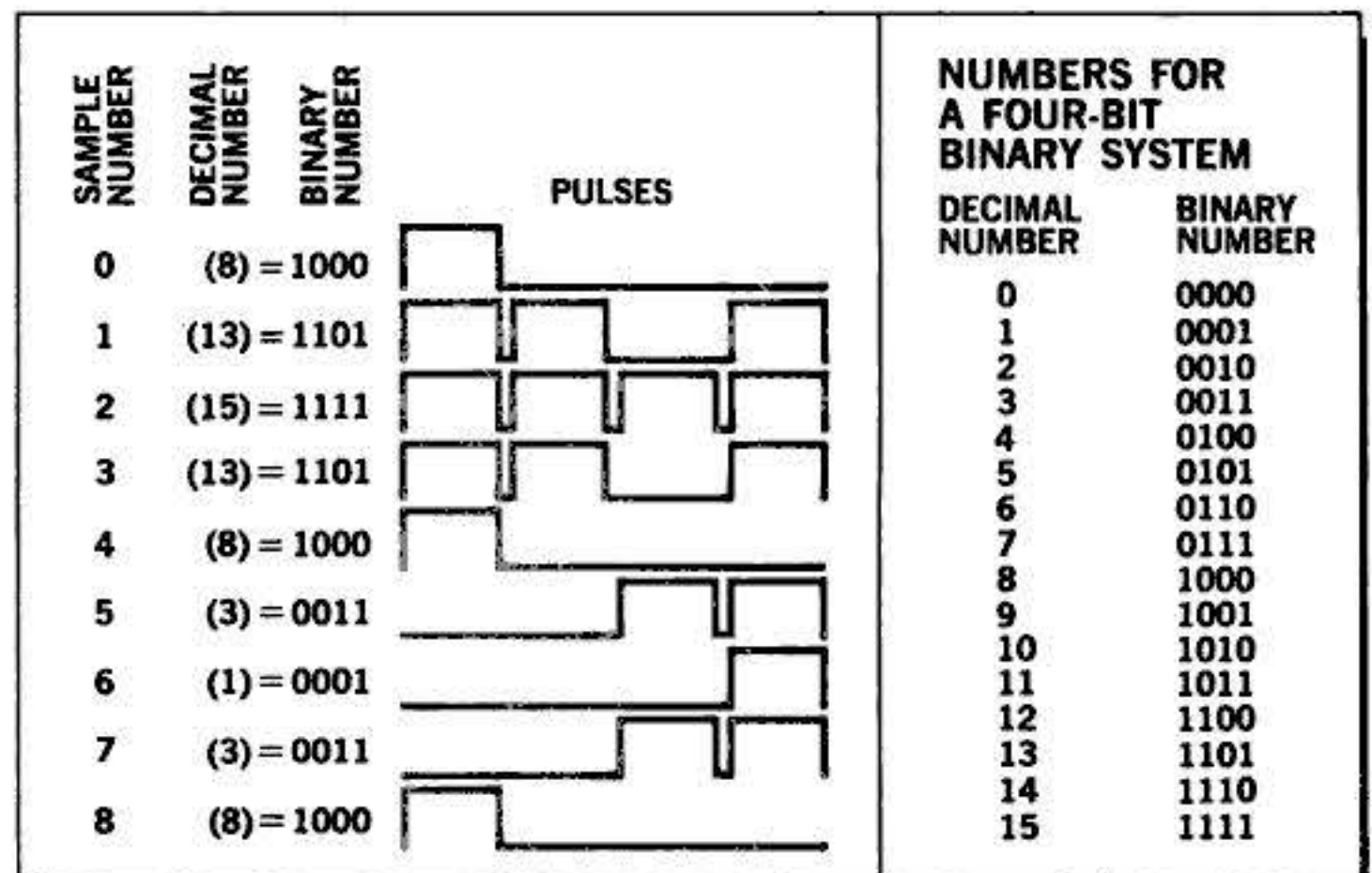
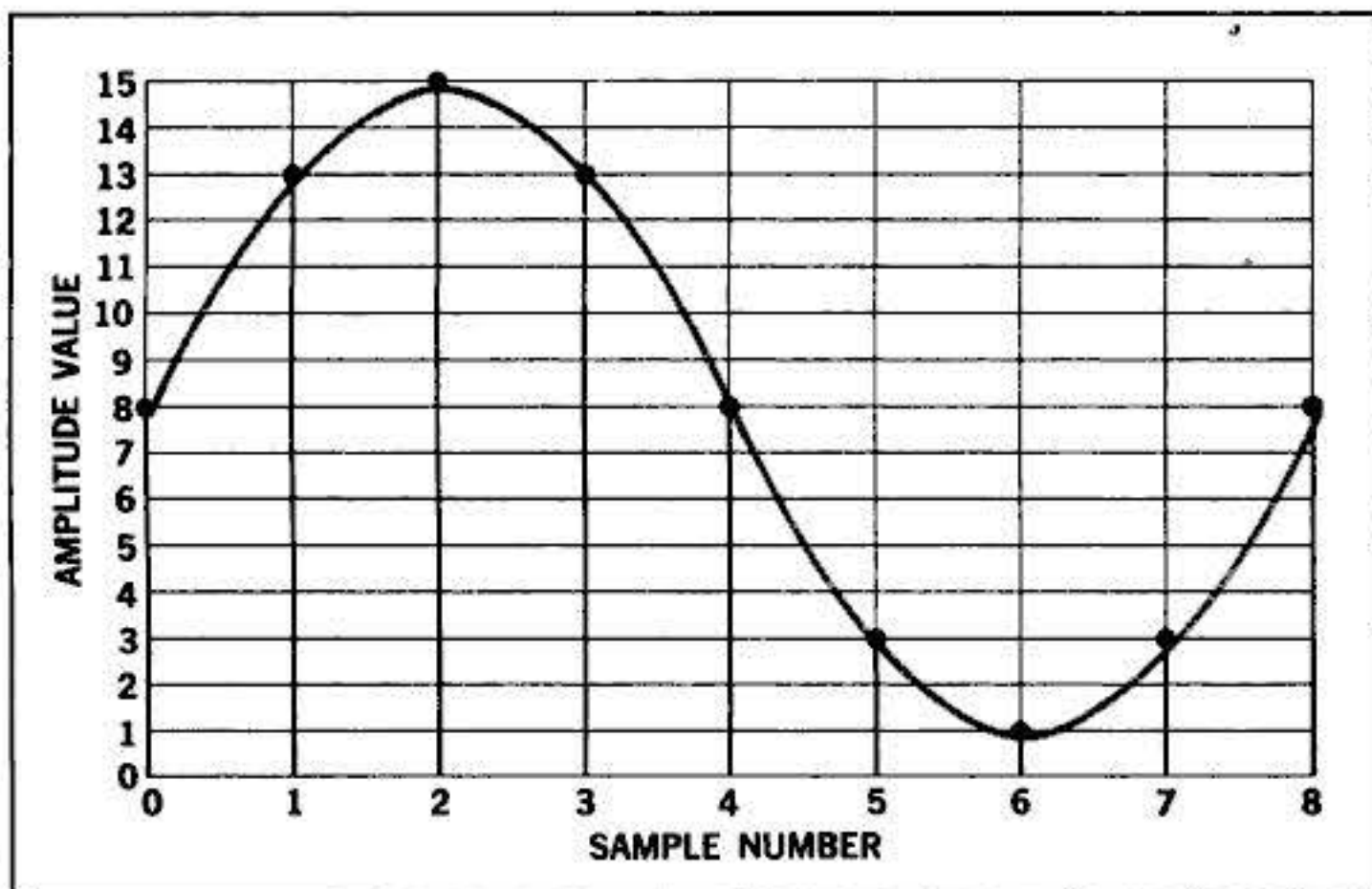
The sonic impact of music from a digital disc player must be heard to be appreciated. But the specifications for the prototype Dr. Doi demonstrated for me at Sony help explain why the sound is so impressive. For one thing, the frequency response is ruler-flat from 20 Hz to 20,000 Hz.

Also, there is no measureable wow or flutter and no audible rumble. The signal-to-noise ratio, dynamic range, and even stereo channel separation are all in excess of 90 dB. By contrast, carefully pressed analog LP records seldom have noise and dynamic-range specifications above 60 dB, and channel separation of 35 dB is available only with superior phono cartridges. Harmonic distortion from the digital discs is less than 0.05 percent, compared with pickup distortion on vinyl LP's that's rarely less than one percent.

These remarkable performance figures are obtained with a Sony or Philips player that's constantly changing the speed at which discs spin. Unlike today's constant-speed record players, the compact DAD is laser-scanned at 500 rpm near the inner circumference, gradually slowing down to about 200 rpm near the outer disc circumference. This variable rotation rate keeps the *linear* speed along the digital

Continued

Translating an audio waveform into digital code



A microphone produces a continuously variable voltage or current as it converts sound into an audio signal. Viewed on an oscilloscope, this signal may appear at one brief instant in time like the sine waveform above. Such a waveform can be sampled or broken up into a series of instantaneous voltage or current levels. Each sample can be described with a number—higher numbers representing louder, or greater amplitude, moments of sound, and smaller numbers representing lower sound levels.

But instead of using common decimal notation to describe these sampled points, the new digital audio systems use binary notation. With this numeric code, only ones and zeros represent numerical values. A set of binary ones and zeros is called a word, and the number of ones and zeros per word is the number of bits it contains.

In this simplified example, a four-bit word is used. This allows only 16 possible combinations of ones and zeros representing decimal numbers 0 through 16 (tabulated above). On the sine waveform, these numbers correspond to amplitude values along the vertical axis. The horizontal axis indicates when eight samples are made during one alteration of the sine wave. These samples, representing amplitudes of the waveform, are then translated into digital signals. A positive voltage pulse represents a binary one, and the absence of a voltage pulse represents a zero. The process of converting the signals into digital words is called pulse-code modulation. The pulses, recorded on tape in digital audio-tape systems or as pits on the

Philips-Sony disc surface, are shown (middle) with the binary number and decimal amplitude for each sample.

To hear music stored in this digital form, the process is reversed by decoder circuits and a hi-fi signal is supplied for any audio system. To achieve their extraordinary fidelity, though, both the JVC AHD discs and the Philips-Sony compact disc use 16-bit words. Each additional bit per word improves the signal-to-noise or dynamic-range capabilities of the system by six dB. So both formats have a theoretical maximum signal-to-noise capability of 96 dB. Also, to achieve flat response out to 20,000 Hz, the audio signal must be sampled at a rate of at least 40,000 times a second. The Philips-Sony sampling rate is standardized at 44.1 kHz, while the JVC disc has a 47.25-kHz rate.

In non-digital audio systems, a momentary loss of signal from a mistracking stylus or tape problem isn't too serious. But with digitally encoded audio signals a signal loss can be interpreted as a string of zeros—translated into an audio signal radically different from the true signal. To prevent this, the Philips-Sony system has special error-correction circuits to modify dropouts as large as 3,548 bits. Errors greater than this, but less than 14,000 bits duration, are compensated for by another technique that averages previous and succeeding digital word values and inserts this information in place of the missing words lost in the optical scanning process.

Philips and Sony have adopted the same 16-bit PCM code now used for professional recording. Compact-disc recordings can be made with today's PCM gear.

tracks constant at about 1.2 meters per second.

Last spring, at a joint news conference held in New York, Sony and Philips announced plans for marketing their disc system. Europe and Japan will see the players in late 1982 if plans hold, while the U.S. introduction may be early in 1983. Both giant electronics firms know that disc availability will be critical for the new system to succeed. They've made arrangements with the Polygram Group, a major worldwide record company, and CBS/Sony Inc., the largest record firm in Japan, to produce albums in the new compact format.

JVC's digital disc

The second digital audio-disc system we're likely to see next year is AHD (audio high density), developed by JVC with its videodisc. This format carries audio information as multiple rows of pits arranged in spiral tracks

on discs. The disc rotates at a constant 900 rpm. A diamond pickup stylus with a metallic section glides along the surface of the grooveless disc, guided by additional tracking signals located alongside the audio tracks. AHD discs are made with an electroconductive plastic. The stylus reads millions of tiny pits as changes in capacitance. This information is translated into digital signals and then into hi-fi audio signals. Discs are 10.2 inches in diameter and are automatically loaded from a protective case slipped into the player.

JVC says it plans to market its videodisc player, used to play AHD digital discs, at a price that's competitive with the \$500 capacitance-type video machines made by RCA and others. But it has not said how much the additional digital audio processor will cost.

The Japanese company has demonstrated a variety of ways a combined AHD/VHD format could be used. An

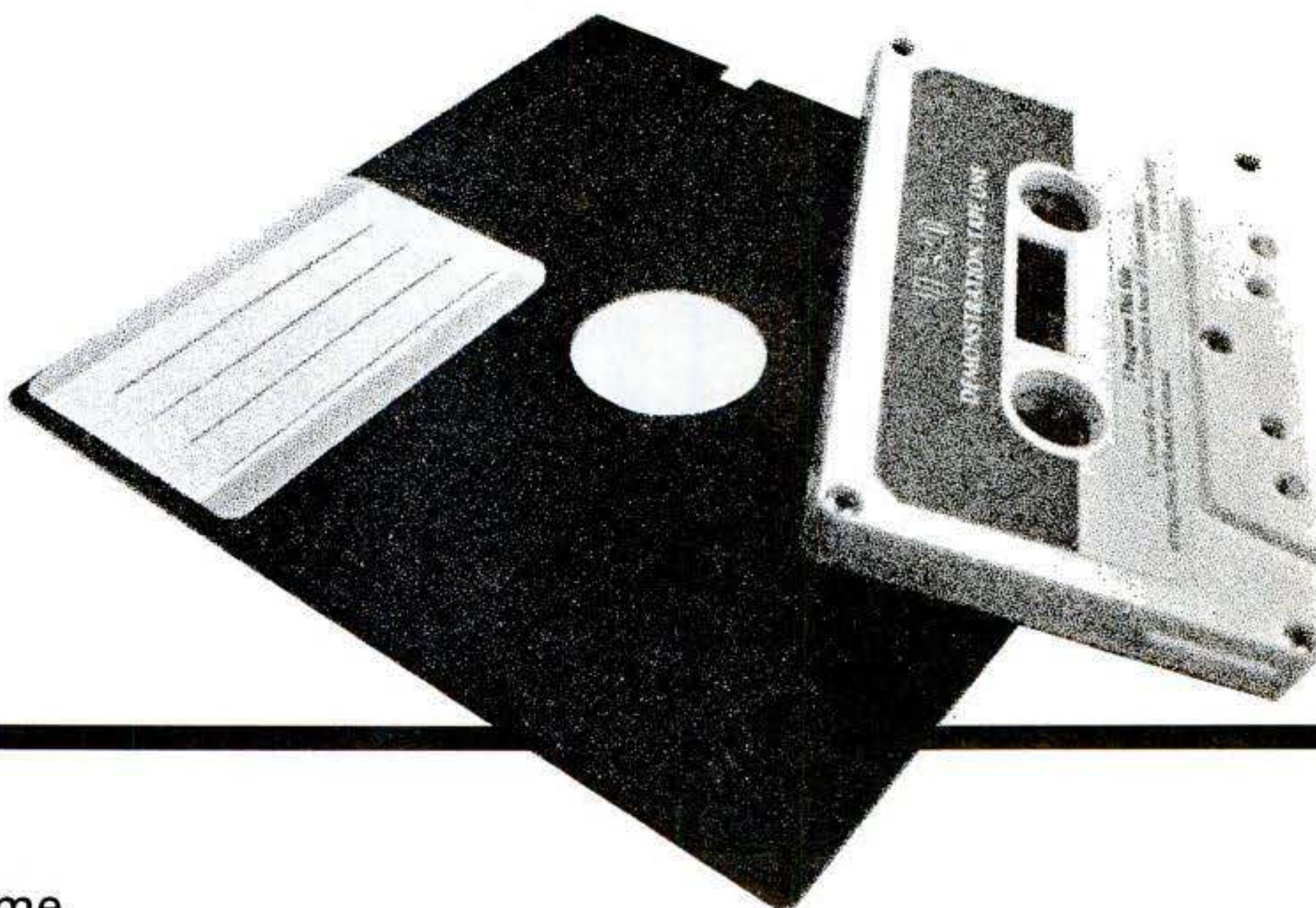
AHD disc I saw demonstrated at an Audio Engineering Society convention was capable of playing either three-channel stereo music or two-channel stereo with still video pictures changing every few seconds.

While JVC's system uses a single player for both video and audio discs, the larger disc size, plus the physical contact between pickup stylus and disc surface precludes adopting the format for car stereo. Sony and Philips executives say this will be an important plus for their compact disc.

Which system, JVC's AHD or the Philips-Sony compact disc, will win? My guess is that JVC's success will be largely with the videodisc portion of its system and that the no-wear, laser-playback compact disc will become a world standard. But the transition to digital audio will be slow. And compact DAD's take up so little space you'll easily find room for your old and new record collections. 15

New software

makes your
personal computer
a real workhorse



No-nonsense "plug-in"
programs you can use at home

By **WILLIAM J. HAWKINS**

A computer is not like any other electronic "appliance" in your home or office. Sure, anybody can buy one, plug it in, and switch it on—it might even light up for you. But beyond that, computers are not designed to do any one particular thing.

To do work, a computer needs software—the programs containing the digital instructions the machine is to follow to get the job done. What job? That varies—from checking your spelling to spelling out your check book. Change the program, by changing the disc or cassette tape, and the computer becomes a totally different beast of burden.

Recently, the number of programs available for personal machines has increased enormously. Hundreds of software producers are creating thousands of new programs to make your computer do a variety of jobs. Naturally there are just too many to list, but the random sampling below will give you some idea of how versatile these programs—and your computer—can be.

The names of computers required to run each program are given or CP/M is specified. (This is a disc-operating system made by Digital Research, Box 579, Pacific Grove, Calif. 93950, which allows the program to run on many different home or personal machines.)

● For lawyers, there's the LTA—Legal Time Accounting—package, from Commodore (681 Moore Rd., King of Prussia, Pa. 19406). Written for use by the Commodore model 8032 computer, LTA keeps track of client

and case files, logs entries with automatic posting, and prints individual statements. LTA comes on disc and divorces you from \$595.

● Time for the yearly budget—time for days of numerical charts and table preparation. The cure: T/Maker II, from Lifeboat Associates, 1651 Third Ave., New York, N.Y. 10028. The T stands for table; the program uses your input info to create any type of table you need. Change a number or redesign the table format and T/Maker reprints everything again—in minutes. The program also allows textual information to be added and edited. That lets you explain all those red numbers—\$275 for CP/M disc-based computers.

● Push a button and your computer checks 20 pages of text for misspelled words in less than a minute. Spellguard, from Innovative Software Applications (Box 2797, Menlo Park, Calif. 94025), comes on a CP/M-compatible disc along with a 20,000 word "dictionary." The program automatically compares each word in the text you've created (using any of the standard text editors) with the dictionary. Incorrect words are flagged in the text for fixing; words can be added to the dictionary at any time. Multiple dictionaries can also be created (for technical terms, for example). This program really demonstrates how a tedious task (if you spell as I do) can be totally eliminated by a computer. I've been using it for some time and wouldn't trade the program for a typing finger.

● Some types of BASIC programs run slowly. That's because BASIC interpreters must translate each pro-

gram step into the machine code that computers use most efficiently. One way to speed up software is to use a program called a compiler that converts BASIC programs into machine code initially. Hayden Book Co. (50 Essex St., Rochelle Park, N.J. 07662) offers a \$200 compiler for Apple computers with Applesoft BASIC in ROM, an autostart ROM, 48K (kilobytes) of memory, and disc drive. Using this, programs run two to 12 times faster. A plug-in module for the game-paddle socket is needed to use the compiler (to prevent illegal copies from being used on other computers).

● The Atari Personal Financial Management System is divided into five parts: A record keeper, budget manager, budget analyzer, budget forecaster, and checkbook keeper—all designed for home use on an Atari (1265 Borregas Ave., Sunnyvale, Calif.) model 800 computer. Disc price: \$75.

● Got to get organized? Get Critical Path Management, from Apple Computer, 10260 Bandy Dr., Cupertino, Calif. 95014. The program accepts up to 2,000 activities and organizes them into a single flow of jobs that makes best use of your time. It then provides deadlines—and even gives a production schedule. Price: \$235.

● Finally, for computer operators requiring just a bit more help with programming—or other matters—there's the program called Questions and Answers from the Gospel of Luke. You ask a question, your TRS-80 Level II with a cassette from Next In Line, Inc. (Box 10295, Largo, Fla. 22609), will give you a scriptural response. Donations are \$5. [E]

High- resolution TV

— here come wide-screen
crystal-clear pictures

New video components speed TV systems that match 35-mm-film fidelity

By **JOHN FREE**

WASHINGTON, D.C.

For several days, groups of government officials, politicians, and journalists crowded into a darkened room at CBS's offices here. We'd come to view a rare, one-time collection of video gear. "What we are going to show you," CBS's Joseph Flaherty, vice-president of engineering development, told my group, "is a combination of high-resolution TV, stereo sound, wide-screen TV, and enhanced-color TV."

During the next hour I watched a variety of amazing TV images that had extraordinary clarity—more than five times the detail of television pictures you see on conventional home receivers. The high-resolution pictures, a dazzling match for sharp-focus 35-mm slides, were shown on special "Cinerama-type" direct-view sets and a large-screen projection TV. Other equipment used by CBS, such as microelectronic encoding circuits and a Sony-built digital video recorder, may have a key role—in improved forms—in delivering this new type of TV to you during the 1980's.

Actually, so-called high-definition TV (HDTV) has been available for closed-circuit use in medical schools and business applications for a few years. But it has been limited to live transmissions using only cameras and TV monitors. Recently, professional videotape machines capable of recording HDTV were unveiled. As a result, Hollywood directors may soon put

high-resolution TV to work in producing movies, and broadcast networks will use it to enhance the quality of standard programming.

CBS has still another reason for promoting HDTV. It and other broadcasters require transmission channels to get these super-fidelity pictures into your home. For reasons detailed below, high-resolution TV can't be carried easily on regular TV channels—and no one plans to disrupt today's standard TV programming based on the 525-line NTSC (National Television Standards Committee) format.

But HDTV can be transmitted into homes by direct-broadcast satellite. CBS is telling officials that it's vital to reserve HDTV frequencies on a new class of satellites slated for launch within a few years.

More pixels, better picture

How does HDTV differ technically from standard TV? Standard NTSC sets, functioning perfectly, can display 483 (not 525) horizontal scan lines created as electron beams paint TV pictures by sweeping back and forth over picture-tube phosphors. Each horizontal scan line can resolve, or display, 436 separate picture elements, called pixels—an NTSC picture can display 210,588 pixels.

In practice, new sets equipped with so-called comb filters [PS, Aug. '78] show only about 330 horizontal elements; most older sets average only about 250 picture elements per scan line. By contrast, although no firm standards have been set, a 1,125-line HDTV picture might contain not twice but some five times as many pixels (one million) compared with an ideal NTSC image. Each one of the high-resolution scanning lines carries more image detail, and each is longer

because of the wide-screen picture format. As a result, high-resolution TV requires more frequency space, or bandwidth—typically, 30 MHz versus 4.2 MHz for standard NTSC TV.

"The NTSC system has given us very good service during the last 25 to 30 years," said Flaherty, "but we are pressing it to its maximum as pictures get larger and larger." A demonstration made this very apparent. Two cameras were set up in an adjacent room overlooking a street. One was a state-of-the-art CBS camera to display standard 525-line TV pictures. The other was a 1,125-line model made for Japan's public broadcasting corporation (NHK).

The 525-line camera piped its pictures to a Kloss projection TV before us with a six-foot-diagonal screen (and to regular TV studio monitors). The NHK HDTV camera sent its pictures to a Matsushita-built wide-format projection TV and wide-format monitors (see color pictures).

Pictures of a bowl of fruit were impressive on the 525-line Kloss and smaller monitors. But contrasted with the crystal-clear images on the HDTV sets, the limitations of NTSC pictures were dramatic. Training both cameras on the street below produced even sharper contrasts. I could read license plates and other vehicle lettering on HDTV sets that were a hopeless blur on 525-line receivers.

Why do today's sets have a squarish picture ratio four units wide and three high? "It was chosen for very simple reasons," said Flaherty. "First, it was all we could do [technologically], and it was the way films were made," he said, describing the 1940's monochrome-TV format.

An HDTV system unveiled by Sony
Continued



Details from images on TV monitor screens contrast the Sony 1,125-line picture (above left) with a standard 525-line view.



High Definition
Projection System



Wide-screen high-resolution monitor developed by NHK and Matsushita has 30-inch-diagonal screen, 5:3 aspect ratio. Phosphor dots are much smaller than on conventional shadow-mask tubes, and NHK uses a digital beam-convergence system.

Projection TV displayed by Matsushita at technology exhibit in Chicago this summer uses red, green, and blue projection tubes like conventional models, but displays high-definition 1,125-line images from TV camera. Screen is 55 inches diagonally.

last spring can show pictures in standard 4:3 format, the extra-wide Cinemascope format, or an intermediate picture width. The high-resolution sets at the CBS demonstration had a 5:3 picture-aspect ratio. In addition to letting you see most or all of the picture from wide-screen movies, sitting close to sharp, wide-screen HDTV images conveys more of the visual impact of a theater screen.

Digital demonstration

Warming up in another CBS office was a special type of videotape recorder completed by Sony just six weeks earlier. Bill Connolly, managing director of development for the CBS-TV network, prefaced another impressive demonstration: "Engineers today are generally agreed that digital techniques are the proper way to record this HDTV information and transmit it," he said [PS, March '78].

Connolly explained that with conventional TV, voltage is proportional to brightness. The brighter the scene at any given point on the screen, the higher the voltage. Since the voltage is analogous to what's on the screen, it's called an *analog* system.

"The *digital* system does something quite different," Connolly said. The voltage generated by the camera is constantly sampled or measured by digital circuits. Each of these samples is then assigned a binary number (zeros and ones) representing its intensity. This technique for each pixel on the scan lines requires considerably more bandwidth, or frequency spectrum, for storage and transmission. While this large-bandwidth requirement is a problem, major efforts are under way to shrink the frequency space needed for digital TV.

"One of the things we can do is reduce the number of bits [binary digits] necessary to describe a picture," Connolly said. He pointed to one of his "favorite symbols," a CBS eye glowing on monitors. Running his finger across one scan line on the eye, he explained that it carried about 150 black pixels, then 200 blue, and 150 black ones again.

"We waste a lot of [frequency] spectrum with analog TV because we transmit every one of those things using the whole bandwidth," Connolly said. With digital techniques, though, a single brief signal can be encoded that tells the digital circuits in the receiver to create 150 black pixels. This coding of the digital signal, requiring perhaps only a few dozen bits instead of hundreds of repetitive signals, cuts the rate at which bits must be transmitted—plus bandwidth requirements. Similar bit-rate-reduc-

tion coding can produce the 200 blue and 150 black pixels for an "eye" scan line.

John Rossi of the CBS Technology Center (Stamford, Conn.) demonstrated a CBS 4:1 bit-rate-reduction system with an analog videotape machine. An NTSC 525-line test pattern shown on monitors was created by a digitally coded signal that required only 28 megabits (million bits) per second instead of the 144 megabits/sec. from the original digital sampling.

"This is a very simple bit-rate-reduction technique," Rossi said. "The circuits can literally be held in the palm of your hand. This leads us to believe that with more-complex circuits much higher bit-rate reductions can be achieved."

"Failing these bit-reduction schemes, HDTV will not be broadcastable," added Flaherty. He hopes to fit digitally compressed high-resolution TV into a normal or nearly normal TV channel. "Much work has yet to be done," he said, "but you can see we've achieved a 4:1 reduction in bits fairly well, transmitting a roughly equal-quality picture."

That test-pattern picture I saw had some noise but carried the fine detail indicating most of the image was getting through. For this demonstration, a normal 4.2-MHz, 525-line NTSC signal became a 114-megabit/sec. digital signal that was compressed into a 28-megabit/sec. signal. But that digital 525-line signal would require about four VHF channels on your TV set. An HDTV signal, even before it's digitally sampled, requires about five.

Pouring marbles

Why, if digital coding of a TV signal takes up so much more frequency spectrum, isn't high-resolution TV more feasible with analog signals? High-frequency noise is one reason. Noise, which can spoil standard TV images, devastates HDTV.

Connolly demonstrated another advantage of digital TV by first showing a 525-line analog-signal picture of a fruit bowl from tape. Then he showed the same picture after it had been re-recorded 10 times—a tenth-generation copy. The image was smeared, full of noise, and color values were shifted. For broadcasting, about five generations is the limit, he said.

But scenes that followed from tenth- and even twentieth-generation *digitally* coded tapes seemed unaltered from the originals. Connolly compared analog taping to pouring water from one glass to others: Some water sticks to each glass; retaping, similarly, robs parts of the original signal with each generation.

Digital signals, by contrast, are either the presence or absence of pulses on tape. They survive transmission and taping much better, and Connolly compared the digital technique to pouring marbles from glass to glass. The marbles (digital bits) get through unchanged.

CBS engineers were impressed with Sony's new digital recorder. "In just seven years there's been a 50:1 improvement in the ability to jam bits into a small area of tape," said Flaherty. "We went from under one million [bits] per square inch to 40 million. We only need a 3:1 improvement over that to record [digital] HDTV."

CBS also presented an NTSC videotape made with stereo sound at a Kennedy Center concert. HDTV researchers believe stereo is needed to bring the realism of wide-screen movies and other programs into your home. During the demonstration of a Mozart operatic aria, repeated switching between stereo and monophonic modes made stereo's advantages obvious.

HDTV offers superior color, too. A future international high-resolution-TV standard will no doubt provide vivid hues that can't be obtained with NTSC color standards. Moreover, HDTV pictures can be transmitted with luminance (brightness) and color signals separated. Standard TV signals have combined these—disastrous for picture fidelity—to achieve compatibility between black-and-white and color receivers.

You may first encounter HDTV not on a TV receiver but displayed on a theater movie screen. Sony might lease its prototype HDTV gear within a year for Hollywood production work that would be converted to film. Videotaping offers advantages in economy and flexibility.

In a different application, CBS plans to use HDTV in about three years to enhance standard broadcasts: HDTV tapes would permit special production techniques, such as image enhancement and zooming without picture degradation, before conversion to regular NTSC recordings.

Also, cable TV and home videodiscs and tapes may bring HDTV to you in the 1980's. You would need a special receiver or player, but such sources could bypass the standards and regulatory problems of broadcast HDTV.

"The real question is whether this is going to be available to the general public or whether it will be something only for the videophile with the money to buy all these ancillaries," said Flaherty. Getting wide-band HDTV into broadcast channels, he said, "depends on the skill of the engineering community to make it fit." E3

Wind farm's first sprout

Now this 2.5-megawatt wind turbine is flanked by a couple of clones

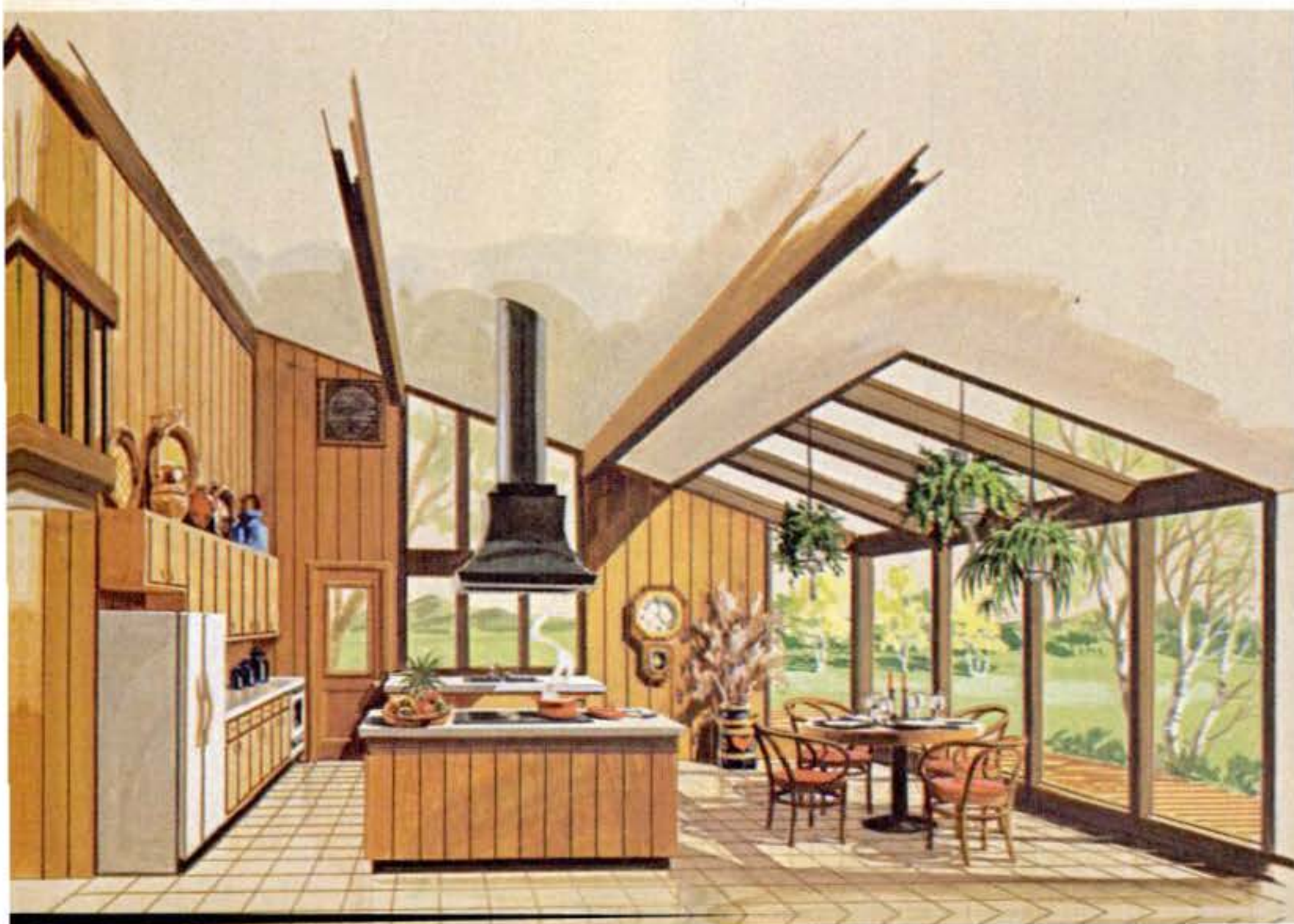
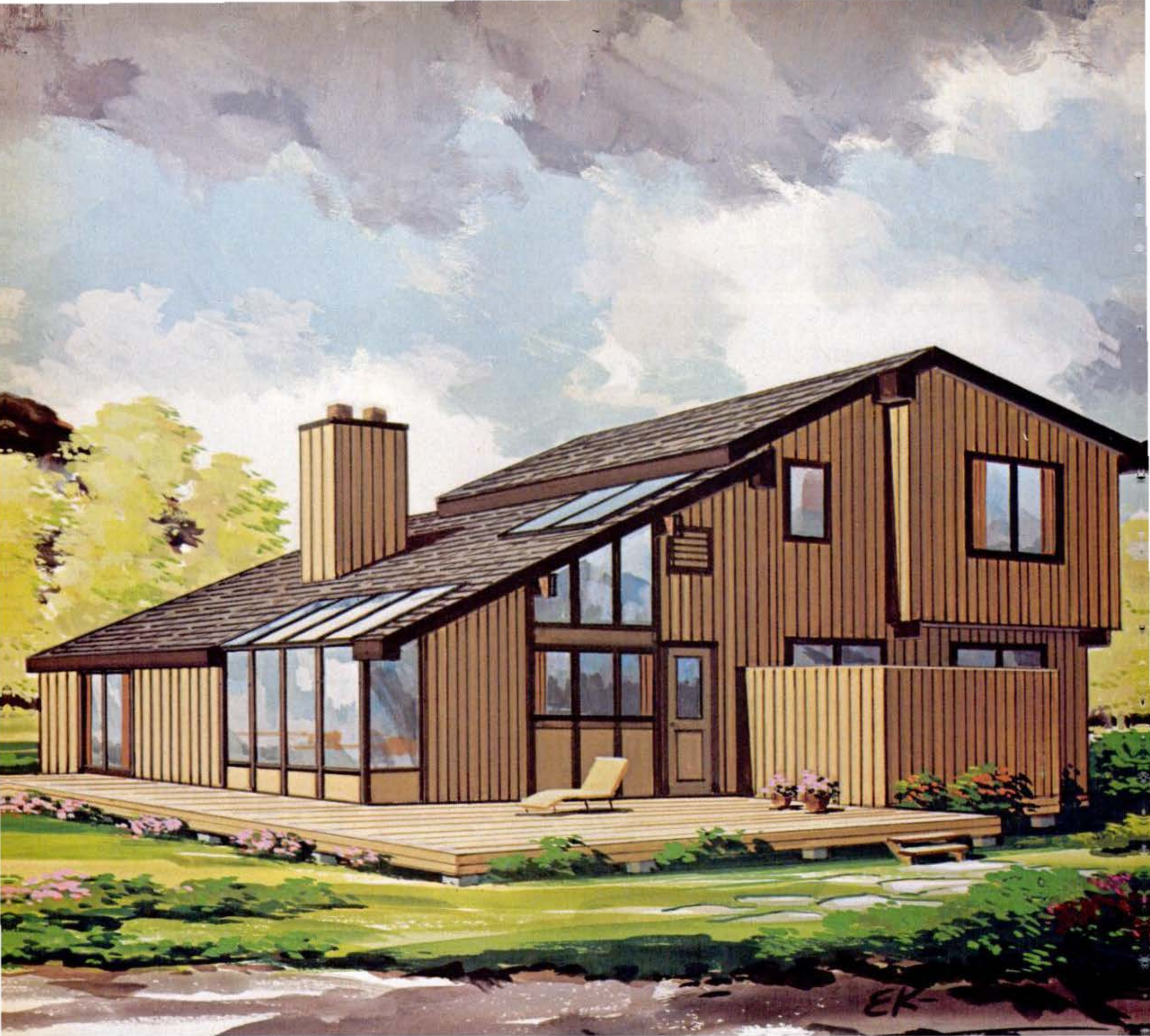
By V. ELAINE SMAY

Silhouetted before snow-capped Mt. Adams, the blade of a wind turbine, a long sliver of white-painted steel, turns briskly in the breeze. A few thousand feet away, placed at the vertexes of an irregular triangle, are two identical turbines. The place: Goodnoe Hills, Wash. The cluster: the nation's first wind farm.

The MOD-2 turbines, built by Boeing under a Department of Energy contract, began generating electricity on an integrated basis last May — "enough for 2,000 to 3,000 average homes," according to NASA's Lewis Research Center in Cleveland, which provided technical management for the project. The electricity is fed into the Northwest power grid by the Bonneville Power Administration.

The turbines' blades are each 300 feet long; the towers are 200 feet tall. Each turbine generates 2.5 megawatts of electricity in 14- to 45-mph winds; the blades rotate at 17.5 rpm. The turbines are completely computer-controlled. Their electricity is expected to be competitive in cost with conventional power. ES





Upper hall features a railed balcony that notches into two-story kitchen space (far left). To right of balcony, note fan near ceiling (above kitchen door) to exhaust hot summer air from entire house.

Solarium kitchen

By AL LEES

COLOR RENDERINGS BY EDWARD KELBISH

Wherever your country site—stream bank, lakeshore, or mountain perch—if you have a view worth framing, this house is for you. Put yourself in that interior on the facing page: Can you imagine a more delightful place to breakfast than that all-glass corner beside the kitchen? It also invites dining under the stars, on evenings too cool to set up on the deck outside.

And if you can site this corner so the big skylight slants due south, you get the bonus of solar gain on bright autumn and winter days—an advantage you can capitalize on with a tile floor over a concrete slab, and with insulating drapes that cover the glass at night.

Though the kitchen corner is the most dramatic feature of this two-story, 1,532-sq.-ft. home, there's a lot to like elsewhere. I wanted to "walk around the corner" to the left in that big rendering, so I asked architect Samuel Paul's artist for the additional sketch, lower right. I like the flair of those two second-story details: the bubble window for the open-stairwell foyer, and the bedroom closet that floats beyond the outer wall. (There's another overhang—an entire wall—for the second upstairs bedroom.) And at the far end of the L-shaped deck you can tack on a hot tub, accessible from both the deck and the downstairs bathroom. For privacy, surround the tub with a six-foot fence, as shown in the big rendering.

Two optional solar collectors uproof of the skylight provide domestic hot water. There's a heat-circulating fireplace in the big living room—plus a backup heater if you plan to winterize the home.

The ceiling of the living room slopes up from the deck wall, just as the kitchen's does. A shrewd floor plan protects the privacy of the ground-floor master bedroom. Note that half of its partitioned bath can be made available for general use, off the foyer. You just lock the door to the private bath section. PS

How to order your plans

One set of detailed, professionally drawn blueprints for this house is \$85; five sets (for construction, financing, obtaining permits), \$115; materials list and specifications included at no extra cost. An additional, mirror-reverse print can be ordered for \$10. Address orders or queries to Homes for Living, Inc. (specify Sonoma Plan), 107-40 Queens Blvd., Forest Hills, N.Y. 11375. Add \$4 to all orders for postage and handling.

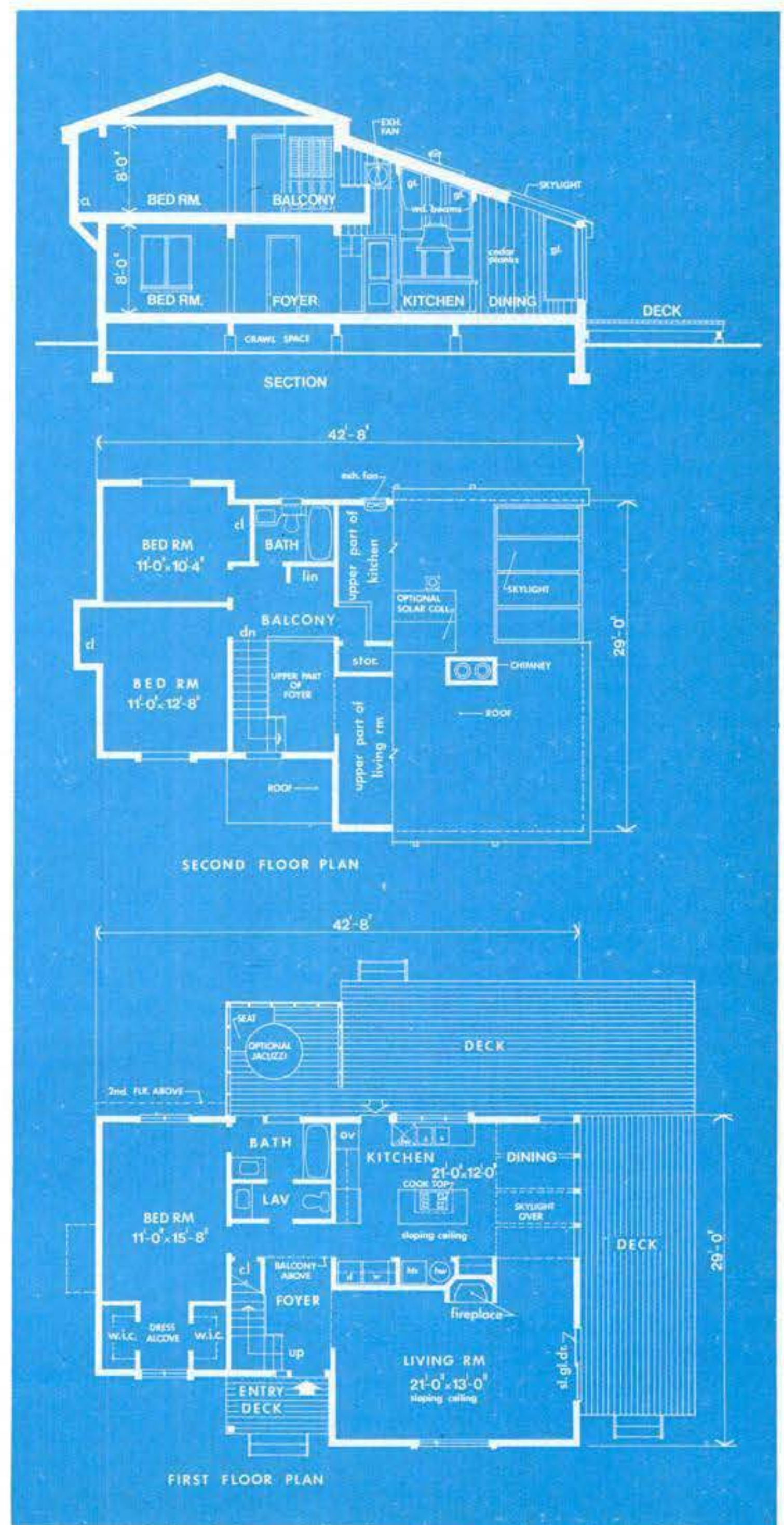


Table-saw alignment

to help you cut like a pro

Precise cuts giving you trouble? They're a snap once you build these jigs

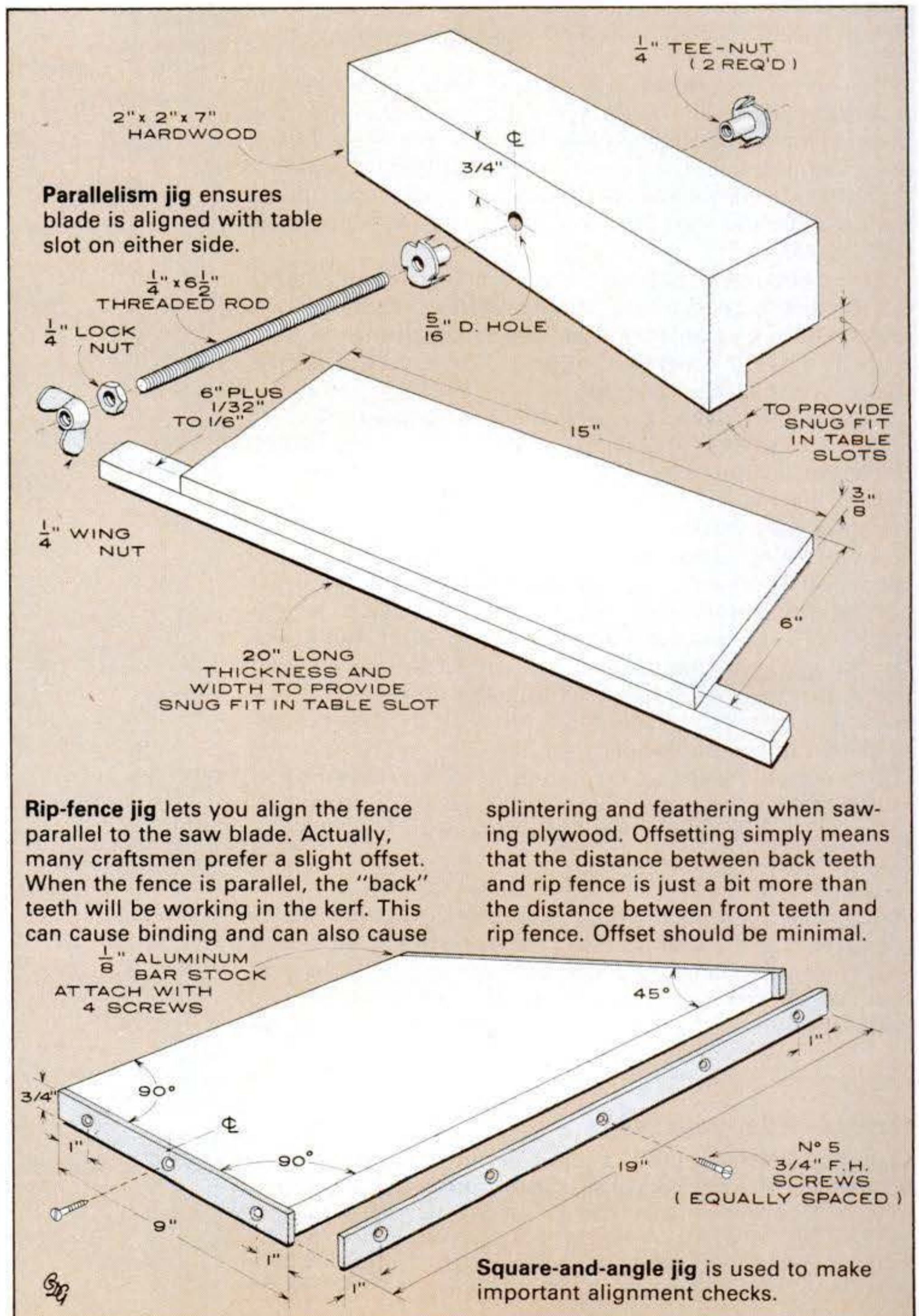
By R. J. DECRISTOFORO

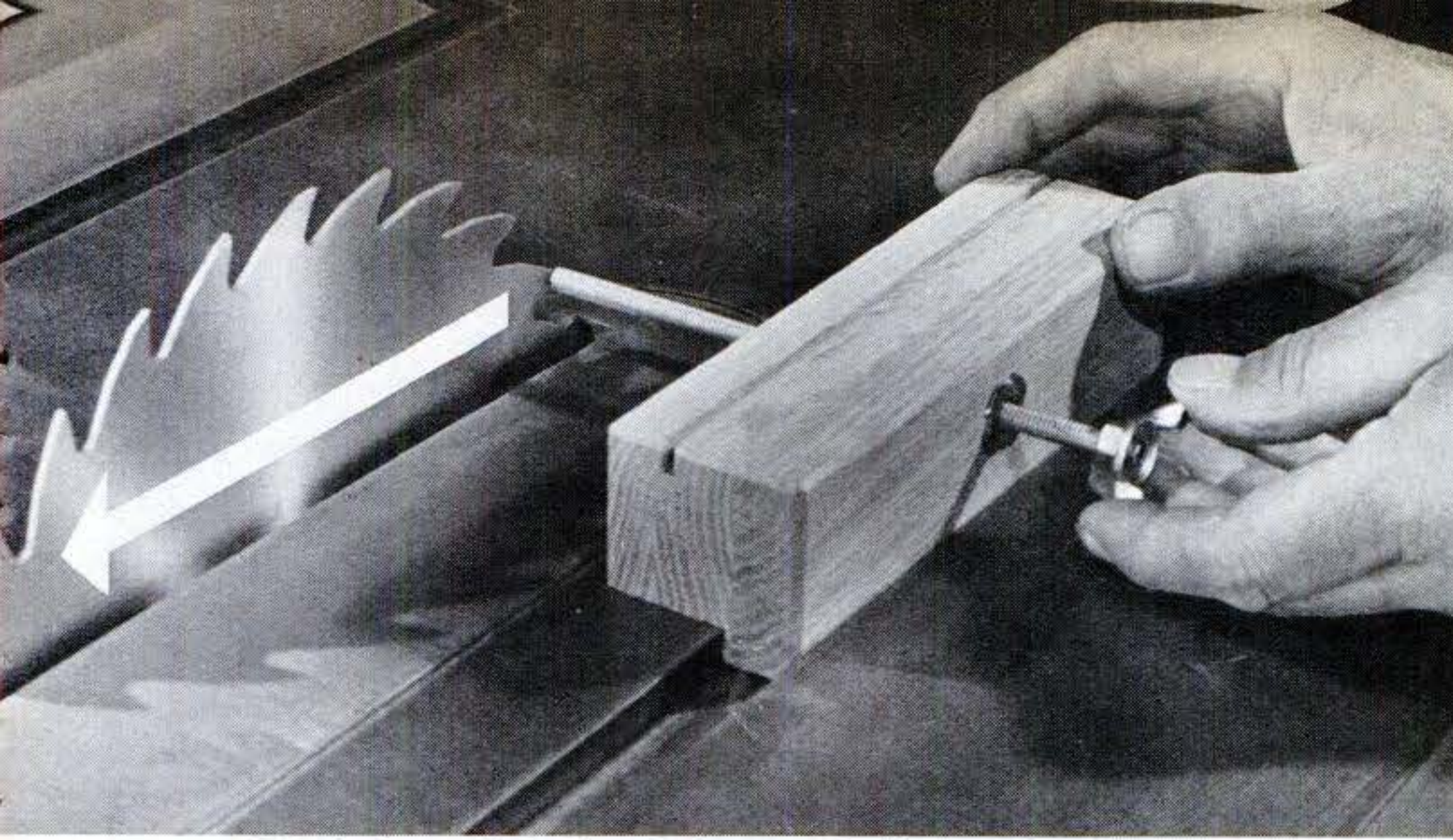
Your table saw is one of the most versatile pieces of equipment in your shop. But modern assembly-line methods being what they are, it's very likely that not all the components of your saw are aligned properly. And in critical cutting situations, such as precisely cutting a frame with mitered corners, your saw's misalignment problems will be magnified.

By making the three jigs shown here and using them regularly, you can be sure that the parts on your table saw are as well aligned as it's possible to make them. Then, when you have a project that requires precision cuts you'll be able to make them with confidence.

One alignment factor you have no control of, however, is how the saw blade mounts on the arbor. Aside from making sure the saw blade, arbor, and collars (or washers) are clean, all you can do is correctly secure the blade, then make all alignment checks in relation to the blade's position. Cleanliness is important: Dirt or wood chips between blade and collars can throw the blade off and even make it work, to a small degree, like a wobble-dado cutter.

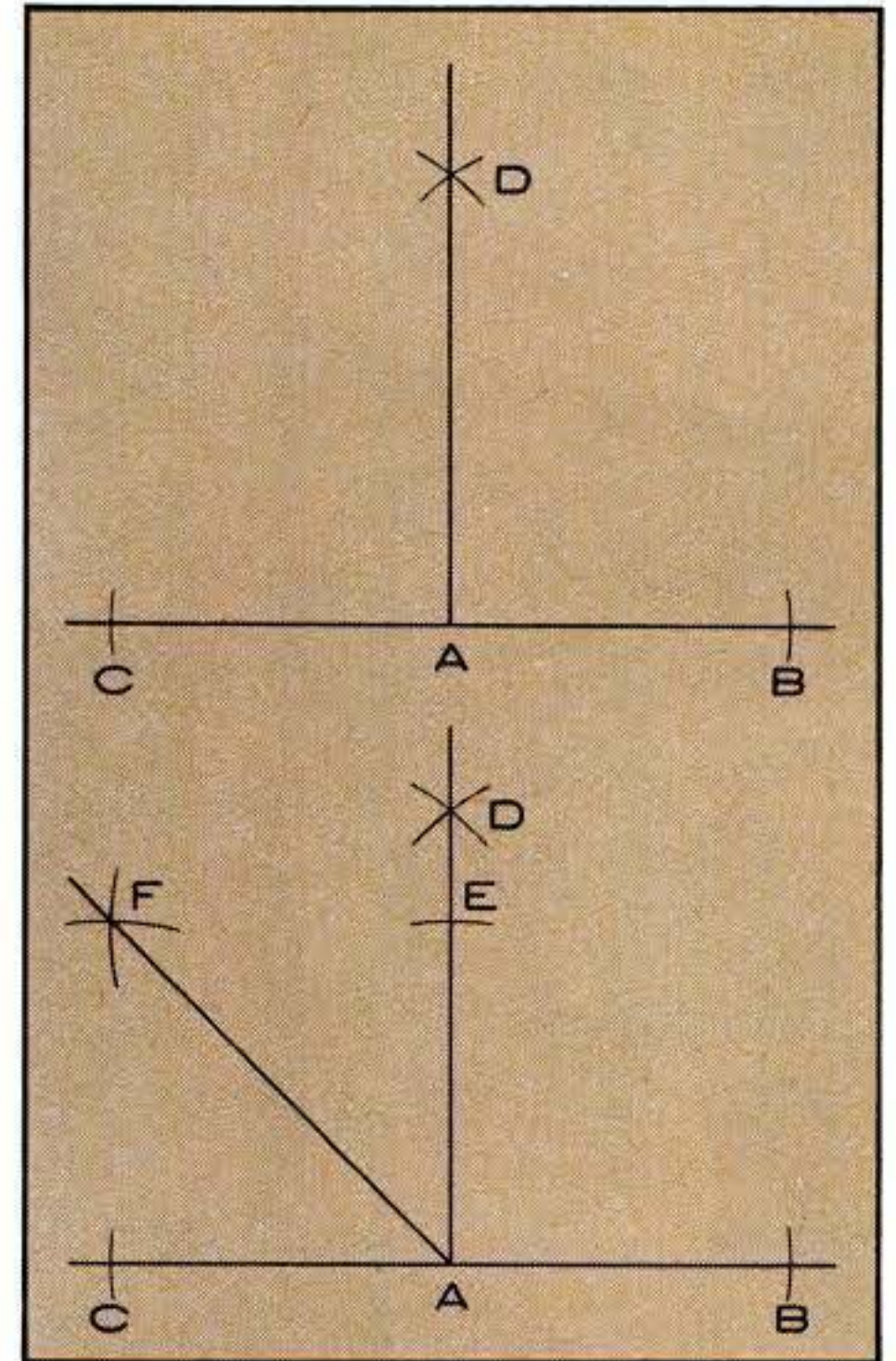
Is it worth making all this fuss about your table saw? If you're a craftsman, it is. Some plus-or-minus tolerances in woodworking are acceptable. But the closer you get your saw to perfection, the better your results will be.





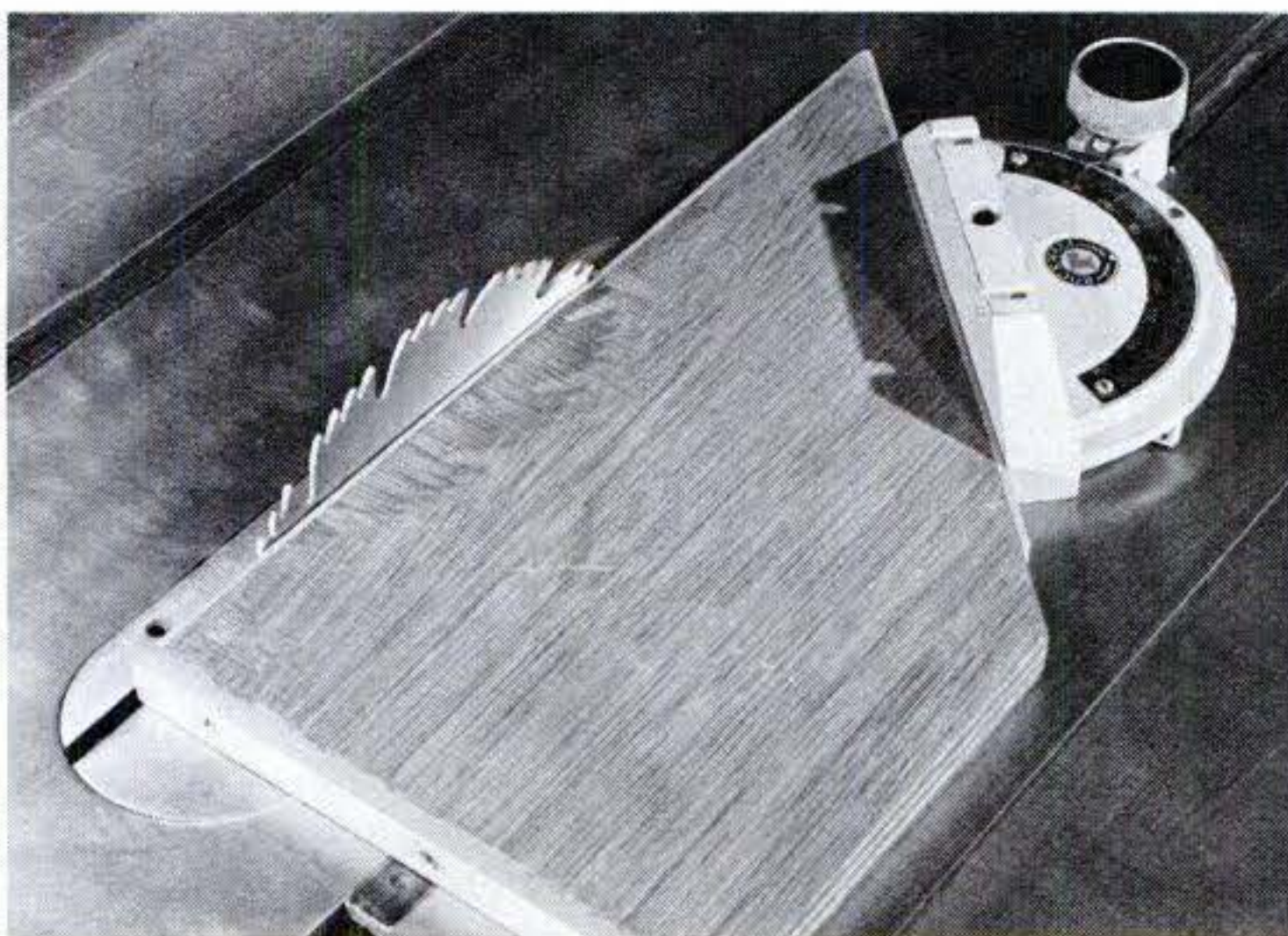
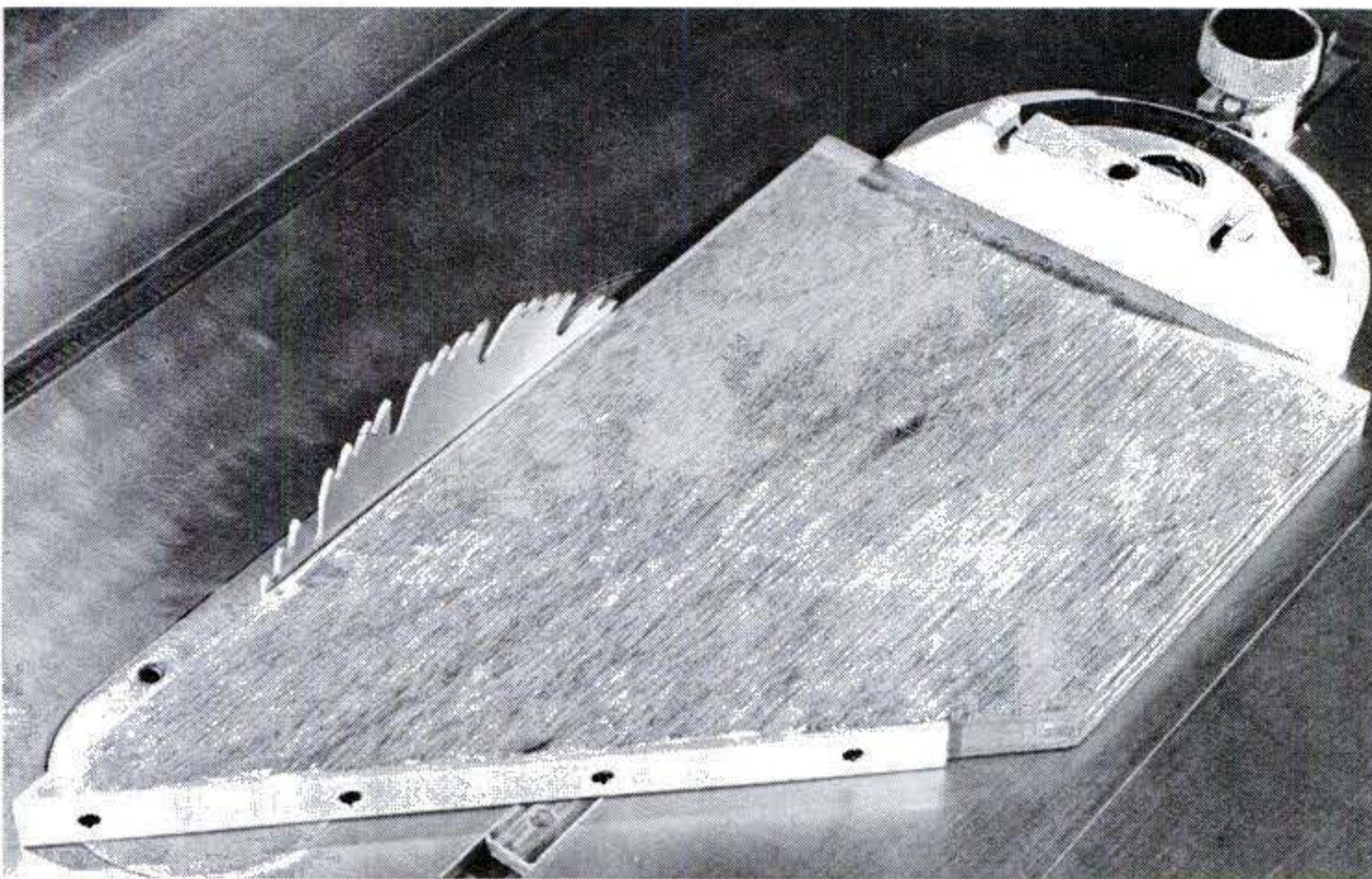
To see if blade is parallel with table's miter-gauge slots, insert parallelism jig in slot. Raise the blade to its maximum projection. Shaft of tool should just barely make contact with a blade tooth. If the blade has set teeth, be sure the tooth is angled toward the tool. Rotate the blade counterclockwise until that same tooth is in the position indicated by the arrow, slide jig along slot until its shaft is in the same relationship with

the blade as it was previously. Shaft should slightly touch tooth as it did previously. If not, loosen the bolts that secure the saw table to the tub and lightly rap the table with your hand to rotate it slightly around the axis of the saw blade until blade and slot are parallel. Then, to guard against disturbing the setting, tighten each bolt in small increments until they are all tight. Make a last check with the jig.

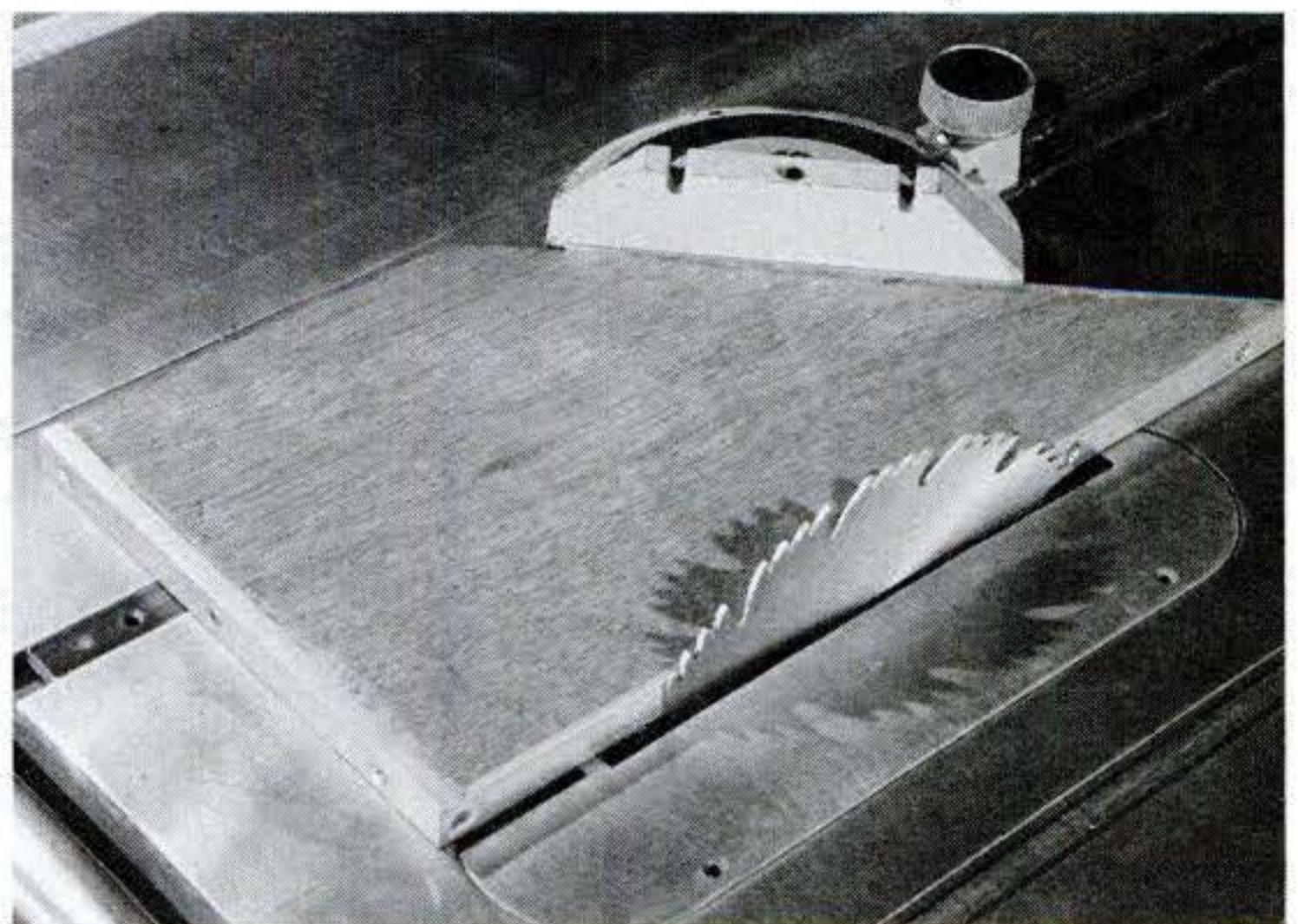


Is your square really square? Is that a true 45-deg. angle? These geometric constructions will tell you. To make a 90-deg. angle (top) set compass for arbitrary radius. From A strike arcs B and C. Lengthen compass, and from B and C strike intersecting arcs D. A line from A through D forms a 90-deg. angle with base line. To make a 45-deg. angle, draw a perpendicular, then using distance A-C, strike arc E. Strike arcs F using E and C as centers. A line from A through F will form a 45-deg. angle between line A-E and A-C.

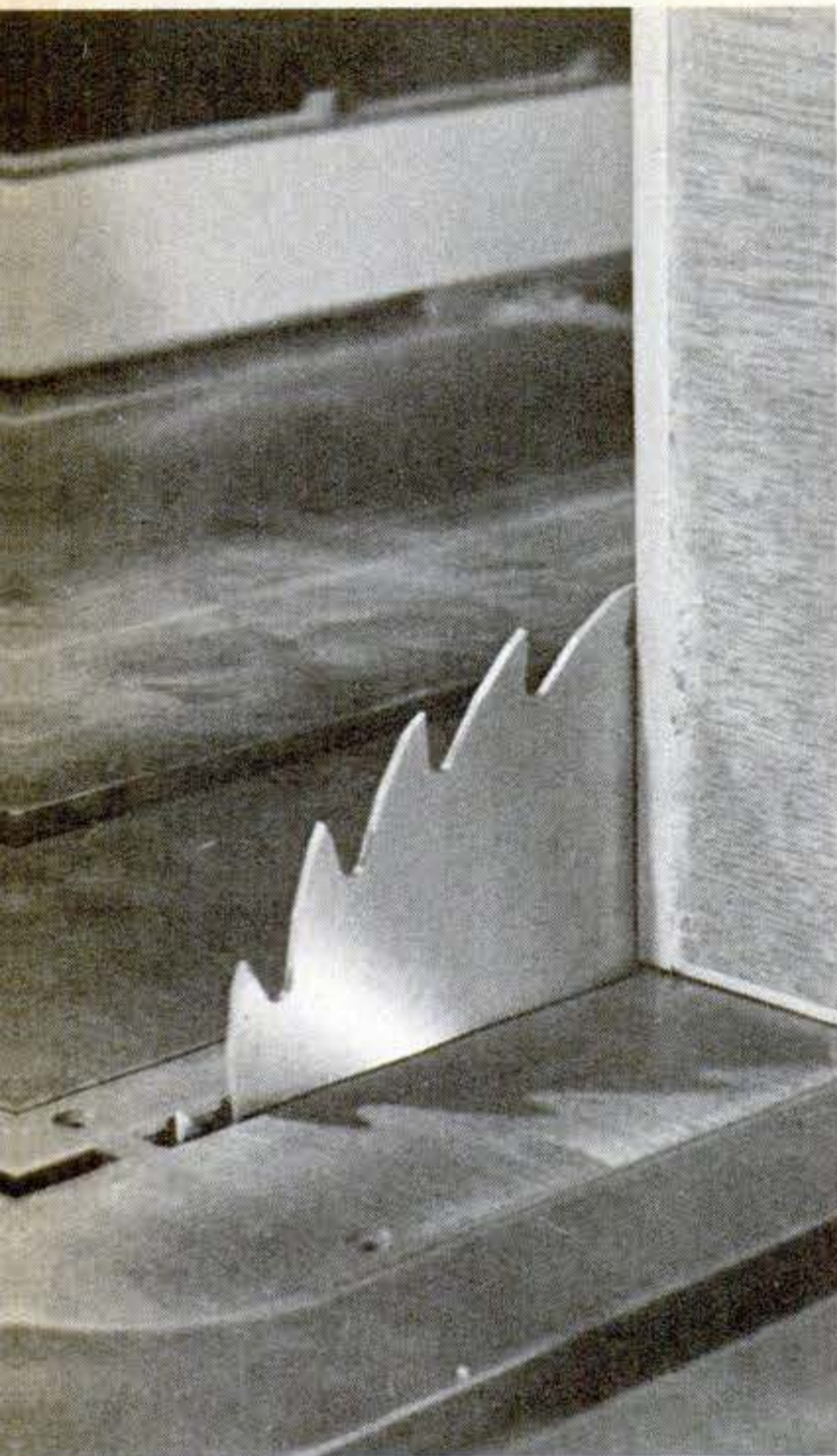
Setting the miter gauge at a 90-deg. angle to the saw blade is easy with the square-and-angle jig. Hold the jig flush against the blade as shown at left. Loosen the locking knob on the miter gauge and advance it until its head sets flush against the jig. Tighten the miter gauge's locking knob. Adjust the pointer on the miter gauge, and, if the gauge is so equipped, adjust the auto-stop so you can return to this position after a change in miter-gauge angle.



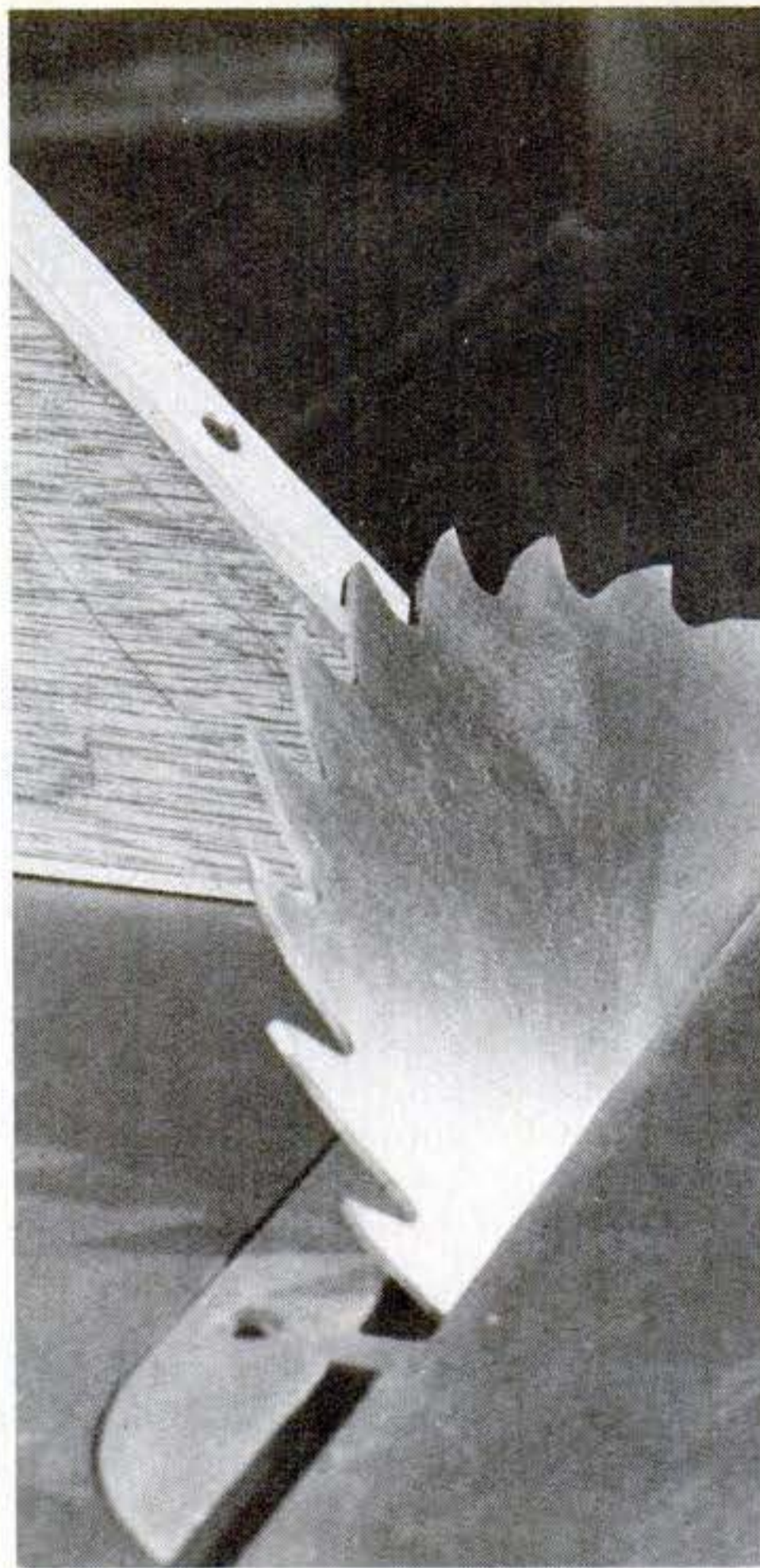
For a 45-deg. cut, follow the same procedure as when setting the miter gauge for a 90-deg. cut, but position the square-and-angle jig so the miter-gauge head can be brought flush against the jig's 45-deg. angle (photo above). Again, lock



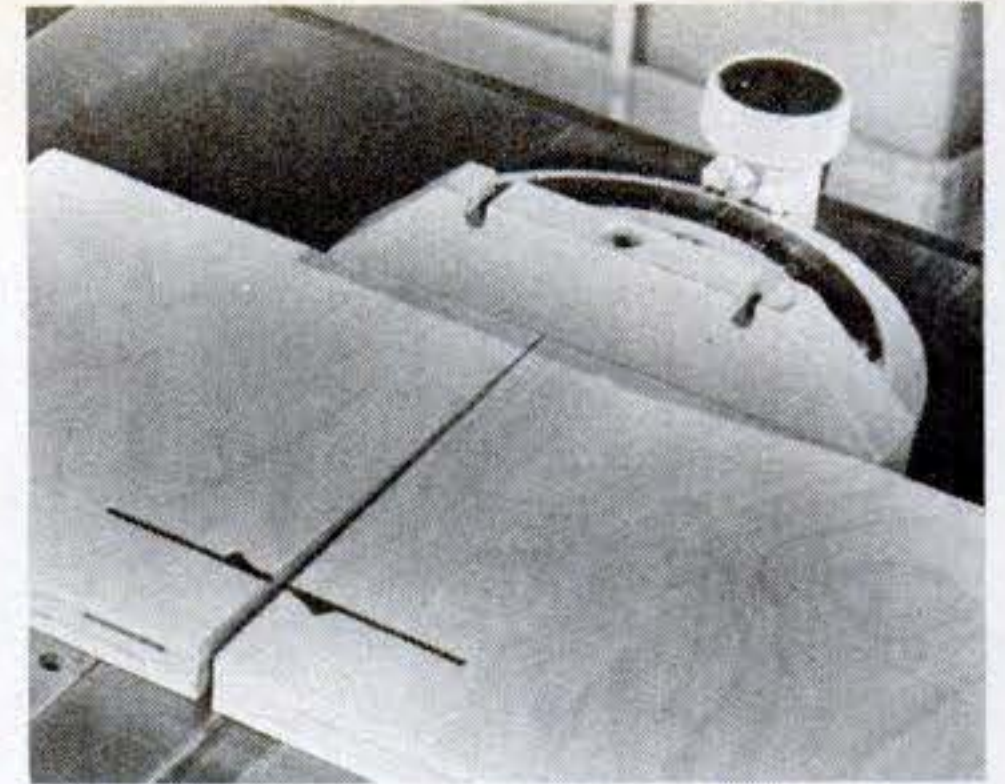
the head in place, adjust the pointer, and set the auto-stop (if any). For an opposite 45-deg. setting, needed when making miter cuts on stock that can't be flipped, follow this procedure with the jig at the opposite side of the blade (above).



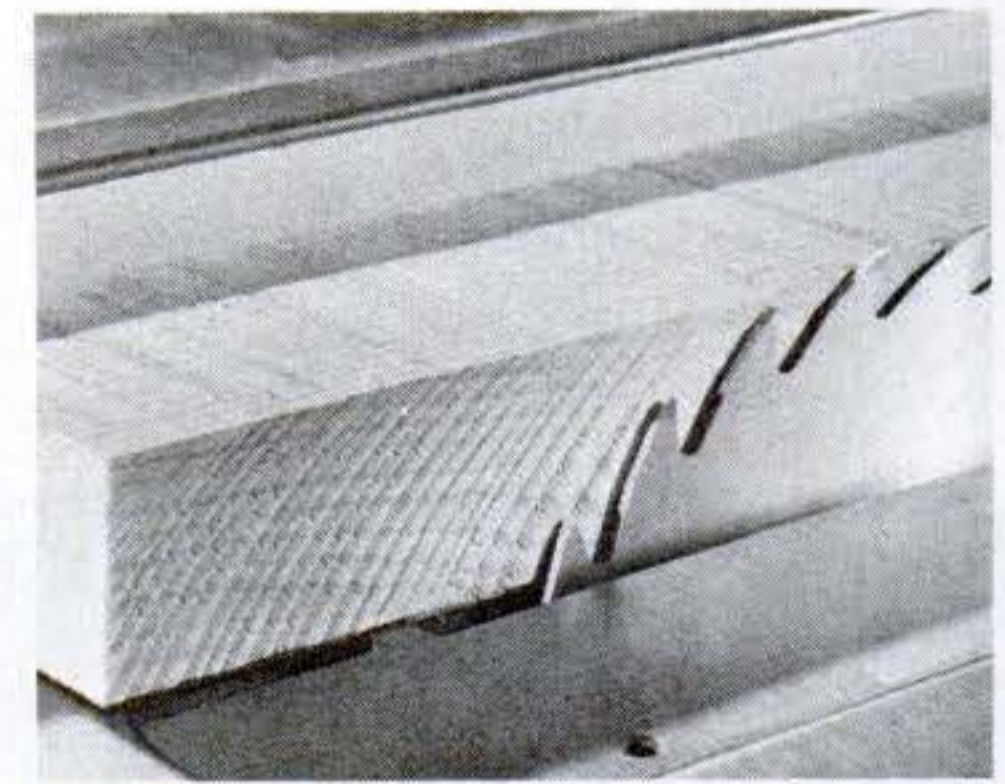
To cut square edges, place the jig upright on the table and against the saw blade. If the blade has set teeth, be sure a tooth that is set toward the jig barely makes contact with it. Set the pointer on the saw's bevel scale, and adjust the



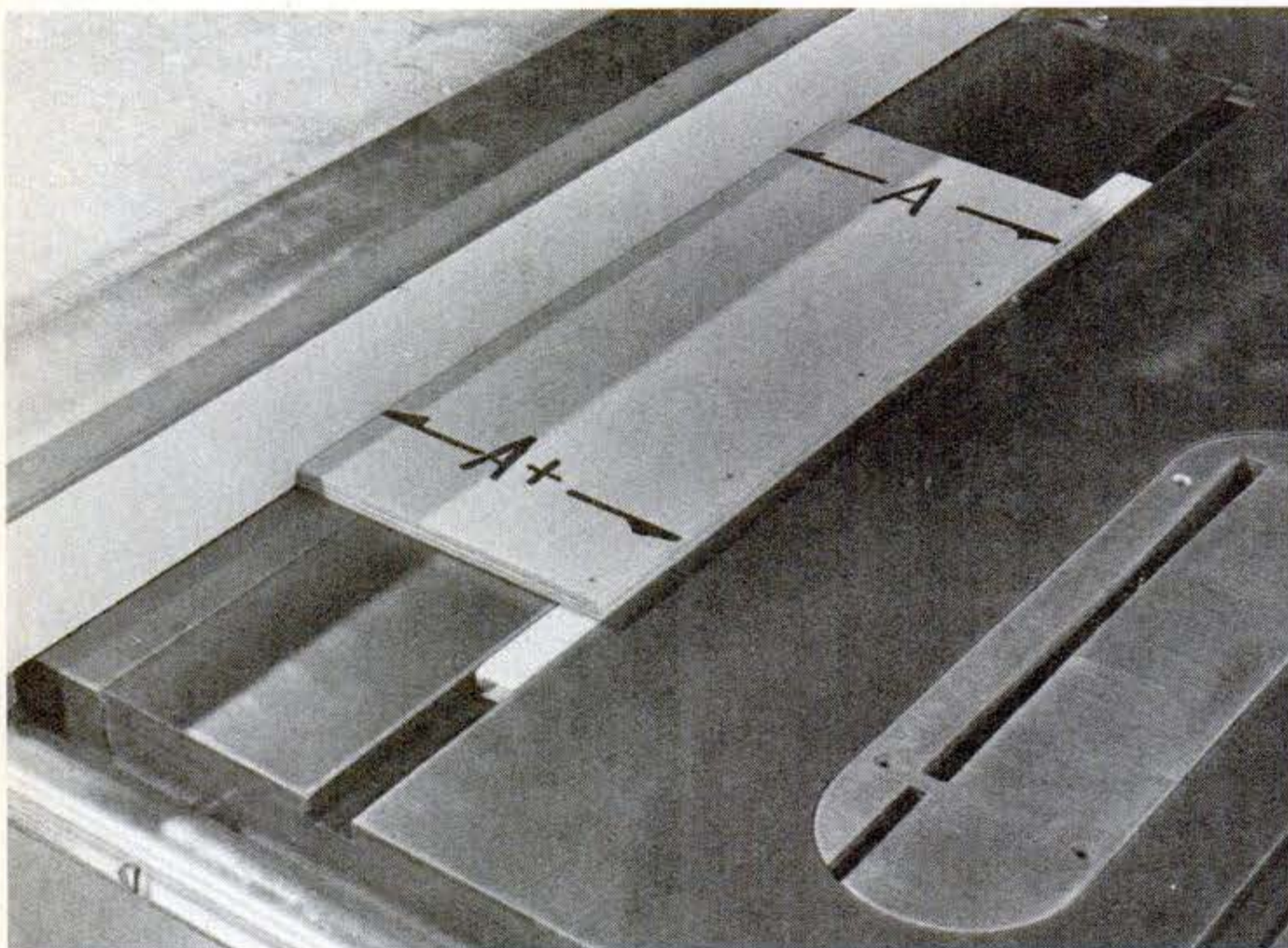
auto-stop. To double-check your work, rotate the blade 180 degrees and recheck. For a 45-deg. bevel cut, follow the same procedure, using the jig's 45-deg. angle. Again, double-check by rotating the blade 180 degrees.



To check crosscut accuracy, flip the cut-off piece and place both pieces against the miter gauge. A V-shape gap, exaggerated here, tells you the cut is not square. Check the miter gauge for correct adjustment and adjust as necessary.

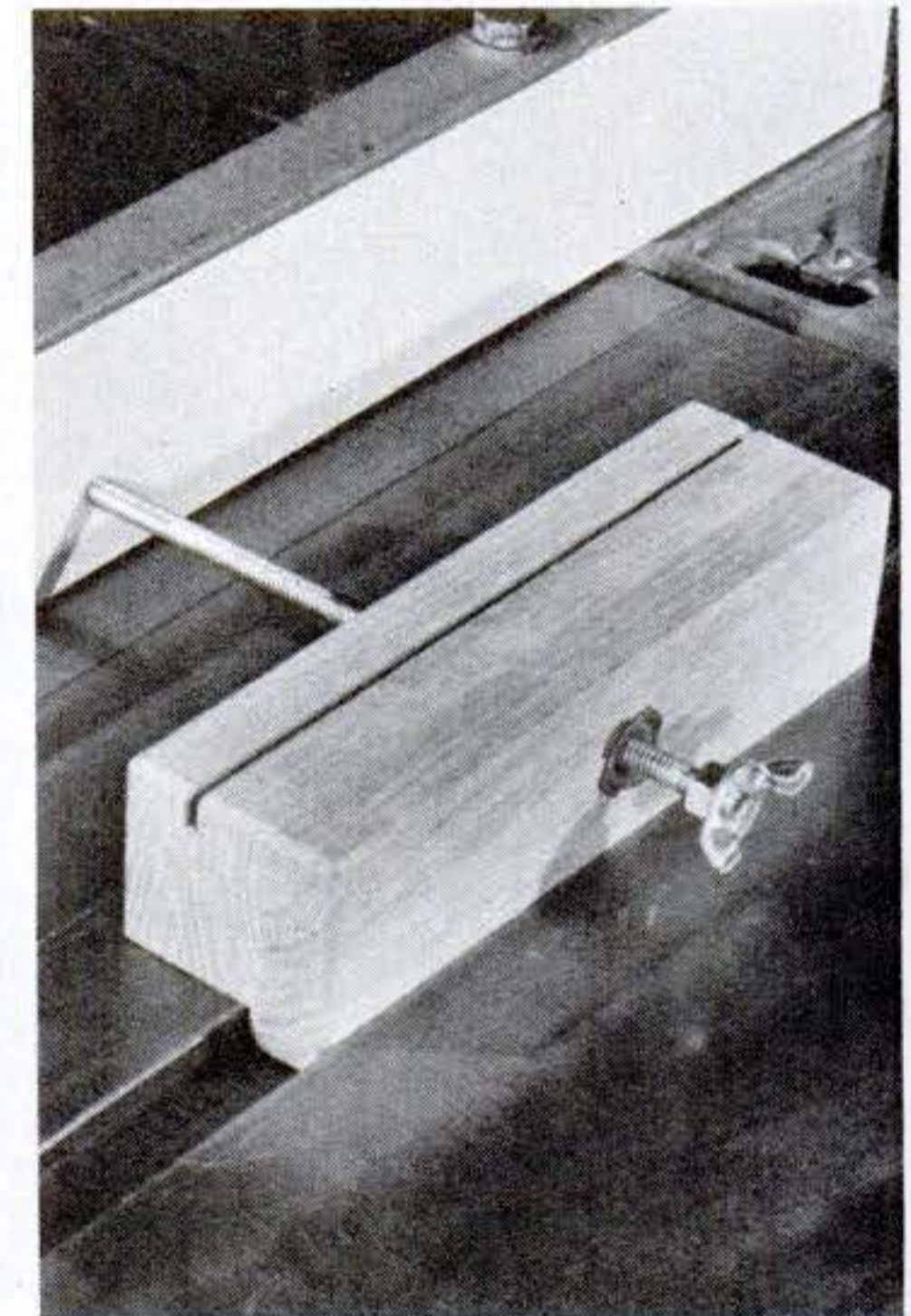


Arc marks occur when the rip fence is not aligned. These indicate that the back end of the fence is closer to the blade than the front end. Marks are more obvious when the blade has set teeth. Realign the fence to solve the problem.



To set rip fence, position jig as shown and move fence until it is flush against the jig. If your jig is six inches wide, adjust the rip-scale pointer to the six-inch mark. Thereafter you can use the scale to set the fence for rip cuts. If it turns out that the rip-fence scale is not precise (and many aren't), then use the scale for

approximate settings. Make the final critical adjustment by measuring between the blade and fence. If the blade has set teeth, measure from a tooth that is angled toward the fence. Remember, changing blades can affect the rip-scale setting. Some blades are thicker than others, and some have more set.



Jig used to set parallelism between the saw blade and table slots can also be used to align the rip fence. If you want to offset the rip fence, turn the threaded rod about a full turn before moving the jig to check the opposite end of the fence. Incidentally, the parallelism jig can also be used as a depth gauge.

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Insulating wall coverings

— energy savings with a decorator look

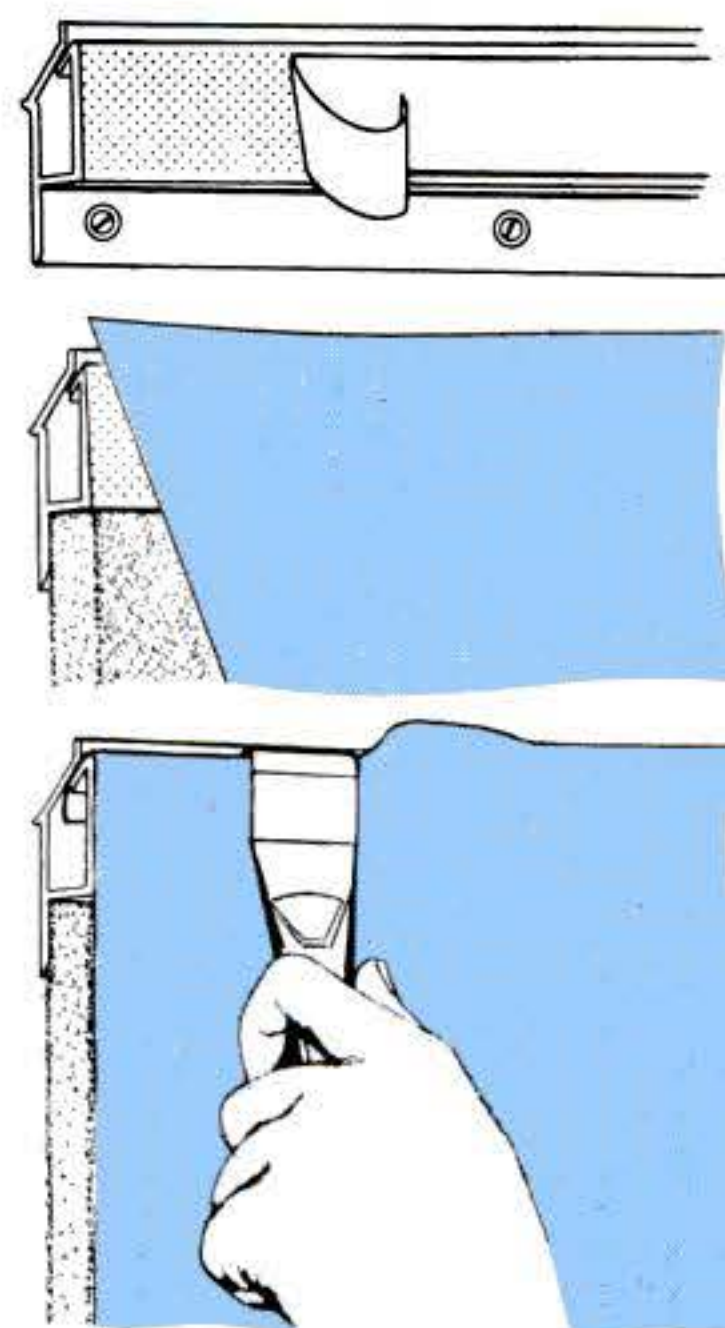
This one boosts the R-value

It started when Floyd Baslow walked into an elegant hotel in London. "The walls were covered with fabric, and I noticed this gimp around the edges," he recalls. "I touched the gimp, and the tape that held it on fell off, revealing a row of nails beneath. There was a lot of confusion," he adds, "so I got out quick."

Thus inspired, Baslow set out to design a system for applying fabric to walls that wouldn't leave nail heads to be covered. The result is Fabri Trak, a PVC frame that grips the fabric. Under the fabric is a 1/2-inch polyester pad, which increases the wall's R-value

by 1.41. It's also excellent sound-proofing. The noise-reduction coefficient is increased by an average of 118 percent when Fabri Trak is put over a concrete wall, according to tests, and by 374 percent with a gypsum-board wall.

Installers are trained by Baslow's company, Unique Concepts, Inc. (59 Willet St., Bloomfield, N.J. 07003), and many work through Sears, Montgomery Ward, JCPenney, and Ethan Allen stores. They put the frame around all edges of the walls and all openings, put up the polyester pad, and attach the fabric to an adhesive strip on the frame. Then, using a special tool, they insert the fabric into the frame. Fabri Trak costs about \$5.50 per linear foot of framing—including everything but fabric.



This one reflects heat

A German-developed wall covering called Thermodecor blocks heat loss through walls by reflecting infrared radiation (radiant heat). The reflective element in the covering is a thin layer of pure aluminum. It's coated with decorative paint that reflects visible light (therefore you see it) but is translucent to infrared radiation. The result: Thermodecor looks like conventional wallpaper, with printed patterns and embossed textures, but reflects 65 to 75 percent of the radiant heat that strikes it (depending on pattern and texture).

Just how much energy you could save by papering a room with Thermodecor depends mainly on your heating system. The more radiant heat it

emits, the greater the potential for saving. About 50 percent of the heat from radiators in a hydronic system is infrared radiation, according to Enertec Systems, Inc. (Box 127, Barrington, Ill. 60010), U.S. distributor of Thermodecor. But a smaller percentage of the heat from a forced-air system would be infrared radiation.

In tests conducted at the University of Munich, Germany, four walls and the ceiling of a small test room were papered with conventional wallpaper, which reflected 13 percent of the infrared radiation, then with Thermodecor, which looked identical but reflected 65 percent of the radiant heat. The room was heated to 21 degrees C (70 degrees F) with three devices: a radiator, a forced-air heater, and a radiant floor heater. With a radiator as the heat source, 15 percent less energy was required to maintain room temperature with Thermodecor on the walls. With

forced-air heat, however, Thermodecor reduced energy consumption by only five percent. The wall covering had the greatest effect with the radiant floor heater, which used 18 percent less energy when the room was papered with Thermodecor.

Reflective wall covering can also save much of the heat given off by objects in a room, which emit infrared radiation after they warm up, and it will reflect back your body heat. The reflective covering makes a room warm up more rapidly, says the company, so it could be a benefit in a room that you heat only for occasional use.

Test marketing of Thermodecor began in early autumn. It sells for \$24.90 a double roll and is applied like conventional wallpaper. Thermodecor-faced ceiling tiles and vertical louvered blinds are to be introduced in the spring.—V. E. Smay



Upholstered walls using the Fabri Trak system need no surface preparation, even if cracked. Nearly any fabric can be used.



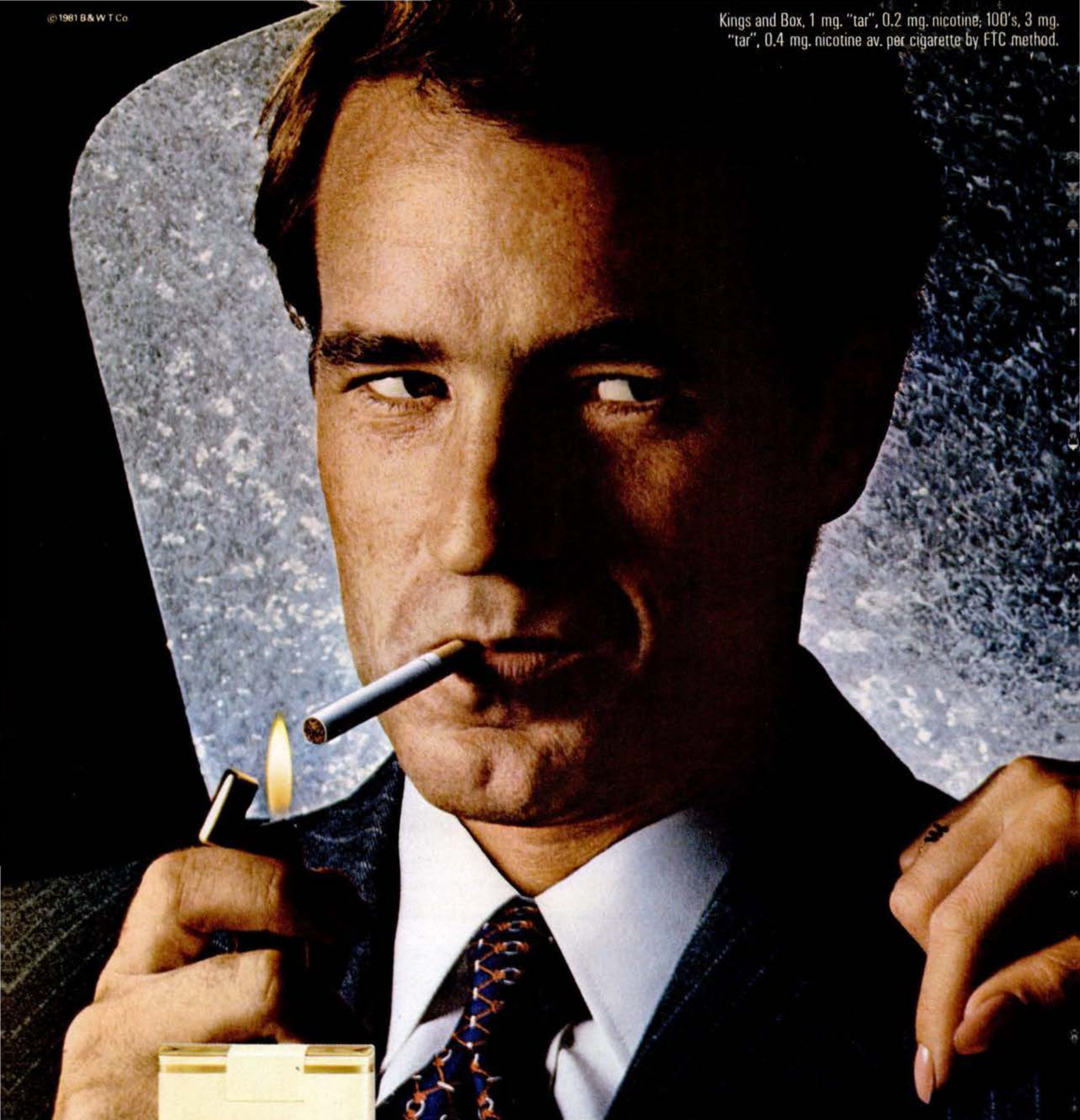
Reflective wall covering looks conventional to the eye (above left) but not to an



infrared camera, which shows that it reflects the body's infrared radiation back



into the room (far right). Ordinary wallpaper (center) shows little reflection.



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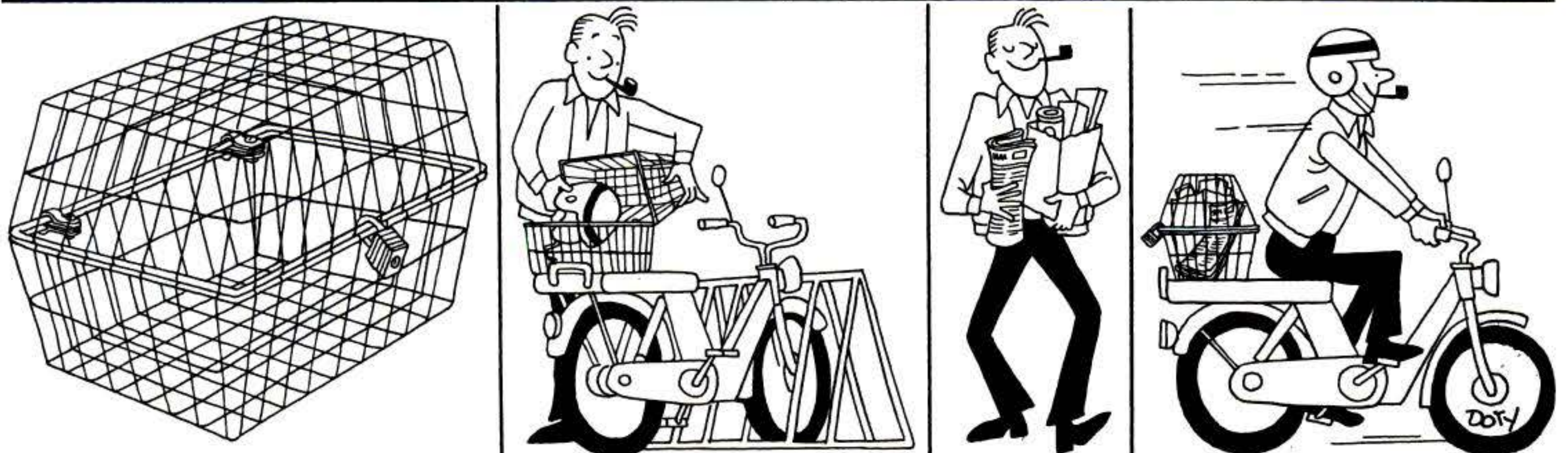
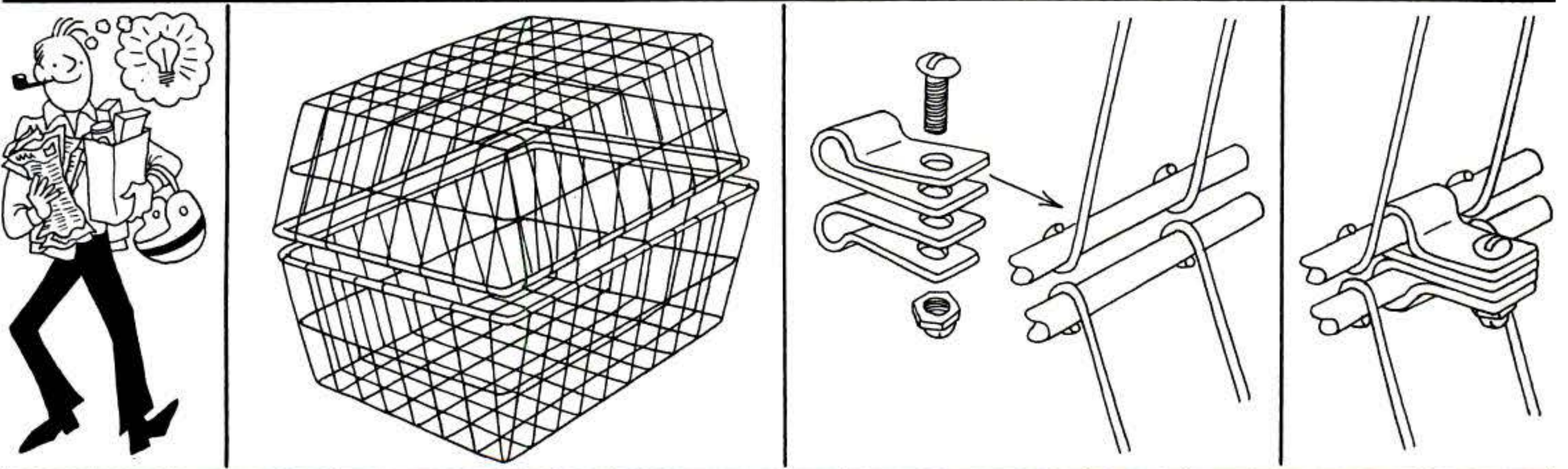
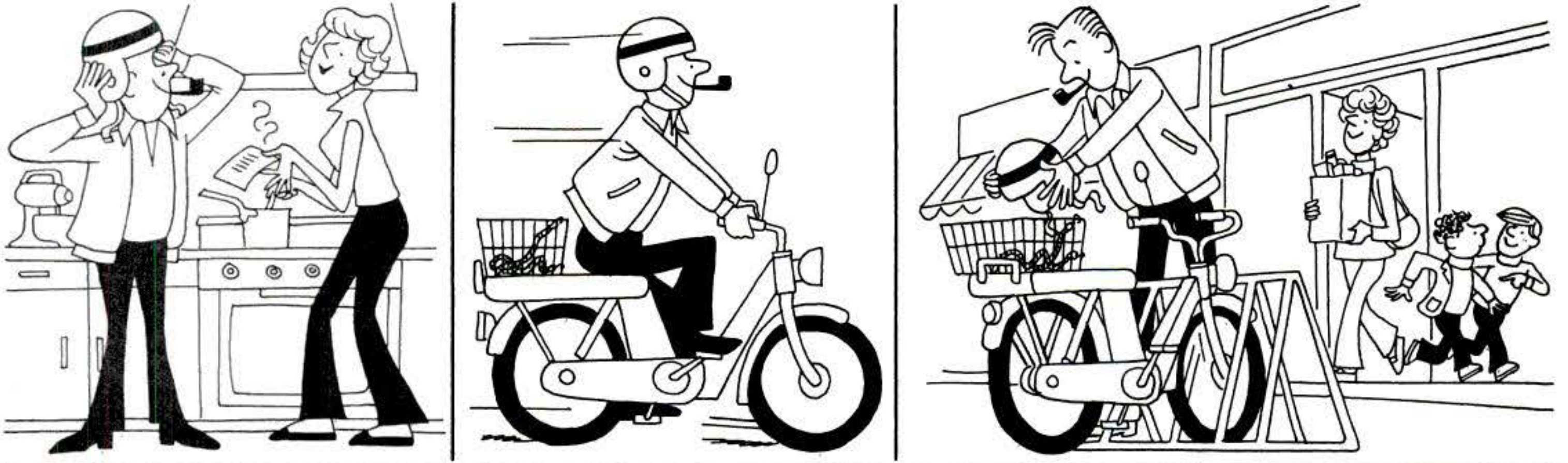
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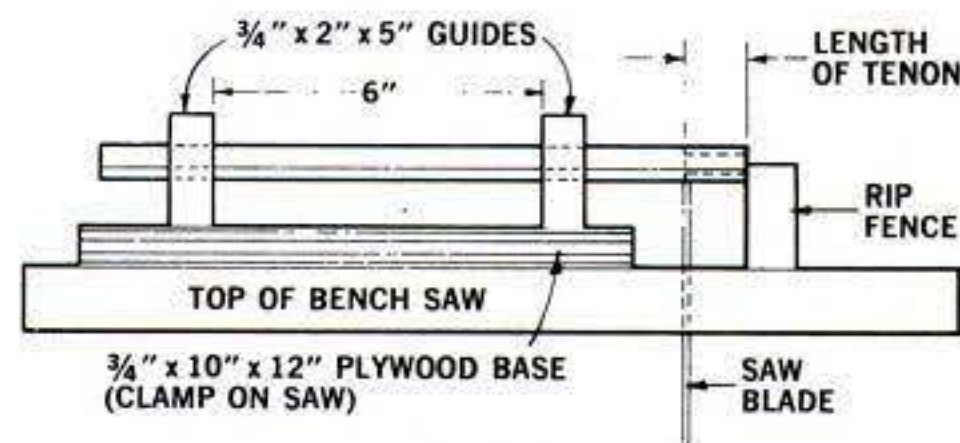
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Bench-saw lathe turning

Don't have a lathe? A simple jig clamped to your bench saw lets you put dowel ends on square rungs. Guide holes 1/4 inch in diameter let you rotate 7/8-in.-square rungs with minimum play. Blade height is set by trial and error to cut off just the right amount as you rotate and slowly advance each rung. I find a plywood-cutting blade gives perfect shoulders with no chipping. A clear plastic shield is useful to block thrown-off chips. The saw gives a rough finish to the tenon, which must be filed smooth.—Arthur V. Baldwin



Radial-saw light



Light up the area around your radial-arm saw by mounting an 18-inch fluorescent tube on the saw arm. The improved lighting makes accurate cutting easier and less hazardous. The added light will also transform the radial-arm table top into a work surface. Connect the light at the saw's on-off switch.—Terry Horton

Glue spreader

White glue should be spread evenly, but many jobs are too small for a brush. I find plastic hair-curler pins useful both as a spreader (flat end) and as a plug for the glue spout (pointed end).—A. V. Baldwin

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Haul-it-yourself concrete systems

The biggest problem with haul-it-yourself concrete is that the water, cement, and aggregate tend to separate ["The Hazards of Buying Haul-It-Yourself Concrete," PS, July 1981]. Now reader William Wetzel writes us about an unusual haul-it-yourself system that he has designed, and is marketing, to solve this problem.

Wetzel's dual-axle Porta-Mix trailer (see sketch) has a transversely mounted mixing drum that holds the ingredients for one cubic yard of concrete. To prevent segregation, the sand and stone are hauled from the batch plant dry and unmixed. At home, you add five bags of portland cement and resecure the loading hatch. The unit's one-hp motor is connected to a 115-volt, 20-amp receptacle and the mixing drum is run through 10 slow revolutions. A garden hose is then connected to the unit's built-in water meter, designed to give

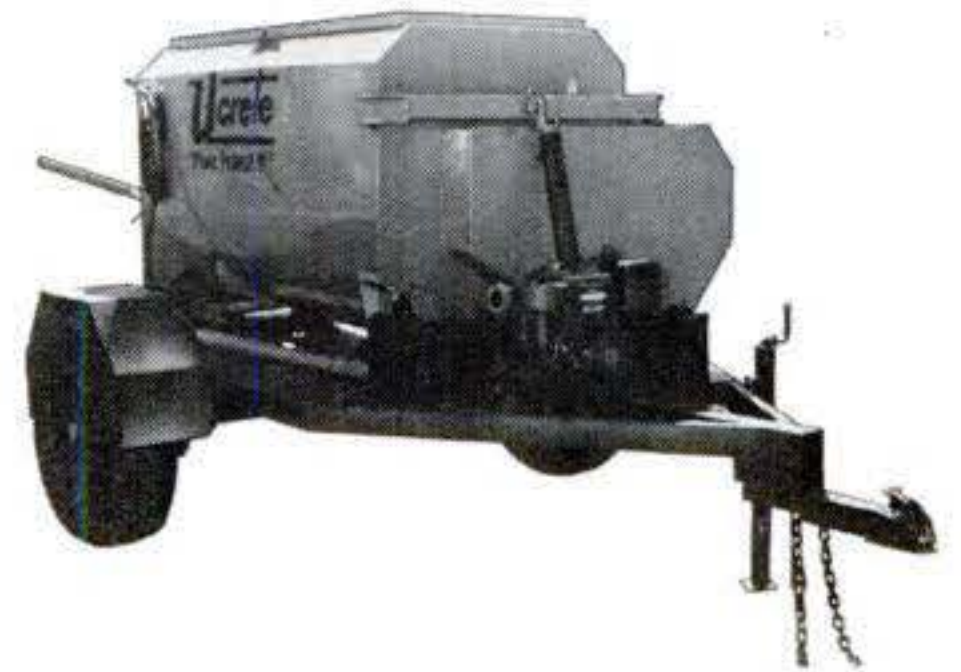
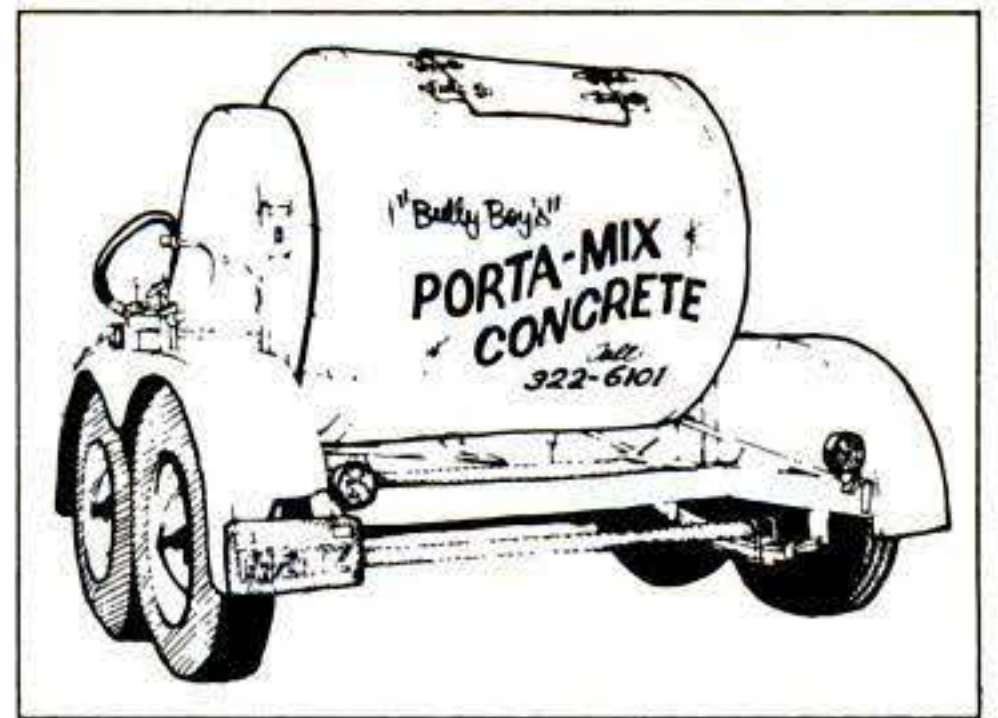
you a workable slump of six inches.

After 40 revolutions of wet-mixing (about 18 minutes), the concrete is ready to use. To dump it, just stop the hatch near the bottom of rotation. One drawback: The hatch must be resecured and the drum turned a full revolution to dump each wheelbarrow of concrete.

Wetzel's success in renting trailers in his home area prompted him to form Bully Boy Co. (2130 E. Brundage Ln., Bakersfield, Calif. 93307) to distribute the equipment nationwide.

PS asked Richard Day, author of our July story, to comment on both the Porta-Mix and another new hauler we'd heard about, made by U Crete Inc., Box 106, Greentown, Ind. 46936. Shown in the photo, it's a tilt-dumping hopper hauler with a paddle mixer. If batched at a ready-mix plant, any settling can be corrected at the job site by remixing before dumping. This unit also holds a cubic yard of concrete and may be towed by a pickup truck. It's self-contained, with an electric-start gasoline eight-hp engine and paddles that are hydraulically powered. The hauler carries a 30-gal. pressurized water tank for cleanup as well as to supply water for site-batched mixes.

Author Day feels that both systems should solve the separation problem.



His only cautions about Porta-Mix are that the dry mix at the plant must still be right, and that dumping might be annoying since the hatch's gasket must be cleaned each time the hatch is closed. As for the U Crete, Day prefers site-batching but feels the remixing option is a good one. PS

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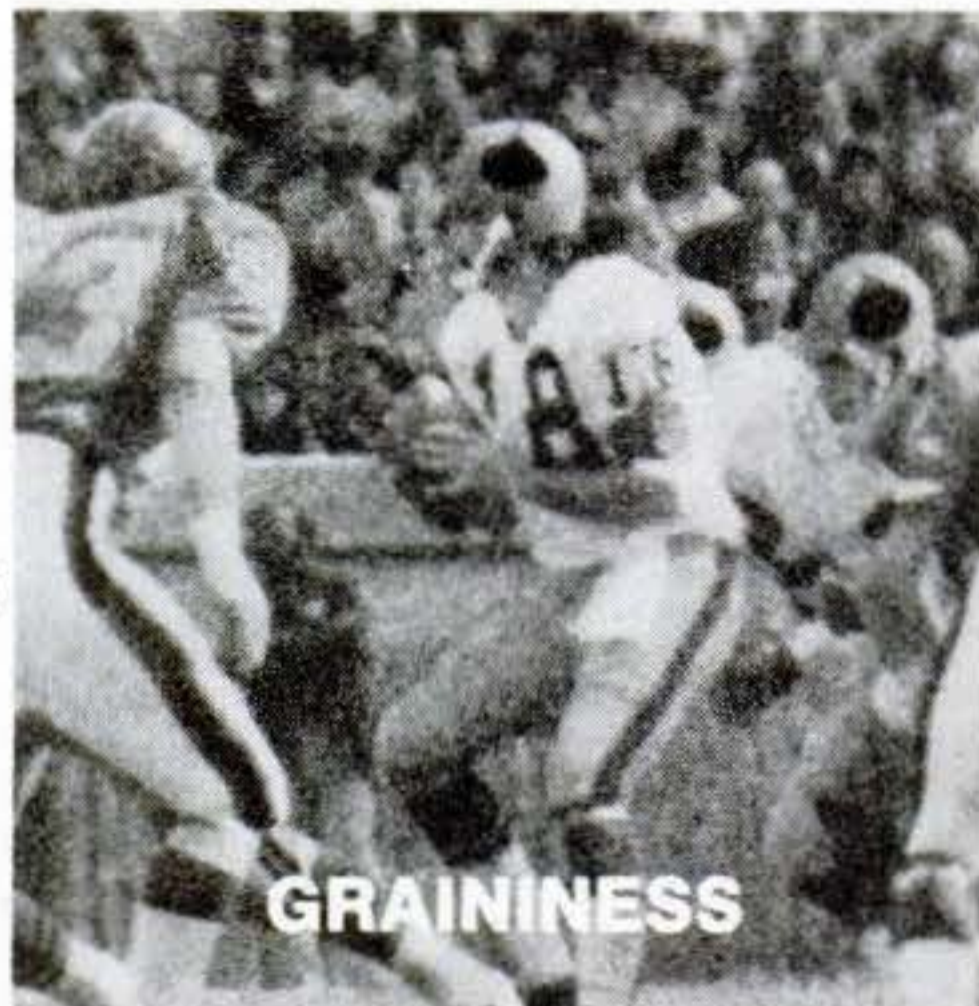
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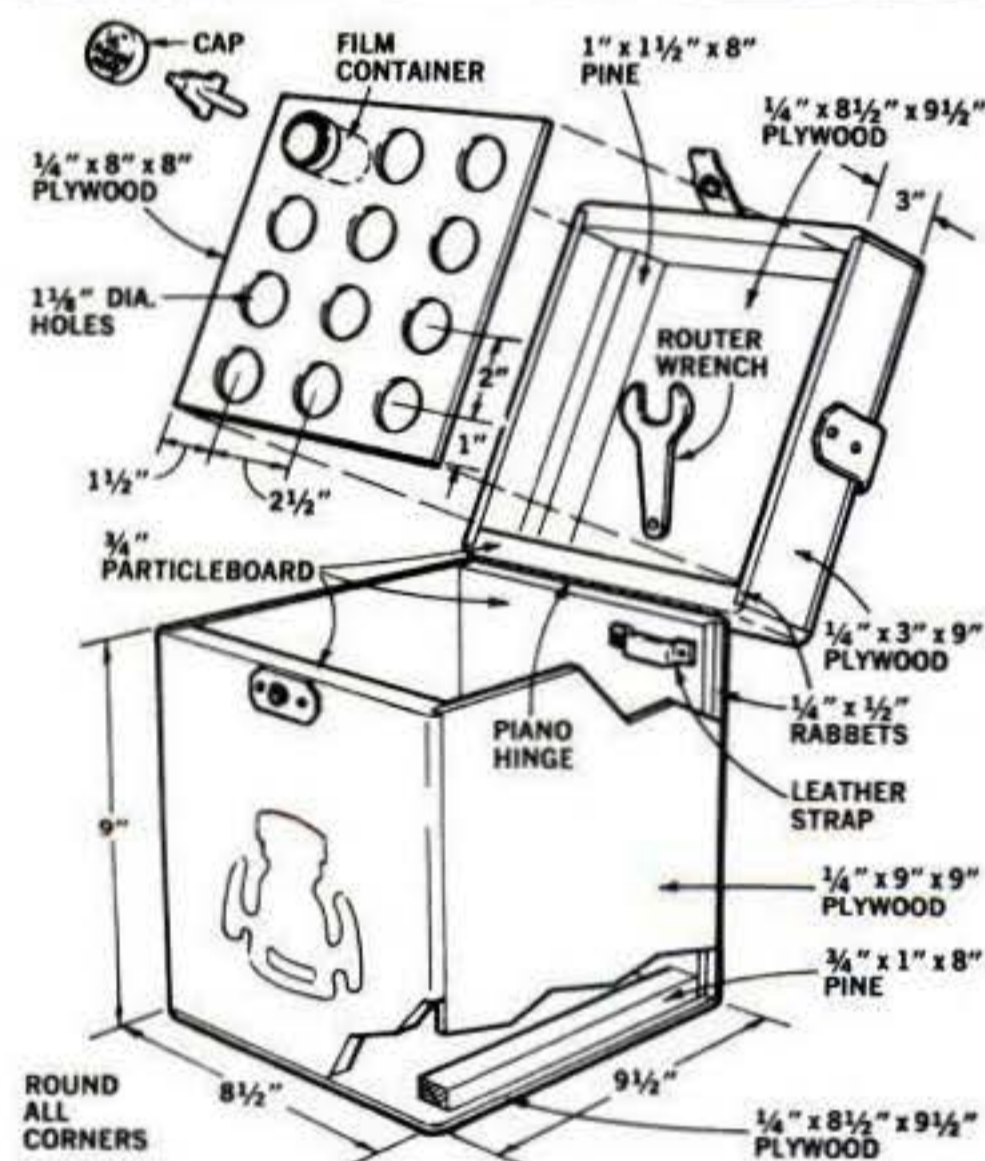
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Handy router case stores bits, too



This router storage case can be built of scraps of 1/4-in. plywood, 3/4-in. particle board, and one-in. pine—all assembled with glue and nails. By boring 1 1/8-in. holes in the false top and press-fitting plastic 35-mm film canisters, you get convenient storage for bits, which can be identified in indelible ink on the snap-on tops. A strip of leather attached inside the case gives you a handy place for the bit-changing key. To be able to spot the router case among other power-tool storage boxes, I stenciled a router silhouette on the front panel in a contrasting color.—*Terry Horton*

Router-bit lube

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PS 111

SHOP TALK

By AL LEES

How sacred is a truss?

There's something unique about a Popular Science article. For the author or editor, it's never a case of "file and forget." If he's truly shed new light on a subject, our readers are bound to challenge or applaud him. Editors on other publications can usually print a story and put up their feet. But PS readers keep us on our toes. Two cases in point from our July issue: heavy pro-and-con comments on both Rich Day's "The Hazards of Buying Haul-It-Yourself Concrete" (see our followup elsewhere in this issue) and the article "Cutting a Roof Truss."

Carl De Groote is among the finest of the draftsmen from whom we regularly commission illustrations. He has solid architectural training and is an avid checker of the technical data that appear in the dimensioned sketches he does for us. So when Carl offered us a piece on how to modify a standard roof truss, we knew he'd give sound, useful advice—especially since he has used the technique on his own home and has supervised similar installations in other homes in his neighborhood.

Even so, our July story stressed precaution: We described the hazards of truss cutting and advised professional consultation before the box-bridging methods we showed were adapted to any homeowner's specific needs.

The response to the article was immediate—and extreme—on both sides. Truss makers wrote commending us for having provided "desperately needed information." A major manufacturer of prefab

chimneys wrote for permission to reprint our article as part of their installation instructions. On the other hand, architects and engineers wrote to upbraid us for printing potentially hazardous data and to predict dire consequences for anyone following our procedures. Edward Allen, a Massachusetts architect who has published in PS, went so far as to tell us:

"The only safe advice is don't do it under any circumstances! Roof trusses are a thoroughbred kind of structure, highly stressed and not amenable to cutting and patching. Readers who live in a house with a trussed roof must simply forget about making use of the attic."

Suspecting that these cries of alarm were knee-jerk responses (and well aware that tract-house owners have been modifying trusses for years without collapsing their roofs), I drove off to central New Jersey to visit De Groote and his community—to inspect a sampling of such installations and interview homeowners who'd lived with them for some time.

Much of this part of the country is dominated by large housing developments—a sort of giant Levittown, though the homes are of a greater diversity and better quality than that might imply. These houses were erected a decade ago, and nearly all of them have trussed roofs. Since most of them are slab-on-grade, they offer no basement storage. So what's a family to do with all those bulky, lightweight items that can't be accommodated in bedroom closets: out-of-season clothing, Christmas decorations, spare dining chairs, or those boxes and cartons that appliances and hi-fi components come in (which you



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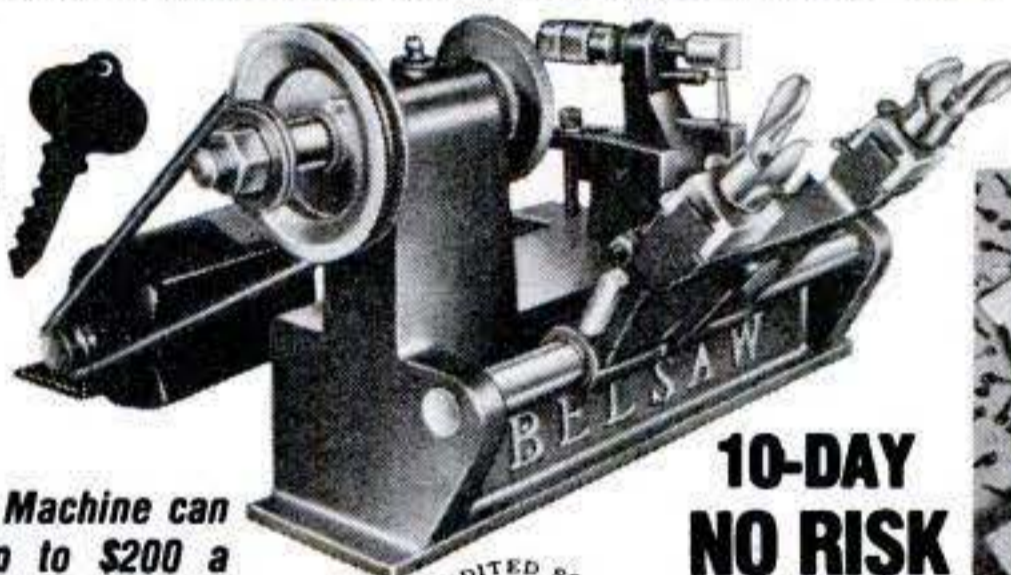
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want to save for moving—or for shipping the items back for repairs)?

Many backyards in this area sprout storage sheds, but these aren't appropriate for the items just listed, and most are already overflowing with lawn tools and deck furniture. The only place to go is up. The space within the roof trusses is not (obviously) a usable living area. The attics I climbed into, here, were bristling with the angled members of Fink trusses set 16 inches on center. But running directly under the ridge was an open corridor eight feet high that was ideal for light storage. Homeowners who had cut a stairway access to this precious space had laid a 1/2-in.-plywood floor between the truss struts and over the insulation.

Sometimes it's cut or move

Alex Zarow, a neighbor who followed Carl's advice in framing a folding attic stair exactly as our July photo and sketch showed, demonstrated to me that there is no deflection whatever in the box-bridged trusses. I jumped around his ceiling opening without causing any cracks in the plaster ceilings below. Alex told me: "The modified studs seem sturdier than the one's flanking them, which are assembled with rather flimsy spur gussets. If we hadn't found this storage space, we'd have had to move to a larger house."

The severest critic of Carl's article—truss designer William Bolduc of Woodco Ltd., Elk Grove, Ill.—pointed out that the 1/4-in. carriage bolts called for were inadequate.

But Fink trusses are usually assembled from 2x4's, and a larger-diameter hole weakens these 3 1/2-in.-wide members. Carl insists (and my inspections confirm) that the pair of 1/4-in. bolts at each joint is adequate for trusses with a 28-ft. span, spaced 16 inches o.c. with a 30-deg. roof pitch. A larger-diameter bolt—3/8 or 1/2 in.—would doubtless be preferable where heavier trusses span a greater-width house and are spaced 24 inches or more apart or where lower-pitched roofs are subjected to severe snow loads.

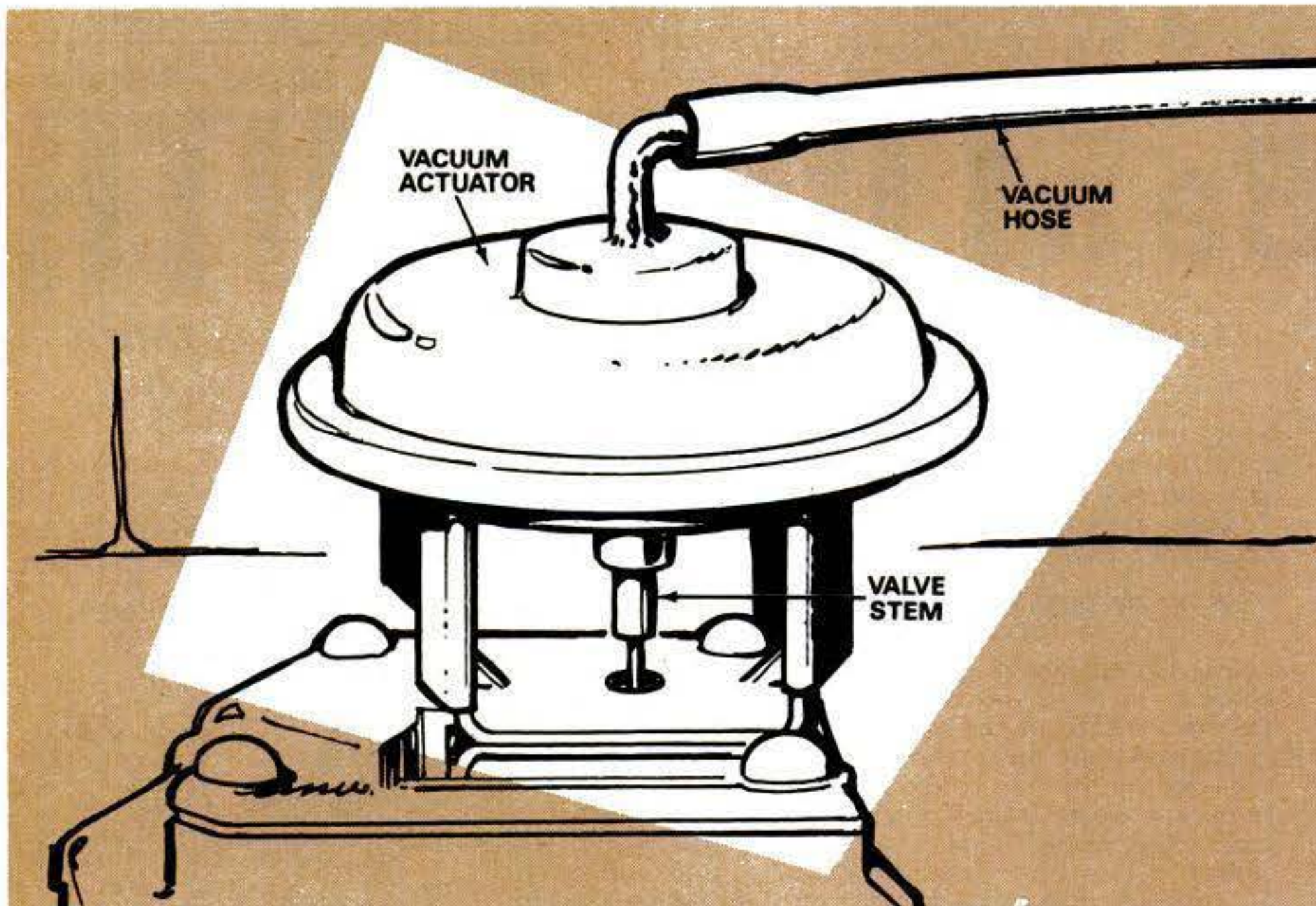
The box-bridge systems we showed are not intended for widely spaced trusses, the type usually linked by purlins running parallel to the ridge. But you'd never need to cut into such a truss anyway, since the purpose of all cutting is to gain access through tightly spaced trusses.

Driving around this vast area of housing, I spotted many handsome homes with large skylights (see photo) obviously installed to channel light through the truss space to a windowless room—requiring the modification of one or two trusses. Other homes of identical style had pull-down-stair access to the truss area over the attached garage on the left. Some had both, indicating that lower chords had been cut on one wing of the home and upper chords on the other. We can only hope all this was done with the care we recommended.

So, the question is less "Should you cut a truss?" than "Can you properly and safely modify the truss or trusses you'd need to cut to make some use of the attic space?" Which is exactly what we said in our July article.

TAKING CARE OF YOUR CAR

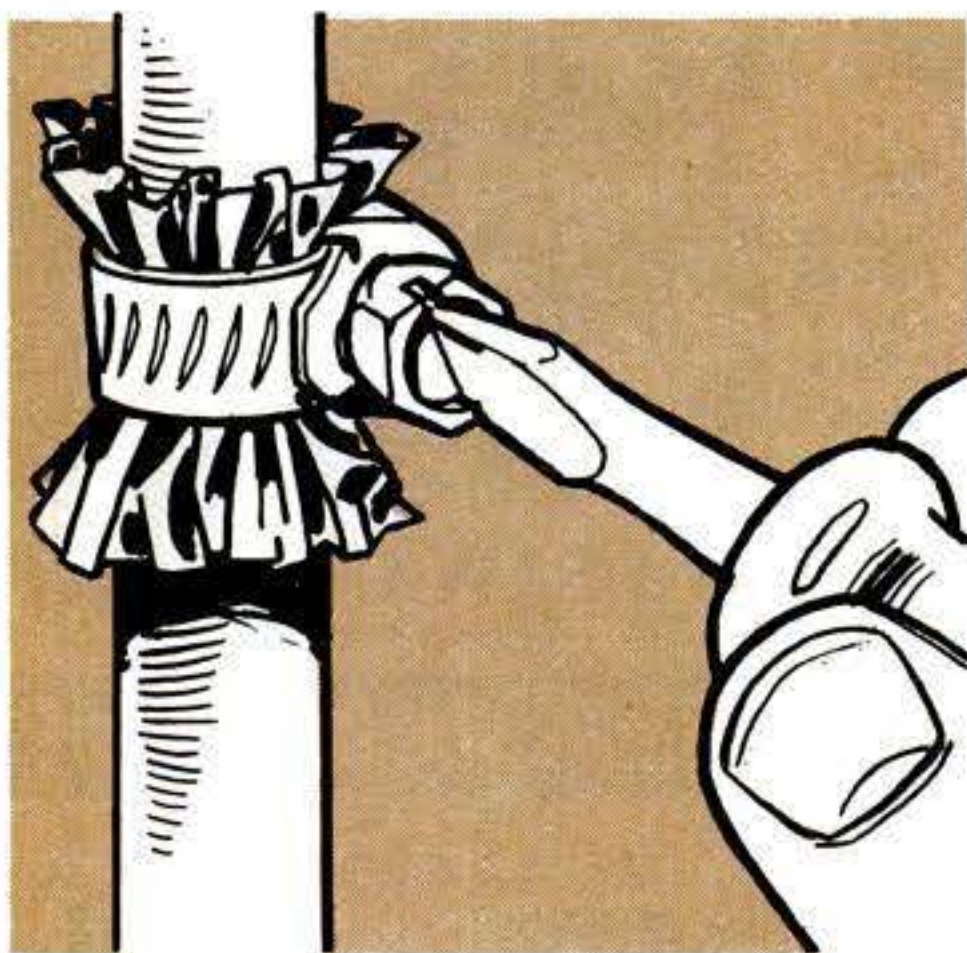
By RAY HILL



Quick checks to determine if the EGR valve is working

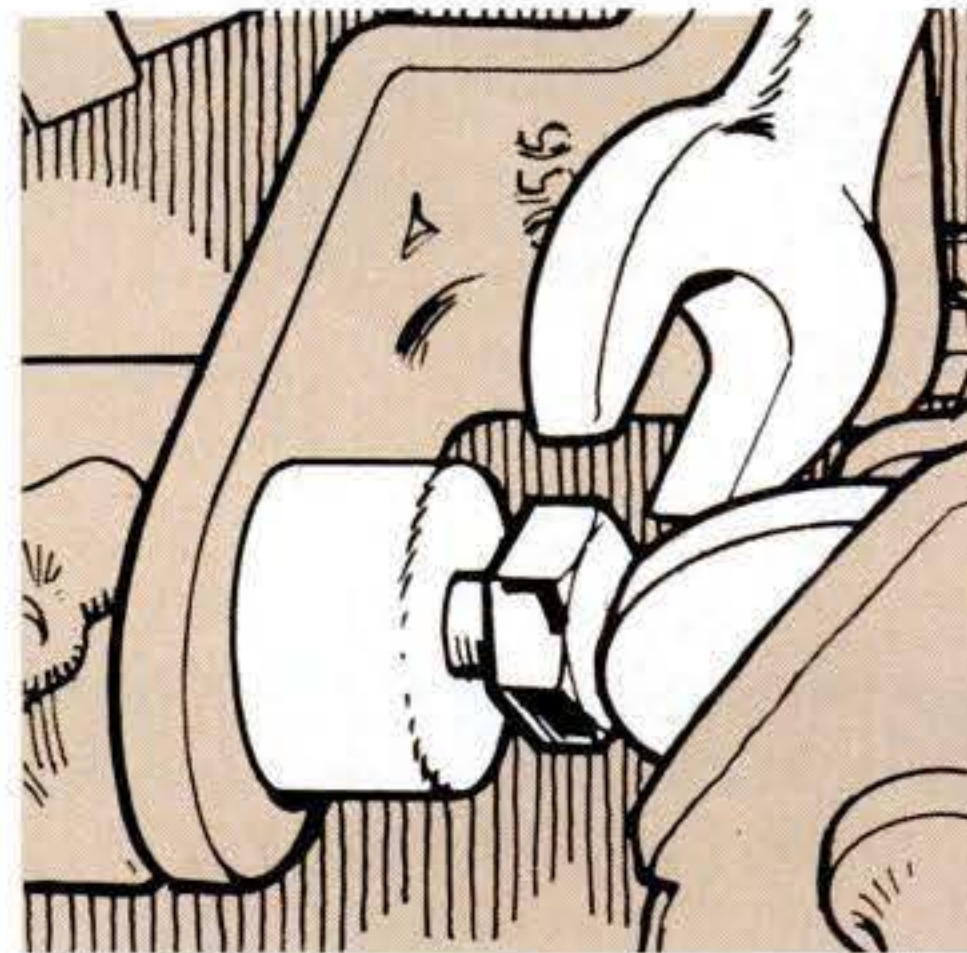
Is your car's EGR valve working as it should? If the engine idles smoothly, it's probably okay. But there are some more-definitive checks you can make: With the engine at operating temperature and running at the maker's recommended idle speed (transmission in park), have a friend rev up the engine to around 2,500 rpm. The valve stem should move. With the

engine idling again, open the valve by hand. This should cause the engine to idle roughly or die. If the idle speed doesn't change, the valve is defective, or the exhaust passage to the EGR is clogged. Another check: With the engine running at 2,500 rpm, disconnect the vacuum hose from the EGR valve. Engine rpm should increase. An EGR valve can't be rebuilt.



Temporary exhaust-leak repair

On older cars, the AIR pipe may sometimes corrode so much that a hole develops, causing an exhaust leak. The fix is a replacement pipe. Until the new pipe arrives, though, you can often make a temporary repair by covering the hole with several layers of aluminum foil. Then tighten the foil against the pipe with a screw-type clamp.



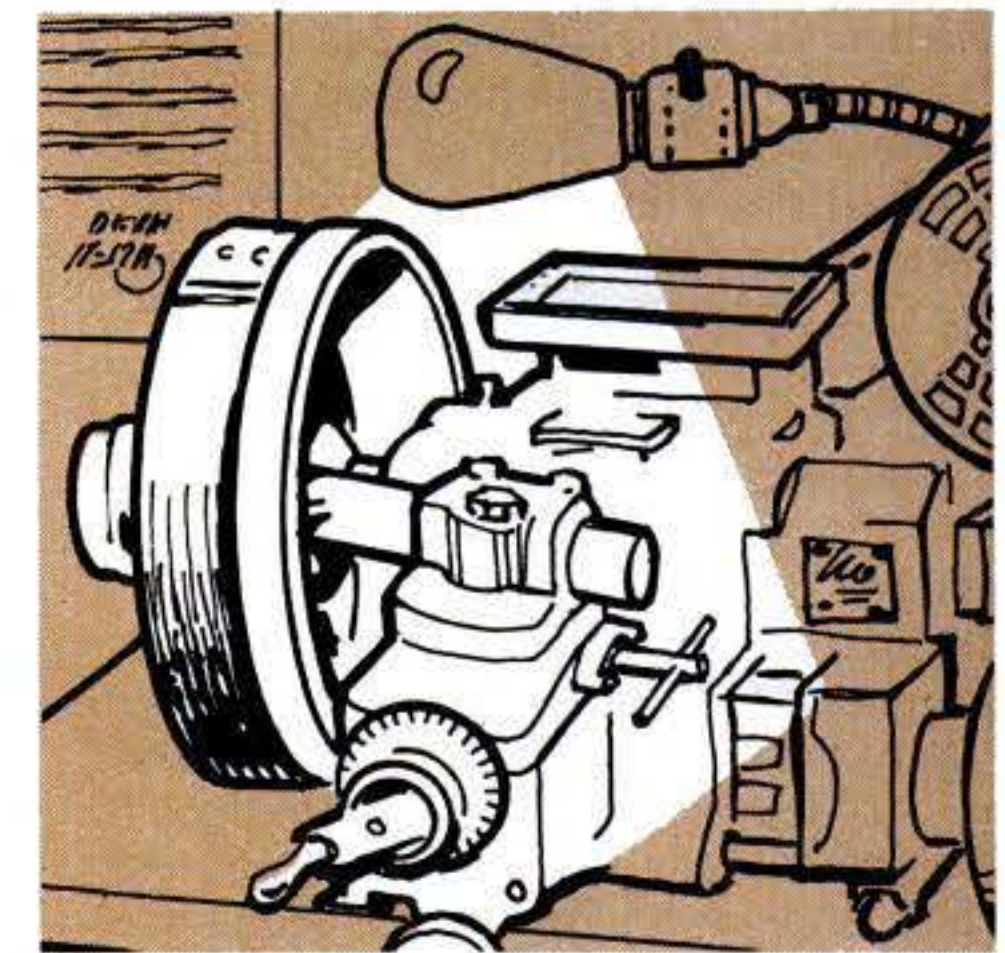
Rough idle with A/C on

Many newer cars with air conditioning use an idle solenoid that is activated when the A/C is turned on. If your car begins to idle roughly when you turn on the A/C, check the idle speed with a tachometer with the A/C on (and the engine at operating temperature). If it's lower than specs call for, adjust the solenoid according to shop-manual instructions.



Locating a short circuit

A short circuit that's causing the battery to discharge when the car is parked can be found by connecting a test lamp in series with the battery's positive terminal. All switches should be off. Remove one fuse at a time from the fuse block. When the fuse from the shorted circuit is removed, the test lamp will go out. Trouble-shoot this circuit to find the short.



On turning brake drums

Brake drums should routinely be turned on a brake lathe at every brake rebuilding. If an old drum has already had so much metal removed that it cannot be turned and stay within specs, the cheapest solution is to buy a drum at the junkyard. After turning, two drums on the same axle must have inside diameters that are not more than 0.020 in. apart.

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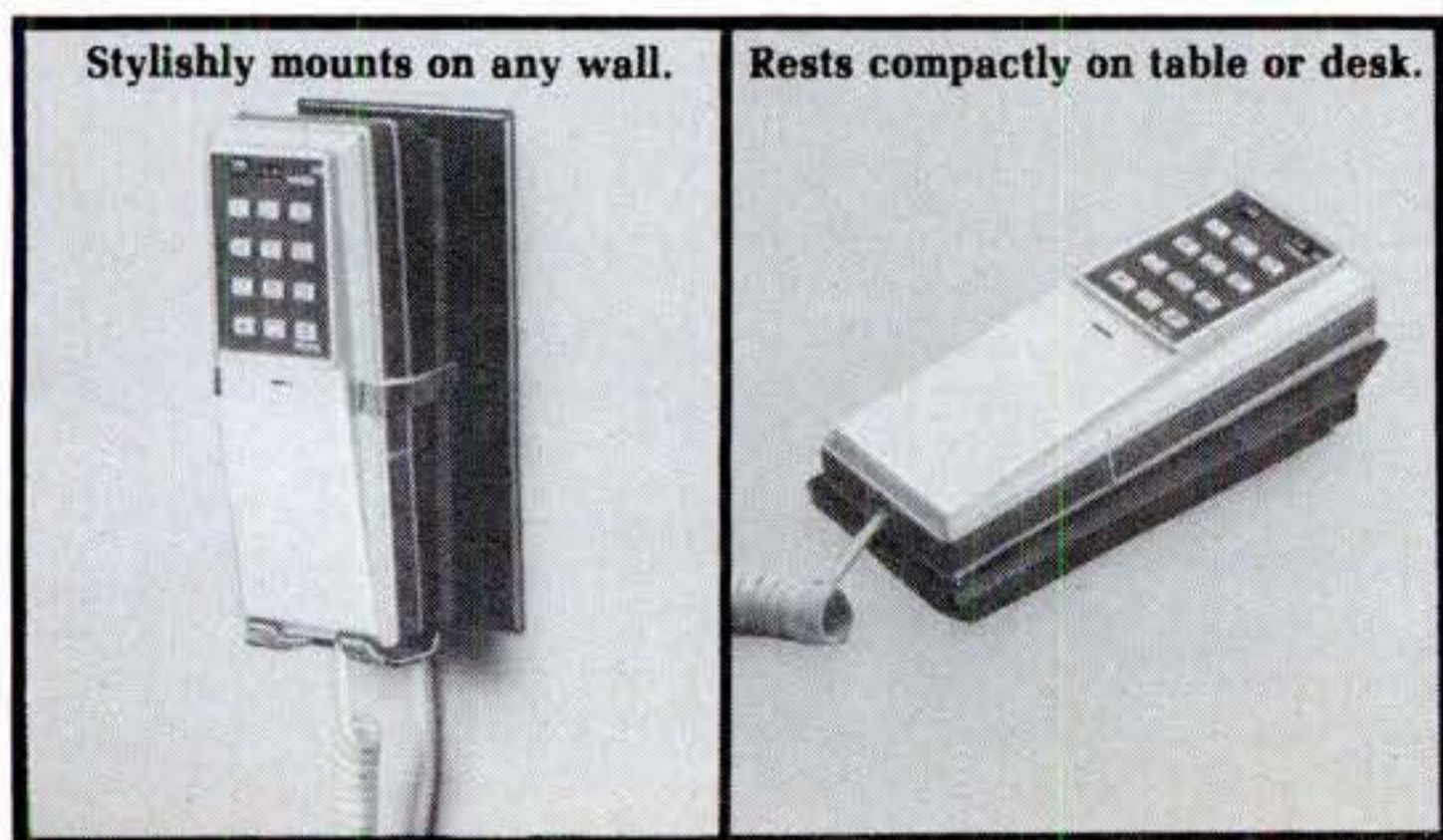
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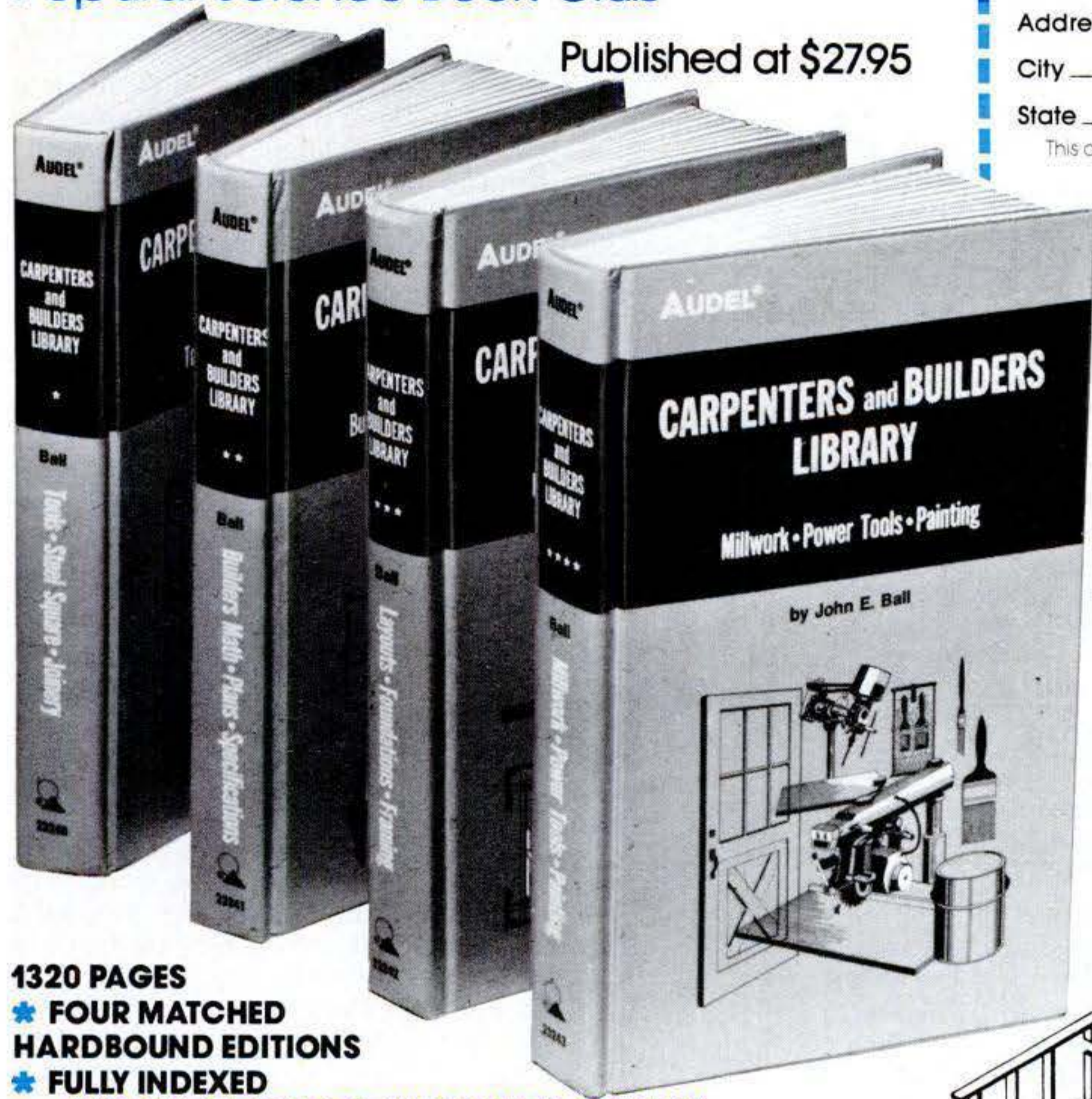
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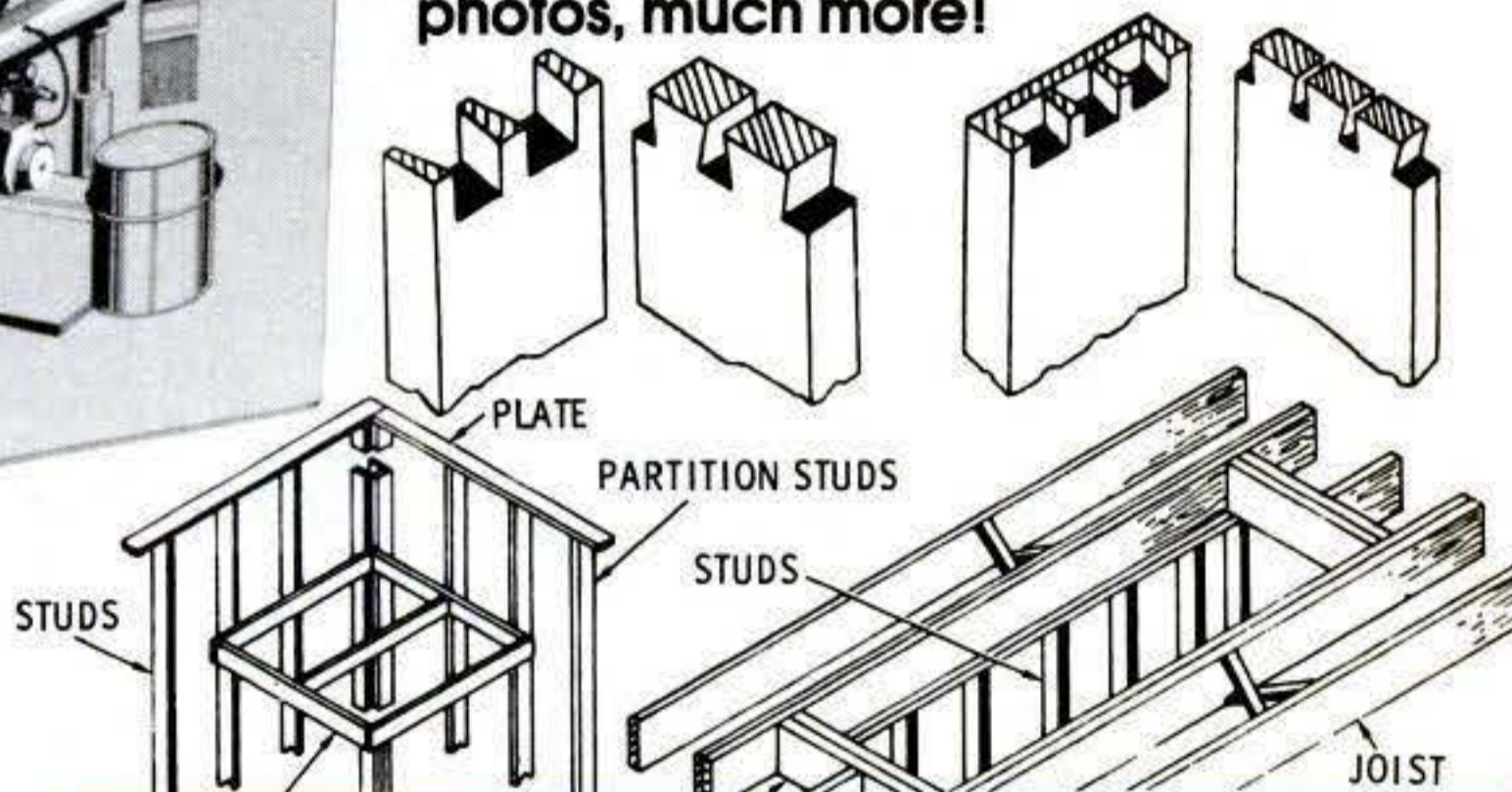
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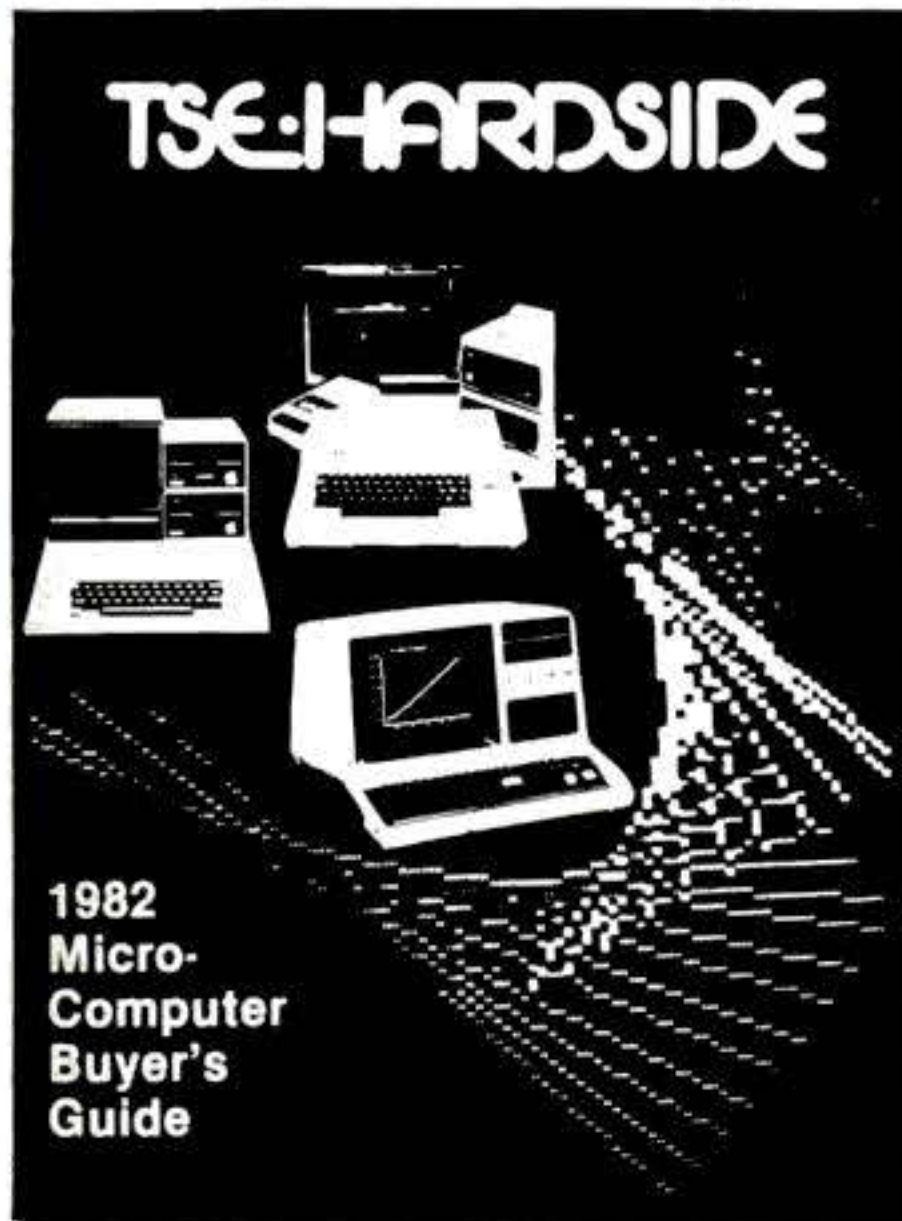
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PS readers talk back

[Continued from page 2]

sedans offered for sale in North America. They are also more aerodynamic than all but one of the vehicles (a sports car) listed in the chart comparing 1981-model cars. Leo Levine, Gen. Mgr. of Public Relations Mercedes-Benz of North America, Inc. Montvale, N.J.

Criminal psychology

I'll bet burglars will love that closet security door ["Walk-in Vault," PS, Aug.]. If I were a thief and I opened a closet door and saw one of those \$500 wonders, I'd know I'd hit paydirt and that a thoughtful homeowner had left everything of value in one place for me. Next, I'd kick, saw, or cut my way through the wall next to the door (probably 1/2-inch wallboard) and clean out the closet. Heck, if I had enough time, I'd take the door, too.

Robert L. Henrickson
Rensselaer, N.Y.

Al Lees replies: "Would Mr. Henrickson prefer to leave all the home's valuables scattered about in accessible view? I'm sure his thief would prefer it. Crime statistics regularly show that most burglars don't want to work very hard. It's fast in, fast out or on to easier pickings."

Gap goof

Bryan Soltner's reply to reader C. Dickson's suggestion that the gaps in Saturn's rings might be due to quantum effects is flat wrong ["PS Readers Talk Back," July]. Any object in a potential well—be it an electron in the electrostatic field of a nucleus or a rock in the gravitational well of a planet—will have quantized orbital levels. Application of quantum mechanics to astronomical orbits is perfectly correct. However, the quantum effects turn out to be exceedingly tiny, so simple Newtonian mechanics can be used as an excellent approximation.

Jack McKay, Research Physicist
Naval Research Lab, Washington, D.C.

Shutter openers

Your article "Sun-Shading Shutters" [PS, Aug.] indicated that the Pease rolling shutter is available in strap operation only. Actually it can be furnished with strap, crank, or electric operation. Optional electric controls, such as timers and sun and wind sensors, are also available. The author stated that there is little difference between the various brands of shutters. There are several subtle differences that I would urge any prospective buyer to investigate. These include color stability of the slat, ease of installation, and the quality of the operator parts.

R. Alan Beattey, Plant Manager
Pease Co., New Castle, Ind.

Correction: The cargo rack identified as Amco's Magic-Rak in a photo in "Compact Cargo Carriers" [PS, June] is actually manufactured by JAC Products, Inc., of Ann Arbor, Mich. 15

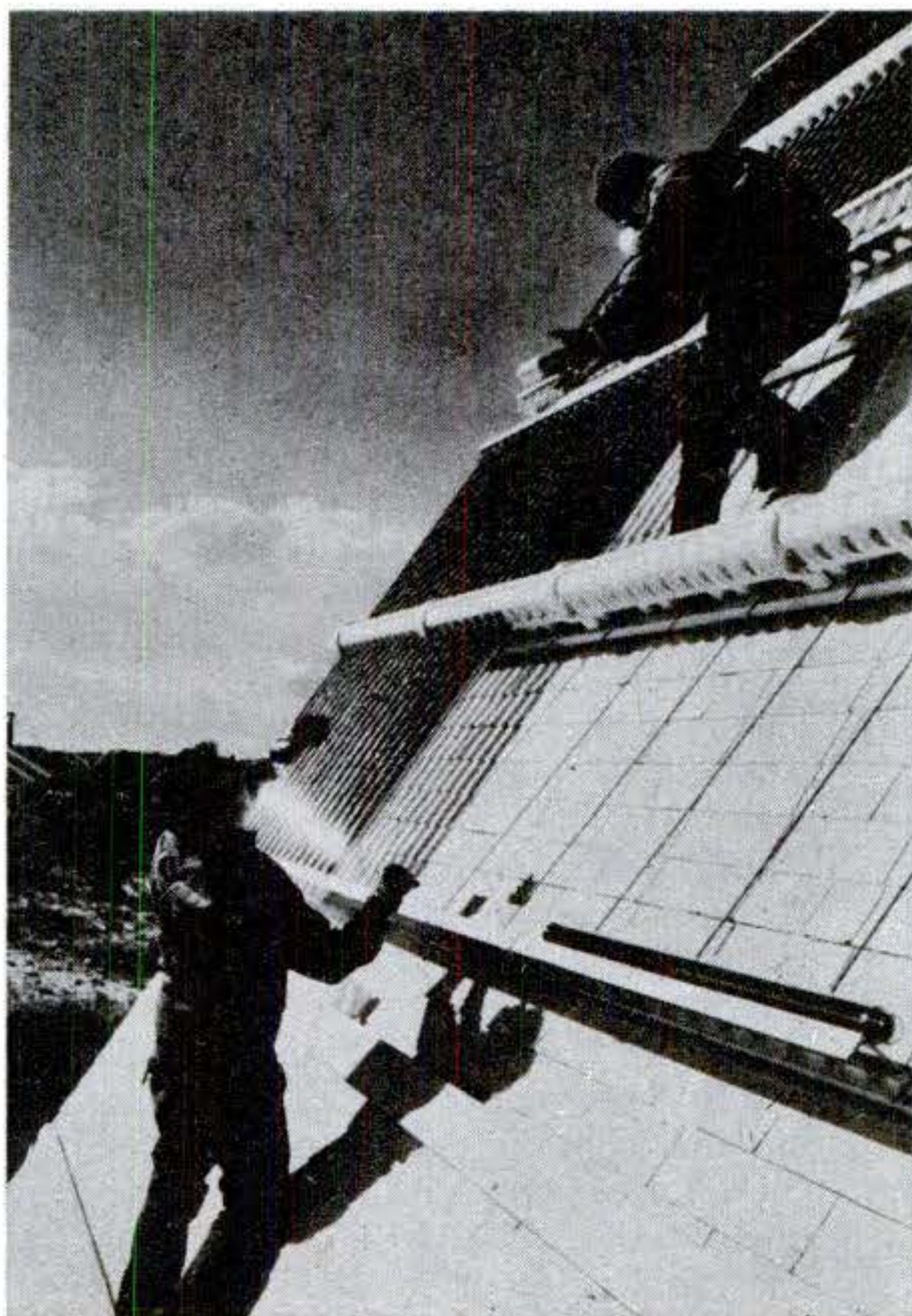
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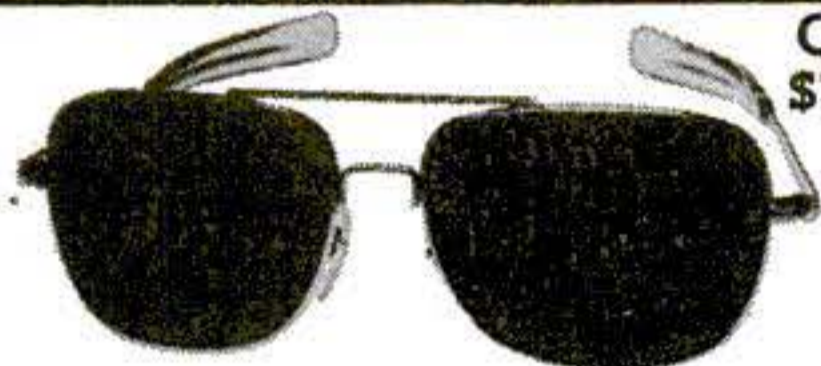
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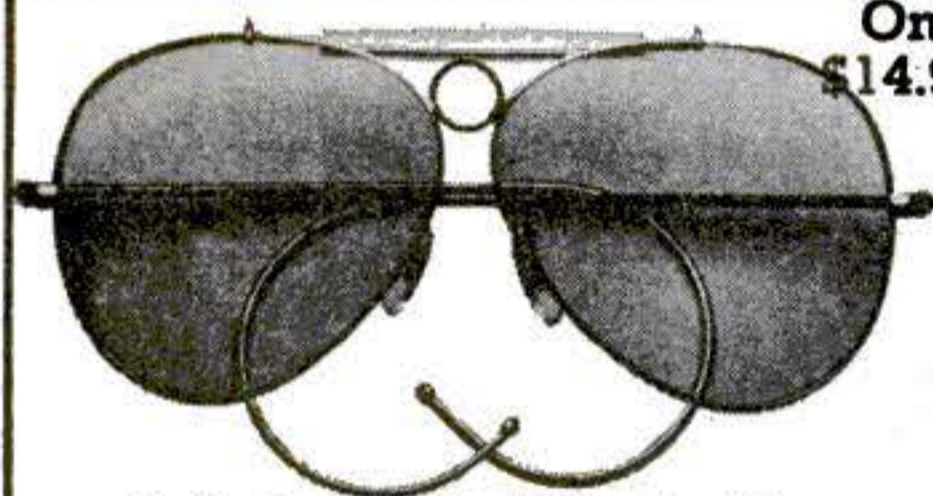
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Beam weapons

[Continued from page 76]

There are many kinds of chemical lasers, each operating at different power outputs, lasing frequencies, and optical-mirror sizes. All of those factors are crucial to the laser's destructive power; the larger the number in each case, the more destructive the laser.

DARPA's leading chemical-laser candidate for space deployment is called Alpha, a device forecast to produce five-megawatt pulses of 2.7-micron laser light using a four-meter glass mirror. It is thus the basis for a mythical weapon called "5/4"—the first number referring to its power output, the second to its mirror size. A single 5/4 would weigh about 100,000 pounds in orbit and require three Shuttle launches to get its pieces on station and plugged together. From 18 to 24 such battle stations would be needed to give full coverage against enemy missiles.

Alpha is under competing development at TRW in Redondo Beach, Calif., and at Rockwell's Rocketdyne Division in nearby Canoga Park. Both companies are silent on the subject, but Sen. Wallop said, "The building of the Alpha laser is well along at TRW and Rocketdyne. The cylindrical combustion chambers and nozzles are there for anyone with a secret clearance to see." DARPA's departing director Dr. Robert R. Fossum added this: "We know how to build an Alpha, but we haven't done it yet."

Something DARPA will soon build is the pointing and tracking system that will aim a laser at a missile and keep it on target long enough to do fatal damage. It's part of a program called Talon Gold.

The Talon Gold equipment, under development at Lockheed Corp., will be tested aboard a military manned Space Shuttle mission in 1985. According to Fossum, that crew will aim a low-power laser at a cooperative satellite target to prove the device. It will not destroy the target, he implied, only touch it with the laser beam.

"Hard" missiles

Ultimately, a laser battle station's pointing system will need an angular accuracy of one part in 100,000. One 1980 report claimed that Talon Gold's accuracy is only half that good. But, according to Sen. Wallop, the current design exceeds DARPA accuracy requirements by a factor of four.

Regardless of the accuracy of its pointing system, a laser weapon's suc-

cess will hinge on the time it takes to burn a fatal hole in an attacking missile. That will depend on the "hardness" of the target's outer skin. All current Soviet missiles are believed to have easy-to-penetrate aluminum skins. (Lighter structural elements allow heavier warhead payloads.) But when laser weapons are deployed, it is likely that missile designers will counter with heavier anodized skins.

That will mean that a larger laser weapon, perhaps a 10/10, will be needed. Such a weapon could kill attacking missiles, even with anodized skins, at a rate of two per second. But a recent Defense Department report concluded that such a system is at least 15 years away.

"Large, lightweight mirrors that can carry the weight of their associated equipment are not easy to build," Dr. Fossum told me. "Even so, we are succeeding. We have met or exceeded all of our specifications to date."

He was referring to Alpha's four-meter glass mirror being developed by Corning Corp. and Perkin-Elmer. Delivery on that is due in 1984. But, according to Senate sources, glass mirrors may already be obsolete. Large composite mirrors of metallic carbon-silicon with finely sputtered non-glass surfaces are possible now. A 10-meter mirror could be delivered in five years if the order were placed right now, according to Sen. Wallop.

Laser gap?

Dr. Millburn agreed with the technology assessment if not the timetable. "The new mirrors are lightweight and don't rely on standard optical techniques," he told me. "We could be ready in three to five years to decide whether to integrate them."

That's not nearly soon enough for space-weapon activists in Congress and industry, who want a Manhattan Project-type commitment to have a laser picket line operating by the early 1990's. They say such a priority is justified because the Soviet Union is far ahead of the U.S. and has already demonstrated one laser in space. Such claims are difficult to verify.

President Reagan is on record as supporting space-laser development. His science advisor, Dr. George Keyworth, told me: "Space-based lasers should be exploited and the technology developed. There's a product here, and the objective is to get that product built. The only argument is how we go about it." 15

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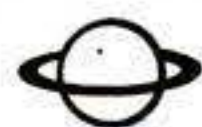
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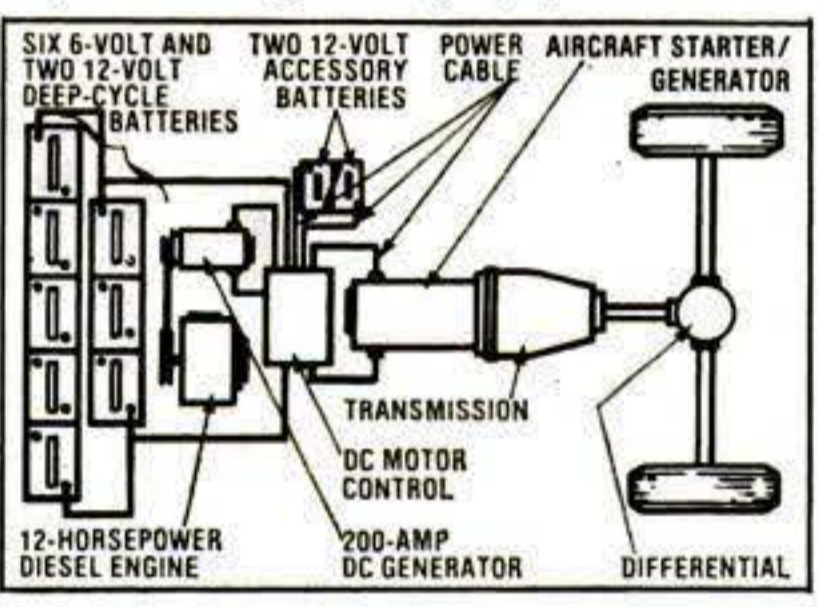


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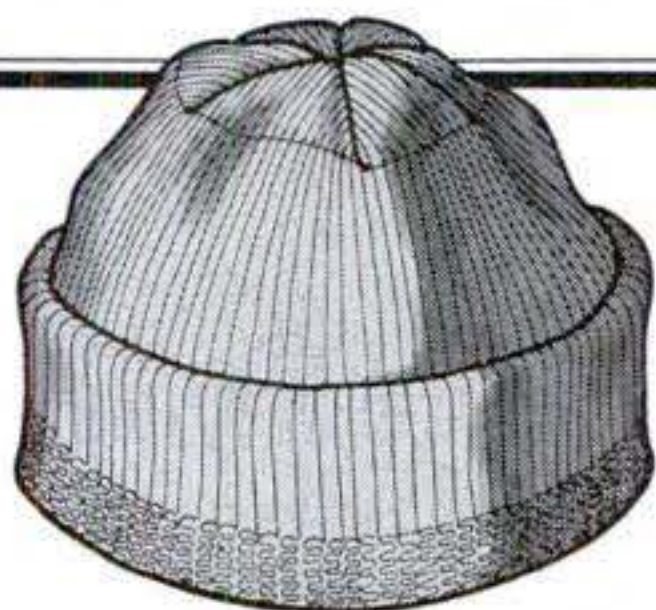
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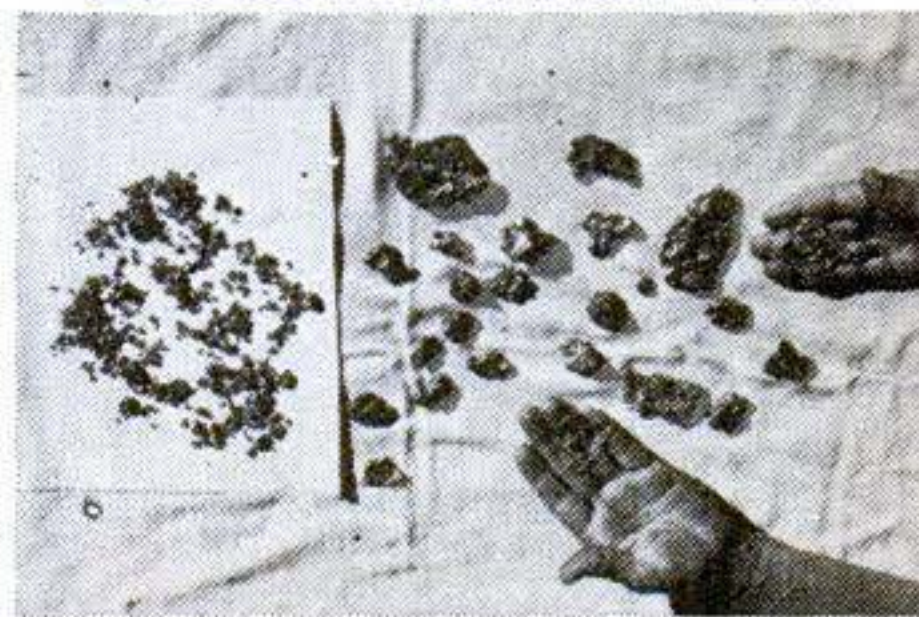
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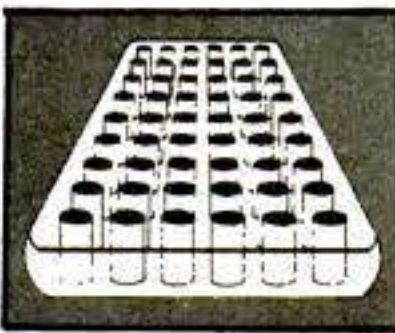
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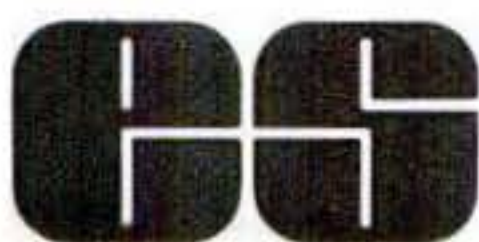
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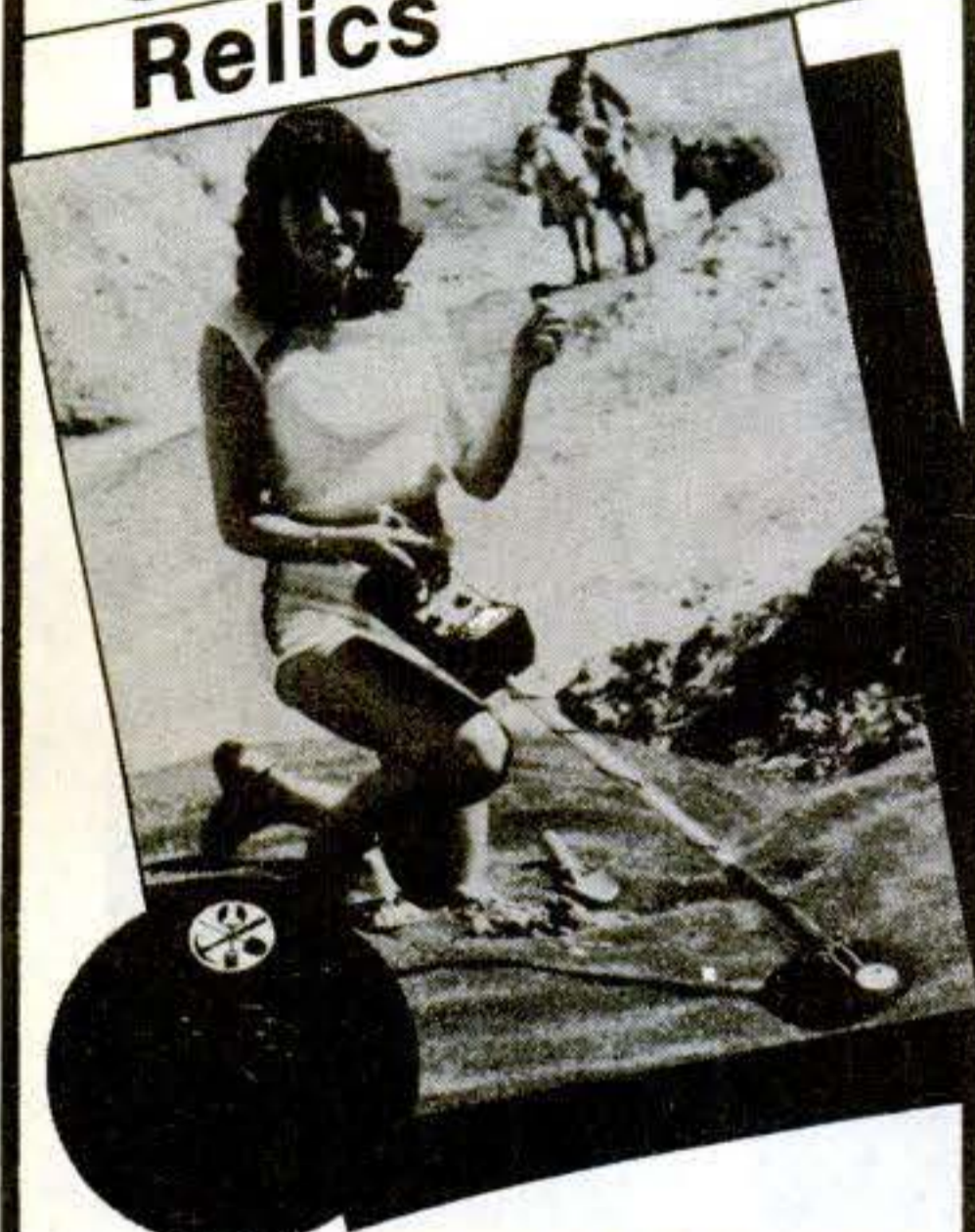
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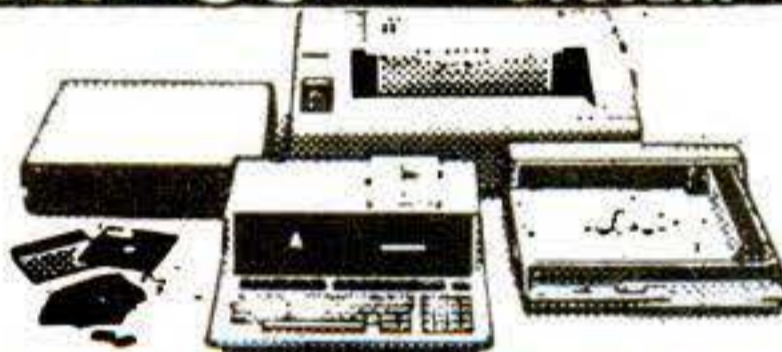
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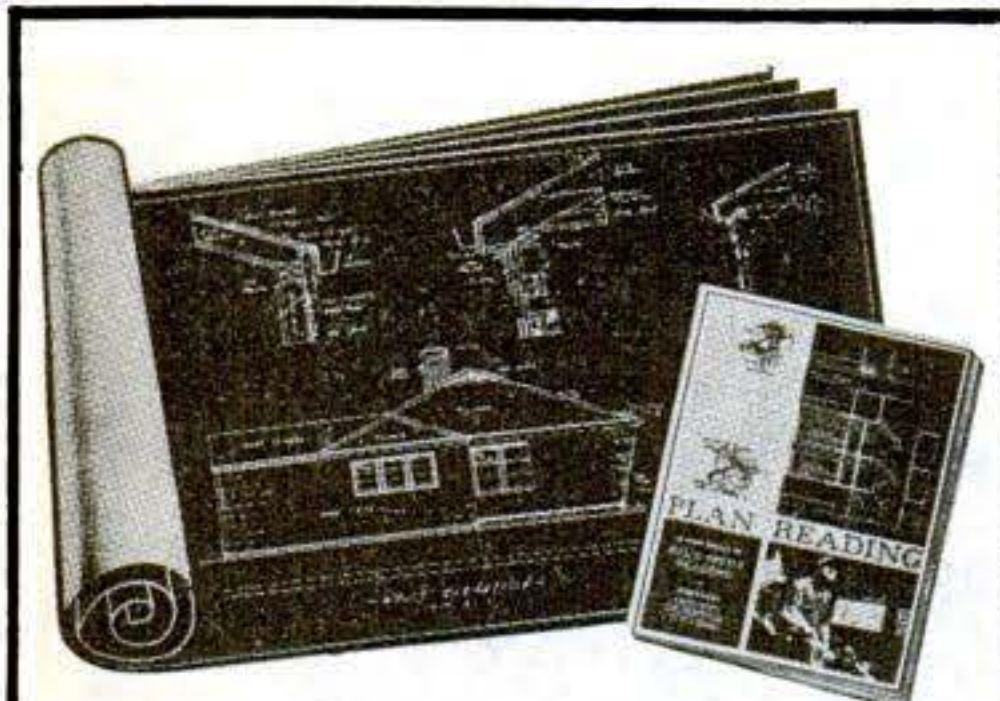
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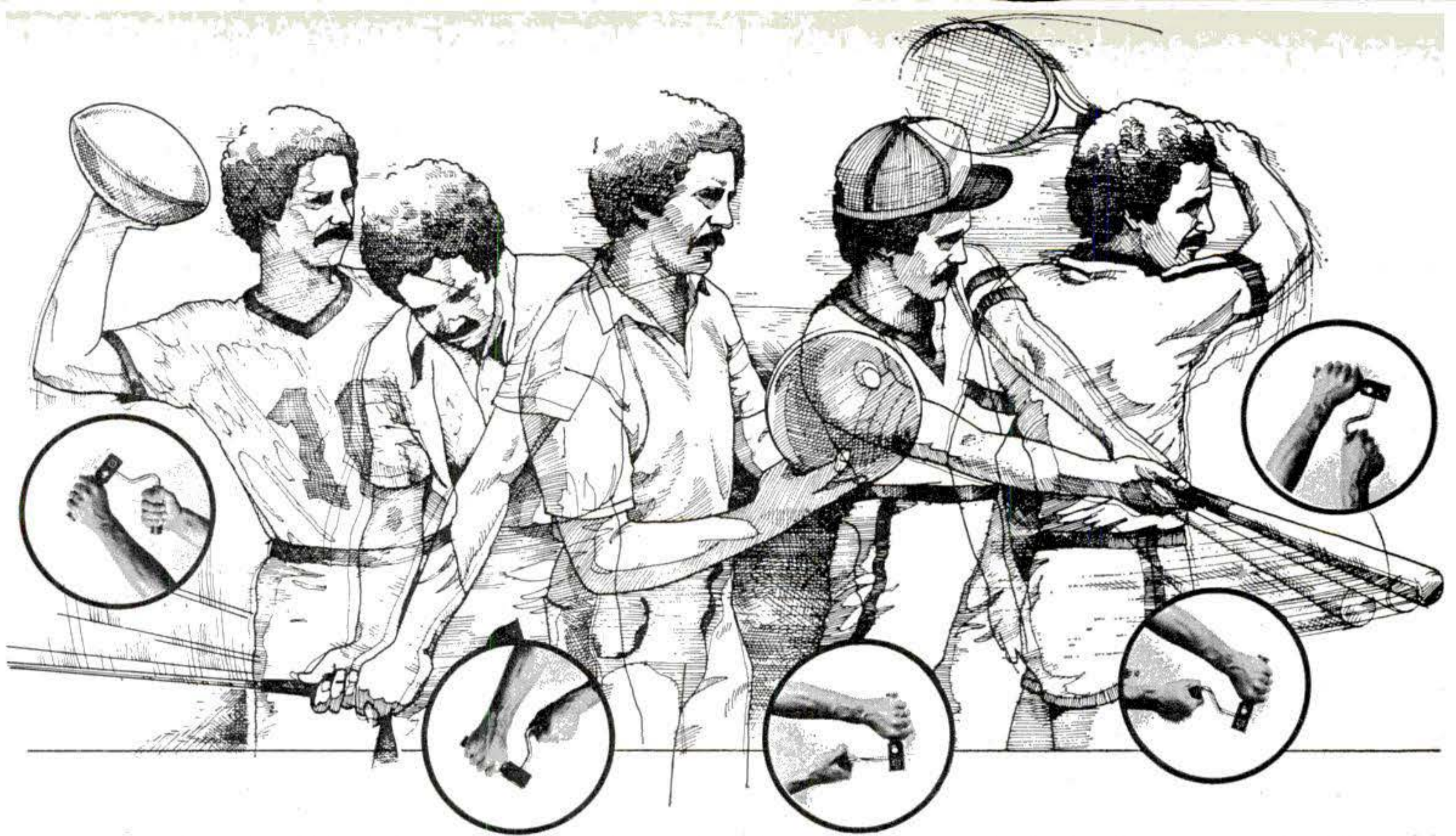
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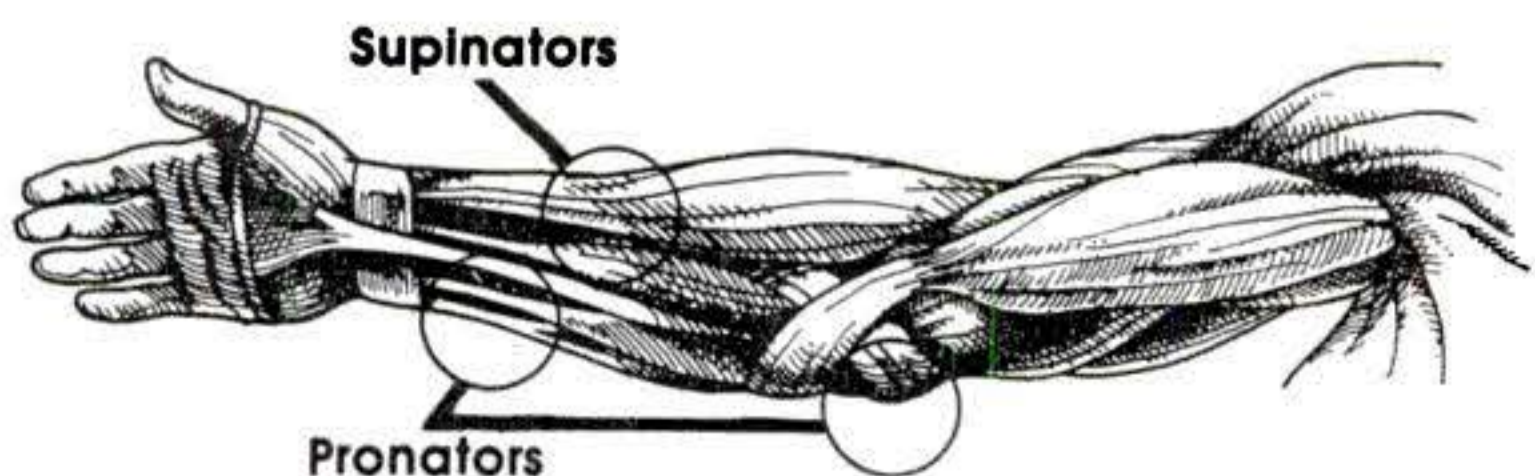
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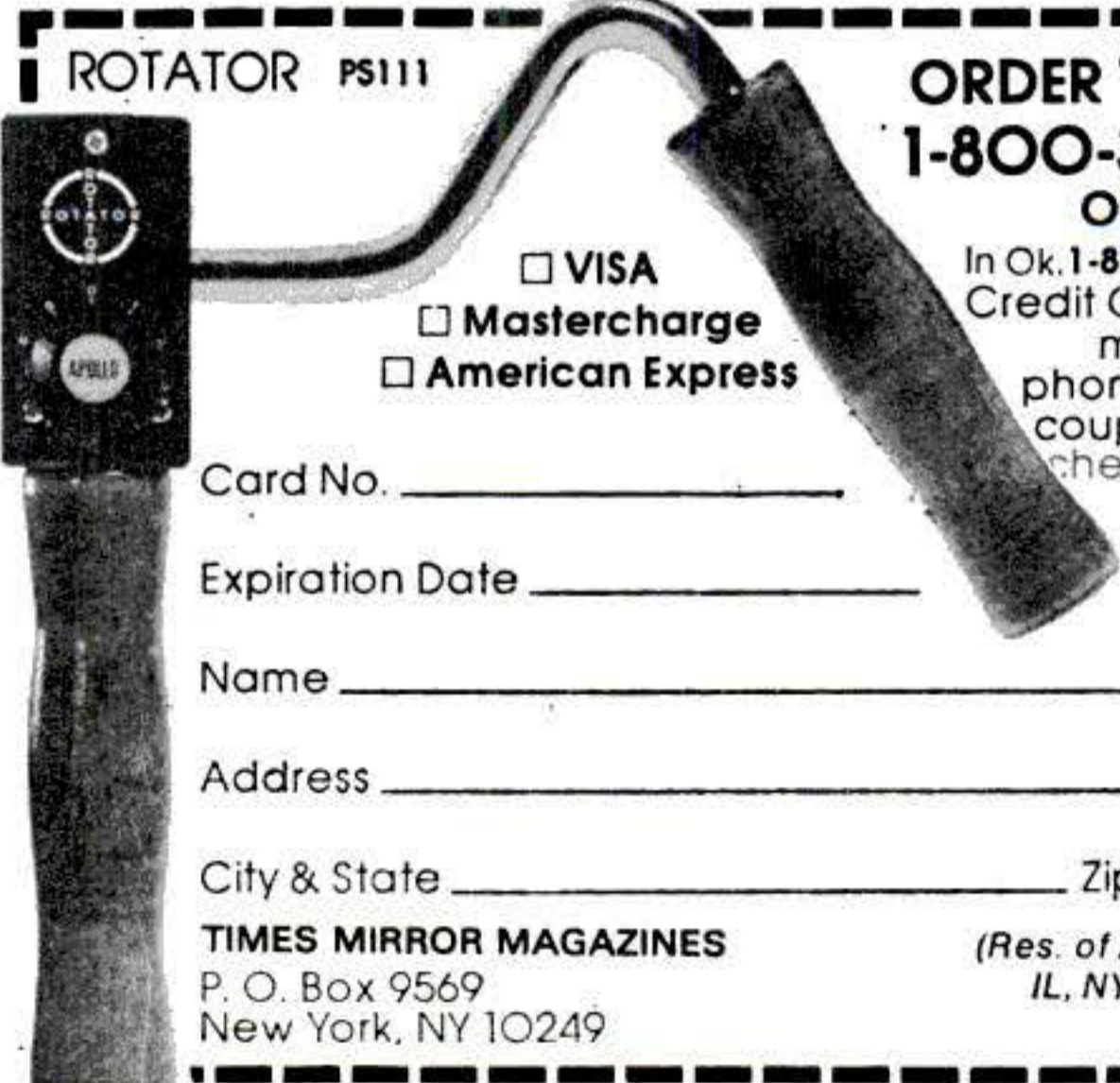
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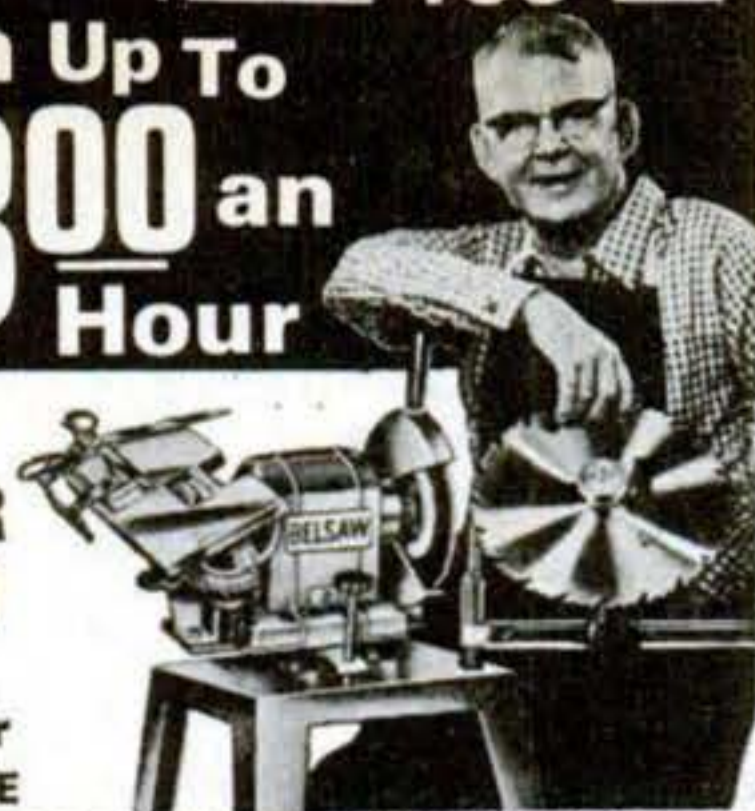
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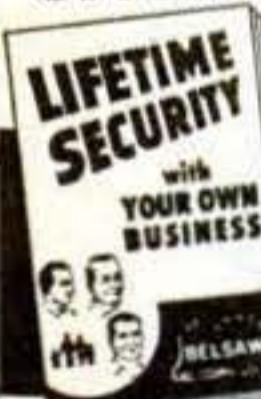
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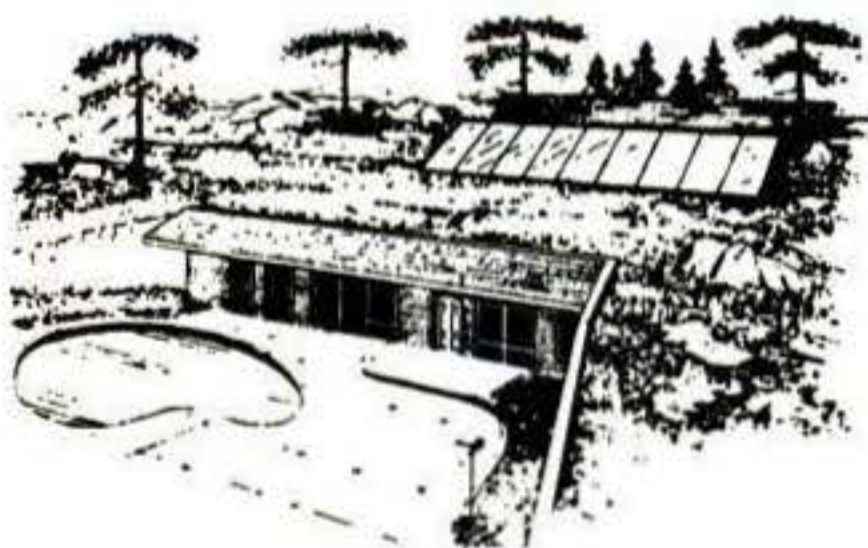
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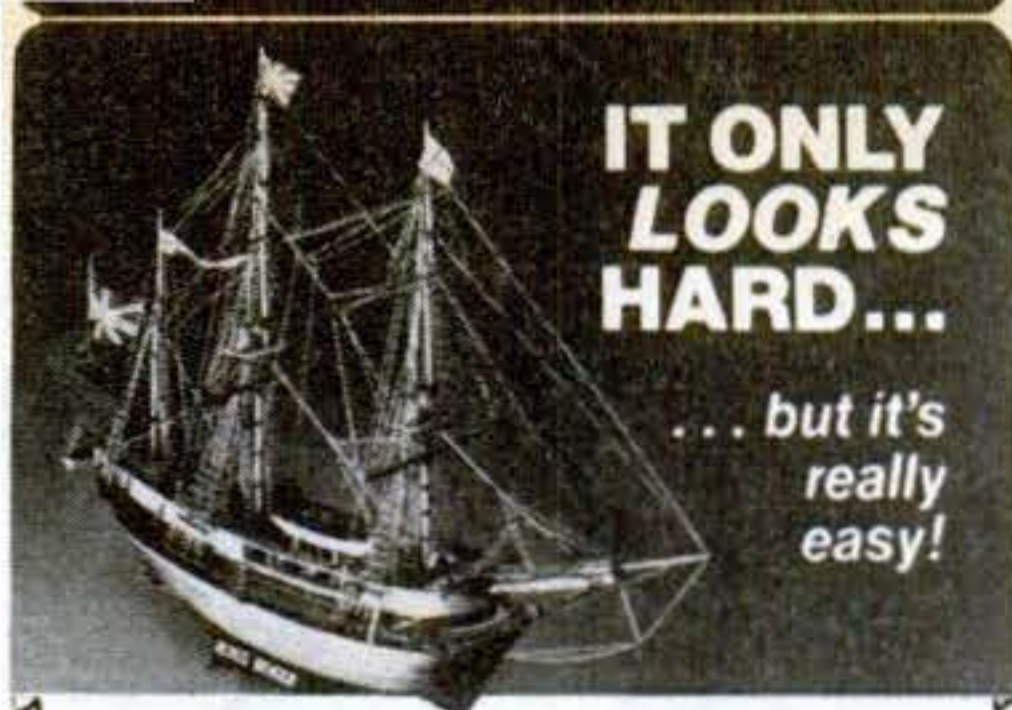
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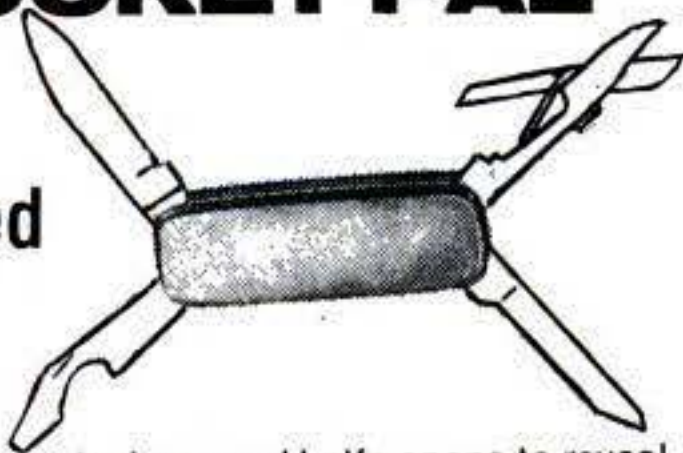
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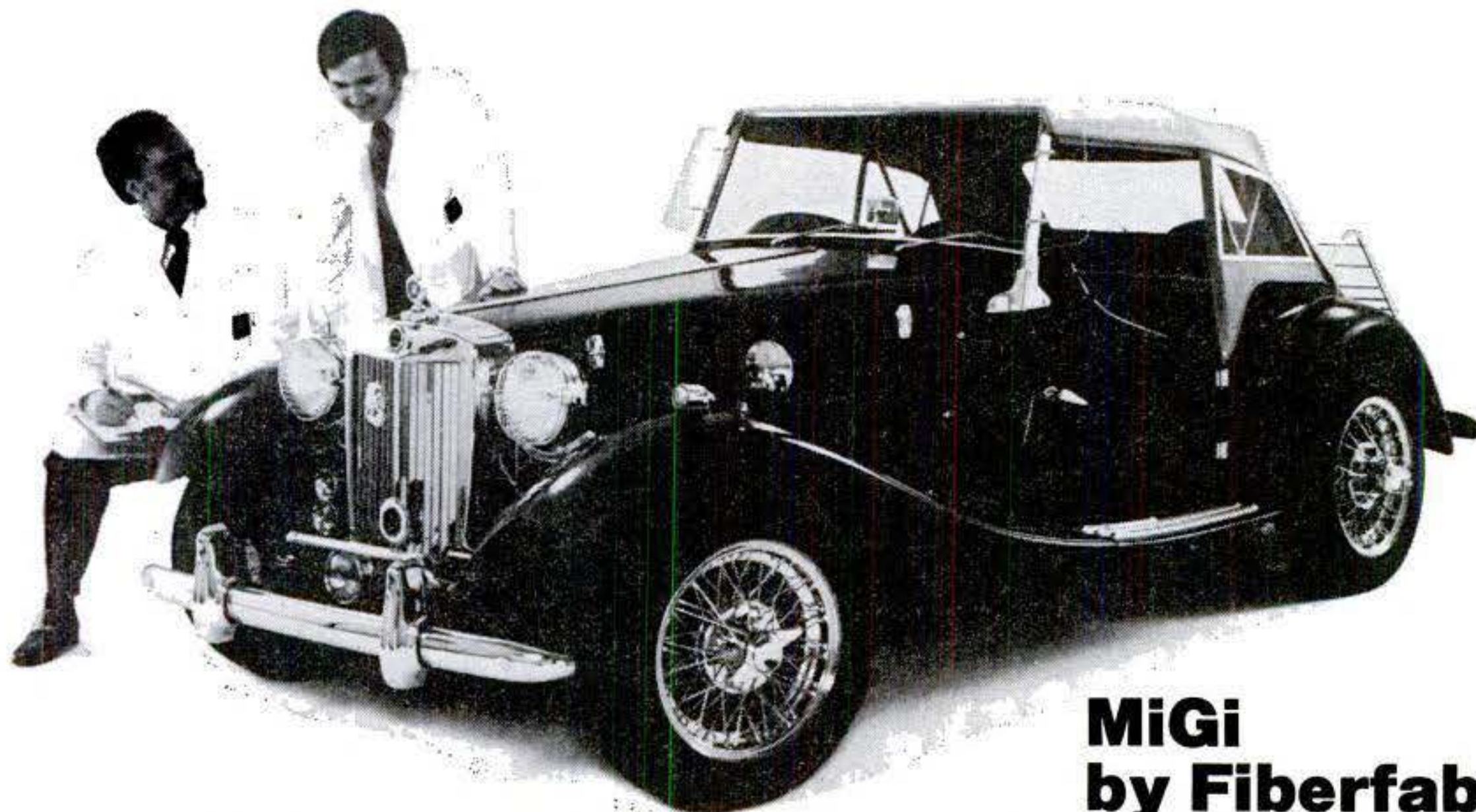
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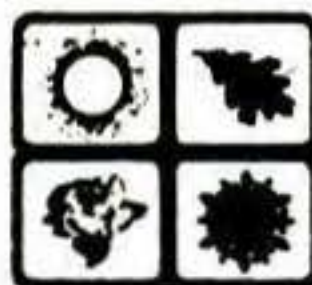
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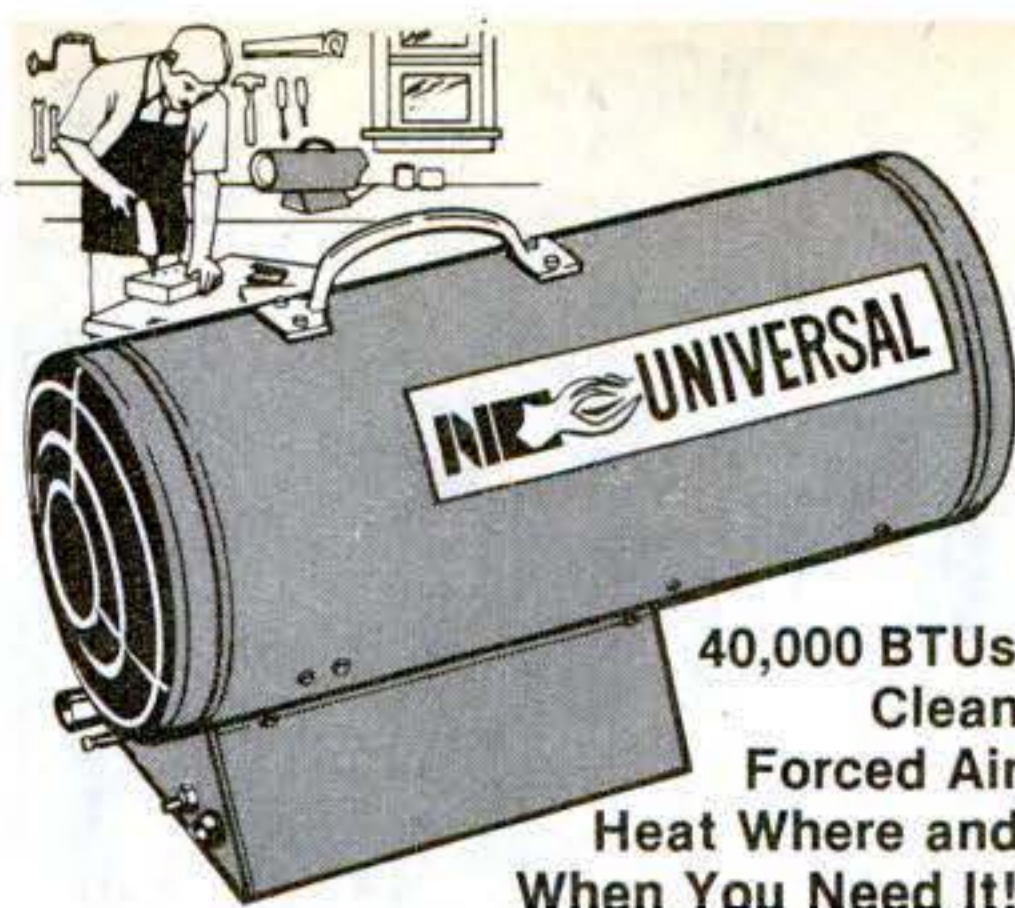
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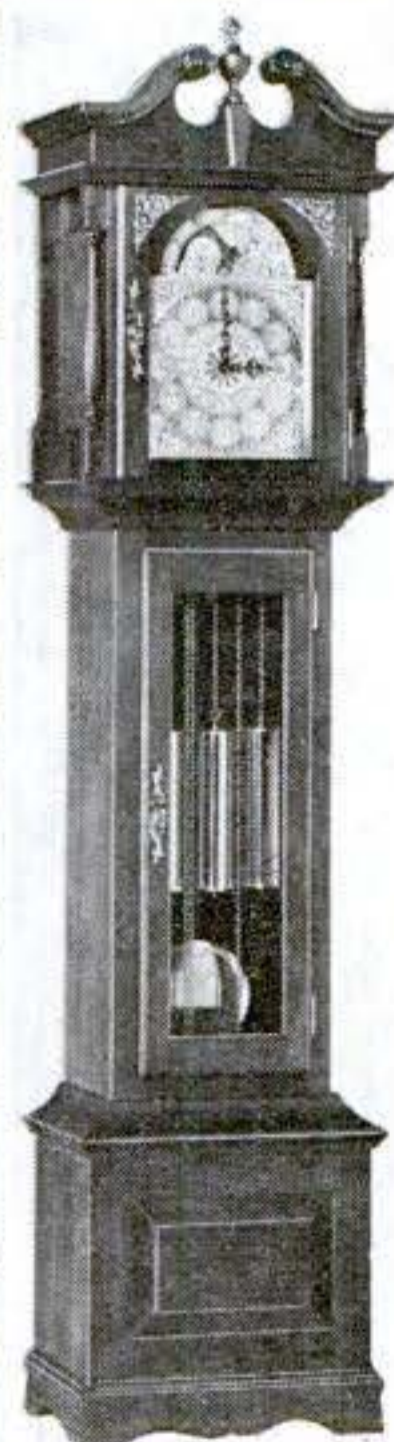
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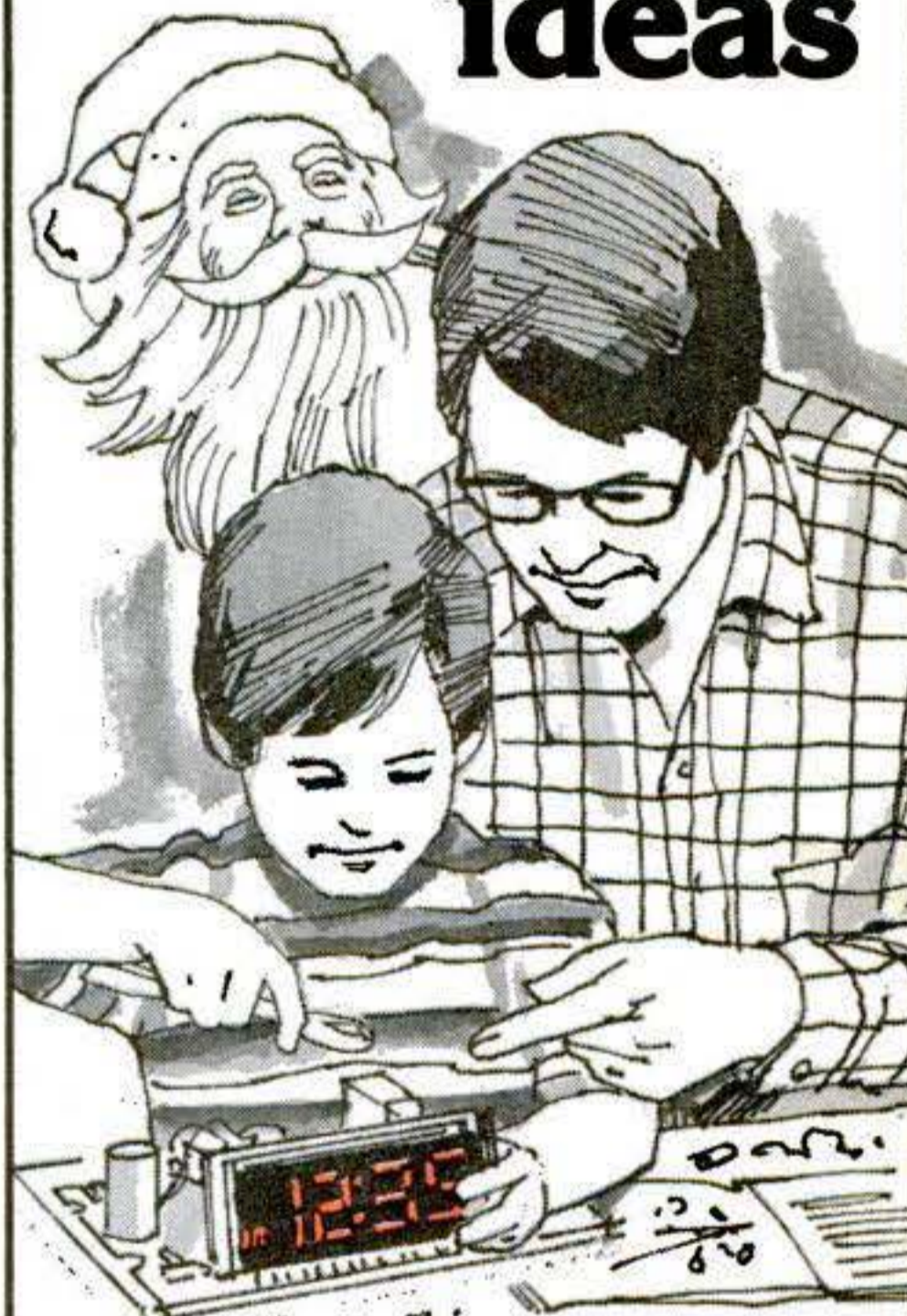
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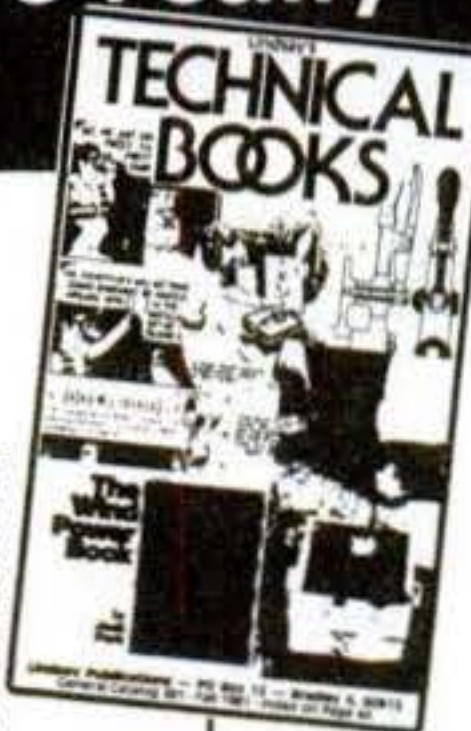
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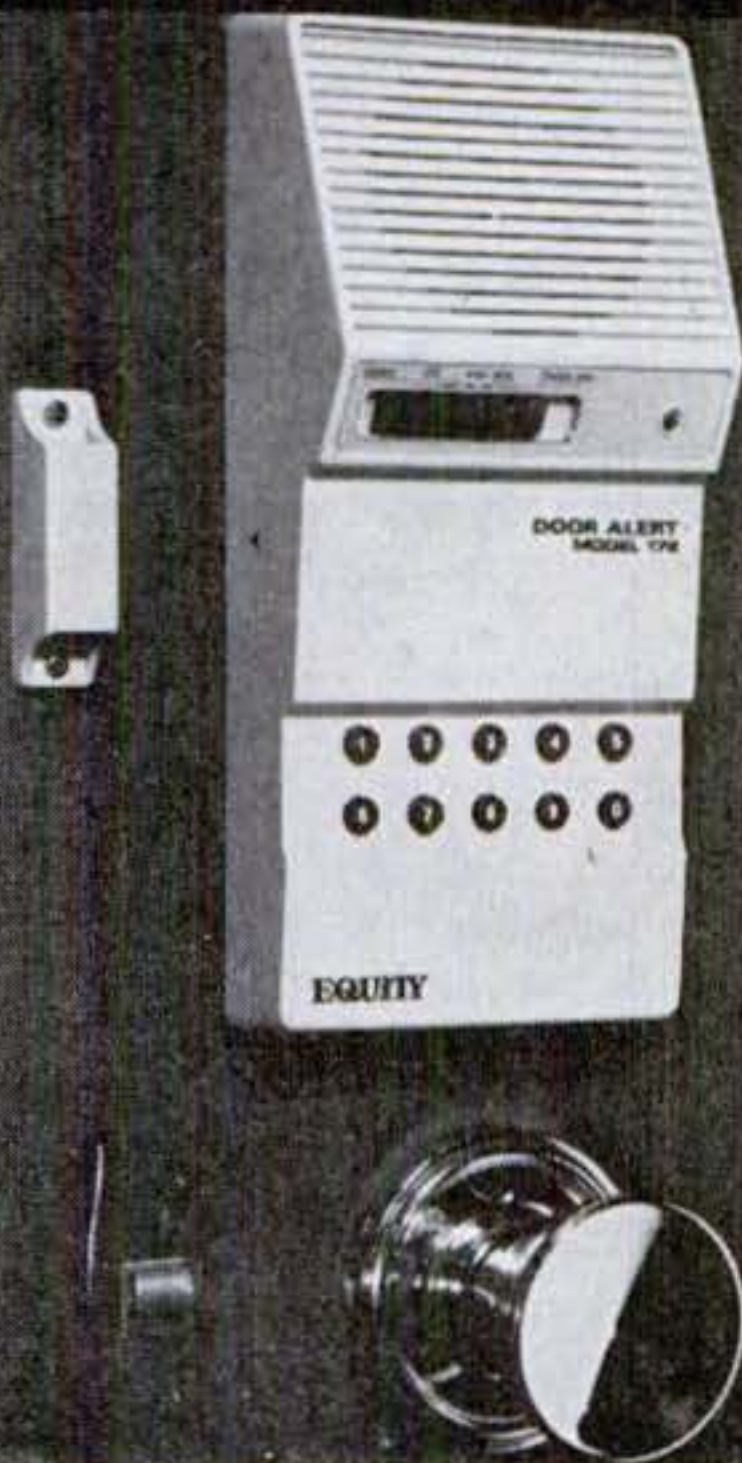
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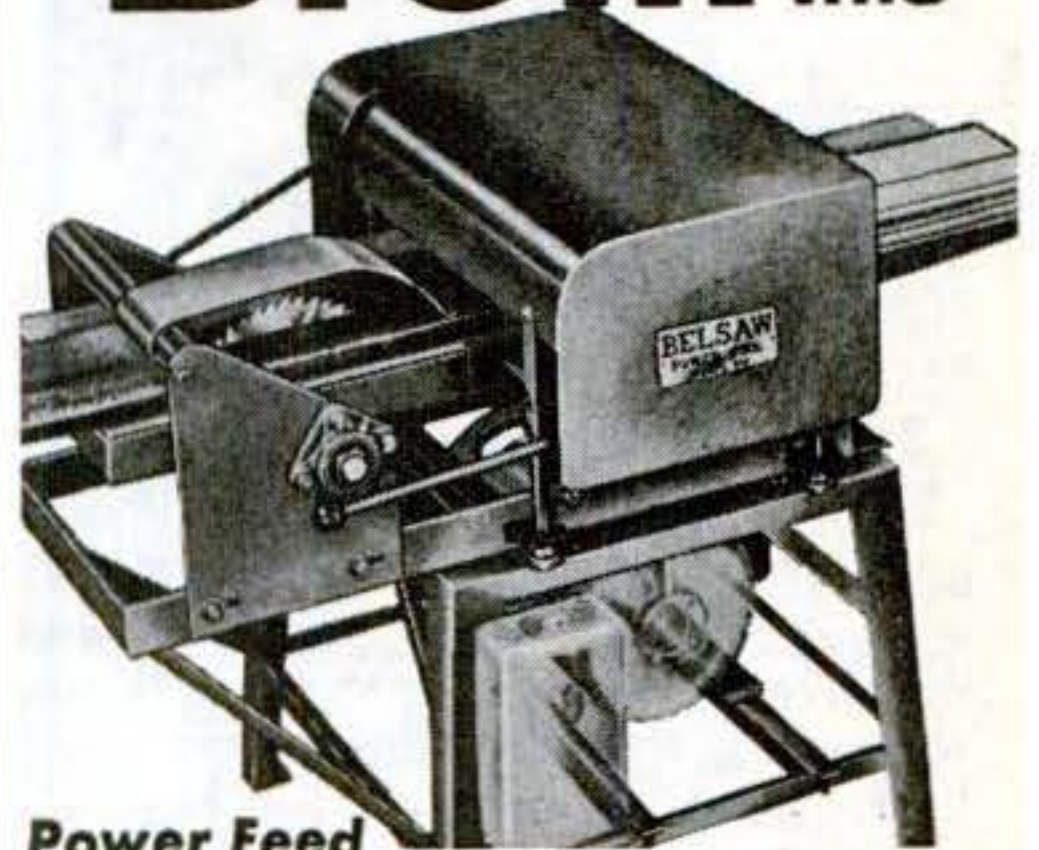
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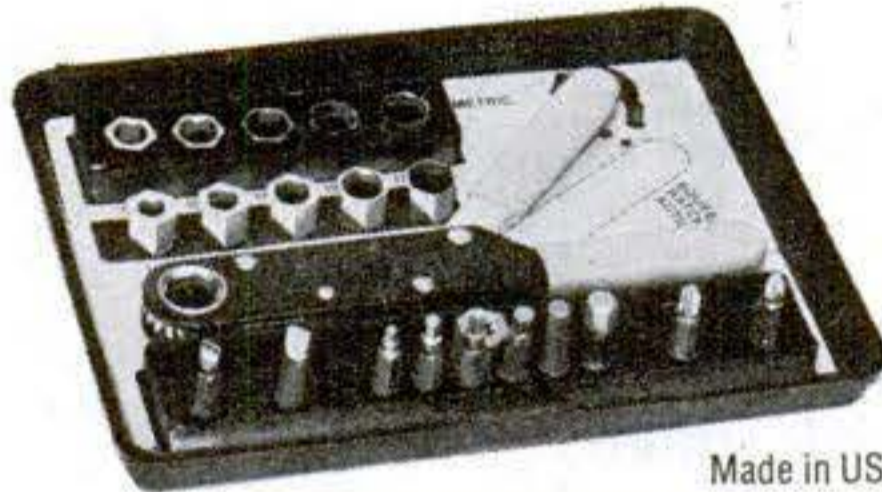


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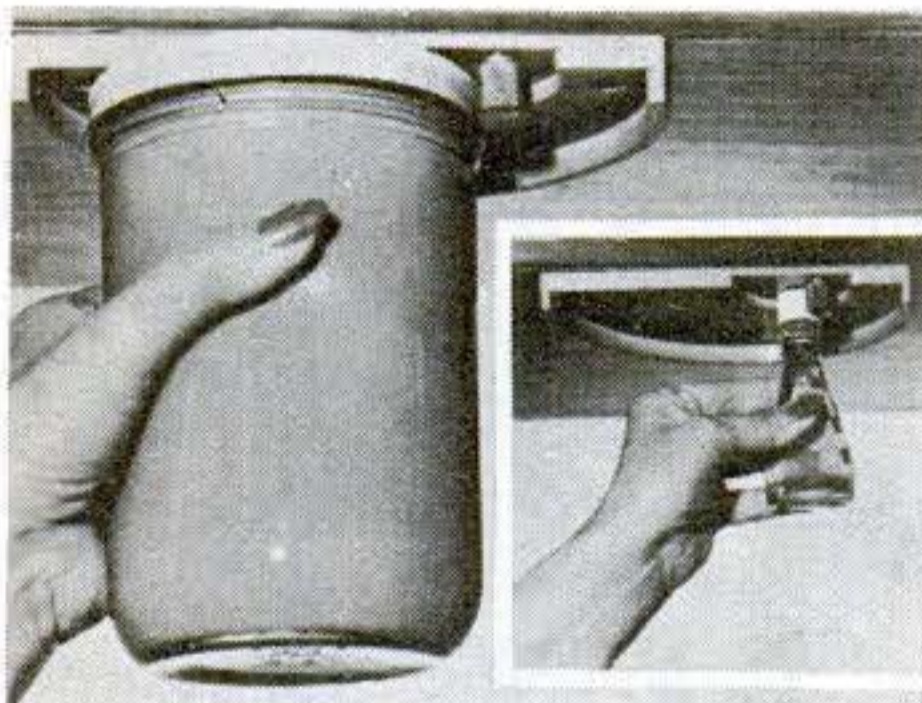
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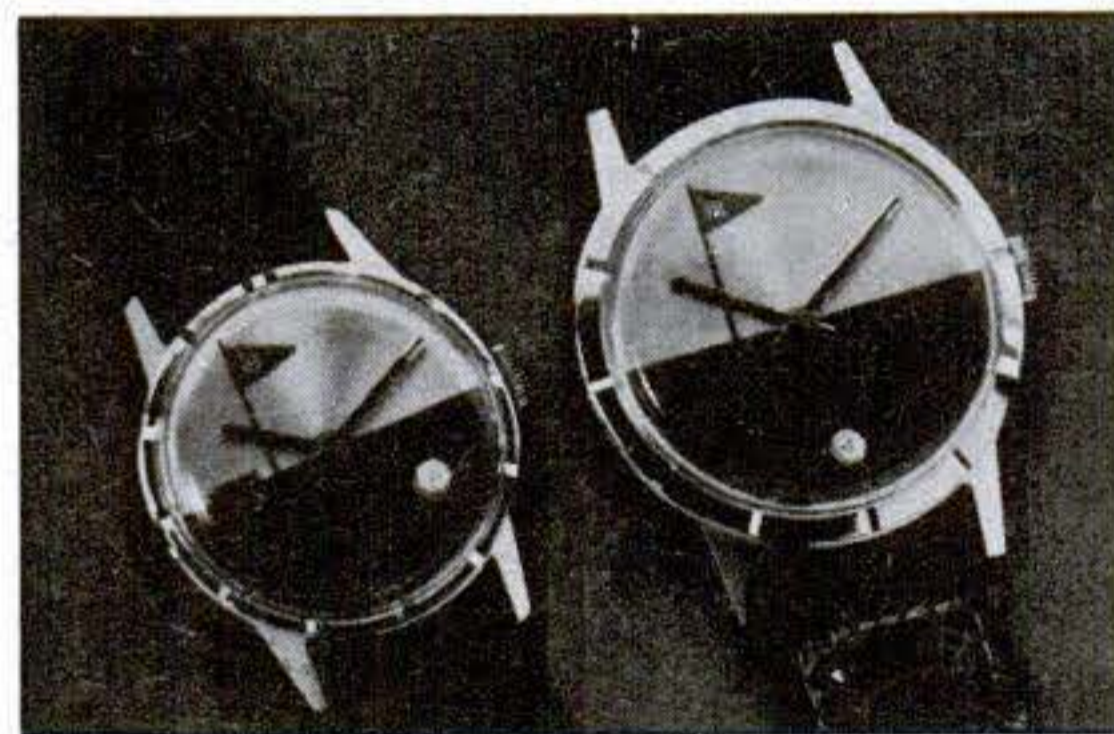
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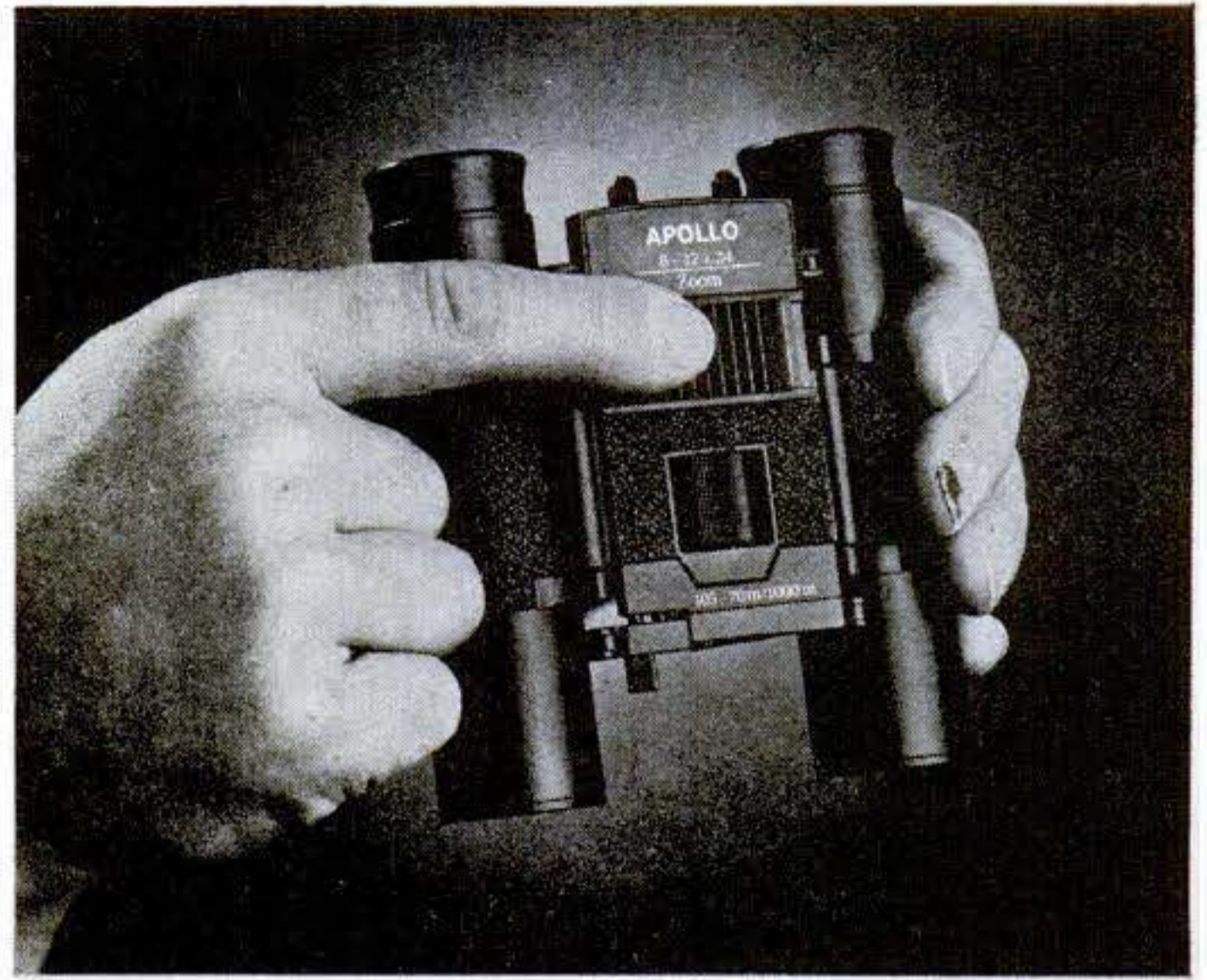
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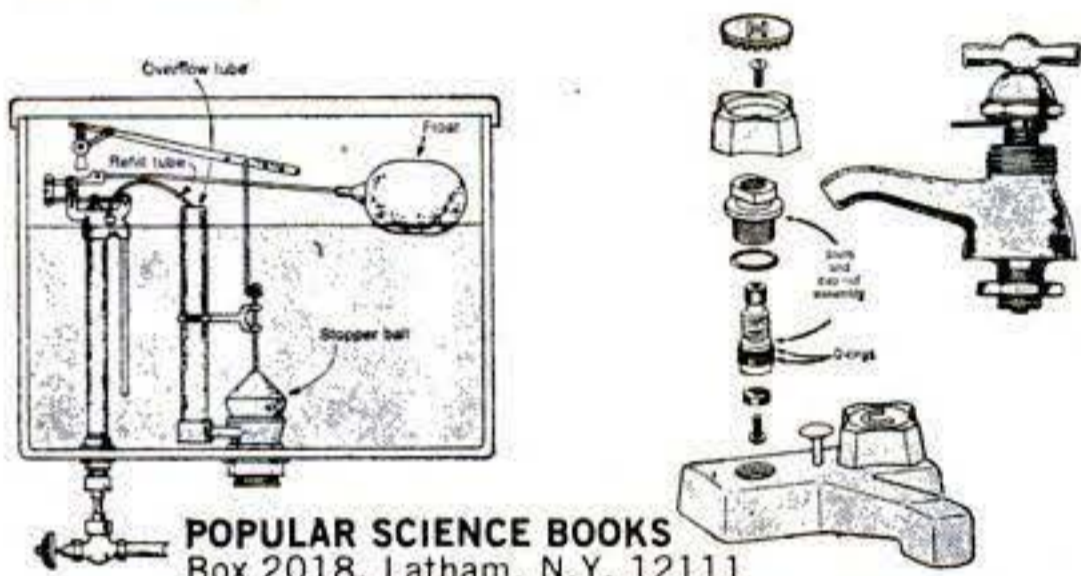
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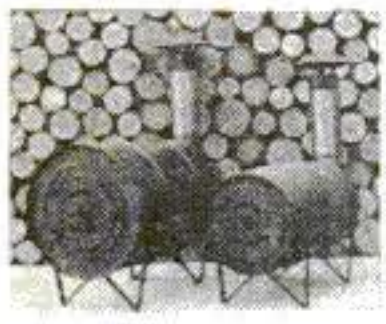
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Operation is simple! Just set the depth-of-field. Aim the camera. Focus. Then press the button. The built-in computer, with the incredibly accurate quartz oscillator, automatically selects the appropriate shutter speed for you. Click! You've got another great picture! The fast, 50mm f/1.7 lens captures the action with amazing sharpness and detail. The shutter speed, in automatic mode, ranges from 1/30 sec. to a super-fast 1/1000 sec. You can also do time exposures. And infra-red photography, too!

MAMIYA EXPANDS WITH YOUR ABILITY!

As your photographic skills expand, so can this Mamiya. That's because this camera is designed for use with a wide range of Mamiya-Sekor interchangeable lenses, filters and other sophisticated accessories. By the way, we DO have some Mamiya Autowinders and Zoom lenses. Phone us for information and prices on them.

FULL INFORMATION VIEWFINDER

LED indicators in viewfinder for shutter speed, flash ready, over or underexposure, weak battery.

MANUAL OVERRIDE FOR UNUSUAL LIGHTING

You can override the automatic exposure by pressing a button. This allows you to make a manual adjustment for the most appropriate exposure when the light is BEHIND the subject . . . or when the subject is partially illuminated by strong light. This gives you error-free photos, like a professional!

MOOD PHOTOGRAPHY

Use the Exposure Level Compensation device to produce high key or low key photos for highly expressive "mood" photos.

FLASH READY SIGNAL

When flash unit is used, the shutter speed automatically shifts to 1/60 sec. (the correct speed for flash synchronization). As soon as flash is fully recycled, a red dot lights up to indicate flash is ready.

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- Lens: 50mm f/1.7; 5 groups, 6 elements. 47° angle of view. Minimum aperture: 16. Fast bayonet mount.
- Focusing distance: From 1.5 feet to infinity.
- Film Speed: ASA 12 to 3200.
- Shutter: Electronically controlled metal focal plane. Speed of 1 sec. to 1/1000 sec. at AUTO position; 1/90 sec. at manual X position; plus bulb.
- Self-Timer: Approximately 10 second delay.
- Sync Contact: X-sync terminal and hot shoe.
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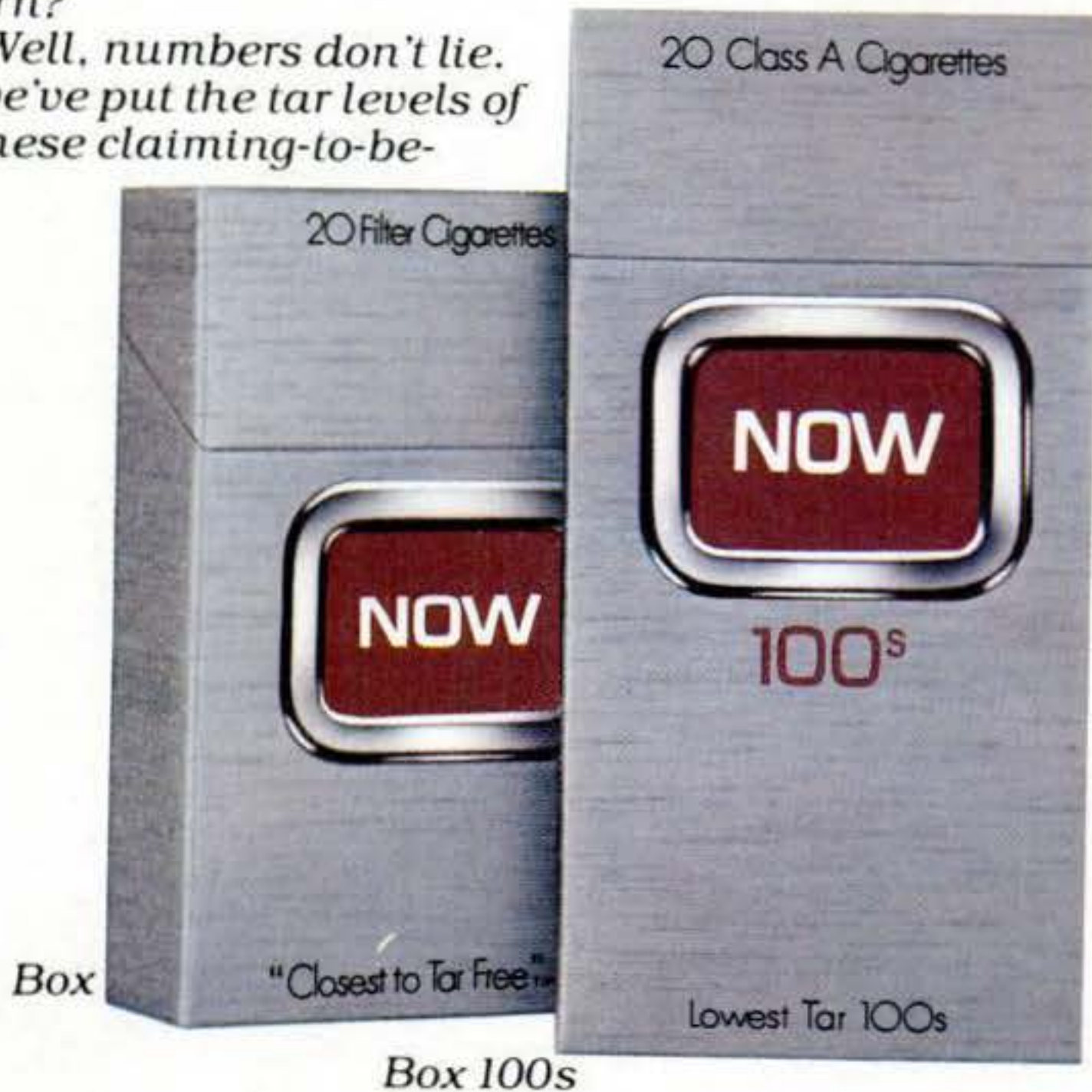
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NOW	Less than 0.01mg	1mg	Less than 0.01mg	2mg
CARLTON	Less than 0.01mg	1mg*	1mg	5mg
CAMBRIDGE	Less than 0.1mg	1mg	—	4mg
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