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The WHAT'S NEW magazine

Popular Science®

NOVEMBER 1983 Founded in 1872/Vol. 223, No. 5

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Pocket TVs aren't new, but *color* is something else. Here's our report from Japan.

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Car test: challenging the Honda Accord

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Joining metal to metal

Soldering, brazing, and welding basics are easy —and fun—to learn. But precaution is needed.

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Cover photo from Suwa Seikosha

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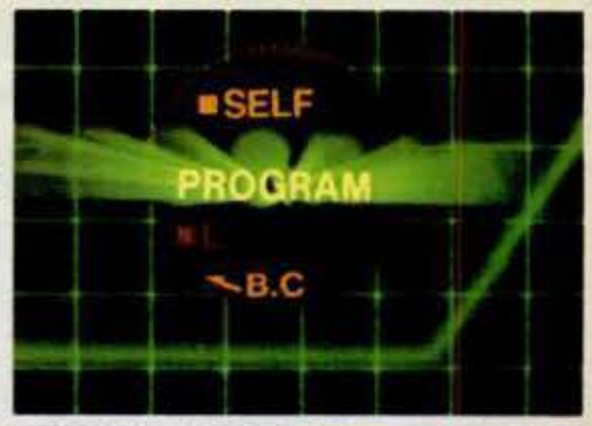

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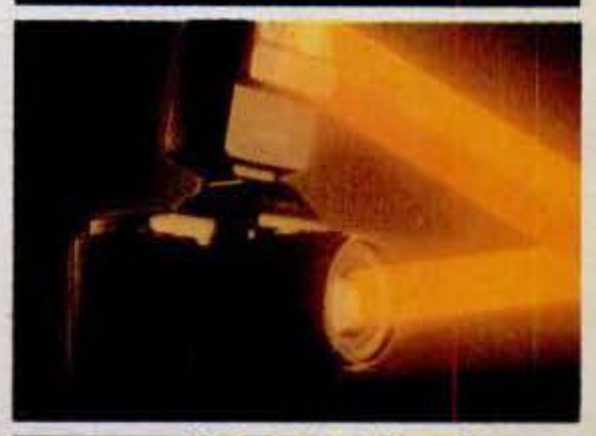

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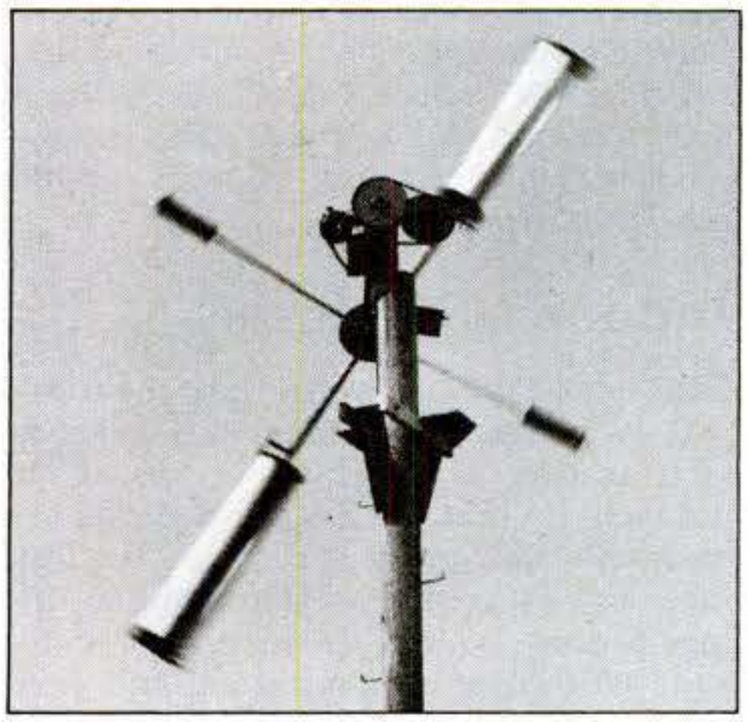

Another Magnus

There are simpler ways of building Magnus-force wind machines than Thomas Hanson's barrel-blade windmill [PS, Aug.]. Modified Savonius S-rotors make good *self-driven* rotor cylinders. The formula given by Savonius for maximum Magnus lift was to make the central gap of the S-rotors ⅓ to ⅗ the diameter of the vanes. I built a mill with such S-rotors (photo) and achieved a very high-torque, low-speed machine. Some efficiency is sacrificed, but it is much simpler.

Richard A. Ford, Columbia, Mo.

Here and now

David Salisbury's article "Nowcasting" [PS, Aug.] focused exclusively on the federal government's approach to the marriage of meteorology and computers. It should have noted that the original work in the area of integrated weather systems was done at the Space Science and Engineering Center of the University of Wisconsin, Madison, under the leadership of Professor Vernor Suomi. It should also have pointed out that many mesonets of automated weather stations had been in use for several years in advance of NOAA's PROFS project. Ours, in California's Great Central Valley, was run by farmers and began operation during 1981.

The article states that we will have to wait 20 years to see widespread use of the PROFS ideas. Actually, private-sector meteorology is in action to realize these technological advances today. It is in all our best interests for the partnership between public and private interests to proceed—full speed ahead.

Rolland K. Hauser, Technical Director
Nowcasting, Inc., Chico, Calif.

Ply winner challenged

As usual, this year's winning plywood-contest projects [PS, Aug.] were creative and exciting. However, one of them—the chair designed by Thomas Parker—had many similarities to a design in a book that I used in college: *Nomadic Furniture*, by James Hennessey and Victor Papanek. I sincerely hope this was purely coincidental because it would be unfortunate to award a non-original design solution.

Frank B. Golley, Decatur, Ga.

Al Lees replies: "Several other readers have noted this similarity. Actually, Jim Hennessey's redesign of the German chair combines elements of both *our tied-for-third-place chairs, and neither of our chairs duplicates the earlier design. Because hundreds of project plans and books are published each year, it would be impractical for PS or APA to memorize them all as an aid to judging. The burden of originality lies with the contest entrant, who must sign a statement that the entry is an original design."*

Cut corners?

I was taught about the problems of neutron embrittlement of reactor vessels ["Thermal Shock," PS, June] while in the Navy Nuclear Power School way back in 1966. I was also taught how to handle the specific stuck-valve problem that occurred in the Three Mile Island reactor—which the TMI reactor operator did not know. Admiral Rickover believes, and I agree, that civilians are not to be trusted with nuclear power plants because they will cut corners on safety and training to make an extra buck.

Michael L. Simon, Chicago, Ill.

Still champion

John F. Woyke's letter concerning the longevity and cost per square foot of batch solar water heaters [RTB, June] should not go unchallenged. First, with minor maintenance, batch heaters typically provide 10 to 20 years of service. Second, although batch heaters might cost more per square foot of collector-glazing area than some other solar water heaters, their outstanding efficiency most often makes batch water heaters winners at the bottom line.

Dan Reif, Amherst, Mass.

Reif is the author of Passive Solar Water Heaters: How to Design and Build a Batch System *($14, Design Works Inc., Box 489, North Amherst, Mass. 01059).*

Payback comeback

As long as you're dealing with misunderstandings about payback calculations for energy devices [RTB, June], let's carry it a little further. Professor Katz said that a

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Tom Stockton, Ann Arbor, Mich.

Prefab solar

It might interest your readers to know that Pre-Cut International Homes has a line of solar houses to go with its foam-core walls [PS, June]. Under contract with the company since 1981, I have developed over two dozen designs specifically for this system; another dozen are in the works. They are of all different sizes and range from medium-to high-performance passive solar. Many include provisions for active-solar hot water and photovoltaic cells.

John Ottenheimer, Architect
Lopez Island, Wash.

Whatever happened to...?

As I was reading through some back issues of PS I came across a Ben Kocivar article, "Ram-Wing X-114" [PS, Dec. '77]. I am extremely interested in finding out if there were any further developments with this "flying boat."

Glen E. Woodworth, Wasilla, Alaska

Ben Kocivar replies: "The aircraft in the article was severely damaged when landing in a crosswind across some waves. The German government is still interested in this project and possibly will have some more developments in the near future. We'll cover it when it develops."

Which sprayer?

I am planning to purchase a sprayer for sealing the cedar front of my house, so I enjoyed E. F. Lindsley's "Portable Compressor" [PS, Jan.]. I would have liked to have seen a comparison between the Power Pal and the airless sprayers that are available, however. How about it?

J. L. Bachman, Coon Rapids, Minn.

E. F. Lindsley replies: "I favor the compressor because it is useful for so many things other than just painting. Just one time pumping up a flat tire can make it worth the cost. For a house-sized job, however, my experience is that it's best to buy or rent a husky two-cylinder compressor and a spray gun made for large jobs."

S-curve solar

I have been trying to think of the drawbacks to Ben Johnson's ingenious S-curve solar absorber [PS, Aug.], which uses black metal plates whose edges curl around straight copper tubing. The only possible weakness I see is that the many plates of each collector would have to be curled very accurately—straight, say, to within 0.01 inch. Otherwise, contact with the tube will be poor. What materials and dimensions does Johnson use?

William A. Shurcliff, Cambridge, Mass.

Ben E. Johnson replies: "There are 14 soft-aluminum panels in one eight-foot panel. They are curled around lengths of 3/8-inch hard-copper tubing on seven-inch centers. I bent the panels to a smaller outside diameter than the copper tubing so the force formed a good fit. The entire panel was assembled before painting to avoid a paint insulation barrier."

Indoor solar tests

Your article on solar-water-heater ratings [PS, June] was a good start but was incomplete in several respects. For one, it did not mention that the SRCC system test is an *indoor* test using sunlamps. The ratings it gives are higher than outdoor ratings because no consideration is given for wind chill, dust accumulation, and variable sunlight on partly cloudy days.

We also would like to inform you that the Sunwizard unit now is being tested outdoors, since the SRCC has finally been persuaded by our technical arguments that the indoor test is unsuitable for our unit's cylindrical shape. We expect our rating will be revised to about 20,000 Btu per day, and if the outdoor test were in a white-painted area as is usual with our installations, it would be about 26,000 Btu per day.

Our experience with standardized ratings, tax credits, and utility rebates has been that their administrators are slow to recognize innovation and may inadvertently help to stifle engineering advances. If you invent a better mousetrap these days, you may be outlawed by the other mousetrap makers.

Mike Mellon, President
Sunwizard, Inc., Des Plaines, Ill.

Got his goat

Responsible herdsmen and goat owners are well aware that goats should not be allowed to forage where toxic plants grow ["Science Newsfront," PS, Aug.]. They should also know that most ornamental shrubs, hedges, garden flowers, and perennial flowers (with the exception of roses) are considered unsafe. Although there always will be isolated cases of the type reported, please don't leave your readers with the impression that any goat outside a large dairy farm is a walking poison factory.

Lawrence E. Wicks, Woodford, Va.

Diagnostic computer

The Smartscope manufactured by Allen Electronics Testproducts Division is not a "comparable machine" to the Coats auto-diagnostic computer [PS, Aug.]. Instead of merely reading specifications, the Smartscope analyzes actual performance variables. Then it prints out potential solutions that the mechanic should check. I'd like to see how the Coats machine would re-

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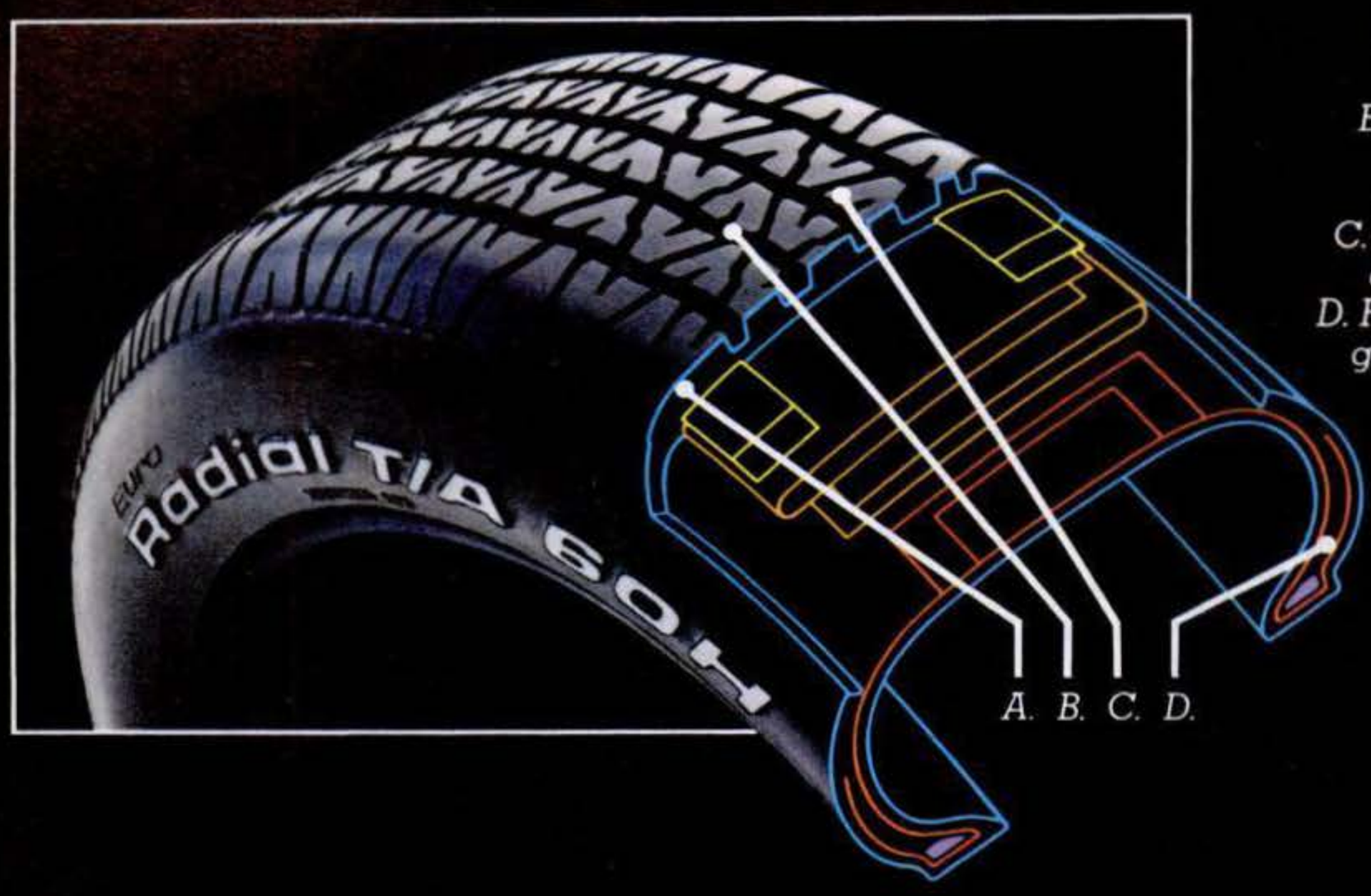

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195/60HR14	5.0- 7.5	23.23	5.76	7.80 on 6.0 rim	886	1210
215/60HR14	5.5- 8.5	24.17	6.54	8.50 on 6.0 rim	859	1365
235/60HR14	6.0- 9.0	25.12	7.11	9.45 on 7.0 rim	830	1580
205/60HR15	5.5- 8.0	24.69	6.20	8.19 on 6.0 rim	843	1365
235/60HR15	6.0- 9.0	26.10	7.11	9.45 on 7.0 rim	801	1630
255/60HR15	6.5-10.0	27.05	7.77	10.05 on 7.0 rim	773	1890

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185/70HR13	5.0-7.0	23.54	5.47	7.31 on 5.0 rim	877	1140
185/70HR14	5.0-7.0	24.57	5.47	7.31 on 5.0 rim	847	1210
195/70HR14	5.0-7.0	25.04	5.70	7.74 on 5.5 rim	833	1340
205/70HR14	5.5-7.5	25.67	6.08	8.10 on 5.5 rim	814	1490
225/70HR15	6.0-8.5	27.40	6.43	8.65 on 6.0 rim	763	1730

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spond to a car with a Ford body, a Holley carburetor, Krager heads, and a Chevy block and ignition system. Believe me, such an auto hybrid could be diagnosed and finely tuned with Allen.

Chris Bernardy
Allen Testproducts Division
Santa Fe Springs, Calif.

Quick pitch

Power and speed control of the Passive Cyclic Pitch wind machine ["5 Wild Windmills," PS, June] are obtained only by yawing the machine out of the wind; there is no pitching motion of the nacelle, as the article said. The pitch feature is located in the hub assembly. Its purpose is to permit the rapid yaw rates without the vibratory shaft load or large flapping amplitudes often associated with the yawing of a two-bladed rotor.

Also contrary to the article, speed control for most wind turbines does not involve yaw control. The prototype tested by SERI and the Corps of Engineers is unusual in that it uses that method for a two-bladed rotor design.

Finally, the teeter, or cyclic-pitch hinge axis, is offset 23 degrees from the blade axis, not 23 degrees from the axis perpendicular to the blade pair.

Andrew H. P. Swift Jr.
U.S. Army Corps of Engineers
Maryland Heights, Mo.

More on slanted glass

Just as "one rose does not a summer make," neither does one successful vertical-glass installation on a solar home say "So Long, Slanted Glass" [PS, Aug.]. Many years of research during my company's development of a prefabricated solar greenhouse leaves me steadfastly convinced that slanted glass will be around a long time because it provides greater solar gain and more-even light distribution.

Various design factors could have overcome the overheating in the original structure, including more ventilating capacity, a shading system, and night insulation. It may be harder for the designer to balance these factors with slanted glass, but these subtleties are the challenge of his profession, and the goal of improved performance is worth the quest.

The real story here is the high-transmissivity 3M SunGain film that was added in the redesign. The best of both worlds will likely result in the use of high-performance glazing in sloped installations (when the glazings become available at a reasonable price). Until then, sloped double glazing with night insulation will continue to be the system of choice.

Scott D. Hicks, Manager
Development and Technical Support
Garden Way, Charlotte, Vt.

It is good to see that the full story on slanted glass is finally getting around to architects and builders. However, it seems the Bakers need to go back to the drawing board once again. The lack (apparently) of adequate roof overhang will let unwarranted summer heat in. As for "real-world" living, how many people wish to live in a fishbowl? Large window expanse with no shades is just that.

Tom Borchard, Energetic Installations
Des Plaines, Ill.

Waferboard and termites

Waferboard sounds like a useful building material. Is it resistant to termites?

Frank Padilla
Frederiksted, St. Croix
U.S. Virgin Islands

Al Lees replies: "Generally, termites have little interest in reconstituted-wood panels; the wood is infused with bonding resins."

Flush hardware

Your item on the Fluidmaster neglected its best feature: ease of replacing the washer. After shutting off the water supply, flushing the toilet, and disconnecting the overflow refill tube, you simply twist the tower ⅛ turn and lift it out. Exchange the washer for a new one, and then reassemble in reverse order. As a former plumber, I've asked myself the same question you did: Why isn't the Fluidmaster standard equipment?

Wayne A. Self, West Palm Beach, Fla.

Here's the answer to your question about the Fluidmaster: The sanitary code of plumbing requires that the ball cock have what's called a vacuum breaker built in. This prevents water in the toilet tank from being drawn into the water lines in case of a drop in water pressure. This can be especially dangerous if toilet-bowl cleaners are used in the tank. American Standard ball cocks have vacuum breakers; the Fluidmaster does not.

Paul Saleaz, Monroe, N.Y.

Dual-purpose tower

The Spanish power tower [PS, July] is an interesting idea, but with its requirement of 11½ acres to produce 50 to 70 kilowatts, it is a terribly inefficient use of land resources. It would make more sense as an add-on cycle to conventional technologies than standing alone. For example, conventional power plants must dispose of ⅔ of the heat generated, at temperatures 40 to 70 degrees above the ambient.

We now build huge cooling towers to disperse this heat to the atmosphere, often using electricity to blow the air up the towers. By adding height to the towers, we could achieve the same effect as the power tower, with essentially the same equipment. The high differential temperature would make the process much more efficient, and we would use heat that is otherwise wasted.

James B. Newman, PE, Cherry Hill, N.J.

Correction: In "Barrel-Blade Windmill" [PS, Aug.], the text should have stated that the combined forces of the wind and the Magnus-effect lift keep the machine facing perpendicular, instead of parallel, to the wind. PS

Smokey's engine—0–60 mph in 6 seconds and 50 mpg, too

Smokey Yunick launched the little Horizon down the street from a screeching cloud of tire smoke. The speedometer jumped to 60 mph before I could get an eye on the sweep hand of my watch. Smokey said, "It's under six seconds." I firmly believed him.

After I reported on Smokey's remarkable 150-hp, two-cylinder engine [PS, April], skeptics said it was one thing to custom-build a high-performance engine from scratch, but it would be more convincing if he could change the combustion system of standard Detroit iron to get the same results. Now Smokey's done just that.

I rode in and drove Smokey's conversion of a standard 2.2-liter (134-cu.-in.) four-cylinder engine in a Plymouth Horizon provided by Chrysler Corp.

Quite honestly, that zero-to-60 run frightened me. But the rest of the ride was enjoyable. Smokey shifted to fifth gear, and we rolled along at a sedate 30 mph with the tachometer showing 900 rpm. Amazingly, there was none of the bucking you'd expect at low engine speed in fifth gear. And when Smokey tramped on the accelerator without a shift, the Horizon surged ahead smoothly. Later, when I drove the car, I was still impressed by the catapult takeoff but more surprised by the engine's smoothness even at idle.

Smokey still isn't satisfied. "We'd get a lot better than 50 mpg on the road if they'd [Chrysler] let me change the pistons and cylinder head," said Smokey. The only thing he did change was the camshaft. He also cut the Chrysler radiator in half. Reuse of normally wasted heat is the secret of both his two-cylinder and this four.

A look under the hood wasn't revealing. Smokey had cleaned up some of the plumbing he'd used with the two-cylinder engine. I could see the heat boxes around the carburetor and the homogenizer, Smokey's term for the little turbo he uses. The handcrafted aluminum manifold gleamed like a jewel. Otherwise, the engine was standard and fit the compartment perfectly.

What's the future for Smokey's combustion system? Chrysler engineers and executives had driven the car the day before. That afternoon Smokey was flying to Detroit for further discussions.—*E. F. Lindsley*

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Alternate-Energy Answers

By JAN F. KREIDER

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

More on paybacks

In the March issue, you presented a formula for figuring the economic payback of energy-saving installations. It included a universal constant of 42,000. How was that derived? Also, how can the effects of lost interest, inflation, and other factors be included in the formula?

Bernard Swan, North Sandwich, N.H.

The constant 42,000 is a conversion factor for units and is equal to one million divided by 24.

Payback period is a calculation of limited use in detailed economic analyses, but it is easy to figure and therefore enjoys wide use. The simple *payback period is defined as the time required to pay back an investment with the saving produced by that investment. For example, if an energy-saving feature of a building costs $750 and saves $100 per year, the simple payback period is 7½ years.*

The discounted *payback period is sometimes used to include the effect of interest payments. The equation is a bit more complex:*

$$Period = -\frac{log(1 - INT \times COST/SAVING)}{log\ (1\ +\ INT)}$$

In this formula, INT is the interest rate expressed as a decimal. You can calculate the required logarithms on a calculator (many are available for this) or by using the logarithm table in a math book.

In the example above, if the homeowner withdrew the $750 from a money-market fund in which it was earning eight-percent interest, then the discounted payback period is:

$$-\frac{log\ (1 - 0.08 \times 750/100)}{log\ (1 + 0.08)} = 11.9\ years$$

The greater time period is a result of the energy savings being used to pay both interest and principal on the $750 investment.

The effect of future increases in fuel prices can be included in the equation by replacing the quantity INT with the quantity (INT − INFL), in which INFL is the expected yearly rise in fuel prices (expressed as a decimal). Other versions of the payback-period equation, incorporating such factors as maintenance, property taxes, and insurance, can also be used.

Comparing glasses

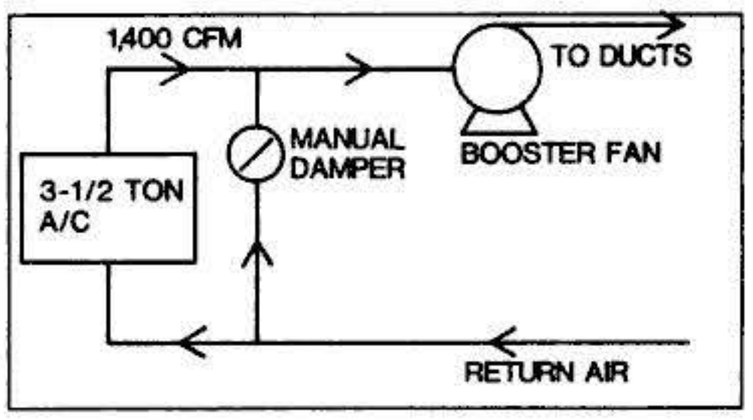
A large glass company suggested I use low-iron glass (manufactured in Europe) instead of conventional glass in my new five-acre, solar-heated, earth-sheltered greenhouse. Low-iron glass would admit more of the light spectrum—mostly in the ultraviolet range—but is it necessary? Also, is there a way I could decrease the loss of reflection from tempered glass?

Joe Sukosd, Alliance, Ohio

Low-iron glass admits six to eight percent more sunlight than ordinary window glass, but at higher cost. It is manufactured in the U.S. by AFG Industries of Kingsport, Tenn., which sells the product in standard sizes for 25 to 30 percent more than standard glass. One very effective method of reducing reflection losses is to etch the glass using a process developed by Honeywell, Inc. Unfortunately the process is currently not commercially available, to my knowledge.

Minimum airflow for A/C

I design air-conditioning-and-heating systems for an air-conditioning contractor. As people continually increase R-values, what I am seeing more and more are highly energy-conserving, 2,000-square-foot residences with 3½-ton, 1,400-cfm equipment. My concern is the lack of air movement in



relatively large structures with low cooling loads. If the cfm rating is increased to get air movement, what happens in the evaporator coil?

Edmund Wilson, Corpus Christi, Texas

Air movement is a very important part of space cooling for two reasons. First, proper air distribution requires a certain minimum velocity. Second, gentle air movement over the skin evaporates perspiration, producing a cooling effect. As cooling-machine sizes are reduced, airflow is also reduced, due to evaporator-design constraints. This causes problems in satisfying both airflow criteria. One way to solve the problem (diagram) is with a bypass duct and a small, in-duct booster fan. The fan is sized for proper airflow, and the damper is set to ensure nominal evaporator airflow.

Unit defined

They invented a new unit since I took my physics: the insulation R-value. How can I calculate heat loss with it?

Wesley Burnhart, Herington, Kan.

You are probably more familiar with heat-loss coefficients expressed in units of Btu/h/sq. ft./deg. F. That expression is termed the U-value, and R is simply its reciprocal. For example, an R-30 ceiling has a U-value of 0.033 Btu/h/sq. ft./deg. F. The R-value can also be used to find heat loss through walls and roofs. For that, you use the expression

$$Heat\ loss = (AREA/R)(T_{inside} - T_{outside})$$

As an example, let's find the heat loss through a 200-square-foot, R-20 wall when the outdoor temperature is five degrees F and the thermostat is set for 68 degrees; (200/20) (68 − 5) = 630 Btu/h.

Solar eyesore?

I really dislike festooning the very expensive landscape here in Southern California with hundreds of square feet of leak-prone and resource-intensive plumbing just to heat a swimming pool. All the manufacturers I have questioned tell me that only massive arrays of unglazed collectors are feasible for this application. Why can't fewer glazed or concentrating collectors be used?

Richard Hahn, Beverly Hills, Calif.

Unfortunately, solar energy is delivered to us in a very diffuse fashion, and because at the low temperatures needed for pool heating the unglazed collector is the most efficient type, the area requirement can't be avoided. In your climate, if a pool is covered at night and an unglazed collector with a selective surface is used, the array size need not be excessive. And if you mount the collector on a cabana or other structure, you'll avoid using any additional site area.

Circulating sunspace air

I am building a sunspace with 250 square feet of vertical windows on my deck. I want to deliver the heat collected to my house using my furnace fan. How much furnace airflow do I need when operating in the solar mode?

Fran Bergonz, Littleton, Colo.

The rule for sunspace air is six cubic feet per minute per square foot of glass—1,500 cfm in your case. If your furnace blower has sufficient capacity, you can use it to tie the sunspace into your existing system. Run a duct with a motorized damper in it to both the return- and supply-air ducts. The controls work as follows: When the sunspace temperature is above building room temperature and *there is a call for heat, the furnace fan is turned on and the sunspace damper is opened. On the other hand, if there's a call for heat but no solar heat is available, the furnace and fuel igniter come on and the sunspace damper stays closed. Depending on the setup of the existing duct, you might need a second motorized damper in the system; it would operate opposite to the sunspace damper. Consult a heating contractor for more details.*

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

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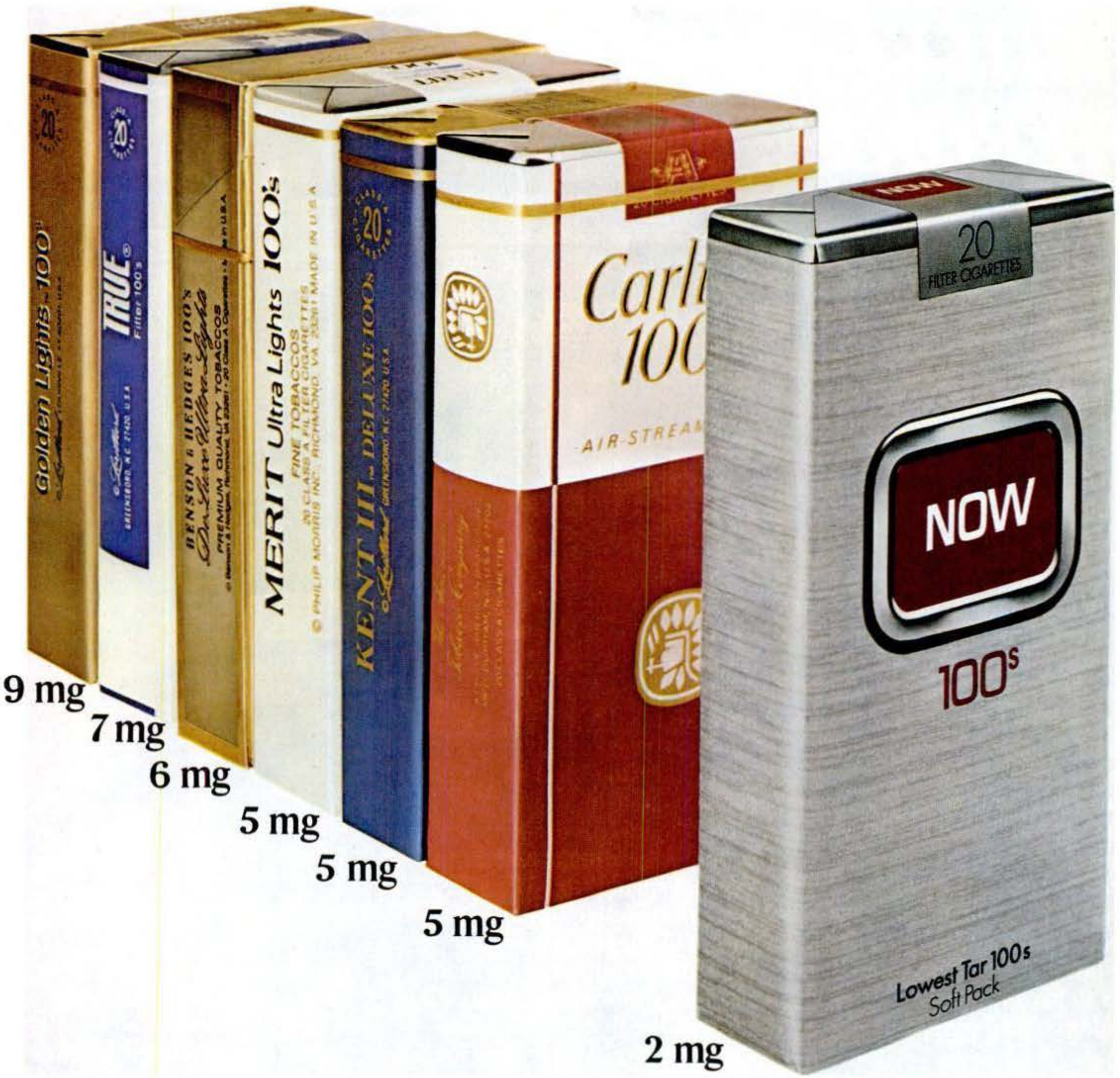

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CHEROKEE
33 '84 EST HWY / 24 '84 EPA* EST MPG

S-10 BLAZER 4X4
31 '83 EST HWY / 22 '83 EPA* EST MPG

BRONCO II
30 '84 EST HWY / 20 '84 EPA* EST MPG

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*Use figures for comparison. Your mileage may vary with speed, weather, trip length. Actual highway and CA figures lower. '84 figures for S-10 Blazer 4x4 not available at printing.

	ALL-NEW CHEROKEE	S-10 BLAZER 4X4	BRONCO II
Wheelbase Length (In.)	101.4	100.5	94.0
Ground Clearance (In.)	7.7	6.9	6.5
2-Dr and 4-Dr Availability	YES	NO	NO
Cargo Room (Ft³)	71.2	62.7	64.9
Seating Capacity	5	4	4
Uniframe Construction	YES	NO	NO
Quadra-Link Front Suspension	YES	NO	NO
Payload (pounds)	1150	1000	726
Selec-Trac 2WD/4WD Available	YES	NO	NO
Rear Window Wiper/Washer	YES	NO	NO

Jeep

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Science Newsfront

By ARTHUR FISHER

New blood analyzer

Laboratories in hospitals and other health-care facilities today are being swamped by enormous numbers of clinical chemistry tests called for by physicians. Now Eastman Kodak Co. has developed a high-volume, high-speed, programmable, fully computerized device that can analyze blood and other body fluids using 25 different tests—with dry chemistry. These 25 tests account for 85 percent of all the medical-lab analyses performed in this country.

The device, called the Ektachem 700 analyzer, is shown in the photo above, together with one of the slides—there is a different one for each test—used to perform an analysis. Only a single drop of blood is needed; the fluid is delivered uniformly by the top spreading layer to the reagent layers below where the chemical reaction takes place. Inside the device, sensitive instruments determine either the color, electrical conductivity, or reflectance of the sample to make the analysis. Incubators inside the machine keep patient samples at body temperature.

The analyzer's computer uses a Winchester hard disk and two floppy disks for a total memory of 20 megabytes (million bytes). And one of the most intriguing features of the computer is a touch-screen CRT. This allows the operator to program the analyzer for any combination of tests merely by touching the appropriate panels displayed on the screen. The analyzer can deliver more than 500 tests per hour.

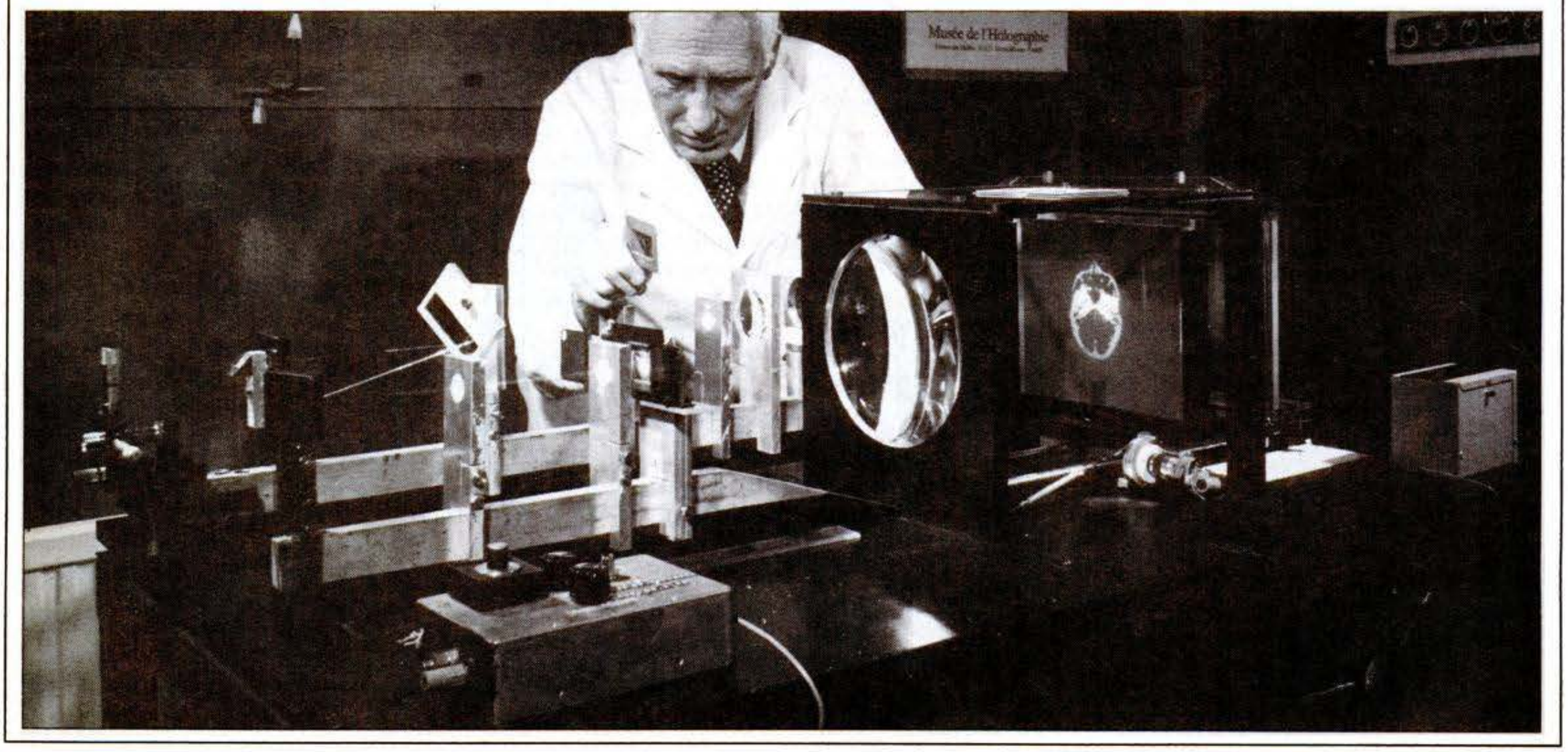
Medical photography

An ingenious use of holography—the making of three-dimensional "lensless photographs"—has been applied to medical imaging. Laurie Wright, a medical physics technician at the Royal Sussex County Hospital in England, appears below, working with a laser camera of his own design. He is assembling a hologram from a series of images made by a CAT scanner through a patient's skull. The scanners, by now ubiquitous or nearly so, operate by taking a large series of X-ray pictures, each through a slightly different plane, and then relying on a computer program to assemble the different sections into a detailed picture. The sections are called tomographs, and CAT stands for computerized axial tomography.

Wright takes a series of parallel tomographs and reintegrates them on holographic film to make a 3-D image. His camera successively projects the tomographs, in the form of 35-mm slides, through a split laser beam onto a single film. Between each exposure, the film plane is advanced by the same distance as that between the sections from the scanner. The resulting holographic image of the patient's head can be viewed when illuminated by any point source of white light and will show the location, shape, and size of a brain tumor.

This application need not, of course, be limited to medical imaging. It could be used to visualize the interiors of industrial objects, for example, by using sections from the CIT scanner PS covered recently [PS,

Continued



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Detroit Report

By JIM DUNNE

Caddy keeps V8

A V6 gasoline engine is not foreseen for Cadillac. The luxury-car division plans to keep a V8 as its premier power plant. There are reports that a smaller version of the current 251-cu.-in. eight is in the works. Primary reasons for the V8 decision are the engine's smoothness, lower operating speeds, and quietness.

More Ford front-drives

Time is running out for the rear-drive Mustang and Capri. When the 1985 model changeover occurs, the new sport coupes will have front drive and will feature inline four-cylinder and V6 power—but no V8s. A turbo version of the four, the same one used in the Thunderbird turbo coupe, will be the high-performance option. Reports indicate that the '85 coupes will be based on the Tempo/Topaz chassis, though wheelbase and track dimensions will differ slightly from those of the passenger sedans. Styling will conform to Ford's new practice, emphasizing aerodynamics in an overall wedge shape. Flush or hidden headlights that retract into the hood are planned. Ford also will make a number of other moves in its sporty-car lineup. It's likely that the Ford EXP, built on the smaller Escort chassis, will go out of production.

AMC pickup

When the XJ Jeep makes its appearance this fall, the line will consist of two models: two- and four-door utility trucks. But American Motors may not stop there. A pickup version is being developed, and it could be ready for production by 1985. "We're not committed to it yet," says AMC vice-president Dale Dawkins, "but it makes sense to have a pickup, just as we have in the present Wagoneer." Another surprise from Jeep: the popularity of the Wagoneer series.

The Beetle lives

At least one of the Beetle's major design aspects might. VW is working on an updated version of the "pancake" four-cylinder engine originally used in the bug. The light-alloy block and head formed an unusual opposed-four layout, which today is seen only in the Subaru line and the Volkswagen bus. Plans for the future of this engine, now built in a water-cooled version, call for installation in a 1986 model—probably the Quantum. It would be mounted ahead of the front axle, where its low profile and light weight (80 pounds less than the Rabbit's in-line four) would be used to full advantage. VW figures that hood lines could be dropped (for better aerodynamics) and chassis balance enhanced. The displacement is projected at 1.9 liters (116 cu. in.), which would make it larger than most economy-car engines.

Auto plastics in the U.S.

At present, the average new car is 12 to 15 percent plastic by weight, and this will increase in the future as problems with the lightweight material are solved. The expanded use of plastic will be mostly in body panels such as those on Fiero and Corvette. Structurally loaded parts and engine components will follow. In addition to its light weight and corrosion resistance, plastic can be formed into more-elaborate shapes than sheet metal. Also, parts are easier to form. Problems with plastic include difficulty in getting smooth, even surfaces; adequate strength and stiffness; and longer fabrication time. General Motors is confident the problems can be overcome because, relative to steel fabrication, plastics technology is in its infancy.

Lightweight trucks

Since the time of the first motorized wagons, cargo haulers have been designed along one theme: Build them strong, powerful, and tough, and don't worry about weight. But the practice will change in 1986 when General Motors introduces a new light (½ to one ton) truck for Chevrolet and GMC lines. Lightweight materials—high-strength steel, aluminum, and structural plastic—are being considered as substitutes for the mild steel presently used. GM believes that a couple of hundred pounds in weight savings will be a big selling point. But the weight reduction is not being done specifically for increased fuel economy, because it would mean only a mile or two per gallon. The trucks will be able to carry bigger loads and get along with smaller engines. Some of the possible sites for the substitution of plastic include the hood, tailgate, and possibly the springs. The frame will probably be aluminum or high-strength steel.

Beijing Jeep

American Motors' agreement to build Jeeps in China will not result in an invasion of these products into the U.S. in the forseeable future. First-market targets are China and neighboring Indonesian countries. The plan is to modernize an existing plant at Beijing (old Peking), where the four-wheel-drive vehicles are now being built. Later, AMC and the Chinese firm—Beijing Automotive Works—will plan and develop a modern Jeep. The new vehicle will be similar to the new CJ lines that AMC is readying for introduction in the U.S. within two years. AMC will supply its 2.5-liter (151-cu.-in.) four-cylinder engine for the Beijing Jeep, but wherever else possible, Chinese components will be used. What's the underlying reason for the AMC-China hookup? In the U.S., labor costs are more than $16 per hour; in Japan they're about $6. The labor rate in China? About 60 cents.

Cars tell age

What type of car you drive might reveal your age. Youngest buyers (those under 30) are the ones that makers like best. That's because research reveals that buyers tend to stick with a brand for a long time. Younger buyers could mean years of repeat business.

It's obvious that youth likes sporty cars. Among models that attract the under-30 crowd are EXP, 024, Prelude, 200SX, Challenger, Capri, RX-7, Le Car, and Firebird.

But as buyers get older, choices change, and bigger, more-comfortable sedans become favorites. Among the oldest group of purchasers are the Lincoln and Cadillac buyers, who have a median age of 60 years. The ages of buyers for other top-selling models sort out this way: Escort, 37; Caprice, 58; Olds 88 gas, 57 (88 diesel buyers are two years younger); Grand Prix, 37; Corvette, 36.

Bent on quality

A time-proven way to make big money in the auto industry is to bend metal: Take a blank and turn it into a form that can be used to build a car. It's surprising that after 60 years in the business, General Motors is still discovering secrets for metal bending that promise better quality in its cars. Problems with sidewall curl and sidewall opening, caused by metal springback, are more severe in the high-strength steel GM is now using. The steel acts like a piece of cardboard that you bend to a right angle. Let go, and the cardboard springs back toward its original shape. GM is finding that the speed of bending, and bending particular sections of the metal first, have a lot to do with the metal keeping its shape after it comes out of the die.

U.S. mini-compact

General Motors hasn't given up plans to build its own mini-compact in the U.S., despite agreements with Toyota, Isuzu, and Suzuki to sell their models through GM dealers. All of GM's divisions were told to come up with their best new designs for a lightweight, cheap-to-build small car that will be as nice to drive as the Japanese types. According to the timetable, the car could be built no sooner than 1988. Among the goodies being considered are a three-cylinder aluminum engine, plastic structural parts for the chassis, and plastic body parts. GM feels that it can match or better what is built overseas, but the overriding problem remains: getting a car into a showroom at the same cost as imports. ■

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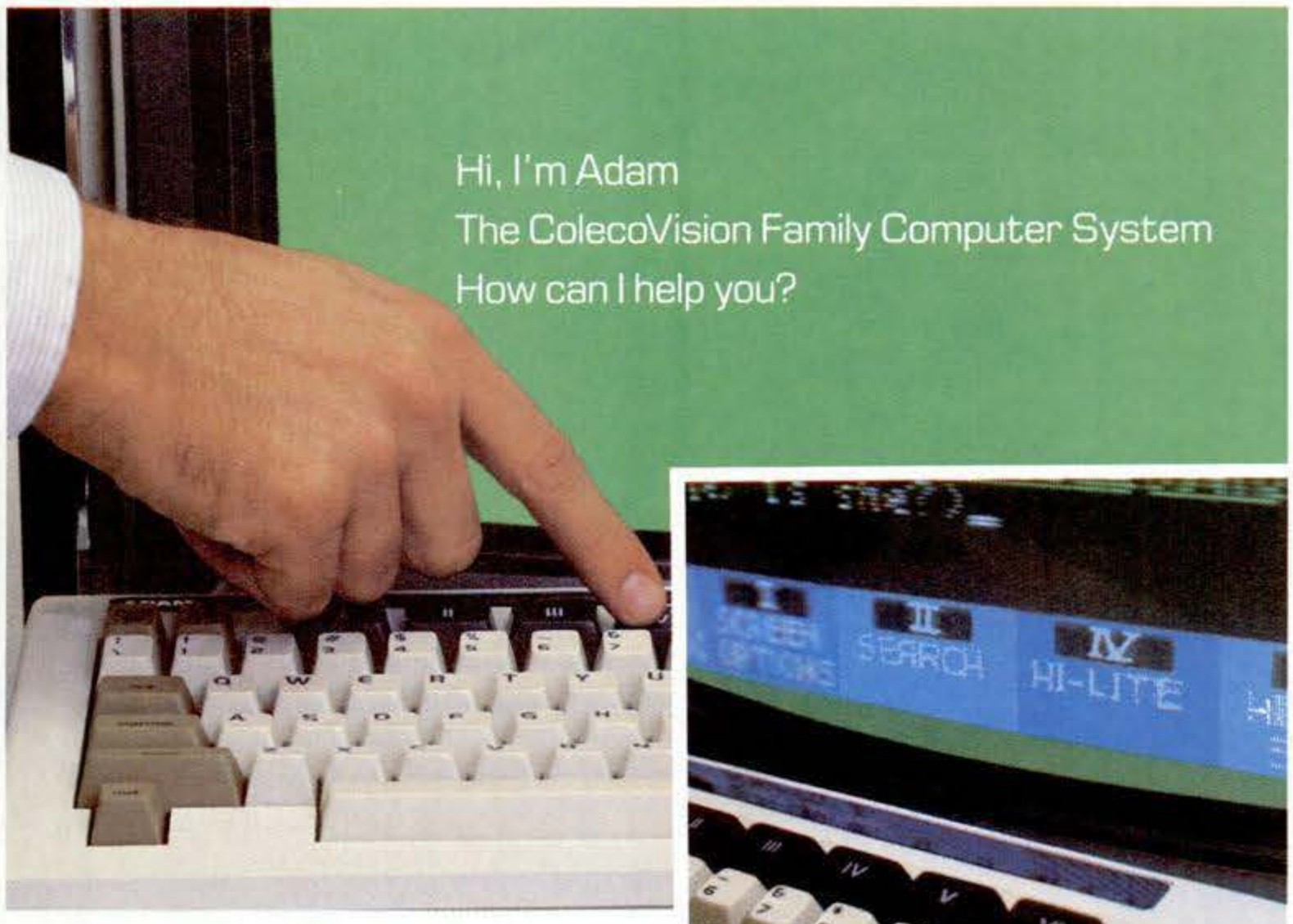

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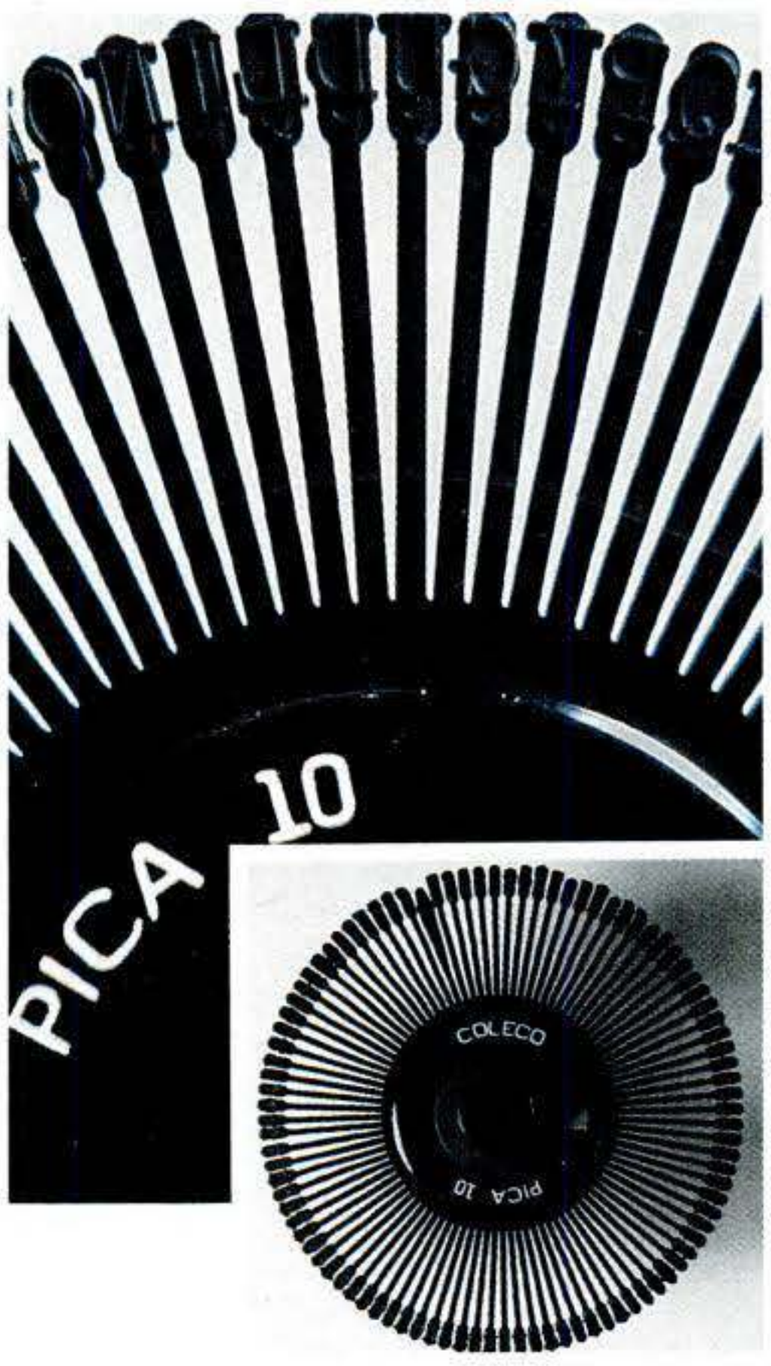

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COMPARE*	The retail price for ADAM™ the ColecoVision™ Family Computer System is the **total price** for the whole system.				With all other computer companies the base price is just the beginning.
ADAM ColecoVision FAMILY COMPUTER SYSTEM	TEXAS INSTRUMENTS 99/4A	COMMODORE 64	ATARI® 800	APPLE® IIe	IBM® PERSONAL COMPUTER
Console with 80K RAM	Console with 16K RAM	Console with 64K RAM	Console with 48K RAM	Console with 64K RAM	Console with 64K RAM
INCLUDED: Mass memory storage drive with FASTRANSFER™ circuitry **INCLUDED:** SMARTWRITER™ word processing built in **INCLUDED:** "Letter-quality" daisy-wheel printer **INCLUDED:** 2 joystick game cursor controllers with built-in numeric key pads **INCLUDED:** Coleco's SMARTBASIC™ program **INCLUDED:** The Official BUCK ROGERS™ PLANET OF ZOOM™ arcade-quality video game	**EXTRA:** Expansion/interface box **EXTRA:** Extra Ram **EXTRA:** Printer interface **EXTRA:** Printer cable **EXTRA:** Daisy-wheel printer **EXTRA:** Mass memory drive **EXTRA:** Joysticks (pair) **EXTRA:** Mfg's. word processing software **EXTRA:** Hit arcade game	**EXTRA:** Printer interface **EXTRA:** Printer cable **EXTRA:** Daisy-wheel printer **EXTRA:** Mass memory drive **EXTRA:** Joysticks (pair) **EXTRA:** Mfg's. word processing software **EXTRA:** Hit arcade game	**EXTRA:** Letter quality printer **EXTRA:** Mass memory drive **EXTRA:** Joysticks (pair) **EXTRA:** Mfg's. word processing software **EXTRA:** Hit arcade game	**EXTRA:** Printer interface **EXTRA:** Printer cable **EXTRA:** Daisy-wheel printer **EXTRA:** Mass memory drive **EXTRA:** Joysticks (pair) **EXTRA:** Mfg's. word processing software **EXTRA:** Hit arcade game	**EXTRA:** Printer interface **EXTRA:** Printer cable **EXTRA:** Daisy-wheel printer **EXTRA:** Mass memory drive **EXTRA:** Joysticks (pair) **EXTRA:** Mfg's. word processing software **EXTRA:** Hit arcade game **EXTRA:** BASIC programming language

*Comparison information obtained by survey taken August 29, 1983.

For what most companies charge for a daisy wheel printer alone, Adam gives you an 80K computer, a word processor, a printer, a memory drive, a detachable professional quality keyboard, and a super game system. All in one package. Ready to use. The most incredible price/value package ever. Use the chart above when you go to buy Adam to compare what you'd have to spend for this package with any ordinary home computer.

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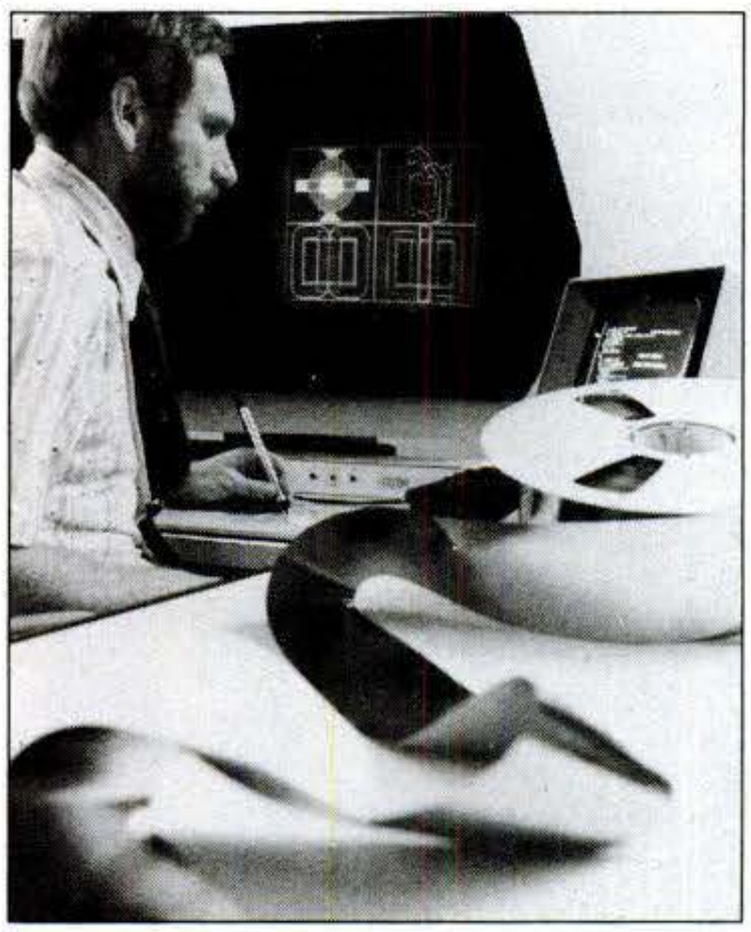
Sept.]. And Wright has even used his laser camera to make a three-dimensional image of an exploding nebula for an astronomer. His system is currently being evaluated by other scientific and medical experts.

Split seconds

Atomic clocks carried by satellites, sophisticated techniques, and time transfer receivers (TTRs) developed by the Naval Research Laboratory and the National Bureau of Standards now make it possible to synchronize the time worldwide with an accuracy of 50 nanoseconds (billionths of a second). But that impressive feat has been bettered by a prototype TTR capable of an accuracy of just 10 nanoseconds. The new receiver is being developed for the NAVSTAR Global Positioning System, a network of navigation satellites to be deployed in the late 1980s.

More about Metglas

The amorphous-metal material PS has written about recently [PS, Dec. '82] is making more news. General Electric has announced a $6.6 million program, cofunded through the Electric Power Research Institute and the Empire State Electric Energy Research Corp., to accelerate the development of transformers with cores made of the new material, which has remarkable electrical and other properties. The aim is to reduce core losses by 70 percent and thus save about $600 million a



year in the U.S. energy bill. Allied Corp. is supplying 100 tons of its Metglas amorphous-metal ribbon for the project.

In the photo above, a specialist in computer-aided design is evaluating one of the candidates for a transformer-core configuration, seen in various aspects in the background. A spool of the Metglas ribbon appears in the foreground.

And from Sandia National Laboratories in Albuquerque, N.M., another application stemming from amorphous metal's unusual capabilities: Physicists there have designed and successfully tested the world's largest and most powerful magnetic switch, which can routinely handle four million volts at

one million amperes. (It may be used in the lab's Particle Beam Fusion Accelerator-II, scheduled to start operating in 1986.) The six-foot-diameter switch has 8,200 turns of Metglas ribbon.

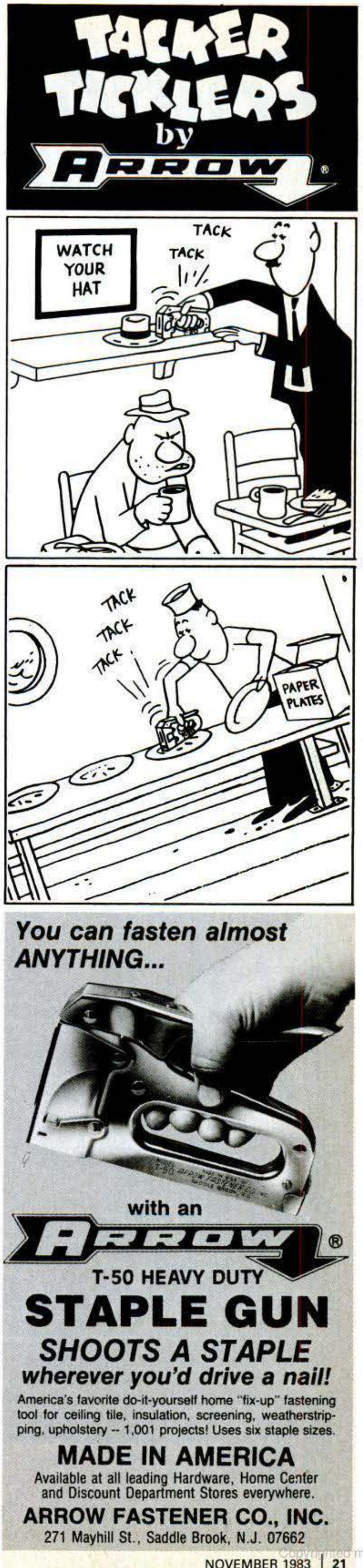
The key property of the glasslike, iron-based alloy—at least for these two applications—is its ease of magnetization, with low energy losses as a result.

Paralysis preventer

The Hines Cervical Splint, seen above in a training exercise, was invented by British physician Ken Hines after he had seen too many accidents in which paralysis was caused by secondary damage to the spinal cord when the victim with a neck injury was moved. It immobilizes the patient in the position he is initially found; the splint is strong enough to support the head and neck and flexible enough to conform to the patient's body. The padded chin support is put on first, then the flexible back section. The splint is transparent to X-rays, so it need not be removed prior to diagnosis of the injury. Dr. Hines is a member of the British Association for Immediate Care Schemes (BASICS), which pioneered on-site medical treatment for victims of road, sports, and industrial accidents to prevent secondary injury and shock. The splint is now being manufactured in England.

No rings for Neptune

Last June 15, Neptune swept in front of a star, masking it from Earth—an event called occultation. If the giant gaseous planet had a ring or rings—akin to its sisters, Jupiter, Saturn, and Uranus—occultation should have revealed them. So astronomers from the University of Arizona went to Guam, Taiwan, Australia, and Tasmania to watch. The result, says William Hubbard of the UA Lunar and Planetary Laboratory, was negative: "This essentially rules out all rings down to the planet's surface." (Although one as tenuous as the ring around Jupiter might be able to escape detection during occultation.) PS



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Folded fluorescents

The newest fluorescents look tiny compared with the familiar bulky tubes. But the new compact devices are as bright and energy-efficient as their predecessors, thanks to rare-earth phosphors and clever cooling designs. Twisted into space-saving shapes, the low-energy lamps can do jobs formerly restricted to incandescents. The folded fluorescents, first developed in Europe and Japan, will soon be available here. At the same time, GE is introducing an advanced, energy-saving bulb that is not a fluorescent but uses metal-halide technology.

By DAVID SCOTT and SUSAN RENNER-SMITH

Fifty years ago, fluorescent tubes were revolutionary. Instead of heating a coiled filament, fluorescents produce light by striking an arc through low-pressure mercury vapor. An inner phosphor coating converts the resulting UV radiation to visible light. This complex cycle consumes far less energy than incandescents with the same light output, and the lamps last many times longer.

The disadvantage: The original long, straight tubes with their external starters and bulky, current-stabilizing ballast, were generally suitable only for ceiling installations.

In recent years, advances in fluorescent technology have produced smaller fluorescents—such as the GE Circlites

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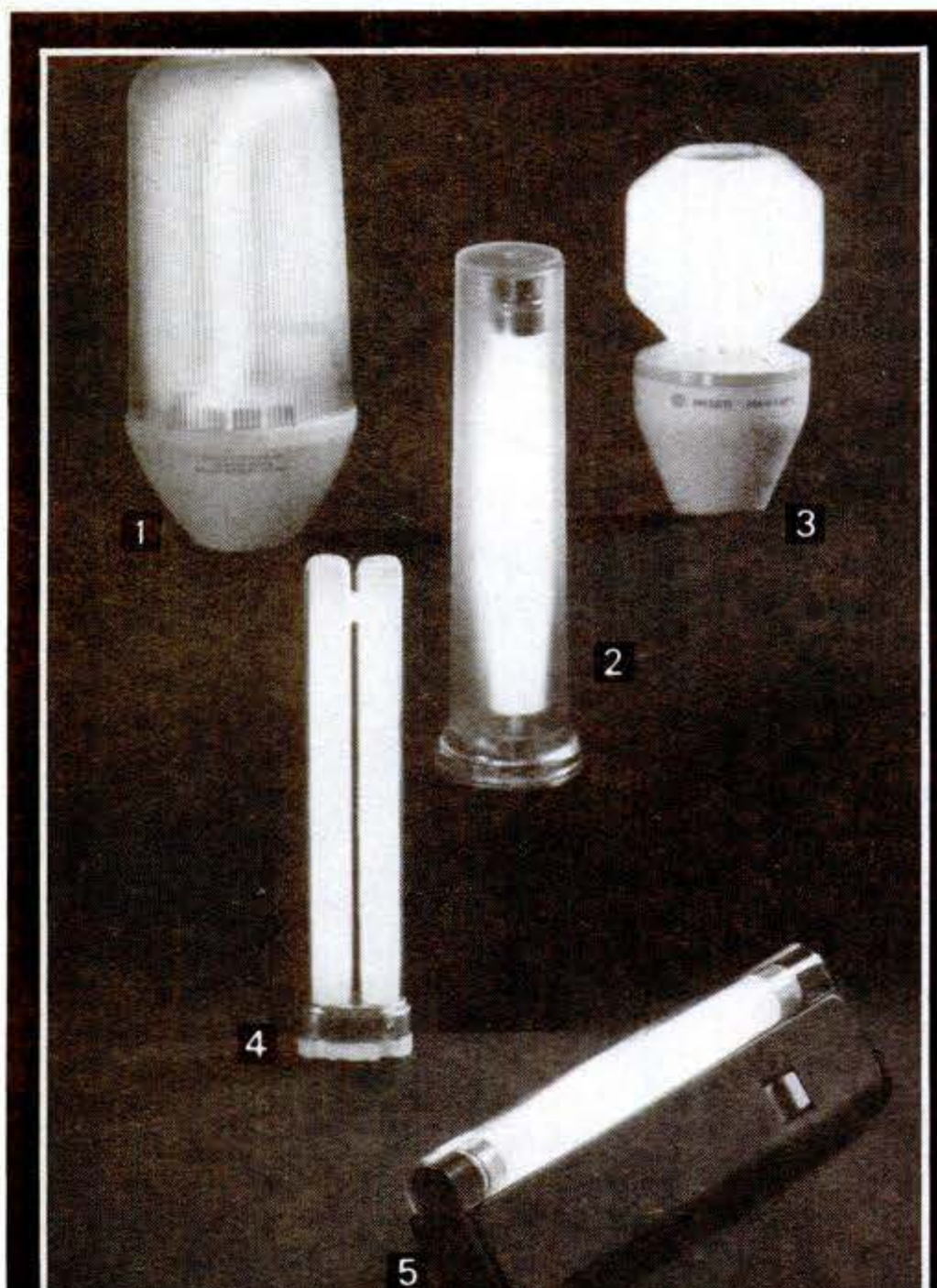

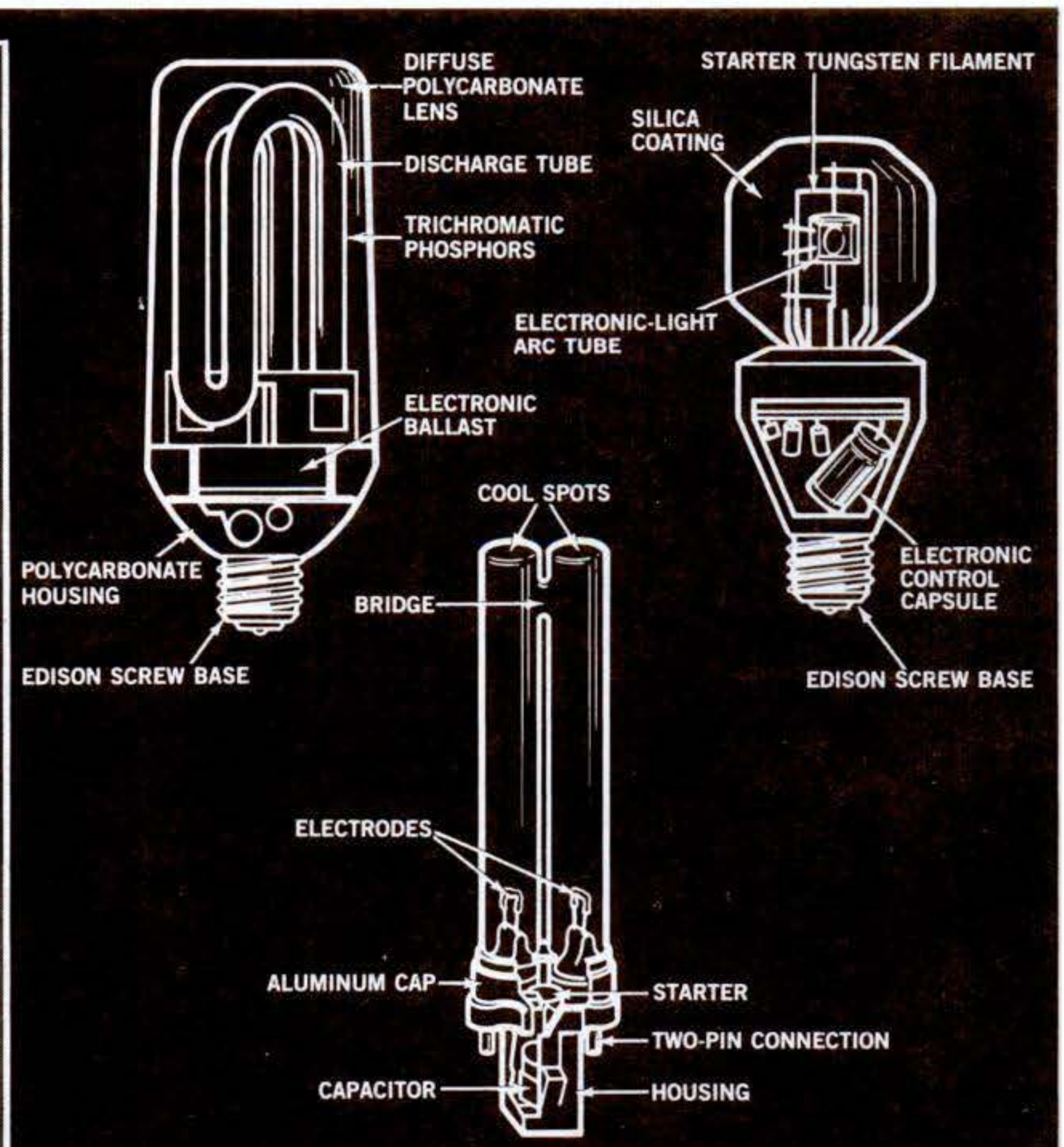

Standard six-in.-long fluorescent tube, used in the Zelco Industries battery-powered "Shirt-Pocket Lantern" (5) and waterproof Lumifier light stick (2), is rated at four watts and produces about as much light as a 25-W incandescent bulb. By contrast, Norelco's twin-tube, nine-W PL 9 lamp (4) is just five in. long but has a light output similar to a 60-W incandescent's. The lamp's two ½-in. tubes are joined by a hollow bridge to provide the necessary cool spot for mercury-vapor condensation (see text). The lamp has a built-in starter (diagram right) with a separate, compact ballast unit. Norelco's six-in.-long SL 18 (1) has the light output of a 75-watt bulb. The fluorescent tube is double-looped like a wire curtain hook (diagram). Starter and electronic ballast are built into the base, making it self-contained though a bit bulky—too big for the harps in some lamps. The GE metal-halide Miser Maxi-Light (3) uses no phosphors, but it has a small incandescent filament (diagram) that lights immediately; it dims after 30 seconds when the light arc brightens. Maxi-Light is short enough to fit most fixtures, but the lamp has to be used base down.

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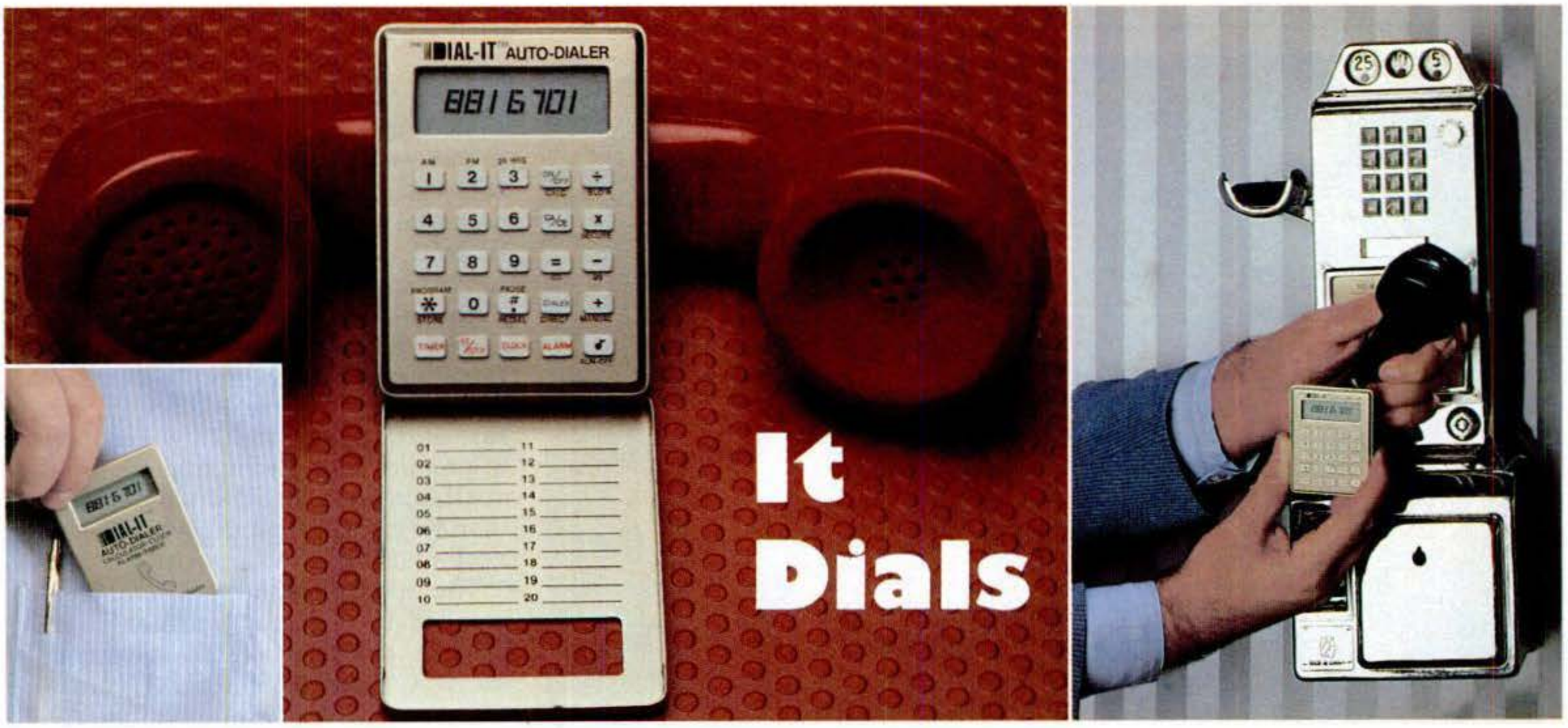


Tone Talking Memory Dialer

Just hold the new Dial-It™ automatic dialer up to the mouthpiece of your telephone, and you can dial 100 phone numbers and save money and time by using MCI, SPRINT and more.

It's a dialer. It fits in your shirt pocket and it automatically dials phone numbers for you. Just hold it up to your phone, and you'll dial numbers at home, at the office or on the road.

Now you can use SPRINT and MCI without having to dial and memorize complicated numbers. And, speaking of memorizing, this dialer will memorize 100 numbers, each up to 32 digits long.

SUPER SMART

It's also an alarm, a stopwatch and a calculator, but it's the automatic dialing breakthrough that makes Dial-It™ unique.

It's only about the size of a credit card, but it's got more power than most desk size dialers. And, here's how it works.

To store a number in memory, just push 'store', pick a storage number, and dial the number on the keypad. You'll see the number on the extra large LCD display for error-free entry.

If the number is correct, just push store again and the number is permanently stored. And speaking of permanent, the batteries last a year and can be changed **without** losing the memory.

Here's a really neat feature. If you use MCI or SPRINT, you only have to key in your code number once. Then each time you want to store a number with your MCI or SPRINT code in front of it, you simply push the special code button.

Now you won't have to redial long complicated codes to store each new number in memory. Plus, you can dial a long distance number that's not in memory by using this button to give your codes first. Then use the Dial-It™ to dial the number.

If you require a pause to get an outside line or to wait for a computer, just push a button. If your phone company can't accept high speed tones, push 'slow' and the Dial-It™ will slow down.

If you reach a busy number, no problem. Just push last number redial.

If your Phone Company can't accept tones at all (most do even if you still have a dial phone), then you can only use the Dial-It™ if you use MCI or SPRINT. So, now you can save big, even if you don't already have Touch Tone® service.

KEEP PRIVATE NUMBERS PRIVATE

You won't have to worry about forgetting your SPRINT or MCI codes once you've stored them in the Dial-It™.

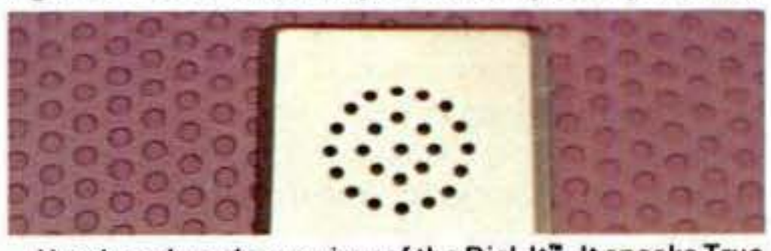
And, nobody can get at your secret codes, because it won't display them. So, even if you lend it to a friend, your codes are safe from prying eyes.

And, if you lose it, all your numbers are protected as well. You program in your own security code using your birthday or other special number. Without your code, Dial-It™ won't work at all.

EASY TO USE

Now your little black book can go where you go. You can dial in True Tone from home, from the office, from a hotel room or a pay phone. You won't have to remember phone numbers ever again.

Just flip open its cover as shown above, touch 2 buttons and put the Dial-It™ against the mouthpiece of your phone.



Here's a phone's eye view of the Dial-It™. It speaks True Tone to the phone company through your phone's mouthpiece. You can use it to dial manually or you can automatically dial 100 of your most important phone numbers.

You'll be amazed at the speed and ease of this shirt pocket dialer. In addition to MCI and SPRINT, it works for credit card calls and phone banking.

The Dial-It™ comes with a pressure sensitive index label that fits in its case for your 20 most frequently called numbers. Plus, the Dial-It™ and a master directory fit in its protective leatherette case.

It's made by Dictograph, a company that's been a pioneer in dialing equipment. It's backed by a limited warranty.

AND, LOTS MORE TOO

It's just you and your Dial-It™. Don't worry about morning wake up calls because there's a 24 hour alarm.

Don't worry about exorbitant phone bills because there's a built-in stopwatch to keep track of your calls.

And, don't worry about dialing wrong numbers because it never pushes the wrong button.

Now, all your phone work becomes easy. You can concentrate on the conversation, not the mechanics of dialing.

And, you can use the full featured calculator to add up just how much you save in time and aggravation with this revolutionary shirt pocket dialer.

TRY THE DIAL-IT™ RISK FREE

Dial some numbers automatically. See how fast and easy it is. Whether you dial across town, across the country or around the world, you'll have 100 memories, each with 32 digits, to make life easier.

Slip the Dial-It™ in your pocket for a risk free test. If you're not 100% satisfied, simply return it in its original box within 30 days for a courteous refund.

To order Dictograph's revolutionary new Dial-It™ 100 number dialer risk free with your credit card, call toll free or send your check for, and look at this, just **$59** plus **$3** for postage and handling. Order No. 9728. CA res add 6% tax.

Forget phone drudgery. **Now, just one dialer** does it all. Now your dialer, not just your phone book, goes where you go.

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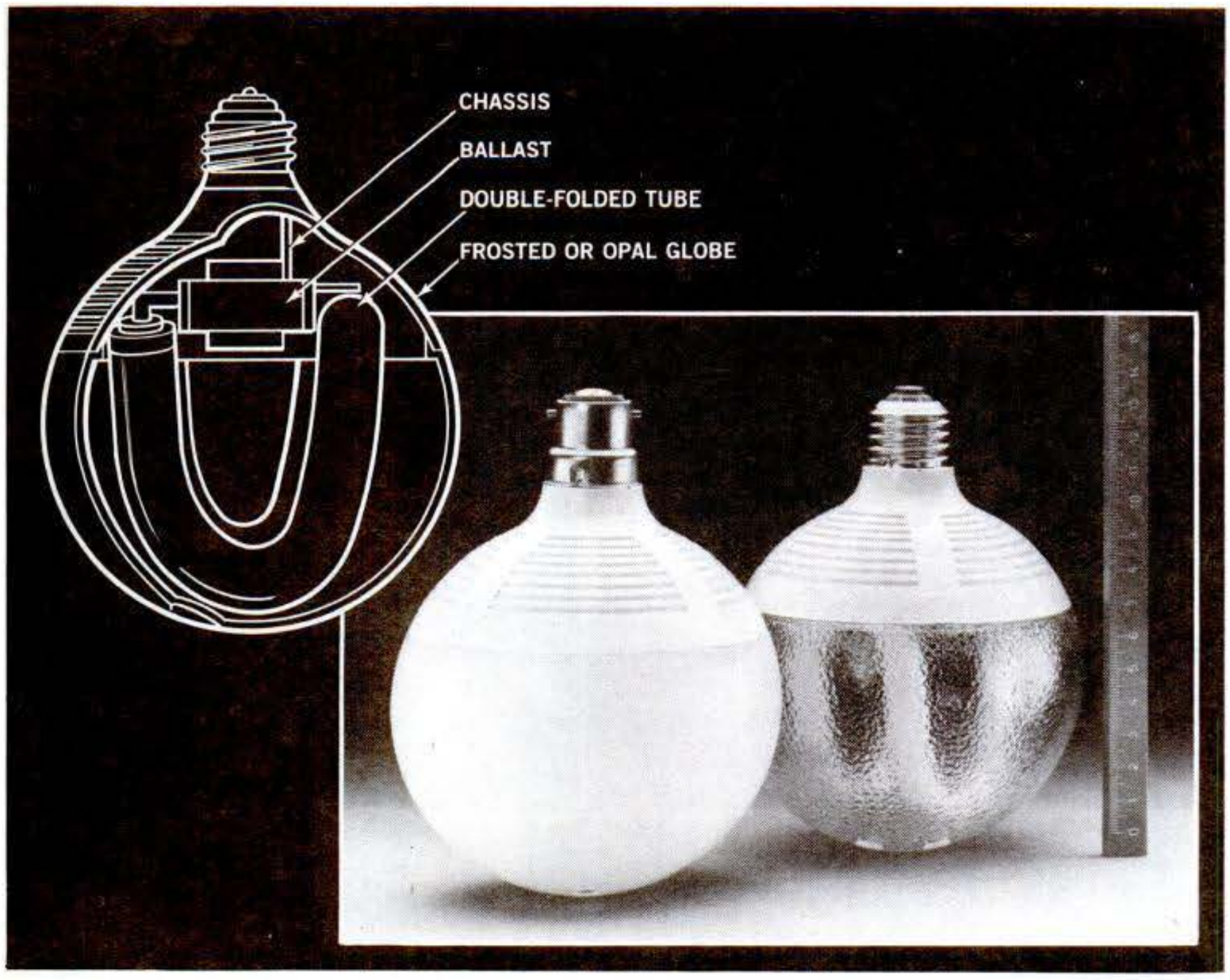
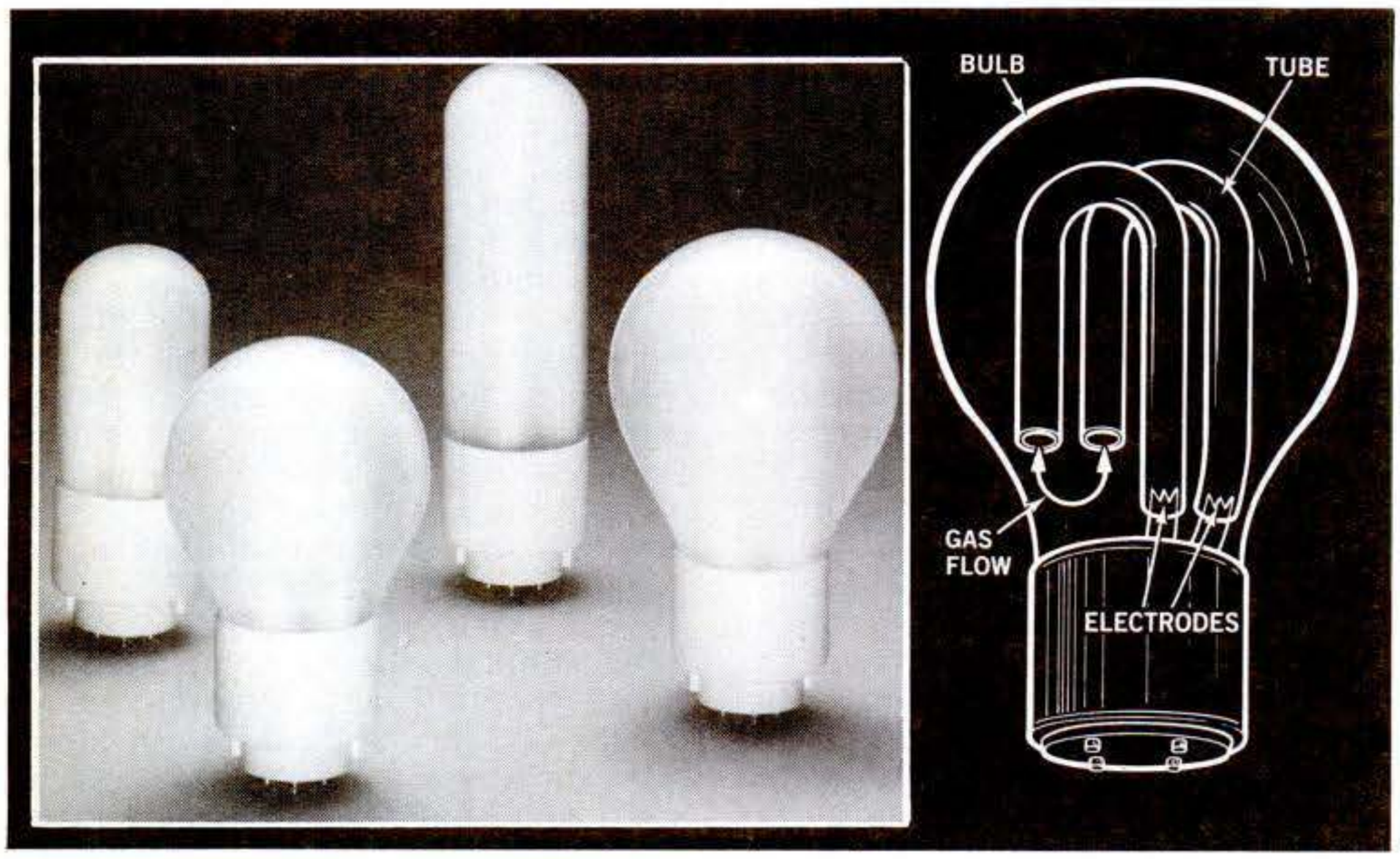
Folded fluorescents



Toshiba Neo-ball has an integral starter and ballast plus a screw base. The 16-W tube is double-folded for a long discharge path and enclosed by a 4.4-in.-dia. sealed plastic globe. Cooling vents at top keep the inner tube near optimum temperature for mercury-vapor condensation. Life rating is 6,000 hours, and it uses one-quarter the power of an incandescent, the manufacturer says.



World's first bulb-shaped fluorescents (above), the Osram Centralux 12- and 16-W lamps have twin U-bend tubes in an evacuated envelope. Gas discharge passes between open tube ends, permitting mercury to condense on cool outer glass for peak luminous efficiency. The four-pin bayonet base takes a special socket, with external wiring to the ballast and electronic starter. The slotted base of Osram Circolux (left) ventilates the electronic ballast housed in the crossbar. The ballast has a microchip circuit that boosts the standard European 50-Hz line frequency to 30 kHz. This gives 12 percent more lumens and at the same time cuts ballast power draw to 1.5 W from the usual seven. The 6.6-in.-dia. lamp gives five times the light output of 18-W bulbs.

[PS, Sept. '80]—that fit most standard table lamps. And now European and Japanese makers have shrunk the tubes still further in both length and diameter. The new skinny tubes can be bent into various compact shapes to replace conventional incandescent bulbs in desk, floor, and wall lamps.

How did engineers shrink the fluorescent tube? According to Norelco's Bill Lally, "We use high-efficiency, rare-earth phosphors. They enable us to produce more light from the area available in a small-diameter tube than we can get from the less efficient, 'cool' phosphors in larger tubes."

The new phosphors can also be blended to produce "warmer" light more suitable for homes. And electronics have replaced the bulky control gear, greatly reducing its size, weight, and power drain. Finally, clever engineering has solved new problems created by the compact design.

To ensure a long discharge path within the confines of a small space, the new compacts use folded or specially contoured tubes. But such high-density configurations can create a cooling problem that could reduce luminous efficiency. That efficiency depends on the pressure of the mercury vapor, which must be kept very low.

The vapor pressure in turn depends on the temperature of a cooling zone on the glass wall where some of the mercury condenses. For peak efficiency, the glass temperature must be around 40 degrees C (104 F). When it's much above this critical point, light output drops sharply.

To keep vapor pressure down in the new compacts, lighting engineers created cooling zones by means of cleverly designed tube joints and bends.

The resulting energy-efficient lamps are pleasant to live with yet use only about one-quarter of the electricity of incandescents with the same output. Philips in Holland was the first to produce the new fluorescents, followed by Britain's Thorn EMI, Osram in Germany, and Japan's Toshiba. All but Osram lamps should soon be available here in the United States.

What about U.S. makers? Duro-Test is working on a high-efficiency incandescent bulb [PS, April '82]. And GE is now test-marketing the Miser Maxi-Light, an energy-efficient metal-halide lamp that's a miniature version of the bright lamps used to light stadiums. (Sylvania has a metal-halide lamp under development.)

"We leapfrogged fluorescents for a more advanced technology," said GE's Nancy Christensen. "We wanted something that would deliver more light for fine-detail work."

Continued

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$89 CLOSE-OUT

Sound Detonator Plus

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

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

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

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

CAN YOUR STEREO SOUND BETTER?

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

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

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

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

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

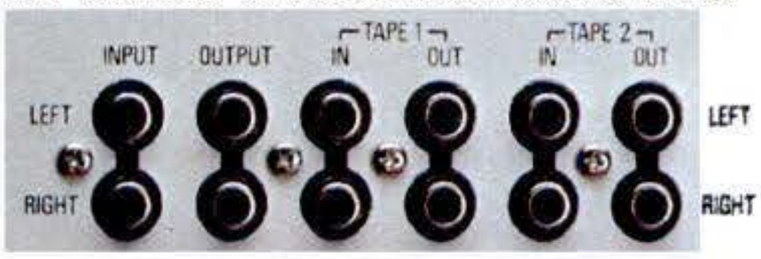
You can boost the mid-range and highs at 1,000hz, 2,000hz, 4,000hz, 8,000hz and 16,000hz. So, you can bring crashing cymbals to life at 16,000hz while at the same time you cut tape hiss or annoying record scratches at 8000hz.

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

GREAT FOR 2 TAPE DECKS

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

Now you can get all the dramatically enhanced sound wherever you are. This is an especially great feature for bass starved portables and high-end starved car stereos to make them come alive.



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

EASY HOOK UP

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

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

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

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

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

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

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

WHY A CLOSE-OUT?

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

Well, as Detroit comes out with new cars each year, ADC comes out with new equalizers. We got them to supply us with just 15,000 of last year's model before they shut down for the new one.

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

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

THE FINAL FACTS

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

There are separate sound detonation slide controls for each channel at 31hz, 62hz, 125hz, 250hz, 500hz, 1,000hz, 2000hz, 4000hz, 8000hz, and 16,000hz.

LED VU meters with ±0.5db accuracy show levels for each channel. It is 17" wide, 6½" deep and 4½" tall.

PUT LIFE INTO YOUR MUSIC RISK FREE

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

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

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

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

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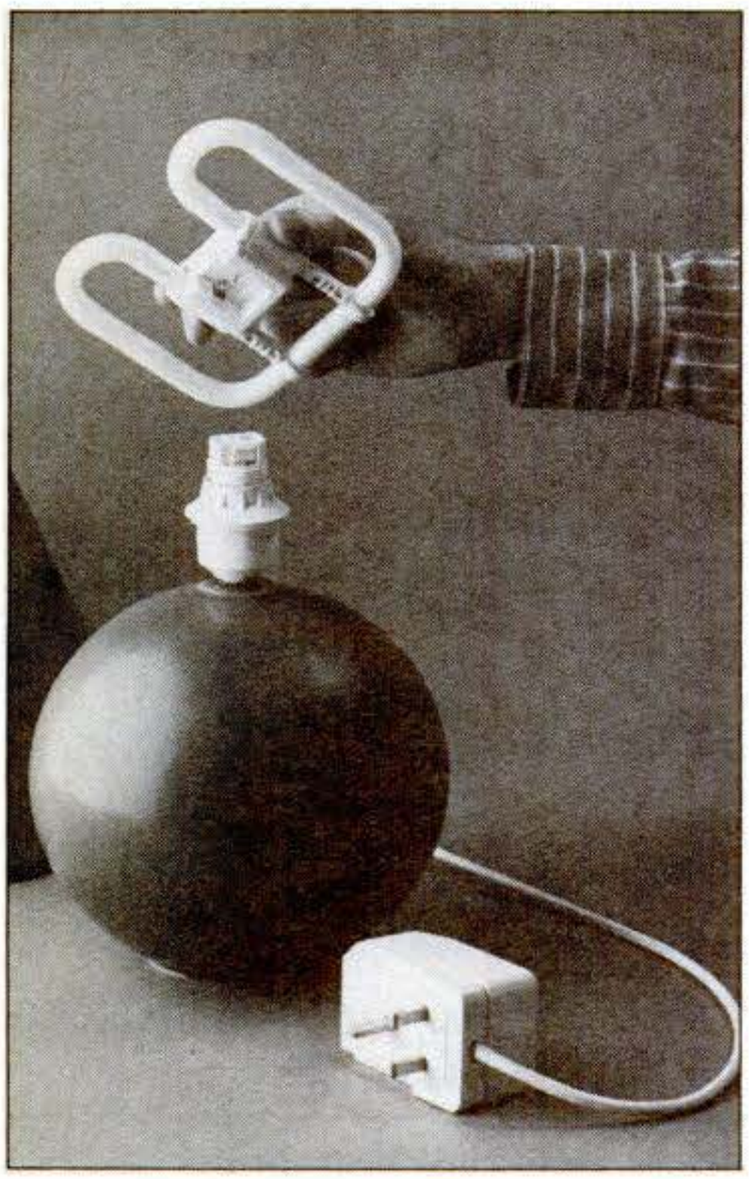
Folded fluorescents

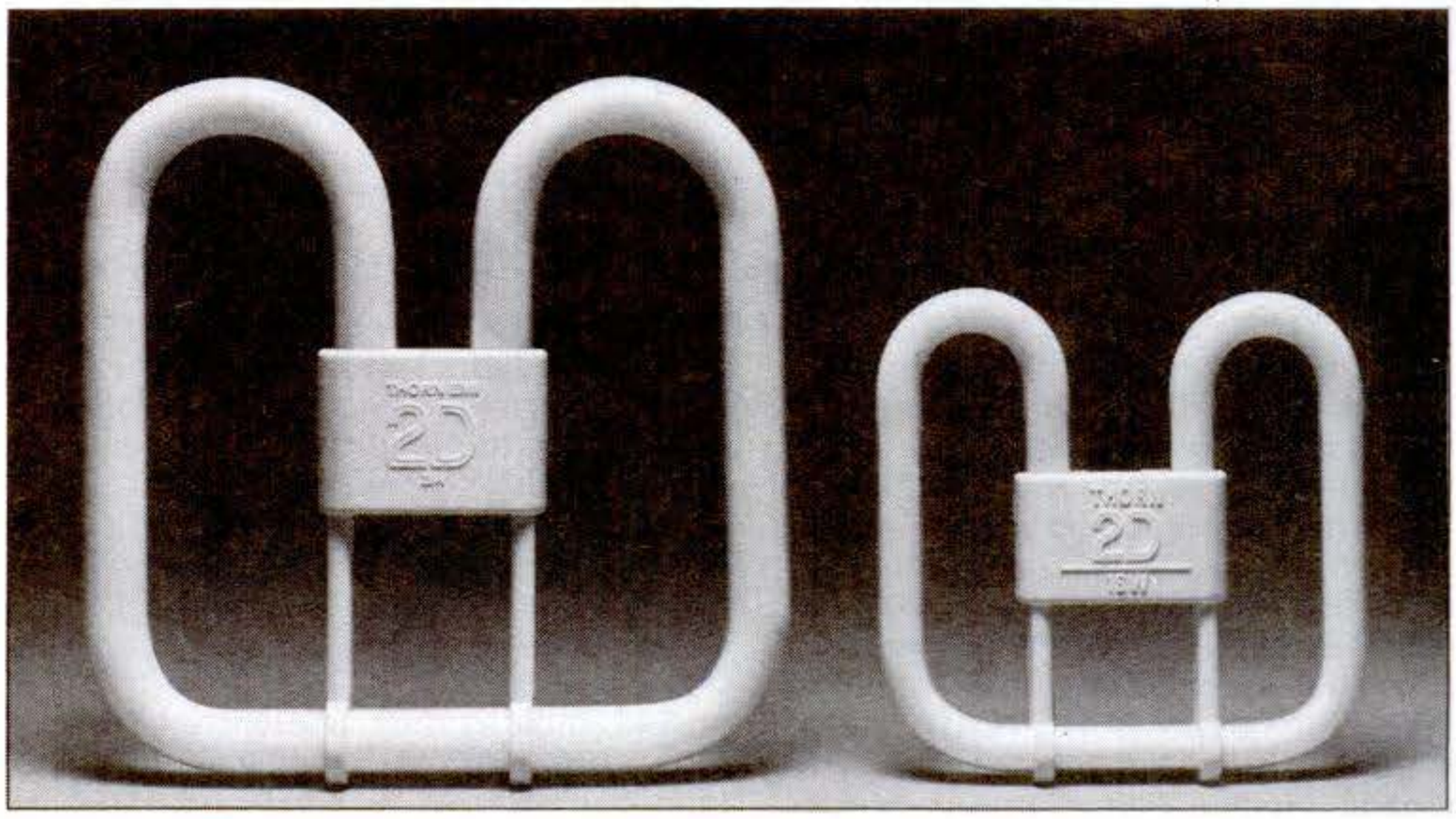


Like the new fluorescents, the GE lamp has compact electronic circuitry that produces light via an arc discharge. But the arc, struck through ionized metal vapors inside a quartz tube, is the major light source—there are no phosphors.

The resulting light has a color quality similar to incandescents'. The 55-watt Maxi-Light produces 2,250 lumens—about as much as a 150-watt incandescent bulb. At 40.3 lumens per watt, that's not quite as efficient as the Norelco SL 18, the highest-wattage compact fluorescent available here so far. It produces 61.1 lumens per watt—about as much light as a 75-watt incandescent.

The $10 GE lamp lasts 5,000 hours, compared with the ordinary 1,200-hour, 150-watt, three-way bulb it's designed to replace. Norelco's $25 SL 18 has a 7,500-hour lifetime, 10 times longer than a 75-watt bulb's.

There are other trade-offs between Norelco and GE lamps (see captions). But so far, no folded fluorescent designed to operate on 110 volts comes close to matching the output of the GE metal-halide lamp. PS



Double-folded Thorn EMI 2D lamp has a starter in the center with a two-pin base. The ballast is integrated into an oversize wall plug (above) designed for Britain's 240-volt current. On European current, the 16-W lamp (far right) gives nearly the light of a 100-W incandescent and lasts 5,000 hours, Thorn EMI claims. The large, eight-in.-square tube (near right) produces 2,050 lumens.

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Finally, the rebates. You don't have to wait till Nov. 11th, the money's right here. For the first time ever, a $10 to $20 rebate on Celestron's precision binoculars — including zoom, armoured and waterproof models and the NOVA and GIANT series. Plus a chance at every participating dealership to win a pair of Celestron 8 x 21 binoculars. Mark your calendar. And call our toll-free number.

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Audiophile Mood Maker?

Set the mood in your home or office with this bi-amplified, cassette, AM/FM stereo receiver with an electronic crossover that thinks it's audiophile equipment. 4 amps separately drive each woofer and each tweeter for superb sound detail. Price Slashed to $168.

It's bi-amplified. There are right and left channels of course. But, in bi-amplification, each woofer and each tweeter is separately amplified and separately controlled, for incredibly pure, transparent sound.

Most bi-amplified systems sell for over $5000. And frankly, that's why DAK was able to get this $289 suggested retail, $183 wholesale dealer cost, system to offer to you at the incredible close-out price of just $168.

You see, no way is this a $5000 super tweak audiophile system. But, on the other hand, it's not a 'compact stereo' that you'd find at a department store.

So, Randix had a problem. Either they had by far the best and most expensive 'compact system' ever made, or they had the worst sounding $5000 stereo. And, they didn't know what to do.

$5000 FEATURES

The FM stereo is superb. You'll tune in your favorite music stations easily and exactly because there are two green arrows on the central tuning dial.

As you tune in a station, this superb tuner guides you by lighting up arrow shaped LEDs to tell you which direction to tune in and lock in each station.

If you go past the station, an arrow pointing in the other direction lights to tell you to back up. When tuning is perfect, both arrows disappear and only the red LED tuning bar is left. Plus, there's an LED signal strength meter too.

It's easy. It's exact. And, it gives you the lowest distortion for each station. It comes with a dipole antenna, or you can use a roof antenna or 75 ohm cable. The receiver also has really great sounding AM reception as well.

The cassette deck features soft touch controls, and it can record from any of the internal sources. Plus, this receiver has inputs for a turntable with magnetic cartridge (compacts usually only take ceramic), and any 'aux', like another tape deck plus external microphones.

The cassette deck is direct-coupled to all the inputs and makes great recordings. Plus, you can play your favorite tapes with complete confidence. This is no cheap cassette-eating compact deck.

BUT IT'S THE BI-AMPLIFICATION

There are no bass and treble controls. The volume control is actually the preamp 'out' volume control. Its output is shown on the 10 element LED meters.

The controls marked high and low are basic amplifier outputs that go directly to the individual woofers and tweeters.

There are absolutely no crossovers in the speakers. The difference in sound is astounding. When you hear this system, you won't believe that you're listening to 6½" woofers and 4" tweeters.

The sound is like 12" 3-way systems because the electronic crossover and circuits are so clean. Each channel only has 17 watts of power, but because of the direct to speaker bi-amping, it sounds like a whole lot more.

Randix says that this system, "provides the user with the ability to control optimum dispersion and transparency reproducion of sound with maximum accoustical detail and information." And, they're not too far off in their description.

The receiver is 15" wide, 11" deep and 4½" tall. Each of the beautiful two-way speaker systems is 11½" tall, 8" wide and 8" deep. Each special bi-amp speaker cable is about 6' long. It's all backed by Randix's limited warranty.

THE AUDIOPHILE MOOD MAKER RISK FREE

It's up to you to decide whether this is the best 'compact system' ever made, or the worst $5000 system ever. Randix no longer cares, they've sold all 2700 to DAK for cold hard cash.

Regardless of which it is, now it's yours on a risk free trial, for less than even a compact system's price. If you're not 100% satisfied, simply return it in its original box within 30 days for a refund.

To order your Randix Bi-Amplified Cassette, AM/FM Stereo Receiver complete with matched two-way speaker systems, risk free with your credit card, call toll free or send your check, not for the $289 suggested retail, or even the $183 dealer cost. Send just **$168** plus **$12** postage and handling. Order Number 9731. CA res add 6% sales tax.

Here's a great sounding system for your office, bedroom, den, family room, or kitchen. Who knows, you might be happy with the worst $5000 stereo as your main system. It's all up to you.

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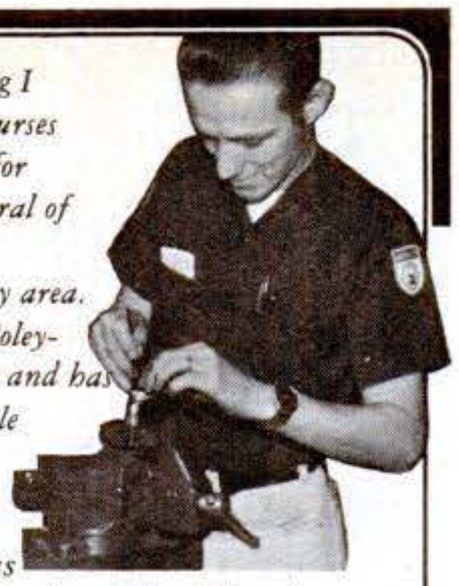
***Sam Walker** Prichard, Alabama*

"I opened my own business, spare time, seven months after I enrolled and made a profit of $329 for the first week."
***B. A. Deberry** Littleton, Colorado*

"Before enrolling I checked other courses and also asked for advice from several of the professional locksmiths in my area. They all said Foley-Belsaw was tops and has the most versatile Key Machine.



"I always wanted to have my own business and now I do, thanks to Foley-Belsaw."
David Fairbrother—Dave's Locksmith Service
Milwaukee, Wisconsin 53209

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You're "in business" ready to earn $5 to $12.50 an hour a few days after you begin Foley-Belsaw's shortcut training. Take advantage of today's unprecedented opportunities in locksmithing for year-round EXTRA INCOME in spare time — or fulltime in a high-profit business of your own. Hundreds we've trained have done it. So can YOU! All tools plus professional Key Machine given you with course. These plus practice materials and equipment, plus simple, illustrated lessons, plus expert supervision, plus business-building guidance will enable you to KEEP THE MONEY COMING IN! Ideal for retirement — good jobs, too.

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Helical-rotor wind turbine

The Allison Helical Rotor, which is claimed to harness 52 percent of the power available in winds as low as 12 to 14 mph [PS, March '80], has come to life in a commercial product—the AT-174-3000, made by Sol-Air Track Co.

The windmill's 17-foot-diameter, horizontal-axis, upwind rotor consists of four fiberglass foam-core blades mounted coaxially. The machine can start by itself in winds blowing less than nine miles per hour, claims the company. It puts out three kW in 24-mph winds and 3.5 kW—its rated maximum—in 30-mph winds. Standard output is 220 volts AC.

The blades drive a helical gearbox hooked to a brushless permanent-magnet alternator. One advantage of using a permanent-magnet alternator is that, unlike induction machines, it doesn't require outside power to excite the windings. Thus, the machine can be used in remote areas that don't have electricity. The tail pivots, shutting down the machine in winds above 30 mph. The device is said to be able to withstand 100-mph gusts.

The system is sold by Air Track Marketing (Three Bridges Rd., Box 108C, Federalsburg, Md. 21632). Its price, including controls and tower-mounting hardware (less the cost of the tower, installation, and on-site wiring), is $7,750.—*Charles A. Miller*

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The $9 Record Vacuum

Now you can clean up annoying clicks and pops on your records. And, you can increase the life of both your records and your stylus for only $9. But, there's a catch.

If you tape. Or, if you seriously listen to records, microdust and dirt can sound like cannons going off in your music.

In order to record, you probably only play a record once. But, over the years, as you listen to your cassettes, you'll get to really know and expect every click and pop that was on the original record.

But now, you can get rid of damaging microdust, dirt and other particles plus static electricity too, with the powerful new Vac-O-Rec from Robins for just $9. But, don't forget there's a catch.

THE YELLOW DIRT ROAD

You may never have a dust problem as large as I've shown above. But, playing a dirty record is like driving on a dirt road.

Just as your car bounces and lurches over rocks and boulders, your stylus bumps and bounces over the smallest dust and dirt particles. The result is wear and tear on your records, clicks, pops and poor sound reproduction of your music.

DIRTY RECORDS NO MORE

Vac-O-Rec is a complete precision record vacuum cleaning system. It gently lifts damaging dust and dirt from delicate record grooves with real mohair fibers.

Then the dust, even microdust, is lifted off and away from the record by a powerful vacuum, while the Vac-O-Rec automatically rotates your record.

To make sure the dust isn't reattracted, static electricity is reduced on the record surface by special mylar filaments.

They drain off, 'to ground', annoying static electricty that not only attracts the dust, but also causes clicks and pops in your favorite music.

IT DOES IT ALL

A precision drive motor gently rotates the record between the real mohair fibers that lift the dirt. Then the dirt is vacuumed away and finally the static electricty is drained off.

It all takes about 30 seconds. You can do it as often as you wish, because unlike harsh systems, the Vac-O-Rec causes no record wear. And, if you're into recording, you won't be making friends with as many clicks and pops in the future.

It's made by Robins, a leader in record care accessories. It's great for records that are new or old. Your records will last longer. Your stylus will last longer. And, all your music will sound better. It's backed by a standard limited warranty.

THE CATCH

Frankly, we are losing our shirts on the Vac-O-Rec, 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 340,000 customers have responded to bonuses like this. We find most of you keep buying once you've tried our cassettes and our prices; and that's a worthwhile gamble.

NOT A BAD CATCH

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

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

TRY NEW DAK MLX90 CASSETTES RISK FREE

To get the record saving, music improving Rec-O-Vac for $9, try 10 MLX high energy cassettes. If you aren't 100% satisfied, return only 9 of the 10 cassettes and the Rec-O-Vac in its original box within 30 days for a refund. The 10th cassette is a gift for your time.

To order your 10 Gold Label DAK MLX 90 minute cassettes and get the Rec-O-Vac 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 Rec-O-Vac and **$4** for postage and handling for each group. Order No. 9735. CA res add 6% sales tax.

Now all your records can be clean for $9 and with DAK's new MLX cassettes all your recordings can sound great.

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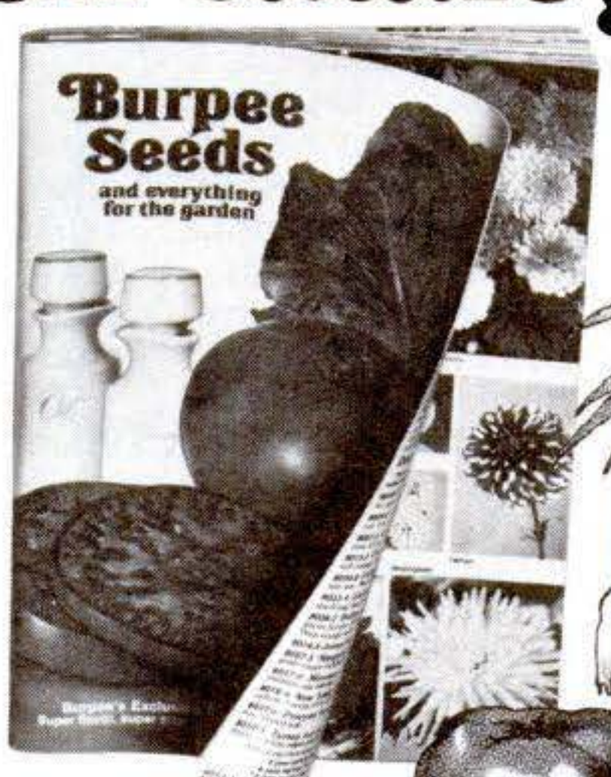
I want your full-color garden catalog describing more than 1,800 vegetables, flowers, trees, shrubs, bulbs, and garden aids. (If you ordered from Burpee in 1983, your new catalog will be sent to you automatically in January.)

Since 1876, Burpee has been developing new vegetable and flower varieties that are easier to grow *and* more productive. Your satisfaction is guaranteed or your money back any time within a year. Special discount for ordering early.



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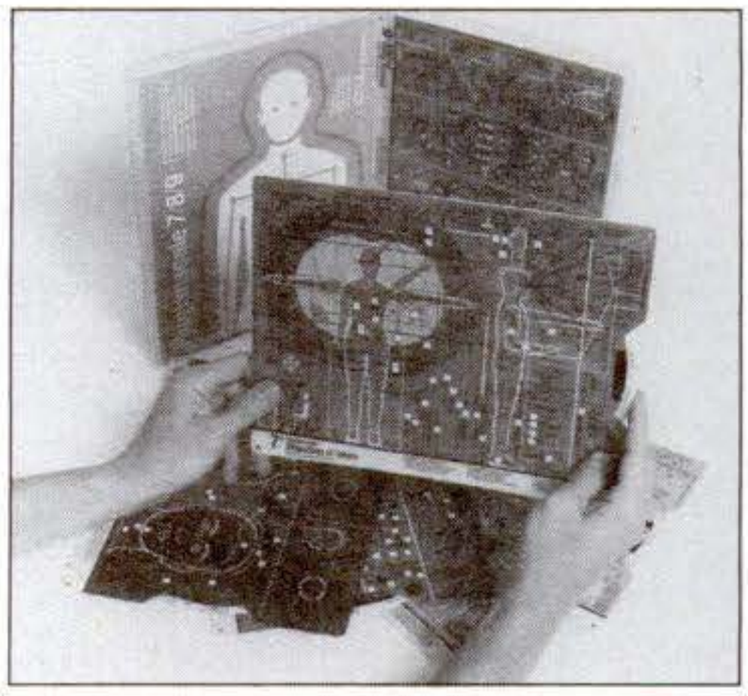
Human engineer in a chart



How big should you make a round table to accommodate eight diners? How do you size a desk and chair for your 10-year-old daughter? How large should you paint your house number so that it's legible from the street?

Such questions are answered through the science of human engineering. Eight years ago, I wrote about a design aid called Humanscale, made by Henry Dreyfuss Assoc., that packed a great deal of such information into three rotary-dial charts and a manual [PS, July '75]. You turn a chart dial to the relevant category (height in inches, for example), and all kinds of corresponding numbers pop up in windows on the pictorial charts. Chart 1 gives basic body measurements. Chart 2 is a seat-and-table guide. Chart 3 helps you design for the handicapped and elderly.

Now the Humanscale library has been expanded with charts 4/5/6 and 7/8/9. In the first set, chart 4 deals with safety and human strength. Chart 5 has data for designing hand and foot controls and displays (where you find that your house number should be at least 1.29 inches high to be read at 20 feet). Chart 6 deals with head size, vision, and hands and feet.

In the second set, chart 7 is for designing work areas for standing and sitting (it will guide you in sizing your daughter's desk). Chart 8 is for sizing public and private spaces (where you find that a round table for eight should be 68 inches in diameter). Chart 9 concerns light and color, as well as access to maintenance areas. Each set—one manual and three two-sided charts—is available for $39.95 from MIT Press, 28 Carleton St., Cambridge, Mass. 02142.—*V. E. Smay*

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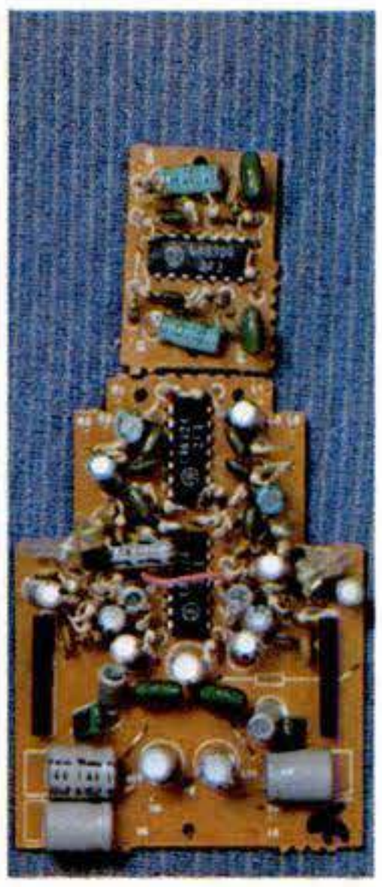

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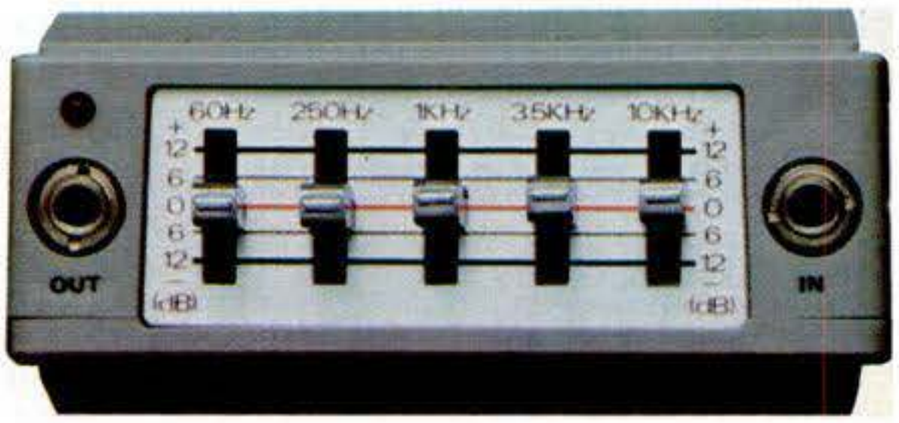

Pocket Sound Detonator

Now at home or on the road, you can bring breathtaking, crashing realism to your headphone listening.

Has DAK finally gone totally insane? After strapping a personal stereo to yourself, can anyone really expect you to strap on an equalizer too?

Well, all I can say is that you've got to hear this thing to believe it. You can add up to 12db at 60hz which will add astoundingly rich bass to the sound of featherweight headphones.

Then you can sculpture the sound by ±12db at 250hz, 1,000hz, 3,500hz and 10,000hz. You'll get vibrant sound that will knock your socks off whether you're listening to a personal stereo, or through the headphone jack of your home stereo.

There is a stereo jumper cable that hooks between your personal or home stereo and the equalizer. Then, plug your headphones into the equalizer, and wow.

THRILLING

No matter which personal stereo you own, this equalizer is worth more than a try. And, wait till you hear your own stereo system through the equalizer and your personal stereo's headphones.

Sure it's a dumb idea to add another thing you have to strap on to your body. But, the sound you'll hear when you do is nothing short of incredible. It operates on 4 AA batteries (not included), comes with a case that attaches to your belt and is backed by a limited warranty.

TRY THE POCKET DETONATOR RISK FREE

Wait till you experience the sound of your personal or home stereo through headphones detonated by this equalizer.

If you're not 100% satisfied, simply return it within 30 days in its original box for a courteous refund.

To order your 5 band Pocket Sound Detonator Headphone Equalizer risk free with your credit card, call toll free or ~~send your check for just $49 plus $2 for postage and handling. Order Number 9453.~~ CA res add 6% sales tax.

Here's one dumb idea that's not nearly as dumb as it 'sounded'.

Audio Telescope

Pick a voice out of a crowd or a sparrow's song out of a tree with this super-directional shotgun microphone.

It's tough. If you've ever tried to record a singer while you're sitting in the audience, or a conversation from across the yard, you know that your microphone seems to pick up everything but what you want to record.

Now you can record a lecture from the back of the room or a bird's chirp from across a field.

The sound will be crystal clear with a full 30 to 15,000hz frequency response from this super-directional electret condenser microphone.

Electret condenser microphones capture sounds never before possible outside the recording studio. By using battery driven circuits, these microphones can use a more sensitive sensing membrane to capture sound vibrations.

Very little mass must be moved, so these new mikes are incredibly sensitive. The Audio Telescope is powered by one AA battery (not included).

It comes with both a conventional mike stand mount and a stand. And, you can mount it on most video cameras.

The microphone itself is totally isolated from the stand by polymer O-rings. So, it actually floats. It will not pick up motor noises or vibrations.

It is 17" long and comes with a full length foam wind screen. There is a mini phone plug for video camera use, plus a 20 foot mike cable with both mini and 1/4" plugs for conventional professional recording. It's backed by a manufacturer's standard limited warranty.

TRY THE AUDIO TELESCOPE RISK FREE

Record lectures, concerts or nature, risk free. If you don't feel you've made totally professional recordings, simply return the Audio Telescope in its original box within 30 days for a refund.

To order your Audio Telescope risk free with your credit card, call toll free or send your check for only **$67** plus **$3.50** for postage and handling. Order No. 9736.

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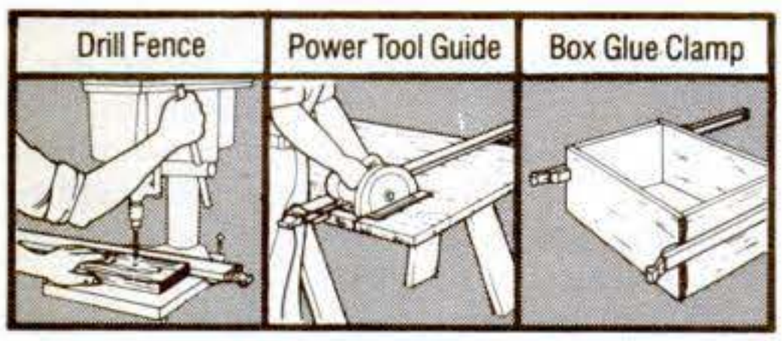
See article, Oct. '83 issue, Pg. 156

REVOLUTIONARY *NEW* CLAMPING TOOLS. ELIMINATE "C" CLAMP HASSLES

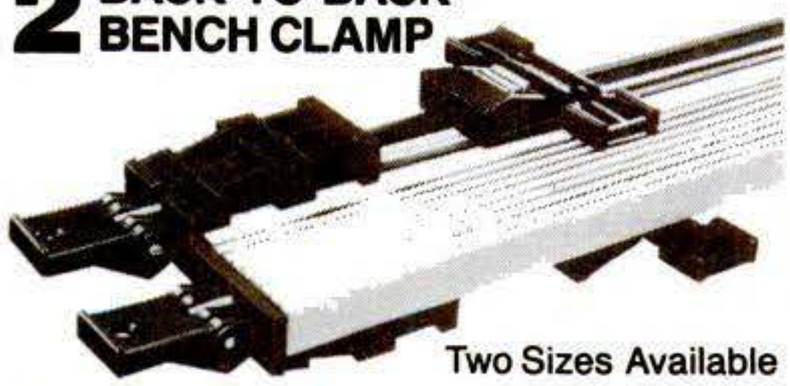
1 CLAMP'N TOOL GUIDE

Two Sizes Available

The first "obstruction-free" straight edged bar clamp with unlimited uses: Glue Clamp • Power Tool Guide • Jig Clamp • Straight Edge • Auxiliary Fence. Wide edge to edge grip. No surface marring. No "C" clamp hassle!

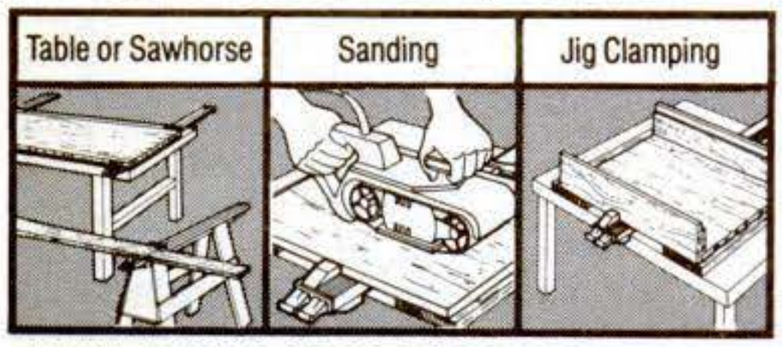


2 BACK-TO-BACK BENCH CLAMP



Two Sizes Available

Instant Bench Clamp. Bottom jaws clamp to table top or saw horse while top jaws hold the work piece. "Obstruction-free—no hold-downs or "C" clamps. Endless jig applications. Superwide capacity.



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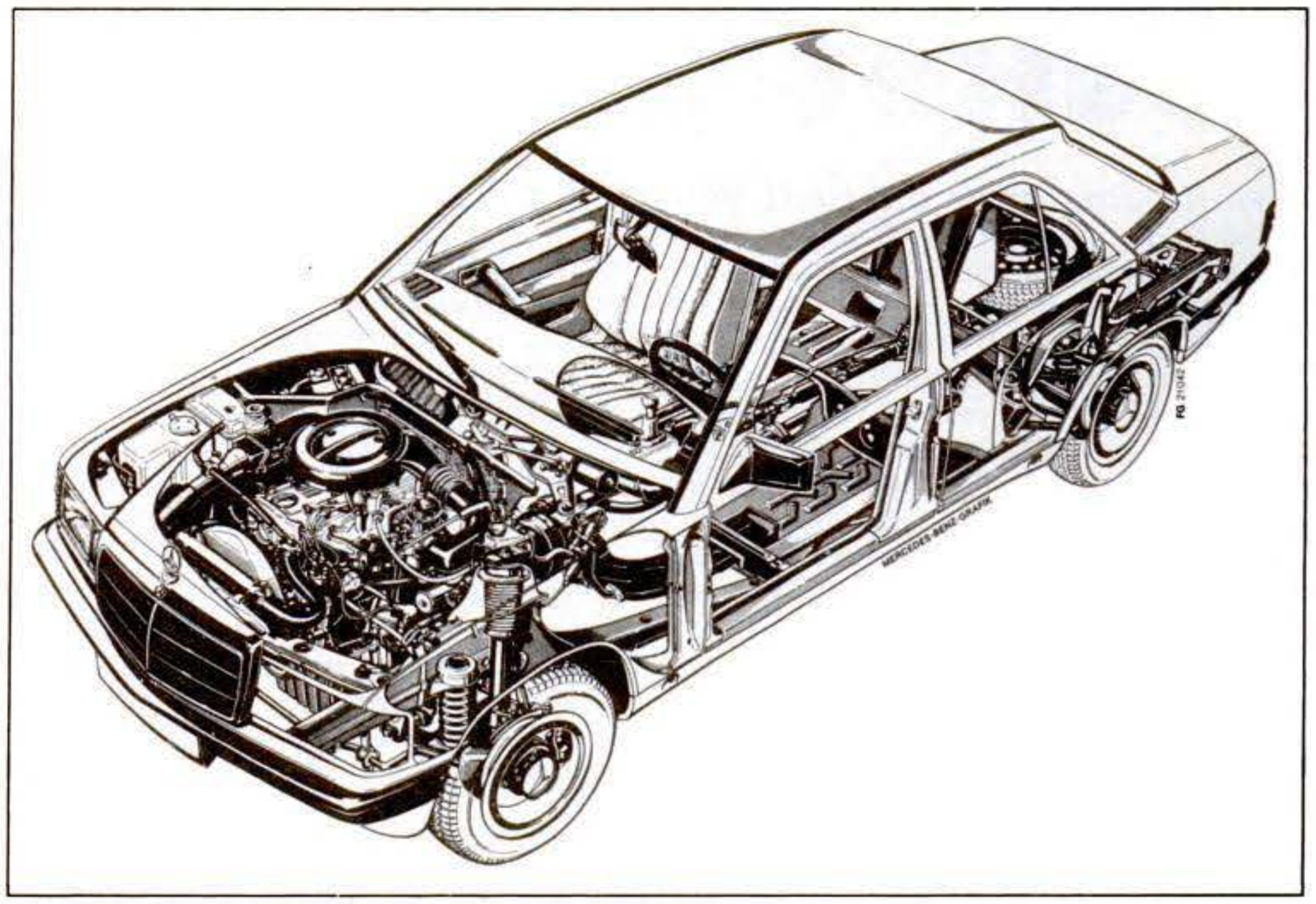

Mercedes' new baby

Sometimes, good things do indeed come in small packages. Those things can also be expensive. The new Mercedes 190 is that kind of small package.

Although it's 600 pounds lighter and 15.9 inches shorter than the 240D it replaces, the 190D will cost about the same—$24,000.

The new compact rear-drive comes in four-cylinder gasoline (E) or diesel (D) versions. The gas engine displaces 2.3 liters (140 cu. in.) and produces an eager 113 hp at 5,000 rpm and 133 ft.-lbs. of torque. The 190E that I test-drove from West Virginia to Indiana pulled strongly and smoothly, making passing a fast and safe procedure even on steep inclines. During the 400-mile trip, my driving partner and I averaged 33 mpg with our five-speed model. On the Indianapolis Motor Speedway, driving an automatic-transmission gasoline model, I timed two zero-to-60 runs at 10.8 seconds.

The 190D's acceleration is less remarkable. "Diesel models require patience," said a Mercedes spokesman. The 2.2-liter (134-cu.-in.) diesel produces a meager 72 hp at 4,200 rpm, and its performance with the automatic transmission is barely adequate. Fortunately, it is also available with a silky-smooth five-speed manual. Patience is then rewarded with outstanding fuel economy. I drove a 190D with five-speed transmission from Indianapolis to New York and averaged just under 44 mpg.

Some of the roads between Indiana and New York were in miserable shape. But the 190's fully independent front and rear suspensions provided a smooth ride and predictable handling.

So if you buy your cars by the pound, you'd hesitate at the hefty price tag on the diminutive Benz. But if your decision is based on craftsmanship and sophisticated engineering, you might find the 190 worth considering.—*Jack Keebler* PS

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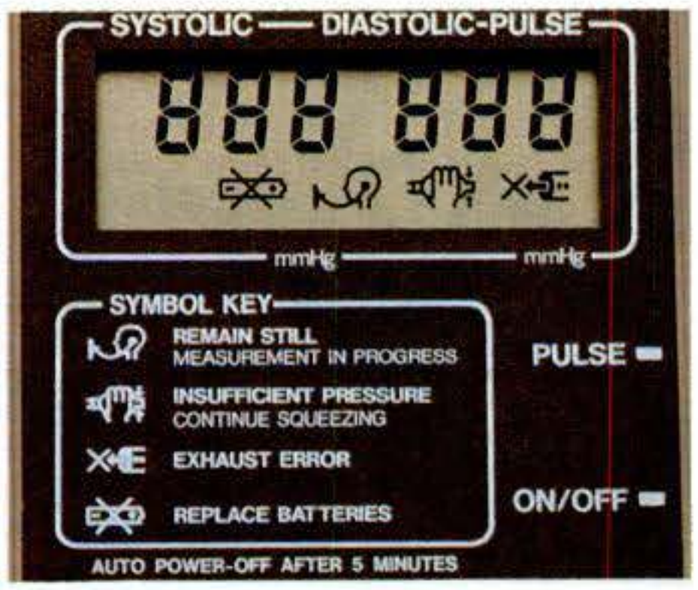

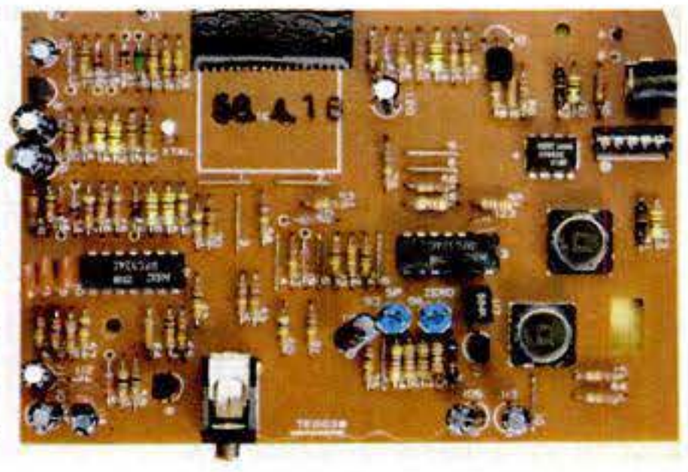

Electronic Heart Decoder Plus

Unravel the secrets of your body. See if your body may be scheduled to be a battleground in the next war.

Do you cheat? Think about the day of your last physical examination. Did you skip your morning coffee, skip a cigarette, and did you ask your doctor to let you relax before he took your blood pressure?

Well, if you did even one of the above, it's like cheating at solitaire. Because like your temperature and weight, blood pressure shows the condition of your body.

Some high blood pressure is related to diet. (Check your pressure after you have had something with caffeine or a cigarette.) Some is tension related. (Check it at the office and then compare it with your pressure on a Sunday morning.)

And finally, some high blood pressure is genetic. Only your doctor can tell you. But remember, your doctor probably only sees you in a relaxed state.

All high blood pressure is bad because it puts an extra strain on your heart and circulatory system that can lead to heart attacks and strokes.

And high blood pressure is doubly bad because you can't tell that you have it. So, unlike a bruise or a cold, there are no symptoms that you can see. That's why it's called the silent killer!

WHAT IS BLOOD PRESSURE?

Two measurements are used to measure your blood pressure. Systolic pressure is the pressure in your arteries during the time that the actual heart beat or pulse passes along your arterial system.

Diastolic pressure is the resting pressure that occurs between the beats or pulses. A pressure of 120/80 (120 systolic over 80 diastolic) is about average for most young adults. You'll get a chart of average blood pressures, but you should always consult your own doctor.

TIME FOR A STETHOSCOPE?

If you can't see it or feel it, how can it be measured? Your doctor probably uses a column of mercury, an inflatable arm band and a stethoscope.

Since you're probably not a doctor, the complicated parts have been automated. Just slip your arm into the Electronic Heart Decoder's adjustable velcro cuff, and simply inflate the cuff.

The mercury has been replaced by a sophisticated computer brain that displays your blood pressure on an LCD display. The stethoscope has been replaced by a microphone implanted in the pressure cuff, and the Electronic Heart Decoder Plus even takes your pulse.

After you've pumped up the cuff, the cuff will slowly de-pressurize automatically. A head with a stethoscope will appear on the display. First you will see your systolic display on the left, and then your diastolic on the right of the display.

The Decoder even shows you what it's doing. As you pump up the cuff, a pump shows on the display, if the air exhaust is incorrect, an X shows, and if the standard 9V battery (not included) is weak, a battery with an X is displayed.

After you've taken your blood pressure, just push the pulse button and your pulse rate will be displayed. It's goof proof. It's quick. And, it's accurate.

EXERCISE--EXERCISE--EXERCISE

You've heard it before, but I'll tell you again because I want you to be around to keep being a DAK customer, and because it's what my doctor told me.

"Drew if you expect to keep your blood pressure down, you've got to keep your weight down and get regular exercise."

But honestly, it wasn't so much what my doctor said, as the way I felt when Steve, a 37 year old slightly overweight friend of mine had a heart attack.

He owns a business like mine. He too works 16 hours a day, 7 days a week. And, neither of us smoke. Now we are both exercising regularly. And as his doctor says, and as I can testify to, we'll probably be in better shape than ever.

But as long as I'm being honest about why I've started to get back into shape, I might as well also let you know that in 6 months or so, I may get lazy again.

I hope that by using the Electronic Heart Decoder Plus as well as my scale to measure my improvement, I'll have the self discipline to keep it up.

The Electronic Heart Decoder Plus is made by Lumiscope, a leader in blood pressure measuring equipment. It's backed by their standard limited warranty.

A $68 JOKE?

No, it's no joke. It's a sophisticated measuring device like those you'll see selling for up to $129.

When my friend had the heart attack and my doctor told me to start exercising, I started looking around for the equipment. Lumiscope happened to show up at just the right time. And, due to DAK's cash purchasing and massive buying power we were able to slash the price.

The Electronic Heart Decoder Plus is accurate, and it's easy to use. Just check your own pressure. If it's up, go see your doctor **now**. Of course, you should have regular checkups either way. I also recommend that you take the Electronic Heart Decoder Plus to your own doctor and have him check its accuracy.

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

To order your Electronic Heart Decoder Plus risk free with your credit card, call toll free or send your check not for $129, or even $99. Send just **$68** plus **$3** for postage and handling to DAK. Order Number 9730. CA res add 6% sales tax.

You don't get your body on a 30 day risk free trial. So, get your body outside and get it some exercise, don't smoke, and maybe lose some weight.

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Heavy-duty aluminum base with flexible magnetized vinyl is easy to install by any do-it-yourselfer. Set includes 17 feet of magnetic weatherstripping, enough to insulate the top and both sides of any standard residential door, plus screws and full instructions. Order now and watch your heating bills drop!

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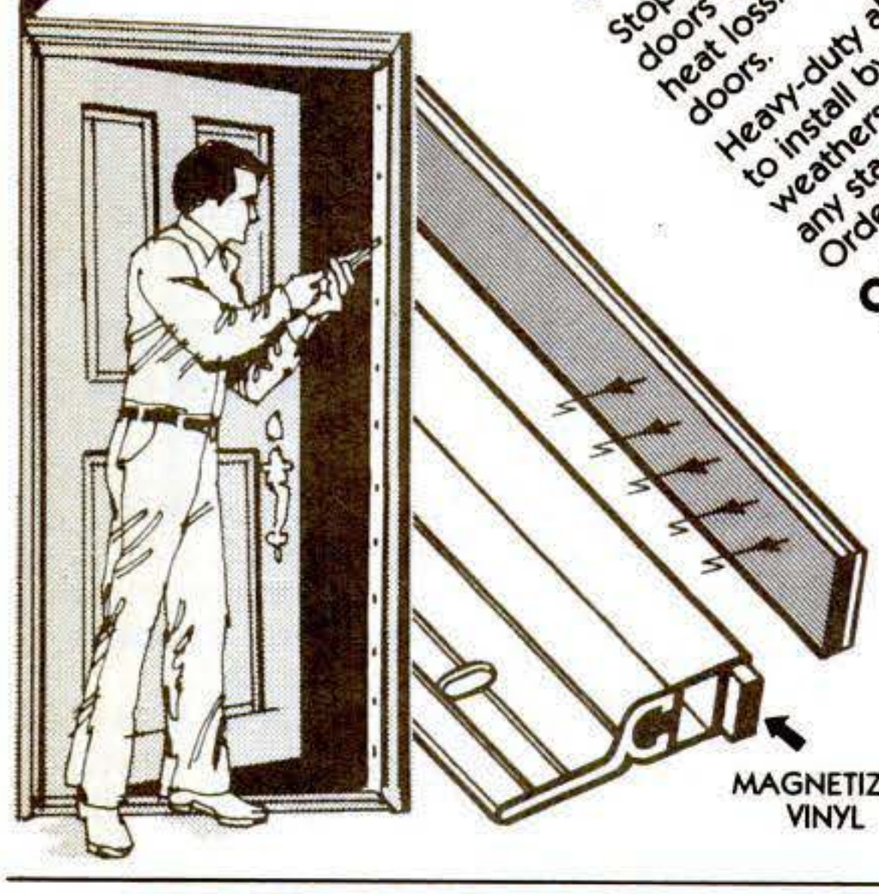

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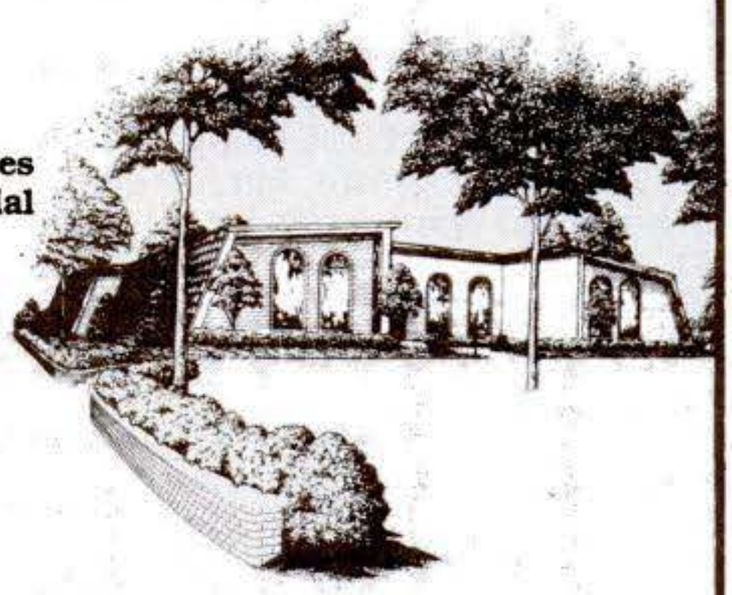

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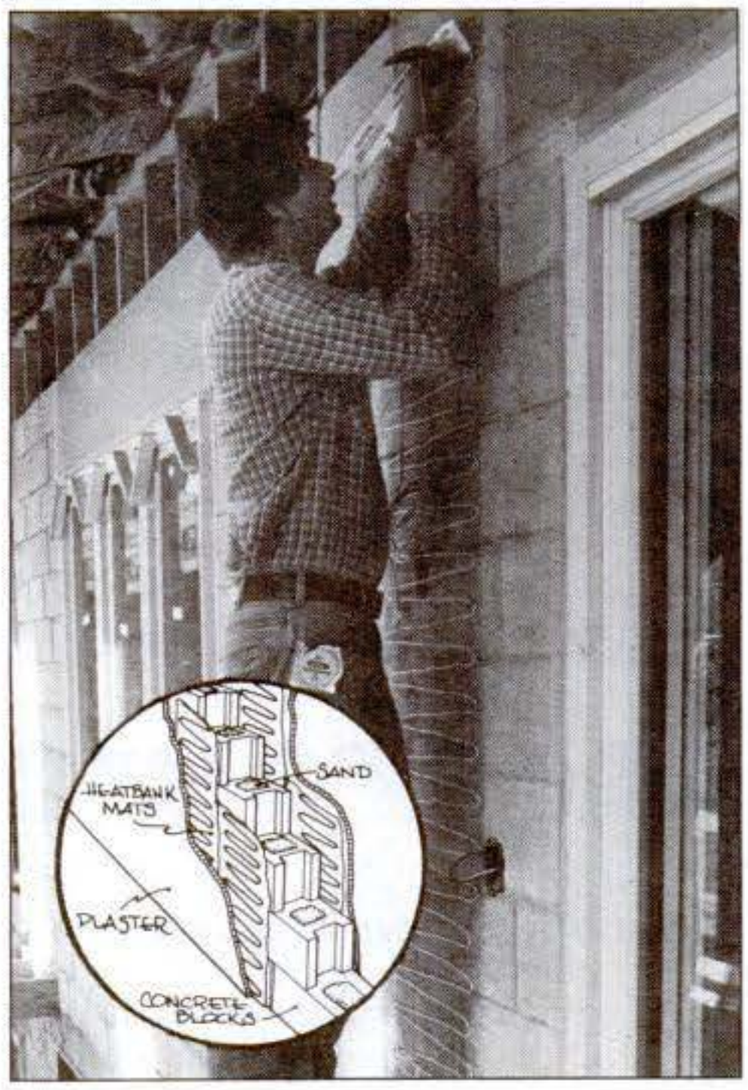
Wired wall for solar houses



Picture a two-story-high atrium glazed from floor to ceiling. The rear wall is made of sand-filled cinder blocks plastered and painted a rich earth brown. A Trombe wall that stores energy for nighttime heating? Yes—with a bonus. At night the wall can store energy for daytime heating.

How? Under the plaster lie Heatbank mats (photo). Made of resistance-heating cable bonded to fiberglass mesh, these mats are generally used as subfloor heaters in commercial buildings. But Heatbank also serves as a unique source of backup heat for a double-shell house in central Indiana. A timer-controlled thermostat, set to work only during evening (off-peak) hours, operates the mats. If the wall temperature falls below 50 degrees F, the mats kick on. Once on, the mats remain at their design temperature of 120 degrees for as long as needed.

In eight hours the temperature of the 555-cu.-ft. wall rises 19 degrees, enabling it to supply 770,000 Btu for house heating. That's enough to warm the 3,000-sq.-ft. house for 14 hours (at 30 degrees outdoors), according to the Indiana and Michigan Electric Co.

The 48 mats in the heater wall shown cost $900; installation was another $1,000. But according to Easy Heat-Wirekraft (U.S. 20 East, New Carlisle, Ind. 46552), it costs the Indiana homeowner less than $2.50 per day to operate the heater when it's needed.
—Susan Renner-Smith

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illegal Phone

It may look like an ordinary top of the line cordless phone but it's not, because it's way over the FCC power limit allotted for cordless phones. It has a range up to 1500 feet.

It's true. According to the FCC rules this phone is illegal. It simply has too much power.

If you remember the days of CB, you'll remember the illegal super power boosters that let one CBer literally stamp out everyone near by.

Well this phone has so much power that you can forget 300' or even 700'. Now you can roam up to 1500'.

SUPER CLEAN SOUND

It's loaded with all the extras. It has two way intercom paging. It has high/low volume, secure, and enough LEDs displaying what it's doing to embarrass the space shuttle.

It even has 10 number memory. But, it's the sound that makes it special.

In addition to the high power for incredible range and fidelity, it uses refined state of the art circuitry. The extra power and circuitry let this phone cut through noise and interference that would leave many other cordless phones in the dust.

So, it's got great features, great sound and phenomenal range. The only problem is, it simply has too much power.

LIMITED TIME OFFER LEGAL FOR YOU

Now for the good part. You may use this phone at home or at your office legally. But, we have to stop selling the phone by next October.

You see, the phone is really strictly illegal because of its tremendous output of power. But, the FCC has granted a 'temporary waiver' to their output power rules for this phone, while they decide exactly what future rules will be.

So, unless they change their mind and stop the test early, we're allowed to sell these phones to you. And, once you have one, it's yours and it's legal.

In fact, to prove it's legal, on the bottom of each and every phone is printed, "...the base station of this phone is a radio link operating within the terms of a waiver granted by the FCC..." with the FCC registration number.

TOP OF THE LINE

From its beautiful decorator styling with inset leatherette to its sophisticated circuits, this phone is deluxe.

Look at all the features. There's a real intercom that can be separate from your phone system. A switch on the front lets you switch any phone plugged into the back into an intercom link or a phone.

So, if you answer the phone in the house, you can put the caller on hold, talk to the person with the remote handset, then transfer the call. Of course, the handset can receive the call directly.

There are call buttons on both the base and handset, so either party can call the other. And, the incredibly sensitive handset has a range of 100' without extending the antenna.

So, when you use this phone in the house, you won't have to worry about hitting the antenna as you walk through doorways or sit at your desk.

But, when you do extend the antenna you'll have up to 1500 feet in any direction, of super clean, reliable duplex telephone communication. This is the first phone we've tested that can even surpass wired-in phones. With its high/low volume, last number redial, mute and hold features, it's hard to beat.

SUPER RELIABLE

From across the room, across the street, or around the block, you'll have the best sound ever. Imagine walking your dog while talking on the phone.

Think of the convenience for your wife of being able to talk on the phone while keeping track of the children in the yard or down the street.

Consider the security of being only seconds away from the police or fire department. You can instantly call a doctor or anyone, anywhere. It's a superb personal security device.

And, look at this. You'll have 10 number memory from the handset. So, you can dial emergency numbers in a flash, or stop trying to remember and dial numbers that you frequently call.

NO INSTALLATION

If you can plug in a lamp, you can install your new cordless phone. It uses universal pulse dialing that's compatible with both rotary and Touch Tone®.

Simply plug its modular phone jack into the wall. Then plug in its AC line cord and start talking.

It's made by Universal Security Instrument Co. The phone is both U.L. listed and, with the special waiver, it's FCC approved. It has a limited warranty.

TRY THE ILLEGAL PHONE RISK FREE

Go for a walk. Chances are your feet will give out before the range on this phone will. Listen to the fidelity. You'll be amazed that there's no cord.

Try it risk free. If you're not 100% satisfied, simply return it in its original box within 30 days for a refund.

To order your Universal Security 1500' 10 memory, Illegal Cordless Phone risk free with your credit card, call toll free or send your check for DAK's incredible 'limited time' price of just **$159** plus **$4** for postage and handling. Order Number 9738. CA res add 6% sales tax.

If you don't want the 10 memories, you can order the same phone for just **$149** ($4 P&H) Order Number 9739, without 10 memory dialing.

It's a risk free investment that will pay for itself many times in convenience, security and time savings. And, it's available now, only at the whim of the FCC.

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POPULAR SCIENCE CAR TEST #176
Total cars tested to date: 646

Challenging the Honda Accord

The Honda Accord has been called the Mercedes-Benz of small cars and has stood for more than seven years as an example of what Detroit found so hard to do—build a fine small sedan at an affordable price. Until this year it has been virtually unchallenged in the mid-price, front-drive class. Mazda 626 and Toyota Camry are the latest attempts to dethrone Honda. PS rounded up these small sedans for instrumented performance tests and came to a split decision.

By JIM DUNNE and JACK KEEBLER

For seven years Accord has been the target that competitors have kept in their sights when planning new cars. In 1981, Accord was upgraded, and though the model was advanced in many ways, competitors had fine-tuned their products to within striking distance.

Now new cars from Europe, Japan, and the U.S. seem to be catching up with, and in some ways surpassing, the industry standard.

We took the newest Accord (a made-in-America version) to our test track for comparison with two other new models, Mazda 626 and Toyota Camry. All were four-door types with four-cylinder engines and automatic transmissions—just what American buyers like. Each was equipped to appeal to purchasers who want economy and more comfort than subcompacts offer.

Continued

Sporty front-drive contenders (clockwise from bottom): Mazda 626, Honda Accord, and the brand-new Toyota Camry.

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Many people are afraid of losing their jobs to computers, but thousands of jobs will be created for those who are prepared to meet the challenge.

With NRI training, you'll be prepared. You can have a profitable, exciting future as an expert who can handle the operational, programming and technical aspects of all kinds of microcomputers and microprocessors.

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We'll give you tomorrow.

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We expected better performance than the subcompacts offer. The test models disappointed us. In our zero-to-60-mph runs, none could break into the sub-15-second range. We attributed this mainly to the cars' automatic transmissions. A five-speed manual with well-matched ratios could clip a second or more off their times.

Each of the three models is designed to compete with similar American-made front-drive sedans, especially GM's X-body, Ford's Tempo/Topaz, and Chrysler's Reliant/Aries. All of these domestic cars are about the same size inside and out, have similar-displacement four-cylinder engines, and carry five passengers. Our comparison tests [PS, Oct.] show that the U.S.-built cars are generally faster and just as comfortable, but less fuel efficient and less extensively equipped than the newest Japanese competitors. Engines and transmissions seem more refined and smoother in the imports. Price comparisons are difficult to make, but, generally, you get more features for less cost in the imports. These include remote release levers for the gas-tank cover and the trunk lid and multiple-adjustment seats that usually cost extra in the domestics. Here's how they looked individually.

Honda Accord

A new four-speed automatic cures one of Honda's most embarrassing problems: poor acceleration and an engine that over-speeds between shifts. The four ratios in this automatic are carefully selected to avoid the impression of too much running up and down the gears. This is a common fault in some domestics in which the transmission cycles constantly between two gears in search of best economy.

Honda's engine is the smallest in the group, but the light weight of the chassis (2,215 pounds) tends to offset this disadvantage. It makes for easily adequate performance with a fuel-economy bonus. The Honda engine also handles the extra load of the air conditioner without lugging.

Honda's service-reminder system on the instrument panel keeps the owner up-to-date on when to change the oil and oil filter and when to make other service adjustments. The trunk is bigger than you would expect in a car this size. The floor is flat and runs forward between the spring towers of the independent rear suspension.

Although straight-line performance was a touch slower than that of its two competitors, it was equal to the competition in high-speed handling and excellent in low-speed maneuverability. We found the lack of feedback from the over-assisted steering a minor problem. Virtually no sense of how the tires are gripping the road is fed into the driver's hands from the wheel.

Mazda 626

The Mazda 626 feels rock steady: Its handling is dead-on-target accurate. It was the fastest on the low-speed maneuverability course and as good as the Accord on the high-speed section of our test.

One innovation that caught our attention was a suspension-change feature called the electronic variable shock-absorber system. According to the maker, if you want sports-car-like firm suspension, you flip the switch to "Sport" from the driver's seat. For a smooth ride, switch to "Normal." We tried to detect a seat-of-the-pants difference between the two settings but could not. Furthermore, there was no measurable improvement in either the high-speed handling or low-speed maneuverability tests.

The 626 offers a considerable variety of convenience equipment. Oscillating vent louvers in the dash panel operate just like table fans that swing back and forth through an arc to cool an entire room. These are the first we've seen of this type, and they seem to quite effectively distribute cool air throughout the cabin. The 626 also has an assortment of chimes to alert the driver to lights left on, key left in the ignition, or doors left ajar. The ignition reminder chimes a tune similar to "How Dry I Am." The significance escapes us, but the tune wears rather well.

What makes the 626 an advanced road car? Good chassis balance primarily, but also the independent rear suspension, unusual 15-inch-diameter wheels, and low-aspect-ratio 60-series tires. Quick steering with adequate road feel also impressed us.

The Mazda's rear hatch was unique to this group: It added extra utility and storage space to a moderately roomy trunk. The split rear-seat back folds down for loads the notchbacks

Continued

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.

	Honda Accord	Mazda 626	Toyota Camry
Acceleration	3	3	3
Braking	3	3	1
Handling	4	4	3
Maneuverability	5	5	5
Quietness	2	2	3
Roominess	3	3	3
Vision	5	5	5
Entry/exit ease	2	2	4
EPA economy	3	3	3
Ride comfort*	3	3	3

*Authors' opinion

Mazda 626 surprised the test crew with a remarkably short 148-ft. cold stop from 60 mph. It hot-stopped in only 151 ft.

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- Elton John: Too Low Zero 10196
- Waylon: It's Only Rock 44193
- Bernstein: Beethoven Overtures . 05416
- Led Zeppelin: Coda 33759
- Bob Seger: Night Moves 43584
- Dolly Parton: Burlap/Satin 44133
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- Anne Murray: Gt. Hits 63530
- Chicago 16 04760
- Alabama: Feels So Right 53632
- Triumph: Never Surrender 53938
- Little River Band: Gt. Hits 53429
- Billy Squier: Don't Say No 54318
- J. Geils Band: Showtime 13346
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❹ **RUSH ME THESE 3 SELECTIONS** (indicate by number)

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❻ Have you bought anything else by mail in ☐ **last 6 months** ☐ **year** ☐ **never**

T-J2 YV

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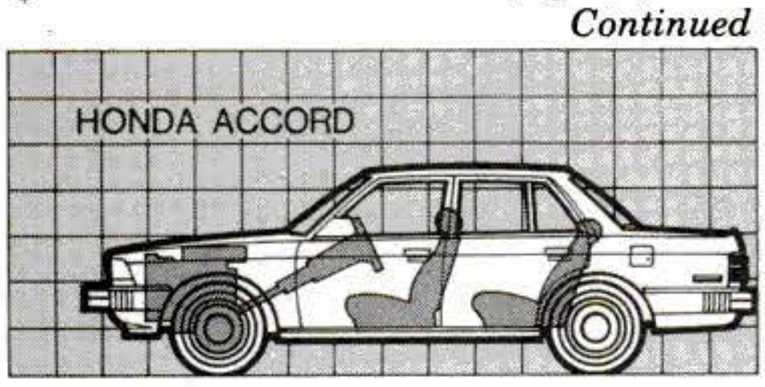
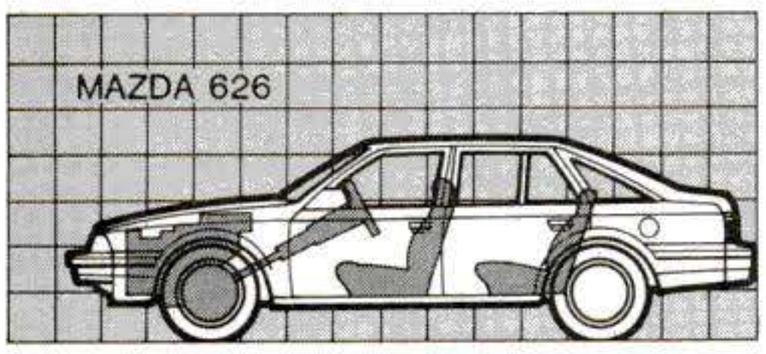
can't even consider. A security panel in the rear hides valuables from outside view when the seat back is in its upright position. (Mazda also sells a notchback 626 with a conventional trunk.)

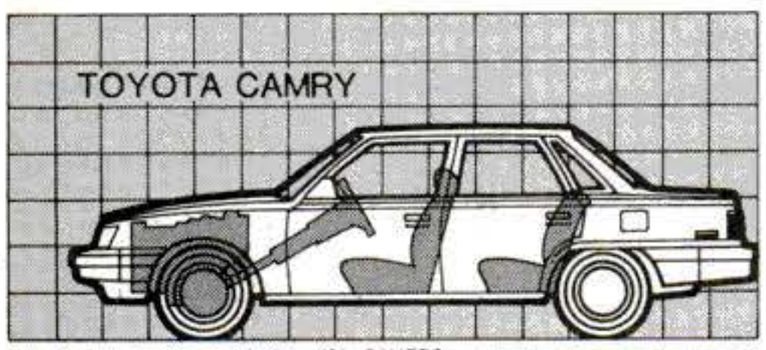
Toyota Camry

Toyota doesn't skimp on quality in designing engines and transmissions, and the new Camry is a good example of that. It's smooth, quiet, and

Continued







ILLUSTRATIONS BY RUSSELL VON SAUERS

PS serviceability ratings

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

	Honda Accord	Mazda 626	Toyota Camry
Checking fluid levels			
Battery	5	5	5
Master cylinder	5	5	5
Windshield washer	5	5	5
Engine oil	5	5	5
Coolant	3	5	5
Checking the engine			
Spark plugs	5	5	5
Distributor	5	5	4
Oil filter	5	3	5
Oil fill	5	5	5
Replacing hoses			
Upper radiator hose	5	5	5
Lower radiator hose	4	3	5
Heater hoses	3	2	5
Changing bulbs			
Headlights	5	4	4
Taillights	4	2	4
Front running lights	3	3	3
Front parking lights	3	3	3
Front directionals	3	3	3
Rear directionals	4	2	4
Rear running lights	5	2	4
Checking fuses	4	3	4
Spare-tire accessibility	5	5	4
Changing belts	2	4	3

Test results, dimensions, and specs

	Honda Accord	Mazda 626	Toyota Camry
TEST RESULTS			
Acceleration (sec.)			
0–60 mph	17.7	16.8	17.4
Brake test (cool) 60–0 mph			
Stopping distance (ft.)	152	148	179
Pedal pressure (lbs.)	100	120	140
Brake test (hot) 60–0 mph			
Stopping distance (ft.)	158	151	194
Pedal pressure (lbs.)	110	120	160
Interior noise @ 60 mph (dBA)	69.0	71.0	67.5
Handling test (mph)	63.9	63.9	60.5
Maneuverability test (mph)	27.8	30.1	27.8
EPA FUEL MILEAGE (mpg)			
Highway	40	36	43
City	29	27	31
Calif. city	26	27	31
PS FUEL-MILEAGE TESTS (steady-state mpg)			
35 mph	43.4	29.2	41.9
55 mph	38.1	29.0	36.7

TEST CONDITIONS: Ambient temperature, 77°F; relative humidity, 60 percent; barometric pressure, 28.7 inches Hg

	Honda Accord	Mazda 626	Toyota Camry
DIMENSIONS (inches)			
Wheelbase	96.5	98.8	102.4
Overall length	173.6	177.8	175.6
Overall height	54.1	55.5	54.9
Overall width	65.4	66.5	66.5
Track, F/R	56.3/55.9	56.3/56.1	57.7/55.9
Ground clearance	5.25	5.0	5.75
Front head room	36.5	35.5	38.8
Front hip room	44.0	44.0	42.0
Front leg room	43.0	42.5	42.2
Rear head room	35.0	33.5	37.0
Rear hip room	47.0	48.0	52.5
Rear leg room (min.)	33.0	35.0	34.6
Rear knee room (min.)	0.5	2.0	2.5
Couple distance	29.7	31.0	32.0
SPECIFICATIONS			
Engine type	OHC in-line 4	OHC in-line 4	OHC in-line 4
Displacement (cu. in./cc)	107/1,751	121.9/1,998	121.7/1,995
Compression ratio	8.8:1	8.6:1	8.7:1
Carburetion	3 bbl	2 bbl.	F.I.
Net hp @ rpm	75 @ 4,500	83 @ 4,800	92 @ 4,200
Net torque (ft.-lbs.) @ rpm	98.5 @ 3,000	110 @ 2,500	113 @ 2,400
Transmission	4-speed automatic	3-speed automatic	4-speed automatic
Axle ratio	3.875:1	3.45:1	3.4:1
Tire make	Goodyear	Goodrich	Bridgestone
Tire type	Corsa GT radial	Radial steel belted	WIDE 70 RD 116 steel radial
Tire size	185/70R13	195/60R15	185/70SR13
Steering	Power, rack and pinion	Power, rack and pinion	Variable, rack and pinion
Overall steering ratio	16.3:1	17.3:1	18.6:1
Turns, lock to lock	2.7	2.95	3.2
Turn diameter (ft.)	39.25	36.25	34.67
Front suspension	Independent, MacPherson struts, coil springs	Independent, MacPherson struts, coil springs	Independent, MacPherson struts, coil springs
Rear suspension	Independent, MacPherson struts, coil springs	Independent, MacPherson struts, coil springs, twin link	Independent, MacPherson struts, swing arms, coil springs
Front stabilizer-bar diameter (in.)	0.67	0.79	0.98
Rear stabilizer-bar diameter (in.)	—	0.63	—
Brakes	Disc-drum	Disc-drum	Disc-drum
Brake swept area (sq. in.)	216.8	181	241.5
Fuel tank (gal.)	15.8	15.8	13.8
Trunk space (cu. ft.)	13.3	21.0	13.6
Liftover height (in.)	31	31	33
Curb weight (lbs.)	2,215	2,410	2,414
F/R weight distribution (%)	61/39	55/45	60.5/39.5
Basic price	$8,645	$10,195	$7,798
Price as tested	$9,664[1]	$11,897[2]	$11,678[3]
Major options (over $100)	[1]A/C $650, stereo AM-FM $200. [2]A/C $650, sun roof $430, aluminum wheels $300. [3]A/C $630; power windows, locks, antenna, mirror $585; AM-FM-cassette $440, two-tone paint $190, cruise control $135		

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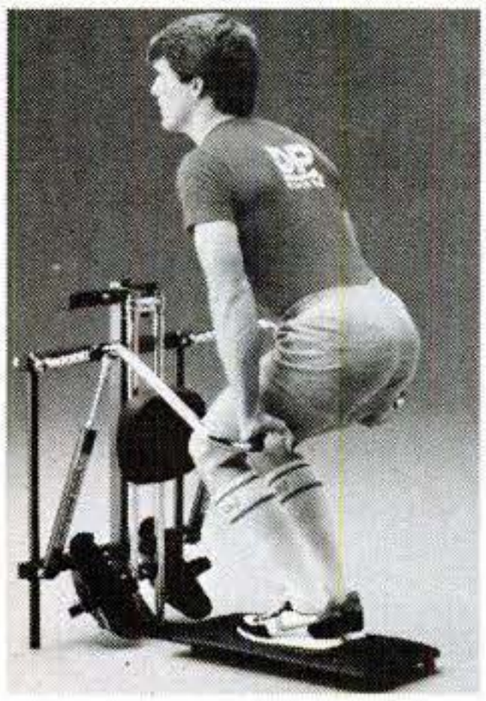
THE TOTAL FITNESS CENTER.

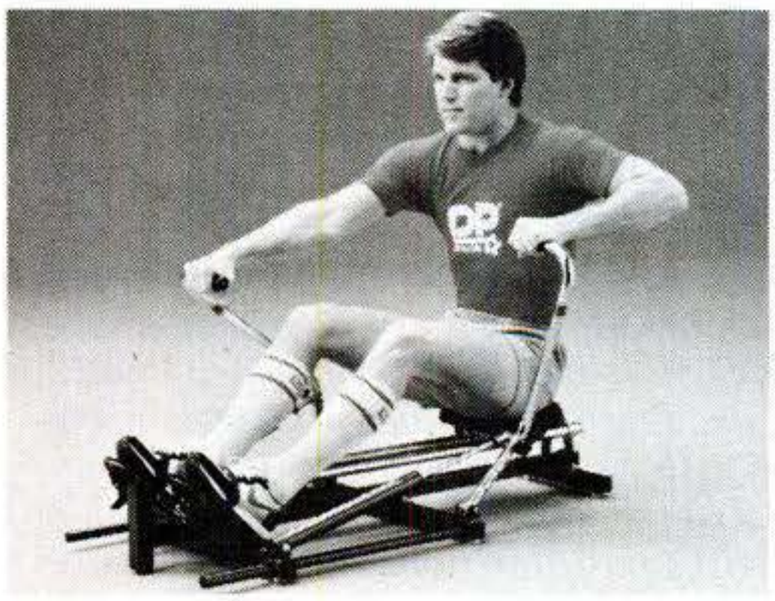
HERE'S A NEW WAY TO DEVELOP A GREAT BODY, HEALTHY LUNGS AND GOOD CIRCULATION—ALL WITH THIS MULTI-PURPOSE GYM.

If you're wondering why we're promoting an aerobic rowing machine...the answer is simple. It's perhaps the best all around exercise you can obtain. Rowing builds endurance and strength while working every major muscle group in your body. And aerobics builds your heart and lungs. It's a combination that can't be beat. And frankly, we've never seen anything like it before.



BUT WHY A ROWING MACHINE?

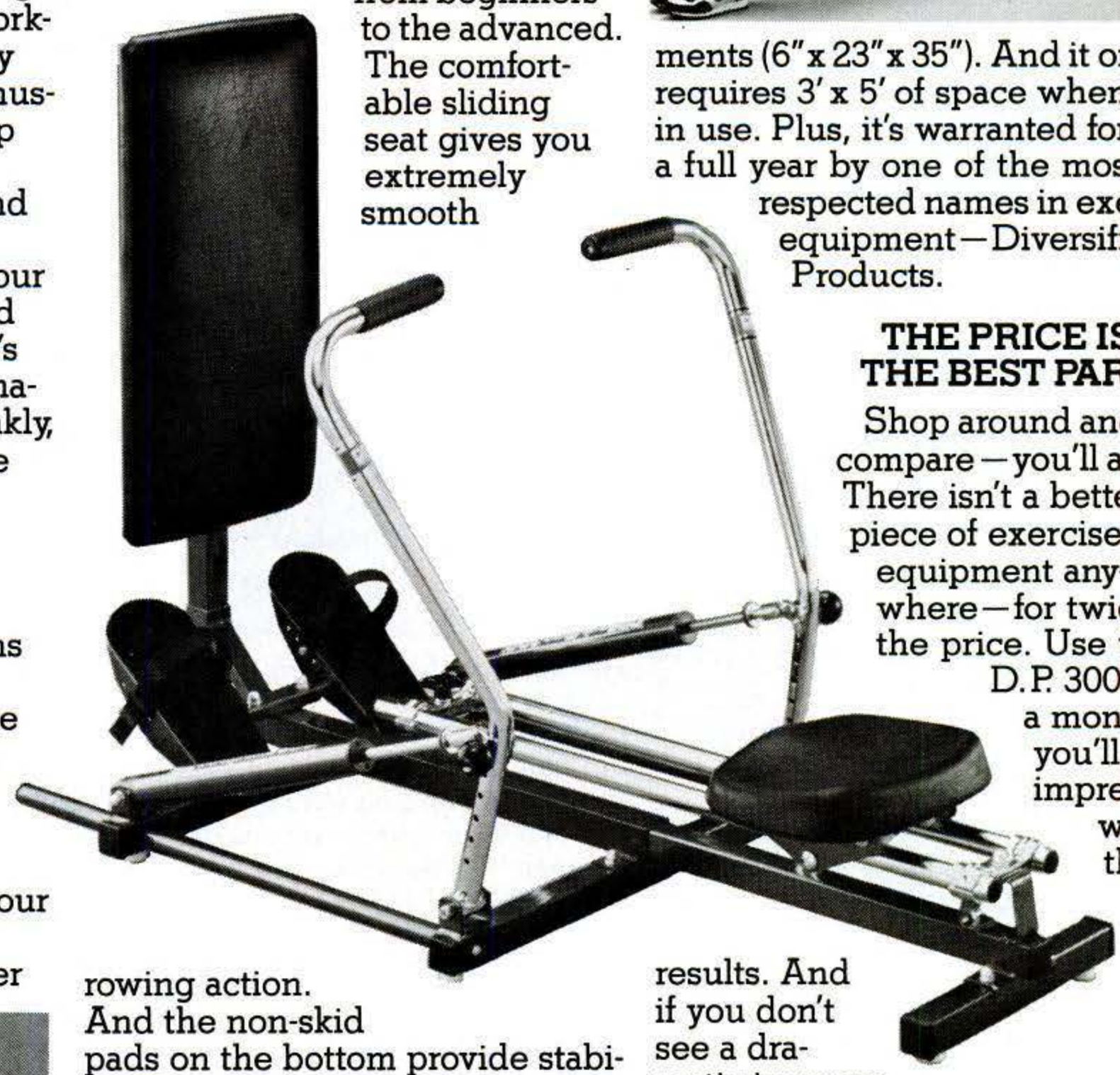
Sure jogging and other forms of exercise are great, however they normally benefit only one part of the body. With rowing, you exercise everything. You build strong muscles in your arms, legs, and stomach. You broaden your chest. You trim your waist. And you build stamina. But there's more...Unlike other



rowing machines, the D.P. 300 is a multi-purpose gym. Flip it on its side. Lay on the comfortable cushion and use it as a bench press...or do curls, squats and slant board sit-ups. The applications are unlimited. You can work virtually every muscle group in less than 20 minutes.

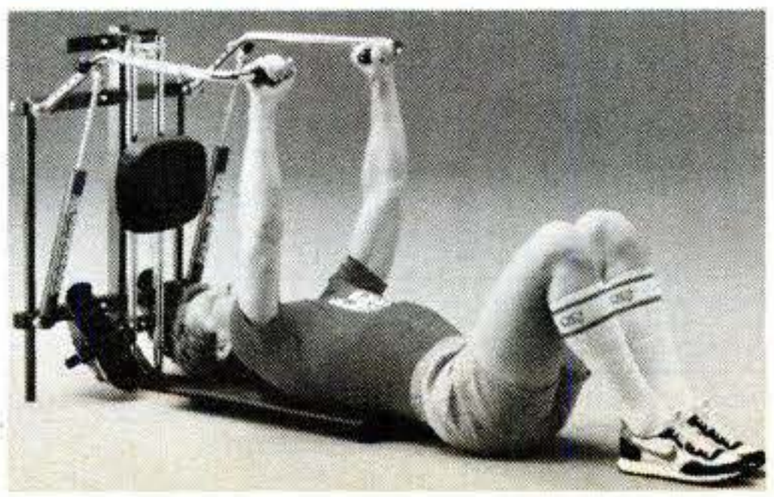
EXPERIENCE ISN'T NECESSARY

Now, everyone can get into shape—year round. With its six different positions for resistance, the D.P. 300 will accommodate any type of exercise routine... from beginners to the advanced. The comfortable sliding seat gives you extremely smooth



rowing action. And the non-skid pads on the bottom provide stability. Plus, there's enough leg room for anyone up to 6'2". Comes complete with an illustrated exercise manual—a tremendous help for someone just starting out.

It's built to last. Constructed of steel, the D.P. 300 has an attractive chrome and metallic grey finish. Storage is easy...it'll fit in most closets—perfect for apart-



ments (6"x 23"x 35"). And it only requires 3' x 5' of space when it's in use. Plus, it's warranted for a full year by one of the most respected names in exercise equipment—Diversified Products.

THE PRICE IS THE BEST PART

Shop around and compare—you'll agree. There isn't a better piece of exercise equipment anywhere—for twice the price. Use the D.P. 300 for a month... you'll be impressed with the results. And if you don't see a dramatic improvement, return it. We'll give you a prompt refund, including the handling charge. Call now, toll-free—and start your program for strength, stamina, and fitness today...you'll be glad you did.

For fast delivery, credit card holders may call toll-free 24 hrs. a day, 7 days a week. Or send a check for $179.00 plus $14.50 delivery. Order product #TDP 21. Add 6% sales tax in CA.

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Challenging Honda Accord

Toyota Camry's soft suspension handicapped it in the high-speed handling test.

Honda Accord sparkled in both low-speed (above) and high-speed handling tests.

fairly responsive. And it gets outstanding fuel mileage.

The transmission works with clocklike precision. There's no over-revving between shifts and no lurching, and the noise level is low.

The engine is a fuel-injection overhead-cam type. It starts easily and is immediately responsive, even before it's fully warmed up.

The Camry's ride is much better than its high-speed-handling ability. The rear wheels lose traction in hard cornering maneuvers or when braking on wet surfaces. The result is a quick loss of control that seems correctable only by reducing speed. We were surprised by this handling problem because Camry has an up-to-date independent rear suspension.

In the race for the title of "World's Busiest Instrument Panel," Toyota has a healthy lead. Its high-priced radio ($440) has 30 separate levers, buttons, and rocker switches. A tilt steering wheel is standard. There are extra storage pockets in the doors and a two-part compartment in the console.

Finally, Camry offers a dual-range automatic transmission. One setting is for additional power; the other is for economy. We posted a zero-to-60 time two to three seconds faster in the power mode than in economy.

Our picks

It's time to try something new, so I'll pick the Mazda, even though a hatchback isn't normally my favorite body style. The 626 handles almost as good as it looks.—J. D.

The Honda's smoothness, stopping ability, and fine handling make it my choice.—J. K. PS

Performance comparison with selected models

	Mpg (city driving)	Acceleration 0–60 mph (sec.)	Brakes 60–0 mph (hot) (ft.)	Handling (mph)	Maneuverability (mph)	Noise @ 60 mph (dBA)
1984 Ford Tempo in-line 4	25	17.4	177	65.1	27.6	71
1983 Chevrolet Citation V6	22	14.7	176	61.0	29.7	71
1983 Plymouth Reliant in-line 4	28	15.2	164	61.4	28.4	72

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Crunch Time

"The professor was so boring that I fell asleep twice."

Think about it. You're listening to a dull speaker and you can hardly keep your eyes open.

Suddenly the speaker speaks faster. You wake up. You're listening more intently. Why?

Scientists have discovered that the faster someone speaks the greater our comprehension. The better our comprehension, the more we benefit from what we're listening to.

TWICE AS FAST

But most people can't talk fast. Certainly not twice as fast. So we're stuck trying to pay attention as best we can. That's soon to change with the new low-priced SoundPacer.

The SoundPacer is a voice compression tape recorder designed to play the human voice faster without changing the pitch. You could record a lecture or listen to a prerecorded tape, double its speed and comprehend more while listening to it in half the time.

But before we describe the system, there is something else even more exciting. The new price. For only $129 you could own an entire voice compression system complete with built-in microphone and be able to record or listen to voice-recorded tapes in half the time, at twice the speed and now at almost half the cost.

The new low price is the result of a purchase made by JS&A directly from Japan. We've got thousands in stock.

TESTED EXTENSIVELY

Voice compression systems have been used extensively at universities and research centers to test human response and comprehension. The tests proved quite positive.

Students can record lectures and review them in half the time. Many doctors who try to keep current with the latest developments in their profession can do so in half the time, even while driving to and from the hospital.

Many conferences, courses, speeches and lectures are often available on tape. Now you can listen to these tapes in half the time and with better comprehension.

IT FIGURES

Your time is valuable. Just figure out how much your time is worth on an hourly basis and divide that amount into the cost of the unit. If you earn $20 per hour, it would take you less than seven hours to save the $129 cost of the unit, but think how much valuable time you'll save after that.

Then, too, there are those who rarely listen to cassettes. Once you experience the increased comprehension and time savings possible with speech compression, you just might be encouraged to listen to more tapes and expand your knowledge.

The new SoundPacer system can be adjusted from double to normal speed and even down to 80% speed to assist in note-taking or learning a language. There is a built-in microphone, the latest tape transport mechanism and a host of features found on expensive audio tape decks.

AUTO STOP

The unit has an auto stop feature which stops the unit at the end of the tape, and sliding controls which operate the pitch and speed plus switch the unit from the accelerated speed to the normal rate. And finally, the unit measures only 2" x 5¾" x 10¾" and weighs a few pounds with its four C-cell batteries (not included) and its AC adapter.

Students, doctors and businessmen—all will find that the SoundPacer is the most valuable new time-saving tool they could own. We urge you to give the unit a try. Remember, JS&A gives you 30 days to judge the value of the product and experience its convenience. Or send your unit back for a full refund plus your $4 delivery charge. With each unit you'll also receive an instructional cassette, AC adapter and one-year limited warranty.

A brand new unit called the Time Cruncher with a few extra features is also available. It has a one-half speed record capability on any of four different sound tracks. This lets you record four hours on a normal one hour cassette—perfect for recording long classes or conferences where changing tapes is inconvenient. And, of course, you can play the tapes back at double speed with the correct pitch. This new unit looks identical to the SoundPacer.

Your time and comprehension are much more valuable than the modest investment in our two systems. Why not give voice compression a test? Order one at no obligation, today.

To order, credit card holders call toll free and ask for product by number shown below or send check plus $4 for delivery.

SoundPacer (5040P 4.00) **$129**
Time Cruncher (5041P 4.00) **239**

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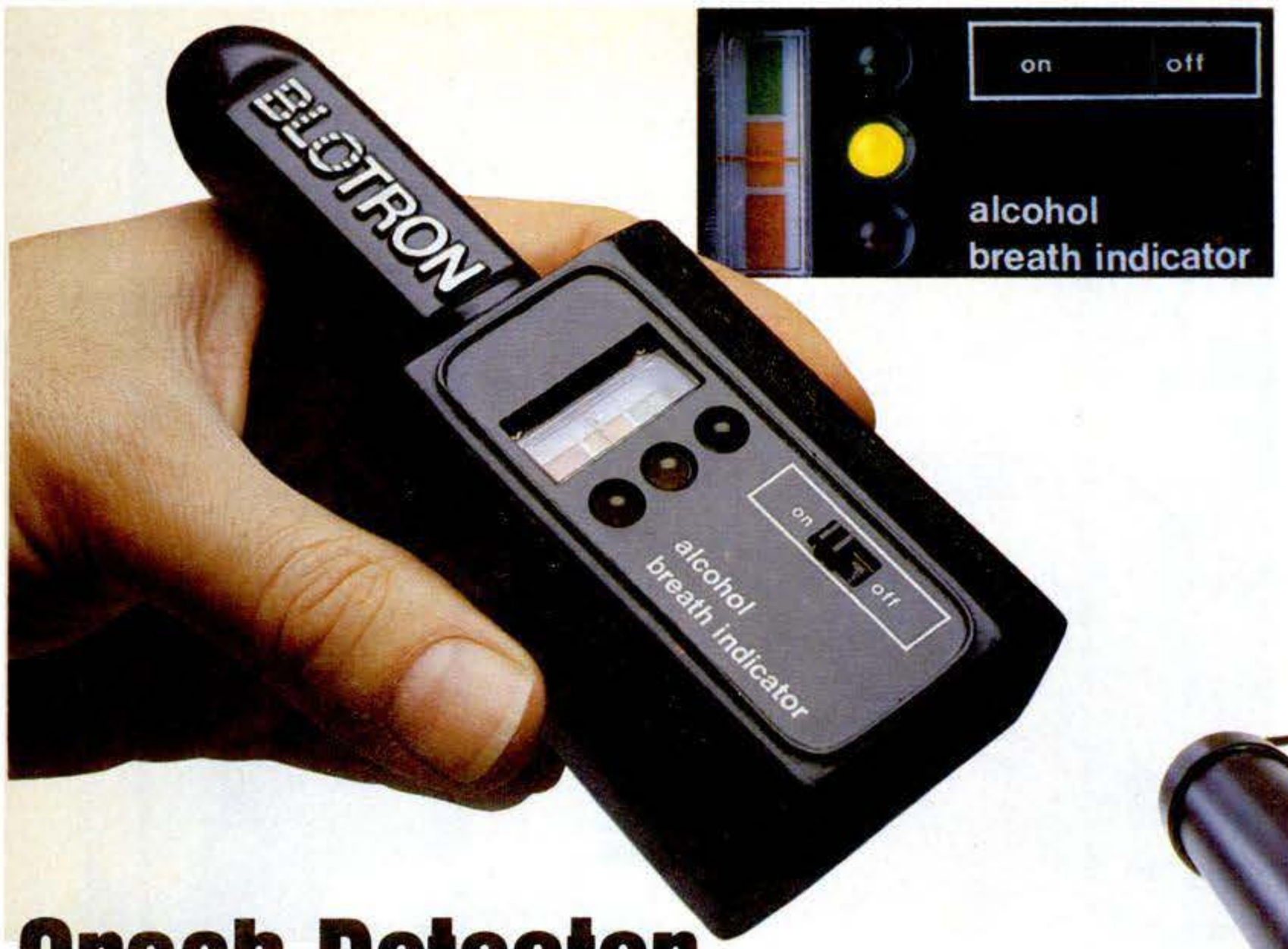

Crash Detector

Even if you never buy one, it may just save your life.

America's biggest killer is the drunk driver. Hundreds of thousands of innocent victims are maimed or killed because somebody had too much to drink and didn't realize it.

Many states have adopted strict jail sentences for drunk drivers. A 32-year old woman from Philadelphia was driving home after a party and had one headlight out. When a policeman stopped to warn her, he smelled alcohol on her breath and asked her to take a breath test. She flunked it and consequently spent a week in jail.

Refusing to take a breath test is no defense either. According to a recent Supreme Court decision, refusal to take a breath test is considered an admission of guilt.

The Blotron is a small pocket-sized electronic device that measures the amount of alcohol in your breath. You simply turn it on, blow into a chamber and the unit compares the alcohol in your breath to a predetermined electronic norm.

If you've consumed too much alcohol, the unit flashes red. If your body contains a minimum amount of alcohol, the unit flashes green. And if you're in between, the unit flashes yellow.

The Blotron is unique for three important reasons. First, is its price. It costs $39—certainly affordable when compared to other units that sell for over $100.

Second, is its technology. With other alcohol breath analyzers you blow through a tube which measures your breath's alcohol content as it passes through.

When you blow into the Blotron, your breath is trapped in a chamber and the chamber then seals itself. Your breath sample is then carefully compared to a sample gas that acts to calibrate the unit. An integrated circuit then computes the amount of alcohol based on the comparison and then powers the lights and meter to indicate the level of alcohol in your breath sample.

Third, the sample gas is supplied by the same company that supplies the comparator gas to the thousand dollar law enforcement systems. This means that the unit is calibrated under very strict standards similar to those of the police departments.

With the Blotron, you've got greater accuracy due to its sampling and comparator functions and a very reasonable price thanks to its ingenious design.

Breath tests are now admissible evidence in court thanks to the strict calibration procedures and the use of the same comparator gas used in the Blotron. If your blood contains over point 1% of alcohol by weight, you are considered drunk and the Blotron flashes a red light. We call the Blotron a 'Crash Detector' for good reason. You don't have to be a criminal to drink too much and not realize it. The lady mentioned earlier certainly wasn't. Very often the most law abiding citizen with the cleanest driving record can get trapped into a circumstance that ends up in an arrest and a jail sentence.

The Blotron is simply an accurate and reliable device to help you determine a safe time to drive your car. And we know for sure that its use will save many lives.

If the courts seem rather harsh in their sentencing and evidence gathering procedures, so is the menace from drunk drivers. Thousands of innocent people are killed each year and the massacre was getting worse until this stronger legislation came into effect.

Technology, high quality standards and mass production has made the Blotron possible. Who knows how many lives will be saved from its sale? Order one, keep it handy and encourage others to do so too.

Blotron (0017P 4.00) **$39**

Flashlight With Ears

Why would one need ears?

The answer, of course, is that flashlight don't need ears. But some clever engineer came up with an idea. They put a highly sensitive and directional microphone inside a acoustic chamber (which just happens to loo like a flashlight), made it completely portabl and attached a great pair of headphones What did they end up with? The Bionic Ear—device that helps you hear distant sound lik it was right next door.

The Bionic Ear is a very useful product. you're a hunter searching out game, a farme trying to find pests in your fields or policeman doing surveillance, the Bionic Ea can really help. Please, however, don't us the Bionic Ear to snoop. First, it's illegal, an second, if you use it on busy streets or wher there's a lot of background noise, it won work very well.

The Bionic Ear comes complete with 9-vo battery, headphones, volume control an there's also a hand-held parabolic dis available which improves the unit's directiona accuracy. You'll be able to locate noises faste with less background interference. Why nc order your Bionic Ear, today?

Bionic Ear (4030P 4.00) **$9**
Parabolic Dish (4031P 3.00) **3**

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Super Value

Here's the secret about a typewriter that may surprise you.

Psst. Wanna buy a great typewriter? We've got one cheap. But before you leap for your telephone, here's a little secret not too many people know.

The Silver Reed EX-42 electronic typewriter is not your average typewriter. For $295 you actually get more than you pay for.

Inside the typewriter is a circuit board that contains the first of the integrated circuits and microprocessors required to expand the unit into a full-fledged, letter-quality computer printer. Simply by plugging in a very powerful computer circuit board module, you can expand the Silver Reed into a printer or even a portable computer terminal.

You just can't take an electronic typewriter and expand it into a printer by adding the computer logic. A printer gets an enormous amount of use and requires a heavy-duty motor for the printing mechanism and the daisy wheel. Unfortunately some typewriter companies have tried to convert their units to printers but their typewriters just don't last.

The EX-42 already has a heavy-duty servo-controlled stepper motor in their units. Silver Reed was planning for their printer expansion and were paying almost ten times more for their motors than they had to. So for the $295 you get a typewriter that is electronically more advanced and mechanically more powerful than it has to be.

What does this mean for you? Simple. If you want to buy an electronic typewriter built better than practically any other similar unit on the market without paying extra for it, the Silver Reed at $295 is a steal.

But later, if you do decide to turn it into a printer, you can easily do so with an expansion module available from JS&A for only $369. But first let's describe the typewriter.

The Silver Reed EX-42 has a daisy wheel printing element and carbon film ribbon that produces an incredibly crisp, clear impression. The unit is whisper quiet. It features a correcting key which can "remember" and lift off the last sixteen letters typed and the daisy wheels quickly pop in and out. A 10-pitch Prestige Pica wheel comes with each machine and other typefaces are also available in either 10 or 12 pitch.

Simply by adding the expansion module your EX-42 can do centering, decimal tabulation, auto indent, 15-pitch mode and it even has a "return zone" feature which automatically gives you a carriage return when you reach the end of a line and press a space bar or hyphen. We'll send you details on the expansion module when you order the typewriter.

If you're looking for the finest typewriter value available with features and expansion capabilities that will keep up with the latest technology, we urge you to order a Silver Reed EX-42 at no obligation today.

Silver Reed (6066P 5.00) **$295**

Hands-Free Headset™

This micro-light headset gives you twice the convenience.

Relief at last. Here's a product that lets you talk on the phone without holding the receiver. With both hands free you can take notes easier, look through files—all while you talk. But there's even a more exciting feature.

The studio-quality headset is a comfort to wear. It's so light you forget you're wearing it. The boom mike and wire headband are fully adjustable and the speaker pad rests gently against your ear.

Most headsets plug into your ear. With the Hands-Free, the pad rests comfortably on your ear. And two ear pads come with it—one for normal conversations and a larger pad for noisy environments.

There's an amplifier that attaches to your telephone with a Velcro® pad so that you can adjust the volume level of the incoming call. You hear the party clearer and the voice reproduction is as good or better than most conventional telephones.

The unit has been approved by the FCC, it weighs only 3 ounces, plugs into any modular phone and has a seven foot cord with a clasp so you can clip it out of your way. The headset works perfectly with any phone which doesn't have its dial or keypad built into the handset. Experience the freedom of using the phone with a Hands-Free Headset. Order one, today.

Hands-Free Headset (1070P 4.00) . . . **$49**

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Rescue slide

for skyscraper fires

From the rooftop of a blazing skyscraper, a simple chairlift can rescue 40 to 60 people an hour, according to developers of the Roco Slide for Life. The gravity-operated lift has been tested on a 51-story building in New Orleans.

By SUSAN RENNER-SMITH

"Fire!" If you work or live in a high-rise, it's an especially feared word. But workers at One Shell Square in New Orleans now breathe a little easier. The building is the first to install the Slide for Life, a new rooftop system for rescuing people trapped above a fire in a high-rise.

The Slide for Life is elegantly simple: A roof-mounted frame holds two chairlifts yoked to counterweighted pulleys (inset photo). Four chairs ride on 1½-inch stainless-steel cable to the ground or an adjoining roof. There's no power source. Gravity runs the lift.

"The ride is very smooth. You don't feel like you're flying through the air because it doesn't jerk," says Lorie Leigh Benjamin, president of Roco Systems, Inc. (2223-B Magazine St., New Orleans, La. 70130). "It's not frightening at all—unless you look down."

Developed by two members of the prize-winning Louisiana State Police rappelling team, the system mechanizes the centuries-old art of rope-assisted descent from high places. During a fire, building personnel push the aluminum-and-steel frame along a track to the roof's edge and lock it in place. One person shoulders a ship-to-ship line-throwing gun and shoots the cables down to firefighters. They attach the cables to quick-connecting tie-down points permanently mounted on a roof or on the street.

"When they throw the line, two chairs go down," Benjamin said. "Then they strap people into the two chairs that remain on the roof. As those people slide down to safety, their weight pulls the first two chairs up." The chairs, aluminum-framed woven-nylon baskets, are rated at 4,000 pounds. A harness provides security for the open-air ride (main photo).

In tests at One Shell Square in New Orleans, the 22-story ride down to the Pan Am Building took about 1½ minutes, Benjamin reported. "Depending on the building's height, we can rescue 40 to 60 people an hour," she said.

One observer at the tests, Carroll L. Herring, Louisiana State Fire Marshall, called the Roco Slide for Life "the safest, most-efficient means of high-rise rescue available." The rope chair wasn't designed to replace a sprinkler system, he noted. "But it's a good, last-resort system that might well save lives when all else fails."

The Slide for Life's $50,000 price includes training for building personnel and local police and fire departments. "But an untrained person could operate it if instructions were given over a megaphone," Benjamin added. PS

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Now computers and robots join

the fight against fire

Is the traditional image of the firefighter, dressed in a heavy black-rubber suit and lugging a fire hose from a bright-red engine, fading into nostalgia? Today's firefighter instead may be dressed in lightweight synthetic garb that resembles what an astronaut wears for a spacewalk. And like the astronaut, the firefighter may be guided by a computer. The fire "engine" may be a mobile tank carrying thousands of gallons of water and chemicals, or it may be a helicopter. A robot may carry the water hose into the heart of the blaze while the firefighter scales a ladder so tall that even spectators get vertigo.

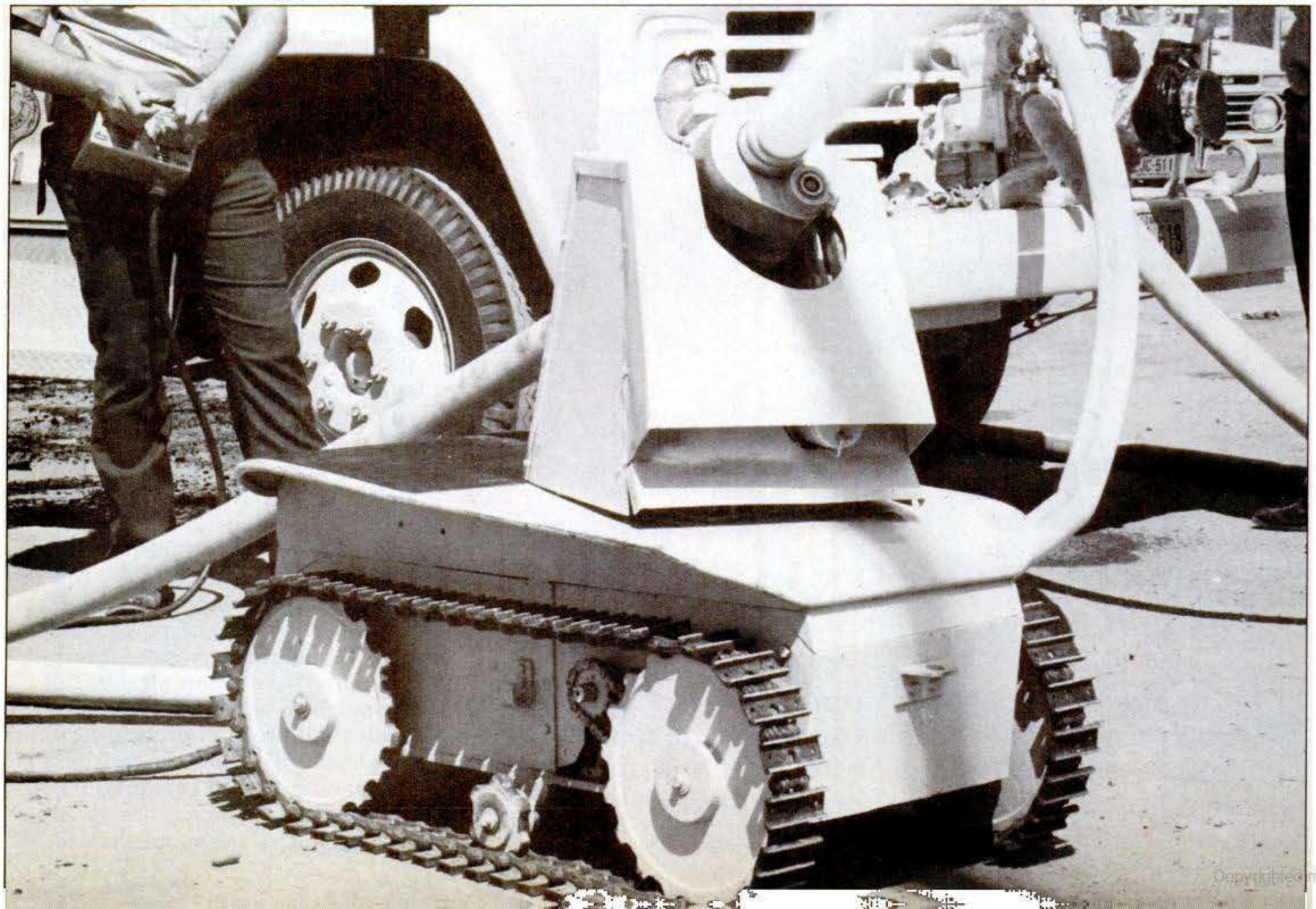
By FRANZ SERDAHELY

At fire-department headquarters in Phoenix, Ariz., the alarm sounds. A staff member hurries to a computer terminal, where his fingers rapidly dance over the keyboard. Within seconds, a few lines, symbols, and words appear on the video screen in front of him. The cryptic images pinpoint the location of the burning building by showing what streets surround it. They also show exits and entrances to the building and the locations of electrical hookups and fire hydrants. Virtually every building in Phoenix that's taller than a few stories has been located, charted, and diagramed; the information is stored in the computer's data bank.

Next, the data on the fire are relayed to the terminals in all the fire stations. The fire is in Company No. 7's jurisdiction. At the station house, an official locates the fire on a wall map, gets a printout from the computer, and the officer in command speeds with his crew to the blaze, armed with the hard copy.

Continued

Snail, a 600-lb. steel robot, carries water lines into fires. Holding a 400-ft.-long umbilical, the operator uses switches to maneuver the robot and thus direct the water at the blaze. Four 12-V batteries provide motive power. Snail, created by the Scottsdale, Ariz., Rural-Metro Fire Department for its own use, may be put into production.



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They kept America safe. Now you can keep them in your den or office as a nostalgic memory of times gone by.

No. E1084
1934 Ford V8
Hose and Ladder Truck
Trenton, N.J. Fire
Department

No. E1083 / 1934 Ford V8
Hose and Ladder Truck
San Francisco Fire
Department

No. E1082 / 1934 Ford V8
Hose and Ladder Truck
Trenton, N.J. Fire
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Collect these famous Ford fire fighters

Each fire truck is built to 1:43 scale—43 times smaller than the original! Hose and ladder truck, above, measures about 5″ long.

It wasn't too long after the horseless carriage appeared on the scene that municipalities realized the value of a motorized fire department. By 1934, as Americans "watched the Fords go by," many of them were Ford tank, hose and ladder trucks like the ones pictured here.

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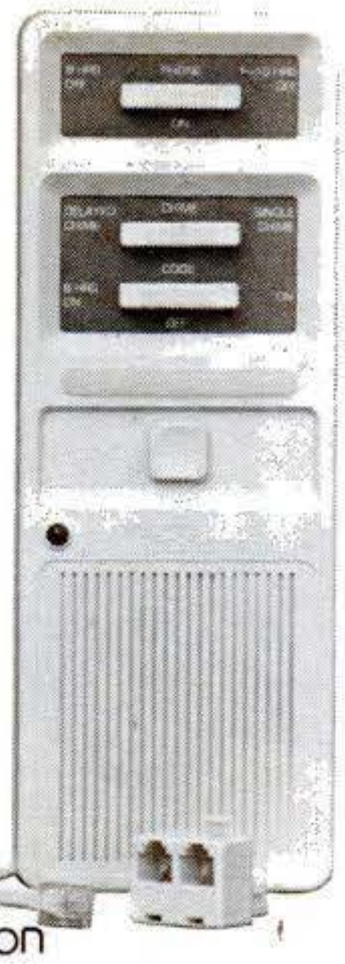

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AN INTELLIGENT PHONE CHIME

PC 200 can chime just once, repeatedly, or waits for several rings. It's smart enough to turn up the volume when you go outside and polite enough to be silent during the dinner hour, intimate moments, and the middle of the night. It lets you know who's calling or who the call is for before you answer the phone. And PC200 even ignores crank calls, sales people, and wrong numbers.

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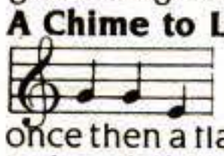
A Chime to Love. A pleasant chime  replaces the harsh ring. Set it to Single — you'll hear it chime once then a flashing light takes over. Or choose Delayed chime, you won't be disturbed if the phone is answered in another room.

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The fight against fire

Proboscis on helicopter is the nozzle for a self-contained firefighting system that can convert a helicopter into a flying fire engine. The C-300 FireMaster carries a 350-gallon tank for water or chemicals, which the nozzle can direct into a window on high floors of a skyscraper. It can also respond to fires in remote areas, such as on oil tankers, or reach highway fires despite traffic.

The fire, in the kitchen of a neighborhood restaurant, hasn't spread beyond one room. Directed by the computer printout, the crew quickly connects water lines and begins blasting water at the blaze. Within minutes the fire is out.

Fighting fires with computers? It's only one example of the quiet but critical revolution that is transforming the ancient craft. "Today's technology, equipment, and firefighter are totally different than those of 50 years ago," says Jack Girard of the National Fire Protection Assn. in Washington, D.C. As a result, fire fighters are finding better ways to save people and property despite ever-taller skyscrapers, apocalyptic flammables, and fires in hard-to-reach places.

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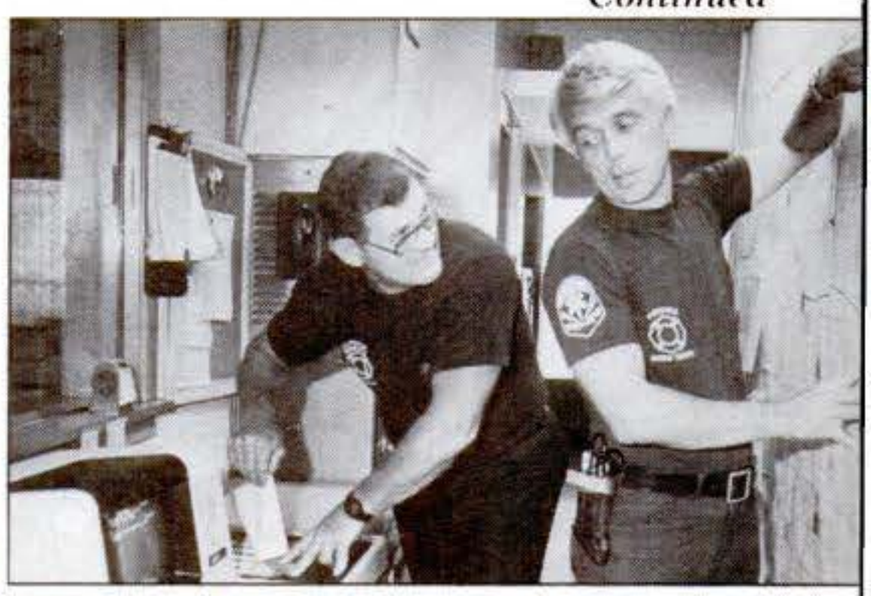

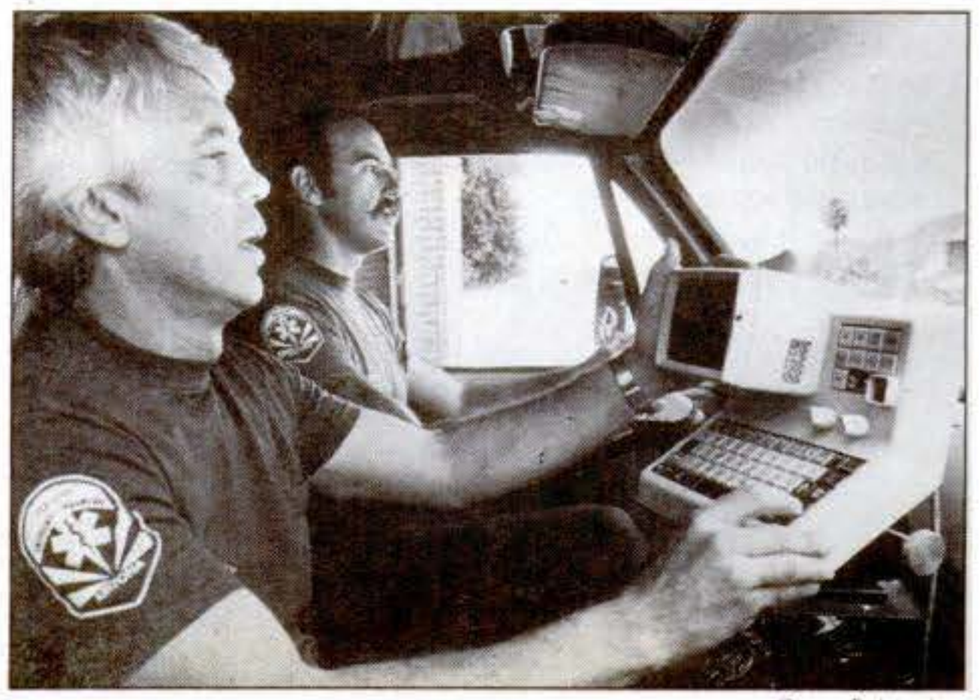

Computerized information on structures larger than four stories aids fire department in Phoenix, Ariz. When a fire alert flashes, building data are displayed on screen (above). A printout confirms all data. At Phoenix Fire Station No. 7, a squad member checks location against city map (above, right). Terminals in vehicles (right) link rescue squad with headquarters.

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Sleep Sheep

We may have found a way to improve your sleep forever.

New Zealanders discovered that sleeping under sheep's wool induced sleep.

The story we are about to tell you may seem rather incredible. And indeed it is. But if you'll have an open mind, what you will learn may indeed change your life.

There is a new product manufactured in New Zealand that is selling very well. It's called the Woolrest—a bed pad made of thick wool. You simply place it over your mattress and then cover it with your bottom sheet as you normally do when you make your bed.

SLEEP INDUCING

Sheep's wool has always had an outstanding reputation for keeping you warm in winter and cool in summer. That is why wool seat covers are so popular. But wool has another property known by New Zealanders for many years. Namely—wool induces sleep.

In New Zealand, for example, a way to cure insomnia was to cover yourself with a sheepskin rug. For some very unscientific reason, the hypnotic quality of the wool encouraged sleep. Counting sheep was another technique that was often recommended. But it was the development of the Woolrest bed pad that suddenly turned an old wive's tale into fact.

DIFFERENT EXPERIENCE

Sleeping on a Woolrest is a different sleeping experience. Whether you sleep on a hard or soft mattress, the Woolrest apparently radiates a feeling of comfort and relaxation from the wool fibers which mold, massage, and conform to your entire body.

Scientific tests conducted by Dr. Peter Dickson of Ohio State University proved that the Woolrest pad indeed helped induce sleep. Testimonials from people who owned them clearly demonstrated that Woolrest not only induced sleep but also provided great relief for backaches, arthritis, and rheumatism. Its natural fibers tend to alleviate the pain and pressure caused by these illnesses and thus make sleep come easier and deeper.

Frank Thornton, a Seattle Washington dental technician, had trouble sleeping for six years. He purchased a Woolrest pad and has been able to sleep through the entire night practically every night. According to Thornton, "I felt a sensation of buoyancy from the Woolrest. I have read in literature that a person sleeps more restfully with natural fibers surrounding their body." Thornton has already purchased seven Woolrest pads for his entire family.

There are hundreds of other testimonials we could mention from the thousands who have purchased them, but one thing is clear. Using a Woolrest pad you know that the rest of your life will be spent sleeping comfortably, with a minimum amount of sleeplessness. Certainly, there will be nights when it will be difficult to go to sleep. But with the Woolrest those nights will be fewer, shorter and without the tradeoff of taking sleep-inducing drugs.

WARM IN WINTER

In the winter the Woolrest holds your body heat and thus keeps you warmer. You'd expect that. But in summer it keeps you cooler through a process of moisture absorption by absorbing up to one-third of its weight in moisture to keep your body cool and dry.

Will the Woolrest work for you? We're willing to prove it with no risk on your part. Order one for a 45-day sleep test. When you receive it, closely examine the surface. Feel the thick pure woven pile of natural New Zealand wool. Place it on your bed and then cover the pad with your regular bottom bed sheet—either fitted or plain.

JUST A FEW DAYS

That night go to sleep on it. But don't judge the effectiveness until you've slept on it for at least a full month. You should actually notice the difference in just a few days, but after a month you'll turn from being skeptical like we were, to a real enthusiastic believer. If not, we'll understand. After all it may not work for everybody. Just return it within the 45-day sleep trial and you'll receive a prompt and courteous refund including the $4 delivery charge. The Woolrest washes easily in your washing machine and has a limited five-year warranty. Complete instructions come with each pad. Sleep on a Woolrest and experience what we mean at no risk or obligation. Order one, today.

To order, credit card holders call toll free and ask for product by number below or send check plus $4 delivery for each pad ordered.

Twin Size (0025P2)	**$129**
Full Size (0026P2)	**179**
Queen Size (0027P2)	**209**
King Size (0028P2)	**269**

The New Zealand wool used exclusively in the Woolrest could be a major reason for its effectiveness. Here's why.

Most sheep are raised in countries where temperature extremes cause their wool fibers to become brittle, rigid and often cracked at the ends. In Australia sheep are often raised in the dusty outback where temperature and rainfall can vary greatly.

In New Zealand however, the sheep enjoy a year-round temperate climate and graze in lush green pastures. Their wool fibers are thick and vibrant with good shape retention.

NEW ZEALAND WOOL

The Woolrest uses only the best New Zealand wool. The fibers are actually woven onto a pure wool blanket base and thoroughly washed and tufted.

We have mentioned the importance of New Zealand wool for good reason. Just as there are several grades of sheepskin seat covers, we suspect eventually there will be several grades of wool bed pads. None will ever compare to the wool used in the Woolrest.

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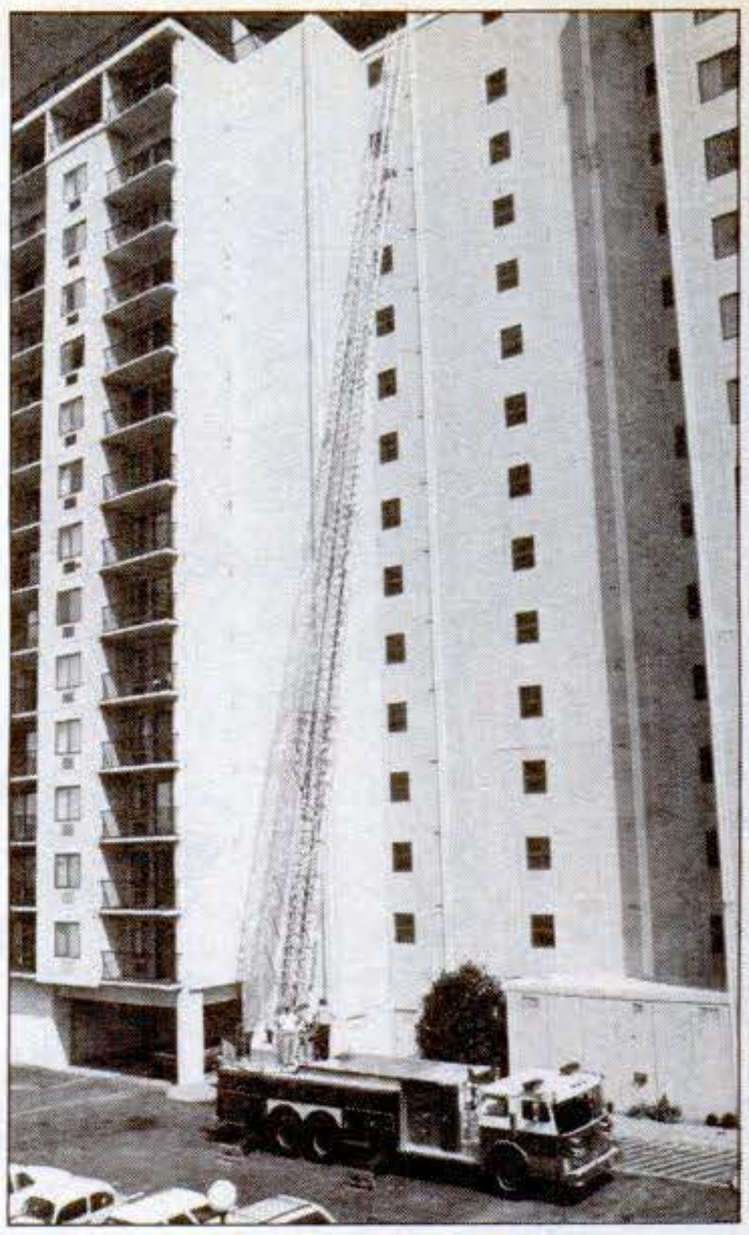

Tallest aerial ladder in the U.S. is 135-ft. Stratospear. It can reach up to 13 stories. In addition to the water line that runs from the truck to the ladder top, a breathing hose delivers air.

Some new technologies also reduce the risk to the firefighters. In Scottsdale, Ariz., the Rural-Metro Fire Department, a privately owned corporation under contract with the city, has a unique crew member—a robot named Snail. The only working, remote-controlled water carrier in operation today, Snail can work a fire hose

Continued

Proximity suits shield firefighters from toxic substances and high radiant heat —some can resist temperatures up to 2,000 degrees F for several minutes. This quilted model is for lesser blazes where temperatures don't exceed 300 degrees F. It's made of synthetic fibers.

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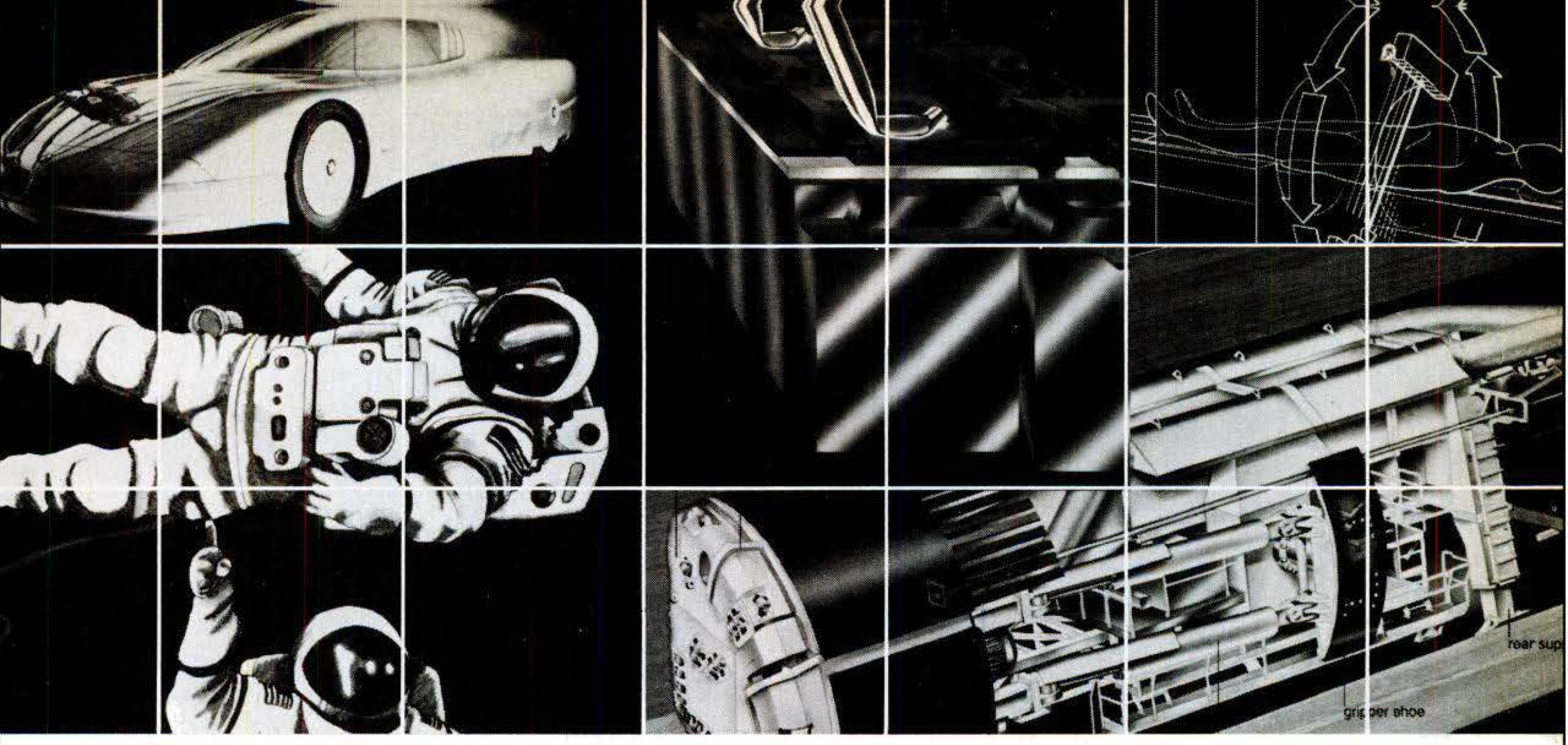

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But those who do manage to keep up will find they've gained unprecedented control over the quality of their lives.

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Technology Illustrated is the one magazine specifically geared to help you put the new technologies to work.

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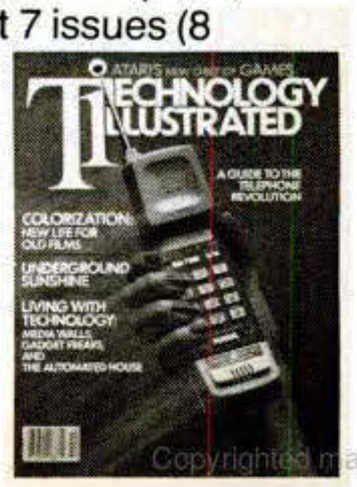

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Fire engine for runways: Titan, a rugged aluminum vehicle, fights airplane fires. Powered by a diesel engine, it can accelerate from zero to 50 mph in less than 25 seconds. Titan carries four crew members, a 1,500-gallon tank of water, and a 190-gallon tank of fire-fighting foam. Self-contained pumps blast foam or water at the blaze.

through narrow passageways (it's only 26 inches wide) and into the heart of chemical fires, brush fires, and burning buildings. "Snail can take the place of two firefighters," says company chairman Lou Witzeman.

Usually, though, the firefighters must go into the flames to do their job. Before they do, they probably don proximity suits, the latter-day replacement for the black-rubber-and-canvas suit and leather helmet with peaked shield. "Each type of fire requires a specific type of proximity suit," says Robert Barr, technical adviser for the National Fire Protection Assn. "These suits range from fire-retardant-fabric clothing worn at a residential fire to hooded, aluminized, six-layer suits, complete with breathing apparatus, which rescue crews wear to fight an aircraft fire or a blaze at a refinery."

Dressed in proximity suits, firefighters resembling the moonwalk astronauts probe the site for victims, who are immediately wrapped and carried out of the fire in blankets of flame-retardant flannel with an aluminized coating.

Getting there

Response time may be even more critical than firefighting techniques and tools. Today's well-equipped firefighters speed to the blaze aboard powerful trucks that contain sophisticated pumping plants. On board are hose lines that stand up to brutal wear and power tools unknown three decades ago. Aerial-ladder trucks rapidly convert into electro-hydraulic bases that, when jacked, thrust lightweight, extruded ladders to the top of 13-story buildings. Water and air lines are quickly extended to the crew at the top.

The Los Angeles fire department takes pride in reducing response time to fires in hard-to-reach areas with its stable of "flying fire trucks." A fleet of six helicopters can be dispatched to fires ranging from a high-rise blaze to a canyon raging with brush fires.

"We have developed the best aerial capability of any fire department in the U.S.," claims Chief Jerry Johnson, the community liaison officer. "Our fire-department pilots and helicopter fighter teams can handle virtually any fire emergency in the Los Angeles area. If freeways are jammed, we fly firefighters, hose lines, and other equipment to the site in a matter of minutes. If necessary, our teams can rappel from a copter to the top of a building or onto a jammed pier."

What is ahead for firefighters? What new equipment and technology are forthcoming? "We will see integrated computerized communications systems in extensive use on vehicles and in stations," Jack Girard forecasts, "and greater use of helicopters in city fires and airplanes in rural fires. We also expect even more improvement in protective clothing (complete with built-in breathing systems) and more use of robotics—with television-radio adaptions. When you protect the firefighter properly and give him the best tools made," he notes, "you broaden your fire protection." PS

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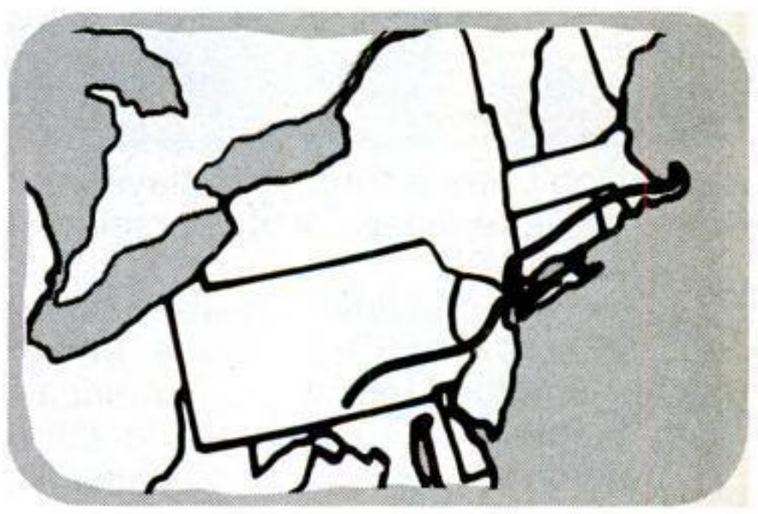
PS 3,000-MILE TEST

U.S.-made Honda Accord



Can American workers build a Japanese-designed car to the same quality standards as the made-in-Japan version? PS drove a Honda Accord built in Ohio for 3,000 miles and found it a paragon of fit and finish.

By JACK KEEBLER

The Honda Accord has been one of the most popular cars in recent American automobile history. A big part of this success story has been attributable to Honda's reputation for durability and craftsmanship.

Until November of last year, when production started at Marysville, Ohio, some observers of the domestic scene wondered whether American workers could build an Accord to the same high standards of quality to which Honda buyers were accustomed.

If the production models are like our test vehicle, they can stop wondering. I inspected the Accord with the eye of a drill sergeant and couldn't find a single quality glitch.

Brightwork and side molding were properly aligned, screws were carefully inserted, and the tan paint was laid on with a creamy, glass-like smoothness. All of the controls, locks, and latches worked with the uncommon ease of those in vehicles costing two or three times as much as this sedan.

The variable rate power-assisted steering is unusually light. Tight parking maneuvers are a one-handed breeze, but Honda sacrifices some road feel for this effortless steering.

Although some early drivers have considered the engine's performance "marginal," I found there was easily enough power for grades, highway entrance ramps, or passing. The four-speed automatic is a big improvement over early Japanese slush boxes. The quiet little unit snaps off clean, crisp shifts without hunting for gears, overrevving, or slipping.

On the highway, fuel mileage hovered around 30 mpg. Driving that consisted mostly of city stop-and-go netted an average of 26.5.

Inside, the seats are soft yet supportive. The beige knit pile upholstery felt comfortable but looked shabby in comparison with the rest of the well-detailed interior.

It's fortunate that the map pockets in the doors are standard because the glove box isn't large enough for anything but a single pair of gloves.

I was surprised at how many items are standard equipment on this model: the four-speed automatic transmission with a lockup torque converter, a tachometer, tinted glass, a quartz clock, power steering, cruise control, and many other items that are usually options on domestic models. The sticker price on our vehicle was a remarkably low $8,645.

"In all, the Accord is an all-star car: comfortable on the highway, great fun on winding roads, and effortlessly maneuverable around town as well" [PS, Dec. '77]. Fortunately, some things don't change. PS

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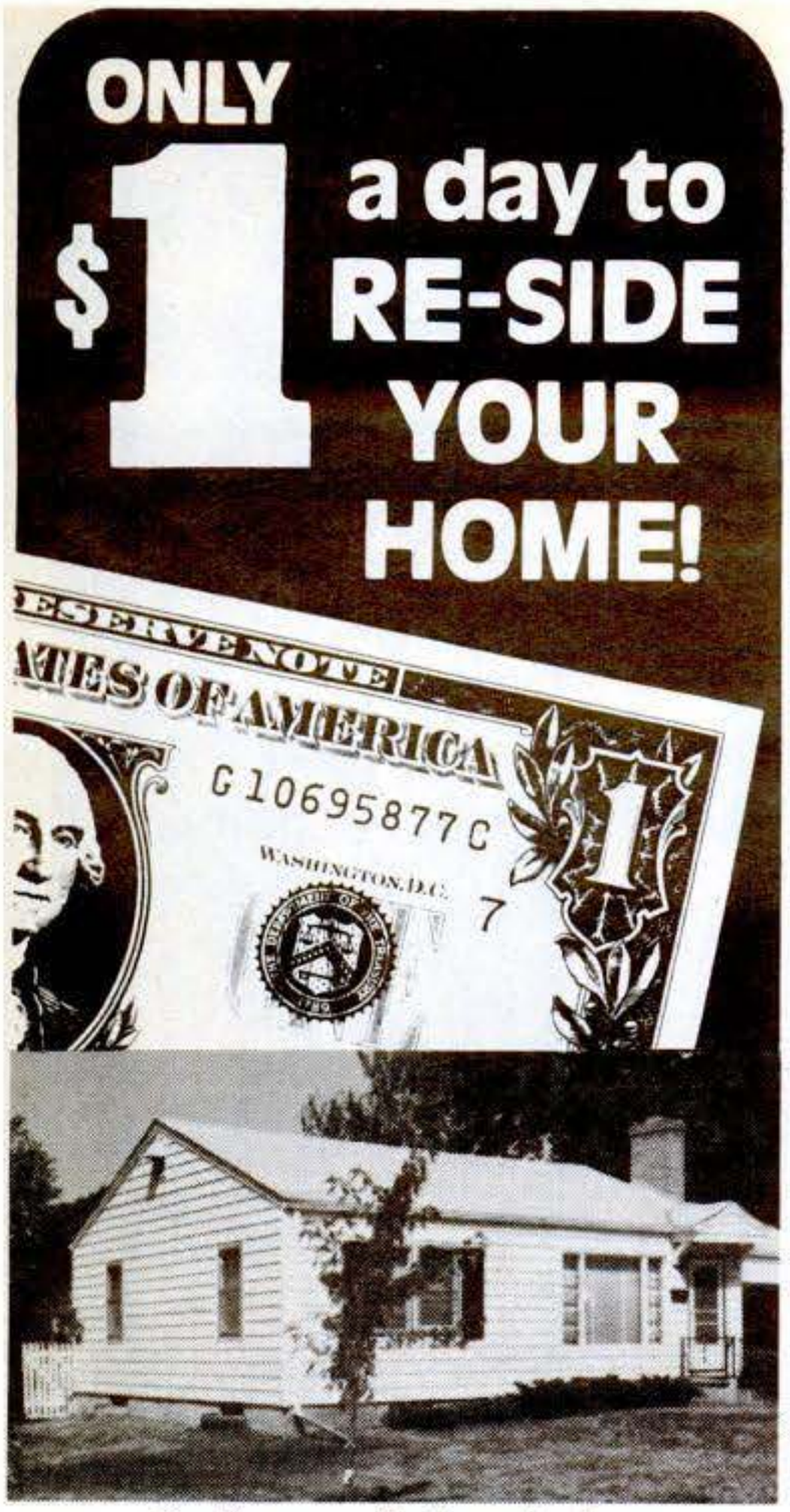

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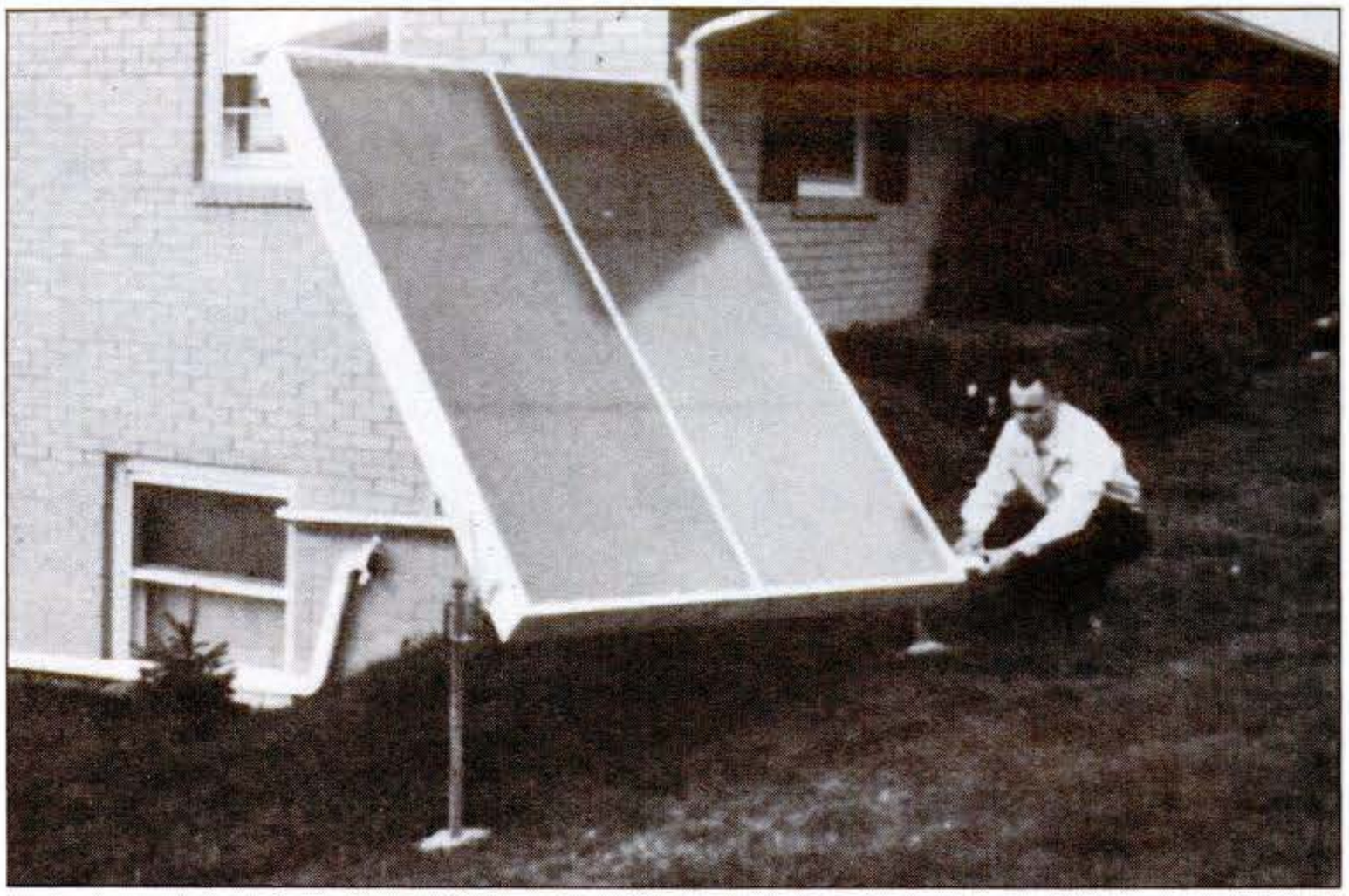
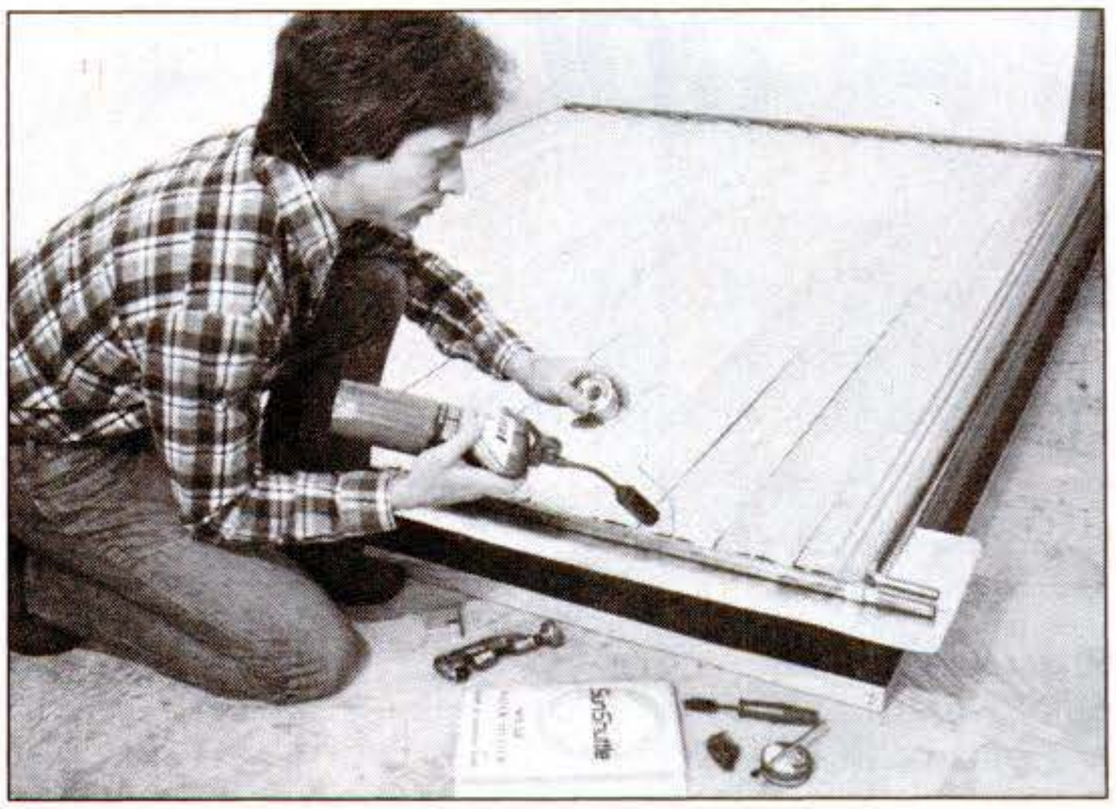


Carl Bozung mounted his collector on pipe legs. Water lines go through window.



You solder fin tubes to a header while building the collector. For the heat exchanger, coil the copper tubing and set it in a 55-gal. drum with plastic liner.

Since 1979, Chris Fried has taught hundreds of Pennsylvanians how to build low-cost solar water heaters. Now the ex-aerospace engineer sells a $379.95 SunShuttle kit that includes 15 copper fin tubes, two copper headers, 48 square feet of fiberglass glazing, aluminum glazing bar, differential thermostat, plastic tank liner, and remote-reading thermometer.

You can buy a pump separately (along with copper tubing, 55-gal. drum, water lines, and lumber you'll also need). Or you can buy one of his. A well-written and -illustrated 65-page assembly and installation manual adds another $6.95; it's essential.

The six-by-eight-foot collector should total about $750 and take two to four weekends to build. Fried figures an equivalent system would cost $2,000 plus $1,500 for installation.

A typical drain-back system, SunShuttle uses two gallons of water to transfer heat from the collector to domestic water in 60 ft. of ¾-in. copper tubing in the drum. Chris Fried Solar, R.D. 3, Box 229 G, Catawissa, Pa. 17820.—*Erik H. Arctander*

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Magic Baloney

You'll love the way we hated the Magic Stat thermostat until an amazing thing happened.

It had no digital readout, an ugly case and a stupid name. It almost made us sick.

You're probably expecting our typical sales pitch, but get ready for a shock. For instead of trying to tell you what a great product the Magic Stat thermostat is, we're going to tear it apart. Unmercifully.

When we first saw the Magic Stat, we took one look at the name and went "Yuck." We took one look at the plastic case and said "How cheap looking." And when we looked for the digital readout, it had none. So before the salesman even showed us how it worked, we were totally turned off.

REAL LOSER

So there it was—at first blush a real loser. But wait, we did find one good feature—a feature that led us to a discovery. The Magic Stat installs in a few minutes and no serviceman is required. Thermostat wires in your wall follow standard color codes. So when you install Magic Stat, you attach the red wire to the red location and the white to the white. That's playschool stuff. And it's safe. Conventional thermostats installed over the past 20 years are generally only 24 volts, so you can either turn off the power or work with the "live" wires without fear.

OK, LET'S TEST IT

The Magic Stat installation was so easy that the least we could do was test it. And that's when we made an incredible discovery. We discovered that the Magic Stat was probably the most consumer-oriented, technologically-advanced and most sophisticated thermostat ever developed on the face of this earth and in our galaxy for all times ever. What made us switch from hating the thing to loving it? Read the following.

The Magic Stat has six setback settings per day and a seven day program. That means that you could set it for 70° when you get up in the morning, drop the temperature to 54° when you go to work, raise it to 68° when you return for dinner, raise it up to 72° after dinner as you watch TV and then drop it down to 62° when you go to sleep. Count them—five settings with one to spare.

In one day the Magic Stat is programmed for the whole week and for the weeks to come. If you want a different schedule for weekends, you can individually program the thermostat for those days, too. "Big deal," you might think. "What's so great about that?" Read on.

You set most electronic setback thermostats to the time you want the furnace to go on in the morning, so when you wake up, your room is once again warm. But what if one morning it's bitter cold outside and the next morning it's much warmer? This means that setting your furnace to go on at the same time may, on one morning, leave you cold and on the next morning cause you to waste energy by warming up your house too soon.

By golly, the Magic Stat has everybody beat on this one too. Throughout the night it senses and computes the drop in temperature and the time it will take to get your room to your exact wake up temperature. So if you want to wake up at 7 AM to 70 degrees—that's the temperature you'll wake up to every time. Because it's a patented concept, no other thermostat has this feature. But wait. There is also a patent on the setting feature.

SIMPLE TO SET

To set the thermostat, you press just one button. A small LED light scans the temperature scale until you reach your desired temperature and then you release the button. You change the temperature naturally, throughout the day, up to six times. The unit responds and remembers that exact living pattern. The present temperature is displayed by a glowing red LED on the scale.

The system also computes the ideal length the furnace should stay on to keep the temperature within a range of plus or minus one and one-half degrees. A battery backup lets you keep your stored program in its memory so power outages as long as eight hours won't let your unit forget. And if something happens and your power is out for a few days, the unit will automatically maintain 68 degrees when the power is restored.

Quite frankly, we were so impressed with the unit, its ease of installation and setting plus its many energy-saving features, we seriously considered advertising it until we realized that our customers would probably not want to trust their future comfort to a product called Magic Stat. What if something went wrong with the unit? How substantial was this Magic Stat outfit? Remember, a thermostat is something you live with as long as you live in your home, and they're supposed to last ages. After all, your comfort depends on it.

Well, we did our homework, We found the company to be a sound, well-financed organization. They have been in business fo several years, and they back their product with a three-year limited warranty. In addition the company has a policy of buying back your unit in one year if you haven't saved its full cost in energy savings. We were satisfied with the company, the people, the product its incredible features, the company's commitment to the product and above all, the energy savings.

We are so impressed now with the Magic Stat that we're going to make buying one irresistible. Buy one from us for only $79. Install it yourself in a few minutes or hire a handyman to install it.

Or order the new deluxe unit for $99 with the exact same features as the regular model but with a beautiful new case.

Then enjoy the savings this next winter, No only will you save up to 30% on your heating bills, but you're eligible for the 15% energy tax credit. Then if you're not absolutely in love with this product one year later, return it to JS&A. You'll get all your money back and you can reinstall your old thermostat.

REALIZE SAVINGS

But we're counting on a few things. First you will realize an energy savings and a comfort that will far surpass what you are currently experiencing. Secondly, you probably wil sleep better breathing cooler air yet wake up to just the right temperature.

Beauty is only skin deep and a name doesn't really mean that much. But we sure wish those guys at Magic Stat would have named their unit something more impressive. Maybe something like Twinkle Temp.

To order, credit card holders call toll free and ask for product by number below or send check plus $4 delivery for each unit ordered.

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"Say, Smokey—"

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

Oil, no; valves, yes

With about 11,000 miles on my 1979 Plymouth Horizon with a 1.7-liter [104-cu.-in.] VW engine, I switched to Mobil 1 oil. From about 18,000 miles to my present mileage of 49,000 miles, my oil consumption has increased from 1,500 to 700 miles per quart. I changed back to regular oil but got no improvement. Could my engine have the same valve-seal problem found on earlier VW Rabbits and Dashers, or could the Mobil 1 be the cause?

Chris Mallick, Stamford, Conn.

I think your problem is valve seals and possibly valve guides as well. I'd have the head pulled, and have a valve job done while you're at it. Take a good look at the exhaust valves and valve guides for condition. I don't think that Mobil 1 caused your problem.

Texas bronco

My 1981 Buick Century with 10,000 miles on it has vibrated, roared, and jerked since new. The jerking is worst at 52 to 58 mph. Also, the air-conditioner compressor moans after a few minutes of operation. I got some improvement in the engine when I had the harmonic balancer, manifold-pressure sensor, and barometric sensor replaced. The A/C noise was reduced a little by installing a new clutch kit and tightening the belt fiddle-string tight. Is there anything I can do to make the car as smooth and quiet as the 1972 Datsun I traded in, or are the problems inherent in the V6 and GM control system?

Henry C. Morkovsky, San Antonio, Texas

The engine itself can be tuned and balanced to run smoothly. But with a touchy electronic engine-emissions control and problems in the lockup converter, it can be very bad. It sounds like you might have a plugged-up catalytic converter to go with your problems. As for the A/C pulley, what can I say? It should be quiet if it isn't bad.

Inside tire wear

The front tires on my 1981 Toyota Corolla wagon wear more on the inside, as if the wheels had negative camber. The alignment has been checked against specs both with my own equipment and at the Toyota dealer. I've looked at a number of other 1981 Toyotas, and about one-third showed evidence of inside tread wear. Is this an inherent problem?

S. Motoike, La Habra, Calif.

Check and reset the toe-in, if necessary, and have the camber adjusted to add ½ degree positive camber over specs. If the tires still wear on the inside, you might have a problem. Be sure to check toe-in and camber with an average load in the car. Heavily loaded small cars can change the setting quite a bit.

Motor odor

My 1982 Chevrolet Malibu smells like rotten eggs after highway driving. The interior of the car reeks with the odor. I suspect some sort of emissions-control problem.

Leonard H. Thibodeau, Nashua, N.H.

The smell is sulfur being cooked out of the fuel that gets into a hot exhaust system. A change of fuel vendors can help; maybe you can get a fuel with less sulfur. If that doesn't do anything, go back to Chevy to correct the collection of fuel in the converter. As a rule, an over-rich fuel system and short-trip driving cause this condition.

Erratic diesel mileage

I've driven my 1982 Buick Estate Wagon with the 5.7-liter [348-cu.-in.] diesel on two trips of over 3,000 miles, mostly on fairly level highways. I kept careful track of the mileage, and on individual tankfuls it varied from 15.2 to 34.6 mpg during these trips; overall it was 22.3 mpg. Is there any explanation for this wide range?

Harold W. Behr, Southern Pines, N.C.

My guess is that the injection pump and injectors are inconsistent in controlling the fuel properly, especially when the engine is working hard. I doubt that it's a fuel-quality problem as much as it's an engine problem. I suggest you find a shop that can flow-check and balance the fuel system and controls.

Changing coolant

After driving air-cooled cars for many years, I have a water-cooled car for the first time. The car has a sealed system and uses an expansion tank. Should the coolant be replaced on a scheduled basis, or should I wait until a problem (such as the hoses getting soft) develops?

Joseph E. Meehan, Columbus, Ohio

With antifreeze at the proper mix ratio and the system kept full, air won't enter the system. It seems that the cheapest route is to change coolant annually in the spring and change hoses and belts every two years. For a minimum-mileage driver, that might be a little too often; but for an average 15,000 miles per year, it's about right.

Cold-driving troubles

For the past year, my 1976 Chrysler Cordoba with 45,000 miles on it has backfired and died for the first five to 10 minutes of driving. After that, it runs well. A rebuilt carburetor and two tuneups haven't helped.

P. Robinson, Shreveport, La.

I suggest you check through this list: carburetor hot-air system not working; manifold and carburetor heat passage plugged with carbon; choke not set correctly; carburetor and choke adjustment incorrect (doing it right is hard); 195-degree-F water-temperature thermostat not working (plus or minus 10 degrees); computer operation in cold mode. For $15 you can get a book from Chrysler Corp. (Service Publications, 20026 Progress Drive, Strongsville, Ohio 44136) to help you trouble-shoot and repair the car. Ask for book No. 81-070-6151, 1976 Service Manual *(Chrysler, Plymouth, Dodge).*

To cool or not to cool

Some imports, police cars, and racing cars use engine-oil coolers as well as automatic-transmission coolers to help protect their engines. Would an oil cooler help on a family car? Do you recommend oil coolers for family cars, and do the aftermarket kits have thermostats so the oil isn't cooled when the temperature drops below zero?

Douglas Lobb, Edmonton, Alta., Canada

Any transmission or engine in which the oil temperature goes over 250 degrees F can be helped with an oil cooler. Transmissions that use synthetic oils (as a rule, automatics) can stand 300 degrees fairly well. I don't know of kits that include thermostatic control. Equipment is available for that kind of installation, but it's expensive in the retrofit mode. Judge for yourself.

Rusty rotors

I have several cars with disc brakes, and the formation of rust on the discs wears the pads, reducing braking efficiency. To prevent this, the cars would have to be used every day. Does anyone make rotors of non-corroding material or maybe disc pads that would leave a protective coating?

Paul Waterman, Annapolis, Md.

The discs for surface-transportation vehicles will remain iron because anything else is just too expensive. Aircraft, race cars, etc. are using ceramics and other materials that are better for wear and oxidation resistance. Linings that are principally ceramic and are not too expensive are available. Disc brakes have some problems: They're exposed to the elements and have a minimum of lining surface area; they also have a higher hydraulic-system cost. But discs are better than drum brakes—at a premium.

Off-and-on starting

Cold or hot, the starter on my 1979 Chrysler Cordoba turns the engine easily, but it doesn't seem to be getting spark. After cranking with no success and sometimes switching to off and again to on, the engine fires. I changed the ballast resistor, but it didn't help. The car runs fine and

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always starts eventually, but it's taxing my patience and the battery.

Frank Romano, Seattle, Wash.

Check the voltage to the coil to see if it's normal in the starting mode. If it's OK, check the emissions system and look for vacuum leaks or dilution of the air-fuel mixture. A good way to check is with timing light and vacuum gauge. The gauge readings on a starting attempt should be about 18 inches of vacuum, and the timing should be around 15 degrees BTDC.

High-mileage vibrator

I've put 75,000 miles on my 1981 Chevy Citation V6. Almost since it was new it's had a front-end vibration that comes and goes, starting at about 55 mph and getting worse at 60. I have had three pairs of steel-belted radials on the front, but they haven't helped. It also seems to me that every Citation I follow dog-tracks to the left. Is that part of the problem, or is it my imagination?

Chris Steinbach, Council Bluffs, Iowa

With your high mileage, you should check the U-joints coming out of the drive case. Try pushing them up and down, and I'll bet you find a ton of play—particularly in the right-front axle. If so, it's bad news and about a $1,500 fix. The car isn't supposed to dog-track. Get it on an alignment rack and have it checked. If the alignment's out, the problem is probably the rear axle; that area is easy to bend.

Cooling-system corrosion

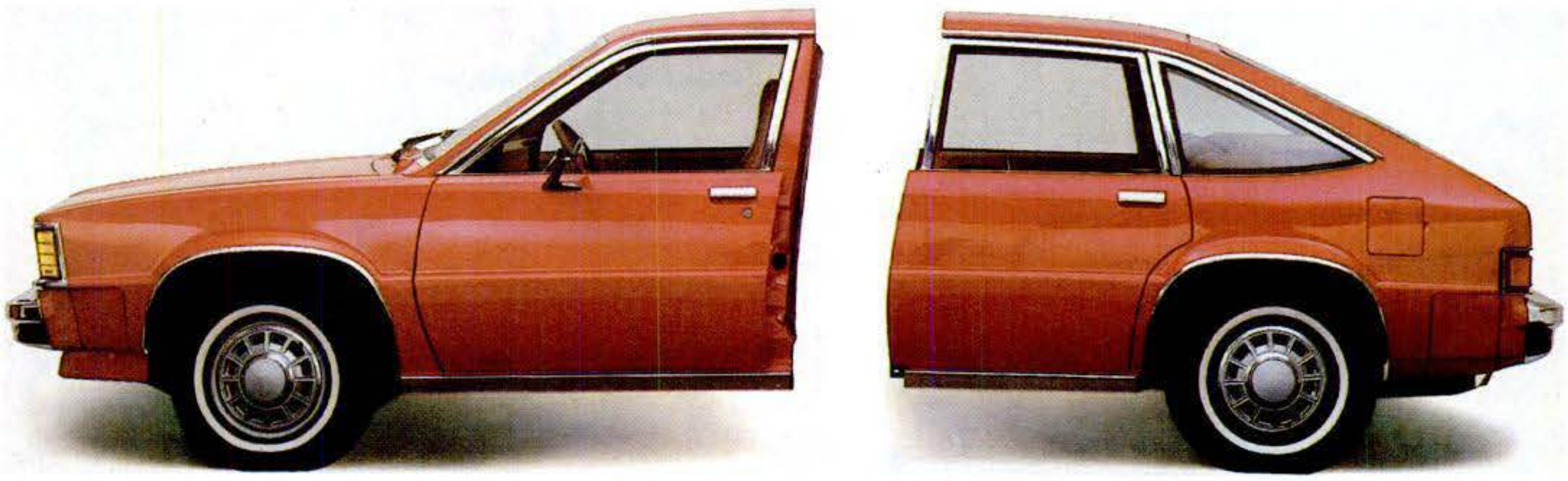
Our water is heavy with minerals, and I've been using distilled water mixed with the correct ratio of antifreeze in my radiator. I've noticed a whitish deposit where the radiator tubes are soldered at the ends, and the radiator shop says I may have an imbalance in which the solution is "mineral starved" and is removing material from the solder. Is this possible? The deposits do not come out when I flush the system.

Jim Manner, Alamo, Nev.

Distilled water should be best. I'd bet the problem is electrolysis of dissimilar metals. The deposits are metal removed from the interior of the engine and left on the ends of the tubes.

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

How Havoline Supreme's 9 additives help you get the most out of your car.



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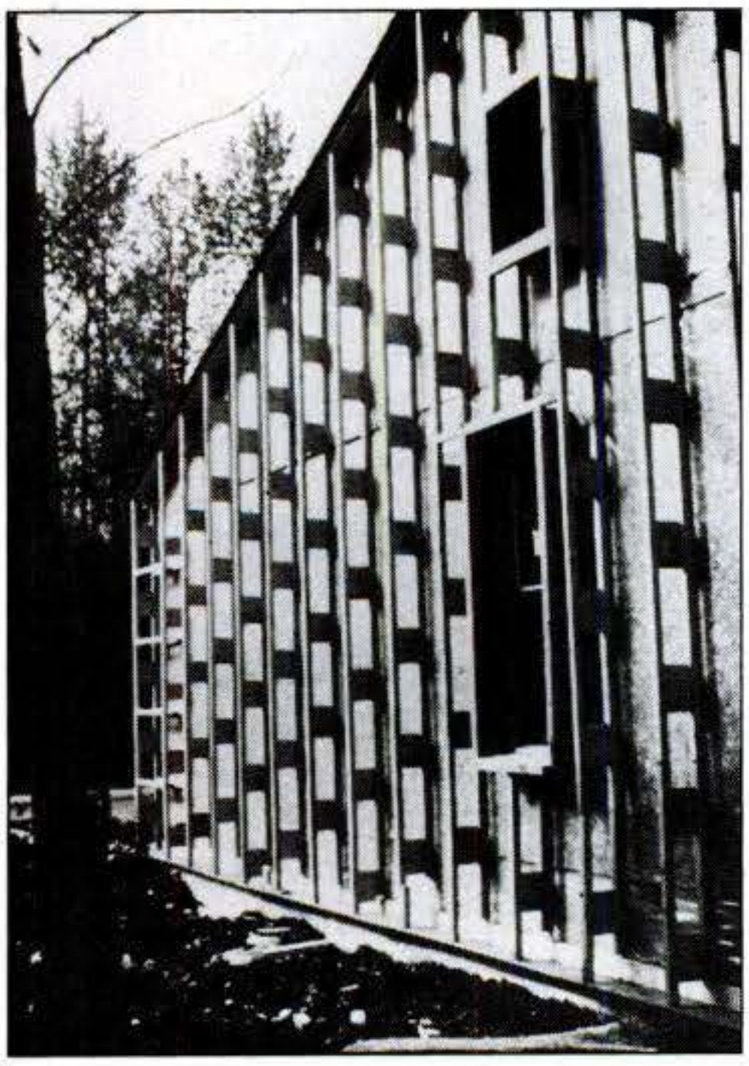
BUCKLE UP FOR SAFETY

Superinsulated house trusses

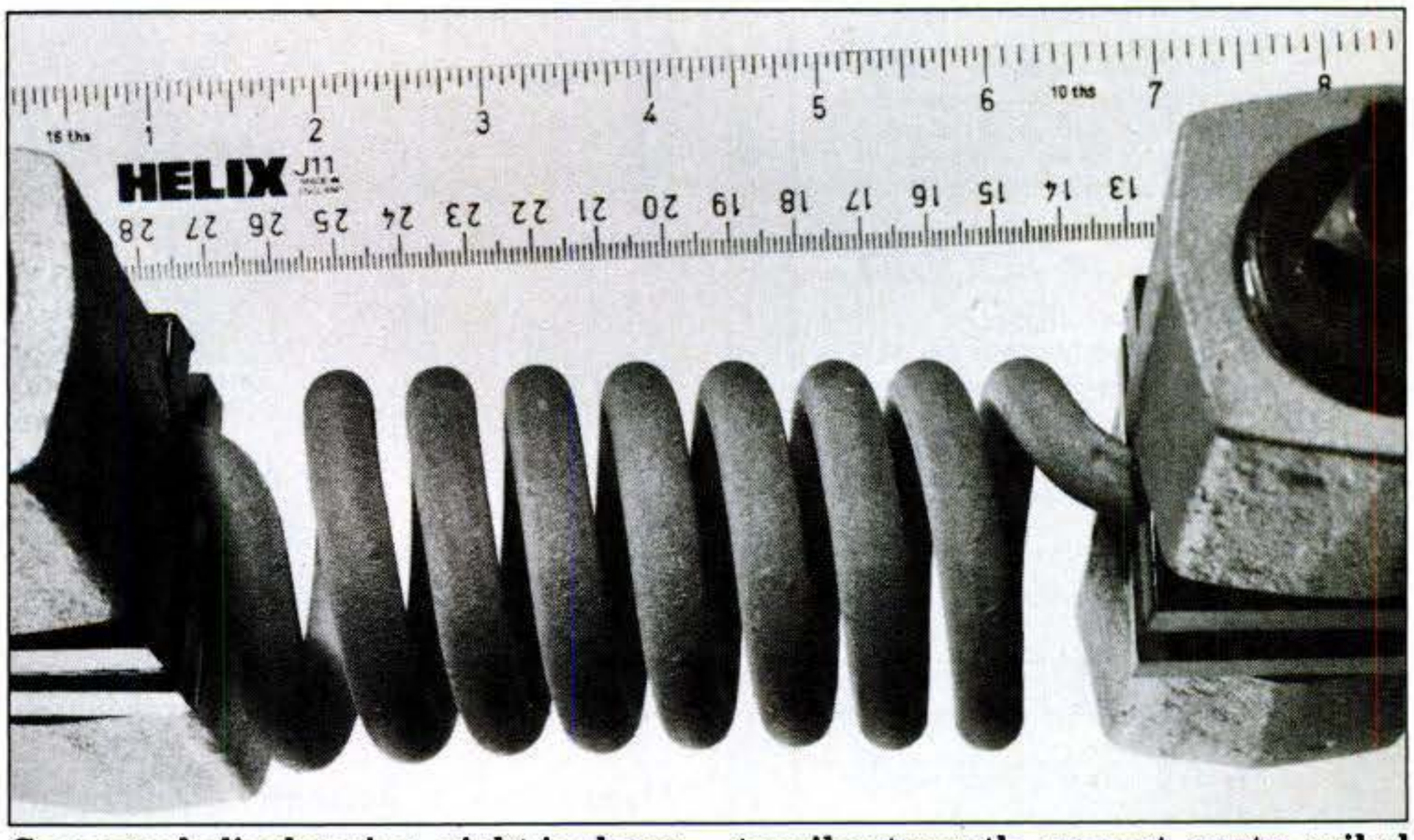


A superinsulated house [PS, May '81] needs at least a 12-inch space in the walls for fiberglass insulation. That gives an R-value of 35. The normal way to do it is to build double stud walls of 2×4s. But John Larsen, a contractor in Edmonton, Alberta, has come up with another way—and his requires much less site work.

His secret is a special wall truss he calls the Larsen Truss. He makes the trusses in the shop by ripping 2×4s in half. He then cuts a series of dadoes in one side of each resulting 2×2. Then he joins two 2×2s with gussets of ⅜-inch plywood, each 6½ by eight inches and spaced 24 inches on center. The gussets slip into the dadoes and are glued and nailed. At the building site, these trusses are nailed to standard 2×4-stud walls. (A polyethylene vapor barrier and sheathing have been installed over the studs in our photo.) Horizontal siding can go directly over the sheathing paper and trusses once the insulation is put in. The trusses can also be installed over the siding of an existing house.

The Larsen Truss sells for 55 cents (Canadian) a foot, but delivery beyond a few hundred miles of Edmonton is uneconomic. However, it is not patented, and it's easy to build. For more information: SunScape Builders Ltd., 9924 152 St., Edmonton, Alta. T5P 1X5, Canada.—*Paul Tatarewicz*

Concrete springs



Concrete helical spring, eight in. long, is made from an extruded rod of high-tensile-strength cement paste coiled around a cardboard tube before curing.

Every schoolboy knows that concrete is strong in compression and weak in tension. Concrete is great for buildings, roads, and sewers, but without steel or fiber reinforcement it cracks under even moderate lateral loads. Yet it has some attractive properties: It's inexpensive and corrosion- and heat-resistant, and it takes little energy to produce. If its weakness under bending stress could be overcome, it could replace costly metals, plastics, and ceramics for everyday products.

Imperial Chemicals Industries (ICI) in Britain claims it has done just that. And to prove it, the company has made a concrete coil spring that can be stretched and compressed. Avoiding the humble image of concrete, ICI calls its high-strength wonder product NIMS, for new inorganic materials.

NIMS can be cold-molded, machined, drilled, and sawed. Potential uses range from floor tiles and corrugated roofing to electrical sockets, barrels, and manhole covers.

How is NIMS made? ICI researchers discovered that large holes in ordinary concrete cause tensile and flexure failures. When solidifying, cement grains react with water to form a porous mass with numerous internal flaws. ICI overcomes these shortcomings by using a carefully proportioned mix of dry cement and water, to which is added a small quantity of an organic chemical that allows the slurry to fill the big pores.

This mixture is cast in the desired form, cured in a damp environment for a week, then dried for another. No heat is used, so energy consumption is low.

Eliminating natural flaws results in a remarkable transformation in concrete. The NIMS composite has 20 times the tensile strength of conventional unreinforced concrete and is 100 times tougher. Density and weight are much the same as aluminum, one-third that of steel. And the material is twice as stiff as glass-reinforced plastics.

Because of its low porosity, NIMS has far greater resistance to acids and alkalies than ordinary hydraulic concrete and absorbs less water. Its hard surface resists damage, and its electrical-insulating properties are similar to those of porcelain. It's not combustible, so it can be used in extreme heat or for fire-retardant paneling.

Thin sheets of NIMS can be bonded to other materials such as wood, porous concrete, and plastic foam—as decorative laminates or protective cladding. It can be colored by blending in pigments before the slurry cures.

Although the patented composite is still in the early developmental stage, ICI is setting up a pilot production unit in England with a capacity of 200 tons a year.—*David Scott*

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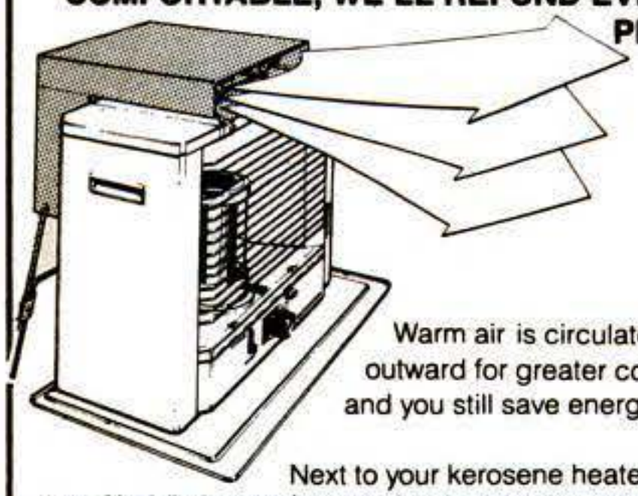

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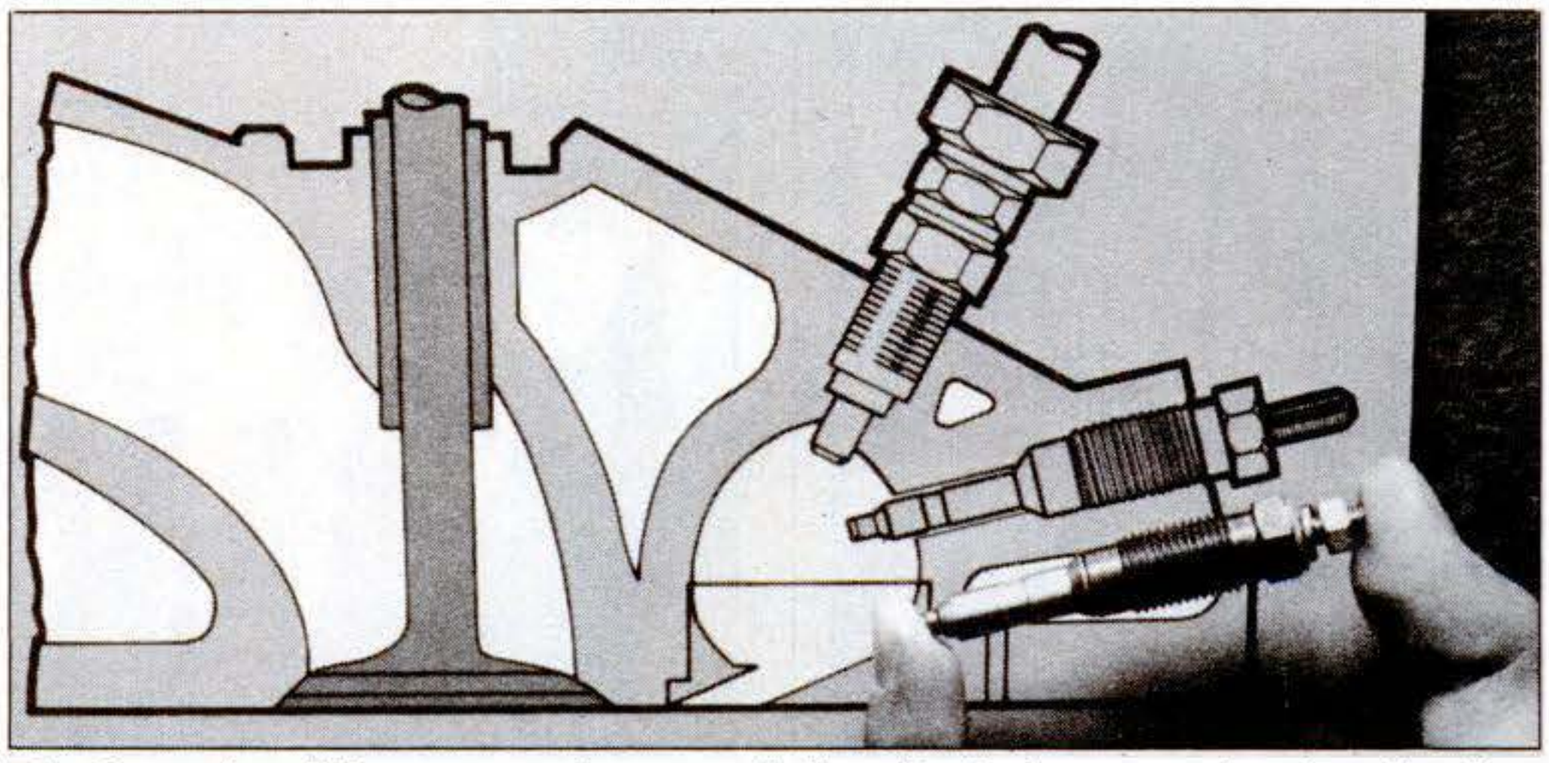
SPEED RADAR DETECTORS

Hot plug for quicker diesel starts



The 60-mm-long Micronova replaces usual glow plug in the precombustion chamber.

Diesel fuel is normally fired by air heated to about 800 degrees C under high compression in the cylinder. It works well—if the engine is warm.

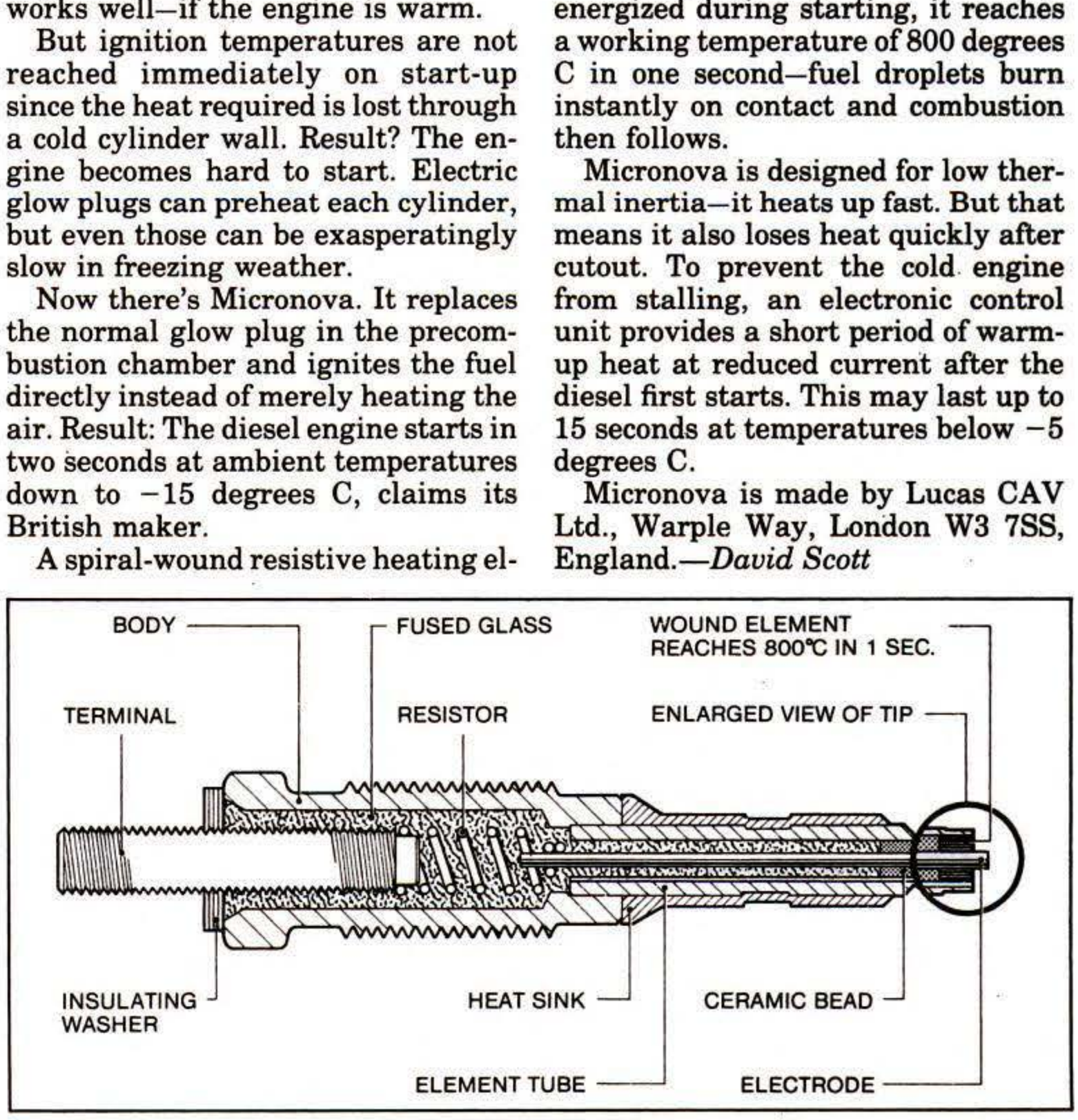
But ignition temperatures are not reached immediately on start-up since the heat required is lost through a cold cylinder wall. Result? The engine becomes hard to start. Electric glow plugs can preheat each cylinder, but even those can be exasperatingly slow in freezing weather.

Now there's Micronova. It replaces the normal glow plug in the precombustion chamber and ignites the fuel directly instead of merely heating the air. Result: The diesel engine starts in two seconds at ambient temperatures down to −15 degrees C, claims its British maker.

A spiral-wound resistive heating element is embedded in the tip, which protrudes 12 mm into the chamber at the fuel-spray area. When the tip is energized during starting, it reaches a working temperature of 800 degrees C in one second—fuel droplets burn instantly on contact and combustion then follows.

Micronova is designed for low thermal inertia—it heats up fast. But that means it also loses heat quickly after cutout. To prevent the cold engine from stalling, an electronic control unit provides a short period of warm-up heat at reduced current after the diesel first starts. This may last up to 15 seconds at temperatures below −5 degrees C.

Micronova is made by Lucas CAV Ltd., Warple Way, London W3 7SS, England.—*David Scott*



Heating element is spiral-wound nichrome strip enclosed in insulating ceramic. Integral resistor controls high initial current needed for rapid heating (about 10 amps). Copper sheath around front section works as a heat sink to keep tip temperature at safe level when engine is running under full load.

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INTRODUCING

3-IN-ONE PLUS™.

The new all-purpose lubricant...

and a big new PLUS in rust fighting.

From 3-In-One®, makers of household lubricants for over 90 years, now comes new 3-In-One Plus™ — the most advanced lubricant and rust fighter we've ever formulated.

This remarkable product not only stops squeaks like magic — not only loosens jammed parts — but helps restore free and easy operation to virtually all moving mechanisms around the home. Spray some into the channel of your sliding door, and see how smoothly it opens and closes. Use it on hinges, windows, locks, lawn mowers — and much more.

And what a powerful rust fighter! To prove it, we left two identical garden shears outside for 18 days. One was unprotected. The other was sprayed with 3-In-One Plus. You can see the dramatic results for yourself*. New 3-In-One Plus. The lubricant and rust fighter no homeowner should be without.

A new addition to the 3-In-One family.

*Results could vary according to weather conditions.

Pilot Max Shauck fuels Mr. Gus III with high-octane ethanol, plus gasoline in a 1.5-gal. auxiliary tank. On cool days he starts with gasoline, switching to alcohol before takeoff.

Candy-power plane

Whenever Mr. Gus III touches down at its home base, McGregor Municipal Airport in Waco, Texas, visitors crowd around the aircraft to inhale its distinctive exhaust—a not-so-subtle blend of sweet chocolate and salted peanuts. Why? The Bellanca Decathlon is the world's first candy-power airplane. It runs on Snickers bars.

Whole bars aren't crammed into its fuel tank, of course, rather they're fermented and distilled into high-octane ethanol. Mr. Gus is also solar powered: The still that renders waste from a local M&M's-Mars candy factory is heated entirely by a solar collector with 200 four-by-eight-foot flat panels.

To test the fuel, Max Shauck, a Baylor University math professor, not only performs strenuous stunts over Waco, but also flies thousands of miles cross-country, sometimes at night. He lands every 200 miles in fields in which supplies of the candy-alcohol fuel await him.

Ethanol, Shauck has noticed, burns cooler than ordinary aviation fuel and is less potent. That raises his fuel consumption slightly but not his flying cost. That's because solar-distilled ethanol can be produced and sold at a profit in Texas for just $1.30 a gallon, whereas ordinary aircraft fuel is about $2 a gallon. In larger batches, solar ethanol should be a lot cheaper.

At first, the ethanol dissolved sludge in the aircraft's fuel system, clogging its injectors. Once the system was cleared, however, Shauck had no further problems.

The experiments—running the Bellanca on ethanol and making a solar-energy still—began at Baylor's Inst. of Environmental Studies. Dr. Merle Alexander, its director, and graduate students were investigating how Third World farmers could produce airplane fuel. The spin-off distillery firm in Waco now can handle grain, garbage, other plant material, and Snickers bars.—*David Lampe*

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Marlboro

Philip Morris Inc. 1983

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

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

Turbocharged Datsun 300ZX speeds down track of Tochigi Proving Grounds in Japan. The car is peppier than 280ZX.

Newest challenger for Corvette:

Nissan/Datsun 300ZX

The Chevrolet Corvette, Toyota Supra, and even Mazda RX 7 all have put a sizable dent in the reputation of the Datsun "Z car." Now there's a new-generation sports car from Datsun—the 300ZX. It boasts a more-powerful V6 engine and the most slippery body of any production car on sale in the U.S. A PS editor tested the new model at Datsun's proving grounds in Japan and found it to be much improved over the 280ZX and a formidable challenger for the Corvette.

By HERBERT SHULDINER

TOCHIGI, JAPAN

Economy cars used to be the reason auto journalists came to Japan. Everyone in the U.S. was starved for news about the latest little car that went a zillion miles per gallon. Today, economy is passé and performance is in. In fact, I came here to test a new model that promises to be one of the all-out hot cars in the world: the Nissan 300ZX.

At Nissan's proving grounds, I made the most of a full day, testing several 300ZX types, including turbocharged and non-turbo models with manual and automatic transmissions. The 300ZX, which goes on sale in the U.S. this month, is noticeably different from its predecessor, the 280ZX—although the dimensions are only slightly changed. The 300ZX is 3¾ inches shorter. Other measurements and weights are virtually identical.

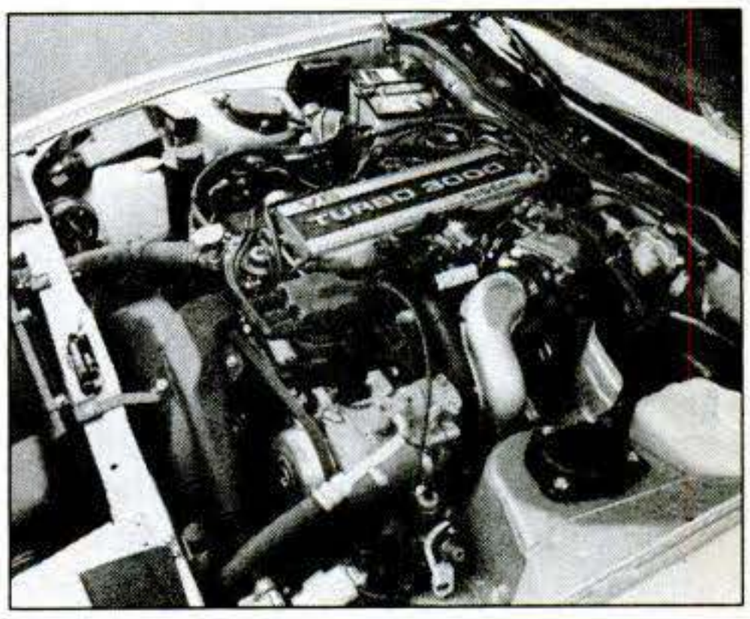
The big difference in looks is a much shorter hood that slopes sharply. But the major story is in engineering: The car has greater power, improved ride comfort, and an astonishing 0.30 coefficient of drag—lowest for any car sold in the U.S.

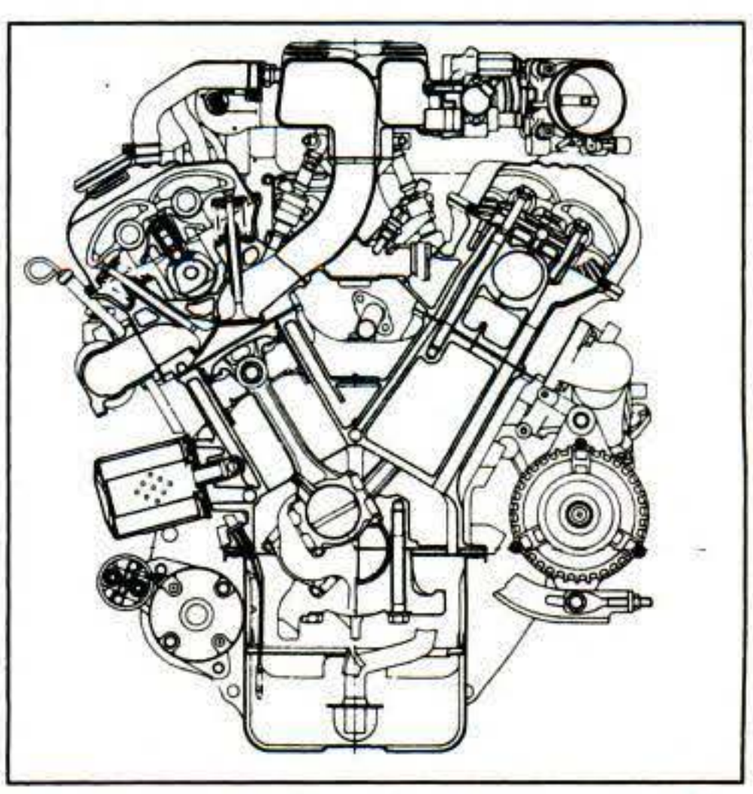
The 300ZX has a new three-liter (183-cu.-in.) V6 engine. The 280ZX had a straight six displacing 2.8 liters and rated at 145 hp (non-turbo) and 180 hp turbocharged. The new engine produces 160 hp in the non-turbo version and 200 hp with turbo. The extra power is noticeable when driving the new speedster. I didn't time zero-to-60-mph runs, but the new car felt more responsive compared with the 280ZX on alternate runs.

Handling is improved, as well. On the smooth-track straightaways, the 300ZX felt completely under control at speeds better than 100 mph. The car sticks to the road tenaciously in high-speed corners. It also feels under control through the low-speed handling course. There was a small amount of bump steer, however, on the rough Belgian block course. I didn't perform any special braking tests, but stopping felt sure and required fairly minimal pedal pressure.

In the top-of-the-line cars, the dashboard is the epitome of electronic instrumentation for which Japanese cars are becoming known. On the 300ZX, the instruments include a digital speedometer and graph LCD tachometer. I prefer the analog gauges in the bottom-line trim level.

Prices for the 300ZX weren't set as this issue went to press but were expected to be $16,000 to $21,000. PS





New Nissan VG series V6 powers the 300ZX. Drawing shows non-turbo version. Photo is of turbocharged engine, which is an extra-cost option.

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Chrysler Vista—van or wagon?

I couldn't decide. The vehicle I was driving seemed tall but not as high as a van. There was plenty of room, too, but I couldn't expect to shove big boxes or a couple of four-by-eight-foot sheets of plywood inside. What is it? Chrysler's new Vista, a cross between a van and a station wagon.

Handling is surprisingly good, thanks to independent struts up front and independent rear trailing arms. It takes corners without unnerving rolls. It doesn't feel sluggish, either. The front-drive, two-liter (122-cu.-in.), 88-hp four-cylinder engine produces 108 ft.-lbs. of torque at 3,500 rpm.

But the real selling point of this vehicle is its seating. It's a people mover without rival for its size—two people in the front, three in the middle, and two in the back.

It's available with an automatic transmission, five-speed manual, or four-speed with two power ranges like the Chrysler Colt. The price, not set at this writing, will start at about $8,000.—*Charles A. Miller*

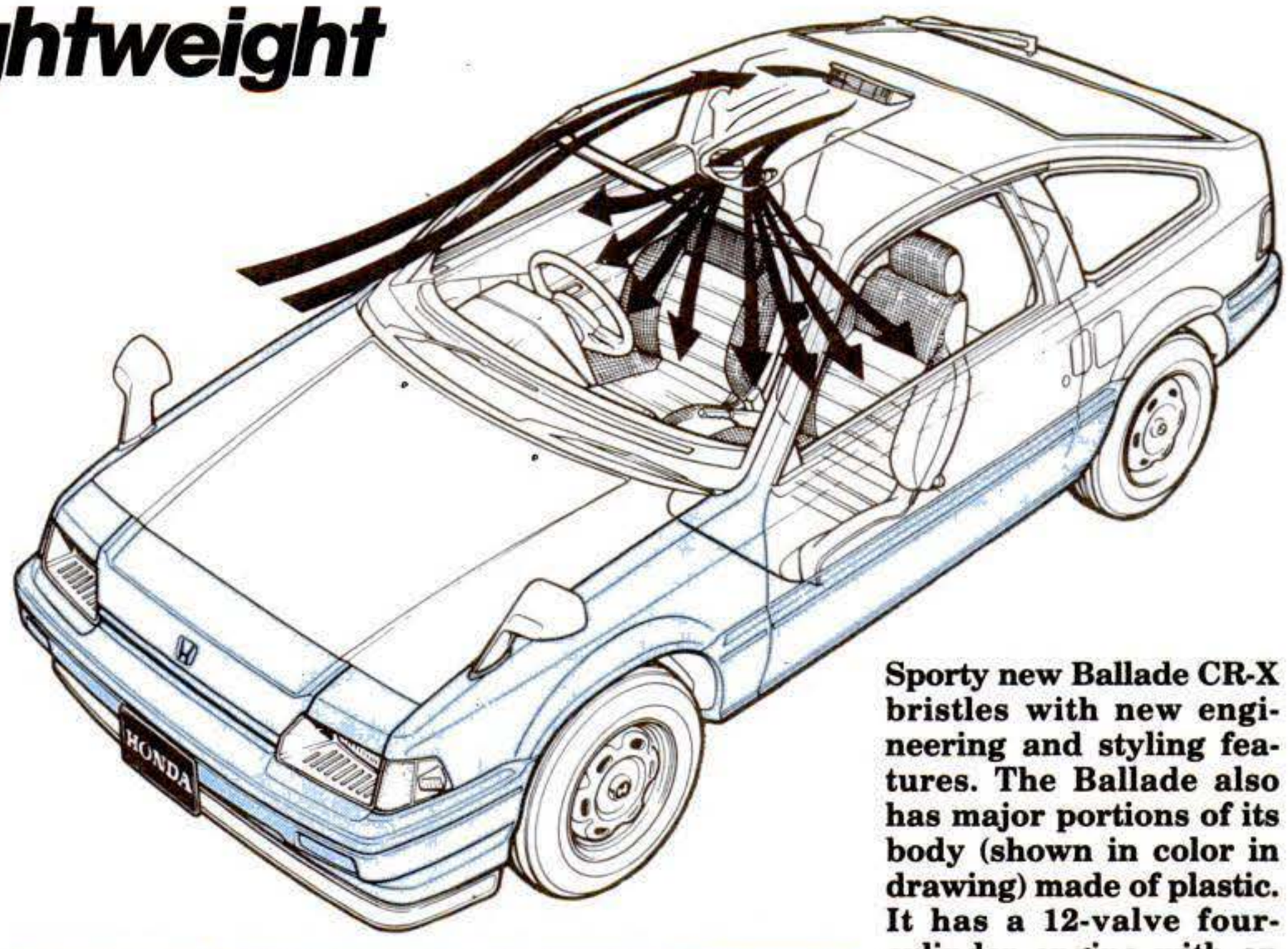
Honda's new lightweight

The name is Old English, but the engineering of Honda's sporty new compact Ballade CR-X is state-of-the-art Japanese. The car, which has a body that's 40 percent plastic, combines distinctive styling, surprising performance, and excellent fuel economy.

The Ballade will be called the Civic CR-X in the U.S. It will be in dealers' showrooms about the time this issue reaches newsstands.

I recently had an opportunity to test the Ballade in Japan. The model I drove had an automatic transmission and was powered with a 1.5-liter (92-cu.-in.) four-cylinder engine that had lively acceleration. Also surprising was the smooth response and quiet interior while the engine was being stressed. In addition, even though the air conditioner was on full blast, there was never any faltering of power delivered by the 12-valve engine.

Although there's a back seat, nobody except the smallest children could use it. The Ballade is essentially a two-seater with lots of accessible space in back. In fact, the U.S. version will be available only as a two-seater.—*Herbert Shuldiner*



Sporty new Ballade CR-X bristles with new engineering and styling features. The Ballade also has major portions of its body (shown in color in drawing) made of plastic. It has a 12-valve four-cylinder engine with an economical 1.3-liter (79-cu.-in.) displacement for economy or an optional 1.5-liter (92-cu.-in.) performance power plant. The Ballade is 144.68 in. long and has an 86.6-in. wheelbase. Weight ranges from 1,672 to 1,815 lbs., depending on the type of engine.

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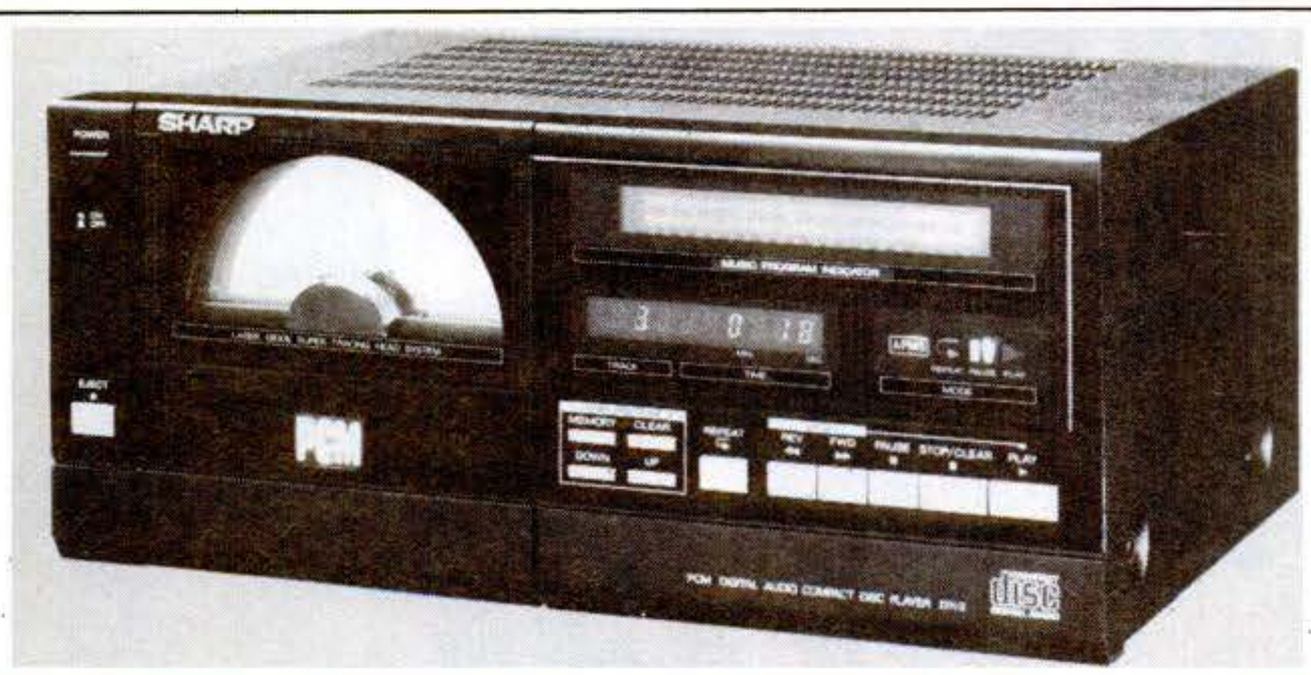
Look and Listen

By WILLIAM J. HAWKINS



Digital audio

Digital. Mention that word, and it automatically conjures up visions of computers, displays, and even a floppy disk or two. But it's meant little to the audiophile—until recently.

Digital has begun to mean near-perfect audio reproduction: no distortion, incredible frequency response, and dynamic ranges that push even the most prestigious amplifier-speaker combination to the limit. But that's only for the moment—if you look a little deeper into digital reproduction, you'll find it could mean a totally new way that you and I acquire, store, and retrieve music in the near future.

Above is the Sharp DX-3 digital audio disc player. I took the opportunity to add it to my home music system and compare it (by ear) with a conventional turntable. The result, as you might guess, is that my record collection (so carefully groomed with cleaners and anti-static cloths) would be better used as placemats for the morning breakfast table. [Compact digital discs, or CDs, are covered in detail in this issue.]

The systems (as well as digital tape) *recreate* an audio sound from a digital signal, which is merely a series of on-and-off pulses. There is no "good" or "bad" sound, only on or off.

That means the source of our future audio could come in a variety of ways. Radio stations, for instance, could transmit digital pulses that represent music to our home receivers. The "data" are then reassembled into sound. The quality will be an exact duplicate of the original at the station, and even normal transmission problems we now must live with (hiss, static, multipath) will be eliminated because they're not part of the reassembled digital signal.

Computers routinely send digital information over conventional phone lines—why not "musical" digital information? Dial an "Album of the Month Club" and tap a button, and the digital stream of music then would be sent bit by bit to a recording device. No stores, no salespeople, no shopping—no records. Play back your copy, and the quality of the reproduction is equal to that of the original master at the other end of the phone call.

"Discs" of the near future might not be discs at all. Instead, a memory chip mounted in a cartridge similar to that of a video game would hold your favorite songs for perfect reproduction, instant selection, and no wear. And by manipulating the musical data, perhaps the player could offer other choices of play: pitch, tempo, special accompaniments, and maybe even a choice of singer.

Am I dreaming? Don't bet on it. Much of it is being done right now on "older" digital home products.

Tests of digital transmission over an FM radio station have already been successfully completed (they contained home computer programs), and a company called Control Video Corp (Vienna, Va.) now offers "Gameline." A box containing a digital memory connects your Atari video game to your phone. Dial Gameline and request a specific video game, and it's instantly sent into memory. You play the game as if you had bought the cartridge.

With new audio gear now based on the same digital techniques, this is only the beginning. The DX-3 may be more than just a new product—it might be the start of a whole new industry.

Super video game

Just a game? Perhaps, but this Atari Star Wars capsule (see photo below) includes 3-D vector graphics color display, stereo sound for music and voice synthesis, operable cockpit controls for maneuvering—and it requires three microprocessors (and two quarters) to make it all work. It is one of the most sophisticated video games created—but it might be old stuff soon, according to research from International Resource Development.

The company predicts that fourth- or fifth-generation games will have "eye tracking," a system that uses infrared light to determine the exact position of the viewer's eyeballs. The games will be played according to how you react and what you see on the viewing screen.

New projection tubes

Zenith is now using self-converging picture tubes in its projection-TV systems. Convergence adjustments, often needed to keep the picture in "focus" as the tubes warm up, are no longer necessary.

"Betamax" case update

It started in 1976: Walt Disney Productions sued Sony to prevent home videotaping of copyright TV shows. In 1979, the U.S. District Court in Los Angeles decided that Sony won, meaning we could legally tape shows. In 1981, the Ninth Court of Appeals in San Francisco reversed the decision, thus making it illegal to record from TV. But it's not over yet. In July of this year, the Supreme Court opened the case again by asking lawyers for both sides to prepare arguments for debates to begin as you read this. A new decision is expected sometime in 1984.

Keeping in touch

Pageamerica and RCA Global Communications have struck a deal: the pocket pagers, which allow you to receive alphanumeric message displays, will use the Globcom communications network. It means you can receive personal messages and data anywhere in the world. The network will be operational in early 1984, and besides personal communications, it will contain stock reports, weather alerts, and international telex messages.

Last minute...

RCA has just introduced the first random-access CED disc player. Any point on the disc can be selected and played, making interactive discs possible. The first two discs—"A Week at the Races," which allows you to bet on the outcome of horse races, and "Many Roads to Murder," which contains mystery stories you must solve—are $30. The SJT 400 player is $500. PS

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Only one anti-freeze formulation is approved by GM, Ford, Chrysler & AMC/Jeep/Renault...

Only one anti-freeze formulation has met the tough standards of all four major car makers. Only one formulation has won their unqualified approval for safe and effective use in all their cars. That formulation contains a high performance corrosion inhibitor system called ALUGARD™ 340-2...and you'll find it in a number of major anti-freeze/coolant brands this year.

All the major car makers have raised their anti-freeze performance requirements significantly, because today's cars run hotter, and because of the potential serious engine and cooling system damage that can be caused by overheating. Anti-freeze/coolants that you've used in the past, simply aren't good enough today.

If you care about your car and want to minimize costly problems, look for and use brands that contain ALUGARD™ 340-2. They're recommended for all new and older cars, including imports.

BASF

Look for the ALUGARD™ 340-2 Symbol on the jug label.

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Introducing the 5/50 Plymouth Reliant

A five-year or 50,000-mile Protection Plan.* Match it, anyone!
For 1984, Plymouth challenges the competition: Match it! Match Reliant K's 5-year or 50,000-mile protection on the engine, powertrain and against outer body rust-through. No extra cost. The quality and durability you demand is built in. The New Chrysler Technology sees to it.

The 5/50 Reliant K.
41 est. hwy. 29 EPA est. mpg:†
Match it for mileage.
Reliant K is America's highest mileage 6-passenger car. It has advanced front-wheel drive and a 2.2 liter engine, perhaps Chrysler's best ever. It's also a car that's computer designed to give you maximum fuel efficiency. No wonder Reliant K's competition find that tough to match.

*5 years or 50,000 miles, whichever comes first. Limited warranty. Deductible applies. Excludes leases. See dealer for details. †Use EPA est. mpg for comparison. Your mileage may vary depend

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K for 1984. Match it! (If you can.)

The 5/50 Reliant K: Match it for price.
Reliant K is the lowest priced 6-passenger front-wheel drive car in America. And standard are power disc brakes, an electronically tuned radio with digital clock, a new instrument panel displaying more vital information including voltmeter and trip odometer, steel belted tires and more. And with 5/50 protection, that's a great deal to match.

The 5/50 Reliant K: Match it for resale value!
Reliant K's resale value‡ is the highest of any American compact. Combined with Reliant K's lowest price and 5-year or 50,000-mile protection, you've got a lot to match. The 5/50 Plymouth Reliant K: Match it! (If you can.) Buckle up for safety.

Reliant K. A product of The New Chrysler Technology.

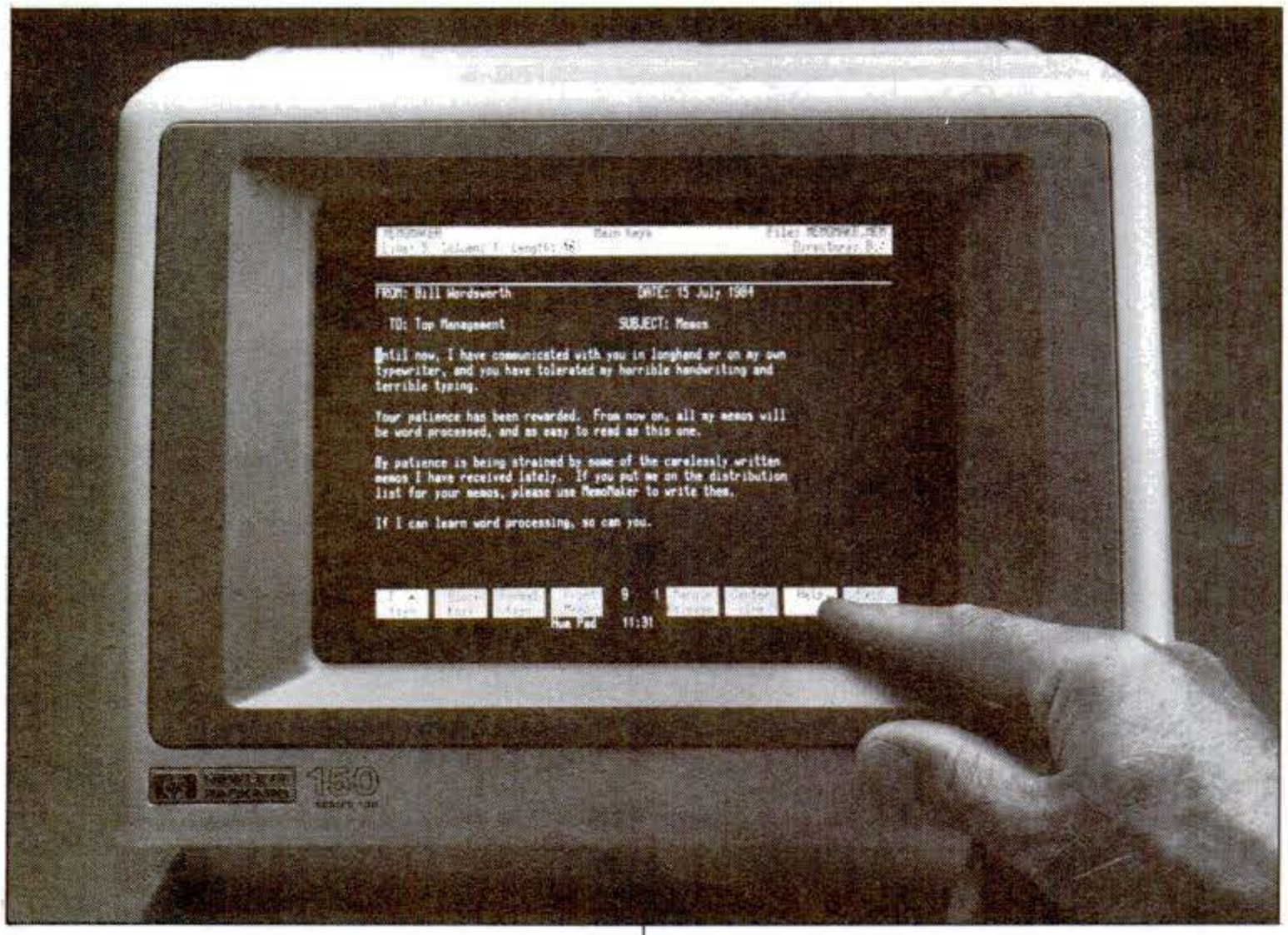
Plymouth

ed, trip length and weather. Actual highway and California estimates lower. ‡Based on Ward's Automotive Report classifications of domestic compact cars and recent issues of NADA Used Car Guides.

material

Bits & Bytes

By WILLIAM J. HAWKINS



Touch control

It sounded fascinating: a new personal computer that accepted commands merely by touch. That meant no keyboard commands to forget, no special buttons with labels I didn't understand, and no "mouse" to swirl around my usually cluttered desk. The computer, according to my source at Hewlett-Packard, is the first home or small-business system that works just by pointing to spots on the screen with your finger.

Jim Schefter, PS West Coast Editor, tested it in Sunnyvale, Calif. "The disk drive whirred briefly, and a half-dozen icons (pictures) appeared on the high-resolution nine-inch screen. I touched the icon showing stacked paper, labeled 'Create Documents.'

"As my finger tip left the screen, the icon instantly stood out against a bright reverse field. Moments later, I was watching a word-processing demonstration on Hewlett-Packard's new personal computer, the HP-150 [photo].

"'You're looking at a full-feature personal computer,' said product manager Miles Kehoe. 'The major difference between this machine and any other on the market is the touch screen. It's designed to be driven by touch, and the touch screen is integrated into most of our software applications.'

"VisiCalc via touch screen? Wordstar without memorizing scores of control commands? Condor 20 or dBase-II for fingertip data-base management?

"'Yes,' Kehoe said. 'And we'll have the top 30 or so best-selling software packages all enhanced for the touch screen, in addition to some new ones of our own. It also runs current HP software.'

"Goodbye, mouse. Hello, index finger—which is the primary digital item you'll need to operate this slick new computer.

"The HP-150, introduced in early October, puts Hewlett-Packard more firmly into the highly competitive personal-computer market. It's a direct challenge to IBM's PC, the Epson QX-10, and similar machines.

"H-P did some things right with the new computer and some other things less right. On the positive side are the touch screen and the small footprint. The unit, including keyboard, takes up only 1.7 square feet.

"Memory capacity is high, with 256K RAM standard, expandable to 640K. The computer has dual RS-232 ports, allowing simultaneous connection of a printer and a modem; or a modem board can be installed in one of two interior expansion slots.

"The two built-in disk drives use Sony's 3.5-inch plastic-cased microdisks, formatted for 256K of storage. With an Intel 8088 microprocessor at its heart, the HP-150 handles operations at high speed. It's twice as fast as the IBM PC or QX-10 on most applications and faster on many others.

"The touch mask surrounding the screen uses infrared LEDs to create a 23-by-40 grid. Operations are activated when you remove your finger, giving you the option of changing your mind.

"Hewlett-Packard redesigned the keyboard for the HP-150, giving it an easy-to-use low profile and logical layout. It includes eight 'softkeys'—keys whose functions vary from program to program—numerous other keys, and a numeric keypad.

"Peripherals available for the HP-150 include a high-speed thermal printer that hides away inside a cavity atop the screen cabinet and either a five- or 15-megabyte hard disk in place of one of the mini-disk drives.

"'We think most users will want a hard-disk version,' Kehoe said. 'That way there's little or no need to change disks. The MS-DOS 2.0 operating system and all software will load directly from the hard disk,' he said.

"The negatives are few. Reading and writing on the small, nine-inch screen could lead to eye strain with prolonged use. Almost no software comes with the machine, beyond the basic operating system and utilities. Everything else must be purchased separately.

"But several programs could be put on a single disk. When it starts, they'll come up on the screen in a touchable menu format.

"Final price of the HP-150 had not been determined when I saw it. But H-P expects the basic unit to sell for under $4,000, with hard-disk versions beginning around $6,000."

Friendly software

When Walt Disney Productions creates a mouse for home computers, they're not thinking mechanically: "Mickey Goes Exploring" and "Mickey Goes Hiking" are the company's first entries in the educational software business. At present, they're for the Atari home computers, but Disney will be creating software for NEC, Panasonic, Radio Shack, and Texas Instruments computers, too.

Computer Yellow Pages

The "Software Directory" lists 21,000 software packages, 2,912 publishers, and 200 computer makers. It's $32.45 from PC Clearinghouse, 11781 Lee Jackson Highway, Fairfax, Va. 22033.

Don't forget

Pull the plug, or just lose power, and your computer's memory goes blank—all data you entered so carefully is lost. One solution is a backup power supply. Its batteries take over when power is removed. But Mostek has a different approach: It's a memory chip that contains built-in lithium batteries. The 16K device (2K by eight-bit) retains data for more than 10 years after power has been removed. It's mounted in a conventional 24-pin dual in-line (DIP) package.

$200 for computer stories

PS is starting a new monthly column for and by readers with personal computers. Each month we'll feature an account of one reader's unusual use (or misuse?) of a computer system—and we'll pay $200 for the story.

We'd also like to know about any hardware or software problems you might have (include brand, model, etc.). We'll try to get answers from manufacturers and print them. Send your report or questions to me, Bill Hawkins, POPULAR SCIENCE, 380 Madison Ave., New York, N.Y. 10017. PS

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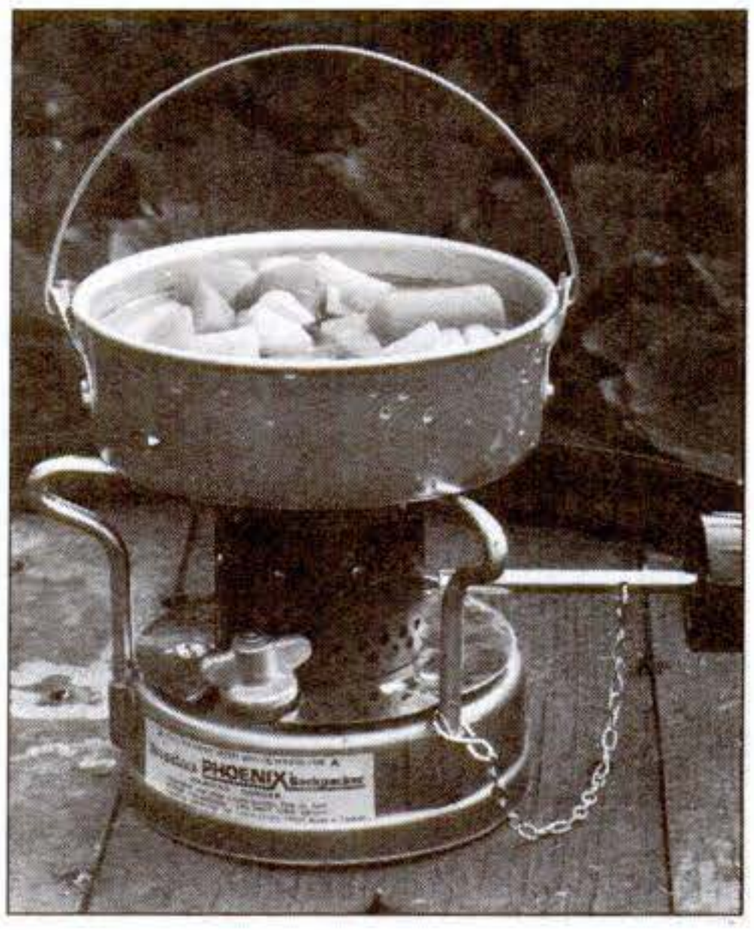
GENERAL ELECTRIC

Recreation Roundup

By HERBERT SHULDINER

Big RVs more popular

Sales of motor homes over 30 feet long are growing in spectacular fashion. RV manufacturers that haven't made them before are now making them, and makers of big motor homes are making them bigger. Rockwood, which hadn't offered conventional motor homes, recently introduced a 31-footer (above)—one of three new models. Prices range from $47,000 to $51,000. All three vehicles are built on a Chevrolet chassis with a 454-cu.-in. engine and offer fully self-contained living conveniences. Also built on a Chevrolet chassis is Winnebago's Chieftain 33RU (top), the largest ever from the longtime motor-home builder. It has a living room in front and a rear bedroom that can be closed off from the rest of the coach. The motor home can sleep up to six. Price: $41,000.



Backpacker's stove

The Phoenix Backpacker stove weighs only 30 ounces with a full tank of white gas. Its tank holds slightly more than a half-pint and can burn for up to 90 minutes. It took me less than five minutes to bring a quart of water to a boil with this stove. The Phoenix Backpacker is made in Taiwan and is imported by Precise International, 3 Chestnut St., Suffern, N.Y. 10901. Price: $30.

Safe lock-backs

The Traveler light-heavyweight series of lock-back folding fillet knives made by Chicago Cutlery (5420 N. County Rd. 18, Minneapolis, Minn. 55438) has a built-in stop that prevents knives from closing while in use. This is an especially handy feature for fishermen working with hands wet. The new series includes six- (opposite, top), five- (opposite, left), and four-inch models. The

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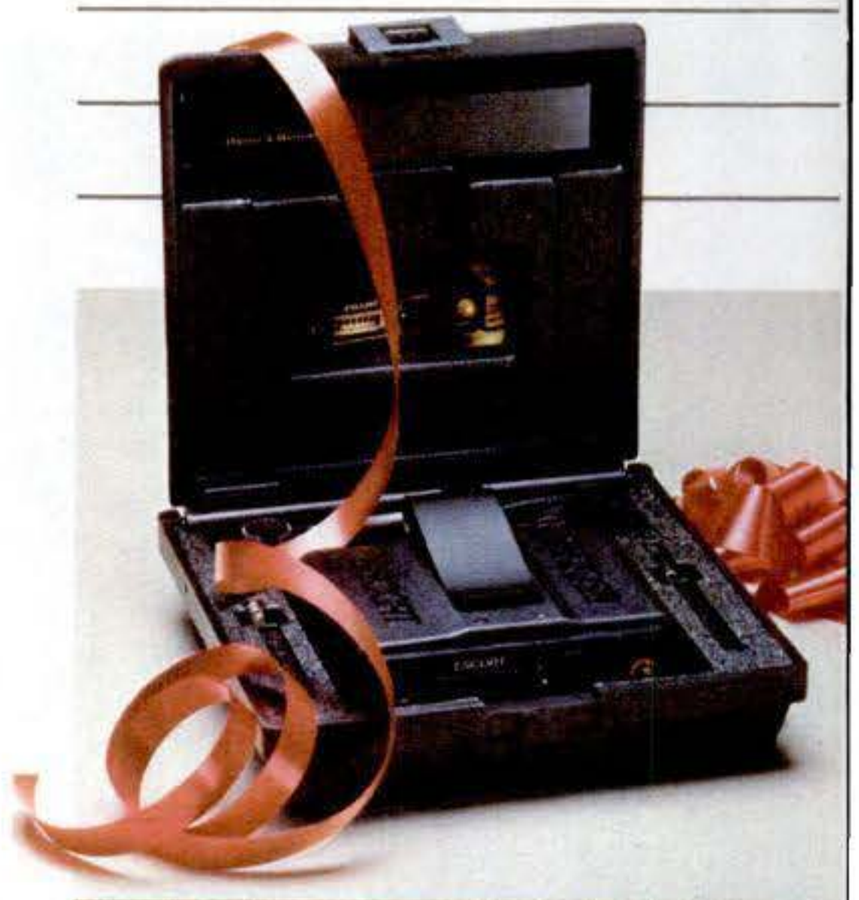

THE RADAR DEFENSE KIT

ESCORT comes complete with a molded carrying case, detachable power cord, visor clip and hook and loop mounting, spare fuse and alert bulb, and a comprehensive owner's handbook.

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For several years after its introduction, demand was so great that customers waited up to six months for delivery. We finally had to build a new factory to keep ahead of the demand.

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ST/O/P *Digital Processor Circuitry*

And last spring we added our STatistical Operations Processor (ST/O/P™), a new electronic circuit—the first in the industry—which rejects false alarms caused by less elegantly designed detectors. With ST/O/P, ESCORT is more desirable than ever.

Attention To Detail

Owners also take great pleasure in ESCORT's look and feel. Its extruded aluminum housing has the right heft. The visor clip is a rugged combination of Lexan and spring steel. The volume control is as silky as that of an exotic stereo. We even add a small photoelectric sensor (you can see it next to the red power-on indicator). It senses the ambient lighting in the car and adjusts the brightness of the alert light to suit. These are just a few of the many details that make ESCORT unique.

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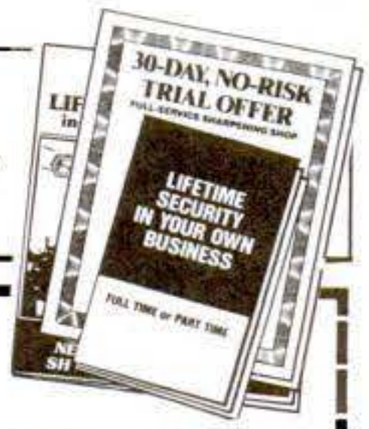

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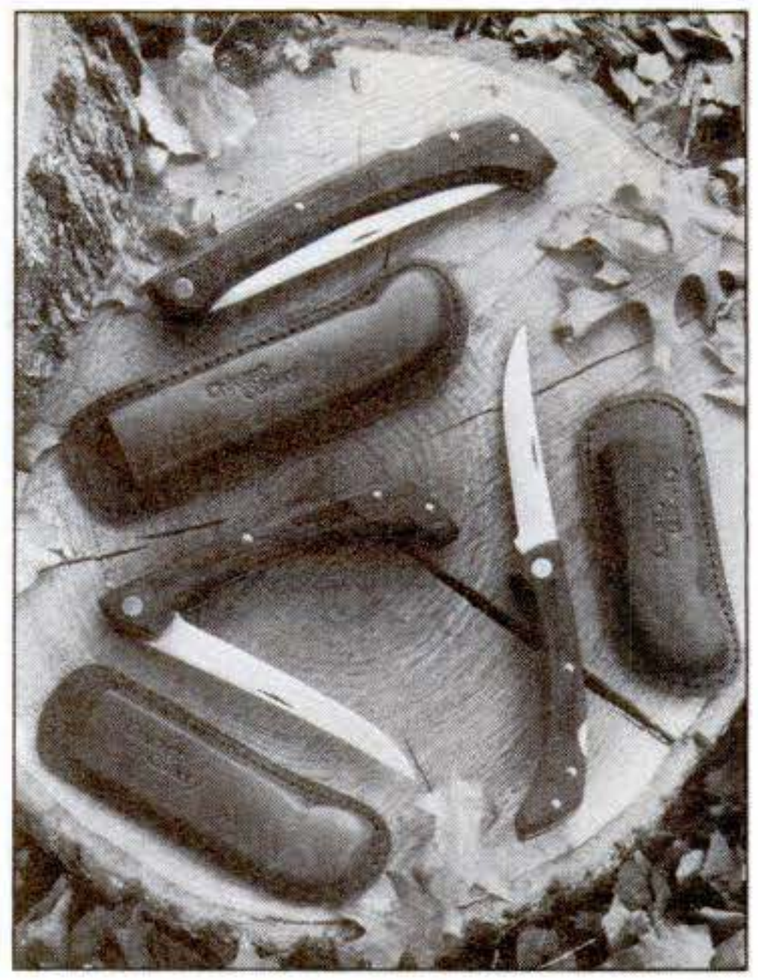
Recreation Roundup



blades are made of rust-resistant carbon stainless steel and have solid-walnut handles with brass rivets. Prices range from $28.25 to $34.50, without sheath.

Inflatable warranties

Inflatable boats seem to be vulnerable to all types of perils. That might be why some enthusiasts have put off buying them. To reassure prospective customers, one company—Avon—now has introduced an extended warranty on its inflatables that even covers buyers of used boats. Avon says the new warranty will cover hull fabric and air-holding seams against deterioration for five years. Other parts of the boat also are protected for one year. Included are floorboards, seats, bellows, and even valves.

Snowmobile manual

Thinking about getting your ski scooter in shape for the coming season? The ninth edition of the Snowmobile Service Manual could help you do it. The 350-page book covers chassis- and engine-service fundamentals. There are also sections on carburetor, torque converter, track, and suspension service. The manual is $12.95 from Technical Publications, Box 12901, Overland Park, Kan. 66212.

Snowmobile festivals

If you do any advance planning for winter trips, you might want to mark these items on your calendar:

Jan. 13–29—Northwoods Snowmobile Festival U.S.A. This takes place in the Wisconsin Northwoods area near Eagle River. The major event of the festival is the World's Championship Snowmobile Derby on Jan. 20–22 in Eagle River.

Feb. 10–12—Second International Snowmobile Festival in Valcourt, Quebec. This is planned by the Quebec Federation of Snowmobile Clubs. Valcourt is the home of Bombardier, maker of Ski-Doo and Moto Ski snowmobiles, and is the hub of one of the best snowmobile-trail networks in North America. Valcourt is easily accessible from most places in the Northeast. PS

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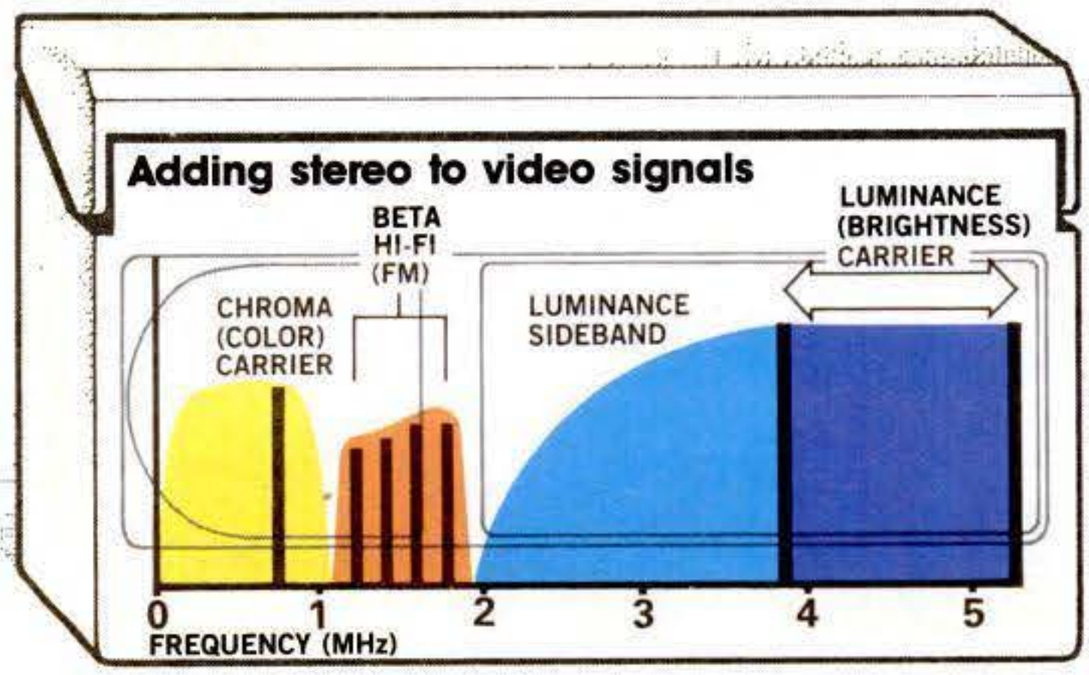
VCRs add super hi-fi

Hi-fi rock performances, such as Fleetwood Mac concert displayed on Sears 20-in. flat-square-tube stereo receiver, may create new VCR fans. Diagram indicates "valley" between VCR color and luminance signals where FM carrier signals are tucked for enhanced stereo.



A new technique converts a VCR's sound track into radio-like FM signals and blends it with video. The result is superb stereo sound. Programming ranges from wallop of rock concerts to hiss-free movie tracks.

By JOHN FREE
Photo by Greg Sharko

Dragons seldom alarm me, but the Sony SL-2700 video-cassette recorder changed that recently.

The new $1,500 stereo deck was connected to my hi-fi system and giant-screen TV. One night I slipped Sony's demo tape into the machine, put on headphones, and dimmed the lights. A scene from the film *Dragonslayer* came on. As the reptile's image filled my wall-size screen, its murderous snarl grew into a roar. Incredibly, the sound seemed *behind* me.

Such hair-raising high fidelity is feasible now that Beta-format VCR firms can squeeze a radio-like stereo FM signal onto the video tracks (diagram). The new recording technique, called Beta Hi-Fi, provides flat frequency response from 20 to 20,000 Hz, a dynamic range over 80 dB, and wow less than 0.005 percent. Only new decks with Beta Hi-Fi circuits can use the new audio format.

This level of audio clarity—soon to be matched by new VHS-format decks—is exceeded only by digital compact discs ["Bye-bye, LP . . . hello, CD?," this issue] and other digital hardware. Both Beta and VHS super-hi-fi tapes also play on older decks because they still have a conventional audio track. Audio fidelity is poor on ordinary videotapes because of the slow tape speed and narrow audio track width. Confusing the stereo-VCR picture are recent "low-fi" machines in both formats that split the monophonic track to achieve stereo.

Watching and listening to several rock concerts and movies on Beta Hi-Fi, I detected clear differences in the quality of the original audio tracks. But true stereo hi-fi added immensely to the video realism. PS

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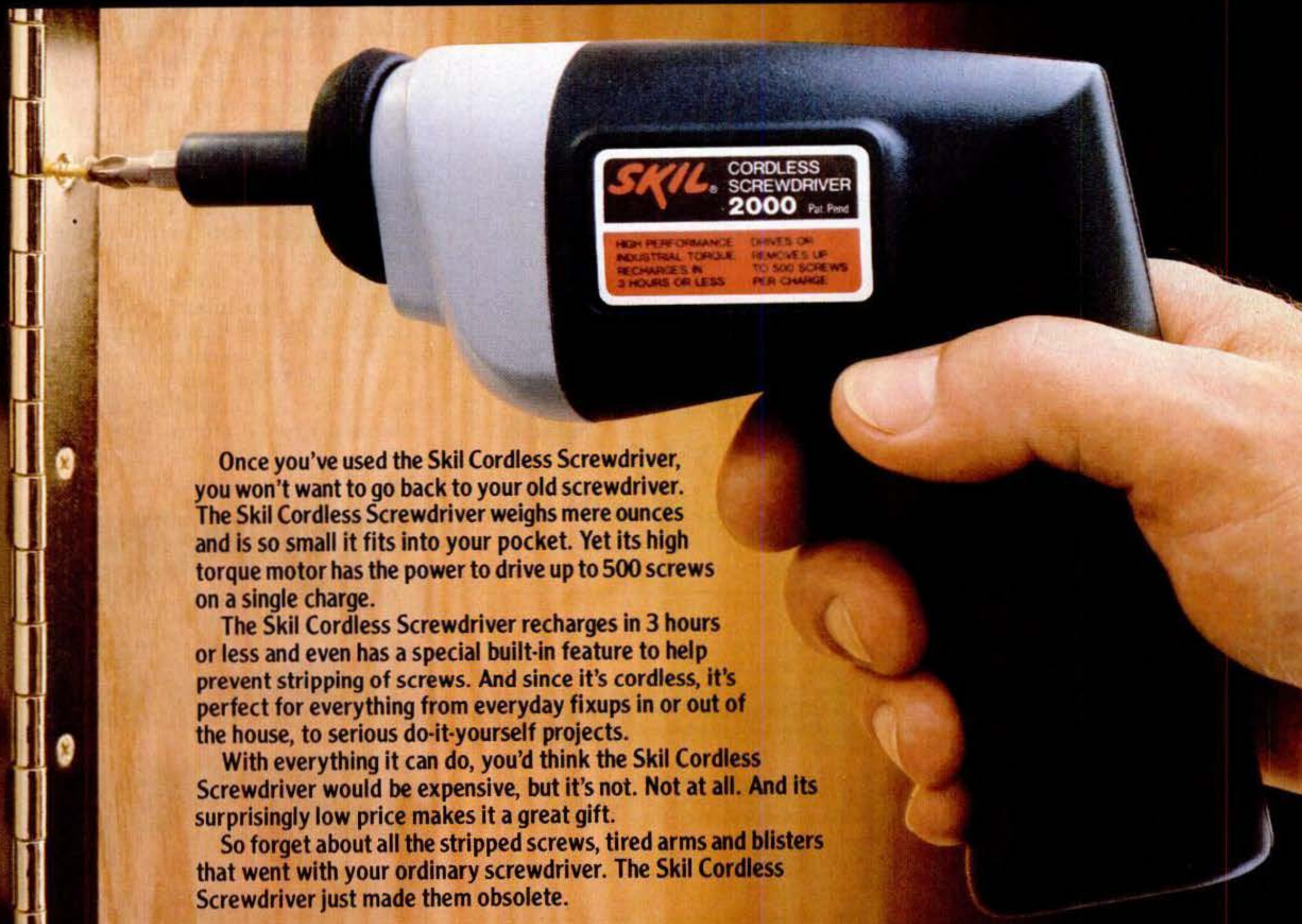
Your screwdriver just became obsolete.



Once you've used the Skil Cordless Screwdriver, you won't want to go back to your old screwdriver. The Skil Cordless Screwdriver weighs mere ounces and is so small it fits into your pocket. Yet its high torque motor has the power to drive up to 500 screws on a single charge.

The Skil Cordless Screwdriver recharges in 3 hours or less and even has a special built-in feature to help prevent stripping of screws. And since it's cordless, it's perfect for everything from everyday fixups in or out of the house, to serious do-it-yourself projects.

With everything it can do, you'd think the Skil Cordless Screwdriver would be expensive, but it's not. Not at all. And its surprisingly low price makes it a great gift.

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De-icing salts? NaCl vs. $CaCl_2$

These formulas stand for sodium chloride (NaCl, common table salt) and calcium chloride ($CaCl_2$). If you want to melt ice—on your sidewalks, steps, and driveway—the latter is a better bet, says Dow Chemical Co.

Both are sold throughout the snow belt as chemical de-icers: Sodium chloride in the form of rock salt, and calcium chloride as little white pellets (see photo). They perform differently when sprinkled on ice because they react differently to moisture and the environment.

Before either one can work, a brine solution must be formed to break the bond between the ice and the sidewalk. "Rock salt must be in direct contact with moisture from ice or snow before it will dissolve and form a solution," explains Henry Kirchner, technical specialist for Dow. "But calcium chloride actually attracts moisture from the air. This allows it to begin melting ice much more quickly." In tests that Kirchner supervised, at 20 degrees F, calcium chloride pellets broke an ice bond in about half the time it took rock salt.

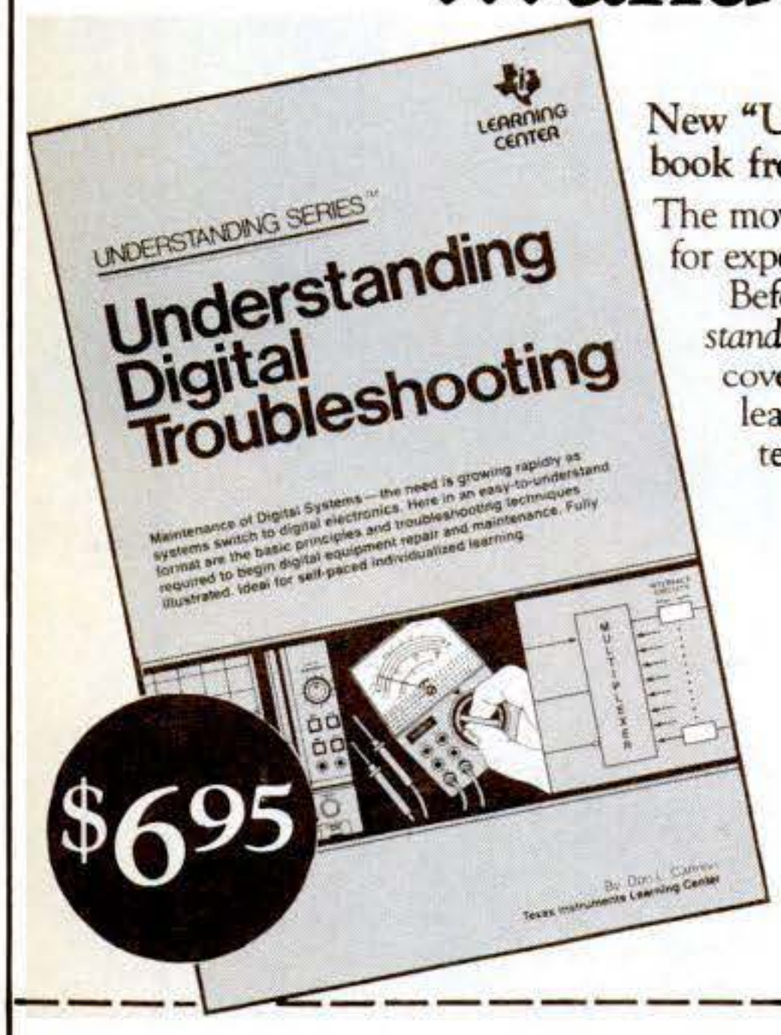
Furthermore, the lower the temperature, the greater the difference in the performance of the two. In tests at 10 degrees F, calcium chloride pellets took eight minutes to work, whereas rock salt took an hour. The reason: rock salt must absorb heat from the environment to begin its melting action. Below about 20 degrees, this becomes a very slow process. Calcium chloride, on the other hand, emits heat as it melts ice. Thus, it is effective even down to minus 25 degrees F.

Finally, calcium chloride continues to melt ice longer than sodium chloride. "That's because calcium chloride is a liquid in its natural state and tends to attract moisture," says Kirchner. "Therefore, it tends to remain in a brine solution. Rock salt is a solid in its natural state. It tends to give up moisture and return to its solid state." Thus, you must apply more rock salt and apply it more frequently to melt the same quantity of ice.

Calcium chloride pellets (made by Dow Chemical, naturally) are sold under many brand names. Check the bag's label for the salt's chemical composition.—*V. Elaine Smay*

Little white pellets of calcium chloride (top) are more-effective ice melters than rock-salt crystals, sodium chloride (above), according to lab tests.

Look for trouble ...and find it.



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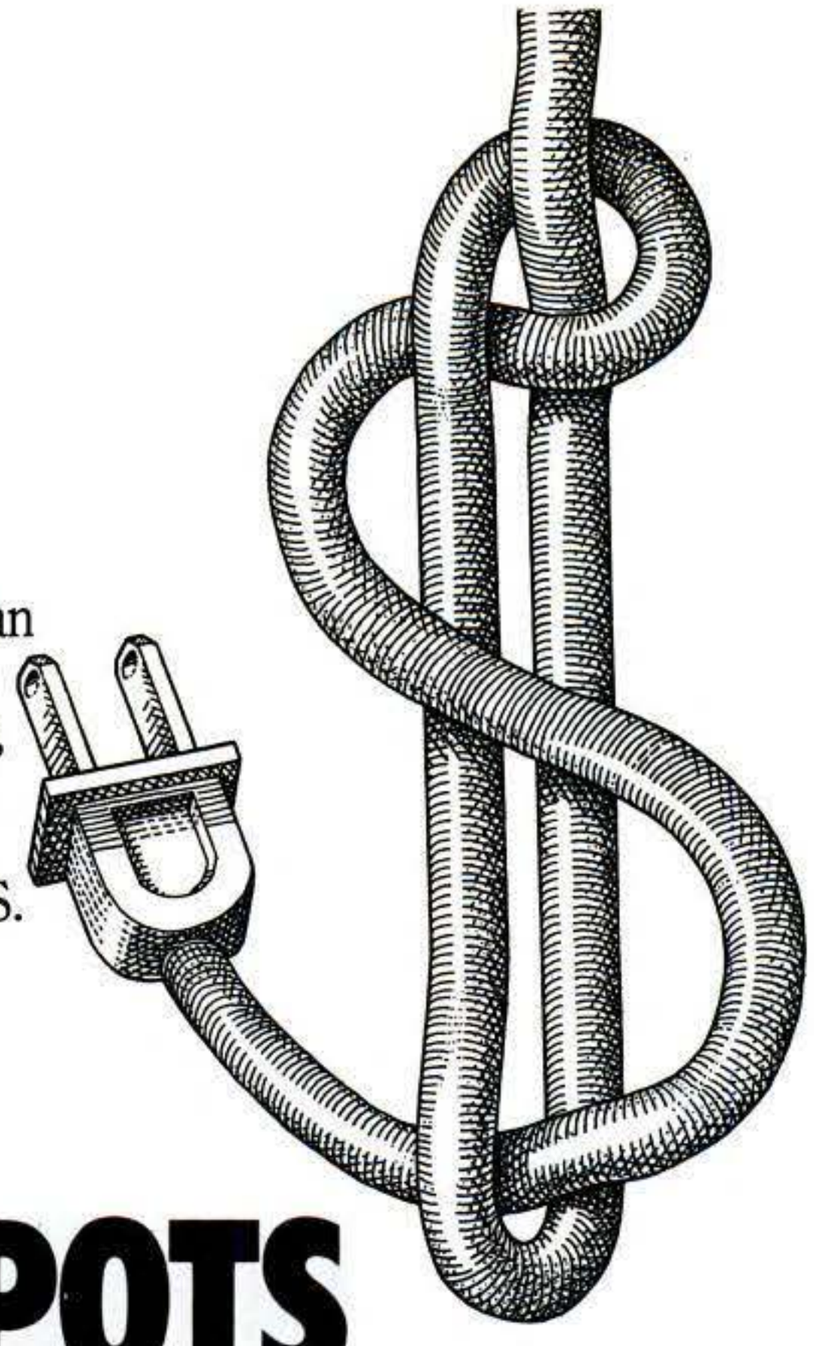

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The WHAT'S NEW magazine

Popular Science

What's News

We've dreamed of it for a long time: A flat-screen television set that would hang on the wall like a picture. POPULAR SCIENCE frequently has reported on developments in the field over the last decade or so as new developments were announced in this country and Japan. Thus, we recently were excited to hear that Seiko had developed a small *color* flat-screen display. What made it even more interesting was that it was not just another lab development but a product. Seiko says the new device will be on the market early in 1984.

Naturally, we wanted to learn all the details, so we sent Executive Editor Herb Shuldiner to Japan. He visited Seiko's research center in Suwa, about two-and-a-half hours from Tokyo by express train. He talked to the engineers who developed the new device and worked with Seiko photographers to get the picture on this month's cover. His report is in this issue.

The longest day

Did you notice that June 30 seemed longer than usual? It was no illusion; it was the longest day of the year. At the end of the minute beginning at 7:59 p.m. EDT, the world's astronomers and precision timekeepers cooperated to slip an extra second—a "leap" second—into the world's timekeeping system.

The practice began in 1972, as reported in Arthur Fisher's article ["Riddle of the Leap Second," PS, March '73]. The procedure became necessary because Earth's rotation is gradually slowing down. The insertion of a leap second is required from time to time to keep Earth's clocks in time with the apparent rotation of the stars around us. The event on June 30 was the 12th such insertion of a second since 1972 and apparently will be necessary about once a year. The slowing of Earth's rotation is believed to be caused by friction in its atmosphere, oceans, and core.

Beam weapons

The idea has been around at least since H. G. Wells wrote *War of the Worlds* toward the end of the last century. Now, apparently, it has become a technological reality.

The idea is the beam weapon. As POPULAR SCIENCE reported [PS, Nov. '81], a great deal of research has been done to develop lasers, particle beams, and other science-fictiony devices that could shoot down missiles and other weapons at the speed of light. Although detailed reports on the results of such work are obviously not available, some information has been released.

The latest news is that the United States Air Force recently fired 13 Sidewinder missiles over the Naval Weapons Center range at China Lake, Calif. The first eight missiles were used to check the system's ability to locate the targets and track them. A 400-kilowatt carbon dioxide laser built by United Technologies was fired at the next five missiles. Each one was knocked down. An Air Force official said that the laser beam did not destroy the missiles, rather it disabled them and caused them to crash. One missile, which contained an explosive charge, blew up. The spokesman did not reveal at what range the missiles were shot down by the beam weapon. The exercise shows that considerable progress is being made in beam development. Two years ago the Air Force tried similar tests, which failed.

Monster dam

The world's largest hydraulic project, in the Netherlands, has passed a landmark occasion.

In 1955, two years after violent storms and high tides killed 1,800 people and did enormous damage along the Dutch coast, a plan was devised to build a gigantic storm barrier along a stretch of that coast. The most massive and difficult part is building a 5.5-mile-long flood barrier across a delta shared by the Scheldt, Rhine, and Maas rivers. It will be made of 66 gigantic 18,000-ton piers. Between the piers will be huge gates, which will remain open most of the time but will be closed when storms and high tides threaten the coast. The structure is more complex and costly than a dam, and because it will allow a free flow of water most of the time, it won't upset the ecology of the area.

As Dave Scott reported ["Monster Piers," PS, Feb. '82], the moving of the monster piers into place was the trickiest part of the whole scheme. Now the first one has been successfully planted. The project worked like this. The first 19 piers were made in a dry construction dock 49 feet below sea level. Early this year, the dock was flooded, and a special ship that can straddle a pier lifted one of the huge structures with on-board cranes. Then it sailed to the site where the pier was to be permanently placed. The sea bottom at the site was prepared by compacting the sand and covering it with a 14-inch mat to prevent erosion from tides and currents. Upon arriving, the 18,000-ton pier was lowered onto the mat.

Ultimately, some 66 piers will be necessary, and present plans call for the 19 made so far to be floated into place at a rate of approximately one a week at low tide when the weather is good. Dutch engineers hope to have the entire 5.5-mile section completed by 1986.

Shooting-star talk

Although most of the time you don't see many of them, tiny meteors are constantly slamming into Earth's atmosphere. When they do, they burn, and the thin air in the vicinity of the event is ionized. In this state, which lasts only a few seconds, the meteor trails reflect high-frequency radio signals very efficiently at distances of up to 1,250 miles. This opens up important communications possibilities.

Although the time of any individual meteor burst is not predictable, it *is* predictable on a statistical basis that meteor bursts will be available for a certain time each week or month. Thus, if you want to transmit information from point A to point B and you can be a little flexible about *when* it is transmitted, you can set up a communications link without having to use something as complicated or expensive as a satellite.

Although work on the system has been going on for some time, the FCC has now decided to set aside radio frequencies for regular meteor-burst communications service. One early application will be gathering weather information from remote unmanned weather stations in Alaska. A central transmitter will constantly send out a signal. When it detects a return of the signal, indicating that it is being reflected from a meteor burst, it will signal all remote transmitters to quickly transmit any data they have collected. The FCC now is ready to start licensing both government agencies and private companies that have use for the new meteor-burst communications system.

Editor-in-Chief

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Super-tech house

Just off the racing trail at Hidden Valley Ski Resort in Vernon, N.J., stands an experimental house that is a wood, glass, and masonry encyclopedia of energy efficiency. Designed by Parsons School-trained Mary Arace, a dynamic grandmother of six, it uses passive-solar design, earth sheltering, super-insulation, and double-shell construction in thoughtful combination. But the big surprise is beneath the house: More than a mile of plastic tubing is buried there and linked to a solar collector and a ground-loop heat pump. The system provides house heating and cooling and preheats domestic water.

Why such an elaborate heating and cooling system for a house that may need neither? Hers is a test house, Arace emphasizes, built to answer questions: What design approaches work best? And which ones are most cost effective? With the help of a monitoring system, Mary Arace intends to find out.

By V. ELAINE SMAY
Photos by Greg Sharko

By the time Mary Arace was 13 years old, she was tired of sharing a room with her sister. So she checked out some how-to books from the library, scrounged scrap lumber from the garage, charged $40 worth of materials to her father at the hardware store, and made a room for herself by finishing half the attic in the family's Victorian house in Lawrenceville, N.J. She did the whole project by herself. Every nail. "It was the talk of the neighborhood," she recalls. "I guess I got hooked on applause."

Petite, vivacious, and stylishly dressed, Mary Arace (rhymes with Harris) looks and acts more like a college student—which she is—than a grandmother—which she also is. Her husband, August Arace, a financial analyst with an engineering background, supervises the finances of his wife's present project, a proof-of-con-

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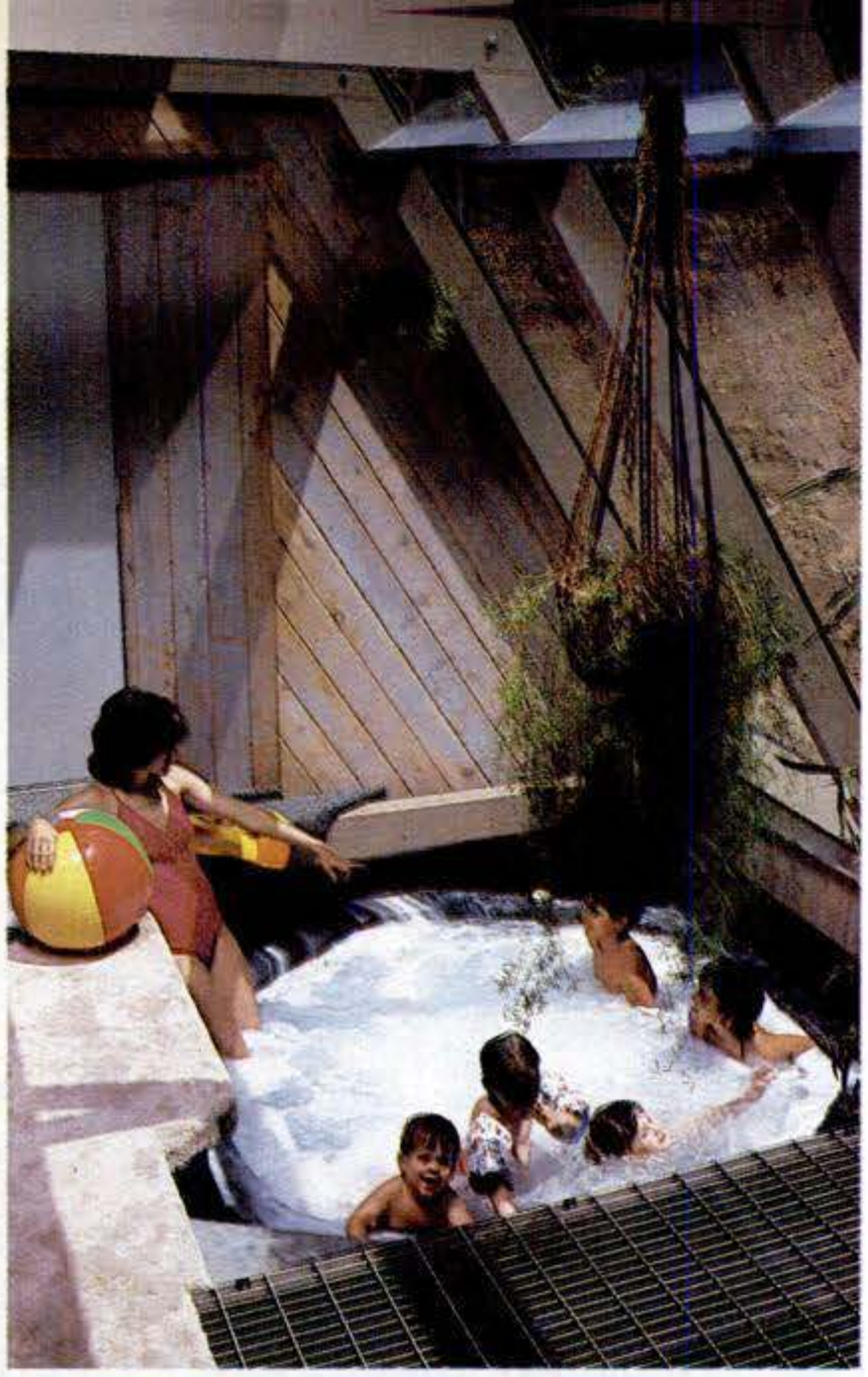

Sunspace of Arace house (opening page) has double-glazed slanted glass, though designer Mary Arace is aware of recent evidence that slanted glass may not be the best choice [PS, Sept.]. Here, though, it takes advantage of the view—which is *up* the mountain. Living-dining room (far left) is separated from sunspace by quad-glazed sliding glass doors from Weathershield, which use 3M Sungain film [PS, April '82]. Arace (on sofa) enjoys a rare moment of leisure with her daughter and two of her grandchildren. Spa (left) at east end of sunspace is great for après ski—and for the grandchildren and their friends. Sunken atrium (bottom) below sunspace is pleasant most of the year since ground temperature keeps it cool in summer, warm in winter. Here, Arace entertains Linda Kabasakalian, wife of solar specialist Andy Kabasakalian. Note that the grating floor of the sunspace above lets the sun penetrate to the atrium.

cept house that is the capstone of a lifetime fascination with design, construction, and energy conservation.

Mrs. Arace calls the project, simply, the solar house.

It is that and much more.

- A south-facing sunspace provides passive-solar heat.
- The lower level is earth sheltered; the hollow walls deliver earth-tempered air to the windows above.
- An earth-sheltered atrium below the sunspace moderates the temperatures there so that the sunspace glass needs no insulation.
- Walls of the upper level are mostly super-insulated [PS, May '81], but include vestiges of double-shell construction [PS, Feb.].
- Quad-glazed windows are used throughout the house except for the slanted glass on the sunspace. Non-south windows have *two* quad-glazed panels plus a four-inch air space.
- An unglazed, fin-and-tube solar collector in the top of the sunspace helps shade and cool the sunspace. Its heat is stored in either a water tank or in the earth beneath the house.
- A ground-loop heat pump also stores heat beneath the house in summer and uses the warm earth there as a heat source during the winter.
- An automatic monitoring system charts the performance of the house.

Overkill? Complicated? Expensive? Yes, but for a reason. Arace designed and built the house more as a test lab than a dwelling, to find out which of its many elements work best and are most cost effective.

Evolution of a hybrid

The house evolved through four years of research. It began in 1978, when Arace saw a TV show about Tom Smith's double-shell house in Lake Tahoe, Calif. [PS, Dec. '79]. She was studying environmental design at Parsons School of Design in New York City, specializing in residential architecture, but an auto accident had confined her to a hospital bed. There she lay when the fortuitous TV show was aired. "I got very excited about the house," she recalls. "But I knew darn well what they said about how it worked just couldn't be true."

What they said was this: Air heated in the south-facing sunspace of the house was supposed to flow by natural convection all the way around through a continuous air plenum: over the top, down the north wall, and under the floor. That was supposed to distribute heat evenly throughout the house and store excess heat in the earth below for use at night.

Arace's skepticism arose from observation and experience, not textbook thermodynamics. "As a child I spent a lot of time at my grandmother's farm in Pennsylvania," she relates. "The barn had an earth-sheltered area and I noticed that it was comfortable year-round." The farmhouse, too, came un-

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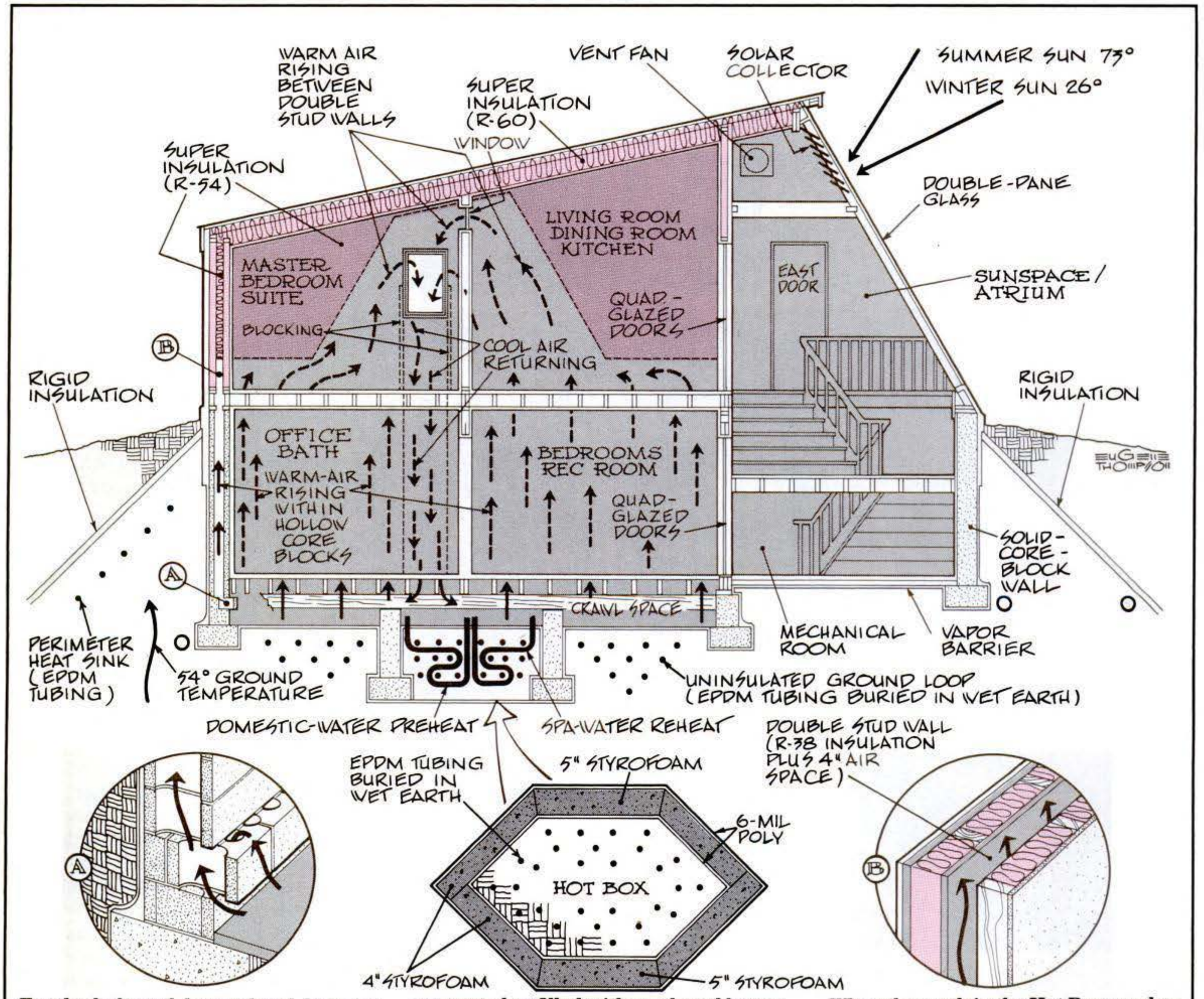
der her scrutiny. "It had a spring running through the stone basement. Even in summer it seemed icy cold down there. Then, when you went up to the attic, it must have been 150 degrees. That amazed me: Only 20-some vertical feet and maybe 100 degrees temperature difference."

Recalling the natural temperature stratification, Arace was convinced that the same thing must happen in double-shell houses. But she saw a different advantage to the air plenum around the house: "It seemed to me that ground heat would rise there and serve as a buffer zone between the inside of the house and the outside air."

In December 1979, Arace read the PS cover story on double-shell houses, which confirmed that many experts shared her doubts about how they work. "My right shoulder was put together with steel pins and I couldn't finish my degree," she says. "But I figured I could build a house that would take advantage of ground heat without being underground."

Vintage passive solar

Building a house was not a far-out notion for Arace. She and her first husband built several. "We'd move in, finish the house, sell it, and move out,"



Earth-sheltered lower level has concrete-block walls (on north, east, and west), built so that earth-tempered air from the crawl space below can rise through the hollow cores (detail A) and flow to the walls above. They are double 2×4 stud walls (detail B), originally built with a four-in. air cavity. But tests last winter indicated that insulating the cavity as shown (above dotted line) would cut heat loss through walls while keeping the buffer of earth-tempered air between the two quad-pane panels of the windows.

Below the crawl space is the ground-loop heat-storage system. The pit was excavated, refilled with earth and layers of EPDM tubing, and topped with a plastic vapor barrier. The Hot Box was built of Styrofoam and wrapped with more plastic. Its unusual shape (inspired by a Chicken McNuggets container at McDonald's) allowed it to be built without structural sides; 1,000 ft. of 5/8-in. EPDM tubing are buried in it. Hot water from the solar collector and heat pump (in summer) passes through the tubes—losing heat to the damp earth around—and returns to repeat the cycle. The heat is transferred to the domestic water, which passes through the Hot Box in two loops.

When the earth in the Hot Box reaches about 105 deg. F, water from the heat pump (in summer) and solar collector is channeled to the uninsulated loop—3,000 ft. of twin 5/16-in. EPDM tubing—to dump its heat. In winter, the heat pump retrieves some of this to heat the house. The perimeter loop—500 ft. of 5/8-in. EPDM tubing—is the ultimate heat sink for the heat pump. It is beyond the foundation of the house but within the 45-deg. insulation skirt (so installed to channel more geothermal heat to the crawl space). The system is automatically controlled with valves, temperature sensors, and aquastats.

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she remembers. One, which she designed and helped build, was a direct-gain, passive-solar house with a large bank of south windows. "I learned all the things that can make direct gain a bad idea," says Arace. "We had a stainless-steel sink with drainboards. You almost needed sunglasses to go in the kitchen." The house also overheated: "We had to close the drapes to eat Christmas dinner." And when the sun wasn't shining, it lost heat just as fast—through the glass and through the barely insulated block walls. "I didn't know much about insulation then. Nobody did." It was 1956.

When she had recovered sufficiently from the accident—and had convinced her husband that her theories were sound—Arace began in earnest the research for her test house. The list of people she consulted reads like a *Who's Who* of energy conservation. When she heard about a house that she thought could teach her something, she'd go have a look. "She was like a bee that visited every flower in town," says Andy Kabasakalian, the solar specialist she later hired. "And she gathered a lot of pollen." The end product, though an amalgam of many people's ideas, adds up to an Arace original.

Ground-loop heat pump

The most original aspect is the heating, cooling, and water-heating system. Arace's collaborators were Kabasakalian, of Sunrunner Industries (Ogdensburg, N.J.), and Dave Emeigh of Conserv-O-Mation (Landing, N.J.). Kabasakalian helped design the solar collector and built the ground-loop, ethylene propylene diene monomer (EPDM) tubing system for heat storage and retrieval. Emeigh modified a York water-to-air heat pump to work with the other elements. "Mary told me what she wanted, and I put it all together."

Water from the heat pump (in summer, when it's used as an air conditioner) and from the solar collector flows through the EPDM tubes, where it loses heat to the surrounding damp earth. The tubes are laid in three independent but integrated stages. The first, the insulated, watertight Hot Box (see diagram), is an earth-filled heat exchanger where the domestic hot water is preheated. By how much, only testing will tell. But one hot summer day Arace reported getting 100-degree-F water at the tap—straight from the Hot Box.

The second stage of the ground-loop system is designed for annual heat storage. Both the solar collector and heat pump (in summer) can store heat there. In winter, when the heat pump reverses to heat the house, it uses the warmed earth as a heat source. "With a straight ground-loop heat pump you rely solely on earth temperatures rising," Kabasakalian points out. "Here we're boosting the earth temperature by storing heat." Under worst-case conditions with no heat stored and the temperature of the water in the ground loop at 45 degrees F, the heat pump will have the same efficiency as standard ground-loop heat pumps [PS, Oct.]. "To put that in numbers," says Emeigh, "its coefficient of performance [COP] will be 3.1," meaning that more than three times as much energy comes out (as heat) as goes in (as electricity). But if enough heat can be stored in the soil to raise the water temperature to 65, which is likely at least early in the heating season, the COP will go up to four, according to Emeigh.

The third stage of the ground-loop system was added in case the earth in the other areas got too warm. Emeigh wanted to be sure that the heat pump had a cool place to dump heat all summer.

Finally, they installed a heavily insulated, 315-gallon water tank, which can be used to store solar heat. A photovoltaic array soon will be added to supply the energy to pump the heating and cooling water.

The passive house

The house is square, for maximum thermal efficiency. It sits on a lovely three-acre plot within Hidden Valley, a private ski area. The Araces are part owners of the resort, and the parcel of land came with the deal.

You enter the house on the west side, where an entry foyer leads up to the sunspace or down to the atrium. From the sunspace you enter the living room through glass doors. All the glass and the 12-foot ceiling make the room feel spacious, though it is not large. The open-plan kitchen is to your left. Arace designed it for both working and energy efficiency. "I learned last winter how well the house holds heat," she told me, "so I was concerned about overheating in summer." Consequently, she eliminated most sources of internal heat gain. In summer, she'll cook with an induction cook top [PS, Feb. '81] and a microwave oven. She'll turn on only fluorescent lights in the kitchen. In winter, she'll also use a convection oven and incandescent kitchen lights. The house has no storage water heater. Point-of-use heaters at each tap [PS, Feb. '82] will bring the water up to temperature after it's been preheated in the Hot Box. The refrigerator is vented: to the master suite behind it in winter and outside in summer. The refrigerator vent joins with the vents from the clothes dryer and bathrooms to exit through one roof penetration. Such attention to detail is an Arace hallmark. On the building permit that was posted at the site she paraphrased Mies van der Rohe: "Tradesmen remember, God is in the details."

A circular stair leads from the kitchen to the lower level. It is a hot summer day, and as we descend, the temperature gets noticeably cooler. "Down here it stays at 68," Arace told me. "Last winter during construction it would get into the 60s in the daytime, then drop to 52 at night."

The lower level could be a separate apartment. There's a good-size recreation room, two small bedrooms, a bath, and a laundry room. Directly under the sunspace is the atrium. The floor between is a metal grid so that light and solar heat penetrate to the atrium and rooms beyond. At night, even when it's zero outside, moderating earth heat rises into the sunspace to keep temperatures there above freezing. In summer, the atrium stays comfortable even when it's hot above.

In the northeast corner of the lower level is a small room with a data logger. As we walk in, it begins grinding out numbers on paper tape, recording the readings of 40 temperature sensors: 12 are buried in the heat-storage area below the house; others are in the walls and in the sunspace at high, medium, and low points; more are in the roof and outside. The team set up the monitoring system in consultation with Vitro Laboratories, which handled the Department of Energy's National Solar Data Network [PS, Aug. '82]. Thus, the data they collect will be comparable with data collected in more than 100 solar buildings monitored in that program.

After they've collected enough data, the team will analyze it. "The data logger can communicate with a computer," Kabasakalian says, "so we can juggle the options. With the right programming we can see what is most valuable under what circumstances—and most cost effective."

Not that Arace thinks her test house will prove that earth-sheltering or super-insulation or any other single approach is best. "It seems to me that the advocates of all these are sooner or later going to agree that a combination is the best way," she says. Based on what she has learned, Arace designed a basic-concept house plan (available through Solar Thermal Systems, Box 25, Towaco, N.J. 07082), which she will modify and update as the experimental house yields test results. "As a contribution to human advancement, I know this is just a little spit in the ocean," says Arace. "But it's my spit." PS

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Spy photos from space

Last March on television, President Reagan displayed pictures of a military buildup in Soviet-backed countries in the Caribbean and Central America. Though very detailed, the spy-plane photos were poorer than those the U.S. was capable of—a capability kept secret for security reasons. Advances in technology have given spy craft powerful eyes. Though information is closely guarded, much can be learned about satellite operations.

By JIM SCHEFTER

The U.S. satellite, code-named White Cloud, crossed the Alabama coast southeastward toward the Caribbean. Trailing like obedient puppies, three small sub-satellites followed at the ends of 10-mile-long tethers.

The spacecraft were equipped with sensitive radars and eavesdropping radio receivers. Their sole mission: surveillance. Now, as the space spies looked down from their 600-mile altitude, they plotted the movement of ships back and forth across the water below. From the data they gathered, one conclusion was inescapable: Soviet cargo vessels, often staging out of Cuban ports, were increasing their runs west toward Grenada and Central America.

A concerned President Reagan agreed to a bold move to make public the growing Soviet activity just beyond our southern doorstep. He ordered a high-flying SR-71 Blackbird reconnaissance aircraft to bring back photographic evidence that he could release to the world.

A few days later, in late March, the President stepped before television cameras to display a few of the photos. The pictures were carefully chosen from among the worst available. "We'd never release our best photos," an Air Force officer said later. "That would let people know how good we are."

Even so, the photos showed a modern electronic intelligence facility in Cuba, complete with a satellite ground station for direct communications with Moscow; Russian-built MiG-21 and MiG-23 aircraft at a Cuban military airfield; a new 10,000-foot runway with massive fuel-storage facilities on the island of Grenada; and Russian cargo ships in a Nicaragua harbor.

Like John Kennedy's release of photos showing Soviet missiles in Cuba 21 years before, Reagan's message was clear: Russian influence in the Caribbean was spreading.

Peeking under the veil

Whether or not the message provoked the reaction Reagan wanted, it briefly lifted the tight veil of secrecy that surrounded U.S. technological advances in aerial and space surveillance. Just how far have we come in the last two decades?

To find out, PS editors sent me into the misty world of the intelligence community with questions. We knew that getting answers wouldn't be easy. No one will discuss activities, capabilities, or results for the record. Yet a wealth of information is available in background briefings, technical papers, and interviews with people whose work puts them into close contact with the data returned from spy planes and satellites. In most cases, experts agreed to talk only under the condition that they not be identified in print. But some were less rigid.

"The fact that we conduct overhead surveillance is no secret," said Eugene Iwanciw, an analyst for the Senate Intelligence Committee. "The whole field comes under the heading of National Technical Means of Collection." That's bureaucratese for the full range of land, sea, air, and space surveillance. Each is important. But in the past two decades the most dramatic advances have come in space. Without satellites, the U.S. intelligence services would be virtually blind.

"Satellites go where aircraft can't," Iwanciw told me. That includes most of the world. And because satellite reconnaissance is so good, the use of aircraft is declining. The fabled U-2 spy plane gave way more than a decade ago to the SR-71, which flies above 100,000 feet at top speeds of more than 2,200 mph. Now even that plane takes to the sky only to photograph specific targets in accessible regions.

"The SR-71 has become far less sensitive in the past few years," Iwanciw said. The important spying is done by satellites, and airborne photo reconnaissance is virtually becoming an obsolete art. At least seven major programs give the U.S. its eyes and ears in space:

- Close Look, a high-resolution photographic satellite launched only when needed.
- Big Bird, a massive satellite for routine medium-resolution photography and electronic eavesdropping.
- KH-11, another large satellite used for full-time surveillance, whose digital images are relayed to two ground stations.
- KH-9, an improved version of the KH-11 with higher-resolution imagery, to be first launched in 1984.
- Defense Support Program, a set of three satellites in geostationary Earth orbit to monitor missile and space launches.

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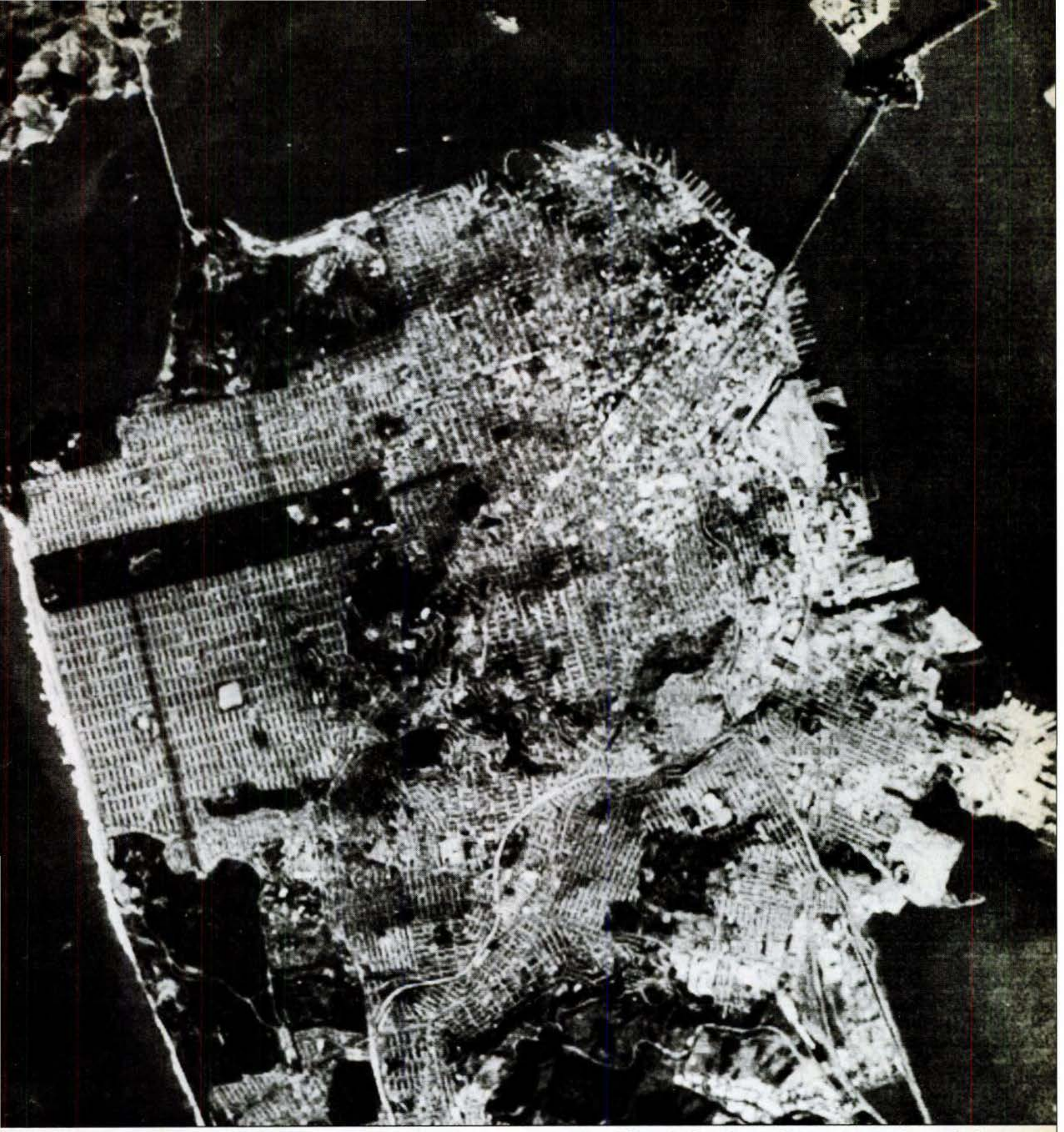

Imaging capability of U.S. satellites exceeds even this shot of San Francisco, made by NASA's Landsat-4 satellite from 438 miles up. Its imaging instrument, the thematic mapper, uses 300 million pixels (picture elements) to attain resolution of 30 meters (98 ft.). An older instrument, using 32 million pixels, had resolution of only 80 meters (263 ft.).

- Rhyolite, a set of two geostationary satellites listening to telemetry from Russian launches.
- White Cloud, a satellite that watches the oceans with radar, radio, and infrared sensors to track surface ships and submarines.

The space fleet gives the United States surveillance capabilities unmatched in the history of reconnaissance.

Close-up spying

Technicians at Vandenberg AFB, Calif., swarmed over a mothballed Close Look satellite, verifying its readiness to fly. In the South Atlantic, Britain and Argentina warred over possession of the Falkland Islands. And in Washington, D.C., the President and his advisers debated about how best to support the British without forever alienating Argentina.

Based on Lockheed's Agena D upper stage, with a restartable engine and plenty of fuel for orbital maneuvering, Close Look can drop briefly to perigees as low as 70 miles. From there, its high-resolution multi-spectral camera, built by the Itek Corp. in Lexington, Mass., can reportedly photograph objects as small as six inches across.

A Close Look sent aloft during the Iranian hostage crisis reportedly allowed analysts to identify individual ayatollahs by the shape of their beards. Such incredible

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"KH-9 can identify lighted windows

resolution is partly the result of a recent development called adaptive optics, which removes image distortions caused by the atmosphere. How adaptive optics works is a closely guarded secret. Close Look carries at least two reentry pods, which are ejected toward Earth with canisters of exposed film and are snagged by their parachutes from modified Air Force C-130s based in Hawaii. But Close Looks are in short supply; no more than three or four remain in storage, to be used in grave crises.

Would such high-quality photographs have helped the British? The decision from the White House was to save the Close Looks. The British needed to know the deployment of Argentine troops and ships. That kind of detail could come from one of the two KH-11s already in orbit.

Little is known about the KH-11. It is not based on the Agena but maneuvers easily in space. Its 130-mile perigee can be adjusted to bring global hot spots into better view, and its cameras are similar to Landsat [PS, Dec. '82] instruments, but better. The KH-11 records a ground scene on tape, then replays digital values, one picture element at a time, to a ground station in Pine Gap, Australia, or Buckly Field, Colo.

At its low point in orbit, the KH-11's television-like camera sees objects as small as six feet wide. A major factor in getting such fine resolution is folded optics, essentially a series of high-quality mirrors that extend the camera's focal length by bouncing incoming light back and forth inside the camera before it finally registers against the video sensors. The rendering of detail improves, of course, with longer focal lengths.

Moving a KH-11 into the best position for twice-a-day Falkland viewing, the U.S. Air Force soon had a bleacher-seat view of the short war. The British presumably shared in the surveillance.

In each space-spy program, military technology goes far beyond anything available to NASA or other civilian agencies. And in each program, security is so tight that much of what I learned came from background briefings, from noting which questions contacts refused to answer, and from piecing together facts from many sources.

The security lid was far looser 20 years ago. Today, the Pentagon refuses even to make available photo interpreters who might discuss what they found in the pictures that Reagan released.

"We just can't talk about specifics," said a Pentagon spokesman. "We can't even tell you where the most critical work is being done."

But the Pentagon provided numerous hints about technical journals, papers, and other sources of information, including the Defense Mapping Agency (DMA), where I saw sophisticated and computerized equipment used to produce finely detailed military maps. Today, many of the maps exist only as digitized data inside a computer.

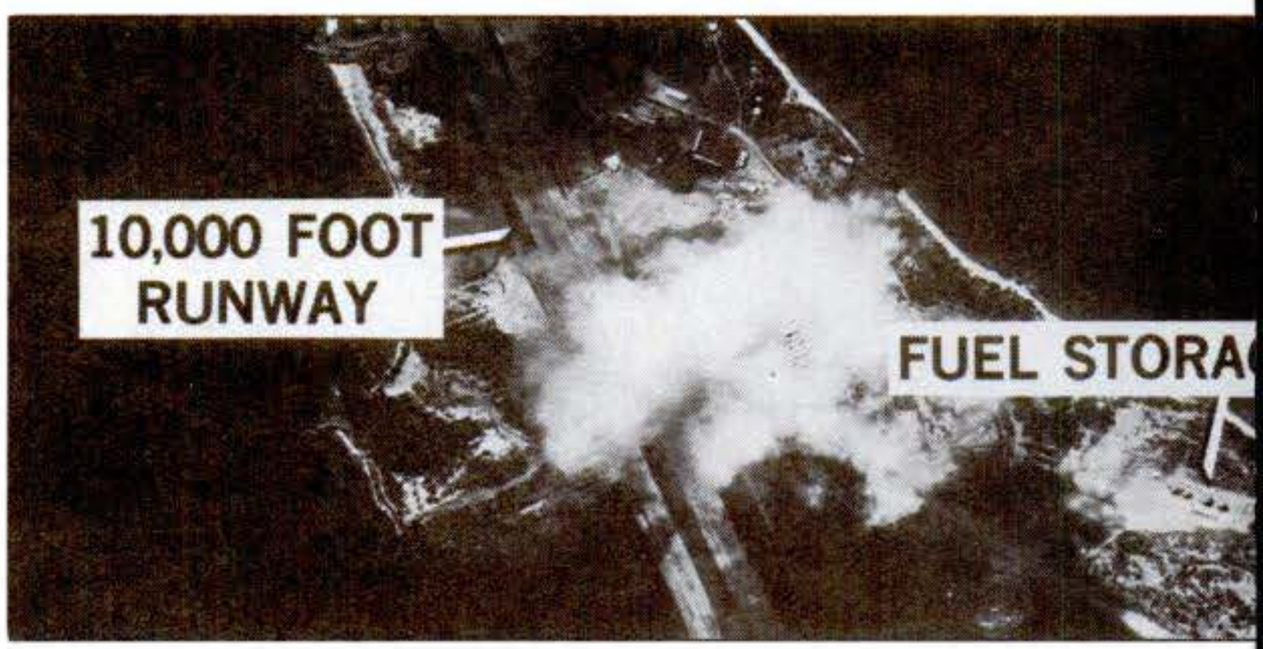
In a secure facility on the Potomac River in Washington, D.C., the mapping agency analyzes and refines data for its customers—mostly the military. Here I saw unclassified segments of its work.

"Sixty percent of the data we receive is digitized," cartographer Charlie Ritch told me. "We see photographs less and less."

"What's the source of your data?" I asked. "What kind of satellite gives you the best information?"

"We don't talk about sources," Ritch said. "I can only show you samples of how we use the data."

One sample was UNAMACE—Universal Automated Map Compilation Equipment. It can use either aerial photography or satellite data to produce three-dimensional terrain images on large, color "reference screens," or highly accurate terrain-elevation maps for field use.



The process is fully computerized. A technician sandwiches overlapping pairs of surveillance photos (there is a 60-percent terrain overlap between successive pictures) between glass in a blue-covered staging table resembling a large coffin. Inside the table's curved lid, intense lights shine through a small hole, sending a tiny, brilliant dot onto the photos.

A sensitive photoelectric eye reads the light level passing through the photos, sampling the intensity at each corner of a ¼-inch square. The data flow to a large blue-and-white computer-connected console that assigns an elevation value to each square.

"We need to know the aircraft [or spacecraft] elevation above the ground and the starting longitude and latitude," Ritch said. The information is recorded on each frame as the photo is taken. Other data fed into the computer include the location of known points on the ground, camera angle, and a distortion factor for the film used.

Digitized cartography

The photos are sharp and clear, despite the high speed of an SR-71 or a spacecraft. Image-compensation techniques built into the cameras eliminate blurring. In the SR-71, the film moves across the open focal plane to cancel relative motions. In spacecraft traveling at 17,500 mph, the problem is more severe, so the entire vehicle also pitches smoothly against the line of flight.

The UNAMACE system makes quick work of a photo set. "The system samples a point every 18 milliseconds, records a point position every 100 meters [328 feet], and stores the data," Ritch said. "The final product is a digitized cartographic data base on tape, with elevation every 100 meters. It's compiled into one-degree squares (about 60 square miles). From that tape we can extract the digital data to do any type of map or plot needed."

The data base is indeed versatile. To demonstrate, a DMA analyst called up a graphic three-dimensional view of a Hawaii coastline. On her screen, the computer drew an amazingly detailed scene. I saw coastal mountains and valleys in full perspective, with clearly defined ridges, slopes, and canyons.

Working with a small joy stick and keyboard, she zoomed in on specific areas, scanned the terrain, and even moved the scene around to let me see initially hidden features. At any point, a simple command could activate a plotter to create a precise paper map.

Other products obtainable from the stored information include radar "operational data bases" for both the Per-

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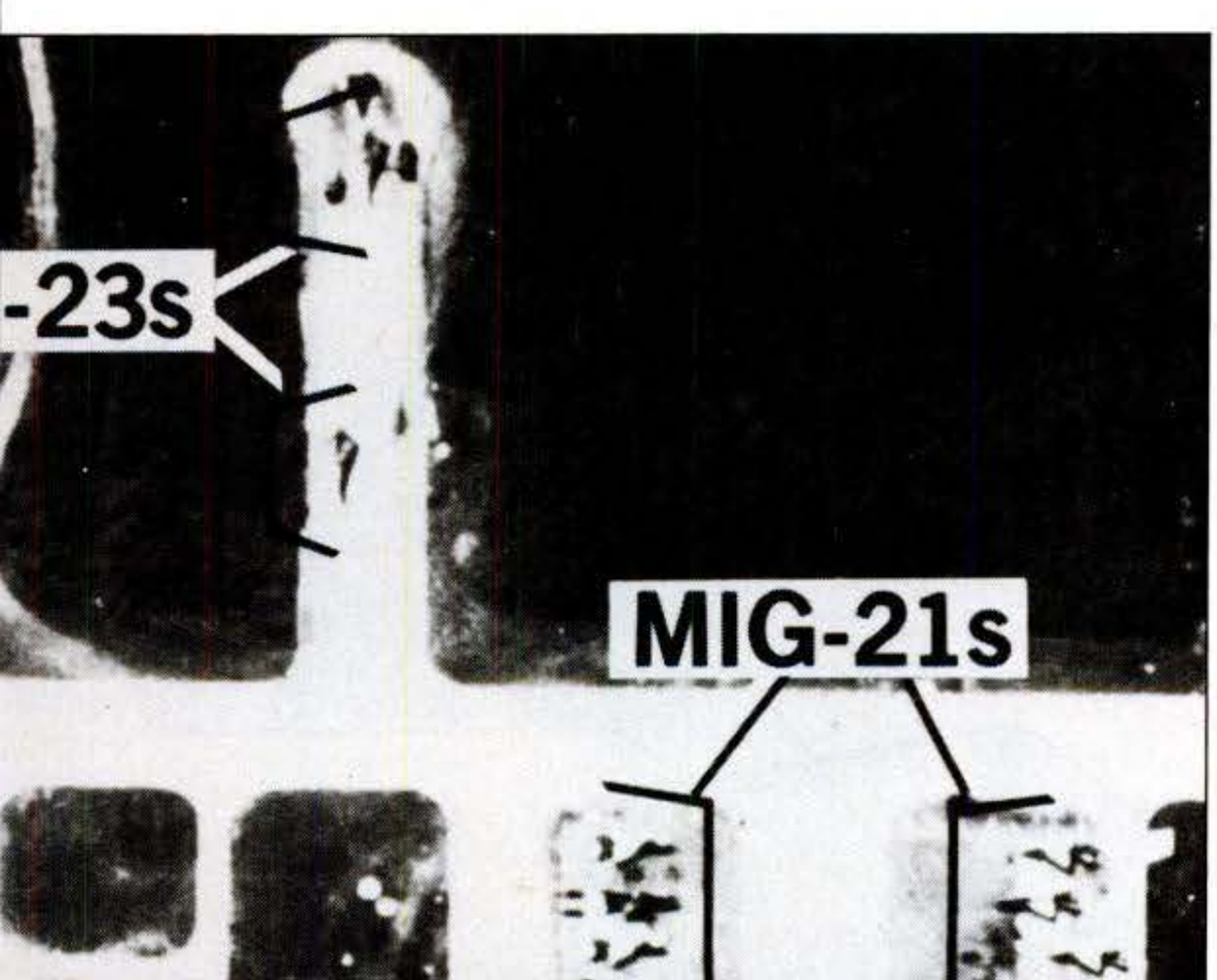
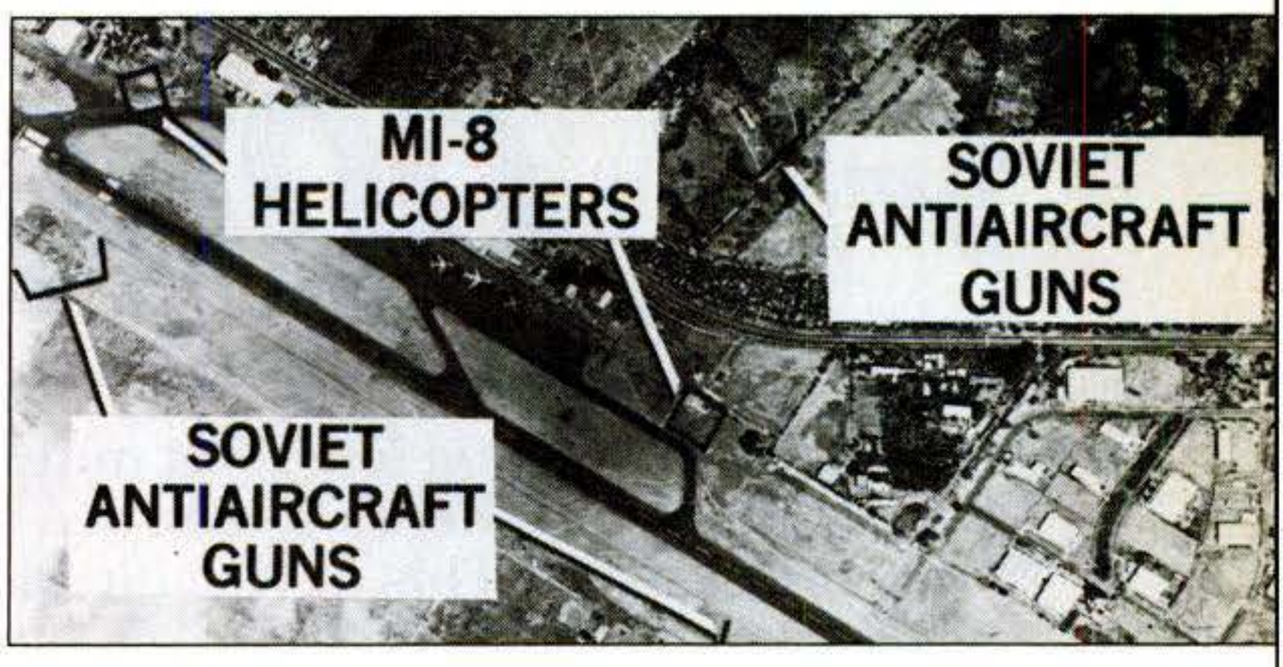
from space"

Department of Defense photos shown here are part of the batch shown on TV by President Reagan in an effort to demonstrate a military buildup in Soviet-influenced parts of Central America and the Caribbean. The photos were taken by an SR-71 Blackbird after original reconnaissance by a White Cloud satellite. At left, an airfield is under construction at Port Salines, Grenada. Below, Russian-made planes are spotted in western Cuba. At right, Soviet equipment appears at Sandino Airfield, Nicaragua.





shing and Cruise missiles. Each uses an on-board computer and radar to reach its target. The Cruise-missile computer stores terrain-elevation data along its entire path. The computer compares periodic radar readings with its stored data, then makes navigational adjustments.

Though it follows the terrain, the missile needs more information than ground elevation. Data supplied by DMA include the height of trees and location and height of man-made obstructions such as buildings or radio towers. With many potential targets being deep inside Russia, how does DMA get its data?

"We can't say anything about that," one analyst told me. But the obvious conclusion is that they come from satellites.

I asked whether DMA used digital data from NASA's sophisticated Landsat-4. "No," Ritch answered. "Landsat's resolution [about 100 feet] isn't nearly good enough for our requirements."

Satellite to the rescue

It was April 12, 1981, and the space shuttle Columbia could have been in trouble. Astronauts John Young and Bob Crippen, on Columbia's first flight, reported some thermal tiles missing near the tail. Worried NASA officials in Houston wondered whether more tiles had fallen off Columbia's belly. If so, reentry could be threatened.

At its space command center in Colorado Springs, the Air Force ran computer projections, then offered to help. One day later, an amazing event occurred in space, 169 miles above northern Missouri.

A KH-11 spy satellite, in orbit since 1978, intercepted Columbia's flight path, passing just 27 miles above and slightly behind the shuttle. Columbia's belly pointed to the sun for perfect lighting.

At that close range, in the vacuum of space and with no atmospheric distortion, KH-11's digital-imaging system could see objects eight inches across. Most shuttle tiles were larger than that. Using image motion compensation both by maneuvering the KH-11 and traversing its optics, the Air Force damped out most of the 3.7-degree angular velocity between the two craft. In a single 10-second window, KH-11 took Columbia's picture.

Neither NASA nor the Air Force officially acknowledge that the photo was taken—only that Air Force assistance helped relieve worries about Columbia's thermal tiles. Not all surveillance, it seems, has to be directed at potential enemies.

Keeping craft together

Military technology surpasses NASA in three primary areas: imaging, tethered satellites, and in-orbit storage. "The safest and cheapest place to store spare spacecraft is in orbit," an officer from Andrews AFB told me. Thus, four Rhyolite craft built by TRW reside today at geostationary altitudes, two over the Horn of Africa and two south of India. One of each pair waits for duty. The other two monitor launches from all Russian missile test facilities, recording Russian telemetry and relaying it to ground stations.

Experiments with tethered satellites began in the Gemini program, when astronaut Buzz Aldrin attached a tether to an Agena target vehicle. After Gemini backed away, the two craft orbited Earth for hours in stable formation flight.

"Some electronic or radar surveillance requires sub-satellites," an Air Force officer told me. "But without tethers, they'd drift away and be useless."

The drift occurs because of the immutable laws of orbital mechanics. Objects orbiting at different altitudes, even a difference of a few feet, move at slightly different relative speeds. And the orbits of objects with different masses decay at different rates.

White Cloud satellites deploy three sub-satellites on 10-mile-long tethers. Each carries radar to scan the oceans below. By combining radar sightings taken simultaneously from separate points, U.S. analysts can quickly plot the speed and course of ships below.

At least two sub-satellites trail behind Big Bird craft, monitoring radio and radar transmissions below. With tether systems proved in space, NASA plans to use the technology again. NASA is working with Italy on a project to drag a small satellite through Earth's upper atmosphere at the end of a 60-mile tether. This joint venture could occur in 1985.

Camera-carrying spy satellites are launched from Van-

[*Continued on page 186*]

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3-D optical blender

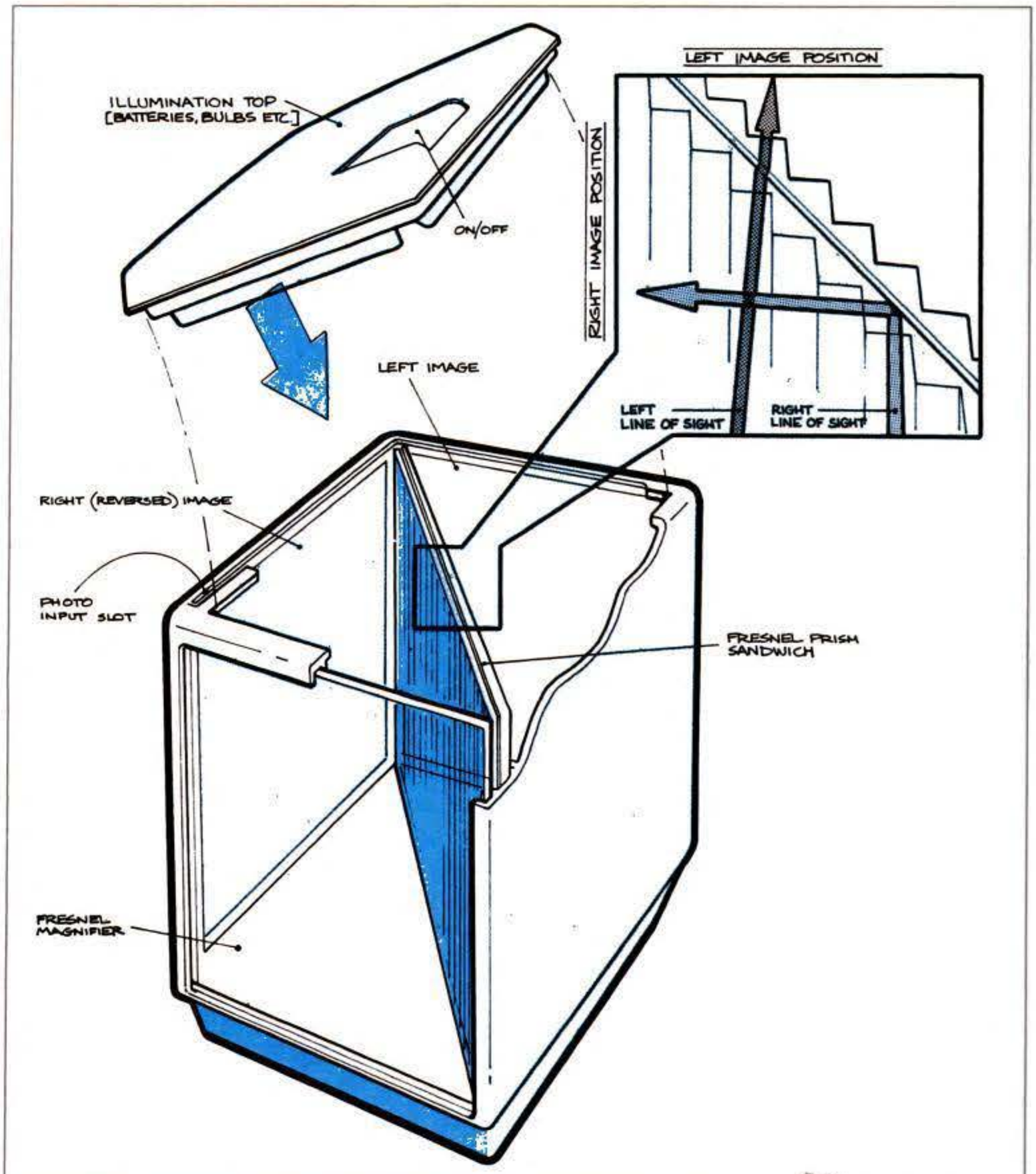
A small box. A plastic lens. Not much to look at—but there's lots to see if you look inside. This device blends two images into one 3-D picture. The result could be a new look at everything from video games to satellite images.

By ED EDELSON

"Come watch a three-dimensional movie," said Elliot Rudell. In a moment, I was seeing a 3-D film of a little boy trotting around a paddock track on a pony. But I wasn't wearing cumbersome 3-D eyeglasses or looking through an expensive apparatus attached to a special camera. What Rudell was showing me was a potential revolution: inexpensive three-dimensional video.

The movie was made with an ordinary home camera and a commercially available split-image attachment. To get the 3-D effect, I looked through an open, boxlike frame in which a simple plastic lens was mounted on a slant. Scattered around the room were models of similar devices for still photos—some so inexpensive that they could be given away in breakfast-cereal boxes.

Lots of industry people have visited the offices of the Bright & Morning Star Co. in Lawndale, Calif., to get the same demonstration that Rudell was giving me. There is corporate interest because inexpensive 3-D could coax fascinating new information out of such things as computer graphics, satellite images of Earth, medical X-rays, and even arcade video games. There have been no bites yet, but executives are taking a good, long look.

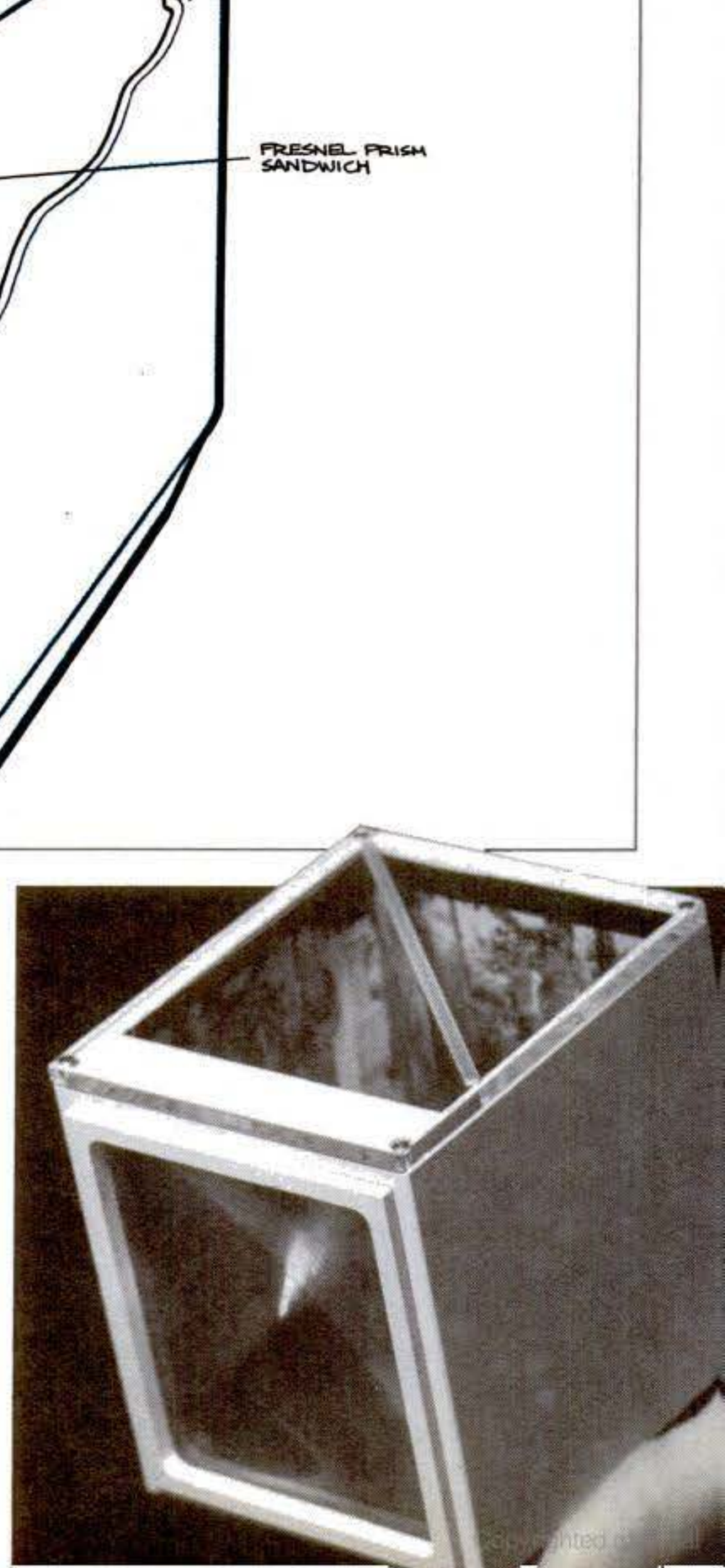


Too simple?

One problem that Rudell's company faces is that the world isn't ready for such a simple, low-cost 3-D system. Even the U.S. Patent and Trademark Office did not accept the patent claim when it was first filed.

"They said it wouldn't work," Rudell explained. "I argued with them by mail, but they wouldn't believe me. Then, three or four years later, when I was on the East Coast, I went to Washington and showed it to them. They conceded that it worked, and we got the patent."

When you see the device, you can understand why the patent-office people were skeptical. The heart of the system is a sheet of clear plastic with sawtooth Fresnel lenses mounted on each side (see drawing). To get the 3-D image, you take two stereo pictures and mount them at right angles, with the plastic sheet bisecting the angle.



Demonstration box at right is only four in. square, but Rudell (opposite page) has sizes for all uses. Each box contains a Fresnel lens (drawing above) to deflect the right eye's vision at a right angle to one photograph. The left eye's line of sight passes through the lens to the second rear-mounted photo. The brain puts the two images together.

PHOTO BY KEN ROGERS

Now comes the part that makes the idea patentable. Because our eyes are a few inches apart, their lines of sight are slightly different. One of the Fresnel lenses reflects the right eye's line of sight at a right angle to just one of the mounted pictures. The other lens lets the left eye's line of sight go through, with only a slight refraction, to the second picture.

When your brain gets the separate images from the eyes, it puts them together into a three-dimensional picture. Result: length, width, and depth from a flat image.

The system sounds simple, but it took years to develop. Rudell, a toy designer, worked on it with David Scheiman, a physician who became interested in 3-D imaging as an emergency-room doctor in Long Beach, Calif., who wished for three-dimensional X-ray images.

The system has its flaws, however. To start with, Rudell said, no artificial 3-D image can equal the real thing, which is mostly psychological.

"Because the eyes are so close together, we really don't get three-dimensional views of anything more than 20 feet away," Rudell pointed out. "Our brain tricks us into thinking we do. Any photographed image lacks real-life quality and will seem a bit unsatisfactory."

Rudell's and Scheiman's system has one practical drawback. You get the 3-D image only from a specific angle, which means that only one person at a time can look. For such applications as 3-D television and arcade games, manufacturers would like a system that many people can view at once. For home use, the system's value is also limited by the need for two television sets mounted at right angles, plus the fact that TV stations would have to transmit two video images.

Rudell has at least a partial answer to the video-game problem. He mounts a conventional magnifying lens on two sides of the viewing box. That not only improves the 3-D image by slightly changing the lines of sight, but it also lets two viewers, one on either side of the box, get mirror-image 3-D views of the same scene. "It's a natural for arcade games that have two players competing," he says.

Industry reaction

"We've shown it to many people, all of whom are impressed," said Mark Gordon, who works with computer-assisted-design and entertainment companies in Cambridge, Mass. "But nobody is quite ready to make the leap into 3-D with both feet."

"There is some clinical interest in it," said Joe Marion, manager of product planning for General Electric's medical-systems operations, "particularly in getting a 3-D view of a plane projection such as a chest X-ray. But there are some questions to be answered. Is the quality of what you see acceptable for medical use? What is the clinical benefit of 3-D viewing?"

An executive of one computer-graphics company called the system "intriguing" and added that the advantages of a 3-D presentation of computer graphics are self-evident. If it works as advertised, he said, the new system could outdo even the best computer-generated 3-D displays. But his company is still trying to make up its mind about the system, so he asked that his name not be used.

It's the sheer simplicity of the system that Rudell says will win buyers in the end. Some of the pictures he showed me were made with an image-splitter camera attachment that Pentax has been selling for years for a conventional stereoscopic 3-D system.

"The real volume is going to be in consumer products," one executive predicted. "If I were Kodak or Polaroid or Atari or Hallmark, I would look at this thing and see tremendous potential." PS

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Hand-size, but here at last:

flat-screen color TV

Pocket-size TV sets using a flat screen and liquid-crystal displays are already in the stores. But they have monochrome (single-color) displays. Now, breakthroughs by a team of Seiko engineers in liquid-crystal chemistry and transistor design are finally going to bring flat-screen *color* TV to the marketplace. The Japanese engineers have created new fast-response liquid crystals and thin-film transistors that overcome the major problems of LCD color TV. The Seiko Pocket Color TV should be on the market in about six months. A PS editor visited Seiko's research and development headquarters in Suwa, Japan. He found picture quality highly satisfactory. Although the colors were not as crisp as the very best produced by cathode-ray tubes, they were bright in daylight, and resolution was sharp and clear.

By HERBERT SHULDINER

SUWA, JAPAN

The image was clear and the colors were bright as I watched a baseball game on the tiny screen of a TV set small enough to slip into my jacket pocket. But the fact that the athletes were Japanese wasn't the only thing different about this TV picture. I was viewing the world's first flat-screen liquid-crystal color television announced for sale.

LCDs aren't new, of course. Many of us have calculators or watches with the displays. And black-and-white LCD TV sets are already on the market, including a tiny wristwatch TV [PS, April]. So why all the excitement about this new system? And why have a handful of Japanese companies, including Hitachi, Matsushita (Panasonic), Seiko, and Toshiba been in a race to be first to market this type of TV? Each one of the companies has demonstrated prototypes at electronics trade shows. In addition, Mitsubishi has exhibited a large-screen LCD color TV designed for industrial displays. Now Seiko has announced plans to market the first consumer LCD color TV. It will be on the market in about six months.

The Seiko TV is a prodigious engineering achievement. A color LCD TV is much more difficult to make than a black-and-white one. The Seiko Pocket Color TV required the use of a new type of liquid crystal, which responds twice as fast as conventional LCs, and virtually invisible thin-film field-effect transistors. The use of thin-film transistors had been limited to exotic flat-screen displays made for the military.

I visited the Seiko research and development center in Suwa to preview the new color-TV system. I also interviewed the three engineers who headed a 20-man research team that developed the system over a period of approximately five years.

"The principle is very simple," Toshiaki Saito, director of Seiko's research and development division, told me as he held the 1.1-pound TV set in his hand. "The system is much the same as that used in an LCD watch," he continued. "Liquid crystals are sandwiched between two panels of glass. When the LC spots are excited by a voltage, the spots turn black, just as they do in an electronic watch."

But there are significant differences between a watch and the color-TV set, Saito says. Besides the new LCs and thin-film transistors, a color filter is used to create an entire spectrum of hues for the TV image.

Twisted crystals

The new liquid crystals used in the Pocket TV resulted, Saito says, from organic-chemistry research carried on by Seiko. But he refused to specify how they differ chemically. "We use twisted-nematic-mode LCs [see drawing on last page of article] because they have high contrast and low power consumption, and they respond in less than half the time of conventional LCs—less than 50 milliseconds compared with about 100 milliseconds." The rodlike, twisted-nematic-mode LCs are used in virtually all calculator and electronic watch displays made today.

Shinji Morozumi, manager of Seiko's research and development department, explained why LC response speed is critical in a TV set: "When you see a baseball game on a screen made of conventional liquid crystals, the image flows. A thrown or batted ball looks like a comet." There was no indication of this, however, as I watched the videotaped ball game on the Pocket TV screen. I could see the ball clearly, and when players ran they could be seen distinctly, without any blurring. To make sure this wasn't due to the fact that I was watching a specially selected tape, I asked Morozumi to tune in a real-time broadcast. He immediately disconnected the VCR cable and extended the set's telescoping antenna. He handed me the little TV, and I tuned in a Japanese soap opera. The colors were still bright, and moving images remained stable. There was no blurring whatever.

The LCs in the Seiko Pocket TV are encased in a 43.2-mm-by-34.2-mm (1.7-by-1.3-in.) glass-sandwich panel (see illustration on opposite page), which is divided into 57,600 pixels, or picture elements. Driving each pixel, Morozumi explains, is a matching thin-film transistor. The transistors, made in a Seiko integrated-circuit plant near here, are virtually invisible, as I found when I examined a screen panel not

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Heart of Seiko's new Pocket Color TV is the panel shown above. It's a sandwich encasing liquid crystals and a vast array of thin-film—virtually invisible—transistors. Liquid crystals form 57,600 matching pixels, or picture elements. Combinations of primary red, blue, and green elements form different colors. The exploded drawing at right shows how the green color on the screen is created. Varying voltages can change pixels from black to transparent. Black pixels (red and blue in diagram) block light; transparent ones allow light to pass and hit color filter. When the voltage is off, the green pixels are transparent; they allow light to pass and strike green elements on color filter. The result is green color on the screen. By turning voltage on and off in various combinations of primary colors, the overall color picture on screen is obtained.

enclosed in a case. The transistors are made on a layer of polycrystalline silicon only about 3,000 angstroms (0.3 micron) thick.

"We made the transistors of polycrystalline silicon," Morozumi said, "because conventional thin-film transistors made of cadmium selenide or amorphous silicon do not have sufficient stability, reproducibility, or reliability."

Continued

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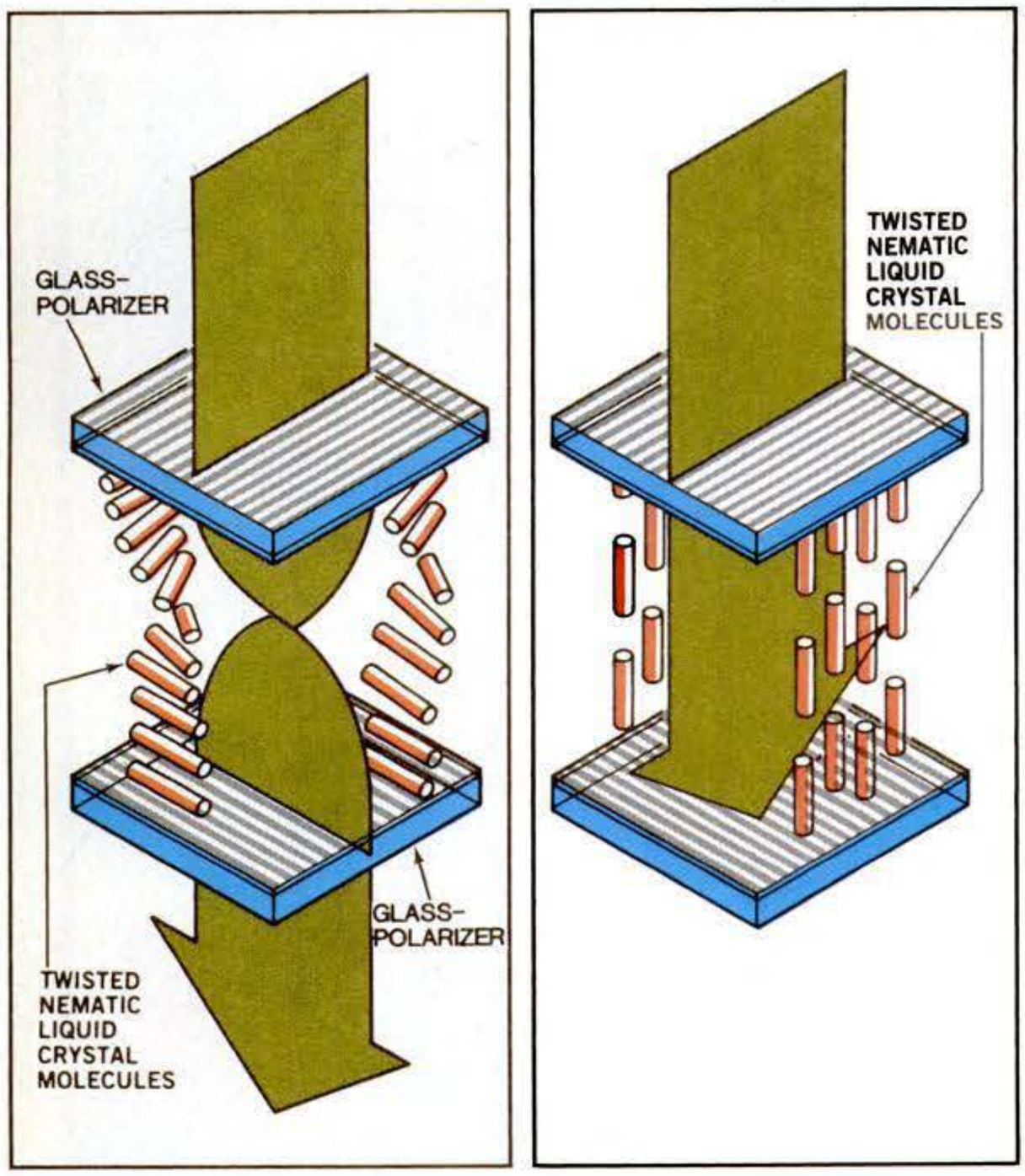
Tiny Seiko TV is slightly more than one in. thick. Measurements of the prototype are 6.3 by 3.15 by 1.1 in. It weighs 17.6 oz. Playing time is four hours on four AA alkalines.

How LCs are used to make a TV picture



New fast-response, twisted-nematic liquid crystals are sandwiched between glass light polarizers in the color-TV panel and activated by adjacent thin-film transistors. When an individual pixel is off, with no voltage applied (left), light passing through the first polarizer is twisted 90 degrees by the liquid-crystal material. This enables the light to pass through the second polarizer (which is oriented at right angles to the first) and to strike a color filter. When voltage is applied to the LC cell (right), the rodlike molecules are aligned. As a result, light passing through the first polarizer is no longer twisted 90 degrees and is blocked by the second polarizer layer. LCs in watches work in much the same way.

Additionally, polycrystalline silicon transistors have high contrast. "A conventional LCD does not have sufficient contrast," Morozumi said.

Overall, the picture on Seiko's tiny screen is adequate once you get used to squinting at such a small image. Close-ups, as in soap operas, are easier to view than distant shots. The colors, though not as bright and crisp as those on a conventional cathode-ray tube, are more than adequate. The reds seemed especially good.

Compared with the Sony Watchman [PS, Nov. '82], the Pocket TV's picture is more pleasing because of the color. Resolution appears to be about the same, even though the Watchman is a flattened CRT and not an LCD. Seiko claims the resolution of its Pocket TV is about 200 horizontal lines (seven lines per millimeter).

The Pocket TV picture is more easily viewed than that of the wristwatch TV that Seiko also makes. I haven't had an opportunity to view either the Casio LCD black-and-white TV that went on sale recently or the EXP Research shirt-pocket LCD TV ["What's New in Electronics," PS, Aug.] scheduled to go on sale shortly.

The Casio LCD screen is slightly larger than that of the Seiko Pocket Color TV—2.75 inches versus 2.13. Screen size of the EXP model is only 1.5 inches. The Casio unit has a backlight made of electroluminescent materials instead of the fluorescent tube used in the Seiko. The backlight is needed to provide uniform illumination during the day and for night viewing. Liquid crystals merely reflect light, and when the viewing area is dark the display cannot be seen without a backlight.

Plummeting prices

Sony started the pocket TV era with its Watchman, just as it launched the tiny-portable-stereo era with the Walkman. The Watchman is certain to get considerable competition from the Casio model, which is bound to drive prices down. The Watchman lists at $350; Casio has announced a price of $299 for the TV-10. EXP Research will price its unit at $275. The Seiko TV wristwatch sells for $495.

Seiko's Saito says the Pocket Color TV will be priced at between $400 and $500 when it goes on sale in mid-1984. Who will buy that kind of device for that kind of money? "We expect it to be a popular gift item," Saito said.

Many industry observers believe, however, that LCD TVs represent more than just another fad potential. There's considerable speculation about whether these small models could eventually lead to an enlarged flat-screen television you could hang on the wall. I asked Saito whether Seiko plans to build a new generation of LCD hang-on-the-wall televisions.

"Right now, we could build a five- or six-inch flat-screen TV," he told me. But he admits that the company hasn't yet done so. The reason? "It would be extremely expensive to do and would not be competitive with other types of TV," he explained. What about eventually building a large-size flat-screen TV with pocket-TV technology? "We could build a 12-inch screen for alphanumeric display at this time," Saito said. "You don't need the response speed for an alphanumeric display. But it is quite difficult to achieve a hang-on-the wall television using this kind of technology." As he thought more about it, Saito admitted: "It would be almost impossible to fabricate thin-film transistors on such a large area. Projection TV is an easier way to achieve a hang-on-the-wall TV."

At the same time, however, Saito told me: "We have yet another way to achieve the large screen area. It uses an altogether different technology, but I can't tell you about it now," he said teasingly. "Perhaps it will take five years—or even more—to achieve this large-area television." PS

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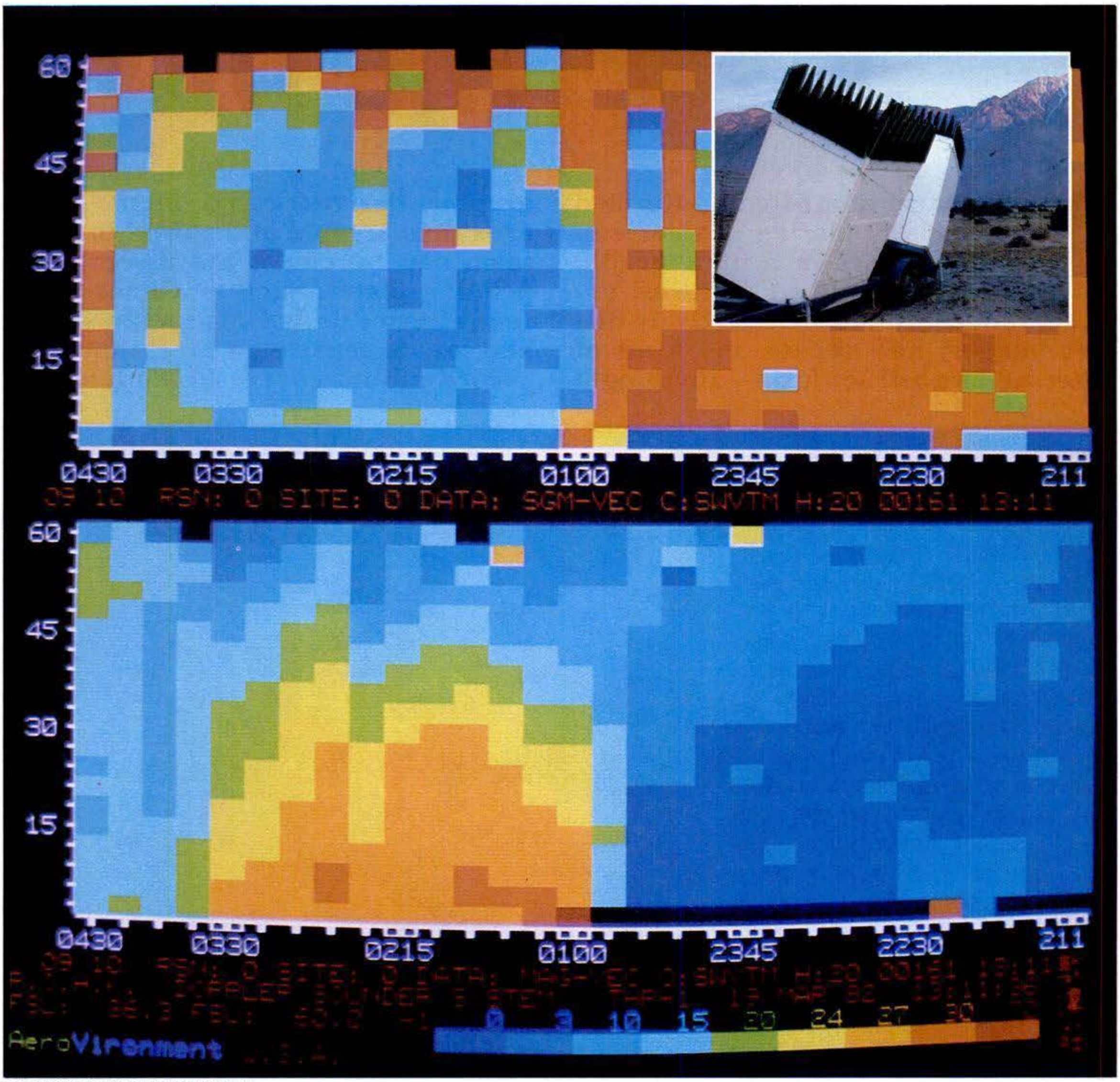

PHOTO: JOHN WORDEN; INSET: CHARLEY ALLEN

Visible wind

Acoustic sounders coupled to a computer make visible the speed and direction of wind over airport runways and power-plant smokestacks.

By DANIEL RUBY

In the past, you just wet your finger and raised it to the wind. Then came windsocks, anemometers, and the like. Now you can get precise digital readings of wind conditions with the Doppler Acoustic Sounder from AeroVironment Inc., the same Pasadena, Calif., company that built the Gossamer Condor and Solar Challenger experimental aircraft.

The device uses two or three antennas to transmit pulses of sound, which are reflected back to the antennas as they encounter turbulence in the air. The frequency of the echo shifts with the speed and direction of the wind, which are calculated by a computer and displayed on a video screen.

To make the wind visible, numerical data are converted into colors. Blues and greens are low numbers; oranges and reds are high ones. The display shows change in wind direction (top) and wind speed (below) over time and through an altitude range of 60 to 600 meters (197 to 1,970 ft.). In the display pictured, the sharp division at one o'clock marks the passage of a cold front.

There are many potential uses for the system, but so far it has been used chiefly at factories to monitor the dispersal of pollutants and at airports to test wake turbulence and wind shear. Try using your pinkie for that. PS

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The magic

A new generation of computerized image-manipulating devices can change colors in a photograph; move objects around in pictures; enlarge, reduce, rotate, or selectively distort images; and create any kind of lettering or abstract form—anything a graphics designer can think of. The images thus created and stored in digital form can be converted directly into printing plates. Such machines are already freeing designers to create—faster and less expensively—everything from record-album covers to trademarks.

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picture machine

By ERIK H. ARCTANDER

In the New York offices of *Time*, I watched magazine pages being created with dazzling speed on a high-resolution video monitor. Betty Otto sat at the console of a Scitex Vista, a computerized graphics-design system, and manipulated images on the screen (photos below). Using an alphanumeric keyboard, zoom dial, positioning track ball, and a "mouse" that moved atop a magnetic table, she finished in minutes what would have taken a layout artist hours with conventional tools.

Not long ago, POPULAR SCIENCE's art director and editors directed a squat little robot called HERO [PS, May] to swing its mechanical arm in a circle while posing for a cover photograph. HERO complied, but a series of multiple exposures turned out overexposed and blurred. So, into the memory of a Nashville, Tenn., graphics firm's Scitex went three separate HERO pictures. Commands to the computer then merged the images into a sharp, colorful cover photo.

Vista is one of several systems (which can cost $1.5 million or more) that are starting to nudge paste pots, ink-spattered drafting tables, and endless page-layout revisions on paper out of graphics-design offices. Catalog firms, newspapers, magazines, advertising agencies, and others are turning to these magical picture machines to save costly production steps. One major advantage is that quick changes can be made right up to press deadlines. And to speed production even more, digitized pages can be converted directly into printing plates.

Computerized graphics systems require a lot of memory. A $35,000, 300-megabyte (300 million-character) magnetic-disc drive, for example, can store only 10 production-quality magazine pages. Electronically separating the colors for a single 8½-by-11-inch picture requires 20 to 30 megabytes. Fortunately, as demand for Vista-like systems grows, better-memory hardware is being made. In addition to higher-capacity magnetic discs, optical storage discs [PS, Aug. '82] with gigabyte (billion-character) capacities are becoming available. Also, semiconductor memory chips that temporarily store screen images as designers manipulate them are quickly growing in capacity.

Along with the new hardware, an enormous amount of software, or computer programming, is needed. Software suppliers are devising new ways to create digitized type that looks as crisp and finely detailed as cast-metal characters.

One day, say experts, publishers may bypass the computer-to-paper step, sending detailed images directly into your home for viewing or printout. PS

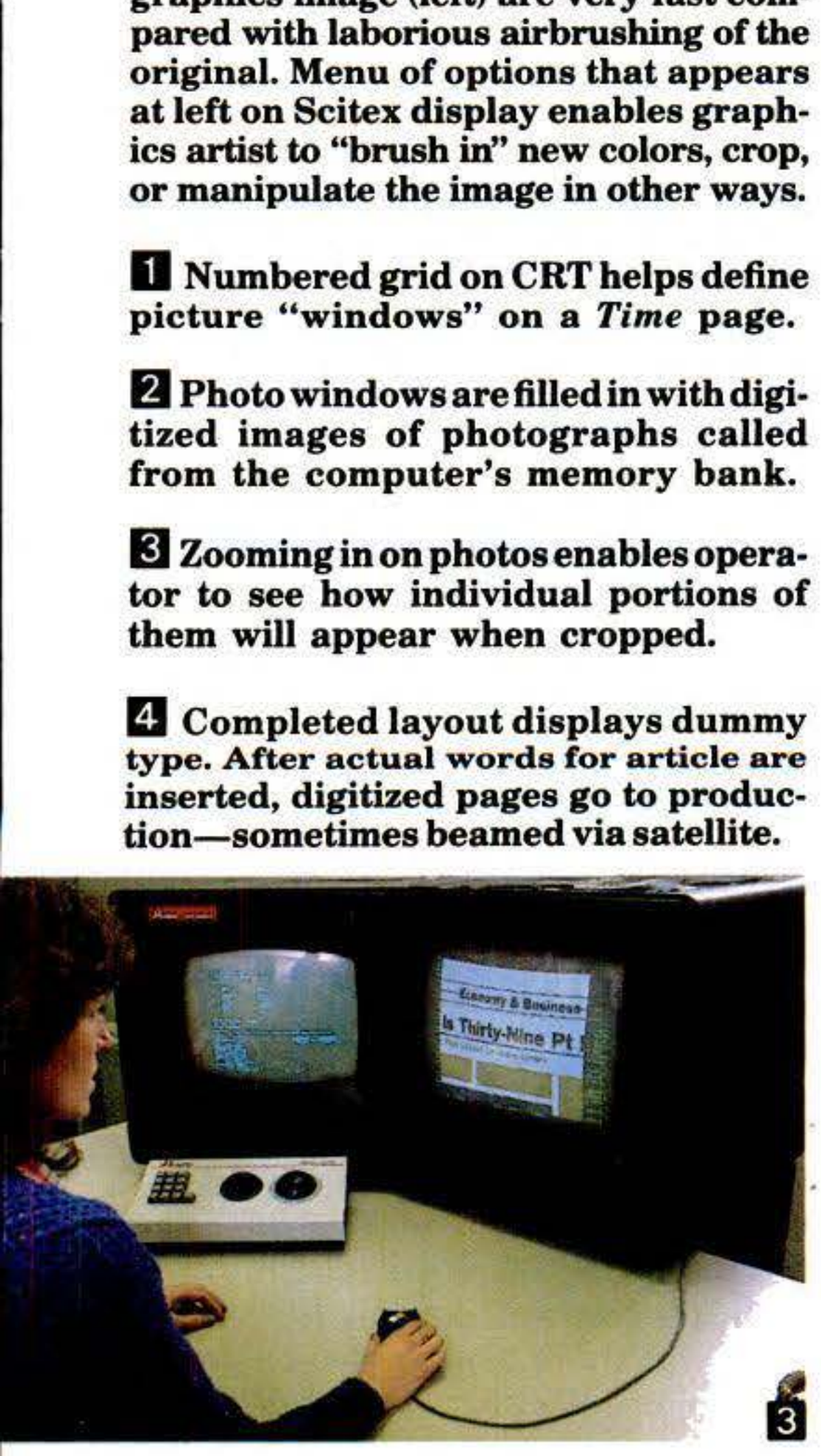
Color changes on a photo scanned by lasers and digitized into a computer-graphics image (left) are very fast compared with laborious airbrushing of the original. Menu of options that appears at left on Scitex display enables graphics artist to "brush in" new colors, crop, or manipulate the image in other ways.

1 Numbered grid on CRT helps define picture "windows" on a *Time* page.

2 Photo windows are filled in with digitized images of photographs called from the computer's memory bank.

3 Zooming in on photos enables operator to see how individual portions of them will appear when cropped.

4 Completed layout displays dummy type. After actual words for article are inserted, digitized pages go to production—sometimes beamed via satellite.



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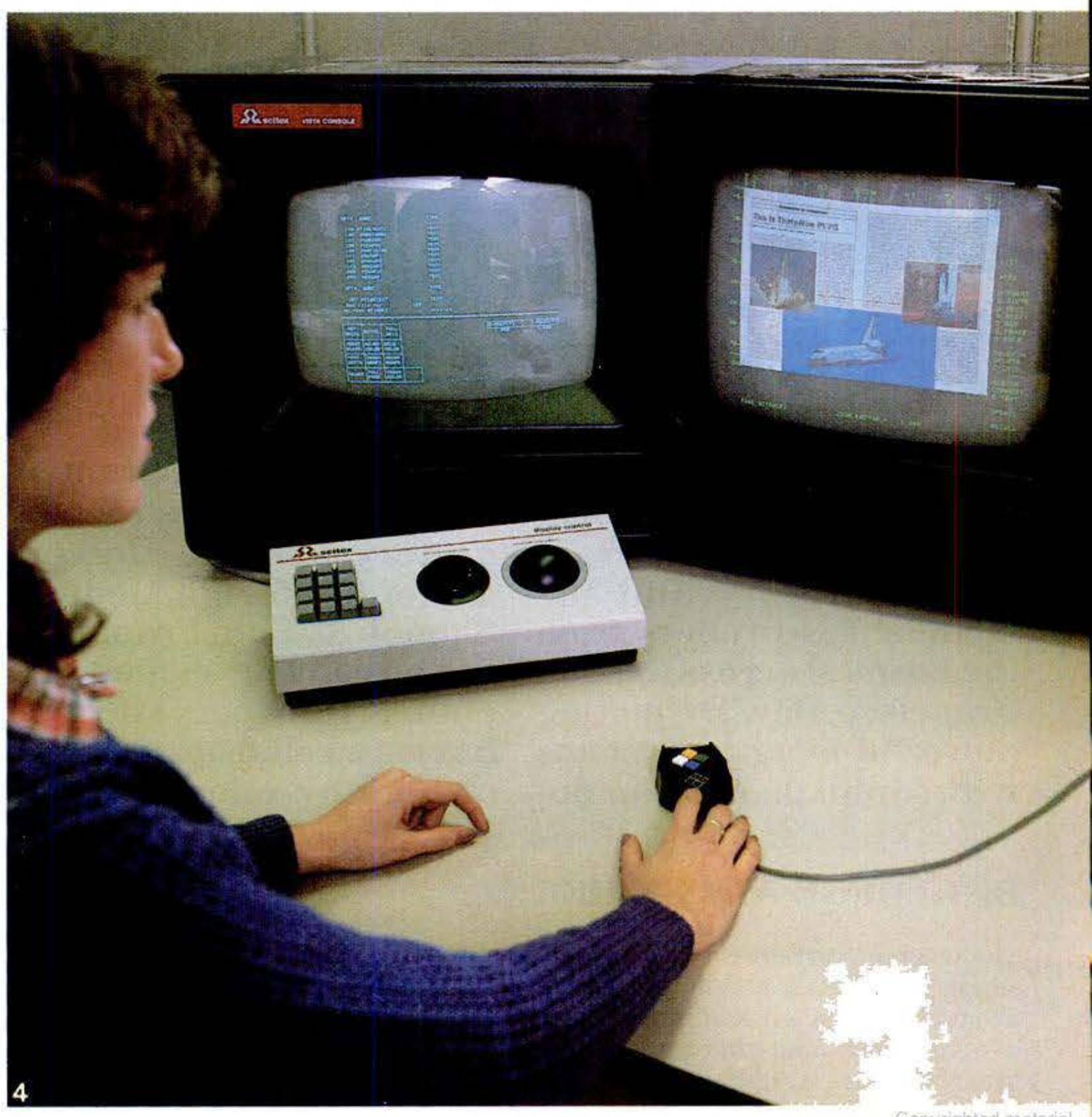

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New weapons in the war against cancer

Machines that

It's a marriage of necessity—the instrument wizards from the weapons laboratory and the medical researchers from the hospital across the San Francisco Bay. By mating powerful imaging systems with sophisticated computers, the joint program of Lawrence Livermore Laboratory and the University of California Medical School at San Francisco has already developed machines that can sift one haywire cell from millions of healthy ones or spotlight single aberrant chromosomes among a tangle of normal ones. The advanced instruments will be used for research into the causes of cancer and birth defects as well as for diagnosis and treatment of the afflicted.

By GEORGE ALEXANDER

The machine certainly didn't look state-of-the-art—just a small, commercial argon laser in a rectangular housing, about the size of a box of long-stemmed roses, with cables dangling here and there and peripheral equipment on breadboards attached as if afterthoughts.

That's the way equipment often looks in a working laboratory, before the state-of-the-art gets neatly packaged in a metal-and-plastic cabinet complete with pastel colors, bells, and whistles. The working lab I was visiting, Lawrence Livermore Laboratory, is well known for nuclear-weapons research. But I was there to see a demonstration of weapons built for the biomedical battleground: new re-

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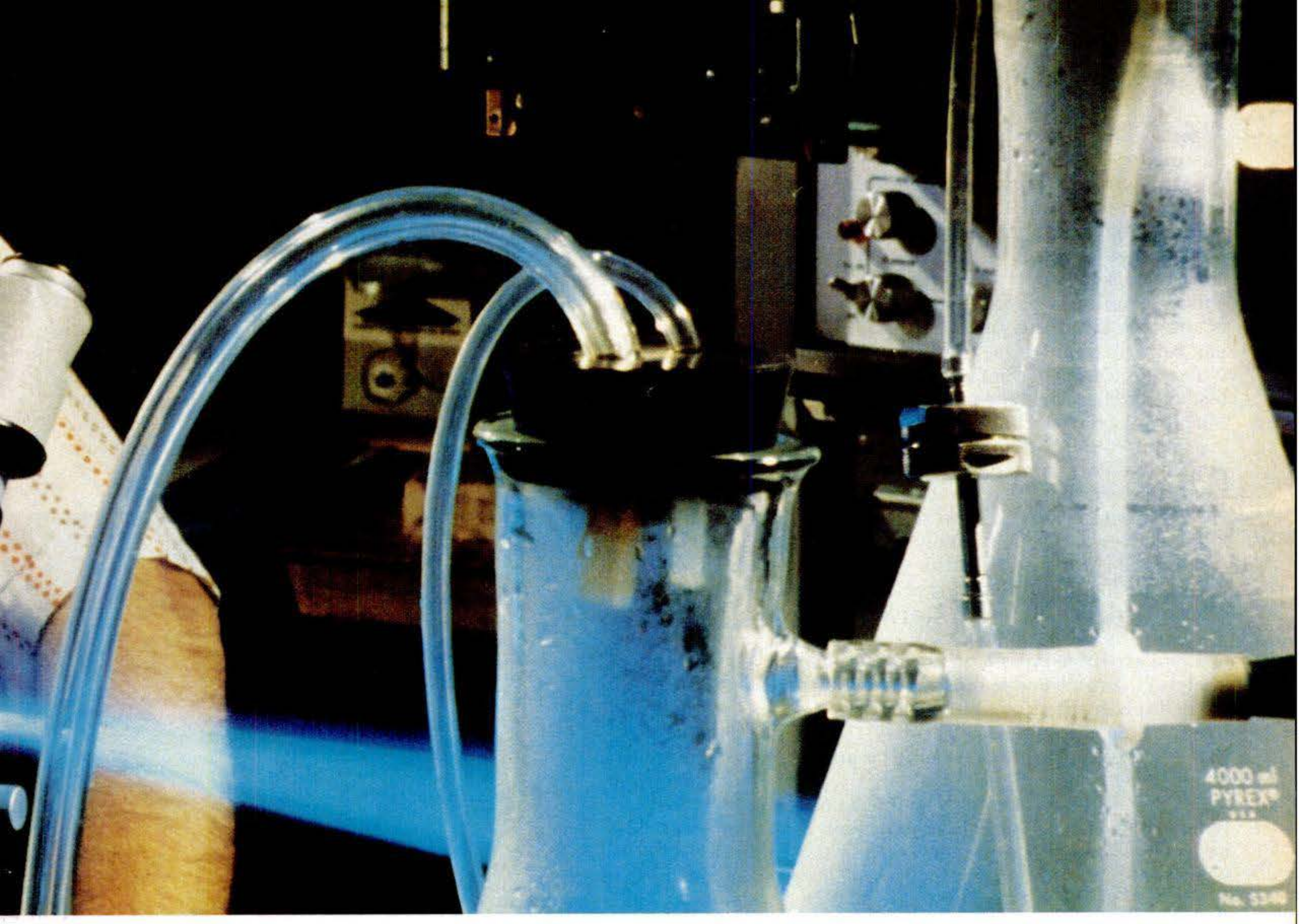

Stained with a fluorescent die and encapsulated by saline water, droplets of single biological cells are forced at high pressure through an argon laser beam. Coherent light excites the stain, which emits an instantaneous flash whose brightness is detected by electronic sensors and recorded by computer. A light microscope helps the researcher align the trajectory of the droplets with the narrow laser beam; however, all analysis is performed electronically.

and birth defects:

sort cells

search tools that will help advance our knowledge of the causes of and cures for cancer and birth defects.

"This machine has been modified so many times, and its operation has been so simplified, that we half-jokingly refer to it as a do-it-yourself instrument," said Brian H. Mayall, the British-born physician-scientist in charge of Livermore's analytical cytology branch, as we examined the cell-analysis machine lying on a table top. "It doesn't require an experienced technician to run it. A visiting scientist can come in, get briefed on how it works, and then start doing his own experiments—all by himself."

Indeed, dozens of visiting investigators—from as far afield as the People's Republic of China—have used this flow analyzer in their basic research, from studies of cervical and bladder cancer to tests of experimental anticancer drugs. They come because this and the other instruments in the lab take the drudgery out of the research process, performing measurements quickly and accurately and freeing the human mind to do the things it does best: reason, analysis, comparison, and insight.

Developing this capability is the major purpose of an unusual joint project involving scientists, engineers, and physicians at Livermore and the University of California Medical School at San Francisco, sister facilities of the University of California located some 45 miles apart in the San Francisco Bay area. "It isn't the automation, per se, of the testing process that makes these instruments so important," Mayall said, "but rather the range of tests they allow you to do and the ease with which you can do them."

Hodgepodge of cells

Biomedical research is an intrinsically complex business because the human body and its processes—both healthy and diseased—are so complicated. The body is made up of a bewildering mix of cells—the self-replicating packets of proteins, chromosomes, and other complex molecules that are the basic units of life. Besides the tremendous variety of types of cells, each type can be found in different stages of development, in different conditions of need, and performing different specialized functions.

Continued

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"Scanners are best when you're

Sorting through a hodgepodge of several million cells looking for a few oddballs, or trying to count how many of a particular type are present, is invariably described as being akin to looking for needles in a haystack. Traditionally, cells have been studied by visually examining microscope slides of tissue under magnification. The work is slow because the operator-technician has to position the slide manually, focus the microscope, and search for cells of interest before he gets any data. "If you could study one cell per minute, you were doing well," Mayall said.

The application of computers to biomedical research enabled researchers to make more measurements on each cell, Mayall told me, but did not affect the speed with which operators could handle slides. Thus, to collect the vast amounts of data needed to solve medicine's most complex riddles, researchers need machines that are faster, more accurate, and more sensitive than humans can ever be.

The joint venture is uniquely suited to developing such machines because it fuses the engineering skills of the Livermore facility to the clinical expertise of the medical school. Thus, the machines are applied to practical as well as "blue sky" situations.

There are three types of instruments under development: analyzers, sorters, and scanners. All work with cells stained with fluorescent dyes, but analyzers and sorters are dynamic machines—they actively transport materials through their apparatus—whereas scanners "view" static displays of tissue.

As Mayall led me through the maze of interconnected rooms at Livermore, the first machines I saw were the analyzers. To understand how they work, consider a user who wants to study the properties of a certain kind of cancer cell at the very earliest stages of its development.

The first step is to apply a particular fluorescent stain to a mixture of both cancerous and noncancerous cells taken from the same patient or laboratory animal. There are any number of biochemical stains available, but for many studies of this type researchers use stains that bind only to the DNA (deoxyribonucleic acid, the molecule of heredity) in the nucleus of the cell. A tumor cell usually has a much larger nucleus than that of a normal cell and so will take up more of the stain.

The stained cells are then placed in a small reservoir and pressure-fed through an unusual nozzle that resembles a hypodermic needle inside a drinking straw. The suspension of cells is squirted through the needle while a sheath of salt water pours through the straw and surrounds the cell stream. The sheath ensures that the cells do not clog the nozzle tip or fly off at odd angles. The nozzle vibrates rapidly to break up the cells into droplets.

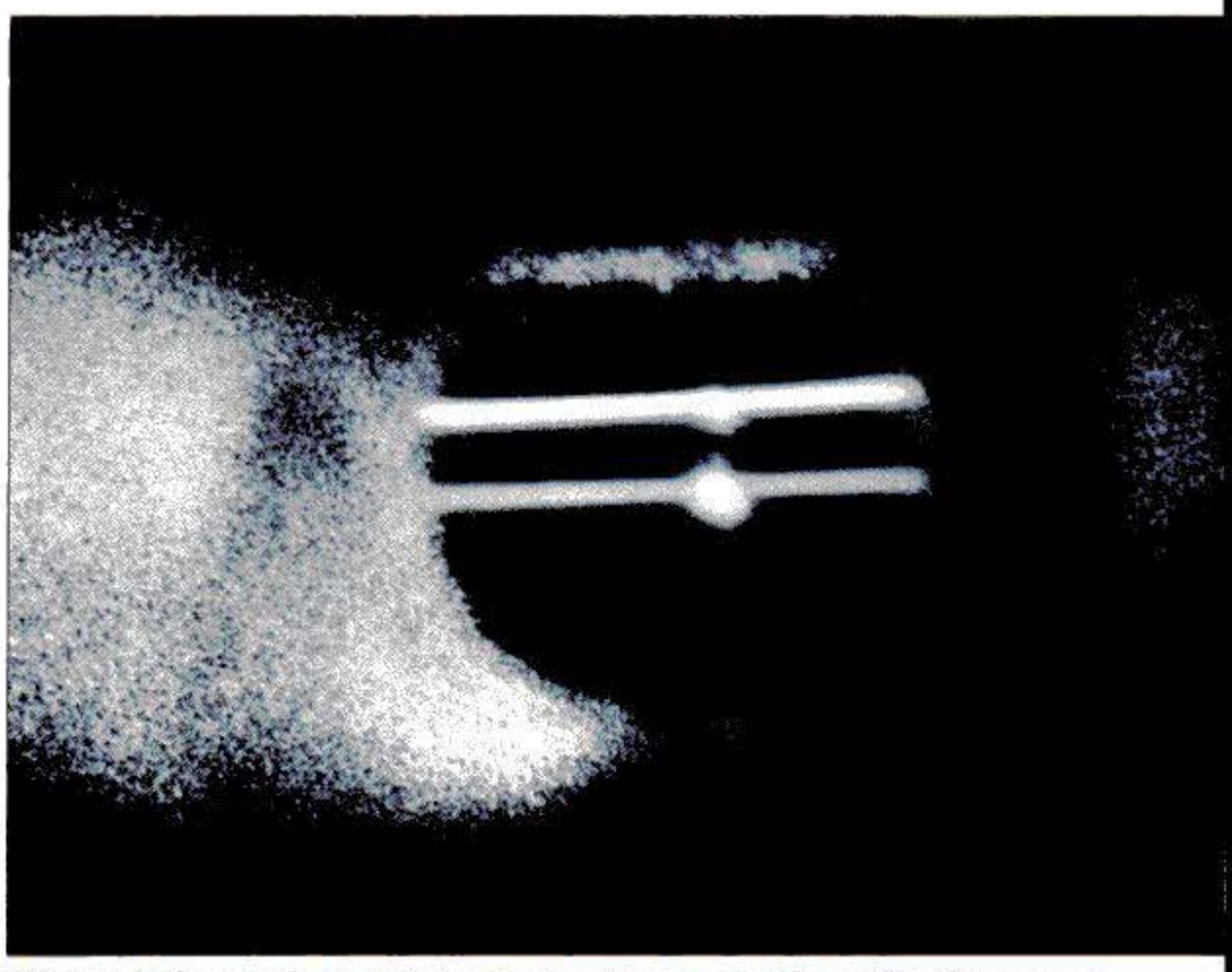
As the droplets emerge from the nozzle, each tiny encapsulated cell crosses the laser beam, causing the dye to fluoresce. Detectors located ahead of and at a 90-degree angle to the beam see the flashes and convert them into digital signals for processing by a computer. The more DNA there is inside the nucleus of the cell, the brighter the flash and the higher the count for the computer. Meanwhile, the forward scattering of the signal gives clues to the shapes and sizes of the tumor cells.

Mapping chromosomes

With an increase in capabilities, machines of this type can do more than count or trace outlines, however. Mayall showed me a second analyzer that is sensitive enough to detect defects in human chromosomes, the threads of material inside a cell that determine genetic traits.

Normal human cells contain 23 pairs of chromosomes. It has been known for some time that malformed or missing chromosomes are at the root of certain genetic defects. Right now, with Down's syndrome and several other defects, it is possible to screen a pregnant woman to see if her fetus has an abnormal chromosome so that she and her partner have the choice of aborting or continuing the pregnancy. But in most cases, the defect is not caught until after birth.

The second analyzer I saw could help identify more such defects before birth. In preparation for tests on this instrument, cells are ruptured and all their contents except the chromosomes discarded. The machine operates similarly to the first analyzer, except that it uses two one-watt argon lasers aimed toward each other. The dual beams



Viewed through a microscope, two sample cells fluoresce as they pass through the flow chamber of a dual-laser cell sorter at Livermore Lab. The relative brightness and scatter pattern of cells' fluorescence in the differently colored beams yield detailed data on the cells' sizes and shapes.

are misaligned, one just below the other, like the barrels of an over-and-under shotgun. Thus, when a droplet passes through the beams, it generates an interference pattern on the detectors. These patterns, which are different for each chromosome, provide high-resolution profiles.

A third analyzer at Livermore is an extremely discriminating device that can distinguish male-producing from female-producing sperm. This analyzer doesn't use a laser because sperm are too flat along one axis to provide a reliable target for the spaghetti-thin light beam. Sperm that slip edgeways through the light source would flash weakly and be missed by the detectors. A mercury lamp, however, puts out a cone of light wide enough to activate the fluorescent tag no matter how the sperm are oriented.

Investigators can distinguish male-producing sperm from female-producing sperm because the latter contain two X chromosomes while the former have one X and one Y. The Y chromosomes are slightly smaller than X chromosomes and so contain a bit less DNA in their nuclei. The analyzer is sufficiently sensitive to distinguish the signals from two sperm whose DNA contents differ by only a few percent.

In many experiments, it is not enough to know that differences exist in a population of cells or chromosomes. "Once you know there's a cell that interests you, the next

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after the one-in-10 million event."

logical step is to extract it for further study," Mayall said as we neared another table cluttered with equipment.

The sorting machine before me was much like the analyzers, except that it used a more powerful laser and was fitted with a pair of electrically charged deflection plates, associated control electronics, and collecting tubes. Cells or chromosomes are processed the same way they are in an analyzer, but their fluorescent signals are fed into a microprocessor for a quick decision: Is this an entity the researcher wants to collect?

If the answer is "yes," the controller instantaneously applies a positive or negative charge to the deflection plates so that the desired droplet is deflected one way or the other into an appropriate receptable. Unwanted drops are

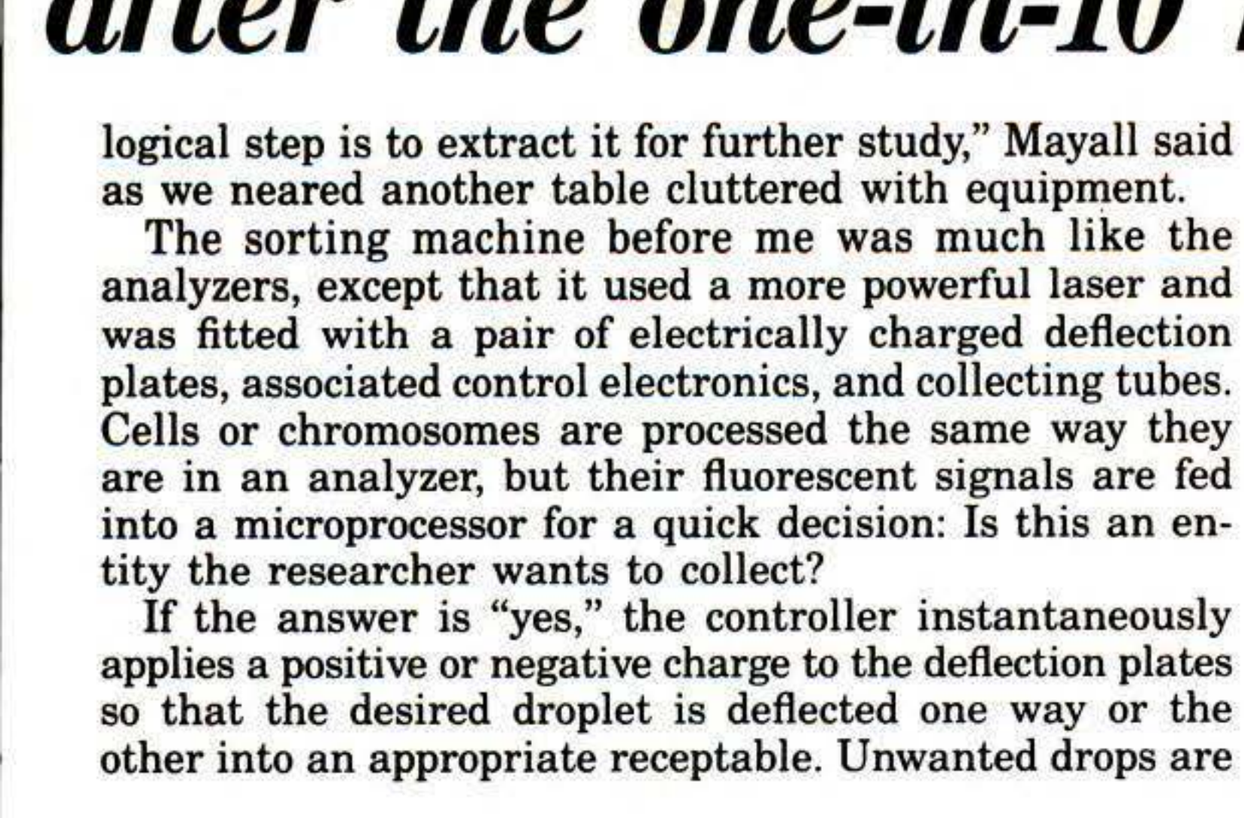

Photo sensors translate flashes of cells in a laser beam into a digital signal for computer processing. A computer instantly classifies the cell and energizes the appropriate deflection plate to direct droplet into one of three collection receptacles. The process repeats 2,000 times per second.

not charged and fall straight through into a third vessel.

A dual-laser sorter that uses two stains and measures four properties has been used extensively for chromosome studies, according to Joe W. Gray, a section chief who joined Mayall and me halfway through the tour. One way it can distinguish between chromosomes is by measuring the varying ratio of DNA sub-units called "base pairs." Some chromosomes are rich in adenine-thymine (A-T), others in cytosine-guanine (C-G).

"This machine can pick out any human chromosome," Gray said, "although No. 9 through No. 12 are hard to sort. For whatever accident of nature, these four chromosomes have identical amounts of DNA and identical A-T and C-G ratios." Fortunately, their centromeres—where the chromosome pairs are joined—are sited differently.

One of the greatest challenges for the Livermore team is to increase sorting speed. Machines on the market can process a stream of droplets at a speed of around 10 meters (33 feet) per second, or about 2,000 cells per second. The team is working to bump that by a factor of 10.

"Let's say you need a microgram of one particular purified chromosome for an experiment," Gray said. "With conventional sorting techniques, it could take up to a week to produce that much material. But if our new machine works out, it could turn out a microgram in an hour."

The day that I visited, however, the high-speed instrument wasn't working. Even as Gray was singing its praises, Donald C. Peters was dismantling its high-pressure feed system. Pressures must be high—800 pounds per square inch—to achieve a stream speed of 100 meters (330 feet) per second, but the best pressure the engineers have been able to consistently maintain is 400 psi.

"There are some fundamental problems with higher velocities," Peters explained. "The faster the droplet is moving, the less time it spends in the electrostatic deflection field and the less it's displaced from its trajectory. Thus, it is more difficult to separate it from a droplet of the opposite or neutral charge."

Increasing the potential on the plates is not the solution because there is a tendency for the current to arc. The engineers have also tried to increase the charge applied to the droplet as it exits the nozzle. "But we're time-limited," said Peters. "We have to apply the voltage to the droplet just as it pinches off from the nozzle."

Despite these difficulties, the Livermore engineers are pressing the development of an efficient, reasonably priced, high-speed sorter. If perfected, it would have great potential for amniocentesis, a test of amniotic fluid from a pregnant woman's uterus for signs of genetic defects in a fetus.

Fly's-eye imager

As versatile as sorters and analyzers are, they cannot meet all the needs of biomedical researchers. That's where scanners come in. These imaging instruments are basically microscopes in which electronic sensors have replaced human vision at the eyepiece. "The value of an imaging system becomes important when you're after the rare event, the thing that occurs once in 1,000 times, once in 10 million," Mayall said.

The Livermore scanners replace the human eye with an array of charge-coupled photodiodes, a fly's-eye arrangement of several thousand tiny devices sensitive to varying levels of light intensity. It works this way: A stained sample of tissue is spread on a slide and placed under the scanner. A quartz lamp illuminates the millions of cells, causing the stained ones to fluoresce, as an extremely narrow-angle lens scans row after row. When the photodiodes detect intense flashes, a computer notes the position of the lens so the locations of the fluorescing cells can be pinpointed.

An automated scanner of this sort can "read" a slide with as many as several hundred million cells in just a few minutes, a job that might take an experienced technician all day. Moreover, Mayall explained, the machine will make far fewer errors.

"The brightest future for imaging instruments is as an aid to pathologists," he pointed out, "to show just where, in a particular tissue, the unusual cell or cells are located. With flow instruments, everything gets busted up into an aggregate so you can never tell where the unusual cells originally were."

Each machine at Livermore serves particular needs; as a group, they will advance the day when science overcomes the continuing miseries of cancer and birth defects. "From a clinical viewpoint," said Dr. Daniel P. Stites, a UCSF immunologist and project member, "technology is way ahead of applications. If you stopped technology where it is today, it would take five to 10 years to do all the interesting biological and medical problems we have now. But if this program works out, we might cut that lag time in half or less." PS

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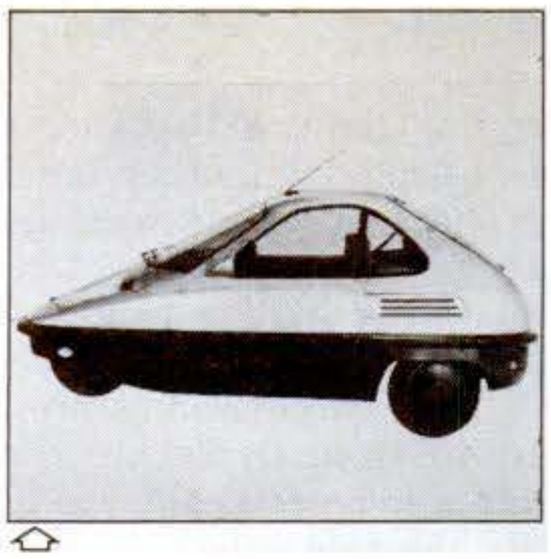
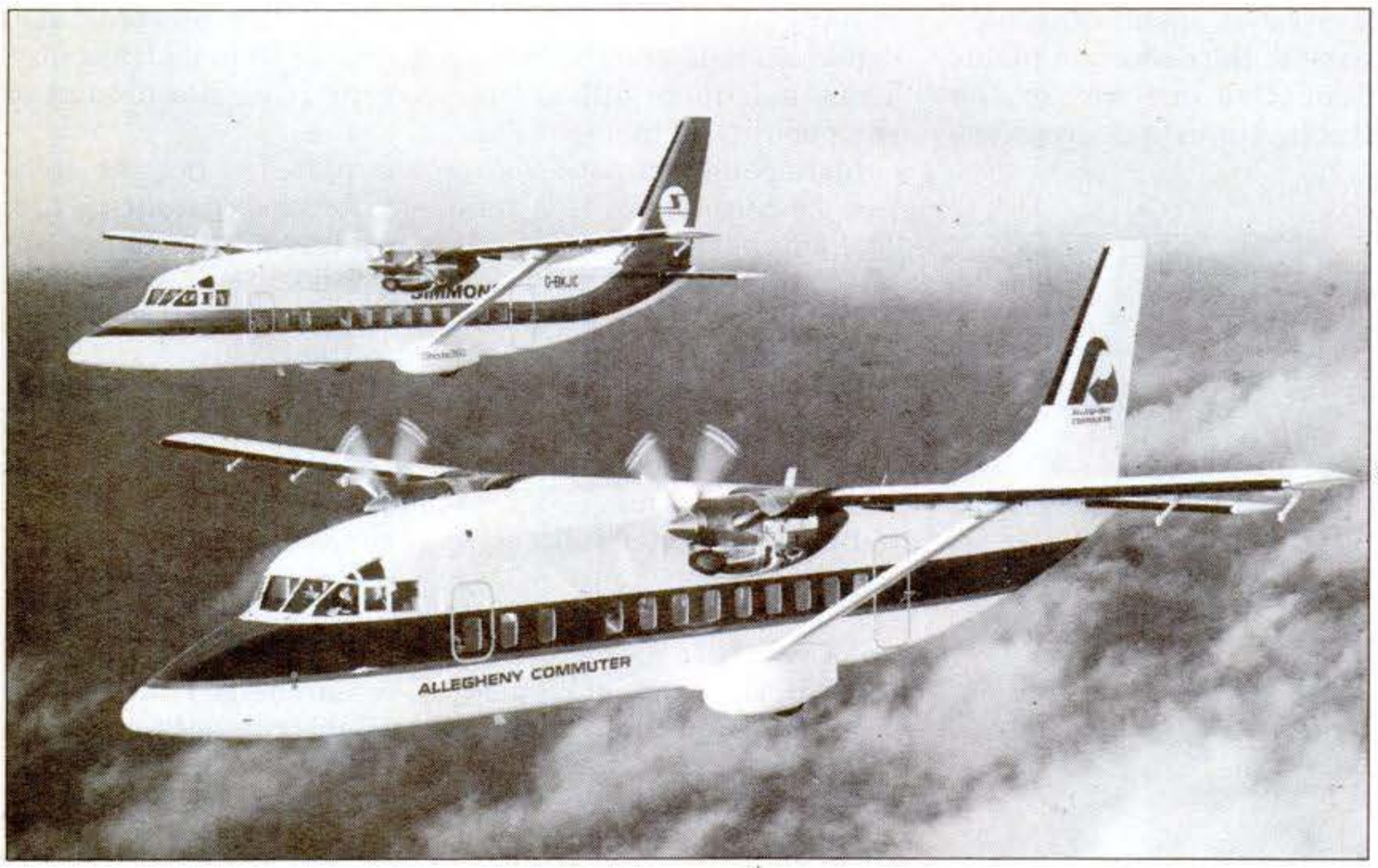
What's New

products/technology



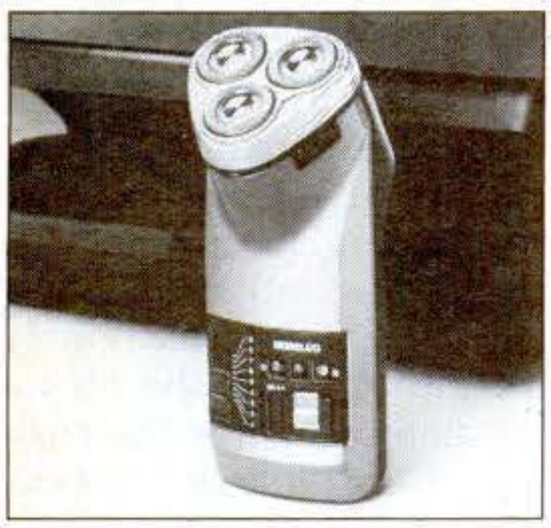
Three-wheeler

Ceres' three wheels provide the handling of four, says Creative Cars Corp. (2500 Freemont St., Rockford, Ill. 61103). The 1,475-lb., 10.4-ft.-long car has a 0.18 coefficient of drag. Estimated fuel economy: 50 mpg city, 62 highway. Price: $13,875, with a one-year warranty.



Short hopper

Built for short hops and frequent takeoffs and landings, Shorts 360 serves regional airlines in U.S. and Europe. The Irish-built twin-engine turboprop carries 36 passengers and cruises at more than 200 mph, as high as 10,000 ft. With its boxy cabin, it resembles earlier Shorts 330.



Quiet shaver

Six new Rotatract models shave you quicker, closer, and quieter than ever, says Norelco. The top-of-the-line $92 HP1328 features three floating heads, nine comfort-closeness settings, 45 hair lifters and self-sharpening cutters, cord-cordless operation, trimmer, quiet motor.

Roomy sedan

European Ford Orion adds a trunk to front-drive Escort, expanding luggage capacity to 13.7 cu. ft. Chassis layout, wheelbase, and body front are the same, but it's longer by nine in. A slit-fold backrest allows long objects, such as skis, to poke through the trunk into the seat area.

Magnetic vehicle

A magnetic-levitation, or maglev, vehicle [PS, May '80] carries passengers between the train station and airport in Birmingham, England. Up to 40 persons can make the 2,034-ft. trip in about 90 seconds. An on-board computer does the driving. The "people mover" runs on a timed cycle.

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Shuttle tanks

These NASA space shuttle external tanks hold 526,000 gal. of liquid hydrogen and oxygen for missions 11 to 13. Each tank fuels a shuttle's three main engines. They're 154 ft. long and 27 ft. in diameter and are made by Martin Marietta Aerospace's Michoud Division.

Rounded Rabbit

VW rounded body lines on the Rabbit to cut drag to 0.34. Length was stretched four in. for more leg room, and the car is wider for added elbow space. Less weight and better engines cut fuel consumption by 20 percent, says VW. There's a two-liter (122-cu.-in.) engine, plus a diesel.

Business jet

Gulfstream Aerospace's model 1500 six-seater, single-turbofan business jet cruises at 393 mph and has a projected range of 1,200 miles. A Pratt & Whitney engine takes the 40-ft.-wingspan craft to 41,000 ft. Wings, tail, and some systems are derived from Peregrine jet trainer.

Laid-back bike

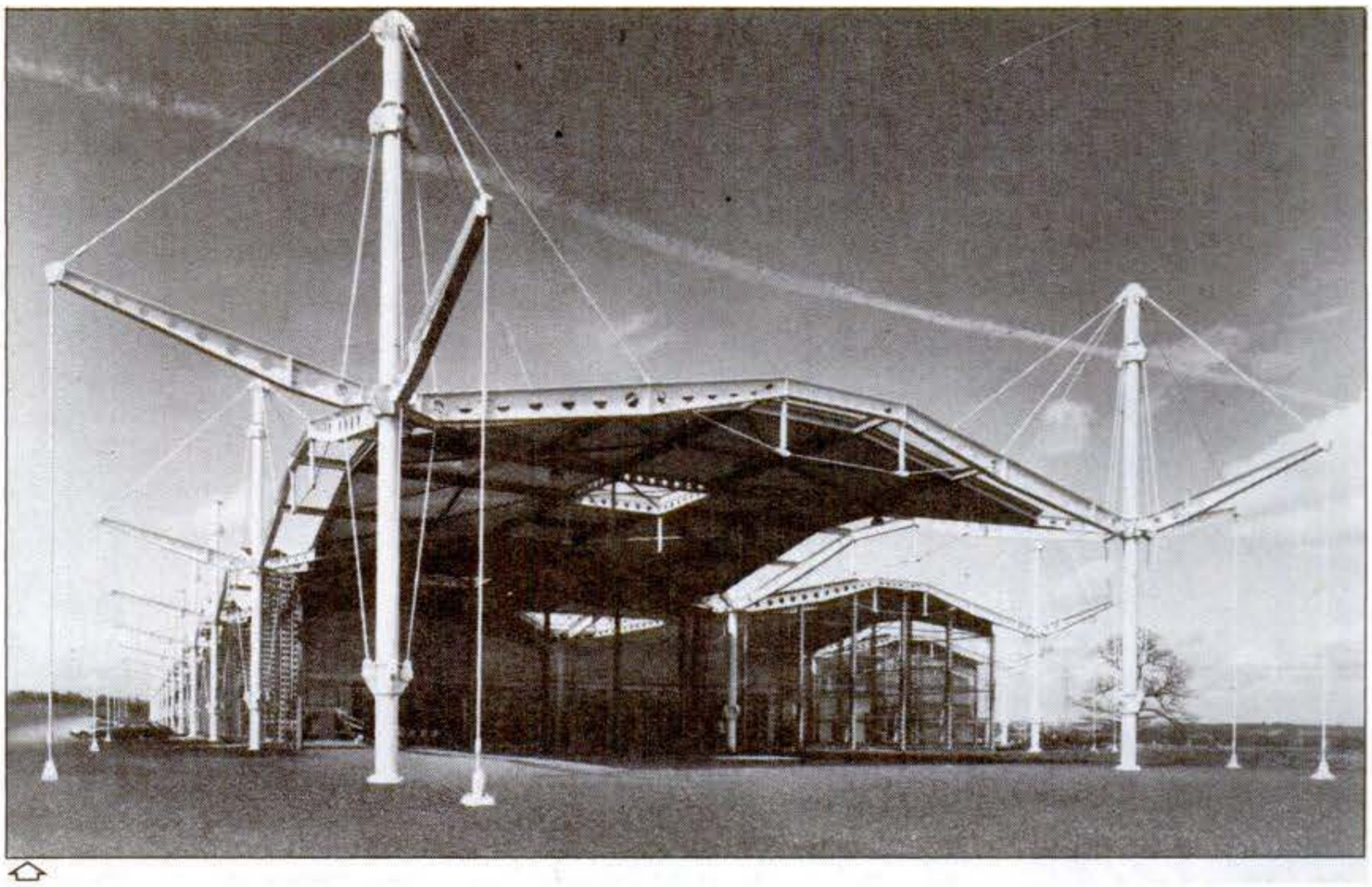
Landspeeder, with better aerodynamics and pedaling efficiency, lets you cruise at higher speeds than those of 10-speed bicycles, claims Landspeeder, Inc. (570 Riverside Ave., Westport, Conn. 06880). The bike has independent wheel suspension and braking. Price: $795.

Field computer

When battlefield data get dense, the Army rolls out its trailer-mounted DAS3 computer system. Terminals and printers plug into an air-conditioned, 35-ft.-long, 10-ton trailer. A 256-kilobyte commercial minicomputer is the central processing unit. GE's MATSCO division built it.

material

What's New

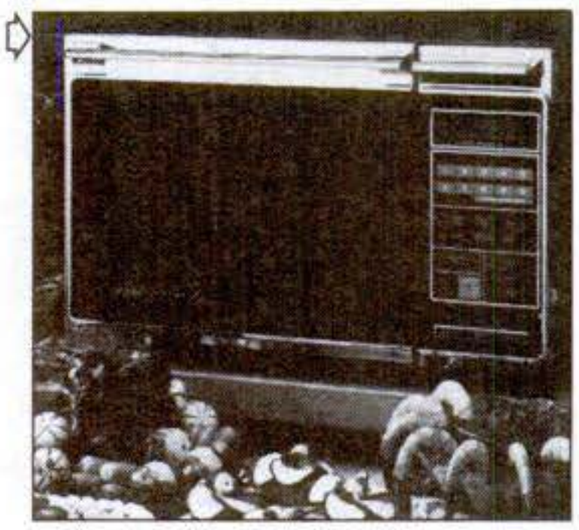


Tent warehouse

Silhouetted against the sky like umbrella skeletons, 42 roof supports frame the Renault warehouse in Swindon, England. Suspended from the 52.5-ft.-high masts, 36 tent-shape plastic membranes form a modular roof. Glass and foam-filled steel enclose the eight-acre space.

Super-fast oven

Think five minutes is too long to wait for a baked potato? Amana's Radarange 1110 cuts that baking time by 70 percent, to 1½ minutes. The 1,000-watt microwave oven also cooks using partial power and can be programmed for automatic temperature control. Price: $600.



Electric faucet

Can't grasp a faucet? Push touchtap's switch, and a solenoid valve releases cold water. The other switch provides premixed hot water. (See "WN in Home Improvement" for another approach.) Enmatic Pty. Ltd., 68 Christian Rd., Punchbowl, N.S.W. 2196, Australia.

Executive raceabout

Mate the Audi Quattro's 2.1-liter (128-cu.-in.), five-cylinder turbo engine with the 100's ultra-slippery (0.3 C_d) body. The offspring is the Audi 200, the world's speediest production sedan, the maker says. With 200 hp driving the front wheels, it attains a speed of 143 mph.

Call holder

Even mom-and-pop shops can put you on hold with the ACS-46 Call Sequencer. It answers calls on up to six lines with a recorded message. The $1,995 unit works with major telephone and PBX systems, says Dacon (8 Industrial Ave., Upper Saddle River, N.J. 07458).

Computer coddler

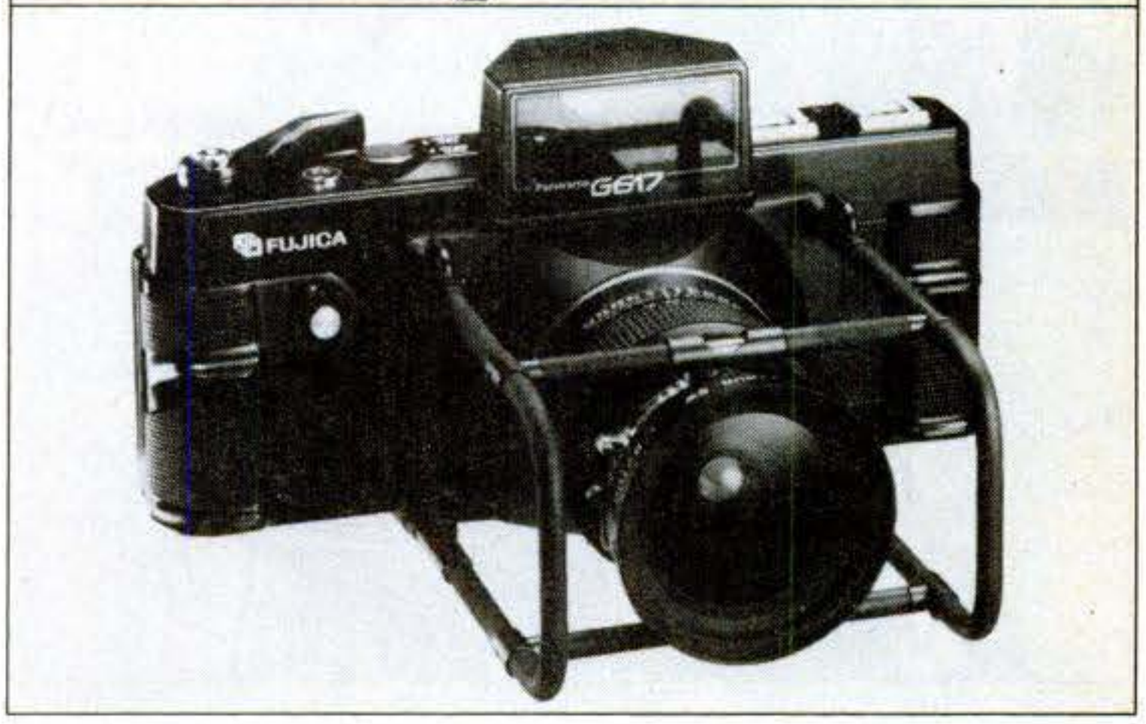
When your portable computer is not on the road, the Microbase I can house it. The commodious, wood-veneered work station has a pull-out keyboard table and a locking roll top. Maker: Microplex, Inc., One World Trade Center, New York, N.Y. 10048. Price: $495.

What's New *in Photography*

BY EVERETT H. ORTNER

Pro formats

Now Fuji adds two cameras to the pro and advanced-amateur armory: the medium-format six-by-4.5-cm GS645 and the extra-wide six-by-17-cm panoramic G617. Press the catch on the GS645's front cover and, as the cover opens, out comes the Fujinon 75-mm f/3.4 collapsible bellows-barrel lens. The format permits direct scale-up to eight-by-10 enlargements without cropping. There are 15 exposures on a roll of 120 film. Price: $530. The G617 puts four exposures on a roll of 120 film to produce super-wide six-by-17-cm (about 2¼-by-6½-in.) pictures. Shock protectors guard the moving 105-mm f/8 lens. Weight: five lbs. List price: $1,900.



Fast tele-zoom

Vivitar's one-touch 75–250-mm f/3.8-4.5 macro-zoom lens replaces its slower 75–300-mm predecessor. And it focuses closer—down to almost half life size for a 1:2.5 image-object ratio. The 6.6-in.-long, 30-oz. lens lists for $330.

Easy mixers

Setting up the amateur darkroom for an evening's work is easier than ever with these snip-and-pour packets. Kodak Hobby-Pac kits come for both film and paper processing. Each kit contains developer, stop-bath, and fixer liquid concentrates; you just add water. $3.50.

Computer timer

Now time-lapse photography can be computer controlled, says GRD Distributors (Box 6383, Bridgeport, Conn. 06606). The 652 TL Programmer permits up to 9,999 sequences and up to 75 different time intervals, using motor-drive still cameras or movie cameras. Price: $400.

Rain cover

Stormy day? But you still want to take pictures with your video or movie camera? Waterproof covers by Goose Enterprises (39 Dorman Ave., San Francisco, Calif. 94124) have a plastic window for easy viewing, Velcro closures, and easy access to the lens. Prices: $130–$170.

Duplicator

Slide duping is decision-free with the Duplimat, claims Spiratone, Inc. (135-06 Northern Blvd., Flushing, N.Y. 11354). You attach the duplicator to your SLR camera, position the flash on the bracket for either Kodachrome 25 or 64, and trip the shutter. With flash, $39.95.

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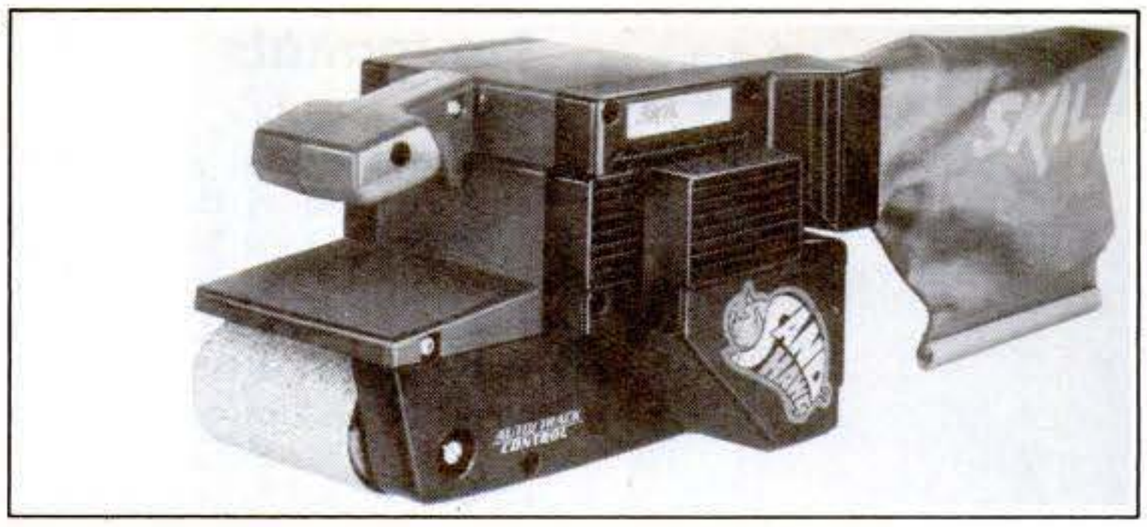
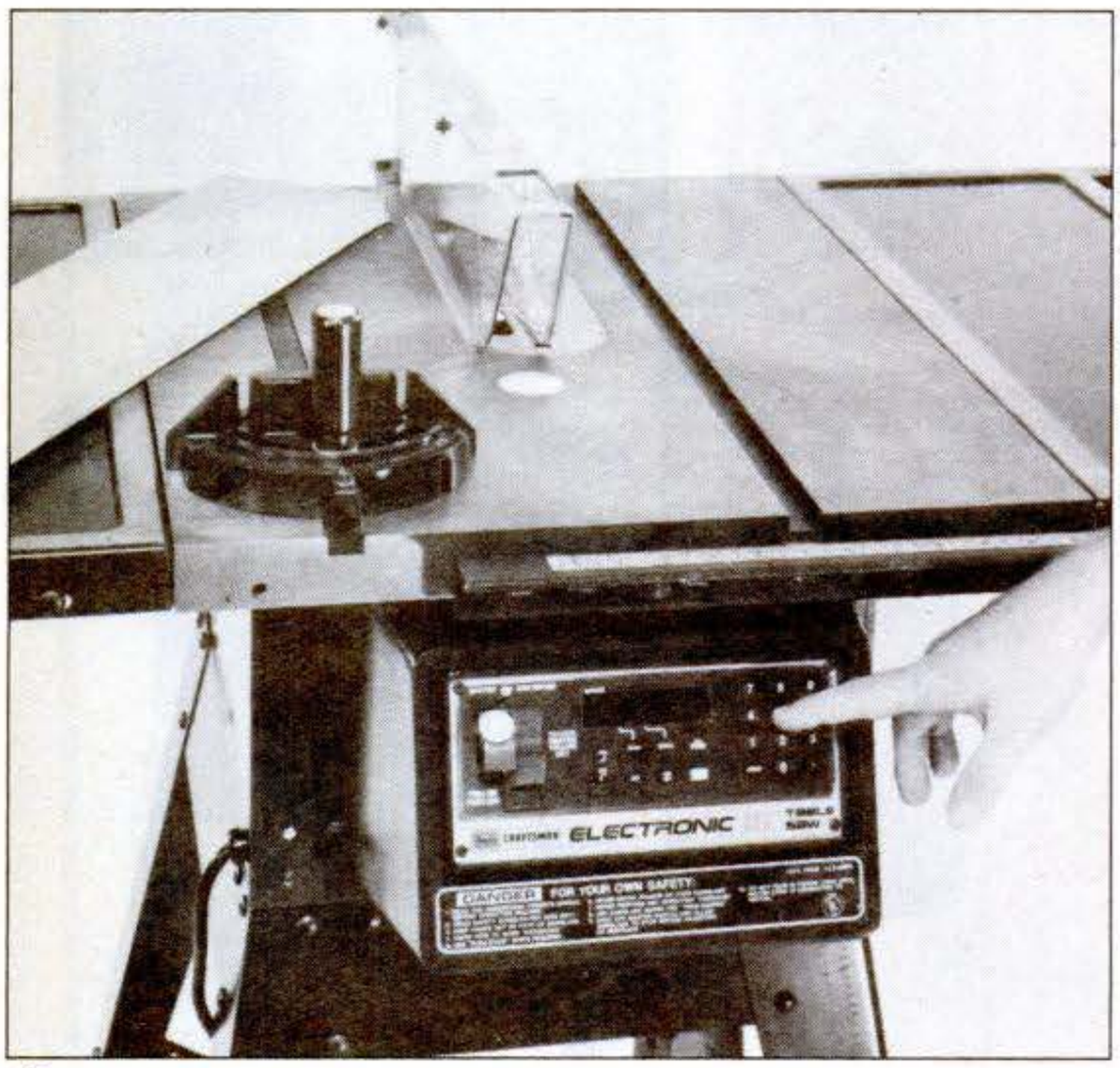
What's New *in Tools*

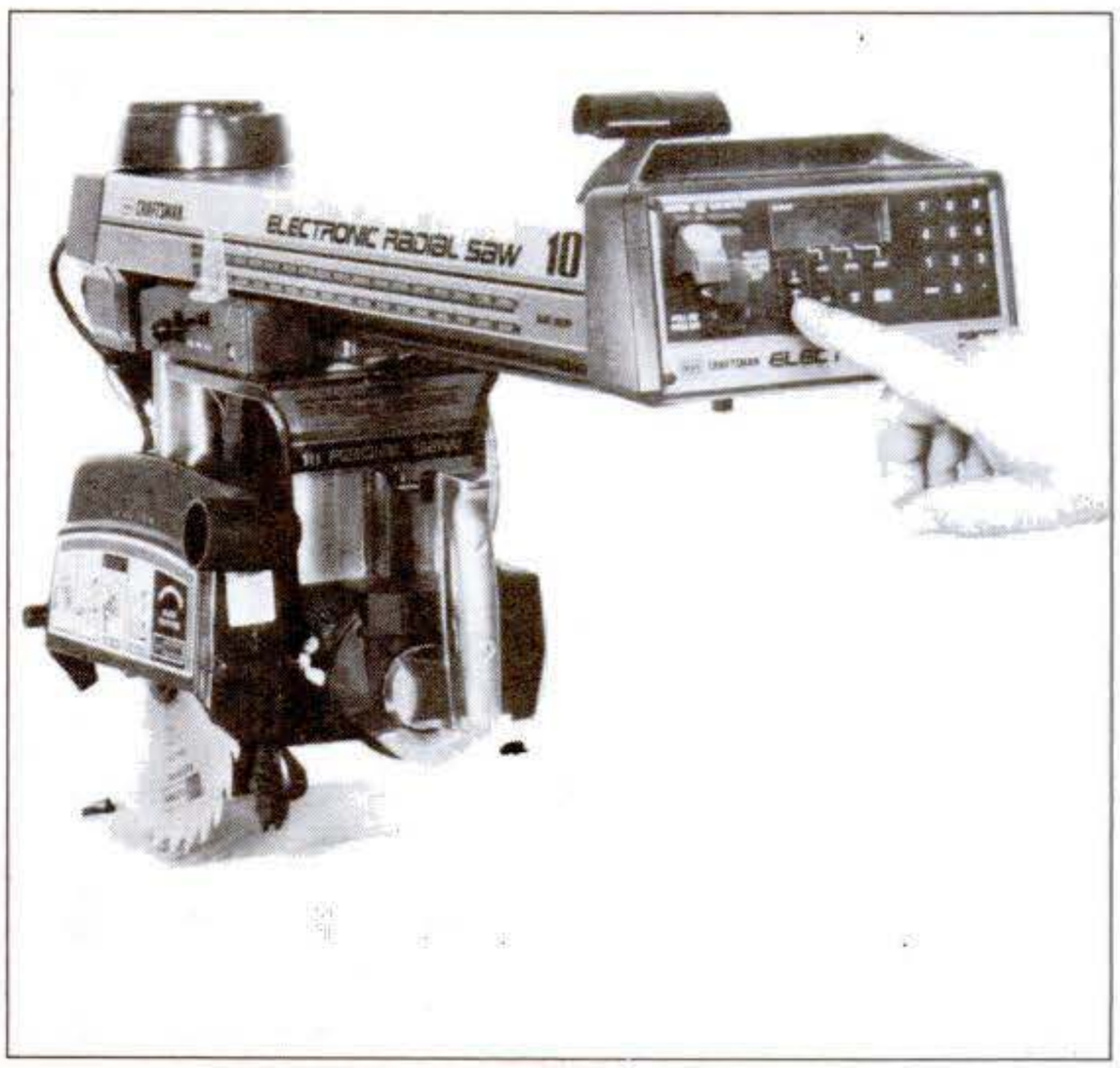
BY V. ELAINE SMAY

Two-way sander

The Sand Hawg belt sander from Skil can be used conventionally as a portable tool or—flipped upside down and clamped to a workbench—can be used as a bench sander. Its patented Auto Track system keeps the four-in.-wide, 21-in.-long belt centered. The suggested price is $249.





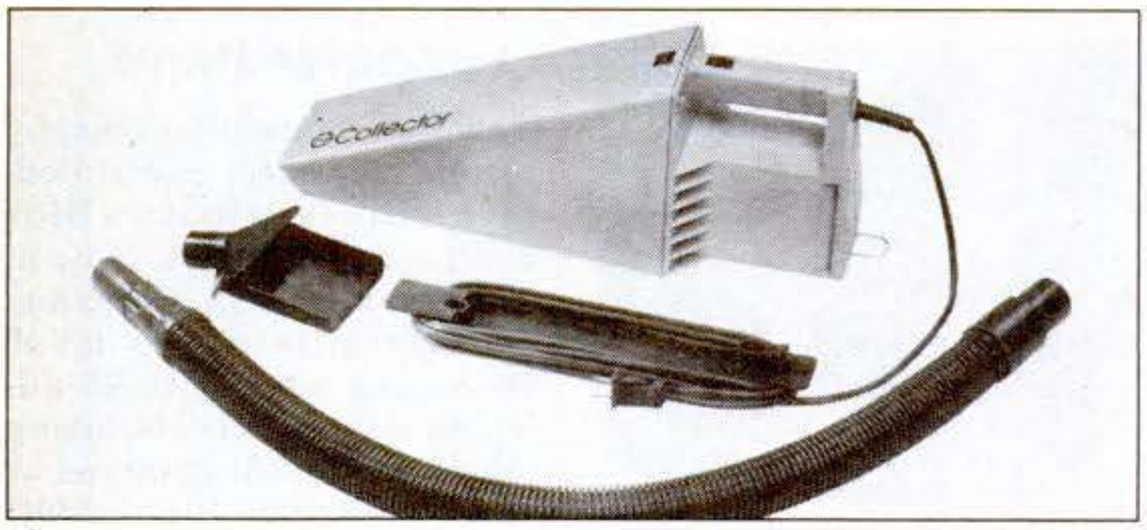


Electronic saws

"No more cranks," says Sears of its two 10-in. Craftsman saws. The table saw (above) and radial-arm saw (above, right) both have power blade elevation controlled by a microprocessor. They also have an automatic "jog" movement that changes the blade elevation 5/1000 in. each time you push the button. Digital displays indicate elevation and bevel angle, and on the radial saw, miter angle. The push-button control panel is conveniently located on both saws. The radial saw has a 1 ½-hp induction motor; the table saw, a one-hp motor. Both will be available in January for about $700 each.

Portable air gun

You can spray liquids, foams, and powders with the Colt 45 air gun, and even inflate toys and decorate cakes, says Colton Creators (216 E. 2nd St., Mineola, N.Y. 11501). Clip-on containers prevent cross-contamination. Nicad batteries run up to 45 minutes per charge. Price is $60.

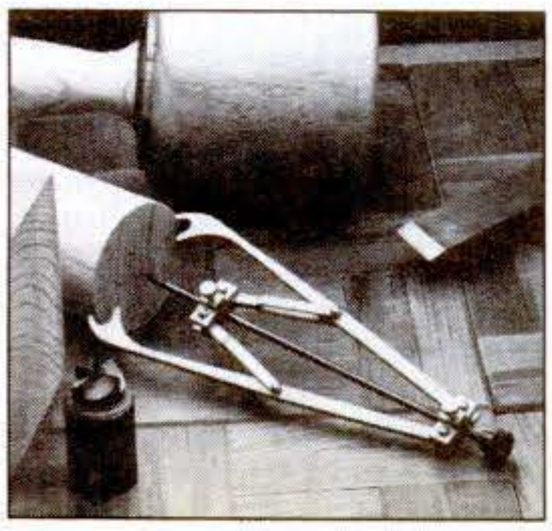


Little vac for big jobs

Hand-held, 120-volt vacuum cleaner "picks up where others leave off," says Black & Decker. The Collector, big brother to the popular Dustbuster, has a 1.5-qt. capacity and a large opening. It comes with an 18-ft. cord, a wall bracket, and a 36-in. hose. Price: $50.

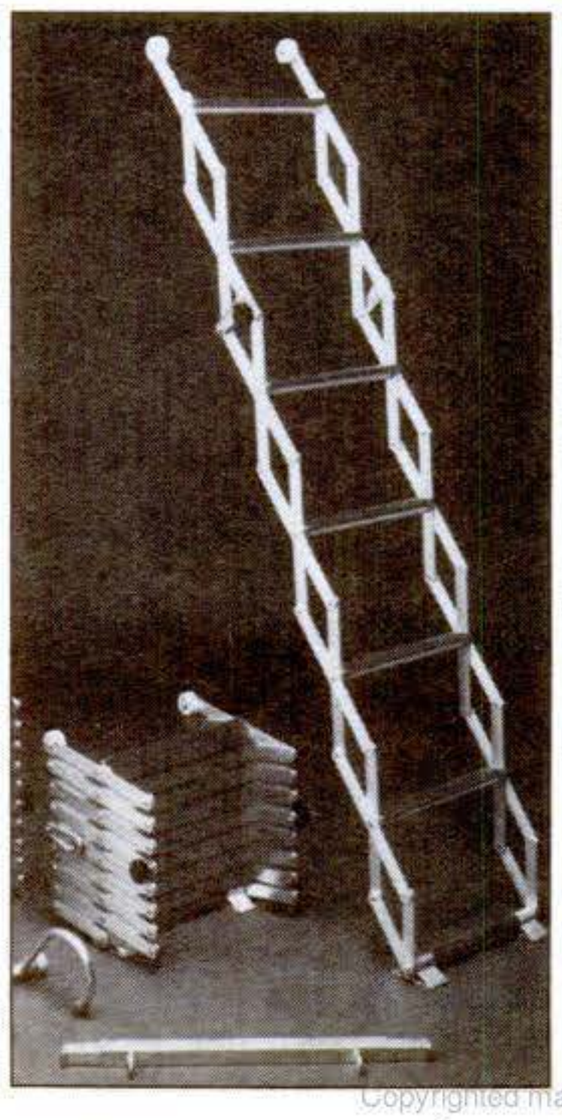
Center finder

This precision caliper quickly finds the center on projects up to 7¼ in. wide. You set the legs on the edges, push down the pointed rod, lock the thumbscrews, and scribe the exact center. Center-Finding Caliper is $18 from Shopsmith, 750 Center Dr., Vandalia, Ohio 45377.



Collapsible ladder

The Swedish-made Stretch'n Step ladder folds accordion-like into a compact stack for easy stowage in a car trunk or closet, according to importer In-Time Services (1118 E. Atlantic Ave., Delray Beach, Fla. 33444). Lengths: 6½, 8½, and 10½ ft. Prices: $169, $199, and $229.



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What's New *in Home Improvement*

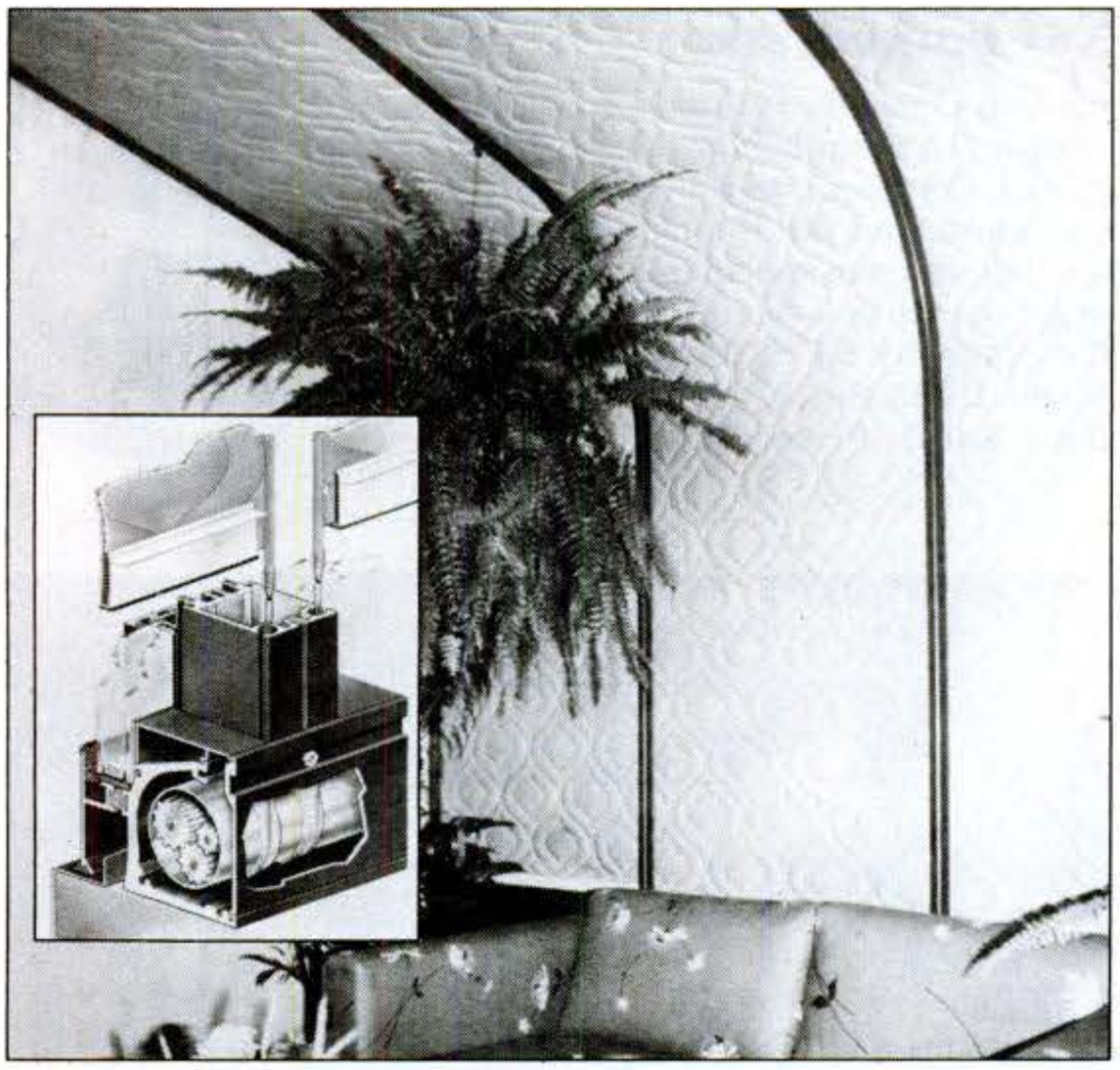
BY SUSAN RENNER-SMITH

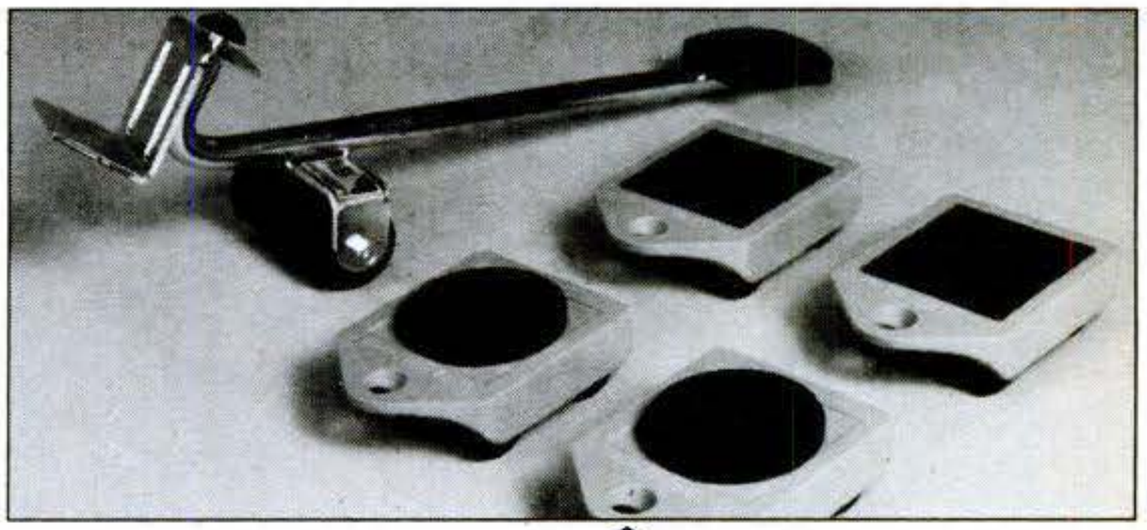
Portable spa

Damp November drizzles make it hard to relax in an outdoor spa. But Kohler's Invitation spa comes indoors for the winter. The 90-by-80-by-30-in. tub fits through most doorways, plugs into a 20-amp outlet, and fills via a hose. A dual-element heater warms the water.

Spray-on silicone

Combine the convenience of an aerosol spray can with the advantages of flexible, waterproof, heat-and-cold-resistant silicone. Result: a superior, easily applied sealant, says Red Devil, Inc. The Lifetime door and window caulk costs $6.89; the others cost $8.79 each.



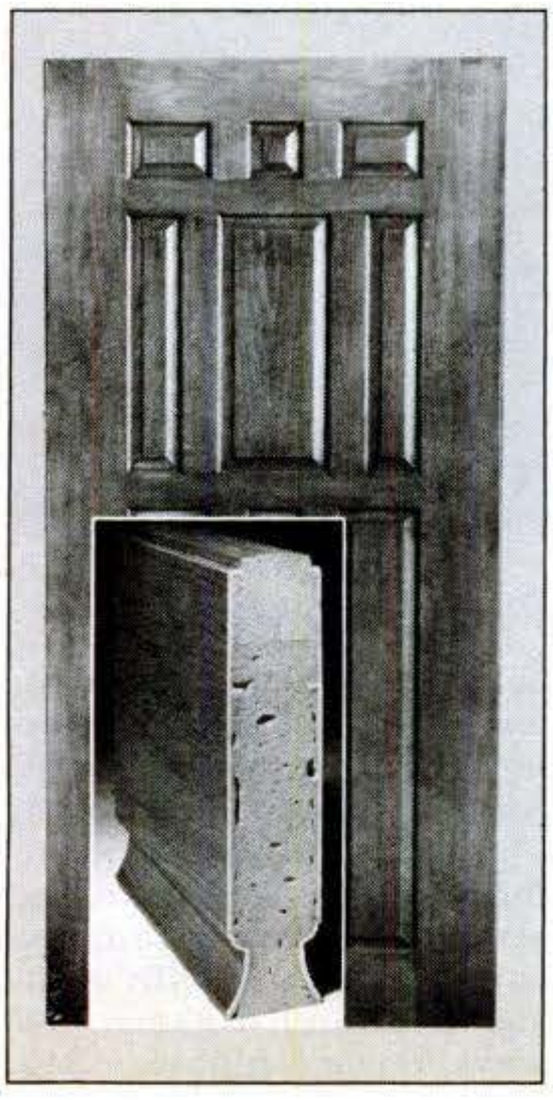


Shaded greenhouse

Grooves built into the structural frame of this add-on solarium serve as tracks for Window Quilt shades (inset). The built-in tracks prevent sagging so the shades provide an airtight seal, says Four Seasons (425 Smith St., Farmingdale, N.Y. 11735).

Modular dolly

Got to move a heavy object? Slip the Magic Mover's lift arm (top) underneath, step on the foot pedal, then slide a rolling block under each corner. You can move 1,500 lbs. with this five-part "dolly," according to Peripheral Systems (Box 6, Manchester, N.H. 03105). Price: $30.



Sandwich door

The Fiber-Classic, a unique fiberglass door, has a compression-molded skin with realistic wood grain. Filled with a 1.5-in.-thick block of foam polyurethane (inset), the door has an R-value of R-10, says Therma-Tru (4747 Holland-Sylvania Rd., Sylvania, Ohio 43560). $300.

Electronic faucet

The Optima no-hands spigot has a sensor instead of a faucet. Hands shoved under the spout deflect an IR beam, triggering a switch. This starts water flowing at a preset temperature. Sloan Valve Co. (10500 Seymour Ave., Franklin Park, Ill. 60131) makes it. $325.

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What's New *in Electronics*

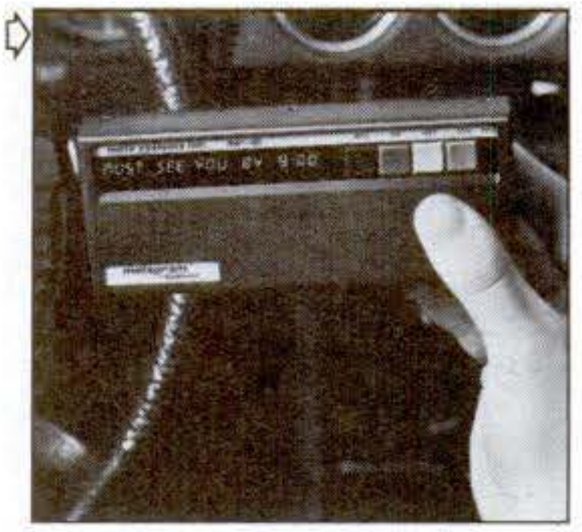
BY WILLIAM H. HAWKINS

Video switcher

Connect as many as six video inputs to this switcher: Push one button, and you direct any combination of inputs to three outputs. LEDs display the routing selected. Electronic switching gives 75-dB isolation. Maker: Videolink, 13038 Saticoy St., N. Hollywood, Calif. 91605; it's $160.

Beeper plus

With the Metagram pocket message receiver, you're never out of touch. The Millicom unit (1031A E. Duane Ave., Sunnyvale, Calif. 94086) receives messages of up to 940 characters from a remote message center. It's $40 a month but is available now only on the West Coast.



3-D game maker

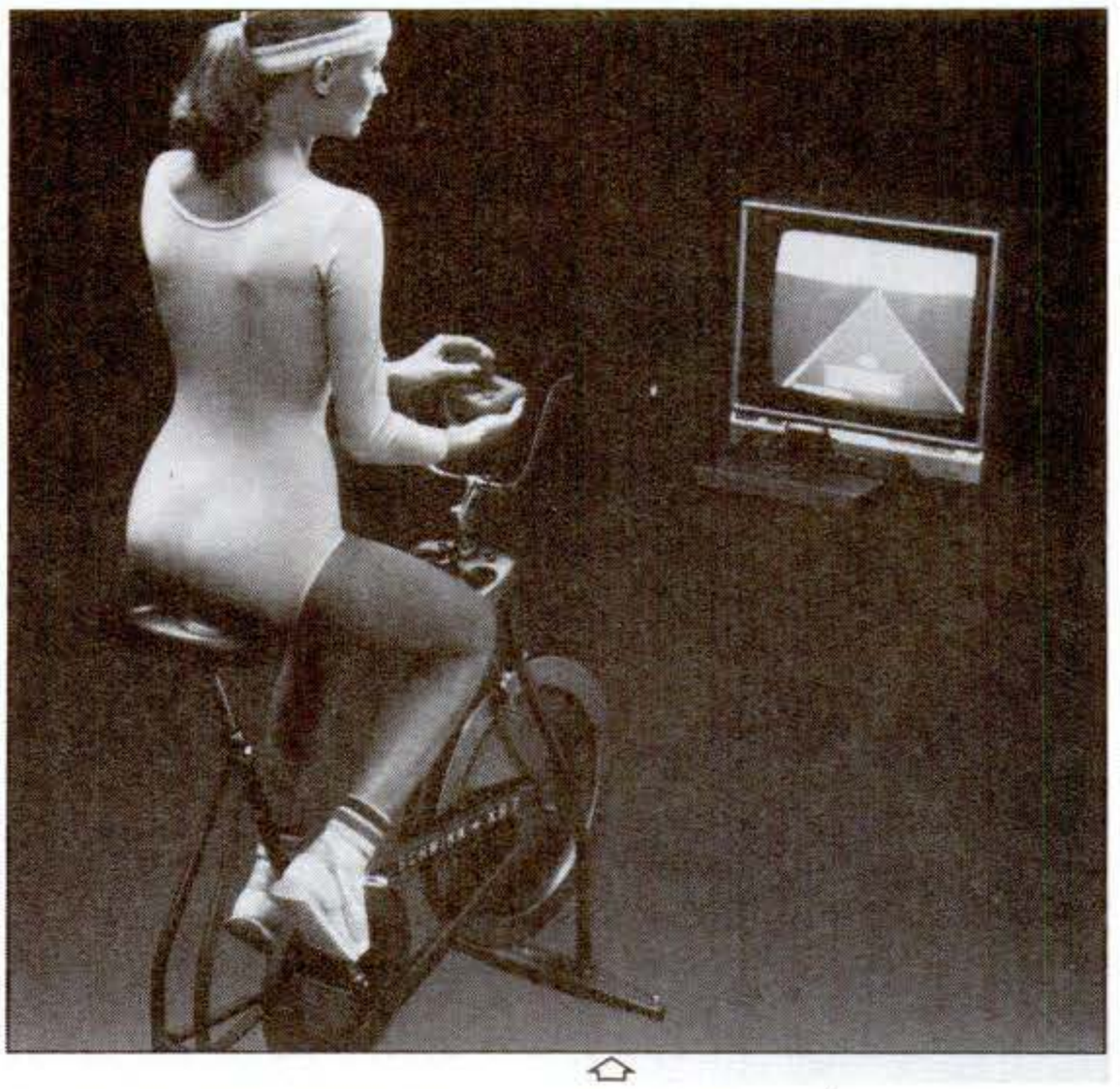
Wear the Vectrex 3-D Imager, and you're literally *into* video games. Connect it to the Vectrex game and put it on, and the images from special plug-in games are in 3-D and color. It's made by GCE, 233 Wilshire Blvd., Santa Monica, Calif. 90401. Price: $50.

2-in-1 computer

One keyboard, one CRT display, one enclosure—but inside there are two computers. The Xerox 16/8 uses Z80-A eight-bit and 8086 16-bit microprocessors, each with a memory. Result: You can run CP/M and MS-DOS simultaneously. Prices: $3,395 to $5,295, depending on disk drive.

Call filter

Add Phone Censor (Chrono-Art, 9175 Poplar Ave., Cotati, Calif. 94928) to your phone line, and up to four codes can be given to friends, enabling you to selectively answer calls. Features include "hold" function and timer that can cut off calls for 10 hours. $70.



Player-programmer

Play a song on the Casio PT-50 mini-keyboard ($200), and it's stored in memory for instant playback. Don't like it? Then pop in a preprogrammed ROM pack ($30) that contains 15 professionally composed melodies, complete with obbligato, rhythm, tempo, fill-ins, and chords.

Pedal power

Take the boredom out of indoor pedaling with an interface box by Suncom (650 E. Anthony Trail, Northbrook, Ill. 60062). It converts pedaling into movement on the screen of a video game or computer. Used with Activision's Enduro game, you travel down a highway. $40.

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What's New *for Your Car*

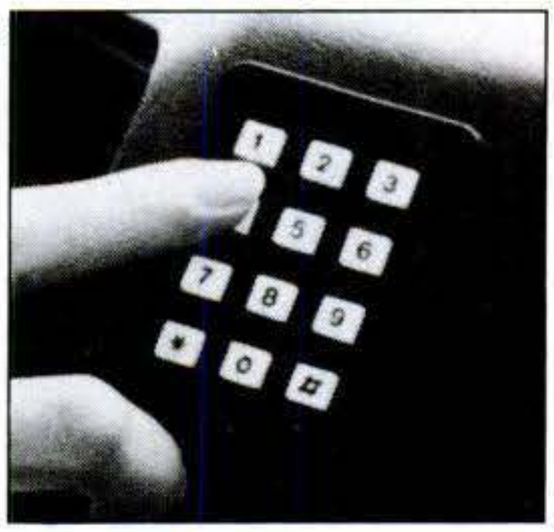
BY JACK KEEBLER

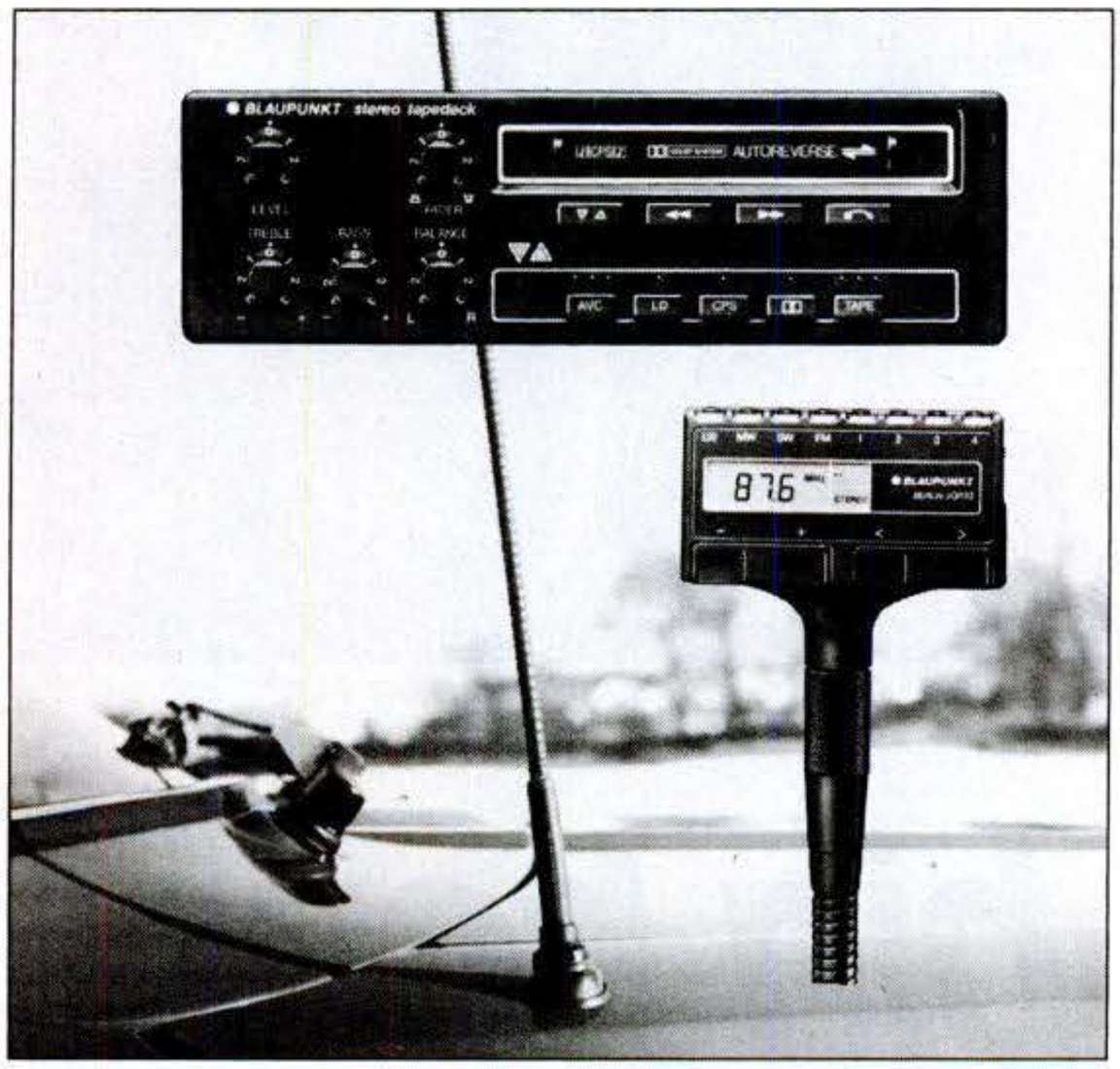
Wind shield

Made of distortion-free, tinted Plexiglas, Air Control wind deflectors keep interiors draft-free, even with the windows open, says Trokir Air Control (40 Cleveland St., Bay Shore, N.Y. 11706). On rainy days, leave the windows down to prevent fogging. Price: $139.95.

Theft protector

To start your car, first punch a four-number code into Theft-Aside. The device cannot be hot-wired or jumped from the vehicle's interior, and no special tools, skills, or drilling is required, says Matthews Exquisite Gifts (344 Hoe Ave., Scotch Plains, N.J. 07076). Price: $49.95.





High-tech audio

A voice synthesizer in the Blaupunkt SQR 83 radio-cassette player announces station call signs after tuning. It also features a control module on a flexible stalk that can be put near the steering wheel. Station frequencies appear as a digital display, and there are selector buttons for four wave bands, four preselected stations, electronic volume control, and auto search. The amp pumps out 20 watts to four speakers. The nonretractile Autoflex aerial is said to give better reception and to be carwash-proof and vandal-resistant. It's coated with a polyamide for protection. Both made by Blaupunkt-Werke GmbH, 32 Hildesheim, Germany.

Sports rubber

Semperit Hi-Speeds have two belts of high-tensile steel and two nylon belts for additional performance and protection. The ribbed-block tread makes this tire a wet-weather performer, according to the maker. A wide range of sizes is available. Prices: $66.39 to $146.16.

Hot washer fluid

Inserted into a heater hose, this device warms windshield cleaning fluid. The wipers can then remove frost or light ice, says Mattco Heated Windshield Washer Co. (200 Nursery Rd., Titusville, N.J. 08560). Installation requires only a knife and a screwdriver. Price: $19.95.

Roll-up cap

This vinyl pickup bed cover retracts into the storage compartment behind the cab like a household blind. Pull the cover out to any length and secure it to a snap bar mounted on the bed side rails. By Style-Rite, 33830 Riviera Dr., Fraser, Mich. 48026. Price: $185.

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PS leisure-home plan

Little big house

John Fulop's tiny solar vacation home can be built two ways. With an open-air deck on the south side, it's a direct-gain solar dwelling with sunlight heating the living space via a pair of sliding glass doors. With a prefab greenhouse and rock-bed heat storage added in place of the deck, it's an indirect-gain solar home. Either way, you have an unusually affordable vacation retreat: The architect designed this house to keep costs low by basing dimensions on standard construction materials and stacking plumbing runs.

By RICHARD STEPLER
Architect: John Fulop

It's just a little house in the woods in western Massachusetts. In fact, the house measures a mere 24 feet square. Inside, however, a sense of spaciousness belies its compact outside dimensions. The key is a soaring cathedral ceiling that opens up the ground floor.

"The idea," says architect John Fulop, "was to design a simple house that wasn't just a box, but one with an expansive use of space—a house that didn't give you the claustrophobic feeling you can get in 24-by-42-foot builder houses, for example, which would cost at least as much."

In fact, perhaps the most remarkable fact about Fulop's little house is that it was built two years ago for just $35,000. I'll describe Fulop's cost-cutting techniques later.

Aside from the cathedral ceiling, the house has several other space-expanding features:

- Double sliding glass doors give onto the deck, opening the interior to the outdoors.

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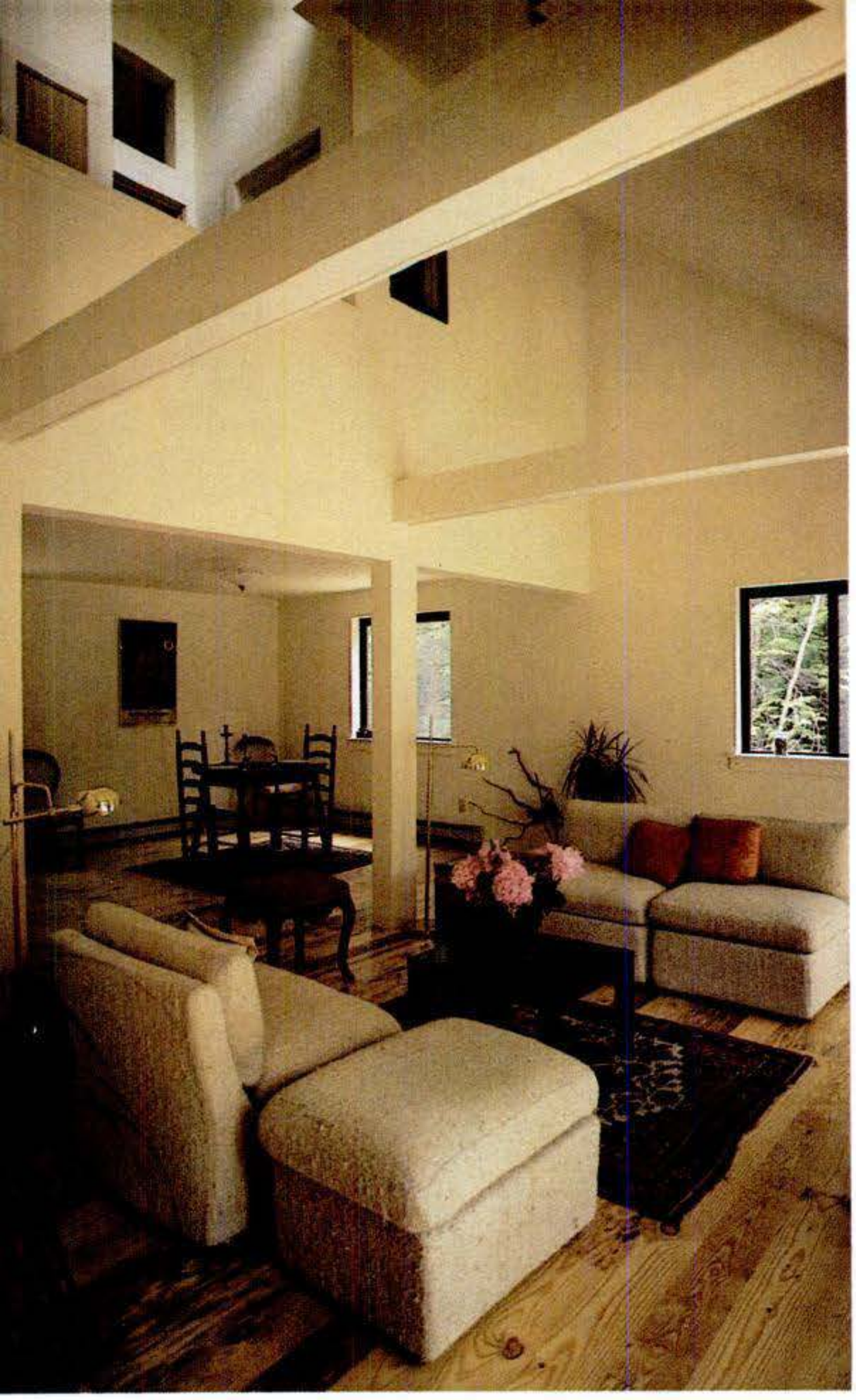
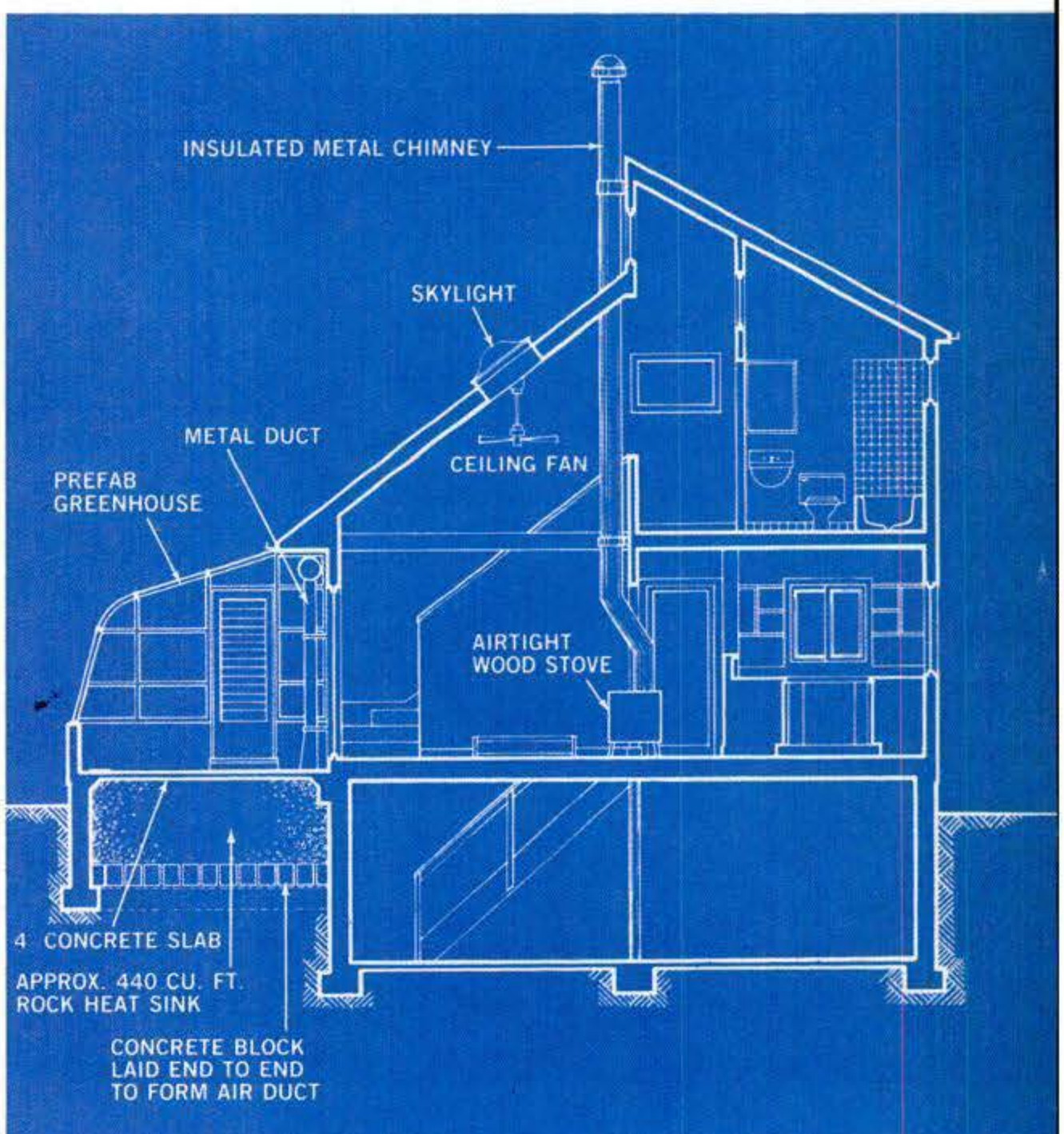
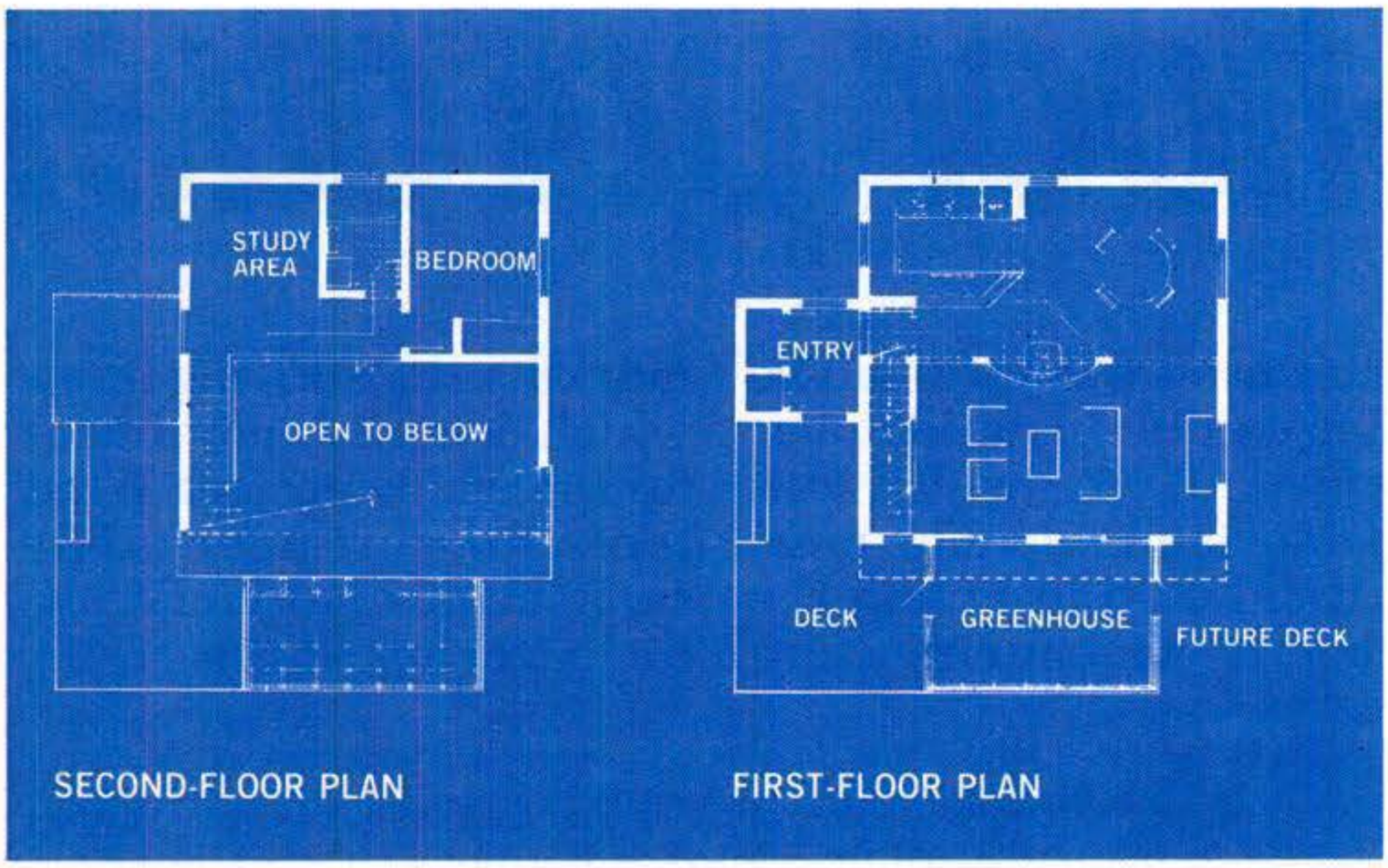


Where to send for plans

Complete sets of working plans with dimensions and construction details, including those for the greenhouse, have been prepared by the architect. Send $55 for one set of plans, $20 for each additional set (needed for construction, financing, and filing) to John Fulop Assoc., 561 Broadway, New York, N.Y. 10012.





- A clerestory admits light and solar heat to the upper-level bedrooms and bath.
- Small windows in the north wall provide a view and balance the light.
- An air-lock entry with storage closets shields the living area from blasts of wintry air.

As built for Fulop's client, the house is a direct-gain solar type: Sunlight enters the living space through south-facing windows.

Fulop's plans call for a greenhouse where the present deck is located. The greenhouse, with its integral rock-bed heat storage (see cross section), is sized to provide a substantial amount of the home's space-heating needs. A thermostatically controlled fan blows hot air from the greenhouse peak onto the rocks under the floor slab. Concrete blocks laid on their sides form the air plenums in the rock bed. At night, the process is reversed to maintain greenhouse temperatures. In this case, the home is an indirect-gain solar type.

An airtight wood stove in the living room handles most auxiliary-heat needs. Electric baseboard heaters are installed as backups but are rarely used. In fact, the owner reports that electric bills average $29 a month.

How did Fulop design the house to keep building costs so low?

- Dimensions are based on multiples of standard building materials to minimize waste and cut labor costs.
- Kitchen and bath are stacked to minimize plumbing runs.
- The home's 24-by-24-foot size permits use of less-expensive 2 × 8 floor joists. (Going to 28 feet would have required 2 × 10s or 2 × 12s.)
- In side walls, 2 × 6s on two-foot centers cost less than 2 × 4s on 16-inch centers and permit extra insulation.

Unfortunately, one of Fulop's cost-saving features wasn't included. Because a local building inspector insisted on a masonry chimney, the double-wall prefab metal chimney specified in the plans had to be dropped. PS

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Off-the-floor parquet

Who said parquet tile must be confined to the floor? Now there are new, exciting ways of using parquet that include covering furniture, counters—even walls. The tiles can be installed over plywood, drywall, and plastic laminate. The most critical step in laying the tiles is measuring and marking the starting lines, which establish alignment for the whole project. What tools do you need? The same basic ones you'd use for covering floors.

By CHARLES A. MILLER

Parquet tile is one of the most enduring and attractive floor coverings, but it needn't be limited to covering floors. You can also apply it to table tops, doors, bars, even walls—the results can be spectacular.

You apply parquet tiles on other surfaces, both horizontal and vertical, much as you would on floors. Wood parquet tiles can be installed over plywood, drywall, and smooth wood paneling. They can even be put over plastic laminate, provided the surface is lightly sanded.

Here are some hints on how to cover vertical surfaces. They're from Color Tile, Inc. (Box 2475, Fort Worth, Texas 76113), maker of Color Tile Oak and Teakwood Parquet Tile; and from Noranda Building Products (7120 Krick Rd., Cleveland, Ohio 44146), maker of Norwood Oak Parquet flooring.

You need only simple tools: a measure, hammer, notched trowel, level, square, saw, and sandpaper. You'll also need parquet primer and adhesive. First prepare the surface. It must be clean, dry, and structurally sound. Fill low areas, cracks, and holes.

Using a brush or paint roller, apply two coats of primer to the surface of the area you're covering. The primer ensures a proper bond by preventing the adhesive from being

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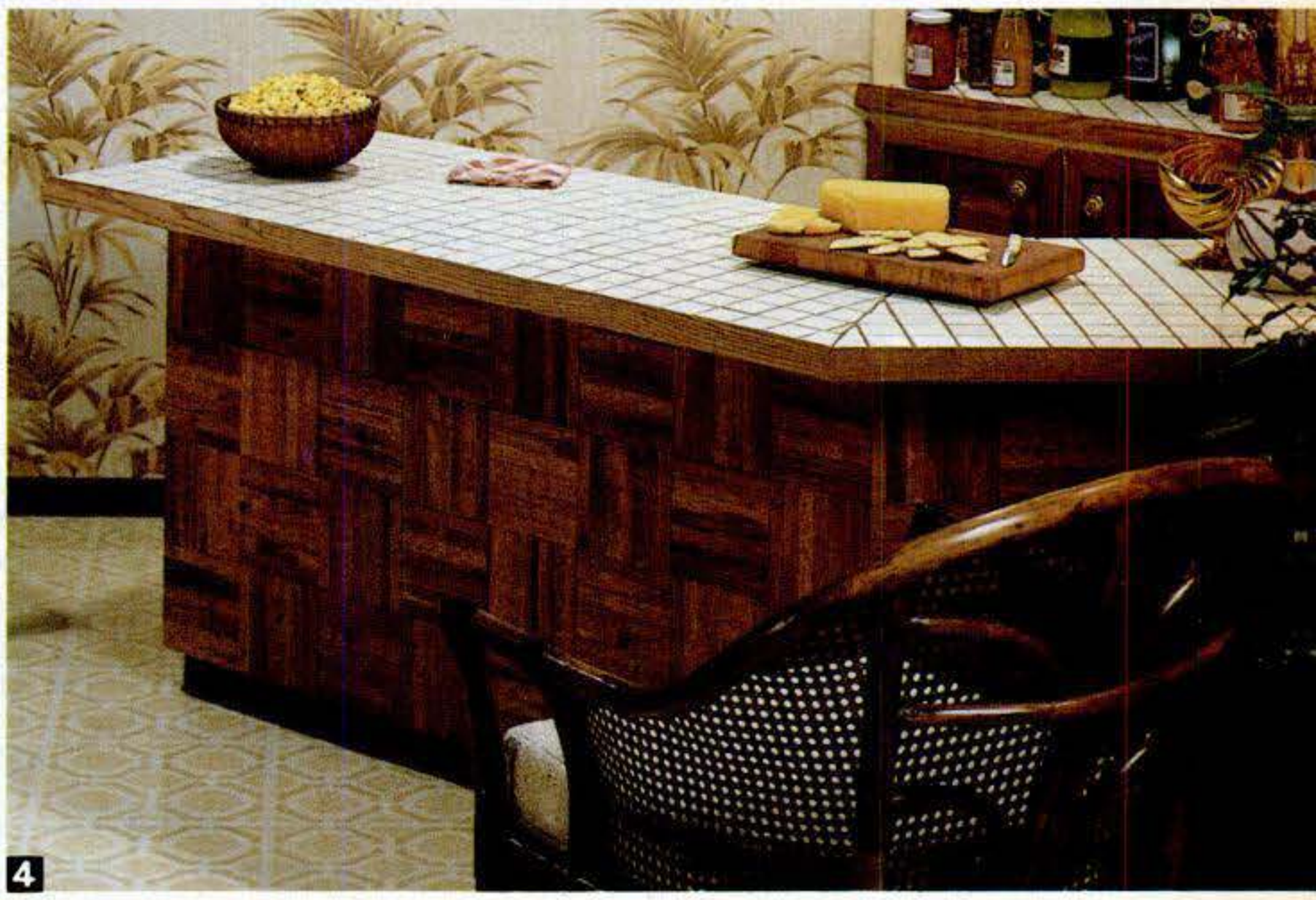
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Built-in-bookcase and cabinet fronts (1) are faced with a handsome covering of oak parquet tile in this combination living room and den. The tile is from Color Tile's Classic series in a medium finish. A conventional table top (2) covered with oak parquet makes a tough, easy-to-clean surface. Parquet tile on a divan (3) in an entry way blends in with the muted color, giving a pleasant, elegant look to the area. The Honey Brustic Oak Parquet by Color Tile, shown on a bar front (4), has natural wood grain and knots, enhanced by a special brushing process. An entire wall (5) can be covered by parquet. This one is covered with Norwood Oak Parquet over a standard Sheetrock base.

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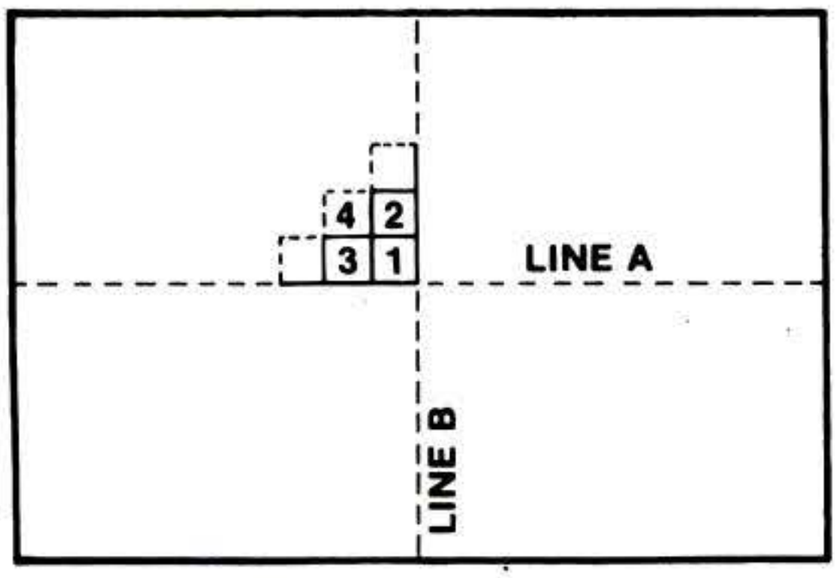
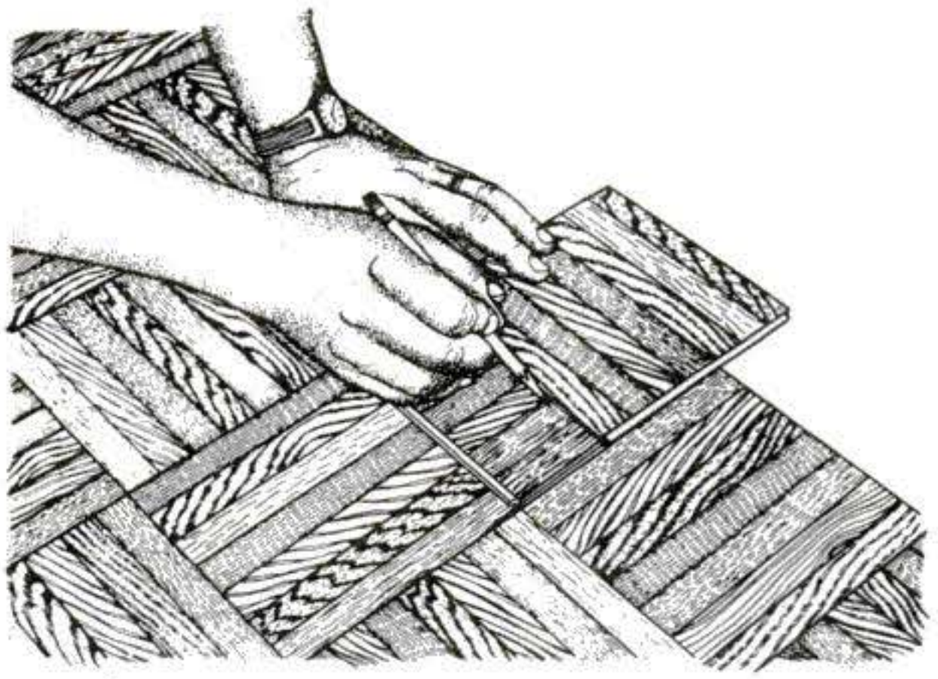
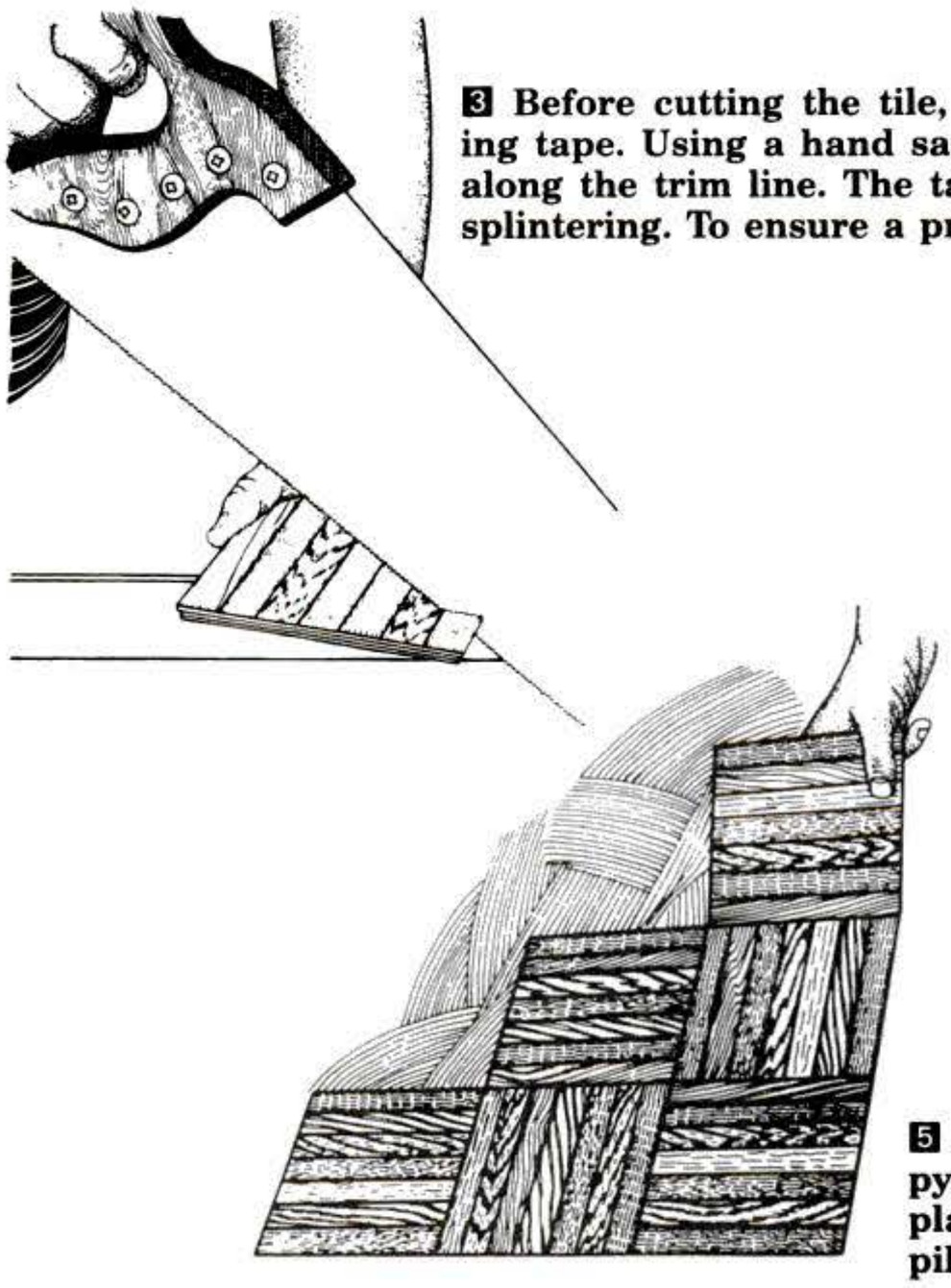
How to lay parquet



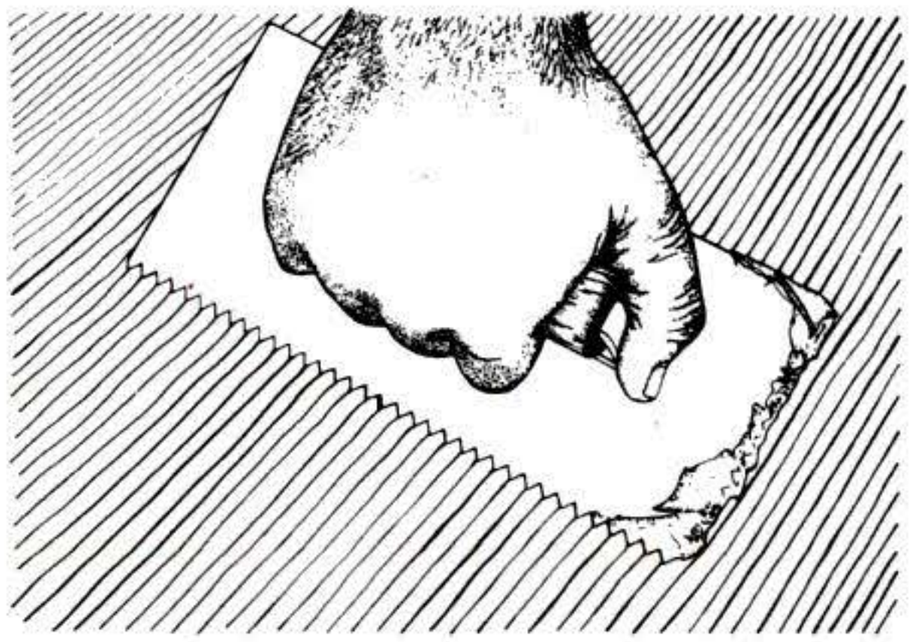
1 Mark center lines. The first tile must be perfectly aligned with the intersecting lines, as shown, because it establishes the reference for the rest. Four square tiles should be centered on the intersection of the two lines.



2 Trial-fit the tiles on a flat surface equal in size to the area to be covered. To trim, place the tile at the edge so it overlaps the last row. Mark cutting line with pencil. Cut and reposition trimmed piece to check for fit.



3 Before cutting the tile, reinforce the back with masking tape. Using a hand saw, make the cut from the front, along the trim line. The tape will help keep the tile from splintering. To ensure a proper fit, sand the rough edges.



4 Use notched trowel to spread adhesive. Comb adhesive with trowel so ridges are even—remove any excess. To see if adhesive is transferring to tile, put a tile down and remove it. If it's not, add fresh adhesive.

5 After placing the starting tile, lay the remainder in a pyramid pattern. In positioning tiles, press them lightly into place without excessive sliding. Sliding causes adhesive to pile up on tile's leading edge, which can impede the fit.

absorbed into the subsurface. Be sure to allow ample drying time between coats.

Now mark your starting lines, or intersecting center lines. These run parallel to the sides and ends and should intersect at a 90-degree angle at the center of the area to be covered. Measure the width of the area and divide by two. Mark the resulting distance at each end to indicate the center line, then snap a chalk line between the two points (or draw along a straightedge). Measure the length (the distance between the top and bottom of the area) and mark that center line, again with a chalk line or straightedge.

Place the loose tiles on a flat area the same size as the area to be covered. If the tiles don't fit evenly—that is, if you find that you have to trim them to fit—mark a new center that compensates for the trimming so that all pieces at opposite edges will be the same width.

The parquet adhesive should be stored at 70 degrees F for 24 hours before use. If it hasn't been, then put the container in a hot-water bath before use. Spread the adhesive with a notched trowel. How thick? A gallon should cover approximately 40 square feet. Too little adhesive might result in poor bonding; too much might cause some of the adhesive to bleed between the tiles. It's best to apply the tile within 20 minutes, so don't apply more adhesive than you can cover immediately. You probably can make a minor realignment of the tiles up to four hours later. A helpful hint: Spread adhesive only in one of the quarter-section areas (created by the starting lines) at a time, then lay the tile and move to the next section.

There are two ways to set the first tile, depending on the kind of tile you use. If you use individual tiles, position the first one at the center so its edges fall on the intersecting center lines as shown. If you use the larger, four-square tile, such as the Norwood tile, center it on the intersection of the lines.

To preserve the beauty of the parquet, don't apply varnish, polyurethane, or water-emulsion self-polishing waxes over the factory finish. PS

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Sanding secrets

Although a belt sander is probably the best all-around sanding tool, some jobs require special tools, such as orbital sanders for final smoothing, sanding drums for convex or concave profiles, and beveled discs for edge sanding. Also, the home workshopper can make a number of useful tools himself, such as sanding sticks for reaching into tight corners, contour discs for sanding inside carvings, and custom-size drums for small pieces of woodwork.

By A. J. HAND

Woodworking is an art. At least until it comes time to sand. Then art steps aside, and mindless monotony takes over. Many professional woodworkers have a solution for this tedium. When they have a piece of work that needs smoothing, they turn it over to a helper and say, "Sand it."

I don't have the luxury of a voice-actuated automatic sander. I have to do all my sanding myself, so I always keep my eyes open for any tool that can make the job easier. Over the years I've accumulated quite a few of these tools. Some are old, some are new, and some I made myself, but they all have one thing in common: They get me through the monotony, giving me more time for the carving, cutting, crafting, and creating that make woodworking the art that it is.

A good selection of sanding tools includes drum, disc, belt, pneumatic, and orbital sanders, plus abrasive cords and tapes, a contour sander, and combination sanding-shaving tools.

Sanding drums are at their best when sanding the edges of convex and concave profiles. They sand parallel to the grain, producing smooth, scratch-free work with crisp, clean corners. Drums come in sizes down to tiny versions for use on flex shafts and mini-grinders. Buy the longest drums available to give you the capacity to sand thick stock. (Some of the smaller drums won't even handle ¾-inch stock.)

Discs range in size from a tiny contour type you make yourself for reaching into carvings and other textured work to sanders intended for floors. The tiny contour discs can be made of several squares (or rectangles) of sandpaper slipped onto a bolt and locked firmly in place with a washer and nut.

A belt sander is what I'd pick if I were forced to own just one sanding tool. Why? It works extremely fast, but despite its speed it can produce smooth surfaces.

With a pneumatic sander, you inflate the drum with a bicycle pump or compressor, locking the sleeve in place. Varying the air pressure gives the drum different degrees of hardness. Low pressure lets the drum and sleeve conform to contours for a smooth, rounded finish. Higher pressures are for sanding crisper shapes. Models for both portable drills and bench grinders are available.

Orbital sanders are best for finishing work or final smoothing before you put on a finish. When shopping for an orbital sander, look for models with the highest speeds (10,000 orbits or

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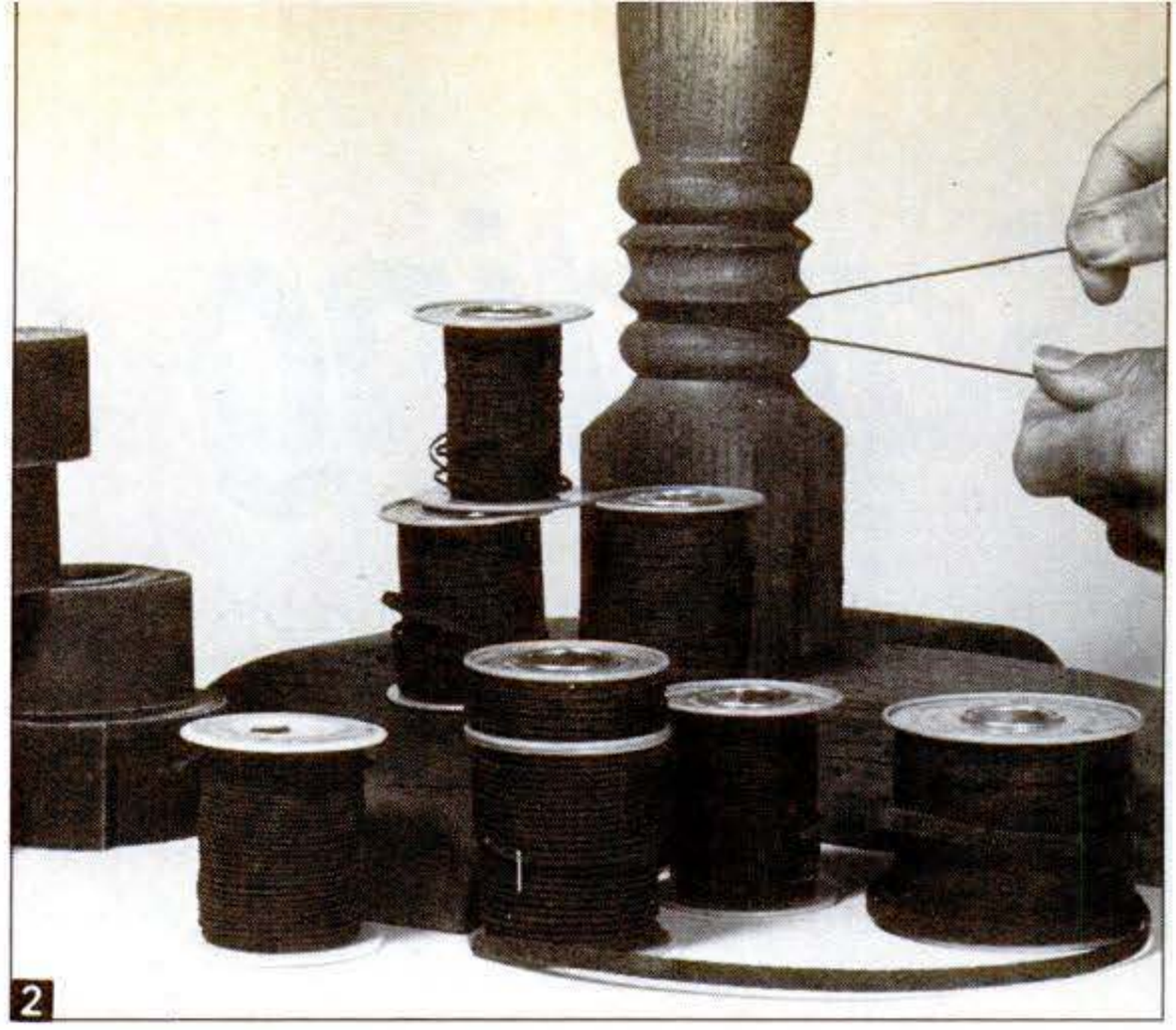
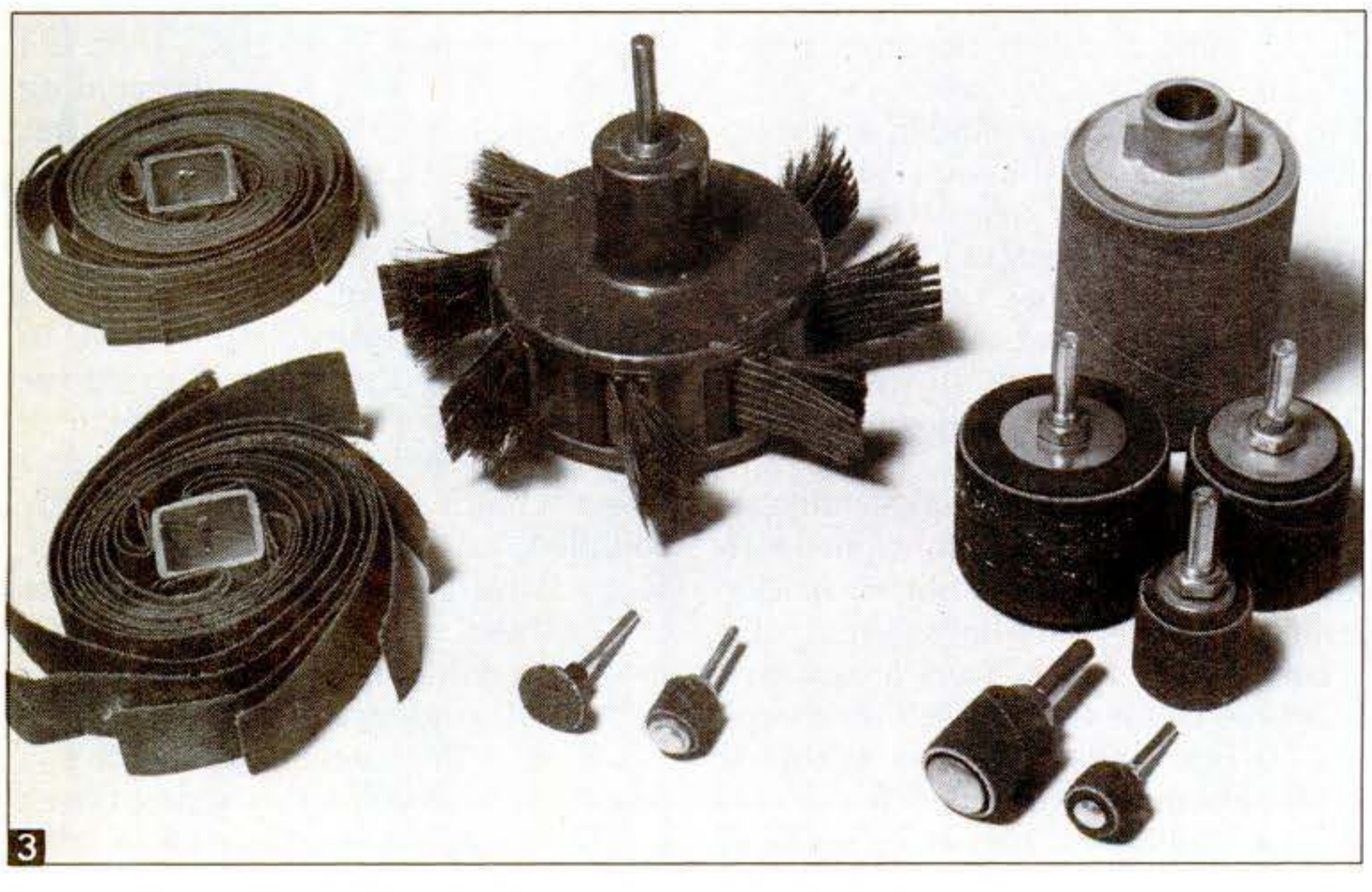
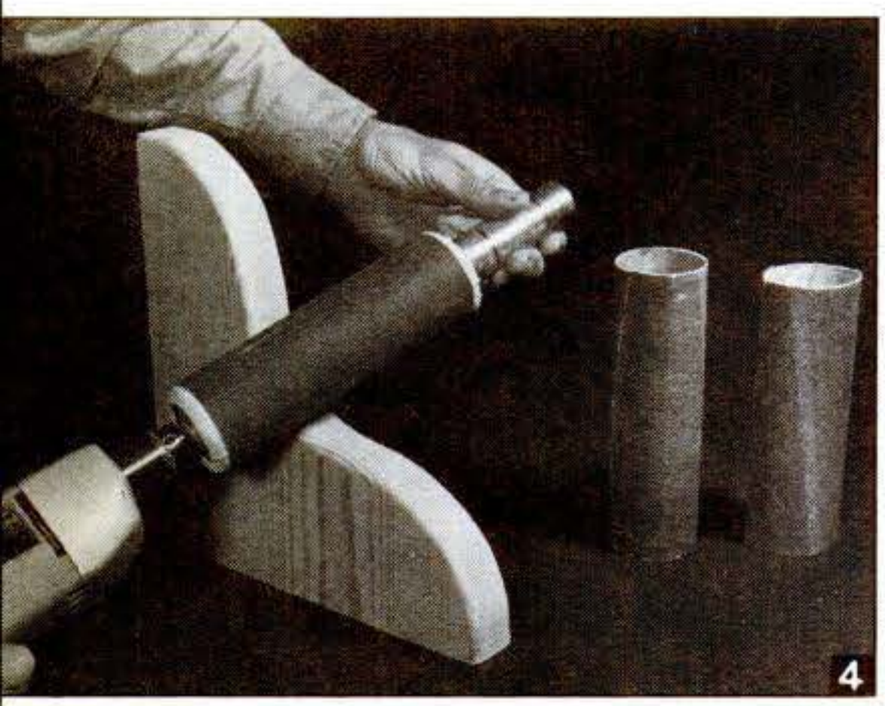




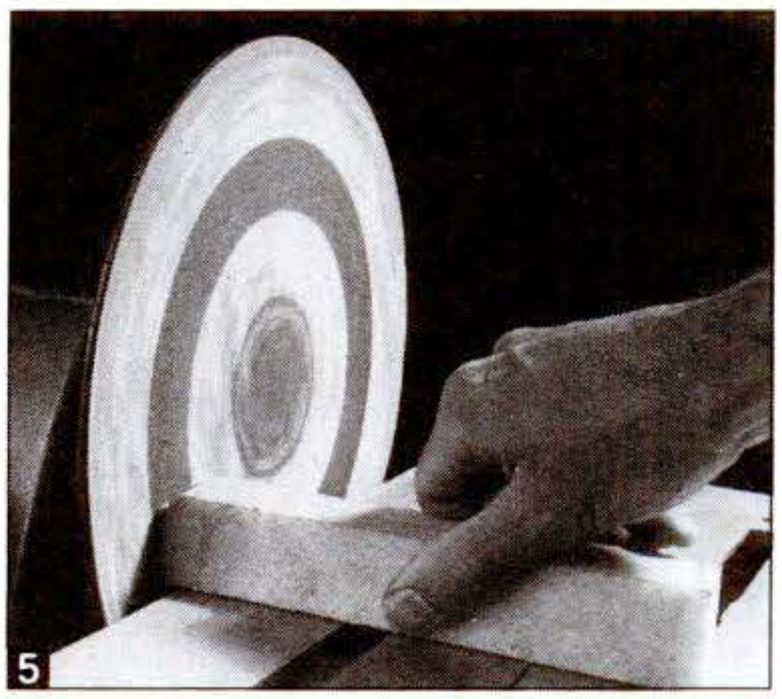
1 Make-it-yourself tools include: sanding sticks made by cementing sandpaper to thin pieces of wood; custom-size drums made from dowels or turned on a lathe; abrasive grit that can be cemented to rods with epoxy; paper inserted into a slot sawed through the length of a drum (no cement needed); and small sanding squares that reach into textured work.

2 Abrasive cords and tapes can be used to smooth otherwise hard-to-get-at turnings. Wide tapes are best for sanding cylinders; narrower cords and tapes are for more-intricate work.

3 Sand-O-Flex tool (shown with various refills, far left) is designed for contour sanding. Sanding drums (bottom and right) are at their best when sanding the edges of convex and concave profiles. Drums come in sizes all the way down to tiny versions for use with flexible shafts and mini-grinders.

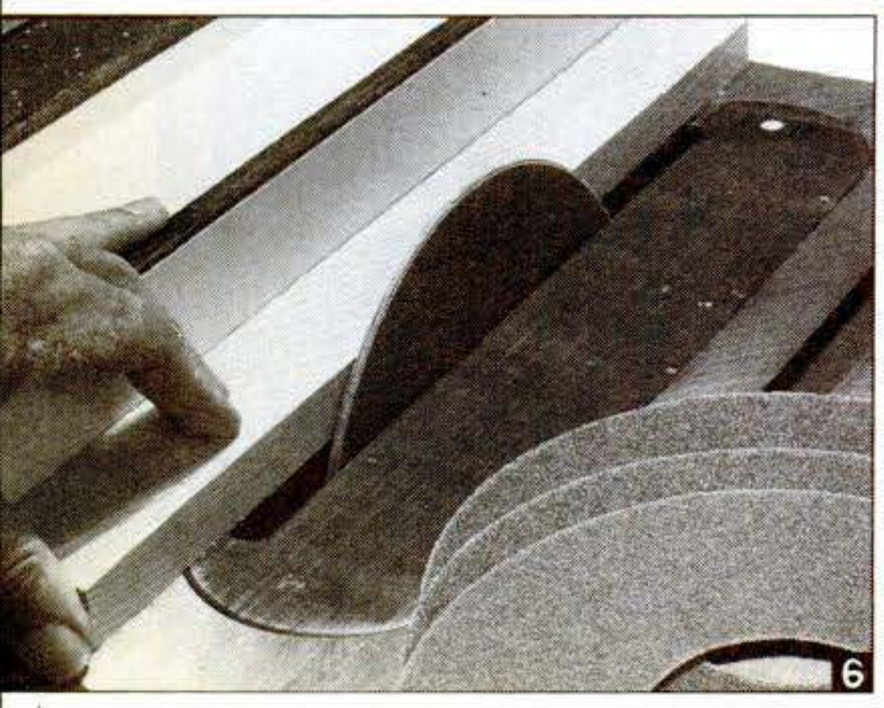


4 Pneumatic sander from Conover Woodcraft consists of an inflatable drum (chucked into a drill here) over which you slip long abrasive sleeves.

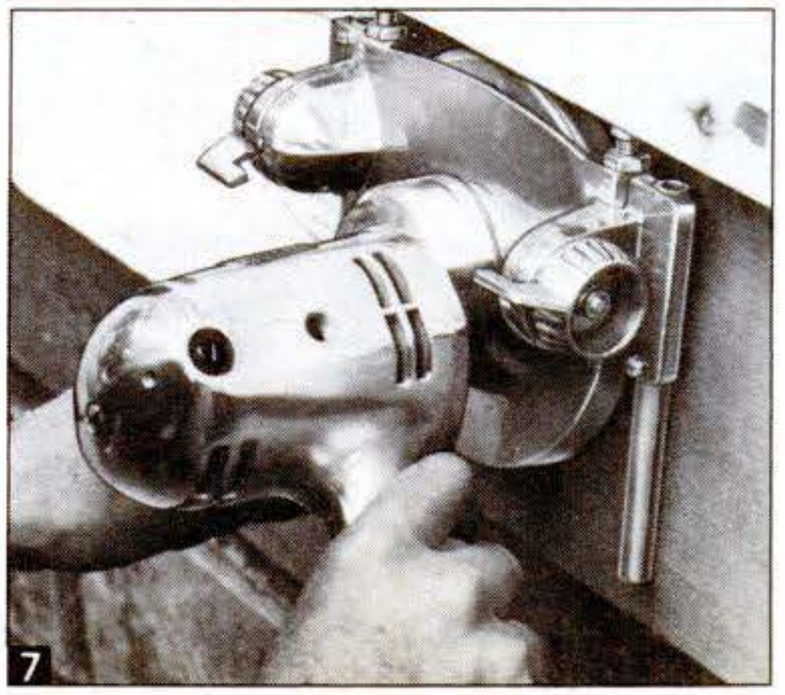


5 Gum-rubber cleaning stick is an excellent accessory for any sanding tool. Press it firmly against a running tool, and it will clean clogged sandpaper, greatly increasing cutting speed and extending the life of the paper.

6 Beveled sanding disc from Sears fits on your table saw. The disc can do a fine job of edge-sanding boards to a uniform size. One side of sanding disc is beveled two degrees. Tilting your saw arbor two degrees to the left puts the upper half of the disc in a vertical position, which gives you a virtually straight sanding line parallel to the grain of the wood.



7 Disc sander from Porter Cable with a power paint-remover attachment is the ideal tool for stripping siding down to bare wood. The sander takes seven-in. steel discs with carbide grit or ordinary sandpaper, and the attachment can be adjusted to the best cutting depth and disc angle for swirl-free sanding or can be used as a polisher.



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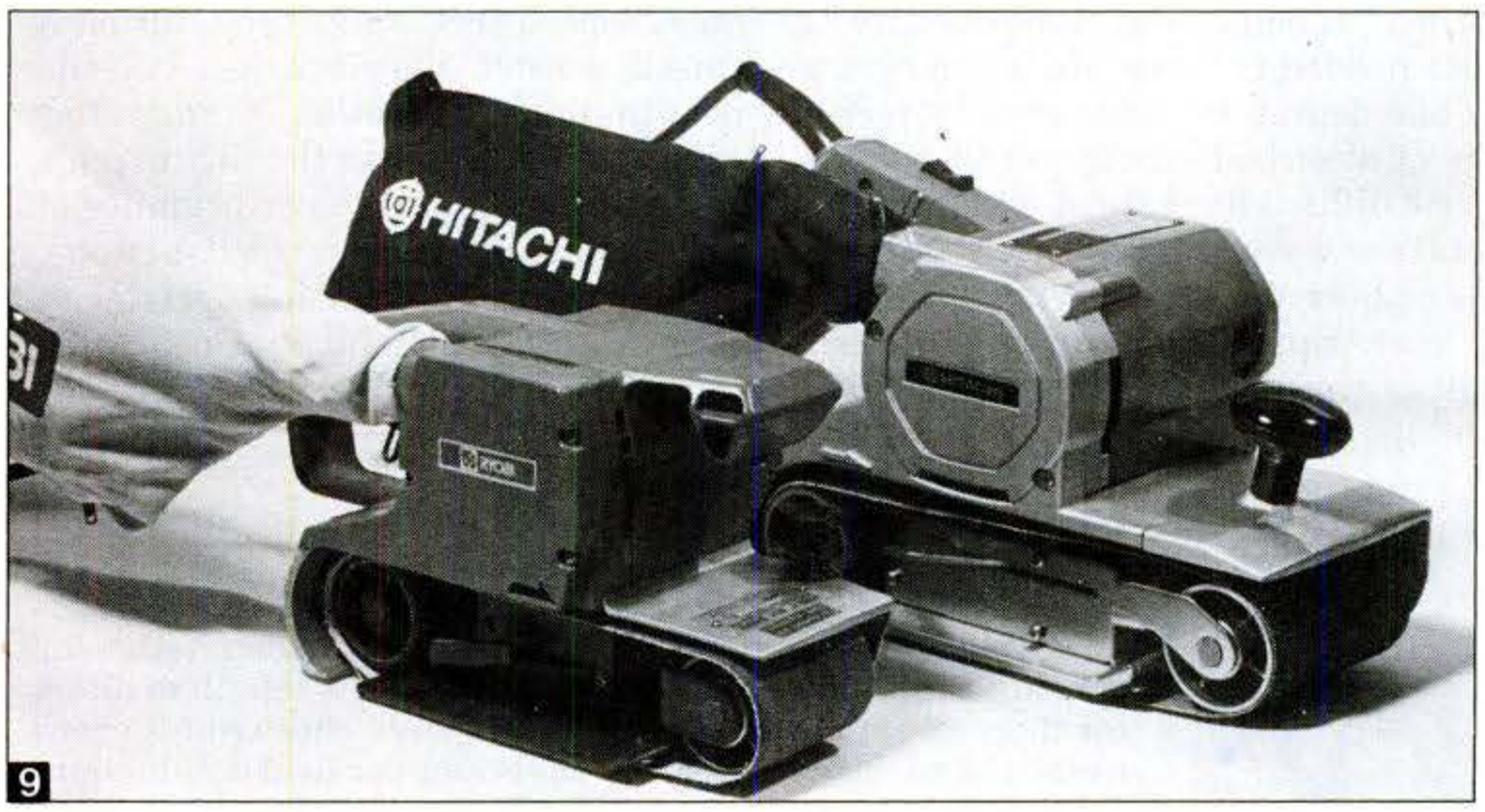

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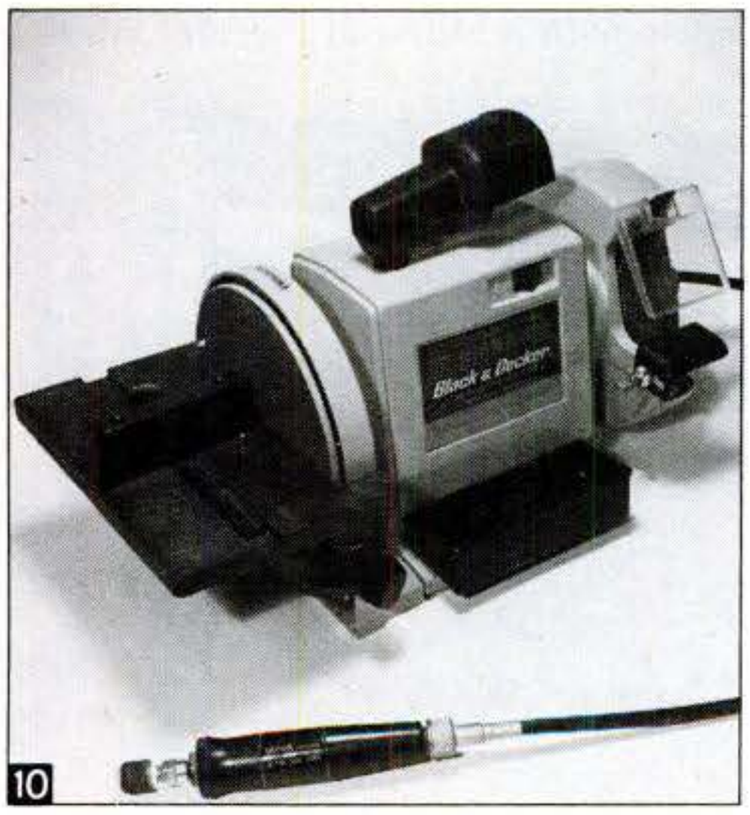

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8 Sanding-block machines, such as the Porter Cable (center rear), Makita (upper left), and Ryobi (front right), are really commercial tools and are surprisingly fast workers for their size. Black & Decker's new 4020-10 sander (lower left) has a dust-collection system that sucks up sanding debris, as does the Craftsman 9GT1068 (far right).

9 Big, powerful belt sanders, such as the four-in. Hitachi SB-10 (right) and Ryobi B-7100, handle work easily.

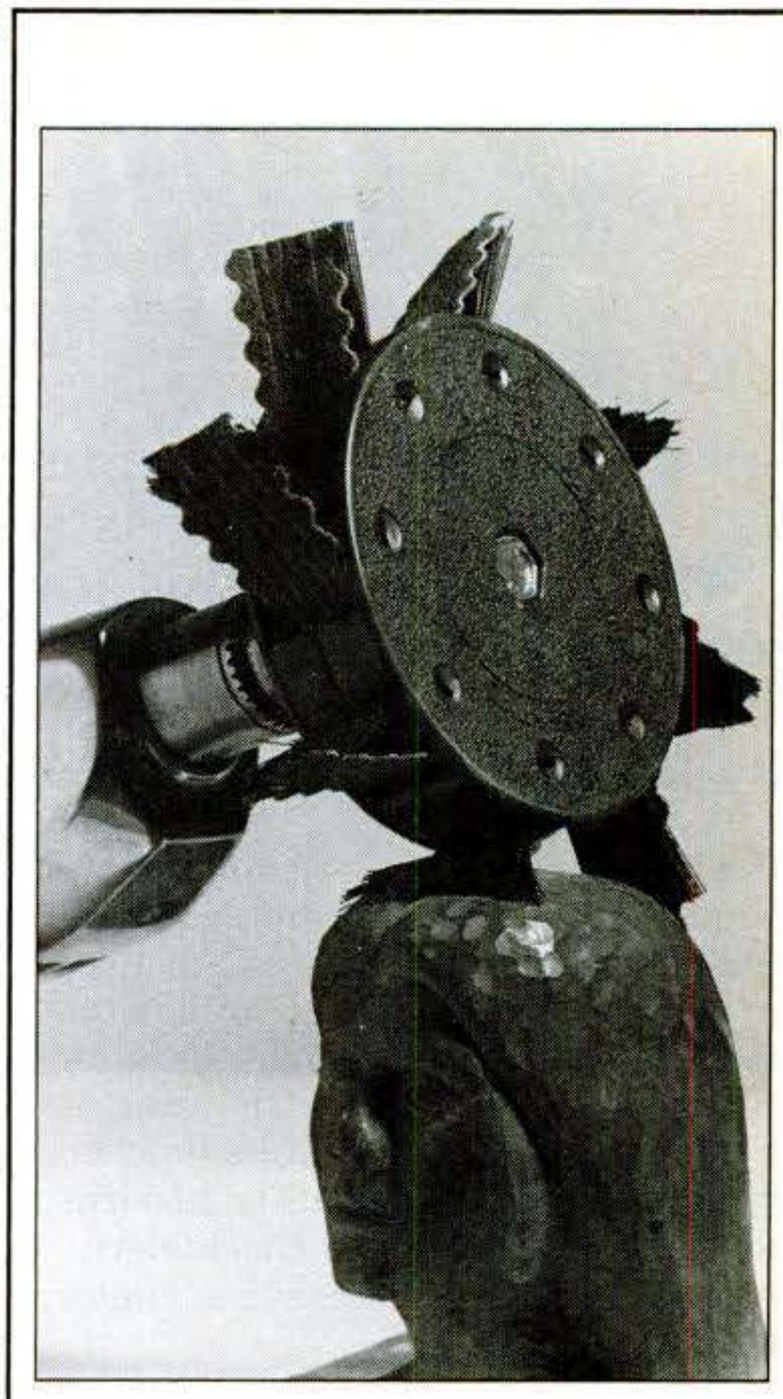
10 Sand, grind, or do fine flex shaft work with Black & Decker's Finishing Machine. The tool takes a six-in. disc, a five-in. grinding wheel, and—with special kit—a flexible shaft.

more per minute). They work fast and give swirl-free work.

Abrasive cords and tapes can sand and clean all kinds of turnings, on a lathe or off. Wide tapes are best on cylinders and straight tapers. The narrower cords and tapes are better on more-intricate work.

Combination shaver-sander tools are good for wood sculpture, and they double as auto-body tools. The tools come with blades for shaving and shaping wood, plastic, and soft metals. If you replace the blades with carbide-grit sanding plates, you'll be ready for coarse to medium sanding jobs. PS

SUPPLIERS OF SANDING EQUIPMENT
Black & Decker, 3012 Highwoods Blvd., Raleigh NC 27625 (finishing machine, $80, and 4020-10 sander, $161); **Clemens Custom Tackle,** Box 860, Wescosville PA 18106 (abrasive grit); **Conover Woodcraft,** 18125 Madison Rd., Parkman OH 44080 (inflatable drum, $75); **Leichtung,** 4944 Commerce Parkway, Cleveland OH 44128 (wide sanding tapes, $12 for three-roll set, and smaller tapes and cords); **E.C. Mitchell,** Box 607, Middleton MA 01949 (sanding cords and tapes); **Porter Cable,** Box 2468, Jackson TN 38301 (power paint-remover disc sander, $240); **Shopsmith, Inc.,** 750 Center Dr., Vandalia OH 45377 (kit of two-in. sanding drums with 24 sleeves, $24); **Woodcraft Supply,** 41 Atlantic Ave., Box 4000, Woburn MA 01888 (Sand-O-Flex, $19).



Eight strips of abrasive on Flap Sander, backed by tufts of stiff bristles, conform to almost any contour. They make short work of jobs you once had to do by hand.

Flush flap sander

Anyone who hates sanding must love brush-backed flap sanders. That's why Merit Abrasive's Sand-O-Flex has been one of my favorite tools for sanding contours and stripping paint and rust.

Now 3M has entered the field with a similar tool that has a few advantages over my old standby. First, the Flap Sander is cheaper: about $15 versus $19. Second, it's lighter and easier to handle in an electric drill. And third, because of its flat end plate, it can sand almost flush into a corner. (The adjusting knob on Sand-O-Flex protrudes from its end plate and makes flush sanding more difficult.)

Unlike the Sand-O-Flex, which uses an eight-arm, octopus-like roll of abrasive cloth, the 3M Flap Sander uses eight individual strips.

Abrasive costs? Sand-O-Flex refills cost more (about $4.60 a roll versus $3.75 for eight 3M strips), but each roll contains about twice as much abrasive cloth, so the edge here goes to the old-timer. Finally, the Flap Sander has almost no tendency to grab the work. And if your hands contact the whirling abrasive, about all you get are smooth fingernails.—*A. J. Hand*

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Tiling for passive

Ceramic tile is a natural choice for flooring in a passive-solar structure, such as this add-on sunspace to a fieldstone house, because of its ability to store and conduct heat. However, when tile is to play an energy role beside its decorative function, there are some important things to keep in mind.

By DANIEL RUBY

The floors of passive-solar buildings are frequently used for thermal mass. An add-on greenhouse built on a poured or concrete-block slab thus avoids the need for water drums, rock beds, or internal masonry walls. However, it is important that the floor be finished with material that readily absorbs heat and conducts it to the underlying mass. The common-sense choice is ceramic tile.

Depending on the color and density (but not the finish or glaze) of the tile, performance will vary considerably. Major tile manufacturers specify the following thermal characteristics for their products: absorptance (the percentage of incident solar energy absorbed); specific heat (the quantity of heat needed to raise tile temperature by one degree F); emittance (percentage of absorbed energy reradiated as heat); diffusivity (rate at which a temperature wave progresses through the tile); thermal conductivity (quantity of heat transmitted through tile per unit of time); and thermal expansion (change in size of tile with change in temperature). Suitable tiles for passive solar have absorptance and emittance of around 80 percent.

Not all sunspaces can be built over concrete. Architect Jeff Milstein's add-on sunspace [PS, May '82], built on a raised wooden platform, used a tile floor to supplement other thermal storage. The drawings on the facing page show the comparative performance of three common tile-floor constructions.

For more information, write to American Olean (Publicity Dept., 1000 Cannon Ave., Lansdale, Pa. 19446) for booklet 1960. PS

Dark colors are best, but medium shades of tile (like these blue-brown Primitive Encore tiles from American Olean) can be sufficiently absorptive for solar applications. Shuffling boxes of tiles before laying (1) ensured a scattered color scheme. Slightly larger-than-usual joint was left (2) to allow for thermal expansion. Random tiles were checked for evenness of bond (3) because air pockets hamper heat conduction. Floor was laid so that cut tiles abutted rear stone wall (4), which provides greenhouse with additional thermal mass.

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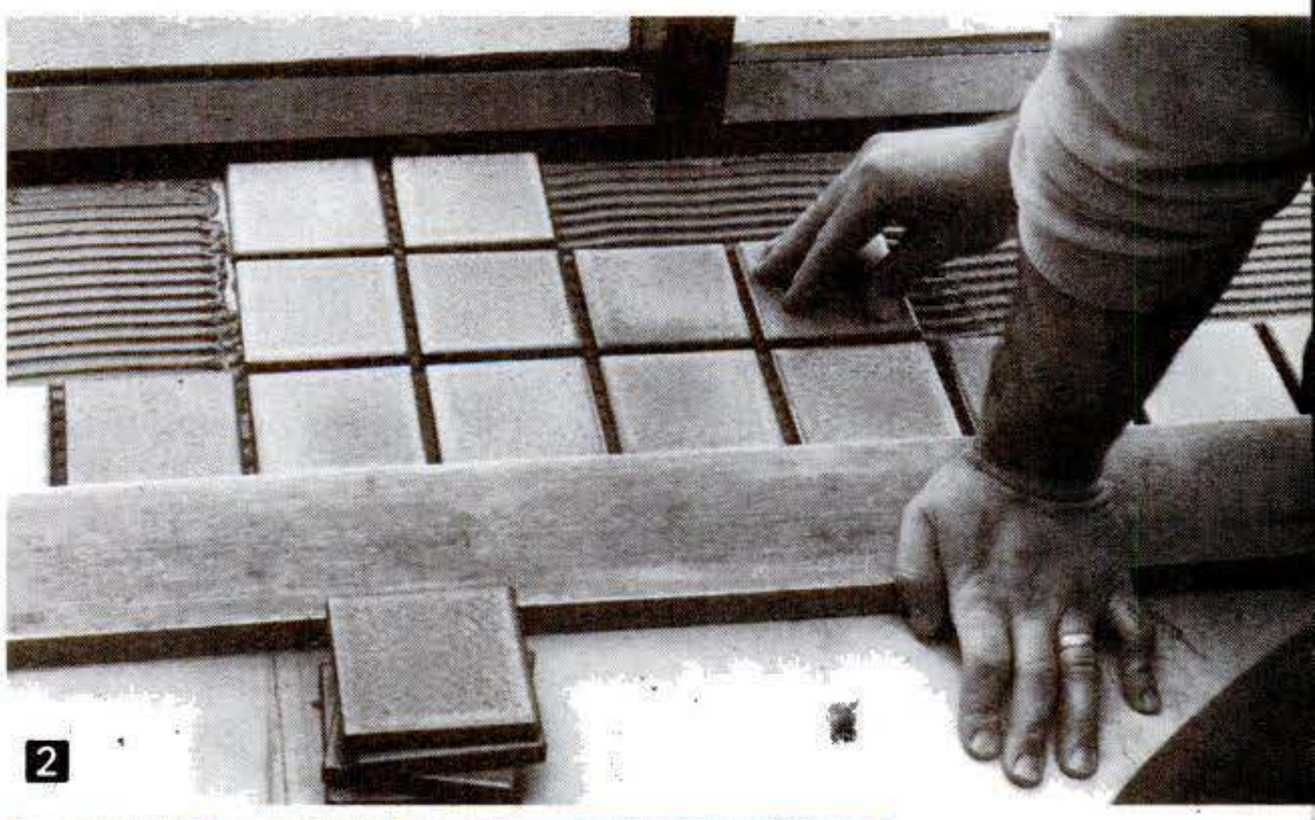
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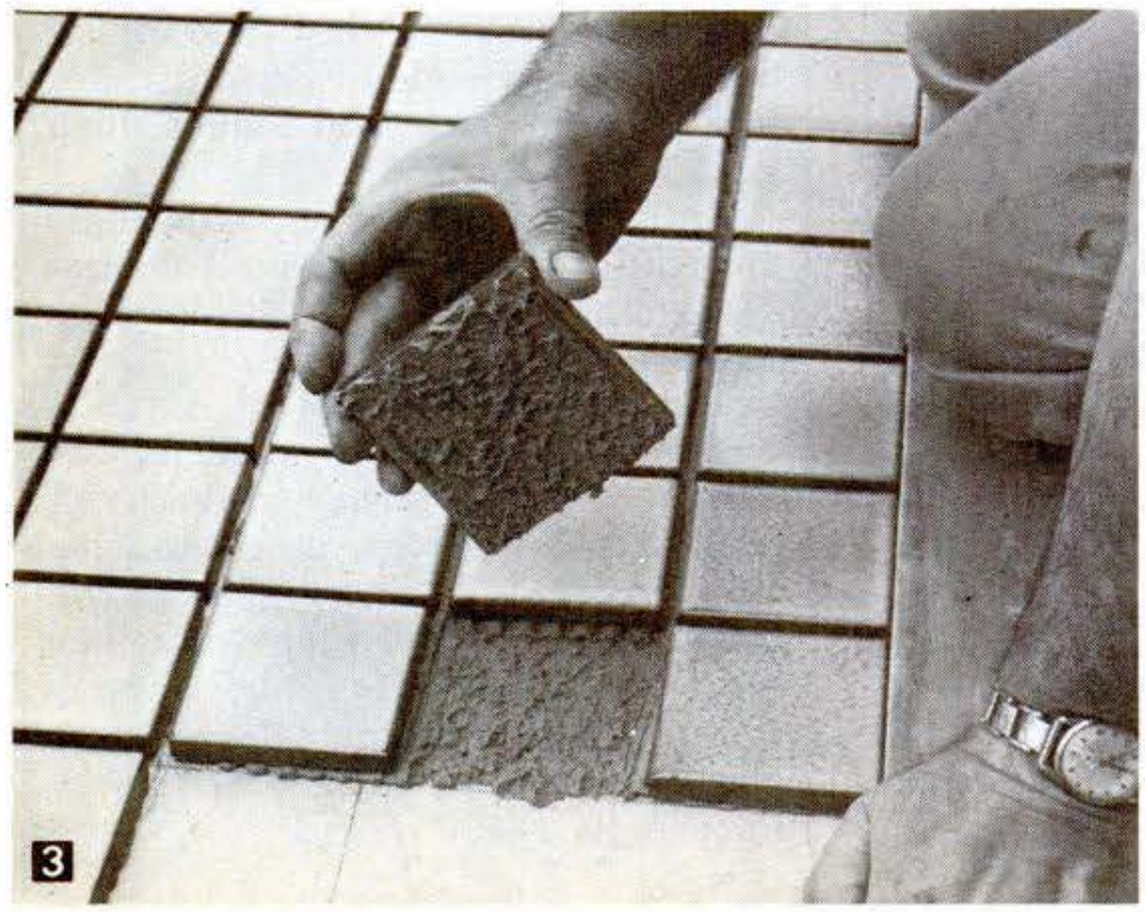
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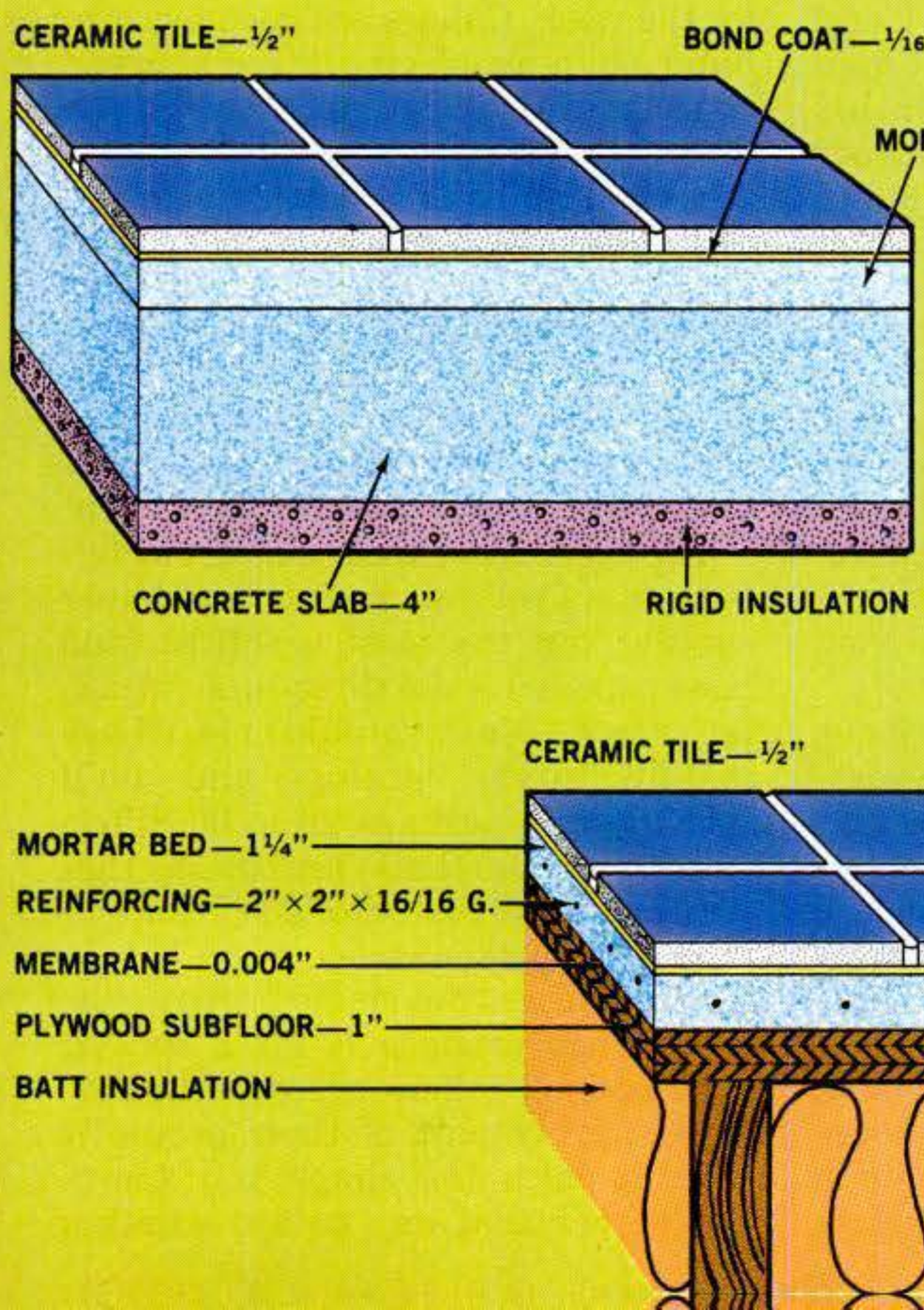
solar

Sunspace for fieldstone house was added over existing patio after reinforcing and leveling. Tile readily conducts heat between slab and room air.

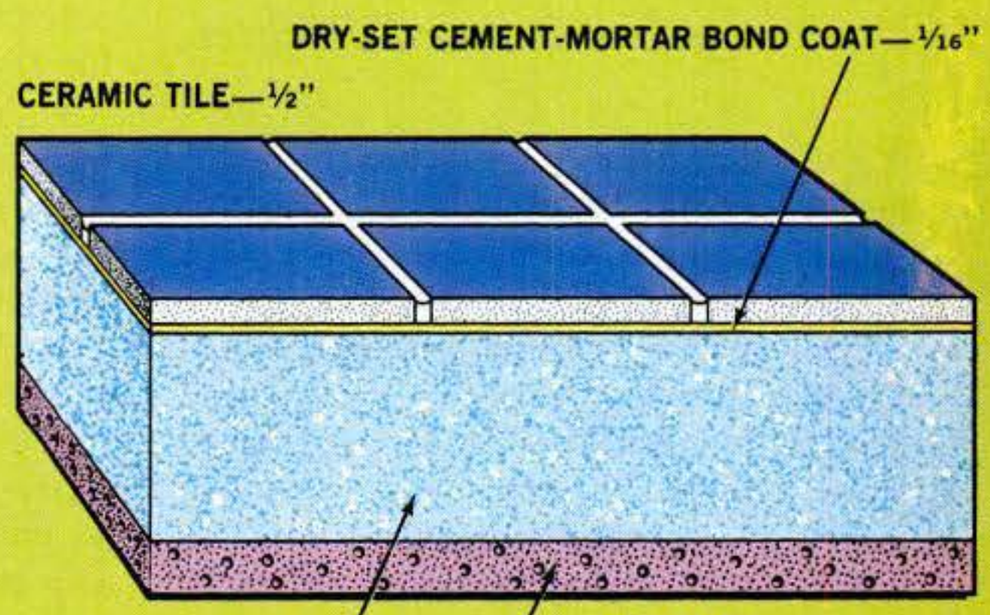
ILLUSTRATIONS BY GERHARD RICHTER



CEMENT MORTAR BONDED

THERMAL CAPACITY (Btu/sq. ft./deg. F): 12.5

THERMAL DIFFUSIVITY (sq. in./sec.): 0.00110



DRY-SET MORTAR BONDED

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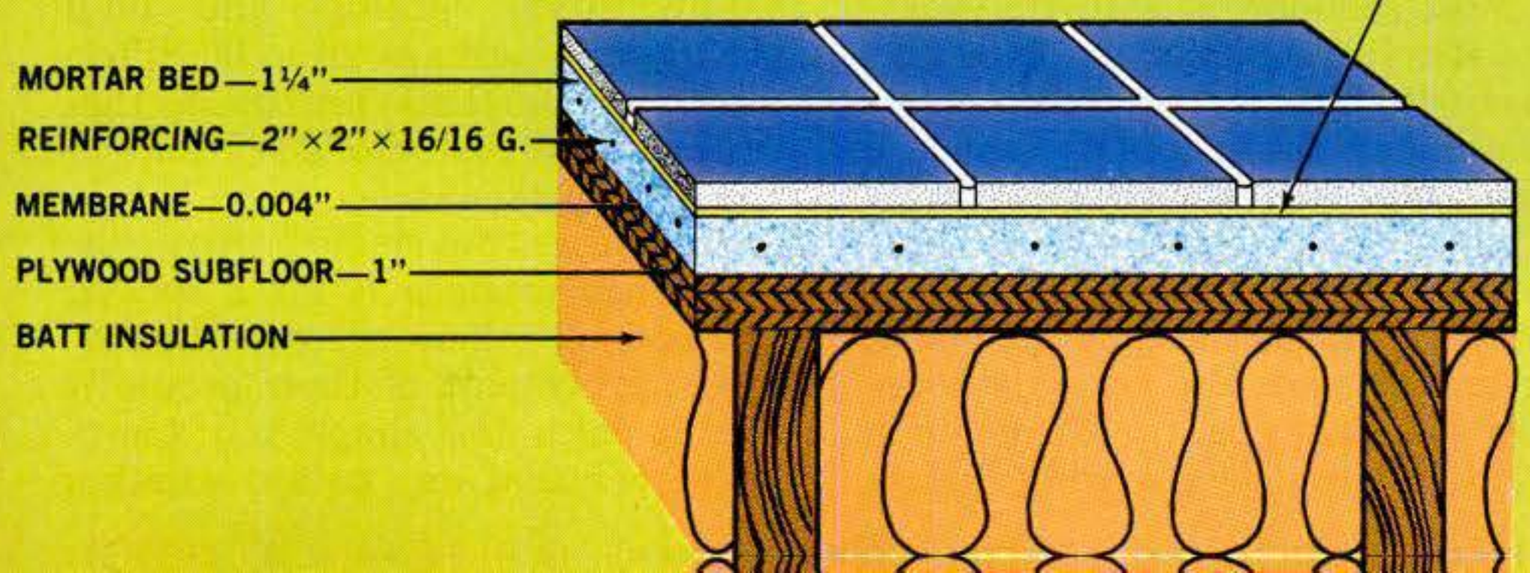
THERMAL DIFFUSIVITY (sq. in./sec.): 0.00108



CEMENT MORTAR ON WOOD SUBFLOOR

THERMAL CAPACITY (Btu/sq. ft./deg. F): 4.2

THERMAL DIFFUSIVITY (sq. in./sec.): 0.00128

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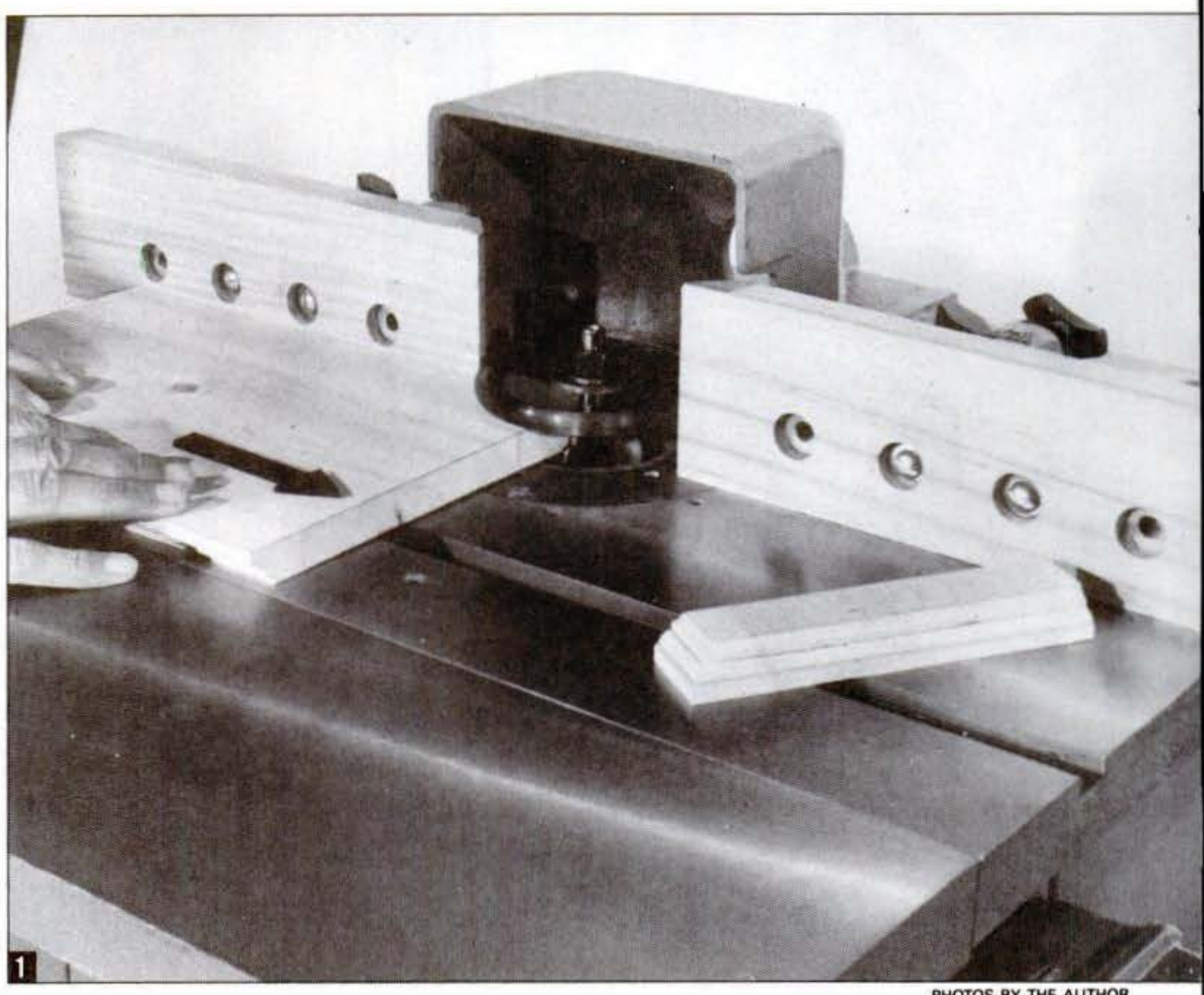
Shapers are for

Many people think of a shaper as a professional luxury. But consider how many ways a shaper can be used in a home workshop. Dozens of joints and smooth forms come easy to it. And for cuts that can't be made conventionally, there are special guides and custom-made jigs. Once you've run through this tool's expanded repertoire, you'll wonder how you ever managed without a shaper. But a prospective buyer needs to know what features to look for—such as easily changed and adjusted spindles and a powerful, high-speed motor.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PHOTOS BY THE AUTHOR

By R. J. DE CRISTOFORO
Drawings by Gerhard Richter

It's a mistake to label the shaper a tool only for professional cabinet shops. It can be as useful to you as a table saw or drill press.

Look around your home, and you'll discover myriad professional joints and smooth forms that can be duplicated on a spindle shaper:

- Lips on cabinet doors.
- Rail and stile joints on wood doors and windows.
- The hinged joint on a drop-leaf table.
- Decorative edges on table tops, chair backs, and cornices.
- Structural and decorative wall moldings.

Basically, a shaper is a power tool in which a spinning cutter of simple or complex design (see sketches) grooves or shapes the edge of a wooden workpiece moved past it on the tool's table. It must be structurally hardy (and most are) because it has to run at high speeds and withstand considerable side thrust without damage. A shaper for the home shop also should have:

- A vertically adjustable spindle for maximum control of cutter height.
- Interchangeable spindles so you can use a variety of cutters.
- High speed (about 10,000 rpm).
- Plenty of power (½ hp minimum, ¾ to one hp preferred).
- A reversible motor—often required by the job but also important so you can get more versatility from any cutter you buy.

Of the four principal ways to shape, the most common is with the workpiece steadied against the fence that comes with the tool. It is adjustable as a unit and has in-feed and out-feed facings, separately adjustable. Always use the fence for straight-line shaping.

A second way to use the shaper is with the work against collars. Collars, used under or over the cutter (or both), do two jobs. They control the depth of the cut and provide a bearing surface for the work. Collars are good for freehand shaping of circular or curved edges that can't be supported by the fence.

Special guides for particular types of work offer a third way to shape. One example, an adjustable V-block, is shown in the photos.

And last, you can use custom-made jigs for cuts that can't be made conventionally. An example: the 45-degree miter-and-chamfer jig shown.

There are more than a dozen different cutters you can mount on a shaper spindle, but the most practical (and most popular) is the three-lip solid cutter with a ½-inch spindle hole. Check manufacturers' catalogs, and you'll find these in perhaps 20 to 60 different shapes. You'll also see options that you can have custom-made—that is, profiles of personal design.

Some cutters are single-purpose (the shape they produce is for a specific kind of job); others are combination cutters (only part of their profile is used to form the shape you want). Remember that any cutter, whether

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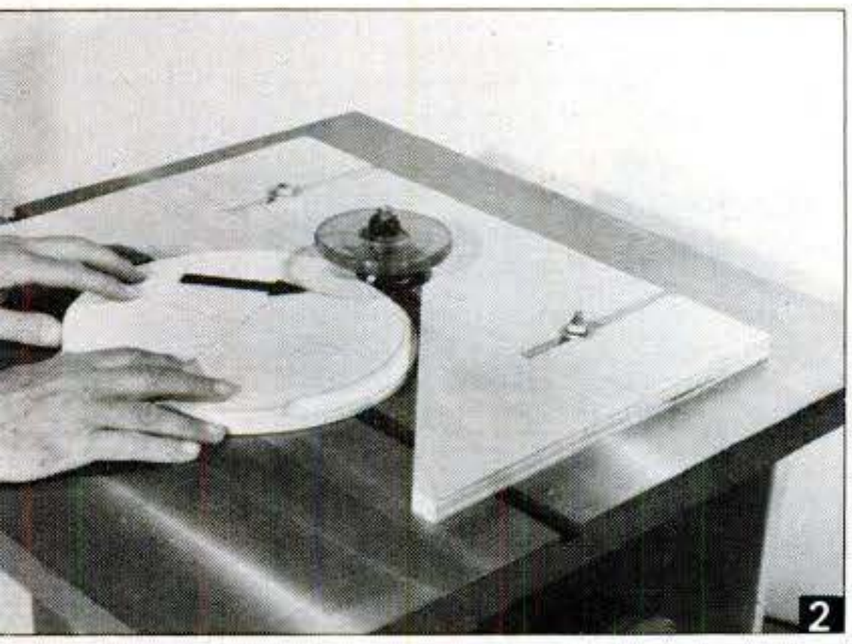
home shops, too



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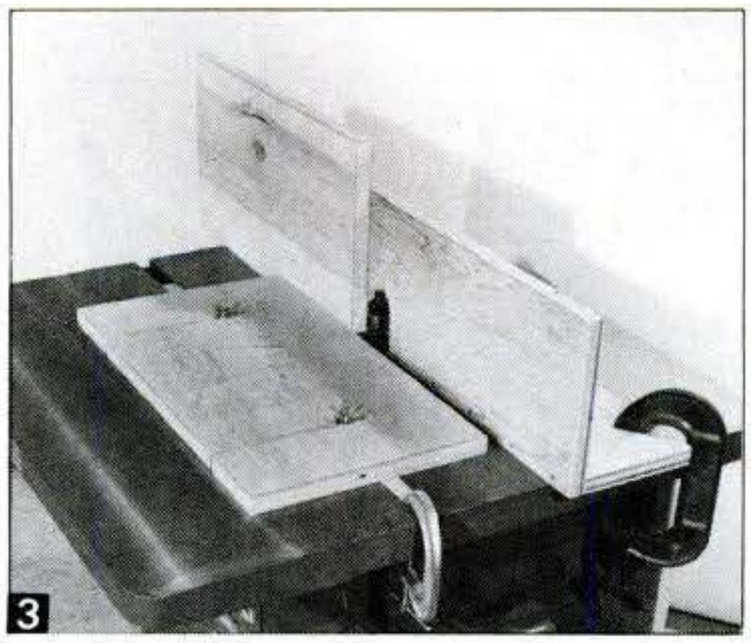

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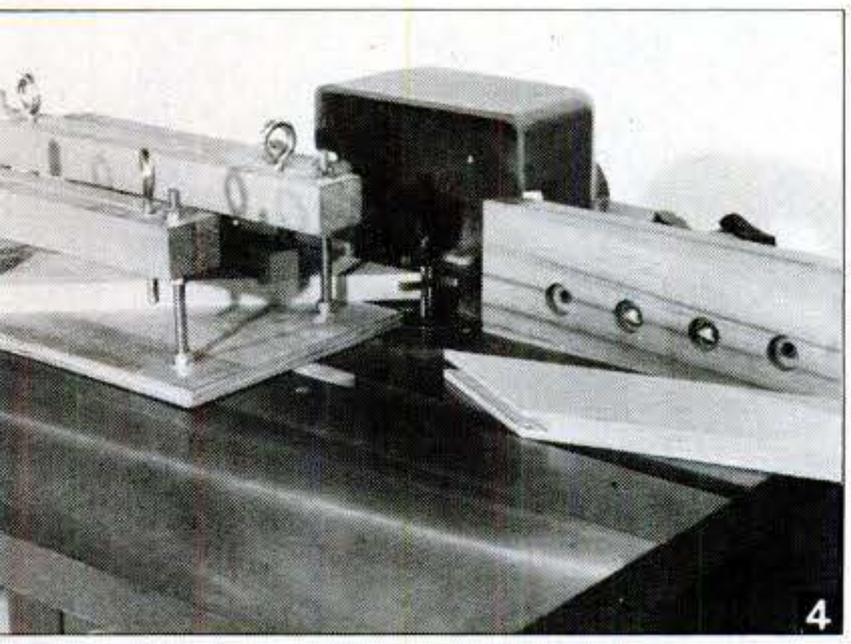

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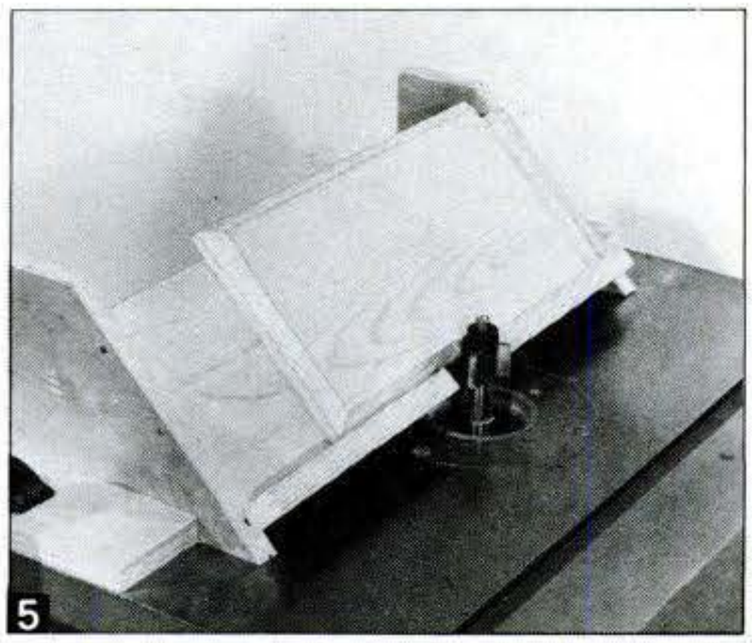

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Slow and easy does it as the work is firmly fed against the cutter (1); the block in the foreground is a return, or end cut. An adjustable V-block (2) aids in edge-shaping a number of similar circular pieces. Short bolts, used in the table's threaded holes, will hold the jig. A special high-rise fence (3) provides optimal support for wide stock. Shaping work on miter cuts goes easier with the angle guide in place (4). Here, parts are being grooved for a spline assembly. On such jobs, the jig can be made to handle wider work by removing the forward, left-hand post. The same jig works for chamfering (5). Cutters may be single-purpose or combination types (6), which can be used in a variety of ways.

single-purpose or combination, can be used for a partial or full cut, depending on the shape you want. Examples of single-purpose cutters include: glue joint, drawer joint, door lip, table edge, multi-bead, and panel raiser. Examples of combination cutters include: half and quarter round, cove and bead, quarter round and bead, and cove and quarter round. There are also matched sets of cutters, among which are tongue and groove, flute and nosing, drop-leaf-table joint, and cabinet set.

The shaper is a high-speed machine, but that doesn't mean you should rush the cut. A steady feed—only as much as the cutter can handle without protest—is best. If you have a light-duty machine and are making an exceptionally deep cut, there's nothing wrong with whittling down to the final

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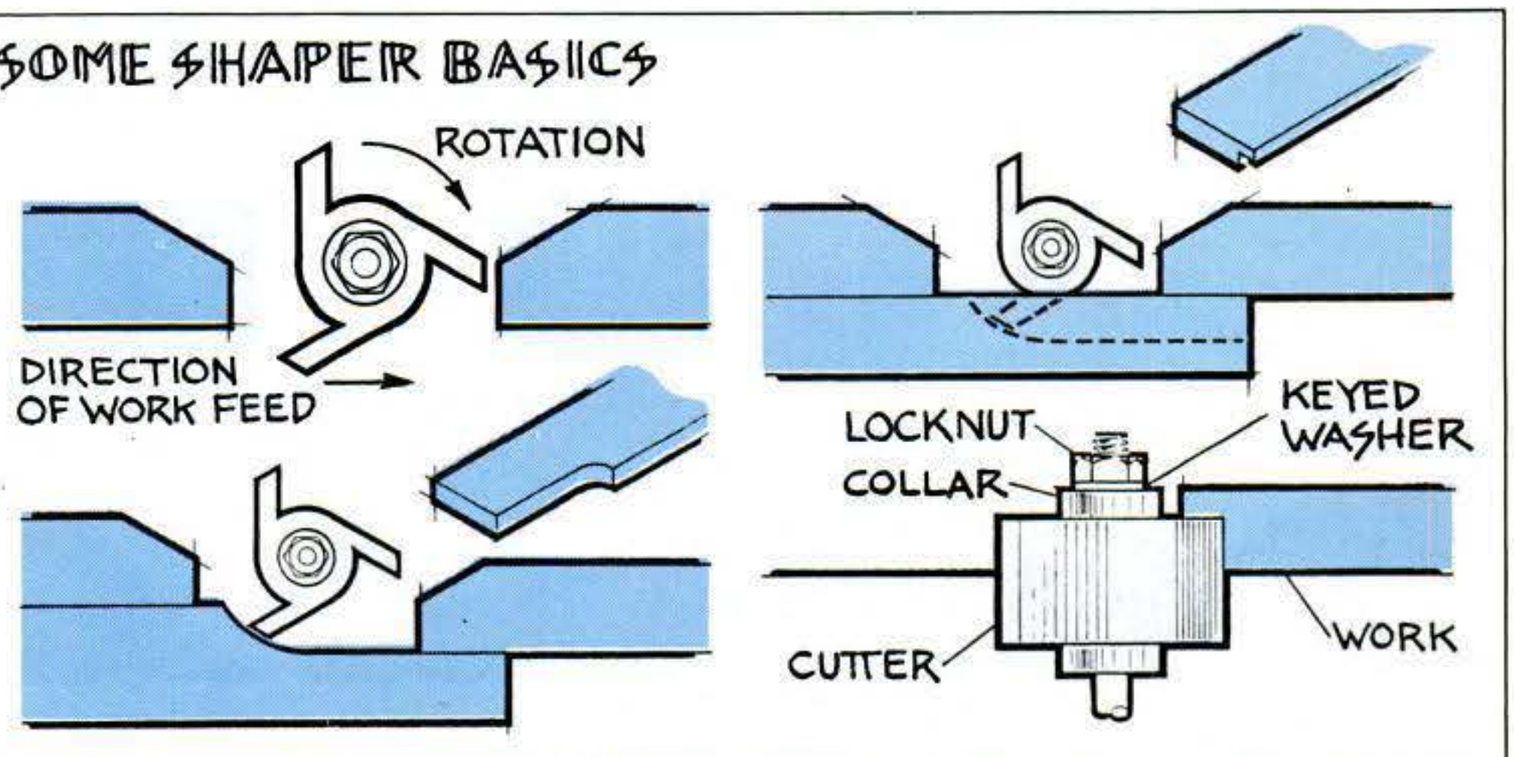

Shaper basics: Work should always be fed against the cutter's rotation. When the entire edge of the stock is to be removed, the out-feed fence should be adjusted to provide support for the workpiece after the cut has been made. The fence surfaces should be set on the same plane if only part of the edge is to be removed. When shaping freehand, be sure the work has ample bearing against the collar, and use at least one fulcrum pin.

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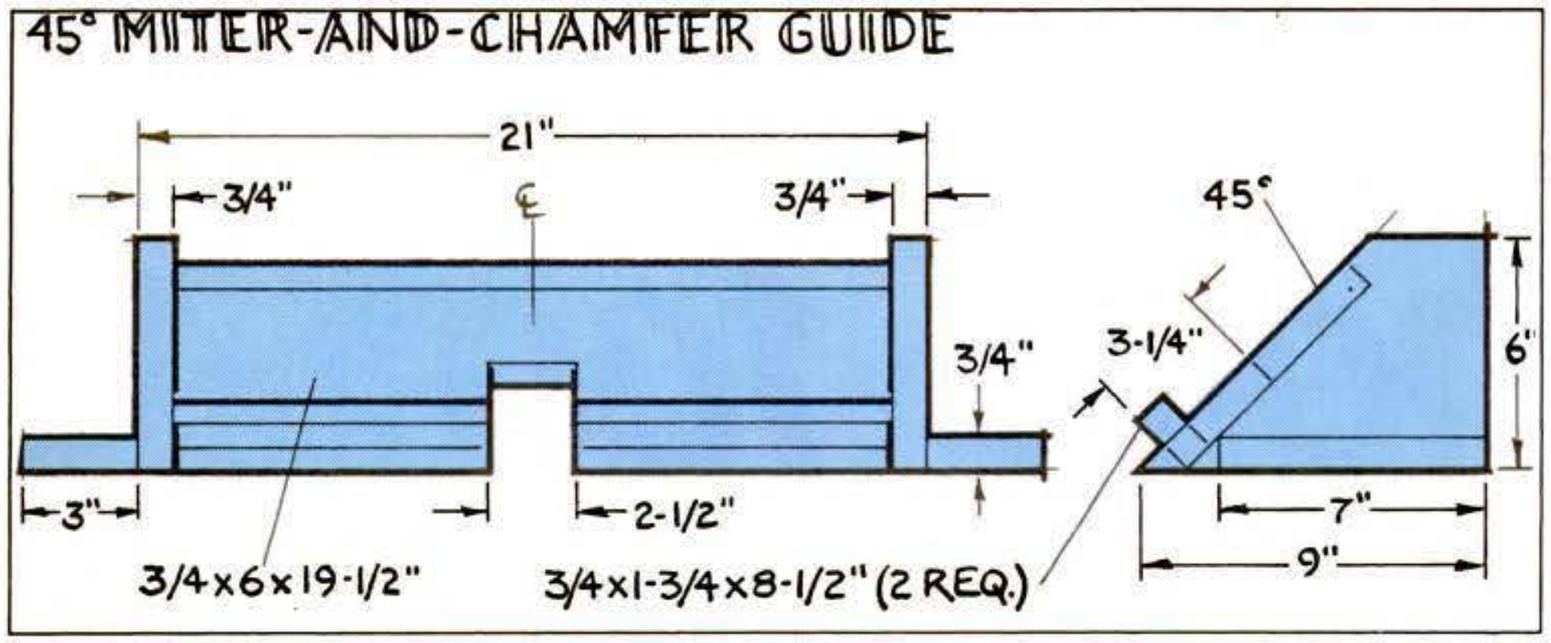

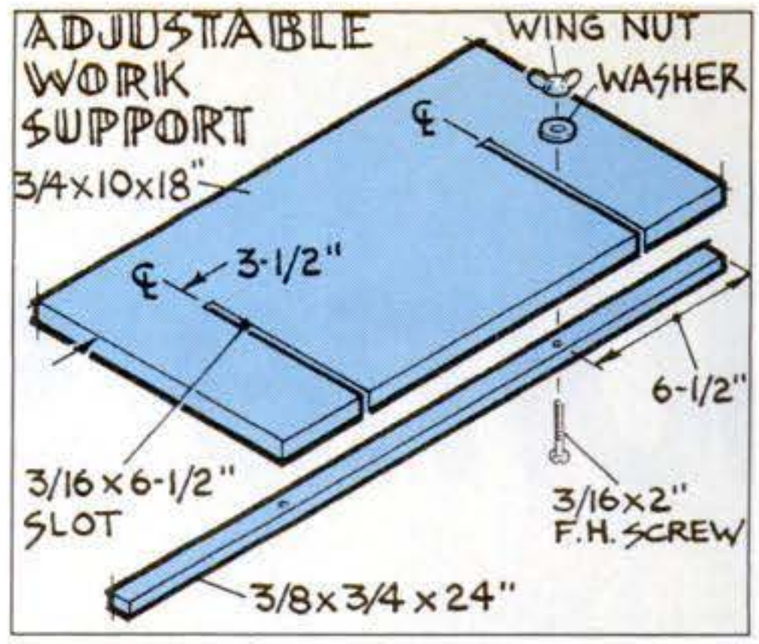

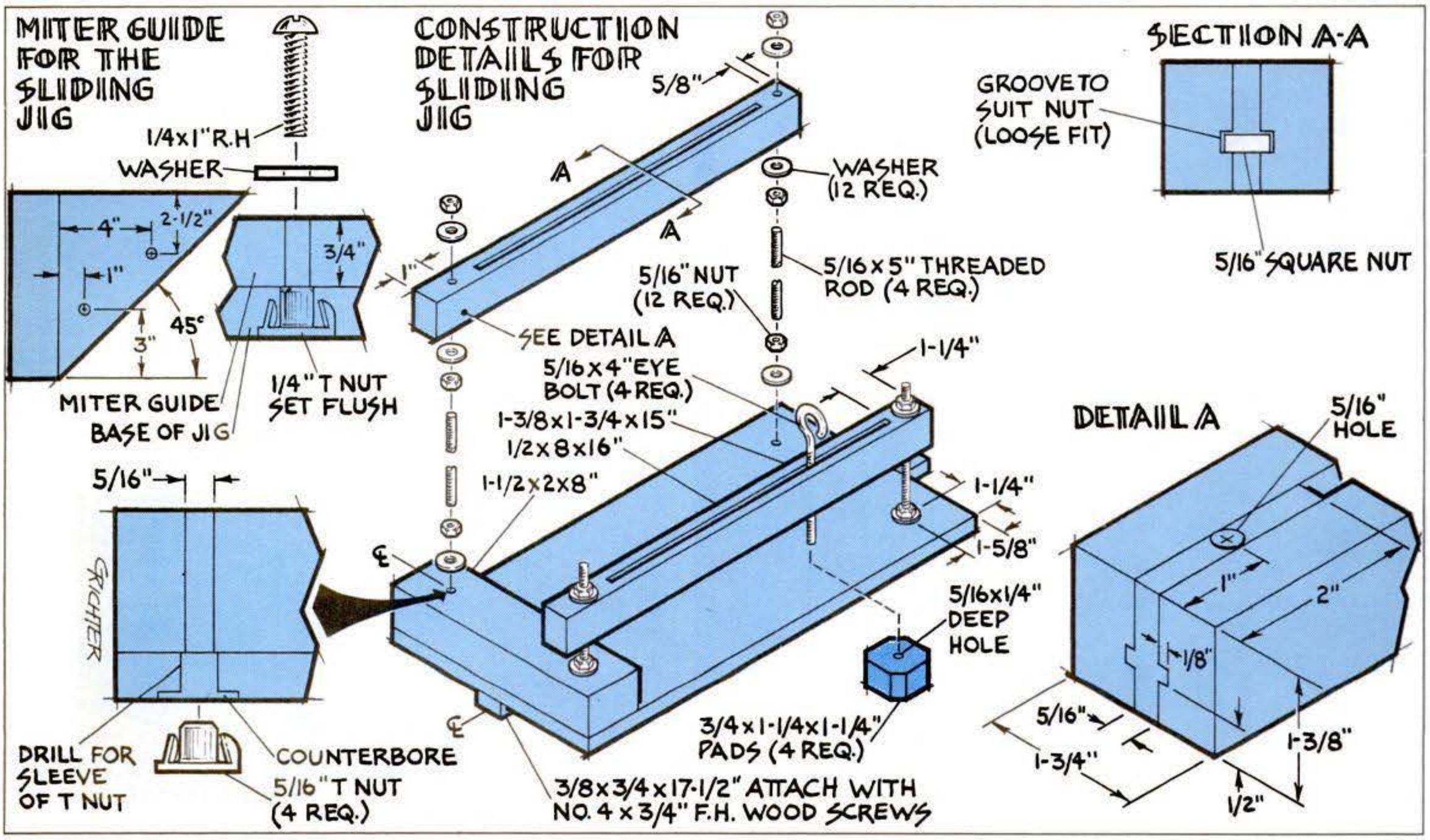

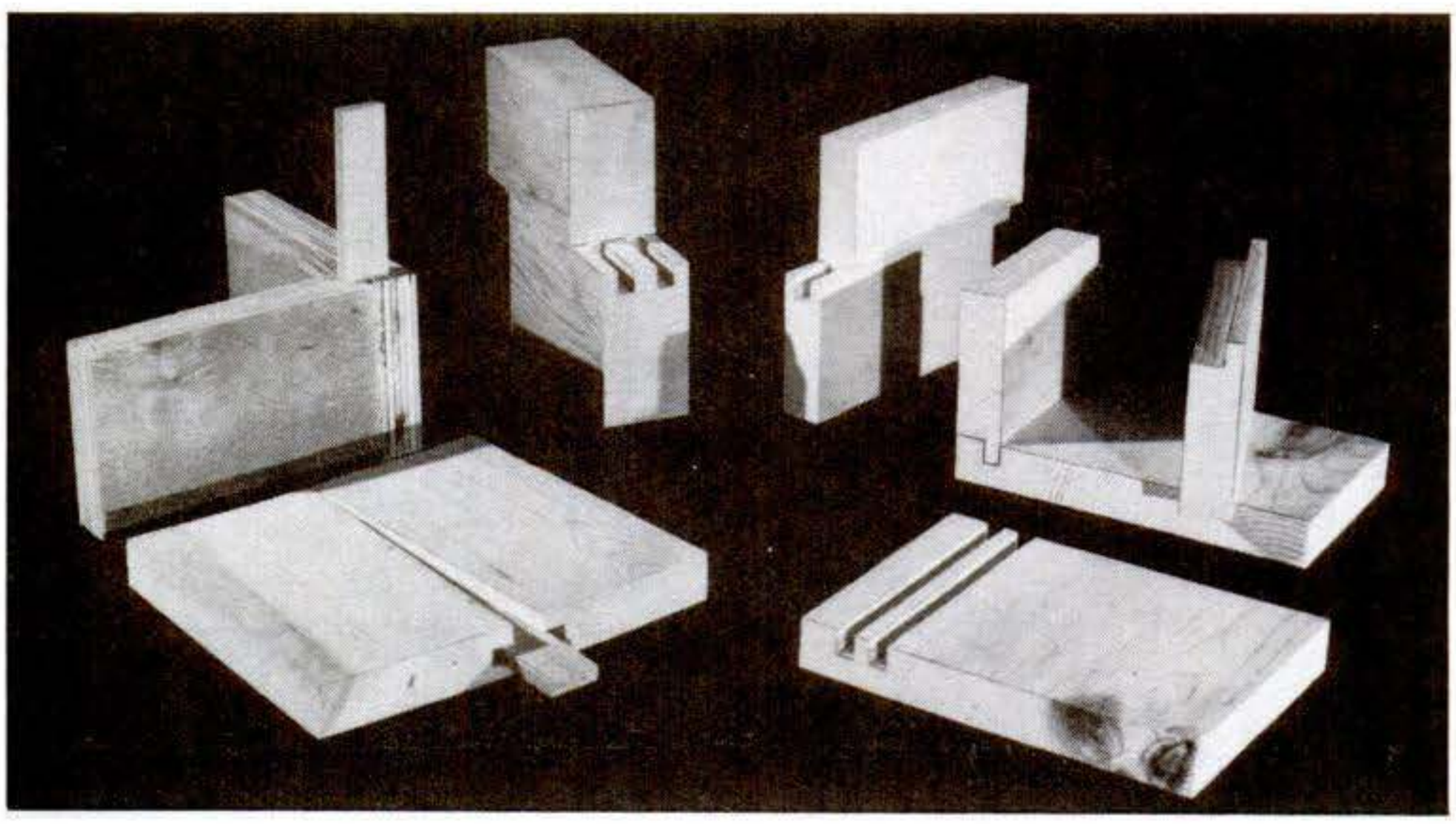

shape by making more than one pass.

You're likely to have some splintering at the end of the cut when end-shaping. This can be minimized by using a backup block. Or you can eliminate the problem by shaping a piece a bit wider than you need, then removing the waste material by sawing or jointing. When shaping four edges, do an end cut first and then work the remaining sides in a sequence that allows the last cut to be made with the grain.

Edges to be shaped must be in good

[Continued on page 184]

A wide variety of joints (top photo) was accomplished on a shaper with a single ¼-in. blank cutter. Clockwise from top: a double tongue-and-groove joint, single tongue-and-groove joint, dado rabbet, rabbet, double grooves for sliding doors, splined edge-to-edge joint, and splined edge-to-surface joint. Bottom photos: A set of matched cabinet cutters shapes the rail (coping cut, far left) and stile (left) for a door frame.

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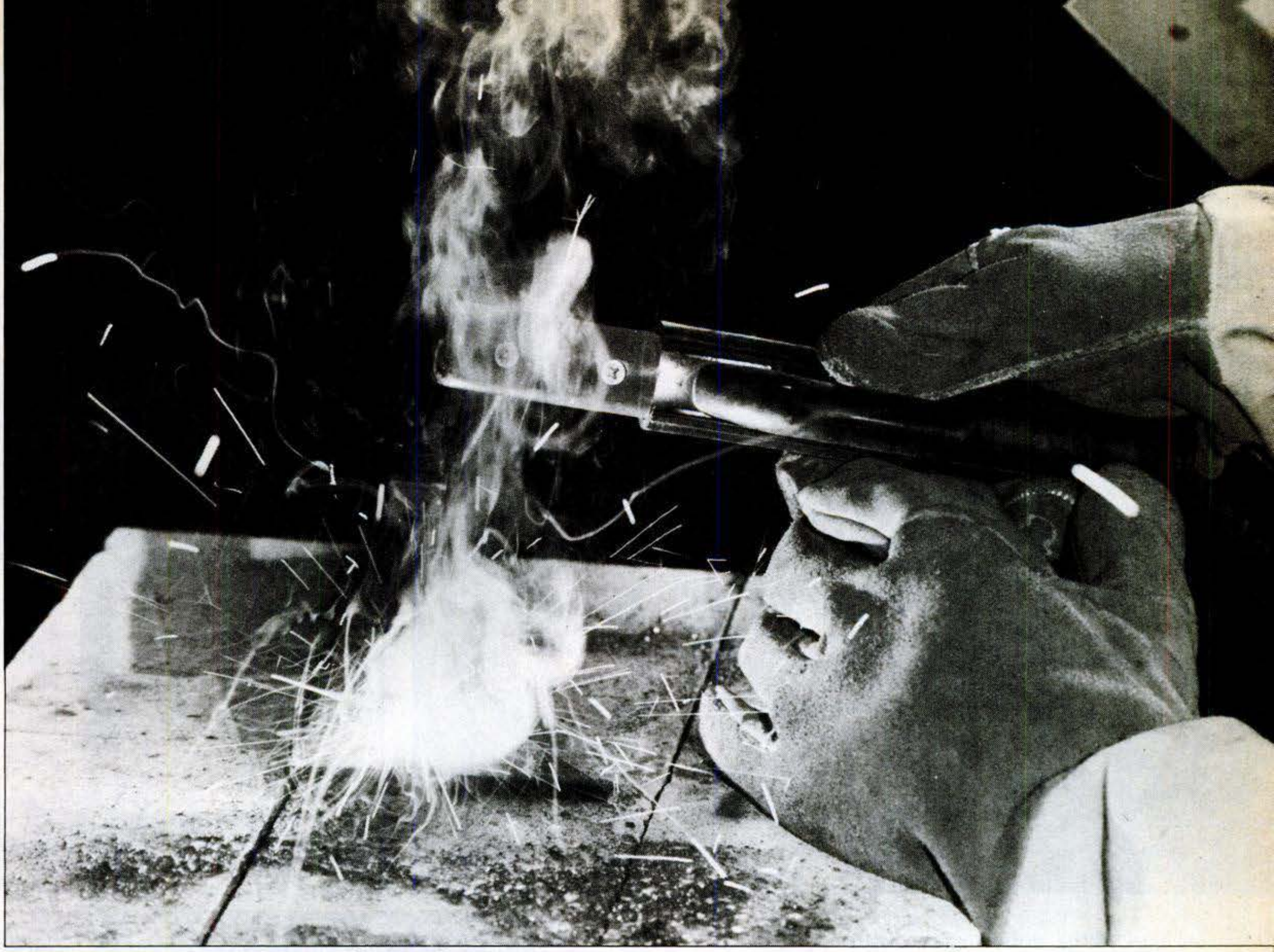

Arc welding is the best way to join heavy pieces of metal. The ¼-in. steel plate above is for a boat-trailer fitting.

Joining metal to metal

Soldering, brazing, and welding are the three basic ways of joining metal to metal. Each requires different equipment, ranging from a simple soldering iron ($12) or propane torch ($19) to an oxyacetylene welding outfit ($240) plus gas tanks ($276). Can you learn these techniques from a book? In most cases, yes—and they're even fun. But you should be aware of a few problems before you start. Above all, proper cleaning and the right heat source are critical.

By E. F. LINDSLEY

When you glue together a wood joint, you usually have to wait overnight before taking the clamps off. But when you solder, braze, or weld a metal joint, it's almost instantly solid. That's one reason why working with metal is fun: The job progresses steadily, without pauses.

You'll find that when you've learned to join metal together, many jobs that once seemed out of reach become routine. Soldering audio-component connections, brazing a cracked bicycle frame or fireplace tool, or building a wrought-iron patio table, trailer hitch, boat trailer, or child's swing set are a few typical metal-joining jobs that become easy with a little practice.

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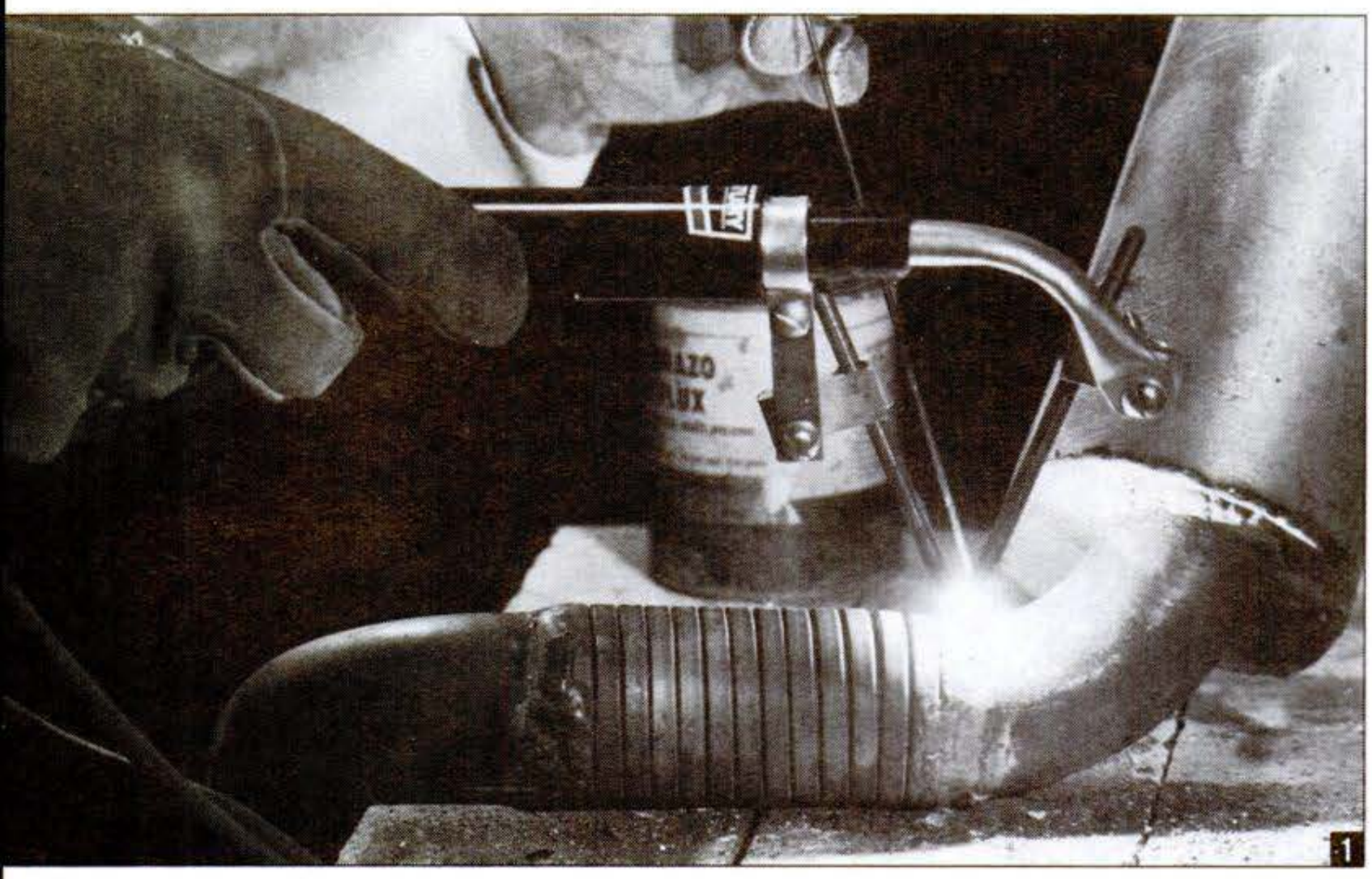
A carbon-arc torch (1) is the least-costly tool to supply adequate heat for a brazing job such as this. It's also great for bending, heating, and hardening and tempering. Arc heat is gentle; there's no blowing, as with a gas torch. MAPP gas or high-temperature propane torch (2) used for brazing might have a flame too ragged for a neat job; however, a wide flame on thin tubing generally works well. Oxyacetylene welding (3) is ideal for tacking parts or making small joints in thin stock. It provides a lot of control, particularly on metal such as this thin-wall tubing. The torch shown is of a small size—sometimes called an aircraft torch—but it's big enough for most jobs around the home.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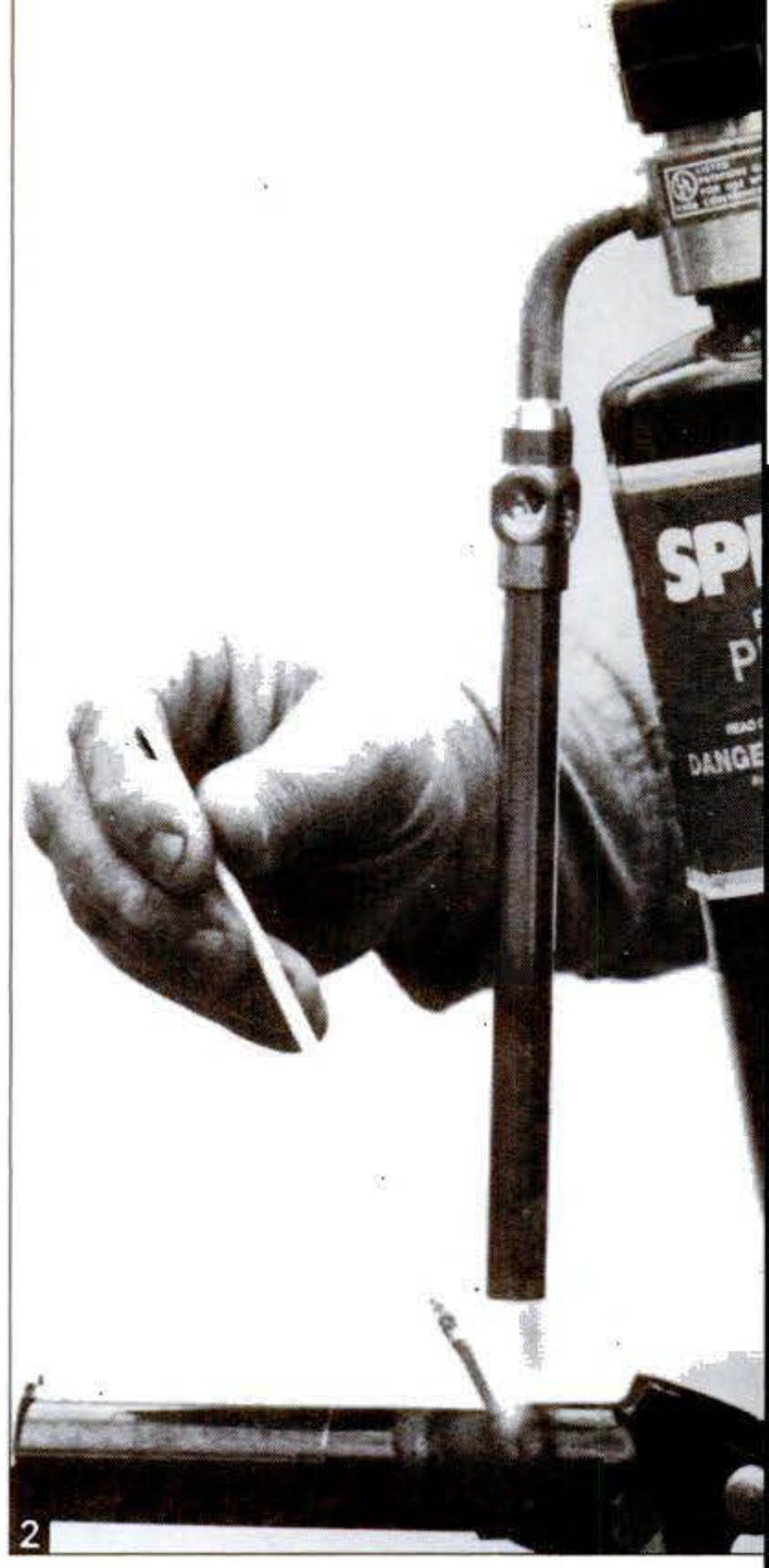
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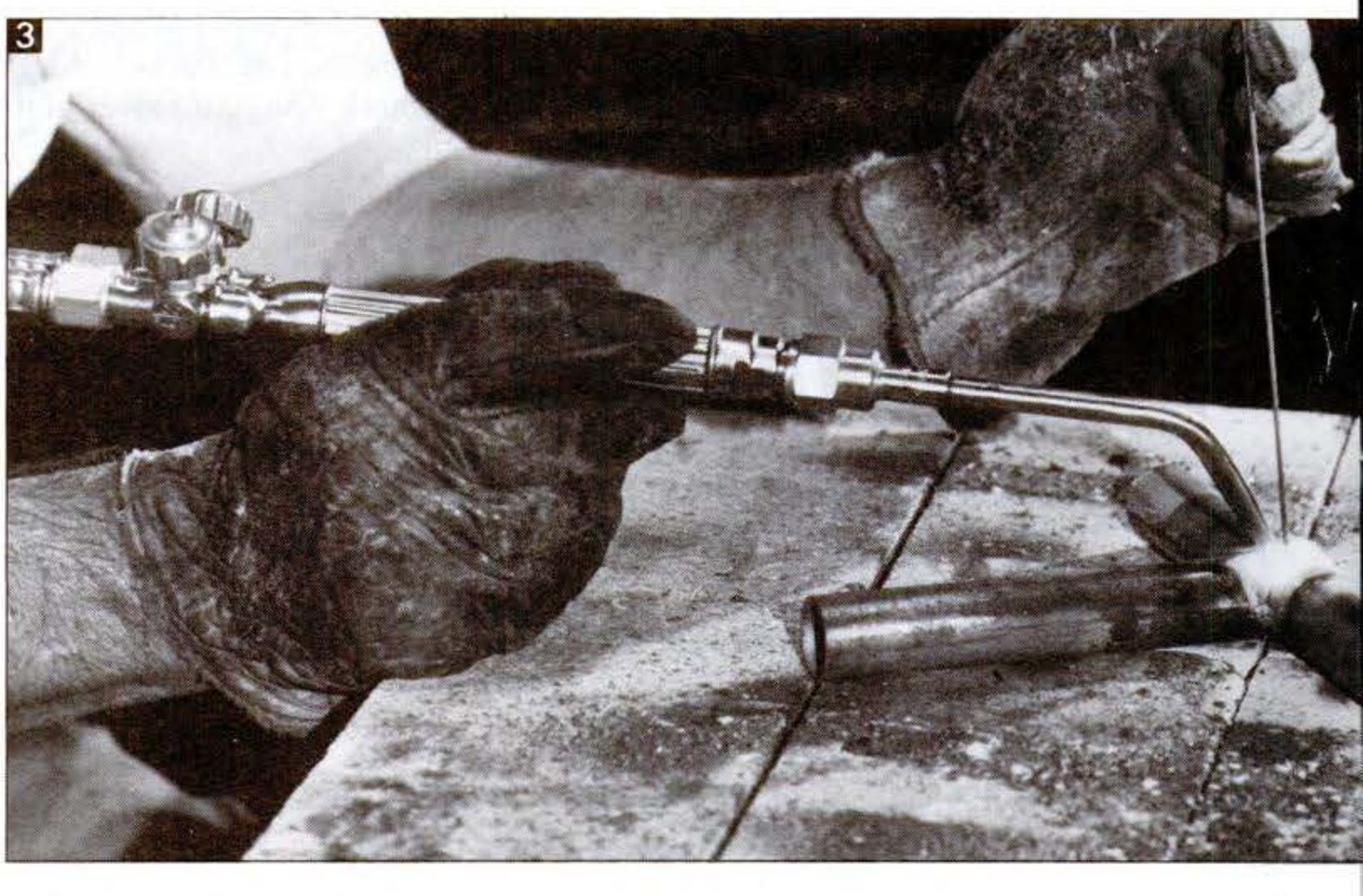
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Most of the skills you need can be self-taught, though detailed instructions are beyond the scope of this article. Once I've given you the basics, check your library and bookstores for books on the aspect of metal joining that most intrigues you. A good start is *Electric and Gas Welding*, which also covers brazing and soldering (available from Popular Science Books, Box 2033, Latham, N.Y. 12111). Learning techniques from a book won't make you a professional pipeline welder or equip you to execute exotic aircraft welds, but you can learn to make most ordinary metal joints.

Basic techniques include:

Soft soldering. You melt solder (a mixture of tin and lead, usually about half and half) so that it flows into the joint and adheres to the pieces being joined. The heat (from 350 to 450 degrees F) typically comes from a soldering iron, gun, or torch. Soldering works best on copper, brass, tin plate, and galvanized- and light-steel parts. Solder has excellent electrical conductivity and seals well, but it doesn't have much strength, so it's not for heavily loaded joints.

Silver soldering. Silver solder contains about four percent silver. It's stronger and stays brighter than soft solder, but it melts at the same temperature. Use it where extra strength is needed.

Brazing. You melt a bronze (copper-zinc) rod and let it flow into the joint much like soft solder, but the melting point of the rod is 800 to 1,000 degrees F. Brazed joints are relatively strong, often as good as a weld where great stress isn't involved.

Welding. You melt the pieces of metal together, usually adding extra metal from a steel filler rod or electrode. Welding makes the strongest joint in common steel. It requires high temperature—over 2,700 degrees F—from either an arc (electric) welder or an oxyacetylene torch with gas supply, gauges, and regulators.

How to solder

Soft soldering is the easiest metal-joining technique to learn, but you must remember three basics: cleanliness, flux, and heat.

First, the joint metal must be clean of grease, bits of insulation (in wiring work), and dull surface oxide that forms on metals.

Second, choose the right flux. Flux brushed on a joint acts to clean away

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oxide and keeps air from the joint so the solder wets the metal and flows smoothly. Some materials, such as galvanized iron or copper roof flashing, solder best with an acid-bearing paste flux. Such flux is also used for copper-tubing fittings, but don't use corrosive fluxes for electrical work: They spatter and cause long-term corrosion. Instead, use a resin flux and resin-core solder.

Your third important decision concerns what heat source to use. For copper tubing, a propane torch is ideal. Propane is also handiest for larger jobs away from an electrical connection.

For heavy jobs, use a husky soldering iron. About 200 watts handles most big jobs, but such irons are too clumsy for smaller joints and wiring. The best choice for average jobs around the home is a 125-watt soldering gun; it heats in a few seconds.

For building or repairing electronic equipment, you'll need one or two electric irons with small tips (25 to 45 watts) to work in tight places and confine the heat so you won't damage parts.

Soldering is easy. Start with a clean iron or gun tip. Clean it by wetting it with solder and wiping it with a damp sponge. Work the tip in solder and flux until it's fully tinned. The trick is to get good contact between the workpiece and the gun so the metal is hot enough to melt solder touched to it. Don't simply melt the solder and drip it on.

Your eye is the best way to judge a joint. The solder should appear to sink into the joint. There should be smoothly blended edges where solder meets metal. Remove the heat and allow the joint to cool; but remember, it's easy to ruin a solder joint by letting the parts move while the solder is still soft. Experienced solderers rig up clamps or holders to secure parts.

Brazing

You can braze almost any steel or cast-iron part, from a heavy garden-tractor casting to the tiny snaps on a purse. Heavy castings or thick pieces of steel should be ground to form a 60-degree V-channel almost to the center of the pieces to be joined. Leave enough metal, however, to match broken edges.

You can buy a flux-coated rod, but my experience has been that a plain rod used with borax flux does just as well (sometimes better, because you can sprinkle flux into the joint). Just before using the rod, coat the tip by heating it for a few seconds and then dipping it into the flux.

To braze a joint well, the heat source must match the job. In recent years, much attention has been given to superhot propane and MAPP torches. Such torches handle only light brazing, such as thin tubing or conduit. Their major drawback is that they must be operated wide open; instead of a neat, pinpoint flame, you get a broad, ragged flame that might put heat everywhere but where you want it. MAPP-oxygen combination torches provide a better flame pattern, but they use expensive oxygen at a high rate and can't deliver the sustained heat needed for brazing castings or large joints.

Carbon-arc or oxyacetylene torches are the two most reliable heat sources for large brazing jobs. Either one gives you flame control and more than enough heat.

Brazing light metal is as easy as soldering. After cleaning the joint, simply warm it with the torch, sprinkle on a little flux, and start heating. When the flux has melted and formed a glassy surface, the metal is hot enough. Touching the rod to the surface should produce a puddle of molten brazing metal. The metal will follow the heat, so lead it along and add rod material as needed. Watch for a smooth flow and even penetration of the joint.

Beginners often use too much heat—the braze metal starts to bubble and skitter on the surface. This indicates that the zinc in the rod is burning out. If it starts bubbling, let the metal cool, clean the joint, and start over using a little less heat.

You can use the same technique, with a couple of exceptions, on castings with deep V-joints. Because cast iron is a brittle metal, expansion and contraction under the torch can cause cracking. To reduce this tendency, warm the casting evenly over a large

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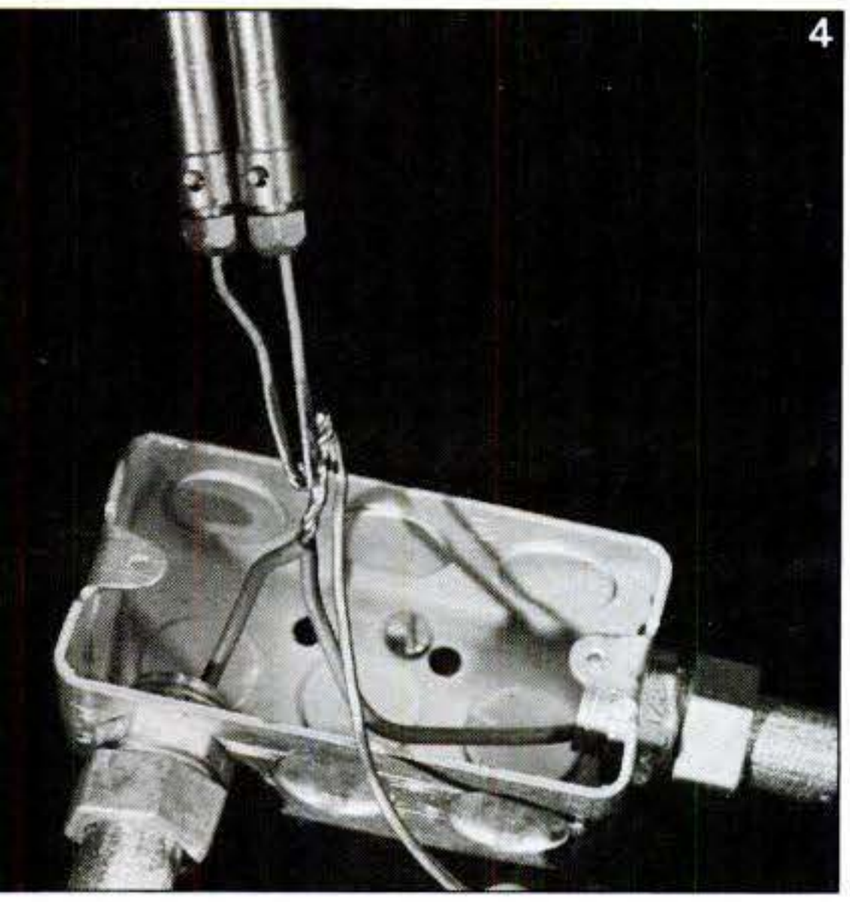
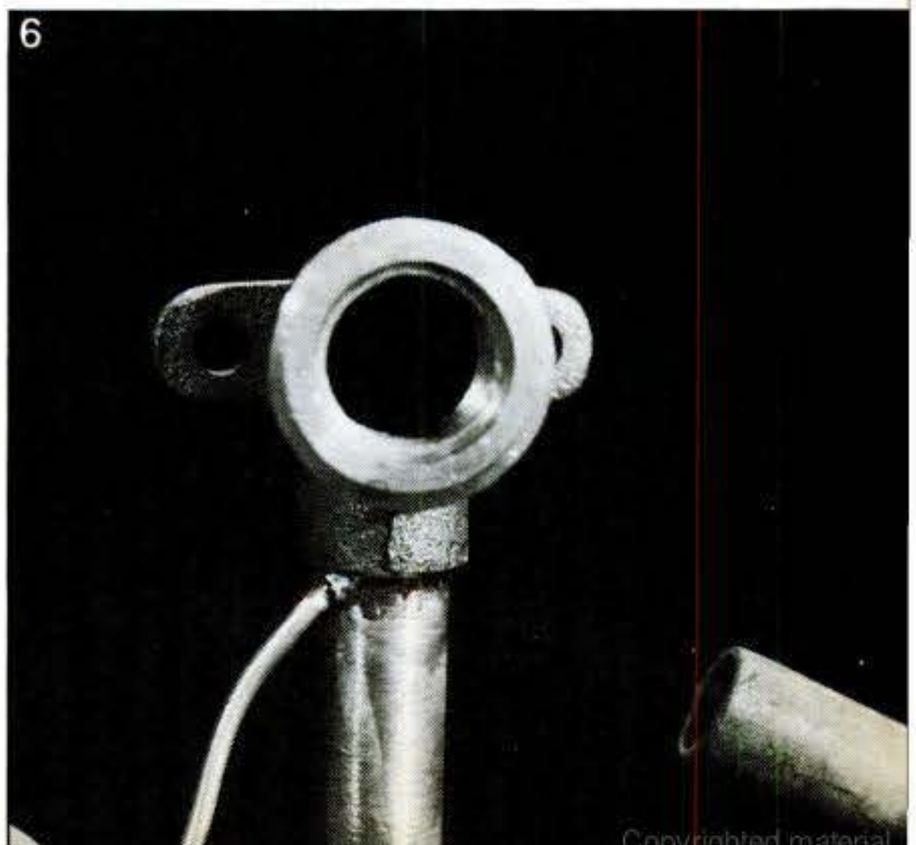


Solder joints are best for heavy-wire electrical connections (4). The gun heats the wire, and when solder is touched to the joint, it flows into the twists. Heavy brazing to fill a V-groove in this broken casting (5) requires a lot of heat. An oxyacetylene torch is being used here, but a 50-amp carbon-arc torch could also do the job. Torch soldering is a standard way of assembling such things as copper-tubing fittings (6). Touch solder to the side opposite the torch; when the proper temperature is reached, solder will flow and be drawn into the joint by capillary action. The flame, which is invisible in the photograph, was modest but concentrated and came from a conventional propane torch.



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area before starting. When the joint is completed, bury the part in dry sand so it cools slowly. If the part is precious or irreplaceable, don't gamble; take it to a professional.

To braze deep V-joints, start by tinning the sides of the groove with a thin coat of braze metal. When the metal has adhered well, fill in with more metal in a series of passes.

Because it's easy to build up tough and durable braze metal, you can often repair a worn part (worn pivot holes, for example) and then drill, tap, or reform the braze metal to restore original contours and dimensions.

Welding

Both electric-arc and oxyacetylene welding require considerable practice, but you can teach yourself.

An electric-arc outfit consists of a heavy transformer to step down household voltage and step up amperage. Typically, you start with 120 volts at the wall plug and wind up with 30 volts at the arc; the amperage may be stepped up to 100 amps from a 30-amp fused circuit.

Home electric-arc welders come in several sizes. A 100-amp model handles most jobs, and you don't need a heavily fused 240-volt circuit, as you would with a larger welder. However, you need a good 30-amp circuit with no other loads on it.

Two cords plug into the welder. One is a ground that clamps to the work. The other has a holder to grip the welding rod. When you touch the rod to the work, the circuit is completed. The arc generates enough heat to melt both the workpiece metal and a flux-coated electrode clamped to the holder. It flows into the joint as you go along.

Another kind of electric welder is the carbon-arc torch. It has two plug-in terminals; two cables run through the torch handle to holders gripping two small carbon sticks. When the two tips are touched together and then separated slightly, you get a continuous, fan-shaped flame (or spark) with a temperature of about 9,000 degrees F.

The advantage of a transformer welder is that its initial cost plus an occasional package of electrodes is the total cost. You'll probably never notice the electrical cost of infrequent welding.

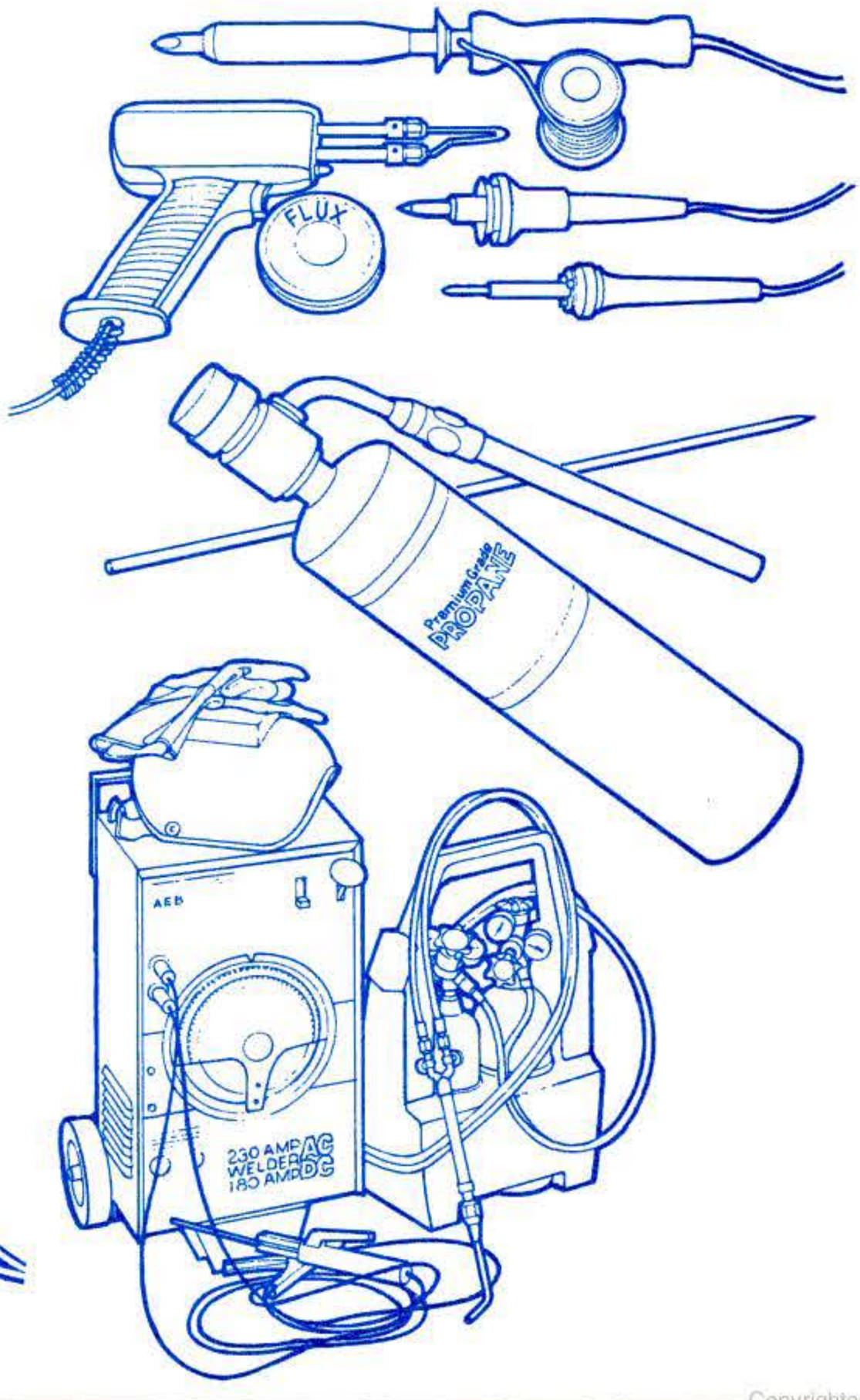
Gas welding, on the other hand, requires a tank of oxygen and a tank of acetylene. A local supply shop quoted $276 as the price of a pair of medium-size tanks, permanently leased.

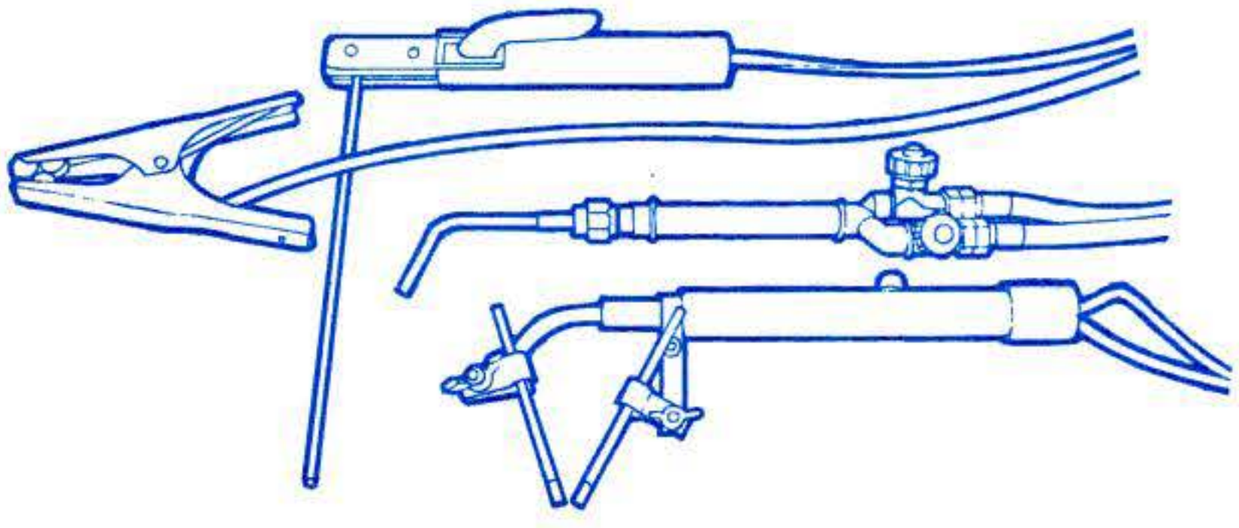
Surprisingly, both gas and electric welding techniques have much in common. You first must generate a puddle of molten metal, usually ¼ to ⅜ inch in diameter. The arc electrode automatically adds filler metal as you move along. For general welding of mild steel, a 3/32-inch-diameter mild-steel rod works best. With gas welding, it takes a little time to develop the puddle, but once started, you move the torch along, rhythmically dipping the tip of the filler rod into the molten pool of metal.

Working with molten metal demands plenty of attention to safety. Gas welding requires good goggles with full side protection, but it's not necessary to wear gloves. On the other hand, never do arc welding or use a carbon-arc torch without heavy gloves and complete face and eye protection. PS

What you need for joining metal

	Approx. price ($)
For Soldering	
Large soldering iron	24
Soldering gun	36
Small-tip soldering iron	12
Propane torch	19
Wire solder, resin core	9.30
For brazing (heat source depends on job)	
Torch, propane or MAPP, with adjustable flame	19
Oxyacetylene gauges, regulators, and torch	240
Tanks of acetylene and oxygen, refill each	15
Oxypropane torch	37
Arc welder, 100-amp with helmet	120
Carbon-arc torch	50
Gloves	15
Brazing flux	4.30
Brazing rod, pre-fluxed (five lbs.)	22.50
For welding (arc or gas)	
Transformer welder and helmet	120
Oxyacetylene gauges, regulators, and torch	240
Gloves	15
Welding electrodes, E-6013 (five lbs.)	7
Mild-steel gas welding rod, 3/32-in. (five lbs.)	9.50
Gas tanks, medium size, permanent lease	276
Tanks of oxygen and acetylene, refill each	15





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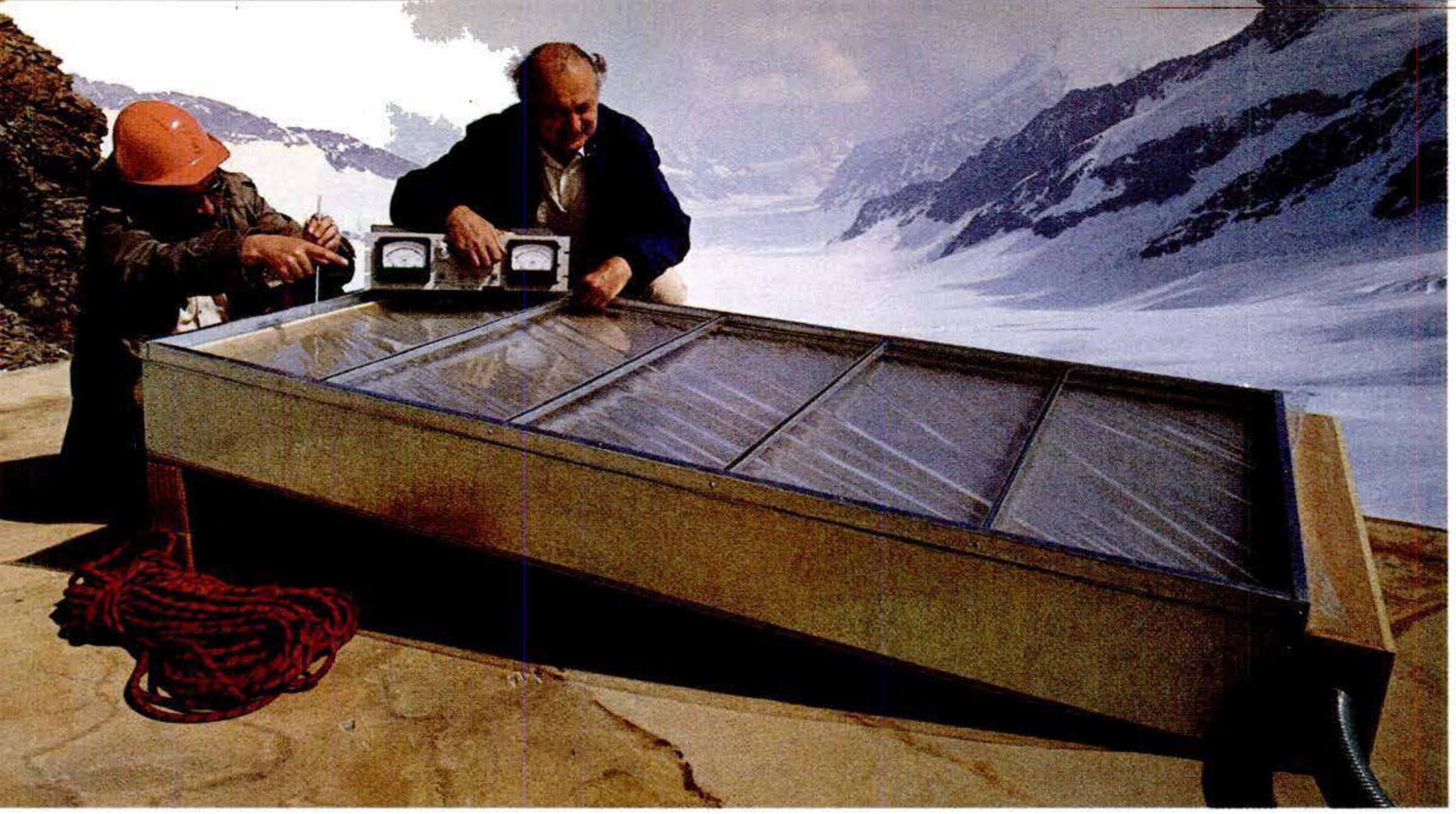


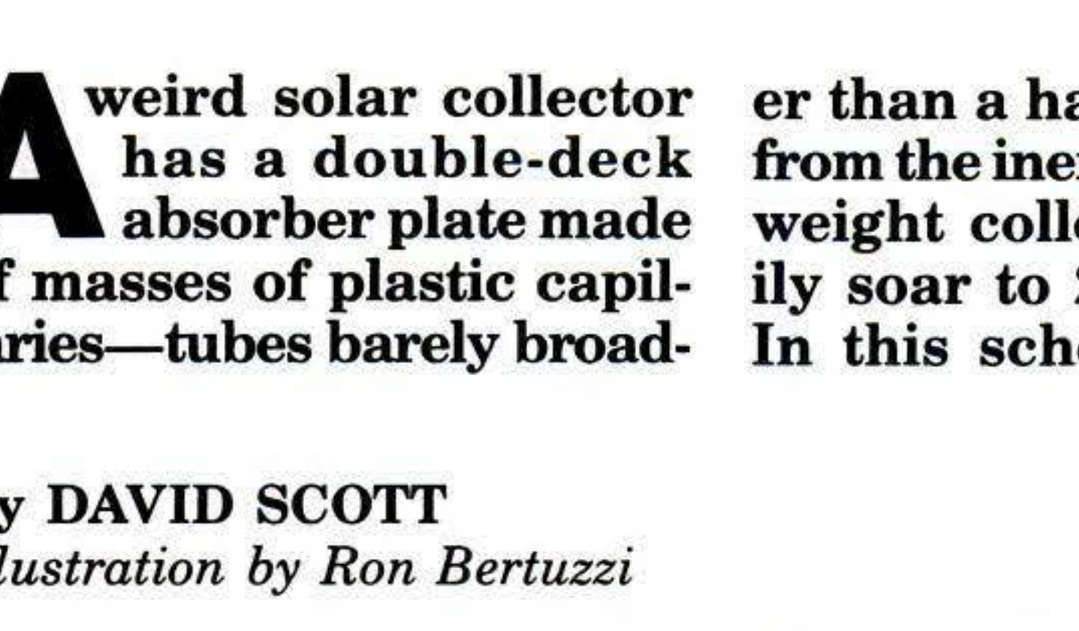
Capillary solar collector

A weird solar collector has a double-deck absorber plate made of masses of plastic capillaries—tubes barely broader than a hair. Air coming from the inexpensive, lightweight collector can easily soar to 250 degrees F. In this scheme, it would be used to vaporize Freon, which would turn a turbine to drive a generator. The goal: low-cost solar electricity.

By DAVID SCOTT
Illustration by Ron Bertuzzi

DONAUESCHINGEN, WEST GERMANY

"See how the bottom part has melted," said Hans-Joachim Dietzsch, holding up a strange-looking block of plastic that's the heart of a solar collector. "It got too hot in one of our experiments." Looking closely at an undamaged block on his desk, I saw that it was made entirely of tiny, densely packed plastic tubes. It was feather-light.



Plastic-capillary panels are spaced 20 mm (0.8 in.) apart. Transparent upper panel transmits solar energy to dark lower panel, which absorbs it. It is reradiated as long-wave infrared and absorbed by the upper panel. Cool intake air passes through all the tubes. Now warmed, it merges in the central space and is drawn from the outlet by a fan.

Two of the capillary blocks, Dietzsch told me, form an energy trap that can easily heat air to 120 degrees C (248 F). "With suitable generating equipment, we calculate that it could produce electricity at one-tenth the cost of that from existing photovoltaic cells or solar concentrators," he said. How so? "The plastic sections are far cheaper than the usual hardware," he explained. "They're fixed, so costly sun-tracking devices are not necessary. Only air flows through the panels, so you eliminate weight, plumbing, and freezing problems you encounter using liquids."

Dietzsch is the director of Diveno Kapillar-Technik, a small firm whose main products are translucent double-glazed windows with a thin insulating filling of the same plastic. The company developed a process for making the panels, and Dietzsch hit upon the idea of using them to tap solar energy. His panels are 40 mm (1.6 in.) thick; the tubes are 0.4 mm (0.015 in.) in diameter, with walls a mere 25 microns (0.025 in.) thick. The plastic is a polycarbonate that can withstand heat up to 140 degrees C (284 F).

"To generate electricity, we'll pass the hot air through a heat exchanger to vaporize Freon, which will feed a Rankine-cycle turbine driving a generator," Dietzsch explained. Meanwhile, tests are under way in the Swiss Alps. The sun-drenched site at a 3,450-meter (11,319-ft.) altitude simulates solar radiation in subtropical climates—Dietzsch's primary targets. A test panel is fed chilly mountain air. Outlet temperature is regulated by varying the fan speed. "That melted plastic I showed you was up there when the fan momentarily ran too slowly," explained Dietzsch, "and the air inside rose to 150 degrees C [302 F]." PS

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Kit plastic greenhouses

Two new greenhouse kits have plastic frames that are unique. One can be used to water the plants: The supporting pipe acts as a conduit for the sprinkling system. The other has a frame made of weather-resistant plastic that supports double glazing. Why plastic? It's thermally more efficient than aluminum, so it won't conduct heat readily to the greenhouse exterior.

By CHARLES A. MILLER

Greenhouses not only add value and beauty to your property but allow you to garden year-round.

However, a greenhouse can be expensive, unless you do part of the building yourself. One way to save is to build the greenhouse from a kit. Shown below are two new greenhouse kits that use a plastic framework. That means they're thermally more efficient than aluminum-frame greenhouses (plastic doesn't conduct heat to the outside as readily as aluminum) and generally less expensive.

One of the designs (insets), from Loren Greenhouses (10837 High Ridge Road, Jacksonville, Fla. 32339), has a built-in irrigation system: The PVC pipe used for the frame conducts water to sprinklers in the rafters. The sprinkling system is automatically operated by a clock, which controls a solenoid valve to turn the water on and off at selected times. The same system can spray fertilizer or insecticide.

The Loren greenhouse comes in two sizes. The larger one, called the American, is 10 by 16 feet; it costs $1,995. The Mini American is eight by 12 feet and costs $1,595.

Home add-on

The System II Garden Wall, made by Thermodular Designs, Inc. (5095 Paris St., Denver, Colo. 80239), uses a frame of Uniroyal's weather-resistant Rovel polymer over an extruded aluminum core. The glazing is ¾-inch insulated double-pane glass.

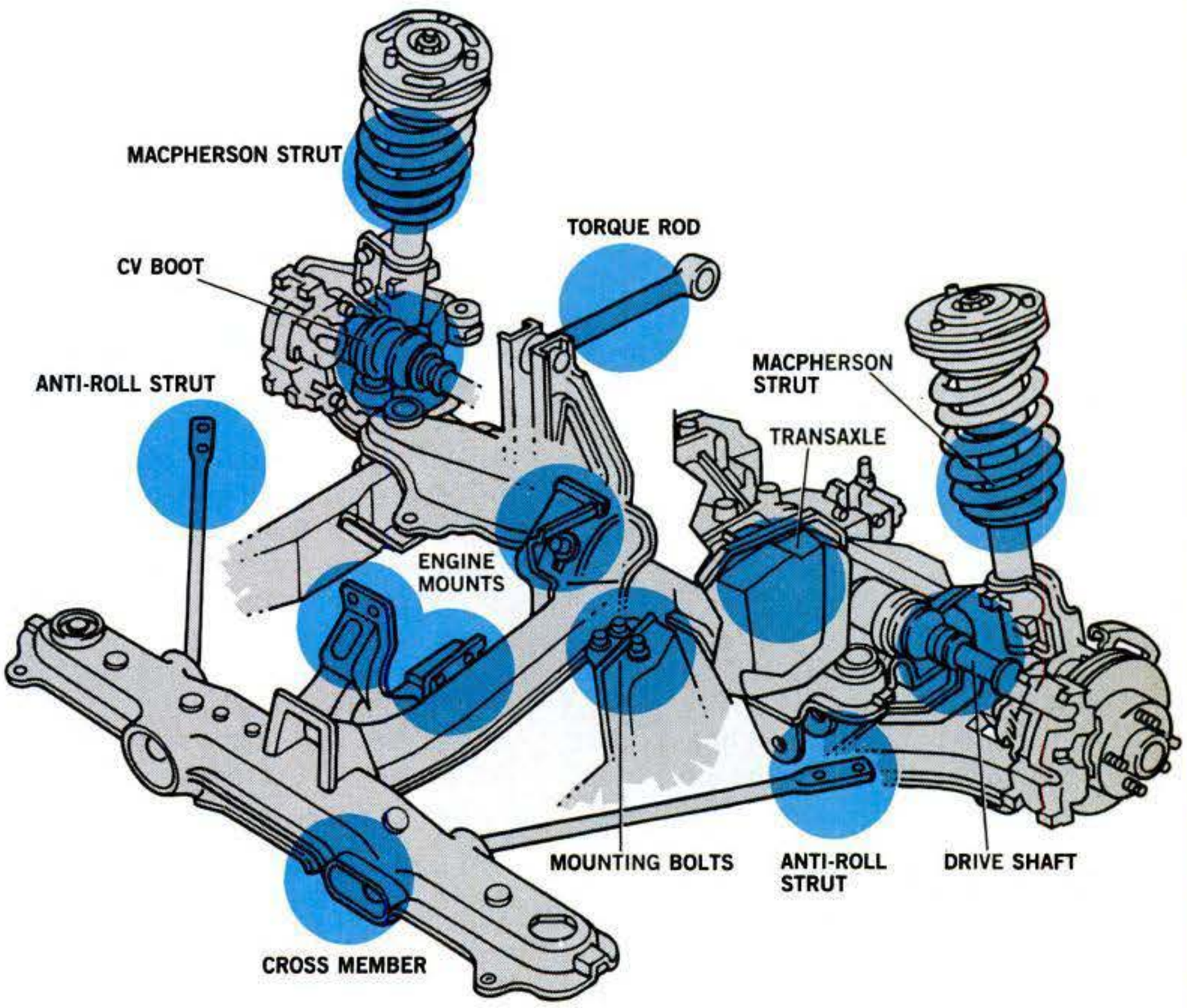
The greenhouse fits onto a sill plate anchored to a standard foundation (the base extrusion fits over the sill plate). It attaches to an outer wall of a house and can be used as a sun room or sauna enclosure.

The kit is modular and comes in a variety of sizes. A six-by-20-foot greenhouse for a knee-wall foundation costs $6,108. Fans, doors, and windows are extra, but you can save by ordering them locally. Both the Loren and Thermodular kits require foundations. PS

PVC pipe provides support and plumbing for Loren greenhouse (insets). Main photo: Thermodular model attaches to house.

Cures for front-drive ills

Some mechanics say vibration and handling gremlins are normal for front-wheel-drive cars. Don't believe it. The key to a trouble-free front-drive is knowing how to trouble-shoot when a problem occurs. Can you read the signs of impending trouble? Does your steering wheel shake from side to side? Do you hear a whine when you coast to a stop? Is there a clunking or snapping noise when you take off? Getting the answers to these tough-to-solve glitches becomes simple after you know when, where, and how to look for clues. Most front-drive problems can be cured using a shop manual, a torque wrench, and the PS trouble-shooting table.



By GEORGE SEARS
Drawings by Russell von Sauers

Front-wheel drive is here to stay. Of the 499,911 new cars made by America's Big Three and registered in this country in March of this year, 208,513 (about 42 percent) were front-wheel-drive (FWD) vehicles. Four years ago only a handful of cars manufactured here had FWD.

Furthermore, about 85 percent of the total domestic automobile production in 1985 will consist of FWD units. Considering that most imports have or will have FWD, you can safely conclude that your chances of eventually owning an FWD car (if you don't already) are practically certain. All of this means that you could be faced with front-drive-related problems sooner than you think.

Finding the clues

So, your front-drive car has a shimmy. How do you know when you drive your car whether what you're feeling is vibration or oscillation?

If the steering wheel shakes from side to side, it's oscillation. The source of this type of problem is usually tire-wheel imbalance, excessive lateral run-out on tires, or wheel damage. But if you notice oscillation only when braking, have your mechanic check for brake-rotor run-out.

Lateral run-out refers to wear on the outer edges of a tire. It can cause the tire and wheel to wobble. Measured with a gauge at the shoulder of the tire, lateral run-out should not exceed two millimeters. If it does, replace the tire.

If the steering wheel shakes up and down when the car isn't moving, check the engine idle speed. If it's even slightly below specification, a transverse-mounted engine can roll and cause vibration—though, technically, this isn't vibration.

However, if the steering wheel shakes up and down while the car is moving, it *is* vibration. First, see that accessory mounting bolts and drive belts aren't too loose, too tight, or damaged. Tighten the mounting bolts to the limits specified by the manufacturer in the service manual. Make a close examination of the accessory mounting brackets for cracks.

An accessory is any component that's attached to the engine by a bracket. This includes the air-conditioning

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Fig. 1

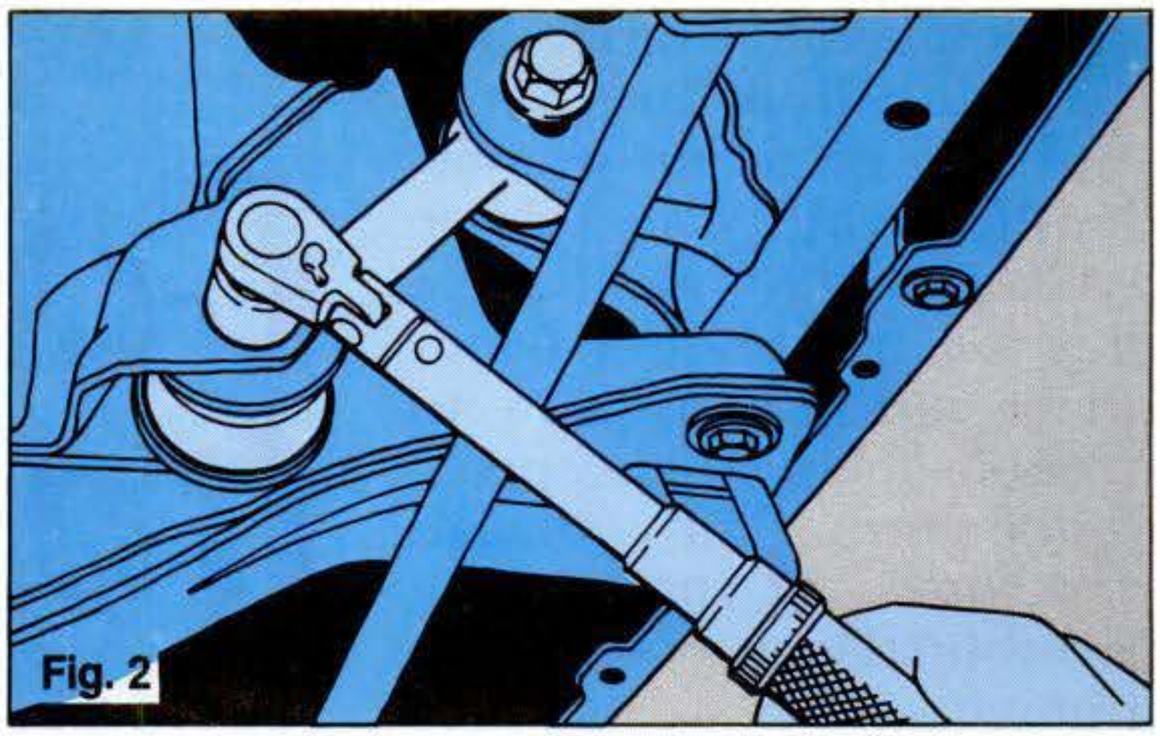
Fig. 2

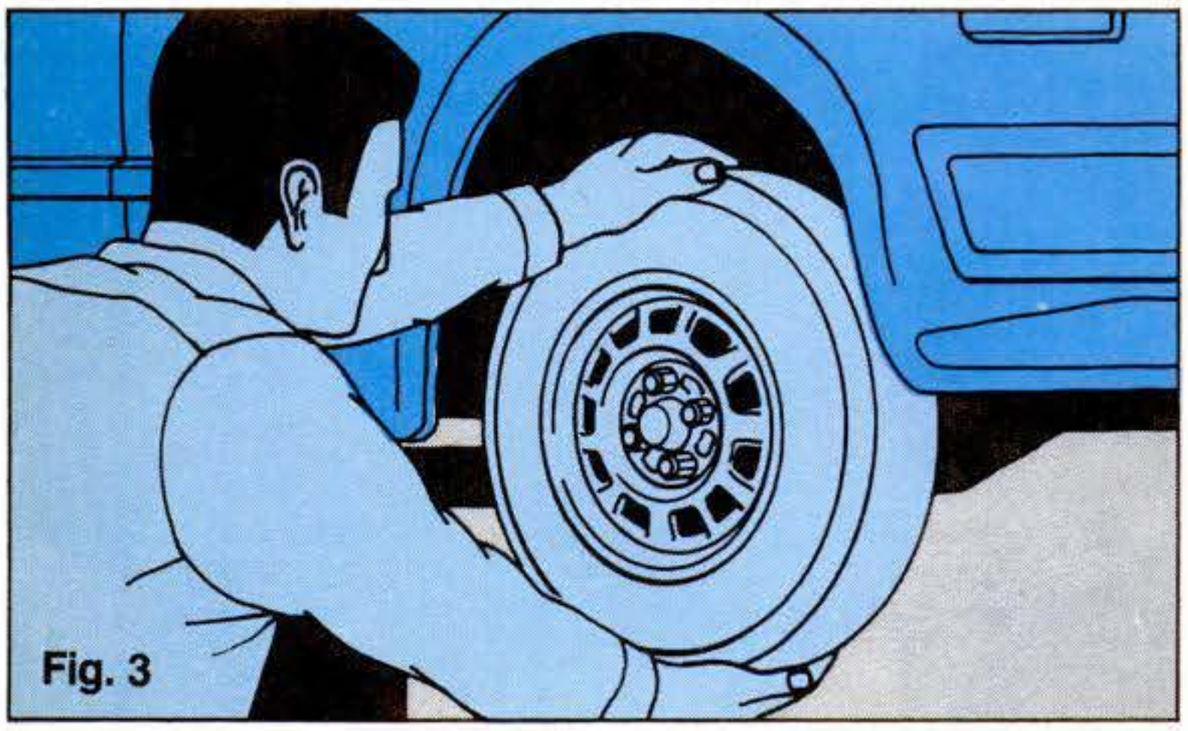
Fig. 3

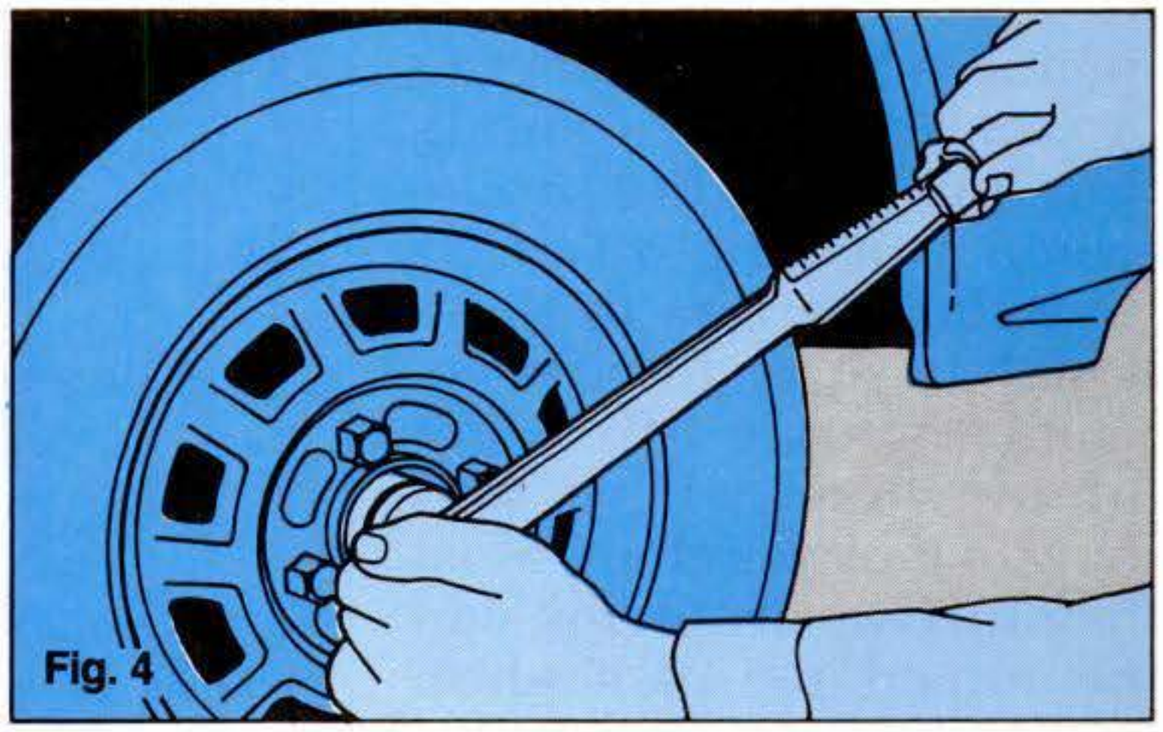
Fig. 4

compressor, alternator, power-steering pump, starter motor, and automatic speed control.

Tach testing

If none of these is causing vibration, it's time to connect a tachometer (sketch 1) and test the car on a long, smooth stretch of road. (When connecting a tachometer for the noise test, thread the tach's leads through the door jamb, not through the window. Otherwise, wind noise will mask the sound you're attempting to hear and eliminate. Shut off all accessories, and close the windows tightly during the test.) On the road, try to determine at what engine rpm the vibration occurs. Now, take the car beyond the speed at which the vibration occurs. Shift into neutral, and take your foot off the accelerator pedal.

As the car coasts down through the speed at which the vibration is first noticed, determine whether vibration is occurring. If it is, the problem is probably caused by excessive radial run-out.

Radial run-out refers to the difference between the high and low spots along the tire's tread. The vibration from this fault can sometimes be corrected by balancing to offset the high spot of the wheel with the low spot of the tire. If balancing doesn't solve the problem, the tire must be replaced.

If there's no vibration during the coast-down phase of the road test, the problem is in the engine or transaxle—the differential-and-transmission combination. To find out which of the major components is at fault, stop the car and put the transmission in neutral. Speed up the engine until the tachometer is reading at the rpm at which vibration occurred.

Feel any vibration? If so, the problem is engine-related. If not, you have a transaxle problem.

Engine problems

Most engine-related problems are not caused by the engine but by subcomponents that hold the engine to the frame or control engine motion. Subcomponents are the engine mounts (usually three), the torque rod (anti-roll strut), and the cross member. The engine mounts support and isolate the engine from the car's frame. The torque rod controls engine pitching motions. Although engine mounts and the engine torque rod might wear and allow the engine to vibrate, the culprits causing engine-related vibration are usually bolts that are either too loose or too tight.

Start with the engine-mount bolts. Using a torque wrench, loosen each bolt and then tighten to the specification in the manufacturer's service manual. Remember to re-secure not only the engine-mount bolts, but also the bolts that hold the engine mounts to the cross member.

Retest the car to see whether you've solved the problem. No? Then turn to the torque rod. Different kinds are used for each application, but generally it's a long rod with large rubber bushings at each end. One end is attached to the cross member, the other to the car body. As the engine tries to roll fore and aft, the torque rod is supposed to restrain it while the rubber bushing absorbs the vibrations.

Check to see whether the bushings are in good shape. Finally, loosen the torque-rod bolts and re-tighten them to specification (sketch 2). Retest the car.

Still have vibration? Check the cross member and cross-member support bolts. See that they're all present. Someone on the production line may have failed to insert one. Loosen each, and re-tighten to specification.

Even after all of this, you might still be experiencing engine-related vibration. The reason might lie with the torque rod. When FWD was still new, some cars were equipped with torque rods that were, to put it mildly, understrength. Even when properly torqued, they can't restrain the engine enough to prevent vibration.

Recently, Moog Automotive, Inc., introduced a retrofit part called Torque Strut, which replaces original-equipment torque rods. It resembles a miniature shock absorber.

Torque Struts are currently available to replace torque rods in GM FWD cars. Others are being designed for Chrysler and Honda. Before you

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rush out to buy one, however, you might want to rule out transaxle-related possibilities that cause vibration.

Transaxle problems

You usually don't have to look far to find the cause of transaxle vibration. It can be as simple as a mismatched drive shaft.

Has your car had a vibration problem from the time it was new? Perhaps the wrong-length drive shaft was installed. Car makers use various-size shafts for different applications. There could have been a mix-up on the production line.

To find out, measure the length of each shaft (there are two) from the edge of one constant-velocity (CV) boot to the edge of the other CV boot. Compare the measurement with the shaft-length specification in the service manual. If your measurement and the manual's specification don't jibe, return the car to the dealer for a shaft replacement.

Now, examine the flange of each shaft. That's where the shaft connects to the transaxle. In some cars the shafts are bolted to the transaxle. Make sure the bolts are tightened to about 40 ft.-lbs.

Finally, examine each CV boot. If a boot is cracked or torn, water and dirt might have seeped into the joint and caused the joint to rust or wear. The boots are weak links in the transaxle system. Inspect them often to determine whether they're in the early stages of cracking. It costs much less to replace the boots than to replace a CV joint.

Listening for trouble

Noises come in all varieties—whines, grinds, clunks, snaps, clicks, drones, moans, rattles, and buzzes. Pinpointing the condition under which the noise occurs is vital.

There are three categories of noises: run-up, coast-down, and torque-sensitive. For run-up, you accelerate normally until you reach the rpm at which the noise occurs. For coast-down, you shift to neutral and allow the car to coast down through the speed at which the noise occurs. Torque-sensitive noises occur when you shift back into gear from coast-down and accelerate to put the engine and transaxle under load to provoke the sound.

But remember, all the suspicious sounds you hear won't necessarily come directly from the front-drive setup. For instance, loose or worn wheel bearings can cause a whining or grinding noise. To check, raise the vehicle on a hoist and place your hands at the six- and 12-o'clock positions (sketch 3). Rock the wheel back and forth to check for wear or misadjustment.

Handling problems

Does your car wander over the road or pull to one side? Is there excessive play in the wheel, or is it hard to steer? Handling problems are rarely the sole fault of the front-drive system. The same problems occur with rear-drive cars. The causes are usually found in the suspension, steering, or braking systems.

For instance, a car that wanders and refuses to track might simply have improperly set toe angles. The front alignment might have been knocked out of whack by the curb you slid into on a rainy Monday.

Steering pull is another problem that can give front-drives an undeserved bum rap. Before you test the vehicle, check tire pressures. Low or uneven pressure causes pulling, instability, and hard steering. You might also want to check to make sure the tires on the same axle are both the same size. Then select a smooth, flat road with as little traffic as possible. Even a road with a slightly crowned surface will cause the car to steer toward the shoulder.

If the car pulls only when you apply the brakes, the problem is obviously in the braking system. When you're trying to diagnose a front-drive's brake system, it's important to keep in mind that most use a "diagonal braking" master cylinder. Today's master-cylinder reservoirs are split into two chambers. In a rear-drive vehicle, one chamber supplies the hydraulic fluid for the front discs, and the other supplies fluid for the rear drums. If there's a leak in either system, the other half of the system can bring the car to a stop. But in a front-drive car most of the car's weight is over the front wheels, and in a panic stop, the front brakes might be handling 80 percent of the stopping. If the front-brake system should fail in a front-drive with the older-style fluid reservoir, the stopping distance would be dangerously long. For that reason, front-drives use a diagonal system: Each chamber provides hydraulic pressure to a front disc and rear drum on opposite sides.

Does the car wander after you've checked the tire pressure? Look for worn MacPherson struts, incorrect front- and rear-wheel alignment, loose wheel bearings, or possibly a broken spring. Are the steering-rack retaining bolts tight? If not, use a torque wrench to snug them to the proper specification. Tightening the wheel bearings to spec (sketch 4) often can produce an instant cure. Loose or hard steering most often results from a malfunction in the steering system. For instance, loose steering is generally caused by worn tie-rod ends or a loose or worn steering-shaft coupling.

Hard steering can occur when the steering gearbox is low on or out of lubricant. Another cause of hard steering is damage. Perhaps you hit a rock or some road debris, and the steering rack is slightly bent and binding. Finally, you might want to have the front and rear alignment checked if you've noticed an increase in steering difficulty.

Front-drives yield their diagnostic clues just as easily as the more-familiar rear-drives. Patience and a thorough step-by-step trouble-shooting procedure are the keys to unlocking the cures. If your trouble-shooting takes you under the hood, avoid standing in the same plane as rotating parts, such as the fan. Also, many front-drive cars use thermostatically controlled electric fans. Be aware that these could start up even after the engine has been shut down. (You might want to disconnect the fan until you've completed your service.) Finally, always jack and support a vehicle on a hard, level surface when service takes you underneath it. PS

Trouble-shooting front-drive noises

Type of noise	Circumstance: Coast-down	Run-up	Torque-sensitive	Probable causes
Whine	Yes	No	No	Loose wheel bearing
Whine	No	No	Yes	Low transaxle fluid; wrong transaxle fluid; transaxle damage
Whine	No	Yes	No	Loose or worn camshaft drive belt; noisy engine accessory
Grind	Yes	No	No	Worn wheel bearings
Grind	No	No	Yes	Dirt or debris in transaxle (remove and examine fluid pan)
Clunk, snap, or click	No	No	Yes	A damaged CV joint
Clunk, snap, or click	Yes	No	Sometimes	Loose wheel nuts; loose or worn MacPherson struts
Steady drone or moan	No	Sometimes	Sometimes	Improperly torqued or positioned engine mounts; misrouted air conditioning line or throttle cable; loose exhaust system component
Rattle or buzz	No	Yes	No	Loose component; broken weld or disconnected bracket allowing sheet metal to vibrate or hit against adjacent area

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Announcing:

Eighth annual PS/APA

• **PRIZES:** A $1,000 check will go to the top entrant in each of three major categories. There will be a secondary award of $250 in each category for a total of $750 additional. An honorable-mention entry in each category will receive a selection of how-to books from the Popular Science Book Division.

• **HOW TO QUALIFY:** Your project must be constructed from a stated amount of an APA-trademarked panel appropriate for the intended use. Projects should be carefully designed for efficient layout of the panel or panels you select; parts should be scaled, arranged, and nested to minimize waste. You may enter your project in any of our three categories, specifying which thickness you choose for your half (four-by-four-ft.) or full (four-by-eight-ft.) panels. Should you choose to enter the multiple-panel category, you have the option of using two or more different thicknesses, if that makes sense structurally.

In all categories, aim for minimal waste and minimal use of additional materials; non-panel purchases must not exceed $100, and the construction panel you choose should remain the dominant material. We're seeking functional, structurally sound design, but decorative or ingenious projects will also qualify if they represent an efficient use of the panel or panels you specify and if they can be built with home-workshop tools.

• **HOW TO ENTER:** Fill out our entry coupon, or list all information the coupon calls for on a separate sheet of paper—including a rough sketch of the APA grade trademark(s) stamped on the back face or edge of the panel you choose. Mail this with at least one clear photograph (black-and-white or color print preferred, but color slide is acceptable) plus a dimensioned diagram of how the project parts were laid out on the panel or panels. A crude pencil sketch will suffice if it's thoroughly and accurately labeled with critical dimensions. Please don't submit scale models, full-size cutting patterns, or plans sheets larger than 18 by 24 inches. We also need a list of all materials used: grade and thickness of your panel(s) plus any lumber, hardware, and finishing materials (paint, stain, plastic laminate). Also jot down for us special construction tips you'd like to pass on to anyone attempting to duplicate your project. If no publishable photo exists, POPULAR SCIENCE and APA reserve the right to arrange photography at your convenience (and our expense). Entries must be delivered to the Tacoma post office box by March 1, 1984; upon delivery, publication rights belong exclusively to APA and POPULAR SCIENCE unless neither exercises the option

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design competition

After seven years of limiting eligibility to projects built of softwood plywood, we now open the contest to all properly identified structural panels. We offer $3,750 in cash awards, including $1,000 First Prizes in the three categories described below. Each entry has nine chances to win.

To those readers who've found the past entry rules for this now-famous project contest restricting or discriminatory: Rejoice! POPULAR SCIENCE and the American Plywood Assn. have just liberated you. You can qualify for next year's prizes by building your project from *any* structural panel bearing an APA stamp. That means you aren't limited to softwood plywood but can choose any of its proliferating cousins seen in the photo at left: particleboard (appropriate only for indoor projects); waferboard (one of the newer construction panels, available in the same thicknesses as plywood); oriented-strand board (OSB); or a hybrid panel called com-ply. (APA doesn't stamp *hardwood* ply.)

The samples of these four panels—with one edge cut at an angle to show inner structure–are displayed on a piece of standard plywood (bearing one type of grade stamp) to demonstrate that you now have a broad choice of five distinct panels for your project entries.

PS reviewed the characteristics of waferboard in the July issue and presented sample projects made from it. And over the years, a number of particleboard projects have appeared in this magazine. But com-ply and OSB are relatively unfamiliar. Com-ply may remain so because as we go to press, no mill manufacturing it. You may find com-ply panels stocked at large lumberyards, and you should be able to order some for later delivery, but com-ply production is erratic. That's too bad because it's a potentially interesting material, and I was looking forward to seeing what the ingenious PS workshopper might do with it. Edge treatments, particularly, could have design value because com-ply has a core of "reconstituted wood" (chipboard) sandwiched between two plywood-like face veneers.

If you walked quickly past a panel of OSB, you might mistake it for waferboard, but generally its wood chips are less flake-like; they're more like slivers—or strands (hence the name). The strands are arranged in three to five layers oriented at right angles to one another (rather like the cross-laminated veneers in plywood), then bonded into a panel using the same phenolic-based exterior resins used in waferboard manufacture.

Both OSB and waferboard are rated for structural characteristics by the same grading standards used for plywood, so they can be substituted for plywood in most applications. But unlike plywood—which is stamped either "interior" or "exterior," depending on its grading—OSB and waferboard are made in only one type and can be used for indoor furniture and shelving or for that doghouse out back.

That's what we're encouraging—a great variety of projects for home and yard. (For inspiration, check the August issue for the portfolio of this year's winners. And if you want plans for any of those, they're available at $2 apiece from the Tacoma address in the coupon below.)

In our judging next March we'll make no distinction between panels, as long as the one you choose is appropriate for your project. So feel free to experiment. Just keep within the basic guidelines outlined below, and you may design yourself into big money.—*Al Lees*

within six months of receipt in Tacoma.

Print the category you're entering (½ PANEL, SINGLE PANEL, 1½ TO 6 PANELS) in the lower left corner of your envelope (one entry per envelope, please). No entries can be acknowledged, and none will be returned, unless accompanied by a written request and a self-addressed envelope with proper postage (no checks, money orders).

• **JUDGING** (by PS Reader Activities Editor Al Lees and representatives of APA) will be for the most efficient and appropriate use of the panel or panels you choose. PS may publish dimensioned plans of those prize-winning projects we feel our readers might want to make. Plans for all nine winning projects will be available from APA after Sept. 1, 1984. Prize winners will be notified by April 16; winning entries will be shown in the August 1984 issue.

ENTRY COUPON (Clip and attach to your plans sketch)

Mail entry to:
POPULAR SCIENCE CONTEST
Box 11700, Tacoma, Wash. 98411

To qualify, entry must reach Tacoma address by March 1, 1984

YOUR NAME (print or type) _____

ADDRESS _____ Daytime Phone No. _____

CITY _____ STATE _____ ZIP _____

Copy the panel's grade stamp here

Description of project _____

Which category? ☐ ½ PANEL ☐ SINGLE PANEL ☐ 1½ TO 6 PANELS

What panel and in what thickness? _____

My signature certifies that this project is of my own design.

Sign here _____

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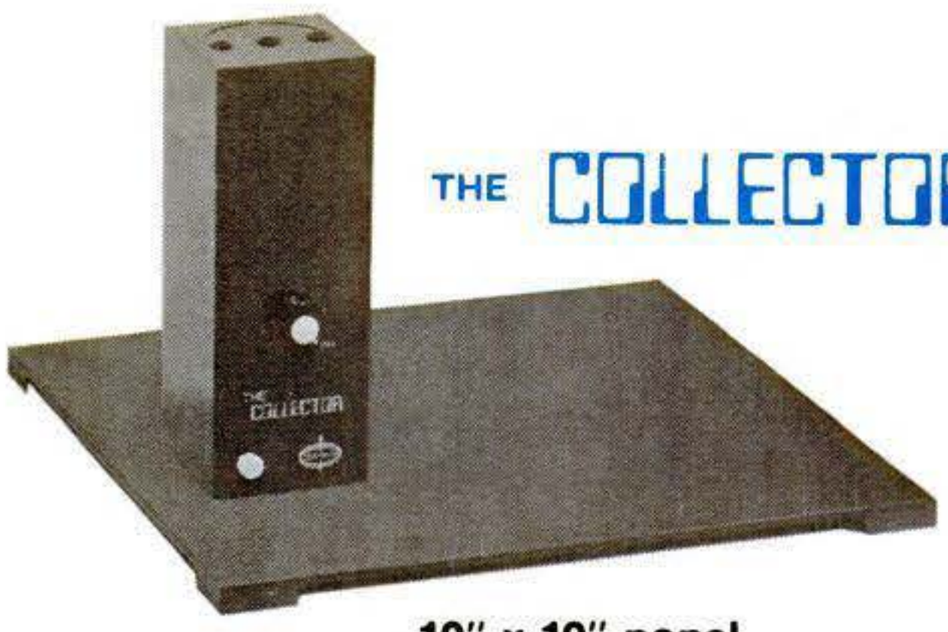

10" x 10" panel

FRESH AIR BREAKTHROUGH!

AT LAST...EFFECTIVELY REMOVE HARMFUL, IRRITATING SMOKE, DUST AND POLLEN FROM YOUR HOME AND OFFICE AIR.

IF YOU WANT CLEAN FRESH AIR OR YOU'VE UNPLUGGED YOUR POPULAR FILTER-FAN UNIT BECAUSE IT DOESN'T WORK THEN READ THIS...

Is your indoor air fresh, clean, and alive? Indoor air pollution is becoming a national health hazard. Energy efficient, airtight buildings are stifled with stale, polluted air which contains tobacco smoke; smoke and soot from fireplaces, heating systems, and cooking appliances; as well as dust, pollen, viruses, and bacteria. Most of these pollutants are so small (under 5 microns) that they are not effectively removed by common, small filter-fan units. Scientific tests show that these noisy, toy-like devices which emit chemical "citrus" odors are no match for The Collector, by Zestron, in thoroughly cleaning indoor air.

ZESTRON BRINGS YOU NATURE'S ANSWER

You know how fresh and vibrant the air feels right after a rainstorm, in the mountains, or near a waterfall. That clean, alive, fresh air is rich in something important that is greatly depleted in our urban and indoor air. That missing element is negative ions, nature's own air cleaners. *Many users experience great benefit from these amazing active ions, including feelings of aliveness, alertness and vitality similar to that experienced in the fresh mountain air. In addition, even hospitals use ionizers in some units.*

Filter-fan units do not emit negative ions. The COLLECTOR, by Zestron, creates trillions of these beneficial ions every second, while giving you the best performance, value, and technology in air cleaning.

THE ZESTRON BREAKTHROUGH!

Most ionizers clean your air but leave an untidy deposit of pollutants on room and furniture surfaces near the ionizer. The COLLECTOR takes ion technology a giant step forward by giving you super-powered ion output while depositing pollutants from your air on Zestron's exclusive easy to clean Collector Panel.

AMAZING DEMONSTRATION!

Unplug your COLLECTOR, place the ionizer unit and an ashtray on top of the panel. Place a lit cigarette in the ashtray and watch the smoke rise into the air. Now plug it in, and amaze yourself and friends as the smoke barely rises above the ashtray and then nose-dives onto The COLLECTOR panel before it can enter the room air. This is accomplished entirely electronically with no moving parts. The COLLECTOR, by Zestron, is the only ionizer on the market that cleans the air powerfully enough to accomplish this test.

THOUSANDS OF SATISFIED USERS

Don't you, your family and friends deserve the healthy, clean, fresh air that Zestron ionizers have brought to thousands of satisfied users? Users write: "I simply cannot believe how much better I feel." Dr. E.K., D D.S. - MA; "I smoke heavily and it has cleared the air as advertised." G.P. —WA: "It has done everything you say. I'm amazed at the clean air, how it absorbs odors and collects dust." P.M. - K.Y.

When you use your COLLECTOR, you'll quickly feel the difference it makes and smell the freshness in your air. You'll actually see the elimination of smoke and dust in your air!

SILICON VALLEY TECHNOLOGY

The COLLECTOR, incorporating years of high reliability design experience, is built with quality parts in the heart of Silicon Valley, USA, to give you years of trouble free service.

The COLLECTOR operates anywhere in your home or office for pennies a month and has nothing to wear out or replace.

SUPERPOWER OUTPUT

The COLLECTOR, by Zestron, is the only bipolar collecting ionizer with superpower output. The thoroughness and speed of air cleaning increases with more ion output, and Zestron ionizers give you the highest output. Check the comparison chart below. Don't buy any ionizer not stating output using the industry standard of ions/cc/sec. at one meter.

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JSA Bubble	not stated	YES
Orbit	not stated	YES
AirEase	not stated	YES
AirCarell	236,000	YES
Ion Fountain	540,000	NO
Modulion	75,000	NO

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Beginning here, a PS special section

Home electronics

Incredible. It seems only yesterday that POPULAR SCIENCE was covering many of today's fantastic electronic products as laboratory prototypes—ingenious ideas from all over the world that began as clumps of wire on a workbench.

Below, for instance, is an audio record unlike any other of the past. It's nearly indestructible. The music it contains is recorded as bits of digital information. A laser beam scans the disc's surface to reproduce sound virtually without distortion.

The computer, of course, has become a home *appliance*. We now expect it to perform work at bargain prices.

In this section, you'll see how the digital audio disc is affecting the audio industry, how computers have dropped in price but not in value, how VCRs are going hi-fi, and how other "clumps of wire" are faring on their way into your home.

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Low-cost computers

Manufacturers have created a whole new generation of home computers that have greater power and lower prices. This makes choosing one tougher than ever. Once-optional luxuries such as color graphics and sound are now standard. Clever new innovations—from high-speed data-saving wafer drives to infrared communications links—have been added. And all have features that give them greater-than-ever flexibility and capability. The key to selecting one of the new machines is matching its capabilities to the jobs you have in mind.

By WILLIAM J. HAWKINS
Photos by Greg Sharko

You waited. You put off buying a home computer. They would become more sophisticated and easier to use, you reasoned. Software would make them more useful than ever, you figured. And stiff competition would keep the price low. Sorry, but you were right. Now your choices are harder than ever.

In recent months, dozens of new home models priced under $600 have

Continued

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Finally, computer games you want your kids to play.

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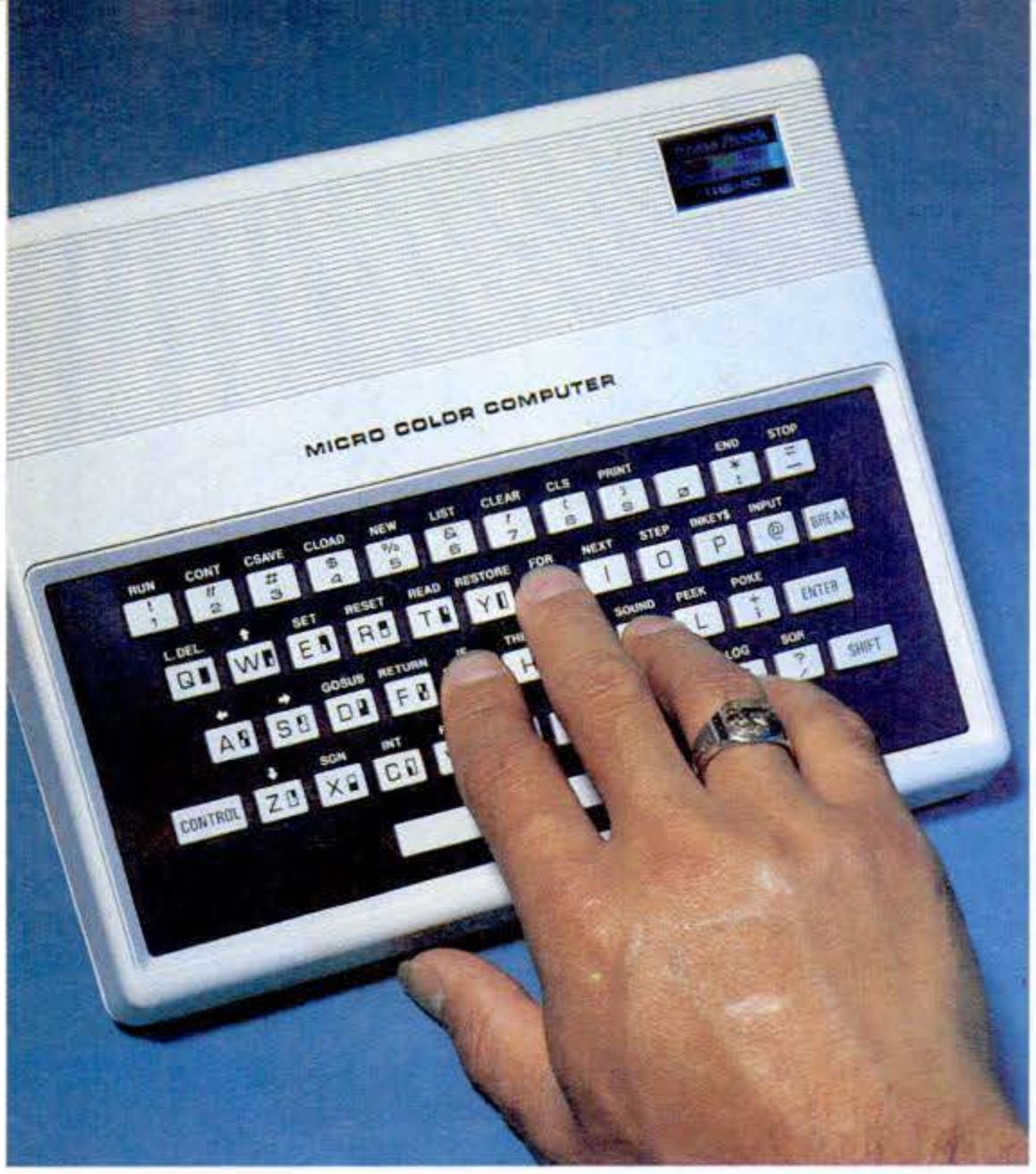
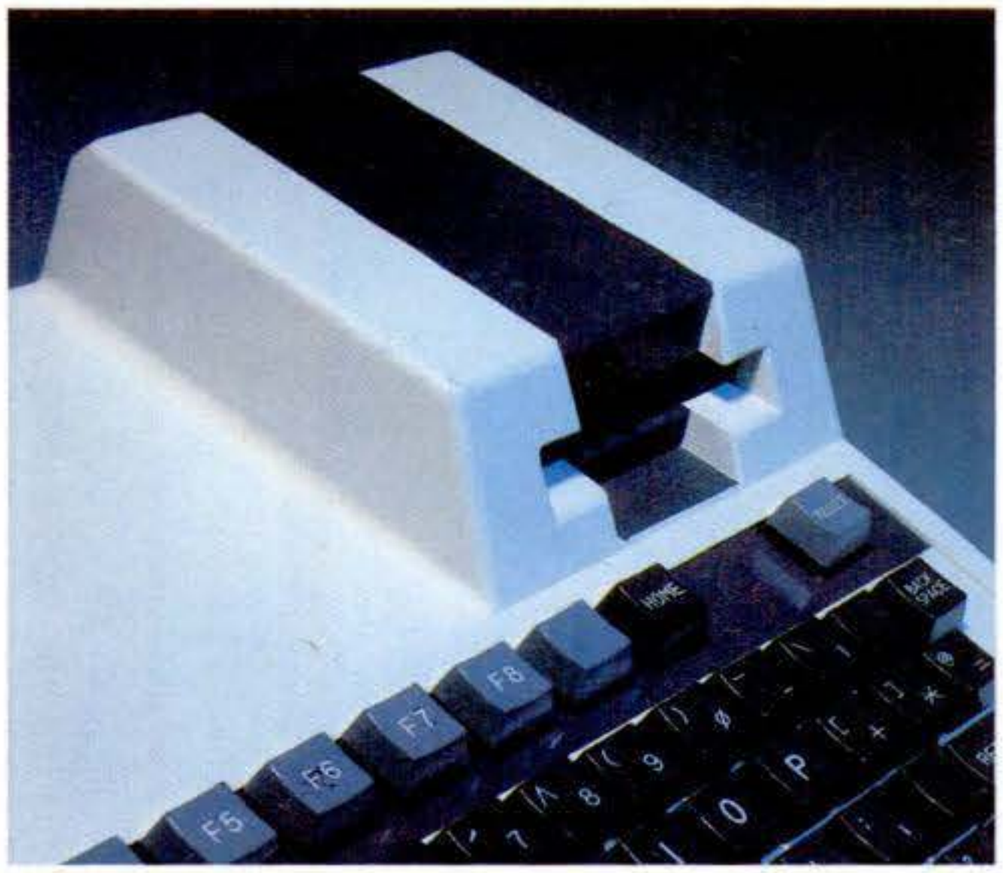
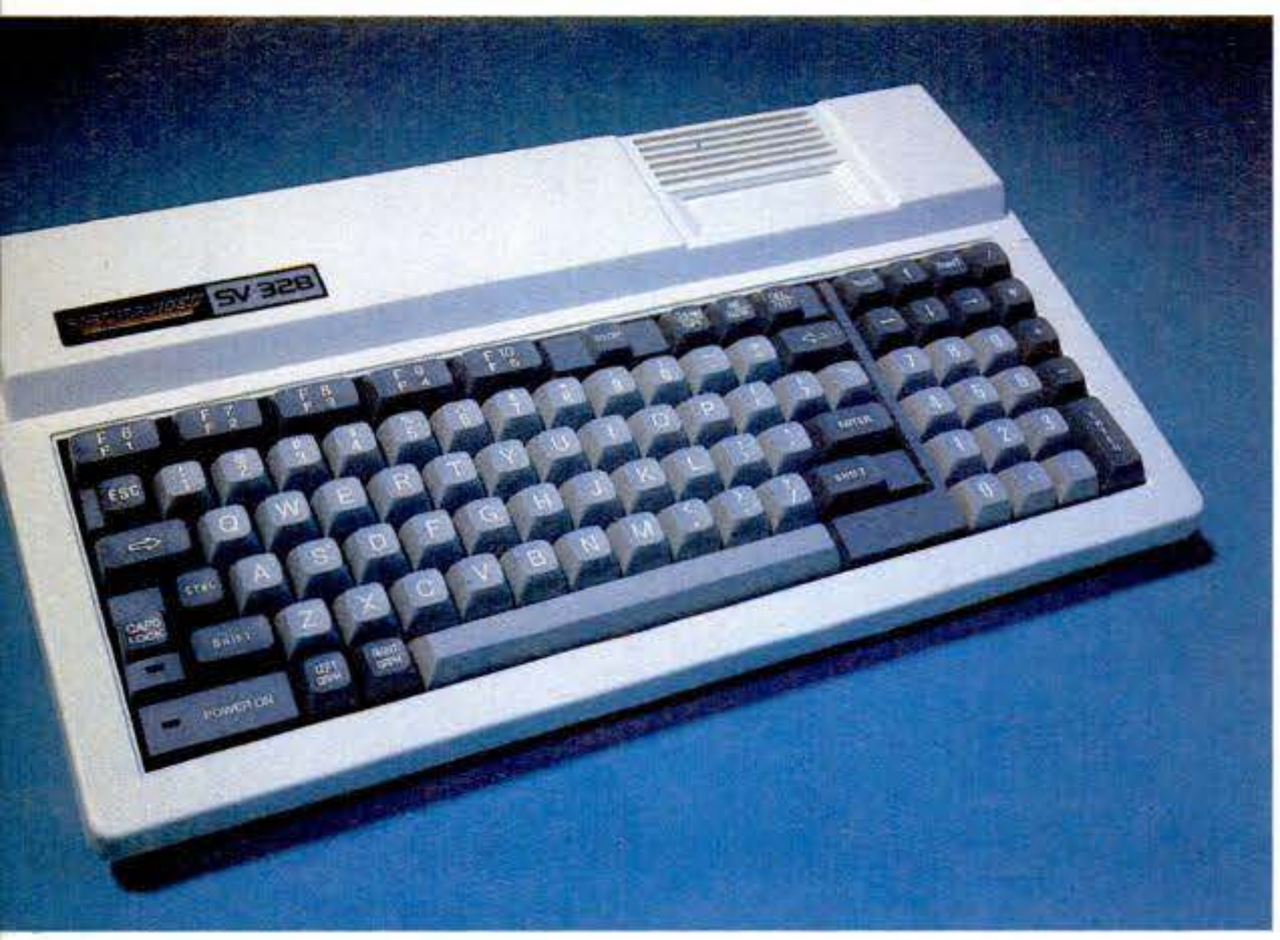
Low-cost computers







Connect these computers to a TV, and installation is complete. The Radio Shack Micro Color computer (upper left) accepts programs written for the company's larger color computer. The slot on Unisonic Sonic computer (top right) is for a wafer cartridge that holds up to 128K. Spectravideo SV328 (bottom left) has a full-size keyboard and special keys for word processing. The Timex Sinclair 2068 (above) can use a monitor to display to 64 characters a line.

been introduced [PS, Aug. '82; June '83; Sept. '83]. And they keep coming. Many are from the well-known computer makers, but now new manufacturers have entered the fray.

They're not just packaged in new boxes, either. They are technically different from their predecessors. Computer graphics and sound synthesis—once luxuries—are standard on all of these computers. Powerful new versions of the BASIC programming language are built in. Serial ports (connectors) are common, enabling you to attach other peripherals, such as a modem for communications with larger computers over the phone line.

Cassette interfaces for saving data on a cassette-tape recorder have been enhanced for greater speed and reliability. And one computer uses a new "wafer drive" for inexpensive data saving at speeds approaching disk-drive systems.

There are portable models for people on the go, and desk-top models for people already there. There's even a model for people in-between: It's a portable that uses infrared light to control peripherals.

All are list-priced from $120 to $600. (Heavy discounting is likely and will mean even-lower prices.) What makes them different? How do you choose? The table gives details and specifications on the new models. Here's what makes the specifications important to you when shopping.

Memory—does it still count?

The $120 Radio Shack MC-10 is the lowest-cost computer in the new group. Like others in its price range, it has a relatively small amount (4K) of RAM —random access memory. Is that bad?

When home computers were first introduced, the rule for memory size was simple: more is better. At that time, there was little off-the-shelf software. If you wanted a job done, you had to write your own program. Because no one could predict how large a required program might be, the rule applied. So if you plan to write your own programs, lower memory size will still limit your imagination.

But with the new computers, there is another point to consider. All manufacturers now provide lots of software for their machines—from games to home finance—that simply pop in and run. Result: Memory size is unimportant if you're content with the programs available.

There's one catch, however. Some programs require more memory than is supplied with the basic computer. A mistake? No, clever marketing. For many computers, it means that you should be prepared to buy the optional memory before you leave the store.

Continued

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A TECHNOLOGICAL BREAKTHROUGH IN HOME AND OFFICE PROTECTION

WHAT IS SENSAPHONE?

Sensaphone is a home and office security system. It will call you in the event of fire or break-ins. Sensaphone allows you to listen in to "live" sounds in your home or office while you are away. It will alert you in case of electrical failure...if the room temperature goes up or drops excessively...even if your basement floods. And Sensaphone is also an automatic phone dialer.

MONITORS ENVIRONMENTAL CONDITIONS

Connected to your telephone, the Sensaphone checks for power failures, monitors the temperature in your home or office, listens for any unusual sounds and three conditions of your choice when used with our optional accessories. If the temperature rises, if the power fails or your smoke alarm goes off...Sensaphone will tell you.

INSTANT TWO-WAY COMMUNICATION

The Sensaphone is so intelligent it speaks to you. This compact, easy-to-use unit identifies itself in plain English, gives the correct time, the room temperature, if the electricity is on and then lets you listen in through its built-in microphone. Even if your power fails, the Sensaphone assures full operation and memory retention with its own battery back-up system. The Sensaphone will call the preprogrammed numbers to warn you the power is off or if its battery power is low.

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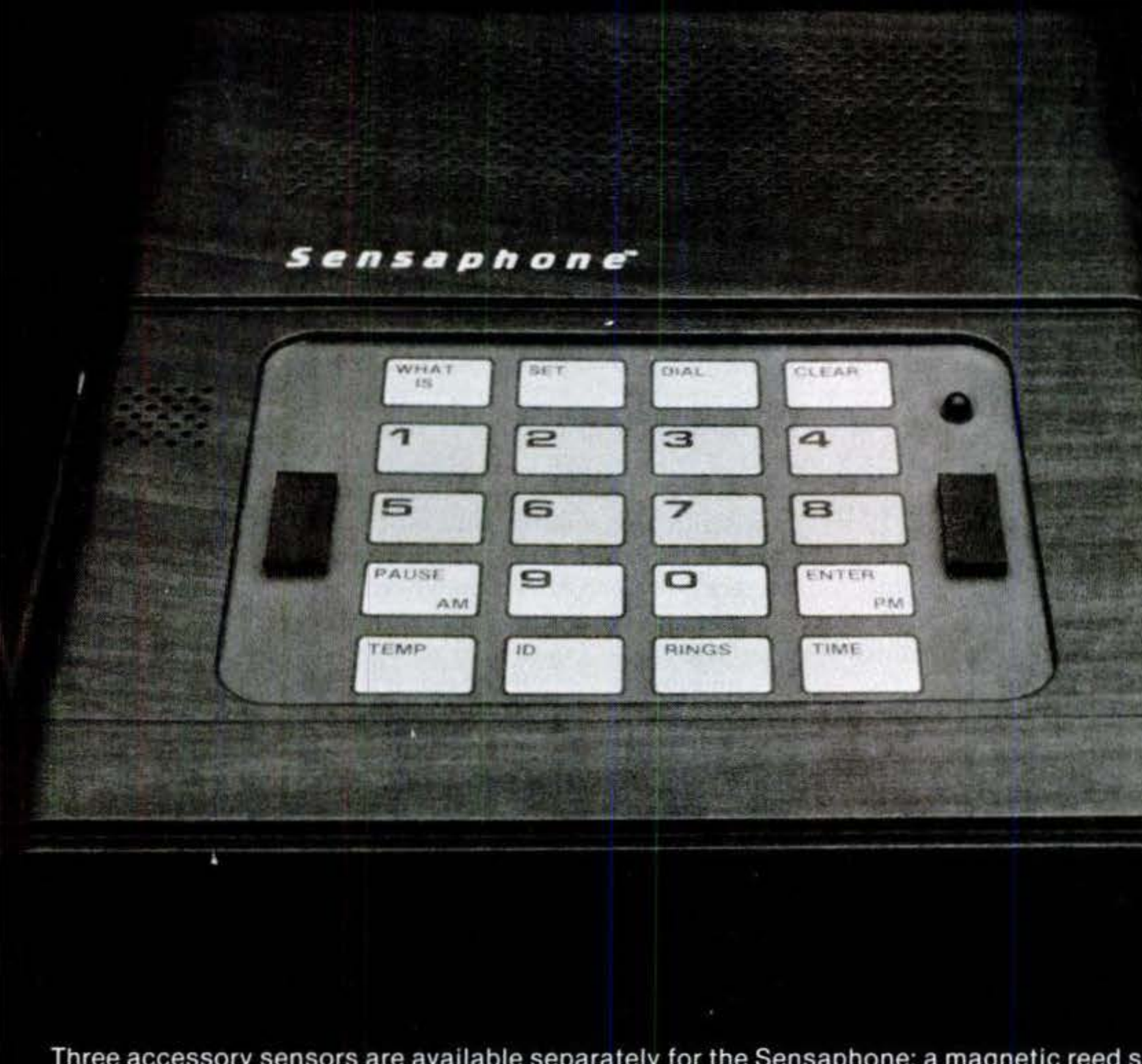
Whether traveling, out for the evening or just checking on your vacation home, you can call from any phone in the world and check the status of all conditions. The Sensaphone will answer with a "hello" and your telephone number. All six conditions will be accurately reported and then you can listen for noise. An excellent way to listen in on the kids when you're away or for unusual sounds in your home or office.



AUTOMATIC DIALER

You can also use the Sensaphone as an automatic dialer when you're at home. Easily program eight of your most frequently used numbers (up to 16 digits long). Press the dial key, and your Sensaphone will automatically dial the number you want.

EASY INSTALLATION

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Three accessory sensors are available separately for the Sensaphone: a magnetic reed switch which can be installed on doors, windows, drawers or anything that opens or closes. A water level switch for any area (such as your basement) where water damage could occur and a remote temperature sensor allowing you to monitor the temperature at a remote location.

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Use the Sensaphone with your home or office phone (or both) for up to 30 days. If you decide for any reason you are not satisfied, return for a 100% refund.

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Canon portable model X-07 communicates with other computers and peripherals via infrared transmitter-receiver X-721 plugged into left side. When attached to a plotter it can be programmed to create four-color graphic images.

Naturally, as the price of a computer increases, so does the amount of built-in memory and ability to accept more. The Spectravideo, Unitronics, Atari, and Mattel computers, for example, accept much more memory for use with a CP/M option. With CP/M, the machines have the capability of using thousands of sophisticated personal and business-oriented software packages.

Data saving

As in the past, nearly all low-cost computers use conventional cassette tape for saving and retrieving programs or data. It's a simple and inexpensive way to use information, but compared with disk-drive systems, there are two problems: slow data-transfer rate and access time (the time it takes to find a particular spot on the tape).

Slow data-transfer rate means a short program could take minutes to enter; you could have your dinner while waiting for a long one. And the longer the entry time, the higher the possibility of errors, which means you'd have to try the tape again from the beginning.

The new computers, however, offer a few remedies. For example, the interface (the electronics between the computer and cassette deck) is now more "forgiving" to differences in tape and tape-deck quality. The result is higher reliability.

An additional way makers such as Atari, Mattel, and NEC have increased reliability is to offer a cassette deck that is electronically matched to the computer. (Manufacturers call it a data recorder.) The circuits can compensate for volume, tone, frequency response, wow and flutter—all the variable characteristics that can create errors from an unknown tape deck. With the increased reliability, data transfer can be speeded. Panasonic, for instance, has an optional tape deck for its JR-200 computer that saves and retrieves data four times faster (2,400 baud) than a conventional cassette recorder.

The Unitronics Sonic computer takes speed one step further with a built-in wafer drive that's capable of holding up to 128K of information. The *wafer* is a small cassette that holds a continuous loop of 1/16-inch tape. Running at relatively high speed (10 inches per second), the tape can transfer data at 7,200 to 20,000 baud. That begins to approach the speeds normally found with more-expensive disk-drive systems. A 16K program (16,000 bytes of information) takes three to five minutes to load using a standard audio cassette. A wafer can do it in about six seconds, which is about two seconds more than disk drives.

Throw away all disk drives? Not yet. The second difference between wafer and disk drives is access time—the amount of time it takes to find a particular area of the tape or disk for a piece of information. If the program or data you want is at the beginning of the tape, finding it will be fast. But if it is somewhere else, "it could take as long as 30 seconds," a company spokesman told me.

Of course, it's not really a long time if you're simply loading a single, entire program or piece of data into memory. But, for example, if you're using a program to locate and update

Continued

NEC PC-6000 keyboard computer works alone but is designed to accept any number of options: 40-character thermal printer, data recorder, disk drives, graphics tablet, color video monitor, joy sticks, and memory expansion.

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PS buyers' guide to low-cost computers

Manufacturer	Model	Price	Micro-processor	Operating system	Display col. × lines	Graphics	Sound channels	RAM Inc.	RAM Max.	ROM Inc.	ROM Max.	Keyboard buttons/keys	Program Load Cass.	Program Load ROM	Program Load Disk	Ports Serial	Ports Parallel	Included software
Atari	600XL	200	650ZC	CP/M opt.	40×24	320×192	4	16	64	24	24	K	X	X	Opt.	X	—	BASIC
	800XL	300	650ZC	CP/M opt.	40×24	320×192	4	64	64	24	24	K	X	X	Opt.	X	—	BASIC
Canon	X-07	300	Z80 compat.	Proprietary	20×4	120×32	1	8	24	20	42	B	X	X	—	X	X	BASIC
Mattel	Aquarius	125	Z80	CP/M opt.	40×24	320×196	1	4	52	8	8	B	X	X	Opt.	—	—	BASIC
NEC	PC-6000	450	Z80	Proprietary	32×16	256×192	3	16	32	16	32	K	X	X	Opt.	Opt.	X	BASIC
Panasonic	JR-200	279	6802 compat.	Proprietary	32×24	256×192	3	32	32	16	16	B	X	—	—	X	X	BASIC
	JR-800	500	n.a.	Proprietary	32×8	64×192	1	16	24	20	32	B	X	X	—	X	—	BASIC
Spectravideo	SV318	300	Z80	CP/M opt.	40×24	256×192	3	32	144	32	96	B	X	X	Opt.	Opt.	Opt.	BASIC
	SV328	600	Z80	CP/M opt.	40×24	256×192	3	80	144	48	96	K	X	X	Opt.	Opt.	Opt.	BASIC, word proc., terminal emulator
Tandy	MC-10	120	6803	Proprietary	32×16	256×192	1	4	20	8	8	B	X	—	—	X	—	BASIC
Timex Sinclair	2068	200	Z80	Proprietary	32×24 64×24	256×192 512×192	1	48	48	24	24	B	X	X	—	X	—	BASIC
Unitronics	Sonic	450	6502	CP/M Apple DOS opt.	80×40	n.a.	4	80	144	4	4	K	X	X	X	X	X	BASIC, word proc., spread sheet, games

many records on the tape, it could be quite time consuming. And sophisticated programs designed to automatically save or retrieve data as you work (to prevent the memory from becoming full) would be impractical.

The importance of all this will depend on what you'd like to do with your computer. Unitronics plans to include Applesoft compatible BASIC, a word-processing program, a number of games, and provisions to make the Sonic compatible with programs written for Apple DOS 3.3 and CP/M operating systems. It sounds promising, but so far, I've been unable to see a working unit. (The photos are of a mock-up.)

Disk drives offer high-speed saving and loading of programs, quick access time (usually a few seconds at most), and high reliability. But, of course, you'll pay for them—from $300 to $500 more as an option.

For normal home-computer use (games, home finances, filing), disks are nice to have but may be a bit of overkill. However, if you think you might be using your system for small-business jobs (spread-sheet computations, word processing), look at the computers that offer disk drives as an option—you can always add them later.

Communications

Even the smartest computer can't do much if it can't communicate with the outside world. Communication for a computer takes two forms: accepting commands for work and using external peripheral gear to process the results.

The most important way a computer gets its commands is through the keyboard. And with the new computers, I've got good news. The membrane-type keyboards are out. All the new computers use buttons arranged in the standard order that look and feel like keys on an electric typewriter. Unlike membrane keyboards, the buttons or keys give much better tactile response—you know they're pressed by feel, and you don't have to check the screen to confirm an entry.

Comparing keyboards isn't easy. In general, I liked buttons that "clicked" over buttons that just bottomed out when pushed, and I liked the conventional keys over buttons. If you intend to use your computer largely for typing (writing programs, word processing), go for the conventional keyboards. The time and frustration saved could be enormous.

If you don't want to type at all (or as little as possible), there are other ways a computer can get your commands. The NEC and Spectravideo computers, for example, have an optional graphics tablet that lets you create graphics or even enter data by writing on the tablet's surface. Other makers, such

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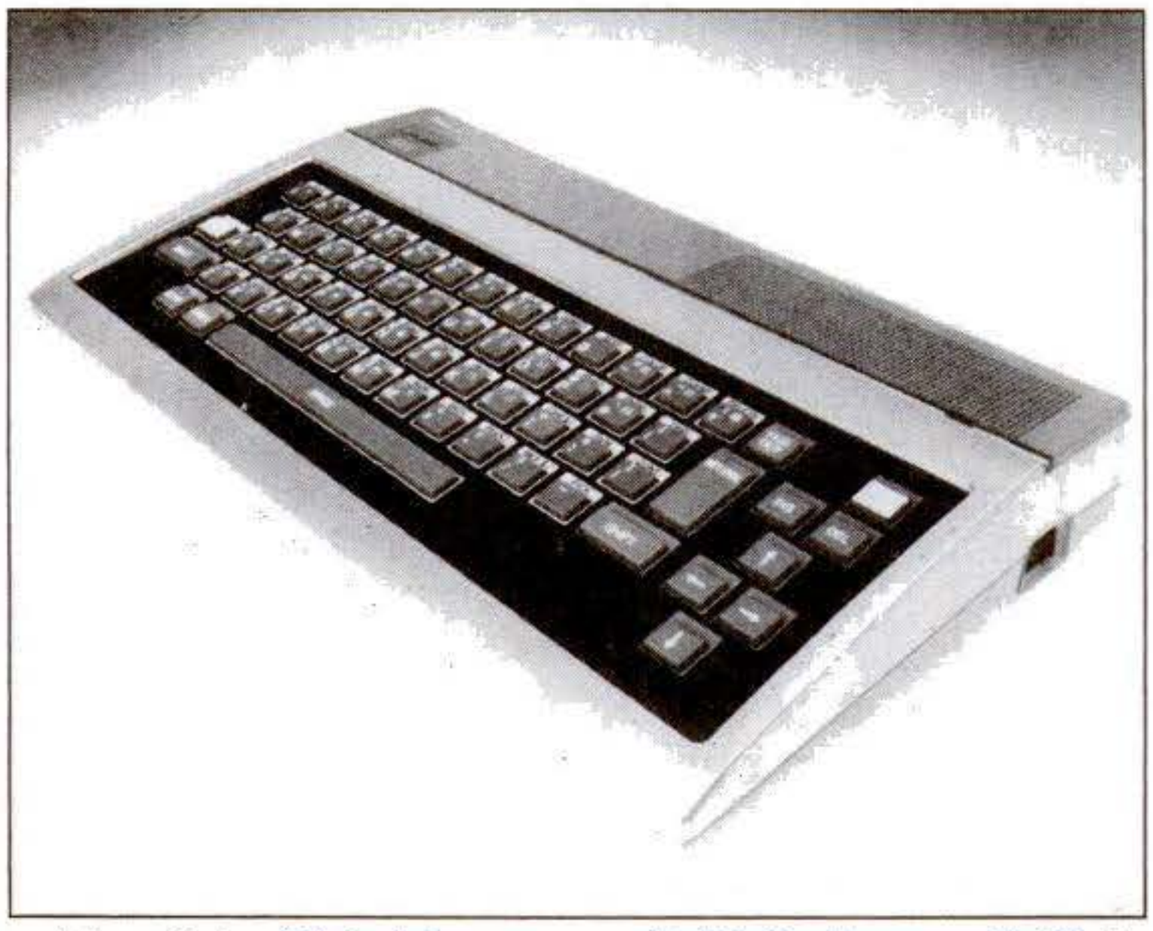

Panasonic JR-800 portable above and JR-200 home computer at right use a high-speed audio-cassette system to save or retrieve data. (Disk drives are available for home unit.) Software is for home, educational, or small-business use.

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as Atari and Mattel, have joy-stick or special-keypad inputs. With these devices, you can move the cursor around the screen to edit text, create graphics, or, for more serious work, move your starship away from the Klingons.

To do real work, your computer also must communicate with other peripherals. A printer, for example, is a necessity. All the computers will accept a printer through a dedicated printer connection or a serial port. A serial port (a particular type of electrical connection to a computer) is becoming a standard feature on most computers. Besides linking the computer to a printer, it is also used for connecting the system to a modem for communication with other computers via telephone. That means you can send or receive data from a friend's computer. Or your system can communicate with any of the large data-base computers such as The Source or CompuServe (and receive everything from airline schedules to POPULAR SCIENCE articles). That gives your computer—whatever its price—the power of a large mainframe.

But communications between computers needn't mean thousands of miles over phone line. To the Canon X-07 portable computer, it means just a few feet over an infrared beam.

The Canon portable can be preprogrammed with credit-card-size RAM and ROM memory packs. Use it for on-the-go word processing or creating programs with its built-in BASIC. When you return home or to the office, the computer uses light to control peripherals and other computers in the room.

"Watch this," a Canon official said to me at a recent demonstration. As he typed on one computer, another one in front of me began to work. Commands appeared on its display; a printer plotted a graph. "It will work up to 17 feet away," he said. "And because light saturates a room, the units needn't be in direct line of sight."

The two computers were linked by a $45 infrared transmitter-receiver option that plugs into the side of each machine. You can use the computer for personal work, then take it to the office. When you turn on the computer, it becomes part of a network of other computers or peripherals equipped with similar infrared devices. No wires. No plugs. Just a room full of invisible light.

Bottom line: software

The high quality, low cost, and clever innovations of the new computers become meaningless without the right software. Unless you expect to write your own programs, look at the programs available for any computer before you buy—it will determine the jobs the computer can perform. If possible, try the software you want at the store. Similar types of programs can vary enormously in ease of operation, usefulness, and speed.

Not only will the software help you choose a computer, it will also determine the peripherals you'll need. Do you just want to learn BASIC and play games? Forget the peripherals, and go for the best price in a computer. Want to do word processing? Be sure the computer accepts a printer with the printing quality you require. (Future PS stories will cover new printers.) Need a computer for record keeping? For small amounts of data, a cassette-based system may work. But for large data bases or the ability to update records quickly, plan on buying a system with a disk drive.

Big decisions? No, just a bit of planning before you hit the store. Sure, there are lots of brands and models from which to choose. But with the built-in quality, features, and capabilities of the new computers, you simply can't go wrong. PS

Mattel Aquarius computer comes in single pieces or may be bought as the COM/PAC, which includes the basic keyboard, expander, hand controllers, 40-column thermal printer, and data recorder. Overlays fit over keyboards.

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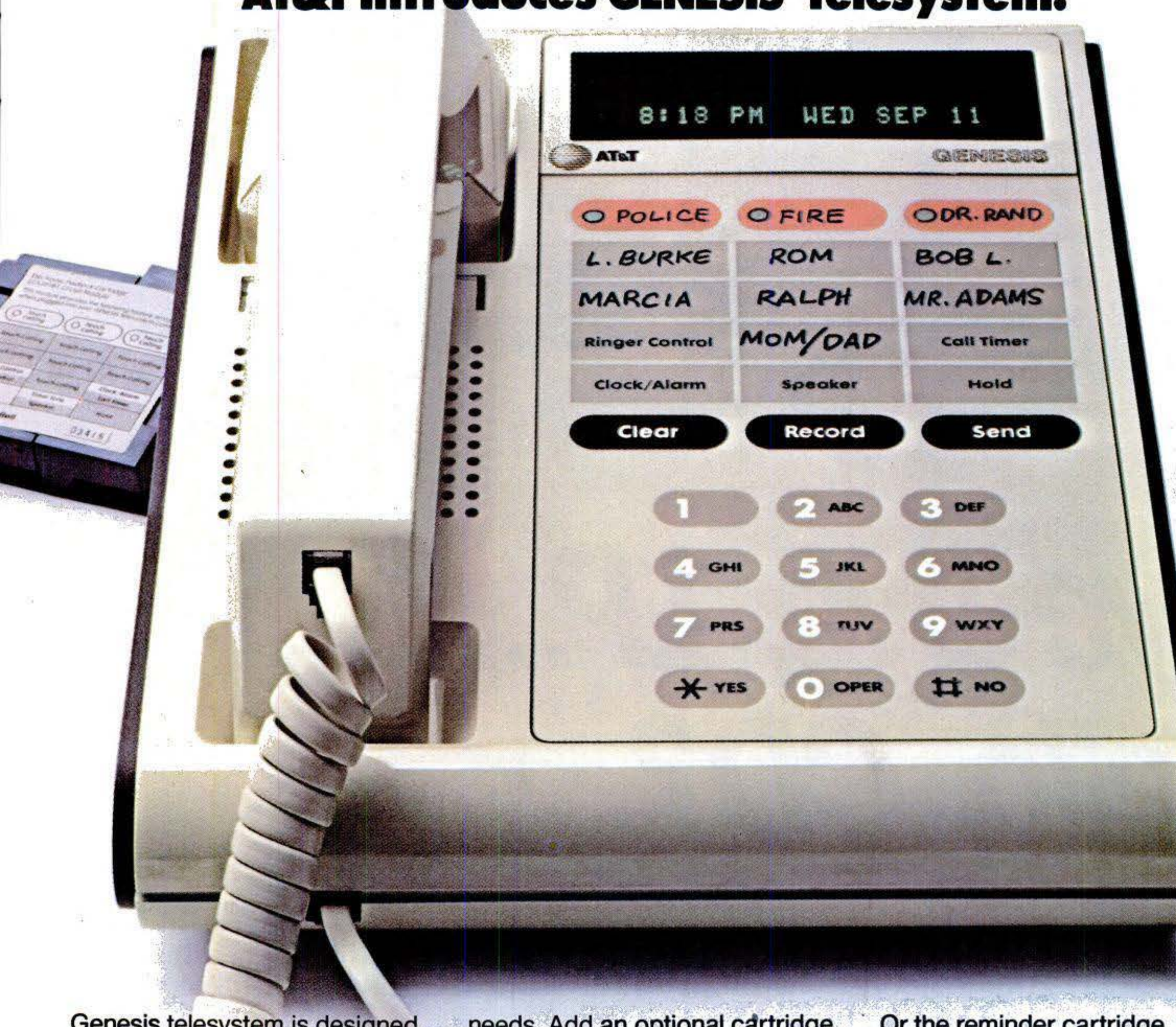

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Soon, you'll be able to add a module with an electronic directory that memorizes names and numbers in alphabetical order. Or the reminder cartridge, to remind you of special occasions and appointments.

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Compact discs, revolutionary new music-playback media, deliver dazzling high fidelity—without clicks, pops, hiss, wow, or flutter. And the discs never wear out—a laser beam in the player "reads" information in digital form from the CD's mirror-like surface. The player's circuits then translate data from the disc into clear, wide-ranging music. High-end CD machines in stores offer many convenience features. But cheaper players are coming.

By LEN FELDMAN
Photo by Greg Sharko

The author is a well-known authority in the audio and video fields. He maintains a fully equipped testing lab to check out the latest products.

Rows of injection-molding machines at PolyGram's audio-disc plant in Langenhagen, West Germany, near Hannover, reminded me, superficially at least, of the pressing equipment for ordinary vinyl-LP records. But something was different: These machines were installed along the walls of a gigantic clean room bathed in filtered, cooled air. The loading doors were accessible only from inside the room. Workers, clothed head to foot in white, lint-free garments to prevent dust pollution, bustled about like helmetless astronauts.

Continued

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Simon's magic box. It's going to change the way the world looks at slides.

Now for the first time, one ingenious compact system lets you sort, edit and view your photographic slides. Conveniently and effortlessly, without a closetful of bulky equipment.

Every detail your camera captures on film, the Simon Slide Viewing System unlocks for you. Simon projects your images with such startling clarity, it's as if you're seeing your slides for the very first time. Sharpness on the big 8 × 8″ optically enhanced screen is superb, with a breath-taking realism no print enlargement can match. Its brilliantly conceived editing rack also makes arranging your slides more pleasurable than you ever thought possible. And the portable Simon sets up instantly—freeing you forever from the bother of slide sorters, projectors and screens.

Three lenses give you a big, bigger or gigantic image.

Conventional slide viewers let you see your slides in only one size—usually doubling or tripling the height and width of the image. You can't enlarge the image to make out fine details, a frustrating drawback. Only Simon lets you view your slides at three steps of magnification—from full-frame to *extreme* closeup. You can inspect your entire slide, then rotate the 3 precision ground lenses to zoom in for a closer look.

Simon's exclusive 3-range magnification. Top: 5× yields full-frame 5 × 8″ image.

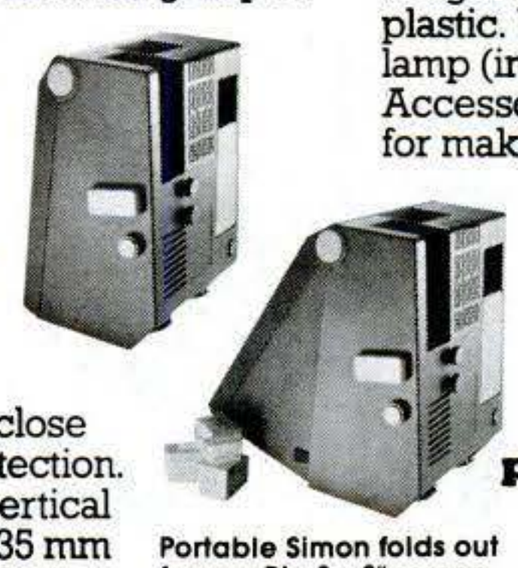
Middle: 8× magnification fills screen (black square).

At 5× magnification, you see your entire slide reproduced as a bright 5 × 8″ image (more than double most standard print enlargements). No need to dim the room lights. Simon's powerful halogen lamp and 3-condenser optical system produce a brilliant clear image. Your slide is evenly illuminated and in focus across the screen—corners as well as center.

Bottom: 22× enlargement for critical inspection of fine details.

Turn the control dial and you move to 8×. Now your image completely fills the screen. Every detail stands out in crisp relief. Only Simon gives you this screen-filling magnification—perfect for group or business presentations.

Another turn of the dial shifts you to 22× — a magnification equivalent to a 22 × 33″ enlargement. Now you can check to make sure a slide is in focus and properly exposed *before* ordering expensive enlargements. This close up, no defect escapes detection.



Portable Simon folds out for use. Big 8 × 8″ screen gives a brilliant image.

Simon's ingenious vertical stack loader holds forty 35 mm slides (or 110 or superslides). Slides load easily—just drop in a stack. The ball-bearing transport mechanism makes slide changing smooth as silk and jam free. The sophisticated heat dissipating design protects your slides, even during extended viewing.

Don't buy a light box to sort your slides. Let Simon do that too.

With its exclusive snap-on editing rack you also save the expense of a separate light box. And it's far more comfortable to use than conventional slide sorters which make you stoop over your work. Simon stands upright, letting you sort 16 slides at a time while relaxing at your desk. Focused light gives brighter viewing than ordinary diffusion light boxes. Remove editing rack to view unmounted film, large-format images, even x-rays. Quick release roller grip holds firmly, won't scratch film like clips.

Simon measures 6 × 9 × 11″ folded, weighs only 8 lbs. The case is high-impact plastic. Uses standard 50 watt projection lamp (included). Plugs into any wall outlet. Accessories include clear overlay sheet for making cropping or editing notes on screen and 6.4 × 8″ mylar mask to visualize proportions of 8 × 10″ blowup. Comes with vinyl dust cover, high-low lamp switch, cord storage retainer, instructions. One year warranty.

Enrich your pleasure in photography. And save $50.

The Simon Slide Viewing System adds immensely to your enjoyment of photography. And Simon's vivid clear image and 3 magnification ranges make it an indispensable tool in the professional studio.

This exciting innovation in photography is available by mail exclusively from The Sharper Image. Right now you can own this complete slide viewing system for $50 off the regular retail price. But supplies are limited. Order your Simon slide viewer today and discover the world of riches hidden in your slides.

ORDER TOLL FREE.

For fastest delivery, credit card holders may call toll free. Order product #MSM754 for the Simon Slide Viewer. Or send a check for $149 plus 6.50 delivery. CA residents add 6% tax.

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San Francisco, CA 94111 ©1983 The Sharper Image

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Your own telephone can become a 24-hour-a-day lifeguard!

If You Aren't Home and a Problem Occurs, This Miraculous Space-Age Instrument Will Do Something About It-Unattended!

The SENSAPHONE

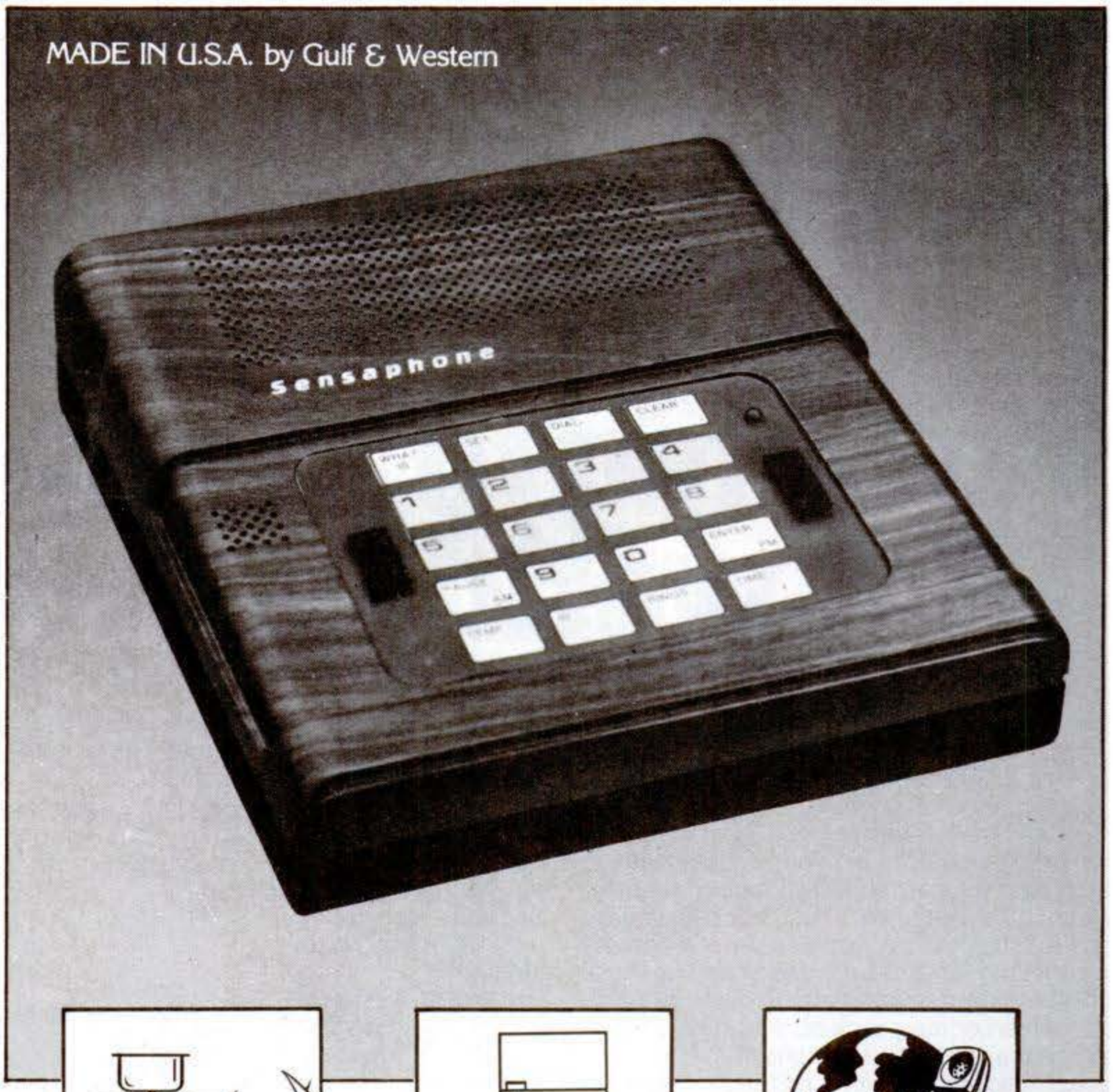
Instead of plugging your phone into the wall, plug it into the Sensaphone, then plug the Sensaphone into the wall. Total time: 10 seconds.

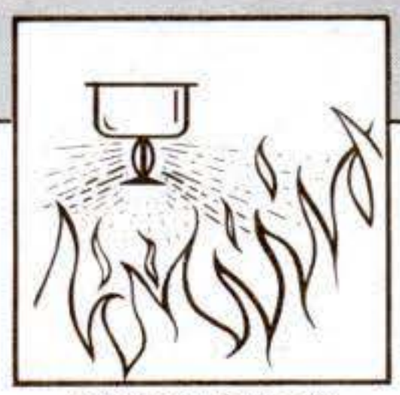
Once hooked up, the Sensaphone reports its findings **in clear English.** For example:

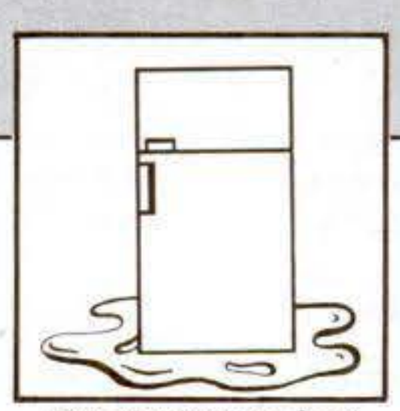
- If you aren't home and a problem occurs — a fire, a power outage, a burglar alarm ring — the Sensaphone will call anyone you've designated and tell whoever answers, in English, what the problem is. If that first phone doesn't answer, the Sensaphone automatically will call up to four numbers in rotation until someone **does** answer and acknowledges getting the call.
- If you call in from the outside to learn how things are, your Sensaphone reports to you on all conditions, in English, then lets you listen to room sounds through its powerful built-in microphone.
- If you want to know the time or the temperature, the Seansaphone will tell you — in English. If the backup batteries protecting the "memory" are low, the Sensaphone tells you — in English.
- You can program the Sensaphone to report on up to three other conditions, such as basement water level, an open door or window, the water heater, or an appliance on. Of course it reports automatically when the room temperature goes above or below the limits you've pre-set.
- An automatic dial feature calls any of eight numbers with one-button dialing.

IF YOU DON'T BELIEVE THE SENSAPHONE CAN DO ALL THIS, GET ONE. TRY IT FOR 30 DAYS. IF YOU DECIDE TO SEND IT BACK WE'LL REFUND EVERY CENT YOU PAID FOR IT.

The Sensaphone **$249.95**
two for **$229.95** each
A FANTASTIC GIFT IDEA!
(add $3.50 per total order for shipping)




Senses and reports problems in the home.


Calls for help so food won't spoil.

Call in from any phone in the world.

WE ABSOLUTELY GUARANTEE!

Plug your home or office phone into the Sensaphone or the Monitor. Use either one for up to 30 days. If for any reason you decide not to keep it, return it for a 100% refund.

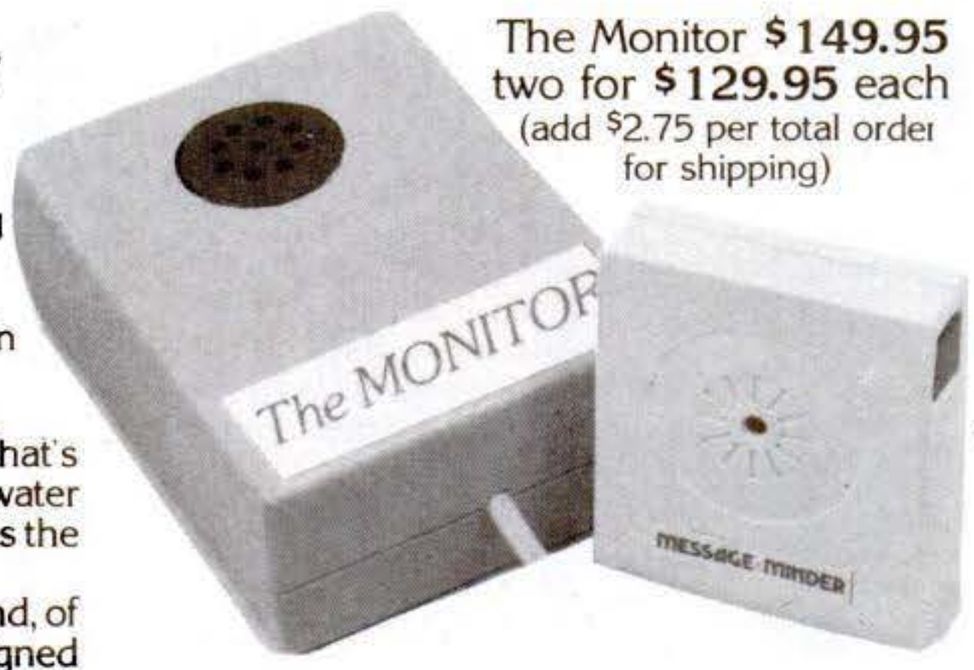
If You Just Want to LISTEN To What's Going On in Your Home Or Office, Get the Less-Expensive MONITOR.

The Monitor is for listening only. Plug your phone into the Monitor, then plug the Monitor into the wall.

You then can call in from any phone in the world. The Monitor answers, then waits 10 seconds for the remote signal.

Enter that signal and you can hear what's going on. Is the baby asleep? Is the water running? Are there unexplained noises? Is the hi-fi blasting?

The Monitor gives you clear, crisp sound, of amazing fidelity and power. It was designed with voice clarity in mind. FCC approved.



The Monitor **$149.95**
two for **$129.95** each
(add $2.75 per total order for shipping)

For fast delivery on credit card orders, call toll-free 24 hours a day, 7 days a week:

800-443-0100
Ask for Extension 111

Or send check or money order.
(Be sure to add shipping cost.)

The **Sensaphone** and The **Monitor** are electronic marvels from

NEW HORIZONS Dept. S11,5-31 Fiftieth Avenue
Long Island City, NY 11101

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Two facts you'll find hard to believe . . .

1. This phone, with engineering for the year 2001, is yours right now.
2. Your cost is only $119.95.

Some of the brightest electronic engineers in the world decided to build a telephone that makes all others obsolete.

This phone would have a **big** memory to remember (and dial with one or two buttons) a lot of phone numbers.

It would handle one or two lines, with a "hold" button, for big-phone performance and convenience.

It would work with rotary pulse or Touchtone®, so you can use it to talk to a computer or to use MCI, Sprint, or any of the tone-code long distance services.

It would display the number being dialed in LED-illuminated figures, to prevent errors even in the dark.

Most of all —

It would be beautiful, a magnificent sleek instrument to enhance any room.

Ladies and gentlemen, we give you...

The **Electronic Secretary-Phone**

Every other state-of-the-art phone we've seen handles either just one line or (bulkily) five lines.

The ELECTRONIC SECRETARY-PHONE is about half the size of most phones, but its innards are crammed with advanced electronic technology.

What a timesaver! It "remembers" up to 32 numbers! Enter them just once — then call any of them by pushing one or two buttons.

Two-In-One, with "Hold" Button

You control two separate phone lines, which means you can have a true multi-line conference call without involving the phone company.

Talk on Line 1; or put the call on Line 1 on hold while you talk on Line 2; or *tie both lines together by depressing both buttons!*

Best of all, you can touch one key and you'll have a hands-free speakerphone whose sound fidelity is surprising. Your phone has a volume control, of course.

Before we tell you how little it costs, here a few more timesavers and conveniences built into your Electronic Secretary-Phone:

Elegant, Expensive-Looking, Easy!

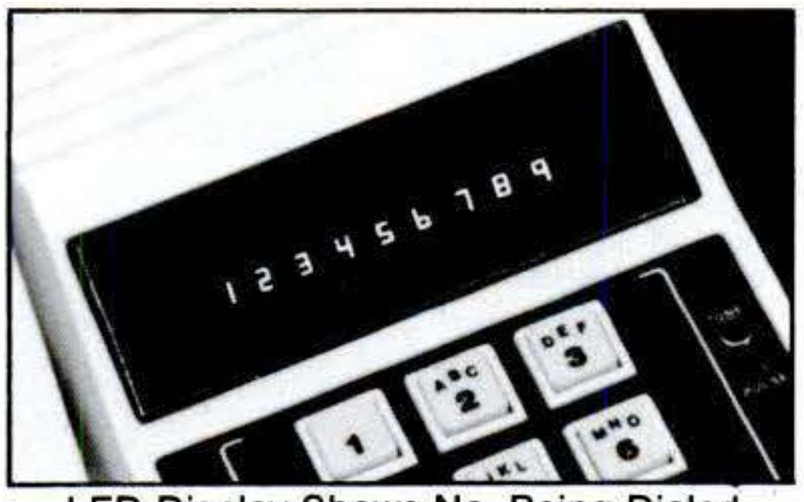
We've seen phones you need an engineer's degree to operate. A child will have no trouble putting this wonder-phone through its paces.

You won't dial a wrong number because an LED display shows you, digitally, the number you're calling.

You can call MCI, Sprint, your computer, or anywhere you need the touchtone signal. A touch of your finger switches back and forth from pulse to touchtone.

Automatic redialling of the last number? Of course. No jangling ringer-bell; the ringer is a pleasant electronic tone.

But we think what you'll like most about the Electronic Secretary-Phone is its beauty. If ever a phone could win an award for design, this is it. You'll be proud to have this phone in your home or office.



LED Display Shows No. Being Dialed.

Get It Far Below Market Place

We originally planned to sell this phone for $169.95, and it would be a bargain at that price. When we decided to feature it in our catalog, we lowered the price to $129.95.

Now we've been able to contract for enough of them that *you can own an Electronic Secretary-Phone for only $119.95!* At that price, while we have them, you should order two.

Our absolute guarantee means you'll have a month to use this phone and see for yourself that our claims about it are true. Enjoy it!

WE ABSOLUTELY GUARANTEE!
Plug in the ELECTRONIC SECRETARY-PHONE. Use it for up to 30 days. If you decide for any reason you don't want to keep it, return it for a 100% refund.

- **Handles TWO Phone Lines**
Use the "Hold" button to switch back and forth, Or use them together for conference calls!

- **Conference Call Feature**
Just push both buttons and both lines are open. They're interactive, so you can tie two calls together!

- **Speaker Phone**
If you have a roomful of people, or if you just don't want to hold the instrument, your Speakerphone has wonderful sound fidelity plus volume adjustment!

- **32 Memories**
Your phone "remembers" up to 32 numbers. Enter them just once, then dial by pushing one or two buttons. Even remembers long strings of numbers like MCI!

$119.95 complete
SAVE $20.00! Two for $219.90
(+ $2.50 per total order for shipping)

Order TOLL-FREE
For fast delivery on credit card orders
call toll-free 24 hours a day, 7 days a week:

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Two days earlier, at Eindhoven, Netherlands, I toured a disc-mastering center of N.V. Philips, the huge Dutch electronics company. This Philips site, where the PolyGram discs begin, demands unusual precision: The mastering lab is built on a massive foundation of stone, which itself floats on a supporting cushion of air. It's immune to the most minute vibrations.

Such extraordinary cleanliness and precision is a must because the Philips-PolyGram facilities produce not vinyl LP records but compact discs (CDs). These discs are the most radical change in record technology since Thomas Edison demonstrated his tinfoil cylinder recordings over a century ago. A CD is only 4.7 inches in diameter, yet it stores more than 60 minutes of music on one side in the form of microscopic pits—some eight billion of them in a spiral track about 2.5 miles long. A CD is played not by a needle but by a beam of light.

At the moment, disc players are expensive and the discs scarce, but prices are tumbling. Should you consider buying one of these machines? At the moment, it's hard to say. Let me tell you what I've learned in seeing CD players demonstrated in both Japan and Europe, and in testing them in my own lab.

My tour of the Philips CD facilities in the Netherlands, Belgium, and West Germany took place recently, just as these discs and their players were being introduced on the U.S. market. This past summer, several firms began selling high-end CD players—$800 and up—here in the U.S. (Sales in Europe and Japan began last year.) But already, with over 20 firms offering CD machines, prices are plummeting; Sears has an under-$600 model.

The discs themselves—the software—are still scarce (see box). But by next year, production should catch up with demand, pushing disc sales here from perhaps one million this year to a predicted eight million or more in 1984.

Unlike ordinary analog recordings, which are physical or electrical representations of the original sound waves, the pits on a CD represent an on-and-off digital code. A laser beam, focused on a spot just over one micron (millionth of a meter) wide, etches this code on the master disc. Another laser in the CD player, which plugs into any hi-fi amplifier, bounces light off the track to "read" the disc.

Light beams, of course, can't wear CDs. And the decoded light beam results in the best music fidelity yet heard, free of ticks, pops, hiss, wow and flutter—all the distractions of ordinary media. Yet, as you'll see, problems exist: Not all recording engineers have learned to use CD technology equally well. And your hi-fi gear may not meet the demands of CDs.

Error codes

My first encounter with CD software and players was in 1980. I visited the Sony Corp. in Japan and heard one of these remarkable laser-tracked discs on a prototype machine [PS, Nov. '81]. Philips, which began CD development in 1974, joined forces with Sony in 1979 to ensure a worldwide standard for digital discs. Sony's technical contributions included a sophisticated digital error-correction code that allows most disc blemishes to go unnoticed. The firms have jointly licensed over 50 hardware or software companies, setting, in effect, a de facto standard for digital discs.

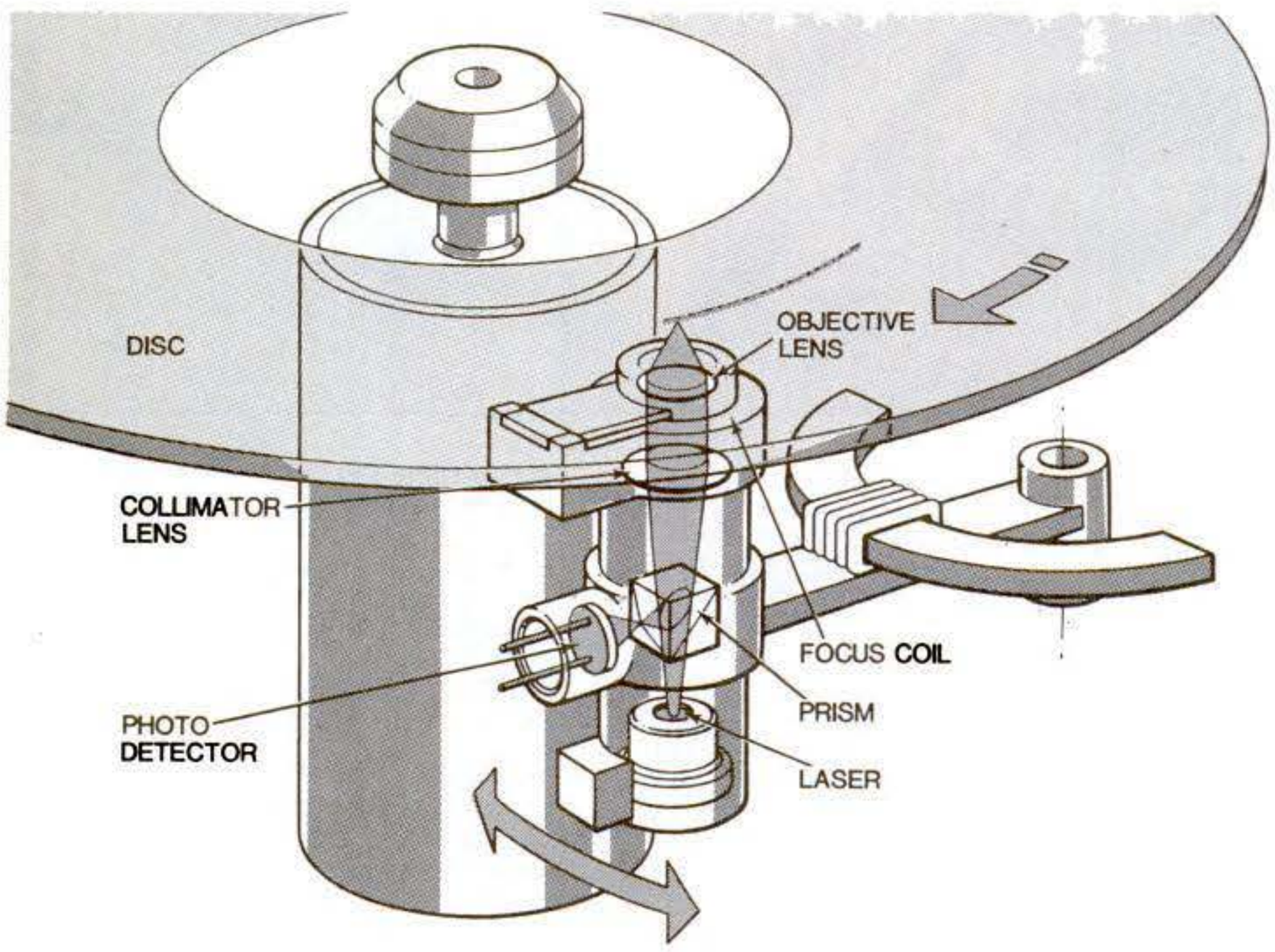
Now, three years after my visit to Japan, I've tested a dozen different CD players in my lab and listened to some 50 discs. Specially pressed test-signal discs were prepared by Sony and Philips.

Perhaps the most obvious difference I've noticed between a CD and its vinyl LP counterpart is the CD's total absence of surface noise. Slip a plastic-coated CD into a player, start the machine, and you may think it isn't working at first. That's because there's absolute silence until the music begins, not the customary veil of noise from conventional record grooves. With the disappearance of that noise, the music comes through with greater clarity and definition.

The protective coating on a CD prevents dust or debris from reaching the reflective metal surface. Only significant scratches or blemishes interfere

Continued

How CD players work



Audio information is put on a compact disc as a track of microscopic pits in a thin reflective layer of aluminum. The spacing and length of these pits—each is about one micron long—determine what data the player "sees." An infrared beam from a semiconductor laser is focused on the pits through a series of lenses and prisms. Light striking a pit is scattered; light hitting the smooth surface between pits is reflected back through a prism to a photo detector—a diode that converts light into an electronic signal. This on-and-off digital signal is decoded by a series of microcircuits, then fed through an electronic filter that changes it from digital form into an analog signal suitable for any hi-fi amplifier. Some manufacturers, using different techniques for digital-to-analog conversion, claim superior performance.

Music tracks on a CD are played back in a manner opposite to that of an ordinary LP record. The first track is on a CD's innermost section, the last track on its rim. (Only one disc side is used, to simplify manufacturing.) When a disc is played from beginning to end, the laser mechanism is positioned near the spindle as the disc starts to spin clockwise at 500 rpm. As playback proceeds and the laser moves in a straight line toward the perimeter, disc speed gradually diminishes to about 200 rpm. This technique, which lets the laser "see" the CD tracks at a constant linear speed, enables more data to be stored on the disc. (Pit size and spacing can be the same along the 2.5-mile-long track.)

Slightly warped discs vary the intensity and shape of the beam reaching the photo detector. Signals sent to the lens-focus coil, or laser-drive motor, instantly refocus the lens or move the laser back on track.

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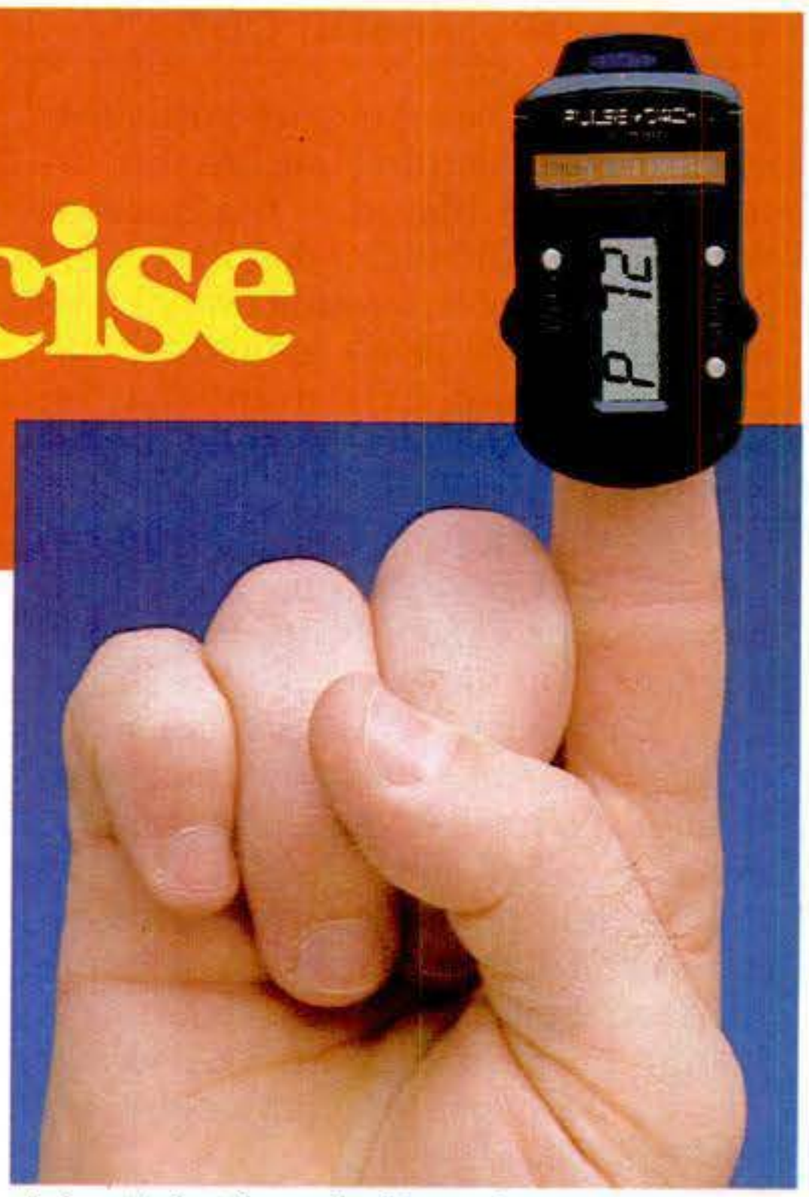
New Pulse Meter makes your exercise safe & effective!



Pulse Tach Fingertip Heart Computer is just two inches long, weighs about an ounce and represents a major advance in personal electronics.

The Pulse Tach™ Heart Computer was originally developed for use in hospitals and doctors' offices. Try it Free for 30 Days!

How fast does your heart beat when you exercise? How quickly does your pulse return to normal? Does your "recovery time" improve as you get into better shape?

Well, guess no more. The Pulse Tach Fingertip Heart Computer accurately reports your pulse to insure maximum benefit from your exercise without dangerous overexertion.

Pulse Tach is actually a microcomputer that fits over your finger. Its custom-made, powerful microchip circuit replaces 5600 transistors and makes Pulse Tach the most advanced pulse instrument ever developed for consumer use.

Pulse Tach measures, calculates and displays what your pulse is doing.

AUTOMATIC, ACCURATE HEART REPORT

Reading your pulse isn't as simple as it might seem. Your heartbeat constantly changes — perhaps three fast beats followed by two slow ones, one fast one, four slow ones and so forth.

Pulse Tach has two ways to overcome the problem. First, in general or light exercise use, it "averages" your pulse every four beats. But after heavy exercise (or if you have an irregular rhythm) Pulse Tach can also compute heartbeats over a longer span of time. In fact, Pulse Tach is accurate to 1%.

After Pulse Tach evaluates and processes your heartbeat, it shows your pulse rate on an extra large Liquid Crystal Display for easy reading indoors or out.

There's more. Press a button and an audio "beeper" lets you "listen" to your heartbeat. It's like having a direct line to your heart.

ALSO A CHRONOGRAPH

Pulse Tach is more than just a way to count heartbeats. It also has an independent quartz stop watch. Now you can time your exercise period, laps or anything else up to one hour.

With Pulse Tach you know when you reach the heart rate at which exercise does the most good. The stop watch feature tells you precisely how long you're at this optimum level. Then combine both functions and compute cardiac recovery time — the most important measure of cardiovascular fitness. The better your shape, the shorter your recovery time.

Additionally, Pulse Tach will show you how your heart is affected by coffee, a cigarette or a stressful day at the office.

It makes a great gift for a wife in aerobics or your tennis partner. In fact, anyone who exercises will appreciate this little heart computer.

THE PRICE MAY BE THE BIGGEST NEWS

Original cost of the Pulse Tach was quite high because quantities were limited to professional use. But just as pocket calculators and computers have dropped in price when made available to consumers, so, too, it is with Pulse Tach.

The Pulse Tach Fingertip Heart Computer is only **$49.95** yet its solid-state microchip components give better accuracy and more features than bulky, old-fashioned pulse meters costing $100-$200.

TRY IT FOR 30 DAYS

Prove to yourself that the Pulse Tach Heart Computer is the smallest, most advanced pulse monitor on the market today. Try it for 30 days. If you're not satisfied for any reason, simply return it for a complete refund — including return postage. You're protected by a 90 day manufacturer's warranty as well as Baystar's reputation for satisfied customers.

Your Pulse Tach will come complete with long-life watch batteries and a necklace-size lanyard to keep Pulse Tach handy when its not on your finger. You'll also receive helpful instructions including information on your "target zone," cardiac recovery time and other exercise hints.

HERE'S HOW TO ORDER

To order, simply send your check for **$49.95** plus $2.45 shipping and handling to The Baystar Company at our address below. Credit card holders can speed their delivery by using our toll-free number.

CALL TOLL-FREE

Monday thru Friday 9 a.m. to 5 p.m. Eastern Time

800-638-6170

All other times call 800-257-7850

Maryland residents call 363-4304

Your heart is thumping. Is it a danger signal or not? Find out. Order a Pulse Tach Heart Computer today!

Baystar

110 Painters Mill Road Dept. 15V
Owings Mills, MD 21117 (301) 363-4304

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with the light beam bounced from this surface. Since nothing touches the surface when it's played, a CD handled with care should last indefinitely. The 1,000th playing will sound every bit as good as the first. That's something that can't be claimed for conventional records, no matter how carefully they're handled and played.

But freedom from noise is only the beginning. CD recordings have a dynamic-range capability of more than 90 dB: That is, whatever residual noise that exists is 90 dB quieter—dead silent, for all practical purposes—than the loudest music. This added dynamic range, far beyond that of the best conventional recordings, now permits recording engineers to capture the true dynamic range—the loudest instantaneous peaks as well as the softest passages of music—in any performance.

In the past, to make master recordings from which LP discs are produced, engineers have almost always had to electronically "compress" music dynamics—trimming peaks, boosting low sounds—so they could "fit" the physical limitations (that is, be heard above the background noise) of ordinary vinyl records. It's this compression that often tells even an inexperienced listener that he or she is listening to a recording, not a live performance.

My own listening experiences and lab measurements confirm other technical claims made for CD players and recordings. Distortion is so low that it becomes difficult to measure—it's insignificant. Frequency response is flat, to within a small fraction of a decibel, from below 20 Hz to 20,000 Hz, the nominal upper frequency limit of human hearing. Wow and flutter (a wavering of musical pitch) are nonexistent in a CD player.

To a great extent, this amazing fidelity can be attributed to the precise computer-like decoding process that takes place after the laser beam "reads" a disc. The coded data on a disc, representing samples of sound waves made at very high speed, are processed and reproduced in a manner that makes them immune to the types of noise or distortion that affect even superior analog hi-fi systems.

"A CD handled with care will last 'forever'—the 1,000th playing will sound as good as the first"

Studio tricks

I've concluded, though, that for the moment at least, the way music is recorded for some CDs may be a limiting factor. Many early CDs were produced from master tape recordings originally used for conventional LP discs. CDs based on these tape recordings no longer sound as compressed or limited in dynamic range as their LP counterparts. But certain tricks of the recording trade that compensate for the deficiencies of ordinary LPs tend to make some CDs sound overly bright, even strident, because of the high-frequency emphasis.

However, recording engineers are rethinking techniques used in the past in order to produce satisfactory tapes for CDs. A number of microphones placed right next to the performers, for example, may contribute to excessive brightness. But placing just a few mikes farther back seems to enhance CD recordings.

Many currently available CDs do show CD technology to full advantage. Some firms making CD players claim that theirs have sonic superiority over other CD machines; however, I've found it difficult to detect any substantial differences in sound quality from one player to another. You wouldn't expect, for example, to hear any difference between a player with 0.003-percent harmonic distortion and one that causes 0.005-percent distortion. Nor would you expect to find a player with a 90-dB signal-to-noise ratio audibly noisier than one with a 93-dB ratio. Whatever subtle differences exist are far outweighed by the clear superiority of CDs compared with the very best "audiophile" LP discs available.

The differences between first-generation CD players, then, are largely in their operating and convenience features. The situation is similar to the video-recorder market: VCRs with complex programming features cost more than those designed only for simple manual recording and playback. All of the CD players listed in the buyers'-guide table, for example, can be directed to play a certain track or selection on a disc. But not all players can be programmed to play a series of tracks in sequence or in random order.

Some machines can repeat a specific musical phrase within a track that interests you. Even among players that can be programmed to play several such selections, some handle far more than others (eight on the Sony CDP-701 and Kenwood L03-DP, all the way up to 99 on the NEC CD-803E). If you plan to use programming capabilities extensively, make sure you test this feature before you buy. Some decks can zip the laser to a disc's end bands in a few seconds; another machine may take much longer.

Special signals stored on CDs enable more-advanced players to perform unusual tricks. An enormous amount of sub-code information can be stored with the music codes. It's possible on some machines to divide the disc's contents into discrete selections culled from different tracks, then subdivide the selections into subsections—a technique called indexing. The third movement of Beethoven's Symphony No. 3, for example, may have index points identified as (1)

Continued

PS buyers' guide to compact-digital-disc players

Make & model	Price ($)	Elapsed time from track start	Remaining time display/ track display	No. selections programmable	Repeat phrase	Remote control	Cueing by time	Cueing by index
Hitachi DA-1000	1,000	Yes	No/Yes	15	No	No	No	No
Kenwood L03-DP	1,000	Yes	*/Yes	8	No	No	No	Yes
Kyocera DA-01	1,050	Yes	Yes/Yes	24	Yes	No	Yes	Yes
Magnavox FD-1000SL	800	No	No/Yes	15	No	No	No	No
Mitsubishi DP-101	1,100	Yes	Yes/Yes	30	Yes	Yes	Yes	Yes
NEC CD-803E	1,400	Yes	Yes/Yes	99	No	Yes	No	Yes
Phase Linear 9500	995	Yes	Yes/Yes	24	Yes	No	Yes	Yes
Sansui PC-V1000	1,000	Yes	*/Yes	*	Yes	Yes	*	No
Sharp DX3	950	Yes	Yes/Yes	20	Yes	No	Yes	Yes
Sony CDP-101	900	Yes	Yes/Yes	—	Yes	Yes	No	No
Sony CDP-701	1,500	Yes	Yes/Yes	8	Yes	Yes	Yes	No
Technics SL-P10	1,000	Yes	Yes/Yes	63	No	No	Yes	Yes
Yamaha CD-1	1,400	Yes	Yes/Yes	15	Yes	No	Yes	No

*No data regarding this feature

Although all of these players have some form of scanning ability, most mute the audio in the fast-search mode. The exceptions are the two Sony models. All but the Kenwood, Sharp, and Sansui models have been lab tested by the author.

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The Man in the Plain Pockets Jeans

He likes jeans made of tough, cotton denim. Jeans that fit right and look good, without frills or fancy stitching. He's the man who knows there's more to quality than an inflated price tag. The man in the

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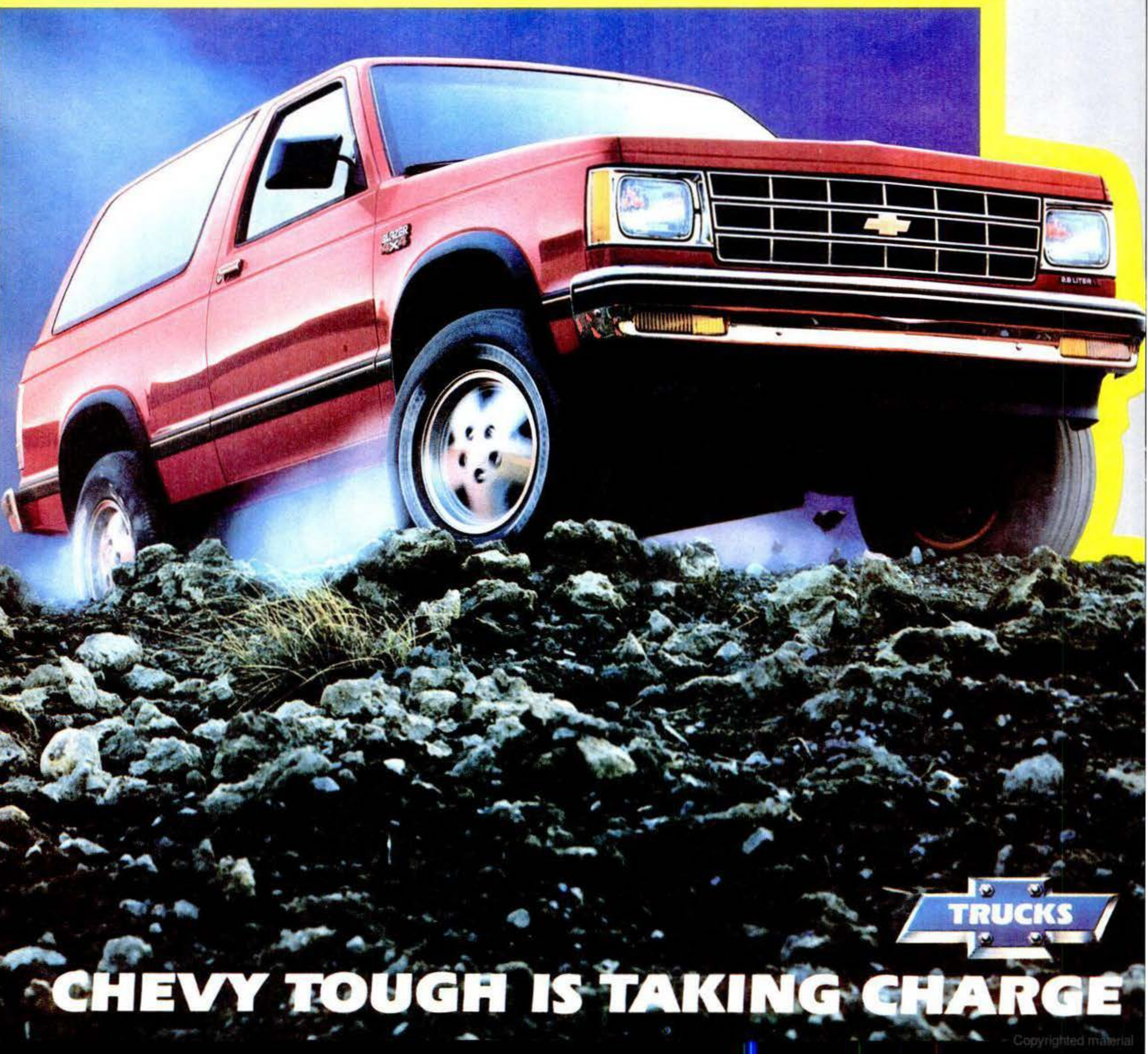
The revolutionary Insta-Trac system is standard on every 4x4 S-10 Blazer, Regular-Cab and Maxi-Cab Pickup. Shift from freewheeling 2-wheel drive to 4-wheel-drive High and back at any speed. A lighted action-display console shows when you're "hooked up" to 4x4 traction.
Number one in sales. Insta-Trac has helped make Chevy S-10 Blazer 4x4 the best-selling sport utility vehicle in the U.S.A. There's also the available muscle of a V6. And, with the optional rear seat folded down, you get a longer cargo length than any full-size sport utility vehicle. Chevy S-10 Blazer. It's a knockout.

Some Chevrolet trucks are equipped with engines produced by other GM divisions, subsidiaries, or affiliated companies worldwide. See your dealer for details. Let's get it together...buckle up.



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Scherzo, (2) Trio, and (3) Scherzo. Some players can find the index points within a given selection; others lack that capability.

When you slip a CD into a player such as the Philips-made Magnavox FD-1000SL and press "play," the disc begins spinning and loads data about its contents into the deck. On the FD-1000, green LEDs light up to show how many programs are on the disc. Then you use the "store" and "select" buttons to program the selections you want, which illuminate indicator lights for those tracks.

Some players I've evaluated in my lab have wireless remote controls that duplicate most front-panel command functions. Most machines have a digital display indicating the elapsed time after a selection starts. Also, many decks show how much playing time remains to the end of a disc.

The information needed for these built-in "smart" functions is encoded on the disc. Manufacturers can build in as much or as little decoding circuitry as they wish to make such convenience features available.

What happens when the narrow beam of laser light in the player strikes an obstruction such as a fingerprint on the protective plastic surface of a CD? In most cases, nothing. Since the laser is focused not on the surface but on the aluminum layer beneath it, the fingerprint may have no effect. But significant defects trigger the player's digital error-correction functions. When these circuits sense that bits of music are missing, they can use duplicate data that's simultaneously read out and compared with the original data to detect when something has gone wrong. Even with 3,000 or more missing bits, the error corrections can reconstruct a music signal that may sound no different from music on the rest of the disc.

Recently, I attended a limited showing of an experimental Technics CD player. I learned that despite all the special data being encoded onto CDs in addition to the music, there's still plenty of space left for additional data. On a table next to a TV receiver was a Technics SL-P10 player. The machine had been modified internally and attached to several boxes of electronic equipment. A few seconds after a disc began playing, a full-color still picture appeared on the TV.

> *"Are you serious enough about music to require the absolute best equipment regardless of cost?"*

After about 15 seconds, a new picture appeared on the screen—then another, and another. A Technics engineer told me that, even after all the music, time, and track data were encoded, enough digital storage space remained on a disc for about 250 color pictures. The subject matter could relate to the music (scenes depicting a song's subject matter, for example) or anything else a producer might dream up.

But Technics engineers stressed that this project was only experimental. No video-CD player was even in the production-planning stages. The demonstration simply indicated the enormous storage capabilities of the Philips-Sony CD system available to hardware designers. Many companies, though, are developing ordinary CD players for cars, and models could be introduced soon.

Surveying the prices of first-generation machines, it's clear that joining the CD revolution now could cost as much as many people spend for an entire audio system. Manufacturers I've talked to believe that they'll sell a good number of CD machines at these prices to serious hi-fi enthusiasts. But they concede that prices will have to come down significantly before CDs become common for home entertainment. The turning point, many think, will be a CD machine costing $500 or less.

Should you buy?

Whether or not you should rush out to buy a CD player and discs now depends on just how important good audio equipment is to you. Are you serious enough about listening to music to require the absolute best equipment regardless of cost? I'd suggest first listening to a few CD albums in an audio store. Many of the better department stores now feature CD players, too. After you've heard the improvements that CD delivers, you'll be in a better position to judge whether the immediate investment is worthwhile.

CD players may, depending on how you use them, create a problem with your current hi-fi equipment. If you listen to music at moderate volume levels now and continue to do so with CDs, you can only benefit from the superb fidelity. But if you crank up the volume, you may find the dynamic range built into CDs to be too much for your audio equipment. Your amplifier or receiver may introduce distortion or overload your loudspeakers.

The truism about the sound of an audio-equipment chain being only as good as its weakest link was never truer. Previously, the program source was often the weakest link. Now, with CDs, you may have to reevaluate all of your hi-fi gear. To gain the full benefits of CDs, much of your equipment may have to be replaced with components equal to the task of reproducing a laser disc's sonic fireworks. PS

CD recordings—what's available?

Philips, stung by a disastrous introduction of software for its LaserVision video-disc system, has attempted a different marketing approach for its CD system: It is trying to limit the number of players on the world market until CD plants can turn out millions of discs to meet the anticipated demand. The results are mixed.

When CD players were introduced in major Japanese cities over a year ago, audio enthusiasts dashed from shop to shop. But stores with players had little or no software. Those CD albums that were available sold out quickly and replenishments were slow. An initial rush to buy players slowed down as audio shoppers discovered the lagging disc supply.

A PS editor checked several audiophile stores in New York City following the introduction of CD players this past summer. At one, he discovered nine discs displayed in a glass case. He selected two, expecting the clerk to fill his order from the stockroom. But he received the two discs on display, leaving only seven for the next CD customer.

In Amsterdam, though, I was able to find shops with a limited number of selections. With a little patience, I located albums in a catalog from the PolyGram record group that I wanted for my collection.

Last June, an organization calling itself the Compact Disc Group, consisting of major CD hardware and software makers, issued its first CD catalog. You can get a copy, and future updated publications, by contacting the Compact Disc Group Information Center, Box 2395, Rockefeller Center Station, New York, N.Y. 10185, phone number: 212-355-6947.

Who's making CD records? The table below shows record manufacturers with CDs available now or by the end of this year. Although a dozen labels are shown, most discs are being pressed by only three or four major firms in Europe and Japan. CBS Records in Terre Haute, Ind., is converting part of its plant for mid-1984 production. Currently, discs cost about $18 to $20 each from these firms:

Mfr. or label	Classical	Popular
Arista Records	late '83	
Capitol Records	late '83	
CBS Records	22 titles	26 titles
CBS/Sony	8 titles	8 titles
Chrysalis Records	late '83	
Denon Records	21 titles	7 titles
Deutsche Grammophon	28 titles	—
London	28 titles	—
Philips	24 titles	—
RCA Records	late '83	
Telarc Records	23 titles	—
Warner/Elektra/Atlantic	—	33 titles

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The race to deliver little-dish TV

Until now, large-dish antennas were necessary to pull in satellite-TV signals. But a new era of direct-broadcast TV, featuring rooftop antennas as small as two feet across, is about to begin. More-powerful satellites and highly sensitive receivers make this possible. Three companies are signing up customers for direct-broadcast TV—and debating the merits of each other's technology. One company claims tomorrow's systems must use super-high-power satellites or suffer interference. Other companies say technology has advanced so fast that the proposed high-power satellites are obsolete. But if the systems fulfill their promise, they may change the way we communicate.

By SUSAN RENNER-SMITH

When I first reported on satellite TV [PS, March '78], it was clear that developing technology would soon permit TV signals to be sent directly to tiny dish antennas. "But commercial considerations and federal regulations make direct-satellite TV unlikely in the near future for U.S. viewers," I predicted.

In 1981, Comsat, a major satellite company, applied to the FCC for permission to build a 200-watt satellite that would transmit signals directly to two-foot-diameter dishes. Eight other companies followed with similar applications. So much for predictions.

The Comsat system, the first to get FCC approval, was scheduled to begin operation no earlier than 1986. But last spring, United Satellite Communications, Inc. (USCI), received FCC permission to offer a direct-broadcast-TV service now scheduled to begin Nov. 15. In response, Comsat has announced plans for an interim service to begin next year. Another company, Skyband, Inc., says it will begin direct-TV transmissions by the end of this year.

These systems represent a new generation of direct-to-home TV broadcasts, different in many ways from what is now available. The most visible difference is the smaller antenna, made possible, in part, by more-powerful satellite transmitters with carefully aimed beams. Advances in receiver technology help make the systems practical.

The new technology sounds straightforward, but it isn't that simple. There are conflicting claims about the relative importance of the various components. To follow the debate, you must first know how the new systems differ from the current version of satellite TV.

In recent years, large, 10-to-15-foot dish antennas have popped up in backyards of the affluent across the country [PS, Nov. '81]. All of these antennas are aimed at about 15 satellites hovering 22,300 miles above the equator. In this geostationary orbit, a satellite rotating at the same speed as Earth seems to stay in one place in the sky. It can transmit microwave signals anywhere along its line of sight.

Today's wide-beam C-band satellites function as repeaters, transmitting radio, telephone, and TV signals between Earth stations scattered across the U.S. The transmissions range from network-TV shows to entire cable channels such as Home Box Office. Although the TV signals are aimed at commercial broadcast stations, anyone with a dish antenna and a clear line of

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And still you have big heating bills month after month. Yet you've done all you can to save on fuel costs.

Except the one thing that can make the really *big* difference. And that's to change the way you heat.

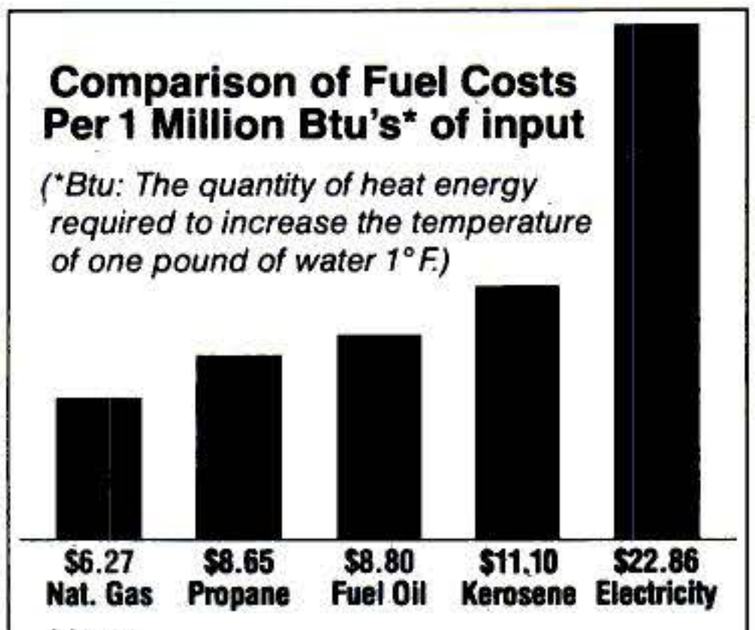
Not by changing to other fuels—because gas is still the lowest cost way to heat your home (see chart). But even gas can be used more efficiently.

What has been needed are more imaginative ways to *use* gas for home heating.

First, that means heating systems that stretch every dollar you pay for gas. But it also means using gas only *where* you need it and *when* you need it. And *not* using it where and when you *don't* need it.

Comparison of Fuel Costs Per 1 Million Btu's* of input

*(*Btu: The quantity of heat energy required to increase the temperature of one pound of water 1° F.)*



Note:

Cost figures for Natural Gas, Propane, Fuel Oil and Electricity are those established by the Federal Trade Commission (Department of Energy) as the revised national average energy costs for 1983. (Refer Fed. Reg. Vol. 48, No. 64/Friday, April 1, 1983/Rules and Regulations.) Cost figure on Kerosene, 1K (water clear) is an established national average of $1.50 per gallon (135,000 Btu/gallon) based on information obtained from the industry association. Costs will vary depending upon the output and efficiency of the heating appliance in use. With Electricity, costs will also vary where special heating or all-electric rates are available.

That's how you save money on your light bill. By turning lights on where you need them and off where you don't.

Now you can follow that same money saving principle to save on heating costs. Instead of one big gluttonous furnace, today's need is for smaller, high efficiency heating systems that use energy in smaller amounts *where* and *when* you need it.

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sight to the satellite can receive them.

The coming direct-broadcast systems will use a new generation of more-powerful satellites to transmit TV signals on the higher-frequency K-band. The signals can be received by small, unobtrusive antennas, roof-mounted to get the best view of the satellite. (The higher-frequency signals can't be processed by existing backyard Earth stations.)

The details of the three companies' systems differ, but each promises five channels of commercial-free movies, sporting events, news, children's programs, and special programs ranging from soap opera to grand opera. All systems plan to scramble their TV signals, and all will have some form of "addressability." Each company will remotely switch a subscriber's receiver on (or off) as well as authorize reception of special "pay-per-view" programs.

Charges will range from $35 to $40 per month, including fees for leasing the home dish antenna and receiver. A variety of dealers, from nationwide retailers to local telephone companies, will install the equipment. (At press time, no company had announced any dealer arrangements.)

Shrinking dishes

The more powerful the transmitter, the smaller the dish antenna needed

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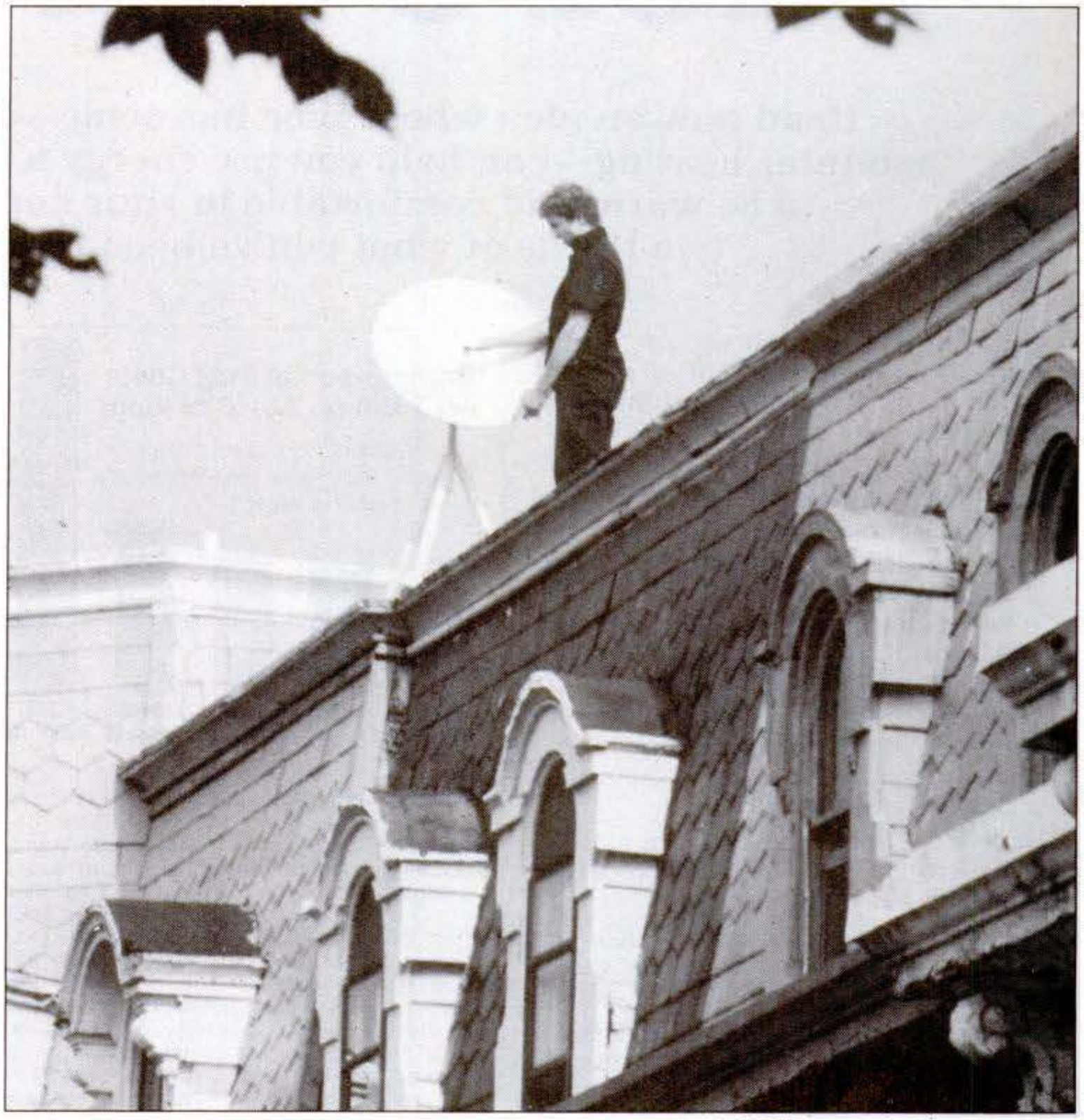
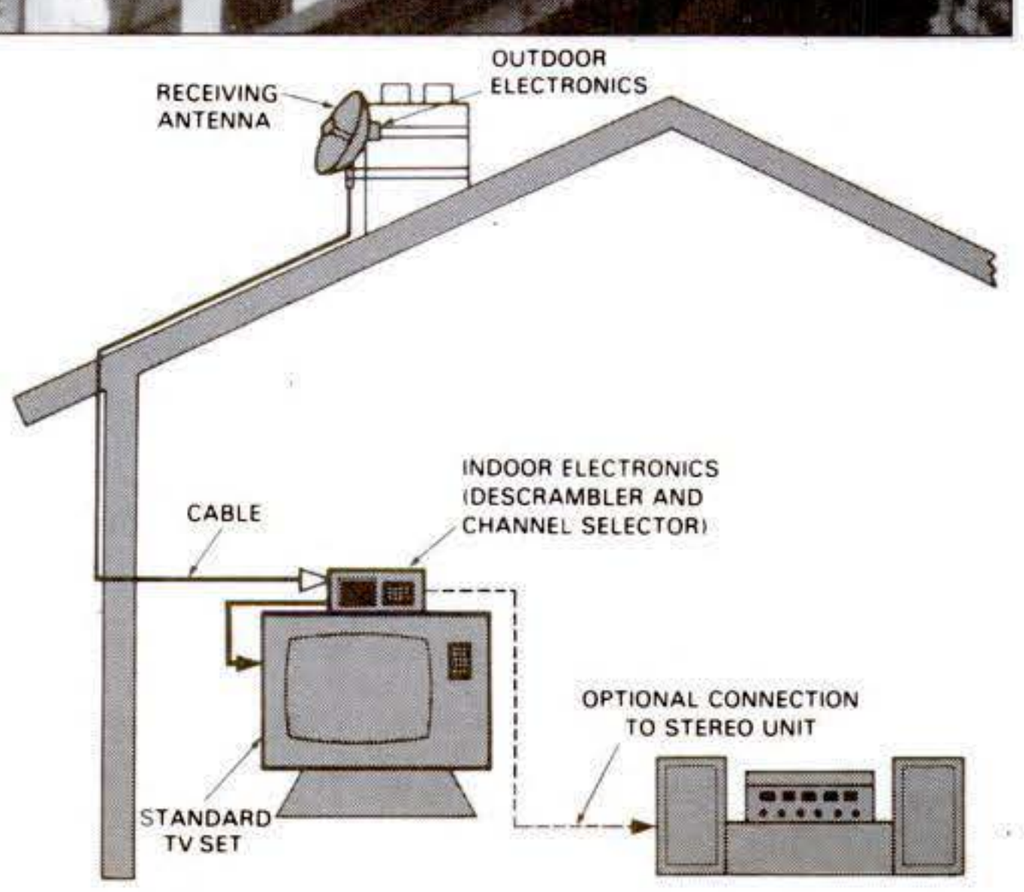


It is small enough to mount on an urban rooftop (above), yet STC's dish can pull in satellite-TV signals—if no large object (such as a tree or building) blocks the southern sky. From the dish, the satellite signal travels to a TV-set-top unit that looks much like a cable converter (right).



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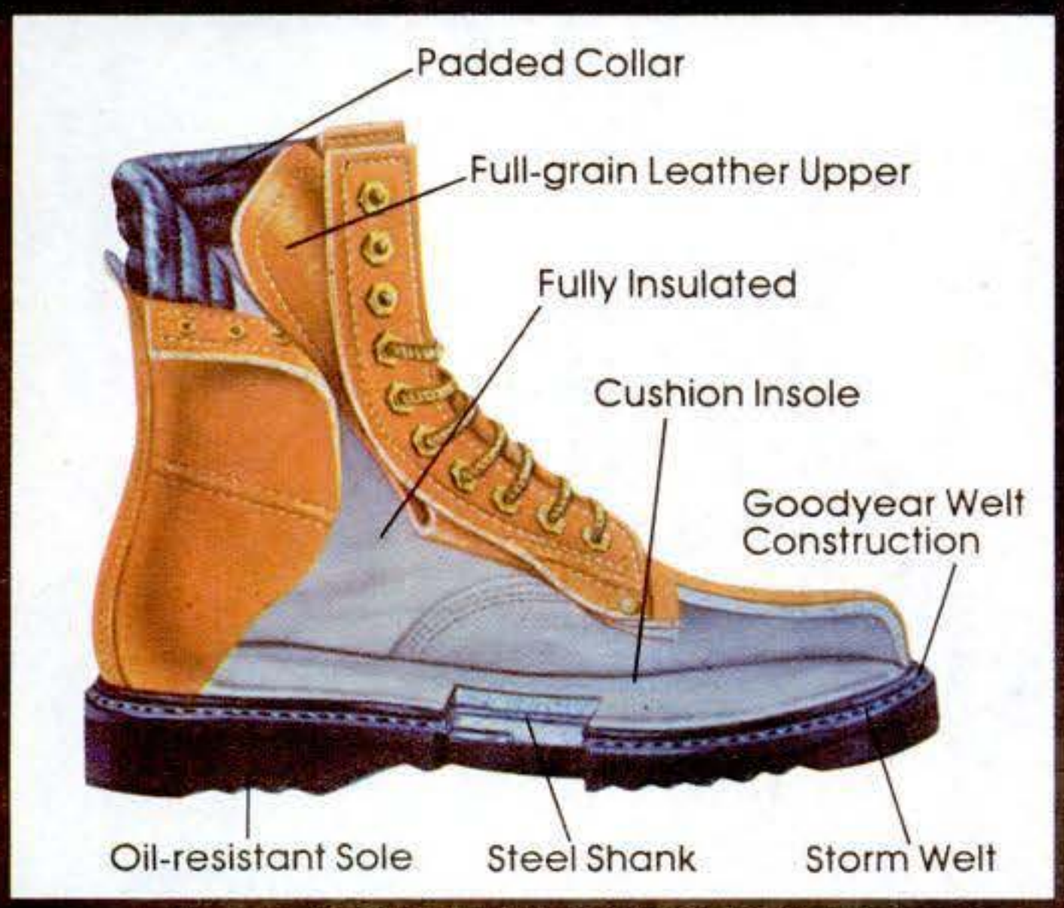

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to receive the signals. That's a basic broadcasting principle. So shrinking a 15-foot parabolic reflector down to two feet obviously requires more power at the transmitter. How *much* power is the question.

Most of today's C-band satellites transmit with a signal strength of five watts per channel. But Satellite Television Corp. (STC), the Comsat direct-broadcast subsidiary, insists that extremely-high-powered, 200-watt satellites are necessary for direct-broadcast TV. "You take the power off the ground and put it in the sky," STC's Mary Pittelli told me. "Then the consumer can use a very small dish, something you can put in the trunk of your car and take home."

But not everyone agrees. "It's our belief that high power is not necessary," USCI's Nathaniel Kwit said, leaning forward on a plush couch in his 33rd-floor New York City office. "With today's technology, you can use a medium-power satellite to get the same effect as high power—a good picture in all kinds of weather using a small dish."

Despite the debate, STC, along with Skyband and USCI, plans to inaugurate service using 20-watt satellites—the low end of "medium power."

Antennas for this first level of direct-broadcast systems will vary in size from 2.5 feet to 5.9 feet. Most will be small enough to mount on a rooftop, a space-saving position that also ensures the best possible "look angle" for the dish.

The small dishes are made possible, in part, by tinkering with the satellite's beam pattern, or "footprint."

"The size of the dish depends upon where you are in the footprint, and also what year you're talking about," Kwit told me. The footprint is the area of the U.S. illuminated by a satellite's microwave beam. For today's C-band satellites, the footprint looks more like a toeprint—a concentric set of vaguely circular whorls [PS, March '80]. The satellite signal is strongest at the center (usually somewhere in the Midwest) and fades at the far edges of the continent.

Skyband is the only direct-broadcast company that's beginning service with a nationwide footprint. "We have leased transponders on SBS-3, which the space shuttle launched last November," Skyband's James Dolan told me. "The smallest dish likely to be useful is 1.2 meters (approximately four ft.). Since the SBS transmissions are tailored to be strongest on the highly populated East and West Coasts, Midwesterners will need larger antennas."

The USCI footprint, transmitted by Anik C2, a recently launched Canadian satellite, will cover 26 states, extending from Canada to Virginia and west to Chicago. Because it covers less territory, the Anik beam delivers slightly more power to the ground, so USCI will be able to install three-foot antennas for many of its subscribers.

The dishes will shrink even further in the fall of 1984 when STC begins service on an SBS satellite it is now modifying. "By modifying the satellite, we've strengthened the signals," STC's Pittelli told me. "The best analogy is if you added blinders to an ordinary wide-beam flashlight to focus the beam."

The focused footprint will extend from Burlington, Vt., to Roanoke, Va., and west to Pittsburgh. Except on the fringes, the signal will be received by 0.75-meter (2.5-ft.) dishes.

Meanwhile, in November '84, USCI will switch to a newly orbited GTE satellite—without interrupting TV transmissions. The two satellites will sit side by side for a day while service is switched from one to the other.

> *"Future satellite receivers may be used for electronic mail, banking, even home shopping."*

"We'll be on G-Star 2 instead of G-Star 1 as everyone thinks," Kwit said with some glee. "That's important because we've reconfigured that 20-watt satellite and increased its power so we can cover the entire West Coast as well as the East and Midwest."

In the Northeast and the Chicago area, the G-Star's footprint will be strong enough for 2.5-foot dishes. And by 1985, USCI plans to have a 50-watt satellite with a focused beam powerful enough to be picked up by 2.5-foot dishes across the nation.

Finally, in 1986, STC's 200-watt satellite will begin beaming signals strong enough to be picked up by two-foot dishes across the Eastern and Central time zones.

Overcrowded orbit

Why bother with a 200-watt satellite when a 50-watt one will do almost as well? Both medium- and high-power satellites transmit on the same K-band, which extends from 11.7 to 12.7 GHz. None of these frequencies is used for Earth-based microwave transmission—an advantage K-band has over C-band. But only 12.2 to 12.7 GHz, the frequency band STC's 200-watt satellite uses, is reserved by the FCC specifically for direct-broadcast satellites. The other satellites transmit on the lower end of the band, which is already assigned to "fixed satellite services"—mainly cable TV and telecommunications. Here's where the high-power debate comes into focus.

Though the geostationary orbit is a 90,000-km (56,000-mile) slice of space, it's already crowded—and expected to get more so. If all the satellites that have been assigned orbital slots are actually launched, the congestion may be so great that the FCC will require fixed-service satellites to be spaced only two degrees apart.

"The smaller the distance between satellites, the larger the dish you need to prevent interference," Pitelli said. "You can't compensate by boosting the power because you'll blast out your neighbor. That's why we believe high-power, high-frequency satellites are necessary, as well as the protected DBS band with its widely spaced orbital slots."

Kwit sees a different scenario. "In theory, two-degree spacing is a problem, because with small dishes you are going to get interference—unless the satellite transmissions are coordinated," he explained. "We can't imagine that 10 years from now, when we have five million customers looking at a signal, the FCC will let another satellite move in there and mess up that signal. We believe the FCC will enforce signal coordination."

Microwave electronics

Power is only part of the equation. The new direct-broadcast services would not be possible without changes at the receiving end.

"We've greatly improved the sensitivity of receiver circuits," General Instrument's Victor Cavallo told me. "Before these improvements, we couldn't use a small dish to pull in usable signals from a 20-watt satellite."

The receiver, or Earth station, includes both the antenna and a component called a Low Noise Block (LNB) converter by USCI. This amplifies the tiny signals from space, filters out the "noise," and converts high frequencies down to ones receivable by the set-top tuner (see diagram).

"We use gasfets—gallium arsenide field-effect transistors—in our LNB," James Fisher, a USCI engineer, told me. "All of the magic there is getting a very low noise figure."

He handed me a six-inch-long metal cylinder. "This is where we catch the signal," Fisher explained. The LNB mounts on the antenna feedhorn, which sits at the focal point of the dish. "If you cut this open," he said, hefting

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the cylinder, "you'd see just three microchips—miniature circuit boards. But these amplify the signal 100,000 times."

A conventional amplifier would boost the noise as well as the tiny signal, Fisher said. "Thanks to gasfet technology, I have a very good signal-to-noise ratio."

Gasfets are not new. "But the whole technology of gasfets is toward thinner and thinner chips," Fisher explained. "The thinner the chip, the better the noise figure."

STC is equally dependent on new receiver technology. "Increased receiver sensitivity means we can use the same equipment we install for the medium-power satellite with our later, high-power satellite," Pittelli said. "I don't mean only the two-foot dish—I mean the low-noise converter, the set-top scrambler unit, and the receiver."

What's the picture?

Experts measure the quality of satellite transmission in terms of "decibel-width," or the strength of the signal as it hits the dish.

Both STC and USCI say the signals from their first-stage satellites will be 53 dBw at the center of the footprint, and in the high 40s at the fringes. "That's better than 60 percent of the cable systems operating today," Kwit asserted.

Unfortunately, I can't give a first-hand report on the quality of little-dish TV. At press time, no company had a demonstration setup available for viewing.

Once the systems are available for all who want them—a process that may take months after the first dishes go up—what's next?

"Don't be surprised if you see set-top receivers with 36 channels," Pittelli told me. "There's a move within the manufacturing community to make compatible equipment, so you can use the same receiver to tune in our high-power service and someone else's."

Future satellite receivers may also become two-way communication stations. "We're working on a technology to make every home Earth station a transmitter," Kwit said. "With a low-cost transmitter, the little dish will send a tiny, very-low-power signal back up to the satellite."

Such a signal transmitting small digital pulses would eliminate the automatic telephone hookup the companies now use to get billing data. But, Kwit predicted, the tiny transmitters could also be used for electronic mail, banking, and even home shopping.

When? "Mid-'80s," Kwit told me. In a few years we'll discover if he is a better prophet than I. PS

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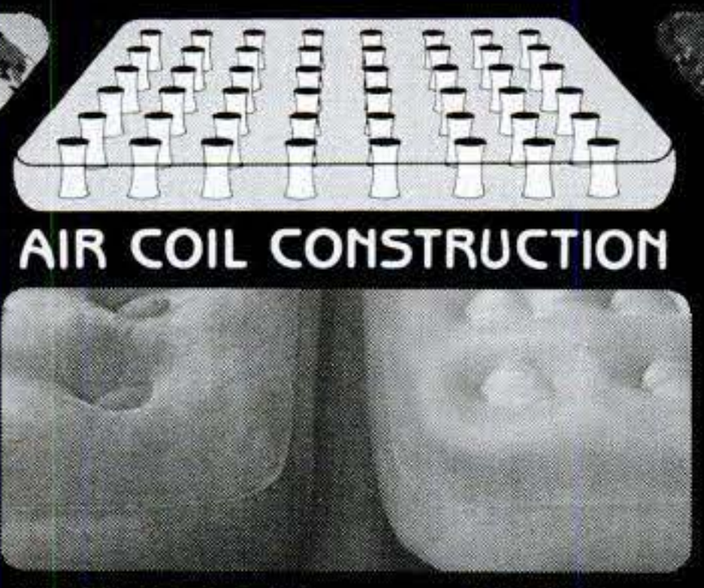

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Video editors

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Lights. Camera. Too much action? That's where these editors come in. You can shoot anything on location. At home, edit your magnetic "movies" at the touch of a button. Several models are now available.

Video editors for the home are available from Canon (top), Chalange, and Quasar.

By WILLIAM J. HAWKINS

Great movie producers: Alfred Hitchcock, Francis Ford Coppola, Alfred F. Hawkins. *Alfred Hawkins?*

My father produced some of the best home movies I've seen. (The cast was terrific.) But it wasn't easy. Every production required hours of editing. Using eight-mm movie film, it meant searching through miles of twisted cellulose, cutting, scraping, and gluing hundreds of ¼-inch sections into a logical order. But now, for a lot of people, film is out; videotape is in.

Once you shoot with videotape, you may never want to see a strip of film again. It's cheaper, easier, and reusable: If the last scene didn't go quite right, rewind the tape and ask the kids to jump in the pool again—this time with their suits on.

However, the greatest advantage of videotape—recording times of up to eight hours—also creates great problems: Nearly everything you shoot has to be edited for length and continuity to get that touch of professionalism. But put away your razor blades. New electronic editors create the scenes you want at the push of a button.

No cutting

Videotape can't (or shouldn't) be cut. Instead, scenes from an original master tape are dubbed (rerecorded) onto a slave tape on a second VCR. Adding two scenes together means dubbing them back-to-back onto the slave tape. Deleting a scene is simpler: just don't rerecord it.

Videotape editors connect audio and video outputs of the first machine with audio and video inputs of the second. They also control tape movement. At present, there are two types of editors. Most, such as the Canon and Quasar units shown in the photo, are for use with the newer microprocessor-controlled VCRs. The second type (the Video Editor, for example) is designed for editing with any VCR deck.

The Quasar and Canon units plug into the "camera" input of the two tape decks. That completes the audio-video connections, but it also gives the editors—and you—complete control over both decks from the key pad.

Run either tape forward or backward to find the spots you want. A built-in digital counter displays each tape position. Then enter the end of a scene you'd like to dub into memory, cue up both machines, and push a button. The scene you want from the original tape is automatically placed in the right location on the copy.

But there's more. Push another button and you only dub over the video—great for adding a special scene to a tape with an existing audio track. Or push another button and copy just the audio—now you've added the soundtrack from one tape to the picture of another.

My kids love "Wonder Woman." Fitted with capes (old towels) and red boots (galoshes), the kids ran around the backyard for hours while I taped all I saw. Days later, I dubbed the video to create a visual story, then added music from the sound track of a "Wonder Woman" rerun I taped from TV. Try doing that with home movie film.

The Video Editor from Chalange isn't as sophisticated as the others, but it is still quite clever. With this, editing is a two-step process. First, you review the original tape for the scenes you want and record a tone on the sound track for each one.

Now for step two. Rewind the original tape, cue up the dub copy for recording, and press "play." As the editor finds the audio tones, it automatically starts the dub tape rolling. When the tone ends, the dub ends—until another tone for the next scene is found. Because the tones destroy the audio track of the original tape, this editor is best for stereo VCRs. One channel can then retain the original audio track; the second channel can be used for the editing tone.

The model 1200 Video Editor is $350 from Chalange Sales (Box 31086, St. Louis, Mo. 63131). The Quasar VE582UQ editor is $170; Canon VE-10A is $150. PS

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By STEVE MERCALDO

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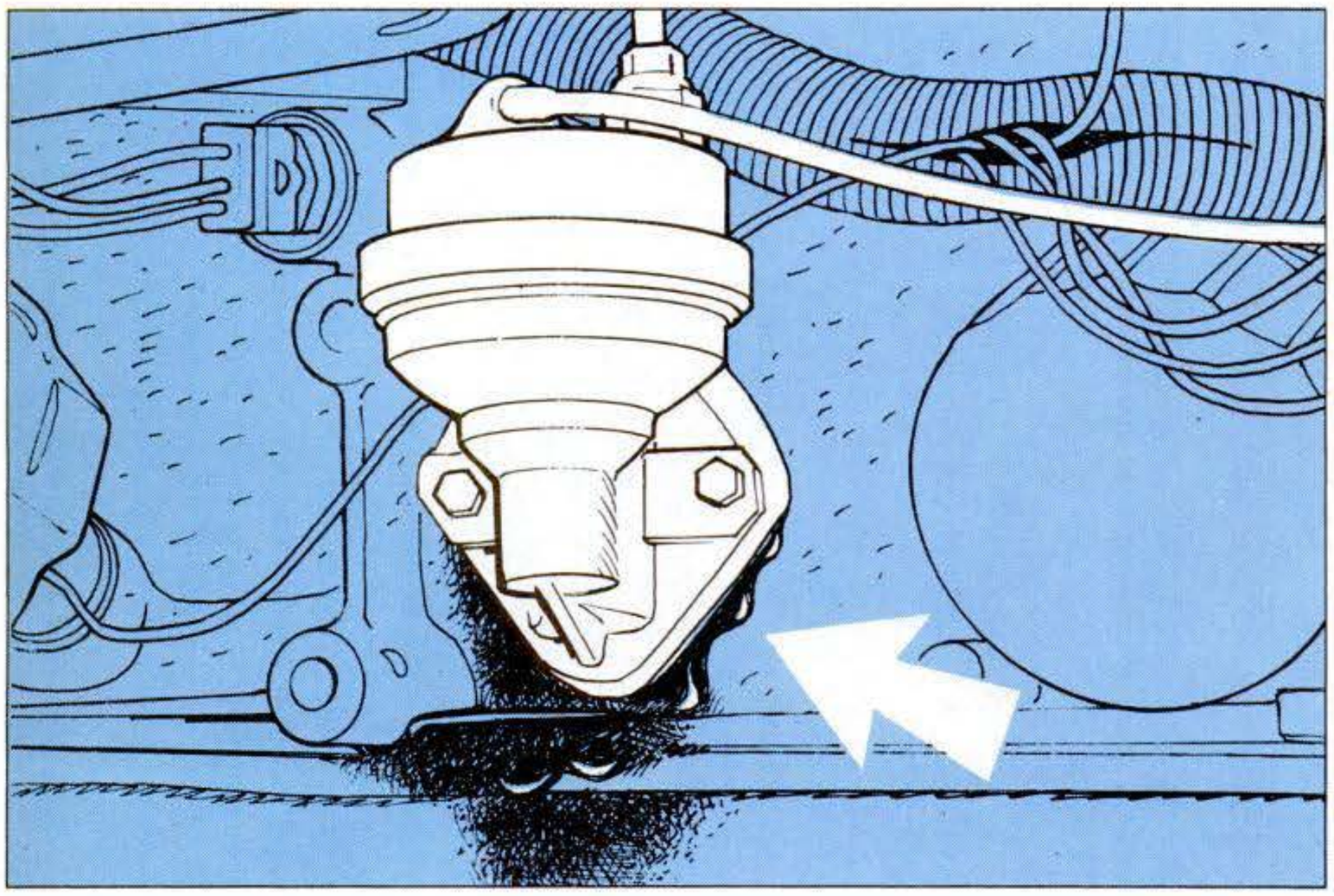
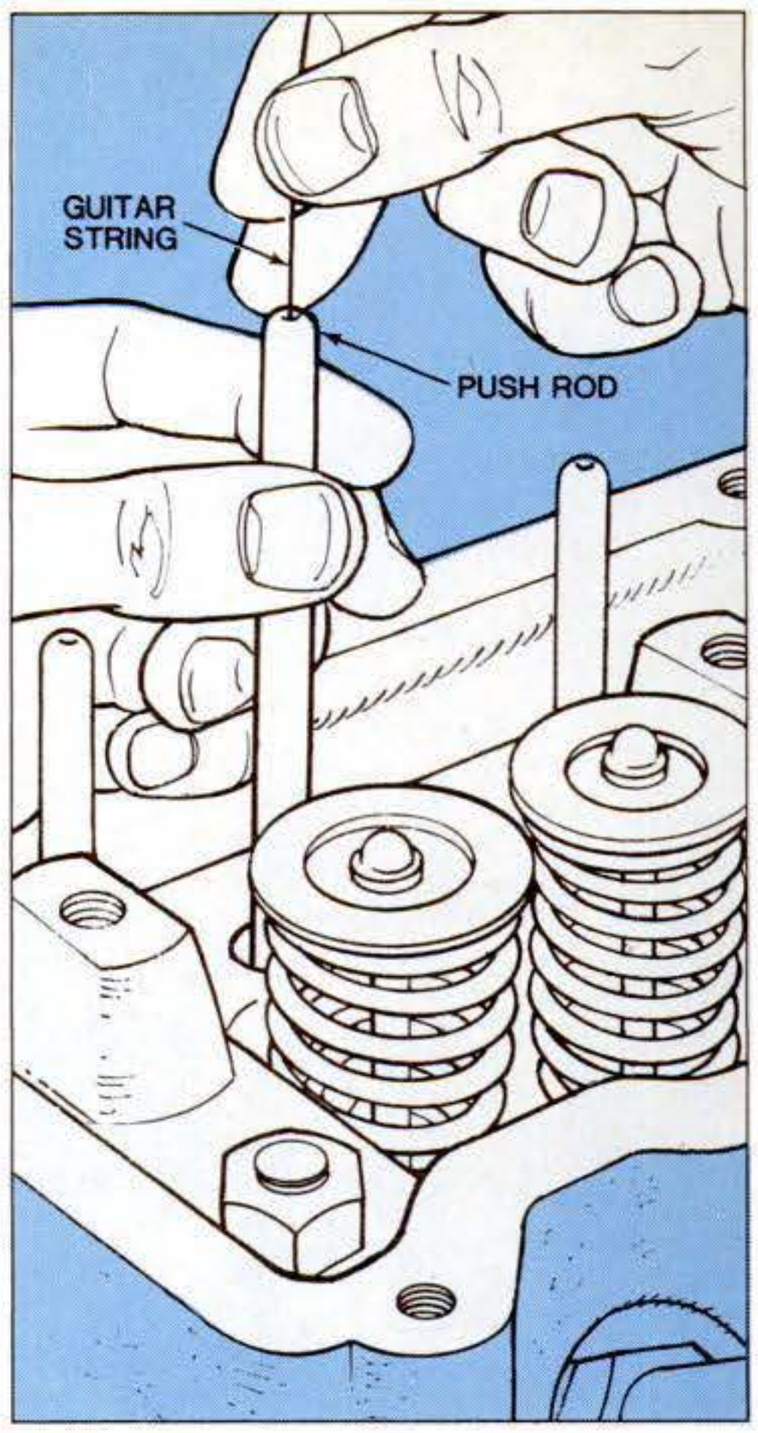


Tracking down an oil leak

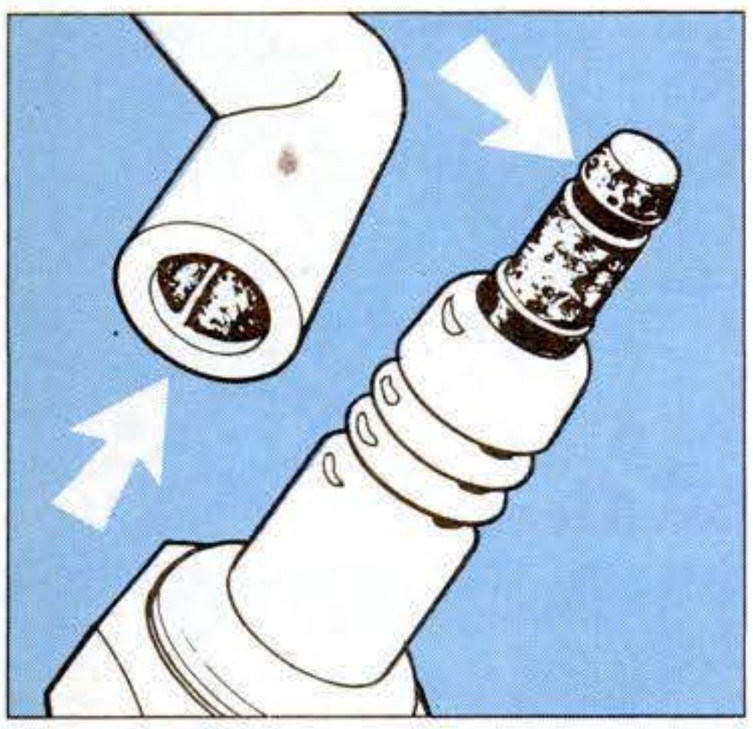
Engine oil leaks are often difficult to pinpoint. One possible source of leakage is a mechanical fuel pump. Your first clue is usually a puddle of oil underneath the engine and directly below the pump. To be sure this is the problem, thoroughly clean the pump and the area surrounding it. Then start the engine and let it idle for at least five minutes. Step on the accelerator several times during the warm-up.

Next, turn off the engine and inspect the pump and its mounting surface for signs of oil. Be patient—the leak may not show up for several minutes. If a leak occurs, tighten the mounting bolts or remove the mechanical fuel pump and replace the gasket. Then if oil is still leaking, you'll probably have to replace the pump.



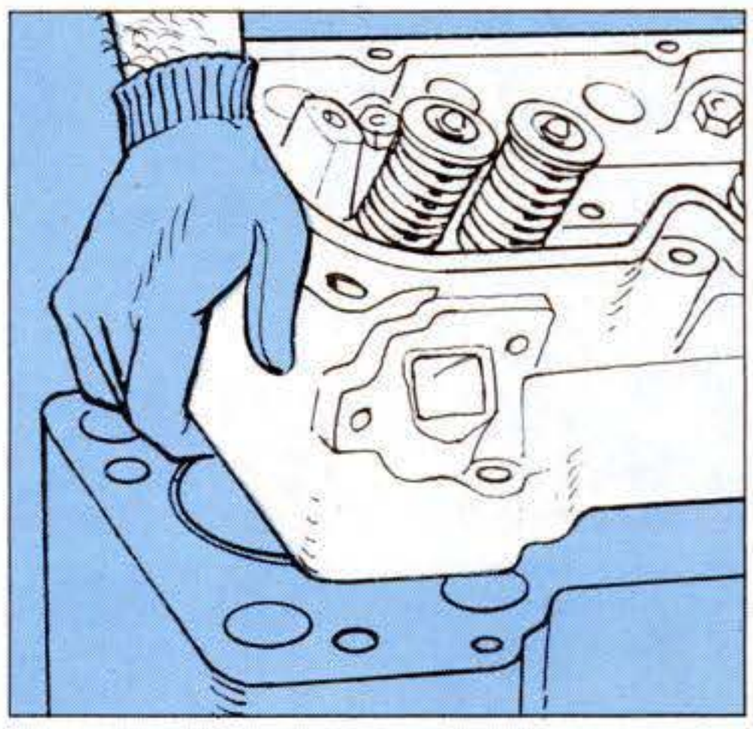
Musical tip

Engine rebuilding is often complicated by the buildup of stubborn deposits in an engine's lubrication system. Steel guitar strings make excellent tools for cleaning the system's small ports and galleries. The strings' springy quality prevents them from binding in tight curves and bends. (The low-E string is perfect for unclogging valve-train push-rod tubes, for instance.)



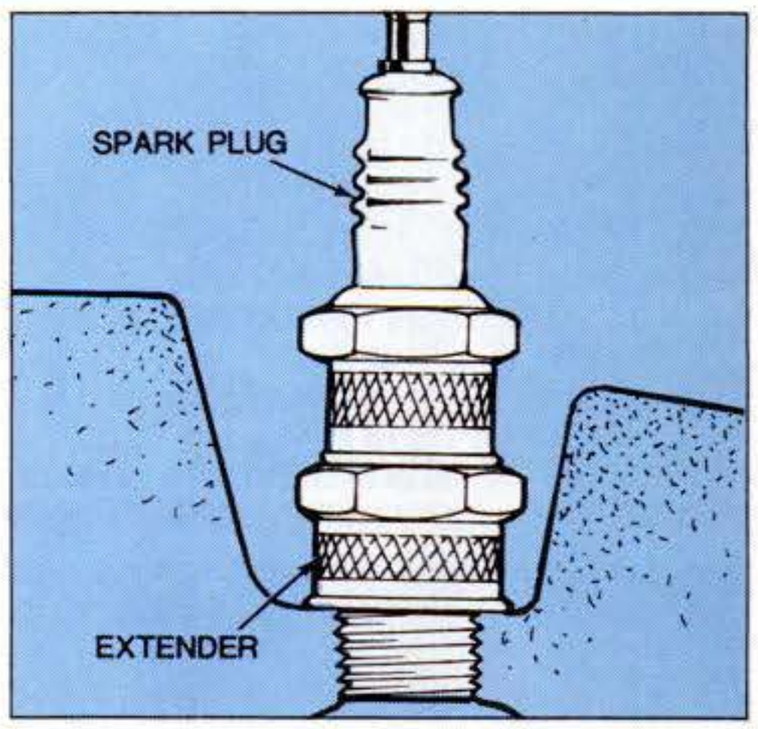
Intermittent misfire

Despite recent technological advances in high-energy ignition systems, plug misfires can still occur because of simple problems. A corroded or damaged spark-plug-wire terminal may be at fault. Twist and then pull the boot to remove it from the plug terminal. Carefully inspect the plug and boot terminals, and inspect the other end of the wire that fits into the distributor cap. Replace the wire that's defective.



Keep a cool head

When disassembling an engine, always let it cool before you attempt to remove the cylinder head. Loosening head bolts while an engine is hot can result in a warped head. When reinstalled, the damaged heads will provoke premature head-gasket failure. This caution is important when working with engines that have aluminum heads, which are even more apt to warp if removed while the engine is hot.



Plug extender

Bad rings or valve-guide seals are two expensive-to-repair problems that may be causing your engine to burn oil. Excessive amounts of oil in the combustion chambers may be the source of engine misfire because of spark-plug fouling. But there is an inexpensive temporary solution for plug fouling. A spark-plug extender will pull the electrode out of the contaminated chamber, allowing it to fire cleanly.

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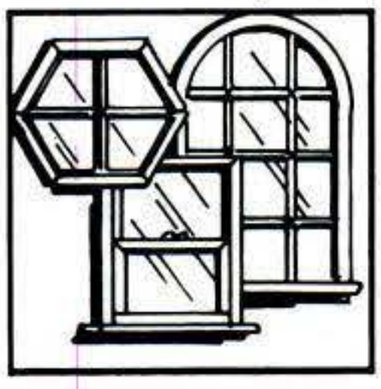

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By ROY DOTY

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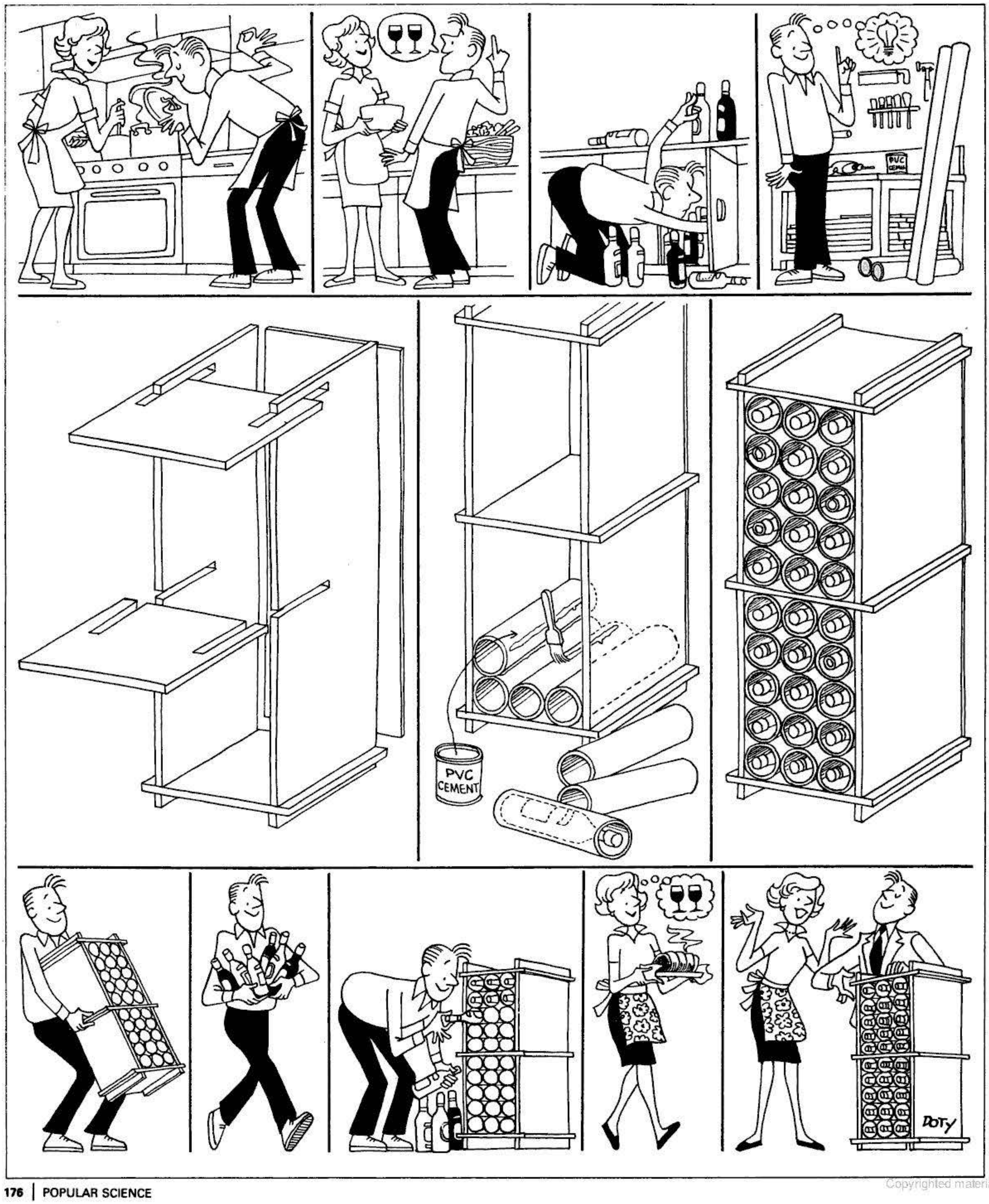

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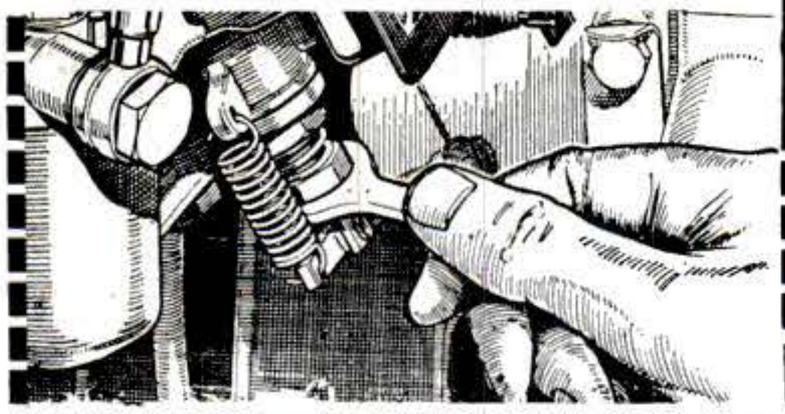

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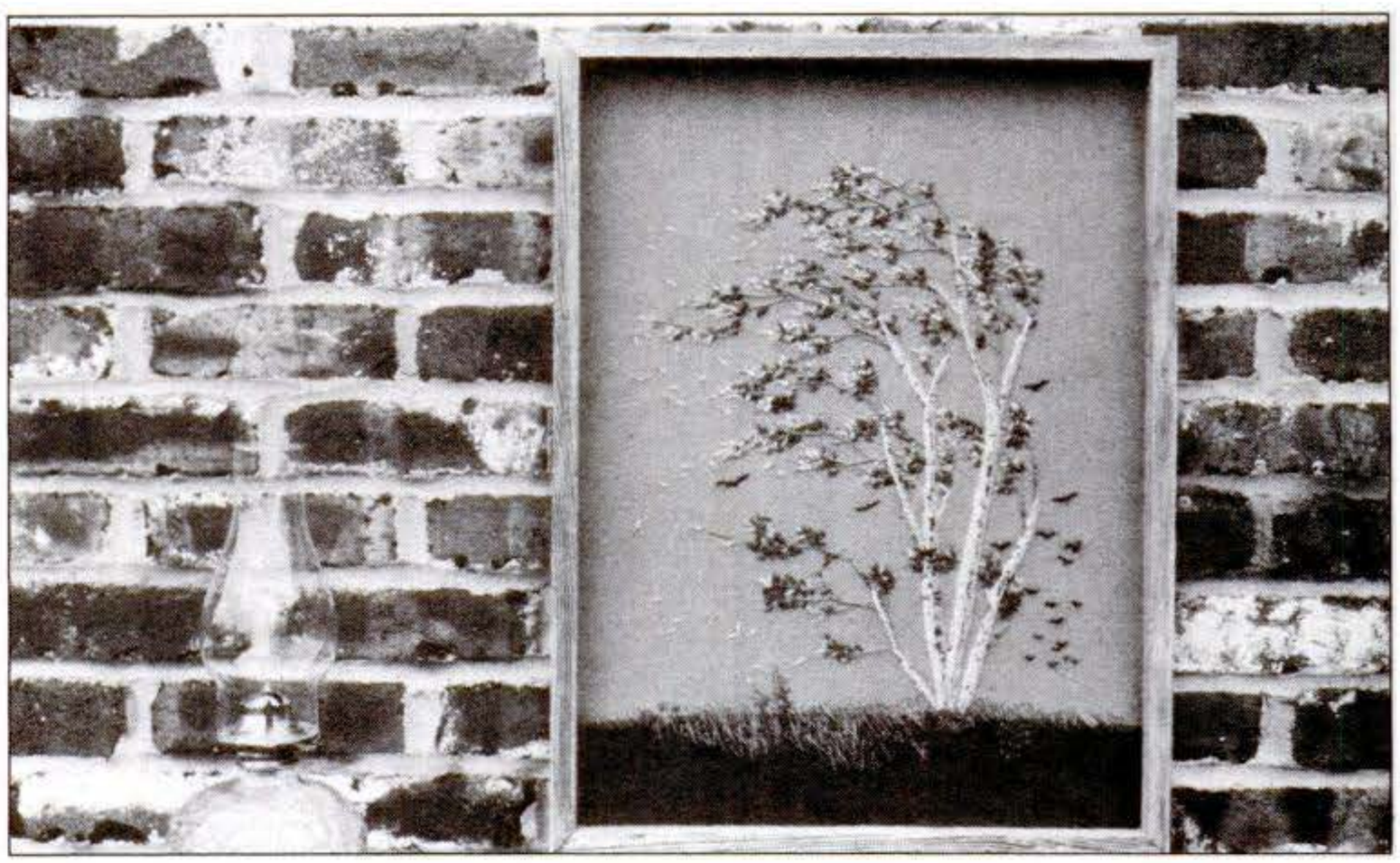
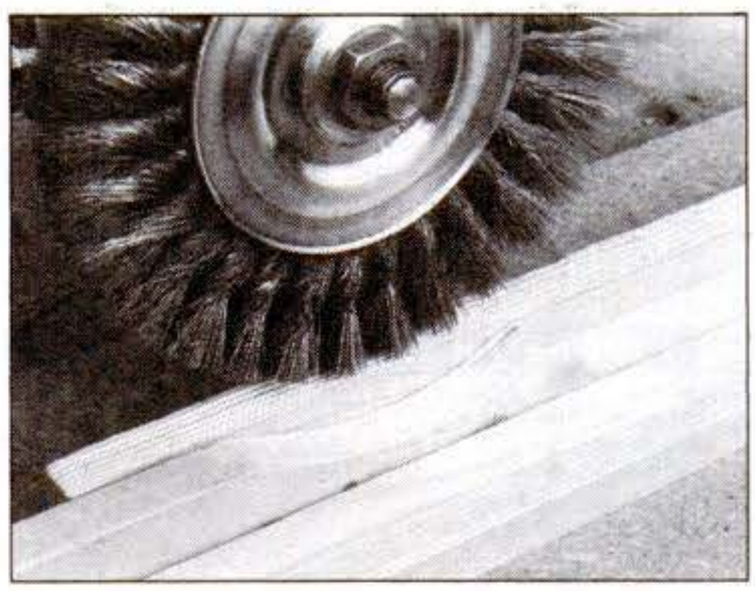
Shop Talk

By AL LEES





Customizing Christmas

Don't give money this Christmas. It's the most impersonal of presents. Instead, offer friends and family an item you've made especially for them in your shop. How about a personally chosen and framed print, poster, photograph, or collage?

As a project, making a frame isn't costly or difficult, but it's labor-intensive, so custom frames come high from commercial shops. And a pro's approach to framing tends to be rigid: Describe an original means of framing something, and a pro may tell you: "That's not the way it's done."

Shadowbox framing with "weathered-wood" molding is ideal for rustic subjects to be displayed in a den or a country kitchen. But commercial barn-wood framing stock is expensive, and because you'll want to customize the finish to the subject anyway, why not make your moldings from scratch? That's the advice of H. N. Cole of Topeka, Kan., who sent me the three photos above.

Cole's starting material is 1×2 furring strips, available at any lumberyard. Check them for straightness, but don't worry about tight knots or minor surface imperfections. Cole creates his weathered textures by wire-brushing the pine to erode the softer wood between annual rings. For light texturing, Cole works with a brush wheel chucked in a portable drill. But for deeper texture and greater speed, he mounts a heavy-duty brush on his radial-arm saw, as shown. A simple jig positions the stock for both edge and face brushing, with minimal adjustment; the wheel moves forward through the notch in the fence for surface brushing. (Because most guards won't fit over a brush, a face mask is recommended.)

After texturing, rabbet the back edge to take the mounting panel, apply your finish (a two-tone wipe is demonstrated in the third photo), then miter the pieces to proper lengths for assembly.

Frames have two purposes: to *protect* and *present* the picture. There's a neat way to achieve both at once—non-glare glass. The last three photos on this page demonstrate its use. One of the crafts that fascinated me on a recent trip to China was paper cutting, in which exquisite detail is achieved by slicing thin sheets with tiny razors. I brought back two fragile opera masks and

Continued

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CODE-A-PHONE

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- ***Receives your phone messages 24 hours a day!***
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- ***Lets you screen incoming calls to avoid taking nuisance calls!***

Sure, you can find "cheapie" models at LESS cost than this Code-A-Phone. And, if you're lucky, those "cheapie" plastic models might even work most of the time. But remember: "Ma" Bell put its reputation on the line with every Code-A-Phone they leased. And only the BEST is good enough for "Ma" Bell!

This is the same model leased by "Ma" Bell to more than 50,000 businesses and individuals. So you KNOW it must be an excellent machine! Ford Industries, Inc. of Oregon produced Code-A-Phones by the thousands. BUT with the "breakup" of AT&T, the Bell System companies were prohibited from purchasing any further products for leasing to its customers. That left Ford with a backlog of more than 10,000 Code-A-Phones!

We are authorized to liquidate the inventory. Now YOU can get a genuine Code-A-Phone for your home AND your office at a fantastic savings! At FAR less cost than AT&T paid!

Code-A-Phone features top quality throughout! Dependable solid-state design. Microprocessor circuitry. Handsome solid walnut frame with sturdy metal cabinet. It's built to take the abuse of a busy office . . . or active youngsters at home.

On "cheapie" models, you can usually find low quality tape and reels. Code-A-Phone has a high quality DOUBLE reel system. One for your "hello" message and one to record incoming calls.

Listen to messages by Remote Control

You can get your messages from any phone, anywhere! A little Pocket Coder device acts as your personal key to "unlock" the messages by remote control from any phone.

The system is voice-actuated to avoid long, silent gaps on the tape. Flip a switch and listen to all your messages. Repeat messages for careful reviewal. Tape both sides of a conversation. When you're busy, screen calls with Code-A-Phone. Turn up the volume and take only the calls you want. Record all other calls.

Code-A-Phone is simple to install with just two quick plug-ins. Don't miss any more important calls. Put this handy wizard to work for YOU in your home AND office. Our supply is limited. Order TODAY!

U.S. District Court

Jan. 1982 (Wash., D.C.) — Justice Department and AT&T settle their law suit and agree to restructure the phone company. After January 1983, Bell System companies can no longer buy and resell or lease telephones and any peripheral equipment to their customers.

News Item

Jan. 1982 (Portland, OR) — As a result of AT&T settlement with Justice Dept., Bell System companies can no longer buy Code-A-Phone telephone answering machines for leasing to businessess. Code-A-Phone's manufacturer is left "stranded" with over 10,000 units!

Public Notice

Aug. 1983 (Minneapolis, MN) — The C.O.M.B. Co., Inc., the nation's largest authorized liquidator, acquires 10,000 Code-A-Phone machines for liquidation to the public at far below the Bell System's cost!

Look At What Phone Companies Charged!

Here are examples of what it cost business firms to LEASE Code-A-Phone from phone companies for a THREE YEAR period:

Ohio Bell charged customers . . . $1375

Indiana Bell charged customers $835

Now YOU can get the very same model at a HUGE SAVINGS . . . and at just a ONE TIME cost!

Manufacturer's Suggested Retail $550.00

OUT THEY GO AT ONLY:

$188

Price subject to change after 60 days.
Offer void outside original 48 states.

TOLL-FREE PHONE ORDER SERVICE!

Credit card members can order by phone, 24 hours a day, 7 days a week:

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If busy signal, or if no answer, call: **Toll-Free: 1-800-328-5727**

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THE NATION'S LARGEST AUTHORIZED MAIL ORDER LIQUIDATORS OF CONSUMER PRODUCTS
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Send ____ Code-A-Phone(s) at $188.00 each plus $12.50 each for shipping and handling. (Allow 3-4 weeks for delivery. Add 2-3 weeks extra if paid by check. Minnesota residents add 6% state sales tax. Sorry, no C.O.D. orders.)

☐ My check or money order is enclosed.

Charge to my: ☐ MasterCard® ☐ VISA ☐ American Express ☐ Diners Club

Acct. No. _____ Exp. _____

PLEASE PRINT CLEARLY

Name _____

Address _____

City _____ State _____ ZIP _____

Phone (Area Code:) _____

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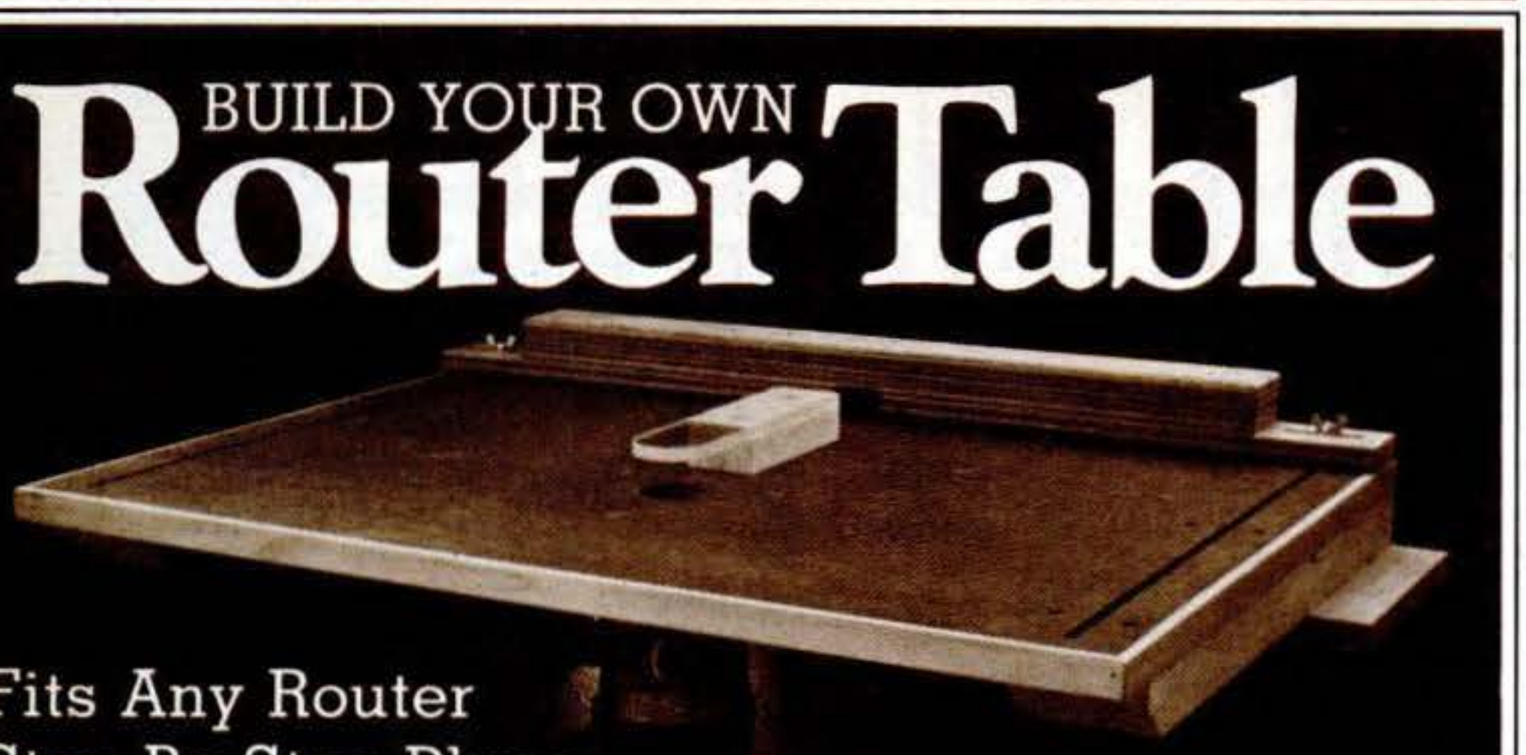
BUILD YOUR OWN Router Table



Fits Any Router
Step-By-Step Plans

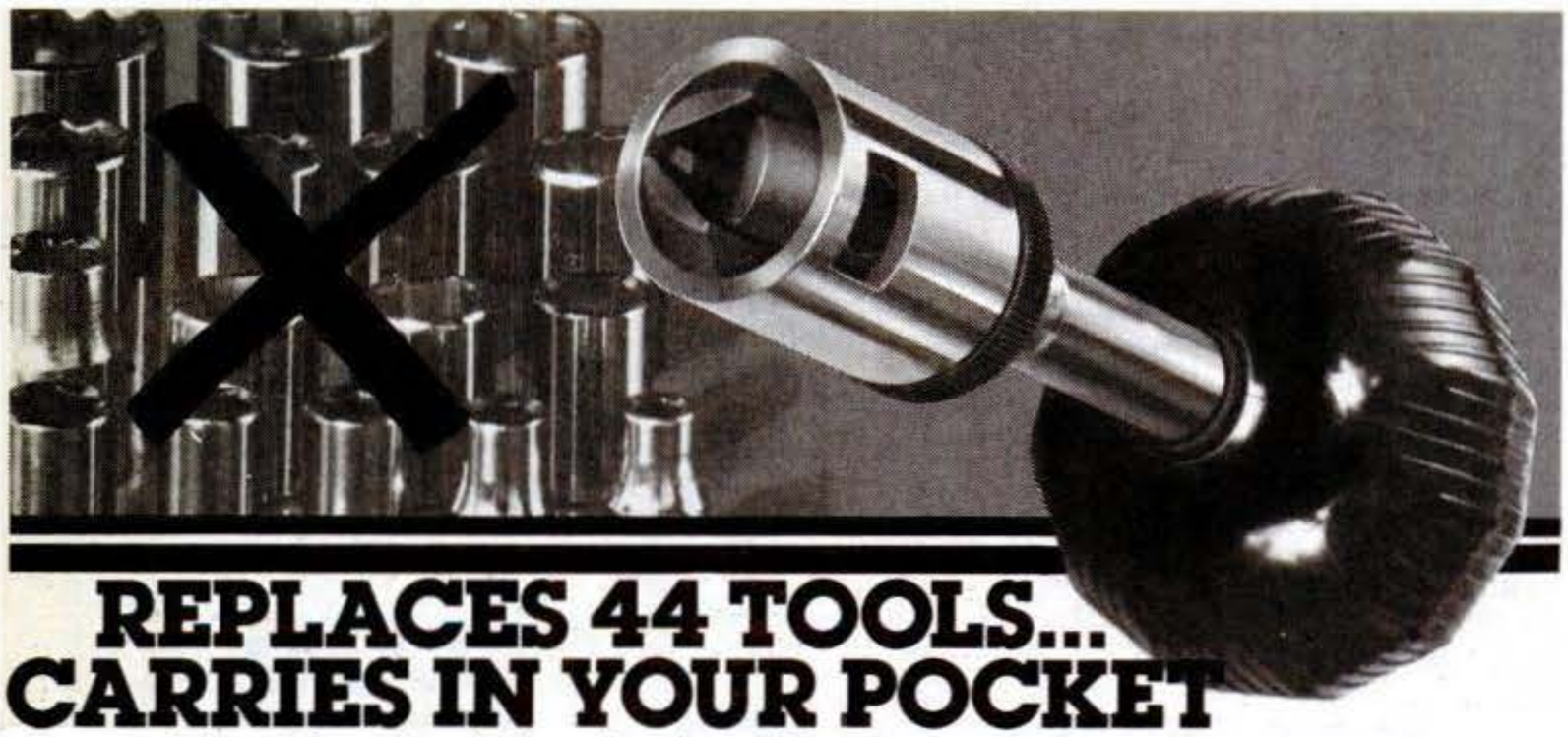
Get the most out of your router by mounting it to this shop-tested router table. The extra-large work surface and fully adjustable fence beat the pre-fab metal tables hands down! And all at a fraction of the cost.

- With this router table you can make molding cuts on narrow boards. Cut rabbets or grooves exactly where you want them. Rout decorative patterns on curved edges. Even make multiple cuts for special effects. And get professional results every time!
- The complete plans for this easy-to-build router table include step-by-step directions for a bench-top model plus a full-size floor model.
- These exclusive plans are now available in a six-page Plan Booklet. The cost? For a limited time the Router Table Plan Booklet is only $1.
- To get your Router Table Plans, send only $1 to: *Woodsmith*, Dept. 47, Box 842, Des Moines, Iowa 50304

Woodsmith PLAN BOOKLET

Name: _____

Address: City: State: ZIP:



REPLACES 44 TOOLS... CARRIES IN YOUR POCKET

The Pocket Socket with Easydriver® Ratchet

The most advanced hand tool combination in 50 years. Ends guesswork and constant trips to the toolbox for the proper size. All 44 tools fit in your pocket.

The Pocket Socket . . . Adjusts to 20 Sizes
Twenty sizes of sockets and 20 sizes of nut drivers in one adjustable 8 oz. tool. Just snap on the Easy-driver ratchet handle, place it over the nut or bolt and turn the knurled collar to a tight fit. Three sided configuration actually outperforms standard socket tools in grasping and turning even rusted or rounded bolts or nuts. Made from heat-treated chrome-molybdenum steel . . . withstands over 100 lbs. of torque.

Easydriver® Ratchet Power Handle with Socket and Screwdriver Shafts
Fits comfortably in your palm, automatic ratchet action rotates tool without a change of grip. Comes with a shaft to fit Pocket Socket and a shaft to hold screwdrivers. Just snap into red side of ratchet for clockwise power drive, black side for counter-clockwise removal of nuts and screws. Easy-driver handle is industrial strength GE Lexan.

Socket adjusts from 5/16" to 5/8"

Includes 3 Screwdriver Tips
Two sizes of regular screwdrivers, and one Phillips head . . . all of tough steel alloy.

The Pocket Socket and Easydriver® Ratchet . . . a Tool Chest in Your Pocket
- Tightens or loosens nuts and bolts
- Fits over 20 standard and metric sizes
- Powers regular and Phillips screws
- Rotates in both directions effortlessly

ONE YEAR LIMITED WARRANTY

Like Having 44 Tools In One—Only $29.95
Why spend a fortune for a bulky tool set when you can own a tool chest that fits in your pocket for just $29.95 plus $3.95 shipping and handling.

30 Day Risk-Free Trial
If the Pocket Socket with Easydriver® Power Ratchet Handle isn't everything we say . . . and more, simply return it within 30 days for a full refund.

MADE IN U.S.A.

Send your check or money order to Dimensions Unlimited, Inc. at the address at right. (If delivered in Illinois, add 7% sales tax.)

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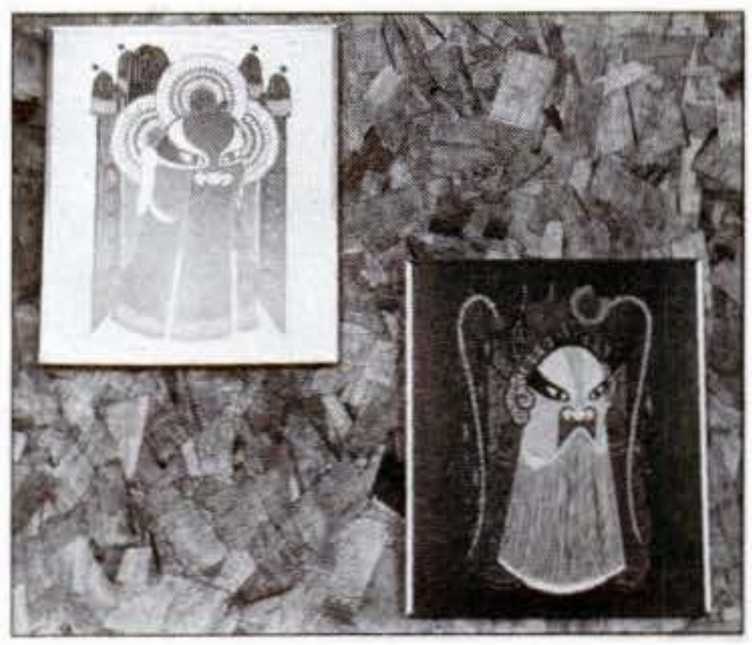
DIMENSIONS UNLIMITED, INC
Dept. 77-2352
500 N. Dearborn Street
Chicago, IL 60610

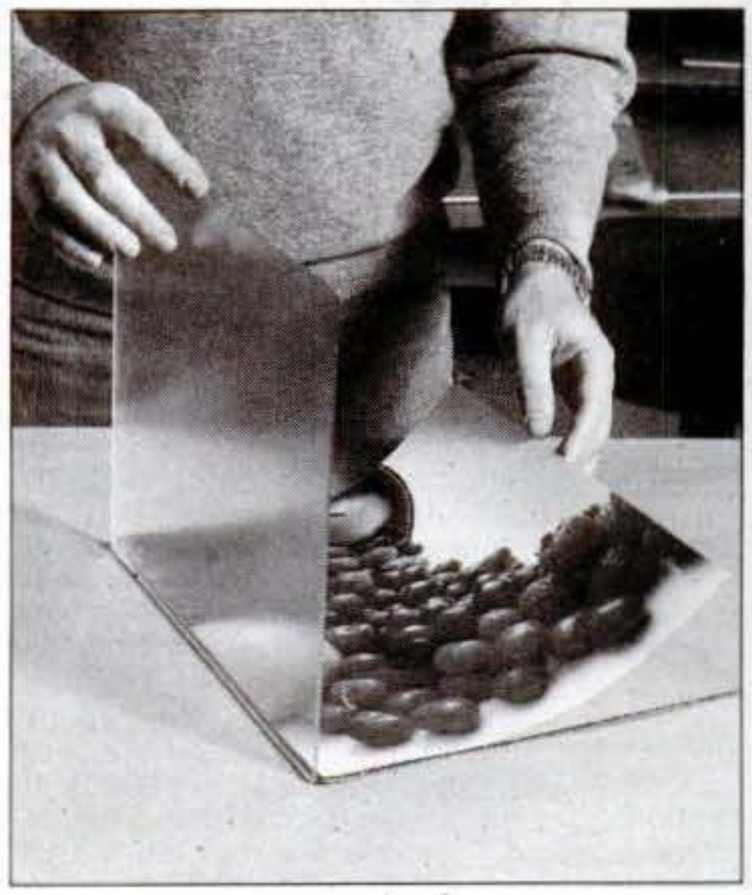
MAJOR CREDIT CARD BUYERS
CALL TOLL-FREE
800-228-5959
(Nebraska residents, call 800-642-8777)
24 hours a day, 7 days a week

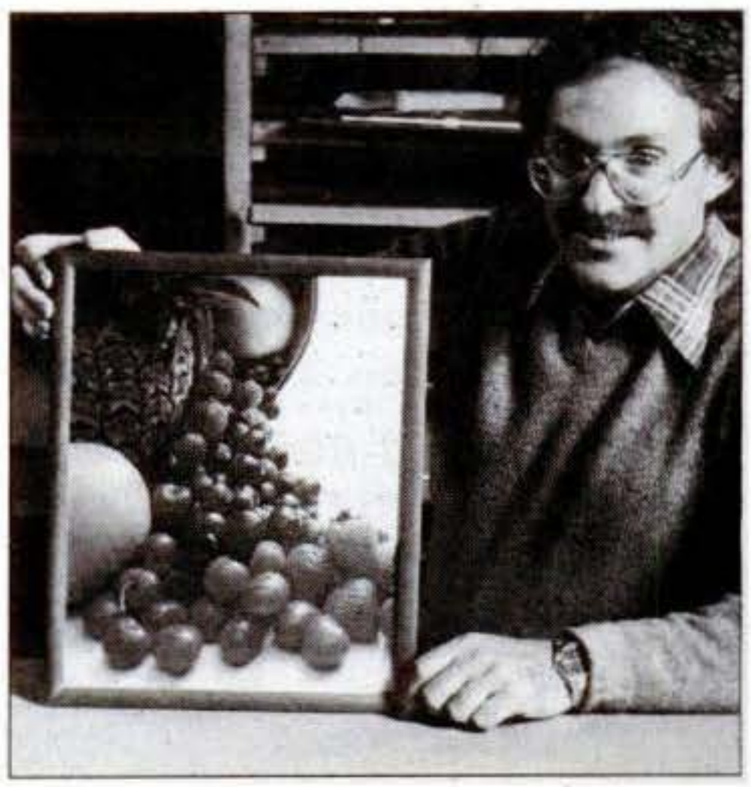
Shop Talk

sought proper frames. Because the white mask of the pair was to be mounted on black, plain glass would have created a mirror. To avoid that, I used non-glare. Wish I'd done the same for the white-mounted mask. (Note the surface glare in the top photo.)

The special glass has a fine grain pattern on its surface. The slight loss in optical quality might not be ideal for a light-colored print with lots of detail, but it's scarcely noticeable over most subjects. As Leslie Desnick of Frameyourself Corp. in Edina, Minn., demonstrates in the last two photos (shot for PS by General Glass Corp.), pro shops now choose non-glare glass for many jobs, and some offer it at the same price as regular glass. PS







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New UDS Computer Telephones To Be Sold For Only $8 Apiece In Mammoth Publicity Drive

All who wish to apply for a new Computer Telephone should write to the company address below before Midnight, December 31, 1983.

NEW YORK—One million new UDS Computer Telephones with electronic memory and pushbutton dialing will be sold as part of a publicity campaign for only $8 apiece to the first one million persons who write to the company address before Midnight, December 31, 1983.

These are the same famous UDS Computer Telephones to be nationally publicized in *The New York Times, TV Guide* and other leading magazines, with *electronic re-dial* (which automatically keeps re-dialing busy or unanswered numbers till they answer) and *electronic "mute"* (which lets you talk "confidentially" without putting your hand over the mouthpiece).

Only half the size (and half the weight) of standard phones, they also have adjustable electronic ringers, which means you can turn them "off"—for complete silence—whenever you don't want to be disturbed. And when you finish your call, you don't have to bother hanging up—simply put the unit down (anywhere you please) and it will hang *itself* up, automatically.

These new UDS Computer Telephones are FCC-approved and require no installation. Simply plug them into the same modular outlets as your present rotary dial or pushbutton phones. *You can then legally return your present phones to the phone company, saving yourself up to $8 a month (or over $90 a year) for each phone you return.*

These new UDS Computer Telephones will not be sold at this price by the company in any store. To obtain one at this price, apply in writing to the company address no later than Midnight, December 31, 1983.

Each phone carries a full one-year money-back guarantee, and the company will replace it, free of charge, if it ever fails to function. There is a limit of two (2) phones per address at this price, but requests which are mailed early enough (before Dec. 25) are permitted to order up to 5 phones.

To apply for a new UDS Computer Telephone, mail *this entire printed ad* together with your name and address and $8 for each phone desired. Add $2 shipping and handling per phone. Mail to: **Delucca, Goldrich & Lord, UDS Computer Telephone Offer, Dept. 191-6, Box 1270, Westbury, New York 11595.** **(D21415)**

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Is Your Cordless Phone Obsolete?
YES — If It Doesn't Have a 1500-Foot Range!

NEW HORIZONS Smashes The Cordless Phone Distance Barrier with These SuperFones

The SuperFone 650 with TRUE TOUCHTONE™

Use it just once and you'll know why we call it the SuperFone.

Most cordless phones will work in Touchtone areas, but they won't generate a Touchtone signal; you can't use them for Sprint, MCI, or computer access.

The SuperFone 650 is a *true* Touchtone phone. From your pool, patio, or neighbor's home, or on the way from your office to your car, you can call any of the tone-generated systems.

You can park your car more than twice as far away as you used to; or walk your dog twice as far while you're talking on the phone. The range is 1500 feet, and that's the *minimum* — users report 1800 to 2000 feet. That's approaching half a mile.

SuperFone 650 is a radiophone, not a gadget, and that's why the signal stays crisp and strong at distances where most cordless phones give you nothing but a frustrated hiss.

WE CHALLENGE ANYONE TO TELL THE DIFFERENCE BETWEEN SUPERFONE 650 SOUND AND CORD-TELEPHONE SOUND.

No one will overhear your conversation accidentally. A private code system lets you choose from 512 combinations. Change the code whenever you like.

NOW: BELIEVE IT OR NOT:

When we say the SuperFone 650 is *super*, we haven't begun to tell you its advantages. Look at all this your phone can do, in addition to delivering a stronger and clearer signal than you've ever had:

- The base station is a speaker-phone in its own right, with a volume control.
- The base station and the remote unit have full intercom capability, which means one person can roam the yard or the warehouse and be in constant touch with the base.
- A privacy button lets you hear the party on the other end of the line without his hearing you.
- Push one button for automatic redialing of the last number you called.
- A *security switch* makes it impossible for anyone but you to make outgoing calls.
- A call-button on the cordless phone can page the base to initiate an intercom conversation.

It's As Small As a Pack of Cigarettes . . . But It Can Do Most of What the SuperFone 650 Can Do!

The SuperFone 620 MINIATURE LONG-RANGE CORDLESS PHONE

The SuperFone 620 is the smallest high-performance phone in the world. But what power! It incorporates state-of-the-art electronic advances in its mighty innards.

Like its big brother, the SuperFone 620 has a 1500 foot range.

It also has 512 private security codes you can choose from and change whenever you like. In fact, except for the speaker-phone, the Touchtone capability, and the paging system, it has all the features of the 650, including *incredible* sound-fidelity.

Don't let the price fool you. Even two or three years ago, this phone would have cost $500 — if it had been available at all.

TRIPLE THE RANGE OF ANY CORDLESS PHONE!

The *SuperAntenna* will give your cordless phone, *regardless of make or model*, THREE times the range it has now.

If the range is 700 feet, it'll leap to over 2,000 feet. If your phone has the super-range of the SuperFones on this page, 1500 feet, the SuperAntenna could push the effective range as far as ONE MILE!

You'll notice vastly improved sound *quality* as well as distance. No more "fuzzy" or unclear sound.

The SuperAntenna connects to your phone in 5 seconds, with a standard modular plug (you also plug it into a standard wall outlet).

The Super Antenna **$79.95**
SPECIAL! Buy the SuperAntenna at the same time you buy a SuperFone and the Antenna is only **$69.95!**

The SuperFone 650
1500-Foot Cordless Phone - **$239.95**
(two for **$219.95** each)

The *SuperFone 620*
1500-Foot Miniature Cordless Phone
$159.95 (two for **$149.95** each)

The SuperAntenna — **$79.95**
(with the SuperFone, **$69.95**)

Please add $4.50 per total order for shipping.

For fast delivery on credit card orders, call toll-free 24 hours a day, 7 days a week:

1-800-443-0100
Ask for Extension 111

Or send check or money order.
(Be sure to add shipping cost.)

WE ABSOLUTELY GUARANTEE!
Try the SuperFone 650, the SuperFone 620, and/or the SuperAntenna in your home or office for up to 30 days. If for any reason you decide not to keep any or all of them, send one or all back to us for a 100% refund.

New marvels are what you expect from

NEW HORIZONS Dept.S11,5-31 Fiftieth Ave.
Long Island City, NY 11101

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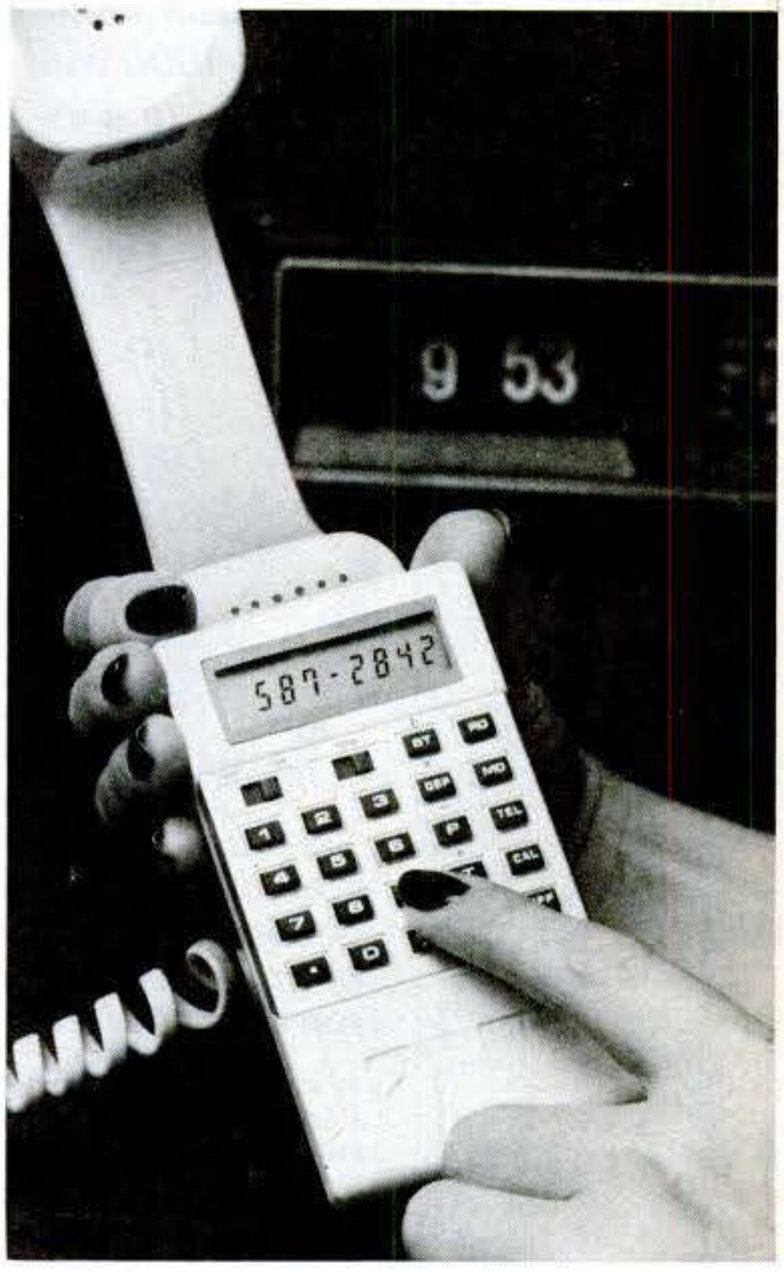
No Matter Where You Are in the World, Take This Portable Dialer Out of Your Pocket And Dial Any of 64 Sixteen-digit Numbers in Two Seconds—With TRUE TOUCHTONE,® Even on a Rotary Phone!

The Portadial 64

Hold it against the mouthpiece of any phone.
Dial any of your 64 numbers by pressing only two keys.



Hottest electronic instrument of the year!

A dialer stores phone numbers. From any phone, you can "fast-dial" any of those numbers. A dialer also converts any old-fashioned rotary phone to Touchtone, so you can call computers and automatic dialing systems.

Our dialer has even more. It displays the number you're calling, and when you aren't dialing, it's a full-function calculator.

HERE'S WHAT THE PORTADIAL 64 CAN DO:

1. It can dial any of 64 stored numbers when you press two keys.

2. It fast-dials (two seconds average) up to 16 digits at a time, with a Touchtone signal.

3. It has a "pause" feature, so you can string together "access code" numbers for Sprint, MCI, or PABX.

4. It has a clear LCD display window, so you can see the number you're dialing while you're dialing it.

MORE!

5. It's a full-function calculator with a percent key.

6. It gives you one-key redialing of the last number you called.

7. It fits easily into your pocket or purse.

Some of our competitors are advertising a similar dialer for $199.95. It has the same features as ours, which we're putting on the market at $69.95!

BUILT TO LAST A LIFETIME!

The Portadial 64 is handsome and rugged. Since you don't attach it permanently to the phone—you just slip it onto and off the receiver—it's a traveling companion you can take anywhere. You'll never again worry about forgetting a number when you're away from your home of ofice. The long-life battery is easily replaced, but you don't even have to think about that for two years. You'll wonder how you got along without it. (P.S.: What a sensational gift idea!)

The Portadial 64 **$69.95**
two for **$64.95** each
(+ $2.50 shipping)

Here's Another New Electronic Wonder

Set this phone to "Auto" and you can answer it. . . from all the way across the room!

The Sheritone Auto Receptionist Phone

Visualize this: the phone rings but you're at the other end of the room, or at the oven, or shaving. If you've preset it to "Auto," after the first ring it opens the speaker so you can answer the call without having to touch the phone at all!

(After the caller hangs up, the phone will disconnect itself in a few seconds and will automatically return to the auto-mode. It will automatically be your receptionist for the entire day!)

As a hands-free phone, this is the jewel of jewels. You don't have to be an electronic engineer to use it, and the quality of sound is superb. You have not only a volume control but a sound-quality control. During the conversation you can switch back and forth from speaker-phone to the handset without disconnecting yourself, as happens on some phones.

A "Mute" switch lets you hear the caller without his hearing you. You can cut this in and out during a conversation.

TOUCHTONE® AND PULSE SWITCHABLE! Use this phone anywhere in the world. At a touch you can change it from Touchtone to pulse.

L.E.D. lights tell you what mode you're in and which features are in position.

One-Button Dialing of Nine Different Numbers

Your Auto Receptionist Phone can store and dial with a single key any of nine numbers (up to 16 digits each).

The easy-touch dial lights up when you want it, so your phone is easy to use even in the dark.

An automatic redial feature lets you call the last number you dialed by pressing just one key.

The Auto Receptionist Phone
$119.95
two for **$109.95** each
(+ $2.75 shipping)

WE ABSOLUTELY GUARANTEE!

Try the Portadial 64, the Auto Receptionist Phone, or both, in your home or office for up to 30 days. If for any reason you decide to return either or both, we'll give you a 100% refund.

For fast delivery on credit card orders, call toll-free 24 hours a day, 7 days a week:

800-443-0100

Ask for Extension 111

Or send check or money order.
(Be sure to add shipping cost.)

The Portadial 64 and The Auto Receptionist Phone
are electronic marvels from

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Long Island City, NY 11101

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MUST LIQUIDATE

AT BELOW DEALER COST!

4000 Watt, Gas Operated, Emergency

Power Generator

FACTORY NEW! FACTORY PERFECT!

PUBLIC NOTICE!

Bankruptcy and Financially Distressed Merchandise!

We are authorized liquidators of inventories that must be quickly sold at sacrifice prices due to a variety of reasons, such as:

Overproduction. Last year's models. Order cancellations. Bankruptcy. Out of season. Plant closings. Economic recession. Financial difficulties. Excessive competition.

If you know of a company with surplus inventories that must be liquidated for immediate cash, call us Toll-Free: 1-800-328-0609. Only products in perfect operating condition will be considered.

DON'T let a storm rob YOUR home of vital electric power! With this 4000 watt generator, you ALWAYS have a reliable standby source of 115V and 230V plug-in power!

- ***8 hp. Briggs & Stratton 4-cycle gasoline engine!***
- ***U.S. made! U.S. quality!***
- ***1 year warranty!***

Over 350 service centers in the U.S.

FOR HOME! Keep sump pump, well pump, appliances operating in case of any power outage.

FOR WINTER STORMS! No freezeups or burst water pipes when you have this generator on hand.

IN THE FIELD! A reliable source of portable electric power anywhere.

FOR CABIN or CAMP! In the wilderness, you can enjoy comforts of electricity with this generator.

Single phase. 60-cycle

15 amp service. Two 115V outlets; one 230V outlet.

Serious storms can occur anytime of year. Be prepared ALWAYS!

To determine max. load you can put on the generator, use this formula: Volts x Amps = Watts. (Don't exceed the 4000 watt max. limit.)

A storm could knock out your electrical power for hours, or for days! Food could spoil in your refrigerator. A motor in your furnace could stop running in winter and leave your family shivering in the cold. A well could stop pumping water needed for cooking or bathroom facilities. The losses could cost you up to hundreds of dollars . . . or maybe even much more! And think of all the discomfort and inconvenience!

But, you never have to worry when you have this excellent quality portable generator. It's U.S. made! And it provides you with 3 convenient plug-in outlets for 115V and 230V service . . . 15 amps at each outlet. Just put oil in the crankcase, pour gas in the tank, and start the engine.

Use the generator to run your lights, a sump pump, well pump or power tools, etc. Plug in small kitchen appliances, a refrigerator, freezer, etc. Of course, you can't run everything at one time. (Remember the 4000 watt limit.) But you CAN run enough things to keep vital functions operating as you need them.

- **4-cycle, single cylinder, Briggs & Stratton engine.**
- **Produces 8 hp. at 3600 rpm.**
- **Recoil start. Manual choke.**
- **4-qt. gas tank. Uses about .83 gal. per hr. at full load. (Runs longer with less load.)**
- **Chrome plated piston and aluminum alloy cylinder help dissipate heat for cooler running.**
- **Size: 17½"W x 25"L x 18"H.**
- **Shipping weight: approx. 140 lbs.**

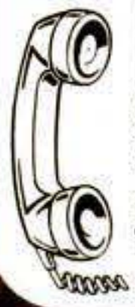
Compare at over $1,000.00

OUT THEY GO AT ONLY:

$488

Pushbutton electric start model available at $588

Price subject to change after 60 days. Offer void outside original 48 states.



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If busy signal, or if no answer, call:

Toll-Free: 1-800-328-5727

In Minnesota, call: **1-800-742-5685**

C.O.M.B. Co.

THE NATION'S LARGEST AUTHORIZED MAIL ORDER LIQUIDATOR OF CONSUMER PRODUCTS
6850 WAYZATA BLVD. ● MINNEAPOLIS, MN 55426

C.O.M.B. Co. / Liquidators Dept. F-179-1196
6850 Wayzata Boulevard / Minneapolis, Minn. 55426

Ship me the 4000 watt Generator(s). (Indicate how many.):

☐ ___ No. 1196 Manual Start at $488 each.

☐ ___ No. 1198 Pushbutton Electric Start at $588 each.

I will pay shipping charge to driver upon delivery. (Allow 4-5 weeks for delivery. Add 2-3 weeks extra if paid by check. Sorry, no C.O.D. orders. Minn. residents add 6% state sales tax.)

☐ My check or money order is enclosed.
Charge my: ☐ MasterCard® ☐ VISA ☐ Am. Ex. ☐ Diners Club

Acct. No. _____ Exp. _____

PLEASE PRINT CLEARLY

Name _____

Address _____

City _____

State _____ ZIP _____

Phone _____

Sign here _____

Rural Route Customer: If truck carriers do not normally deliver to your home, include note with this order stating town address of nearest store, friend or truck terminal to ship to.

Shapers are for home shops

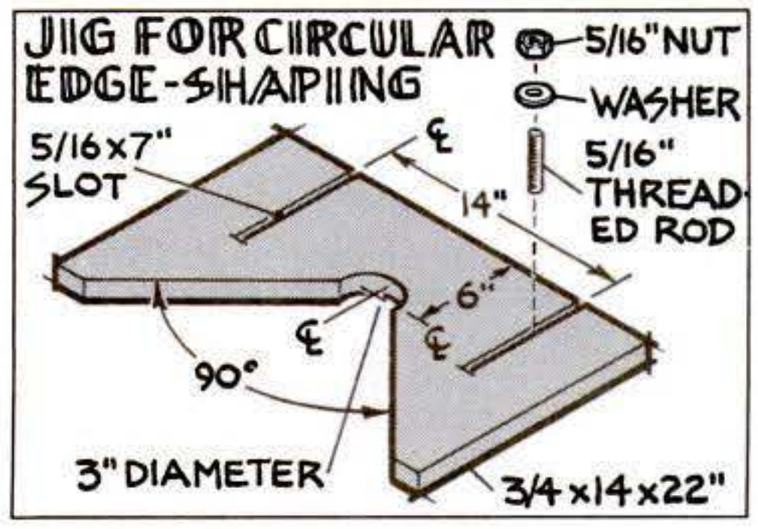
[Continued from page 130]

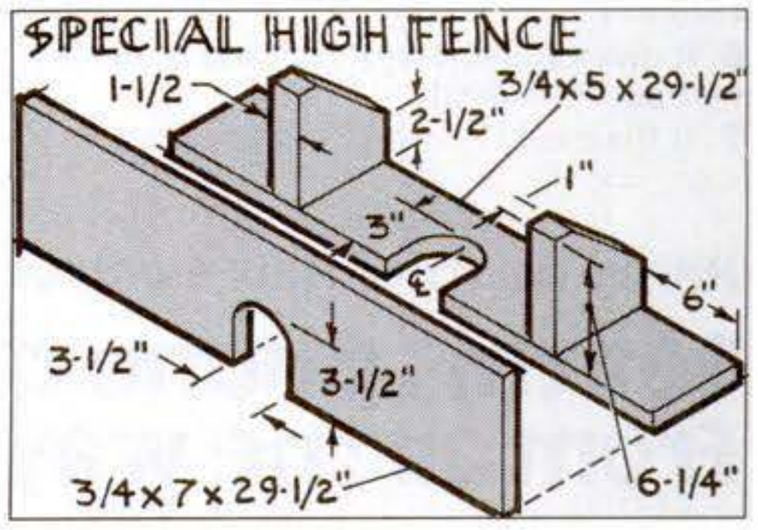
condition, especially when you're working against collars. Any bump or dent in the working edge will be followed by the cutter.

Keep the machine, cutters, and collars in pristine condition. Dull or clogged cutters make it difficult for you to feed smoothly and, because collars turn with the cutters, can scorch or score the wood.

Keep your hands away from the cutters. (This may seem obvious, but the point must be made.) Never shape pieces too small for safe handling: Do the work on a large piece of wood and then saw off the part you need, even if it means wasting some wood.

When possible, situate the cutter so that it's under the work. This puts the work between you and the cutter and won't cause any flaws if you accidentally lift the work during a pass.





Always use a miter gauge, preferably with a hold-down, when doing end-shaping, even on reasonably wide stock.

Be sure to work with a fulcrum pin (usually supplied) when doing free-hand shaping against collars. The table is drilled so the pin can be used on either side of the cutter. I think it's a good idea to buy an extra pin and use both to help support the work through the pass.

Work with the guards supplied with the tool where possible. You might consider buying any that are listed as accessories. However, you'll always come upon an operation that doesn't allow the use of guards. In those cases, use extreme caution. Try a dry run: Go through the motions with the tool turned off so you can preview the procedure and judge how best to place yourself and your hands. PS

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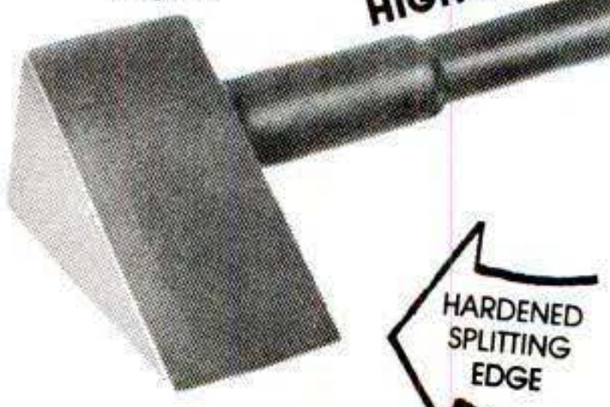
SOTZ MONSTER MAUL

FAST-N EASY WOOD SPLITTING

12-LB. HIGH CARBON STEEL HEAD

HIGH STRENGTH STEEL HANDLE

1-YEAR TRIAL OFFER AT OUR RISK



$24.94

DELIVERED (INCLUDES TAX)
LOWER PRICED THAN IN 1980

OUR 27th YEAR

- Ends broken handles, stuck axes and flying wedges.
- **Hardened splitting edge lasts and lasts. Resists deforming.**
- Splits most logs in one lick.
- **No struggling lifting heavy logs up to high priced power splitters.**
- No gasoline, no set-up, no takedown.
- **Shape of head prevents sticking.**
- Drop'em, saw'em, stand'em up and split'em.
- **No gimmicks, just simple physics.**

GUARANTEED 10 YEARS AGAINST FAILURE

For many years, you've seen our ads and read unsolicited letters from folks just like you, saying how unbelievably effective the Monster Maul really is. Try a **MONSTER MAUL AT OUR RISK!** Within one year, if you don't think it's the fastest, least tiring method of splitting firewood, let us know, and we will give you your money back, including shipping . . . plus it's guaranteed against failure for 10 years.

Weight: **(Total weight 15 lb.)**
Price: **$19.94** Factory pickup.
$24.94 Delivered to your door.

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CALL TOLL FREE 1-800-321-9892
Inside Ohio 1-216-236-5021
OR SEND CHECK OR MONEY ORDER.
Sorry No C.O.D.'s

Sotz Inc., 13639 Station Rd., Columbia Station, OH 44028

MONSTER TALES

Have been as busy as a fox in a hen house with your Monster Maul. Have been splitting tough red elm which could be some of Minnesota's toughest wood. Can now split without a crew. The winter of '78 and '79 sold 300 loads with a pickup truck. Come May, 1983, I will be 74 years old and enjoy splitting with the Monster Maul. Have been heating our home with wood the last three winters. Do like to heat with wood it is such a welcome heat. The good thing about this Maul, you can stand it on end and will stay upright. My good friend "Leonard" may you find a bass under every lily pad.

Math Reimer, Long Lake, MN

NEIGHBORLY LESSON

I visited my neighbor last week to find his son and son-in-law struggling to lift heavy cross-sections of oak and hickory onto a tractor-powered hydraulic splitter. I pulled the Monster Maul out of the back of my pickup and went to work. After 15 minutes with aching backs, they and their 80 hp fuel-eating rig had split about 2/3 of what I and the Monster had, and I was just getting loosened up. The first question they asked was where they could buy such a maul.

Bill Dieckman, Letts, IA

DOCTOR REPORTS!

I recently purchased your "Monster Maul". It is gratifying to find a mail order item that is exactly as advertised. I split knotty, live oak with little difficulty. The most amazing thing to me is that compared to all the other systems, I have ever used, the Monster never gets stuck. Also, the newspaper that accompanies the maul is full of useful information. Being on the receiving end of many work-related injuries, I appreciate the emphasis on safety as well.

Ira B. Fishman, M.D., King City, CA

UNDOUBTEDLY THE BEST!

I have one of your Monster Mauls and it's the greatest splitter I have ever used. I split 3 cords of oak in 1 day; approximately 2 hours per cord. The oak was 16"x 18" and the maul split it with ease in just one and two shots. Enclosed is $15.95 for a set of your woodstove tools. I have no doubts that it will be as good a product as your monster maul. Thank you for prompt delivery. P.S. Please send me one of your up-to-date newspapers, I really enjoy reading it. Thanks.

Louis A. Colasante, Hatboro, PA

NO ROOM FOR IMPROVEMENT

After reading your advertisement in a magazine, I decided to order a Monster Maul. I did this with some reservations, not believing everything I read. Immediately upon receiving the maul I went to the woodpile which consisted entirely of oak logs greater than 16" in diameter, which were too cumbersome to lift onto my screw-type splitter. I was just amazed at the ease of which I was able to split the pieces. I only wish I had purchased your maul before I acquired the array of splitting equipment I now have. Thanks for a great tool that can't be improved upon & fantastic material, workmanship, and design.

Gerald Peterson, Lino Lakes, MN

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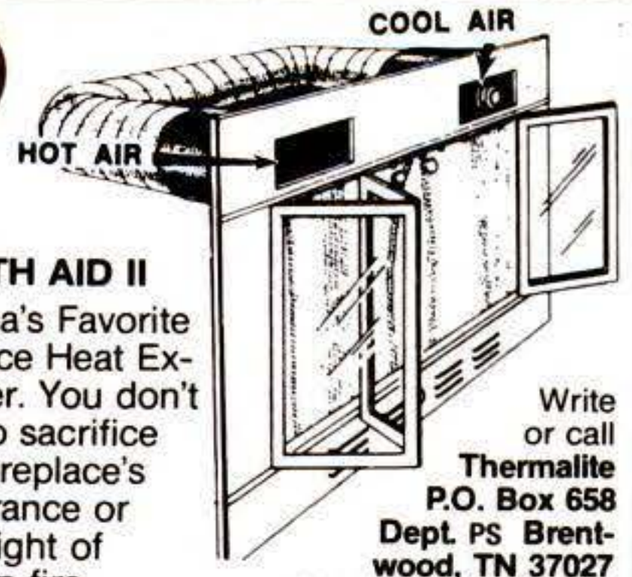

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Spy photos from space

[Continued from page 97]

denberg AFB, Calif., at about 10 a.m. The timing puts them into sun-synchronous, near-polar orbits. In such an orbit, the ship passes over almost every point on Earth at least once a day at midmorning, when sun angles and lighting are best for photography.

Big Bird, the largest U.S. spy craft, carries two camera systems. Its digital system, built by Eastman Kodak, transmits medium-resolution images to ground stations. Film from its high-resolution camera, built by Perkin-Elmer, is periodically jettisoned in reentry pods and recovered in midair, south of Hawaii. The Air Force will not allow either of the companies to discuss its cameras. Many of the photos undoubtedly find their way to DMA and its UNAMACE system.

Reconnaissance video—live

Even better technology for real-time surveillance is expected when KH-9 satellites begin operating in 1984. The KH-9 can be launched by the shuttle and later recovered for repair or refurbishment. Sources say it will carry a high-resolution imaging system based on charge-coupled device (CCD) technology.

Such a system has been under development by Itek since 1978. Each CCD element reads light intensities in a tiny square within the field of view. The readings, enhanced and combined in a computer, yield a high-quality television image that should be available seconds after it's transmitted to the ground.

"You can literally get live pictures instantaneously," an Itek researcher told ABC News. The resolution is good enough to identify lighted windows in a building or vehicles or aircraft on the ground.

Shortly after the interview, the Air Force clamped down on Itek, the company that also makes other spy-satellite cameras and that built a large-format survey camera to be used aboard the shuttle [PS, July '81]. Even the shuttle-camera technology is now under wraps. "We don't talk about our special customers," an Itek spokesman told me.

Nor does anyone talk about how much surveillance data flows daily into the intelligence community. But the DMA's workload is so heavy that many of its sections operate around the clock, seven days a week. "What kind of security clearance is needed to work here?" I asked. "Top secret?"

"Oh, no. Much higher than that," Charlie Ritch replied. "We need 'special access.' "

"What's that?"

"I can't tell you." PS

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Burns over 24 hours

TRY A SOTZ HEATER FOR ONE YEAR AT OUR RISK!

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- **Tremendous radiating surface area gives you more heat with less wood.**
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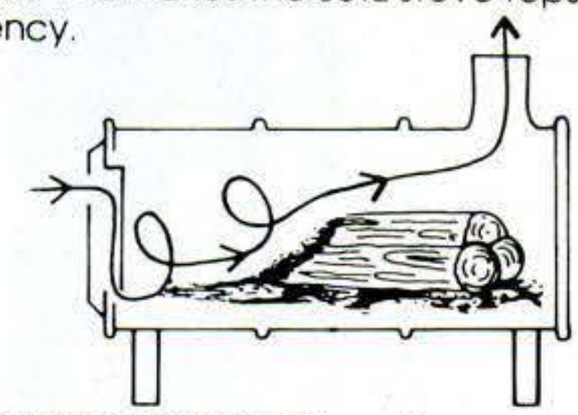
SPECIFICATIONS: Door, door frame, flue collar, draft control, internal draft channel of 13 ga. steel; legs, 1/8 in. steel; hinges, latch, catch of 3/16 in. steel; nuts and bolts. Top Drum; Connector flanges, pipe assembly, 4 nesting brackets, nuts and bolts.

OUR 27th YEAR

Patented INTERNAL DRAFT CHANNEL-Air entering top draft control is preheated as it is drawn down inside of door and is sucked into bottom of heater with a turbulent action, mixing with the wood gases. This makes the Sotz stove tops in efficiency.



SPARK-PROOF DESIGN . . . Because of our internal draft channel, hot sparks cannot jump out of heater as in others with draft straight open to fire.

$34.92 55-Gal. bottom kit factory pick-up

$26.94 30 Gal. bottom kit factory pick-up

Kit converts 55 gal., or 30 to 15 gal., drum (not supplied) into high capacity stoves.

You've seen our ads and read unsolicited testimonials from folks just like you for many years. Before you spend $400 to $500 on a wood heater, try a **SOTZ HEATER** kit. If (within one year) you don't agree it outperforms any wood heater money can buy or (within 10 years), if the kit cracks, warps or burns up, your money will be refunded, including shipping charges.

Use of draft control allows you to heat large or small areas. Basement installation heats your entire home. Great for your garage, workshop, or cabin. Top drum squeezes 60% more BTU's from heat normally lost up the chimney. Heavy steel kit bolts together quick and easy.

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- **55 Gal. Stove has king size 15½" diagonal fuel door. Less wood splitting, easier fire tending.**
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FREE INFO: Add even more efficiency to the already super efficient Sotz Stove with a genuine **Corning** Brand® Catalytic Combustor, easily fits existing Sotz 2-Drum Heaters. Learn about heating water, drying wood, fireplace-to-woodstove.

Sotz Inc., 13639 Station Rd., Columbia Station, OH 44028

STARVING TERMITES

As an attorney I am a natural skeptic. While building my own passive solar house in La Grange, Kentucky, I did considerable research concerning wood stoves. After reading and studying all the information I could get my hands on, I determined that the Vermont Castings Defiant and the Franklin Scandia stove of the same design were the most efficient wood heaters on the market. I purchased a Scandia. I installed it, fired it up, and continued to shiver. It ate wood like a swarm of starving termites, and the only heat it seemed to generate was ... from my constant trips to the woodpile. After this $441.00 mistake, I decided to risk $50 on your double drum kit. The results are nothing short of amazing. Our owner-built house is 3700 square feet, and the Sotz stove in the basement, centrally located, easily heats the entire three story house using only about one-third of the wood previously used! The stove may not be esthetically beautiful (according to my wife), but this is a case of "pretty is as pretty does". I also find that because of the double-drum configuration the flue temperature is considerably lower. About a month ago, faced with the necessity of splitting several cords of wood for the coming winter, and having had poor success with a regular maul and wedge, and preferring the easy way of doing things, I seriously considered a hydraulic splitter but decided to rely on your Monster maul advertisement, the truth of your advertising having been previously proven by your drum stove ads. I ordered the Monster Maul. You saved me several hundred dollars. I actually ENJOY using the monster Maul. You may now send me a set of your stove tools, poker, rake, etc. Below please find my home address and credit card number.

Konrad Poth, LaGrange KY

"THE COMEDIAN"

I knew there was a catch to the stove kit and Monster Maul. For the past 3 years I've read your ads and successfully resisted. Finally I weakened and bought both the maul and kit for the 2 Barrel stove and as I suspected, there had to be a catch. It does heat a basement and upper floor of a 25'x40' building. I'll admit that it does hold the fire for 16-18 hours effortlessly. Sure there are not hot spots or sparks. And maybe the ease of assembly does impress me. Some of my neighbors even agree that the maul is better than a 6-pak of wedges and axes. But: If this whole set-up is so all fired great, efficient, convenient, dependable, clean, and low cost, why won't my wife volunteer to cut the wood?

Dr. Larry Vickrey, Louisiana, MO

COZY AT 50° BELOW

I built your double drum model. It works like a champ, heating my 32' geodesic dome to fifty below zero. Also please ship one Monster Maul. . .

Richard Scott, Fairbanks, AK

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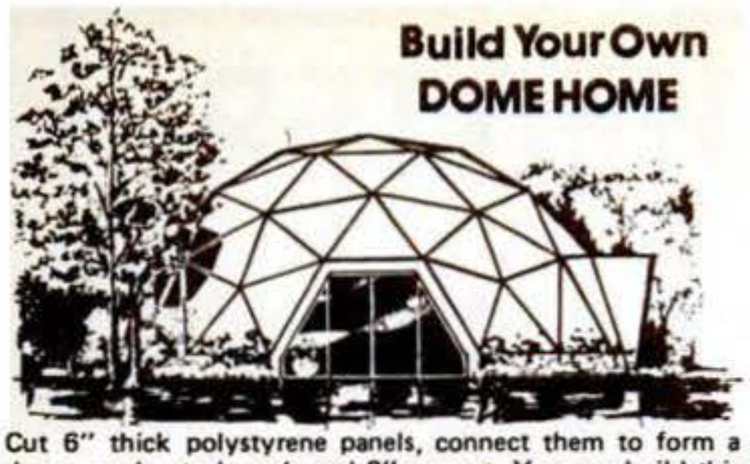

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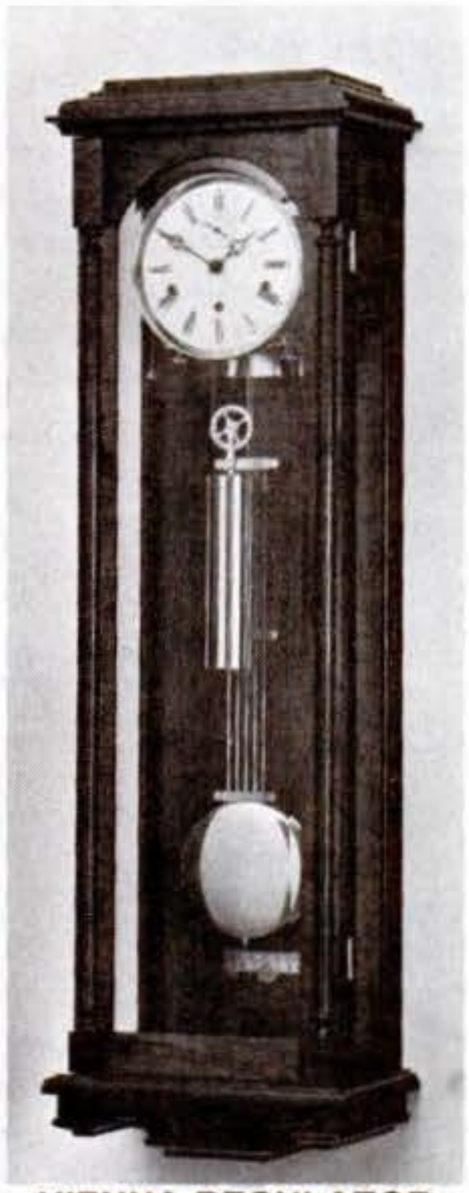

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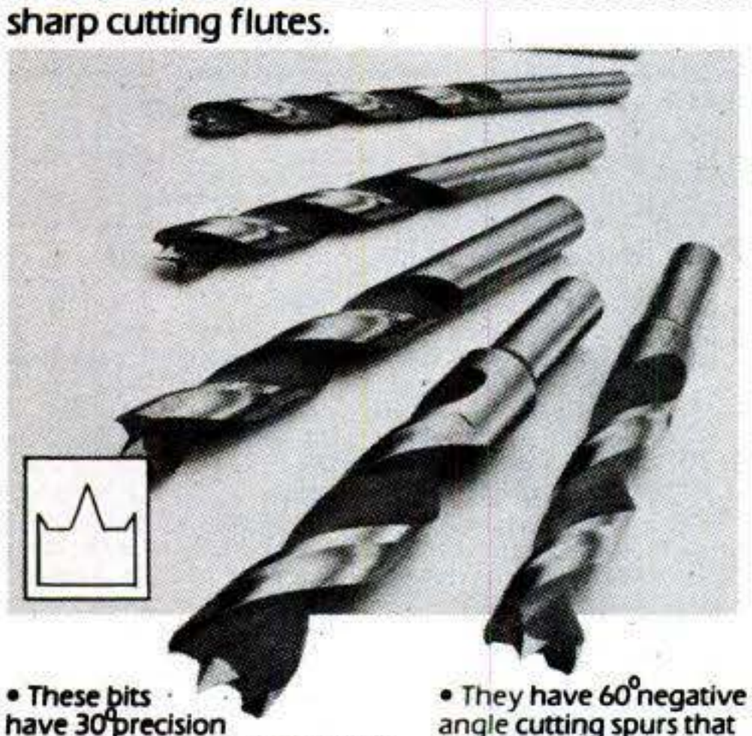

- These bits have 30° precision ground center spur to prevent skating or dancing.
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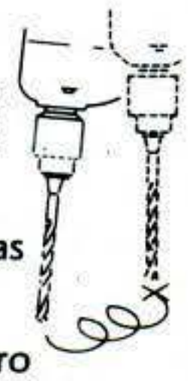

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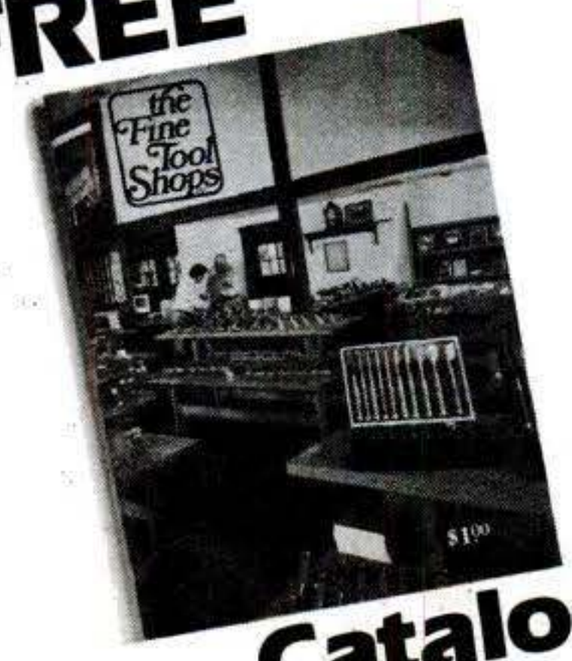

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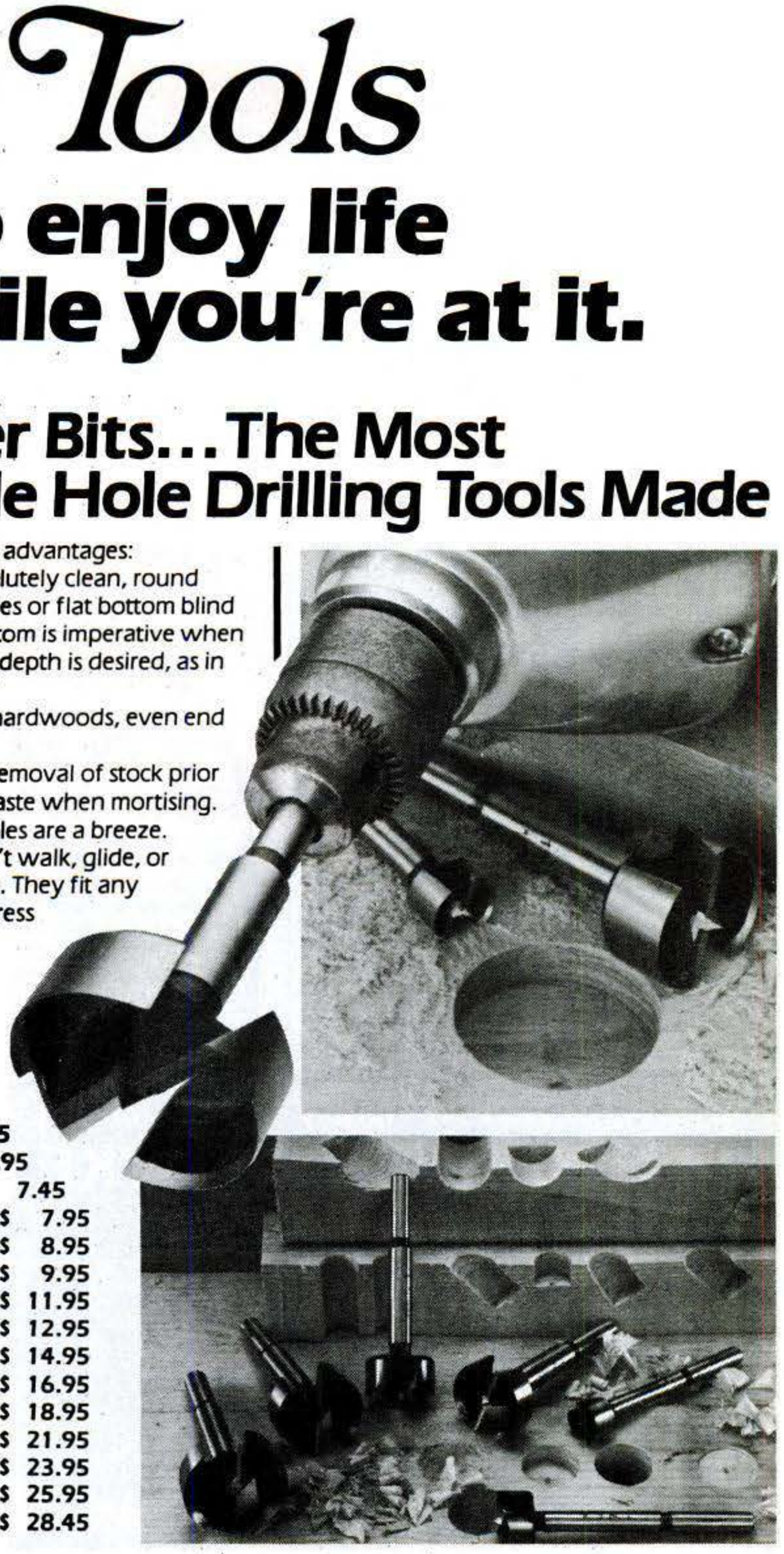

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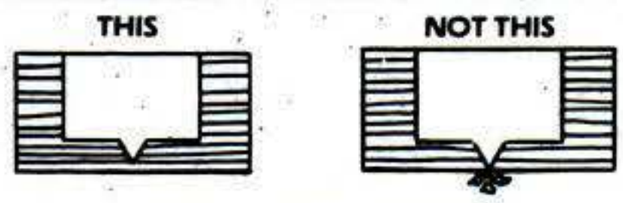

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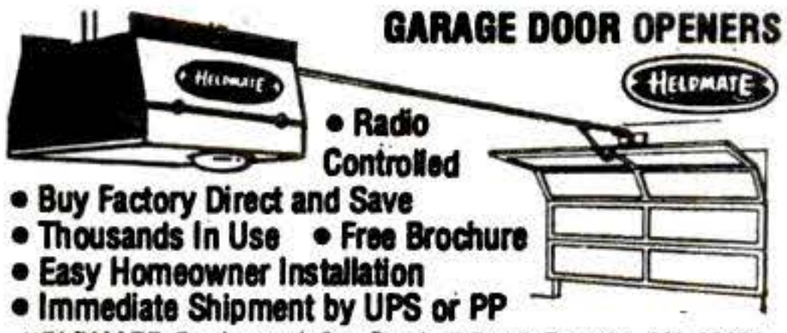

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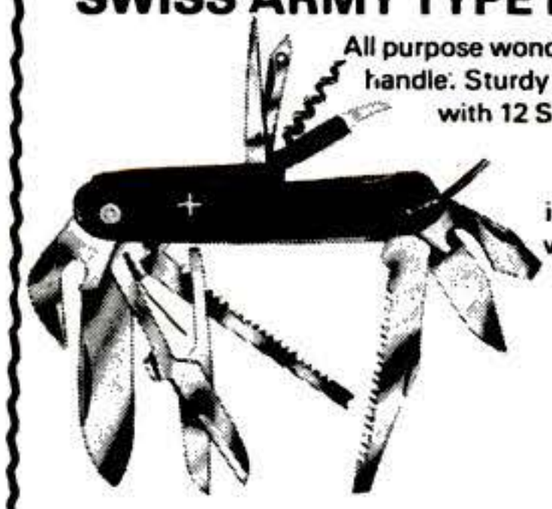

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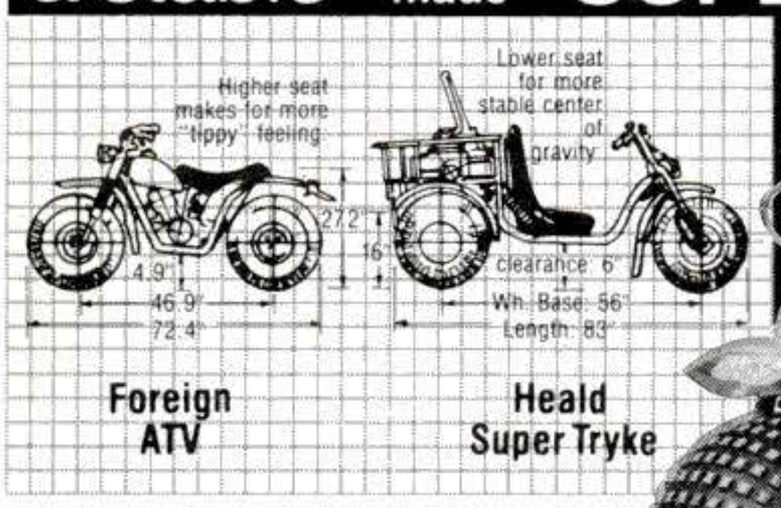

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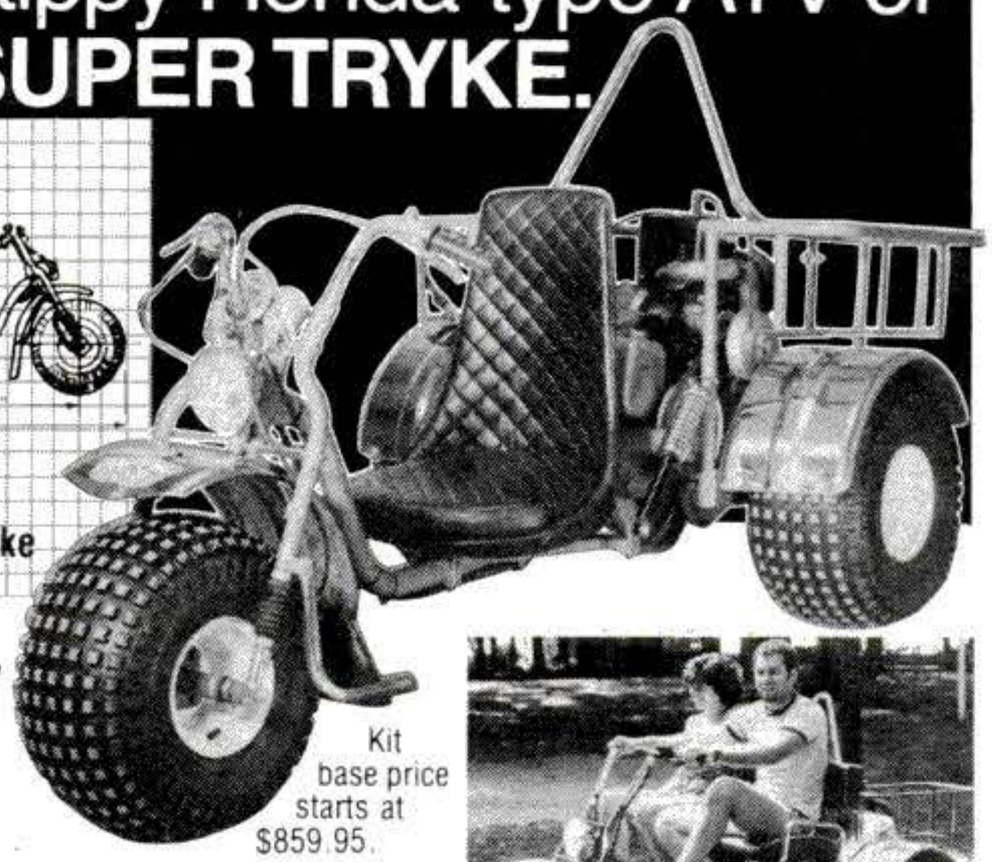

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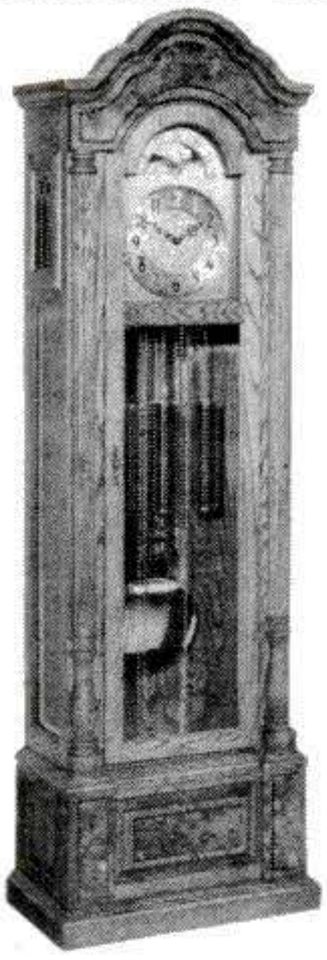

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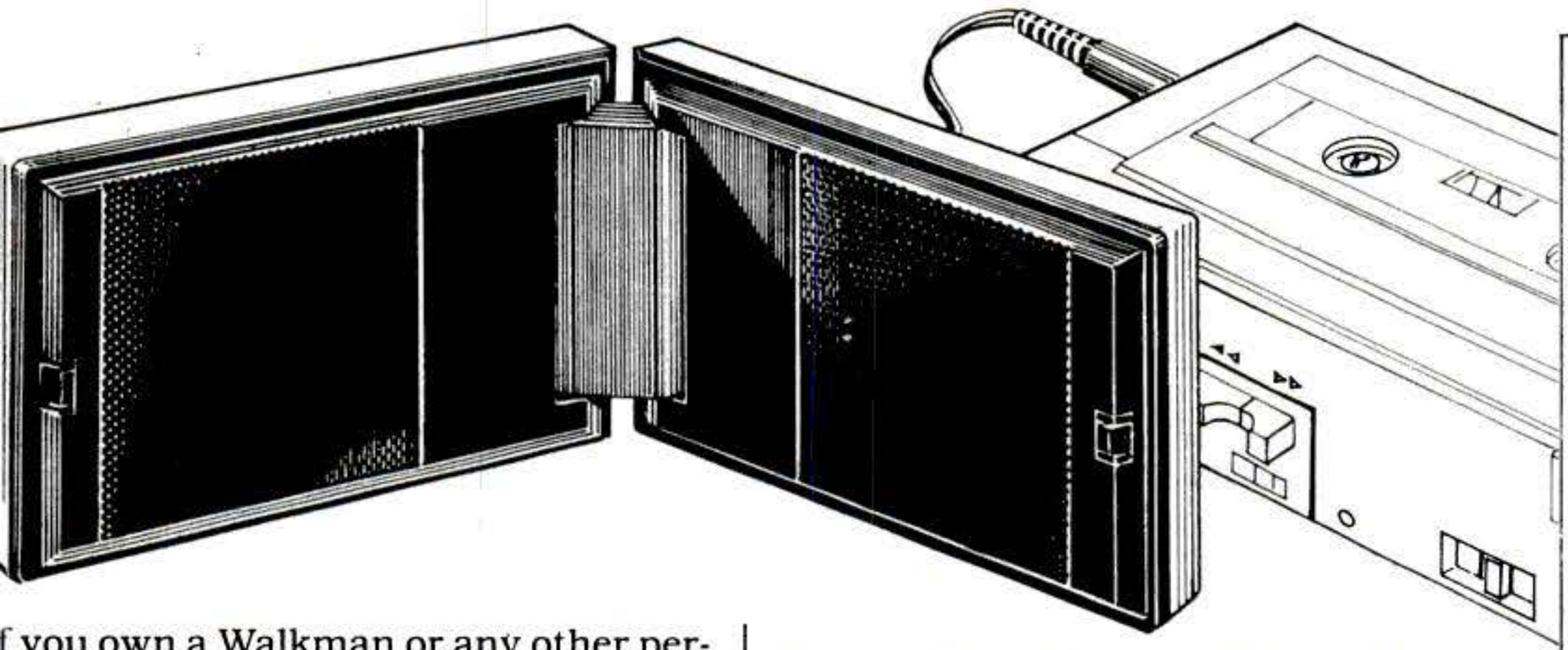

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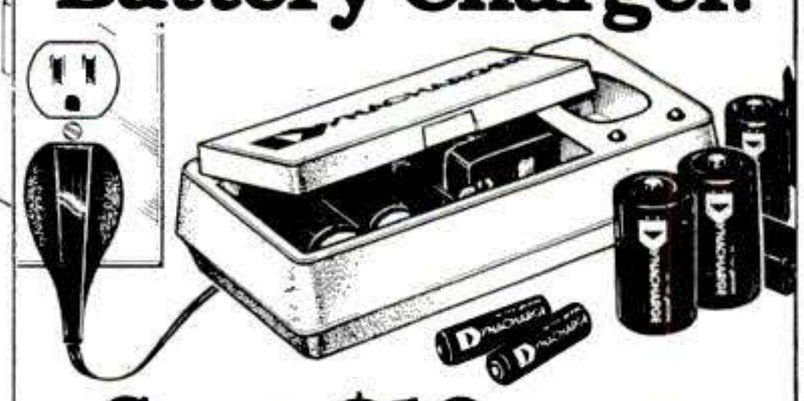

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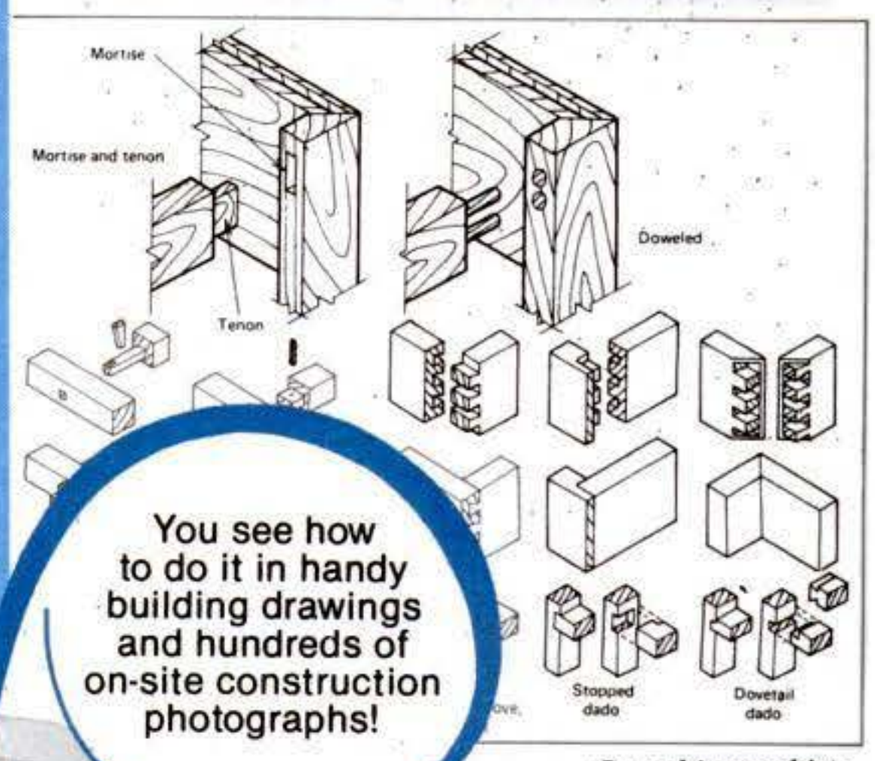

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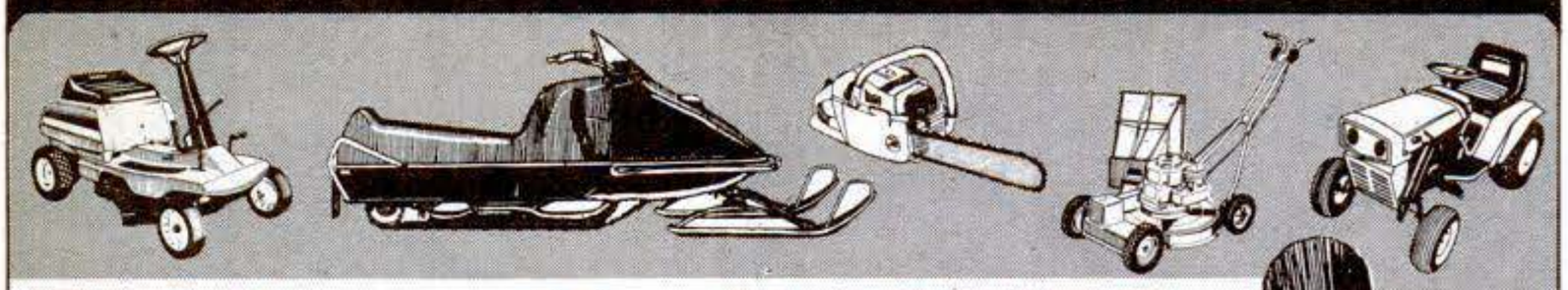

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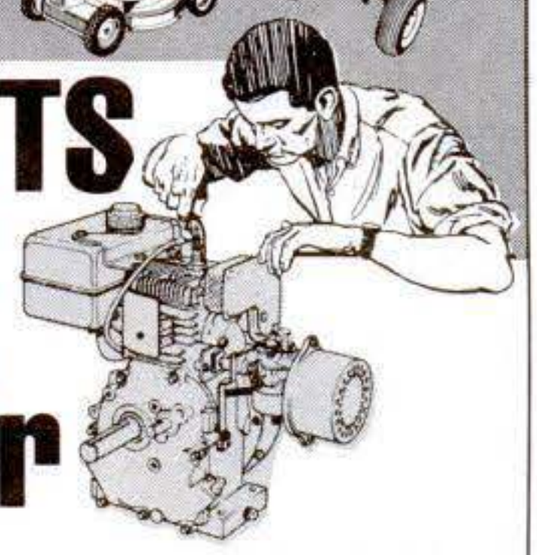

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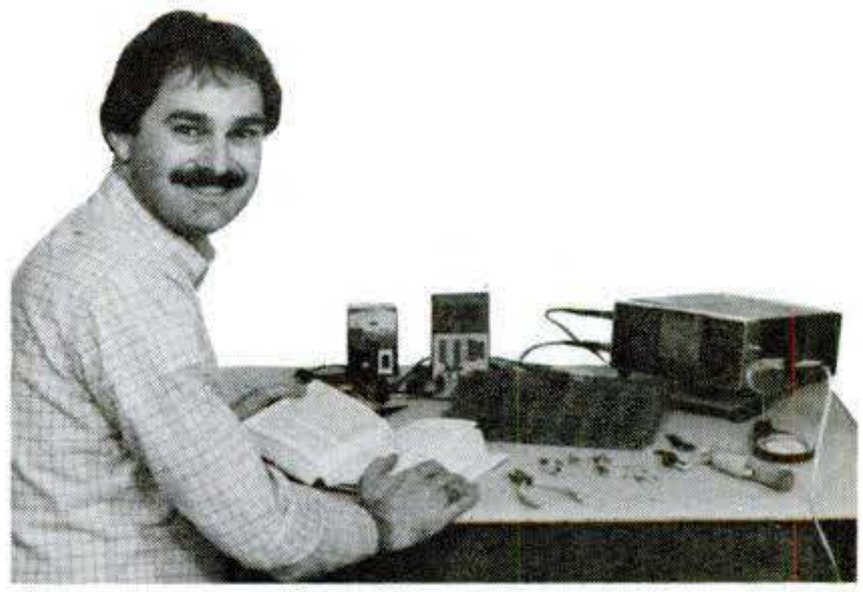

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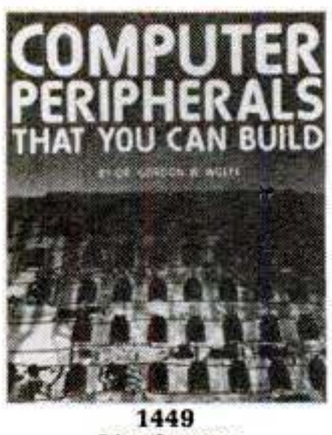

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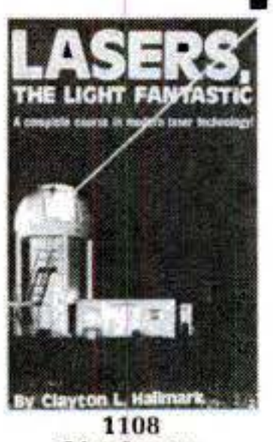

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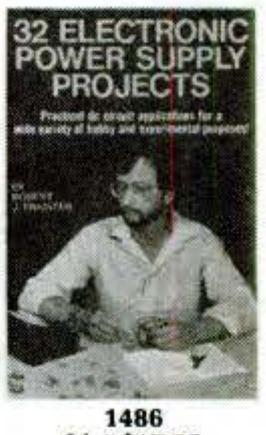

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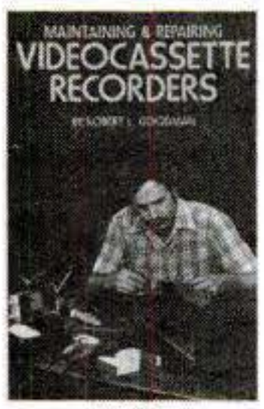

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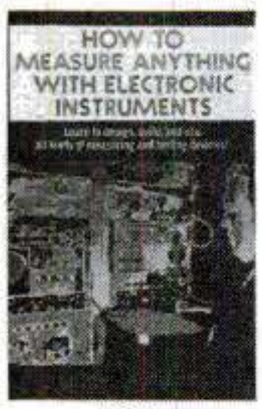

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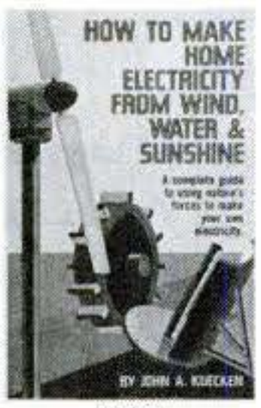

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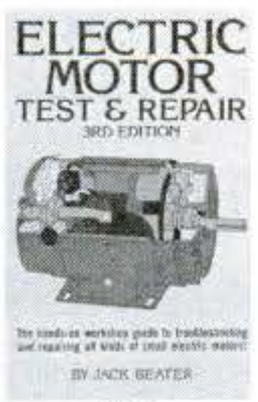

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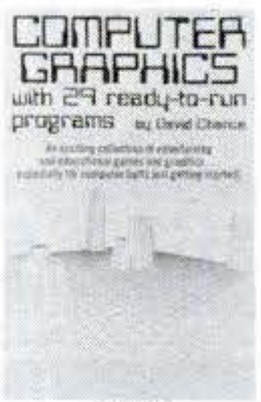

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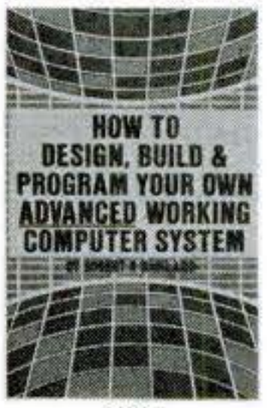

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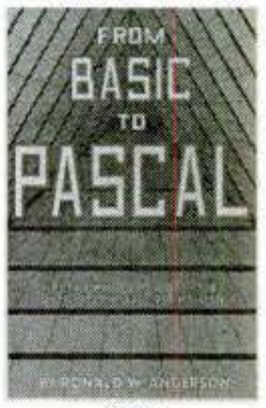

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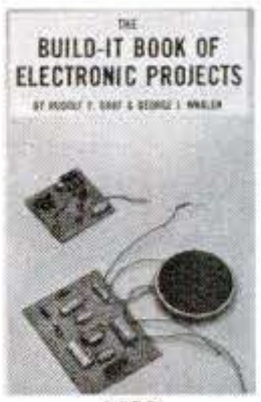

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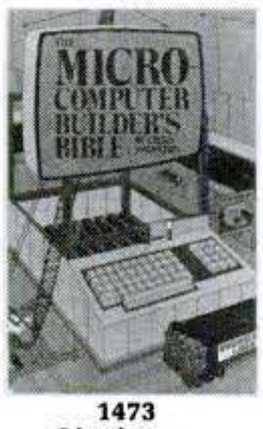

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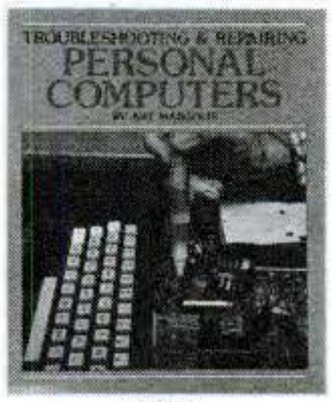

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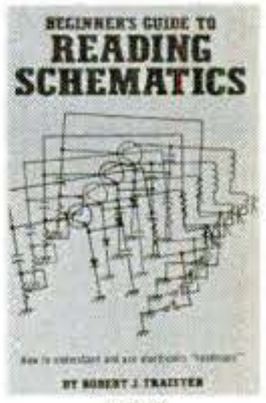

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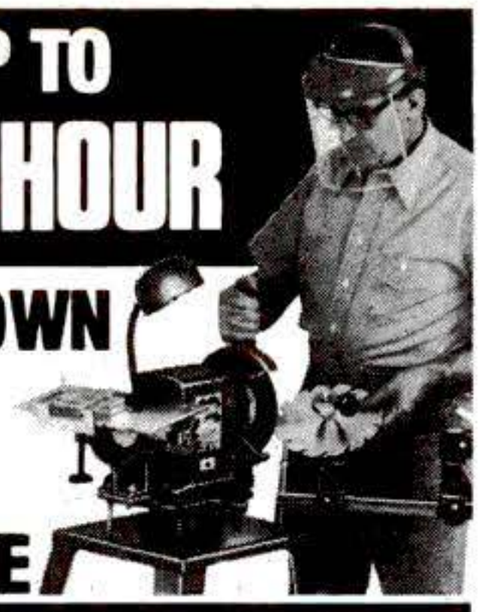

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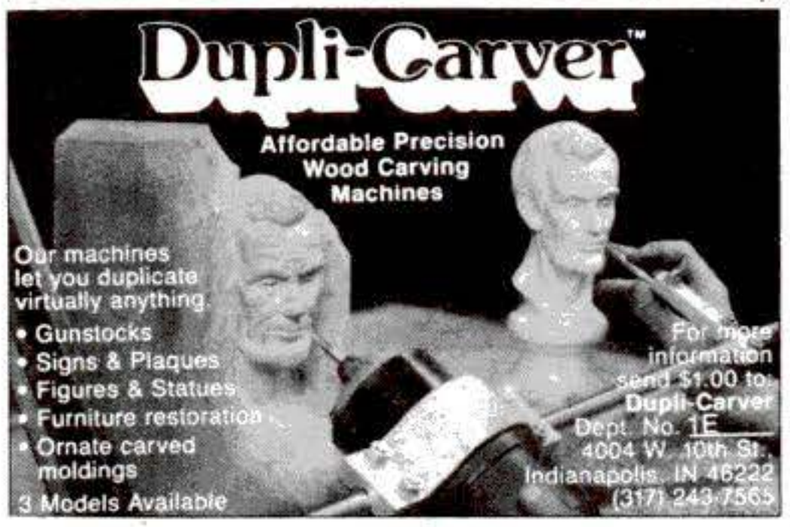

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"Marge, my wife, discovered the perfect answer. She had run across a Duraclean story—a message much like this one—and we looked into it. Well, believe me, when we saw the superior Duraclean service demonstrated and found out what a low investment it took, we were sold.

"With a fireman's schedule, I was able to start out in my spare time. (I didn't want to burn all my bridges behind me.) Marge and I mailed out company provided mailings describing our service and soon the phone began to ring. She made the appointments. I rendered the service. When we discovered how much money there was to be made in a Duraclean dealership, I took early retirement from the fire department. Before long, I had to hire part-time servicemen. Soon, profits paid for our first van. Now most of the work is done by our four servicemen. Marge schedules the jobs, sends out mailings and does the bookkeeping. I do the job estimating, special spotting jobs and contact new prospects."

Now at this point you're probably asking yourself, what is this Duraclean business Wilt Hildenbrand keeps raving about? Well quite simply, it's a unique, superior system for cleaning upholstered furniture, rugs and carpets (don't confuse it with "steam cleaning" or ordinary shampooing methods). It not only cleans but restores and revives colors. It does not wear down the fiber or drive the dirt into the base of the rug as ordinary cleaning methods do. Instead it *lifts out* dirt by means of an absorbent dry foam.

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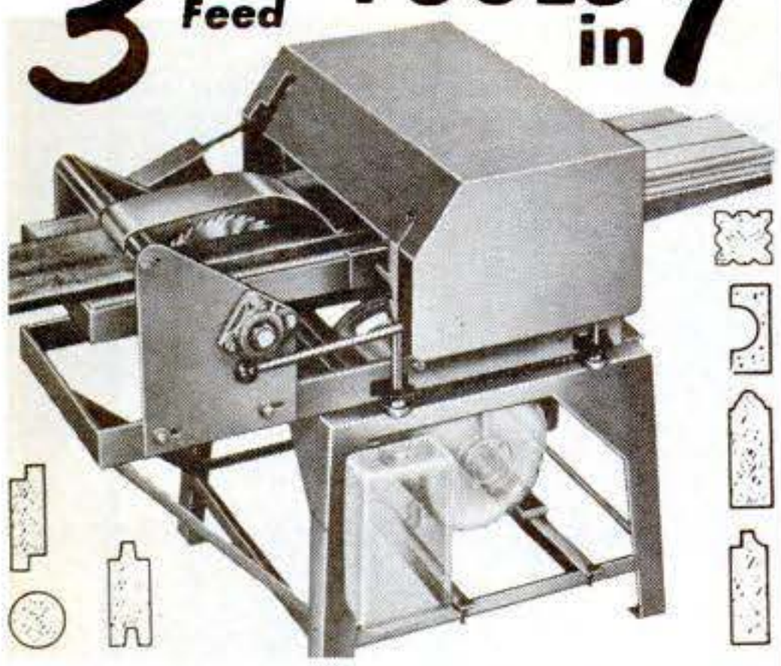

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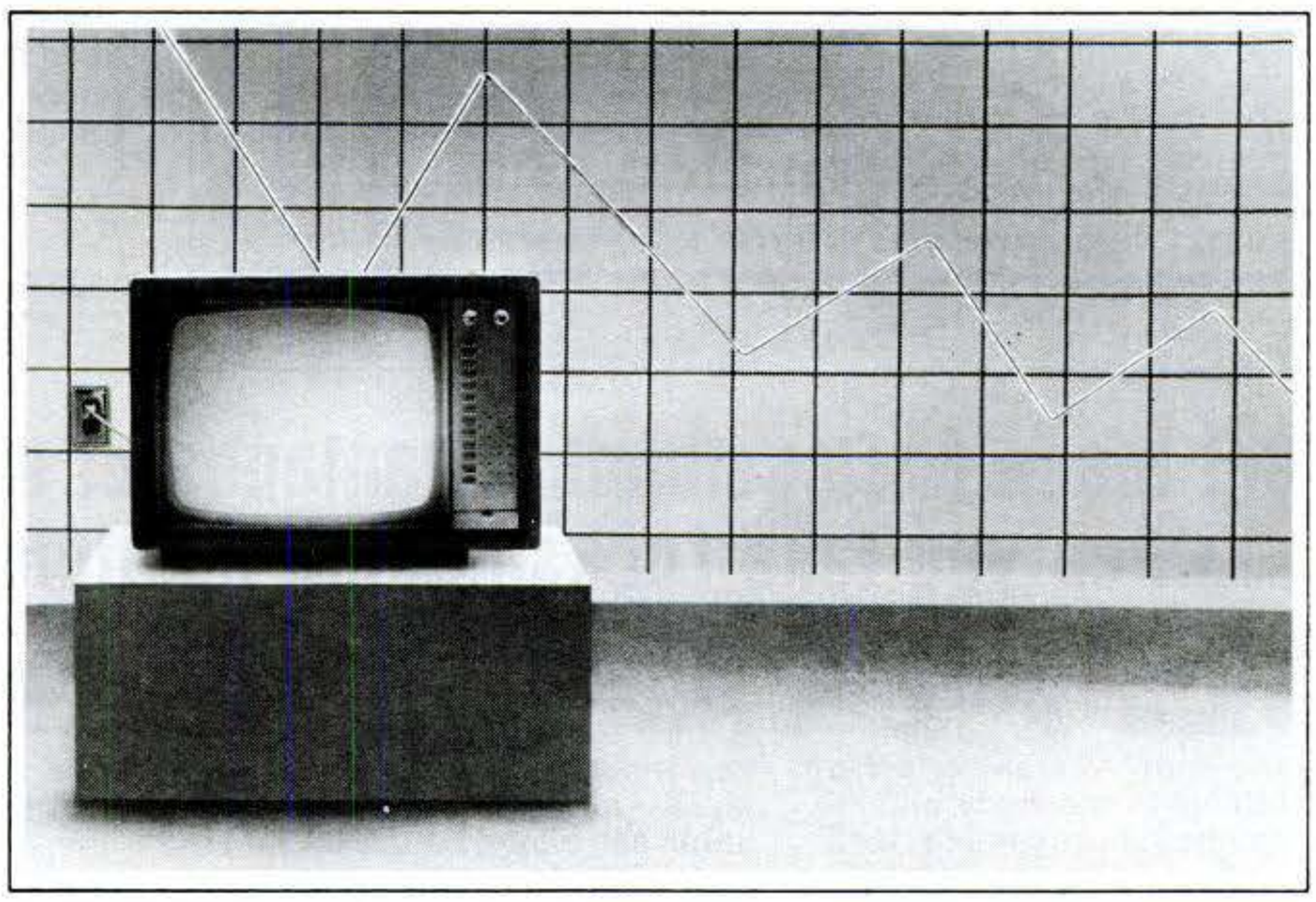

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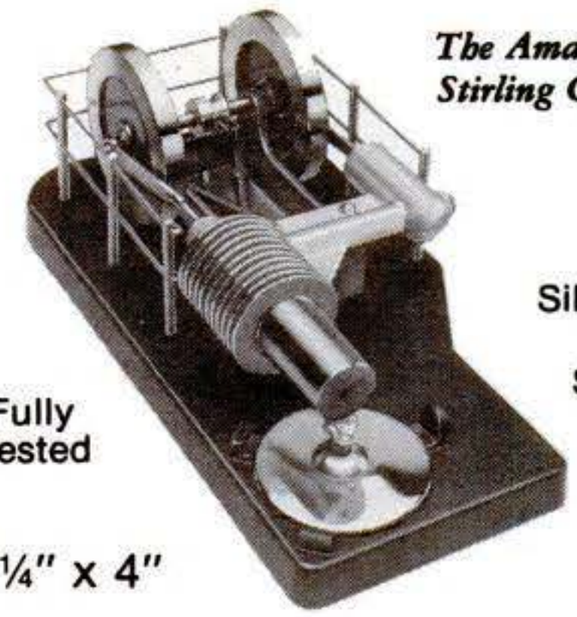

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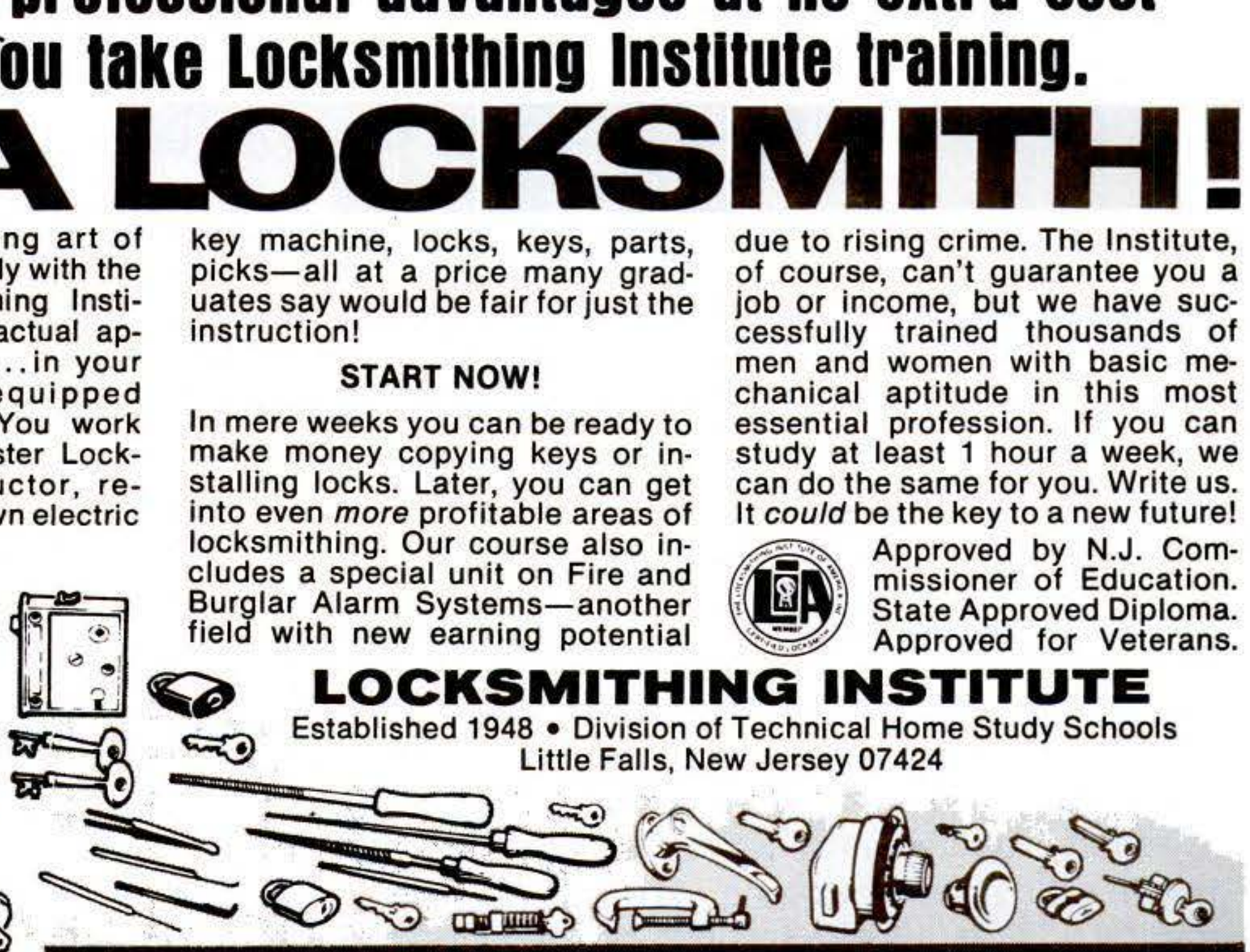

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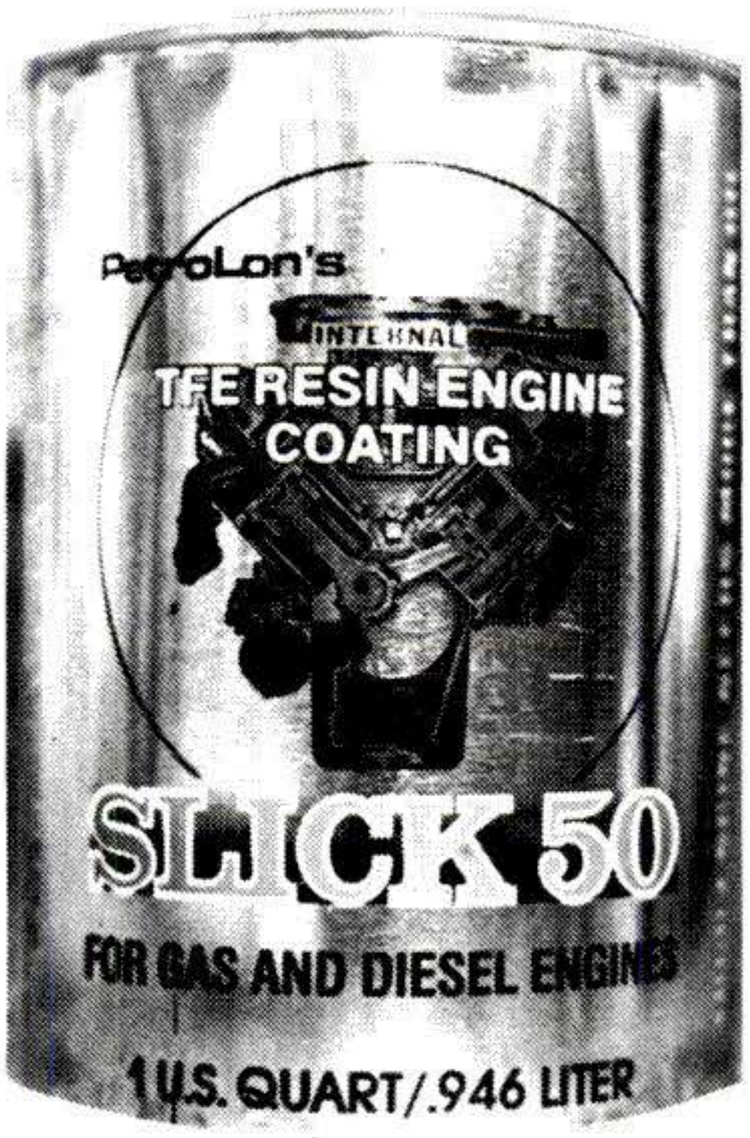
HOW DO I KNOW THIS ISN'T A FRAUD? Slick 50 has some very impressive credentials. The **"Consumers Digest"** magazine (March/April 1982, p. 35) states "Slick 50 does reduce engine heat and ordinary wear, and our informal tests indicate that it will improve gas mileage by about 2 or 3 miles per gallon." Researchers at the **Franklin Institute Research Laboratory**, after applying a powerful ultrasonic cleaning process to a Slick 50 treated engine part, were surprised at its permanence. They stated, "We actually expected the PetroLon Slick 50 TFE Resin coating to also be removed, but later found it was still there."

The **FAA (Federal Aviation Administration)** has fully accepted Slick 50 Aircraft Piston Engine Treatment (F.A.R. **#33.49**). An FAA test simulating 1400 hours of engine use (equivalent to about 70,000 miles on a car) showed almost zero engine wear!

Twenty-five hundred miles after removing Slick 50 from the crankcase, tests done at the **University of Utah Engineering Experiment Station** showed that the benefits of Slick 50 were still there. They reported a horsepower increase of 16.9% and 9.9% for light and heavy loading respectively. The senior engineering researcher at the **University of Southern California** in San Diego stated this, "Slick 50 does increase horsepower and decreases fuel consumption in tests done at the university." **The Space Shuttle Columbia** uses the chemical "poly" in its gears and bearings because it is the only chemical lubricant which can withstand the heat and corrosive elements of space.

Perhaps most dramatic of all is a torture-test overseen by the **Automotive Services Council for Pennsylvania** and



shown on television station WTVE. Three cars with between 75,000 and 129,000 miles on them were treated with Slick 50. Six months later the oil was drained from each vehicle and the cars were driven without the oil plugs for about a half hour. The water temperature never rose and the engines sustained no apparent damage. The Southwest Daily Times (Dec. 19, 1982, p. 6), reports that a man from Liberal, Kansas, flew his airplane without oil for 30 minutes. There are many more tests available. If you are still skeptical, send $2.00 to defray printing and postage costs and we will send you additional, more detailed, test information, etc.

HOW DO YOU TREAT AN ENGINE? Very simply. A few minutes before oil and filter change add engine flush (sent free with each order) to clean out your engine. Let your engine idle for 5 minutes. Then drain your oil, change filters and add the proper amount of oil less one quart. Add one quart Slick 50, drive for 30 minutes, and leave it in the crankcase for 3,000 miles. As the engine operates, the oil carries the polytetrafluoroethylene between the parts where it is burnished into the pores of the metal. Once impregnated it is permanent, so you do it only once, not each time you change oil. One quart of Slick 50 will treat all standard 4, 6 and 8 cylinder gasoline and diesel engines.

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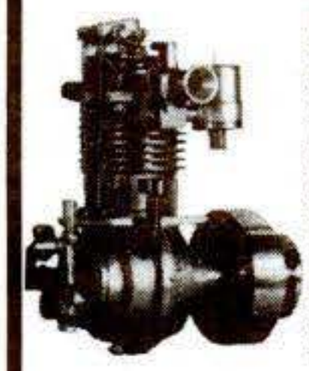

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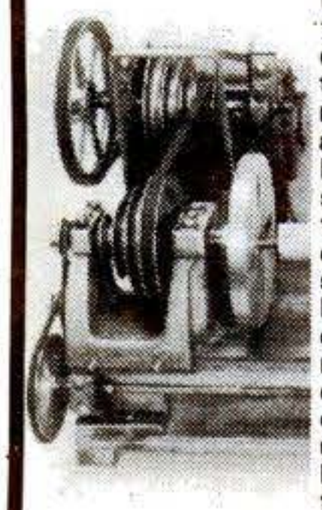

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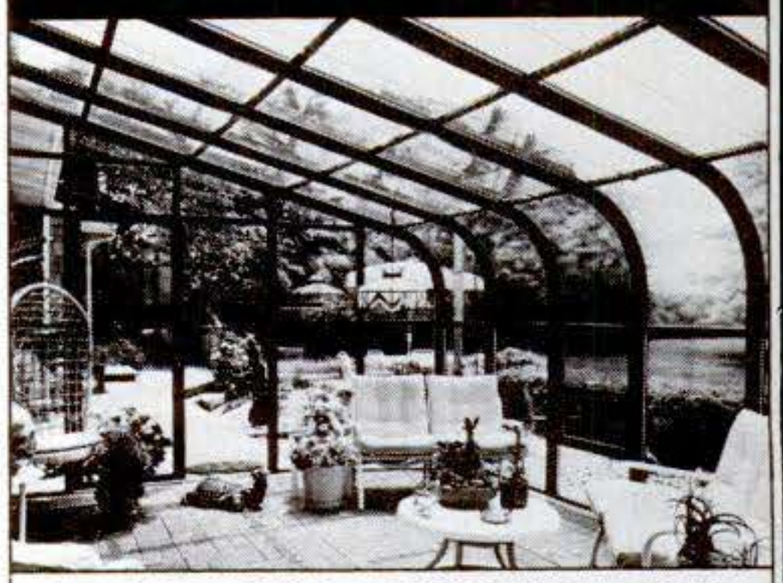

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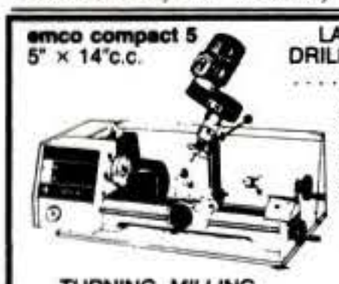

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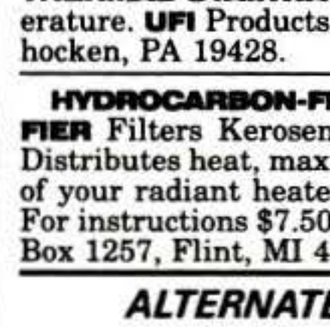

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1124 Cameras Full-color brochure features Nikon's entire camera system—from the professional F3 to the new subcompact "One-Touch" L35AF. Free

1125 1984 Automobiles This catalog from Oldsmobile features the Cutlass Cruiser and other great 1984 Oldsmobile models. Free

1126 Ceiling Fans This 20-page, four-color brochure lists all Hunter Original, Designer Choice, Comfort Breeze, and new low-profile ceiling fans plus more than 125 distinctive accessories. Available from Robbins & Myers. $1

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1129 Solar Greenhouses This color catalog from the Vegetable Factory provides information about a double-wall greenhouse with a heat-storage system that may qualify you for a 40-percent federal energy tax credit. The greenhouse comes in many models and sizes, or you can get just the solar panels to build your own. $2

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