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This trouble-shooting guide tells how your car's emissions systems may impair performance.

Cover photograph by Ron Lindsey/Phototake

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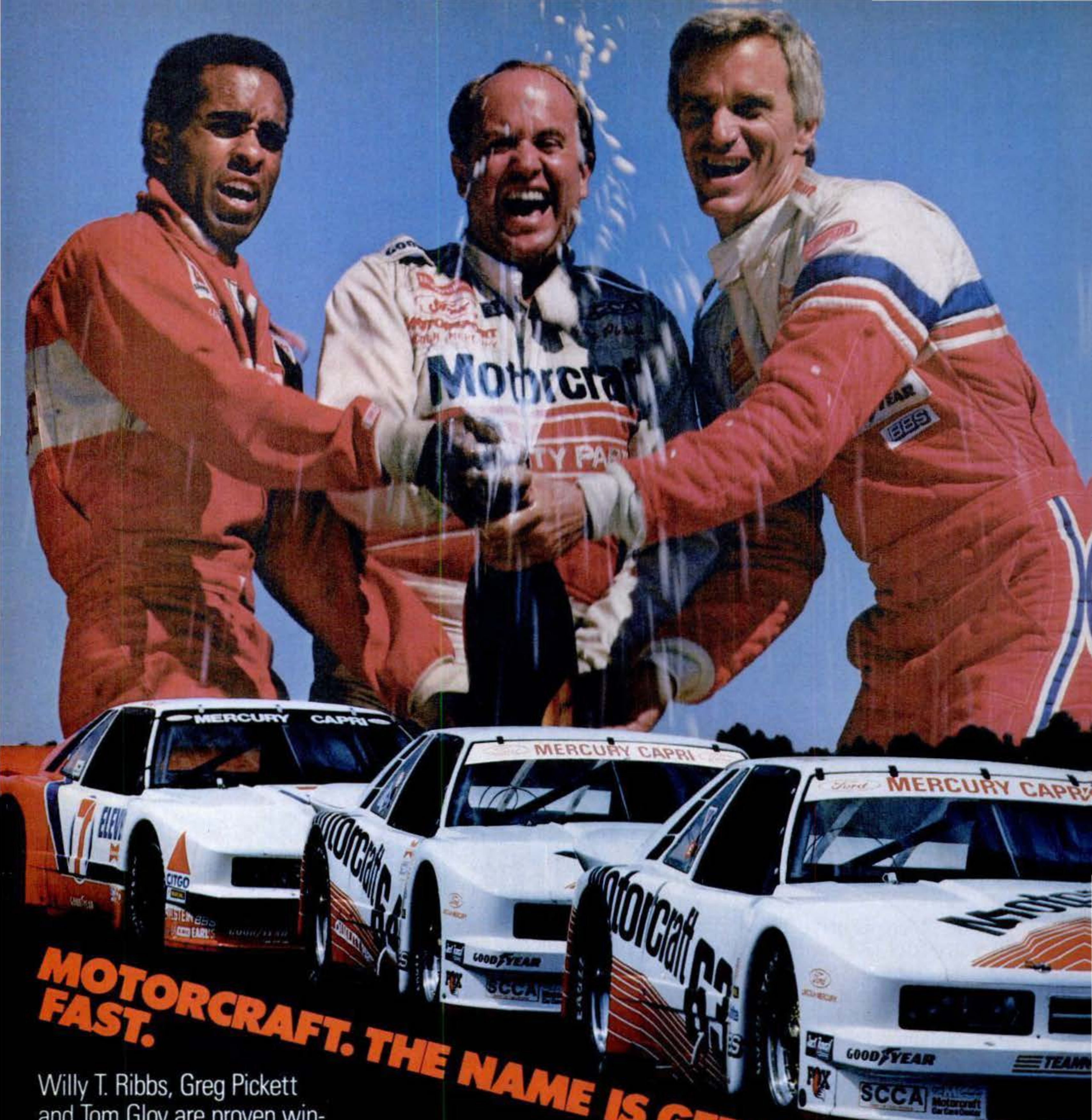
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Of senators and dishes

I finally gave up construction on my outdoor dish ["Install Your Own \$1,000 Satellite Dish," July] and went out and bought one. I have two receiving units in my house, and I am the most enthusiastic satellite nut who ever came down the pike. I look forward to every improvement that comes out, and I am grateful to people like you who have brought this art so far along.

Sen. Barry Goldwater
Washington, D.C.

Fifty years ago when I was in school, we were taught that America was a free country. You could do anything that didn't violate the rights of others. Now giant corporations flood our air space with electromagnetic waves and then tell us that we can't convert those waves or we will be considered criminals. I suppose next, some big agricultural company will plant our yards full of strawberries without permission and then fine us for eating them. Freedom is going down the tubes—and no, I don't have a dish.

Frank McNeely, Casper, Wyo.

Star Wars battles

There is one important point that your otherwise informative article on space weapons [July] failed to make: There's no reason to believe that our enemies, when faced with space-based weapons, won't simply change the mode of attack. Chemical warfare can be made just as devastating as nuclear holocaust. The only true defense is mutual respect and trust.

Paul Rosner, Richmond, Va.

Edward Edelson wrote a very interesting and complete analysis of the "Star Wars" laser-based defense against nuclear missiles. But like the press in general, he totally missed the point. Lasers are not the key to a space-based defense. The main proposal for such a defense is called "High Frontier" and does not use lasers or exotic weapons of any kind. It uses kinetic energy to collide with the missile—and the necessary technology is already available.

Jonathon Moseley
Sanibel Island, Fla.

Edward Edelson replies: "High Frontier is not the main proposal for a space-based defense—the strategy of the Reagan administration. Nor would it be as effective against attack as the strategy that Reagan outlined."

Hot on hot shapes

As a builder of Rutan's Long-Eze, I read "Hot New Shapes—Passenger Planes that Will Revolutionize Aviation" [June] with great interest, but I wish to point out two errors in the article: The Vari-Eze is a two-passenger plane, and the Starship 1 is powered by turboprop engines, not fanjets.

Kirk Nickman, Bloomington, Minn.

Jim Scheffer replies: "The original copy mentioned Rutan's 'small one- and two-person aircraft,' but was changed during editing. Several careful readers have pointed out that the term 'fanjet' is incorrect; the correct designation is, indeed, turboprop."

Neglected ion engines

The article on nuclear-powered ion engines ["Ion Engines for Our Mission to Neptune," June] was fascinating. I have taught and spoken on the subject of nuclear energy for years and have observed a decline in the recognition of the importance of nuclear-powered ion engines for many commercial applications—ranging from electricity to food preservation—and an increase in apprehension about its use anywhere. I hope this trend does not affect the exciting nuclear programs for space exploration, because there is essentially no other source of energy to fuel the types of deep-space missions we would like to and should engage in.

Monica E. Bainter, Ph.D.
Professor of Physics (Emeritus)
University of Wisconsin
Stevens Point, Wis.

Mini-van fan

I waited months to read your first car test on the new mini-vans ["New-Generation Mini-Vans," May] and was disappointed when I did. Every positive point you raised about the Voy-

Continued

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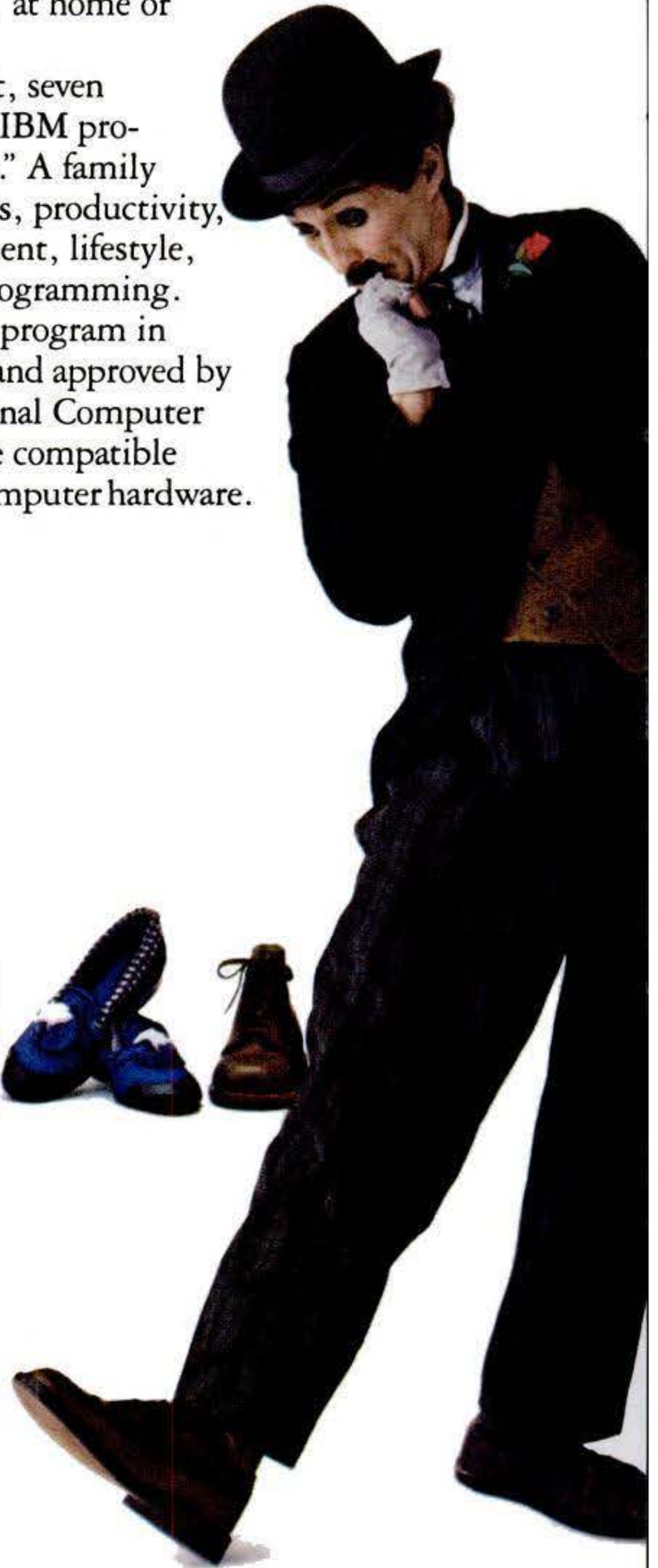
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Readers Talk Back

ager is also true for the Vanagon, except front-wheel drive, which is debatable: Try handling a fully loaded front-wheel-drive van on snow and ice! You also neglected to point out that when hauling seven passengers, the Voyager, Vista, and Toyota have no room for extra cargo—but the Vanagon does. My pick for best mini-van? The Vanagon.

Clare Sutton, Forest, Ont.

Swifter swapping

Although I enjoyed "Engine Swapping—Shop Tips from a Pro" [May], I have to disagree with some of the advice. Only one out of 30 cars needs to have its air conditioning discharged while changing its motor. Instead, unbolt the compressor, and tie it to the hood hinge or inner fender with solid wire. A piece of wood should be placed directly behind the condenser to elimi-

nate any chance of the water pump going through it. The same procedure should be followed for the power-steering pump to avoid fluid loss and accompanying mess.

Kent Purcell, Norfolk, Va.

Thanks for your article on engine swapping. We've been swapping engines for years. The price of premium gasoline last year drove us to swap a turbo engine for one that burns regular gas—a new way to cut down on fuel bills.

Len and Lily Dudicz
Hayward, Calif.

Bob Cerullo replies: "Reader Purcell's tips will work when the air-conditioning compressor is on the right side of the engine. However, when the compressor is on the left side, as in many V6 engines, it must be removed. It also takes more time to tie off the compressor than to remove it and recharge the system later. In any case, placing wood behind the condenser is a good idea."

Superinsulation superiority

You're right—passive solar heating is becoming very popular ["What's News," June]. But what's catching on even faster is superinsulation. In Saskatchewan, Canada, for example, 50 percent of all homes built in the past year were superinsulated. Such houses can outperform passive-solar homes by cutting heating bills from \$100 to \$200 a year. Superinsulated homes don't have big swings in room temperatures on sunny days and cold nights and don't overheat in summer. Also, there's no need for a furnace, oil tank, or chimney.

William A. Shurcliff
Cambridge, Mass.

Differing DIY

Though I'm usually in agreement with the high caliber of DIY information in PS, I don't agree with some of the tips in "Build-It-Yourself L-Shape Patio Deck" [May]. In photo 4 the bottom step disappears under the step above it, which is a waste of lumber. In the same photo the steps are being nailed down in a straight line—a poor practice. Centering the nails in the stock can lead to split supporting members. It's better to stagger the nails, which will prevent splitting by pinning boards together. Finally, the ends of the deck boards should be capped to prevent splintering and twisting.

Scott T. Gleason, Campbell, Calif.

Al Lees replies: "Not all contractors build alike. If reader Gleason had studied photo 3 on the page, he would have realized that the step technique employed here avoided putting in another series of piers or clumsy stringers. The nailing pattern this professional builder chose is much neater than a staggered one. Any splitting problem can be avoided by pre-drilling. Capping the ends of pressure-treated lumber, however, is a waste."

Corrections: In "A Pro's DIY Guide to Auto A/C" [July], the orifice tube in the drawing on pages 86 and 87 should have been labeled a thermostatic expansion valve.

In "Space Weapons—the Science behind the Big Debate" [July], the location of the Antares Laser system was incorrectly identified. Antares is, in fact, part of the Los Alamos National Laboratory. P.S.

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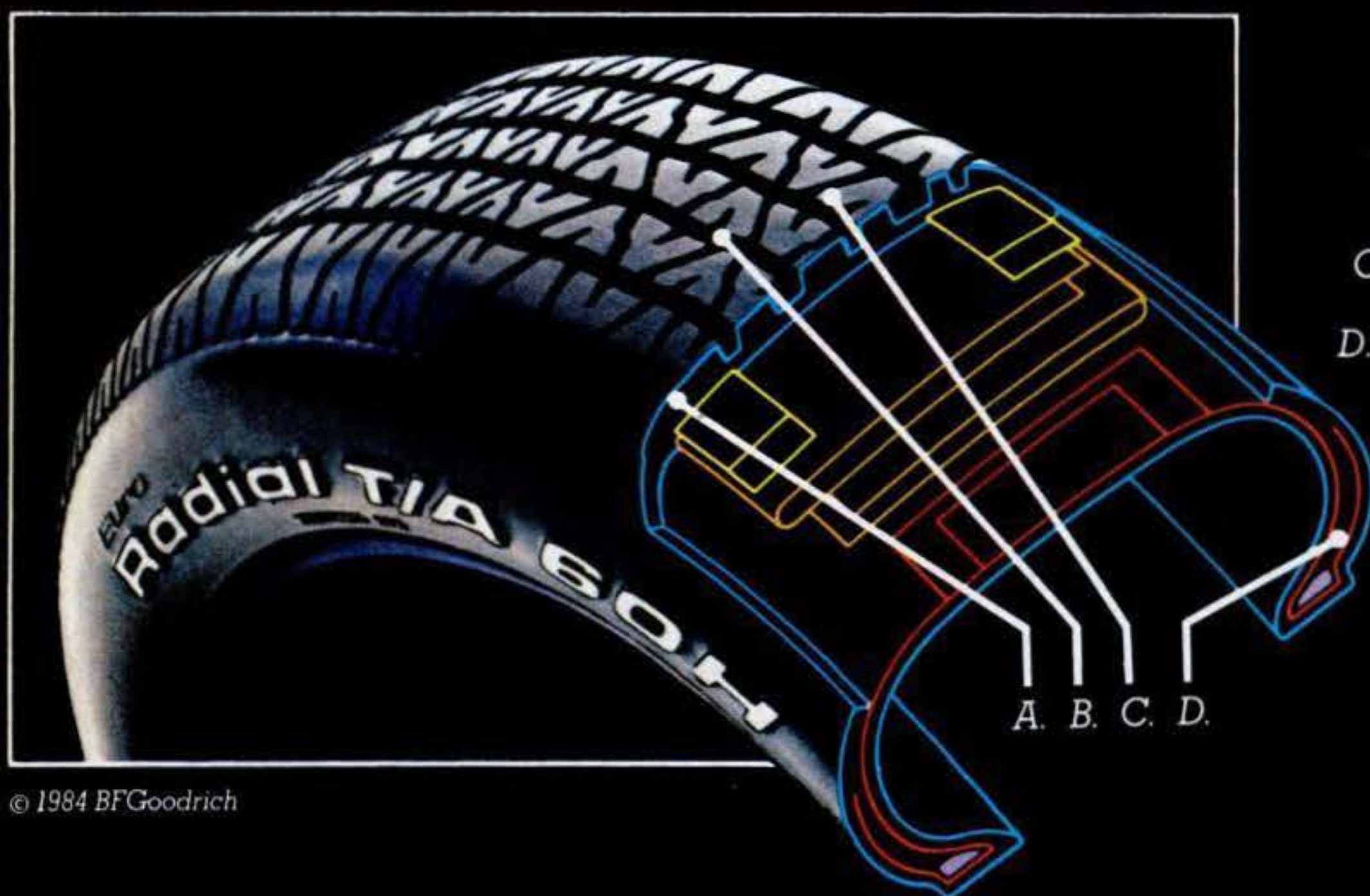
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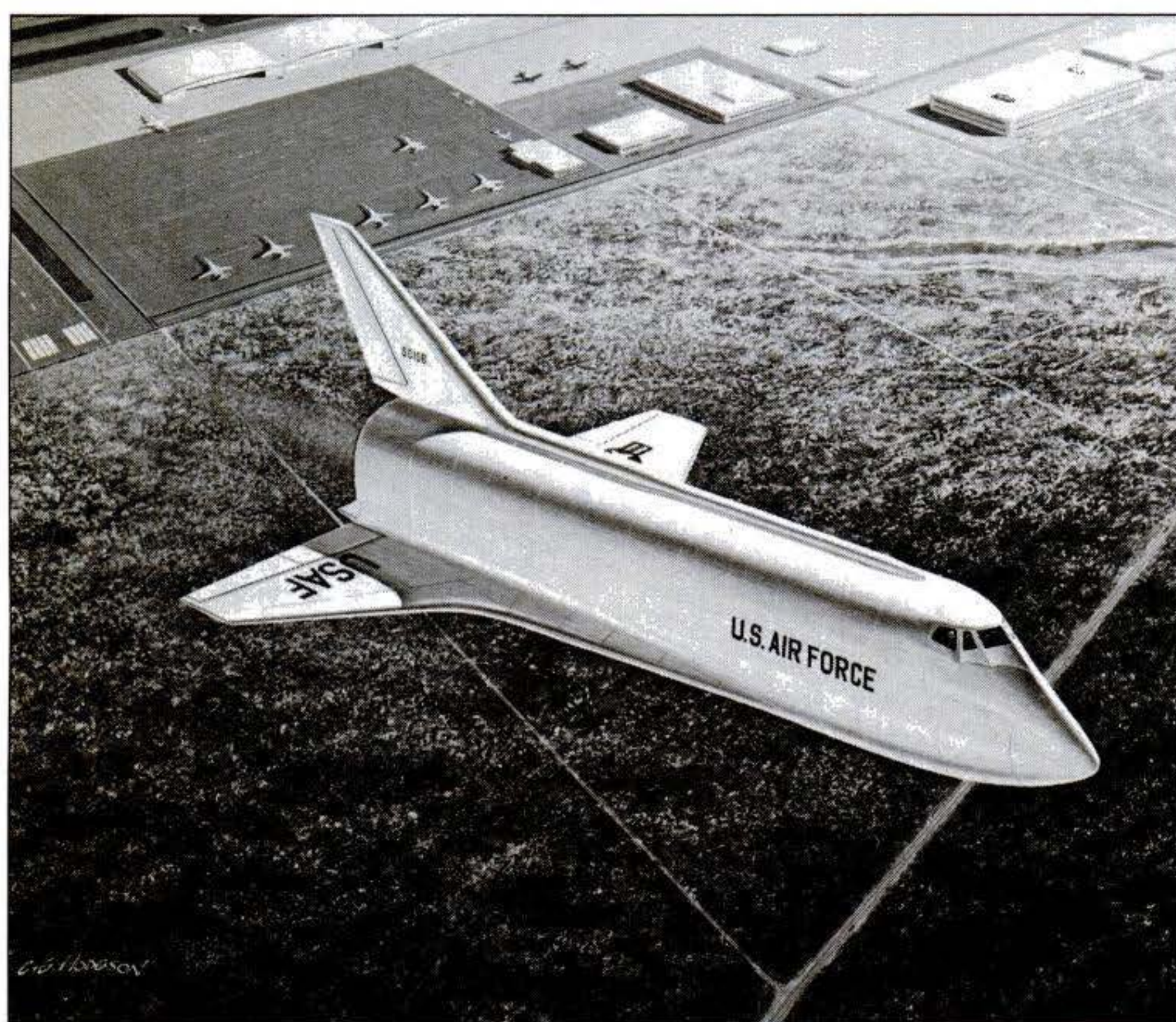


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Science Newsfront

By ARTHUR FISHER



Trans-atmospheric craft

The artist's concept above may resemble the space shuttle, but it's a totally different kind of aircraft. Called the TAV, for trans-atmospheric vehicle, it could blend the characteristics of an atmospheric flyer and a spacecraft to a greater extent than the shuttle. To wit: It could fly subsonically, like an airliner, or jump 70 miles to the edges of space where it could speed between New York and Australia in just 30 minutes.

The multipurpose-vehicle concept is being studied by Lockheed-California Co. under an Air Force contract. "Versatility is the key to Lockheed's design," says Norman E. Nelson, vice-president and general manager of Lockheed-California's Advanced Development Projects Unit, known fondly in the trade as "the skunkworks." "Our proposal," he says, "combines elements of a spacecraft with those of a conventional air transport. It will be both larger and more maneuverable than the space shuttle orbiter."

Unlike the shuttle, the TAV would take off horizontally from typical commercial airports in heavy-weather

conditions, dispensing with the elaborate verticle gantry and launch precautions needed by the shuttle. Depending on the mission, the TAV could hop from New York to Los Angeles in 12 minutes, reaching an altitude of 300,000 feet in a suborbital trajectory. If deemed necessary or appropriate, it could then make the



return trip subsonically at 40,000 feet with few alterations.

The Air Force is considering the TAV for military missions, but it could have commercial importance as well. It would have a launch weight of 1.5 million pounds and could carry payloads of up to 20,000 pounds in its cargo bay. It would be slightly smaller than Lockheed's C-5 Galaxy—the world's largest air-cargo plane—but twice as heavy. It would fly at speeds up to Mach 30 in a circular orbit of up to 100 miles above Earth.

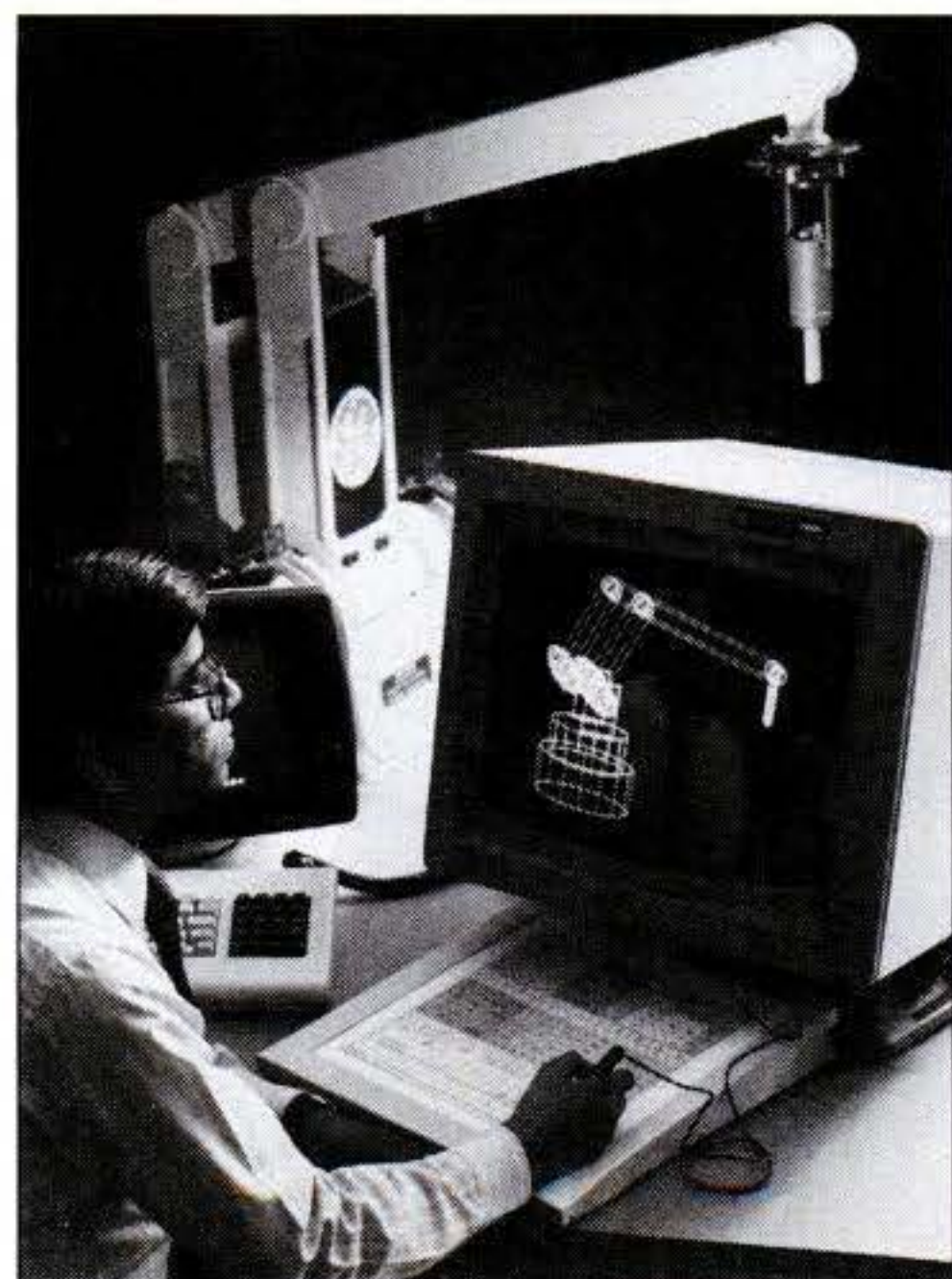
Jet set for glass cutting

An English firm, Jetin Industrial Ltd., has developed a glass-cutting system using high-pressure jets of sand and water, as seen in the photo below (left). The stream of fine sand and water is ejected from a special tungsten carbide cutting nozzle at 13,000 psi. The process has been used to carve out aircraft windshields and bulletproof windows for cars, among other things.

Robot testing

Rather than putting an industrial robot through its paces on a factory floor, why not use a computer program to simulate its performance? That's what's going on in the photo below. Calma Co., a subsidiary of General Electric, has designed software called ROBOT-SIM. With it, an engineer can design a factory work cell, simulate a robot's movements and activities within it, and then modify the robot's actions and the equipment surrounding it to achieve greatest efficiency. According to GE estimates, 60 to 80 percent of the time needed to place a robot in use in the automotive, aero-

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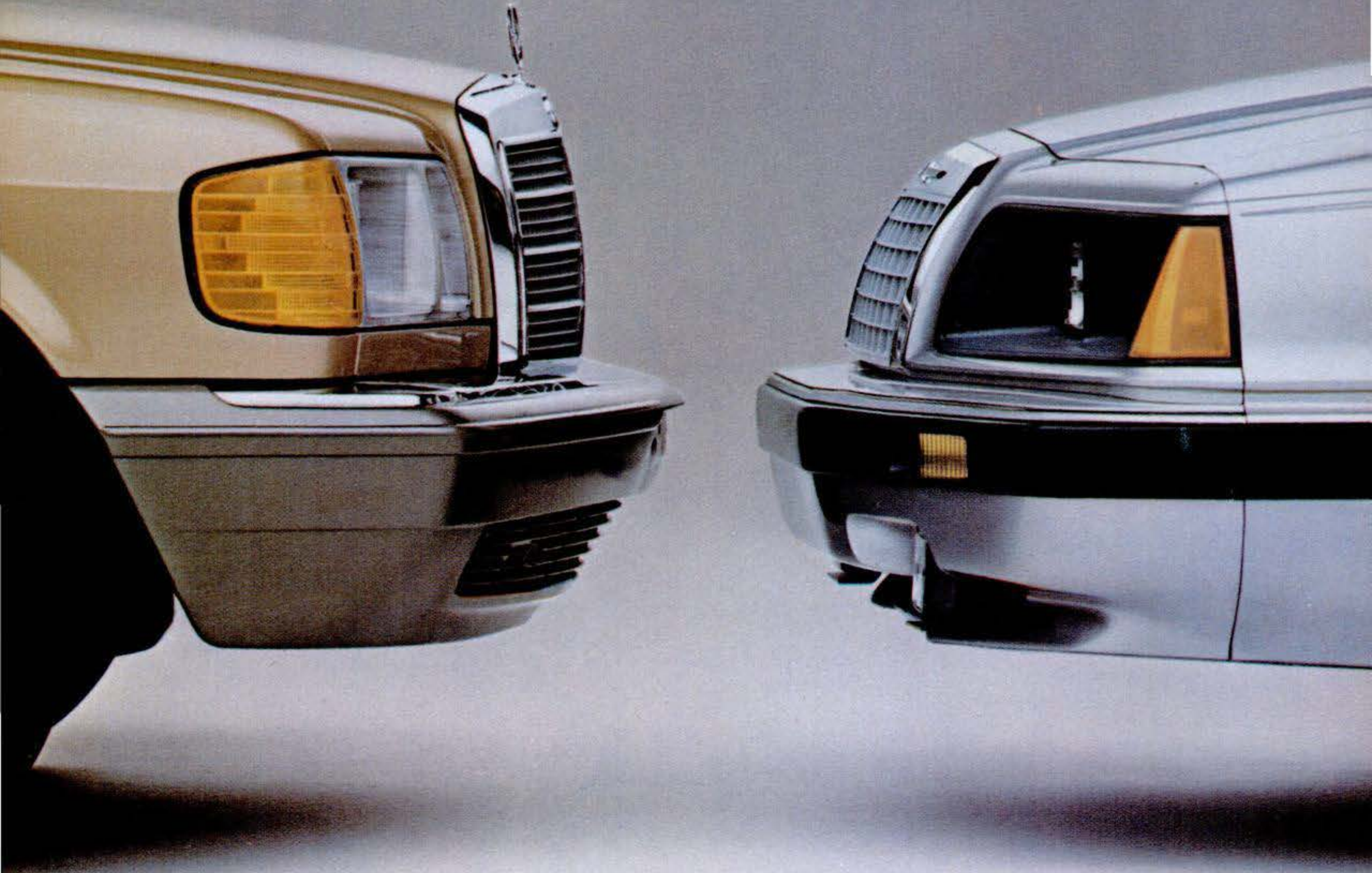
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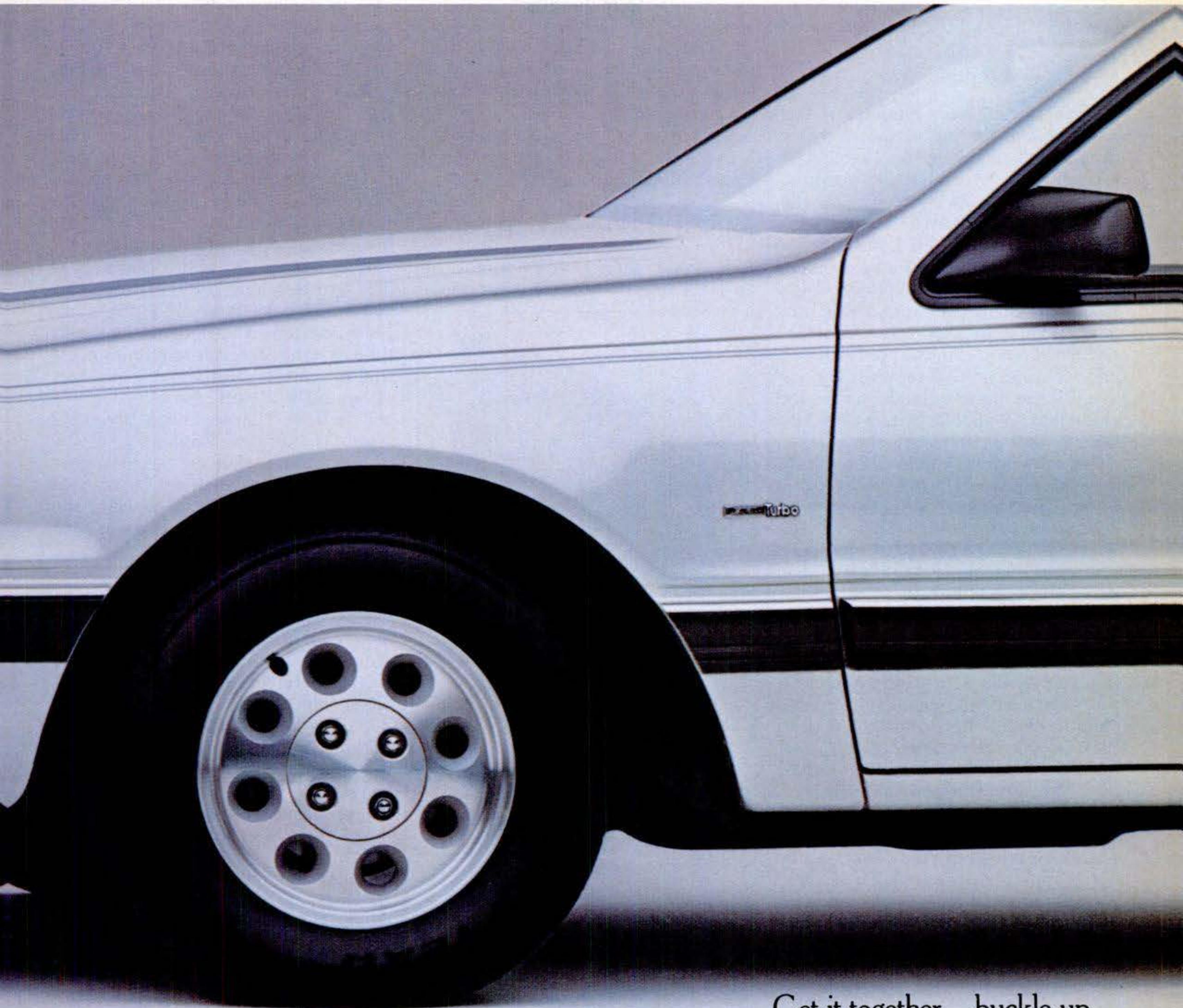
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space, and other manufacturing industries is devoted to designing the work cell, which is defined as the robot itself, the robot's manipulators, part orienters, parts being worked on, and the surrounding mechanisms.

Very, very cold water

The National Science Foundation has reported the finding of liquid water in cirrus clouds at by far the coldest temperature ever recorded—minus 32 degrees F, or 64 degrees below the freezing point. Researchers at the University of Utah, in Salt Lake City, located the supercooled water droplets about 5.1 miles above Boulder, Colo., in a cirrus-cloud layer. It had been previously thought that these tenuous, narrow bands of clouds were composed only of ice crystals because they are usually the highest clouds in the sky, at 20,000 to 40,000 feet, where the temperature is extremely low.

According to Dr. Kenneth Sassen of the University of Utah, a water droplet will not freeze unless there is a nucleus around which to form ice. Such nuclei often consist of dust particles, but at these high altitudes the air is typically too clean to contain dust.

The effect of high cirrus clouds on Earth's global climate has been receiving particular attention in recent years. "Global and zonally averaged climate models have illustrated that cirrus clouds can profoundly affect the transfer of solar and terrestrial radiation through the atmosphere and thereby influence the temperature structure of the Earth-atmosphere system," Sassen reported. "Ice crystals with simple shapes have been utilized in these models. However, the potentially significant modifications to the radiation balance caused by the presence of liquid cloud droplets and the related changes in the shapes of ice crystals nucleated from them have not received attention."

Animal aberrations—I

The monster bee you see in the photo (right, top) is not the product of Steven Spielberg's special-effects lab. It is the world's largest bee, thought extinct for the last 100 years but rediscovered on an Indonesian island by a graduate biology student. It dwarfs the common honeybee, which is included in the photo for comparison.

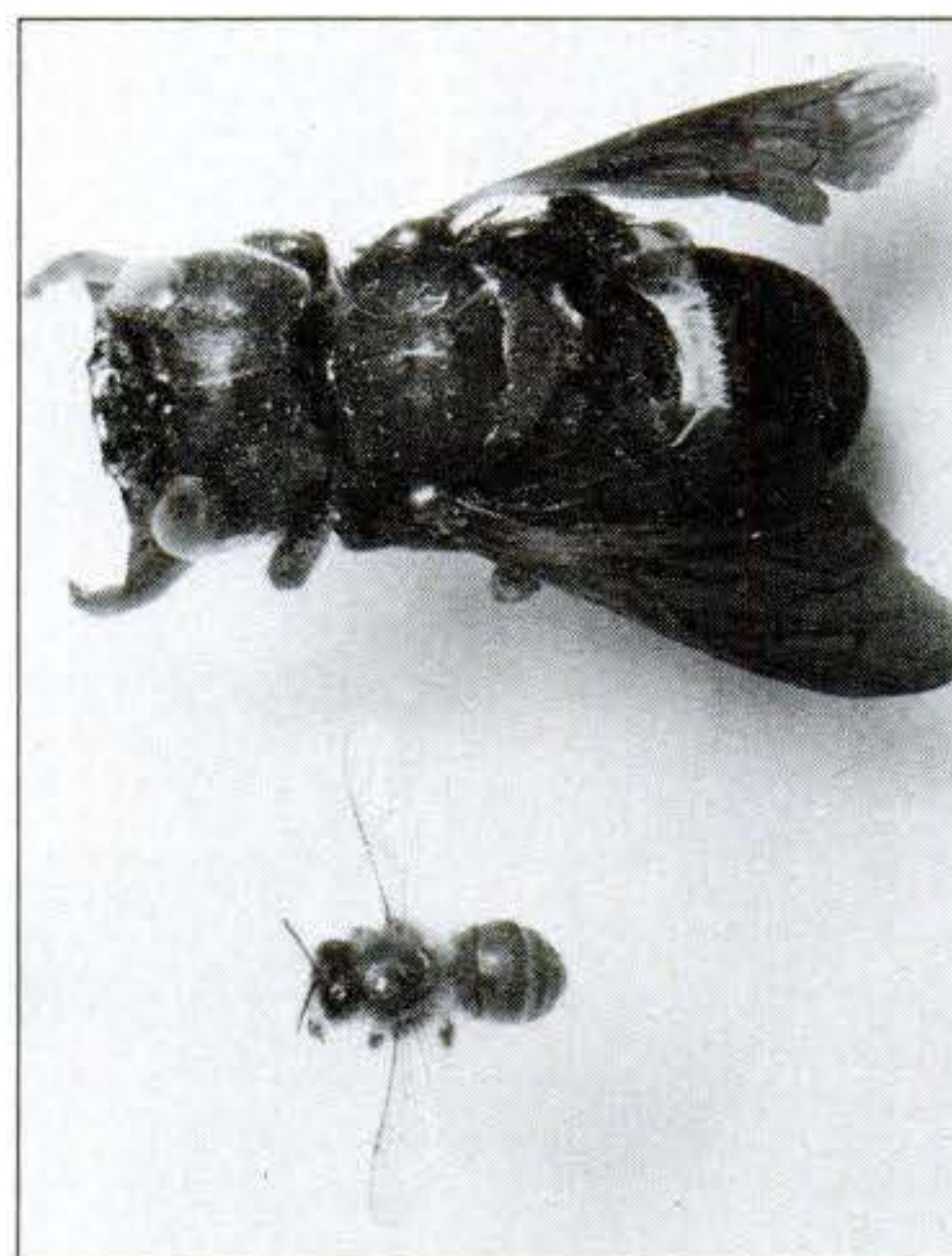
Chalicodoma pluto, or "king bee," as the Indonesians call it, was first reported by Darwin's contemporary, A. R. Wallace, in 1859, on an island in

the North Moluccas. A specimen was collected and sent to a British museum, but there have been no observations of the 1¾-inch giant since. Then, on a trip to Hamahera Island, Adam Messer, of the University of Georgia (Athens), saw two huge bees gathering resin by scraping the sticky stuff off tree trunks with their weird, outsize, plier-like mandibles.

Do they sting? Yes, says Messer, but because the stinger is not barbed, it doesn't hurt "too much."

Animal aberrations—II

The second in our series of unnatural animals appears in the bottom photo.



The larger animal is obviously a mule, and the youngster is her thoroughbred foal. Impossible, of course. Mules are the offspring of a horse and a donkey, and, by the laws governing such interspecies matings, are sterile, incapable of reproducing themselves, much less producing a thoroughbred horse.

How did she do it? Through the ever-evolving technique of embryo transplantation. The fertilized egg from a thoroughbred mare named Crystal was implanted in the mule's uterus at the James Baker Institute for Animal Health, a unit of the New York State College of Veterinary Medicine at Cornell University, Ithaca, N.Y. The foal was born without complications 366 days later. The attending physician was Dr. Douglas Antczak, an assistant professor of immunology, and his collaborator was Dr. William Allen of the Equine Fertility Unit of the British Thoroughbred Breeder's Assn., Cambridge, England.

The information on fertility garnered in this experiment could help physicians and veterinarians lower the rate of spontaneous abortions in both humans and animals.

Top quark found

The team of 151 scientists headed by Harvard's Carlo Rubbia at CERN, the European Laboratory for Particle Physicists in Geneva, Switzerland, has done it again. Capping the discovery of the W and Z particles, the intermediate vector bosons required by modern unification theories [PS, May '83], the physicists have finally found evidence for the existence of the long-sought "top," or T, quark. Five other quarks had previously been identified: the bottom, up, down, strange, and charmed quarks. The top quark was predicted by theories on the nature of matter—theories requiring a symmetry among the so-called "fundamental" particles.

Conducting plastic

Raimond Liepins and Mahmoud Aldissi, chemists at the Los Alamos National Laboratory's Materials Technology Group, have developed a new soluble plastic that conducts electricity virtually as well as metal. The material is a lightweight, easily molded polyacetylene polymer. When it is doped with an unusual chemical, cesium electride, its conductivity is increased about 100 times over that achieved with other conducting plastics ["Plastic-Metal Batteries," PS, Feb. '82].

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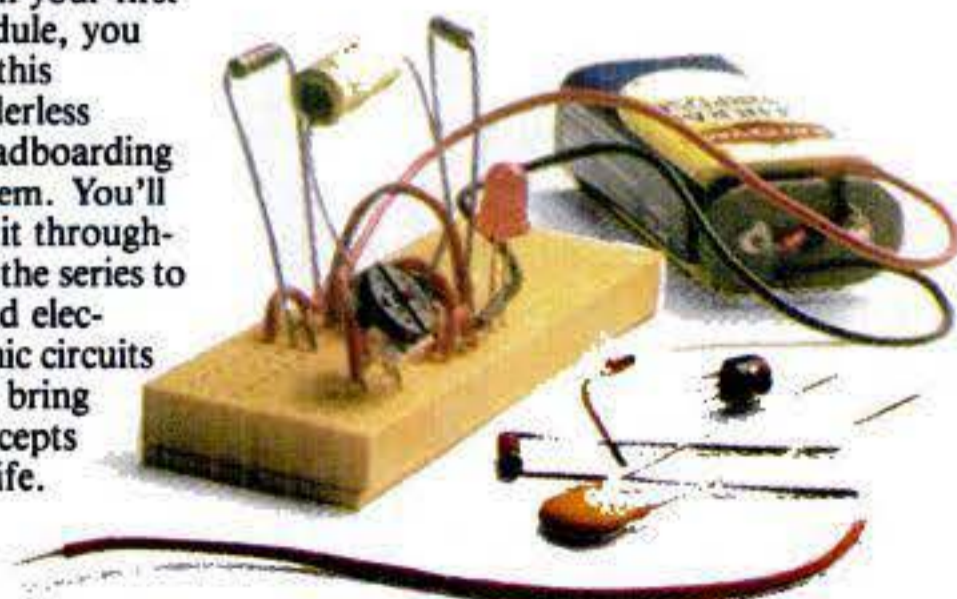
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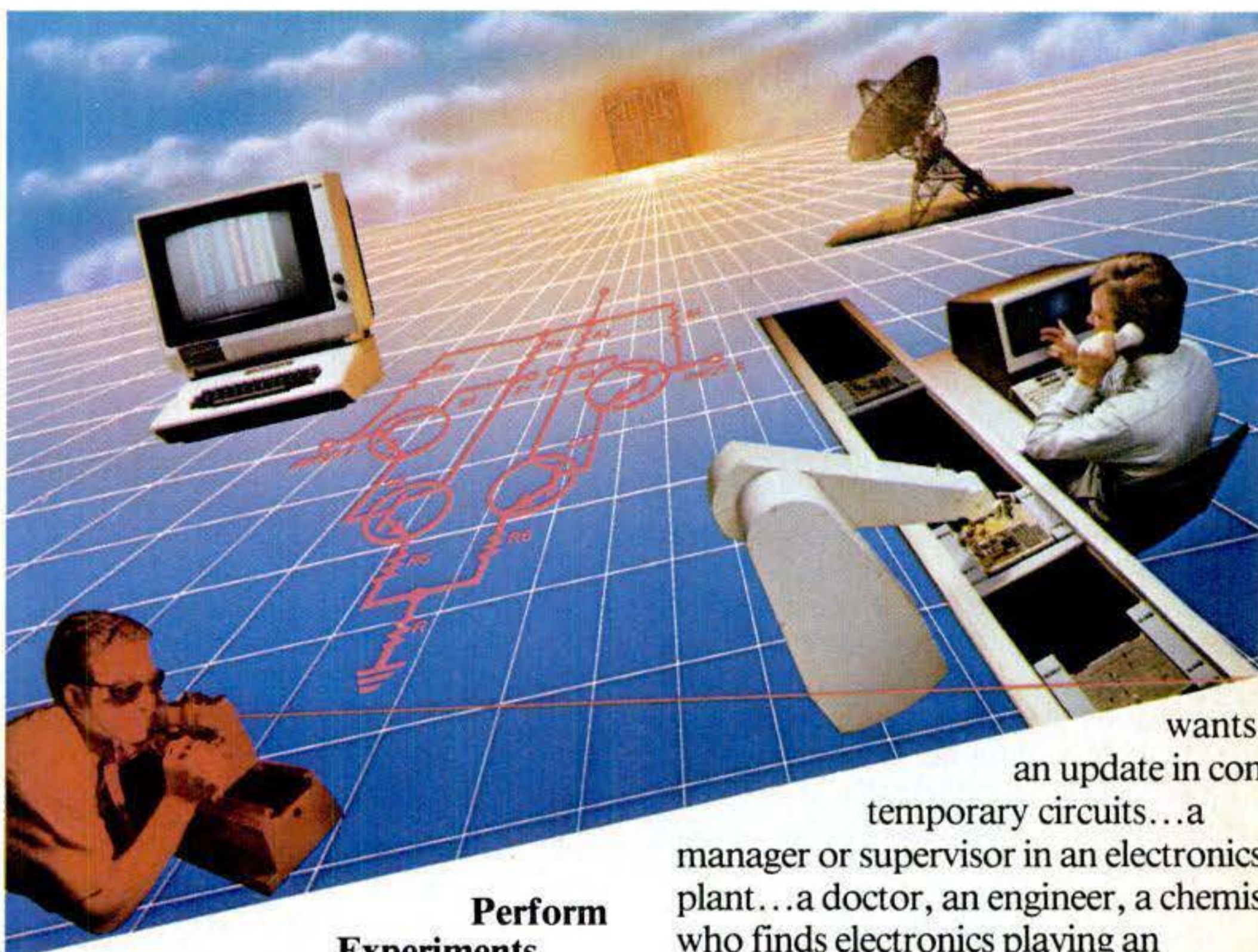
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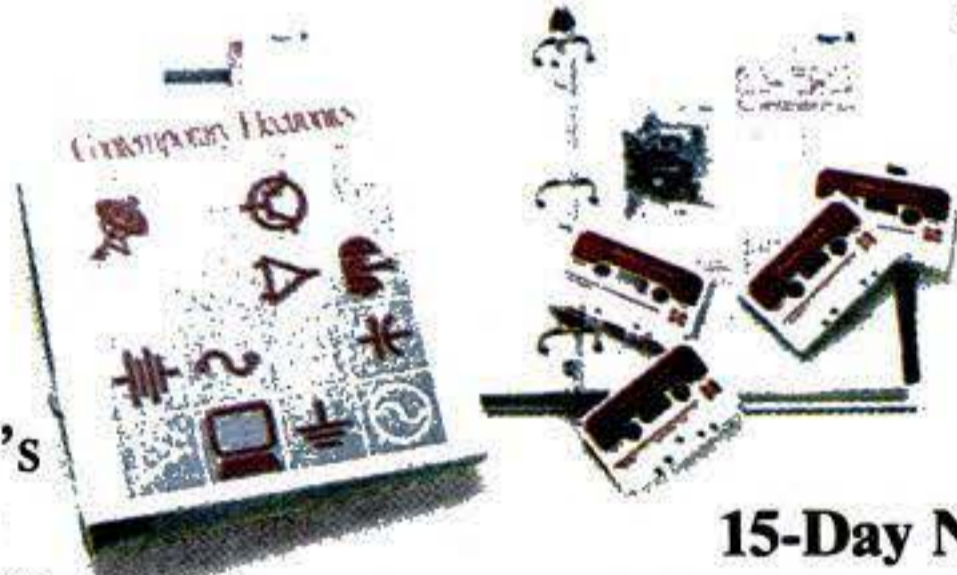
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Forced-air heating with wood

An oil- or gas-fired furnace can be easily adapted to circulate heat from a stove.

By **STUART F. BROWN**

When real-estate developer Larry Pina installed an airtight wood stove several years ago as the primary heat source for his home in Westport, Mass., he found that winter temperatures were varying by an uncomfortable 10 to 15 degrees in different parts of the house. Unhappy with these too-hot and too-cold areas, Pina devised a way to convert his existing gas-fired furnace and its accompanying hot-air ducting into an automatic wood-stove heat-distribution system. The cost of the project was only about \$50 for some widely available electrical parts.

Pina replaced the standard heat-only subbase assembly on the gas furnace's room thermostat dial with an interchangeable heat-cool subbase. In addition, he wired a fan relay into the circuit that supplies current to the furnace's blower motor. "Whenever we get a good fire going in the wood stove, we simply switch the new thermostat subbase from 'heat' to 'cool,'" Pina

Schematic diagram (below) shows new components wired into furnace circuit.



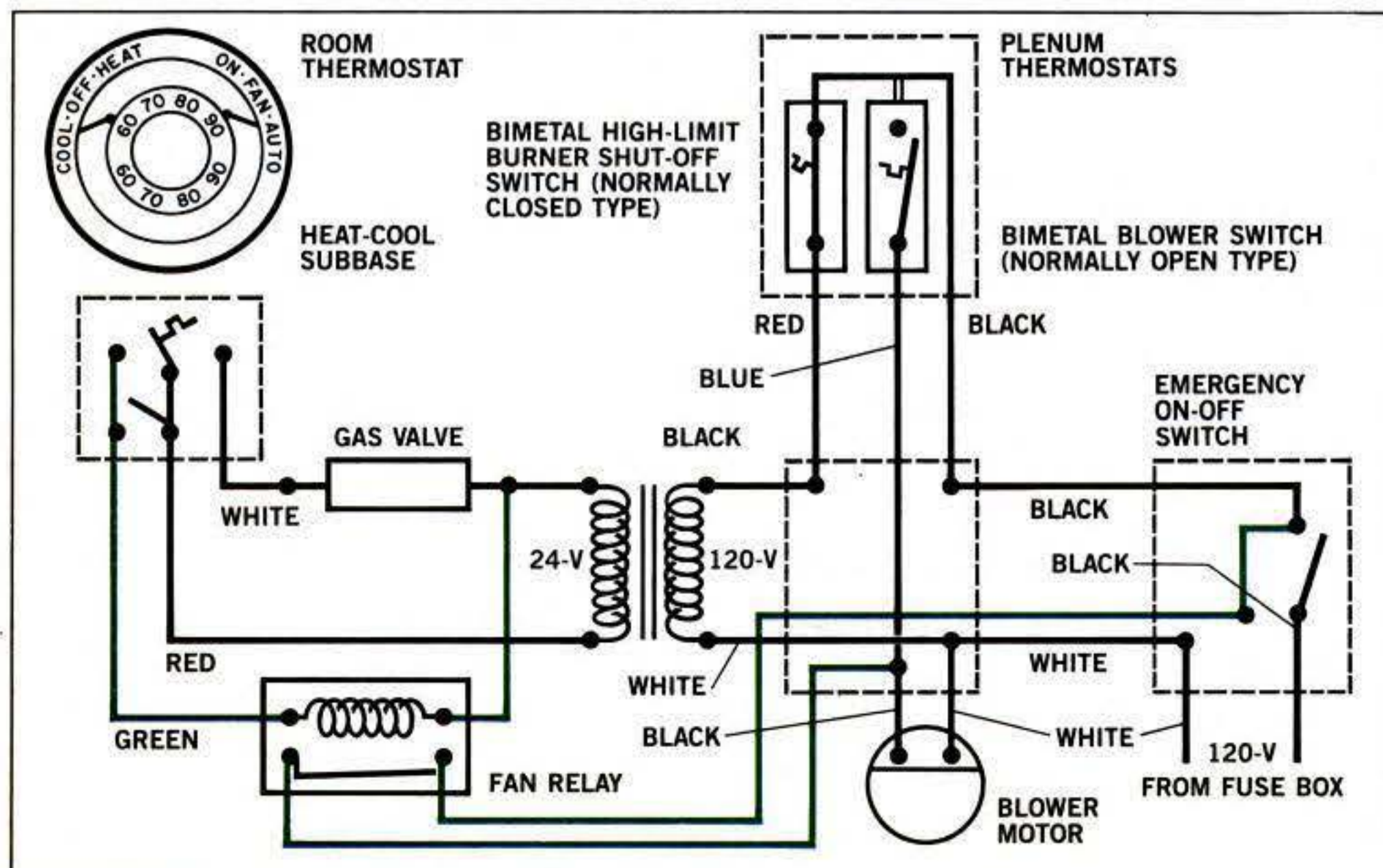
Heat from Pina's wood stove (above) flows through gas furnace's ducting.

explains. "This disengages the electrical connection to the furnace burners and engages the connection to the new blower relay. As the temperature in the living space rises, the room thermostat opens. This closes the normally open contacts in the fan relay, which turns on the furnace blower but not the gas burners. Hot air from the wood stove is then drawn into the furnace ducts and mixes with colder air from the other rooms. In just a few minutes

the whole house equalizes. At that point the temperature at the room thermostat has dropped, so it closes, pulling the fan relay open and shutting off the blower." The wood stove once again warms the living area, re-starting the heated-air distribution cycle.

When heated exclusively with the wood stove, all rooms in Pina's three-story house now stay within two to three degrees of each other in temperature. In the summer, Pina also uses the system to mix cool air from the cellar and from a small room air conditioner aimed at the main air-intake duct with the warmer air in the upper floors. The subbase assembly (part Q539A) for the system's T-87-series thermostat and the fan-relay assembly with 24-volt transformer and coil (part R-8239B) are both standard central-air-conditioning-system components. Manufactured by Honeywell, they are sold through heating-supply houses. Sears also sells the same fan relay (Sears part 9211) for \$34.99. If no heat-cool subbase is available for your particular thermostat, you will have to invest \$30 to \$40 for a new one.

Pina says owners of houses equipped with both oil- or gas-fired forced-air heating systems and central air-conditioning systems can use them to circulate heat from a wood stove without making any modifications. By simply turning off the 220-volt circuit breaker in the electrical line to the air-conditioner compressor and setting the heat-cool thermostat to "cool," the existing blowers, ducting, and temperature controls are utilized as an automatic circulation system that "will respond to any heat source," he notes. **PS**



Your idea can bring you \$250

Every other month, POPULAR SCIENCE presents a reader-submitted project that demonstrates an innovative method to replace or conserve fossil fuels. To enter your alternate-energy project, send black-and-white photographs, a sketch, and a written description to Energy Adventure, POPULAR SCIENCE, 380 Madison Ave., New York, N.Y. 10017. We will pay \$250 on acceptance. Materials cannot be returned unless a stamped return envelope is enclosed.

The \$9 Duplex SpeakerPhone

Now you can have a hands free full duplex speakerphone for your kitchen, workshop or den. Plus, it's a push button phone and it has an LED clock and alarm. It's yours for just \$9. But, there's a catch.

You're free. You can walk around the room while you talk on the phone. You can talk on the phone with both hands totally free.

You can answer your phone by simply pushing a button. Plus, anyone else in the room can join in too.

You'll hear the person you're talking to through a large full range speaker. A full range level control lets you adjust the volume to suit your taste.

You'll be heard loud and clear whether you are nearby or across the room. This speakerphone has a built-in condenser microphone. And, the sensitivity of the mike is controlled by the computer brain in the speakerphone.

This incredible duplex speakerphone, complete with a large built-in LED clock and alarm is yours for just \$9. But, don't forget there's a catch.

TOTAL FREEDOM

Just think about the freedom. You'll really appreciate this speakerphone whenever you'd like freedom of movement.

You can read your mail, work with your hands or move over to your easy chair while you talk. Plus, you can have a conference call at work or let the whole family talk and listen at one time.

TRUE DUPLEX

Most speakerphones are simplex, which means that when you are talking you can't hear the other person. And, when they are talking, they can't hear you. So, you're likely to cut each other off.

This all new speakerphone from Callmate is true duplex. With duplex, you and the person you're talking with can interact and talk without pausing. In short, both of you can talk at once.

So, for your office, workshop, study, bedroom or kitchen, this is an ideal phone. And with its beautiful wood-grain and ivory appearance, it's a handsome addition to any room.

The phone itself is loaded with features. It has last number redial, mute, a ringer off switch and the full range volume control. It uses universal push button pulse dialing for use anywhere.

NO INSTALLATION

It's simple. Just plug it into any standard modular phone jack and convenient AC plug and start talking.

You won't even lose your phone jack. There's a spare jack on the back of the speakerphone for you to plug in your regular phone, or perhaps an answering machine or cordless phone.

THE CLOCK

The LED clock is loaded. It has all the convenience features. The 24 hour alarm with snooze will repeat automatically each day or may be switched off to suit your needs.

You'll have your choice of high or low intensity for the oversized LED display. And time setting is really easy. There are both hour and minute setting buttons.

And, look at this. You really don't have to worry about power failures. There is battery back up (battery not included)



for the clock. And, this battery back up even sounds the alarm if the power is off.

SET YOUR HANDS FREE

It's sharp looking. But, you've got to hear the sound. Call a friend. See if they know you're on a speakerphone.

Experience the convenience of total hands free telephone conversation. It's backed by Callmate's limited warranty.

THE CATCH

Frankly, we are losing our shirts on the speakerphone, but we're looking for audiophiles who use audio cassettes.

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

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

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

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

WHY, YOU MAY BE ASKING?

You're very valuable to us in the form



of future business. Over 620,000 customers have responded to bonuses like this. We find most of you keep buying once you've tried our cassettes and our prices; and that's a worthwhile gamble.

NOT A BAD CATCH

DAK manufactures a cassette with no problems and great sound. We've been hot on the heels of the frequency responses of Maxell and TDK for years.

With our all new housing and new Gold Label MLX tape, with a frequency response to 19,500hz, we'll go head to head against any tape on the market.

TRY NEW DAK MLX90 CASSETTES RISK FREE

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

To order your 10 Gold Label DAK MLX 90 minute cassettes and to get the Duplex SpeakerPhone LED Alarm Clock for only \$9 with your credit card, call toll free or send your check for only \$24.90 for the tapes plus \$9 for the speakerphone and \$4 for postage and handling for each group. Order No. 4124. CA res add tax.

Wait till you hear the sound. Wait till you experience the convenience. Wow, a speakerphone for \$9 and DAK's new improved MLX. Time to stock up.



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STEREO FREQUENCY EQUA



model

Smart Sound Detonator

Obliterate the wall between you and the individual instruments in your music. Infuse your own stereo system's sound with a breathtakingly vibrant 30 to 50% improvement in sound quality that you can measure with this superb BSR Equalizer/Spectrum Analyzer limited \$149 close-out.

By Drew Kaplan

Close your eyes. Touch a button. And you'll hear your stereo system literally explode with life.

You'll hear the gentle brushes on a snare drum, the startling bone-jarring realism of a thunder clap, or the excitement of a full cymbal crash.

You'll hear string basses and other deep low instruments emerge from bass (that will sound murky by comparison), with such clarity and such definition that you'll feel you can almost touch each instrument.

This astoundingly distinct yet powerful bass adds such a full bodied warm feeling to your music, you'll feel as if you've been lovingly wrapped in a warm soft blanket on a cold winter's night.

But don't take my word for the sound quality improvement. With the Pink Noise Generator, Calibrated Electret Condenser Mike and the 220 Element Spectrum Analyzer, you can instantly measure each and every improvement you make.

Plus, there's more. A subsonic filter effectively adds the equivalent of many watts onto the power of your amplifier.

Plus, with its provision for two separate tape decks including two way dubbing, you'll have much more than just greatly improved sound.

You can count on great sound from this top of the line Equalizer/Analyzer. It has a frequency response from 5hz to 100,000hz ± 1 db. And, it has an incredible 100db signal to noise ratio.

BSR, the ADC equalizer people, make this super Equalizer/Analyzer and back it with a 2 year standard limited warranty. Our \$149 close-out price is just a fraction of its true \$379 retail value.

**FIRST THE EQUALIZER
YOUR STEREO'S HIDDEN SOUNDS**
Your stereo can sound incredibly bet-

ter. Just a 5db roll-off at the high end, up around 14,000hz to 16,000hz, can just decimate the harmonics that give you the open feeling you'd experience at a live concert. A similar roll-off at 60hz, causes the fundamental bass notes to just fade away into the 'murk'.

An equalizer isn't some magical device that manufactures sounds that don't exist. Most of the frequencies that will make your music really vibrant, are actually already recorded in your music.

You'll be able to prove this with a few simple tests we'll try when we discuss the Spectrum Analyzer.

You see, certain frequencies are simply not reproduced with as much volume as are the mid-range frequencies which stretch from about 800hz to 2,000hz.

An equalizer simply lets you establish accurate control of all frequencies to fit your equipment, your recordings, your taste, and your listening environment.

TOTAL MUSICAL CONTROL

And, what a job it can do. It's totally unlike bass and treble controls which simply boost everything from the mid-range down for bass, or everything up for treble. You can boost the low-bass at 31.5hz, 63hz and/or 125hz to animate specific areas or instruments.

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

The high frequencies really determine the clarity and brilliance of your music. The problem is that highs are very directional. Wherever you move in your listening room, you'll find a big difference in high end response, as you'll see when we test the Analyzer.

No recording engineer or equipment manufacturer can even begin to control your listening environment.

You can control the highs at 4,000hz, 8,000hz and/or 16,000hz, to bring crashing cymbals to life at 16,000hz while at the same time you can cut tape hiss or annoying record scratches at 8,000hz.

But there's more. Don't leave out the mid-range. You can boost trumpets at 300 to 500hz or a clarinet at 1000hz. You can boost or cut any part of the frequency spectrum a full ± 15 db.

TAPE DECK HEAVEN

You can push a button and transfer all the equalization power to the inputs of two tape decks. Now you can pre-equalize your cassettes as you record them and get all the dramatically enhanced sound recorded right on your cassettes.

This is an especially great feature when you play your cassettes on bass-starved portables or high-end starved car stereos.



SIMPLY PLUG IT IN

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

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

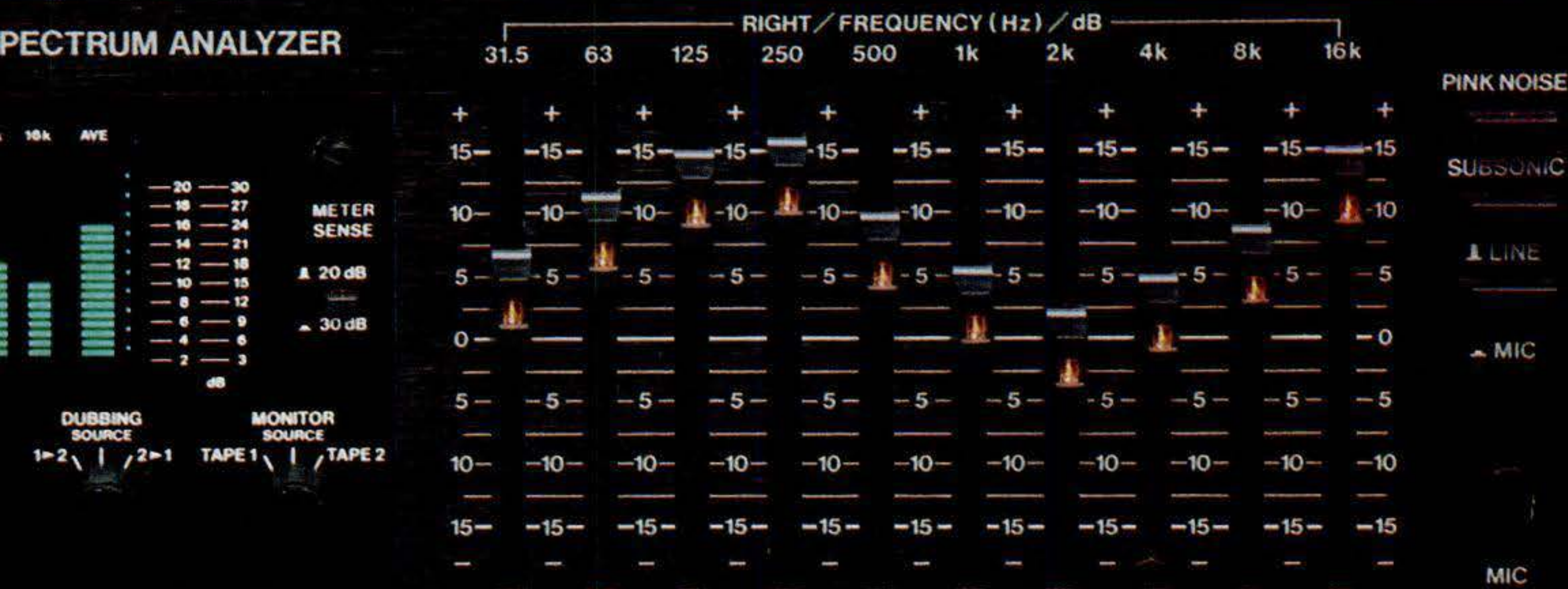
As you listen to your records, FM or any 'Aux', any time you push the tape monitor switch on your receiver you'll hear your music jump to life.

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

When you want to listen to a tape deck, just select which tape deck you want, turn the switch on the equalizer,

\$149 CLOSE-OUT

SPECTRUM ANALYZER



and your tape deck will work exactly as it did before. Except, now you can listen with or without equalization.

Look at this. You can dub tapes from deck 1 to deck 2, or from deck 2 to deck 1 with or without equalization.

THE SUBSONIC FILTER

Much of the power drawn from your amplifier is used to drive your woofers. When you drive the amplifier too hard, it clips and you end up with distortion.

A subsonic filter removes a lot of non-musical material you can't hear that exists below 20hz. So, it relieves your amplifier of a lot of work. It doesn't actually create more watts (Please, no letters from my 'technical' friends) for your amplifier.

But, it's like turning off the air conditioning in your car. It saves you using about 7hp of what you have. And therefore, you'll have more watts for clean powerful sounding music.

THE SPECTRUM ANALYZER

Now you can scientifically analyze your stereo listening room and test your equipment by using BSR's Real Time Frequency Spectrum Analyzer.

Plus, you'll see your music not as a single level on a VU meter, but as a kaleidoscopic parade of 10 individual 20 element VU meters.

Each is tuned to a specific octave of the sound spectrum. An eleventh 20 element meter averages all levels.

The effect is awesome. You can visually isolate a string bass or cymbal, and actually see each individual instrument almost as a wave moving across the 220 individual florescent elements.

THE MOUTH AND EARS

It talks. The Analyzer speaks with a voice of pure calibrated Pink Noise. Pink Noise is the standard composite 'sound' of all frequencies used for testing in labs around the world. All frequencies from 20hz to 20,000hz are generated at the exact same level at the exact same time.

It listens too. If you are testing a cassette or a component in your system, use the 'Line Button'. If you're testing your whole system with speakers, use the matched calibrated electret condenser

microphone (included). Either way, you'll have a quick, easy and accurate way to evaluate the total sound of your system.

HOW TO TEST

SPEAKERS, EQUIPMENT AND TAPE

Testing your speakers in your listening room is the really crucial test. Simply place the calibrated microphone where you normally sit to listen to your stereo.



At the end of an 18 foot cord is the ear of the system. Just clip the mike wherever you sit and test your room.

Turn on the Pink Noise. You can switch to Left Channel, Right Channel or both. There's a meter range button, a sensitivity control, and even a switch that lets you freeze the meter.

Just sit down at the equalizer. Start with one channel. You'll see all 10 octave bands on the meter. Just slide the corresponding controls to increase or decrease any area that needs help.

You have now set up your system to its maximum capability. But as you'll see, location is very important. Move the microphone 5 feet to the left or right.

Then turn on the Pink Noise and check the Spectrum Analyzer. Now you can see why the specifications that come with your system are only a starting point.

Here's a way to test your tape deck and tape. First record Pink Noise for 3 minutes at -20VU. Then play it back and note the readings on the meters.

Now, record the Pink Noise again at 0VU or +3. Wait till you see how much the high end falls off. Now you'll see why all specifications are listed at -20VU.

With the Equalizer/Analyzer you can enjoy the finest stereo sound from your system and be a test lab too.

WHY SO CHEAP

BSR now only sells equalizers under their ADC name. Well, as Detroit comes out with new cars each year, ADC comes out with new equalizers. We got them to supply us with just 30,000 of last year's

ADC model before they shut it down.

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

THE FINAL FACTS

There are 20 slide controls, each with a bright LED to clearly show its position. Each control will add or subtract up to 15db. (That's a 30db range!)

There are separate sound detonation slide controls for each channel at 31.5hz, 63hz, 125hz, 250hz, 500hz, 1,000hz, 2,000hz, 4,000hz, 8,000hz, and 16,000hz.

BSR backs this top of the line Graphic Equalizer/Spectrum Analyzer with a 2 year standard limited warranty. It is 17 1/8" wide, 3 1/2" tall and 8 3/4" deep.

MAKE YOUR MUSIC EXPLODE RISK FREE

It's startling. Music so vibrant with life you'll swear it's 3 dimensional. Sculpture your music any way you want it. If you're not 100% satisfied for any reason, simply return it to DAK within 30 days in its original box for a courteous refund.

To order your BSR EQ3000 Smart Sound Detonator 10 Band Graphic Equalizer with Real Time Spectrum Analyzer and Calibrated Mike, with Subsonic Filter and Two Way Tape Dubbing risk free with your credit card, call toll free, or send your check, not for the \$379 retail value. Don't even send the \$227.97 dealer cost. Send just \$149 plus \$8 for postage and handling. Order No. 4100. CA res add sales tax.

The sound of your stereo will explode with life as you detonate each frequency band with new musical life. And, you can see and measure exactly what you've done.



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\$129 PRICE EXPLOSION



The Complete Computer

Here's a 50 character per second, plain paper, dot matrix printer that you can use with virtually any home or office personal computer. It's built really tough to withstand heavy use. And, it's really easy to use. Price Slashed to \$129.

By Drew Kaplan

Let's clear the air. This printer isn't the fanciest. It doesn't have the most features. And, it's not the fastest.

But, it uses plain paper and it's super reliable. It prints both upper and lower case characters. And, if you aren't using a printer with your computer, read on.

LISTING/INDEXES/LETTERS AND MORE

Experience the thrill of actually writing your letters and reports on your computer. Now you'll be able to use all of your computer's word processing and **correcting** capabilities to really explore your creative talents.

It's easy. Some of the new word processing programs are so 'user friendly' that you can learn to use them in just about 10 minutes. Change a line, change a word, move a line. It's all just a push of a button away.

Are data bases a four letter word? Not on your life. Now you can use your computer to organize all your telephone numbers, your stocks, stamps, and recipes.

If you're using your computer for business, you can have a complete, instantly accessible file for each customer by name, what they bought, when, etc.

A data base will let you find or organize and print out any information you want, however you want, whenever you want.

There's no more complicated programming. Here's how you'd build a telephone/address data base.

A menu will come up and say, Field 1? You put in 'Name'. Field 2? You put in 'Phone Number'. Field 3? You put in 'Address' and so on.

Now that you've entered your headings, the computer will ask you for the information that goes with the headings. It will say, Name? You put in 'DAK'. It will say, Phone Number? You put in '1-800-325-0800'. And so on.

Then the fun begins. Just type search. The Computer will say, For What? You say 'DAK', or '800' or '325' etc. Your computer can search every letter and every number almost instantly to find just what you are searching for.

You can print out a phone directory in alphabetical order, numerical order, by area code, or even by zip code.

PERMANENT RECORD

If you have a modem, you're in for a treat. You can access encyclopedias, stock market reports, and much more. When you sign on a service like CompuServe or The Source, the world is quite literally at your finger tips.

With a printer, you can get a 'hard copy' of all the incoming information. You can get everything from SAT test simulations and IQ tests to loan amor-

tization schedules.

With this printer, we will send you all the information you'll need about how to access, and use modems for fun, information and profit.

And in addition to the large dial-in companies, there are over 400 Electronic Bulletin Boards that let you access information about everything, from buying computers, to diamonds, to finding the ideal date.

AFRAID OF PROGRAMMING?

You don't need to know the first thing about programming to use this or any printer. But, if you've never typed in and run a program, here's the easiest one I know. Turn on your computer.

Commodore Owners, and Atari Owners, your computer, and most others will say 'Ready'. Just push Control and Reset on an Apple. Then type the following:
10 PRINT "DAK IS WONDERFUL"
20 GOTO 10
RUN

You should type a carriage return at the end of each line. Why not try this program now? Next time, I'll tell you how to get out of the program, and maybe even discuss peeks and pokes.

If the program isn't running, type LPRINT instead of PRINT in line 10.

To you sophisticated programmers, think how easy your life will be when you

can print out program lists that you can study at length.

And, you won't have to load a bunch of disks to find a program when you print out a menu for each disk.

WHY BUY A CHEAP PRINTER? OR, THE SALES PITCH

An ad in several August computer magazines listed a \$149 thermal printer as the lowest priced printer in the U.S. Obviously they haven't seen this printer.

Imagine a 50 character per second, plain paper, full 80 column dot, matrix printer with a built-in standard Centronics Parallel Interface, slashed to just \$129. Then add the extras.

This printer handles plain old cheap standard fanfold pin feed computer paper from 4.5" to 9.5" wide, with its built-in adjustable tractor pin feed drive.

It's so powerful you can even use two-part forms for a carbon copy. Plus, there's an impact control for print darkness.

It understands and prints 116 upper and lower case characters, numerals and symbols. And that's not all.

You can even print Double Width characters. **And, look at this.** This printer has full graphic capabilities with 480 dot horizontal resolution and 63 dot per inch vertical resolution. So, you can print out your pictures, pie charts or graphs.

It prints 10 characters to the inch, six lines to the inch. In short, it's going to make typewriters into dinosaurs. When hooked to your computer, you'll never have to retype anything again. If you find an error, just make the correction and let the computer retype your work for you.

The printer is made by C.I.TOH/Leading Edge in Japan. It's built to really take heavy use. But in the unlikely event that it should need service, there are approximately 400 service centers nation wide.

It takes standard long life inked ribbon cassettes that are readily available nation-wide. This is a printer that will give you many years of continuous reliable service.

AND NOW THE BAD NEWS

If you're the president of a large company sending important business letters, you may want a \$1000 daisy wheel printer. But for most uses, dot matrix printers are incredibly faster, less expensive and there isn't any way to print out a graph or picture on a daisy wheel printer.

But, there are two things you need to know about this printer. First, it has about the dumbest name I've ever seen.

Its built tough and rugged without a lot of fancy features. So, they named it The Gorilla Banana Printer.

The second thing is more important. Like many dot matrix printers, there are no decenders on lower case letters.

The letters g, j, p, q, and y are all raised up. They are perfectly formed, but the whole letter sits level with the rest of the alphabet. Upper case letters are unaffected and so are symbols. So, if you want super fancy business letters, this printer probably isn't for you.

But for social letters, term papers or reports, programming and all the data bases and information you'll get through a modem, this printer is perfect.

COMPATIBLE COMPUTERS

Any Computer with a standard Centronics parallel port, such as: **Apple, Franklin, IBM PC, TRS80, Osborn, Atari, Com-**

modore VIC 20, Commodore 64, Kaypro, and virtually any other personal computer. Plus, most briefcase portables. FEAR OF INTERFACES?

Your computer is smart. But, it doesn't know how to 'talk' to other devices. That's why you need an interface.

An interface isn't just a simple cable. It's actually an intelligent translator that lets your computer talk to another piece of equipment.

Usually the computer manufacturers don't include the various interfaces when you buy your computer, because they don't know if you'll ever add peripherals such as disk drives, printers or modems.

So, rather than sell you something you don't need, you don't buy an interface until you add onto your computer.

There are two types of printer interfaces. The first allows you to do text word processing. For 99% of computer use, this is all that is needed. It translates all the possible letters and punctuation known as ASCII. This printer understands 116 characters and symbols.

A second type of interface also allows you to dump pictures or graphics from your screen or memory. This is more complicated because every dot must be told where to go. This interface, or 'driver program' as it is called, is available in two forms. Built into an interface card, or as a program on a disk which you use in conjunction with any standard interface.

Either way, you'll have the printer operating in just a few minutes. And if you already have a printer, the same Centronics parallel interface and cable (about 85% of all printers are compatible) should work with this printer.

WHY SO CHEAP

A new model will emerge soon with a different name. Leading Edge had just 21,000 of these remarkable printers which have been selling at discount for as little as \$199, left in stock.

DAK bought them all for cold hard cash. And now we're offering them to you for less than the original price we were quoted as wholesale. The only difference is our price. Each comes packed with a ribbon, ready to plug in.

The printer is approximately 16½" wide, 9" deep and 7" tall. It's backed by Leading Edge's standard limited warranty. Of course, parts and service are guaranteed to be available for at least 3 years. So you can buy with confidence.

ADD PRINTING POWER TO YOUR COMPUTER RISK FREE

Now you can really make use of your computer. 50 characters per second printing on plain paper for just \$129. Wow!

Now you can print out your programs, your notes or your letters. If you're not 100% satisfied, simply return the printer and any accessories in their original boxes to DAK within 30 days for a refund.

To order your 50 Character Per Second Dot Matrix, Plain Paper Printer with a built-in Centronics Parallel Interface, risk free with your credit card, call toll free, or send your check for the breakthrough close-out price of just \$129 plus \$8 for postage and handling to DAK. Order No. 4101. CA res add 6% sales tax.

Special Note: If you need a serial printer for a computer, such as the TRS80 Color Computer, order the identical printer with a built-in Serial Interface for the

same price. Use Order No. 4102.

The Printer comes packaged with a long life ribbon. Extra ribbons are available at computer stores. DAK has them for \$4 each (\$1 P&H) Order No. 4103.

Standard Centronics Interfaces for your computer are available at any computer store. This Printer has its receiving interface built in. You simply need one, complete with its cable, to plug into your computer 'to send' information. Below are our favorites for 5 of the most popular computers.

For your Apple. We have Practical Peripherals' text interface for just \$49 (\$2 P&H) Order No. 9877. We have their graphics capable interface for just \$79 (\$2 P&H) Order No. 4104. If you already have a Centronics Parallel Interface, we have a graphics driver program on disk for just \$7 (\$1 P&H) Order No. 4105.

For your IBM PC, you don't need an interface. It's already built-in. But, you do need a cable. We have a cable, ready to connect this printer to your computer, for just \$19 (\$2 P&H) Order No. 9879. We have a graphics driver program on disk for just \$7 (\$1 P&H) Order No. 4106.

For your Atari 800, 800XL, 400, or 600XL, we have a text interface for just \$69 (\$2 P&H) Order No. 9881. We have a graphics driver program on disk for just \$7 (\$1 P&H) Order No. 4107.

For your Commodore VIC 20 or 64, we have a text interface for just \$39 (\$2 P&H) Order No. 9883. We have a Graphics Interface for just \$54 (\$2 P&H) Order No. 4108.

Special Bonus for Commodore 64 owners. We have a powerful word processing program with editing, including changing a line, a word or moving a line.

Plus, we have a super data base program that lets you use 8 fields of information on up to 200 subjects at a time. Then you can search for any part, sort alphabetically or numerically and print out an address book, a list of your stocks or anything you can imagine. It's yours for just \$5 (\$1 P&H) with purchase of the printer. Use Order No. 4122 for Disk, or Order No. 4123 for Cassette.

For TRS80 Computers, you don't need an interface, just a cable. For the Black and White Computers, we have a Parallel Cable for just \$18 (\$2 P&H) Order No. 9885. For the Color Computers we have a Serial Cable (You need the Serial Printer as well) for just \$18 (\$2 P&H) Order No. 4109.

For briefcase-type portables, the Centronics Interface is usually built in. Just stop by any computer store. All Centronics Printers use the same cable at the printer end, but you'll need a cable that fits your particular computer's plug.

Get hard copy print-outs of your programs or your graphics. Turn your computer into a powerful word processor. Forget retyping ever again.

Apple, Atari, IBM PC, Franklin, Commodore VIC 20 & 64, TRS80, Osborn, and Kaypro, are registered trademarks of Apple Computer, Atari Inc., International Business Machine Corp., Franklin Computer, Commodore Electronics Ltd., Radio Shack/Tandy, Osborn Corp. and Kaypro respectively.



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Computer Yellow Pages

Reach out and grasp the world's information. Gain effortless access to the world of Data Banks and Electronic Bulletin Boards. You can test your IQ, check the history of a stock or access an encyclopedia. You can even get a date. It's all easy when you simply hook the all new Modem Phone to your computer.

By Drew Kaplan

It was nearly 1 AM. I was about to head off to bed. I had already accessed Grolier's Encyclopedia to get some information on magnetism for an article I'm writing.

I had a print-out of 73 of San Francisco's top restaurants, complete with phone numbers, menus and addresses to take with me for a weekend trip. And, I'd already studied the detail and the history of a few stocks I'm interested in.

But look at this. Before I signed off, I called up Entertainment for a few minutes of games to help me unwind. As I was deciding between Trivia Unlimited, MegaWars, or Hangman, I spotted something I didn't recognize.

It was called, "Do you know me?". It looked like a 20 question type game about people. And, since I'd just read the 'Personal Profile of the Day' about Greg Louganis, the Olympic Diver, I was ready.

Well, was I in for a surprise. It turned out to be a compatibility test between you and your mate. Or, you and your kids.

Well, my wife is really terrific. Here it was 1 AM, she'd been trying to get me to leave my computer and call it a night for an hour, but she said OK. So, off we went.

The test was sort of like the old 'Newlywed Game', only more sophisticated. The computer takes your names and then asks one of you to leave the room while it asks a long series of really searching questions of the other. Then it asks you to trade places and it re-asks the questions.

Finally, it asks for both of you to sit down while it compares answers. Well, we haven't called in the divorce lawyers, but we're still laughing about some of our answers. I plan to take the next test with my son.

ALL THE INFORMATION

Imagine being able to find out about anything you want to know without ever leaving home. Think of your hobbies, think of your occupation, think of your interests. Now information about anything is just a push of a button away.

There are data bases about medicine, law, education, computer programming, aviation, investing, exchanging and hundreds more. Just dial a number on the Modem Phone, switch to 'Data', and the world of information will rush into your home or office.

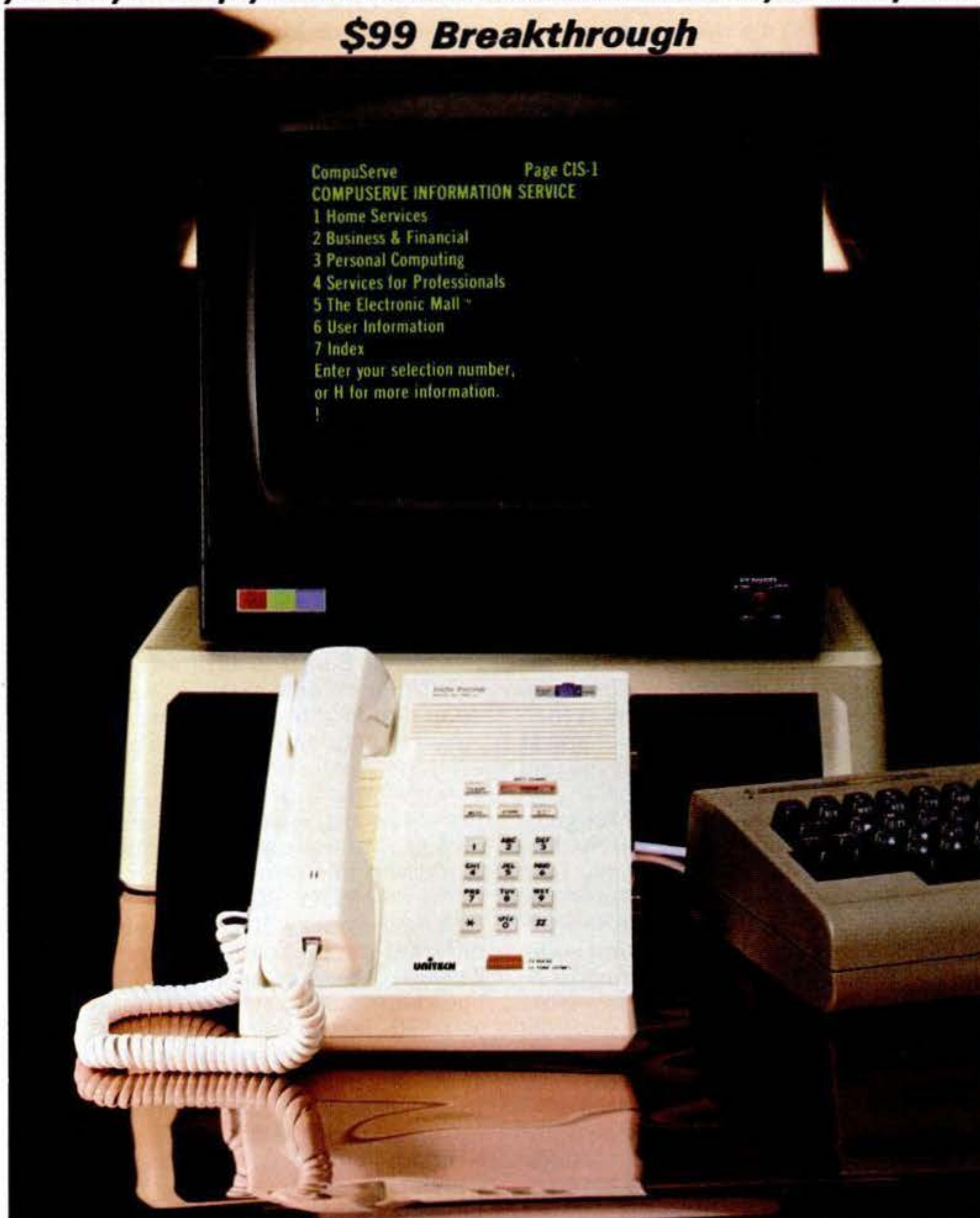
And, look at this. You can transfer information from your computer to a friend or business associate. It's called electronic mail. Just call them on the Modem Phone. (They need a modem too.) You can send them files, letters, figures or you name it. It's great for business and personal use.

A TECHNICAL MOMENT

There's so much you can do once you're hooked in, it's hard to break away to talk about the equipment.

After all, the Modem is just your gateway to the seemingly never-ending wealth of information and entertainment that's available. The more hours I spend 'on line', the more totally new things I find.

I've had my biorhythms charted for a



month, looked up information about public companies, and played Concentration.

I've looked in on Apple, Atari and Commodore User groups to see what's new. (I have one of each). I've played Lunar Lander (I crashed), and checked the loan amortization rates on my new home.

Every day you'll find a list of what events occurred on that day in history. You'll choose from classic quotes or an almost non-ending list of one line political jokes. The list just goes on and on.

By now you must be wondering how hard all this information is to get and how much it's all going to cost. Well, fear not. It's all incredibly easy.

The main problem has been that there just aren't enough people around to tell you how to do it. With the Phone Modem, you'll get all the numbers and addresses you'll need, and with our Optional (\$24) CompuServe Kit, which includes 5 free hours of use, you'll be able to sign on the moment your package arrives.

Later you'll read about both the free and pay data bases and bulletin boards. But, first let's look at the phone.

IT'S A PHONE TOO

The DATA Phone is a unique state of the art device. It acts just like a regular telephone. It has a conventional phone company style handset, a built-in speakerphone and 10 number memory, including last number redial.

It's Tone/Pulse switchable, desk or wall mountable, and has all the features you'd expect, including flash and mute. But, nestled within the phone's circuits is a powerful 300 baud full duplex Modem.

You'll use it as a regular automatic telephone. But, when you want to hook into a data base, the fun really begins. Here's all you do. Just dial the number manually or automatically. You can use the speakerphone or the handset.

When you reach a data base, you'll hear a tone instead of a person answering the phone. Just switch the blue switch at the top of the phone from 'Phone' to 'Modem' and you'll be on line.

It's easy, it's fast. And, it's your gateway to information and entertainment that would take an encyclopedia to describe.

The Modem Phone simply plugs into

any modular phone jack in your home or office and an AC outlet. It even has battery back up (batteries not included) to protect the memory and operate the modem in case of a power failure.

To hook the Modem Phone to your computer you simply need one of our inexpensive cables (\$8 to \$12) and a serial interface.

But look at this. Computers such as Commodore and Radio Shack's TRS80 Color Computers already have serial interfaces built-in.

Interfaces are easily available at any computer store. Plus, we're offering them for the Apple and IBM PC.

Finally, you need a program to tell your computer that it's no longer a computer. You need to tell it that it's a 'Terminal' and that it's going to talk to the world. We've got these programs on disk for the most popular computers for just \$10. But Terminal Programs are universal and are available very inexpensively at any computer store for virtually any computer.

So, you'll need the (\$8 to \$12) cable from us, maybe the interface, and our \$10 terminal program or anyone else's.

BUT WHAT ABOUT THE INFORMATION?

The information is everywhere. There are over 400 Electronic Bulletin Boards listed in just one book. I'm using one in Los Angeles called 'Buy Phone'. It's like an educated yellow pages. I tell it where I live. It asks me what I want to buy.

I've asked for cars, hamburgers, TVs, stereos, phones and a dozen other things. 'Buy Phone' will arrange all the possible stores it finds that carry the product I want, by the geographic distance each store is from my home.

I just turn on my printer. (You don't need a printer, but they sure are nice to have.) And when I leave the house to go shopping, I've got a list of as many as 30 stores, complete with phone numbers, addresses and business hours, to take along.

Another service I've used is an electronic department store. It has 5 floors with about 12 stores per floor. You can walk forward, back, left or right.

You even go up and down the elevator. Anyway, with your credit card you can actually buy from any of the stores you're in.

My next effort was a 'Social Bulletin Board'. I didn't know quite what I was into until the question about 'sexual preference' popped up. Well, being married, I signed off. But, there are lots of dating bulletin boards. And, if you'd like a date with someone into computers, wow!

All of the above boards are free. And with the Modem Phone we'll include an address where you buy a directory of 400 of the estimated 1500 Electronic Bulletin Boards in operation. I've also found that there are lots of boards that aren't listed in the directory that have their numbers listed on the Boards I call.

THE TOP BANANAS

I'm using two top professional data base services. The Source and CompuServe. In my opinion, The Source is stronger in daily news and CompuServe is stronger in history and research. They are both loaded with educational thinking games and the type of wide ranging

special interest information I've described above.

Enclosed with your Modem Phone will be a discount application to the Source, complete with an 800 number for instant signup. It's a great service. I use it mostly at night at the \$7.75 per hour rate.

CompuServe is my favorite. But since I'm selling it direct, you'll have to judge it for yourself. The \$24 kit includes a full manual, your secret ID number and password to sign on. Both The Source and CompuServe offer local telephone numbers for you to call in many cities.

CompuServe only costs \$6 per hour after 5 PM. And with our kit you get 5 free hours to really look around and enjoy the service. It has everything, from 1300 recipes and menus, to the National Satirist. Auto Net/Auto Base tells you how the new cars match up and much more.

CompuServe has Grolier's Academic American Encyclopedia and 14 reference data bases including Science, Wine, Family, Election 84, and Gardening. Of course there are hundreds of data bases, each with its own menu of specific information.

From Stocks and Business news, to Translations, CompuServe can answer your questions. I printed out an on-line index that contained 285 entries, from Aviation Rules and Regulations to the Belmont Golf Association to the Department of State to Educational Research. The volume of information is astounding.

There's a host of games and tests, including a full IQ test and the compatibility test I mentioned at the beginning. A few services cost extra, but most are included in the \$6 per hour rate.

Now that you know all about data bases, isn't it time you turn your computer into a window on the world of information? The Modem Phone is made by Unitech. It's backed by their full one year limited warranty.



This switch and some very sophisticated electronics inside turn a phone into your window on the world.

JOIN THE INFORMATION REVOLUTION RISK FREE

Calculate your net worth. Check a user's group to see what's new for your computer. Check the Hollywood Hotline.

Look through Computer Programming. Go shopping in the Electronic Mall. Or, see what the weather's like in Dallas.

Try The Modem Phone in your own home or office with your own computer risk free. If you aren't 100% satisfied, simply return the modem in its original box within 30 days for a refund.

Here's how to order your Unitech 300 Baud Modem Phone, complete with 10 Number Memory Dialing, SpeakerPhone and Pulse/Tone Switching.

Plus, you'll get sample indexes of information on data bases, including a discount on The Source. You'll get information on bulletin boards, including the address to buy a super book on 'Hooking In' to data bases, complete with a list of 400 Electronic Bulletin Board numbers.

It's all yours, risk free with your credit

card when you call toll free, or send your check for DAK's incredible introductory hook-in price of just \$99 plus \$5 for postage and handling. Order No. 4110. CA res add tax.

You'll need just three things to turn your computer into a communications marvel. 1) You'll need our special cable. 2) You'll need a serial interface card if your computer doesn't have one built-in. 3) You'll need a modem program. It can be ours or anyone's.

You'll really love DAK's Modem Program. It lets you send and receive files and upload and download files to and from disk. Below, you'll find everything you'll need for some popular computers.

For your Apple. (Or Franklin) Your special connecting cable is just \$8 (\$1 P&H) Order No. 4111. We have Practical Peripherals' Serial Interface for just \$79 (\$2 P&H) Order No. 4112. And we have a Modem Program on disk for just \$10 (\$1 P&H) Order No. 4113.

For your IBM PC. (Or Clone) Your special connecting cable is just \$8 (\$1 P&H) Order No. 4114. We have Practical Peripherals' Serial Interface for just \$79 (\$2 P&H) Order No. 4115. And we have a Modem Program on disk for just \$10 (\$1 P&H) Order No. 4116.

For your Commodore. (Both Vic 20 and 64) Your special connecting cable is just \$12 (\$1 P&H) Order No. 4117. And, the great news is that you don't need an interface. The Modem program is available for just \$10 (\$1 P&H). Use Order No. 4118 for disk, or Order No. 4119 for cassette.

For TRS80. Your special connecting cable is just \$12 (\$1 P&H) Order No. 4120. For the Color Computer you don't need an interface. For the Black and White Computer Interface, you'll have to see Radio Shack. You'll also need a standard Modem Program as well.

SPECIAL SUPER BONUS

We've made a large cash purchase of CompuServe Starter Kits. You get a full manual, a detailed description of the service. **And, look at this.** You'll get 5 free hours of online information. It's a \$39 value. It's yours for just \$24 (\$2 P&H) Order No. 4121.

Everything you need, including phone number, secret passcode and instructions, is included. You'll be on line immediately. Note: The CompuServe Kit is covered by our standard 30 day risk free trial. But, if you return it you will be billed \$6 per hour only for the time you used.

It is said that knowledge is king. With the information you can acquire through the all new Modem Phone, you'll have informational power of 10 kings. And you'll have a full range of entertainment thrown in as an extra bonus.

Apple, IBM PC, Franklin, Commodore VIC 20 & 64, and TRS80, are registered trademarks of Apple Computer, International Business Machine Corp., Franklin Computer, Commodore Electronics Ltd., and Radio Shack/Tandy respectively.

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Detroit Report

By JIM DUNNE



Slippery treatment

Ford's 1986 Taurus/Sable (top) continues the company's trend toward severe aerodynamic body styling. In this case, the mid-size cars are receiving the slippery treatment. Aerodynamic touches not apparent in the photo are the smoothly rounded grille and curved headlight lenses. Also, note the wrap-up doors that extend into the roof and the almost-flush glass in the windshield and doors. Many of the prototypes in Ford's early testing are heavily disguised with painted bumpers, fake grilles and headlights, and a thick bogus C-pillar that slips over the car's sleek roof line. At the rear, the fenders are pinched in to form a narrow profile. Ford is preparing a 2.5-liter (153-cu.-in.) four-cylinder engine with balance shafts à la Mitsubishi for this car.

'86 Eldorado

Traditional styling cues are apparent in the 1986 Eldorado model (above). What you can't see is the crossways layout of the engine and transmission. Smaller and lighter, the baby Eldo will

remain a front-drive. Power will be supplied by a 4.1-liter (250-cu.-in.) V8. An optional 4.3-liter (262-cu.-in.) diesel engine will also be available. Both power trains are currently used in the Cadillac sedans. Reduced outside dimensions (the wheelbase has been chopped from 114 to 108 inches) and a weight reduction (from 3,700 to 3,100 pounds) are in keeping with General Motors' shrinking-vehicle program, but this may be the final size reduction. Despite the obvious savings to GM because of reduced size and weight, prices are expected to increase.

Gray-market luxury

German-luxury-car importers are complaining about the gray market in the U.S. for their products. Here's how it works: A German-specification (more powerful) Mercedes or BMW is shipped to a dock on the East Coast, where it's modified to meet U.S. safety and emissions standards. The car is passed by U.S. customs and driven away by the purchaser. What's wrong with the setup? Plenty. Mercedes and BMW of North America lose a sale—but still are obligated to perform war-

ranty work under the parent companies' worldwide policies. Also, the cars are modified on a one-shot basis and need not be checked after they are modified. So some of the modifications—such as 2½-mph bumpers, sealed-beam headlights, side-door protection beams, emissions-control devices—can be removed immediately after inspection.

In addition, although catalytic converters take care of most of the emissions requirements, many of the vehicles made for foreign sale were not designed for their installation. That means that plastic tubing or fuel lines might be routed near the converter's intense heat.

BMW estimates that 1,000 cars come in this way each year. Mercedes thinks that about 3,500 of its cars are gray market.

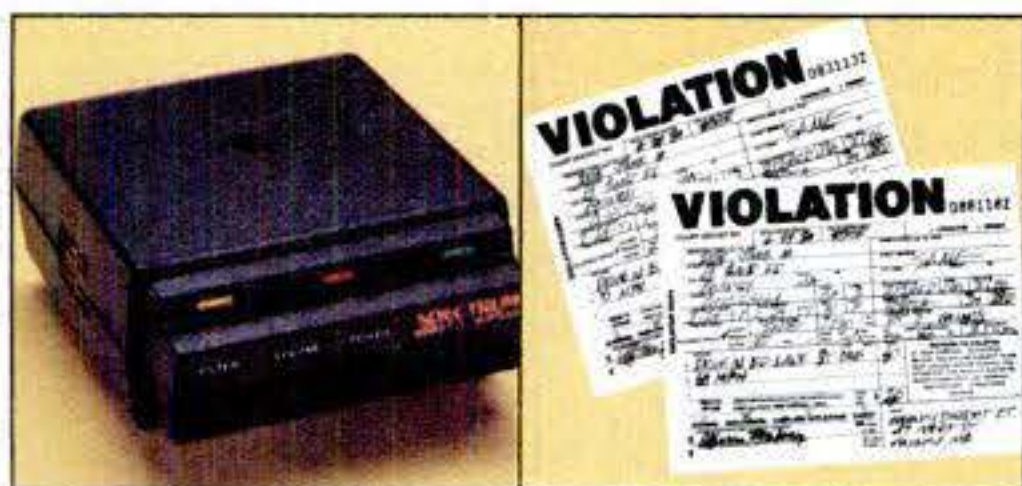
Turbo Corvette

The power plant for the 1987 Corvette—a smaller V6—will be turbocharged to match the power of the current model's 350-cu.-in. V8. The new high-output engine will displace only 260 cu. in. However, with the turbocharger boosting horsepower to about 240 and a weight reduction through the use of more aluminum and the smaller engine, performance should match or exceed that of the 1984 model. It's still unclear whether Chevrolet will offer the turbo V6 as the sole engine for the sports car or whether it will be an option to the base 305-cu.-in. V8 to be offered next year.

Plastics puzzle

The problem of producing high-quality injection-molded plastic parts is being tackled by General Motors computers. Until recently, the fairly simple process of forcing molten plastic into a mold was complicated by flashing (excess material forced out of the mold that remains attached to the finished part) and warping due to uneven cooling. GM, with the help of its computers, is tracing the flow of injected materials, tightening up on flow paths, monitoring cooling times, and plotting gate placement (points where the material is injected into the mold). By changing the gate placement, GM is now producing parts as large as fender liners—about 30 inches long and rounded in shape—without flashing and without undue warpage. Computer analysis is also being used on small parts, including plastic headlamp bezels. P S

Gotten a speeding ticket lately? Read this.



This... instead of these.

Last year, more than 8 million* citations were issued for driving over 55 mph on US highways.

If you were unfortunate enough to receive one of these tickets, maybe it's time to protect yourself. With the Whistler® Spectrum™ radar receiver.

Gives you earliest possible warning of police radar.



© Motor Trend, Aug. 1983

When Direct Response, Inc. started looking for a radar detector to offer our customers, we went to the experts first: car magazines.

Their opinion was nearly unanimous. **Motor Trend, Auto-**

week, and BMW Roundel had all recently completed independent, comprehensive tests of all the leading radar detectors. And all had picked a winner: the Whistler Spectrum. **Motor Trend** said "The Whistler Spectrum resides at the top of the list. A world-class radar detector."

Whistler is also first choice of truckers and other professional drivers. Whistler

Spectrum detects all kinds of speed radar. Stationary - moving - trigger - even pulsed radar. On the straightaway - from behind - over hills and around curves. If there's police radar in the area, Spectrum lets you know. Long before radar can lock onto you.

Spectrum cuts down on annoying false alarms.

Unfortunately, the FCC authorizes some security systems and traffic signals to also operate on police frequencies. And any sensitive radar detector will report these signals.

That's why Spectrum developed two features not available in any other radar detector: **The Filter Mode™ and Pollution Solution™**. Both features cut down on false alarms.

For city driving (where microwave intrusions are frequent) switch to the **Filter Mode**. You'll get the same early warning - but it will be quieter, less urgent. When the microwave signal reaches a critical speed radar level, you'll see the amber warning light switch to a flashing red. And hear the soft tone gear up to a high-frequency, geiger-effect sound.

Most other radar detectors give off false signals. Spectrum's **Pollution Solution**, built into each unit, can tell the difference between these signals and real police radar. Spectrum automatically screens the polluters out.

Dash/Visor or Remote model.

You have your choice of two top-line Spectrum models - both reliable performers.



Filter Mode for city driving.

The Spectrum Dash/Visor model is portable and compact. It plugs into the cigarette lighter socket, and mounts easily on dash or visor. It's quickly removed for use in another car, or to prevent theft.



Remote receiver hides behind car grille.

The Spectrum Remote gives you the same great radar protection. But it's hidden from view. The weather-proof receiver installs behind your car grille. And the small console fits handily in, on, or under the dash. You can install the Remote in about 30 minutes. After that, you're in operation every time you turn on the ignition.

No-risk trial. Free gift.

Order your Whistler Spectrum - Dash/Visor or Remote - from Direct Response, Inc., for just \$255 complete.

Call toll-free, 1-800-824-2408. (In NH, 603-886-1310.) Use your VISA, MasterCard, or American Express.

Write to Direct Response, Inc., at 472 Amherst St., Nashua, NH 03063. Send us your credit card account number, expiration date, and your signature. Or enclose a check or money order. (Allow an additional 15 days for personal checks.)

Or visit Direct Response, Inc., in Nashua, and pick up your Spectrum in person.

Satisfaction guaranteed. We tested it. Now you can test it yourself. Use your Spectrum for 30 days. If not completely satisfied, return for a full refund.

Free, Rand McNally Road Atlas & Travel Guide, with map light, if you order now.



DIRECT RESPONSE, INC.
1-800-824-2408

Ask for Operator 33



Dash/Visor



Remote console

*Source: Speed Limit Enforcement Certification Data, October 1, 1982 through September 30, 1983.

By JIM DUNNE
and JACK KEEBLER
Photos by Greg Sharko

High-performance

European turbo sedans

On Europe's high-speed roads, motoring prestige is often measured by a car's top speed, handling, and braking capability. POPULAR SCIENCE track-tested a European turbo trio—Audi 5000S, Saab 900, and Volvo GLT—to determine how well this status concept works on U.S. roadways.


Turbocharging is a relatively new concept for American car buyers. But in Europe, traditionally high fuel prices, smaller engines, and high-speed roads make the on-demand power of a small-displacement turbo engine a logical solution for high-performance automobiles. How does this engine configuration translate on this side of the Atlantic? To answer that question POPULAR SCIENCE put together three of Europe's top turbo-charged sedans.

What we found was surprising. The lasciviously sleek Audi 5000S was agonizingly slow in our zero-to-60-mph acceleration tests with a 15.4-second time. The eccentric-looking Saab placed second in the acceleration trials by posting a respectable 11.5-second average. And the stodgy-appearing

Continued

Elegant performers (clockwise from top) Volvo GLT, Audi 5000S turbo, and Saab 900 turbo are high-speed touring sedans.





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European turbo sedans

Volvo, with all the styling panache of a tool shed, outdistanced the competition with a tire-smoking 10.4 seconds.

In ordinary driving, fuel economy for this trio was good but not outstanding. It was about what you'd expect from 3,000-pound-weight-class vehicles with relatively small two-liter (122-cu.-in.) engines. But when the turbos

began to work, fuel economy plummeted to that of a V8.

We found that living with these turbos is more comfortable than with some of the smaller turbo coupes we've tested this year [PS, July '84; April '84; March '84]. Perhaps because of their longer experience with turbocharging, Europeans have had more time to refine

their engines and isolate vibration and noise.

The Volvo and Audi have an advanced feature that is beginning to appear on many American turbocharged cars: an intercooler. This is a radiator-like device that fits between the turbocharger outlet and the intake manifold. Its job is to cool the intake charge after it has left the turbo's compressor. Cooler air is denser, and more of it can be packed into the combustion chamber. More air means more power. An important but secondary benefit of the intercooler is a reduction in operating temperature.

Despite the lack of an intercooler, the Saab turbo system is quite sophisticated. All turbocharged engines are particularly sensitive to spark knock because of the high pressure and temperatures generated by the turbo. Most turbo applications have a knock sensor that retards ignition to control knock, but this reduces power and fuel economy. Saab's solution is called Automatic Performance Control. When the Saab's electronic sensor detects knock, a waste gate is opened to route exhaust gas around the turbocharger to reduce the boost pressure and protect the engine.

Here's a peek at each car:

Audi 5000S turbo

We were surprised to find that the non-turbo Audi 5000S we tested last year was faster to 60 mph than the turbo car. Of course, the non-turbo car had a five-speed manual transmission, and the turbo can be ordered only with an automatic. But turbo cars are usually less sensitive to transmission differences. Why the slower times with the turbo? Evidently the large turbocharger on the Audi was selected for best response at high engine speeds

Continued



Saab 900 rolls slightly as it makes a pass through the low-speed maneuverability grid. The steering unit's quick response is important in this test.



Volvo GLT's powerful four-cylinder easily provided throttle oversteer for extra-fast maneuvering through the cones. Volvo took the top grades here.



Audi 5000S squats on its front coils as it slides to a 175-ft. cold stop from 60 mph. A second stop with the brakes warm netted the same distance.

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.

	Audi 5000S turbo	Saab 900 turbo	Volvo GLT
Acceleration	4	5	5
Braking	2	2	3
Handling	5	3	4
Maneuverability	5	5	5
Quietness	2	3	3
Roominess	3	4	3
Vision	4	5	4
Entry/exit ease	5	3	3
EPA economy	3	4	3
Ride comfort*	4	3	3

*Authors' opinion

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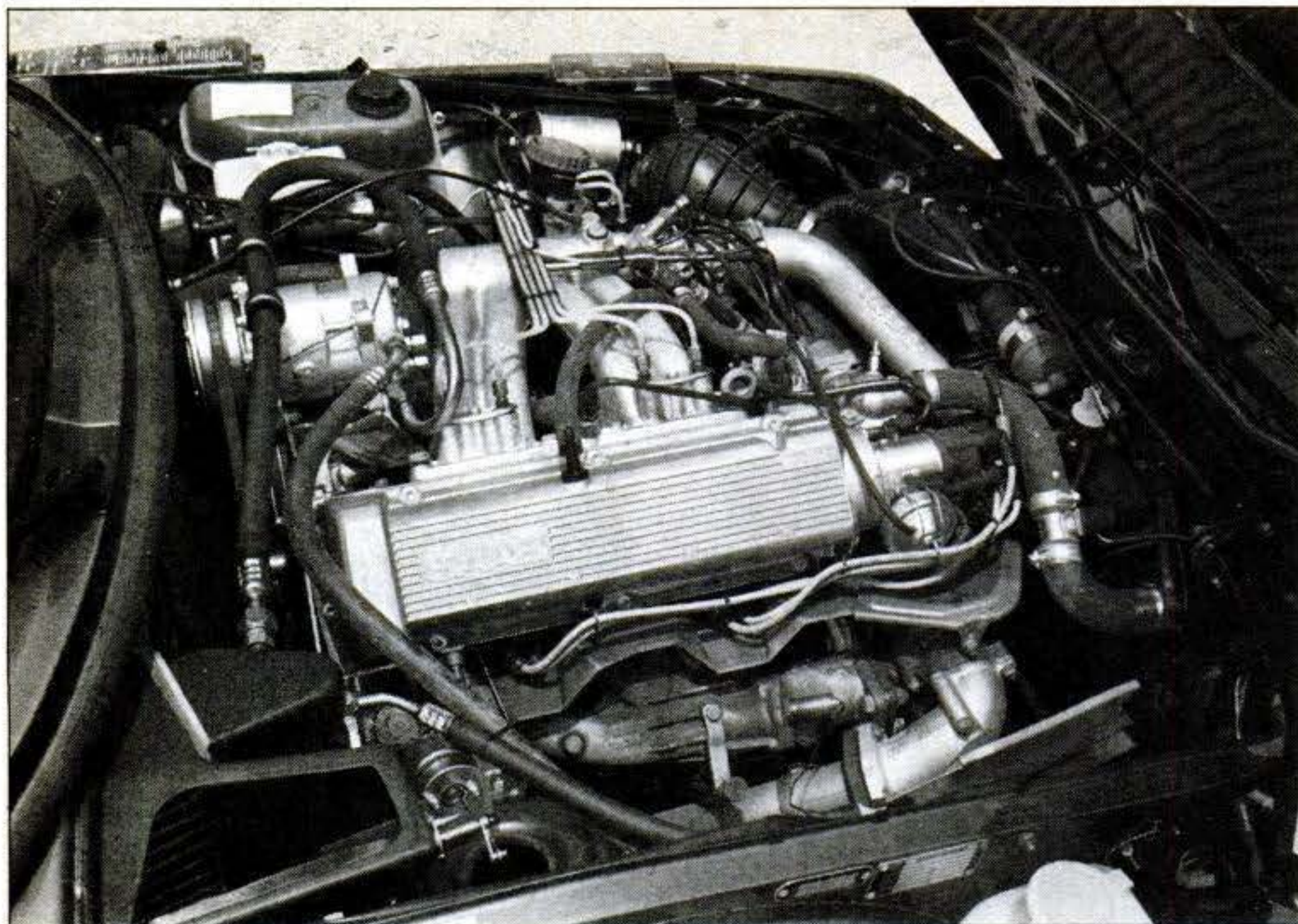
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European turbo sedans



Saab 900 turbo's four-cylinder is fitted longitudinally in the front-drive's en-

gine bay. Note A/C compressor is belt-driven from the rear of the engine.

with correspondingly high exhaust flow. Although that's fine for acceleration from 20 to 70 mph or high-speed passing, the turbo's sluggish response to low exhaust flow won't get the heavy chassis off the line quickly.

Audi has one of the most striking and efficient sedan shapes on the road.

The near-flush windows, high trunk deck, and shallow hood and windshield angles all contribute toward making this one of autodom's slipperiest shapes. Audi claims a drag coefficient of 0.32 for this five-passenger sedan—a number many sleek sports coupes can't match.

The Audi is comfortable in the Teutonic fashion. Big, sharply formed bucket seats hold passengers tightly in place. Firm and seemingly unyielding at first, the seats slowly reveal a remarkably plush and supportive character on long highway stints.

All the hand controls, except the hand brake and shifter, are conveniently mounted on the steering column. One item we found especially convenient was the trip computer, which at first glance appears to be a digital clock. By pressing a button, the driver is able to see elapsed time, fuel used, miles per gallon, average speed, and distance to empty.

Saab 900 turbo

The basic design for this car is more than a decade old. However, careful and continuous updating of the body, chassis, and power train has kept the 900 a strong competitor in the sports-sedan class.

Two odd Saab features are the floor-mounted ignition lock between the front buckets and the upright windshield. The former is a nuisance in comparison with the handier column-mounted locks found on most cars. But the latter is no problem when driving the car; in fact it cuts down on the

Continued

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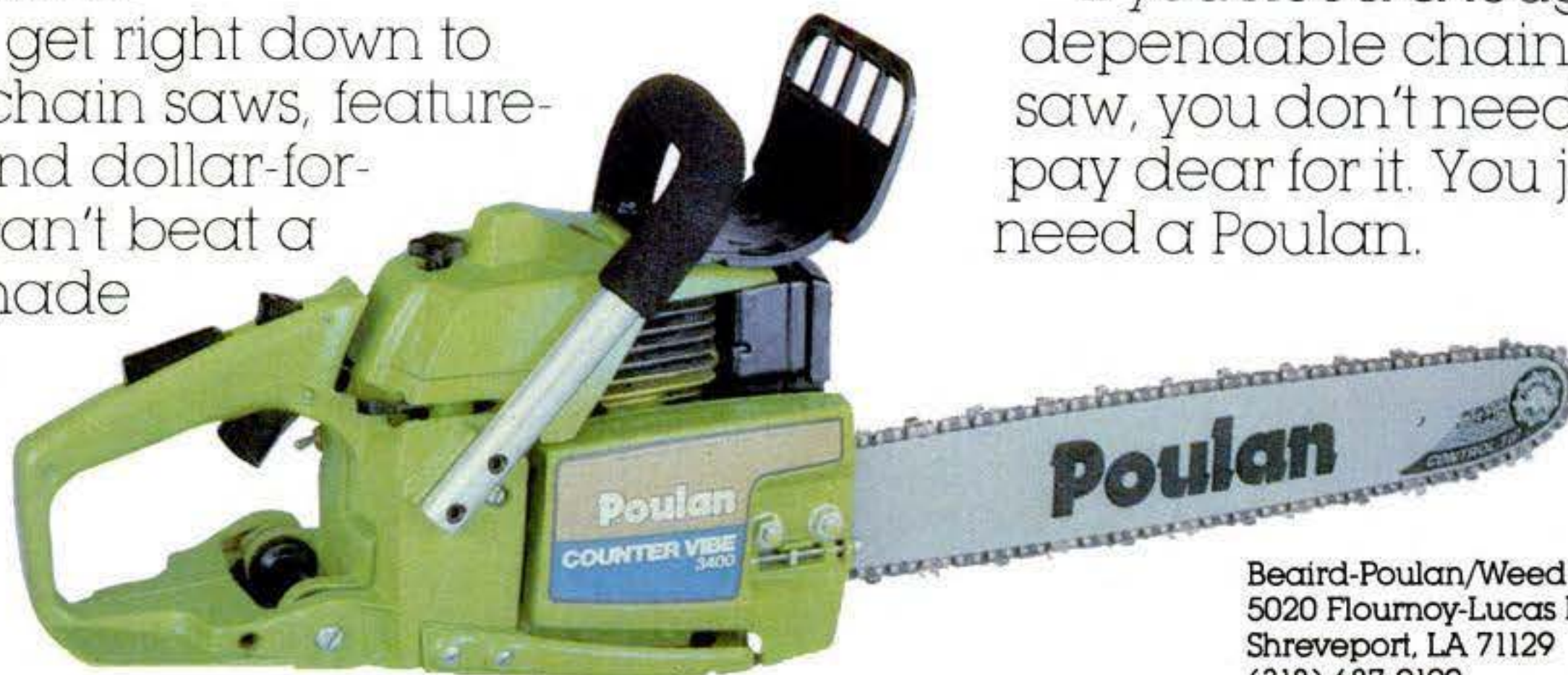
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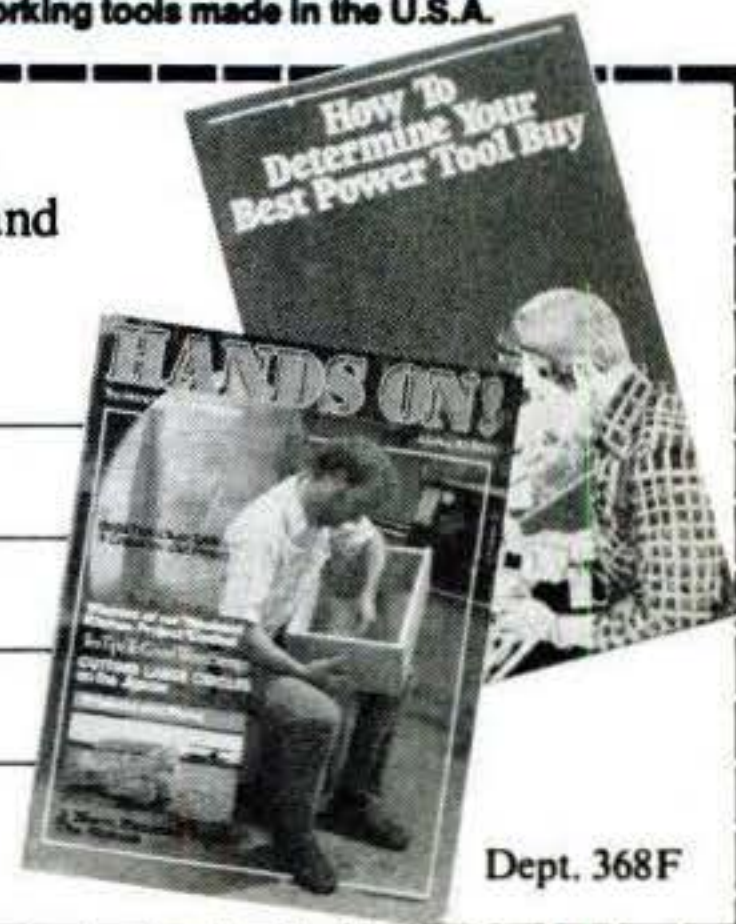
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European turbo sedans

strong solar gain that drivers of most modern sedans experience because of sharply raked window glass. And it provides an excellent view of the road.

Inside, the Saab feels smaller than its competitors because of its narrow shell. Head and leg room are generous, but the seating arrangement is really for four passengers.

The 900 turbo is a driver's car. All the controls are well marked and close at hand. Frequently read gauges and hand controls are positioned high, where they're easy to refer to with a flick of the eye.

Domestic car companies that are having trouble building smooth-shifting front-drive transaxles should examine the Saab: Its shift gate is precise, with a short, quick action for clean, positive shifts.

We noted one severe problem during

our regular zero-to-60-mph acceleration tests. The 900 turbo could not leave the line under full throttle. Attempts at hard takeoffs resulted in a savage wheel hop that shook the entire car. Only careful acceleration-pedal and clutch work got the front-drive off the line smoothly.

Volvo GLT

Don't let this car's shoebox shape fool you. This is a well-balanced sedan with the kind of no-nonsense performance that makes a driving enthusiast out of a new owner. The only exterior giveaway is the combination of low-profile tires and alloy wheels.

One of the important features that promotes the sports-sedan feel is the quick-shifting manual transmission. Short, sure throws between gears make speed shifting the boxy sedan a cinch.

After going quickly through the four gears, you can punch a button on top of the shift handle to get into a high-economy overdrive.

Another important part of this winning package is the 2.2-liter (134-cu.-in.) turbo engine. It's extremely responsive, with little, if any, turbo lag. From 2,000 rpm to redline the smallish four-cylinder pulls strongly.

Despite the barn-door-shaped hole the GLT punches through the air, the rear-drive chassis under the sheet metal is highly competitive. In fact Volvo was easily best in acceleration, maneuverability, and braking.

Passenger comfort is slightly different from that in the other two vehicles. The front seats are individual types that are too wide and plush to be called buckets. In back there's room for three without crowding. As in the Saab, the seat cushions are set high for better comfort and easier entry and exit.

Instrumentation is typically European but just slightly below both Audi and Saab in the delivery of information. Although the gauges show speed, engine revs, coolant temperature, fuel level, time, turbo boost, oil pressure, and amps, their placement is not as handy for a glance stolen from a quickly moving landscape.

Continued

Performance comparison with selected models

	Mpg (city driving)	Acceleration 0-60 mph (sec.)	Brakes 60-0 (hot) (ft.)	Handling (mph)	Maneuverability (mph)	Noise @ 60 mph (dBA)
1982 Saab Turbo 900 in-line 4	19	11.0	158	64.7	27.6+	72.0
1983 Pontiac 6000 STE V6	21	12.3	169	61.6	28.2	70.0
1983 Volvo GLT in-line 4	20	12.2	189	62.3	29.0	71.0
1983 Peugeot 505 ST1 in-line 4	22	18.3	196	57.0	27.0	71.0
1983 Audi 5000S in-line 5	22	13.4	193	62.8	31.2	69.0
1983 Honda Accord in-line 4	29	17.7	158	63.9	27.8	69.0

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- 3 Digital Signal Processor (patented)** differentiates between X and K band, triggering separate warnings for each.
- 4 Scan Time of .016 Seconds** captures all police radar, even Kustom Signals KR11 in the pulsed moving mode.
- 5 Statistical Operations Processor (ST/O/P™)** rejects false alarms broadcast by poorly designed imported radar detectors.
- 6 Analog Signal Strength Meter** indicates at a glance not only radar strength, but the strength's rate of change.
- 7 Amber Alert Lamp** has highest reflectance/transmittance ratio for optimum visibility, day or night.
- 8 Photoelectric Eye** automatically dims alert lamp at night to minimize glare.
- 9 Coherent Audio Tone** pitched at 1024 Hz for clear, yet annoyance-free warning.
- 10 Separate Audio Warnings** for X and K bands to distinguish the two types of radar.
- 11 Variable Rate Audio** pulses faster as radar nears, to indicate radar strength.

12 Audio Volume Control allows exact adjustment to suit interior sound level of car.

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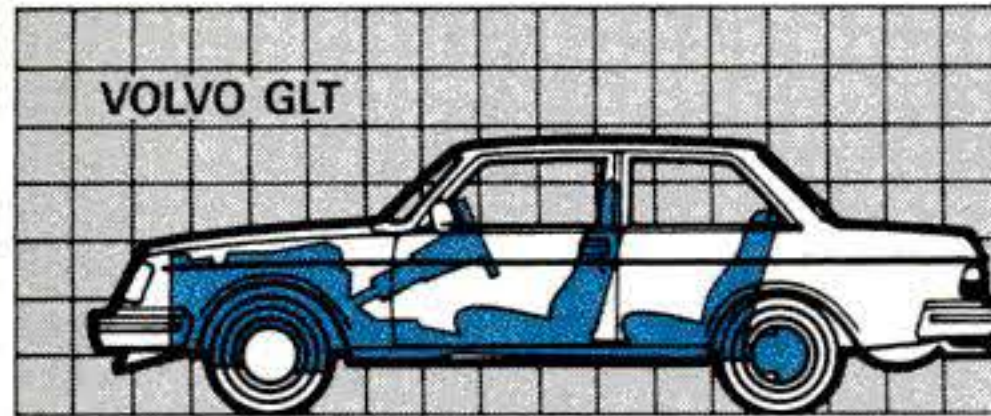
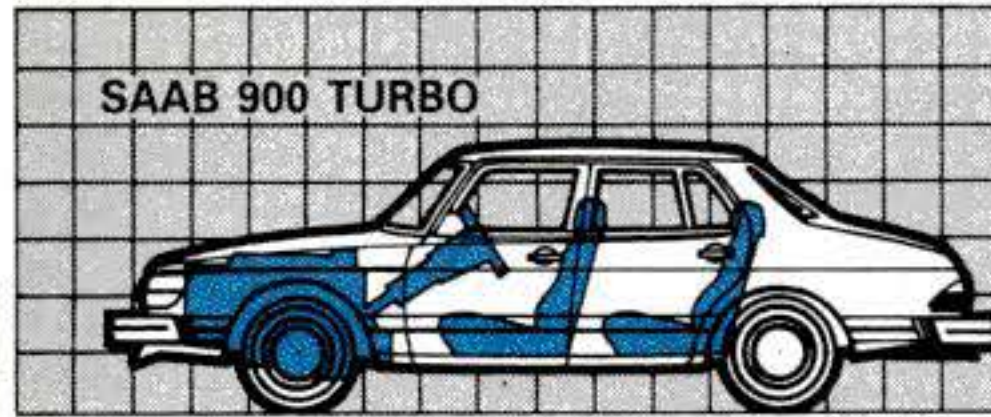
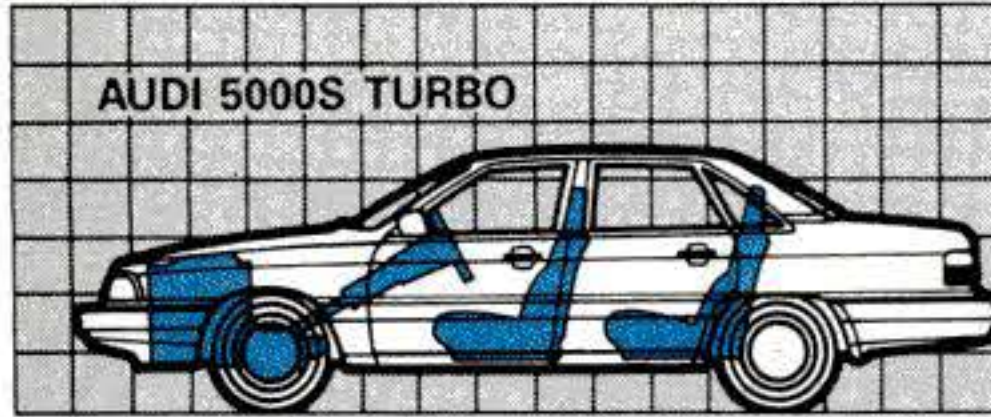
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European turbo sedans

Our picks

The Volvo's a surprise for me. Although probably the least glamorous of the three models, its acceleration, braking, and handling are outstanding. —J. D.

For ultra-fast highway cruising the Audi is my favorite. But I refuse to believe that a "performance" sedan does zero to 60 mph in 15.4 seconds. Give me the Volvo GLT.—J. K.



ILLUSTRATIONS BY RUSSELL VON SAUJERS

Test results, dimensions, and specs

	Audi 5000S turbo	Saab 900 turbo	Volvo GLT
TEST RESULTS			
Acceleration (sec.)			
0-60 mph	15.4	11.5	10.4
Brake test (cool) 60-0 mph			
Stopping distance (ft.)	175	151	167
Pedal pressure (lbs.)	40	120	90
Brake test (hot) 60-0 mph			
Stopping distance (ft.)	175	178	150
Pedal pressure (lbs.)	70	120	80
Interior noise (at 60 mph) (dBA)	69	69	71
Handling test (mph)	65.1	60.0	63.4
Maneuverability test (mph)	28.1	28.1	31.8
EPA FUEL MILEAGE (mpg)			
Highway	28	34	27
City	19	21	20
Calif. city	19	21	20

NOTE: Due to equipment failure, the PS test crew was unable to obtain steady-state mpg numbers in the fuel-mileage tests it conducted.

TEST CONDITIONS Ambient temperature, 78°F; relative humidity, 80 percent; barometric pressure, 29.9 inches Hg

DIMENSIONS (inches)			
Wheelbase	105.8	99.1	104.3
Overall length	192.7	186.6	188.8
Overall height	54.7	55.9	56.2
Overall width	71.4	66.5	67.3
Track, F/R	58.1/57.4	56.3/56.7	56.3/53.5
Ground clearance	4.9	6.7	4.3
Front head room	35.5	37.6	37.4
Front hip room	44.0	52.9	42.0
Front leg room	47.5	41.2	44.0
Rear head room	35.5	37.6	36.3
Rear hip room	53.5	53.4	56.0
Rear leg room (min.)	40.0	36.6	36.6
Rear knee room (min.)	2	0	4
Couple distance	34	30	38

SPECIFICATIONS			
Engine type	In-line 5	In-line 4	In-line 4
Displacement (cu. in./L)	131/2.1	121/2.0	134/2.2
Compression ratio	8.0:1	8.5:1	7.5:1
Carburetion	F.I.	F.I.	F.I.
Net hp (at rpm)	140 (at 5,500)	135 (at 4,800)	162 (at 5,100)
		160-175 (fuel)	
Net torque (ft.-lbs.) (at rpm)	149 (at 2,500)	(at 3,500)	181 (at 3,900)
Transmission	3-speed automatic	5-speed manual	4-speed manual overdrive
Axle ratio	n.a.	3.67:1	3.73:1
Tire make	Goodyear	Pirelli	Pirelli
Tire type	NCT VR 60	P8	Cinturato 86H P6
Tire size	205/60VR15	185/65SR15	195/60R15
Steering	Power, rack and pinion	Power, rack and pinion	Power, rack and pinion
Overall steering ratio	18.4:1	18.9:1	17.3:1
Turns, lock to lock	3.4	3.6	3.6
Turn diameter (ft.)	34.0	32.9	32.0
Front suspension	Independent MacPherson struts, coil springs	Independent MacPherson struts, coil springs	Independent MacPherson struts, coil springs
Rear suspension	Torsion crank axle with panhard rod, coil springs	Semi-independent trailing twist axle, coil springs	Rigid axle, four trailing links, panhard rod, coil springs
Front stabilizer-bar diameter (in.)	0.91	—	0.90
Rear stabilizer-bar diameter (in.)	None	—	0.83
Brakes	Disc/disc	Disc/disc	Disc/disc
Brake swept area (sq. in.)	n.a.	388	398
Fuel tank (gal.)	21.1	16.6	15.8
Trunk space (cu. ft.)	17.5	53.0*	13.9
Liftover height (in.)	27.0	26.0	30.7
Curb weight (lbs.)	2,900	2,890	3,050
F/R weight distribution (%)	61/39	61/39	54/46
Basic price	\$22,705	\$17,400	\$17,850
Price as tested	\$23,730 ¹	\$19,315 ²	\$18,901 ³

Major options (over \$100): ¹Leather seats \$1,025; ²metallic paint \$375, exclusive appointments group (sun roof, leather seats) \$1,540; ³Lambda Sond emissions control system \$137; AM-FM stereo cassette \$324; leather seats \$590

*With rear seat folded

PS serviceability ratings

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

	Audi 5000S turbo	Saab 900 turbo	Volvo GLT
Checking fluid levels			
Battery	2	5	4
Master cylinder	5	5	5
Windshield washer	5	5	5
Engine oil	5	5	4
Coolant	5	5	5
Checking the engine			
Spark plugs	5	5	4
Distributor	5	5	4
Carb adjustment	F.I.	F.I.	F.I.
Oil filter	5	3	4
Oil fill	5	5	5
Replacing hoses			
Upper radiator hose	5	5	5
Lower radiator hose	4	2	4
Heater hoses	4	2	4
Changing bulbs			
Headlights	5	3	5
Taillights	3	3	5
Front running lights	3	3	n.a.
Front parking lights	3	3	4
Front directionals	3	3	4
Rear directionals	3	3	4
Rear running lights	3	3	n.a.
Checking fuses			
	5	5	5
Spare-tire accessibility			
	4	4	4
Changing belts			
	3	1	3

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New search for life in space

Are we alone? Is anyone else out there? The questions have been asked for millennia. And for a few decades, astronomers have made sporadic and unsuccessful efforts to answer them by eavesdropping on the torrent of radio frequencies spewed out by the galaxy. Now the National Aeronautics and Space Administration has begun a 15-year program, using the most sophisticated signal processors ever built, to answer the questions once and for all.

By **ARTHUR FISHER**

Sometime this fall a truck loaded with bulky wooden crates will rumble some 500 miles south and east from NASA's Ames Research Center in Mountain View, Calif., to the Jet Propulsion Laboratory's Goldstone Observatory deep in California's Mojave Desert. Nesting inside one of the padded crates will be a chest-high VAX main-frame computer. In another, a standard gray equipment rack will bear vertical circuit boards wrap-wired with miles of copper strands and interconnected by yards of flat cable. A third crate will house a shiny copper box within a vacuum bottle that will be filled with liquid helium.

Together with specially created computer software, these components will constitute arguably the most sophisticated apparatus for receiving, analyzing, and processing radio signals ever built. This brainchild of teams of engineers, physicists, and astronomers working at Ames, the Jet Propulsion Laboratory, and Stanford University will be yoked to Goldstone's 26-meter (85-foot) radio telescope, part of NASA's Deep Space Tracking Network. As the great scope scans the heavens, the equipment will split the galaxy's chaotic outpouring of radio signals into 74,000 narrow frequency channels and then sift patiently through the data, seeking the one unambiguous pattern

that would signify something totally extraordinary. It will be the first stage of a newly organized, long-term, highly complex search—there have been earlier, more-primitive attempts—for intelligent life in space.

Even as the new search begins, an old quarrel continues. One group of scientists, including astronomers and biologists, has emerged with the conviction that extraterrestrial intelligent life—ETI, for short—is overwhelmingly probable and that a well-planned search should be able to detect it. Yet to others the search for extraterrestrial intelligence (SETI) is a chimera; they consider the quest itself anti-scientific and a waste of time, intellectual resources, and money.

Question with a history

The belief that intelligent life might exist elsewhere in the universe—for some a near-mystical article of faith and for others a logical outcome of rational thinking—was not subjected to a truly scientific inquiry until recently. Yet it undoubtedly antedates recorded history and was stated as early as the fourth century B.C. It was then that Metrodorus of Chios wrote in his book *On Nature* that "to suppose that Earth is the only populated world in infinite space is as absurd as to believe that in an entire field sown with millet, only one grain will grow."

The first actual suggestion that the human race try to communicate with

other intelligent races was made by the brilliant German mathematician Carl Friedrich Gauss in the middle of the 19th century. He wanted to plant a gigantic forest in the shape of a right triangle. Astronomers on other planets who saw this symbol would then immediately realize that Earth is peopled with creatures cultivated and intelligent enough to be familiar with the Pythagorean theorem.

The man who first moved from speculation to experiment, the man who put the S in SETI, was Frank Drake. Now a silver-haired professor of astronomy at Cornell University, Drake in 1960 was a young radio astronomer at the National Radio Astronomy Observatory in Green Bank, W.Va. By 1960 radio astronomers had discovered that the heavens were full of radio emanations from every direction—a cosmic cacophony. Following a 1959 recommendation of two Cornell University physicists, Philip Morrison and Giuseppe Cocconi, Drake decided to canvass two nearby stars, Tau Ceti and Epsilon Eridani, to see whether he could detect the kind of pulsed or coded radio signal that another intelligent race might use to send a message. So Drake wheedled some time on the observatory's huge-for-the-time 85-foot antenna, and thus began Project Ozma (named for the princess in the Oz books), the first serious attempt to find other races. It failed to do so.

Continued

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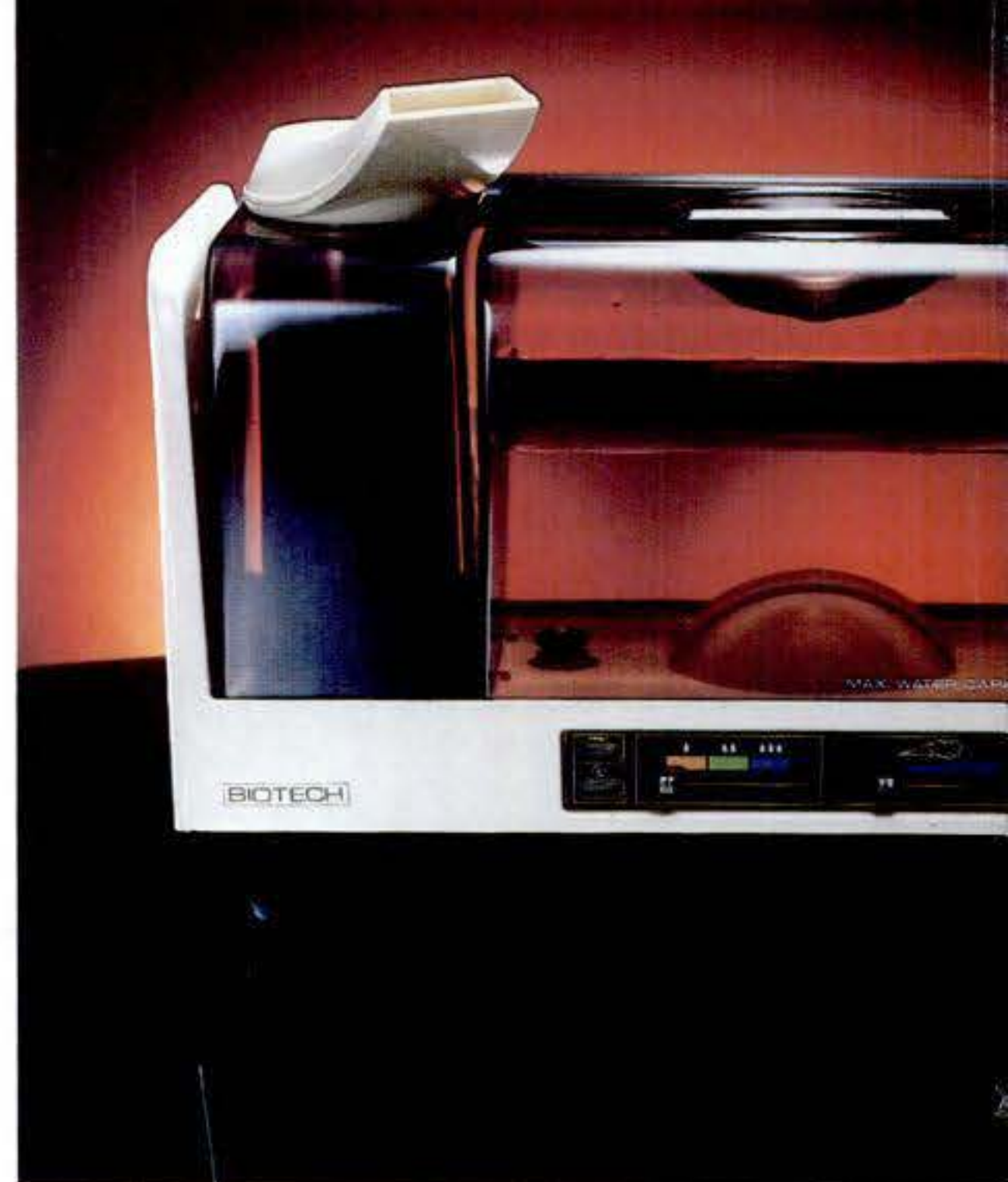
You feel more comfortable and breathe easier. You look better too—without the parched, irritated skin often caused by summer dryness and winter heating.

Attractive, portable Ultrasonic

plugs into any wall socket. Removable 4¾ quart reservoir supplies water for 8–12 hours. Unit shuts off automatically when desired humidity is reached (low, medium, high settings), or if empty or tipped over. Measures 15 × 13 × 7", weighs 11 lbs. Two year warranty.

Try this revolutionary humidifier for yourself in your home or office. If not completely satisfied, return it within 30 days for a full refund. Discover the pleasure of surrounding yourself with fresh, moisture-balanced air.

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The clear sound cordless. With speakerphone and memory dialer.

For reliability, range, and superior voice clarity, this new top-of-the-line Uniden cordless phone is outstanding. It transmits over the newest 46/49 MHz frequencies for quality sound without interference over a powerful 1000' range. A sophisticated digital coding filter (256 possible combinations) prevents false rings and keeps other cordless phones off your line.

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The handset batteries recharge automatically and are easily replaced. Telescoping antennas for clearest sound. Quality design, of rugged ABS, can be wall mounted. Measures 4 × 5½ × 9½", weighs 4½ lbs. Plugs into phone jack and AC socket. One year warranty.

Memory dialing, speakerphone, cordless handset, intercom—this remarkable Uniden gives you everything. Order today.

- Uniden Cordless Phone #YEX480 \$269 (7.50)
- Long Ranger Antenna (not shown) #YTB490 \$59 (7.50)



24 carat calculations.

Pull out this slim golden case, flip it open, and you're holding the newest miracle in calculators from Panasonic. There are no buttons, no batteries. The 24 keys, embossed into the case, respond instantly to your touch. An array of solar cells powers the 8-digit display in room light or outdoors.

Plated with 24K gold, the case measures just 2½" square; is an incredible ⅜" thin. Yet this calculator is a powerful performer—with 3-key memory, automatic constant and punctuation, 16-digit approximate calculations, and keys for percent, square root and sign change. Weighs 2½ oz. Quality Japanese construction. Comes with velvet slipcase, instructions, and

one year warranty.

Slip this handsome calculator into your suit pocket beside your gold pen. And meet the demands of business in style.

- Panasonic Golden Calculator #YPA371 \$69 (3.50)



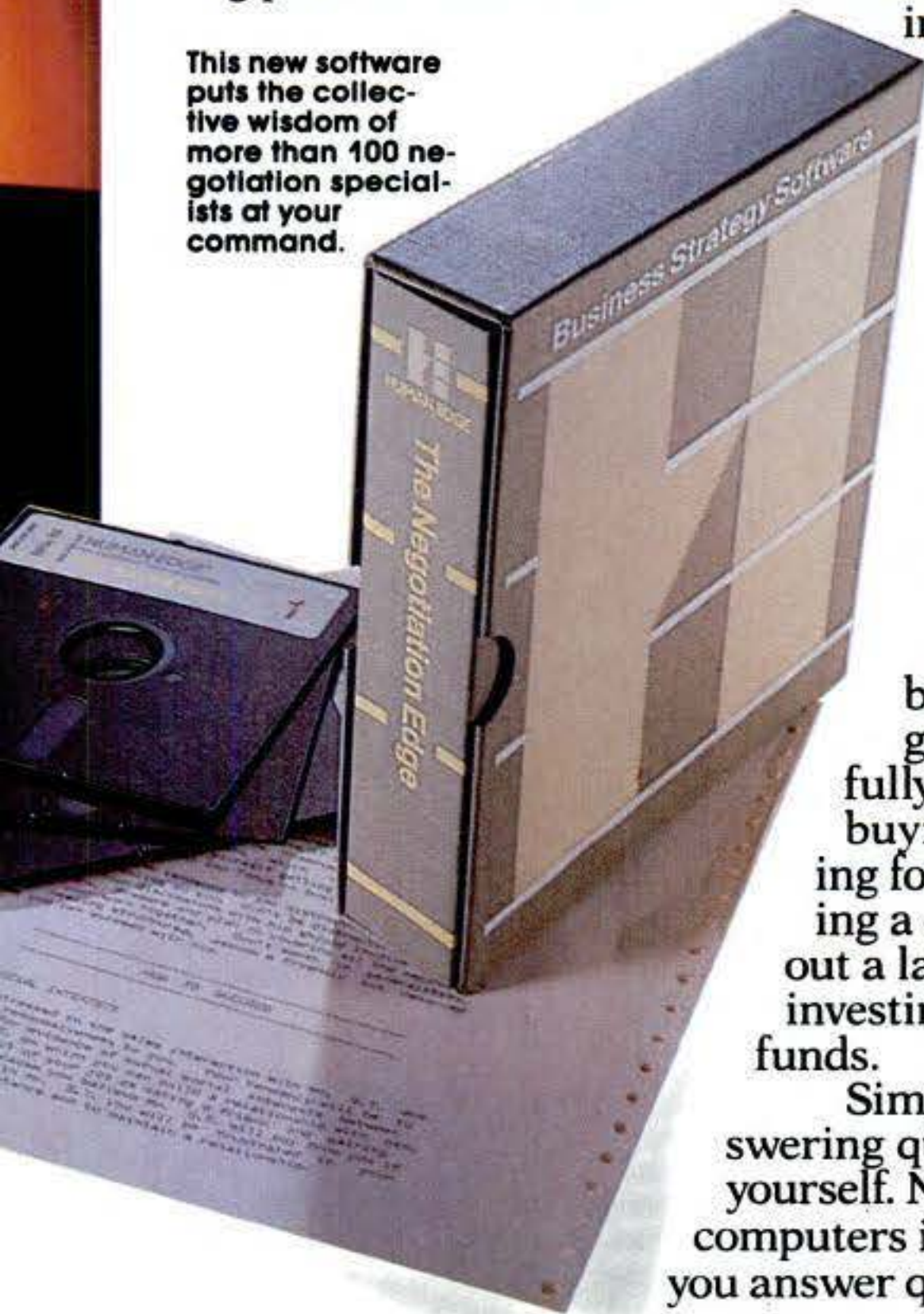
Wallet not included.

Software that makes you a master negotiator.

You just signed the papers. But instead of feeling exhilarated, you walk out of the room shaking your head. Somehow, you lost control of the negotiations—and settled for much less than you wanted.

Sound familiar? Psychologists agree the bargaining process involves some of the most intricate forces

This new software puts the collective wisdom of more than 100 negotiation specialists at your command.



in all human interaction. Power and status, body language, hidden agendas—all come into play. And a negotiator attuned to these forces has tremendous power.

Now Negotiations Edge™ software gives you a *specific* battle plan for bargaining successfully in any situation: buying property, asking for a raise, negotiating a contract, working out a labor agreement, investing corporate funds.

Simply begin by answering questions about yourself. No knowledge of computers is required. Next, you answer questions about

your opponent. Is he or she cautious? Sarcastic? Impatient? Talkative? Uncertain?

The final series of questions tell your computer about the context of your negotiations—the relative power of the participants, the complexity of the issues, time available for bargaining, and your previous experience with your opponent.

Then, in seconds, you have a detailed 5–7 page battle plan for winning your negotiations—onscreen or printed out. Not generalities, but a detailed, step-by-step strategy. Suggestions like these samples from an actual test:

"Adam R.'s impulsiveness will result in unreliable offers and shifting bids... Don't be distracted by such manipulations... Launch full steam into your agenda... Arrange the seating to minimize his appearance of authority over you... Say you need time to consider his proposals... Does he have a hidden agenda?"

To close successfully, the strategy recommends a 3-point plan:

1. Hold out on a final agreement... Expect Adam R. to camouflage his positions that give him greatest gain...
2. Attribute Adam R.'s concessions to factors unrelated to him... to spare him from feeling weak or incompetent...
3. Avoid direct confrontation... Adam R. will not exercise self-control so you must take the lead...

Your personal assessment is always on file. Each new evaluation takes just 5–10 minutes. The system includes a clearly written user's guide, output and program diskettes, helpful manual on negotiating, and worksheets to chart your success. Requires a monitor, double-sided disk drive and 128K of memory.

Use your 30-day return privilege to discover this remarkable new negotiating tool. Now, you'll sign on the dotted line with pleasure. Because you got what you wanted.

- The Negotiations Edge (for IBM PC or compatible) #YHM275 \$295 (3.50)
- Apple #YHM295 \$295 (3.50)
- Macintosh #YHM285 \$295 (3.50)

Brainy robot that doesn't cost a bundle.

Omnibot is the brilliant new robot from Japan designed for fun, experimentation and entertainment. With his built-in microprocessor and cassette recorder memory, you can teach him to follow a path through your home, delivering wake-up messages or serving hors d'oeuvres to

surprised guests (serving tray included).

Omnibot remembers seven different programs, or you can control his movements with the master remote control unit. Built-in clock/timer brings him to life at any pre-programmed time. He can recite taped messages or use the built-in microphone to give him a "voice." With his manual grasping hand, Omnibot can carry objects.

He rolls quietly on 7 rubber wheels, powered by built-in rechargeable batteries and recharging unit. Remote control and clock require a total of 6 AA batteries (not included). Sturdy polystyrene robot measures 12 x 12 x 15". Comes fully assembled with instructions, demo tape and 90 day warranty.

With his bright flashing eyes and quick-learning

brain, Omnibot will win your heart. And provide countless hours of entertainment and learning experiences.

- Omnibot Robot #YTM540 \$299 (8.50)



Send Omnibot on an odyssey through your house, or use his remote control unit with built-in microphone to play a tape, record a new program, or talk through Omnibot's on-board speaker.

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24 hour programming for your lights and appliances.

Discover the luxury of a living environment that responds to your every need—*automatically*. The Anova Control Center gives you manual remote control *and* timed automatic switching of electric devices in your home.

Awake to music and fresh-brewed coffee. Away for a week? Program lights and television to give your home a lived-in look for security. And save energy by setting air conditioners to start cooling just before you return home.

Program up to 16 different lights (includes dimming) and appliances (up to 1500 watts), with different schedules for each day of the week. No wires to install—the Control Center communicates with remote plug-in modules through *existing AC wiring*. Comes with 2 lamp/dimmer modules and 1 appliance module (others available from manufacturer). 8 x 6½ x 3". 3 lbs. One year warranty.

Call now to experience the unparalleled convenience of this total home commander.

• Anova Control Center #YAN800 \$199 (4.50)



The Swedish convertible.

From Sweden comes an elegant contemporary phone with the unique ability to change color to suit your mood—and decor. Tired of basic black? In seconds you can exchange the screw-on face plate for gleaming white. Or playful red. It's like getting three phones for the price of one.

Beneath the graceful Scandinavian exterior is the latest in solid state electronics. The high-fidelity linear microphone is so sensitive you can whisper and still be clearly heard. Soft-touch True Tone dialing gives you access to money-saving long distance services like Sprint and MCI. Ringer volume is adjustable.

This new Ericsson phone is built by the same Swedish craftsmen whose designs have been cited by the Museum of Modern Art in New York as among the 20th century's finest. Durable injection-molded ABS construction makes the phone extremely light (less than 2 lbs.), yet it stands completely stable on soft plastic feet that won't mark your fine furniture. Measures 7½ x 6½ x 3". Plugs into phone jack. Includes 3 face plates. One year warranty.

Now you can change your telephone as easily as you change your clothes—with striking results every time.

• Ericsson Phone #YAE301 \$89 (3.50)



Clean air and warmth from one machine.

First Bonaire set new standards of air purity with their revolutionary air-purifier/ionizers. Now the new Bonaire 750 adds a convenient heater—for complete control of the air quality *and* temperature of the air you breathe.

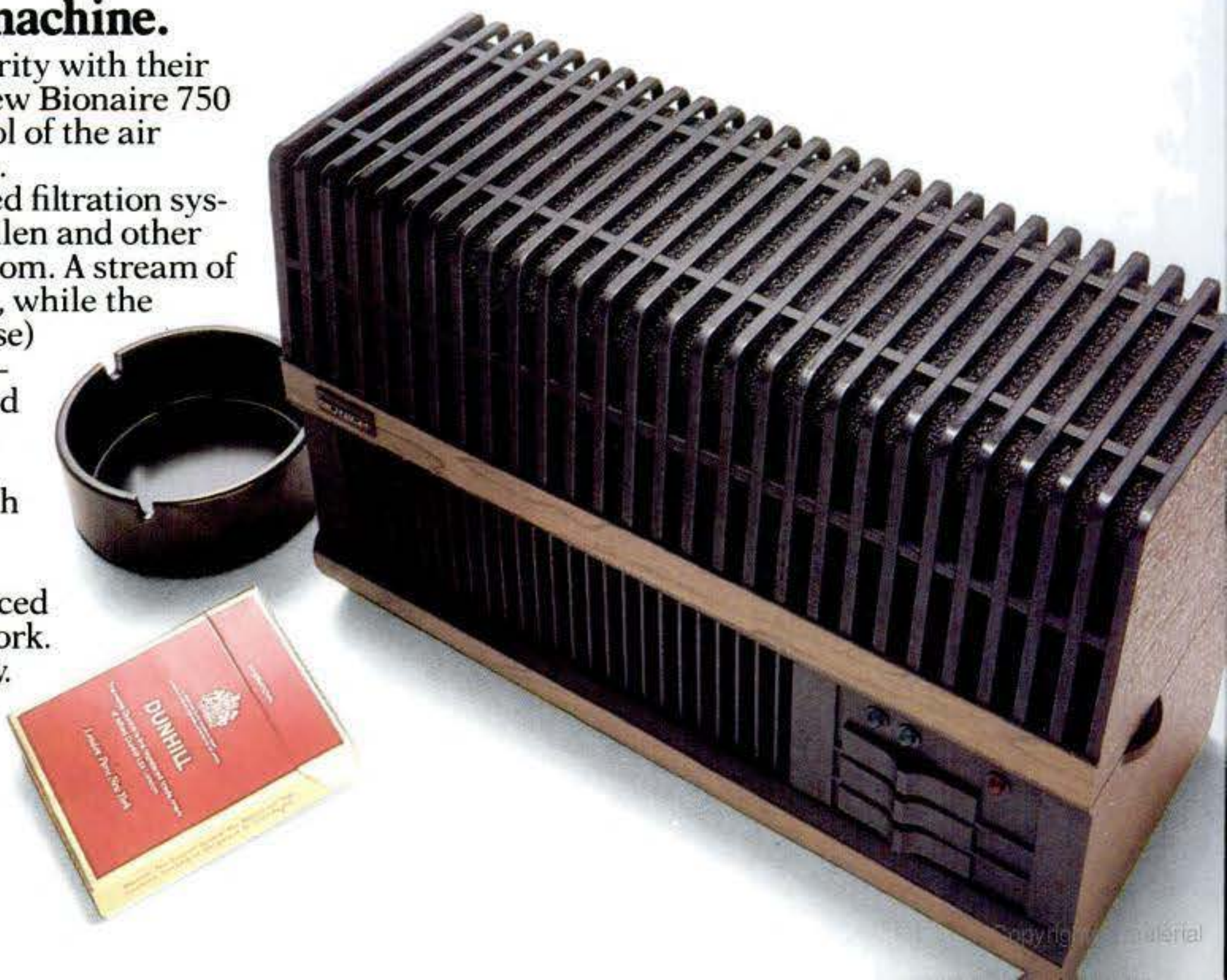
In just 15 minutes, Bonaire 750's advanced filtration system removes up to 99% of the dust, smoke, pollen and other particulate pollutants in an average 12 x 12' room. A stream of negative ions attracts pollutants like a magnet, while the three-speed fan (whisper-quiet for bedroom use) draws air through the patented electret filter—removing particles as small as .01 microns. And Bonaire's allergy-fighting capabilities make it tax deductible with a doctor's prescription.

Dual temperature heater (use alone or with filter system) provides 500 or 1000 watts of power to take the chill from an average room. Filters last up to 3 months and are easily replaced (order below). Filtro-Scope eliminates guesswork. 12¼ x 8½ x 5", 8 lbs. Two year limited warranty.

Try the new Bonaire in your home or office, and discover the invigorating pleasure of breathing particulate-free, temperature-controlled air.

• Bonaire 750 #YBB750 \$199 (6.50)

• Replacement Filter #YBB799 \$12.95 (2.50)





Let sound waves soothe your body.

From West Germany comes a satisfying new way to invigorate your body. The Novafon sonic massager emits 10,000 pulses of sound each second, sending waves of vibrating energy deep within tired muscles and inflamed joints. This "intra-sound" (audible frequencies) stimulates blood circulation as much as 2 1/4" beneath the skin. Helps soothe over-stressed muscles and joints—without drugs.

More than 500,000 Europeans now enjoy the benefits of this innovative technology. Completely safe, it has been used by health clinics and physiotherapists for over 30 years. (Requires no doctor's prescription.) Endorsed by sports trainers and athletes around the world.

Built in West Germany of a light metal alloy, Novafon has no moving parts to wear out. Measures 7 1/2" long, weighs 8 oz. Adjustable intensity control. Comes with handsome case, two washable heads (one flat, one rounded), and 14" coiled cord (extends to 7'). One year warranty. Use your 30 day return privilege to enjoy a deep, penetrating massage on your own body. Order this remarkable sonic massager—and experience how wonderful your body can feel.

• Novafon Sonic Massager #YED801 \$149 (5.50)

Communication for the hands-free adventurer.

Now you can get the same kind of hands-free radio communication used by pro football coaches. Voice-activated, Maxon automatically transmits when you speak. Its advanced quartz crystal super-heterodyne circuit provides virtually noise-free FM operation, up to a half mile away.

The lightweight 3 oz. headset has foam-padded earphone and a miniature boom microphone with windscreen. Control pack fits in a shirt pocket or attaches to belt. Separate mike/receiver volume. Measures 5 x 2 1/2 x 1". 6 1/2 oz. Takes 9V battery (not included). FCC approved. 90 day warranty. Works with 2 sets or more.

Maxon is perfect for cyclists, backpackers, skiers—anyone who wants to stay in contact over long distances.

• Two-Way Communicators #YMX978 \$39 each (2.50)
Minimum of two required.



St. Louis Jeweler
6.96 ct. at \$44.68/ct.
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The Sharper Image
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An opportunity to own exquisite gems. Without paying a jewelry store price.

By the time a gemstone reaches your local jewelry store, it may have passed through the hands of an importer, wholesaler, and dealer. Your jeweler is not trying to overcharge you. But he has to pay for that long line of profit-takers.

Take the case of blue topaz—a brilliant, sparkling gem that's become especially popular since aquamarine soared to over \$250 per carat. (Its index of refraction is actually higher than aquamarine's.)

As you can see from the samples above, blue topaz prices at two typical jewelry stores visited by The Sharper Image averaged about \$45 per carat.

Now check The Sharper Image stone on the right. It's the same hand-cut, faceted and polished oval stone. It's larger than the other stones. And it's a deeper, richer color. Yet it can be yours for as little as \$12.44 per carat.

This dramatic price difference is possible because The Sharper Image operates more efficiently. Our tough buyers go to Brazil and purchase 5,000 carats at a time—directly from the mines. This gives us tremendous leverage on price and quality. Every stone that fails to meet our exacting standards is rejected on the spot.

When you buy direct from us you bypass all the middlemen. And you receive a 30 day trial period you can use, if you like, to have your gemstones appraised. Call today and own a large blue topaz at a price impossible through traditional sources.

Blue Topaz:

- 6 ct. Mounted #YTG081 \$119 (4.00)
- 6 ct. Unmounted #YTG082 \$79 (4.00)
- 10 ct. Mounted #YTG027 \$179 (4.00)
- 10 ct. Unmounted #YTG028 \$139 (4.00)
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Oval-cut stones are mounted in a 14K gold bezel, ready to hang from a chain or bracelet. Or choose unmounted stones so you and your jeweler can create a unique setting. Chain not included.

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Total Gym. Exercise that moves you. Instead of weights.

The ingenious Total Gym uses your *body* for resistance—instead of weights. Simply adjust the glide rail—the steeper the incline, the greater percentage of body weight you work against. Nine settings from mild to advanced change in seconds to give you a tremendous workout—whatever your fitness level.

Total Gym offers 70 exercises in all. Training programs build specific muscles for running, racquet sports, swimming, skiing, even surfing. And Total Gym works your muscles through a full range of motion—increasing your flexibility. You can even do modified inversion exercises (with glideboard at high setting)—counteracting the compressive forces of gravity on your spine.

Smoothly pull yourself up and down the rail with the *two-handle arm pulley*. Reversible handlebars turn outward for shoulder-building exercise, inward for squats. For slant board sit ups, a unique foot-holder (with velcro straps) moves with you as you exercise. Or use the soft-lined leg cuffs to tone calves and hamstrings. Optional arm curl accessory strengthens biceps. And advanced body builders can add the optional 34" weightlifting bar to hold additional weights.

Chrome-plated steel frame is welded for super-strength. Self-lubricating bronze bushings and 2,000-lb. test cable handle any load.

All contact surfaces are comfortably padded. 24 x 53 x 108". 100 lbs.

Folds and stores easily in less than 48" of floor space. Comes with exercise chart and one year warranty from West Bend.

Order today and glide into shape with Total Gym's smooth, rolling motion.

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- Weight Bar #YWB428 \$14 (2.50)

Arm pullovers build your chest, lats, front of shoulders and arms.



The lambswool underblanket. Nature's own lullaby.

For years, Europeans have been enjoying the relaxing comfort of fleecy wool underblankets. Science can't explain why, but thousands of people have found the gentle cushioning of wool promotes a deeper, more restful sleep.

The secret seems to be in the unique quality of natural wool. The long, cushioning fibers mold to your body, reducing the concentration of pressure at your shoulders and hips. You fall asleep faster and sleep more comfortably, with less tossing and turning. For several years now, American hospitals have used wool underblankets in place of mattress pads, as they allow full blood circulation.

You spend a third of your lifetime in bed. Now you can make these hours far more pleasant with the restful comfort of DownUnder.[™] Made of 100% pure Merino lambswool knitted into a polyester back, forming a dense, deep uniform pile. So durable it's been given the Superwash designation by the U.S. Wool Bureau—fully machine washable.

Wool underblankets are nature's perfect insulator. In the winter, they retain body heat to keep you warm without over-heating. In summertime, they keep you cool by absorbing moisture.

DownUnder comes in five sizes to fit any bed, including your child's crib. (They're great for soothing a restless baby.) Twin size measures 39 x 75", full size is 54 x 75", queen: 60 x 80", king: 78 x 80", crib: 28 x 52", California king: 72 x 84".

Sleep-test a DownUnder yourself for 30 nights. You'll fall asleep faster, enjoy a deeper sleep, and awake refreshed—or return it for a full refund. Discover the pleasure of a peaceful, undisturbed night's sleep on natural lambswool.

- DownUnder Wool Underblanket
- #YNM711 (Twin) \$99 (10.50)
- #YNM712 (Full) \$129 (14.50)
- #YNM713 (Queen) \$159 (18.50)
- #YNM714 (King) \$199 (20.50)
- #YNM715 (Crib) \$49 (5.50)
- #YNM716 (California King) \$199 (20.50)



Portable power for cars, boats and planes.

Carry this amazing portable power pack in your glove compartment and you'll never be stranded by a dead battery again. Just plug Charge It into your cigarette lighter (or attach to your battery with included clips), then relax 5-15 minutes while its built-in GE batteries recharge your car battery.

Add the optional adapter, and Charge It will power your 12V spotlight, air compressor, and car vacuum. Take it camping and run your cooler or TV set.

Works on cars, boats, airplanes, and many types of garden and RV equipment. Recharges your battery about 500 times. 6 x 3 x 2 1/2", 2 lbs. Recharge monthly and after each use (with included AC adapter or from your car battery). Comes with carry case and one year warranty. Order today and always travel prepared.

- Charge It #YEE757 \$149 (5.50)
- 12V Appliance Adapter #YEE758 \$29 (2.50)



Boaters will find Charge It especially useful. Provides a vital backup system to charge your battery. And with the optional adapter it will run your emergency radio. Its uses are endless. You can even use it to power your VCR camera.



The Anova Communications Center. An answering machine, speakerphone, and auto dialer.

Anova's astonishing Communications Center gives you every imaginable state-of-the-art phone convenience—in one powerful console. Its voice-activated answering machine provides not one, but 7 outgoing message channels—and crisp, pause-free playback on dual minicassettes. Fluorescent panel light displays the exact time and date of each message as you listen. At home or away (with remote beeper) you can skip, erase or repeat messages. No messages? A tone lets you hang up *before* you're charged for a call.

Talk on the comfortable handset, or hands-free with the duplex speakerphone. Store and auto-dial up to 16 (15-digit) numbers, with continuous auto-redial. You can even record two-way conversations. Pushbutton phone is Tone/Pulse switchable for access to Sprint and MCI. Display panel doubles as call timer and calendar clock. Hold and Mute buttons for privacy. 14 x 9 1/2 x 3", 9 lbs. One year warranty.

Call today, risk-free, to discover the phone center that breaks every barrier to communication.

- Anova Communications Center #YAN700 \$399 (6.50)

The cordless phone that breaks the interference barrier.

Webcor's talented 3rd generation cordless phone makes reception problems a thing of the past. You talk over any of 6 newly approved FCC channels for unexcelled sound clarity. (Compared to 1 or 2 other channels on most cordless phones.) So if you ever encounter interference, simply press the scan button and automatically switch to a clear channel—without interrupting your conversation.

Webcor's audible out-of-range signal is also unique. It warns you when you're too far from the base unit, so you avoid misdialing. And a sophisticated digital coding filter (with 1,728 quickly changed combinations) keeps other phones off your line over the entire 1000' range. Last number redial recalls busy numbers with the press of a button. Pulse/Tone switchable for access to long distance services like Sprint® and MCI®.

Advanced circuitry reduces the number and length of rechargings. And permanent batteries work 12 hours on a single charge. Has low-battery indicator. Quality Japanese engineering. Constructed of durable ABS. Handset measures 9 x 3 x 3 1/2". Weighs 1 1/2 lbs. Plugs into standard phone jack and AC outlet. 1 yr. limited warranty. For long range and superior sound quality, you won't find a better cordless phone—at any price.

- Webcor Channel Search Phone #YWE560 \$199 (4.50)
- Long Ranger Antenna (not shown) #YTB490 \$59 (7.50)



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The Frequent Buyers™ Reward.

Good customers deserve a reward. Now, every product you buy from The Sharper Image earns you points toward valuable gift certificates. You receive one point for each dollar you spend between Jan. 1, 1984 and Dec. 30, 1984. And this is how your reward adds up:

750 points earn a \$50 gift certificate.
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How to claim your reward.

1. Save your sales receipts.
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5. Return sales receipts and form by March, 1985.
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Refunds are matched against original purchases. Points are earned when products are delivered, and are not transferable. Please save your original receipts (packed with items). They are your sole proof of points and must be returned by mail for redemption when requesting gift certificates.



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For quickest delivery, simply call toll free with your MasterCard, Visa, Amex or Diner's Club card. Or mail a check. Most orders are shipped within 48 hours and should reach you within 30 days.

Delivery charges are in parentheses () after the purchase price. For delivery outside the 50 U.S. states, please triple the amount. For questions about orders, call our toll free customer service line, 800-344-5555.

Return Policy: We want you to be pleased. If for any reason you are not delighted with the order you receive, just return it (via insured parcel post or UPS) within 30 days of receipt for a prompt and courteous refund or credit. Sorry, only returns in new condition can be accepted.

Our staff is ready to answer questions and assist you with your mail or phone order. Please use this form to organize your phone order before you call our toll-free number.

1 DATE OF ORDER							
2 ORDERED BY							
Name _____							
Address _____							
City _____							
State _____ Zip _____							
3 METHOD OF PAYMENT							
<input type="checkbox"/> Check <input type="checkbox"/> Money Order <input type="checkbox"/> VISA <input type="checkbox"/> Master Card <input type="checkbox"/> Am. Exp. <input type="checkbox"/> Diner's Club / Carte Blanche							
Account Number _____							
Expiration Date _____ Authorized Signature _____							
4 ITEMS ORDERED							
ITEM NO.	QTY.	ITEM PRICE	ITEM DESCRIPTION	SIZE COLOR	CA TAX	DEL. ()	TOTAL CHARGE
						CALIFORNIA DEL. ONLY ADD 6% SALES TAX. 6% WHERE APPLICABLE.	
						DO NOT ADD TAX TO DEL. CHG.	
5 GRAND TOTAL							

6 BILLING ADDRESS	
Name _____	Company Name _____
Address _____	
City _____	
State _____	Zip _____

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Item No. _____	
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City _____	State _____ Zip _____

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In the years following Project Ozma some three dozen different radio searches for ETI have been aimed at more than 1,000 stars and a few galaxies—conducted primarily in the U.S., the Soviet Union, and Canada. (Some have had rather wistful names, including “Qui appelle?” “Serendip,” and even “Mania.”) In the 1970s Project Ozma II, headed by Ben Zuckerman and Patrick Palmer at the National Radio Astronomy Observatory, tuned in on more than 600 stars within 80 light-years of the sun.

Neither these nor any other searches were rewarded with a true “encounter,” although there have been a number of false positives. For example, in 1967 Cambridge astronomers Jocelyn Bell and Anthony Hewish were trying to measure the scintillations of quasars. Suddenly they began to receive from a point in the sky a series of radio pulses that had a precise, unvarying rhythm. Said Cambridge astronomer Sir Martin Ryle, “Our first thought was this was another intelligent race trying to reach us.” But in fact they had discovered a pulsar—a kind of rotating neutron star that mimics a radio beacon. This first pulsar was dubbed “LGM,” for little green men.

What dictates the frequencies at which such searches are conducted? They result, Drake explains, from the limits imposed by certain cosmic phenomena: “You don’t use the state of your technology to select a frequency. You select optimum frequencies as set by the laws of physics in the universe. One of these laws says that the energy required to communicate a bit of information rises directly

with the frequency—in other words, the signal-to-noise ratio gets worse as the frequency increases. There’s no overcoming that with any technology. If that were all, you could say that you should use the lowest frequencies. That would be horrible because they don’t penetrate the ionosphere and wouldn’t propagate in the galaxy at all.

“Moreover, there is a second phenomenon: galactic radio noise. That increases as you lower the frequency, so going too low, in essence, jams the radio telescope.

“So on the lowest frequencies you are jammed by the galaxy, and on the highest you have a bad signal-to-noise. And there is yet a third phenomenon that gets into the act: the three-degree black-body radiation left over from the primordial fireball. That imposes its own noise level. If you take these three sources of noise and sum them at every frequency, you find the range of frequencies in which the total noise is at a minimum.

“It turns out that the best signal-to-noise ratio is at about a 10-centimeter wavelength. But the minimum is broad because there isn’t much more noise at 21 centimeters or at three centimeters.”

Interstellar oasis

Most of the past radio searches have been in this band or at something aptly called “the water hole,” a designation apparently first used by Bernard Oliver, a vice-president of Hewlett-Packard and a SETI pioneer. In the summer of 1972 he and John Billingham of the Ames Research Center conducted a summer study ses-

sion named Project Cyclops, in essence a SETI think tank. Describing the results of the study some years later, Oliver wrote: “The Cyclops team felt that it found an appealing reason to favor a rather narrow region at the optimum part of the spectrum. At 1.42 GHz there is a strong spectral line caused by interstellar hydrogen. Just a little bit higher in frequency, at 1.66 GHz, is another spectral line caused by hydroxyl ions in space. We think that this may be the interstellar communication band, defined for all of us by nature itself.

“Detecting just one signal would answer many fundamental questions about life in the universe”

“Water separates into hydrogen and hydroxyl ions, both of which are important in all life processes. So is water. Thus the band lying between the two spectral lines of the two dissociation products of water is a poetically symbolic place for water-based life to search for its kind. Where shall we find intelligent species? Why, at the age-old meeting place of all species—the water hole.”

Despite all the sporadic attempts to find extraterrestrial life, and the lively debate over the quest, today’s serious attempt got under way only recently. In 1982 the Astronomy Survey Committee of the National Research Council, under the chairmanship of Harvard-Smithsonian Institution’s George Field, issued a highly influential report titled “Astronomy and Astrophysics for the 1980s.” It recommended that SETI be one of our national goals.

In August 1982 the august International Astronomical Union, with members from more than 70 countries, established a new commission: Commission 51, Search for Extraterrestrial Life, under the chairmanship of Boston University’s Michael D. Papagiannis. Drake was vice-chairman.

Two months later the correspondence pages of *Science* (October 29) carried a long letter in the form of a petition, written by Carl Sagan and co-signed by 72 other prominent scientists from 14 countries, including seven Nobelists. The petition began: “The human species is now able to

Continued

The mathematics of searching for intelligent life

When Frank Drake launched Project Ozma in 1960 he sought a way to calculate the probability of finding other intelligent races. Within a few years he had formulated the equation that remains a kind of tablet from the mount for SETI researchers—an expression in mathematical terms of the likelihood of the number of extraterrestrial civilizations willing and able to communicate across the galaxy. The equation goes like this:

$$N = R^* F_p N_p F_i F_c L$$

Though somewhat formidable looking, this is simply the number (N) of technological civilizations in our galaxy, as the product of a string of probabilities:

R* = the average rate in stars per year of star formation in the galaxy.

F_p = the fraction of stars having planets.

N_p = the number of suitable planets per planetary system.

F_i = the fraction of planets on which life starts.

F_c = the fraction of life that evolves to intelligence.

F_c = the fraction of intelligent species to develop the means of communication.

L = the longevity (in years) of the technological phase of such a society.

Drake and other early extraterrestrial-life enthusiasts, including Carl Sagan, arrived at a value for N between 100,000 and one million—still only about one technological civilization per million stars in the galaxy, which astronomers reckon contains approximately some 200 billion stars.

When asked whether his own assessment of N has changed over the intervening years, Drake replies:

“The terms in the equation still seem to me to be right. The precise numbers or estimates or guesses that are put in the equation have changed over the years—some have gone up and some have gone down. But the product N has stayed about the same. Sometimes I ask myself whether it’s just that I want to come out with the same answer as 20 years ago, and I finally decide no... it’s just coming out that way.”—A. F.

Life in space

communicate with other civilizations in space, if such exist. Using current radio-astronomical technology it is possible for us to receive signals from civilizations no more advanced than we are over a distance of at least many thousands of light-years. The cost of a systematic international research effort, using existing radio telescopes, is as low as a few million dollars per year for one or two decades. The program would be more than a million times more thorough than all previous searches, by all nations, put together. The results—whether positive

or negative—would have profound implications for our view of our universe and ourselves.”

The letter concluded: “We urge the organization of a coordinated, worldwide, and systematic search for extraterrestrial intelligence.”

In November 1982 Congress approved a modest \$1.5 million in the NASA budget to begin the development of a long-term SETI project.

Technical challenges

The new work under way grows out of an unfortunate fact: The equip-

ment typically used by radio astronomers is not good for SETI projects. The reason, explains Jill Tarter, a research astronomer at the University of California at Berkeley, is that SETI requires extremely high-frequency resolution.

Tarter, a svelte young woman with a penchant for ice-cream lunches, spends much of her time working at Ames, one of NASA's SETI Project Offices. In a trailer at Ames festooned with computer printouts and star maps, she explained the technical challenges of the program:

“Signals generated by natural phenomena in the cosmos have a bandwidth of kilohertz or megahertz. The kind of signal we want to look for is very narrow, only a few hertz wide, because if we did detect such a narrow-bandwidth coherent signal, we'd be pretty sure it was generated by another technologically advanced civilization. Why? It's the one type of signal we don't know nature to produce. Of course, if we happened to discover a previously unknown class of physical phenomenon—that would certainly be interesting in itself.

“The narrowest kind of phenomena in the universe are hydroxyl maser sources, with bandwidths of about ½ kHz. The channels we are now looking at are just five kHz wide. That's the kind of signal we ourselves create for communications—carrier waves that are one kHz or narrower [there is some amount of spreading of any radio signal due to multipath scattering as the signal travels through ionized gases in the interstellar medium].

“The reason one would use as narrow a channel as possible—so long as the bandwidth doesn't get narrower than the broadcast frequency—is to get the best possible signal-to-noise ratio. On the one hand, we want to scan very narrow channels; on the other, we don't know—within a fairly broad range—which particular frequency another civilization's signal might arrive on. So we want to listen to very many frequencies on very narrow channels.”

Until now, Tarter and her associates have been using special high-speed tape recorders, developed for the very-long-baseline-interferometry astronomy program, to generate 65,000 channels of spectral data—recorded directly at the 305-meter (1,000-ft.) dish at Arecibo Observatory in Puerto Rico—each channel only five Hz wide. That observing program looked at 200 to 300 stars.

The long-term program approved for NASA is far more ambitious. It calls first for the development of a prototype instrument called a Multichannel

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Spectrum Analyzer. That is the phase just completed at Ames, Stanford, and the Jet Propulsion Lab. Its purpose is to filter a wide-band signal into many narrower bands and to do it in real time. "The prototype now built," says Tarter, "has 74,000 channels, each one Hz wide. Eventually it will grow to eight million channels—maybe more, depending on how fast the electronics program progresses in the next five or six years."

Later in the program the signal analyzers will be yoked to the Deep Space Tracking Network's 64-meter (210-ft.) radio telescopes at Goldstone; Tidbinbilla, Australia; and Madrid, Spain, as well as to the Arecibo antenna. In a sense it will be the most powerful dedicated computer ever made. Generating a billion bits of information a second, the analyzer will examine more interstellar data in minutes than the total of all SETI projects heretofore, from a broad region of the radio spectrum in which background noise is low.

John Billingham is chief of NASA's Extraterrestrial Research Division at Ames, under which the SETI program falls. "The way it is structured now," he says, "we have a five-year R&D program in which to check out exhaustively the design of the SETI systems,

including the analyzer. By that time we will have tested the prototype extensively. Then we will have roughly a 10-year period during which we will build the search machine proper, which will cover a much wider spectrum than the prototype; we will distribute search machines to various large radio telescopes and then begin the search according to a very specific pattern that we have developed over the years.

"We would not expect to detect anything during the R&D phase because

“Extraterrestrial life could establish a colony somewhere in the asteroid belt”

we're not going to make that many observations—it's going to be mostly checking out the instruments. I would say there is a chance of making a detection during the following 10-year period. Beyond that it's difficult to say, because our technology will have improved enormously 15 years from now.

"Just the detection of one signal would answer many fundamental questions. They have to do with the

nature and distribution of life in the universe. What are we doing here? Where are we going? Are there others, and if so, what are they like?"

The hope that some of those questions just might eventually be answered lures even some who had turned skeptical into supporting the SETI program. Take Ben Zuckerman, for example, who talked to me during a lunch break at the University of California at Los Angeles:

"The searches that Pat Palmer and I carried out ended about 1976. I guess I was an agnostic in the matter of intelligent life in the universe when we first started those searches. But in the late '70s my view started to shift. I felt more and more that they weren't out there, and that there might be very few or no civilizations in the Milky Way more advanced than ours.

"That was partly because the searches didn't find anything, but even more because of an argument Michael Hart [professor of physics at Trinity University in San Antonio, Texas] presented in a paper in 1975. Essentially he said that if advanced civilizations existed in such great numbers—100,000 or more according to people like Drake and Sagan—then at least one of them ought to have

Continued



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been here already; they should have colonized not only us but the whole galaxy. Because they are clearly not in our solar system, and there is no evidence for them elsewhere, maybe there just aren't any anywhere.

"But even so, I signed the petition in *Science* that Sagan drew up because although the negative arguments are strong, I don't think they are airtight. I think we are extrapolating so far from our own civilization to possibly super-advanced creatures that we still have to do more searching. The searches up to now have not been

sensitive or comprehensive enough that we can give them a great deal of weight. It would be nice to get that extra radio data."

The basic argument against the existence of any other advanced civilization in the galaxy—or the universe—was formulated years ago by that very enquiring mind, Enrico Fermi, and has become known as the Fermi Paradox. If there are so many of them and they are so advanced—certainly possessing the secrets of nuclear power, for example—then, Fermi asked: "Where are they?"

An elaboration of this viewpoint is given by Michael Papagiannis, whose speech—and perhaps the intricacy of his reasoning—suggests his native Greece. "Radio searches," he says, "are based on the assumption that an evolving civilization stays within its own solar system. Implicit in Drake's equation [see box] is the notion that it was impossible to travel from star to star to initiate a colonization process. The reasons were based on our thinking of 25 years ago that no race would be willing to make the trip if it took longer than a lifetime.

"But our thinking on this score has changed. Perhaps a very large self-sustaining colony, with many individuals willing to spend generations on spacecraft, could travel at a fraction of the speed of light—perhaps only a few percent. That is feasible with forms of energy we have now. Four years ago at an International Astronomical Union meeting, someone said that would exhaust the total stockpile of nuclear weapons on Earth. Then everybody laughed when they realized what a terrific idea that would be!

"Thus arose the idea of 'star-hopping,' of civilizations expanding—like a gas filling empty space—and going from star to star until a colonization wave would fill the whole galaxy."

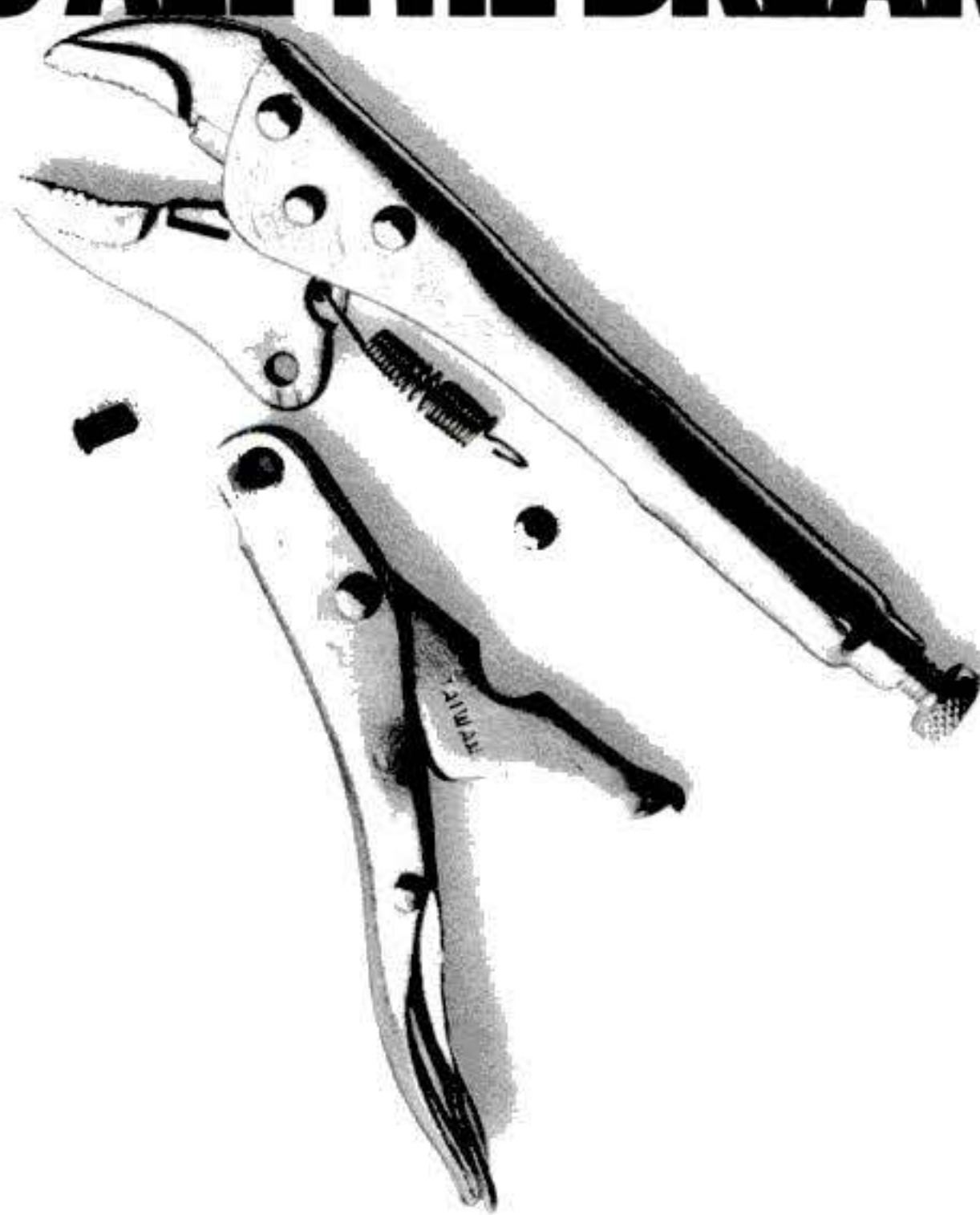
The calculations that attend this speculation are fascinating. "Has colonization started?" asks Papagiannis. "If so, they must be everywhere in the galaxy. If travel took place at the speed of one percent of the speed of light, it would take about 10 million years to colonize the whole galaxy. Now 10 million years is a very small fraction of the lifetime of the galaxy—10 billion years. In this context the conversion of a vast desert to a galaxy teeming with life would be almost instantaneous."

Drake resists the idea of the inevitability of an advanced civilization colonizing away from its own star system: "My argument is that any civilization that takes a look at the time, risks, and energy requirements of such a trip will stop and say, 'This is crazy—we'll colonize our own system.' For example, the kinetic energy of something just the size of a 747 going at one-tenth the speed of light is equal to the total energy generation of the United States."

Probability dictates that because colonization could have started any time within the last five billion years (leaving a few-billion-year developmental period for an advanced civilization), the chance that it started only yesterday is very small. "After all," says Papagiannis, "if you visit a family

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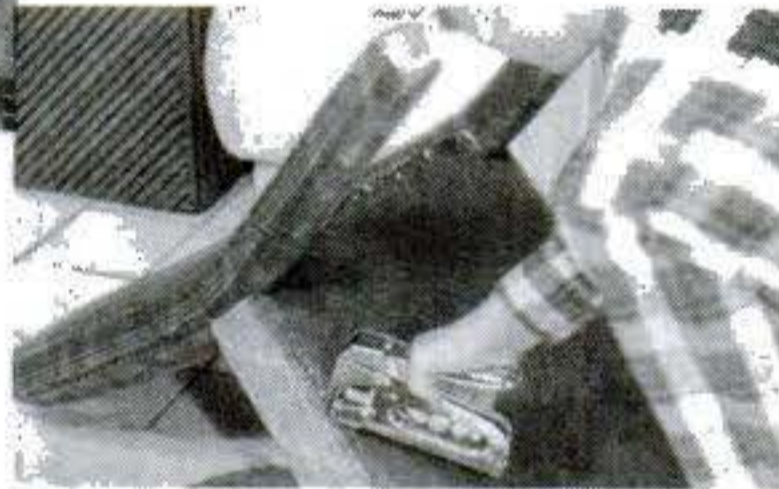
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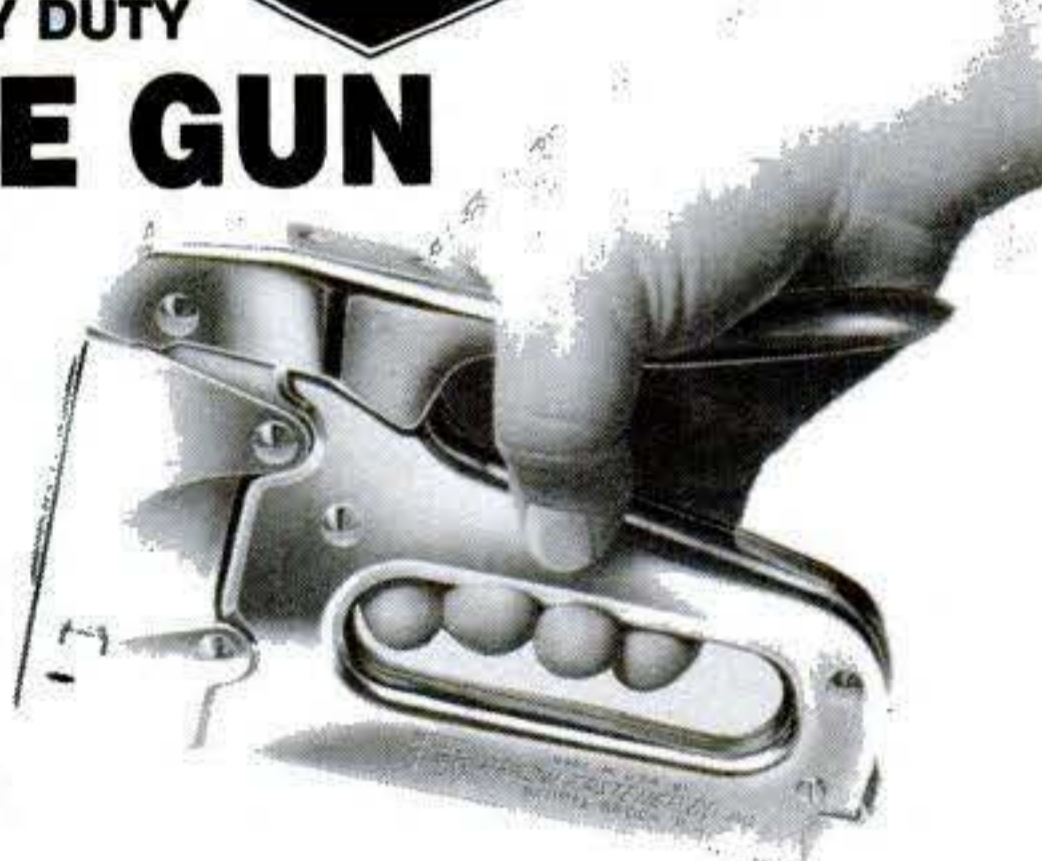
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Life in space

with children in Boston, the chance that a baby was born last night is very, very slim. So if we grant these assumptions, we have to conclude that the galaxy is colonized now. The next question is one that has been making the rounds for a long time—the one attributed to Fermi: 'Where are they?'

"Some people have answered by saying they're going around in flying saucers or they built the pyramids, but there has been no scientific evidence for these notions. For the time being it does appear that we are indeed alone. There are several hypotheses to account for this observation:

"1. They are in fact around but they don't want to interfere with us, regarding Earth as a kind of zoo or preserve.

"2. Perhaps they are not communicating with us because they don't know whether we are some kind of cosmic disease that should be eradicated or promising youngsters that should be helped to join the galactic club. Maybe the ethic of cosmic civilization is to leave us alone to demonstrate which we are. I have myself suggested this possibility.

"3. Most likely," Papagiannis continues, "they are not around to contact us, although we can't completely exclude hypotheses 1 and 2. The next question is, what is so special about Earth that made us develop a technology here but nowhere else?"

There are two possible answers, both somewhat chilling. They are, according to Papagiannis:

"1. Intelligence leads to technology, but civilizations with advanced technology simply don't last very long—they end up destroying themselves. Then it would not be surprising that there were no colonizing civilizations—they self-destruct before they start. Such civilizations could have appeared and disappeared many times in the history of the galaxy—like shooting stars, just a flicker and then out.

"2. Another possibility is that because of the very long time that it takes life to evolve—four billion years on Earth from the first appearance of life until technology appeared, a substantial fraction of the age of the universe—conditions on a planet may change to become unfavorable to life rather than hospitable. It's possible that on many planets life appears and begins evolving, but then conditions change for the worse. For example, water freezes or boils, and evolution is interrupted."

Hide and seek

What if extraterrestrial beings exist but have chosen not to show themselves? "Then it won't be long before they have to, or we will find them," Papagiannis explains.

Papagiannis has suggested that it would be worthwhile to search the asteroid belt for possible extraterrestrial colonies: "This is based on the assumption that if they have colonized the solar system, they would probably have parked their space habitats somewhere in the asteroid belt to be close to the least expensive and most plentiful source of raw materials. They could establish a perfectly self-sustaining colony there.

"Out of all the confusing arguments put forward," adds Papagiannis, "no one has come up with a statement that has convinced everyone. I think that in the next 10 or 20 years we will either have detected some sort of signal from SETI, or we will begin to accept the fact that we are alone in our galaxy. If the latter happens, it shouldn't be considered a failure of the process. To know that you are the only technologically advanced civilization in the galaxy is important. It would also have some effect on our own future behavior. Knowing we are the only ones might make us realize that we are too valuable to destroy." PES

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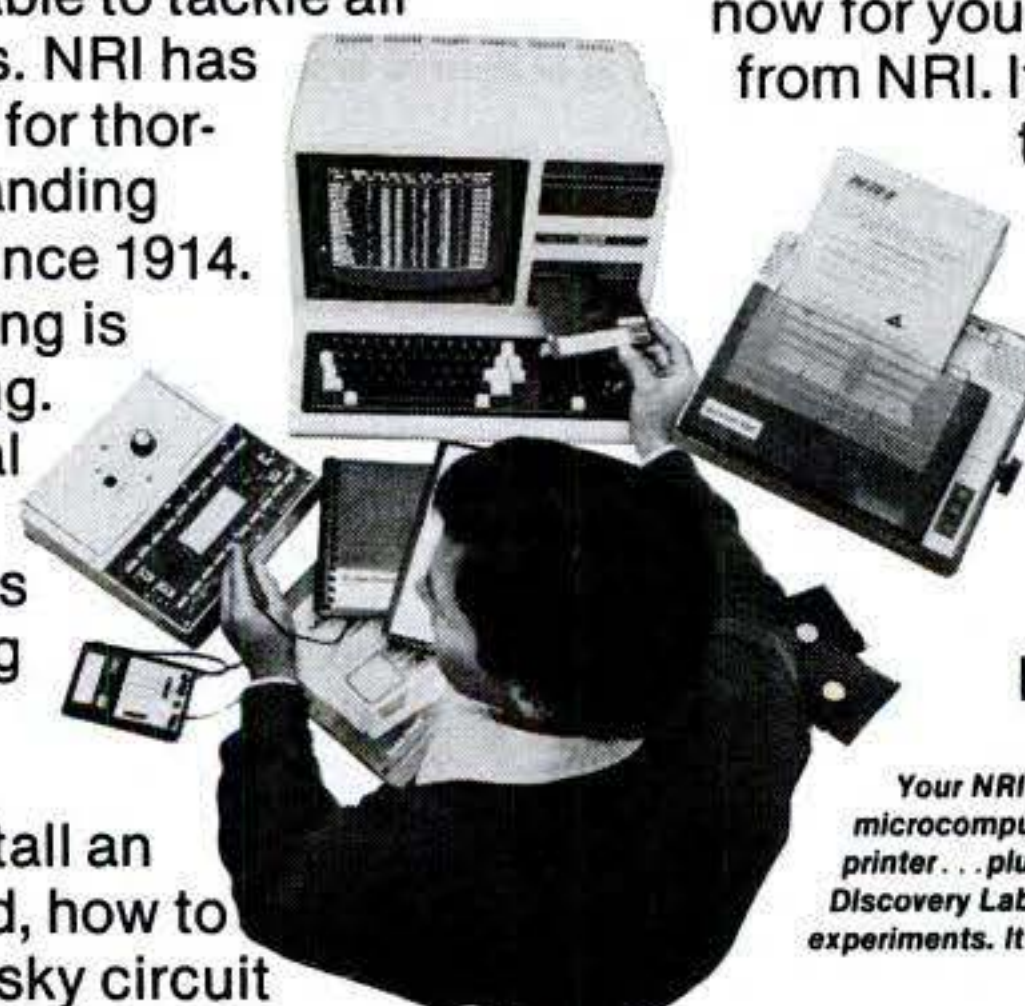
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Through the Viewfinder

By EVERETT H. ORTNER



Now: an AF lens for any SLR

With those wonderful do-everything compact autofocus rangefinder cameras [PS, Dec. '83] practically a dime a dozen (anyway, frequently under \$100 in discount stores), you may have wondered why the big guns of the 35-mm world, the single-lens reflexes, haven't all switched to automatic focus. Two reasons: complexity and cost.

Both Nikon, with its F3 AF ["Viewfinder," PS, June '82], and Pentax, with its ME-F ["New Autofocus SLR," PS, Aug. '82], have developed autofocus SLRs. But in both cases the combination of a special camera, with a built-in autofocus sensor, and a special lens, with its own focusing motor, made a cumbersome package.

Now Vivitar, that enterprising West Coast company, has combined the two elements—sensor and motor—in one unit: a well-designed 200-mm telephoto lens that can convert most popular SLRs to autofocus. At its heart is a Honeywell TCL (for through-the-camera-lens) system, the SLR counterpart to Honeywell's seven-year-old Visitronic system for cameras with the shutter in the lens ["Viewfinder," PS, Dec. '77].

Every image that enters a camera's lens has a signature—a composition of light and dark elements. The Visitronic system compares the signatures entering through two windows in a rangefinder camera and racks the lens forward or back until the signatures coincide. The TCL system com-

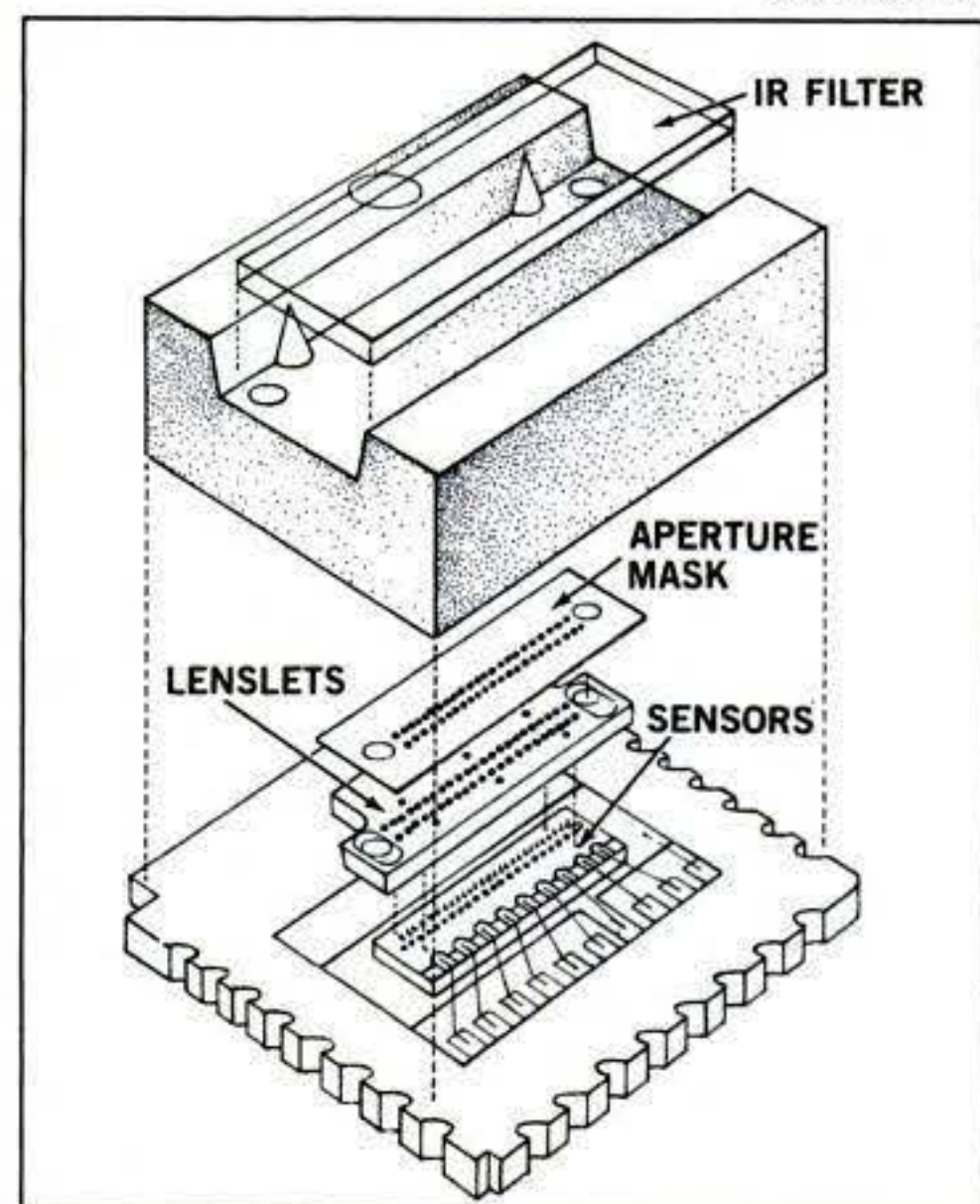
pares the signatures of light passing through different segments of the lens. The system's developers, Norm Stauffer and Denny Wilmerding, explain it this way:

"Light from each point in the object arrives at the film plane at many different angles. Light from every point in the object passes through every sector of the lens, but the image contributed by each sector to the film is displaced from the others if the lens is not in focus....The signatures of light from different areas...will be similar but relatively low in contrast, and one will be shifted from the position of the other. As the lens is brought into focus, the signatures display sharper peaks and valleys, become more nearly identical, and move toward superposition."

Inside the Vivitar lens a slitted mirror routes a fraction of the image to a Honeywell TCL detector module (drawing below). Here, with the IR portion filtered out (most lenses are not corrected for aberration at IR wavelengths), light is directed through an aperture mask to a series of microlenses, and then through a sensor die with paired openings to a detector array. The light has now been converted to two electrical transcriptions of the luminance (light-dark) variations across one line of the image. These variations, via a series of electronic and mechanical commands given every 50 milliseconds, determine the focus of the lens.

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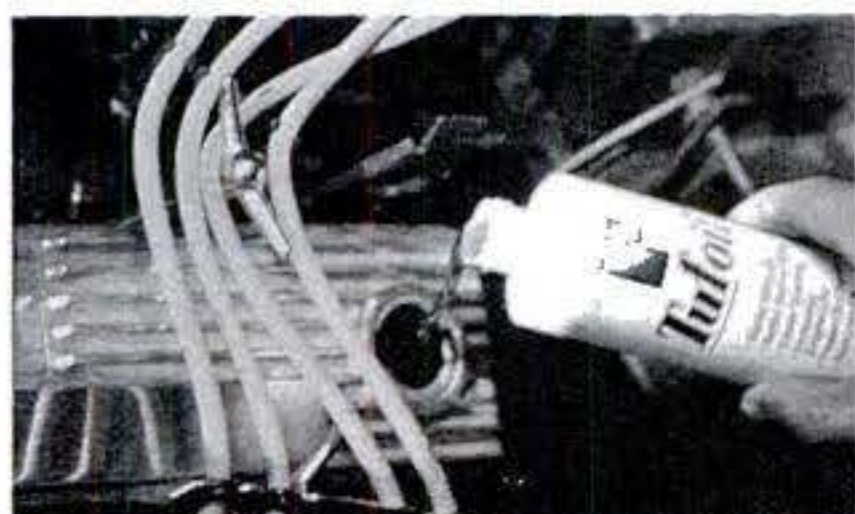
Less friction means your engine runs cooler. During hard summer driving, temperatures don't build up as high in a TUFOIL-protected engine. When you shutdown and try to restart, TUFOIL prevents overheated parts from clamping together to give you hot-start problems.

Less friction helps in winter too. TUFOIL'S slippery coating lets your engine turnover easier on sub-zero mornings. Your battery and your starter last longer.

...And, of course, with less friction eating up your engine power, TUFOIL **saves you gas.** How much depends on the condition of your car and how you drive. Some old-car owners report gas savings that even we have trouble believing. Static tests done by researchers at the University of New South Wales in Australia found TUFOIL gave fuel savings of up to 7%.

Satisfaction Guaranteed

If TUFOIL doesn't do what we say it will do for your engine, just let us know for a complete refund.



How Do We Back Up Our Claims for TUFOIL?

Well, there's those Australian tests, and they were required by the government, which looks into all product claims to protect their consumers.

But there's more.

Popular Mechanic's test team found that TUFOIL was the **"super-slick lubricant that does what it promises."** They reported fuel savings of 10.3% for one test car. **"Absolutely spectacular," they said.**

Israeli researchers at the Technion Research Institute, who were looking for a reliable lubricant for scorching desert driving, found that TUFOIL kept a test engine's heat at safe levels no matter how fast they turned it over—saved fuel, too.

Stationary engines used to pump natural gas in Texas are **lasting more than twice as long** and running cooler on hot summer days. A big toymaker now claims he produces the fastest toy cars in the world after he put a drop of one of our TUFOIL derivatives, "Lubit," on each wheel bearing. Machine tool users report vastly improved bearing life on heavy grinders with another TUFOIL derivative, "Lightning Grease," according to Design News magazine.

The most Important Group of All — Our Customers

Here is what they say: Their letters come in from all over the world. From Cinnamon, N.J., a father reports that the engine of his son's 1979 Maverick "performs as good or better than when it was new." A salesman who covers the upper Midwest says he first started using TUFOIL in his 1976 Cordoba at 40,000 miles. He now is up to 110,000 miles and says **"it starts without any trouble at 20 below zero."** A Texas truck operator states "TUFOIL in his Kenworth and Freightliner added 100 RPMs to both, gas mileage was up 8%."

How To Use TUFOIL

Just add one 8-oz. container of TUFOIL to your standard crankcase. (It'll treat 4 to



6 quarts of engine oil.) If you want to super treat your engine, add two bottles! You will see the results in less than 1,000 miles. Once your engine is broken in on TUFOIL, add 4 ounces (1/2 bottle) with each oil change to keep new performance levels. Use TUFOIL repeatedly over the life of your engine to help keep it purring like new!

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Viewfinder

is the lens? It focused rapidly enough for me to catch joggers in mid-stride and even helicopters landing and taking off near historic Pier A at New York's Battery Park. Fast-moving cars or motorcycles? No. The lens couldn't focus fast enough. Useful? Yes, if you wish to be relieved of the nuisance of constant focusing and refocusing—taking pictures of a wriggling baby, for example, or of friends at a boating party. There are two autofocus modes—one for stationary subjects (with a beep tone to tell you when you're in focus) and one for tracking moving subjects and shooting with a motor-drive camera.

The Series I 200-mm f/3.5 lens weighs 26.4 ounces with its three AAA batteries—which, says Vivitar, will see it through 40 rolls of 36-exposure film. Besides which, you can focus the lens manually in case of battery failure. List price: \$750.

Snapshots

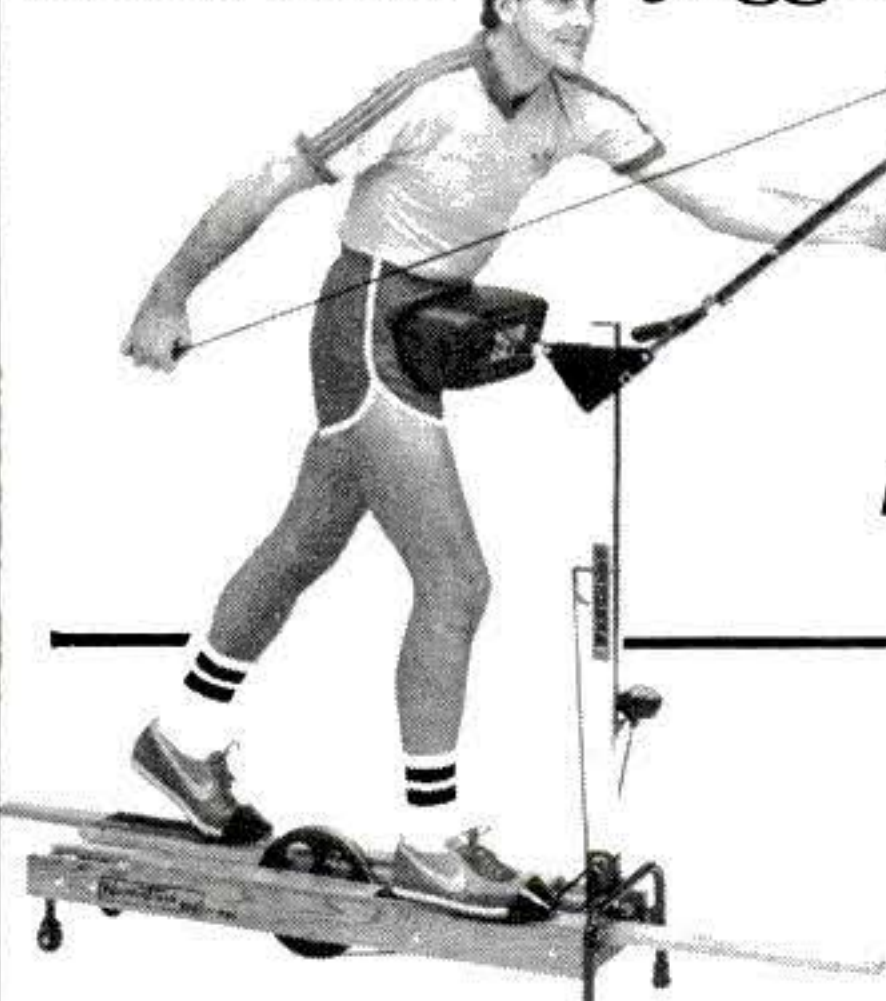
- Remember electrically coded film [PS, June '83]? The DX code (current name for the system) was introduced by Kodak for its Kodacolor VR films and Kodachrome Professional 64. Right now, its main use is to ensure accurate sorting in the processing labs (so your Kodachrome film doesn't go into the Kodacolor tub) and optimum processing. But of course it could also be used to set the ASA of your camera automatically. By now, all of Kodak's 35-mm film should bear the DX coding. And other manufacturers are following: Both Agfa and Fuji started to add DX to their films in June.

- The first cameras to use the DX code are Pentaxes, according to the maker, Asahi Optical Corp. They are two Pentax Autorons, completely automatic, including focusing, that went on sale in Japan this summer.

- Professional photographers who use Nikons and own computers now have their own network. Called Photonet, it links Nikon Professional Services via local phone numbers, coast to coast and in 30 countries. The address: Photonet Computer Corp., 250 W. 57th St., New York, N.Y. 10019.

- If you're like me and tend to squirrel your color film away in the fridge for use even after its expiration date, don't do it with Kodacolor VR 1000 film. The reason: Tests show, according to Kodak, that when the supersensitive film is used after its expiration date "it may show excessive grain due to the effects of cosmic and gamma rays that are around us everywhere." PS

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Fuel-cell power for electric cars

The solid-polymer-electrolyte fuel cell powered the Gemini spacecraft flights in 1963. Now it's being considered as an economical alternate energy source for automobiles.

By JOHN CONWAY

A battery powers an electric motor; the motor turns the wheels for clean, efficient, gasoline-free transportation. That's the marvelously simple concept of an electric car, but it is still far from reality.

A new power source is needed. Conventional wet cells are expensive. Also, because they use a liquid electrolyte, they're prone to corrosion and leakage, which limits their life expectancy and makes them potentially hazardous in an accident. Though many new sources are under study [PS, Oct. '80, April '81], perhaps a relatively old idea—the

solid-polymer-electrolyte (SPE) fuel cell—may be the answer.

"The SPE fuel cell has been under development since the mid-1950s," says L. J. Nuttall of General Electric's Aircraft Equipment Division. "But only now has it been considered an economical alternative to the gasoline-turbine or internal-combustion engine."

The SPE fuel cell powered the early Gemini spaceflights. Its solid electrolyte is safe and virtually corrosion-free, giving it a life expectancy that far exceeds the 5,000 hours needed for a passenger car.

Nuttall and his associate, James F. McElroy, believe that newer designs

can create a less-expensive cell that meets the power, size, and weight requirements for small cars. But they warn that although research and testing at GE under a contract with the Los Alamos National Lab show great promise, much remains to be done.

Inside the cell

To make a battery (or a cell within a battery), two dissimilar, electrochemically active materials are needed to form the anode and cathode terminals. In a lead-acid battery, for example, lead and lead dioxide are used. As one terminal gives up electrons, the other accepts them, and ions are passed internally through an electrolyte—sulfuric acid—to complete the circuit.

In an SPE fuel cell, hydrogen and oxygen are the active materials, and a solid ion-exchange membrane forms the sole electrolyte. Because no liquid is used, leakage and corrosion are eliminated.

The electrolyte is a solid sheet of plastic somewhat similar to the silicon compound used to coat cookware. Sulfonating the plastic gives it the ability to conduct hydrogen ions. And because the sheet is solid, it can provide a high electrical efficiency and serve as a barrier between the hydro-

Continued

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Fuel-cell power

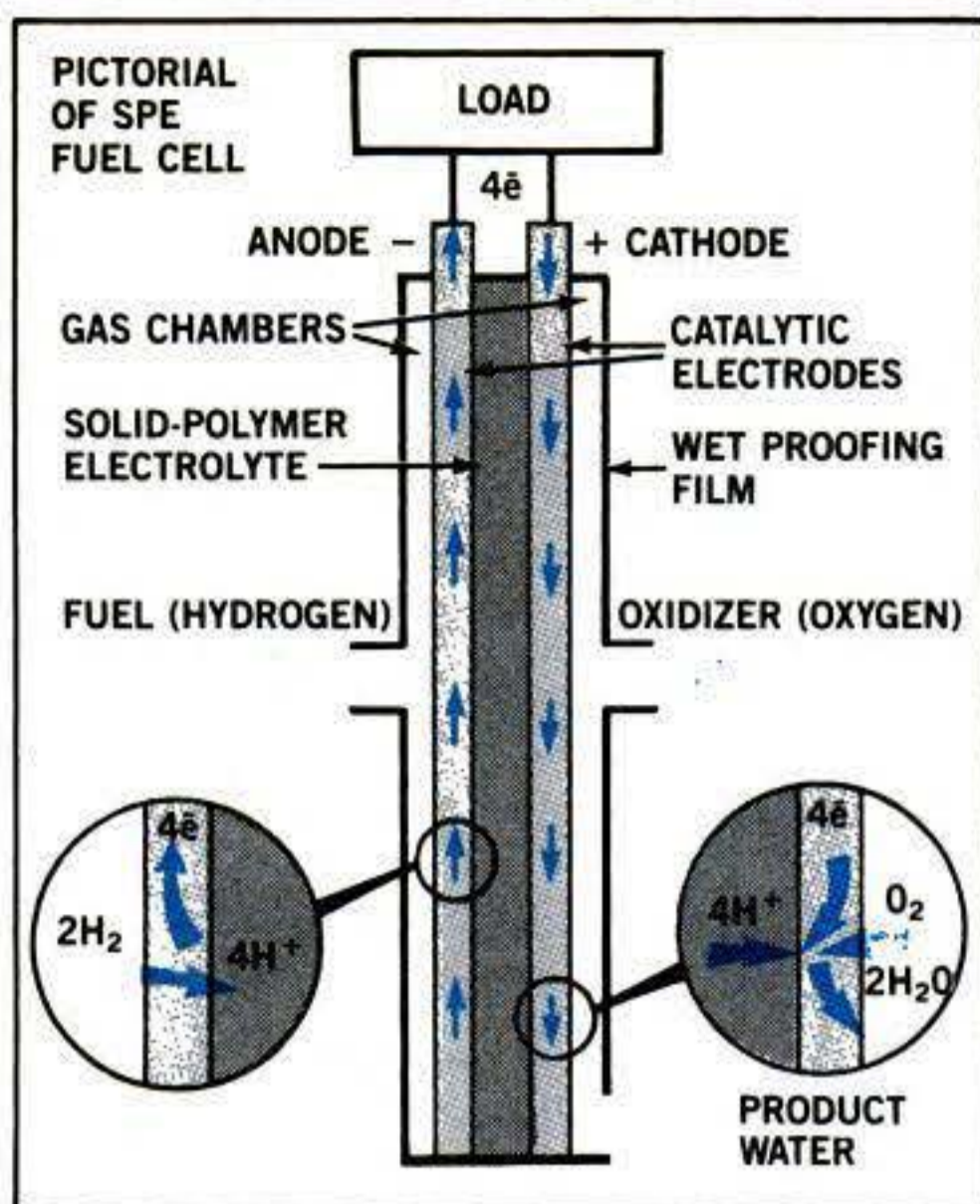
gen and oxygen reactant gases as well.

The hydrogen required by the cell is created by heating dry methanol stored aboard as fuel for the vehicle. The heat required comes from the cell itself.

"A small amount of hydrogen and oxygen is stored aboard the vehicle for start-up," explains Nuttall. "The reaction within the fuel cell produces waste heat and water. The dry methanol is then vaporized by this heat and passed through a catalytic cracker, which dissociates it into hydrogen and carbon monoxide. It's then humidified with the product water to form a three-to-one ratio of steam to carbon for use in a shift reactor. The reactor converts the carbon monoxide into carbon dioxide and water."

The mixture delivered to the fuel cell is approximately 75 percent hydrogen, 25 percent carbon dioxide, and less than 0.2 percent carbon monoxide. Most of the hydrogen is consumed by the fuel cell in producing the electrical power for propulsion of the vehicle. A small amount of hydrogen and carbon dioxide is combined with primary combustion air to fuel the burner used in the methanol cracking.

A compressor provides the 150-psi air pressure for the cathode reaction. But because it's powered by expansion



of the cathode exhaust gas and the waste heat generated by the system, there is no need for external power.

The cells have been tested for more than 60,000 hours with little change in performance. Simulated testing (performed on a computer) of the cell in a General Motors X-car and a GE-Chrysler Electric Test Vehicle have coupled the fuel cell with a 20-horsepower electric motor. The cell performed well enough (zero-to-50-mph acceleration times of 12.1 and 10.2 sec-

onds and fuel consumption equivalent to 55 and 66 mpg of gasoline, respectively) to compare favorably with diesel and spark-ignition versions of the X-car.

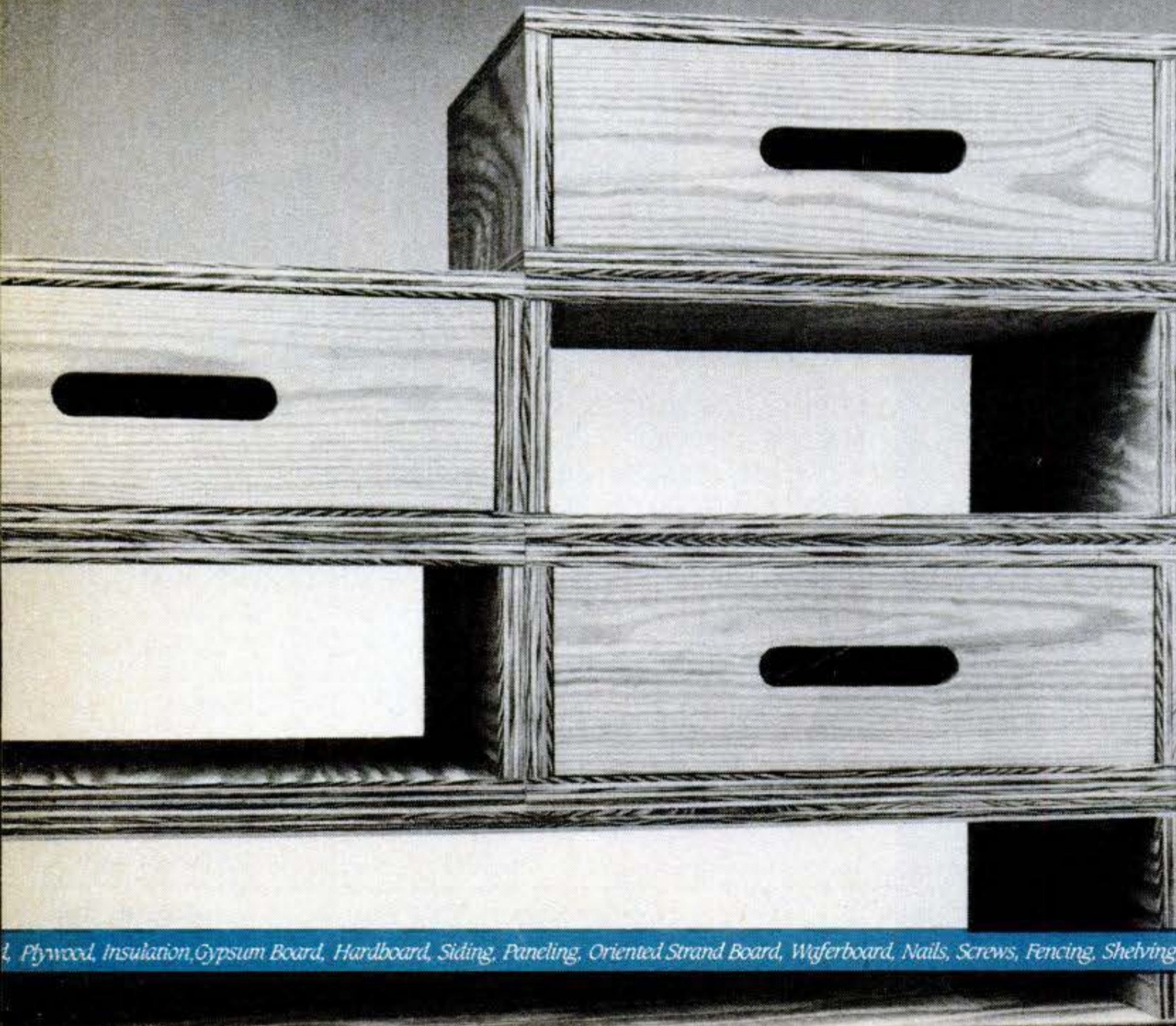
The top speeds attained in the tests (70 to 80 mph) were determined by the motor and controller characteristics and by the final drive ratio. But, says Nuttall, "Research shows the fuel cell can provide enough power for substantially higher speeds."

Both Nuttall and McElroy caution, however, that cost is still a factor in determining the ultimate feasibility of the fuel cell for use in an automobile.

"For the SPE fuel cell to be competitive," says McElroy, "it must have a capital cost considerably less than \$200 per kilowatt." Nuttall and McElroy believe that significant savings will come by reducing the amount of platinum (used as a catalyst) from eight grams per square foot down to 0.75, and by changing the electrolyte film. (It's now good for 100,000 hours of use when only 5,000 hours are needed.) But that will also take time.

While McElroy says, "A power plant that will meet the performance, size, weight, and cost objectives of the auto makers is possible," Nuttall adds, "It will take several more years of comprehensive development effort." **PS**

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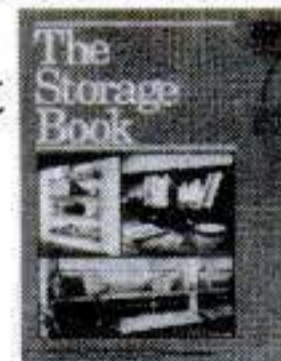


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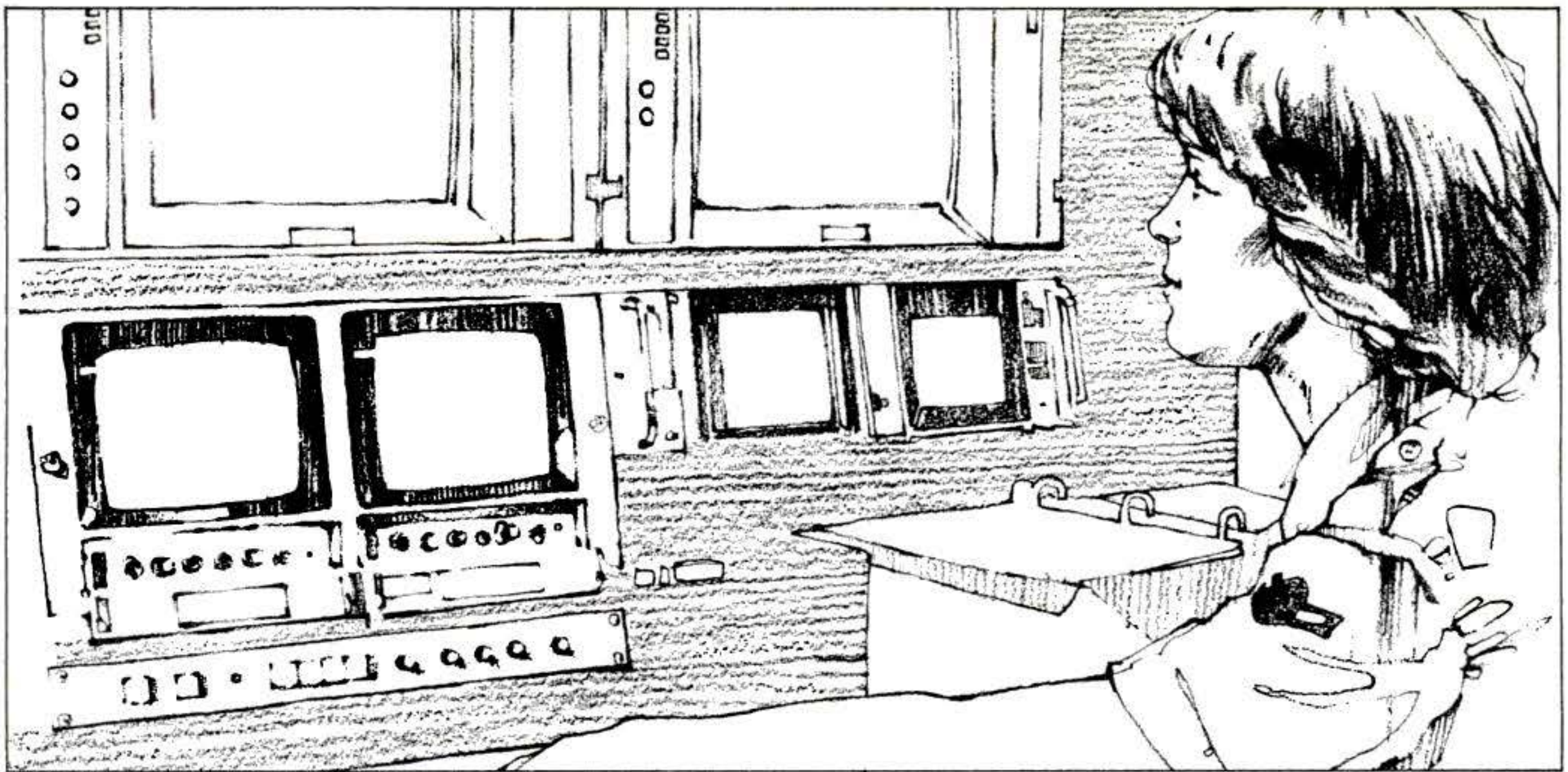
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ENUMCLAW, WASH. Slogging along logging trails axle-deep in mud can reveal interesting things about a four-wheel-drive.

I found that it's back to basics with Isuzu's new Trooper II utility vehicle. Under Trooper II's welded steel body is a conventional ladder frame. The front suspension is a fully independent system with torsion bars and wishbone arms. In back, there's a leaf-spring setup with a semi-floating rear end and stagger-mount shock absorbers. The braking system consists of 10.6-inch ventilated front discs and 10-inch drums mounted on the rear axle. Troopers are shod with P225/75R15 tires mounted on white spoke-type steel wheels. Although conservative in design, this setup provides a taut but not uncomfortable ride with good handling and sure-footed braking, despite a healthy ground clearance of 8.3 inches.

The engine is a 118.9-cu.-in. in-line



SOHC four-cylinder. Although the block is the usual cast iron, the head is an aluminum cross-flow type. A two-barrel carburetor rides atop the intake manifold. This configuration develops a modest 82 hp at 4,600 rpm and 101 ft.-lbs. of torque at 3,000 rpm.

The four's power proved adequate on the muddy off-road sections of my test drive, but the taller highway gearing made maintaining my position in four-lane traffic difficult, even with frequent downshifts.

Fortunately, standard equipment is a smooth-shifting four-speed manual box with an integral two-speed transfer case. The front hubs are the automatic-locking type. Shifting into 4WD and moving forward engages them.

Shifting out of 4WD and backing up three to four feet disengages the hubs. This enables the vehicle to get better fuel economy and reduces wear on the front axles and differential. (EPA figures for the Trooper II: 21 mpg in the city, 27 on the highway.)

The Trooper II's appearance is boxy. There are only a few curves in the sheet metal, and the glass, including the windshield, is perfectly flat. That should make replacement easier and cheaper. Except for a few decals, there's virtually no exterior ornamentation. Three underbody skid plates protect vital internals from damage, so Trooper II should slip through the rough stuff with its mechanicals intact. The price: a basic \$8,683.—*Jack Keebler*

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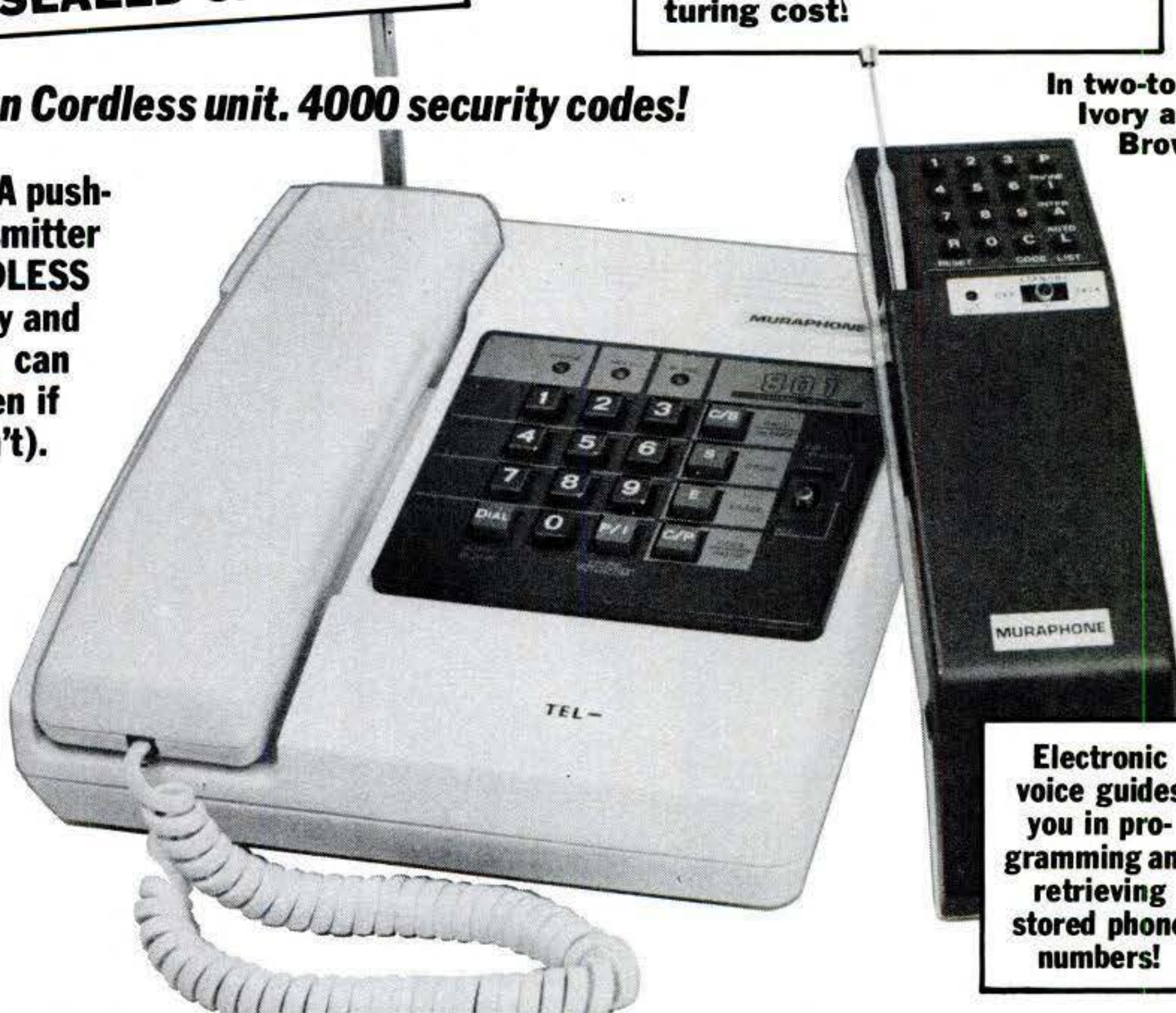
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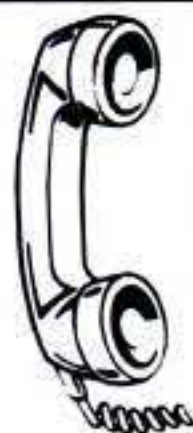
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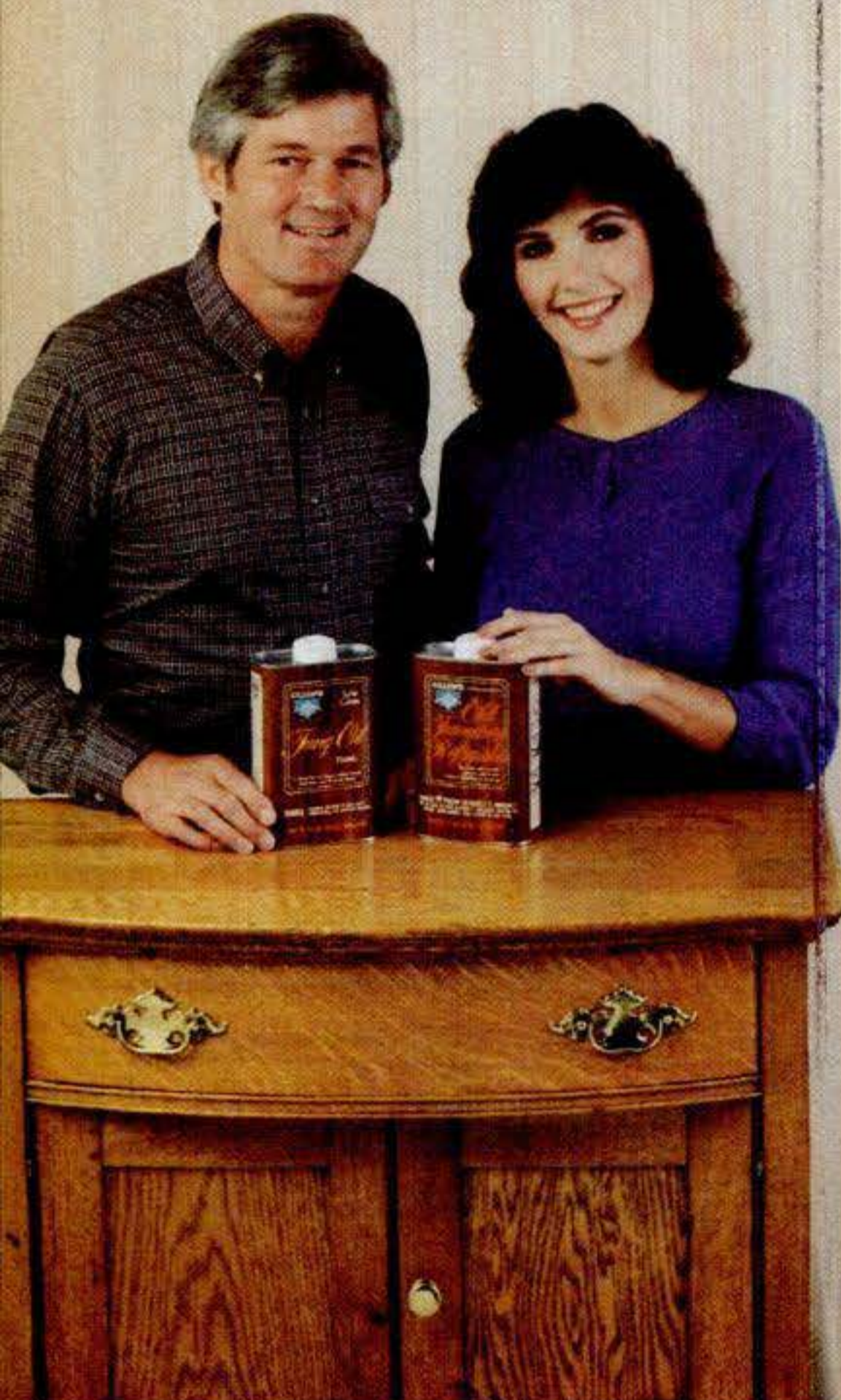
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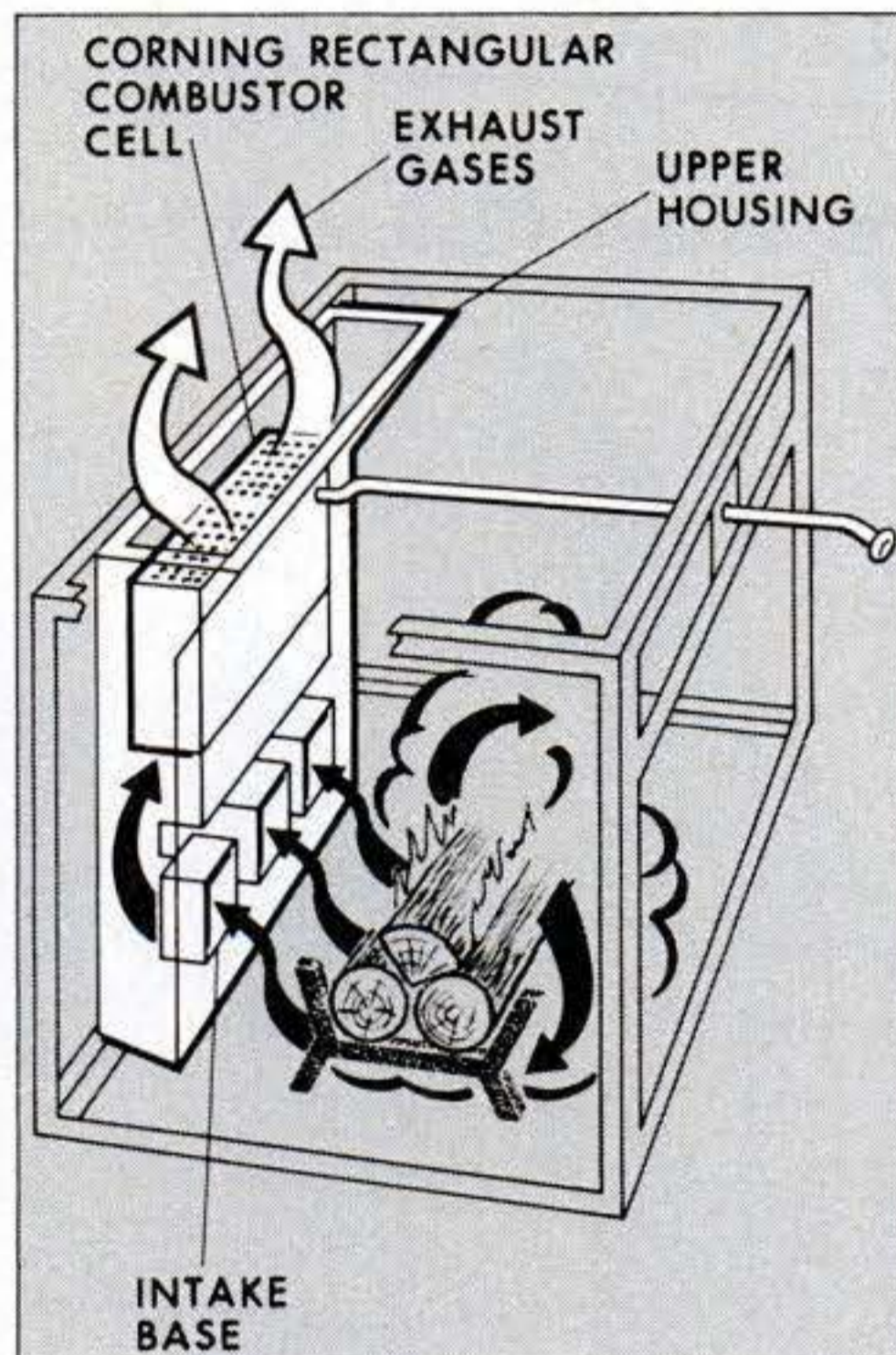


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Add-on catalytic combustor for wood stoves



If you own a woodburning stove or fireplace, you know that the smoke going up the chimney represents heat lost and energy wasted. Smoke also suggests the danger of creosote buildup.

The solution to those problems could be a catalytic combustor [PS, Jan. '82]. But attempts at retrofitting these devices to stoves lacking them have come up short in all but two cases [PS, March '82].

Now there's Smoke Genie, a combustor that can increase your stove's efficiency by 20 percent, and drastically cut creosote buildup by 90 percent and emissions by 75 percent, according to Arden Industries (951 Sand Hill Rd., Asheville, N.C. 28806). The Genie, which sells for \$200, fits against the flat back of fireplace inserts and many wood stoves.

The catalytic combustor, first developed by Corning Glass four years ago, burns and processes smoke. In the Genie, smoke recirculates down through the fire and enters smoke inlets at the base of the unit. The circulation ensures that the smoke is at its hottest and is rich in carbon dioxide and heavy hydrocarbons, the sources of pollution and creosote buildup (the major cause of 100,000 chimney fires a year).

Smoke represents heat potential; reheated smoke will light off the com-

burner at 500 degrees F with the least amount of fuel. (A conventional stove would need to be heated to 1,000 degrees F to burn smoke.) With the combustor on, the heat yield will be higher, and the burn rate will also be more even. If you've been burning five cords of wood during the winter, for example, you'll get the same heat from four, and you'll only need to feed the fire twice a day.

Less wood and a more-consistent burn rate translate into less time at the woodpile, which means you may not notice the greatest benefit of the catalytic combustor: the absence of billowing smoke from your chimney. That's because carbon dioxide and heavy hydrocarbons have been converted primarily into carbon monoxide and water vapor by the combustor.

There are three basic parts to Smoke Genie: the upper housing and damper assembly, made of heavy-gauge low-carbon steel; the damper handle; and the ceramic base and smoke inlet. The housing can fit anywhere from one to 1½ inches over the refractory base, and the two parts need to overlap only ½ inch. The elasticity of fit compensates for the variation among stoves. Before you begin installation, measure the distance from the damper opening at the back of your insert to the floor, and check this against the height of the Genie. If the unit isn't tall enough, adapter bases are available.

Removing the damper is the first step in installation. This may entail nothing more than removing a bolt or two. In some models, such as the Buck stove that served as my guinea pig, it is necessary to cut one of the hinge pins on the side of the damper. Use a close-quarter hacksaw or a jigsaw or reciprocating saw with a metal-cutting blade.

Insert the Genie, base first, against the rear wall. Tilt it upward until the combustor housing is just below the damper opening. Use the bolt supplied to secure the unit snugly against the opening.

Your stove or insert must be airtight to ensure maximum efficiency, so check the doors, gaskets, air intakes, and other areas that might leak. Also, seal the housing to the refractory base.

—Evan Powell

Open-and-shut roof for sports stadium



Baseball fans hate to watch their team play under a roof. At least that's the contention of Space Structures, Inc., of Plainview, N.Y. So to please Toronto baseball fans—and summer concert-goers—without offending hockey fans, the firm suggests that the city build a sliding roof stadium.

Like many other modern stadiums, the proposed Stardome (top photo) is capped by a dome—a 765-foot-diameter aluminum space frame. Standard insulated aluminum decking covers the outer three-quarters of the dome. At its center, translucent vinyl-polyester fabric stretches across six aluminum segments.

In warm weather the pie-slice sections slide back onto curved rails (photo above), opening the dome to the sky. The spectators are shaded while the baseball team plays the game in old-fashioned direct sunlight. The roof can close in as little as eight minutes, so there should be no rained-out games.

Stardome's retracting roof has additional advantages. It cuts lighting and cooling costs, and it's cheaper and more durable than the air-supported fabric roofs now used to cover large stadiums, its developers claim. —Susan Renner-Smith

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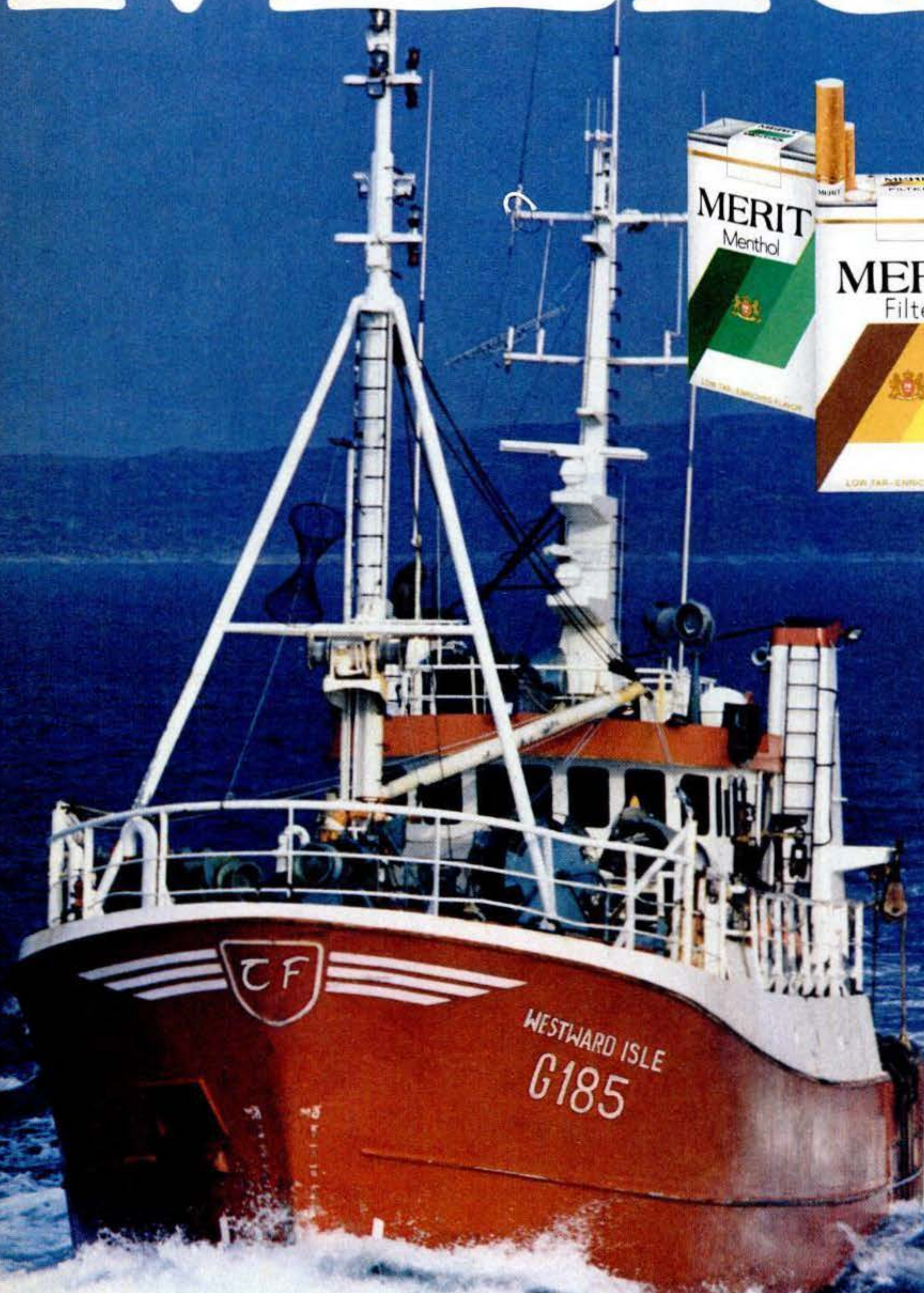


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What's News

Are we alone in the universe? It's a question that's been asked almost ever since our ancestors first looked into the sky and wondered what it all meant. Now for the first time we're going to make a serious effort to answer the big question.

The first attempt to tune in on radio signals from other races—if any exist—was made about 25 years ago. But it was a small effort. Now scientists around the world are pooling their resources and preparing for an all-out 10-year search. If there is anything there, they'll have a good chance of finding it.

To do the job, they're designing the world's most powerful and sophisticated computerized receiver. It will be able to monitor millions of channels simultaneously and spot any patterns that would be characteristic of signals designed to communicate between intelligent beings. Such receivers will be hooked to the most powerful radio-telescope antennas, including the world's biggest at Arecibo, Puerto Rico. The details are in Arthur Fisher's report elsewhere in this issue.

Computer setback

With the constant stream of successful developments in science and technology, we sometimes lose track of the fact that things don't always go well. A case in point:

A couple of years ago a highly successful computer designer named Gene Amdahl announced that he was developing a super-sized computer chip [PS, Jan.]. Most chips are made by manufacturing dozens of chips simultaneously on a piece of silicon several inches in diameter. They're tested individually, then cut apart. The good ones are kept and the bad ones discarded. Then good ones are wired together into complex circuits.

Amdahl decided instead to make giant chips containing dozens of smaller chips on a single piece of silicon. They would already be connected, thus eliminating all of the sawing and reconnecting. They would also operate

much faster than conventional circuits.

Amdahl called the new process wafer-scale integration. And with it, he said, he would leapfrog current technology and build a main-frame computer faster, smaller, and cheaper than those produced by his giant arch-rival, IBM. He would do all of this, he said, by 1985. He easily raised some \$200 million from those impressed by his previous track record and went to work.

Alas, all has not gone well. First, an aluminum alloy selected for making the super-thin connections on the wafer didn't work, and short circuits were developing. But more important, the basic strategy went wrong. To save time, Amdahl had had his engineers design the final computer at the same time other teams were developing the wafer that would make up the central processing unit. Problems cropped up with the wafer design, and it turned out that some sections would have to be split and put on two wafers. This meant that much of the increased speed he had expected would be lost. At the same time many wafers had to be redesigned—a time-consuming process. That won't be over until at least the end of this year.

Faced with these difficulties, Amdahl recently announced that plans to market a computer have been scrapped completely. He will concentrate on the trouble-plagued wafer-scale-integration project. He hopes to have it on the market by 1986—a year after he had originally predicted he would have developed both the chip and the computer built around it. Unfortunately that may be too late, even if he succeeds. Many other companies—including IBM—are also working on wafer-scale integration. And by the time Amdahl can get on the market, others may have similar or even faster chips available.

The fifth generation

When Japan's Institute for New-Generation Computer Technology launched what quickly became known as the

fifth-generation computer project [PS, April '83], there were three main goals to be accomplished. First, a method would have to be devised for the machine to communicate with human beings by speaking, writing, or drawing. Second, there would have to be a new kind of computer architecture that would allow the computer to solve problems the way human beings do: by deduction, by inductive inference, and by making informed guesses where information is missing. And third, something would have to be devised that would store a knowledge base: huge amounts of information, judgments, test results, and so on.

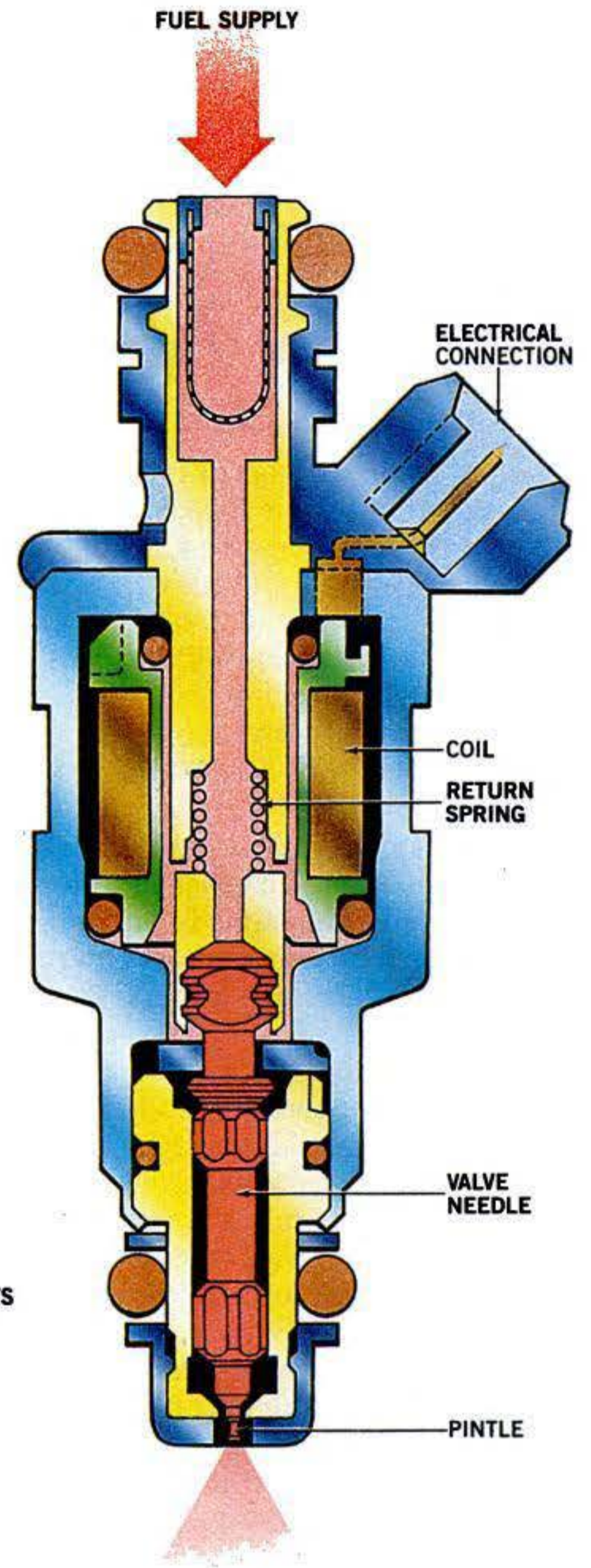
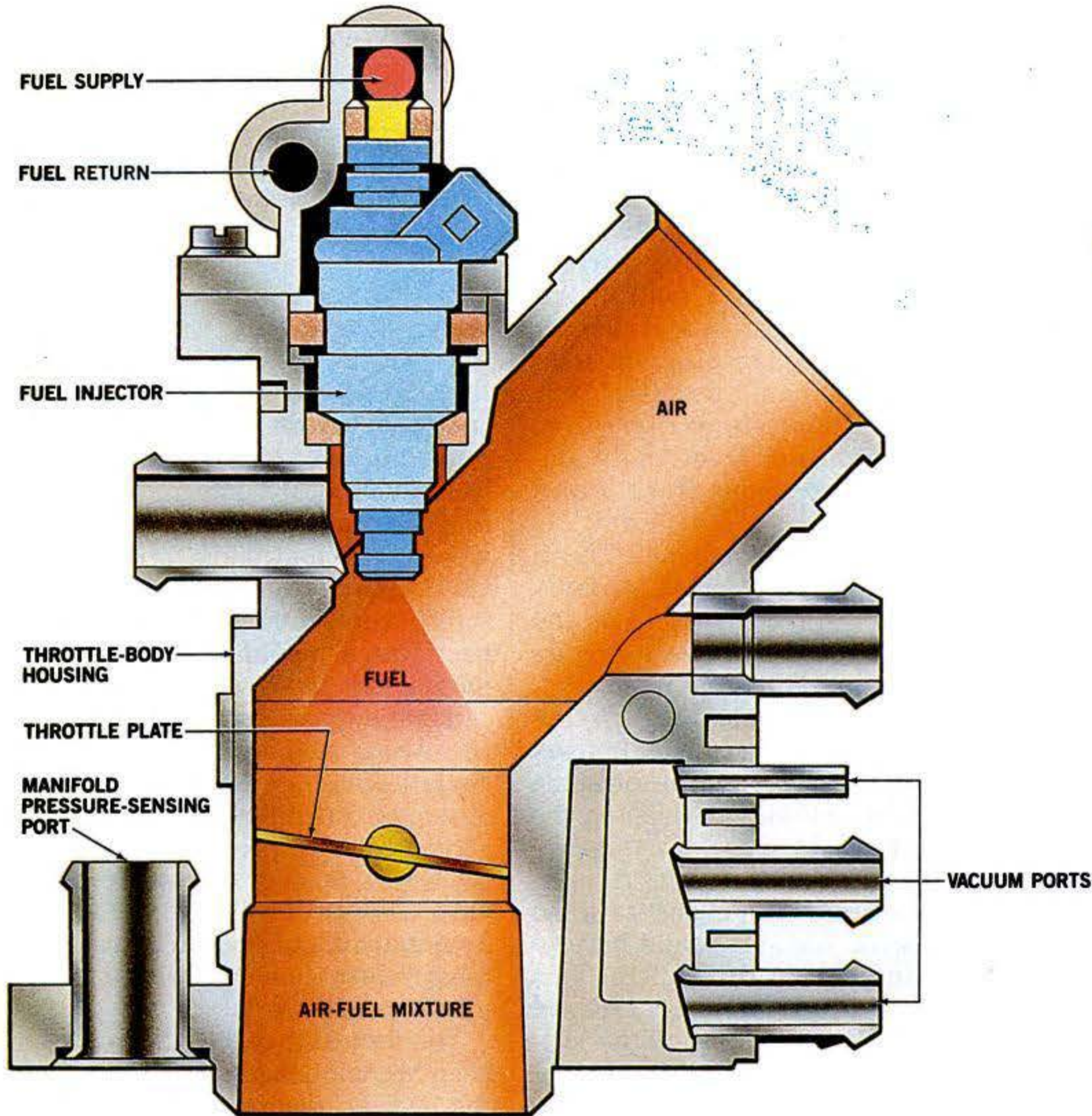
Some months ago the hardware for the second step above was completed. Project scientists built what they call a sequential-inference machine designed to solve problems the way we do. Now a team of 45 researchers has built what they call a relational database machine to store and process the huge information base with which the machine will work.

The fact that two of the goals have been accomplished doesn't mean that the 10-year program is running ahead of schedule. In fact, what has happened so far is the easy part. The development of the first two pieces of hardware can be looked on as the preliminaries needed before the researchers could really get to work on the major problems.

The attempt to build an intelligent machine, meanwhile, has turned into an international race. Since Japan announced the project several years ago, other advanced computer projects have been started in the United Kingdom, France, West Germany, and the United States. We'll be watching the results in years to come.


Editor-in-Chief

THROTTLE-BODY FUEL INJECTION



Single-point fuel-injection units are simple by design. The throttle-body unit mounts on virtually the same type of intake manifold used by the more conventional carburetor. Although the carburetor depends on air being drawn into the cylinders to meter the fuel, the throttle-body unit relies with greater accuracy upon an electrical signal sent from the computer. The signal is based on inputs from engine sensors that measure coolant temperature, manifold pressure, vehicle speed, exhaust-gas oxygen content, and airflow mass.

Detroit switches to electronic fuel injection

Fuel injection was once used almost exclusively on expensive sports and luxury cars. But low-cost electronics and tightening exhaust-emissions standards have changed the picture. Detroit is switching to electronic fuel injection: By mid-decade it will totally replace the carburetor, even on the least-expensive subcompacts.

By **THOMAS RANDOLPH**
Illustrations by Russell von Sauer

It was on a sparkling, sub-zero Ohio morning last winter that I really learned to appreciate electronic fuel injection. It was so cold that I could hardly turn the key in the frozen door lock of the new subcompact. Once inside, my breath instantly frosted the windshield. But when I slipped the key into the ignition and twisted, the engine cranked for only an instant before revving smoothly, if a bit stiffly, to a fast idle.

I hadn't pushed the accelerator pedal to set the choke, much less pumped it furiously to prime the engine, as I would have done on some cars. I just turned the key, and it started. A few seconds later I eased out the clutch, gave the engine a little gas, and the car pulled smoothly onto the street, snow squeaking under the tires. It didn't buck, hesitate, or stall once. The reason? Electronic fuel injection.

Like most drivers, I used to think of performance cars when I thought of fuel injection: Ferraris, Corvettes, and Porsches. True, Volkswagens and some lower-priced imported sedans have been equipped with fuel injection since the late 1960s. But suddenly it seemed as if every U.S. maker was adding it to its everyday economy cars—cars like the Chevrolet Citation, Dodge 600, and Renault Alliance.

Why the sudden switch? I had certainly discovered at least one benefit of electronic fuel injection: better cold starting and smoother warm-up. But what else does this technology offer? What will the changeover mean for the average driver and for the U.S. auto industry?

One place I looked for answers was the Rochester Products Division of General Motors. For decades the name Rochester has been almost synonymous with carburetors. But now the company is rapidly becoming one of the world leaders in fuel-injection technology. Few people realize that Rochester has been involved for many years in the development of electronic fuel injection.

"In 1970 we worked on an electronic multi-point fuel-injection system," recalls Roland S. Taylor, chief engineer for gasoline and emissions-products design. "But we were unsuccessful as far as the marketplace was concerned. You couldn't justify the cost because you had to buy the electronics. The carburetors won out because they gave adequate performance for the least cost."

Tipping the balance

It wasn't long, however, before the new clean-air standards began to tip the balance. To control exhaust emissions, the air-fuel mixture fed to the engine had to be precisely controlled. If too rich (too much fuel and not

enough air), emissions of carbon monoxide and unburned hydrocarbons soared. If too lean, oxides of nitrogen and engine misfiring became a problem.

If the air-fuel mixture could be tightly controlled, exhaust emissions would be kept low enough so that a catalytic converter in the exhaust system could handle the light cleanup. But a typical engine operates under a wide range of temperatures, loads, and altitudes, all of which require subtle changes in the mixture ratio.

Toward a solution

Then, in the mid-1970s, two breakthroughs promised a possible solution to the mixture-control problem. The first, the inexpensive microcomputer, needs no further introduction. The second, the oxygen sensor, is less famous but almost as amazing. This hollow, platinum-plated ceramic probe can measure the oxygen level in the blazing 1,112-degree-F exhaust gas and then tell the computer whether the engine is running lean or rich.

If the air-fuel mixture is rich, there will be little oxygen left in the exhaust gas. Oxygen ions flow from the inside surface of the probe—which is exposed to the atmosphere—to the outside surface exposed to the exhaust gas. Just as in a one-cell battery, this ion flow generates a voltage (in this case about one volt).

Continued

"Throttle-body injection is cheaper"

When the mixture is lean, however, and there is oxygen in the exhaust gas, the ion flow slows, and the sensor output drops to nearly zero.

At first the engineers used the oxygen sensor to fine-tune the carburetor while the engine was running ["Feedback-Carburetor Systems," PS, Sept. '82]. The voltage signal from the oxygen sensor, along with data from sensors measuring engine temperature, speed, and manifold vacuum, was fed into the on-board computer. An input signal from the computer then adjusted a mixture-control solenoid in the carburetor body. However, because a carburetor is a maze of separate air and fuel circuits, this closed-loop control, as the engineers call it, is still something of a compromise.

"We went through the whole closed-loop interim because that was all we really had," says Taylor. "We had to respond very rapidly to the emissions standards. But we really felt that the carburetor wasn't the best way to meet the standards."

Moreover, the carburetor was growing increasingly complex, even without the addition of electronics. Owners were starting to complain that cars were hard to service and sometimes didn't run well no matter how often they were fixed. And because of the closed-loop systems, many cars already had small microprocessors tucked under the dash.

A love affair

Engineers love electronic fuel injection. The first time I picked up an injector—the part that actually me-

ters the fuel into the engine—I understood why.

The injector is nothing more than a solenoid-operated valve, small enough to fit in the palm of your hand. Although some precise machining is involved in manufacturing the valve, its operation is simplicity itself. There are inputs—information from sensors that measure things like engine temperature, load, vehicle speed, and exhaust-gas oxygen content. A program in the computer under the dash or in the kick panel then calculates the precise amount of fuel needed to give near-perfect combustion and sends a pulse of current to one or more fuel injectors. Supply the injector with fuel under pressure, zap the solenoid coil with about six volts of direct current, and you get precisely metered fuel. The length of the electrical pulse determines the amount of fuel.

"By switching to fuel injection and controlling one variable—the length of the injector pulse—we were able to do all of the things we needed to," Taylor explains. "Cold-start, warm-up, warm-running, power-enrichment, and altitude compensation—all of these can be done by simply adjusting the pulse width." Not only did more-precise fuel metering reduce exhaust emissions, it also did wonders for drivability.

Like General Motors, Chrysler also sees a big future for fuel injection. The company plans to switch its entire passenger-car line to fuel injection by 1986 or '87. "Why electronic fuel injection? Drivability—clean drivability," Bernie Robertson, chief engineer for power-train systems, emphasizes.

"It does give us some fuel economy. It does give us better performance. But the primary motivation is drivability and performance feel."

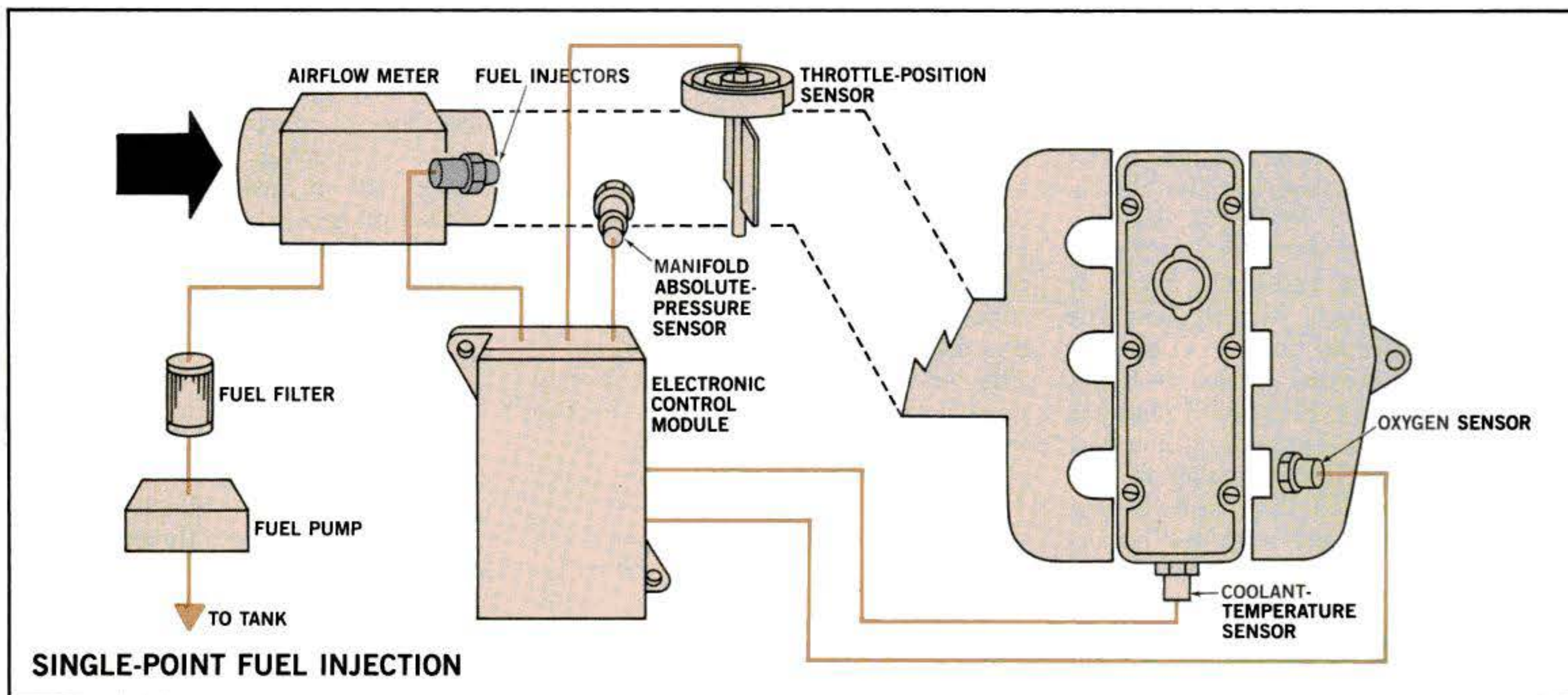
Two systems

In the switch to fuel injection at Chrysler and elsewhere, two basic systems have emerged. The first, called throttle-body injection, bolts onto a conventional intake manifold and looks much like the familiar carburetor. The throttle-body casting carries one or two injectors (depending on the fuel demands of the engine), a fuel-pressure regulator, an idle-speed control motor, and a sensor to tell the computer how far open the throttle is.

The second type, called multi-point, uses a separate injector for each cylinder. A throttle body in the intake passage houses the throttle plate, the idle-speed control motor, and some type of sensor to tell the computer how much air is being swallowed. But the intake manifold carries only air, not an air-fuel mixture as in a carburetor or throttle-body-injection manifold. Fuel from the individual injectors is sprayed onto the back of the hot intake valves just as the air enters the cylinders. This not only cools the valves but also ensures that the fuel is completely vaporized.

Each type of fuel injection has its advantages. Essentially, throttle-body is cheaper, and multi-point gives slightly better performance.

"There will be a division just like the one you used to see between two-barrel and four-barrel carburetors," Taylor predicts. "The car you drive to



"Multi-point gives better performance"

the drugstore and use to carry the kids to school—that's going to be a throttle-body car. On heavier cars, luxury cars, and sports cars, you'll see multi-point."

Multi-point provides better performance because it allows careful tuning of the shape and size of the intake manifold. Passages up to a foot long are often used to give good horsepower and torque at normal driving speeds.

"If you try to do that with a carburetor or throttle-body injector, you get long transport time. Some of the atomized fuel drops out into liquid form again, which can result in poor warm-up performance," explains Taylor. "You can add heat to the manifold to keep the fuel from condensing, but you lose power because the volumetric efficiency [the amount of fuel and air entering each cylinder] drops."

Multi-point is also used with turbocharged engines for similar reasons. Again, the engineers need not worry about transporting vaporized gasoline through the intake passages. Instead they can concentrate on designing the turbocharger system to deliver exactly the right amount of compressed air for each driving condition.

All three of the major domestic car makers sell both throttle-body and multi-point systems. U.S.-built Renaults use a Bendix throttle-body system for cars sold in 49 states and a Bosch multi-point system on those destined for California, where emissions standards are tougher.

In addition to the technical change involved, the switch to fuel injection is also bringing a new multinational

supplier to the U.S. Bosch, which made its fame and fortune building sophisticated multi-point systems for European cars, sees America as a growing market for its products. Ford, Chrysler, and GM use Bosch injectors and other components in their multi-point systems. Bosch also builds the throttle-body injection systems used by Chrysler and supplies injectors used by Ford in its throttle-body unit.

Other injection-system parts for U.S. cars are being built by traditional suppliers to Detroit. The heart of the system, the computer, is built by each manufacturer for its own model line. Such a mixture of domestic and foreign sources might have been frowned upon at one time, but no longer. As one engineer for a U.S. car maker said recently, "We're going to use the best that's available in the world."

And what about servicing these electronic wonders? Many mechanics have encountered problems working on the newest electronic fuel-injection systems. After all, they're part of a strange new world, complete with sealed black boxes and sensitive sensors. And although the electronics are usually reliable, when one of the parts does break or malfunction, it can cost a lot more than an old-fashioned tuneup. But for the mechanic who learns the ropes, these systems can be far simpler and more logical than the complicated emissions controls and carburetor they replace. An added bonus is the self-diagnostic function that most of the computers possess, which checks not only its own function but also that of its sensors.

And while the jury is still out on the long-term durability, the auto makers seem happy. "We're seeing much better customer satisfaction and a lot fewer warranty claims," says Taylor. "Though that still doesn't say you can't do a botch job of it."

Every engineer I spoke with predicted that electronic fuel injection would replace the carburetor on passenger cars within three years. Only one could think of a car that would keep its carburetor.

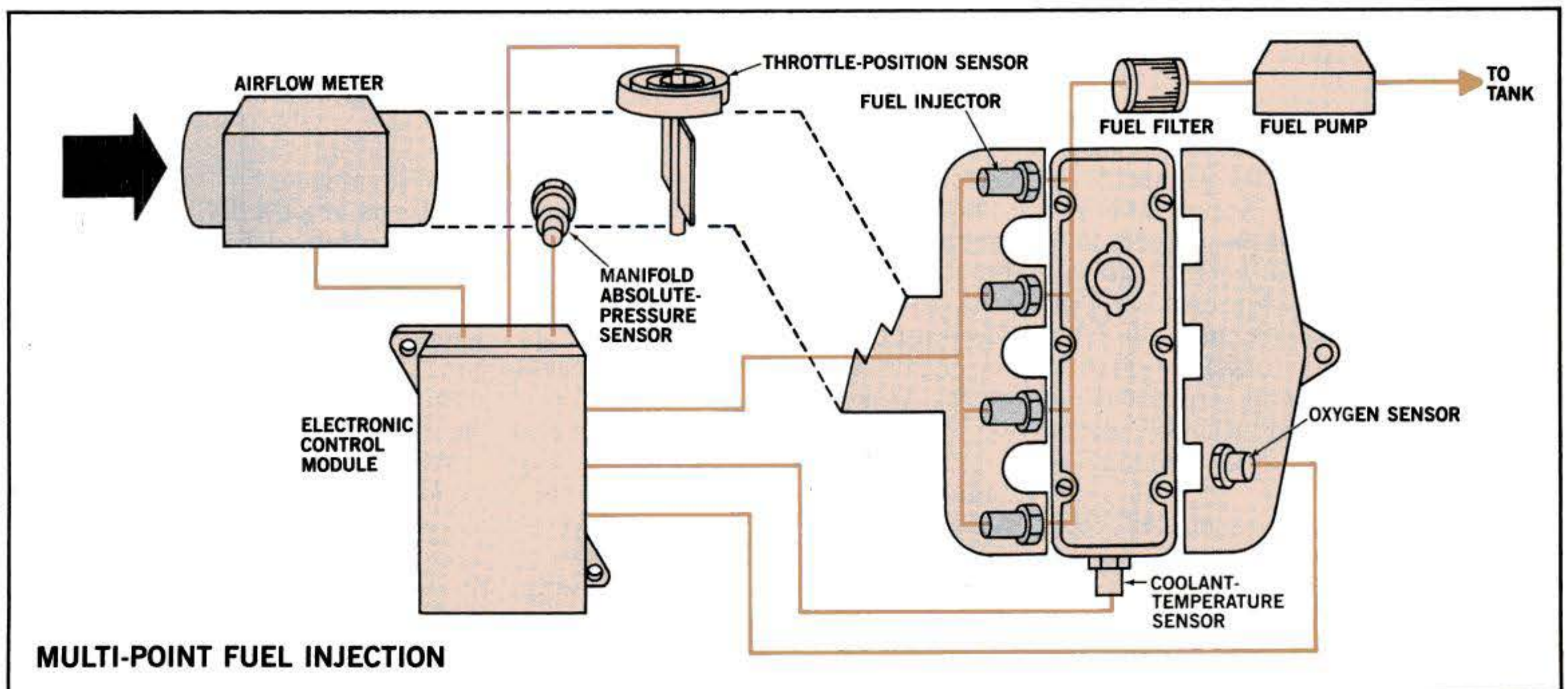
A holdout

At Ford's Service Research Center in Dearborn, Mich., a service engineer and I were going over service changes for the 1984 cars. I couldn't help noticing the sleek fenders and slippery body panels that made up the front-end test models for the 1985 and later cars. Nestled inside were four-cylinder and V6 engines, each wearing the tell-tale aluminum air box that could only mean fuel injection. So I asked the engineer whether any Fords would still have a carburetor a year or two down the road.

"The use of fuel injection will be expanded," he predicted. "The major exception will be the Mustang GT."

I was puzzled. Why would Ford stay with a carburetor on such a high-performance car? Anticipating my question, the engineer smiled at me and continued.

"We think the person who buys that car is someone who likes to tinker on the weekends," he said. "And we think he will be more comfortable with the old familiar Holley four-barrel." **ES**



MULTI-POINT FUEL INJECTION

At last, maglev goes public: **Britain's flying train**

Wheelless trains that float on air—suspended by a magnetic field and propelled by linear motors—have been under development for many years. Now the first maglev (for magnetic levitation) train is in commercial service, connecting the Birmingham, England, airport with a rail terminal in the National Exhibition Centre ¼ mile away.

By DAVID SCOTT

BIRMINGHAM, ENGLAND

At the new airport terminal in this industrial city 100 miles north of London you can catch a "flight" to Britain's vast National Exhibition Centre, though it's only ¼ mile away.

You walk to the shuttle lounge in the terminal, where sliding doors match up with those on a 40-passenger car drawn up alongside. You step in, and in a moment the doors close. A subdued hum comes from under the floor as the car takes off, floating forward gently, almost silently. In 90 seconds the car stops. The doors open, and you step out into a railroad station in the exhibition center.

Your ¼-mile flight was on the world's first working maglev (for magnetic levitation) train, a wheelless vehicle that floats 15 millimeters (0.6 in.) above its elevated track, suspended by a magnetic field.

Maglev trains have been under development since the 1960s [PS, March '67; Dec. '73; Aug. '79], primarily in Germany and Japan. A number of research vehicles have been built and run on test tracks in both countries, and development work is ongoing. But Birmingham's maglev, developed by British Rail at its research facility in Derby and built by a consortium called the People Mover Group, is the first of the breed to enter commercial service.

Its two cars, each six meters (19.7 ft.) long, run on a dual-track concrete guideway elevated on columns five meters (16.4 ft.) high. The system can carry 1,500 passengers an hour for each vehicle, and this could be ex-



World's first commercial maglev service links Birmingham airport and a nearby rail station. Two cars, with fiber-

glass bodies on aluminum chassis, travel on an elevated concrete guideway (inset) built of prefabricated sections.

panded easily by using two-car trains.

For levitation, the Birmingham maglev uses attraction magnetism: Each car has four groups of electromagnets that ride beneath two steel suspension rails. These lift the car off its support pads. The upward force is precisely controlled by a voltage chopper to maintain a 15-millimeter air gap. (A different maglev technology, being developed by the Japanese National Railway, accomplishes levitation by repulsion: Superconducting magnets generate opposing magnetic fields to suspend the vehicle above the track.)

A linear-induction motor (LIM) pro-

vides propulsion for the floating cars. A LIM is essentially a conventional rotary motor with its circular rotor and stator cut open and laid out flat. Here the stator is a block of iron-core windings fixed to the underside of the car. The "rotor" is merely an aluminum reaction plate running along the entire track.

With the car levitated, there is a 20-millimeter (0.8-in.) gap between the rotor and stator. The alternating current fed to the LIM windings induces corresponding currents in the reaction plate below, and these generate a magnetic flux that drives the vehicle.

Top speed on the short Birmingham line is limited to 30 mph. The motor is also used for normal braking, when it acts as an induction generator. Electric power for both the lift magnets and the LIM is picked up from copper conductor rails fixed to the track. Inverters change the DC supply voltage to three-phase AC.

The trains are unmanned and automatic: During busy hours they make scheduled runs at two-minute intervals; at other times you summon them, elevator fashion, with a push button. An on-board computer controls their operation. As there is no mechanical contact between the moving car and the guideway, a chain of inductive cable loops fitted along the track serves as a multichannel data link with the maglev terminal. Various inductive and capacitive sensors monitor the car's speed, levitation height, magnet temperatures, and many other criti-

cal operating factors. The continuous stream of information is fed back to the central computer, which controls all driving functions. An additional automatic protection system with fail-safe electronics avoids all possible running or passenger-loading hazards.

Safety is an important feature of the maglev system. The underslung suspension effectively secures the car to the guideway, preventing it from falling or being blown off the elevated track. In case of a power failure the car drops onto its support pads and skids safely to rest.

Economically sound, too

This maglev link is no high-tech gimmick; it makes sense economically, the Birmingham airport authorities claim. Maintenance needs are low because there are no rotating parts and no track wear. Unlike standard rails, maglev tracks need no heating in win-

ter to melt snow and ice, because traction doesn't depend on wheel-to-rail contact. Maglev's energy consumption is similar to that of a comparable wheeled vehicle, but overall running cost could be up to 10 percent lower.

Until now, maglev trains have been widely regarded as most promising for high-speed, long-haul transport. Not so, says British Rail, which, after detailed study, concluded that magnetic-suspension systems offer no great technical or economic advantages on long-haul lines at speeds below 180 mph. In addition, ridership on intercity routes is not sufficient to justify such major construction projects, the study found.

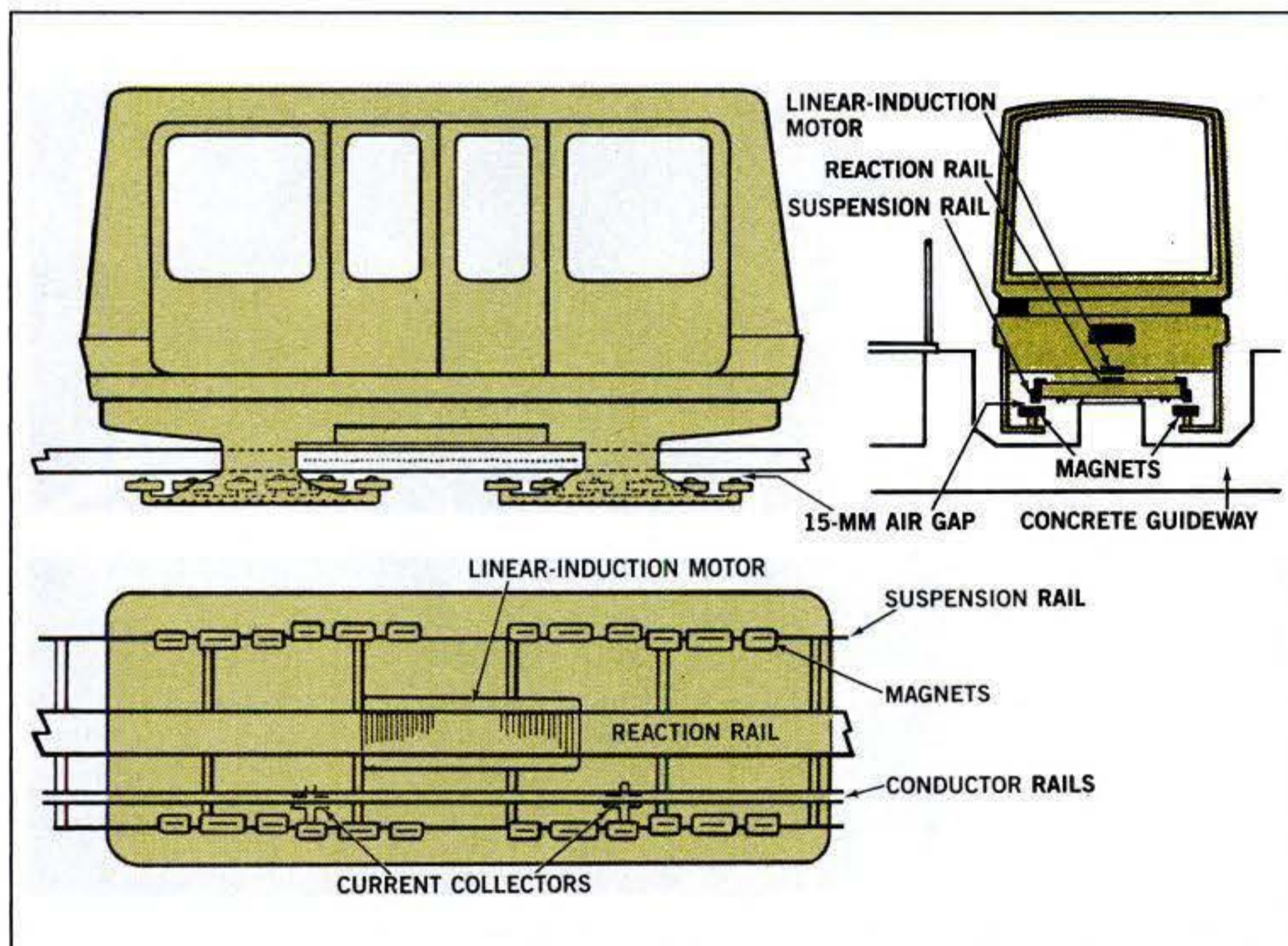
British Rail thus sees maglev as best suited for short links in shopping and conference centers, seaports, and other places of high-density people movement. It also sees a bright future for the technology in urban-transit systems and commuter services, in which efficiency, convenience, and environmental factors are more important than speed and distance. Flexibility in route layout gives maglev an edge over conventional railroads in dense urban areas. The cars can safely manage tighter curves, of a radius down to eight meters (26.3 ft.), and climb steeper gradients—up to 10 degrees. That enables tracks to snake through congested areas and over hilly ground. And a novel arrangement for track switching developed by British Rail could hasten the birth of "flying" commuter trains.

Points for maglev

Although such short links as the Birmingham maglev can use relatively simple parallel tracks, track switching is necessary to make possible the more complex routings needed for an urban-transit system. At its experimental lab in Derby, British Rail has installed a maglev switch: two 12.5-meter (41-ft.) lengths of track, a straight one and a shallow S-curve, supported on a common base that pivots near one end. This assembly connects a single track line on one side with a double one on the other.

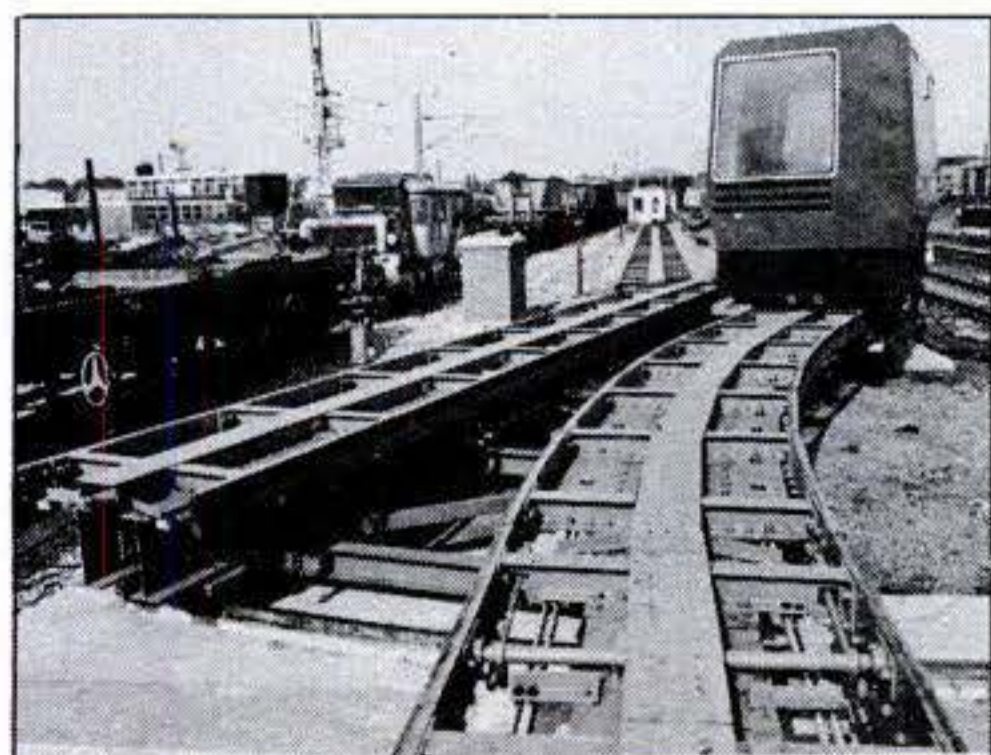
A linear electric actuator on the ground alongside is coupled to the center of the roller-mounted switch section. It swings the section between the two positions rather like ordinary railroad points. The maglev car can traverse the switch at normal cruise speed.

With the Birmingham airport shuttle, maglev has made a real start as a practical people mover. British Rail's switch design could advance it further along the road as an urban-transit system with many advantages. **PS**

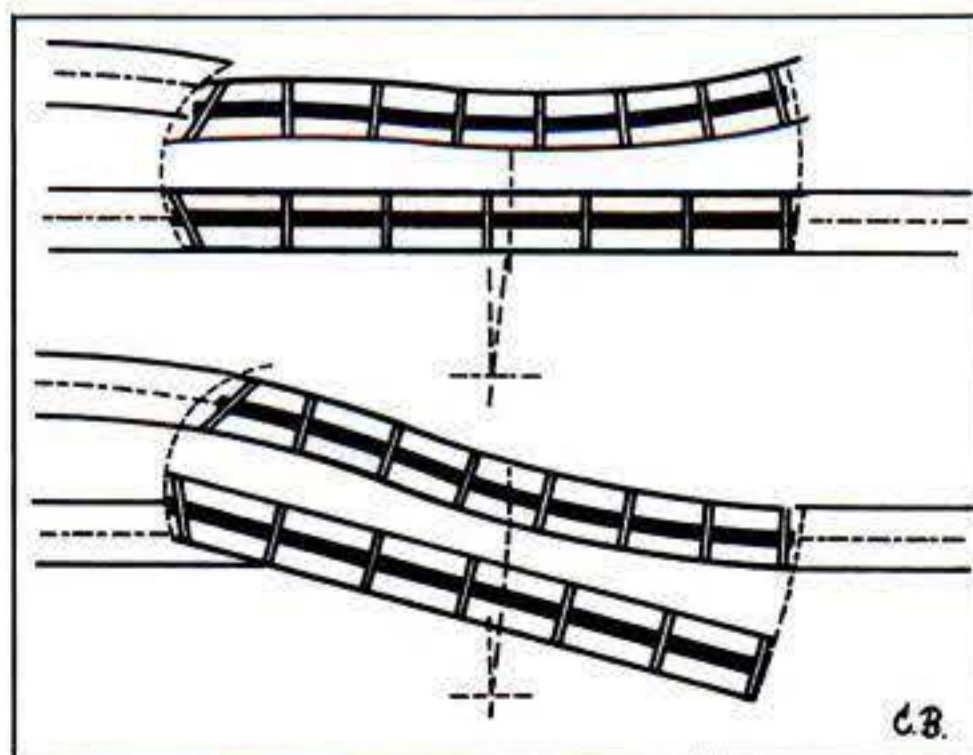


Aluminum reaction plate on the track is LIM's "rotor"; windings beneath cars are the stator. Varying power differen-

tially to lift magnets in each group (slightly offset on either side of the rails) gives directional stability.



Experimental track switch at British Rail's research center in Derby has straight and S-curved lengths of track on a common base frame, pivoted near one end and supported by rollers at the



other. A linear electric actuator swings the entire assembly between straight-ahead (upper drawing) and diverted (lower drawing) positions. Sliding wedges lock switch in either position.

New space venture: micro-gravity factories

The first permanent space station may be a privately owned, unmanned platform for manufacturing and scientific experiments. Launched from the shuttle, the craft will travel to a higher orbit and return to the shuttle twice yearly to exchange payloads.

By **SUSAN RENNER-SMITH**

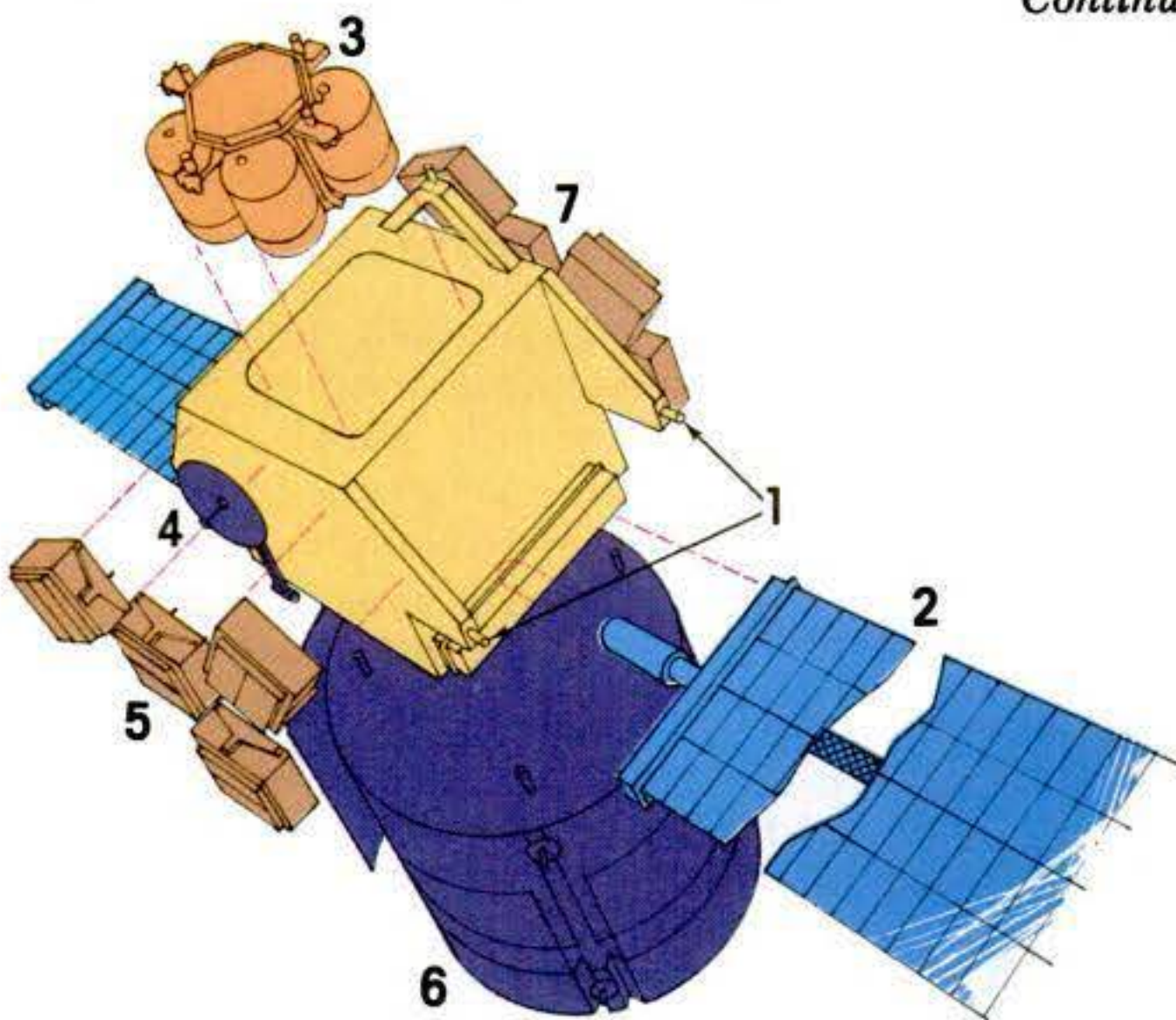
Illustrations by Adolph Brotman

Ace Satellite Repair Co." read the T-shirts sported by jubilant shuttle astronauts after April's Solar Max mission.

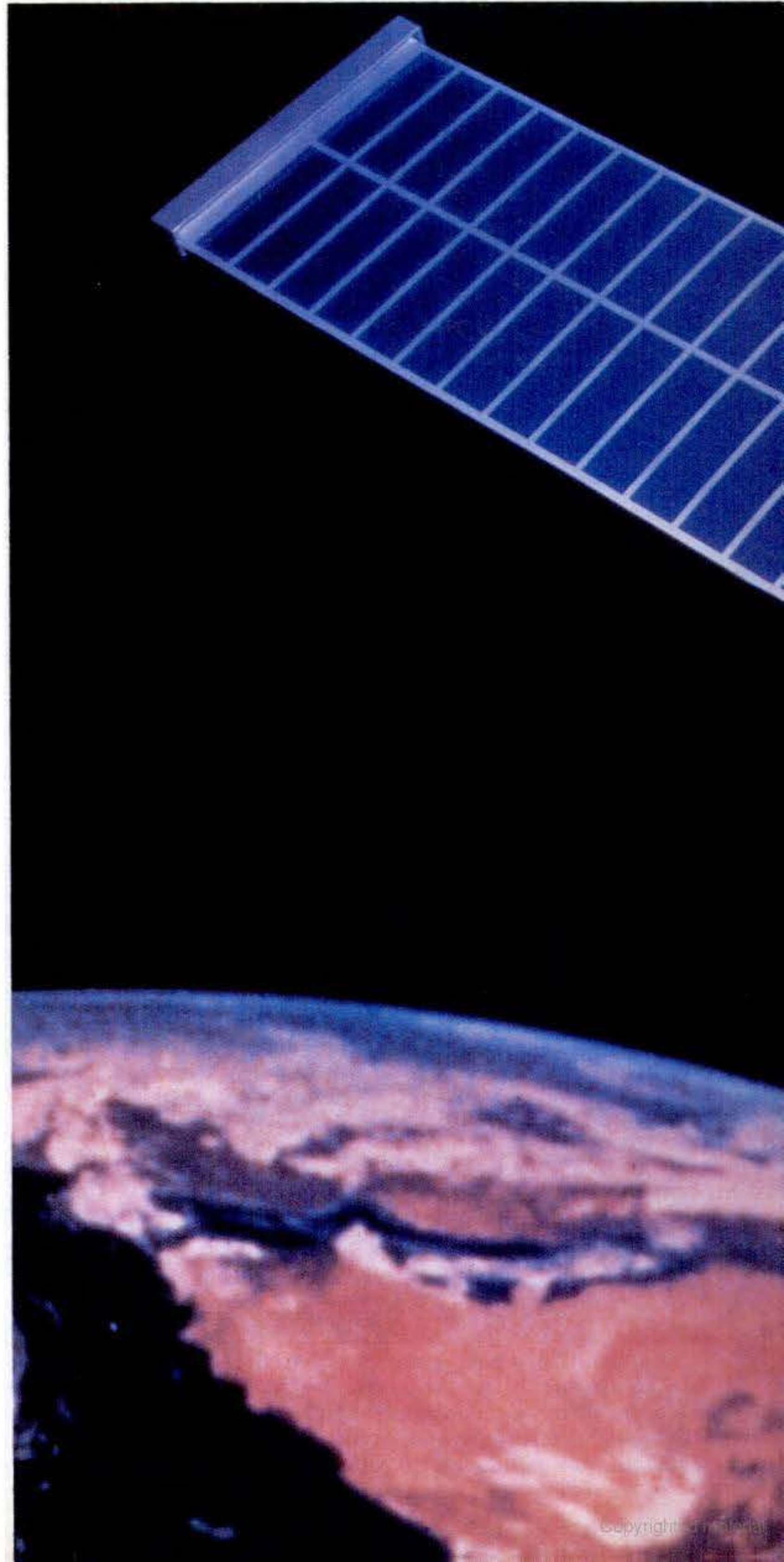
That successful satellite repair paved the way for permanently orbiting space stations serviced by shuttle astronauts. The first of this new breed, planned for launch in 1987, may be Leasecraft—a satellite for hire. Cargo berths aboard the orbiting platform will be rented to companies that want to manufacture materials under gravity-free conditions. The self-propelled modular spacecraft will rendezvous regularly with the shuttle to change payloads.

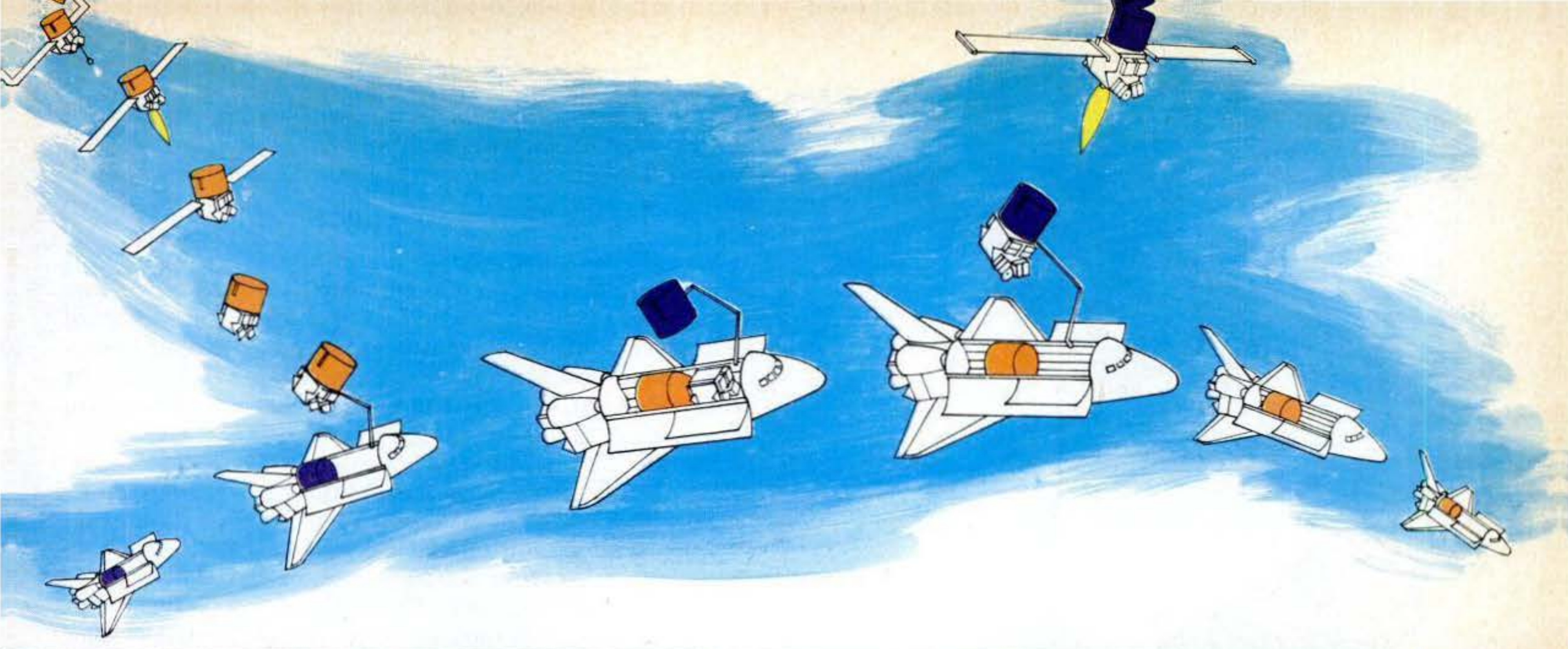
On Sept. 22, 1983, NASA and Fairchild Industries of Germantown, Md., signed a "joint endeavor" agreement

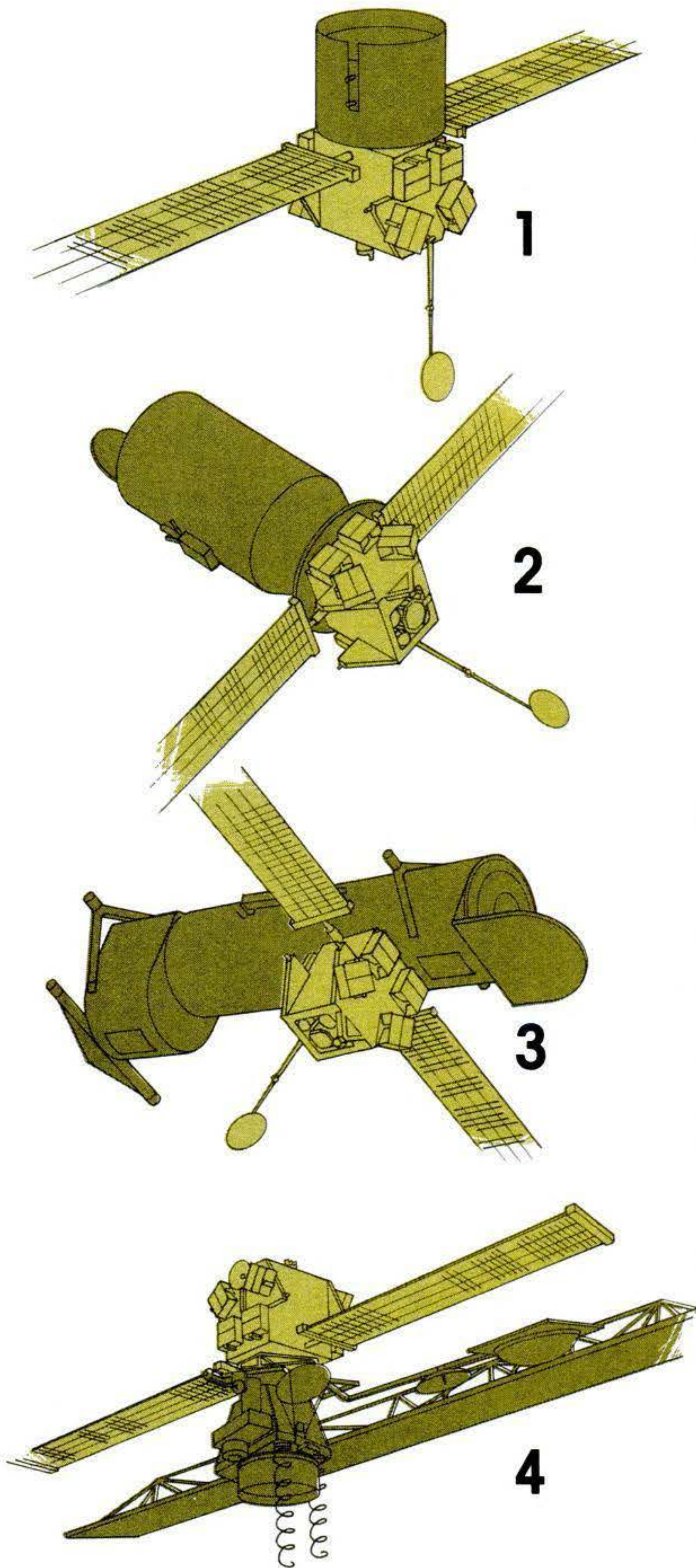
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A 15-ft. aluminum cube (above), Leasecraft has trunnion pins (1) for mating with the shuttle robot arm. Fittings accept a bolt-on seven-kW solar array (2), propulsion unit (3), communications antenna (4), and separate four-ft.-sq. "multi-mission" modules (5). These house an on-board computer for communications and data handling, an attitude-control system with momentum wheels for stability, batteries, and systems controls. The craft carries a primary payload (6) and auxiliary payloads mounted in containers (7). To exchange payloads, Leasecraft flies down (top right), retracting its solar array and antenna as it maneuvers within reach of the shuttle's robot arm. The arm lowers Leasecraft into the shuttle bay, removes and stows a payload of space-processed materials, then installs a new payload. After systems checks, Leasecraft flies back to its higher orbit while the shuttle returns processed materials to Earth.







Providing power for a micro-gravity factory (1) is just one of Leasecraft's jobs. Loaded in orbit, the spacecraft can accept massive loads of up to 25,000 lbs. Extra momentum-wheel modules provide stability. Possible payloads include an astronomical observatory (2) designed for a multi-year flight and a large astrophysical telescope (3). Each relies on Leasecraft's star sensors for accurate pointing and uses the on-board computer. Though dwarfed by a multi-detector earth-and-ocean scanner (4), Leasecraft can easily ferry it back to the shuttle for periodic maintenance.

to develop Leasecraft. NASA will provide launch services for the craft's first two flights. Fairchild will build the spacecraft, sign up customers, and manage the program.

Versatile, multipurpose spacecraft

With its two solar panels extending 66 feet, Leasecraft looks like a stereotype of a satellite. But all components are modular (see illustration on opening page), designed for replacement by astronaut repair teams. "All of Leasecraft's modular components are being built right now for other programs," says Bernard Raab, director of program development for Leasecraft.

Despite its modular origins, Leasecraft is fundamentally different from single-purpose satellites. It is self-propelled, for one thing. "The shuttle will drop us off at its normal parking orbit of 160 miles," says Raab. "We'll fly up to about 300 miles, where drag is much less."

Unlike Solar Max, the self-propelled Leasecraft can maneuver into easy grapppling range of the shuttle's robot arm. The arm pulls the craft into the shuttle bay and changes the payload (see illustration on previous page).

"Our big breakthrough was the idea that we can change payloads—as well as modules—on orbit," Raab says. "That seminal idea made it clear that we could stay on orbit permanently."

The second breakthrough was the realization that payload size is unimportant. "Because we only attach on orbit, where the loads are very low, the payload can be huge—much bigger than Leasecraft itself," Raab says.

Such versatility means that for the price of one satellite and one launch, Fairchild gets a multipurpose spacecraft. On one tour of duty Leasecraft might carry a remote-sensing satellite for detailed Earth observation; on the next the craft might carry a giant telescope—or a miniature factory. And Leasecraft can service at least two or more payloads at once.

The primary payload dictates the altitude and position and has first call on power and computer systems. Most primary payloads will be either data-collecting instruments or materials-processing factories. "The commercial future of space is in materials processing," says Raab.

Micro-gravity changes the way materials behave. Large super-pure silicon crystals grow uncontaminated by convection currents. Rare superconducting alloys too heavy to combine in gravity can be formed in micro-gravity, and living cells that clump together on Earth readily separate.

Each Leasecraft will also carry an auxiliary payload or two. Small enough to fit into a basic module, these require little service. "Plant-growth experiments would make good auxiliary payloads," says Raab. "They don't care where they're pointing; they need very little power; they just want low gravity."

Fairchild will charge up to \$1 million a month for auxiliary payloads and up to \$4 million for primary payloads. The charges include planning, mission control, and data collection.

Why not use the shuttle payload bay to do these jobs? "The shuttle fires thrusters to maintain orbit. And the astronauts bounce around and hit the walls," says Raab. "There are experiments that are very sensitive even to those milli-G pulses." But Leasecraft, in its higher orbit, can drift for long periods. "We could go from six months to a year without having to compensate for drag," Raab says.

Won't NASA's manned space station, authorized by President Reagan in January, make Leasecraft obsolete? All versions of the space station feature unmanned platforms circulating nearby. "We hope to become one of those platforms," Raab says. "And we felt we could get into space a lot sooner than the space station." P.S.

Plug your computer into the world by
**choosing the
right modem**

A modem links your computer with other computers—over the telephone line—to add capabilities far beyond those of any other peripheral device or software program. But the speed and manner in which a modem exchanges data and the amount of built-in *intelligence* it contains are important considerations when deciding on which one to buy.

By **JAMES R. BERRY**
Illustration by Roy Doty

Ah, vacations! Book a hotel. Make plane reservations. Shop for clothes. Hit the bank for cash. Buy gifts for relatives... lots of work. But I did it all—this morning.

Tired? Not me. I never left home. I merely typed at the keyboard of my home computer. My electronic requests—ordering, communications, and information—were instantly carried out by a network of larger computers at the other end of the telephone line.

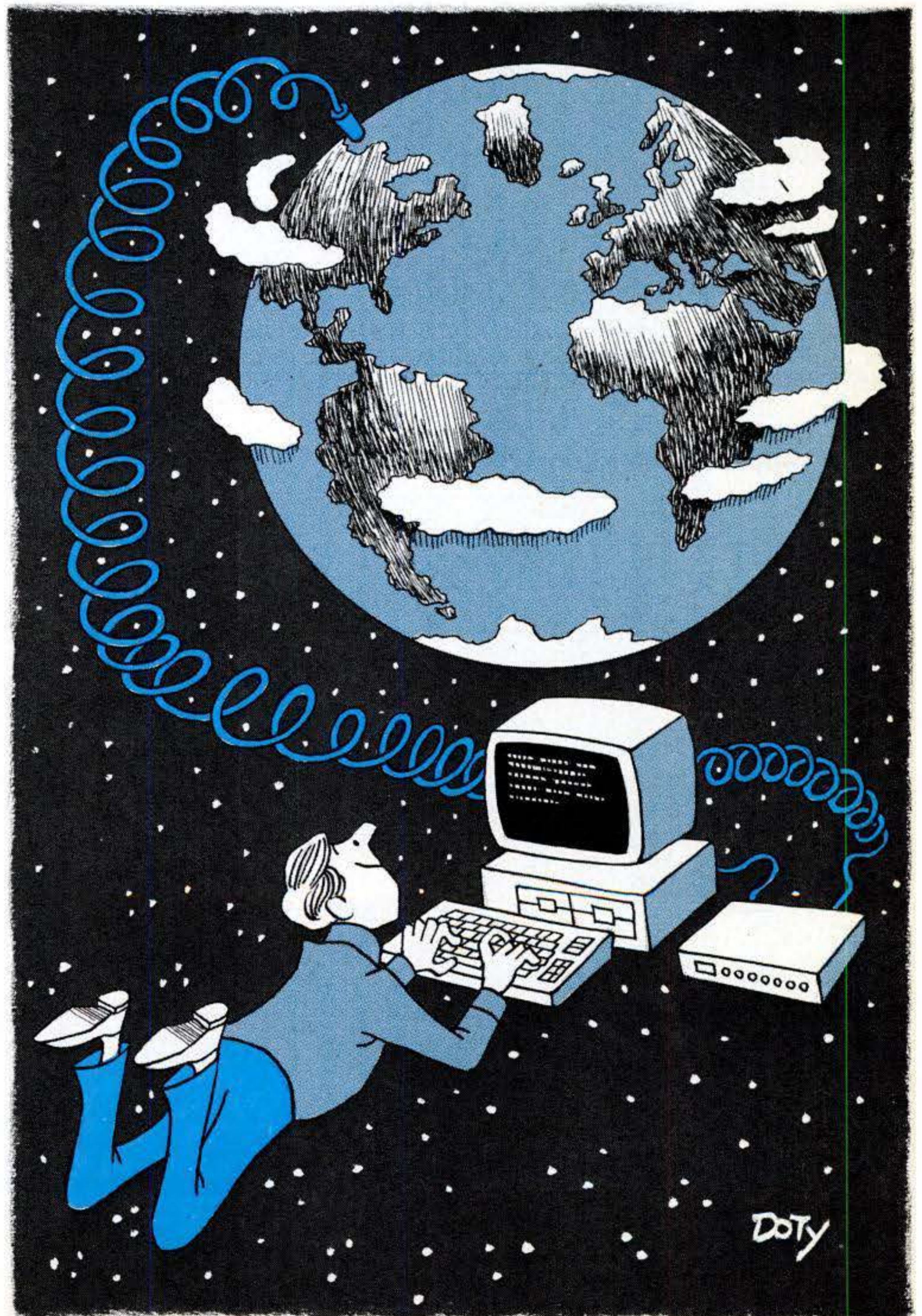
To do it, I simply added a modem—a little black box—to my system. The computer plugs in one end; the other end attaches to the phone line. I then just dial the phone number of the service I want.

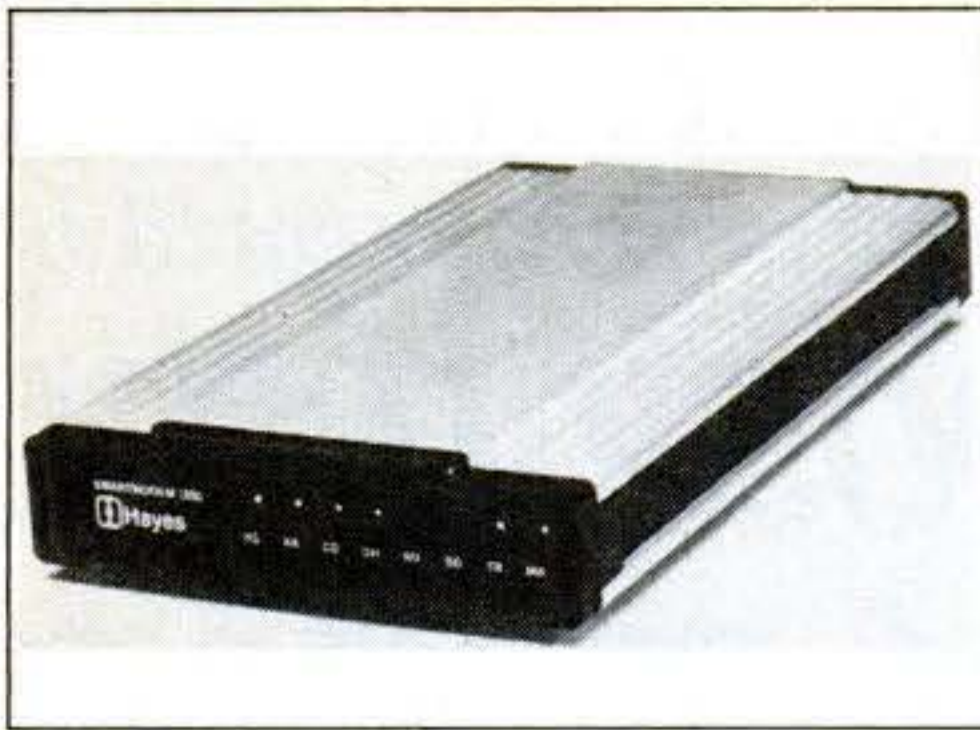
The services available include more than a dozen commercial data bases and hundreds of privately run computer bulletin boards that send information that ranges from Smokey Yunick's tips on car care in *POPULAR SCIENCE* to the weather forecast for Zanzibar. With a modem you can transfer bank funds, order airline tickets, look for a job, get a date, send letters, receive programs, list a house for sale, shop for bargains on cameras, cars, and TV sets... and lots, lots more.

But plugging into this electronic universe can be filled with thorny choices and aggravating frustrations. Manufacturers offer a bewildering array of features, and making the connection between modem and computer can turn a saint mean (see box).

Understanding what makes modems work, along with some vital terminology, can save you a lot of trouble in

Continued





LEDs on Hayes Smartmodem 1200 display status. Baud rate changes automatically for the service you call.



Buttons on Novation J-Cat smart modem allow manual connect and unit test. Status is given by LEDs.



Acoustically coupled modems, such as the Lexicon Lex 11, send and receive data via handset placed in rubber cups.



For portable use, this Anchor Automation's Volksmodem is powered by a nine-V battery. It lasts for about a year.

Some representative modems

Make and model	Baud rate	Direct connect	Acoustic	Full duplex	Half duplex	Smart features	List price (\$)
Anchor Automation							
Volksmodem	300	•		•	•		70
Mark VIII	300	•		•	•	•	159
Mark XII	1,200	•		•	•	•	399
Hayes							
Smartmodem 300	300	•		•	•	•	289
Smartmodem 1200	1,200	•		•	•	•	699
Lexicon							
Lex 11	300		•	•	•		145
Lex 12	300	•	•	•			180
Lex 15	1,200	•	•	•			360
Novation							
Cat	300		•	•	•		189
D-Cat	300	•		•	•		199
J-Cat	300	•		•		•	149
103 Smart Cat	300	•		•		•	249
212 Smart Cat	1,200	•		•		•	595
Tandy Corp.							
IB	300	•		•			100
AC-3	300		•	•	•		150
DC-Modem II	300	•		•		•	200
DC-2212	1,200	•		•	•	•	400
U.S. Robotics							
Phone Link	300		•	•	•		269
Micro Link 300	300	•		•	•		239
Auto Link 300	300	•		•	•	•	269
Password	1,200	•		•	•	•	449

buying, installing, and using a unit. But first you should know why you need one at all.

What modems do

The basic idea is to connect two computers by means of a conventional telephone line. But there's a technical problem.

Computers work with single "bits" of information. A bit is either "on" (a voltage is present), or it's "off" (no voltage). Strung together, the bits of on (1) and off (0) data represent digital information.

A telephone, however, is designed to use analog signals—a constantly changing voltage that normally represents a voice. It simply won't pass the single on or off pulse used by digital circuits.

That's where the modem (for modulate, demodulate) steps in. A modem assigns a certain analog tone to each 0 and each 1 bit. To send a 0 over the telephone line, it uses one tone; to send a 1, it uses another. The receiving modem converts the tones back to their original bits to recreate the information in the receiving computer.

Modems are connected to the phone line in two ways: acoustically or directly. Acoustic modems have rubber cups into which a telephone's handset fits. The tones are transmitted and received through the telephone's ear- and mouth-piece. Direct-connect modems plug directly into a modular wall jack just like an extension telephone. Data flow directly over the telephone line, bypassing the handset entirely.

You need acoustic modems when a wall jack isn't available. If you're an on-the-road "computerized" salesman, for instance, you'll need the acoustic type because many hotel rooms don't have modular wall jacks.

Direct-connect modems are more convenient and reliable, and usually offer more features. (I'll tell you about these shortly.) The direct-connect modem electronics may be in a separate box that attaches to your computer with a cable, or they can come on a printed circuit board that installs inside (or on) your computer.

Although most modems use AC power (through a step-down transformer), those designed for specific computers often use the computer's internal power supply. Still others use a battery, making them perfect for portable computers.

Tech specs

Whether you plan to buy an acoustic or direct-connect unit, getting acquainted with some of a modem's technical characteristics will help you make a shrewd choice. There are four

main items to check: baud rate, compatibility, half or full duplex, and answer-originate mode. Here's what each of the terms means:

Baud rate. This is the speed by which a modem sends data over telephone lines. The most popular rate is 300 baud. How fast is that? As a general rule, divide the baud rate by 10 to get the number of characters per second. A 300-baud modem, therefore, sends or receives up to 30 characters per second, about as fast as speed reading.

Another common baud rate is 1,200—four times faster. At this speed, messages whip across a screen. Commercial data bases that transmit at this rate (as well as 300 baud) often charge double the fee for the higher speed. But because you are charged by the length of time you use the system, this can still be a saving.

The disadvantage of a 1,200-baud modem? Price. It usually costs more than twice as much as a 300-baud unit. For most people, the more sedate pace of 300 baud is fine. But if you intend to use a service routinely for sending and receiving lots of data, the more expensive 1,200-baud models will eventually save you money.

Compatibility. For two modems to communicate with each other, they must both use the same tone-encoding and -decoding method. To ensure compatibility, modems must conform to certain technical standards. Although there are several different standards for tone encoding, the two you should look for are called Bell 103-J (often abbreviated to Bell-103) and Bell 212-A (or Bell-212). Bell 103-J is the standard on which most 300-baud modems operate; Bell 212-A is the standard for 1,200-baud use.

Full or half duplex. This designates two-way or one-way-only transmission. In half duplex, a modem communicates in only one direction at a time. If it's sending, it can't receive; if it's receiving, it can't send. A full-duplex modem can send and receive data simultaneously.

Full-duplex capacity is a *must* for communicating with many data bases. (Data are exchanged constantly as you work.) Even inexpensive modems have full-duplex capacity. Check with your dealer to avoid models that have only half duplex. (Some models have a switch or command that forces a full-duplex modem into half-duplex operation. This is for special communications and is not often needed.)

Answer-originate. A modem with answer capability can only receive data. Originate modems can only send data. Answer-originate modems do both. Even inexpensive modems in-

Connecting a modem

If you buy a modem that's designed for a specific computer, you'll rarely have difficulty making it work. This type of modem merely plugs into a socket within the computer. An external, stand-alone modem usually comes with a cable that's pre-wired to the computer's serial port.

Most modems, however, are designed to be used with any computer. That means the wiring between them and the computer could vary, depending on the computer you own. Happily, one semblance of a standard does exist: All modems use a computer's serial port, called the "EIA RS232-C" serial interface, usually abbreviated to RS232. (If your computer doesn't have a serial interface, you must add one. Check your computer's manual.)

There are two ways in which a computer's serial interface may be internally wired. The first is called data terminal equipment, which means the interface represents the connection from a computer. This is the correct configuration for connecting it directly to

a modem. (The connector may be marked DTE, MODEM, or COMMUNICATIONS.) Just add a direct (pin-for-pin) cable, and you're done.

However, some serial interfaces may be internally wired as data-communications equipment. That means the interface represents the same connection as from a modem and is designed to run a printer or to simulate a modem for special applications. Because a modem-to-modem connection won't work, you'll have to do some rewiring. But don't get nervous—it's easy. You simply reverse the wires on pins two and three (data in and out) of the interface connector. Although this can be done inside the computer, it's easier to simply reverse the wires on the modem cable connector. (Sometimes, depending on the modem, other wires must be cut; check the modem instruction manual carefully.)

An even easier solution? Check with your dealer or the modem maker. Usually, pre-wired cables (\$15 to \$40) are available for a particular computer-modem connection.—J. R. B.

clude answer-originate capability, so there's little reason to do without this feature.

Finally, you may also see the term "asynchronous transmission." This means that data are sent in spurts from the computer. All modems designed for personal computers accept asynchronous transmission.

Intelligence

Acoustic modems require human help to make or answer a phone call. You must install the handset and dial the number for outgoing calls, for instance, and throw a switch to answer incoming ones. But many direct-connect modems have built-in intelligence; they're usually referred to as "smart" modems.

Smart modems work automatically. They make outgoing calls by dialing pre-programmed numbers and establishing contact with a remote computer. Or, when someone calls you, a smart modem answers the phone and readies your system to accept incoming data.

But smart modems—depending on their IQ—are capable of more. Some store 10 or more telephone numbers in a memory, any one of which can be dialed by a simple command. In addition, passwords and ID numbers necessary to connect with data bases can be stored and transmitted by one or two taps on the computer's keyboard. Some modems re-dial a number up to 10 times when necessary, and others may dial many different numbers until a computer answers.

Other smart-modem features: built-in speaker for monitoring the line while dialing is done; automatic ad-

justment to baud rate (300 or 1,200 baud); push-button or rotary dialing; an internal clock to send data at a specific time; a ring counter so it answers only after a certain number of rings; and LED lights to show the modem status.

But whatever modem you buy—smart or not—you'll need a communications-software program to tell your computer how to use it. Software ranges anywhere from \$15 to \$250 and more, depending on capabilities. At the least, a simple program will put your modem on-line with any data base within reach of a telephone line.

The more sophisticated software, however, is written to use other peripherals in your system and to take advantage of a smart modem's brainpower. (Even though a modem has built-in intelligence, it still needs to be told what to do.) Menu selections give the modem instant instructions or allow you to use your printer or disk drives for saving and retrieving data.

Finally, when buying a modem, do some comparison shopping. List prices are regularly discounted, and in some instances no-frills software is included. In addition, manufacturers often include free time on one of the popular data bases—such as The Source and CompuServe. That feature alone is sometimes worth more than the modem itself. **ES**

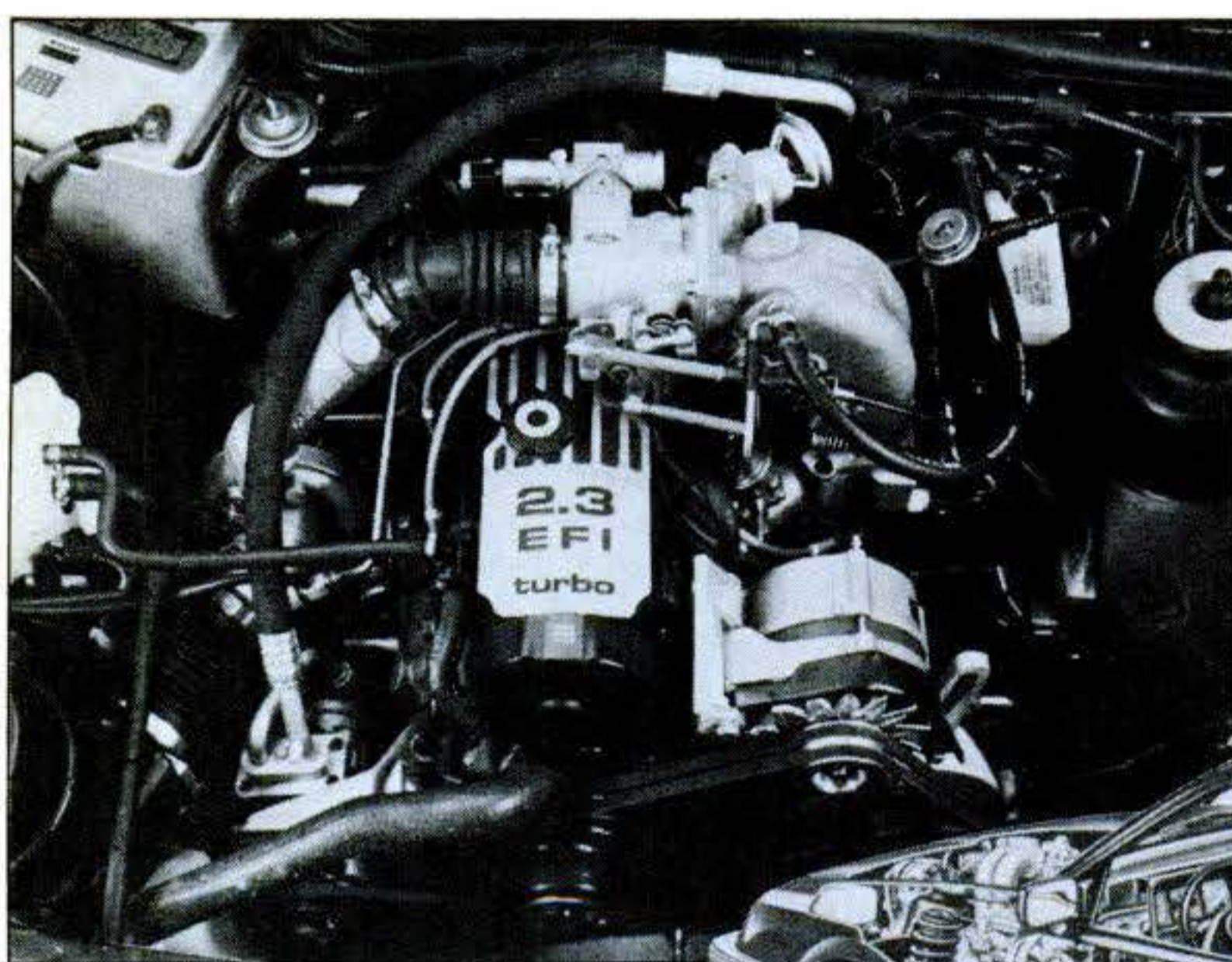
SELECTED MANUFACTURERS' ADDRESSES

Anchor Automation, 6913 Valjean Ave., Van Nuys CA 91406; Hayes Microcomputer Products, 5923 Peachtree Industrial Blvd., Norcross GA 30092; Lexicon Corp., 1541 65th Ave. N.W., Fort Lauderdale FL 33313; Novation, Inc., 20409 Prairie St., Chatsworth CA 91311; Tandy Corp. (Radio Shack), 1800 One Tandy Center, Fort Worth TX 76102; U.S. Robotics, 1123 W. Washington, Chicago IL 60607

FORD
for **'85**

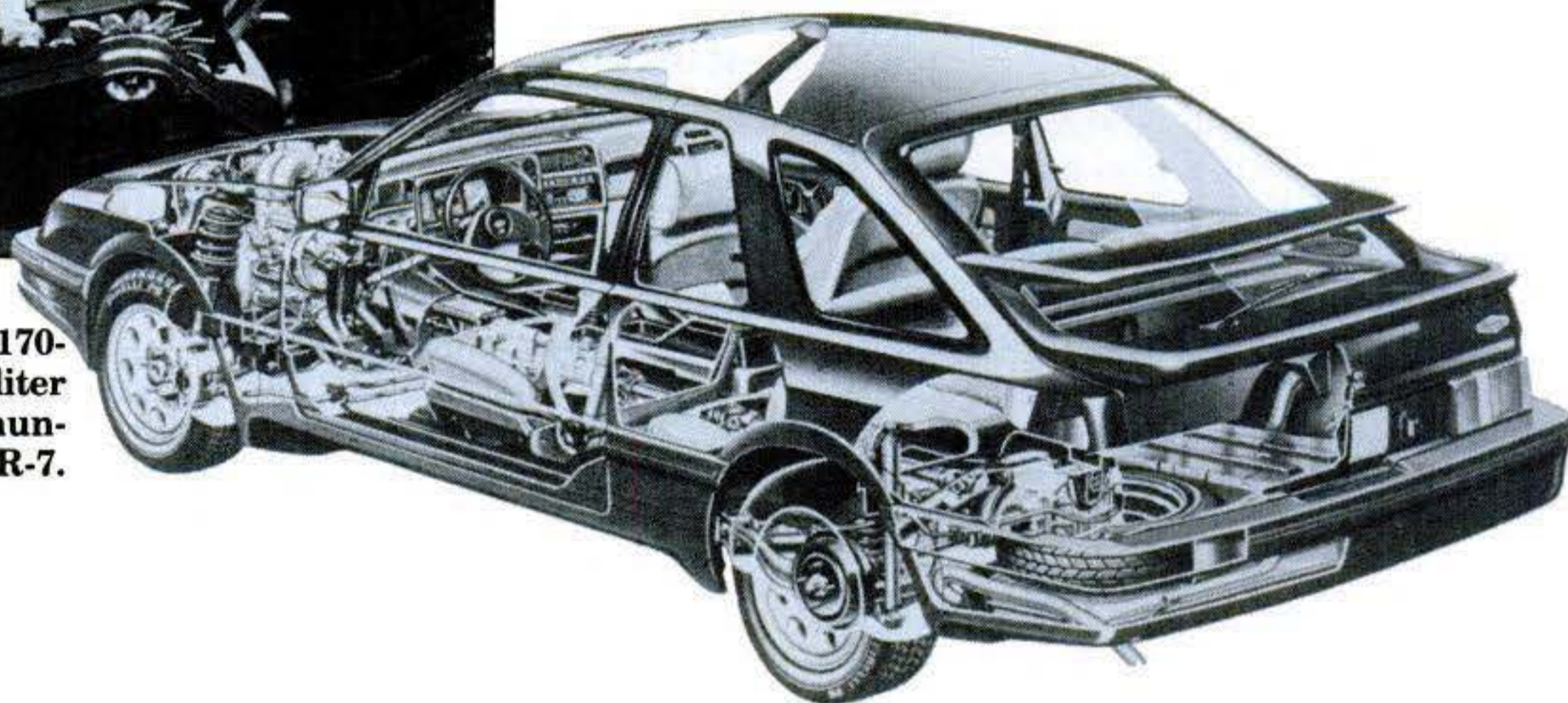
A performance aero sedan

*plus hotter engines and a new
skid-control brake system*



Merkur's power will come from a 170-hp version of the turbocharged 2.3-liter four-cylinder already found in Thunderbird turbo coupe and Cougar XR-7.

The 130-mph Merkur is Lincoln-Mercury's alternative to the European performance imports. Higher-output versions of the 2.3- and five-liter engines pump new muscle into performance models, and a new type of electronic anti-lock brake system gives increased control in skid situations.



By **JACK KEEBLER**

From what I saw in Dearborn, Mich., the building blocks are in place for a performance renaissance that will rival or even eclipse the Big Four production-car performance wars of the late 1960s.

At Ford, the centerpiece of this go-fast smorgasbord is the Merkur (pronounced mare-coor), designed and built by Ford of Germany. I ran a pre-production model up to an indicated 130 mph on one of the straightaways at Ford's Romeo proving grounds, and hand-timed four sub-eight-second zero-to-60-mph runs.

But economy has not been forgotten. Ford's Hank Nickol, power-train engineering director, predicts that Merkur EPA numbers will be about 22 mpg

for the city and 30 on the highway, pending certification.

Despite the industry trend, the new car is a rear-drive. German engineers at the June preview cited several reasons for the rear-drive setup: more engine-bay room; superior chassis balance for performance driving; and easier service access to transmission, drive shaft, and independent rear suspension. Also, rear-drive allowed engineers to optimize the angle of the hood (because of the north-to-south orientation of the engine) for the smoothest air penetration.

And Merkur is a showcase for some of the most effective aerodynamic-efficiency tweaks in the industry. These mean reduced exterior wind

noise, better cooling for the engine and brakes, reduced power requirements to maintain a given road speed, and, of course, lower fuel consumption. The Merkur, for example, will get fully integrated aerodynamic headlights similar to those already on the Mark VII. At its rear is Ford's biplane spoiler. Adapted from the Probe III, a concept car, the spoiler not only cuts drag but reduces lift at high speeds. The net result is a 0.32 drag coefficient, which Ford claims is the best in the five-passenger-sedan class.

How much is all this European technology going to cost? "Merkur will be fully equipped at around \$16,400," according to Robert Rewey, vice-presi-

Continued



Merkur XR4Ti, sold by Lincoln-Mercury and built in Cologne, West Germany, will soon zig and zag down American roads. Ford Mustang GT sports a 210-hp V8 engine, 60-series unidirectional tires, and a short-throw five-speed manual transmission.





A fuel-injection-equipped V8 and taut suspension make the four-door Mercury Marquis LS the car for fast-lane families.



Ford Thunderbird's 2.3-liter turbocharged four-cylinder engine has been tuned to deliver more power and less noise.



Mercury Cougar XR-7, T-bird's sister model, gets a new grille, fog lamps, and a wind-cheating front air dam for 1985.

dent and general manager of the Lincoln-Mercury division.

Hotter engines

The hottest engine from Dearborn will be the five-liter (302-cu.-in) four-barrel V8. With tubular headers, dual mufflers, and roller tappets, the engine should develop as much as 210 hp. An electronic-fuel-injection version will also be available in the Mustang, Capri, LTD LX, and even the Mark VII LSC.

The 2.3-liter (140-cu.-in.) high-swirl-combustion engine in the Tempo/Topaz will get electronic fuel injection for 1985. In addition, a stronger version,

dubbed the HSO-EFI, with modified combustion chambers, larger-capacity injection system, hotter camshaft, and less-restrictive exhaust system, will produce 20 percent more horsepower and 15 percent more torque. The overhead-cam 2.3-liter turbo engine in the Thunderbird and Cougar XR-7 has been improved with an electronic waste-gate control system. The turbo itself has also been modified to improve low-rpm engine response. Higher-flow injectors will handle the increased fuel demands. Ford is looking for 10 more horsepower from this engine. Ford engineers hinted that an improved (SVO Mustang only) version

of this engine may produce better than 200 hp before the end of 1985.

Appropriately, Ford will introduce a more-effective braking system as it beefs up its line with stronger-running models. Electronic four-wheel skid control will be standard equipment on all Mark VII and some Continental models. With this system, a computer and its sensors monitor and compare the individual rotational speed of each wheel. If one wheel slows quicker than the others, the computer compares the signals and modulates hydraulic pressure to the appropriate channels. This, says Ford, prevents wheel lockup and loss of steering control. **PS**



Alliance convertible (above) has power-operated top. Standard power train is

1.7-liter fuel-injection four with five-speed manual transmission (automatic

is optional). A 2.1-liter turbo diesel is available for Wagoneer (below).

**AMC '85
for '85**

Alliance gets a ragtop



Besides the convertible, AMC offers a larger four-cylinder engine plus a turbo diesel for its 4WD vehicles.

By **JIM DUNNE**

American Motors, with the help of its French connection, Renault, offers some welcome improvements in its most important product lines for 1985: a convertible model for Alliance, more power for Alliance and Encore, and a turbo-diesel engine for Jeep Cherokee and Wagoneer.

The changes that went into the Alliance convertible are all American. The new model is built on the Alliance two-door platform. Details are similar to those in convertibles of old, but with a few extras. The top is lined with an extra layer of fabric inside for

better appearance and a slight noise-control advantage. The quarter windows can be lowered, and the vinyl rear window can be zipped out. However, because of the folding-top mechanism, the rear seat is only wide enough for two adults.

A new 1.7-liter (105-cu.-in.) engine gives Alliance and Encore models more muscle. It's standard on the convertible and top-of-the-line Encore GS hatchback and Alliance Limited models, and optional on lower-priced models. The engine is an overhead-cam type that overcomes a weakness of the 1.4-liter (85-cu.-in.) engine: lack of midrange power. The 1.7 will furnish passing power at highway speeds, in addition to being quicker in stop-and-go traffic. I hand-timed a zero-to-60-mph reading of less than 15 seconds in an automatic-transmission-equipped convertible.

The big news for the four-wheel-drive Jeep Cherokee and Wagoneer

lines is a 2.1-liter (128-cu.-in.) turbo diesel. Rated at 85 horsepower and 132 foot-pounds of torque, the diesel will be slow compared with gasoline engines. (I hand-timed a 19-second zero-to-60 run.) But mileage will be high for this type of vehicle. In ordinary driving, buyers can expect economy in the 30-mpg range; gas engines with the same five-speed manual will reach only about 20 mpg.

Three features of the turbo diesel are different: an aluminum block, an intercooler for the turbo, and an overhead-cam design. The turbo, with the added power from the intercooler, is designed to pump the air-fuel mixture to the engine at lower speeds. There is also less lag between power demand (when the accelerator is depressed) and power delivery (when the turbo kicks in). A water separator is included in the diesel-fuel-delivery system to prevent burning of water-laden fuel.

PS

**GM '85
for 85**

Chevy's new-generation mini-van



Astro's electronic instrumentation generates brightly colored information.



Aerodynamic details include near-flush door handles, a bonded windshield, flush side glass, and sleek side-view mirrors.

After trailing other mini-van makers, Chevrolet unveils its rear-drive Astro, betting that V6 power and a higher payload will appeal to those waiting for Chrysler's front-drive.

By **JACK KEEBLER**

The Chevrolet Astro mini-van is the latest in vehicle shrink-think from General Motors. Power for the M-van, which is about 800 pounds lighter than the full-size G-van, will come from either the 2.5-liter (151-cu.-in.) "Iron Duke" four-cylinder engine rated at 92 horsepower or the op-

tional 4.3-liter (263-cu.-in.) 90-degree V6 rated at 145. EPA city fuel economy should be about 25 mpg for the four and 20 for the V6, say Chevy sources. Combine that kind of mileage with the 27-gallon fuel tank, and you can see the potential for long-range cruising. There are three transmission choices: a Muncie four-speed manual, a Borg-Warner five-speed manual, and a four-speed automatic.

Why did GM decide on rear drive? "We considered front drive," said Harvey Edson, assistant staff engineer for M-van development. "But we felt that for this application, which is commercial as well as passenger, the traction and gradability [hill-climbing ability] of rear drive would be superior to that of front drive."

A more obvious indication that the

vehicle was designed with an eye toward the commercial market is the Astro's 2,500-pound payload. (Compare that with the Chrysler van's 1,700-pound payload.) Astro also has a 5,000-pound towing capacity; the Chrysler, with the optional 2.6-liter (156-cu.-in.) engine, can tow only 2,000 pounds. And to brake the bigger loads Astros will haul, Chevy fitted 12-inch vented discs in the front and 9½-by-two-inch drums in the rear.

Suspending the sleek (0.38 drag coefficient) sheet-metal body are coil springs and unequal-length upper and lower A-arms in front. Innovative fiberglass variable-rate leaf springs and a live axle support the rear. Watch for a head-to-head PS road test of the Astro, Chrysler mini-van, and Ford Aerostar van early next year. **PS**

A small car can tow this 20-foot trimaran, thanks to retractable floats. Extended, the outriggered floats create a spacious, stable sailboat.

By SUSAN RENNER-SMITH


Swift as a racer in brisk winds yet stable as a raft—that's the Eagle. More, this 19½-foot-long craft is roomy enough to seat six day-trip sailors and to sleep three overnight. Yet the 14¾-foot-wide trimaran telescopes to just eight feet, making it legal for trailering.

The unique craft was designed by New Zealander Ian Farrier. Farrier is known for his "Trailer-tri" sailers—folding home-builts made of plywood. Though the Eagle is a commercially built fiberglass boat (U.S. maker: Pyramid International, 7503 Chipewa, Houston, Texas 77238), its floats, or amas, fold for trailering like Farrier's early designs.

The amas are bolted to tubular outriggers. Two A-shaped supports extend from the main hull to the midpoint of each tube. The supports allow the amas to swing down 90 degrees, snug against the main hull. It takes two minutes to fasten the tubes in place for trailering and about the same amount of time to extend the outriggers to their full length.

Once underway, this commodious craft has features that appeal to both family-oriented day-trippers and serious sailors. First, there's speed. In light winds the Eagle keeps pace with similarly equipped mono-hulls. But in medium to heavy winds the craft's amas slice through swells without getting swamped (as a heeling mono-hull can), while its large sail plan (225 sq. ft.) moves the boat briskly at reported speeds of up to 20 knots (23 mph).

An open boat, the Eagle has some features not found on some boats with cabins. The optional canopy, for example, can stay up under sail—a boon if you've ever traveled before the wind on a hot, cloudless day. A large icebox holds three beverage cases.

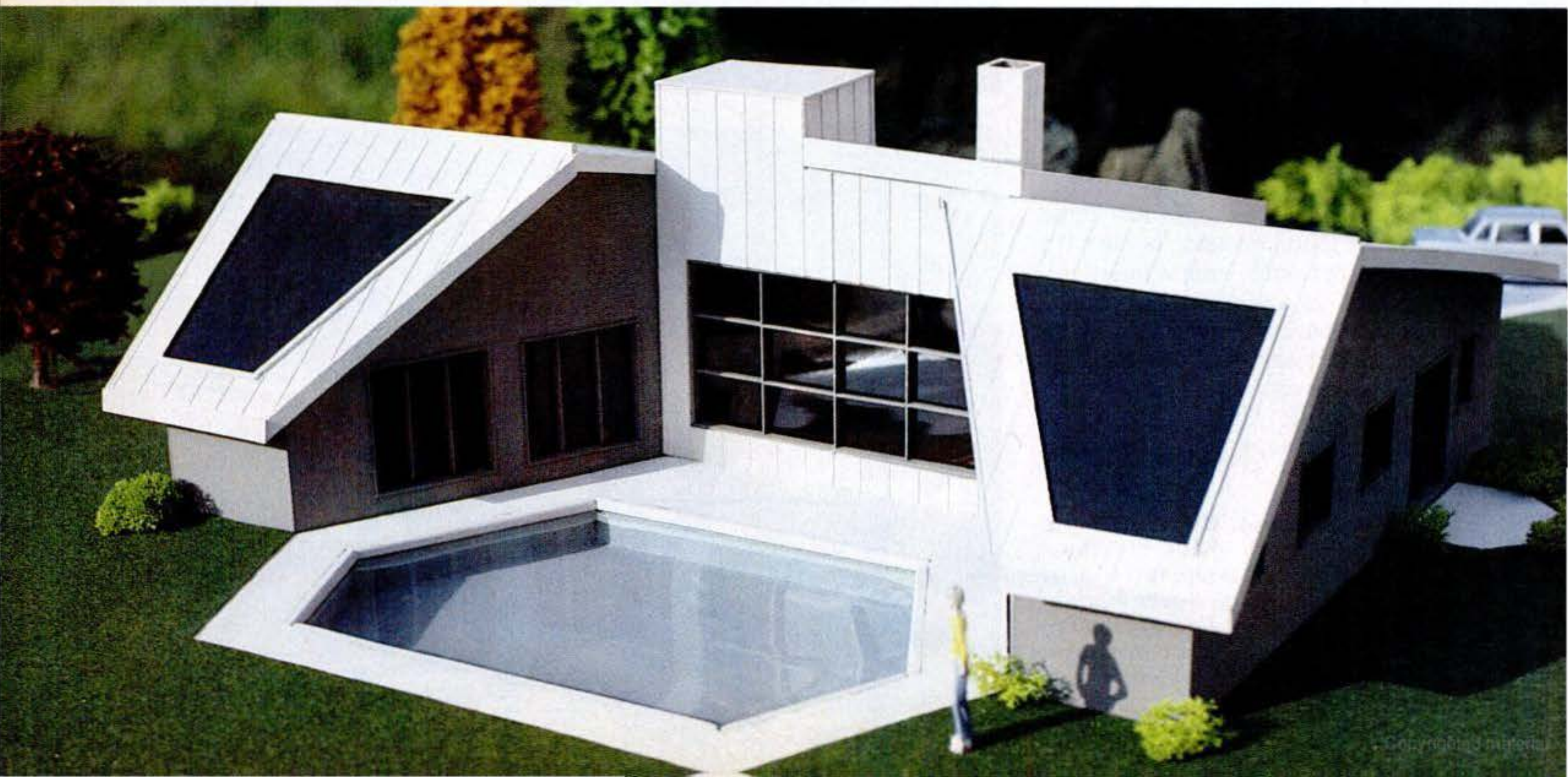
With trailer, the Eagle costs \$12,658. The canopy adds \$385. 

A go-anywhere boat, the Eagle (top) has a shallow draft. With the four-ft. centerboard up, it floats in 15 in. of water. On land, it can go where equally beamy boats can't. Folding outriggers (middle) telescope the boat to trailer size (bottom). Launched folded, it uses standard ramps.



Popular Science leisure-home plan

Compact solar—with pool



A gracious home packed with amenities needn't exceed 1,000 sq. ft. of floor space. This laboratory-tested passive-solar model has a metal roof—and a swimming pool.

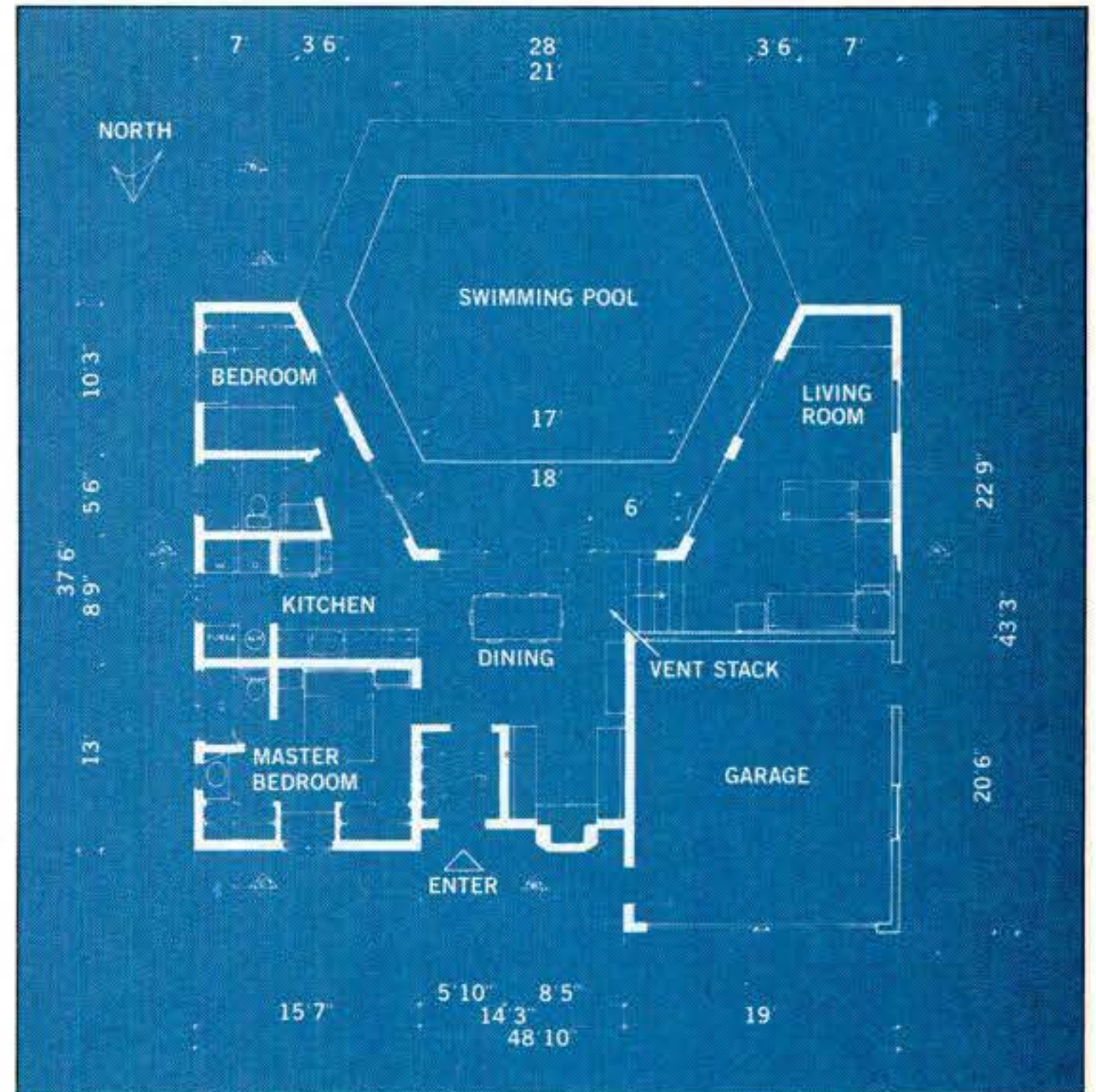
By AL LEES

While offering fairly conventional "curb appeal"—except for the novelty of that ribbed metal roof (top photo, opposite page)—this home changes its personality when viewed from the south (bottom photo, opposite page). This house is presented as a scale model, rather than in the usual artist's rendering, because San Francisco Bay-area architect Suzanne P. Booth has access to the sky dome (for testing solar gain) at Lawrence Berkeley Laboratory, and such testing requires an accurate model. During tests Booth adjusted the model for optimum results then drew up final plans.

Though infrequently used on houses, metal roofs can be a design feature [PS, Oct. '83]. The type chosen for this house has two-inch battens, is light-colored to reflect the sun (to prevent overheating), is lightweight and fireproof, and lasts the life of the building.

It's hard to believe that so much gracious living has been packed into a 994-sq.-ft. floor plan (Plan A), but bear in mind that a well-designed small house offers many advantages: lower construction time and cost, of course, but also lower taxes and insurance, lower energy consumption, and lower maintenance. For those who want a slightly larger version, Booth has incorporated an additional 300 sq. ft. in Plan B, which offers larger bathrooms and bedrooms and an optional basement.

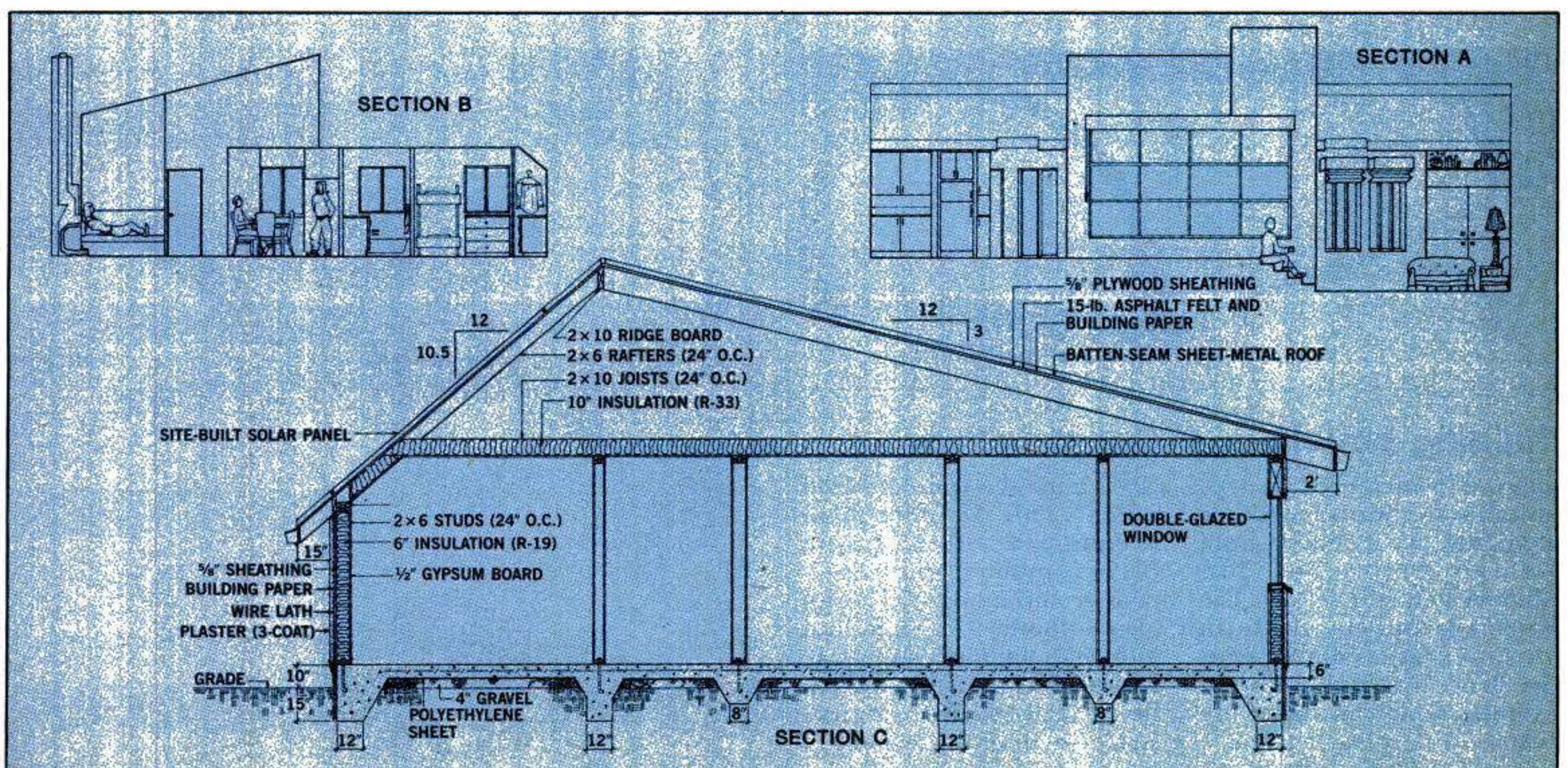
The two south wings that flank the pool define living areas. The west wing is a large sunken living room entered by five-foot-wide stairs (for extra party seating). A ventilation chimney above contains a bidirectional fan: It exhausts heated air through vents in summer and blows it back into the house in winter.



The kitchen, laundry, and bathrooms are adjacent to each other in the east wing for efficient plumbing runs. The moderating effect of the pool's water mass is part of the solar design. Thermosiphon collectors on the 45-degree-angle roofs heat the pool and domestic hot water. Concrete floors in the living room and the central "great hall" are covered with ceramic tile to provide storage mass for direct solar gain. **PS**

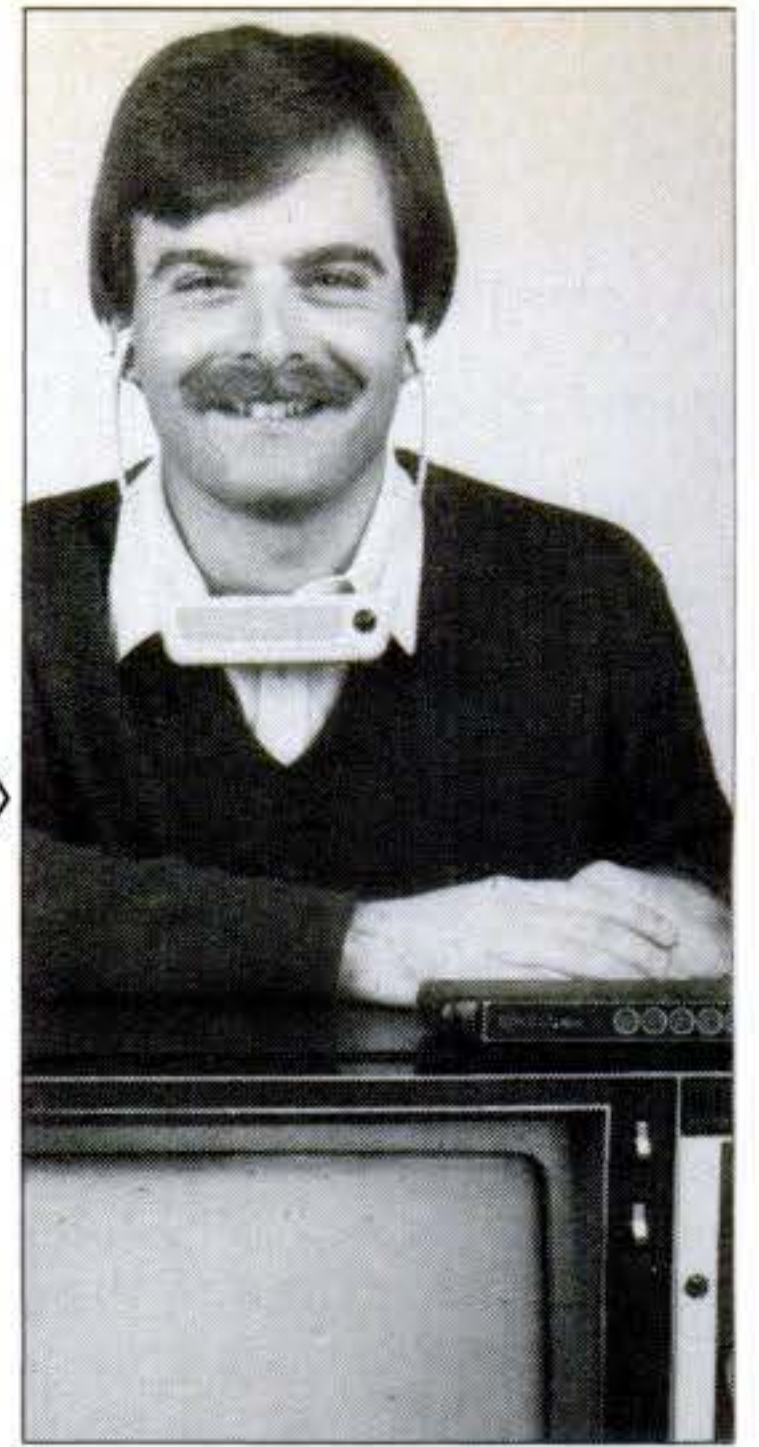
How to order your plans

One set of detailed, professionally drawn blueprints for this house is \$75 and includes a solar diagram; each additional set ordered at the same time (for construction, financing, and obtaining permits) is \$15. A materials list costs \$20. Address orders or queries (specify Plan A, 994 sq. ft., or Plan B, 1,300 sq. ft., with or without basement) to S.P.B. Design, 3106 Sweetbrier Cir., Lafayette, Calif. 94549. Add \$3 to all orders to cover postage and handling.



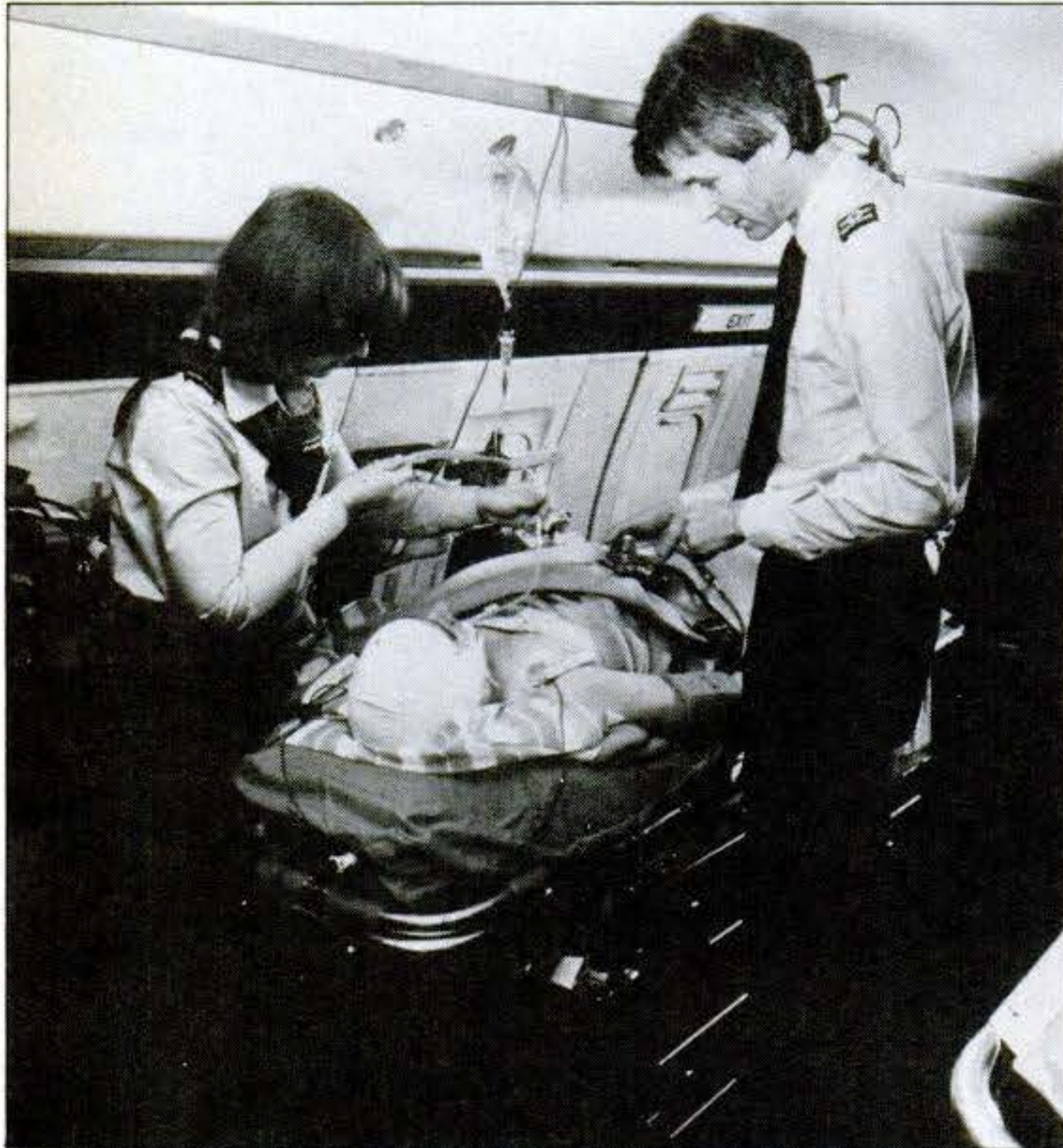
What's New

products/technology



TV headphones

Sound Plus boosts the sound volume for hearing-impaired persons, while others hear programs at normal levels. A TV mike and transmitter relay audio to headset receivers via infrared light. Price: \$200. Controlonics Corp., 5 Lyberty Way, Westford, Mass. 01886.



Flying ambulance

Doctor and nurses can supervise up to eight patients on a Canadair Challenger jet converted by Swiss Air-Ambulance REGA. The service also has two Learjets and 12 helicopters. Since 1960 some 6,000 patients have been returned to their countries by the donor-backed service.

Hot wagon

VW's test-bed Polo Sprint has a rear-mounted fuel-injection 155-hp engine instead of the usual 50-hp front-drive. A supercharged flat four delivers zero-to-60-mph acceleration in less than eight seconds and top speed of 125 mph. VW modified the car for handling tests.



Building panels

Curved translucent panels, suitable for walls, roofs, or skylights, are available from Kalwall Corp. (Box 237, Manchester, N.H. 03105). The Kalcurve panels, made in various sizes, complement the firm's flat wall-and-roof system, which is based on bonded fiberglass sheets.

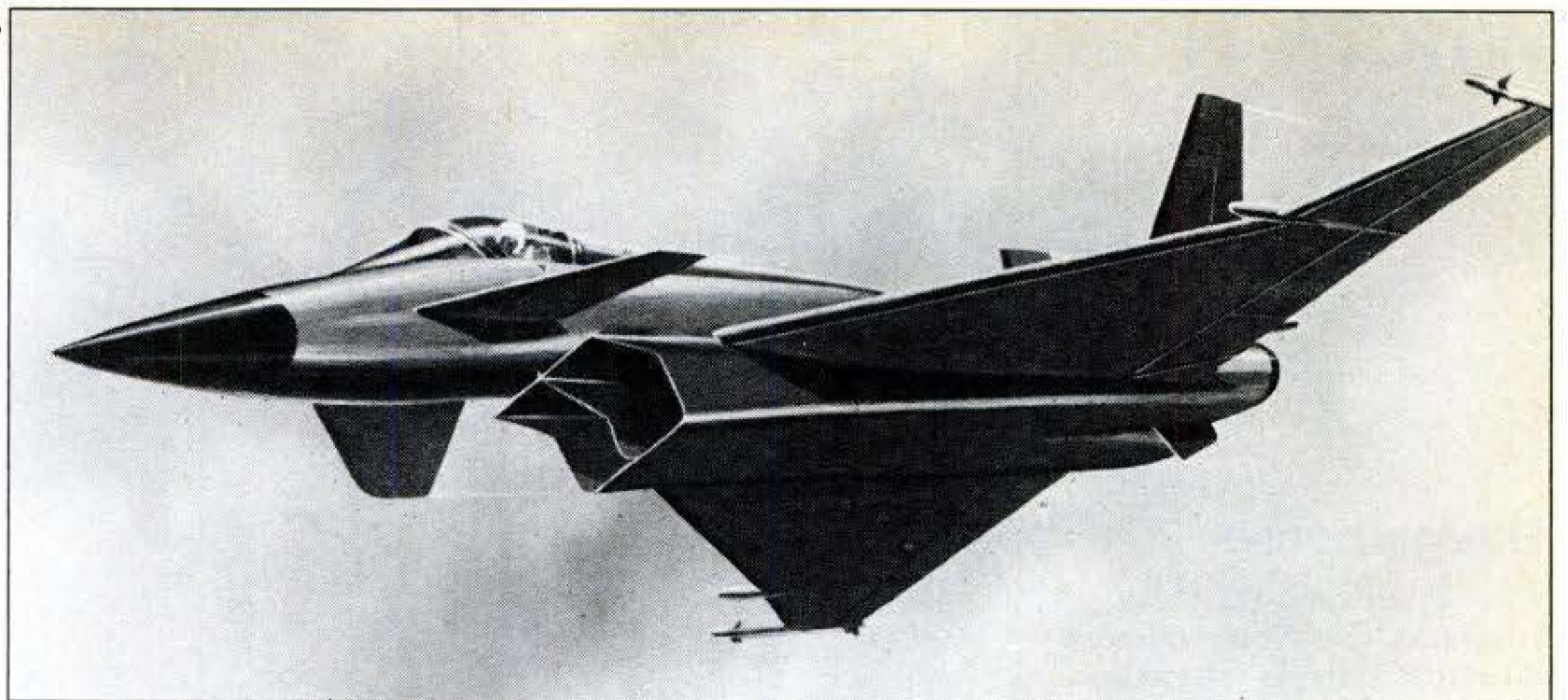
Computer car

Need a mobile computerized office? This Daimler limo is equipped with an Epson HX20 computer and a Sony printer and monitor. There's also a phone, TV, VCR, and hi-fi gear. Jaguar's super-car is powered by a 164-hp 4.2-liter (256-cu.-in.) engine. Price in Britain: \$68,000.



Future fighters

To dodge missiles and other supersonic jets, says West Germany's MBB, highly maneuverable fighters for the 1990s will have these features (right, top): a modified delta main wing, small front canard, twin rudders, and intakes for twin jet engines mounted under the single-seat fuselage. Rockwell International's idea for a subsonic-to-supersonic fighter (right, bottom) is also a twin-jet, twin-tail single seater, but without the canard. Rockwell engineers plan to use big leading-edge flaps for tight maneuvering. A deflected jet exhaust would reduce takeoff time and aid combat maneuvering. The plane would be 60 ft. long with a 47-ft. wingspan.

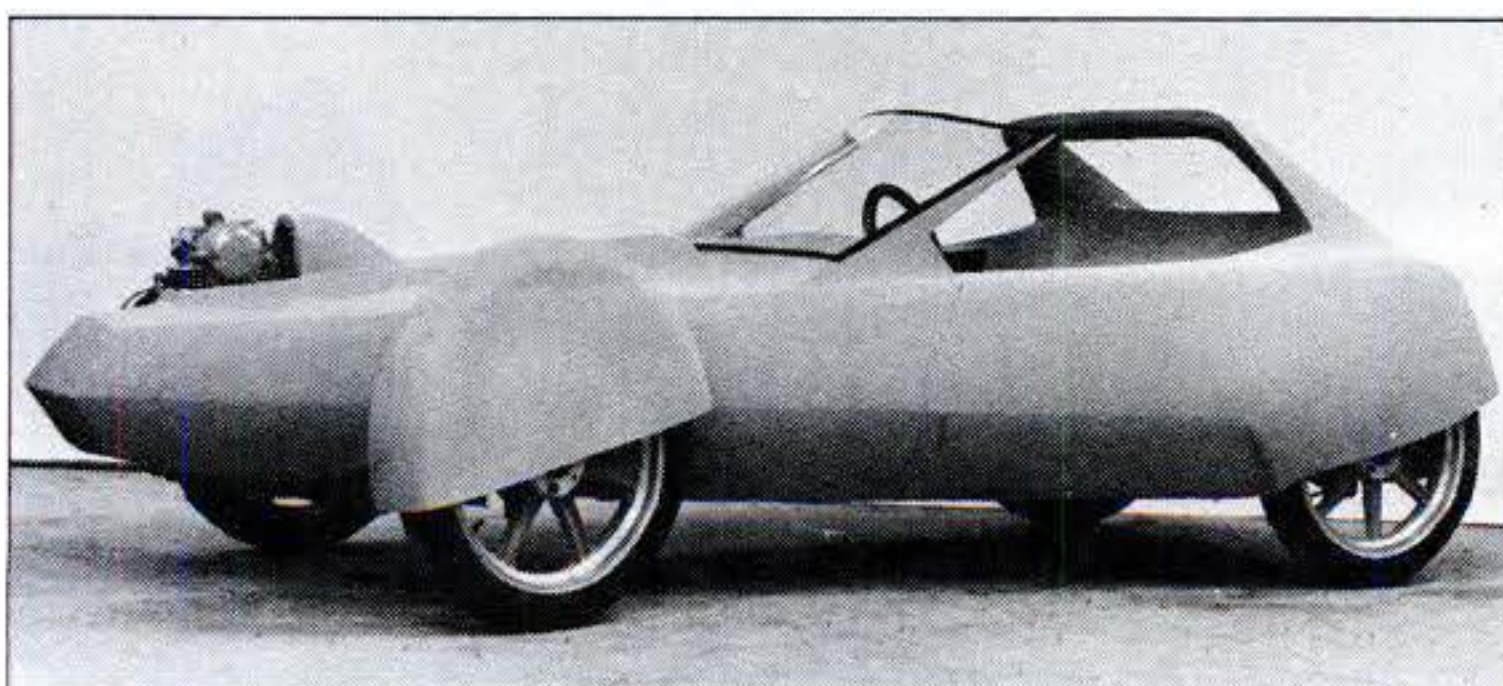


Solar charger

Hook up the M82 solar module to trickle-charge batteries for recreational vehicles, camp lights, and other applications, says Atlantic Solar Power, Inc. (6455 Washington Blvd., Baltimore, Md. 21227). The charger measures 11¼ by 14¼ in.

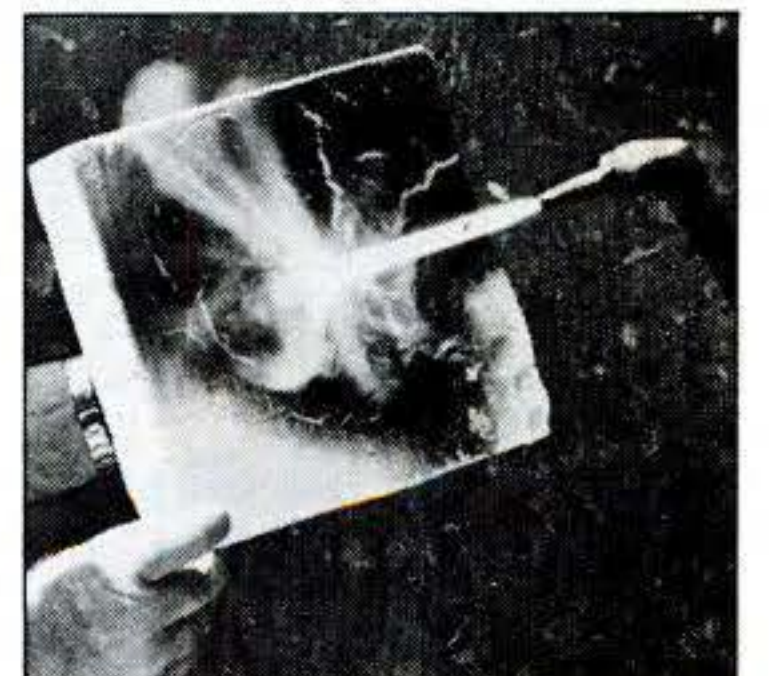
Plastic-body van

The 65-in.-high Espace has a glass-reinforced polyester body with a drag coefficient of 0.32, says Renault. The front-drive van seats seven in three rows. Cargo capacity: up to 160 cu. ft. A 110-hp gasoline engine and 88-hp turbo diesel are options. It's not available here.



100-mpg car

Top speed for its 100-mpg \$5,500 commuter car is 85 mph, says Design Evolution 4 (Box 143, Lebanon, Ohio 45036). The 40-hp single-cylinder engine drives a five-speed transmission. Zero-to-60-mph time: 13 seconds. A plastic body cuts weight to less than 500 lbs.



Sporty hatchback

Fiesta XR2 from European Ford has a 1.6-liter (98-cu.-in.) 96-hp engine that gives it a top speed of 112 mph. Acceleration to 60 mph takes 8.7 seconds. Ford says mileage is 39 mpg highway, 26 city. Ventilated front disc brakes and a beefed-up suspension are standard.

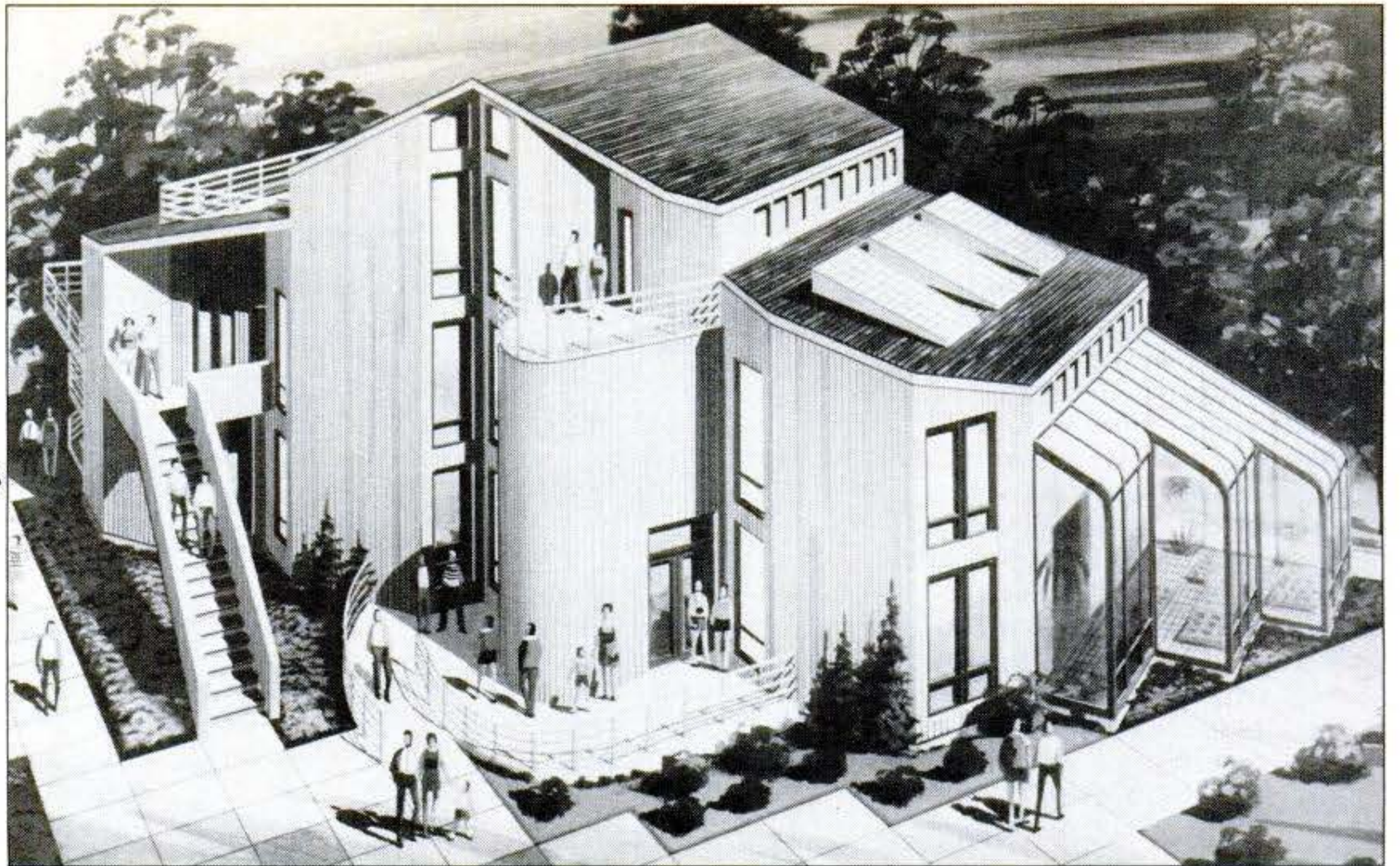
Plastic insulation

Red-hot Positherm sheets block heat from bare hands, but Feuchs Technologies (16 Lake St., White Plains, N.Y. 10603) says its new plastic building insulation will help trim fuel bills. The cellular plastic has an insulating value of about R-5 per inch and the highest fire rating.

What's New

Energy house

The 7,500-sq.-ft. Design Home at the New Orleans World's Fair is sheathed from roof to foundation with 6,800 sq. ft. of $\frac{3}{4}$ -in.-thick foam board. Cedar siding faces the "thermal envelope," which encloses four in. of batt insulation. The wall system has an R-value of 19.



Advanced STOL

A unique rectangular wing with angled wing tips distinguishes this Dornier amphibian from its ancestor—a World War II flying boat that was used for rescue missions until the '70s. Three Pratt & Whitney turboprop engines power the experimental STOL craft.

Bike bags

A lever-locked mount secures the Kirtland ST II panniers on even the roughest rides, claims Hine/Snowbridge (Box 4059, Boulder, Colo. 80306). The \$100 packs snap together to be carried like luggage when off the rack. The \$80 handlebar bag has a shoulder strap.



Light amphibian

Another amphibian, the Sun Ray, weighs just 250 lbs. The key? High-strength, lightweight Kevlar aramid fibers, honeycomb foam, and Mylar polyester foil. The 13.3-ft.-long plane's fuel-sipping 30-hp engine hits speeds of 63 mph. Sun Aerospace, Box 317, Nappanee, Ind. 46550.

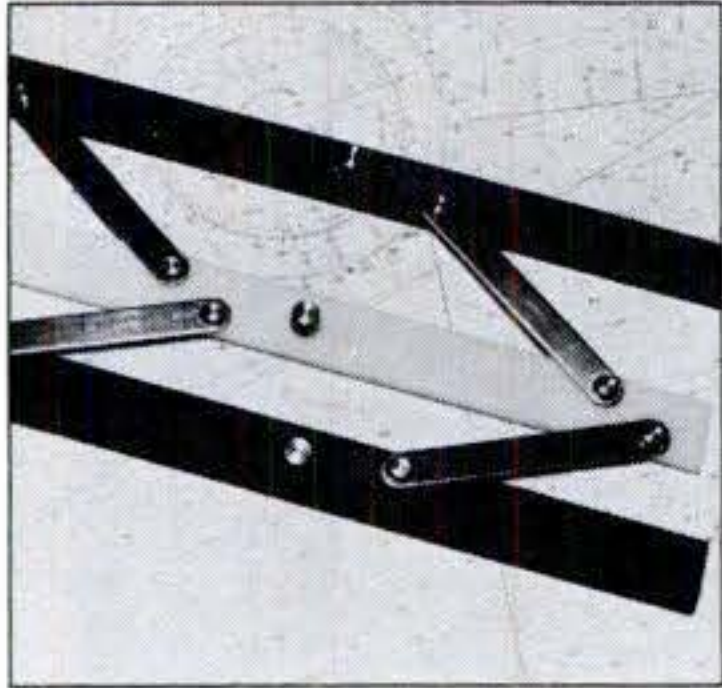
Sit-down skis

Like a downhill skier, this toboggan rider zigzags on a slalom course. The Swingrodel sled's flexible-plastic control arms twist and angle the broad runners, giving a smooth, safe ride over ridges and troughs, says Rudisport (Johannes-Weisser-weg 8, 7900 Ulm, West Germany).



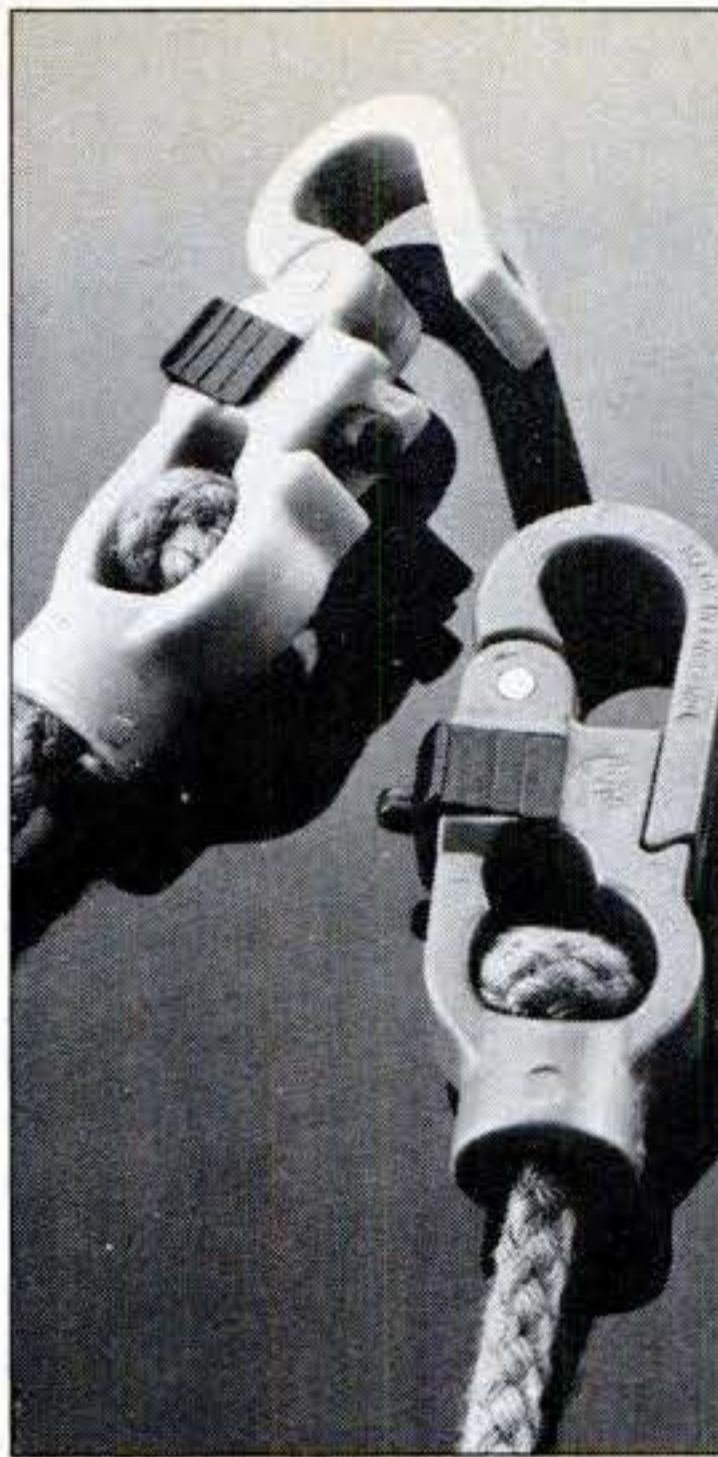
What's New in Boating

BY SUSAN RENNER-SMITH



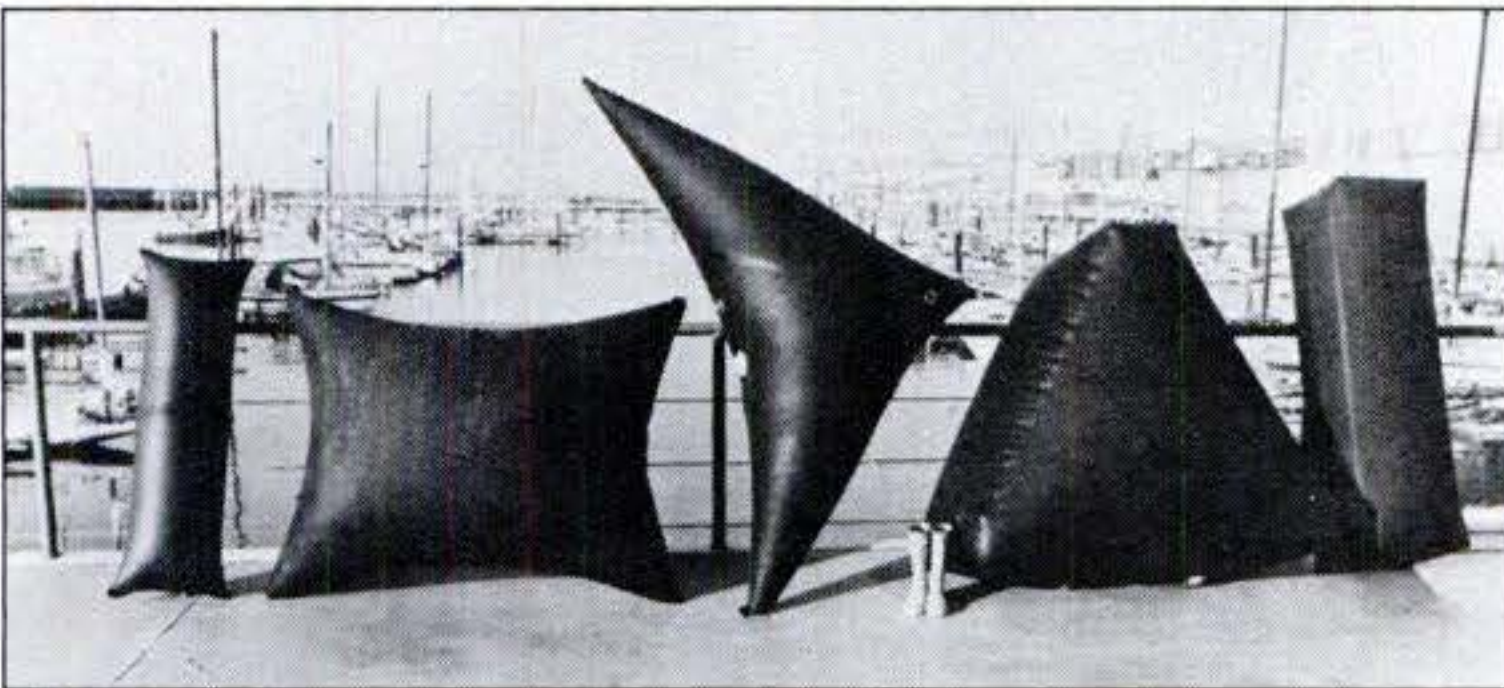
Triple rule

A parallel rule with an extra blade cuts error-causing slips when charting a course. It moves in four directions so it's easy to transfer a course line to the compass rose without moving the chart. Page Machine, Box 1197, Port Washington, N.Y. 11050; \$23.



Quick shackles

No splicing needed—a single knot secures a line to the S-Clip shackle. A sliding plunger locks the high-strength plastic shackle closed; finger grips retract it for quick release. A pair costs \$28.25 from Imtra Corp., 151 Mystic Ave., Medford, Mass. 02155.



Safety pillows

Unsink bags have lift ratings of up to five tons to convert a capsized boat into a life raft. The bags stow in less than one cu. ft. of space and inflate in one minute with compressed air, according to Mountracken (Brighton Marina, Brighton, Sussex BN2 5UF, England).

Double-duty heater

The Minibachi cabin heater burns coal, charcoal, or wood, and doubles as a cook stove. Sliding doors adjust cooking temperatures. The \$399 stainless-steel-and-ceramic unit conforms to safety standards, says The Meredith Co. (Box 6907, San Diego, Calif. 92106).



Contrasting catamarans

Molded-plastic bows on inflatable hulls and a 107-sq.-ft. sail make the 16.3-ft. Catapult (top) a performance craft, says Catapult Craft (84 Broom Park, Teddington, Middlesex TW11 9RR, England). Disassembled, the 179-lb. boat stows in a car. At 650 lbs., the 23-ft. Stiletto (above) can be towed. Yet the super-strong, Kevlar aramid-fiber-composite hulls stand up to the high speeds created by their "lifting body" design. The rotating airfoil mast carries a 245-sq.-ft. main; the roller-furling jib is 105 sq. ft. Maker: Force Engineering, 5329 Ashton Ct., Sarasota, Fla. 33583.

What's New in Tools

BY V. ELAINE SMAY



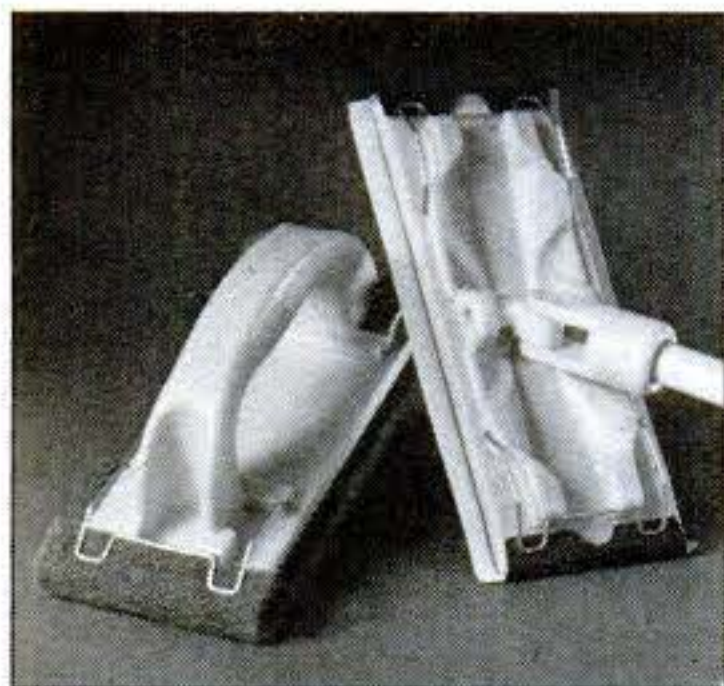
Shop shape-up

Bins, brackets, hooks, and shelves all fit into the grooved wall panels and cabinets of this German-designed modular storage system. You can buy one cabinet or panel (of foamed PVC) or outfit the whole shop. Concept 2001, Inc., 1321 N.W. 65th Pl., Fort Lauderdale, Fla. 33309.



Tube trimmer

Soon-to-be-introduced Swing-Saw (about \$40) cuts tubes dead-square every time. An integral vise grips metal or plastic tubes, rods, or flexible conduit up to 1½ in. in dia. As you pull the hand lever, a hacksaw makes the cut. Seatek Co., 396 Pacific St., Stamford, Conn. 06902.



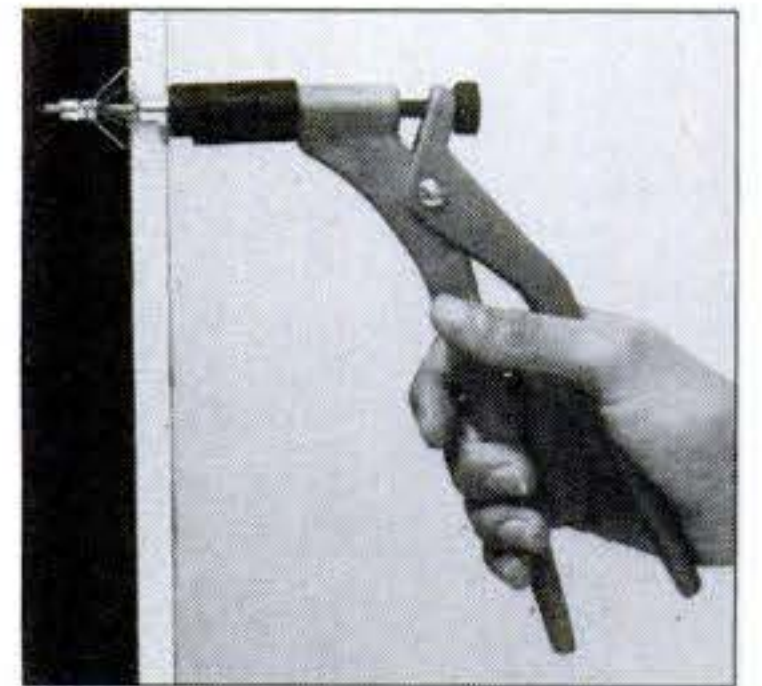
Handy sanders

Attach any threaded broom handle to Allway's Universal Pole Sander (\$8), and you can sand walls and ceilings while standing on the floor. Like the company's Universal Hand Sander (\$6), it takes four-by-11½-in. sanding sheets. Allway, 1513 Olmstead Ave., Bronx, N.Y. 10462.



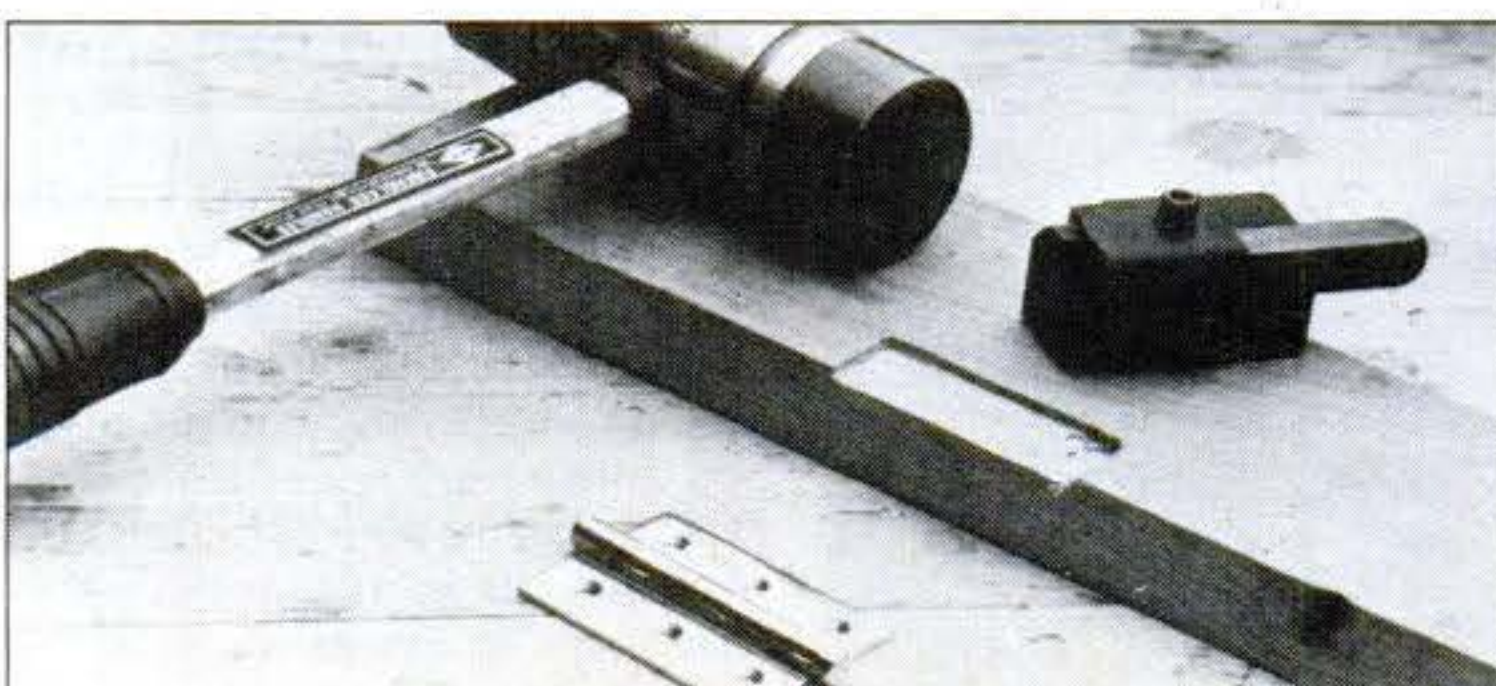
Jointed ladder

The Professional Adjusting Ladder has special hinges that lock in many positions. Result: The aluminum ladder can assume 24 shapes. Chase Marketing (1110 W. Pembroke Ave., Hampton, Va. 23661) sells it in 8½-, 12½-, and 16½-ft. lengths for \$219, \$229, and \$249.



Molly squeezer

Does your hand grow numb around the screwdriver when you install hollow-wall anchors? With the Molly Lightweight Universal Installer (\$12; Emhart Fastener Group, 504 Mt. Laurel Ave., Temple, Pa. 19560) you need no screwdriver; you expand the anchor by squeezing the handles.



Square chiseler

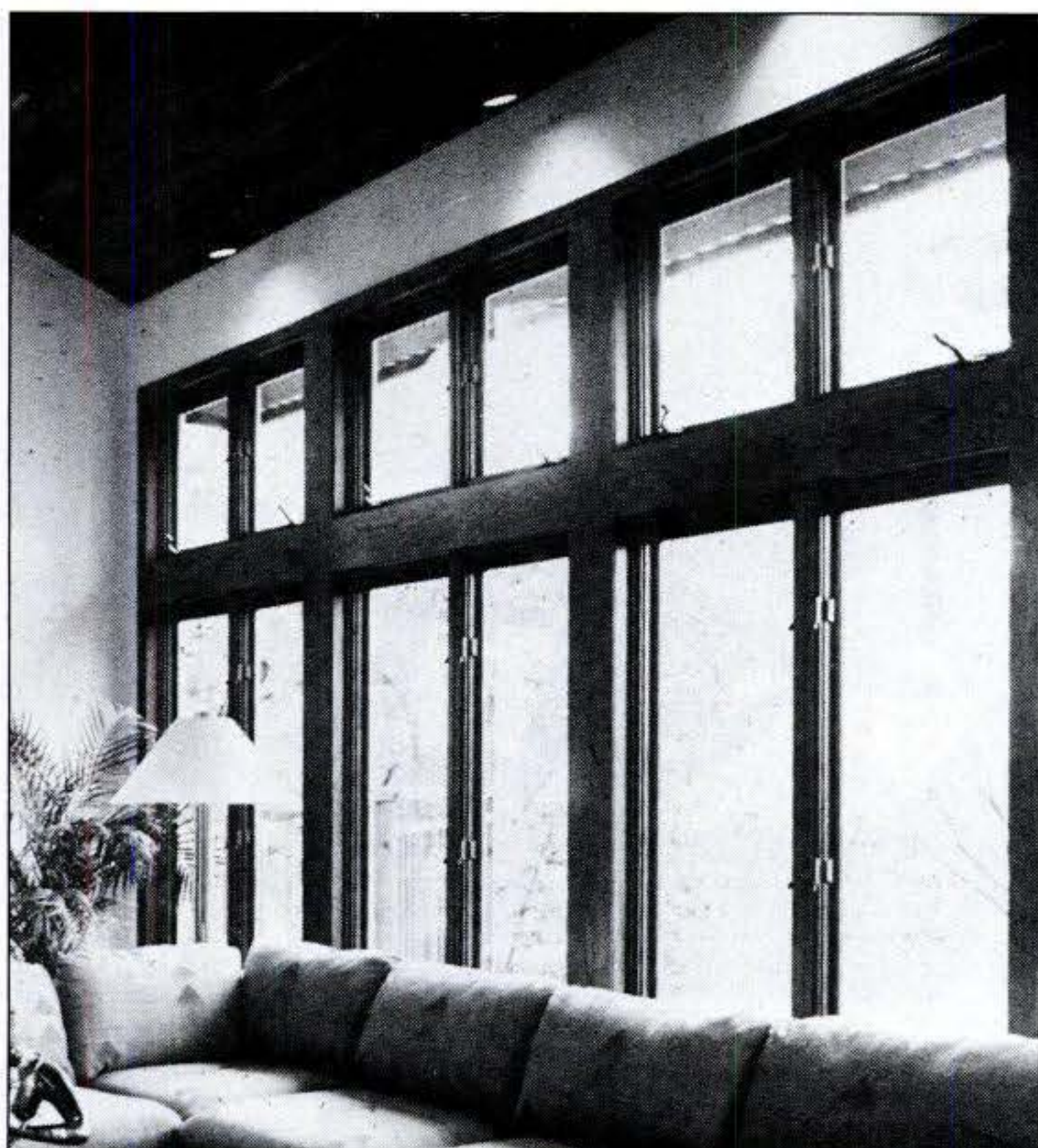
Just hold the self-aligning Corner Chisel in place, and strike several times with a hammer to cut perfect square corners every time, says Shopsmith Inc. (750 Center Dr., Vandalia, Ohio 45377). The quick spring action of the \$9 chisel makes it strong enough to last, it's claimed.

What's New in Home Improvement

BY SUSAN RENNER-SMITH

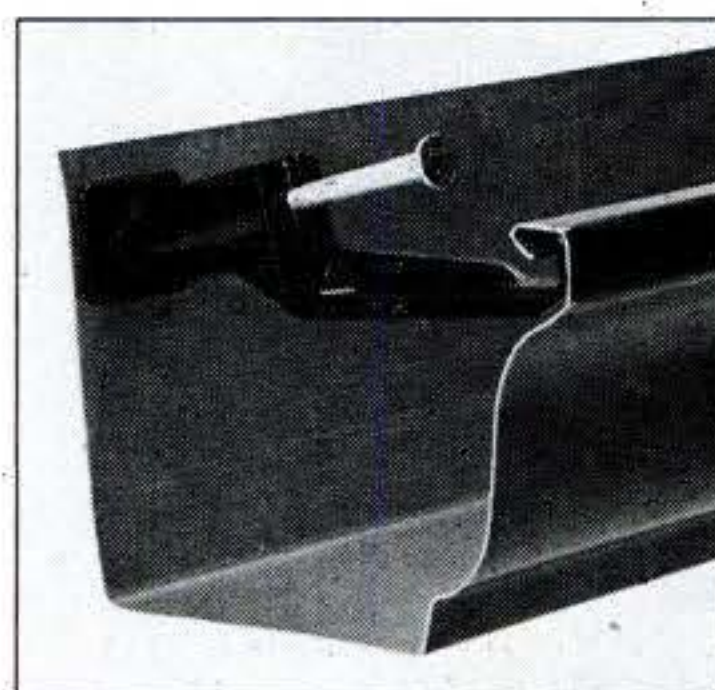
Skylight blind

The pleated-polyester Skyblind not only dims glare, it reflects heat from its aluminized outer surface. The same coating blocks winter heat loss, claims its maker (APC Corp., Box 515, Hawthorne, N.J. 07507). Price: \$70 to \$170, depending on size.



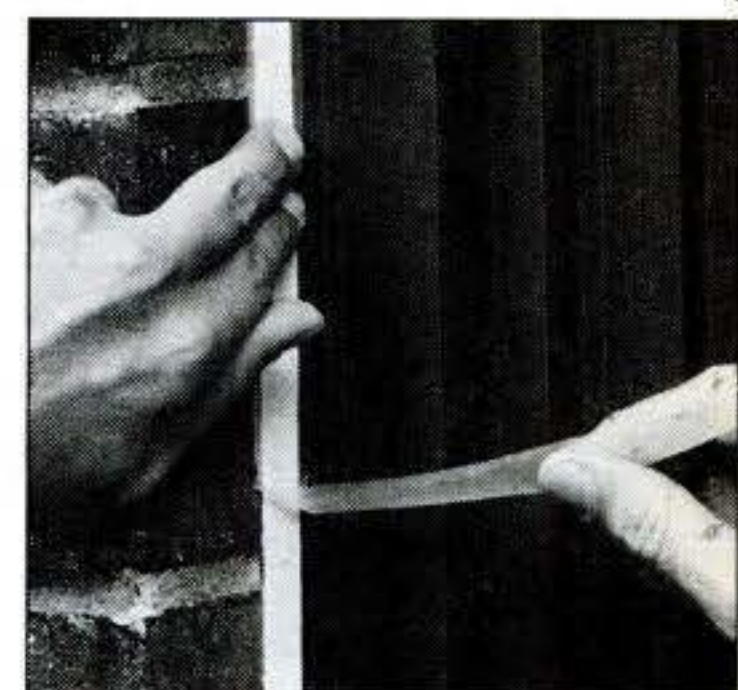
Heat-trapping windows

Double-pane windows coated with a thin layer of metal reduce winter heat loss (and summer air-conditioning loads) better than triple-pane glass [PS, April '82]. The transparent coating transmits visible light but blocks infrared radiation, keeping heat in—or out in the summer. The insulating glass is available from Marvin Windows (8030 Cedar Ave. S., Minneapolis, Minn. 55420) in Marvin Terrace doors and Casemaster windows (top). Andersen Corp. (Bayport, Minn. 55003) features the glass in its line of Perma-Shield Narroline double-hung windows (above).



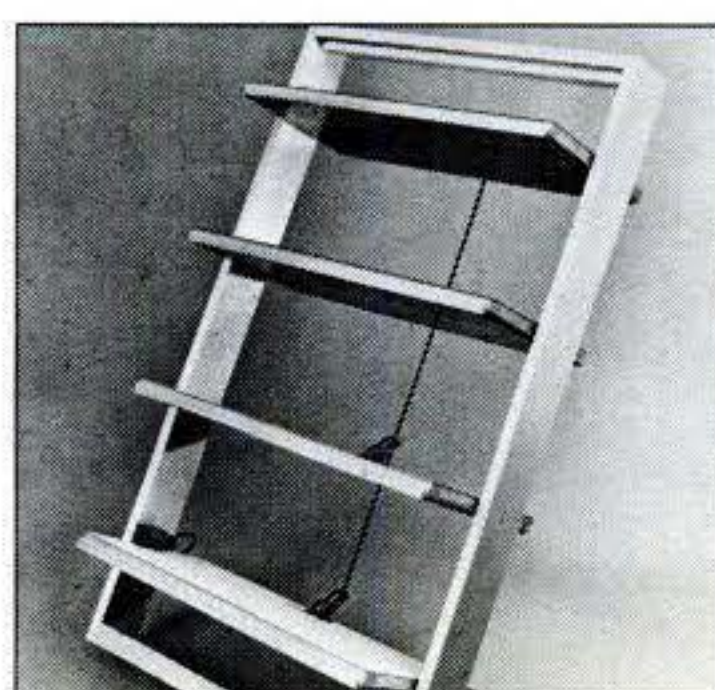
Gutter hanger

The polycarbonate Skyhook is stronger than ordinary gutter hangers, so fewer need be used, says Wolverine Distributing (1140 Crawford, Windsor, Ont., Canada N9A 5C9). Just 50 (\$30) are needed for an average house. The pre-drilled hook is also easier to install, says the maker.



Ribbon caulk

No guns, no tubes, no cans—Press-in-Place caulk is a preformed version of the old rope caulks. But this blend of two premium butyls makes a permanent seal and resists expansion better than most cartridge caulks. 3M backs it with a 20-year warranty. A 22-ft. roll is \$5.



Sky louvers

Prefer shutters to shades? Foil-faced InsulLouvers have an insulating value of R-9.1, says the maker (First Law Products, Box 888, Keene, N.H. 03431). The hardwood louvers for skylights come with a high-torque electric motor mounted in the frame. Price: \$18 a sq. ft.

What's New in Electronics

BY WILLIAM J. HAWKINS



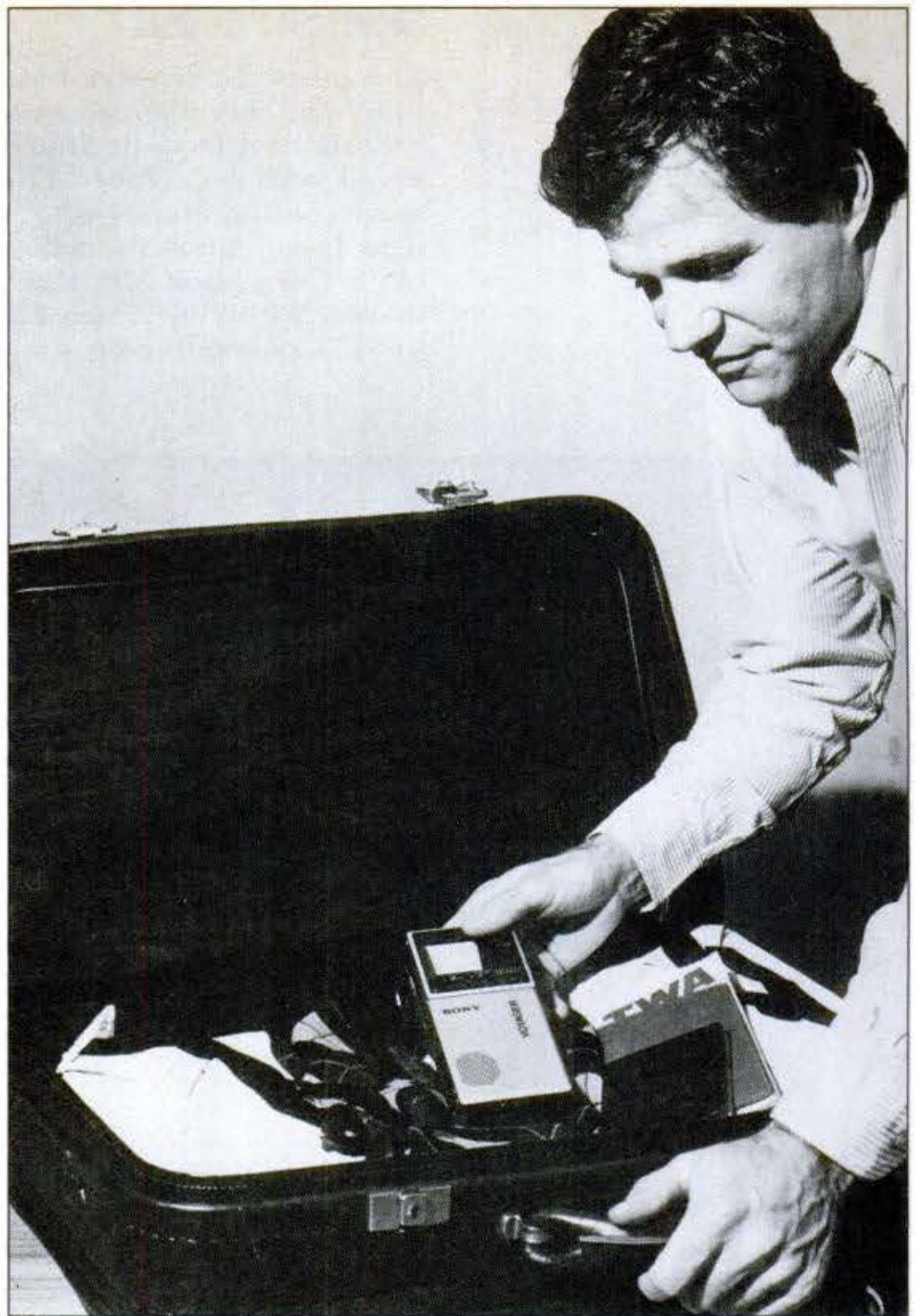
Auto-redial phone

Busy—again? Don't get angry. Get the GE MainFone Speakerphone. If it reaches a busy number, it tries again—every 30 seconds—and beeps when it gets through. The \$140 desk/wall phone has a 16-number memory and a built-in speaker for hands-free conversations.



Lightest camera

Autofocus, f/1.5, 3:1 zoom lens, internal LED status displays, through-the-lens viewfinder, and four light-balance control settings—what doesn't the Konica CV-601 video camera have? Weight. It's only 1.8 lbs. It will be available soon; the price has not yet been set.



TV to go

Inside the Sony Voyager Watchman portable TV is a multi-system tuner. That means the pocket portable can tune in broadcasts in the U.S. and in more than 60 foreign countries that use European broadcast standards. The black-and-white set with two-in. screen costs \$240.



Ruler calculator

A solar-powered calculator is built into this $\frac{3}{32}$ -in.-thick six-in. ruler. Now you can measure the accuracy of your computations. It's distributed by Technico, 1328 Broadway, New York, N.Y. 10001. Price: \$20.

Waisted batteries

This battery belt goes around your waist and powers a VCR and camera for up to four hours, says Saft America (Box 1886, Valdosta, Ga. 31603). A battery charger (included) brings the gel cells up to full strength in 16 to 24 hours. Price: \$100.



Call recorder

Connect Dial Log 1 to your phone line. Whenever you place a call, the clever box records the number dialed and the date, time, and length of the call. Compare the printout with your phone bill. XEX, Box 1109, Carson City, Nev. 89702. \$395.

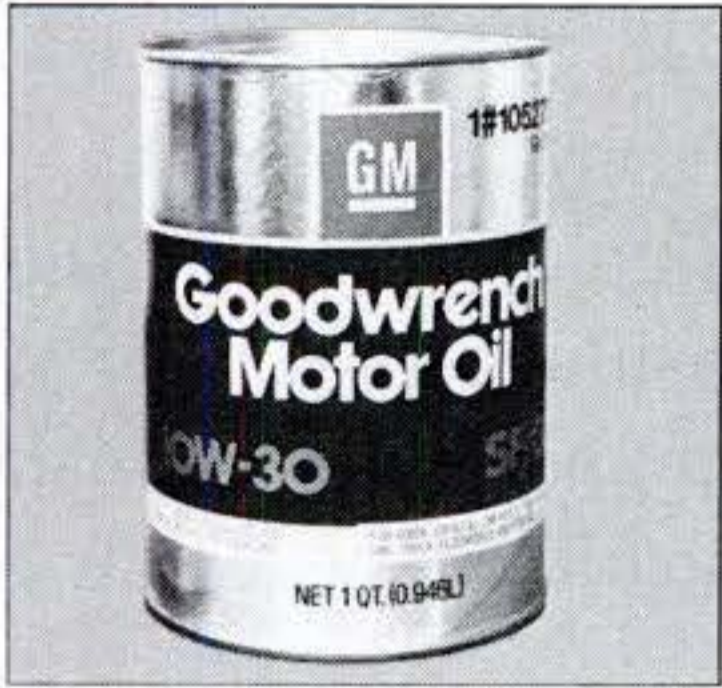


Family member

It sings "Happy Birthday," recites poetry, speaks two languages, roams through rooms to guard your home, wakes you up for work, plays games, and takes orders for special jobs. Other than that, Heath/Zenith's Hero Jr. is just your average \$1,000 pre-built home robot.

What's New for Your Car

BY JACK KEEBLER



GM motor oil

General Motors is now marketing its own motor oil. Produced by outside suppliers to GM's requirements, Goodwrench Motor Oil is available in four grades: SAE 5W-30, SAE 10W-30 SF/CC, SAE 15W-40 SF/CD, and SAE 30 SF/CC. It's available at GM dealerships.

Wagon loader

Load the four-legged platform with cargo. Wheel it out to the empty wagon. Combideck's legs fold automatically as you push the loaded platform into the car. Hooks on the pallet permit strapping down loose loads. Trivselprodukter, Box 192, 151 22 Sodertalje, Sweden.

Compact players

Now compact-disc players are small and rugged enough to go in a car. Pioneer's compact CDX-1 system (top) has two parts: the "operating" module in the instrument-panel cavity and the "processing" module in a remote location. Sony's CDX-R7 disc player (bottom) incorporates a quartz-frequency-synthesis AM-FM tuner. A laser-optic assembly one-third the size of designs for its home players makes possible the small auto unit, says Sony. Retail prices and availability haven't been announced.



Anti-theft audio

Aiwa's CT-X500 has two anti-theft features. When its hinged panel is closed, a would-be thief can see only a flat black plate. In addition, the radio can be easily removed with a special Allen wrench when the owner parks in a high-risk area. Price is not yet set.

Dash fix

Repairing or replacing a cracked dashboard can be expensive. Dash-Caps, made of ABS plastic, fit over the original dashboard. They're available for a variety of car models in five colors. Trendsetter Industries, 10183 Croydon Way, Suite E, Sacramento, Calif. 95827.



Keep the heat inside with **outside insulation**

It's been used for years on banks, hotels, and office buildings. It shows in the newly stuccoed look. Now designers are using exterior insulation—a layer of plastic and concrete—on the walls of homes. It's a tough, permanent finish with 10 times the insulation value of conventional sheathing.

By MARK BITTMAN

It makes sense: Wrap your home in plastic, and you're bound to keep heat in and drafts and cold air out. A new idea? Well, not really.

Exterior insulation has been used for some time on commercial buildings: the tall white hotel with the rough finish; the newly stuccoed office building; and the bank with the "sculptured" look. They may all have been insulated with a layer of polystyrene. Although exterior insulation has had a reputation for being expensive, more recently the cost of materials has made it competitive with brick and stucco for use on concrete structures. (It's not economical for use over wood.) And now some two dozen manufacturers offer it for residential use.

Exterior insulation typically consists of four basic component layers:

- **Insulation board.** Made of expanded or extruded polystyrene, the two-by-four-foot-by-one-inch-thick (or more) board is the primary material. It is glued or nailed directly to the shell of the house. Some boards have tongue-and-groove edges; with others, the joints between the boards are covered with adhesive tape. Extruded polystyrene has a slightly higher R-value and costs more than expanded polystyrene, but either works well.

- **Reinforcing mesh.** Made of woven fabric or fiberglass, the "chicken wire" mesh adds strength to the insulation-board base to prevent surface cracks.

- **Adhesive coat.** Typically, it's a mixture of portland cement and an acrylic or acrylic-latex bonding agent used to bond the mesh to the polystyrene board.

- **Finish coat.** This is a stucco-like coating, which protects the polystyrene from the elements and ultraviolet rays. The finish may be pre-colored or painted.

The result is "outsulation": a clean, modern-looking covering offering enormous energy savings for a variety of reasons.

Conventional cavity insulation has inherent problems: Studs (and bridges between them), corner posts, sills, electric boxes, floors, ceilings, settled insulation, and missed areas can allow heat to escape from your house. And any large temperature difference in a poorly insulated interior wall can be harmful to its finish as well. Though a careful job of cavity insulation can plug most of these problem areas, it will not insulate as well as wrapping with polystyrene board.

Just an inch of polystyrene gives about 10 times the R-value of conventional structural sheathing. And according to tests by Dow, makers of Styrofoam boards, the tongue-and-groove polystyrene sheets can reduce air infiltration by as much as 25 percent. This, of course, means lower thermostat settings, fewer drafts, and greater comfort. But there's more.

"When you wrap a house in polystyrene, any concrete-block or foundation material becomes a thermal mass," says Steve Day of Conproco, a company that uses exterior insulation on masonry structures. "Concrete and similar materials are awful insulators, but they store heat magnificently when moved inside."

Exterior insulation covers the entire external wall space, including the foundation, a tremendous siphon of heat. [For more information on exterior insulation of foundations, see PS, Feb. '83.] That makes it a particularly appealing option for any concrete-block structure in which cavity insulation is difficult to install or requires a great deal of preliminary framing. Such buildings benefit greatly by moving the thermal mass of their walls into the living space. And by adding south-facing glass, the house can become a passive-solar showcase.

Friedrich Goeman of W. R. Bonsal, makers of the Sure-wall system, points out that exterior insulation also "reduces the dangers of fire-related smoke inhalation by placing combustible insulation materials on the house's exterior." Also, because the interior of the building remains undisturbed, no interior floor space is lost. A retrofit can even be done while the house is occupied.

The tough and permanent finish coat of exterior insulation protects the building from the elements and essentially waterproofs the structure. Many of the finishes are "self-cleaning" as well: They are easily hosed down or even rinsed clean by rain. But there are some differences.

Flexibility

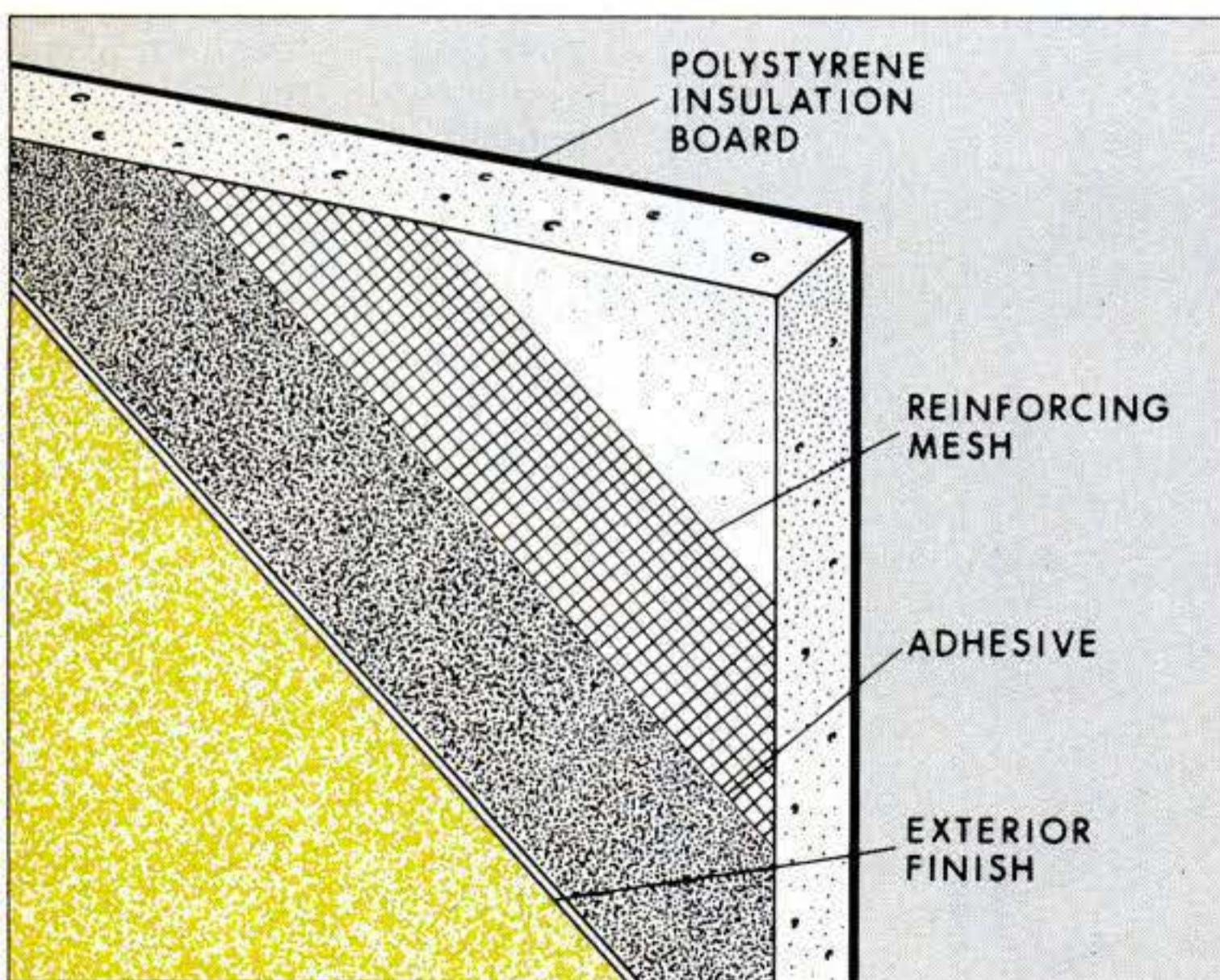
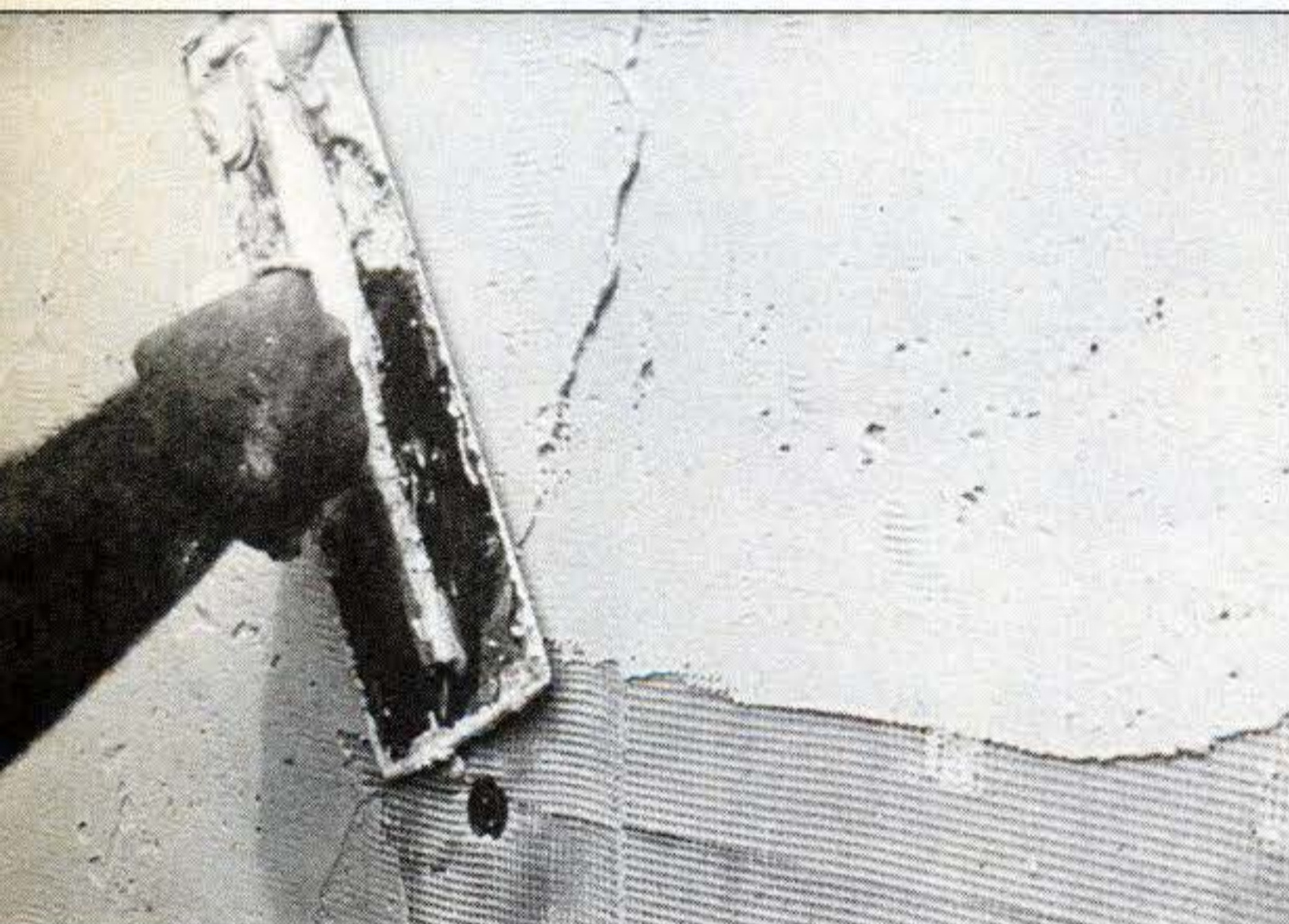
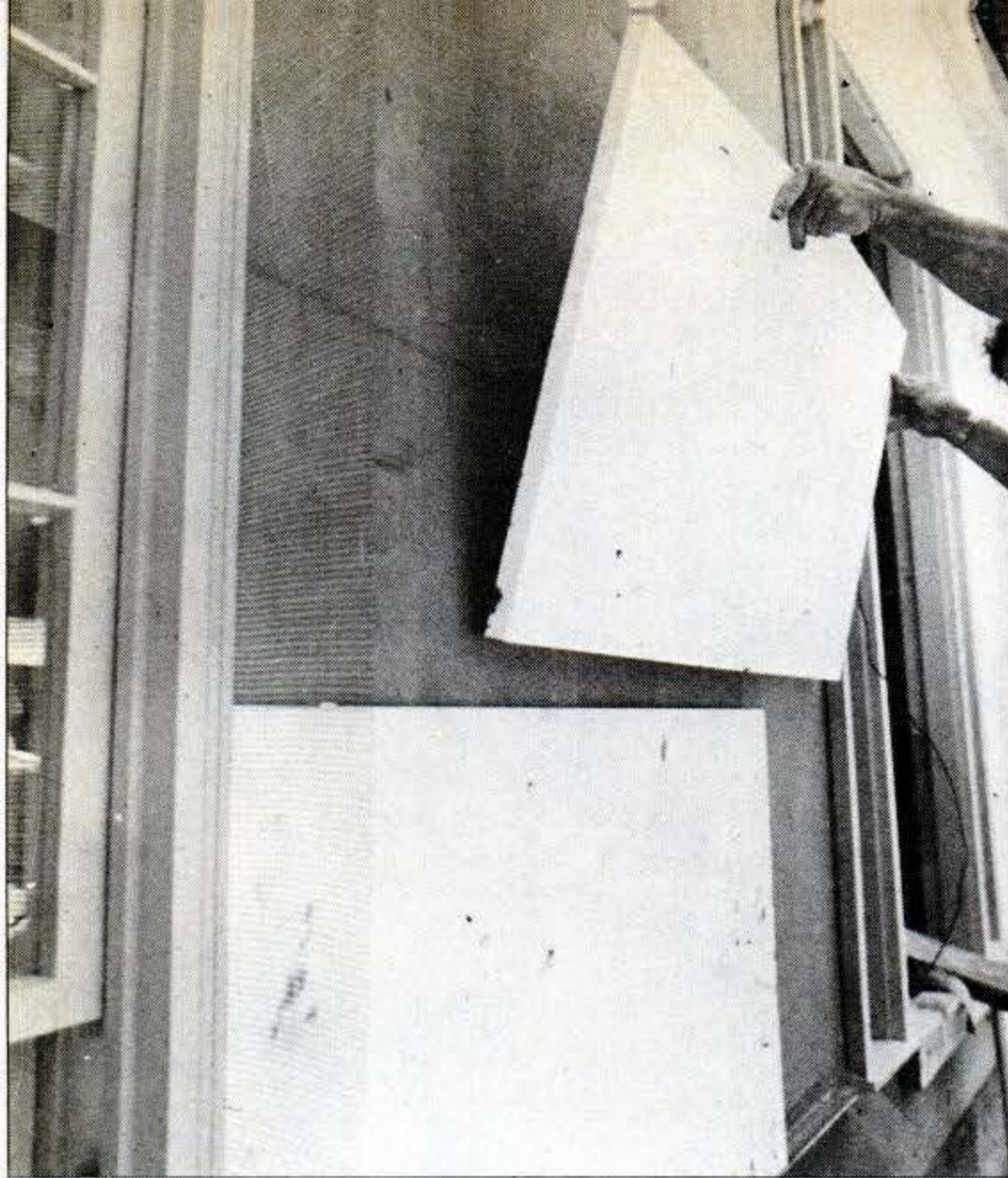
All polystyrene expands and contracts significantly due to temperature swings. To prevent cracking, manufacturers deal with the problem in two ways: One way is to make the top coating flexible enough to tolerate the changes; the other is to make it so tough that it limits them.

The coating used to limit the movement is typically a mixture of portland cement reinforced with fiberglass and an acrylic or acrylic-latex bonding agent. This coating is hard enough to withstand hammer blows, but because the

Continued



Covered with Dryvit exterior insulation, homes such as these have a tough, newly stuccoed appearance. "Outsulation" is 10 times more energy efficient than conventional sheathing, and it's claimed to last 25 years or more without maintenance. Dryvit offers 21 colors in four types of finish coats.



Insulation board (photo, top) is fastened to house wall with spot patches of adhesive. Reinforcing mesh is added (photo, middle) and covered with next adhesive layer. Edges of mesh overlap by 2.5 in. Final step, adding a finish, varies with color and texture desired. Each layer, as shown in drawing above, must be smooth to obtain best results.

panels still move, expansion joints are needed about every 12 feet. The advantage of this system is that it is relatively easy to install (it can be done by a do-it-yourselfer, but that is not usually recommended by the makers). It's also lower in cost—about one-quarter the cost of lath-stucco.

The more-flexible systems usually have a fiberglass mesh that is held in place by the coating compound. The coatings often contain a higher percentage of acrylics—making them more expensive—and may require two applications. They may also need a backing board between the polystyrene and the studs. Until recently, these systems had the disadvantage of providing less impact resistance. But Dryvit, STO, and other makers have since introduced flexible coatings that have a rock-hard surface.

"We went with the flexible system because we felt that the one-piece look and real insulation advantages of exterior insulation without expansion joints are far more attractive," says Ray Di Giacomo of Dryvit. "And there are now no real disadvantages." STO's Buck Buchanan adds that the systems with more acrylics in the cover coat give "greater crack resistance and better color consistency."

Which is the one to choose? Stuart White, a Hanover, N.H., architect who has worked extensively with both types of systems in northern New England, feels that neither is truly superior. And some companies offer both.

Costs

"Exterior insulation combines perfectly with mortarless cement-block construction," says Conproco's Day. "The same compound used on the surface of the cement blocks can be used—with the addition of a latex-acrylic modifier—as a mastic for applying the polystyrene boards and as a coating for the boards as well. That makes building, insulating, waterproofing, and finishing a home a much more compact, cost-efficient operation."

But owners and builders of wood-frame houses are unlikely to consider exterior insulation, especially when retrofitting. The detail work around doors and windows is difficult, and the labor costs—whether measured in time or money—are prohibitive. Who wants to change their lovely clapboard to stucco, anyway?

Few companies wanted to be pinned down on the cost of exterior insulation jobs because they vary greatly and are ultimately set by contractors. But about \$4 a square foot for a solid straight wall should pay for installation of even the most complicated system. Simpler systems may cost as little as \$2.50 a square foot. Walls with windows or doors will probably cost more.

These prices are not likely to be competitive with those of vinyl, aluminum siding, or shingling, but they are comparable with those of new brick or stucco. And many industry experts claim a life expectancy of 25 years or more.

Are longevity, lower energy costs, and tremendous insulating value all decided pluses for exterior insulation? Yes, but there's one more advantage. Seventy-two percent of the architects in one survey expected an increase in their use of these systems over the next five years—but not necessarily for its practical value.

"It's got a pure, sculptural look that can go over everything except the roof," says White. P S

SOME MANUFACTURERS OF EXTERIOR INSULATION PRODUCTS

Conproco Corp., Box 368, Hookset NH 03106; Cota Industries, Inc., 5512 14th St. S.E., Des Moines IA 50320; Dow Chemical, Midland MI 48640; Dryvit System, Inc., Box 1014, W. Warwick RI 02893; Exterior Insulation Manufacturers Assn., 1000 Vermont Ave. N.W., Washington DC 20005; H. B. Fuller Co., 315 S. Hicks Rd., Palatine IL 60067; Insul/Crete Co., Inc., 4311 Triangle St., Mc Farland WI 53558; ISPO USA, Inc., Box 382, Mansfield MA 02048; Kern-Tac, Inc., 4421 Orchard St. S., Tacoma WA 98466; SENCON, Inc., 21 Elm St. W., Chicago IL 60610; STO Energy Conservation, Inc., 2189F Flintstone Dr., Tucker GA 30084; Synergy Methods, Inc., 1367 Elmwood Ave., Cranston RI 02910; Therm-Clad, Inc., Box 40096, Tucson AZ 85717; Thoro Systems Products, 7800 38th St. N.W., Miami FL 33166; W. R. Bonsal Co., 8201 Arrowridge Blvd., Charlotte NC 28210.

Energy's new champs?

A two-speed compressor plus extra-large coils and heat-transfer surfaces have nudged the new Lennox heat pumps and air conditioners to the top of the efficiency charts.

By EVAN POWELL

In 1973 I installed a central air conditioner that was the ultimate in efficiency—with a whopping 6.8 energy-efficiency ratio. Now, only 11 years later, Lennox has introduced a new Power Saver series of air conditioners with ratings more than double that of the older one. With one of the new models I could have cooled the house for one-half of what I spent.

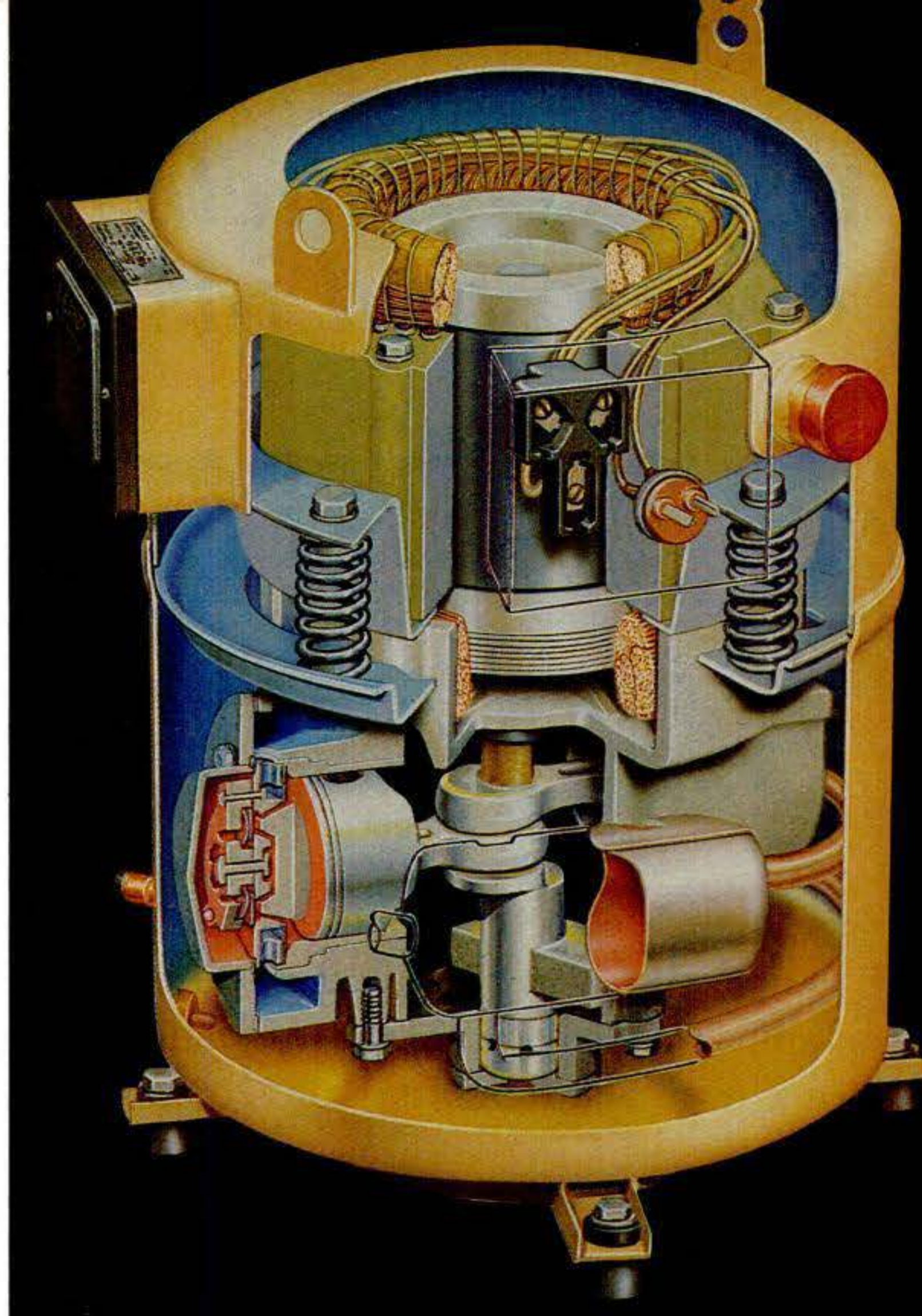
Lennox has also introduced a new heat-pump series, dubbed Legend, that is based on the same technology. Both stand at the top of the efficiency charts—for the moment at least—as tested according to Department of Energy standards. The Power Saver air conditioners top out at 15.0 seasonal energy-efficiency ratio (SEER), and the Legend heat pumps go up to 11.35. In heating mode, the heat pumps have a coefficient of performance of 3.05 and a heating seasonal performance factor of 8.05.

A big reason for the high efficiency is a two-speed compressor that tailors the capacity according to the load. When ambient temperature reaches a set level, a two-stage thermostat actuates the compressor at low speed (1,750 rpm). If the temperature continues to rise (or fall in the heat pump's heating mode), a second set of contacts closes, energizing the high-speed motor winding (3,500 rpm). During much of the year the compressor runs on low and thus uses less electricity than a one-speed compressor (about one-half, says Lennox). Low-speed operation also extends the compressor's life, Lennox claims.

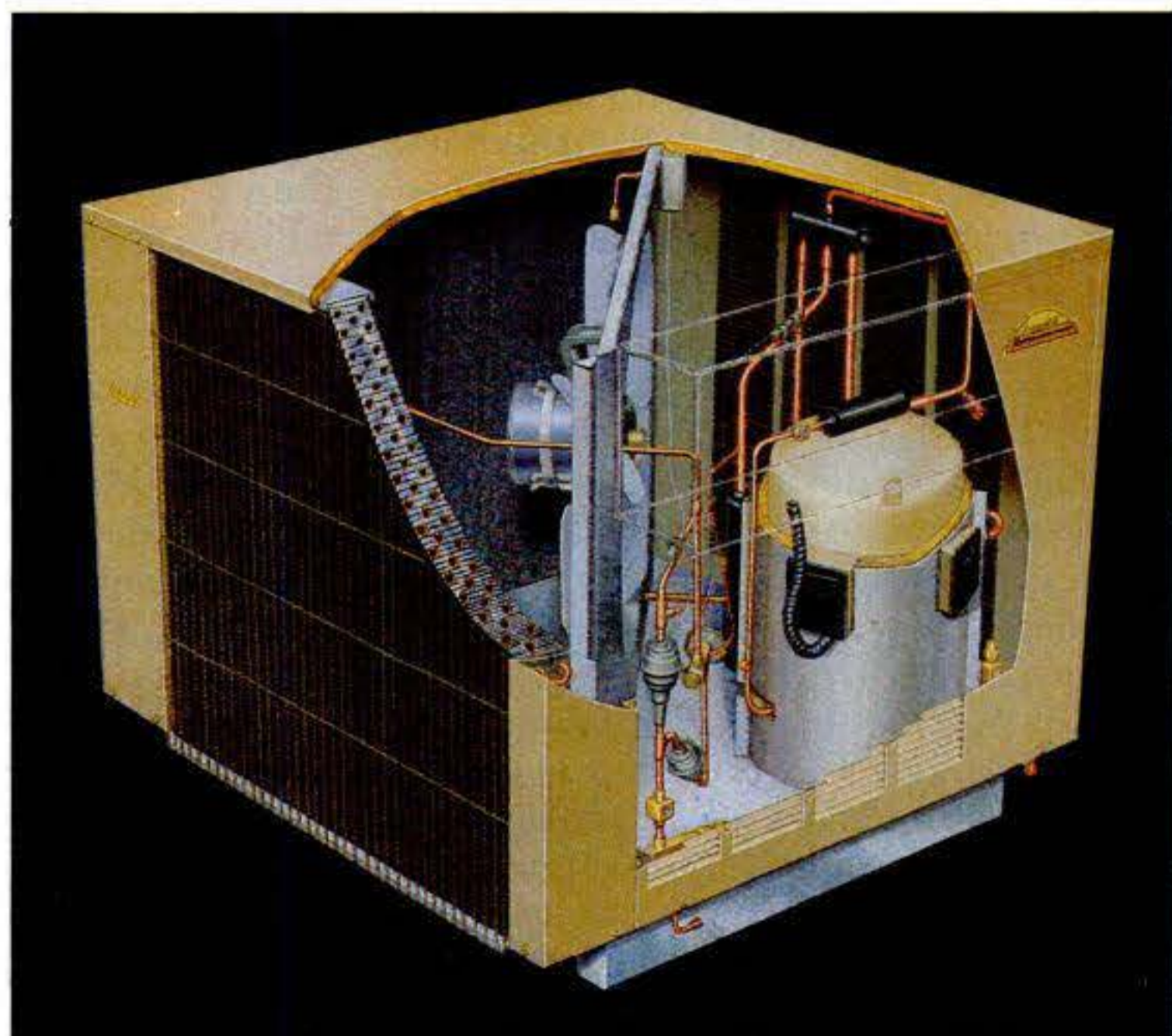
Otherwise, these appliances rely on standard technology but get the most out of it with extra-large coils and heat-transfer surfaces (fins). They also maximize airflow across both the indoor and outdoor coils.

An option called a Latent Load Discriminator can further improve efficiency. It controls the speed of the indoor blower motor according to humidity. With it, the blower runs at high speed—the most-efficient mode—until the humidity rises to a selected level; then it drops to low speed whenever the compressor is running on low. That reduces the temperature of the evaporator coil and increases moisture removal when required for comfort. But most of the time the blower runs at high speed.

Power Saver air conditioners are available in three-, four-, and five-ton capacities, at prices from perhaps \$2,500 to \$4,000, installed. (See caption for specs on Legend heat pumps.) Annual operating cost of a Power Saver, based on 1,000 hours of cooling (the national average) and 5.6-cent-per-kWh electric rate, would be \$145, according to Lennox. A three-ton air conditioner with an SEER of seven would cost twice as much to run. ■



Compressor is derived from Lennox commercial air conditioners. Fail-safe controls prevent starting under stress such as pressure from recent shutdown. Computer-balanced crankshaft and design of cylinder and piston ensure long life, says company. Thermistor-controlled crankcase heater warms oil before compressor starts. Motor winding is in refrigerant path for low-temperature operation.



Outdoor portion of heat pump has inverted circulation (bottom to top) in defrost mode to prevent ice buildup at base of unit in cold weather. Demand-type defrost control initiates defrosting cycle only when necessary. Lennox Legend heat pumps come with cooling capacities of three, four, and five tons and heating capacities ranging from 35,000 to 63,000 Btu/h. Price range: \$3,000–\$4,500, installed.

*An expert helps you
choose and install*



heating-system add-ons

Sophisticated setback thermostats, thermostatic radiator valves, fresh-air intakes, boiler-temperature controls, automatic burner cyclers, and such old standbys as humidifiers, dampers, and booster fans can reduce home-heating costs and improve comfort. And you'll save from \$30 to more than \$200 if you install the add-ons yourself.

By **EVAN POWELL**
Drawings by Eugene Thompson

You surely know the importance of annual maintenance and fine-tuning in keeping your heating system performing at its best. If you heat with gas or oil, you've probably had the burner's firing rate reduced—or at least have investigated the possibility [PS, Oct. '80]. What more can you do to reduce heating costs?

Add-on devices may be the answer. Over the years I have installed and evaluated many of these, but judging their effectiveness can be tricky. Heating systems, houses, and life styles are not all alike, and a device that produces significant savings in my home may be of little benefit in yours. However, because of the way they work, some add-on devices should improve the performance of nearly any heating system for which they are intended. They are the ones I have included here.

Another feature these items have in common: Their installation is within the skills of most do-it-yourselfers. And the latest models seem to be easier to install than previous versions I've used. DIY installation can save you from \$30 to \$200, but check your local building codes; in some areas professional installation is required.

I have listed the items in the order of priority I would assign to them *if they are needed*. You wouldn't, of course, install a booster fan if there is adequate airflow through all ducts,

or a humidifier if you live in a tight, damp house.

Some devices must be installed when the heating system is off. Be sure the power is disconnected before inspecting, installing, or testing equipment with electrical hookups.

Setback thermostats. These are available for hydronic (hot-water) and forced-air systems (including heat pumps). By reducing the house temperature at night or when you're away—automatically—they can reduce heating bills substantially ["Thermostat Setback," PS, Oct. '80]. I recommend the multiple-setback kind, which allows you to reduce the temperature more than once during a 24-hour period.

I also recommend the "anticipator" type such as the Intellistat 2 (made by Euro-Med. b.v., Box 1092, 3260 AB, Oud-Beijerland, Netherlands; an American distribution system for the unit will be in place soon). This type monitors the number and duration of furnace running cycles, compares that information with the setback differential, then calculates the starting time required to bring the temperature up at the preset time—and, on a heat pump, without kicking in the resistance heat. The Intellistat 2 has other advanced features (see caption) and is simple to program.

Read the instructions and operator's manual carefully at the outset, and consult the wiring diagram for your heating system. Before you remove your old thermostat, make a diagram

of each terminal designation and the color of wire connected to it. Connect the wires to the corresponding terminals on the new stat.

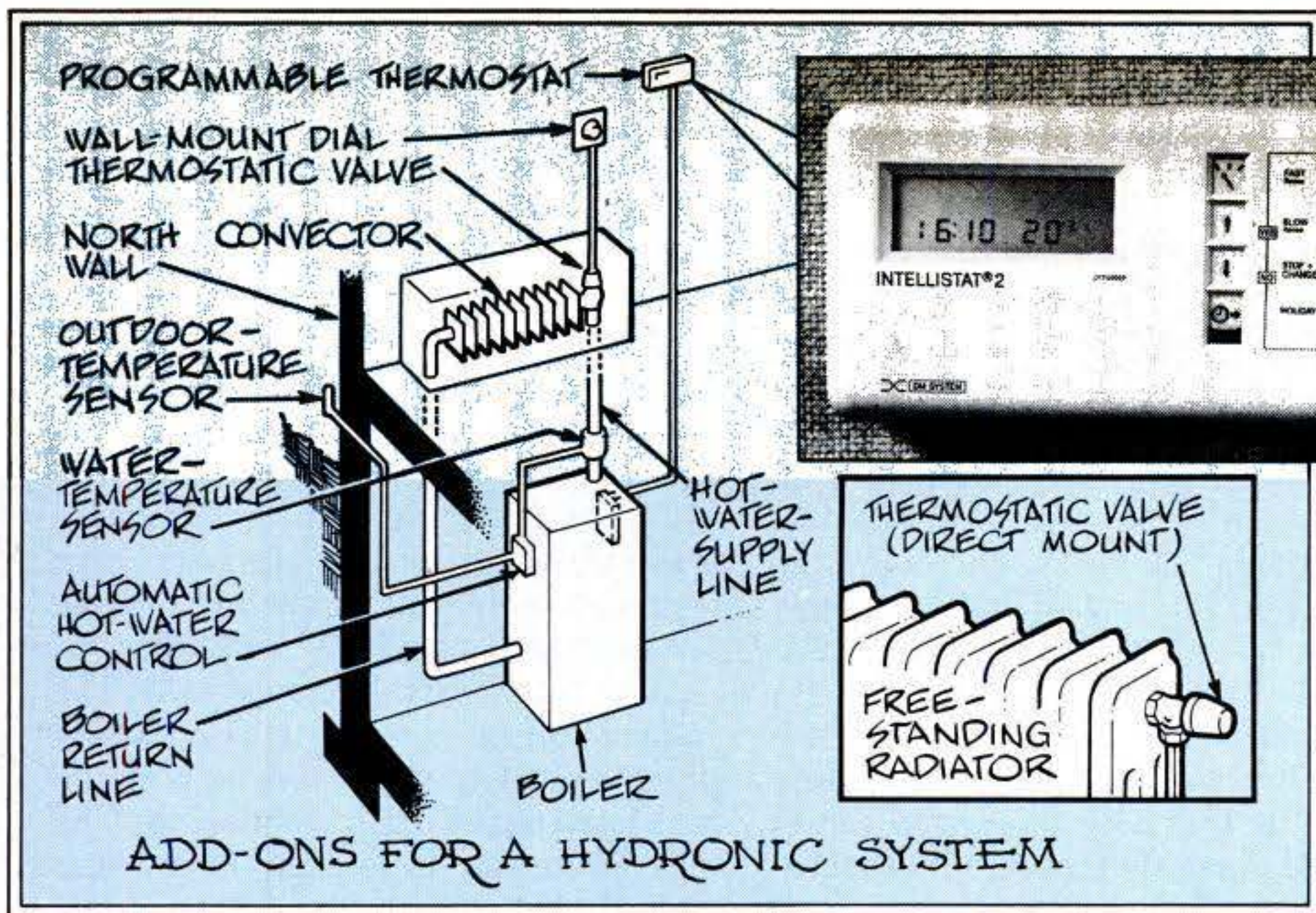
Fresh-air intakes. If your house has a low air-infiltration rate and you heat with fossil fuel, a fresh-air intake may improve your heating system's performance. An air intake can be as simple as a duct from outside that delivers combustion air for the burner, or as sophisticated as a whole-house heat exchanger ["Heat-Saving Vents," PS, Jan. '83].

The Skuttle air intake (Skuttle Mfg. Co., Rte. 1, Marietta, Ohio 45750) is somewhere between these in sophistication; it costs about \$60. It ducts outside air into the return-air duct of a warm-air furnace. Its barometric damper allows air to flow in whenever a negative pressure exists in the house. In a tight house, that can occur when the furnace or other combustion appliance is on or when bathroom or kitchen vents are running.

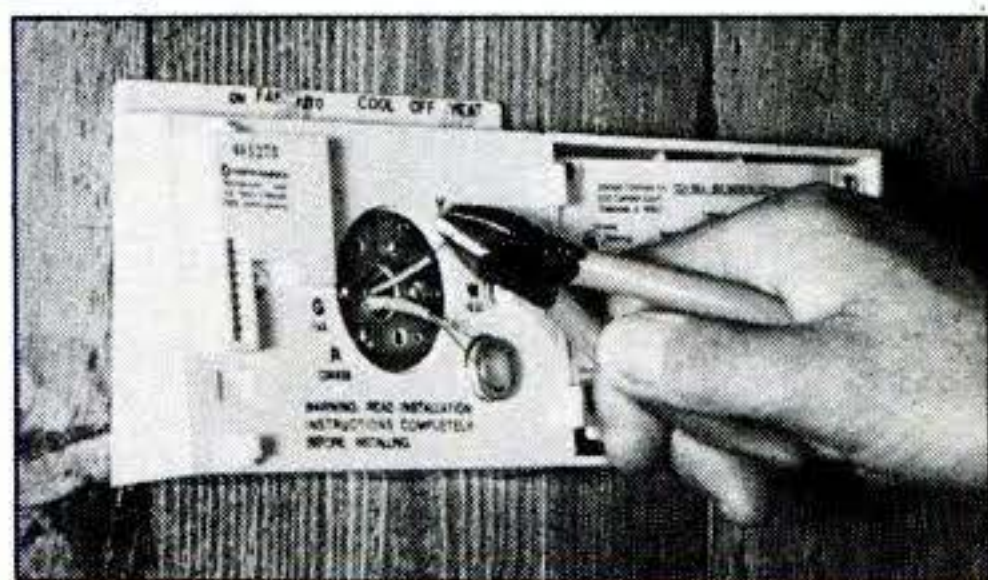
To install the Skuttle you cut a hole in the return-air duct and mount the unit in the opening. Then cut an opening in the outside wall, and pass the connecting duct through, terminating it with a screened cap.

The best way I've found to adjust the Skuttle is to open the doors and windows in the house and turn on the furnace blower. This equalizes the pressure inside and out. Next, adjust the weighted arm on the barometric damper until the damper is just closed.

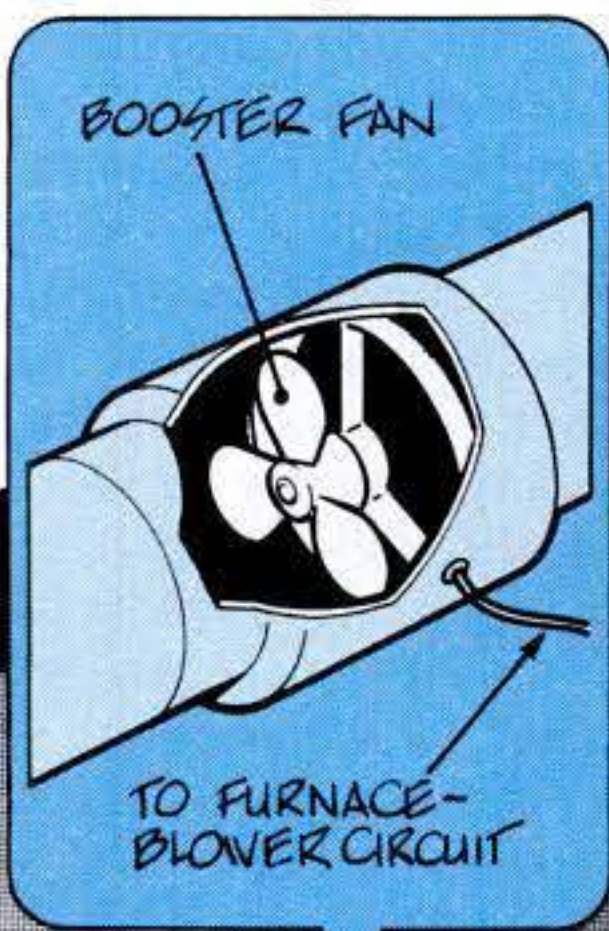
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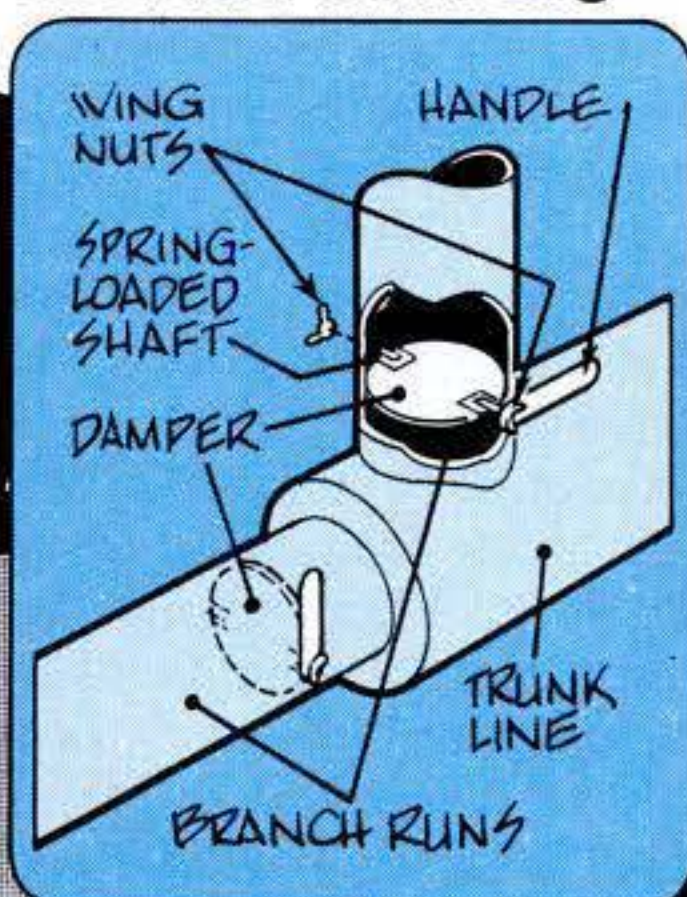
Advanced setback thermostat, the Intelstat 2 (\$169-\$189), lets you set upper and lower temperature limits—and even program fuel savings you desire (one to 10 percent). Its LCD prompts as you program. Most setback thermostats, such as the Johnson T-53 (\$89-\$105), work from the low-voltage power supply of your furnace controls.



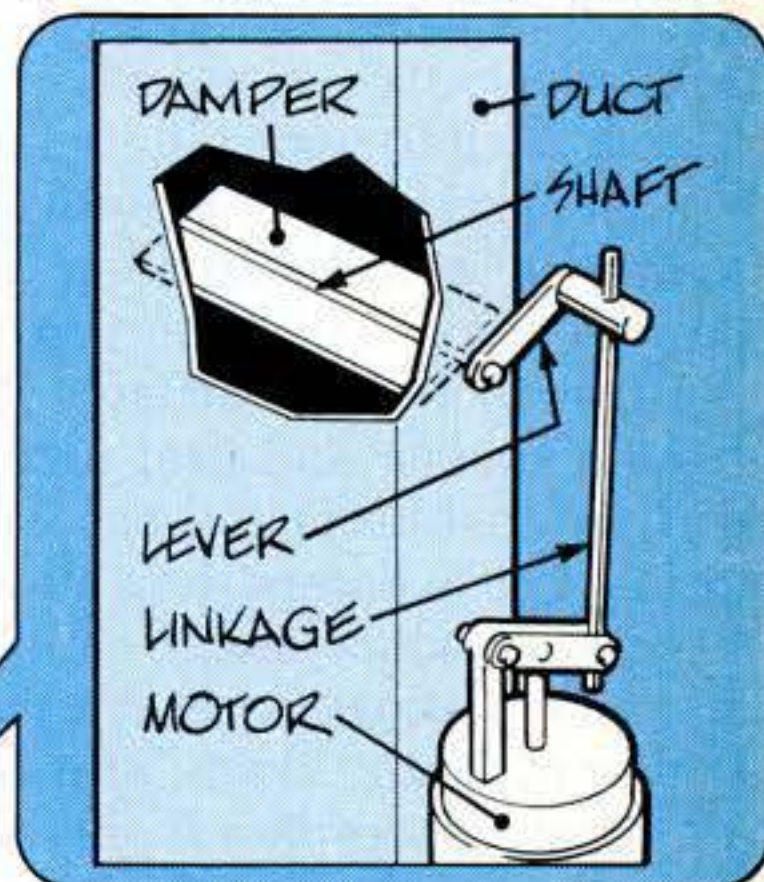
BOOSTER FAN



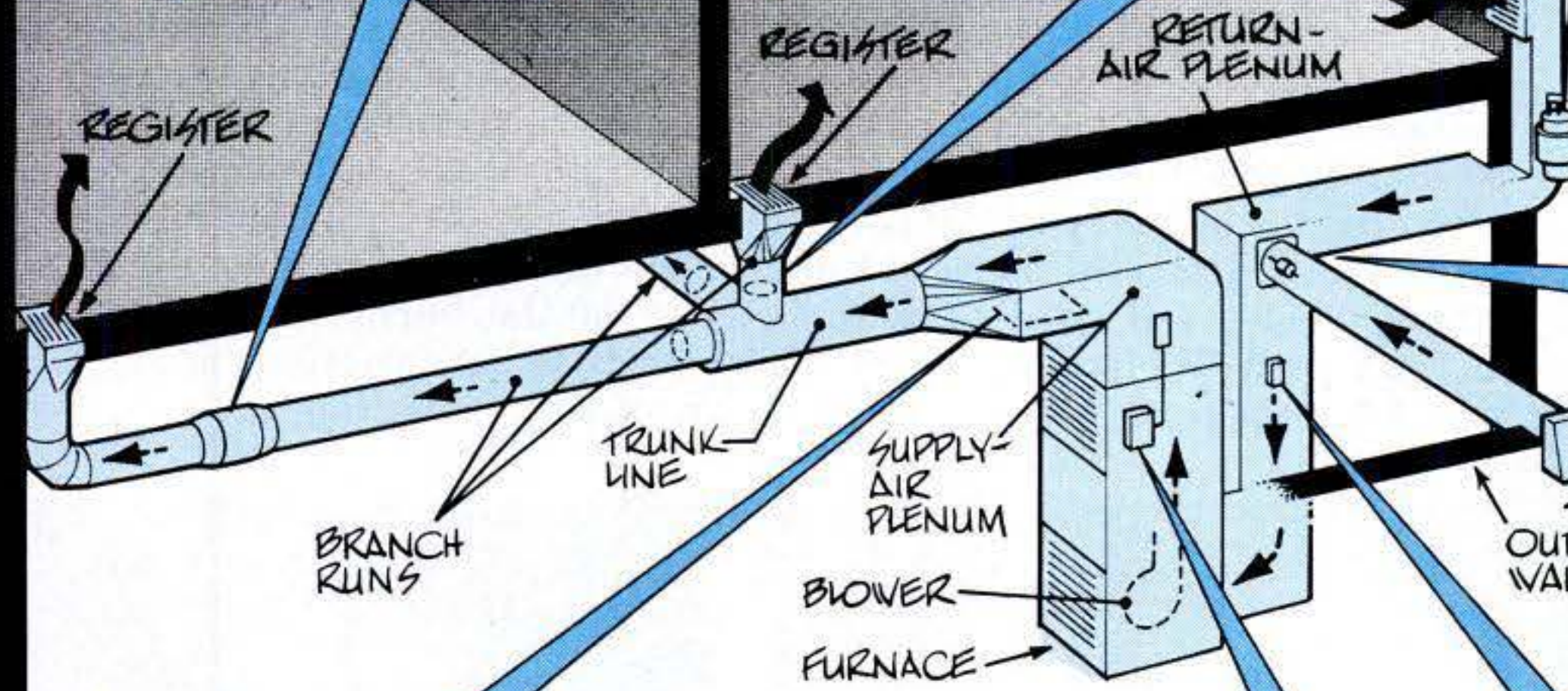
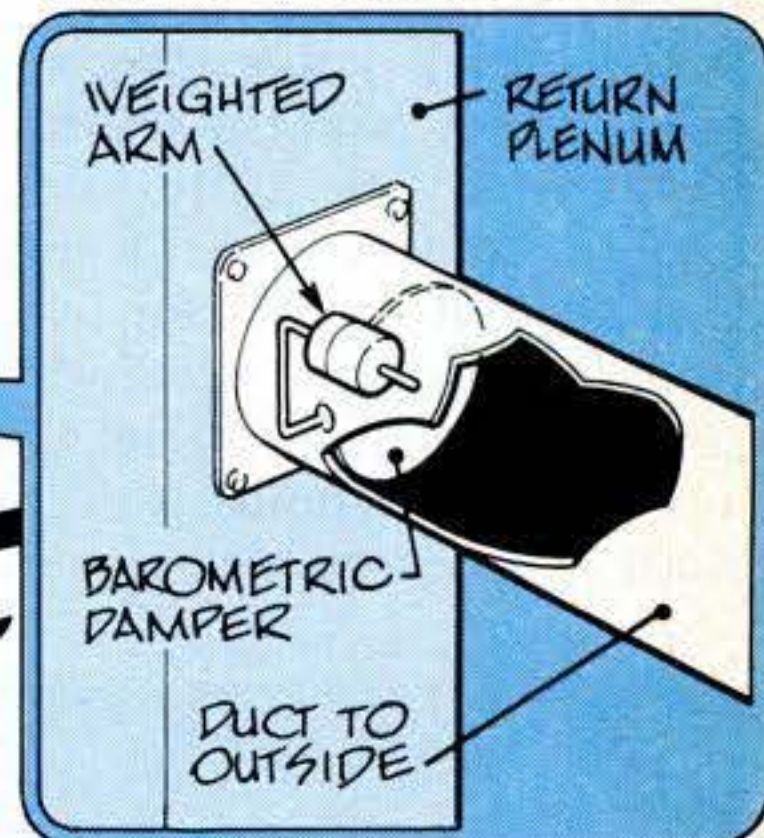
MANUAL DAMPERS



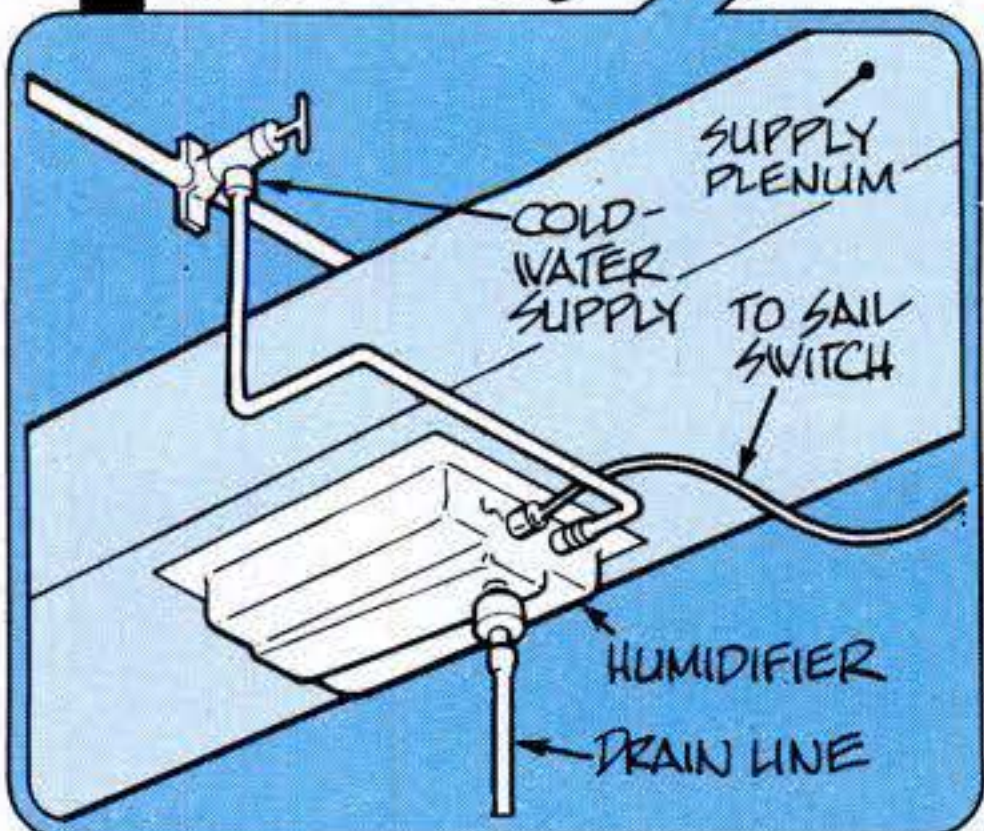
MOTORIZED DAMPER



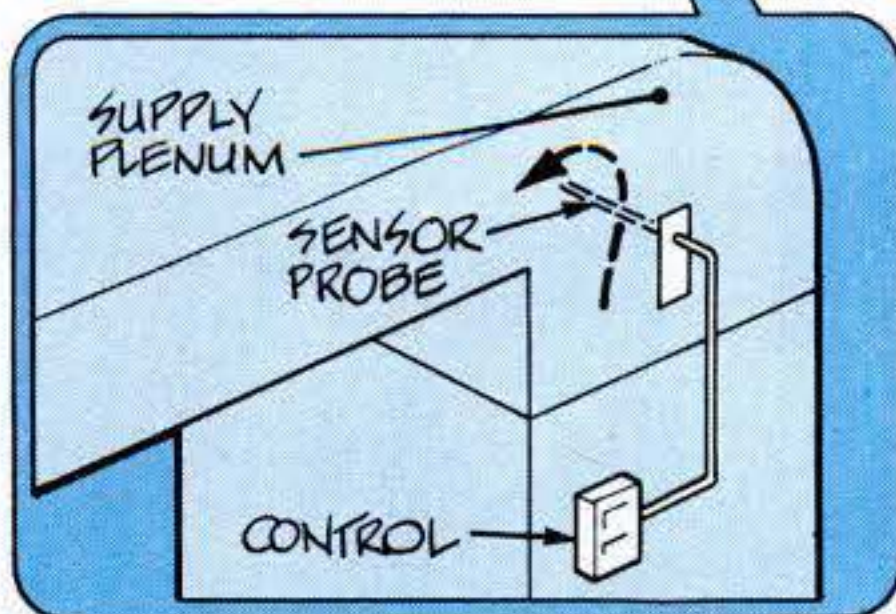
FRESH-AIR INTAKE



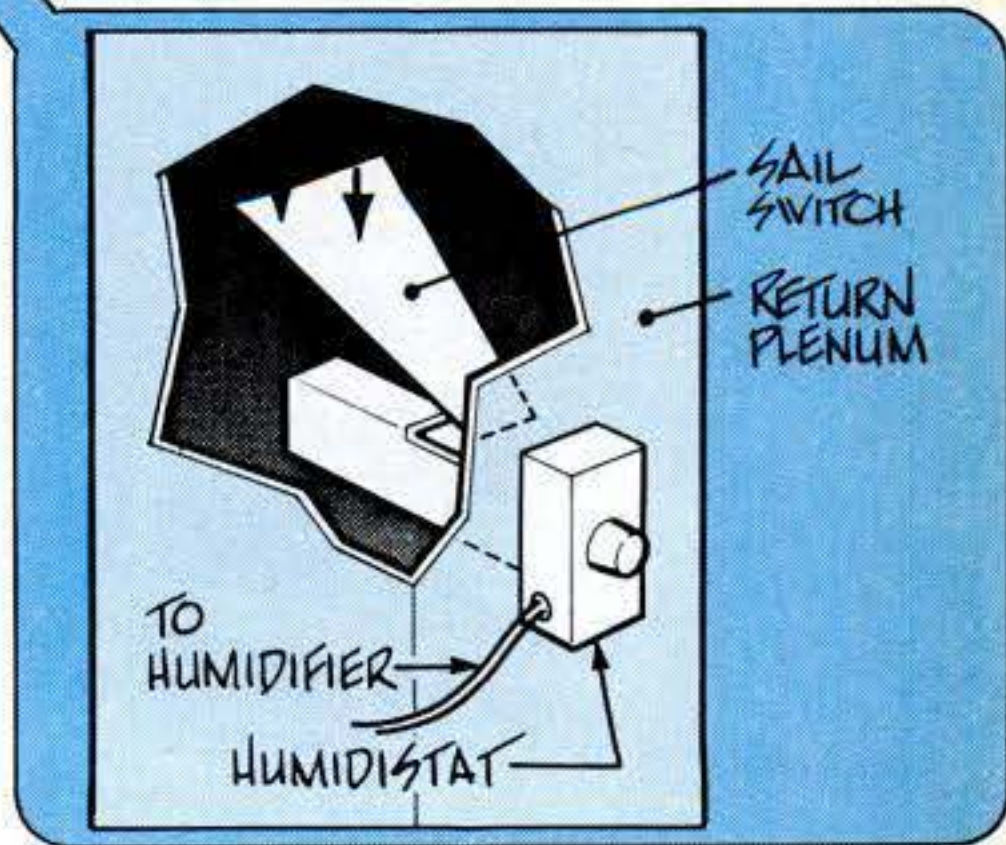
HUMIDIFIER



BURNER CYCLER



HUMIDIFIER CONTROLS



ADD-ONS FOR A FORCED-AIR SYSTEM

Selected add-on devices for a forced-air heating system are shown in the diagram above; some for a hydronic (hot-water) system are in the diagram

at top left. The benefit of such devices is not necessarily additive (if you install two devices that would each have saved 10 percent, total saving likely

will not be 20 percent). Therefore, evaluate your situation, and attack obvious weaknesses first. Then live with those changes before making others.

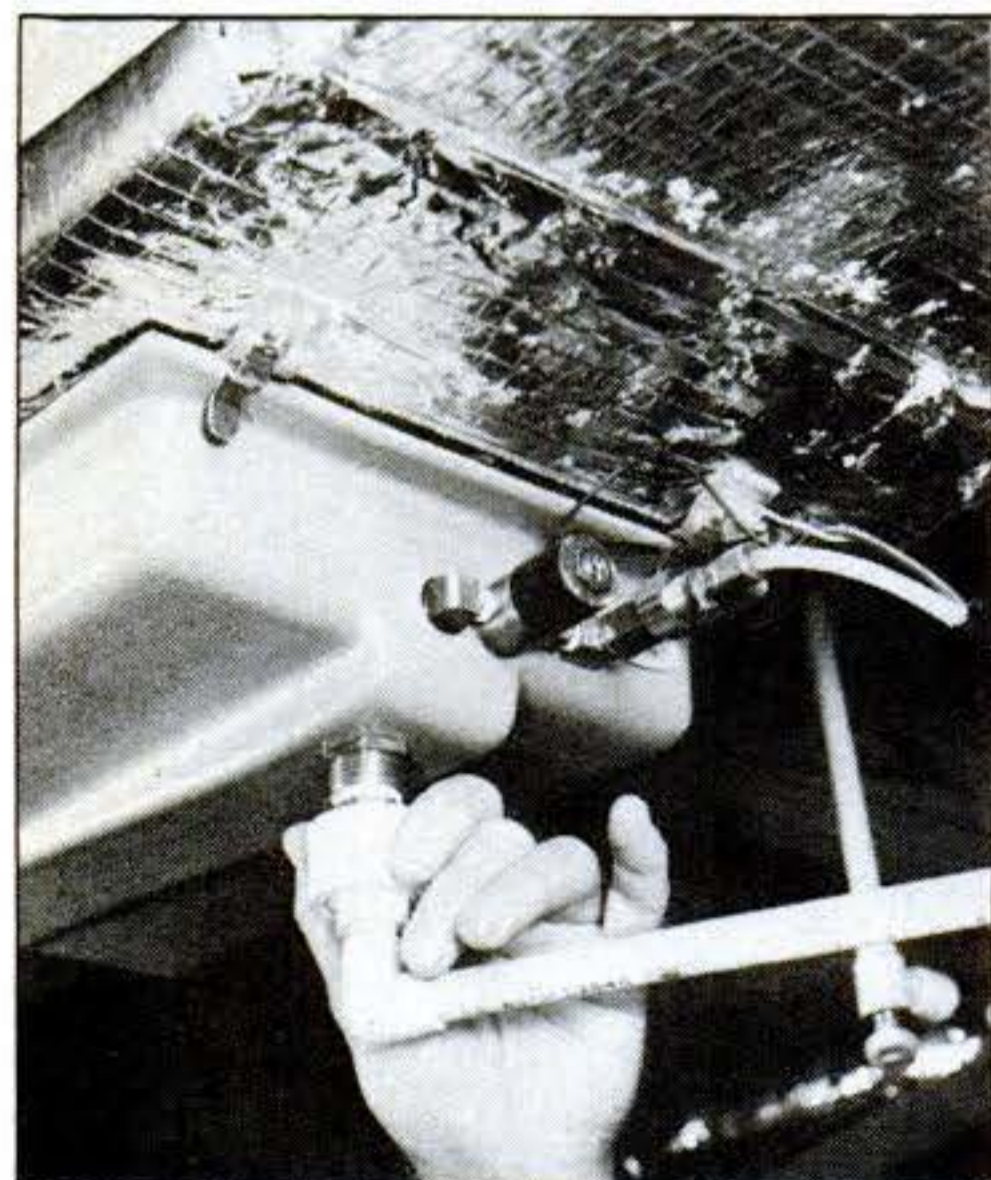
Now when a negative pressure exists, the damper will open to let in air.

Humidifiers. Properly humidified air reduces the rate of evaporation from your skin and thus makes you feel warmer at lower thermostat settings. There are humidifiers for use with heat pumps as well as fossil-fuel forced-air systems.

A humidifier can be installed under a duct, on the warm-air plenum, or as a "bypass" version between the return and supply plenums. Several units, such as the Aqua-Mist (3980 N. Liberty St., Winston-Salem, N.C. 27105) shown, are specially suited for DIY installations because they have plug-in transformers and operate on low voltage. Once the humidifier and controls are mounted, you tap into a nearby cold waterline (see caption).

Dampers. When some rooms are too hot and others too cold in a forced-air system, you may be able to solve both problems by installing dampers in the supply ducts. In use, you turn the damper to reduce airflow to the overheated rooms; and that increases the airflow to harder-to-heat areas. You can also use dampers to shut off heat to rooms when they're not in use. Manual dampers are available to fit standard round ducts and cost \$5 to \$18 each. Sheet-metal shops will fabricate rectangular dampers; in my area they charge \$15 to \$65, depending on size.

To install a damper you separate the branch duct from the main trunk line at the first joint. If the joint is stuck, apply a detergent-and-water solution and allow it to soak for five minutes. Place the damper within the duct as close as possible to the trunk line, and drill two holes for the damper shaft. Use a grounded or cordless drill.



Humidifiers can be installed on supply duct or plenum. Many newer models, such as Aqua-Mist (\$160), are self-flushing, require floor drain for runoff.

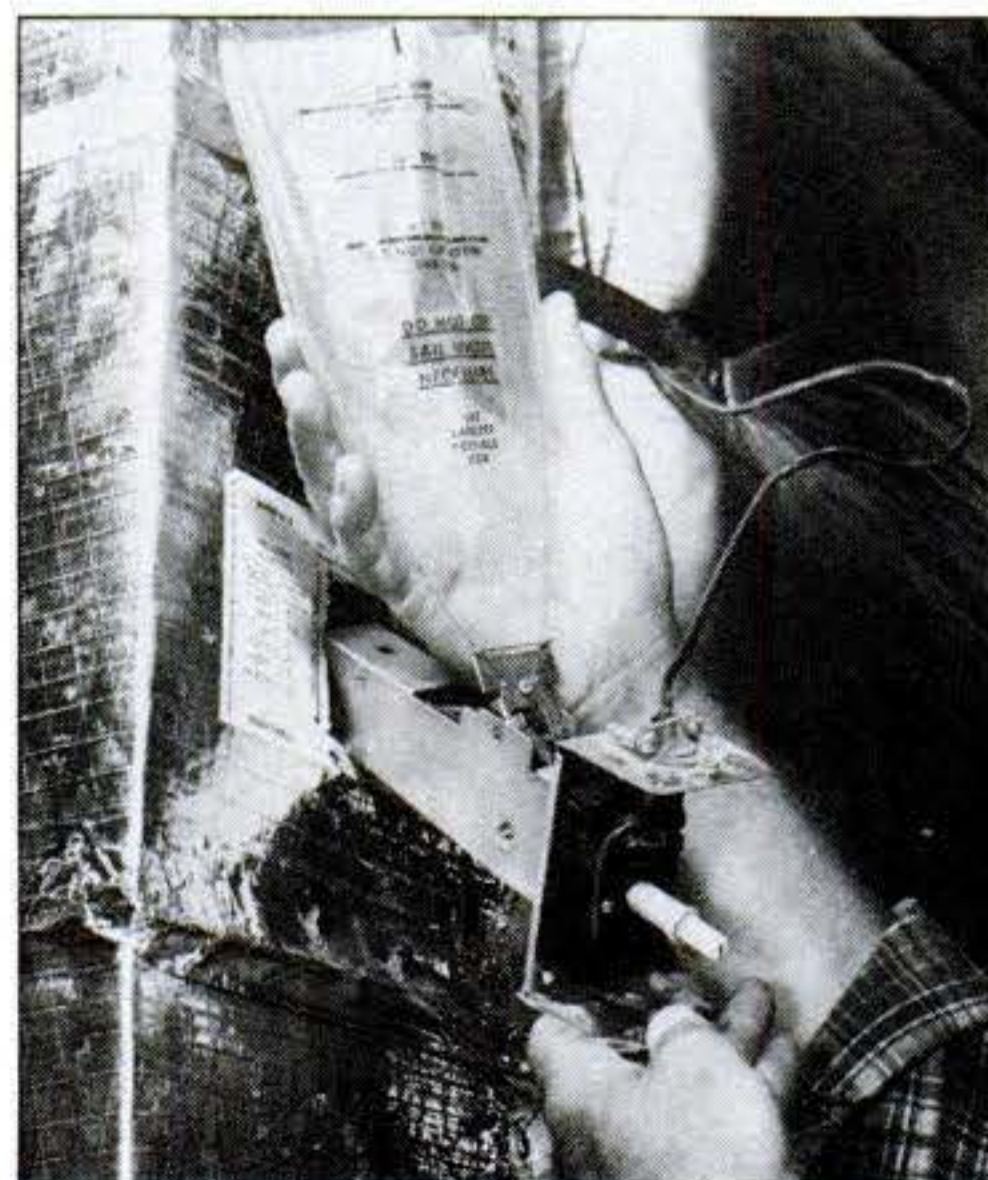
Install the damper, then put the handle on the outside, placing it in the same plane as the damper for accurate adjustment.

Motorized dampers (\$70–\$250), controlled by a switch or a thermostat, are often used in inaccessible areas, where heat is to be zoned, or where excess heat is available, as in a room with a wood stove ["Automatic Flue Dampers," PS, Oct. '80]. You install them just as you would the manuals. In addition, you install a plug-in, low-voltage transformer to provide the power for the motor.

Thermostatic radiator valves. These are to a hot-water system what dampers are to the hot-air system—only better because they provide temperature control for individual radiators. They work on hot-water and two-pipe steam systems and cost \$20–\$60 each.

With the heating system shut down and pressure off, you remove the old valve and install the new one. Use standard plumber's tape on all threaded fittings. Some thermostatic valves have a remote sensing tube; others have a sensor on the control knob. If a remote tube is used, be sure to locate it away from windows.

Booster fans. When a long supply duct in a forced-air system delivers too little air to distant rooms, a booster fan may solve the problem for much less (\$55–\$75) than it would cost to enlarge the duct. A booster fan comes within a section of duct, which you install in place of an existing section. Some plug into an outlet and run constantly, but that can create drafts when the furnace isn't running. Most are connected to the furnace-blower circuit or to a sail switch and come on only with the blower. Follow the manufacturer's instructions carefully



Humidistat and sail switch install in the return plenum. When humidistat calls for moisture and sail switch is tripped by airflow, humidifier is energized.

ly to make the electrical connections.

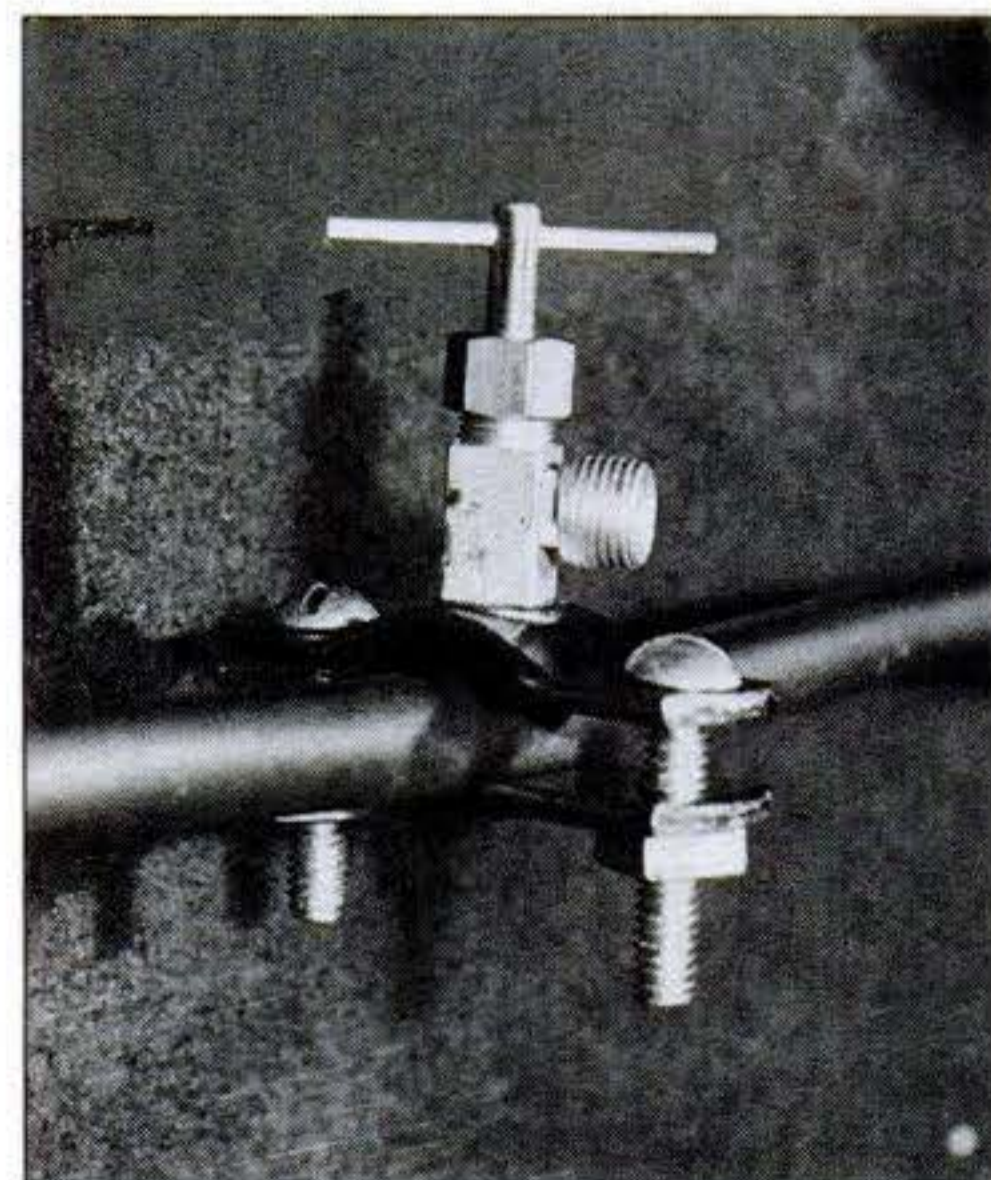
Automatic hot-water controls. These devices for hydronic systems are called outdoor-reset controls, boiler-temperature programmers, or computers. Normally, the burner maintains the boiler water at a fixed temperature. With these controls, when the outside temperature rises, the boiler-water temperature is allowed to fall. They are particularly useful in moderate climates and in climates with frequent temperature swings in winter months. Cost: \$110 to \$250.

Mechanical installation is easy: The indoor sensor clamps to the supply pipe as close to the boiler as possible and is wrapped with insulation. The outdoor sensor is located on a north wall. Both are wired to the control unit, which is wired into the low-voltage control circuit of the burner. Some models also require a 115-V input from the power line.

Burner cyclers. The simplest of these are timing devices called "duty cyclers." They turn off the burner at pre-set times during the burning cycle.

Another type, the Heat Miser, made by Economic Energy Products (Grass Valley, Calif. 95945; \$120), is temperature actuated. It is calibrated to the furnace duct temperature and cycles the burner just enough to maintain the necessary temperature.

In theory at least, cyclers allow the air, which continues to circulate across the hot heat exchanger, to deliver heat to the house while the burner is off. Actual savings vary, but generally, older furnaces with massive heat exchangers benefit most. You wire cyclers into the low-voltage control circuit of the burner and install any remote sensors according to the manufacturer's instructions. PS



Self-piercing valve included with most humidifiers makes it simple to connect waterline. (For iron pipes you drill a 1/4-in. hole and use a saddle valve.)

Drivability problems?

Check your emissions systems

A car's engine can have as many as 17 parts that control emissions. Most car owners—and many mechanics—are not familiar with all of them; yet they are responsible for many engine problems. The cure is usually replacing the faulty part.

By **GEORGE SEARS**

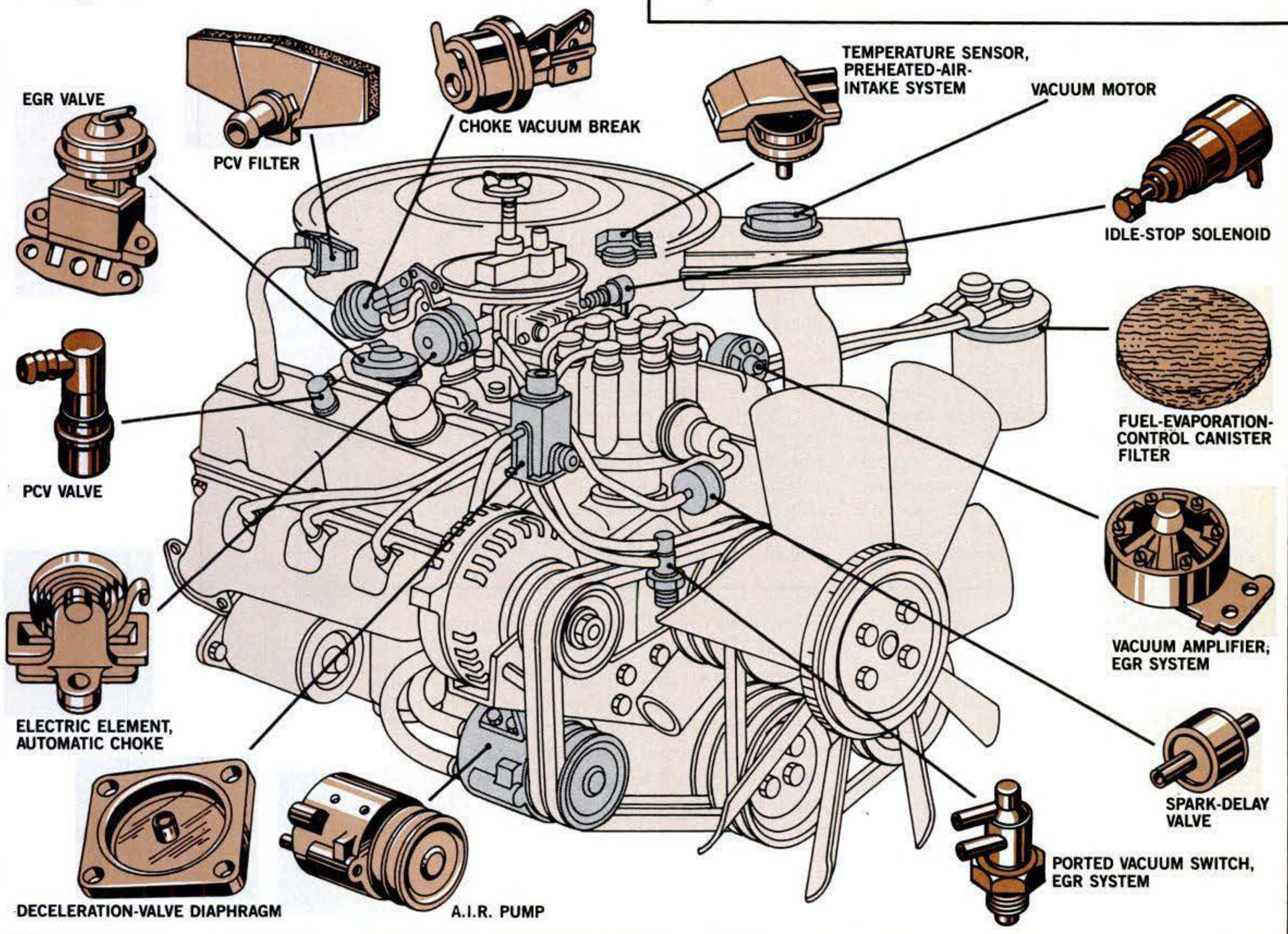
Drawings by Russell von Sauers

If a part in one of the emissions-control systems in your car goes bad, the quantity of noxious fumes the engine blows into the atmosphere will increase. That's pretty obvious. But here's a fact that's not as apparent: Malfunctioning emissions-control parts can also cause practically every drivability problem in the book.

"Drivability problem"—that's car-manufacturer lingo for a host of troubles that irk drivers, including hesitation, surging (stumbling), power loss, spark knock (pinging), poor fuel economy, rough idling, hard starting, and run-on after engine shut-off (dieseling). Countless carburetors and ignition-system components have been needlessly replaced in efforts to cure these problems, for which faulty emis-

Continued

The systems



PCV system

The positive-crankcase-ventilation (PCV) system draws combustion gases that accumulate in the crankcase into the engine, where they are burned. PCV was the first emissions-control system put on cars—in the early 1960s.

Malfunctioning PCV components can cause excessive oil consumption, hard starting, stalling, rough idling, missing at slow speeds, and power loss. Parts that cause trouble are the PCV valve, PCV air filter, and PCV hoses. Check them this way:

1. Pull the PCV valve from the engine. In most cases, it's located in a rocker-arm cover (see drawing).
2. Shake the valve. If it doesn't rattle, replace it.
3. Start the engine, and hold your thumb over the end of the valve. If you don't feel vacuum, replace the valve and test again. If there is still no vacuum, remove the PCV hoses. Replace any hoses that are cracked. Are the hoses OK? Then clean out any carbon by ramming a dry cloth through them. In

most cars there's a PCV hose between the air cleaner and the rocker cover, and another between the PCV valve and the intake manifold or carburetor.

4. Find the PCV filter. In most cars it's inside the air-cleaner housing, as shown. If not, look in the end of the PCV hose where it connects to the rocker-arm cover. (Chrysler uses a crankcase-inlet air cleaner at this spot on many of its engines.) Inspect the filter if you can. If it's dirty, replace it. If you can't see the filter, wash the air cleaner in carburetor cleaner, turn it upside down to drain the solvent, and fill the air cleaner with SAE 30 oil.

(Note: Many imported and some domestically built engines, such as the Chrysler 2.2-liter and the Ford 1.6-liter, don't have PCV systems of the traditional variety. They use a closed-crankcase-ventilation system with a fixed orifice [instead of a PCV valve] through which crankcase gases enter the intake manifold. The part of this system that clogs and causes engine problems most often is the carburetor air-cleaner filter.)

Carburetor-control parts

Depending on the vehicle, a carburetor may be equipped with an idle-stop (anti-dieseling) solenoid, electrically operated automatic choke, and a vacuum break (choke pull-off). Although these cannot technically be called emissions-control parts, they work closely with the emissions systems to maintain sound engine performance—which the emissions systems working by themselves would tend to disrupt.

The idle-stop solenoid overcomes the tendency of some engines to run on (diesel) after the ignition is shut off. This solenoid allows the throttle to close beyond the normal idle position when the ignition is turned off. Many modern engines require a high idle for efficient operation of emissions controls.

(Note: Many engines use a device resembling an idle-stop solenoid that is activated by the air conditioner. It opens the throttle slightly when the air conditioner is turned on, to prevent stalling that could occur when the load imposed on the engine by the compressor is applied. Refer to the emissions-control information label in the engine compartment to determine whether the solenoid on your car's carburetor is an anti-dieseling solenoid or an air-conditioner speed-up solenoid.)

The following procedure could be used to determine whether a defective idle-stop solenoid is causing dieseling, or whether a defective air-conditioner speed-up solenoid is causing the engine to stall when the compressor is on:

1. Turn on the ignition switch, but don't start the engine. When testing an air-conditioning speed-up solenoid, also turn on the air conditioner.
2. Watch the plunger of the throttle-lever end of the solenoid as you disconnect the electric wire at the solenoid. The plunger should draw away from the throttle lever. When you reconnect the electric wire, the plunger should extend out and make contact with the lever.
3. If the plunger doesn't move, connect a test light between the solenoid wire terminal and ground. If the light glows, showing that current is reaching the solenoid, the solenoid is defective. Replace it. If the light doesn't glow, there's a problem with the wire or with the circuit feeding the wire. Test the wiring, checking for short circuits.

sions-control components were really to blame.

Car makers are currently waging a campaign urging professional mechanics to test emissions-control parts before plunging into expensive repairs. Here's what one expert at the General Motors Research Center in Warren, Mich., told me about just two of these parts:

"If mechanics would make sure that preheated-intake-air cleaners and exhaust-gas-recirculation (EGR) valves

were working before doing tuneups, they'd resolve innumerable spark-knock, stalling, and hesitation complaints, save themselves time, and save their customers money."

Your car could have more than a dozen emissions-control parts. If you can't find these emissions parts on your engine (manufacturers locate them differently) and you turn the car over to a mechanic, tell him to test those parts before looking for other reasons for your trouble. **PS**

Other emissions-control components

The components discussed to this point are the ones you'll find on the majority of engines. However, depending on the make of your car and its engine, there might be other emissions-control parts that can cause drivability problems.

The following is a list of these components, the functions they perform, and the trouble they can cause:

Deceleration valve: It prevents backfiring in the exhaust system during deceleration, when the fuel mixture becomes richer, by allowing more air to bleed into the intake manifold. If the valve fails, an engine idles roughly and may backfire, which can cause engine damage.

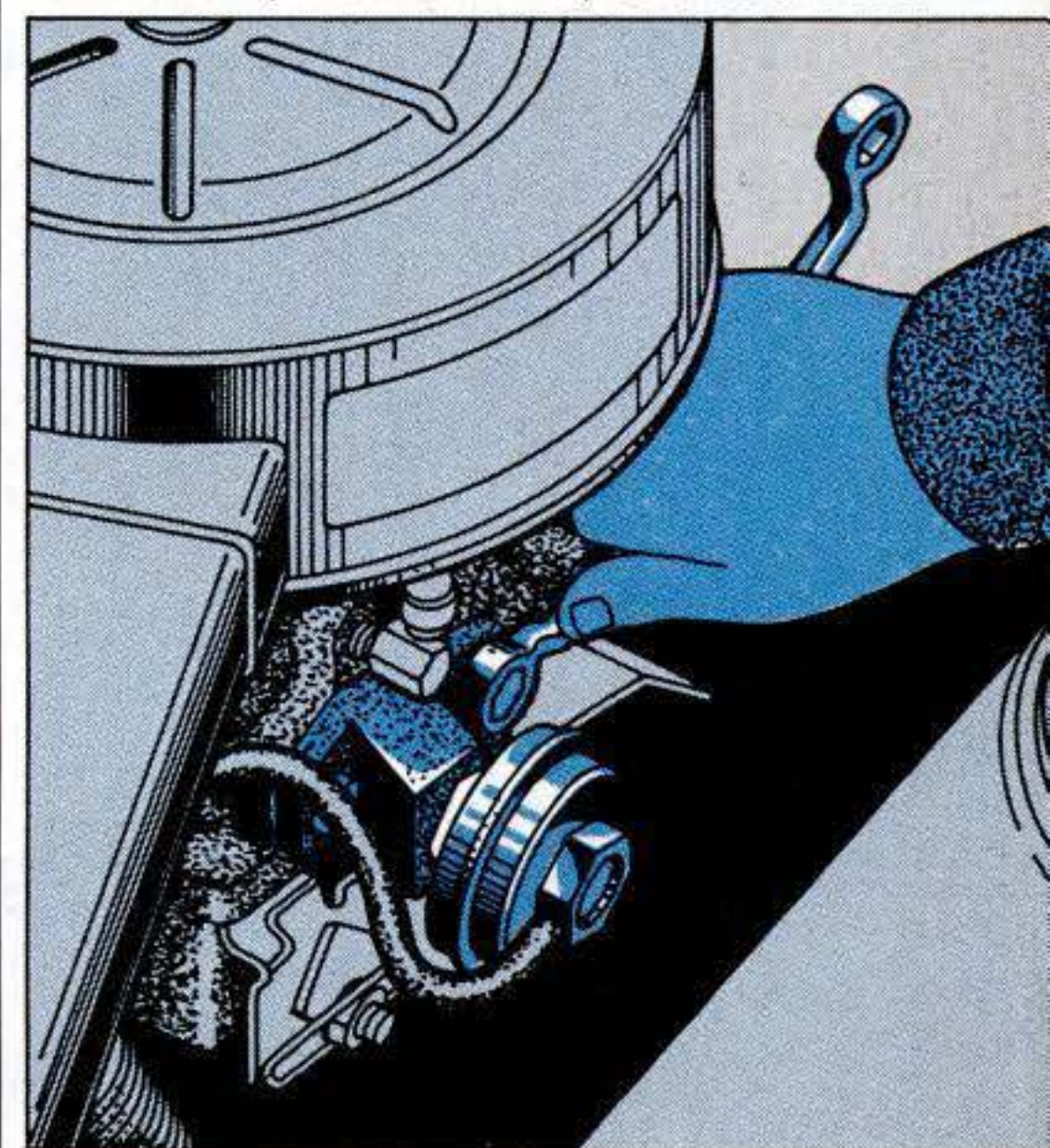
Air-injection reactor (AIR), found on six- and eight-cylinder engines, and pulse-air-injection reactor (PAIR), on six- and four-cylinder engines: Both of these systems inject air directly into cylinder exhaust ports to aid in the burning of hydrocarbons and carbon monoxide. The major problem caused by a malfunctioning AIR or PAIR system is a strange and unpleasant noise (rumbling, chirping, knocking, or squealing) from the engine compartment.

Spark-timing controls: There are spark-delay valves, thermostatic vacuum switches, spark-advance vacuum modulators, and vacuum-reducer valves. Which one is used depends on the engine. If a spark-timing-control device is on your engine, it would probably be positioned in the vacuum line between the distributor vacuum advance and the vacuum source.

These emissions components control the vacuum signal to the vacuum advance under various engine conditions, including acceleration, deceleration, idling, and cruising. The component in your car, if in fact your engine has one, can also be responsible for most of the drivability problems outlined at the beginning of this article.

EGR system

The EGR system recirculates exhaust gas back through the intake manifold into the engine, where it acts as a cooling agent to lower combustion temperatures. This prevents oxides of



Preheated-intake-air system

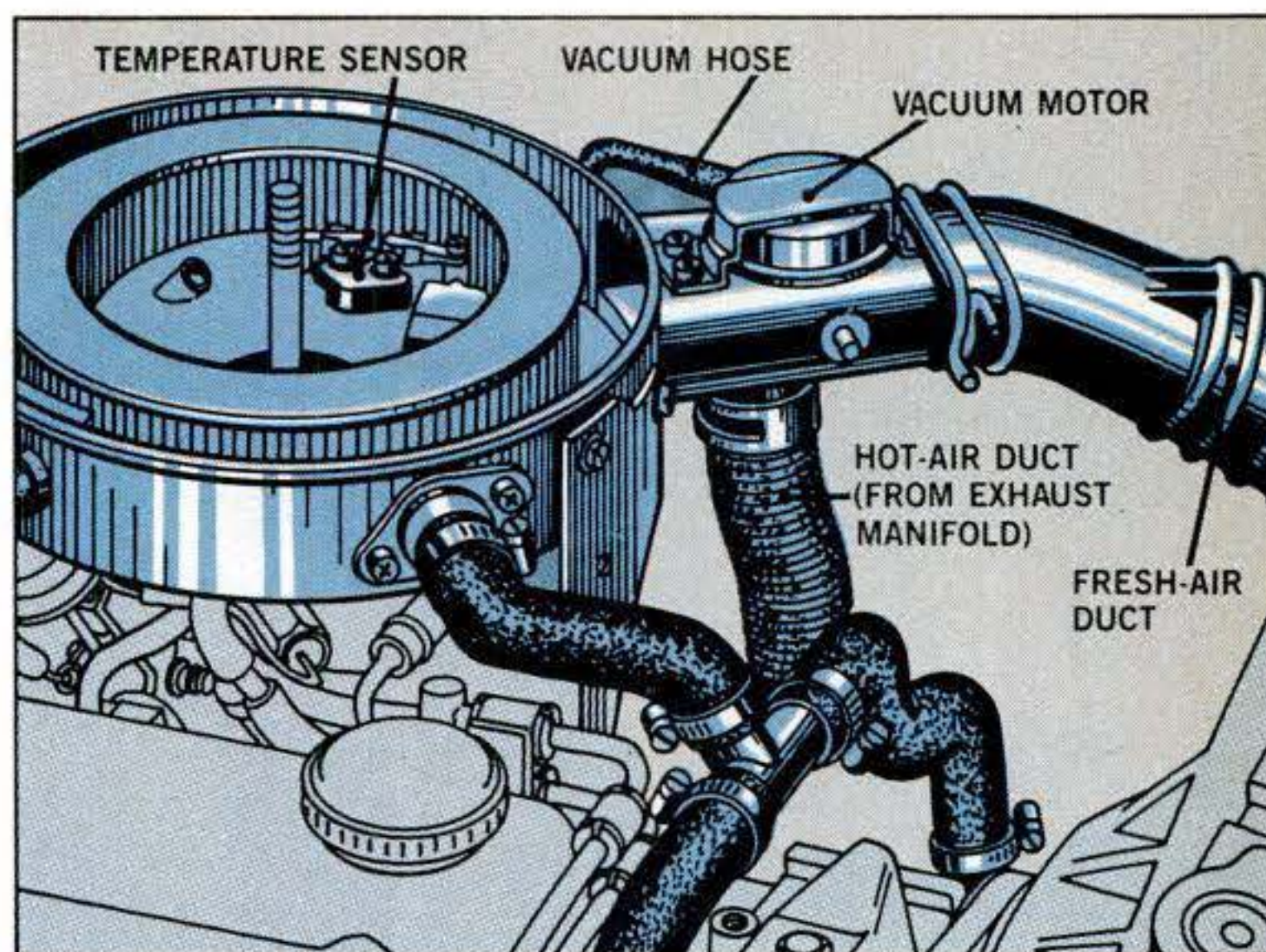
Given different names by different manufacturers—Thermac Air Cleaner system (GM), Inlet Air Temperature system (Ford), and Heated Air Inlet system (Chrysler)—the purpose of this system is to keep warm air flowing into the carburetor at all times, even when the ambient temperature is below zero. Warm intake air curtails emissions by allowing a leaner carburetor setting and shorter choke-on time. Problems caused when a part fails include spark knock, stalling, surging, power loss, hesitation, and a drop in fuel economy.

The parts that can fail (see drawing) are the vacuum motor (normally in the air-cleaner snorkel), temperature sensor (normally in the air cleaner), and ducts. To trouble-shoot the system, do the following:

If there's a duct over the end of the air-cleaner snorkel, unclamp and remove it. Start the engine cold, and look inside the snorkel. As the engine warms up, the valve you see should move (downward in most cases). If the valve moves completely opposite to its cold position as the engine warms up, the system is operating properly.

If the valve doesn't move, shove it with your finger. Is it binding? Shoot compressed air into the snorkel to try to free it. If this doesn't work, replace the valve by replacing the air-cleaner housing. If the valve does move without binding, pull the vacuum hose from the vacuum motor. With the engine running at idle, hold your finger over the hose. If there is no suction (vacuum), check each duct and the hose to make sure they're tightly connected and that they aren't kinked or cracked. If a duct is an accordion type, look closely inside the folds; an unseen tear may be allowing cold air into the system. Replace any damaged duct or hose.

If ducts and hose are OK, the cause of an inoperative preheated-



intake-air-system valve is a malfunctioning vacuum motor or temperature sensor. Check the motor by attaching a hand vacuum pump to the vacuum-motor hose nipple. Apply 10 inches Hg of vacuum, and watch the vacuum-pump gauge. It should maintain the vacuum for five minutes. If it doesn't, replace the motor. If it does, replace the temperature sensor.

Choke system

Most engines have an electrically operated automatic choke for more-precise choke operation. They also have one or two vacuum breaks to pull open choke valves slightly when the engine is first started cold. When the electrical element or vacuum break is not functioning, stalling and poor fuel economy result. Check these parts as follows:

1. With the engine cold and ambient temperature less than 80 degrees F, remove the carburetor air cleaner to watch the choke valve.

2. Have someone depress and let up the accelerator pedal. The valve should close the carburetor throat.

3. Start the engine. The choke valve should open slightly. If not, suspect a faulty vacuum break.

4. As the engine warms up, the choke valve should open fully. If not, check the electrical choke element.

(Note: Dirt-encrusted choke linkages and

choke valves cause many more choke problems than do the above components. Before proceeding, clean the linkage and choke valve, and test the system again.)

5. To test the electrical choke element, disconnect the wire terminal at the element, connect a voltmeter between the terminal and ground, and run the engine at idle. If the voltage is between 12 and 15 volts, replace the choke element. If the voltage is less than 12 volts, there is an open circuit, so check all wires and connections.

nitrogen—a type of pollutant—from forming in the engine and being expelled into the atmosphere. A malfunctioning EGR system can cause spark knock (particularly when the engine is cold), hesitation or stalling on acceleration, stalling on deceleration and during quick stops, rough idling, hard starting, lack of power, and engine surge at a steady driving speed.

The heart of the system is the EGR valve, which is on the intake manifold near the carburetor (see drawing at left, opposite page). Here's how you can tell whether the system is working properly:

1. With the engine warmed up and running at idle speed, the transmission in "Park," and the parking brake engaged, place your fingers under the EGR valve so they touch the diaphragm. Have an assistant increase engine speed. (Caution: The EGR valve will be hot, so wear soft work gloves.) The diaphragm should move up (open position) as the engine is accelerated, and down (closed position) as the engine returns to idle speed.

2. If the EGR-valve diaphragm doesn't move, pull off the valve nipple, and hold your finger over the hose opening. Accelerate to a speed that approximates 2,000 rpm for six- and eight-cylinder engines, and 3,000 rpm for four-cylinder engines.

3. If you feel a strong pull (vacuum), the EGR valve is faulty. Replace it. A faulty valve is usually the cause of EGR-system failure. If there is no vacuum, trace the hose to its other end. Make sure it isn't kinked. Then pull it free. Check the hose for cracks, and be sure it isn't clogged. If the hose is OK, reconnect it securely, and look to the other EGR parts for the cause of the trouble: They are all involved in making sure that exhaust-gas recirculation takes place at the temperature and time it will do the most good without adversely affecting drivability. These parts include: back-pressure variable transducer, temperature-control valve, vacuum amplifier, ported vacuum switch, temperature vacuum switch, temperature-sensor vacuum valve, engine-heat-sensing valve, and sub-EGR valve.

Fuel-evaporation-control system

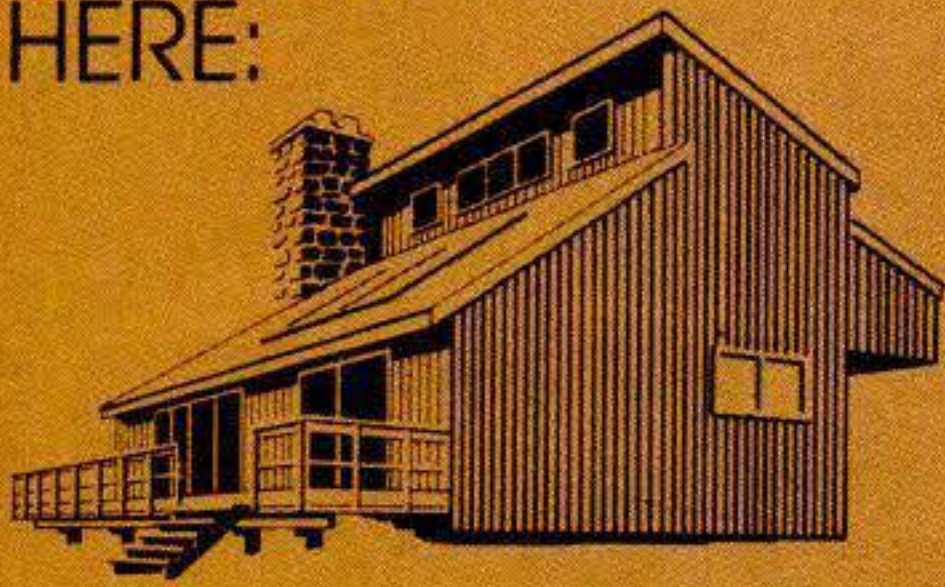
This system has as its main element a charcoal-filled canister that you'll find in the engine compartment. Hoses attached to it extend to the carburetor, fuel tank, and intake manifold. The system traps gasoline vapors that would otherwise escape into the atmosphere and diverts them to the engine, where they are burned.

A clogged or damaged fuel-evaporation-control system is a major cause of gasoline odors in cars. The system may also cause hard starting and rough idling when the engine is hot.

To resolve problems caused by the evaporation-control system, first check hoses for cracks. Replace damaged hoses with those specifically manufactured to handle fuel vapors.

The next step is to determine whether the charcoal canister has a replaceable filter, which is usually in the bottom of the unit. Replace the filter. If there is no filter, you'll have to replace the canister. Generally, manufacturers suggest doing this every two years or 30,000 miles.

BEGINNING
HERE:



Fall Home Improvement

As previewed last month, this special section leads off with the latest in POPULAR SCIENCE'S continuing Storage from Scratch series of constructions, which create volumes of storage space where none existed.

After detailing the bedroom cabinet at right, with its many closed compartments, Reader Activities Editor Al Lees follows up with a brief article on what continues to be America's favorite comeback appliance—the paddle-blade fan. He shows how to solve problem installations, and he examines the mystery of how such fans are efficient fuel savers in winter as well as summer. And to save still more this winter, you can read how to insulate windows to prevent nighttime heat loss.

Actually, this special section already started a few pages earlier: Two heating-related articles you've just thumbed past also involve home improvements. But PS traditionally includes such articles in the October issue because it arrives at a time when homeowners are concerned about yet another heating season and what steps they might take to reduce fuel costs. For that reason, those articles are not grouped in this second half of the two-part fall home-improvement section kicked off in September.

The average price of a new American home recently topped \$100,000, so it looks as though most of us will be improving what we've already got—for years to come, no matter who wins next month's election. Accordingly, this section ends with still more practical how-to that will help you upgrade your present home.

And don't forget to check out the home-improvement contest announced in the September issue. The rules will be reprinted in January, toward an entry deadline of Feb. 1.

STORAGE
from
SCRATCH

Two-faced



This hard-working unit can split a room to create a private sleeping area. It tucks away a pivoting bed and flanking clothes closets, with storage compartments above—and as an island it can offer a display wall as its “public” face.

By **AL LEES**
Cabinetry by Rosario Capotosto

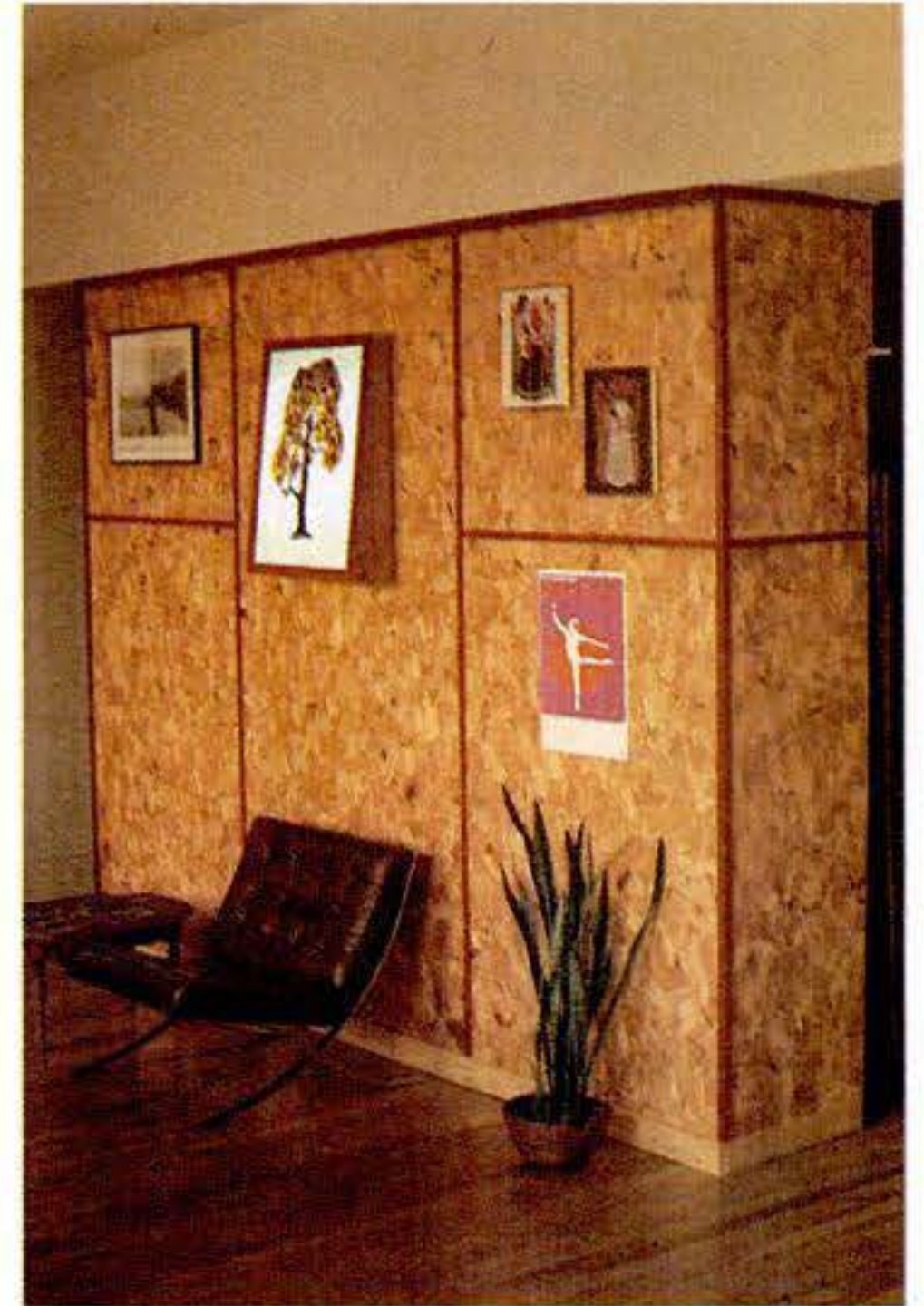
Bedrooms don't come any more compact than this. Built as a divider partition in an island location, as shown here, the unit provides not only the bed alcove and clothes closets, but a handsome display wall on the back plus end walls for mounting light switches and outlets. Or you could butt the unit against an existing wall for a peninsula divider—or build it flat against a wall if you don't have space to divide.

Whatever location you choose, you'll

have added a bedroom that's readily available for overnight guests or for regular use by family members. Because there can be no bedside tables here, the sleeping alcove features built-in amenities such as the little “pockets” at each side for storing those things you'll want to keep handy during the night—medicines, tissues, eyeglasses, and wristwatch. The light fixture on the alcove ceiling is ideal for reading in bed, and switches for both it and the fan's speed control are mounted on an alcove wall where you can reach them without rising.

Frame-panel construction uses in-

bed/wardrobe divider



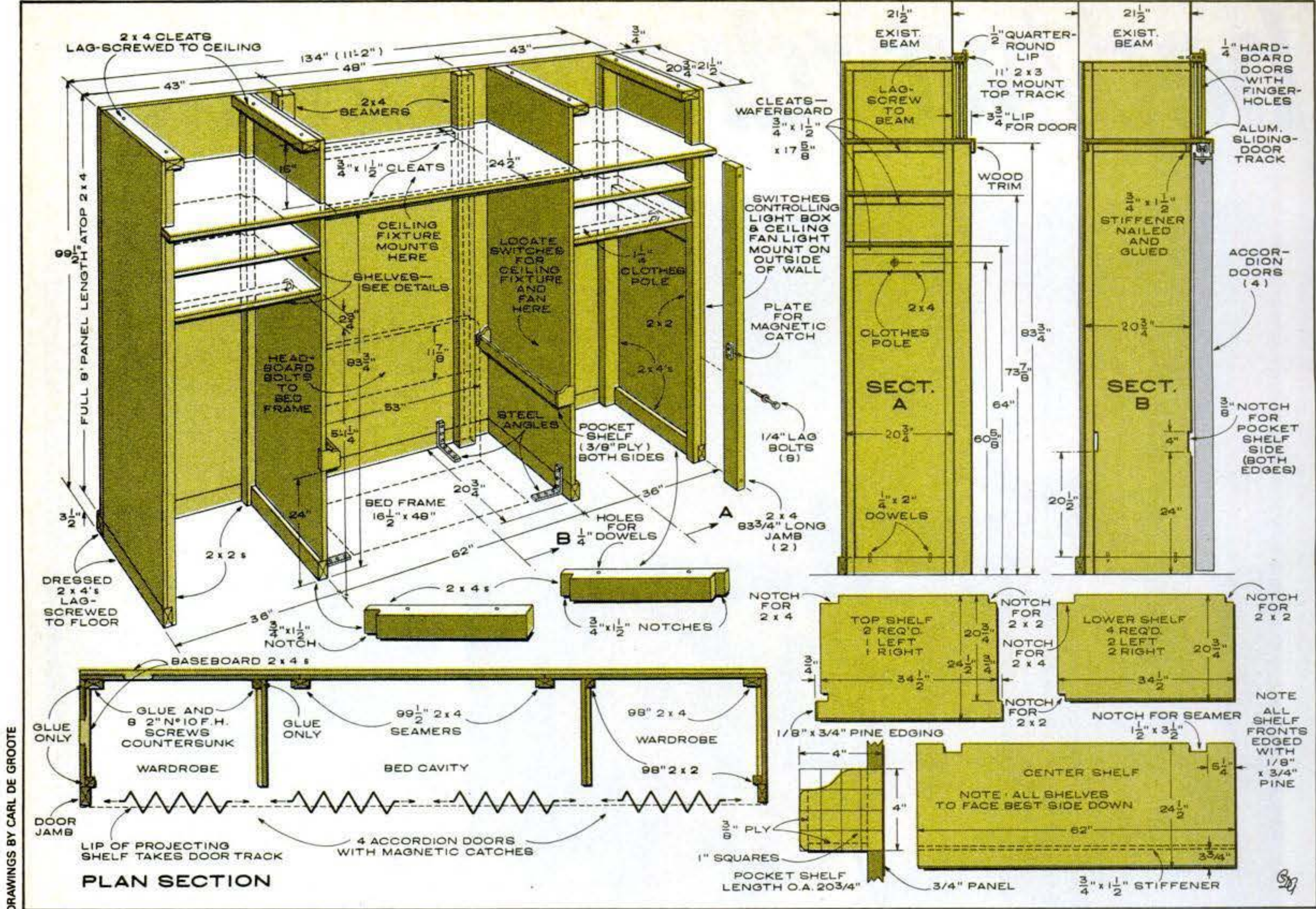
Four accordion doors present neutral 11-ft. wall until center pair is parted (opposite page) to expose bed frame. Doors fold to each side so bed can be pivoted down (left); note opened sliding panel for storage (right of fan). Doors fold farther open for access to clothes (below). Switches for light and fan are on right partition. Enameled wall above headboard is ideal for fragile art that shouldn't be exposed to sun. Back face of waferboard (above) is left natural as background for display.

expensive $\frac{3}{4}$ -inch thick waferboard over a frame of 2×2 s and 2×4 s. In my loft location, shown here, the height to be filled (from the floor to an overhead structural beam) was greater than the standard eight-foot length of structural panels, so I stood the panels atop dressed 2×4 s set on edge to serve as baseboards.

The "public" faces of the structure were left natural. The wood-chip mosaic of a quality waferboard is most attractive when finished with clear shellac or a low-luster polyurethane varnish. Joints and corners are capped with molding strips painted a contrasting color before application. The bedroom faces of the unit were enameled. A prime coat plus a semi-gloss topcoat brushed on waferboard gives a strikingly textured surface suggesting rough-troweled plaster. With its many depressions waferboard isn't

Continued





DRAWINGS BY CARL DE GROOTE

easy material to finish, but the results are worth the effort. And there's little surface preparation involved except on faces you'll leave natural. On these some sanding is required to minimize wax-burn spots that occur during manufacturing. What cabinetmaker Rosario Capotosto did in assembling the closet units for me was select the least-blemished faces for the public side because I'd be painting the faces on the bedroom side. Here are other construction tips from Capotosto (in addition to his clamping photos):

- Start construction by ripping the panels to width: four pieces at 20³/₄ inches and two at 43 inches. If you're using a portable circular saw, face the good side down.

- Before any subassembly, cut the recesses for the pocket-shelf ends on the edges of the two inner partitions. The four 2 × 2s and four 2 × 4s used for vertical framing are all more than eight feet long, so they must be cut from stock 10-footers.

- When gluing panels to framing, sand surface areas to remove all traces of manufacturing wax before applying glue. After the vertical members are attached, cut four pieces of 2 × 4 20³/₄ inches long. Rabbet notches ³/₄ inch deep and 1¹/₂ inches wide on both ends of the end baseboards and one end of each partition baseboard. Two ¹/₄-inch dowels are used to attach these to their panel edges.

- You can cut shelf cleats from waferboard scraps, attaching them with glue and ¹/₄-inch finishing nails. Cut the shelves from ³/₄-inch plywood, notching as shown above.

Photos (6) and (7) on the facing page show the final assembly steps for the bed cabinet. The two wardrobe assemblies are spaced slightly more than four feet apart on an 11-foot-two-

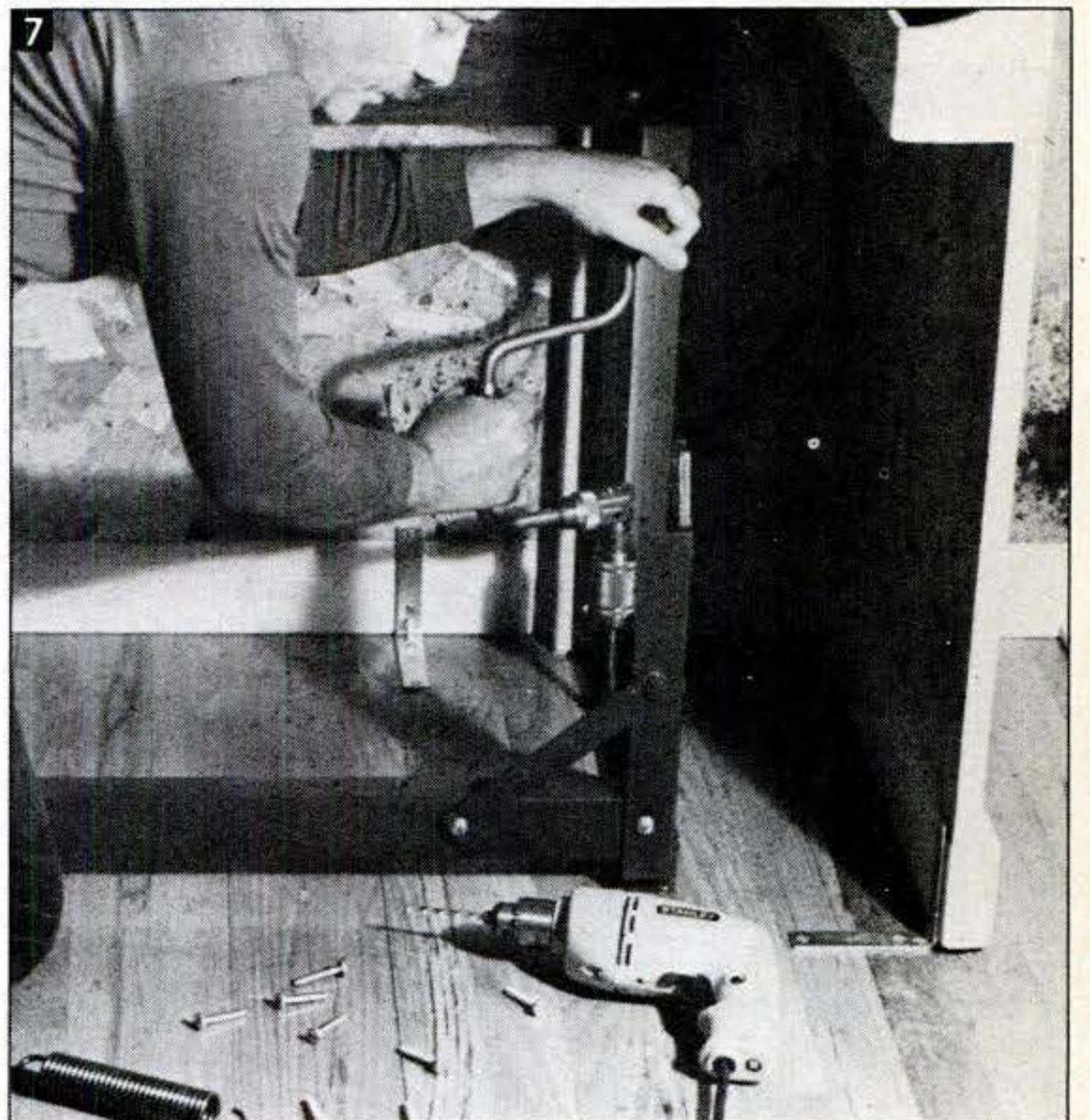
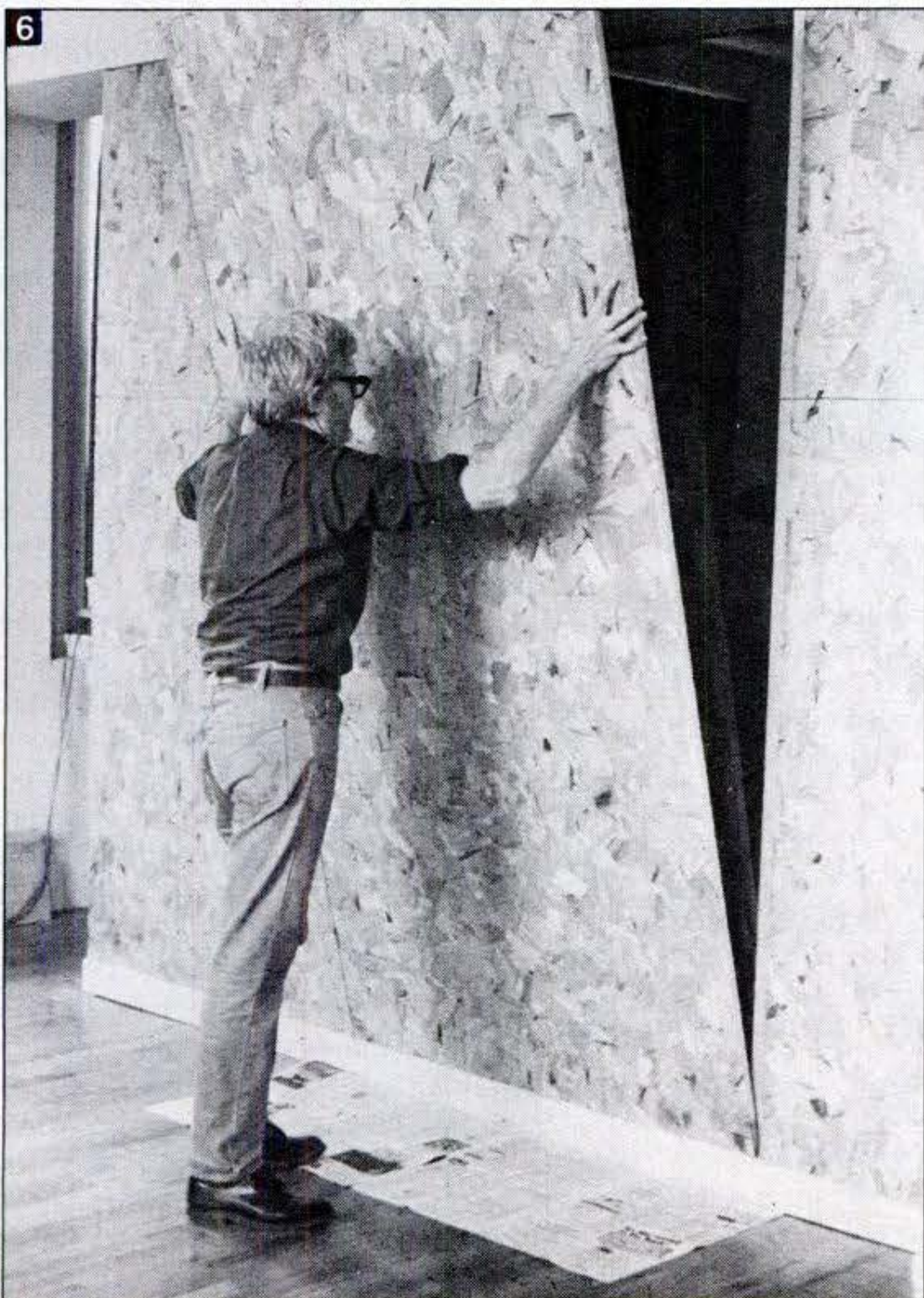
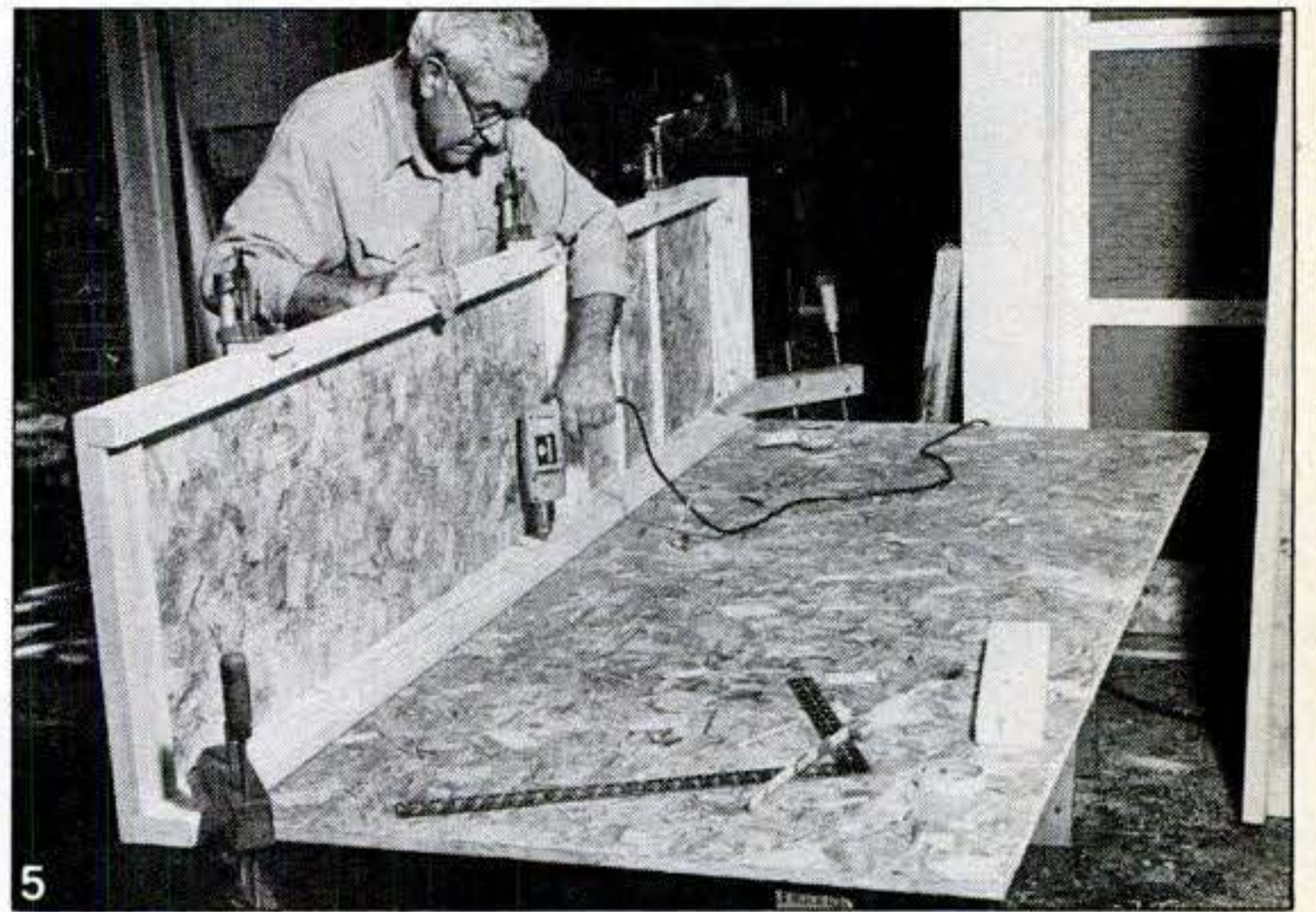
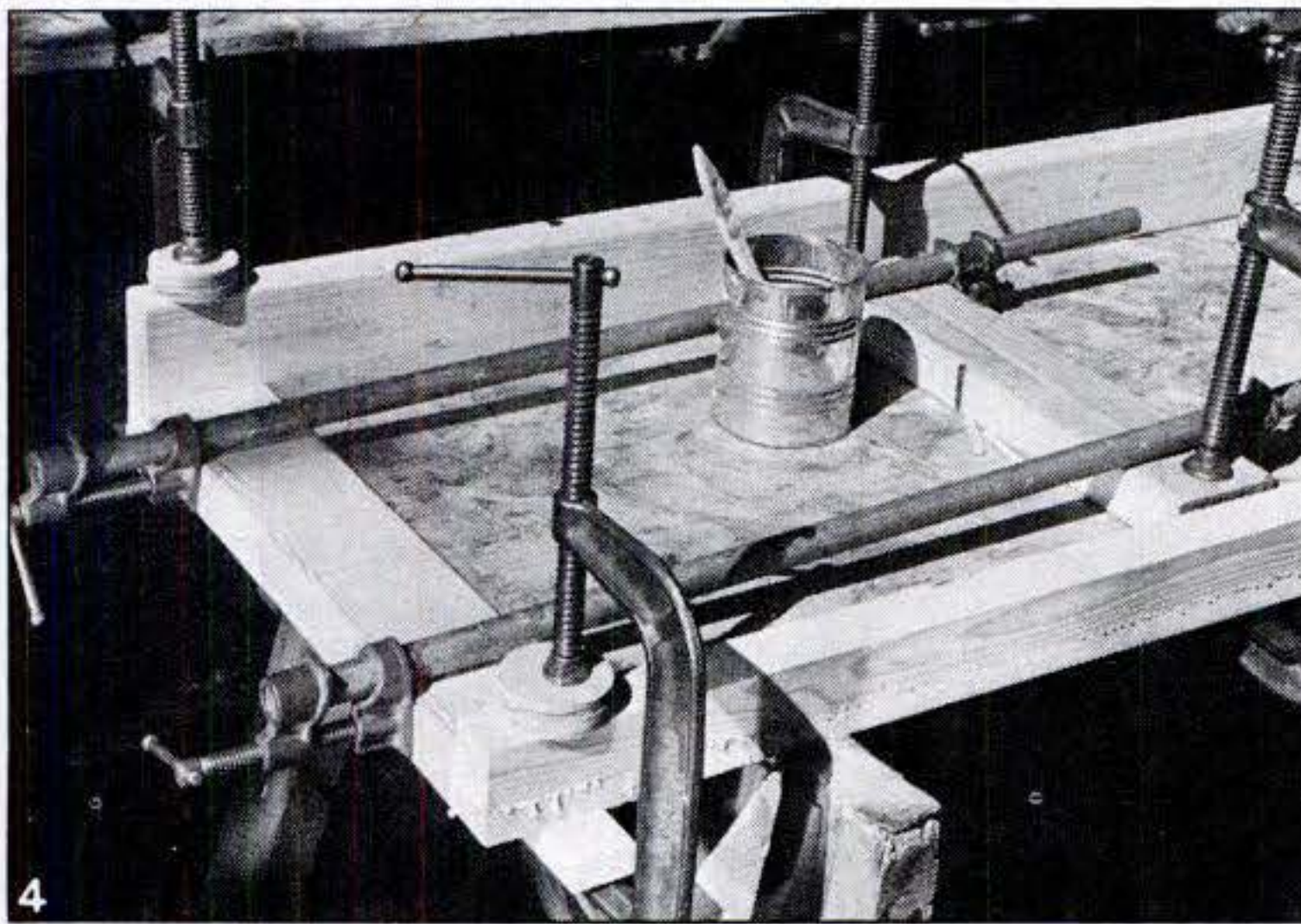
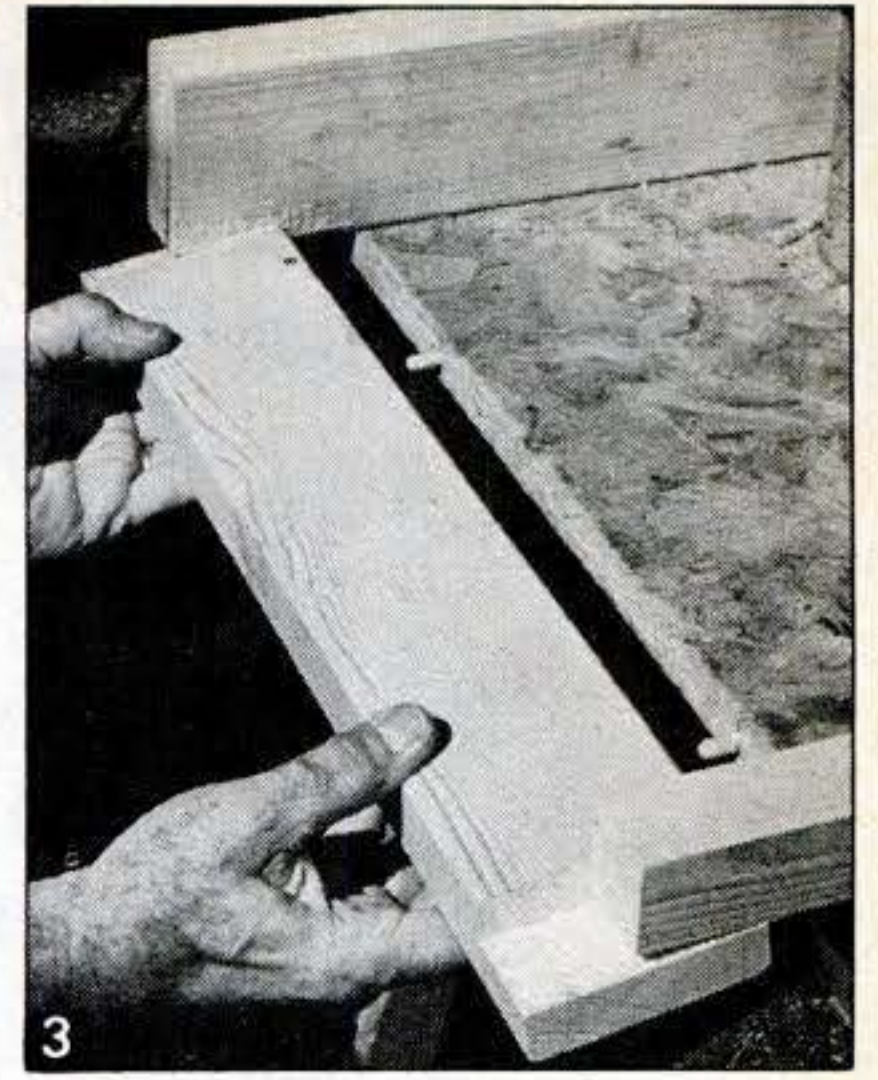
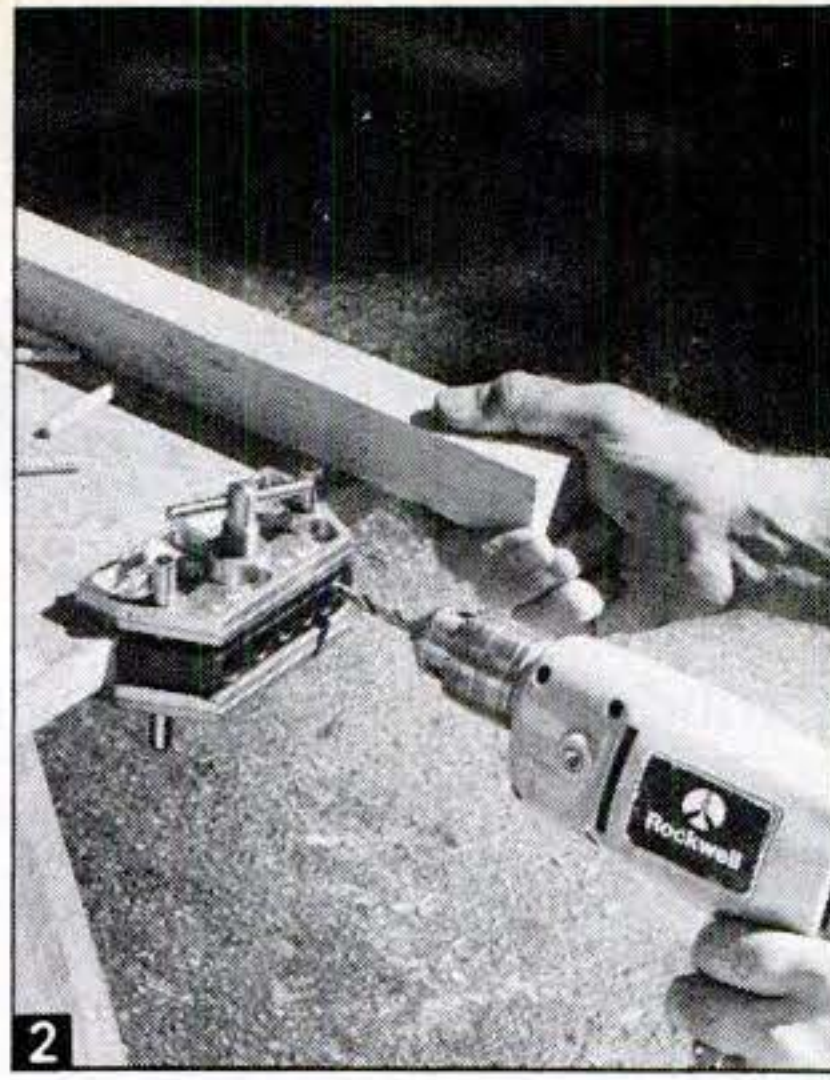
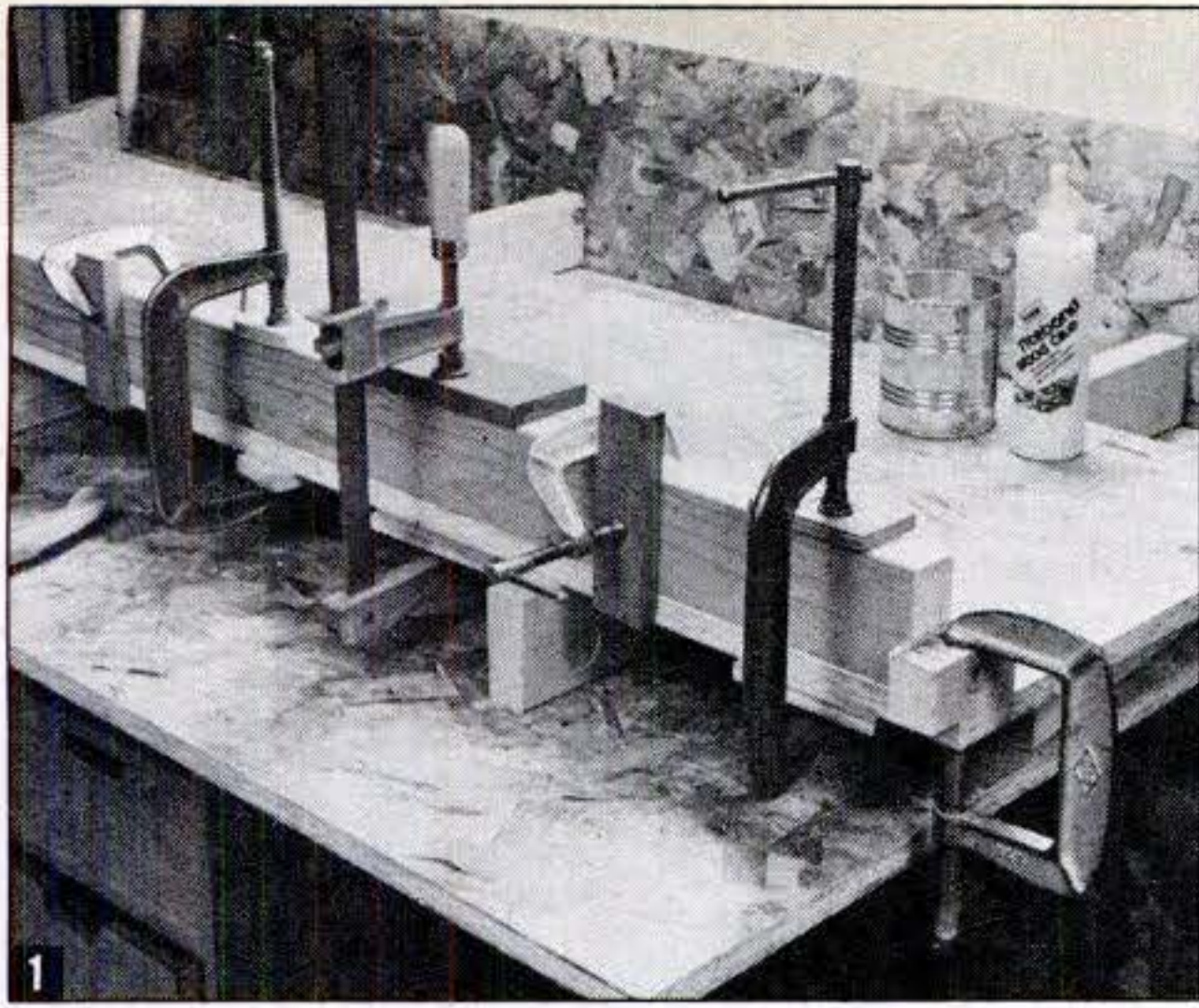
inch 2 × 4 baseboard anchored to the floor with steel angles. Cabinet assembly is completed by bridging these units with a full four-by-eight-foot panel of waferboard (6), gluing and screwing it into the vertical 2 × 4 seamers already attached to the wardrobe panels.

The pivoting-bed headboard frame is anchored to the floor within the alcove (7) before you set the pivoting bedspring frame atop it. Then you link the two with heavy springs such as the one shown in the lower-left corner of the photo. You add only as many as needed to balance the weight of your mattress for easy lifting.

Doors to close the upper storage compartments are simple panels of ¹/₄-inch hardboard sliding in aluminum tracks. The full-width accordion door is actually four folding panels hung from a continuous aluminum track screwed to the bottom of the protruding shelf. (The track will come in four pieces when you buy the doors.) The doors come with magnetic catches on each stile; magnets of adjacent doors catch one another. At the outer ends you must provide a jamb on which you can mount a metal plate for these doors to close against. I simply bolted a vertical 2 × 4 on edge.

The following manufacturers were selected by POPULAR SCIENCE for participation in this project. Retail prices are listed where appropriate, as a guide only; for further data, contact the source.

Source	Item
Louisiana-Pacific Corp. 111 S.W. Fifth Ave. Portland OR 97204	Waferwood, five panels (³ / ₄ in. × 4 ft. × 8 ft.)
Murphy Door Bed Co. 40 E. 34th St. New York NY 10016	Coil Spring frame, model CRH-54 (\$448)
Reynolds Metals Co. Box 27003-A Richmond VA 23261	DIY Aluminum double track, model 3621, for ¹ / ₄ -in. doors (two 6-ft. sets)
Robbins & Myers, Inc. 2500 Frisco Ave. Memphis TN 38114	Hunter Comfort Breeze 52-in. ceiling fan, model 22531 (\$235), plus light-adaptor kit
Wood Specialty Products 24300 60th Ave. W. Mountlake Terrace WA 98043	Spacesaver 350 Winwood Floating Doors



Capotosto's clamping tricks speed assembly. Scrap block clamped at end (1) allows for cleat. The 1×2 blocks are clamped across face of 2×4 to hold it flush with panel edge while glue sets. Self-centering doweling jig is ideal for panel drilling (2). Check fit before applying glue (3); poor alignment could split out waferboard. Clamped crosspiece (right in photo) lets you use short pipe clamps (4). Clamp the end units while boring the pilot holes into the back panel (5). See text for comments on photos 6 and 7.

Now paddle fans mount on any ceiling

New models and special techniques adapt the popular overhead fan to virtually any ceiling—even dropped, suspended types. And these paddle fans are energy savers in winter as well as in summer.

By AL LEES

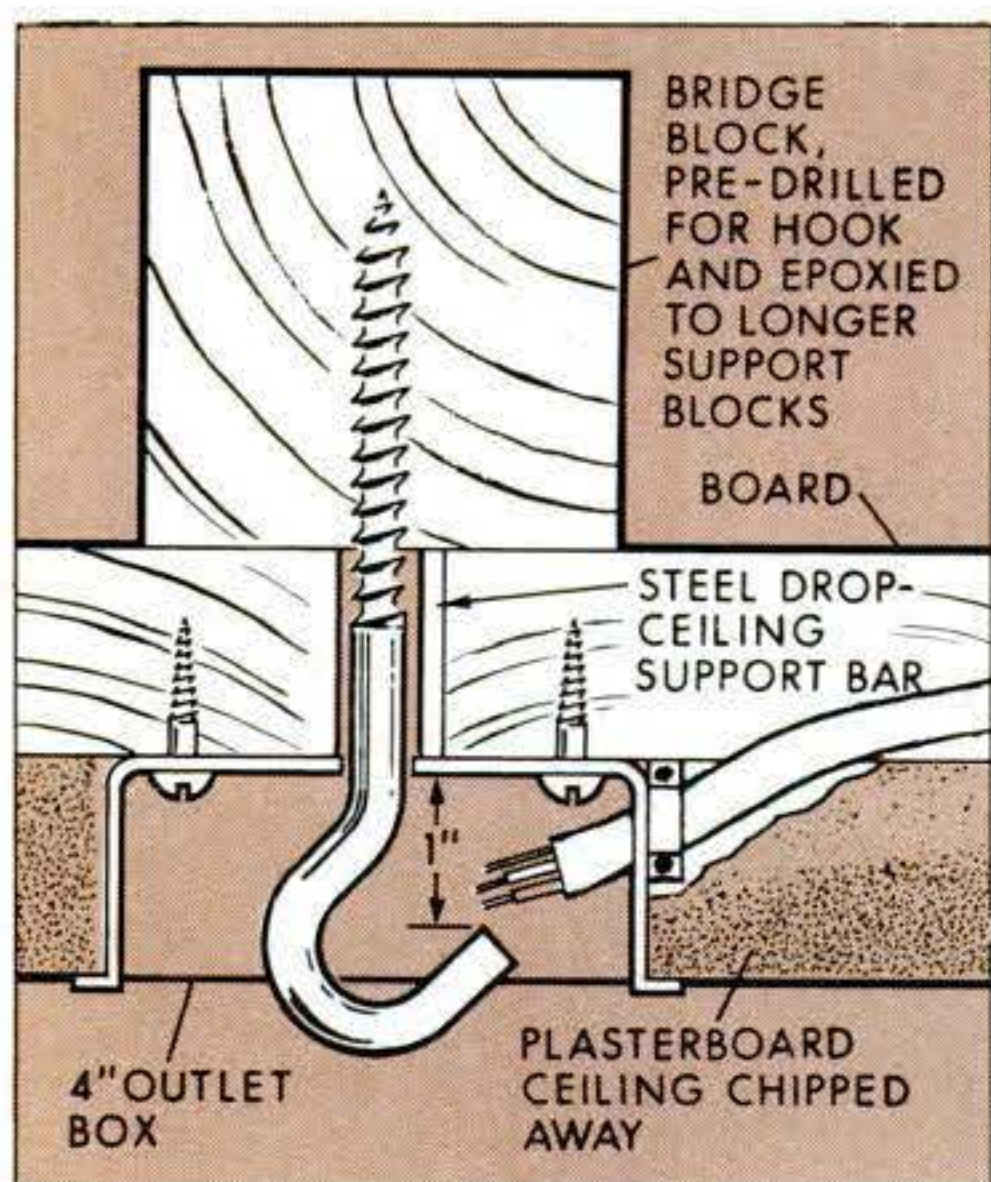
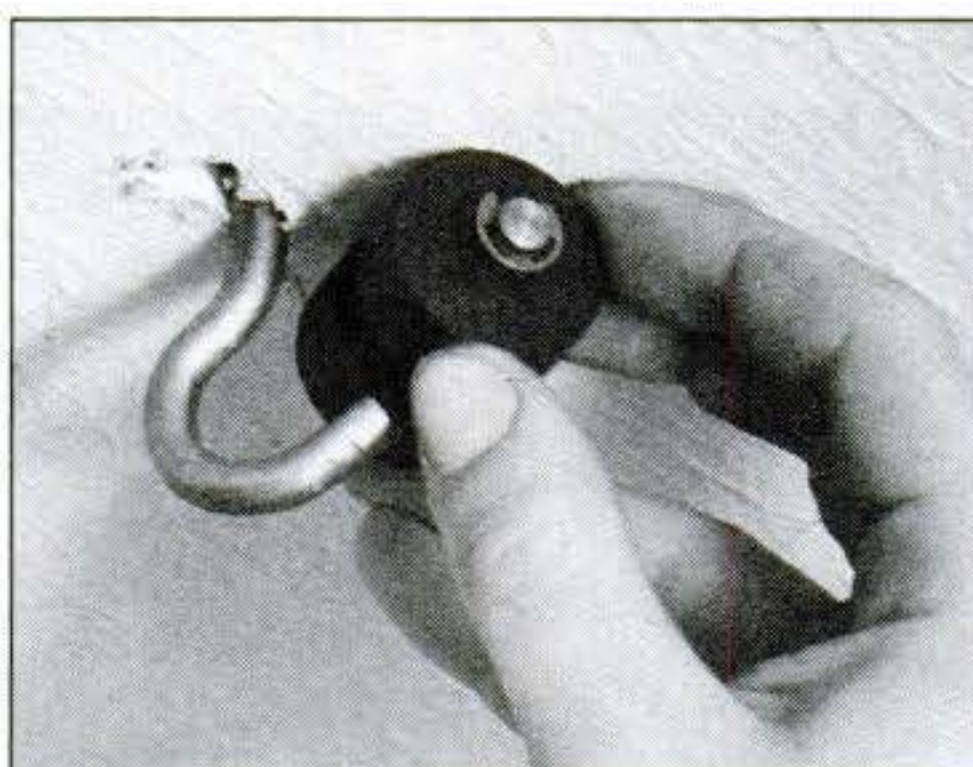
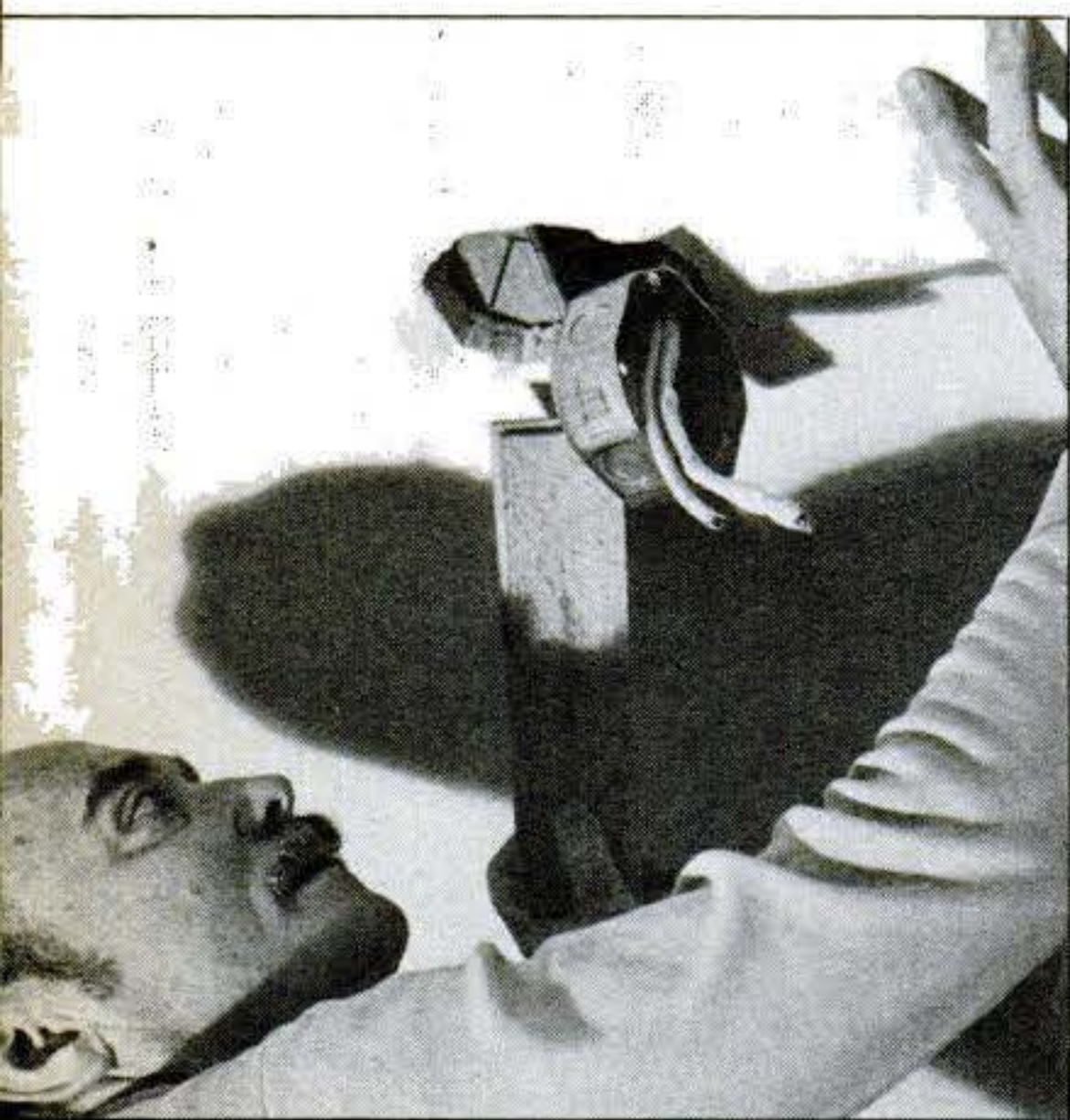
When I decided to install a 52-inch-diameter paddle fan over the Murphy bed shown in the preceding article, I learned that the instructions that come with even the best units can't possibly cover all mounting situations. My own was complicated by the fact that I wanted:

- A light globe operated by a wall switch. Most fans come with a blunt base closed by a metal disc. A light-fixture kit from the fan's maker is extra.
- A wall-mounted speed control. The pull chain on many fans gives you two or three speeds, but chain operation is awkward above a bed.
- Blades at the optimum height of seven feet above the floor, though my ceiling is 10 feet, nine inches high. This called for a three-foot extension of iron pipe.

• A secure anchorage for my 30-pound fan, even though my finished ceiling is suspended plasterboard. When I cautiously cut my ceiling hole exactly where I wanted the fan, I found the hole bridged by one of the steel bars of the supporting grid.

The solution to the last problem is sketched at left. After snaking two Romex cables over the ceiling to my outlet box, I slipped two boards through the hole to spread the weight, one on each side of the grid bar. (Prongs pass through the boards—in this case, scraps of oak flooring—to serve as positioning handles. Push them up, or clip them off later.) A pre-drilled and epoxy-faced block was inserted atop the boards, then the right block was moved against the bar. After the glue had set, I screwed the box to the boards and turned the soaped threads of the hook up into the block.

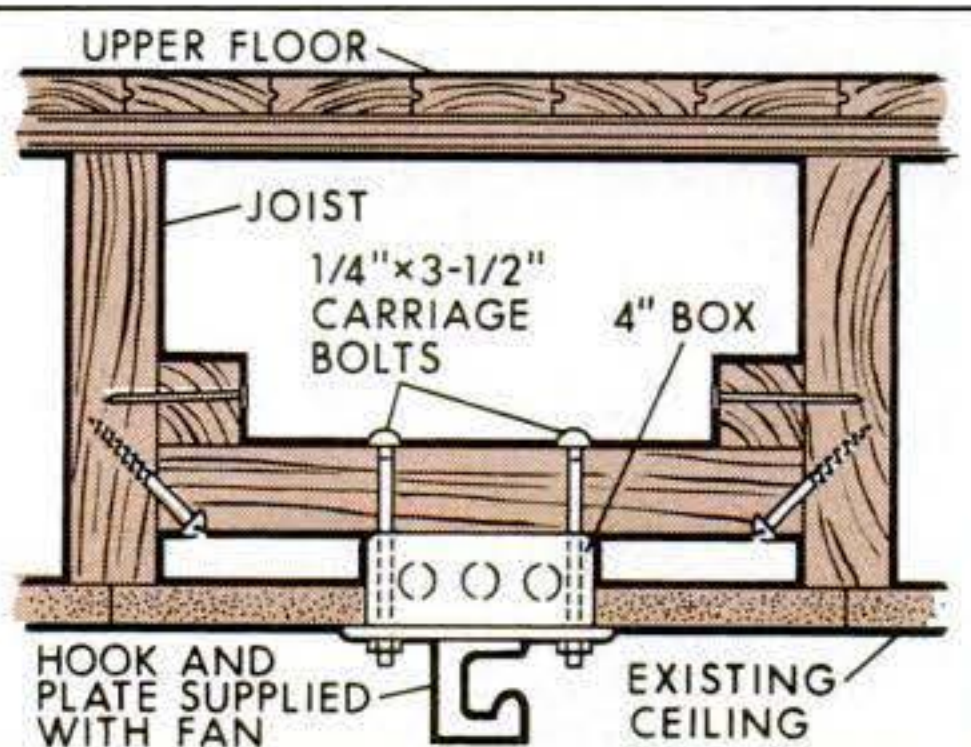
Some fans come not with a hook but with a mounting plate that bolts right onto an outlet box. It's rarely possible to just remove an existing ceiling fixture and hang a paddle fan in its



Installation instructions for most fans make it sound simple: Just drive a hanging hook up into a joist, add dumb-bell bushing (top right), and hook the bracket over its protruding axle (above). But when you have a suspended ceiling, you must provide a good anchorage for the hook. The photo and sketch at left show the author's solution.

Beef up the mount

Fan makers that offer a mounting plate for a standard outlet box often tell you to attach it with two 8-32 cover screws. Instead, bolt the boxes through a 2 x 4 cross brace screwed between existing joists. Make a four-inch-wide slit in the ceiling (to be patched later), and hammer in a couple of positioning blocks. Hold the preassembled brace and box in place, and drive screws at an angle through pre-drilled holes at each end.—H. B. Pratt

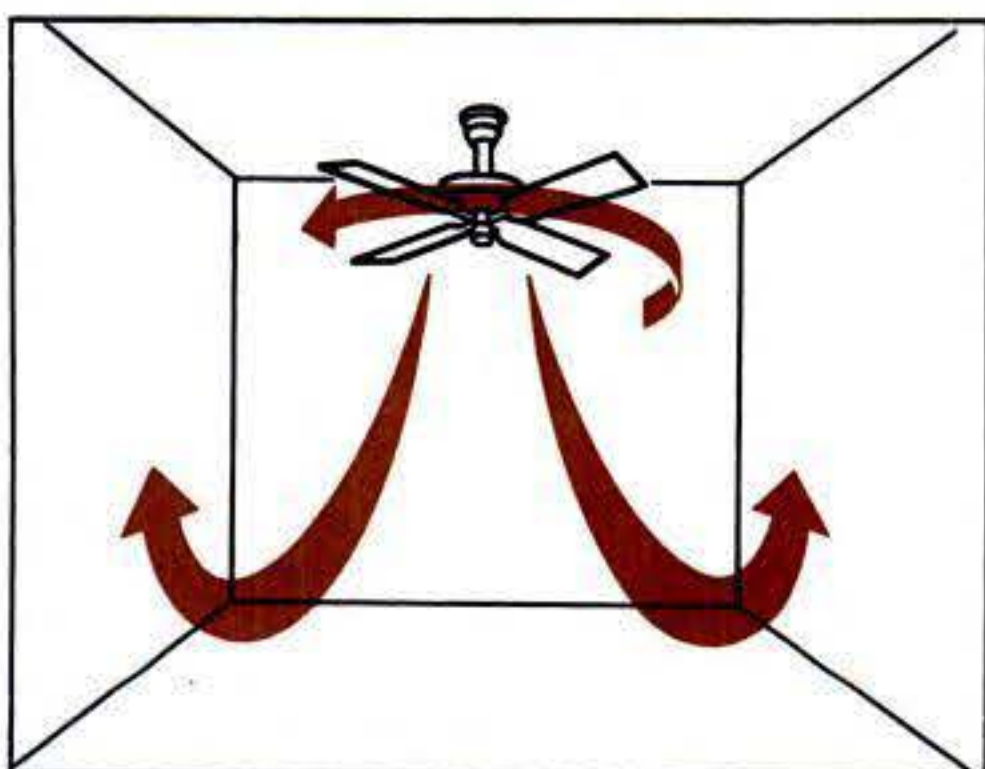
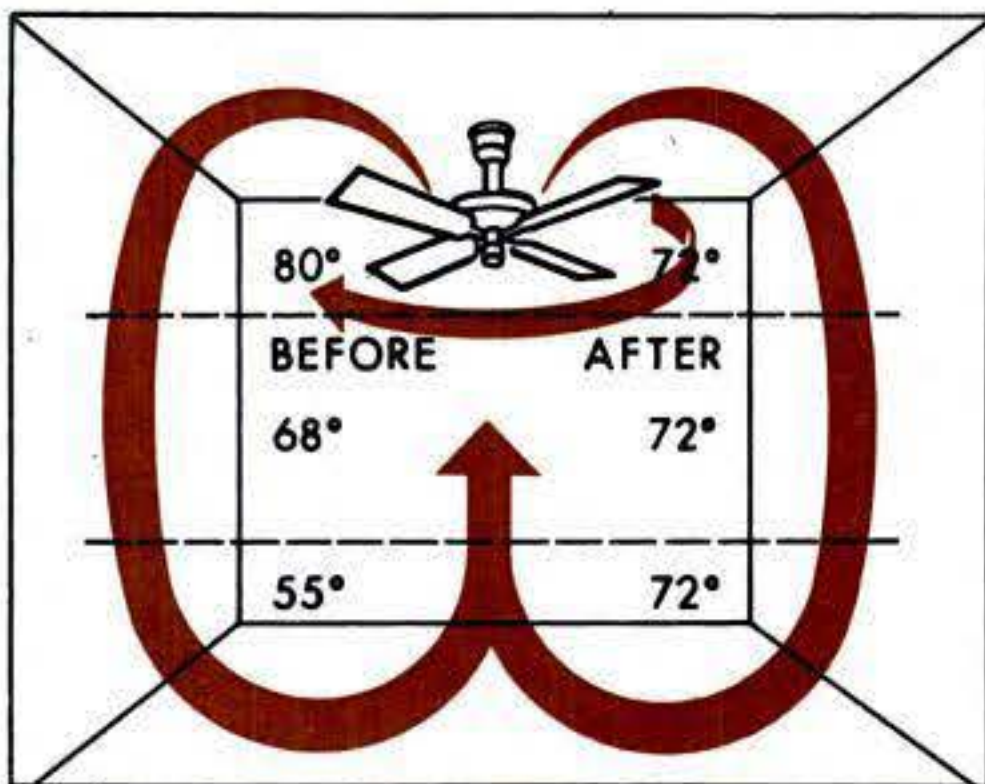


place; the fan's sure to be heavier, and the outlet box may not be anchored firmly enough. (For one way to be certain, see box on preceding page.)

The standard mount and canopy—the housing that hides the top wiring and four-inch outlet box—that come with most fans are for flat ceilings. If you're hanging from a pitched ceiling or exposed rafter, you must order a special kit.

Because I used plain 3/4-inch iron pipe, threaded at each end, to lower my fan, I needed to match this to the brass of my housing and canopy. My dealer offered a thick plastic sheath in a brass finish to slip over the pipe before hanging. But when trimmed to the exact length of the exposed pipe, it butted the canopy bottom, making it impossible to lower the canopy to make wiring connections. My solution: Chop the sheath six inches short, slip the long piece back on the extension pipe, rehang the fan and wire it, and raise the canopy and secure it against the ceiling with its setscrew. Then I slit the six-inch piece lengthwise, heated it for momentary flexibility, and snapped it over the gap. **ES**

Seasonal reverse



A fan with reversible rotation does double duty. In winter (top diagram), hot air rises near the ceiling, leaving the living area with cooler stratifications. Clockwise-whirling blades push air up across the ceiling and down the walls, mixing the air within the room to a uniform temperature. Greater heating efficiency means lower fuel bills. In summer (lower diagram), switching to counterclockwise rotation means that the fan can save up to 25 percent of cooling costs. A gentle, steady flow of air across your skin can make 81 degrees F feel like 72 degrees, so you can set your air conditioner to run less frequently.

Pocket shutters

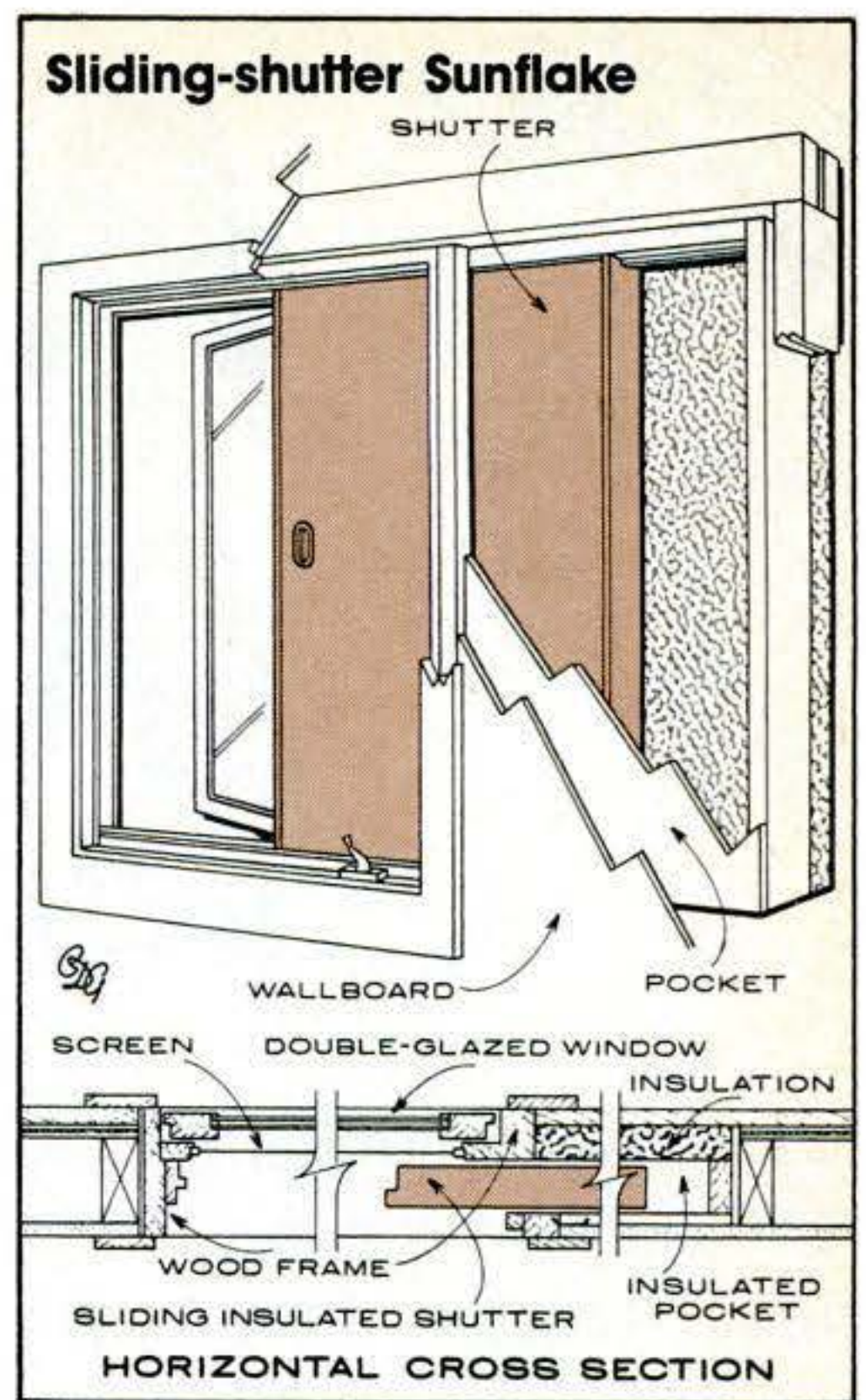
It admits sunlight and fresh air when you want them, seals them out when you don't—and foils burglars. The Sunflake window is a unique combination of window, insulating shutter, and storage pocket in one unit. The unit is designed for new construction, but there's also a retrofit system for insulating existing windows.

The Sunflake window looks and works like any wood-framed casement or picture window—until you pull the shutter from its concealed wall pocket. Rated at R-14, the shutter has a 1½-inch core of polyisocyanurate foam faced with handsome ash paneling on the inside and with textured aluminum (for summertime sun reflection) on the outside.

When closed, this shutter in effect converts the window to a well-insulated wall. An optional dead bolt that locks the panel to the steel-framed pocket makes the aluminum-clad shutter a burglar-resistant barrier.

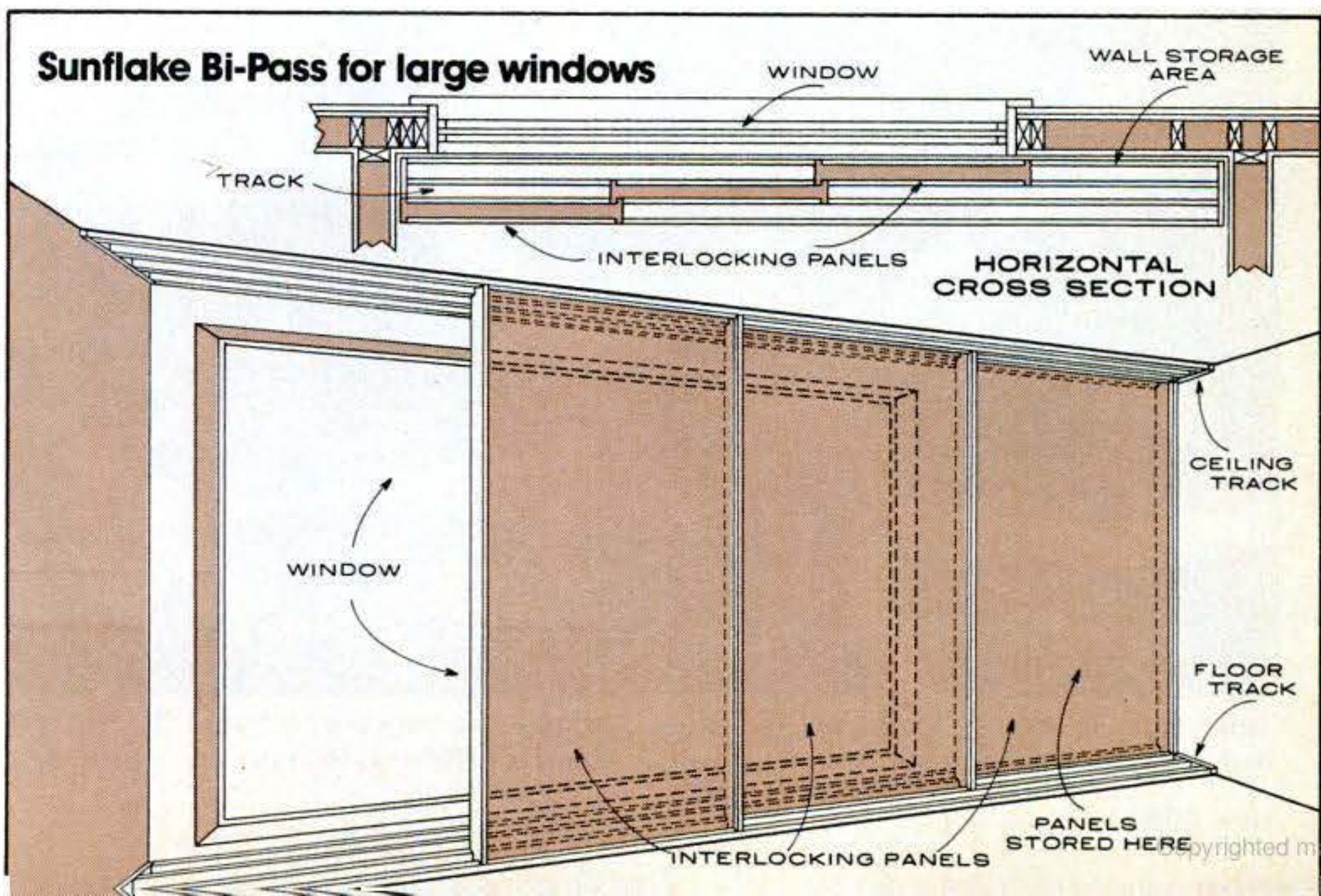
The pocket fits into the cavity of a 2×4-frame wall (see diagram above). The pocket's rigid R-12 Thermax insulation covers insulated metal framing studs. Wallboard and exterior siding fasten with self-tapping screws to these studs.

The Sunflake window can be installed only in new walls. But the maker (Sunflake Window, Box 28, Bayfield, Colo. 81122) has a related system to insulate existing patio doors, French windows, greenhouse walls,



and other large floor-to-ceiling glass expanses. The Bi-Pass system (diagram below) uses the same ash-faced, R-14 insulating shutters. These interlocking panels glide in series along extruded-aluminum tracks attached to floor and ceiling. The tracks extend the length of the window and beyond to accommodate the length of one panel. When not in use, the panels store on the track section that runs along the wall. The three-panel system shown insulates an 11-foot-wide window and requires that three feet of wall space be set aside for shutter storage. For wider windows you add more panels.

The Bi-Pass system works for windows as narrow as three feet and as wide as 23 feet. To reduce the wall storage space needed for super-wide windows, some panels can be stacked on each side, then pulled toward the center.—*Susan Renner-Smith*

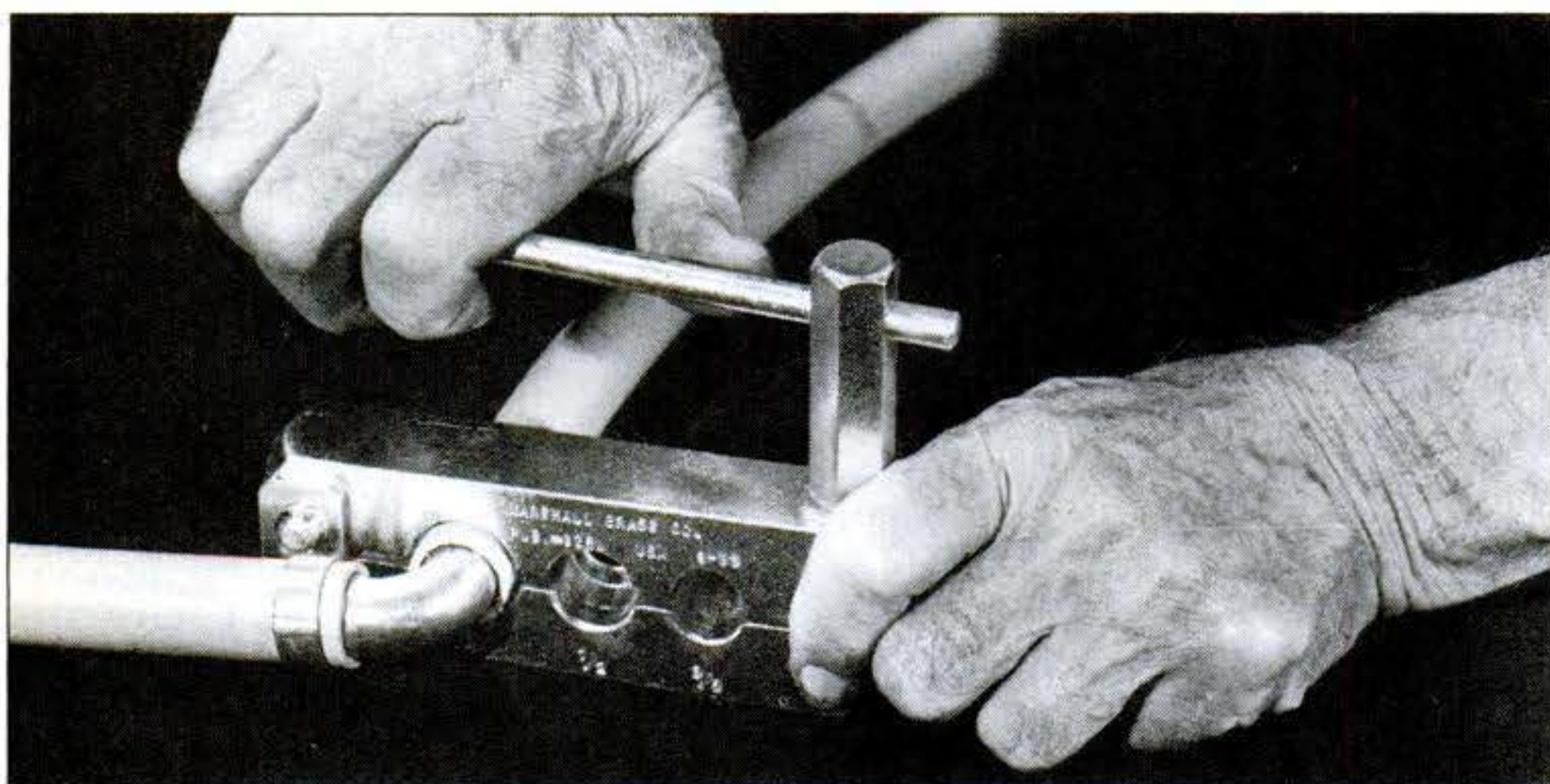


IMPROVE YOUR
HOME

Polybutylene goes DIY

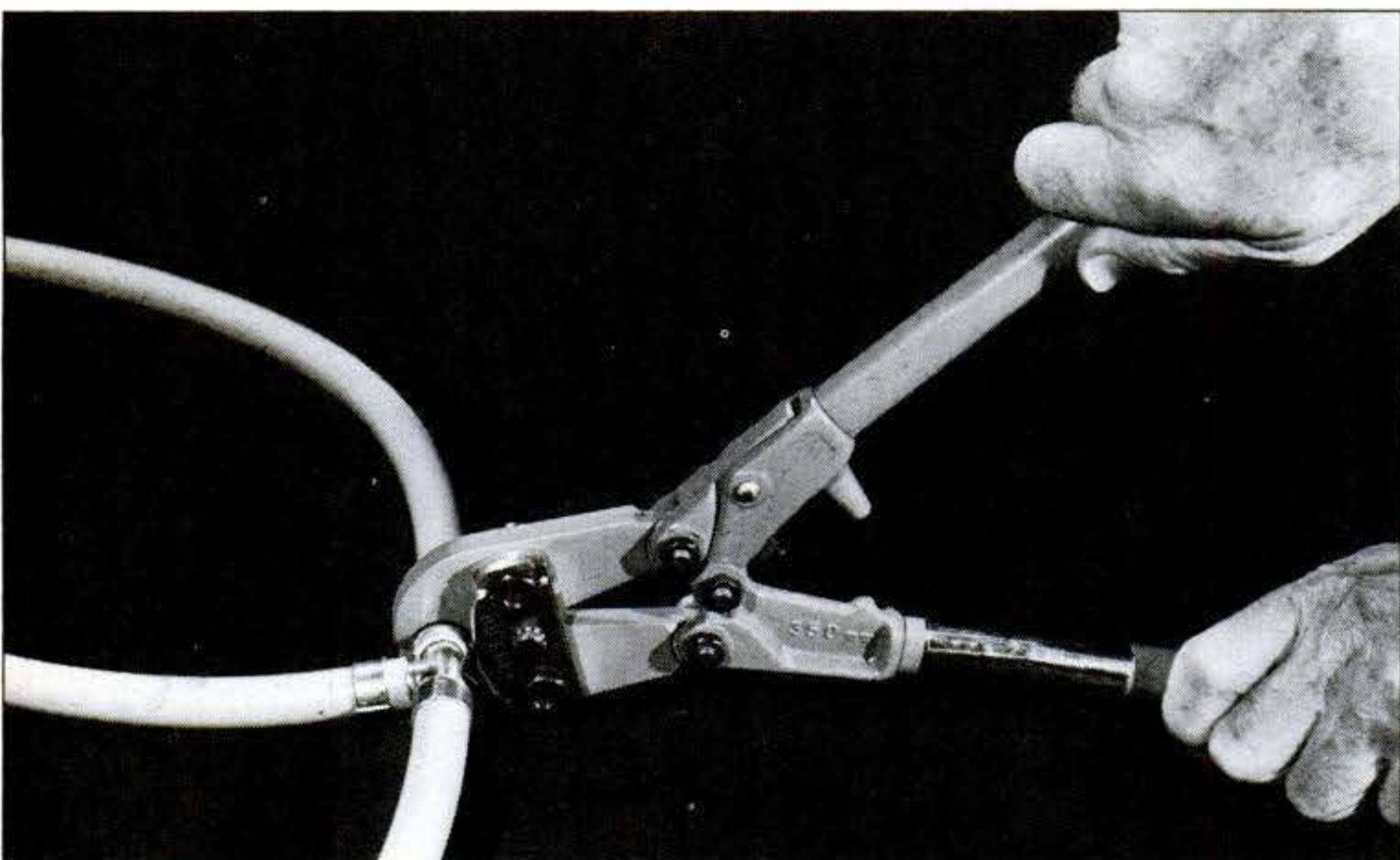
with new crimp-on fittings

Flexible polybutylene pipe, now available in sizes for home-plumbing needs, can handle 180-degree-F temperatures and 100-psi pressures. Put it together with a new line of solid-brass, crimp-on fittings, and do-it-yourself plumbing becomes more goof-proof than ever.



Powerful crimping action compresses a copper ring clamp to secure PB pipe around a brass fitting, forming a leak-

proof joint. This crimping tool is easier to use than the other (see below) and handier still when used in a vise.



Tong-type crimping tool can be used where the other one won't fit. But you need a different tool for each pipe size.

By E. F. LINDSLEY

Whenever you extend or cut into an existing plumbing system to add a dishwasher, wet bar, or the like, you can expect some awkward hours. In addition to cramped working areas, you'll have to couple new pipes onto the old ones, size new lines, and dodge obstacles. Choosing the right kind of pipe and fittings can simplify the job. One of the newest, easiest, and most reliable systems I've found uses polybutylene pipe and solid-brass, crimp-on fittings.

The new pipe-and-fittings system I tried is called Failsafe. The flexible polybutylene pipe, often called PB, is approved by the National Sanitation Foundation and rated by the American Society for Testing Materials for temperatures of up to 180 degrees F and pressures of up to 100 psi. And now it's available in the popular $\frac{3}{4}$ -, $\frac{1}{2}$ -, and $\frac{3}{8}$ -inch sizes for home-plumbing use.

The fittings, made by Marshall Brass Co., are solid brass or copper and are husky enough to resist the forces you must apply to worm the piping into place. They resemble typical automotive brass couplings except one end, at least, is not threaded. Instead, it has a series of turned grooves, sometimes called barbs. You simply insert the barbed end into the pipe, and slide a copper ring over the joint. By squeezing down on the ring, you compress it around the pipe and force the pipe into a firm grip on the fitting. The com-

Continued

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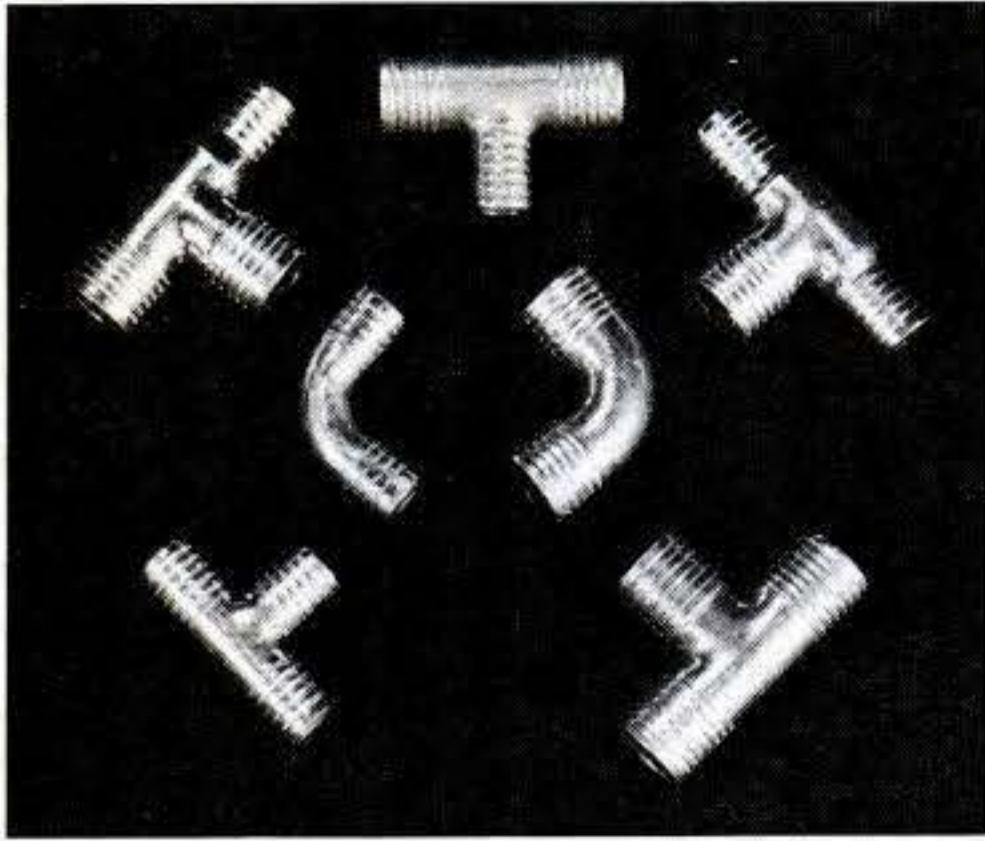
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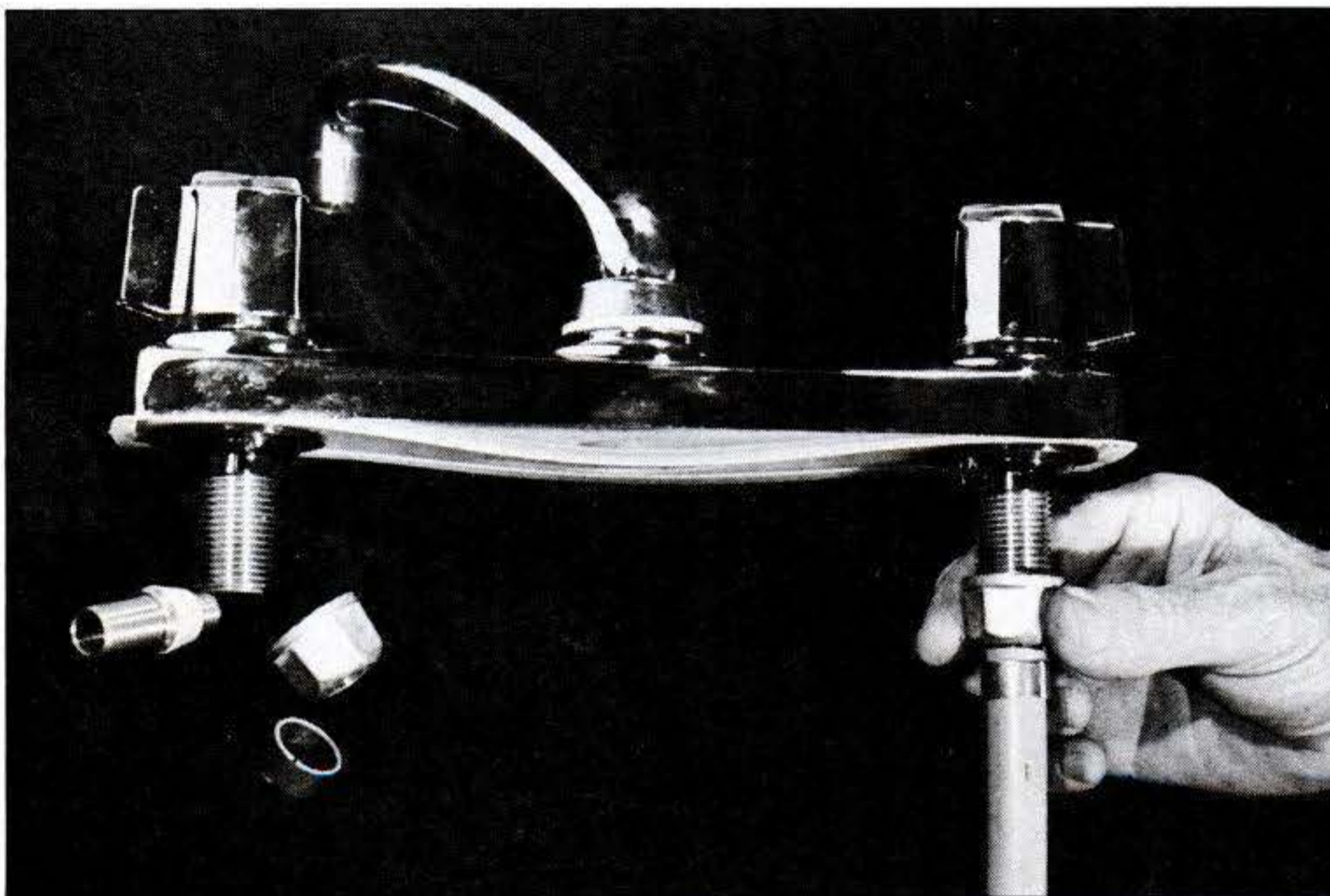
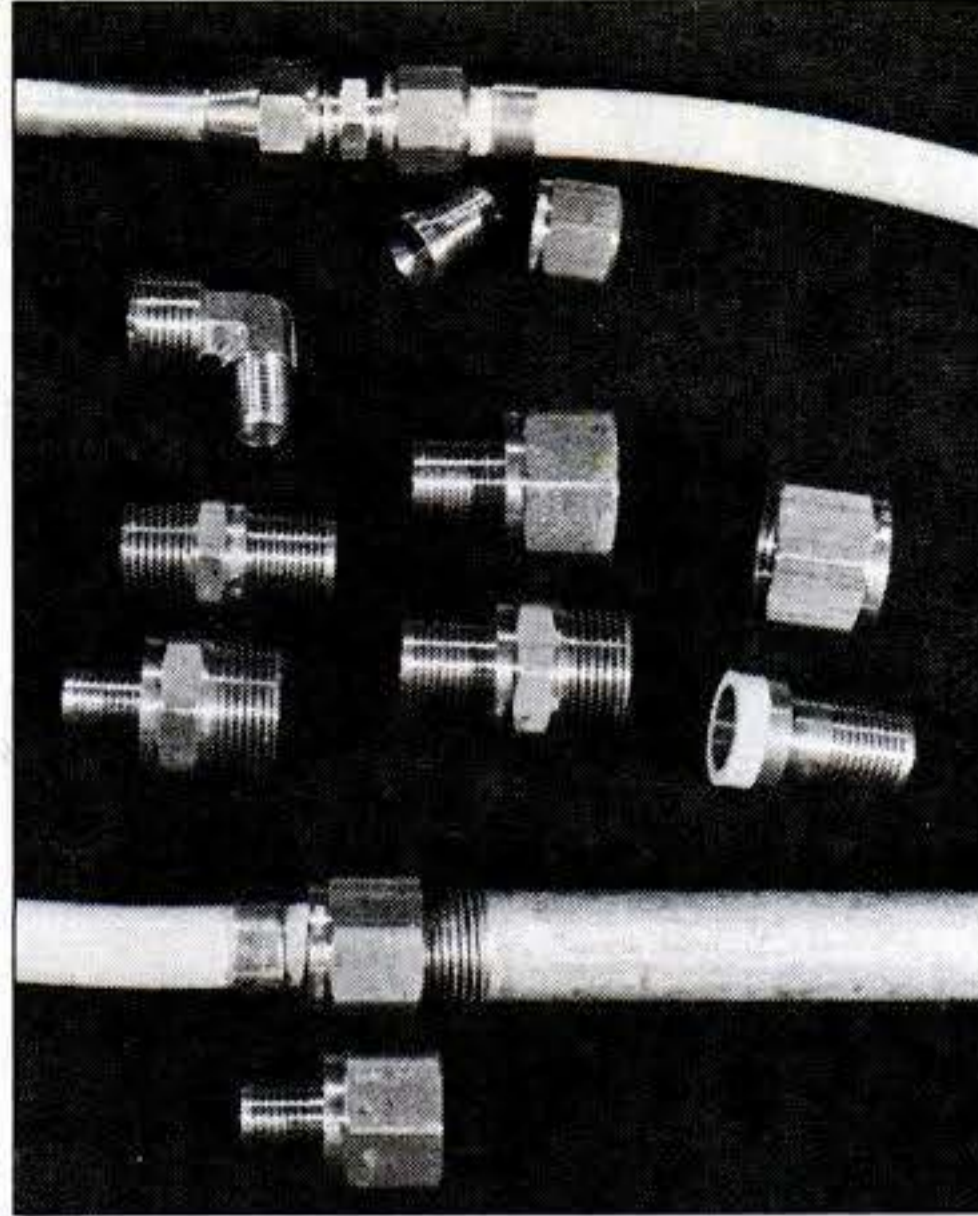
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Gas gives you more for your money.

Polybutylene goes DIY



Failsafe elbows and tees (the latter available with reducer ends) are solid copper (above). Transition fittings (right) can be coupled to straight pipe (male or female), flared or soldered copper pipe, and plastic pipe.



Sink-faucet connection is an easy do-it-yourself project with PB pipe, flanged brass fitting, rubber cone seal, and cou-

pling nut. Remember to put the coupling nut in place before crimping the copper ring over the pipe to form joint.



Pocket knife easily cuts PB pipe if you bend a little tension into the area you're cutting. Pipe also saws freely, but after sawing, the cut needs trimming.

pany sells two special crimping tools for this job: one to use on location and the other to use at the workbench.

Newer is better

The PB pipe and copper and brass fittings solve many of the problems of older plumbing materials:

- Threaded iron pipe is heavy, inflexible, and hard to measure, and it depends on angled fittings, which may not point where you want. The pipe is a chore to cut, thread, and tighten.

- Soft copper pipe is better because it can be bent and shaped, but perfect flare fitting joints are hard to form and make leakproof.

- Using sweated solder fittings on rigid or soft copper pipe is extremely hazardous because it requires a torch and flame. And you're often working in areas where you can't be sure about fire safety.

- Ordinary plastic pipe may or may not resist the temperatures and pressures in your water system, and the plastic fittings and hose clamps normally used with plastic pipe are not always reliable.

Polybutylene is one of the latest materials for plastic plumbing. After some earlier dismaying results with polyvinyl chloride and other plastic pipe, Oklahoma State University, doing extensive research on earth-coil heat pumps [PS, Oct. '83], found this remarkably tough pipe to be the most durable of the pipes tested, even for underground use.

High-quality PB pipe can be identified by light stampings on its surface. Expect to find it carrying both ASTM and NSF designations and pressure and temperature ratings.

In my experiments with PB pipe and the Marshall Brass fittings, I learned several things:

- Although PB is light and fairly flexible, a four-inch radius is about the tightest curve you can make. For a tighter bend, use an elbow.

- You can make the same mistake you might make with a copper flare fitting by forgetting to put on a coupling nut before you secure the clamp.

- The two-handle tong crimper for clamps can be used in tight areas, but it's easier, when the situation allows, to clamp the simpler screw-down crimper in a vise and build up an assembly as a bench job, using tees, ells, and terminal fittings.

- It's a good practice to plug one end of such an assembly and connect the other to your water line to check for leaks before you install it.

- I got leaks only when I sawed the tubing and left burrs and plastic scraps inside in the fitting area. When I trimmed the pipe to a clean end with a sharp knife, I had no trouble at all.

One of the eternal challenges of the do-it-yourself plumber is making transitions from one type of pipe to another, or coupling to a faucet or appliance. Often you must resort to a gaggle of couplings and adapters to make the connections. Marshall Brass has simplified the procedure by coming up with a huge collection of fittings, adapters, reducers, and go-betweens. You'll find exactly what you need for almost any conceivable job. The trick, of course, is to first make a sketch of what you plan to do with PB pipe and then decide which fittings you'll need.

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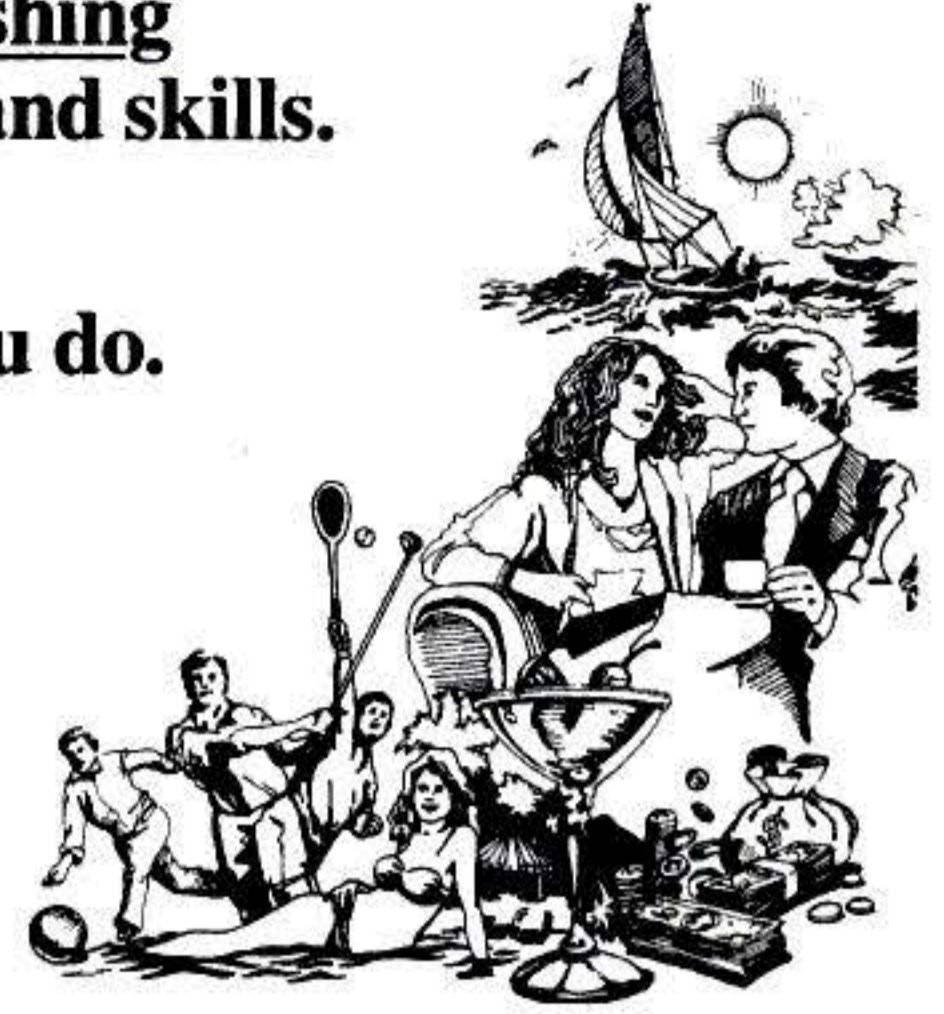
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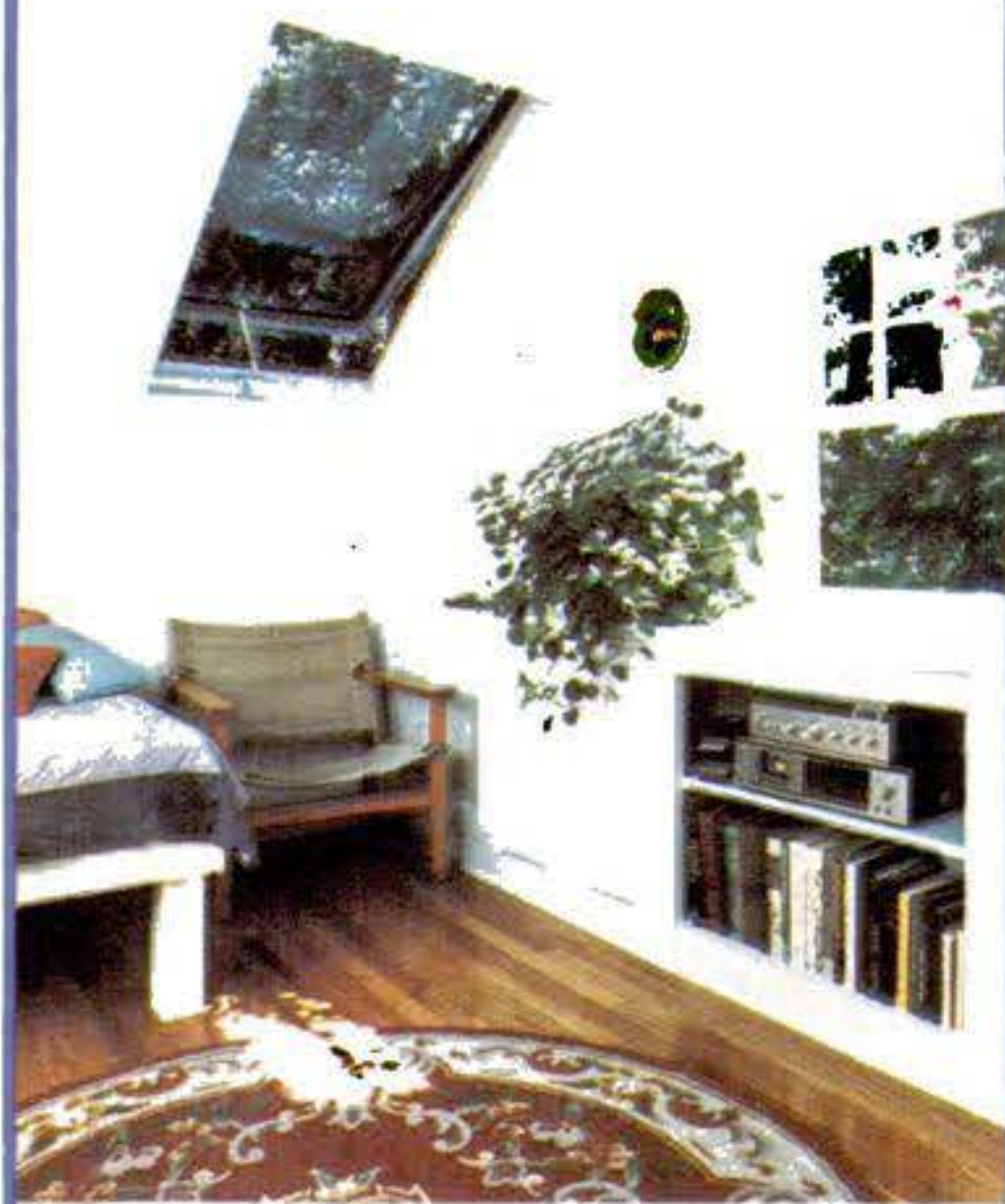
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Silencing a printer

My home-computer room adjoins my baby daughter's bedroom, and the chatter of my dot-matrix printer kept waking her. To quiet the printer, I built an enclosure: a foam-padded box with a plastic front and top.

To muffle your printer, plan to build a box that's several inches larger for easy access to controls. Also allow for the foam padding, which you can buy at a hobby or sewing shop.

When figuring how much plastic glazing to buy for the box top and front piece, note that the front is lower than the sides and back; this dimension is just slightly more than the thickness of the plastic top. The plastic supplier will cut it to your measurements, or you can do it yourself. Use the back edge of a hacksaw blade to scrape the saw marks away. To fire-polish the edge, wave a propane torch across it.

Use either 3/4-inch plywood or white pine for the basic box. Before cutting, lay out the box pieces for the sides and bottom so you can cut a dado groove across the three pieces 1/4-inch from one end. When assembled, this will form a U-shape channel to hold the plastic front piece in place.

Cut a similar dado groove into a

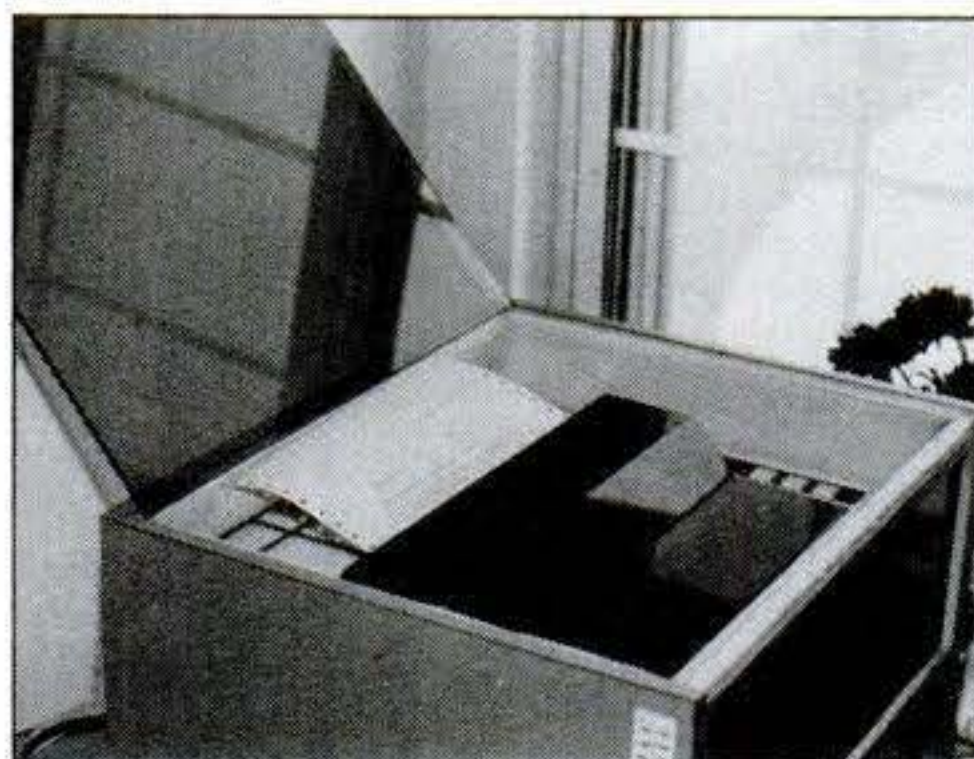
piece of one-by-1/2-inch scrap, and set it aside. This will fit atop the plastic front, framing it and providing a lip for the top to sit on. To support the top along the sides, cut a rabbet along the inside top edge of each side piece, cutting through and perpendicular to the top of the dado groove (see diagram).

Cut a matching rabbet along the top edge of the back piece; then cut a paper slot and any holes needed for cords and cables. Use the back as a template for cutting the foam padding; then cut the foam for sides and bottom.

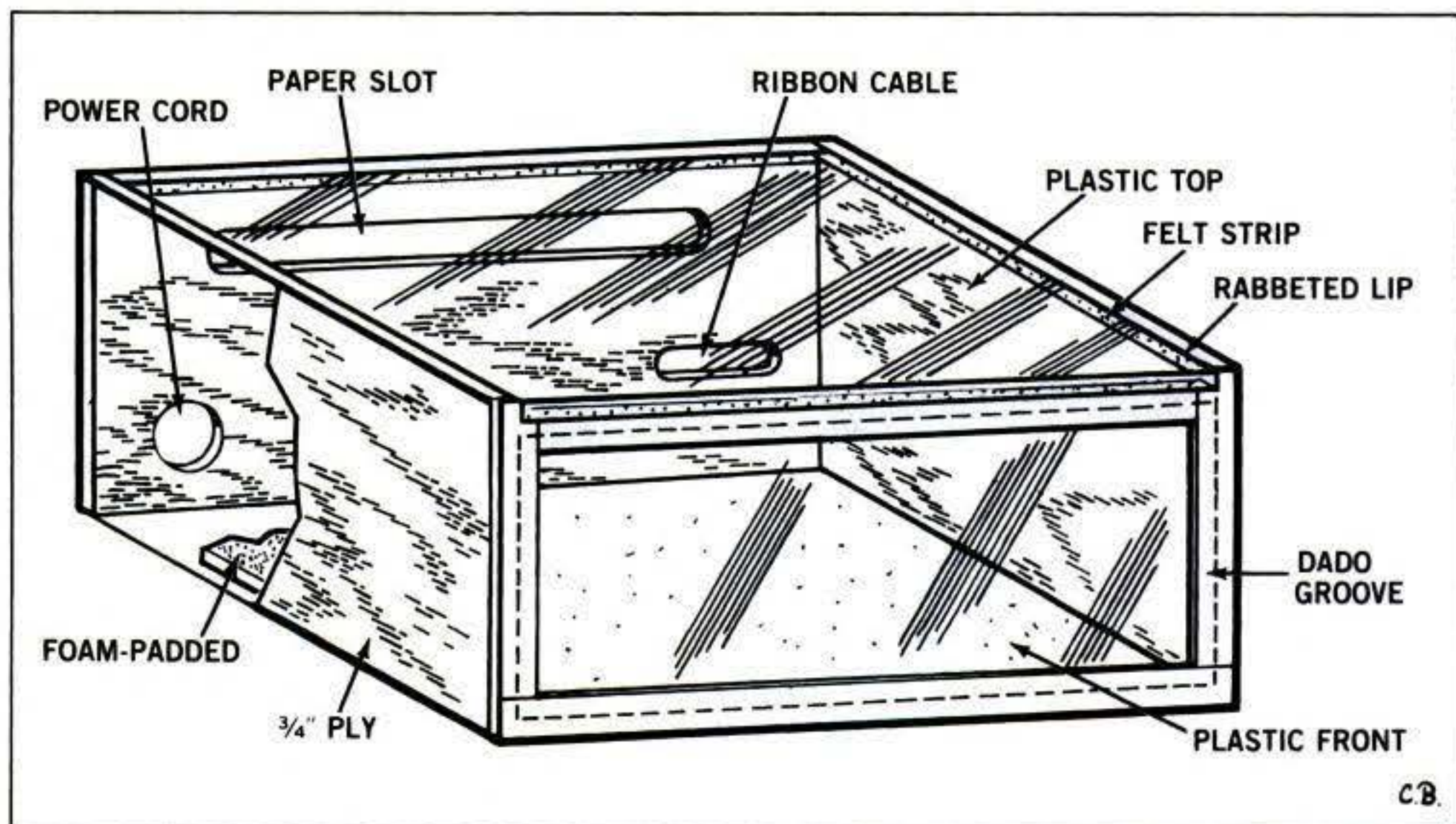
Glue and nail the box pieces together, making sure the dado edges line up. Glue the foam padding to the inside, and glue a thin strip of felt along the rabbet to cushion the top.

Finish the box before inserting the plastic front piece into its groove. I covered the box with plastic laminate to match my laminated trestle computer desk ["Two Computer Carrels," PS, March], but any finish is fine.

Finally, slide the plastic piece into the front groove, and cap it with the grooved top strip. Fasten this to the box sides, flush with the bottom edge of the rabbet cut. Rest the plastic top on the rabbet, and then listen to your printer purr.—Bryan Shumaker



When lifted (left), the plastic top rests against the back rabbet, so no hinges are needed. With the top down, the foam-padded box mutes printer noise.





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Decimate 500C will help keep pests from inhabiting and nesting in vacation homes, campers, and boats both during summer and off season. Use it to control pests where food is kept and stored. Hard to seal areas, such as garages, toolsheds, and farm outbuildings will benefit most from Decimate Ultrasonic protection.

DECIMATE 500C is a home sized version of an electronic pest control used by professional exterminators. Bakeries, schools, hospitals, etc., use them. With a technological breakthrough the cost has been dramatically reduced. Now, every home or plant can afford DECIMATE.

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Decimate 500C has an ultrasonic intensity output of 152db. Decimate 500C sweeps two levels of frequency from 25,000 to 65,000 Hz in each cycle. (Beware of units of low intensity and constant frequency). The overall efficiency of the unit is greatly enhanced with the changing frequencies. Decimate 500C protects up to 3,500 ft.² (25,000 ft.³). Other units may cover as little as 1500 ft. or less.

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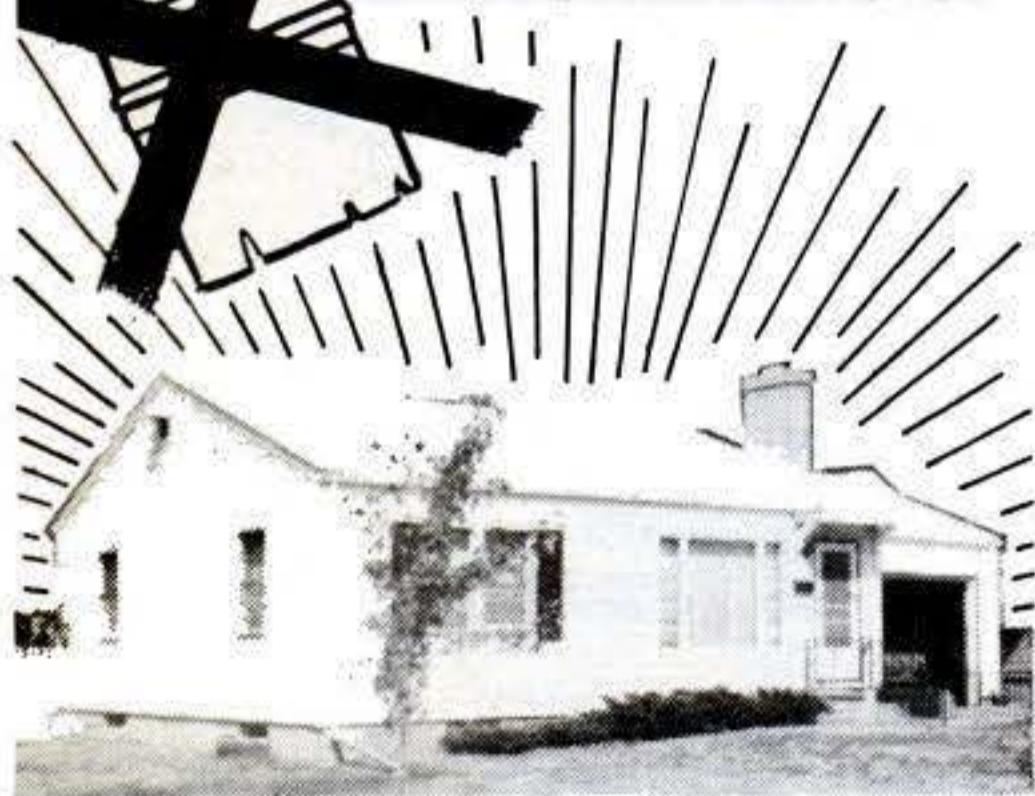
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Housepower Clinic

By EVAN POWELL



DIY repair is here to stay

That's the opinion of Whirlpool Corp.'s Bob Stanley, division vice-president for consumer affairs, who noted that "do-it-yourself appliance repairs have proved to be more than just a fad." The occasion for Stanley's remark was the company's introduction of four new appliance-repair manuals that cover machines including an automatic washer and dryer introduced last year. Both Whirlpool, with these Do-It-Yourself publications, and General Electric, with its Quick Fix manuals, are making a welcome response to the DIY trend among consumers. The impact of these DIY programs is also being felt in other areas that benefit the consumer. Throughout the industry there is a trend toward making products more easily serviceable. The removable front panel on washing machines is a good example. Parts packaging now often includes instructions for installing the part, for those who may not be familiar with the procedure. And if you're still stumped after reading the manual, both Whirlpool and GE offer hot lines that will help you deal with specific repair problems. The toll-free number for Whirlpool is 800-253-1301 (in Michigan dial 800-632-2243 and in Alaska and Hawaii 800-253-1121); the GE number is 800-626-2000.

Why this sudden focus on owner repairs when 15 years ago they were almost universally frowned upon by the manufacturers? One reason is renewed industry interest in customer satisfaction and brand loyalty. The idea is to keep the cost of service low by training consumers to make minor repairs themselves, reserving expensive technicians for the major jobs. This eliminates the bad taste of big repair bills for minor problems. For many reasons, the ranks of do-it-yourselfers have grown enormously in the past 10 years and now constitute a considerable market segment. It's no longer unusual for consumers to base purchase decisions on the serviceability of products and the amount of information provided to allow them to make their own repairs. The manufacturers report that there have been very few problems with repairs performed at home by consumers.

Q&A Parts problems

According to the Frigidaire parts outlet and some independent parts vendors, they receive quite a few calls for replacement clock motors for the Frigidaire Cook Master range, model RDE3-20W. These motors, originally made by International Register Co., previously sold for \$8 but are no longer listed in Frigidaire catalogs. Instead the parts suppliers sell the entire Cook Master clock unit for approximately \$85. Do you know of a source that could supply this small but very hard-to-find part?

Roger Wills, Milwaukie, Ore.

I've had no luck in obtaining the clock motor locally. This is a problem that comes up repeatedly in letters. I sympathize with those who don't want to pay \$85 when an \$8 part would do. Here's my advice: Check around town for appliance-repair centers that have some used parts on hand. Very often they will take trade-in ranges and refurbish them, perhaps assembling one range from three and keeping the remaining good parts for future use. With many older parts of this type, when the factory no longer offers them, these repair shops are usually the best bet for obtaining a replacement.

Continued

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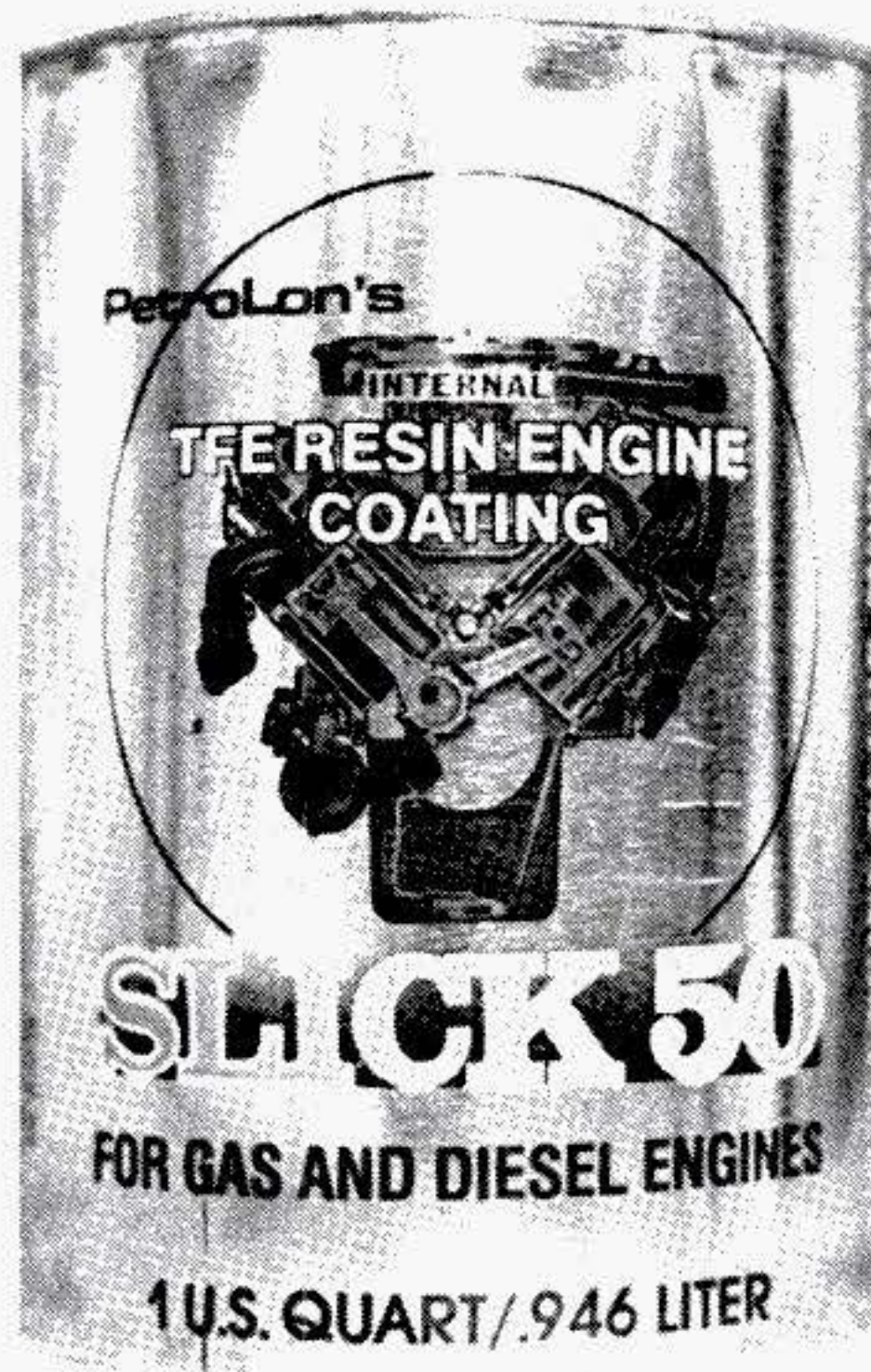
WHAT IS POLY? "Poly" is short for polytetrafluoroethylene (TFE). It is the slipperiest substance known to man (1981 Guinness Book of World Records, p. 188). The PetroLon Corporation, makers of Slick 50, has invented a way to permanently bind this slippery chemical to your engine with one treatment. All you do is add one quart of Slick 50 to your oil during oil and filter change. By reducing engine friction, Slick 50 increases gas mileage and horsepower and reduces engine operating temperature thus causing your oil and engine to last longer. Just as important, it reduces metal wear, defraying costly overhauls.

HOW DO I KNOW THIS ISN'T A FRAUD? Slick 50 has some very impressive credentials. The "Consumers Digest" magazine (March/April 1982, p. 35) states "Slick 50 does reduce engine heat and ordinary wear, and our informal tests indicate that it will improve gas mileage by about 2 to 3 miles per gallon. . . . Slick 50 does exactly what PetroLon claims it does." Researchers at the **Franklin Institute Research Laboratory**, after applying a powerful ultrasonic cleaning process to a Slick 50 treated engine part, were surprised at its permanence. They stated, "We actually expected the PetroLon Slick 50 TFE Resin coating to also be removed, but later found it was still there."

The **FAA (Federal Aviation Administration)** has fully accepted Slick 50 Aircraft Piston Engine Treatment (F.A.R. #33.49). An FAA test simulating 1400 hours of engine use (equivalent to about 70,000 miles on a car) showed almost zero engine wear!

Twenty-five hundred miles after removing Slick 50 from the crankcase, tests done at the **University of Utah Engineering Experiment Station** showed that the benefits of Slick 50 were still there. They reported a horsepower increase of 16.9% and 9.9% for light and heavy loading respectively. The senior engineering researcher at the **University of Southern California** in San Diego stated this, "Slick 50 does increase horsepower and decreases fuel consumption in tests done at the university." The **Space Shuttle Columbia** uses the chemical "poly" in its gears and bearings because it is the only chemical lubricant which can withstand the heat and corrosive elements of space.

Perhaps most dramatic of all is a torture-test overseen by the **Automotive Services Council for Pennsylvania**



and shown on television station WTVE. Three cars with between 75,000 and 129,000 miles on them were treated with Slick 50. Six months later the oil was drained from each vehicle and the cars were driven without the oil plugs for about a half hour. The water temperature never rose and the engines sustained no apparent damage. **The Southwest Daily Times** (Dec. 19, 1982, p. 6), reports that a man from Liberal, Kansas, flew his airplane without oil for 30 minutes. There are many more tests available. If you are still skeptical, send \$2.00 to defray printing and postage costs and we will send you additional, more detailed, test information, etc.

HOW DO YOU TREAT AN ENGINE? Very simply. A few minutes before oil and filter change, add engine flush (sent free with each order) to clean out your engine. Let your engine idle for 5 minutes. Then drain your oil, change filters and add the proper amount of oil less one quart. Add one quart Slick 50, drive for 30 minutes, and leave it in the crankcase for 3,000 miles. As the engine operates, the oil carries the polytetrafluoroethylene between the parts where it is burished into the pores of the metal. Once impregnated it is permanent, so you do it only once, not each time you change oil. One quart of Slick 50 will treat all standard 4, 6 and 8 cylinder gasoline and diesel engines.

WILL IT WORK WITH MOST OIL? Yes, Slick 50 will work with all petroleum based oils and all synthetics compatible with petroleum based oils.

WHAT ARE THE BENEFITS OF SLICK 50? Your actual benefits in

percentages may vary, depending on the kind of driving you do, vehicle condition, etc. By reducing friction, Slick 50 does all of the following: it increases gas mileage. It increases horsepower - small economy cars and large RV's really need this. It makes for easier starting. It reduces operating temperatures, thus increasing the lubrication and life of your oil and your engine. Last, but not least, the drastic reduction in engine wear defrays or eliminates costly overhauls which can save you over \$1,000. Slick 50 eliminates the "lubrication starvation" that all cars experience when first started before the oil has a chance to circulate. Up to 90% of the wear on a car can be caused by this lubrication starvation. You receive all of these benefits for less than the cost of two tanks of gas (\$34.95).

WILL SLICK 50 HARM MY ENGINE OR AFFECT MY WARRANTY? No! Slick 50 is suspended in an excellent grade of petroleum oil which meets or exceeds every manufacturers engine warranty requirements. In addition, this oil carries an API (American Petroleum Institute) service classification SF-CC-CD. It also carries the military specifications MIL-L-2104C and MIL-L-46152-A.

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[In Canada, call 416-828-0166 or send Canadian funds of \$39.95 and \$4.00 shipping to: PetroLon/Slick 50, 2219 Dunwin Drive, Mississauga, Ontario L5L1X1.]

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Name _____

Street Address _____

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Housepower

Summer algae

We've cleaned the drain in our refrigerator twice this season, and now it needs cleaning again. This problem occurred last year as well. When it happens, the drain stops up and water accumulates in the bottom of the refrigerator compartment. Even when using a portable air tank, cleaning the drain can be a chore; it's necessary to unload the entire top portion of the refrigerator. Why does this problem occur only in summer, and what is causing it?

Jack Johnson, Philadelphia, Pa.

The cause is practically invisible. It's usually a buildup of algae or bacteria that forms a clear jelly-like substance that can hardly be seen but can plug the drain in a hurry. This time, after you clean out the drain, flush it with a cup of water followed by a tablespoon of household laundry bleach. The bleach should kill the spores and keep the bacteria from reproducing and clogging the drain again. You may have to repeat the treatment next spring.

Tankless heaters today

What do you think of tankless hot-water heaters now, several years after you first reported on them? Some of the literature I've seen seems to muddy the issue. Still, if there is any real saving I would like to cut my hot-water tank to the 110-to-115-degree-F range and boost my dishwasher only. Did your installation really save you much? How has it stood up for the five years during which you have had it?

Louie Reese, Birmingham, Ala.

Tankless heaters are an option that can work well for some homes, not so well for others. And times have changed—they don't lend themselves to either time-of-day or load-control rate structures offered by many utilities because there is no storage tank. The best application for most homes, in my opinion, is just as you describe—as a booster for the dishwasher.

There is a more practical approach to heating water, especially in moderate climates such as yours and mine: the heat-pump water heater. It's even better than solar in my book, and the winter disadvantage of cooling and dehumidifying the surrounding air is a big plus for nine months of our year.

Got a home-equipment problem? Write to Evan Powell/Housepower Clinic, Chestnut Mountain, Rte. 1, Box 322A, Travelers Rest, S.C. 29690. Give appliance make and model number. Unpublished questions cannot be answered by mail.

California Millionaire Wants To Share The Wealth

You think times are tough and you've got problems?

Well, I remember when a bank turned me down for a \$200 loan. Now I lend money to the bank — Certificates of Deposit at \$100,000 a crack.

I remember the day a car dealer got a little nervous because I was a couple of months behind in my payments — and repossessed my car. Now I own a Rolls Royce. I paid for it in full — with cash.

I remember the day my wife phoned me, crying, because the landlord had shown up at the house, demanding his rent — and we didn't have the money to pay it.

Now we own five homes. Two are on the oceanfront in California (I use one as my office). One is a lakefront "cabin" in Washington (that's where we spend the whole summer — loafing, fishing, swimming, and sailing). One is a condominium on a sunny beach in Mexico. And one is snuggled right on the best beach of the best island in Hawaii — Maui.

Right now I could sell all this property, pay off the mortgages, and — without touching any of my other investments — walk away with over \$750,000 in cash. But I don't want to sell, because I don't think of my homes as "investments." I've got other real estate — and stocks, bonds, and cash in the bank — for that.

I remember when I lost my job. Because I was head over heels in debt, my lawyer told me the only thing I could do was declare bankruptcy. He was wrong. I paid off every dime.

Now, I have a million dollar line of credit; but I still don't have a job. Instead, I get up every weekday morning and decide whether I want to go to work or not. Sometimes I do — for 5 or 6 hours. But about half the time, I decide to read, go for a walk, sail my boat, swim, or ride my bike.

I know what it's like to be broke. And I know what it's like to have everything you want. And I know that you — like me — can *decide* which one it's going to be. It's really as easy as that. That's why I call it "The Lazy Man's Way to Riches."

So I'm going to ask you to send me something I don't need: money. Ten dollars to be exact. Why? Because I want you to pay attention. And I figure that if you've got \$10 invested, you'll look over what I send you and decide whether to send it back... or keep it. And I don't *want* you to keep it unless you agree that it's worth at least a hundred times what you invested.

Is the material "worth" \$10? No — if you think of it as paper and ink. But that's not what I'm selling.

PROOF!

Don't take my word for it. These are excerpts from articles in newspapers and magazines:

Time:

He only works half the year in his stunning office on California's Sunset Beach, and even when he's there he puts in short hours... In other words, Joe Karbo... is the prototype for... "The Lazy Man's Way to Riches."

Money:

Joe does more than dwell on personal problems; he solves them...

Which is a nice change: Karbo almost went bankrupt back in '62...

Boston Herald-American:

The book has drawn hundreds of letters from persons who have profited by it...

Los Angeles Herald-Examiner:

"Going broke was the best thing that ever happened to me," explains Joe Karbo who went from one business trouble to a million-dollar business fortune...

Forbes:

After bouncing around show biz, advertising, and real estate, he made his fortune... \$250,000.

Money Making Opportunities:

Maybe Joe Karbo has the secret. Don't you think you owe it to yourself to find out what it is all about?... I just finished it — and I'm off on a vacation myself. Get the idea?

Long Beach Independent:

He's programmed the path to riches for the lazy man.

The Kansas City Star:

He prints statements like "Most people are too busy earning a living to make any money." He should have added that too many people these days are too busy earning a living to do any living.

What I am selling is information. *More* information than I give when I'm paid \$1000 as a guest speaker. *More* information than I give in a one-hour consultation for \$300.

But you're really not risking *anything*. Because first, I don't want you to send me any money — at least none that I can use. Instead, as a token of your sincerity, send in your check or money order and *postdate* it for *six weeks* from today. You see, it's not really money because it's not negotiable — besides, I won't even touch it for six weeks anyway.

In this way you'll have plenty of time to receive my material, look it over, try it out and *prove* to yourself that everything I am telling you is true.

I know what you're thinking: "He got rich telling people how to get rich." The truth is — and this is very important — the year before I shared "The Lazy Man's Way to Riches," my net income was \$216,646. And what I'll send you tells just how I made that kind of money... working "part time"... a few hours a day... about 8 months out of the year.

It doesn't require "education." I'm a high school graduate.

It doesn't require "capital." Remember I was up to my neck in debt when I started.

It doesn't require "luck." I've had more than my share. But I'm not promising you that you'll make as much money as I have. And you may do better. I personally know one man who used these principles, worked hard, and made 11 million dollars in 8 years. But money isn't everything.

It doesn't require "talent." Just enough brains to know what to look for. And I'll tell you that.

It doesn't require "youth." One woman I worked with is over 70. She's travelled the world over, making all the money she needs, doing only what I taught her.

It doesn't require "experience." A widow in Chicago has been averaging \$25,000 a year for the past 5 years, using my methods.

What does it require? Belief. Enough to take a chance. Enough to absorb what I'll send you. Enough to put the principles into *action*. If you do just that — nothing more, nothing less — the results will be hard to believe. Remember — I guarantee it.

You don't have to give up your job. But you may soon be making so much money that you'll be able to. Once again — I guarantee it.

I know you're skeptical. Well, here are some comments from other people. (Initials have been used to protect the writer's privacy. The originals are in my files.) I'm sure that, like you, these people didn't believe me either when they clipped the coupon. Guess they figured that, since I wasn't going to deposit their checks for six weeks, they had nothing to lose.

They were right.

And here's what they gained:

'Made \$50,000 just fooling around'

"In February you sent me (for ten bucks) your Lazy Man's Way to Riches. Since then I have made approximately 50 grand (\$50,000) just fooling around on the basis of your advice. You see, I really am lazy — otherwise I could have made 50 million! Thank you!"
R. McK., Atlanta, GA

'\$24,000 in 45 days'

"...received \$24,000.00 in the mail the last 45 days. "Thanks again."

E.G.N., Matewan, WV

From \$50 to \$565 per week

"...when I sent for your (Lazy Man's Way to Riches), I was delivering the L.A. Times for \$50 per week... Now... I earn an average of \$565 per week, have \$7,000 in the bank and a condominium that's worth \$85,000..."

J.N., Culver City, CA

'There's no stopping me'

"Since I've got your (Lazy Man's Way to Riches) in July. I've started 4 companies... there's no stopping me and I'm so high I need chains to keep me on the ground."

M.T., Portland, OR

\$260,000 in eleven months

"Two years ago, I mailed you ten dollars in sheer desperation for a better life... One year ago, just out

of the blue sky, a man called and offered me a partnership... I grossed over \$260,000 cash business in eleven months. You are a God sent miracle to me."

B.F., Pascagoula, MS

\$7,000 in five days

"Last Monday I used what I learned on page 83 to make \$7,000. It took me all week to do it, but that's not bad for five days' work."

M.D., Topeka, KS

What I'm saying is probably contrary to what you've heard from your friends, your family, your teachers, and maybe everyone else you know.

I can only ask you one question.

How many of them are millionaires?

So it's up to you.

Six weeks from today, you can be nothing more than a little older — or you can be on your way to getting rich. You decide.

The wisest man I ever knew told me something I never forgot: "Most people are too busy earning a living to make any money."

Don't take as long as I did to find out he was right.

I'll prove it to you, if you'll send in the coupon now. I'm not asking you to "believe" me. Just try it. If I'm wrong, all you've lost is a couple of minutes and a postage stamp. But what if I'm right?

Some have called it a Miracle. Some have called it Magic. You'll call it "The Secret of the Ages."

As for me, I thank God that before he died Millionaire Joe Karbo left, for all to share, the secret of "The Lazy Man's Way to Riches." The above story, which is in his own words, is his gift to you.

Because of the nature of this special offering, we can guarantee delivery *only* to the readers of this publication who respond within the next 10 days.

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©Joe Karbo - 1979, 17105 South Pacific, Sunset Beach, CA 90742

Sworn Statement:

"On the basis of my professional relationship as his accountant, I certify that Mr. Karbo's net worth is more than one million dollars."

Stuart A. Cogan

Bank Reference:

Bank of Westminster
8251 Westminster Avenue
Westminster, CA 92683

Financial Publishers

17105 South Pacific, Dept. 147
Sunset Beach, California 90742

You may be full of beans, but what have I got to lose? Send me The Lazy Man's Way To Riches. Enclosed is my check or money order *postdated* six weeks from today!

If I return your material — for any reason — within that time, return my uncashed check or money order to me. On that basis, here's my ten dollars.

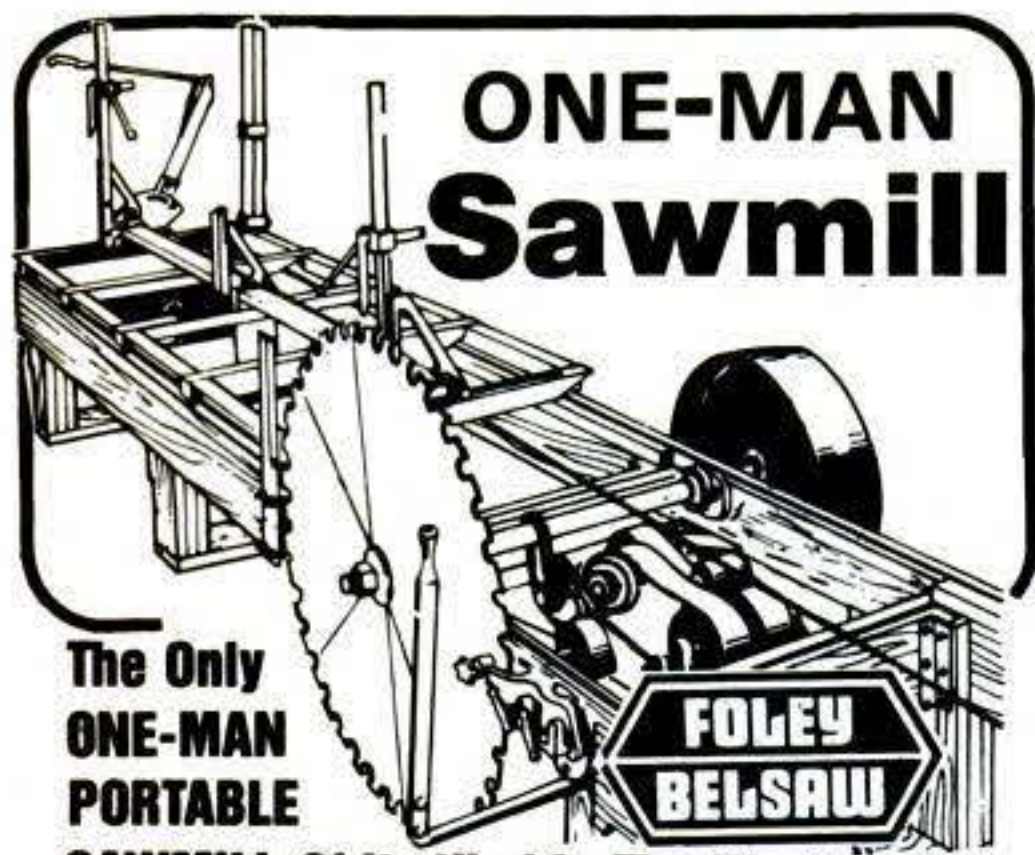
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Bits & Bytes

By WILLIAM J. HAWKINS



Proliferating portables

They just keep coming: portable computers. Last month *POPULAR SCIENCE* ran a feature story covering 75 of the latest models. But before the ink dried on the pages, even more were introduced. With tremendous competition, makers are adding features and cutting prices at the same time.

For instance, there's the Pivot, above, from Morrow, Inc. (600 McCormick St., San Leandro, Calif. 94577). It's a nine-pound portable that folds into a 13-by-9.5-by-six-inch package and unfolds to show you its work on a 16-line-by-80-character LCD display. The unit has 128 kilobytes of RAM (expandable to 512K) and a serial and parallel interface, and it uses the MS-DOS Version 2.0 operating system.

Built-in features include: a 5.25-inch floppy, modem, clock, calculator, and special-function keyboard keys. Push one of the special keys while you're using a word-processing program, for example, and the bottom right corner of the screen becomes a calculator display. Compute numbers and add them to the document where needed. Or push another button, and you can work through the modem; return instantly to the word processor when you're done.

Pivot costs \$2,500; for another \$50 (and 1.5 pounds) you can add a battery pack. The battery module fits in-

side the unit and provides power for up to five hours of use.

Other new portables: Color Chameleon by Seequa (8305 Telegraph Rd., Odenton, Md. 21113) has a nine-inch color CRT display and accepts both MS-DOS and CP/M software. It weighs 28 pounds, has 384K of RAM, and costs \$3,595. Eve II, made by Eve II Computer Corp. (200 Murray Hill Pkwy., E. Rutherford, N.J. 07073) is Apple DOS and CP/M compatible. It has a five-inch display, two 5.25-inch drives, and 64K of RAM for \$2,195.

Nibbles

- New chips: Motorola's MC68020 is a 32-bit microprocessor. That means, according to the company, that the single integrated circuit has the computational power of a large main-frame computer. Intel has a 256K CMOS (complimentary high-performance metal-oxide semiconductor) RAM chip that uses 10 percent of the power a conventional chip uses. Its 600,000 transistors, capable of storing such things as 10,000 phone numbers, are no larger than a postage stamp, and its low power requirement will help make small battery supplies practical. Need more? IBM has a one-megabyte (1M) RAM chip in the lab.

- Peachtree Software (3445 Peachtree Rd. N.E., Atlanta, Ga. 30326) has recently released more than a dozen

Continued

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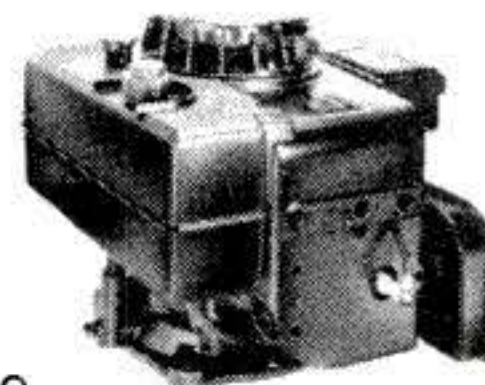
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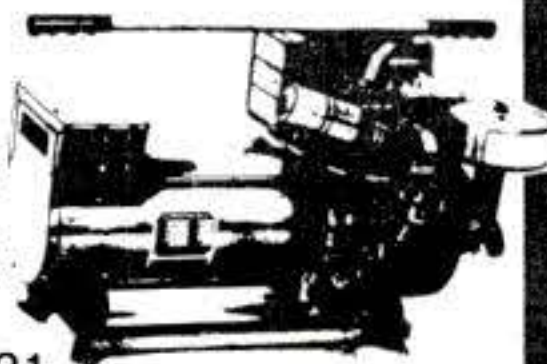
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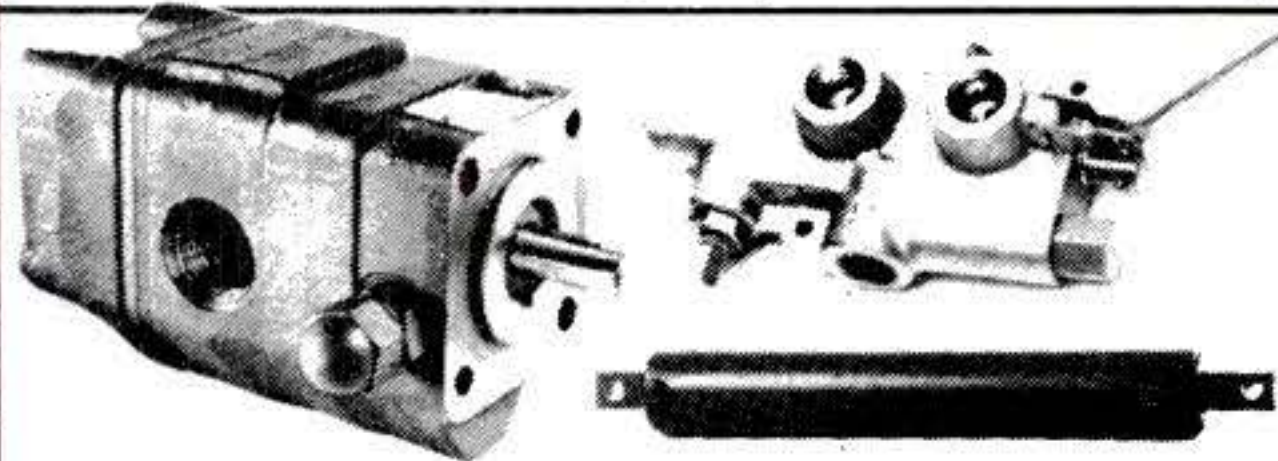
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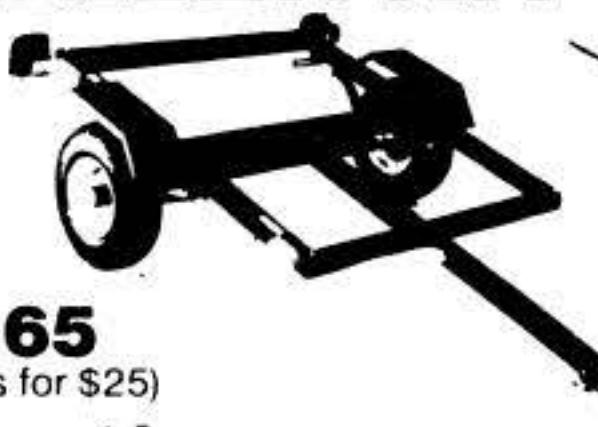
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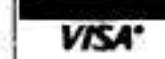
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Bits & Bytes

new business and educational programs. You can make backup copies of the programs, but if you give them to friends, they won't work. Secret: The master disk contains a software key that can't be copied—and the program will run only with the key installed in a drive. That protects the disk from piracy, but if the program should develop a problem, you can replace the original program on the master disk with the backup copy. That appears to be a clever solution to the piracy problem that doesn't hurt legitimate buyers who want to back up their programs. Here's another approach: Quicksoft (219 First Ave. N., Seattle, Wash. 98109) is offering a word-processing program for the PC and PCjr called PC-Write. It costs \$10, and the company encourages you to copy it for friends. If you like the program, you (and your friends) are asked to send a \$75 donation to the company. (They'll send you a bound manual for being honest.) This type of distribution is called "Shareware," and other companies are also doing it—because, according to a spokesman, people do send the money.

• AT&T has a personal computer. It's a 16-bit machine (8086 micro) that starts with 128K of memory and two floppies for \$2,810. Many people are surprised, however, that it uses the MS-DOS operating system and not UNIX (a popular multi-user operating system developed by AT&T). Bad move? Think again. You can bet the company will have it running UNIX when there is sufficient software. (When asked about UNIX, a smiling company spokesman said, "There will be other announcements from us soon.") For now, the AT&T PC is capable of using the thousands of programs written for MS-DOS.

New keyboard for jr

IBM has announced a new keyboard for PCjr, replacing the button-type that has received so much criticism.



The 62 full-travel programmable keys make it feel like the PC keyboard, and the system runs by infrared remote. Price: Free, to new and present PCjr owners. More about other changes next month.

PSI

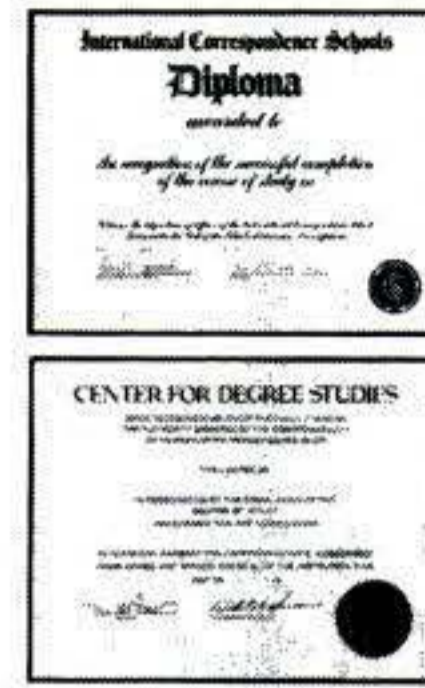
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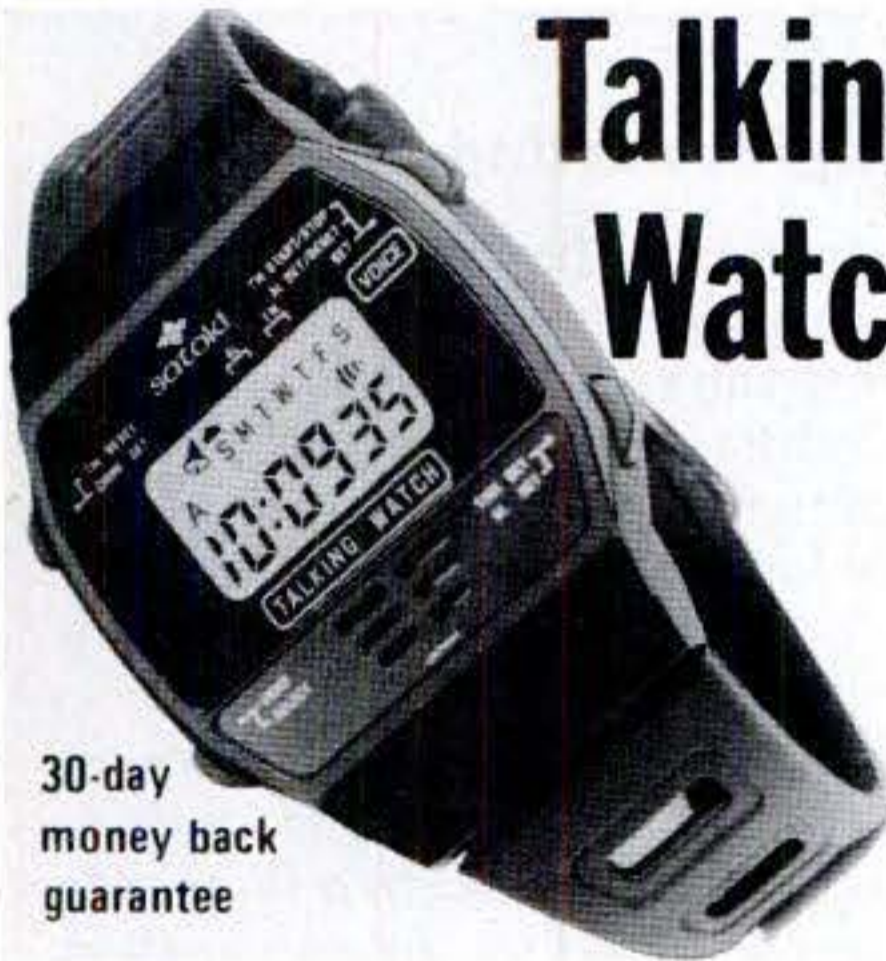
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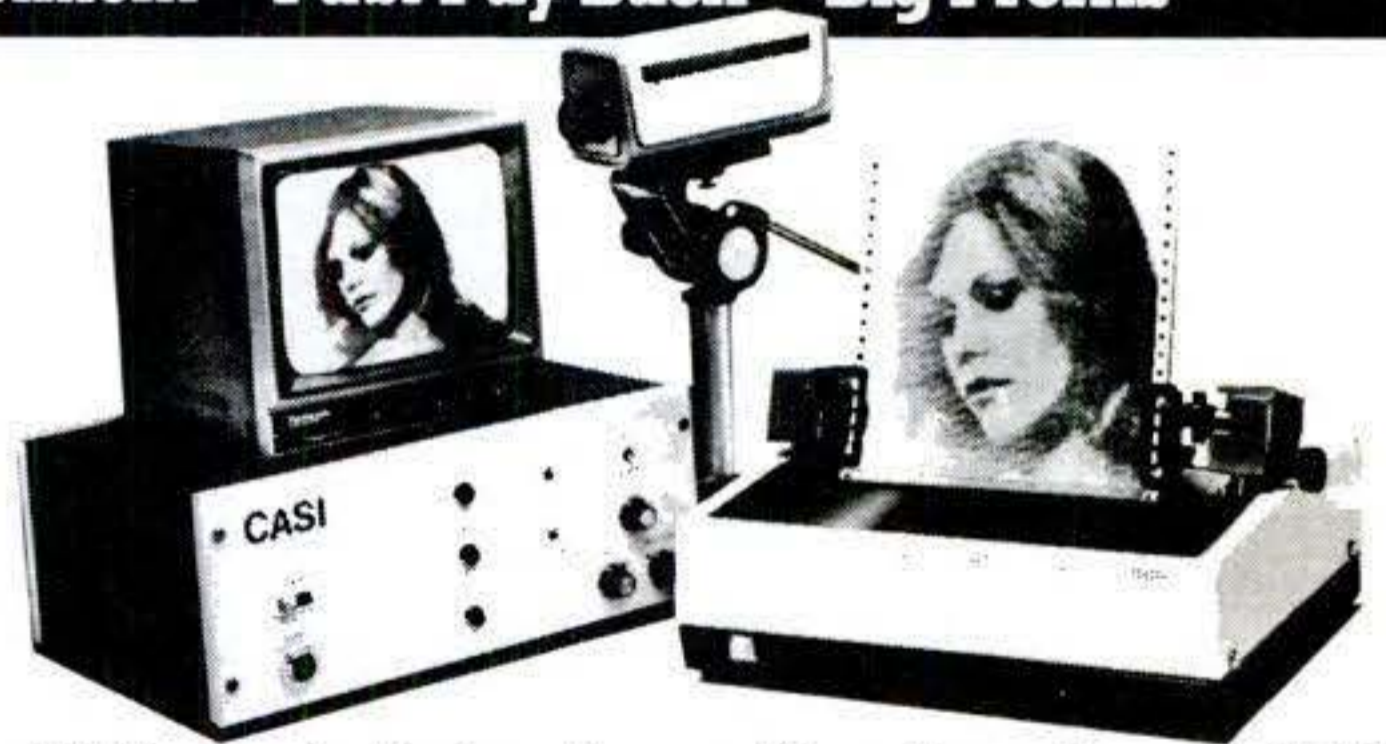
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Alcohol and engine damage

My 1982 Mercury Zephyr with a 140-cu.-in. engine runs better and diesels less often on unleaded gasoline with alcohol. Do you think the alcohol will harm the engine?

Raymond E. Kutcher, Iowa City, Iowa

Alcohol will cause engine damage; how much depends on the percentage of alcohol in your fuel. Ten percent isn't too good, and more than 15 percent is definitely bad. Alcohol eats aluminum and rusts steel; it then turns to jelly and finally to chalk. It's even more of a problem when the vehicle isn't used frequently. Alcohol also dilutes engine oil rather badly.

Powerless steering

From the start, I've had nothing but trouble with the power steering on my 1978 Ford Fairmont station wagon. The steering wheel will not turn to the left until the car has been completely warmed up. I was told that the problem was the power-steering pump, but replacing it did not help.

Kurt L. Minich, Onondaga, Mich.

Ford has an extended warranty for 1978 to '83 vehicles with rack-and-pinion steering. It seems that the seal in the original system gets into trouble in cold weather. The only solution is remanufactured steering gears with the fix built in. The cost will probably be borne by Ford if there are fewer than five years or 50,000 miles on the car. Those who qualify should have the steering fixed and should document their expenses; Ford should reimburse them. Isn't that wonderful?

Vapor-lock woes

I'm plagued by vapor lock in my Datsun 260Z. I've considered switching from the stock S.U. carburetor to a Weber carb. Do you recommend this?

Matthew McLaughlin, Phoenix, Ariz.

Do all you can to cool the fuel tank and fuel lines. Use rubber-and-fabric lines because they are less of a heat sink than metal lines. Direct ambient air to hot areas, particularly the carburetor, and devise shields for fuel-

carrying areas to stop exhaust heat from radiating to the fuel system. Baffle the carburetor fuel bowls, and insulate exhaust parts with Carborundum Fiberfax. Also, all fuel is not alike. Check the vapor pressure; the best information is from the state. More pressure on the push side of the pump helps, but the carbs can't handle an excessive amount. I don't know whether switching to a Weber carb will help.

Running on empty

About six months ago I had a rebuilt cylinder head put in my 1976 Volkswagen Rabbit. Since then the engine wants to keep running. At first it was only a few putts, but now it won't stop for 30 seconds or more. Could the head be fouled with carbon?

Craig Rae, Cornwall, Ont.

First pull the coil wire and see whether the run-on stops. If it does, you have electrical feedback, probably through the instrument panel, and it's usually a ground problem. Also, the carburetor needs to close tightly. Make sure that the carb adjustments are correct and that you don't idle on lots of throttle, which would be the signal to pull a lean idle mixture. You could try different brands of fuel; they're not all at the same vapor pressure. It's possible that the head is milled and compression is too high, or the culprit could be carbon buildup because of a bad valve-stem seal.

Hesitation blues

My 1977 Jeep CJ-7 with a 258-cu.-in. six-cylinder engine and one-barrel carburetor has 66,000 miles on it. The engine stumbles and hesitates when cold. A rebuilt carburetor and many other new parts and spec checks haven't helped. The carburetor-air heat had been disconnected for four years, but reconnecting it didn't help. Also, could I improve mileage and torque with a two-barrel carburetor?

Glenn Wegner, San Jose, Calif.

You're coming off the choke too quick, but I think the manifold preheat is the problem. Get it back to spec, and check the airflow for excess carbon. Also, the carburetor-hot-air system must be

working. There's not much mileage gain with a two-barrel carb, and you'll lose a little horsepower.

Oily air cleaner

Oil is coming into the air cleaner through the valve-cover hose in my 1979 Chevrolet Malibu V6. Why does this happen?

J. C. Gozzo, Bristol, Conn.

Oil in the air filter is caused by improper crankcase or engine venting. A PCV problem, or any engine leak such as in a dipstick or breather hose, can cause a pressure buildup that pushes oil vapor through the vent hose and into the air cleaner. All PCVs are not the same. The difference is usually based on engine size, and the wrong PCV can really mess up the condition of oil, idle, and crankcase pressure.

Plugged manifold

Why do the preheating passages in the 318-cu.-in. V8 engine in my 1975 Dodge van plug up so soon? I've cleaned them out twice, and now it's happening again.

Jerome Marah, St. Paul, Minn.

There's no easy answer; poor design is to blame for this condition. It's aggravated by over-rich combustion, cold starts, deceleration, and a little too much oil burning.

Cutting out cylinders

What would be the trade-offs of running on six or even four cylinders by disabling the rockers and plugs in my 1972 Cadillac with the 472-cu.-in. V8? Is a numerically lower axle a better answer for fuel economy?

David Satre, Waterloo, Iowa

Systems that eliminate cylinders in various modes and under certain driving conditions aren't worth a thing. My statement is based on the supposition that your idea would be applied across the board. You still have to tow too much weight; and airflow, heat balance, pulse tuning, and other critical factors go in the trash can. A reduced engine-rpm level for a given road speed is the way to go, assuming that the engine has enough torque and power to capitalize on the lower revs.

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

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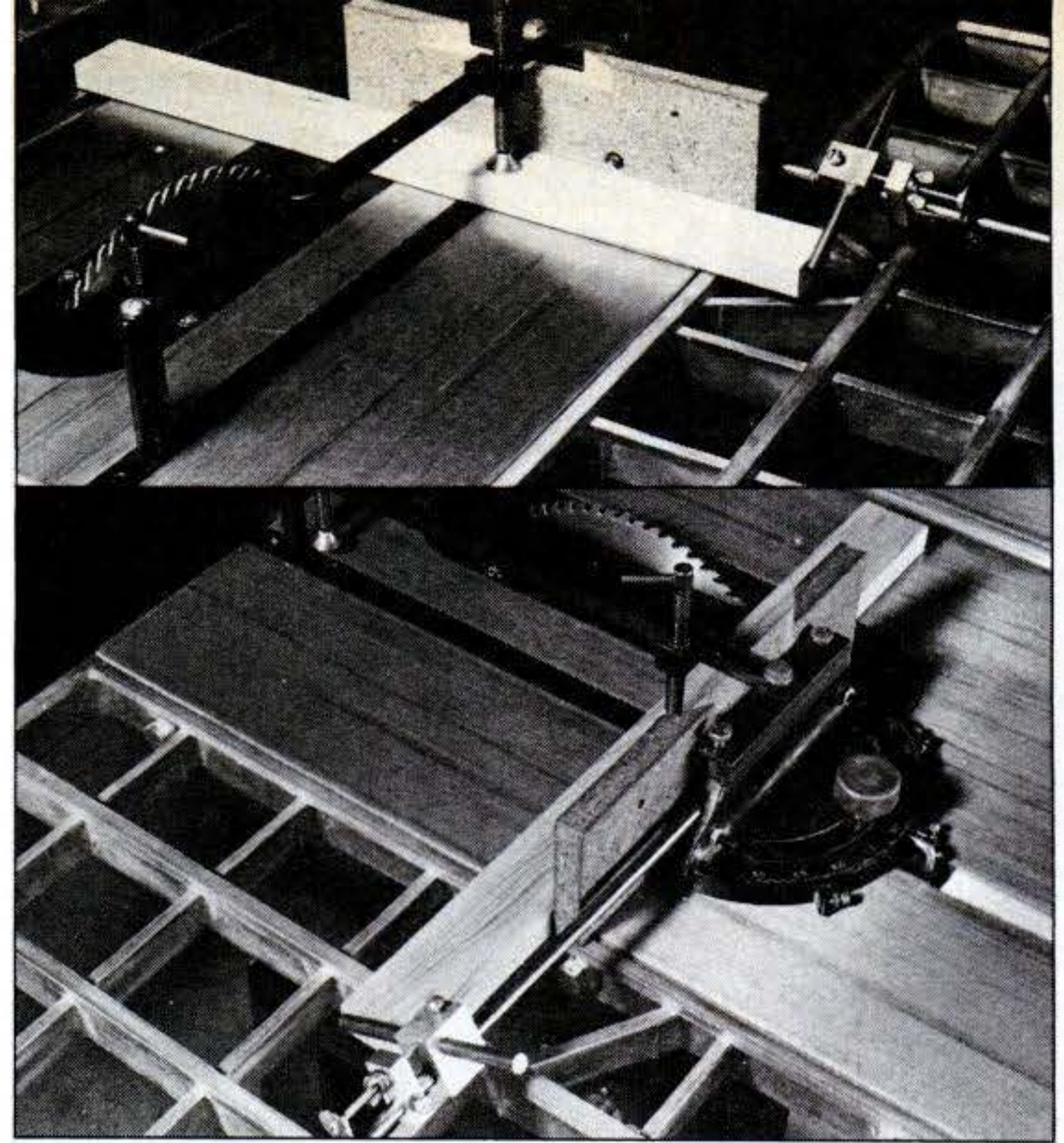
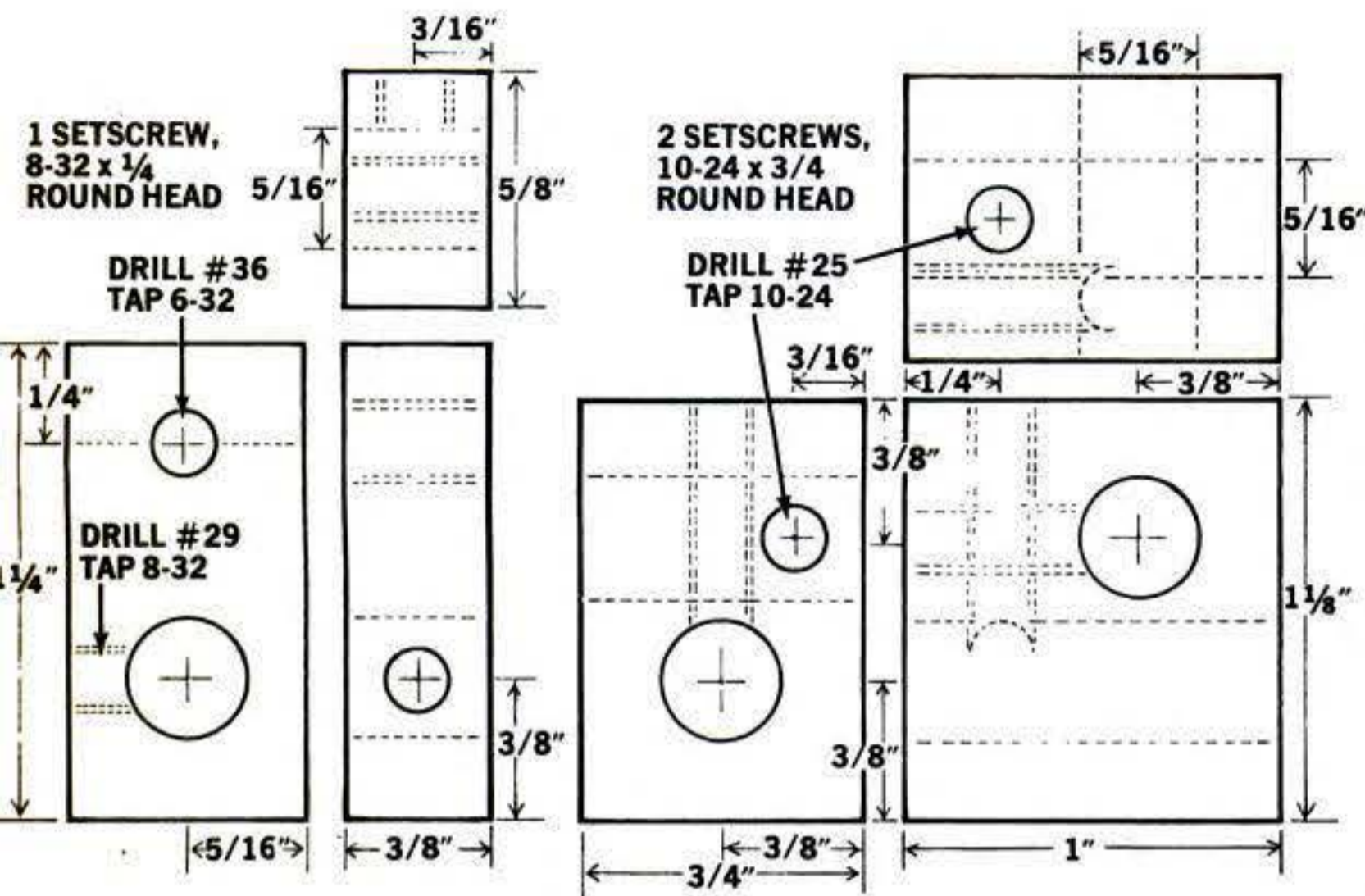
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Miter-gauge stop



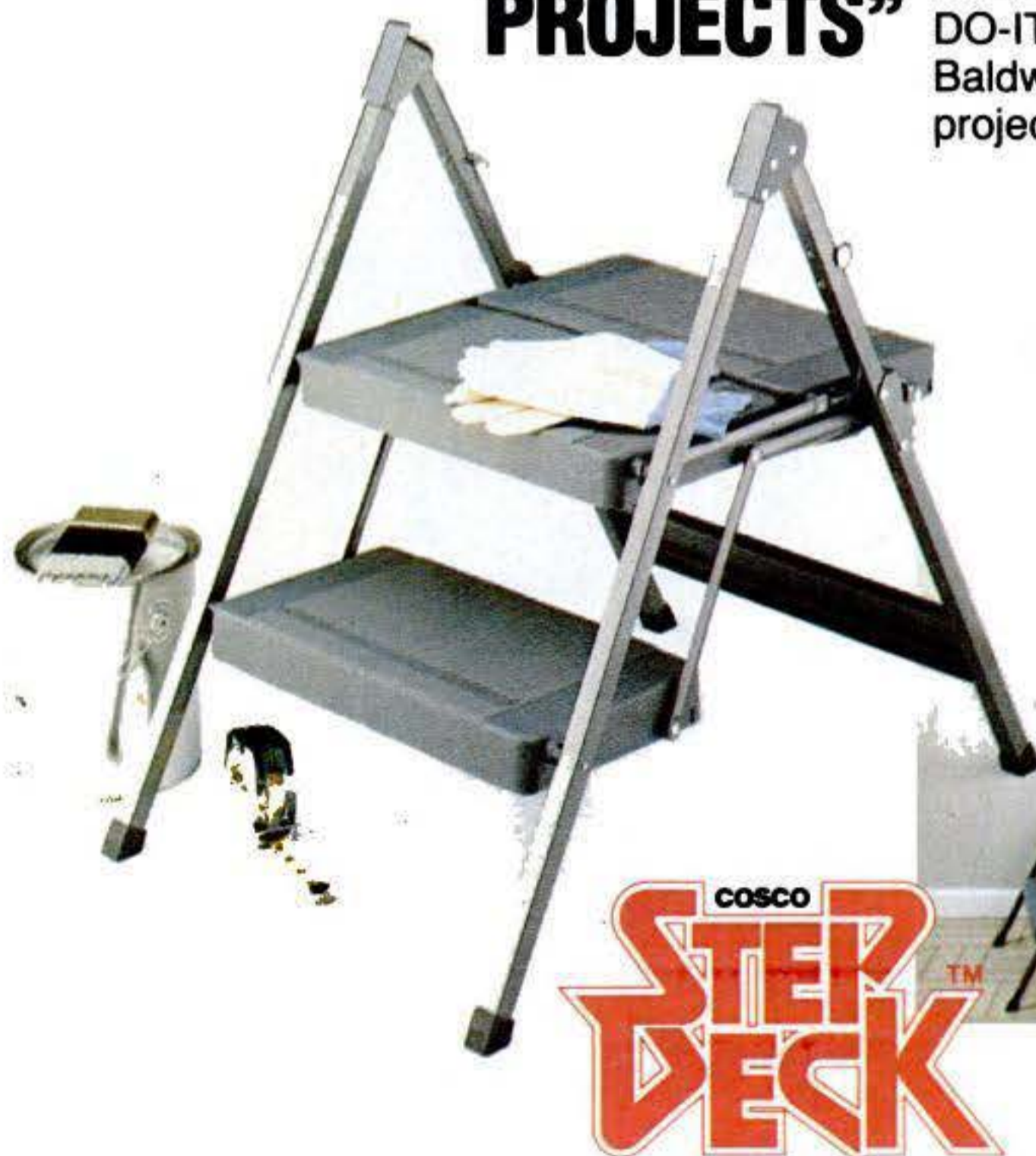
Borrow a trick from the metal trades and make your own "micrometer" work stop. This handy device will free your table saw's work surface of most special clamps and reduce setup time. It provides an accurate left-to-right position reference that travels with the miter gauge.

The dimensions in the drawing are not critical; you may wish to alter them to adapt to stock at hand. However, 5/16-in.-diameter rod is a minimum for rigidity and sufficient bearing surface. Also, the setscrew locations were selected for simple access from top or side when adjusting the saw. The third requirement: Use a 6-32 lead screw so

that one revolution of the "dial" corresponds to a 1/32-in. change in position. This makes increments of 1/64 in. or less possible in making a final cut.

Mount the support rod with clamp brackets if your miter gauge does not have prepared holes. On some gauges you will find a shallow trough that adapts nicely. Alternatives: Modify the wooden faceplate by end drilling, or use a top-mounting clamp. A convenient feature of the shorter stop rod is that it pivots horizontally as well as running in and out to catch the most awkward projections on semifinished work.—*John A. Haase*

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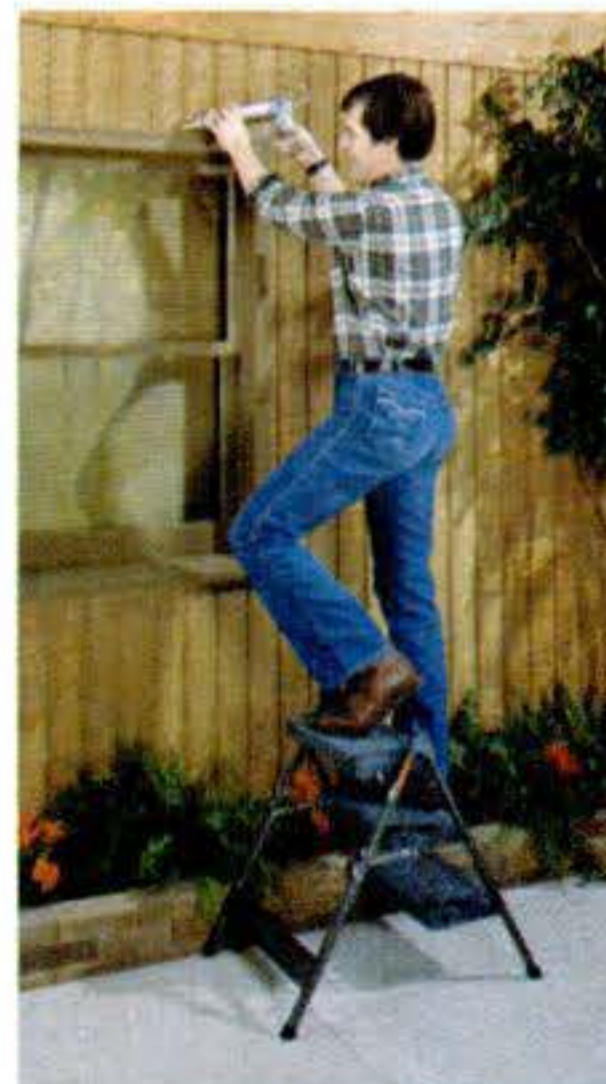
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Clean your own VCR heads

Dirt particles accumulating on VCR video heads damage picture quality until—finally—you see snow instead of show. Therefore, VHS and Beta VCR makers recommend that the heads be cleaned after every 100 hours of use.

You could use a cleaning cassette, but it can't remove dust that collects in areas other than the tape path. Nor will it demagnetize the heads for a better signal and sharper picture. The best way to do the job is manually. It takes only a half-hour, and for less

than \$15 you can buy everything you need to do a thorough job: cleaning solvent, swabs, and a head demagnetizer.

The solvent cleans metal oxides from the parts that touch the tape. It should contain pure ethyl alcohol (not isopropyl alcohol and water, which leaves behind residue that can scratch tapes). And you should use an aerosol rather than a liquid. Dipping a dirty swab in a bottle contaminates the whole batch.

Swabs are made from chamois, foam, or cotton. Chamois is excellent but expensive; foam does a fine job for a lot less money. Do not use cotton swabs—they leave lint behind.

Begin by removing the cabinet and cleaning the video heads. They are small, copper-colored projections at the bottom of a large silver drum. (Your VCR may have two or more heads.) Touching only the top of the drum, turn it as needed to line up each head so that you can reach it easily with the tip of a swab.

Use soft side-to-side strokes to clean the heads. (Up-and-down motions can misalign them.) When a swab tip begins to darken, discard it so it doesn't



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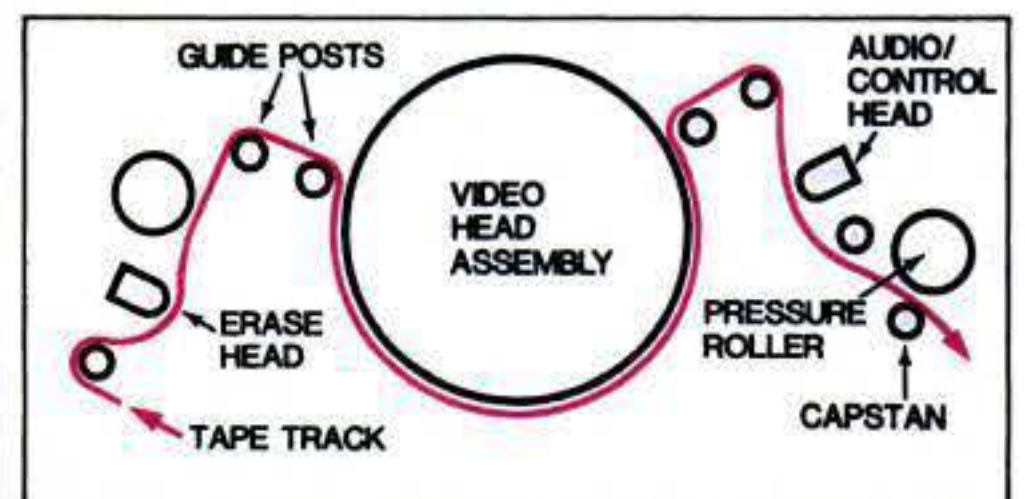
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spread the dirt. Clean the circumference of the drum, too.

Next tackle the audio head, capstan, guide posts, and inertia rollers. Clean the rubber pinch roller and check it for wear. If the tape path gets too deep (deeper than the thickness of the tape), tension is reduced, leading to crinkling and other tape damage.

If it's necessary to replace the pinch roller, pop off the ring that holds it in place and pull the roller straight up and off its shaft. The new one is simply dropped into place and secured with the ring.

Now the heads must be demagnetized. There are two rules to remember: Never touch the heads with the tip of the demagnetizing tool (the vibration could damage the head), and never turn the tool on or off while near the head. (The on-off pulse could permanently magnetize the head.) Merely turn on the demagnetizer and bring it as close as possible to each video head for a few moments. Then pull it about a foot away and switch it off.

Final step: Replace the cabinet, and slip in your favorite tape. Your VCR is ready for another 100 hours of use.
—Mary Pawlak

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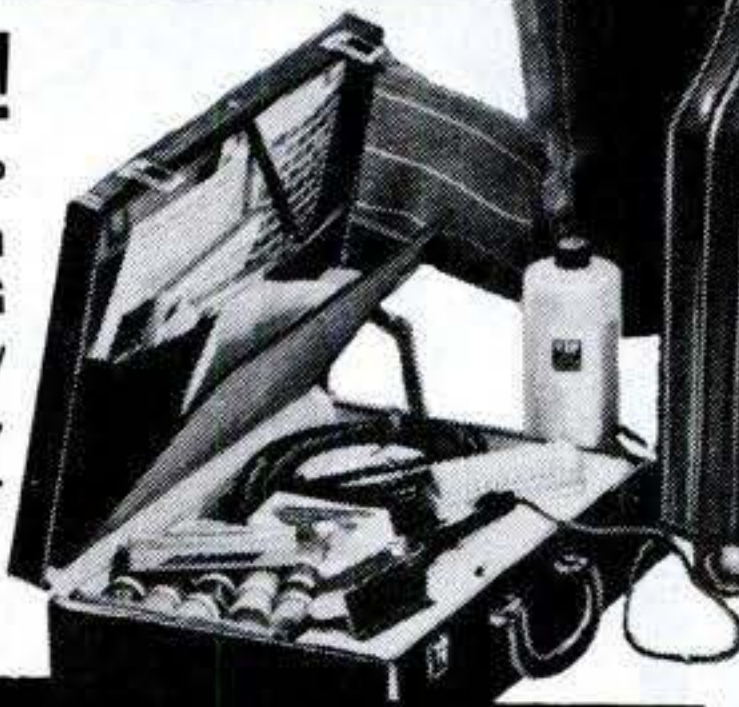
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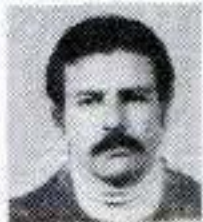
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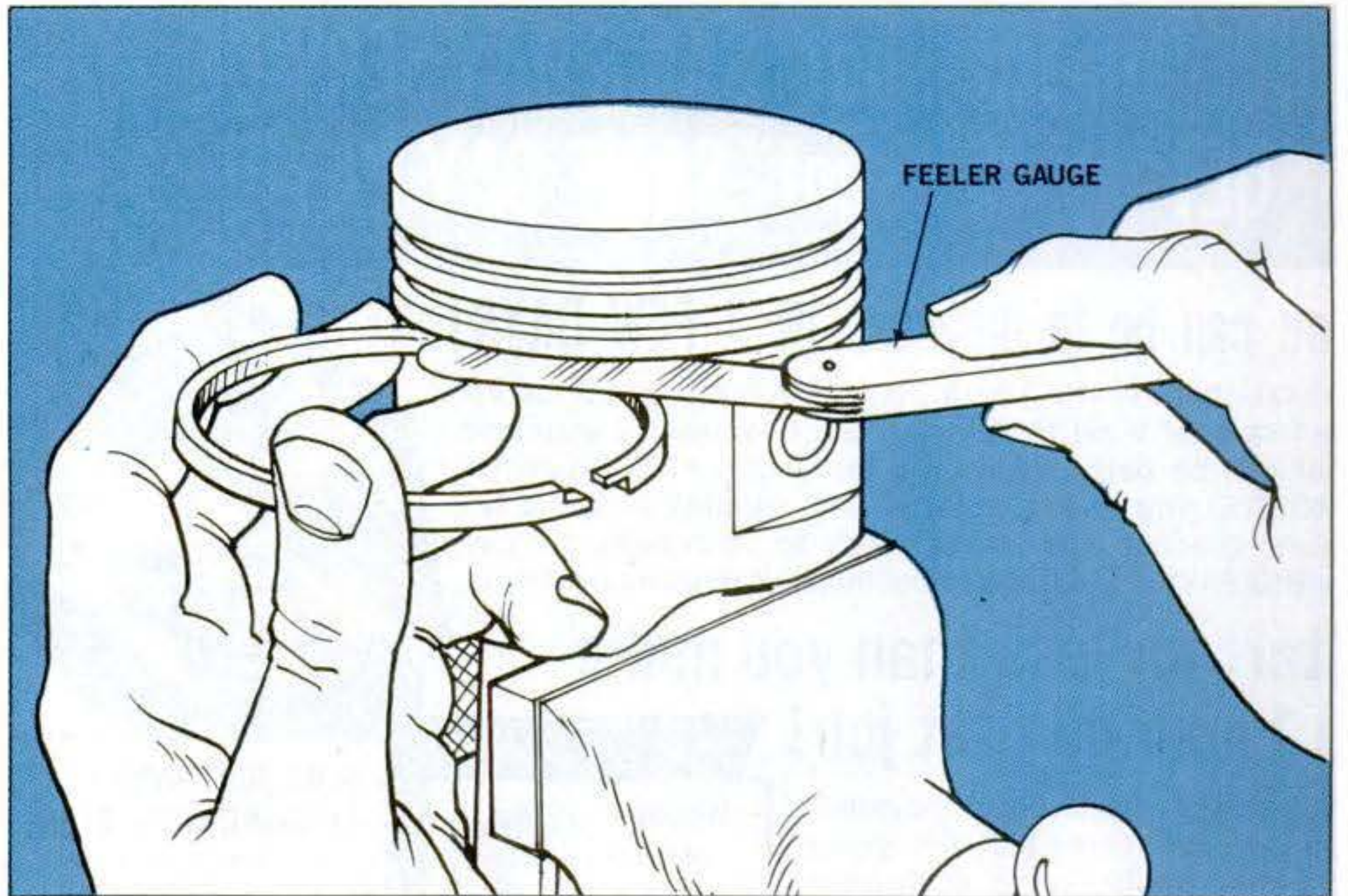
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Taking Care of Your Car

By STEVE MERCALDO

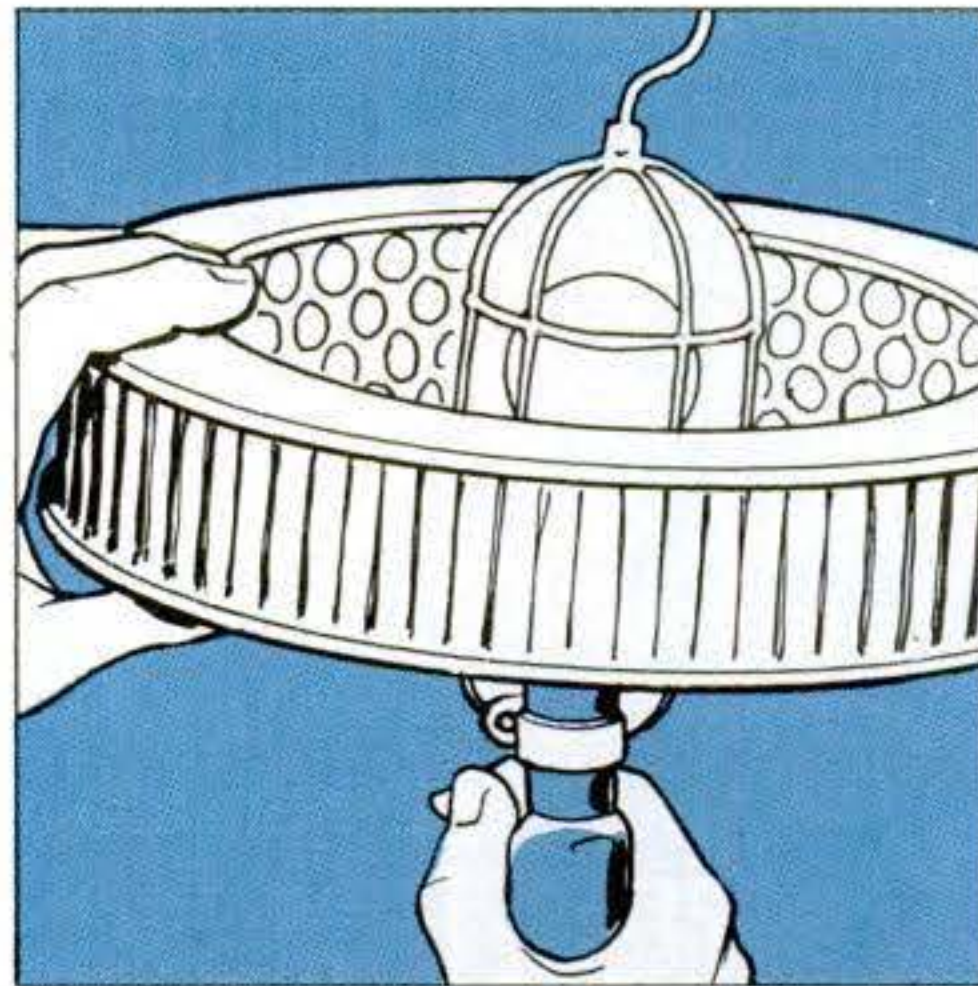
Got a useful car tip? Send it (with Social Security No.) to Car Care, POPULAR SCIENCE, 380 Madison Ave., New York, N.Y. 10017. We'll pay \$50 if we use it. If two or more readers send the same tip, payment goes to the one with earliest postmark. No tips can be returned.



Ring fit

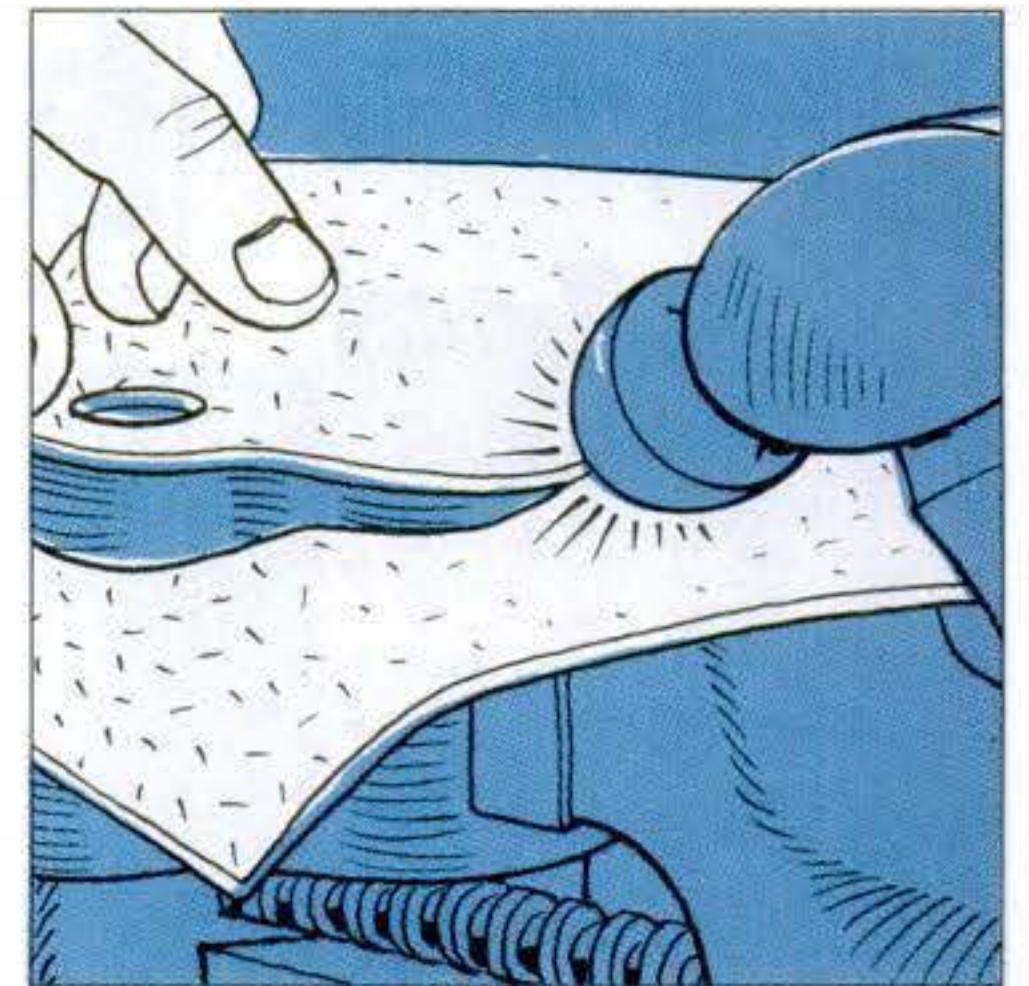
Before installing new rings on an engine piston, it's a good idea to check the ring side clearance. A loose-fitting piston ring can cause low compression, excessive blow-by, and oil burning. To check the ring side clearance, thoroughly clean the piston-ring grooves with a ring-groove cleaner. Hold the

new ring in the groove, and slide a feeler gauge between the top of the ring and the groove. If a groove is worn beyond specification, it can be reconditioned to a wider size. A steel spacer is then placed next to the ring to take up the extra space created by the machining operation.



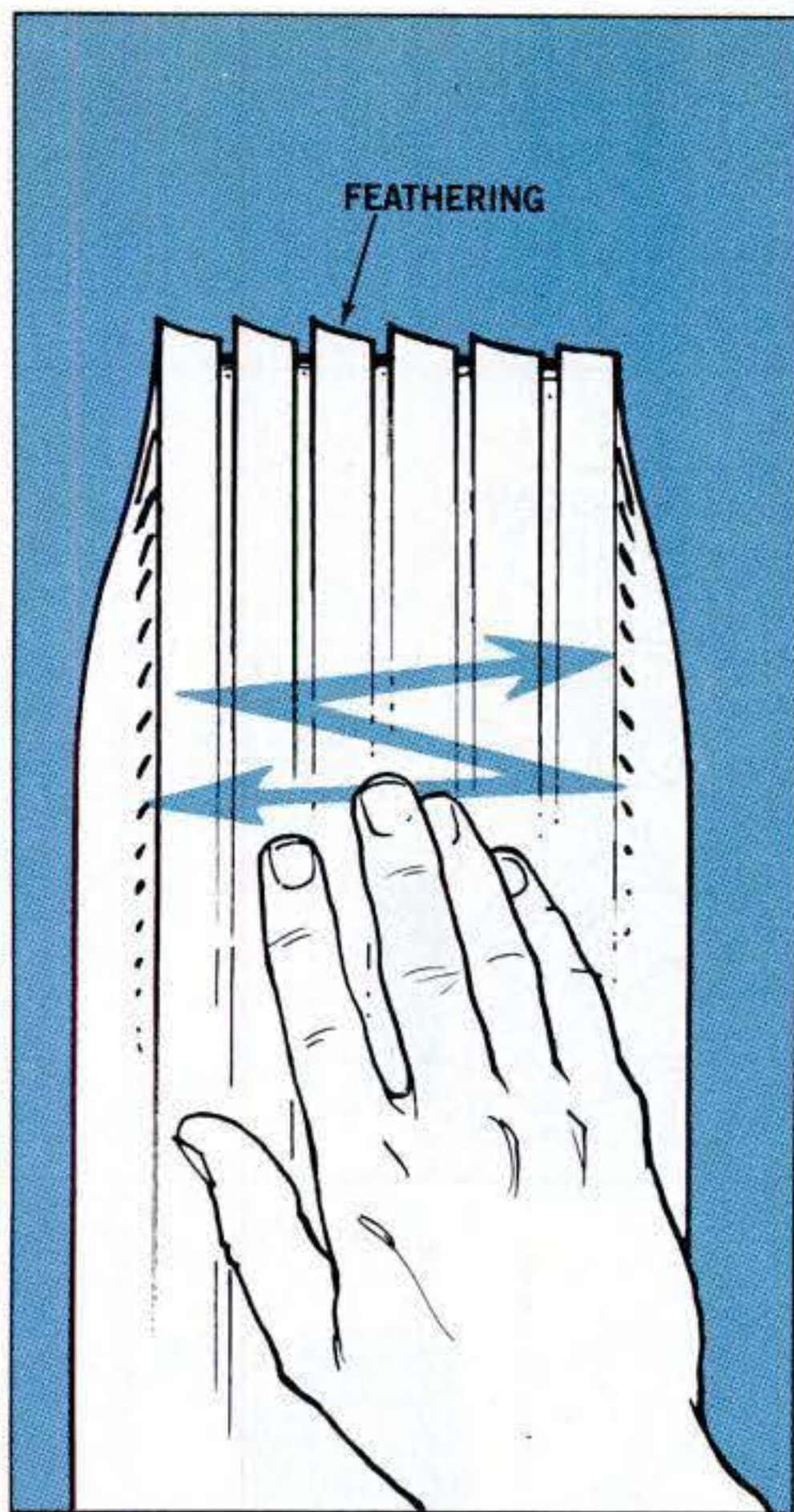
Filter check

As part of a routine tuneup, always check the engine-air-cleaner filter element. A dirty air filter can adversely affect engine performance and fuel economy. Remove the filter, and examine it with a droplight as shown. If light passes through the filter and you can't find any holes or oil stains in the paper, the filter can be used again.



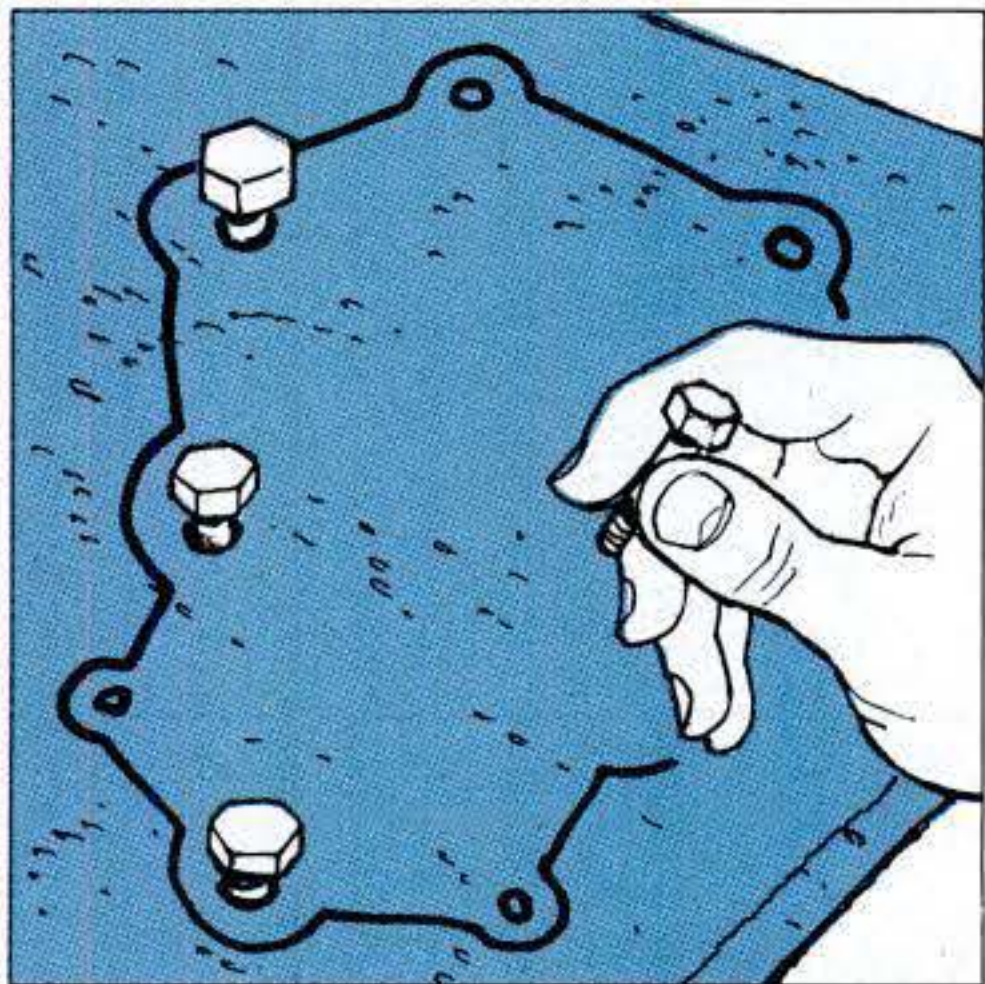
Making gaskets

A hard-to-find or oddly shaped gasket can be made by holding a piece of gasket paper firmly against the machined sealing surface of the part. Using a small ball peen hammer, tap lightly along the edges of the part, including bolt holes and other indentations. The edges will cut the paper to form an accurate sealing gasket.



Feathered edge

To check your front tires for a feathered edge, move your hand slowly across the tread in both directions. A feathered tread will feel smooth in one direction but rough in the other. This type of wear indicates that the front end is out of alignment. Have it re-aligned and checked for wear.



Bolt guesswork

Keeping track of different-size bolts when replacing components can often be confusing. It helps if you take a piece of polystyrene foam and press the bolts into it in the order in which you remove them. Trace an outline of the component (such as a water pump) on the foam to clearly mark the correct locations of the bolts.

FAMILY OF SEVEN CUTS HOT WATER BILLS IN HALF!*

Tankless Heater Provides Endless Hot Water



The Hughson family of Pennsylvania

The Hughson family just took 7 showers in a row — the 7th was as hot as the first — and they're saving hundreds on their hot water bills too.

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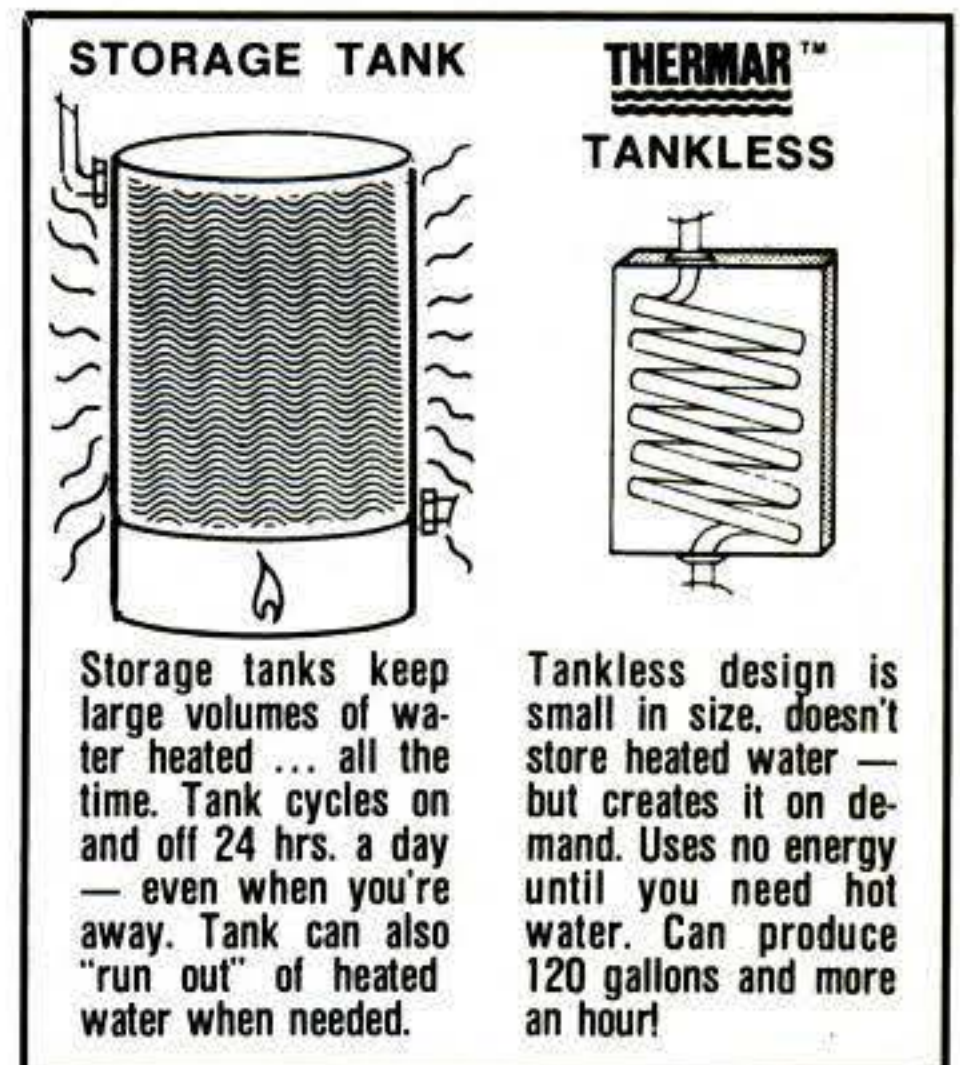
Did you know that much of the energy used to heat your basement tank of water is dissipated right through the walls of the tank itself and into your storage or crawl space area?

The Perfect Answer—New Thermar™ Tankless Instant Hot Water Heaters

If heat losses are created by the need to keep large volumes of water standing in a tank, why not eliminate the tank? And, that's just what Thermar™ has done. In its place we have developed a tiny, super powerful instantaneous heating unit which ACTUALLY CREATES HOT WATER AS YOU USE IT. A microswitch on the unit automatically turns on the moment hot water is needed. Then a continuous stream of delightful, sparkling hot water flows from the tap for shower or wash basin. IMAGINE — as much hot water as you want — produced in a never-ending stream as long as you need it.

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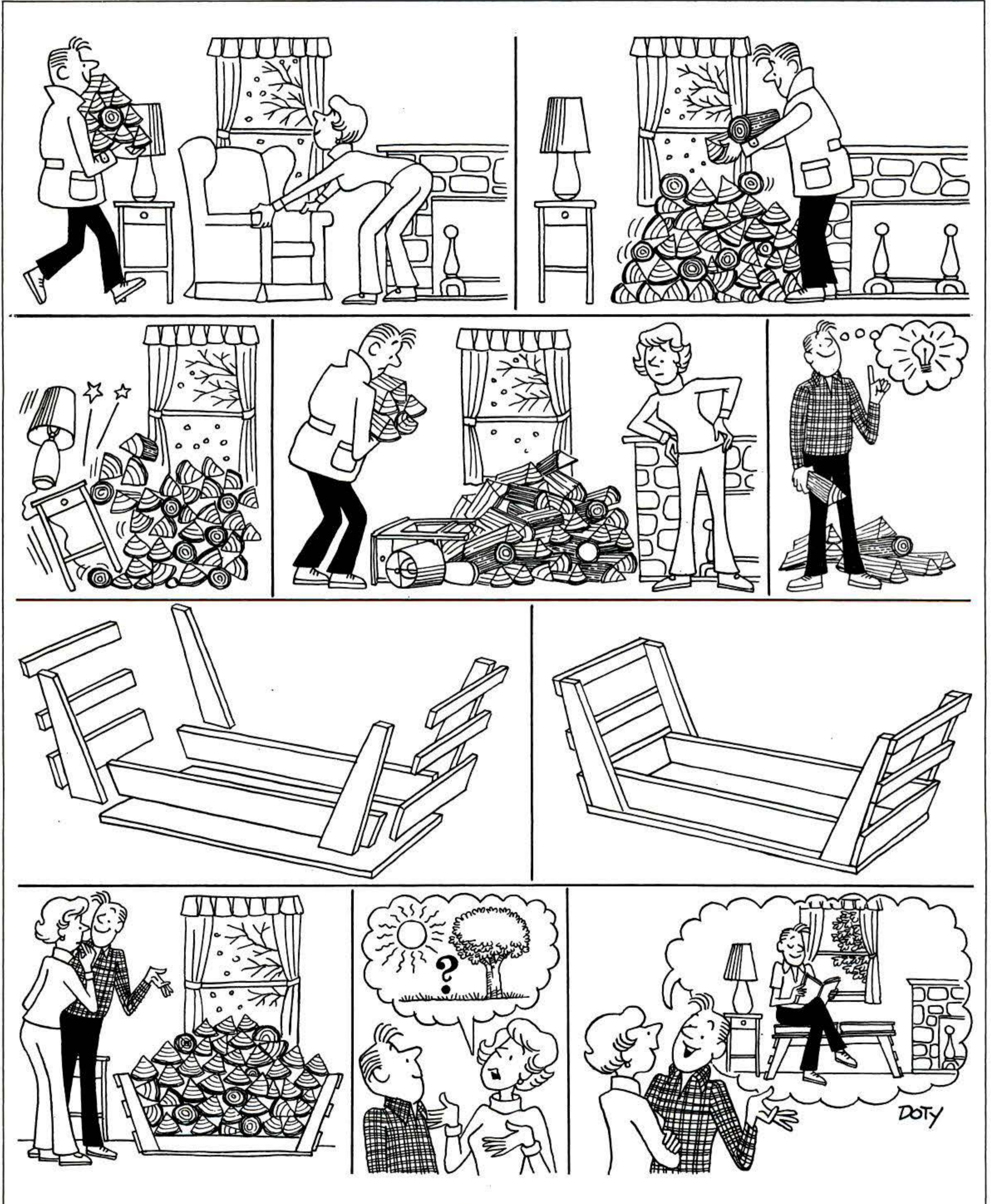
Canadian Residents send to: 56 Bramsteele Rd., Suite 8, Brampton, Ontario L6W3N4

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Wordless Workshop

By ROY DOTY

\$50 to Gary Nelson of Oakland, Ark., for this idea. Send yours (with Social Security No.) to Wordless, POPULAR SCIENCE, 380 Madison Ave., New York, N.Y. 10017. Only purchased ideas are acknowledged.



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Low-cost plans for solar homes

Many utility companies offer plans for energy-efficient homes, but according to Jan Sayko, solar-program administrator for Connecticut- and Massachusetts-based Northeast Utilities, "The Solar Home Planbook" NU has

just published is the most complete. "The others don't tell you anything about energy," he says. "We do: We make energy predictions in our book. And besides being a catalog of home plans, we also cover the basics of

passive-solar-design concepts." I have to agree, and at \$1.50 a copy the Planbook is one of the least-expensive solar primers around.

The list of architects and firms responsible for the six homes included in the book reads like a "Who's Who" of solar design for New England: Brattleboro Design Group (Brattleboro, Vt.), Inglese/Kitchell (Amherst, Mass.), Scully and Fuller (Peterborough, N.H.), Sunspace, Inc. (Monroe, Conn.), Tully and Ingersoll (Cambridge, Mass.), and Donald Watson (Branford, Conn.). Here's a brief description of the home designs, along with their estimated costs of construction (for Connecticut in 1983).

The Cape: 1,700-sq.-ft. two-story with three bedrooms (shown below); \$86,500.

The Compact Colonial: 1,340-sq.-ft. two-story, two bedrooms; \$67,500.

The Country Classic: 1,820-sq.-ft. two-story with sunspace; \$96,350.

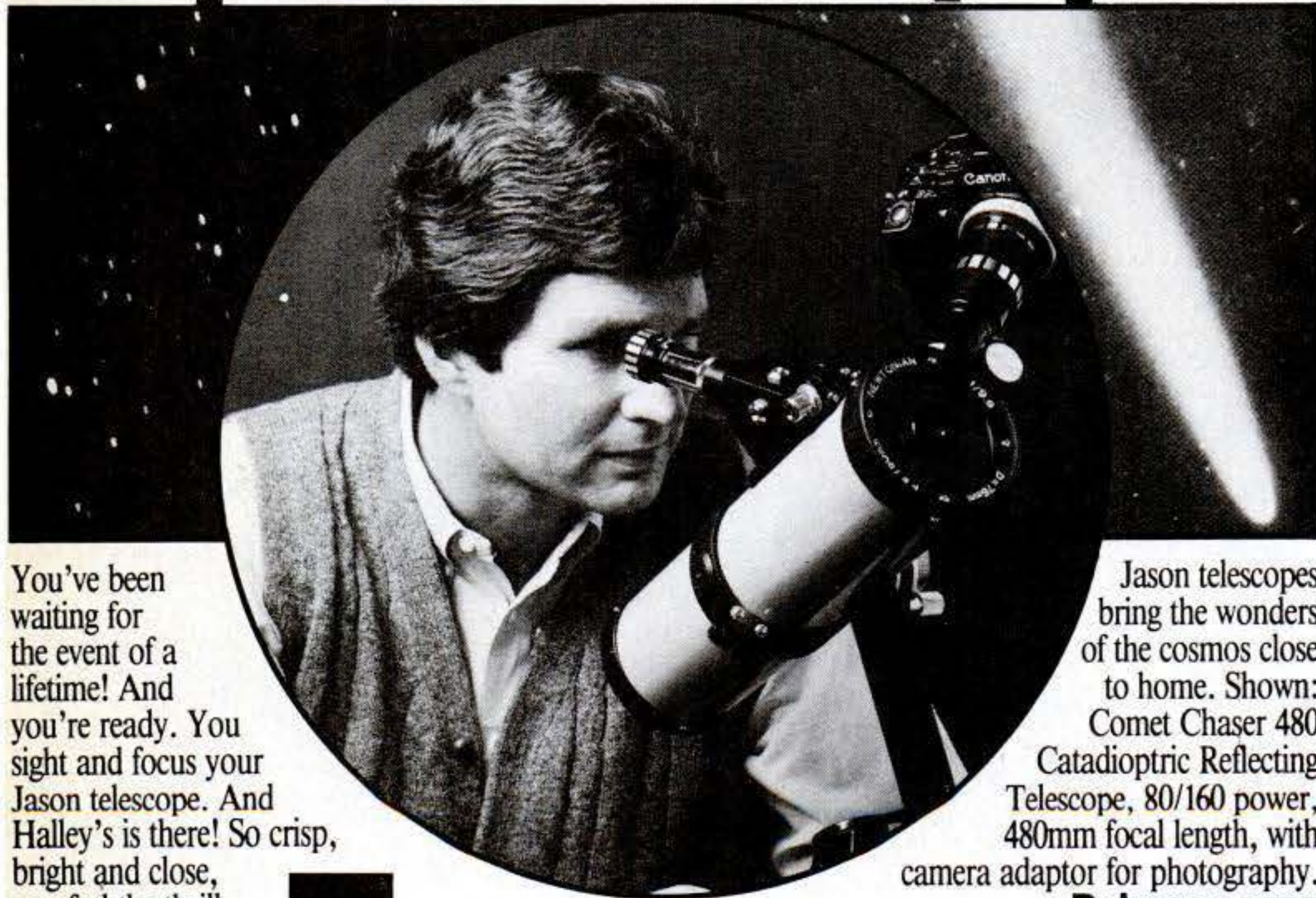
The Raised Ranch: 1,500-sq.-ft. two-story with three bedrooms; \$85,800.

The Ranch: 1,640-sq.-ft. one-story with three bedrooms; \$83,150.

The Saltbox: 1,600-sq.-ft. two-story with three bedrooms; \$84,900.

Although the homes were designed for southern New England, Sayko says they'd work almost anywhere. For a copy of the Planbook send \$1.50 to Northeast Utilities, Box 270, Hartford, Conn. 06141. Construction drawings cost \$25 a set for NU customers and \$50 for non-customers.—R. L. Stepler

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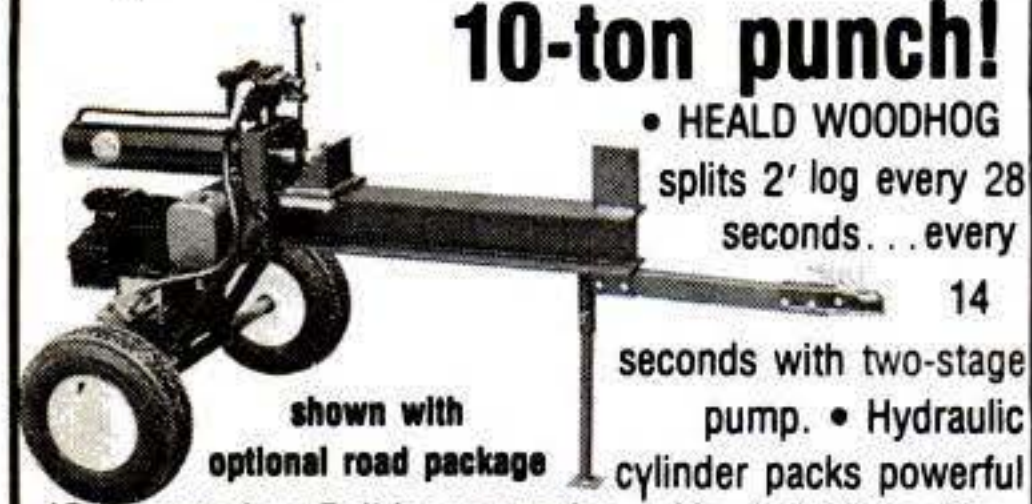
Jason telescopes bring the wonders of the cosmos close to home. Shown: Comet Chaser 480 Catadioptric Reflecting Telescope, 80/160 power, 480mm focal length, with camera adaptor for photography.

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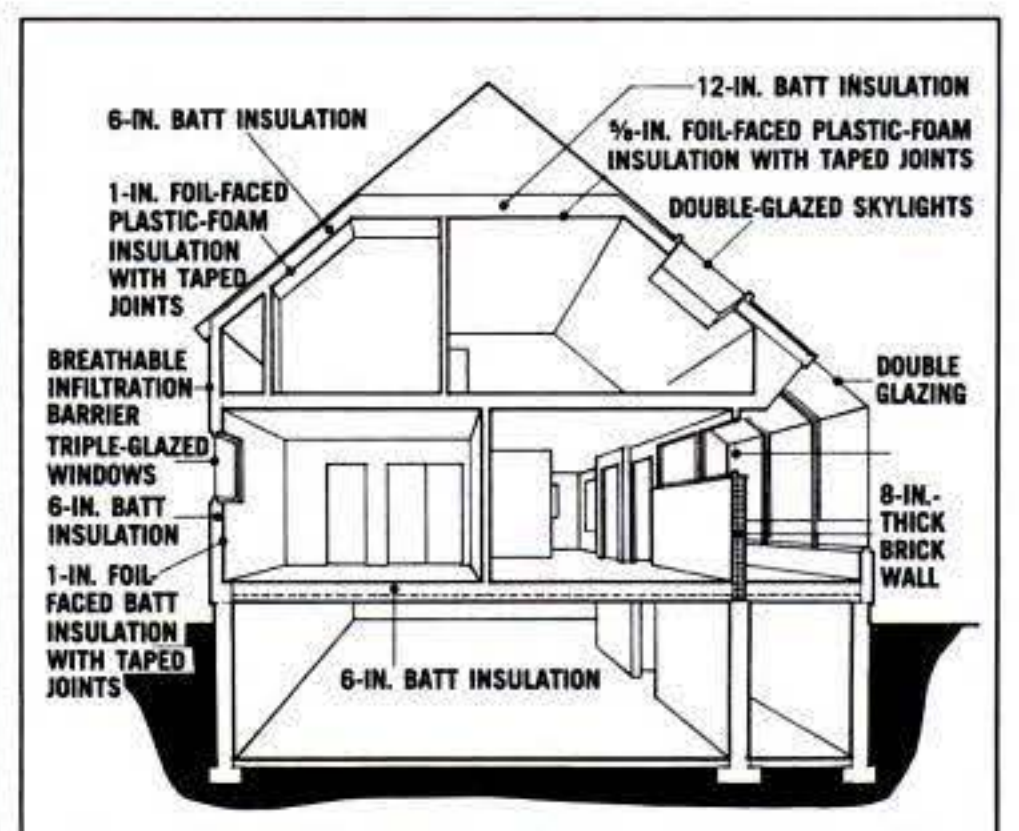
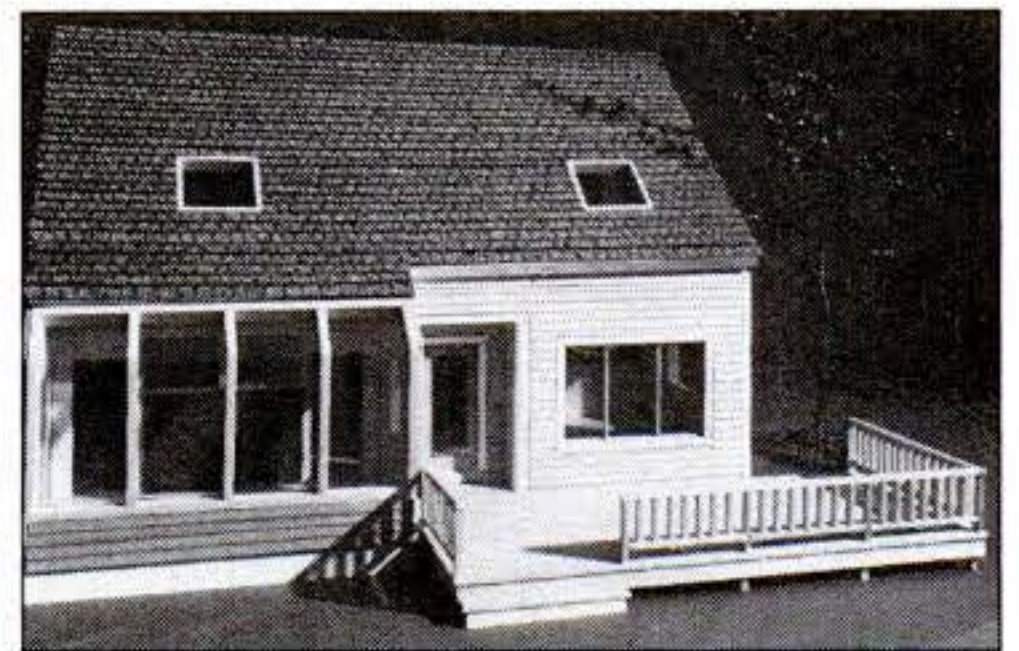
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The Cape, a direct-gain passive-solar home with sunspace, is shown above. Using \$1.20/gal. oil in Connecticut, the home costs \$264 yearly to heat.

New Ionizer Makes Indoor Air Country Fresh For The Lowest Price Ever!

A powerful EnergAire® Air Purifier will continuously clean smoke-laden, polluted air so it's breathable again. Try one in your home or office FREE for 30 days.

This winter say goodbye to stale, contaminated air. The amazing EnergAire Air Purifier uses a powerful stream of negative ions to turn up to 4000 cubic feet of dirty air into invigorating fresh air and keep it that way.

In its natural state, air is free of pollutants and has a balance of positive and negative ions. But today's air is filled with auto exhaust, industrial emissions, dust and other chemicals — all positively charged. Indoors the problem doesn't really get better. In fact, when you add tobacco smoke it can become unbearable. The result? Allergies, asthma, chronic coughing, inflamed eyes and other respiratory ailments.

An EnergAire Air Purifier cleans the air and restores the natural negative ion balance.

Rated Number One Many leading magazines have studied air cleaners and concluded that ionizers are the number one method for cleaning the air. No wonder. You've felt it during a thunderstorm or by a waterfall. The dynamic action of water and air produces negative ions that "scrub" the surrounding air. It's fresh and clean!

EnergAire is a solid-state ion generation system. Its special alloy emitter pours trillions of negative ions each second into the air. These negative ions combine with the positively charged pollutants in the air causing both to fall harmlessly to the floor. Dust, pollen, soot, smoke, even airborne bacteria that would have been inhaled into your lungs is simply vacuumed up during regular cleaning.

No Noise, No Maintenance EnergAire has no filters or panels you have to replace. An occasional swipe with a dustcloth keeps it clean. Solid-state construction makes it noiseless and maintenance-free. And since it uses less than two watts of power, you can keep it operating round the clock for under a penny's worth of electricity a day.



Sleek EnergAire is just 9 inches high, weighs 24 ounces. This handsome ionizer will remove pollutants from the air, leave it smelling fresh and clean.

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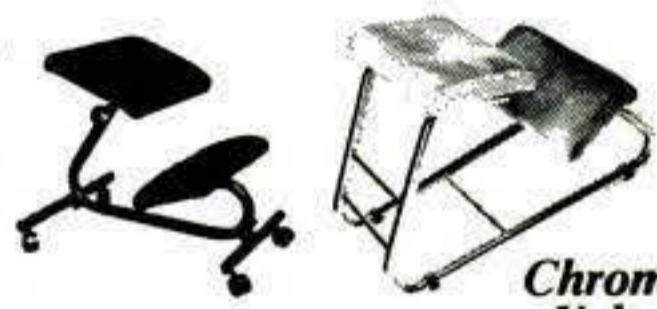
New design relieves lower back stress and lets you sit comfortably for hours. Try one free for 30 days.

Can a chair that looks so good actually be good for you? Anyone who has experienced the benefits of this chair would say YES! With the natural support the Back Chair gives to your spine and muscles, you automatically sit more comfortably, breathe more easily, finish your work without strain and discomfort.

Because all parts of your body are in perfect balance, no back rest is required. Unlike conventional seating which cramps body organs into an unnatural 90-degree angle, the Back Chair uses the body's own structure to give maximum comfort and support.

Ergonomic design positions muscles and skeletal structure in natural, relaxed position, very similar to the way children sit instinctively.

The Back Chair is now available with wheels. Styled steel frame with matte black finish and wear resistant gabardine seat.



Chrome/Velour

Many users — especially those who must spend long hours sitting — have discovered using the Back Chair brings relief from aching neck and back muscles, improves circulation, reduces muscle tension.

Compare! Similar chairs sell for almost \$200. But we're able to bring it to you for only 1/3 the price. The Back Chair is handsomely made of solid wood with oak finish and is upholstered in luxurious dark brown velour. Chrome chair is upholstered in gray velour.

Soothe Your Back For 30 Days. Try the Back Chair for a full month. If you don't find that it makes those long hours of sitting pleasurable again, simply return it for a full refund.

Discover the natural way to sit with the Back Chair.

To order a Back Chair, see ordering information in center shaded area of this page. Oak Back Chair \$59.95 (6.45 shipping/ handling) Chrome \$59.95 (6.45 shipping/ handling) With wheels \$89.95 (7.85 shipping/ handling).



Shop Talk

By AL LEES

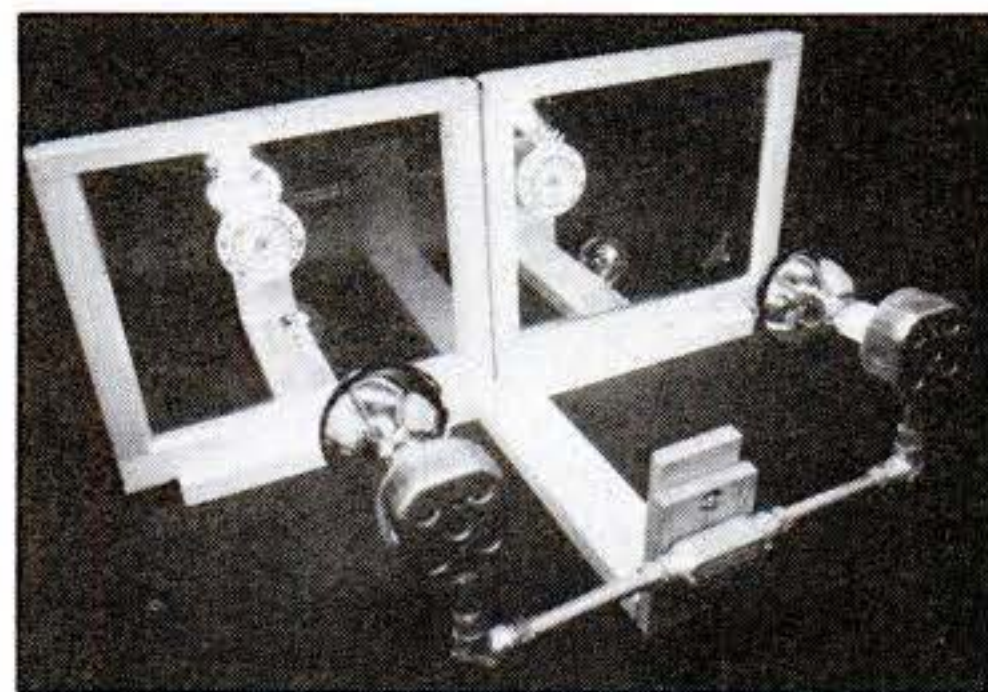
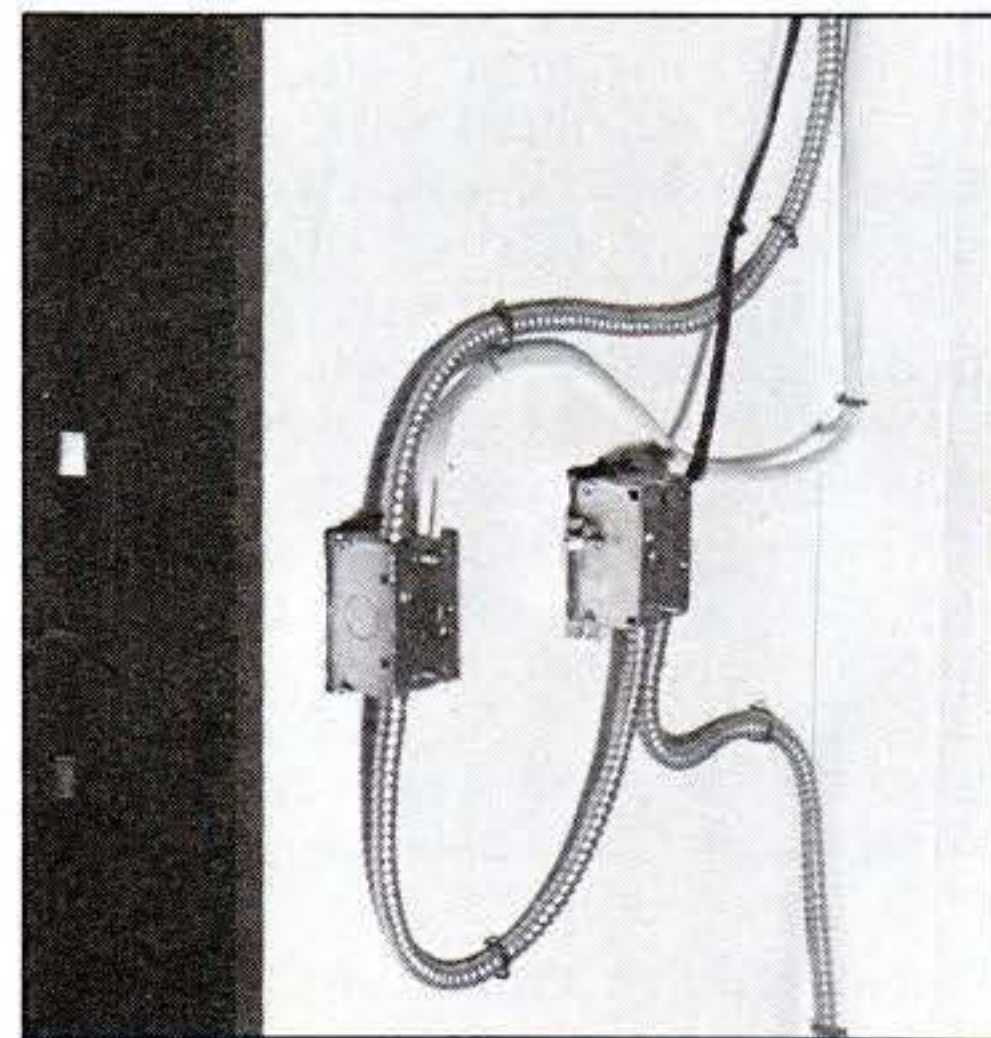
More-efficient windows

Folks from Andersen Corp. (Bayport, Minn. 55003) recently dropped by to set up on my desk the demonstration pictured below. A pair of 250-watt infrared heat lamps were aimed at two window sashes, with identical dial thermometers behind them to compare how much radiant heat passed through. The sash on the right is glazed with Andersen's new 5/8-inch-thick high-performance glass, the one on the left with standard double-pane insulating glass. Both thermometers registered 70 degrees F before the lamps went on. After 10 minutes of radiant heat, the dial behind the standard double glazing registered 86 degrees, while the thermometer behind the new glazing had risen only five degrees.

What accounts for the 11-degree difference in radiant-heat transmission? A microscopically thin transparent metallic coating is permanently bonded to the outer surface of the interior pane of the double glazing—that is, it's on the interior side of the air space.

Andersen has researched the effect of coating various faces of double glazing and has found that this location

Andersen claims that this new coating gives two panes of glass 14 percent greater insulating value than triple glazing. (The windows are 42 percent more energy efficient than uncoated double glazing and 72 percent better than single-pane windows.) If these figures check out, coated twin-pane could make costly, cumbersome triple glazing obsolete.



is the best compromise for increased performance in both winter and summer. In winter the coating admits the sun's warming rays then blocks loss of the interior radiant heat they produce, so the inside surface of the glass stays about 10 degrees warmer than that of uncoated insulating glass, increasing your winter comfort near windows. In summer this coating is equally effective at reducing passage of the heat radiating from sun-baked patios, driveways, and sidewalks, thus reducing air-conditioning loads. The coating also blocks 80 percent of ultraviolet rays, so fabrics won't fade.

Hiding eyesores

Many home projects that look relatively simple on the sketch pad turn out to be complex. A case in point is this month's featured home improvement—the bed/wardrobe divider. It's an island structure supporting electrical elements on both sides, so, after my basic assembly, I had an electrician bring shielded (BX) cable across the floor (to be capped later with a threshold) to several outlets. Then I carried Romex wiring from a speed-control switch (its box pierces the partition at left in the photo above) up to a ceiling fan; and I ran other wiring on to two fluorescent fixtures. All this wiring ended up looking like a vertical snake pit with sharp points to snag clothes in this closet.

So, as a finishing touch, I glued a vertical 2x2 along the front edge of this partition and screwed on a 1/4-inch-thick panel of waferboard, painted to match the closet interior. It bridges the wiring cavity. You can get an "after" glimpse of this partition in a color photo earlier in this issue.

For a future article, I'm collecting other ideas for hiding ugly necessities around the home. If you have one to

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share, send a sketch and a snapshot to Shop Talk, POPULAR SCIENCE, 380 Madison Ave., New York, N.Y. 10017. If we can use it, we'll send you a check.

Guides for home hunters

This home-improvement issue is a logical place to alert you to two guides on shopping for a new house. A. M. Watkins has just updated his paperback, *How to Avoid the Ten Biggest Home-Buying Traps*, to include cautions about financing with an adjustable-rate mortgage.

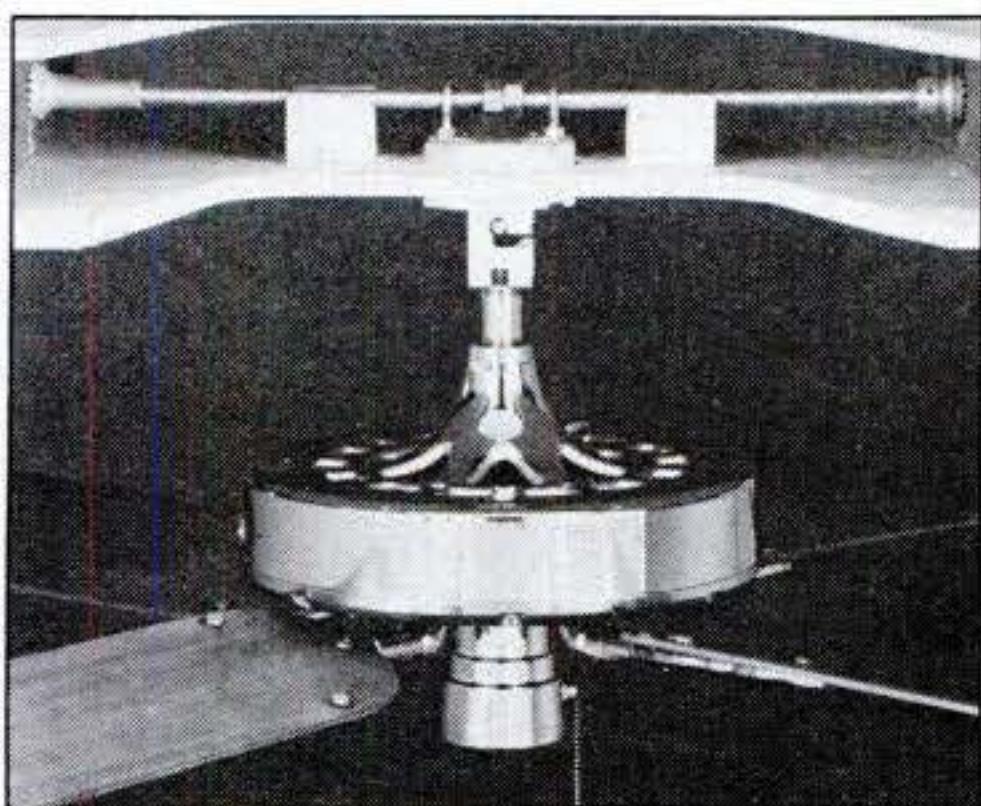
Are you thinking, instead, of building a new home? Watkins has also compiled a new directory entitled "150 Top Manufacturers of Factory Houses That You Can Build Yourself," listing sources for various types of house kits. New factory-made housing offers higher construction quality than site-built, Watkins claims, because of tighter quality control and conformance with stiff national building codes.

The book is \$7.95, and the directory is 50 cents—both from The Building Institute, Piermont, N.Y. 10968-1099.

One last word on fans

This issue's piece on paddle-fan installation lacked space to mention that there are commercial devices to ensure anchorage of ceiling outlet boxes. The cutaway photo below shows one fan manufacturer's cross-brace hanger bracket for areas where you can't gain access from above the ceiling. You can insert this hanger through a small ceiling hole (such as one for an existing fixture box) and expand it to provide a solid anchor. Hunter offers it in two sizes, for joists 16 inches and 24 inches on center. The current Sears catalog lists a similar device for \$30.

I've just survived a sweltering sum-



mer—without air conditioning—thanks to paddle blades whirling above my bed. The fan cut my cooling costs to near zero because the average ceiling fan draws about as much power as a light bulb. PS



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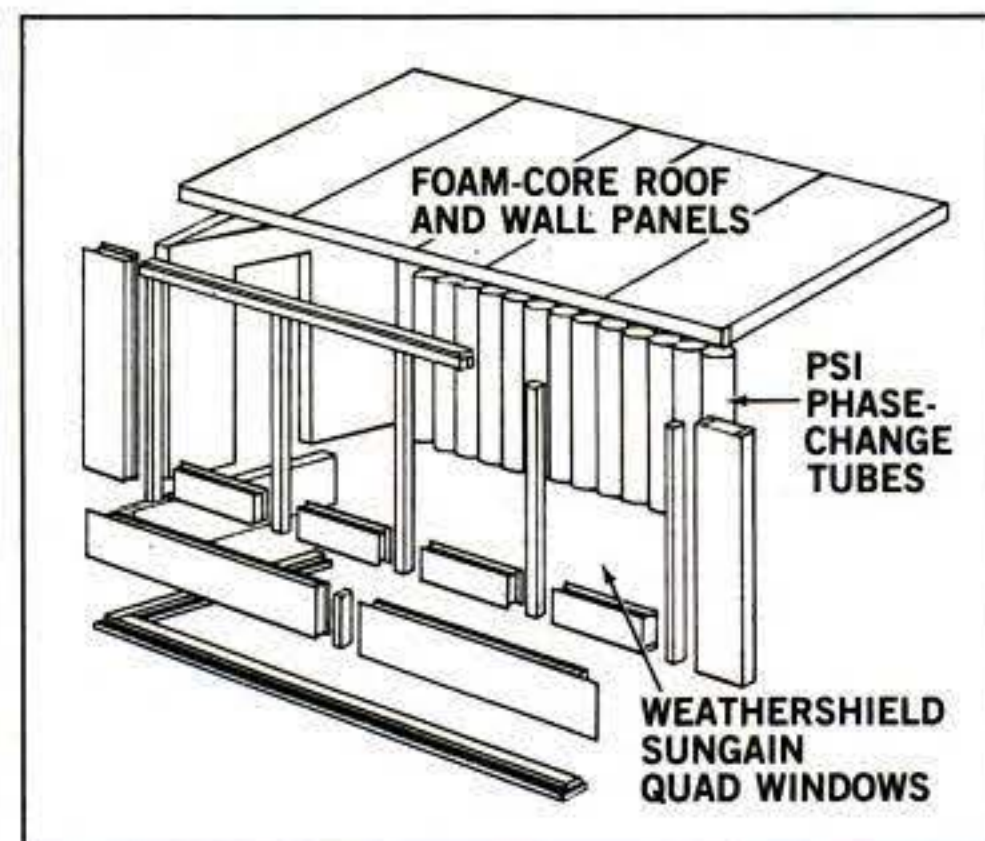
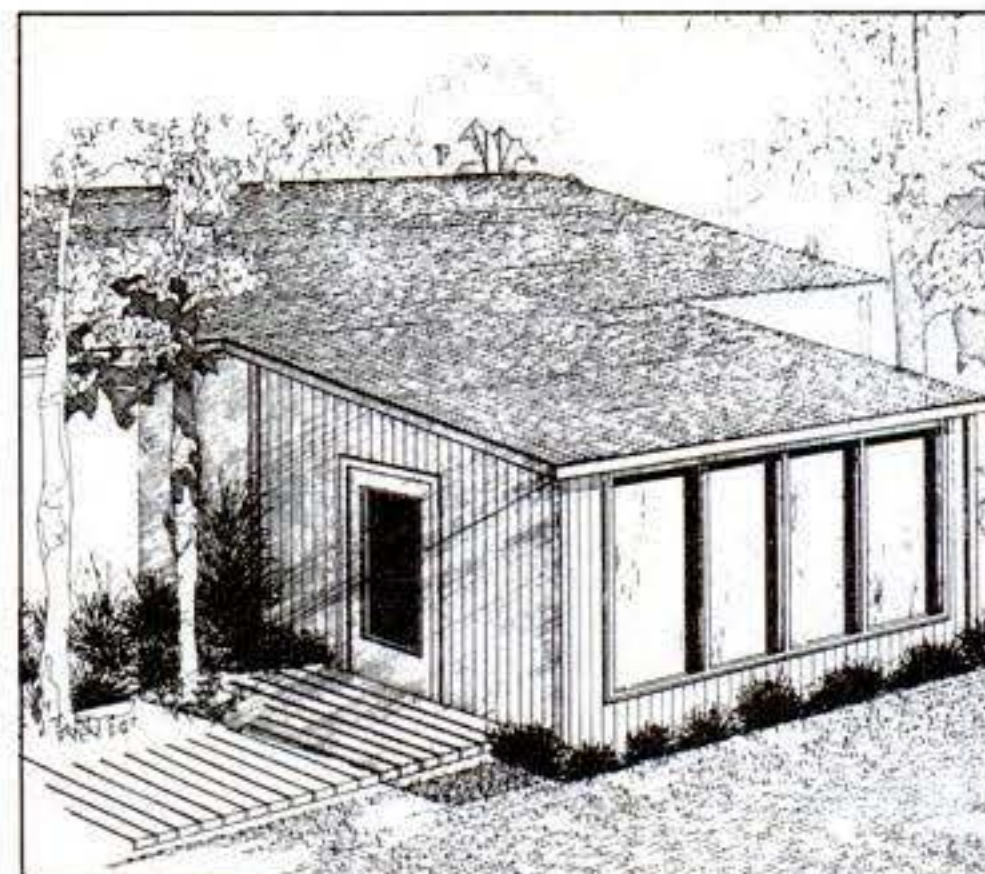
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TOLL-FREE 1-800-237-2559
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Add-on sunspace for your home



Kit solar greenhouses have proved to be popular home additions in recent years [PS, Sept. '81]. Not only do they provide extra living space for plants and people, they also can deliver a bonus in the form of solar heat. Now there's a kit that promises to be the most efficient yet. Designed by Ray and Bruce Baker of Baker Homes, Inc.—responsible for SolarGreen I ["So Long, Slanted Glass," PS, Aug. '83]—the kit features several advancements:

- Foam-core roof and wall panels provide R-40 and R-30 insulating values, respectively. Shipped in four-by-eight-foot panels, they are easy to erect and provide a tight structure.

- Quad-glazed windows with two inner layers of 3M SunGain film are as effective as double-glazed windows with insulating shades in place.

- PSI Thermol 81 phase-change heat-storage tubes absorb solar heat during the day, then release it at night.

Called SolarGreen Sunspace, the kit is sold in modular form (four-foot sections) in one- and two-story models. PSI Energy Systems Div. (1533 Fenpark Dr., Fenton, Mo. 63026) handles distribution.—R. L. Stepler

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There are all kinds of ways to make money. Good golly, golly — if anyone knows that, I do! For the past 20+ years I've concentrated on finding, investigating, creating and specifically singling out only the very finest legal and ethical methods for carving out a mass of wealth in a hurry. But believe me, in all those years never have I experienced anything remotely as exciting as this one! Recently, I came across a fairly new way to make big bucks, but after a thorough study I discarded it because it required too much investment of time, money and personal effort. But my study did serve as inspiration to develop yet another fantastic and unusual wallet-strengthening — something that until now has never been done — yet fully complies with the tough set of standards I'm noted for demanding of any potential wealth-producing concept:

Must be able to be started with **minimum investment**

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Naturally, you're wondering what all this is — but I'm not going to tell you here. No, it's going to cost you ten

For the past two decades Du Vall has captured the imagination of men and women the world over by providing solid, unique direction for their quest for financial freedom. His firm is headquartered in Michigan with international marketing offices in Hong Kong (known as DAX International, John W. Lane, President). In addition to producing some three dozen publications on money-making/self-improvement themes, DuVall is also the creator of the popular Derek Dax adventure/mystery/romance series and the author of the political intrigue novel, "The Big Dream" (published by Lyle Stuart, Inc., New York). Unlike most, he has never had to resort to outlandish money-back guarantees to attract only the finest DAX-DOERS worldwide and no such policy is expressed or implied.

His writings have been used in numerous style and content workshops and accredited courses at such institutions as California State University, UCLA, Fordham, University of Illinois and Worcester Polytechnic Institute.

smackers to find out. But I will tell you what *isn't* so you'll not be off on some wild goose chase:

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WHO CAN DO IT

Anyone with even a smidgen of ambition.

WHAT IS REQUIRED

Other than my step-by-step detailed report ... nothing. I have thought long and hard about it; A person virtually without a shirt on their back or a pot to plant petunias in could do it. You will of course, have to put my plan into motion — but that's both fun and easy and totally accomplished from the comfort of your own home. (By the way, no one will be coming to your home, either.)

Finally, let me make this clear: Once you have my report, **that is all you need to get going!** I have nothing else to sell you for this deal. Your purchase of this extraordinary report is NOT a "foot in the door" to get you to buy some extra or expensive "course" or whatever ... this is all you need from me!

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"We are so impressed . . . have our 13 and 16 year olds involved . . . thanks for giving our family new hope."

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WHAT TO DO NOW

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1. Put this ad aside, wait 90 days or so and perhaps lose your chance at \$100,000.



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2. Do the only sensible thing. Send me the ten bucks and get started on wearing in that path to the bank.

P.S. One more thing (say, this Du Vall is a windy so and so, isn't he!). There are lots of people right now in bad financial straits. I hope you're not one of them, but if you are, having read this ad you now have absolutely no excuse for being broke, because as the saying goes, "This is it!" This could truly be the once-and-for-all solution to any money miseries you have. I guess you'll have to take my word for it until you receive these fabulous reports — but if it eases your mind any, over 1,000,000 men and women worldwide have been, over the years **repeat buyers** of my books, courses, reports, cassette tape programs and newsletters. There must be a reason . . .

— Dean F. V. Du Vall

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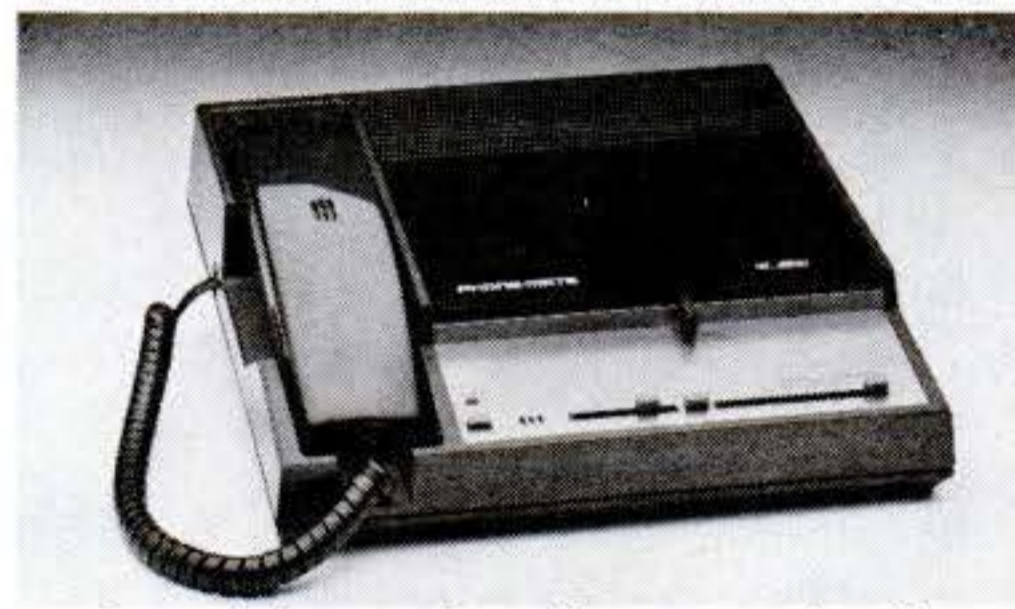
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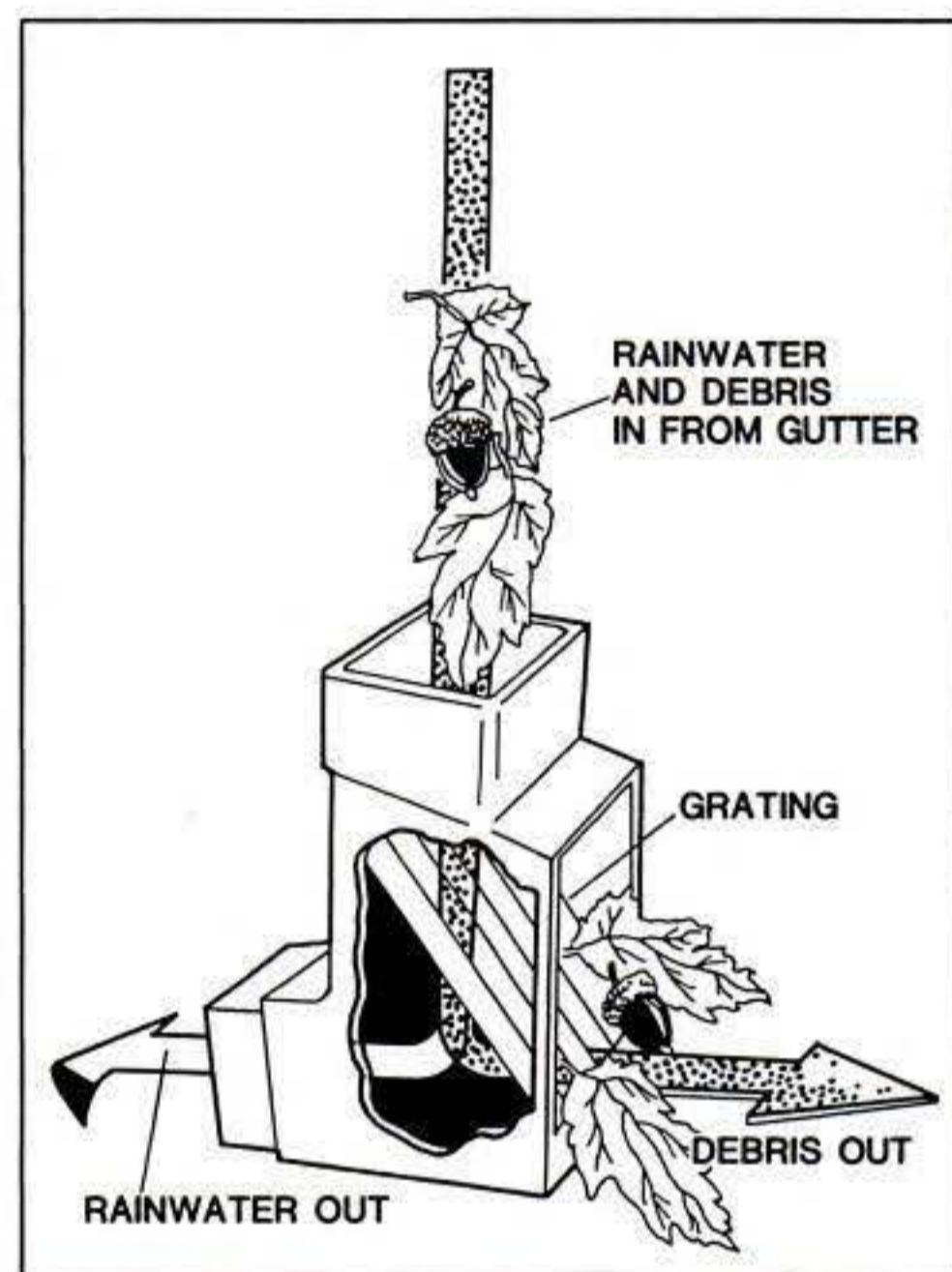
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CRUTCHFIELD

1 Crutchfield Park, Dept. PS, Charlottesville, VA 22906

Leaf ejector for clog-free gutters



Do clogged gutters make your house look like a waterfall during a rain-storm? The Leafgo debris separator prevents gutter floods by kicking out leaves and twigs before they hit the first downspout elbow.

The rain-powered leaf ejector fits between the gutter and downspout. Leaf-laden rainwater drops easily through the knife-edged grating and flows to the downspout (see diagram above). But the angled grating catches leaves and other debris. Water flow then shoots the debris out the ejection window and onto the ground below.

I tested the unit on my shop building, which is built under live-oak trees that stay green but shed leaves year round. A light rain did not produce enough flow to eject the debris. But when I dumped five gallons of debris-filled water into the drop outlet, leaves poured out the Leafgo window like concrete out of a ready-mix truck. My conclusion: The heavier the flow, the better this rain-powered garbage disposer works.

Although Genova, Inc. (Box 309, Davison, Mich. 48423-0309), designed Leafgo to work with its vinyl-gutter system, the unit can be adapted to metal gutters by replacing the downspout with a Genova downspout and converter. Leafgo costs about \$10. You need one unit for each drop outlet.—Richard Day

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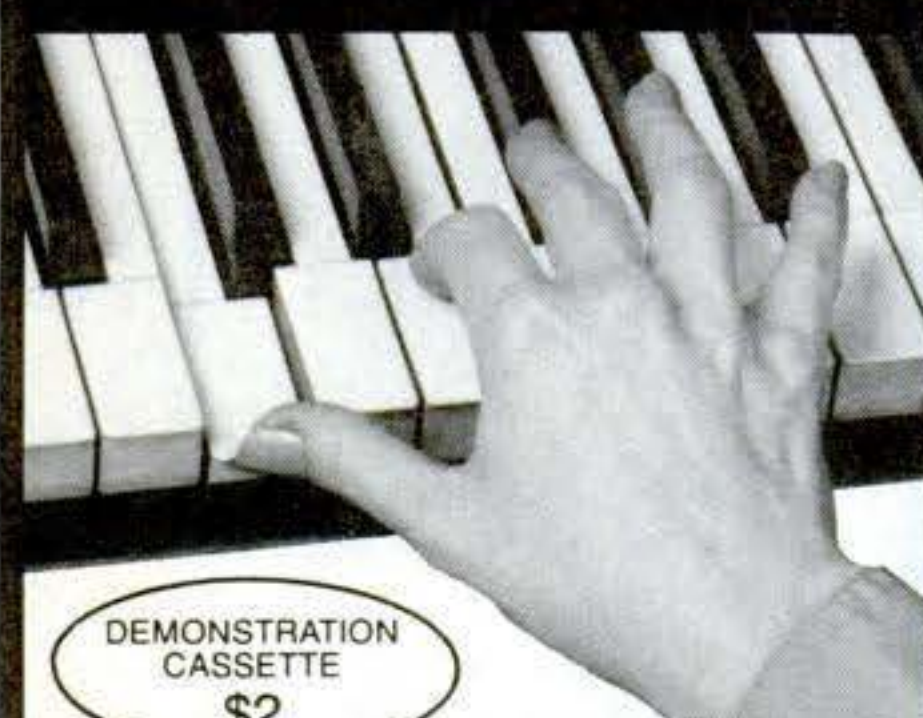
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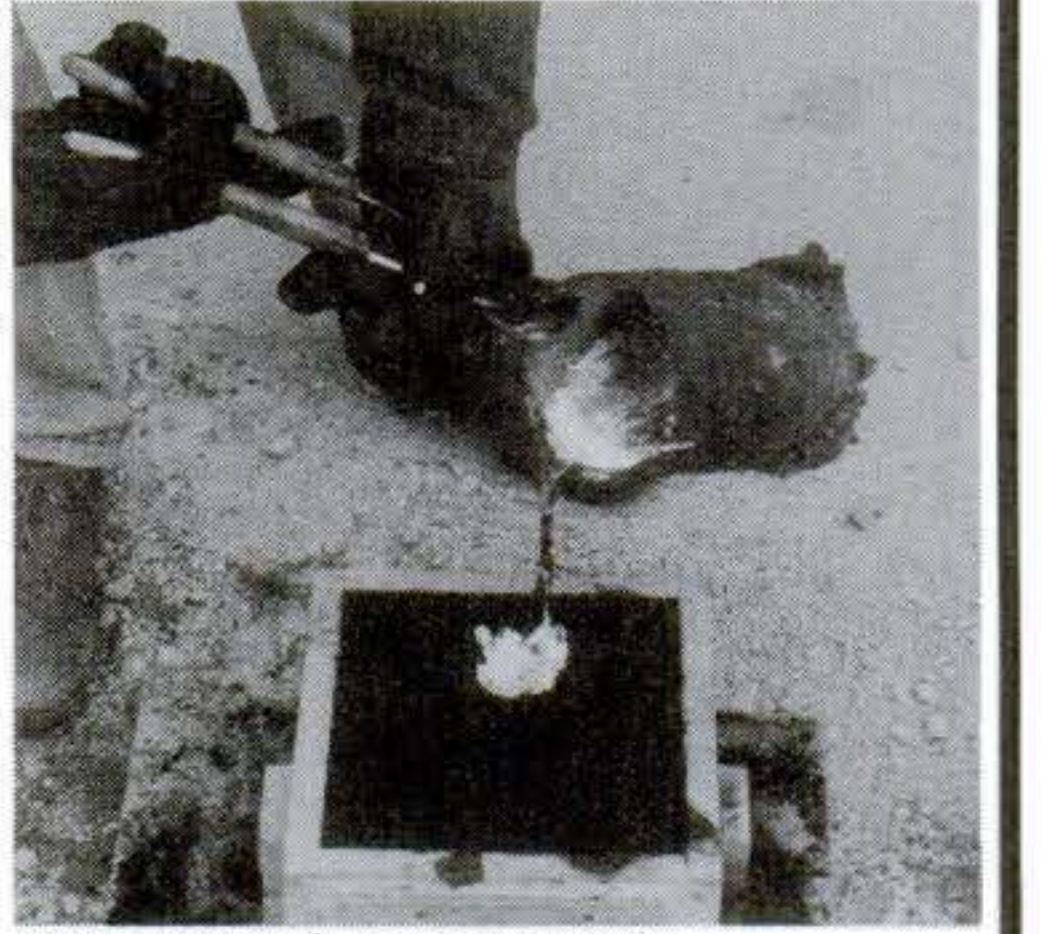
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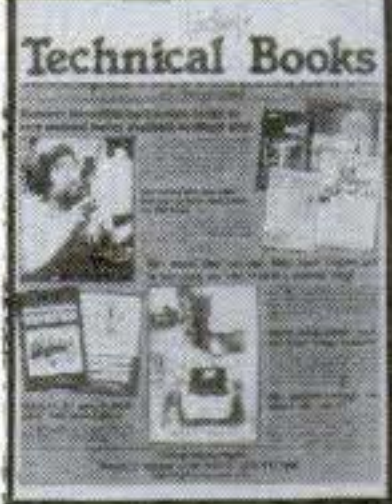
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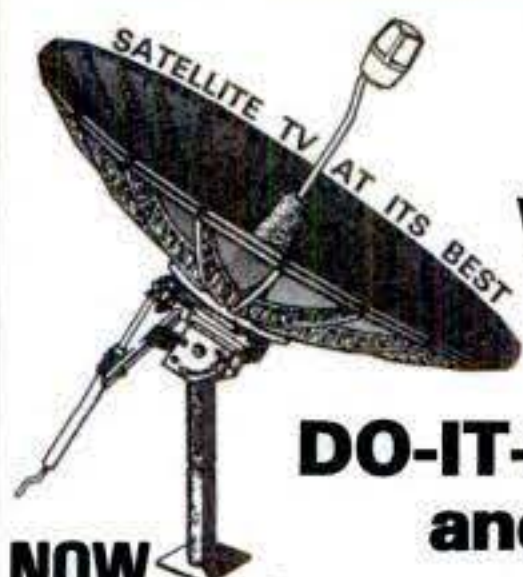
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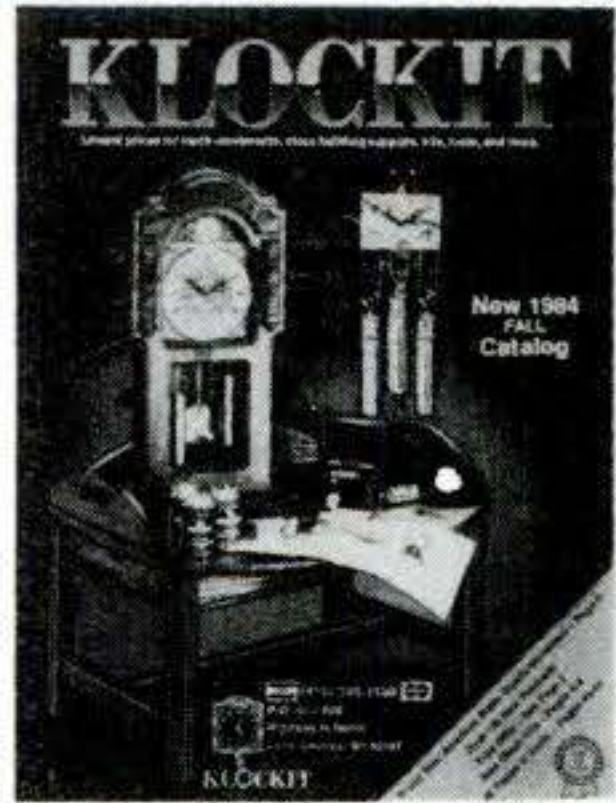
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That could handle snow like a snow tire. Drive through rain as if that were its only purpose in life.

And perform like a highway tire when the weather's

fine. The result: the Michelin XA4 All-Season Radial.

We put it through 20,000,000 miles of testing to prove it did everything we wanted it to do.

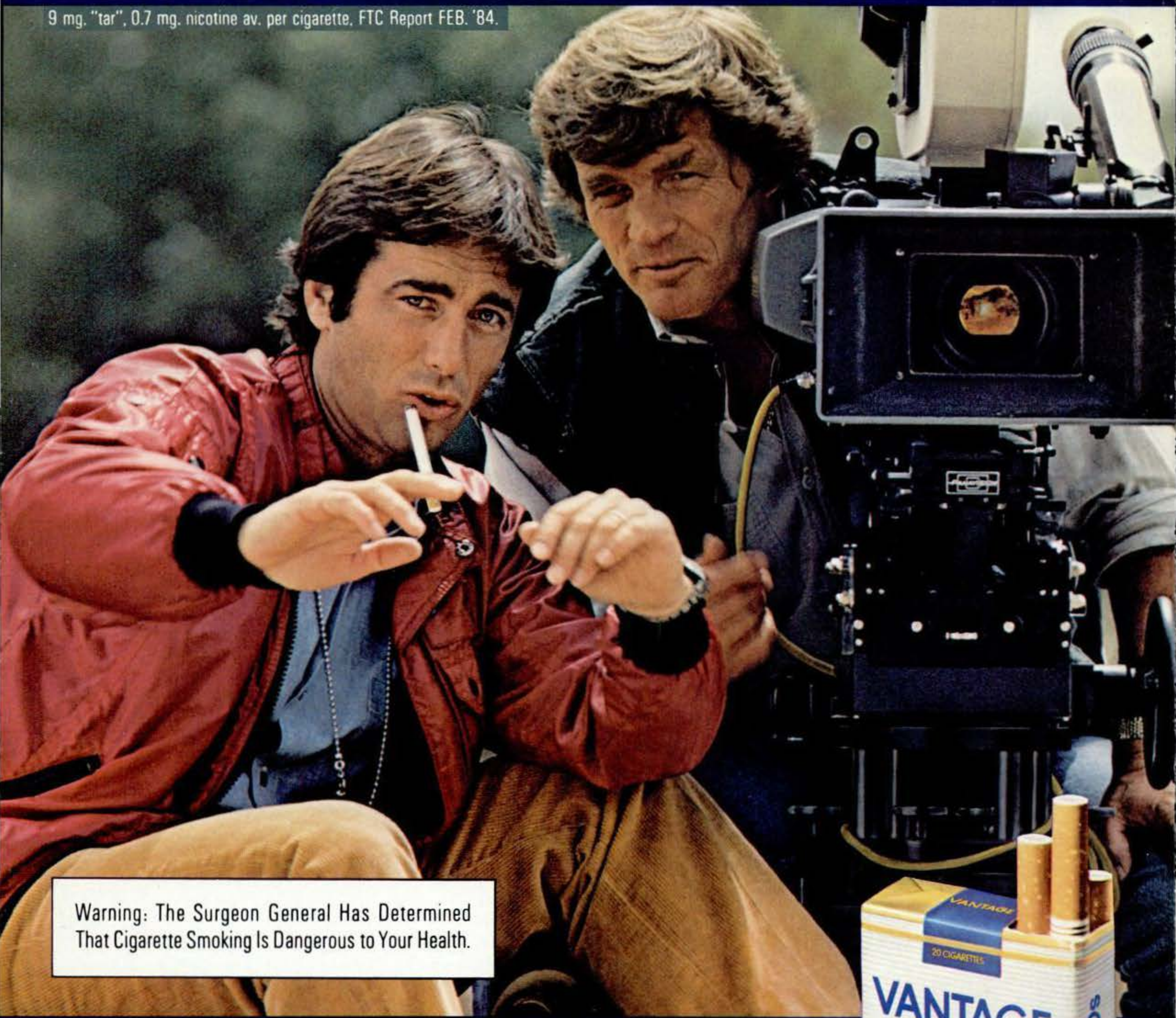
It did. And then some.

The XA4 can actually give you increased gas mileage. Because it reduces rolling resistance. And with proper care, it can get up to 60,000 miles of tread life. That's a lot of miles.

But then again, the XA4's a lot of tire.



9 mg. "tar", 0.7 mg. nicotine av. per cigarette. FTC Report FEB. '84.



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

VANTAGE. THE TASTE OF SUCCESS.

*Great Taste
with Low Tar.
That's Success!*



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