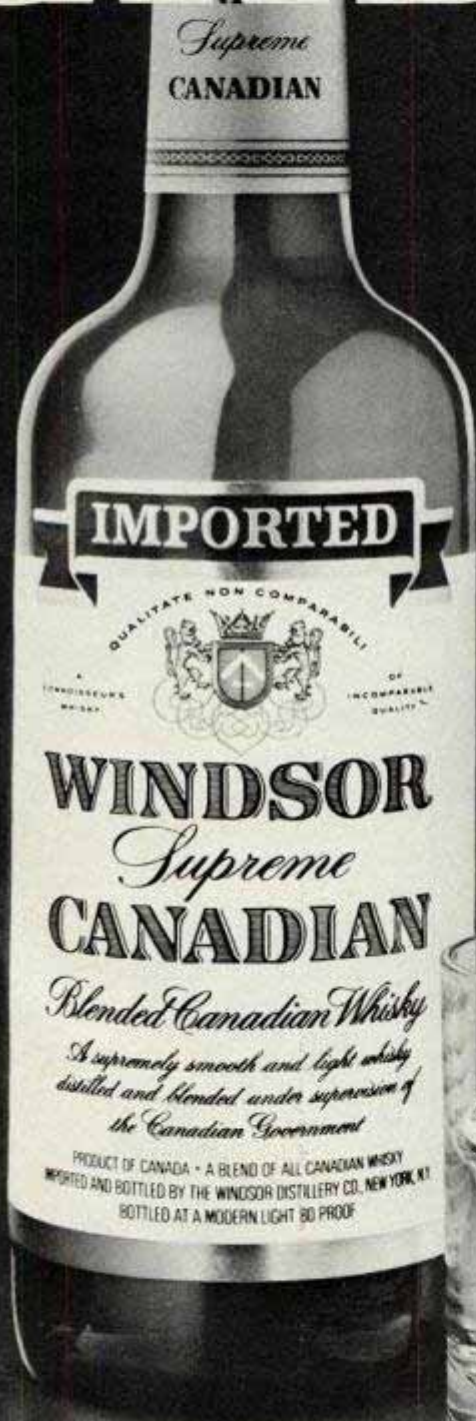


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It's not an imaginary prop for a space movie. It's a daring new concept for a supersonic fighter jet that lands and takes off like a helicopter. Read how it may revolutionize aerial warfare in the exciting story on page 59.

—PM painting by Ed Valigursky



Popular Mechanics®

VOLUME 161 NO. 6

JUNE 1984

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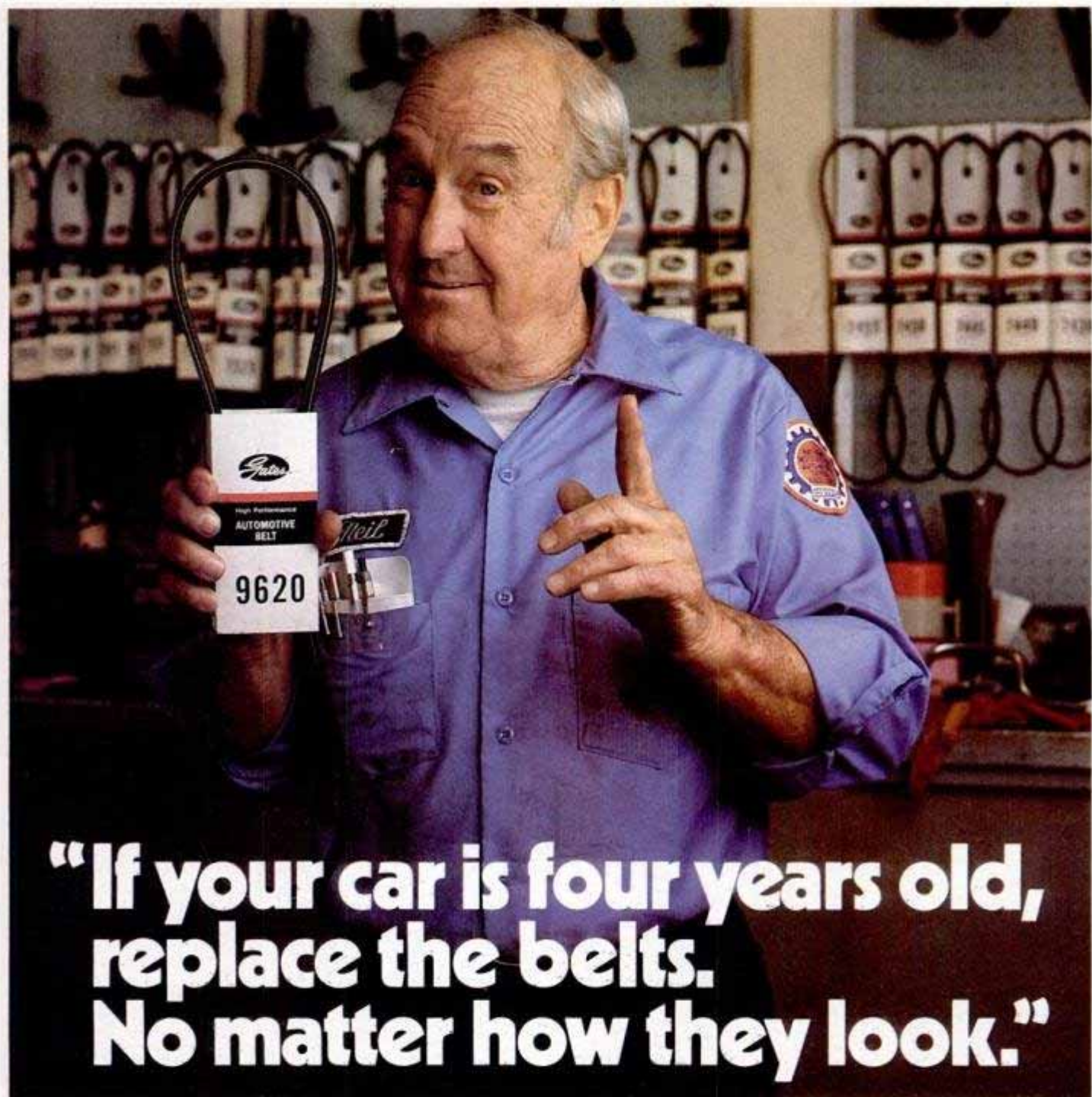
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EDITOR'S NOTES

PM's auto editor, Wade Hoyt, may have entertained certain Superman fantasies as he casually held aloft an automobile engine block (right). But there's a secret. The block, cast of magnesium, belongs to the experimental Volvo LCP 2000; it weighs only 26½ pounds. Wade drove the new Volvo while attending the recent Geneva Auto Show in Switzerland and reports on the car in this issue (*I Have Driven The Car Of The Future, And It Works!* page 134). At city speeds, the three-cylinder engine yields 100 miles per gallon! . . . **Meanwhile, back at the ranch,** the hands were getting restless, and at least two of the art staff found reason to escape to California. Bryan Canniff, graphics director, showed his California models how flapjacks are made in his native Minnesota (photo below) as he directed photography for *Camping—Go Lightly* (page 66). And Ira Herrick, design director, put the best face on a redwood deck (*A Deck You Can Put Anywhere*, page 90) while shooting for a cover for this issue. (As it turned out, we opted for an airplane cover; the photo at bottom is the way it might have been.) . . . **There's still time to enter** our Space Shuttle contest (page 68). As you'll recall, the original deadline is already upon us. But delays in the Shuttle program have kept our "reservation" open. Give us a suggestion for an experiment that could work in the weightlessness of space. We have three college professors—in physics, biology and electronics—as judges to pick one entry to be built at the New York Institute of Technology. It'll go aboard a Shuttle—and you'll be flown to Florida to watch the blastoff. See you at the launch pad! . . . **We found at least a half dozen** computer whizzes ("hackers," as they call themselves) who would have helped us penetrate the "secure" systems of big agencies. The idea: Just prove it can be done. But cooler heads prevailed. There's enough of that kind of mischief going on, as you'll read in *Catching Computer Crooks* (page 63). Matter of fact, after talking with FBI officials, Science Editor Dennis Eskow is convinced the agency uses those same hackers to catch other hackers engaged in crime.



Auto Editor Hoyt hoists a three-cylinder engine with the greatest of ease.



PM's Canniff (top) and Herrick (above) escape to the West Coast and fall easily into the California lifestyle.

John A. Silbitt

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LETTERS TO THE EDITOR



Hook-on backhoe



PM's backhoe adapted by reader Deetz to fit on a commercial toy tractor. Sketch at right shows how the quick-disconnect mount makes it easily removable.

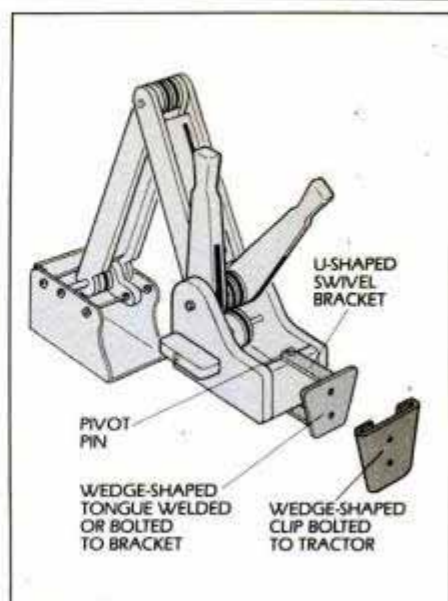
Your article *4 Great Playthings To Make For Youngsters* (page 118, May '81) had a clever design for a toy backhoe. I

adapted the arm-and-bucket assembly to fit on the back of our son's tractor so he can operate it from the tractor's seat (photo, left).

The digger is attached by means of a quick-disconnect arrangement consisting of a wedge-shaped metal tongue that locks into a matching clip bolted to the tractor's frame (sketch, right). A U-shaped bracket allows the backhoe to swivel sideways as well as move up and down. I thought other readers might be interested in the idea.

DON L. DEETZ
STONECREEK, OHIO

A nice idea. For others who may be interested, photocopies of the backhoe plans are \$3.50 postpaid from Popular Mechanics, Box 1014, Radio City Station, New York, N.Y. 10101.



Fords were still fast

The turkeys who wrote your article *Ford: Racing Through History* (page 148, Mar. '84) must have poor memories. They said, "Stock Ford V8s could outrun all but the most expensive heavies of the early Depression."

How about the Pikes Peak Hillclimb of 1933? Four Essex Terraplanes, two of them only Sixes, took the first four places ahead of all Ford V8s. Are we to believe that the Terraplane 8, at \$565, and the Terraplane 6, at \$425, were "expensive heavies"?

J. T. HORSTMEIER
PASADENA, CALIF.

Authors Mike Lamm and Wade Hoyt reply: It's true that Ford V8s didn't win everything—just almost everything. The Terraplanes had their day at Pikes Peak in '33, but only that one day. In the '33 Elgin Road Races, Fords came in 1-2-3-4-5-6-7. Then in '34, they won Mines Field, Ascot and Pikes Peak. The Ford V8 went on to be the street engine to beat up until 1955.

Camouflaged carrier?

Since when does grass grow on aircraft carriers? In your caption for the Super Étendard fighter (*Technology Update*, page 64, Mar. '84), you said the plane was shown on a French carrier. Unless the French have gotten awfully good at

camouflaging their ships, I'd say it's sitting on a grass-lined taxiway nowhere near the sea.

WALTER F. MUSIAL
NEWPORT NEWS, VA.

A last-minute switch in pictures caught the caption writer off guard.

Flying cars are odd, too

Pete Warren's article *Automotive Oddballs* (page 82, Feb. '84) was immensely entertaining, but I think he missed one of the most unusual oddities when he said that amphibious automobiles were the only true dual-purpose cars. In the late '40s or early '50s, there was something called an Airphibian, a car with folding wings that could be converted into an airplane. I'd say that cars that fly are at least as oddball as those that swim.

RICHARD J. SAWYER
NAPLES, ME.

We agree, but we were talking mainly about cars that were actually made and sold. The Airphibian, along with several other flying car prototypes, never made it into production.

As the owner of five Citroen DS-19s over the years, I must take exception to Pete Warren's statement that the hydraulic system in the DS-19 also lubricated the engine. It did a lot of things,

but had nothing to do with the engine. It used vegetable oil in contrast to the engine's mineral oil. In an emergency, you could fill it with ordinary olive oil, but never with motor oil.

ALF AGDLER
MODESTO, CALIF.

Too much power

I enjoyed your article *Mom & Pop Power Turns A Profit* (page 100, Mar. '84). The future for home-grown electricity is indeed very bright in light of ever-increasing utility costs.

I was surprised, however, to see that our \$12,000, 3.5-kilowatt windmill had grown to a \$27,000, 10-kw machine without my noticing it.

DELBERT GIBSON
WINPOWER CORP.
NEWTON, IOWA

The \$27,000 figure we were given pertained to the total cost of installation, not just the price of the windmill alone. As you say, however, its output is 3.5 kilowatts, not 10.

We're sorry, Detroit

In our article *The 10 Scariest Places To Drive* (page 84, Apr. '84), we erroneously referred to "Detroit's new Renaissance Center area." It should have read "Detroit's New Center area." We regret the confusion. **PM**

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Cars you wear



Opel Junior, 11-ft. idea car, has seat upholstery that unsnaps and becomes sleeping bags.

There's something irresistible about tiny cars. It probably has something to do with nostalgia for the simple pedal cars and wagons of our childhood. Or maybe the fascination is from seeing

too many James Bond movies—the idea of achieving perfect mobility from something you just strap on your back. A lot of minimobiles have been seen in the pages of PM, including Japanese

micros like the Suzuki GX, and the smallest one we see here, Honda's CRX.

The two latest models in the cute-car category are from Germany: The Junior from Opel and Student from Volkswagen were just shown at the Geneva Auto Show. Both of these "downsized Beetles" are only idea cars for now, but they sure look like fun.



Tiny but not slow, VW Student hits 98 mph.

Toyota 4Runner

It's a brand new model but it sure does look familiar—at least up to the beltline. That's because the sheet metal identifies it as a Toyota 4×4 pickup. But what



Nice factory cap job transforms Toyota's 4×4 pickup.

distinguishes the 4Runner is the factory-added camper shell. Toyota took the 103-in.-wheelbase pickup, cut out the back of the cab, built in a rollbar (note the wide B-pillar) and then bolted on the plastic cap. The handsome cap is equipped with a convenient electric tailgate window.

In the SR-5 version, classified as a car, there are seats for five travelers. The Deluxe version gives you front seats only, but what a lot of cargo room aft—call it a good rumrunner.

Car from Krypton

The new Maserati Biturbo is the Clark Kent of cars. It can slip past you in the street and because of its unassuming styling you'd never suspect that it can absolutely F-L-Y. You have to look under that mild exterior to find the powerful twin-turbo V6. And you have to open the door and get in to know that you've found a luscious, Jaguarlike in-



The Biturbo is a supercar in gray flannel.

GTO Speedwagon

What's it like to accelerate from 0 to 60 mph in 4½ seconds? Don't ask me. Bounce that one off an astronaut or someone who has already driven Ferrari's new 308GTO. If you keep your foot in it as the dial blurs past 60 on the speedo, you'll soon be looking at 190

mph. Ferrari is making 200 of these machines in two versions: base engine with 400 hp and the full-race setup at 600 hp. The GTO badge is used in its purest sense: *Gran Turismo Omologato* means Grand Touring car recognized for racing (homologated). Don't miss it at your local track.

terior in the darndest place. If you saw the Biturbo with sticker still on (bottom line about \$26,000), you'd know that something is going on here. The 2.5-liter V6 is symmetrically laid out with a turbocharger for each bank of cylinders.

The turbo lag is minimized with this arrangement and the Biturbo whooshes to 60 mph in under seven seconds and tops out at 125 mph. So, if you're a drag racer and see a pitchfork on the grille of the car next to you (the Maserati badge is actually a trident, symbol of the marque's home town of Bologna), you'll know not to mess.



Ferrari 308GTO V8, for World Endurance Cup and IMSA racing, gets 600 hp from 2,855 cc.

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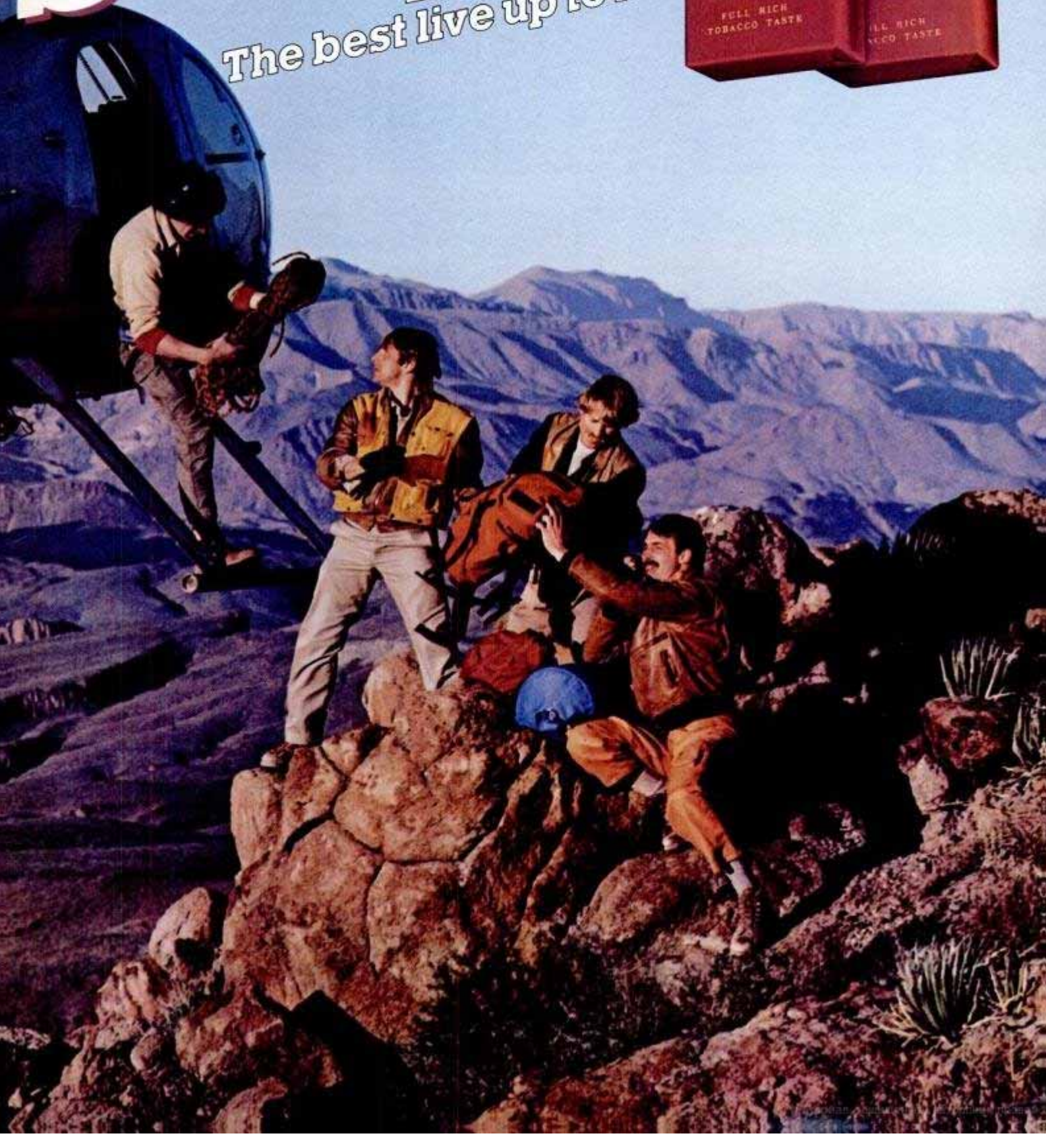
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ALL OUTDOORS



Formula One outboards in U.S. waters



Two Formula One tunnel boats jockey through a turn with V8 outboards blasting.

Drivers of the 400-plus-hp Formula One powerboats will leap to 140 mph on rivers near six U.S. cities this summer. Slowing to round two single py-

lons at 70 to 90 mph per 1.4-mile lap, they'll compete for more than \$300,000 in prizes. Two of the U.S. races, Minneapolis and Pittsburgh,

count toward the 10-race international World Drivers' Championship.

Formula One tunnel boats mount 3.5-liter (214-cu.-in.) V8s. The Johnson, Evinrude or other outboards scream at 10,000 rpm and suck fuel through eight carbs with two venturis feeding each cylinder. This summer, the Bud Light Formula One Grand Prix Series includes six two-day weekend events. Time trials and a 20-lap preliminary race take up the first day, followed by a 20-lapper for grid positions and then the 50-lap main event on Sundays.

Races will be at Chattanooga, Tenn., on June 23 and 24 at the River Bend Festival; Sacramento, Calif., on July 7 and 8 at Water Festival '84; Minneapolis on July 28 and 29 at the Aquatennial; Pittsburgh on Aug. 1 and 2 at the Three Rivers Regatta; Toledo, Ohio, on Sept. 1 and 2 at the Toledo Festival; and Cincinnati on Oct. 6 and 7 at the River Rally. For tickets and more information on attending races in the second American Grand Prix Power Boating racing season, write to the U.S. International Formula One Racing Assn. Inc., Box 941138, Schaumburg, Ill. 60194.

Touring by bike



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are the most popular, with longer rides available. Vermont Bicycle Touring (Box 711, Bristol, Vt. 05443) is one tour organizer.

We're also familiar with tours sponsored by the ever-popular American Youth Hostels. Information about its nationwide program of trips is available from national headquarters at 1332 I St. NW, Washington, D.C., 20005. And, when you're ready for that special trip, contact the national tourist offices of the European countries you would like to bicycle in.

A trip we're interested in is through Holland, and a good organization for going Dutch is Frank Behrendt's International Bicycle Tours at 12 Mid Place, Chappaqua, N.Y. 10514.

Plans from Boatsmith

You know that PM covers the waterfront in search of great ideas and stories. Recently, we discovered plans for an inner tube bass boat (see page 93, Feb. '84), which we found in Boatsmith, a quarterly that runs boat plans and projects, and has a \$12 per year subscription price. It's at Box 06476, Fort Meyers, Fla. 33906.

Boat bandages



Water-activated fiberglass tape seals hulls.

Poking a hole in your boat can turn a minor nudge into a serious problem. Syntho-Glass is a new one-component, resin-impregnated, emergency repair tape. It comes in a \$14.95 packet from Neptune Research Inc., 2611 Old Okeechobee Rd., Suite No. 3, West Palm Beach, Fla. 33409, and could keep you from sinking. Fresh or salt water activates the tape as you apply it inside or outside the hull. Wear the gloves supplied. It sets in about 30 minutes. **PM**

Coleman coolers. For fun in all shapes and sizes.

From barbecues to band concerts, there's one for every occasion.



Coleman® Snow-Lite® cooler models are Steel Belted™ with an automotive-type enamel finish, and feature a tough scuff-proof base.

NEW

This new 100-quart model holds enough for a family reunion. And its built-in divider doubles as a convenient shelf or cutting board.



Our popular 48-quart Poly-Lite® cooler, the "People's Choice," is loaded with convenient features and plenty of urethane insulation.



NEW

Nothing beats the Coleman Oscar® cooler as a carry-along cooler. It's at home at ballgames, on the beach – wherever you want food and drinks handy.



Our new jug holds two liters of refreshment, dispenses it easily through a flip-top spout.

Look for new outdoor clothing from Coleman, too. And an option of rebates on selected Coleman products, or donations to the National Park Service Outdoor Safety Fund. For our free catalog, write to Coleman, 250 N. St. Francis, Wichita, KS 67201.

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We outfit your outdoors.

PM SOFTWARE MONITOR



Electronic filing

Even if you can't program in BASIC, haven't the slightest idea of what programming is all about, and have never used your Apple IIe, Atari 800/1200 or Commodore 64 personal computer for anything more complicated than playing games, you can now write a sophisticated datafile program. Not only will the datafile store the information about your home, family, hobbies or business, it will allow you to quickly locate any bits of information by simply keying in a word or phrase.

The magical force is called *FileWriter* by Dynatech Microsoftware Inc.

FileWriter is a disk-based program that literally writes a BASIC program from designs the user has created on the video screen by moving the cursor around and typing the words and phrases which describe the information to be filed. A touch of a key causes the disk drive to whirl, the screen to flash BASIC statements, and within a few minutes *FileWriter* has actually created a BASIC program that provides the functions the user had "painted" on the video screen. Simply LOAD and RUN the *FileWriter*-created BASIC program the same way as for any other disk-based BASIC program.

The two Commodore screens show what appears from a user-created "MAGAZINE ARTICLE" datafile program. At right is the "prompt screen," on which the user enters information about the article: the "Subject" (which serves as the keyword for this datafile), the name of the article, the magazine and issue it appeared in, a short de-

scription of the article, and even where the magazine is filed or stored. Each dot represents a possible character entry. After data are entered in the last field, the data record is automatically stored on the disk.



The screen at left appears when *FileWriter* has located the desired information. Entering the keyword "Software" for the "SUBJECT" prompt caused the program to search the disk for a copy of the original data record. In this instance, it's located the record for a *Popular Mechanics* article about "Learning Is Fun" computer software.

If several entries have been made using a keyword, such as "Software," each record will be displayed in its entirety, sequentially, when the RETURN key is pressed. When all the entries have been displayed, the pro-



gram returns to the main menu which was also automatically created. *FileWriter* can be used to create any number and types of datafiles. Whatever the user "paints" on the screen will be turned into a separate and distinct BASIC program. Since each BASIC program is assigned a unique name by the user, several different programs and their associated data can be stored on the same disk. If a file is very large, a disk might have one program, so the maximum amount of disk storage will be available for the data records.

FileWriter is available only for the Atari 800/1200 and Commodore 64 (\$59.99) and the Apple IIe (\$89.99). Dynatech Microsoftware Inc. is located at 7847 North Caldwell, Niles, Ill. 60648.—Herb Friedman

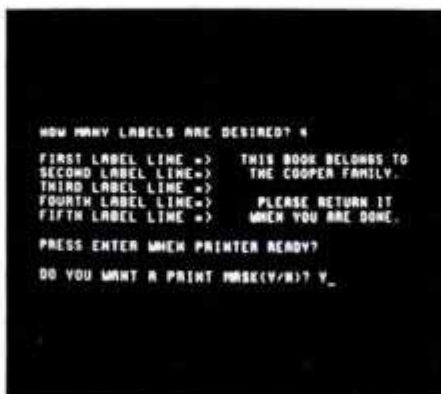
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A dollar a program

Business Pac-100 consists of 100 useful BASIC programs that you never can seem to find when you need them. There are programs which calculate how much you'll need to put away yearly to pay for a child's education, or your vacation; how much you'll pay monthly on a home mortgage or car loan; automobile expense analysis; computerized phone directory; and lots more.

Need to print decent-looking "stickers" or return-address labels? There's a program that allows you to make just one copy, or multiple copies, of the same label. Need a small in-memory



One of the *Business Pac-100* programs is for a variety of labels, such as this one to put in books to help them get back to you.

mailing list for your church or social club? You'll also find that program, along with a program that calculates UPS zones from ZIP codes. And there's a checkbook maintenance program.

The 100 programs work out to \$1 a program for most computers. They're real low-budget workhorses. *Business Pac-100* are those programs you would write yourself if you had the time or expertise.

Business Pac-100 is \$99 for TRS-80, I/III/4, Commodore, Apple or Atari and \$149.95 for TRS-80 II and Osborne. It's from Computronics, Inc., 50 North Pasack Rd., Spring Valley, N.Y. 10977.

—Herb Friedman

Home
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At Last! A Rear-Tine Tiller
Especially for Small Gardens!

the 3½ HP TROY-BILT® "JUNIOR"

If your garden is 30'x50' or less, here's why it will pay you to get the full story about the Newest, Greatest Breakthrough in rear-tine tillers in over 50 years!...

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- **SAVES GARDEN SPACE!** Narrow 14" tilling width allows you to plant your rows closer together. Grow more in less space!
- **EASY TO USE!** With its tines in the rear and engine out front, the "JUNIOR" is so well balanced you can handle it with JUST ONE HAND. Won't shake you to pieces like front-end tillers do!
- **EASY TO TURN & MANEUVER!** Because the "JUNIOR" is light and compact (but strong!) you can turn it and maneuver it in tight places with wonderful ease!

There's much more to know about this wonderfully different and better idea in small garden tillers...like how you can use it to build super rich soil, no matter what your soil conditions...or, how it can help you grow two, even three crops of vegetables where you could only grow one before!

So why not mail the coupon TODAY, and get all the exciting facts about the amazing new TROY-BILT "JUNIOR"...Plus our mid-sized PONY and large garden HORSE Models. We'll include prices, attachments and complete information about our special "OFF-SEASON" Savings discount now in effect!



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YES! Please send me complete information on the new JUNIOR and all other TROY-BILT Tiller Models ranging from the 5 HP PONY to the 8 HP "PROFESSIONAL" including details on prices and big "OFF-SEASON" Savings now in effect!

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Limp service when computer fails

Now that cars have computers that regulate engine functions, what happens if the computer fails on the road? What has to be done to run the engine so I can get to a service facility?—Michael Abruzesse, Worcester, Mass.

You do nothing. If something can be done, it's done automatically.

Essentially, the computer controls three systems (really more, but these three are the ones having to do with your question)—ignition, spark timing

and fuel. When any part of these circuits fails, the "check engine" light will come on. In some cases the engine may shut off, but most of the time it will continue to operate in a "limp-in" mode.

If the circuit in the computer that operates the ignition system is lost, you may end up dead in the water. Some of these failures can result in a loss of current to the ignition coil and, consequently, the engine won't run.

If the spark timing control fails, most computer systems will maintain a fixed advance rate, which will give the car at least minimal capability.

If the fuel circuit fails, most computer systems will go to a predetermined air/fuel mix that will permit you to continue driving. In most cases, this failure mode will be notably less efficient than normal operation.

Repair any failures as soon as possible, so that further damage to the oxygen sensor or catalytic converter does not result.

Frozen dough

In case you're keeping a record of how many of your readers are experiencing freeze plug failure on GM engines (see Car Clinic, page 22, Jan. '84), add my name. I own a 1981 Oldsmobile Cutlass that sprung leaks from two plugs. A dealer said it would cost \$200 to repair. I decided I'd try my own fix before going that route, so I poured DuPont Stop Leak into the radiator. That was several thousand miles ago. So far, so good.—E.V. Finn, Cape Coral, Fla.

I have been keeping count. So far, seven others told me they've experienced freeze plug failure. (The correct term, incidentally, is core plug.) I hope Stop Leak will work for them, too.

Remember that these failures may be caused if vehicle owners don't provide adequate corrosion protection for their cooling system. Even Florida motorists should have at least 50 percent antifreeze in their cooling systems. And don't forget the annual system flush and refill.

Your own Ford TSBs

Ford Motor Co., like GM (see Car Clinic, page 28, May '84), is now making technical service bulletins (TSBs) available to owners of Fords, Lincolns and Mercurys. To get them, call 1-800-241-3673, unless you're in Alaska, Hawaii or Georgia. Call 1-800-241-3711 in Alaska and Hawaii; call 1-800-282-0959 in Georgia.

You will be asked for your name and address, the vehicle make, model and year, plus engine size and type of transmission. Not only will you be sent all TSBs issued for your car so far, but you'll also get bulletins that may come along later. And it's all free.

A 'Hondin' we will go

Maybe you can tell me why the engine of my 1983 Honda Accord surges at a steady road speed. The dealer's worked on the engine several times without results.—Joe Carver, Fresno, Calif.

I went over the list of what the dealer has done, which you enclosed with your letter. It seems to be a complete engine workup, but I noticed that your Accord has an automatic transmission. The engine probably isn't causing the trouble—the lockup torque converter is continually locking and unlocking ("hunting"), and that's what is giving the surge.

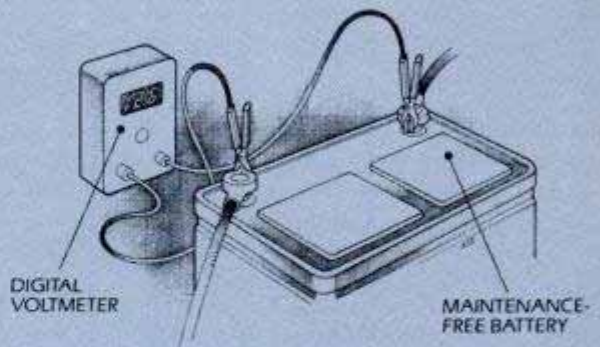
TSB 83-004 outlines the action to take in this case. The dealer should first

adjust the throttle control cable to specification (see page 15-64 of the 1983 Accord service manual) and then test the car on a level road at a steady 55 mph while watching the car's tachometer.

If the needle wavers, converter hunting is still occurring, and the throttle control cable should be shortened 1 mm at a time to a maximum of 3 mm until the surge is gone.

The car should again be driven at 55 mph, this time with the cruise control activated to see if hunting occurs. If the engine surges with the cruise control engaged—but not with the cruise control disengaged—readjust the cruise control cable at the actuator to its

(Please turn to page 24)



Teaching an old dog new tricks

When they bought maintenance-free batteries, many Saturday mechanics discarded their old hydrometers, since you can't draw electrolyte from a sealed battery to check the state of charge.

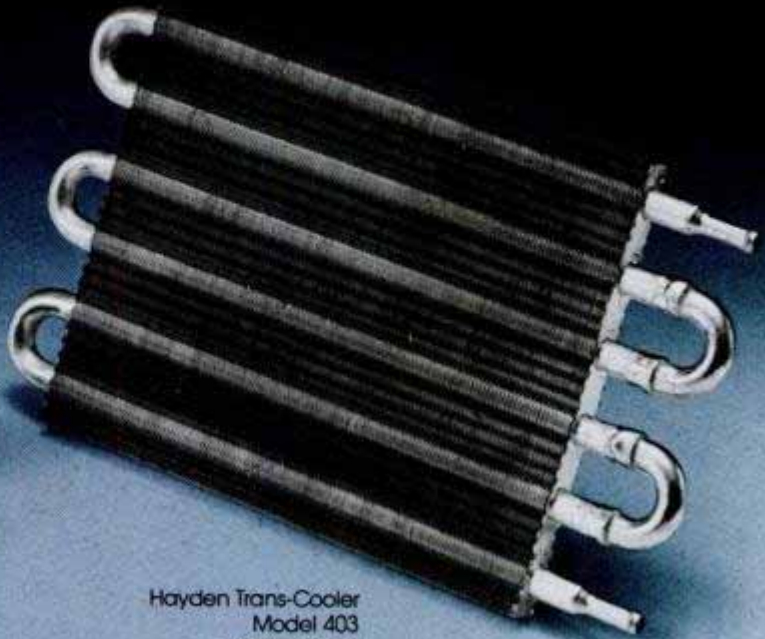
This raises an interesting question: How do you determine a sealed battery's state of charge if it's not equipped with a hydrometer "eye"?

The way it's done is to connect a digital voltmeter to the battery terminals and turn on headlights for one full minute. Now, check the voltage reading. If it's 12.6 volts, the battery has a 100 percent state of charge. A reading of 12.45 volts indicates a 75 percent charge; 12.30 volts, a 50 percent charge; and 12.15 volts, a 25 percent charge.

Over 13 million transmissions will fail in 1984.*



Typical OE
transmission oil cooler



Hayden Trans-Cooler
Model 403
medium duty

90% of these transmissions will fail due to overheating.

You be the judge. Compare an original equipment transmission oil cooler with a Hayden Trans-Cooler®. Located in the radiator tank surrounded by 240°F coolant, the original equipment oil cooler stands little or no chance of cooling transmission fluid that runs up to 286°F under normal driving conditions. You can't cool hot oil effectively with hot water. It's that simple. Even at 110°F air cools better than coolant at 240°F.

More and more people are installing Hayden auxiliary Trans-Coolers on their cars. A mid-size Hayden Trans-Cooler can reduce your transmission's operating temperature as much as 70°F. Remember,

each 20°F drop in temperature doubles oil and equipment life.

Quick do-it-yourself installation. If you can change the oil in your car, you can make the installation yourself using Hayden's patented Quik-Mount and Quik-Connect systems.

Don't become a statistic. See your local auto parts store, automotive chain store, RV dealer, hitch installer, mechanic or installer today and ask for Hayden oil cooling protection. **The car's life you save may be your own.**

*Courtesy ATRA (Automatic Transmission Rebuilders Association).

Send today for free product brochure.

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Hayden Trans-Cooler prices start as low as \$29.95. Does not include installation.
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THE TASTE OF SUCCESS



VANTAGE

Great Taste with Low Tar.
That's Success!



Say goodbye to America's favorite can of motor oil.

CAR CLINIC

(Continued from page 20)

minimum length (see page 25-44 in the manual).

What happens if the converter doesn't respond after shortening the throttle control cable 3 mm? Shortening it any more will probably present a new problem in the form of harsh shifts. At this point, the torque converter should be repaired or replaced.

Overdosed

My 1981 Mercury, which has a 4.2-liter engine, has suddenly blown its cork, and no one can find out why. After starting and running, the engine acts as if it loads up on gas. It then stalls and is hard to restart. Mechanics agree that there's something wrong with the automatic choke, but what that something is no one knows. All parts have been replaced. Have you heard of this problem?—William Rooney, Springfield, Ill.

Replacing parts isn't enough. In Section 2 of Ford's big loose-leaf engine and emissions diagnosis guide there are tests to pinpoint the problem.

Since you've probably already replaced the choke cap, the difficulty must be in the electric control circuit or the vacuum pulldown mechanism.

PM CAR CARE

TIP

↓

The art of locksmithing

If the hood latch fails to unlock when you pull the hood release, don't panic—you don't have to cut a hole in the hood. Try these suggestions:

1. Slide a thin-bladed screwdriver between the hood and grille to trip the latch release. If this suggestion doesn't work—
2. From under the car, maneuver a long tool or wooden rod up between the grille and radiator to try and trip the latch release. If it's still no go—
3. Remove the grille.

Within the electric circuit, possible failures include the choke lead wire, the relay assembly, the fuse and even the oil pressure sending unit.

A visual inspection of the oil pressure sending unit may reveal a lot. If the unit is leaking oil, its terminals may become insulated. If this proves to be the diffi-

culty, check the connector and clean any oil from its contacts before you attach it to the new sending unit.

The symptoms you describe are typical of a failed or misadjusted pulldown mechanism. This device is supposed to open the choke plate slightly as soon as the engine starts. The carb must be

removed from the car to adjust pull-down since the adjusting screw is sealed and must be heated in order to break the seal.

Slippery business

In the April '84 *Car Clinic* (page 14), I said the front end boots (also called drive axle boots) of GM front-wheel-drive cars should not be lubricated. The statement was made in answer to a question by Barry Wood of North Bergen, N.J., concerning his 1984 Chevrolet Cavalier. The boots were dry when Barry took delivery of the car.

Although the owner's manual says nothing about lubricating the boots, the maintenance schedule (a separate document) says to grease them. The dealer didn't know what to do. Neither did dealers I contacted, so I advised Barry not to grease them, because grease can cause rubber to deteriorate. That was wrong.

Grease boots as often as the maintenance schedule for your car advises. Boots aren't lubricated during production, but dealers are supposed to grease them before delivering cars. As for the part about rubber deteriorating when subjected to grease, that's true. But the boots that are supposed to be lubricated are made of a neoprene compound

that a petroleum-based product (grease) won't harm.

It'll all pan out

Since the day I bought my 1982 Chevrolet Caprice, the automatic transmission oilpan has leaked. The dealer installed several gaskets, replaced the cover, which he said was cracked, and tried Permatex. He now says he doesn't know what else to do. The engine is a 305-cu.-in. V8.—E.Z. Milner, Enola, Pa.

Original pans on several GM automatic transmission models have been leaking. That's why the company recently issued redesigned pans. The transmission in your car is probably a 700-R4. The new repair kit for it has GM part No. 8642999. Other transmissions for which new pans have been issued are the 200 and 200C (repair package No. 8638929) and the 125 (repair package No. 8653942 is for a leaking oilpan, and repair package No. 8653943 is for a leaking valve body cover). There will soon be a repair package for the 200-R4 tranny. **PM**

DO YOU HAVE A CAR PROBLEM?

Just ask Mort about it. Send your question to the *Car Clinic*, *Popular Mechanics*, 224 West 57th St., New York, N.Y. 10019. While letters cannot be answered individually, problems that are of general interest will be discussed in the column.

SERVICE TIPS

■ GM states that because of lightweight bumper materials, installing a bumper-mounted hitch on some models should be avoided. To tow a trailer, use a frame/body hitch with these station wagons: 1984 Impala, Caprice Classic, Parisienne, Delta 88 and LeSabre. Also use frame/body hitches on 1983-84 Camaro and Firebird; 1983-84 Cavalier, J-2000, Firenza, Skyhawk, Cimarron; 1984 Fiero; 1984 Citation, Phoenix, Omega, Skylark.

■ Defective four-port water valves on 1984 Chrysler front-wheel-drive cars and Caravan and Voyager light trucks result in no heat from the heater. The problem is on vehicles with air conditioning and 2.2-liter engines with either carburetors or electronic fuel injection. TSB 24-01-84 offers the repair.

■ Changing the radio amplifier of a 1984 Lincoln Town Car equipped with a premium sound system should stop a popping-back noise from speakers when the car's turn signals are on or when the brake pedal is pressed. The new amplifier has part No. E4VY-18B849-B.

■ If the torque converter of your 1983 Celebrity, Citation, 6000, Phoenix, Ciera, Omega, Century or Skylark with 2.5-liter engine "hunts," especially when the cruise control is engaged, replace the computer PROM. If the PROM now in the car has part No. 1226439, replace it with No. 1226647. If the faulty PROM No. is 1226441, install No. 1226648.

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America has put its trust in Quaker State for over 70 years. One reason is that Quaker State's leading motor oils are refined from 100% Pennsylvania Grade Crude Oil.

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Say goodbye to spouts, oily rags, dirty hands and leaky cans. Best of all, this unique plastic bottle is made to cost you nothing extra.

If the new bottle isn't in your store now, it'll be there soon.

Today you need an oil this good in a package this good.



DETROIT LISTENING POST



M-van unveiled

General Motors took the wraps off its M-van project at the Chicago Auto Show. The Astro, a fiberglass mock-up with full interior, was shown there for the first time. Like Ford's Aerostar minivan, the Astro departs from Chrysler's front-drive power train layout and will debut as a conventional front-engine/rear-drive van in commercial and window versions in late 1984. Why rear drive? "We wanted to put the driving wheels where the mass is going to be," said Astro's chief engineer Carl Freeman. M-van styling is conservative compared to Chrysler's T-van and downright frumpy next to the Aerostar.

New Chevy boss Bob Burger, most recently the top man at Cadillac, was on hand to help introduce the vehicle, which the division expects will sell primarily to commercial users.

Astro's commercial appeal is apparent: It's taller, longer, lower and wider than the Chrysler T-van, for example, and has a heavy-duty maximum GVW of 5,600 pounds—1,000 more than the T-van. For ease in loading or unloading, the Astro's floor is flat from the driver's seat rearward to the bumper, which is 22.5 inches off the ground.

In passenger configuration, the Astro can be had with one, two, four, five, seven or eight seats, in combinations of captain's chairs and benches. The vehicle will be available in three trim levels



Blunt but rounded nose gives Astro a 0.38 Cd.



Camaro-like interior of Chevy's new minivan is as sleek as the exterior is plain.

and with two gasoline engines: Pontiac's 90-hp, 2.5-liter fuel-injected Four or Chevy's new 155-hp, 90°, 4.3-liter V6. No diesel option will be ready at introduction, but an Astro has been "packaged" with an Oldsmobile diesel.

The suspension makes use of a single-leaf fiberglass rear spring, similar to the one used in Corvettes. The front suspension is independent and consists of unequal-length A-arms and coil springs.

Transmissions will be floor-mounted four- and five-speed manuals, and a column-mounted four-speed automatic. Chevy says no sporting derivatives are on tap for now, but the five-speed manual and V6, with an optional 4.11:1 final drive ratio, should make a potent package for more than just commercial usages.

The Astro—and GMC's version, to be called *USV* (for "utility sport van")—will be built at GMC's Baltimore plant later this year.

Tooling up at Renault

With many new products being developed jointly, AMC/Jeep/Renault is getting serious about the market here. Coming in only a matter of months is the Renault turbo-dieseled Cherokee. This is a peppy 2.85-liter Four with an output of 85 hp.

Pending for the family that needs more get-up-and-go is a turbocharged version of the current 1.4-liter Four for the Alliance. This engine is said to feature an intercooler and develop a decent 105 hp in the little grocery-getter. And an Alliance convertible that's on the way will be just the car for summer cruising.

In addition, the Alliance will get a new base engine—the Renault "F-engine." It's a cast-iron block, aluminum head, overhead-cam Four that's now

being used in the European R9, and is available in two versions, a 1.6-liter diesel and a 1.7-liter gasoline Four. Will the Renault 2.2-liter Four now going in the Fuego and 18i Sportwagon get into the Alliance, too? Apparently not, according to a Renault engineer. The current sheet metal in the Alliance is too restrictive for the 2.2-liter in the traverse "east-west" configuration.

Also on tap is a restyled version of



Rear-engine 150-hp 2+2 Renault Alpine A310 is being rebodied for U.S. market.

the radical-looking 2+2 Renault Alpine A310 sports car. The first fiberglass prototype panels were pulled off the molds at AMC's Amtek facility a few weeks ago. The A310—a low, lethal-looking cruise missile of a car—will likely debut here in 1986, despite AMC's public denials. The European version develops 150 hp from a rear-mounted 2.8-liter aluminum V6 also used by Peugeot, Renault and Volvo (and also found in DeLoreans), and has a five-speed transaxle. The price of the A310 in Europe is \$17,500 to \$21,000, depending on options.

Another slick new Renault is the luxurious mid-size 25 sedan, just introduced at the Geneva auto show. It's sold in France in eight models, from a 144-hp version of this same V6 to a 64-

(Please turn to page 28)

MOST POWERFUL OF 'EM ALL! FORD'S NEW 5.8L MID-SIZE V-8!



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**NOW...27% MORE
POWER THAN CHEVY
MID-SIZE V-8.**

For '84, America's best-selling pickups* pour on the power! Ford introduces a new 5.8L High Output V-8** with 4-barrel carburetor. It's the mightiest mid-size engine in any pick-up. It tops Dodge

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Only Ford, the best-built full-size pickup of 'em all, offers you such a power choice for 1984!

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Most Powerful V-6	Ranger 2.8L V-6
Most Powerful Six	Ford 4.9L I-6
New! Most Powerful Mid-Size V-8	Ford 5.8L/4V V-8
Biggest Pickup V-8	Ford 7.5L V-8
Most Powerful Diesel	6.9L Diesel

*Based on registrations of full-size pickups for '83 MY.
†Optional, not available in Calif. or with manual transmission.
‡Optional; 4.9L I-6 standard.

Quality is Job 1.

Ford's commitment to quality results in the best-built American trucks, based on a survey of owner-reported problems during the first three months of ownership of 1983 trucks. And the commitment continues in 1984.

BUILT FORD TOUGH.



Get it together — Buckle up!

DETROIT LISTENING POST

(Continued from page 26)

hp diesel. AMC sources deny that it will be imported to or built in the United States, but it would make a great step up from the Alliance/Encore, and I wouldn't be surprised to see it on a Kenosha, Wis., assembly line before too long.

Cadillac exotocar

Rumors have circulated for months about the expensive, high-tech and exclusive new model Cadillac wants to put in its line. It now appears more likely than ever that the car will be built. Cadillac will assemble the cars in the United States—but the bodies will be built in Italy by Pininfarina. GM is assessing the notion of "just-in-time" delivery made popular by the Japanese car industry and under test at Buick City, but with a twist. It's said that Cadillac will air freight the bodies from Italy to the United States aboard Flying Tiger jumbo jets with flights leaving Turin daily.

Speculation suggests the hyperexotic Caddy coupe could carry a sticker in excess of \$35,000, and would be available in numbers as high as 8,000 a year.

GM's Opel/Jag plans

In an interview with PM at the Chicago Auto Show, General Motors President James F. McDonald admitted that GM has had conversations with the British government about the announced "privatization" of Jaguar. McDonald said the interest was being expressed by Opel, GM's European division.

Does that mean Jags by GM might be sold here through Bob Stempel's Buick-Olds-Cadillac group? No, according to Stempel, who said he thought the cars could be sold through Opel dealers. Of course, there are no Opel dealers in the U.S. right now, but GM has been showing top-of-the-line Opel Senator and Monza models to West Coast Audi and BMW owners in secret "product clinics." If Opels are imported again, they might get their own dealer network due to the poor job Buick dealers did with Opels in the '70s.

Ear to the ground

Good news, bad news: The Auto Club of Michigan (AAA) conducted a survey of repair and theft costs over a range of vehicles, and adjusted its insurance rates accordingly. As an indicator of popularity to the rest of the nation, the Cadillac Eldorado was hit with a whopping 41 percent average increase in

insurance rates. The Pontiac Phoenix, however, rated a 22 percent average decrease.

Honda Channel 2: Honda Motors is going to develop and sell a "high-tech, high-performance and high price" car in a second network of dealers called "Channel 2." The new V6 "executive" car is seen as too radical an approach to be successfully sold and serviced in conventional Honda dealerships, which are considered places where economy cars are sold.

Short drives: Given time in a *Chevrolet Camaro Z28 H.O.*, one gets a red, white and blue blush in the cheeks. This L69-powered automatic, laden to the gunwales with options, is stickered at about \$16,000. Handling, acceleration and quality were outstanding—in a class with significantly more expensive German cars. The four-speed automatic, however, needs work. Great on the highway, but **FOURTH** gear was annoying in the city.

AMC/Renault Alliance is a great package looking for power. The standard-issue 1.4-liter Four with automatic transaxle is almost dangerous, and will barely enter a freeway safely without a long run-up. A turbo version is coming, not a moment too soon. Comfort is good, however, and once on the freeway the ride was excellent. **PM**

How to Tow With Today's Car and save up to \$15 at Hitch World



New cars are built lighter to save gas. So when you tow, you want added protection. Here are a few tips to follow:

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Hitches differ. The wrong one can cause body damage, or tear out. Hitch World provides the hitch to fit your towing needs, using top brands like Draw-Tite and Reese. Each hitch has a nationwide warranty, good as long as you own your tow vehicle.

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A standard suspension is basically made to carry passengers. Frequent trailer towing can reduce the life of your springs and shocks. Hitch World installs air lifts or air shocks, such as Monroe and Hellwig, that give your tow vehicle added frame support, and reduce suspension and tire wear.

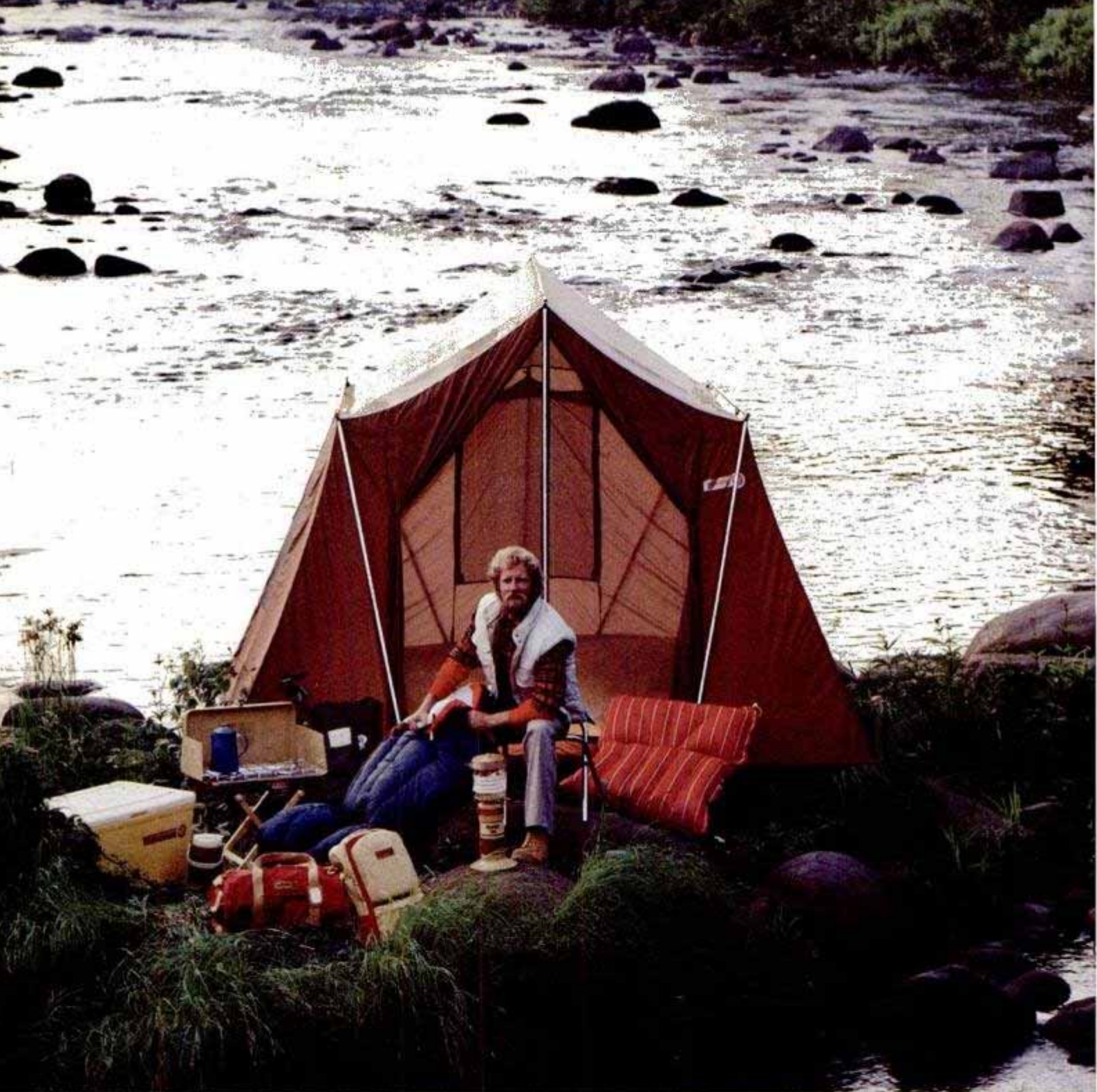
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This ad is good for \$5 off the price of a hitch, a transmission cooler, and a suspension system (\$15 maximum discount, offer expires 12/31/84). It's all at your nearest Hitch World. Look in the White Pages under U-Haul Centers. Write for a FREE HITCH GUIDE: HITCH WORLD, Dept PM, P.O. Box 21503, Phoenix, AZ 85306



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The Radial Mud-Terrain T/A is built strong and rugged to maximize truck dependability—off the road or around town. Its tread has self-cleaning grooves for remarkable traction in deep mud or snow.

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FREE GLUE!
Inside specially marked packages.
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PM PHOTO HINTS

Metering silhouettes



First attempts at silhouettes may present exposure errors. For a correct exposure, you should always meter the background—not the subject.

—Bob Berger

'Ad hoc' camera grip



Even though taking handheld shots with long lenses is not a recommended practice, it's sometimes necessary. All you have to do is take a folding-type camera grip, reverse the mounting screw and attach the grip to the tripod mount under the lens barrel.—A. Weber

Reflector holder



An adjustable reflector holder, which is essential when you are photographing shiny metal, can be improvised from a utility lamp that has a spring clamp attached to it.—David W. Roberts

It takes a stress-tested oil to stay ahead of the little guys.

If you're driving one of today's higher revving, small engine cars, you need a motor oil that can stand the strain.

Here are facts that Pennzoil has worked with to exceed the lubrication requirements of today's small engines.

Situation

FACT: Small car engines are built to tighter tolerances than V-8's. Varnish and sludge build-up become an even greater problem, robbing the engine of power and performance.

FACT: Like racecars, small engines need optimum oil viscosity performance at high operating temperatures. Also, small engines are harder to start or crank when cold, so they need greater fluidity for easy start-up just like racecar engines.

FACT: Small engines work 20% harder over sustained periods. Reduced friction is critical to minimize wear in engines which are running near the edge of their operating capability.

Knowing these vital facts, Pennzoil has been stress-tested to protect small engines that work harder to do the same job as a large engine. And since a smaller engine is under the stress of working at much higher rpm, it needs all of Pennzoil's extra protection. That's why you need Pennzoil protection in your car.

Solution

FACT: Pennzoil is the leader in the development of motor oils with high tech additive properties...such as Z-7... which help prevent varnish and sludge build-up in engines.

FACT: Pennzoil led the way in developing high tech multi-viscosity racing oils. The same technology has been applied to Pennzoil Multi-Vis Motor Oil for your car.

FACT: Pennzoil was first to introduce friction reducers in all their multi-vis oils.

Pennzoil doesn't just keep up with the stress of today's small engine demands...it stays ahead. So you can depend on the latest Pennzoil state-of-the-art technology to give your car the protection it needs.

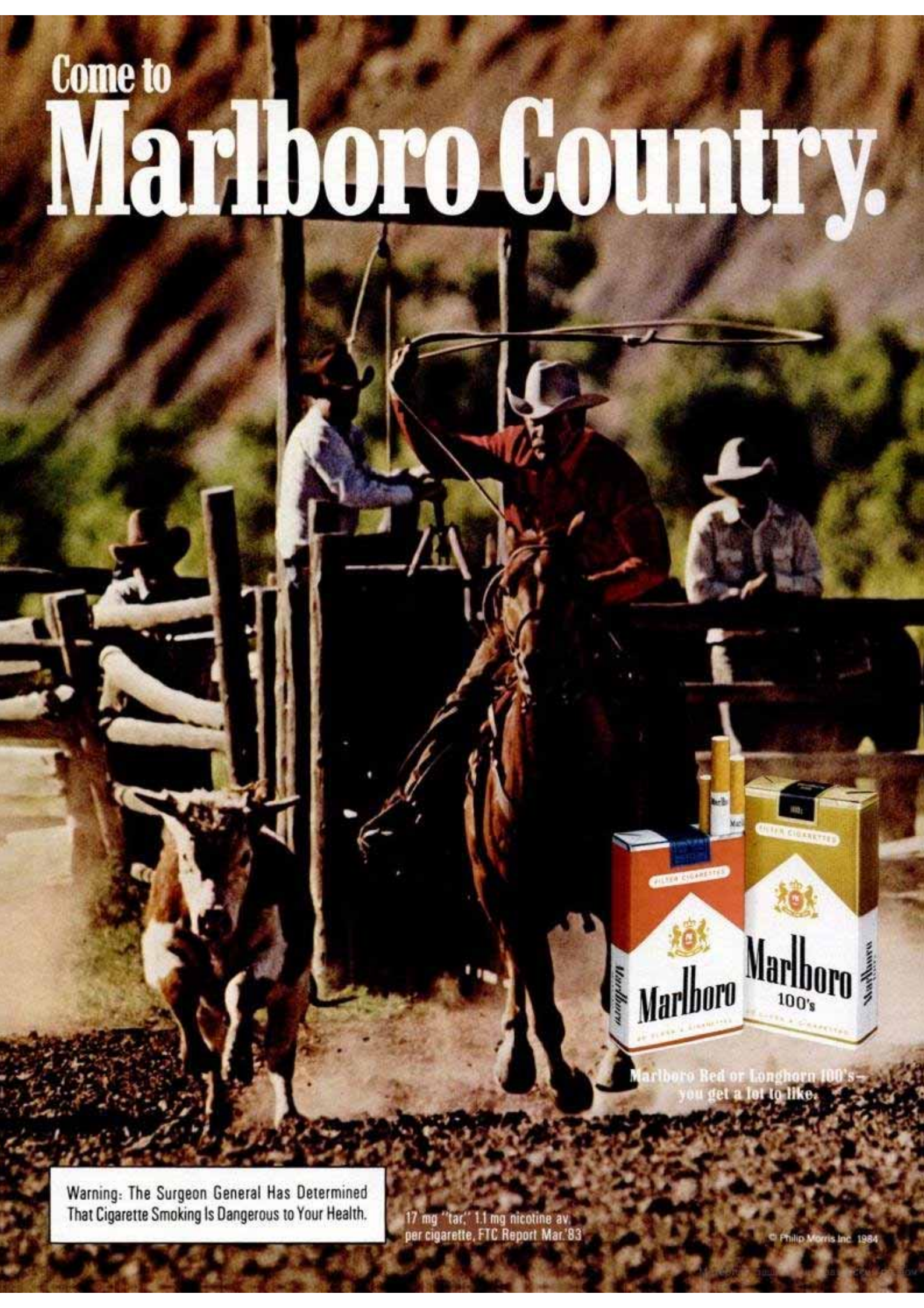
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per cigarette, FTC Report Mar. '83

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THE PM GARAGE



The ultimate battery



The Incredicell System, installed at a Sears Auto Center, includes connectors that are covered to resist corrosion.

You can buy one of Sears' new DieHard Incredicell batteries for \$82. That's a mighty powerful package: 650 cold-cranking amps, warranted for 60 months, in a compact no-maintenance case with built-in handles.

That's the do-it-yourself way to get a lot of cranking for the long haul. But for

the complete Incredicell System, which includes an under-dash electronic monitor, a Sears Auto Center must do the installation. It's an extra \$18 that way, but we found it to be quite a deal: You get the monitor and all the hookups. The monitor gives you battery condition, undercharge and overcharge conditions (by means of an electrolyte temperature sensor)

and it sounds an alert if you leave your headlights on. Five leads connect to the monitor, which is mounted in a spot you choose, so scout your firewall and dash before going to Sears for the job. When they install the battery, Sears adapts your car's 12-v. and ground cables to the Incredicell's clever corro-

sion-resistant shrouded connectors. And the battery warranty when you buy the complete system is 72 months. You get the longer warranty because the monitor alerts you as soon as a problem begins; Sears trusts your prompt fix will spare the Incredicell excessive discharging or overcooking.

This is \$100 well spent—for a complete energy system, not just a car battery. And with the installation included, it's one of the few times you'll find that doing it yourself doesn't pay.—B.H.

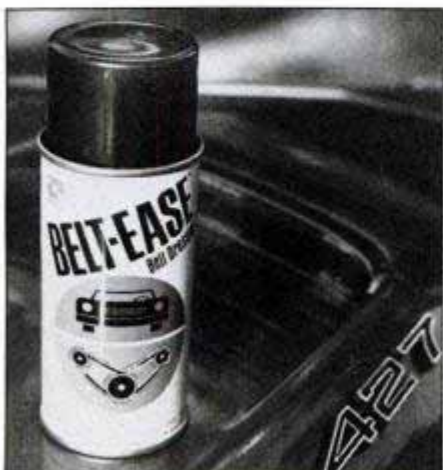


Under-dash monitor alerts you to battery condition, overcharge or undercharge, and power drain if lights are left on.

Stop that squeaky belt

Every summer I go through the same ritual with my car collection: I pull out my favorite big block, start it, and the belts squeak. Then the kids laugh, the dog howls and I decide that maybe I don't want to drive it after all.

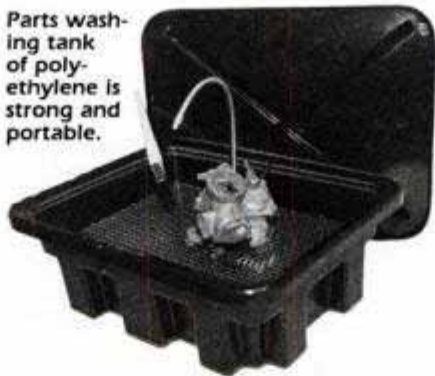
Held hostage by my car's fan belts for too long, I picked up some AGS Belt-Ease by American Grease Stick Co. After shooting a tiny bit onto the belts, they're as silent as can be. It's a good deal at about \$2.29 a can from auto parts retailers.—M.L.



One shot of spray silences any noisy belts.

Bath for car parts

Parts washing tank of polyethylene is strong and portable.



Whether I'm rebuilding a carb or an entire engine, I often need a parts washer. But most are built for pro use and priced accordingly. A new arrival, The Degreaser, is designed for the back-yard mechanic. Its tank and lid are 1/8-in., high-density polyethylene, making it strong but light enough for easy portability. The 12 x 16-in. tank can be recess-mounted in a benchtop. Cleaning fluid is circulated by a UL-approved 100-gph pump.

Suggested retail price is \$119. For the nearest dealer, write to Gator Manufacturing, 4561 West Dickman Rd., Battle Creek, Mich. 49015, or you can phone the firm at 1-800-336-0044.

—Bob Berger

Tough treads

With today's road conditions and the cost of new tires, I worry plenty about every upcoming pothole. Armstrong Rubber Co.'s new Assurance series tires take some of the cringe out of driving. It has an interlocking woven belt construction so tough that it comes with a 55,000-mile limited road hazard warranty. Using Kevlar fiber for strength, the premium line Assurance is based on Armstrong's successful RV/off-road tires. Look for them at Armstrong tire dealers.—N.M.



Woven Kevlar belts make supertough tires.

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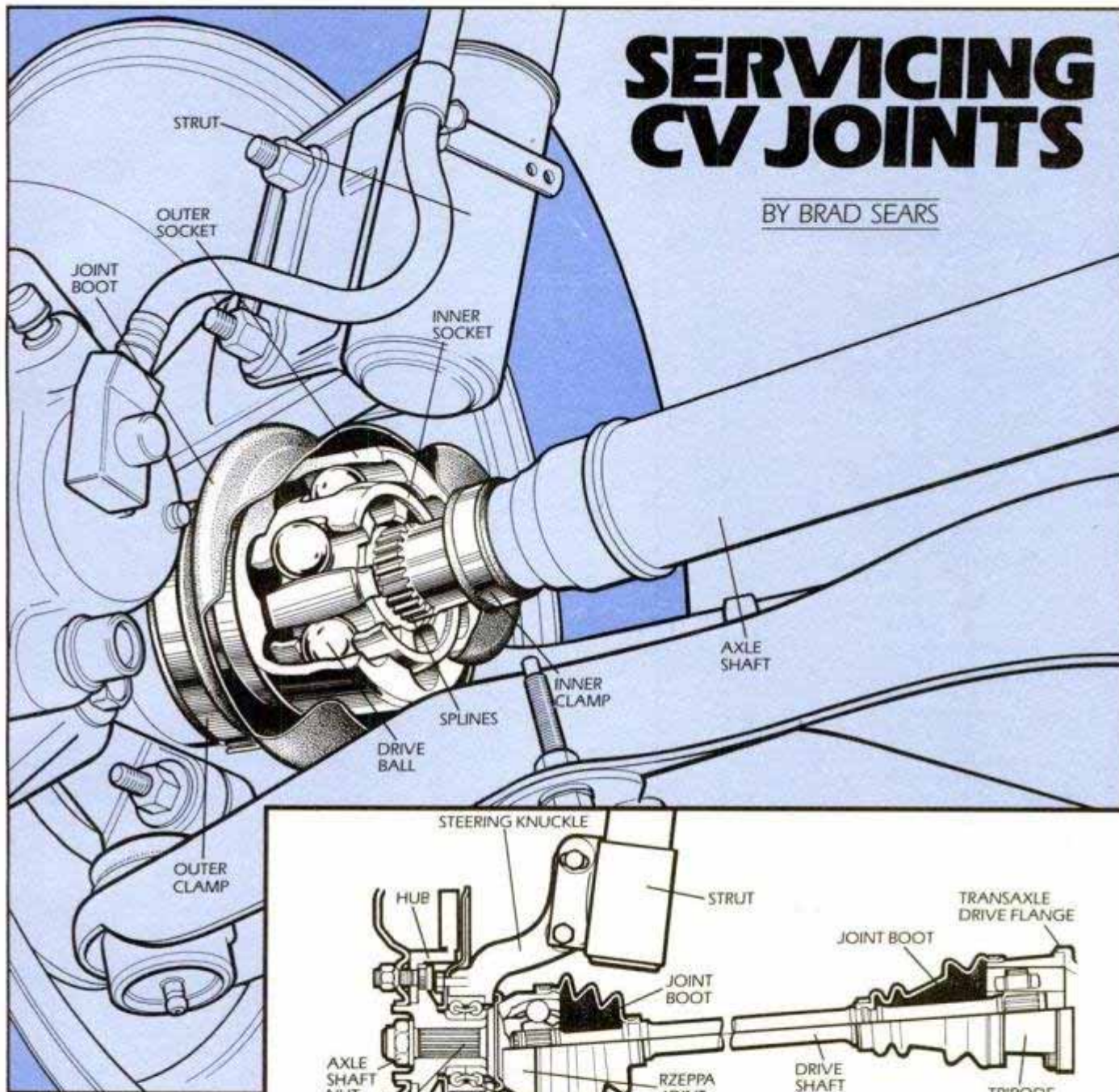
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SERVICING CV JOINTS

BY BRAD SEARS



Front-wheel-drive automobiles require special constant-velocity joints at both axle ends (inset) for up/down and left/right suspension travel. Rzeppa detail is above.

Typical GM front-drive axle

Constant-velocity joints are taking the place of universal joints that Saturday mechanics know so well. In a rear-drive car, U-joints connect the driveshaft to the transmission and rear axle, allowing the axle to move up and down on its suspension. In a front-drive car, CV joints connect the drive axles to the transaxle and front wheels.

Four CV joints are used—one at each end of each axle—to allow the front wheels to move up and down with the

suspension, and to steer through angles of about 20°.

The old type of universal joint from rear-wheel-drive cars would not take the abuse of the front-drive system. Furthermore, a shaft driven by a conventional U-joint will not maintain a constant velocity unless it is perfectly aligned with the driving shaft. If the conventional U-joint is flexed, the driven shaft speeds up and slows down as it rotates.

So, for fwd cars, a joint is needed that will not only deliver power at sharp angles, but also will not cause serious vibration and make driving unpleasant.

There are two types of joint that fit the bill. One, the Rzeppa joint, achieves these goals by joining the two shafts with a ball and groove arrangement. The second, called a tripod or tri-pot joint, joins the shafts with grooves and roller bearings. Tripode joints are usually found at the inboard ends of most

fwd driveshafts, while Rzeppa joints are generally used at the outboard ends.

Both types are quite durable, but there are certain precautions that must be taken with these units to ensure long life.

Because the CV joint flexes farther than the older U-joints, it requires a softer seal to protect the innards from grime, dirt and salt that splash up from the road. The easiest method of protecting the unit is to cover it with a boot similar to the old U-joint covers used on Chrysler cars from the 1930s through the '60s.

As with the old Chryslers, if this boot should rupture, all of the abrasive junk on the road collects on the lubricant in the joint and begins to act more like a grinding compound than a lubricant.

Taking care of a front-wheel-drive car, then, begins with getting the car on a lift or being able to get under it safely a few times a year to check the CV joint boots for damage. You should do this before winter sets in, then once during the winter and again in the spring. If you do an oil change and lube at 3,000-mile intervals, check the boots as part of this service.

Cold temperatures and accumulated ice and snow can tear a perfectly good boot to shreds in a matter of minutes.

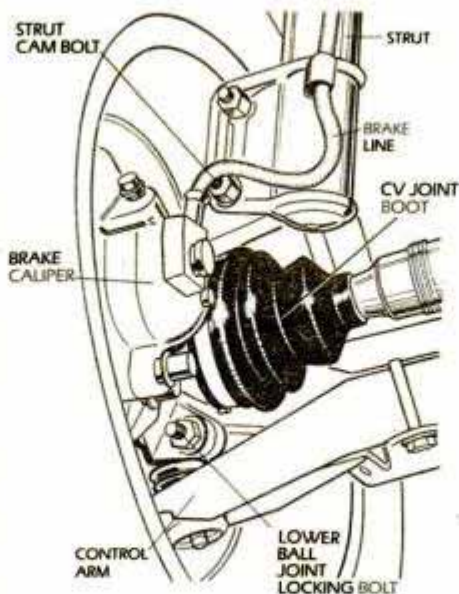
CV joint inspection

During the inspection, the wheels must be free to rotate so that you can see all the way around the boot. The clamps on each end of the boot should be checked to be sure that they are tight and not rusted through or broken (see Fig. 1). The boot material, a rubbery substance, should be flexible to the touch. A boot that's hard and brittle is likely to rupture soon and should be replaced. Grease spray around the joint is a sure sign of a damaged boot.

There should be no signs of tears or holes in the boot, since any hole will allow water and dirt to enter the joint. A damaged boot must be replaced immediately.

If the boot is torn, check the lube inside for grit or particles by rubbing a bit of it between clean fingers. If grit is present or if the car has developed symptoms of joint failure, the shafts will have to be removed for joint service. A boot that has become soft and mushy should also be replaced.

Serious joint damage can usually be detected when driving. A clicking noise when turning indicates a worn or damaged outboard joint. A clunk during acceleration indicates a worn or damaged inboard joint. And shudder or vibration during acceleration usually



1 Protective boots enclosing CV joints must be flexible and have an unbroken seal to keep out destructive road grit.

indicates a damaged or sticking inboard joint.

On the other hand, if a boot is only slightly damaged or worn and there's no indication of further problems, the boot alone can be replaced. There's more than one way to do the job. You can install a factory original boot or one of the new aftermarket quick-fit boots.

Quick-fit boots

With the quick-fit boots the job can be done without removing the axle because the boots come with a lengthwise split in them. You simply cut the clamps that hold on the old boot and use a knife to cut the old boot off the car. In the package of the new boot you will find a container of lubricant to be used on the joint once you've cleaned it. The new boot is slipped in place and the end clamps are loosely attached to position the boot.

A special bonding solvent supplied in the kit is applied to the edges of the split (Fig. 2). The edges are tied together and in 40 to 60 minutes the solvent will cure, permanently sealing the seam. Simply finish tightening the end clamps and you're on your way. The quick-fit boot is available from most parts stores.

If your inspection revealed that the joints are damaged or contaminated with grit, or if you decide to replace the boots with conventional factory units, you'll have to remove the driveshaft and joint assembly.

You may decide that you don't want to attempt this job yourself. On some cars, you will need a two- or three-leg hub puller to push the shaft out of the steering knuckle. On other cars, partic-

ularly GM models, it may be difficult to pry the inner CV joint away from the transaxle without a special tool. If you do decide to have a professional do the job, find one you know, or one who's NIASE certified in front end and suspension work.

If you decide to do it yourself, you must obtain a factory service manual or general auto repair manual that includes specific, detailed instructions for performing this service on your particular vehicle.

Removing the axle

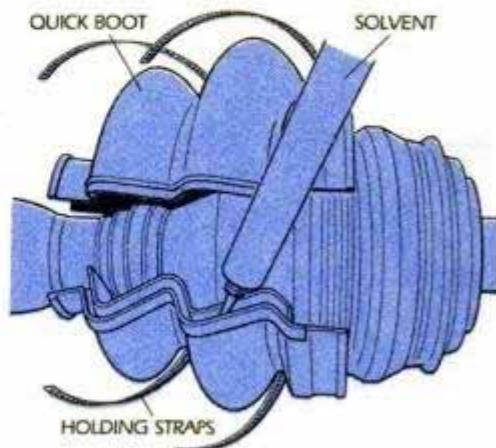
The procedure begins with the removal of the large axle shaft retaining nuts that are found where the front wheel bearing nuts would be on a rear-wheel-drive car. This is best done by loosening the nuts while the car is still on the ground. These nuts are usually torqued to between 180 and 225 lb.-ft. and require a good heavy socket and a long breaker bar.

Chock the wheels, apply the emergency brake and put the car in gear or an automatic transmission in PARK.

There are three methods of locking the axle nut to the shaft—with a cotter pin (just like the front-wheel retaining nut on a rear-drive car), a staked nut or a self-locking nut.

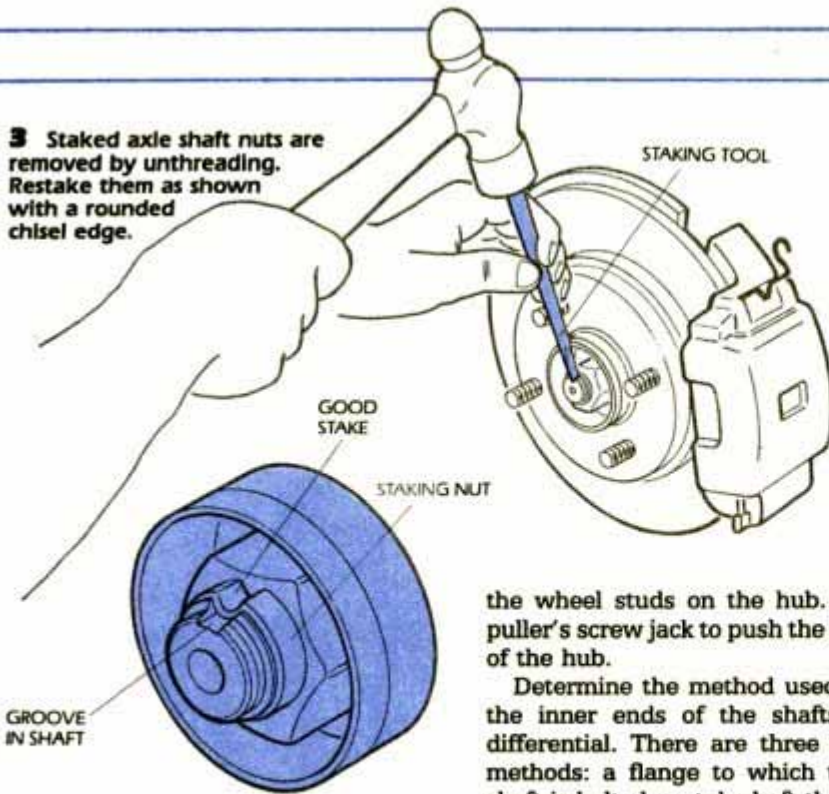
The staked nut looks much like a castle nut—one that could be used with a cotter pin—except that it doesn't have the cotter-pin grooves. The threaded portion of the shaft has a groove cut into it and, once the nut is tightened, the neck of the nut is staked in place.

When removing this type of nut, make no attempt to relieve the staked portion, just unscrew it as found. You can make a tool from a small cold chisel to stake the nut on reassembly. Grind the sharp edge from the chisel, leaving a rounded edge. The recommended



2 Split seam of quick-fit CV joint boot is permanently joined with a special bonding solvent that's supplied in the kit.

3 Staked axle shaft nuts are removed by unthreading. Restake them as shown with a rounded chisel edge.



radius is $\frac{1}{16}$ in. Place the tool directly over the groove in the shaft and, wearing safety glasses, use a couple of solid hammer blows to complete the staking (Fig. 3).

The third type of self-locking nut uses a nylon insert to keep it from backing off the shaft once it's tight.

You should replace a staked nut as well as a self-locking nut each time they are removed.

Once the axle nuts have been loosened, jack the car up by the frame and place stands under the frame in the locations shown in a shop manual, letting the wheels hang free. Remove the wheels and finish removing the hub nut and washer.

Chryslers and Fords

On Chrysler and Ford vehicles, remove the nut that connects the tie rod to the steering knuckle, then separate the rod end from the knuckle. Take care not to tear the rubber seal on the tie-rod end.

Remove the pinch bolt that holds the ball joint to the steering knuckle and use a pry bar to separate the lower control arm and ball joint from the steering knuckle. If the car is equipped with a front sway bar, unbolt it before you try to separate the ball joint from the knuckle. Don't use a pickle fork on the ball joints or tie-rod ends unless you plan to replace them, as the fork will tear the seals.

Attempt to move the knuckle assembly and strut away from the driveshaft, allowing the shaft to drop out of the hub. If the shaft won't release from the hub, get a puller that can be attached to

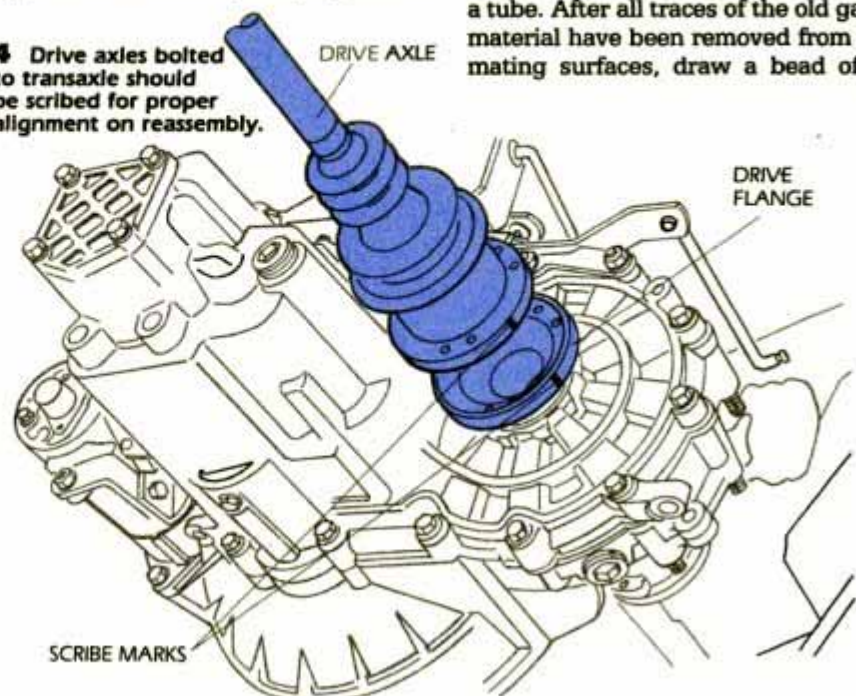
the wheel studs on the hub. Use the puller's screw jack to push the shaft out of the hub.

Determine the method used to hold the inner ends of the shafts to the differential. There are three common methods: a flange to which the half-shaft is bolted, a stub shaft that enters the differential and is held in place with a circlip, or just stub shafts that enter the differential. The latter are held in place with thrust bearings in the hub assembly. Stub shafts are common on General Motors and Ford vehicles.

On all Chryslers, except those equipped with the A-412 transaxle, the speedometer drive gear must be detached from the transaxle before the right-side driveshaft can be removed.

If the inner axle end is held in place by a bolted flange (Fig. 4), as on some Chrysler and Volkswagen cars, mark the flanges with a scribe to ensure their proper relationship when you reassemble them. The attaching bolts on this type are socket-head (Allen) capscrews.

4 Drive axles bolted to transaxle should be scribed for proper alignment on reassembly.



Use a good $\frac{3}{8}$ -in.-drive socket-head wrench with a ratchet to remove the screws and a torque wrench to reinstall them. The socket-head screws may be hidden behind protective plastic caps on some Chrysler models. Apply 33 lb.-ft. of torque to the screws during reassembly.

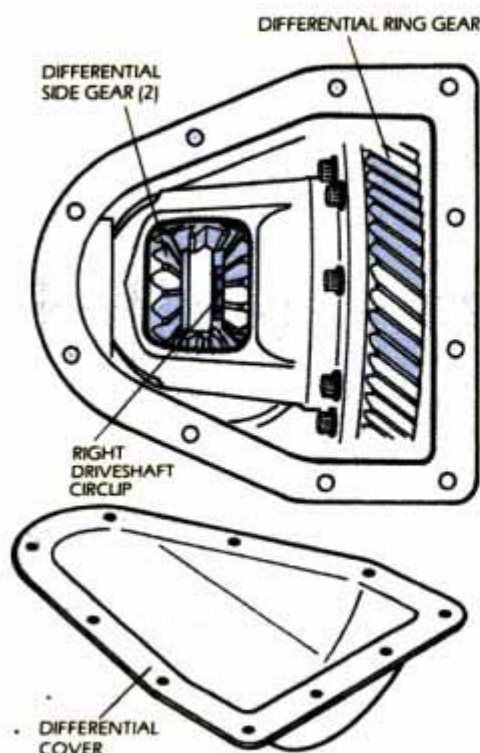
When there are no flanges on the inner ends of the drive axles, the differential cover may have to be removed to relieve the pressure on the circlip that retains each shaft. This arrangement is used on early Omni/Horizon models.

Omni/Horizon axles

To begin with, the procedure is the same: Loosen the hub nut; jack up the car and support it on stands with the wheels and suspension hanging free; then remove the hub nut, washer and wheel. Next, place a drain pan under the differential cover. Loosen the bolts and remove the cover. Rotate the drive-shaft until the circlips' ends are visible (Fig. 5). Squeeze the tangs of each circlip with a pair of needle-nose pliers and push the stub shaft into the side gear by prying with a screwdriver inserted between the stub shaft and the differential pinion shaft.

Release the ball joint and tie-rod end as described below. Separate the splined end of the shaft from the knuckle by pushing the knuckle away from the CV joint. Remove the driveshaft assembly from the vehicle by pulling outward on the inboard CV joint. Don't pull on the shaft.

When reinstalling the differential cover, Chrysler recommends that you use the silicone RTV gasket material in a tube. After all traces of the old gasket material have been removed from both mating surfaces, draw a bead of the



5 Some inner axle ends are retained by circlips. Release the clips after the differential cover has been removed.

RTV material on the cover, going completely around the cover and making a circle around each bolt hole.

Allow the material to skin over—about five minutes—and install the cover loosely. Just snug the bolts up a bit more than finger tight and allow the material to set for about five more minutes. Then finish the job by torquing the bolts to 12-15 lb.-ft. for Chrysler-built cars.

Removing the third type of axle shaft requires the use of a couple of O-ring pullers. Some auto parts jobbers who carry rebuilt axle shafts or a stock of CV joints will either lend or rent the tools to you. You still must remove the axle hub nut and washer as before, as well as the wheel.

GM joints

When removing CV joints on GM cars, you should disengage the steering knuckle from the strut rather than from the control arm (see lead illustration). Before the strut can be disengaged, the brake line must be disconnected from the strut and the caliper must be detached and supported.

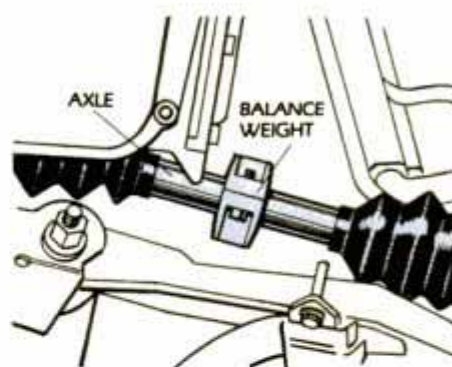
You must also mark the cam bolt on the strut mount so it can be reinstalled in the same position to retain wheel alignment (Fig. 1).

A special adapter is used with a slide hammer to remove the stub shaft end (inner end) from the differential of a

GM fwd car. You should have a drain pan handy, as fluid will leak from the differential.

The next step requires a puller that resembles a steering wheel or harmonic balancer puller. It is used to force the axle shaft out of the front wheel hub. Don't use a hammer here since the blows would probably ruin the front wheel bearings, which cost over \$100 each.

Once the shafts are on the bench, you must determine whether to replace them with rebuilt units or to disassemble them and replace only the CV joints and boots. (The CV joints would be making noises if they are defective or worn out—noises like snapping on turns or grinding and backlash when



7 To prevent unwanted vibrations, axle balance weights should not be removed.

applying the throttle or letting the car coast.)

CV joints that need replacement can also cause a shimmy in the steering system. If you've managed to get the shafts out of the car and know that the joints will need to be replaced, you should consider replacing the entire axle shaft assemblies with rebuilt units. (A rebuilt shaft assembly for the right side of an Omni, for example, carries a list price of \$240, while the parts needed to rebuild the shaft in the shop carry a list price of \$195). Then the procedure boils down to bolting in the rebuilt shaft, which is already assembled and lubricated.

Replacing CV joints

However, if you are adventurous, you can remove the CV joints and install new ones on the axle. To perform the job, you must have a service manual with specific instructions for your car.

Most CV joints are held together by a series of circlips which, when removed, allow the joint to be disassembled (Fig. 6). Before disassembling the joint, make sure your work area is really clean. Cover the entire work surface with a piece of towel. The thickness of the towel will stop any pieces that drop from bouncing and becoming lost.

Some axles have balance weights (Fig. 7) which should not be removed.

Without a doubt, servicing front-wheel-drive components is a more involved job than many home mechanics are willing to take on. In some cases it may require special tools to torque the axle shaft nuts (which must be tightened to 225 lb.-ft.), pullers to remove the driveshafts or equipment to realign the front end after unbolting and re-installing front strut components. But regular inspection and maintenance of the CV joint boots, coupled with the knowledge of how these parts function, will go a long way toward making life with front-wheel-drive cars easier and less costly.



6 CV joints may be serviced individually after the axle has been removed. Disassemble the CV joints by removing circlips.

Save Gas, Save Engine with 'POLY'

The following introduces one of the most fully tested and credentialed gas-saving, friction-reducing engine treatments ever to reach the market!

WHAT IS POLY? "Poly" is short for polytetrafluoroethylene (TFE). It is the slipperiest substance known to man (1981 Guinness Book of World Records, p. 188). The Petrolon Corporation, makers of Slick 50, has invented a way to permanently bind this slippery chemical to your engine with one treatment. All you do is add one quart of Slick 50 to your oil during oil and filter change. By reducing engine friction, Slick 50 increases gas mileage and horsepower and reduces engine operating temperature, thus causing your oil and engine to last longer. Just as important, it reduces metal wear, defraying costly overhauls.

HOW DO I KNOW THIS ISN'T A FRAUD? Slick 50 has some very impressive credentials. The "Consumers Digest" magazine (March/April, 1982, p. 35) states "Slick 50 does reduce engine heat and ordinary wear, and our informal tests indicate that it will improve gas mileage by about 2 or 3 miles per gallon." Researchers at the Franklin Institute Research Laboratory, after applying a powerful ultrasonic cleaning process to a Slick 50 treated engine, 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!

2500 miles after removing Slick 50 from the crankcase, lab tests at a leading university 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 tor-



ture 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. 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 the engine. Let the engine idle for 10 minutes. Then drain the oil, change the filter, and add the proper amount of oil less one quart. Add one quart Slick 50, drive for 30 minutes, and leave it in the crankcase for 3,000 miles. As the engine operates, the oil carries the polytetrafluoroethylene between the parts where it is burnished into the pores of the metal. Once impregnated, it is permanent, so you do it only once, not each time you change oil. One quart of Slick 50 will treat all standard 4-, 6-, and 8-cylinder gasoline and diesel engines.

WILL IT WORK WITH MOST OILS? Yes, Slick 50 will work with all petroleum-based oils and all synthetics that are compatible with petroleum-based

oils. An exception is graphite oils. However, once an engine is treated, you can go back to a graphite type if desired.

WHAT ARE THE BENEFITS OF SLICK 50? Your actual benefits in percentages may vary, depending on the kind of driving you do, vehicle condition, weather, and geographic area. By reducing friction, Slick 50 does all of the following: It increases gas mileage. It increases horsepower—small economy cars and large RV's really need this! It reduces operating temperatures, thus increasing the lubrication and life of the oil and the engine. Last but not least, the drastic reduction in engine wear defrays or eliminates costly overhauls which could save you up to \$1,000. Slick 50 eliminates the "lubrication starvation" that all cars experience when first started before the oil has a chance to circulate. Up to 90% of the engine wear on a car can be caused by this lubrication starvation. You receive all of these benefits for \$34.95, less than the cost of two tanks of gas.

WILL SLICK 50 HARM MY ENGINE OR AFFECT MY WARRANTY? No! Slick 50 is suspended in an excellent grade of petroleum oil which meets or exceeds every manufacturer's engine warranty requirements. In addition, Slick 50 is the only product of its kind to have both an API (American Petroleum Institute) and an SAE (Society of Automotive Engineers) rating imprinted on the package. It also has a SF-CC-CD service classification.

ARE DEALERSHIPS AVAILABLE? Yes. Here's an opportunity to make handsome profits. Having such solid test results from major institutions makes Slick 50 easier to sell than many other products. Free dealership information is sent upon request.

Free engine flush sent with each order. Free shipping with orders of 2 or more.

For purchase or further information, call toll-free 1-800-525-8624 (in Colorado call 1-303-762-1385) or send to SLICK 50, 3148 S. York St., Englewood, CO 80110.

I enclose \$34.95 + \$4.00 shipping and handling.
 I want 2 or more (free shipping and handling).
 Check C.O.D. Visa MasterCard
 Card No. _____ Exp. Date _____
 Name _____
 Address _____
 (Give street address if possible for UPS delivery)

SCIENCE WORLDWIDE



Time travelers under the sea

This fall an Israeli underwater archaeology team will return to Caesarea on the Eastern Mediterranean to travel back to the time of Christ. Last year, divers identified the wooden ribs of a submerged shipwreck as parts of a Roman Empire cargo ship. The 114-foot hull, with bow and stern missing, is located in about 6 feet of water. If the vessel can be brought to the surface and reconstructed, scientists expect to have the first example of a Roman supertanker. Archaeologists note that the ship probably had no valuable cargo—it most likely carried grain.

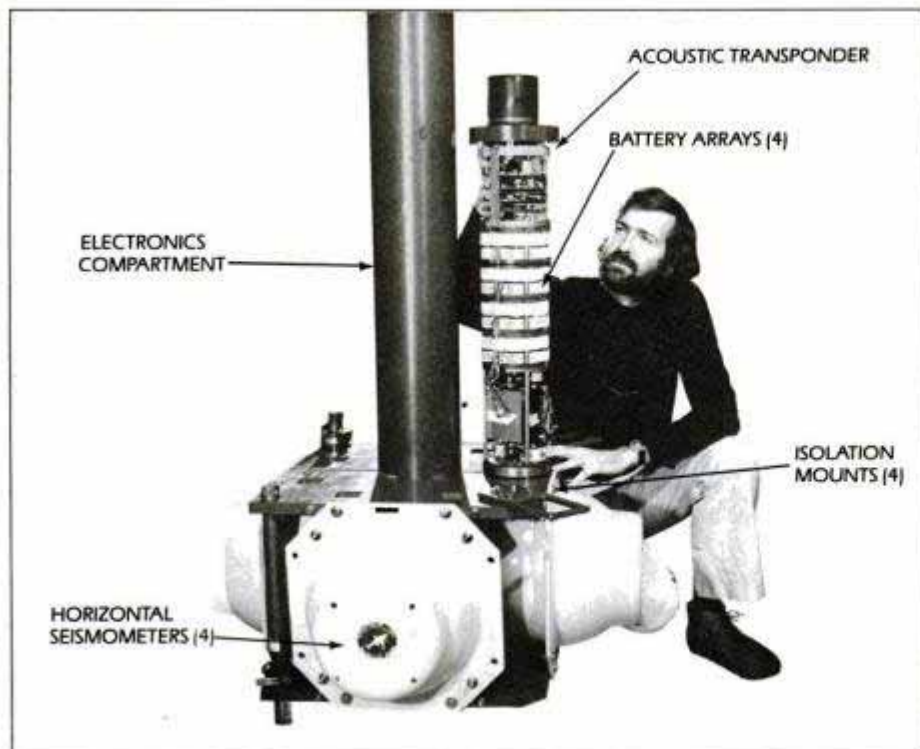


Israeli divers off the coast of Caesarea examine an ancient Roman cargo ship.

Submersible to a fault

Most of California's strongest earthquakes have their epicenters—point of origin—in the ocean. Little is known about undersea faults in the Earth. But now geologists are studying the bottom of the Santa Barbara Channel off the California Coast. Helping them is a machine designed by geologist William Prothero of the University of California at Santa Barbara.

The Ocean Bottom Seismometer (OBS) looks like a wood stove with an extra appendage. At its base are four horizontal seismometers topped off by a metallic stack filled with electronic controls. Four arrays of batteries keep the unit powered for up to one year of subsurface duty. Its acoustic transponder is highly sensitive and gives the rig the ability to "hear" a quake hundreds of miles away.



Submersible seismometer takes undersea quake readings from hundreds of miles away.

Coming: brain transplants

Are human brain transplants just around the corner? It looks that way. University of Rochester researcher Don Marshall Gash says he and his colleagues have successfully transplanted healthy brain tissue from an African green monkey to the scarred brain of another of the same species. Next, the scientists will do a brain transplant in a higher primate. The technique may mean restored memories to humans suffering from Alzheimer's disease.

Halley turnoff

The Astronomical League's newsletter *Reflector* recently carried with it the first issue of another newsletter. Called *Dark Skies for Comet Halley*, the four-page journal urges those interested in seeing Halley's comet in the spring of 1986 to lobby for the killing of all unnecessary outdoor lighting just for March and April of that year. Halley is not expected to be as bright this time as it was on its last pass. For a copy of *Dark Skies*, write to: Fred Schaaf, DSCH, RD No. 2, Box 248, Millville, N.J. 08332.

It all adds up

Factoring is the breaking up of a large number into smaller units. Thus the number 10 has factors 2 and 5. I figured out that one by just closing my eyes. But suppose you want to factor a number 69 digits long? You need some kind of formula. Scientists at Sandia National Laboratories have come up with a formula for factoring a 69-digit number. They used a powerful Cray computer to establish the technique. Next, Sandia scientists hope to factor a 71-digit number, creating a secret computer code.

Cloudy vision

Scientists using the Multiple Mirror Telescope in Arizona have made the first measurement of what may be a galactic-size cloud. The swarm of dust particles about 19 billion light-years from Earth measures 15,000 light-years across. Our Milky Way galaxy is about 100,000 light-years in diameter. The cloud may be a new galaxy forming at the source of the original Big Bang that many believe started our universe.

PM

MONROE[®] GAS-MATIC[®]

THE SHOCK THAT SHOULD'VE BEEN ON YOUR CAR IN THE FIRST PLACE.

Now there's a replacement shock that's so superior, so advanced, you'll wonder why it didn't come on your car in the first place. Monroe Gas-Matic. The most advanced shock we've ever made.

ADVANCED DESIGN.

Gas-Matic features a nitrogen gas charge (1), and a Teflon/steel priming valve (2), that drastically reduce aeration for less shock fade. This advanced technology allowed us to open up the valves (3) for reduced ride harshness.



The results are dramatic.

In comparison testing to conventional shocks, Gas-Matic handles better. Rides better. And gives you greater control without sacrificing comfort.

The conventional shocks didn't even come close.

Consider this: Gas-Matic improves handling by reducing body roll as much as 14%. It reduces shock fade up to 43%. And reduces ride roughness and vibration up to 63%.

SO SUPERIOR, GAS-MATIC IS PREFERRED 3 TO 1 ON ALL ROAD SURFACES.

We built Gas-Matic to be the best. On every type of road surface. In a recent

consumer ride test that included potholes, washboard bumps, railroad tracks, curves and a slalom course, Gas-Matic was preferred 3 to 1 over conventional shocks.

GUARANTEED TO GIVE YOU THE BEST RIDE EVER.


The best shock we've ever built deserves the best ride guarantee in the business. And that's what we gave it.

"If in 60 days you don't agree Gas-Matic shocks or struts give you the best ride ever, we'll replace them—at no charge—with any comparably priced shocks or struts."*

So if you want a better riding, better handling car, get the shock that should've been on it in the first place.

Get a set of Monroe Gas-Matic shocks or struts.

*See retailer for details.

Monroe Auto Equipment 
Division of Tenneco Automotive



GAS-MATIC[®]

THE MOST ADVANCED SHOCKS AND STRUTS
MONROE HAS EVER MADE.

APPLIANCE CLINIC



Repairing an old sealed-system refrigerator

Help! I have lost a dear friend. It's my 1946 Servel gas refrigerator, model No. UR-600A, serial No. 646105. It's been with me for years and now it's quit working. The flame burns, but it will not cool the refrigerator. Can this Servel be recharged? Is there anyone in the Houston area that repairs them?—Bernard L. Lenhart, Houston

Servel Co. was sold to Whirlpool Corp. way back in the late 1950s. Whirlpool may have a limited supply of

functional parts in stock for your refrigerator. Unfortunately, you'll have to pinpoint the malfunction *before* you order parts. The mailing address is: Whirlpool Corp., 1900 Whirlpool Dr., La Porte, Ind. 46350. Attention: Customer Service. Include the model, serial number, and the type of gas you are using, LP or natural. Explain what parts you are looking for. They will check their stock and find out if the parts you need are still available.

As far as having the unit serviced or possibly getting a sealed system repaired, my only suggestion is to check your local phone directory under motor homes or travel trailer dealers. They use gas-absorption-type refrigerators in their vehicles. It's possible that they may be able to help you with the sealed-system repair.

Or check with your local gas utility. They may know of someone who can service or repair the system.

Noisy defrost timer

I own a Coldspot frostless side-by-side refrigerator freezer with model No. 1067630512, serial No. E33875005. The problem is that the defrost timer became noisy and often sounds like a high-strung horse running on hard pavement.

I had a new timer installed by Sears and it wasn't long before the new timer got noisy again. Am I stuck with this horsey noise in my home?—Frank G. Bird, Abingdon, Va.

I think not. Replacement timers are not usually noisy. The timer may have a defective part. I suggest that you get in touch with the Sears service people again and have them replace the timer. Most likely, the part is still under warranty.

Warped refrigerator door

I have an Amana side-by-side refrigerator-freezer, model No. SR22-1, serial No. H11466544, in which the refrigerator door seems warped and out of shape near the bottom on the left side. How do I repair this? All the door seals are good.—Nick Valli, Trenton, N.J.

Sounds as if your door may need realignment, or possibly the door gasket may need adjustment. The first thing to do is to open the refrigerator door and remove everything from the door shelves on the liner.

Next, roll back the door gasket. Loosen all the retaining screws around the door seal. Once the screws are loosened, the door will lose much of its rigidity.

Shut the door and hand-shape it to

the face of the cabinet by pushing in on the door at all four corners. Then open the door carefully and tighten two screws which are in the corner. Shut the door again to see that it hasn't changed shape. Reopen the door and tighten the rest of the screws.

Sometimes after aligning the door, the door gasket won't rest flat against the face of the cabinet where it seals. The easiest repair is to put something behind the gasket to hold it out so that it makes contact with the cabinet. Try a silicone sealer or something behind the gasket to help retain its full height.

Thudding motor

We have a 1975 Hotpoint refrigerator with a top freezer, model No. IGPPF702C, serial No. OV2264291, which gives off a sharp thud whenever the compressor stops. The noise began three months ago with a quiet thud. Then the refrigerator began to rattle. We're afraid the refrigerator might explode one of these days. Please advise.—Mrs. Bessie Takemoto, Laguna Niguel, Calif.

There is no danger of it exploding. It sounds as if one of the internal suspension springs inside the compressor has broken. What you are hearing is the motor and pump assembly hitting against the side of the compressor case that envelops the whole hermetic compressor. The only real cure is to have the compressor replaced. **PM**

Kids, adults, appliances

Children are doing more household chores these days, especially in homes where there are two working parents. Whirlpool has published several booklets to help teach children safety and energy savings in using home appliances. Two booklets in the form of coloring books are: *Color Me Safe* (written in English and Spanish) and *Saving Energy*. Another booklet is *Laundry Tips For Kids*. It's written for children at the sixth-grade reading level. Pictures in the publications show step-by-step procedures to make them easy to follow and fun for kids to use.

Nice Things To Know About Safety With Appliances is geared toward teenagers and adults. This booklet contains information on installing and using appliances.



Two booklets dealing with safe use of appliances are available from Whirlpool.

To obtain copies, write to: Appliance Information Service-PM, Whirlpool Corp., Administration Center, Benton Harbor, Mich. 49022. Specify the booklet you want by title. Allow four to six weeks for delivery.

If you have a problem with any appliance, send your question, along with the model and serial numbers, to Appliance Clinic, Popular Mechanics, 224 West 57th St., New York, N.Y. 10019. Sorry, but letters cannot be answered individually. Problems of wide interest will be discussed in this column.

DRIVE A DIESEL OVER YOUR LAWN.

It looks like a riding mower. It cuts like a riding mower. But this Kubota is something else.

We call it a Kubota G. You might just call it great. Because it's the first lawn and garden tractor of such remarkably small size to have a diesel engine.

A Kubota G tractor comes with a powerful 2- or 3-cylinder water-cooled diesel engine. The engines are built to the same exacting standards as our bigger tractors. And the advantages of a diesel engine vs. gas are many.

Diesel is thriftier on fuel.

Maintenance is cheaper, too, with no spark plugs, carburetor or distributor to wear out. So you can just concentrate on maintaining your lawn instead of your lawn mower.

Most important, a Kubota diesel will last longer. A good

deal longer than any gas mower.

Other big tractor features include a live front PTO shaft drive to the mower. Unlike a belt drive, the shaft can't stretch and is unlikely to break. The result is a smooth, more even cut.

You can also attach a front

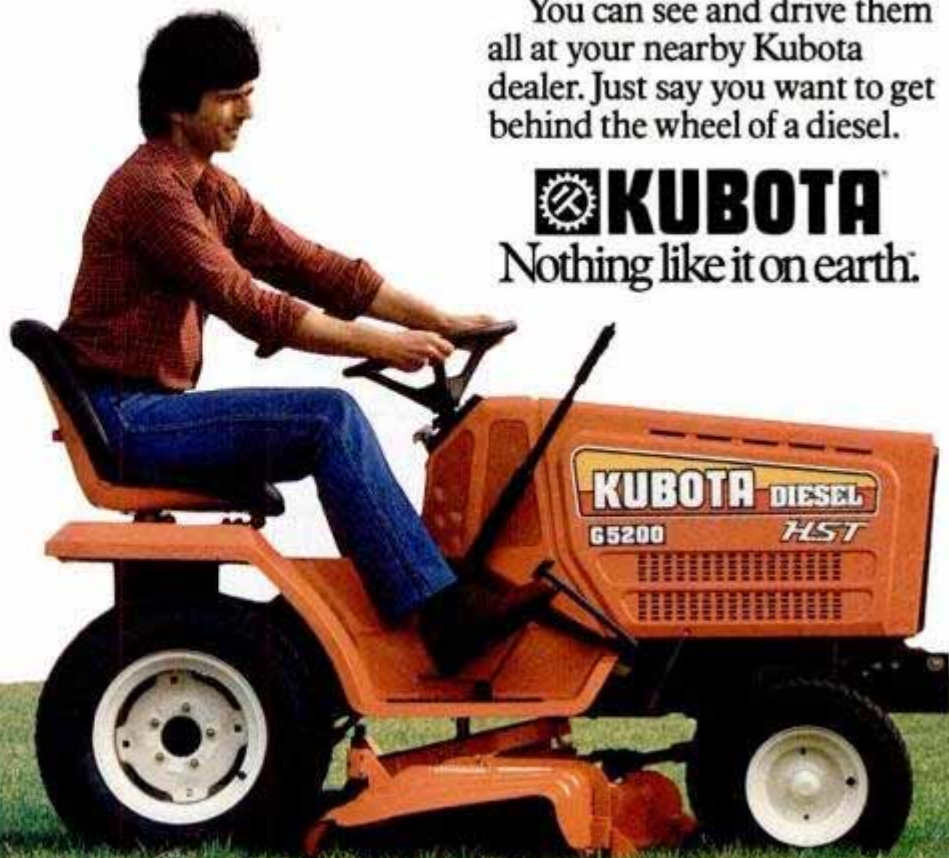
blade or snow blower. While an optional rear power take-off lets you operate a tiller.

There are four Kubota G lawn and garden tractors, from 10 to 14 horsepower. Two models come with an easy-to-drive hydrostatic transmission.

You can see and drive them all at your nearby Kubota dealer. Just say you want to get behind the wheel of a diesel.

 **KUBOTA**

Nothing like it on earth.



HOMEOWNERS' CLINIC



Regluing a Formica countertop

Our Formica kitchen countertop is glued onto fir plywood. Over the years, the contact cement has let go in spots. Formica is also glued tightly along the edges. Can a glue be injected between the Formica and plywood to reglue them, even though the old contact cement is still there?—Douglas Santy, Green Bay, Wis.

The countertop is probably loose

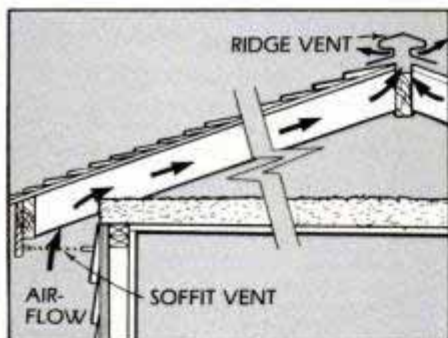
because someone periodically places a hot pot on it. When the temperature goes above 150° F., the contact cement softens and starts to let go. If the contact cement is not too old, it may be reactivated by heating the area with a gun-type hair blower. You need a temperature of about 200° F. on the surface of the Formica to reactivate the cement. Then roll the area with a roller and

cover it with a board that is clamped in place.

If the contact cement is aging and cannot be reactivated, you can bore a tiny hole into the area from the underside of the plywood so as not to damage the surface. Inject a white wood glue into the area. Push the loose section of the countertop up and down to spread out the glue. Then cover the area with a board and clamp it in place until the glue dries.

Mildewing

After removing the wood shingles from the roof, filling in the roof deck spaces and re-covering the roof with asphalt shingles, we developed a mildew problem on the interior walls. Even though



For good airflow from the attic, a combination of vents, such as the soffit and ridge vents shown, is recommended.

we installed two attic gable vents, the problem still exists. The house is not getting enough ventilation, but I'm not sure how to rectify this.—Jack Rutler, Burlington, Colo.

By filling in the roof deck spaces you altered the ventilation pattern of the house. The attic no longer breathes as easily as it used to. This causes a moisture buildup which results in the mildew.

Gable vents are helpful, but only if they are adequately sized. The effective openings for louvers is not the same as the actual opening cut out for those louvers.

The gross area of the actual opening can be reduced by as much as 65 percent because of the resistance introduced by the louvers. If you have a gable vent with outside dimensions of 2 × 2 ft., depending on the type of

louvers and insect screen used, you may only have an equivalent opening of about 1 × 1 ft.

An attic should have effective openings which are equivalent to 1/300 of the attic floor area. A single vent opening in an attic, even though it satisfies the total area requirement, is not considered adequate. The best method for ventilating an attic is to use a combination of vents such as soffit (fascia) and gable vents, or soffit vents and a ridge vent.

Hot water hassle

My water heater is at one end of my home and my bathroom is at the other end. In order to get hot water through the faucets, at least 80 ft. of cold water has to come out of the hot water line. Is it possible to continue the hot water line past the bathroom and then return it into the water heater? Will this save a lot of water?—Anthony A. Wolak, Aliquippa, Pa.

The hot water distribution system that you have is a noncirculating type

and is found in most homes. It is generally installed because it costs less for labor and materials than a circulating hot water system. Even though the noncirculating system is very common, it does have the disadvantage that you describe.

You can convert your system to a circulating hot water system by installing a return loop on the distribution line which runs from the last faucet to the hot water heater. If the elevation difference between the hot water heater and the faucets is greater than 5 ft., then the hot water circulation can usually be achieved by gravity (this is because hot water rises, forcing cooler water down).

However, if it is less than 5 ft. or if there is a long horizontal run, then you'll need a pump for effective recirculation of the water.

This system has the advantage of making hot water instantly available at all the fixtures because it is continuously circulating between the faucets and the hot water heater. This type of circulating system will also save some water.

Assuming there is a 3/4-in.-dia. water pipe between the hot water heater and the bathroom faucet, the 80 ft. of pipe will contain 1.8 gal. of water which would have been wasted. To minimize heat loss and conserve energy, don't forget to insulate the hot water distribution pipes. **PM**

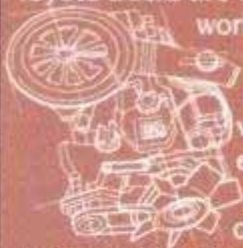
WELCOME

PM is pleased that Norman Becker will be writing the *Homeowners' Clinic* and will offer solutions to the home repair and maintenance problems of PM readers. Norman is president of Universal Home Inspection Inc., a company he founded in 1971 to inspect and evaluate residential structures. He is a charter member and past national director of the American Society of Home Inspectors, and a licensed professional engineer in four states. He has a Master of Science degree in mechanical engineering from Penn State. Norman has also written a book, *The Complete Book Of Home Inspection*, published by McGraw-Hill.

Do you have a home-maintenance or repair problem? Send it to Homeowners' Clinic, Popular Mechanics, 224 West 57th St., New York, N.Y. 10019. Letters cannot be answered individually, but problems of wide interest will be discussed in the column. For more home-repair and maintenance help, get PM's Home Care Guide, \$4.95 postpaid. Send your order(s) to Popular Mechanics, Box 1014, Radio City Station, New York, N.Y. 10101.

The new generation 1984 Toyota trucks are turning the truck world upside down, because they're the most advanced trucks ever built. But if one truck had to do it all by itself, this would be the one.

It's the all-new Standard Bed with a big, powerful 24 liter SOHC engine, powering a 1400-pound payload* with ease. However, the biggest news is the price — \$5998** — making it Toyota's lowest-priced truck. Low price doesn't mean compromise, either. Besides the 24 liter SOHC engine, 4-speed synchromesh transmission, and fully transistorized



ignition, the Standard Bed comes with all this equipment: power-assisted brakes with ventilated front discs and rear drums, steering-column controls designed for ease of operation, mist cycle wipers with twin stream washer, and the comfort of full three-across seating.

This truck is designed to be easy on the eyes. But the exciting new wedge-shaped front is not just for good looks. It's part of overall improved aerodynamics. Add-



ing to the lowered drag coefficient are the new flush surfaces on the

OH WHAT A FEELING!
TOYOTA

front and side windows with the bonus of reduced wind noise. The Toyota Standard Bed.



It'll measure up to your tough demands for an all-around machine. And you'll see why it's one of the new generation 1984 Toyotas turning the truck world upside down.

*Including occupants, equipment and cargo.
**Manufacturer's suggested retail price. Dealer's actual retail price may vary. Price does not include tax, license, transportation, optional or regionally required equipment.

MOST ADVANCED TRUCKS EVER BUILT!

**THE NEW GENERATION
TOYOTA STANDARD BED.
IT MAKES HARD WORK LOOK EASY.**



NO SWEAT!

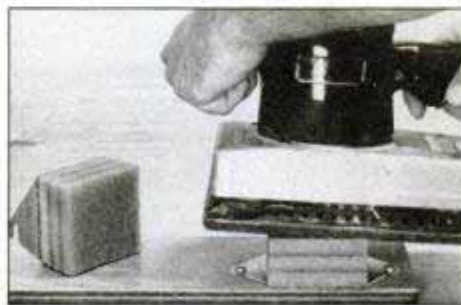
THE PM WORKBENCH



Abrasive erasers

Sanding Insurance is the name of giant erasers made by Granlund Engineering Co., Ware, Mass. 01082. The company claims the erasers are effective in removing all kinds of embedded material from sanding belts, discs, drums and sheets, thereby increasing the life of all abrasives. The three sizes shown here are available in most hardware and home center stores and range in price from about \$3 (for the pocket size) to \$9 (for the bench-mount model). The small pocket-size eraser is 1 in. square by 6 in. long, while the workshop size (\$8) is 1½ in. square by 8 in. long. The bench mount design is 3 in. square and 1½ in. thick. If you can't find the erasers in your area, write to the company for more information.—Mike Stowers

Use the smaller, handy, pocket-size eraser shown in foreground for any cleaning jobs when away from the shop.

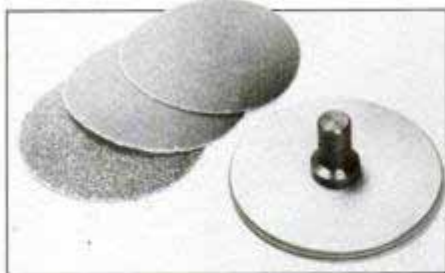


Clean belt sanders, drums and other large sanders with the workshop-size eraser at left. The bench-mount model frees up both of your hands for cleaning orbitals and discs.

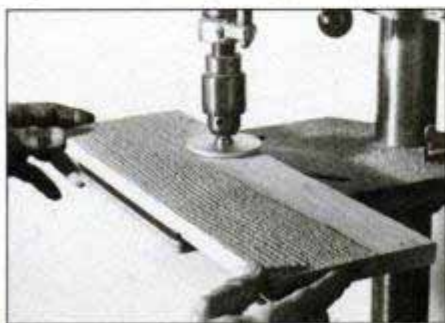
Drill press sander

You'll find this drill press accessory handy for sanding small workpieces to a precise thickness. The rigid aluminum disc lets you remove from a few thousandths of an inch to more than 1/32 in. on each pass. Made by Allen Co., Div. of Mote Inc., 1201 South 6th St., Hopkins, Minn. 55343, the Cyclo-Sander with six abrasive discs is \$18.95 postpaid.

—Rosario Capotosto



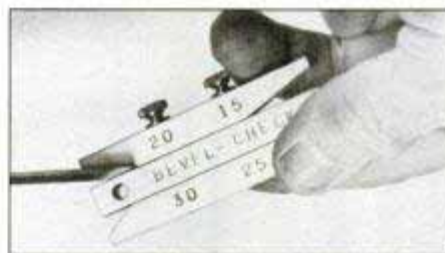
Use the nonflexible aluminum disc and abrasive (above) in your drill press for precise sanding jobs. Remove raised grain in just one or two passes (below).



Bevel check

This solid brass, precision-milled sharpening gauge gives you an accurate way to set the tool rest on your grinder. It also allows you to check the honed edge after the sharpening job is finished. Made of three separate parts that are assembled with two screws, you take the tool apart and line up the grinding surface or rest with the angle you need. The Bevel-Check contains the four most popular angles for sharpening plane irons and chisels. The price is \$17.50 postpaid from Alder Ltd., Box 19500, St. Paul, Minn. 55119.

—Rosario Capotosto



Check your bevel after grinding with tool assembled (top). Use individual tool parts to set specific angles.



Super router

If you do a lot of routing in hard materials, consider this brute from

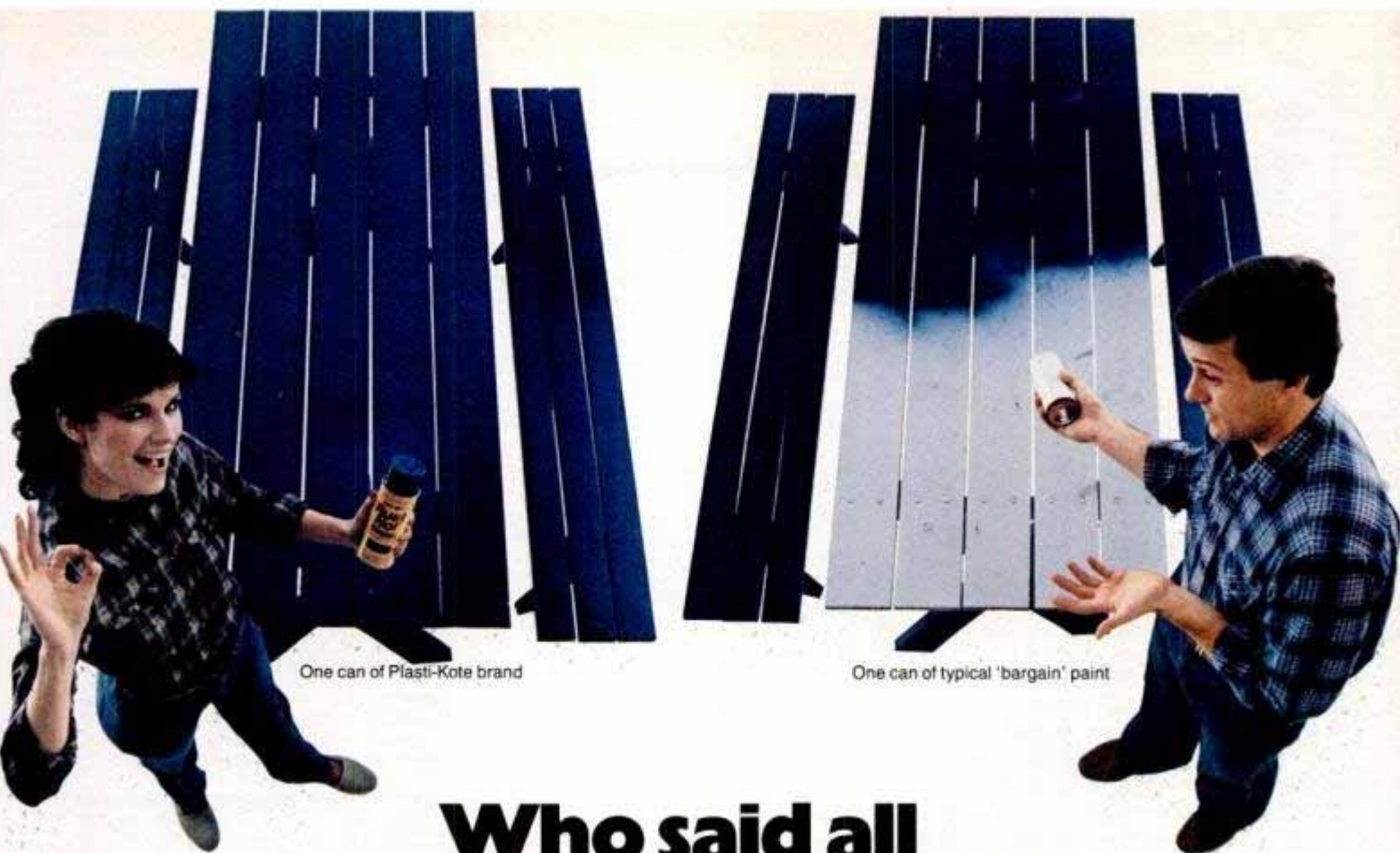


The maker claims that this monster router is the most powerful one on the market.

Black & Decker. With 3½ hp, it offers a 20,000-rpm operating speed for wood and other soft materials and a 16,000-rpm speed for harder workpieces, such as aluminum. Even with that much power, the tool still has an electronic speed control and overload protection system. The 15-pound tool's other features include a topside on/off thumb-switch for operator safety and control, and a shutoff probe device. The router is \$458. Black & Decker Inc., Industrial/Construction Div., 626 Hanover Pike, Hampstead, Md. 21074 makes it.

—Mike Stowers

If you've come across a new product with some special features, let us know about it. Write to PM Workbench, Popular Mechanics, 224 West 57th St., New York, N.Y. 10019.



One can of Plasti-Kote brand

One can of typical 'bargain' paint

Who said all spray paints were created equal?

If you're from the 'I'll believe it when I see it' school, you just saw it. Plasti-Kote brand spray paint simply goes farther, lasts longer than the so-called bargain paints.

You get more coverage, and a tougher, longer-lasting finish with all Plasti-Kote paints. It stands to reason. We're the leader in automotive spray paints, where second-best finishes don't count.

Let's face it. The best part of painting is getting done. Get done faster, better, and stay done longer with Plasti-Kote. We make good paint. And that's the real bargain.



Left, no bargain in hiding power.

Right, Plasti-Kote makes painting jobs disappear a lot faster.

Left, no bargain in durability.

Right, Plasti-Kote's beautiful finish stands up to a lot more.



plasti-kote®

We go farther. We last longer.

1000 Lake Road, Medina, Ohio 44256

Don't Buy a BIG TILLER...



for a small job

If your garden is an acre or more, hire somebody to plow it once a year . . . and buy a Mantis-20 for yourself. Mantis tills and weeds a practical 6" to 9" wide, turns on a dime and weighs only 20 pounds! Simply turning a 300-pound tiller in a backyard garden is a challenge.

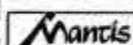
Most big tillers were designed to just till (but many now offer clumsy "add-on" attachments as an attempt to justify their high cost). The Mantis was designed from the beginning to precisely match a small, powerful engine to a variety of useful attachments for your yard and garden.

Most big tillers cost an arm and a leg. The Mantis-20 is a tough, durable precision instrument . . . yet it costs a fraction of what you'll pay for a big tiller.

Most machines are partially covered for 90 days to a year. Mantis has a *Lifetime Warranty* on the tines, a *Lifetime Replacement* agreement on the engine. Best of all, you get a *3-Week In-Your-Garden Trial* (If you don't like it, we'll buy it back for every penny you paid!)



**Tines so strong
they're guaranteed
for life!**



Mantis Manufacturing Co.
1458 County Line Rd., Dept. 439
Huntingdon Valley, PA 19006

Please RUSH me information on the Mantis-20 Tiller/Cultivator

Name _____

Address _____

City _____

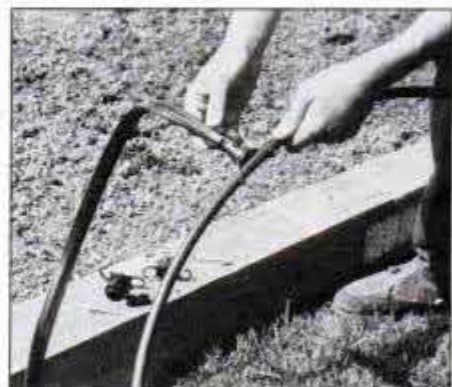
State _____ Zip _____

PM LOOKS AT...

Drip Irrigation Kit



Garden kit from Rainjet/Cascade contains all the parts (specially designed tubing, hose and fittings) and instructions you need to irrigate a 10 x 20-ft. garden.



Attach the Bi-Wall drip tubing to the Dura-Poll hose with easy to install fittings. A hole punch is supplied with the kit. Use ordinary scissors to trim tubing to length.



Lay the tubing alongside the intended plant rows or bury the tubing up to 6 in. for maximum efficiency and conservation.



Irrigation tubing is ideal for watering those plants whose roots must be kept wet, while its foliage remains dry.

For convenience and efficiency in watering your garden, consider this drip irrigation system from Rainjet/Cascade. The system sends an even flow of water directly to the roots, drop by drop. This feature eliminates runoff and erosion and is an ideal way to keep water off certain foliage plants.

Tubing in the kit is made of a unique, dual-chamber construction which allows water to pass through at low pressure, even if the tubing is buried under ground. The company guarantees an even water distribution in a continuous, uniform pattern. This kind of control means you can be selective in watering plants, and discourage weed growth.

Both hose and tube are extruded from low-density polyethylene for flexibility and minimal brittleness at low temperature. The fittings are molded

from polypropylene for durability. The company claims these materials have been tested under radical temperature changes and are resistant to cracking or breaking with normal use and care.

The kit comes complete with all the parts you need to install a watering system for a 10 x 20-ft. garden, including an antisiphon device. Accessories available include regulators, filters and a fertilizer injector. The company also makes systems for the landscape. With these systems you can water trees, shrubs, potted plants or hanging baskets and flower boxes.

Made by Rainjet/Cascade, 27671 La Paz Rd., Laguna Niguel, Calif. 92677, the systems are available at garden and home supply centers. Landscape systems range from \$20 to \$30, and the garden system is about \$30.

—Rosario Capotosto

HINTS FROM READERS

Power plunger



This hydrant-fed force cup unclogs drains in a hurry and increases drain efficiency by flushing out sediment.



A hose adapter screws into kitchen and bath faucets after aerator is removed.

Turn a conventional rubber force cup (plumber's friend) into a power plunger by altering it to force hydrant-pressure water through a drain. Bore or cut the rubber at the handle socket and substitute a $\frac{3}{4}$ -in.-dia. pipe for the handle.

I used a $\frac{3}{4}$ -to- $\frac{1}{2}$ -in. reducer and a short $\frac{1}{2}$ -in. nipple between the pipe and a length of $\frac{5}{8}$ -in. rubber garden hose. Hose clamps around the neck of the suction cup and at the pipe-hose connection make the joints watertight. In the kitchen and bathrooms, you may need a faucet adapter.

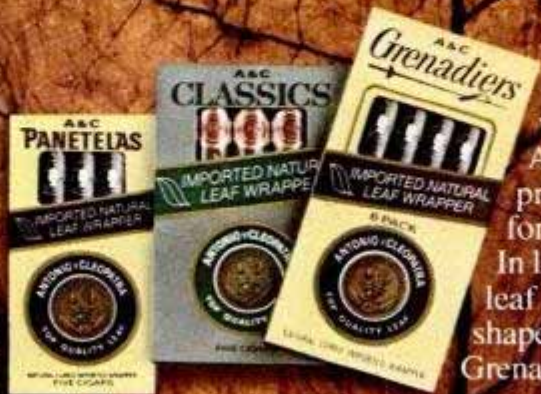
—David W. Roberts

Taste the difference. A & C is still made with the natural leaf wrapper.

The *imported* natural leaf wrapper. That gives Antonio y Cleopatra its rich, distinctive, real tobacco taste. The most expensive, best-tasting cigars are still made with the natural leaf wrapper.

And at a very reasonable price, A & C is the best cigar for the money.

In light or dark imported natural leaf wrapper. In a variety of shapes to fit your style, including Grenadiers, Classics, Panetelas.



A & C. The natural leaf wrapper cigar.

Garden and lawn tractor

Designed to fill the niche between lawn and garden tractors, Ford's YT-16 can mow your lawn, till your garden, haul materials or remove snow. Its twin-cylinder 16-hp engine can handle a 16-in.-wide tiller or power a 42-in. mower. It has an electronic ignition and a manual transmission with five forward speeds and one reverse speed. Other features include large tires for good traction, a blade flotation system for uniform cutting height and a belt-driven power takeoff. Suggested retail price of the YT-16 is \$2,091. Write to Ford Tractor Operations, 2500 Maple Rd., Troy, Mich. 48084.



Grill design makes changing tanks easy



Convenience is the key feature in the Patio Range II gas barbecue grill from Arkla Industries Inc., Box 534, Evansville, Ind. 47704. The wheels for the grill are part of a detachable rack that holds the propane tank. When changing the tank, you just wheel the empty one away. Replacing a full tank is just as easy and requires no back strain. Burners work together or separately. The suggested retail price is \$349.

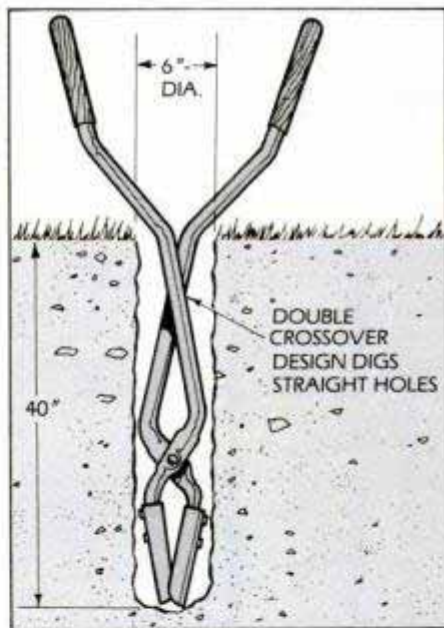
Digger makes straight holes

The secret of the crossover design of this hole digger is that it lets you dig a narrow hole straight down without widening the hole at the top to maneuver the handles. Manufactured by Can-Do Diggers, 750 North Milford Road, Highland, Mich. 48031, the new homeowner's model LW 56 weighs in at 9 pounds and is 56 in. tall. Can-Do Diggers claims it can dig a 6-in.-dia. hole 40-in. deep in hard soil. The digger is made of steel blades

and 16-gauge, 1/4-in. steel tubing with hardwood handles that are painted bright orange for safety. The homeowner's model is about \$35 at hardware and home center stores. Write to the company for more information.

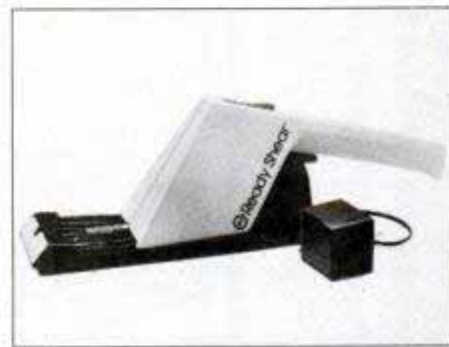
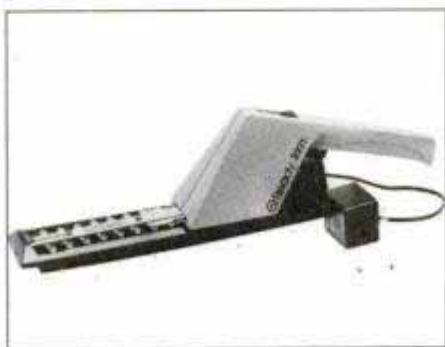


You operate the handles like a posthole digger, but the crossover design allows you to keep the hole narrow.



Two rechargeable lawn tools

Cordless and rechargeable, Shrub Trimmer Model 8170 (near left) and Grass Shear Model 8270 (far left) are from Black & Decker, 515 Glebe Rd., Easton, Md. 21601. The company claims that both tools provide at least 30 minutes of operation on one charge in a storage/charger base. The Trimmer weighs 2 3/4 pounds and the Grass Shear weighs 2 pounds. They cost about \$47 each and can be found at garden and home supply centers. **PM**



That deep, deep black. That lean, swift shape. That recognized symbol of boating excitement. A Mercury® outboard.

It's a machine made for your dreams. And a machine made to run like a dream, engineered to deliver the kind of superior performance and dependability that make a Merc one of boating's best investments.

MORE EXCITEMENT FROM MERC.

In 1984, the Mercury dream machines offer you more than ever before, with new features to choose from like factory-installed oil pre-injection on the 150 and 200. And today's best power trim.

And behind every Merc stands the Mercury Outboards System, the marine industry's strongest manufacturer-to-dealer-to-customer network ever. From the newest technology, to dealers who help you buy right, The System keeps Mercury owners satisfied.

MAKE YOUR DREAM COME TRUE.

Over 6,000 Mercury dealers worldwide are ready to show you what the 1984 Merc dream machines can do.

Now's the time to make your boating dream as real as a fast slalom ride over your boat's wake. Now's the time to make it a Merc.

DREAM MACHINE.



**OIL INJECTED
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**MERCURY
OUTBOARDS**

The possible dream.

Maybe the best way is to go strictly

Most of us buy cars with our hearts. Not always our heads. We'd like to change that a little. First, by giving you some information about Lynx now. And, second, by inviting you to call us toll-free at 1-800-MERCFAUX to get a 1984 Lynx catalog for a closer look.



56 EST. HWY.
37 EPA EST. MPG*


OK, maybe the gas crisis isn't going to plunge us all back into the Stone Age. But we'll bet numbers like these are easier for your pocketbook to swallow than some others you've been looking at.

*Compare to the estimated MPG of other cars. Your mileage may differ depending on speed, weather, and trip length. Actual highway mileage less. Not available with air conditioning, power steering. Not available in California.

\$6151.†

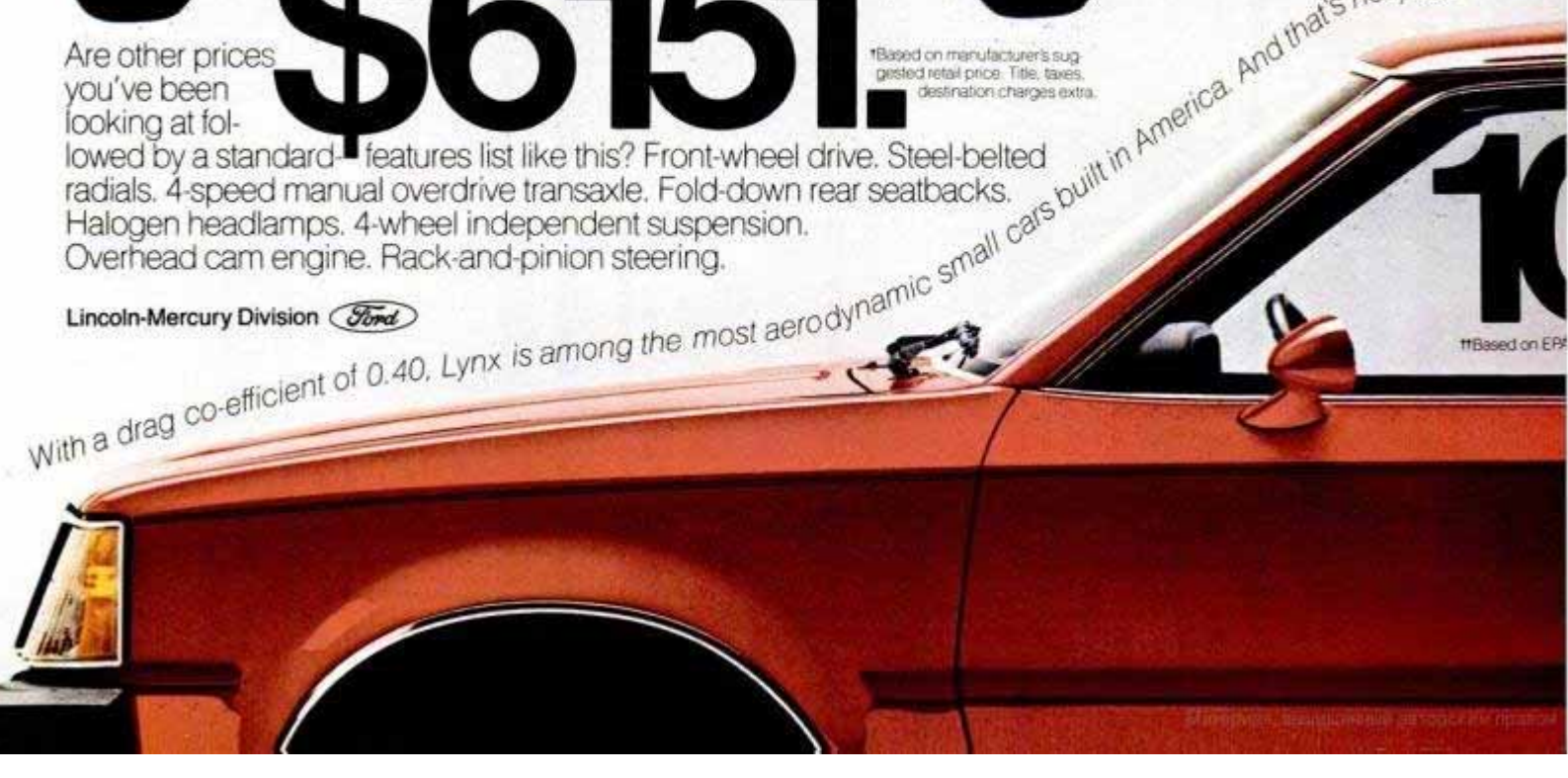
Are other prices you've been looking at followed by a standard-features list like this? Front-wheel drive. Steel-belted radials. 4-speed manual overdrive transaxle. Fold-down rear seatbacks. Halogen headlamps. 4-wheel independent suspension. Overhead cam engine. Rack-and-pinion steering.

†Based on manufacturer's suggested retail price. Title, taxes, destination charges extra.

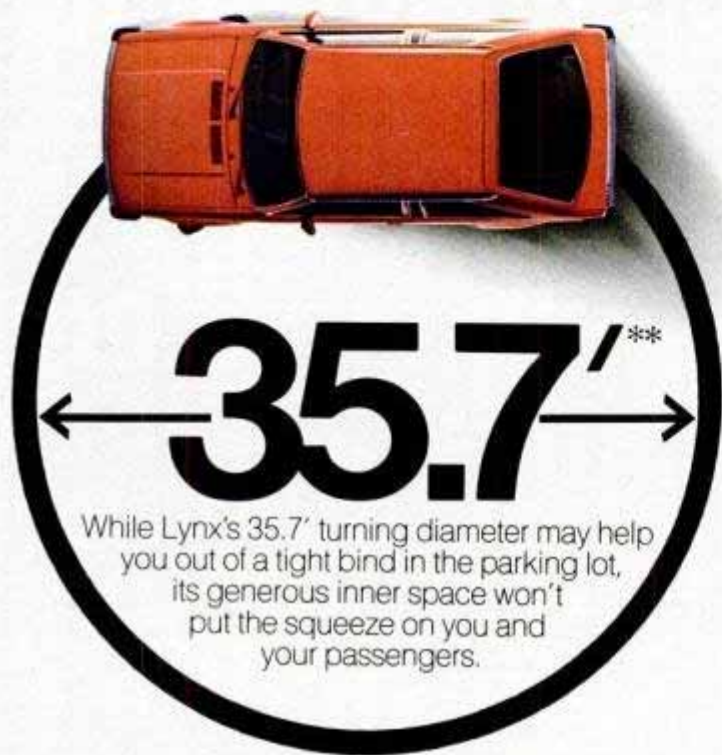
Lincoln-Mercury Division 

With a drag co-efficient of 0.40, Lynx is among the most aerodynamic small cars built in America. And that's not just a bunch of...

10
 ††Based on EPA



to choose a small car by the numbers.



35.7'**

While Lynx's 35.7' turning diameter may help you out of a tight bind in the parking lot, its generous inner space won't put the squeeze on you and your passengers.

51.4"**

**Based on 1984 MVMA Passenger Car specifications.



A Lynx doesn't make you apologize for the fact you've grown up. It gives you 51.4 big inches of shoulder room up front. Buckets of hip room. And almost double the rear-seat leg room of Honda Civic Hatchback.



As part of Ford Motor Company's commitment to your total satisfaction, participating Lincoln-Mercury dealers stand behind their work in writing with a free Lifetime Service Guarantee. No other car companies' dealers, foreign or domestic, offer this kind of security. Nobody. See your participating Lincoln-Mercury dealer for details.

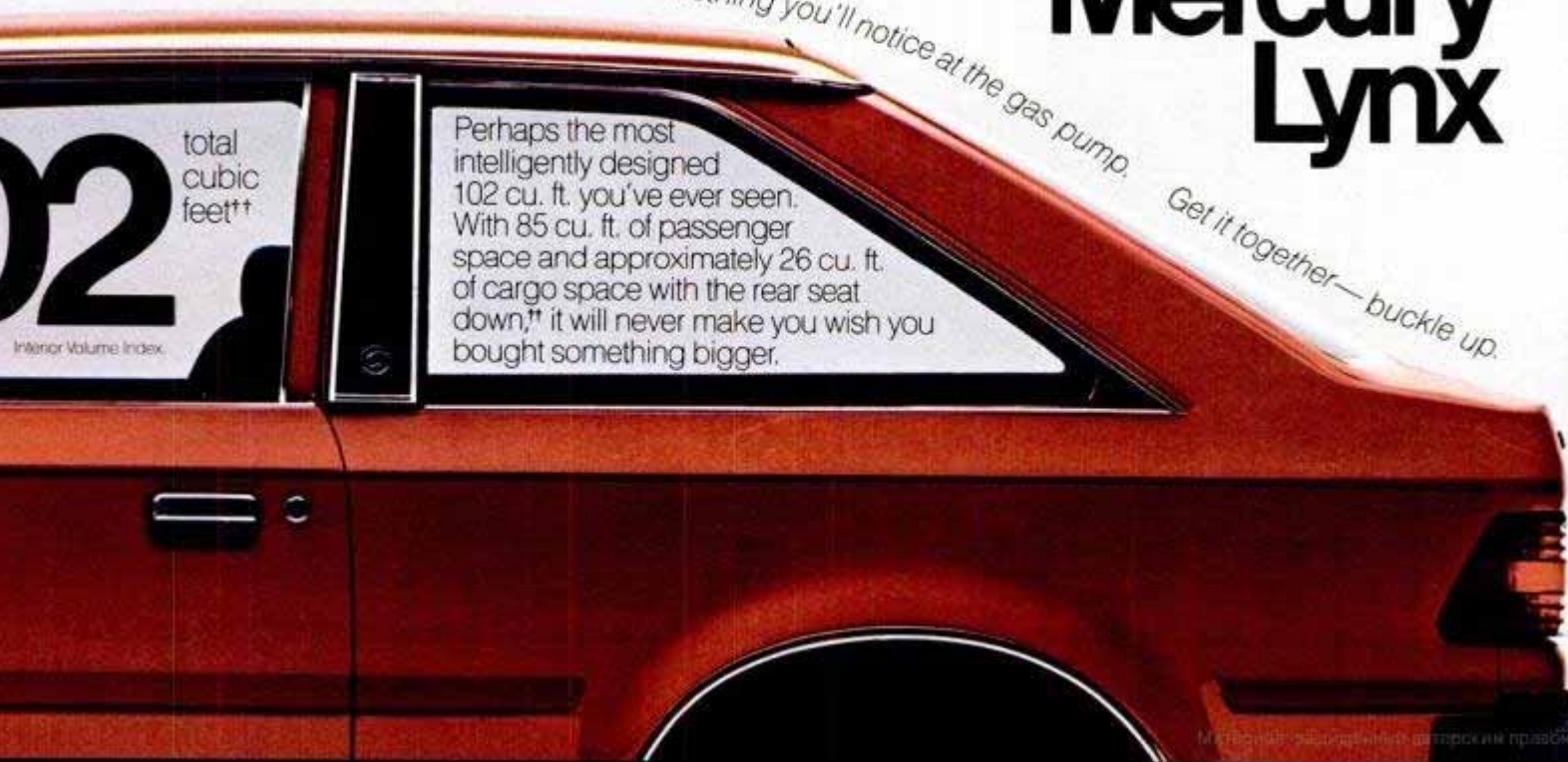
Mercury Lynx

0.40

hot air.

It's something you'll notice at the gas pump.

Get it together—buckle up.



102 total cubic feet**

Perhaps the most intelligently designed 102 cu. ft. you've ever seen. With 85 cu. ft. of passenger space and approximately 26 cu. ft. of cargo space with the rear seat down,** it will never make you wish you bought something bigger.

PM ELECTRONICS MONITOR

Clever, inexpensive robot kits

Robot kits are now available from several sources. They're relatively expensive because they're equipped to perform a variety of tasks. The basic \$999.95 Heathkit Hero 1, for example, is a computer on wheels, with sensors for sound, light, motion and range.

Now there's a new line of ingenious Movit minirobot kits from OWI. These simple battery-operated kits, which range from \$24.99 to \$74.99, feature sound-sensor or infrared-activated movement, and transparent bodies.

The \$44.99 Piper Mouse has a built-in sound sensor and is activated by voice or by the high-frequency whistle included in the kit.

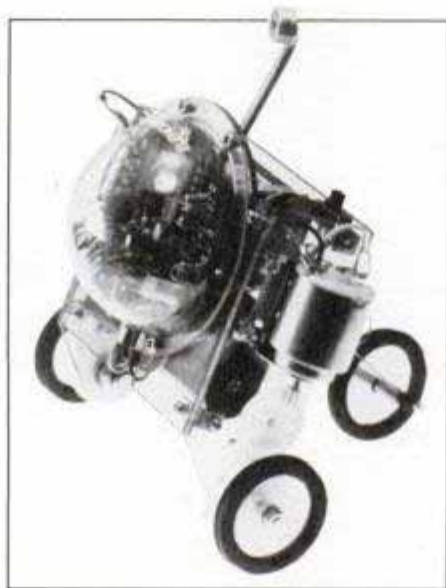
Piper Mouse's circuit board (like all Movit circuit boards) is already assembled, so all you do is put the mechanical parts together, using scissors, a small Phillips screwdriver and long-nose pliers.

The three-wheeled Memocon Crawler (\$74.99) is the most sophisticated OWI Movit robot. A cable-connected keyboard lets you load up to 256 steps into a ROM memory, which controls a sequence of movements. You can even build an interface from the Crawler to your personal computer.

The OWI Movit robot kits are available at some Heathkit stores. Three more kits will be available this summer.

Peppy senses both noise and objects in its path. Mr. Bootman can walk or run forward or backward on six insect-like legs. And Medusa takes a few steps on long legs, then stops.

Circular, the most fascinating of them all, is awaiting FCC approval. The robot rolls silently on two large wheels via remote control.



The Piper Mouse robot stands only a few inches high. It's controlled by an ultrasonic whistle or by your voice.

Hold the phone!

If you have more than one telephone in your house, you know how desirable it would be to have a "hold" feature for them.

Now, a new standard-type wall phone manufactured by Mura Corp., lets any phone in your house be put on hold. A unique, proprietary microprocessor-based circuit, called Masterhold, is the part of the Muraphone WP-460 that does the job.

Once this phone is installed, you can make a call at another phone in the house—a Western Electric phone, for example—put the call on hold by tapping the hook switch, pick up the call at still another phone (of any make), and complete the call.

The hold feature automatically releases after two minutes if the call hasn't been picked up during that time.

The WP-460, which has a suggested list price of \$79.95, also offers switchable tone/rotary dialing, a 10-number memory with automatic last-number redial, and in-use indicator. The WP-460 is a fully modular, standard-style wall phone that mounts directly into an AT&T wall plate.

This new Mura telephone is sold through department stores and home-entertainment centers. For details and more information, write to the Mura Corp. at 385 West John St., Hicksville, N.Y. 11801.

Good timing

Most clocks, even those regulated by a quartz crystal, need to be reset now and then. If you need the exact time, you can dial it, or build the most precise clock available in kit form.

Dial 1-900-410-TIME and you'll get the time from "the most accurate clock system in the world" for the 50-cent phone call. The service is provided by the U.S. Naval Observatory and is based on the average of about 20 commercially available cesium clocks.

For \$249.95, you can build the Heath GC-1000 Most Accurate Clock, which is \$389.95 assembled and tested. Using an external antenna, the clock scans the 5-, 10- and 15-MHz frequencies of the National Bureau of Standards broadcasts until it locks onto the strongest signal.

The microprocessor-based GC-1000

has a zero accumulative error and is guaranteed accurate to within plus or minus 10 milliseconds because it's based on the NBS "atomic clock," which in turn is based on the resonant frequency of the cesium atom. The NBS



Heathkit's GC-1000 Most Accurate Clock will keep time to within .01 second.

clock is more precisely calibrated than the Naval Observatory clocks, although the Observatory claims its averaging provides a better time standard.

The Heathkit clock, which sets itself to the correct time when first plugged in, or after a power failure, displays hours, minutes, seconds and tenths of a second. Switches on the chassis bottom can be set for the preferred time zone, 12-hour or 24-hour mode, Daylight Savings, and so on. For an additional \$49.95, Heath's RS-232C output accessory provides ASCII time for computer use, including month, day and year.

Whether you use the GC-1000 Most Accurate Clock for timing critical experiments, or just for the pleasure of knowing you've got the *right* time, you've got a clock "whose perfect time is synchronized to the heartbeat of an atom," as Heath puts it. **PM**

A HOT TIP FOR BETTER MILEAGE FROM MOTORCRAFT.

Motorcraft Extended Tip Spark Plugs are engineered to save gas in any properly tuned, normally driven car. As you drive, they actually burn away sooty carbon deposits that sap your car's performance and power. They're also designed to

handle power surges of up to 38,000 volts—twice what your car should ever experience. For more protection and better gas mileage, get the Extended Tip Spark Plug from Motorcraft. Quality parts for all makes of cars and trucks.

Motorcraft
EXCEEDS THE NEED

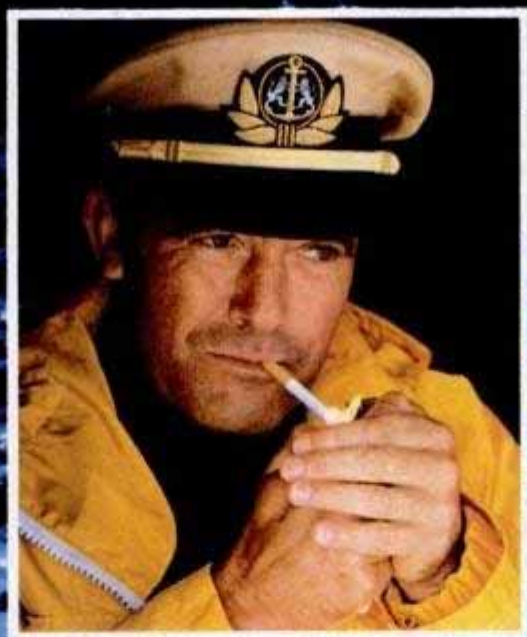


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Reach for a world of flavor.

MERIT



The low-tar cigarette
that changed smoking.

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

© Philip Morris Inc. 1984

8 mg "tar," 0.6 mg nicotine av. per cigarette, FTC Report Mar '83



Wild new look in wings: Futuristic concept for a supersonic V/STOL fighter combines radically new forward-swept wings with an advanced three-burner, thrust-boosted turbofan engine. Under study by British Aerospace, it could push speeds up to Mach 2, more than double that of current Harrier. Benefits of forward wing sweep are higher lift, lower drag, lack of wing-tip stall and improved combat maneuverability.

COMING: JUMP JETS THAT BREAK THE SOUND BARRIER

Our vertical-takeoff Harrier is a great plane, but it can't go supersonic. Now the push is on for a Mach 2 fighter that can still land and take off like a helicopter.

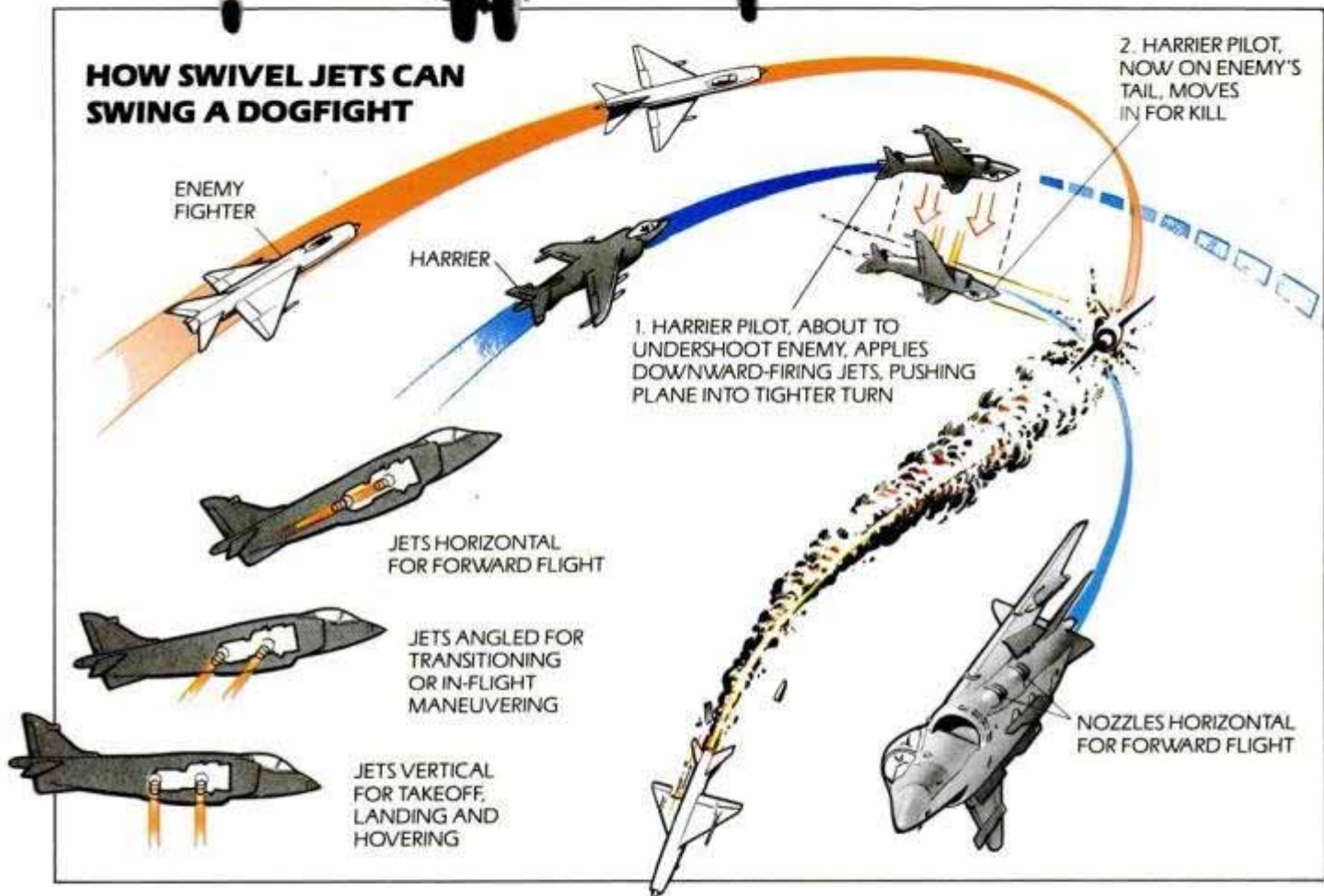
BY SHELDON M. GALLAGER
Illustrations by J.A. Lapinski and Fred Wolff

The exotic shape you see above is not a scriptwriter's prop for a space-war fantasy. It's one of several dramatic new concepts for a supersonic V/STOL fighter that could combine Mach 2 speeds in combat with the ability to stop dead in mid-air and land or take off like a helicopter.

The only V/STOL (Vertical or Short Takeoff and Landing) fighter we currently have is the famed Harrier jump jet, pioneered by the British and recently upgraded in this country by McDonnell Douglas. The Harrier, which has been in service with the U.S. Marines for more than 10 years, is a tough, versatile performer with uncanny maneuverability, but it has one critical shortcoming—it can't go supersonic. Its top speed



HOW SWIVEL JETS CAN SWING A DOGFIGHT



Steppingstone to the future: Newest U.S. Jump Jet, the McDonnell Douglas AV-8B Harrier II (top), is a greatly improved derivative of the earlier British Harrier with

twice the range and payload. Though still subsonic, it could provide the basis for a supersonic version to come. Diagram shows how downward-swiveling thrust

nozzles make possible vertical takeoffs and landings and also permit trick moves in combat, such as deceptive jump-turn in this dogfight sequence.

is Mach 0.93, or about 690 mph, putting it at a disadvantage when striking deep at distant targets or when tangling with enemy fighters of twice the speed.

Somewhat embarrassingly for the West, the Soviet Yak-36 Forger, a V/STOL fighter/bomber comparable to the Harrier, has a reported speed of Mach 1.1—not a great deal faster than the Harrier, but definitely and disturbingly supersonic.

The need for speed

There was a time when jump jets were looked upon as curiosities, some-

what like the gifted child who's a whiz at math, but not very good on the football field. They were regarded as useful for a few very specialized jobs, but not really able to play in the big leagues.

Now this thinking is changing fast. The startling success of the Harrier in the hands of British pilots at the Falklands in 1982 proved it could go against technically superior opposition even with its subsonic limitation. A supersonic version would have been even more effective.

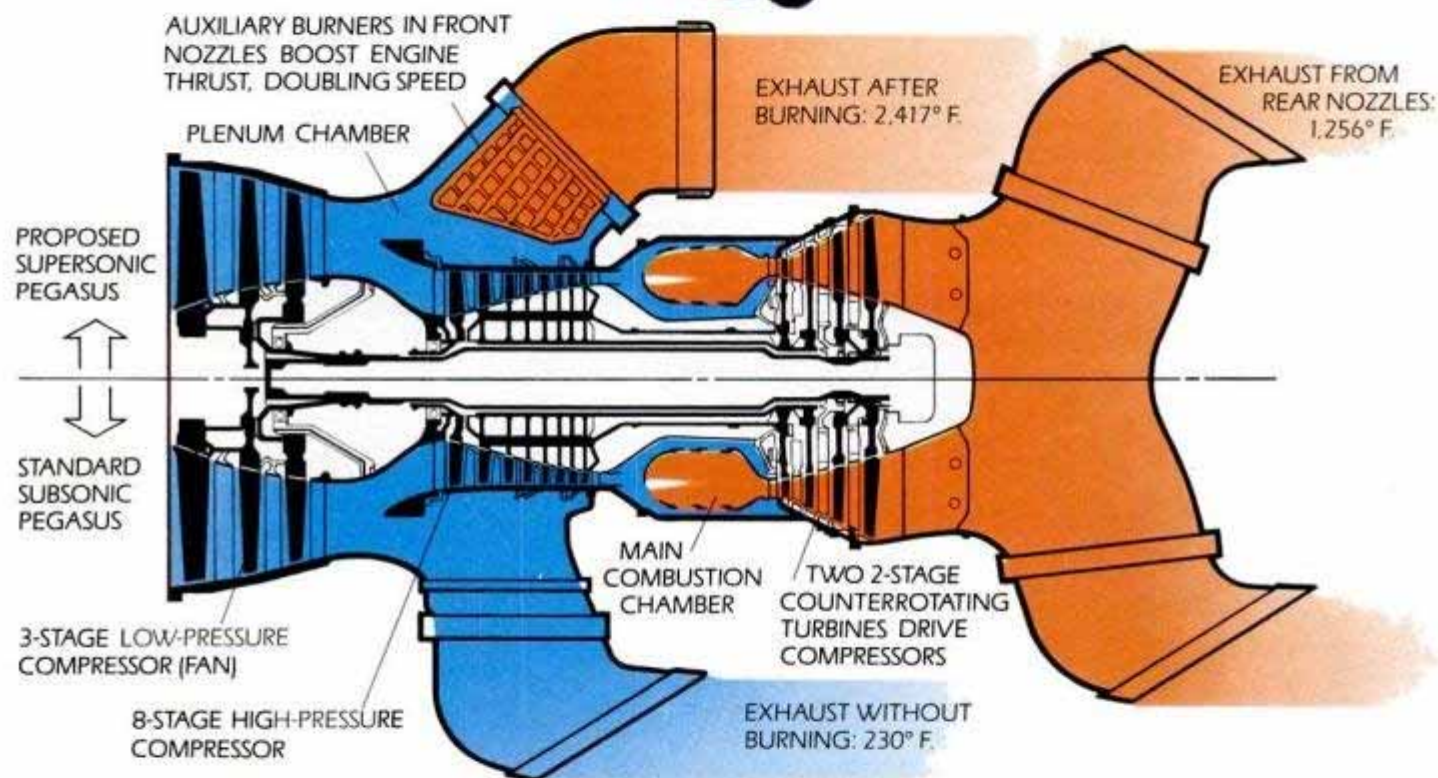
Add to this such grim realities as the soaring cost of giant supercarriers needed to handle conventional jets, the

ease with which airfields can be rendered useless through new mass-destruction bombing techniques, and Russia's ominous lead in V/STOL technology. All these factors combine to make the development of a supersonic jump jet an imperative need for U.S. and NATO security.

A Harrier can land and take off in a space no bigger than a tennis court, enabling it to operate from jungle clearings, battle-damaged runways, short makeshift airstrips, even a country road. At sea, it can be handled by small, fast assault vessels, easily converted cargo ships and low-cost "pocket carri-



HOW PCB PRODUCES SUPERSONIC THRUST



Modified Harrier, called the AV-8SX (top), will test feasibility of using new Plenum Chamber Burning (PCB) to give supersonic thrust. Diagram above shows Rolls-Royce

Pegasus engine divided into two halves. Lower half represents current subsonic powerplant without PCB. In upper half, more fuel is burned in plenum chamber

ahead of main combustion stage. This raises exhaust-gas temperatures in two front nozzles to a sizzling 2,417° F., boosting thrust to supersonic Mach 2 range.

ers" without all the catapult launchers and arresting gear that conventional jets require. Moreover, with jump jets, a carrier doesn't have to alter course to put its deck into the wind as it does to launch and recover today's aircraft, and landings and takeoffs can occur simultaneously, without one interfering with the other.

A hotter Harrier

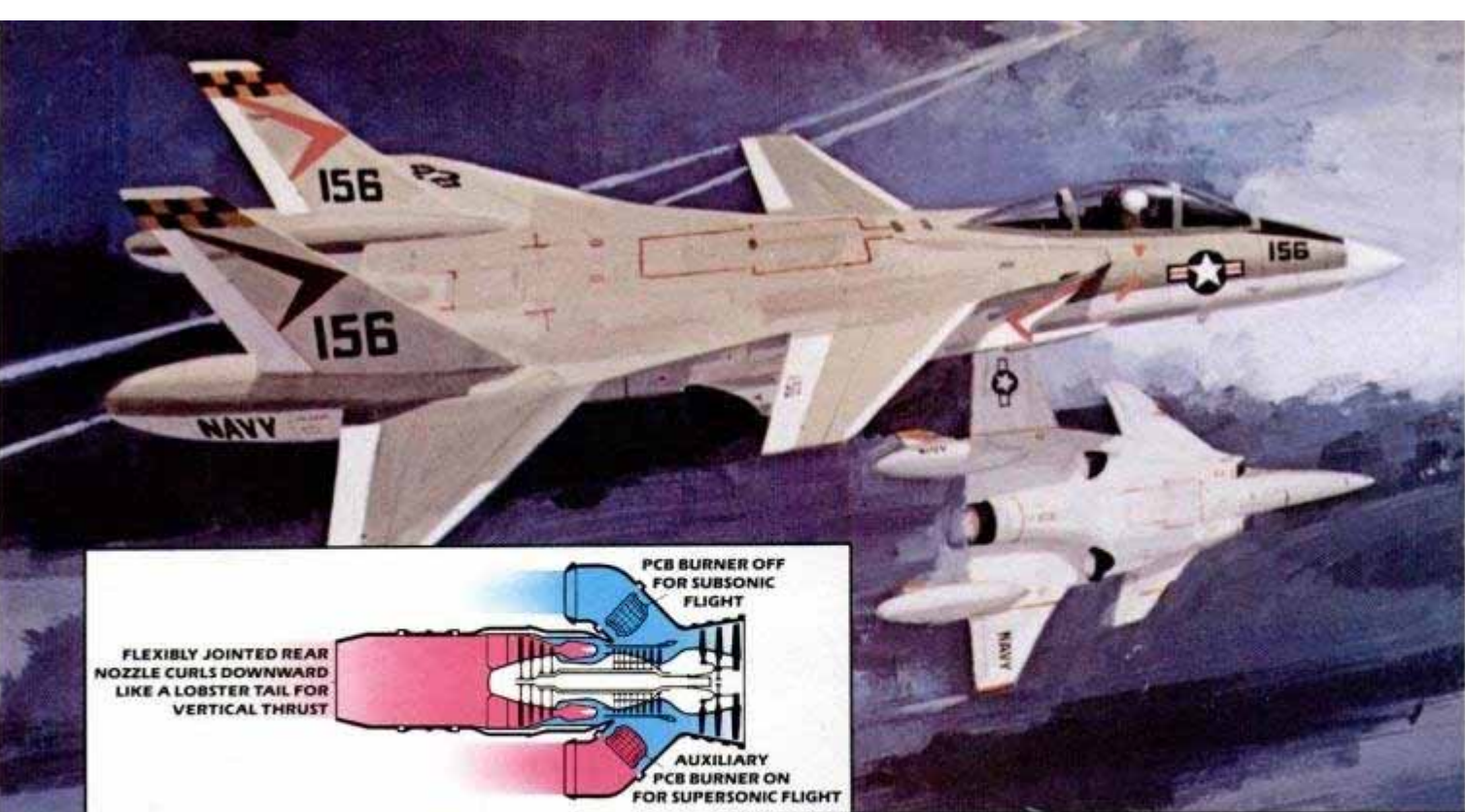
Our newest jump jet, the AV-8B Harrier II developed by McDonnell Douglas, is a greatly improved derivative of the earlier British AV-8A that could become a steppingstone to an even

more awesome supersonic version. Although it's powered by the same Rolls-Royce Pegasus engine as the AV-8A, it has twice the range and payload capacity due to a larger high-lift wing, is considerably more agile in combat, and carries advanced avionics that give it new all-weather capability as a deadly ground-attack fighter/bomber.

A sophisticated laser-guided fire control system automatically calculates the range, bearing and slant angle of a target, tells the pilot what course to fly, then releases the bombs or missiles at the precise instant to assure a hit. A hands-off, blind landing system also

enables a Harrier pilot to set the plane down in the vertical hover mode in any weather, day or night, without his touching the controls.

The Pegasus turbofan engine is a marvel of engineering ingenuity. It consists of a three-stage low-pressure compressor or fan, an eight-stage high-pressure compressor, and two separate two-stage turbines turning in opposite directions on concentric driveshafts. One turbine drives the first compressor clockwise, while the other turbine drives the second compressor counterclockwise. The reason for this tricky counterrotation is to cancel out gyro-



Dramatic Rolls-Royce concept for a supersonic V/STOL jet (above) features movable canard foreplanes, plus a new three-nozzle engine to replace Harrier's current four-nozzle arrangement. Auxiliary PCB

burners in front nozzles provide added thrust for supersonic speed, but can be shut off during subsonic flight to save fuel. Advantages: simpler engine layout, lighter weight, better-balanced thrust control.

scopic forces that would make the Harrier difficult to control in the delicate hover mode if all engine parts were spinning in the same direction.

Four swiveling nozzles, two on each side of the engine, direct the pressurized exhaust gases up or down in a process known as thrust vectoring. Tilted downward, the nozzles produce lift for vertical landings and takeoffs. For forward flight, they swing backward to provide horizontal thrust.

Thrust vectoring can also be used in aerial combat, permitting abrupt changes in speed and direction to fool an enemy. By applying downward thrust in flight, a Harrier pilot can push his plane into a tighter turn to intercept a faster quarry, or he can use reverse-thrust braking to force an unsuspecting pursuer to overshoot him and suddenly become the target instead of the attacker. Such deceptive tactics enable a Harrier pilot to outfly a normally superior opponent.

Next step: supersonic

The new AV-8B Harrier II, now in production, is scheduled to go into service with the U.S. Marines next year. Meanwhile, the search for an even more potent supersonic version is already under way. The U.S. Navy and Air Force, until recently lukewarm to the V/STOL idea, are now eagerly eyeing the prospect of a supersonic jump jet that could eventually fulfill all the functions of conventional fixed-thrust fighters, both on land and at sea, without the need for 2-mile-long runways and 4-acre flight decks.


Fortunately, supersonic capability may not be as far off as it once seemed. Rolls-Royce is working on a method,

(Please turn to page 96)



Modified Air Force F-15 (above) is fitted with swiveling thrust nozzles and canard mini wings to test effectiveness for STOL operation. Though it can't move straight up and down like true V/STOL jet, it lands and takes off

in half the distance normally required. At the top is Boeing's proposal for advanced supersonic STOL fighter. It also has swiveling thrust nozzles and canards, plus recessed missile racks to lessen drag.



Computers, because of their "user-friendly" nature, are vulnerable to break-ins.

CATCHING

COMPUTER CROOKS

Experts are scrambling to keep up with a growing number of keyboard crooks who swindle \$300 million a year.

BY DENNIS ESKOW, Science Editor, AND LEE GREEN

Neutral Switzerland and neighboring France are embroiled in a war of words that may end in the downfall of the famous numbered Swiss bank account system. And it's all because of a small group of computer hackers and a team of French internal revenue officials who committed what Swiss diplomats have called "an outrageous computer crime." Computer crimes have been with us since computers. But with the advent of personal computers in the past five years, electronic crime has gone from a trickle to a torrent.

First word of the French *coup de computer* emerged late last year when officials in Paris sent out thousands of tax notices to citizens who had made cash deposits in what they had believed were secure numbered Swiss accounts. The French government, already dealing with a growing computer crime phenomenon, apparently decided to enlist the ser-

vices of a group of teenage computer buffs—hackers to us Americans—to help them break into the Swiss banking system. The youngsters made random phone calls to telephones in Switzerland based on information gathered by the French tax sleuths. Within days they contacted several Swiss banking computers. And within weeks, having used trial and error to figure out the computer codes, they gained access electronically to the accounts of people with addresses in France.

Many of the cases are still in litigation, and the affected banking institutions have since changed their software. But the damage has been done. Computer crime is the newest kid on the block, be it in France, Switzerland or America. So rapid is the growth of high-tech burglary that the FBI only this year began keeping statistics.

Still, most experts agree that computer crime is a lusty baby, siphoning \$300 million a year from the

PHOTO BY LAYMAN/NEWMAN

In the box-office hit *War Games* (right), the Pentagon was baffled by a hacker who broke into a computer and nearly started World War III. A real-life preventive measure (below) uses fingerprints as a "pass key" into the system. TV's *Whiz Kids* (bottom, right) are good-guy hackers.



national economy by even the most conservative estimate.

The crimes range from hackers breaking into computer networks to bank robbers electronically transferring funds to their own bank accounts. Both the hardware and software industries are racing to stay ahead of the computer crooks, but the task of defending against intruders is made extremely difficult by the very nature of computers. They're supposed to be accessible, or user-friendly, as their creators like to say.

Computer crime surfaced in a small way in 1967 when a New York bank fired and prosecuted a vault trustee who had been using the institution's computer to shave fractions of pennies from interest on long-term accounts. His take reportedly exceeded \$100,000. But back in the 1960s and early '70s such crimes were isolated. With the advent of personal computers that can get on-line to most any system with the use of a telephone connection (modem) the computer crime industry has burgeoned.

To combat computer criminals, programmers have been seeking the perfect secret code, and hardware manufacturers have produced machines that take fingerprints of the user, switch phone lines and even trace calls. The

FBI, which has cracked a couple of sensational computer cases, has also gone to work. In some instances they've even recruited computer hackers to help catch electronic burglars, according to some reports which the agency doesn't deny.

Last year, the FBI broke up a ring of Milwaukee area hackers who had discovered a way to bring a Federal Energy Department laboratory's system on-line. In addition to several colleges and hospitals, the "414 gang" (so-named for the Milwaukee area code) broke into a computer at Los Alamos National Laboratory, where sensitive work is done on nuclear fission. Did the FBI employ teenage hackers to help arrest the gang members?

"I can't comment on any such reports," replied Tony Adamski, chief of the FBI's Financial Crimes Investigation Unit. "It's an ongoing case." But he wouldn't deny that the FBI has used and still uses young hackers. "With computers, as with anything else, we go to people who have the information," he said.

The 414 gang, apparently inspired by last summer's box-office hit movie *War*

Games, reportedly started its illicit computing on a lark. It doesn't take much expertise to perform the break-ins they accomplished. To get into a computer network, they would call telephone numbers randomly, using telephone prefixes listed in the book. By varying the last four digits in a phone number, such computer burglars frequently stumble onto a system, sometimes a secret system.

Hitting the password

Once they reached a computer, it was a matter of trying scores of passwords until they hit on the right one to open electronic files. Computer passwords can be given in the form of numbers or words. In either case, a bright operator, with a hint at the type of work being done at a particular institution, can often come up with the code.

Still, many systems try to make themselves accessible and only somewhat hidden. In one case, a vice-president at a New York area technical college told us he was fooling around with his personal computer one night when he stumbled onto a research computer at a West Coast university famous for its



PHOTO BY NORM SCHINDLER, UCLA

TV viewers of the 1984 Rose Bowl saw a great computer prank: Cal Tech students tapped into the Rose Bowl scoreboard (left) and changed team names from UCLA and Illinois to Cal Tech and MIT. MicroSentry (below) can divert an unauthorized computer entry and trace the call to the intruder's terminal. Early form of system protection (bottom, far left) used a simple combination of letters as a code. Computer goes out of service after the third illegal attempt to gain access. Encryption/decryption codes (bottom, center) let you log onto the computer easily, but display will be garbled without a secret code.



PHOTOS BY TOM CRISSINGER



work in computer technology. "On my screen came the identification. It told me I was in the school's main computer system and asked for a password," the technical college officer says. "I tried a few and kept getting the message, 'Invalid Password, try Again.' On the third pass, I got the message, 'Wrong Password—Need Help?'"

"I asked for help, and within a few minutes, the computer showed me how to gain access to its files," he said. "I took myself off-line quickly."

The most vulnerable of today's sophisticated systems are the large networks. Computer terminals located in several different places are tied to a central computer by telephone lines, which have never been tightly secure. A user with sophisticated software and a telephone modem can reach such computers by turning on his workstation and calling telephone numbers. Given some basic knowledge, a bit of inside information and a larcenous personality, any sharp user can get into computer crime.

The defenses against such crimes can be broken down into four broad categories: physical security, access control, transmission security and encryption/decryption (or coding/decoding).

Physical security is the simplest and cheapest form of computer protection. It starts with locking up computers, tapes and disks, and hiding printed matter that could help a criminal. The Maine Manufacturing Co. sells a large steel enclosure for a terminal. The Anchor Pad Co. makes a mat placed under

the computer. With a patented adhesive, the mat holds the computer to a desk and it takes 5,000 pounds of force to remove the machine. Good physical security is a basic part of any computer security system.

Access control is probably the most common approach to keeping the wrong fingers out of the computer cookie jar. The most prevalent access control is the password, such as the one you use to get into your electronic banking account. The problem with such systems is that passwords are often easy to guess. But hardware and software manufacturers are working furiously on that problem.

The Fingermatrix machine, made by Fingermatrix Inc. of North White Plains, N.Y., eliminates the possibility of gaining access simply by learning a password. When someone tries to log on to a computer terminal using this system, a display panel on an attached Fingermatrix box asks him to enter an identification number and then place a finger on the device's scanner. The fingerprint is "read" by a laser scanner. If your fingerprint matches that stored in the system under the ID number, a connection to the computer is made.

Call-back technique

Other new systems use a call-back technique. Digital Pathway's Defender II provides a specific password for each phone tied into a system. Call the main computer, give your ID number and the system tells you to hang up. Once the connection is broken, the computer calls

you back at a number matched to your ID number.

Such a system might have prevented one not-too-celebrated crime from happening in New York in 1981. A Board of Education computer systems manager was charged with theft of services for using a school computer system to handicap horses. He worked on his system for well over a year before getting caught. An access control system likely would have stopped him, or at least clearly identified him, early in the game.

Transmission security is a highly sensitive area, one which most experts don't care to discuss. Since the invention of the telephone, both the cops and the robbers have come up with a plethora of ways to invade a phone line. Even when detection devices alert a user that his system is being invaded, it's difficult to trace the invasion to its source.

The security chief for one lab, who asked not to be identified, says switching systems often are used to trace an unauthorized call. When an outsider tries a bad password on a system, he's told to try again. Sometimes, authorized users forget their ID code or make a typographical error in entering the ID. The user gets a second chance and, if he's wrong again, the system switches

(Please turn to page 98)



The Sierra Designs Flashlight II tent weighs 3 lbs., 2 oz., and the MSR Firefly stove is a scant 15 oz. At the base of the tree are (left to right): Alpenlite Superlite pack at 1 lb., 8 oz.; Tourlite pack at 1 lb., 2 oz.; and the Warm II down jacket from Marmot Mountain Works at 1 lb., 4 oz.

CAMPING—GO LIGHTLY

Now you can hit the trail with a load off your back.

BY BOB WOODWARD; Photos by Ed Zak

The latest lightweight gear takes as much as 15 pounds off your back without sacrificing comfort when you arrive in camp. Some backpackers and rabid hike-in campers have long been so weight-conscious they cut half the handles off their toothbrushes and do without many of the comforts of wilderness life. They have the right idea, but many campers don't know how much lighter—and better—some of the latest ultralight gear has become. It can shave pounds instead of mere ounces from your load.

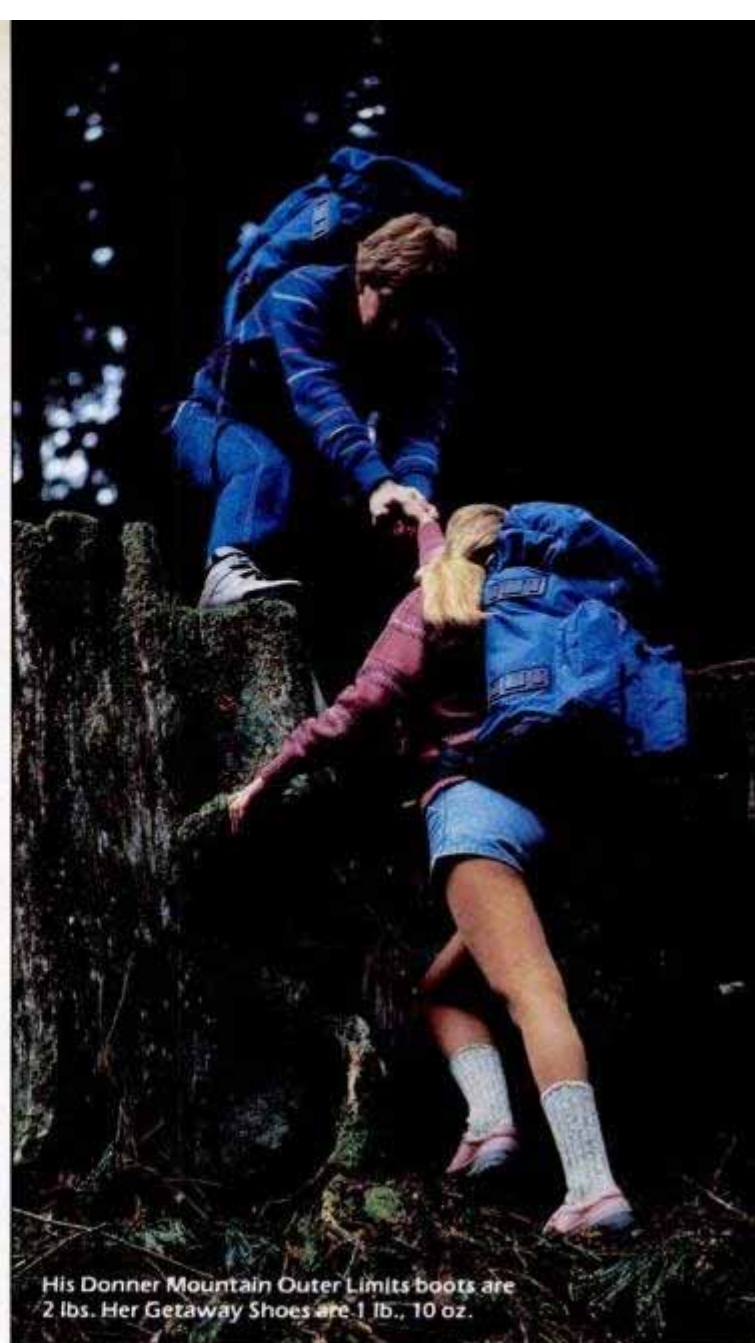
Improvements in fabrics, design, construction and materials make the canvas tents and heavy blankets of the past obsolete. Almost every piece of camping gear has sweated at least half of its one-time weight to make your excursions less work and more fun. You not

only have to lug less, but can live better when you get there.

Paying more for less has never been a favorite American sport, but in buying ultralightweight camping gear, you really can achieve this architectural ideal—less is more. If it weighs less and works as well or better, it is indeed worth more.

Take tents. The two-man A-frame canvas pup tent of the '50s weighed about 12 lbs. The Army's shelter-half of that period was so heavy each man carried only half his tent—no buddy, no shelter. And even when buttoned together, it had no floor. Then came the 6-lb. nylon mountain tent of the '60s and '70s, which was half the weight for a whole tent. Now, in ultralights,

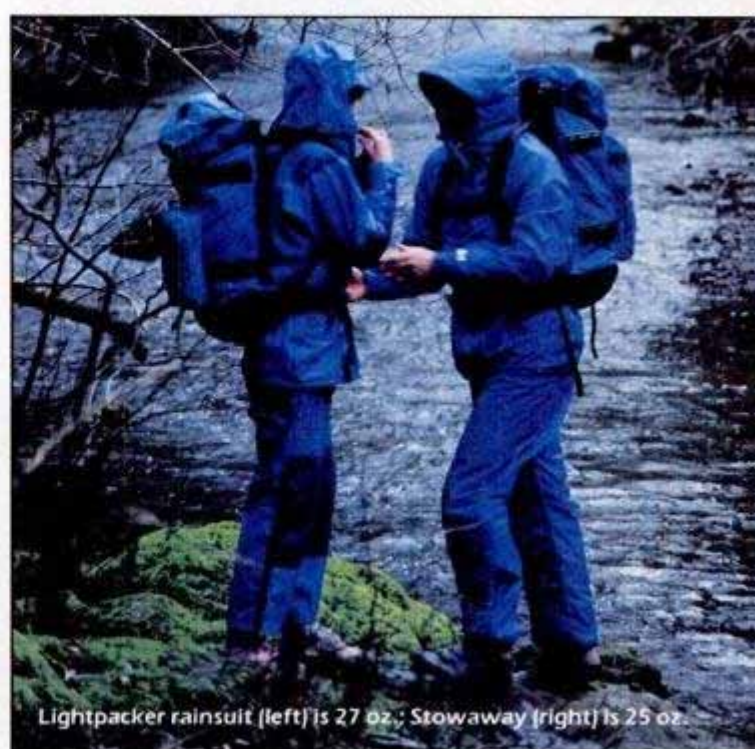
(Please turn to page 100)



His Donner Mountain Outer Limits boots are 2 lbs. Her Getaway Shoes are 1 lb., 10 oz.



Northface Dragonfly tent is 5 lb., 5 oz. Her Lifa Vermont top is 4.5 oz.



Lightpacker rainsuit (left) is 27 oz.; Stowaway (right) is 25 oz.

Launch Your Experiment On The SPACE SHUTTLE

It's T-minus three months and holding. And the cargo bay door is still wide open on the Space Shuttle. Due to changes in the NASA container configuration, *Popular Mechanics'* Space Shuttle competition (see *Put Your Own Project On The Space Shuttle*, page 102, Apr. '83) has been reopened. And your project could be launched into orbit sometime next year.

You don't need an advanced degree to join our Space Shuttle competition. Just a little imagination. If your idea wins first prize, you'll travel to the launch site, mission control and the landing site courtesy of the Bushnell Div. of Bausch & Lomb. The winner also will receive Bausch & Lomb's Criterion 4000 telescope. Second prize is a Celestron C-90 spotter scope. And third prize is an Edmund Scientific Astroscan telescope.

Phase 1

We've already received hundreds of experiment proposals from our first call for entries last year. Those are being held by the competition judges at the New York Institute of Technology. But if you missed the last deadline, you've got one more chance. The competition is in two phases. In the first, you dream up an experiment and send it to: Shuttle Competition, *Popular Mechanics*, 224 West 57th St., New York, N.Y. 10019. The first-phase entry should be typewritten or block printed on a single sheet of white paper. Your name and full address should be centered at the top of the page.

PM's Shuttle container can be launched as early as the end of 1985. Your proposal should call for an experiment or experiments that can fit into a 5-cu.-ft. canister. Total weight of the



A canister like the smaller models above will hold PM's experiment.



**You design the experiment. PM builds it.
NASA sends it up. And the winner
goes to the launch.**

BY DENNIS ESKOW, Science Editor

experiment must be under 100 pounds. Don't worry about the technical details of the experiment. A graduate school team at New York Tech will supervise construction of our rig. Just keep in mind some general constraints. If your experiment involves plant or animal life, you should explain how life would be sustained in the airlessness and weightlessness of the cargo bay. The experiment should be able to withstand temperatures up to 200°F and gravitational forces of 4g's.

No project involving lithium batteries will be accepted. Projects using structural plastics or composites will be subject to outgassing, and your proposal should take that into account.

Your entry must be postmarked by midnight, Sept. 15, 1984. If you already have entered and want to take advantage of the larger cargo container, you may submit a second entry.

Phase 2

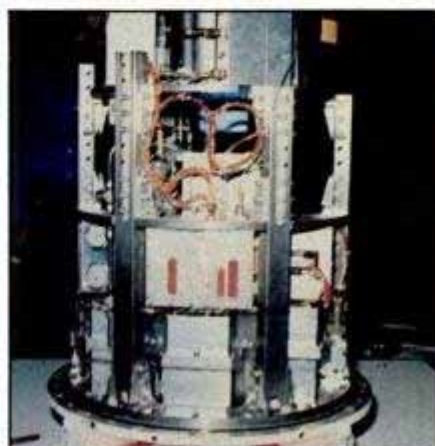
The top 25 competitors from the first phase will be notified in late October and will be provided with more details on cargo bay conditions. Each finalist must then write an expanded proposal to a maximum of 10 pages, including illustrations. All entries in both phases become the property of *Popular Mechanics*, which reserves the right to print all or part of the entry and the author's name. Devices designed for the launch may be patented by PM.

The second-phase proposal must be submitted to PM postmarked no later than midnight, Feb. 15, 1985. Winners will be chosen by a distinguished panel on Mar. 30, 1985. **PM**



First prize in the contest is a trip to the launch and Criterion 4000 telescope.

PHOTO BY JAMES L. LONG ASSOCIATES



A Japanese experiment (top) videotaped snow crystal formation. A West German experiment (above) called for low-voltage melting of metal, but the unit malfunctioned.

A Look At The Competition

PM's Space Shuttle experiment will be launched in a canister as part of NASA's Getaway Special (GAS) program. Thus far, NASA has flown over 20 GAS payloads, including pure science and practical technology experiments.

Japanese experimenters chilled their GAS canister and ran a fan in it to simulate wind. An internal injector added moisture to the chamber and a video camera photographed the formation of snow crystals. They appeared to be spherical with patterns or facets on their surfaces.

West Germany's space agency sponsored a GAS payload with some practical do-it-yourself material inside. A small X-ray camera was installed to examine various samples of metal as they melted under the heat of a low-voltage electric oven. Unfortunately, the battery pack powering the system malfunctioned and the experiment didn't come off. The West Germans will get a second chance next year.

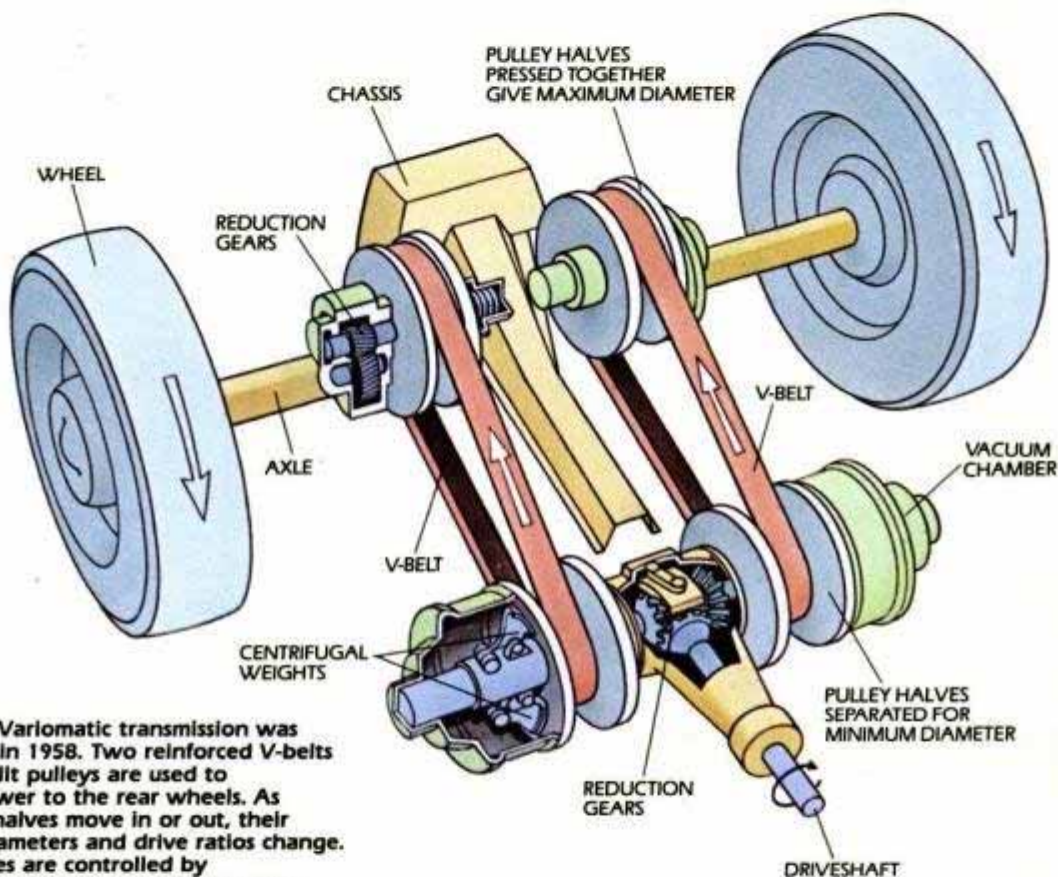
Other GAS payloads have included samples of quick-sprouting seeds to measure the effect of weightlessness on plant growth, and soldering small strips of metal in orbit.

—Dr. Herbert Fox
New York Institute of Technology

Get Ready For A New Kind Of Automatic Transmission

An overgrown snowmobile transmission with belt drive may propel your next car.

BY MICHAEL LAMM, West Coast Editor



DAF/Volvo Variomatic transmission was introduced in 1958. Two reinforced V-belts and four split pulleys are used to transfer power to the rear wheels. As the pulley halves move in or out, their working diameters and drive ratios change. Pulley halves are controlled by centrifugal weights and engine vacuum.

What would you say to an automatic transmission that gets up to nine percent better gas mileage than a five-speed manual? One that also delivers better acceleration above 40 mph? One that never bumps or jerks when shifting, that's simpler, smaller, lighter, and will eventually cost less than a conventional automatic?

That transmission is here today. It's the result of new technology wrapped around an old idea. The continuously variable transmission (CVT) is coming on strong with at least four overseas automakers, and we'll soon be seeing it in Detroit cars, too.

Volvo already sells a CVT in its Dutch-built, subcompact 340 series. The Volvo 340 isn't sold in America, but it might be in the future.

Fiat recently announced a CVT called the Unomatic. Ford of Germany will put a CVT into production shortly that's similar to Fiat's. The similarity isn't surprising, though, because the transmissions were developed jointly. Fiat and Ford worked together on

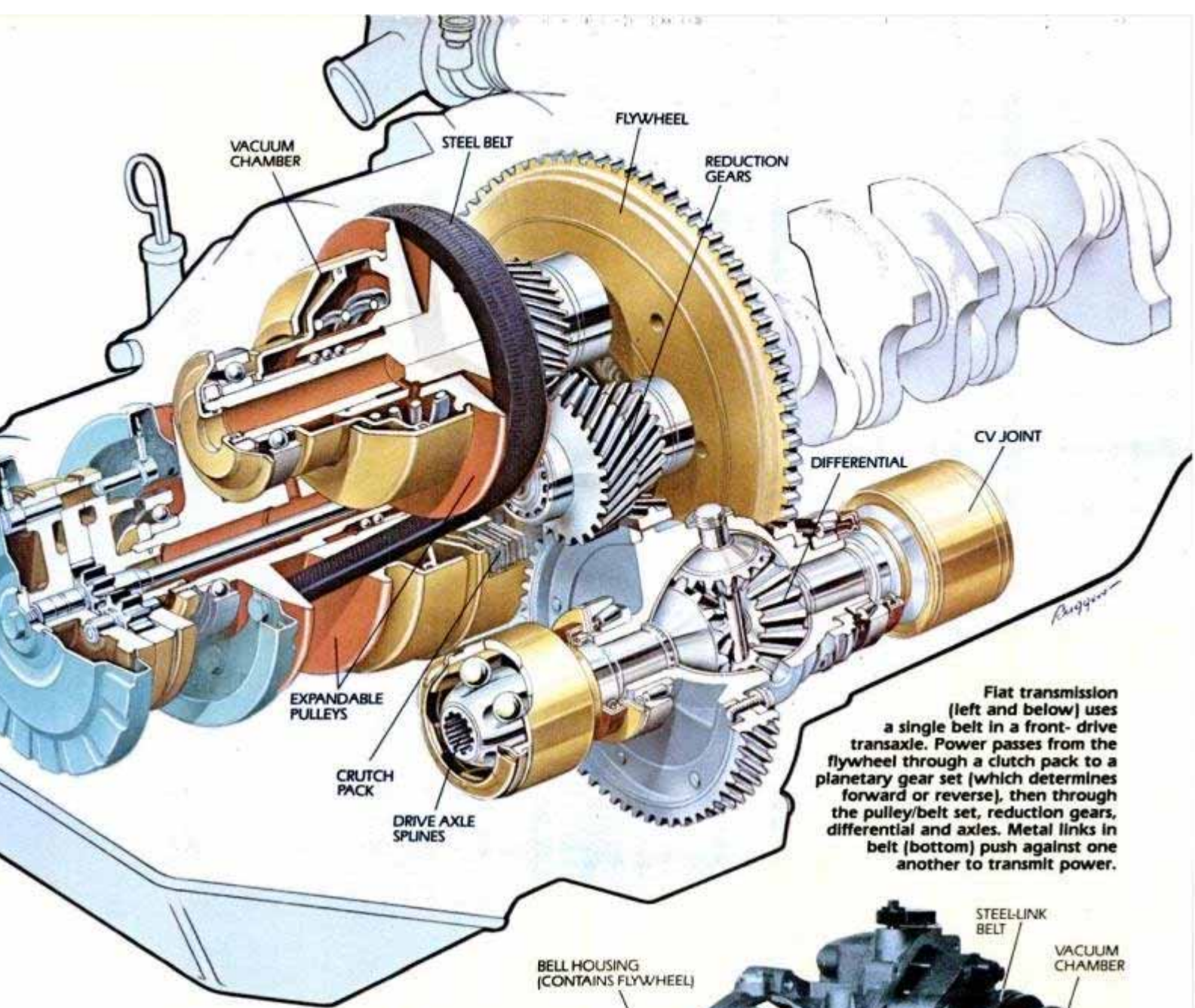
the design, and Ford plans to manufacture CVTs for Fiat, among others.

Not that the Ford/Fiat engineers worked alone. Development took place under the experienced eye of a Dutch firm named van Doorne's Transmissie BV. Back in 1958, the van Doorne family launched the tiny DAF automobile and gave the world the Variomatic CVT. That same basic transmission survives today in the Volvo 340.

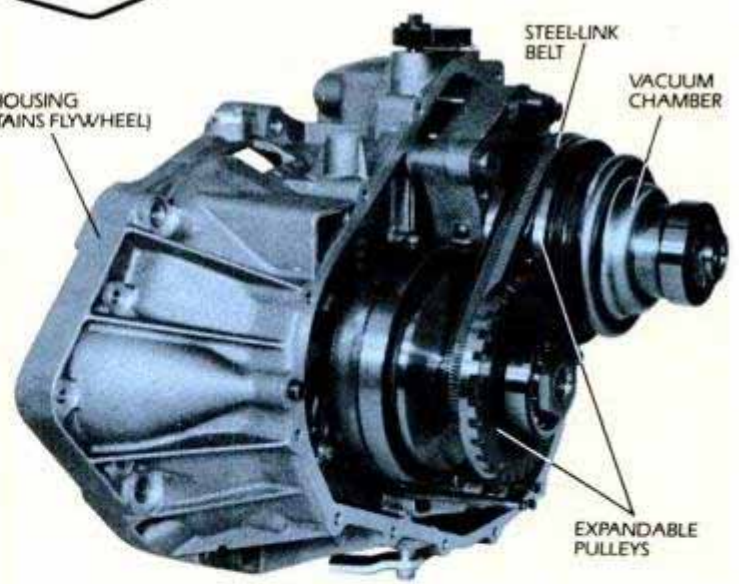
Fiat will be selling its Uno-matic by the time you read this. Ford hopes to introduce a more sophisticated, microprocessor-controlled version of this same CVT, dubbed the CTX (for Continuously variable TransaXle) next year in European Fiestas and Escorts.

The Fiat/Ford CVT differs mechanically from the Volvo type in several ways. For one thing, the rear-drive Volvo 340 uses two steel-reinforced rubber belts and two sets of split pulleys, each unit driving one rear

Illustration source material: *Automotive Engineering*



Flat transmission (left and below) uses a single belt in a front-drive transaxle. Power passes from the flywheel through a clutch pack to a planetary gear set (which determines forward or reverse), then through the pulley/belt set, reduction gears, differential and axles. Metal links in belt (bottom) push against one another to transmit power.

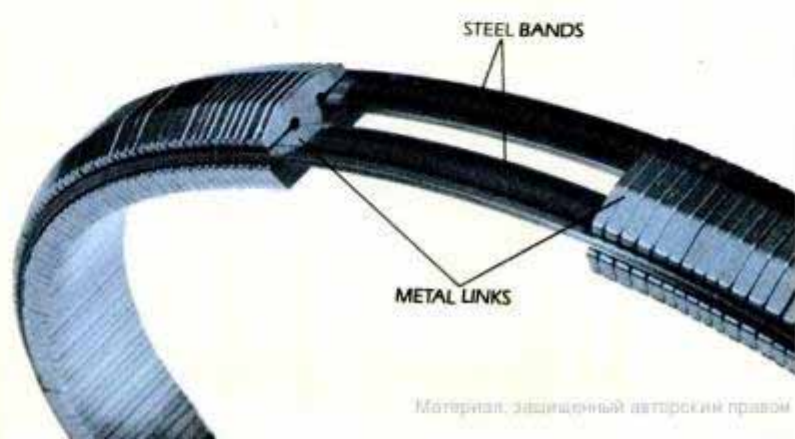


wheel. The Fiat/Ford CVT, in contrast, uses a single steel belt, only two pulleys, and is designed specifically for front-wheel-drive cars. The Fiat/Ford CVT fits into the same space as a standard five-speed gearbox.

General Motors is also experimenting with a steel-belt CVT for its small Opel Corsa and Nova models. GM hopes to be in production by 1986. In addition to Opel, General Motors' CVT might find its way into the upcoming Chevette replacement (T-car) as well as Toyotas, Suzukis, Isuzus and perhaps other Japanese automobiles. Rumor has it that GM of France is revamping its huge Strasbourg gear plant in preparation for building a "radically different generation of automatic transmissions," most likely a CVT.

Two independent German transmission manufacturers, PIV in Bad Homburg and ZF in Friedrichshaven, are likewise experimenting with CVTs and hope to supply them to such automakers as Volkswagen, Audi, BMW and Mercedes-Benz. The PIV and ZF

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3-D More Thrilling Than Ever!

BY ARMAND ENSANIAN

Illustration by Nighthawk Studios

You'll duck for cover when you see the latest in 3-D. Twin-camera techniques, holography and 3-D television are joining the familiar Land system, which uses two polarizing filters to bring pictures to life.

3-D theory

Attempts at 3-D imaging go back to 1838, a year before photography's birthday. Sir Charles Wheatstone recognized that it's our binocular vision that lets us perceive depth. He demonstrated this with experiments based on the fact that each eye sees an object from a slightly different point of view (about 2½ inches apart). The brain combines these two views to create images of visual depth.

Wheatstone drew pairs of pictures of simple shapes, one as seen from the right eye, the other from the left. He mounted these in a device he called a stereoscope (from the Greek for "solid" and "to see"). It enabled a viewer to see each pair as a single image that showed depth. Photography soon popularized stereoscopy beyond Wheatstone's expectations.

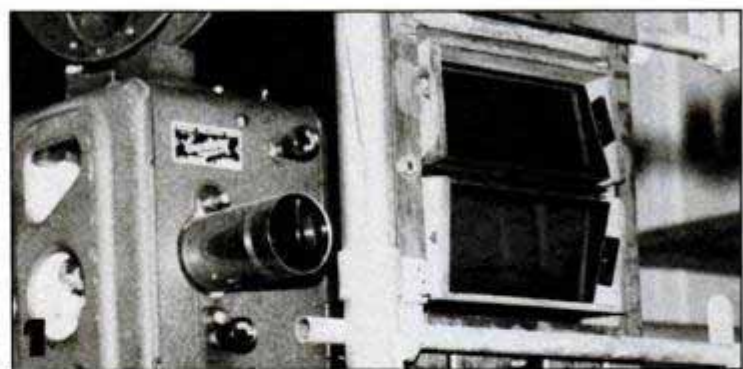
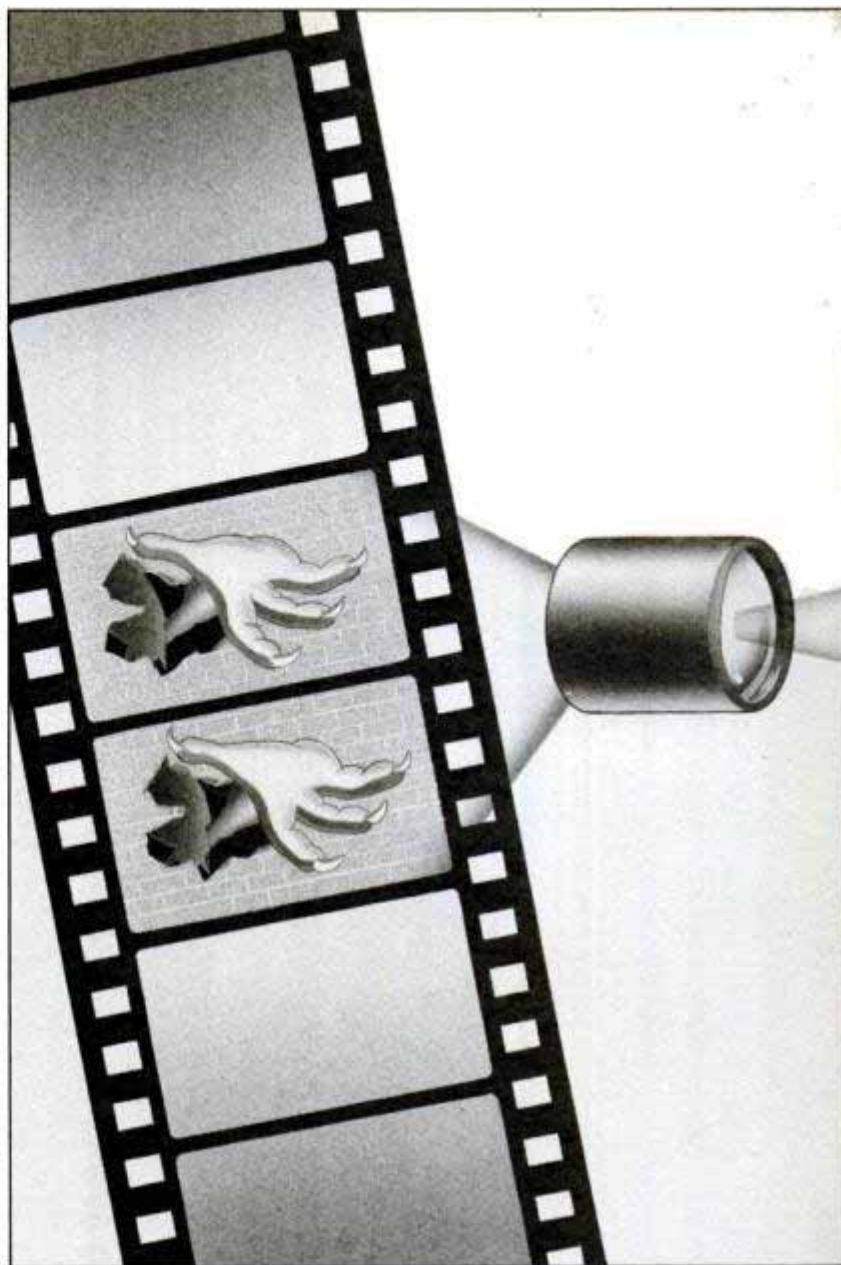
3-D movies

Stereoscopic cinema applies the same basic techniques as 3-D still photography. Actually, the first motion picture was filmed in 3-D in 1889 by William Friese-Green (yes, before Edison).

Two images of the same scene are recorded on film with matching lenses about 2½ inches apart. This interocular distance may be changed, depending on subject distance and effect desired. The pairs of images are filmed simultaneously by either two individual cameras or with a single unit using a beamsplitting device attached to the lens. The latter places two individual views either side by side on the film or stacks one on top of the other via complex prisms, as in Spacevision's Trioptiscope lens system.

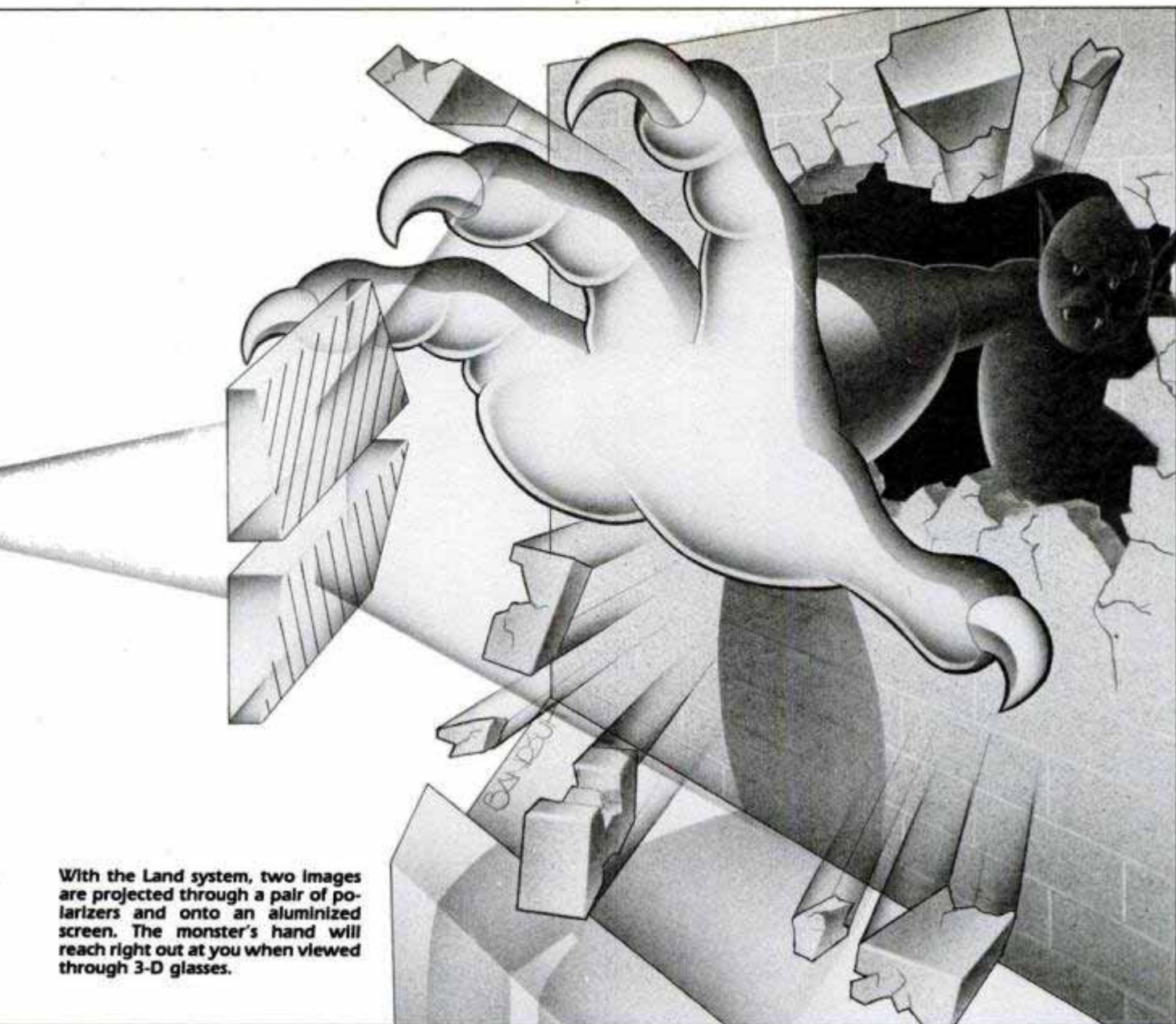
Both images are then projected superimposed

(Please turn to page 110)



THREE WAYS TO SEE 3-D

- 1** The traditional Land system requires two polarizers between the movie projector and the screen. Polaroid-filter glasses must be worn to separate images so viewer sees one in each eye.
- 2** Multiplex holograms require viewing from several angles to get the full 3-D effect. Walk past this hologram, called "The Kiss," and you see the right side of our model. She raises her hand, wafts a kiss to you and lowers her hand, then you see her left profile.
- 3** Twin video cameras are the basis for the StereoDimensional system recently announced by Stereographics Corp. for 3-D TV viewing. The drawing at far right shows the dual-camera setup. Twin-camera technique is also used for the incredible film *Magic Journeys* at Disney's EPCOT Center.



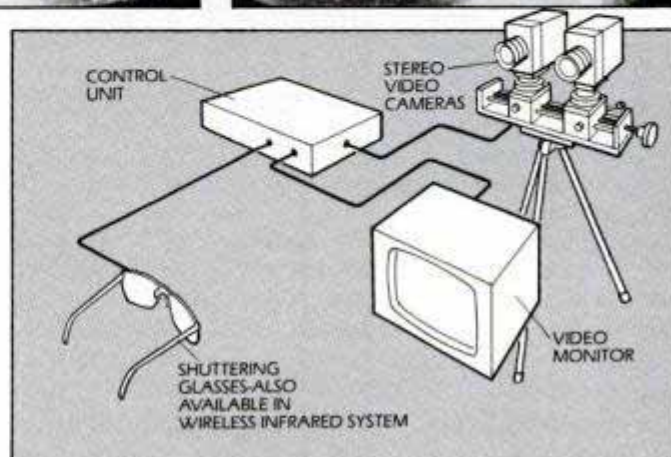
With the Land system, two images are projected through a pair of polarizers and onto an aluminized screen. The monster's hand will reach right out at you when viewed through 3-D glasses.



2



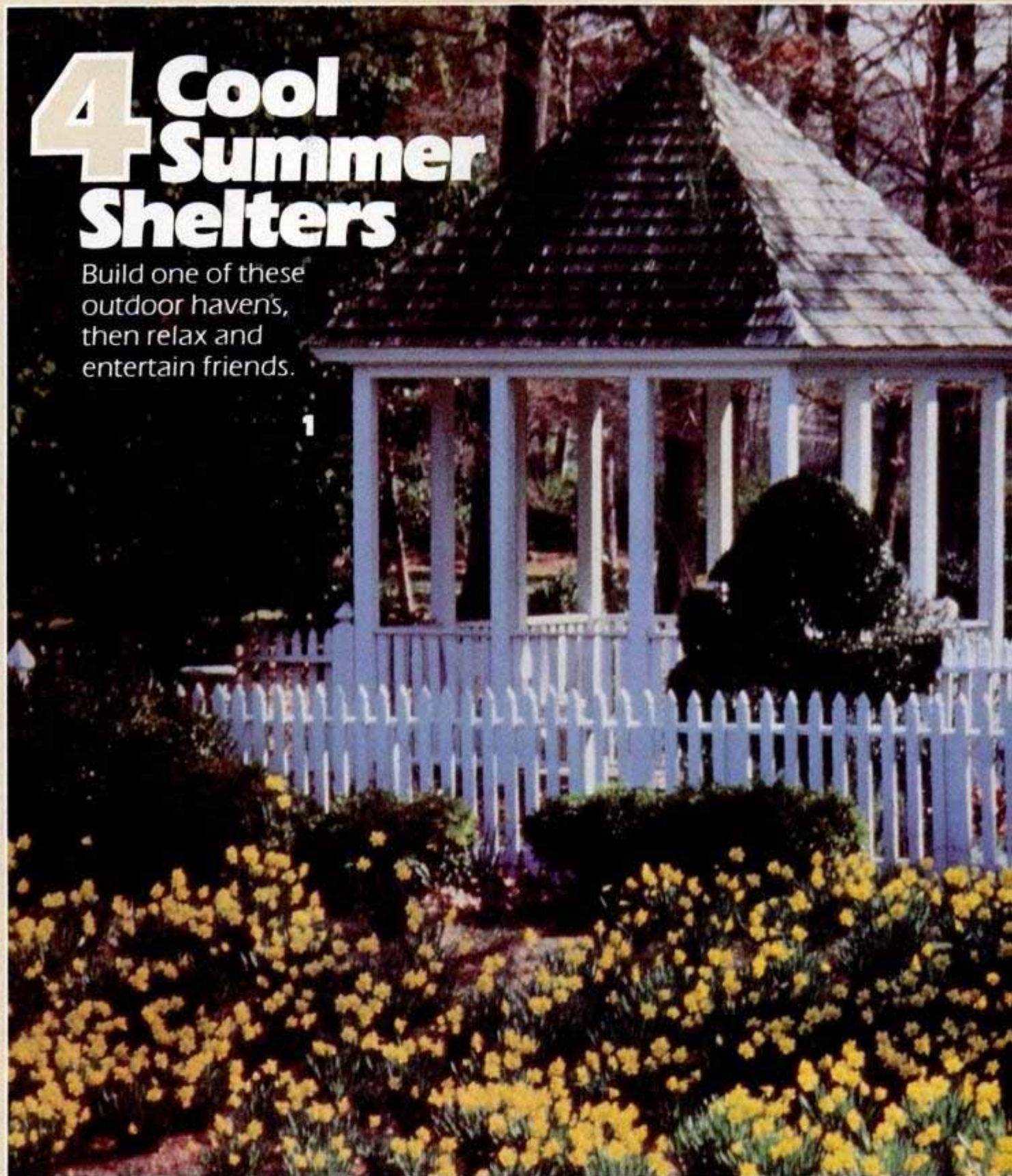
3



4 Cool Summer Shelters

Build one of these outdoor havens, then relax and entertain friends.

1

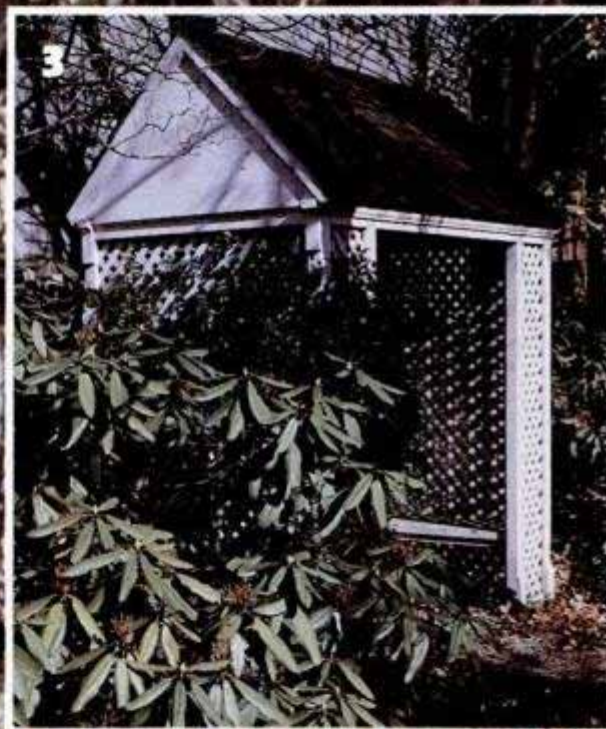
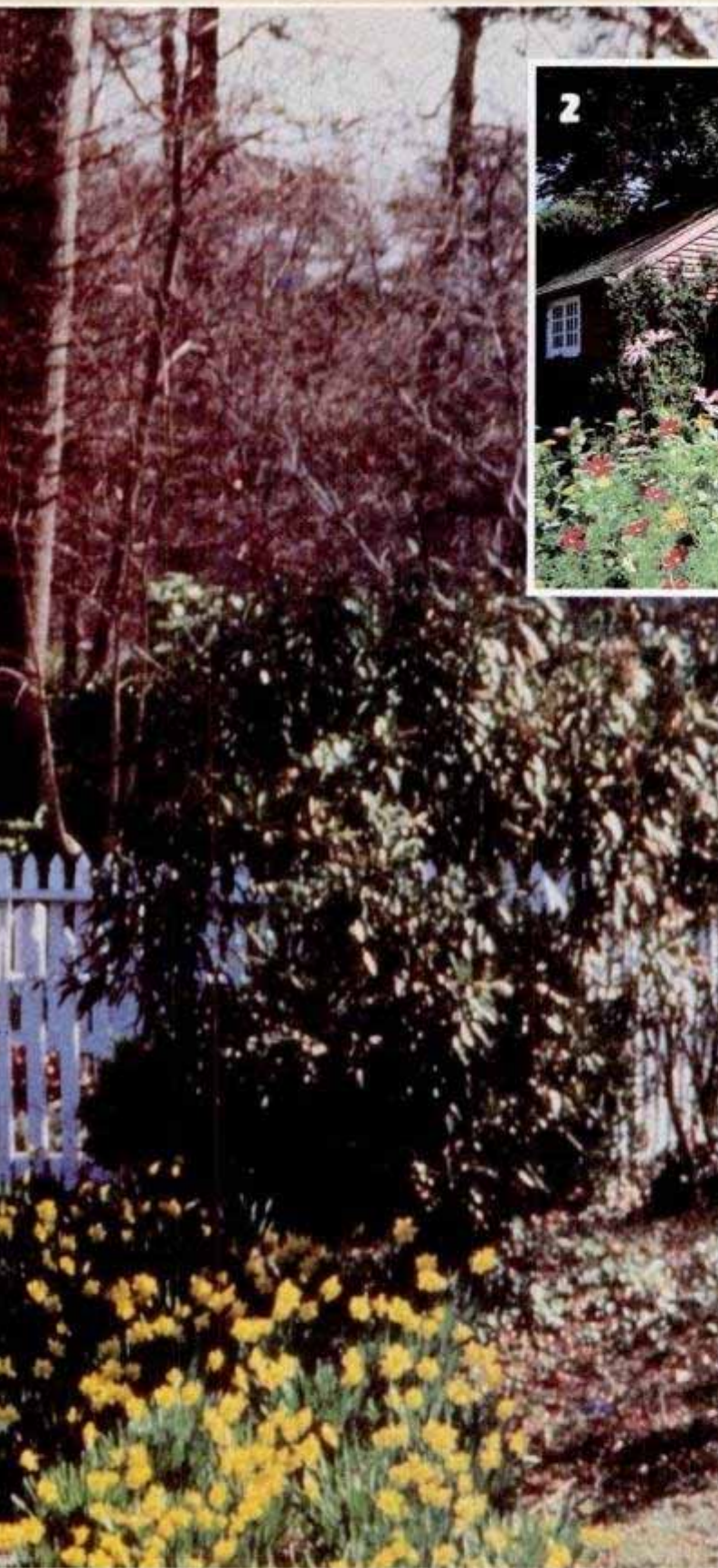


Any one of these yard structures will shield you from the hot summer sun while letting the cool breezes through. They're handsome additions to your garden, and they can serve as supports for climbing vines.

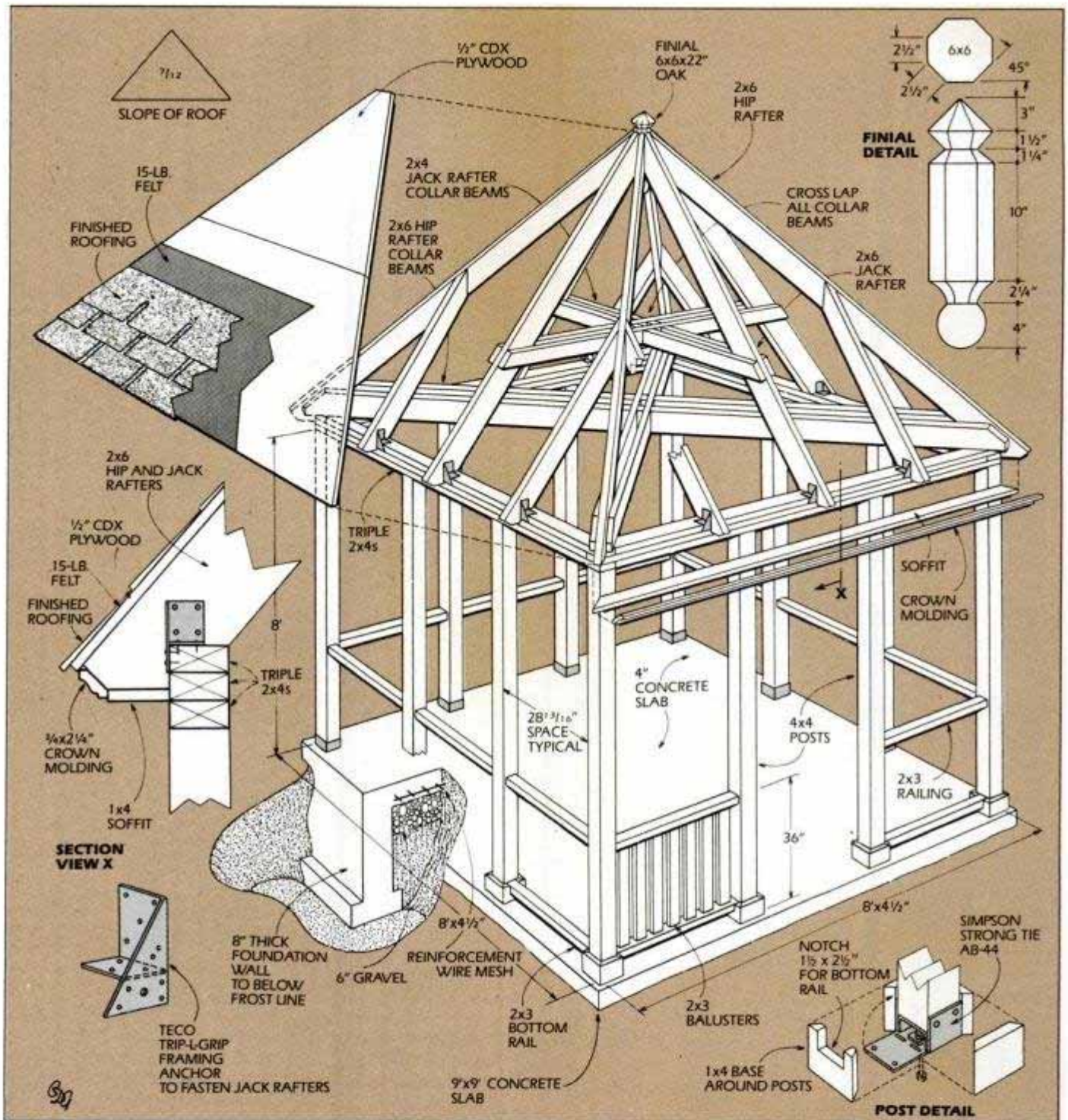
The gazebo (project No. 1) is a retreat you can use for picnics, reading or just sitting and thinking. It's also a picturesque spot to have a party. The attached

arbor (No. 2) shades one side of the house while providing a place for outdoor lounging on sunny days. The lattice enclosure (No. 3) is a play area during the day. In the evening, adults can relax within it. The arched trellis (No. 4), with its built-in bench, provides an attractive touch at the yard entry.

If a project catches your fancy, stop to consider how it will fit into your overall landscape. Consider its



- 1** This square gazebo is built on a slab. The hip roof is supported by 12 posts. A railing surrounds the structure.
- 2** The arbor, attached to the house, has notched crosspieces that are perpendicular to the rafters for added support.
- 3** Lattice walls of this enclosure help air circulate. It's a hideaway for kids by day, retreat for adults in the evening.
- 4** The open latticework of the arched trellis supports clinging vines. The structure serves to enhance the yard entry.



placement for maximum enjoyment and sun and wind protection. If the project involves excavating, know where any septic tanks, sewer and in-ground electrical lines are located.

Check the local building codes. Verify your property lines and see your property deed for possible restrictions before you purchase materials.

Any wood that comes in contact with the ground should be a heartwood that

is naturally decay resistant—for example, redwood or cedar. Pressure-treated wood designated for in-ground use is also a good choice. Other parts of the structure can be fir or pine. However, they should be painted with a good quality exterior paint or finished with another exterior finish.

Although they are slightly more expensive than galvanized nails, stainless steel and aluminum nails are preferred, since they will never rust. For overhead projects such as roofs and arbors, common nails are recommended. For closer, decorative work, such as lattice, use finishing nails. Set their heads and fill the holes with wood putty.

Use resorcinol where glue is needed,

for example, in conjunction with finishing nails. Mix a small amount at a time, especially if you are working outdoors in bright sun.

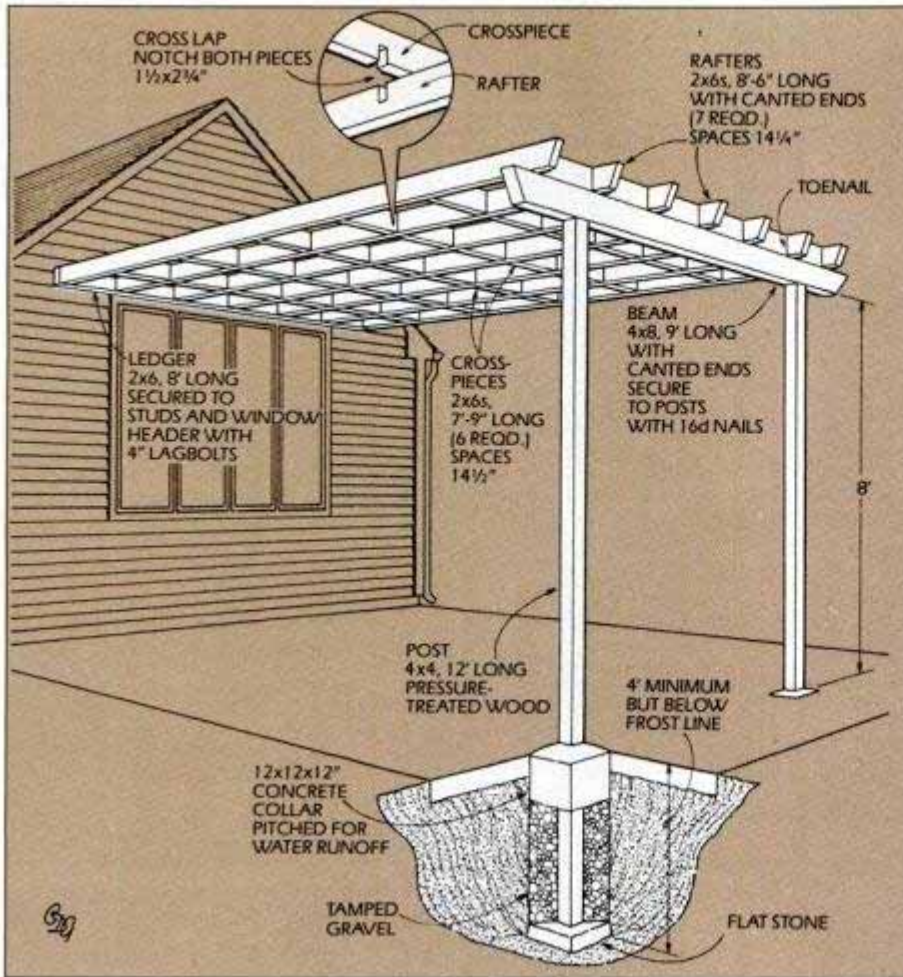
1 Garden gazebo

This gazebo is built over a poured concrete footing and an 8-in.-thick concrete foundation wall which supports a concrete slab. First, lay out the 9-ft.-square area of the slab using stakes and a mason's line. To check each corner of the rectangle for square, measure 3 ft. from the stake along one line and 4 ft. along the second side. Measure the distance between these two points. If it is 5 ft., the corner is square. If it isn't,

Text: Penelope A. Spangler, Assistant Home and Shop Editor

Photo No. 1: Pamela Harper; No. 2: Derek Fell; Nos. 3 and 4: George Talouris

Hardware: Teco, 5530 Wisconsin Ave., Suite 720, Chevy Chase, Md. 20815; Simpson Co., 1472 Doolittle Dr., San Leandro, Calif. 94577



adjust the lines until the corner is square. Repeat for the other corners.

After the corners are defined, set up batter boards for use as reference points about 4 ft. outside each corner. Each set of batter boards consists of three 2x2 stakes joined by horizontal 1x6s so that the assembly will duplicate the right corner angle of the slab area.

Transfer the strings of the slab area from the corner stakes to the batter boards. Then remove the stakes that define the slab so you can dig the trench for the footing and foundation wall. Check your local codes for needed depth and other specifications, and make arrangements for inspection if needed before pouring. In areas with sandy soil, you must use foundation wall forms.

Pour the footing and key it by making a center groove with a 2x4 about 2 in. deep so the footing and foundation wall form a good bond. Let the footing set 24 hours, then pour the wall and slab at the same time.

Preparing the slab

To prepare the slab, dig the slab excavation 10 in. deep and 2 ft. wider on each side than the planned slab. Make a form of 2x8s secured to stakes driven into the ground to define the edge of the slab. The top edge should be the proposed height of the slab. Brace the forms at least every 3 ft.

With a sharp shovel, dig the area for the foundation wall around the perimeter of the slab to the required depth. Cover the slab area with 6 in. of gravel, making sure it doesn't fall into the foundation wall area. Screed the gravel to level it. A 2x4 about 10 ft. long can do the job and will come in handy later for screeding the concrete. Install reinforcement wire mesh over the slab area, placing it on brick located about every 3 ft., so the mesh will be centered within the slab.

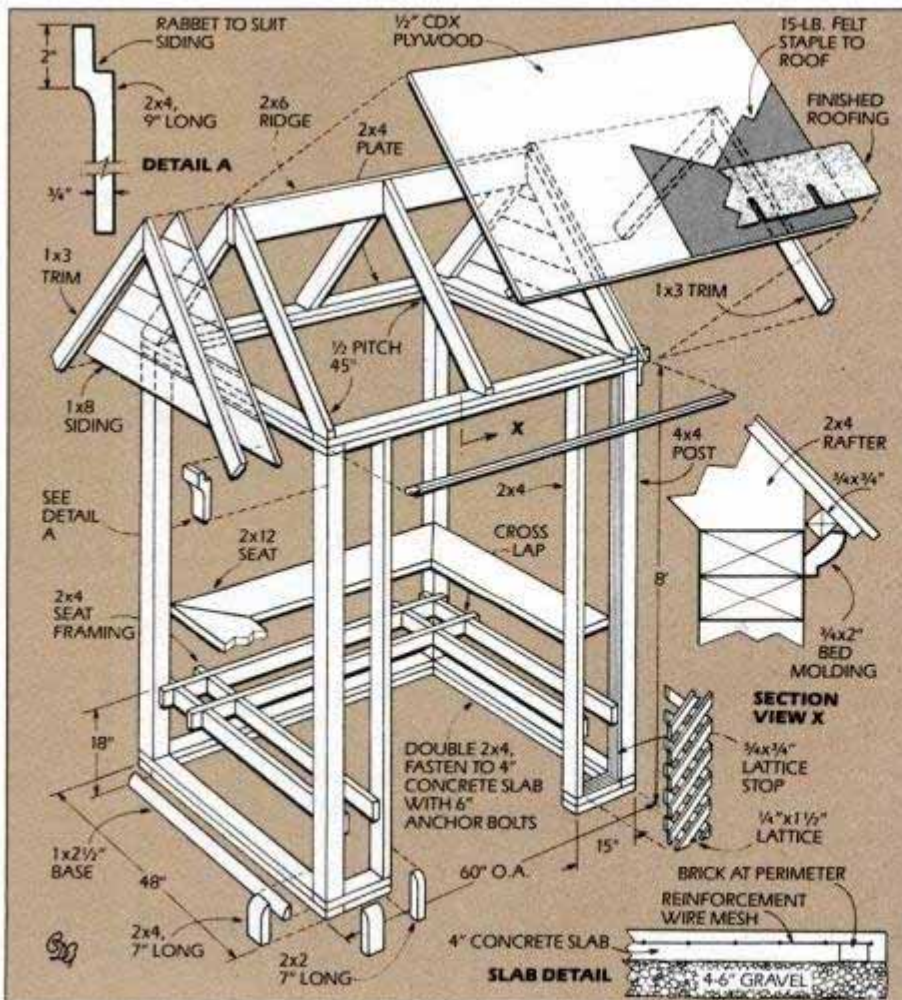
Hose off the gravel and forms before pouring concrete. Spread the concrete in place with a spade. Use a screed to compact and level the slab. Install anchor bolts for the post fasteners before the concrete hardens.

Smoothing the surface

You can eliminate lumps of large aggregate on the concrete surface with a bull float. This is a tool with a long handle and a flat working surface that's broader than a long-handled broom. It's available at masonry supply houses. Suspend a board across the forms so you can reach all areas.

After the top water has evaporated and the surface has become dull, smooth and compact the concrete with a wood trowel. Then cut 3/4-in.-deep

(Please turn to page 116)





The charming country design of the patio bench makes it a favorite for use in gardens or along paved walkways.

2 Garden Benches You Can Build

Relax on one of these easy-to-build country benches—right in your yard.

Build one or both of our outdoor benches for wherever summertime relaxation is convenient: by a garden, at poolside, under a tree, in a breezeway, or on a sun deck or porch.

The patio bench and park bench are easy to build, comfortable and weatherproof. Pressure-treated lumber should be used for both benches, but redwood heartwood (which is naturally decay-resistant) or wood treated with an exterior finish could be used as well.

Patio bench

Start by cutting six 21-in.-long legs from 2×3 stock. Then cut a 1/2 × 2 1/2 × 2 1/2-in. tenon on one end of each leg using a radial-arm or table saw. Next, cut parts for the two frames that support the seat slats of 1×4s. Assemble the frames with 1 1/2-in. galvanized finish nails and butt-joint corners. Now, screw the legs to the



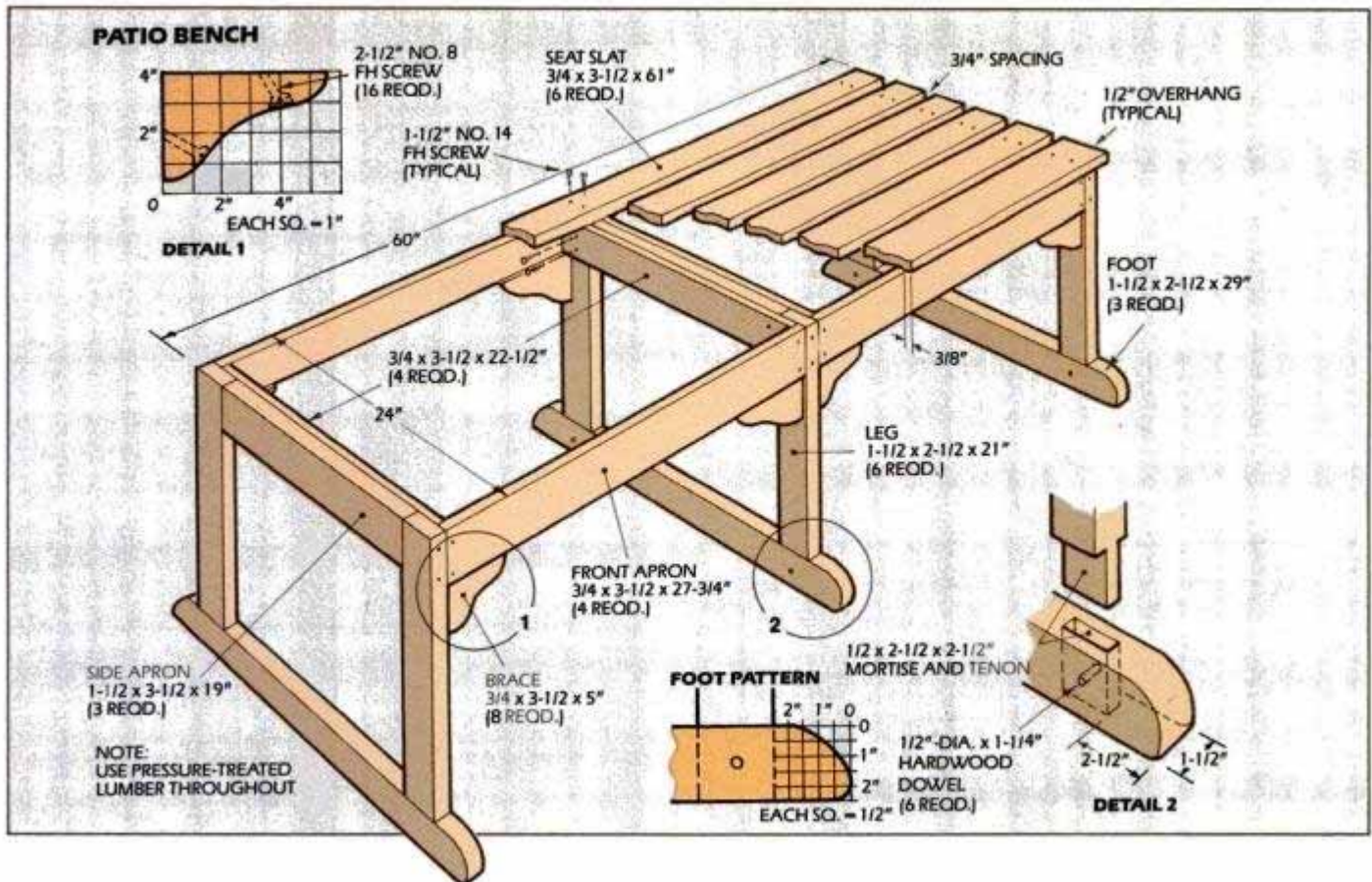
PHOTO BY DAVE SMITH

This ruggedly built park bench will see many years of service.

frames, as shown, using 1 1/2-in. No. 14 flathead screws. Keep the legs square and flush with the front apron. *Note:* Be sure to countersink and bore screw-shank clearance holes for every screw that's used in this bench.

Next, cut three aprons from 2×4 stock to fit snugly between the three pairs of legs. Attach the aprons to the 1×4 frame using 1 1/2-in. No. 14 flathead screws and waterproof resorcinol glue. The aprons hold the legs square while stabilizing the bench. *Note* that the center 2×4 apron fits between the two frames to stabilize the middle pair of legs.

Cut the three bench feet from 2×3 stock. Mark the mortise locations on the ends of each foot. Then use a 1/2-in. mortising chisel mounted in a drill press to cut the mortises. The mortises can also be made by first



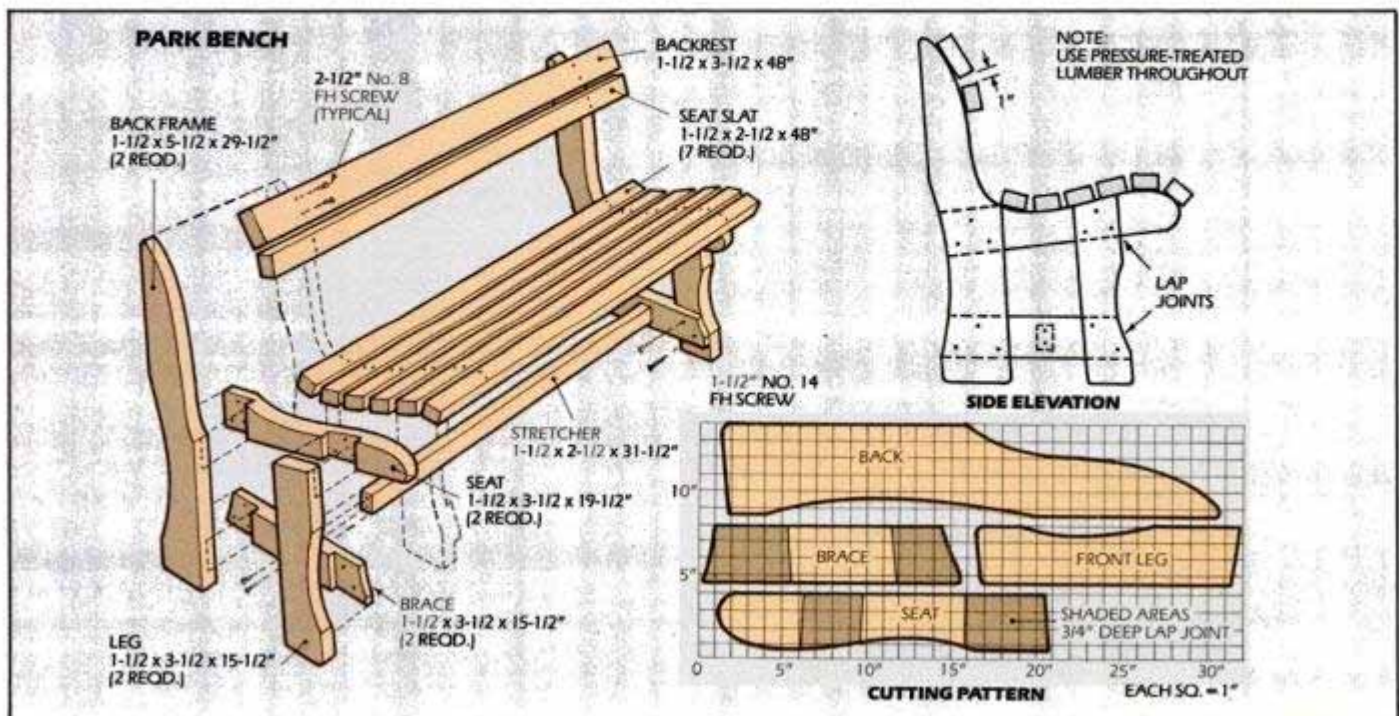
boring a series of overlapping 1/2-in.-dia. holes and then clearing the remaining waste with a sharp chisel. Round the ends of each foot as shown, using a wood rasp or Surform tool, then sand smooth. Dry-fit the tenons into the mortises. The fit should be snug, but not too tight.

Now, bore a 1/2-in.-dia. x 1 1/4-in.-deep hole into the center of the mortise and tenon. Apply resorcinol glue to the end of a 1/2-in.-dia. hardwood dowel, then tap the dowel tightly into the hole to lock the foot onto the

leg. Cut off the protruding dowel and sand smooth. Repeat this procedure for all six joints. Cut and install the eight corner braces as shown. Be certain to cut the braces square.

Next, cut six 1 x 4s for the seat slats. Round the top edges of the slats using a router and a 1/4-in. rounding-over bit or a sanding block to prevent splintering. Sand the slats smooth before fastening them. Leave about a 3/4-in. space between each slat. Finally, apply an exterior stain if desired.—*Joseph Truini*

(Please turn to page 118)





Solid wood wainscoting can change the appearance of any room. It's easy to work with and takes a natural finish, stain or paint well.

How To Wainscot A Wall

Here is a step-by-step guide to redecorating with wainscoting.

BY STEVEN WILLSON

If you're looking for a way to change the appearance of a room radically without devoting a great deal of time or money to the job, consider installing solid wood wainscoting. This traditional building material is enjoying a comeback, and it's a fair bet that the renewed interest is based on its adaptability. It can be installed easily on almost any wall. And it can complement nearly every decorating scheme because it takes a natural finish, stain and paint equally well.

Actually, wainscoting is a general

term applied to many different wall treatments. Some traditional examples are: flat-panel wainscoting, which consists of a series of flat panels surrounded with rails and stiles, much like cabinet doors; raised-panel wainscoting, which is fabricated in a similar manner, but is usually considered more elegant because of the time and effort re-

quired; and the double V-joint and bead wainscoting that we show here, which is probably the most prevalent. It's still available in open stock at many lumberyards and is usually made of pine or fir, sometimes in different grades. If you plan to paint it, as we did, you can save money by using the less expensive grade. In fact, your choice of wainscoting materials is by no means limited to these traditional examples. On a following page, we show three of the many possible alternatives.

Color photo: Harry Hartman
Photo stylist: Gabe Herrick
Black and white photos: Steven Willson

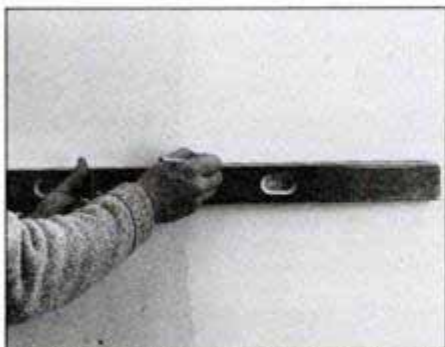
First, decide at what height you want your chair rail. We chose 36 in., which is fairly standard, but by no means a rule.

No matter what height you choose, the same basic installation methods shown here will apply. Just keep in

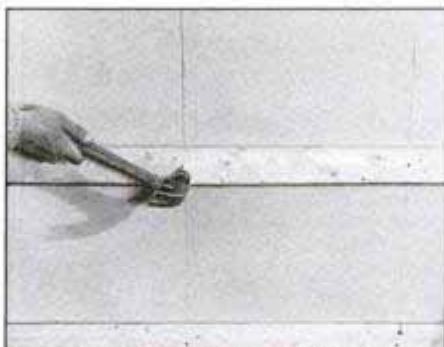
mind that you need horizontal nailing for the boards at least every 24 in. This is required because the boards are narrow *and* are applied vertically. The studs within the wall are aligned the same way, typically on 16-in. centers. Therefore, the voids between the wall

studs have to be spanned to provide nailing surfaces for the wainscoting boards.

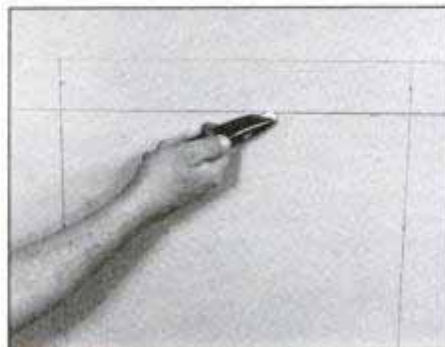
There are several ways to accomplish this, three of which are shown in the drawings below. The first, and probably easiest, is to nail furring strips



Begin by establishing height of boards. Mark wall at this point, then draw a level line through mark and continue it around room, maintaining precise level as you go.



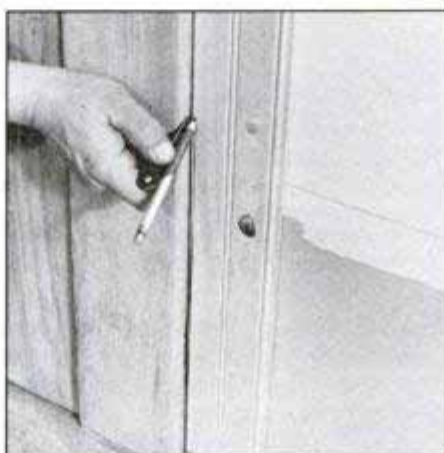
If you don't have horizontal blocking between studs, nail furring strips directly onto surface to receive the wainscoting nails. Nail into every wall stud.



If you'd rather recess the furring, draw an outline around each strip and cut out the drywall behind with a utility knife. Then nail furring directly onto studs.



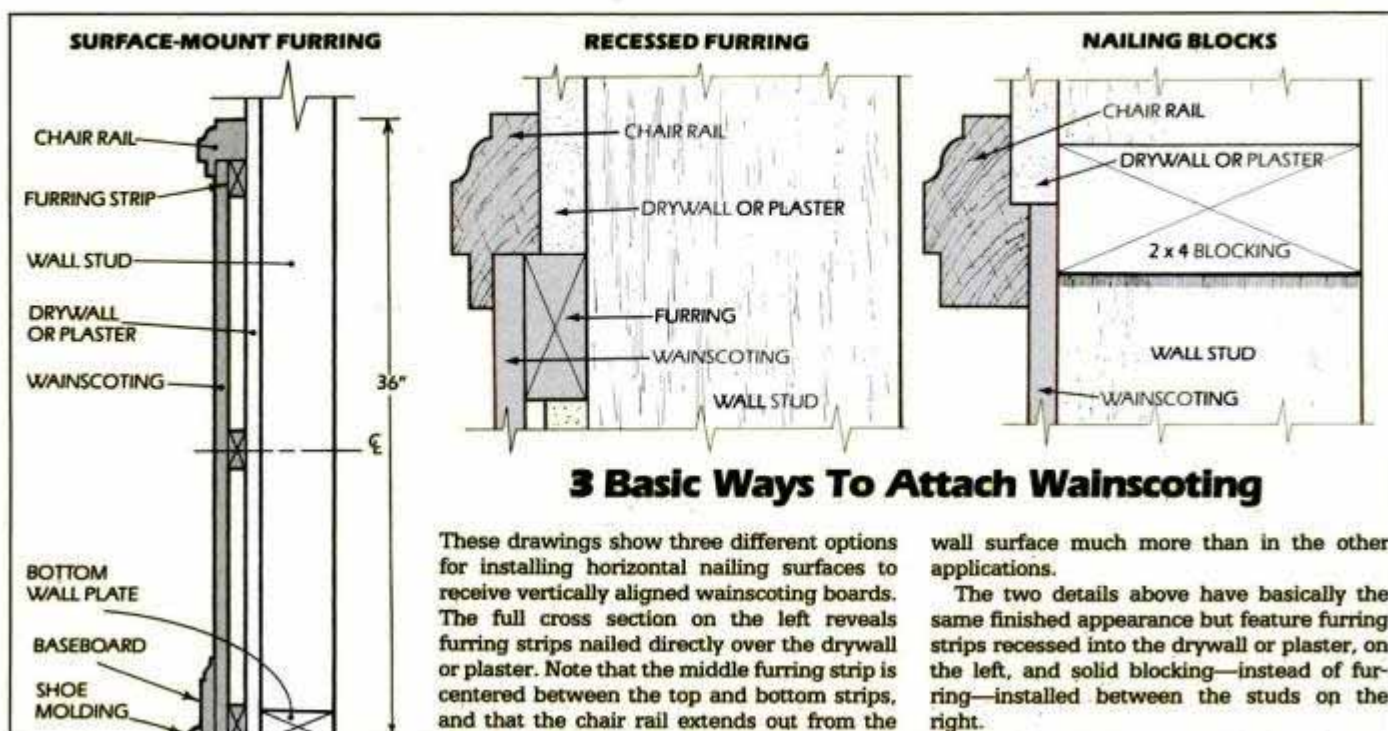
Start installing boards at room corner or door casing as shown here. For pro results, use level to plumb first board in place. Mark plumb position for reference.



If first board doesn't fit tightly to casing or room corner when held in plumb position, scribe back edge to conform to irregularities. Then plane edge to meet line.



Once board is planed to fit, nail in place with finishing nails near back edge. The end boards are only ones nailed through surface. Set heads and fill holes.





Attach tongue edge of board by driving nail through rear corner where tongue and bead meet. Angle nail at approximately 45° and set head.



Drive next board into place so groove fits over first board's tongue. Use scrap block of wainscoting to prevent damaging edge. Nail second board through tongue only.



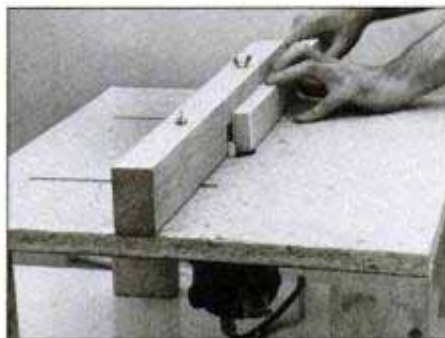
If board is slightly warped, you can often pry it tight by driving a chisel into the wall or furring strip and pulling back on chisel. Hold in place while driving nail.

across the surface of the wall, hitting each wall stud with a nail. This method has one minor drawback. Because both the furring and the wainscoting are applied over the drywall or plaster, the finished surface extends at least 1 in. into the room, depending on the materials you use— $1\frac{1}{16}$ in. or $\frac{3}{4}$ in. for the furring and $\frac{5}{16}$ in. or $\frac{3}{8}$ in. for the wainscoting.

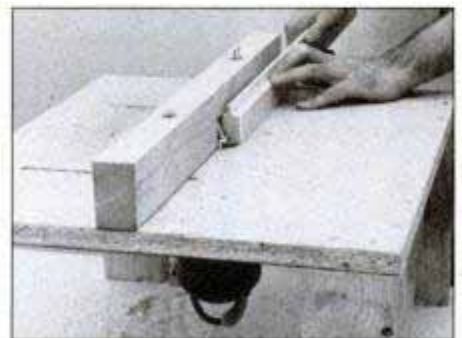
The second method shown gains some space because the furring is recessed into the drywall or plaster. To do this, just position the furring strips in their proper place on the wall, trace their outlines, then cut out the wall covering material behind. Nail the furring directly onto the studs. Of course, you can remove all the drywall or plaster, but this is time consuming and messy.

A third option

If you do remove all the drywall and plaster, you have a third option which reduces the projection of the wainscoting to a minimum. This is to nail solid



If you want to fabricate your own chair rail, use a router table to make the cuts. To duplicate our pattern, begin cutting the back rabbet with a straight cutter.



Next, cut bottom rabbet on board face, then turn board over and cut roman ogee shape near top. Don't cut full depth in one pass. Use two or three passes for clean cut.

blocking between the studs, flush with the outside edge of the studs. Then nail the wainscoting directly across these framing members.

A variation of this method was used on the installation shown here. The room had been gutted, solid blocking added between the studs, and new drywall installed on the walls and ceiling. We wanted the finished surface of

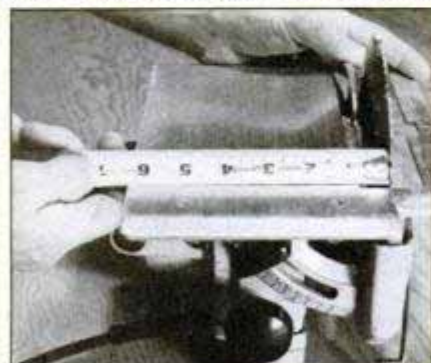
the wainscoting boards to project the extra $\frac{1}{2}$ in. into the room, so we installed the drywall over the lower part of the wall.

Next, cut all the wainscoting boards to length using a radial-arm saw or a circular saw and the cutting jig shown below. Start installation at a room corner or alongside a door casing. Plumb the first wainscoting board in place,

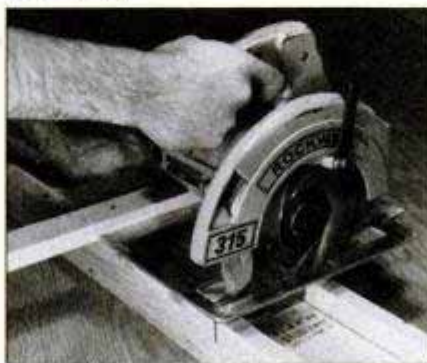
Cutting Jig For A Circular Saw

If you're installing a lot of wainscoting, you've got a lot of straight cuts to make, all the same length. A radial-arm saw is the ideal tool, but if you don't have one, this simple-to-build jig for a circular saw will save a lot of time. Assemble the parts as

shown in the drawing, making sure the fence is installed square to the sides. Then just slide the boards into the jig and make the cuts. Clamp a stop block at the far end of the jig so you won't have to measure each board.

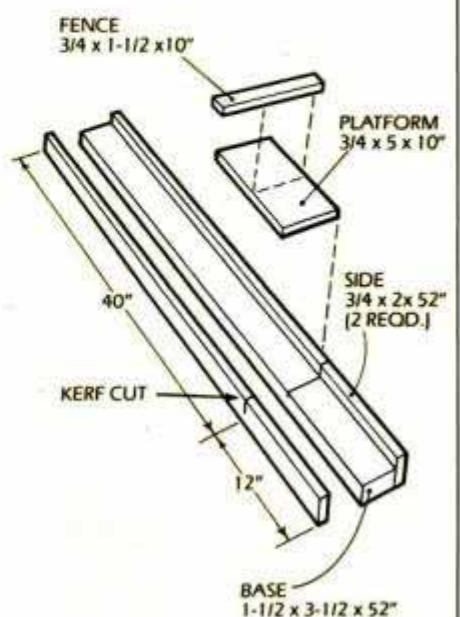


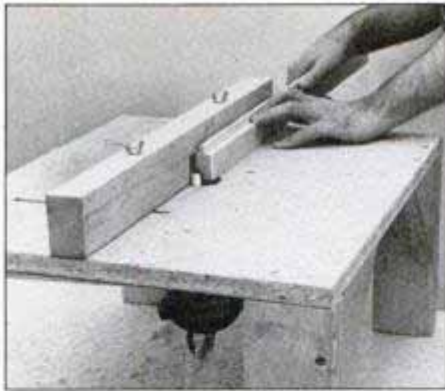
Measure distance from side of shoe to saw blade, then install fence on jig so blade just clears end of saw platform.



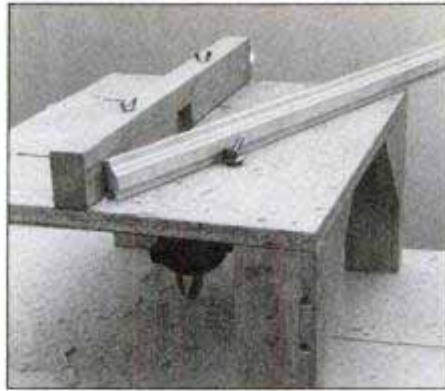
When parts are assembled, set blade to cut $\frac{1}{8}$ in. into top of 2x4. Then make kerf cut, keeping shoe tight to fence.

CUTTING JIG

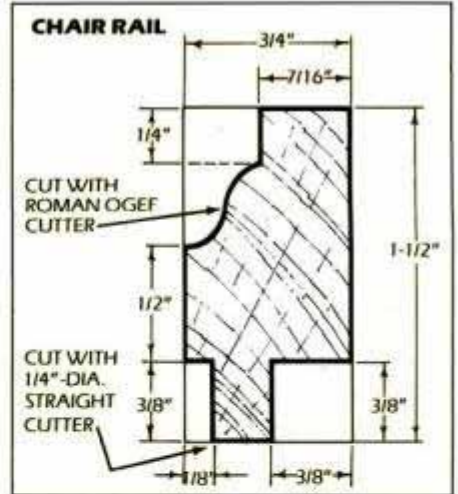




When ogee has been cut to depth shown in drawing at right, install straight cutter in router and trim off waste below ogee to complete the finished shape.



Lightly sand rail to remove any sharp edges and you're done. Completed shape required only two cutters: roman ogee shown and straight cutter still in router.



scribe and plane it to fit flush, then nail it in place.

Keep in mind that these boards have a tongue on one edge and a groove on the other. Because of this built-in joinery method, once the first board is nailed soundly in place, all following boards are nailed only through the tongue. These nails will be hidden by the groove of the next board. You must work carefully when nailing so that you don't split the tongue. Angle the nails at approximately 45°.

For right-handed people, working left to right on the wall is generally more convenient. For left-handed people, the opposite direction is better.

When you come to an electrical outlet, turn off the power to that circuit at your fuse box or breaker box. Then remove the covering plate and the screws that hold the receptacle in the wall box. Pull the receptacle away from the box, being careful not to damage any of the insulation on the wires. It is not necessary to remove the wires—you just need enough room to work around the receptacle.

Cut the board or boards so the perimeter of the box is just visible. Then nail the boards on the wall. Screw the receptacle back in place so its positioning ears, on the top and bottom, bear directly on the surface of the boards.

Then attach the covering plate and turn on the power.

Installing the chair rail

Once all the boards are nailed on the wall, cut and install a chair rail of your choice. You can either buy a stock rail at a lumberyard or cut one of your own design on a shaper or a router table. The pattern for the one we used is shown on this page.

Finish up by installing a baseboard at the floor and a shoe molding over it if you choose. Now you should sand the whole wall with 220-grit sandpaper, remove the dust and apply a finish of your choice. **PM**

3 Alternatives For Wainscoting A Wall



One innovative approach to wainscoting a wall is shown above. The material is a grooved, solid-color plastic laminate called Primeline Tambour Plus. It's designed with a flexible backing covering individual laminate strips which makes it ideal for permanent installation on both curved and straight surfaces. It's installed by gluing to a drywall base using contact cement and finishing it off with any type of chair rail and baseboard treatment you want. It's available in solid colors, metallic colors, woodgrain finishes and unfinished wood veneer, and solid wood slats. The veneers include red oak, white birch and American walnut. The solid slats are red oak. It's made by Ralph Wilson Plastics Co., 600 General Bruce Dr., Temple, Tex. 76501, and is sold at Wilsonart distributors nationwide. It comes in a wide variety of sizes and costs about \$7 to \$10 per square foot.



If you'd prefer the appearance of knotty pine wainscoting without going to the effort of installing solid wood boards, Pickwick paneling is a new alternative. The 1/4-in.-thick wood fiber product comes in 4 x 8-ft. prefinished panels which can be installed directly onto the wall with a few nails and some panel adhesive. No nailing blocks or furring strips are required. The flat panels are embossed with six random-width plank designs that are set off by a beaded groove to replicate the look of solid wood boards. You add the chair rail and baseboard of your choice. Two designs are available, Natural Pine (above) and Rustic Pine, which has a slightly darker, reddish-brown look. Both are made by Masonite Corp., 29 North Wacker Dr., Chicago, Ill. 60606. Each panel costs \$11 to \$13 at yards and home centers that handle the maker's products.



Although fir and pine are probably the most frequent woods used for wainscoting, any species will work, including hardwoods like oak, maple, cherry and walnut. These hardwoods, however, are more difficult to work with and generally require a good deal of machining to achieve a finished look. Other softwoods like cedar and redwood have a distinctive appearance and are easier to install. The wainscoting shown above is made of shiplapped, factrisawn solid redwood boards. They are installed much like the pine wainscoting we used: They require nailing blocks between the studs or furring strips across the studs. According to the California Redwood Assn., redwood is available in square-edge, eased-edge and V-joint tongue-and-groove boards; and in square-edge and V-joint shiplapped boards. Such redwood stock ranges from \$1.50 to \$2 per board foot.



How To Work Wonders With Tile

Here's how to use three handsome and practical types of tile: quarry, glazed ceramic and wood parquet.



Quarry tile in the solarium (top photo) continues onto the patio for visual continuity. Parquet floor of the family room (above, left) contrasts handsomely with the adjoining quarry tile. Backsplash of tile (above, right) is a good first project.

BY DAVID WARREN AND WILLIAM BEYER

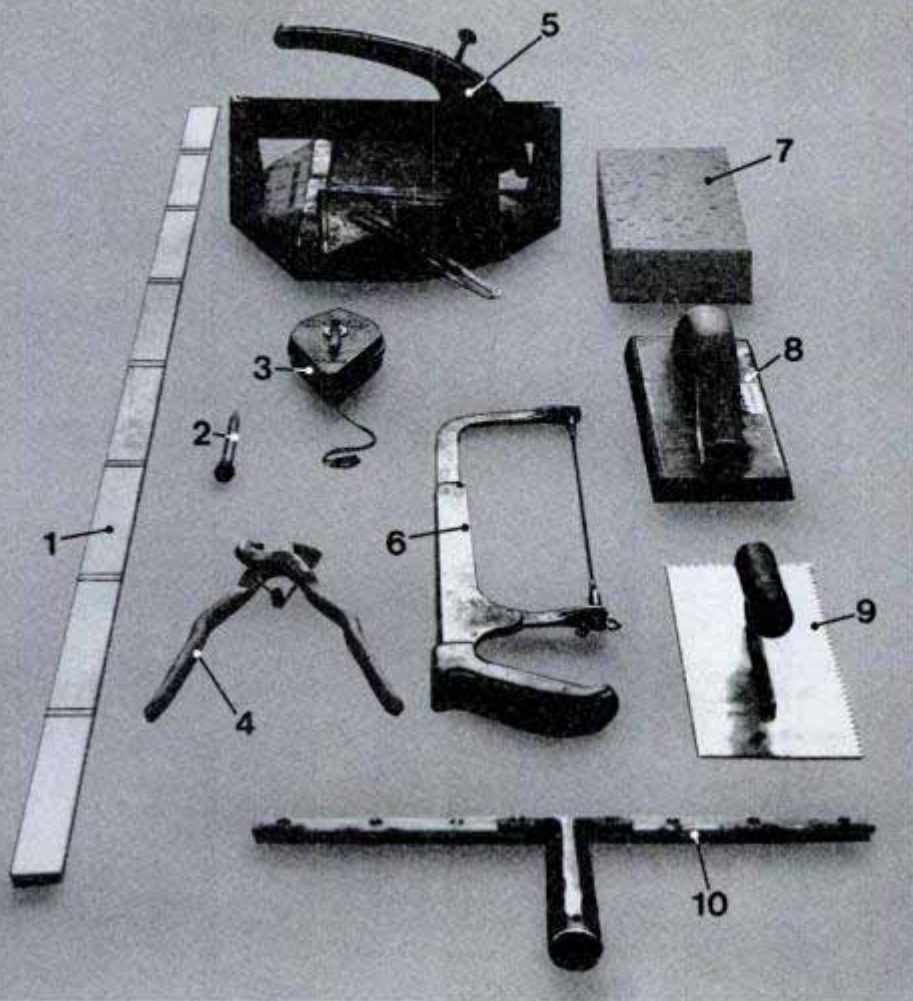
Whether you're remodeling or building an addition to your home, tile can add a distinctive look to a wall or floor—a look that won't soon go out of style. The small size of the pieces, whether they're ceramic or wood,

makes working with tile easier than manipulating many other finishing materials. Cutting errors in tiles are less costly than making such errors on larger finishing materials. Here, we detail three tile applications, give an idea of

the diversity of materials, and explain the effects that can be created with tile.

Ceramic tiles

Some do-it-yourselfers shy away from ceramic tile because they think it's too difficult to work with. This was true years ago, when tiles had to be set in a



You'll need about 10 tools (left) to lay ceramic tile: 1, homemade measuring stick; 2, pencil; 3, chalkline to mark the floor; 4, tile nippers; 5, tile cutter; 6, hacksaw with a rod saw blade to cut shapes; 7, sponge to clean grout; 8, rubber-faced float to apply grout; 9, V-notched trowel to spread adhesive; and 10, squeegee to remove excess grout. Often, you can rent needed tools from the tile dealer. Technique of framing a square of tiles, then filling in the square, helps to keep the tiles straight and evenly spaced (above).

thick mortar. Today, however, pre-spaced sheeting and new, easy-to-apply adhesives make setting tile relatively simple.

A few special tools are needed to lay ceramic tile. They are usually available through the tile dealer or at a local rental shop. They include a tile cutter or glasscutter, tile nippers, hacksaw with a rod saw blade, notched trowel, rubber float and squeegee.

You probably have the basic tools that are also required: chalkline, plumb line, carpenter's level, square, Carborundum stone and putty knife. Professional tile people sometimes use a power saw with a diamond blade to cut tile. This can be rented with the other specialized tools.

A measuring stick of lattice stock made for the size of the tile you are setting is a handy tool. Mark off tile widths, alternating with 1/4-in. grout spaces over the length of the stick. If you're using sheeted tiles, mark the width of a sheet and leave the same space between sheet marks as exists between tiles on a sheet.

Use the measuring stick to determine the approximate number of tiles you'll need to do a floor, wall or kitchen

countertop. You'll have some breakage, so add about 5 percent to your needs. Some dealers will give a refund for unused tile. Check before you buy.

Ceramic tiles come in many shapes, colors, designs and textures. They are used indoors and outdoors, on floors, walls and fireplaces, as solid surfaces or as borders. Ceramic tiles come glazed or unglazed. Quarry tiles are a type of unglazed tile.

Prespaced sheeting and easy-to-apply adhesives make tile work simple.

Tiles less than 4 1/4 in. square are usually mounted on sheets, with all tiles properly spaced. You just have to make sure the space between sheets matches the space between tiles.

Ceramic tiles 4 1/4 in. and larger are usually set individually. Some have built-in spacers that are covered when grout is applied. Other large tiles must be spaced visually or with separate spacers that are shaped like small plus

signs positioned at each tile corner. Remove them when the mortar has set sufficiently. You can also use thin plywood strips as temporary spacers.

Adhesives and grout

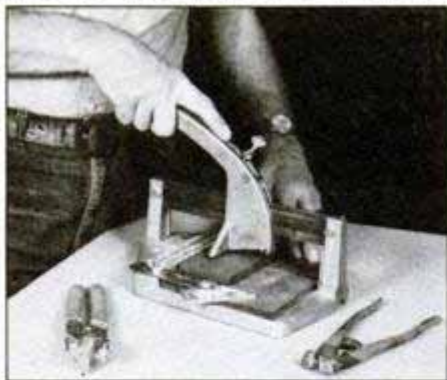
Ceramic tiles are held in place by adhesives. Traditionally, tiles were held by a mortar bed. Today, there are adhesives that are much easier to use. They fall into three categories: organic-based, cement-based and epoxy-based. The kind you use depends on the kind of tile, the type of subsurface, the location of the tile installation, and whether you're tiling a wall or a floor. Read the label on the adhesive can and check with the tile dealer to make sure the adhesive is suitable.

Organic adhesives, also called mastics, are of two types. Type I is water-resistant for use in damp areas, and type II is for dry areas.

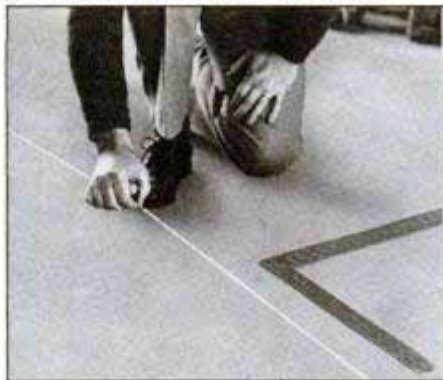
Cement-based adhesives are also of two types. One is a Portland cement base mixed with a latex additive. The other is a dry-set mortar that's mixed with water. Both can be used on concrete slabs. With an additive, the first type is used on wood.

Epoxy adhesive provides a strong

HOW TO INSTALL A QUARRY TILE FLOOR



A tile cutter is one special tool you'll need. It makes straight cuts. Pull the handle backward to score the tile, then press down to break it at the score.



Mark a starting point on the floor by snapping chalklines at right angles to each other in the center of the floor. Use a carpenter's square to ensure 90° angles.



Use a measuring stick to mark locations of other chalklines to form a grid over the entire floor. These lines help you lay straight, evenly spaced rows of tile.



Work out from the room center to the edge, tiling a quarter of the room at a time. Apply mortar so chalklines remain visible. Then set tiles in a frame along lines.



After you've framed a square with tiles, position the center tiles. A final tile completes the square. This method of framing and filling centers keeps tiles aligned.



An epoxy-based adhesive lets you lay frostproof tile outdoors. The temperature must be at least 45° F. The lower the temperature, the longer adhesive takes to set.



Use a rubber-faced float to spread grout diagonally over the tiles, forcing it into the joints. Be sure to fill the joints. Scrape off the excess with a squeegee.



Wipe off the remaining grout with a damp sponge, rinsing it as needed. Let the tiles dry until a haze appears over the surface. Use a dry cloth to rub off haze.



Sealing unglazed tile and tiles with cement-based grouts offers protection against stains. Wait at least 72 hours before applying sealer to let grout dry.

bond over plywood, concrete, wallboard and ceramic tile. Use it outdoors.

Grout is the substance applied after the tile is laid to fill spaces between tiles. The three common types of grout are cement-based, silicone rubber-based and epoxy-based. Cement-based

grout is most commonly used by professionals and do-it-yourselfers. However, epoxy-based grout should be used when epoxy adhesive is used. Grout comes in many colors to match the tile. Grout can come premixed or as a powder that requires mixing.

Unglazed tile and tile that has been grouted with cement-based grout should be sealed. A silicone-based sealer is best for use in wet areas.

Ceramic tile for a floor

If you're applying ceramic tile to a floor, preparing the surface beneath the

tile is the key. If you're laying tiles on a wood floor, be sure there are no protruding nails, that all boards are nailed down tightly and that the floor is level, with no board edges raised.

Do not try to lay ceramic tile directly on a floor covered with resilient flooring, "no wax" tile or urethane-coated flooring. A resilient underlayment will crack the grout and loosen the tiles. A no-wax floor covering will produce a weak bond with the adhesive.

If you must lay tile atop these materials, nail 1/4-in. plywood or underlayment-grade hardboard over the floor to

Quarry tile, glazed ceramic tile No. 610355 and Classic-style solid oak parquet tile with honey finish; Color Tile Inc., Dept. PM, Box 749, Fort Worth, Tex. 76101
Sliding glass doors and casement windows: Marvin Lumber & Cedar Co., Highway 11, Warroad, Minn. 56763

Photography: Bill Laskey
Styling: Virginia Howley, IDS
Technical consultant: Kirby's Floor and Carpet Center

provide a base for the tile. Stagger the joints, nailing at least every 6 in. in the center and every 3 in. around the outside edges with 6d ring shank nails. Set all nails.

Quarry tile for a floor

We laid quarry tile from Color Tile on a new concrete floor and on a new patio. To provide a strong, durable bond both inside and out, we used a three-part

epoxy-based adhesive mix. Two liquids are mixed, then a powder is added. The amount mixed should be limited for use in 20 to 30 minutes. This adhesive will set in 45 minutes to 1½ hours, depend-

Installing A Glazed Ceramic Tile Backsplash

Tiling a kitchen backsplash is a good introductory tile project. With careful attention, you should be able to align tiles in the limited space.

Wall preparation is important. Patch holes left from relocating light switches, electrical outlets or telephone jacks. Fill the wall space beyond the hole with fiberglass insulating material. Then gently press spackle into the hole with a putty knife. Overfill slightly to allow for shrinkage. When the spackle is dry, sand it flush with the wall.

You don't have to fill small nail holes unless the plaster or drywall surrounding them is broken or loose. In such a case, remove the loose material and patch the area. Remove wallpaper before tiling. Old wallpaper can come loose and cause the tile to sag.

When the backsplash area is ready for tile adhesive, mark a base line and a plumb line at the starting point. When working on a kitchen backsplash, you can use the top of the counter as a base line if it is relatively level. In a limited area such as this, where the top edge of the tile will be concealed below wall cabinets, slight variations

along the base line can be taken up by the grout space.

Test-lay a full row or sheet of tile across the width of the wall. If one of the end tiles is less than ½ in. wide, remove a tile.

Most tile adhesives set up in 15 to 45 minutes, depending on the temperature. It's best to work a small area at a time. Use a ⅜-in., V-notched trowel to spread mastic for most ceramic wall tile sizes. If you are using ceramic tiles that are 9 or 12 in. square, use a ¼-in., square-notched trowel. Hold the trowel at 45° while applying the adhesive.

When working around a kitchen backsplash, bathtub or shower where water will be splashed onto the wall, apply a skim coat of adhesive with the flat edge of the trowel. Allow this to dry, then apply a coat with the notched side for setting the tiles. The double coat will help waterproof the area.

While applying the skim coat, you can also pack cracks between the countertop and wall so water cannot seep in. (For more information on tiling a bath surround, see *Surround Your Tub With Tile*, page 141, Apr. '84.)

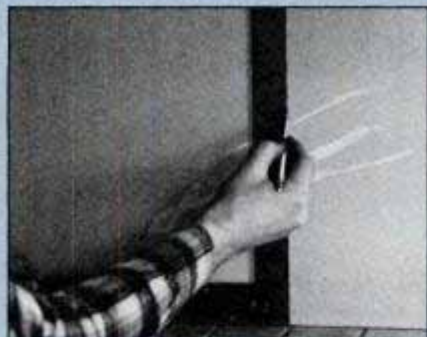
When you need individual tiles to fit around light switches or other openings, peel sheet tiles from their backing. Make straight cuts with a tile cutter and make shaped cuts with tile nippers, a rod saw or a masonry drill bit.

At one or both ends of the backsplash, you will probably have to cut tiles to fit. Since most walls are not plumb, cut end tiles as you work, to ensure a good fit. Allow space for grout when cutting partial tiles.

After the wall has been tiled for about 24 hours, apply grout to fill the spaces between tiles.

Follow the procedure discussed for grouting quarry tile, mixing only enough grout for 10 to 15 minutes of work. Allow it to stand for 10 minutes before remixing. Spread the grout with a rubber float. Then use the edge of the float or a squeegee to clean away as much as possible from the tile surface.

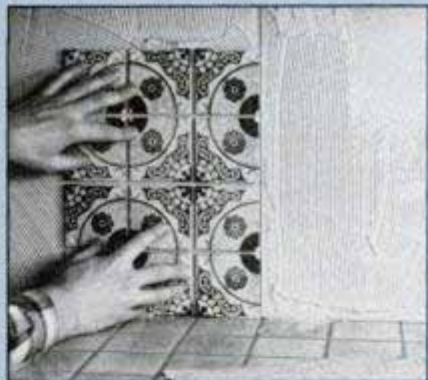
After 15 to 20 minutes, clean the tile surface with a damp sponge. After 30 minutes, polish the surface with a cloth, and after 72 hours, seal the backsplash with two coats of silicone sealer.



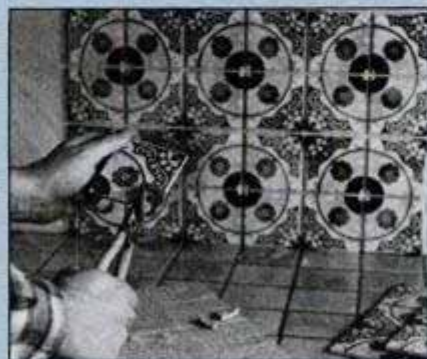
Check the joint made by the counter and the wall with a level. If relatively level, the joint can serve as a base line. You can correct slight discrepancies when spacing tile. Use a carpenter's square to draw a vertical workline.



Use the smooth edge of the trowel to spread adhesive so that the vertical line remains visible. Then hold the trowel at a 45° angle and comb the adhesive.



Position sheeted tiles intact, one edge along the vertical line, another edge along the base line. Accurate placement of the first sheet is essential.



Nippers will make odd-shaped cutouts of the tile for fitting around pipes and fixtures. To prevent the tile from breaking, remove only ⅛-in. bits at a time.



You can use an adhesive remover to clean the face of tiles before grouting them. Note that backing of the tile sheets is visible between tiles before grouting.



Apply grout and polish the tile using the same procedure that was detailed for the quarry tile floor. Let the work stand for 72 hours, then seal the grout.

ing on the temperature. If you're laying tile outside, the temperature should be at least 45° F. Remember, the lower the temperature, the longer the setting time.

When you're ready to begin the installation, measure and mark the center points of two facing walls and snap a chalkline between them.

Now you should snap a chalkline at center points of the remaining walls, after checking with a carpenter's square to make sure the lines are perpendicular to each other.

As a test, place a row of tiles from the center to the wall along one line. If the width of the last tile is less than half, readjust the other line. Then continue using the chalkline to mark off the floor into squares that will encompass anywhere from 9 to 12 tiles, starting at the center of the room.

Apply adhesive inside these squares and up to but not covering the chalklines. Be sure to use the trowel recommended on the label. Work on two or three squares at a time. Set tiles along the lines to form a square frame, then fill in the remaining space. Set tiles in place with a slight twist—don't slide them.

Good contact

Test the first tile you set by putting it in position, pressing it firmly, then lifting it off to see if good overall contact has been made with the adhesive. This will help determine if you are applying enough adhesive.

Don't allow the adhesive to develop a dry film or the tiles won't adhere properly. Take care to space the tiles evenly if they have no built-in spacers. Forming squares helps to visually align and space the tiles.

Cut the edge tiles with a tile cutter. To make a straight cut in a tile, use a tile cutter to score the tile, then break it along the score. You can also use a metal straightedge and glass cutter to score the tile. To break it along the score, lay the tile over a finishing nail or coat hanger wire and press down on the edges.

To shape a tile, use nippers to chip away small bites until the desired shape is achieved. Snap away about 1/8 in. at a time. Larger bites may break the tile. You can also use a rod saw to cut rounded shapes or enlarge holes started with a masonry drill bit. Finish a quarter of the room before proceeding to the next section. Always wear protec-

tive goggles when cutting ceramic tile.

Wait at least 24 hours before applying grout. If you use a dry grout mix, mix only enough for 10 or 15 minutes of work. Allow it to stand for about 10 minutes after mixing, then remix. Wear rubber gloves when mixing and applying grout to avoid skin irritation.

How to apply grout

Apply the grout with a rubber-faced float, making sure the spaces between the tiles are tightly packed. Go over each area two or three times to be certain the grout is packed into the joints.

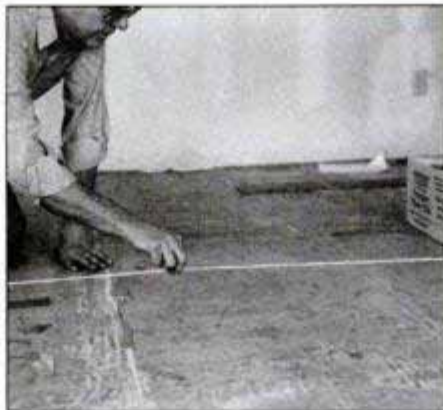
Wipe off excess grout by drawing a squeegee diagonally across the grout lines. Remove as much excess as possible to reduce the cleaning effort later. This is particularly important with quarry tile, since it is porous. You can prevent a thin film of grout from remaining on the surface of quarry tile if you apply a grout release product before grouting. Follow the instructions carefully regarding removal time.

Allow 15 to 20 minutes for the grout to set, then clean the tile surfaces with a damp sponge. After about 30 minutes, polish the surfaces with a coarse, dry

HOW TO INSTALL A PARQUET TILE FLOOR



Old or new, prime the subfloors to ensure proper bonding with the adhesive. But before this step, drive in protruding nails, fill holes and nail loose boards.



Locate the center of facing walls and snap a chalkline across the floor. Repeat on the other pair of walls after making sure the second line is at 90° angle to the first.



Apply parquet tile adhesive along the intersection of the chalklines. Spread only enough for about 10 minutes of work, to allow time for properly aligning tiles.



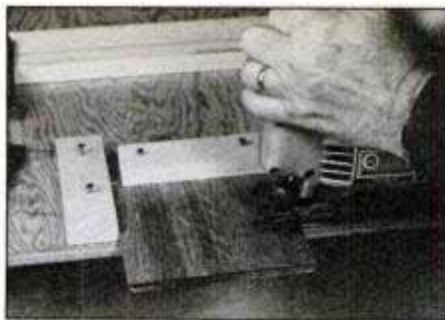
Set the first tile at the intersection of the lines. Be careful to align edges carefully with the working lines, since other tiles are aligned with the first tile.



Follow the two worklines as you add tiles. Lay the second and third tiles on either side of the first one. Work from the center of the room toward the edge.



Work on a quarter of the room at a time, filling in the area between the two intersecting guidelines. You may have to trim the tiles to fit at the edge.



Trim the perimeter tiles to allow 1/2-in. expansion space at the walls. This jig consists of parallel wood scraps positioned on both sides of a tile. A third wood scrap is tack-nailed perpendicular to the others in order to hold the tile for cutting.



When the entire floor is laid, roll it with a 150-pound steel roller to ensure that the tiles make good contact with the adhesive and that they are level.

cloth. When the grout has cured for 72 hours, brush on two coats of silicone sealer to make the grout resistant to water and soiling. Wait one hour between coats and rub the tile with a clean cloth after the second coat to restore luster.

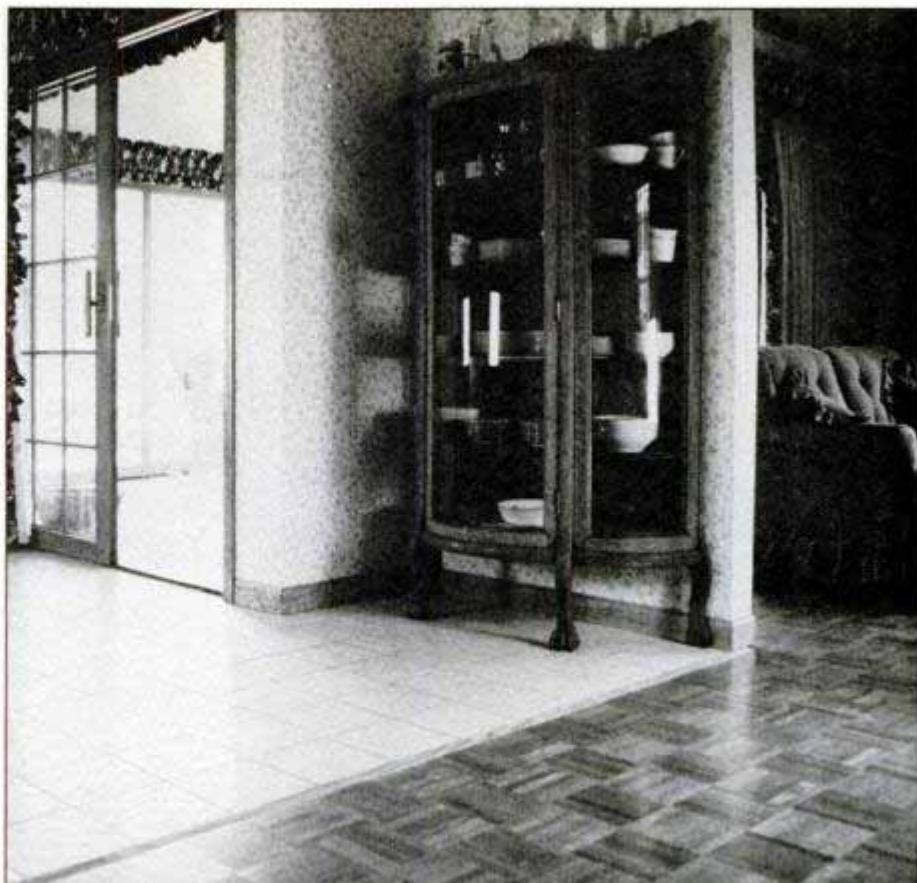
Laying wood parquet tile

Working with wood parquet tiles is somewhat different from setting ceramic tiles. Edges are butted together tightly. Some, for example the Classicstyle parquet tiles by Color Tile, have tongue-and-groove edges. This keeps individual tiles from lifting with changing humidity conditions.

As with applying other types of tiles, preparation is the key to a successful installation.

Make absolutely sure the floor is sound before laying tiles. If it has been previously covered, the old material should be removed and the subfloor surface cleaned of old adhesive. For best results, use an adhesive remover for this task.

Parquet tile can be laid over nonresilient floor coverings provided the material is firmly bonded and is free of all wax, grease and dirt. Do not lay parquet tiles over no-wax or urethane-coated floor coverings. Remove the coverings or nail on 1/4-in. plywood or underlayment-grade hardboard as described before. Remove base and shoe molding and door thresholds.



After installation, let the adhesive set for 24 hours before replacing the furniture. Nail moldings to the wall, not into the floor. But make sure they're tight against the floor.

Also, inspect the floor before starting. Depending on the subsurface, drive in or remove protruding nails. Fill holes and cracks with a floor leveling product such as Color Tile Redi-Mix Underlayment. Trowel it on with the flat edge of the mastic trowel and smooth the surface, feathering the edges to blend with the area around it. Nail down any loose subflooring with 6d ring shank nails. Paint on the recommended floor primer so that a good bond with the adhesive is assured.

Buying the tile

To determine how much tile to buy, measure the size of the floor and convert the measurements to inches. Multiply the length times the width, then divide by the length times the width of the tile. The answer will be the number of tiles needed. Add at least 5 percent—it's always best to have a few tiles left over in case of repairs later on, or you can often return them for a refund. Acclimate the tile by removing it from the container and keeping it in the room of installation for 72 hours beforehand.

Determine a starting point near the center of the room by locating perpendicular lines. Adjust the location of the lines to eliminate pieces less than half the tile width at a wall.

Spread only enough adhesive to cover an area that can be managed. You can use the same 5/16-in. V-notched trowel used for laying ceramic wall tile.

Spread the adhesive along the lines, starting at the intersection. Work only a quarter of the room at a time. Be careful to spread the adhesive evenly and to the proper thickness. If there's too little adhesive, the tiles will not stick properly. If there's too much, it will ooze up. Lay the first tile at the intersection of the lines. Lay the next along one of the lines, then the third on the other line next to the first tile. Fill the area between tiles.

A quarter at a time

Continue laying tiles in this manner until a quarter of the room is completed, then begin another quarter. Periodically, remove a tile after placing it to make certain that proper contact is being made.

Use a fine-tooth blade in a sabre saw to cut partial tiles, allowing 1/2 in. around all walls and obstructions for expansion due to temperature and humidity changes. Quarter round can be used to hide small voids at the baseboard. Attach the quarter round to the baseboard and not to the floor.

When the entire floor is complete, roll the tiles with a 150-pound steel roller available from dealers or rental shops. The pressure of the roller will assure good tile adhesion. Finally, clean your tools with cement remover. Allow the mastic to harden for at least 24 hours before walking on the floor or replacing furniture.

PM

A Deck You Can Put Anywhere



This free-standing design allows for greater flexibility in positioning the deck on your property.

BY JOSEPH TRUINI
Asst. Home and Shop Editor

As property values continue to rise and building lots shrink, many homeowners are searching for ways to develop additional living space. One of the most popular and economical methods is to build a wood deck attached to the house. This extends interior space for eating, playing, working and entertaining.

The deck shown here offers all the benefits of a house-attached deck with one unique difference—the freedom to be built independent of another structure. Its free-standing design means that it can be placed near a garden or lake, at poolside, under shady trees, or

Place this redwood deck where you want it. It's independent of any other structures.

on sloping, rocky or otherwise unmanageable terrain. The deck's size and shape can be altered to suit your particular site, but the basic structural design can be used in any situation. Be certain to check the local building codes before you begin construction.

This deck was built to extend beyond an existing concrete patio to afford views of the picturesque canyon below. It's made of construction heart redwood, one of the garden grades of redwood that is used for outdoor applications (see the grade chart on the opposite page).

Redwood was chosen for more than its looks. It's also dimensionally stable, so it resists warping, cupping and checking; it is lightweight and easy to work with; and redwood heartwood resists insects and decay. Redwood readily holds a finish and doesn't burn easily because it contains no volatile substances.

Note: Use only redwood heartwood or pressure-treated lumber in, on or

near the ground. Redwood sapwood is not decay resistant.

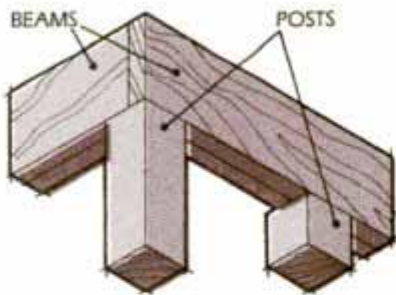
Choosing a location

The first step is to pick a spot on your property to build the deck. This decision is important because it's the key to the deck's usefulness. When choosing a site, consider the following: the path of the sun, the amount of available shade, privacy from neighbors and traffic, access to the house, and protection from wind and noise.

Next, to help you visualize the completed deck, lay out the deck's shape using wood stakes and nylon string. The deck size and shape are most often determined by the site's terrain and your budget. But remember, even a modest-size deck like the one shown provides over 250 sq. ft. of extra living space.

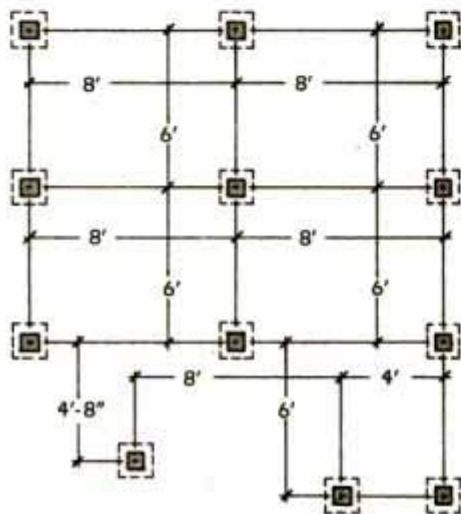
Construction: Frank Buzga
Color photo: George Lyons
Black and white photo: Kim Brun
Technical art: Eugene Thompson

PLAN VIEW

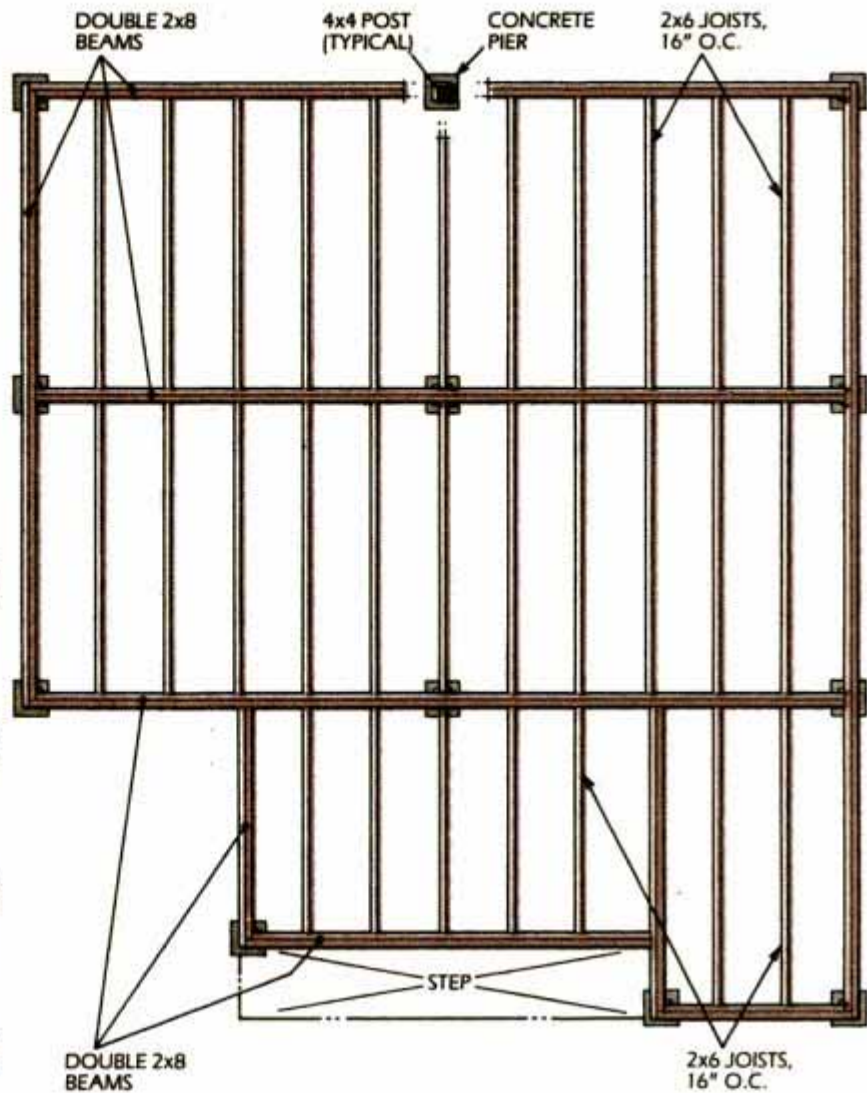


ALIGN BEAMS FLUSH WITH POSTS
AROUND THE PERIMETER OF THE DECK

DETAIL—BEAM AND POST



FOOTING AND PIER LOCATIONS



BEAM AND JOIST LAYOUT

Note that time-saving galvanized metal fasteners are used throughout the deck construction to join structural wood members. Fasteners are available at lumberyards, home centers and hardware stores. Refer to drawings for the specific model Teco fasteners used.

Footings and piers

Footings, generally made of poured concrete, support the posts which transfer the weight of the entire deck to the ground. A concrete pier is often poured on top of the footing to raise the post off the ground (see the drawing of typical footings on page 93). Generally, footings measure 8 in. deep \times 16 \times 16 in.

Pour the footings onto undisturbed or well-compacted soil or rock, not loose backfill. In colder regions dig footings below the frost line to avoid heaving during freeze and thaw cycles. Check the local building code for specific footing size and depth in your area.

Lay out and dig the 12 footings as shown in the plan view above. Next,

decide whether you want to use ready-mixed concrete or to mix your own from cement, sand, gravel and water. Ready-mixed concrete costs more, but you only need to add water and mix.

GARDEN GRADES OF REDWOOD

Construction Heart: All heartwood, but does contain some knots. Suitable for posts, beams and structural framing near or on the ground.

Construction Common: Similar to construction heart, but contains sapwood. For use as deck boards, fences and other above-ground applications.

Merchantable Heart: Economical heartwood grade with larger knots and holes. Used for fences, garden structures and other applications on or near the ground.

Merchantable: Same as merchantable heart, but contains sapwood. Suitable for trellises, deck furnishings and other above-ground uses.

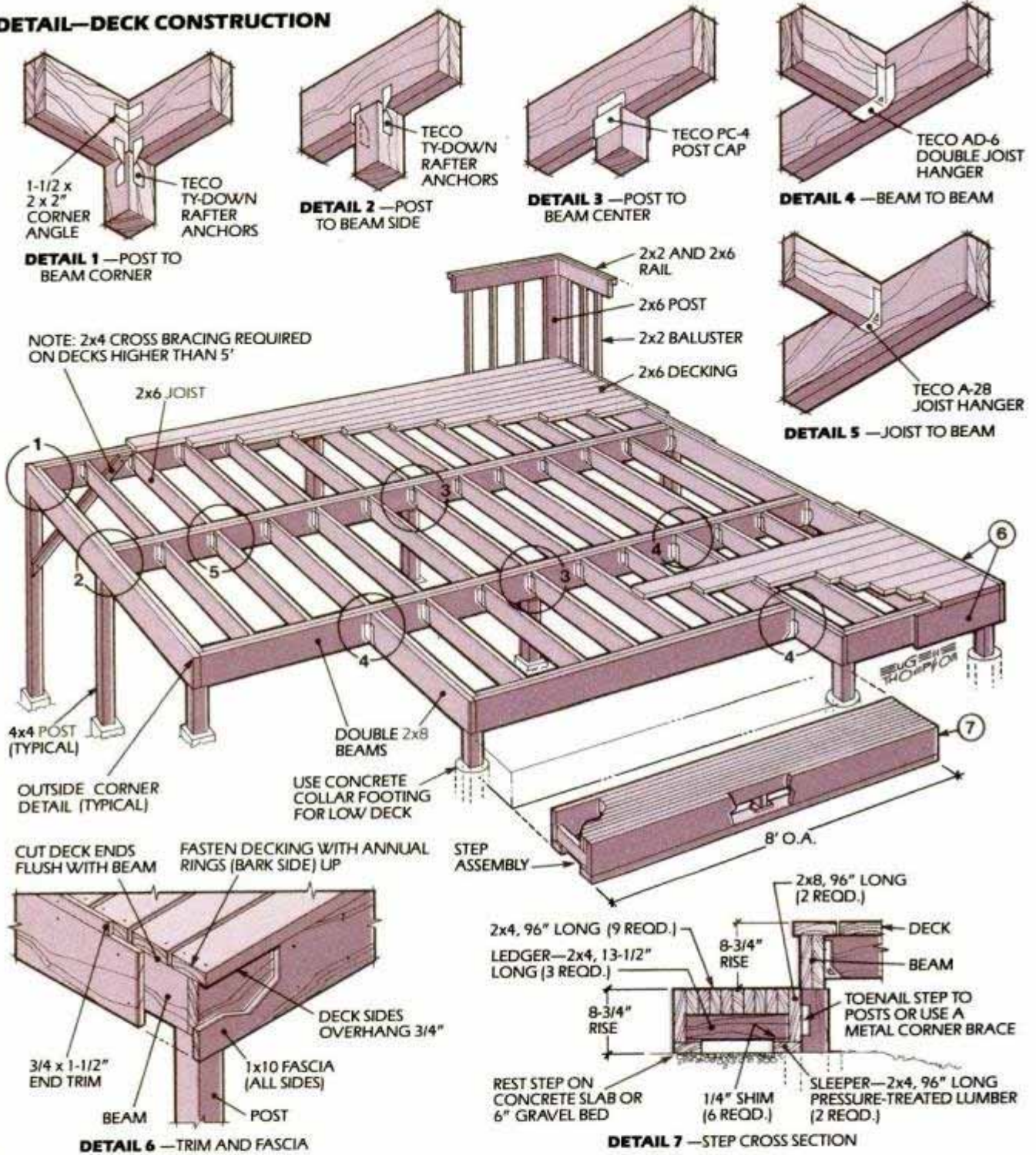
If a pier is to be poured on top of the footing, be sure to leave three to four short reinforcing bars (rebars) protruding out of the footing about 6 in. to create a strong bond between the pier and the footing. After the footing has hardened, you can form up and pour the pier.

Build the pier's form using $\frac{3}{4}$ -in. exterior plywood or an 8-in.-dia. spiral-wound fiber tube. The tube, commonly known by the trade name Sonotube, is a thick-walled paper tube designed for use as a concrete form. Piers should be at least 8 in. wide and project above the ground a minimum of 6 in. If a drift pin or metal post anchor is to be used, be sure to insert it into the pier before the concrete hardens. Cut the pin from a length of $\frac{5}{8}$ - or $\frac{3}{4}$ -in.-dia. rebar. Then centerbore the bottom of the post to accept the pin.

Posts and beams

First, cut the 4 \times 4 posts slightly longer than needed, then position each post

DETAIL—DECK CONSTRUCTION



on its pier. If a drift pin is used, place a 4×4-in. square of heavy roofing paper over the pin to prevent the post from absorbing moisture. Now, brace each post temporarily with 1×3s. Use a carpenter's level to be sure each post is plumb.

Next, determine the posts finished height by subtracting the decking thickness and the beam width from the desired finished deck height. For example, if the finished deck height is 30 in., subtract the 2×6 decking (1½ in. thick)

and the 2×8 beam (7¼ in. wide) to arrive at a post height of 21¼ in.

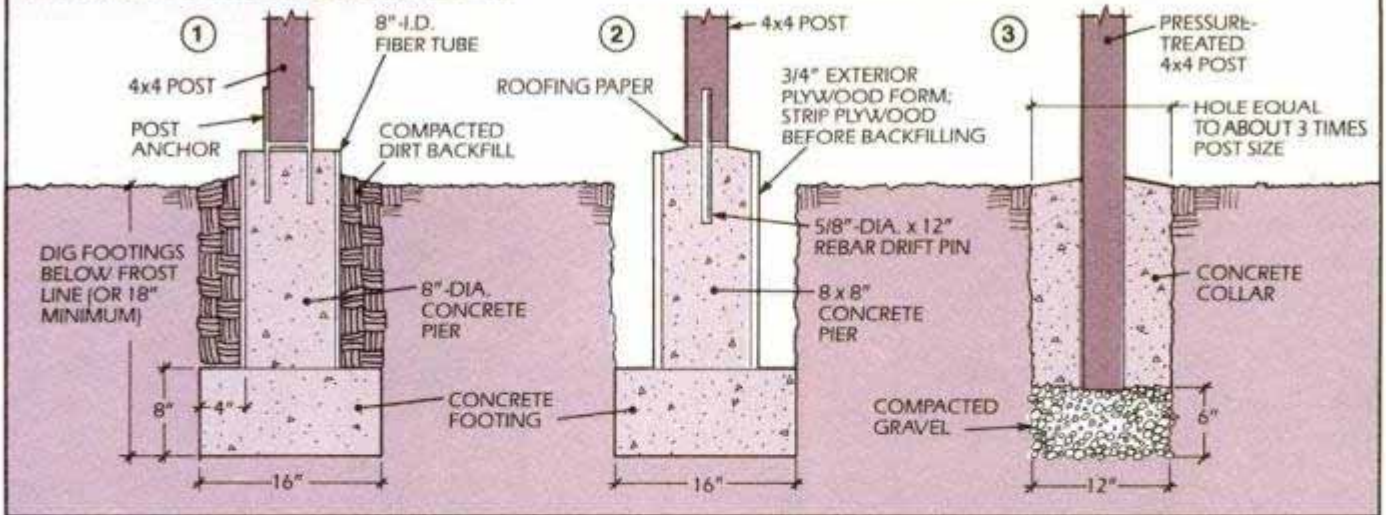
Now mark the post height onto the post that is sitting on the highest point of ground. From here, transfer the post height to the other posts using a nylon string and a line level. Then carefully mark and cut each post where indicated by the level string.

At this point, the posts may be different lengths because of sloping or uneven terrain, but the tops of all the posts should be level with each other.

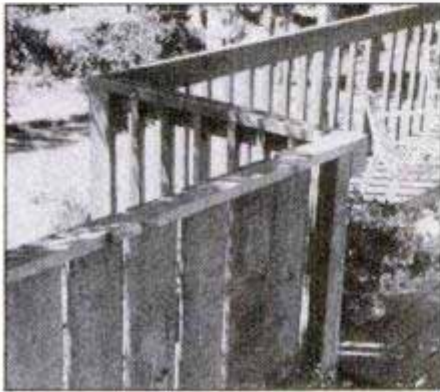
Nail together the double 2×8 beams using 3-in. (10d) top-quality, double hot-dipped galvanized nails. Note that the beam ends which meet to form outside corners are assembled with the inside 2×8 held back 1½ in. in order to form a strong interlocking corner joint.

Next, get the metal fasteners ready for use. Use two Ty-down rafter anchors on each of the 10 posts located around the deck perimeter (details 1 and 2). Fasten one angle-iron brace in each

TYPICAL FOOTING CONSTRUCTION



Shown above are three common footings. Make certain that you check with local building codes before starting construction.



The back railing wraps around both sides of the deck to join a redwood yard fence.

corner to further strengthen the joint.

On the two posts located in the center of the deck, use a Teco No. PC-4 post cap (detail 3). For the six places where a beam meets a beam, excluding the outside corners, use a 3-in.-wide double-joist hanger (detail 4).

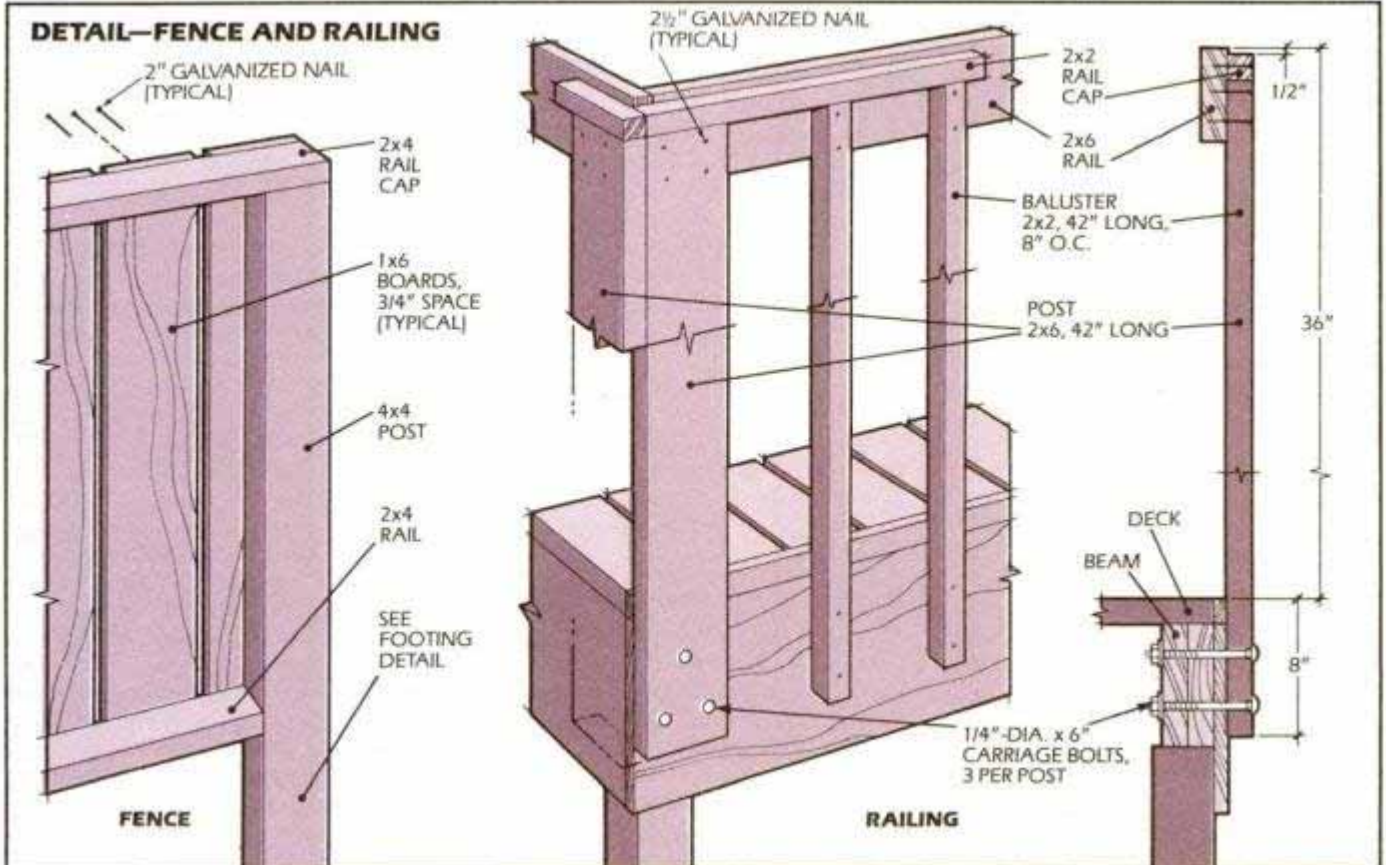
Now, with the aid of a helper, lift one of the perimeter deck beams onto the posts. Fasten the rafter anchors to the beam first. Then position the beam flush with the outside of the posts and nail the anchors to the posts. Continue nailing the beams in place to form the deck perimeter. Now install the two beams that cross the center posts. Use a

double-joist hanger (detail 4) where a center beam meets a perimeter beam.

Joists

Mark 16-in. on-center locations for all the 2x6 joist hangers (detail 5). Next, nail the hangers in place, but fasten only one side of each hanger. Then cut the joists and drop them into the hangers. Before nailing the joists in place, sight down the joist edge. If a noticeable crown (crook) exists, position the joist with the crowned edge up. The weight of the deck will straighten the joist. Now, finish nailing the hangers. For single-joist hangers, use 3-in. (10d)

DETAIL—FENCE AND RAILING



nails. Use 4-in. (20d) nails for double-joint hangers.

Bracing

Braces are required on decks higher than 5 ft. to prevent lateral movement. Bolt the braces to the underside of the deck, as shown, using 1/4-in.-dia. x 6-in. carriage bolts.

Decking

Starting at the back of the deck, nail down the first 2x6 deck board using 3 1/2-in. (16d) galvanized nails. Allow the board edge to overhang the beam 3/4 in. to conceal the fascia (see detail 6). Start with a straight board since measurements taken from here are used to keep subsequent boards straight.

If more than one board is used to span the deck, butt the boards over the center of a joist. Be sure to stagger the next row of boards to prevent the joint from falling on the same joist as the previous row. Also, leave space between each row of deck boards for expansion and drainage. The shank of a 16d nail is commonly used as a spacer. You can also use a block of 1/4-in. plywood.

As you nail each row, let the board ends overhang the sides of the deck. Later, snap a chalkline and trim all the boards using a portable circular saw.

After every five or six rows, stop and take measurements from the starter board. If the boards are out of alignment, make several small adjustments to consecutive rows rather than one large adjustment. When you reach the final board, allow it to overhang the front edge of the deck 3/4 in. As with the first board, this overhang will conceal the fascia.

Next, snap a chalkline on both sides of the deck flush with the outside edge of the beam. Then trim off the board ends using a portable circular saw. **Caution:** Be certain to wear eye protection when operating any power tool.

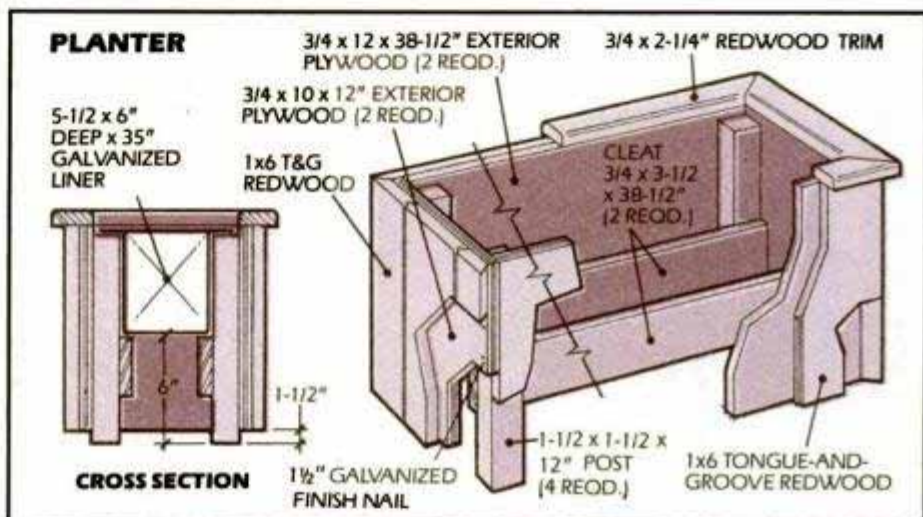
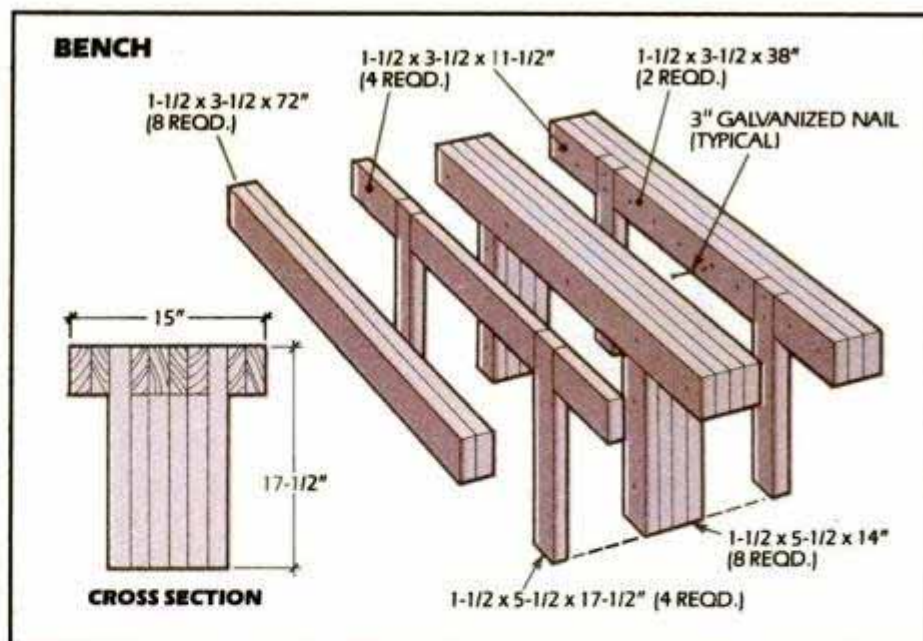
Build the butcher-block step as shown in detail 7. Fasten the step assembly to the posts using metal corner braces or by toenailing.

Trim and fascia

Since a free-standing deck is often visible from all sides, nail fascia board and trim around the deck perimeter to provide a finished look. Use 1x10 redwood for the fascia and 1x2 redwood for the end trim. Use rough-sawn cedar for a more rustic look. Keep the trim flush with the top of the decking, then nail the fascia under the trim and under the 3/4-in. overhang in the front and back of the deck.

Railing and fence

Unless the deck sits directly on the ground, a railing is recommended.



Make the railing from 2x2 and 2x6 redwood stock. Assemble the railing on the ground and bolt it to the deck using 6-in. carriage bolts, as shown in the drawing on page 93. Finally, plumb the balusters using a level, then secure each one with 2 1/2-in. galvanized nails. Pre-drill the balusters to prevent them from splitting.

Build the fence frame using 2x4 rails and 4x4 posts. Then nail 1x6 redwood or cedar fence boards to the frame. Leave a 3/4-in. space between each board. Secure the fence to the ground by pouring a concrete collar around each post.

Bench and planter

The sturdy redwood butcher-block bench consists of a 2x4 top with 2x6 legs. Cut and assemble the bench as shown. Although it's not necessary, the bench can be screwed to the deck for additional stability.

The planter is made from exterior plywood and tongue-and-groove redwood. The galvanized liner which holds

the plants, can be made by a heating and air-conditioning contractor.

Finishes

A clear water repellent containing a mildewcide should be applied to all garden-grade redwood. For best results, apply the water repellent directly to the lumber before construction, covering all surfaces. Then apply a second coat after the deck is completed.

If water repellent is applied every 12 to 18 months, it will eliminate the natural darkening process and help stabilize the color of the redwood to a buckskin tan. Water repellent also serves as a base for other finishes such as exterior oil-based decking stains.

For more information, contact the California Redwood Assn., 591 Redwood Highway, Suite 3100, Mill Valley, Calif. 94941. Write to Teco, 5530 Wisconsin Ave., Chevy Chase, Md. 20815, for details about metal fasteners. For Sonotube dealers in your area, contact Sonoco Products, Second St., Hartsville, S.C. 29550.

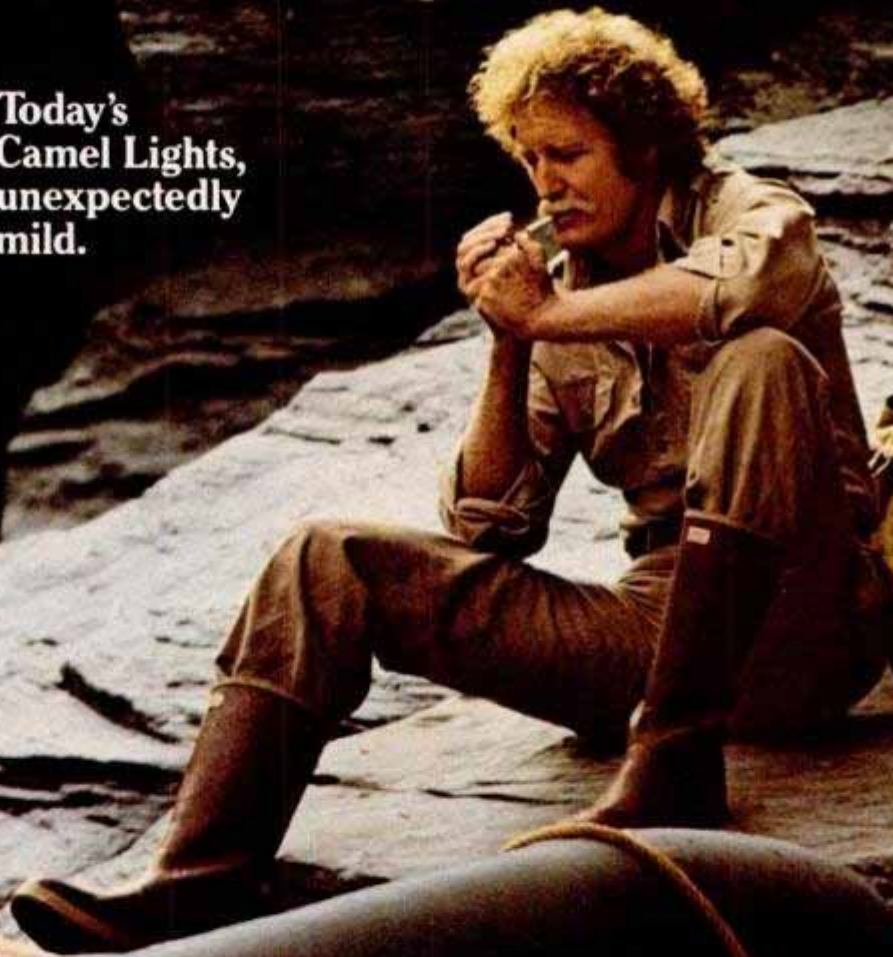
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JUMP JETS

(Continued from page 62)

called Plenum Chamber Burning (PCB), that would produce supersonic thrust through a relatively simple modification to its existing Pegasus engine. In the present Pegasus, fuel is burned only in the main combustion chamber leading to the two rear exhaust nozzles. The two front nozzles discharge compressed but unburned air supplied by the low-pressure fan. This provides sufficient thrust for vertical lift, but not enough for supersonic flight.

In the PCB scheme, fuel is burned in additional combustion chambers installed in the front nozzles, raising their exhaust-gas temperature from a relatively cool 230° F. to a scorching 2,417° F. This tremendous increase in heat and pressure boosts engine thrust from the current 21,500 pounds to a projected 36,000 pounds—enough to push speeds up into the Mach 1.5 range or about 1,100 mph. Further refinements are expected to increase this to Mach 2—twice the speed of sound, or nearly 1,500 mph.

Why not just use an afterburner like conventional jets? The big advantage of PCB is that fuel is burned in cool, dense, oxygen-rich air before it reaches the main combustion chamber. Here the potential for thrust augmentation is great—as much as 100 percent. By contrast, ordinary afterburning, used to provide short bursts of extra speed, is limited in the amount of added thrust it can generate because it follows the main combustion chamber and relies on the reburning of exhaust gases that are already hot, thin and low in oxygen content.

Supersonic test bed

To test out the effectiveness of PCB, McDonnell Douglas is modifying a standard Harrier to take a PCB-boosted Pegasus engine as soon as Rolls-Royce can make one available. The plane will be known as the AV-8SX (the SX standing for Supersonic Experimental) and is expected to have a speed of about Mach 1.6.

At the same time, McDonnell Douglas is also working on a much more ambitious project, a sleek, canard-winged supersonic V/STOL jet code-named the Model 279-3. Scheduled to be built in the early 1990s, it will combine vectored-thrust propulsion with movable canard mini wings to achieve both vertical operation and vastly improved in-flight maneuverability. It will carry 18,000 pounds of weapons—double the Harrier's payload—and fly twice as fast.

Still farther down the road, McDonnell Douglas has plans for a twin-engine version, called the Model 279-4,

that would provide added thrust along with the safety of backup redundancy if one engine should fail.

Other prominent U.S. aircraft makers, including Vought, Grumman and General Dynamics, are also entering the supersonic V/STOL sweepstakes, though just what propulsion method they will use is not yet definite. General Dynamics, maker of the highly successful F-16 interceptor, has been testing a system known as Ejector Lift in a delta-wing prototype called the E7. In the E7, compressed but unburned air is used for vertical lift only. For forward flight, the same air is diverted to an auxiliary combustion chamber at the rear, where it's burned to provide the added thrust needed for supersonic speed.

Wild new wings

But perhaps the boldest proposal for a supersonic V/STOL jet is a futuristic, forward-swept-wing design now under study by British Aerospace, maker of the original AV-8A Harrier. The craft, as yet unnamed and still only on the drawing board, would combine vectored-thrust propulsion with the higher lift, lower drag and superior maneuverability afforded by wings that sweep forward instead of back.

The advantages of forward wing sweep have long been known, but were not attainable until the recent advent of high-strength graphite-epoxy composites durable enough to withstand the tremendous stresses to which such tip-first wings are subjected. Grumman's radical X-29A prototype, though not itself a V/STOL design, will put the forward-swept-wing concept into the air for the first time when the craft undergoes flight tests this summer (see *Tomorrow's Shifty Dogfighters*, page 73, Nov. '83).

The British concept for a forward-swept-wing V/STOL fighter will use either a more powerful version of the current four-nozzle Pegasus engine or a newer three-nozzle configuration being proposed by Rolls-Royce. The latter will have two front nozzles with PCB boost, but only a single, central rear nozzle fed by the main combustion chamber. The arrangement is said to simplify engine construction, save weight and provide more uniform thrust control.

New STOL designs

Because a true supersonic V/STOL fighter is not likely to be around until the late 1990s, attention is also being given to new STOL (Short Takeoff and Landing) designs. These lack the vertical takeoff capability of a V/STOL craft, but would be easier and faster to produce. Using downward-swiveling exhaust nozzles to provide added lift at low speeds, plus movable canards for improved control at high angles of

attack, a STOL fighter could land and take off in less than half the space required by conventional fixed-thrust jets. It could also use in-flight thrust vectoring to permit new forms of combat maneuvers that are not possible today.

Actually, the STOL approach has one important advantage over V/STOL. A fighter making a short rolling takeoff can lift two to three times as much payload weight as it can in a vertical takeoff. The Harrier II, for instance, given a mere 1,000-foot takeoff run, can carry more than 9,000 pounds of bombs and missiles, compared to only about 3,000 pounds in a straight-up launch. Thus, a STOL fighter would be able to operate from small airfields and flight decks and still have maximum payload capacity.

The Navy, Air Force and NASA are currently evaluating a number of competitive STOL proposals as part of an overall program to develop a so-called Advanced Tactical Fighter, a next-generation superfighter that will ultimately replace the present McDonnell Douglas F-15 and the General Dynamics F-16 some time in the 1990s.

One early step in the program will be to test an existing Air Force F-15 that's been modified for STOL operation with downward-tilting exhaust nozzles in the tail and movable canards mounted behind the nose like small ears. If successful, this unusual hybrid, with speeds in excess of Mach 2.5, could become the first U.S. fighter capable of both supersonic performance in combat and low-speed STOL performance during landings and takeoffs.

Last fixed-thrust jet?

Boeing and Grumman have already announced proposals for a supersonic, vectored-thrust STOL fighter, and other makers are expected to follow soon. In the meantime, NASA is conducting extensive wind-tunnel tests on both the McDonnell Douglas 279-3 and General Dynamics E7 concepts for a supersonic jet with true V/STOL capability.

Such encouraging progress in the development of vectored-thrust technology has prompted some Pentagon experts to speculate that the Navy's newest carrier jet, the F/A-18 Hornet, could conceivably be the last conventional fixed-thrust fighter built, at least in the United States.

Ironically, it could have come even sooner. Rolls-Royce was well on its way to developing a supersonic version of its Pegasus engine as far back as 1965 when a sudden change in government funding policy forced the project to be shelved for almost a decade. If it hadn't been for that one stroke of political whimsy, we might well have had a supersonic Harrier today. **FM**

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COMPUTER CROOKS

(Continued from page 65)

his call to another line. At that point, the would-be electronic burglar is given one more chance. If his third attempt fails, the computer starts to give him bogus information, keeping him on-line, while security personnel trace the call. Such a system is obviously expensive to maintain. And if a criminal is larcenous enough, the system remains vulnerable to an "inside job."

Fiber-optic cables

For local computer networks—where all the terminals are located under one roof—fiber-optic cables can be used in place of outside phone lines. Visitron Inc. of Washington, D.C., markets a fiber-optic cable and "light modem." By using specialized inside lines, the user protects himself from a break-in by an outside hacker. The computer is not hooked to an outside line.

Encryption/Decryption methods will make data unintelligible to an unauthorized user. These are the systems that have kept mathematicians busy for the past decade. The codes have to be simple enough for users to remember, yet too difficult for outsiders to decipher.

Some basic systems intended to meet these criteria include the Data Encryption Standard (DES) and the Public Key system. DES, endorsed by the National Bureau of Standards, is made up of a combination of 56 ones and zeroes. The sender and receiver of a DES must have the same code number. This, of course, presents a security problem if you want to change codes frequently, since users at a distance have to somehow get the new key in a secure manner, such as a courier pouch.

If you have the right key with a DES system, you receive the sender's message. With the wrong key, you get unintelligible garble.

Two code keys

The Public Key system uses two code keys, one for the sender and one for the receiver. The encryption key is public so that anyone can transmit data into the secured system. To decode the data, however, you have to know a second private code.

Both types of systems come with specialized hardware and software. Encryptor, made by Lehigh Valley Logic of Bethlehem, Pa., uses a DES card that plugs into several commercial systems. A version for the IBM personal computer is expected on the market later this year. Datasafe, made by Imai of San Rafael, Calif., is a software DES package.

Public Key systems are marketed by Merritt Software Inc. of Fayetteville,

Ark. Using a 256-bit code, it makes trial and error break-ins unlikely.

Encryption/Decryption systems are popular in high-security fields, including secret research labs and international banks. The problem is that such institutions attract a very high class of criminal. Thus, the challenge is made to mathematicians to come up with highly sophisticated codes.

Late last year, one such code, which had taken two Stanford University scientists several years to develop, was broken by Donald Coppersmith of IBM's Thomas J. Watson Research Center. He was acting not as a crook, but as a scientist interested in testing what seemed to be an unbreakable code.

The Stanford code, as most other present-day codes, used a mathematical procedure that any college student could compute, but that only someone knowing the code could reverse. A simple and standard version of such a code is the type that uses prime numbers. There is no mathematical formula for factoring the product of two prime numbers after they are multiplied together. But anyone can multiply. Thus, a public code of this type might be the number 143, which is the product of 11×13 , two prime numbers. Anyone can multiply the two and come up with 143. But to decipher a message, you'd

have to know how to factor the code number 143 into its two primes. Our example, of course, is very simple. The real codes might be the products of primes that run into hundreds, even thousands, of digits.

The Stanford code used a different mathematical proposition with similar decoding problems. Coppersmith, however, deciphered the code because of a flaw in the nature of digital coding—the fact that it uses only ones and zeroes.

'Unbreakable' system

Israeli scientists early this year published a paper announcing a new "unbreakable code." Unlike their American counterparts, the Israelis have declined to publish details of their system even in highly technical journals. That protects the secrecy of the code, but it doesn't do non-Israeli security chiefs much good.

While the scientists and engineers continue digging for the perfect computer protection, the crime wave goes on. Some of it is serious, some a bit comical. The FBI says it has begun 1984 by keeping statistics on computer crimes. But officials say they won't know until the end of the year whether their statistics reveal any useful patterns.

On a lighter note, two Cal Tech

students brought a grin to the faces of football fans coast-to-coast in this year's Rose Bowl game. The day before the big game between UCLA and Illinois, the pranksters reportedly spliced a computer terminal into the line running to the Rose Bowl scoreboard. Then, police later reported, the two stood on a hill outside the Rose Bowl with a radio control unit.

Late in the game, they signalled the terminal to change the names of the teams to Cal Tech and MIT. For a few glorious minutes, students at the two institutions—neither of which has a football team—enjoyed national collegiate football notoriety.

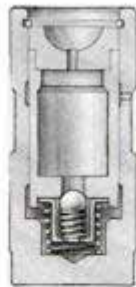
The lighter side of computer crime has been depicted on the popular TV show *Whiz Kids*. And a good joke was had by all in last summer's *Superman III*, when a larcenous computer whiz shaved fractions of a penny from each of a corporation's paychecks, amassing a veritable fortune.

Still, there's a serious side to the newest crime on the block. "With the scenario being virtually 'a computer on every desk,' the potential for abuse of those powerful pieces of equipment is tremendous," says Anchor Pad president Paul Gassaway. That's the potential crime fighters are zeroing in on today. **PM**

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Johnson max ASSOCIATE

CAMPING—GO LIGHTLY

(Continued from page 66)

you can get a two-man shelter that weighs just over 3 lbs.

Sierra Designs' Flashlight II, complete with ripstop nylon body, coated rainfly, and fiberglass or aluminum poles, weighs 3 lbs., 2 oz. and packs down into a 4-in.-diameter roll 17 in. long. That's the good news. The bad news is that lightness costs. Its list price is \$170.

The roomier Northface Dragonfly tent, with 45 square feet of space and a see-through netting canopy, kicks the weight up to 5 lbs., 5 oz. and the price to \$250. It packs down to a 5 by 20-in. roll and lets you see the stars as you lie there in bug-free comfort.

Waterproof coatings

Laminates that shed water droplets, yet allow water vapor to pass through, make possible much ultralight camping equipment. By laminating Gore-Tex, a microporous PFTE (Teflon) membrane originally used to make artificial arteries, onto nylon fabric, you can make clothing that keeps you dry from both the outside and your own perspiration. This does much to end the discomfort of damp gear and wet weather camping.

Originally, Gore-Tex had the weight of three laminations, but the latest two-layer Gore-Tex on lightweight nylon weighs just 1.2 oz. per square yard. It makes great sleeping bags, down jackets, rainsuits and other gear, as well as some super tent tops and flies.

Sleeping bags, like the Marmot Mountain Works' Nighthawk, use this material to chop weight to a mere 2 lbs., compared with 4 lbs. for a similarly sized goose-down bag rated for the same 15° F. temperatures. It squoshes down to a 7½x13-in. package.

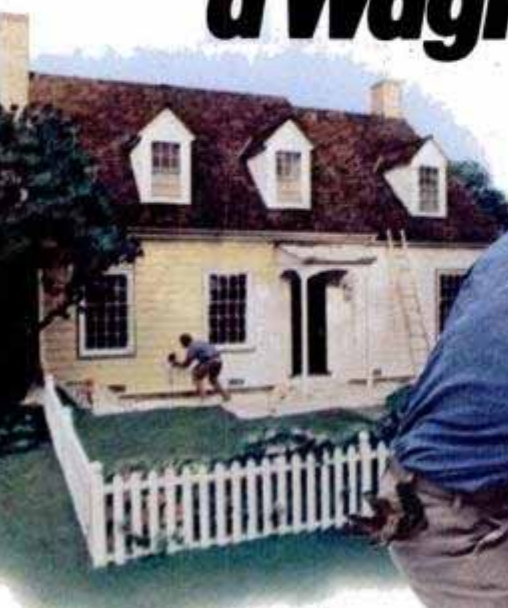
More important than its size and weight, it breathes, so you don't wake up wet with your own perspiration. If rained on, it doesn't become soggy.

Lightweight down jackets with the same Gore-Tex outer layer can keep you from freezing your ears and whiskers on the coldest, windiest days. Marmot Mountain Works' Warm II chops weight to 1 lb., 4 oz. The \$225 list price is high, but staying really warm in the worst weather makes it worthwhile.

Getting caught out in a chilling rain can be a killer. Serious wilderness wanderers carry rainsuits. Here the Gore-Tex really pays off in comfort and portability. It sheds the rain from the outside without steaming you on the inside, and weighs about 1½ lbs. when you lug it around in nice weather. The North Face Stowaway rainsuit (jacket \$130, pants \$85) weighs 1 lb., 9 oz. Marmot Mountain Works' Lightpacker

(Please turn to page 102)

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6½ hrs.

We painted this house in 6½ hours with a Wagner Power Painter. It took us 17 hours with a brush. Both were done excluding trim.

The time it takes to paint with a Wagner® Power Painter® is just a drop in the bucket compared with the time it takes if you use a brush.

An eight-foot section of picket fence that took 1 hour and 20 minutes to paint with a brush, we painted in just 21 minutes with a Power Painter.

A shutter that took us 22 minutes, we finished in only 3.

And while speed is the most obvious advantage of a Wagner Power Painter, you'll quickly find out it's not the only one.

4½ mins.

We painted this wicker chair in 4½ minutes with a Wagner Power Painter. It took us 1 hour with a brush.



In fact, it sprays almost any liquid. Even pesticides.

And because a Power Painter is run by an electric pump, you won't have a bulky compressor to drag around.

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CAMPING—GO LIGHTLY

(Continued from page 100)

ups this weight by 2 oz. and ups the price, too (top \$165, pants \$119).

Even long johns have gone the lightweight route. They also use plastics to keep the water away from your skin so it cools the clothing rather than you as it evaporates. Hike hard enough to overheat on a cold day and the knitted polypropylene underwear next to your skin keeps you dry. It also doesn't itch like wool and dries five times quicker when washed. A top and bottom combination weighs about 9 oz. For example, the Lifa Vermont top for women weighs 4 1/2 oz. and costs \$25; the Wickers polypropylene T-neck top for men weighs the same and costs \$15.

Treading lightly

To get where you're going, you need boots—proper hiking boots with good ankle support. These, too, have gone the ultralight route. Sturdy nylons like Cordura and the Gore-Tex laminates crossed with running shoe technology make for a new breed of lightweight boots. Velcro closures instead of laces alter appearance while improving function. They work better and weigh less than their leather predecessors.

Donner Mountain's Outer Limits

boots (\$90) weigh 2 lbs.—1 lb. each—with a breathable nylon Gore-Tex laminated upper on a Velcro-closed running-shoe-based design. This is a full 1 1/2 lbs. lighter than traditional leather hiking boots. Taking a pound off your feet makes hiking easier than unloading 10 from your back.

Camp stoves and flashlights also come lighter and in smaller packages these days. MSR's \$60 Firefly stove uses a standard fuel bottle for its tank so it can pack down to a 6 by 5 by 2 1/2-in. packet weighing just 15 oz. This tucks neatly into the side pocket on any pack.

Techna's 5 1/2-in. flashlight weighs half as much as most and can be held comfortably in your teeth when both hands are busy setting up a tent in a dark campsite.

The pack in which you carry all this lightweight gear has also gone on an effective diet. Among the best bets are the Alpenlite Superlite and Tourlite backpacks. These replace aluminum frames with a foam laminate backing sewn to the bag to form a convex shape for even load distribution. They also save weight by being slightly smaller than traditional packs. A typical 4,500-cu.-in. frame pack weighs 5 lbs., 9 oz. The Superlite? Just 1 lb., 8 oz.

The Superlite has only 3,200 cu. in. of packable space, but when carrying ul-

tralight gear, this capacity becomes more than adequate because most of it takes up less space.

Add up the weight savings and you find that going all the way with ultralight camping gear takes about 15 lbs. off your back, 1 1/2 lbs. off your feet and thins your wallet perhaps twice as much as heavier old-style equipment. At the end of a 20-mile hike, though, you know it's worth every penny. **PM**

SOURCES—CAMPING GEAR

- Alpenlite, 3891 North Ventura Ave., Ventura, Calif. 93001.
- Donner Mountain Corp., 2110 Fifth St., Berkeley, Calif. 94710.
- Early Winters Ltd., 110 Prefontaine Place S., Seattle, Wash. 98104.
- EMS, Vose Farm Rd., Peterborough, N.H. 03458.
- Jansport, Paine Field Industrial Park, Building 306, Everett, Wash. 98204.
- Kelty Pack Inc., 9281 Borden Ave., Sun Valley, Calif. 91352.
- Marmot Mountain Works, 331 South 13th St., Grand Junction, Colo. 81501.
- Moss Tent Works, Box 309B, Camden, Me. 04834.
- The North Face, 999 Harrison St., Berkeley, Calif. 94710.
- Recreational Equipment Inc., Box C-88125, Seattle, Wash. 98188.
- Sierra Designs, 247 Fourth St., Oakland, Calif. 94607.
- Sierra West, 6 East Yanoli St., Santa Barbara, Calif. 93101.
- Stephenson's Warmlite, RFD 4, Guilford, N.H. 03246.
- Trailwise, 2407 Fourth St., Berkeley, Calif. 94710.
- Wilderness Experience, 20675 Nordhoff St., Chatsworth, Calif. 91311.

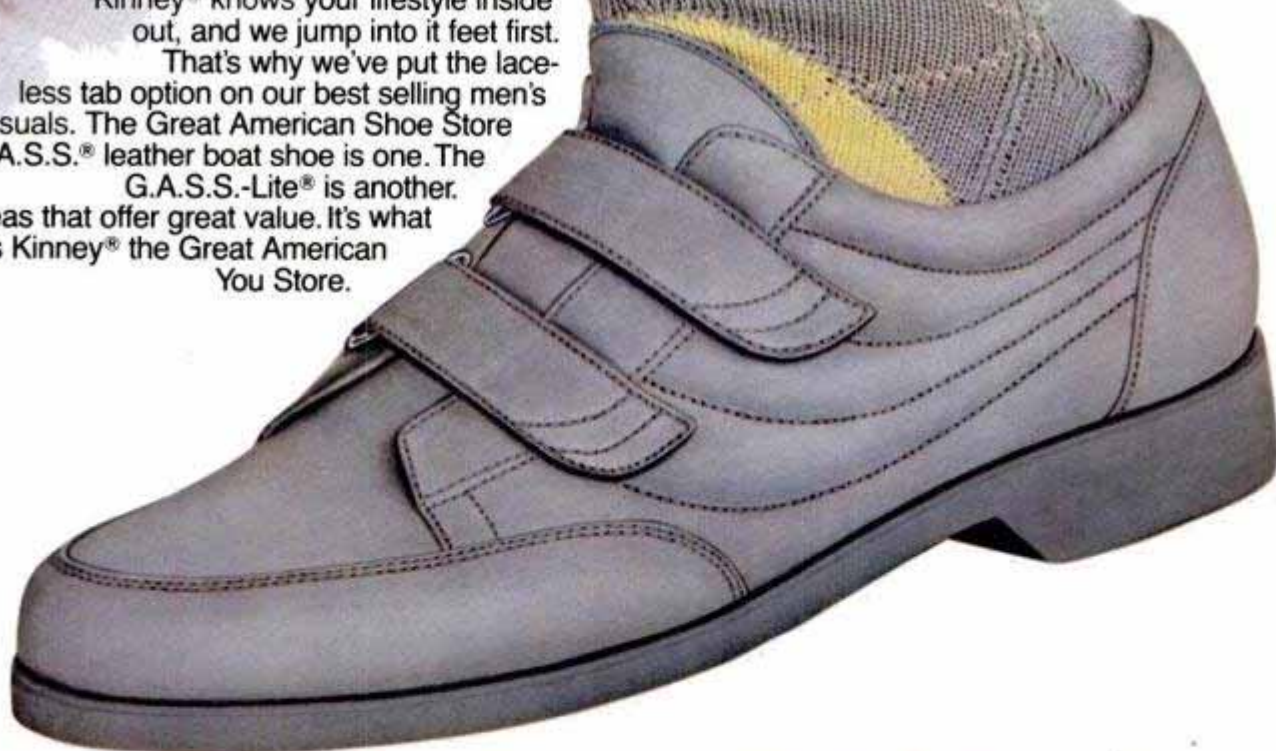
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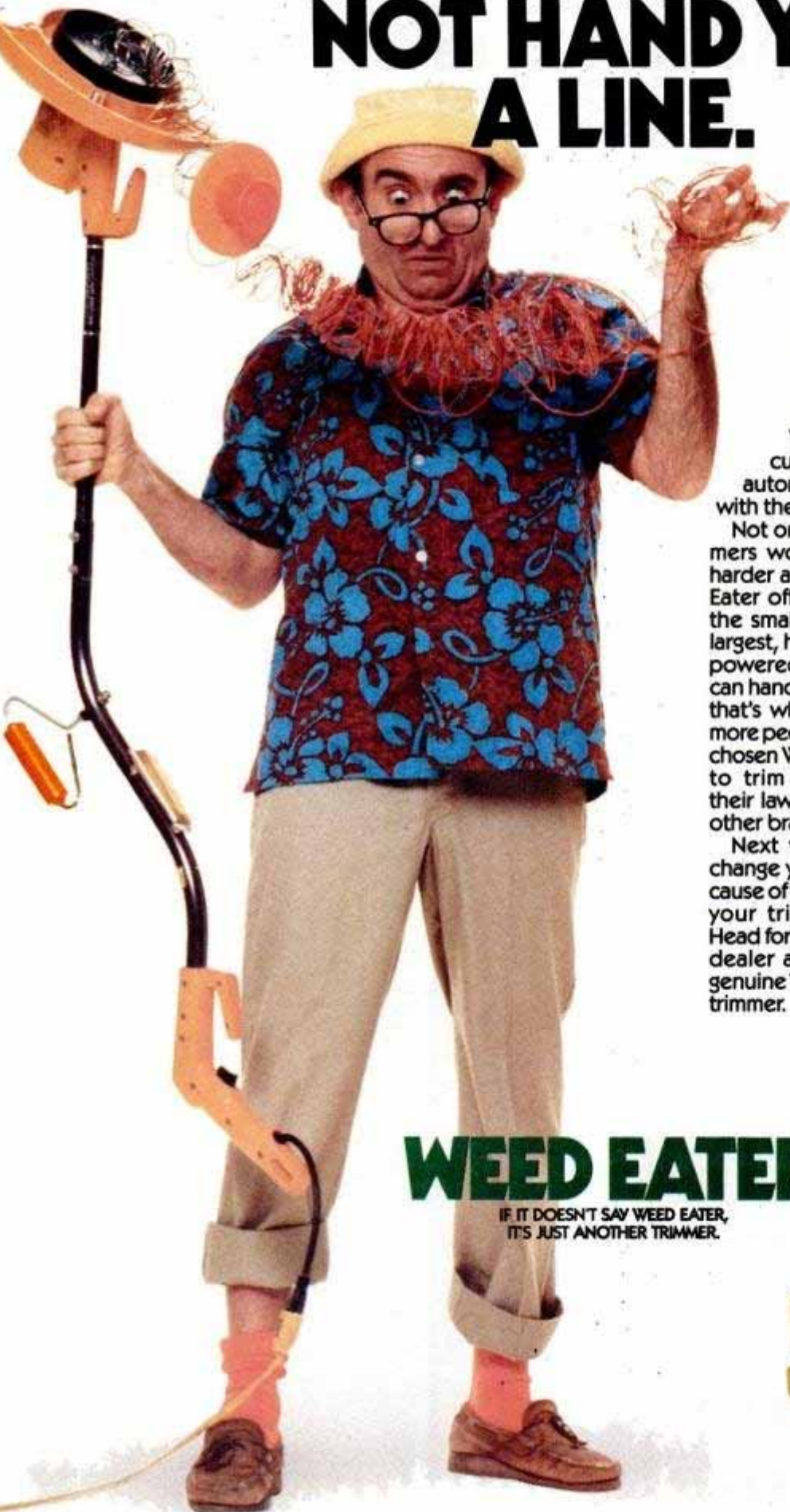
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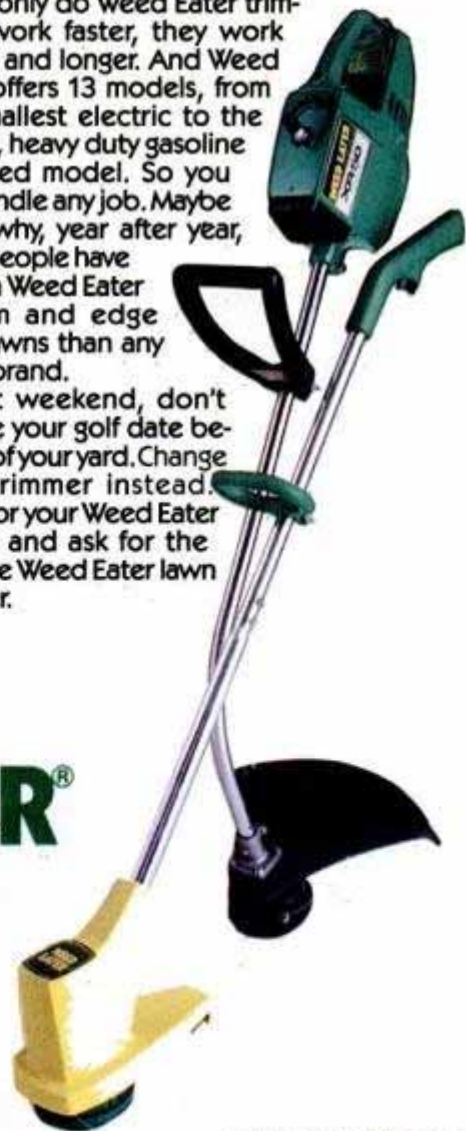


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AUTOMATIC TRANSMISSION

(Continued from page 71)

transmissions also use steel belts, but their belts are completely different from those in the Fiat/Ford CVT.

And while we have no direct word from Japan, indirect evidence tells us that several Japanese auto manufacturers are meeting with GM, Ford, Good-year, Morse and other potential suppliers of CVT units and belts.

How CVTs work

Anyone who's ever adjusted the V-belt on an air-cooled Volkswagen will understand immediately how a CVT works. The generator pulley on the VW is split into two tapered halves, with several washers between them. When the belt stretches and becomes loose, you remove a couple of washers and bolt the pulley halves together again. This brings the halves closer to one another, forcing the belt to ride higher

in the pulley groove and tightening the belt. It also increases the effective diameter of the pulley and changes the drive ratio between the crankshaft and generator pulleys.

On the VW, that's beside the point. In a CVT, it's the whole point. As the halves of one pulley are forced closer together, the halves of the second pulley separate to maintain constant tension on the belt while changing the ratio between the drive pulley and the driven pulley. These changes in ratio can be made gradually, in minute increments, with none of the giant steps found between the gears of a conventional transmission—automatic or manual. Hence the name "continuously variable" transmission.

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(Please turn to page 106)

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DRIVING THE CVTs

At the time this story was written, there were no cars equipped with CVTs available for test drives in the United States. But I have driven cars with both systems—the DAF/Volvo rubber belts and Fiat's metal-link belt—and they left vivid impressions.

I drove the Volvo 343 briefly through a large industrial park some time ago and, although I never reached highway speeds, I got a good idea of what it would be like to drive around town. Starting up from a stop sign, the engine immediately accelerated to its most efficient governed speed while the car slowly caught up to the 60-mph roar of its motor! This disconcerting conflict of sensory inputs was accentuated because the 343 was a noisy car.

Depending on the amount of vacuum in the control system when you lifted your foot off the gas, it would sometimes free-wheel—seeming to coast forever—and







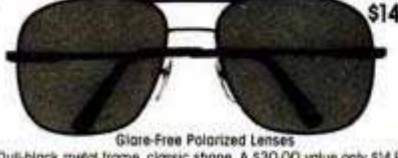






Volvo 343 (top) was a unique experience. Prototype of Fiat Uno-matic (above) was an excellent performer in traffic.

sometimes "gear" down to provide engine braking. The newer 340 models have a switch on the dash that allows the driver to select freewheeling for maximum fuel economy or "down-shifting" for safety on hilly roads.

I drove a prototype Fiat through the rush-hour traffic in Turin, Italy, and it behaved much more like a "normal" automatic, even creeping a bit if you took your foot off the brake at lights. It, too, was always trying to catch up to its engine noise, but it was a lot peppier than most small, four-cylinder cars, which are hobbled by conventional automatics.—W.H.

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<p>2 Only \$9.95</p>  <p>Girl Watcher Gray mirrored lenses, black frames. A \$20.00 value only \$9.95. 2 pairs for \$18.00.</p>	<p>8 Only \$9.95</p>  <p>Aviator Teardrop Flight Glasses Flexible cable temples, gold frames. A \$20.00 value only \$9.95. 2 pairs for \$18.00.</p>
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AUTOMATIC TRANSMISSION (Continued from page 105)

bile. Belt drives with adjustable-gap pulleys were common in cycle-cars before World War I. In the 1930s, an American inventor named Hayes talked British Austin into offering his rendition of a CVT in that company's light cars. Then in 1958, the Dutch DAF minicar introduced what's now the Volvo 340 CVT, using reinforced, cogged rubber belts and pulley halves controlled by centrifugal weights and vacuum. And it's the transmission of choice in the snowmobile industry.

The DAF/Volvo/van Doorne pulley and belt system still forms the basis of nearly all major CVTs being developed today. The big difference between the DAF Variomatic of 30 years ago and today's emerging CVTs focuses on two technical advances: 1, the microprocessor, which replaces the DAF's weight and vacuum controls for pulley spacing; and 2, flexible steel belts instead of the rubber belts now used by Volvo. The Volvo rubber belts were designed in conjunction with Goodyear and are made in America.

In theory, the CVT holds at least seven advantages over conventional automatic transmissions for small cars, particularly front-drive cars:

1. The CVT is considerably simpler, both to manufacture and to repair, than conventional automatics, which have become highly complex in recent years, especially new models with lockup torque converters, four speeds and overdrive gearing. Ford's experimental CVT, called the CTX-811, has about 35 percent fewer moving parts than a production Fiesta or Escort torque-converter automatic.

2. A CVT can offer performance equal to a five-speed; better, in fact, than a five-speed above 40 mph. If you've compared economy cars with and without conventional automatics, you've noticed the damper that type of transmission puts on acceleration. The average CVT, though, comes much nearer to a five-speed than a conventional automatic in overall performance.

3. A CVT can be made more compact, so it takes up less space than today's typical automatic transaxle.

4. A CVT tends to weigh less because of its simplicity and compactness.

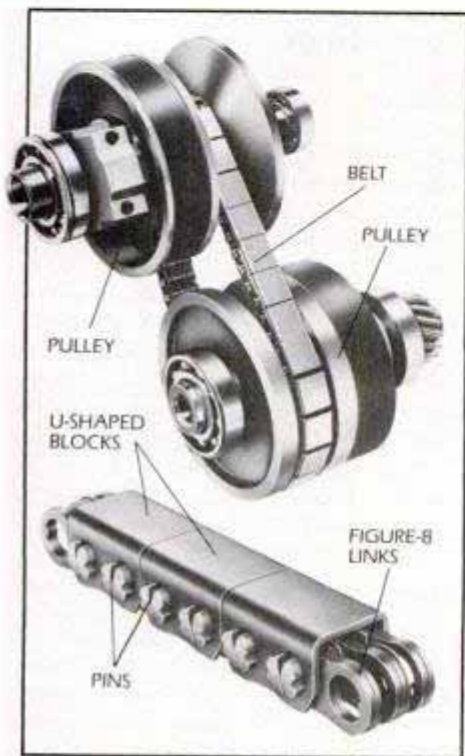
5. It also costs less for the same reason. Fiat's new CVT adds \$345 in Italy to the price of a new Uno 70 automobile—roughly the same as a conventional automatic. When market competition and production volume increase, though, the CVT's price is expected to come down to nearly the level of a five-speed manual.

6. The CVT is "stepless," so that you don't feel any shifts or jerks as it

moves through its infinity of ratios.

7. Perhaps most importantly, the modern CVT delivers better fuel mileage than a conventional automatic, and it does so in two ways:

First, because of the potential difference in pulley sizes, the CVT can cover a greater span of gear ratios than is practical with either a five-speed manual gearbox or a four-speed automatic. A standard five-speed has a ratio span of about 5.0:1, while a CVT's normal span is 5.6:1, meaning the highest



German PIV company has a CVT whose metal belt looks like a bicycle chain. Pins provide only contact with pulleys.

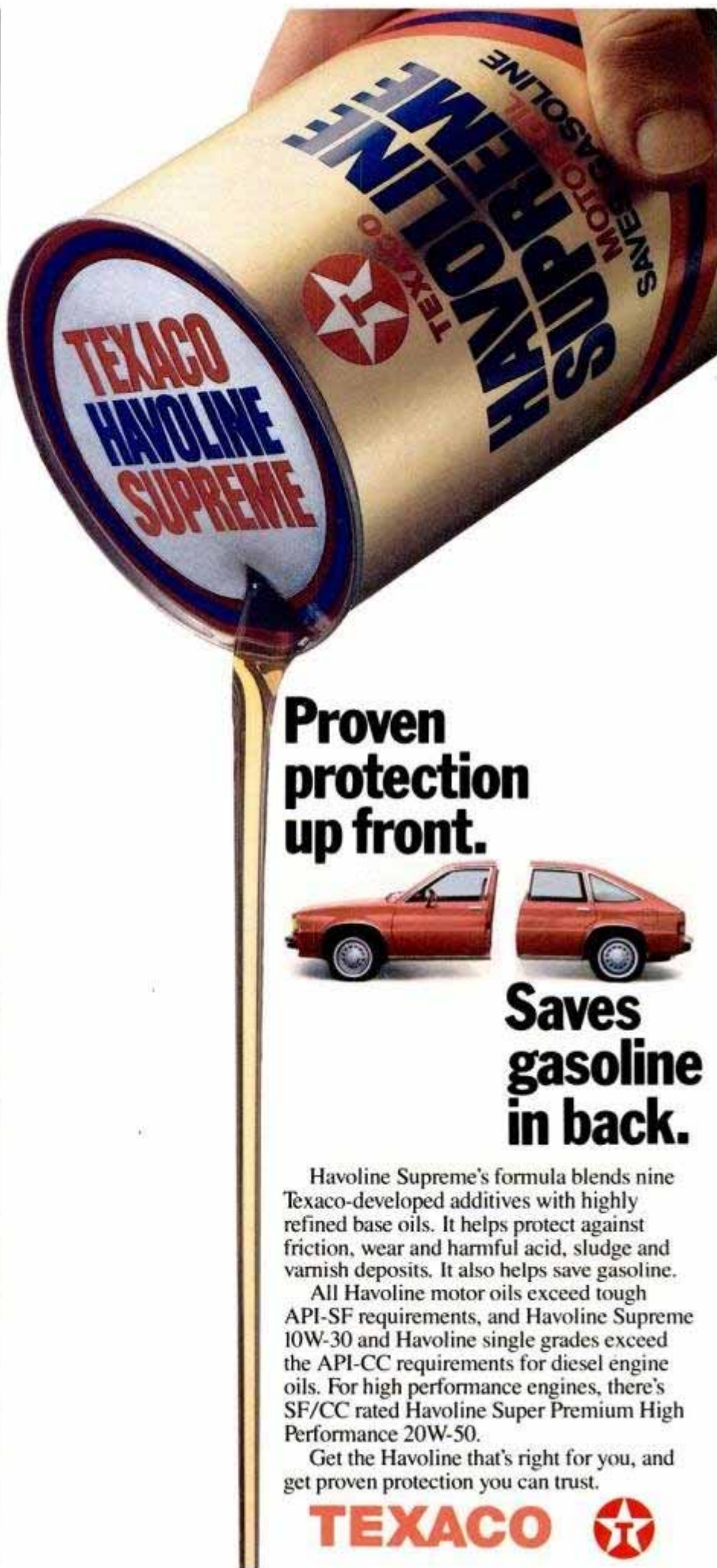
gearing is 5.6 times higher than the lowest. And, PIV's experimental system covers a span of 6.0:1. That's equivalent to a seven-speed manual transmission!

This greater ratio span means the car with the CVT can have deeper gearing on the bottom end and higher gearing at the top end. It can thus accelerate faster in some speed ranges, yet can cruise on the highway at a higher overdrive ratio than any automatic or five-speed currently in production.

The second reason the CVT helps get better gas mileage has to do with the way its microprocessor can be programmed. Keep in mind that almost any modern car with an onboard microprocessor has the "brain capacity"—the room in its memory—for many more functions than it's now called on to perform.

During both acceleration and cruising, the microprocessor can set the engine to run at the rpm that delivers

(Please turn to page 108)



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TEXACO 

AUTOMATIC TRANSMISSION

(Continued from page 107)

maximum torque plotted against minimum fuel consumption. That's something that can't happen with any other type of transmission, and it's the key to good gas mileage.

The microprocessor responds to a number of inputs: throttle position, car speed, engine rpm, pulley gaps and gear selector position. If you program the black box to give you the ideal engine rpm and pulley ratio for every anticipated torque/mpg situation, the CVT responds quickly and correctly.

The Ford CXT-811 has two driving modes. The shift-selector quadrant gives you the choice not only of PRND but also, in DRIVE, of E (for economy) or S (for sport). Drop the lever in E and the car accelerates and runs via a microprocessor program that dictates maximum fuel economy. Put the lever in S, though, and the pulley ratios tend to stay lower—more toward faster acceleration—and the car moves out more quickly. This same S mode can be called upon for engine braking on long downhill runs. I'm told that in the S mode, the CXT-811's performance comes very close to that of a car with a manual five-speed up to 40 mph, and then walks away from it above that.

Ford, experimenting with 20 CTX-equipped European Fiestas, found they were getting 9 percent better fuel mileage at 56 mph than identical cars with manual five-speed gearboxes. Although the CTX's fuel economy tended to drop slightly over and under that magic speed, it always matched or bettered the five-speed's.

Fiat, which doesn't use microprocessor or E/S controls, reports identical fuel economy figures for the Uno-matic and its five-speed equivalent, but with a small penalty in acceleration. Even so, the Uno-matic does give vastly better performance than Fiat's regular automatic.

Operating details

There has to be a way to disconnect the CVT from the engine—a clutch or fluid coupling built into the system. In the Fiat/Ford CVT, clutching is accomplished by two sets of multiplate wet discs spinning in oil. They're similar to the clutches in a normal automatic and are actuated hydraulically. The clutches engage progressively and smoothly over a low, preset engine rev range.

The clutches drive a planetary gear-set. One clutch locks the sun gear to the planet carrier for forward; the other gives reverse by locking the annulus to the gear case. Neutral comes when both clutches disengage. You can choose D, R and N on the shift quadrant via a conventional selector lever.

The German PIV and ZF CVTs accomplish the clutching function through a torque converter, and the Volvo does it with centrifugal weights.

Another CVT add-on has to do with reduction gears. If unreduced CVT rpm went directly into the differential, the differential's gearing would be too high and the ring gear would be larger than practical. So a set of reduction gears with a ratio of around 1.6:1 is interposed. This way, the differential can be carried over from other production models and no new tooling is needed.

Only one side of each pulley moves. In the newest Fiat/Ford CVT, oil pressure within servo cylinders at each pulley widens and narrows the gaps. This pressure is supplied by an engine-driven gear pump that delivers up to 435 psi—very high by automotive standards. But such high pressures are needed to clamp the belt tightly between the pulley halves. Otherwise, there'd be too much slippage and wear under hard acceleration.

CVT belt design

Several different types of steel belts have been tried, and what's amazing about the Fiat/Ford system is that this particular belt is designed to push instead of pull! Unlike the fan belt in your car or the rubber belts in the Volvo CVT, the Fiat/Ford steel belts work in compression, not in tension. That's an important distinction, and its purpose is to prevent drive torque from spreading the driven pulley. (The steel link belts being used by PIV and ZF do pull.)

The Fiat/Ford pusher-type steel belt developed by van Doorne uses two seamless, multilayered, highly flexible flat bands that run side by side and carry what look like hundreds of small, flat, trapezoidal metal spacers between them. These spacers, or links, have horizontal slots by which they ride or slide back and forth on the bands. The bands themselves only guide the links; they don't transfer any torque and thus can't stretch. Individual links are of slightly different thicknesses to prevent resonant whine at high rpm.

When you look at one of these steel belts turning inside a pulley, there doesn't seem to be much surface making contact, yet there's virtually no slippage. That's even more surprising when you consider that the entire system runs in oil, inside a sealed housing.

The secret lies in the clamping force of the pulleys. They clamp the links very hard, the result being analogous to a locomotive getting metal-to-metal traction on very thin rails—sometimes even wet rails—simply by virtue of its tremendous clamping force (weight). Despite these high clamping forces, there's very little energy lost through friction. There is an oil cooler built into the CVT,

much like the one in normal automatics.

The other type of steel belt, the pull-type used by the German firm PIV, looks more like a bicycle chain with U-shaped metal blocks clamped around the outside. Like a bicycle chain, individual links are made up of several figure-8 stampings. Pins tie these figure-8's together, and the pins also hold the blocks on the chain's perimeter. It's not the sides of the blocks, though, that provide the chain's friction surfaces; rather, it's the heads of the pins. The advantage of the PIV belt is that it can negotiate a tighter arc than the van Doorne link belt.

In the case of Ford's CTX-811, the gaps and clamping forces of both pulleys are determined by a microprocessor, which sets the pulley gaps by routing hydraulic pressure via solenoids from one pulley piston to the other. One pulley sets the ratio, the other keeps the belt taut.

Even though the hydraulic pump and reduction gears rob the CTX of some of its power, the system's overall loss isn't nearly so great as in conventional automatic transmissions. Fiat claims an 86 to 90 percent mechanical efficiency for its Uno-matic. That's about 2 percent below a manual gearbox, but roughly 10 percent higher than the average torque-converter automatic.

The future of CVTs

All automakers and suppliers currently involved in CVTs feel these transmissions have tremendous potential. For the time being, CVTs seem confined to fairly small cars, and they adapt particularly well to fwd models. Rubber belts—because they're inexpensive and quiet—will dominate in the micro-mini range. And for now, even steel belts will be limited to cars with engines of under 2.8 liters. As belt and pulley technology progresses, however, there's a good chance that CVTs will show up in larger cars, as well.

One of the immediate concerns of CVT manufacturers will be to get these transmissions to the international markets where automatics dominate. Europeans, frankly, don't care for automatics. They prefer to shift for themselves. Yet Ford and GM are both investing huge sums in French factories that can turn out millions of CVTs each year.

For the "economies of scale" that will make these operations pay, the manufacturers figure on selling most of their transmissions not in Europe, but in America, Japan and Canada, where drivers demand automatics. We in the United States now think of automatic transmissions not as luxuries, but as necessities. That means we're probably going to see a lot of European-made CVTs in American and Japanese small cars very soon. **PM**

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THRILLING 3-D

(Continued from page 72)

using one or two projectors, depending on how they were originally filmed. The 3-D movies of the '50s used "anaglyphic" stereoscopic imaging to separate the left and right views. This is identical to the red/blue or red/green comic books of that era. Each half of the pair is projected through its own color filter.

Special glasses

Viewing the screen without the special red/blue glasses was enough to cause nausea. But with the proper colored eye filters, each eye saw its corresponding view. The brain then assimilated both views into one 3-D image. Anaglyphs, however, cannot separate

images enough. A lot of color overlap and poor synchronization resulted in more eyestrain than enthusiasm.

More recent 3-D films create stereo separation using Dr. Edwin Land's neutral polarizing material made available in 1932. These filters allow light to pass through only on one plane, something like microscopic Venetian blinds. Each projected view has a polarizer in front of it, with its axis of transmission 90° from the other.

Wearing polarizing filter glasses with corresponding transmission angles gives each eye only the view it is supposed to see. The screen has to be silver (aluminized) to reflect polarized light. The results are true separation.

The problems associated with 3-D

(Please turn to page 114)

How To See Your Own Photos In 3-D

If you haven't dabbled with 3-D before, here's a quick way to experiment with stereophotography of nonmoving objects. Using any type of camera, including self-processing models, you take two photos of the same scene from slightly different angles.

After taking one photo, move your camera left or right a distance that depends on how far the subject is from your lens. You can use the following chart as a guideline:

Subject Distance Lens Separation

12-15 feet	4 inches
10	3
8	2.5
6	1.75
4	1.25

It helps to have a shooting platform for your camera. Here's a simple one you can make: Take a scrap piece of wood about a foot long—a 2×4 will work fine. Counter-sink a spiked ¼×20 T-nut through the center of this platform for a tripod mount. Nail a small block of wood across one end of the platform and mark off a scale in inches, starting from the inside of this stop block.

Mount the platform on a tripod and put the camera up against the stop block. Focus on the subject and select the interocular distance. Clamp a second block across the other end of the platform, the specified distance from the fixed block. Now shoot a stereo pair by taking two photos of the same scene, one from each end of your platform.

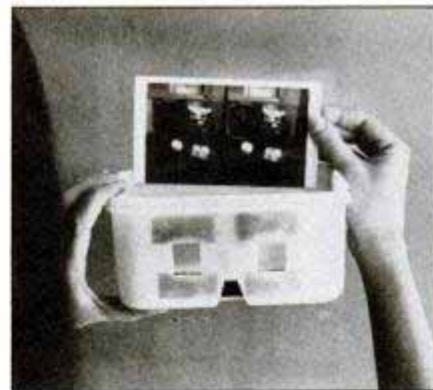
Building a viewer

Unless you have an old stereoscope lying around in your attic, you'll have to build a 3-D viewer to see the effects of your pictures.

Start with two identical convex magnifying lenses (glass or plastic, from a five and dime store) which, when held up to the eye, can focus on something from 5 to 7 inches away.

Now find a cardboard or plastic box at least 6 inches wide and as deep as the focal length of the lenses. Cut the white borders off the photos and glue them side by side to stiff cardboard with rubber cement. Now you should place the two photos at the back of the viewer.

If there's a double image, check that the right image is on the right side. Further fine tuning can be done by sliding one of the lenses left or right until a sharp 3-D picture is achieved.—A.E.



Two photos taken from slightly different angles are mounted side by side and placed in the rear of a box. Eye openings are 2½ inches between centers.



Tape the lenses to the eye openings and mount a black cardboard divider that reaches two-thirds of the way into box.



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THRILLING 3-D

(Continued from page 110)

films include jittering frames, improper setups and, most of all, poor use of the medium.

Twin-camera technique

Currently, two films are playing in Florida which show 3-D at its best. Both are by Academy Award-winner Murray Lerner. *Sea Dream*, shown at MarineLand, was filmed with Spacevision; *Magic Journeys* is playing every 18 minutes at the Kodak pavilion at Disney's EPCOT Center.

Magic Journeys, written and directed by Lerner, involves the audience in a true illusion. Images of clouds, kites and a lion jumping through a flaming hoop literally float between the 54-foot silvered screen and the audience, encouraging the 600 participants to reach out and touch what they see. The film's \$7 million tab for 15 minutes of show is justified in that it sets some high standards and abounds with new technology.

The film was shot with dual 65-mm cameras on Eastman 5247 color negative film. A 35-mm color-reversal intermediate is printed on 70-mm film for projection. Dual projectors are kept in synchronization by a master sound tape, encoded to keep the film-drive servomotors in near-perfect unison.

Magic Journeys sets standards against which all other 3-D films will be compared. It truly complements EPCOT's technology-of-tomorrow theme.

Holography

Holography is a young science conceived by Dr. Dennis Gabor in 1947. But he had to wait for the invention of the laser in 1960 to put his theory to work. A Noble prize resulted in 1971.

Holography is genuine 3-D imaging. Unlike all other processes, which use 2-D images to create a 3-D effect, a hologram re-creates the exact pattern of lightwaves that originally reflected off an object. Shifting your head to the side while viewing a hologram reveals an image of what you would expect to see if it were real.

In a standard setup for making a transmission-type hologram, a single laser beam is split into two beams and spread out by lenses. One half, called the object beam, illuminates the object and consequentially reflects onto the film. The other, a reference beam, showers the film with a steady flow of coherent light. Light reflecting off the object will arrive at various phases, depending on which part (near or far) of the object it is bouncing off of. When the two waves meet, they interact to form a specific interference pattern.

Exposure to film creates a jumble of

light and dark bands invisible to the eye. All of this has to be done without any vibration. Holographic setups are therefore mounted on large, heavy tables floating on air or in a bath of mercury.

After development in standard photo chemicals, this hologram contains information to redirect a beam of laser light to recreate the exact image it originated from. The image seems to float behind the film as if looking through a magic window.

Variations of this basic transmission hologram are called reflection holograms or white-light holograms. They permit viewing in ordinary light but result in a rainbow image. Versions of this type are sold as jewelry.

Combining stereophotography with holography yields dramatic multiplex holograms. These are mounted in circular or semicircular plastic displays that show a 3-D image floating in its center. You can walk around and look behind the subject. Another version of this produces a moving-picture effect. Basically, the subject is filmed conventionally as it rotates in front of the movie camera.

Each frame is then converted to a 1-mm-wide slit hologram on a sheet of holographic film. Thousands of these combine to form 3-D images.

Current developments in holography include color holograms using three lasers, 70-mm movie holograms and a variety of optics that range from interferometers that measure surface variations down to a 10-millionth of an inch to reading the product code on a box of cereal at the supermarket. The Museum of Holography in New York offers an outstanding exhibit with many beautiful examples of holographic art.

3-D television

Within the last couple of years, a number of attempts have been made to revive the old 3-D movies of the '50s by showing them on TV. You needed to use special red/blue glasses to view these films, all of which were specially converted for TV broadcast by 3-D Video Corp. in North Hollywood, Calif. The results were novel, but contained many of the flaws associated with early 3-D films. However, 3-D imaging in TV is not a new idea. Experimenters have been devoting energy toward this for over 40 years.

As in stereoscopic cinema, one or two cameras may be used to create a stereo pair of views. One method synchronizes each of the two images separately to appear on one screen. The right field is created by the odd scanning lines, the left by the even ones. To the naked eye, the image is confusing, but special viewers enable each eye to see its own field. Some experimenters used lenticu-

lar screens stuck to the tube to redirect each set of lines to the appropriate eye. This limited the number of viewers considerably.

Other systems developed in the early '70s sent information about the left/right views on different portions of the carrier wave, something like FM-stereo radio. But, since regular TV changes its video picture only 30 times a second, flickering plagued most of these systems.

The late James Butterfield resolved this problem with the use of two CRTs, viewed through a stereoscope attachment. This type of system is used in 3-D microscopy, surgical and industrial applications. The two separate images may also be projected through polarizing filters onto a silvered screen, as in 3-D movies.

New approaches

A new development announced last December by Stereographics Corp. in San Rafael, Calif., achieves true high-fidelity color 3-D video. The two-camera system results in 120 image fields appearing alternately on the screen every second.

Electro-optical shuttering glasses have to be worn. They synchronize the alternating views with each eye to create a 3-D image in the mind. New viewers eliminate wires to the set by using infrared pulses.

Stereographics Corp. has developed this system around the same band width currently in use for TV. This will allow future transmission through the air, via cable and video recording on existing equipment. This system lends itself ideally to 3-D industrial applications for remote viewing of danger areas (Lockheed just purchased one), computer imaging and arcade games.

Other developments continue in 3-D TV as well. Experiments with 3-D TV viewable without glasses have shown interesting results. One Long Island firm, 3-D Systems, has introduced what it calls Tri-Dimensional TV, which creates the illusion of depth on any color TV regardless of the show being watched. The units will be available locally by this summer for a test market and can be attached in 15 minutes by an authorized dealer.

The circuitry creates a fixed amount of separation of the red and blue/green colors. In addition, a slight time delay is introduced between them. The results we saw on a prototype, using the needed glasses, had some color fringing and caused minor eyestrain, but showed promise if refined. There is a definite illusion of depth created without the use of stereo pictures or special shows. Its application seems to lend itself ideally to the home-video game market as well as music video programs. **PM**



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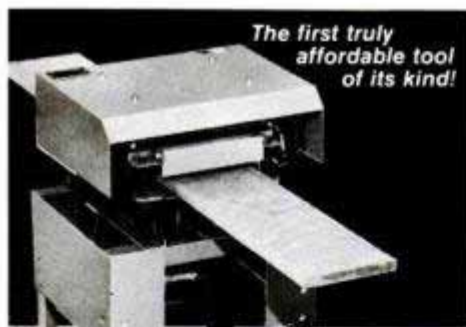
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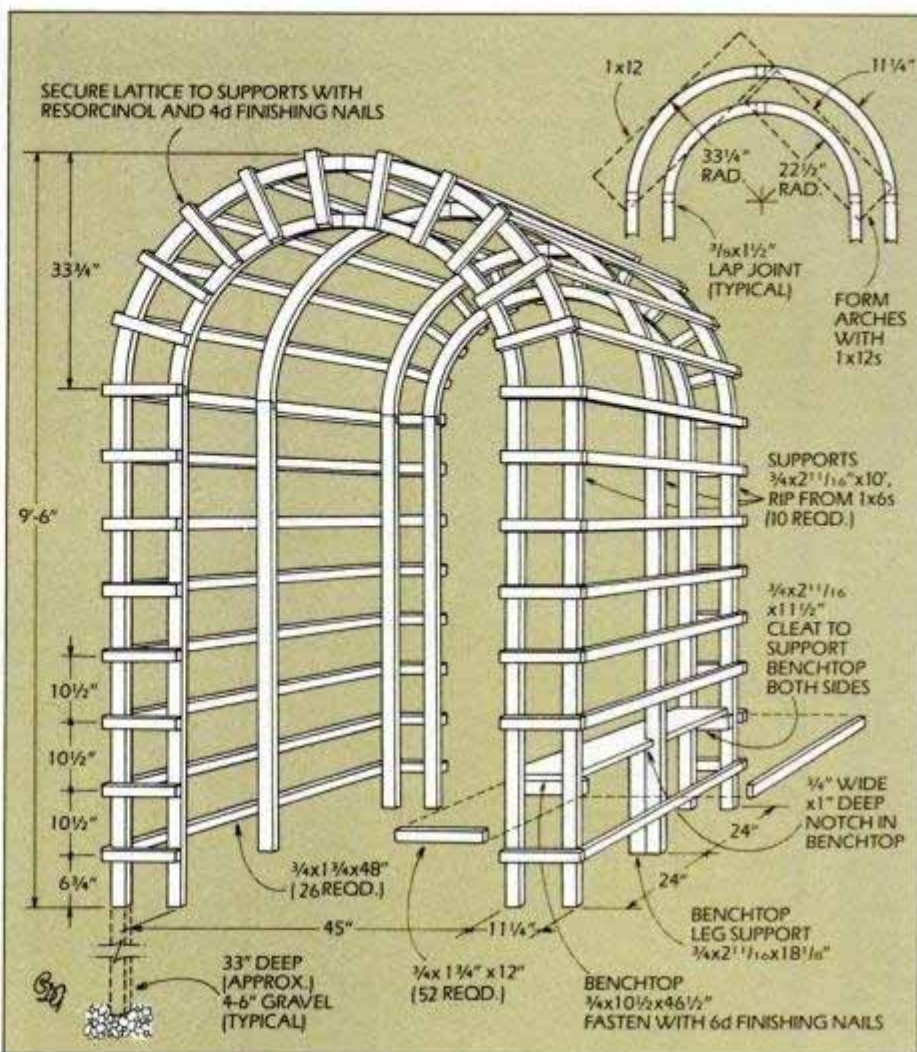
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4 COOL SUMMER SHELTERS

(Continued from page 77)



control joints across the slab every 4 ft. Special tools for making these joints are readily available at masonry supply stores.

Cure the slab by keeping it moist and covered with polyethylene for at least one week. Carefully remove the forms after three days. Don't walk on the surface for several more days.

The posts are 4x4s secured with Simpson strong ties. Use a spirit level to make sure all posts are plumb in both vertical directions. Brace them in two directions with 2x4s while installing the triple 2x4 top plates.

Make the fence in sections. Install each section so the bottom rail rests in the notches cut into the base supports.

The roof is a square hip roof with a 7-in. pitch (7-in. rise in a 12-in. run). Construction is of 2x4 and 2x6 framing skinned with 1/2-in. CDX plywood sheathing. A shaped finial to which the hip and jack rafters are attached takes the place of a ridge board.

The plumb cut for the hip rafter is 50°-30 min.; its seat cut is 39°-30 min. Trim 9-ft. hip rafters to length, notch and toenail them to the finial and to the

plate with 10d nails. The plumb cut for the jack rafter is 40°-40 min.; its seat cut is 49°-20 min. Trim 7-ft. jack rafters to fit, notch and toenail to the finial or hip rafters with 10d nails. Cut 12-ft. hip rafter collar beams, then cut cross laps and face-nail to the hip rafters with 12d nails. Cut jack rafter collar beams with crosslaps and face-nail to the jack rafters with 12d nails.

Nail on the sheathing with 8d common nails. Apply 15-lb. building felt and shingles to the roof. A 1x4 soffit and crown molding complete the structure.

2 Attached arbor

Your house framework does half the job of supporting this attached arbor. While the structure is relatively simple to build, it can add to your outdoor living enjoyment and enhance the landscape.

For safe support, sink the posts at least 4 ft. into the ground and below the frost line. Dig holes with a clamshell posthole digger. For drainage, rest the posts on a flat stone and fill the area

with gravel to within a foot of ground level. Use a pipe with a capped end to tamp it in place. Brace the posts with diagonal 2x4s, making sure they are plumb in two directions, then pour the concrete collar.

Cut the ledger to size and carefully mark the arbor rafter locations on it. Secure the ledger to the wall studs of the house with 4-in. lagbolts.

The rafters and crosspieces fit together with cross-lap joints in an egg crate configuration. Cut all rafters to size, canting one end of each. Carefully mark and cut notches in the inside rafters for the crosspieces. You can cut the notches by making successive passes with a table saw and cleaning waste with a sharp chisel.

Cut the crosspieces to size. Carefully mark and cut the notches. Test-fit parts on the ground. Now cut the beam and mark rafter locations. Then bolt it to the posts with T-braces and lagbolts.

Install the rafters, toenailing them to the ledger and to the beam with 8d common nails. Or consider installing metal connectors on the ledger and hanging the beams in them for extra support. Install the crosspieces by toenailing them with 8d nails. Finish with paint to match the house trim, or as desired.

3 Latticed enclosure

This little nook located in the backyard is a pleasant spot to pass the time with friends. It's built on a 4x5-ft. floating concrete slab. For tips on pouring the slab, see the information on how to build the gazebo.

Fasten double 2x4 plates to the concrete with 6-in. anchor bolts. Bolt the 4x4 posts and the vertical 2x4s flanking the entry to the plates with steel post anchors. Check that the posts are plumb in two directions and brace with diagonal bracing. Nail top plates to the studs with 16d nails.

The seat is supported by 2x4s along front and back edges, joined in cross laps. Cut notches for these joints, then assemble and face-nail the 2x4s to the posts with 8d common nails. Miter cut seat members and nail them to the supports with 8d nails.

Nail 3/4 x 3/4-in. lattice stops within the posts, making sure the stops are plumb. Install 1/4 x 1/2-in. lattice panels, or individual lattice strips with 4d nails and resorcinol glue. If you install individual pieces, use a section of lattice as a spacer.

Cut the six 2x4 rafters and ridge board to length. Shape the rafter ends as needed. Nail the rafters to the ridge board with 10d nails. Nail the rafters to the top plate with 10d nails. Cut 1x3 gable trim and 1x8 siding to size and secure to the end rafters with 8d nails.

Now, cut 1/2-in. CDX plywood for the roof sheathing. Secure it with 8d nails. Staple 15-lb. felt to the roof and apply fiberglass shingles or other finished roofing.

The finishing details complete the enclosure. Install bed molding under the roof overhang with a 3/4 x 3/4-in. cleat. Install 1x2 1/2-in. base molding along the bottom of the enclosure. Shape corner pieces for the top and bottom of the posts and secure them with resorcinol and 10d finishing nails. Make sure you set the heads and fill the holes.

4 Arched trellis

This arched trellis can support a full growth of vines. Our trellis is cut to fit over and conceal a backyard garbage shed. The lower part of the arched supports is 3/4 x 2 1/16-in. pieces ripped from 1x6s. Cut 3/8 x 1 1/2-in. lap joints in the vertical members by setting the blade of the table saw to a 3/8-in. depth and making successive passes.

The top part of the arched supports is made of two 1x12 boards. First, cut the vertical members. To plot the arches on the 1x12s, use a pencil on the end of a string, with the other end of the string secured and at proper radius. Cut out the arches on a band saw or with a sabre saw. Position the arch members over the vertical members and use a sliding T-bevel to mark carefully the angle of the lap joints. Cut the top and bottom lap joints.

Glue and clamp the arched support members and let the glue set. In the meantime, cut the 3/4 x 1 3/4-in. lattice strips. Cut 26 strips 48 in. long and 52 strips 12 in. long.

Mark off the location of the shorter lattice strips on the two front arches. Secure the lattice with resorcinol, nailing the lattice with 4d finishing nails to make sure the wood parts make good contact. Mark and install the shorter lattice strips on the back arches.

Working with an assistant, align the vertical supports. First, glue and nail several upper lattice strips across the vertical supports and several lower strips on both sides of the supports. Then fill in with the remaining lattice strips.

Dig the postholes and fill the bottom with gravel to a 4 in. depth for drainage. Set the trellis in place and rock it slightly to seat it. Check that the supports are plumb in both directions and fill the holes, packing the earth. If the trellis is next to a fence, use lagbolts to attach the trellis to the fence for additional support.

Cut the bench and bench cleats. Notch the bench to fit over the center support. Install the cleats and bench with 6d nails. Finish as desired. **FM**

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GARDEN BENCHES

(Continued from page 79)

Park bench

Begin by cutting all the parts to the lengths shown. Use 2×3s for the seat slats and stretcher, 2×4s for the front legs, backrest, leg braces and seat frames, and 2×6s for the back legs. Then shape the eight frame pieces as shown in the cutting pattern using a band or sabre saw. Note that the frame pieces are assembled with 3/4-in.-deep half-lap joints. The stability of the bench depends upon tight-fitting joints. Loose, sloppy joints will allow the bench to rock.

An easy way to mark the half-lap joint locations is to first clamp together the four parts that form each bench frame: the back and front legs to the seat frame and leg brace. Be certain that the two legs are on the outside of the other two parts. Then use a pencil to mark the seat frame and brace where they meet the legs.

Disassemble the frame and cut the half-lap joints where indicated by the pencil lines, using a radial-arm saw, table saw or router. Sand all the parts before assembly.

Next, reassemble the two bench frames using waterproof resorcinol glue and 1 1/2-in. No. 14 flathead screws. Drive the screws in from the inside of the bench—that is, through the half-lap members and into the legs. *Note:* You must be certain that you countersink and bore screw-shank clearance holes for every screw that is used in this bench.

Bore the screw locations in all the seat slats and both backrest parts. Each part is attached by two 2 1/2-in. No. 8 flathead screws on each end. The seat and the backrests should overhang the seat frame by about 8 in.

Note: The backrest screw locations are 3/4 in. closer to the board ends than are those of the seat slats because of the offset due to the half-lap joint. For example, if the seat-slat screws are 8 in. from the end, bore the backrest screw locations 7 1/4 in. from the end to fall on center on the back leg.

Next, round the top edges of the seat slats and backrests using a router and a 1/4-in. rounding-over bit. Sand all parts smooth, using first 80-grit abrasive paper and then 120-grit. Now you should screw the slats and backrests to the frames, but make sure you leave about a 1/4-in. space between each slat. Be certain that all screwheads are below the wood surface.

Finally, cut a 2×3 stretcher to fit between the leg braces. Fasten the stretcher with four 3-in. No. 12 flathead screws. Complete the bench by applying two coats of exterior stain.

—Dave Smith

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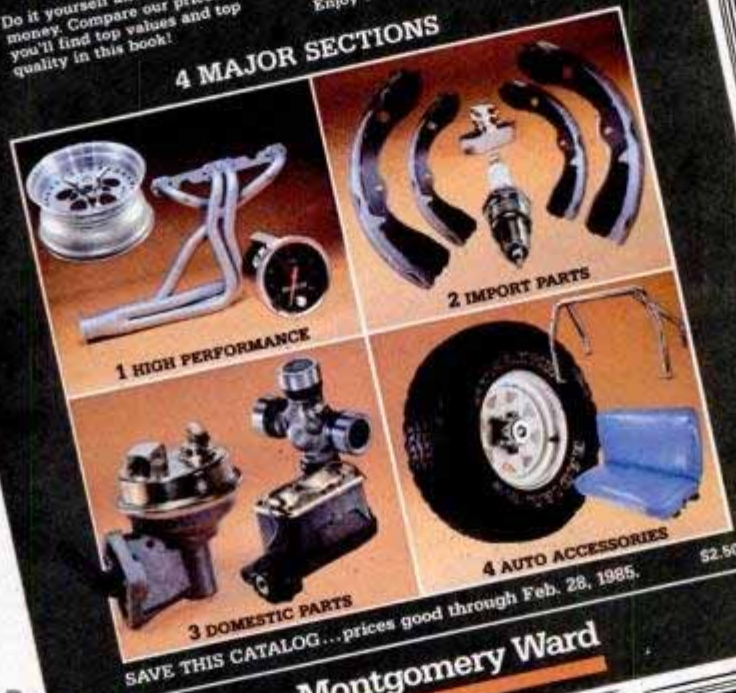
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Grow PM's Experimental Garden

Experts from the New York Botanical Garden helped PM develop two exciting genetic experiments anyone can do.

BY BRUCE RIGGS AND DAVID T. SCHEID
New York Botanical Garden

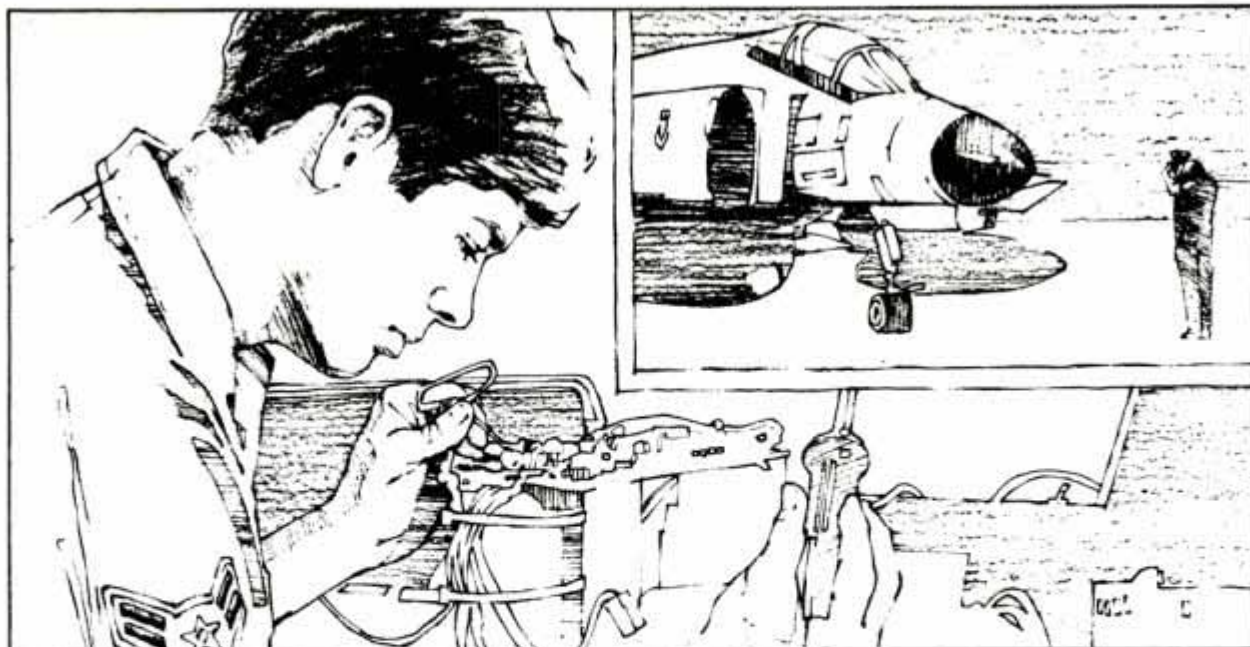
Genetics. The word itself sounds awesome. It's a fast-growing science that has grabbed the attention and imagination of workers at the nation's most prestigious universities and labs. Yet a broad field of this science is dominated by amateurs. And anyone with an interest in gardening and the ability to follow a basic recipe can make an important contribution.

Just ask Mrs. F. Leighton (Kathryn) Meserve of St. James, N.Y. She not only made some major contributions to the science of horticultural genetics (plant cross-breeding), but she also turned her backyard hobby into a profitable business. She crossed English Holly (*Ilex aquifolium*) with Prostrate Holly (*Ilex rugosa*). The offspring has a deep, glossy, bluegreen foliage. In

(Please turn to page 122)

In one experiment, you'll cross long, slender White Icicle radishes with round and red Crimson Giant radishes (top). The result will be a round, pink radish whose plants are shown in our test garden (above, right). For a real challenge, try zinnias (right).

PHOTOS BY DEREK FELL



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A GREAT WAY TO SERVE

GROW PM'S EXPERIMENTAL GARDEN

(Continued from page 120)

1964 she patented two "blue hollies": Blue Boy and Blue Girl. And in 1972 she patented Blue Prince, followed by Blue Princess and Blue Angel hollies.

The new species, among the most hardy evergreen hollies, bear her name: Meserve Hollies (*Ilex x Meservae*). And she is paid royalties by the nurseries that sell this species.

You can complete a classic genetic experiment this summer by following our simple directions. And once you've obtained a feel for how it works, you'll be ready to take off on your own in search of a new hybrid species. We'll help you to get started in that as well.

A pioneer's work

To help build your confidence and understanding, we have devised a simple experiment calling for a 3x3-foot plot. This will be an adaptation of Gregor Mendel's 19th century experiments that helped get the modern science of genetics started. He worked with garden peas, but our adaptation calls for two varieties of garden radishes. Because they have a fast growing-season, radishes will yield results in just one summer's work.

Before you dash off to the garden supply shop, here's a brief rundown on the Mendel experiment: The Augustinian monk planted varieties of peas which he marked for identification in a small garden plot. Some of the peas had white flowers while others had colored flowers. Some were short (18 inches), while others were tall (80 inches).

He carefully crossed a tall variety with a short plant and noted that all the new generation were tall. (He called the cross F1. Our drawings use the designation TT or Tt to emphasize the height factor for tallness).

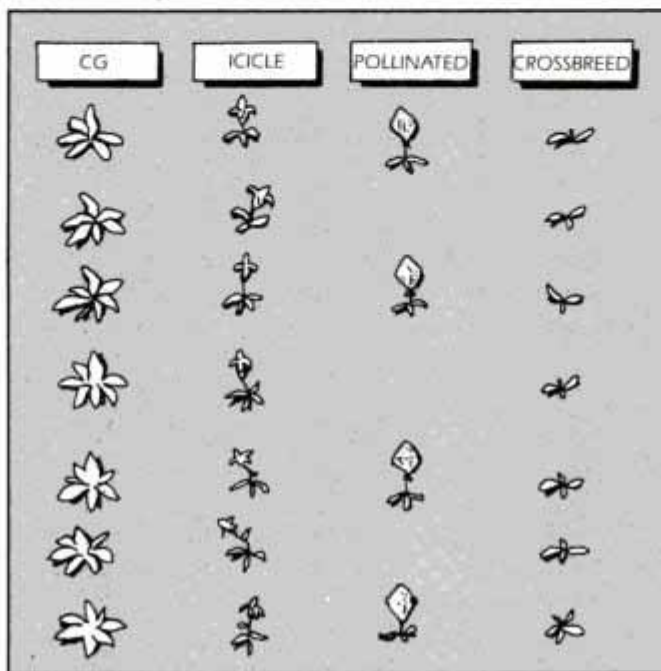
In the next generation, he crossed the hybrids and got a mix of short and tall plants—787 tall and 277 short plants for a ratio of 3 to 1. Following up his initial work, Mendel found that the tallness was uniformly dominant over the shortness. He now concluded that factors for tallness and shortness occurred in pairs. The traits of both factors—later called genes—showed up in the future generation in a way that followed the 3 to 1 ratio.

Your own equipment

You can set up your own genetic experiment very easily. To start with,

go to any seed supplier or catalog house and buy packages of Crimson Giant and White Icicle radish seeds. Crimson Giant has a globe shape and crimson skin. White Icicle looks like an icicle—it's long and white. In our experiment, we'll cross the two radishes to produce a long, rounded, pink radish.

After selecting and marking off your experimental plot, add some compost, leaf mold or peat moss to make a loose soil mix and rake the surface smooth.



Two starter species are planted in separate rows. Pollinated plants are thinned. A new row is needed for crossbreeds.

Then carefully mark and plant two rows of each variety within the plot. Follow planting and growing directions on the seed package, thinning each row as necessary (you'll be able to eat the radishes that are thinned out.) Grow several plants in each row to the flowering stage. Select the healthiest, most vigorous and best-looking plants of each variety to grow to flowering stage.

As each flower begins to open, carefully remove the six male parts (sta-

mens) from the flowers of one of the varieties (see drawing on page 124). Be sure to leave the rest of the flower on the plants. Remove some fully open flowers from the second variety and brush the pollen from the stamens of that plant onto the female parts (stigma) of the flowers from which you've removed the stamens. (Note: For simplicity, our art shows the breeder holding just the stigma without the flower.)

Best time to pollinate

Cover the newly fertilized flowers with small paper or cheesecloth bags tied at the base to keep away undesirable pollen and insects. The best time to pollinate is the day the flower opens or the day after. The potential for getting a successful crossbreed decreases each day after the flower opens. Thus it is very important to visit your experimental garden every day as the plants come into flower.

After covering the plants, watch for seed pod development. The seed pods will be formed as the flower withers and you'll see the seeds formed inside the pod. When the seed pods are dry, carefully remove them from the plants. Now prepare two new rows, cleared of plant life and raked as before. Sow the new seeds, water and care according to directions on the original seed packets and in about

30 days you should have a long, rounded pink radish.

Even if you never go any further with your experimental garden, you'll enjoy a good harvest of radishes and will have grasped some of the basics of plant genetics. If you want to read a little more deeply about this subject, we suggest *Plant Breeding And Genetics In Horticulture* by C. North, published by John Wiley & Sons, New York, N.Y. (1979, Halsted Press).

First blue zinnia

If you decide that genetic experimentation is your cup of tea, we have a challenge for you. Using the same small garden plot, try producing the world's first blue zinnia. The process is similar to the radish experiment, but it takes a bit more patience and there are no guarantees of success.

The production of a blue zinnia is of interest to The New York Botanical Garden. In fact, the first seeds sent to the Botanical Garden, in care of *Popular*

(Please turn to page 124)

Try producing the world's first blue zinnia. The first seeds sent to the New York Botanical Garden, in care of *Popular Mechanics*, that produce a blue zinnia not less than 1 1/2 inches in diameter will be featured in an exhibit at the Garden.

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I tried all those "Get Rich" gimmicks that are advertised, that never tell you anything until you've sent them your \$25, and then you find out their gimmicks were not for you. Well, I've tried them all and I'm still not rich.

All I ever wanted was something I could do in my spare time with my hands, make a little money and enjoy myself and not have to buy \$3000 worth of tools or merchandise to do it.

Believe It Or Not

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hours of work is selling for over \$228 in the stores. I can sell my chaise lounge for anything I think my labor is worth. For once, the big manufacturing companies cannot compete with me or you on prices. You will find you will have more orders than you want!

Where can you buy the P.V.C. Pipe?

You can buy the P.V.C. pipe from any local hardware store to start. Plus I will supply you with the names and addresses of cushions and pipe manufacturers who will sell to you wholesale, plus I will supply you with my shop manual and six detailed shop drawings with pictures and measurements of six different designs.

Do you need my shop drawings?

No, you don't need my shop drawings unless you want to save hundreds of hours of trial and error work and thousands of dollars that I had to spend before I finally

found the right design and measurements and tricks to the manufacturing of P.V.C. pipe furniture. I only wish that when I started, I could have bought these shop drawings and I would have gladly paid \$100 for just one of them.

I will pay you!

Yes, I will pay you \$25 for any unique design shop drawing that I can use in my collection and workshop manual.

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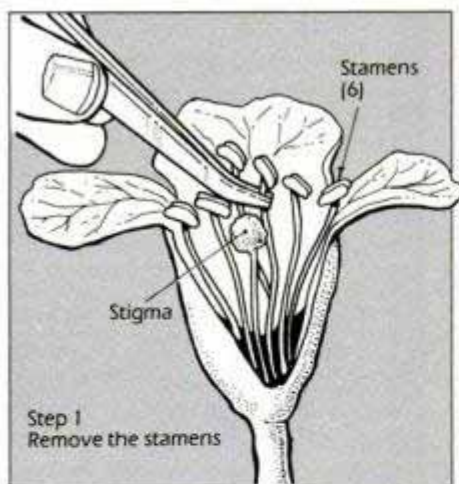
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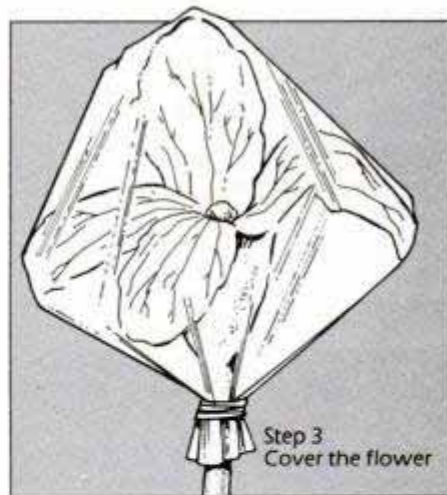
GROW PM'S EXPERIMENTAL GARDEN (Continued from page 122)



Radish experiment begins with removal of stamens from the flowers to be pollinated.



Brush pollen from the other species onto stigma of flowers with stamens removed.



Then cover the pollinated plant with a plastic bag to keep out any contaminants.

Mechanics, that produce a blue zinnia not less than 1½ inches in diameter will be featured in an exhibit at the Botanical Garden. (Blue is defined as "fan 3, page 111A" of the Royal Horticultural Colour Chart published in 1966 by the Royal Horticultural Society, London.) If we show your plant, you'll be credited as the discoverer.

To start your blue zinnia experiment,

get a package of zinnia seeds of mixed color and plant the seeds in a plot prepared the way you did in the radish experiment. Make sure that you thin out the weaker plants, leaving the healthier zinnias.

At flowering, choose plants with dark red to purple or lilac coloring and allow them to "self-pollinate." This can be done either by hand, following the

process used for the radishes, or you can leave only the flowers of desired color in the plot and let them pollinate themselves.

Allow the self-pollinated flowers to develop and ripen seeds. Plant those seeds again and begin the process of selecting flowers from the next generation that have the bluest coloring in them. Pollinate the next generations in

the same way until you have achieved the desired color.

Remember, the color won't be considered blue unless it matches the Royal Horticultural Society's color chart. (If the chart isn't in your local library, contact any nearby botanical garden, horticultural society or university botanical department).

Pure science

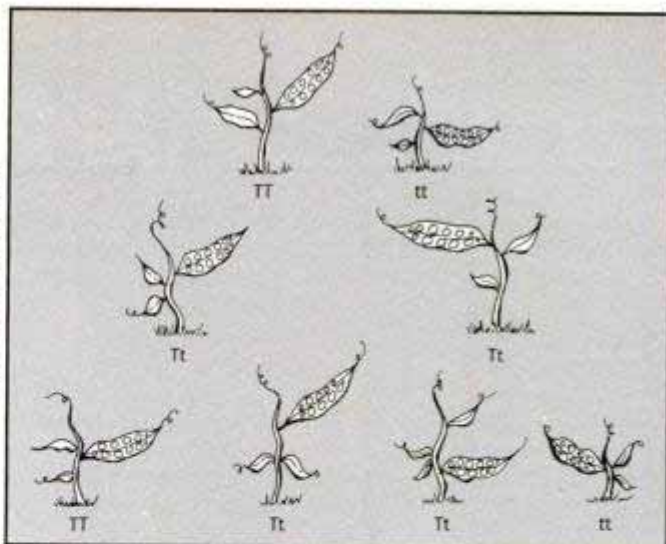
Many people have shown an interest in plant breeding for other than display purposes. Some are interested in pure science: Barbara McClintock won the Nobel Prize in 1983 for her work with corn. She proved that genes are not fixed to rod-like chromosomes—which hold the genes within individual cells like beads on a string. Instead, her experiments showed, genes can move from place to place on a chromosome.

ABOUT THE AUTHORS

Bruce K. Riggs, executive assistant to the vice president for horticulture at The New York Botanical Garden, is a graduate of the University of Vermont's School of Agriculture.

David T. Scheid, vice president for horticulture at The New York Botanical Garden, is a graduate in horticultural science from Ohio State University and the University of Delaware.

In Mendel's experiment, tall pea plants were crossed with short plants (top), producing tall plants with mixed genes (second row). Crossing these produced three tall plants and one short plant.



Her discovery of "jumping genes" is now beginning to explain some of the mysteries of hereditary traits.

Some back-yard geneticists are interested in preserving older seed stocks. This group of people, referred to as "guerilla gardeners," are committed to growing and bartering seed of fruits, nuts, grains, vegetables and ornamentals that may no longer be available from seed suppliers. If you should find that your current crop of tomatoes doesn't have as much flavor as the ones you remember from your youth, such a

group might help you re-establish the crop you loved best. One of the most active groups is the Seed Savers Exchange, Kent Whealy, Director, Route 2, Princeton, Mo. 64673.

If you plan to try producing the first blue zinnia, or if you have a question on genetic gardening experiments, write: Genetic Garden, Popular Mechanics, 224 West 57 St., New York, N.Y. 10019. The volume of mail may prevent us from making a personal reply, but we will try to answer your questions in our Letters column or in a future story. **FM**

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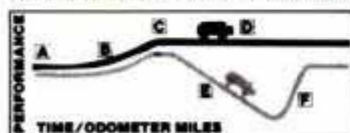
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Chart shows... how TUFOIL improves and maintains high performance levels in new cars and helps restore older cars to their best performance level.



A. Performance level of Black and Grey cars when new. B. Improvement in performance as both cars break in. C. Further improvement of Black car's performance when TUFOIL is added. D. Regular use of TUFOIL in Black car significantly slows decline in performance through age and mileage. E. Decline in performance of Grey car with age and mileage without use of TUFOIL. F. When TUFOIL is added to Grey car, performance dramatically improves.

of Grey car with age and mileage without use of TUFOIL. F. When TUFOIL is added to Grey car, performance dramatically improves.

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*U.S. Patents No. 3,933,656; 4,127,491, & 4,224,173. Other U.S. and Int'l. Patents Pending.



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PM'S TIME MACHINE

75 YEARS AGO: June 1909



Acetylene shells explode.

Hot shell game

Last month an article in this magazine explained the danger in which a battleship was placed when using her searchlights to pick up an enemy boat. Now for the next move on the war board: The Germans are experimenting with acetylene shells, which are fired as far as six miles from a special gun. Upon striking the water, a tube admits the required amount of water to the carbide, producing sufficient acetylene gas to make a light of 3,000 candle power.



Greener housing

A greenhouse or conservatory made as a lean-to forms an ideal house for the gardener. The foundation can be best made from concrete blocks set on a concrete base made in a trench.

Calling all cabs

The number of taxicabs in Paris at the beginning of this year was 2,937, while the number of horse cabs was 8,790. Twelve months previous the number of taxicabs was 1,465 and horse cabs 9,608.

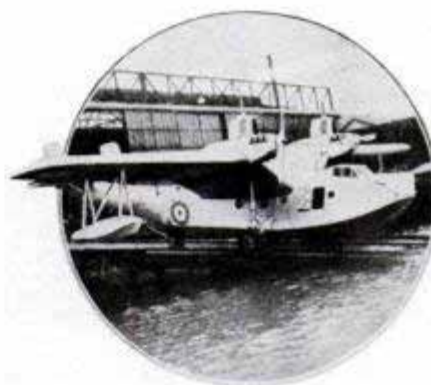
50 YEARS AGO: June 1934



Airborne rainbow is reported.

Rainbow's height

A few transatlantic flyers and other aviators have been lucky enough to see the sight, among them Miss Amelia Earhart on her first crossing of the Atlantic. Late in the afternoon of the first day she saw ahead, not a rainbow, but a rain-circle lying flat upon the top of a fog bank below. The ship was then flying at an altitude of between 4,000 and 5,000 feet and all around the circle of luminous colors tumbled a mass of clouds of varying hues lighted by the rays of the evening sun.



Britain's new flying boat

Great Britain is experimenting with a giant military flying boat powered by two steam-cooled engines. The wings greatly resemble those of a bird in flight.

Slower earth will mean longer days

Millions of years hence, the day will be as long as the month, due to tidal friction on the earth's

rotation. The earth always will present the same hemisphere toward the moon.

25 YEARS AGO: June 1959



PM dives with the Navy.

Dive and shoot

Yesterday they handed you a "routine" assignment: Ride a submarine's deck to 10 fathoms, filming the dive in 35 millimeter color. Now, alone on the sub's seaswept bow, you're poised for the plunge—your face mask set, your breath timed to conserve the bottled air strapped to your back, your hands tense on the camera. "Take 'er down" you signal, as you trigger the camera. There's a roar as the sub sinks.



A raft and a rake

With a hayrake on the front and outboard motor on the rear, a home-built raft swoops cut weeds from New Jersey resort lakes. It can pick up 40 loads an hour. It's preceded by a water-weed mower.

Mailing bricks

Ever hear of anyone ordering bricks by mail? The town of Vernal, Utah, did. That's how Vernal built its bank. All 50,000 bricks that went into this two-story, 97 by 70-foot building were shipped by Uncle Sam. In 1916, directors of the community ought to have a modern bank. But the nearest brick kilns were at Salt Lake City. Because of treacherous roads, freight haulers asked \$3 per hundred.

PM



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STOP

Statistical Operations Processor

We're particularly proud of that quote because it credits ESCORT with more than just industry-leading performance. Just as we designed ESCORT to be the best detector possible, we knew there had to be a way to take better care of customers than the usual retail distribution system. That's why we have no dealers. From the beginning, we've sold all ESCORT's direct from the factory.

Informed Source

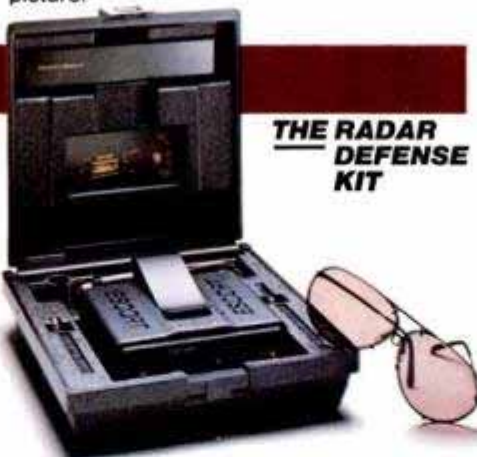
You see, we know how difficult it is to buy a camera or stereo component, or any precision gear. Every store has different prices so you feel obligated to shop around. Then you have to wait for a salesman. He may not know much about the products or may try to get you to choose another brand. And the week after you buy, they go on sale.

We don't want any middlemen speaking for us. When you're buying precision electronic products, we think you'd prefer to deal with experts. Dial our toll-free number and you're talking to the factory: **One Microwave Plaza**. All of our engineering, manufacturing, sales and service happen under this one roof. The buck stops here, you might say. And you always know where to find us.

No Comment

If you've ever taken any high-tech equipment back for service, you may have noticed another problem with retail distribution. Once in a great while, the dealer can fix the equipment. But sometimes they fix it wrong, or say they can't get parts and try to sell you a replacement.

Or you find they "don't carry that brand anymore;". Then you're stuck with the task of tracking down another dealer, or trying to deal direct with a factory that isn't set up to serve consumers. And if the manufacturer happens to be in another country, well, you get the picture.



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FIRSTHAND REPORT



Driving Nissan's New 200SX

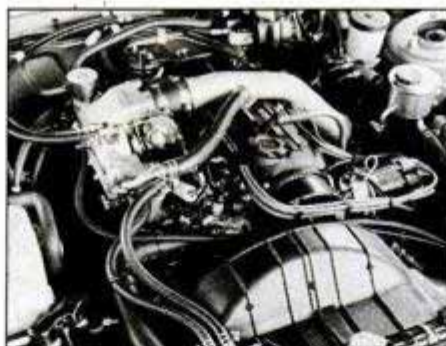
Restyled bodies live up to sporty image with turbo and suspension options.

BY MICHAEL LAMM
West Coast Editor

Nissan recently launched its second-generation 200SX—the first big redo since this series began in 1979. It's very much the same car, yet interestingly different, with noticeable styling changes and some mechanical improvements.

The two traditional body styles remain: notchback and hatchback. Both now sport hidden headlamps and semi-concealed wipers. The new 200SX also lists two engine sizes—a normally aspirated 2.0 liter and a 1.8 turbo. Both use port injection, and the 2.0 is the same engine that powers the Stanza.

The '84 200SX is offered in three series: Deluxe (base), the luxurious and generously equipped XE and the performance-oriented Turbo. You can get the Turbo only in the hatchback which, when so equipped, includes an independent rear suspension system, four-



Crossflow cylinder head requires long over-engine duct for turbo and extra hood bulge for clearance. Nonturbo models get flat hoodline, cleaner overall looks.

wheel disc brakes, 15×6-inch alloy wheels, special hood, fiberglass rocker extensions, a rubber rear spoiler and special interior trim.

Up to now, the sporty but essentially bland 200SX served Datsun as the car of the secretary. The new Turbo aims to counter that image by pumping some muscle into the nameplate. Nissan feels it can attract more male buyers with the Turbo's extra punch, and the company's U.S. product planners project that 65 percent of future 200SX sales will be the hatchback. This reverses the body-style ratio of the previous generation.

Both engine sizes are scaled-down, lightened versions of Nissan's CA-18

ohc Four which, in 1982, went to 2.2 liters (2,187 cc) and took on an eight-plug, NAPS-Z aluminum head. From 1979 to '82, this engine had been 2.0 liters, and it's back to 2.0 for 1984.

Horsepower for the normally aspirated version remains 102 as before, but torque is down by 13 lb.-ft. The redone engine now uses a cogged rubber cam belt instead of the previous chain.

The 1.8 turbo engine cuts displacement even further by reducing both bore and stroke, but horsepower and torque stand at a healthy 120 @ 5,200 rpm and 134 @ 3,200, respectively. The turbo unit has a water-cooled center bearing to ward off "hot coking" after engine shutdown.

Standard gearbox for all series is the manual five-speed, with a four-speed overdrive automatic optional. The automatic uses a lockup torque converter.

Driving impressions

As expected, the turbocharger makes quite a difference in the 200SX's performance. It's what this vehicle needed all along. With it, the car becomes, for the first time, interesting to drive. Without the turbo, performance certainly

(Please turn to page 130)

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DRIVING NISSAN'S 200SX

(Continued from page 128)

isn't bad, but you're left with just another pretty face.

Turbo boost comes in at around 2,000 rpm and moves almost immediately to the maximum 7.5 psi. While this doesn't exactly raise your feet off the pedals, you get a very gratifying shove in the back. You're talking 0-to-60 mph in the low 11s with the turbo and in the high 11s without it.

The five-speed upshifts easily, but in downshifting I had some trouble finding third. The gate's a little vague coming down. I'd probably get it right with practice. I also noticed some clutch chatter in one nonturbo 200SX but, by and large, both engines make this a very easy, cooperative, pleasant car to drive.

Rack-and-pinion steering replaces the former recirculating-ball type, and I found the new system much more responsive and positive, especially on center. Power assist is again standard,

THE PM REPORT CARD

	GRADES		COMMENTS
	TURBO	NON-TURBO	
Acceleration	B	C	Fairly strong on turbo; average without.
Handling	B+	B	Lower profile tires on Turbo give it an edge.
Braking	A	B	Turbo models have 4-wheel discs.
Steering	A	A	New rack and pinion gives good feel despite power.
Transmission	B	B	Downshift to 3rd sometimes tricky.
Ride	A	A	Very comfortable on both types of rear suspension.
Fuel economy	A	A	EPA says 29/42 max.
Seating	B	B	Butt still sits too low. Sport seats should be available on Turbo.
Vision	B	B	Bad veiling glare from instrument panel; otherwise fine.
Gauges/controls	B	B	Optional digital instruments harder to read than analog.
Ventilation	A	A	Good with windows open or shut.
Noise @ 55 mph	B	B	Amplly silent, but engine (especially Turbo) makes some noise.
Cargo capacity	A	A	Excellent for this car's size and purpose.
Engine serviceability	B	B	Looks good.
Fit and finish	A	A	Looks good.

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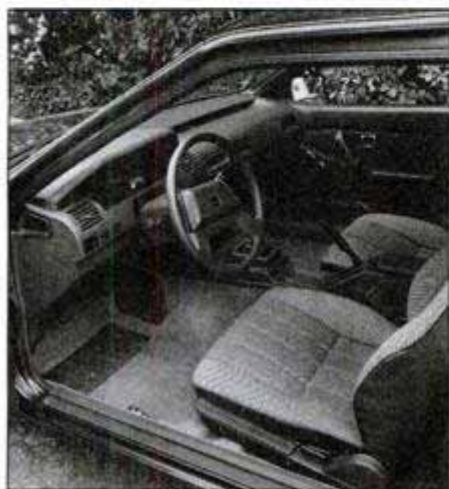
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but it's not overboosted, so you get plenty of road and cornering feel.

The 200SX handles well under all normal conditions, and on the road (as opposed to race track), I frankly couldn't feel any difference between the normal live axle and the Turbo's independent rear suspension. If there is a marked difference in the way the Turbo handles, credit the bigger wheels and tires. The tires are 195/60HR-15s instead of 185/70SR-14s.

Both rear-axle setups use coil springs, the Turbo's independent system using the 300ZX's four semi-trailing arms and gas-filled shocks. Except for stabilizer bar and spring rates, the 200SX Turbo and the 300ZX's rear



Standard seats (shown) are improved, but the optional sport seats are better yet.

suspensions are identical. The solid axle, on the other hand, uses a novel, fluid-filled lower bushing for improved isolation and vibration damping. Front suspension is by MacPherson struts.

Interiors have been totally redesigned, with two different instrument panels and revised seats. Even the standard buckets now have a lumbar adjustment. It's a feature I thoroughly appreciate but, as in previous 200SXs, the bottom cushion slopes down toward the rear and, in my opinion, positions

the coccyx too low. Unfortunately, there's no way to raise this butt bucket without putting spacers under the seat tracks. If it's any consolation, '83 200SX seats were worse.

There is, however, a sport seat option, very much like the 300ZX's, with electrically controlled adjustments for wings, thighs and lumbar. This is a lot better seat, but here I found *too much* lumbar support. And, unfortunately, you can't get the sport seat in anything but the luxury XE series.

The standard analog instrument panel is fine except for bad veiling glare in

the windshield. I don't care for the optional digital instrument cluster, but then I've never liked the digital instrument panel in any car I've ever driven. As a final criticism—and this is again very personal—I can't get used to Nissan's (or any carmaker's) voice synthesizer.

In summary, the 200SX is again a very nice car: comfortable, roomy, well equipped and appointed, beautifully built and nicely behaved. It's an automobile anyone can drive with pride and confidence, and the turbo now gives it clout.

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NISSAN 200SX COMPARISON

	1983	1984
Standard engine displacement (cc/cu. in.)	2,187/133	1,974/120
Standard horsepower @ rpm	102 @ 5,600	102 @ 5,200
Standard torque @ rpm	129 @ 2,800	116 @ 3,200
Turbo horsepower @ rpm	—	120 @ 5,200
Turbo torque @ rpm	—	134 @ 3,200
Wheelbase (in.)	94.5	95.5
Overall length (in.)	176.4	174.4
Overall width (in.)	66.1	65.4
Overall height (in.)	51.6	52.4
Min. curb weight (lbs.)	2585	2370

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Build An Heirloom Wagon

This sturdy child's wagon is built of solid oak to last for generations. It features a smooth-operating steering mechanism which utilizes a Lazy Susan.

Start by cutting all parts as shown in the materials list. Make all 1 1/2-in.-thick parts by gluing-up two pieces of 3/4-in. stock. Next, cut box joints into the wagon sides and ends (parts A and B) using a box-joint jig on a table saw or router table (see *Perfect Joints From Your Router*, page 75, Jan. '84). Glue and clamp together the wagon frame. Attach the six floorboards with 1 1/2-in., No. 8 roundhead brass screws. Leave a 1/4-in. space between boards.

Next, glue up and shape the front (G1) and rear (G) suspensions. Then clamp the end caps (H) to each suspension and bore a 1/2-in.-dia. hole for the axle (S). Remove the end caps and bore out all parts to hold a nut.

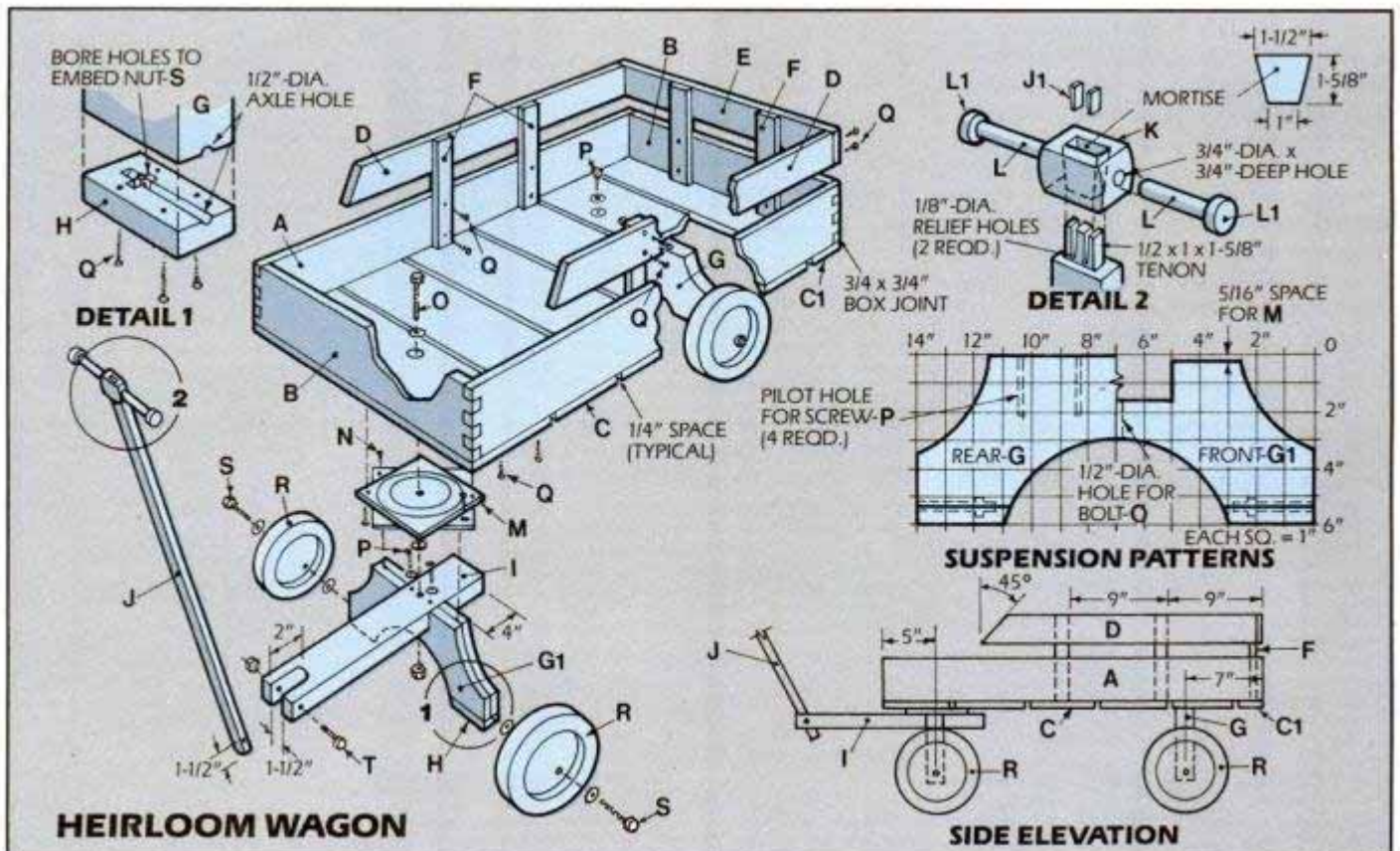
Now reassemble the parts with the nuts embedded. Assemble the steering mechanism with the Lazy Susan in position. Then bore through the floorboard, steering tongue (I) and front suspension to install the pivot bolt (O). Bore and chisel out the mortise in the handle block (K) as in detail 2. Secure the handle by driving in two wedges (J1). Attach the remaining parts and connect the wheels by screwing the axles (S) into embedded nuts. Apply waterproof finish.—Mark C. DiBona



This handsome oak wagon will give years of enjoyment to your kids and your grandkids.

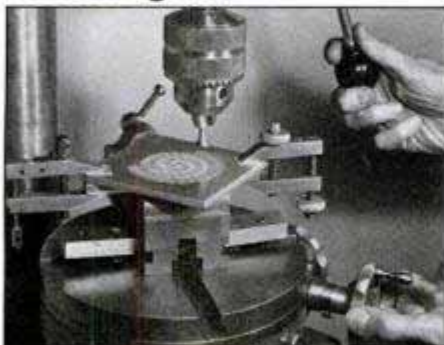
MATERIALS LIST—HEIRLOOM WAGON

Key	No.	Size and description (use)		No.	Size and description (use)
A	2	3/4 x 4 1/2 x 36" oak (side)	L	2	3/4"-dia. x 5" oak (handle)
B	2	3/4 x 4 1/2 x 18" oak (end)	L1	2	1/2 x 1 1/4"-dia. oak (handle cap)
C	5	3/4 x 6 1/2 x 18" oak (floor)	M	1	3/16 x 6" steel Lazy Susan
C1	1	3/4 x 2 1/4 x 18" oak (floor)	N	6	1/2" No. 6 fh screw with washer
D	2	3/4 x 2 1/2 x 26" oak (side rail)	O	1	1/2"-dia. x 6" carriage bolt, 3 washers and locknut (handle pivot)
E	1	3/4 x 2 1/2 x 18" oak (back rail)	P	6	1/4"-dia. x 3" lagscrew and washer
F	6	3/4 x 1 1/4 x 8 1/2" oak (support)	Q	1 1/2	No. 8 oval or rh brass screw
G	1	1 1/2 x 6 x 14" oak (rear suspension)	R	4	8"-dia. wheel with ball bearing
G1	1	1 1/2 x 5 1/8 x 14" oak (front suspension)	S	4	1/2"-dia. x 6" carriage bolt, two washers and locknut (axle)
H	4	3/4 x 1 1/2 x 3" oak (end cap)	T	1	1/4"-dia. x 4" carriage bolt, washers, locknut
I	1	1 1/2 x 4 x 18" oak (steering tongue)	Misc.		Carpenter's glue, pinstripe tape, sandpaper, waterproof finish or marine varnish.
J	1	3/4 x 1 1/2 x 32" oak (steering post)			
J1	2	1/4 x 1/2 x 1 5/8" maple (wedge)			
K	1	1 1/2 x 1 5/8 x 3" oak (handle block)			

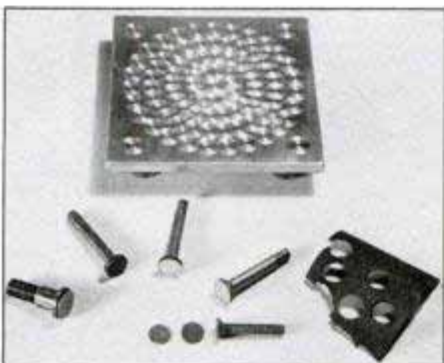


HINTS FROM READERS

Decorating tool



The drill press decorating tool makes a circular spot-polished design on aluminum with a rotary table on the drill press.



The aluminum plate becomes a trivet (background) with glass marble feet fastened with epoxy glue. Foreground at right is 320-grit silicon-carbide paper. At left is a machine screw with rubber pad and abrasive, and four polishers.

This tool chucked in a drill press makes polished designs in metal and plastic. Cut off two-thirds of the threads on a 3-in. No. 12 flathead wood screw and file down the remaining threads. Punch a round disc of scrap rubber and secure it to the fastener head with contact cement. Punch a disc of 320-grit silicon-carbide paper and secure it to the rubber with contact cement.

—A. Kenneth Bell and Walter Burton

Hints for vacationers

The professionals at ADT, who make electronic home security systems, suggest these vacation tips: Don't broadcast your trip. Ask a friend to use your trash cans. Have your grass cut. Use timers to turn on lights and leave drapes partly open.—Lisa Mercer

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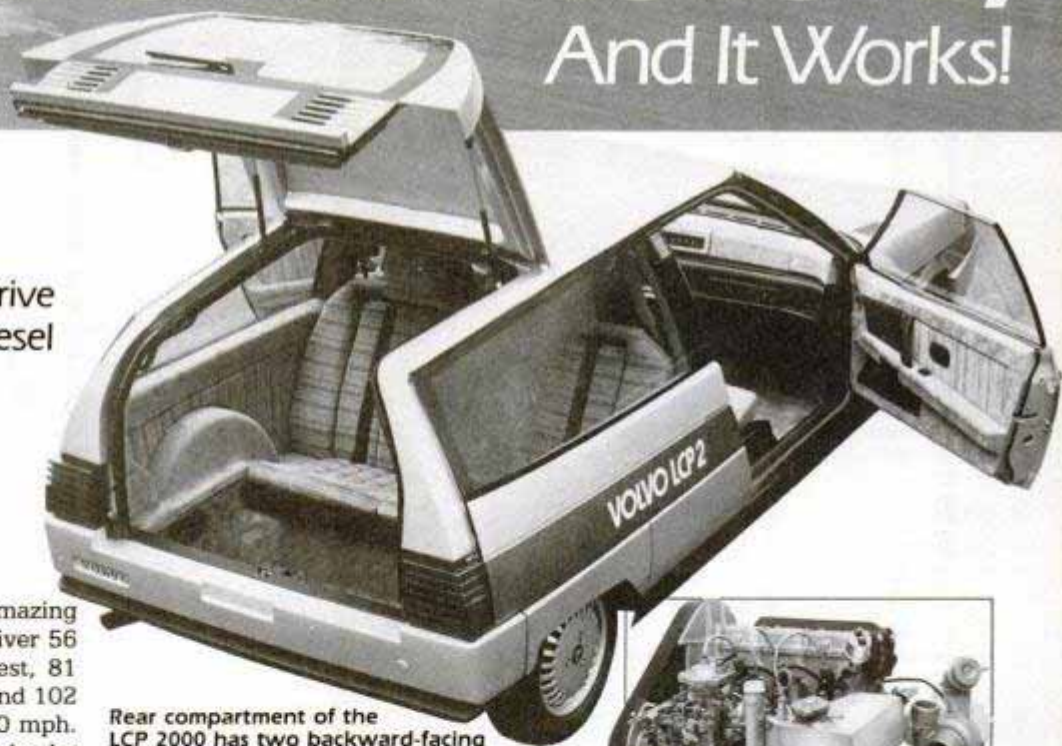
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Volvo's front-wheel-drive three-cylinder turbodiesel delivers better than 100 miles per gallon.

BY WADE HOYT
Auto Editor

I've just stepped out of an amazing 2+2 hatchback that can deliver 56 mpg in the EPA city driving test, 81 mpg in the EPA highway test, and 102 to 113 mpg at a steady 30 to 40 mph. Does anyone care? Since we're in the middle of a gas glut and fuel prices have stabilized, few car buyers seem very interested in economy at the moment. Hot rods, sports cars and big luxury barges are selling as fast as their manufacturers can crank them out.

AB Volvo, the Swedish carmaker, cares. There is a 5- to 10-year lead time required to develop an entirely new car, and Volvo was caught flat-footed in the last two energy pinches. So, in 1979, Volvo unleashed its engineering department on a "Light Components Pro-



Rear compartment of the LCP 2000 has two backward-facing seats that fold flat to create a cargo bay.

ject" to see just how much weight they could reasonably take out of a car and how far they could make it go on a gallon of fuel. The result was a quartet of sleek front-drive hatchbacks with variations of a unique engine—a three-cylinder turbocharged diesel that displaces 1.3 to 1.4 liters and produces 52 to 88 hp in various permutations.

The car Volvo calls the LCP 2000 achieves its outstanding fuel economy [\(Please turn to page 136\)](#)



The three-cylinder diesel engine has a magnesium block that weighs only 26½ pounds. A second, counter-rotating flywheel helps absorb low-speed vibrations. The thermally insulated engine can run on different fuels.

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CAR OF THE FUTURE

(Continued from page 134)

via a three-way effort to save weight, improve engine efficiency and cut aerodynamic drag. The Cd is 0.25 to 0.28, far better than anything on the road today.

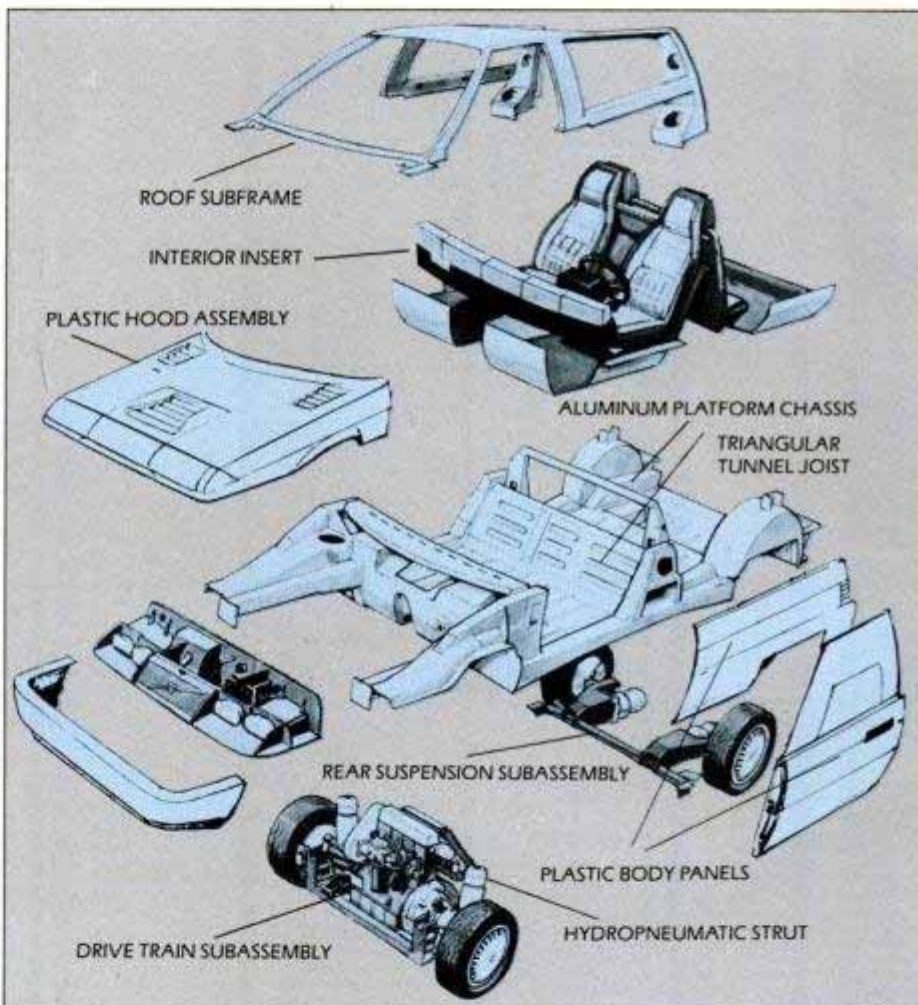
The LCP diet

To pare the LCP's overall weight to 1,555 pounds (300 to 600 pounds less than similar-sized conventional cars), extensive use has been made of lightweight, high-tech, high-cost materials. The wheels, engine block, intake manifold, rear subframe, suspension A-arms plus the transaxle and clutch housings are made of magnesium, which is one

The steering knuckles, though steel, are elegantly slim castings made by the lost-wax process. Hydro-pneumatic struts replace the springs and shock absorbers. The all-plastic, sealed-beam headlights are feather-light. The aluminum chassis panels, bonded together with epoxy, require less than 500 spot welds to hold the aluminum in position while the epoxy sets, instead of the conventional 4,000 welds. Conscientious Volvo even uses a polyurethane film on the external body surfaces because it creates less pollution than painting.

Drive train innovations

Direct injection is used in the diesel combustion chambers to improve fuel



The LCP 2000 could easily be mass-produced. Drive train and rear suspension subassemblies are bolted in from below. Pre-assembled interior goes in before the roof is installed.

third lighter than aluminum. The chassis platform is aluminum, as are the brake discs, drums, calipers, master cylinder and power booster body. The aluminum drums and discs are plasma sprayed on their wear surfaces with a thin coating of iron—rather than made of cast iron.

Strong, lightweight plastics are used for the body panels, side and rear windows and the gas/brake/clutch pedal assembly. Door arches and motor mounts are made of carbon fiber.

efficiency, in place of the quieter pre-chamber designs preferred by most auto makers. To absorb unpleasant engine vibrations below 1,500 rpm, an extra counter-rotating flywheel is mounted at the front of the crankshaft. This, of course, adds dreaded weight, so the starter and generator have been combined in one unit reminiscent of the old NSU Dyna-start system (see *Automotive Oddballs*, page 118, Feb. '84).

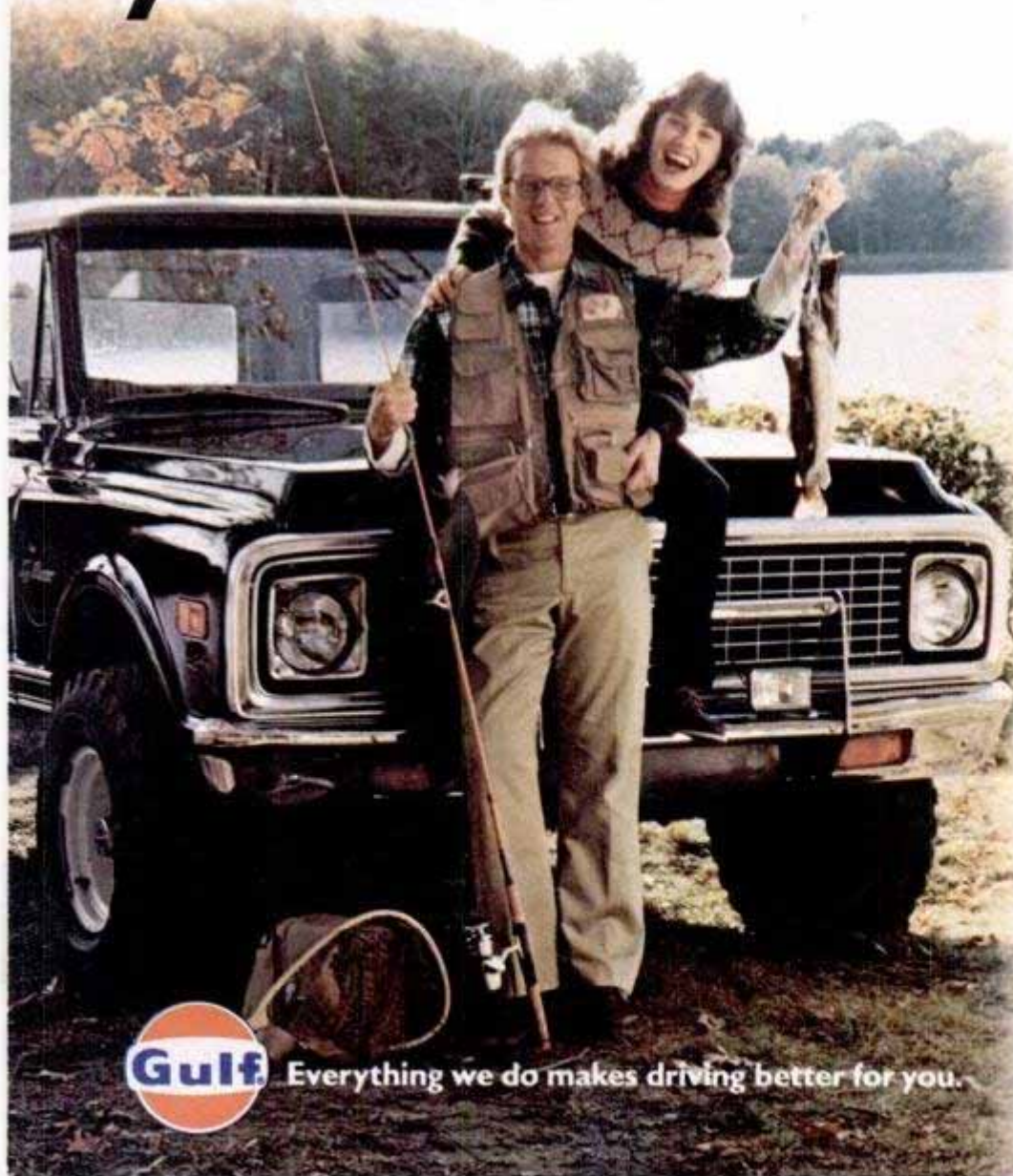
Various fuels have been used in the

(Please turn to page 138)

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

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

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



A '72 Blazer, raised on Gulfpride.[®]

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CAR OF THE FUTURE

(Continued from page 136)

LCP cars, including very low-octane gasoline, diesel fuel, sunflower oil and rape seed oil. (Rape is a small flowering plant—Canadians call it "coiza." It's become an important cash crop because of its many commercial uses—from animal fodder to fuel oil. It is related to the mustard plant.)

The running prototypes all use five-speed manual transaxles, but a continuously variable transmission (CVT—see page 70) is being developed with an ultrawide ratio spread to make it the equivalent of a seven-speed manual.



The author says the front-drive Volvo has peppy performance, adequate comfort.

This should give even better fuel economy. Project engineers feel that the LCP 2000 can eventually be coaxed up to EPA city/highway figures of 75/100 mpg, with a combined figure of 83 mpg. Today's stingiest car, the Honda Civic CRX, gets "only" 51 mpg.

Although the LCP cars are small by United States standards, they do not scrimp on modern conveniences. A central door-locking system has electronic keyboards instead of mechanical locks. The driver's seat, pedal cluster and steering wheel are individually adjustable. The graphic LCD instrument pod moves in or out with the telescoping steering wheel. The car has full ventilation, an AM-FM radio, rear window wiper and power windows (actually little "toll hatches" at the bottom of the fixed side windows).

Despite the car's light weight, Volvo has not ignored traditional safety concerns. A massive triangular "tunnel joist" runs from side to side between the front and rear seats to protect the occupants in a crash and also to house the fuel tank and battery out of harm's way. Although the tank holds only nine gallons, the car's extraordinary fuel economy gives it a range of well over 500 miles between fillups.

Although the LCP is only a concept car, Volvo has given serious consideration to its practical production. Parts

suppliers have been located in eight countries (Budd and Alcoa are American participants in the project). A mass-production scenario has been carefully thought out: two subframes carrying the rear suspension and front drive train can be built on separate assembly lines and bolted into the chassis platform from below. The preassembled interior is dropped into the platform from above, then the roof is bonded in place and plastic body panels attached.

Volvo figures that the payback period for an LCP-type of car will be two to three years. That is, fuel savings will make up its extra cost in that time. Its corrosionproof design should give the LCP car a long life and high resale value. In addition, there is a cost bonus of about 20 percent due to all of the recycleable materials used. Eighty percent of the materials in auto batteries are recycled so why not the whole car, says project manager Rolf Melde.

Driving impressions

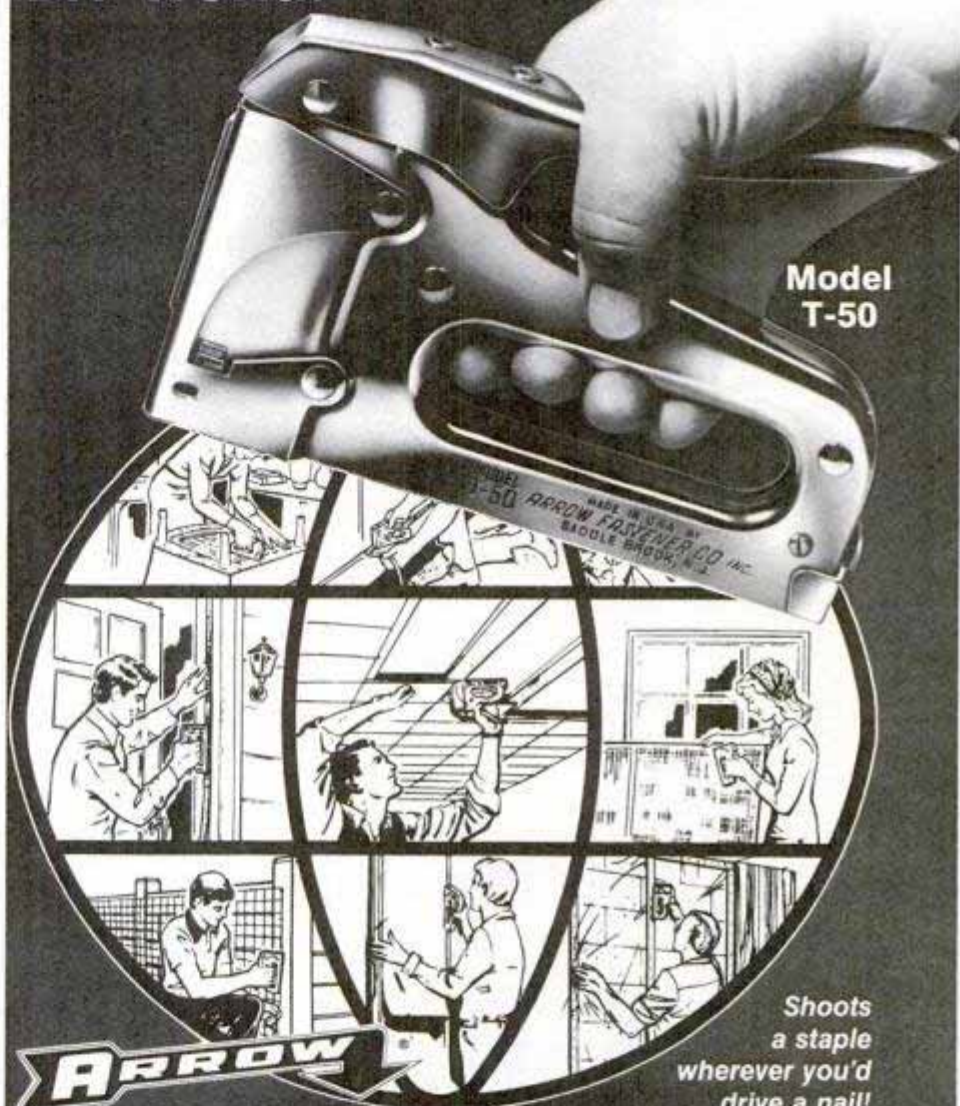
A test drive in the LCP 2000 reveals that a few sacrifices have been made in the name of fuel economy. It is a small two-seater that can carry 35 cu. ft. of cargo or two rear-facing passengers, but not both. The brakes on this rough engineering testbed were a bit spotty, and the engine's noise obtrusive. The combination of a bouncy ride, the rearward view of passing scenery, subtle distortions in the plastic windows and the odor of burned rape seed makes the rear passengers wish for airsick bags.

Most of these bugs could be overcome in a production model, except for the backwards seats, although they don't seem to cause problems in big station wagons, save for headlight glare. Volvo views these as "occasional seats," pretty much for emergency use. They're much better than the back seats in many 2+2 sports cars. Basically, the LCP 2000 is a two-seat wagonback grocery-getter/commuter car.

Within these limits, the LCP is a viable proposition. Its fuel efficiency is fantastic—right up there with the freakish contraptions from Shell Mileage Marathons. Performance is unexpectedly peppy, with 0-to-60 times of 11 seconds and a top speed of over 110 mph. Ride and creature comforts are no worse than in many little econocars, and better than in a few bestsellers like the rear-drive Corolla and Chevette.

Volvo has no immediate plans to produce the LCP 2000, but many of its lightweight components may find their way into the company's more conventional sedans and wagons, helping to improve their fuel economy when the world is ready for such things. And if oil supplies are cut off again in this century, AB Volvo has the situation covered. Let 'em burn rape seed! **PM**

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This camera really gets around

The Globuscope camera is a new and nifty device that gives an almost 400° field of view. It synchronizes a revolving slit on the outside of the camera body with an "orbiting" wide-angle lens on the inside. Best of all, it uses ordinary 35-mm film you can process almost anywhere.

As the lens rotates and the film moves, the slit acts as the camera shutter. The supply spool unwraps the film through the film guide behind the lens where the shutter would normally be. During exposure time, the film is fixed between the spools. As the camera rotates, light enters the slit for a preset exposure,

and then each of eight frames is wrapped onto the takeup spool.

To set up the mechanical motor, you simply wind the handle, which in turn winds a ribbon spring motor and engages the camera's one-way clutch. When you take the photo, the motor gives you exposures of $1/200$ of a second or $1/40$ of a second. Note how sharp our ice rink photo is—it captures the skaters in motion and doesn't blur the action. Our first use of the Globuscope was unsuccessful—the photos did have a blurred look. But once we learned how to use it, the camera worked perfectly.

The Globuscope has no viewfinder—you focus it and frame

AUTOMOTIVE

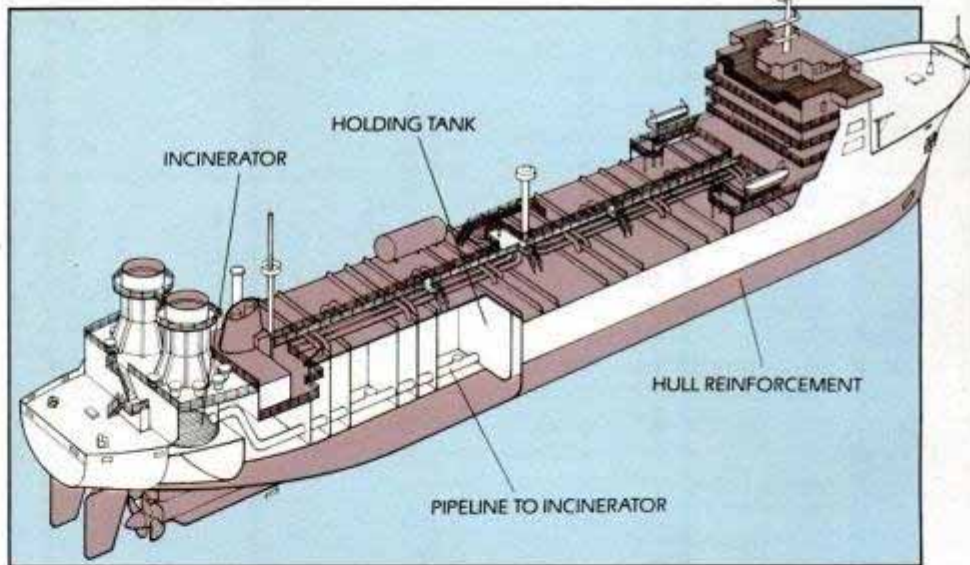
MARINE



Production car (top) pulls rolling-resistance rig (above), which simulates terrain.

A real dragster

Mercedes-Benz has developed a "rolling-resistance trailer" to measure the effect of different kinds of roads on tires. The trailer also is used to test new suspensions and braking systems. A production-model car pulls the trailer on a flat. Driving resistances on the pulling car are compensated by the trailer's independent computerized motor. By adjusting the trailer's roll, the rig measures resistance as if it were traveling on different kinds of terrain.



Fired-up chemical wastes

America's first seagoing chemical waste disposal plant—the \$37 million Apollo 1—is undergoing tests this summer off the New Jersey coast. Officials at the U.S. Environmental Protection Agency hope the ship will provide an important solution to the nation's growing chemical waste problem.

The Apollo 1 holds liquid chemical wastes in a relatively safe liquid nitrogen-cooled tank. The waste—generally chlorinated organic chemicals used in solvents and petrochemicals—is then pumped at sea into a pair of incinerators

fired-up to over 2,000° F. Up to 70 gallons of waste are destroyed per minute. The heat itself reportedly destroys about 99 percent of the chemicals, creating hydrogen chloride emissions that will be absorbed by the alkaline content of the sea.

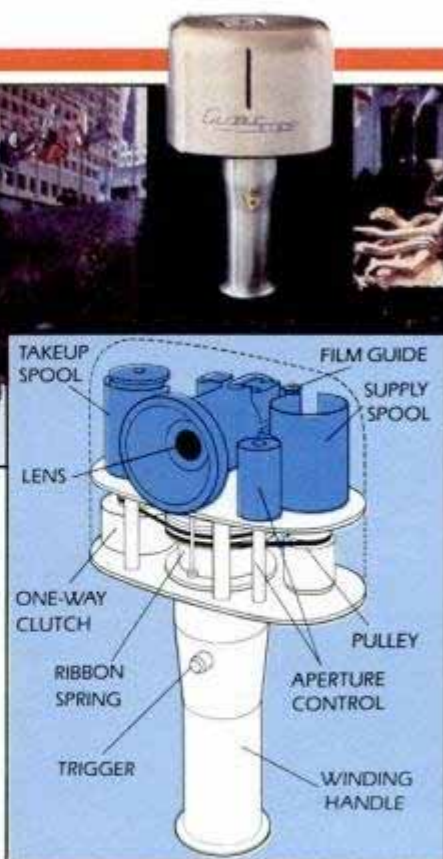
The chosen incineration sites, about 50 miles off the coast, are deemed environmentally clean by the EPA. Equipment aboard the Apollo 1 will measure any change in the chemical content of the air or sea around the ship. If early trials succeed, Apollo 1 could be the first in a large fleet of incinerator ships.



PHOTO BY MARTIN LOUIS GARDIN

your photo according to where you stand with respect to the subject. The unit will rotate as long as you keep the one-way clutch disengaged by depressing a button on the camera handle. The aperture control is a thin metallic strip that winds back and forth behind the lens.

After shooting the panoramic view, the user must instruct the lab to develop the film in one continuous strip. Then you cut each photo, which covers 6 inches of the processed film. For more information on the Globuscope, write to Globuscope Inc., 44 West 24th St., New York, N.Y. 10017.



Globuscope photo of New York's Rockefeller Center ice rink (above) covers 400°. The Globuscope camera (top right) uses a slit instead of a shutter. A ribbon spring motor is wound by turning the handle (right). Press the trigger and slit rotates. A pulley moves the 35-mm film.

ENGINEERING



Jack Cermak notes wind on model of Houston's Republic Bank.

Windy city

Skyscrapers create an ecology of their own, transforming wind movements by their size and by the heat they generate. In recent years, those changes have become important in the design of tall buildings. Colorado State University's Fluid Dynamics Lab studied 300 skyscrapers, and the effects of the study are noted in the final appearance of the latest big buildings. Seemingly cosmetic changes, such as street-level canopies, may have been the result of tests in the Colorado State wind tunnel. Canopies, explains lab director Jack Cermak, are effective wind barriers, protecting pedestrians from gusts created in the new environment. The lab builds models of buildings scaled from 1:240 to 1:600. Smoke blown into the chamber simulates how the wind will effect the model, which is rotating on a computerized turntable.

In the next two or three years, the wind tunnel tests are expected to have an impact on all new building designs. Among other things, architects are considering ways to build foundations that allow for more give in windy conditions.

INVENTIONS

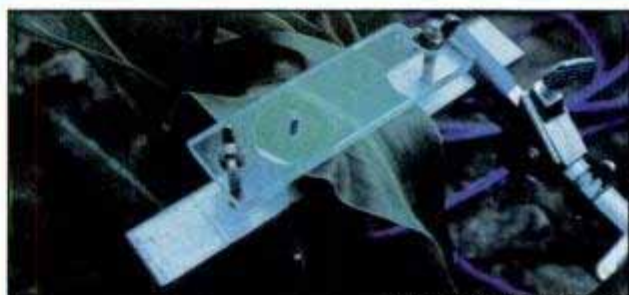


PHOTO BY BRUCE W. MOST

HIGH-TECH VEGETABLES

There's a field just outside Greeley, Colo., where corn plants, when they get thirsty, ask a computer for a drink. The U.S. Agriculture Dept.'s Agricultural Research Lab placed "mass flow porometers" on the leaves of selected plants. These sensors tell a computer when tiny pores, or "stomata," in the leaves close. It's a signal that the plants need water, and the computer then supplies it.

HAPPINESS IS DEPRIVATION

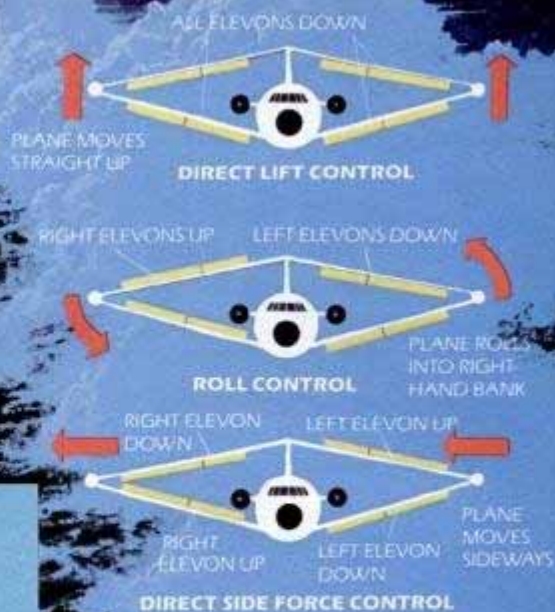
The Ova is the newest "think tank." Made of marine fiberglass with foam insulation, the sensory deprivation tank is a high-tech place to get away from it all. The tank bottom is filled with water that is warmed to body temperature. Step inside, lie down and close the lid, and all sight and sound, but not air, is shut out. It costs approximately \$6,000, but athletes and executives who use the unit say the relaxation is worth the price.



PHOTO BY JACK GRAZIER



AVIATION



Funny wings for future airliners

A daring new idea in wing design may enable airliners of the future to fly at supersonic speeds without the weight, drag and huge power requirements that make the present-day supersonic Concorde expensive to operate. Known as a Joined Wing, it actually consists of four wings, one pair sweeping backward from the nose and the other pair projecting forward from the tail, with their wingtips joined together to form a diamond. The result is a rigid, self-bracing structure that makes possible thinner, lighter wings without sacrificing strength, reducing aircraft weight by as much as 24 percent. The superthin airfoils also reduce drag.

The Joined-Wing concept, currently under study by the Office of Naval Research, offers other advantages as well. Unlike a horizontal stabilizer, the rear wings become lifting surfaces, not only helping to support the aircraft, but at the same time eliminating the power-robbing download that's imposed on a

conventional tail to keep a plane in trim. Multifunction elevons in all four wings make possible such trick maneuvers as moving sideways without turning, known as direct side force, and rising straight up like an elevator while remaining level, called direct lift. Such versatile controllability could simplify maneuvering in congested airspace and permit shorter, safer takeoffs and landings. A split rudder, its two halves fanning out like an open book, would serve as a giant air brake for killing speed during landings and aborted takeoffs.

What's the Navy doing working on a civilian airliner? Actually, it isn't. It all started with research aimed at producing a small, fast, unmanned cruise missile that, with folding wings, could be fired from a submarine's torpedo tubes. If this military application proves successful, the next step could be a scaled-up, NASA-sponsored passenger version for high-speed commercial air travel.

ROBOTICS

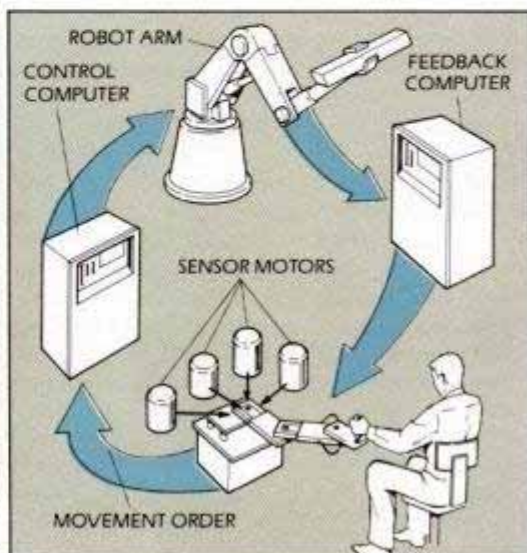
Robot feelings

The next generation of robots will let the operator feel what it's like to lift an object. That's important if your robot is handling a weapons detonator or a flask of germs. Gary Matthew and a University of Florida team are working on a "load sensor" system. The operator controls a robot arm with a remote sensor whose four motors adjust the feel of the joystick. This conveys to the operator the weight and balance of the object. The system uses two computers—one to control the robot and one for feedback.



PHOTO: HERBERT M. PRESS, UNIV. OF FLA.

Operator moves load sensor robot.



Editor: Dennis Eskow
Contributors: Sheldon M. Gallager, Fran Wenograd
Golden, C.A. Perkin, Jack McIntire, Jack Grazier,
Mark M. Meinerio, Martin Louis Gardlin



PHOTOS BY FRANK LUSK

Helicopter designer Frank Piasecki (above, right) introduced the helicopter-powered aluminum truss (top) that will power a 1 million cubic foot balloon (above, left).

Heavy lifter propped up

When finished next year, it will lift 100,000 pounds of lumber and carry it in the air for 50 miles. It's called the Heli-Stat, designed by Frank Piasecki, one of the earliest helicopter designers. The Heli-Stat's aluminum truss,

which will carry a 1 million cubic foot helium-filled balloon, was rolled out this past winter. On each corner is a modified H-34 helicopter that provides extra lift and steering capabilities previously unknown to airships.



ELECTRONICS



FLYING DEW LINE

Maneuvering at 30,000 feet, an AWACS plane equipped with a new rig of sophisticated computers can code and decode radio information on enemy aircraft and missiles. The Joint Tactical Information Distribution System is the Defense Dept.'s new "flying dew line." The AWACS craft also are equipped with special jamming and unjamming software to thwart the enemy.



SKYSHIP 600 FLIES

Britain's resurging airship industry (see *Airships Rise Again*, page 92, Apr. '83) is getting a new surge this summer with test flights of the Skyship 600. The craft, which has a 1 million cubic foot helium-filled Kevlar body, can carry 6 tons of passengers or freight. It is expected to see passenger duty in Greece in the fall. The airship's smaller forerunner, Skyship 500, is carrying passengers.



A PICTURE IS WORTH . . .

British researchers have created a video game to teach children how to speak properly. Pronounce the word correctly and an image forms. The images move at the proper commands.

ROBOT HAND EVOLVES

Some evolutionists say the thing that separates a human hand from an ape hand is the human ability to grasp tools. Now robots are evolving. MIT's Kenneth Salisbury has developed a three-finger robotic hand. The standard has been two fingers. The jointed hand will let robots do detailed work.

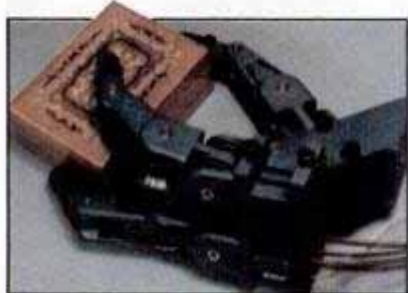


PHOTO: KENNETH SALISBURY, MIT

GUIDING ROBOT

Sir Plus is a new, \$1,400, 200-pound, 4-foot robot who works as a tour guide at the Palm Beach, Fla., Science Museum. Its ultrasonic eyes keep it from bumping into people as it follows an aluminum strip through the museum. It uses tiny sensors to feel its way along the tape. A pair of tape recorders carry the robot's "talk" as it leads people along, stopping at foil markers that switch off its motive power and turn on its vocal function circuitry.



PHOTO BY EDWIN J.C. SOBEY



NEW SUNDIAL

Pulsar Time Inc. has introduced a new solar-powered watch whose amorphous silicon crystal cells can recharge in ordinary room light. The charge will keep it going through the day. When the watch needs a "deep" charge, no more than once a week, you expose it to sunlight for three minutes. It holds a full charge for 48 hours.

WORKSHOP MINICOURSE



Using a spokeshave

The spokeshave is a special two-handled plane used for shaping and smoothing irregular or curved surfaces. It has a wide blade and a short base, which allows it to follow curves easily. Spokeshaves are indispensable for smoothing out ripples and bumps on edges cut by hand, sabre or band saws. They are particularly useful for rounding compound curves.

The two major types are flat-bottom and convex-bottom. The flat one is most widely used because it handles both convex curves in stock and moderate to long sweep concave curves equally well. The curved bottom spokeshave is meant for use on concave curves with radii as small as 5 in.

Blade projection is the only adjustment made on a spokeshave. This is done by turning two adjustment nuts while sighting across the bottom. The blade should project evenly and enough to make a fine shaving.

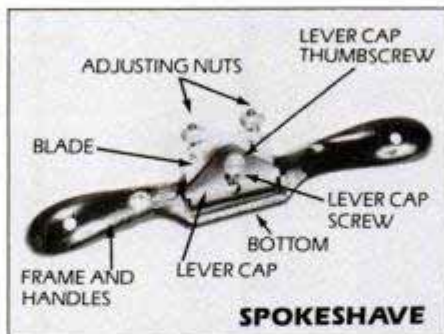
Mastering the tool

You can master the tool easily if you keep the blade very sharp and your strokes with the grain. Cutting against the grain results in lumps and gouging, and possibly ruined work. Change the direction of the strokes as the curvature changes in relation to the grain. You can't always tell the true direction of the grain by eye, but it's time to change direction when the blade meets resistance and begins to chatter and skip.

The spokeshave tool itself only makes flat cuts. By changing the angle continuously and making successively finer cuts, you can form almost the entire contour. Then, final sanding completes the curves.

Spokeshaves can be pushed or pulled, but greater control results from a pulling stroke. Try both ways and go with the way that's best for you.

Two final tips: First, spokeshaves come with or without adjustment nuts. The ones with nuts are much quicker to adjust. Second, spokeshave blades are wider and much shorter than plane irons. A honing guide may work if your sharpening stone is wide enough. Otherwise, sharpen the blade by hand, holding it slightly askew so the whole blade fits on the stone.—R. Capotosto



A spokeshave is a two-handled tool with few parts. Align blade with adjusting nuts and secure it with lever cap thumbscrew.



Turn spokeshave upside down and sight along bottom to adjust blade position. Then tighten the lever cap thumbscrew.



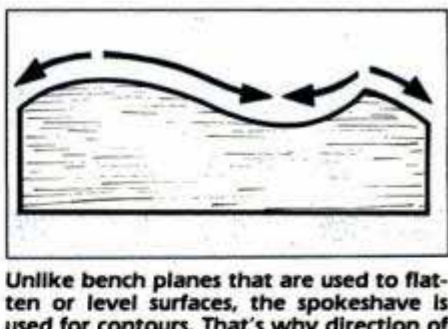
Trim saw ripples from a curved edge with a flat-bottom spokeshave. In this position, the spokeshave is pulled toward you.



Use the convex-bottom spokeshave to trim a small radius concave curve. Always pull or push with the grain for all strokes.



Stroking against grain produces rough, gouged area as shown here. It's time to change stroke direction when blade skips.



Unlike bench planes that are used to flatten or level surfaces, the spokeshave is used for contours. That's why direction of grain necessarily changes on peaks and in hollows. At these midpoints, you must change direction of your strokes.



Use pencil guidelines to cut a chamfer. Position a lamp directly over this kind of work to make it easier to see results.



Contour an arm for a chair by first chamfering, then adding guidelines as shaping progresses. Use long strokes.

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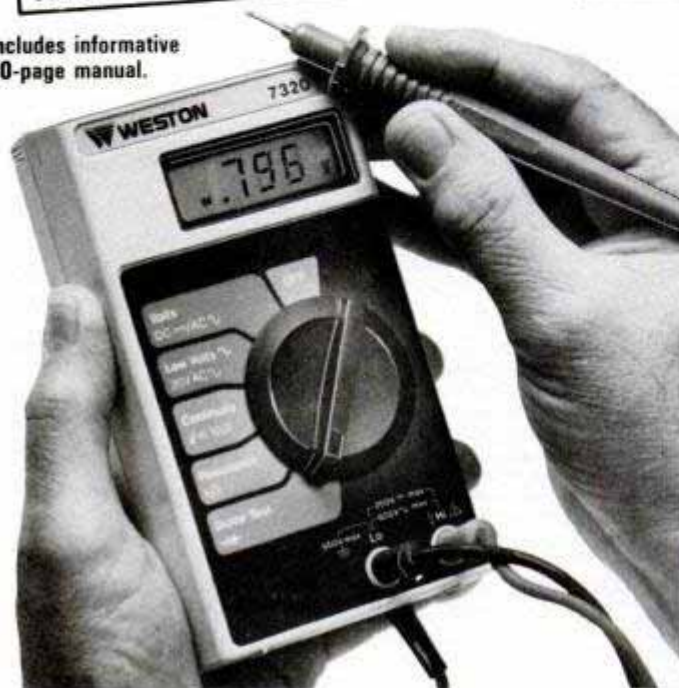
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HINTS FROM READERS

License plate prop



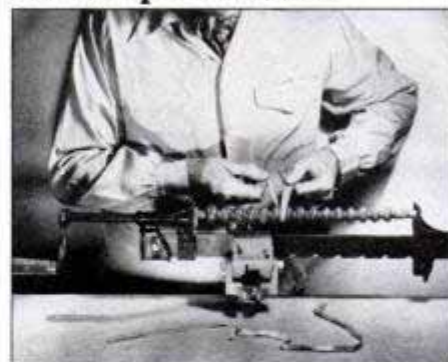
If the gas cap on your car is hidden behind the license plate, you can reduce the chance of skinning your knuckles when filling the tank by using a license plate prop. The prop is a $\frac{3}{4} \times \frac{3}{4} \times 6$ -in. piece of plywood and a $\frac{1}{16} \times \frac{3}{4} \times 3$ -in. piece of sheet steel.

Bend the steel in a U-shape to fit the piece of wood and bolt the parts together with a $\frac{1}{4}$ -in.-dia. by 1-in. hexhead bolt centered $\frac{3}{16}$ in. from one end of the prop and centered $\frac{1}{4}$ in. from the ends of the steel.

Bolt the bottom of the steel U to the license plate cover with a $\frac{1}{4}$ -in.-dia. by $\frac{3}{4}$ -in. bolt and use a lock washer. The prop must be able to swivel out of the way when the plate is closed.

—Earl Greenlee and Rod King

Bar clamp acts as vise



By gripping a bar clamp firmly in a bench vise, you can produce a convenient holder for long workpieces such as stairway and furniture spindles, or contoured furniture legs. This makes it easy to sand, apply finish and polish or otherwise treat the work. The photo shows a wax-finished spindle from an antique fireside cot being polished with a tapered felt strip cut from an old hat.—Walter E. Burton

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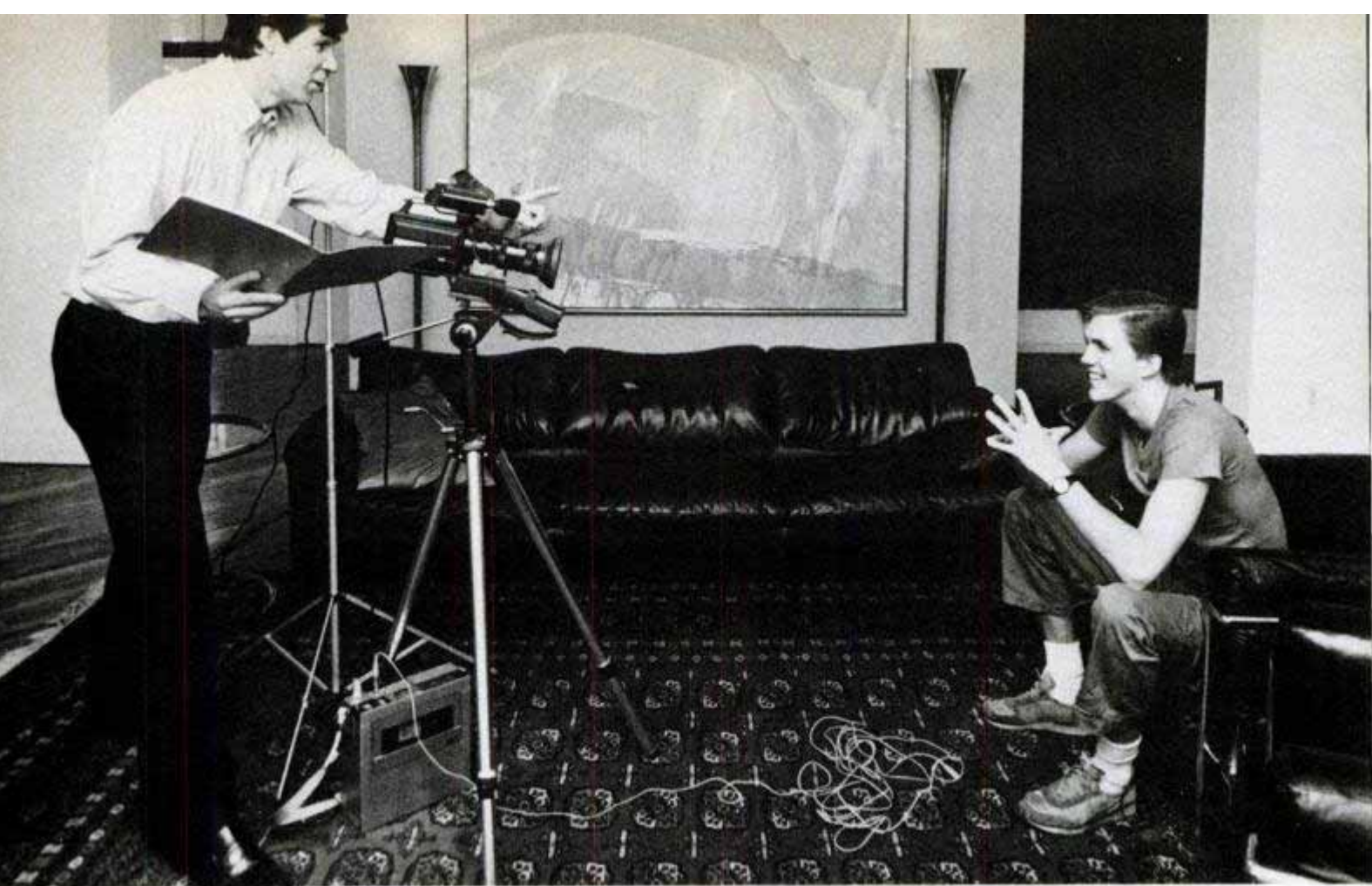
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Camera is set for minimum use of zoom lens. All lighting is away from subject to avoid ghostly appearance.

Create Your Own Made-For-TV Movie

Shoot fast—by July 1—and you can submit a screen test for Stanley Kubrick's new film.

BY FRED YAGER; Photos by Frank Lusk

Lights! Camera! Action! The home video bug has bitten America to the point where industry sources say one family in four owns a video cassette recorder system. The lure is movies without commercials. But there's a growing number of video users who have replaced their motion picture camera with a video system. The picture quality may not be quite as high, but the cost of video is very low and you can edit film as you go.

And now there's an added attraction to shooting a home video drama, but you have to act quickly. Stanley Kubrick, director of films like *Dr. Strangelove* and *A Clockwork Orange*, is looking for some new talent. Specifically, he's looking for a few good men to play Marine Corps recruits in his upcoming

film *Full Metal Jacket*, which is based on the novel *Short-timers* by Gustav Hasford. Anyone who thinks he can play the role of a Marine in the new film is invited to send a screen test to Kubrick. We'll give you some tips on shooting your entry, and then give the details on submitting it at the end of this story.

Our tips come from professional casting directors and video-drama directors, and you can follow them with ordinary video equipment. We used a Panasonic PK 972 VHS and a JVC 2650 VHS recorder for one screen test. We made a second test with a Sony HVC 2400 Beta camera working on a Sony SL2000 deck. If you can get a battery-operated video recorder, use it for any outdoor shooting. You'll have enough

work to do just setting up your shots without having to trip over extension cords.

We did all our outdoor shooting with the Sony. It was portable, lightweight and easy to use, but had one major limitation: You can't play back what you've just shot. That makes editing very difficult. (Manufacturers in the VHS camp are about to introduce one-piece carry-corders with playback functions. But these will use a minicassette which limits recording time to just 20 minutes).

Lights . . . camera . . . action and sound. These are the four elements of a movie. Without proper lighting, you will not have a movie. While most new home video cameras will operate in

(Please turn to page 149)



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YOUR MADE-FOR-TV-MOVIE

(Continued from page 147)

very low light, results will be far from optimum. Low-light pictures are grainy, with pale color and deep shadows.

To get lighting that appears normal you have to use artificial lights. Too much light such as a direct spotlight will wash out the subject's face, making him look like a suspect in a police lineup. Too little light, and all you have are shadowy silhouettes. Light that is too spotty will confuse the camera's automatic light level circuits, resulting in a blacked-out background.

We used a \$50, 600-watt quartz home movie lamp. We bounced the light off the ceiling, producing the diffused effect and allowing for just the right blend of light and shadows.

Make sure the eyes of the subject are lighted. Often, when you use only available overhead lights, the eyes are shadowed. The eyes show life, and without them you might as well be taping a tree.

Next, you have to decide where to place the camera. Whenever possible, use a tripod to keep the frame steady. You'll want to experiment with different angles and composition.

Set up your shot, look into the small monitor in the camera to see if that's what you want and if it is, shoot it. Always use the monitor to determine the shot and not what you see over the top of the camera.

As an example of using angles for mood, in our screen test our subject was playing a Marine recruit looking up at his drill instructor. Therefore, we shot down from a high angle to give the feeling of intimidation.

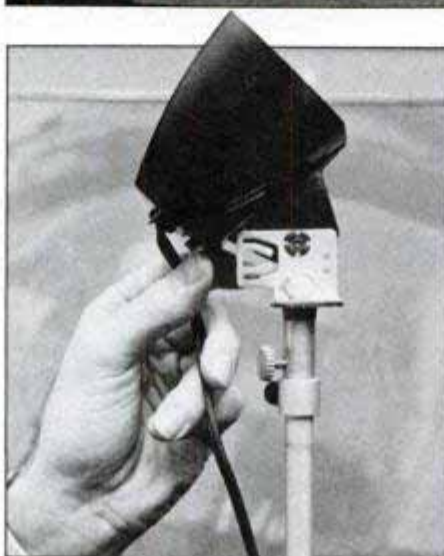
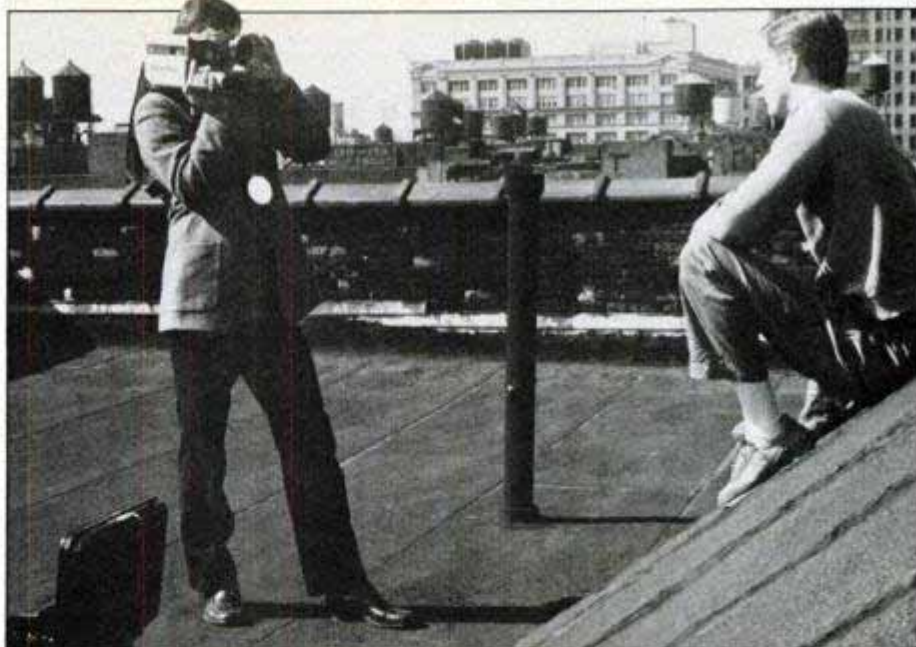
Test the lense range

As for distance from the subject, test the range of the camera zoom lense and then set up accordingly. Avoid the temptation to overuse the zoom, since constant zooming becomes distracting.

If there is a lot of variation in terms of distance from the camera, focusing could be a problem. The cameraman will have to "follow-focus" to keep the image clear. Run through the action a few times and you will be able to anticipate focus changes.

This leads us to the action part. Action is everything that happens in front of the camera, including all motion and dialogue. It should be blocked out and rehearsed before you start taping. Blocking out action simply coordinates camera movement with the subject's movement.

Then there are things that even pre-planning may not prevent, which leads us to the sound element of "movie-making." Since you will want to hear your subject as well as see him, sound is



Outdoor shooting (top) is done with a battery-pack setup to avoid wiring problems. An inexpensive home movie light (above, left) is a must for indoor shooting. A lavalier mike (above, right) is preferable to the one that comes with the camera rig.

just as important as light. But sometimes it is harder to control.

Unless you are shooting an extreme closeup, do not use the microphone on the camera. It picks up too much room noise and the subject's voice will be muddled, echoed and hard to hear. Use an auxiliary mike such as a simple \$20 lavalier or the kind that comes with tape recorders. Wireless mikes range from about \$30 to hundreds of dollars.

If you do not want the mike to be seen, either you have to hide it on the subject, which is what we did, taping it to the inside of his shirt and running the cord down his pant leg, or you can rig a boom mike overhead and out of the frame. If you have two or more people in the shot, you may have to use a boom. Just remember that the closer the mike is to the mouth of the subject or subjects, the better the audio quality.

Now that you have taken precautions for the best sounds, be prepared for

outside sounds you can't control. Hollywood studios have expensive sound stages that control this sort of thing. Shooting in your home, you will just have to work around it.

Some of the sounds we had to deal with were a hungry cat, a telephone ringing and a siren. These things happen. Sometimes you can use them as sound effects. But most of all, they reinforce the versatility and economics of using tape. If you have to reshoot, and you probably will, just rewind and tape over the mistakes. Or, you can keep on shooting and later edit out the mistakes with a video tape editor.

We did both, editing in the camera as we shot and then later on a Challenge tape editor loaned to us by Hammacher-Schlemmer.

Editing after shooting always involves two VCRs. Use one machine to dub desired tape sections to the other

(Please turn to page 150)

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YOUR MADE-FOR-TV MOVIE

(Continued from page 149)

deck. You can't simply cut and splice videotape the way you can film.

Whether you are shooting a screen-test or your own movie, here are some other tips:

■ In the beginning, keep things sim-



After any tape editing that is necessary, get your screen test in the mail by July 1.

ple. Use an uncluttered set for the audition. It's *you* Kubrick wants to see, not your living room.

■ Be natural. That means don't over-act and try not to use cue cards. When you watch live TV, you can usually tell when someone is reading a cue card.

■ Even though the screen-test calls for about five to seven minutes of tape, it is still cheaper to buy a 120-minute tape than a 30-minute cassette. This is because 120-minute tapes are by far the largest sellers and competition among dealers usually keeps selling prices low.

Now you're ready to shoot Stanley Kubrick's screen test. Remember, you have until July 1 to mail it to London. All you need is a 1/2-in. VHS or Beta tape set at the fastest recording speed for the best video quality. Wear a T-shirt and pants. Begin the recording session with a three-minute action scene of your choice. Then tape about one minute talking about yourself and your interests. Next, hold up a piece of paper on which you have printed your name, address, phone number, age and date of birth. While doing this, say the same information out loud. Finally, do a close-up, a full-length shot from a front view and left and right profile.

Stick a label on the cassette with this same information and airmail it in a padded bag to Stanley Kubrick, Warner Bros., 135 Wardour St., London, W1V, 4PA, England. The audition must be postmarked by July 1.

Make sure you write "magnetic video tape" on the outside of the bag to protect it against accidental erasure. Unfortunately, the film company can't return any of the tapes. And... good luck!

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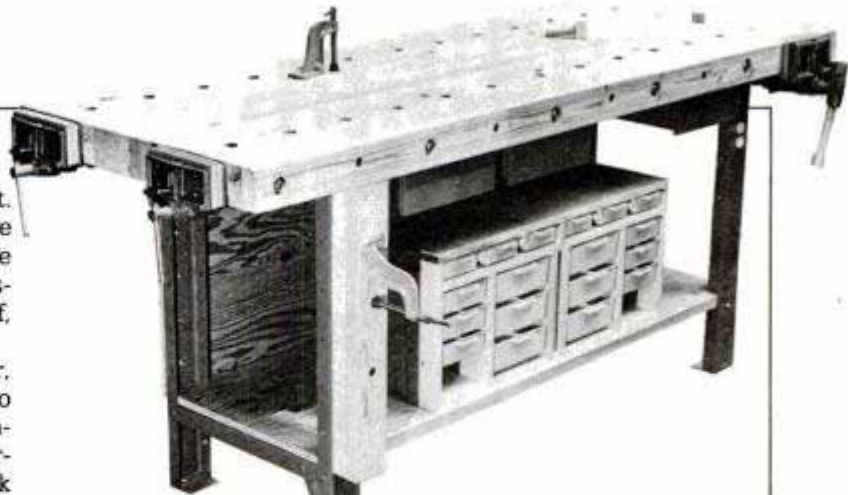
A workbench kit

Making anything from a kit is a savings in labor cost. Shopsmith has come up with an additional way to save money on workbench kits. The company offers three models that include specialized hardware, legs and accessories, but not the wood. By supplying the wood yourself, you save on shipping costs.

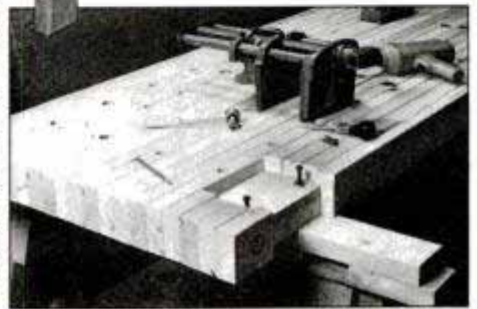
The three kits available include the Do-It-Yourselfer, the Cabinetmaker and the one shown here, the Pro Cabinetmaker. A feature I particularly like is the disengage mechanism in the 9-in. vise. A turn or two counter-clockwise and the screw releases the jaw for quick adjustment. A turn clockwise and the jaw is again engaged to clamp the workpiece securely.

The hold-down clamps are designed for quick mounting at various places on the benchtop or front and front left leg. Also included in the Pro kit are 18 rugged, plastic, small-parts drawers and a 36-in. tool rack.

The Pro Cabinetmaker bench is priced at about \$275, plus shipping, the Cabinetmaker at about \$179., and the Do-It-Yourselfer at about \$125. Only the Pro includes all the accessories shown here. For details and more information, write to Shopsmith, 6640 Poe Ave., Dayton, Ohio 45414.—Rosario Capotosto



The Pro Cabinetmaker kit includes: sturdy steel legs, three steel drawers, two 7-in. Woodcraft medium-duty vises and one 9-in. Rapid Action heavy-duty vise. Turn the benchtop over as shown (right) to install the heavy-duty vise with two lagscrews and two flathead wood screws.



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PM-6



FIRSTHAND REPORT



Functional race car styling includes dual rear wings, deep chin spoiler, hood scoop.

FORD MUSTANG SVO REVISITED

When we first tested the Mustang SVO, we were not impressed (see *Corvette Takes On The World*, page 88, Jan. '84). Every other magazine had raved about it, and we would have worried about our judgment if the car that Ford supplied had not been such an obvious ringer. As we said in that article, the car had shaved tires and we suspected other modifications. Obviously, Ford wanted its car to do well in our track-testing sessions. And, while the changes did make that SVO Mustang a terror on the race track, it was inhospitable on the road.

A few months later I got to spend some time in a "real" SVO, and it was a much better car than the monster we met at our first encounter.

The SVO Mustang is no Porsche or Ferrari, but then, you don't pay Porsche or Ferrari prices for it. Within the confines of its price, the SVO is a high-tech, high-performance machine that stands head and shoulders above your average Mustang.

The engine is based on Ford's 2.3-liter overhead cam Four that normally produces 88 hp. The SVO version uses electronic fuel injection and a turbocharger with an intercooler to raise this to 175 hp. A switch on the dash recalibrates the electronic engine control system for regular or premium gas. Brakes are discs at all four wheels. The suspension incorporates six adjustable, gas-filled Koni shocks. The two horizontal shocks at the rear help tame the Mustang's axle tramp under hard acceleration. A five-speed manual transmission is standard.

The car looks positively sinister with its off-center hood scoop positioned over the intercooler, twin rear spoilers, blunt snout, ultra low-profile tires, flush

The SVO we tested at first had been set up for the race track, so we tried another.

BY WADE HOYT
Auto Editor

Porsche-type 16-in. aluminum wheels and thickly padded steering wheel.

Acceleration is startling as long as you keep the engine above 3,000 rpm. Below that speed, the turbo lags, even though you'll find boost registering on the gauge. You can feel the turbo's power come on with a rush at 3,000 rpm. At lower engine speeds, you're aware that you're driving a four-cylinder automobile. The ride is really excellent for a sports car. It handles dips and potholes well, with only a little harsh-

ness at low speeds. The brakes on this car were first-rate—no fuss, no fade, just straight, sure stops.

With 30 hp less than the Mustang GT V8, and much less weight in the nose, the SVO handles a lot better, too, although it's not yet perfect. It still tends to get skitterish when pushed too hard on bumpy surfaces. The Goodyear 225/50VR16 NCT radials, superb on dry roads, make the car a real handful on snow, ice, or sandy roads, especially when the turbo power kicks in suddenly.

There are a few other drawbacks inherited from the standard pony car that make the SVO less than a total pleasure. Although the multiadjustable, racing-style seats are very nice, you feel like you're sitting in a hole inside the high-sided Mustang. They're just too

(Please turn to page 154)



Engine bay is businesslike, if not pretty. Engine is set far back for better weight distribution. You must remove the intercooler in order to reach the sparkplugs!

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FIRSTHAND REPORT: MUSTANG

(Continued from page 152)

low. Many of the controls are awkward to use including the short wiper lever, which is located behind a long turn signal lever. The center console, folding rear seatbacks and glove compartment door are all sticky to deal with. Some friction has been added to the numb Mustang power steering, but no road feel. This combination of no low power, awkward controls and numb steering doesn't exactly inspire confidence when zapping through heavy traffic.

More important, perhaps, than what the Mustang SVO can and cannot do is what it represents: a commitment to high performance after so long a drought in Detroit. Not the irresponsible high performance of the muscle car era, but performance with fuel economy, brakes and handling. Ford has spent a lot of time, effort, money and thought on the SVO, rather than simply dumping a big engine into a small car.

This new commitment is not only refreshing, but to some people it's totally unexpected. As a friend of mine admired the turbocharged engine, fat tires, biplane spoiler and functional hood scoop, he exclaimed, "Can you really buy this?" Yes, you can. But commitment doesn't come cheap.



The controls are simple and clear, but a bit awkward to use. Heavily padded leather wheel has the horn button in its center, a position the new Fords are changing back to.

In the case of the Mustang SVO, it starts at \$15,970 or \$6,018 more than the Mustang GT and \$8,498 more than the base Mustang. Our test car, with air conditioning, metallic paint, AM/FM sound system, power windows and door locks and more had a sticker price of \$17,651.

Is all this technology worth the premium price? It may be if you really must own the most technologically advanced Mustang ever built, but the SVO still suffers from hereditary shortcomings. In this price range, you can find a lot of civilized GT cars with excellent performance and more creature comforts. **FM**

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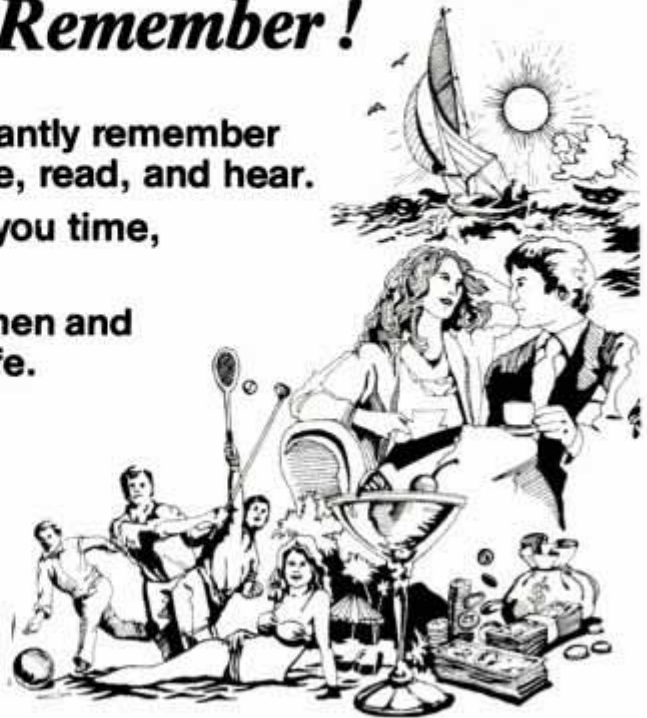
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NISSAN 300ZX

"I would prefer to buy American, but I don't think Detroit will ever respond to the sports car enthusiast."

— MISSOURI PHYSICIAN

"I appreciate the quality, workmanship and reliability of the Nissan line."

— MARYLAND FINANCIER



"They have made the engine very difficult to work on."

— CALIFORNIA RETIREE

"The most disappointing thing about this car is the stereo."

— NORTH CAROLINA MAINTENANCE ENGINEER

"Light years ahead in quality over the Corvette."

— FLORIDA MANAGER

"Electronics don't work in cold weather."

— DELAWARE SALESMAN

PHOTOS BY BILL ASHE

High quality and good dealer service draw raves from Z-car loyalists.

The last time we surveyed owners of Nissan's (Datsun's) sports car, back in 1981, we got pretty much the same answers (see *PM Owners Report: Datsun 280ZX*, page 128, Feb. '81). And, yes, we asked the same questions. When you compare responses for the old 280ZX with those for the new 300ZX, you end up with a very good idea of how far the Z-car has and hasn't come.

The cars were different, of course. For one thing, the 280ZX didn't have a turbo option at first. About 6 percent of the owners we queried in early '81 said they'd appreciate more horsepower, and 5 percent recommended a turbo



Analog gauges are standard on Nissan's sportiest model, but digital instruments come with leather interior option.

specifically. Then in April 1981, Nissan heeded that advice and began offering a turbocharger.

This time, for the 300ZX, only 9.4 percent ordered the turbo, and no one complained about power—obviously,

the new V6 is giving owners all the kick they want. The price of the turbo-charged car, however, did bring forth some muted gripes, as did the fact that you couldn't—at the time of our most recent survey—combine the turbo with a five-speed gearbox. Borg-Warner now

A NATIONWIDE SURVEY BASED ON 798,476 OWNER-DRIVEN MILES

supplies a five-speed for the 300ZX turbo, a combination that had been available for the 280ZX since '81.

In terms of fuel mileage, the 280ZX and 300ZX are very similar. Even so, our figures leave no doubt that the 1984 car has a more efficient automatic transmission. This is Nissan's new four-

(Please turn to page 158)



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OWNERS REPORT: 300ZX

(Continued from page 156)

speed overdrive automatic with torque converter lockup in every gear. The 300ZX automatic posted 19.4/24.3 mpg against the 280ZX three-speed automatic's 17.9/23.0.

The mpg contest between manual transmissions turned out to be closer. The 280ZX five-speed showed 20.4/26.8 versus the 300ZX's 20.8/27.0. So, while there's a measurable difference between automatics, cars with five-speed transmissions were a draw.

Quality, too, remains amazingly consistent. For the 280ZX, 97.8 percent of our respondents rated workmanship good to excellent. The 300ZX pulls a score of 98.4 percent.

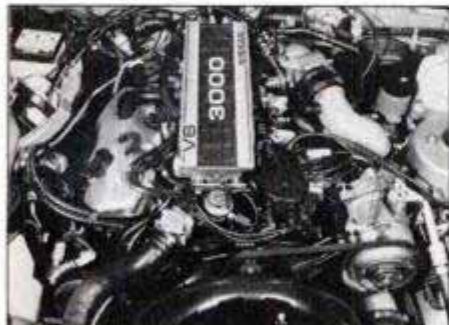
The biggest difference between the 280ZX and the 300ZX seems to be the types of repairs needed. Actually, about

SUMMARY OF 1984 NISSAN 300ZX OWNERS REPORTS*

Total miles driven 798,476	Specific likes:	Good..... 24.4	Dealer service opinion:
Average miles per gallon	Styling..... 68.9%	Average..... 1.7	Excellent..... 30.5%
Five-speed manual	Performance..... 40.9	Poor..... 0.0	Good..... 49.2
In town..... 20.8	Handling..... 39.1		Average..... 15.3
On the highway..... 27.0	Comfort..... 33.8	Comfort opinion:	Poor..... 5.1
Four-speed automatic	Ride..... 24.9	Front seats	
In town..... 19.4	Specific dislikes:	Excellent..... 76.6%	Number of vehicles owned:
On the highway..... 24.3	Poor stereo sound..... 9.7%	Good..... 22.1	This car only..... 28.7%
Body style choices:	No complaints..... 9.1	Average..... 1.2	Two cars..... 43.0
Two-seater..... 76.6%	Price too high..... 7.8	Poor..... 0.0	Three cars..... 15.6
2+2..... 23.4	Design not distinctive enough..... 7.1	Rear seats	Four or more cars..... 12.7
Engine choices:	Handling could be better..... 5.8	Excellent..... 21.4%	Makes of other cars owned:
Nonturbocharged 3.0-liter V6..... 90.6%	What changes would you like?	Good..... 25.7	Datsun (Nissan)..... 27.0%
Turbocharged 3.0-liter V6..... 9.4	No changes..... 43.0%	Average..... 32.9	Chevrolet..... 18.9
Transmission choices:	Reposition headlight switch..... 4.1	Poor..... 20.0	Ford..... 18.4
Five-speed manual..... 74.3%	Redesign front end..... 4.1	Had any mechanical trouble?	Toyota..... 11.5
Four-speed automatic..... 25.7	Better stereo..... 3.1	No..... 63.6%	Cadillac..... 11.5
Why did you choose the 300ZX?	How much did you pay?	Yes..... 36.4	Would you buy another 300ZX?
Styling..... 53.5%	Range..... \$13,900-21,500	What type of trouble?	Yes..... 78.6%
Performance..... 30.3	Average with nonturbo engine..... \$16,456	Fuel-door release mechanism..... 11.5%	No..... 1.6
Past experience..... 28.2	Average with turbocharged engine..... \$19,513	Heater controls..... 9.2	Maybe..... 19.8
Handling..... 10.6	Workmanship opinion:	Hood latch (recall)..... 9.2	Would you buy another Nissan?
Reputation..... 8.5	Excellent..... 74.0%	Stereo system..... 9.2	Yes..... 83.3%
		Headlight mechanism..... 8.0	No..... 0.4
		Dealer repairs satisfactory?	Maybe..... 16.3
		Yes..... 69.6%	Age distribution of owners:
		No..... 30.4	15-29 years..... 28.0%
			30-49..... 56.4
			50-plus..... 15.6

*Percentages might not equal 100% due to rounding or insufficient data.

7 percent fewer 300ZX owners reported problems of any sort. And the troubles they did have weren't hardcore mechanical—just minor items, such as sticky fuel-filler doors (the remote fuel door latch apparently has a habit of not unlocking at certain times; it's an intermittent problem that plagued 11.5 percent of our respondents), noisy heater fans, grainy-sounding or wandering



The V6 meets everyone's performance needs. And it gets more mpg than 280ZX.



Luggage tiedowns keep cargo secure in the hatchback when the roads get twisty.

stereo reception, and poor operation of the hood latch and headlamps.

The 280ZX, however, while by no means bristling with problems, did have a more serious menu of mechanical maladies. For example, 7.1 percent of our 280ZX owners reported in 1981 that their engines were burning oil between changes. They also mentioned troubles with fuel injectors, the shifter, air conditioner, brakes, and electrical system. Nothing this serious plagued the 300ZX.

Better service

Dealer service, too, is rated a little better. This time, nearly 70 percent of all repairs were corrected the first time—a good figure. For the 280ZX, the tally stood at 64.7 percent, which wasn't bad either.

Nissan purposely made evolutionary styling changes in the 300ZX, but nothing too radical. Most owners of the new car appreciate the subtle upgrade, with 53.5 percent of our respondents listing styling as their main reason for buying. Back in '81, styling again ranked as the main attraction at 58.8 percent. A few people, though, didn't feel Nissan had

(Please turn to page 160)

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OWNERS REPORT: 300ZX

(Continued from page 159)

made the 300ZX distinctive enough. "I'd like a little less look-alike front styling," said a North Carolina retailer. "The Z is too much like a Firebird up front and too much like the previous 280ZX around back."

All other judgments of the car, including specific likes and dislikes, stayed virtually the same. Nearly 30 percent of 300ZX owners had owned Nissan Z-cars before, so comparisons became inevitable.

"I loved my 1981 280ZX," said a

Delaware flight engineer, "but this 300 is far more comfortable. The steering has much quicker response, and the car rides and handles superbly, with no rear-axle squat during fast shifts or hard acceleration."

A Massachusetts executive assistant added, "I drove my 280ZX for seven years, had no serious problems and would still be driving it except for rust. However, after test-driving the 300ZX, I bought it immediately. The 280 pales by comparison. This is the most comfortable, enjoyable car I've owned."

Yet a minority of owners (5.8 percent) felt that the 300ZX is too softly

sprung. One Wisconsin surgeon put it this way: "I updated my previous 280ZX with special swaybars and struts. The 300ZX, too, is way too soft in suspension, even on the firmest of the three shock settings. My new Camaro and my wife's Celica GTS both handle, corner and ride better."

A Tennessee registered nurse disagreed. "With the standard Bridgestone Potenza tires, my 300ZX corners very well on tight curves and during emergency maneuvers. Wet-weather driving is also excellent."

The power got away from some hands last winter, though. "It's a great-handling car," remarked a Maryland yardman, "except in snowy and icy weather. There's not enough weight over the rear wheels, and the tires break loose without much provocation."

Quality wins praise

As for quality: "I've owned this car for four months now," noted a Wyoming corporate executive, "and have never had to go back to the dealer for anything. This is my fourth Z-car. I'm always impressed with these cars' reliability, fuel economy, performance and excellent resale value. The 300ZX represents a great improvement over the three 1975-82 Zs I owned previously. It's an excellent GT luxury/sports car."

A Louisiana airline pilot: "I've had some tiny problems with my car, but nothing serious. The power antenna sometimes sticks, the headlights were out of adjustment and one power window failed. I've also received notice of a factory recall to correct a potential problem with the primary hood latch. And it looks like the sparkplugs and oil filter are going to be bears to change! Then, too, a couple of switches are hidden behind the steering wheel.

"But overall," he continued, "I enjoy the 300ZX driving environment—the car's handling with its excellent road feel and quick steering, the silence, and especially the aesthetics. I love the car's looks, as do friends and strangers."

A Texas manager: "They have to do something about that 'fingertip' headlight switch because it can be turned off inadvertently while using the turn-signal lever."

Some thoughts about price: "I wish the dealer hadn't loaded up my car with expensive, unwanted extras like rust-proofing, mats, paint sealer, fabric dirt repellent, and so on," observed a Florida newspaper adman. "But I guess the demand for the car is so heavy that people will pay for this junk. I did!"

And a Maryland store manager: "My 1976 280Z cost me \$7,000, which seemed like a lot at the time. But this 300ZX cost \$16,000, and while I believe it's a fantastic car, it ought to be

(Please turn to page 162)

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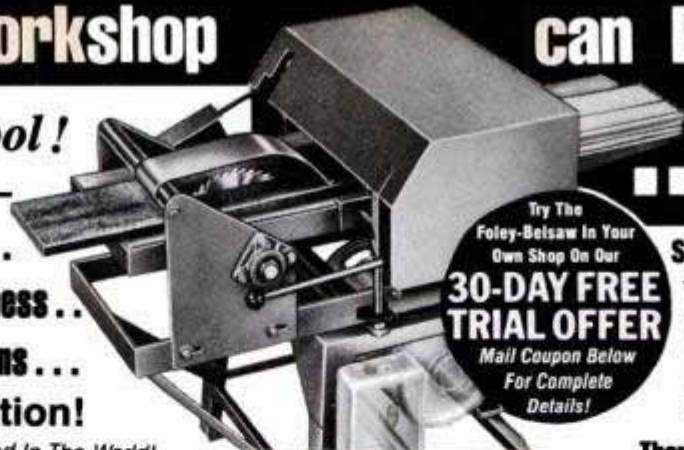
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OWNERS REPORT: 300 ZX

(Continued from page 160)

totally loaded at that price. I would have liked the digital instruments, but I didn't want the leather seats (I prefer velour). Digital and leather only come together. They ought to be standard so you can delete one or the other."

As it is, the only options offered for the 300ZX are the automatic transmission, T-bar roof and the leather/digital package. Everything else is standard, including automatic air conditioning, 40-watt AM/FM stereo, cruise control, eight-way adjustable seats, adjustable shocks, security alarm system, tilt wheel, electric windows, mirrors and door locks, power everything, four-wheel disc brakes, voice and graphic display monitors, 15-inch alloy wheels and premium tires. Those are just the highlights. The turbo includes even more and, in all, there's more than we can possibly list here.

Not everything worked

Despite this staggering array of standard equipment—or perhaps because of it—not everything worked for everyone. An Ohio production supervisor capsulized it when he wrote: "The heater fan makes an awful lot of noise, and tape-player quality isn't up to the standards I'd expected. Worse yet, the complexity of this stereo system prohibits an owner from swapping it with another make."

The bottom line, then, on the 300ZX becomes pretty obvious. Every owner we surveyed agreed that this new car beats the 280ZX in every way, which in itself takes a lot of doing. They also agree that, dollar for dollar, the 300 also beats the competition, and a number of owners specifically mentioned the Porsche 944.

But most harked back to the previous generation. "The 1982 280ZX that I owned before was so reliable," said a Florida sales rep, "that there wasn't a question of what to buy next. Another Z was the obvious choice. The only money I ever put into my 280 was for oil changes and tuneups. After 1 1/2 years and 50,000 miles, nothing ever went wrong. I now have 5,800 miles on my 300ZX, and its reliability matches the 280. In ride, comfort, performance, handling and looks, though, this new car surpasses it."

Finally, from a Texas data consultant with an unusual view: "I only wish Nissan would import fewer 300ZXs so it would improve the resale value of these cars even more. I easily sold my 1979 280ZX for more than \$6,000, which is why I came back for another one. How can you beat total satisfaction plus such an excellent return on investment?"

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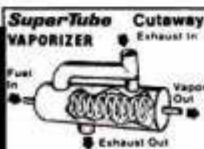


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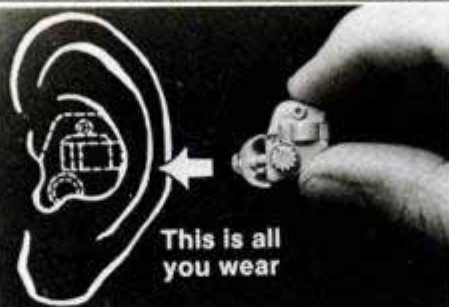
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Will Ship 48 States for \$60.

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Heavy Duty 4" x 24" cylinder, 5 gal Reservoir, 11 gal 2 Stage pump, 5 Hp Motor, 8" Hydraulic Wedge, Suction Strainer, Filter, 480 x 8" High Speed Tires, 1 1/2" Hitch, Heavy Duty Frame. These will split the toughest trees. High and Low Profile only **\$869**
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A 24 1/2 ton Block Buster



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500 watt, 115 volt AC or 100 watt, 12 volt DC. wt 40 lbs

Item # 1660 **\$299** EX-800, 800 watts
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- | | |
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| 5 Hp Tecumseh 1/2 Shaft #6051 | \$134 |
| 8 Hp Tecumseh cast iron sleeve #6081 | \$186 |
| 10 Hp Tecumseh cast iron sleeve #6010 | \$224 |
| 10 Hp Tecumseh 1" shaft Electric start. #60101 | \$269 |
| Vert 8 Hp Tecumseh 1 shaft #7082 | \$199 |
| 8 Hp Briggs 1 shaft #7080 | \$208 |
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