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Popular Mechanics

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STONE FENCE

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This One



93RC-D52-ZPH6

Not to mention VW's fuel-injected overhead cam engine that can take this pickup from 0 to 50 in just 8.8 seconds.

Which means on top of everything else it gives you something you usually don't get in a pickup.

Pickup.

Nothing else is a Volkswagen.



A cowboy wearing a white hat and a red shirt is riding a brown horse through a field of green brush. He is holding a lasso in his right hand. In the foreground, a brown and white cow is running towards the viewer. In the bottom right corner, there are two packs of Marlboro cigarettes: a red pack labeled 'Marlboro' and a gold pack labeled 'Marlboro 100's'.

Come to Marlboro Country.

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

Kings: 16 mg "tar," 1.0 mg nicotine—100's: 16 mg "tar,"
1.1 mg nicotine av. per cigarette, FTC Report Dec'81



On the cover

Though the radical lines of its fuselage were drawn more than two decades ago, the SR-71 "Blackbird" strategic reconnaissance aircraft still looks like something out of science fiction. And over trouble spots like El Salvador and the Falklands, it carries on intelligence unmatched by anything else now flying. On page 70, read how this remarkable plane was developed.
—PM painting by Ed Valigursky

Popular Mechanics®

JULY 1982

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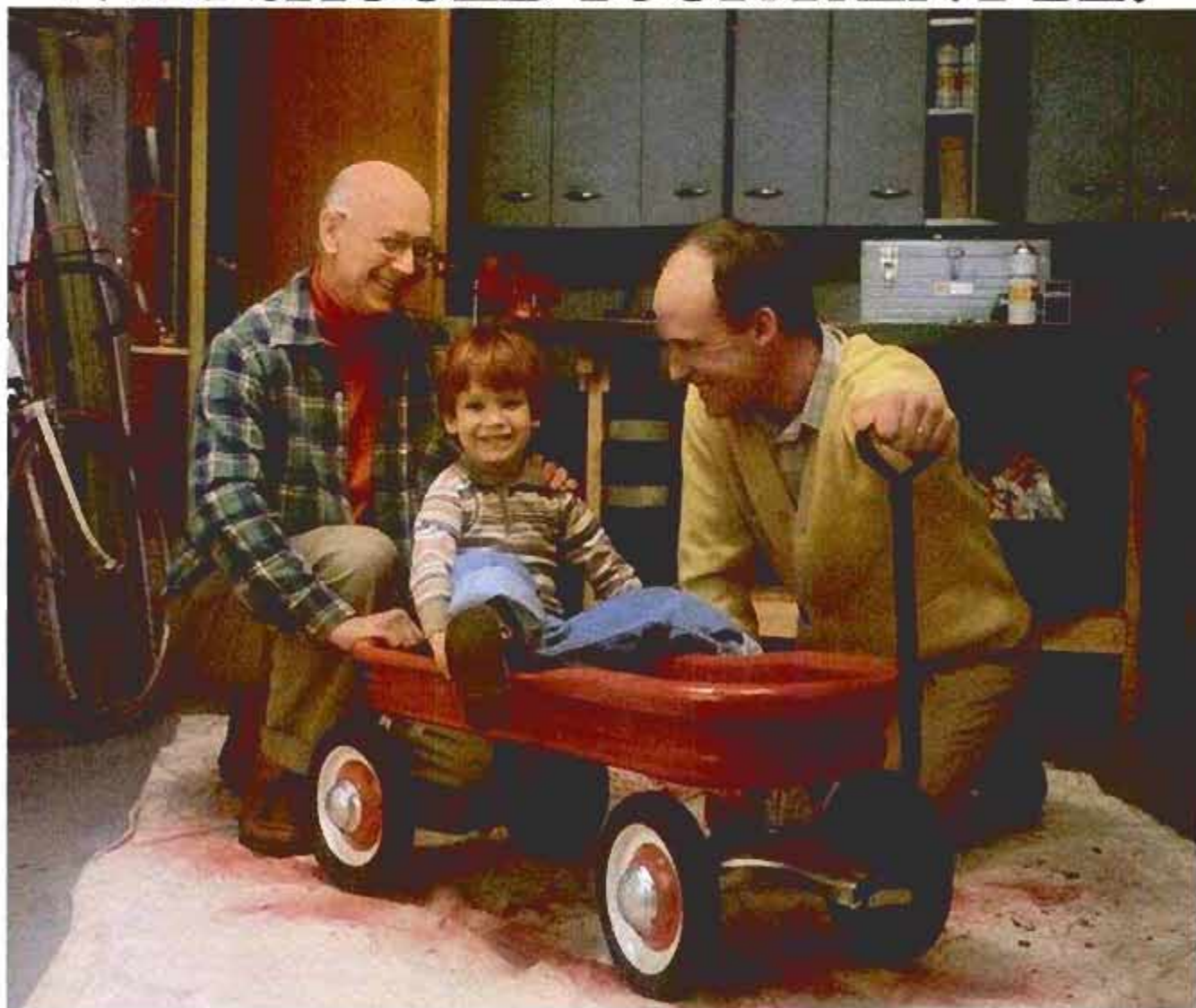
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LETTERS TO THE EDITOR

Who was really first?

I just recently had an opportunity to read your December '81 issue and became intrigued by the article *Was Whitehead First?* (page 68). We New Zealanders have our own aviation hero, Richard Pearse, who also achieved powered flight before the Wright Brothers.

According to published accounts, Pearse made his flight at South Canterbury in March 1903, predating the Wrights' feat at Kitty Hawk by nine months. In fact, Pearse is officially recognized as the first man to fly in a new book, *Jane's History of Flight*, by John Taylor, editor of the authoritative *Jane's All the World's Aircraft*.

I realize, however, that much depends on how you define powered flight. Pearse himself was disappointed by his lack of control, causing his short flight to end in a gorse bush. As a result, he apparently never claimed to have achieved true "sustained and controlled" flight. In this respect, the Wright Brothers certainly must remain the undisputed fathers of aviation—but Richard Pearse deserves a place in history, too.

PETER McCULLY
AUCKLAND, NEW ZEALAND

We agree; thanks for this fascinating sidelight on a question that may never be truly settled.

Telling it like it is

I'd like to compliment you on your new series on gas-saving devices called *High Mileage Files*, starting with your December '81 issue (*Aerodynamic Devices For Better MPG*, page 77). I appreciate this kind of reporting because it not only describes each gadget, but discusses its efficiency and payback period. This really helps.

KENNETH MARKS
ANTWERP, OHIO

Thanks for the kind words. For those who may have missed it, we took a look at Holley's new Z system last month (New Carburetor And Manifold Yield Better MPG, page 58, June '82). We'll have more in this series in upcoming issues.

Updating PM's pedal car

Here's a photo (upper right) of the pedal car my son and I built from your plans (*Build The GT-8: PM's*

Grand Tourer For 8-Year-Olds, page 124, June '80). The only change I made was to use 20-inch bike wheels in place of solid ones to give the car a classic wire-wheel look. The plans were easy to follow, and the car pedals quite easily, even up slight grades.

RICHARD VANDERNOOT
PETERSBURG, W. VA.

Thought you might like to see another version of your pedal car



Above: PM's GT-8 pedal car built by reader VanderNoot. Below: Powered version by reader Moore uses 12-volt starter motor driving ring gear mounted on rear axle.



(photo above) that I built for my granddaughter. Because it had to be used on rough terrain, I powered it with a 12-volt starter motor. The motor drives an old flywheel ring gear mounted on the rear axle.

The battery is safely hidden under the seat, and a sheet-metal guard keeps fingers and clothing out of the gear teeth. The car runs at a brisk walk and was a fun project, well received by all the neighborhood kids. Thanks.

DONALD N. MOORE
POULSBORO, WASH.

You both did a great job, and the

motor drive is a clever idea. For others who may be interested, plans for building the GT-8 are \$6 from Stevenson Publications, Box 584, Del Mar, Calif. 92014.

Also see next month's PM for a new variation on this popular pedal car. It's a mini delivery van that can be converted quickly into a roadster or dump truck to suit a youngster's changing fancy.

Are fuel meters practical?

I greatly enjoyed Robin Nelson's article *Eight Days On Straight Alcohol* (page 89, Apr. '82). I particularly noted his mention of the Halda fuel-flow meters used by the rally participants.

Since proper driving technique is so important to fuel economy, I've been wanting to install a similar fuel meter in my own car. Would the Halda meters be practical for all of us to use?

CARL L. KERNS
NASHUA, N.H.

Author Nelson replies: The Halda meters were lent to the participants. They are intended primarily for use by large commercial fleets and are neither compact nor inexpensive. Unfortunately, in the experience of PM's auto editors, reliable fuel-flow meters are not available for a price most of us would want to pay (under \$500). All those we've tested malfunctioned or proved inaccurate within a short time.

A driving computer made by Zemco Inc. (12907 Alcosta Blvd., San Ramon, Calif. 94583) gave somewhat better service than others. Interested readers might wish to contact the company for information on current models and prices.

From England, with love

As avid readers of PM, we'd like you to know how much we enjoy your fine magazine. We have nothing like it here in England, but are fortunate in having a daughter in Canada who sends it to us.

(Mr. and Mrs.) T. N. SIMPSON
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PM ELECTRONICS MONITOR

Yo, ho, ho computing

They say that imitation is the sincerest form of flattery—but some people in the computing industry feel that copying software is the next best thing to murder. The copying of software, often referred to as piracy, has become a widespread practice.

Infoworld, an influential weekly tabloid which is devoted to microcomputers, recently featured a bright, blood-red cover emblazoned with a white skull and crossbones. Obviously, the computing community is somewhat disturbed.

Let's say that you buy a game on floppy disc for your Apple II. Your friend asks you for a copy. If the game is on an unprotected disc, copying it is child's play. So, you make a free copy; you're what I would call a pirate in the third degree.

Then, suppose you go to a computer club meeting and 50 people want copies. You make them and give them away—now you're into piracy in the second degree.

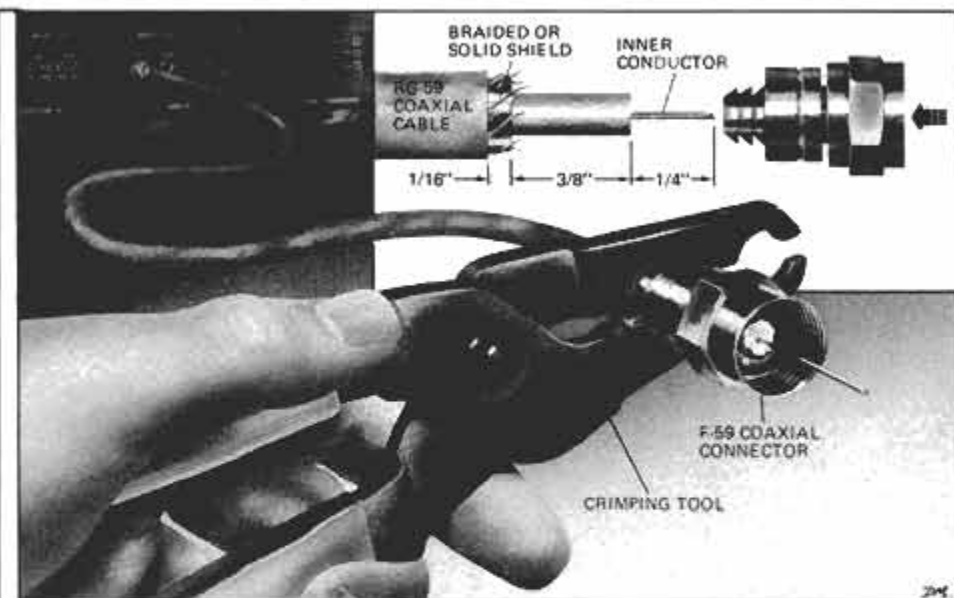
Next meeting, you realize that the cost of last month's discs (blanks) set you back almost \$100. This time, you charge just a couple dollars for the program copies to "cover your costs." Now you're into first degree piracy.

Finally, let's assume that all your moral principles have vanished in a welter of situational ethics. At the next meeting, you announce, "This program sells for \$40 and I'll make copies for \$25." Now you have graduated to Pirate Grand Master!

All of the above situations have one thing in common: the making of copies of software, from which neither the programmer nor the legal manufacturer derives any profit.

To combat this, many manufacturers have taken to specially encoding their software. These "copy-protected discs" cannot be copied using just a bare computer and its usual copying software.

However, many consumers feel that they should have the right to make backup copies for themselves. Suppose, for instance, that your cat sits on your favorite game. If you don't have a backup, it may be a few weeks' wait and a \$5 fee for a replacement (if you remembered to send in your warranty card). Or—even worse—what if your ex-wife sneaks in and uses her nail clippers on your company's payroll program. (Not only will this result in a delay,



Crimp your style

It used to be that only TV repairmen and professional antenna installers had to be concerned with the F-59 connector (shown above). But nowadays, with the advent of the home videotape recorder—and more people installing their own antennas—this has suddenly become an important connector.

We prefer the F-59A style, which can be crimped onto a cable as the artwork details. But please, don't crimp with pliers, or—worse—hammer the connector to death. Instead, you should invest in a good crimping tool, like the one shown. It will give you a neater and more reliable connection.

but, perhaps, a large charge for another disc.)

Pick-a-lock

The law states that the user of a program is entitled to make backup copies, for personal use only, if he (or she) can figure out how. There are now all sorts of copy programs with which you can attack a copy-protected disc.

I have been using one such copy program, called *Back It Up II*, from Sensible Software, and have found it easy to use.

It has a "decode" option, so that it will automatically decode many of the protected discs. In fact, this program is a real champ at decoding without using any kind of special techniques.

But for many programs, you still have to investigate the software and "change parameters" to break the code. Lists of current software parameter changes are available from many computer clubs, as well as on national computer networks (such as Micronet's Apple Users Group).

Back It Up II is probably the first in a new generation of "automatic" programs to copy software (though such a program often requires much work on the code breaker's part). It's obvious that copy protection is not really working.

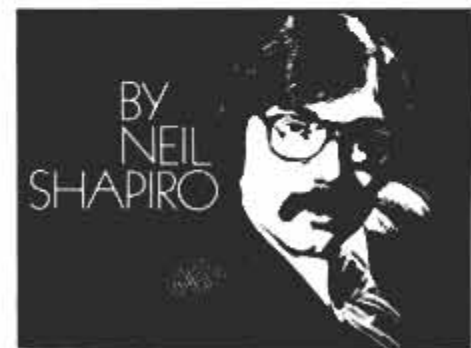
Pirated futures

With programs like *Back It Up*, almost anyone can now get around copy protection. And this has been causing quite a stir.

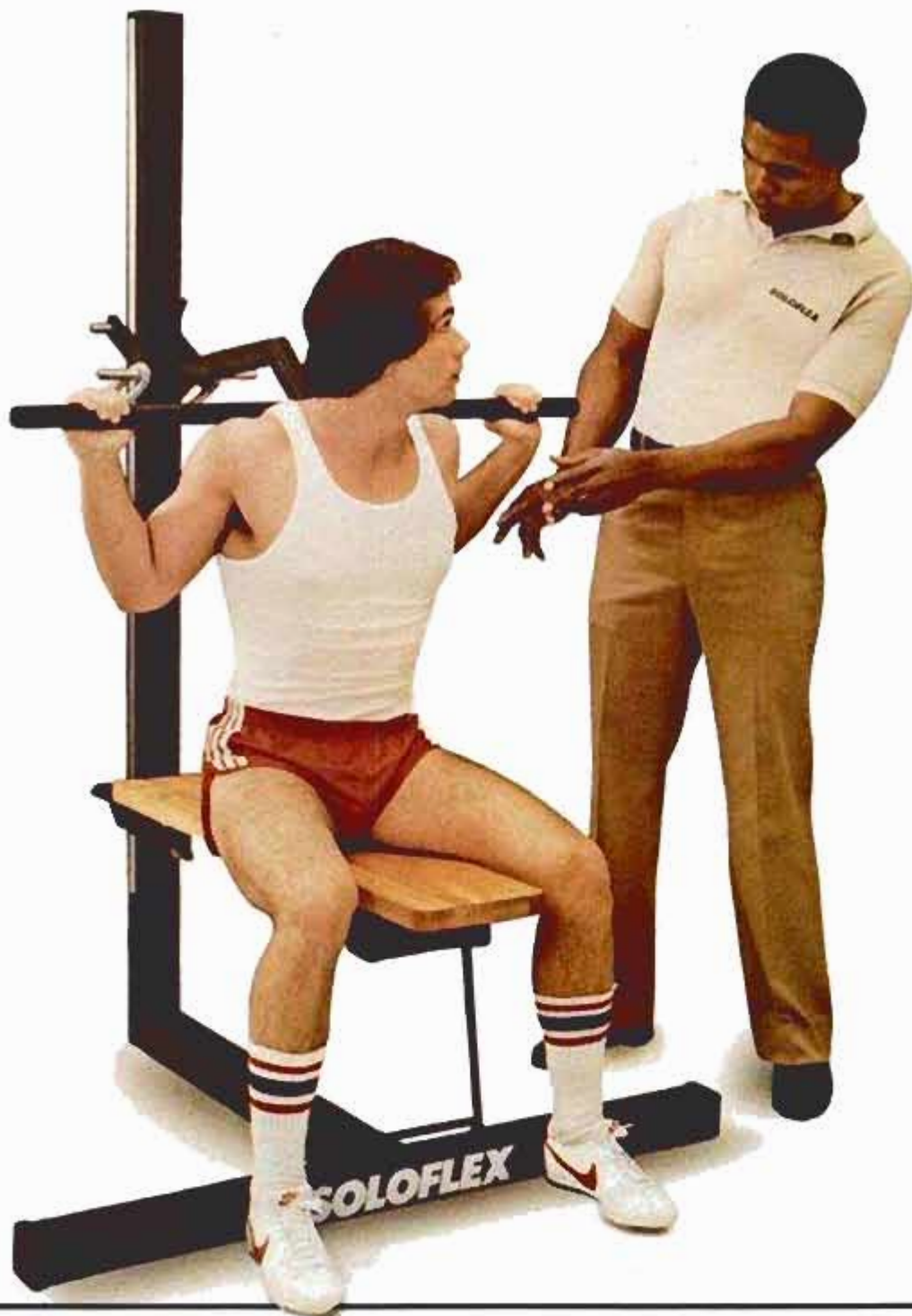
Software vendors complain that people who wouldn't steal an apple from a grocery will go to a friend's house and copy, for instance, a few thousand dollars' worth of Apple programs.

But many consumers maintain that the copy-protection-cracking programs are necessary so they can back up—and count on—important programs they have bought.

The controversy seems to be reaching a boiling point now, with a few cases threatening to go to legal action. It shouldn't be long before the word "pirate" starts appearing in national news reports. Shades of the 18th century high seas! **PM**



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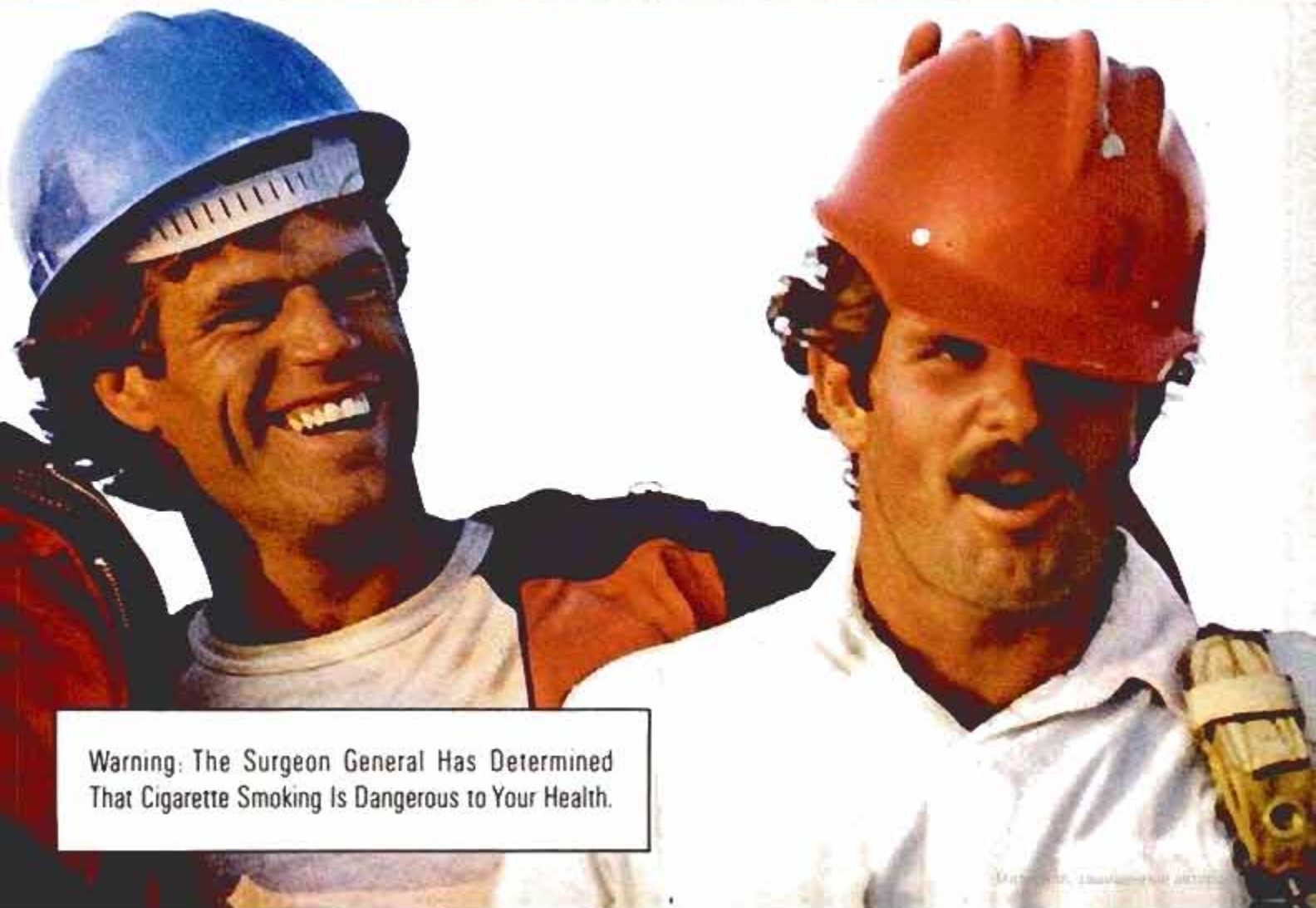
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ALL OUTDOORS

Expedition camera

We had arrived by night flight at Bogota, Colombia, flown on over the crest of the Andes, and now, after a run down the Rio Vaupes in a dug-out canoe, were hiking along a path through the Amazonas jungle near the famous El Dorado fishing camp. The high noon sun of the equator flicked through thick branches as a baseball-sized beetle ambled out in front of us.

We stopped to watch while noted naturalist George Harrison of PM's companion publication, *Sports*



Palm-sized Olympus XA packs easily, and the sliding cover opens to expose wide-angle lens for sharp 35-mm shots.

Afield, set up his tripod. Only a true professional would have carried one all the way here to be sure that each photo was razor sharp. On it, he mounted his light Olympus OM-10 35-mm while the rest of us took pictures of him and his beetle model with our assorted equipment. Later, we sat around a palm-roofed patio discussing insects, fishing, and the perfect camera to take afield.

The camera has to be strong, we agreed, but not heavy. Ideally, it would be pocket size, with a sharp lens, fast shutter, built-in meter and flash, constructed to ward off travel hazards. There was no such camera, we decided, so the only solution is to carry several cameras.

But a number of months later, several of the same outdoor writers gathered to explore the great hunting and fishing around Pierre, S.D. This time Homer Circle, Bud Leavitt and Howard Blackwood were all using Olympus XA and XA-2 cameras, the compact little pocket models with the sliding, clam-shell lens covers. Pictures, they reported, were sharp enough for big enlargements. Flash was particularly easy to attach. The miniature units proved small and light enough for any pocket or tackle box and could

be used with just one hand. They're excellent back-up cameras, I was told, but I noticed these top pros were using them all the time when lens changes were not necessary. We then ran some tests with both models and also got excellent results. For outdoorsmen, the Olympus XA series is certainly a new on-the-go camera to consider.

Travel alarm

Most smart homes now have smoke and fire detectors. But not many vacationers think to pack one for hanging in a tent, cabin or recreational vehicle when campfires, lanterns and camp stoves pose a real hazard.

Now, Viking Industries, 475 Tuckahoe Rd., Yonkers, N.Y. 10710, has assembled what it calls its Viking Home and Travel Security Kit. It's in a neat case that's ready to go, and



Fire alarm, burglar intrusion warning, flashlight and whistle are fitted in the handy Viking Home and Travel Security Kit.

includes the smoke detector with test button and weak-battery signal, plus a hanger to hook it on any door. But there is also an anti-intrusion alarm, a wedge-shaped device that is slid into the bottom crack of a door, or can be triggered with a lath across the entrance to a tent, and sounds off loudly if anyone tries to open the door or walk in. The \$35 kit also supplies a small flashlight, whistle and review booklet for escaping hotel fires. Packing along the small kit seems very worthwhile for the added peace of mind.

More for the money

Outdoor sports have always been among the most inexpensive forms of recreation, but now there are some additional ways to save. For fitting out on a budget, TAB Books, Blue Ridge Summit, Pa. 17214, has a

new, large-format \$14.95 paperback that tells in detail how to make your own clothing and sleeping bag, tents and backpacks, canoe and bicycle bags, even a super stainless sierra cup and cooker. The book is called *How To Make Your Own Lightweight Camping & Hiking Gear*, by Vick Hines, and is also worth having as a manual for making repairs in the field. A good discussion of the latest materials and sources is included.

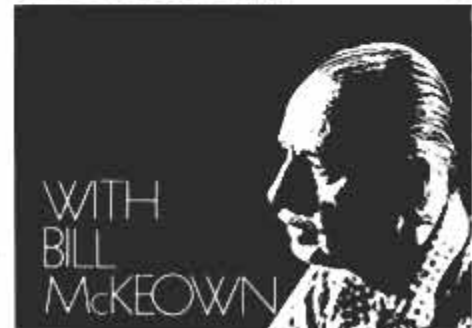
Additional useful books from TAB are *How To Make Your Own Knives*, *How And Where To Prospect For Gold*, *The Complete Handbook Of Leathercrafting*, *The Complete Step-By-Step Boat Repair And Restoration Handbook*, and *How To Build Your Own Log Cabin From Scratch*.

If building a log cabin seems like a major project to start from scratch from a book, Minnesota Trailbound, 3544 Grand Ave., Minneapolis, Minn. 55408, sponsors 10-day log construction courses at a logging camp on the edge of the Boundary Waters Canoe Area, near Ely, Minn. Timber felling, chain-sawing, wood selection, hoisting methods, notching and grooving, and other skills are taught as a log building is actually constructed.

Kits give the craftsman on a budget a head start. Frostline Kits, at Frostline Circle, Denver, Colo. 80241, has a wide variety of outdoor clothing, while Country Ways, 15235 Minnetonka Blvd., Minnetonka, Minn. 55343, offers new kits for boats, birds and banjos. Assemble or carve your own mallard, dulcimer or rowing shell.

Be the first

Not every backpacker on your block is likely to have his own solar battery charger strapped atop his bed roll, but you can get your SunCharger from The Yak Works, 2030 Westlake Ave., Seattle, Wash. 98121, for about \$31. It'll keep flashlight or radio batteries ready. **PM**



NOW FIRESTONE LIGHT TRUCK RADIALS COME WITH A SPECIAL BONUS: COLEMAN CAMPING GEAR.

Here's a deal so good no true outdoorsman can pass it by.

It starts with the Firestone line of steel belted light truck radials: ATX,[™] the one that's been winning big in off-road racing; Steeltex,[™] our tough all-position light truck radial; and the Steeltex Radial Town & Country[™] with its special deep biting traction tread.

And now, for a limited time, with each one you buy, we'll give you a coupon good for a special super saver's discount on your choice of a Coleman[®] portable air compressor, cooler, stove, or lantern.

To be sure you don't miss out on this great offer, get the details now at your participating Firestone tire retailer. He's got the tires to get you to that special spot. Plus the Coleman camping gear to help you enjoy it more.

Coleman Inflate-All[®] Portable Air Compressor

\$29.33 plus shipping and handling

Coleman "Lunch Pack"[™] Cooler

\$10.47 plus shipping and handling

Coleman Deluxe 2 Burner Stove

\$35.91 plus shipping and handling

Coleman Double Mantle Lantern

\$28.60 plus shipping and handling



Firestone

Offer ends November 30, 1982

IMPORTS & MOTORSPORTS

Cars German style

German automakers seem to know exactly how a car should look. That's why we, and the Japanese, have been copying them like crazy. We're all familiar with Ford's models that are Mercedes look-alikes; Honda's adaptation of teutonic styling and, going back to the mid-'70s, Chrysler's imitation of Volkswagen's front-wheel-drive economy car: The Omni and Horizon still appear to be chromed Rabbits.

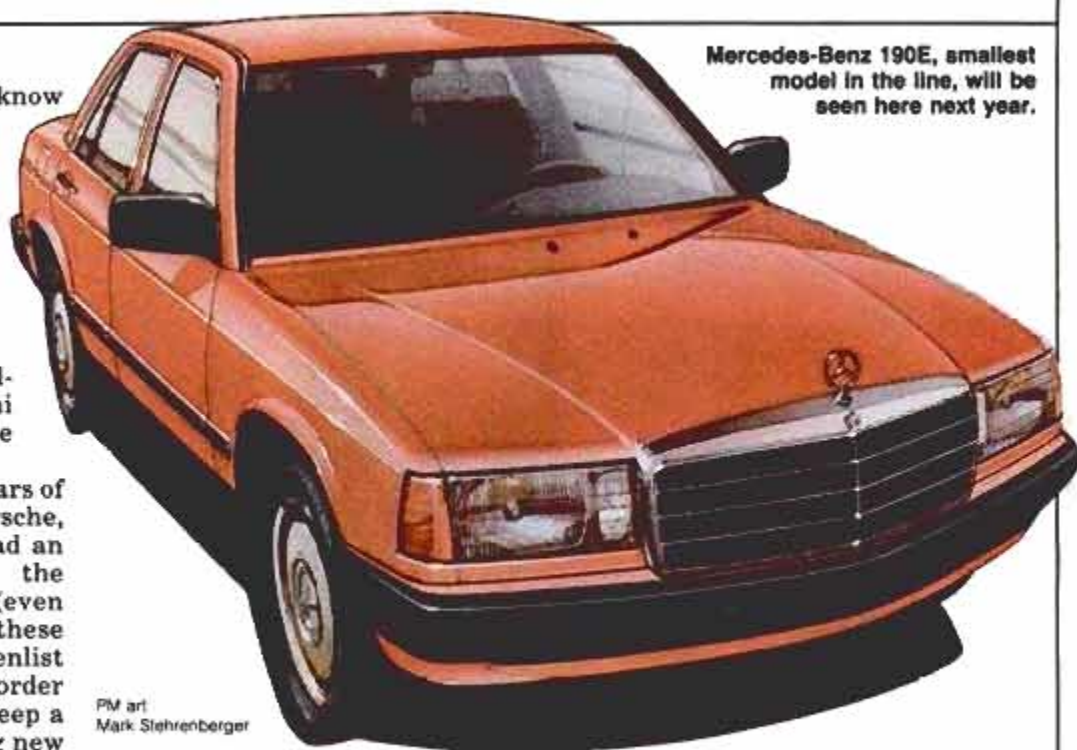
During the last decade, the cars of Mercedes-Benz, BMW, Porsche, Audi and Volkswagen have had an extraordinary influence on the shape of the modern motorcar (even though we know that some of these manufacturers occasionally enlist the services of south-of-the-border stylists like Giugiaro). So we keep a special eye peeled for anything new from Germany.

Mini Mercedes

This is the year Mercedes-Benz will introduce its long-awaited W201, the corporate code number by which the car has been known up until now. While artist Mark Stehrenberger was putting the last brush strokes on his concept of the car as gleaned from early information, prototypes were spotted in Scandinavia undergoing winter testing. The two



Prototype of the Mercedes 190E, as seen in an unofficial photo, matches up closely to illustration. The four-door, rwd sedan will be introduced in Europe this fall as an '83 model. It'll be about 175 in. overall and 2,250 pounds. Initially, car will mount a 1.9-liter gas Four; later, a new family of diesels will be available for the mini.



PM art
Mark Stehrenberger

Mercedes-Benz 190E, smallest model in the line, will be seen here next year.

illustrations and spy photo give you an excellent idea of how the Mercedes 190E will look when introduced this fall in Europe (and here, sometime in '83, as a 1984 model). Initially, the mini Mercedes will be powered by a fuel-injected, 1,945-cc, ohc Four from which it takes its 190E designation (1.9 liters and E for the German word for fuel injection: *einspritzung*). Later, other powerplants will be available, including four- and five-cylinder diesels.

Estimates are that the 190E four-door will weigh in at an extraordinarily light 2,250 pounds, and be roughly 175 inches overall, which scales it close to BMW's 320i. Like all its big brothers, the 190E has rear-wheel drive, and it's expected to be every bit as luxurious as the larger cars. The price, we guess, will be a shade under \$20,000.

VW Polo Coupe



New Polo Coupe joins wagon-back model.

Volkswagen's wagon-like little Polo (see *Imports & Motorsports*, page 12, Oct. '81), a car that's not sold here, is one of the world's great basic cars. You can leave it an economical and practical box on wheels as it comes fresh from the factory, or transform it into a really racy rascal, as is being done by several of the top German customizing shops. Now there's a Coupe version that's, well... okay, but to me it doesn't have the same magic. We'll watch and see if German buyers feel the same way. **PM**

BY BILL
HARTFORD





YOURS FREE with membership Infamy

Pearl Harbor! 19 ships sunk or damaged... 2,300 dead... a date that will live in infamy. Was it necessary? Did F.D.R. know in advance that Japanese carriers were approaching? John Toland, dean of World War II history, provides the startling answers. 408 pages • 75 action-packed photographs. \$17.95 in publisher's edition!



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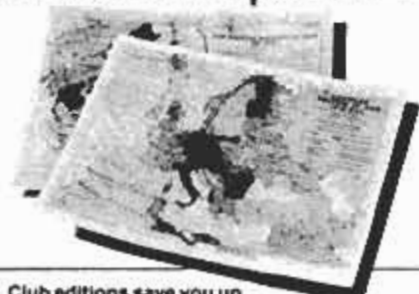
THE TEN THOUSAND DAY WAR \$16.95	THE AIR WAR 1939-1945 \$16.95	THE BLACK ANGELS \$10.95	WWII \$12.95
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* Explicit sex, violence, and language.

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NOTES FROM THE EDITOR

John A. Fullerton

For someone who claims to scare easily, PM Boating Editor Bill McKeown puts on a good show when he gets his hands on high-powered boats. This month, for instance, he reports on a test he made of the world's largest outboard engine (page 68).

Bill admits that he did "ease back" a bit when he hit an indicated 110 mph. But even at that, he kept on at 100 mph—still a brisk pace!

The speed test was far from a first-time experience for Bill. Driving with Jim Wynne, two-time world offshore champion, he has competed in seven consecutive Miami-Nassau power boat marathons, as well as three Cowes-Torquay English Channel classics. In those events, he drove as a member of the Volvo Penta and Don Aronow factory teams. Bill has also driven in endurance contests against the likes of international drivers Sam Griffith, Tommy Sopwith, Dick Bertram, Sir Max Aiken and Count Agnelli. Out of these events came such developments as deep-V hulls and Jim Wynne's first sterndrive.

Bill cites as one of his most memorable boating trips an Atlantic

PM's Bill McKeown (in the cockpit) receives a final checkout from Jimbo McConnell, top Outboard Marine test and factory racing team driver. Among McConnell's boat-racing accomplishments is the setting of three new world speed records on three consecutive weekends.



crossing by diesel from Stockholm to Miami via England, Portugal, Africa and Antigua. It was during the trip, he claims, that he decided to become a boating editor.

"It's got to be a more important job than any other," he says, "because there's simply a lot more water than anything else on Earth."

I can't remember when we've presented such disparate examples of American technology as we have in this issue. On page 84 we have contributor Richard Dempewolf's instructions for building a New England stone fence, and on page 70 you'll find Clarence Johnson's story on how he built the world's fastest airplane. In their areas, the products are superlative: No fence will outlast a stone fence, and no airplane outflies the Blackbird.

The airplane, incidentally, has become an international "figure" of late because of its surveillance abilities. Back in 1981, the Blackbird was given a certain recognition by North Korean ground forces, who launched a missile at one (and missed). They perhaps were acknowledging its ability to photograph 100,000 square miles every hour.

Today's New Englanders might say it takes good airplanes, as well as good fences, to make good neighbors.

PM

PONTIAC GIVES ECONOMY A NEW KICK



1982 J2000

Pontiac has charged-up its fantastic J2000 with a newly available 1.8 liter, overhead cam 4-cylinder engine with Electronic Fuel Injection!

A product of advanced technology and our unwavering love of driving, this efficient little beauty delivers the tough and responsive performance you need, with free-breathing excitement you can feel!*

Pontiac's fun new overhead cam J2000! Economy with a kick!

THE DRIVER'S CAR

The makings of a sports machine:

- 1.8 liter overhead cam engine with Electronic Fuel Injection, requires avail. auto trans.
- Front-wheel drive
- MacPherson front struts
- Rack and pinion steering
- Power front disc brakes

*Coupe, Sedan and Hatchback
44 HWY. EST. (EPA EST. MPG)
Without available air conditioning or power steering. Use estimated mpg for comparison. Your mileage may differ depending on speed, distance, weather. Actual highway mileage lower. California mileage, all models:
41 HWY. EST. (EPA EST. MPG)
Some Pontiacs are equipped with engines produced by other GM divisions, subsidiaries, or affiliated companies worldwide. See your Pontiac dealer for details.



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PONTIAC  **NOW THE EXCITEMENT REALLY BEGINS**

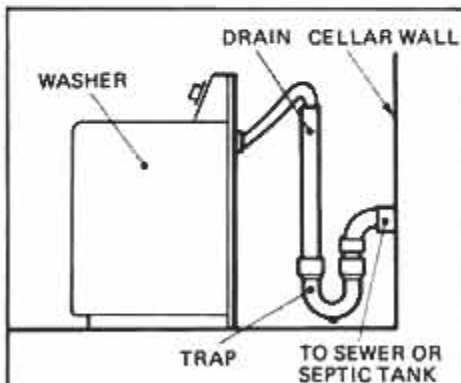
APPLIANCE CLINIC

QUESTIONS ANSWERED

Corrections

Several observant readers caught some slips in the February '82 *Appliance Clinic* (page 48). I'd like to set the record straight.

In "Stagnant Water," Harold Fately wrote that his nonsuds Kenmore washer emits an odor of stagnant water. There should be a drain



Water remains inside the trap to prevent any sewer gas from entering the basement.

trap in the plumbing, as shown here, to prevent sewer gases from entering the building. Another possible cause of the odor might be a buildup of some type of residue on the inside of the outer tub.

In "Dry Cycle Not Drying," J. Westheimer had a problem with his KitchenAid dishwasher, model KDS 17A. The dishes weren't hot when the cycle was over and the door was opened. The fan seemed to be working.

I suggest that you make sure the hot-water temperature at the dishwasher is 140° to 160° F. Then check to make sure that the current is reaching the dryer heating element (during the dry period on the timer). If no current is reaching the element, check for a faulty energy-saver switch on the door panel or possibly a bad timer contact. If current is reaching the element through the thermal protector, which is in series with the element, the heating element is probably defective.

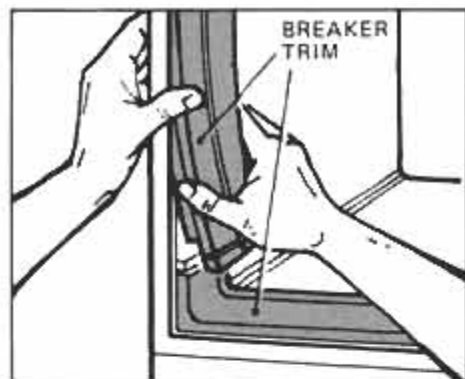
To check for continuity across the heater, turn off the power. Disconnect both wires to the element. Place a volt/ohmmeter across the heater element. Set the meter to the R × 1 or R × 10 scale. If you get no reading, the heater is defective and should be replaced. The thermal protector (button thermostat) can also be checked in the same manner for continuity.

Frozen debris

I'm attempting to clean the freezer compartment of my Sears Coldspot refrigerator model No. 106-6652500. But I can't remove the floor grate in the freezer compartment. It's fastened down with removable screws, but I can't pry it up, even after the screws are removed. Debris has dropped through the grate holes and made an underlying mess. How do I remove the grate?—Robert A. Grace, St. Joseph, Mich.

To remove the floor grate on your model refrigerator, remove the two-piece breaker trim from the freezer compartment to get at two hidden screws which are under the trim. They hold the bottom.

First, unplug the refrigerator. Next, remove everything from the freezer compartment. Pull off the knob from the air control which is on the back wall of the freezer. Then pull the plastic air-control cover off. Remove the six visible screws which hold the freezer floor grate down. Wipe the freezer compartment breaker trim with a warm, wet cloth to make it flexible, so it won't crack;



To remove the freezer floor, you must remove the two-piece breaker trim (plastic strip used to reduce heat transfer from the outside cabinet to the inner liner). Then remove two screws (hidden under the trim) which secure the freezer floor.

or warm the trim with a hair dryer before attempting to remove it.

Work carefully when you remove this trim; improper or excessive tension can break it. Start at the left side. Pry the trim out and pull forward. Then repeat this procedure on the other side. Lift up and pull out

If you have a question about any appliance, send it, 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.

the bottom trim. Next, remove the two screws (now visible) that hold down the freezer floor grate. Now you'll be able to pry up and lift the grate to get at the debris.

Oven short

We own a Magic Chef electric range model 156W-2CW. The bake element shorted. My wife turned the oven control to OFF, but the element continued to burn and travel toward the oven wall. I had to pull the circuit breaker to stop this. The wiring diagram shows two switches in the thermostat. My meter shows 120 v. to ground when the oven is in the OFF position, which I suspect is a fire hazard. Should I open the control and repair it or order a new control?—Leon A. Barefield, Spokane, Wash.

Sounds like you'll have to replace the bake element along with the oven thermostat. When the bake element shorted, it fused a set of contacts inside the thermostat which were closed at the time. The thermostat can't be repaired. It is part No. 1890-289; approximate cost is \$50. The bake element is part No. 1938-326; it's about \$30.

These parts are available in your area through Lloyds Sales and Service, 1233 North Division, Spokane, Wash. 99207.

Repairing dishwasher baskets

Reader J. Reback of Blue Mounds, Wis., tried the following repair of a worn dishwasher basket with, he claims, resounding success. He writes:

"Often the plastic veneer wears out on the basket tips. We used silicone rubber and pill capsules to make the repair. Fill half of a capsule with silicone rubber, place the half on the basket tip and let the rubber cure overnight. The next time you cycle the dishwasher, the gel capsule will dissolve, leaving a new rubber tip." **PM**



BY
STEVE
TOTH

*How does
Now stack up?*



At the bottom. 2mg

NOW/The Lowest
The lowest in tar of all brands.

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SOFT PACK 100's FILTER, MENTHOL: 2 mg. "tar", 0.2 mg. nicotine, av. per cigarette by FTC method.

CONFIRMED
BY LATEST
U.S. GOVT.
REPORT ON TAR

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

THE PM GARAGE

CAPSULE REPORTS ON NEW AUTO PRODUCTS

Pliers that stay set

It's annoying to set your adjustable-jaw pliers down and find them at a different setting when you pick them up again.

So, consider adding Neverslip Pliers to your toolbox. Although this tool resembles the adjustable-jaw-type pliers, it has a small button at the base of the jaws. When depressed against a sprung steel part on the opposite side, the tool may be adjusted to the desired width for the job. You can set down or even drop the Neverslip Pliers and they'll still hold



Adjustable-jaw-type pliers will hold a setting until you press the release button.

the setting—until you press the retaining pin and readjust the tongue-and-groove setting.

Neverslip Pliers are available for about \$14.95 from Neverslip Tools, Route 3, Box 280, Alvin, Tex. 77511.—*Joel Breault*

Battery tester

There is absolutely no safe way an automotive hydrometer will work on a smaller motorcycle battery. However, the Yuasa Battery Corp., the leading original-equipment battery supplier for most of the Japanese motorcycle manufacturers, sells a special one just for testing the smaller cells.

The Yuasa battery tester has five small colored balls housed within a



Tester is made especially for motorcycle batteries. Position of balls shows charge.

glass tube and a squeeze bulb at the end. All you do is insert the tube into the battery cells, and draw up enough acid to fill the tube. Tap lightly to remove air bubbles. The number of floating balls indicates the charge condition of the battery. Zero balls floating shows no charge, two balls floating equals 50 percent charge and up to five balls floating shows an overcharge. Rinse the hydrometer with fresh water and place it back into its protective storage tube.

I found the Yuasa battery tester at a motorcycle shop. It sells for around \$2. Yuasa's address is Box 1262, Reading, Pa. 19603.—*Joel Breault*

Brake cable tool

If you've ever tried to reconnect the commonly used, spring-loaded parking brake cable to the arm, you know what a struggle it is. The stiff spring breaks out of your grasp as you're trying to get the cable pin on the arm, and in many cases you end up getting your fingers pinched. A new



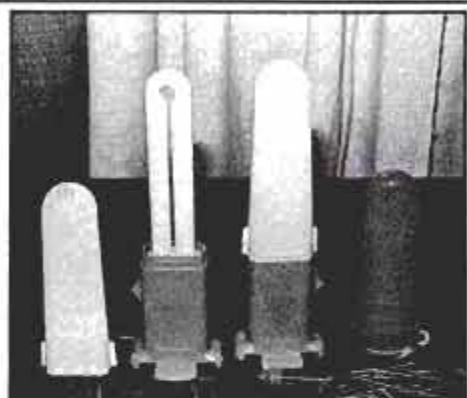
Special pliers will compress and hold the parking brake spring during installation.

pair of specialty pliers eases this task by compressing the spring and holding it while you reconnect the cable. At \$9.60, it isn't cheap for infrequent use, but the safety aspect is worth it.

The tool is made by Thexton Mfg. Co. Inc., Box 35008, Minneapolis, Minn. 55435.—*Paul Weissler*

Trouble light

Looking for a trouble light that plugs into a cigaret lighter? There's a new one out that uses a 15-watt fluorescent light and does a double-duty job: With the switch in one position and with an amber lens on top, it flashes to warn oncoming traffic. Move the switch and change to a translucent white lens and it glows



Plug-in, fluorescent light doubles as a worklight and flashing emergency light.

steadily so you can work on the car in the dark.

Called the Vital Lite, it comes with a 14-foot cord. It's \$9.50, including both lenses. It's sold through discount houses and auto parts jobbers by American Triangle Industries, 5749 Venice Blvd., Los Angeles, Calif. 90019.—*Paul Weissler*

Bendable light

Finding a nut or bolt that you've dropped into one of today's tight engine compartments isn't easy. You can't fit in a conventional drop light to look, so you poke around with a magnet and hope. Now, there's a new tool that gets around this and other problems.

Called Bend-A-Light, it's a thin lighting tool you can bend into



Bendable light rod snakes through crowded engine boxes and illuminates work area.

almost any shape you need. A magnet fits on the end, so you can pick up the lost part when you spot it. The tool also is available with an inspection mirror attachment so you can see around corners.

The tool, which lists for \$25 (\$37 with all attachments), is made by L&W Inc., 200 South Washington, Royal Oak, Mich. 48067.—*Paul Weissler*

Build your own computer for \$79.95



The Sinclair ZX81 personal computer kit

Imagine building your own computer for only \$79.95!

That's exactly what you can do with the ZX81 kit. It comes with all the parts you need and complete diagrams and instructions for putting it together. All you have to supply is soldering iron, solder, and a screwdriver. Plus, of course, a little bit of work.

But you get a lot more than several hours of kit-building fun. You also get a surprisingly powerful personal computer. The ZX81 hooks up to any TV for a 32-character by 24-line display (we provide the connecting cables). You can also use a standard cassette recorder to store your programs (again, we provide the cables).

Most important, you get a BASIC programming language that's powerful enough to challenge and interest the most experienced programmers. The ZX81 can handle multidimensional string and numerical arrays. It has full mathematical functions accurate to eight decimal places. Single-key entry for every command. Syntax error detection, debugging codes, and easy editing. Plus features that are ideal for creating games, such as 20 graphic symbols, continuous

display, and random number generator.

The ZX81 can be expanded too. You can increase the memory from 1K to 16K with our Memory Module for \$49.95. And you get a comprehensive manual that completely documents the capabilities of the ZX81, and teaches programming from the ground up.

In short, you get all the features that have made the Sinclair ZX81 the fastest selling personal computer in the world. And you get the satisfaction and fun of building it yourself.

A few years ago, this kind of computer power was simply unavailable to the individual. Even today, most personal computers are too expensive to buy for personal use.

But the ZX81 kit can be yours for only \$79.95. Take advantage of this unique offer today. To order, send the coupon along with a check or money order. Or for faster delivery, call our toll-free number and use your MasterCard or VISA.

To order call toll free: 800-543-3000.
Ask for operator #509. In Ohio call: 800-582-1364; in Canada call: 513-729-4300. Ask for operator #509. Phones open 24 hours a day, 7 days a week. Have your

MasterCard or VISA ready.

These numbers are for orders only. If you just want information, please write: Sinclair Research Ltd., 2 Sinclair Plaza, Nashua, NH 03061.

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	PRICE*	QTY.	AMOUNT
ZX81 Kit	\$79.95		
16K Memory Module	\$49.95		
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*U.S. dollars	TOTAL		
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Sinclair technology is also available in Times/Sinclair computers under a license from Sinclair Research Ltd.

sinclair

DETROIT LISTENING POST

More new concept cars

Ford continues to generate excitement with a solid stream of interesting new show and idea cars, both here and abroad.

Latest on the U.S. auto show circuit is this front-wheel-drive, Escort-based Avant Garde, which combines superslick aerodynamics with electronic instrumentation, an ultraplush suede interior and matching detachable suede shoulder bags recessed into the doors. Meanwhile, a larger, five-passenger, mid-engine aerodynamic concept car called Quicksilver is wowing attendees at the major European shows.

And Chrysler is showing a sexy 2+2 sports car based on the fwd Plymouth TC3 hatchback. Dubbed Stealth (after the planned "invisible" bomber plane?), it's designed to accommodate the turbo engine and five-speed transmission now under development—and may or may not be a styling preview of the *real* production sports car said to be coming "sometime in 1983."

GM falling behind?

By the time you read this, the long-depressed domestic auto business is supposed to be recovering. If it is, everyone will be smiling. If not, there may be agonized auto executives diving from tall buildings all over Detroit.

Either way, I don't see how ultra-conservative, gray-pin-striped General Motors can maintain its coveted 60-percent slice of the U.S. market. Why not? Because, as Avis constantly reminds us, when you're No. 2—or 3, or 4—you try harder.

Not that old No. 1 hasn't been trying. Just that they've been putting too many of their eggs into the same tired, old basket: middle-of-the-road, mid-priced, mid-sized, generally boring cars. Granted, family-type, four-wheeled appliances have been the General's bread and butter for as long as most of us can remember. But things aren't the same as they've been, and may never be.

When times are tough, it takes automotive excitement to pry people loose from their carefully guarded dollars. It seems that most people who really *need* new everyday cars can't afford them; and those who merely *want* new wheels are putting off their purchases until conditions improve—or until something comes along that they simply can't resist.



Exotically styled concept car, called Stealth, may be a preview of the Chrysler sports car currently under development. It's powered by a turbocharged 2.2-liter engine.



Ford's idea car, Avant Garde, is based on the front-wheel-drive Escort. It features superslick aerodynamic styling along with advanced electronic instrumentation.

The fact that the only really hot numbers (other than certain small trucks and expensive luxury cars) in the current GM catalog are the wonderful new Camaros and Firebirds ought to give the corporate management a clue. These aren't especially fuel-efficient, inexpensive or mechanically state-of-the-art. But they *are* exciting to look at and delightfully fun to drive. Lots of people who don't *need* these new cars are buying them anyway—because they *want* them.

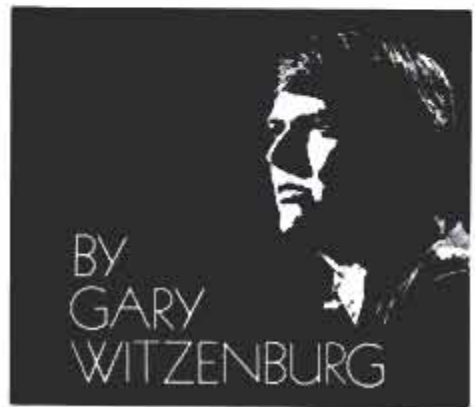
Yet the evidence is everywhere that GM still hasn't caught on, that it's continuing to conservatize itself into a corner. Where are the GM "idea" cars that used to create so much excitement and interest in years past? Where are the high-tech new engines? The startling hardware and technology innovations that get people talking and walking into the showrooms to see what's what?

Seems Ford and Chrysler are making all the news these days. It took poor, old Chrysler to invent the affordable four-cylinder performance car (Charger 2.2 and Turismo

2.2) and to reinvent the American convertible. It took Ford to put America openly back on the world's racing scene and the convertible configuration back where it belongs—on the youth-oriented Mustang.

The only truly modern engine on GM's shelves is an overhead-cam, 1.8-liter Four being imported in small quantities from Brazil for the nice but anemic J-cars. GM's idea of a convertible (so far) is an expensive Buick Riviera conversion for middle-aged doctors and lawyers. GM's

(Please turn to page 24)



If you think STP is only for racing cars... think again.

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DETROIT LISTENING POST

(Continued from page 22)

idea of getting back into racing is to loosen its reins a bit on the divisions providing back-door assistance, while maintaining the tiresome "we're not involved" public posture.

Chrysler's about to start building its own five-speed manual transaxles for its small fwd cars, while GM's Chevy Div. says it's still "thinking" of doing the same. Chrysler's working feverishly on a turbocharged small sports car, while GM (as this is

written) continues to delay Pontiac's exciting mid-engine P-car and Buick's Mercedes-type luxury two-seater.

Ford's going whole hog on graceful, rounded, ultra-aerodynamic styling for large and small cars alike, while GM Design (based on sneak pictures I've seen) continues to pen conservative, square-roofed, family sedans and "personal" coupes for the foreseeable future.

Perhaps I'm overreacting. Maybe I'm all wrong and they're dead right to drag their feet, conserve their money and take no chances. But (as

Lee Iacocca likes to say), if you stand still in the middle of the road these days, you're going to get run over.

Smart suspension coming

From the future file comes word that Britain-based auto supplier Lucas Girling Ltd. is developing a sophisticated, electronically controlled strut suspension that maintains proper ride rates and heights at all four corners under all conditions.

Called the Lucas Girling modulated ride suspension (MRS), it's smart enough not to overreact to transient responses from bumps, sharp corners and sudden changes in load, and is said to be capable of eliminating heavy, load-carrying suspension springs altogether.

Along the same lines, Mercedes-Benz is working on a computer-controlled suspension system. By using sensors in the suspension, a computer works the "active" hydraulic shocks for best traction under any conditions.

Plastic engines?

And Ford says it's serious about developing engines made largely of fiber-reinforced plastic, testing them first in race cars and putting them into production cars by the late '80s. The company's Special Vehicle Operations (SVO) group, responsible chiefly for racing and hot street-car programs, is working on several configurations with the engine's inventor, Matthew Holtzberg, and his firm, Polimotor Research Inc. in Fairlawn, N.J.

The experimental Polimotor engine has metal combustion chambers and cylinder liners and ceramic piston crowns, but most of the rest of it is composite plastic. A current 2.0-liter Formula Two racing version weighs just 152 pounds, yet puts out 318 hp at 9,200 rpm. Holtzberg says his firm has already sold "thousands" of composite connecting rods and pushrods to the high-performance market in the last four years.

AMC four-cylinder engine

About a year from now, American Motors will begin pilot production of its first four-cylinder engine, slated for use in '83-model cars and Jeeps. Essentially the company's rugged 4.2-liter Six minus two cylinders, it will be a very large Four at about 2.8 liters and will replace the Pontiac 2.5-liter currently standard in all AMCs except "senior" Jeeps.

The all-new '83 fwd cars being jointly developed by AMC and its French partner, Renault, will use a much smaller, Renault-designed four-cylinder, however. **FM**

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Nylon

BLIND RIVETS
All Steel

FINISHING NAILS
Steel

HOG RINGS
Copper Plated Wire

HANGER HOOKS
With Nails

CONCRETE HOOKS
High-Impact Plastic

EXTERNAL RETAINING RINGS
Spring Steel

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Grade 2 Steel, Zinc-Plated

SELF-TAPPING SCREWS,
18-8 Stainless Steel

WING NUTS
Die Cast Zinc

SPADE TERMINALS
Copper, Tin-Plated

WIRE & CABLE HOLDERS
Nylon

BLIND RIVETS
Aluminum

STEM SNAPS
Black Nylon

WIRE HOSE CLAMPS
Spring Steel

WALL ANCHORS
Conical, Plastic

COTTER PINS
Steel, Zinc-Plated

E-CLIPS
Carbon Spring Steel

HEX NUTS
Grade 2 Steel, Zinc-Plated

MACHINE SCREWS,
18-8 Stainless Steel

MALE DISCONNECTS
Copper, Tin-Plated

SOCKET HEAD SET SCREWS
Alloy Steel, Phosphate Coated

BUTT CONNECTORS
Copper, Tin-Plated

CABLE TIES
Nylon

RIVET BACK-UP WASHERS
All Steel

TACKS
Tempered Steel

WORM SCREW HOSE CLAMPS
Stainless Steel

WALL ANCHORS
Steel

CLEVIS PINS
Steel, Zinc-Plated

COMPRESSION SPRINGS
Music Wire, Zinc-Plated

"S" HOOKS
Steel, Zinc-Plated

CAP SCREWS, Hex Head
18-8 Stainless Steel

SOCKET HEAD CAP SCREWS
Hardened Steel, Phosphate Coated

CLOSED END CONNECTORS
Copper, Tin-Plated

GROMMETS
Rubber

PLASTIC RIVETS
High-Impact Plastic

BUTTON SNAPS
Brass, Nickel-Plated

FRAME HANGER WIRE
Steel

SCREW HOOKS
Steel, Zinc-Plated

ROLL PINS
Steel, Zinc-Plated

EXTENSION SPRINGS
Music Wire, Zinc-Plated

SPLIT-LOCK WASHERS
Grade 2 Steel, Zinc-Plated

FINISHING WASHERS
18-8 Stainless Steel

CASTLE NUTS
Steel, Zinc-Plated

OPEN/CLOSED BUSHINGS
High-Impact Plastic

THREADED RIVETS
Aluminum

COMMON RIVETS
Steel, Nickel-Plated

FRAME HANGERS
Pronged

SCREW EYES
Steel, Zinc-Plated

PIN CLIPS
Steel, Zinc-Plated

SPACER BUSHINGS
Steel

SELF-TAPPING SCREWS,
Grade 2 Steel, Zinc Plated

COTTER PINS
18-8 Stainless Steel

SNAP CAPS SCREW COVERS
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FEMALE DISCONNECTS
Copper, Tin-Plated

SNAP BUSHINGS
High-Impact Plastic

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Steel, Brass-Plated

COMMON RIVETS
Aluminum

FRAME HANGERS
Saw Tooth

SHOULDER HOOKS
Solid Brass

HITCH PIN CLIPS
Spring Steel, Zinc-Plated

O-RINGS
Neoprene Rubber

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Grade 2 Steel

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Multi-Thread Steel

THREADED INSERTS
Brass Alloy

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Soft Steel

UNIVERSAL BUSHINGS
High-Impact Plastic

DECORATIVE NAILS
Steel, Chrome-Plated

GROMMETS
Brass

PLASTIC HOOKS
Adhesive Back

CUP HOOKS
Solid Brass

SQUARE KEYS
Steel, Unplated

CHRISTMAS TREE CLIPS
Nylon Copolymer

INTERNAL TOOTH LOCK WASHERS
Grade 2 Steel, Zinc Plated

TINNERMAN NUTS
Single Thread, Spring Steel

THREAD REPAIR INSERTS
Steel, Zinc-Plated

SNAP SPLICE CONNECTORS
Plastic

STRAIN RELIEF BUSHINGS
High-Impact Plastic

COMMON NAILS
Diamond Steel

COMMON SENSE FASTENERS
Steel, Chrome-Plated

CLOTH HOOKS
Adhesive Back

GATE HOOK & EYE
Steel, Zinc-Plated

HALF-MOON KEYS
Steel, Oil Coated

PUSH-PULL FASTENERS
Polycarbonate

CAP SCREWS, Hex Head
Grade 5 Steel, Zinc-Plated

NYLON INSERT LOCK NUTS
Zinc-Plated, Nylon Insert

WOOD BUNGS & BUTTONS
Hardwood Birch

ELECTRICAL WIRE
Copper, Thermoplastic Insulated

HOLE PLUGS
High-Impact Plastic

SINKER NAILS
Cement Coated

LIFT-THE-DOT-FASTENERS
Brass, Nickel-Plated



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Ford's



Ford Motor Company is back in racing after ten years. Challenging the highly sophisticated European and American cars that compete on tracks across America, from Connecticut to California.

But we're not going racing like we did in the sixties. This is a small team with a small budget. And a small car. A specially prepared and modified Ford Mustang with a modified 4-cylinder Ford Fiesta engine.

Last season we won two races out of five, leading home 6 and 8-cylinder cars. Not through any outright power advantage, but

through subtle, skillful engineering. For example, we used turbocharging and 4 valves per cylinder to produce a staggering 560 horsepower from the small 1.7 litre engine. Which gives the Mustang a top speed of 185 mph. And because we made the Mustang light and efficient, it was more nimble around the corners than its heavier competitors.

But highway drivers will benefit most from our return to racing. Because when you learn how to improve a car's performance on the track, you can apply

Back.



Get it together-buckle up.

that knowledge to improving your road cars as well. And that's exactly what we're doing. Next year's special high-performance turbocharged Ford Mustangs will feature refinements we learned in handling and engine performance. Such as the use of modified low pressure gas-filled shock absorbers, and the positioning of an intercooler between the

turbocharger and the cylinder head, which significantly improves horsepower.

We are building these cars with you in mind. Because people want cars that provide all-round performance efficiently, cars that are fun to drive. Coming in first on the track is important. But using what we learn from racing to build better road cars for you is really where we're winning.



There's A Ford In America's Future.

PM WORKBENCH

PM EXAMINES PRODUCTS AND SERVICES

Waterproof patching compound

This new patching compound displaces moisture chemically as it cures, making bonding possible even in the presence of water. This permits such work as plugging dripping water pipes without draining the system and patching cracks in leaking basement floors and walls. Since it also works completely under



New two-part patching compound is formulated to cure and bond in presence of water. To use it, mix equal quantities from both tubes and apply.



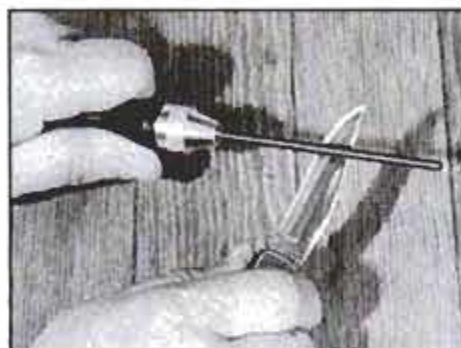
water, it can be used on full swimming pools. The kit contains a pair of 2-oz. tubes and sells for \$8.95 post-paid from Arthur L. Shapiro Associates, 315 Heathcote Rd., Scarsdale, N.Y. 10583.—Rosario Capotosto

First-rate honing tool

This pocket-sized honing tool is a whole new idea in sharpening. Called the Brass Rat, its retractable tungsten carbide rod has a ridged cutting surface that shaves away blade metal without the use of honing oil. The tool can both shape and hone a blade by changing the pressure of the edge on the rod. Smooth oval strokes are recommended along



Honing tool has a brass chuck, hardwood handle, retractable tungsten carbide rod.



Use firm, oval strokes from tip to tang to shape blade, lighter strokes to hone.

the full blade length. When the edge is sharp, loosen the chuck and slide the rod back into its hardwood handle. The tool is available for \$29.50 from Brass Rat Industries, Box 187, West Seneca, N.Y. 14224.—S.W.

Heavy-duty shop knife

Though constructed of plastic, this knife is extremely rugged. It feels particularly comfortable in the hand, and changing blades is literally a snap. All you do is advance the multiple blade a notch, then break off the old one, using the tool's end



Well-made utility knife is comfortable in the hand and has eight-piece razor blade.

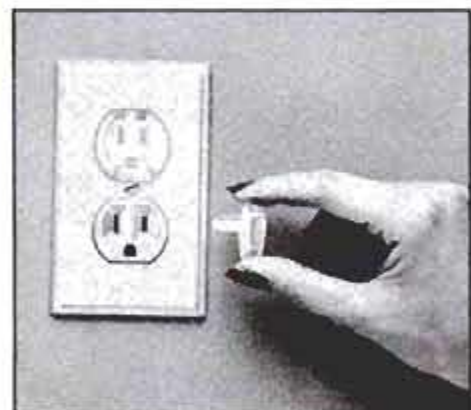


When blade dulls, remove knife end cap, place over used section and break off.

cap, as shown. The knife also boasts a safety lock that secures the blade. The KDS-HiCutter GC-401, \$6.75 in hardware stores, is from Anderle Sales Inc., 3189 Sechelt Ave., Coquitlam, B.C., Canada V3B 5X8.—H.W.

Outlet protectors

These electrical outlet protectors are designed to prevent small children from inserting objects into an outlet and suffering a potentially dangerous shock. Made of white plastic with hard-to-grip edges, they just push into prong holes and



Plastic plugs prevent small children from inserting objects into electrical outlets.

remain firmly in place. Manufactured by Stanley Hardware, Dept. PID, Box 1800, New Britain, Conn. 06050, a package of six sells for \$1.55 at hardware stores.—S.W.

Home and shop updates

We were recently informed of a potential safety hazard in some 200,000 rotary tillers sold between 1963 and 1980. Made by the Roper Corp., they were marketed through independent dealers and Sears, Roebuck and Co. catalogs and stores. All were two-speed, stick-shift models with one of the following numbers stamped on the nameplate: 917, D84351 R0, D84351 R1, D84361 R0, D84361 R1, D54252 R0, D54252 R1, D44152 R0, D44152 R1. To correct the faulty clutch-locking device, write to Roper Corp. Dept. PM, Box 867, Kankakee, Ill. 60901 for a free repair kit.

In our story *6 Lathe Chisels You Can Make From Scrap* (page 104, Feb. '82), we recommended lightly grinding a file on the side of a grinding wheel. We have since been informed this is unacceptable unless your wheel was designed for such use. If yours isn't, you can still make the chisels by doing all grinding on the wheel edge. **PM**

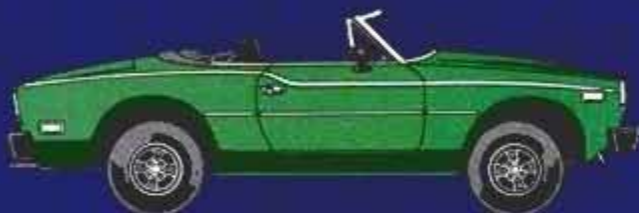
If you've come across a new product with some special features, let us know about it. Write to PM Workbench, Popular Mechanics, 224 West 57th St., New York, N.Y. 10019.

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The most eye-opening day of your life

The day was so long ago, it may be blurred by the years.

Was it a day as gray as the clouds or was it a day as gold as the sun? And exactly how long ago was it?

It's difficult to say. You were, after all, only a child at the time. And yet, you experienced a moment like no other moment in your life.

Suddenly, it was as if the world were in your hands. But there was no clap of thunder. There was only silence, for you were alone with nothing more than a printed page when you made an awesome discovery: *you could read.*

The words and sentences were simple enough, and even though they came slowly at first, the wonders of storybook friends such as Alice, Dorothy and Christopher Robin were just around the corner.

So, as time went on, were countless writings to move your mind, tug your heart and capture your imagination, for the power of the printed word had become forever yours that day nearly a lifetime ago. And the more you have made it yours through the years, the more it has changed the way you have lived and learned and hungered for more.

Americans by the tens of millions share the

same insatiable hunger for new information, new ideas and new ways to understand the ageless mysteries around them and the uncharted depths within them.

The more innovative their lives become and the more sophisticated their technologies become, the more they seek out ideas on every conceivable subject from arts to sciences and from politics to economics.

Does it surprise you that they depend on magazines more than they depend on any other sources of information for those precious breaths of fresh air we call ideas? It doesn't surprise the magazines of America. Today, they are more successful than they have ever been, because they are more challenged and more rewarded by their readers than ever before.

There are more than 10,000 magazines across America today, and while no two of them are quite alike, all of them have one thing in common.

They know that the essence of a magazine is to go deeper than the clamor and clutter of daily events, to strike a unique chord with its readers, and to touch them, one by one, with insights and inspirations that will open their eyes again and again.

Nothing opens your eyes like a magazine.

This message is one in a series from America's magazines.

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PM's Whatsit

As is occasionally done here, we'll tell you what this is not: It's not a collision between two or more bicycles. And it's not the property of Ringling Bros., Barnum & Bailey. To see how it works, turn the page.



Early birds

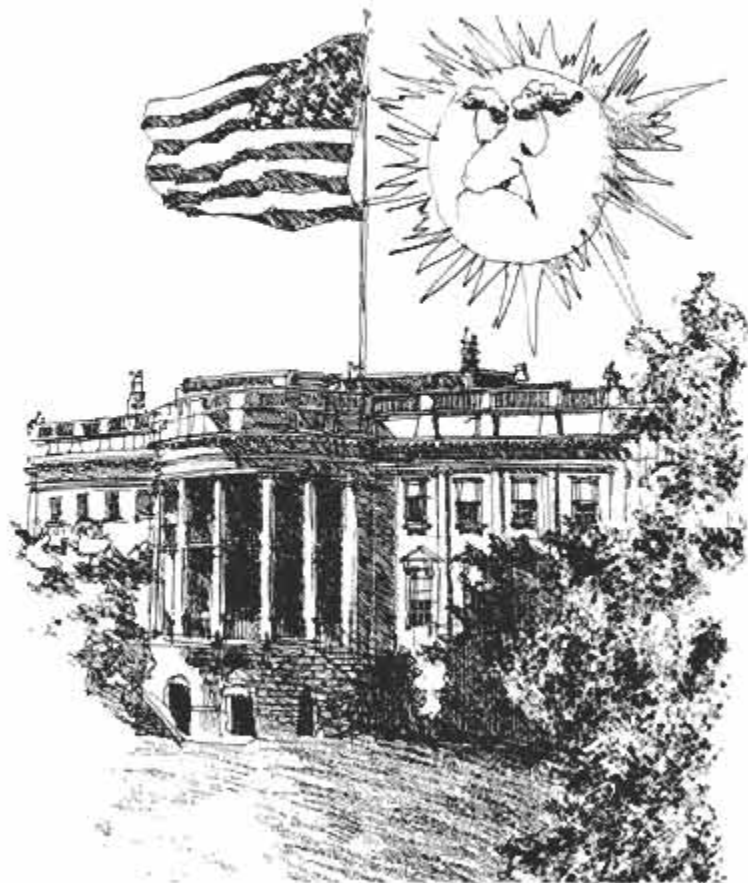
An organization called the American Society of Aerospace Pilots (1305-I Remington Rd., Schaumburg, Ill. 60195) has opened a school for spaceflight—*commercial* spaceflight. And they're not kidding, according to ASAP chairman David C. Koch. "We want to prepare airline pilots to operate commercial spacecraft," Koch says. "Some people say it's 20 years away, but it's not—it's two or three years."

The ASAP ground school is seeking inquiries from holders of commercial and private pilots' licenses who are interested; the program includes home study courses, seminars, lectures and field trips (including time in a Space Shuttle simulator), and is based on NASA astronaut training.

Heat's on Washington

Whether the indifference was intended or alternate energy planning just got lost in the shuffle of the Reagan administration's priorities, the effect has been a real turnoff for the budding solar industry and related interests. Recently, a national coalition of energy-concerned groups that included the Cousteau Society, National Audubon Society and other environmentalist interests joined with the solar lobby to denounce Washington's failure to provide leadership—read "funding"—for energy alternatives.

People in the solar hardware business have an even sadder tale to tell: While passive solar design is spreading to the extent that a limited residential construction complex can accommodate it, the active end of solar energy (with the exception of occasional photovoltaic experiments—see page 110) has practically gone underground. As a milestone worth noting, the company that made the solar collectors installed with considerable fanfare on the White House roof a few years ago in the Carter residency is no longer in business.



IPM BRIEFS



Whatsit revealed

"Aerodynamically, it's a mess," says Robert Barrett, the winningly candid developer of the Barrett Side-By-Side Bicycle. But it does have an advantage (see photo) over conventional tandems, in that the rider not in control (right side) needs absolutely no skill other than that required to hang on. The problem of balance is not what it appears; weight differentials of 100 pounds or more between riders are simply a matter of a few degrees' lean, which puts the center of gravity over the wheels. A lightweight, 40-pound version sells for \$1,150 (load limit: 375 pounds), and a less expensive, balloon-tired model is also available. Barrett Side-By-Side Bicycles is in Angola, N.Y. 14006.

Balancing act



Central span of Houston Ship Channel Bridge is built out to meet adjoining sections. It opened in May.

The recently completed Ship Channel Bridge near Houston already has an interesting history: Its construction included two 750-foot box girder spans, the largest ever made in this hemisphere and the fifth largest in the world.

While this technique has been commonly used for decades in Europe, it is still considered innovative in the United States—and the Ship Channel Bridge was the first erected here using American-supplied equipment. The necessity for keeping the channel below open to navigation while the central span was being constructed made the process—called "cantilevered, free-balanced, cast-in-place construction"—mandatory.

On top of each of two, 200-foot-high piers, freeway sections were laid down, virtually balanced, and then extended to connect with each other and the shore-based sections. This required movable forms into which as much as 110 cubic yards of concrete were poured, adding up to 15 feet at a time on alternate ends of the roadway. This actually deflects—bends—the pier. And when the form travels to the opposite end for the ensuing pour, it straightens back out again.

This balancing act was done over and over again until 750 feet of roadway were extended over each pier. If anything had gone wrong, you would have already heard about it.

This is war

Radio-controlled model attacks cabbage looper moths in a government experiment.



In an effort to develop biological agents that will replace toxic chemical pesticides, U.S. Dept. of Agriculture researchers at a project near Columbia, Mo., are pulling out all the stops. To wit, a radio-controlled model plane, piloted by members of a local R/C club, is being used to "bomb" selected areas of an experimental cabbage patch with a spray containing viruses.

The viruses infect only the larval offspring of the cabbage looper moth, which then become food for other parasites and pests. The object is to check the effectiveness and spread of viruses released in specific local areas.

Perhaps cabbage loopers may learn to take cover, or evacuate, when they hear the sound of an approaching aircraft. If that happens, however, the scientists may bring into play their deadliest weapon yet—stink bugs, trained in the laboratory to deliver the virus.

Low-Cost Gas Saver Now Marketed

PATENTED WATER/VAPOR INJECTOR HELPS ELIMINATE PING, HELPS REMOVE CARBON, INCREASES HORSEPOWER, EASILY INSTALLED, GUARANTEED

DENVER—The Copley News Service reported that a U. S. Patent has now been issued to Wm. Trevaskis, veteran electrical engineer, for his Vapor-Jet® water/vapor injector (Pat. #4,119,062).

Trevaskis has developed what can amount to a 15 cents per gallon "rebate" potential on gasoline by designing a low-cost injector for all domestic and foreign cars, vans, light trucks, and RVs.

People have noticed for years that their car runs better on a cool rainy day. Vapor-Jet® gives a constant rainy-day effect to the engine. The water injection principle was used during World War II to give combat aircraft increased power and speed.

Trevaskis' new Vapor-Jet® is one of the least expensive on the market (\$29.95 + \$3.00 shipping and handling) and can be easily installed even by a novice in 15 minutes.

The Vapor-Jet® has an unconditional 60-day guarantee. If for any reason you are not satisfied, you may return it within 60 days of the day you installed it for a \$29.95 refund.

How does the Vapor-Jet® System work?

Vapor-Jet® operates very simply with no moving parts to wear out. It uses engine vacuum to pull outside air through a reservoir containing a water-methanol mixture which is attached to the car under the hood. This causes the fluid to bubble and splash forming a mist of water droplets and vapor in the upper part of the reservoir. The mist is then drawn by vacuum through a hose which is connected to a manifold suction hose. The connection is made very simply by our patented injector nozzle which contains a regulator to allow the right amount of mist to pass into the combustion chamber.

Will Vapor-Jet® help eliminate engine ping and dieseling?

Yes. The introduction of this mist into the fuel mixture has a cooling effect that increases mixture density, extends the burning rate, and improves combustion efficiency. This has the same effect as increasing the octane of the gas which helps eliminate the engine-damaging ping that is a problem to many vehicles because of the low octane gas sold today. The mist also helps remove the mileage-destroying carbon from the spark plugs and cylinder walls and keeps it removed. All of these effects together with the fact that water, when it turns to steam, expands 1700 times (the principle used in the steam engine) gives your car more horsepower (SAE Bulletins #690018 and #215).

How much mileage increase is expected?

Mileage improvement may vary due to vehicle, driving habits, geographical area, and weather conditions—but we guarantee your satisfaction or your \$29.95 refunded, no questions asked.

Vapor-Jet® can improve your mileage in



three ways: First, moisture actually causes the gasoline to burn more efficiently.

Second, Vapor-Jet® also allows in many cases the possibility of spark advance without ping. This can also increase gas mileage.

Finally, by helping remove mileage-destroying carbon from spark plugs and cylinder walls, Vapor-Jet® helps restore and keep your car in fresh tune-up condition.

A recent study of about 3,000 cars by the U. S. Dept. of Transportation shows that a startling 70% of the spark plug sets examined were in poor enough condition to cause one or more of the following spark plug induced performance problems: High fuel consumption, miss firing, engine ping, surging, hard starting and/or stalling and an increase in hydrocarbon emissions. One reason for spark plug failure is fouled plugs caused by carbon or oil (DOT Report #PB301062).

If carbon is causing a problem with your spark plugs, certainly the carbon-removing feature of Vapor-Jet® has the potential to further increase your mileage. Also, the removal of carbon from your engine can potentially have a money-saving benefit of longer engine life.

Will Vapor-Jet® fit all cars, and is it easy to install?

Yes. The same kit fits all cars and contains everything needed. It will work on fuel injection, cars with super chargers, rotary engines, and catalytic converters. It will work with leaded and unleaded gas, gasohol, or propane burning cars. Simple installation instructions with a diagram are

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CAR CLINIC

SOLUTIONS
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HEADACHES

BY
MORT SCHULTZ



Six-ring circus

At about 10,000 miles, I found oil covering the six-cylinder engine of my 1980 Ford Econoline. The problem was traced to cracked ring lands in four of the pistons. All six pistons were replaced, but at 17,000 miles four of them succumbed again. This time, pistons were replaced with "modified" units.

My Ford dealer can't explain what's been happening, but he says "modified" pistons should prevent a recurrence. I'm dubious. I'm also worried. Do you have any advice to ease my mind?—Kevin Kelly, Athens, N.Y.

You'll just have to wait and see what happens. Ford says the original pistons in its 8.9 to 1, six-cylinder engines are failing because people are advancing ignition timing beyond the recommended setting, are disconnecting the EGR system or are running the engine with an EGR system that has failed.

According to a Ford spokesman, the ring lands of the original pistons aren't thick enough to resist pressures created by advanced timing or an inoperative EGR.

"New pistons with thicker lands, which are announced in technical service bulletin 81-14-6 (7/15/81), have been successful in eliminating the issue," he claims.

That may be so. But if I were you, I wouldn't take chances. Keep timing where it's supposed to be and make sure the EGR system is working. This way, you'll have a leg to stand on when looking for compensation if the "modified" pistons wipe themselves out.

If your EGR valve has failed or if your timing is advanced too far, you'll hear audible ping under light throttle acceleration. Continuous audible ping or spark knock will eventually damage the ring lands of any powerplant.

Back on the trail

In the article *Driving The '82 GM Cars* by Mike Lamm (page 92, Oct. '81), a statement was made that the

700-R4 automatic overdrive transmission was not suitable for trailer towing, because it does not provide engine braking while coasting.

This is not an accurate statement and could mislead someone interested in purchasing a vehicle with this transmission for such a purpose.

Braking is provided in fourth gear with the shift selector in the overdrive position. However, because of the overdrive ratio (.6964 to 1), it won't feel as effective as a nonoverdrive transmission.

It should be noted that coast braking will not be provided in first, second or third gear if the overdrive mode is selected. If braking is desired in any of these gears, the shift selector should be placed in drive range No. 3, 2 or 1. This allows the overrun clutch to apply, and normal braking to be obtained.—Ronald J. Polonski, Pinckney, Mich.

Mr. Polonski is an engineer at General Motors and was instrumental in developing the 700-R4 automatic overdrive transmission.

Dice rolls a seven

I'm interested in repairing a chip made by a stone thrown against my car windshield. Is it possible?—Mike Dice, Muncie, Ind.

This is your lucky day, Mike. It's possible and desirable to repair a chip before it works its way into a crack. Once that happens, there's no way to save the windshield.

I recently had occasion to use a windshield repair kit put out by Clear Star Products Inc., 475 Montauk Highway, East Moriches, N.Y. 11940. It worked nicely for me (see *The PM Garage*, page 53, Feb. '80).

The repair material is a two-part resin liquid that's mixed together by emptying two small syringes into one large syringe. The resin is then injected into the chip with the help of a template; it cures in about four hours.

Keep in mind that this kit works only on windshield chips up to the size of a quarter. It won't fix a crack, so don't waste your money trying. The kit costs \$16.95.

Mort writes a letter

Dear Readers: Unfortunately, Dr. David Hanselman of DeWitt, N.Y., found out that I haven't just been clicking my choppers about keeping your eyes on the rubber boots that cover the constant velocity (CV) joints on front-wheel-drive cars. He learned the hard way what I've warned you about several times in the past.

One day, Dr. Hanselman discovered that the boots on his 1980 Subaru GL had cracked (at only 14,000 miles) and road dirt had damaged the CV joints. It cost him \$305 to make repairs.

"I've learned there have been at least 30 cases of failed boots in the Syracuse area, and there are a known 70 cases in Vermont," he says. "Perhaps you would like to use your column to warn Subaru owners of this problem."

Sure, but I won't pick on Subaru. Every front-wheel-drive car is a can-

(Please turn to page 36)

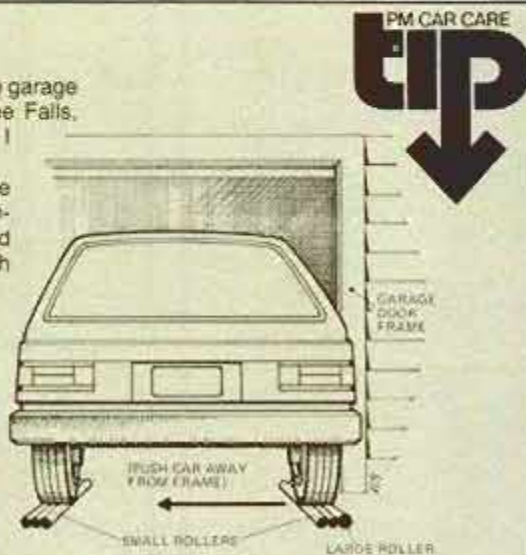
Sideways is the right way

"I ran the fender of my car up against the garage door frame," J.P. Lyden of Menomonee Falls, Wis., relates. "To avoid more damage, I had to move the car sideways."

"I cut one 2-ft. piece from a closet pole and five 2-ft. pieces from old broom handles. I jacked up each wheel and placed three rollers lengthwise under each tire.

"The closet pole roller—the one having the larger diameter—is placed closest to the garage door frame. This prevents the car from rolling in that direction.

"I lowered the car on the rollers and then eased it sideways. It moved 4 inches, which was enough to let me drive it forward without damaging the car's side and/or the door frame."



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CAR CLINIC

(Continued from page 34)

didate for this expensive repair, which only a frequent inspection can help prevent. Get under the car every 2,500 to 3,000 miles and see if the boots are cracked or torn. If so, replace them pronto. Now, you've been warned—again. Yours truly, Mort.

Skunk works

The absence of a screen over the air vent in front of the windshield on my 1978 Ford Granada Ghia has raised a stinking problem. Leaves falling into the vent rot and then fill the car with an odor when I use the air conditioner, heater or defroster. The dealer has told me to park away from trees, but that's silly. Is there a sensible solution?—Carl Schultz, Rogers, Ark.

Yeah, Carl, but I don't know if you're going to like it any better than the one suggested by the dealer. You should use a strong spray of water from a garden hose to periodically flush the area where leaves and dirt fall. That's the only way I know to get rid of leaves and dirt that fall into a cowl area which isn't screened. If any reader has a proven

solution to this problem (Ford doesn't), Carl and I would like to know about it.

Doubting Thomas

The dealer keeps telling me that the loud growling noise I hear when starting the diesel engine of my 1982 Chevrolet is characteristic of this engine, but I've got my doubts. I

haven't owned a car with a diesel engine before this, but none of my gasoline engines ever started this way. Could the dealer be right?—Tom Fox, Carlisle, Pa.

Not unless he's taken steps to satisfy warnings issued by GM about starter motor problems with 1982 4.3- and 5.7-liter diesel engines.

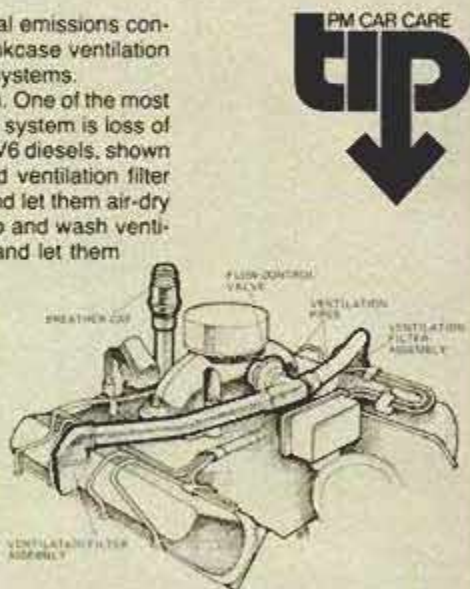
He should consult Chevrolet ser-

Few, but mighty

A diesel engine doesn't have as many external emissions controls as a gasoline engine—only positive crankcase ventilation (PCV) and exhaust gas recirculation (EGR) systems.

PCV systems, in particular, require attention. One of the most serious problems caused by a restricted PCV system is loss of oil. The most elaborate setup is in GM V8 and V6 diesels, shown here. You should wash the breather cap and ventilation filter assemblies in clean, nonflammable solvent and let them air-dry every 15,000 miles. Replace the breather cap and wash ventilation pipes in clean, nonflammable solvent and let them air-dry every 30,000 miles. In 1978-80 models, replace the flow control valve at 30,000 miles. The 1981 GM diesels, except those built for sale in California, and all 1982 models have a crankcase depression regulator. This part is not to be serviced or replaced.

1982 diesels use a modified PCV system. On these cars, gases are drawn from the valve covers through a crankcase depression regulator valve (CDRV), a fairly large, kettle-shaped device. You can wash the ventilation filter, but don't allow any solvent to come in contact with the CDRV.



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vice bulletin 82-T-8. Because this is a new-for-'82 gear-reduction starter motor, some bugs had to be worked out in production. Before they were, a number of these starters got into the field with an incorrect clearance between the flywheel ring-gear teeth and starter drive gear.

Have the dealer remove the starter and install .015-in. shims (part No. 10008053) where the starter mounts. If shims totaling .045 inch don't solve the problem, he should replace the starter-drive housing (part No. 1972698) and center bearing support (part No. 1972700).

It's possible that improper meshing of the starter-drive gear teeth has caused the starter-drive housing to break, so the dealer should look for this and replace a damaged housing. If the housing is broken, the reduction drive gear and starter armature may have been damaged. Ask him to check.

Let me caution you about one more thing. If your car has a 5.7-liter engine and the dealer looks for the part number for a gear-reduction starter motor (part No. 1998552) in his 1982 5.7-liter engine parts manual, he's not going to find it. This part number is listed only in the parts manual for the 4.3-liter diesel. Don't

let him put you off because of this. That gear-reduction starter motor is used with 5.7-liter diesels.

By the way, this information applies to all 1982 GM cars having 4.3- and 5.7-liter diesel engines.

Gasket case

The 318-cu.-in. V8 engine of my 1978 Plymouth Volare station wagon has developed a recurring problem. At about 17,000 and 27,000 miles, the intake manifold gasket failed. What can I do about this?—George A. Joseph Jr., Omaha, Neb.

First, I'd check the PCV system to make sure it isn't clogged. The crankcase must vent itself to prevent excessive engine pressure.

Chrysler has issued a new rubber-impregnated cork gasket that holds up better than the original. The one for your engine is part No. 3837605. A new gasket was also issued to replace the foam intake-manifold gasket in the 360-cu.-in. engine. It's part No. 3514187.

GOT A PROBLEM WITH YOUR CAR?

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 published in the column.

SERVICE TIPS

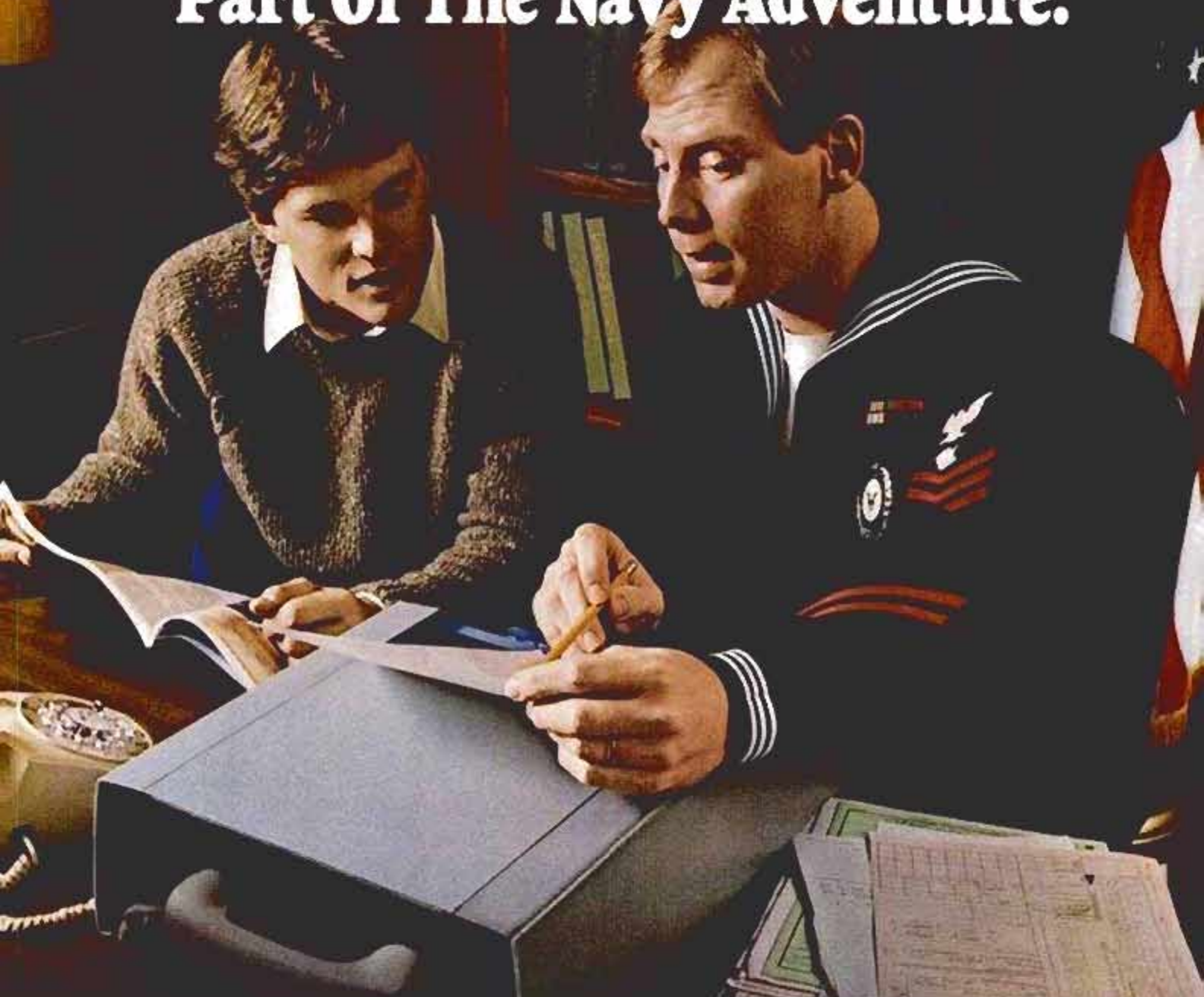
■ Self-adjusting clutches need a little help at least once every 5,000 miles. Pull the pedal up as far as possible with your hand or toe, and then depress the pedal slowly. You may or may not hear a click.

■ In replacing the coolant in 1982 GM engines, install an ethylene glycol base antifreeze that meets GM specification 1825-M. This is a new formulation that's needed to prevent corrosion in engines with aluminum cylinder heads. In pre-1982 models, ethylene glycol base antifreeze meeting GM specification 1899-M is used. You can use 1825-M in the cooling systems of these cars when you drain 1899-M, but don't mix the two.

■ If your 1981 or 1982 Dodge Omni or Plymouth Horizon (2.2-liter engine) experiences a loss of air conditioning (compressor not engaging), have your dealer consult service bulletin 24-01-82. He may have to install a new air conditioning cycling clutch switch (part No. 4205830) and position the switch so it doesn't hit against the power steering pump pulley, which is what caused the trouble originally.

■ The Department of Transportation (DOT) has expanded its consumer services. By calling DOT's toll-free number (800-424-9393), you can get information on recalls, the fuel economy rating of a car you're thinking of buying, crash test results, uniform tire quality gradings, estimated operating and maintenance figures for vehicles, and information about the odometer tampering law—all free. **PM**

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SCIENCE WORLDWIDE

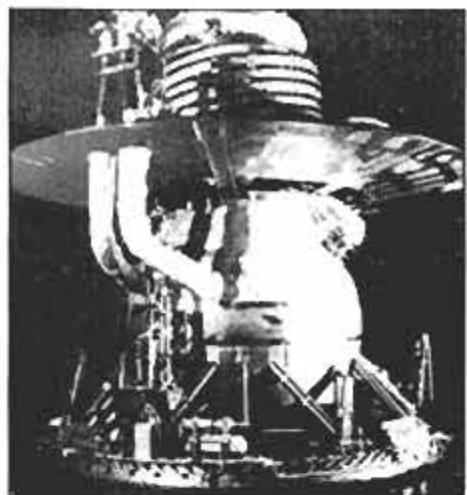
Venus: the red planet?

NASA officials think Soviet cosmonauts will be on their way to Venus, or will build an Earth-orbiting space station as early as next year. Venus seems the more likely target in view of the back-to-back landings on the planet earlier this year by two Soviet landers. The craft were rocketed to the planet in six months each—two months faster than any previous launch.

Venus Lander-13 stood temperatures of over 900° F. for 2 hours, 7 minutes. Lander-14 lasted about 30 minutes.

NASA spokesman Charles Redmond wouldn't say that Venus is the Soviet target for certain, but he noted that the Russian cosmonaut program centers on keeping men in space for months on end. An orbit or two around Venus is likely, he said, adding that "even a manned landing is believable."

The landers took soil samples and photographs in a region selected by American scientists under a cooper-



Soviet lander lasted two hours on Venus. ation pact with Russia that was initiated in the Carter administration. Ironically, the Reagan administration has ordered this information exchange ended, ostensibly to protect American space secrets.

Volcanic gurgles

During the geologically explosive 1970s, an average of 60 volcanoes erupted each year worldwide. But the 1980s have begun with a relative whimper—despite the Mount St. Helens blast of May 1980 and the eruptions this past March.

According to the U.S. Geological Survey, a mere 53 volcanoes erupted worldwide in 1980, followed by 41

eruptions in 1981. But as one geologist put it: "Two years does not make a trend."

All in the family

Recent findings suggest the nuclear family—father, mother and child—began taking shape among tree-dwelling ramapithecus apes about 10 million years ago. Duke University paleoanthropologist Richard Kay



PM art: Donna Gregory and Richard Kay
Tree-dwelling ramapithecus of 10 million years ago may have been a family "man."

says he came to this "leap of faith" conclusion based on studies of the fossil record.

"It appears there was little difference between male and female canine teeth in these animals," Kay notes. When he considered the fact that modern apes with same-size canine teeth practice monogamy and maintain family units, he felt justified in transferring the behavior—at least tentatively—to ramapithecus.

TCTCACAGTGTA

And that's just for starters. It takes 39,936 letters to describe the type, number and order of chemicals making up the longest DNA sequence known to man. (DNA, chemical groups joined together in a chain sequence, carries information from generation to generation in cells.)

Brookhaven National Laboratory biologist John Dunn determined the sequence by analyzing T7, a bacteria-eating virus. Why all the fuss? Now that the sequence is known, biologists can take apart the virus DNA to study how it lives, dies and

mutates. The previous longest DNA molecule sequence was 16,569 letters long.

New bag for air bags

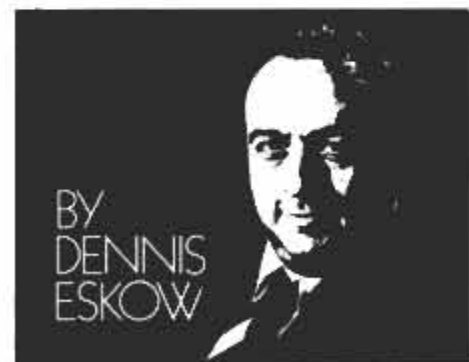
Those paper sacks supplied by airlines for sudden cases of air sickness may have even more important medical uses for passengers. The American Medical Assn.'s Commission on Emergency Services says the bags can be used to relieve hyperventilation—the rapid, deep breathing brought on by high anxiety.

Writing in the *Journal of the American Medical Association*, commission chairman Robert Gillespie says hyperventilating passengers should breathe into the bag or a disconnected oxygen mask until the condition subsides. In hyperventilation, the body takes in too much oxygen. By breathing into the bag, the patient draws in mostly carbon dioxide, balancing the level of the two chemicals in the bloodstream. This "tricks" the brain into believing that the patient is no longer frightened—the condition that triggered the heavy breathing in the first place.

Let them eat plastic

Cattle need to eat roughage to keep their stomachs free of ulcers and disease right up to the day of slaughter. The roughage massages their stomachs and induces secretion of protective stomach saliva. But in the final weeks, when beef cattle are kept in production-line feed lots, providing hay is a bother.

Now Kansas State University researcher Erle Bartley is working with a far less complicated way of keeping cattle stomachs healthy. He feeds cough-drop-size plastic pellets to experimental bovine. The pellets induce the required response in the stomach, and they pass through the animal's digestive tract, so there's no danger of plastic winding up in a human digestive tract. **PM**



HOMEOWNERS' CLINIC

QUESTIONS ANSWERED

Paint spatters on woodwork

One of the previous owners of the house I just purchased repainted with latex paint. He spattered the paint all over the dark Mediterranean-type woodwork. I have read of products that will remove dried latex without harming the underlying finish. Do you know of a specific product or formula that will do the job?—Hugh R. Williamson, Weatherford, Okla.

I checked with my paint chemist friend at Sherwin-Williams and two local paint stores. No one I contacted has heard of this material. Any paint remover they know of will also remove, or at least alter, the finish beneath, depending upon the degree of application of the remover. I would remove the trim before using a paint remover. If you feel that you can do the work while the trim is in place, be sure to mask off adjacent walls and floors. Also, follow the manufacturer's directions about wearing gloves and goggles and providing ventilation.

Air-stapling roof shingles

I plan to reshingle my 10-year-old roof. I have a compressor on which I can regulate air pressure; but I've been told that an amateur shouldn't try to use an air-stapler, especially when shingling over an existing roof. I want to use fiberglass shingles on top of my present asphalt ones. What precautions should I take to assure a satisfactory application?—James Olsen, Austin, Tex.

The wrapping on each bundle of shingles will usually have tips on how to do the job. Also, your supplier may have a free booklet on installation tips. But they steered you right about the air-stapler. I checked this with the people at the Celotex Corp., Box 22602, Tampa, Fla. 33622, one of the larger manufacturers of shingles. The company doesn't even want a *pro* to air-staple over an existing shingled roof. They will allow an experienced roofer to air-staple their shingles only on new applications. Here's why:

On new work, if there's too much pressure, the staple could cut through the shingle. If too little pressure is applied, the staple will project above the shingle. On a second roof application, this will result in a rippled effect, because the new shingles won't lie flat over the uneven staples.

One reason Celotex doesn't want shingles air-stapled over an existing roof is that the extra shingle thickness cuts down staple holding power by reducing staple penetration into the wood sheathing.

Tell your shingle supplier the type and thickness of your roof sheathing. He'll tell you the proper length and gauge of galvanized roofing nails to use.

Mildewcide wash

Mildew has developed on the white shingles of our house. Recently, we repainted the house and didn't use a mildew inhibitor in the paint. We are able to wash off the mildew with comparative ease, but it reappears short-



Two-pound container of X-14 crystals makes enough mildewcide solution to prepare an average-size house for painting.

ly thereafter. Is there any additive we could use when washing the house that would get rid of the mildew permanently?—Clare Y. Reick, Madison, Wis.

White Laboratories Inc., Box 15335, Orlando, Fla. 32858, makes a line of X-14 mildew-fighters and cleansers. One, in particular, is formulated for use on building exteri-

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 this column. For more home repair and maintenance help, get PM's Home Care Guide, \$4.95 postpaid. Send orders(s) to PM, Box 1014, Radio City Station, New York, N.Y. 10101.

ors. However, you should use it only on surfaces that are going to be repainted. The reason for the recommendation, according to a company spokesman, is that, depending on age, condition or type of existing paint, X-14 may cause streaking. Next time you repaint, consider using such a product first.

Popping burner

My 7-year-old ranch house is heated by a hot-air, oil-fired furnace. Frequently, when the burner is energized via the thermostat, a mild "explosive" ignition occurs before the normal burning. The burner is a retention-head type with a two-pipe (inlet/return) oil-feed system. The explosion may be the result of fuel accumulating inside the firebox, which ignites when we reignite the burner. The fuel inlet line does not include a solenoid cutoff valve.

In your opinion, do I need a solenoid fuel cutoff valve? Also, do you know of a good, comprehensive reference on oil-burner operation?

—Ralph Walsh, Oceanport, N.J.

The best I can do is to tell you that any answers along these lines would have to come from the manufacturer. My mechanical engineer consultant says that most burners and assemblies are U.L.-listed and that any changes or additions must be approved by the maker. I also believe it would require that the work be undertaken only by an approved technician.

You can write to the manufacturer for its manual, which may list minor adjustments a homeowner can make. Although I have a "Homeowners Installation and Service Manual" that was supplied with my furnace, I limit my "adjusting" to changing the air filters at least once every three months. I employ a competent maintenance firm to check and adjust my entire system each heating and cooling season. **PM**



BY JOHN GAVNOR

WHAT DO ALL THESE CARS HAVE IN COMMON?



THEY RUN HOT.

Heat — Your Car's Greatest Enemy.

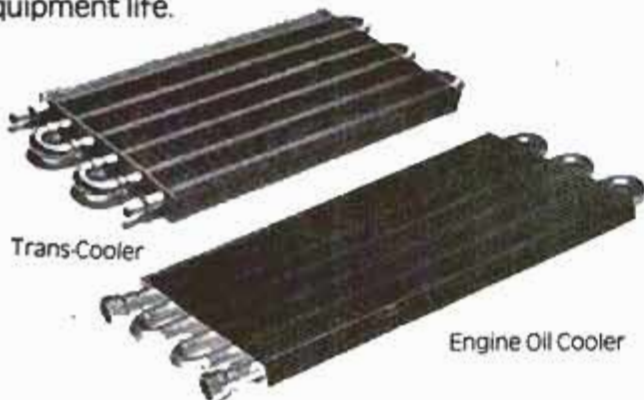
Today's down sized cars run hotter due to emission controls, optional equipment, smaller engines and higher RPMs. Heat problems develop when you carry extra passengers . . . extra baggage . . . drive in stop-and-go traffic . . . drive on ice or snow . . . drive in hot temperatures . . . climb steep grades . . . and do towing. The strain produces heat build-up, and heat destroys engines and transmissions.

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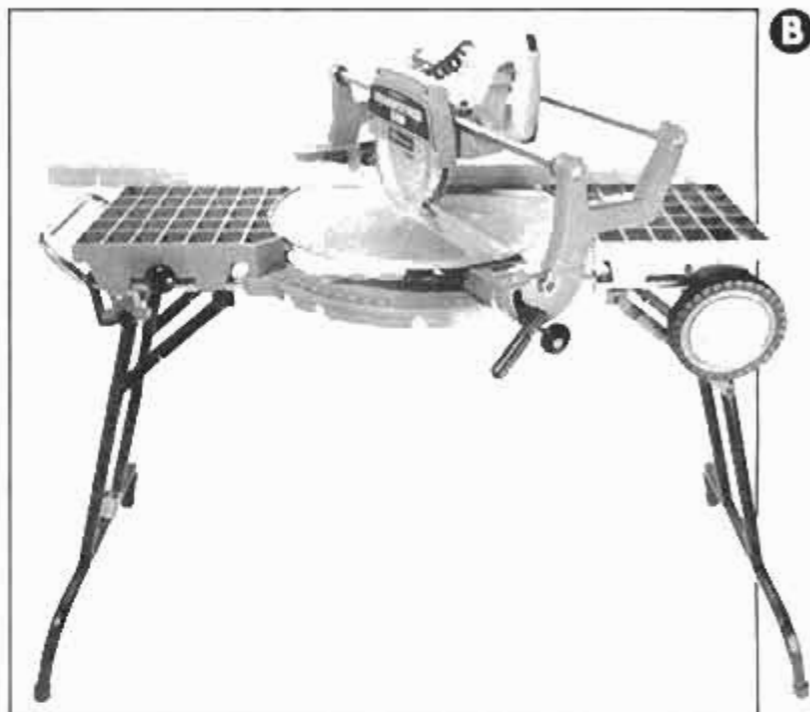
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B



C



D

A The Hellberg Quik-Snap System is a group of head protection devices that were originally designed for loggers. The low-profile Safe-T-Cap (\$4.90) is made of high-density polyethylene and has an adjustable, perforated vinyl headband. The protective earmuffs (\$14.25) have foam-filled cushions and snap into place in slotted grooves on the helmet sides. The visor (\$6.50) is made of nylon mesh and hooks onto the earmuff brackets. These and related products are available from Global Marketing Corp., Box 308, Wilton, Conn. 06897. Write to Global for a catalog.

B The Sawbuck is a new, table-mounted, 8-in. saw that can make cross-, miter and bevel cuts in any stock, up to and including 2×12s. The saw rides on two steel guides connected to a cast-aluminum bench insert. The circular insert rotates slightly more than 45° to the right and left and has positive miter stops at 0°, 31½° and 45°. The 95-pound unit folds into a 22 × 32 × 50-in. area and sells for \$589 at power tool dealers. It's from Rockwell International, 400 North Lexington Ave., Pittsburgh, Pa. 15208.

C This Windsor chair is a kit offering from Heath Co., Dept. 485-015, Benton Harbor, Mich. 49022. It's made of three different solid woods, used as follows: The upper chair section (back, supports and armrests) is ash; the seat is pine; the legs and stretchers are maple. According to the manufacturer, the chair can be assembled in a weekend by following the instruction manual supplied with each kit. It sells for about \$190 and is available at Heathkit Electronic Centers or from the maker's catalog.

D The Duro Adhesive Tool Workshop is a collection of six adhesive and sealant-repair products, sold together for consumer convenience. Each 4-fluid-ounce tube has a plunger-type applicator, a slender nozzle for use in tight areas and a resealable top to protect the unused product. Included are Household Cement, Plastic Mender, Professional Wood Glue, Plastic Aluminum, Liquid Steel Filler and Liquid Solder. The entire set of six tubes sells for \$10.99 at hardware stores and home centers. It's manufactured by Loctite Corp., 4450 Cranwood Ct., Cleveland, Ohio 44128. **FM**

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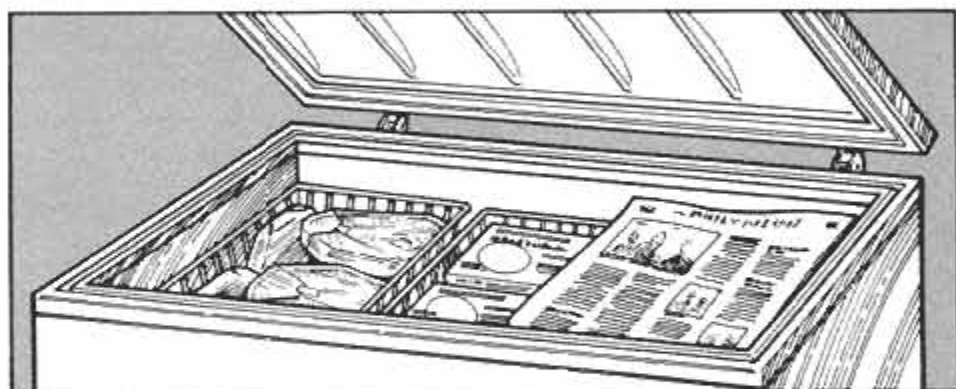
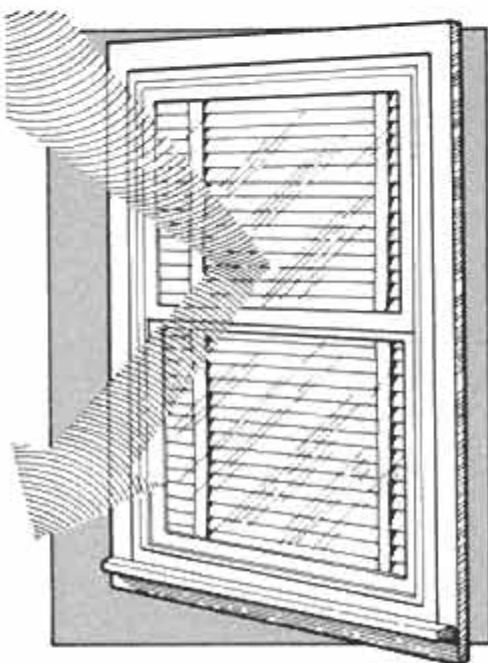
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5 Energy-Saving Tips From Readers

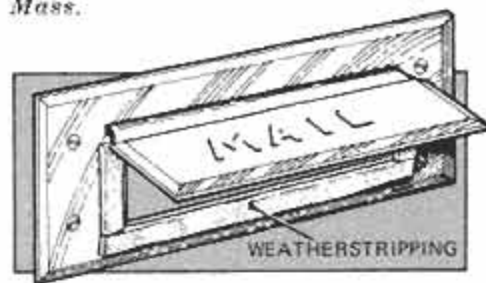
Blinds save energy

Blinds help keep out undesirable solar radiation in summer, yet let in cool breezes. In winter, they can let in solar radiation and diffuse sunlight to give natural lighting.—*Louise Lavelle, Lodi, N.J.*



Sealed mail flap

Make certain that your mail slot flap closes tightly after mail has been delivered. Weatherstrip around the flap if necessary, to keep cooled air from escaping in summer, and cold gusts from entering in the winter.—*Marsha Hallahan, East Lynn, Mass.*



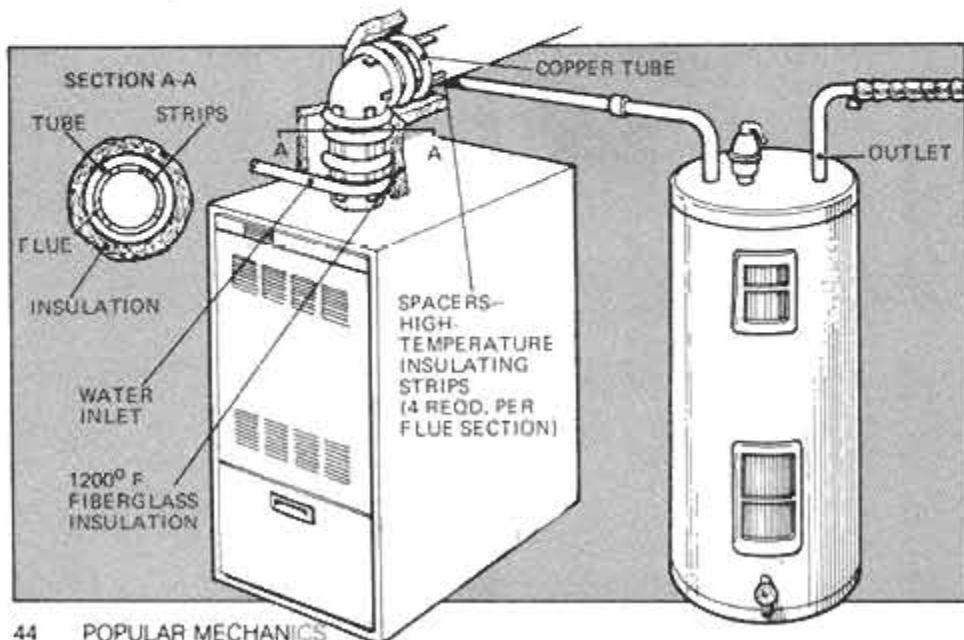
Freezing newspapers

As you empty your freezer, or when you buy a new one, fill the empty sections with newspapers. The paper displaces airspace with solid, cold-retaining material, so your freezer won't run as often. In a power outage, a filled freezer keeps food frozen longer than a half-filled one.—*Sherrine Whalley, Springbrook, Wis.*

Preheating water

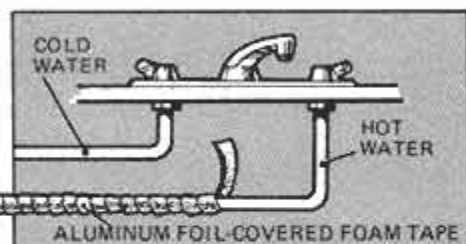
To reduce the cost of heating water, I wrapped 25 ft. of flexible copper tubing around the exhaust flue of my furnace. (I prevented contact of dissimilar metals by separating them with high-temperature insulating strips.) Then I hooked one end of the tubing to the water source,

and ran the other end into my water heater. I covered the copper with 1,200° F. fiberglass insulation. In this way, water going into the heater is preheated by the furnace.—*Kevin Callahan, Scranton, Pa.*



Insulating water line

Water from our water heater must travel a long distance, dissipating heat en route to the opposite side of the house. I realized that for the water to reach our sink and dishwasher at the proper temperature (at least 140° F.), it had to leave the hot-water tank at a slightly higher temperature. However, I was able to turn



down the water-heater thermostat after I blanketed the hot-water line with an inexpensive foam tape covered with aluminum foil. Not only do we save money, but we expect that our den, through which the line runs, will stay slightly cooler this summer.—*John D. Bowman, Birmingham, Ala.*

Share your home energy-saving ideas. PM will pay \$25 for each published idea. Include sketch or photo, if necessary, as well as your social security number. Also include a stamped, self-addressed envelope if you want unused material returned. Send to: Energy-Saving, Popular Mechanics, 224 West 57th St., New York, N.Y. 10019.

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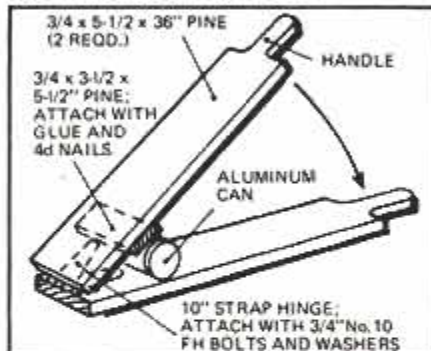
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HINTS FROM READERS

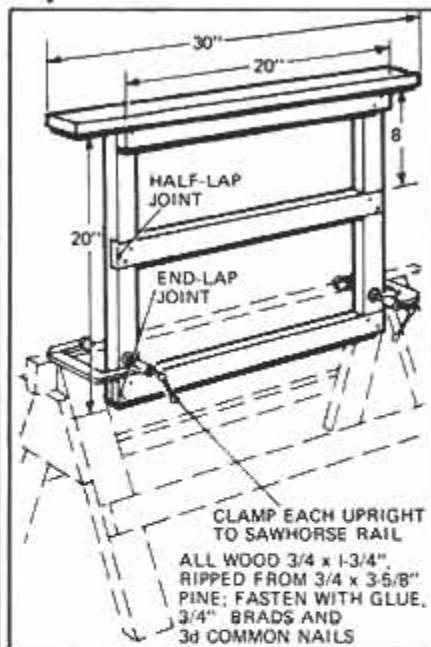
Aluminum can crusher



When recycling aluminum cans, you can reduce to a fraction the bulk of the two dozen or so aluminum cans it takes to weigh a pound. Simply flatten them with this handy can crusher. Cut the wood parts to size, roughly shaping the handles; then smooth them with a rasp and medium (120-grit) abrasive. Hinge the main wood parts together and attach a flattener block with glue and nails. Using the crusher requires minimal effort.

—Charles H. Hardy

Adjustable sawhorses



A pair of these simple racks clamped to two sawhorses, with several 2x4s laid across the top rails of the jigs, provides a work surface of virtually any height you wish. I sometimes lay 2x4s across the center and the bottom rails to provide additional surface for drying painted panels.

—George Obradovich

Tough protection doesn't come any easier.

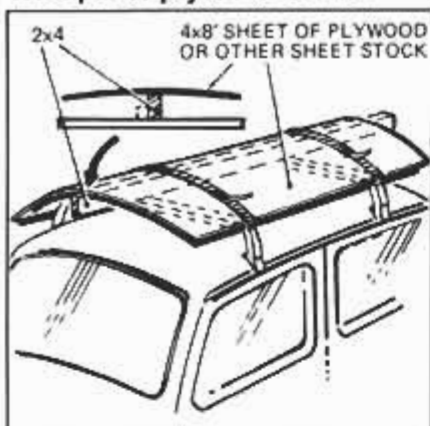


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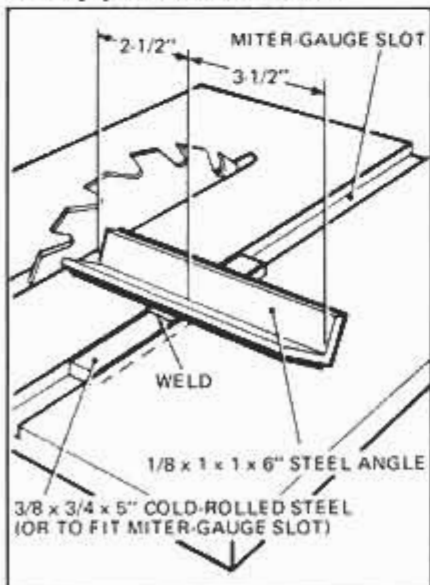
HINTS FROM READERS

Windproof plywood carrier



The problem of transporting a sheet of thin building material from the lumberyard to house or shop is a tricky one, as the sheets flutter and flap when carried flat on a car's roof rack. However, if you secure the sheets over a single 2x4 laid flat, then twist the 2x4 onto one edge as shown in the drawing, the sheet material will be curved and rigid enough to withstand the wind.—A. Weber

Handy power-tool fixture

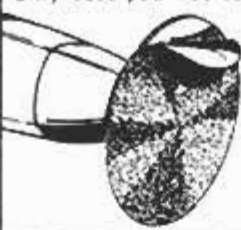


I use this fixture to work on square, round or other stock on my band saw, circular saw and disc sander. Many power tools have a $\frac{3}{8} \times \frac{1}{2}$ -in. miter-gauge slot to hold this device. With the angle welded off-center ($2\frac{1}{2}$ and $3\frac{1}{2}$ in. on each side) onto steel bar, you can use it in several ways. Rotate it 90° for use with a 1-in. belt sander, resting bar against the table edge.—Jay Wallace

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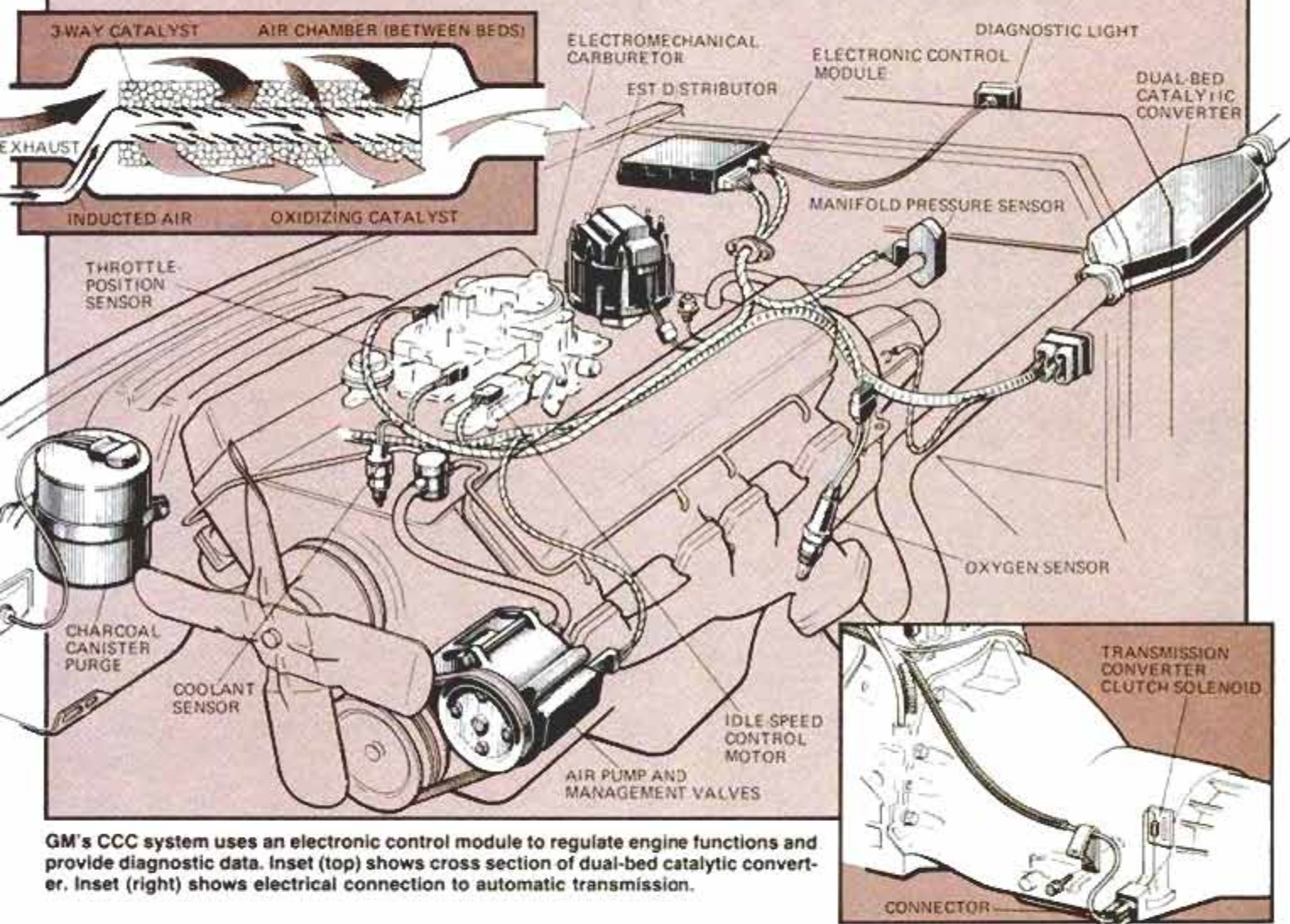
Seat belts save lives—buckle up.

Ford Extended Service Plan 

Troubleshooting GM's Computer Command Control

by Mort Schultz

PART 1



GM's CCC system uses an electronic control module to regulate engine functions and provide diagnostic data. Inset (top) shows cross section of dual-bed catalytic converter. Inset (right) shows electrical connection to automatic transmission.

General Motors' Computer Command Control (CCC) system is the most common electronic engine control system in use today. CCC, which uses a computer to control engine variables, is used on both carbureted and fuel-injected engines to help control exhaust emissions, while improving fuel economy and maintaining good driveability.

While the actual repair of the CCC system calls for extensive troubleshooting of various components, the diagnostic procedures are relatively simple. On the other hand, just knowing how the control system

works will give you a better understanding of what makes your late-model GM car tick.

CCC is installed on some 1980 and on all 1981 and 1982 passenger car engines, except diesels.

"We'll probably install CCC on gasoline engines for years to come," says Ken Jacobson, who is staff supervisor at GM Service Research in Warren, Mich. "It keeps exhaust emissions and corporate average fuel economy within ranges set by law."

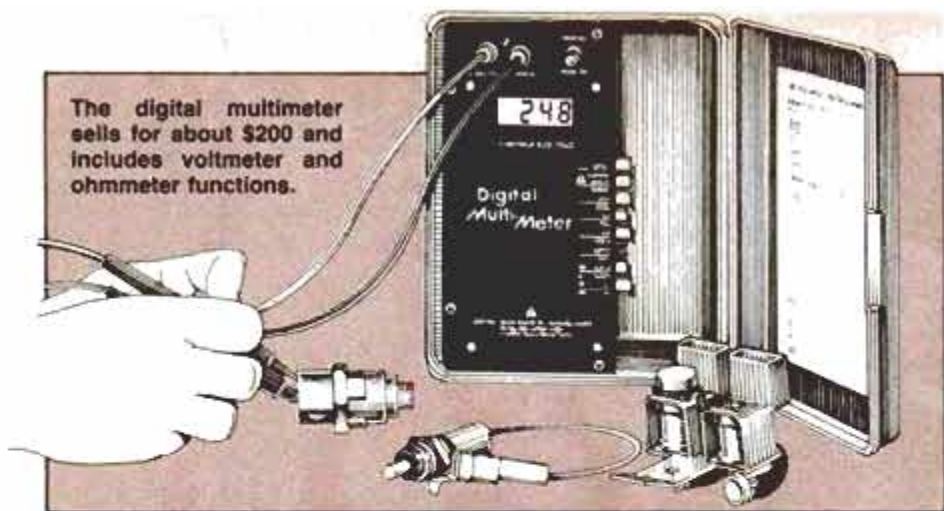
This GM "all-computer" policy may hit you in the pit of your stom-

ach. You may think, "I can't troubleshoot an engine problem caused by a bum computer-system part. The system is just too complicated."

I admit to being as unelectronic as a 1965 Chevy carburetor. But, on a recent visit to GM, I was able to locate faulty computer-system parts on a Pontiac J2000 that Jacobson had purposely sabotaged to test me.

Of course, it's a lot more complicated in a real-world situation where many more variables are present. The computer can only determine that its input from one particular

The digital multimeter sells for about \$200 and includes voltmeter and ohmmeter functions.



sensor is incorrect. It can't, for example, distinguish between a broken wire or a leaking vacuum line and a failed component.

You don't need sophisticated, automated test equipment for troubleshooting: You can use your old dwell/tach, left over from the days of breaker-point ignition systems; a handheld 10-megohm input-impedance digital multimeter; vacuum gauge; hand-vacuum pump and a 12-volt test light.

If you do decide to troubleshoot a GM CCC system yourself, you'll have to fabricate six jumper leads. Use 16- or 18-gauge wire, six female terminals (part No. 12014836) and six male terminals (part No. 12014837). Buy terminals from a GM or auto parts dealer.

Make each jumper lead about 6 inches long. Connect female terminals to both ends of one wire, male terminals to both ends of another wire, and male and female terminals on opposite ends of the four other wires.

Although you may learn basic system diagnosis, the complete isolation of a fault requires more extensive troubleshooting. Furthermore, repairs of the CCC system components are covered by a five-year, 50,000-mile warranty.

CCC system basics

Before you can troubleshoot a problem on an engine with CCC, you have to know something about the system. Depending on which component fails, the engine may knock (detonate), stall, idle roughly, idle too fast, surge, hesitate, not start, use too much fuel, or fail to meet emissions standards.

However, you don't even have to recognize a symptom to realize that a problem may exist in a CCC system. A CHECK ENGINE warning light on the dash is illuminated whenever the on-board computer calculates that something is not functioning properly.

The snafu is that the on-board

computer can be fooled. Before any attempt is made to troubleshoot a CCC system, you have to make sure that normal engine problems, like bad sparkplugs, vacuum leaks, faulty ignition components or damaged internal engine parts are not causing changes in engine operation that fool the computer. Reports from the field suggest that many problems that are fairly common to all automobiles will trigger the CHECK ENGINE light.

Although all GM engines don't have every CCC component, the system in cars that have it controls fuel mixture, idling speed, spark timing, air delivery to the exhaust system, exhaust gas recirculation and purging of the fuel evaporation control system canister.

If your car has an automatic transmission, the CCC system also controls the operation of the torque converter clutch.

Keep in mind that the computer, which is also called the Electronic Control Module (ECM), is at the center of everything. It receives signals (information) from various CCC components. Based on these data, the ECM transmits orders to other CCC components that control engine operation.

Fuel-mixture control

Fuel mixture control is the principal chore of the CCC engine control

system. An exhaust oxygen sensor, engine temperature (coolant) sensor, intake manifold pressure sensor(s), throttle position sensor and engine speed (revolutions per minute) indicator gather information for the computer. The part receiving orders from the computer to control the gas and air content is the fuel-mixture control solenoid.

Most times, the slice of the CCC pie controlling the fuel mixture keeps the air-to-fuel ratio at 14.7 to 1. This ratio is the one at which the catalytic converter is best able to transform exhaust pollutants—hydrocarbons (HC), carbon monoxide (CO) and oxides of nitrogen (NO_x)—into harmless by-products before they are emitted from the tailpipe.

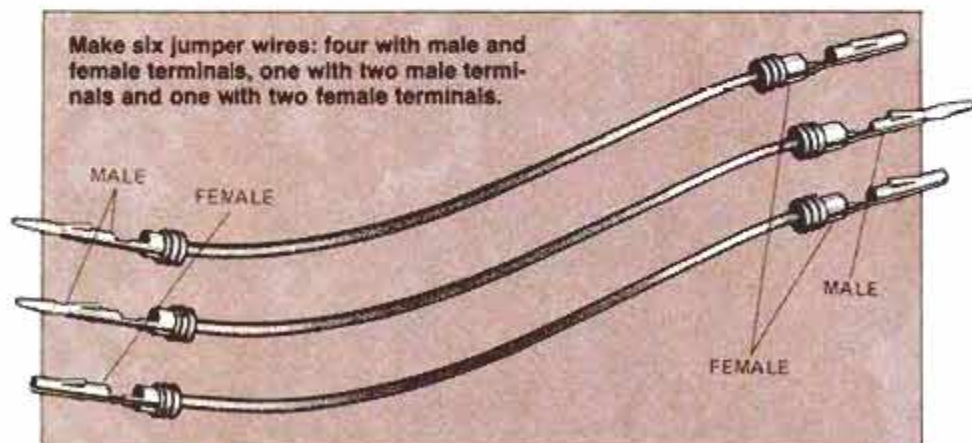
The oxygen sensor is responsible for keeping tabs on whether the 14.7 to 1 ratio is being maintained. Positioned in the exhaust stream, it measures the amount of oxygen (air) in the exhaust gas and, therefore, whether the exhaust is too rich (not enough air) or too lean (too much air).

The computer measures the strength of an electronic signal that the oxygen sensor produces. The strength of this electronic signal varies in respect to the oxygen content of the exhaust. The computer then decides whether the carburetor's mixture control solenoid or the injector's fuel nozzles should lean or enrich the mixture. When the oxygen sensor signal and computer are being used to regulate fuel mixture, the engine is said to be running in "closed loop."

When the computer moves the mixture control solenoid to a neutral position and allows the engine carburetor to control fuel mixture, the engine is said to be running in "open loop." Fuel-injected CCC engines control all engine fuel requirements electronically, but rely on the oxygen sensor signal for mixture control only under normal cruise conditions.

As long as we're discussing the

Make six jumper wires: four with male and female terminals, one with two male terminals and one with two female terminals.



oxygen sensor, here are a few tips to remember:

■ The sensor has to be warm (about 600° F.) to work. If the engine idles long enough, the sensor may cool to below 600° F. and not emit signals. Keep this in mind if you fail a state emissions-control inspection after you have waited in line for some time.

■ There's a specific way to test the oxygen sensor, which we'll cover next month in Part 2.

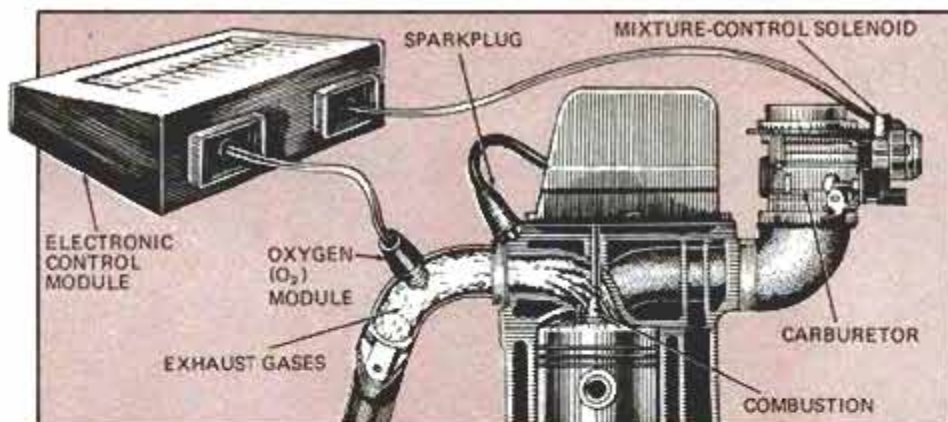
■ Don't remove the sensor without good cause. For one thing, it takes muscle. For another, the threads are coated with a special antiseizing compound (part No. 5613695) that's necessary to prevent the sensor from seizing in the exhaust manifold.

■ If you use engine sprays (belt dressing, waterproofing agents or whatever), first find the oxygen sensor. Then, shoot away from it. Over-spray that enters the sensor vents, which are open to the atmosphere, will disrupt sensor signals.

Altering the ratio

There are times when an engine needs a fuel mixture richer than 14.7 to 1. That's when the other sensors come into play.

The temperature sensor tells the computer if the engine is too cold for 14.7 to 1 and needs a richer mixture. At 14.7 to 1, a cold engine may stall or run poorly. As soon as the engine gets warm enough, the temperature sensor tells the computer to go the closed loop or start "listening" to the O₂ sensor.



An oxygen sensor determines the fuel mixture by measuring oxygen content of the exhaust. The ECM computer processes this information and regulates carburetor.

Other times when the engine needs a richer mixture are when it's under load and working hard, or when you drive the car to a higher altitude.

Determining when this rich mixture is necessary is the job of the pressure sensor(s). For example, when the engine has a load put on it, such as when you're going from cruising to climbing a hill, manifold vacuum drops. (Another way of saying that vacuum drops would be to say that absolute pressure increases.) A pressure sensor in the intake manifold picks this up and signals the computer.

Some engines have two pressure sensors: a manifold absolute pressure (MAP) sensor to measure variations in manifold vacuum and a barometric (BARO) pressure sensor to measure variations in atmospheric pressure.

Other engines have one sensor

that is actually two-in-one, measuring both manifold vacuum and barometric pressure.

Most CCC engines also have a sensor that signals the computer about changes in throttle position. It's called the throttle-position sensor (TPS). When you tromp on the throttle to pass another car, the engine temporarily requires a richer mixture. The job of the TPS is to tell the computer, "Hey, pal, the engine needs a shot."

Finally, when an engine runs at low rpm, it requires a different fuel mixture than it does at high rpm. A reference signal from the distributor to the computer indicates required rpm.

The computer gathers and digests all the data. It then sends signals to the carburetor mixture control solenoid, which plays electric pitter-patter with the carburetor metering rod(s) and idle bleed valve to keep control over the air-to-fuel mixture.

Fuel-injected CCC engines change the amount of fuel delivered by varying the duration of the injector squirt.

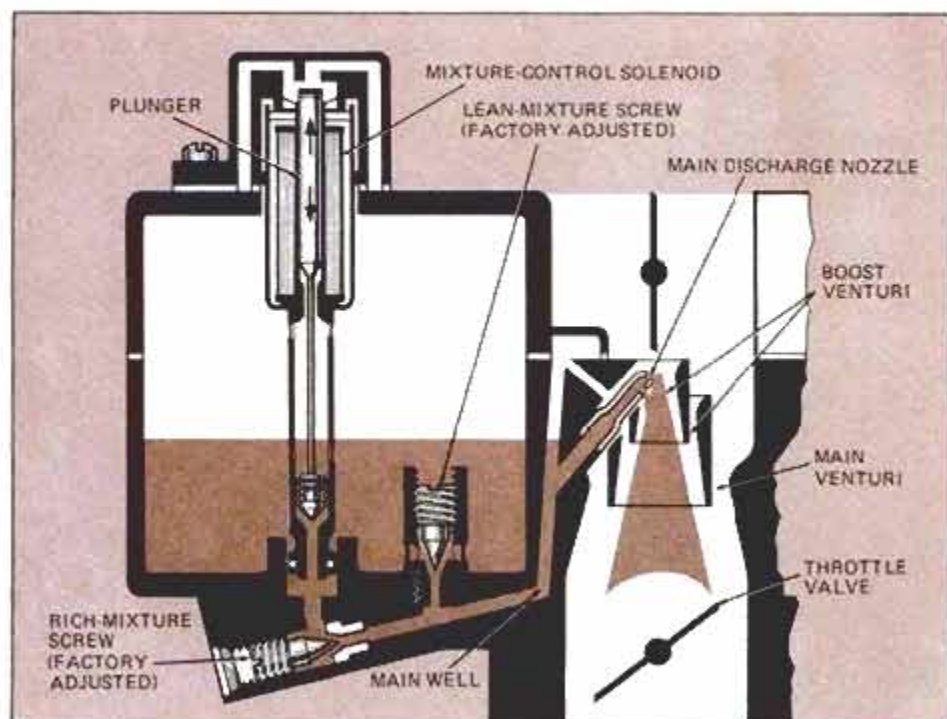
Idling speed control

Depending upon the operating conditions—that is, engine cold, engine warm, air conditioning on or off—the carburetor throttle valve(s) in any engine, has to set itself at different openings to maintain correct idling speed. Otherwise, the engine will stall or gobble too much fuel.

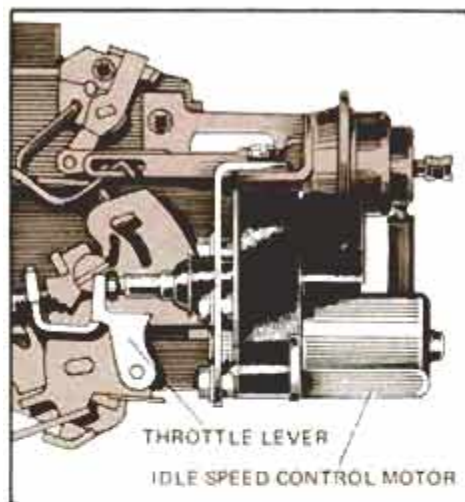
On some CCC engines, maintenance of correct idle speed is controlled electronically by the computer, which tells an idle speed control (ISC) motor on the carburetor what to do. The ISC is a small, reversible electric motor that sets the opening of the throttle valve(s) by working the throttle lever.

In order to give the ISC correct information, the computer needs the following input:

1. **Temperature sensor**—The same



The CCC system uses a computer-controlled solenoid to regulate the air/fuel ratio. The energized solenoid closes a fuel valve and opens an air bleed to lean the mixture.



Idle-speed control motor regulates idle speed by adjusting throttle opening as instructed electronically by the computer.

one used in the fuel-mixture setup. When the engine is cold, the sensor signals the computer to tell the ISC that a higher idling speed is needed to prevent stalling.

2. RPM reference signal—Again, the same one used for fuel mixture. It signals the computer at what rpm the engine is turning, so the computer can tell the ISC to increase or decrease idling speed to bring rpm to specification.

3. An air-conditioning clutch switch that signals the computer to tell the ISC to "up" idling speed, so the engine won't stall when the air conditioner is on.

4. A battery voltage measurement that signals the computer to tell the ISC that charging-system output is falling below normal and to "up" idling speed.

5. A park-neutral switch that signals the computer to tell the ISC that the transmission is being moved out of PARK or NEUTRAL. These movements put a heavier load on the engine, which would produce an uneven idling speed unless the ISC motor compensated for it.

Spark-timing control

You won't find a vacuum advance chamber or centrifugal advance weights in the High Energy Ignition (HEI) distributor of later CCC engines. Spark advance is done electronically.

Information from the various sensors I've mentioned is fed into the computer, which then sends a signal to the electronic module in the HEI distributor by means of a four-terminal connector at the end of a harness coming from the distributor. This signal, called Electronic Spark Timing, allows the ignition system to either advance or retard timing.

Turbocharged engines have another assembly consisting of a deto-

nation sensor and electronic spark-control module. This assembly is placed in the circuit between the computer and electronic ignition module.

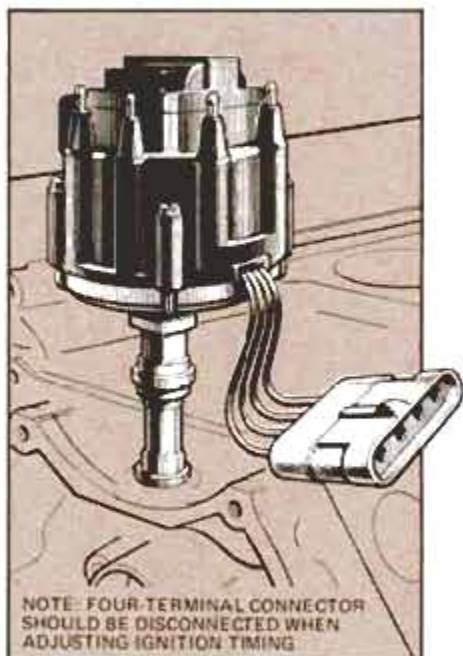
If the detonation sensor picks up an engine ping, it signals to the electronic spark-control module, which retards timing until the detonation stops.

One of the most important parts of the spark-timing control to remember is the four-terminal connector on the harness coming off the distributor. It may help get you out of a jam someday.

For example, if the signal from the computer to the distributor is interrupted for any reason (loose connection, bad part or whatever), the engine, if it's running, may stop dead in its tracks. If it's not running, it may not start.

In any case, you probably won't be able to get it started unless you disconnect the four-terminal connector. By doing so, you bypass the computer and the engine will start. Timing will be retarded, but you'll be able to use the car until you find the cause of the trouble. However you should immediately have the car serviced because prolonged operation in bypass mode can damage the expensive oxygen sensor and catalytic converter.

Also remember that it is necessary to disconnect this four-wire connector when adjusting ignition timing. If you don't, you won't get timing set properly, since the computer will be modifying the timing signal. It would be like adjusting timing with the vacuum-advance



Four-terminal connector connects the distributor to the computer's electronic spark-control function.

unit connected to a vacuum source in a non-CCC engine.

Air-delivery control

Without air delivery, exhaust emissions would be very high when a cold engine is started, because the O₂ sensor wouldn't be working and the catalytic converter would be too cold to be effective. To combat pollutants until things warm up, an air pump and air-management valve assembly is installed on the engine. Air-management valves are the components the computer controls. There is no control over the air pump, which runs constantly.

Air (oxygen) is pumped into the exhaust system upstream from the catalytic converter (in the exhaust manifolds). This mixes with unburned hydrocarbons allowing them to ignite. The extra oxygen also allows heat to rise so the sensor and converter warm up quickly.

In cars that use a dual-bed catalytic converter, air is also pumped into the rear bed of the converter. The front bed treats the NO_x portion of exhaust gas, which is converted into harmless elements when air is not present. If exhaust gas were too lean (air present), the catalytic converter would have little, if any, effect on NO_x. The conversion of NO_x is one reason why the 14.7 to 1 fuel ratio must be maintained.

The air pumped into the rear of the converter ensures that HC and CO are fully burned.

The job of the computer in this case is to take signals sent by the various sensors and turn the air-management valves on and off, controlling air to the exhaust manifold and catalytic converter. When air isn't needed in the exhaust manifold or in the converter, the computer tells the particular air-management valve to close, and air is diverted to the carburetor air cleaner.

Torque converter clutch control

Suppose your CCC engine is coupled to an automatic transmission and starts using slightly more gas than usual. One possible cause is that something may have happened to that part of the CCC which controls the operation of the torque converter clutch (TCC).

When vacuum drops, the computer tells the TCC solenoid to disengage the clutch, which allows the transmission to downshift, if it has to. The converter clutch is only applied when the vehicle is in high gear.

In Part 2 next month, we'll explain how the CCC system is switched into diagnostic routing. We'll also explain how the system's trouble codes are read and what they mean.

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14.8 gallon fuel tank
for long range:
562 EPA estimated
highway miles.

Swing-out
side vent
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Intermittent
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standard.



Steel-belted
radial tires,
standard.

5-speed
overdrive transmission,
standard.

It's hard to believe this is the lowest-priced truck sold in America.

1982 Mazda B2000 Sundowner
\$5895*

You can believe it. The Mazda B2000 Sundowner is today's lowest-priced truck. Yet it comes with an astounding number of standard features, including a 5-speed and steel-belted radials.

Not one of these features is available on Toyota's or Datsun's lowest-priced truck, each of which costs hundreds more.

Just one look inside the cab and you'll see more of the Mazda B2000's exceptional



value. There you'll find a three-passenger seat detailed in textured vinyl. New instrumentation with electronic check panel. And handsomely trimmed door panels complete with armrests.

You can also believe this

truck is built to haul a heavy payload—1400 pounds of it. Even so, its 2-litre, 4-cylinder engine delivers outstanding fuel economy.

38

27

EST. hwy. mpg

EST. mpg

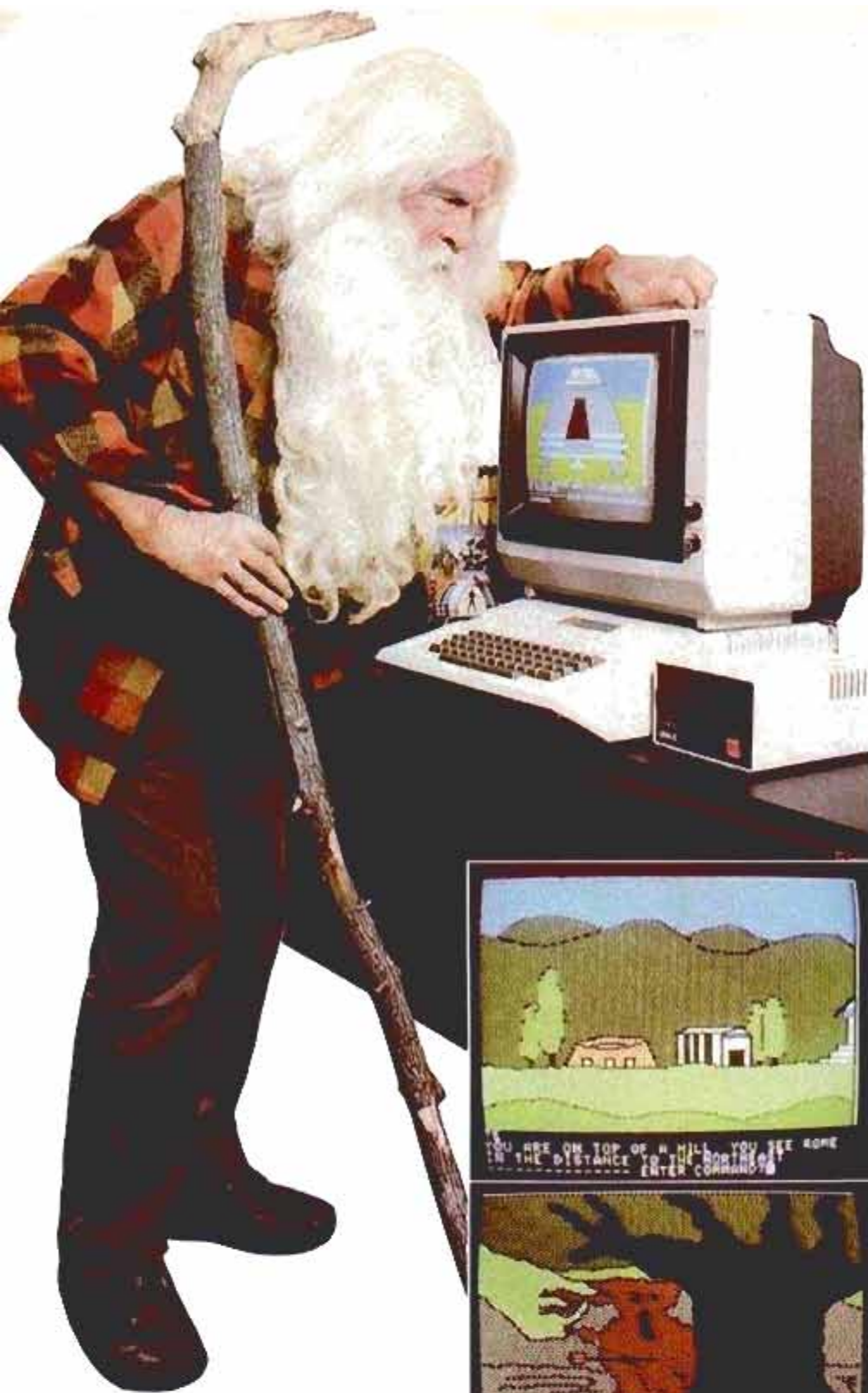
If you still find it all a little hard to believe, we invite you to visit your Mazda dealer for a close-up look at the B2000 Sundowner.

Seeing is believing.

MAZDA

The more you look,
the more you like.

*Manufacturer's suggested retail price for B2000 Sundowner Shortbed. Actual prices set by dealers. Taxes, license, freight, options and other dealer charges extra. Prices may change without notice. Availability at dealers of vehicles with specific features may vary. **1982 EPA estimates for comparison purposes for B2000 Sundowner Shortbed. Your mileage may vary with trip length, speed and weather. Actual highway mileage will probably be less. Calif. 36 Est. hwy. mpg, 26 Est. mpg.



The World's Longest Game

by Neil Shapiro ELECTRONICS EDITOR

From swampy, dinosaur-infested lands to the mechanistic world of 4082 A.D.—across 400 million years and spanning two planets—the computer game *Time Zone* from On-Line Systems is delighting thousands of adventurers. A graphic adventure game for an Apple II computer, with over 1,400 full-screen pictures, *Time Zone* is one of the most challenging, fun—and certainly the longest—of all computer games.

Time Zone presents the player with a goal (in this case, saving the Earth itself). To accomplish this mission, he must solve many puzzles along the way. The puzzles involve the player in such adventures as a forest quest made at the behest of Robin Hood; a perfume delivery to Cleopatra's court and visits to various other times and places that fill both sides of the game's six floppy discs.

Roberta Williams, who began the whole graphic adventure craze with her earlier program, *Mystery House*, is the chief writer and programmer of *Time Zone*. She told us, "When I used to play adventure games, I didn't want them to end." As it turned out, Roberta wasn't alone in her wish. In just a few months, *Time Zone* has already become one of the most popular computer adventure games.

Like most computer games structured along "adventure" lines, *Time Zone* requires the player to communicate with the program by typing in two-word minisentences. Players move from scene to scene, acquire various objects, face menaces and generally indulge in some sophisticated problem solving. To do

Would you believe our model, above, was 18 years old when he began playing *Time Zone*, a new computer game that has lasting excitement? As player progresses through the game, he will view a series of over 1,400 colorful, high-resolution screen-sized pictures. At top right is view of Rome during the reign of Caesar. A strange creature within Robin Hood's Sherwood Forest is seen center right. And at bottom are the 13 Colonies' heroes in 1776.

PM photo: Frank Lusk



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*Based on the reg. sugg. selling price of \$29.95.

floppy disc and assure yourself of reincarnation later.

Every detail of *Time Zone*, from the artistic talent and care in the rendering of the thousands of frames, to the varied puzzles and surprises—even the originality of the concept—illustrates the amount of time that was lavished on this game's development. We asked Ken Williams, On-Line president, how they were ever going to top their production of *Time Zone*?

"We can't. No one ever will. It was such a serious commitment of all our lives for the past two years. Why would somebody else want to do that to themselves?"

It took a team of programmers, working under project coordinator Bob Davis, two years to program the game; but it could actually take the average player even longer to "finish." There are already informal clubs and discussion groups of *Time Zone* players throughout the country. If you have a computer and a phone attachment (called a modem), you can check the Micronet Apple user's group on the CompuServe network for details on such groups.

Time Zone (\$99.95) is already a classic. It seems sure that no one will think of computer games in quite the same way again. **EM**

this, a player types into the computer what he really might do in the situation which is presented, in cartoon style, on the screen.

The first puzzle which the adventurer must solve, for example, is to find the time machine itself, and figure out how to operate its controls.

At the beginning of the game, the time machine appears before the player in the middle of a field. The wise player would immediately type GO MACHINE and the computer would then quickly display the colorful interior of the time machine, complete with a chair and control console. If the player should then type SIT DOWN, the scene would change again to a view of the control console as seen from the time machine's operator's chair.

In this way, a person moves through the world of *Time Zone* in a realistic fashion. You might be walking along a lake when a gigantic dinosaur blocks your way, for example. And it's a good idea to watch your step in ancient Rome, especially when you become a participant in the bloody Roman games.

Luckily, there is a SAVE GAME feature. So even if you are killed when you're stepped on by a mastodon, tomorrow is another day. At any point, you can store your game on

Gabriel computer tuned 254 shocks for the world of small cars.



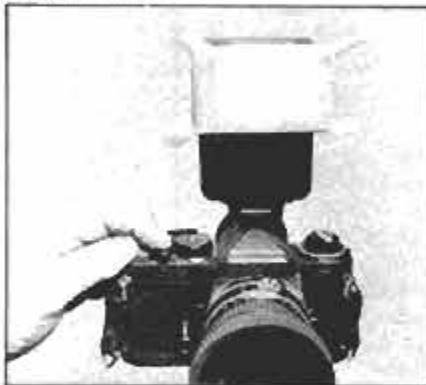
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PHOTO HINTS

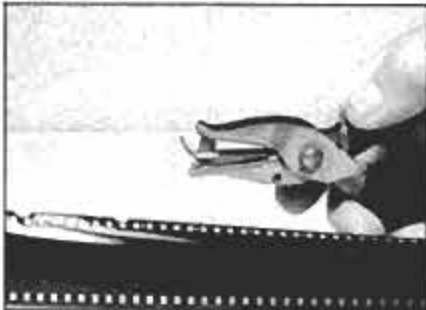
Soften flash



To relieve the disconcerting effect of close-up shots on human subjects, cover the face of your flashgun with one or two folds of a thin, clean, white handkerchief. Secure it with rubber bands.

—Robert Hertzberg

Nip for ID



Finding a single frame among several rolls can be hard, but a paper punch can solve this problem. Lightly nip the edges of a frame to be marked, but not beyond sprocket holes.—Robert Hertzberg

Spotting palette



Retouching prints and negatives is more convenient if you use a plastic coffee-can lid as a mixing palette. Make notches on the rim to hold your brushes so they won't tip or roll away.—A. Weber

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Circle A, B or C for each question:

1 How much experience have you had in woodworking, home repair and/or home maintenance?

- (A) Little or no experience
- (B) Some experience
- (C) Quite a bit of experience

2 Which phrase best describes your workshop?

- (A) A selection of hand tools and portable power tools
- (B) A table saw or radial arm saw, along with hand tools and portable power tools
- (C) A good selection of stationary and portable power tools, along with hand tools

3 How involved do you want to become with woodworking, home repair and/or home maintenance?

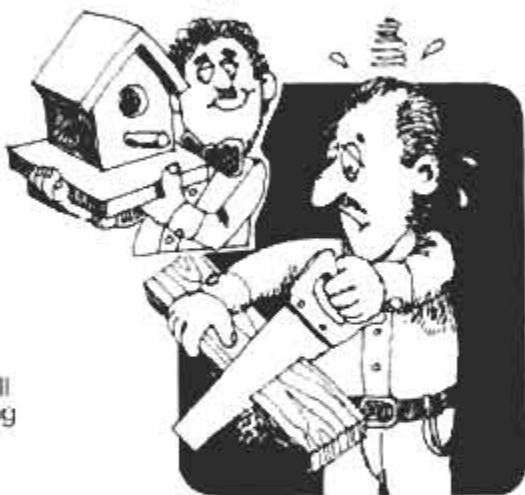
- (A) Not very involved
- (B) Moderately involved
- (C) Heavily involved

4 What's the likelihood that you'll buy some kind of woodworking tools within the next year?

- (A) Not likely
- (B) Somewhat likely
- (C) Highly likely

5 Which best describes you?

- (A) I do home repairs and maintenance only when it can't be done any other way
- (B) I do some woodworking and a variety of home repairs and maintenance
- (C) I'm primarily interested in fine craftsmanship woodworking



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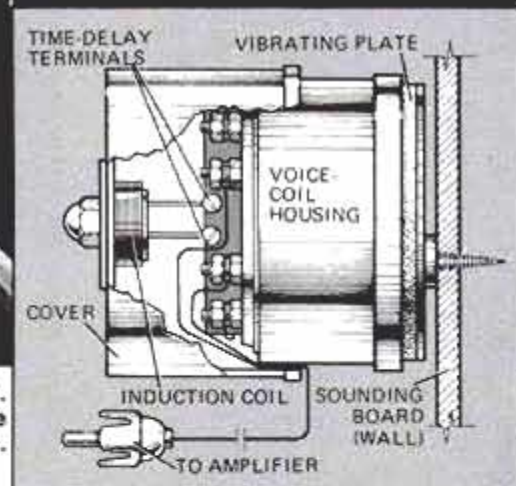
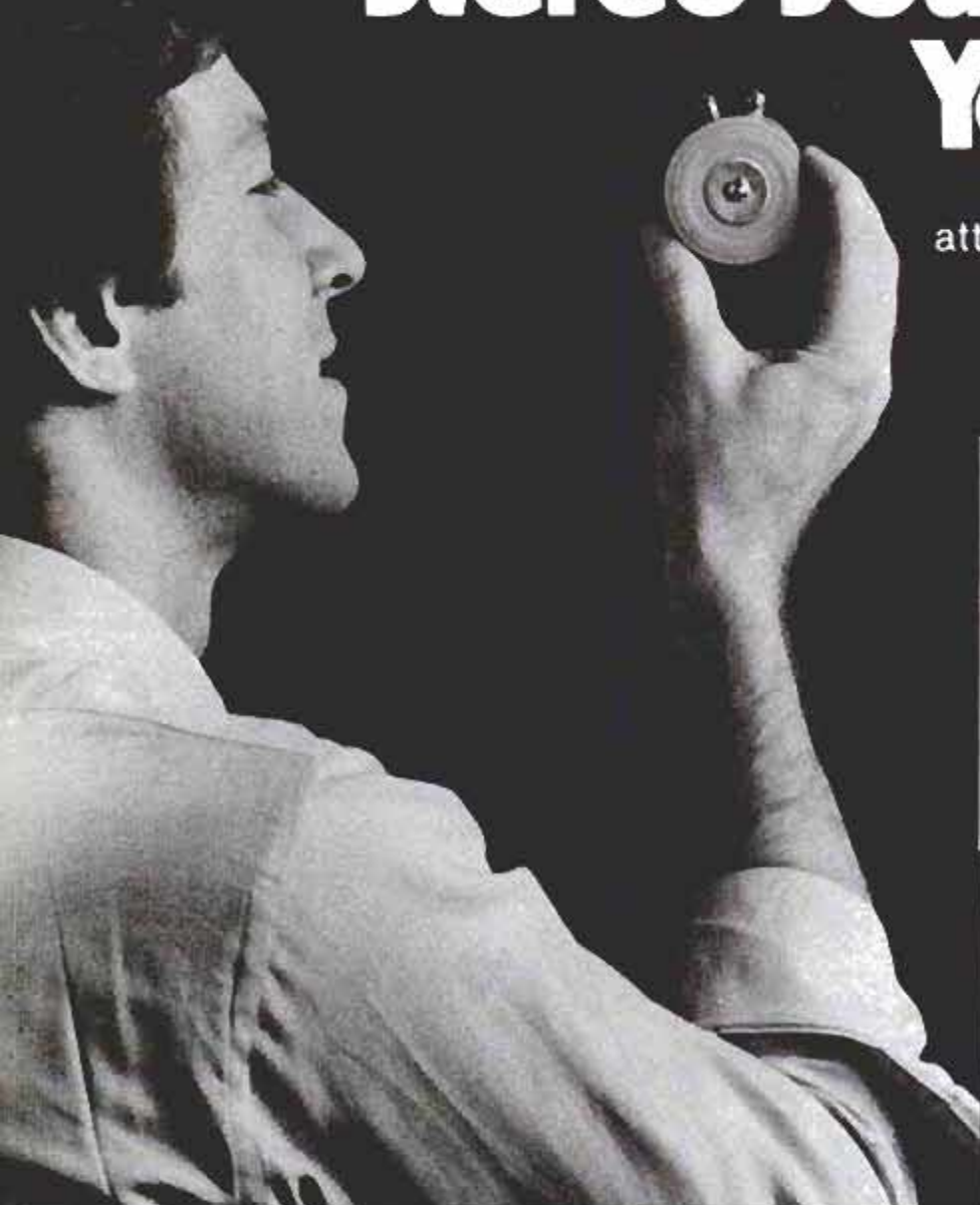
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Stereo Sound From Your Walls

This teacup-shaped device attaches to wall surfaces and turns them into speakers.

by Neil Shapiro
ELECTRONICS EDITOR



Acoustic 2000 AC is a coneless speaker that uses walls as a sounding board. Inset photo (top) shows components. The illustration shows connections inside the 2000 AC and the unit's heart: the voice coil that drives the vibrating plate.

I almost laughed when inventor Bill Ashworth took what looked remarkably like a teacup, screwed it into a section of wall paneling, and hooked the tiny device to the speaker output of a powerful stereo amplifier. But when he turned the amplifier on, and the whole room filled with clear, pleasant sound, I knew he had something. I started listening.

The "something" is called a coneless speaker and it's the result of 20 years of painstaking research on Ashworth's part. In fact, long-time PM readers may recall an article about his original invention which ran in the December 1965 issue

(*Fantastic Coneless Loudspeaker*, page 36).

Then, the sound was only fair. Now, according to tests conducted for PM by Tridac Labs, the coneless speakers can make your walls sing out in much the same way as conventional speakers. There are still a few drawbacks, but for many purposes, these little teacups—coupled to your wall—could be a substitute for large, space-eating speakers.

Notes from a teacup

This coneless speaker is an audio transducer. Most conventional speakers have transducers, called voice coils, which convert electrical

signals into mechanical vibrations. These vibrations cause the speaker's flexible cone to move back and forth, moving air and producing sound.

But Ashworth's coneless speakers work on a different principle. The back side of the coneless speaker is a special metal plate which has been acoustically designed to transmit vibrational energy to a wall surface, instead of to a paper or polymer cone (note the small gap between the plate and wall in the illustration on this page).

According to Ashworth, much of the secret of his speaker's operation

(Please turn to page 132)

HOW TO SAVE YOUR LIFE AND THE ONE NEXT TO YOU

OVERCOMING YOUR PSYCHOLOGICAL RESISTANCE TO SEAT BELTS MAY BE THE KEY.

The facts are startling. Experts estimate that almost half of all automobile occupant fatalities and many serious injuries might have been avoided if the people had been wearing seat belts. That's because most injuries occur when the car stops abruptly and the occupants are thrown against the car's interior or out of the car. Belts reduce this risk.

Many people say they know the facts, but they still don't wear belts. Their reasons range all over the lot: seat belts are troublesome to put on, they are uncomfortable, or they wrinkle your clothes. Some people even think getting hurt or killed in a car accident is a question of fate; and, therefore, seat belts don't matter.

If you're one of those people who don't use belts for one reason or another, please think carefully about your motivations. Are your objections to seat belts based on the facts or on rationalizations?

Here are a few of the common rationalizations. Many people say they are

afraid of being trapped in a car by a seat belt. In fact, in the vast majority of cases, seat belts protect passengers from severe injuries, allowing them to escape more quickly. Another popular rationalization: you'll be saved by being thrown clear of the car. Here again, accident data have proved that to be untrue—you are almost always safer inside the car.

Some people use seat belts for highway driving, but rationalize it's not worth the trouble to buckle up for short trips. The numbers tell a different story: 80% of all automobile accidents causing serious injury or death involve cars traveling under 40 miles per hour. And three quarters of all collisions happen less than 25 miles from the driver's home.

When you're the driver, you have the psychological authority to convince all of the passengers that they should wear seat belts. It has been shown that in a car, the driver is considered to be an authority figure. A simple reminder from you may help save someone's life.

Another common myth: holding a small child in your arms will provide the child with sufficient protection during a crash. The safety experts disagree. They point

out that even during a 30 mph collision, a 10-pound child can exert a 300-pound force against the parent's grip. So please make sure Child Restraint Systems are used for children who aren't old enough to use regular seat belts.

If you're an employer, encourage your employees to wear seat belts. At GM, we've made it a matter of policy that everyone riding in company-owned vehicles is expected to wear lap and shoulder belts.

We heartily support the program initiated by the National Highway Traffic Safety Administration to encourage the use of seat belts. So please fasten your own belt, and urge your family and friends to follow your example. Even the best driver in the world can't predict what another driver will do.

This advertisement is part of our continuing effort to give customers useful information about their cars and trucks and the company that builds them.



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Homer Formby Says: "Paint removing sure needs improving."

All the scraping and sanding. All the misery and mess. No wonder most people would rather do almost *anything* than remove paint.



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Start With The Liquid.

My Liquid Paint Remover can remove virtually any kind of paint. From any kind of wood.

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Brush on Formby's® Liquid Paint Remover and you



can actually watch the old paint layers being bubbled away. That's thanks to my formula. It's *heavy-bodied*, so it works fast and holds tight.

Making it easier to work on vertical surfaces.

And since there's less need for hard scraping, you're less likely to gouge the surface of the wood.

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Paint Remover Wash and steel wool pads to remove stubborn holdover residue.

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Paint Removing System

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PM RIDES THE WORLD'S HOTTEST BIKES

In a quarter-mile and 11 seconds,
you can be going 125 mph.

by Joel Breault

This year's motorcycles are the most radically styled and most technically advanced bikes ever built. While the auto manufacturers reserve their most daring styling concepts for the auto shows, the motorcycle makers put their advanced ideas right in the showrooms. If you haven't been to a motorcycle store in the last two years, your next visit may lead you to believe you've been locked in a time warp.

The big four from Japan (Honda, Kawasaki, Suzuki and Yamaha) offer over 200 models that



While it isn't the fastest of the bunch, the CX500T is Honda's ultimate futuro-styling statement. It features a V-twin, 500-cc, water-cooled, turbocharged motor, shaft drive and the most head-turning fairing ever bolted to a frame. The Turbo has a top end of 130 mph and blasts through the quarter-mile in a mere 12.6 seconds.



Kawasaki 1100 Spectre (above left) produces 100 hp from its vertical four-cylinder engine. It features "American" styling, a stepped seat and bolt-upright riding position. The Kawasaki GPZ750 (above) has cafe racer styling, pumps out 80 hp and runs the quarter in 12.0 seconds. The Yamaha 650 Seca (left) is the quickest 650 around. Low riding position, lots of ground clearance make this bike a real handler.



will suit anyone, from the pattering commuter to the 11-second quarter-milers for whom only hyperdrive is acceptable.

With so many bikes to choose from, wading through all the models and variants within model lines becomes a real chore. Rather than go through each and every model, we picked the most significant—and fastest—of the new models from each of the big four and gave them a thorough thrashing on the roads of southern California.

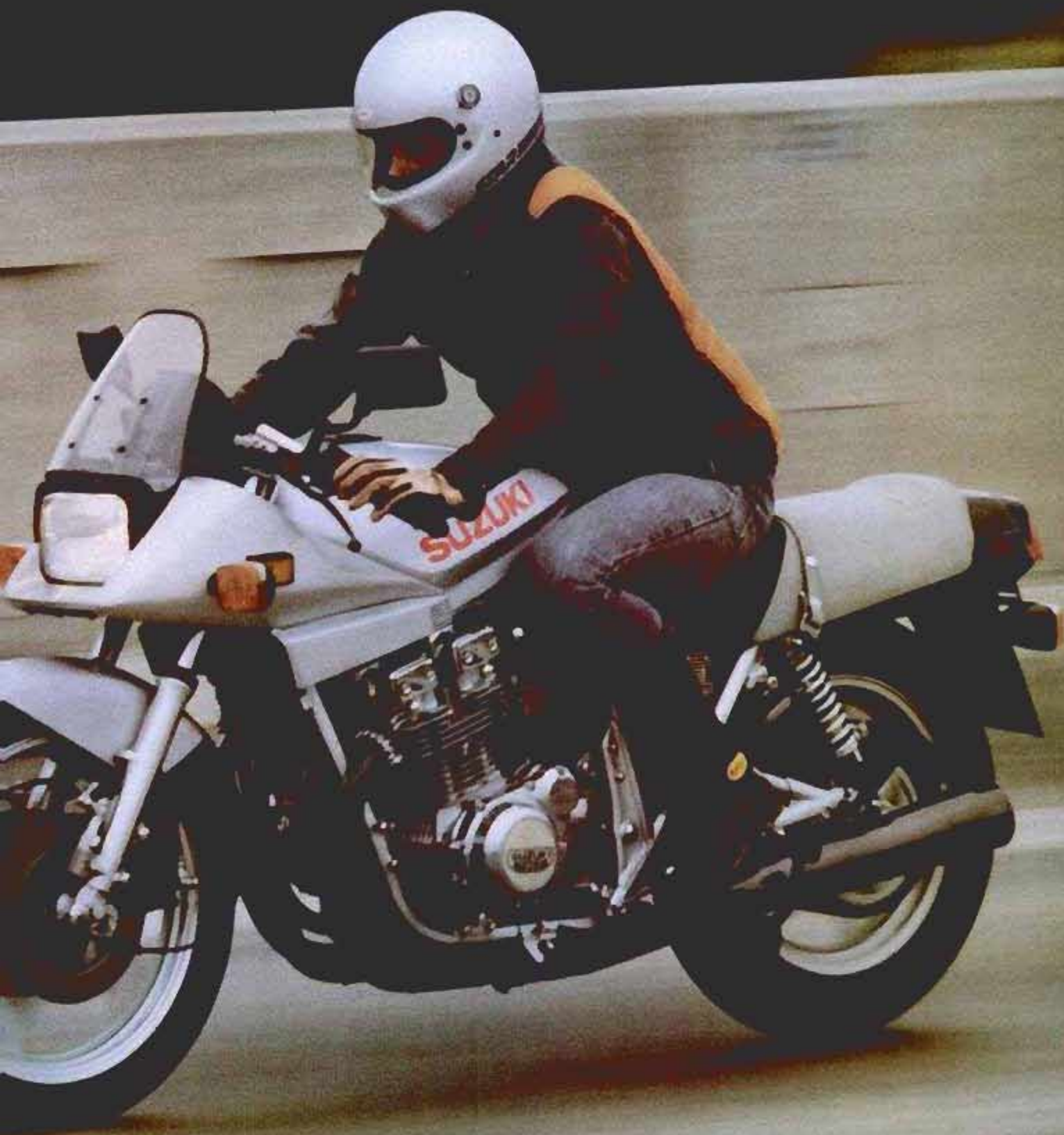
Honda CX500T

The Honda Turbo may *look* like it's the fastest bike in the world,

but it isn't. With an ET of 12.65 and a trap speed of 112 mph in the quarter-mile, it is eclipsed by the much larger Suzuki GS1100E (11.0 seconds, 125 mph). But then, again, speed and ET in the quarter-mile is not everything. What the Honda lacks in brute acceleration, it compensates in precise handling, responsiveness and exotic styling.

The heart of this motorcycle is the V-twin, 500-cc, water-cooled engine. This engine first appeared in the nonturbo CX500 in 1978 and really broke the mold in its class. Previously, if you wanted a 500-cc bike you were limited to either vertical Twins, transverse

(Please turn to page 115)



Suzuki Katana 1100's bizarre styling is matched by its wild, 16-valve mill that propels it through the quarter-mile in 11.2 seconds. It features an antidive braking system and clip-on handlebars.

Superscopes Beam Us

Scientists working with the electron beam are currently rewriting many of the physics books.

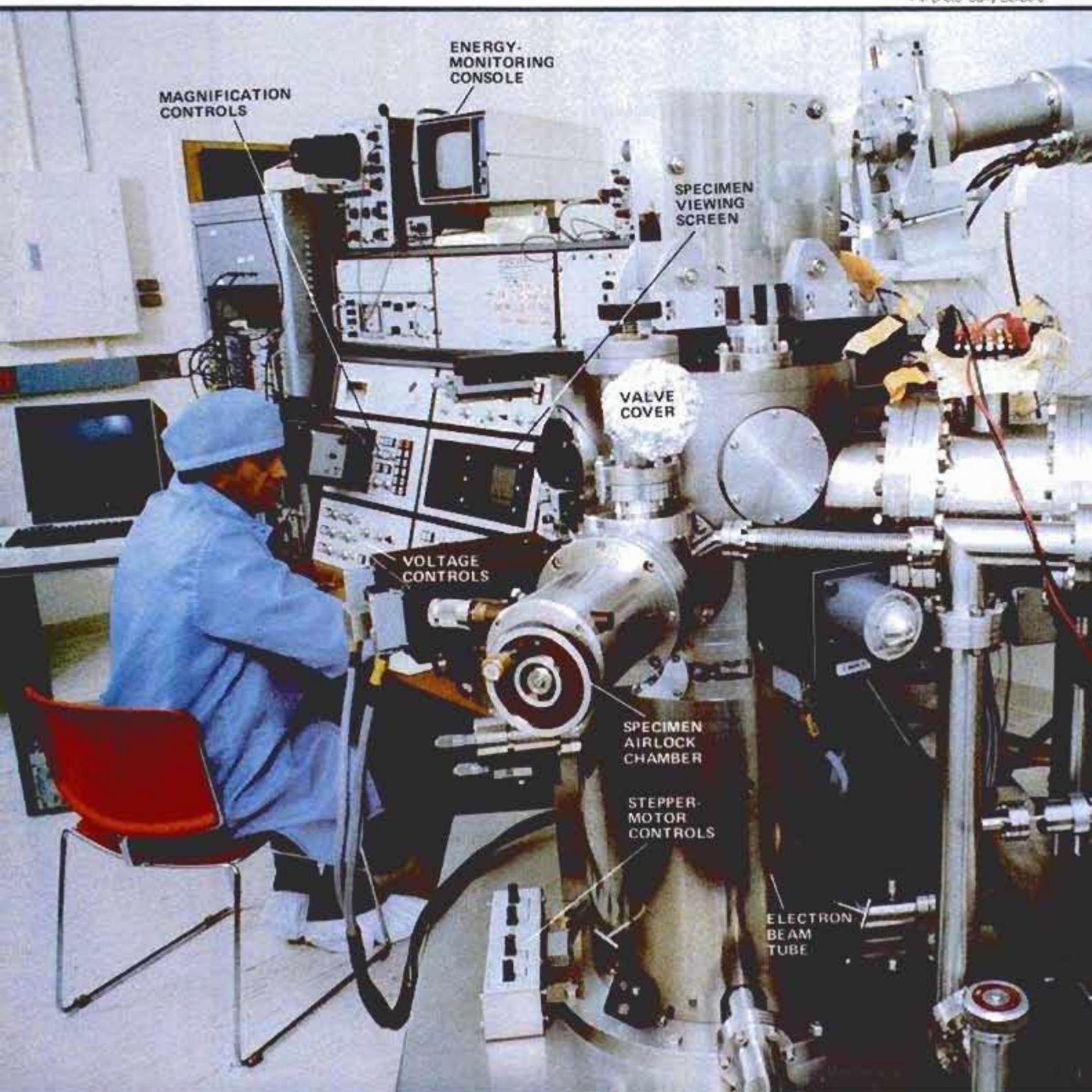
by Dennis Eskow SCIENCE EDITOR

Enter a universe where a grain of salt looms larger than a mountain range and where two channels dug deep and parallel have been known to leap together without warning—or explanation. Scientists have long been able to peer around the corners of this submicroscopic world, but now—using powerful electron beams—they're delving into its mysterious innermost parts.

And the results are nothing less than a revolution in physics, promising technologies that will let us watch a virus grow or etch a microchip hundreds of times faster than today's minicomputer.

Starting with a device that's little more than a souped-up TV picture tube, science has developed sophisticated magnetic lenses and advanced lab techniques to harness the amaz-

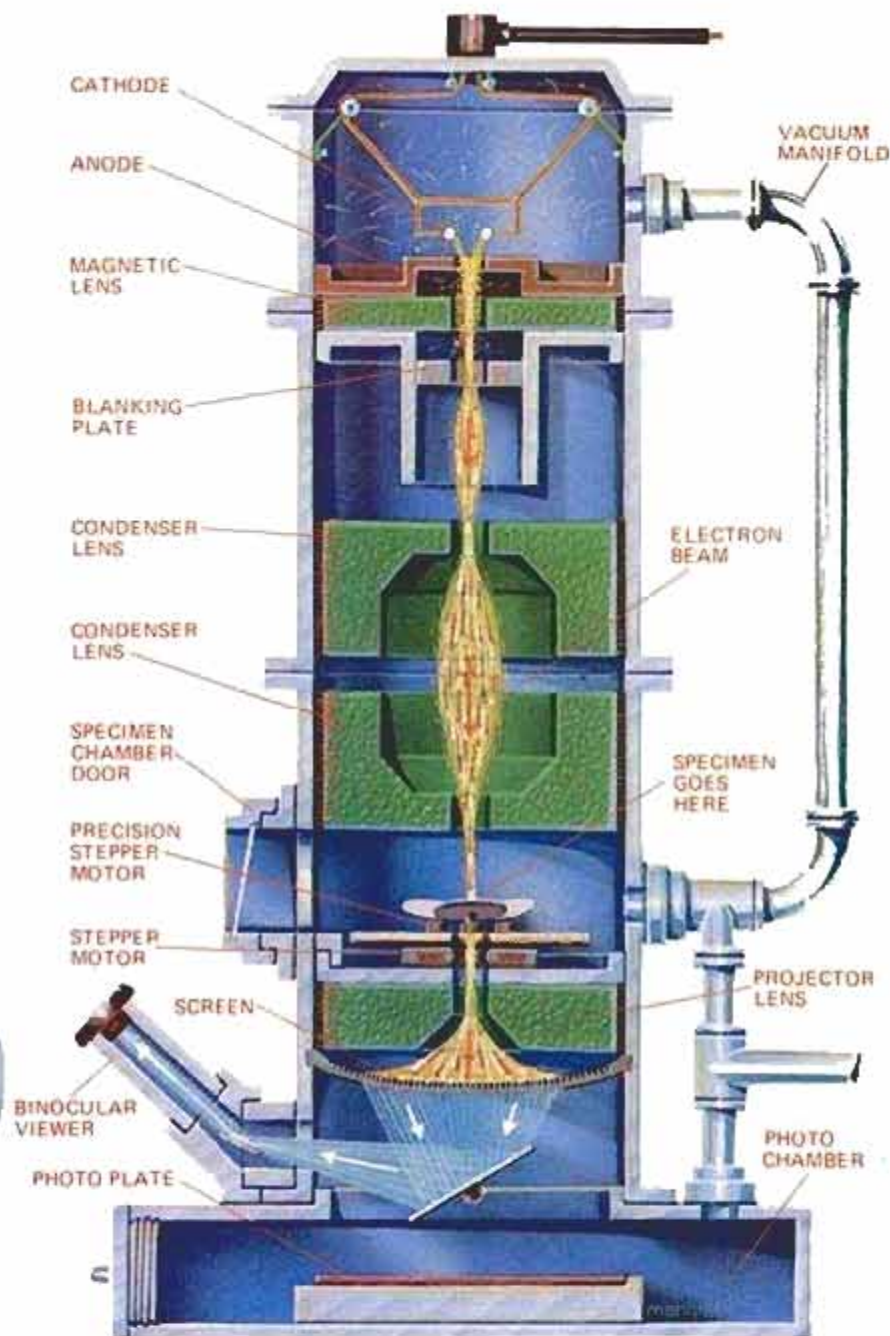
PM photo: Barry Delber



Into Atom-Sized Worlds

ing electron beam. The basic equipment is a particle "gun" that shoots electrons from a cathode to an anode down a vacuum tube. The vacuum keeps out air and particles that might distort the beam.

Further down the tube, the beam is focused through disc-shaped magnets in the same way that light is focused through glass lenses. Electron-absorbing "blanking plates" are used to prevent the beam from striking the walls of the tube.



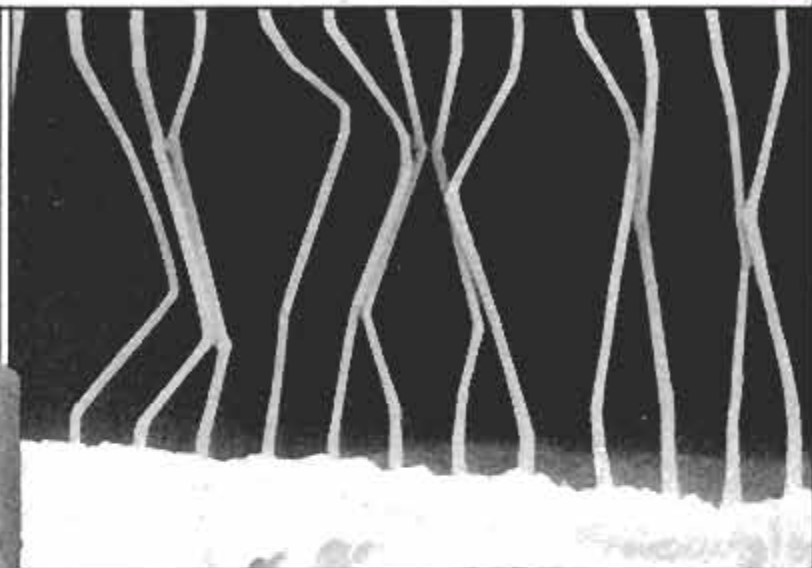
The electron beam (above) is a basic tool of the new physics. Streams of electrons are focused through magnetic lenses to specimens. Used at Cornell (left), it etches lines 20 atoms apart, the kind of work done to make fast computer chips. Used as a microscope, it can easily magnify an impurity in an experimental alloy 3,000 times (right). It can magnify by as much as 200,000x.



Microphoto: G.E. Research Laboratories



PM photos, Peter Tenzer



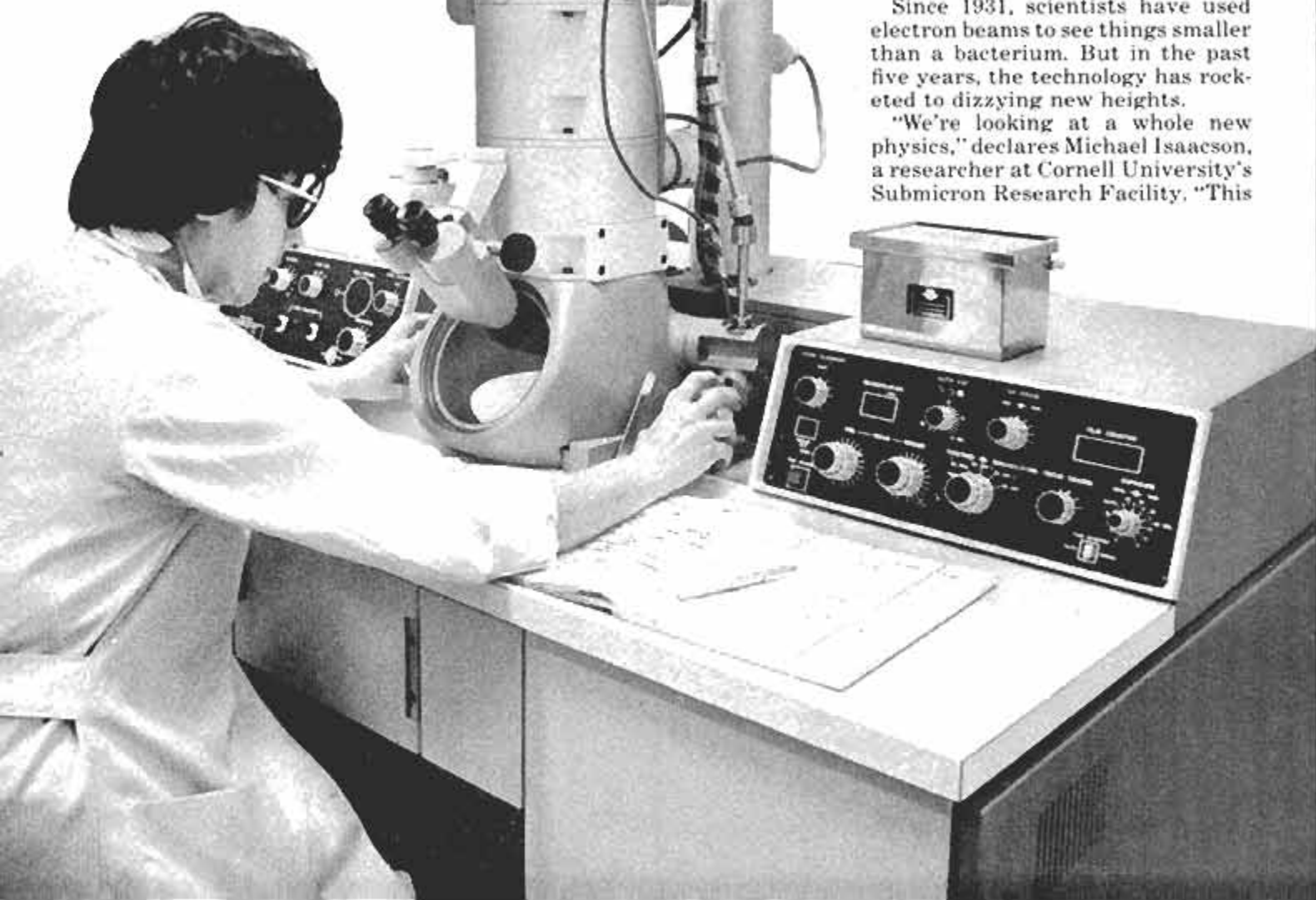
In the strange world of the superscope, a swatch of silicon fiber (above) takes on the appearance of an exotic jungle when magnified to 300x. The wood shaft of a cotton swab (above right) shows splinters magnified to 300x. And at Cornell, Janet Mouradian is able to make diagnoses, using up to 100,000x power.

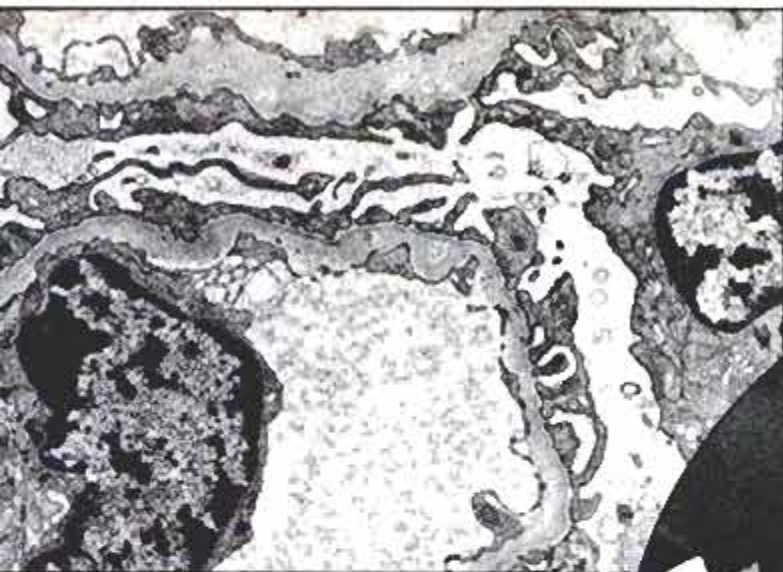
keep the highly charged particles from flying off every which way.

Finally, the beam strikes the object being studied or etched. (If the beam is used as a microscope, the exposures are shorter, and thus less energetic, than they would be for etching.) Depending upon the design of the machine, the beam passes through the object onto a projection screen, or falls in a high-energy shower all around the object onto a screen. Then, the picture is projected through the lens of a standard microscope or photographed in a special chamber.

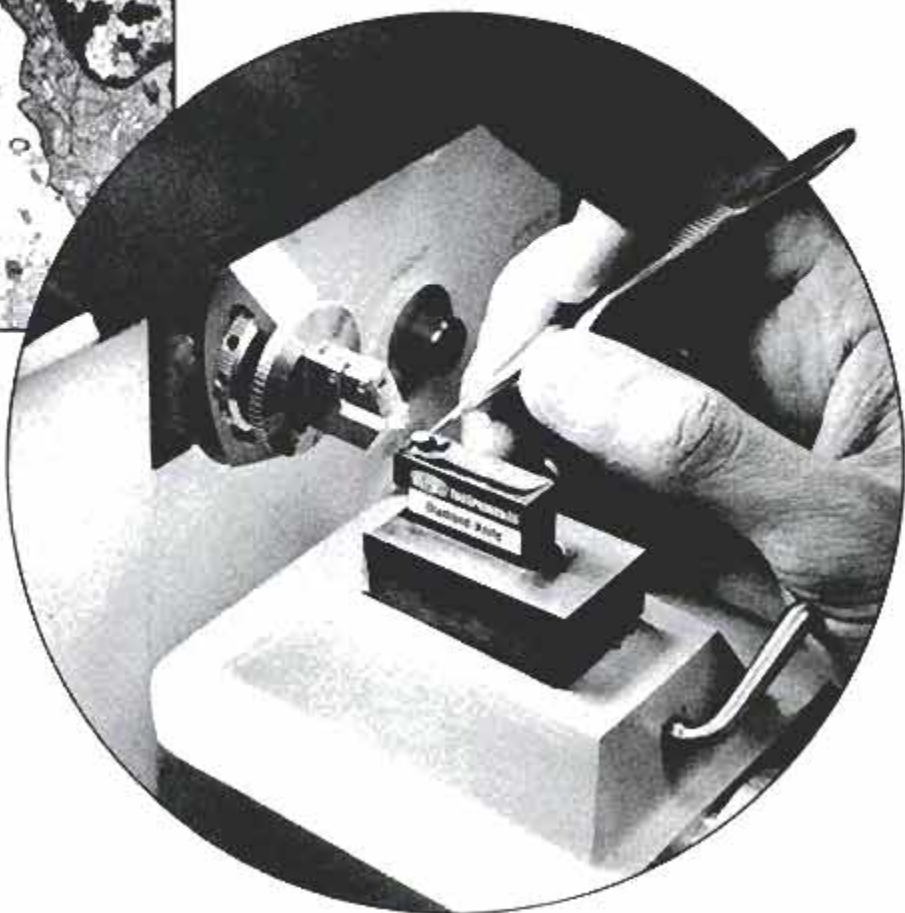
Since 1931, scientists have used electron beams to see things smaller than a bacterium. But in the past five years, the technology has rocketed to dizzying new heights.

"We're looking at a whole new physics," declares Michael Isaacson, a researcher at Cornell University's Submicron Research Facility. "This





The very "cement" that holds human cells together, the basement membrane (left), becomes visible when it's magnified to 7,000x. To get a specimen under the electron beam, it must be sliced superthin with an industrial-quality diamond blade under the light of a microtome (below). The specimen is then lifted with a tiny pair of tweezers and placed on a copper disc, or a "grid," which is smaller than a pinhead.



isn't the stuff you studied in high school." As evidence, Isaacson offers the mystery of the "20-angstrom barrier."

Unbreakable barrier?

Using a beam about 5 angstroms across—the size of a single atom—Isaacson has etched perfectly parallel lines remarkably short distances apart. But when he tries to dig canals 20 angstroms or less apart, the two lines survive only fractions of a second and then jump together to form one line. Isaacson is working on an explanation. "It just might be that there's a limit to how small a scale we can work in," he says.

The electron beam was the invention of scientists frustrated with the limitations of the standard light microscope. With maximum magnifications of less than 2,000x, they needed something that would let them see cells and structures thousands of times smaller. The earliest electron scopes magnified objects by as much as 12,000x. Today, we can blow up the image of a cell or other object 200,000 times. But limitations and frustrations persist.

"With the electron microscope, you see only in black and white," notes Rockefeller University researcher Maria Rudzinska. "And you cannot study the living organism because specimens must be dead."

If cutting doesn't destroy living tissue headed for an electron microscope, then "fixing" will. The samples must be cut razor-thin to let electrons pass through. But even if they survive the process, they then have to be "fixed" on a mount with epoxy to keep the cell from moving and distorting the image. No one has found an epoxy that will hold the cell perfectly still and keep it alive at the same time.

"The answer may be in going back to light microscopes," says Cornell

researcher Aaron Lewis, whose work may lead to the creation of the first light-powered superscope. Ironically, the light-powered invention is made possible by work Lewis is doing with the electron beam.

Heart of darkness

At the heart of the present limitation of light microscopes is the fact that a beam of white light won't pass through an opening smaller than about 5,000 angstroms, meaning you can't look at items smaller than that. But Lewis has found that by pounding a gold leaf to less than 1,000 angstroms thick—then electron-zapping a hole in the leaf about 500 angstroms in diameter—he can get a tiny beam of light to pass through.

He is now working on the delicate construction of an array of such gold leaves. In future experiments, the leaves will be set side by side in front of a tissue sample. A high-energy beam of laser light will be shot through the sample, passing onto a tiny screen for magnification. Theoretically, with dozens of "eyes" look-

ing at points the size of less than 30 atoms, the array will be able to produce pictures of cancer cells in the midst of reproduction, to name just one potential use of the arrays.

For some things, however, the electron microscope will always have an important use. "For difficult diagnoses, it's hard to think of a way to improve on the electron microscope," says Cornell surgical pathologist Janet A. Mouradian. "By studying the cells at various magnifications, we can tell the exact kind of cancer involved. We can look at the juncture between cells and understand how the cancer is invading the body—and perhaps how to kill the cancer."

Her lab assistant, Jose Avello, prepares samples to be magnified up to 100,000 times. In surgical gown and gloves, Avello runs the tissue sample under a microtome, a device that looks like a light microscope, with its binocular eyepieces and yellow light. Placing the sample under 100x magnification, Avello sets a super-

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PM Tests The Biggest Outboard Ever

Outboard Marine's new 3½-liter V8 powerhouse can challenge all previous records.

by Bill McKeown BOATING EDITOR

The rumors are true! A year ago when Outboard Marine Corp. introduced the biggest two-cycle outboard ever built, there was a suspicion that OMC was out to create performance that could win the world's closed-course racing championships. And further, these new Johnsons and Evinrudes would also be adaptable to offshore marathons—an entirely different league—and lead to production motors for big pleasure boats.

So far, this exotic machine has not competed in the United States. But in five races in Europe, it has won them all. No one is quite sure of the top speed. The engine has been handled carefully and hasn't needed the ultimate push to come in first. The present outboard world speed record is 137.96 miles per hour, but the few experts who have driven this new V8 report more speed than that on straightaways.



Speedometer that starts at 60 mph and OMC tach are explained by Jimbo McConnell and Jack Leek to PM test driver McKeown.

Is this the outboard of the future? In an exclusive first-ever test, Popular Mechanics got an opportunity to judge.

Up close with the engine cover on, the powerhead is only slightly taller than previous motors. Looks do not give away the massive horsepower hidden inside, and, once underway, the motor is muffled to

hide any ear-splitting roar. Under the hood is no secret, and throngs at boat shows have already crowded around to study the twin banks of four cylinders set in a 90° V, with one dual-barrel carburetor mounted on each for a total of eight. Displacement of 3½ liters (214 cubic inches) probably pours out 400 or more horses of power, depending on the setup.

I decided on the test-ride day that I wouldn't quibble with the 400-plus estimate.

With ace racing driver and OMC test technician Jimbo McConnell and director of Marine High Performance Jack Leek, we first went over cockpit controls. Thumb buttons right and left on the steering wheel control "up" engine trim, and an alternate toggle switch under your right thumb chokes the engine. A gauge taped to the front top of the cockpit cowl shows trim position. A button

(Please turn to page 97)



Cees van de Velden-enduro and Molinari-sprint tunnel hulls (above and below) handled smoothly at 100-plus mph. The potent new V8 powerplants are trimmed out with tilt and elevator-mount adjustments, which are controlled by steering wheel, foot and toggle switches in the cockpit.



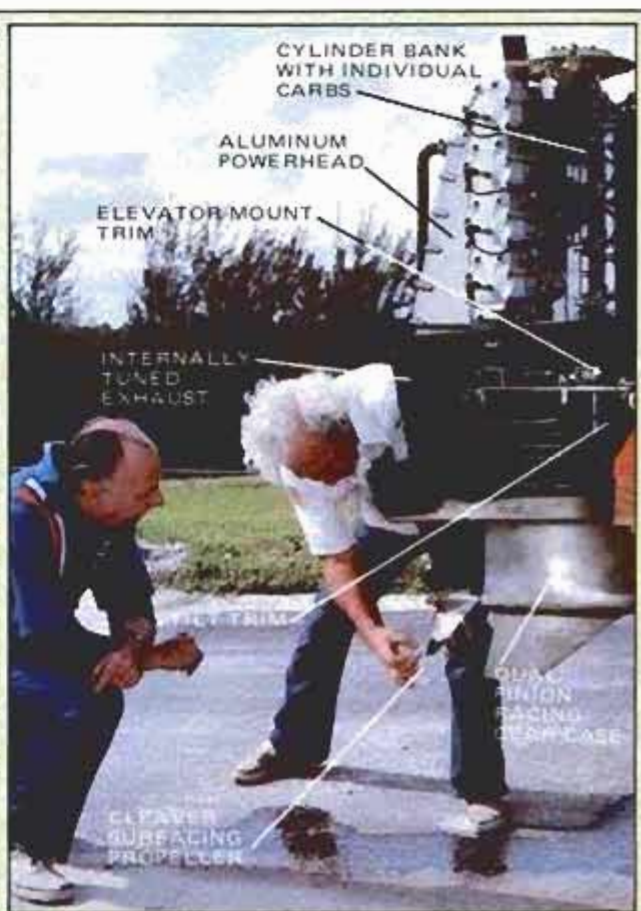
PM photos: Rex Robinson



For safety in tunnel hull like Molinari (top), McConnell suits up PM's McKeown in drogue chute life jacket, radio helmet.



One of dual banks of four cylinders apiece (above) shows twin-barrel carbs for each of eight cylinders of 90° V8. Block is aluminum with cast-iron liners for cylinders. CD ignition handles rpm approaching 10,000. Tuned exhaust boosts hp estimated to be above 400. Streamlined lower unit, plus electric one-inch lift adjustment of mount, positions surfacing cleaver prop for optimum closed-course racing. Offshore marathon setup uses deeper units.



The 'Blackbird'



by Clarence L. Johnson

The Lockheed U-2 subsonic, high-altitude reconnaissance plane first flew in 1955. It went operational a year later. It became obvious to those of us who were involved in the U-2 program that Russian developments in the radar and missile fields would shortly make the U-Bird too vulnerable to continue overflights of Soviet territory, as indeed happened when Francis Gary Powers was shot down on May Day of 1960.

Starting in 1956, we had made many studies and tests to improve the survivability of the U-2. Few gains were forthcoming except in cruise altitude, so we took up studies of other designs. We examined the use of new fuels such as boron

slurries and liquid hydrogen. The latter was carried into the early manufacturing phase because it was possible to produce an aircraft with cruising altitudes well over 100,000 feet at a Mach number of 2.5. This design was scrapped, however, because of the terrible logistic problems of providing fuel in the field.

It was still apparent that we would need a manned reconnaissance aircraft that could be dispatched on worldwide missions

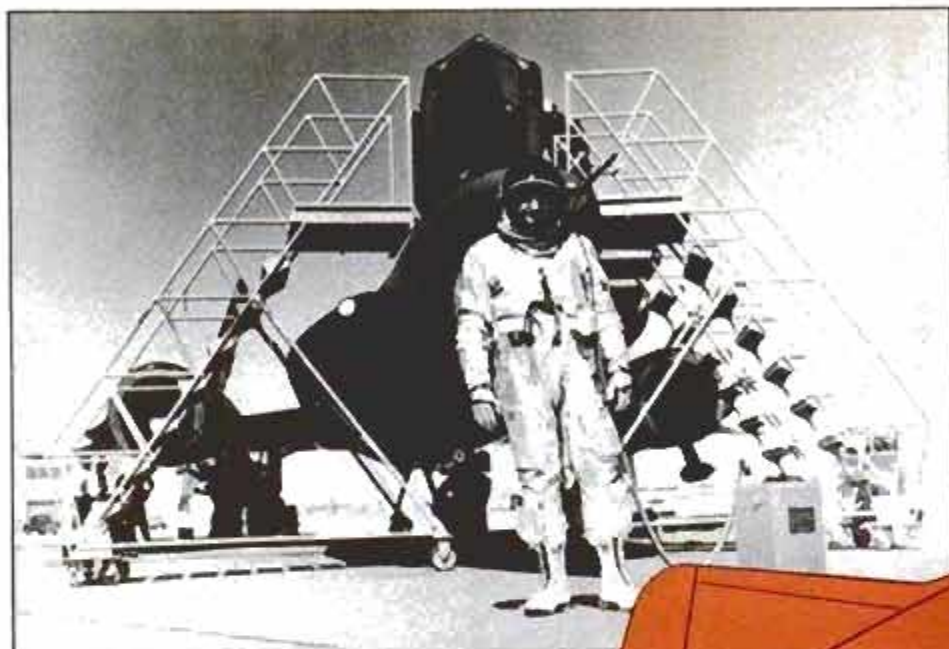
Clarence L. "Kelly" Johnson is a consultant to Lockheed's advanced projects group, which he headed at the time it earned the industry sobriquet, "Skunk Works." This is the story of one of its most successful products, an aircraft whose ultimate capabilities are still a highly guarded secret and one still ahead of its time.

Story

The world's first titanium plane flew 20 years ago. Even now, nothing outperforms it. It has photographed every hot spot from Cuba to the Falklands. Here, for the first time, is the builder's story.

Artist's conception (right) of an SR-71 at altitude is a view only a spacecraft—or another Blackbird—would have. Among world aircraft records still held by the design are: speed over a straight course—2,193 mph; speed over a closed circuit—2,092 mph; and altitude in horizontal flight—85,069 feet. The photo at right shows the only method available 20 years ago for testing the plane's new J58 engine: Exhaust of another jet engine was run through its intake, simulating high ram-air temperatures at cruise speed.





Two-person SR-71 crews wear pressure suits very similar to astronaut gear; cooling load (skin temperatures at right—"L" means lower surface) was a major design challenge.

when required. From vulnerability studies, we derived certain design requirements for this craft: a cruising speed well over Mach 3, a cruising altitude over 80,000 feet and a very low radar cross section over a wide band of frequencies. Electronic countermeasures and advanced communications gear were mandatory. The aircraft needed at least two engines for safety reasons.

Operating at ram-air temperatures of over 800° F. immediately ruled out aluminum as a basic structural material, leaving only various alloys of titanium and stainless steel. It meant the development of high-temperature plastics for radomes and other structures, as well as a new hydraulic fluid, greases, electric wiring and plugs, and a whole host of other equipment. The fuel had to be stable under temperatures as low as -90° F. in subsonic cruising flight during aerial refueling, and to over 350° F. at high cruising speeds when it would be fed into the engine fuel system. There, it would be used first as hydraulic fluid, at 600° F., to control the afterburner exit flap before being fed into the burner cans of the powerplant and the afterburner itself.

Cooling the cockpit and crew turned out to be far more difficult than on the X-15 research airplane, which could fly twice as fast (but only for a few minutes per flight). The rubber tires of the landing gear had to be protected from the heat

474°

489°

519° L

538°

501°

1050°

521° L

523°

512°

568° L

518° L

501°

505°

587°

with the Air Force in March 1960. They were very pleased with our proposal. In early January 1961, I made the first proposal for a strategic reconnaissance bomber version.

We were encouraged to continue our company-funded studies on the aircraft. As we progressed in the development, we encountered very strong opposition in certain Air Force quarters on the part of those trying to save the North American B-70 program, which was in considerable trouble. Life became very interesting in that the SR-71 was competing with an airplane five times its weight and size.

The first A-12 flew on April 26, 1962. In June, the Air Force evaluation team reviewed our design and the YF-12A mock-up, and we were given good grades.

Our discussions continued with Gen. Curtis LeMay and his Strategic Air Command officers. In December 1962, we were finally put on contract to build the first group of six SR-71

by burying the retraction wells in the fuselage fuel tanks for radiation cooling.

Special attention had to be given to the crew escape system to allow safe ejection from 0 mph at sea level to Mach 4 at over 100,000 feet.

The problems of taking pictures through windows subjected to a hot, turbulent airflow on the fuselage also had to be solved.

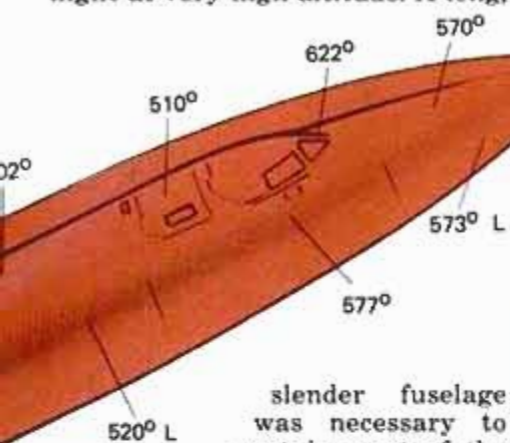
Beginning in April 1958, I made a series of competitive proposals for Mach 3-plus reconnaissance aircraft to the C.I.A. and to the U.S. Air Force. These airplanes were desig-

nated in the Skunk Works (Lockheed's advanced projects group) by design numbers of A-1 through A-12. In August 1959, our A-12 design was declared the winner, which gave us a limited go-ahead for a four-month period to conduct tests on certain models and to build a full-scale mock-up. In January 1960, we got a full go-ahead on the design, manufacturing and testing of 12 aircraft.

We discussed the next version of the aircraft, an Air Defense long-range fighter (designated YF-12A),

aircraft. The first YF-12A flew early next August.

Going back to the origins of the final design, the required performance in speed, altitude, and range made it evident that a thin, delta-wing platform with a very moderate wing loading was required to allow flight at very high altitude. A long,



slender fuselage was necessary to contain most of the fuel, as well as the landing gear and payloads. To reduce the wing trim drag, the fuselage was fitted with lateral surfaces called chines, which actually converted the forward fuselage into a fixed canard which developed lift.

The hardest design problem on the airplane was making the engine inlet and ejector (tailpipe) work properly. The inlet cone had to move almost three feet to keep the shock wave where we wanted it. A computer-controlled hydraulic actuator was required to provide operating forces of up to 31,000 pounds under certain flow conditions in the nacelles. To account for the effect of the fuselage chine airflow, the inlets were pointed slightly down and in toward the fuselage.

The use of dual vertical tails canted inward on the engine nacelles took advantage of the chine vortex in such a way that the directional stability improved as the angle of attack of the aircraft increased.

All the usual low- and high-speed wind-tunnel tests were run on the various configurations of the A-12 and YF-12A, and continued on the SR-71. Substantial efforts went into optimizing chine design and conical camber of the wing leading edge. No useful lift increase was realized from the use of wing flaps of any type, so we depended entirely on our low wing loading and powerful ground effect to get satisfactory takeoff and landing characteristics.

Wind-tunnel data on fuselage trim effects were of marginal value because of two factors: structural deflection due to fuselage weight dis-

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THE BLACKBIRD'S POWER PACKAGE

In many ways, the development of the J58 engine by Pratt & Whitney more than 20 years ago paralleled the Lockheed adventure into unknown engineering. Not only would the new mill be required to handle inlet air temperatures of 800° F. (see the photograph below) at speeds of Mach 3 and above, but it would burn a fuel that would also be used as a hydraulic fluid and coolant, reaching temperatures as high as 600° F. before combustion.

"We had to learn how to form sheet metal from materials which previously had been used only for forging turbine blades," recalls William Brown, then engineering manager on the project for Pratt & Whitney. "I do not know of a single part that could have been made from the same materials as those used on previous engines."

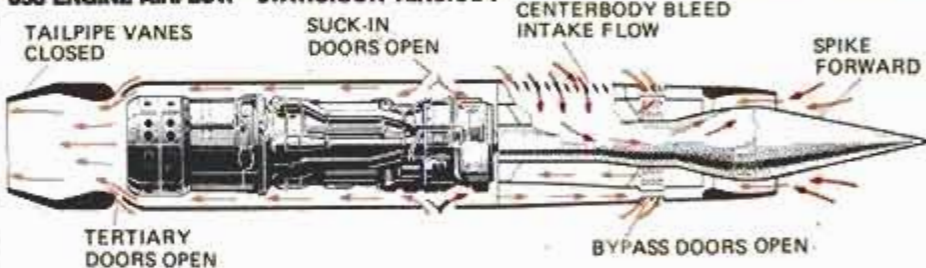
Because of the great difficulty of maintaining a smooth airflow through jet

engines at high Mach numbers, a "bleed-bypass cycle" involving several sets of nacelle orifices (see drawing below) was originated. This cycle maintains an optimum ratio between the intake and exhaust flow rates at all speeds. A movable "spike" is also required to position the supersonic shock wave that forms in the inlet.

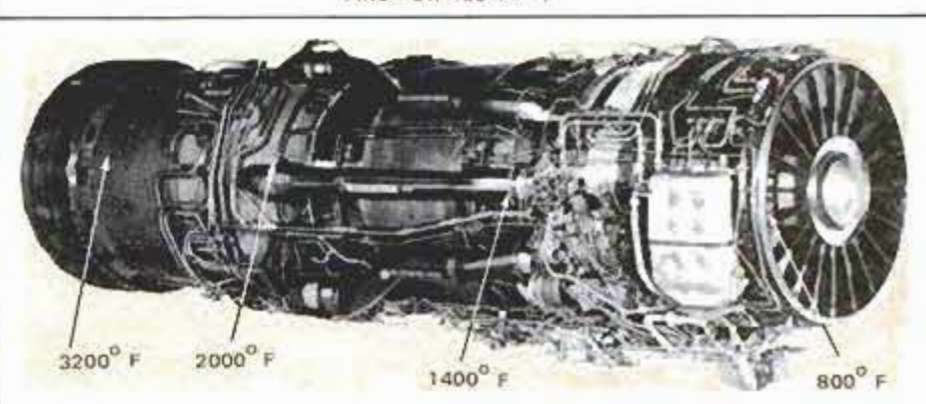
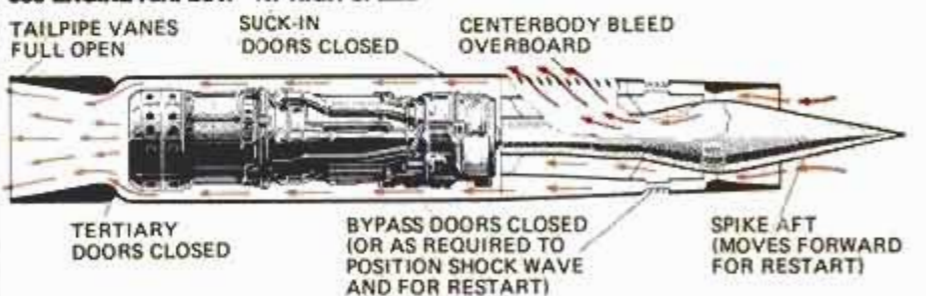
Computer simulation was unavailable, so engine/airframe integration was mainly a matter of flight and ground testing. Inlet "stalls" followed by dangerous overheating were an early flight problem. It was also discovered that the placement of an air-conditioner dump valve too near a temperature sensor was causing one engine to constantly run faster than the other. And in one instance, during a ground run-up to peak power, a J58 actually ingested its own Pratt & Whitney nameplate, mounted near the inlet, causing major damage to the engine. —Robin Nelson

Drawings show the changes necessary in the J58 engine's configuration as it progresses from ground start to high cruise speed. High-angle-of-attack maneuvers contribute to inlet "stalls"—air refuses to flow—which necessitate a restart procedure.

J58 ENGINE AIRFLOW—STATIONARY AIRCRAFT



J58 ENGINE AIRFLOW—AT HIGH SPEED



New Looks For The Blow-Up Boats



Sailing is only one talent of this multipurpose craft. Leeboards, rudder and dingy convert 13-foot Juce Metzeler model from motor to wind power.

Flatter sides and deeper keels of longer lasting materials give these versatile craft softer rides and longer life.

Inflatables are growing up. They are still the small, simple-to-store, easy-to-carry, multipurpose boats that can pack away into car trunk or closet and come out to blow

up for launching in minutes. But quality models are no longer considered surplus liferafts or plastic swimming pool toys. The latest space-age materials make them stronger and more durable, while new designs make them look more like conventional craft. And new higher prices complete the resemblance.

A price tag of over \$10,000 for a

19-footer puts them in the hard-hull, big-boat league.

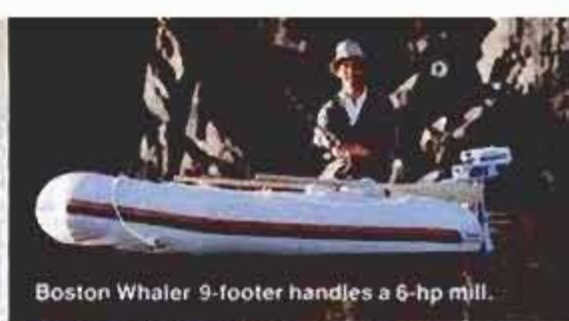
The early rubber hulls that rotted out from sun and water exposure have been replaced. Now, synthetic fabrics that are specially treated with synthetic rubber can resist oxidation and ultraviolet attacks. Neoprene, Hypalon, nylon, PVC and polyester in multilayered applications are producing waterproof fab-

Concorde, from Metzeler, is an 18-foot runabout that can seat four, clamp on up to 150 hp and pull water skiers.





A sailboard that goes to the beach in just a shoulder bag, the 33-pound Pesked rides on inflated PVC float chambers that support a three-piece deck and a two-section sail.



Boston Whaler 9-footer handles a 6-hp mill.



The 13-foot Sport inflates keel.



The Sport 10 takes up to 10 hp.

rics of great strength and abrasion resistance. Kevlar fibers, like those in bulletproof vests, are incorporated into some models. New adhesives to seal seams of the air chambers also extend the life of the latest models.

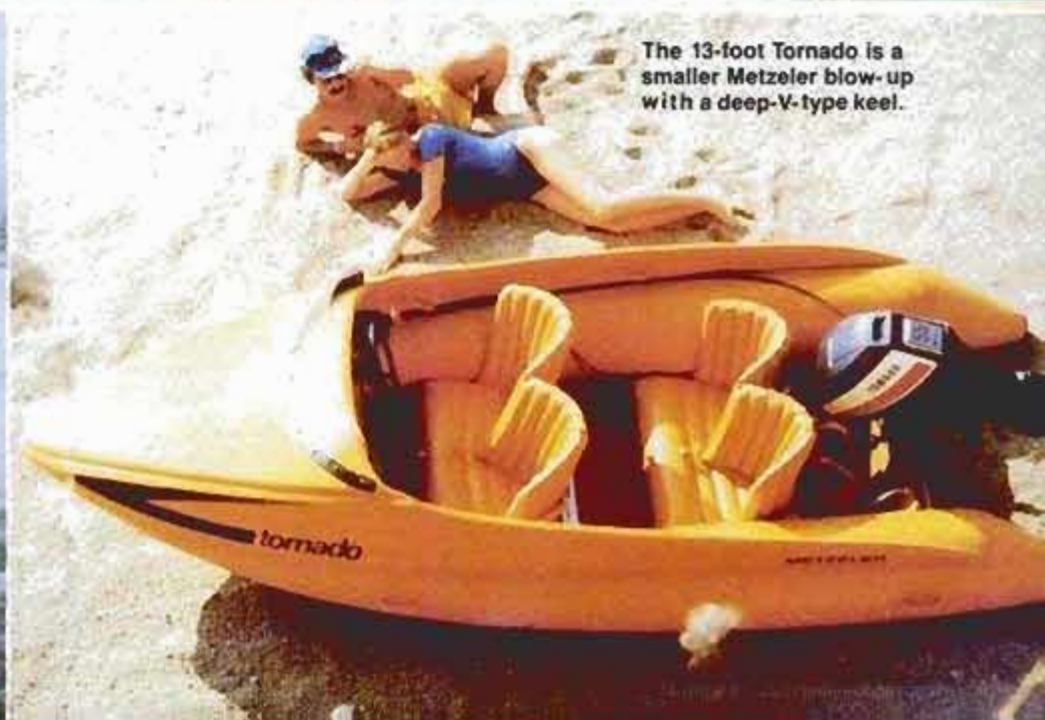
Examples of a new sleeker look for inflatables come from Metzeler inflatable boats in Germany. To its line of dinghies, runabouts, canoes,

kayaks and river rafts, an 18-foot, 4-inch Concorde and a 13-foot, 8-inch Tornado have been added. New engineering has made possible flat topsides and deck above the rounded flotation chambers. Semi-deep-V inflatable keels for these and other makes provide a much smoother ride.

The larger Concorde is rated for outboards up to 150 hp, seats four in

inflated bucket seats, weighs 565 pounds and can carry a payload of 1,672 pounds. It has eight air chambers, floorboards of wood, forward steering, and it can easily tow water skiers. The Tornado takes motors of 50 hp that can pull two water skiers, has an optional dashboard with steering wheel and controls, and weighs 242 pounds. Both

(Please turn to page 120)



The 13-foot Tornado is a smaller Metzeler blow-up with a deep-V-type keel.

SUPERBIKES: Built Like Airplanes

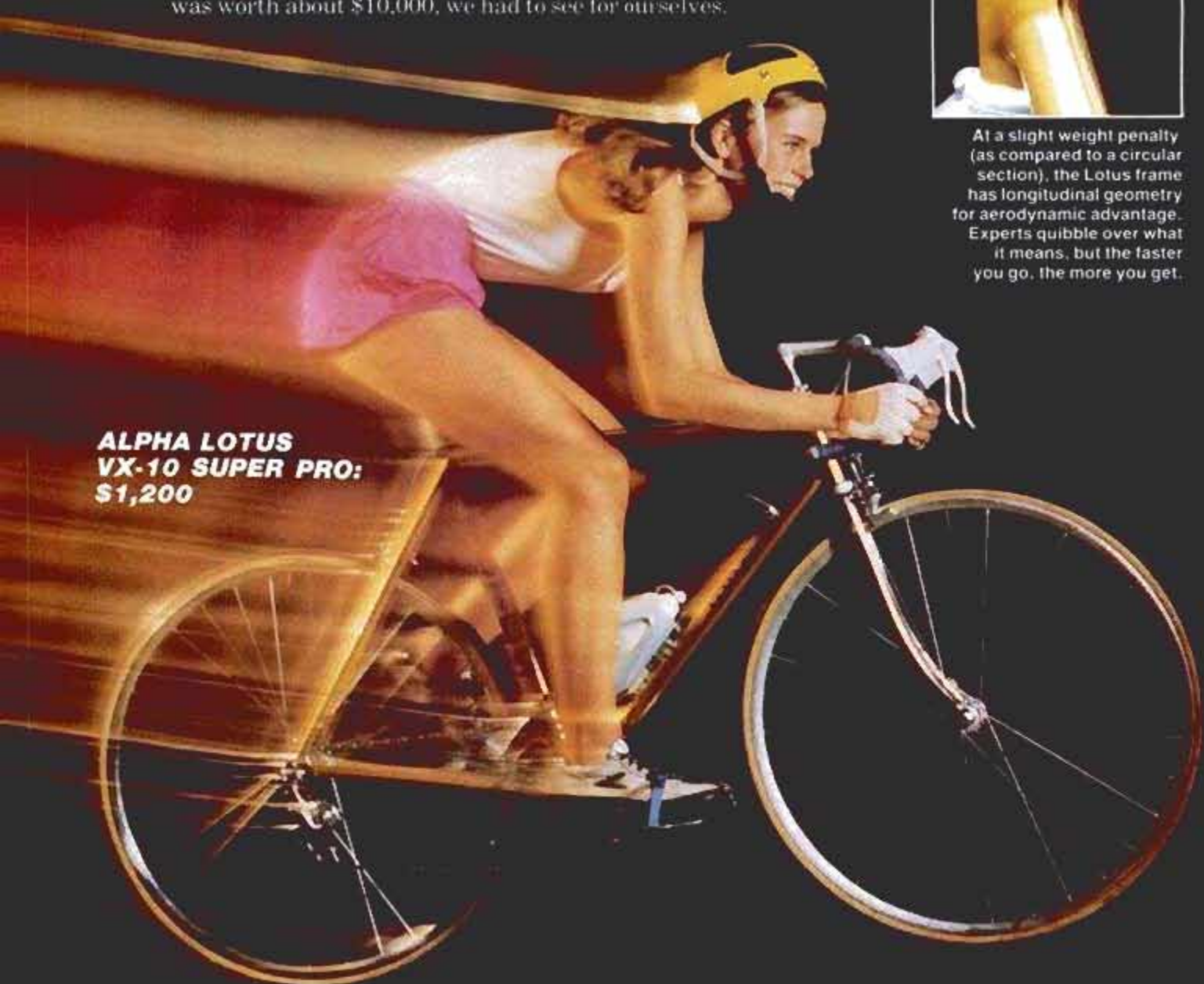
Priced accordingly, the aerospace spin-off bicycle is no mere pedestrian conveyance.

It got started in earnest about a decade ago. That was when a rising tide of interest in bicycling on this side of the Atlantic combined with a marketplace full of new alloys and composites that had been developed largely through aerospace research. It meant that people who could work with these materials could build lighter, faster bikes for a growing army of customers at all levels of the sport—from all-out racers to bike-touring vacationers. PM recently asked cycling savant Eugene Sloane, author of *The New Complete Book Of Bicycling*, to give us an evaluation of the latest exotic two-wheelers. When he told us one of them was worth about \$10,000, we had to see for ourselves.



At a slight weight penalty (as compared to a circular section), the Lotus frame has longitudinal geometry for aerodynamic advantage. Experts quibble over what it means, but the faster you go, the more you get.

**ALPHA LOTUS
VX-10 SUPER PRO:
\$1,200**



Bicycles that shave off seconds in a long road race are the ones that are winning all of the big races in Europe; they are also the kind of bikes that we'll be talking about in this article.

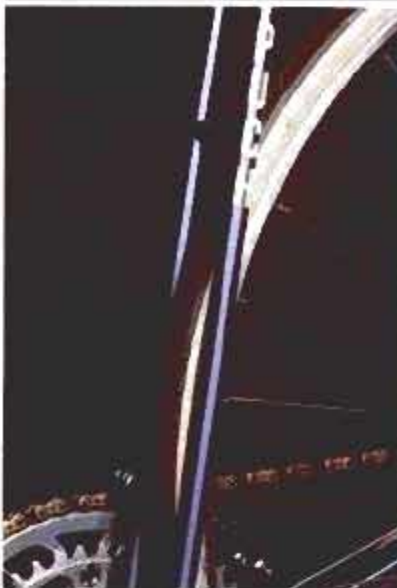
What's exotic about the Lotus (left), however, is not its price—at least compared to some of the other bikes described here. It's the use of the aerodynamic component: the streamlined shapes of these parts reduce wind resistance and, therefore, make any kind of cycling a bit easier. Obviously, the faster you go, the more significant this aerodynamic advantage becomes.

The Lotus has aerodynamic oval frame tubes, handlebars and a seat post. Even the fork tube crown and the streamlined water-bottle shape (see photos below) are designed to cut wind drag. Now, all it needs is an ovoid rider. —Eugene Sloane



PM photos, Bill Ashe

AUSTRO-DAIMLER EVEREST: \$1,965

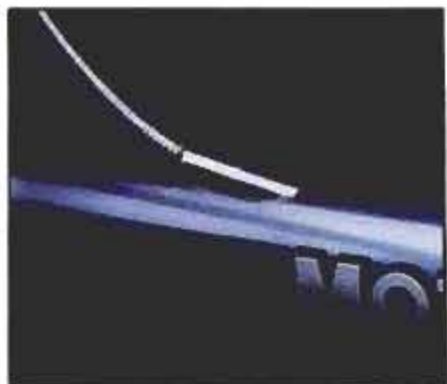


This bike comes from one of the oldest and most respected European manufacturers, the Steyr-Daimler-Puch plant in Graz, in the south of Austria. The Everest is the top-of-the-line road-racing machine. It has a hand-brazed silver frame. Frame tubing is double-buttressed Reynolds 531 in both main tubes and the fork blades.

By a combination of careful component selection and precision frame geometry, the Puch people have reduced the weight of this bike to 18 pounds. This fantastically light weight, on a 12-speed bike, compares very favorably with aluminum bikes.

Frame geometry is typical racing style, with a short wheelbase of 38 inches and a 1 7/8-inch fork rake. The frame is stiff and responsive; the steering is quick and accurate. —E. S.

The Puch split seat tube (above, left) allows rear wheel to sneak into the frame for shorter racing wheelbase. It has side-pull brakes which are preferred by racers for quick action, although center-pull design (like that on the Lotus in photo at left) is more efficient and softer. Puch uses Campagnolo Super Record rear derailleur.



Motobecane's all-aluminum-alloy tubes (above) are expanded at the joints to provide greater area for aerospace cementing technique, which uses no lugs. Bike's lightness and finish are superior in its price range.

MOTOBECANE PROLIGHT: \$1,149

Although the ProLight is one of the least expensive of the exotic bikes in this collection, it's one of the most innovative. For example, the frame tubing is the new Vitus No. 979 Duralinox aluminum; it's lugless and is cemented together, with the joints then sealed. This eliminates joint heating, which could affect the heat treatment

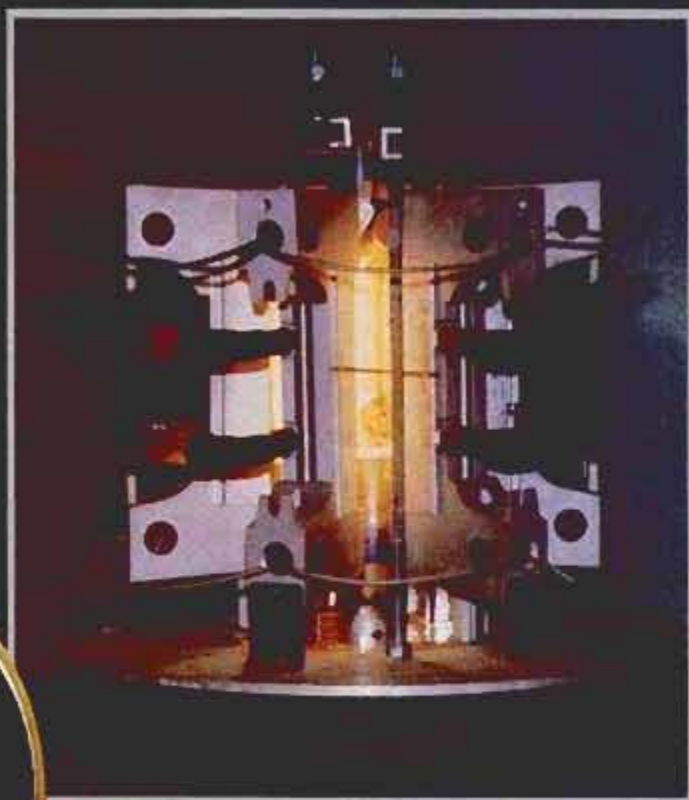
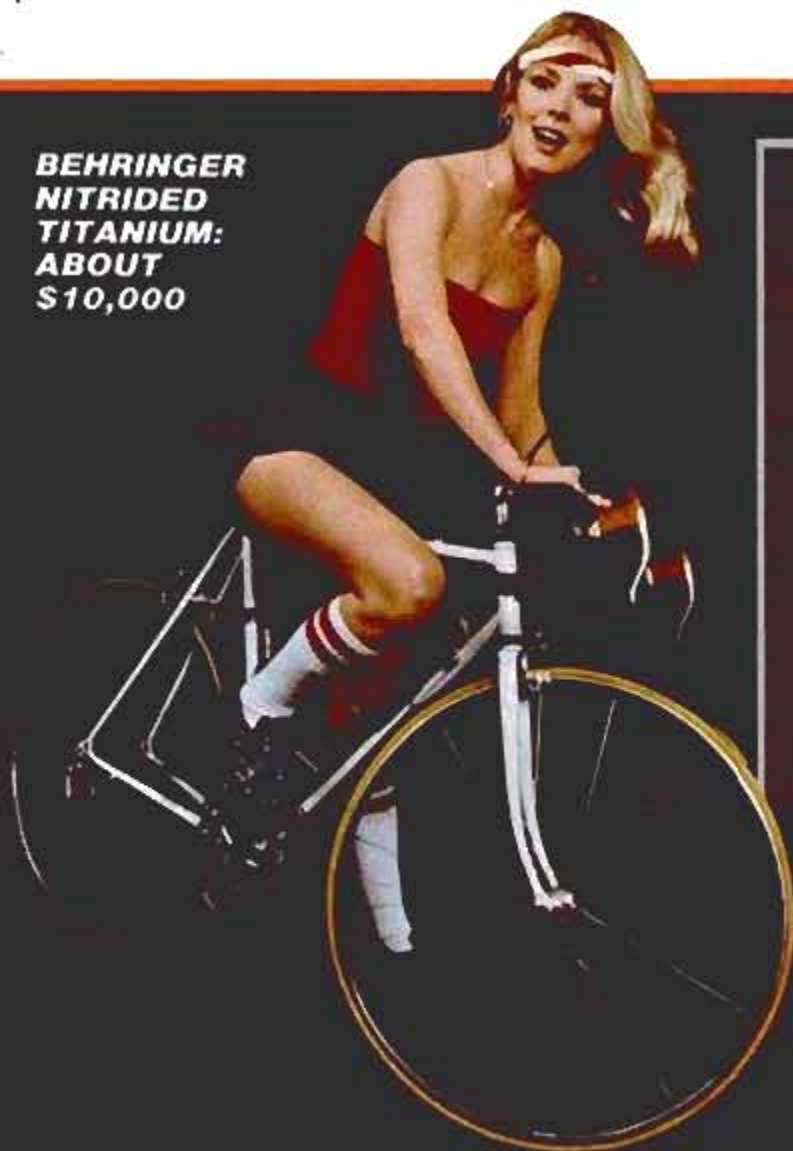
and strength of the tubing. It's the same technology used today in aerospace construction.

At 20.6 pounds, the ProLight is the next-to-lightest bike in its price range. It is the third all-aluminum alloy bike I've ridden and, like the other two, its comfort and frame stiffness were excellent. Frame elasticity was just

enough to smooth out road bumps, but not so much as to absorb your pedaling power in "frame whip."

The ProLight, unlike the custom models, is available off the shelf in bike shops. This frame has been sold for about two years in Europe. The cement, called Bador, developed in France, seems to be failure-free.—E. S.

BEHRINGER NITRIDED TITANIUM: ABOUT \$10,000



The subassemblies for both titanium and steel frames built by Cecil Behringer are brazed in an argon-filled quartz furnace (above). Completely assembled, a track-version Behringer titanium weighs a meager 10 pounds.



Raleigh Team Pro's 12-speed setup is based on top-line Campagnolo crank set and derailleurs; its tires are 260-gram Clements, which are mounted on Fiamme rims. This is the combo that took the 2,500-mile Tour de France—most prestigious road event in the world—two years ago.

RALEIGH TEAM PROFESSIONAL: \$1,985

This is the bike that, in 1980, won the world's most grueling, punishing road race—the Tour de France—an event that covers 2,500 miles (including sections of the French Alps) in a little more than three weeks. The Team Professional is a custom bike, so if you want to run right out and order one, you must send Raleigh your mea-

surements, via one of their dealers.

The bicycle frame is made of the new Reynolds 731 ultra thin, light weight tubing. The requisite low-temperature silver brazing of this material is so demanding and tricky that Reynolds won't sell it to a frame builder unless he first demonstrates his proficiency.

The Team Pro uses top-line Cam-

pagnolo components; it has a six-speed rear freewheel that gives 12 speeds with its dual chainwheel. Brazed goodies on the frame include water-bottle cage mounts on the down and seat tubes, shift-lever mounts on the down tube and brake-cable stops on the top tube. The finished bike weighs in at about 20 pounds.—E. S.

Europe is still undoubtedly the hub of competitive bicycling, and, therefore, is regarded as the technical epicenter, as well. But out in Shakopee, Minn., near Minneapolis, an American metallurgical engineer named Cecil Behringer has built titanium bikes that are literally museum pieces in Rome.

A number of people have investigated titanium as a bike-frame material. If you make a quarter of a million dollars a year as a bike racer, after all, the price of exotic metals is no deterrent. Several years ago, Teledyne Corp. sought to produce welded titanium bicycles, building about 400 frames. But not only didn't the welds hold up, the high temperatures involved also made the metal brittle; the bikes were expensive failures.

Behringer, who rode in six-day bike races back in the 1930s and who is a consultant to NASA and aerospace companies for reactive metals technology, believed titanium could be used as a frame component if the joints were brazed at a lower temperature.

With his associate, Pino Morroni, who is now based in Rome, Behringer began experimenting with brazing of Morroni-machined titanium parts in a quartz/argon furnace (reactive metals can't be brazed in other than an inert, oxygen-free environment). They took some finished frames to an industrial vacuum furnace for final joining. As the result of an error in the furnace operation, nitrogen was substituted for argon as a coolant following the brazing. Two frames

were ruined, primarily because of numerous impurities, but two frames exposed only to nitrogen were found to be as stiff as steel at half the weight.

Set up as a track racer, the titanium bike weighed 10 pounds complete. A road-racing version weighed 12.

Morroni took them to Rome, where European racing hotshots hefted them and snickered in disbelief. Morroni then made a proposition: You do with your competition bike what I'm about to do with this one. He proceeded to ride the titanium bike down the famous Spanish Steps, a giant 138-step terrazzo staircase that is one of the tourist haunts of the city. The racers swallowed hard; Morroni had no takers.

Since then, the Behringer titaniums have been ridden several thousand miles in competition and time trials; they've been back and forth between Rome and Shakopee for stripping, inspection and repainting. And those incredible, feather-light frames have held together.

The nitrated titanium frames represent nothing more than an interesting experiment to Behringer, since the cost of the titanium components is so high and the effort required to work and finish them is so great. Asked what it would take to get him to build one for a customer, he just shrugs. "About \$10,000."

(Please turn to page 96)



Titanium (left) and steel bottom brackets are contrasted in photo above. At right, Cecil Behringer readies frame for inert-atmosphere brazing inside a plastic bag.



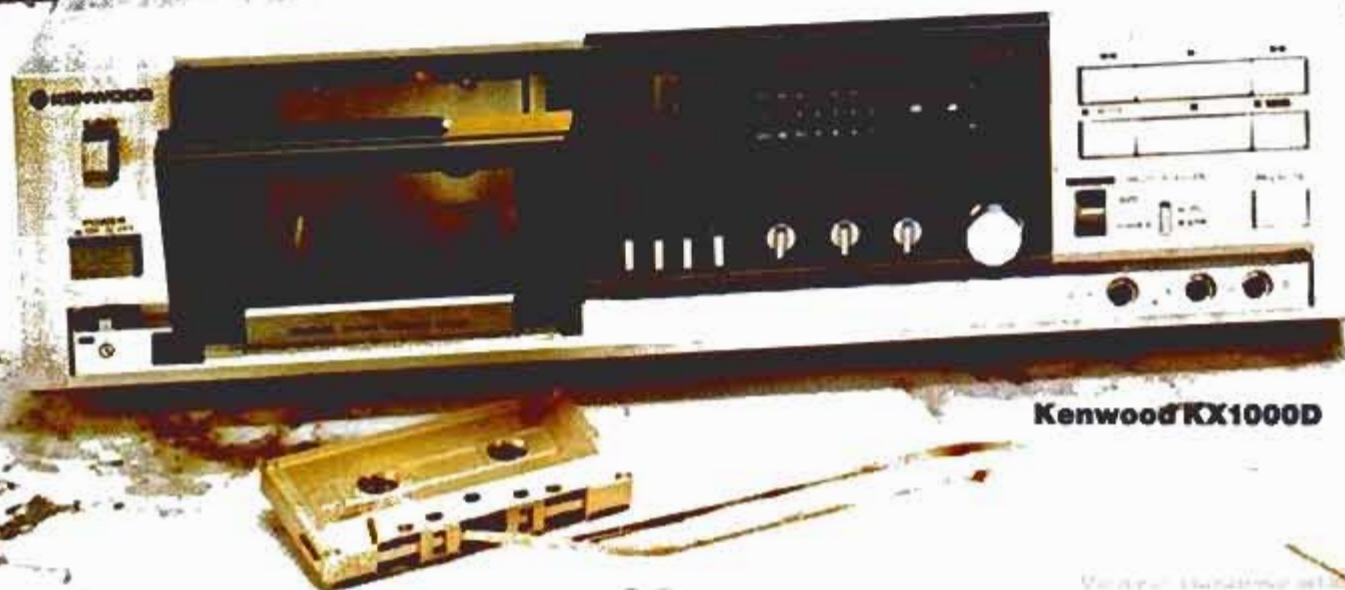
TODAY: THE GOLDEN AGE OF TAPE

Cassette decks are the best they'll ever be.
We listened to nine that sound as crisp and
clear as a fine record player.

by Christopher Greenleaf



Optonica RT5050



Kenwood KX1000D

"That sound is from a *cassette*?" Again and again, this is what professional musicians kept asking us. To test the newest in cassette decks, PM participated in a live recording session. Backstage at a large concert hall, the signals from thousand-dollar microphones passed through ultraquiet, state-of-the-art circuitry and onto tape. For comparison, the cassette decks we tested were played off against a big, professional, open-reel deck.

Does that sound like a standard test for home tape decks? We hadn't intended to cart a station wagon load of brand-new tape machines to a major New York-area stage for a live recording job. Once we'd started testing them at home, though, they were so good that this ultimate challenge became a natural. It says a lot for the state of the audio industry that the sound from each of the small

(Please turn to page 118)

The *Optonica RT5050* is a dual-mouth cassette deck—one tape bay for playback, the other for record. The *NAD 6050C* features both forms of dolby, as well as a very reliable tape transport. The *Sony TCFX-6C* unit has a record mute and a real-time tape counter. The *Bang & Olufsen 2400* features sleek styling with slide controls. The *Kenwood KX1000D* uses two-color LED meters.

NAD 6050C

Sony TCFX-6C

Bang & Olufsen 2400

PM photo: Bill Ashe

TOYOTA CELICA SUPRA

Supra is super, but owners want better stereo and tires.

"The same car made by the Germans would cost \$6,000 to \$10,000 more."

CALIFORNIA ARCHITECT

"Good handling, good power, good mileage."

TEXAS CONSTRUCTION FOREMAN



"Plastic on fender flares gets pitted from pebbles."

WEST VIRGINIA INVENTORY ANALYST

PM photos Bill Ashe

Toyota went all out to improve the Supra this year. Previous Supras had been soft, silent, six-cylinder Celicas loaded with long lists of standard equipment. The 1982 version, Toyota decided, would keep all those former attributes, but add some important new ones, notably state-of-the-art engineering, seating and instrumentation, plus vastly improved handling, braking and more distinctive styling.

What's the verdict? Has Toyota succeeded in making that great leap forward?

Absolutely. A California teacher was so delighted with his car that he scrawled, "Oh, what a feeling!" across his questionnaire and en-



Owners loved spacey digital gauge package, but found the stereo less than thrilling.

closed snapshots. A nurse from Minnesota exulted, "So far, so wonderful." A California salesman: "It's a Ferrari serviced by Toyota!"

Obviously, this is one automobile owners are happy with. Those just quoted are only a few who took the time to include notes telling us how much they like their cars. In fact, owners think so much of the Supra that a record 95 percent said they'd buy another when the time came. For a car of this type, that's a compliment indeed.

Of the owners we surveyed, 70.5 percent said that they bought the Supra because of its new styling. An Alabama drama coach rhapsodized, "This car is a work of art!" Though from the windshield back, the Supra shares its liftback body style with the four-cylinder Celica, up front it's entirely different, and people seem

"HOW CAN I
CLONE ONE FOR
MY WIFE?"

ARIZONA
MARKETING MANAGER



"Toyota really did
its homework for
this car."

CALIFORNIA AIRLINE
POWERPLANT ENGINEER

"A pain to get into
the back seat."

WYOMING REAL ESTATE BROKER

"As good an automobile
as you can buy
for the money."

CALIFORNIA OFFSET PRINTER

to love the shark nose and pop-up headlights.

The Supra's 2.8-liter, double-overhead-cam Six helped sell another 37.1 percent of our group. This engine gives the Supra a kick that's quite respectable these days, though 12.2 percent called for more power, with several people suggesting a turbocharger. Still, almost all owners seemed at least satisfied with the 145 horses that the Supra offers.

"The car's power makes for some really fun driving," beamed a California real estate salesman, and nearly everyone made mention of performance in our "specific likes" section.

The fact that many people bought the Supra because it's fun to drive is reflected in the 76.7 percent who chose the five-speed manual gear-



Dual-overhead cam, 2.8-liter injected engine has only "usable" power, owners say.

box over the four-speed automatic. Oddly enough, owners with the automatic reported slightly better gas mileage than those shifting for themselves—about one mpg more in town and 0.1 mpg on the highway.

There's no doubt that Toyota has detuned its twin-cam Six for decent fuel economy. And the fact that this engine doesn't give blistering acceleration came in for some criticism. A Missouri manager summed it up for a 12.2-percent minority in our survey when he wrote, "Needs more power." But even those who called for turbocharging and added horsepower usually made it a point to mention that what *was* there was

(Please turn to page 100)

Build A New England Stone Fence

Solid and handsome, these stone walls will stand for years. Here's how to construct one in your yard.

by Richard F. Dempewolff

Handsome, mortarless stone walls, like those that still define and terrace the land of many New England farms and homesteads, can beautify your own home and garden. All it takes is patience, an assortment of readily available tools, some old-fashioned sweat and a few sensible rules laid down by old-timers whose handiwork has survived two or more centuries.

There are three basic types of dry stone walls: free-standing, low terrace and high retaining wall. Construction techniques vary slightly for each.

A lot of arbitrary data have been published about how wide a dry stone wall should be for a given height, and whether or not it should taper from base to cap rock. Most old-time wall builders made the sides of their free-standing walls plumb, regardless of height. But the higher the

wall, the wider they built it. Actually, 8 or 9 ft. is about as high as anyone would want to go with a dry wall. Any number of such walls (mostly in barn foundations)—about 4 ft. wide from top to bottom—still stand throughout the Northeast countryside.

Except for basic plans, the old-timers worked largely by eye, using common sense, a spirit level and, perhaps, a plumb bob. Nowadays, most experts agree that free-standing dry walls 3 ft. high or less require no taper. For anything taller than that, some wall builders recommend differing slope angles for stability. The diagram on page 86 provides a reasonable slope for the sides of free-standing dry walls. Rule of thumb calls for a base that is 6 in. wider than the top for each

foot of height above 3 ft. There is no question that you'll use about one-third less rock—and less building time and effort—by tapering a high wall. And if it's properly constructed, its firmness and stability won't be impaired.

Low terrace stone walls, properly trenched and drained as shown, will stand solidly if built with plumb corners and sides. High retaining walls, also trenched and drained as shown, should lean toward the soil bank they hold in place (2 in. for every foot of height) to allow for frost heave. The base should also be wider than the top of the wall—1 in. for each foot of height—and the cap rocks should be a minimum width of 16 in.

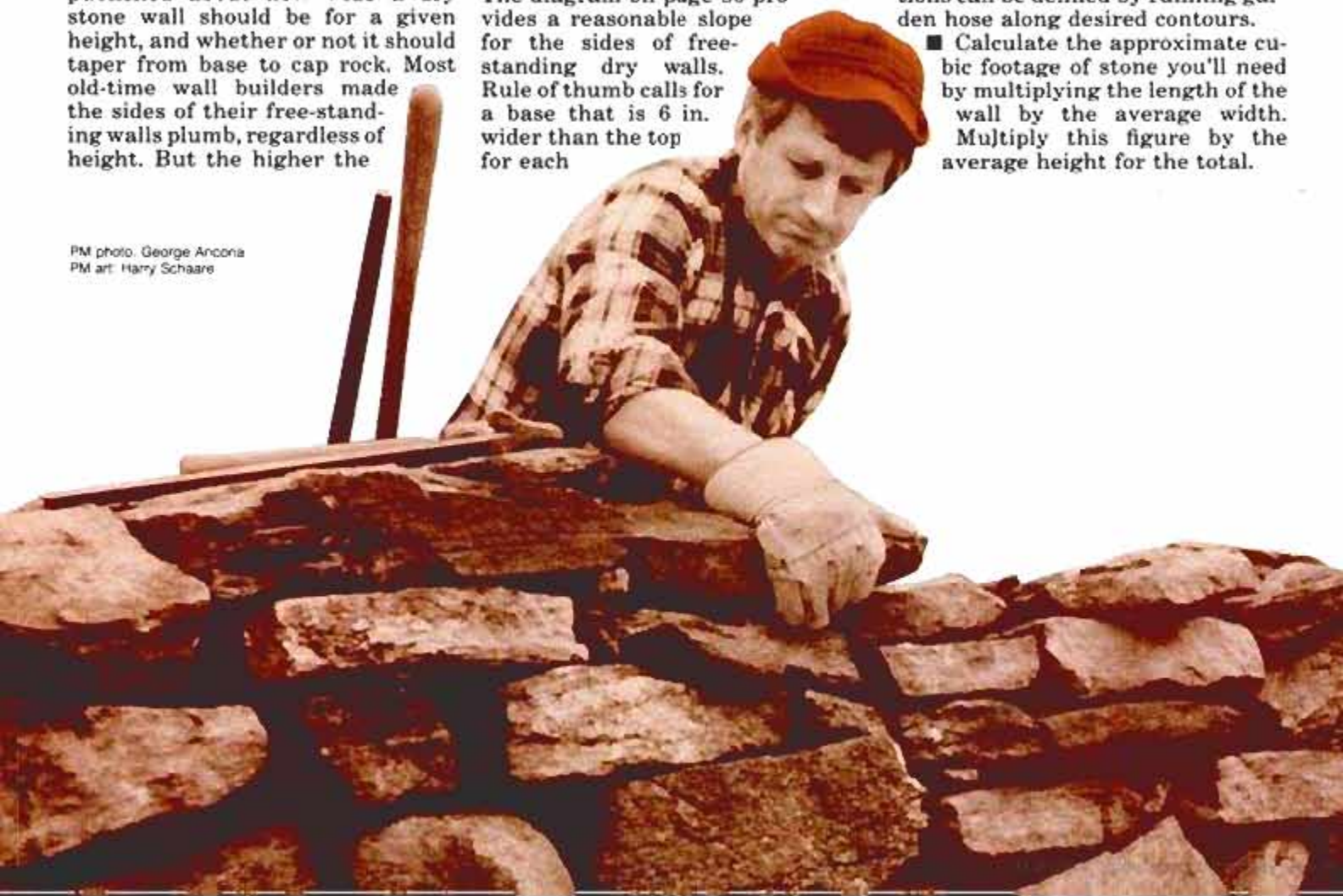
Construction tips

■ The first step is to assemble the basic tools for the job: 3-lb. sledge with one beveled edge for chipping rocks, 10-lb. sledge, pinch bar and needlebar, cold chisels, star drill, steel shims and wedges (see page 86), mason's string, 3- or 4-ft. level, a pair of sturdy gloves, safety glasses to protect your eyes when chipping the stone, and heavy boots.

■ Next, sketch a plan for the wall and lay it out on the site, as you would a building foundation. Stake the corners and string mason's line for height and level. Curving sections can be defined by running garden hose along desired contours.

■ Calculate the approximate cubic footage of stone you'll need by multiplying the length of the wall by the average width. Multiply this figure by the average height for the total.

PM photo: George Ancona
PM art: Harry Schaare



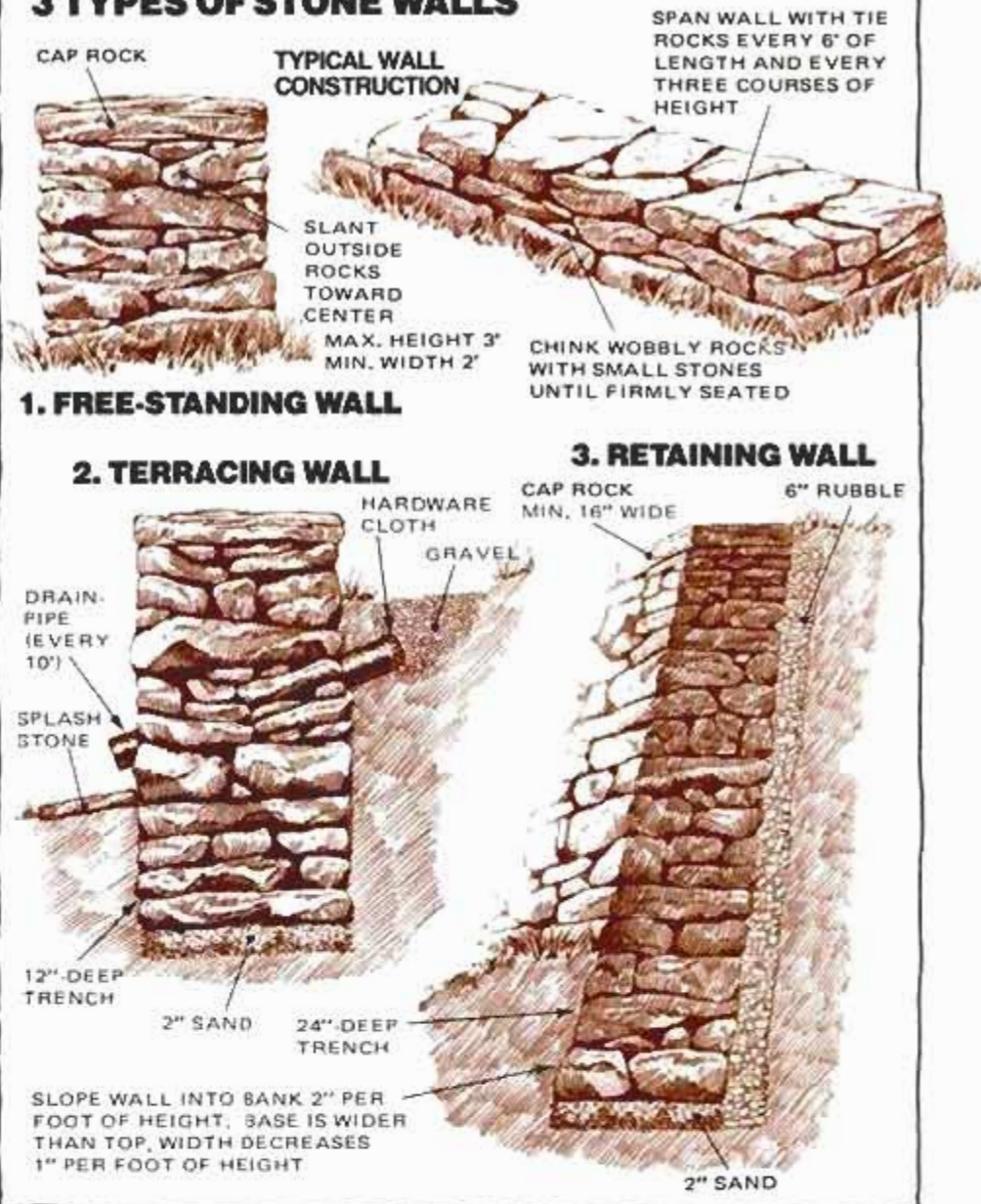
■ Nearly any kind of rock can be used in dry stone-wall construction, but some shapes, sizes and types are more adaptable than others. Angular-shaped rocks with flat surfaces are best. Rounded fieldstone can also be used, but you must chip it with a cold chisel and hammer to face and square the stone a bit so it will sit firmly in a wall. If possible, avoid this type, along with brook boulders. Igneous rock such as granite and basalt is fine, if you can find usable chunks. Large specimens that must be broken require hours of work with star drills, stone hammers, shims and wedges—not to mention trimming with a cold chisel or mason's hammer.

■ Where do you find rock? In the Northeast, if you hike through any rural or exurban woodland, you won't go far before stumbling on an adequate supply. Old potato cellar foundations, played-out quarries with piles of discards and ancient stone rows that the oxen of pioneering farmers stone-boated to the periphery of hard-won fields are all excellent sources.

Frequently, the property owner will let them go for the asking, or for a small fee. In any case, make certain you get permission from the property owner *before* removing any stone from the land.

In almost any part of the country, some commercial quarry rubble is available. And in other areas with outcrops of layered sandstone, slate or foliated schists, look for weathered slabs that have broken off and lie at the base of the rock face. These can be split easily at the seams and rough-cut into usable shapes with a

3 TYPES OF STONE WALLS



Laying up a traditional dry stone wall isn't as difficult as it looks. All it takes is patience, a few specialized tools and some hard work.



cold chisel and hammer (see top drawing at right).

■ Rock without stratification—igneous types and hard limestone—must be hand-drilled and wedged apart as illustrated. Score a line with a broad-edged cold chisel and bore a series of 4-in.-deep holes, about 8 in. apart, along it with a star drill and a hammer. Give the drill a one-eighth turn with each stroke. Insert steel shims and a wedge in each hole and tap the wedges until firmly embedded. Then whack each in turn with a 3-lb. hammer, repeating in series until a crack appears.

If further hammering doesn't cleave the rock, broad steel wedges, pinch bar and crowbar can be used to finish the job. Be careful not to drive a single wedge too hard and deep, or you'll break off a corner instead of splitting the rock down the line. (The steel wedges and shims shown in the illustration on this page are invaluable when it comes to splitting solid rock, but sometimes they can be difficult to find. If you can't get them through your local masonry supplier, contact Richard Pokrandt Manufacturing, RD 3, Box 182, Tamaqua, Pa. 18252.)

■ The most practical way of hauling large blocks to the building site is on a stone boat (see the illustration at the end of this story). The rugged, sledlike device, used by early farmers to move rock from the fields, was much larger than the one shown here. But this smaller version, held together by lagscrews as illustrated, will handle just about any rock one man would care to wrestle.

A garden tractor can haul the sled, or you can slip the tow line over the ball hitch of a station wagon or Jeep-type vehicle. Rocks up to 250 lbs. can be loosened with a crowbar and rolled aboard the low platform. And the 2x4 lip will keep the cargo from sliding or jouncing off en route to the site. (To build the stone boat, just follow the plans. You should be able to get a local blacksmith or welding shop to shoe the runners inexpensively.)

■ In selecting stone, put aside pieces with a distinct right angle for corner blocks. Large, flat slabs should be saved for cap rocks to top off the finished structure—and for step treads if you plan stairs. Large, heavy rocks make a good base; the more of these you use in the first course, the fewer you'll have to lift into position later.

■ For walls less than 3 ft. high, a shallow trench 2 or 3 in. deep,

(Please turn to page 102)

SPLITTING ROCKS

STRATIFIED ROCK

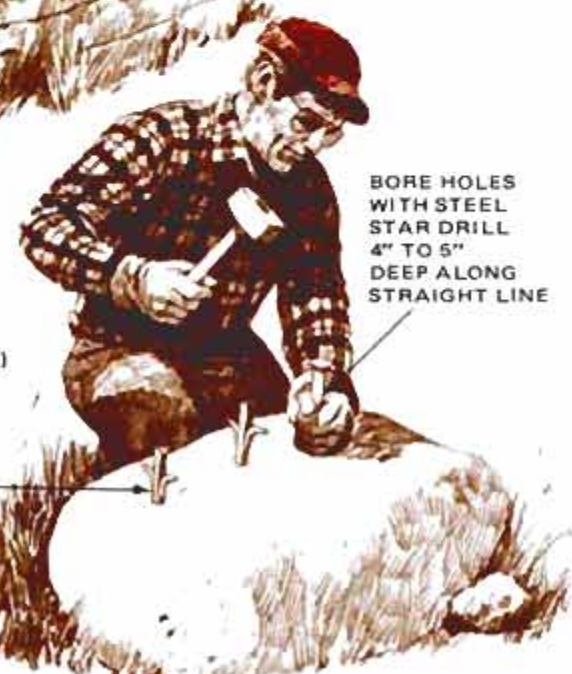
(SEDIMENTARY SANDSTONE, SHALE HARDPAN, SLATE)

DRIVE STEEL WEDGES INTO SEAMS AS THEY OPEN



DRIVE COLD CHISEL INTO SEAM

BORE HOLES WITH STEEL STAR DRILL 4" TO 5" DEEP ALONG STRAIGHT LINE



SOLID ROCK

(GRANITE, SCHIST, LIMESTONE)

DRIVE STEEL SHIMS AND WEDGES INTO DRILLED HOLES

CHECKING WALL SLOPE

NEEDLE BAR FOR MOVING HEAVY ROCKS

HOLD LEVEL PLUMB, THEN MEASURE TO ROCK EDGE FOR PROPER SLOPE

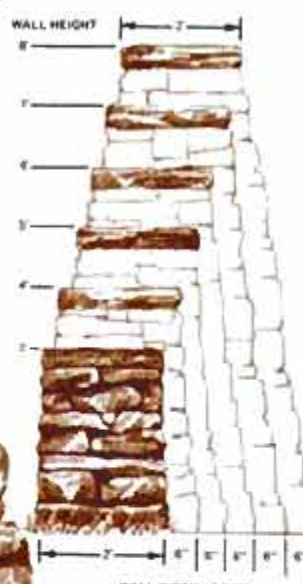
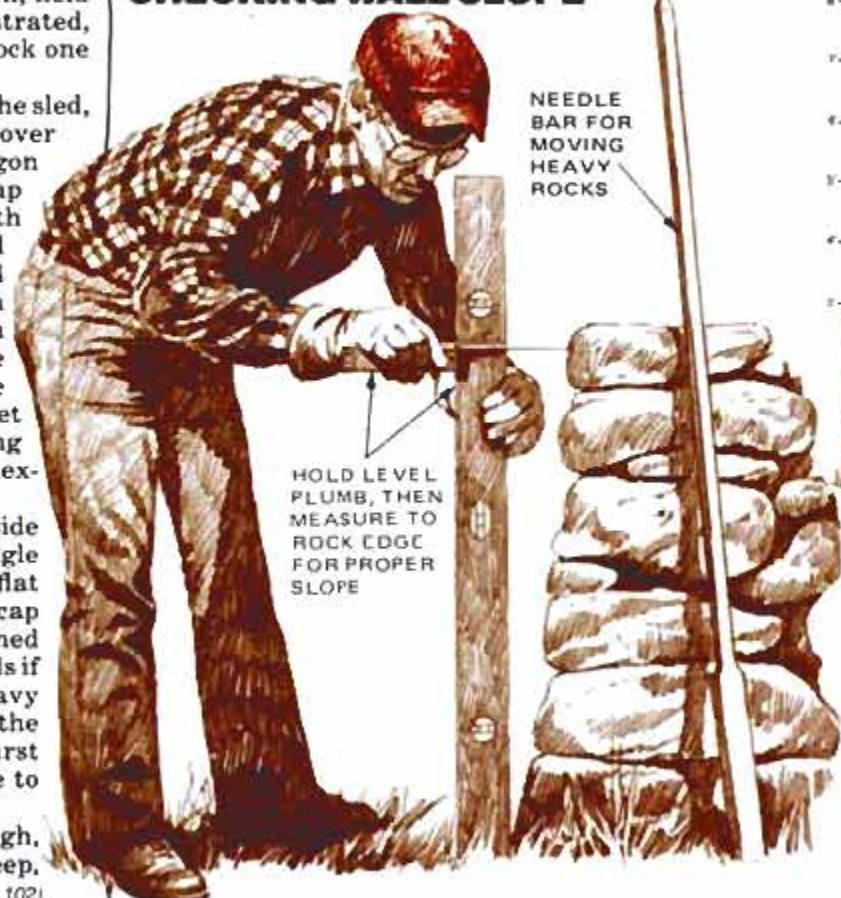
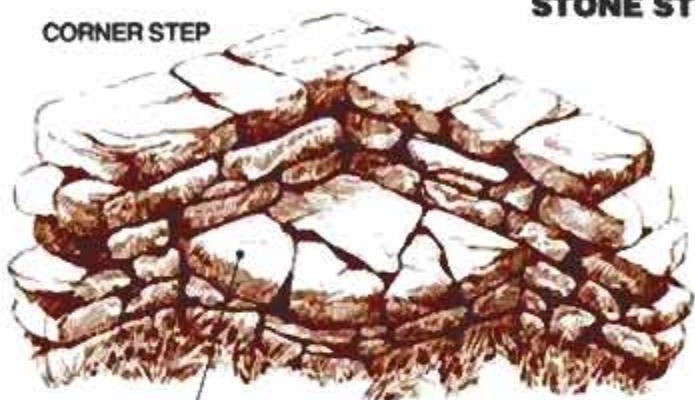


CHART SHOWS RELATIONSHIP OF WIDTH TO HEIGHT FOR FREE-STANDING WALLS OVER 3' HIGH

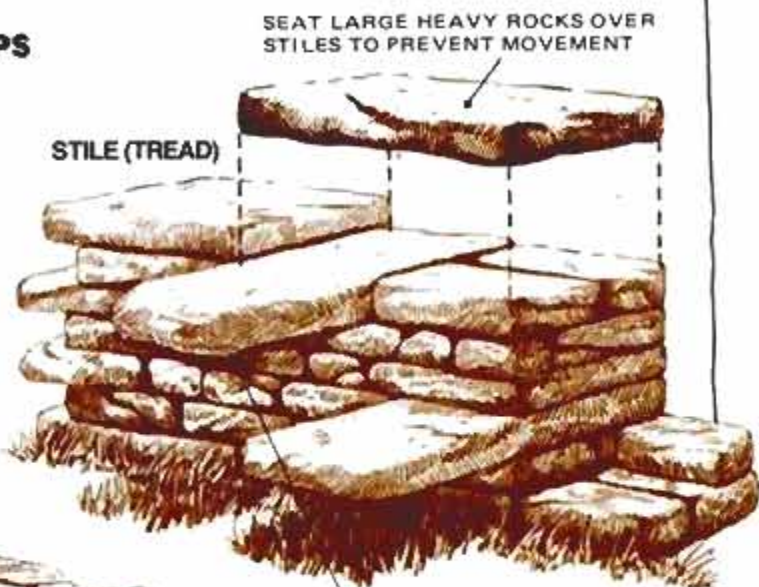
STONE FENCE—CONSTRUCTION DETAILS

CORNER STEP



MAKE LARGE TREADS OF SEVERAL ROCKS; CHINK CREVICES BETWEEN ROCKS THOROUGHLY

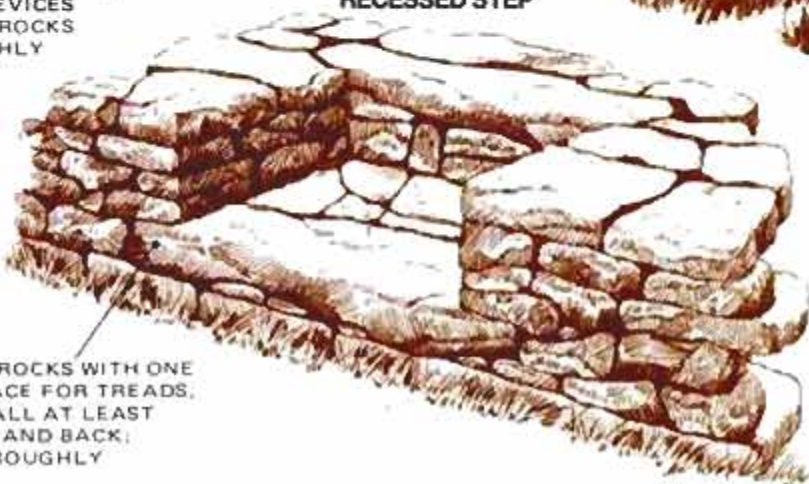
STONE STEPS



SEAT LARGE HEAVY ROCKS OVER STILES TO PREVENT MOVEMENT

STILE (TREAD)

RECESSED STEP

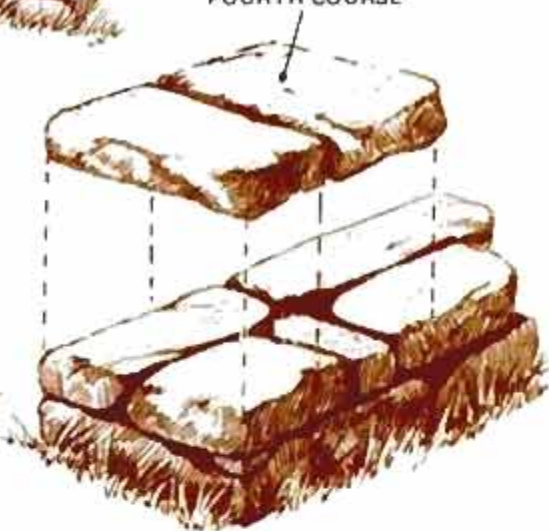
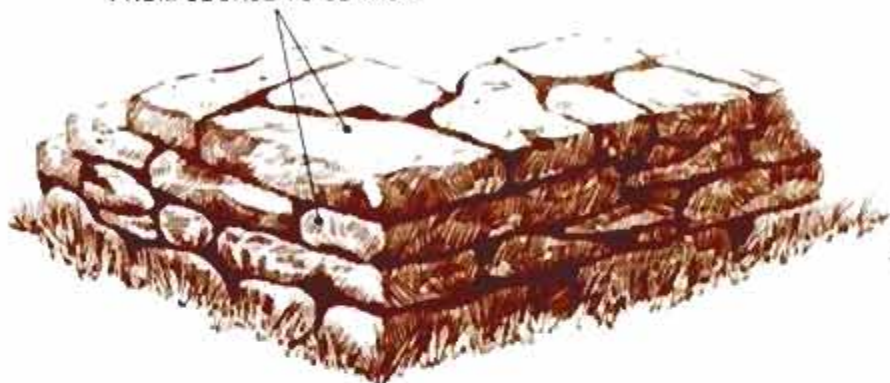


USE LARGE ROCKS WITH ONE FLAT SURFACE FOR TREADS. SET INTO WALL AT LEAST 3" ON SIDES AND BACK; CHINK THOROUGHLY

POSITION FRONT OF UPPER STILE IN VERTICAL LINE WITH BACK OF STILE BELOW; MAINTAIN 8" TO 12" RISE BETWEEN STILES

CORNER AND WALL END

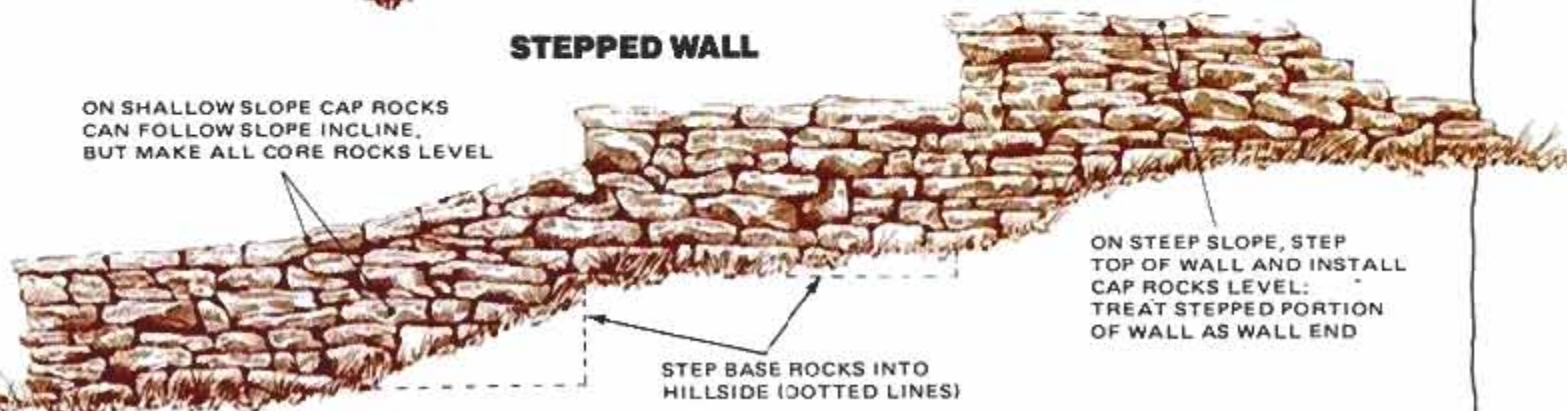
MAKE CORNER WITH LONG RIGHT-ANGLE ROCKS; ALTERNATE LENGTH DIRECTION FROM COURSE TO COURSE



BASIC RULES: MAKE ROCKS IN EACH COURSE LAP JOINTS BETWEEN ROCKS BELOW; SPAN WALL END WITH LARGE TIE ROCKS EVERY THIRD OR FOURTH COURSE

STEPPED WALL

ON SHALLOW SLOPE CAP ROCKS CAN FOLLOW SLOPE INCLINE, BUT MAKE ALL CORE ROCKS LEVEL



STEP BASE ROCKS INTO HILLSIDE (DOTTED LINES)

ON STEEP SLOPE, STEP TOP OF WALL AND INSTALL CAP ROCKS LEVEL; TREAT STEPPED PORTION OF WALL AS WALL END

A woman with blonde curly hair, wearing a brown cowboy hat, a dark patterned sweater, and purple pants, is sitting on a wooden crate in a barn. She is playing a banjimer, a hybrid instrument with a white circular body and a long neck. A horse's head is visible in the background to the left. The barn walls are made of weathered wood.

Make Music In Your Shop

What do you get when you cross a dulcimer with a banjo? A banjimer. Here's a musical instrument you can make, and instructions for playing it.

by Sam Allen

Tuned like a dulcimer and played like a banjo, a banjimer combines the sound and qualities of both instruments. So whether you strum or pick, it's a joy to play and a great source of pride to the maker.

PM photo: George Arconia

One of the most interesting and rewarding areas of woodworking is instrument building. But since it usually calls for advanced techniques, a neophyte woodworker is often left out of this exciting area. Here is a project for the beginner or intermediate woodworker that is both challenging and fun to build.

No two musical instruments are ever exactly alike. The drawing and materials list provide dimensions for an instrument of ideal construction in a technical sense. To make your instrument fit together well, you will have to adjust and fine-trim some of the dimensions, such as rounding the ends of the brace and the body end of the fret board. This is expected, and the dimensions in the materials list will allow you to do this without adversely affecting the sound or the principles of musical instrument construction.

Locating the frets

Start construction by making the fret board. Choose a piece of clear, straight hardwood for the board. Lay out the positions of the frets and the nut by carefully following the measurements given in the drawing. This is one of the most crucial steps in the construction of the

instrument. If any of the frets are in the wrong location, the notes will be off pitch. Thin down by ripping the end of the fret board that attaches to the body of the instrument. This allows clearance between the sound board and the fret board to let the sound board ring.

Use guitar tuning pegs (called tuning machines by instrument builders). Buy the tuning machines (available in pairs) from an instrument repair shop or by mail from Albert Constantine & Son Inc., 2050 Eastchester Rd., Bronx, N.Y. 10461. The dimensions of the peg box depend on the type of tuning machine you get, so buy a pair before doing more work on the fret board.

Use the machine to position $\frac{1}{8}$ -in.-dia. pilot holes for the slot and then bore them. Next, bore three holes in the edge of the peg box to accept the tuning machine. The holes in the edge are blind; they don't go all the way through the board. Use a coping saw to cut out the slot. The end of the peg box is made a little more decorative by cutting a curve in it with the coping saw. Try the tuning machine in the peg box to make sure it fits properly. Then cut the notch for the nut. The nut is a piece of hard plastic about $\frac{1}{4}$ in. thick. Use a piece of

scrap sheet acrylic or buy a guitar nut.

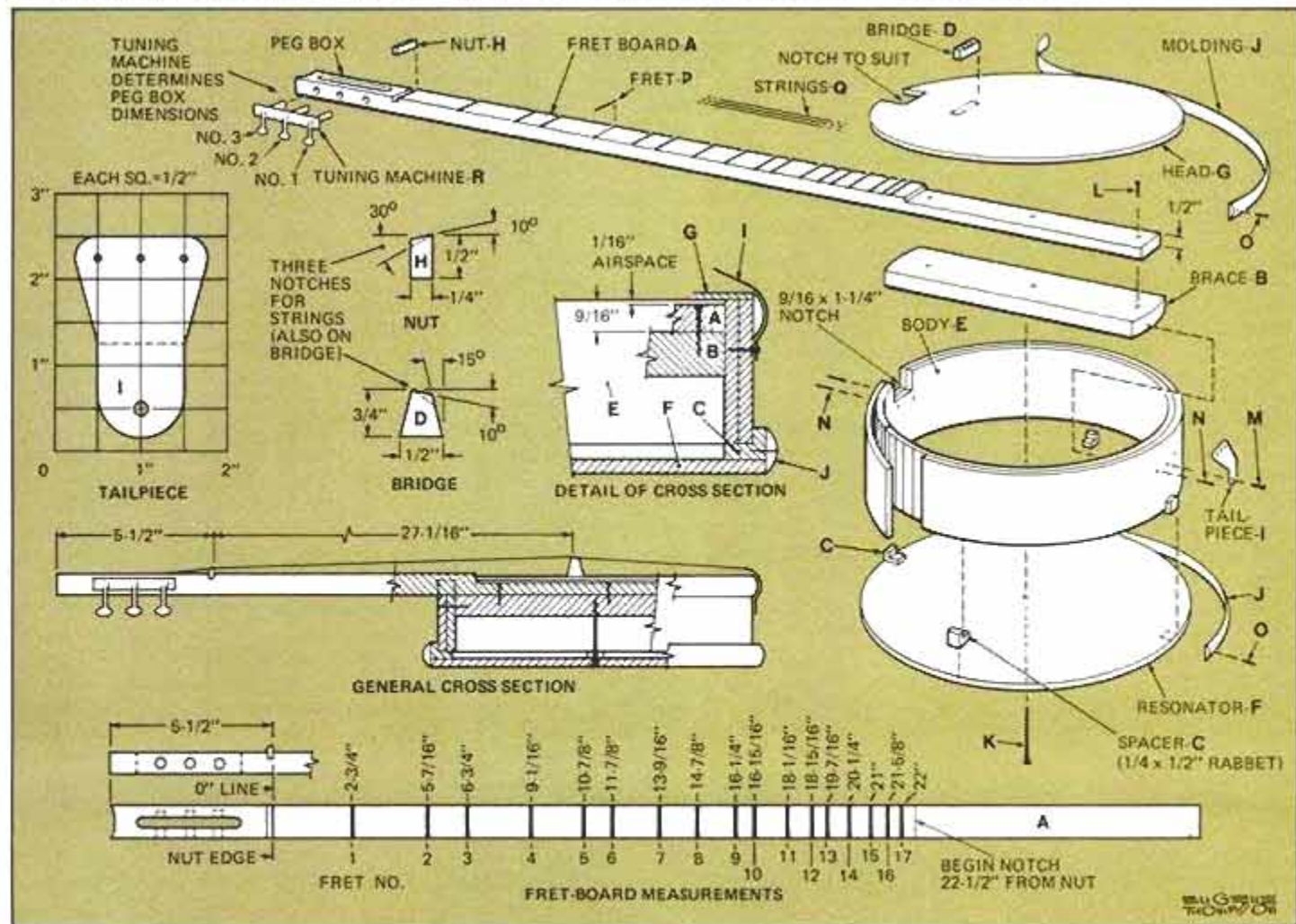
The frets are made of commercial fret wire. Fret wire has a T-shaped cross section with small barbs on the tail that extend into the wood. It requires no gluing, but the slot cut for it must be very thin. Use a coping saw or a very thin hacksaw blade to make the kerf. You can buy fret wire from an instrument repair shop or Constantine's (see materials list).

Use a file and sandpaper to round over the rear edges of the fret board. Stop the rounded edge where the

MATERIALS LIST—BANJIMER

Key	No.	Size and description (use)
A	1	$\frac{3}{4}$ x $1\frac{1}{4}$ x $38\frac{1}{4}$ " hardwood (fret board)
B	1	$\frac{3}{4}$ x $2\frac{1}{2}$ x $10'$ pine (brace)
C	4	$\frac{1}{2}$ x $\frac{1}{2}$ x $3\frac{1}{2}$ " hardwood (spacer)
D	1	$\frac{1}{2}$ x $3\frac{1}{8}$ x $2'$ hardwood (bridge)
E	2	$\frac{1}{4}$ x $23\frac{1}{2}$ x $36'$ plywood or paneling (body)
F	1	$\frac{1}{4}$ x $11\frac{1}{2}$ "-dia. plywood (resonator)
G	1	$\frac{1}{8}$ x $11"$ -dia. tempered hardwood (head)
H	1	$\frac{1}{4}$ x $\frac{1}{2}$ x $1\frac{1}{4}$ " plastic (nut)
I	1	$1\frac{1}{2}$ x $2\frac{1}{2}$ " sheet metal (tailpiece)
J	1	$\frac{3}{4}$ " x $6'$ vinyl molding
K	1	$2\frac{1}{2}$ " No. 12 fh screw
L	3	$1"$ No. 10 fh screw
M	1	$\frac{1}{2}$ " No. 6 fh screw
N	4	$1\frac{1}{2}$ " finishing nail
O	4	$\frac{1}{2}"$ brad
P	1	Fret wire, Constantine No. G36
Q	3	No. 3 banjo string
R	1	Tuning machine, Constantine No. G31

Misc.: Carpenter's glue, flat white (spray) paint, finish
 *Tuning machines are sold in pairs for \$6.95 plus shipping. A 20-piece set of nickel silver fret wire is \$3.25 plus shipping. Order from Albert Constantine & Son Inc., 2050 Eastchester Rd., Bronx, N.Y. 10461.



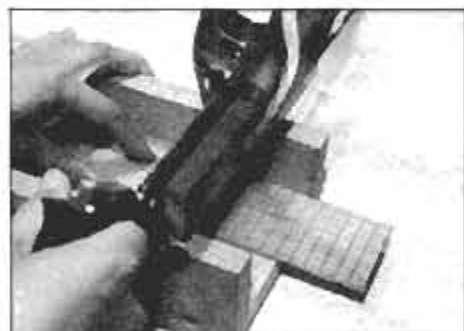


Mark the positions of the frets and nut carefully, using a combination square. This is most critical step in construction.

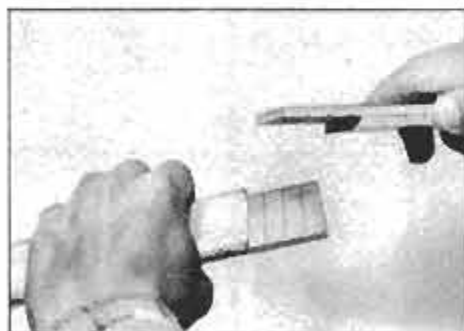


Tuning machines like the one shown here have a rigid metallic construction. The machines must fit firmly into the peg box.

You will have to use your tuning machine for positioning the peg holes accurately. Cut the slot in the peg box with a coping saw after you have finished boring the peg holes.



Clamp a wood stop to your miter saw for a 1/8-in.-deep kerf. Then use the miterbox to make kerf cuts 1/2 in. apart along entire inside length of both body parts.



Join the body parts as shown with half-lap joints and glue. Be sure that the body parts are cut to produce a fine fit before the glue is applied. Stagger the kerfs.



After glue is applied to inner sides of body pieces, wrap body unit around a circular mold, such as a 10-in. outside-diameter pot; secure with a web clamp or rope.

fret board will join the body, and just below the peg box. If you prefer, a router and rounding-over bit can also be used to perform this step.

Once all the woodworking operations are completed on the fret board, put the frets in place. Tap each fret in with a block of wood and a hammer. File the ends of the frets flush with the sides of the fret board and round them slightly so no rough edges catch your fingers.

Cut two 1/4-in.-thick strips of plywood or prefinished paneling to form the cylindrical body. The two strips will be laminated together to form a 1/2-in.-thick piece. Make saw kerfs across the width of the strips 1/2 in. apart and 1/8 in. deep to allow the body pieces to bend. Use a cylindrical object like a large pot with a 10-in. outside diameter as a mold and wrap the strips around it. Cut the strips to the exact length necessary to fit around the form and make a tight lap joint, as shown in the photo above. This may require some fine trimming. The materials list dimensions will allow for this. Stagger the kerfs in the two strips to achieve maximum strength. Spread carpenter's glue evenly on the kerfed side of each strip and place the glued sides together; clamp the strips around the form with a web clamp or a rope twisted like a tourniquet.

When the glue is dry, remove the body from the mold and cut the notch for the fret board. Make the brace and install it inside the body with glue and four 1 1/2-in. finishing nails; then, screw the fret board to the brace.

Making the sound board

The head, or sound board, is made of 1/8-in. tempered hardboard. This gives the banjimer the characteristic ring of a banjo without the complicated construction of a stretched drum head. Cut the head slightly larger than the outside diameter of the body and cut a notch to fit over the section of the fret board that extends inside the body ring. Glue the head in place and clamp it securely. When the glue is dry, file the edges of the head flush with the sides of the body.

Prefinished vinyl molding (the type used in wall paneling) is used to cover the joint between body and head. Because it is vinyl plastic, it will bend easily to the required curve. Use contact cement to secure it in place. Put a small, prefinished paneling nail at each end of the molding for additional strength.

The resonator, or back of the instrument, is made of 1/2-in. plywood or prefinished paneling. Cut it 1/2 in. larger in diameter than the diameter of the body and glue the four L-

shaped blocks in place, as shown in the drawing. The rim around the resonator is also made of prefinished vinyl molding. Use contact cement and 1/2-in. brads to attach the molding to the resonator.

The resonator takes a single screw in the center that screws into the interior body brace. The L-shaped blocks space the resonator away from the body to allow the sound to escape.

A penetrating oil finish is well suited for the fret board. It is durable and can be wiped off the frets easily. If you use varnish or lacquer, you must mask off the frets or install the frets after the fret board is finished. If you install the frets after the finish has been applied, you will have to be very careful when filing the ends flush. If you used prefinished paneling for the body, no further finish is needed. If you used unfinished plywood, you can use a penetrating finish or varnish. Once the finish has been applied to the rest of the instrument, mask around the head and spray it with flat white paint.

When the finish has dried, install the strings. Start by installing the tuning machine. Then make the tail-piece from any type of sheet metal. Cut it out, using the full-size pattern in the plans and attach it to the end

(Please turn to page 104)

WORKSHOP MINICOURSE

STEEL CORRUGATED NAILS

Last semester when a student in my adult education woodworking class brought up the subject of steel corrugated fasteners, I was surprised to learn that these handy pieces of hardware were unfamiliar to many in the shop.

Frequently referred to as "wiggly" nails, steel corrugated fasteners are a perfectly valid woodworker's tool—when used for the proper job. You wouldn't turn to them to close the joints on a fine walnut Pembroke table, of course, but you certainly should consider them for out-of-sight applications within the strength limits of the nails.

For example, corrugated fasteners are commonly used by professionals to strengthen glued miter joints. It makes sense to use these fasteners on all four corners of a picture frame, for instance, because the nails are out of sight when the frame is hung on the wall. With them, you wind up with a strong miter joint—which would be a weak joint without the wiggle nail (or other form of reinforcement).

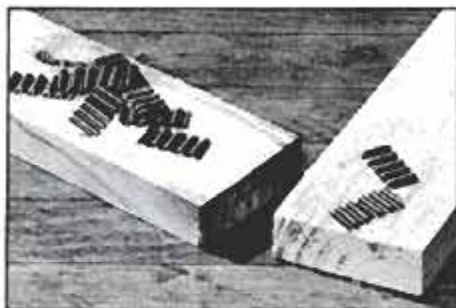
How they are sold

The nails are available in widths of $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{8}$ and 1 in. This dimension refers to the width shown (as A) in the photo at top right. Many hardware stores stock the type with one edge filed to a sawtooth configuration. These are for use in softwoods such as pine. If you plan to use corrugated fasteners in hardwoods, you will have to lay in a supply of the plain, non-sawtooth-edge nails. If you are an active woodworker, you should have both on hand.

Corrugated fasteners are made in two styles: One has the ridges running parallel; the other has two sets of ridges running at a very slight angle to each other. (If you carefully study the photo at the upper right, you will see this convergence.)

The nails with the angled ridges are designed to compress the joint because the ridges are closer together at the top than at the base (teeth). Thus, it is obvious that as the nail is driven, it will help to draw the two members toward each other.

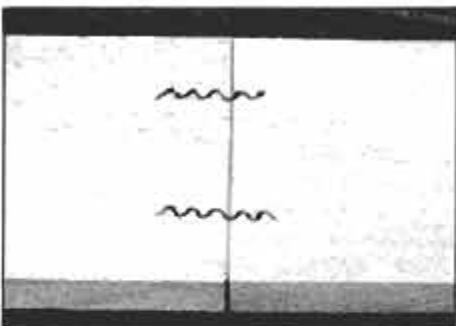
There is a small tool available that makes driving these nails especially easy. It is an oblong-shaped device with a sliding, free piece of steel inside. The sleeve is placed over (around) the corrugated fastener



Steel corrugated nails are used extensively by furniture manufacturers when two surfaces in the same plane are edge-joined. Often called "wiggle" nails, they are available in several different widths.



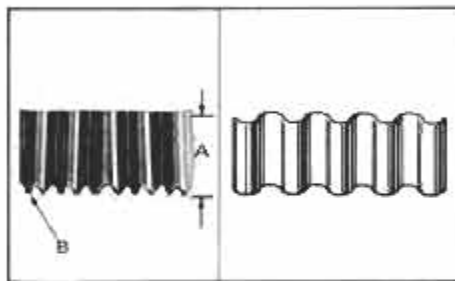
Hold butt-joined boards securely together—with clamps if necessary—while you drive wiggle nails. Author prefers to start one end in one board, as here.



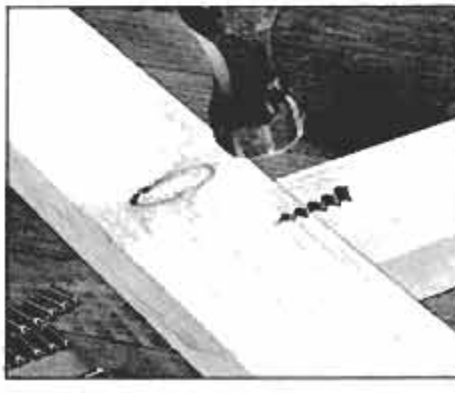
Though steel corrugated nails can be used to butt-join two boards, end-to-end, this is a weak joint unless it is beefed up (such as supported by a backup board).

and the loose bar is struck with a hammer to drive and set the nail. All hardware stores may not stock this handy gadget, but the one that I own is made by Stanley Tools.

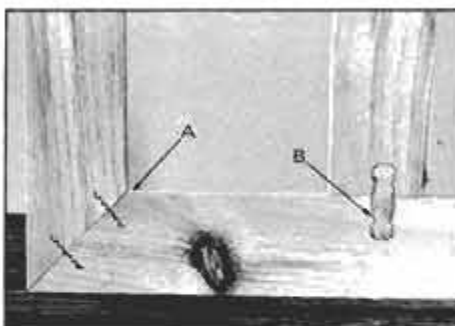
Another type of connector that you should be at least familiar with is the Scotch Connector shown in the photo at right, above. This type has eight very pointy nails—four on either side of the wasp-shaped bar, which straddles the joint. **FW**



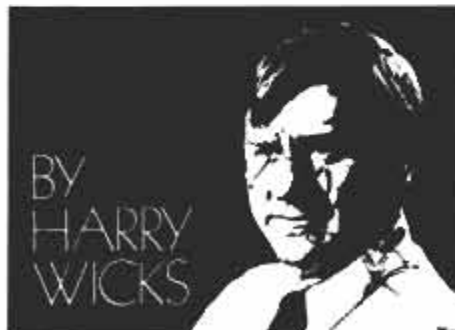
The designated size of a nail, $\frac{3}{8}$ in. left, pertains to nail width (A, in the above photo). This one has a sawtooth edge and is for use in softwoods. Corrugated nails for use in hardwoods have a plain edge, as shown in the drawing on the right.



Then, the other end is tapped into the second board and the nail is driven home, using straight blows. As is the case with an ordinary nail, a corrugated nail will bend if it is struck improperly.



Typical use for wiggle nails: A, to strengthen a miter joint. Fastener in B is called Scotch Connector and works like a charm. Glue should be used with both types.





This handsome piece of furniture—made of solid pine—easily converts from a table to the bench shown here; simply tilt back the tabletop.

Build PM's Hutch Table

Use this versatile piece of furniture as a table or a bench—and there's storage beneath the seat.

by James R. Berry

The hutch table has so many attractive design features that if it hadn't been developed in Europe in the 1600s (and brought to the United States in the early 1700s) it would have been invented here.

No other piece of furniture is quite

as versatile. One moment, our version can be used as a dining table—with ample room for six—and the next, as a cozy, two-person bench with a large storage area under the seat.

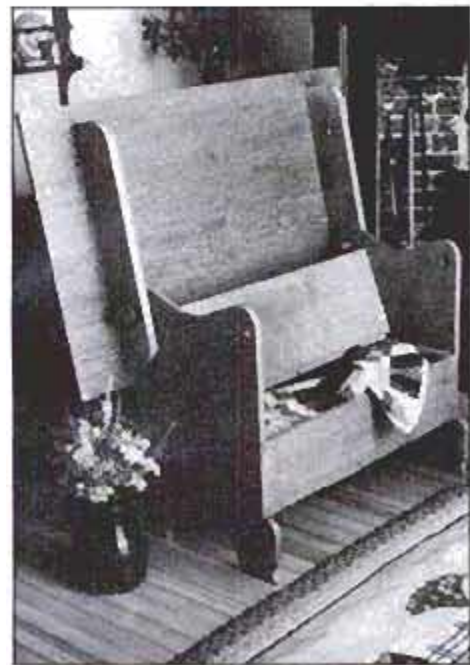
The table featured here is a reproduction of an early design, measured from an antique. If you want to duplicate it, just follow the plans and instructions on these pages.

Table sides

Begin building the table by edge-joining enough stock for both table sides. Use glue and $\frac{3}{8}$ -in.-diameter dowels, and clamp both assemblies overnight.

Next, lay out the arcs on each side by drawing a series of circles with a compass and pencil, starting with a 5-in.-radius circle along the bottom edge. Because the center point falls precisely on the edge, temporarily tack-fasten a small block to support the compass point.

Move to the top side corners and draw the 2-in.-radius circles shown on the drawing. (This is also a good time to locate the center points for the hinge peg holes. Measure down $2\frac{1}{2}$ in. from the side's top edge and



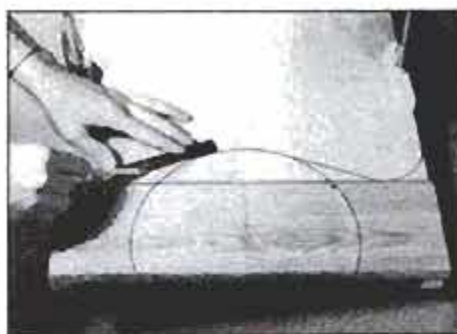
Large storage compartment, ideal for extra bedding (above), is nearly undetectable with the lid closed (above right).



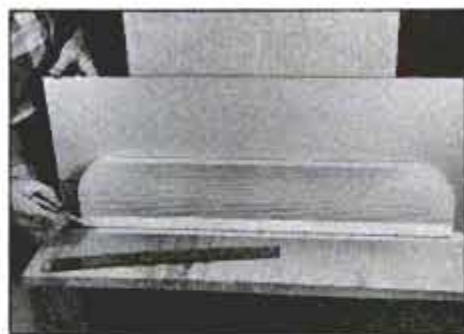
1 Lay out arc on bottom of each side using a compass. Because the circle's center-point falls on the board edge, add block.



2 Make cut with sabre saw and pivot guide. Apply tape to cut line and support waste with clamp to prevent splintering.



3 Top of side has three arcs. Draw outside ones first, then the middle one. Connect them with tangent lines. (See text for jig.)



4 To avoid having to sand pencil marks, apply masking tape to stringer and tabletop, then mark screw locations on tape.



5 Prebore screw holes in leg wing, then cut concave arc with hole saw. Block clamped to wing provides center for saw.



6 After both panels are joined to sides, bore hinge-peg holes. Use Portalign tool or other drill guide to ensure accuracy.



7 To make hinge pegs, bore dowel holes in larger dowel and wooden door pull, then join the two with smaller dowel and glue.

1½ in. in from the side edge and mark the intersection. Do this for both corners, then bore ¼-in.-diam. holes through these points. Do not enlarge the holes yet.)

Next, draw the 5-in.-radius arc between the two circles as shown. Because the arc's center point falls 3 in. off the board's surface, you'll need to make the simple jig shown in photo No. 3. Just nail a ¾ × 5 × 28-in. board to two ¾ × ¾ × 18-in. "legs,"

MATERIALS LIST—HUTCH TABLE

Key	No.	Size and description (use)
A	2	1½ × 5 × 23" pine (stringer)
B	1	¾ × 29 × 48" pine (tabletop)
C	2	¾ × 17 × 28" pine (side)

D	2	¾ × 8 × 34" pine (panel)
E	1	¾ × 15½ × 32½" pine (bottom)
F	1	¾ × 10¾ × 32½" pine (seat lid)
G	1	¾ × 7¼ × 32½" pine (seat)
H1	3	¾ × ¾ × 32½" pine (cleat)
H2	4	¾ × ¾ × 15½" pine (cleat)
H3	4	¾ × ¾ × 5¾" pine (cleat)
I	4	¾ × 1½ × 6¾" pine (leg wing)
J	4	1½"-dia. wood door pull
K	4	1"-dia. × 3" dowel
L	4	½"-dia. × 1½" dowel
M	2	¾ × 3" hinge
N	4	2" No. 10 fh screw
O	20	1½" No. 10 fh screw
P	51	1¼" No. 10 fh screw
Q	24	Dowel plugs

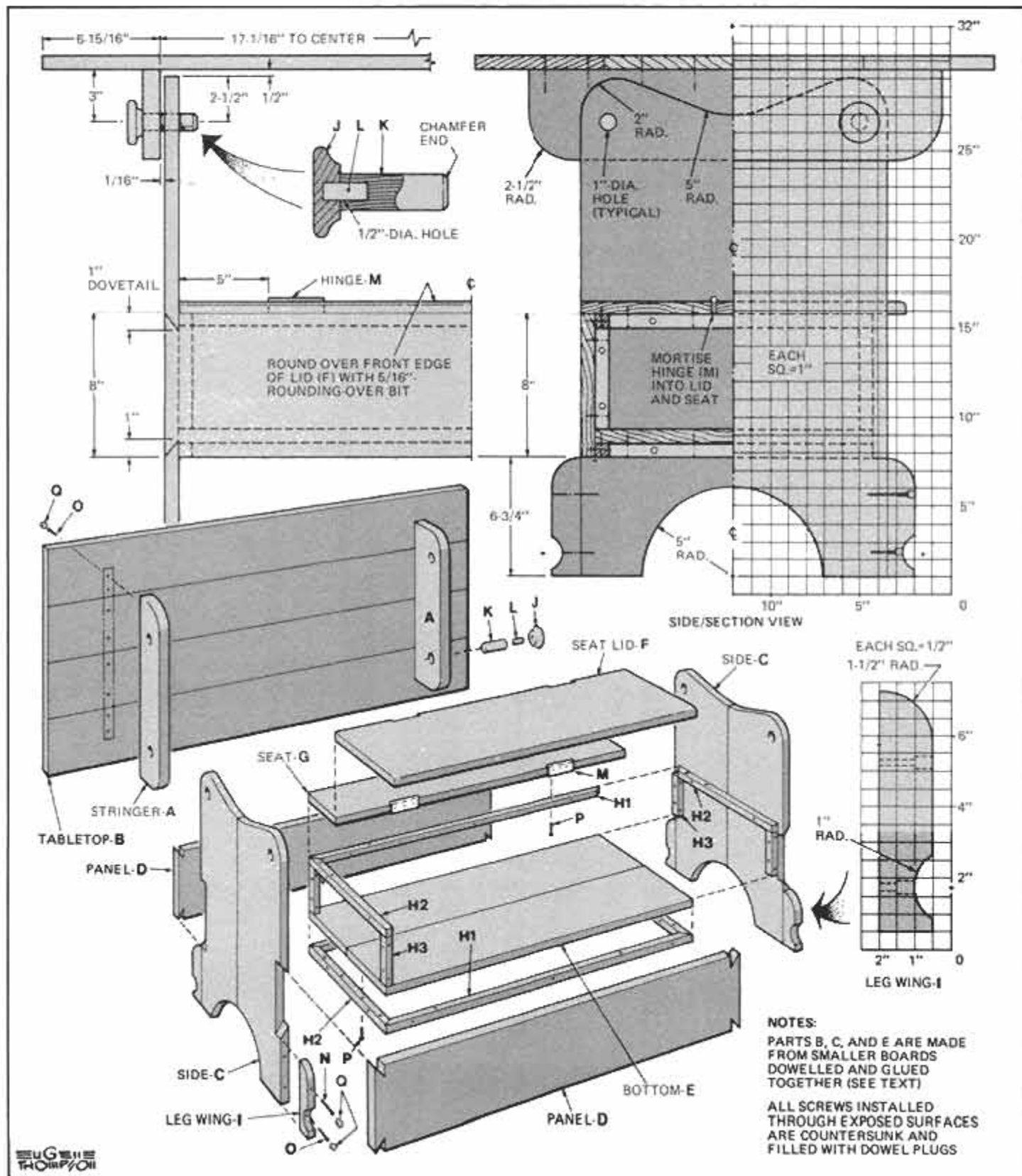
then simply clamp the legs in place.

Join the three arcs with tangent lines, then bore a blade entry hole and a sabre-saw pivot guide hole in the jig.

Cutting these curves with a piv-

(Please turn to page 98)

*Constructed from four 1 × 8s, each 48" long



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SUPERBIKES

(Continued from page 79)

was a recent estimate. For about \$2,700, he will build, on special order, a nitrided steel bike. "It's usually for some heavier rider, a guy trying to win a sprint championship," says Behringer. These frames don't weigh too much more than track-version titaniums.

But the bulk of Behringer's business (really more of a hobby combined with technological research) is in his finely machined and painstakingly brazed steel frames. For about \$600 (with fork), they can be assembled into racing or touring bikes with another \$1,000 or so put into top-grade components; finished, they weigh about 16 pounds.

At the moment, Behringer is back ordered. "I figure I make about \$3 an hour building them," he says.

A typical Behringer frame fits so precisely that the brazing material (metal powders mixed with petroleum jelly) must be injected into the joints with a hypodermic needle. Lugged subassemblies are then placed into the central tube of a quartz furnace (see photo, page 78). Heavier-than-air argon gas is pumped in from below, evacuating the oxygen and atmospheric impurities, before the furnace rheostat is touched. "Under a special light," Behringer told us, "you could see the argon flowing up just like water."

For final assembly of a frame, the heat is supplied by electrical resistance of the frame itself. With electrodes attached on either side of the joint to be finished, the entire frame section is placed in a plastic bag, which is evacuated by pump and filled with argon. The process is repeated several times to assure that no reactive gases remain. The extremely high-amperage current is turned on and the joint is brought to brazing temperature, then cooled. He does this for each frame joint.

State of the art

Behringer's background as a racer and his close affinity with contemporary competitors keep him on the cutting edge of bicycle technology. Interrupted by the occasional NASA metallurgy symposium, or other consulting chore, he gets to his shop whenever he can to try something new. Recently, it was an aerodynamic-shape frame—like the Lotus's—for a customer in Cleveland. Like other custom frame builders, he has little regard for the mass-produced product. "Too many Americans," he says, "are trying to ride bikes that don't fit them."—Robin Nelson

PM TESTS BIGGEST OUTBOARD

(Continued from page 68)

bottom-center on the wheel keys radio transmission for the crash-helmet microphone. Clamped to the wheel is the speedometer, which starts reading above 60 mph. Behind is OMC's great new tachometer, with steady digitals up to 10,000 rpm. Toggle switches control starter, fuel boost and engine height on the transom. A kill switch is attached to your life vest by lanyard. The right foot pedal is the throttle; the left trims the engine "down."

Unless you flight-test 100-mph tunnel hulls every day, you'd better

the engine acceleration, minimal porpoising, and now the tunnel hull skims as if on tracks, with the steering geared to control torque.

"It's trimmed out for around 100," Jimbo had told me. (100 mph!) I push the throttle, and the amazing thrust shoves me back in the seat, as the speedometer surges from 90 to 110. I carefully back down to 100, at 7,020 indicated rpm, and probably 3,000 more to spare. "I'm sold," I radio Jack Leek and the pit crew.

Buying one would probably cost \$18,000 to a qualified racing team. That's a lot for an outboard, but there's never been one like it. And now OMC marketing vice president



Prop-walking, with the hull flying clear, the world's most powerful outboard shows the thrust that also should make it the fastest for closed-course racing and marathons.

get OMC's chairman, Charles Strang, to assign his high-performance-engineering pit crew to check you out with his latest creation. Then suit up in a high-collared Life-line racing vest with drogue 'chute and thigh-patch straps that slow you down if the boat cartwheels and you bail out in midair. In the tiny cockpit you attach helmet radio, kill switch and parachute static lines.

Away from the launching ramp, the new V8 starts instantly in gear with a muted roar and I idle out into a sheltered canal near Outboard Marine's Stuart, Fla., test station. First, slow runs give a feeling for the boat and steering. Then I line up, ease throttle, and suddenly I'm on plane and skimming. The shore flashes by, but apparently the speedometer is not hooked up. A slow turn and up to speed again for a run back down the straightaway. Suddenly, the speedometer starts climbing and I realize that before I'd only been idling along below 60 mph. Now readings slide quickly past 70 and 80. There are no rough spots in



Emergency litter and stop-watch clipboard are vital as project engineer Ric McChesney checks runs from crash boat.

Ron Ingram has announced that a Wellcraft Scarab will race offshore with two this summer. Production V8 models may be on the way. **PM**



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BUILD PM'S HUTCH TABLE

(Continued from page 94)

ot guide will assure the best cut and the least sanding later.

Also, bore a pivot guide hole in the bottom support block and cut out that are similarly. Finish-sand all curves with a drum sander.

Front and rear panels

Cut the front and rear panels to size, then lay out the pins of the large dovetail joints on the panel ends. Cut the panel ends, then carefully trace the resulting shape onto the table side edges. Use masking tape and orientation marks to label which end goes where.

Cut the socket of all four joints and then carefully fit the panels to the sides, using fine-grit sandpaper. If you don't have experience cutting dovetail joints, it's worthwhile to practice first on some scrap to perfect your technique.

Dry-assemble the four parts and clamp them in a square position. Tack-nail a temporary diagonal brace across the top edge of the front and rear panels. Now measure the exact dimension between the sides and the panels, and cut the cleats (parts H1, H2, H3) to matching sizes.

Next, bore and countersink screw clearance holes in all the cleats as shown on the drawing. Note that cleats H2 only have two holes bored in their top edges. These will be used to fasten the stationary rear portion of the seat. The front lid is movable.

Disassemble the table, then reassemble it with glue. Check for square, then reinstall the diagonal brace across the top edge of the panels and add one across the bottom edges, in the opposite direction.

When the glue is dry, remove the clamps and braces and install the upper cleat on both sides of the table and the rear panel. The front panel does not need an upper cleat.

Next, cut both portions of the seat to size and check for fit. The rear portion should abut the sides tightly; the front board should have $\frac{1}{8}$ -in. clearance on each end ($\frac{1}{4}$ in. overall). Once you're satisfied, mark the hinge positions and remove both boards.

Mortise the edges to accept the hinges, then install the hinges on both boards and carefully slide this assembly into place. If both still fit properly, unscrew the front board and set it aside. Install the back portion permanently by turning screws through the cleats into the underside of the board.

Install the vertical cleats in simi-

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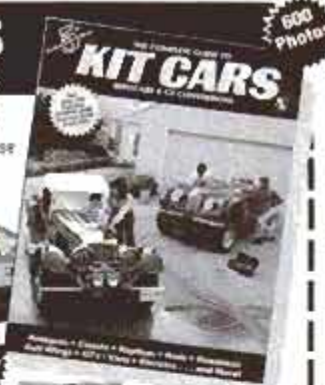
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lar fashion, then glue up stock for the compartment bottom. When it is dry, cut it and fit it into place. Install the lower cleats around the bottom and attach.

Tabletop and stringers

Begin making the tabletop by doweling and gluing up stock to the size given in the materials list. I used four 1x8 boards and made every effort to avoid portions of the boards that were cupped or twisted.

When the top is dry, place the poorer side down on the bench and invert the rest of the table assembly on top of the better side. Center the assembly, then place a stringer against each side with a 1/8-in. spacer between. (A scrap piece of plastic laminate is perfect for this.) Apply masking tape to the outside face of both stringers and to the tabletop underneath the stringers. Then mark the position of the attaching screws. (See photo No. 4.) Allow two screws per board of stock that was glued up to make the top.

Next, counterbore the clearance holes in the tabletop and the pilot holes in the stringers. Install the screws and conceal the heads with dowel plugs.

Invert the top once more, slide the table assembly between the stringers and mark the position of the hinge peg holes. To do this, slide 1/2-in.-thick shims between the tabletop and the top of the sides. Then insert a finishing nail into the 1/8-in.-diameter holes that were bored earlier in the table sides. Tap the nail with a hammer so it leaves an impression on the inside of the stringers. Remove the assembly and bore the hinge peg holes in the sides and the stringers.

Next, assemble the hinge pegs as shown in photo No. 7 and make sure that when installed, the top works well.

Cut the leg wings to size and shape and install them, then reinstall the movable lid and the assembly is complete.

Finish-sand the whole piece in a 120-, 150-grit progression, dust between sandings, and wipe clean with a tack cloth to finish. Then apply the finish of your choice to complete the project.

The piece shown was first rubbed with a thick application of Minwax (Early American) then, after 24 hours drying time, rubbed with 4/0 steel wool. After wiping with a tack cloth, the table was finished with Minwax Antique Oil Finish. **FM**

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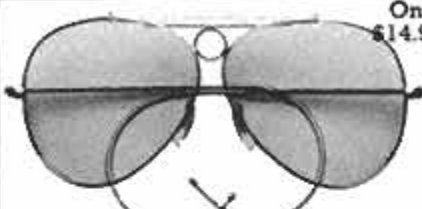
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OWNERS REPORT: CELICA SUPRA

(Continued from page 83)

enough; they just wanted more to play with.

The owner of a Florida auto-painting franchise praised the Supra for its "usable performance." Usable seems to be the key. There's not enough brute strength to make the Supra a stoplight drag star, but there's plenty to make it an exciting car to drive, as well as a practical one in terms of gas mileage.

Many of the owners surveyed claimed to be auto enthusiasts and a good many confessed to looking at other performance and handling machines before choosing the Supra. A Texas personnel manager mentioned, "I checked out the Mazda RX7, Datsun 280ZX, Camaro, Firebird, Mustang, Audi Coupe and Porsche 924 and concluded that the Supra was the best car in this class on the market."

A Minnesota video distributor, whose family also happens to own a 280ZX, noted, "I looked at all the '82 cars, including the new Z28 and Trans Am, and found the Supra a better buy, with more room and more options."

Price, of course, had to enter the buying picture, and while the Supra isn't an inexpensive car, virtually no one complained.

One reason owners consider the Supra such a good value is its overall quality and workmanship. Workmanship, in fact, was rated *excellent* by 85.8 percent of the owners we questioned. A Michigan human-resources manager wrote, "It's a beautiful sports car with unbelievable standard equipment at an exceptional price. I've carefully tried to locate any and all quality flaws; I'm still searching."

An electrical inspector from California added, "Fit and finish are flawless. This car just *drips* quality." An Illinois service supervisor: "I can't find a stitch out of place."

However, 4 percent of our respondents noted problems with paint chipping on the fender flares. One Supra owner said he'd even tried mudflaps to stop this problem. A Florida banker explained it this way: "The paint on the plastic fender flares doesn't seem to adhere, especially at the rear, where sand and grit from the front tires chip away at the finish."

On the topic of dealer service and the need for repairs, only 22.0 percent of our owners reported mechanical difficulties of any sort. And they were all minor—a fairly even split between wheel alignment, high-speed vibrations and cold-starting

problems. Not surprisingly, only 4.1 percent attempted to repair the trouble on this mechanically sophisticated car themselves.

Dealer service departments were rated *good to excellent* by 82.2 percent of the owners we queried, with only 5.3 percent giving a mark of *poor*. That's a very good showing.

When asked their opinions of the Supra's overall comfort, owners reminded us that the Supra is no family car, nor was it designed as one. Yet most gave the front seats considerable praise, particularly the



This handy, console-mounted map light is one of many clever touches that abound.

driver's new eight-way adjustable bucket. Both front seats look alike, but the driver's seat back has a triple-air-bladder lumbar support whose pressure can be controlled with a bulb-type hand pump (like the pump on a blood-pressure cuff). This, plus hip-hugging wings and adjustments for thighs and height, make the Supra seat one of the car's great talking points.

A California physicist, in fact, warned us, "My Supra was broken into by professional thieves. Luckily, all they took were my front seats, but I believe this might be a problem for Supra owners in the future."

Handling scored as a major factor in Supra purchase decisions. The car's all-independent suspension, its rack and pinion steering and well-chosen spring rates all converged to make this a satisfying handler.

A fairly common and unexpected complaint was Toyota's choice of tires for the Supra. The problem showed up most graphically during winter. "The standard tires that came with our car," explained an Ohio homemaker, "were Dunlop's 'racing' type and were nearly useless in snow. Toyota wouldn't do anything about it, so I personally bought a set of Dunlop GT Qualifiers; now I'm quite satisfied."

And an Alabama salesman and former racing champion (Solo I and

II) noted, "The Supra doesn't seem to have its feet on the ground like the 280ZX. The problem could be solved with stickier tires and a little softer rear suspension."

Another area of controversy had to do with the Supra's standard sound system. Some people loved it, others didn't. "Very good stereo system with built-in power booster, graphic equalizer and five speakers," observed a California telephone assigner. However, another

Californian, a computer technician, grumbled, "Stereo speakers are very poor."

But these were all minor complaints compared to the glowing praise that owners heaped on their Supras. The final summation comes from an Illinois designer of aviation test equipment. He wrote on the back of his questionnaire: "A lot of thought went into the design of the Toyota Supra. Everything is well laid out to make it a driver's car,

which was one of my main reasons for choosing it. I enjoy driving and believe a car should be for more than just transportation. Cars, notably sports car racing, have been my hobby for over 20 years. I don't race now—I've 'retired' to officiating—but I mention this to point out that I investigate a car thoroughly before I buy. My purchase of the Supra was no quick decision. I consider the Supra an excellent car and a fine value; I'm pleased to be seen in it." **RM**

SUMMARY OF 1982 TOYOTA CELICA SUPRA OWNERS REPORTS*

Total miles driven	1,535,003	Comfort 29.3	Average 2.0	Average 12.6
Average miles per gallon:		Economy 19.3	Poor 0.3	Poor 5.3
Automatic transmission		Specific dislikes:	Comfort opinion (rear seats):	Number of vehicles owned:
In town..... 21.6		No complaints..... 38.0%	Excellent..... 10.9%	Supra only..... 32.0%
Long trips..... 27.3		Disappointing standard stereo..... 8.0	Good..... 39.1	Two cars..... 44.3
Manual transmission		Tire quality..... 6.7	Average..... 35.0	Three cars..... 15.2
In town..... 20.5		Not enough power..... 5.5	Poor..... 15.0	Four or more cars..... 8.6
Long trips..... 27.2		Paint chips too easily..... 4.0	Had any mechanical trouble?	Makes of other cars owned:
Transmission choices		What changes would you like?	No..... 78.0%	Toyota..... 30.2%
Manual five-speed..... 76.7%		No changes..... 13.1%	Yes..... 22.0	Chevrolet..... 15.1
Automatic..... 23.3		More horsepower..... 12.2	What type of trouble?	Cadillac..... 12.9
Why did you choose the Supra?		Better seat shape..... 6.6	Wheel alignment..... 9.3%	Oldsmobile..... 10.8
Styling..... 70.5%		More headroom..... 6.2	High-speed vibrations..... 9.3	Ford..... 9.5
Performance..... 37.1		Better stereo..... 5.6	Poor cold starting..... 8.0	Age distribution of owners:
Handling..... 18.1		Workmanship opinion:	Dealer repairs satisfactory?	15-29 years..... 27.6%
Economy..... 11.7		Excellent..... 85.8%	Yes..... 73.4%	30-49 years..... 59.1
Quality..... 11.4		Good..... 13.0	No..... 26.6	50-plus..... 13.5
Specific likes:		Average..... 0.6	Dealer service opinion:	Would you buy another Supra?
Styling..... 60.1%		Poor..... 0.6	Excellent..... 41.5%	Yes..... 95.0%
Handling..... 56.2		Comfort opinion (front seats):	Good..... 40.7	No..... 5.0
Performance..... 38.7		Excellent..... 79.7%		Would you buy another Toyota?
		Good..... 18.0		Yes..... 96.2%
				No..... 3.8

*Percentages might not equal 100% due to rounding or insufficient data.

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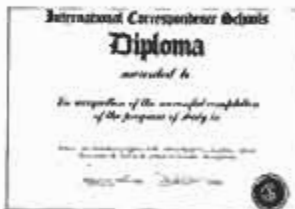
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NEW ENGLAND STONE FENCE

(Continued from page 86)

leveled with sand, will provide enough footing in firm soil. Higher free-standing walls, terracing walls and retaining walls should be started at least 1 ft. below the surface, on a sand bed as shown. First-course rocks become a guide for the rest of the wall, so take care to align them with reasonable precision.

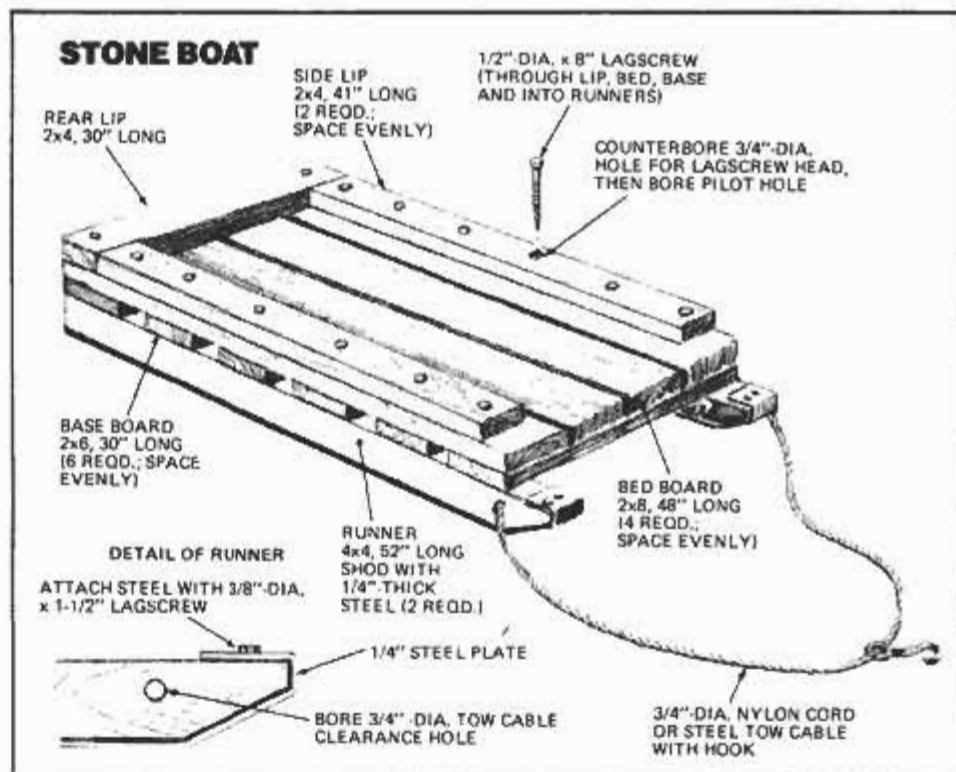
■ Free-standing walls that climb a slope call for special foundation tricks. For proper strength and integrity, the courses of rock in the wall must run horizontally. Where the slope rises, the wall is stepped (see page 87), with base courses set into the hillside as shown. On gentle inclines, the cap rocks may follow the slope contour, but all the core rocks must be laid in the horizontal plane.

■ Rough stone doesn't form the same kind of nice, even courses as brick or concrete block. Some rocks will be inches higher than others. So before you start the next course, select rocks to fill low spots and gaps. For this purpose, keep a pile of smaller pieces, slivers and wedge-shaped stones on hand. You'll need them in all succeeding courses to shim and chink the "wobblers." It is particularly important in dry-stone construction that each rock be seated firmly in position. One large, wobbly rock can make a whole section of wall come tumbling down.

■ The construction of succeeding courses calls for a few simple rules. First, use a spirit level and mason's line to keep courses running true. Rough stonework tends to dip and rise sneakily. Make sure that the joints between rocks in one course are lapped by rocks in the next. Some flush joints are unavoidable, but in no case should they extend beyond two courses.

An extended vertical division, where rocks don't tie each other together, creates a weak point where the entire structure can separate and, eventually, tumble. A New England wall-builder credo states: "One over two; two over one." Actually, there's nothing wrong with one over three or four and vice versa. The main point is to ensure that most joints are lapped from course to course.

■ Along the same lines, dry stonework less than 3 ft. wide requires "tie rocks" every 6 ft. along the wall's length, staggered in every third successive course (see page 85). These rocks span the width of the wall, tying the side faces together for transverse integrity. They are particularly important every second



or third course at the ends of a free-standing wall.

■ For appearance sake, the flattest edge of all rocks should be on the wall's face. Some roughness is inevitable, of course, and provides the characteristic appeal of dry-stone construction. But an "averaged out" alignment of the wall faces is important to the overall firmness and strength of the structure. Smaller rocks used along the face should be set level, by shimming if necessary, or they should slope slightly toward the center of the structure—not outward toward the face.

For the same reason, any wedge-shaped shimming stones should be positioned with the thick edge toward the wall center so it is locked in. Outward-sloping rock surfaces eventually work loose due to freeze-and-thaw action. If they fall out, they weaken the structure and provide a starting point for disintegration.

■ Terrace-wall steps should be built into the structure, rather than tacked on later. Pick the largest, flattest rocks for the top tread piece of each step. It should tie into the side walls of the stair slot at least 3 to 4 in. (see page 87).

Every rock in a stair section should be absolutely firm and immovable. If you hear the slightest click or grinding sound when you walk on the steps, there's movement. Continued traffic eventually will work the rocks loose and the stair will be rendered unsafe and useless.

■ Wide, shallow steps, semicircular corner steps and other sophisticated

landscaping techniques rarely feature single rocks for the whole tread, since such steps are usually too large. For these applications, the pieces abutting the wall should still be part of the wall structure. Individual rocks making up the tread platforms should be thick, heavy slabs with a broad, flat surface. Small stones for chinking are hammered into the crevices between tread rocks to keep them from shifting position.

■ Free-standing walls once used as livestock enclosures on farms often had stiles (cantilevered steps), rather than stairs. Most animals can figure out how to manipulate conventional stairs. But steps created with rocks or timbers projecting from the sides of a wall are a little too complex for anything but a goat.

Such stiles can be an attractive adjunct to a long stretch of dry stone wall. They can be easily incorporated when the wall is being built (see page 87). Be careful to pick flat-surfaced rocks that are long enough to span the width of the wall and project beyond it about 1 ft. Laid into the structure, like tie rocks, these units must be buried under large, heavy rocks in the next course to prevent movement. If the person using the stile is heavier than the rocks holding the stile in place, the stepper is apt to raise the entire top section of the wall and bring it sliding down on him.

Despite all the foregoing tips and cautions, remember that the rough, uneven texture of a dry stone wall is the very thing that provides its beauty and character. **PM**

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MAKE MUSIC IN YOUR SHOP (Continued from page 90)



Screw the fret board to the brace. Nail the brace (with small finishing nails) and glue it in place immediately after you have removed the body unit from its gluing mold.



Use prefinished vinyl molding to cover the joint between the body and the head. Vinyl bends easily. Use a contact cement and a small nail at each end of the molding.

of the banjimer with a roundhead screw. Make sure all the edges are rounded to prevent cutting your fingers as you play.

The bridge is made of a hardwood (maple). Shape it to the cross section shown in the drawing. File notches in the nut and bridge for the strings. Use a triangular file and file the notches at an angle, so that the highest point of contact with the string will be closest to the playing surface of the fret board. If the slots are not sloped in this manner, the strings will buzz, rather than produce clear notes.

Installing the strings

The three strings are No. 3 banjo strings. Run each string through a hole in the tailpiece until the end stops against the metal. If your strings have loop ends, install three small screws in the tailpiece for the loops.

The strings then pass through notches in the nut and the slot in the tuning peg. Turn each tuning peg to wrap each string around it. Once all the strings are installed, but not

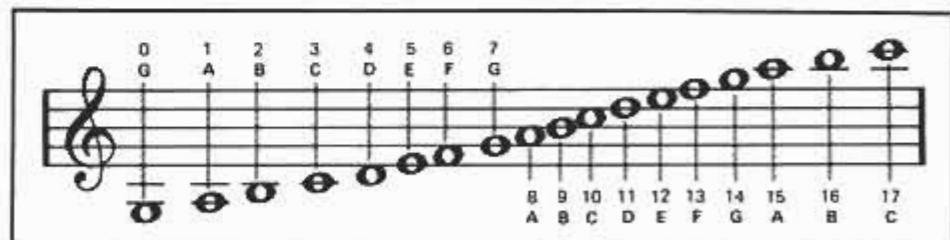
tightened, install the bridge. The bridge is not glued in place; it is held on by string tension alone.

The distance from the edge of the nut to the bridge must be exactly 27 $\frac{1}{16}$ in. Note that string No. 1 is the upper string when the banjimer is held with the fret board to the left. Attach this string to the peg marked No. 1 in the drawing and so on with string Nos. 2 and 3.

Adjust the height of the nut and bridge by filing them until there is $\frac{1}{32}$ -in. clearance between the strings and fret No. 1 and $\frac{1}{8}$ -in. clearance between the strings and fret No. 17.

Tune the melody string (No. 3) to any pleasing note, then fret that string at the fourth fret and match the drone strings (Nos. 1 and 2) to the pitch produced. To "fret" a string means to press it firmly to the fret board, just to the peg box side of the fret.

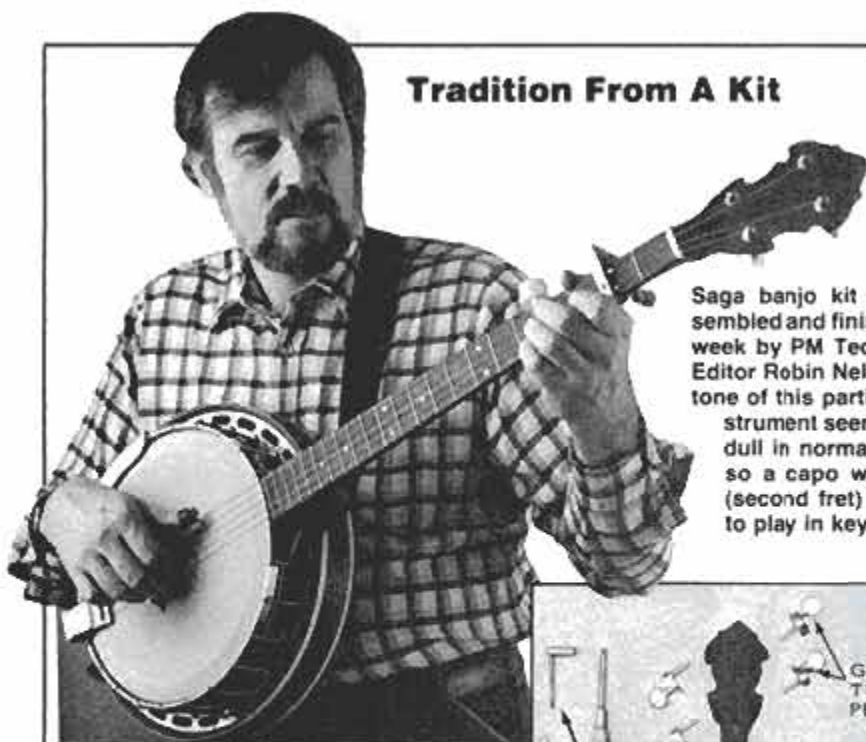
Pluck the strings with a guitar pick held in your right hand and fret the third string only. Now refer to the key below to play a few bars of "Red River Valley." **PM**



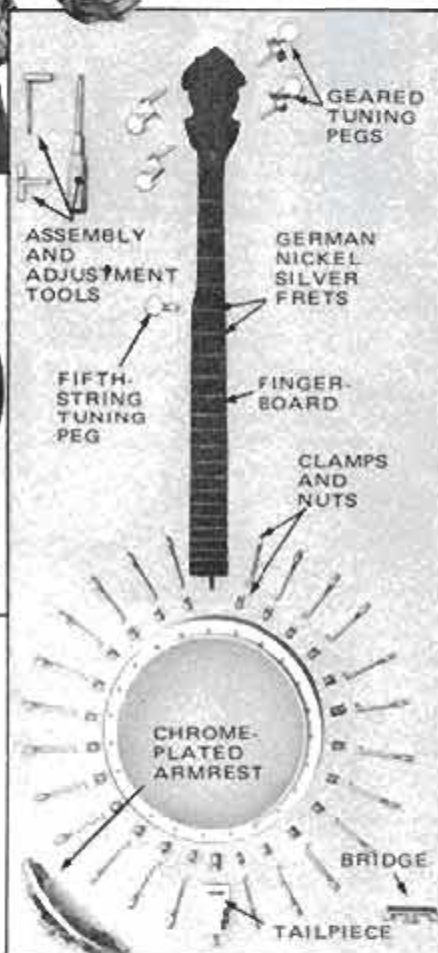
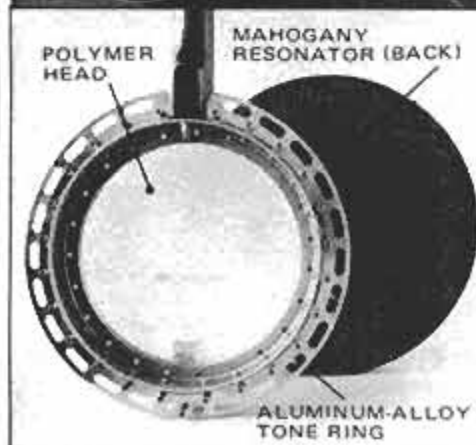
The notes on the musical staff are identified above, along with a number which corresponds to the numbered fret on your banjimer (see the drawing on page 89). Use this key to play the melody for a few lines of the traditional folk song, "Red River Valley," below.

FROM THIS VALLEY THEY SAY YOU ARE LEAV-ING. WE SHALL MISS
4 7 9 9 9 9 8 9 8 7 4 7 9
YOUR BRIGHT EYES AND SWEET SMILE. FOR THEY SAY YOU ARE
7 9 11 10 9 8 11 10 9 9 8
TAK-ING THE SUN-SHINE, THAT HAS BRIGHT-ENED MY PATH FOR A-WHILE.
7 8 9 11 10 5 5 4 7 8 9 8 8 7

Tradition From A Kit



Saga banjo kit was assembled and finished in a week by PM Technology Editor Robin Nelson. The tone of this particular instrument seemed a bit dull in normal tuning, so a capo was used (second fret) in order to play in key of A.



Unlike PM's banjimer, the five-string banjo comes from a long-established tradition. It is an original American instrument. And because of the growing popularity of the styles of music to which it lends itself, it is more widely played today than at any time in its history.

I recently got the itch to start playing after a long hiatus, but I became dismayed by the current price (at least \$500) for a high-quality instrument. So I decided to try building my own banjo from a kit. For \$209, including shipping, I assembled an instrument that satisfied my urges. I got my kit from Saga Musical Instruments, Box 2841, South San Francisco, Calif. 94080.

A bonus in building a musical instrument—whether from kit or scratch—is that when it goes out of adjustment, as they all do, you'll have a good idea of how to fix it. The Saga kit was largely a matter of assembly—clamping the head (formerly calfskin, now various polymers) to the cast-aluminum tone ring and fitting the flanges and armrest.

I sanded and finished the neck and the resonator (wooden back) before assembly. I was tempted to try lacquering—in fact, the kit instructions suggest

it. But a banjo's tone doesn't depend on vibrating wood sections (and the requisite shell-like finish) to the same degree as a guitar or violin. So I chose a Minwax antique oil finish over a mahogany stain, instead. Both the neck and the resonator are seasoned mahogany and took the treatment very well.

Final assembly of neck to tone ring, plus bridge placement requires some patience. In most kits, some shimming will probably be necessary, as well.

Now I've got a banjo that plays smoothly and sounds good. And if I want to move up to a high-class instrument, I can sell this one for more than I paid for it.—Robin Nelson

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THE 'BLACKBIRD' STORY

(Continued from page 73)

tribution; and the effect of fuel quantity and temperature. The latter was caused by fuel on the bottom of the tanks keeping that section of the fuselage cool, while the top section got increasingly hotter as fuel was burned. This tended to push the chines downward due to differential expansion of the top and bottom of the fuselage.

By far, the most tunnel time was spent perfecting the nacelle inlets, bleed designs and the tailpipe. We

took more than 250,000 pressure readings on a quarter-scale model. We knew nacelle air leakage would cause high drag, so an actual, full-size nacelle was fitted with end plugs and air leakage was measured carefully. Proper sealing paid off well in flight testing.

With the engines located halfway out on the wing span, we were quite concerned with the very high yawing moment that would develop in an engine-inlet stall. So we installed accelerometers in the fuselage to immediately sense the yaw rate and command the rudder booster to ap-

ply 9° of correction within 0.5 seconds. This device worked so well that our test pilots very often couldn't tell whether the right or left engine had blown out. They knew they had a blowout, of course, from the bad buffeting they received with a "popped shock." Subsequently, an automatic restart device was developed which limits this engine-out time to a very short period.

Titanium alloys

The decision was made to use various alloys of titanium for the basic structure of the Blackbirds. Only titanium and steel had the ability to withstand the operating temperatures encountered. Aged B-120 titanium weighs half as much as stainless steel per cubic inch, but its ultimate strength is comparable, so conventional construction was possible, using fewer parts than with steel.

High-strength composites weren't available in the early 1960s. We did develop a good plastic which has been remarkably serviceable, but it wasn't used for primary structure.

Having made the basic material choice, we decided to build two test units to see if we could reduce our research to practice. The first unit would be used to study thermal effects on our large titanium wing panels. We heated up this element with the computed heat flux that we would encounter in flight. The sample warped into a totally unacceptable shape. To solve this problem, we put chordwise corrugations in the outer skins and ran the tests again. At the design heating rate, the corrugations merely deepened by a few thousandths of an inch and on cooling, returned to the basic shape. I was accused of trying to make a 1932 Ford Trimotor go Mach 3, but the concept worked well.

The second test unit was the forward fuselage and cockpit, which had over 6,000 parts in it of high curvature and thin gauges, as well as a highly complex canopy. This element was tested in an oven where we could determine thermal effects and develop cockpit cooling systems.

We encountered major problems in manufacturing this test unit because the first batch of heat-treated titanium parts was extremely brittle. In fact, if you pushed a piece of the structure off your desk, it would shatter on the floor. We finally resolved the problem by replacing our whole acid pickling setup.

We developed a complex quality-control program. For every batch of 10 parts or more, we processed three test coupons which were subjected to the identical heat treatment of

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the parts in the batch. One coupon was tensile-tested to failure to derive the stress-strain data. A quarter-inch cut was made in the edge of the second coupon by a sharp, scissorlike cutter which was then bent around a mandrel at the cut. If the coupon couldn't be bent 180° at a predetermined radius, it was considered too brittle. The third coupon was held in reserve if any reprocessing was required.

Heavy documentation

For an outfit that hates paperwork, we really deluged ourselves with it. Having made over 13 million titanium parts to date, we can trace the history of all but the first few parts back to the mill pour; for about the last 10 million of them, we've even recorded the direction of the grain in the sheet from which the part was cut. We found out the hard way that most commercial cutting fluids accelerated stress corrosion on hot titanium, so we developed our own.

Titanium is totally incompatible with chlorine, fluorine, cadmium and similar elements. For instance, we were baffled when we discovered that wing panels which we spot-welded in the summer failed early in life, but those made in the winter lasted indefinitely. We finally traced this problem to the Burbank, Calif., water system which had heavily chlorinated water in the summer to prevent algae growth, but no chlorination in the winter. Changing to distilled water to wash the parts resolved this problem. Mechanics using cadmium-plated wrenches worked on the original engine installation. Enough cadmium was left in contact with tightened bolt heads so that when they became hot (over 600° F.) they dropped off! We had to clean out hundreds of tool boxes to remove cadmium-plated tools.

Drilling and machining high-strength titanium alloys, such as B-120, required a complete research program to determine the best tool-cutter designs, cutting fluids and speeds and feeds for best metal-removal rates. We had particular trouble with wing extrusions, which were used by the thousands of feet. Initially, the cost of machining a foot out of the rolled mill part was \$19. This was reduced to \$11 after much research.

To prevent parts from going under gauge while in the acid bath, we set up a new series of metal gauges two thousandths of an inch thicker than the standard gauges. When we built the first Blackbird, a high-speed drill could bore 17 holes before it was ruined. By the end of the program

we had developed drills that could bore 100 holes and then be resharpened.

Throughout this and other programs, it became clear to me that our country needed a 250,000-ton metal-forming press (five times as large as our biggest one available today). When we have to machine away 90 percent of our rough forgings today, both in titanium (SR-71 nacelle rings and landing gears) and aluminum (Lockheed C-5 fuselage side rings), it seems that we are nationally very stupid! My best continuing efforts to solve this problem have been fruitless for many years. Incidentally, the Soviets have been much smarter in this field: They have more and larger forging presses than we do.

Prospecting for oil

Very difficult problems were encountered with the use of fuel-tank sealants and hydraulic oil. We were finally able to produce a sealant which does a reasonable job over a temperature range of 90° F.

Our experience with hydraulic oil started out on a comical footing. I saw ads in technical journals for a "material to be used to operate up to 900° F. in service." I contacted the producer who agreed to send me some for testing. Imagine my surprise when the material arrived in a large canvas bag. It was a white powder at room temperature. If you put it in a hydraulic system, you would have to thaw out all the lines and other elements with a blowtorch! We finally got a petroleum-based oil developed at Penn State University to which we had to add several other chemicals to maintain its lubricity at high temperatures. It cost \$130 per gallon, so absolutely no leaks could be tolerated.

Rubber O-rings couldn't be used at high temperatures, so a complete line of steel rings was provided. Titanium pistons working in titanium cylinders tended to gall and seize until chemical coatings were invented which solved the problem.

For the first flight of the A-12, we had to fly with Pratt & Whitney J75 engines, because the J58 engine wasn't available until January 1963. Then our problems really began!

The first dilemma was caused by foreign-object damage (FOD), a particular problem with the powerful J58 and the tortuous flow path through the complicated nacelle structure. Small nuts, bolts and metal scraps not removed from the nacelles during construction could be sucked into the engines on starting with devastating results. Be-

(Please turn to page 108)

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Compressor evacuates car's airconditioning system prior to adding new refrigerant (far left). At left, routine inflation of tires saves trip to gas station.

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THE 'BLACKBIRD' STORY

(Continued from page 107)

sides objects of the above type, the engine sucked in rocks and asphalt pieces from the taxiways and runways. An intensive campaign to control FOD at all stages of construction and operation brought the problem under control.

Initially, air-temperature variations along a given true altitude would cause the Blackbird to wander up and down over several thousand feet in its flight path. Improved autopilots and engine controls have eliminated this problem.

There are no other airplanes flying at our cruising altitude except an occasional U-2, but we wanted to avoid weather balloons sent up by the FAA. If we were to hit the instrumentation package while cruising at over 3,000 feet per second, the impact could be deadly.

Lowering the boom

Flight planning had to be done very carefully because of sonic-boom problems. We received complaints from many sources. One man stated that the mules on his pack train wanted to jump off the cliff trail when they were "boomed." Another complainant protested that fishing stopped in lakes in Yellowstone Park if a boom occurred, because the fish went down to the bottom for hours. I had my own complaint when one of my military friends boomed my ranch and broke a \$450 plate-glass window. I received no sympathy on this, however.

The SR-71 first flew in December 1964. It was in service with the Strategic Air Command a year later. In-flight refueling turned out to be very routine. Over 18,000 such refuelings have been made to date by all versions of the Blackbird and it has exceeded Mach 3 over 11,000 times.

It has also flown over 15,000 miles with refueling to demonstrate its global range. It is by far the world's fastest, highest flying airplane in service. I expect it to be so for a long time to come.

Editor's Note: Many months of effort were required for Kelly Johnson to clear the above material for publication through Defense Dept. and C.I.A. authorities. Because the aircraft is still routinely performing the most critical and sensitive reconnaissance missions, its ultimate performance capabilities may not be known for many years. Trouble spots, even those as far-flung as the Falkland Islands, become immediately subject to unseen Blackbird "migrations"—proof that its range is truly worldwide. **PM**

TECHNOLOGY UPDATE

Electronics

The shortest

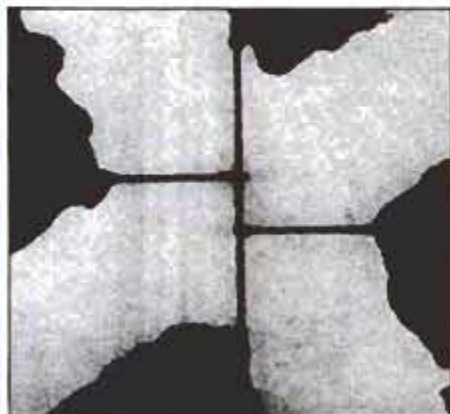
Scientists at Bell Labs merely wanted to create ultrashort bursts of laser light, as a means of "stopping" electronic phenomena for precise measurement.

However, what they came up with may well be the briefest discrete occurrence on record. The laser burst lasted 30 femtoseconds (30 millionths of a billionth of a second). In this amount of time, individual light photons, or electrons in an integrated circuit, would travel (at 186,000 miles per second) a distance of about one-third the thickness of a human hair. The precision bursts will permit scientists to measure any early physical changes in energized circuit chips.

The thinnest

IBM Corp. scientists have patented a process that can draw raised lines less than 100 angstroms wide on metal films. As there are 250 million angstroms in an inch, such lines are invisible to the human eye. The process enables the fabrication of metal wires only 20 to 30 atoms thick; this will allow construction of X-ray microscope lenses with 25 times the present maximum magnification.

The inventors recently obtained



Superconducting circuit made during early experiments with electron beam, seen through electron microscope. Wires are 100 atoms thick, invisible to naked eye.



Bell Labs laser apparatus, which was used to develop shortest pulse ever measured.

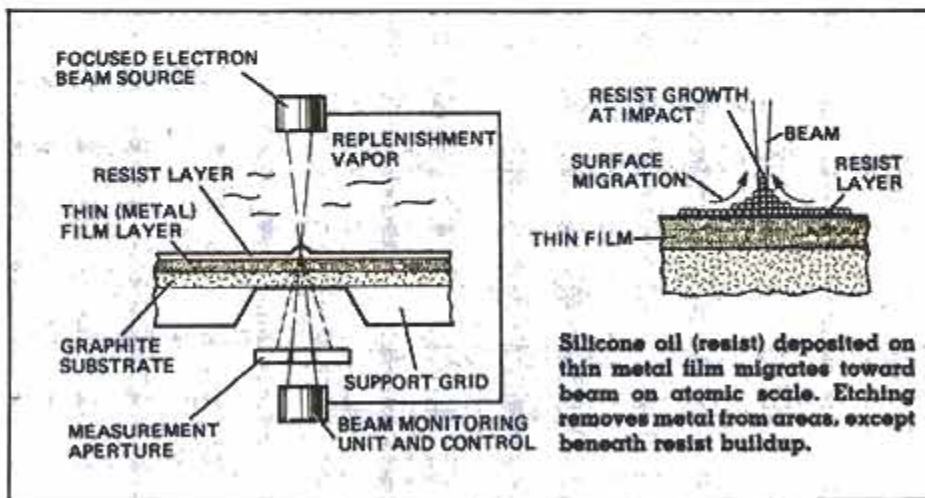
Patent 4,316,093, embodying improvements in the pattern fabrication they had patented in 1980.

In the process, a thin film of metal is vacuum-deposited on a self-supporting layer of graphite or silicon nitride, and the lines are raised with a focused electron beam. Metal film is then removed from unmarked areas by etching.

IBM has disclosed that lines 80 angstroms wide have been formed repeatedly by this technique. It is expected that this could be cut to 25

angstroms if finer films were used. The space between the lines could be just as narrow.

Although no commercial use of the process has begun, metal wires that the IBM scientists have made are recognized as the finest ever fabricated. The focusing X-ray lenses that could be produced should be useful in the study of living specimens. And the microstructure provided could lead to X-ray lithography and the creation of new solid-state electronic devices.



Silicone oil (resist) deposited on thin metal film migrates toward beam on atomic scale. Etching removes metal from areas, except beneath resist buildup.

Drawing based on patent application: elements in electron beam wire fabrication.

Alternatives

Total sunpower

Even in the sun-washed land of New Mexico, with its thousands of solar buildings, this solar house was special enough to merit a ribbon-cutting ceremony.

Why? An array of photovoltaic (PV) cells on its roof marks it as the first solar-electric house in the state. It is also the first in the country to be built as a "spec" house by a builder without government financing, and the first to go "on line" as a power-producing plant for a local utility.

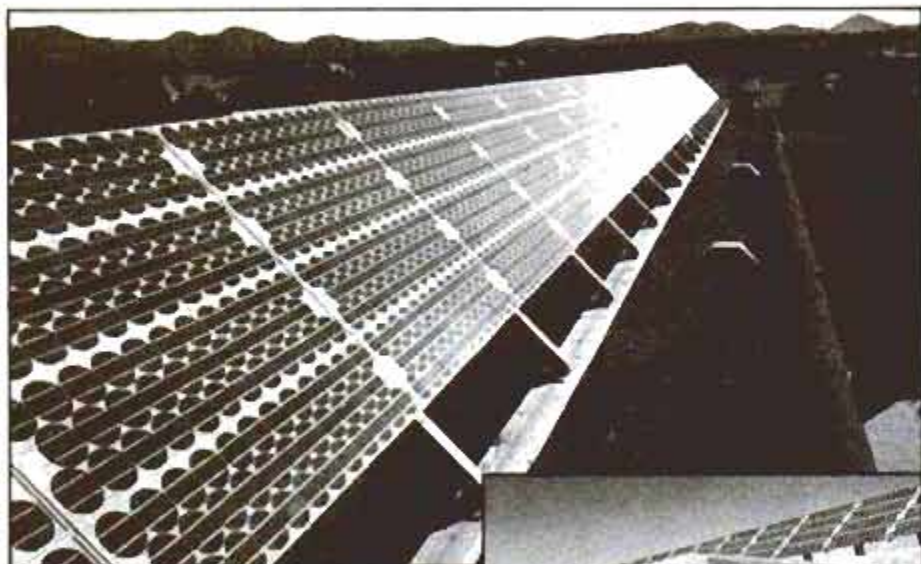
Indeed, the day the system was turned on, the PV array, rated at a peak 3 kilowatts, began feeding back electricity to the Public Service Co. of New Mexico for about 3.5 cents a watt credit.

The PV house is part of a projected 214-unit solar community in El Dorado at Santa Fe, 12 miles southeast of the historic city. It's being developed by Rational Alternatives Inc., a company known for its direct-gain passive solar houses.

Mark Conkling, vice president of Rational Alternatives, sees the PV house as a progression in his company's intention to build well-constructed, affordable solar houses.

"Affordable"? Although the price of solar cells, which convert sunlight to electricity, has fallen in the past decade, PV power still costs some \$10 per watt, initially. Local Santa Fe utilities sell that same watt for 7 to 7.5 cents.

Nonetheless, Rational Alternatives decided it was time to take PV technology to the marketplace—free of government subsidy.



Photovoltaic array (above) plus related equipment account for about \$30,000 of this totally solar home's \$190,000 selling price. It's near Santa Fe, N.M.

Conkling sees photovoltaic-produced electricity dropping to \$2 a peak watt in three years. "That means buyers will have a solar-electric option for an additional \$10,000 to \$15,000," he says.

The price would include the PV array, the grid interface equipment and d.c. to a.c. conversion. (PVs produce direct current electricity which must then be converted to alternating current to interface with the utility.) A PV array's life expectancy is estimated at a minimum of 25 years.

The El Dorado house uses an array made by ARCO Solar Inc., a subsidiary of The Atlantic Richfield Co. It is made up of 78 Model 16-2300 ARCO PV modules. Total area is 312 square feet. Nominal capacity is 3 kilowatts. Domestic water is heated by 200



square feet of flat-bed solar collectors from State Industries.

Conkling calls the area around Santa Fe "the best of all worlds" for the introduction of PV power to the housing market.

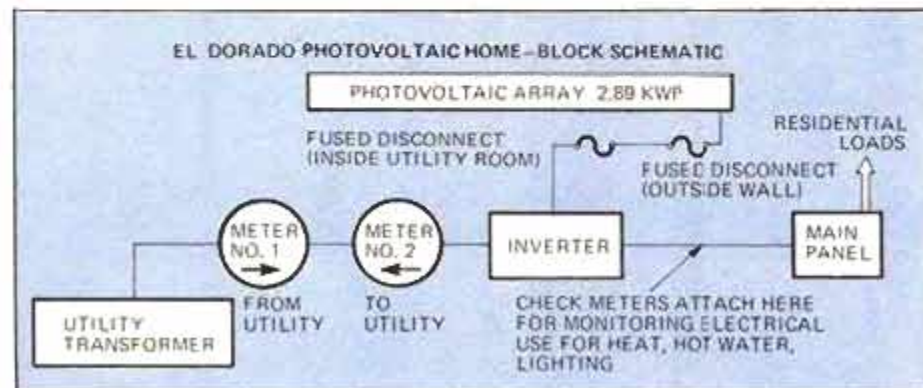
In the first place, solar gain is abundant. This defrays the cost of heating space and hot water with electricity.

Second, El Dorado is 7,200 feet high, with mountain breezes and cool, dry, summer nights making air conditioning generally unnecessary. Cement, brick, tile and adobe serve as heat sinks and help smooth out temperature swings.

With heating and cooling needs met largely by the passive elements in the building, the El Dorado PV house was engineered for only a 3-kilowatt PV array. That means that \$30,000 of the \$190,000 market price of the 2,400-square-foot house could be attributed to the solar-electric capability.

Editor: Robin Nelson

Contributors: Shiel Gallager, Stacy V. Jones, Denise McCluggage



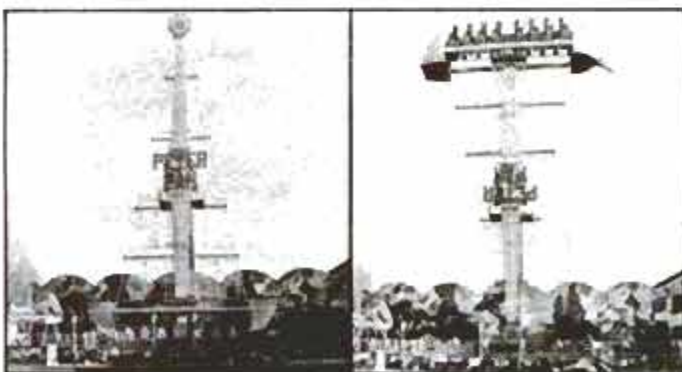
Outgoing meter lets house pump photovoltaic current back to power grid—for credit.

Recreation

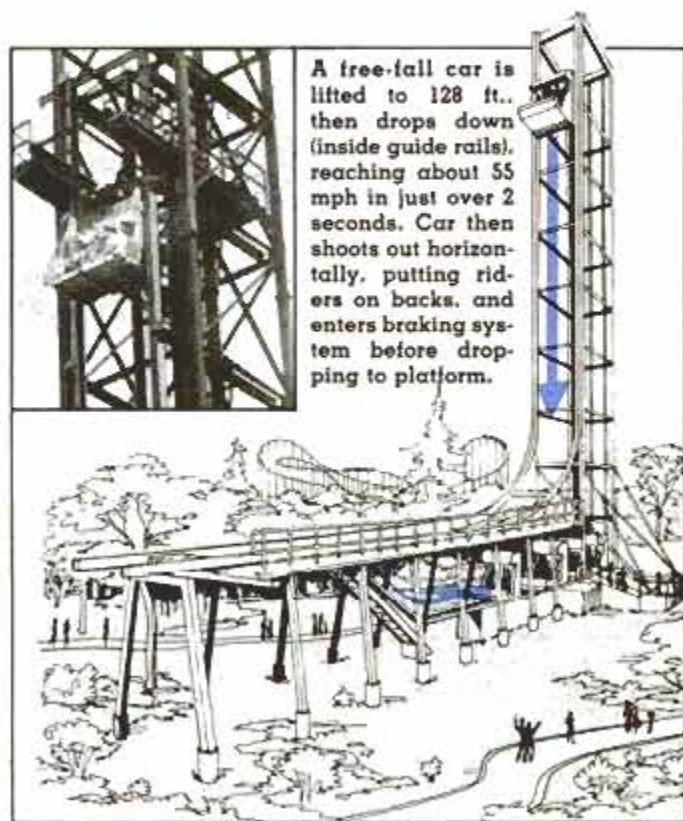
Screamers

Knoxville's World's Fair, opened last spring, offered the vertical orbiter called Peter Pan (below) as its most lunch-threatening ride. It couldn't hold a can-

dle, however, to what the Six Flags theme parks unveiled this year, first in Dallas and later in Los Angeles: a two-second, zero-to-55-mph *free fall* from almost 130 feet up. The Swiss-built ride only takes about 20 seconds, but it leaves a lasting impression.



Peter Pan in operation at the World's Fair in Knoxville, Tenn. The German-built ride orbits vertically around central hub.



A free-fall car is lifted to 128 ft., then drops down (inside guide rails), reaching about 55 mph in just over 2 seconds. Car then shoots out horizontally, putting riders on backs, and enters braking system before dropping to platform.

Marine

Back to canvas

A sailing tugboat? It all started several years ago when Skipper Lane Briggs, a salvage expert who operates Rebel Marine Service in Norfolk, Va., organized the seaport's Annual Crab Sailing Regatta, an event limited to participants with sailboats. Not to be barred from his own outing, Briggs—with tongue planted firmly in cheek—fitted out one of his salvage tugs with sails—a

motley collection of tattered castoffs and old bed sheets.

To the astonishment of everyone—including himself—the sails worked. With the price of diesel fuel soaring, Briggs then decided to make a serious try at a wind-power-augmented tugboat. Working with marine architect Merritt Walter and prominent shipbuilder Howdy Bailey, he came up with the *Norfolk Rebel*. He calls the strange hybrid a "tugantine." The 52-foot, 33-ton vessel can carry up to 1,700 square feet of sail.



Under sail, tug hits 10 mph. Note the huge Genoa "racing" jib.



Shown under construction, unusual hybrid hull has stubby keel.

The hull combines the squat, beamy displacement of a conventional tug with a decidedly untuglike keel. The shallow keel runs the full length of the hull and is heavily weighted. This provides good stability without hampering the boat's operation in shoal waters.

Under sail plus partial

power, Briggs can make 13 mph and figures his fuel savings at 40 percent. At this rate, the payback period for the investment in sails and rigging will be about five years.

And the sails offer Briggs another bonus: They can get the *Norfolk Rebel* back home if her 320-hp diesel quits.

Aviation

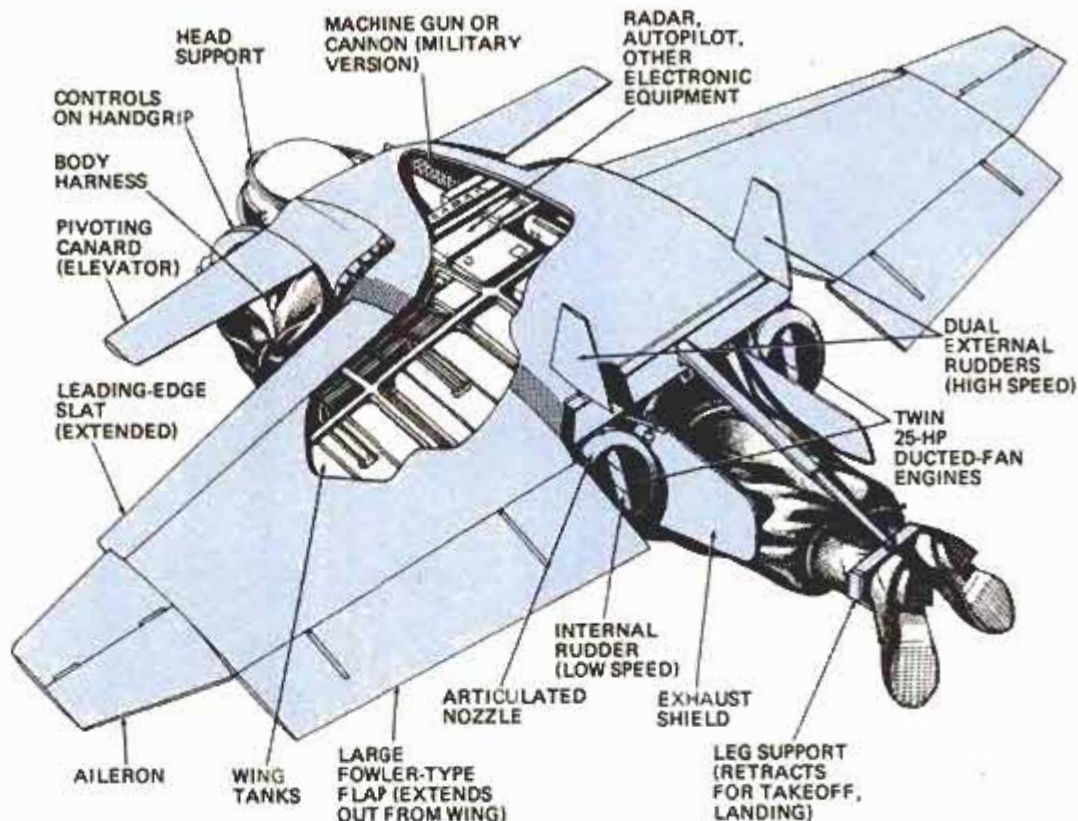
Strap-on plane

Someday, a kid may ask his father, "What did you do in the war, Daddy?" And Daddy may answer: "I was a jet airplane."

It could happen. All you have to do is put on the jet-powered wing shown here and you become a human airplane, soaring off into the wild blue yonder at better than 100 mph.

Strap-on wings have been a dream of man since the ill-fated, mythical flight of Icarus. Now, a young engineer, Igor Dmitrowsky, has come up with a modern version—the ultimate in sophisticated technology—that might just have a shot at success. Dmitrowsky's company, Booster Technical Associates (92-36 54th Ave., Elmhurst, N.Y. 11373), is currently hard at work on an operational prototype that is expected to fly later this summer.

The craft is appropriately called Homo Avis (man-bird). It straps on your back like a parachute, leaving both your hands free to



Ultimate-form Homo Avis will have twin ducted-fan engines, complex variable-geometry wing.

operate controls on the two pistol-grip handlebars. You take off vertically, level out into horizontal flight as your speed increases, then swing upright again for a two-point landing on your feet—just like a bird.

Requiring no runways, the craft could be stored on a garage wall and flown out of your back yard. It could also come in handy for aerial observation, such as highway and border patrol, military reconnaissance and wilderness rescue work.

There's even a gun-toting version suggested for airborne commandos, that would come complete with autopilot and target-seeking radar.

In its initial form (photo at left), the Homo Avis is designed around a mini-turbojet engine of the type used in Air Force target drones. But such engines are expensive (\$30,000 or more). To cut the cost, Dmitrowsky is developing a

ducted-fan system, using two small, 25-hp, turbo-charged piston engines (drawing above). These drive rotary blades which are set inside tubular shrouds in order to produce thrust.

Fabricated of superlight materials, including titanium, graphite-epoxy and honeycomb composites, the craft could weigh less than 100 pounds and hit a top speed of 110 mph. With a 5-gallon fuel supply, it would have a range of 150 miles.

With more powerful engines, it would have the potential to do up to 300 mph, although it would require telescoping legs to support the added weight required on takeoffs and landings.

The wing spans 13 feet and looks like it's right off a Boeing 747. Large Fowler-type flaps and leading-edge slats extend out on tracks to increase lift at

low speeds. Dual rudders above the wing provide directional control during cruising; during hovering, when there's no airflow, auxiliary rudders in the engine ports take over.

The ports themselves are also articulated for further vectoring of engine thrust, permitting precise maneuvers even at low speeds, when conventional controls become ineffective.

Dmitrowsky estimates that a sport model of his craft could sell for as little as \$10,000—just a fraction of what a helicopter of comparable performance would cost.

In addition, the Homo Avis might even qualify for unlicensed operation under the newly proposed FAA rules which govern ultralight aircraft.

Icarus may have blown his chance, but Dmitrowsky is taking steps to make sure that his Homo Avis won't suffer a similar fate.



Single-engine prototype, powered by turbojet, develops 176 pounds thrust in pod over wing (shown suspended).

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kill wasps
and hornets
in their nests
from...**

PM RIDES THE WORLD'S HOTTEST BIKES

(Continued from page 62)

vertical Fours or a single thumper. Honda not only changed the standard configuration, but also added water-cooling and shaft drive.

When the CX500 was transformed into the CX500T the basic virtues of water cooling and shaft drive were retained, but engine power was augmented by the addition of the turbo. This accomplished two desirable design objectives. First, it gave the 500-cc engine nearly the same horsepower as that of an engine twice its size and, secondly, the motorcycle as a whole retained the same weight as a conventional 500-cc bike. Less weight means more responsive handling and better mileage at less than breathtaking speeds.

On the road, the Turbo is as tractable as any small-bore, nonturbo bike, but when you crack open the throttle, those two cylinders suddenly feel as if they've multiplied into four.

The turbo isn't the most fearsome handler on the really twisty bits, but it does more than respectably well. Its real forte, though, seems to be in pushing back the frontiers of motorcycle technology.

Kawasaki GPz750

The GPz designation in the Kawasaki lineup denotes a sport bike, designed for the road racer. Last year there were two GPzs, the 550 and 1100, each on the opposite end of the displacement spectrum. This year, Kawasaki fills in the middle of the spectrum with the 750, and it does so with a vengeance.

Like its two siblings, the GPz750 is done up with a flat black engine treatment, red fairing, air cleaner covers, gas tank and fender, lowrider handlebars and a slightly stepped cafe racer seat.

JULY 1982 115

Its 738-cc, four-cylinder engine is fitted with four CV carburetors which have been modified for improving airflow at full throttle. The engine whips out 80 hp which propels it through the quarter-mile in 12 seconds at a trap speed of 110 mph. We measured terminal velocity at a shade under 124 mph.

The advances in combustion technology are evident when you compare the horsepower of this 750 with that of 900-cc bikes of a few years ago. Most 900s used to produce about 83 hp. This 750 almost matches that number (with 80 hp) without any compromise in cold-start light-up, tractability or throttle response at less than racing speeds.

Even though it is a sports racer, which, by inference, means stripped of all amenities, the GPz750 comes with a remarkably complete instrument panel. There are LCD indicators for low fuel level, low battery fluid level and sidestand down indicator. The tachometer has a voltmeter built in which you activate by pressing a button.

On the road, the GPz750 is a blast to ride. You can dial in the adjustable suspension from rock-hard for racing, to ultraplush for leisurely cruising, and any increment between. Despite the generous ground clearance, you can get things to scrape in severe cornering. The folding footpegs are the first to get gutter rash and after that, if you've got the nerve, the center-stand tab on the left side of the bike.

All in all, the GPz750 is the best 750 on the market and one of the most exciting bikes for the money.

Yamaha Vision

Also known by its full name, XZ550RJ, the Vision joins the Yamaha ranks this year as one of the most highly styled bikes around. The Vision is powered by

(Please turn to page 116)

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PM RIDES THE HOTTEST BIKES

(Continued from page 115)

a longitudinally mounted V-twin engine, displacing 552 cc carrying four valves per cylinder and two overhead camshafts per cylinder. The motor is water cooled and uses an electric fan behind the front-mounted radiator to keep the temperature within limits. Carburetion is also a departure from the norm; it uses two 34-mm downdraft carbs mounted between the V of the cylinder banks.

Another unique feature of the Vision is the engine mounting system. Rather than cradling the engine with two downtubes on either side of the bottom of the engine, the Vision uses downtubes that bolt up at the middle of the engine, near the base of the cylinders. This effectively allows the engine to sit lower in the frame for a lower center of gravity and better handling.

At the rear, Yamaha has dispensed with conventional dual shock absorbers mounted on either side of the rear wheel, and has gone instead with a single shock absorber mounted centrally below the seat. It is acted upon by a pair of rods that rise up from the swing arm and bolt to the bottom of the shock absorber.

At the drag strip the Vision turned in respectable quarter-mile times of 12.9 seconds and 98.8 mph trap speeds. Top speed is only 112 mph.

The Vision is perhaps one of the best compromises on the market. For the commuter, it provides excellent ride qualities and isn't tiring to maneuver through traffic. But, when the traffic thins and you head for your favorite racer road, it has enough power and handling to let you play out whatever Kenny Roberts fantasies you have.

The Vision has a clean, but complete gauge package, with analog speedo and tachometer, warning lights for low fluid levels plus, naturally, a water-temperature gauge.

Yamaha Seca 650

The Seca 650 is a sport bike, pure and simple. From its narrow 17-inch engine to its low bars and flat seat, it's made for the purist who likes simple, clean lines, straightforward design and good performance.

The Seca is powered by a 653-cc, four-cylinder engine which carries only two valves per cylinder activated by two overhead camshafts. It has four carburetors and is fitted with the YICS (Yamaha Induction Control System). This system provides tiny intake ports near the intake valves, which promote mixture swirl and help increase power,

as well as throttle response and tractability.

Yet, even with this relatively straightforward arrangement (no four valves per cylinder), the 650 engine powered the Seca to 12.7 seconds and 103 mph in the quarter-mile.

To keep handling compatible with the available horsepower, Yamaha cleaned up the engine by relocating the alternator from the side of the engine to the back of the engine, just behind the cylinders.

Rather than go with chain drive, Yamaha has adopted a shaft-driven rear wheel for this motorcycle. Shaft drive does away with the constant lubrication and cleaning associated with chain drive and also eliminates other problems, such as chain snatch and stretch which upsets a bike's handling.

There are some problems with shaft drive which the Seca 650 hasn't completely solved. With shaft drive, the pinion of the shaft wants to climb up the rear-wheel gear when you apply power, loading and unloading the wheel. This isn't too bad when traveling down a straight road. But, when you're shutting down before a corner, this phenomenon compresses the rear springs and effectively gives you less ground clearance to work with. In very severe cases, you can shut down before a corner and find yourself hitting the bump stops. While this never happened with the Seca 650, the compression of the rear suspension was noticeable.

Compared to some of the other bikes mentioned, the Seca 650 is a no-frills sportster that does a decent job of getting you around quickly, and rewards you with fun.

Suzuki GS1000S Katana

In Japanese, Katana means a samurai sword. Just one look at this motorcycle and you can see that it's been aptly named. It's sleek, it looks powerful and somewhat menacing. From its 16-valve, four-cylinder, dual-overhead-camshaft motor to the radically shaped gas tank, the Katana is all sport.

Horsepower figures aren't available, but at the drag strip this rocketship turned in a sizzling 11.1 seconds and 125-mph quarter-mile times.

The engine uses a system by Suzuki called TSCC (Twin Swirl Combustion Chamber). This system helps atomization by creating swirl turbulence in the intake charge. As with the Yamaha YICS system, this creates more immediate throttle response and better airflow.

Along with this hot engine, Suzuki

GET THE EDGE

has added an antidive braking system into the front forks. During hard braking, brake fluid pressure is applied to a valve in the forks. This valve closes and prevents fork oil from circulating in the fork. With this braking system, the forks are blocked effectively from travel and the front end remains rigid.

At the rear, the dual shocks come with four damping settings, as well as five preload adjustments on the springs.

At legal cruising speed the Katana is uncomfortable. It simply isn't happy pattering along at 55 mph. Even in the softest suspension settings the ride is harsh and bumpy. In addition to the firm suspension, the handlebars are the clip-on variety, virtual stubs that sprout from the triple clamps, which means you ride in an almost prone position. The footpegs are high and set to the rear, which means you're riding in true road racer fashion. This can be a real problem if you're doing a lot of riding in stop-and-go traffic.

But on the back roads, where you can let the beast have its way, the Katana begins to demonstrate its real purpose in life. It gobbles up pavement quicker than a government project going through tax dollars.

Lean it into a corner, aim for the apex, hold your breath and throttle through. This bike handles. And it makes no bones about its real purpose. There is only room for one person. And that person had better not be faint of heart.

Kawasaki KZ1100D1 Spectre

Where the Katana is fast, furious and a bit unforgiving, the Spectre is equally fast, but more of a sports tourer. The sitting position is bolt upright in the best American tradition. The rest of the bike is equally American with its black and gold engine treatment and longhorn steer, pull-back handlebars.

Power comes from a 1,089-cc, dual-overhead four banger coupled to a five-speed gearbox and shaft drive powering the rear wheel.

It doesn't have the handling of the Katana, but its mission in life isn't the same. If you need to cover several hundred miles of freeway very quickly and don't want your spine bent or the fillings shaken out of your teeth, then the Spectre is your bike.

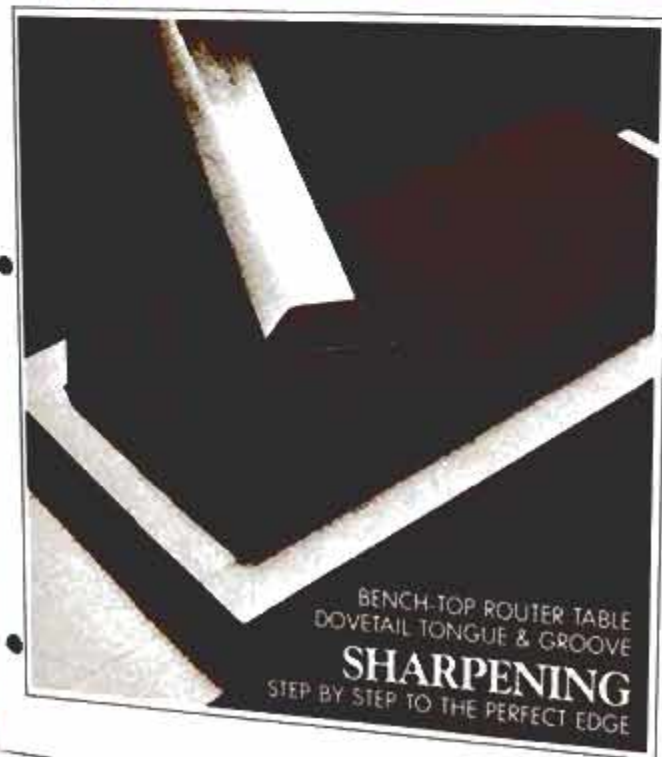
The suspension is air adjustable at the front and the dual rear shocks can be dialed in for a very comfortable ride. The blazing acceleration is there, but this bike won't make you pay for it every time you hit an expansion joint. **PM**

NO. 20

NOTES FROM THE SHOP

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TODAY: THE GOLDEN AGE OF TAPE (Continued from page 81)

machines was equal to that of an audiophile record.

If our pleasantly surprised musicians are any indication of the reception awaiting the new cassette decks, the cassette has indeed arrived! The prices of the machines we tested (\$295 to \$595) hover roughly in the middle of the overall cassette-deck range. This makes them moderately priced, or maybe just slightly on the expensive side. But compared to video recorders and amplifiers, the cassette deck looks like a golden-age bargain.

Some developments that once appeared in just a few decks are now available in most companies' models. Here's a rundown of the features that, in various combinations, make the tape decks we tested so outstanding.

■ **LED meters:** Currently, the most important use of light-emitting diodes (LEDs) for taping is level indication. While the standard VU meter, with its swinging needle, is still popular, the mechanical meter can't show the peak levels at the upper extreme of musical dynamics. The VU meter needle shows only an *average* level (often 10 dB below peak signals). The LED, on the other hand,

shows peaks as brief, but unmistakable, pulses of light, while maintaining a very good representation of the average level. For recording, this provides the very best metering. LED meters are not yet available in very inexpensive decks, but most of the ones in our survey use them.

■ **Memory:** Tape machines use either an LED numeric readout or a mechanical tape counter to show where the tape is relative to its beginning or a selected point. Set the memory button and a deck equipped with this feature will stop at the "000" setting from fast forward or rewind. An exotic variation on this is the *memory scan* or a related function, the *band sensor*. The former locates several preselected places on the tape; the latter detects pauses between musical selections—equivalent to record bands—and stops the tape at these spots from its fast-search mode.

■ **Noise reduction:** *Dolby B* is the type of noise reduction most of us think of when we say "dolby" or "NR." It removes a significant amount of tape hiss during playback of dolby-encoded tapes. A new and even more effective version is *dolby C*. The Teac, Aiwa, NAD, Sony and

Nakamichi decks have dolby C, paired with dolby B on an either/or basis. While dolby dramatically reduces hiss, *dbx* (Yamaha) practically eliminates it. Either dolby format permits acceptable playback of tapes without decoding, but a *dbx*-encoded tape or disc *must* be decoded for listening.

■ **Variable bias:** To accept a recording signal properly, magnetic tape must receive a very high frequency signal along with the musical signal. The strength of this signal is crucial to both low and high musical frequencies. It affects tone if it's poorly matched to the tape. In serious mismatches, there are audible distortions and lots of tape noise. Many decks set recording bias by a knob or button that matches the tape type to the proper machine setting. These settings, and corresponding tape types, are: Type I (normal/ferric), Type II (CrO₂/chrome), Type III (FeCr/ferrichrome) and Type IV (metal).

There are variations as to the bias current needed even within these types, so some decks now include a *variable bias* knob. For fine tuning bias, you follow the manufacturer's instructions for specific tapes, or you make test recordings (brief segments of FM interstation hiss or very well-recorded records are a good source) and compare the original with your recording.

Put through their paces

Here are the decks we tested:

■ **Aiwa 3200:** This is an affordable, easy-to-use machine with two big pluses: dolby B/C and LED meters. Add an MPX filter (to remove the carrier signal FM radio uses to stabilize the broadcast signal) and you have a good buy for \$295.

■ **Bang & Olufsen 2400:** The good looks of the B & O line have always been subordinate to sophisticated and innovative engineering. This is not a beginner's deck in price, even though it's B & O's next-to-least expensive. It is, however, the most uncomplicated of the nine we tested. A thoughtful alternative to the usual recording level controls is a slide that sets both levels, while balance between channels is left to a separate slide. Sound from this deck was second only to the Nakamichi. And with "unseen" features, such as a super tape transport that just *can't* eat your tapes, the price of \$550 is high, but not outrageous.

■ **Kenwood KX-1000D:** The LED meters are set up so that signals over a certain level are displayed in a different color from low-strength ones. This helps you avoid over-recording. Another feature of the meters is the

peak hold: Very brief peaks register for a second or so, rather than fractions of a second. This permits accurate gauging of signal strength. The noise reduction is dolby B and a recent dolby improvement, *hx*, which adds dynamic range. This is the only deck in this price range with *hx*. Solenoid transport controls, variable bias adjustment, a timer, an MPX filter, an auto-lead-in switch and a control for auto-rewind/replay fill most of a serious home recordist's needs. Two other features place this top-flight model firmly in the big leagues: a monitor switch (tape/source) and an input selector (line/mic). This is a deck certain to appeal to the recording engineer in you. It's \$500.

■ **NAD 6050C:** NAD is a company known for sophistication inside and restraint outside. Simple, all-black styling hides a wealth of careful circuitry and transport design, giving a professional look to the deck. Dolby B/C and an MPX filter join variable biasing to allow recordists to feed a near-perfect signal onto the tape. The LED metering is handy, but what the PM test really demonstrated was the excellence of the NAD transport. Our most determined efforts to sabotage the machine's ability to handle the tape failed. This unit's a pleasure to work with and reasonable at \$298.

■ **Nakamichi LX-5:** This is both the best and the most expensive of our nine decks. As if dolby B/C, an MPX filter, variable bias and LED metering aren't enough, listen to this: There's a rear-panel plug for a remote-control cable (an accessory ordered separately), output level control, memory, automatic takeup of slack tape in the cassette shell and a two-speed recording level fader. A light tap on the proper fader fades the record signal in or out (without affecting the record-level knobs); a harder push will cause a much faster fade. No more resetting levels after each fade! The sole drawback to this deck is the lack of microphone inputs. An impeccably engineered tape recording machine, the LX-5 costs \$595, and we think it's worth it.

■ **Optonica RT5050:** This is the second generation of a novel and useful sort of deck. The 5050 is a dual-mouth cassette deck. That is, it has one bay for playback only, and one for recording only. Not only can you wind one tape while another is playing, you can dub from one cassette onto another without a second deck and an intermediate amplifier. When duplicating cassettes, this deck will run at 3/4 inches per second, twice the normal speed, so that

a C-60 cassette with 30 minutes a side will be dubbed in 15 minutes per side. Optonica wants only \$380 for this deck.

■ **Sony TCFX-60:** This unit features small touches like a separate headphone volume (so you can control headphone listening without an amplifier) and a record mute (to eliminate brief sections during recording). LED metering, dolby B/C and a tape counter with either real-time or the standard four digits are a few of the useful features. Automatic memory and a selector for full or partial tape repeat round out this attractive deck, which goes for \$420.

■ **Teac V-70C:** This polished-looking piece of equipment did everything for us that any really decent component should, and even a bit more. A front-panel switch chooses between microphone and (rear-panel) line input. To ensure dead silence right until you want a signal to go on the tape, the V-70C has a record mute button. The dolby B/C is well regulated and the tape counter uses either the standard four digits or real-time counting. LEDs handle the simple metering, and the tape transport is smoothly controlled by the solenoid controls. It's all yours for \$390.

■ **Yamaha K-960:** This unit and the Nakamichi LX-5 show that it's possible to get top sound without paying thousands of dollars. Solenoid transport controls, variable biasing, MPX filtering, a subsonic filter (to cut out superdeep thuds and rumble that strain the tape's capacity) and an output-level control knob are obviously handy things. One unusual control is a button which subtly shapes the treble response. It puts high frequencies either in sharp focus or in a soft, mellow perspective.

The real clincher is the noise-reduction system. The tantalizing choice is between dolby B and the revolutionary dbx circuit. The dbx tapes we made were so close to the professional masters that the pickiest FM station would have been able to broadcast them just as they were. Until home digital sound is a reality, there are few better alternatives. Its \$495 price tag isn't cheap, but this is an unusually refined and flexible deck.

Although it is difficult to make a choice, as all nine of these decks showed superior noise reduction and other features, two were outstanding in every area. Both the Nakamichi and the Yamaha had all you could want and more. But all nine of these decks would fit in a true "dream" system. **PM**

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NEW LOOKS FOR BLOW-UP BOATS

(Continued from page 75)

have been successfully tested in strong winds on open seas.

Three leeboard sailing sloops of 11, 12 and 13 feet are also in the Metzeler 14-boat line, which is handled by Leisure Products Marketing, Roslyn, N.Y.; Trans-Atlantic Agencies in Baltimore; Inflatable Boat Center, Santa Monica, Calif.; and Auto Marine Specialties, Calgary, Alta.

Rigid wood transoms and floorboards are now being used by a number of makers to take the thrust of outboard motors and help the boats maintain shape at planing speeds.

The Pesked sailboat, from International Marine Crafts, 225 Broadway, New York, N.Y. 10007, is an unfold and blow-up model with a polypropylene stiffening deck that mounts on six float chambers.

Special talents

In addition to convenience, there are times when only an inflatable seems suitable for rugged jobs.

■ River running down the white water of rocky rapids is a test that lets "rubber" rafts bounce off instead of breaking up.

■ Landing in the surf of a rock or cobblestoned cove is difficult, but still easier than with a rigid hull.

■ As a dinghy for larger craft, the inflatable gives and receives fewer topside dents, and its lighter weight means hauling it is much simpler.

■ For skin and scuba divers, its stability and low freeboard of the sides, plus good speed with minimum outboard power, make it a favorite.

Many blow-ups also can convert from motor to sail. This requires the addition of leeboards and rudder, as well as spars and canvas. The shapes of their hulls usually keep blow-ups from real speed under wind power, but versatility is a plus.

A new mix of materials—hard fiberglass hulls with inflatable flotation collars—is undergoing testing for lifeboats. Recently, the U.S. Coast Guard has been trying out the Arctic 24 made by Osbourne Rescue Boats in England. Called an RHI (for rigid-hull inflatable), the \$68,000 open, 24-foot craft can run 40 mph with a pair of Johnson 90s, and has an inflatable-bag, self-righting device that is reported to right the cap-sized boat in 15 seconds.

The growing success of inflatables is seen in the array of makes available. Achilles, Avon, Boston Whaler, Camp Ways, Hutchinson, Maravia, Metzeler, Novurania, Sea Eagle, Sears, Semperit, Sevytor, Sillinger, Zed and Zodiac are among the better known names.

SUPERSCOPES

(Continued from page 67)

thin knife made of industrial diamond to cut a sliver of sample so small that it can't be seen with the naked eye. Still under the microscope's magnification, the sample is lifted by tweezers onto a copper "grid" the size of a pinhead. The grid is mounted on a tiny cube-shaped slide, fixed with epoxy and inserted in the scope.

Under the electron microscope's magnification, the grid fills up a TV screen measuring 4 inches diagonally. The lines of the grid help the viewer focus the object.

The use of electron beams to etch messages onto tiny silicon chips is a more recent development. Only in the past 20 years have scientists



Janet Mouradian removes micrograph film from vacuum beneath the viewing screen.

been able to burn patterns onto chips so tiny that they can contain the memory once lodged in computers that filled up suites of offices.

Depending upon how limited the physics of the tiny world turns out to be, the computer end of the business can be expected to create memory storage capacities thousands of times more compact than those available today.

"Today's state-of-the-art chips are 2.5 microns," says Martin P. Lepsetter of Bell Labs (a micron is one millionth of a yard). "But we've been experimenting at sizes far smaller than that." Lepsetter declines to speculate on just how much storage man will get on the increasingly smaller chips, but he adds, "We haven't reached the limit of the silicon chip. We still have a lot of room in which to develop."

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FIRSTHAND REPORT



Sentra can be flung around, but it protests when pushed hard: the suspension bottoms, and the engine gets buzzy at high revs.

Driving The Nissan Sentra

Nissan cranks up the fuel economy wars a notch with its replacement for the aging 210.

by Joe Oldham EXECUTIVE EDITOR

Drive reports are supposed to tell you how exciting it was to drive a new car. The fact is, Datsun's 210 replacement, the new Nissan Sentra, is boring to drive.

The Sentra is the newest entry among econobox cars that make no bones about driving excitement—they don't have any. They are merely transportation modules that are meant to move you and several other people from point A to point B. Period.

Nissan calls all the Sentra's body styles five-passenger models. Don't believe it. You wouldn't want to be the fifth guy in one of these cars. Assuming you're one of the four a Sentra was *really* meant to transport, you'll actually find yourself in an exceptionally roomy interior for a car this size, with lots of glass area to make the interior seem even more airy.

Unfortunately, the two cars we drove at the press preview were not up to the quality standards we've come to expect from Japanese cars.

One car had several pieces of interior trim hanging down off the windshield pillar. The other had an annoying buzz emanating from somewhere under the dash, in the general neighborhood of the speedometer.

Both of the cars we drove were five-speed models, and neither had the wider wheels and tires included with the XE equipment package. Perhaps those tires would have made the Sentra a more pleasant handler. We found the car to be an excellent highway cruiser, as did the Arizona highway patrolman who tagged us for 78 mph in a 55-mph zone on the way to Tombstone.

Once up into the mountains, we found the Sentra to be wanting. The suspension bottomed quite easily on large road dips and we had to be extra alert powering through tight corners, else the car would get twitchy and want to spin out. Admittedly, this was at illegal speeds. Still, we think Nissan should reconsider the tires it's using on the Sentra.

They lack responsiveness, and, in general, feel pretty flabby. Lifting our foot off the throttle in the middle of a corner gave the rear end an excellent excuse to start sliding out. Correcting with steering and throttle was easy, but the car should wear tires that are able to control such torque load changes.

The new E-15 engine doesn't fare too well in these circumstances, either. As the engine nears the top of its rev range, it becomes loud and buzzy and vibrates quite a bit. It runs out of breath pretty quickly and doesn't have much steam left for passing at highway speeds. In short, it's short—on power and smoothness.

Reason to buy: gas mileage

So why would anyone buy a Sentra? Gas mileage. Pure and simple. Nissan's Sentra gets better mileage according to EPA ratings than any other gasoline engine car sold in the United States. That's right—better

(Please turn to page 124)



On the road, the Sentra is an efficient, high-mileage cruiser that holds four people.



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Sportiest of the Sentras is the XE hatchback, which features wide tires, extra trim.

DRIVING THE NISSAN SENTRA (Continued from page 122)

than any car using a gasoline engine. The EPA ratings are 58 mpg highway, 43 city, for a combined 48 mpg. That, sports fans, is sucking the very last drop out of a gallon of gas.

By the way, those ratings are for a special Sentra MPG model (not available in California) with special gear ratios and five-speed transmission. Other models get slightly less mileage. Still, the Sentra's ratings top even a couple of diesel-engined cars—the Isuzu I-Mark and the Chevrolet Chevette.

Nissan USA officials were just as proud of the fact that the Sentra is one of the first small economy cars to make extensive use of lightweight materials to reduce overall weight. The car weighs just 1,875 pounds, thanks to lots of high-strength, low-alloy steel in such areas as the transmission, driveline, suspension components and steering. Plastics, composites and aluminum are also used extensively.

The crisply styled body makes the old 210 look like something out of a Japanese museum, and the coefficient of drag is just .40 for the sedan and .39 for the hatchback. Slick by any standards.

Engine, suspension details

Power for the Sentra comes from a new Nissan E-Series engine. It's a single-overhead-cam configuration displacing 1.5 liters. Technical highlights include semi-hemi combustion chambers, high-swirl intake ports and a dual exhaust manifold. The engine is transversely mounted and drives the front wheels. The E-15 engine is rated 67 hp at 5,200 rpm and 116 foot-pounds of torque at 3,200 rpm.

The chassis layout is small-car conventional. Suspension is independent all around with MacPherson struts up front, and full trailing arms and coil springs out back. No sway bars are used. Rack and pinion

steering is standard with power assist optional. Radials are standard on all but the base model. Curb-to-curb turning radius has been cut down to just 14.7 feet—one of the tightest in the industry. Power front disc brakes are standard.

Sentra body styles include four basic models—two-door sedan, four-door sedan, three-door hatchback, and a five-door station wagon. Trim levels are many and varied. There are deluxe models with upgraded interiors for those of you who want more plush. An XE option available for the hatchback will get you goodies like a center console, quartz clock, sport steering wheel, tachometer, AM-FM stereo, and wider wheels and tires.

Car wars: serious business

If you don't think the car companies are taking their car wars seriously these days, you're crazy. At the press introduction of the Nissan Sentra, executives from the Japanese automaker made it very clear that Nissan USA is out to knock off Toyota, Honda, Subaru, and anyone else who gets in the way of Nissan increasing its market share of the small economy car market. With only 12 percent of the market compared to Toyota's 21 percent, Nissan has pulled out all stops to close the gap.

Its latest stopper could very well be the Sentra, the second car to wear the Nissan badge in the United States. The first was the Stanza, introduced several months ago. With the Sentra, Nissan is arming itself for battle right in the middle of ground zero in the car economy wars.

Up against such combatants as the Honda Civic, Chevrolet Chevette, Ford Escort, Toyota Starlet, and so on, the Sentra has its work cut out for it. But as the new gas mileage champ, it's the Sentra that's setting the battle strategy. **FM**

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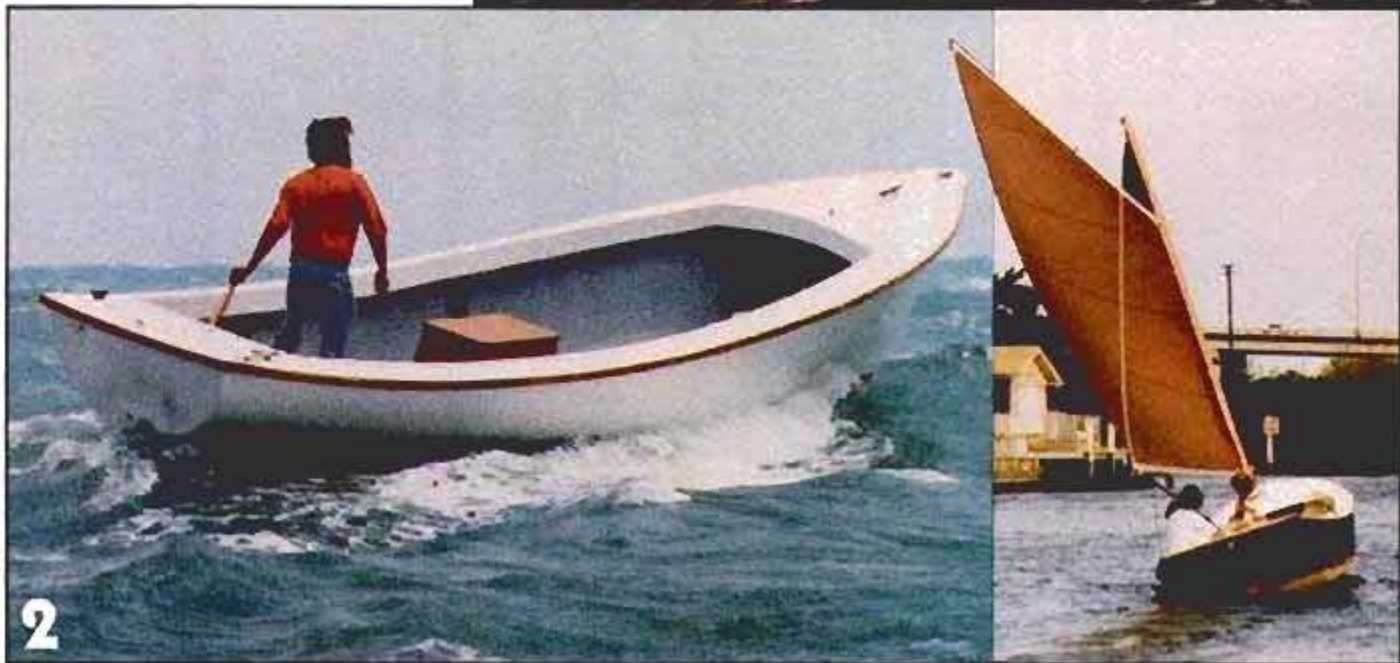
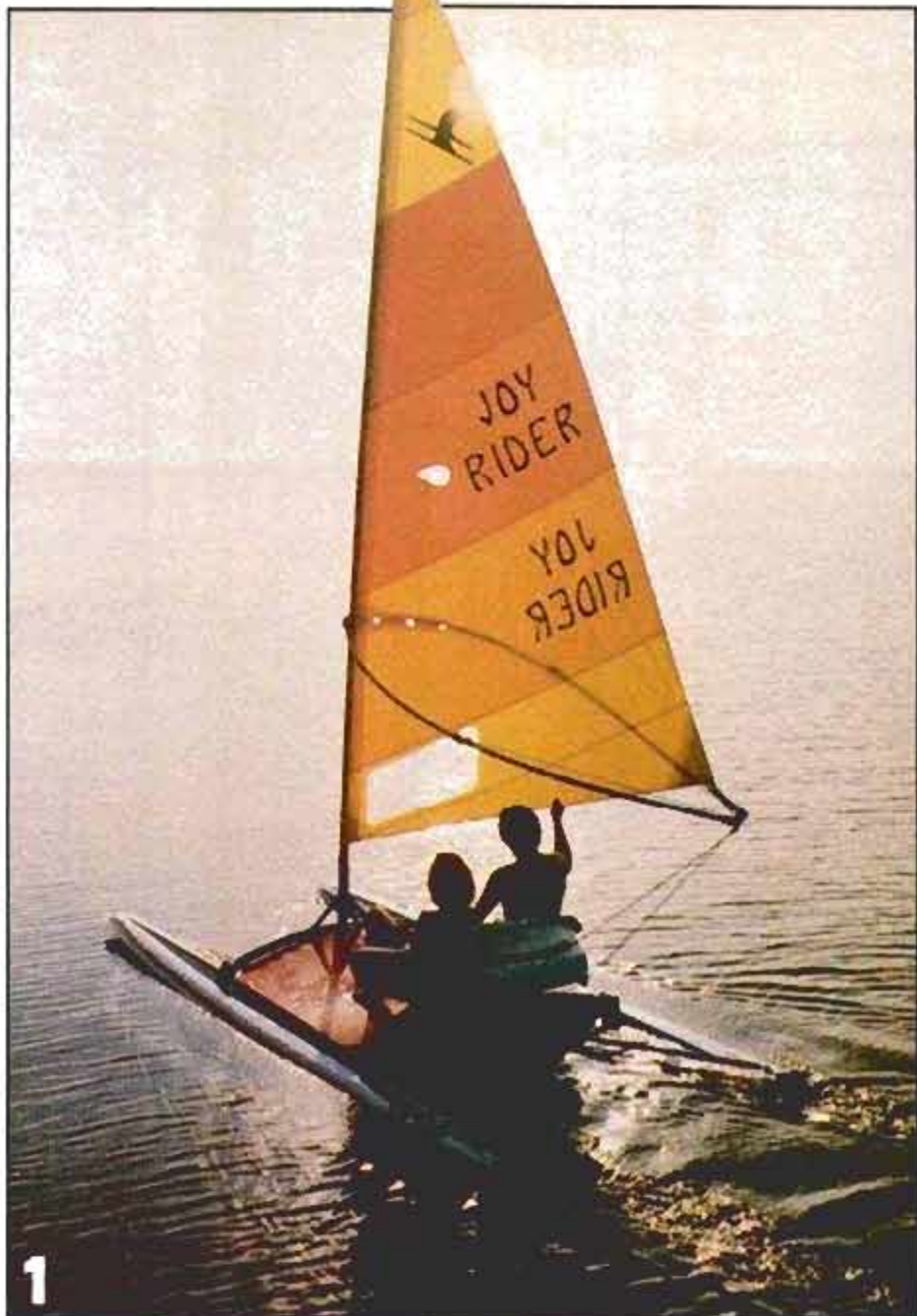
Paddle, power or tack your way across the bay; these convertibles let you choose.

There aren't many vehicles that let you choose a different power if the price of gas goes up, the strength of wind goes down, or you just feel like cruising along in a different way. But a few specialized craft offer that choice. Here are some new examples.

The Multi-Craft 18, from American Multi-Craft Northeast, Box 297, Sparta, N.J. 07871, is an 18-foot switch-sailer with trimaran hull, rated for up to 115-hp outboard motors, plus a sloop rig that stores aboard. The three-piece mast, when assembled, mounts 220 square feet of sail. For down-wind running, a loose-footed wrap-

1 Kona Kat's Joy Rider catamaran can be sailed or paddled sitting, and is rigged like a sailboard.

2 Sea Gypsy, with handsome workboat lines, can cruise three hours on a gallon of diesel (below) or sail with gaff rig (below right).



around mainsail can be opened on each side of the mast for wing-and-winging.

Padded seats become four bunks under camper canvas, and the under-8-foot beam is quite suitable for trailering.

With the look of a traditional New

3 A trihulled 18-footer that switches quickly from power to sail, new Multi-Craft 18 takes outboards to 115 hp or jib and double wraparound main.

4 Almost any sailboat can take outboard with an adjustable spring-loaded bracket—this one from OMC—that lowers or lifts motor.

5 New, steam-powered Morven skiff resembles a classic launch and trailers easily with five-foot beam.

6 Multiaction Bullfrog, from O'Brien, is a swim and snorkel board or speedy kneeboard for towing tricks.

England lobster boat, the 23-foot Sea Gypsy, from New River Boat Co., 2007 Southwest 11th St., Fort Lauderdale, Fla. 33312, can cruise along at up to six knots and burn only one quart of fuel per hour with its 10-hp diesel. Yet, if even that seems excessive, you can set the gaff-rigged sail. Options include cuddy or full cabin, center console and wheel steering, bunks, head and galley.

Classic launches that can replace gasoline power with steam are built in England, using the modern wood-epoxy West System, from designs by Glyn Jones.

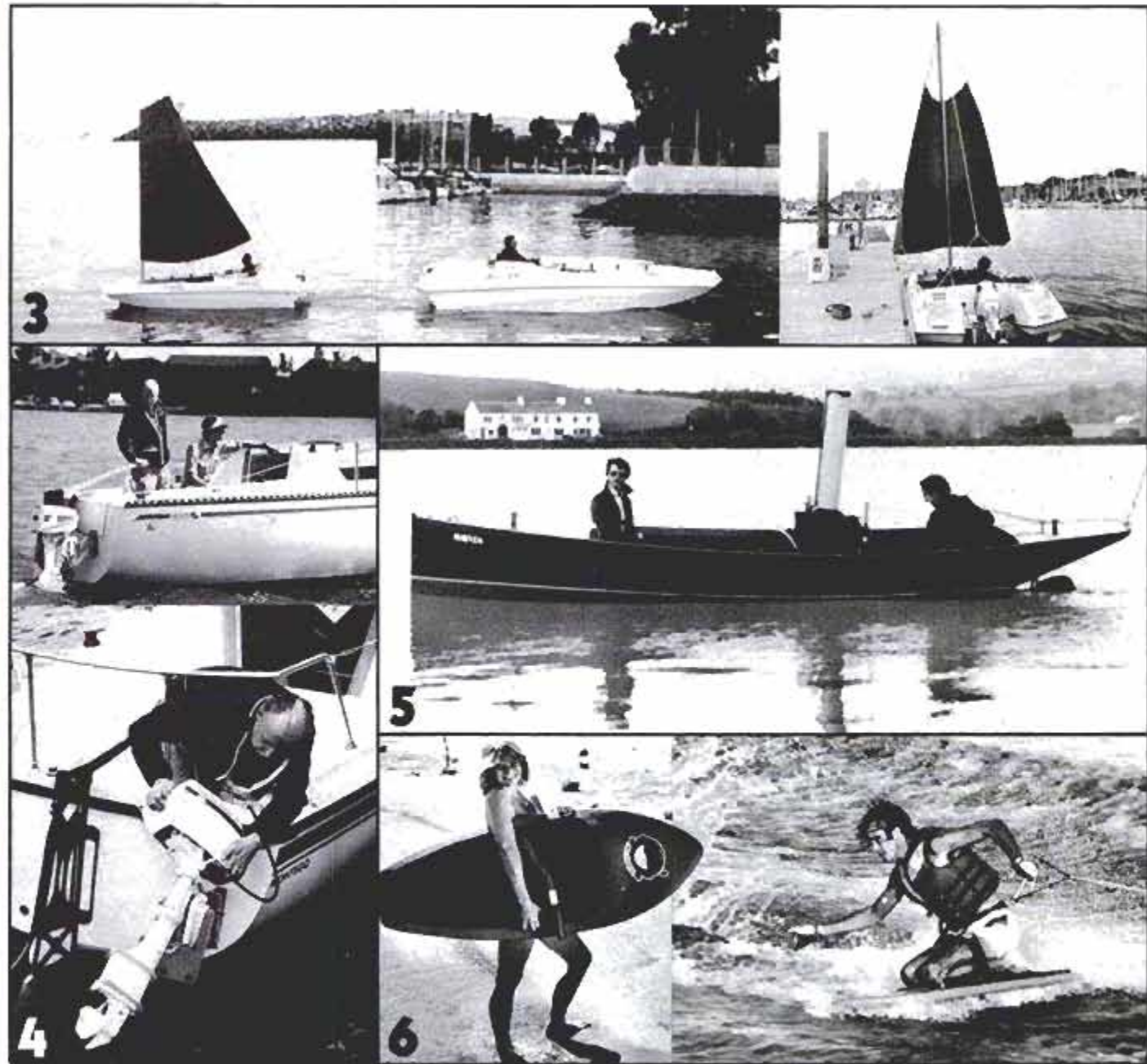
Now, however, one is available from Rhode Island Marine Services, Box 209, Snug Harbor, R.I. 02880. The 20-foot Morven Elegance class has a Simple single-cylinder, 5-hp steamer. Jones also has plans for 16- and 24-foot

launches plus a trailerable, paddle-driven, 24-foot side-wheeler.

Kona Corp., Box 878, Oak Hill, Fla. 32759, builders of the twin-hull Kona Kat sailboard, has a new sit-down two-seater sailboard catamaran with a "joy stick" steering system. The Joy Rider has kick-up rudders and centerboard that let it float in three inches of water, and it can be paddled if the wind goes down. The 150-pound cat can be cartopped or trailered.

High-speed fun without the skills of water skiing is an advantage of kneeboards. The Bullfrog, from O'Brien International, Redmond, Wash., doubles as a snorkeling float or planes behind outboards of 10 hp and up.

And to convert sailboats easily to power, up-down transom brackets from OMC Accessories and others are the answer. **FM**



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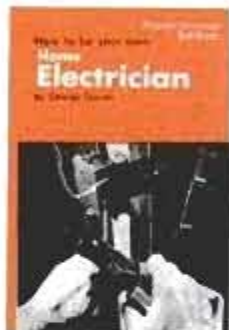
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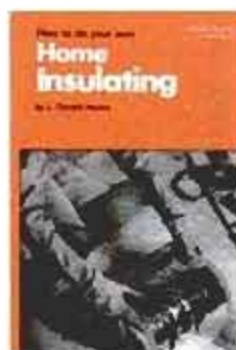
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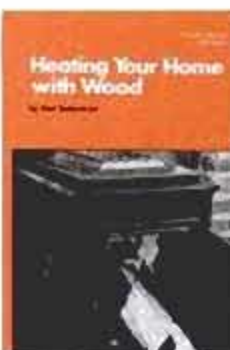
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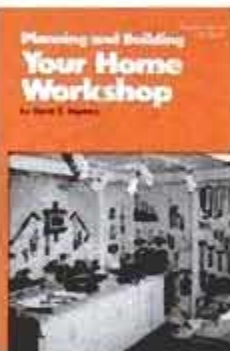
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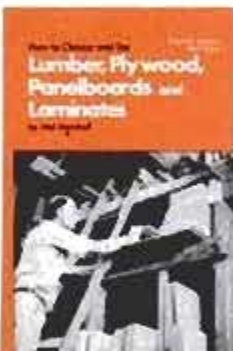
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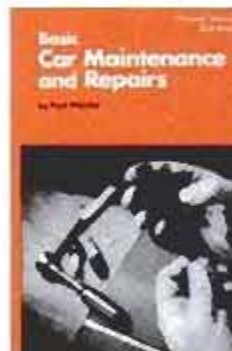
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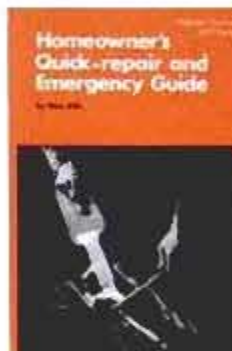
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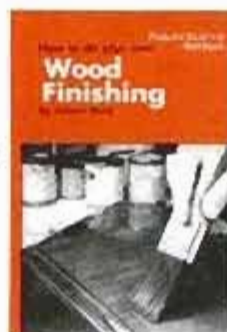
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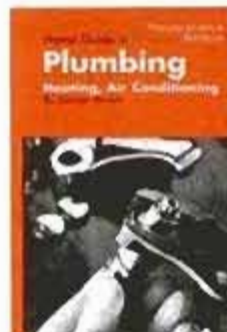
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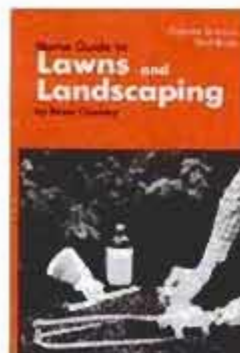
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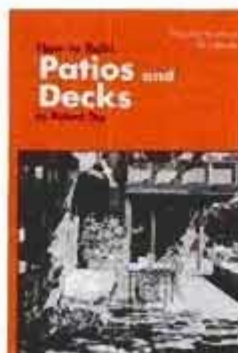
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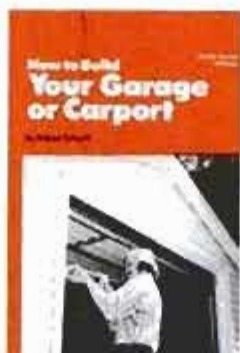
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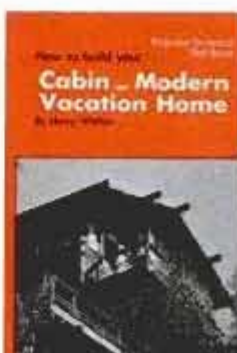
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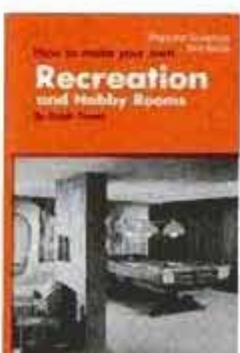
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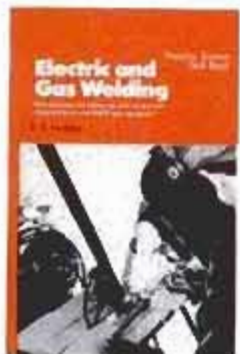
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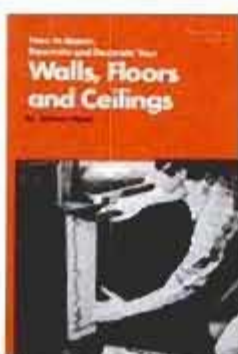
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STEREO SOUND FROM WALLS

(Continued from page 58)

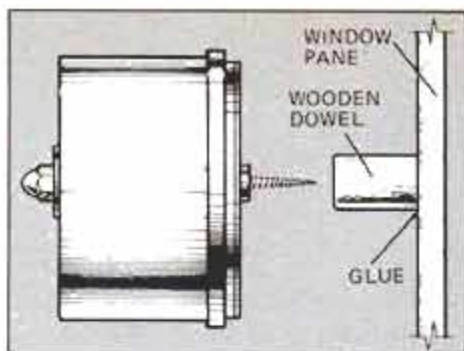
lies in the design of this plate. For, designed improperly, it would transmit noise, instead of music.

Think of the way a violin operates: The vibrating strings resonate the instrument's sounding board which amplifies the music to a listenable level. The difference between a Stradivarius and a violin from your neighborhood music store is in how well the sounding board responds to the vibrating strings.

And, likewise, the sound quality you can expect from Ashworth's Acoustic 2000 ACs depends on the type of wall surface you attach it to.

The first thing you must do is plan on giving your Acoustic 2000 ACs an acoustically good home. The best surface to install them on is wall paneling—between two studs at eye level. For stereo, allow at least 8 feet between speakers. In this way, the paneling will be able to vibrate as freely as possible. To take full advantage of the unit's capabilities, speakers must be mounted on the room side of the paneling.

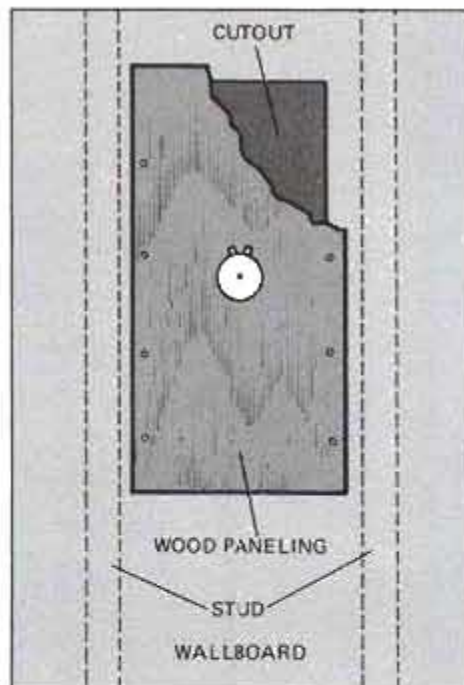
The worst thing you could do would be to install a 2000 AC onto a surface of nonvibratory wallboard,



You can install speaker on a large window. Use a wooden dowel glued to the surface of window to anchor mounting screw.



An analysis of the sound of the Acoustic 2000 AC speaker on a wall (top) is compared to a Bose 601 speaker near the same wall (above). The 2000 AC showed a frequency response very close to the Bose, but without the same volume level.



To install speaker on a nonvibratory surface (see text), you may have to cut out part of your wallboard and install a sounding-board surface of wood paneling.

such as plasterboard or dry wall. Of course, surfaces such as brick or concrete could not be expected to vibrate at all.

But if all you have in your home is wallboard—or if your paneling is

glued to a dry wall, rather than nailed directly to studs—you can still install these speakers. But first, you'll have to install a sounding-board surface of wall paneling as detailed in the drawing at left. Cut away the wallboard and, between the studs, install as large an area of paneling as possible.

Once you have a suitable sounding-board area, the Acoustic 2000 AC installs in a minute. It screws into the wall on its own self-driving screw. Then, attach the stripped ends of a separately purchased cable to the speaker and the cable's RCA plug to your amplifier.

What to expect

Ashworth's previous-model coneless speaker is currently being used by the U.S. Navy. Exactly how is not being revealed, but it seems a good guess that the speakers are being

used on the walls of submarines to provide sonar masking to hide from enemy ships.

But now that Ashworth has surfaced with his new Acoustic 2000 AC, what can you expect in your own home?

We asked Tridac Labs to compare the sound of an installed Acoustic 2000 AC with a Bose 601 speaker system. The report verified the findings of our own ears! The sound was good, although it distorted at medium-high volume.

"Optimum performance," the report detailed, "is achieved when the speaker is mounted on a paneled wall, approximately midway between studs. In this location, the frequency response was nominally within 3 dB from 63 to 5,000 Hz. The Bose 601 went down to 31.5 Hz., with a similar high end above 5,000 Hz."

So, properly installed, the 2000 AC reproduces the sound spectrum very well, except for the lowest frequencies.

"The efficiency of the 2000 AC is less than that of the Bose 601," according to our lab tests. This means the coneless speaker arrangement will overload long before it reaches a volume that will satisfy a devotee of hard rock. But the lab did measure a sound pressure level of 68 dB at 6 feet before distortion set in—and this is a comfortable, middle-volume listening level.

So, for areas such as recreation rooms, offices or anyplace where superb high fidelity isn't critical, we recommend the Acoustic 2000 AC.

Special effects

Ashworth has included many little design touches in his invention. One of them allows you to connect a normal pair of speakers to the 2000 AC. Connection is made at the terminals that stick out of the unit like "ears" (see photo, page 58). The sound to the normal speaker is inductively delayed for a tiny fraction of a second. If you place the auxiliary speakers properly in the room, you'll generate a time-delay effect that seems to "open up" the sound.

But the surprising applications of the 2000 AC are many. For instance, research is underway which shows that some deaf people can be made to hear if one of the speakers is held near the auditory nerves.

These new coneless speakers (which will retail for \$39.95 each postpaid from Reliance Electric Mfg. Co. Inc., Route 2, 1024 North Lake Brantley, Maitland, Fla. 32751) seem to be more than a gimmick. We found them to be enjoyable—and our walls have never sounded better!

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Readers' Turn To Be Traffic Cop For A Day



There's no law on the books about courtesy, but lots of people would love to write up this kind of driver anyway.

Our readers sound off with their own pet peeves on rude and dangerous drivers.

by Wade Hoyt

The article *Oh, To Be A Traffic Cop For A Day* in the September 1981 issue of PM (page 96) generated more mail than anything within recent history.

It was gratifying to learn that so many of you readers are interested not only in PM, but in traffic safety, as well. I asked if you had any favorite driving goofoffs that had been overlooked and, boy, did you ever! We got answers from as far away as the Philippines! We even heard from a few police officers, among them Tim Fischer of the Jefferson Police Dept. in Jefferson, Wis., who writes:

"Cops are human, too, and cannot be every place and catch every vio-

lator. And, unfortunately, we don't get to write the laws, just the fun of trying to enforce them. I thought I'd let you know that my sentiments are the same as yours, but that, as cops, we are out there trying to do our best within the confines of our job."

Officer Tim Jackson (I always call 'em "officer" when they're mad!) of Ft. Morgan, Colo., disagrees, writing:

"I suggest to Mr. Hoyt that he ride with the police for about a week and see firsthand just what goes on out there. It might open his narrow mind. I think it's time for Mr. Hoyt to actually meet some policemen and see that there still are a few of us out here who really do care."

Some of my best friends are cops, and Officer Jackson is right. Police officers would rather be catching criminals, protecting the public from dangerous crazies, or helping in an emergency than writing up Mom and Pop for doing 57 mph. But

some of them also tell me about nasty things called quotas and the need to sometimes write up not-so-dangerous drivers in order to meet the quota.

Driving instructors are probably more aware of bad manners on the road than most of us, and we heard from several of them. Bobby McMillan of Kinston, N.C., writes:

"I see the things you wrote about happening every day. I tell my students they can learn more about driving by watching the mistakes of others than they can by observing good drivers. Here are a few you missed.

"Pulling into a crosswalk at a red light. (Sometimes all the way, forcing pedestrians to walk dangerously close to cross traffic.)

"Lane-straddlers or centerline huggers (especially on expressways).

"One-handed drivers with their left arm hanging out the window or

(Please turn to page 136)

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"It's true! I don't care how fat you are (Some of my patients are hyper-obese). I don't care how many diets you've been on in the past, or how many times you've thrown away your money on the latest weight-loss fad or gimmick. If your only health problem is fat, your problem is over."

"My Wean-Away™ Plan will take that excess weight off fast and keep it off without pills, drugs, devices, or injections. My plan allows your body to lose the most weight it is capable of losing in a short period of time without regular visits to my office."

"You can lose 5 to 8 lbs. in 48 hours, 20 lbs. in a week, or 40 lbs. in a month. But even if your loss is only average, your clothes will start feeling loose this week and your pants or skirt will be falling down within 30 days!"

FAT BURNING FORMULA

"You'll start out on my specially developed Wean-Away™ Formula, a tasty and nutritious mixture that will help turn your body into a fat-burning furnace from glassful to glassful. You will literally burn up fat, melt away excess weight and reduce bulging body measurements THE VERY FIRST DAY!"

"This is the fastest medically sound over-the-counter plan to reduce weight and waistline, EVER. With just the formula alone, you will lose more weight than hours of running, calisthenics, weight-lifting, or swimming. Of course, I recommend exercise with my Wean-Away™ Formula. This combination is the fastest, most permanent weight loss method known to medical science—the same method that results in losses up to 20 lbs. the first week!"

TAKE OFF EVERY EXTRA POUND—AND KEEP IT OFF!

"Step by step, I'll reprogram your eating habits. In just a short time, I'll "wean" you off the formula and you'll be eating 3 full meals, plus a snack!"

"Now, the food you eat no longer turns to fat. Thanks to my Wean-Away™ Plan, you will actually reverse your body's process for building up fat! You will stop excess fat-building calories from entering your system. And, you will keep them from being turned into ugly bulging fat!"

IT WILL WORK FOR YOU—COMPLETELY AT MY RISK!

"That's right. You can lose weight fast. And, you don't have to pay me for personal visits to my office. You see, my Wean-Away™ Plan is completely safe. Of course, as with any weight-loss plan, check with your own doctor. But no matter how many pounds overweight you find yourself right now, if you're in good health, my Wean-Away™ Plan will let you take it off fast and keep it off—or your money back in full (less postage and handling, of course)."

"So, try it. Take your choice of tasty chocolate, delicious vanilla, or new strawberry and banana. Use my formula for five full days. You will be trimmer. You will be slimmer. You will be lighter. And, you will see the difference in your mirror and by the fit of your clothes. Just the same, if you're not happy with my plan for any reason, simply return the unused portion within 30 days for a prompt refund, no questions asked."

DON'T DELAY!

"Send me your order now. I guarantee that if you follow my plan compared with any other over-the-counter plan, you will lose the most weight that you're capable of losing in a short period of time. And, you will continue to lose as much weight as you want to. Best of all, you will keep that weight off!"

"But don't just take my word for it. Try it. Order now, at my risk. Mail in the coupon today!"

Dr. Morton W. Levine, Plastic Surgeon and Bariatric Specialist



"My individual plans have been successful with over 10,000 patients, some of whom are pictured here. Now, I've created an over-the-counter plan that will work for you. In 4 easy steps, my Wean-Away™ Plan will help you take it off and keep it off or your money back in full (less postage and handling, of course)."

"Take a look at some of my patients. Though you may not lose as much or as fast, remember... compared with any other over-the-counter plan, your body will lose the most weight it is capable of losing in a short period of time."

SEE FOR YOURSELF!



After 10 lb. loss

Newer's bumps!

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'LOST 69 lbs.'

SUSAN HOFFMEYER
Baton twirling champ

"I LOST 69 lbs. and I'm still losing! I was never hungry or tired. I have more energy than before. It's wonderful! You lose the weight and Dr. Levine does all the worrying. He's changed my eating patterns and my life."



Before



After

'LOST 55 lbs.'

NORMA B. NADDEO

"I LOST 55 lbs. and I feel great! I have maintained my weight for over 3 years. My waist and hips are each 10 1/2 inches smaller and I look and feel better than ever. Even my business has benefited!"



Before



After

'LOST 93 lbs.'

HARVEY LEONARD

"I LOST 93 lbs. in 5 MONTHS and kept it off for 5 YEARS! I lost 12 inches from my waistline and 9 inches from my hips. I never felt better. I have more energy and I'm more alert."



After 42 lb. loss



After 69 lb. loss



After 5 yrs. Still 93 lbs. lighter and running in the N.Y. Marathon

'LOST 117 lbs.'

CHRIS SABATINO
1981 Class I, NBA, Teenage Mr. America and graduate of Dr. Levine's Weight-loss and body-building Camp Stanley

"I'm LOOKIN' GOOD! Thanks Dr. Levine. I went to Camp Stanley and kept at Dr. Levine's programs. First, I lost 117 lbs. of fat in 8 months (from 252 to 135). Then I built up 37 lbs. of muscle. Now, I'm going to work at Camp Stanley and show others how to do it!"

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Ms. Miss _____
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Phone No. _____

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Visa M.C. Int'l # _____ Exp. date _____
Account # _____

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Chocolate (#7591)
15-Day Supply \$49.95 = \$2.00 each (Total \$27.00)
Available only in check one box only:
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Assortment #7015 - Strawberry and Banana
Assortment #7017 - Vanilla and Strawberry
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Non - \$34.95 = 1.25 each (Total \$38.20)
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Assortment #7055 - Vanilla, Strawberry, Banana
Assortment #7077 - Chocolate, Strawberry, Banana
30-Day Supply was \$69.95 = \$2.00 each
Non - \$49.95 = 4.00 each (Total \$54.00)
Available only in check one box only:
Assortment #7107 - Vanilla, Chocolate
Assortment #7117 - Strawberry and Banana
Assortment #7127 - Vanilla, Chocolate, Strawberry
Assortment #7137 - Vanilla, Chocolate, Strawberry, Banana

TRAFFIC COP FOR A DAY

(Continued from page 134)

holding onto the top of the car as if the door were going to fall off.

"Parallel parking two feet from the curb.

"Turning back into a lane too soon and too fast after passing, and with no signal, yet!"

Driver Ed teacher Dale Wunsche of Pendel, Pa., adds: "The squirrel who, as soon as another driver pulls out to pass, steps on the accelerator to keep pace with the passing car. This could cause a head-on collision."

A number of people defended the practice of intentionally taking up two parking spaces in order to avoid damage from the "inconsiderate oafs" who fling open their doors and ding adjacent cars. My mama always told me that consideration is a two-way street.

The latest trick where I live is for car snobs to park catty-cornered across two spaces in the lot. When I can't find any other space, I will often wedge my old Honda into the space available, pinning shut the door of these guys who think their car is more important than mine."

Jim Graver of Springfield, Ohio, tells us:

"The person I would like to arrest is the one who waits on a side road to a main highway until you are right up where he wants you, then pulls out in front of you! (Naturally, there's no car behind you, so he could have waited until you passed.) Then, to top it off, he drives 15 mph below the speed limit and you can't pass due to oncoming traffic."

Fioravante Bares of Winchester, Mass., sends us this list:

"Double parking just before or just after an empty curb space.

"Turning without signaling.

"Cutting off a bicyclist.

"Letting your car run out of gas so it stops dead in the middle of the street.

"Keeping studded tires on the whole year.

"Losing a large part of the family garbage on the road to the town dump.

"Driving at high speed through slush, mercilessly spraying the poor pedestrians."

Harold Povill of Brooklyn, N.Y., sends in some "favorites" of many city dwellers:

"Motorcycle drivers who gun their machines to 500 decibels.

"Bicycle riders who blithely disobey every traffic rule in the book. (And then they have the nerve to blow their whistles at pedestrians trying to cross on the green!)"

"Pedestrians who cross streets diagonally and ignore traffic lights."

Complaints about physically normal but mentally deficient people who hog up the handicapped spaces came from all over. Jo Ann Green of Madison, Wis., sends a long list of parking beefs, including:

"The driver who thinks he is privileged and parks in the fire lane or in the driving lanes.

"Drivers who obviously can't read and insist on going in the OUT slot and out the IN slot."

Richard Paone of Wharton, N.J., complains of:

"The eternal blinker who drives 15 to 20 miles with one of his blinkers on so you have to guess if and when he will turn or change lanes.

"The two-footed driver who keeps his left foot on the brake and right foot on the gas. He always seems to be braking so that, when he does, you'll never know it."

Ivan Berger, a colleague of mine from New York City, writes:

"You mention driving without lights after dusk, but not driving without lights before dusk in fog or snow or overcast. Lights don't help you to see at all under these circumstances, but they do let you

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be seen, which is equally important."

We got several letters about a practice so horrifying that I never even thought of it: People who drive with children in their laps or arms! Or people who let sonny steer while dad works the pedals. As Henry Curole of Cut Off, La., points out:

"Even in a minor collision, the child could be crushed between the driver and the steering wheel."

Bruce Riley, a medical student in Sacramento, Calif., grouses about a widespread pollution problem:

"I am especially sickened by a car that's billowing out clouds of blue-gray smoke. I know new piston rings can be expensive, but they're not as much as medical costs for people with destroyed lungs."

Louis Perlman of New York City, who has a legal turn of mind, suggests that we would not have to pass seat belt laws to protect people if the insurance companies and the courts would automatically lower awards to injured people who hadn't been buckled up at the time of their accidents. I'm with Lou!

A number of people took me to task for describing law-abiding citizens as "self-righteous drive-55ers who clog up the fast lane." Emil Mabeosone of Brooksville, Fla., writes: "I wasn't aware that the speed limit was higher than 55 mph." Well put, Emil.

Curt Schlueter of Crete, Ill., is "burned up when you are at a light or just driving down the road and some nut roars past you, only to slow down to a crawl and then turn at the next corner. These drivers should be made to follow a funeral procession for 30 miles for 30 days."

R. Pappadake of Mahopac, N.Y., sees red over "the color-blind oafs to whom amber and red have taken on new meanings: FAST and FASTER!"

"How about the driver who is certain he has the right of way when he makes a right on red?" asks Donald Gworek of Buffalo, N.Y.

Mike Hinson of Lafayette, La., relates the common experience of "cruising down the interstate at a reasonable distance behind another vehicle and having some yo-yo cut between you and the car ahead. Of course, you have to slow down to maintain a safe distance."

Donald McGovern of Dubuque, Iowa, faults drivers who "swing to the left before making a right-hand turn."

Carl Gausewitz of Magnolia, Ohio, reminisces sadly about "drivers who slow down or stop at the end of freeway entrance ramps, rather than merging smoothly into traffic. Invariably, when you have one of these

idiots in front of you, a tailgater appears behind you to make the situation even more memorable."

Another reader, who shall remain nameless, would smash the bright and expensive halogen headlights of drivers who forget to dim them.

My favorite letter comes from a Jesuit priest in Malaybalay, Bukidnon, the Philippines. The Rev. Joseph I. Stoffel writes:

"I live next to a church and too many worshippers forget about the Golden Rule as they take turns parking in front of my driveway. My dad always used to joke that the biggest

problem facing Christianity today is parking. I'm not so sure it isn't driving. Just listen to yourselves out there, calling one another idiots, nincompoops, hoodlums, yo-yos, oafs, nuts, dummies, hockey pucks and dingbats! And gleefully plotting all sorts of dangerous revenge! I'm glad I take the train to work! Now I'm considering taking the bus to the railroad station. There's just too much hostility out there, even for a kid from a tough neighborhood! If we'd all apply a little Christian charity (me, too!) this would be a better world to drive and to live in." **PM**

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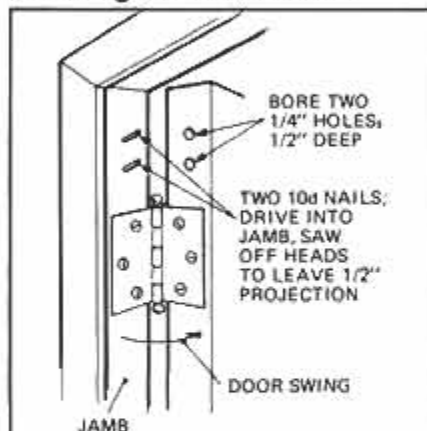
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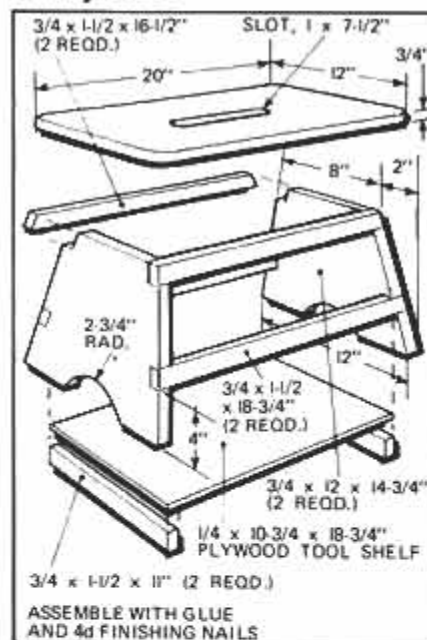
HINTS FROM READERS

Securing an exterior door



To keep intruders from removing hinge pins of an exterior door opening outward, hacksaw the heads off two 10d nails. Drive them into the jamb so they protrude 1/2 in. Close door to mark it with the nails. Then bore 1/2-in.-deep holes in the door at the marks. Close the door so the nails seat.—Gus B. Doppes

Handy stool



A plastic-laminate sink cutout makes a good stool top. Cut a centered finger slot for carrying the stool. Round all edges slightly. Cut the sides and make the bottom cutouts. Cut cross braces. Then carefully lay out and cut notches in the sides for the braces to ensure a neat and strong fit. Assemble parts with white glue and 4d finishing nails, toenailing the top. Cut and attach the shelf and cleats.—Robert Udesen

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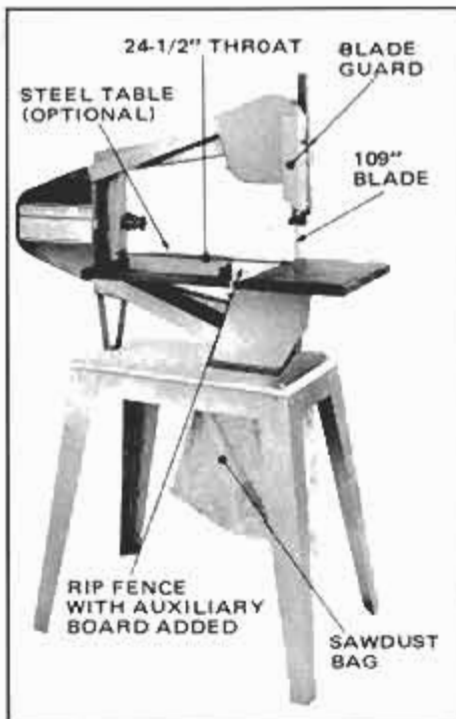
PM LOOKS AT A SUPER NO-FRILLS BAND SAW

One of the most interesting aspects of our work is getting the opportunity to use a wide variety of tools, then sharing the findings with PM readers. Every once in a while, a tool comes along that triggers an instinctive feeling that it is equal to, or better than, any similar tool we have used. Such was the reaction to the band saw shown here. From the moment it was unpacked, we sensed that it was a no-nonsense type of tool. Subsequent tests proved our initial judgment correct.

Manufactured by Dupli-Carver, the saw represents an interesting approach to tool design. The designer started by asking professional cabinetmakers what features they do—and don't—use on a band saw. His findings showed that most band-saw users don't use many of the "extras" commonly found on a band saw.

His findings coincide with our own experience. For example, this isn't the tool we use to make accurate cut-offs. Similarly, when a professional makes a bevel cut on a band saw, he rarely relies on the tool-affixed

(Please turn to page 142)



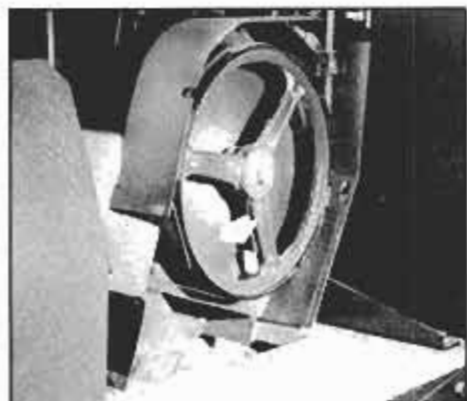
Ruggedly built saw comes with bare minimum of extras, but is long on quality and important features—for example, throat capacity is Paul Bunyan-sized 24½ in. and tool will cut a 9-in.-thick piece of stock.



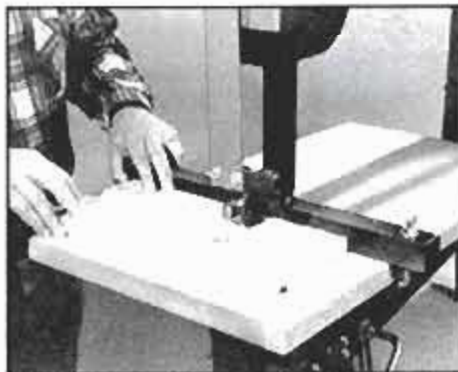
With rip fence locked and an auxiliary (high) board added, authors made test cuts by sawing this log from the woodpile.



The fourth and last cut brings the log to a fairly accurate square shape. The next step for the stock is the jointer.



Sawdust is coaxed into bag below by tiny fins (arrows) added to lower wheel spokes.



Straight ripping is a snap; the plain-looking rip fence locks positively and quickly, using two 90° studs and wingnuts.



Band saw does not come with a miter gauge; maker's survey showed that most cabinetmakers don't use a band saw for accurate cutoffs. Here, authors plow a groove with a router and straight cutter so they can use table-saw gauge, if desired.



To lock fence, you simply swing the L-shaped studs at both ends under the table.



Next, tighten the pair of wingnuts at top. The hardware's grip on table is absolute.



There is no scale for setting the table for a bevel cut. Instead, tilt the table to desired angle using a bevel T-square for a guide, then lock the arm in place.

NO-FRILLS BAND SAW

(Continued from page 141)



This locking device, which secures the blade guard, isn't fancy, but it works as well as any locking device authors have ever used on a band saw. Like the studs on the rip fence, this has a 90° bend which makes for effortless turning either direction.

gauge; he generally uses a bevel T-square or a jig to set the angle.

Based on these findings, Dupli-Carver has produced a saw that is unbeatable for \$500. You can purchase an optional steel table, or work with the particleboard top that comes with the tool. A rip fence—which doesn't ride on scribed rails—also comes with the tool. The fence was reliable and, since we always use a ruler to set the band-saw fence, as quick to use as the single lock-lever type of fence.

All the locking devices are very simple. On the blade guard in the photo at left, for example, the locking device prompts the reaction: "Why didn't I think of that?" We raised the guard, locked the control



This hefty piece of walnut was quickly and accurately resawn using fence as guide.

knob and tried to pull the guard down. It didn't budge.

Based on its price tag, we have to rate this as one of the best stationary tools we've ever used or tested. If you're a serious woodworker in the market for a band saw, you should strongly consider this tool.—*Al Sittner and Harry Wicks*

SPECIFICATIONS—BAND SAW

Model: B-245
Throat capacity: 24½ in.
Blade length: 109 in.
Blade tooth speed: 3,600 saw ft. per minute
Cutting capacity: 9 in.
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Accessories (at above price): Stand, built-in dust collector, ½-hp capacitor-start motor, scroll saw table, rip fence, ¾-in. blade.
Manufacturer: Dupli-Carver, 4004 West 10th St., Indianapolis, Ind. 46222. For brochure and dealer information, send \$1 to manufacturer.



The resawn piece is now smooth and ready for planing, jointing or turning on the lathe.



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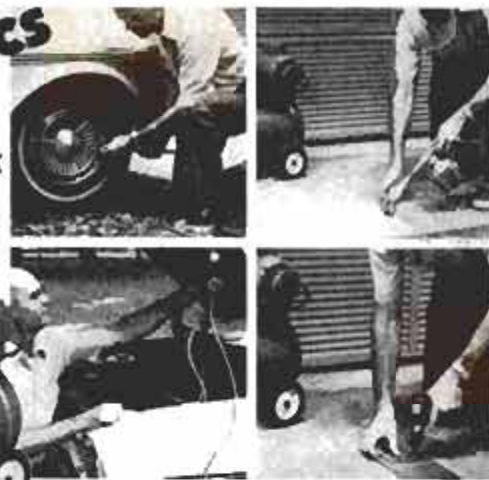
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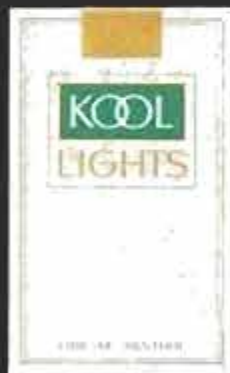


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