

APRIL 1987 \$1.50

Popular Mechanics

**EXCLUSIVE
REPORT**

**HOW THE
SOVIETS ARE
TAPPING
OUR PHONES—
AND WHY WE
CAN'T DO
ANYTHING
ABOUT IT**

By Sen. Daniel
Patrick Moynihan

DESIGNED TO BE INVISIBLE

AMERICA'S NUCLEAR STEALTH SUBS

FAST AND FLASHY

America's Most
Exotic Cars

BLOW-UP WAVE BUSTERS

We Test 6 Fast
Inflatable Boats

NEW LOOK FOR HOLLYWOOD CLASSICS

Video Paintbrush
Adds Color To Old
Black & White Movies

STEP-BY-STEP GUIDE HOME IMPROVEMENT

- Finish A Room In Redwood
- Install Vinyl Tile
- Add A Cedar Shake Roof
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This One



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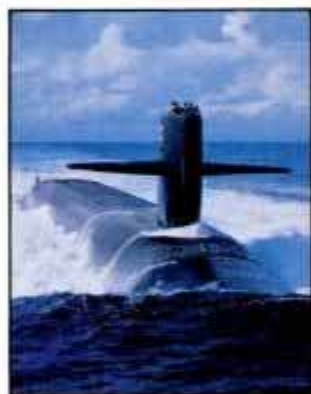
After all, both feature powerplants that evolved from innovative Honda engineering. Mid-mounted for optimum maneuverability, the advanced Overhead Valve

engines that drive our riding mowers set the industry standard for fuel and oil efficiency. Like our automobiles, our riding mowers are easy to handle. With Honda's exclusive Mechanical Autoclutch Transmission (MAT™), there's no clutch pedal to operate. You just shift gears and mow. Of course, all Honda products share an impressive reputa-

tion for reliability.

Admittedly, a top speed of 5 mph is slow for a Car-of-the-Year, but a beautifully manicured lawn may help you overlook that. Indeed, you may be inclined to overlook our competition, once you realize that for the price of a riding mower, you can own a Honda.

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ON THE COVER

The \$1.5 billion TRIDENT is the U.S. Navy's largest and most heavily armed ballistic-missile submarine. The huge 4-deck vessel, the quietest sub in the fleet, contains sensors and deceptive decoys able to confound searching enemy ships. Find out more about the technology behind the Navy's newest sub in the exciting story on page 86.

—PM photo by Skip Gandy



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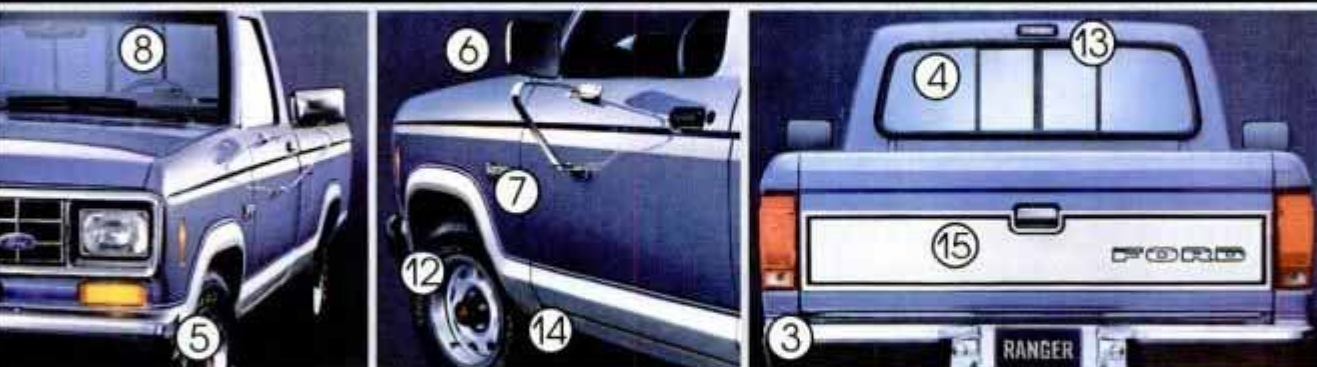


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Editor's Notes



Nineteen eighty-seven marks our 85th year of publishing POPULAR MECHANICS. Our first issue was the January 1902 edition. Interestingly, our first cover depicted the inside of a submarine. This month's cover story is, once again, on submarines (page 86). But what a difference! Today's nuclear-powered attack subs can stay submerged almost indefinitely, and one can carry more destructive firepower than all the bombs dropped in World War II. And thanks to the latest stealth technology, they're almost impossible to detect. All this in just 85 years.



Sutton, Graphics Director Bryan Canniff, and gear.

Makes you wonder what the next 85 years will bring. . . . The first time I met Humphrey Sutton, he was wearing an aluminum umbrella on his back and a bunch of camera equipment around his neck. I was introduced and we shook hands. But being a dumb cub reporter on another magazine back then, I didn't know who he was and I wasn't overly impressed. It wasn't until later, when I saw his photographic work in other auto magazines, that I realized that I had met one of the premier automotive photographers of our time. In the ensuing years, Humphrey's work has appeared in every major auto magazine and other types of publications as well, including POPULAR MECHANICS. In fact, Humphrey shoots most of our car photography, and we always call him when we want the impossible shot. For instance, to get the fantastic photo that kicks off our *Hot Rubber* high-performance tire article (page 82), Humphrey had to rig up fender brackets, remote-control shutter releases, shock absorbers for his camera, and much more. But he got the shot, which is typical of Humphrey's attitude. No shot is too tough. The other side of Humphrey Sutton's work is the sensitive portraiture that he did for our special issue last July. The man is a genius with a camera, and we're glad to be able to present his work in our pages. . . . What do you think of the new color versions of classic Hollywood films like "It's A Wonderful Life" and "The Maltese Falcon"? While the debate over the merits of film colorization goes on, the fact that such a thing is possible today is what is remarkable to me. Imagine a person sitting at a computer adding color, frame by frame, to a film and having it come out looking like it was always there in the first place. It's a miracle, of sorts, although I'm not sure about the ethical aspects of a computer operator sitting there and deciding what color suit Jimmy Stewart wore that day without consulting either Mr. Stewart or Frank Capra. Still, the process is fascinating, and we've got the story for you on page 98. . . . So now we find out that the Soviets are monitoring every long-distance call that goes in and out of this country—and that we can't do a damn thing about it. The calls are traveling through the air, up and down to satellites, and everyone has equal access to the air in this country. Sen. Daniel Patrick Moynihan (D-NY) performs a public service by letting us know about this threat to our right of privacy (page 102). But he's just as frustrated as the rest of us in doing something to prevent the theft of that privacy. 'Til next time.


Joe Oldham

Popular Mechanics

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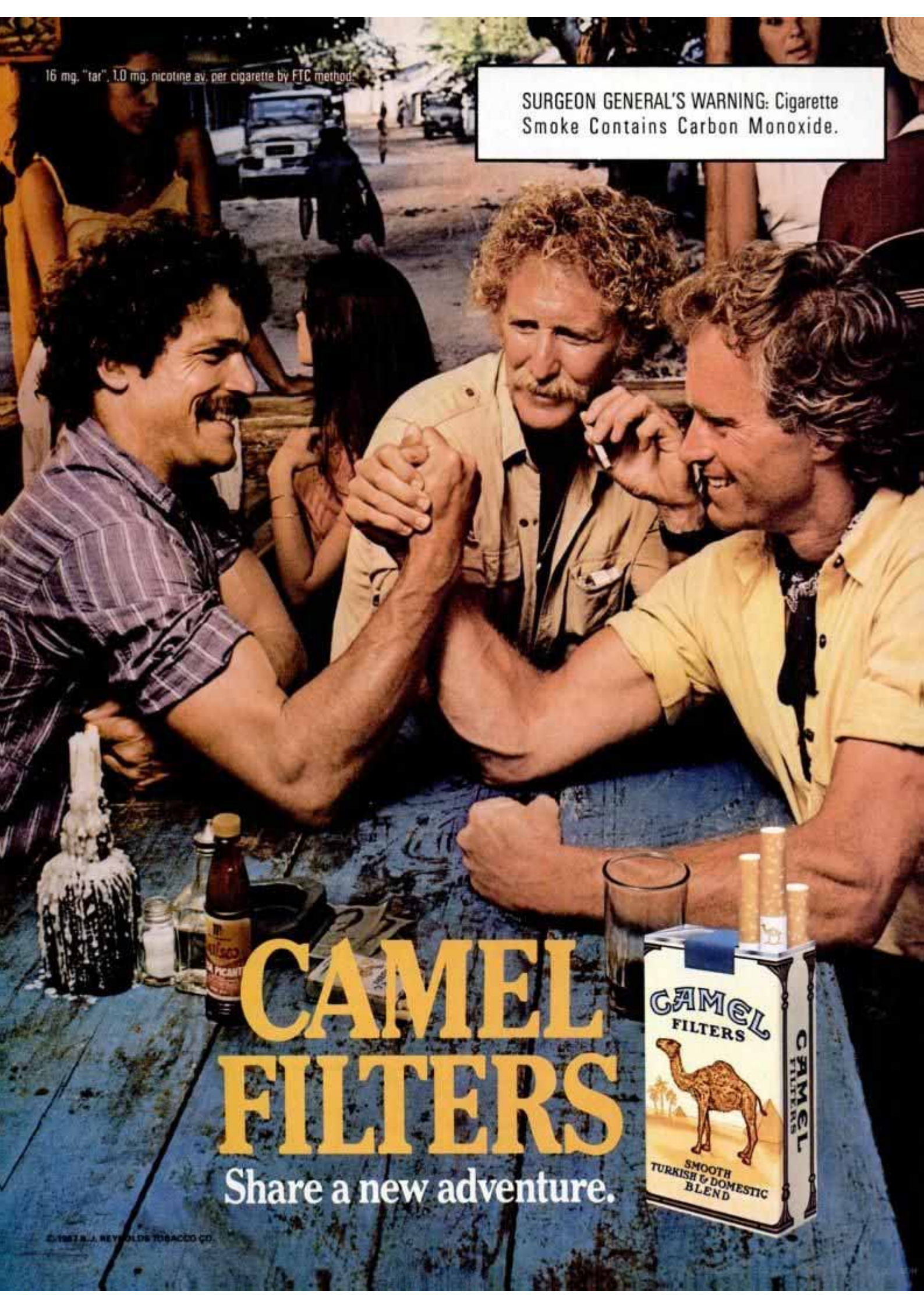
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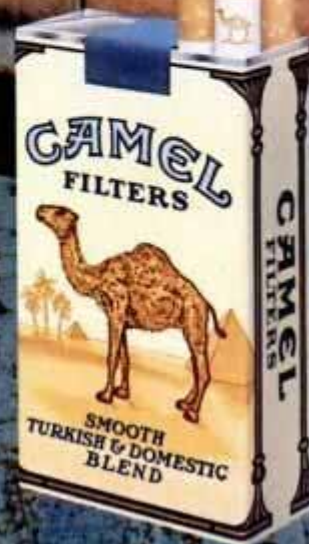
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Letters



Be A Sport!

I received my January '87 issue and went straight for the article titled "This Sportin' Life" (page 60). Because I drive one of the cars listed, it was of specific interest to me. My concern was the ranking of the Toyota Cressida as last in an 8-car race.



Cressida should have had sport options.

As I read on, I found that the model tested was the family sedan, equipped with automatic transmission, and not the sport sedan which is equipped with a 5-speed transmission, limited-slip differential and electronic-modulated suspension system (adjustable shock absorbers).

These few options could materially affect many of the tests used to evaluate the cars as sport sedans. To be specific, gasoline mileage, 1/4-mile speed slalom and skid pad.

I have never written to a publication before, realizing that the tester is voicing an opinion, but please do not compare apples to oranges.

When a sport sedan is included in a model line, please use it when testing sport sedans. Many people, including myself, are unwilling to give up creature comforts, such as automatic transmission and a softer ride, in exchange for slightly improved economy and tests that are of value only when driving a car to its limit.

Now that I have gotten this

off my chest, I'll say that I have been, and still am, an avid reader of POPULAR MECHANICS. I enjoy the diversity of topics covered and read the magazine from cover to cover. My primary interest is automotive and I find your coverage on car care and troubleshooting outstanding. Keep up the good work and fine articles.

WILLIAM O. ROBARDS
BONNE TERRE, MO

Like most magazines, PM cannot buy every car it tests. We borrow them from

the manufacturers and importers. We may ask for the best-performing "sport" version, but we don't always get it, even when we make it clear to the car company that it's in their best interest to supply a car comparable to the others in the test.

When we don't get a car equipped the way we'd like it, we have two options: First, we can drop it from the test and pretend it doesn't exist; or second, we can test the model we've got in order to give readers some idea of what the vehicle is like. We usually choose the latter. In the case of Toyota, we couldn't pretend that the best-selling import doesn't exist. You can be sure that your letter will be seen and heard at Toyota and other car companies and result in fairer PM car tests.

Architects first

Don't put the cart before the horse. The first step anyone should take in a restoration project is to get in touch with an architect for a consulta-

tion. If readers follow the advice in Bob Vila's column "Working With Contractors" (*Old House Restoration*, page 22, Jan. '87), they may be put in a precarious position. Mr. Vila only briefly mentions consulting with an architect after asking the reader to decide whether one is necessary or not. I'm a subscriber to PM and am all for "doing-it-yourself," but tearsheets from magazines and photos of other neighborhood jobs are a poor substitute for well thought out, carefully prepared documents done by a professional architect.

ROBERT L. RODIN, ARCHITECT
PORT WASHINGTON, NY

Don't lock 'em!

Millions of dollars have been spent to develop antilock brakes that prevent locked wheels in panic stops, yet you recommend having "brakes that are capable of locking up a wheel in a panic

stop if it is necessary . . ." (*Wonder Wagons*, page 80, Dec. '86).

Too many drivers think locked wheels stop a car best. It's unfortunate that you are perpetuating the myth.

EDWARD NEPARKO
SOUTHWESTERN OKLAHOMA
STATE UNIVERSITY
WEATHERFORD, OK

You're right about not locking the wheels. We didn't mean to imply, nor did we say, that the best way to stop a car in an emergency is to lock up the wheels. What we did wish was that Taurus's brakes were better, powerful enough to lock up a wheel. For example, race cars aren't allowed on the track if their brakes can't lock up the wheels. Once you've got strong brakes, it's up to the driver to modulate braking pressure to avoid lockup and really stop the car in the shortest distance.

Affordable housing



Perfect playhouse, thanks Dadi!

I got the necessary push to build a playhouse for my kids from your *Space Expanders* story ("Build A Playhouse For The Kids," page 106, July '85).

The construction explanations and the detail drawings were excellent. I followed them to the letter.

The total cost of building the playhouse was \$220.

You should run this article every couple of years for other parents; without it, my kids (pictured top to bottom: Melissa, Jennifer and Joey) probably wouldn't have their playhouse today.

LARRY ENGLISH
GLEN DALE, WV

As longtime subscribers of PM, we are constantly amazed at the originality of your projects. My husband decided that originality was what was needed for a Barbie Doll Playhouse after seeing commercial houses that are so expensive and cheaply made. Ours is scrap cedar with Plexiglass windows and hinged decks that fold down for storage. I made the curtains from scrap material. Techniques learned from your stories helped it all go smoothly.

EDNA BERKEY
MILLVILLE, DE



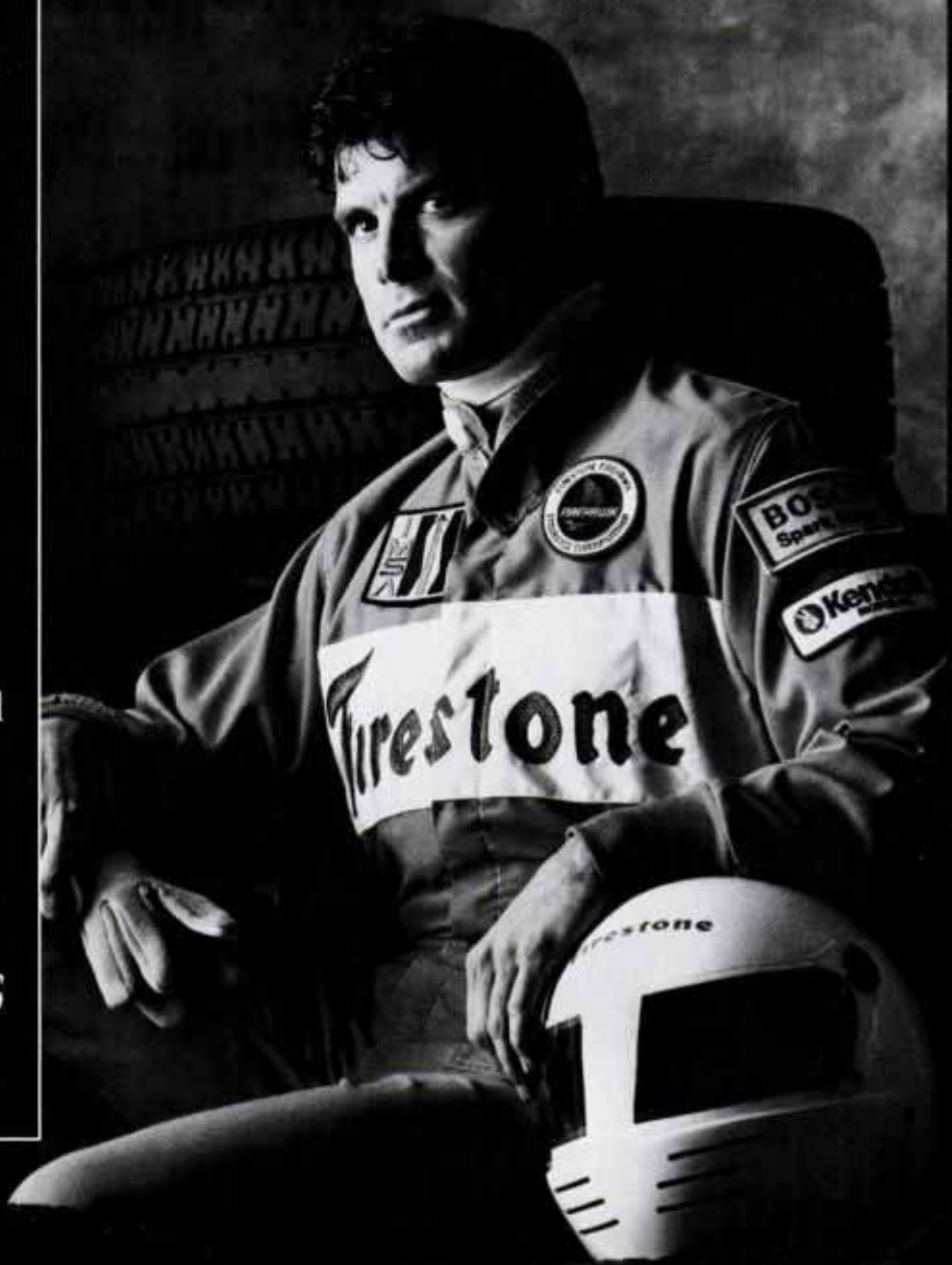
Superscale dollhouse designed by reader Berkey is 5 ft. high.

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Imports

BY BILL HARTFORD



The 1988 Renault Medallion DL wagon has a base price of \$11,000.

April In Paris



If you thought the fine art of "cruisin'" was strictly a Main Street phenomenon, you've never strolled France's main drag—the Champs Élysées—on a warm spring evening. The street and sidewalks are a clog of cars, and café racers, punctuated by pedestrians admiring the vehicular fashion show. Now, *that* would be the place to try Peugeot's car of tomorrow, the Proxima. You wouldn't need any of this prototype's 600 hp or the anti-lock brakes or the electronic navigation system, but you could use the anticollision ra-

Peugeot Proxima is a striking car-of-tomorrow prototype.

dar to keep from bumping the cars ahead as you watch the parade from under the glass bubble canopy. Anything you missed you could catch on the rear-view TV screen. You can't buy this cruiser, but you can see it at the New York Auto Show at the new Javits Center starting April 18.

Peugeot's production cars will be at the show, too—from the 505 GL at \$14,160 to the \$23,750 505 STX V6. Turning several laps at Lime Rock using all of

the latter's 145 hp was how we discovered that Peugeot has the perfect balance of performance and luxury built into its new flagship. Another place you'll see the 505 perform is on U.S. road circuits where it will compete in IMSA and SCCA events.

Renault's latest, the first of its new cars for 1988, has just arrived here from its point of origin in Maubeuge, just north of Paris. The front-wheel-drive Medallion is the biggest and best Renault ever to hit our shores. It's been proven in Europe where the sedan, called the R21, was introduced a year ago, and the wagon, called the Nevada, had its debut last fall. The wagon isn't as big as Peugeot's, but it's still a whopper that's available in 5- and 7-passenger versions. Power is from a 2.2-liter, 103-hp, fuel-injected Four with choice of 3-speed automatic or 5-speed manual transmission. This is a Renault that's going to be very competitive against the other European and Japanese imports in its class. Next up is the Alpine, the "French Vette" we've already driven (*Imports*, page 12, Aug. '85), and the Giugiaro-styled Premier. In the world of cars, 1988 is already here.

Not a mirage

Mitsubishi's 1987½ Precis is the new entry-level car in the Japanese automaker's lineup. And if it looks familiar, you're right. Mitsubishi owns part of Hyundai and helped get the Korean-built Excel to market. Now the company is bringing its own version of the car here—just as we predicted in our Hyundai report (*Imports*, page 12, Oct. '85). The Precis comes with Mitsubishi's 1.5-liter, ohc Four (the same engine Hyundai puts in the Excel). It delivers 29 mpg city and 34 highway with the 5-speed stick. The Korean-built Precis allows you to shop a Mitsubishi store with a \$6000 budget



The Precis is Mitsubishi's version of the Hyundai Excel.

and still bring home a car. Offered in base and LS trim levels, the Precis replaces the low-trim versions of the Mirage. The Mirage models still in the line are the luxurious 4-door and the pocket-rocket Mirage Turbo. Winners both.

Top-down time



Jaguar XJ-S conversion loses hardtop, but keeps 262-hp V12.

It'll take a fair-sized fresh-air fund to breeze out to the country in Jaguar's XJ-S convertible — about \$50,000, in fact. But the Hess & Eisenhardt conversion, special-ordered and warranted through Jaguar dealers, gives you a soft-top automobile that's got it all over the competition in that stratospheric price class. **PM**



Catch wind of Porsche's topless 944 (above) and new Lotus (top)! Both are on the way.

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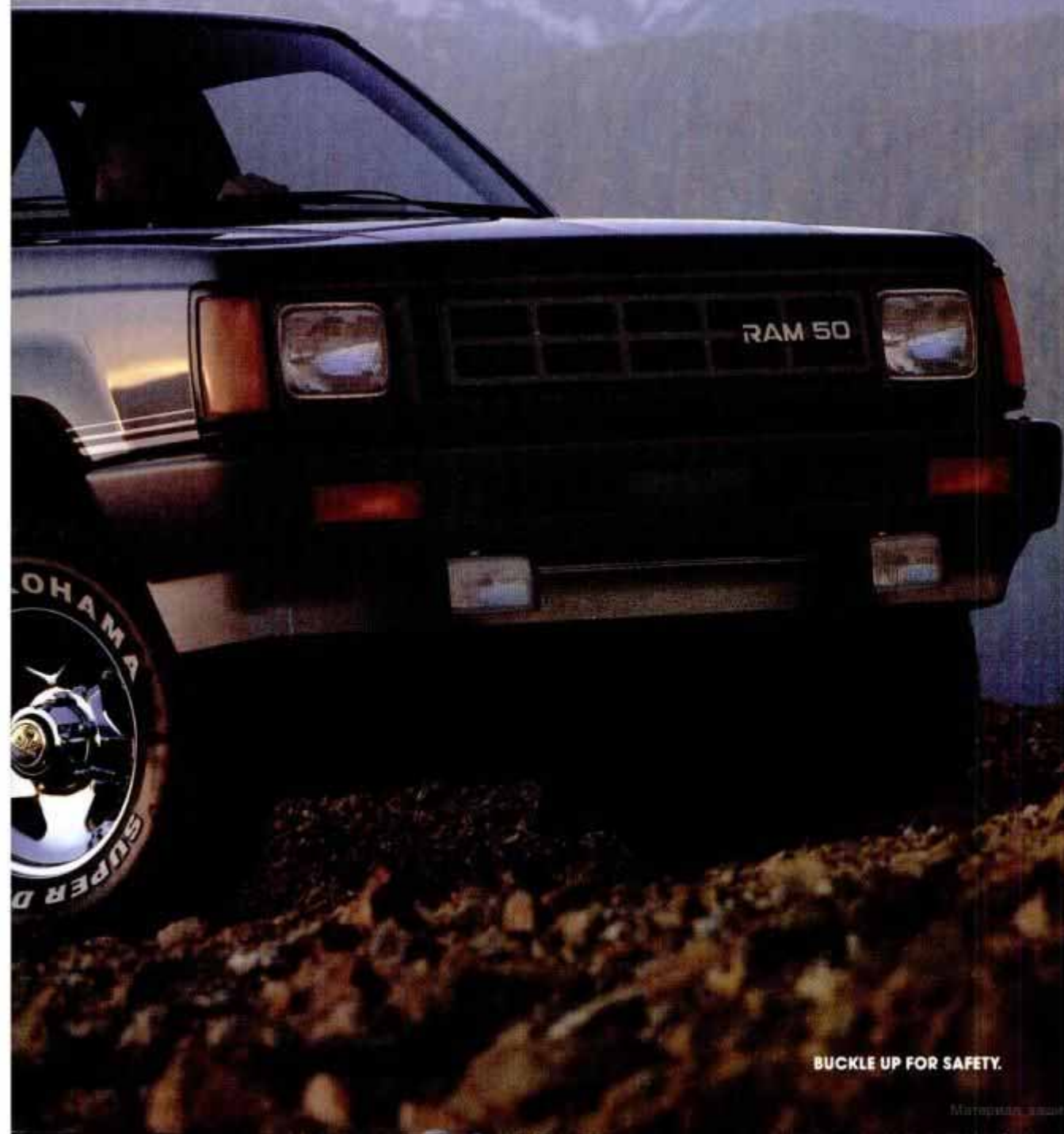
There's also a double wishbone type front suspension to smooth out the bumps. And if all that sounds good, how about an available stereo system with 25 watts-per-channel, cassette, 4 speakers, graphic

equalizer, the works. Buy or lease the new four-wheel drive Power Ram 50. It's ready whenever you are.



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BY FRED MACKERODT

New Power To The Props

When it comes to engines for general aviation aircraft, there's good news and there's bad news.

The good news is that these engines are tremendously rugged and reliable. Accidents due solely to mechanical failure do occur, but they're probably on the order of a couple for every 100,000 hours flown.

The bad news is that general aviation engines are hopelessly archaic, technologically speaking. The current crop of air-cooled piston powerplants are more closely related to the engines that powered the B17 than to the existing standards of technology. Magnetos in this day and age of foolproof electronic ignition systems? Come on fellas, you have to be kidding!

Liquid cooling

The good news from one of the two domestic manufacturers of general aviation engines—Teledyne Continental Motors—is that they're in-

roducing liquid cooling. This news would add up to a minor blip in any other field, but because of the snail's pace of aircraft engine development, it has to be viewed as a major breakthrough in this context.

The Voyager 550, a 550-cu.-in. engine rated at 350 to 400 hp, will be the first to get FAA certification—by the end of the year, they say. Essentially, the liquid cooling is added to an existing air-cooled design by shrouding the outer end of each cylinder near the combustion chamber with an integral coolant jacket. Other than this modification and the addition of a radiator, the liquid-cooled engine is identical to the air-cooled powerplant.

The benefits of liquid cooling are many. It provides more uniform cooling, which allows closer tolerances. Closer tolerances provide much better engine wear characteristics and extend the time between engine overhauls. It also decreases

fuel consumption and increases power by allowing higher compression ratios without risking engine-destroying detonation. Because it retains heat, liquid cooling removes much of the problem of shock-cooling, which occurs when a pilot is forced to make a quick descent by pulling the power all the way back and descending at a high rate of speed. Liquid cooling also offers reduced cooling drag by concentrating the area to be cooled with the radiator area.

Continental may eventually convert all of its engines to liquid cooling. A proof-of-concept, 200-cu.-in. version was one of the engines used to power Dick Rutan's nonstop flight around the world.

More good news is that the liquid-cooled engines will be priced about the same as the air-cooled versions. The bad news is that with some of the bigger engines exceeding \$40,000 a copy, general aviation engines are outrageously expensive to begin with.

Rotary possibilities

Meanwhile, the good news at Avco-Lycoming—the other domestic engine manufacturer—is that the company has developed a stratified-charge, turbocharged rotary engine. The displacement of the twin-rotor prototype is 210 cu. in. and power is estimated at 400 hp.

Liquid cooling is also part of the design. The benefits of a rotary engine over a conventional piston engine are numerous. It develops significantly more power per pound of weight. Its appetite is omnivorous, being able to burn almost any fuel that will fit through the injectors. The rotary is also inherently smooth running and quiet. And it has many fewer parts, simplifying maintenance.

Avco-Lycoming was on the road to developing the aviation engine of the future, but the project was canceled due to a 500 percent increase in liability insurance, and a lack of interest from any airframe manufacturer due to their own liability-based woes.

If technological development in general aviation isn't going to remain at its present standstill, something has to be done about this problem of increasing liability insurance. John Deere Technologies International, Lycoming's partner in the project, will continue to develop the engine for other applications.

Good news

The good news at Norton Motors Ltd. of Great Britain is that they've developed their own rotary engine which might be available to homebuilders in this country by the end of this year. Rated in the area of 50 hp and also liquid cooled, the price is also rumored to be reasonable enough to make the engine accessible to builders of experimental airplanes. We'll keep you up to date on any developments.

Teledyne Continental has a licensing agreement with Norton to develop two versions of this engine.

Training bargain

Most people recognize the name Flight Safety International as belonging to the organization that trains and re-trains the pro pilots who fly heavy iron like the Lear's, Citations, Gulfstreams, MD80s and DC10s of the world.

But few people realize that Flight Safety also offers training for the private pilot license.

Its Vero Beach, Florida, division—where I recently took a 3-day Multi-Engine Instrument Refresher Course—has a 5-week intensive program leading to a private ticket. It includes 53 hours of ground school, 37 hours of flying and 10 hours of private tutoring, and costs only \$2919. This even includes the fee for the FAA flight examiner. Dormitory-style accommodations are available for about nine bucks a night.

If you know anybody interested in getting their first ticket, who has five weeks to spare in the Florida sun, have them call John Mareno at (305) 567-5178. **PM**



Aviation breakthrough: Voyager 550 liquid-cooled engine.

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Old House Restoration



BY BOB VILA

Paint Problems

Today's house paints are higher in quality and more versatile than ever. On most surfaces, they can retain their good appearance for 10 years or even longer. Nevertheless, many paint jobs are short-lived, and you can't blame the paint. In most cases, the cause lies elsewhere. Let's take a look at several exterior painting problems, discover their causes and see how to prevent them.

Blistering—This is the earliest stage of peeling and is usually caused by moisture trapped under the new paint coat or by poor surface prep-

aration. If it occurs within the first few weeks, it's probably caused by trapped moisture. While latex paint can usually be applied to damp surfaces without any problem, alkyd and other oil-based paints form a moisture barrier skin that traps the water inside. The water then turns to vapor and forms blisters. To avoid this, never paint with alkyds after a rainstorm, when the relative humidity is more than 85 percent, while dew is on siding, or too soon after you've washed the old surface. Also, never paint when the temperature is more than 90° F.

If the blisters appear after a month or so, the problem is probably poor surface preparation. If you washed the surface down with detergents, did you take the time to rinse completely? Is there heavy local air pollution or salt spray? Unless such films are removed before painting, they can cause blistering. Also, glossy surfaces must be given a light sanding beforehand, so the new paint will grip well.

Peeling—This is the curling of large pieces of dried paint and is merely a later manifestation of blistering. Severe peeling may also indicate use of a poor primer, or a very heavy film of dirt, grease, dust or other foreign material on the original wood surface. To minimize the chance of the new coat peeling, you should sand or wipe the old finish with a deglossing liquid. Then follow the manufacturer's directions carefully as to what primer, if any, is required before applying the top coat of paint.

Alligatoring—This is a cracking and flaking, in a square pattern, of the paint surface. It can result from applying paint over a previous coat that had a high-gloss finish but was not sanded, use of the wrong primer or

use of old paint, particularly paint that's been stored in an unheated space and allowed to freeze.

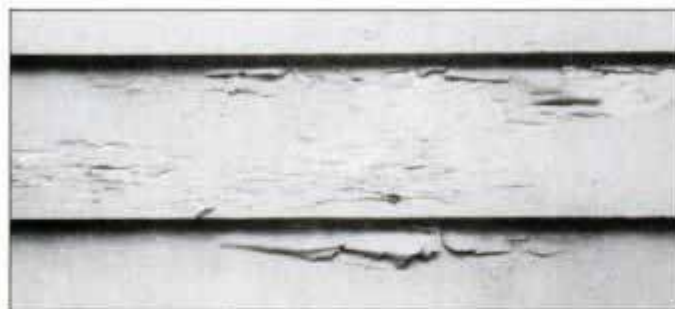
To repair the condition, sand the surface smooth then apply a proper primer or undercoat before applying the new top coat.

Checking—Checking is a series of long lines, with shorter check marks crossing between, usually caused by the wood underneath expanding and contracting. This can be a problem with exposed plywood siding regardless of the kind of paint used. Sanding and then applying a new coat of wood primer—Chek-Gard by Sherwin-Williams is a good one—will usually solve the problem. But if the new paint shows signs of coming loose, complete removal of the old paint is required.

Wrinkling—This results in a crinkled surface that is caused by interfering with recommended drying time. Contributing factors are: too-thick finish coat, buildup of too many layers, undercoat

(Please turn to page 21)

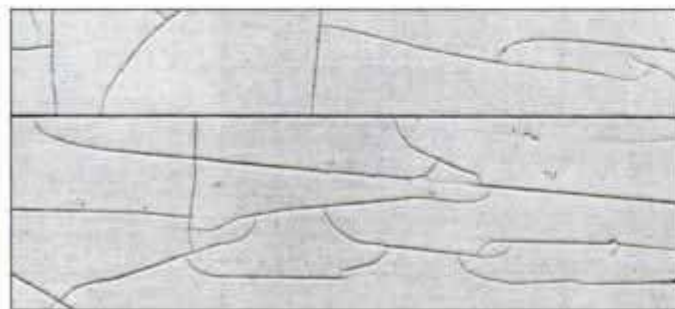
Contributing Editor Bob Vila is host of public television's "This Old House," funded by Owens-Corning Fiberglas.



Blistering and peeling are caused by trapped moisture.



Alligatoring is caused by painting over a glossy finish.



Checking is caused by movement of wood under paint coat.



Wrinkling is caused by paint that doesn't dry properly.

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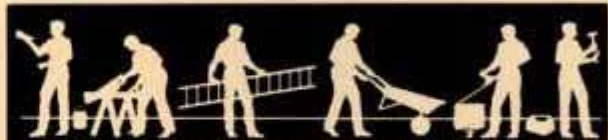
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OLD HOUSE RESTORATION

(Continued from page 16)

that was not completely dry, wrong solvent or improperly stirred paint. Repair by sanding the surface smooth, covering with the proper primer and then painting the top coat.

Chalking or powdering—Some paints are designed to chalk to keep the surface looking new. Chalking of old paint can interfere with proper bonding of a new coat, so scrub off as much of the residue as possible beforehand.

In severe cases, you may have to apply a bonding primer or sealer—Flood Co.'s Emulsa-Bond for instance. Follow the specific manufacturer's instructions for such products.

Mildew—This manifests itself as patches of black spots. Though most exterior paints contain mildew-inhibiting ingredients to retard growth of this damaging mold, none work under all circumstances. To remove mildew, wash down the affected area with a bleach solution. I recommend the following mixture: one-third cup of powdered laundry detergent, two-thirds cup of household cleaner containing trisodium phosphate, and one quart of household bleach. Wear long pants, a long-sleeved shirt, gloves, goggles and a respirator to avoid breathing the fumes.

Stains that bleed through the paint—These are often the result of sap from knots in the wood seeping through the surface. But it can also be caused by rust from nails or metal hardware. Many discolorations "bleed through" coat after coat of paint, so repainting alone is not the answer. Instead, apply a primary coat of stain-killer, such as pigmented shellac-base sealer.

Painting guidelines

Here are some guidelines to keep in mind for any exterior painting project:

1. **Repair structural defects first.** Before applying primer or finish coat, it is necessary to repair all damaged exterior areas which may be possible sources of leaks and subsequent paint deterioration. Replace all caulking that is cracked, missing or pulling away. Caulk cracked siding and trim or replace the cracked pieces entirely. Patch cracks in stucco or masonry; small cracks can be filled with caulk and larger ones with a vinyl-concrete patching cement.

2. **Follow the manufacturer's directions for mixing, thinning or applying the paint.** Thorough mixing before you start is especially important with exterior paint. Don't try mixing in a full can—you should first pour half the contents into an empty can, then use a paddle to mix what's left in the original can until it's uniform in color and consistency. Then pour this into the second can and mix again. Pour back and forth

two or three times, then mix once more with the paddle.

You can apply most exterior paints with any of the common applicators such as brushes, rollers or painting pads. The choice should depend on the type of surface being painted. For stucco, smooth concrete and similar large surfaces with moderate texture, a deep-nap roller with a long-fiber cover is the best tool. For surfaces with a very heavy texture, buy a roller with the longest fibers available (1½-in. pile). On clapboard siding, a large brush is okay. But keep in mind that a synthetic brush, made of nylon, polypropylene or polyester bristle, should be used with latex paints, while natural bristle brushes are designed for oil-base paints. Don't use natural bristle with latex paints—water will penetrate the bristles and cause them to go limp, making the application of paint very difficult.

For wood shingles and shakes, a flat painting pad is probably the best tool.

3. **Prepare the old surface before you apply new paint.** Proper surface preparation is essential for the new coat to live up to expectations. First, scrape away all loose paint, sand and scrub the surface, then rinse. Remove any mildew, let dry for 48 hours, then prime and apply the top coat.

4. **Use the proper paint for the surface or conditions involved.** Despite advertising claims to the contrary, different paints or finishes are required for different surfaces. Wood shingles and shakes are better left unpainted unless they already have paint on them. Ideally, they should be stained with a semitransparent stain or treated with a clear wood preservative. These products soak into the wood, so they can't peel or blister. However, if the surface is already painted, stay with paint or use a heavy-bodied opaque stain specially formulated to go over paint.

Wood siding may be coated with house paint that dries to a gloss, semi-gloss or dull finish. If you are using latex to paint over latex, no primer is needed. You can also use latex over weathered oil-base paint, but if the oil paint is still glossy, prime the surface first with an acrylic latex primer to provide a grip for the final coat. If you paint over latex with oil paint, no primer is needed. Paint stucco and masonry with specially formulated alkali-resistant paints. As a rule, latex-type masonry paints work the best, last the longest and are the easiest to apply.

One final note: Of all home maintenance chores, painting is perhaps the easiest and most cost-effective for do-it-yourselfers. In addition to the gratification you'll receive from tackling the job yourself, you can save at least two-thirds of the money you would spend by hiring a contractor, probably more. **PM**



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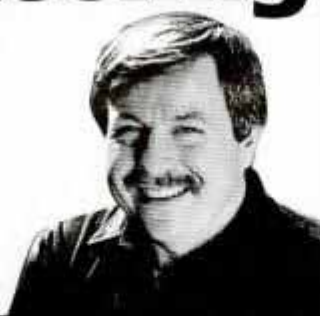


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Freewheeling

BY WADE HOYT



Art And The Automobile

When Jacques Vaucher worked for former U.S. Ferrari importer Luigi Chinetti, he discovered that wealthy clientele were interested in buying artwork depicting their favorite subject—Ferraris in particular and great cars in general. Jacques held several art shows for Chinetti, then went into business for himself six years ago, opening a modest gallery on New York's tony Up-

per East Side. It's a fascinating place for any car nut, packed with paintings, posters, books, antique toys, classic hood ornaments, sculpture and case after case of models—all of cars. The gallery is called, appropriately enough, *l'art et l'automobile*.

Most of the books are motoring classics, long out of print. The posters go back to the turn of the century—magnificent things like the pastel 1906 Michelin ad by Ernest Montau (left), depicting a 600-km race in 1905 between a car shod with Michelins and a crack express train. In those innocent days before gridlock, the car finished a half hour before the locomotive. There are cases full of model cars, from

$\frac{1}{43}$ -scale race cars—meticulously painted, with all the right decals and numbers, to match actual cars in actual races—to a \$4500 $\frac{1}{8}$ -scale '29 Miller Indy car that's a real museum piece. Most fascinating to me was a series of $\frac{1}{43}$ -scale race cars from England complete with $1\frac{1}{2}$ -in. hand-painted sculptures of their drivers—a mini Stirling Moss, Graham Hill, Mike



This 3.0 CSL by Alexander Calder was raced in '75 by Sam Posey.

Artmobiles

Another patron of the arts in a unique way is BMW, which has commissioned contemporary American artists to paint cars raced at the 24 Hours of LeMans. The cars were re-



Peter Gregg raced the Stella "blueprint" (above) in 1976. Roy Lichtenstein 320i (right) won its class at LeMans in 1977.



Andy Warhol painted the '79 M1 with a broad brush.

cently displayed at the BMW Gallery in Manhattan, perhaps one of the world's classiest car showrooms. Over in one

Hawthorne (with a microscopic polka-dot bow tie), John Surtees and James Hunt.

Prices range from 50 cents for some stickers and postcards depicting old cars to \$14,000 for a startlingly realistic painting of a classic Duesenberg Phaeton by Dennis Fritz, an old-car lover and celebrity portrait artist (he's done the Reagans). For the man who has everything, there's a striking \$1500 crystal Ferrari Daytona.

So far, Jacques has done a brisk walk-in business catering to race fans, drivers and collectors who can come to New York. By now, his first mail-order catalog will be ready. You can get one by sending \$5 to *l'art et l'automobile* gallery ltd., 354 East 66th St., New York, NY 10021.



Rauschenberg festooned '87 635CSi with Great Masters.

corner you can sit down at a computer terminal and "shop" for a BMW. The exhibit floor was packed with a 1975 3.0 CSL decorated by the late Alexander Calder, a 1976 blueprint version by Frank Stella, a polka-dot '77 320i by Roy Lichtenstein, a gaudy '79 mid-engined M1 by pop artist Andy Warhol, and an '87 635CSi road car with coy Great Masters reproductions done by Robert Rauschenberg. **PM**



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Appliance Clinic



BY STEVE TOTH

Worn Out Rings

We have a Frigidaire 3-Ring Agitator Washer, model No. WCI-60, serial No. 23E90854. We bought it in 1960 and have been very satisfied with its performance up until now. Our problem is with the three rings, which have worn to the point where the two top ones no longer function and the bottom one is in bad condition.

Considering the otherwise dependable nature of this machine, we would like to get it repaired. Can you tell me whether these rings are still available? If so, how do I replace them?

EDWARD BRUTSCH
CANAAN, NY

I checked with Frigidaire and, unfortunately, the two upper cones (the rings) are no longer made, though the large bottom one is still available.

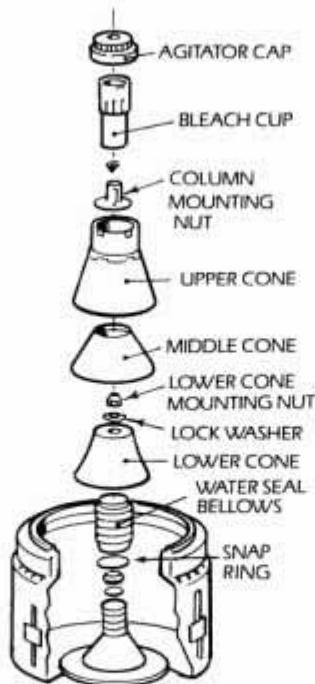
You may want to keep your vintage washer in service by replacing its agitator with a similar one available in a replacement kit, Frigidaire part No. 9956770 (about \$65). It can be ordered through your local Frigidaire parts or service company.

The kit contains a plastic upper and middle cone and a flexible lower cone, water seal bellows, an agitator cap, bleach cup and various nuts, washers, sealants and installation instructions.

If you intend to install just the three cones, then you shouldn't need any special tools. But if you intend to install the entire agitator set, then you'll need a spe-

cial snap-ring removal tool (Robinair part No. 12071, about \$9.50). The tool is available from your Frigidaire dealer. It will enable you to remove the snap ring that fastens the water seal bellows located below the lower cone.

To remove your old agitator, first pull off the rubber or plastic cap from the center of the agitator. Down in the agitator you'll find a bolt with either a No. 3 Phillips screw head or a $\frac{7}{16}$ -in. hex head bolt. Remove the screw or bolt. This will allow you to take off the top section, which includes the two cones. Below that, remove



Replace the agitator cones or the entire agitator in certain Frigidaire washers using the company's replacement kit.

the cone-shaped nut; keep the tub from turning while you're doing this. Below this nut is the lower diaphragm. Lift the diaphragm off its shaft.

If you're unable to lift off the diaphragm, it may be because it's stuck to the shaft by corrosion or residue. Lightly tap the diaphragm back and forth with a rubber hammer. Rock it back and forth until it's loose, then remove it. Clean the shaft with a piece of steel wool and spray it with a light coat of silicone spray lubricant before installing the new agitator kit.

Locked out

I have a Montgomery Ward electric range made by Tappan, model No. 4361. This model is equipped with a self-cleaning oven. I was advised never to try to open the door when the oven is in the cleaning cycle. I adhered to this precaution but found that after the last cleaning, the door refused to unlock.

I thought perhaps putting the oven through another cleaning cycle might solve the problem, but nothing happened. Can you tell me how to unlock the door and save the \$75 service call?

SYDNEY HENSLEY
DAYTON, OH

There are several steps you should try before calling a service technician. First, check the pointer on the stop-time dial on the range's clock. It must be set on the time of day and popped out. Next, move the selector switch to the clean position and wait 45 seconds (the oven must be cool during this test). It takes about this long for the locking motor to turn and unlatch the door. Once the motor stops, the door should open.

If this doesn't work, start another clean cycle. First, push in on the stop-time knob. Set stop time two hours ahead of the time of day. Be sure the selector switch is still in the clean position. Wait about a minute and turn back the time of day, this should cause the

stop-time knob to pop out. Wait another minute and the door should open.

*If this still doesn't work, unlock the door manually. First, unplug the range and move it away from the wall. Remove the lower rear access panel. Behind and under the control panel, near the top, you will see a small electric motor and three switches mounted to a channel of the door-locking mechanism. On top of the motor is a cam to which the door-locking rod is held by a cotter key. Remove the cotter key then push the locking rod forward. This will open the door. The self-cleaning feature cannot be used until the range is repaired by a service technician. **PM***

SERVICE TIP

Have you ever wanted to give up on an appliance when you have exhausted every conceivable avenue to get it repaired professionally?

Let's face it—most simple problems are taken care of by homeowners themselves. Occasionally, the more complex problems demand that a trained technician be called in. But every once in a while, you come across a problem that can't be resolved no matter how much time and effort are put into it.

Well, there is help. The Major Appliance Consumer Action Panel (MACAP) was founded in 1970 to help the consumer solve problems such as these.

Staffed with volunteers, each having a particular area of expertise in the appliance field and an interest in consumer rights, MACAP claims to have resolved 80 percent of the 36,000 complaints it's received since its inception.

MACAP offers a brochure that explains the steps to take when trying to resolve a complaint. To receive this brochure, send a self-addressed, stamped envelope to MACAP, 20 N. Wacker Dr., Chicago, IL 60606.

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



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hi-potency Formula in the super
5.7 liter size.**

Ready for a mega-dose of excitement, Pontiac style? Ingredients include available 210 fuel-injected hp, WS6 performance suspension, Goodyear Eagle VR tires on 16" x 8" aluminum wheels, domed hood, rear spoiler, sport mirrors and full instrumentation. Giant-size 5.0 liter engine standard. Super-size 5.7 liter engine availability limited. See dealer for details.

PONTIAC FIREBIRD FORMULA
WE BUILD EXCITEMENT

Tool Tests



Sears new modular tool system features three tools that are powered by a single motor pack (foreground). Soft nylon carry-all pouch accommodates the three tools, motor pack and accessories.

Modular Power Tools

New from Sears is a modular power tool system for the cost-conscious tool buyer. The system's three power tools—drill, sabre saw and orbital sander—are powered by a snap-in-place motor pack. I shop-tested each tool and was surprised by the power and performance. I also liked how easy it is to change the motor pack

from one tool to another.

The motor pack is a compact 1/4-hp, 2.5-amp, all-ball-bearing motor. To use, simply slide the motor onto a tool and engage the locking lever.

The drill is a 3/8-in., variable speed (0 to 1200-rpm) reversing model. It performed admirably in hole-boring and sanding tests.

The 1/2-in.-stroke sabre

saw operates at speeds from 0 to 3000 spm. A sturdy blade-drive bar promotes smooth cutting.

I did find the grip a bit awkward since the ON/OFF switch must be pushed forward and held.

The 1/4-sheet pad sander operates at 11,000 orbits per minute. Its palm-grip shape is comfortable to use.

The three tools and motor pack cost about \$20 each. A woven-nylon tool pouch is also available for about \$20. The 5-piece package costs about \$85. Sold at larger Sears stores and through the Sears tool catalog. For more information, contact Sears, Sears Tower, Dept. 703-PM, Chicago, IL 60684.

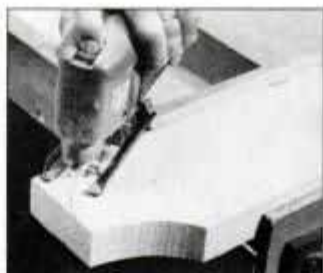
—Rosario Capotosto



Slide motor onto tool and engage locking lever. The 1.6-lb. motor pack has a 6-ft. cord.



Palm-grip orbital sander uses 1/4 sheet of standard sandpaper. Orbit stroke is about 1/16-in. dia.



Variable-speed sabre saw cuts easily through 2-in. stock. Base tilts 45° for bevel cuts.



The 3/8-in., variable-speed, reversing drill has a comfortable, center-balanced handle.

Variable-speed Moto-Tool

The Dremel Moto-Tool enjoys a fine reputation as a versatile power tool. Therefore, I was anxious to try the new variable-speed Moto-

Tool (Model 395). Like other Moto-Tool models, this compact power tool accepts various bits, brushes and abrasives to cut, engrave, rout, grind, polish, carve, clean and sharpen various materials. (There are more than 150 accessories available for use in a Moto-Tool.)

The Model 395 has a variable-speed switch that allows you to select the right speed for the job. Speed selection ranges between 5000 and 30,000 rpm. With its new motor, the Model

395 boasts 30 percent more power than previous models. I also liked the tapered shape of the housing that provides a comfortable grip and good control. The Model 395 Moto-Tool costs about \$60 at hardware stores, home centers and hobby shops. It's

also sold in a kit (Model 3950) for about \$75. The kit includes a No. 395 Moto-Tool, plastic carrying case and 40 assorted bits and accessories. For details contact Dremel, Marketing Dept.-PM, 4915 21st St., Racine, WI 53406.—Rosario Capotosto



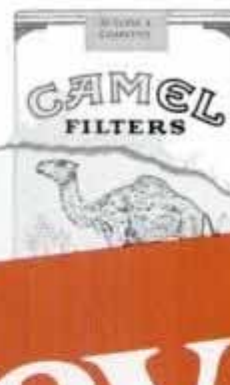
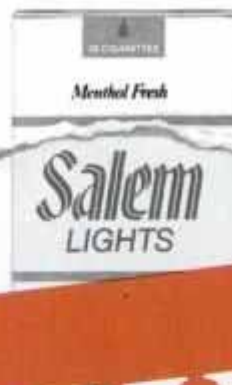
Superversatile Moto-Tool is sold separately or in a kit, as shown. The kit includes plastic storage/carrying case and 40 accessories.



Conveniently located sliding switch allows speed selections between 5000 and 30,000 rpm.



Keyless chuck makes bit changes quick. Chuck is available in kit or as an accessory.



Breakaway

TURN PAGE TO FIND OUT HOW.

Get the flavor
of these leading brands,
but less tar...

Comparisons based on king-size versions of product shown and tar levels from latest FTC report.

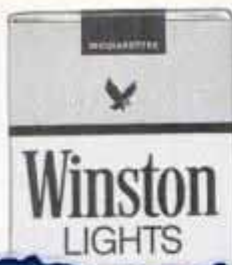


Breakaway to flavor.

© Philip Morris Inc. 1987

SURGEON GENERAL'S WARNING: Smoking By Pregnant Women May Result in Fetal Injury, Premature Birth, And Low Birth Weight.

Kings: 8 mg "tar," 0.5 mg nicotine
av. per cigarette, FTC Report Feb. '85.



Breakaway to Merit.



Great flavor,
less tar.



Homeowners' Clinic



BY NORMAN BECKER, P.E.

Crawl Space Troubles

I have the following situation: A crawl space, approximately 3 ft. below grade. A poured concrete foundation and a 2-in. concrete slab as a floor. Four inches of insulation, foil faced down, between 2 x 8-in. floor joists. A thin plastic sheet covering both the insulation and the floor joists.

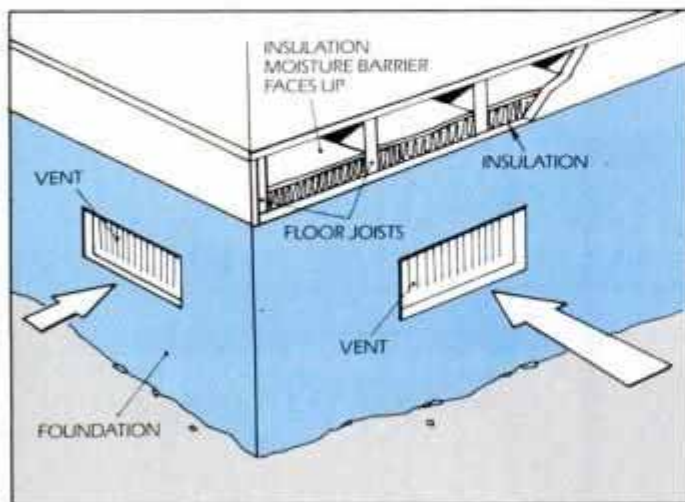
The crawl space is constantly damp and moldy, causing a terrible smell. Heavy rains force water up through the slab. It drains back down in a day or two.

I was told by the local utility company that fiberglass absorbs water and all of it should be replaced with 3/8-in. or 1/2-in. rigid insulation nailed perpendicular to the floor joists. Will this rid the house of the terrible smell, provide insulation and eliminate the possibility of dry rot?

ERROL SCHNEEGURT
OCEANSIDE, NY

The musty odor you smell is caused by spores of fungi (mildew) which flourish in damp environments such as crawl spaces. Replacing the insulation will not get rid of the odor. You must dry out the area to kill off the mold that produces the odor. In order to dry it out, you have to ventilate on all sides of the crawl space for cross air ventilation.

A formula for determining the total square footage (T) of vent openings is $T = (6L + A) \div 300$. L is the perimeter of the crawl space in linear feet, A is the area of the crawl space in square feet. You will probably have to use an electric dehumidifier with a built-in humidistat to reduce the moisture level in the crawl space. These steps not only control the mold that produces mildew and musty odors, but also control rot-producing



The moisture barrier should be installed on the warm side of the insulation. Also, sufficient ventilation should be provided.

fungi. Because the insulation was installed improperly, with the vapor barrier facing down, the musty odor may also be the result of a mildew buildup around the floor joists, above the insulation.

Because the vapor barrier did not face the heated portion of the structure, interior moisture may have condensed and accumulated around the joists. Damp joists are a source for the molds that cause mildew and musty odors as well as rot.

I suggest you remove the insulation and allow the joists and the insulation to dry. If the insulation and vapor barrier are not damaged during removal, they should be replaced with the vapor barrier facing up. A vapor barrier is not needed over the joists as long as the moisture buildup in the crawl space is controlled.

Visual doorbell

My wife has seriously impaired hearing, as do many people her age. I would like to connect a light, probably actuated by a relay to get up to 110 volts, into our doorchime wiring. How can I do this?

C.R. McALISTER
WINTER SPRINGS, FL

It's really quite simple. There are a number of devices that are available for the deaf and hearing impaired that can do the job. One such device is called the Watchman Signal Master (about \$50). It's easy to use and doesn't require wiring into the doorbell circuit. Plug a lamp into the Signal Master and then plug the Signal Master into a 110-volt outlet.

The sound of a doorbell, telephone or other sounds activate a control in the Signal Master that interrupts the power to the lamp. This causes the lamp to flash on and off. The lamp can be initially on or off—it doesn't matter.

The unit is equipped with an adjustable sensitivity control. This enables it to distinguish between a ringing doorbell and, say, a telephone or a crying baby.

There is also a Watchman Receiver (about \$30) that provides remote capability. The receiver is plugged into an outlet in any room, even the garage, and if there is a lamp plugged into the receiver, the lamp will flash when the Signal Master flashes. Both units are available at stores that sell communication and noise-alerting devices.

Some sources are Converse Communications Center, a nonprofit organization, Box 94, West Hartford, CT 06107; and Hearing Impaired Telecommunication Inc., 2429 Bryn Mawr Ave., Ardmore, PA 19003.

Mold removal

I moved to a newer house, and the basement was damp. A few days with the dehumidifier on dried it out. The problem we have is that mold forms on the floor.

How can I clean off this mildew and keep it from forming again?

CLIFFORD OLUFSON
AMERY, WI

Mold and mildew spores are always present in the air and thrive in damp locations (see Crawl Space Troubles, this page). A mold buildup is not very unusual in a new house due to the initial high moisture content of the building materials, which eventually dry out. Clean mold and mildew from concrete and tiled floors (and walls) with a solution of 1/2 to 1 cup of household bleach to 1 gallon of water. Rinse with clear water then dry. Wear gloves and avoid skin contact while cleaning. Also, keep the dehumidifier running to reduce further moisture buildup.

PM

Do you have a home-maintenance or repair problem? Send it to Homeowners' Clinic, Popular Mechanics, 224 West 57th St., New York, NY 10019. Letters cannot be answered individually, but problems of wide interest will be discussed in the column. For more home-repair and maintenance help, get PM's Home Care Guide, \$2.45 postpaid. Send your order(s) to Popular Mechanics, Box 1014, Radio City Station, New York, NY 10101.

Five years ago this water heater was new.



Now it's garbage.

The problem is sediment.



Sediment buildup inside an ordinary water heater forms a harmful barrier between the water and the burner. It drives operating costs up, reduces storage capacity, and can quickly turn a water heater into garbage!

Reliance Aqua-Force design is protected by U.S. Patent Nos. 4,157,177 4,263,879



A self-cleaning Sta-Kleen water heater has the patented Aqua-Force Ring. It helps keep sediment from collecting in the tank, so Sta-Kleen stays energy-efficient, and lasts a long, long time!



...the solution is Sta-Kleen.®

A patented Sta-Kleen 805 self-cleaning water heater will give you all the hot water you need, save you money on fuel bills, and stay off the junkheap! It's all because of Aqua-Force® design, that keeps nasty lime, sand and other sediments from collecting inside the tank.

Want proof? How about an 8-year limited warranty against tank failure, and a 5-year limited warranty on all parts! What more can we say?

See your Reliance dealer, or call 1-800-251-4054 to get a self-cleaning Sta-Kleen water heater.



RELIANCE®

WATER HEATER COMPANY

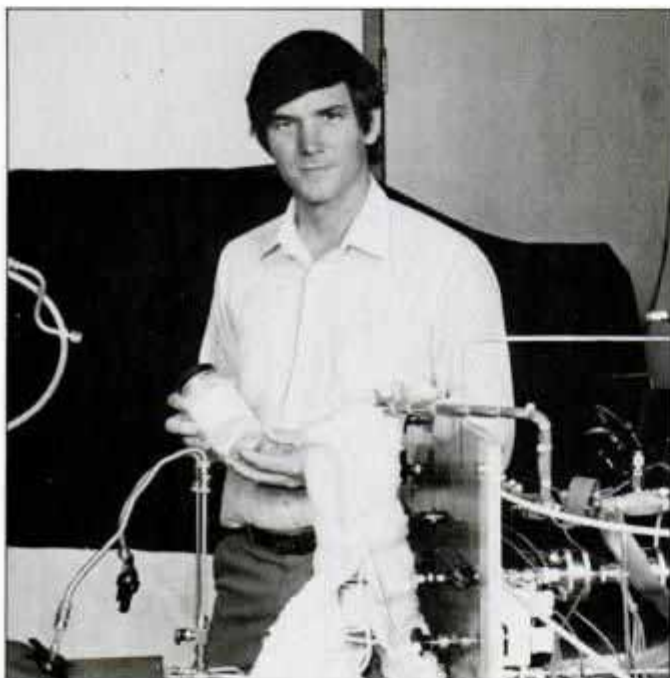
130 Cumberland Street, Ashland City, Tennessee 37015

Science



BY DENNIS ESKOW

Automotive Acid Trips



Sandia Chemist Robert Perry with his revolutionary antipollutant.

Nitrogen oxides (NO_x), found in automotive and other combustion exhausts, are major contributors to smog and acid rain. Current engine-cleaning technologies are able to reduce NO_x output by as much as 90 percent. But they do the job at great expense. Scientists at Sandia National Laboratories have come up with a NO_x removal method that is more effective than current exhaust cleaning devices and cheaper.

"We have discovered a chemical means of removal of NO_x from the products of combustion," researchers Robert Perry and Dennis Siebers wrote in a paper published in *Nature*, the British scientific journal.

In the Sandia process, the exhaust gas itself is used to heat cyanuric acid, a compound found in swimming pool water stabilizers. The heating transforms the acid into isocyanic acid, which mixes with the exhaust gases, reacting with nitrogen oxides. The result is nitrogen, carbon dioxide, carbon monoxide and water. These byproducts are relatively harmless when released into the atmosphere. The good news is the NO_x is reduced by 99 percent.

The Sandia experiments were conducted on a diesel engine, one of the most difficult combustion devices for NO_x control. At present, the Sandia team is running experiments to be certain that no new pollutants are produced.

Flying south

Lots of Americans go south of the border in the winter, but some of them don't come back. These include snow geese and bobwhites. U.S. Fish and Wildlife Service researchers last year published papers expressing concern about the future of these birds. While not extinct, the birds were getting beyond the merely endangered point.

Following joint research with Mexico's Ecological Conservation Department, the American scientists announced that Mexico and the U.S. will work together to replenish the vanishing species. The two countries have begun joint studies of the distribution of the birds. The U.S. group will train Mexican ornithologists in capture and release. Meanwhile, the Mexicans have agreed to trap 60 wild turkeys, which have been overhunted in the U.S., sending 50 to Arizona for breeding and release into the wild.

Shake 'em up

The University of California at Santa Cruz has started a new research project to predict earthquakes. Under a \$250,000 W.M. Keck Foundation grant, the school will use satellite images to detect slight shifts in the Earth's crust to predict earthquakes.

Rice is nice . . .

. . . but some find the food grain too bland for their taste. Researchers at the U.S. Department of Agriculture have developed a test procedure to determine chemically the aroma of rice. Using gas chromatography methods, they've determined that certain species of rice popular in Asia have aromatic chemicals in them similar to popcorn. By recreating the chemicals in the lab, the USDA researchers have developed a technique for giving the mild popcorn aroma to rice. It should be popping up on grocery shelves next year.

UFOs and UFOs

It happened again. Several airline pilots flying the North Polar route earlier this year reported sightings of Unidentified Flying Objects. This happened on several occasions in the 1970s, and the UFO reports were given currency until science writer James Oberg pointed out, through painstaking research, that the flashes of light came from a Soviet launch site for space vehicles. Unlike the last episode, the Russians this time are not giving credence to the UFO reports. But several NASA scientists told me they suspect the UFOs are a repeat of the earlier secret launches.

Computer screen feels

Blind people will soon be able to make use of the most advanced personal computing equipment thanks to a breakthrough at the IBM Research Division. Any user who can read Braille will be able to do word processing, number crunching and a minimum amount of graphics with the new Braille "mouse."

The computer control device has a Braille card in its center. Buttons on the card are raised and lowered by a set of pistons. The pin-sized buttons represent Braille code. Using the Braille mouse, the blind person can learn where the cursor is on the screen and what is under the cursor. **FM**



IBM's Braille computer card on control device can be read by feel.



New Jeep Comanche Sport Truck

\$6495.*

AND IT'S ALL JEEP.

1987 COMANCHE SPORTTRUCK: It's not only the newest 2-wheel drive Comanche pickup, it's also the most affordable vehicle Jeep builds. At just \$6,495, Sport Truck has the most powerful standard engine of any truck in its class... delivering an impressive 121 horsepower. Plus, it's the only vehicle in its class with big 15-inch wheels and tires, standard.

POWER: This year, Comanche comes with an all-new optional 4.0 litre *Power-Tech Six* engine that puts out

173 horsepower and 220 foot-pounds of torque. That makes Comanche by far the most powerful truck of its kind.

A WIDE RANGE OF VEHICLES: Comanche gives you the choice of two-wheel drive or shift-on-the-fly four-wheel drive. And you can choose between the new shortbed model or longbed with the largest optional

4-wheel drive payload capacity of any truck in its class.

OTHER OPTIONS: Comanche already has a lot going for it. And there's a long list of available equipment that includes a responsive new 4-speed automatic transmission with overdrive.

Check out the new Sport Truck and all the other Comanche pickups. It's the kind of truck just about anybody can afford. But it's also the kind of truck only Jeep can build.



*MSRP. Manufacturer's suggested retail price. Title, taxes and destination charges, and options are extra. Price may change without notice. Safety belts save lives.

Jeep  Comanche
Available in 2WD and 4WD

Electronics



BY STEPHEN A. BOOTH

Computer Maladies



GlareDown mesh screen (foreground) protects your eyes from glare.

Computers are supposed to make our lives easier—but no one ever said that living with a computer is easy.

The problems begin before you own one. You have struggled through all the conflicting product claims just to decide on a format and brand to buy. Once you get the computer and its peripherals home, you have to hook them up: This makes installing a VCR or hi-fi system seem like child's play. At last, you get to tackle the operating software. After an hour's wrestling with the "perfect" word processor or spreadsheet program, you begin to think that the manual typewriter and one-arm-bandit adding machine weren't so bad after all.

Assuming you've got your PC up and running, you soon

begin to encounter problems that the sales clerk and advertising never mention. These aren't necessarily bugs in the machine. More often, they're external annoyances that affect your computer's performance, or your performance on the computer.

Let's discuss your performance first. The personal computer is a product of late 20th-century high technology which unfortunately often finds a home in 19th-century work environments. With rare exceptions, most computers get plunked down on desks or tables designed for typewriters. The height of these surfaces is fine for look-

ing down on a piece of paper, but all wrong for the computer's TV screen monitor. Not only is the monitor situated higher than a typewriter's platen, but it's oriented nearly 90° perpendicular to the viewer. This forces you to crane your neck backward to read the screen, instead of inclining your head comfortably downward. The result is neckaches, headaches and ultimately, user fatigue.

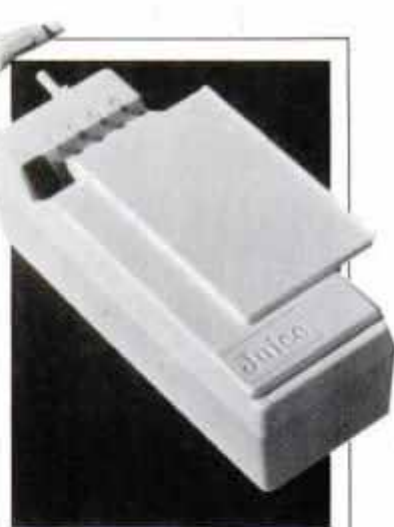
Complicating this situation is the lighting scheme in most offices and homes. Paper could absorb much of the glare from overhead lamps. Monitor screens reflect it, with a vengeance. Even if the lamp isn't shining directly on the monitor, the screen will pick up the light reflected from your clothing and bounce it right back to your eyes. Eyestrain is the result, and all the maladies it in turn engenders.

Short of buying special computer furniture, there isn't much you can do about the table-height and neckache problem except take painkillers. Such specialized furniture can set you back as much as the whole computer setup. But for glare-induced eyestrain, there's an inexpensive remedy. It's called a glare screen and it's found wherever computers and accessories are sold.

Typically, the glare screen is made of a fine, nonreflective transparent mesh. Its frame attaches to your PC's monitor with a Velcro-type adhesive. The mesh prevents ambient light from striking the monitor and reflecting, but permits the



Touchpad drains away static charges.



Uninterruptible power supply runs computer during blackouts.

monitor's display to reach your eyes. To some extent, the mesh softens the flicker of the seemingly stationary monitor display. This is good, because a monitor, after all, is a television. You wouldn't watch TV for eight straight hours each day—at least not from a distance of 18 in. One glare screen that recently hit the market is Suncom's GlareDown. It comes in two sizes, at \$20 and \$22, to fit all monitors.

Yet another computer-generated headache comes from static electricity near the workspace. Static, like dust and taxes, is unavoidable as we pass through this life. It won't kill you, but it can blow a chip in your computer or cause its memory to go blank.

Static has many causes, the chief of which are carpeting and dry air. You can't conveniently eliminate these, but you can protect your computer at the point of contact. Some 18 months ago we explained how to make a static-shunting device (*Zapping Static*, page 62, Oct. '85). Now you can buy one ready-made for very little more. It's called the Scooter Model STP10 Anti-static Touch Pad, from Ohm/Electronics. An adhesive back secures the 3 x 4-in. pad to any surface. A 10-ft. wire ends in a clip you attach to any ground. You touch the \$13 pad before you touch your computer to drain away any static you're carrying.

Perhaps the King Kong of computer migraines strikes when the power goes. You not

(Please turn to page 36)

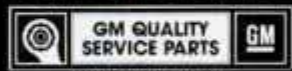
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The StormShield

Box 966-PB, Binghamton NY 13902

ELECTRONICS (Continued from page 34)

only can't complete what you're doing, but it's likely you'll lose what you've already completed. Remember, a computer's random access memory (RAM) is volatile. Anything you haven't filed onto magnetic disc will be erased if the power fails.

To prevent this unhappy experience, a variety of manufacturers sell a device called an uninterruptible power supply (UPS). This is essentially a battery that patches into the computer's power supply. If the AC line current fails, the stored-up juice in the UPS continues sending electricity to the computer.

The capabilities of each UPS device vary: Some supply power for hours while others give you just enough time to save the file you're working on and shut off the computer in an orderly fashion.

Perhaps one of the smallest and most versatile UPS devices available is called Juice, from Orbic Controls of San Diego (1-800-433-4221). It weighs 3 pounds and snaps onto the side of an Apple IIC portable computer. If AC power fails, the Juice carries on for two hours. It can also be used as a 2-hour battery when AC's not available. The \$170 UPS can be recharged through a car's cigaret lighter, to save time when you're on the go. It will power the LCD display on an Apple IIC,

but not the cathode-ray tube monitor often used for home installations. Even so, it should be reassuring to know the computer itself maintains power. Right now, Orbic doesn't offer versions of the Juice for other computers. If that changes, you'll read about it here.

Space pirates

Last month in this space (page 57), we reported the circulation of illegal devices that purport to defeat the VideoCipher II system used to scramble some satellite TV programming. We also described the penalties for manufacturing, selling, buying or using these devices—and the possibility that some are nonfunctioning frauds, and that others can be rendered useless by the satellite TV programmers.

Now, word arrives of legal action against one alleged distributor of these black boxes. General Instrument Corp., which owns the VideoCipher II patents, recently filed a civil suit in federal court against Picture Perfect Engineering of Phoenix, Arizona.

The suit claims that PPE infringed on VideoCipher copyrights and violated the Cable Communications Policy Act of 1984. That law prohibits the manufacture, distribution, importation, sale or use of

products designed to receive encrypted signals without authorization. You can read "authorization" to mean payment of a fee to receive the programs.

General Instruments' suit seeks to prevent the defendants from making or selling the "black boxes." It also seeks monetary damages. Though this is the first legal action taken against satellite piracy, General Instrument says it is investigating other operations in order to pursue additional suits.

News flash!

We're just back from the Consumer Electronics Show in Las Vegas with armloads of news on new products, technical innovations, and developments that will affect the audio, video and communications products you'll use in the future. Keep your eyes on the appropriate columns in the issues ahead.

For the time being, some of the highlights include: a "super" VHS video recorder format with broadcast-quality resolution, a tiny 4mm video camcorder that uses the same cassettes as the forthcoming Digital Audio Tape system, DAT itself (due here this year) large-screen tube TVs and pocketable color LCD models.

FM

Learn robotics and industrial control as you build this robot

New NRI home training prepares you for a rewarding career in America's newest high-technology field.

The wave of the future is here. Already, advanced robotic systems are producing everything from precision electronic circuits to automobiles and giant locomotives. By 1990, over 100,000 "smart" robots will be in use.

Over 25,000 New Jobs

Keeping this robot army running calls for well-trained technicians . . . people who understand advanced systems and controls. By the end of the decade, conservative estimates call for more than 25,000 new technical jobs. These are the kind of careers that pay \$25,000 to \$35,000 a year right now. And as demand continues to grow, salaries have no place to go but up!

Build Your Own Robot As You Train at Home

Now, you can train for an exciting, rewarding career in robotics and industrial control right at home in your spare time. NRI, with 70 years of experience in technology training, offers a new world of opportunity in one of the most fascinating growth fields since the computer.

You need no experience, no special education. NRI starts you at the beginning, takes you in easy-to-follow, bite-size lessons from basic electronics right on through key subjects like instrumentation, digital and computer controls, servomotors and feedback systems, fluidics, lasers, and optoelectronics. And it's all reinforced with practical, hands-on experience to give you a priceless confidence as you build a programmable, mobile robot.

Program Arm and Body Movement, Even Speech

Designed especially for training, your robot duplicates all the key elements of industrial robotics. You learn to operate, program, service, and troubleshoot using the same techniques you'll use in the field. It's on-the-job training at home!

Building this exciting robot will take you beyond the state of the art into the next generation of industrial robotics.

You'll learn how your completely self-powered robot interacts



You get and keep Hero 1 robot with gripper arm and speech synthesizer, NRI Discovery Lab for electronic experimentation, professional multimeter with 3 1/2-digit LCD readout, 51 fast-track training lessons.

with its environment to sense light, sound, and motion.

You program it to travel over a set course, avoid obstacles using its sonar ranging capability. Program in complex arm and body movements using its special teaching pendant. Build a wireless remote control device demonstrating independent robot control in hazardous environments. You'll even learn to synthesize speech using the top-mounted hexadecimal keyboard.

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WE'LL GIVE YOU TOMORROW.

Inside Detroit



BY JIM DUNNE

'89 Fiero Bagged!

Pontiac will give Fiero a complete redesign in less than two years, fulfilling the promise made when the revolutionary sports model was introduced in 1985. New exterior lines are in store all around, a major change made simple by Fiero's bolt-on plastic body panels.

Unlike most other cars, which have welded-on body panels, Fiero's are attached by bolts or clips. To change styling, you simply take off one panel and bolt on another. When Fiero was



Next generation Fiero will feature all-new bodywork, not nose jobs of the past.

introduced, Pontiac designers pledged to use this technique to change the design of the car more often than the customary 6- or 8-year cycles that steel-body cars follow.

The changes planned for 1989 are the result of that pledge. What you will see is a huskier-looking body, one with more rounded lines. The bumper assembly in front will have a massive appearance. Pop-up headlights will be kept, but their lids are shaped differently. Outside door handles are similar to those on the Beretta, moved up to the B-pillar.

A more rounded shape at the rear will be formed by a large plastic panel that serves as bumper, fender, modesty panel and backup light housing.

Lido letdown

Call it the Chrysler Turbo Convertible by Maserati. After all the speculation about what to name Chrysler's new 2-seat convertible, the company chose something that probably came out of a committee meeting. No drama. No punch. Just a straight, descriptive label. Even Imperial, one of the real name

candidates, would have been better. Surely, a car that costs \$25,000-plus deserves more than this. But we shouldn't protest too much. Another candidate was Lido—Lee Iacocca's real first name. That didn't make it either, so there's something to be thankful for. The last car named after an auto executive was the Edsel.

Olds Incas

Olds bought this concept car from Ital Design in Italy, then gave it Olds badges, and installed an advanced Quad Four engine inside. The car features a 2-door body design with a couple of special twists. The front doors are attached to the windshield.



Oldsmobile Incas Show car by Ital Design features radical doors.

When the driver steps in, the whole front of the passenger compartment opens up—windshield, side glass and door openings—all in one piece. Rear-seat passengers get in through a clamshell door on the right side.

Olds claims that the Incas is a mid-engine 4-seater designed to contribute fresh ideas for its cars of the future. But don't look for that windshield to show up on a production car. The inside of the car will get soaked in a rainstorm if the front roof is raised and the interior exposed.

Tempo/Topaz freshening

For '88 Tempo/Topaz gets some major freshening changes. The grille, headlights and bumper alter the front end, though the changes are not major ones. Rooflines on the 4-door are new too, with a tuck-in at the rear of the roof that alters the

quarter window there and makes the trunk look longer. The changes follow Ford's aero-styling direction, but produce less of the "melted candy bar look" than some other new Fords.

Stop!

You people down at GM's Moraine Assembly plant have made your point. I agree you make the best quality car or truck put out by GM. Your S-10 and S-15 pickups are the class of the company. Now will you please stop sending me letters that remind me how wrong I was in naming the Corvette and Fiero GM's top quality vehicles in my October column (page 28)? *Mea culpa.* Your stack of letters pointing out my mistake keeps growing. I stopped counting when I got to 60 pages. All your signatures have to run well over 1200 in number. But I'm not surprised that trucks are the best built vehicles coming out

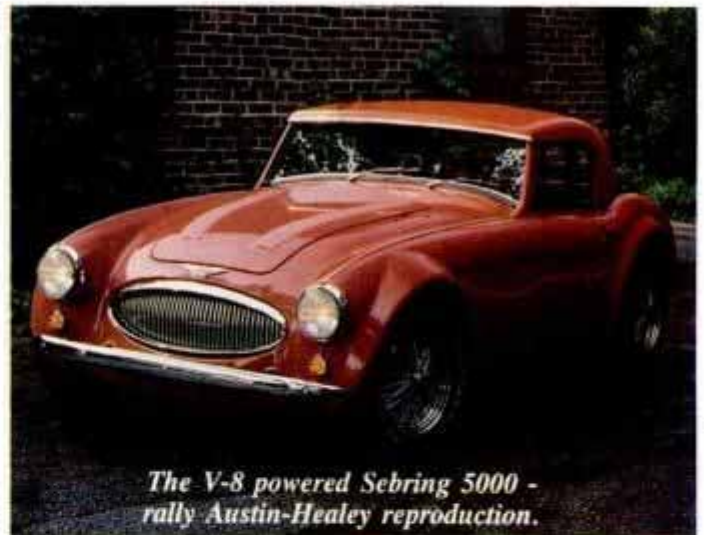
(Please turn to page 42)



A strained look at the pleasantly restyled 1988 Tempo/Topaz.



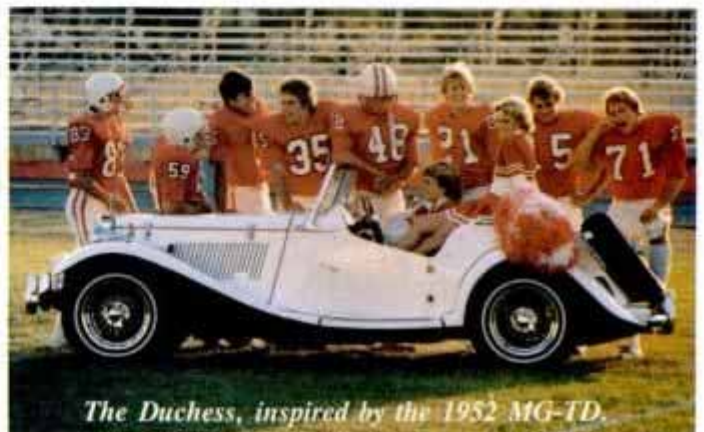
The Duke - inspired by the 1939 Jaguar SS-100.



The V-8 powered Sebring 5000 - rally Austin-Healey reproduction.



The Saxon - 1962 Austin-Healey reproduction.



The Duchess, inspired by the 1952 MG-TD.

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Portable Ironing Center—Unscrews from the wall to move when you do. Plans feature a receptacle for the iron, a fluorescent light and storage space for all materials. The ironing board folds up behind louvered doors. (PA-1005—\$5.95)



Roll Top Desk—Nostalgia buffs will especially appreciate the always popular roll top desk for both home and office: it's an antique cherished by many. Make one yourself in fine cherry and take pride in this charming heirloom. You build it as two separate units, a base and a roll top. (PA-1736—\$5.95)

INSIDE DETROIT

(Continued from page 40)

of U.S. plants. Ever since I started testing vehicles 20 years ago, I've been convinced of that. U.S. pickups—including Ford, Dodge and AMC types—are world class when it comes to quality. Now, if only you can spread your skills to the automobile factories at GM. . .

Justy

The name doesn't mean anything specific. "We liked it because it's simple, and sounds right for our small car," says Tom Gibson, Subaru president. The tiny 2-door hatchback model is aimed at the Yugo-Hyundai market, and priced about as low as you can get a Japanese car nowadays—\$5495 for the base DL model. Add \$700 and you can get the GL, which is equipped with convenience and comfort extras like intermittent wipers, bumper guards, split rear folding seats, tachometer and high-line trim.

Subaru expects that buyers will be "entry level" people in the 25- to 30-year-old group who are getting a new car for the first time on a limited income. Or, multiple-car families who need a runabout. Notable design features of the Justy include a 3-cylinder, 9-valve engine, 5-speed transmission, variable-rate steering and 4-wheel independent suspension. Its tiny engine is a mere 12 in. long, but puts out an adequate 66 hp. From bumper to bumper, Justy is only 139 in. long.

Stretch Caddy

A change in the basic body of the Cadillac deVille will lengthen the 4-door by 6 in. Three inches will be added to the wheelbase, and the rear overhang will be stretched out another 3 in. Insiders call the new deVille the "C-Plus" car, referring to the "C" code designation of the basic body that is shared with Olds 98 and Buick Electra. The "Plus" refers to the added half foot. The big Olds and Buicks will get a 3-in. longer trunk, but no change in wheelbase. As a final part of the rearrangement, the 98 and Electra will drop the 2-door version of the C-body and sell only the 4-door.

Cadillacs in Japan

About 300 Cadillacs are sold in Japan each year, mostly purchased by companies. The price runs about \$50,000 for a deVille sedan, the most popular model. Seattles, which would cost \$70,000, are not imported because of the price and the small size of the vehicle.

The Japanese importer says that D-body cars, the rear-drive Broughams, have to be repainted in Japan to bring the finish up to luxury car standards there. "Otherwise, we only make minor modifications, like parking and turning lamp placement to meet Japanese laws." **PM**

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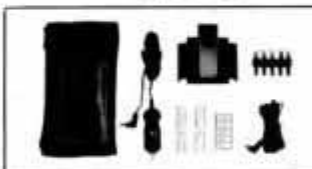
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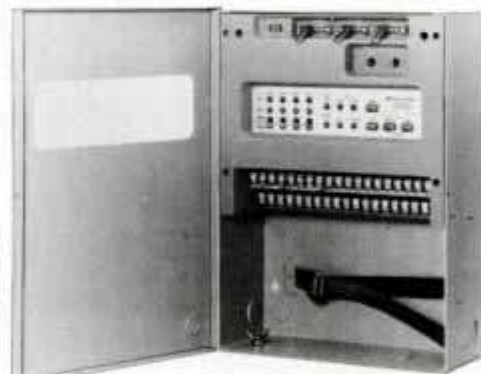
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NEW/HOME

Outdoor Cooking Center



The Thermos gas grill is mounted on a mobile redwood cart that has plenty of storage space for cooking utensils and accessories.

The Thermos is more than a gas barbecue grill. It's an outdoor cooking center. Mounted on a rolling redwood cart with fold-up extensions, its two front doors conceal the storage space for a 20-pound LP fuel tank, with room to spare for cooking utensils and supplies.

The 140-pound grill has a 2-piece, 452-sq.-in. cast-iron cooking surface, porcelain-

ized so it can be cleaned in a dishwasher.

Features include a 21-sq.-in. warming rack above the cooking surface, a heat-tempered glass viewing window, fuel gauge and a cooking timer. The tank provides 25 to 30 hours of cooking.

It's about \$400 at department stores and home centers. Write Thermos, Route 75, Freeport, IL 61032.

Smart sprinkler

Unlike most impulse sprinklers, which are limited to spraying in a circular area, the programmable Patternmaster (\$25) can water almost any shape lawn or garden, its maker claims.

Simply adjust pins in the detachable memory disc so it sprays a pattern that matches the lawn's shape. No water is wasted falling on driveways, patios, decks or walks. It can reach from 16 to 43 ft. in an arc ranging from 30° to 360°.

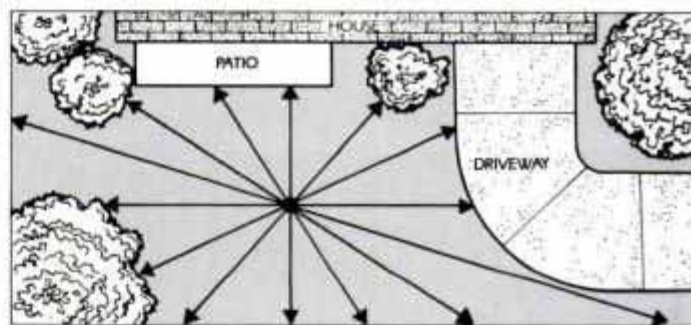
An extra memory disc is part of an expansion kit that sells for approximately \$5. It allows the polymer plastic sprinkler to be moved to a



The Patternmaster sprinkler follows custom spray patterns.

new location without being reprogrammed.

The Patternmaster is sold at hardware and lawn and garden stores. For further details and more information, write Gilmour Group, 332 West Broadway, Suite 815, Louisville, KY 40202.



Program the sprinkler so that its spray pattern matches the lawn's shape. It waters the lawn and not the patio or driveway.

Concrete stain remover

FADE is formulated to remove oil stains from concrete driveways, patios or garage floors. Its maker claims that it almost completely removes recent stains and greatly reduces stains that have accumulated over 25 or 30 years.

To use FADE, pour the liquid on the stain and let it soak into the concrete. Use a broom to mix the solution thoroughly with the oil. Complete the cleanup by hosing down the area with water. FADE emulsifies with water and is rinsed away.

The product is intended for

use on concrete and nonpetroleum-based surfaces only. It's sold at hardware stores, home centers and directly from Sakrete, Box 17087, St. Bernard, Cincinnati, OH 45217. One gallon covers 1000 sq. ft. and costs \$9.95 postpaid; \$10.95 west of the Rocky Mountains. **PM**



To use FADE, just pour it on an oil stain and let it soak to penetrate the concrete.



On stubborn stains, use a stiff broom to thoroughly mix the cleaner with the oil.



To complete the cleanup, just rinse the stain thoroughly with a constant stream of water.

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THE NEW PRESTOLITE CENTURA BATTERY. TRUST YOUR INSTINCTS AND GET TOUGH.

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NEW/AUTO

No Slippin' And Slidin'



Lego-like pegs and rods keep stuff from rolling around your trunk.

Tidy-Trunk Mat kit consists of a black plastic mat covered with 1/4-in. pegs. Holders 4 in. high snap onto the pegs to keep cargo in

place. Each \$14.95 kit contains 3.8 sq. ft. of mat and six holders. It's from Tidy-Trunk Mat, P.O. Box 217, Merrimac, MA 01860.

Bits with grip

Anti-Cam-Out Phillips bits have little teeth that help hold the bits in Phillips-head screw slots so they won't slip out. The \$1.75 set of three magnetic bits fits into a \$6.14 handle or \$7.70 Hollow Handle with bit storage space. Allen, Torx and straight bits are also available. The bits are from Brownell's Inc., Route 2, Box 1, Montezuma, IA 50171.

A small vise

The miniature versions shown below of the famous Vise-Grip locking pliers are only 4 in. long. These tiny tools are great for precision



"Dimension 4" mini Vise-Grips have built-in wire cutters.

applications or working in tight spaces where standard-size Vise-Grips won't fit. The long-nose model sells for \$10.40 and the curved-jaw model costs \$8.75 at tool and hardware stores.

They're manufactured by Petersen Mfg. Co. Inc., DeWitt, NE 68341.

Teeth keep Phillips bits from riding out, chewing up screws.

Foiled for good

Car Radio/Cassette Lock is a cassette-shaped lock that prevents unauthorized use of your tape deck. Unless you have the key, it can't be removed without damaging the deck, making it worthless to thieves. Reflectors make it visible at night. It's \$24.95 from Top Sound International, 37-54 East LaSalle, Colorado Springs, CO 80909.



"Take the wheel, Stanley."
"I already did, Ollie."

Something missing?

One way to keep a crook from wheeling off in your car is to take the wheel with you. Vehicle Security System allows you to unlock and remove the steering wheel. It costs \$138 to \$250, depending on wheel selected, from Grant Products, 700 Allen Ave., Glendale, CA 91201.



Car Radio/Cassette Lock makes car radios worthless to thieves.

If you can't beat 'em, fool 'em

Need a burglar alarm for your car, but reluctant to pay the price for a really good one? Stop Thief attaches to the dashboard of your car with Velcro, and blinks it's little red LED lamp just like a real burglar alarm system. Stop Thief doesn't really do any-

thing, but the idea is that thieves will see it and look for easier pickings before they rip off your car. It runs for months on two AA batteries. Stop Thief costs \$9.95 plus postage; Wallfrin Industries, 94-61-W Jefferson Blvd., Culver City, CA 90230. **PM**



Stop Thief attaches to your car's dashboard with Velcro. It looks like a real auto burglar alarm, but is a fraction of the cost.



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BEHIND ITS
THUNDER.**



It stormed onto the American performance scene. The Thunderbird Turbo Coupe, moved by a sophisticated four-cylinder turbocharged engine that's as powerful as a V-8. And the lightning behind its high-revving thunder: Motorcraft extended-tip spark plugs. Their nickel-chromium-alloy electrodes are designed to cope with the intense heat of today's high-performance engines. There's a Motorcraft spark plug, as well as a full line of quality-made Motorcraft parts, available for all makes of cars and trucks.



Motorcraft from Ford
EXCEEDS THE NEED

Cycles

BY NORMAN
MAYERSOHN



More Pro, Less Stock



Wheelie bar keeps front wheel on pavement for 162-mph sprints.

If there's any motorsport that 125-hp superbikes are ideally suited to, it's drag racing. A Porsche might go around corners with less drama, and a Lamborghini might prevail in a contest of top speed, but there simply isn't a streetable vehicle in the world that can outspurt 1987's fastest motorcycles in a 0-to-60 runoff—under 2.5 seconds for the quickest showroom stock models!

An increasingly professional attitude in sanctioned motorcycle drag racing is building a bigger-than-ever following this season, and spectators are being treated to the closest competition ever. Factory support for racers like Suzuki-backed Terry Vance is elevating the quality of competition, too. To best promote the performance image of sponsors, Vance and partner Byron Hines race a GS1150 model in the Pro Stock category. Factory-look bodywork that

fans can easily relate to makes Pro Stock the class of choice as a manufacturer's showcase. Its growing popularity prompted the National Hot Rod Assn. (NHRA) to add this crowd-pleasing competition to a number of its car races, including the prestigious Labor Day Indy Nationals and the season-ending World Finals.

Of course, Terry Vance's Pro Stock Suzuki is no more like a showroom sample than Dale Earnhardt's NASCAR Monte Carlo is like the Chevy in your driveway. For starters, it will cover the quarter-mile in 8.1 seconds from a standing start, running out the far end of the timing lights at 162 mph. The dohc 16-valve Four has been bored to 1260-cc by Hines, the mechanical maestro of the team, and fitted with a cylinder block and cams designed in the Vance and Hines shop. Wound out to the 11,000-rpm power peak, it makes 220 hp.

Visually, the Vance and Hines Suzuki shows the spectators a believable profile. The stretched wheelbase of the chassis, built by Sandy Kosman's San Francisco frame shop, is not apparent, thanks mostly to the long wheelie bar extending from the suspension swing arm. This keeps the front wheel from bumping the sky while Vance concentrates on leaving the line and pushing the buttons for the pneumatic gearshift selector. Lightweight wheels and fiberglass body pieces allow the Suzuki to hit the starting line at 612 pounds with Vance aboard.

The combination of Terry's skillful riding and Byron's masterful tuning has brought two World Championships and 22 National Event wins to the Vance and Hines combination in NHRA competition. But even more important than what they've reaped from their racing successes is what they've brought to the sport. Their chosen vocation could well be a public relations man's nightmare, given the outlaw image of motorcycling and the backstreet connotations of drag racing—a most unholy marriage in the eyes of the unknowing. But with ideally clean-cut approaches to their racing, they've become the sport's unequaled image leaders. Solid backup—in the form of Suzuki advertising campaigns



Crew chief Byron Hines develops the 220-hp Suzuki Fours.

and product endorsements on the order of Vance-replica Bell helmets—have made the duo racing pop stars. Take a look at the crowds flocking to the Vance and Hines Racing trailer for a signed poster for proof of this. No wonder Suzuki has seen the wisdom in retaining these successful spokesmen for nearly 10 years now.

Not surprisingly, Vance and Hines have been able to convert their racing successes into business security as well. First it was a line of VHR high-performance exhaust systems, then a line of engine components, later complete competition engines, which helped to revive the Pro Stock category by making all the latest technology available to anyone with \$10,000 in hand.

Now they've turned to franchising retail locations that both sell products and provide high-quality repair and installation services. Cautiously, they've dabbled in road racing, too, though in this arena they are up against enormous factory expenditures. As the saying in the pits goes, Honda has an unlimited budget, and always exceeds it.

The \$22,000 it costs to build a top-qualifying Pro Stock motorcycle is a bargain, compared to the costs of other forms of racing at this level of professionalism. With high-profile teams like Vance and Hines leading the way, and many others hard



Vance's many fans seek out their hero for signed posters.

on their heels, Pro Stock bikes are yet another form of motorsport that bears close watching as it grows in stature.

Transfer of power

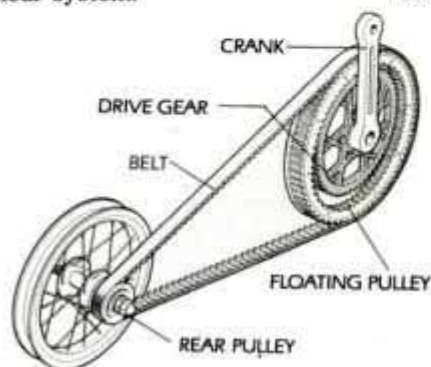
As mind-clearing and body-toning as a bicycle ride might be, there are still some mechanical gremlins able to turn a fine day's ride into a greasy-fingered maintenance drill. Chain-drive systems are the time-honored method of carrying the pedal crank's motion to the rear wheel, but for all their simplicity, they are somewhat long in the tooth.

Bridgestone, Japan's No. 1 bicycle manufacturer, already has done its part to unchain bicyclists with the belt-drive Picnica model, a 1-step collapsible for urbanites. Now Bridgestone's gone one better, building a self-adjusting tension mechanism into the new Beltrex. Unlike the belt-drive motorcycles, which can slide the rear wheel back to keep the belt taut, the Beltrex uses a floating pulley that's cogged to the drive gear. Tension on the pedal cranks drives the floating pulley forward, taking up belt slack and preventing tooth slippage. The belt, reinforced with Kevlar, ought to last 10 years.

An even more significant drive system from Bridgestone, the stepless transmission, has made it to a prototype bicycle at last. Undergoing refinement for the last two years, the infinite range of gear ratios available in this transmission has the same wealth of advantages offered by the continuously variable transmissions (CVTs) under development by all major carmakers.

As installed in the Spider prototype bike now making the show circuit rounds, the stepless transmission is entirely contained in the rear wheel hub. The design originally used planetary gear sets; the latest version that Bridgestone has displayed uses an eccentric and ratchet mechanism, steplessly changing ratios by varying the angle of the engaging pawl.

The advantages are many: You'll never miss a shift or be out of gear, the chain never goes slack, the mechanism is entirely internal and it is claimed to be stronger and more durable than a derailleur system. **PM**



Beltrex drive uses floating pulley.



We took this picture on Mule Appreciation Day right here in Lynchburg, Tennessee.

A TENNESSEE MULE is a lot like a Tennessee whiskey-maker: Good, and stubborn.

For seven generations in Jack Daniel's Hollow we've refused to budge from a whiskey-making method called charcoal mellowing. That's where every drop of just-made Jack Daniel's is seeped through tightly packed charcoal before aging. And nothing (not even aging) makes it more mellow. So when folks call us ornery and mule-like, we're quick to agree. You see, if we hadn't been so stubborn all these years, our whiskey wouldn't be so smooth.

SMOOTH SIPPIN'
TENNESSEE WHISKEY

Tennessee Whiskey • 80-90 Proof • Distilled and Bottled by Jack Daniel Distillery
Lem Motlow, Proprietor, Route 1, Lynchburg (Pop. 361), Tennessee 37352



Car Clinic



BY MORT SCHULTZ

Special Treatment

Despite attempts by several brake shops to get rid of a squeal and pedal shudder when I apply the brakes of my 1985 Honda Prelude Si, the trouble continues. New pads have been installed and all four discs have been removed and refinished.

What has to be done to make this otherwise fine automobile perfect?

KEVIN EICHENBAUM
HUNTSVILLE, AL

If a brake shop treats the Prelude Si 4-wheel disc brake system in the same way the brakes of other cars are handled, noise and shudder will never go away. The two conditions are unrelated. Therefore, two repair procedures are needed: (1) discs have to get special handling to eliminate the shudder; (2) a new pad kit to get rid of the brake noise has to be installed. That kit can be ordered using Honda Control No. 2451474.

Let's discuss the discs first. The front discs must be refinished on the car using a portable Honda, Snap-on or Kwik-Way disc grinder. The procedure has to be done precisely. For example, if the Honda brake disc grinder is used, discs must get a 17-minute-long rough cutting and a 3-minute-long final cutting. If the rear discs are to be refinished, they should be taken off the car and put on a conventional disc brake lathe.

The minimum thickness variation for both the front and rear discs, as given in the service specifications,

has to be maintained. If the safety limit of any one disc is exceeded, not only that disc, but its mate on the other side, should be replaced. Otherwise, vibration will continue.

As for that squeal, the new pads and shims in the kit I mentioned should take care of it, but it's essential that pads and shims get treated with a product called Molykote M77 before they're installed. Molykote should be smeared on the backs and ends of pads and on both sides of each shim.

Finally, whoever is repairing your Prelude's disc brake system should use a torque wrench to tighten lug

nuts 80 ft.-lb. If a power impact tool is used, disc damage may result, which could put you right back where you are now.

Lip service

Was I surprised to learn that my 1985 Ford Escort was performing badly because oil was getting into the distributor through a worn seal in the base of the distributor? I received an even greater shock when my dealer told me I'd have to replace the distributor at a cost of \$137, plus another \$50 for labor. All for a 25-cent seal? I'm sure there's a better way.

Isn't there?

MICHAEL ROSSI
EAU CLAIRE, WI

There is. To repair a worn 25-cent lip seal—that's what it's called—advise your dealer you have it on good authority (Technical Service Bulletin [TSB] 85-9-30, to be exact) that only the distributor base, which contains the seal, has to be replaced. This simple replacement will cost \$22 plus labor. You may get some lip from the dealer about this part not being available, but insist that he try. The part number he should use is E3FZ-12130-A.

Pass the crow

I said something last month in my answer to Don McEachern's question about the cruise control in his 1983 Buick LeSabre Limited (page 28) that I want to put right. He asked why the cruise control will engage as it should at all times except when the windshield wipers are going. I explained that, as the windshield wipers sweep back and forth, the arm linkage is probably striking the cruise control servo wire harness and causing a short that keeps the cruise control from engaging. Well, gang, that could happen if Don's car were a Regal, but not with a LeSabre. The LeSabre wiper linkage is in the cowl plenum, nowhere near the wire harness. More likely, the reason for the odd way in which his cruise control acts is a faulty two-in-one multipurpose on-off switch that controls both the cruise control and wipers. If the switch isn't bad, then the wiring harness from the switch to the wiper motor and cruise control servo has a short. To find the short, the steering column will probably have to be opened.

(Please turn to page 53)



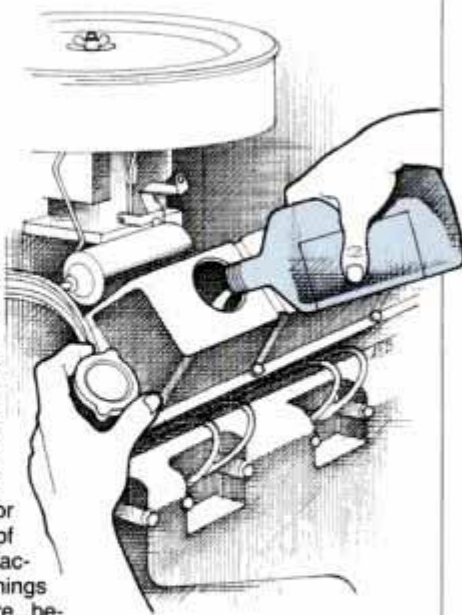
Up to his neck in trouble

Most of us probably never give it a second thought, but failure to remove loose material from the neck of those plastic oil containers before sticking the neck into the oil fill hole could be dangerous to your engine's health. Listen to the experience of Ed Moore of Lancaster, California:

"The neck of the Pennzoil plastic bottle forms a very snug fit in the oil fill hole of my 1984 Olds Delta 88 5-liter V8. While removing an empty bottle from the hole recently, the tight fit caused the loose bottle cap plastic lock ring around the neck to snag, pull off and fall into the fill hole. Luckily, the ring lodged

partway down the hole, and I was able to retrieve it with mechanical fingers."

This means that before you stick the neck of an oil container into your engine, make sure there's nothing attached to that neck that can break loose and fall inside. This goes for locking rings and pieces of aluminum foil that manufacturers use to seal the openings of oil bottles. Furthermore, before putting a funnel into the oil fill hole, wipe it off with a rag. Dirt and foreign particles transferred from the end of a funnel to the interior of an engine aren't exactly engine "health foods."



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The best live up to it.



CAR CLINIC

(Continued from page 50)

Dry try

I lucked out and was able to buy a used but sharp-looking low-mileage 1986 Oldsmobile Delta 88. It has only one flaw—the taillight lenses keep getting coated with moisture. An Olds dealer says the assemblies are defective and new ones should be installed. I find this hard to believe. Is there no inexpensive solution?

DENNIS CHESNUTT
SAN DIEGO, CA

New assemblies have holes drilled into them to allow ventilation, which prevents the formation of condensation. So why not just drill holes into the assemblies now on your car? Remove the two taillight fixtures and place them face down on a workbench.

Using a 3/16-in. bit, drill two holes into the base of the fixture. Center each hole between the sides of the fixture retainer on each end of the assembly, but be careful not to drill too deeply or you'll damage the lenses. The end of the bit should penetrate the assembly housing only 1/4 in.

Now, Voyager

I own a new (200 miles) 1987 Plymouth Voyager Minivan with the 2.6-liter engine. While driving along at any speed with the air conditioner on, the compressor engages and disengages once every 30 seconds or so. When it engages, speed drops off enough to be felt. When the compressor disengages, the car surges forward slightly.

The service manager says "Normal." I say, "Phooey." What do you say?

HERMAN WEISS JR.
MIAMI, FL

There's no way to know who's right until you do some investigating, but I can tell you that at present there aren't any TSBs covering this condition. The cycling you describe is normal for temperatures under 90° F. What you have to determine is whether the surging is normal.

Ask the salesperson who sold you the van to let you drive a demo. Determine if you feel the same phenomenon with it as you do with your vehicle. If so, you'll have to reorient your thinking and realize that this probably is the way things are.

Suppose, though, you find that the dealer's demonstrator outperforms your Minivan? Your "phooey" is justified, and the surge you feel may be due to an engine performance problem that's aggravated by the normal operation of the compressor. Ask the dealer to look for a fouled sparkplug, ignition timing that's out of adjustment, a misadjusted carburetor or a bad car-

buretor. Yes—a bad carburetor. It's not unusual for a carburetor as complex as the Mikuni on your Mitsubishi-built engine to have a flaw accidentally introduced into it during manufacture. If the engine checks out normal, it could be that a bad compressor is putting an excessive load on the engine.

Attention Ford truckers

Two of the most frequently asked questions I receive concern Ford-built light trucks, vans and utility vehicles that have a steering pull and abnormal tire wear. Sometimes both conditions affect the vehicle. Sometimes one is present, but not the other.

These problems have been with us for several years. Now it appears that engineers at Ford Parts and Service Div. have them in their sights, and they've contacted me about it. Since space is limited, I'll discuss steering pull here and leave abnormal tire wear until next month.

The shop manual lists several possible causes why a light truck, van or utility vehicle could be pulling to one side. These include uneven tire pressure, tires of different sizes being used on the vehicle, unevenly distributed cargo, loose steering linkage or steering gear mounts, a bent spindle or spindle arm and front-end misalignment.

In checking on these things, pause when you get to front-end misalignment, because even if front-wheel caster angles are at or near the specified amount, the vehicle will pull toward the side having the least caster if the caster split is 3/4 of a degree or greater.

So far, Ford has issued two important TSBs describing installation of a kit to equalize side-to-side front-wheel caster. TSB 85-13-12 applies to 1980-86 F100/150 4x2 and 1983-87 Ranger 4x2 models; TSB 85-19-15 covers 1980-86 F250/350 4x2 and 1976-87 E150/350 models. A TSB that deals with 1980-86 Bronco and F150 pickup 4x4 models will be published soon. I'll let you know when it's out.

Watertight

Both rear wheel wells in the trunk of my 1986 Taurus have puddles of water in them after a rain. The dealer keeps the car a day or two, then tells me the trouble's corrected. He's right—as long as the sun keeps shining. But when it rains again, I'm right back where I started. Several other Taurus owners

DO YOU HAVE A CAR PROBLEM?

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

SERVICE TIPS

■ If your 1982 GM J-car 1.8-liter engine is suddenly suffering a loss of power or stumbles at part throttle, surges, or occasionally backfires as you accelerate, it could be that the mixture control solenoid is in bad shape—to be exact, the solenoid tip. In 1982, cars were equipped with mixture control solenoids having either neoprene rubber or stainless-steel tips. It's taken this long for the rubber tips to come apart and cause problems. Check. If the tip is rubber, replace it with stainless steel (part No. 17081807). This repair is covered under the 5-year/50,000-mile emissions equipment warranty.

■ A spark knock condition in a 1986-87 Chrysler Corp. Ram Van or Wagon may be caused by the negative battery cable. According to TSB 18-38-86, the cable may be allowing the creation of a magnetic field. To find out, drive the vehicle with the alternator field leads disconnected. If the driveability problem disappears, install kit No. 4419441, which includes a different negative battery cable.

■ Nissan 200SX automatic transmission upshifts from FIRST to SECOND gear? A newly designed servo piston spring (part No. 31621-X8604) may be just the thing you need. You should ask your dealer to check TSB 86-176.

I've spoken with have the same problem. Can you do us a favor and tell us why?

L.N. GRIFFIN
HIGH POINT, NC

Obviously, there are open seams around the trunk, and water is winding up in the wheel wells. The most likely places for these unsealed seams are around taillights, along the tops of water troughs and where the rear window glass meets the body metal at both corners.

This is one reason why manufacturers place drain holes around the body—for water that leaks through a gap to drain instead of collecting and eventually causing rust. Manufacturers put tiny dart-shaped drain holes in spots that will let water drain from the wells.

Your Taurus wheel wells have these holes, but Ford says its interior designers went a little wild and carpeted not only the trunk, but also the floors of the wheel wells, preventing drainage.

Assuming your dealer tries but fails in his resealing efforts, you can do something on your own. Go to a hardware or department store that sells housewares and buy a plastic kitchen drain board or any item made of extruded plastic or aluminum.

Pull the carpet out of a wheel well, cut a length of the drain board to the size of the well, lay it in the well and place the carpet over it. The pan will hold the carpet about 1/8 in. off the floor of the well. Now water leaking into the well will fall under the carpet and will drain, instead of being trapped by the carpet.

PM

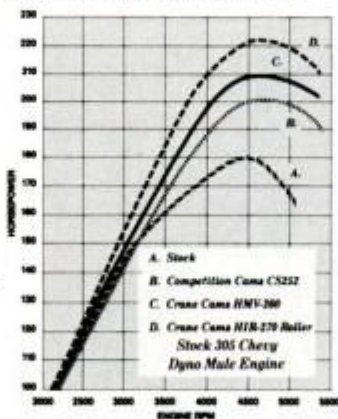
12 Crane Means Reliable Power... on the Street or Off!

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Consumer direct — HMV 260 Camshaft — pn 113901 — fits small block Chevy — sugg. resale — \$112.00. Add \$10.00 handling. Send certified check or money order

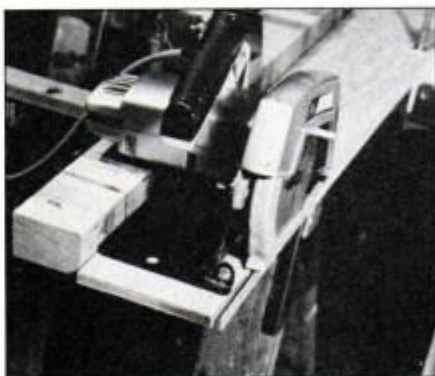
to Crane Cams, Inc., Dept. PM, 530 Fentress Blvd., Daytona Beach, FL 32014. "Not legal for sale or use in CA on pollution-controlled motor vehicles." Tech help: 904/258-6174.

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CRANE Cams

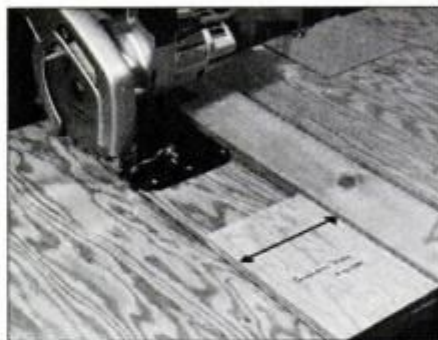
HINTS FROM READERS

Precision spacers



The most time-consuming part of cutting straight lines with a circular saw and guide is setting the guide so the cut appears precisely where you want it. The key to speed lies in making a spacer that defines the distance from the edge of the saw base to the inside of the blade. To make this spacer, first true the edge of a length of 1/4- to 1/2-in. stock and clamp it to a sawhorse. Then clamp in place a straight guide rail against the true edge of this stock. Hold the base of the saw against the guide rail and cut the thin stock to get the spacer, as shown above. To use the precision spacer, simply line up one edge of the spacer with the desired cut, and clamp your cutting guide against the other edge, as shown below.

—Gregory R. Cohen



Adjustable wrench caliper

Measuring the outside diameter of a pipe or other cylindrical object without calipers can be an exercise in estimation. Next time, use your adjustable wrench for a caliper. Tighten the jaws around the pipe and then remove to measure with a rule or tape.

—Victor LaMoy

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11 THIRD PRIZES — (1) Humminbird 3004 Depth Sounder - A.R.V. \$219 (10) sets Berkley Series One Rod, Trimax Fishing Line, Strike Solid Bass Sticks, Blockaid SPF 15 - A.R.V. \$150 per set.

45 FOURTH PRIZES — (25) ABU-Garcia Cardinal Rod and Reel Combo - A.R.V. \$35 each. (20) Igloo 48 Qt. Coolers - A.R.V. \$25 each.

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SALE

AND SWEEPSTAKES

March 26 - May 2, 1987

Entry form must be deposited in a participating retail store. See sweepstakes rules on reverse side for eligibility and exceptions.

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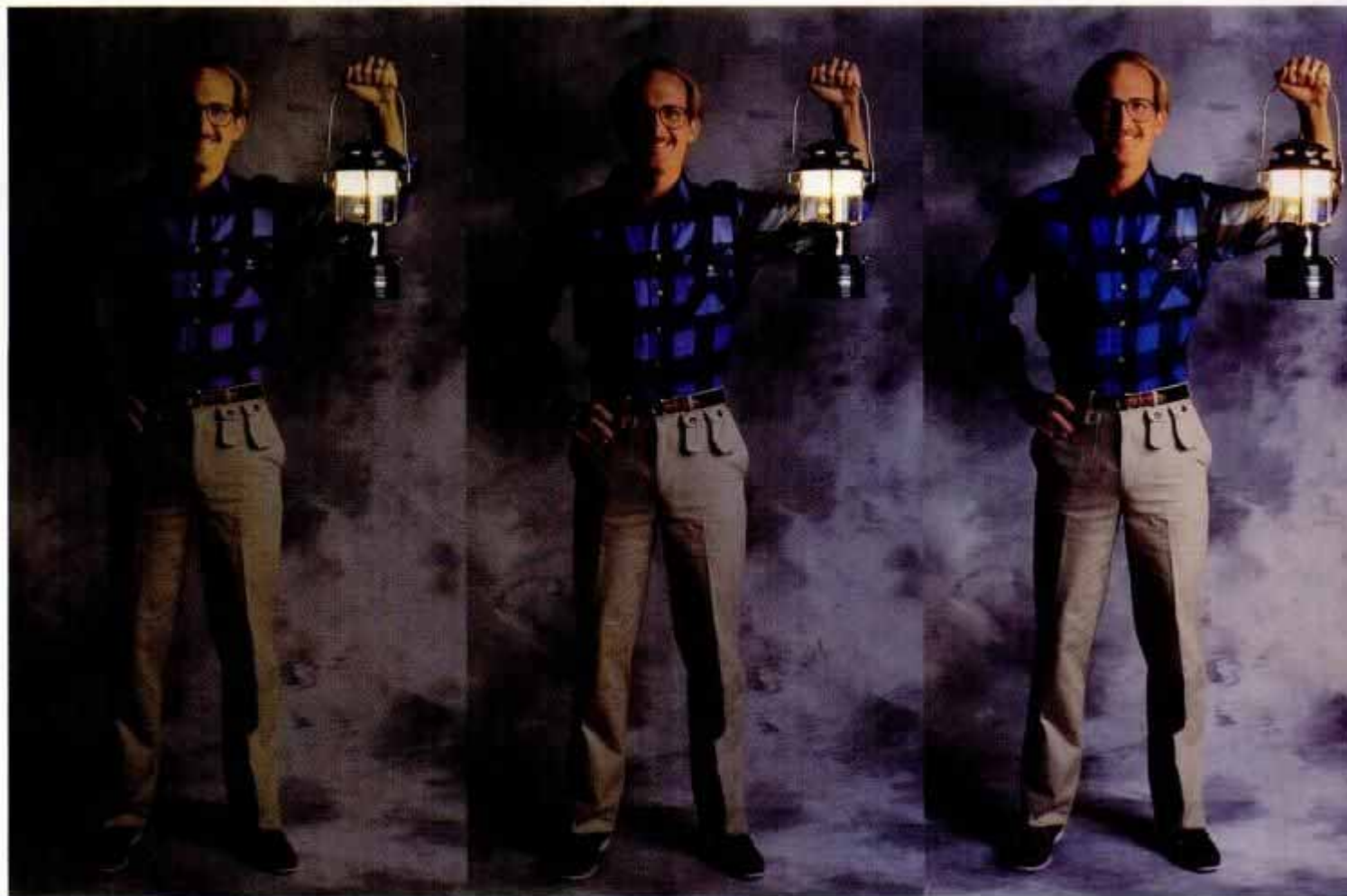
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Nothing to buy or write. Enter at retailer's store before May 2, 1987. Sweepstakes subject to Federal, State and Local laws. Void where taxed or prohibited by law. All prizes will be awarded on a national basis.



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The Grand Prize Winner (1) will receive up to \$12,000 towards the purchase of a 1987 S-10 Maxi-Cab Pickup Truck by Chevrolet. First Prize winners (2) will receive either a 1987 Starcraft MR-160 and Trailer with a Yamaha pro 50 hp Outboard Motor or Coleman® Sequoia™ Folding Camping Trailer. Other prizes will be awarded as listed in store displays and on the first page of this section. Limit one prize per family. All prize winners will be notified by mail.

Prizes are non-transferable and non-redeemable. All taxes and licensing are the sole responsibility of the prizewinner. The odds of winning a prize will be determined by the number of entries received. All prizes will be awarded on a national basis.

Sweepstakes open to residents of the U.S. and Canada. Ohio residents can mail entries to address below.

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A list of major prize winners may be obtained by sending a stamped, self-addressed envelope to SPRING NATIONAL GREAT OUTDOORS SALE SWEEPSTAKES WINNERS LIST Box 328, Pittsburgh, PA 15230.

No purchase necessary. Simply fill out and deposit an entry coupon at a participating retail store before May 2, 1987.

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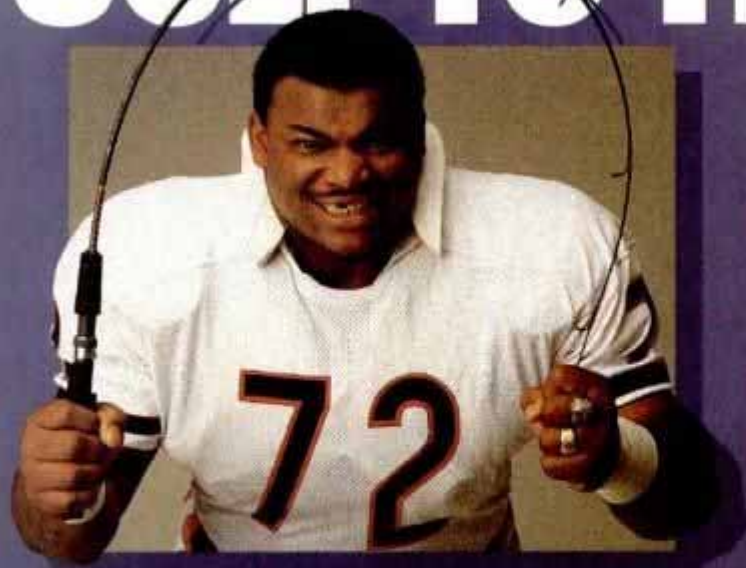
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Check products purchased (limit ONE rebate per product).

- | | | |
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| <input type="checkbox"/> 01 Trilene Filler Spools—\$1 Rebate | <input type="checkbox"/> 04 Berkley Blockaid—\$1 Rebate | <input type="checkbox"/> 06 Specialist Fly Line—\$3 Rebate |
| <input type="checkbox"/> 02 Berkley Strike Liquid—\$1 Rebate | <input type="checkbox"/> 05 Lightning Rod—\$5 Rebate | <input type="checkbox"/> 07 Specialist Fly Reel—\$3 Rebate |
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Only one coupon may be redeemed per product purchased and only one will be honored per family, group, organization or address. Products must be purchased between March 26 and May 2, 1987. Offer void where taxed, restricted or prohibited. Allow 6 to 8 weeks for receipt of rebate check. Offer good in U.S.A. only. Offer expires May 9, 1987.

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If it's fish, it's red. It's that simple. Humminbird's LCR 4 • ID features a unique, new microcomputer that can actually separate one type of signal from another, then display them on its unsurpassed, high-contrast screen in a way that eliminates all the guesswork. The result? Fish appear in red on the easy-to-read screen. You don't need hard-to-understand "white line" or "gray line," because objects as close as 3 inches to the bottom are clearly shown in red. And anything attached to the bottom, such as structure, appears in black.

Plus, there's more. Large fish give off stronger signals than small fish. With the LCR 4 • ID, these stronger signals are displayed in a darker shade of red (a red dot with a black dot behind it), so they're easy to differentiate from the weaker signals displayed on the screen.

Best of all, the big 4" x 3" LCD screen is easy to read in direct sunlight. In fact, the brighter the sunlight, the better the contrast. And, when you add in a fish alarm that sounds only for objects between surface and bottom, you've got a winning, "can't miss" combination for finding fish!



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Home Video



BY JAMES B. MEIGS

8mm Crystal Ball

Although it's been more than two years since the first 8mm video camcorders were announced, people are still confused about where 8mm fits into the video picture. Is it the best way to go for camcorder buyers? Will it soon make VHS obsolete?

I recently made a visit to Japan, where I got a chance to pose some of these questions to the people who invented 8mm—the engineers and executives at Sony Corp. Sony is staking its future in the video world on the long-term success of 8mm.

Instead of trying to get people to give up their VHS VCRs (VHS is by far the most popular video format worldwide), Sony wants to take 8mm into new applications, places where the much larger VHS cassettes can't go.

For example, Sony recently introduced a new supercompact, tabletop 8mm VCR in Japan. Called the Page One, the new model is only about a third the size of most VHS decks. Sony hopes it will catch on with students and others who want a very small VCR they can carry from room to room or over to a friend's house.

Of course, the most important application for 8mm is in camcorders. There, the tiny size of the 8mm cassette gives the format a significant edge. Sony recently introduced a new camcorder that nicely demonstrates 8mm's strength.

The new CCD-V3 (\$1500) is almost as small and light as

Sony's original Handycam, and yet it includes virtually all the features users expect in a full-size camcorder: autofocus, zoom lens and playback in the viewfinder.

Meanwhile,



Sony's new 8mm camcorder records and plays.

Canon, Olympus, Nikon and other famous camera makers have also weighed in with impressive—and extremely compact—8mm camcorders. With friends like these, I think Sony can make a strong case for 8mm as a first-rate format for home moviemakers. Nevertheless, some of the new VHS-C models offered by Sony's VHS competitors (including JVC, Hitachi, Panasonic and RCA) are also quite impressive.

My guess is that most camcorder buyers will feel torn between these two options. That means that although 8mm should continue to grow in popularity this

year, it will still be a long way from getting the upper hand—even in the camcorder field.

If you're in the market for a VHS VCR, don't worry about VHS becoming obsolete in the foreseeable future. With more than 100 million VHS decks in homes worldwide, it's destined for a long reign. But if you're looking for a camcorder, take a close look at the 8mm option. With the latest models, it shows off some impressive advantages. The bottom line: 8mm is off to a good start as a specialty format, but it won't pose a big challenge to VHS for a long time to come.

RCA goes VHS-C

RCA has thrown its considerable weight on the other side of the mini-camcorder battle, by bringing out its first camcorder that uses the VHS-C type of miniaturized VHS cassette. Until now, the only camcorders the company offered used full-size VHS tapes.

RCA's newest camcorder is an impressive lightweight contender.

RCA calls its new CPR100 the Small Wonder, borrowing a name the company once used for its tiny handheld videocamera. That popular product had to be connected to a separate VCR to record, but the new Small Wonder does it all: It can record for up to an hour on a small VHS-C cassette (about the size of a pack of cigarettes).

For playback, either connect the camcorder to your TV set or monitor, or place the mini cassette in the special adapter tray that lets it play in any VHS VCR. Cables and adapter are included.

The Small Wonder camcorder weighs in at about 4 pounds complete with battery. That's light enough for easy 1-hand operation. It includes all

standard camcorder features—zoom lens, autofocus, electronic viewfinder—and one additional benefit: It uses the same solid-state MOS (metal-oxide semiconductor) image sensor RCA builds into its full-size camcorders. That should mean some of the best low-light performance available in a mini camcorder.

At a list price of \$1399, the Small Wonder should help make the VHS-C approach to tiny camcorders extremely popular this year. What does all this mean to people who can't decide between VHS-C and 8mm camcorders? Just this: There are now excellent choices available in both configurations. Don't worry about which format is more popular or claims to be the wave of the future—they're both here to stay. Just look for the features you need, and, the approach that works best with your current equipment and likely uses.

Can you copy?

If you're among the millions of Americans who've acquired a video camcorder recently, you've probably already discovered the biggest drawback of shooting home movies on video: It's too easy. With today's camcorders it's all too simple to record hours of footage. What's hard is finding an audience to sit through it.

The answer, of course, is to copy, or "dub," the best scenes onto another cassette, creating a concise, edited program from the

(Please turn to page 62)



RCA's latest Small Wonder uses mini-size VHS-C cassettes.

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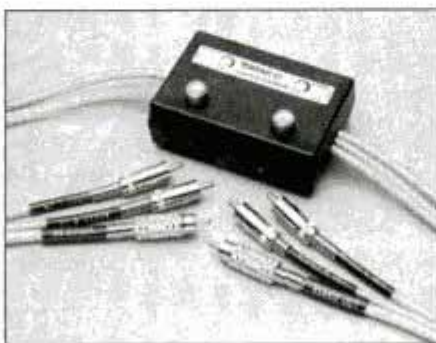
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HOME VIDEO

(Continued from page 61)

sprawling rough footage you originally recorded. But if you've already tried dubbing your home movies, or making copies of any sort of videotape, you've probably also made another discovery: Copying videotapes usually means sacrificing picture quality. There are some things you can do to minimize the loss. Here are a few pointers:

- Start with the best quality images you can. Plan ahead by boosting room lighting before you start shooting. Replace 75-watt bulbs in table or overhead lamps with 150- or 200-watters.
- Record any movies you plan to keep on top-quality cassettes.
- To dub from a camcorder to a VCR, connect a set of audio/video cables from the camcorder outputs to the direct audio and video inputs of your VCR. If dubbing between two VCRs, always use separate audio and video hookups.
- Make sure all contact points are untarnished, cables are in good condition and all connections are solid. Keep cable lengths short to minimize signal loss.
- You can keep an eye on your masterpiece by making sure the VCR is hooked up to a TV set or monitor. If you are dubbing from a camcorder, use its electronic viewfinder for monitoring.
- When video images are copied, they tend to lose picture detail while they gain video "noise," a kind of electrical interference usually visible as snow. If you are copying between two tabletop VCRs, you can experiment with the playback VCR's picture sharpness control to minimize either of these problems. If your dubbed image seems soft, turn up the sharpness control. But, if noise is the major problem with your dub, turn down the sharpness control on your playback deck. You will lose a little picture detail but snow will disappear.
- If you do a lot of dubbing you may want to invest in a video enhancer to boost the higher frequencies in the video signal and increase picture detail. Most enhancers offer a wider range of control than a VCR's sharpness control can, and some even offer separate controls for picture detail and video noise.



Super-Duper, a \$50 video enhancer from Ambico, comes with gold-tipped cables.

Hot laser

With all the excitement over VCRs and videocassettes, it's easy to forget that the videodisc is not dead. While VCRs may offer convenience and the ability to record, dedicated videophiles know that today's laser videodiscs offer the ultimate in picture sound quality.

Now there's a new option in laser videodisc players. Pioneer Electronics has just introduced a compact, affordable player that includes a feature previously available only on expensive top-of-the-line models: the ability to play the digital soundtracks found on many recent laser videodiscs. The programming includes movies and concerts. Played back on a player with digital capability, they deliver the impeccable sound quality of a Compact Disc.

Pioneer's new LD-838D is the first mid-priced player to include this digital circuitry. At a suggested retail of \$550, it's still more expensive than many VCRs, but considering that it offers the unsurpassed sound quality of digital combined with the traditionally superior laser picture, it seems well worth it.



Budget-price Laserdisc has digital sound.

Beta fights back

There's good news for all you videophiles who prefer the Beta format championed by Sony. It comes in the form of a new Betamovie camcorder that corrects the shortcomings of previous models—and then some.

In the camcorder battle PM reported two issues ago (*Instant Replay*, page 74, Feb. '87), we noted that Betamovie—though the world's first camcorder—was a bit outdated compared to recent 8mm, VHS and VHS-C entries. Among other things, it lacked the ability to play back the images you record. You need a home Beta VCR to do that.

The new Betamovie sports an electronic viewfinder, so you can monitor what you're recording as you record. Additionally, you can connect the camcorder to any TV or video monitor to watch your handiwork (or a prerecorded movie). But that's not all.

The original Betamovie, with its picture-enhancing SuperBeta circuitry, could already boast the best resolution of all the camcorder's we tested. Now, it's even better. The latest model incorporates the Beta I-S (for superwideband) recording mode. The result is pictures that nearly resemble what you'd get from broadcast-quality 1-in. videotape. Stay tuned for a hands-on report on Sony's new marvel. **PM**



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The overall shape is designed to enhance Taurus' stability on the road. Even the underbody is shaped to reduce aerodynamic

lift and channel cooling air to the engine compartment.

► **INTERIOR DESIGN.** Taurus seats are designed to satisfy two important criteria. One: For refreshing comfort during long drives. Two: For firm lateral support in turns.

Controls are placed and shaped so your hands can find and identify them easily (your eyes stay on the road). The steering wheel is sized, placed and designed to make it comfortable to grip. Even the safety belts are easy to fasten and adjust.

Taurus will often carry rear seat passengers, so they figure equally in the overall design: With wide, comfortable places for their feet; rear seat heat ducts; and if the rear seat passengers happen to be children, Taurus' child-proof rear door locks offer some peace of mind.

► **THOROUGH DESIGN.** To carry a lot of cargo, the trunk is deep and commodious. To carry two bags of groceries, most models include an elasticized net to keep them upright. When it rains, Taurus has 20" wipers



to clear the windshield. And for bright days, a secondary driver's visor, on most models, provides simultaneous front and side protection from the sun.

▶ **NEW 6 YEAR/60,000 MILE POWERTRAIN WARRANTY.** Ford's powertrain warranty now covers all new 1987 cars for 6 Years or 60,000 miles, whichever comes first. This limited warranty covers all major powertrain components and certain deductibles and restrictions apply. New, longer corrosion warranty coverage for outer body panel rust-through is 6 Years or 100,000 miles. See your Ford Dealer for details and a copy of this new warranty.

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▶ **FORD TAURUS. ON CAR AND DRIVER'S TEN BEST LIST TWO YEARS IN A ROW.** For the second straight year, *Car and Driver* magazine has named Ford Taurus to its prestigious Ten Best list. A list that includes some of the finest automobiles in the world. Fitting company for a car like Taurus. Its innovative design and responsive road

manners continue to impress people everywhere. Especially those sitting behind its wheel. And for those of you who prefer the feel of a 5-speed, get behind the wheel of the Taurus MT-5.

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Outdoors



BY TIM COLE

Polaris' Better Mousetrap



The Polaris Trail Boss automatically shifts into 4x4.

Polaris has recognized that 4-wheel drive in an ATV is a double-edged sword—indispensable when you need it, inconvenient when you don't. Unlike the Honda Fourtrax, which has continuous 4-wheel drive, and the Suzuki LT 4WD Quadrunner, which has a lever-actuated 4-wheel drive, Polaris has gone the final step with automatic on-demand 4-wheel drive.

The Polaris Demand 4 Drive system has a unique front hub clutch that compares front-wheel ground speed to front driveshaft rpm. If ground speed is slower relative to shaft revolutions, the clutch senses the difference and automatically engages positive drive to the front wheel. When the wheels gain traction again, the front clutch automatically shifts to NEUTRAL and the Trail Boss 4X4 returns to 2-wheel drive. There are no switches, levers or hubs to

lock in and out, so the driver can concentrate on the terrain. Extra long travel in suspension front and rear, along with the possibility of differential rotation between inside and outside wheels during cornering, give the \$3399 Trail Boss powerful attributes in comfort and control. For more information, contact Polaris Industries Inc., 1225 North County Road 18, Minneapolis, MN 55441.

Small-outboards update

Kickers for canoes and rowboats offer unbounded range and convenience for fishermen and hunters. And so far we've managed to put up with the minor inconveniences in fill-up and stowage caused by integrated fuel tanks found on most small units.

Engineers at OMC's Evinrude division have recognized

the difficulties, however, and have addressed them nicely with the new \$800 Excel 4. This putt-putt features a removable fuel tank attached below the powerhead and surrounding the engine's swivel bracket. The new tank allows refueling off the engine, and increased fuel capacity allows greater cruising range than most engines with built-in tanks offer.

The 4-hp Excel's 5.29-cu.-in. displacement can churn a feisty 5000 rpm on a 100:1 fuel/oil blend. A clutch permits starting in NEUTRAL—an interesting safety innovation in this size range—and a special fuel-pump on the engine permits the use of a standard portable tank to increase range. The Excel 4 is known as the Ultra 4 under OMC's Johnson label. Who says good ideas can't come in small packages. Contact Evinrude Motors, P.O. Box 663, Milwaukee, WI 53201.

And it'll cook your breakfast

Up 'til now, do-it-all marine navigation equipment has been confined to the bridge-decks of merchant ships and megayachts. But the Apelco division of Raytheon has been working hard to bring big-boat electronics to the casual mariner. They've used high-density LCD pixels in their low-cost radar unit (*Great Gear*, page 104, Mar. '87). And LCD simplicity is at the forefront of their new loran



Apelco's DXL 6600 merges position on digitized marine chart.

Navigator/Plotter, a system that combines position fixing and digital chartwork in a tiny unit that replaces the large, expensive equivalent of just two years back.

The DXL 6600 has all the features of a sophisticated loran, including the ability to store up to 100 waypoints, compensate for true and magnetic variations, steering guidance, ground speed estimate and a cross-track error alarm. The unit establishes the boat's position with a tiny blip, and merges position with an LCD chart of the area that's derived from a standard PROM cartridge.

The LCD chart graphically illustrates coastlines, landmarks, depths and navigation aids. There's also a zoom feature and scales ranging from five to 100 nautical miles. Course track is indicated by a dotted line.

Now it's possible to get state-of-the-art position reports in an unbelievably inexpensive \$1395 package. Contact Apelco, 1107 N. Ward St., Tampa, FL 33607.

Power to go, hold the pull-start

Portable generators are getting more sophisticated as they appeal to a wider slice of the buying public, and Kawasaki's new GD-700AS1, known by the overused tag "Ninja," is the most high-tech offering in the class. Its major highlight is a 1-touch start.

(Please turn to page 75)



Removable fuel tank fits snugly underneath Excel's tiny powerhead.

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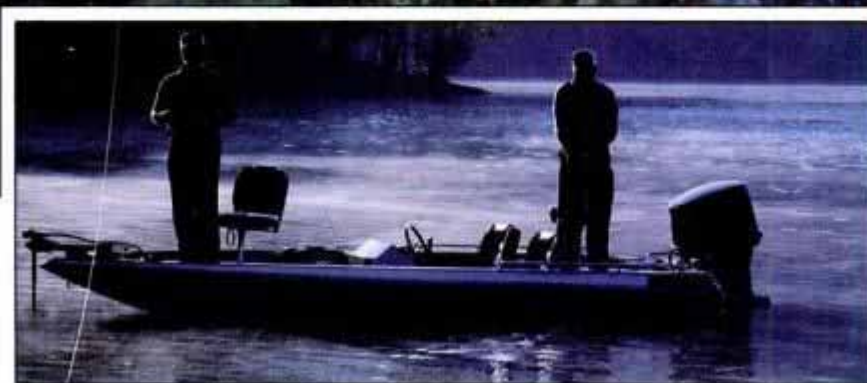
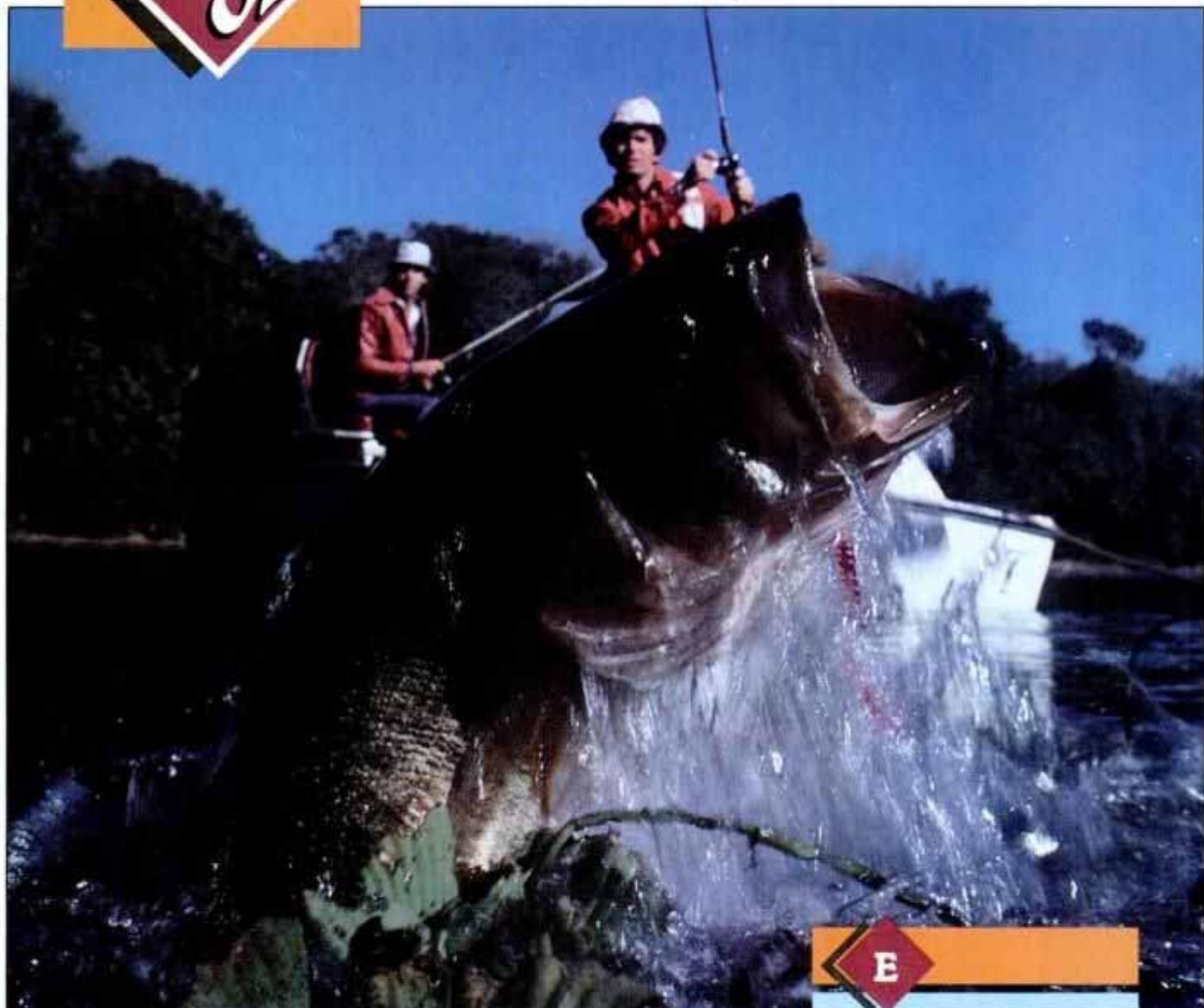
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1987 BOAT SHOW SCHEDULE

Boat shows provide boat buyers many opportunities throughout the year to shop and compare. Local boat dealers listed in the "Yellow Pages" have additional information on boat shows in their areas.

CITY	1987 DATES	PHONE NUMBER
Annapolis, MD	Apr. 17-19	(301) 268-8828
Boston, MA	Jan. 31-Feb. 8	(617) 536-8152
Boston, MA	Feb. 18-20	(617) 242-6092
Chicago, IL	Jan. 7-11	(312) 836-4740
Cleveland, OH	Jan. 16-25	(216) 621-3618
Detroit, MI	Jan. 31-Feb. 7	(313) 427-5770
Fort Lauderdale, FL	May 7-10	(305) 764-7643
Hartford, CT	Jan. 29-Feb. 1	(203) 529-2123
Hartford, CT	March 12-15	(203) 529-2123
Houston, TX	Jan. 10-18	(713) 526-6361
Jacksonville, FL	Jan. 29-Feb. 1	(904) 725-3111
Los Angeles, CA	Jan. 30-Feb. 8	(714) 633-7581
Miami Beach, FL	Feb. 12-18	(305) 531-8410
Nashville, TN	March 4-8	(312) 836-4740
New Orleans, LA	Jan. 31-Feb. 8	(504) 885-9709
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PMX

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Freedom is also available in outboard configuration for engines rated up to 120 h.p.

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tural, engine and sterndrive, and all other major boat systems and components...all at no extra cost.

A MerCruiser 130 hp sterndrive propulsion system (up 10 hp from last year!) provides plenty of muscle for serious skiing. The

quick-planing, 16-foot, deep-vee hull, with its generous 7-foot, 2-inch beam makes a stable, easy-handling platform for up to 7 passengers.

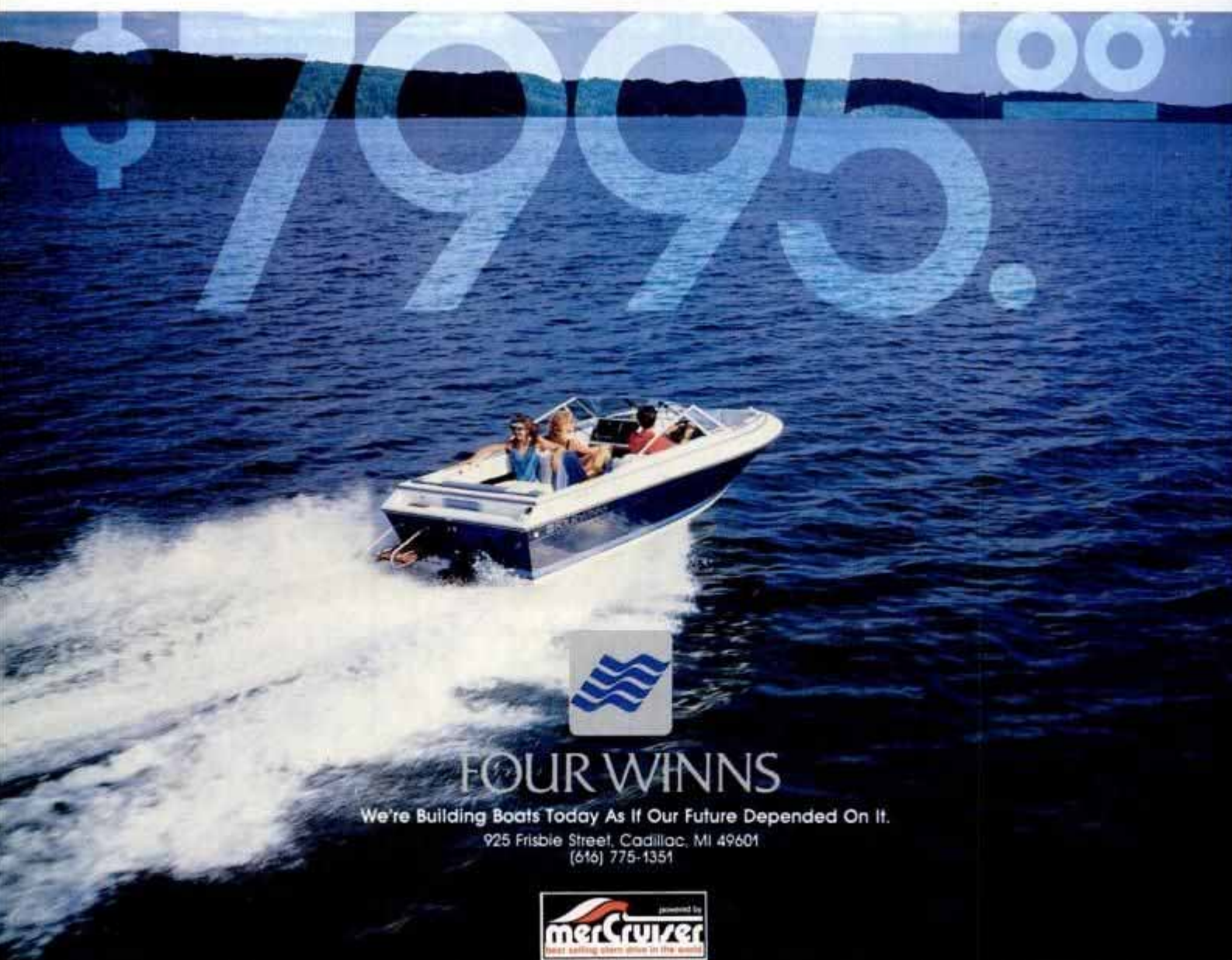
Just considering all its standard features puts the Four Winns Freedom in a pretty elite class. Considering it's \$7995* price puts it in a class all by itself.



*List price for Freedom with factory installed, sterndrive propulsion, excluding taxes, license fees, optional equipment and destination charges.

**Full warranty details are available at all Four Winns Dealerships.

A group picture of the Four Winns Freedom and all the other Boats in its class.



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- 345 VISTA
- 367 QUEST
- 211 LIBERATOR
- 241 LIBERATOR
- 261 LIBERATOR

OUTDOORS

(Continued from page 66)

Pumping out a maximum of 700 watts, the Ninja comes with a motorcycle-style Yuasa battery which, combined with an automatic choke and fuel valves, helps to practically guarantee easy 1-touch starting even under the most severe conditions. The unit also comes with a recoil start backup.

The Ninja also features AC/DC circuit breakers, an automatic voltage regulator that keeps output within 5 percent of a chosen level, efficient 1-fan cooling, and a low-oil warning system that shuts



Light weight and pushbutton convenience mark Kawasaki's new "Ninja" generator.

off the engine and lights a warning not to restart because oil level is too low.

The quiet (54.5 dBA at 23 ft.) Ninja 700 sells for the same price as the larger 1000-watt, recoil-only Kawasaki model (\$529), but the electric-start convenience should make the 51.8-pound lightweight a popular new addition. Contact Kawasaki Motors Corp., Box 25252, Santa Ana, CA 92799.

In the bag

If you've wondered how boat and aircraft builders create tight, void-free bonding in composite structures, look no further than that Hoover in your closet. Assembly lines designed for lightweight, high-strength composites are relying on pots of epoxy resin and yards of glass, graphite and Kevlar. This material is joined in layers that deal with localized loading, directional stress and bonding to dissimilar composite materials. And it's accomplished not with mechanical devices, but with a film of evacuated plastic.

At CS Yachts, for instance, laminators "vacuum bag" a core of end-grain Baltec balsa wood (a truly high-tech material in composite manufacturing) to a typical cruiser's outer fiberglass skin. The white pipe in the photo is applied to a seam between two plastic sheets. Air is extracted and the plastic compresses



Vacuum pipe removes air from beneath plastic sheet, creating a uniform bond.

evenly across the core material, which has been "resinated." The procedure ensures uniform pressure in the laminate and eliminates air bubbles, which could jeopardize structural integrity.

Maybe it's too soon to throw away hammer and nails, but vacuum-bagging may also be the wave of the future for the do-it-yourselfer. **PM**

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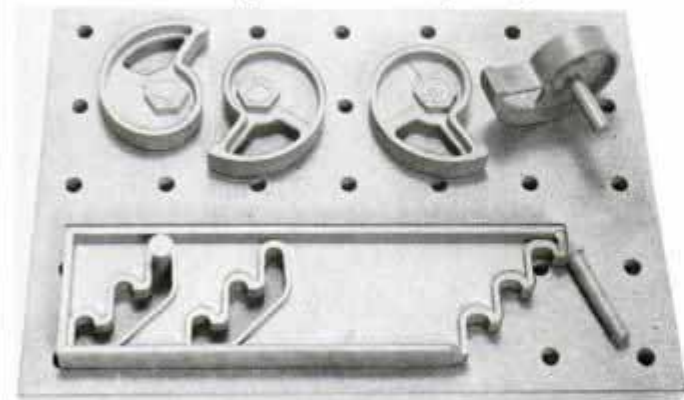
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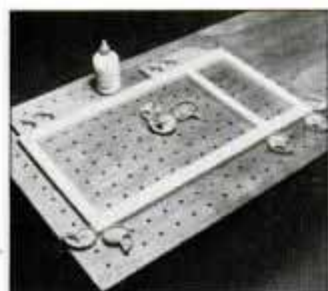
Dissolves varnish and gum for carburetor, automatic choke, PCV valve and linkage.

NEW/WORKSHOP

Benchtop Clamp System



This benchtop clamp system fastens a workpiece using four cams (top) and an adjustable fence, pegged into $\frac{3}{8}$ -in.-dia. holes.



Two sets of clamps can be used together to hold large projects, like frames, doors or panels.

Secure irregularly shaped objects with this benchtop clamping system (\$13). Its four cams lock a workpiece against its fence. Slightly less than $\frac{3}{4}$ in. high, the PVC plastic parts allow for tool clearance and peg into a grid of $\frac{3}{8}$ -in.-dia. holes



The clamp system's grid allows you to position its cams around the edge of a curved object.

bored in the benchtop (clamps also sold with a pre-drilled work surface, \$30). The system is limited only by the size of the grid area. It's sold at Sears stores and catalogs. Write Sears, Sears Tower, Dept. 703-PM, Chicago, IL 60684.

Lightweight belt sander

Skil's Model 7313 belt sander (\$66) features Auto-Trak, a system designed to keep its belt aligned during use. The

5 $\frac{1}{4}$ -pound sander has a $\frac{3}{4}$ -hp, 4 $\frac{1}{2}$ -amp motor that's centered on its composite-plastic body for balance and control. The motor uses ball, needle and sleeve bearings and turns the 3 x 18-in. belt at 700 fpm. Sold at hardware stores, it comes with a mounting kit for use as a bench sander. Write Skil, 4801 W. Peterson Ave., Chicago, IL 60646.



Skil's lightweight, 3-in. belt sander comes equipped with a dust bag and a mounting kit for use as a bench sander.

Safety cabinet

Designed to store flammable liquids safely, this UL-listed cabinet (\$735) features welded 18-gauge, double-sided steel panels with a 1 $\frac{1}{2}$ -in. air space in between. A 3-point rod lock fastens its doors, and its two adjustable shelves have spill-catch grooves. The cabinet is 18 in. deep x 43 in. wide x 65 in. high. Weighing 322 pounds, it's free-standing and comes finished with baked-on yellow enamel. It's sold at industrial suppliers. Write Justrite Manufacturing Co., 2454 Dempster St., Des Plaines, IL 60016.



Justrite's flammable liquid storage cabinet has welded construction and a 2-in.-high bottom sill to contain leaks.

Router bit storage box

Keep your router bits from getting damaged by storing them in this box molded from high-density polyethylene plastic. When it's closed, it measures 2 in. deep x 4 in. wide x 7 in. long. It holds 24 bits in a range of sizes and shapes. The storage box has a reversible snap lock that acts as a hook for open-case hanging. It costs \$7.75 postpaid from Woodcraft Supply, Box 4000, 41 Atlantic Ave., Woburn, MA 01888.



Keep your router bits organized and safe from damage in this storage case.

Heavy-duty bench grinder

You can grind, buff, brush and sharpen with this 10-in. grinder (about \$160). The 80-pound machine comes equipped with a coarse and a

medium wheel. It accepts buffing and grinding wheels and wire brushes up to 1 in. wide with a 1-in.-dia. arbor hole. The grinder's 1-hp.,

single-phase motor produces 1720 rpm. Some of its other features include adjustable spark deflectors and tool rests. Its ON-OFF switch is lighted. It's sold at Delta machinery dealers. Write Delta International Machinery Corp., 246 Alpha Dr., Pittsburgh, PA 15238. **PM**



This 10-in. bench grinder features a 1-hp, 1720-rpm motor, double-strength eye shields and adjustable spark deflectors.



AMERICA

THE

BEAUTIFUL

Designer cars from American studios now compare with the best Europe has to offer.

Those elegant block-long limousines of the '20s and '30s didn't just come off the lot. Unlike today's luxury cars, they were built to customer order. Many luxury carmakers produced only the running chassis. The wealthy buyer then hired a specialty shop to design and build custom bodywork to order. Later, companies like Rolls-Royce and Cadillac offered "catalog" bodywork to people who didn't need, or couldn't afford one-of-a-kind exclusivity. Still later, all body design and construction was brought "in-house," to the assembly line, sometimes when big compa-

BY JIM DUNNE, Detroit Editor

nies bought up the coach-builders, name and all.

But human nature hasn't changed. The TV commercial that pokes fun at lookalike GM luxury sedans is no joke. A new generation of custom body builders has sprung up in the U.S. to meet that demand for the exotic. The names are not as familiar as old-time coachbuilders Fisher, LeBaron, Murphy or Fleetwood, but the intent to produce a unique vehicle is the same.

Man-made materials have been a bonanza for customizers, so platoons of highly skilled craftsmen don't have to hammer out individual body panels with hide mallets. The trick in

Vector W2 (above) is a Chevy-powered, twin-turbo rival to Porsche, Ferrari and Lamborghini.

AMERICA THE BEAUTIFUL

making new shapes now is not in constructing a first-class body. That's the easy part. The difficult part is getting an outstanding design that will last.

Vector

One of the most exotic of the so-called designer cars is this 2-seater from Vector Cars (see lead photo). A creation of Jerry Wiegert, the Vector W2 is called "aerospace technology for the street."

"We were determined to build an American car that is superior to anything in the world," boasts Wiegert. "Our 0-to-60 time is under four seconds." The engine is a transverse, midships aluminum version of a GM 350-cu.-in. V8 with twin turbos and a twin fuel-injection system. Horsepower, at a mild 5 pounds of turbo boost, is claimed to be 600 plus.

Vector wants to build 250 cars this year in three versions that range in price from \$80,000 for a kind of entry-level model to \$150,000 and more for the W2 and W2A. For your cash, Vector offers a free high-performance driving course, so your new toy won't drive you. Vector Cars, 400 North Marine, Wilmington, CA 90744; (213) 775-2277.

Kolb-Design Taurus

From the Kolb-Design shop that has been turning out boutique kits and performance models since 1972 comes this bargain for the mid-price sedan set. What Bill Kolb calls a Taurus ground-effects package will cost you well under \$1000, plus \$516 for the BBS wheels. High-performance tires of your choice are extra. Body parts are a space-age mix of nylon and urethane called Nylethane. Kolb will do the customizing for you at his Blauvelt, New York, shop for under \$2000, plus the cost of tires. A precision designed Koni-Kolb suspension package runs an extra \$995.

Like most of Kolb's designs, the Taurus offers more than you see. Front air dams are built to direct air to the front brakes so you don't lose stopping power in heavy use; rocker panel covers are formed to keep the same ground clearance as



Kolb-Design Taurus features slick aero aids and uprated tires/wheels/suspension.

production cars; and the add-on parts don't wrap all the way around the car in the rear, so it can be towed, or cabled up onto a flatbed without damage. Bill Kolb, Rt. 303, Blauvelt, NY 10913; (914) 359-8185.

Eurovette

Inspired by the stunning Ferrari Testarossa, the Eurovette combines the best of American and Italian designs in a package that can be serviced at your local Chevrolet dealer. Bring in a stock Corvette and Special Edition Corvettes Inc. will turn it into a Eurovette in 14 days. What you will get is all-new body panels below the beltline and to the rear of the front fender panels. Electric door handles will be added, and all the changes will be painted in your original color. Wraparound taillights are the major disguise at the rear.

In addition, Gotti 16-in. modular aluminum wheels, which increase the rear track by 6½ in., will be exchanged for your original equipment Vette wheels. The cost: about \$12,000. "What we have is obviously something that looks like the Testarossa for \$100,000 less," says Dave Samuels, marketing director for Eurovette. "We build about 30 per year, mainly for male professionals who want to be seen in something more striking than just the standard Corvette." Special Edition Corvettes, 1619 Clearwater-Largo, Clearwater, FL 33516; (813) 584-4660.

Zimmer Quicksilver

Take a V6-powered Fiero, stretch the wheelbase a whopping 16 in.—all in front of the door—replace the body

panels with all-new fiberglass shapes, and you have an idea of what the Quicksilver is all about. It blends the styling of many of the newer luxury coupes like Toronado, Mark VII and LeBaron with a production chassis and drivetrain that promise long life and dependability. The engine is the Fiero's 2.8-liter V6 performance option, hooked up to an automatic transmission. Performance, like that of the premium Fiero, is excellent, though not in the class with some true sports models.

"We're not after the performance driver," reports Carl Severe, president of Zimmer. "Like the early Thunderbirds, we have lots of chrome, lots of leather and white sidewall tires to set us apart from the street dragsters." List price is \$48,000. But you may have to wait if you want to park one in your driveway. Severe says that only about 110 will be built each year. Zimmer Motor Cars Corp., Papano Beach, FL 33061; (305) 953-7600.

Cars & Concepts Mark VII

Take an LSC version of the Lincoln Mark for your base car, and add just about anything you want to build on that will be hot. Cars & Concepts will put this GTC (Grand Touring Coupe) in your driveway for about \$5500 over the price of Ford's factory version.

For those buyers who like their money's worth in something you can see, the GTC delivers lots to look at. Subtle ground-effects panels at sides, front and rear, plus a complete new panel for the lower side body area make the car look lower and more solid. Wheels are

Eurovette is a Ferrari Testarossa-like body on a Chevrolet Corvette chassis.





Zimmer Quicksilver, believe it or not, is a stretch job on a mid-engine Pontiac Fiero.

BBS 15 x 7 cast-aluminum type that match the body color. And the whole car gets a single-color paint job in buyer's choice of white, black, platinum, maroon, blue or champagne. Grille, bumpers, window moldings—everything but the wheel rings, lights and badges—are painted one color.

For an extra \$6000 or so you can get the Stage II GTC, with dramatic changes in the way the car handles. The air springs up front are stiffer, Koni shocks are added, 16-in., 50-aspect ratio Goodyear tires give better grip, front and rear stabilizer bars maintain balance, and semimetallic brake pads



bring out the best in the car's standard antilock brakes. Cars & Concepts, 12500 Grand River, Brighton, MI 48116; (800) 227-7016.

Hot to trot

Then, there are the specialty cars that emphasize power rather than styling. One is the limited run of Shelby Dodge

Omni GLHS pocket rocket that packs 175 turbocharged horsepower into an innocent-looking econobox.

Another low-profile rocket is the Gale Banks Firebird, featured in our February '87 issue (page 78). "We'll give you 500, 600, 700 hp, and you can drive 'em on the street," says Banks, who also builds turbodiesel Ford and Chevy light trucks. "It looks stock 'til you pop the hood. It's a sleeper that catches people by surprise."

Sleepers or stunners, there probably is a personalized car that fits your ambitions and pocketbook somewhere in the U.S.

FM

Cars & Concepts GTC is a monochromatic version of Continental Mark VII with an AMG Mercedes look.





It's no secret that the tires on your new car are far better than anything you could buy even a few years ago. How much better? Dan Gurney told me, "The tires available on today's passenger cars are better than the racing slicks I used at LeMans in 1967." Considering that Gurney was hitting 230 mph down the Mulsanne Straight, you ought to feel pretty secure as you race down to the 7-Eleven.

According to Fred Kovac, Goodyear's vice-president of tire technology, much of this advancement is due to computer engineering. As he puts it, "Computers can be used to design tread patterns, predict wear, engineer internal construction, analyze stress, test behavior and permit modal modeling of the entire tire/vehicle system."

Leo Mehl, Goodyear director of racing, is more blunt: "In the old days, we'd make up some tires, put them on a race car and see how they worked. That kind of blind testing was not only very wasteful, it was potentially dangerous.

Today, we can take a new idea, refine it on the computer, and have that tire on the racetrack or a passenger car within 30 days. And we know before we make it how that tire will perform.

"The revolution in tire molding came in the late '60s," says Mehl. "That's when tires started getting lower and wider, and we learned how to mold them with a concave tread, so that when you blow them up, they have the right

HOT RUBBER

The third generation of high-performance tire design promises safety, speed and (finally) foul-weather flexibility.

shape. The revolution in tire compounds came only in the late '70s. Before, to get the necessary amount of tire wear, you had to give up traction. Now we have rubber compounds that give good wear, but also good traction."

The third great revolution in tire development is happening right now, with incredible advances in tread design. Asymmetric tread designs—the Yokohoma A008R, for example—put more rubber on the outside where most cornering takes place. Unidirectional designs like the Bridgestone RE71 and Goodyear "Gatorback" squeegee water so effectively they can corner nearly as quickly on wet asphalt as on dry.

Speedway to driveway

With the exception of Goodyear's NASCAR tires, just about every racing tire in the world is now a radial tire. Since virtually all street tires are radials nowadays, this means racing technology is directly applicable on the street.

The famous "Gatorback"—the tire with the distinctive V-shaped tread pattern that's original equipment (OEM) on the Corvette, Z-28, Mustang GT, et al—is literally a street-legal version of Goodyear's Formula One rain tire. Bridgestone's similar RE71 is derived from a rain tire used in European Formula Two. Most of the other leading-edge high-performance street tires were also developed and tested in racing.

According to Rick Brennan, performance tire engineering manager for Bridgestone, a number of techniques developed for racing have been incorporated in high-performance tires like the RE71. Competition-inspired rubber compounds resist heat buildup. Nylon cap and strip plies molded over the steel belts in the tread restrict movement of the tread and tire "growth" at high speeds. Ultrahard rubber in the bead area and wire reinforcements in the lower sidewall improve steering response.

Right now, you have a choice of similar tires from

BY RICH TAYLOR, Contributing Editor

PM PHOTO BY HUMPHREY SUTTON



Fat-cat award goes to huge Michelin XGT Plus tires designed for the Corvette.

Porsche and the special 255/40VR-17 Bridgestones are designed for sustained speeds up to 200 mph. It's not likely in the near future that you'll need a capability for sustained speeds of 130 mph—not to mention 200—but it's nice to know that your tires have so big a safety cushion.

One problem with high-performance tires derived from racing is that many of them don't work so well if the pavement is wet. Racers switch tires at the first drop of a shower, but that's not practical on an everyday street machine. No matter, Yokohama recently introduced the AVS series of Dry, Intermediate and Wet street-legal tires. Each one has a different tread design and compound, for superior traction under its specific set of conditions. They're all V-rated, but capable of sustained speeds of 186 mph. No doubt, Yokohama expects to supply more to Showroom Stock racers than to everyday motorists who like to do 4-tire pit stops at every change in weather.

American, Japanese and European manufacturers. American companies are generally considered world leaders in tire technology, and their top offerings include Goodyear's Eagle VR Gatorback and Eagle GT, BFGoodrich's Comp T/A, General's XP2000V, Firestone's Firehawk GT and S-660 and Michelin's American-designed and built Sport EP-X.

Until two or three years ago, Japanese tires of any sort were derided by racers as "rim protectors." Today, some of the best Showroom Stock racing tires are built in Japan. They include Bridgestone's RE71, Toyo's Series 600 and Yokohama's A001R and A008R. European tires in this class are the Goodyear NCT, Pirelli P700, Continental CV51, Fulda Y-2000, Michelin XWX and Dunlop D40.

Speed ratings

Most of these "ultraperformance" tires are "V" speed-rated. There are speed ratings for everything from lawn-mower to heavy-equipment tires, but there are only four relevant to automobile tires. Speed ratings were developed in Europe, where it is still possible to drive as fast as you can go down the *Autobahn*. If your Ferrari or Porsche can hold 150 mph for hours on end, you need tires that won't blow up after 10 minutes at 110.

S-rated tires have been laboratory-tested at sustained speeds of 112 mph without failure. H-rated tires are capable of a sustained 130 mph, while V-rated tires will sustain 150 mph. Goodyear has just introduced the first Z-rated tire, the Gatorback ZR-S, cleared for sustained speeds over 150 mph. While it is not yet Z-rated, Porsche has selected Bridgestone's RE71 as the OEM tire on its 959 supercar. Both the

Winter performance

Virtually every V-rated high-performance tire has truly abysmal traction on ice or snow. The wide footprint, high-traction tread compound and small-element tread design combine to "float" on snow. You'll either not be able to go at all, or you'll slide dangerously at even low speeds. You *must* switch to snow tires on all four wheels for winter driving if your car has conventional high-performance tires.

Goodyear has just solved the problem of finding fast snow tires by introducing the first low-profile, V-rated snow tires. The Eagle M+S passes the standard industry tests for mud and snow traction, yet it comes in all the usual performance tire sizes and can be run all day long at 150 mph. No one is suggesting that you drive 150 in the snow. And there is no way any M+S tire can equal today's high-performance tires for dry-road traction, but the Eagle M+S is far better than conventional snow tires on dry asphalt. It's the all-around winter tire that high-performance cars can wear until spring.

About 90 percent of all new cars are equipped with all-season tires, according to Goodyear's Fred Kovac. In our experience, most of these "do-everything" tires don't do *any one thing* very



All-season tires will evolve into constant-performance designs.



well. Goodyear's answer is the Eagle GT+4. The GT+4 is H-rated for 130 mph cruising, but also M+S rated for equally good performance over a wide range of weather conditions. Unlike the typical V-rated "dry" performance tire, or Goodyear's Eagle M+S winter tire, the GT+4 and Michelin's EP-X are year-round tires not intended to be changed with the seasons.

The GT+4 is what Marshall McLuhan used to call "the opening wedge of the trial balloon." Fred Kovac says that in the future, today's all-season tires will evolve into what he calls the "constant-performance" tire, a tire that "will deliver equivalent input to the driver in the dry, wet or snow—at low speeds or high—on any surface." The idea is to provide the driver with predictable performance and no surprises.

As tire aspect ratios get lower, the sidewalls get shorter and wheel diameters have to increase in order to preserve reasonable ground clearance. In the last five years, the leading edge has gone from 14- and 15-in. wheels to 16- and 17-inchers. Designers are already testing extremely low-profile tires on 19-in. rims, and wheels greater than 20 in. in diameter have been tried on road-

Leading-edge technology used in the JJD System 8 fits two skinny tires to each wheel (above) to provide superior traction in very heavy rain with deep puddles. The Eagle M+S from Goodyear (below) is a snow tire that's good for 150 mph on clear pavement. It beats the high-performance winter blues.



racing cars. It's just a matter of time before you see them on the street.

Shorter sidewalls give more predictable handling because they can be stiffer. But stiffer sidewalls make for a harsher ride. Most tire companies are testing experimental wheels that have different diameters on the inside and outside of the rim—say 17 and 19 in.—so that the outside sidewall can be stiff for good handling, while the inside sidewall is softer, for a smooth ride.

Two-for-one tire

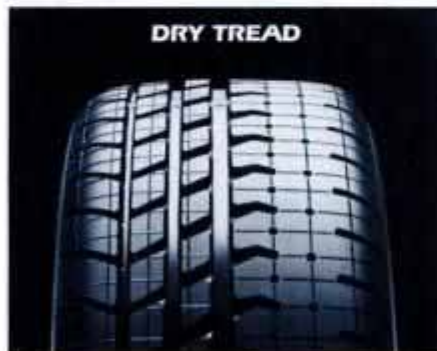
This inner/outer concept has been taken one step further by Swiss inventor Jerry Juhan. Instead of one wide tire, his JJD Twin Tire System 8 uses a pair of narrow Avon tires fitted side by side on a single wheel. Juhan claims dry road performance comparable to a single wide tire, but with much less danger of hydroplaning in the rain.

On JJD's current production tire/wheel combinations, both the inside and outside tires are identical. But as Dr. Ferdinand Piech of Audi says, "Imagine having the outer tire made of a tough compound for traction and comfort." Then there's the possibility of different tread designs, different size inner and outer rims, three or even four narrow tires per wheel, and so on. Of all the futuristic tire concepts around, the JJD seems to be the most versatile . . . though at \$2000 to \$4500 a set, hardly the least expensive.

We had an opportunity to do extensive real-world testing of the JJD concept on a BMW 325. The wet-weather performance is as spectacular as expected, with the added benefit of a perceptibly smoother ride over potholed pavement. JJD dual tires can go some 30 mph faster through deep water than conventional tires before they start to hydroplane (skid).

Since the chance of getting two flats at once is small, the JJD system can

(Please turn to page 162)



DRY TREAD



WET TREAD



INTERMEDIATE TREAD

Yokohama's AVS tires are available with treads designed for use in sunny weather (left), rain or sprinkles (right).

RUN SILENT, RUN DEADLY

America's newest submarines pack the speed and technology to win a war.

By LT. STEVEN R. SOUTHARD
U.S. Navy Submarine Service

The fierce wind stirs up whitecaps on the restless ocean surface. Twenty-foot waves cascade into one another as the storm churns the water. Yet 150 ft. below, a giant black vessel glides, nearly oblivious to the seething tempest. The gentle rocking of the U.S. Navy's TRIDENT-class submarine is the only clue to the violence of the storm above. But the crew is not alone in this undersea world.

"Conn, Sonar, I hold a contact, a probable Soviet submarine, bearing two-five-eight." The sonar supervisor peers over the shoulders of the sonar operators at their console screens, vividly bright in the otherwise dark

sonar room. In the control room, the officer of the deck, or OOD, has ordered the crew to battle stations and informed the captain of the situation. The "old man" hurries from the wardroom, where he and other officers were enjoying a movie, to the control room.

There, he receives the reports from his battle station's fire control party:

"Contact now bears three-zero-two. He's drawing right."

"Contact classified as Soviet submarine, VICTOR III class."

"Ship manned for battle stations."

Acknowledging the reports, the captain mentally calculates the course, speed and range of the VICTOR, confirming the infor-



mation given him by his executive officer, or XO. In front of the XO are the operators of the Mark 118 Fire Control System. While the digital computers solve the complex geometrical problems of target position and necessary torpedo settings, other watchstanders are busy constructing paper plots of the action, both as a vital backup to the computers and for a permanent record.

"Right 15 degrees rudder, all ahead standard, make your depth 400 feet," the captain orders. Repeating and acknowledging the orders, the diving officer of the watch and the helmsman hasten to respond. The watch ensures that the helmsman and the planesman guide the 18,000-ton vessel swiftly yet

smoothly, with a precision of movement surprising for such a large ship.

An order to "Make torpedo tubes 1 and 2 ready in all respects" sets the anxious men in the torpedo room in motion, making their checks of torpedo conditions and ensuring that the tubes will fire when the switch in the control room is thrown. Just 250 ft. astern of the control room, highly trained engineering personnel operate the nuclear reactor and its associated steam plant, under the orders of the engineering officer of the watch.

"Match sonar bearings and shoot!" the captain orders. The torpedos run true. The TRIDENT has destroyed the enemy! This time, however, it is a training exercise, with

RUN SILENT, RUN DEADLY

a U.S. STURGEON-class submarine acting the part of the Soviet sub. The torpedos contain recording instruments instead of explosives and have been modified to turn away from the target.

Actually, ballistic-missile submarines like the TRIDENT usually *avoid* such confrontations in order to remain undetected. Even so, the realism of the exercise has demonstrated that if forced to attack in a real encounter, the TRIDENT would be victorious.

The most recent addition to the U.S. submarine fleet, the TRIDENT is also the largest and most heavily armed. The huge 4-deck vessel measures 560 ft. in length and 42 ft. in diameter. It weighs in at 16,600 standard tons. The \$1.5 billion TRIDENT submarine—also known as the OHIO class, after the lead ship launched in 1979—can dive deeper than 400 ft.

Cigar-shaped for high underwater speed, the smoothness of her hull is broken only by a small "sail"—the descendant of the World War II sub's conning tower—and the after control

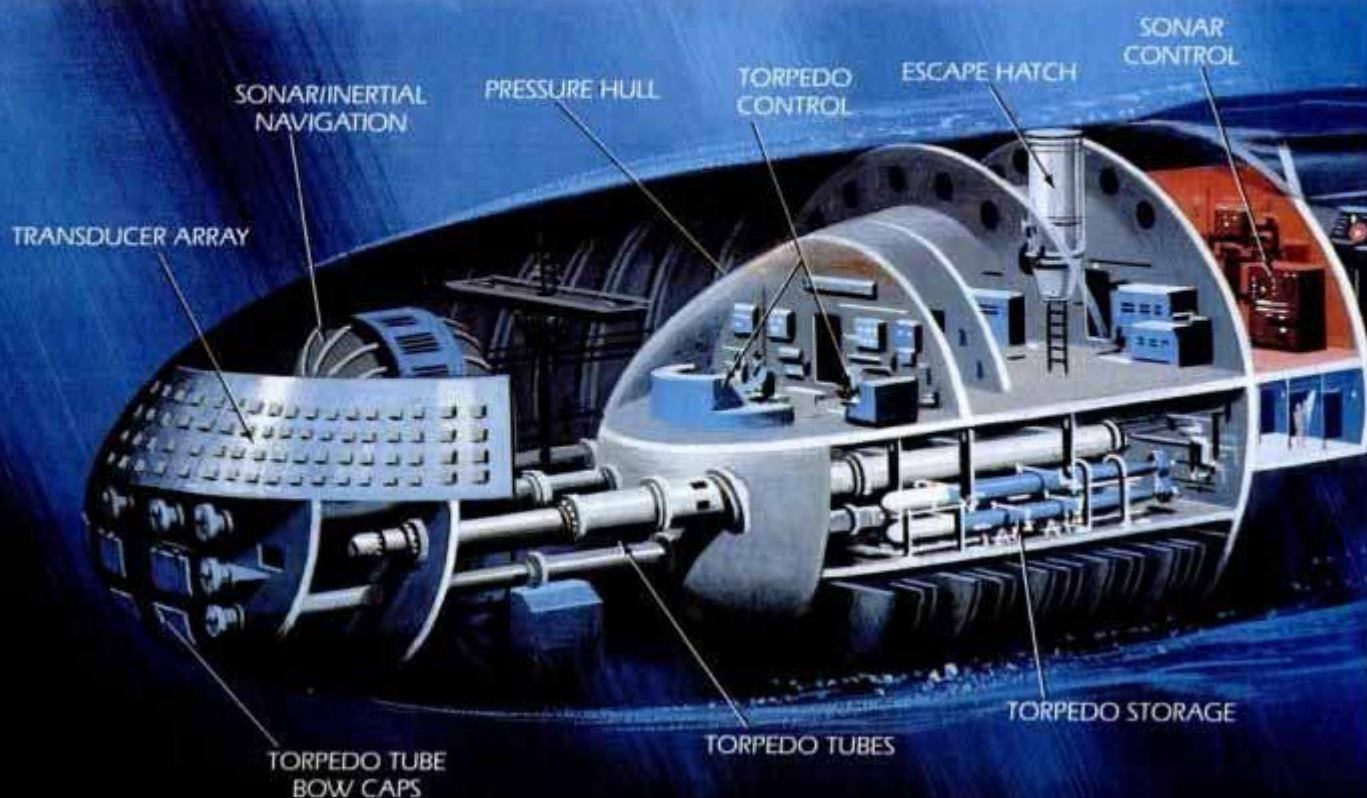


PHOTO BY FRED MARDOON

Trident is steered in control room (above).
Topside, open hatches reveal missile silos.



PHOTO BY BRIAN WOLFF



surfaces: the rudder and stern hydroplanes. The single screw aft is specially designed for quiet operation while providing a top speed of more than 20 knots. Driving that screw, and providing electric power for the machinery, is a General Electric S8G nuclear reactor.

The 24 Trident-1 missiles, which represent a quantum leap in accuracy, range and warhead size over the earlier Polaris and Poseidon missiles, enable the submarine to fulfill its prime mission as a deterrent to nuclear war. In addition, she is armed with deadly Mk. 48 torpedos for active defense. To confound searching enemy ships and submarines, the TRIDENT is the quietest of U.S. subs, contains sensors to find hiding places, and can deploy acoustic decoys to deceive enemy sonars.

Because of their construction, the interior spaces of underwater vessels tend to be more cramped than surface ships. However, the TRIDENT's dual "Blue" and "Gold" crews, each with 15 officers and 150 enlisted men, have more living space and better accommodations than those aboard any other U.S. submarine. Roomy 9-man berthing areas are nestled between the mis-



PHOTO BY TASS FROM SOVIET PHOTO

Soviet Victor II subs pass in rare review photo shot during a Baltic Sea operation.

sile tubes. Entertainment facilities include a videotape player, stereo system, jukebox, gym with body-building equipment, Ping-Pong table, ice-cream machine and library. The heads even contain porcelain toilets with 1-valve operation, a true luxury on a submarine. The increased emphasis on crew comfort is important during the TRIDENT's 70-day patrols.

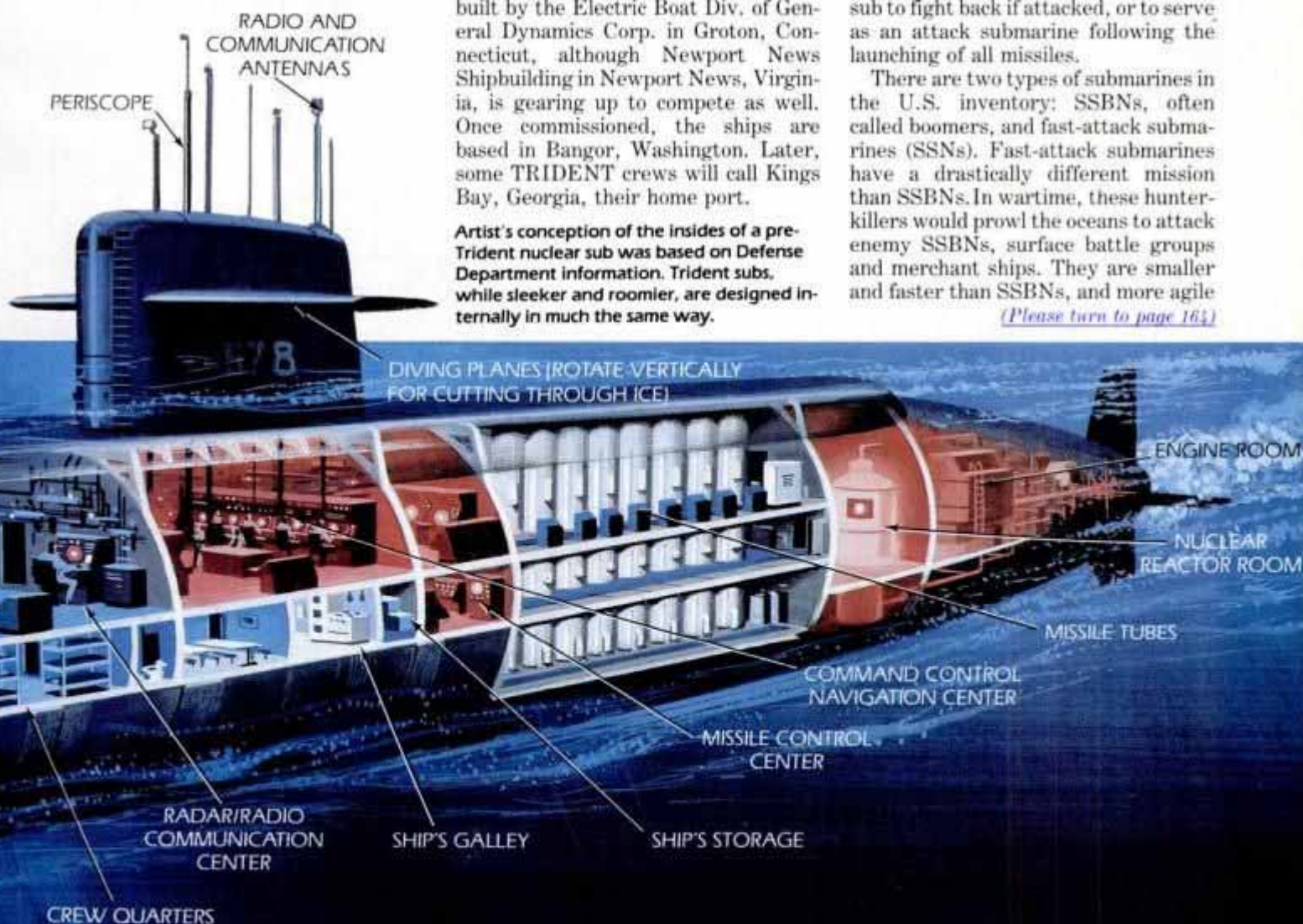
The commissioning of the USS *Nevada* in August 1986 brings the total number of OHIO-class subs to eight. At present, all TRIDENT subs are being built by the Electric Boat Div. of General Dynamics Corp. in Groton, Connecticut, although Newport News Shipbuilding in Newport News, Virginia, is gearing up to compete as well. Once commissioned, the ships are based in Bangor, Washington. Later, some TRIDENT crews will call Kings Bay, Georgia, their home port.

Artist's conception of the insides of a pre-Trident nuclear sub was based on Defense Department information. Trident subs, while sleeker and roomier, are designed internally in much the same way.


To accomplish its mission, a fleet ballistic missile submarine (SSBN) must employ long-range missiles, resulting in a patrol area large enough to hide in, and close enough to home port to minimize transit time. The ship must have a highly accurate navigation system, since the targeting of the missiles depends on the firing platform's knowledge of where it is. The SSBN must be very quiet, to remain undetected in an environment where sound can travel for great distances. Sufficient torpedos must be carried aboard to enable the sub to fight back if attacked, or to serve as an attack submarine following the launching of all missiles.

There are two types of submarines in the U.S. inventory: SSBNs, often called boomers, and fast-attack submarines (SSNs). Fast-attack submarines have a drastically different mission than SSBNs. In wartime, these hunter-killers would prowl the oceans to attack enemy SSBNs, surface battle groups and merchant ships. They are smaller and faster than SSBNs, and more agile

(Please turn to page 164)



PM ILLUSTRATION BY DEAN ELLIS

A collection of five knives and a fish on a wooden surface with wood shavings. The knives are arranged diagonally from top-left to bottom-right. The fish is in the bottom-left corner. The background is a wooden surface with wood shavings and sticks.

**TURNBULL CPM
10V CUSTOM**

**CALMONT POINT
PROTECTOR**

**COLD STEEL
SHINOBU**

AL
MAR

**SHADDER
SNAPPER**

SHARPEN UP

Specialty steels and 21st century synthetics transform the knifemaker's art.

BY BUTCH WINTER; Photos by Bill Dolce

New designs and materials influence knives for every purpose: From left: The Turnbull Custom is made of powdered steel. The Calmorit field-dresser has a folding "point protector." Laminated steel forms the blade of Cold Steel Inc.'s Shinobu. Al Mar uses ultrasophisticated ATS-34 steel. Case Snapper integrates high-carbon stainless and a thermo-plastic handle. Buck uses Kraton in its easy-to-use filet knife.

AL MAR FOLDER



CASE SNAPPER FOLDING FILET



BUCK KRATON FILET



Basic knife design really hasn't changed since the time our Cro-Magnon cousins first skipped a woolly mammoth. A blade of metal or stone honed to a keen edge has always been the basic business-end; wood or bone the traditional grip.

But there's been enormous progress within this basic context. Great leaps of ingenuity have produced knives for a variety of special purposes. And today, knifemaking is undergoing a renaissance of creative energy, with remarkably innovative knives made of space-age plastics and powdered or laminated high-carbon steels. Where once primitive alloys would suffice, today's blades are being produced of the same metal you might find in the high-speed turbine blades of a 747 jetliner.

This technological encroachment on the ancient craft of making knives actually began in 1913,

when Harry Brearly discovered stainless steel. The 440-series cutlery steel commonly used today is actually a product of the 1920s. Variations ranging from high ductility 440-A, to high carbon content 440-C, to stain-resistant Universal-Cyclops T441 have sought to balance competing objectives of edge-holding, ease of sharpening and flexibility.

The big news in steel as the 20th century draws to a close is called, cryptically, 154CM—the steel aircraft makers use to power the aforementioned jumbo jet. This specialty metal has the fortuitous attribute of retaining its hardness at the high temperatures generated inside a turbine engine. But the molecular composition of 154CM is also attractive to knifemakers, especially those interested in edge-holding.

Inevitably, the Japanese have discovered 154CM, have modified it and are calling it ATS-34, which has taken high-tech knifemaking by storm. It's a trifle better than 154CM in edge-holding, and it's being sold in convenient blank sizes. ATS-34 is available in the U.S. in one production knife—the lightweight Al Mar knife that's pictured here.

Blades made from powdered metals—called CPM 10V—have also entered the field. Powdered metal is crafted like you'd bake a cake. The ingredients are mixed in powder form, then forced through ceramic nozzles at high temperature and high pressure. CPM 10V is very high in carbon (2.45 percent), very, very high in vanadium (9.75 percent) and high in molybdenum (11.30 percent). This produces steel that has exceptional wear resistance and toughness.

Ralph Turnbull of Rockford, Illinois, makes an excellent knife out of CPM 10V, the all-purpose design shown on this page. I tested Turnbull's creation over several months and found CPM 10V to have exceptional edge-holding.

SHARPEN UP

But it's difficult to sharpen and has no stain resistance. The answer to the staining problem in the future will be CPM T440V. High in carbon, very high in vanadium, and high in chromium, this steel also has good stain resistance and, in some tests, has demonstrated outstanding edge-holding.

The excitement in knife-making certainly isn't limited to specialty steels, however. Cold Steel Inc. is importing a line of knives called the Shinobu Lockbacks, whose blades are ground out of what they call San Mai steel. It's a stainless-steel laminate consisting of a hard core sheathed by spring-steel sides that are forged into one inseparable piece. The blade offers strength, sharpness and edge holding. While laminating knife blades is hardly new, laminating temperature-sensitive



Bucklite pocket folder (top) relies on lightweight Valox handle. Gerber uses tough Vasco Wear steel in its folder (bottom).

stainless is indeed unique, particularly in a small pocket lockback like the Shinobu.

Gerber Legendary blades makes a line of knives using a steel called Vasco Wear. Vasco Wear is, as its name implies, a wear-resistant steel. It is high in carbon content (1.12 percent), high in molybdenum (1.35 percent), and high in vanadium (2.40 percent). Either

the molybdenum or the vanadium alone would make this steel tough, but with both elements in the mixture, this steel is extremely tough.

Despite these advancements, though, the answer to the perfect knife steel has never been found. And it's my guess that it will be a while before knifemakers find the perfect balance of flexibility, edge-holding and ease of sharpness, always the elusive objectives.

Handle materials, on the other hand, are undergoing an interesting transformation as the progression from the wood/bone era to modern synthetics continues. Tracing the lineage, '60s-era Delrin took the place of Celluloid and natural materials like bone, ivory or stag commonly used in the 19th century. Later, Micarta, a phenolic plastic made by Westinghouse, allowed handles to be made that were impervi-

Enter The 'Smart' Bayonet

Devotees of "mispeak" are calling it "the Multiple Individual Soldier Tasks tool," a *nom de guerre* that may get cumbersome when a squad commander orders his men to "Fix bayonets!"

But whatever you call it, soldiers in the field this year will be wearing a new knife on their web gear. For a really very reasonable cost to the Army of \$49.50 per copy, it's intended to help GIs do more work faster.

Ex-GIs took the Army to task late last year when Materiel Command decided to replace the venerable bayonet with a new multifunction knife. Their "if it ain't broke" argument failed to convince the Army that the bayonet badly needed updating, though, and infantry testers at Fort Benning took less than a year to move the new bayonet procurement from bid to contract. That's something of a record for the Department of Defense.

There were several compelling reasons for replacing the soldier's basic tool. Most important, the bayonet as a pure killing instrument has gone the way of the cavalry charge. The last time soldiers were commanded to fix bayonets in battle was during the Korean War, and bayonet training was phased out in 1976. The Secretary of the Army reinstated bayonet training in 1983, but the real spark that caused the Army to consider replacing the

soldier's field knife was the increasing reliance on personal knives in the field. The infantry simply wasn't getting proper use out of the M-7 standard-issue bayonet, which was developed in the early '60s to attach to an M-16.

One interesting feature of the new bayonet, designed by Phrobis III of Oceanside, California, is the wire-cutting recess on the bottom of the sheath. A lug above this U-shaped indentation accepts the oval hole near the blade's tip. The

sheath and knife hinge together like a pair of shears to cut wire inserted in the recess.

Other features of the Phrobis III creation include T425 Modified stainless steel that's been refined for toughness, edge-holding and corrosion resistance. The glass-filled Zytel handle is insulated to withstand up to 240 volts of electricity. And the new bayonet, designated the M-9, has turned in some impressive performance stats: like cutting through 18 in. of aircraft aluminum in 45 seconds, and snipping 50 double strands of barbed wire in a minute flat, and withstanding a 5-ft. drop—point first—with no damage.

Picatinny Arsenal in New Jersey is completing additional destructive testing and the first 600 bayonets will go to the 75th Ranger Battalion at Fort Benning. Next in line are Special Forces, Light

Infantry and Combat Engineers. And someday when the Army decides that it needs to replace the Phrobis III M-9 with some fancy-pants 21st century utility tool, present-day GIs will *really* have something to complain about.—Tim Cole



The M-1, developed in 1942 (left), is forebear to the Army's M-9 field tool (right).

In addition to easy adaptability to today's Army standard shoulder arm—the M-16 A2—the Army was looking for a knife that could cut wire, saw wood, cleave through aluminum aircraft skin and pop the steel bands that fasten ammo containers.

ous to heat, cold, water, oil, corrosion and impact. As a recent example, the gentlemen at Timberline Knives use traditional Micarta in a survival-knife concept that relies on removable handles, the scales, which are filled with special aids like fishing equipment, line and a compass. The knife also stows in a belt holster and disassembles in a small Allen wrench.

The latest wave of technology relies on thermoplastic materials. Kraton, Thermoplastomer AR have caused a vibberized material design. The AR found in the handles also and Kraton made Aron Kar land between rubber by She... adenic copolymer and be... ke rubber. While they much more durable than a plastic. They are strong, to water, acids, bases and can short exposure to solvents and they can even withstand temperatures as high as 250° F should they need be sterilized.

Zytel and Valox

Hard glass-reinforced Nylon copolymer compounds such as Zytel and glass-reinforced polyester alloys such as Valox do not resemble the rubberized thermoplastics. But they, too, have the advantage of withstanding wide ranges in temperature.

In addition, handles of Zytel and Valox can be colored any shade desired and the wear-proof color will be distributed throughout the material. Best of all, they combine lightness and strength, which produces comfort and confidence when the knives are hanging from your belt.

What's available in knives using these new materials? Case has produced a filet knife like no other on the market. The Snapper is a lockback folder with a handle that can be opened for cleaning purposes. In addition to having stainless steel throughout for all metal parts, Case has used a thermoplastic rubber for the handle.

Case developed its own bonding process to hold the thermoplastic to the steel, and tested the handle material and bonding by immersing it in water for up to two weeks.

Even further, Case operated the locking mechanism more than 4000 times with no sign of deterioration. This testing was topped off by dropping the knife repeatedly from a height of 15 ft. with no damage. Best of all, the



Handsome Micarta is the handle of choice in Timberline's pocket survival knife. Fishing line, files and compass are inside scales.

Snapper is right for both tackle box and countertop butcher block.

Gerber, Buck and Al Mar all use the rigid glass-reinforced polyesters to make handles for very lightweight knives. Gerber uses Zytel for its interchangeable blade series as well as small lockbacks and even large, folding file handle and holster in knives designed to



Western has combined skinning blade and drop-point hunter in a dual sheath. Thermoplastic Kraton forms the grip.

be used in wet conditions. Zytel and Type 441 stainless steel, generally, make good partners for knives to be used in a harsh environment.

Buck has a series of knives it calls Bucklite, which uses Valox. Valox is very similar to Zytel and is used for the same purposes—light weight and strength. Buck's Valox handles come in a wide range of colors: brown, red, green, blue and black.

Buck uses Kraton in its filet knife handles. The rubber-like feel of this handle keeps the knife from slipping when it gets wet. Buck teams T425 Modified stainless with all these thermoplastic knife handles to make them truly high tech.

Superior edge-holding

Vasco Wear blades by Gerber are meant for the hunter or outdoorsman who needs superior edge-holding. The Vasco Wear, combined with a Micarta handle, makes a knife that will also stand up to severe use.

Perhaps the newest line of knives to come on today's market is the line that's being sold by Calmont Cutlery. Calmont's knives are all designed by Calvin Montgomery and they are an exciting new concept.

The patented "point protector" on all Calmont knives was designed to aid the hunter in field-dressing game. The point protector covers the point of the blade when there is a danger of penetrating the internal organs during the field-dressing chore. When this danger is past, or at other times when the protector may be needed, the point protector folds back along the handle and is completely hidden.

'1-piece' construction

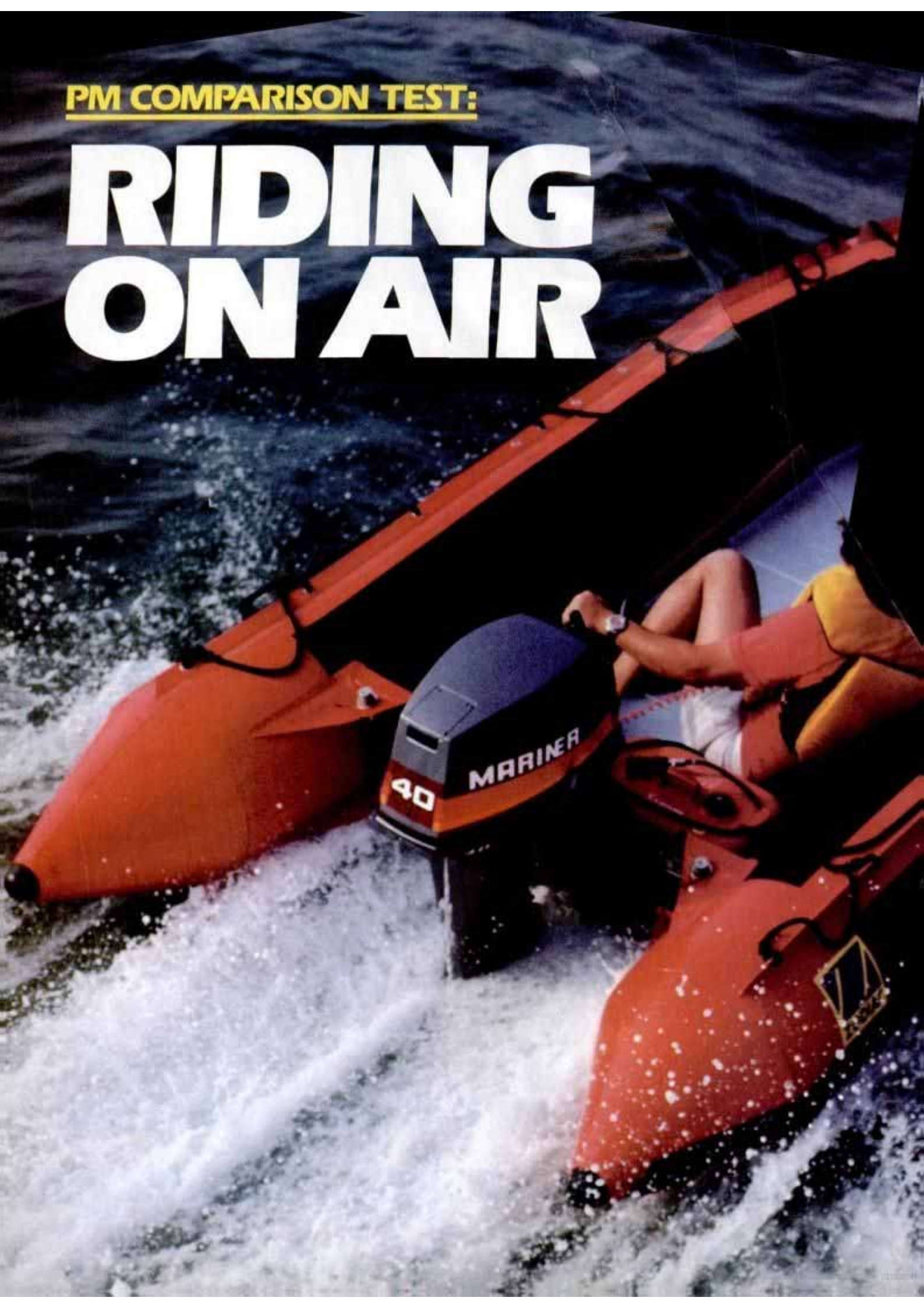
There are several models of Calmont knives and they are all made from a steel in a "1-piece" construction. Elastomer AR handles have been added to some models to aid in gripping the knife under adverse conditions. The owner wish to remove the handles for cleaning, or any other reason, a simple screwdriver is the only tool required.

Newest in Calmont's line is a knife with a blaze orange handle. All thermoplastics, the color penetrates the handle and the owner worry that it will fade or wear.

These are just some of the bargains. They're all in the price range, with the exception of the Turnbull custom, which sells for \$100. There are other designs from the various cutlery companies. And the search for better handle materials seems on. Caveman ancestors knew there's no end to what minds can accomplish with

PM COMPARISON TEST:

RIDING ON AIR



ous to heat, cold, water, oil, corrosion and impact. As a recent example, the gentlemen at Timberline Knives use traditional Micarta in a survival-knife concept that relies on removable handle scales. Small compartments are cut into the scales, which are filled with survival aids like fishing equipment, snares, line and a compass. The Timberline stows in a belt holster, which also carries a small Allen wrench for disassembling the handle.

The latest wave of handle technology relies on thermoplastics. Zytel, Valox, Kraton, Thermorun and Elastomer AR have caused a virtual revolution in knife design. The new field of synthetic knife handles also includes rubberized material like the Elastomer AR found in the Aron Kasei of Japan and Kraton made by Shell. These particular products inhabit a never-never land between rubber and plastic. They are made from styrenic and butadienic copolymer and block copolymer rubber. While they look and feel like rubber, these thermoplastics are much more durable than rubber and can be molded and processed like a plastic. They are strong, resistant to water, acids, bases and can stand short exposure to solvents and oils. They can even withstand temperatures as high as 250° F should they need to be sterilized.

Zytel and Valox

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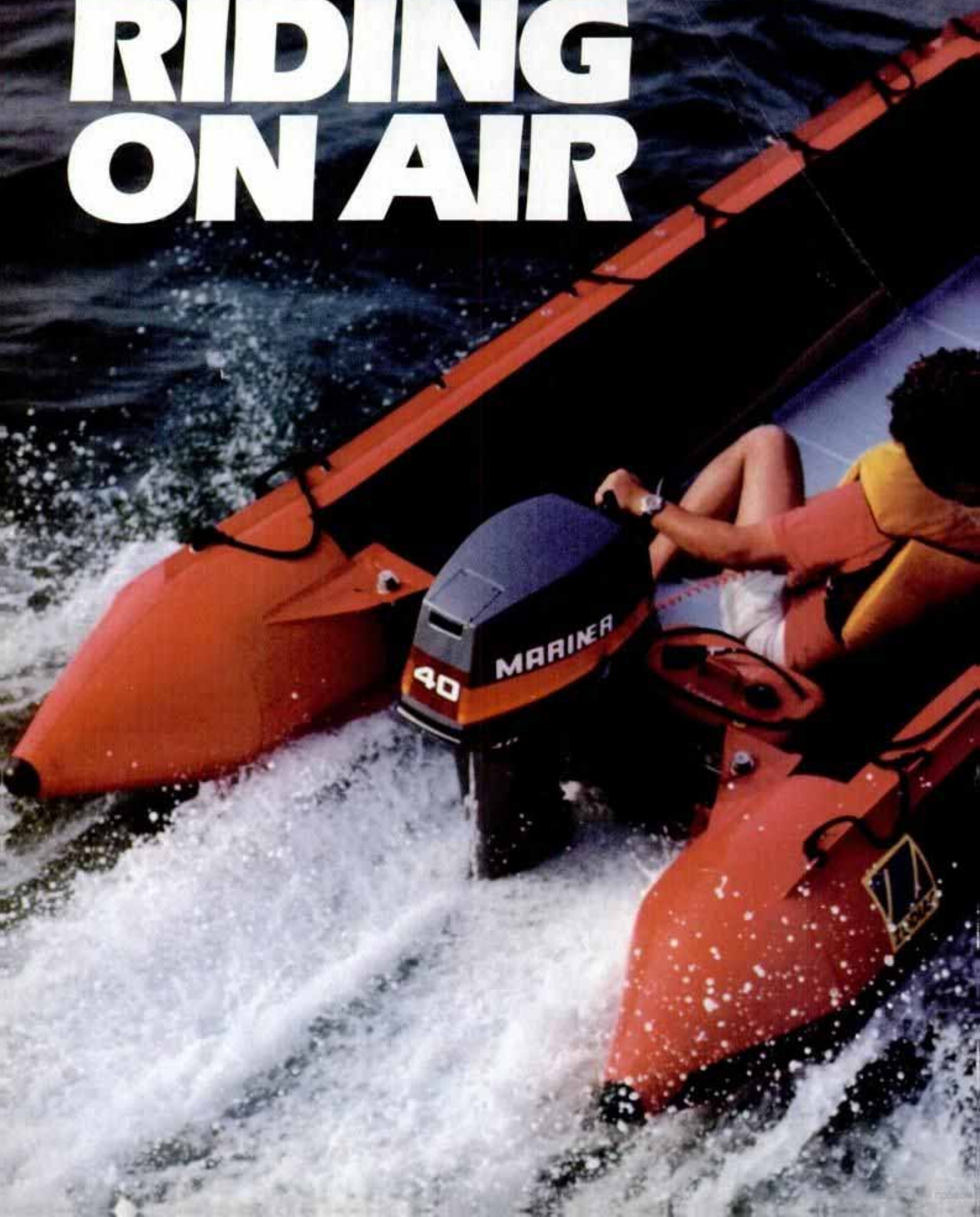
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There are other designs in the works from the various cutlery companies. And the search for better steels and handle materials seems ongoing. As our caveman ancestors knew only too well, there's no end to what some creative minds can accomplish with a knife. **PM**

PM COMPARISON TEST:

RIDING ON AIR





More than just a rubber boat, a modern inflatable can be the ultimate in sport, utility and easy storage. We test six top sellers.

BYTIM COLE, Boating/Outdoors Editor
Photos by Dan Nerney

Nowhere will you find a boat that will do as much—or as little—as a soft-bottomed inflatable. It's perfect as a tender for a larger vessel, as a beach boat or river runner—even as a low-cost utility platform for diving or exploring. But let the seas kick up the merest fraction, and the rough ride produced by a conventional inflatable can knock you into the next county.

It thus becomes both versatile and limited, a boat for all reasons, and yet a boat that's only suited for a narrowly defined environment—inappropriate for big lakes and unsheltered seaways, indispensable for flat-water rivers and tropical coves.

Most manufacturers have tried to broaden the inflatable's proper operating band with a variety of add-ons—like shock-absorbing inflatable seats behind wheeled steering attachments, and rigid bottoms. This last feature successfully suppresses the bounce, but then you're right back where you started from in the stowage department.

With this in mind, POPULAR MECHANICS decided to compare six stripped-down soft-bottomed models relative to handling, interior volume and construction. There aren't enough rigid inflatable boats (RIBs) on the market to warrant a full-blown 6-way test (though that day is coming soon) and testing a clutch of contemporary soft-bottomed boats allowed us to gauge how various manufacturers approach the deceptively complex task of building a boat you can stow in a closet.

With Mercury Marine providing identical Mariner 40s, and John Izzo of Marine General in New Haven, Connecticut, providing rigging expertise, we put 15-footers from Zodiac, Novurania, Novamarine, Achilles, Avon and Lancer through a mixture of sea states and wind velocities. The winner demonstrated clear superiority in handling, but not without a price.

Zodiac Mark III Futura

While interior volume, top-end speed, acceleration, stowage convenience and detailing are all pretty compelling test criteria, scooting over the wavetops is, in essence, all an inflatable is supposed to do. So it better do it well. The leader of the band in that case was

Zodiac relies on stability tubes to blast into the lead of PM's mega 6-way inflatables showdown.

RIDING ON AIR

clearly Zodiac, which has parlayed a generation of experience with little rubber boats into the safest, best handling—and priciest—inflatable on the market. The Zodiac performed so well that testers cried foul. Akin to comparing a Mercedes with a Cadillac, it literally outclassed the competition.

The keys to Zodiac's success are the unique "secondary tubes" running longitudinally port and starboard down the bottom of the boat. The Zodiac may be a couple of seconds off the pace in speed and acceleration (see chart), but secondary tubes permit right-angle cornering at wide-open throttle without cavitation. Be wary, though—the Zodiac is so responsive to tiller movement that it's quite possible to become separated from the boat with any radical high-speed maneuver. Routine use of the emergency stop lanyard is strongly advised.

The secondary tubes possessed a certain shock-absorbing quality, too, which enhanced the overall ride. The Zodiac also managed to achieve level high-speed flight without excessive "nose rise" on acceleration, which we particularly appreciated in rough, crowded conditions.

The Zodiac we tested could have benefited from a spray hood, but the boat's full-length rubrail has a significant downturn, which helped deflect wash. The boat also has an incredibly strong bow handle, an inflatable's perennial weakness.

Most manufacturers in today's infla-

tables market hand-build their products. But the French have developed a mechanical process for building their boats based on "thermal bandaging" technology. Mass manufacturing doesn't seem to have detracted from Zodiac's quality, though, and if we have a complaint, it's with the boat's meager stowage capacity.

Novurania Canguro 450 GS

The next three boats in our test ranking were all within a shade of one another following our empirical performance runs and subjective analyses, with the Novurania earning the nod for the No. 2 spot. We developed a lot of affection for this Italian entry. Its large-diameter inflation tubes give it a Michelin-man pudginess, which was truly comforting in a steep chop.

Of the "also-rans" behind the Zodiac, the Novurania performed the best. We experienced some cavitation in the tight spots, but not as much as with the rest of the fleet. We attributed this handling edge to the boat's full-length wooden keel (an important stowage consideration) and its deep-vee forward entry. Downturned inflation tubes also helped deflect water, producing the driest ride in our fleet.

Novurania exhibited a lot of savvy in certain areas, like the asymmetrical transom cutout, which allowed room for the tiller during hard right-hand turns. You don't realize the safety value of this feature until you have to execute a sudden dodge.

Novurania also approached—but

didn't quite achieve—a proper stowage solution with its semi-dry but unsecured stowage compartment forward. Heavy objects still managed to slither aft on acceleration, but the Velcro-secured envelope stowage for registration papers and other valuables was a step in the right direction.

Novamarine Navy 765

Its strong point is the dry, securable stowage pod forward underneath a neat wooden folding platform lid. This varnished wooden area is finished with nonskid grit and you can stand on it when climbing onto the deck of a larger vessel. The stowage area is secured at the rear, so stowed items stay stowed.

The Novamarine also boasted the greatest cockpit volume, and its unique squared-off bow increased total volume and helped in offloading passengers. Novamarine's bailer was also clearly superior to those found aboard other boats, except for the primitive but elegant approach adopted by Lancer.

While cavitation in tight corners was problematical, it wasn't as bad as some, and testers naturally turned to the Nova for errand-running, a sure sign of practical acceptance.

Achilles SD 156

The Achilles' transom is mounted farther forward than usual, which necessarily places weight well forward in the cockpit. That equates to level acceleration and a slightly smoother rough-water ride. It also subtracts from important cockpit volume, an irksome detail in an otherwise well-designed



1. ZODIAC Mk III Futura	2. NOVURANIA Canguro 450 GS	3. NOVAMARINE Navy 765
LOA: 15'5"/Beam: 6'3"/Payload ¹ : 2866	LOA: 14'9"/Beam: 6'9"/Payload: 2700	LOA: 15'7"/Beam: 7'1"/Payload: 2640
Weight ² : 250/No. chambers ³ : 7 + keel	Weight: 250/No. chambers: 4	Weight: 220/No. chambers: 4
Cockpit volume ⁴ : 42.57 ft. ³ /Floor: aluminum	Cockpit volume: 46.75 ft. ³ /Floor: wood	Cockpit volume: 50.79 ft. ³ /Floor: wood
Material ⁵ : Strongan plastomer-coated Poly.	Material: 1000-denier Neo./Hyp.-coated Nylon	Material: 1500-denier Neo./Hyp.-coated Poly.
Construction ⁶ : Butt-joined thermal bandaging	Const.: HLU, seams lap 1", taped, 2-ply bottom	Construction: HLU, seams lapped 1", taped
Top-end speed ⁷ : 32 mph	Top-end speed: 31 mph	Top-end speed: 33 mph
Acceleration ⁸ : 4.26 sec.	Acceleration: 3.38 sec.	Acceleration: 3.62 sec.
Performance ⁹ : 27.66 sec./Handling rank ¹⁰ : 1	Performance: 29.08 sec./Handling rank: 2	Performance: 30.02 sec./Handling rank: 3
Set-up rank ¹¹ : 4/Price as tested ¹² : \$6100	Set-up rank: 1/Price as tested: \$3875	Set-up rank: 2/Price as tested: \$4230

Test Specs: 1. Payload in pounds recommended by manufacturer. 2. Weight in pounds according to manufacturer in two packed bags, ranging in size from the largest—Zodiac, 13.37 ft.³ plus 5.8 ft.³—to the smallest—Novamarine, 7.88 ft.³ plus 2.42 ft.³. 3. Total number of air compartments plus inflatable keel where applicable. 4. Cockpit volume in cubic feet obtained by multiplying internal length by internal width by cockpit height. 5. Neo. = Neoprene,

boat. Running, the Achilles top-end, acceleration and performance-course figures were all respectable. But the boat has no integrated dry stowage, and we disliked the detachable spray hood on the nose of the boat. It fit poorly and got in the way when climbing over the bow.

Avon Supersport S4.60

Avon's position in the inflatables market remains high, based on the company's long-standing reputation. But we uncovered some serious shortcomings in key areas. Poor acceleration and performance course figures revealed major handling flaws. The boat rears up on its stern tubes for several seconds after throttle up, which is not only slow, but limits the helmsman's ability to see. No other inflatable behaved so abysmally. The Avon also experienced severe cavitation, even in lazy cornering, and pitched water over the transom into the cockpit at high speeds.

With a complete failure in the boat's side grab handle on top of these performance deficiencies, it appeared that this major inflatable manufacturer has to work hard to restore past glories.

Lancer Maxi 450SP

We like to throw worthy newcomers into PM boat comparisons whenever possible, and Lancer from New Zealand happily agreed to participate. The boat's strong suit is not exactly evident, however: According to Lancer's Kenneth Catt, it's a special coating to resist the high temperatures and high ultraviolet light that prevail in the Pacific rim.



While handling was PM's prime test criteria, proper detailing wasn't overlooked. Clockwise from top left: Zodiac's secondary tubes; Novamarine's useful grab handle/mooring cleat combo; Nova's stowage lid/bow platform; and Lancer's elementary but highly efficient bailer system.

We took a real shine to the Lancer's simple but hardly attractive bailer system, a pair of duckbills fashioned from a couple of heavy-gauge rubber tubes. Other manufacturers solve the problem with more complicated, less efficient bailing systems.

Beyond these details, and the boat's basic construction, however, the Lancer has a major task in competing with its European contemporaries. The boat suffered cavitation problems in almost every condition including smooth-water, straight-ahead operation, even with the long-shaft engine stipulated by the manufacturer. This materialized in poor speed and performance figures across the board. And, like the Achil-

les, the soft spray shield fitted over the nose got in the way during boarding and was hard to see over.

Lancer has no doubt discovered that the inflatables market is a tough field in which to compete. These aren't just hastily glued rubber blobs with an egg-beater pasted on the back. They're highly engineered vessels that rely on sophisticated synthetics, coatings, localized support for point loading, and nuances in bottom shape to cope with an ever-changing sea state. They can be the answer to your prayers—or literally a pain in the butt when the conditions aren't right. How they fit into your boating plans depends on where you're coming from.

PM



4. **ACHILLES**
SD 156



5. **AVON Supersport**
S4.60



6. **LANCER Maxi**
450SP

LOA: 15'6"/Beam: 6'3"/Payload: 2750	LOA: 15'/Beam: 6'2"/Payload: 2090	LOA: 14'9"/Beam: 6'4"/Payload: 2320
Weight: 230/No. chambers: 5+keel	Weight: 274/No. chambers: 4+keel	Weight: 242/No. chambers: 3+keel
Cockpit volume: 35.79 ft. ³ /Floor: aluminum	Cockpit volume: 45.69 ft. ³ /Floor: aluminum	Cockpit volume: 47.17 ft. ³ /Floor: wood
Material: 840-denier Neo./Hyp.-coated Nylon	Material: 840-denier Hyp.-coated Nylon	Material: 1680-denier Hyp.-coated Nylon
Construction: HLU, seams lapped 1", taped	Construction: HLU, seams lapped 1½", taped	Construction: HLU, seams lapped 1", taped
Top-end speed: 31 mph	Top-end speed: 32 mph	Top-end speed: 28 mph
Acceleration: 3.97 sec.	Acceleration: 4.14 sec.	Acceleration: 6.20 sec.
Performance: 30.30 sec./Handling rank: 4	Performance: 29.60 sec./Handling rank: 5	Performance: 30.17 sec./Handling rank: 6
Set-up rank: 5/Price as tested: \$3590	Set-up rank: 6/Price as tested: \$3350	Set-up rank: 3/Price as tested: \$4833

Hyp. = Hypalon, Poly. = Polyester. 6. HLU = Hand layup. 7. Measured on flat-water with no wind or current using MPH X-band radar gun. 8. From 0-25 mph. 9. Timed on closed 1/8-mile flat-water course using Heuer digital stopwatch. 10. Subjective ranking based on performance in various wind and sea states, including cross-chop. 11. Subjective ranking based on time and effort in installing floor and inflating. 12. Prices do not include engine.

COLOR-BY-



NUMBERS



Hollywood's latest headline involves no starlets or matinee idols. The hot stuff's about a digital computer process that brings living color to old black-and-white film.

BY STEVE PARKER, West Coast Editor
Photos by Dave Gooley

You're flipping through the channels when you come across a familiar image, one you recognize as a favorite, late-night, old-time movie. You watch for a few moments, the images are there but somehow—different.

No, you're not in "The Twilight Zone," but your black-and-white favorite is now in color. Recent advances in computerized video processing bring this new dimension to b&w photographic film. The magic wand has already touched classics such as "The Maltese Falcon" and "Yankee Doodle Dandy." More are on the way, including "The Treasure Of The Sierra Madre," "White Heat" and a host of series from TV's golden age.

Adding color to b&w motion pictures had its start in the days of silent films, when producers might hire scores of artists to hand-paint special effects onto already-processed films. Today's color-adding technology is a far cry from those painstaking attempts to liven up a dull, gray image.

It's still a tedious, time-consuming and expensive process, but two large companies formed expressly for the purpose of adding color to b&w images are working three shifts a day, seven days a week, in an attempt to meet massive orders placed by the owners of huge film and TV libraries.

Colorization, a firm located in Toronto, Canada, and Color Systems Technology (CST) of Marina Del Rey, California, are two

Finger painting? Well, almost. A colorist at California's CST uses the keyboard of an Apple Macintosh computer to pick frame from a black-and-white Errol Flynn movie, and manipulates the computer's mouse controller (under right hand) to select and apply shades of colors.

COLOR-BY-NUMBERS

companies at the forefront of the color-adding industry. They utilize computer techniques with many similarities, but some vital differences. Colorization is affiliated with Hal Roach Studios—owner of many b&w oldies, and CST has contracted with media mogul Ted Turner to add color to 100 classic films Turner acquired when he purchased the huge MGM film library.

Both companies rely on color-adding systems with some top-secret circuit boards that read digital video signals off a copy of the original b&w film and then assign color values to the signals, frame by frame.

Pick a color . . .

The first step in the color-adding process is making a high-quality, 1-in. videotape copy of the b&w film. Next, a computerized shot-list must be made of the entire movie, detailing every item and movement in each shot within a scene. In "Yankee Doodle Dandy," for example, more than 1400 separate shots had to be detailed and cataloged before any color-adding work could begin. At more than \$3000 for each minute of color-added tape, edit machine operators want to be sure all the information is in-hand before the computers start their work.

It is at this point that researchers, art directors and colorists combine as the team to determine what color Humphrey Bogart's smoking jacket should be, if Shirley Temple's eyes are hazel or brown, and if the railroad car in "42nd Street" should be red or black as the cast "Shuffles Off To Buffalo."

Much of this information can be gleaned from still photos shot for publicity while the movie was being made, but some of it is unknown.

CST and Colorization researchers might visit Hollywood's Western Costume Co. to see the actual costumes used in many of the productions. Or the researchers might take a trip to a local historical library to check on the colors of buildings, signs and so on. Even a flag used in a scene can give a hint as to the other colors involved.

Computer painting

After the shot-lists are compiled and the colors are agreed upon, the engineers and videotape operators take over, under the watchful eye of the color-adding artistic team.

Utilizing a system run through Apple MacIntosh computers in the "edit bay" rooms, with software designed in-house for this specific application, colorists scroll through the b&w videotape



There's as much art as science involved in adding color to a b&w film. First, every item in this busy frame ("Captain Blood") must be listed. Then, art researchers seek out old color publicity pictures and original costumes to find the colors that were filmed. Sometimes, clues come from period paintings and historical documents. After a colorist applies shades to a reference frame, a computer takes over until the scene changes.



frame by frame, adding appropriate shades of color.

Both systems prescribe luminance values to each frame of videotape, now individually captured in a frame-storage device. These brightness values are an indication of the varying gray levels in the original black-and-white produc-

tion, and help in determining the brightness and shade of the specific colors to be added to the film.

Colorization's system highlights picture elements or "pixels" in the scene—tiny pinpoint areas which can be colored and shaded individually. CST's color-adding system puts "masks" or

The Color Of Money: A New Technology Under Attack

An example of mindless insipidity . . ." That's the term venerable director John Huston used to describe the recent color-added telecast of "The Maltese Falcon," his 1941 black-and-white classic.

"It's not color any more than pouring tablespoons of sugar water over a roast constitutes flavoring," protested Huston, whose criticism is echoed by most of Hollywood's creative community.

What's at issue is artistic integrity. Most of colorizing's detractors believe that adding color to a black-and-white film tampers with the director's original intent. Even when color film was available, black-and-white often was chosen for creative reasons—perhaps to set a mood. Movies such as "Paths Of Glory" and "Raging Bull" come to mind. When color wasn't an option, directors still had to use b&w imaginatively: Lighting, costumes, sets and makeup were manipulated to convey depth and tonal distinc-

tions in the absence of color.

In its defense, the proponents of colorizing say it will expose more people to movie classics. They correctly point out that in many countries, no b&w shows of any kind are programmed for TV. Moreover, they state that colorizing will preserve many film classics, because a fresh black-and-white print must be made before colorizing.

If this defense smacks of "doing well by doing good," some of Hollywood's artistic pieties are equally self-serving. As *Chicago Tribune* funnyman Mike Royko points out, "This is an industry that never worries about artistic integrity when it takes fine books and turns them into commercial trash." Russell Baker, in *The New York Times*, quips that "Most movies were ruined years ago . . . chopped into small bits to bracket commercials, served with chunks torn out . . . to fit TV's time schedule." Baker might have added a word about TV's



At CST, original b&w movies and color-added versions are stored on 1-in. open-reel videotape recorders. Tape operator (above) can access any frame for colorist. Psychedelic Cap'n Blood (left) shows possibilities of colorizing.

"polys" over areas with the same luminance values, and colors broad areas of the scene instead of individual shapes or items, as is done with Colorization's method.

Both systems have up to 50,000 hues which can be added. Despite company claims concerning the quality of fin-

ished product, to the untrained eye both systems appear to produce about the same results.

Once color is applied to the opening frame in a shot, the computer can literally take over. It will compensate for movement in the shot by determining whether a pixel (or a masked area) has



pan-and-scan process, which crops off the edges of a movie frame to fit TV's narrower screen proportions. Nobody complains about this when the movie rights are sold for broadcast.

Ethical issues won't decide whether colorizing is here to stay. TV ratings and videocassette revenues will. Viewers will vote with their wallets and their backsides, thereby telling video distributors and TV advertisers whether colorizing is worth the money.

Quality might be an issue on the ballot: It remains to be seen whether the pastel hues of colorizing—a video process—can satisfy generations raised on vibrant color-film photography and live color telecasts.

Once the novelty wears off, colorizing might encounter the same resistance as those "rechannelled for stereo" remakes of monaural Elvis Presley songs. Alternately, public indifference might institutionalize a fad.—*Stephen A. Booth*

changed in luminance value, and whether the added color should move with that change or remain stable.

Machine vision

Of course, any major movement in a shot or the entry of a new character changes things considerably, calling for additional colorist work. "Yankee Doodle Dandy," whose song-and-dance extravaganzas involved many extras entering and leaving the stage, took three shifts of colorists, working in 10 editing rooms, nearly 60 days to complete.

In order to accomplish this seemingly never-ending chore, CST uses 42 Sony BUH-2500 animation recording machines. These 1-in. videotape recorders can record not only frame by frame, but video field by field—essentially adding, checking and rechecking the color movement in a frame 60 times a second. Harris 654 Quad Framestore devices allow the colorists to keep a single image on their monitors for as long as necessary, without the glitches and jumpiness you'd experience with most home-use videocassette recorders. From the master 1-in., color-added videotape, copies can be made into any format (VHS, Beta, etc.) to be replayed anywhere in the world.

Future applications

According to its proponents, future applications for color-adding abound. Already, medical technologists find that by assigning colors to b&w X-ray film procedures such as angiograms, more diagnostic information can be gleaned from a single test. In the field of exploration, color-added satellite images can reveal natural resources beneath Earth's surface. For pilot training, colored high-speed b&w films shot at Mach II add a dose of realism never before experienced on the flight simulator. Even music videos and other artistic ventures are being shot in b&w with color added later at the whim of the director.

At this writing, only a relative handful of color-added feature films have made their debut. Many more are likely to come. California's CST estimates that of the 16,000-odd b&w movies available in the U.S., some 5000 are candidates for a facelift. The company also reckons that about 150 TV series, from the 1500 produced in b&w, are suitable for coloring. So whether you're watching a young Steve McQueen in a color-added version of "Wanted: Dead Or Alive" or vintage Bogie in the classic "The Maltese Falcon," what you're really witnessing is a technology in the earliest stages of its growth. **PM**

HOW THE SOVIETS ARE BUGGING AMERICA

When the Reagan administration sent 55 Russian 'technicians' packing last fall, it put only a slight dent in Russia's U.S. spy network.

BY SEN. DANIEL PATRICK MOYNIHAN



Soviet agents may be listening to your personal telephone conversations. If you're involved in the government, in the defense industry or in sensitive scientific activity, there is a good chance they are.

In fact, a recent unclassified Senate Intelligence Committee report on counterintelligence indicates more than half of all telephone calls in the United States made over any distance are vulnerable to interception. Every American has a right to know this.

You should also know that the Reagan administration has recognized this threat for a long time now, but so far, the bureaucratic response has been

piecemeal, and at times reluctant.

Consider this as background: In 1975, when I was named permanent U.S. representative to the United Nations, Vice President Nelson Rockefeller summoned me to his office in the Old Executive Office Building. There was something urgent he had to tell me. The first thing I must know about the United Nations, he said, is that the Soviets would be listening to every telephone call I made from our mission and from the ambassador's suite in the Waldorf Towers. I thought this a very deep secret, and treated it as such. Only later did I learn that Rockefeller had publicly reported this intelligence breach to the president in June 1975.

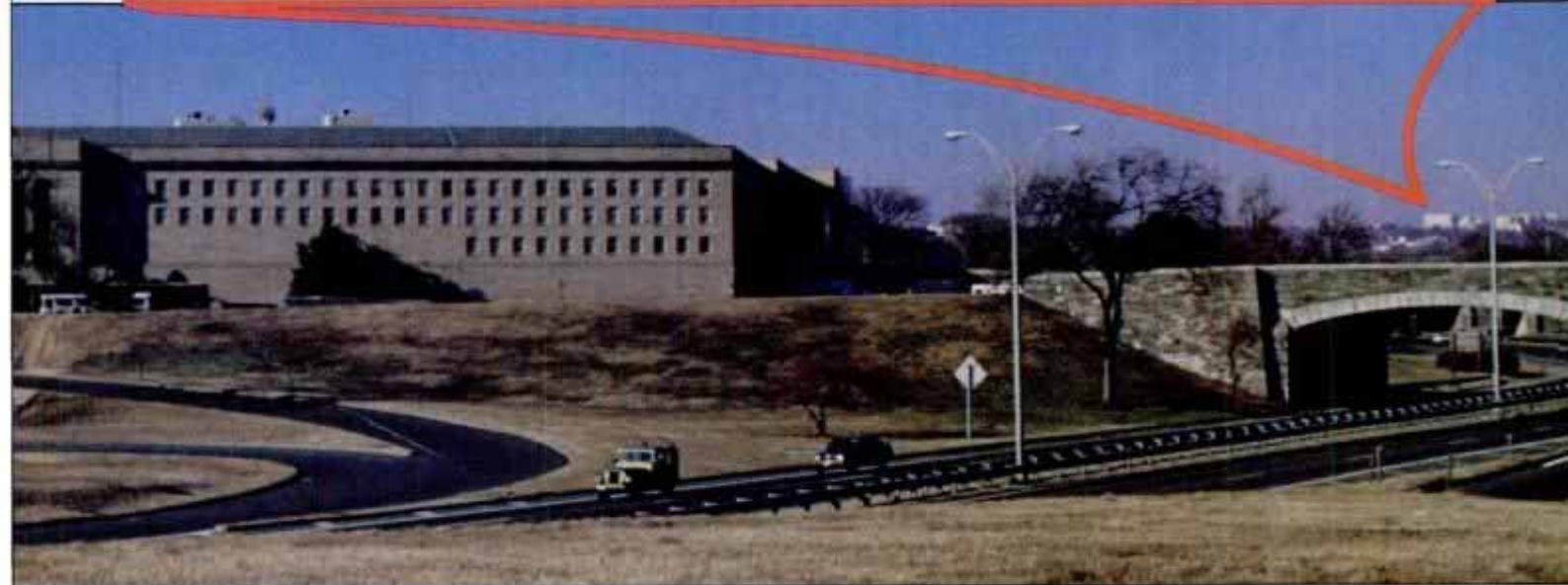
The Rockefeller Report to the President on CIA Activities Within the United States notes:

"We believe these countries (communist bloc) can monitor and record thousands of private telephone conversations. Americans have a right to be uneasy if not seriously disturbed at the real possibility that their personal and business activities, which they discuss freely over the telephone, could be recorded and analyzed by agents of foreign powers."

The Soviets conduct this eavesdropping from their "diplomatic" facilities in New York City; Glen Cove, Long Island; San Francisco; and Washington. By some estimates, they have been



WIDE WORLD PHOTOS



doing so since 1958. President Reagan knows this well. He sat on the Rockefeller Commission and signed its final report concluding that such covert activities existed.

If we had any doubts about this eavesdropping effort, Arkady Schevchenko dispelled them when he came over in 1975 and subsequently defected in 1978. As you will recall, Schevchenko was, at the time, the second-ranking Soviet at the United Nations and an up-and-comer in the Soviet hierarchy. He describes the listening operation in New York City in his book *Breaking With Moscow*: "The rooftops at Glen Cove, the apartment building in Riverdale, and the Mission all bristled with

antennas for listening to American conversations."

But we have to worry about more than just parabolic dish antennas tucked behind the curtains in the Soviet "apartment" building in Riverdale, New York.

There are also those Russian trawlers that travel up and down our coast. They are fishing, but fishing for what? Communications. And now the Soviets have taken their eavesdropping a step further and have built two new classes of AGI, or Auxiliary Gathering Intelligence, vessels. From the hull up, these new vessels are floating antennas, I suppose.

Most dangerous of all, perhaps, is the

New Soviet embassy (top) is on a rise overlooking the Pentagon. Its spy electronics are concealed in a rooftop structure.

Soviet listening complex in Lourdes, Cuba, just outside Havana. This facility is the largest such Soviet listening facility outside its national territory. According to the president, it "has grown by more than 60 percent in size and capability during the past decade."

Lourdes allows instant communication with Moscow, and is manned by 2100 Soviet technicians. 2100!

By comparison, our Department of State numbers some 4400 Foreign Service Officers—total.

Again, to cite the recent Senate Intelligence Committee report: "The

HOW THE SOVIETS ARE BUGGING AMERICA

massive Soviet surveillance efforts from Cuba and elsewhere demonstrate . . . that the Soviet intelligence payoff from interception of unsecured communications is immense." Intelligence specialists are not prone to exaggeration, they do not last long that way. You can be assured that "massive" and "immense" are not subtle words as used in this context.

There are, however, two things you should know.

First, our most secret government messages are now protected from interception or are scrambled, and all classified message and data communications are secure. In addition, protected communications zones are being established in Washington, San Francisco and New York by rerouting most government circuits and by encrypting microwave links which continue to be vulnerable to intercept. But there are still communications links which carry unclassified, but sensitive, information that we need to protect.

Second, it is a truism in the intelligence field that while bits of information may be unclassified, in aggregate they can present a classified whole. The Senate Intelligence Committee informs us, "Due to inherent human weakness, government and contractor officials, at all levels, inevitably fail to follow strict security rules. . . . Security briefings and penalties were simply not adequate to prevent discussion of classified information on open lines." If the Soviets can piece it together, you must assume that they will, given the resources they invest toward this effort.

But the intelligence community needs no reminder that we are up against a determined and crafty opponent. In 1983, for example, a delegation of Soviet scientists were invited to tour a Grumman plant on Long Island. No cameras. No notes. All secure, right? Wrong. The delegation had attached adhesive tape to the soles of their shoes to gather metal fragments from the plant floor for further study at home. The Soviets are pretty good at metallurgy—probably the best in the world—and we don't need to help them any further.

But concern is not always translated into budgetary action, at least not in the realm of communications security. Let us take a look at the technical problem confronting us.

As you know, there are two basic ways voice can be transmitted over telephonic media: digital and analog.

Analog refers to voice waves which are modulated (amplified) up to a very high frequency (HF). That is, they are increased in speed from hundreds of cycles per second to thousands of cycles per second. This facilitates their passage over distance.

Nevertheless, because analog radio waves diminish rapidly over distance, it's necessary to periodically amplify, or boost, the signal either at a microwave relay tower repeater or satellite transponder. (Actually, the signals are diminished in frequency to voice quality and then brought back up to high frequency.)

Digital transmissions are voice or data vibration signals which are converted into a series of on-and-off pulses, zeros and ones, as in a computer. Like analog telephone calls, digital calls go through a process of modulation and demodulation.

For the purposes of this discussion, we need only remember two things about analog and digital telephony.

First, analog telephony is fast being replaced by digital telephony because it better translates computer language. But, more importantly, after a high initial overhaul cost, it's possible to send thousands of digital calls (bundles) over a single conduit. Therefore, as we expand our digital capacity, we must ensure that both our analog and digital communications are protected from Soviet eavesdropping.



Lourdes, Cuba, satellite station as seen from a U.S. satellite.

Second, sending bundles over a single conduit is the base block at which we introduce the encryption I am talking about.

When you place a long-distance telephone call from point A to point B, there are three communications paths, or circuits, over which your call might travel: microwave, satellite or cable.

Cable is the most secure. However, it is the least practical and economical method for bulk transmission over long distances. As a result, 90 percent of our long-distance telephone traffic is sent

by microwave or satellite, and that which is in the air can be readily intercepted.

As your signal travels along the cable from your home to the local switching station and then on to a long-haul switching station, it is combined (stacked and bundled might better describe the process) with as many as 1200 other signals trying to get to the same region of the country.

This system of stacking and bundling signals is called multiplexing and it's how the telecommunications industry gets around the problem of 7 million New Yorkers all trying to call their senator at the same time on the same copper wire or radio frequency.

If you use a common carrier, that is, if you have not rented a dedicated channel from a telecommunications company, a computer at the long-haul switching station will select the first available route to establish a circuit over which your call signals may travel.

Therefore, calls that the caller believes to be on less vulnerable circuits may be automatically switched to more vulnerable ones. All this takes place in 1 to 3 seconds.

So let's follow your call as it goes by either microwave or satellite.

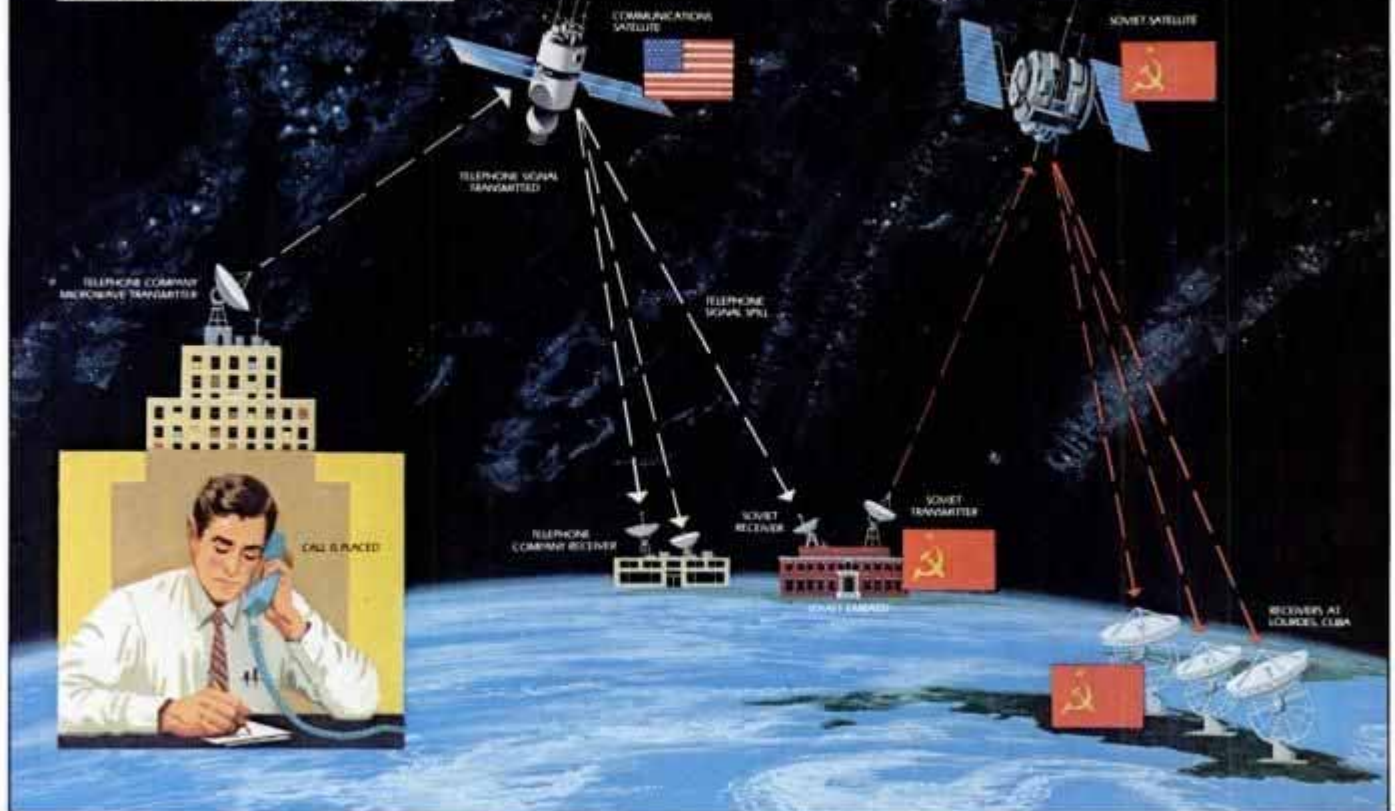
If your call goes via microwave, it will be relayed across the country as a radio wave in about 25-mile intervals from tower to tower (watch for the towers the next time you drive on an interstate route) until it eventually reaches a distant switching station where it is unlinked from the other signals, passed over cable to your friend's telephone, and converted back into voice.

The problem with this system: Along these microwave paths there is what we call "spill." This measures about 12.5 meters in width and the full 25 miles between towers. This is where the microwave signal is most at risk. Using a well-aimed parabolic dish antenna (located, let's say, on the top of Mount Alto, one of the highest hills in the District of Columbia, and site of the

new Soviet embassy) you can intercept this signal and pull it in. And that is just what the Soviets are doing.

My solution: Throw the bastards out if they are listening to our microwave signals. Nothing technical about it. On three occasions I have introduced legislation requiring the president to do just that, unless in doing so, he might compromise an intelligence source. On June 7, 1985, this measure was adopted by the Senate as Title VII to the Foreign Relations Authorization Bill, but it was dropped in conference with the House

HOW SOVIETS TAP OUR PHONES



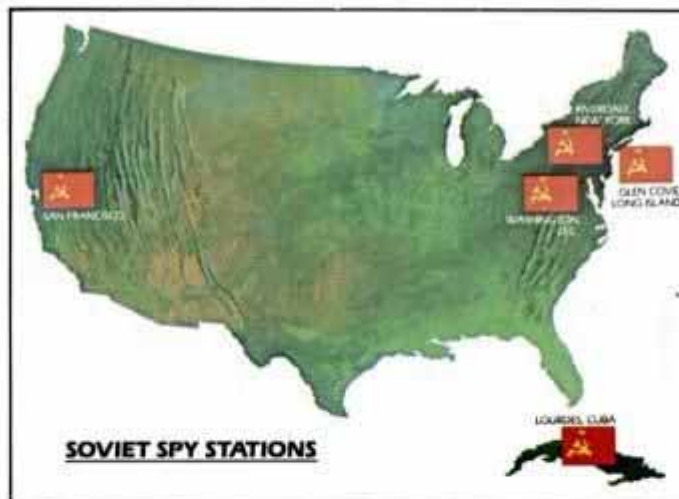
In the ultimate phone tap, you place a call and the signal goes to a phone company microwave transmitter, which beams the call to a receiver. Some of the return signal "spills," allowing Soviets to pick it up. Signal is transmitted to a Russian satellite, which sends it to Cuba. Map shows location of Russian spy stations.

of Representatives at the urging of the administration.

Nevertheless, I think the administration accepted the simple logic behind the proposal when at the end of October, 55 Soviet diplomats were ordered to leave the country, including, *The New York Times* tells us, "operatives for intercepting communications." Now, let's not let the Soviets just replace one agent with another.

The process is much the same for a satellite telephone call. Today, approximately eight telecommunications carriers offer satellite service using something like 25 satellites. Let's suppose your signal has traveled to a long-haul switching station and all microwave paths are filled. The carrier's computer searches for an alternative path to send the signal and picks out a satellite connection. At the ground station, your call is sent by a transponder up to a satellite and then down again to a distant ground station.

Using an array of satellite dishes at Lourdes, the Soviets can seize these signals from the sky just as a backyard satellite dish can pull in television (and telephone) signals. High-speed computers then sort through the calls and identify topics and numbers of particular interest. And if the information



provided is real time intelligence, the Soviets have the ability to transmit it instantaneously to Moscow. And yes, the Soviets have the range at Lourdes to grasp our satellite transmissions as they travel from New York to Los Angeles or Washington to Omaha.

Here, too, there is a solution: Develop and procure cryptographic hardware for use at the common-carrier long-haul switching stations. This hardware will encrypt the multiplexed telephonic signals (that is, approximately 1200 calls at a time) before they are transmitted as radio waves from

ground station to ground station, a technique analogous to the cable networks scrambling their signals. This can be done for under \$1 billion. If we start by encrypting just those unclassified signals we categorize as sensitive, those having greatest impact on the national defense or foreign relations of the U.S. government, it would cost us about half as much. It would cost us so much more not to do so.

Communications security has no constituency. There is no tangible product and the public can never really be sure that we have done anything. But National Security Decision Directive 145 says it is a national policy and national responsibility to offer assistance to the private sector in protecting communications. It's time to make communications security (ComSec in the lingo) a true national security priority supported with resources as well as rhetoric. This was certainly the conclusion of the comprehensive Intelligence Committee report.

I agree, and have suggested a way to get on with it. If someone has a better idea—if you have another idea—I would be happy to know it. The important thing is that we stop this massive leak of sensitive information and protect your privacy.

PM

ONE-MAN BAND

Want a dance-hall combo at your fingertips? Plug into one of today's new-technology electronic instruments and make some beautiful music.

BY FRANK VIZARD, Contributing Editor; Photos by Brian Kosoff

The expression "one-man band" conjures up the image of a guy in a funny straw hat alternately mouthing a trumpet and harmonica while beating a cymbal and bass drum strapped to his back. The more talented of these entertainers might sing and tap dance as well.

"One-man band" remains a viable phrase, but its meaning is gaining respectability. This solo orchestra has dumped the weighty apparatus of the past in favor of electronic keyboards that produce the sounds of many musical instruments.

Electronic keyboards have been around for a while, mostly in the hands of pioneering professional musicians. But these early models were priced well beyond the reach of the average music fan.

Now, pro and amateur alike have the opportunity to play any musical instrument they wish—regardless of musical training—at the touch of a finger. An electronic keyboard looks like a piano, but at your command it will sound like a flute, guitar, trumpet, harp or even a glockenspiel. About the only musical option missing from the electronic keyboards PM surveyed was the bagpipe.

Each instrument capable of being reproduced by an electronic keyboard is called a "voice." Technics' SX-K50 (\$690) electronic keyboard, for example, offers 16 voices—meaning the ability to reproduce the

sound of 16 musical instruments. Voice capability is a major factor in keyboard pricing.

How good do today's electronic keyboards sound? The scores for such themes as "Miami Vice" and "Chariots Of Fire" were produced electronically. And where it once took 20 musicians to play a score, four musicians can now produce the same composition using electronic keyboards.

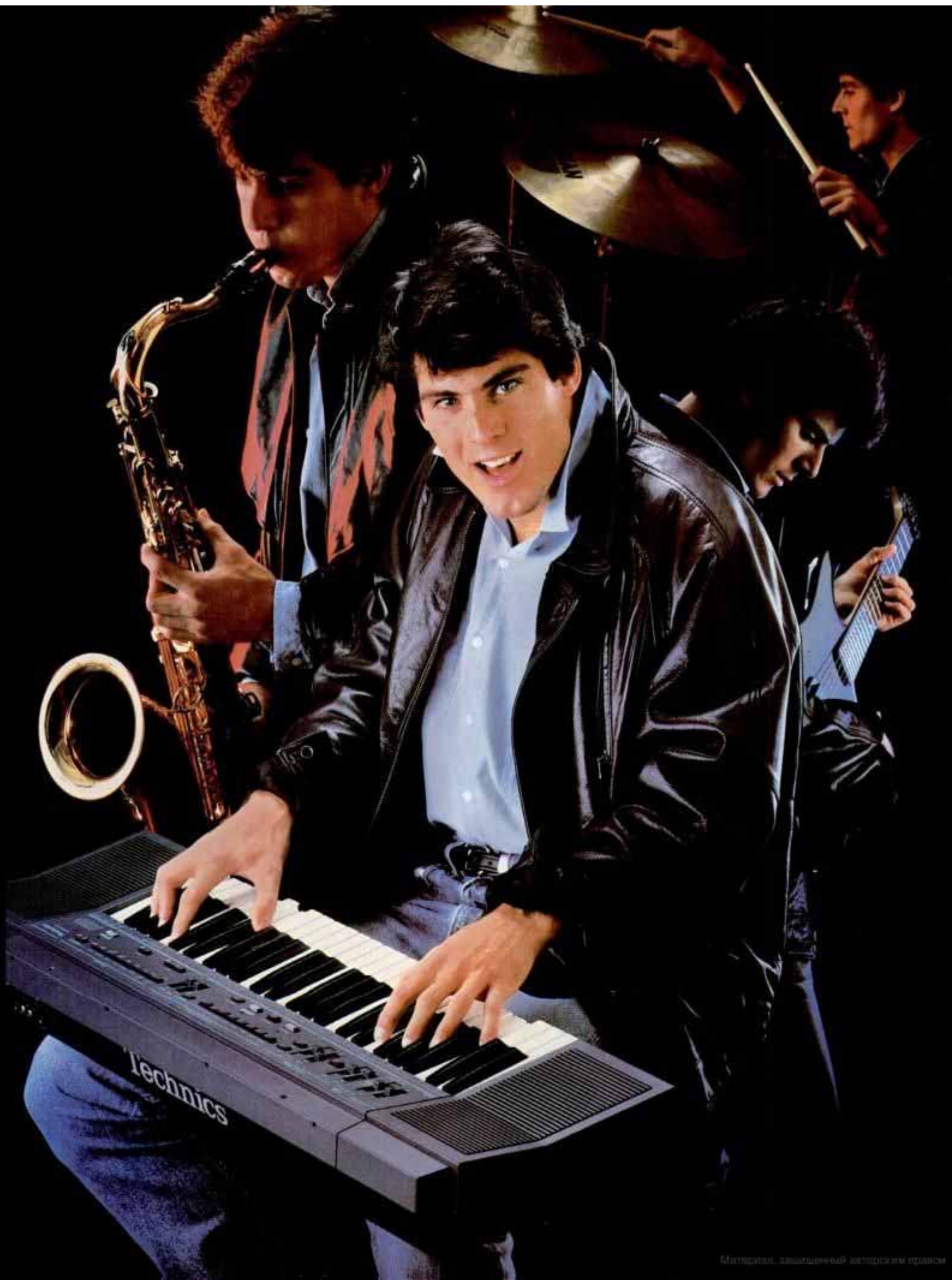
The popularity of electronic keyboards made by Casio, Technics, Yamaha, Bontempi and other companies coincides with steeply rising prices for conventional pianos and acoustic instruments. A good piano now costs more than \$2500 while a decent electronic keyboard can be had for just a few hundred dollars.

The newest electronic keyboards produce truer, more lifelike sounds than earlier models because of a feature called Pulse Code Modulation (PCM). This means that the actual sound of a trumpet, for example, is digitally recorded onto a memory chip instead of being created electronically—or synthesized—as with older or very inexpensive models.

By pressing the button marked "trumpet" and then pressing a key or series of keys, you tell the keyboard that the series of notes you'll play should have the sound timbre of a trumpet. This digital, electronic signal is then converted to an analog soundwave signal capable of being reproduced by a loudspeaker built into the keyboard. In stereo keyboard models,

Casio's MT-500 keyboard (below) has four drum pads on top plus built-in percussion rhythms. Company's SS-1 Sound Sticks (\$100) produce drum sounds from any surface. Technics' SX-K50 (right) offers 16 voices—including brass.





ONE-MAN BAND

the sound can be routed to your home hi-fi system for even better sound reproduction. For nonstereo models, external amplified speakers designed specifically for electronic keyboards are also available.

Sound creations

Some keyboards give you more than prepackaged voices: They let you create and add your own. This feature is called "digital sampling" and it means the keyboard can sample any external sound—perhaps the revving of your car's engine—and store that sound in its memory. For example, Casio's SK-1 lets you record the sound through a microphone built into the keyboard. You can also use an external microphone, or feed the keyboard from a tape recorder. Once the sound is sampled and stored (in an auxiliary voice bank) you can play this voice just as you would any other, such as a trumpet.

Most keyboards sold today produce only one voice at a time. Models priced at \$900 or above are generally able to produce two voices—say guitar and trumpet—simultaneously. In models that let you record as you compose, each voice is recorded individually and then the ensemble is played back together. Some models particularly well-suited for composing offer MIDI (Musical Instrument Digital Interface).



Follow the bouncing ball with Yamaha's TYU-40. Cartridges (top) lead you through melody.

cal Instrument Digital Interface). This feature allows you to connect an electronic keyboard to a computer. With the proper software, the notes played on the electronic keyboard can be displayed on a TV monitor or printed out on musical notepaper, aiding those who can't write or read music but who can play by ear.

Pick your beat

Each voice produced by an electronic keyboard can be backed up by a variety of electronic rhythm sections, everything from rock to reggae, available at the touch of a button. The number and choice of rhythm sections varies from model to model.

Alternately, you may decide to provide your own rhythm on a model such as Casio's \$299 MT-500 unit. The MT-500 comes with four tiny yellow drum pads built-in for more control over percussion. The optional and larger DP-1 drum pad set allows a second person to play percussion as accompaniment. Once you've got the basic rhythm going, most keyboards permit the bass and drums to be adjusted further for varying degrees of emphasis. The appropriate chord is selected for the music to be played, using the keys to the far left of the keyboard. For an E minor, for example, you'd press the third and fourth keys simultaneously.

Special effects

Special sound effects are available on most models as well. Typically, there is a vibrato switch for a slight, rapid variation in pitch. Often the vibrato switch can be adjusted so that the vibrato effect is delayed. A sustain switch makes the sound linger after the key is released. A reverb switch creates a concert hall ambience. And in stereo models, a stereo chorus switch creates a sound that swells between the two speakers.

Other features to choose from include

mini- versus full-size keys. The latter often makes playing easier, and in some models, these keys are as touch-sensitive as piano keys in order to provide greater tonal control.

Multiple production

"Polyphonic" means that an electronic keyboard can produce a number of notes together—so you can create chords. Most keyboards are either 4- or 8-note polyphonic. If an electronic keyboard is not polyphonic, then it is monophonic, meaning that it can play only one note at a time.

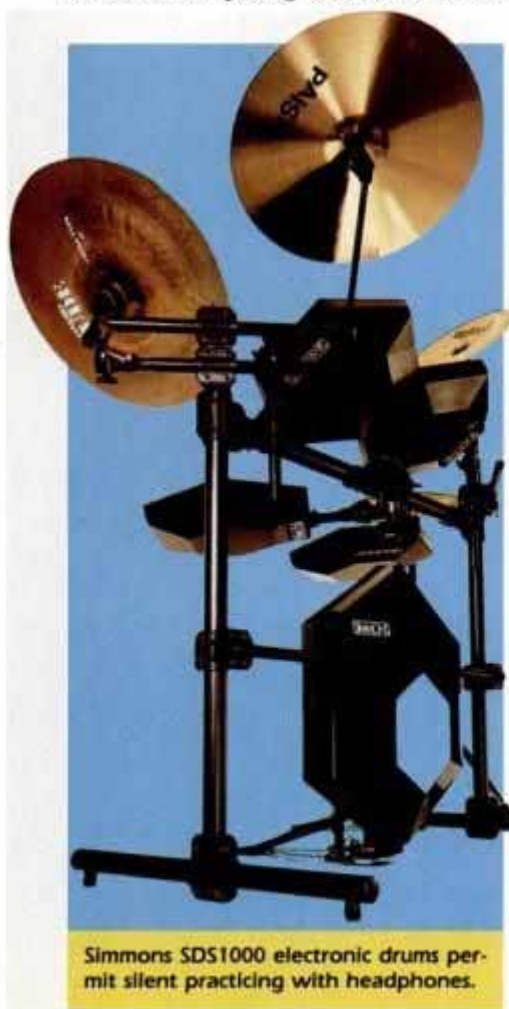
Musical novices might enjoy keyboards that allow them to follow a bouncing light from one key to the next. The snap-in song cartridges in Yamaha's TYU-40 (\$40) help you play the melody this way. Some models are available with built-in tape decks so you can play along with your favorite musical artist. These models generally include radios as well.

Affordable fun

Electronic keyboards range in price from below \$50 to \$1000 and above. At the upper end of the scale, the serious musician will find a whole range of solo electronic instruments such as pianos, organs, and even nonkeyboard instruments such as cellos.

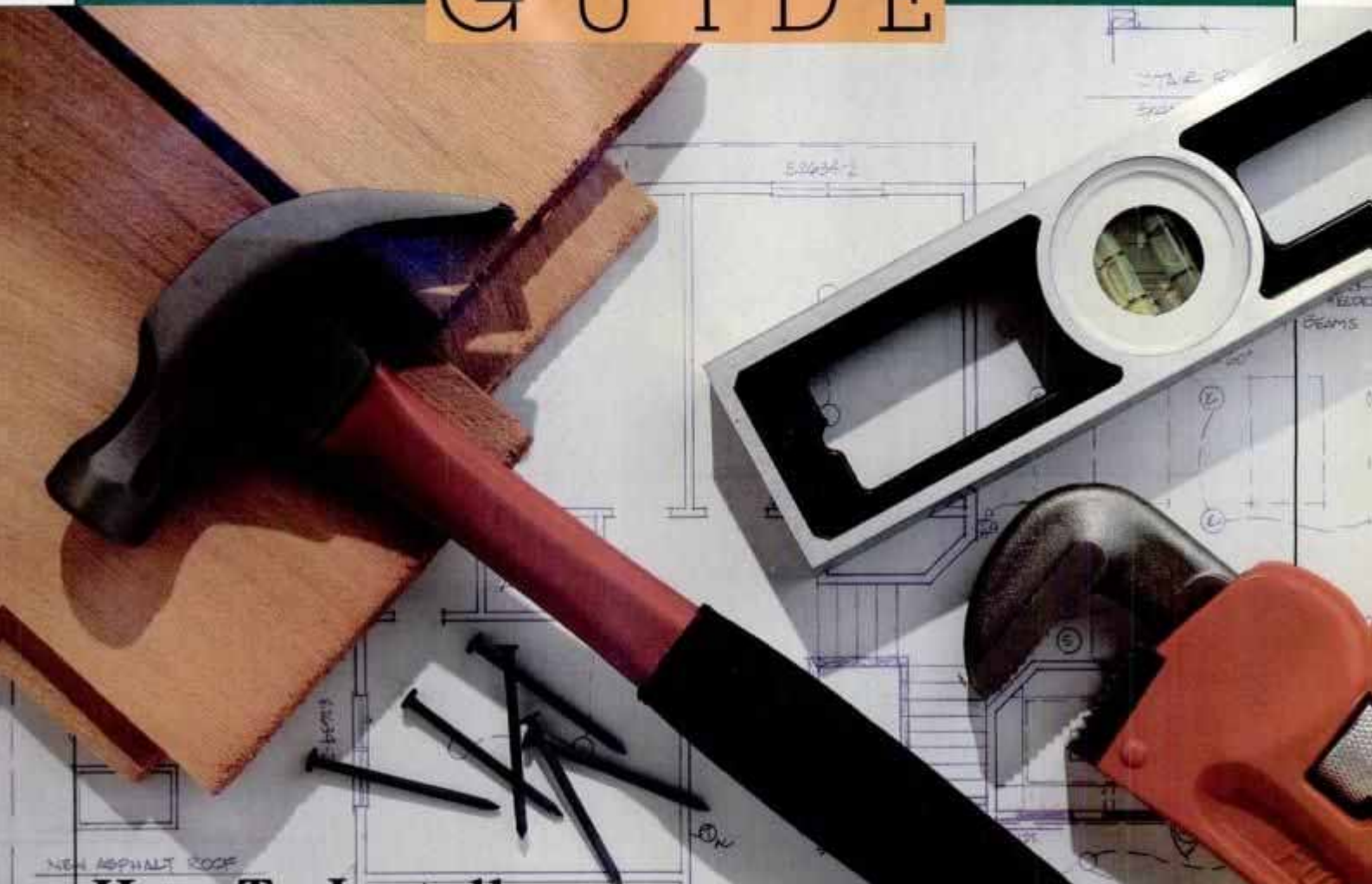
While many of these solo instruments are expensive at present, they are destined to come down in price. Among the most recent advances in this direction is an electronic 5-piece drum set made by Simmons. The MIDI-capable SDS1000 drum set costs \$1000, but offers a great deal more versatility than the traditional drum set. From the snare pad, for example, a drummer can choose among four digitally sampled percussion sounds and play the "sound" that best suits the music. Practice can be performed silently, too. All the drummer has to do is plug in a pair of headphones.

PM



Simmons SDS1000 electronic drums permit silent practicing with headphones.

HOME IMPROVEMENT GUIDE



How To Install:

- A clever redwood paneling system
- A cedar shake roof
- New vinyl floor tiles

Plus:

- Five quick fixes for the bath
- The latest in home improvement products

PRODUCED BY THE HOME AND SHOP DEPT.
DESIGNED BY ALAN ANDRESEN
PHOTO BY BRIAN KOSOFF

Doing It Yourself

More and more people across the board are getting involved.

Recently, I read an interesting study. It was published by the Do-It-Yourself Research Institute, an organization that tracks our participation in all sorts of activities, from changing engine oil to installing new windows in the home, and much more. The pages were filled with numbers stacked on top of other numbers like stones in the Great Wall of China. In spite of this, a few points were very clear and very impressive.

One was the total size, in dollars, of the American home-improvement market. In 1984 it was \$69.2 billion and by 1990 the report predicts it will grow to \$123.9 billion. The do-it-yourself portion of this market—the money we spend to improve our homes ourselves—stood at \$38.1 billion in 1984, with a projected rise to \$73.1 billion by 1990.

In this day and age of trillion-dollar federal budgets, these numbers may seem a bit dull. But when you consider that in 1983, the Gross Domestic Product of Australia was approximately \$150 billion, you get a better idea of just how large these numbers really are.

The report goes on to say that 73.5 percent of all American households are involved in some do-it-yourself activities. And even more surprising, men and women seem to be approaching these tasks with the same enthusiasm: In 55 percent of the DIY households, the man was listed as most involved; in 45 percent of these households the woman was considered most involved.

Not only are these numbers high, but there has been a steady increase over the preceding 15 years. From 1970 to 1984, the DIY market grew more than 250 percent, adjusted for inflation, which is a growth market if there ever was one. While such numbers may describe, in their own way, what is going on, they don't do much to reveal why such a remarkable thing is happening.

The first explanation that comes to mind is saving money. Certainly the committed do-it-yourselfer eliminates much, if not all, of the labor costs on any given job. Furthermore, the sweat equity we put into our homes often has a way of returning a very pleasant percentage at sale time. This is especially true these days when the cost of housing seems to rise every year regardless of feast or famine in other sectors of the economy.

Another contributing factor to this growth phenomenon must be the shared perception that we can do a better job ourselves. This idea is summed up best in the frequently heard expression, "You just can't get good help anymore." This cliché is so pervasive it now may be entrenched forever in the American state of mind.

But at its core, this notion also turns on a financial axis. Certainly good help is still out there, it's just expensive. And

for those millions of homeowners saddled with painfully high mortgage payments and other costs of maintaining a family, there aren't many dollars left over for anything else. In such an atmosphere, a homeowner can afford more time on a specific job than a contractor can, which means a greater attention to detail. And that often translates into higher quality results.

But beyond these considerations of saving money and obtaining affordable quality rests the issue of personal fulfillment. This is, in many ways, the most intriguing reason why people do things for themselves. This sense of satisfaction is implied when we say how much we enjoy "working with our hands." Part of this enjoyment must be the simple physical pleasure, especially for those who spend most of their time working in a sedentary environment. This can be reinforced by simple pride in ownership, the inclination some have to spend hours of hard labor hand-waxing their hardwood floors or trimming a hedge row to perfection.

With all these factors taken into account, it still seems that the benefits of working around the house must touch something deeper. One possibility was implied by Tracy Kidder in his remarkable book titled *House* (Houghton Mifflin, 1985). On page 303, when he discusses the New England Puritans' relationship to their homes, he writes:

"... some of the New World's poets and diarists conceived of houses as human imitations of divine handiwork. A roof was like a head, rafters were like bones, posts were shoulders, clapboards were skin, windows were eyes, doors were mouths, a threshold was lips and a chimney was a breast in which lay the heart, which resembled the hearth, which contained the flame, which stood for the soul."

Leaving aside some of the more ethereal aspects of this passage, the basic organic metaphor for a house is particularly apt. A home is not merely a shelter or a possession or an investment, at least in the financial sense. It is most importantly the place where we live, where we raise our children, where each of us tries to define what is the best part of our lives. Our homes are invested with our most special feelings and in these terms, taking an active and creative role in this environment seems perfectly sensible and profoundly rewarding. Our homes offer all of us not only the opportunity but also the location to improve our lives in a tangible and unequivocal way.

In the pages that follow, and in our home improvement stories throughout the year, we are trying to service this interest. We do understand and appreciate the financial benefits that come from doing things for yourself. But we also hope to cultivate some of the more subtle pleasures of improving your home so it will become even more responsive to the lives being lived there.—S.W.

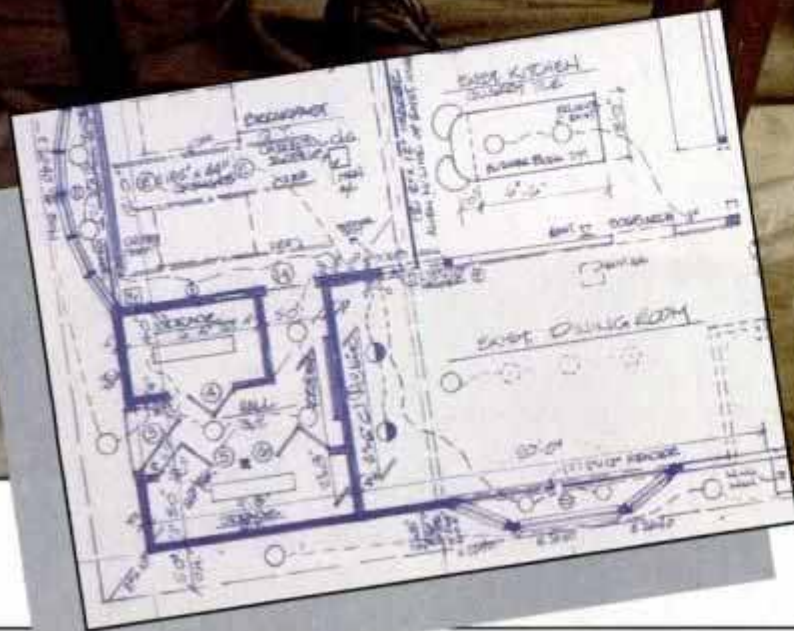


PHOTO FROM THE IMAGE BANK

Redwood Renovation

An ingenious redwood paneling system with movable, wall-hung shelving units creates a handsome den/guest room.

BY JOSEPH TRUINI, Shop And Tools Editor

Architects, interior designers and do-it-yourself homeowners share a common predicament: Finding creative ways to use space most efficiently. This is especially important in home improvement jobs where it's often less expensive to get more quality living space from an existing space than to add onto your house. It's with this thought in mind that we present the room interior shown here.

The decision to remodel was prompted by a very common situation: A spare bedroom, no longer occupied regularly, was being wasted. The homeowners wanted to reclaim the space but keep the option to accommodate overnight guests. The completed room provides them with that opportunity. By day the room is a casual den/living room. At night, when necessary, it converts into a comfortable guest bedroom. A futon sofa bed makes the transition easy.

The room features a clever wall paneling system composed of preassembled 14 × 29-in. redwood panels. Between each row of panels is a 1½-in.-wide horizontal channel on which the shelving units, called book boxes, are suspended. This flexible design allows you to position the book boxes virtually anywhere in the room.

Place a box in a lower channel for use as an end table or nightstand. Raise it to a higher channel, with the shelves at eye level, for display purposes. Also, the book boxes slide easily in the channels so you can create new designs quickly. Each book box has one adjustable shelf. Shelves can also be placed between two boxes.

The wall panels and book boxes are made of clear all-heart vertical grain redwood—the finest grade redwood available. Redwood was chosen for its warm, rich color, dimensional stability and, from a do-it-yourself standpoint, its workability. Its fine texture and even grain pattern make redwood easy to mill, saw, join, sand and finish.

Make the panels and book boxes from ¾-in. redwood. You should use 1½-in.-thick stock for the upper and lower panel cleats. For the reveal that's visible in the channels, use ⅝-in. redwood plywood.

For other ideas on how to use redwood, contact the California Redwood Assn., 591 Redwood Highway, Suite 3100, Dept. PM, Mill Valley, CA 94941.

Room design: Osburn Design, San Francisco, CA; **Construction:** Michael Bear; **Photos:** Peter Christiansen; **Room stylist:** Tres McKinney; **Technical artist:** Eugene Thompson

Solid redwood panels create this handsome, functional room interior (right). Shelving units, which fit in channels between panel rows, can be put virtually anywhere on wall. Futon sofa bed converts den into a guest bedroom (below).





Wall preparation

Before beginning work on the walls, remove all existing baseboard and other moldings that will interfere with the panel installation. Also, check to see if the electrical wall outlets and switches can be extended for remounting to the panels. If not, rewiring is necessary. (*Caution:* Be sure to shut off the power at the fuse panel before checking the electrical components.) This is also a good time to paint the ceiling, if necessary.

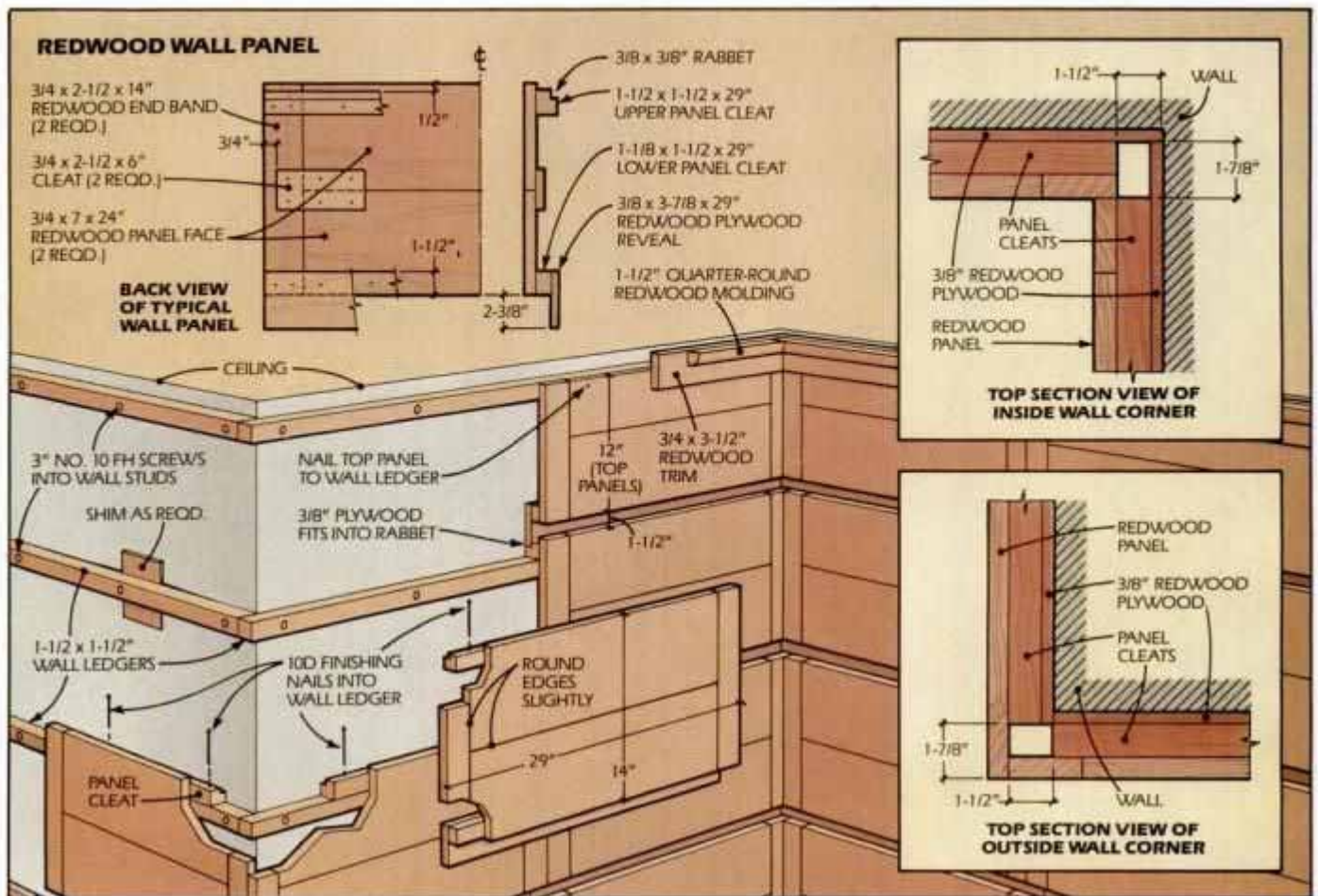
Next, snap level chalklines for installing the wall ledgers. Cut the ledgers from kiln-dried 2×2 stock; actual dimension: 1½ × 1½ in. The ledgers are used to support the wall panels

(see drawing detail 2). For a typical 8-ft.-high wall, center the first ledger 16¼ in. off the floor. Position the remaining ledgers 15½ in. on-center.

Nail or screw the ledgers securely to the wall studs. On uneven and extremely rough walls, you'll need to shim behind the ledgers to keep them straight (photo 2).

Panel assembly

Each panel is an assembly of nine redwood parts. The panel face is made of two ¾ × 7 × 24-in. boards that are flanked on each end by a ¾ × 2½ × 14-in. end band. Four cleats and the ¾-in. plywood reveal are glued and nailed to the panel back.



To speed the production of the identical panels, build the simple jig shown in photos 3, 4 and 5. Cut the parts to size for all the wall panels. Using 100-grit sandpaper, slightly round-over the front edges of the parts that form the panel faces. Now assemble the panels one at a time.

Start by placing the panel face parts face down in the jig. Next, glue and nail two $\frac{3}{4} \times 2\frac{1}{2} \times 6$ -in. cleats to the panel back to hold together the four face parts. Saw or rout a $\frac{3}{8} \times \frac{3}{8}$ -in. rabet in the upper cleat and glue and nail it to the panel back. The rabet accommodates the plywood reveal on the panel installed above it on the wall (see cross-section drawing detail). Attach the lower cleat to the panel back, and then glue and nail a $\frac{3}{8} \times 3\frac{1}{2} \times 29$ -in. redwood plywood reveal to the cleat (photo 6).

Note that the plywood reveal must extend beyond the panel face when installed at an *inside* wall corner. The reveal must be held back from the edge of the panel when installed on an *outside* wall corner (see top-section drawing details). Also, the panels in the first row, those closest to the floor, receive a $6\frac{1}{2}$ -in.-wide plywood reveal that doubles as baseboard molding. After all the panels have been assembled, finish-sand them with 120-grit sandpaper. Now you can begin mounting them to the wall.

Mounting the panels

Start at the floor and work toward the ceiling. Hold a panel against the wall with the upper panel cleat on top of the wall ledger. Using 10d finishing nails, nail down through the upper cleat and into the ledger (photo 8).

Also, on the *first* row of panels only, nail through the reveal/baseboard into the wall studs.

To start the second row, position a panel so that its plywood reveal is in the rabet of the panel directly below.

1 Use 12d or 16d nails to attach 2 x 2 ledger strips to the wall. You could also screw the ledgers in place with 3-in. drywall screws.



2 This shows the room with all the ledgers installed. Note that shims are needed to correct uneven walls and straighten ledgers.



3 A simple wood-frame jig is used to speed the production of the redwood wall panels. Place the four panel parts face down in the jig.



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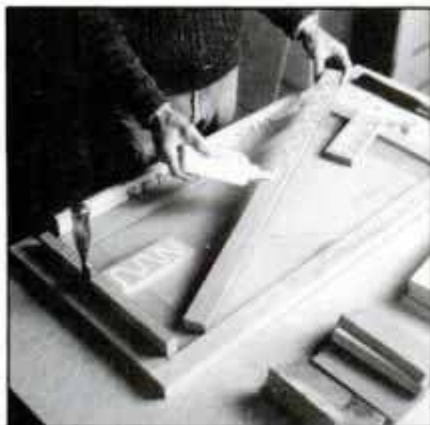
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4 Apply glue to the panel cleats. To keep the parts from shifting during assembly, wedge a chisel behind spacer board placed in jig.



5 Attach the cleats to the panel's backside with 3d finishing nails. Position the two 6-in. cleats so they straddle joint lines.

Secure the panel by nailing down through the upper cleat and into the wall ledger. Continue installing the remaining panels in this manner. The uppermost row of panels must be face-nailed to the wall ledger (photo 10). Conceal the small space between the top panels and ceiling with 1×4 trim and 1½-in. quarter-round molding (photos 11 and 12).

Book box construction

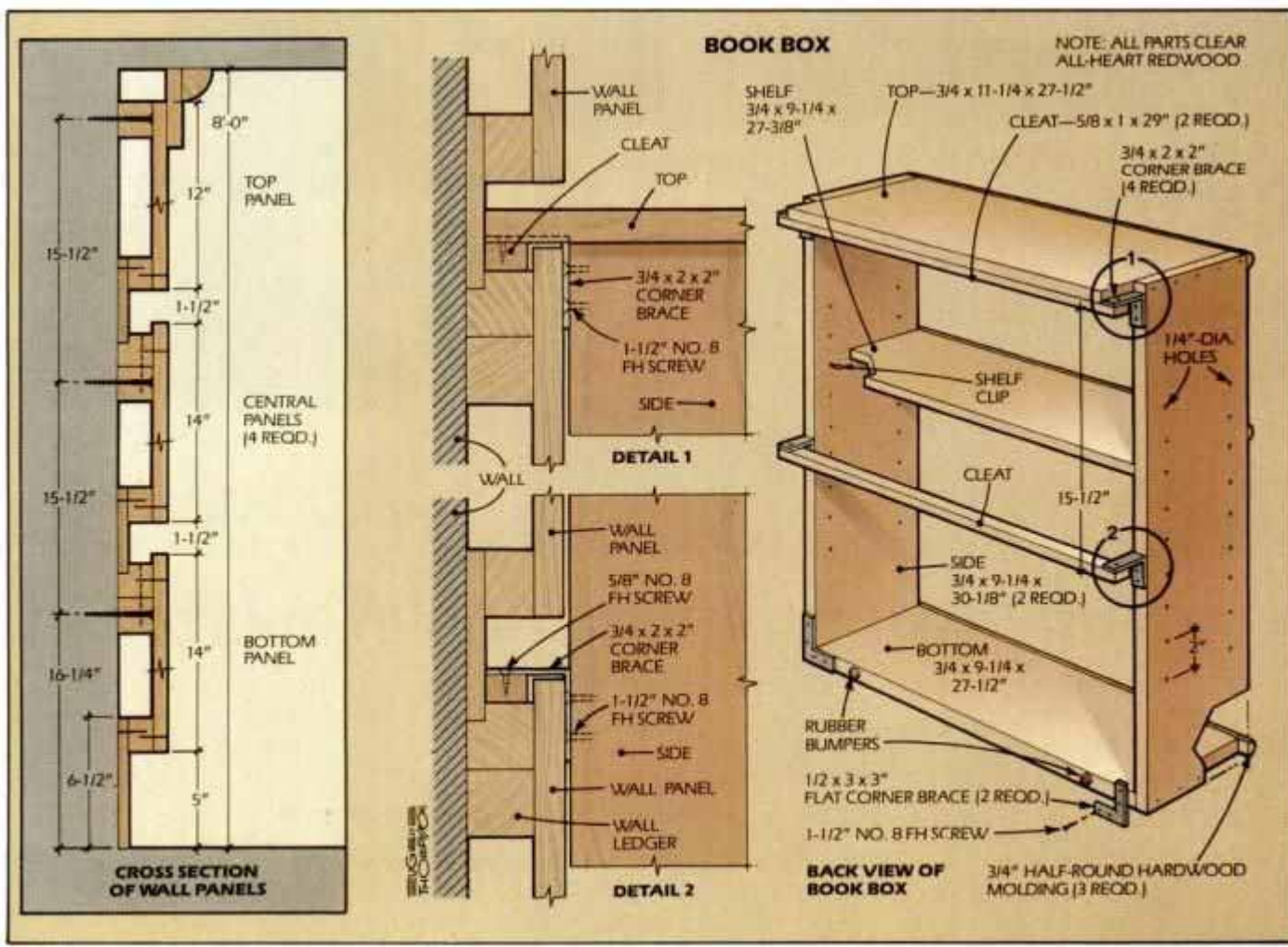
The easy-to-build book boxes feature simple glue-and-nail butt joints. Cut each box side, bottom and shelf from 1×12 redwood stock. Make the box tops from 1×12 stock.

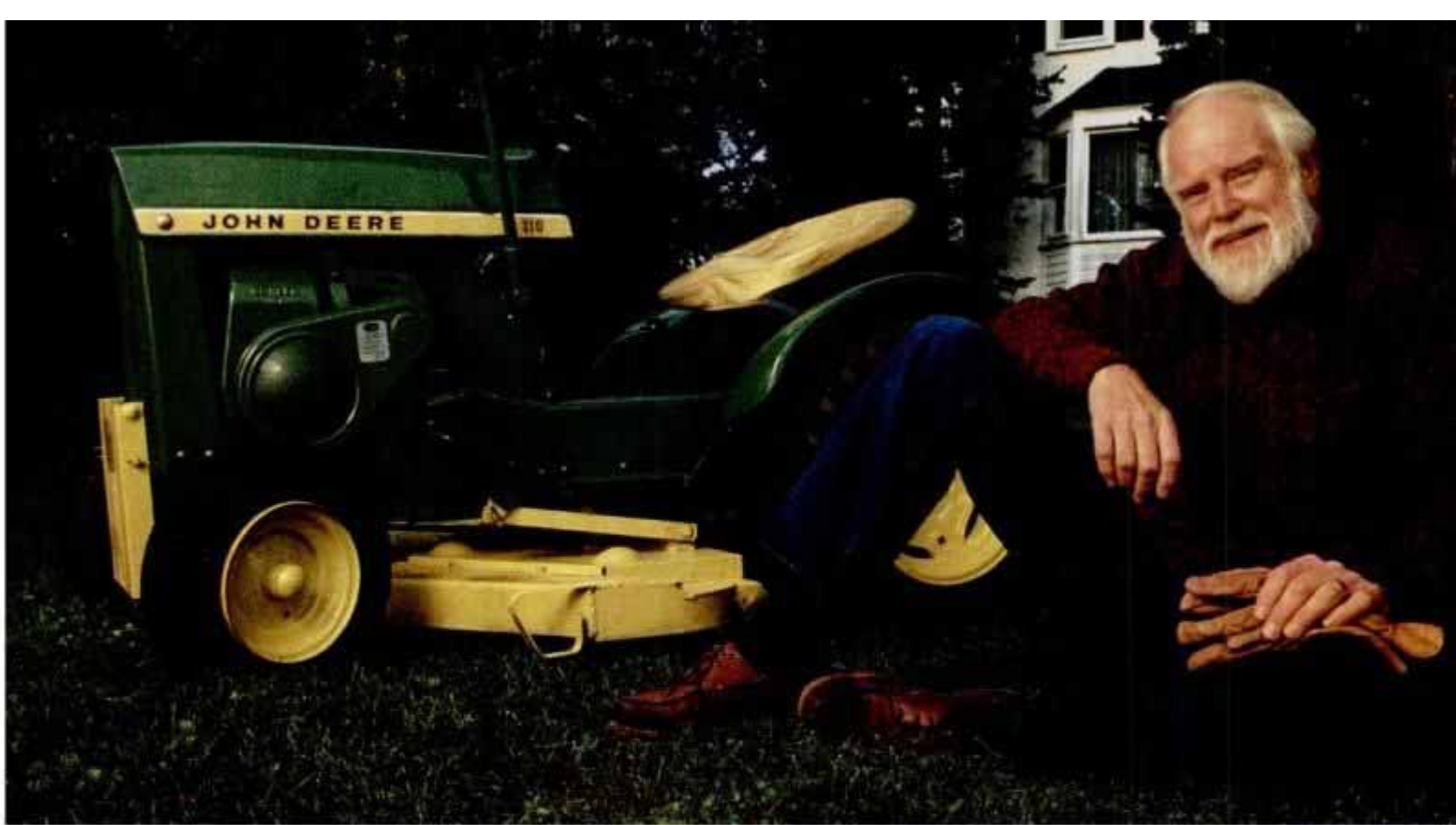
The top overhangs the box sides to support a 5/8×1×29-in. cleat that fits in the channels between the rows of wall panels. Note that a second cleat, located 15½-in. below the first cleat, provides additional support for the wall-mounted box. Use steel corner braces to support the cleats and flat corner irons to strengthen the box side-to-bottom joints (see back view drawing detail). Before assembling the box, bore 1/4-in.-dia. x 3/8-in. shelf clip holes in the inside surface of the box sides. Space the rows of holes about 2-in. apart.

Assemble each box with glue and 6d finishing nails (photo 14). Then, attach 3/4-in. half-round hardwood molding to the front edge of each box top, bottom and shelf. Finish-sand the boxes and shelves with 120-grit sandpaper.

Finishing touches

Dust the panels and book boxes with a tack cloth and apply a coat of clear, semigloss lacquer. When dry, rub the surfaces with 4/0 steel wool and apply three more coats. Apply the lacquer with a spray gun or paintbrush. We masked off the room and sprayed the panels after they were mounted to the





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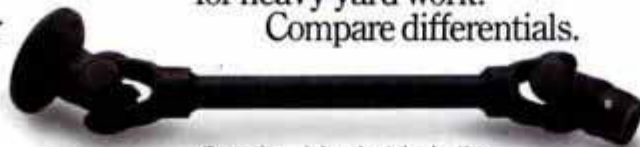
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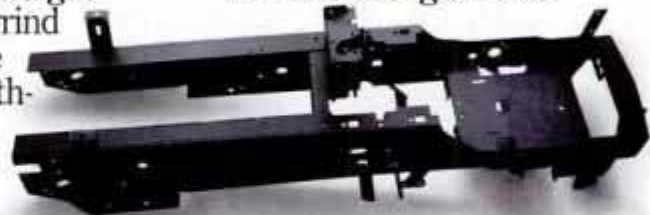
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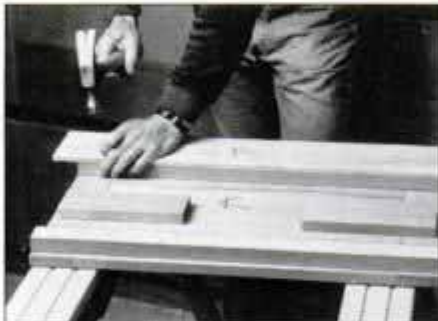
HOME IMPROVEMENT GUIDE

walls. (*Caution:* Always wear an appropriate respirator when spraying any finish. Make certain you spray only in a well-ventilated area.)

You could also lacquer each panel individually before installation. Once the final lacquer coat has dried, apply two coats of paste wax and buff with a soft cloth. Other finishing options include polyurethane varnish, Danish rubbing oil or

just a few coats of paste wax. To hang a book box on the wall, simply insert its two cleats into wall channels at the desired height. Be sure that the box is seated securely behind the panels (see drawing details 1 and 2). Install the shelf clips and position the shelf. Always empty the book box and remove the adjustable shelf before raising or lowering the box to another channel. **PM**

6 Glue and nail $\frac{3}{8}$ -in. redwood plywood strip to lower panel cleat. The strip creates a reveal between the rows of redwood wall panels.



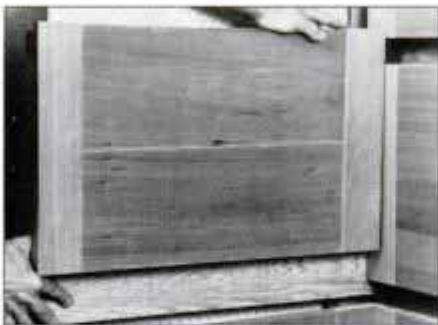
7 Use $\frac{3}{8}$ -in. redwood plywood as baseboard molding. Nail plywood directly to wall studs, as shown, or attach it to first row of panels.



8 Attach the panels to the wall by nailing down through upper cleat and into the 2×2 wall ledger. Three nails per panel are sufficient.



9 To install remaining panels, insert plywood reveal into the rabbet of the panel below. Nail down into wall ledger to secure panel.



10 Secure uppermost row of panels by nailing through panel face into the wall ledger. Bore pilot holes to prevent splitting panel.



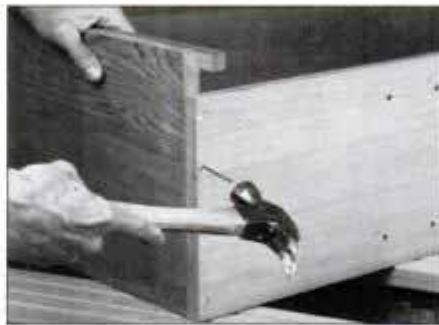
11 To conceal the space between the uppermost panels and ceiling, nail up 1×4 redwood boards. Secure with 6d finishing nails.



12 Complete the trimwork by installing $1\frac{1}{2}$ -in. quarter-round molding to the 1×4 trim. Secure the molding with 4d finishing nails.



13 Cut the book box tops from 1×12 stock. Then, glue and nail a $\frac{3}{8}$ -in. \times 1-in.-wide cleat to the rear, underside surface of the box top.



14 Assemble the book boxes with simple glue-and-nail butt joints. Use 6d finishing nails to join the parts. Set the nailheads.



15 Trim the horizontal book box parts only—that is, the top, bottom and shelf—with $\frac{3}{4}$ -in., half-round hardwood molding.



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Split Personality

How to re-roof your home with cedar shakes.

BY FRED L. WOLFF AND JEANNE WOLFF

Try to imagine the most traditional early American country home and chances are you'll have it roofed with handsplit cedar shakes. Shakes harken back to the days of making nearly everything yourself and they remain one of the few products you can buy where much of the production is done by hand. Functional as well, shakes are durable, naturally resistant to decay, and provide an increase in the strength and insulation value of your roof. Applying a shake roof can be a relaxing and enjoyable experience requiring a minimum of simple tools, but demanding careful preparation and layout.

The ranch-style house chosen for our project suffered from several typical problems resulting from inadequate roofing. Attic and ceiling damage was traced to improperly installed roof valleys, and insufficient shingle overhang had allowed water to drip over and seep behind the fascia, causing deterioration. Poor attic ventilation encouraged excessive heat buildup, which contributed to blistered shingles and structural heat warping.

Types of shakes and coverage

Shakes are slabs of wood split radially from a log and are either tapersplit or straightsplit. A third type is called handsplit and resawn, in which the underneath face is sawn at a taper. Split shakes resist moisture absorption because the cells are not severed by sawing. Wood shingles, on the other hand, are always sawn. Shakes are made from red cedar and come in 18- or 24-in. lengths.

Determine the slope of your roof by measuring the vertical rise of the roof deck over a horizontal run of 12 in. For roofs with a slope less than 4-in-12, shakes are not recommended. For slopes between 4-in-12 and 8-in-12, use 24-in. shakes with a maximum 7½-in. exposure. This provides the best coverage for shallow roofs. For slopes greater than 8-in-12, you can use 18- or 24-in. shakes. At these slopes, the exposure can be increased to a maximum of 10 in. for the 24-in. shake, and 7½ in. for the 18-in. length. For more detailed information on shake coverage and specifications, write to the Red Cedar Shingle & Handsplit Shake Bureau, 515 116th Ave. N.E., Suite 275, Bellevue, WA 98004.

It's a good idea to take into account the length of the slope from eave to ridge when working out a suitable exposure. Subtract the width of the ridge shakes (6 in.) from the slope length and divide by what seems like a good exposure to get the number of courses. Try to avoid a less than 3-in. exposure of the last course. You may have to experiment with different exposures to achieve this. On solid-sheathed roofs,

Hand-split cedar shakes offer the homeowner a way to transform a bland and uninteresting roof into a dramatic design element of the house. With more than 5600 sq. ft. to cover, we encountered most of the tricky roofing problems, including valley flashing, ridge construction and roof ventilation. New aluminum fascia and soffits completed the job, giving us a roof that not only looked better, but worked better than our original roof.





Color photos: George Arcona
Black-and-white photos: Fred L. Wolff and Wendy Wolff
Construction consultant: Peter McKenna
Aluminum soffits, fascias, gutters: Alumarc, Inc., Box 61, Roxboro, NC 27573
Cuprinol wood preservative: Danworth Co., Tower Lane, Box K, Avon, CT 06001
Pneumatic nailer: Paslode Co., Div. of Signode Corp., 8080 McCormick Blvd., Skokie, IL 60076
Roof fans with heat and humidity sensors: Nutone Div. of Scovill, Madison & Redbank Roads, Cincinnati, OH 45227
Gas-powered airless sprayer: J.C. Penney Co. Inc., 1301 Avenue of the Americas, New York, NY 10019
Top Hat chimney spark arrestors: Consolidated Dutchwest, Box 1019, Plymouth, MA 02360
Lighting fixtures: Thomas Industries Inc., 207 E. Broadway, Box 35120, Louisville, KY 40232

SPLIT PERSONALITY

experienced roofers often begin making adjustments in exposure when the roof is about halfway done to insure that the last course comes out just right.

How much to buy

Roof measurement is made in 100-sq.-ft. units called squares, and shakes are packaged so that five bundles will cover one square at a 10-in. exposure. But your roof may require an exposure other than 10 in. If so, use this simple formula to figure bundle coverage. Divide the specified exposure (10 in.) by your new exposure and multiply by the number of bundles per square as specified by the manufacturer (5). For a shake roof with 6 in. to the weather, figure: $\frac{10}{6} \times 5 = 8\frac{1}{3}$ bundles per square. Then, divide your roof area in square feet by 100 to get the area in squares, and multiply by the number of bundles per square as calculated above.

Eaves, valleys, hips and ridges require additional shakes. The eave starter-course must be doubled. Most roofers use sawn shingles for the first course underlay and these should cover 60 linear ft. per bundle. For ridges and hips, figure on one bundle of shakes covering about 16 linear ft., and allow roughly two extra squares for each 100 ft. of valley. To save time at the ridge and hips, prefab units are available.

Types of sheathing

Due to their strength, cedar shakes may be applied over solid or open sheathing. In an open-sheathed roof, boards are only necessary along the nailing line of each course, and are centered at a spacing equal to the shake exposure. We laid 1 x 3 nailing strips over the existing roof to create a second open deck. On new open-sheathed roofs, use solid sheathing over the entire eave overhang and begin spacing thereafter.

Other materials and tools

Shake roofs require a 36-in.-wide layer of 15-pound roofing felt for the eaves and valleys. Additional 18-in.-wide strips are laid over the upper edges of each course extending on to the sheathing, and a 12-in.-wide strip is needed for ridges and hips.

Tools for shake installation can be as simple as a hammer, tape measure, square and power or handsaw. A chalkline will insure straight courses, and a shingler's hatchet comes in handy for both nailing and trimming; it features a sliding gauge which aids in laying uniformly spaced courses. For fine trimming, use a block plane and have a staple gun on hand for tacking the felt in place.

On a job as large as ours, we found the Paslode automatic nailer to be an invaluable tool. It's loaded with strips of 2 $\frac{3}{8}$ -in. galvanized ring-shank nails and provides fast and consistent nailing. For hand nailing, you'll need 6d (2-in.) hot-dipped galvanized nails for laying the courses, and 8d (2 $\frac{1}{2}$ -in.) for hips and ridges. Always make sure the nail penetrates the sheathing at least $\frac{1}{2}$ in.

Don't take chances when working on roofs. Our 4-in-12 slope roof was easy enough to walk and work on, but as slopes get much steeper you should rent roofing brackets. Eave work often requires the renting or building of scaffolds. If you build your own, be sure it's securely fastened to the building and cross braced. Use double-headed nails for easy dismantling when the job is done.

Getting started

We began our roofing project by stripping away the old shingles along the eaves and gables so the nailing strips could be securely nailed to the perimeter of the roof. If necessary, replace the existing felt by sliding new material under the old

1 Nail 1 x 3 strips along the gables and valleys, and across the roof centered at the exposure dimension. Triple the strips at the eaves.



2 Double the strips in the valleys. Space the nailers about 4 in. from the valley center to correspond to the finished shake line.



3 Remove the old ridge-cap shingles and lay a double nailing strip on both sides to provide adequate material for nailing the cap shakes.



4 Flash the valleys with a layer of 15-pound roofing felt covered with 20-in.-wide rolled aluminum sheet nailed at the edges.



5 Build an eave jig for a straight and accurate 1/2-in. shake overhang. Saw the jig off when the first course is done.



6 Use 18-in. flat-sawn shingles for the first course underlay. Align the butt ends with the eave jig and fasten with 6d nails.





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shingles. Next, fasten the eave nailing strips in place. These should be cut 4 in. short of any valleys and extended flush with the gable edges. Then, install nailing strips along the gable edges and up the valleys. Maintain a 4-in. space between the valley center and the valley strip on both sides.

To insure good weather resistance and provide a firm base for the first course, nail two additional strips at the eave alongside the first. Also, double the nailing strips in the valleys for better flashing and shake support. Locate the first nailing strip above the eave strips by marking off exposure increments—from the eave edge—on the gable nailer. Center a 1 × 3 on the first mark above the eave strips and nail in place parallel to the eave.

To space the remaining strips, cut a spacer block to a length equal to the exposure less the nailing strip width. For full 3-in. strips and a 7½-in. exposure, the spacer will be 4½ in. When you reach the ridge, remove the old ridge-cap shingles and nail down double strips on each side.

Eave and valley preparation

Before you begin laying the shakes, install 36-in.-wide roofing felt along the eaves. Valleys should be underlaid with 36-in.-wide felt and then covered with 20-in.-wide rolled-aluminum sheet or a specially prepared center-crempled metal valley. The valley flashing should extend 10 in. from the valley center on both sides.

Carefully lay the aluminum in the valley and mark the ends for trimming. Leave a 2-in. radius where the valley corner meets the eave and allow for a 1- to 1½-in. overhang. Tack the flashing in place along the edges into the nailing strips. Strike chalklines on both sides of the valley about 4 in. from the center. These are used to gauge the trimming angle for valley shakes and guide their installation.

Applying the shakes

When preparing to lay the first course, use a guide to insure that the overhang will be uniform and the course straight. Stretch a string between the gable rake overhangs slightly below the first-course shingle position, and align the first course with this string. Or, you can build a jig by nailing two first-course underlay shingles near the ends of a spare nailing strip. (See photo 5.)

Secure this strip over the eave by nailing the two shingles to the roof so that a 1½-in. space remains between the strip and the eave edge. Use your rafter square as a spacing gauge. If you need to use several of these jigs in a row, install the end ones first and sight down the eave to align the rest. When you're done with the first course, remove the jig by sawing through the shingles that support it. The gables should also have a 1- to 1½-in. shake overhang. Tack a 2 × 4 to the gable rake, flush with its top edge. Then, trim the shakes back to the face of the 2 × 4. Don't forget to take into account any gable trim that may be applied later.

Next, install the first row of underlay shingles, allowing each to rest against the guide strip, and cover these with the first course of shakes. Try to maintain a minimum 1½-in. offset between the shingle gaps on all courses. Use two nails per shake regardless of the width of the shake. Place the nails about 1 in. from the shake edges and about 1½ in. above the next course line. To compensate for possible expansion, never lay the shakes tight. Leave a ¼- to ½-in. gap between them. When driving nails, avoid setting the heads deep. Drive only until the head contacts the wood. For subsequent courses, cut a scrap of wood to the exposure length to use as a gauge for course spacing, or simply mark off the length on your hammer handle.

7 Temporarily fasten a 2 × 4 spacer board to the gable rakes and trim the shakes flush to this edge for a neat rake overhang.



8 Marking the first course with a chalkline starts the second course. Strike a line every third or fourth course to insure uniform spacing.



9 Rough trim the shakes with a shingler's hatchet and use a block plane for fine tuning. Use only two nails per shake.



10 An automatic nail gun speeds up the job. Place the nails 1 in. from the edges and about 1½ in. above the next course line.



11 Strike a chalkline on the valley flashing about 4 in. from the center to gauge the trimming angle and guide the shake application.



12 Interlace felt strips between each course. Allow the felt to cover the upper portion of each course and extend on to the sheathing.





13 Frame around the ventilator hole with the nailing strips. Leave about a 1-in. gap between the unit and the surrounding shakes.



14 Use your circular saw to trim the last few courses at the ridge. Follow with a 12-in.-wide strip of roofing felt before applying the cap shakes.



15 Secure the ridge-cap shakes with 8d nails in an alternating lap. Start at a gable end and double the first course. Trim to fit as you go.



16 Carefully remove the old fascia and soffits. Then cut and fit new wood in preparation for the aluminum fascia.



17 Cut and install new aluminum soffit sections. Vented sections allow for air circulation in the eaves under the roof sheathing.



18 For extra longevity apply a wood preservative. Use an appropriate respirator and goggles, and adhere to manufacturer's precautions.

Continuing up the roof

After the first and each successive course of shakes, apply a strip of 18-in.-wide roofing felt over the course. The upper edge of the felt is attached to a nailing strip so that it extends over the shakes, leaving about twice the exposure length of each shake uncovered.

When your course reaches a valley, lay a shake in place and line up a straightedge with the valley chalkline to determine the correct cutting angle. You can save this shake to use as a gauge for precutting the valley shakes on the ground.

It's a good idea to strike a chalkline every so often as you progress up the roof to correct any accumulating error. Save the larger shakes for use in the valleys and put aside the best of those about 7 in. wide for capping hips and ridges.

We installed the Nutone RF 69N attic fan with heat and humidity sensors to exhaust heated air and control attic humidity. Apply shakes to the fan position and then frame the hole to be cut with nailing strips. Cut the hole and install the unit following manufacturer's instructions. Leave about a 1-in. clearance between the shakes and the unit to avoid debris accumulation.

At the peak

When you reach the ridge, allow the ends of the shakes to extend over the top, then cut them back with one pass of your circular saw. Next, lay a 12-in.-wide strip of roofing felt along the ridge extending 6 in. on each side.

Ridge shakes are applied at the same exposure as the rest of the roof and are started at a gable end with a double course. When fitted, these should extend roughly 6 in. down both sides of the roof and just cover the roofing felt. Nail guide strips, or strike chalklines, along the last courses on each side of the ridge. When aligned with the guide strip or chalkline, the untrimmed ridge shakes should be slightly wider than necessary. Nail the first shake in place and trim a bevel on the upper edge so that a shake on the opposite side can overlap it neatly. Nail the opposite shake in place and trim its edge flush.

Continue covering the ridge in this manner, alternating the lap from one side to the other. You can also apply shakes from each end to the middle, and then install a saddle made from the butt ends of two shakes to cover the center joint.

Finishing the job

When the roof was completed, we turned our attention to rebuilding the trim and soffits.

We removed the old fascia and replaced it with new wood. This was then clad with prefab aluminum fascia. We cut the old soffits away and installed new aluminum soffit sections, and used Styrofoam "proper vents" between the rafters to insure air circulation.

Most cedar roofs are left untreated and have a life expectancy of about 30 years. If you are planning your shake roof for an area of high humidity and temperature, consider a clear chemical preservative such as Cuprinol to retard moisture penetration and protect against rot and mildew. An airless sprayer makes it easy to apply. We used the J.C. Penney engine-powered airless sprayer. Always observe the manufacturer's precautions when applying chemical preservatives. In very dry climates, a treatment of linseed oil or other commercial wood-oil product will keep the cedar from drying out and losing its resiliency.

Although a shake roof of this type can easily cost five times as much as a conventional asphalt roof in materials alone, we felt the advantages of cedar were well worth it. Handsplit shakes offer the warmth and elegance of traditional simplicity while aging gracefully and providing protection from the elements.

PM

Friendly Footing

A step-by-step guide
to installing floor tile.

BY PAUL BARRETT

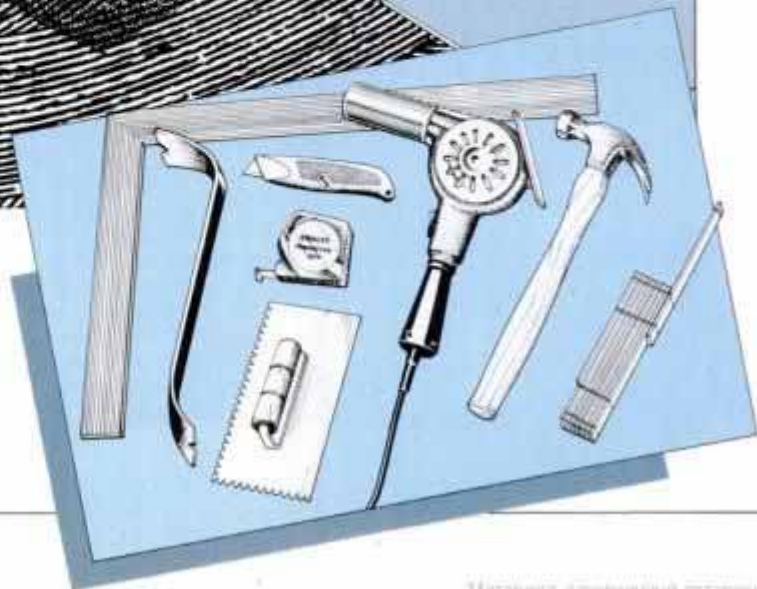
Illustrations by George Retseck

Installing a resilient tile floor is a simple, straightforward job that gives you a terrific return on time and money spent. Floor tile manufacturers have come up with a remarkable variety of tiles. The different styles and colors offer hundreds of possibilities. But the results you get will only be as good as your surface preparation because the tiles are flexible enough to show serious irregularities in the floor beneath them.

Resilient floor tiles are made of asphalt, solid vinyl or vinyl reinforced with mineral fibers, called vinyl composition. The preparation process is similar for all of these floors,



† The minimum tools required for installing floor tile include a framing square, pry bar, utility knife, tape measure, notched trowel, heat gun, hammer and a folding rule. A chalkline and a linoleum roller may also come in handy.

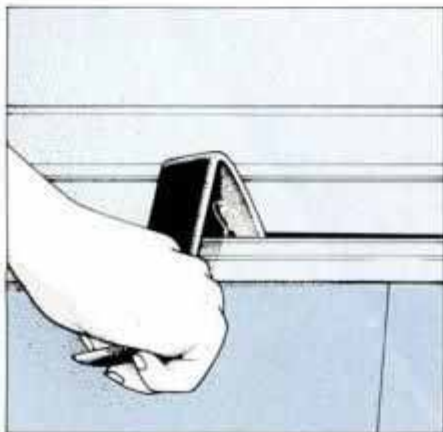


though the adhesive you'll need varies according to the type of tile, and the floor to which you'll glue the tile. Your local flooring dealer can provide the proper adhesive for your situation. No matter what tile you choose, plan to warm the room in which you will install the floor to 70°F for 24 hours before beginning, and keep it at that temperature for 24 hours after installation. Also, be sure to keep the tiles warm for at least one day prior to laying them down. For this story, we installed vinyl composition tile in a kitchen.

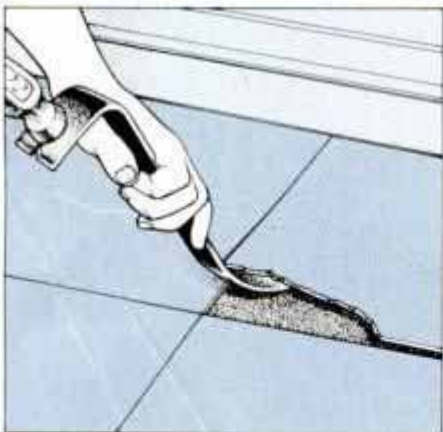
If you are also working in a kitchen, remove the refrigerator and range, and place them in another room. If you have an electric range, simply slide it out and unplug it from its wall socket. If you have a gas range, make arrangements with the gas company to disconnect the appliance before you begin work. If you have a built-in gas range, which you will leave in place, be sure to shut off the gas before you use any flammable adhesive, since the pilot lights could ignite fumes.

Next, remove any shoe molding from the bottom of the baseboard. Pry off the molding with a flat pry bar, then pull

2 Begin work by removing any baseboard shoe molding with a flat pry bar. Pull out the nails from the back using locking pliers.



3 If floor is covered with heavily damaged tiles, remove these with a flat pry bar. Begin by driving the pry bar under one corner.



4 Once old tiles are removed, scrape glue from floor. Try dampening floor because many old glues are water soluble.

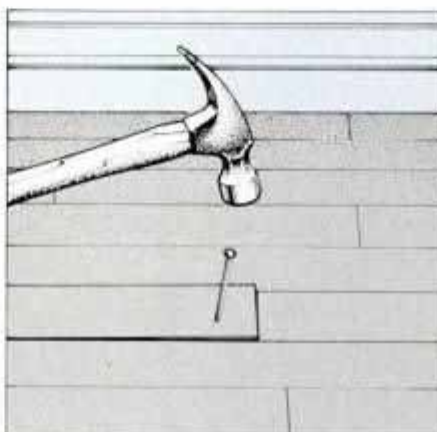


out the nails from behind with locking pliers to avoid damaging the wood. The shoe molding can be reused. Manufacturers claim you can install new tiles over old tiles or linoleum under certain conditions. Your present floor covering should be firmly stuck to the floor, have a smooth surface (not an embossed one), and have no foam backing.

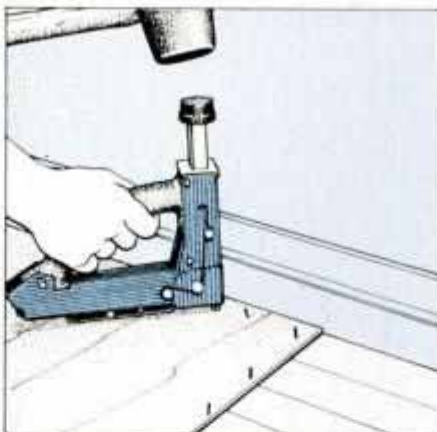
If your floor meets these requirements, first remove wax and floor finish by scrubbing with a cleaner and steel wool. (Never sand a resilient floor, since it may contain asbestos fibers.) If you have a few slightly loose areas, nail them down with underlayment nails, sinking the nailheads just below the surface. Fill over the heads—and any other depressions—with patching compound, such as Dashpatch.

If your existing floor is in poor condition, you have two alternatives. The first is to cover it with 1/4-in. underlayment-grade plywood. Nail the underlayment in a 6-in.-sq. pattern (every 3 in. along the edges) with underlayment nails; sink the heads just below the surface. On this job, we rented a floor stapler, specially made for stapling underlayment. It

5 Replace severely damaged floor boards with new ones and renail any loose board ends. Set nailheads below floor surface.



6 If existing floor boards are in bad shape, cover them with underlayment. Special stapler drives and sets staples in one operation.



7 Fill seams between underlayment sheets, and cover staple heads, with patching compound. Spread compound with putty knife.



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cost about \$20 for one day (including staples) and drives and sets the staples in one motion. Lay out the plywood to minimize seams in doorways and other heavy traffic areas. Stagger the sheets so that the seams at the ends are not continuous. Then, fill the depressions over nailheads, and seams between sheets, with patching compound. When dry, sand the compound flush with the surrounding surface. Use 100-grit sandpaper, and clean the dust very thoroughly.

Your second alternative for repairing a bad floor is to lift the existing floor covering and start fresh. This method has the advantage of giving you access to the subfloor, which may be in need of repair. Also, you will not be raising the floor height, which makes the finish work later that much easier. To lift the tiles, use a flat pry bar or wide putty knife. Then, do your best to scrape away any backing paper and adhesive left on the floor. Some adhesives are water soluble, so it's a good idea to dampen the floor first.

Once the old tiles or linoleum have been removed, examine the floor underneath. Replace any broken boards with new wood of equal thickness, making sure to begin and end your new boards over floor joists. Nail down any loose boards, and fill any cracks between boards with patching compound. Sand the compound flush, remove the dust, then glue 15-pound asphalt felt to the wood. Your flooring dealer can supply the proper adhesive for this job. Be sure to butt the edges of the paper, and keep the lines on the paper facing up. Roll each row of paper with a linoleum roller or rolling pin before setting the next piece.

Once the surface is prepared for the tile, you can take a step that will save some trouble later on. It is possible to cut and fit the tiles around any door stops and casings, but it is far easier to cut off approximately $\frac{1}{8}$ in. from the bottom of these trim boards to allow the tiles to slide underneath. Place a tile next to the stop or casing, then cut the wood with a sharp handsaw, using the flat tile as a guide.


Laying out the floor

Next, you can begin to lay out the floor. The layout is figured from the center of the room, so that the tiles around the perimeter are balanced, and at least one-half tile wide. If your floor is to include a pattern which continues from one tile to the next, balance the pattern on the exposed surface, disregarding the areas that will be covered by appliances. You might find it helpful to draw out your pattern to scale on graph paper before you begin. The easiest way to get an idea of the eventual appearance of your floor is to lay the tiles dry, so you can experiment freely with patterns and borders.

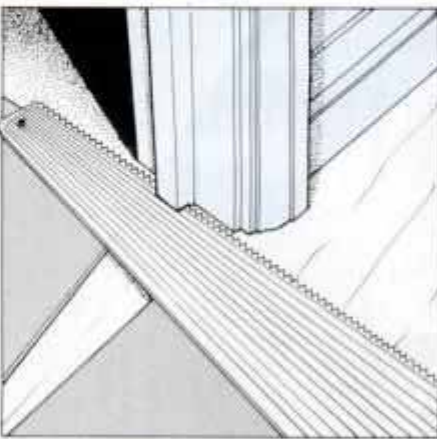
First, find the centerline between two opposite walls, and mark the floor at this point at both ends. Snap a line on the floor between these marks. Place the tongue of your framing square on the chalkline at the center point of its length and make a pencil mark along the blade, perpendicular to the chalkline. Using the mark as a guide, snap a perpendicular line on the floor. These lines are reference lines, and can be used to find your actual starting point.

Lay the tiles dry, and move them one way and another, until you find the placement that yields the best results. Use cardboard patterns of appliances to get a true picture of the floor that will be exposed to view. Shift the starting point in the center of the room until you find the point which will yield the biggest border tiles. Once you've found your starting point, snap new lines in the proper position, parallel to your original reference lines. The new lines should intersect at one corner of your first tile, and extend to the walls.

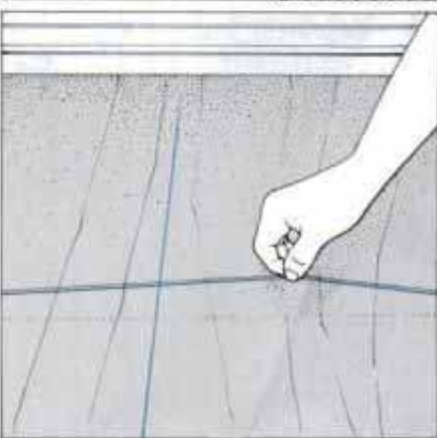
The adhesive you use is determined by the tile you buy. Many of the reinforced vinyl tiles are available with adhesive




8 Once compound is dry, sand it flush to surrounding surface using 100-grit sandpaper. Be sure to vacuum up all dust.



9 For better fit in door openings, cut off door stop and casing so tile can fit underneath. Use loose tile as saw-blade guide.

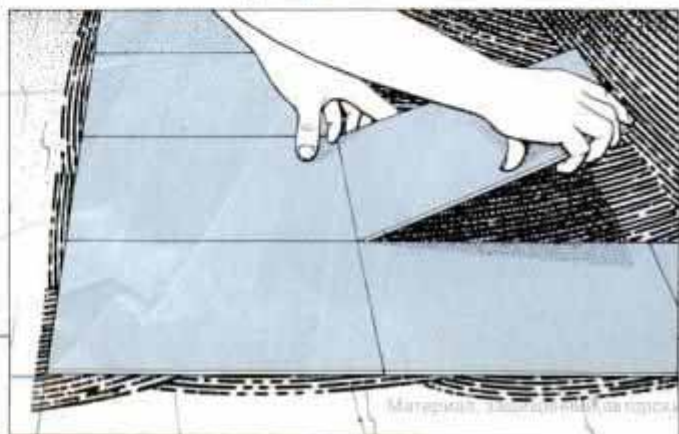


10 Draw initial reference lines on floor, then distribute tile to check for fit. When satisfied, snap final chalklines onto the floor.



11 Spread adhesive onto floor according to manufacturer's instructions. Most adhesives require use of notched trowel.

12 Install tiles along both chalklines first, then lower ensuing tiles into place as shown. Make sure all edges align perfectly.





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backing. If you go this route, be very careful when laying the tiles, as they can't be adjusted once they've been pressed down. Do any trimming before you remove the paper backing.

If you are using adhesive, keep in mind that different types require different methods of application. Some can be applied with a paintbrush or short-nap roller, while others need to be spread with a notched trowel, which was the case in this installation. Instructions for spreading glue, as well as any cautionary notes, are printed on the can. Be sure to read and follow the instructions on the label.

It's a good idea to do the room in sections, to allow yourself room to move, so plan to cover one quarter of the room at a time. Cut a 2 x 2-ft. piece of plywood to kneel on, so you won't be kneeling on the freshly laid tiles.

Begin spreading the adhesive along one of the starting lines, then work into the corner and back to the other line. Spread the adhesive just over the line. The colored chalkline will read through the adhesive.

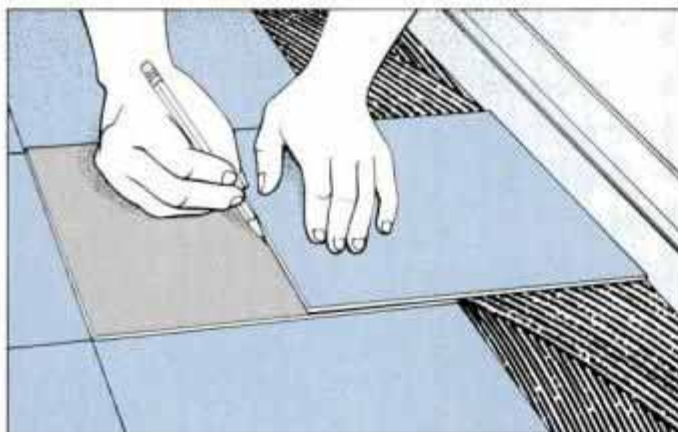
Set the first tile at the intersection of the guidelines, as carefully as possible. Then, set the edge of the next tile against the first tile, so that the corners are perfectly aligned, and lower the tile into the adhesive. Work out along the two lines, then fill in between in a pyramid fashion. Avoid sliding the tiles into place, as this will force glue in between

the edges. If you are installing solid vinyl tiles, roll the tiles as you install them with a linoleum roller or rolling pin. After you have laid 20 or so tiles, go back and roll them again. Use firm pressure to ensure that the tiles are pressed into the glue. For other tiles, simply press them firmly into place with both hands.

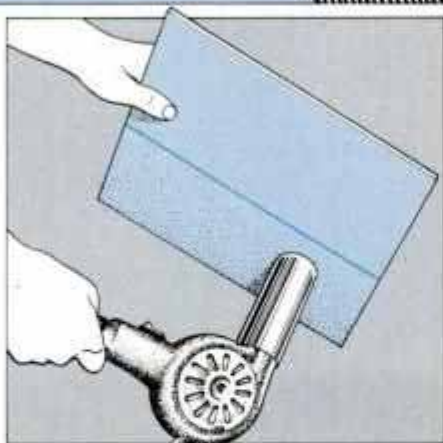
Set only the full tiles at first, then go back and cut the border tiles. For the most accuracy, scribe the border tiles to the wall. To do this, place a loose tile upside down over a tile in the last row installed. Be sure the tile is lined up perfectly with the tile beneath it, and that the pattern runs in the proper direction. Then, place a full tile over the loose tile, with one edge against the wall. Run a pencil along the upper tile, marking the tile beneath. Heat the tile along the cutline with a heat gun. When the tile softens, lay it on a smooth surface and cut it with a utility knife and straightedge.

Once all the tiles are installed, remove any adhesive spots on the surface with mineral spirits or the solvent mentioned on the can label. Reinstall any shoe molding, then move any appliances and fixtures back into place.

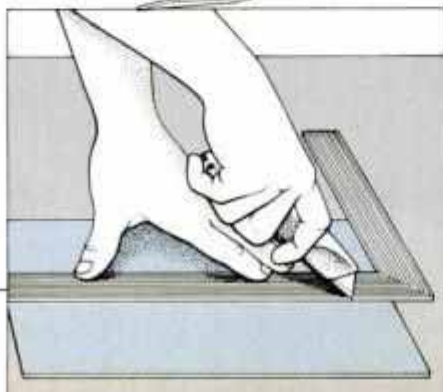
If necessary, cut down any doors that swing over the tile. Allow 1/8-in. clearance between the bottom of the door and the new floor. Then, rehang them. Apply metal trim strips where the tiles meet other floors, nailing them in place with the special nails provided. Finally, avoid washing your floor for three days, so the adhesive will have a chance to set. **FM**



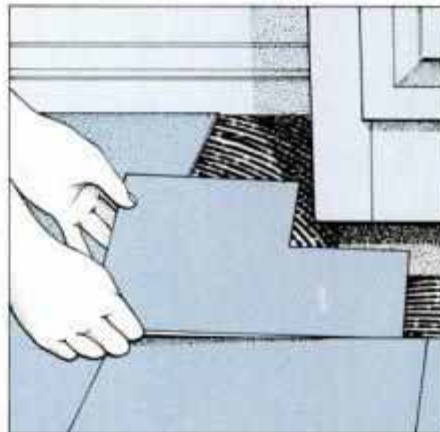
13 To scribe a border tile, place it upside down on the last row. Cover it with a tile that bears against the wall. Mark the tile as shown.



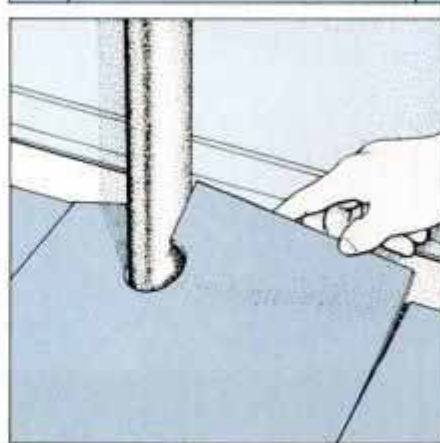
14 Once the cutline is drawn, heat the back of the tile with a heat gun. Direct the warm air along the cutline until the tile is soft.



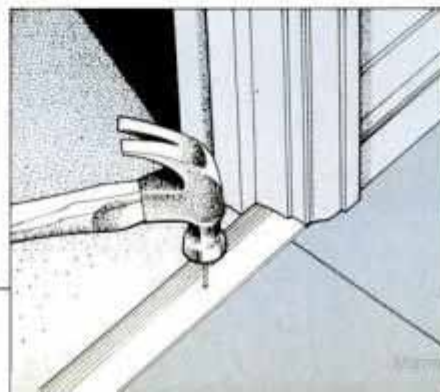
15 Lay heated tile on a smooth surface, then cut along the line with a sharp utility knife. Use a framing square as a straightedge.



16 When laying cut tiles—especially notched ones—be sure to lower them into place. Sliding a tile will force glue into the cracks.



17 To fit around a pipe, first cut a matching diameter hole in the middle of the tile and then make a straight cut to the edge.



18 When all the tile is installed, be sure to cover any edges that abut other floors with metal trim strips. Nail these in place.

5 Foolproof Fixes

A mini-guide to some of the most common bathroom repairs.

TEXT AND PHOTOS BY MERLE HENKENIUS

Faucet Repair

The faucets in your home will eventually need repair, and because replacement parts are inexpensive and plumbers are not, it makes sense to do

the job yourself. All that's required is a basic knowledge of faucet components, an adjustable wrench, a utility knife or awl, a screwdriver, heat-proof grease and assorted washers or replacement cartridges, depending on your faucet.

These days you are likely to encounter two types: the older valve stem-and-seat units and newer washerless cartridge types.

In stem-and-seat units, the movable valve stem connects to the handle and the valve seat is threaded into the fixture. By turning the handle counterclockwise, the stem moves off seat and water passes through. By turning the stem the other way, it bears down on the seat and stops the water. To get a tight seal in the closed position, the bottom of the stem has a replaceable washer. To prevent water from leaking around the stem in the open position, the outside of the stem is covered with either graphite packing or a small O-ring. Because replacing the washer and packing is easier than replacing the valve seat, undertake the repair as soon as you see water beginning to drip. Otherwise, you can damage the seat by overtightening the valve stem.

The washerless cartridge-type units work in a similar way. The cartridge simply moves up and down within the fixture to start or stop the flow. When these become worn, however, the entire cartridge must be replaced.

To repair either type, begin by shutting off the water. If the faucet has its own shutoff valves, just turn these off.



1 Begin repair by removing decorative caps from handles using a utility knife. If your faucets don't have caps, look for a setscrew at the bottom of the handles.



2 Remove faucet screw, then gently pry off handle with screwdriver. If stuck, use handle puller, as shown, to prevent damage.



3 To remove valve stem, slide adjustable wrench over lock nut and turn counterclockwise. Valve stem should come out easily.



4 Remove worn washer from valve stem, then replace with new one. Tighten screw so washer just begins to compress.

If not, shut down the entire system at the water meter. Next, remove the faucet handle. To do this, you must pry off the decorative cap on the top of the handle and remove the screws underneath. Some faucets have a setscrew at the bottom of the handle that holds the handle to the stem.

If you have trouble removing the handle, gently pry under its edge with a screwdriver. If this doesn't work, then use a handle puller to remove it (photo 2). With the handle removed, you will see the valve stem and its locknut. Using an adjustable wrench, loosen this nut and back out the entire stem. You can see if it's a washer-and-seat type or a cartridge model. If it's the former, remove the washer screw and discard the old washer. Replace it with a new one that fills the stem flange completely. Then replace the stem O-ring or graphite packing and apply heat-proof grease to the washer and all faucet and stem threads. This grease can easily double the life of washers and make removing the stem easier next time. Reinstall stem and handle.

To install new cartridges in washerless faucets, just press the new unit into place, tighten the locknut and replace handle and cap. Some models, as shown in photo 6, have a spring-loaded rubber cap that seals against bottom of cartridge. These must also be replaced, then carefully guided—with new cartridge—into the fixture.



5 Carefully remove old O-ring from side of valve stem with awl or knife. Then replace with size recommended by manufacturer.



6 On washerless faucets, entire cartridge—including spring cup on bottom—must be replaced. Use awl to guide both.

Grout Repair

Sooner or later a tiled shower wall will need grout repair. If crumbling grout goes untended for long, water will find its way through the tile joints and into the building material behind. Once this happens you could be looking at a very expensive repair bill. It is much better to treat the problem while it is still manageable and affordable. All you need is an inexpensive grout removal tool, a small tube of premixed grout, and a tube of latex or silicone caulk. A grout float is optional.

Begin by examining the tiles closely.



1 Begin repair by digging old cracked grout from joints using grout removal tool. Clean out to a depth of at least 1/16 in.

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Look for dark or discolored grout or joints where grout has fallen out. Also, look for tiny cracks where the grout meets the edge of the tile. Scrape out all loose grout—to a depth of at least $\frac{1}{16}$ in.—with the grout removal tool.

Once you have removed every trouble spot, wipe all joints clean with a damp cloth. On small areas, use your fingers to work the new grout into place; use plenty of grout. On larger areas, use a rubber-faced grout float (photo 2). When the spreading is com-



2 Force new grout into joints using rubber float. Then wipe excess grout from surface with damp cloth. Let dry and buff.



3 Complete bathroom regrouting by applying latex or silicone caulk around fixtures. Wipe off excess caulk before it dries.



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4 When regrouting countertops, pay close attention to sink area. First remove grout then remove old caulk from under sink rim.



5 Force grout into joints under sink rim using finger. Wipe away excess and carefully clean rim so caulk will grip well.



6 Wipe away excess grout with damp cloth, then when surface is dry, buff it with clean rag. Overcoat of sealer is optional.

plete, wipe all excess grout from the surface using a damp sponge. Work the sponge in large diagonal passes and rinse the sponge frequently.

Wait about an hour, or until the grout residue turns white. Then polish the



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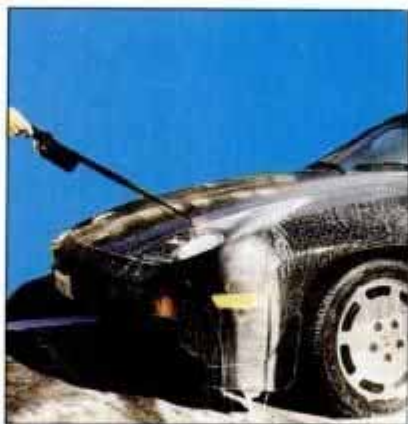
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tiles with a soft cloth until they shine. If you want added protection, wait at least 12 hours and brush the joints with a clear silicone sealer. This liquid is available from most ceramic tile outlets. Because many grout problems start around the faucet handles and where the tile meets the tub or shower base, it pays to caulk these areas with latex or silicone caulk.

If you have a tile countertop in your kitchen, you should watch for needed repairs there as well. With garbage disposers and built-in dishwashers now vibrating cabinets and countertops several times a day, the grout has a tendency to loosen or break.

Regrouting a countertop is accomplished in much the same way as shower repairs. The only real difference is

that you should use a sand-mix grout compound instead of standard grout. This type has greater strength and durability and is available in either premixed tubs or dry-mixed bags. Also pay special attention to the area around the sink. Remove as much grout and old caulk as possible from under the sink rim. This will result in a better bond for the new grout and caulk.



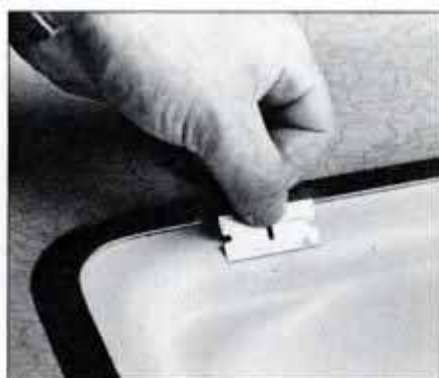
1 Begin porcelain repair by thoroughly sanding the chipped area to remove rust and soap residue. Use fine-grit emery cloth.



2 After sanding, wipe the area with isopropyl alcohol. Be sure to use a clean cloth and go over the area several times.



3 Mix equal parts of resin and hardener on a clean glass surface. Then add colors gradually until you match the fixture color.



4 Fill the chipped area with patching compound using a single-edge razor. Make sure patch is flush with surrounding surface.



5 Before the patch sets, smooth the surface with alcohol and your finger. Use alcohol sparingly because it thins the patch.

Drain Cleaning

Cleaning clogged plumbing drains need not be difficult. The trick is knowing when to hire a professional and when to do it yourself. As a general rule, clean small, easily accessible drains on sinks and tubs, and leave larger toilet and sewer lines to the pros.

To do a good job, most drains require a 2-step cleaning process. First, snake the drain line, then use a plunger and hot water to force debris into the larger sewer stack. A handheld snake and a plunger are good investments for this job. Because you'll probably use the snake every few years, it's better to buy one than to repeatedly rent one.

Start by removing the trap from the clogged drain line. This can be the most

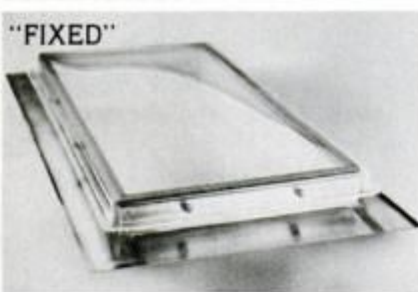
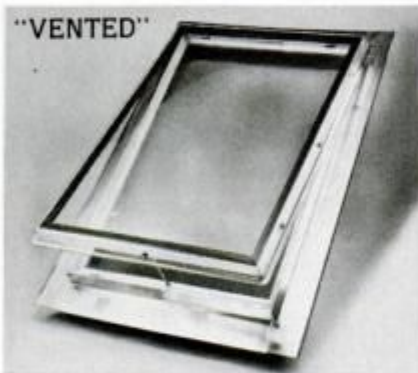


1 Begin by removing the trap. Adjustable pliers will loosen plastic fittings, but a pipe wrench is required for chrome.



2 Slide snake cable into drain line one foot at a time. Tighten setscrew on cable, then turn crank and push in cable gradually.

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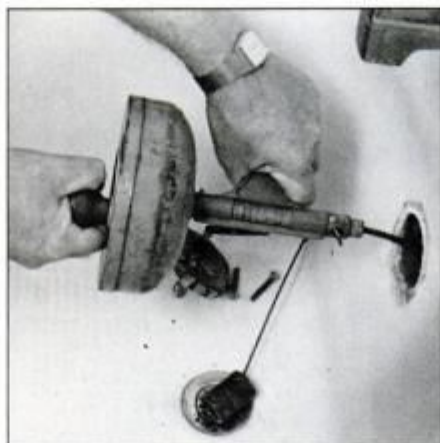
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3 After snaking, reconnect trap, then run very hot water into drain line. Plug overflow with rag, then plunge drain opening.



4 Bathtub drains must be snaked through overflow opening, not drain hole. Begin by removing trip-lever plate and mechanism.



5 Slide snake into overflow opening and crank. Trap is within 2 ft. of opening, so you'll feel resistance almost immediately.



6 Remove snake and run very hot water into drain. Plug overflow opening with rag, then plunge drain opening repeatedly.

troublesome part of the job. Chrome traps become fragile with age and can crumble or break when taken apart. Plastic traps, on the other hand, are joined with compression fittings which are much easier to remove.

When you have the trap out, begin feeding the snake cable into the drain line one foot at a time. Some clogs will fill the entire drain line, from the trap, while others might be lodged between fittings 10 ft. away. You don't have to crank the cable until it no longer pushes in easily. When you do feel resistance, lock the cable to its housing with the setscrew and slowly push the snake and turn the cable at the same time.

When the snake housing is against the drain opening, stop, pull out another

foot of cable, lock it into place, and crank again. Repeat the process until you have worked through the entire line. Then reverse the steps to remove the snake. Pull it out and crank the cable one foot at a time.

When all the cable is retrieved, reconnect the trap and run hot water into the line. Then plunge the drain until the water passes freely. When plunging fixtures with overflow openings, these openings must be plugged with a wet rag; otherwise, you will lose the force of the plunger.

The process for cleaning tub drains is basically the same, except the snake is operated through the overflow opening. To gain access, just remove the trip-lever mechanism as shown.

Automatic Drain Vents

It is sometimes impossible to vent a plumbing fixture with a conventional vent pipe, especially on jobs when you relocate the fixture. But to operate properly and keep your house free of

sewer gas, every fixture must be vented. To make this easier, manufacturers have designed automatic venting devices that are easy to install, inexpensive—around \$5—and almost foolproof. Keep in mind, however, that some codes prohibit their use, so check with

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1 An automatic vent installation usually requires the replacement of existing fittings with plastic ones like those above.



2 The vent piece threads into a 1½-in. female adapter. The adapter is then glued directly onto a length of drain pipe.



3 Above is typical installation if drain comes through wall. Vent piece is on top of vertical pipe behind sink bowl.

your local building department before proceeding. A typical vent has a 1½ × 3-in. plastic cylinder with a hooded passage on one end and male pipe threads on the other. Inside is a spring-loaded diaphragm. When drain water rushes past the vent, suction opens the diaphragm and pulls in surrounding air, instead of pulling water from the trap. When pressure is equalized, the diaphragm closes to keep sewer gas from escaping. To install one, disassemble your existing fittings, and buy proper fittings and pipe for your situation. Install these so you have an arrangement like the one shown in photo 3. **PM**

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Home Work

A guide to the latest home improvement products

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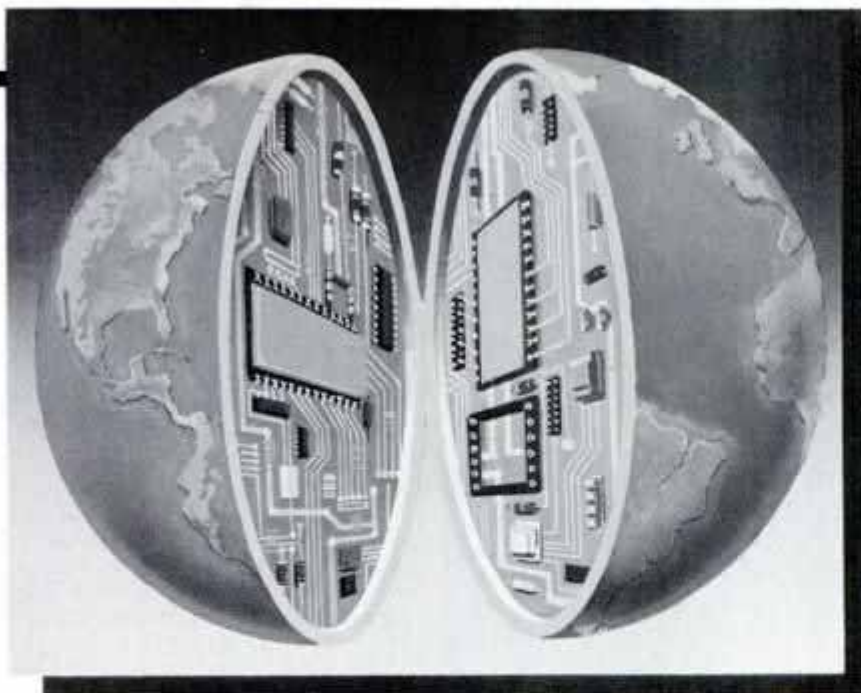
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Side lines

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Affordable oak

The Haas Cabinet Co. now offers homeowners affordable red oak cabinets with its American Autumn cabinet line. Frame and panel doors with 3/8-in.-thick raised panels are constructed of solid oak, as are the cabinet face frames and drawer fronts. The drawers feature dovetailing at all four corners, and they glide on center-

mounted steel drawer slides. The upper wall units have a 3/8-in. fixed center shelf and adjustable 1/2-in.-thick shelves of vinyl-covered particleboard. A 36-in. sink unit sells for approximately \$235; a 36-in. upper wall unit costs about \$220 at kitchen dealers. For more information, contact Haas Cabinet Co., 625 W. Utica St., Sellersburg, IN 47172.



Nostalgia fans

For moving stale air and distributing heat nothing compares to the old-time grace of a ceiling fan. Hunter now offers the Studio Series 42-in. ceiling fan in brass, antique brass and white finishes. These fans feature real wood blades and matching blade irons.

The Studio Series fans come with a 3-speed, electrically reversible motor for complete air-flow control, and are covered by a 5-year limited motor parts warranty. The brass or antique brass 42-in. ceiling fan costs about \$110, and the white fan costs about \$100. The Studio Series ceiling fans are sold at hardware stores and home centers. For more information, write to Hunter Fan Co., Marketing Service Dept., 2500 Frisco Ave., Memphis, TN 38114.

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AVIATION MAINTENANCE

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in aviation maintenance could never be better than now. A recent FAA report indicates that by 1990 there will be an average of 40,000 job openings each year in general and commercial aviation, the government and aeronautical firms.

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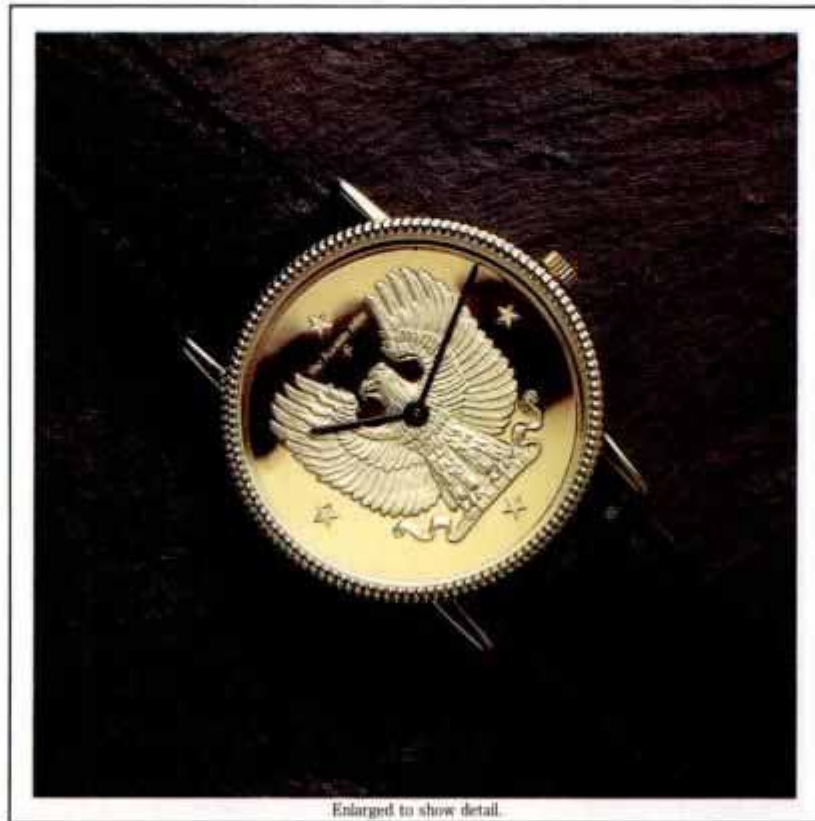
- Earn your A&P and Associate Degree in Aviation Maintenance Technology in just 18 months.
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Wear the watch only a mint could create.



Enlarged to show detail.

At a time when high quality "coin watches" are the ultimate in fashion jewelry for men—this watch is something *special*.

The spectacular sculpture on its face is actually *minted*. Just like a coin. In 24kt gold electroplate on solid sterling silver. It has to be, to capture all that detail.

It's an *original*. By famed artist Gilroy Roberts, whose portrait of President Kennedy made the U.S. half-dollar one of the most collected coins on earth.

It's *exclusive*. From The Franklin Mint, of course. The one source world-renowned both for minting exceptional coins *and* for creating fabulous jewelry.

And it's a superb timepiece. With a fine Swiss quartz precision movement and black leather strap. Impressive. Quietly elegant. The price? Just \$195, payable in convenient monthly installments.

Please order by April 30th.

The Franklin Mint Eagle Watch by Gilroy Roberts

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Order Form

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Franklin Center, Pennsylvania 19091

Please enter my order for The Franklin Mint Eagle Watch. I need send no money now. I will be billed for a deposit of \$39.* when my watch is ready to be sent to me. The balance will then be billed after shipment in four equal monthly installments of \$39.* each.

*Plus my state sales tax and a total of \$3. for shipping and handling.

Signature _____

ALL ORDERS ARE SUBJECT TO ACCEPTANCE.

Please mail by April 30, 1987.

For Warranty information, write to Customer Service,
The Franklin Mint, Franklin Center, PA 19091.

Mr./Mrs./Miss _____

PLEASE PRINT CLEARLY

Address _____

City, State, Zip _____

Please allow 6 to 8 weeks for shipment.

58

HOME IMPROVEMENT GUIDE



Multifunction ventilator

With the NuTone model 9965 Heat-A-Ventlite, you can provide your bathroom with heat, ventilation and a bright ceiling light or night light. It features a convenient 4-function wall switch with separate ON/OFF controls so each function can be used separately or in combination. For low maintenance, the model 9965 has a white Noryl grill that never needs painting. The 1500-watt nickel-chrome heating element provides instant heat where you need it, saving fuel costs for the entire house.

Other features include a 70-cfm blower and 100-watt light with hinged glass for easy lamp changing. The model 9965 Heat-A-Ventlite costs about \$180. For more information and the location of the dealer nearest you, write to NuTone Inc., Madison and Red Bank Roads, Cincinnati, OH 45227.

Serviceable surface

What won't burn, mark, scratch or stain; is nonabsorbent; and comes in a selection of designs to suit any decor? Vance Industries has the answer with its new Surface Saver. Offered as a built-in model or portable tray version, the Surface Saver is made of nonporous tempered glass for easy cleaning. It can be used as a cutting board, nonstick kneading surface and heat-resistant resting place for pans direct from the stove. The built-in model comes with instructions and hardware and costs about \$43 for the 16 x 20-in. size; \$35 for the 12 x 15-in. size. You can buy the Surface Saver at kitchen remodeling suppliers and home centers. For more information, contact Vance Industries, 7401 W. Wilson Ave., Chicago, IL 60656.



New air for old

NuTone now offers an air-to-air heat exchanger for a single room or small apartment up to 1000 sq. ft. Model AE-70 (\$500) weighs about 25 pounds and can be installed permanently in a wall or window. It exhausts stale indoor air and replaces it with filtered outdoor air. The two streams never mix, but heat is transferred. NuTone claims the AE-70 will save up to 80 percent of heating and cooling energy that would otherwise be lost. The ventilation rate varies from 30 to 70 cfm. Contact NuTone Inc., Madison and Red Bank Roads, Cincinnati, OH 45227, for the nearest dealer.

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TIME - RAINGO's complete, carefree system can be installed by one person in a few short hours.



WORRY - with features like exclusive RAINGO Ridges for faster water flow, plus HIGHFLO™ and LEAFGO™ for elimination of clogged downspouts, RAINGO stays virtually maintenance free.



MONEY - RAINGO's solid vinyl, weather-tested system is BUILT TO LAST, at a price competitive with old-fashioned metal systems.

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RAINGO™
Solid PVC Vinyl
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7034 E. Court St., Box 309
Davison, MI 48423-0309

For Further Information Call: Michigan 800/572-5398, Outside MI 800/521-7488

See March 1987 issue of P.M.
"Better Home Section"



Compact luxury

For those short on bathroom space, American-Standard now offers the Lexington Soaking Bath. Fitting neatly in a standard 5-ft.-long space, the new bath measures 36 in. wide and 20 in. deep. Construction is heavily reinforced high-gloss acrylic and special features include a slip-resistant floor and grab bar. The basic bath costs about \$990 and can be equipped with an acrylic front apron (\$225) as shown. The bath is sold through bathroom supply dealers. For more information, write to American-Standard, Plumbing Products, 1 Centennial Pl., Box 6820, Piscataway, NJ 08854-6820.

The real thing

Here's an exception to the old rule—you can't judge a book by its cover. These colonial-design doors from Morgan Products are no imitation. Featuring traditional frame-and-panel construction, the solid red oak interior doors will lend a touch of distinction to any living space.

The six double-hip raised panels are a full 1 1/4 in. thick and the doors are available in eight sizes ranging from 1 to 3 ft. wide x 80 in. high. They are available through building supply dealers. Prices range from about \$185 for the 1 ft. width to \$350 for the 3 ft. width. For more information, contact Morgan Products Ltd., Box 2446, Oshkosh, WI 54903.



Steeling the show

With an exterior that looks like raised wood paneling, this 2-in.-thick garage door has a heart of Styrofoam and a body of 24-gauge sheet steel. For corrosion resistance, the steel is galvanized and factory precoated. Construction features include a unique no-weld system and the door sections fit together with tongue-and-groove joints. The model 4501 is sold through Windsor Door distributors. Prices range from \$250 to \$300 for an 8-ft.-wide door; installation extra. For additional information, you should write to Windsor Door Div., Ceco Corp., 5800 Scott Hamilton Dr., Little Rock, AR 72209.



Shadow control

Designed around a self-supporting arm system, the Pease retractable arm awning can be installed by the average handyman, claims the manufacturer. The standard hand-crank operation can be replaced by an optional motor-drive, which can be further enhanced by installing wind and rain sensors that provide automatic retraction. Available at

building suppliers, the unit comes in lengths up to 19 ft. with an 8- or 10-ft. extension. Prices start at about \$950 for the 8 x 10-ft.-long hand-operated model. For winter storage on homes with short eave overhangs, an aluminum hood is also available for approximately \$150. For details and more information, contact Pease Industries Inc., 7100 Dixie Highway, Fairfield, OH 45014.



Standing on the corner

Make your kitchen more efficient by freeing up straight runs of countertop with the Lustertone double-compartment corner sink (\$425). This satin-finished sink is made of stainless steel and is completely undercoated to deaden noise and reduce condensation. It's available with soap dispensers and a choice of two faucet designs. Fully equipped as shown, the sink costs about \$650. Contact Elkay Manufacturing Co., 2222 Camden Ct., Oak Brook, IL 60521.

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AIR-FLO DESIGN. Blades won't lift in high winds, high speeds. 6 claws grip firmly, distribute pressure evenly.

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PRICE PER PAIR ONLY

\$12.95 \$1.95 Shipping & Handling
Specify make, model, year of car.

YES! Send me _____ pair of Triple Edge Lifetime Wipers—the only wiper **GUARANTEED** for the life of your car.

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Car #1: Year _____ Make _____ Model _____
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Car #3: Year _____ Make _____ Model _____
Car #4: Year _____ Make _____ Model _____

1 pr. \$12.95
2 pr. \$23.90 Save \$2.00
3 pr. \$34.85 Save \$4.00
4 pr. \$45.80 Save \$6.00
(Single Blades \$6.50 ea.)
Shipping \$1.95 first pair
(Shipping 2nd, 3rd, & 4th pair, only \$1.00 each)

Amt. Enclosed: _____
Pa. Residents Add Sales Tax

Many Hearing Problems Can Be Helped.

Chicago, Ill.—A free offer of special interest to those who hear but do not understand words has been announced by Beltone. A non-operating model of the smallest Beltone aid of its kind will be given absolutely free to anyone who sends for this free model now.

Send for this model, it will show you how tiny hearing help can be. It is not a real hearing aid and it's yours to keep free. The actual aid weighs less than an eighth of an ounce, and it fits completely into the ear canal.

These models are free, so we suggest you write for yours now. Again, we repeat, there is no cost, and certainly no obligation. All hearing problems are not alike and some cannot be helped by a hearing aid but many can. So, send for your free model now. Thousands have already been mailed, so be sure to send your name, address and phone number today to Department 4830, Beltone Electronics, 4201 West Victoria Street, Chicago, Illinois 60646.

Offer not valid in California.

EARN \$20/hour
With Your Own **MAGNATRAC®** Bulldozer!

- NEW ENGINE - 18 hp Twin Cylinder
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Catalog - showing Magnatrac—Kit construction & uses \$1.00
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2 to 18 HP Engines, 500 to 5000 watt Generators, all at Discount Prices
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PM TECHNOLOGY UPDATE 4/87



The Queen Elizabeth 2 on her last visit to America before refitting.

The Queen Of Ocean Liners Sails Again

The *Queen Elizabeth 2* will sail again next month following a 6-month stay in dry-dock. The 20-year-old luxury liner has been refitted with a 9-diesel-engine propulsion system, replacing the steam turbine plant that once took her to a stately 28½ knots. The new powerplant will give the *Queen* a maximum 42½-knot speed with half the fuel consumption of the original

rig. Each diesel engine is hooked to a 10.6-MW generator. A waste-heat recovery system with a total efficiency rating of 74 percent gives the vessel extra power. The refitting of the 67,000-ton ship is expected to keep it seaworthy through the first decade of the 21st century. On a recent Atlantic crossing, Capt. Lawrence Portet, who has spent more than 40 years at the

helm of Cunard ships, told us, "Speed is everything. Conversion to diesel will give us the speed we need." He also pointed out that the 6-blade, variable-pitch propellers being installed in the *Queen* will reduce cavitation—the forming of a vacuum in the propeller draft. That vacuum creates drag, slows a ship down, and reduces control over the vessel. The new propellers

will eliminate those problems. The first voyage of the *Queen Elizabeth 2* is from Southampton to New York in mid-May. The *QE2* will ply the Atlantic coast and the Caribbean through the summer and will make cross-Atlantic trips in the fall.

Editor: Dennis Eskow
Contributors: Josh Eppinger, Steve Eskow, Irena Scott, Solange DeSantis, Jack Hammond.

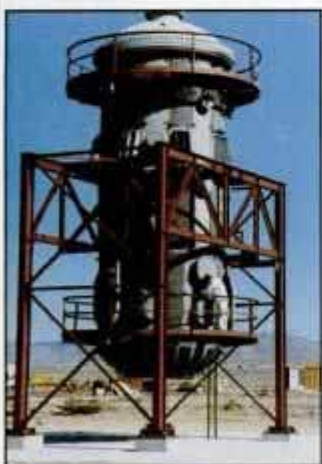


TECHNOLOGY UPDATE 4/87

ENERGY

Melt-down for our safety

Say the word "melt-down," and we all shudder. The word is used to describe the



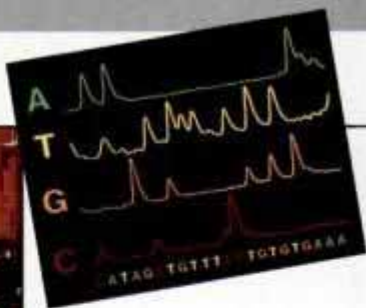
scariest kind of accident that can happen at a nuclear powerplant. In the scenario, nuclear fuel heats up beyond 3000° F, melts down the core of the reactor, and starts a chain of events reminiscent of the Chernobyl disaster. Scientists at Sandia National Laboratories have built a 34-ft.-tall, 12-ft.-dia. steel pressure vessel in which they can run controlled near-melt-downs to find out how they would affect various construction materials like steel and concrete, the major constituents of a nuclear reactor containment wall. The test vessel is a 1/10-scale model of a typical pressurized water reactor. Testing later this year is expected to reveal better formulas for building containment walls.



MEDICINE

DNA machine builds genes

Genetic engineering already has produced artificial insulin, supergrowth hormones and other exotic chemicals. But the field has been slowed down by the process of mapping any DNA (dioxiribonucleic acid) molecule. DNA, the basic building block of life, consists of strings of four units in a sequence that determines everything from eye color to blood type in humans. Mapping the molecules has been a complex process involving dozens of steps. But Cal Tech researchers have unveiled a laser-powered device called a sequenator which reduces the process to hours. As the sequenator reads the layout of a DNA strand, the parts are recorded numerically and graphically on a computer screen.



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AVIATION

Superskin for supersonic jets

We are moving closer to the era of ultralightweight skins that can keep an aircraft covered beyond Mach 2. McDonnell Douglas researchers have developed an aluminum-lithium alloy which has been flight tested at close to Mach 1 on the wing of an F-



15 Eagle. Early tests indicate the material will take the heat of Mach 2 and cut the weight of future jets by 20 percent.



'X' marks the wing

Sikorsky has begun flight testing a revolutionary hybrid called the X-Wing. The

chopper is so-named because its rotor blades can be stopped in flight and lined up to become fixed wings for higher speed and lift. During the 30 seconds when the ro-

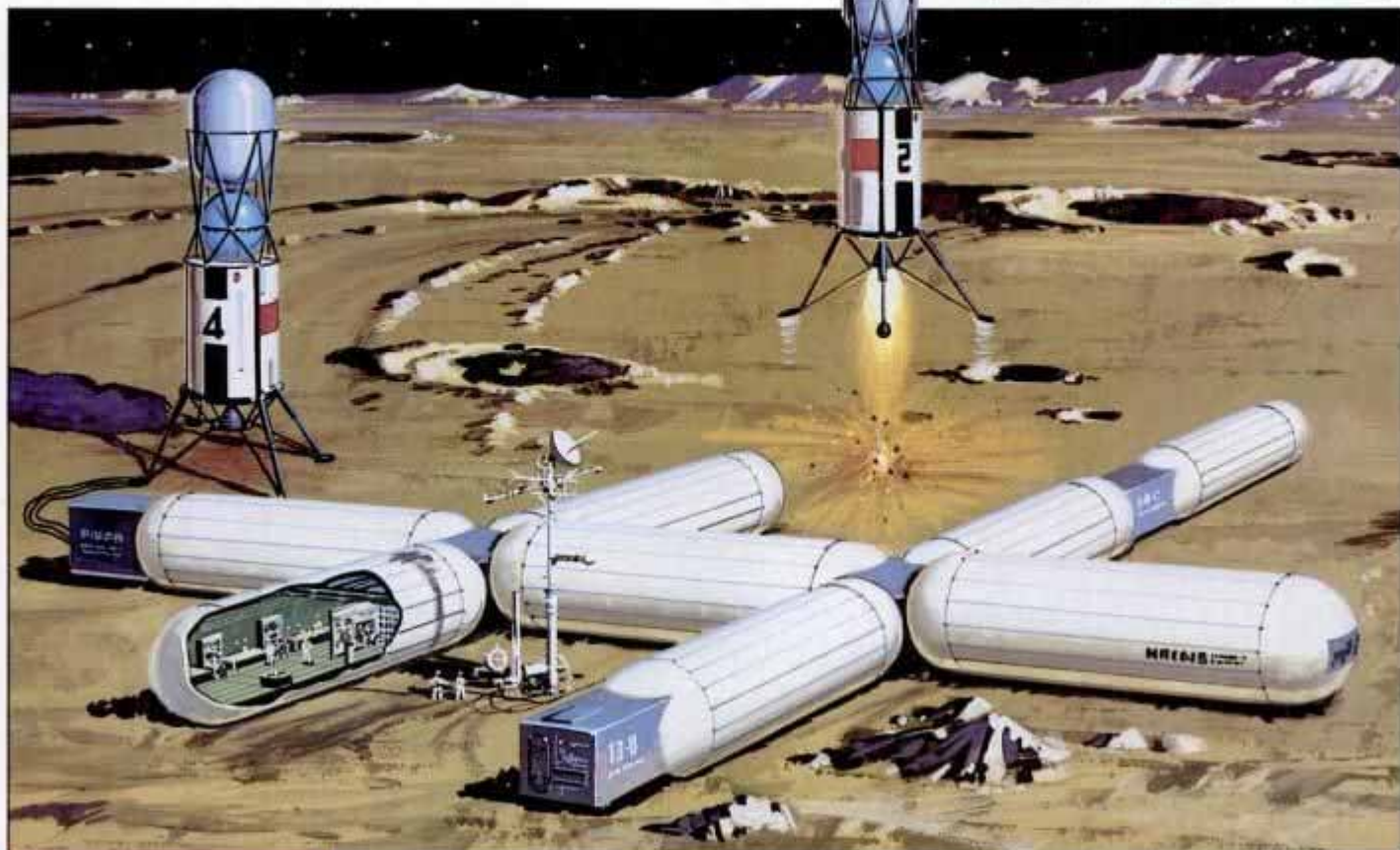
tor is stopped, pressurized air is blown through slots along the 27-ft. length of the blades to provide lift and flight control.

"Here you have something

that could fly at 30 to 40 knots and also fly at 400 knots," says Sikorsky engineer Arthur Linden.

Testing will continue throughout the year.





SPACE

A base for the moon

Scientists working on the Columbus Project at Lawrence Livermore Labs have come up with the basic design for a moon base that could be functioning by 1992.

The Space Station is expected to be operational at that time. The base would be serviced by lunar lander/return craft designed to deliver inflatable modules of the base.

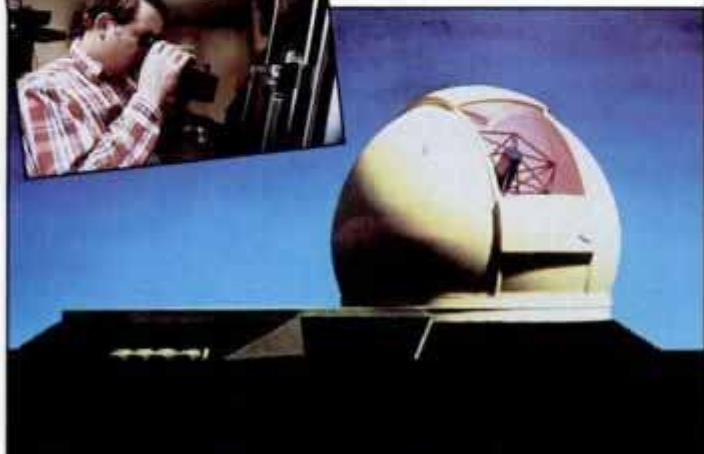
Workshops, habitats and labs would operate inside the modules. Oxygen would be drawn from lunar rocks. The project is expected to cost \$250 million just to design.

ASTRONOMY

Star search starts anew

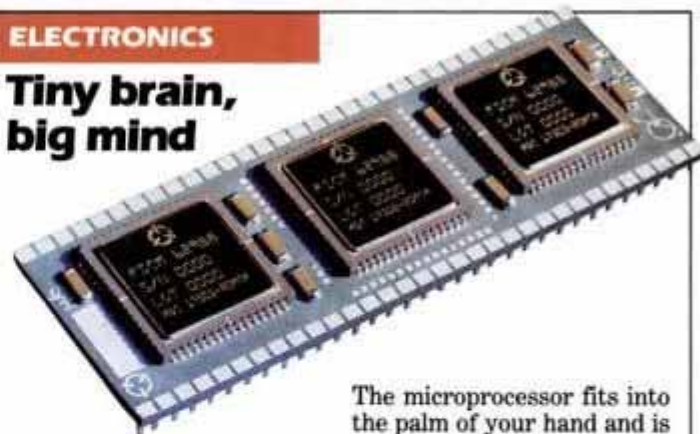
Cal Tech astronomers are in the first year of a 5-year project to photograph the entire northern sky using sensitive new photo techniques

resulting in a basic astronomical map. The Palomar Sky Survey will update a survey done in the 1950s when films were less sensitive. Astronomers can watch what the camera sees through new instruments (inset photo). Meanwhile, on Mona Kea, Hawaii, a multiuniversity consortium plans a similar southern search.



ELECTRONICS

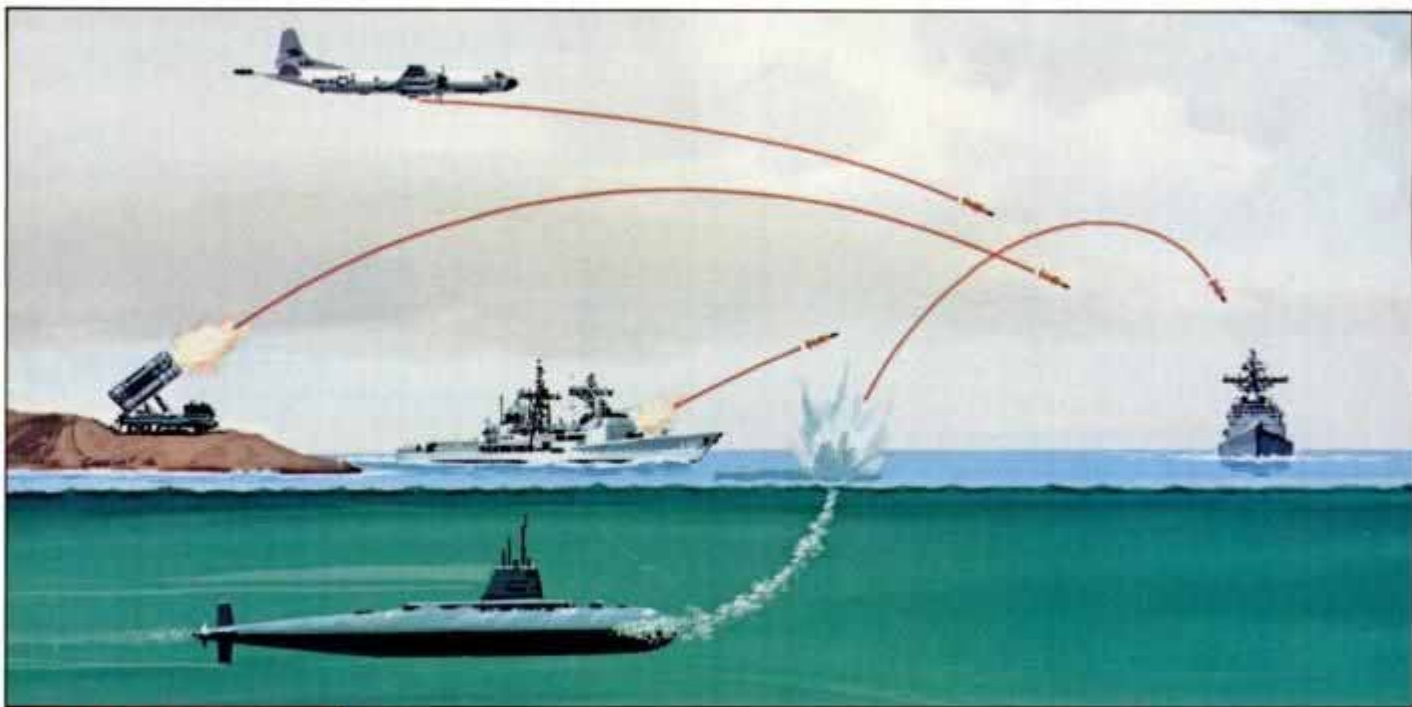
Tiny brain, big mind



We're a step closer to the artificial-intelligence cockpit. McDonnell Douglas has built a powerful new microprocessor for F-18 jets. The processor allows the jet's computers to handle information 80 percent faster than in the past. The MDC281 has a 16-bit, integrated-circuit module specifically designed for the 21st century aircraft.

The microprocessor fits into the palm of your hand and is so good it eliminates eight other avionics data boxes used in early production models of the F-18. This is the memory that monitors fuel supplies, damage to the aircraft, air temperature and other important data. Avionics researchers are looking to a time when all the brains on a highly intelligent jet will take up less space than a personal computer.

TECHNOLOGY UPDATE 4/87



MILITARY

Harpoon is for ships

With delivery earlier this year of the 4000th Harpoon missile, the Defense Department now has the weapon operational in all types of

delivery systems. Originally designed for ship-to-ship combat, the McDonnell Douglas missile is now part of the armaments of subma-

rines, land-launching sites and Naval aircraft. It flies on a solid-propellant booster and packs a 488.5-pound, high-explosive warhead.

Short-range nuke missile

Boeing Aerospace has begun work on the Short-Range Attack Missile (SRAM) II. The missile is to be used by the B-1 bomber. Capable of carrying a nuclear warhead, the SRAM II will be

powered by a Hercules Bacchus rocket. It will carry a Boeing flight-control computer. First tests for the missile are scheduled for 1989. The missile is scheduled for deployment in the 1990s and may become part of the Advanced Technology Bomber (ATB) program.

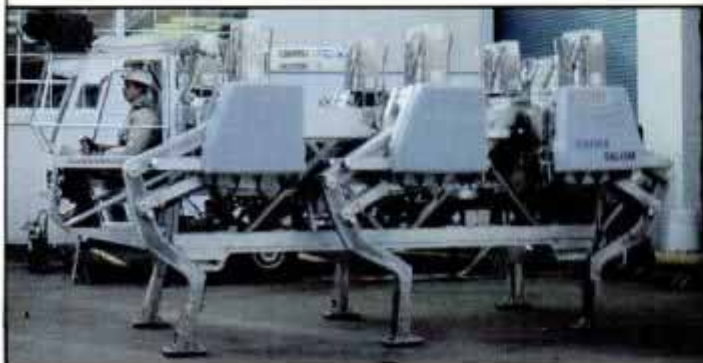


ROBOTICS

Taking a walk the robot way

Ohio State University has demonstrated the first working-model of its Adaptive Suspension Vehicle, a 17-ft. machine designed to walk

rather than roll over rough terrain at speeds up to 8 mph. The 6-legged machine, which can be remotely controlled and functioned as a robot, can also be manned by a crew of six. With a crew, the driver can operate it with a joy stick connected to the motorized legs.



Guidance rates high

A Standard sea missile has been fired with new guidance systems designed for a variety of combat situations. Designed for the Harpoon missile, the guidance system is covered with a coated plastic radome containing solid-state radar. A general-purpose digital computer and other chip-based technologies help the fire-and-forget missile home in on a moving target preselected and programmed into it. The computer lets the missile move with the target. Depending on the launching

platform, any missile using the Navy's missile-guidance system can have a varying trajectory, which means it can be fired over the horizon and follow targets whose altitudes are changing. 



Save Gas, Save Engine with "POLY"

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

The Secret is "Poly"

"Poly" is short for polytetrafluoroethylene (TFE), the slipperiest substance known to man. (1981 Guinness Book of World Records). Petrolon Corporation, makers of Slick 50, invented a way to permanently bind this slippery chemical to your engine with one treatment. Just one quart of Slick 50 can reduce engine friction, increase gas mileage and horsepower and reduce engine operating temperature, causing your oil and engine to last longer. . . plus it reduces metal wear, defraying costly overhauls.

Years of Testing and Use Have Proved It True!

Slick 50 has been thoroughly tested in independent laboratories and out on the road:

The March/April 1982, p. 35 issue of "Consumer Digest" magazine stated, "Slick 50 does reduce engine heat and ordinary wear, and our informal tests indicate that it will improve gas mileage by about 2 or 3 miles per gallon."

One of the country's most respected research institutes reported applying a powerful ultrasonic cleaning process to a Slick 50 treated engine and were surprised at its permanence. "We actually expected the Petrolon Slick 50 TFE Resin coating to also be removed, but later found it was still there."

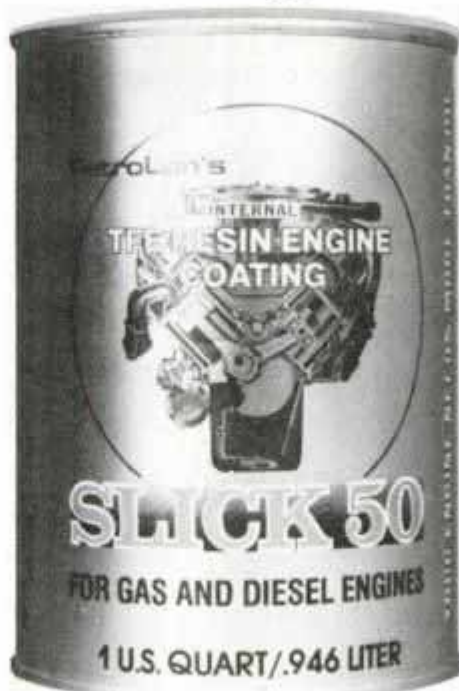
"Dune Buggies & Hot VWs" magazine April 1983 issue records the results of their one year testing of Slick 50. "We can indeed say scientifically that Slick 50 does work, and that it does reduce engine wear! . . . for the price of one treatment when compared to engine rebuild, we feel that you'd be money ahead using Slick 50."

The Federal Aviation Administration has fully accepted a similar product for aircraft—Slick 50 Aircraft Piston Engine Treatment (F.A.R. #33.49). This FAA endurance test simulated 1400 hours of engine use.

The power technology laboratory at a leading southwestern university stated, "Slick 50 does increase horsepower and decreases fuel consumption in tests done at the university."

The Space Shuttle Columbia uses the chemical "poly" in its gears and bearings because it is the only chemical lubricant which can withstand the heat and corrosive elements of space.

Perhaps most dramatic of all is a torture test overseen by the Automotive Services Council for Pennsylvania and shown on WTVE television. Three cars with 75,000 to 129,000 miles on them were treated with Slick 50. Six months later the oil was drained from each vehicle, and the cars driven without the oil plugs for about a half hour. The water temperature never rose and the engines sustained no apparent damage.



There isn't room here to tell you about the dozens of other tests proving that Slick 50 is everything we say. However, if you're still skeptical, send \$2.00 to cover printing and postage costs, and we'll send you detailed test results plus actual letters from users who report how Slick 50 saved their engines and saved them money!

It's Easy to Treat Your Engine

A few minutes before oil and filter change, add the engine flush you get free with each order to clean out the engine. Let the engine idle for 5 minutes. Then drain the oil, change the filter and add the proper amount of oil, less one quart. Add one quart of Slick 50, drive for 30 minutes, and leave it in the crankcase for at least 3,000 miles. As the engine operates, the oil carries the "poly" between the parts where it is burnished into the pores of the metal.

Only One Treatment Necessary

It's permanent, so you do it only once, not each time you change oil. One quart of Slick 50 will treat all standard 4, 6 and 8-cylinder gasoline and diesel engines.

Works with Most Oils

Slick 50 will work with all petroleum-based oils and all synthetics compatible with petroleum-based oils with the exception of graphite oils. However, once an engine is treated, you can go back to a graphite type if desired.

4 Ways Slick 50 Saves You Money

Your actual percentages may vary depending on your driving, vehicle condition, weather and geographic location, but no matter what your conditions, Slick 50 can:

1. Increase mileage
2. Increase horsepower (small economy cars and large RV's really need this)

3. Reduce operating temperatures, thus increasing the lubrication and life of the oil and engine

4. Minimize or eliminate costly overhauls by reducing engine wear

Up to 90% of the engine wear on a car can be caused by lubrication starvation cars experience when first started before the oil begins to circulate. Slick 50 can eliminate this problem for less than the cost of two tanks of gas.

Slick 50 Will Not Affect Your Warranty

Slick 50 is suspended in an excellent grade of petroleum oil which meets or exceeds every manufacturer's engine warranty requirements. In addition, this oil carries an American Petroleum Institute service classification SF-CC-CD.

There's No Risk with Our Money Back Guarantee

Use Slick 50 for 3000 miles. If you don't notice an improvement in engine performance, return your invoice with a short note telling why, for a prompt full refund — no questions asked.

Profit from Selling Slick 50 Yourself

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

For purchase or further information call toll-free 1-800-525-8624, ext. 4 (in California 1-800-233-9559) or send to: Progressive Energy Corporation, 255 South Bent Avenue, #B-1, Dept. PM487, San Marcos, California 92069.

Yes, I want to improve my car's performance and save my engine — rush me risk free

One Slick 50 at \$39.95 + \$4.00 shipping and handling. Calif. Residents add 6% Sales Tax.

Give me free shipping and handling for my order of 2 or more at \$39.95 each.

Check C.O.D. Visa/MasterCard

Card # _____

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PEC
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HOME IMPROVEMENT GUIDE

Flow-through storage

Cage-type ventilated drawers and modular design highlight Closet Maids new ventilated drawer system. Constructed of heavy gauge, epoxy-coated steel wire, the drawers are available in depths of 4, 7 and 10 in., and fit in 17-in.-wide support frames. The

homeowner can buy prepackaged units or customize to suit particular needs. The system also features such options as laminate tops, and casters. Prices start at about \$50. The system is available at department and hardware stores. Contact Clairson International, 720 S.W. 17th St., Ocala, FL 32674.



Concrete cover-up

Here's a product created specifically for concrete that allows the homeowner to color-coordinate patios, walks and driveways. Kemiko Col-R-Tone II stain is designed to be used either straight from the can as a solid coat, or thinned for use as a stain. A gallon costs about \$25 and will cover roughly 300 sq. ft. Col-R-Tone II is available in a wide assortment of colors and produces a matte finish. Apply it over new or old concrete. Previously coated surfaces must be covered with an unthinned solid coat. Kemiko Col-R-Tone II is available direct from the manufacturer. Contact Epmar Corp., Box 3925, Santa Fe Springs, CA 90670.

HOME IMPROVEMENT GUIDE



Stick-on chalkboard

Kids and grownups alike will find the new Con-Tact brand chalkboard a useful addition to the household. It's not only a playtime and teaching tool for preschoolers, but serves as a memo pad for the whole family. The 18-in.-wide rolls contain 2 yds. and sell for about \$2 at home centers. Contact Rubbermaid Specialty Products Inc., Taylorsville Rd., Box 5050, Statesville, NC 28677.

Creative tap

Add some class to your sink and increase utility, too, with the new Casa Kitchen-Mate faucet. This European-inspired design features a unique pull-out spout for wide-ranging applications. The spout extends up to 4 ft. and has a convenient pushbutton control that allows you to switch from stream to spray in either the extended or tucked-away position. The faucet body is constructed of durable solid brass and the pull-out spout is made of translucent brown acrylic mounted on a



flexible brass hose. The Casa Kitchen-Mate faucet is available in traditional chrome finish (\$175) or contemporary Deco-White (\$195). It can be installed with or without the base plate. For details, write to the Moen Group/Standyne, 377 Woodland Ave., Elyria, OH 44036. **PM**



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MITSUBISHI VANS

Mitsubishi's the late-comer in the downsized van market. We think the wait was worth it.

BY MIKE ALLEN
Assistant Auto Editor

Mitsubishi is a late-comer to the downsized van field, the one that Volkswagen invented in the '50s with its Microbus. Lately, everybody has jumped into the market, with an assortment of vehicles. In fact, the distinction between full-sized vans, station wagons and minivans has gotten downright fuzzy. And that's okay, because that means it's possible to fit a vehicle to exactly your own needs and lifestyle. If you'll recall our Minivan comparison test (*A Family Affair*, page 86, Jan. '86), we found that even though all the entries were of roughly similar exterior dimensions, there were substantial differences in interior appointments and driving quality. And Mitsubishi, by dint of waiting until the dust settled, had the advantage of seeing all the mistakes everybody else made. Its new Van/Wagon (the wagon's got side windows) may be one of the better buys in the field for all-around comfort, driveability and utility.

Mitsubishi started with the engine from the Galant, coupled to a 4-speed auto transmission and rear-wheel drive. That means a single-overhead-cam 107-hp 2350-cc Four, with 132 ft.-lb. of torque, the most powerful of the imports. It also has multipoint fuel injection, hydraulic valve adjusters and Mitsubishi's own counter-rotating engine balance shafts. This engine pulls strongly all through the rev range, right up to the redline. If you're in a hurry, you'll do that without wincing at the vibration or noise. And, no, you can't get a manual transmission.

Acceleration is okay, but like any of the vehicles in this class, serious trailer pulling is out. Urban commuting will be easier with the overdrive locked out, tall gearing making freeway-speed acceleration more stately than vigorous. Payload for the Wagon is 1576 pounds, with the Van just under a full ton. The front seats are well to the front, reminiscent of the Vanagon and Toyota. This makes for excellent visibility and good use of interior space, although imparting a certain sense of vulnerability in front-end crashes, which you may find disconcerting. The engine snuggles in between the seats, in an engine bay as cramped as any we've ever seen. Even simple operations like checking the oil requires removing the engine

(Please turn to page 160)



Wagon interior can be arranged just about any way needed by moving, rotating seats. Van gets the usual sheetmetal box.

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MITSUBISHI VANS

(Continued from page 158)

cover, although an indicator light Mitsubishi calls an "electronic dipstick" warns of low oil levels every time the vehicle is started.

One option, the Converter Convenience package, has full instruments, a/c and cruise control, several other high-end options, together with the cheapest vinyl seats and no carpeting. It's aimed at the numerous aftermarket customizers, who often wind up throwing out many perfectly good parts in order to build their recreational vehicles. With one of the larger carrying capacities (in terms of cubic footage) in the field, it's sure to be a big hit with the conversion crowd as well as the commercial market, especially at only \$690 more than the base cargo van's sticker price of \$9839. The base Wagon is \$12,789, and the LS is \$14,289.

The LS Wagon interior includes seats and a table that offer tremendous flexibility as to how they're placed, simply by loosening thumbscrews. Two center seats swivel 360°, as well as slide fore and aft on tracks, permitting a lot of permutations in seating arrangements. Just the thing for a rolling bridge game one day, and taking the trash to the dump the next. The remotely lockable rear door is huge. Because of the short 88-in. wheelbase, the side door doesn't seem to open quite far enough, although it's not a serious problem.

Cockpit appointments are excellent, although the controls are strewn sort of aimlessly around the fascia. Typically Japanese, most of the important stuff is on stalks, reachable without taking your hands from the wheel. The shift handle has a button for locking out the overdrive, and you'll find yourself doing so on anything but the Interstates. Unlike several other minivans, the cockpit door windows roll all the way down, permitting elbow-on-the-window sill, fresh-air motoring in comfort.

But the most amazing thing has got to be the handling. In terms of wheelbase and full-forward seating position, it's reminiscent of the VW—but without the Vanagon's high weirdness quotient. Big, tall breadboxes aren't expected to handle well. With a tall center of gravity and a short 88-in. wheelbase, you'd be happy with anything that'll stay on the road.

Surprise! Take this baby out onto a twisty back road and carve up a couple of corners. Thanks to a thick antiroll bar and stiff springs, it corners as flat and predictably as many "performance" cars. No more hanging onto the window frame to avoid falling off the seat because of body lean. And this handling comes without a ride that turns your

internal organs into jelly. The two rear-most seats, right over the solid rear axle, are a trifle harsh on you, but everybody up forward should have no complaints. Just be careful, because the rear brakes are biased for a laden vehicle. If you aren't carrying a ton of bricks, the rear wheels lock up way too early and stay that way, resisting any attempt to unlock them short of getting off the brake pedal completely and counting to three. This is a perennial problem with any vehicle designed to carry a lot of payload—the center of gravity simply shifts too far. Others have found ways around it, either by a proportioning valve keyed to ride height, or some sort of active antilock brake. So don't surprise yourself.

Standard are 205-14 radials, and optional on the wagon are the attractive alloy wheels shown in our lead photo.

The Mitsubishi is all new—except for the drivetrain—and strikes a pleasant middle ground between something as trucklike as the Astro and a "tall K-car" like the Plymouth/Dodge vans. Some of us like to drive vans that have a tall seating position for good visibility, plenty of cargo/passenger space, and just because they aren't cars. And up until now we had to put up with tippy boxes that rattled, big full-size commercial-rated trucks, and a very limited selection of others in the downsized marketplace. Welcome the Mitsubishi, for it may very well spark off a new second generation of vehicles in this class. **PM**

THE PM REPORT CARD

MITSUBISHI VAN/WAGON	GRADE	COMMENTS
Acceleration	B+	Most hp in class; we're waiting for a 5-speed
Handling	A+	Wow! Flat cornering
Braking	C	Rears lock up early, won't unlock
Steering	B+	Power is a tad overboosted
Transmission	B+	4-speed auto has lockout for OD
Ride	B-	Okay up front, but rear-seat passengers will get a pounding
Fuel economy	B	EPA says 21-22 mph on the highway
Seating	B+	If you don't like the seating arrangement, you can change it
Vision	A	Excellent
Gauges/controls	B	The windows even roll all the way down
Ventilation	B-	Hard to clear up fogged side windows
Noise @ 55 mph	B+	The commercial version is louder, of course
Cargo capacity	B+	Not the biggest, but almost
Engine serviceability	D	Get another elbow in at least one arm
Fit and finish	B+	On a par with contemporary Japanese practice

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The Bluenose II kit, tool package and VHS videotape are worth \$124.85, but now they're yours for the price of the kit alone - only \$69.95! Save almost \$55 by taking advantage of this offer now!

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HOT RUBBER

(Continued from page 85)

eliminate the spare. We drove ours for three days before we discovered one of the eight tires was flat! A porous alloy wheel was cordially replaced by TBS Inc. in Elmsford, New York, probably the world's most knowledgeable and enthusiastic tire store. A car with the JJD system was recently driven coast to coast with four flats to prove that each tire has load capacity to spare.

Winter slush of the right consistency will pack between the tires, creating an out-of-balance condition until you stop

and clear it out. And be prepared to spend time explaining why your car has eight tires. We got stopped by a policeman who was convinced there was something wrong with the car.

JJD tires to fit Corvette, Camaro, Porsche, BMW, Honda, VW, Toyota, Mercedes and Fiero are imported by Global Imports Ltd. of St. Louis. Tires and wheels are available by mail order from Mark Wallach Ltd., 27 New St., Nyack, NY 10960.

Front-drive tires

Some 80 or 90 percent of driving, braking and cornering forces are transmit-

ted through the front tires of a front-drive car, while the rear tires are just along for the ride. And yet no manufacturer has come out with tires specifically designed for the very different needs of the front and rear wheels. Within the next few years, look for front-drive cars with tires that differ in size, width, tread pattern and compounds between front and rear. Don't rotate them!

You should know that the tires supplied as OEM on your new car are often not the same as the seemingly identical replacements for sale in tire stores. Bridgestone's Rick Brennan says that all car companies specify handling, ride and noise characteristics that differ from those that tire engineers prefer. Usually, the tire engineers are more willing to trade-out some noise or harshness for performance, while the car companies are after a more middle-of-the-road tire. The differences are not drastic, but they do exist.

You do pay for this performance. Yokohama A001Rs or BFGoodrich Comp T/As are sold by mail-order tire discounters for under \$70 each, at least for the smallest economy car sizes. By the time you get to V-rated Corvette tires, however, you'll be spending at least \$175 each, discounted. You can easily spend \$1000 for a set of high-performance tires—plus half that much again for the necessary winter tires.

Unfortunately, these big prices only buy you superior performance, not superior wear. Because of the softer compounds used to achieve stickier handling, most high-performance tires last about 25 percent *less* than normal tires. The average lifespan of an ultraperformance tire, driven hard, is in the 15,000- to 25,000-mile range.

"In the next two or three years," says Leo Mehl, "Goodyear will expand into selling complete passenger-car suspension packages: an air-suspension unit, a wheel and a tire—engineered from the ground up." That will surely lead to even higher prices, not to mention more involved discussions between engineers in Detroit and Akron, as they try to agree on the desired ride, handling, noise, fuel economy and tread-life characteristics.

Maybe they won't have to. Fred Kovac talks about not only the Total Suspension, but the Intelligent Tire. He's working on a future tire that contains a sensor that will transmit data to an on-board computer through optic fibers. The sensor will record tire pressures, tread wear, spring rates, friction coefficients, brake antiskid information—even suspension alignment.

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RUN SILENT, RUN DEADLY

(Continued from page 89)

in an underwater dogfight. Even the Arctic Ocean is a potential battleground for SSNs, and the U.S. interest in it was reinforced in May 1986 when three submarines (USS *Archerfish*, *Hawkbill* and *Ray*) rendezvoused at the North Pole.

Underscoring the strategic importance of this Arctic region, Secretary of the Navy John Lehman also visited the North Pole aboard USS *Trepang* in the spring of 1985.

The complexity of nuclear submarines requires highly trained officers and enlisted men to operate them. The late Admiral Hyman G. Rickover, called the "Father of the Nuclear Navy," set up the training program for the nuclear-trained personnel, but his ingenious principles are in use throughout the Navy.

Indoctrination

After completing college and an officer training program, whether Officer Candidate School, Navy Reserve Officer Training Corps or the Naval Academy, the new ensign proceeds to Nuclear Power School, a rigorous 6-month classroom introduction to naval nuclear power. Then comes another six months at one of three Nuclear Prototype Training Units, which are essentially the engineering spaces of a ship or submarine mounted on land. Thus, in a single year, the young officer is taught the theory and practice of operating a naval nuclear reactor.

After an additional three months at the Submarine School in New London, Connecticut, the ensign is ready to report to his first ship—after only 1½ years.

Upon reporting to his first submarine, the young officer begins his training again, this time on the specific systems relating to his ship. Qualifying first as engineering officer of the watch, he learns to take responsibility for the unit that propels the vessel. Next he trains to be an officer of the deck, the captain's direct representative in the control room. These qualifications culminate in the awarding of the coveted gold dolphins insignia which indicate those "qualified in submarines."

The adversary

The Soviets have not ignored the submarine's potential. Avid chess players, Soviet strategists see the underwater vessel as a chessman that remains unseen by the other player until it strikes with devastating power. In little more than 20 years, the USSR has built the world's largest submarine fleet. Their huge shipyards have turned out seven entirely new classes of subs in the past

five years, compared to two U.S. classes in the past decade.

Typhoon, their latest SSBN, is the largest submarine in the world, displacing 25,000 tons. Soviet SSNs are typified by the deadly VICTOR III, and more recently, the AKULA, MIKE and SIERRA classes. Although many U.S. SSNs are capable of launching cruise missiles as a secondary mission, the Soviets have subs specifically designed for the purpose. Called SSGNs, the CHARLIE and OSCAR classes represent this type. Finally, the USSR has a vast inventory of diesel submarines, both because of their lower cost and their quietness.

In general, nuclear vessels must always keep cooling water pumps running, but a diesel/electric sub can shut down all equipment and remain silent—a big advantage in the underwater cat-and-mouse game. The recent advanced-design TANGO and KILO classes demonstrate the continued Soviet interest in this propulsion method.

Diesel/electric attack subs are designated SS, but the Soviets also have SSBs and SSGs, carrying ballistic missiles and guided missiles, respectively.

The first nuclear submarine, the USS *Nautilus*, was a tremendous advancement. Submarine design has improved so much since 1954, when *Nautilus* was launched, that today's subs are as far ahead of the *Nautilus* as she was from the WW II fleet boats.

Extended periods submerged and longer range deployments also meant that improved inertial navigation was needed. The Ship's Inertial Navigation System, or SINS, has progressed rapidly to become a reliable, accurate navigation method. The advent of navigation satellites has provided a means of checking on the performance of SINS. However, to obtain satellite data, the sub must go up to periscope depth, risking detection and limiting its mobility. Fortunately, even when a satellite fix cannot be obtained, the inertial navigation has proved to be very close.

Room to breathe

Pinpoint navigation won't help, however, if the atmosphere on board is unbreathable. With no opening to the outside, the air must be continuously monitored for pollutants and freshened by the atmosphere control system. The monitoring is done by the Central Air Monitoring System, or CAMS, a technological spinoff from the space program. The controlling is done by CO₂ scrubbers to remove carbon dioxide, CO-H₂ burners to remove deadly carbon monoxide and hydrocarbons, and charcoal filters to remove odors. Fresh oxygen is produced by oxygen generators, which splits water into hydrogen and oxygen by electrolysis.

The tactical weapons that modern submarines can carry are potent and varied. All U.S. subs carry the sophisticated, long-range, wire-guided Mk. 48 torpedo. Many subs are capable of launching SUBROC, a rocket-propelled nuclear depth bomb. Over-the-horizon cruise missiles are represented by Harpoon and Tomahawk, the latter available in both ship-attack and land-attack versions. Submarines are ideal for covert minelaying, and SSNs can carry many types of mines. Lastly, the Mobile Submarine Simulator, though not a weapon, is a programmable acoustic decoy which is launched from a torpedo tube.

To solve the complex computations necessary to launch a weapon in the right direction at the right target, a Fire Control System is used. Progress in this area has led from the old mechanical analog systems, with gears and handcranks, to modern digital computers, like the Mark 117 and 118 systems. The capability to integrate over-the-horizon targeting is provided by new Combat Control System Mark 1.

Perhaps the most rapidly advancing submarine technology is in the field of sonar. Few other forms of energy travel well in water, so the quieting of ship's noises and the ability to hear other ships at long range are prime considerations. In general, active sonar—emitting a sound and waiting for the return echo—is less useful than passive sonar, which involves listening for contacts. An active "ping" gives away a sub's location, and may be detected by the enemy at over twice the range that the pinging ship will hear the return echo.

Advances have been made in the hydrophone arrays, like the towed array, which the sub streams behind it to separate the hydrophones from propulsion noise. Signal processing has also improved, and today's sonar men watch computer-generated video displays on the BQQ-5 and BQQ-6 sonar systems.

Nuke-powered subs

Nuclear reactor improvements have also been incorporated into the newer classes. The results include greater shaft horsepower and equipment that is easier to operate and maintain. The Navy nuclear propulsion plants continue to have an admirable safety record with more than 3000 ship-years of accident-free operations.

The complexity, cost and potential hazards associated with nuclear power have led some to suggest that the U.S. Navy should supplement its current all-nuclear submarine fleet with diesel/electric subs, or build diesel boats in its shipyards for export to foreign nations. Studies indicate that such vessels are not cost-effective in carrying out the

(Please turn to page 170)

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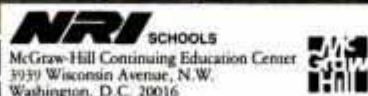
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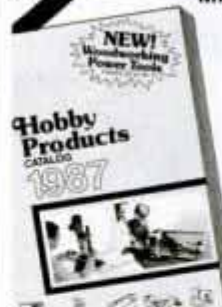
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RUN SILENT, RUN DEADLY

(Continued from page 165)

current U.S. global maritime strategy. Diesel subs suffer from slow speeds, short range, limited underwater endurance and high noise levels when snorkeling—obtaining air through a tube for running the diesel engines to recharge batteries. Because of these problems, they have difficulty going great distances rapidly, without being detected.

The nuclear sub, however, remains covert during its entire mission, travels quickly and silently, and runs for years between refuelings.

SSN-21, the SSN of the 21st century, is already well into the design stage. The first ship, at \$1.6 billion, will be called SEAWOLF, signaling a return to naming submarines after sea creatures. This multimission vessel will include many innovations. The hull shape will be more blimplike than previous designs, yielding more interior space without sacrificing speed. Retractable bow planes will minimize drag.

The great strides made in the area of sound silencing will be reflected in the SEAWOLF class, making the ship considerably quieter than the LOS ANGELES SSNs. The sonar system will fea-

ture a passive conformal (fitting to the shape of the hull) array which will deliver information to an advanced combat control system designed to integrate data from all sensors. The ship will have eight large-diameter torpedo tubes, twice as many as other U.S. nuclear subs, and will hold double the normal weapons load. Finally, a stronger hull material will enable deeper dives. Many of these innovations are to be tested on LOS ANGELES-class subs now under construction.

There are exciting possibilities in the future of military submarines. In the field of communication, one of these has already come to pass—ELF, or Extremely Low Frequency radio signals, which transmit easily through deep water. Future communication possibilities may include the use of blue-green lasers, which penetrate the ocean to significant depths, and neutrinos, which pass through any substance.

Undersea mechanization

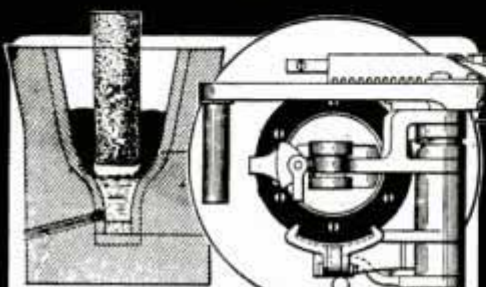
The extensive training required of submarine crews and the large percentage of ship volume used by the crew has led some to consider robot submarines. Miniaturization technology and artificial intelligence research have progressed to the point of making robot subs possible. Advantages include lower cost, and zero cost in lives if the robot is destroyed. Disadvantages revolve around reliability. Can we trust an important mission to a machine?

Perhaps, initially, they would only be used for very specialized tasks. Reportedly, robot subs were used by the British during the Falkland Islands War for locating and detonating mines. One design is for a Small Mobile Sensor Platform to use on-board sonar to search for hostile submarines and report back to the manned mother sub.

If the idea of unmanned nuclear-powered submarines seems too far-fetched, perhaps the submarine crew could be reduced in number rather than eliminated. To this end, automation techniques for the torpedo room and other areas are being studied. The Soviet ALFA-class SSN already incorporates automation to a great extent.

Although submarines have progressed remarkably since the first nuclear sub, *Nautilus*, there are still many exciting developments in store. For those now entering the Navy's Submarine Service, there is much to learn, and a lot of hard work to do, but also exciting opportunities. There are a wealth of submarine museums in the U.S. for those interested in these vessels and their history. For example, the USS *Nautilus* is now decommissioned and has returned home where she is on display at the submarine museum in Groton, Connecticut. **PM**

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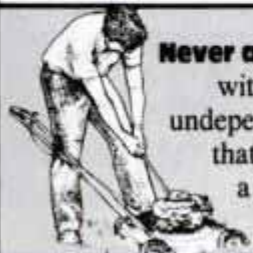


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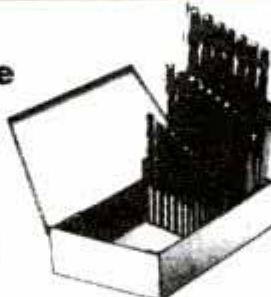
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SMOOTH THAT ROUGH IDLE

There are a lot of little car problems or malfunctions that you can learn to live with. There are others, however, that make driving unpleasant and sometimes lead to more expensive failures if ignored. One of

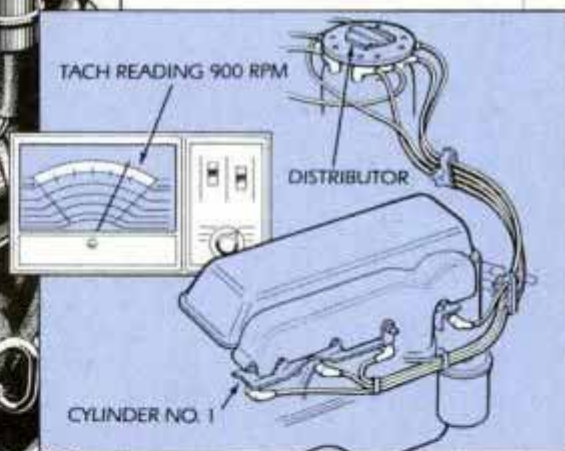
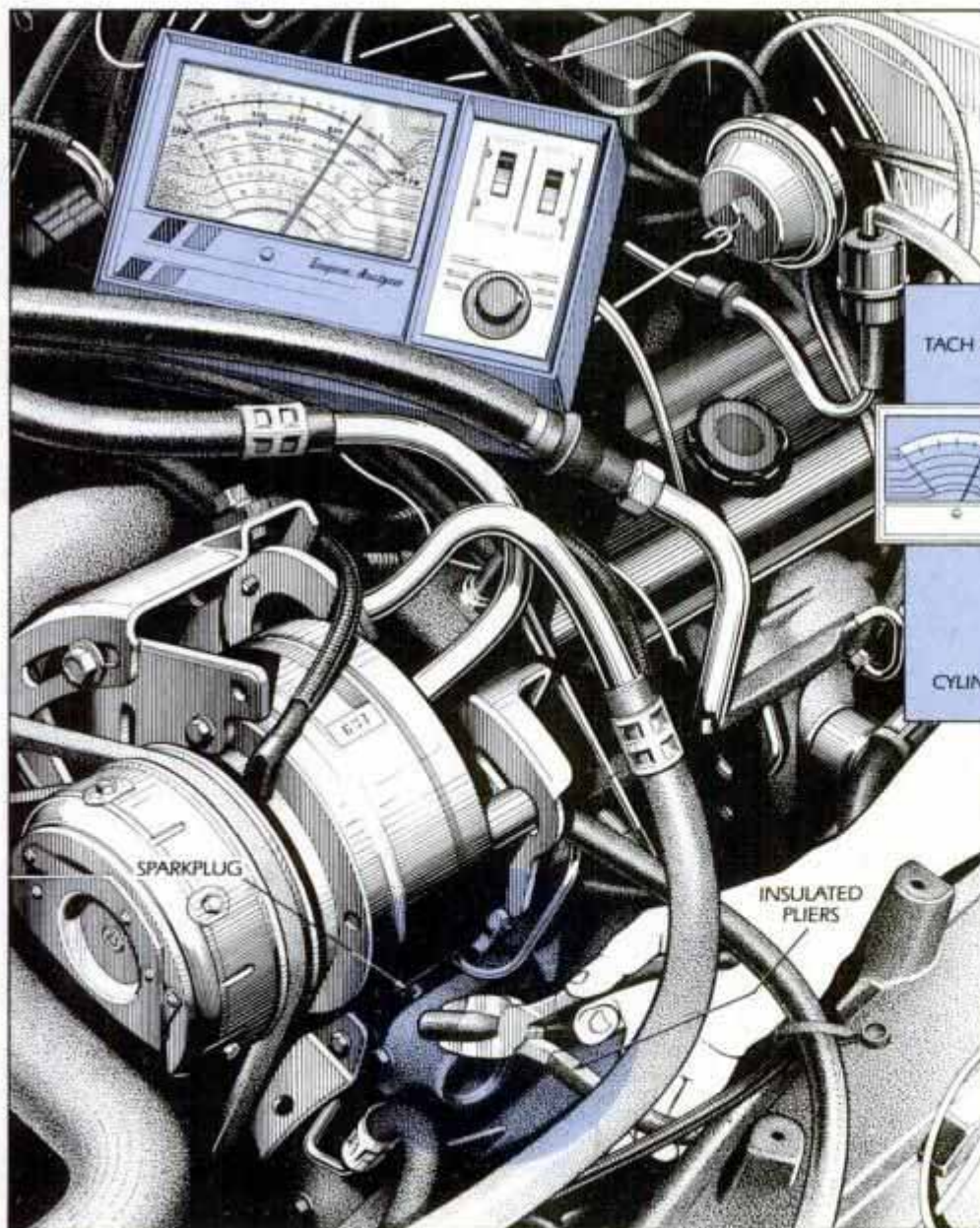
BY PAUL STENQUIST

these is a rough idle. In its most benign form, a rough idle may be nothing more than a slight vibration and spitting from the exhaust. More severe cases may

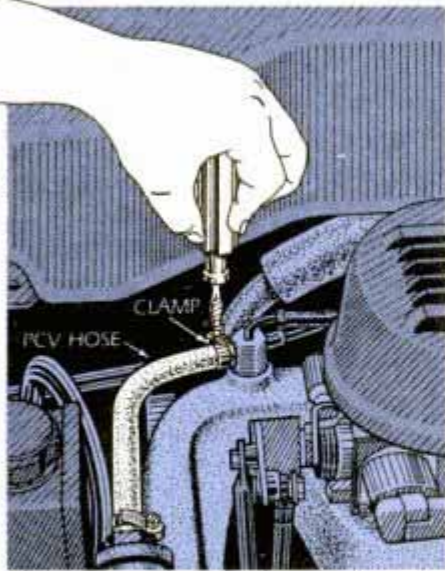
shake the vehicle so hard that other parts threaten to rattle off. Eventually the hydrocarbon-laden exhaust will ruin the catalytic converter and O₂ sensor.

What's going on?

When an engine idles roughly it's because one or more cylinders are running out of sequence, inefficiently or are completely dead. If the misfire clears up above idle, you can usually rule out internal engine problems right away. An engine may seem to run okay at



Cylinder balance test can pinpoint a problem cylinder. Remove and ground plug wires sequentially to see which cylinder isn't firing. But be careful and use insulated pliers to avoid a very high-voltage surprise. Rpm won't drop when you've found the bad one.



1 Secure larger hoses with screw clamps to cure misfire from vacuum leaks. Tighten until rubber extrudes through clamp.

high rpm even with a misfire because the increased speed masks the roughness. Before attempting any diagnosis, make sure timing and idle speed are adjusted to spec. Then check to see that the choke (if any) closes when the engine is cold and opens when the engine is warm.

Engine control system

Most cars produced since 1981 have a computerized engine control system. The computer will record trouble codes when engine operating faults occur. Some manufacturers, including Ford and Chrysler, suggest that the computer system troubleshooting routines should be performed after conventional diagnosis. GM instructs its mechanics to check for computer-system trouble codes and carry out the indicated diagnostic operations prior to conventional troubleshooting. You'll find detailed instructions for diagnosing GM, Ford and Chrysler computer systems in past issues of *POPULAR MECHANICS*, or your factory service manual.

The most important thing to remember in respect to computerized engines is that conventional troubleshooting and computer-system diagnosis are interrelated. In other words, a fault such as a vacuum leak can be uncovered through normal diagnostic routines yet it might set a trouble code in the computer's memory.

Vacuum leaks

Sometimes a rough idle can be cured with a visual inspection. This is particularly true if the engine has just been worked on, as it's easy to leave a hose

disconnected or mix up the engine's firing order.

To check vacuum hose connections, find the vacuum hose diagram for your car, probably in the engine compartment somewhere, frequently on the Vehicle Emission Control Information Label. Make sure all hoses are connected as indicated on the diagram. Make sure they fit tightly on their respective pipes. If not, replace them or, if they're larger hoses like those used for power brakes and are in good condition, secure them with screw-type hose clamps (Fig. 1). Visually check every hose for kinks or splitting.

Once you're sure all the vacuum hoses are in good shape and properly connected, have the engine running at idle and squeeze each hose closed near the point where it connects to its vacuum source (Fig. 2).

If the idle smooths out when you squeeze off the hose, either the hose itself is leaking or the component it's connected to is defective.

When you're certain that the vacuum hoses and the components they're attached to are not causing the rough idle, check the intake manifold gaskets by spraying nonflammable solvent on them while the engine is running. If the idle smooths out, the manifold gaskets are leaking and you'll have to remove the manifold to replace them. While the intake manifold is off, check it for cracks or warpage.

Check the bolts that hold the carb or throttle body onto the intake manifold (Fig. 3). These bolts frequently come loose and can cause a rough or erratic idle. Check the carb base or throttle-body gasket by spraying nonflammable solvent on it like you did for the intake manifold.

Most cars produced since 1975 have exhaust gas recirculation valves (EGR). If the valve sticks open at idle or if an improper hose connection causes vacuum to be applied to it at idle, it will make the engine run rough. To check, warm the engine fully, disconnect the vacuum hose to the valve, and plug the hose. If this clears up the idle, the hose is improperly connected or there is a fault in the valve's vacuum control system.

If disconnecting and plugging the EGR vacuum supply doesn't clear up the idle, remove the EGR valve and cut out a piece of cardboard to the same shape as the base of the valve. Cut holes for the bolts but not for the valve's ports. Grease both sides of the cardboard and reattach the valve to the engine with the cardboard under it, blocking the exhaust and intake pas-

sages. With the valve's vacuum hose disconnected and plugged, start the engine. If the idle is now smooth, the valve is defective and must be replaced. If the idle is still rough, the valve is not at fault. Unbolt the EGR valve, remove the cardboard and reinstall the valve with a new gasket.

Ignition wire routing and condition

A check of ignition wire routing is next. Determine the firing order for your engine and make sure all the plug wires are connected properly.

The firing order for most engines is stamped on the intake manifold, or you should check the shop manual. On late-model GM engines, it's marked on the plug wire retaining ring.



2 Squeezing off vacuum lines with pliers can isolate a suspect component. Use smooth-jawed pliers or cover with rag.

On GM and Chrysler V8s, cylinder No. 1 is farthest forward on the left bank of the engine. Left bank means the left side as you would see it from the driver's position. The other cylinders on the left bank are 3, 5 and 7. On the right bank are 2, 4, 6 and 8.

On Ford V8 engines, cylinders 1, 2, 3 and 4 are on the right bank; 5, 6, 7 and 8 are on the left bank. The same two numbering systems apply to the various makers' V6 engines. In-line 6- and 4-cylinder engines are simply numbered front to rear.

To check firing order, simply take the first number in the order, usually 1, and trace that wire back from the corresponding sparkplug to the distributor cap. Then, moving around the distributor cap in the direction of distributor rotation, check to see that each wire is connected to the proper sparkplug. If you don't know the direction of distributor rotation, remove the cap and bump the engine with the starter to see which way the distributor shaft rotates.

For example, if you were checking plug wire connections on a Chevy V8,

you'd find that the firing order is 1,8,4,3,6,5,7,2. The rotation is clockwise, and No. 1 cylinder is front, left bank. So you'd trace the wire from the front, left bank cylinder back to the distributor cap. Then you'd locate the next wire on the cap in a clockwise direction and make sure it was attached to the sparkplug for the No. 8 cylinder, the last one on the right bank.

As you check, examine each wire for cracks, hardness or splits. Make sure that the wires are securely connected and that the terminals are free of corrosion. Sometimes you can detect bad wires by watching the engine idle at night, as you'll see blue sparks where the current arcs to ground. If you're not sure about the condition of the wires and if they're several years old, replace them. For high-voltage ignition, like GM HEI or Ford EEC IV, use the same 8-mm silicone-jacketed wires that the car was originally equipped with.

While silicone-jacketed wires are much more expensive than conventional types, they also offer much better insulation and will last much longer. The silicone-jacket wires are available in 7-mm size for conventional ignition systems. On cars with computer systems or radios, make sure you get carbon-core, TVRS-type wire.

Cylinder balance test

If the visual or computer system tests don't uncover the cause of the rough idle, a cylinder balance test can determine which cylinders are misfiring.

You'll need a tachometer and a pair of pliers with insulated handles. Remove the air cleaner and plug the vacuum line or lines that are joined to it. Connect the tachometer and unplug the idle speed control motor, if there is one (most computerized systems have this).

Then, while watching the tach, pull the plug wire off the No. 1 cylinder's sparkplug and hold the wire terminal next to the cylinder head so it can arc to ground. Note how much the engine speed drops when you remove the wire (see lead illustration). Continue in the same way, checking each cylinder for rpm drop.

If the engine speed doesn't drop on one or more of the tested cylinders, or if it drops much less than it did on the others, the cylinder is probably not running or it's running very poorly (see chart, Fig. 5).

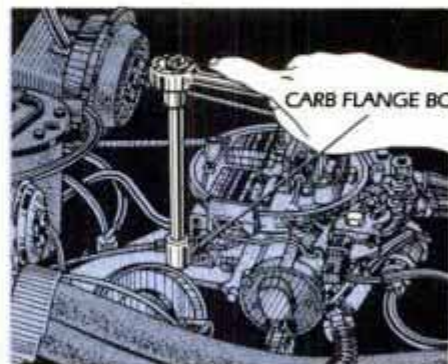
If you don't see the spark arc to ground when the wire of a dead cylinder is removed, attach the wire terminal firmly to the end of a screwdriver with the shaft close to a clean metal ground while an assistant starts the engine.

For cars with high-energy ignition, use a spark tester instead of the screwdriver to prevent shock. Spark testers are available from GM dealers (ask for the ST 125 tester) or from most auto parts stores.

The wire attaches to one end of the tester and the other end has a clamp that you attach to ground before starting the engine. In either case, you

should see spark when the engine is running. If you don't, the wire or the distributor cap is defective.

Replacing both the cap and wires is an almost certain cure if you're not getting spark at one or two wire ends, but you can check individual wires with an ohmmeter if you wish. Connect the



3 Loose carb or throttle-body base bolts can be a source of vacuum leaks. Chase leaks with nonflammable spray solvent.

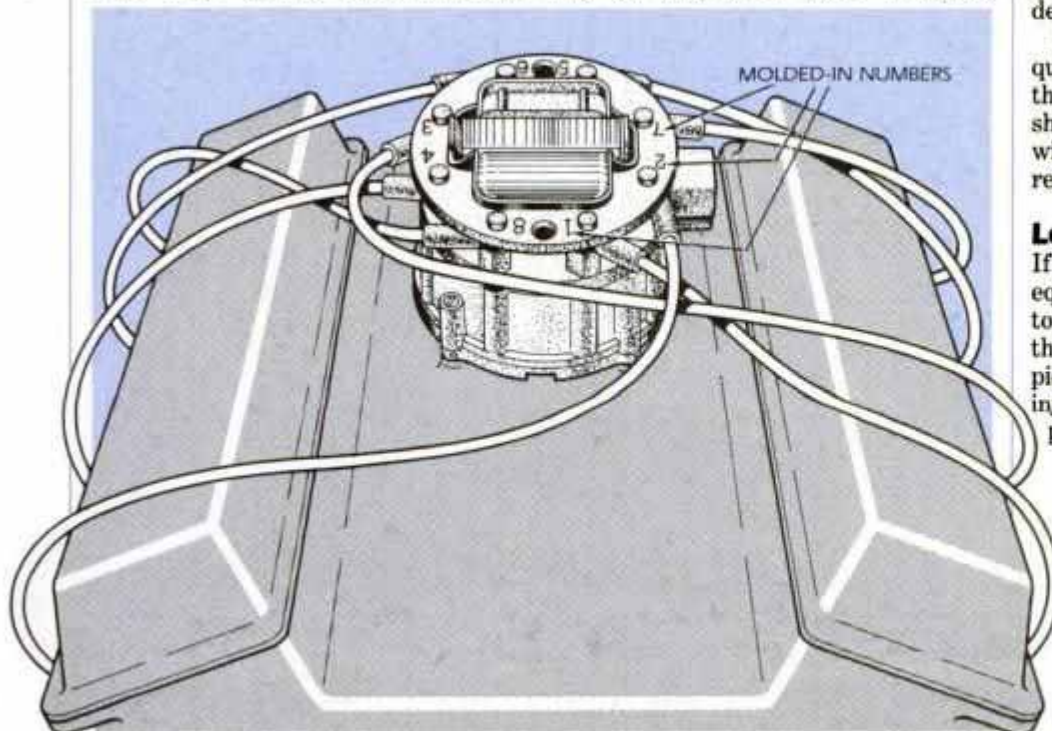
meter leads to each end of the wire. Resistance should be less than 30,000 ohms for most applications (Fig. 6). If you're not sure about the condition of a wire, compare its resistance reading to a known good wire. Examine the cap for cracks or corrosion. Replace it if you're not certain of its condition.

If you do see spark but the cylinder failed the balance test, either the plug is bad, there's an intake manifold vacuum leak that you missed, an internal engine problem is affecting that cylinder, or the cylinder is not getting fuel.

Remove the plug for the cylinder in question. If it really wasn't running and the cylinder was getting fuel, the plug should be black and wet. Replace it with a good plug, start the engine and repeat the balance test.

Lean misfire

If the plug is okay and your car is equipped with port fuel injection, listen to the injector for the weak cylinder as the engine idles. Use a stethoscope or a piece of hose. You should hear the injector open and close rapidly. Compare its sound to that of the other injectors. If it doesn't open and close, turn off the engine, unplug the injector and connect a test light to the harness connector. Crank the engine; the light should flash on and off. If it does, the injector is bad. If it doesn't, there's a problem in the wiring or in the engine computer system. Repair as necessary or repeat the computer system diagnostics. If the light does flash, the injector is probably just dirty. In



4 Connect plug wires according to sequence on distributor cap and intake manifold.

many cases if one injector is dirty, the others are as well. This may be evidenced by numerous cylinders showing marginal rpm drops on the power balance test.

Sometimes dirty injectors can be cleaned by adding a can of injector cleaner to the fuel tank. One such product, which seems to be more powerful than most others, is available through Chevron filling stations. At about \$8 a can, it is also considerably more expensive than other injector cleaners.

Some manufacturers of port-injected vehicles recommend the Chevron product and supply it through their parts department. Remember, however, that there is always some danger in using any high-powered solvent in that it could cause deterioration of fuel-system parts on some vehicles. All owners of injected cars, both throttle body and port, should use fuel that includes a detergent.

On carbureted or throttle-body injected cars, it's not likely that one cylinder could be totally fuel-starved unless there's an internal engine problem. However, the engine can idle roughly due to intermittent lean misfire on all or some cylinders. On V6 or V8 engines with dual-plane intake manifolds, you may sometimes find the misfire and poor power balance readings on one bank only. This means that the idle circuit on the side of the carburetor that feeds that bank or the injector on that side of the throttle body is clogged, or misadjusted.

Checking the valve train

If a valve for a particular cylinder doesn't open or close, the cylinder won't run. To check valve-train parts, remove the valve cover on the side of the engine with the dead cylinder. Check the two pushrods, rocker arms and valve springs for that cylinder. Look

for bent pushrods, broken rockers, broken valve springs, misadjusted rockers or—on engines with ball-and-socket rockers like the Chevy V8—a rocker stud may have pulled out of the head. A stuck valve is fairly common on engines that have been in storage for a considerable amount of time.

If you find a broken spring, you can pressurize the cylinder with a spark-plug hole air-hose adapter and an air compressor. This will prevent the valve from falling into the engine when the spring is removed.

Then use one of the widely available "on engine" valve-spring compressors to remove the spring and replace it with a new one. You may need to hold the engine in position with a wrench on the front pulley when you pressurize the cylinder.

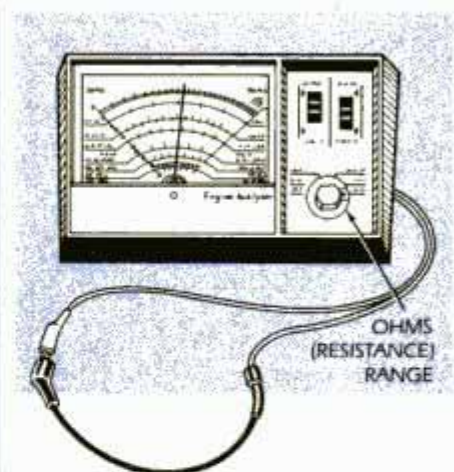
A stuck valve can usually be freed up by squirting penetrating oil on the guide and then pushing on the valve. Sometimes a few taps with a plastic or brass mallet, square on the end of the valve stem, may be necessary to loosen the stuck valve.

Bent pushrods are easy to replace on most engines. If the pushrod is damaged, check the rocker arm carefully for galling or burrs, and shine a flashlight down into the camshaft valley to make sure the lifter is secure and hasn't hopped out of its bore.

If you don't see any signs of valve-train damage, rotate the engine with a wrench on the front pulley and watch both valves for the offending cylinder to make sure they open and close. If one or both don't open, either the camshaft has been worn flat, the rocker arm adjustment is backed off, or—with ball-and-socket rockers like those on a Chevy V8—the stud may have pulled out. If the stud has pulled part way out, remove it by removing the rocker arm and stacking washers on the stud until

you have just enough room to screw on the nut. Then run the nut down, raising the stud. If you get to the end of the stud's threads before it's out of the head, add more washers. Install a new stud using an anaerobic stud and bearing retainer compound.

Put a nut on the end of the stud and tap it in carefully. Don't start the engine for at least 24 hours.



6 Check the resistance of the sparkplug wires with an ohmmeter. Resistance should be no more than 30 Kohms.

If the camshaft is flat, you're in for a major repair job. Consult your shop manual for instructions on removing and replacing the cam. You can be sure that you'll have to remove the radiator and grill. And remember, all those metal filings from the old cam are in the engine. You might end up spinning a bearing or wiping out the new cam. A complete engine rebuild is best. If you don't want to go that far, at least pull the oil pan and clean it. Then flush the engine's valley with solvent before installing the new cam. While you've got the pan off, you ought to have a look at the bearings and oil pump.

Other internal problems

If the valve train checks out okay, the cause of the misfire is probably a compression leak, either a bad head gasket, a burned valve or extremely bad rings. Check compression with a compression gauge and compare it to other cylinders. If down more than 30 percent, it could cause a rough idle.

Pressurize the cylinder with a spark-plug hole air-hose adapter and a compressor. Then listen for the air leak. If the culprit is an exhaust valve, you'll hear it in the exhaust pipe. If it's an intake valve, you'll hear air rushing out the throttle. If it's the rings or a broken piston, you should hear air through the oil filler hole. You'll hear at least some sound of air rushing in all these places; you have to compare them to see which is the real source. A bad head gasket will usually produce air bubbles in the cooling system. Remove the thermostat housing to check for them.

For specific information on giving your car a valve job, see *Saturday Mechanic* in the March '87 issue of *POPULAR MECHANICS* (page 145). **FM**

CYLINDER	ENGINE RPM PLUG WIRE ON	ENGINE RPM PLUG WIRE OFF	CONCLUSION
1	900	825	OK
2	900	835	OK
3	900	900	NOT RUNNING
4	900	840	OK
5	900	890	VERY WEAK
6	900	830	OK
7	900	820	OK
8	900	835	OK

5 Cylinders should show similar rpm drop when wires are off.

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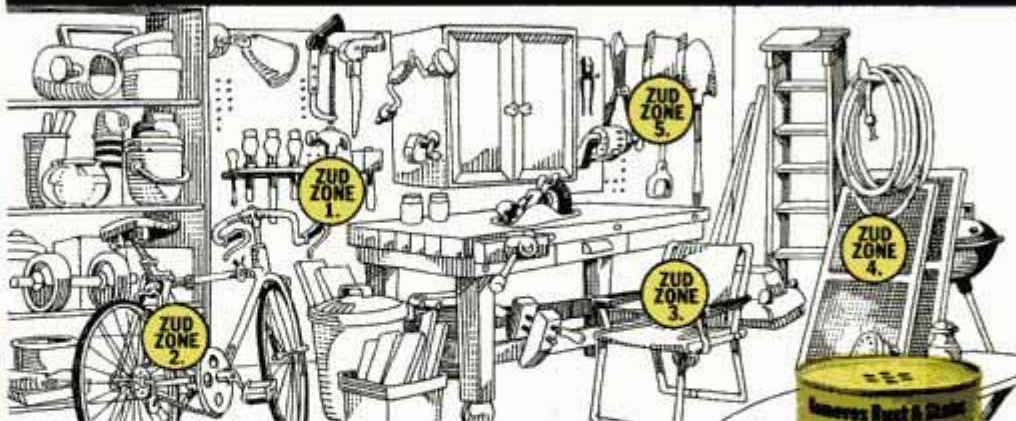
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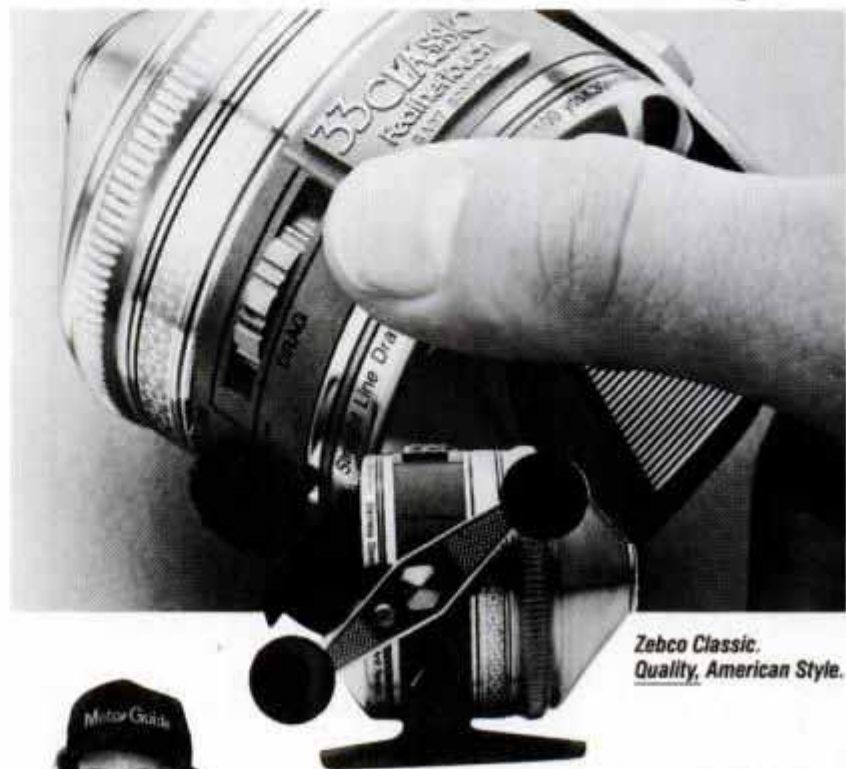
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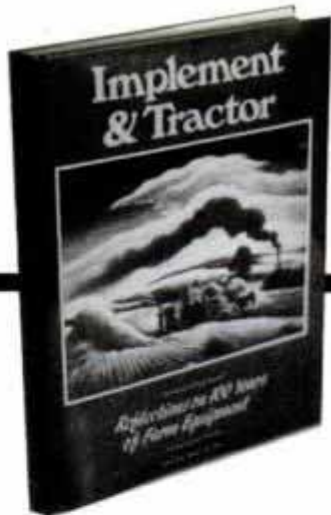
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TIME MACHINE

75 YEARS AGO: April 1912



Seeking electricity in the sky.

'Electric Niagaras'

The world was generating large amounts of electric power from running water like Niagara Falls in 1912 when the French Academy of Sciences got an idea. Suppose the lightning generated in the frequent hail storms of Paris could be tapped for down-to-earth use. Teams of scientists climbed to the top of the Eiffel Tower with rigs that were part lightning rod and part transformer, hoping to draw electric current from hail clouds in the hours just before a storm. Paris never did adapt the method.

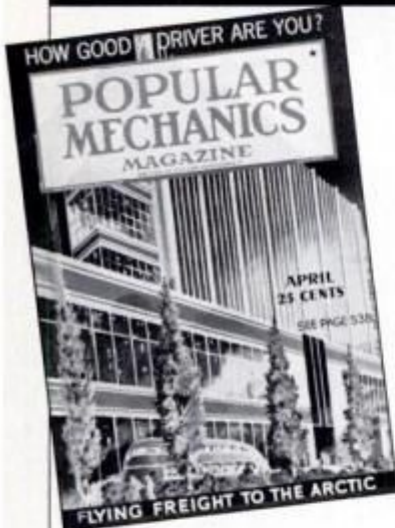


Sailing with extra steam power

The motorized ocean liner was a drawing board item in 1912. But the first big breakthrough was expected with the launching of the 5000-ton *Jutlandia*, designed for passenger and freight service between Europe and Southeast Asia. She was driven by

two 8-cylinder internal-combustion engines powered by crude oil and rated at a combined 3000 hp. Exhaust from the engine room was piped up through the backup mast. Passenger accommodations included amenities not possible on steamships.

50 YEARS AGO: April 1937



Buildings made of wood.

Wood is good

In the metal and granite era of post-depression construction, wood had taken a back seat. But PM's cover depicted a large laboratory designed to be built of new high-tech wood. Among the breakthroughs were fire-retardant chemicals that could impregnate construction wood. Also, new curing methods reversed the old process. By soaking green wood in brine, experimenters were able to dry from the inside out. It made fewer cracks and splits in structural wood, suitable for large buildings.

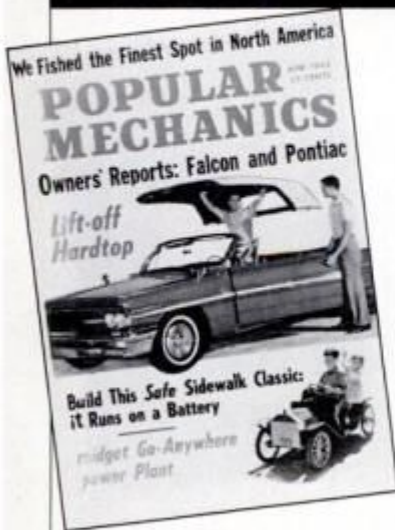


Indianapolis racers drive at 135 mph

It was getting hotter on the bricks as drivers prepared for Indy. Louie Meyer said drivers in 1937 would have to make an average speed of 115 mph with speeds of up to 135 in the straightaway. "The best way to win a race,"

he said, "is to guess as closely as you can what the speed of the winner will have to be and drive at that speed consistently." The other goal was to break ahead of the pack early and make it an endurance contest.

25 YEARS AGO: April 1962



Roof is for convertibles.

Instant hardtop

Convertible owners could now give their cars a dual personality. LeMans of San Diego engineered a lightweight, fiberglass hardtop that turned full-sized convertibles into snug, closed cars. Everything was snap-on. No drilling or modification was required to lift the 80-pound roof into place. The limousine-style rear window was made of laminated safety glass. It listed for about \$400 and was designed for Chevrolets, Pontiacs, Buicks, Oldsmobiles and Cadillac full-sized convertibles.



Short-hop chopper debut

Rotodyne helicopters started producing a new class of chopper: the commuter. It had seating for 28 people. The twin-rotor vehicle was designed for takeoffs and

landings on small taxiways. But it could float in the water, a feature more for safety than utility. It could go from New York to Washington in 1 hour, 27 minutes. **PM**

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C O R

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