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av. per cigarette, FTC Report Feb '85

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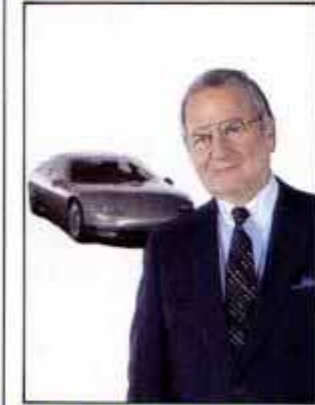
58 Super home video



65 Saw blades



50 Dirt boats



## 45 COVER STORY

The business of divining the automotive future has become a much more exact science than in the past. Here's an industry overview presented by some of the men who will give shape to the ongoing dream of that just-over-the-horizon Car of the Future.  
—PM photo by Guy Morrison



54 Fail safe '88

## SPECIAL REPORT: IMPORTS '88

**73 Cover**  
**74 A Wider World Of Choices**  
With close to 200 different model lines to choose from, it's a Buyer's Market. We cover all the new models, all the changes and add a complete price list.

### All The New Convertibles!



Mazda RX-7 rotary-engine ragtop

## AUTOMOBILES

**45 Car Of The Future**  
Modern automotive transportation has captured our collective imagination. And these interviews with Detroit's automakers will set the stage for a series of stories describing the car you'll drive in the year 2001.

**113 Saturday Mechanic**  
The automatic choke system on your carbureted engine is easier to reach for maintenance and repair than you might think.

## AVIATION

**54 Fail Safe '88**  
Science/Technology/Aerospace Editor Tim Cole finds out firsthand how well America's newest bomber, the swing-wing B-1B, performs its mission.

## ELECTRONICS

**58 Super Home Video**  
The latest super VCRs and TVs surpass today's broadcast standards—and set tomorrow's pace.

**42 And The Winner Is . . .**  
Reader Lawrence Jedlicka wins our Sansui Super-Compo Contest with an illuminating answer—infrared light.

## SCIENCE/TECHNOLOGY

**62 Ice Divers**  
Risk is the reward for a small band of wintertime scuba devotees who cut through the ice to experience the ultimate, death-defying adventure.

## OUTDOORS

**50 Dirt Boats**  
Skimming over the desert floor, wind-powered landsailers break the 100-mph barrier.

## HOME/SHOP

**65 Saw Blades**  
Check out our comprehensive guide to today's best saw blades.

**69 Band Saw Basics**  
A craftsman's guide to using the band saw—your shop's most versatile saw.

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# FORD RANGER...FUN WITH ALL THE TRIMMINGS.

**GEAR UP FOR FUN AND VALUE IN THE '88 FORD RANGER. THE XLT SPECIAL VALUE PACKAGE DELIVERS THE FUN WITH FUEL INJECTION, AM/FM STEREO CASSETTE, POWER STEERING... AND MORE!**

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## **PEAK PERFORMANCE.**

For real spunk and spirit, Ford packed EFI Power into Ranger XLT. You'll have the world at your feet with the quick response and smooth performance of XLT's multiple-port electronic fuel injection. Just one more







Buckle up—Together we can save lives.

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**RANGER PAYLOADS**

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\*Ask your Ford Dealer for copies of these limited warranties.

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**FORD RANGER**

BUILT FUN TOUGH



# EDITOR'S NOTES

# Popular Mechanics

**M**OOON Mullins, the PR man from Chrysler, told us we'd have 10 minutes. That would be it. A date was set to shoot the photo six weeks down the road. The day before the shoot, Graphics Director Bryan Canniff, Auto Editor Tony Swan and photographer Guy Morrison were in Detroit, or more specifically, Highland Park, Michigan, setting up the shot. Chrysler's latest dream car, the Portofino, was rolled into the eerily lit Styling Dome across from the main headquarters building. The round room, odd lighting, photographer's equipment and the futuristic car gave the whole scene a surrealistic quality. It took almost the whole day to set up the lighting to get just the right reflections and highlights Canniff wanted. Canniff, Swan and Morrison were back in the Dome at 6:30 a.m. the next day to make final checks. At precisely the time promised six weeks before, Lee Iacocca, Chairman of the Board of Chrysler Corp., strode into the room, shook hands and went to work. For 10 minutes, Morrison blasted away with the cameras, Canniff and Swan moving Iacocca from pose to pose. The Chairman was totally cooperative, in good spirits and seemed to enjoy his time in front of the camera. He is an imposing presence in a room—tall, taller than you'd think from his TV commercials; always impeccable right down to the tie bar; and, well, imposing. When precisely 10 minutes were up, he thanked everyone, shook hands and was gone. And we had this month's cover. . . . **Speaking of the cover**, our cover story starting on page 45 is the first of an important new series, "The Car Of The Future." The fact is, all the technology you'll find in cars five to 10 years from now exists today. It's already here. It just isn't all perfected yet, and all of it hasn't been packaged into one vehicle. So in the next six months, we're going to tell you, system by system, component by component, what your 2001 car will be like. Hope you'll be along for the ride. . . . **Our Science/Technology/Aerospace Editor**, Tim Cole, went for a ride of a different kind recently—in the controversial B-1B bomber. Taking off from Dyess Air Force Base in Abilene, Texas, Cole participated in a mock attack run, then refueled in mid-air before returning to base. All to find out how the new technology B-1B is performing on-line and how the crews like the plane. As Cole explains in his report starting on page 54, the B-1B is more than just an aircraft: "It's a whole weapons system that makes the old B-52 system it replaces seem like something from the dinosaur age." . . . **Television is such a pervading influence** in our society, that every new advance in home video technology touches all of us. Such an advance is

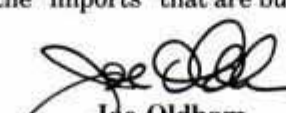


Chairman of the Board.

the development of Super VCRs and the monitors that go with them. "The color and the clarity are simply unbelievable," says Electronics Editor Steve Booth. Contributing Editor Jim Meigs' full report starts on page 58. Read it, then see it. . . . **With imported cars taking about one in every three new car sales nationwide**, and one in every two in California, more and more readers are looking forward to our annual new-model imported car report. So we moved it up one month this year (page 73) and increased our coverage to give room to the ever-expanding variety of cars that originate outside the U. S. of A. And of course, we included all the "imports" that are built right here in America, too. 'Til next time.



Cole (left) and the B-1B crew.

  
Joe Oldham

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## Instant-on radar: How to defend yourself

Instant-on radar—also called “pulsed” radar—has been a threat for years. However, as radar operators try to defeat radar detectors, instant-on is being used more and more. Understanding how it works is the first step in defending yourself.

### How radar works

In an ordinary radar trap, a radar gun is aimed at oncoming traffic and continuously transmits a beam of radar waves. Although invisible, this beam behaves very much like a spotlight. The effective range for the radar to “see” your car’s speed is less than a half mile for most cars, somewhat longer for trucks.

### How radar detectors work

A radar detector works like a radio tuned to radar frequency. And just like your eyes can see a spotlight before the spotlight’s beam is directly on you, a good detector is sensitive enough to see this radar beam before the radar sees your car. Even over hills and around curves.

### How instant-on radar works

Instant-on radar does not transmit until triggered by the operator, so there is no radar beam to detect as you approach. After you are within its range, the operator triggers the radar. It transmits the radar beam and reads your speed in less than a second, too quickly for most drivers to respond. But there is a defense.

### The best defense...

The only defense against instant-on radar is to identify it before you are within its range. You must detect it when traffic ahead of you is being clocked by instant-on. For this, your detector must reach out for distant radar signals.

You’re looking for weak radar that lasts only a few seconds. Finding even one such “pulse” is cause for alert. Finding a series of them, each stronger than the last, indicates you’re approaching an instant-on trap that’s picking off traffic ahead.

Identifying instant-on radar before you come in range is the only defense today, just as it was ten years ago when we introduced Escort. That’s why Escort and Passport have always had a warning system that tells you everything you need to know about every radar encounter. The strength of the signal, and the length of it, are critically important.

### Nothing but the truth

Our warning system indicates signal strength by both a meter and a smooth variable-rate beeper that pulses like a geiger-counter. The length of the signal is indicated by the duration of the alert. But there’s more to it.

False alarms destroy the reliability of any warning system. If you can’t trust the accuracy of each alert, eventually you’ll ignore a real radar threat. That’s why we’ve added AFR™ circuitry to identify and ignore the K-band signals of the Rashid VRSS, a device used in some trucks that sets off other radar detectors.

### Best in the business

Escort and Passport are the highest performance, most complete radar warning systems available. But don’t take our word for it. In 1987, *Car and Driver*, *Popular Mechanics* and *Roundel* each published independent tests of radar detectors.

And each gave us its highest ratings (for complete copies of the tests, call us toll-free).

### Find out for yourself

We only sell direct to you, and we guarantee your satisfaction. If you’re not entirely satisfied within 30 days, return your purchase. We’ll refund your money and return shipping costs.

To order, just call us toll-free, we’ll be glad to answer any questions. Orders in by 3:00 pm Eastern time go out the same day by UPS, and we pay for shipping, if you’re in a hurry, overnight delivery by Federal Express is only \$10 extra.

Call now and the best defense against instant-on radar can be in your car tomorrow morning.

### Order Today

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## THE WRONG STUFF

Once you understand how instant-on radar works, it’s obvious that being well-informed about the presence of weak radar signals is the only protection available. However, one detector maker hopes you’ll believe otherwise, and based on that they’ve added a so-called “Pulse Protection” feature to one of their detectors.

**What it does.** When this unit detects the sudden presence of a “high strength signal” (to quote the maker), a “P” (for “pulse”) appears on its display, and it sounds a special alert. They call this “Pulse Protection.”

Unfortunately, under some circumstances radar close enough to produce the “P” can also be strong enough to

clock your speed. You can already be in range, which is not the time to find out about instant-on.

**You know better.** Remember, the only defense against instant-on is to find it while the signal is weak. By highlighting strong signals only, this so-called “Pulse Protection” leads you away from the only defense against instant-on. The maker says this feature “tells you when you’re being shot at.” The problem is, when you’re being shot at, it’s too late. Maybe “P” really stands for placebo.

**The same old song.** In its most recent radar detector test, *Car and Driver* noted, “While other makers have spent their energy on funny features or zippy styling, Cincinnati Microwave has found a way to improve function in a quiet and systematic way.” We intend to continue on our path. And apparently, others intend to continue on theirs.



# LETTERS

## Home Recording Studio

**T**HE first POPULAR MECHANICS magazine I ever bought on the newsstand was your November issue. It was Bruce Willis on the cover that got me. I've taped him on my VCR doing his commercials, "Moonlighting" and his appearance on "Dolly," the Dolly Parton show. I've got his video "The Return Of Bruno" and I love it. I'm a senior citizen (66 years young) who's not only a Bruce Willis fan, but an obvious fan of today's recording technology.

CATHERINE CATAGNUS  
NORRISTOWN, PA

*Sounds as if your tape recording setup is almost as high-tech as the professional studio equipment we described in our story featuring Bruce Willis: "American Hot Wax" (page 79, Nov. '87).*

It was a thrill to see my console, which was designed and built for Cherokee Studios, on your November cover. "It would be right at home on the bridge of the starship *Enterprise*" is one of the best responses I've received about it.

GREG THOMPSON  
DIR. OF VISUAL DESIGN  
NEOTEK CORP.  
CHICAGO, IL

## Against All Odds

I have to register a protest against the irresponsible sensationalism with which you promoted what was, at its core, a good and accurate article ("Killer Coasters," page 56, Sept. '87). Anyone who reads clear through to the end of the story will be reassured that riding roller coasters is "remarkably safe." The ratio of rides to mishaps is indeed "almost infinitesimal." The National Transportation Safety Board estimates that your chances of being involved in a fatal airplane crash are about one in five million. Your chances of being fatally injured on an



November cover: Recording console was created using computer-assisted drafting system.

amusement ride are one in about 70 million, as statistics from government and private research organizations indicate. The industry's safety record should be highlighted rather than buried behind a barrage of frightening headlines.

JOHN R. GRAFF  
EXECUTIVE DIRECTOR  
INT'L. ASSN. OF AMUSEMENT  
PARKS AND ATTRACTIONS

## PM Test Bench

Thanks for your October "The Better Home" section, especially "How To Use An Ohmmeter" (page 103). I used it to translate the instruction booklet for my new multitester!

F.K. HOLLOCK  
SEVERNA PARK, MD

I was shocked at your statement that telephone receivers use carbon granules in "How To Repair Telephones" (page 99, Oct. '87). The receivers are electromagnetic. Only the transmitters use carbon granules.

ELMER C. CARLSON  
COCOA, FL

*Our wires got crossed when we presented the theory, but otherwise, the repair steps are correct. Just don't bother tapping the receiver to loosen the carbon granules that aren't there.*

## False Security

Don't mislead your readers into thinking that a radar detector will keep them completely safe from a speeding ticket. I've been a traffic officer with the Fairfield, Ohio, Police Department for 10 years and can assure you that every radar unit I've used since 1977 can lock onto moving objects. So, your advice about hitting the brakes immediately after receiving a full-bore alarm escaping detection because "police radar won't lock onto an accelerating or decelerating object" is wrong. Most police have "moving mode" instant-on radar guns. About 20 percent of the speeding tickets I write are to drivers using radar detectors.

MIKE HANDLEY  
PATROLMAN  
FAIRFIELD, OH

## Mow Down

Sears' big garden tractor would have done well in your comparison test ("Tractors For All Reasons," page 74, Sept. '87). We've had one for seven years, mowing more acres of pasture, brush and blackberry bushes than lawn.

We've worn out several sets of blades and finally replaced front tires with trailer tires to better roll over locust tree thorns. Really no complaints. I've read PM since the '30s and I learn something every issue.

ANDY KYLE  
LIBERTY, TX



John Deere tractor handles the hills of southwest Virginia.

You were right on the mark in your assessment of the John Deere. We're using our second John Deere, mowing and tilling on slopes, and it's unsurpassed in safety, convenience and overall performance. Now, if Mr. Deere would just make automobiles . . .

GLEN MUSSER  
MARION, VA

## Shady Deck

Thanks for the fine deck ideas and plans in your April '86 issue ("Stacked Deck," page 114).

I adapted several of the ideas, making some modifications of my own, and it worked out beautifully. I've had nothing but rave compliments from everyone.

JAMES WILLIAM POAGE  
ROANOKE, VA

*The "Stacked Deck" article, was a feature in our "Home Ideas Guide." A photocopy of the complete story, including plans, is \$4 from POPULAR MECHANICS, Dept. L, Box 1014, Radio City Station New York, NY 10101. PM*



Deck ideas from PM were used by reader Poage in his construction.



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POPULAR MECHANICS is published monthly by the Hearst Corporation, 959 Eighth Avenue, New York, NY 10019, U.S.A. Frank A. Bennack Jr., President; Randolph A. Hearst, Chairman; Harvey L. Lipton, Vice-President and Secretary; Edwin A. Lewis, Vice-President and Treasurer. Hearst Magazines Division: Gilbert C. Maurer, President; D. Claeyn Bahrenburg, Executive Vice-President; K. Robert Brink, Executive Vice-President; George J. Green, Executive Vice-President; Mark F. Miller, Executive Vice-President, General Manager; Raymond J. Petersen, Executive Vice-President; Thomas J. Hughes, Vice-President & Resident Controller; Daniel J. Coleman, Vice-President for Popular Mechanics.

INTERNATIONAL EDITIONS: CARIBBEAN, MEXICO, SOUTHERN HEMISPHERE

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# OLD HOUSE RESTORATION

BY BOB VILA

## Restoring Ornamental Plaster

**T**HERE'S nothing like the beauty and grace ornamental plasterwork gives an old house. Consider yourself lucky if plaster moldings embellish the walls of a room or two in your home.

Unfortunately, the shifting and settling that's bound to occur over the years can damage these decorative relics. Water, too, is a major culprit in plaster deterioration. For example, an old, leaky roof can ruin lengths of cornice or ceiling medallions. Usually, the hardest part of restoring a damaged plaster molding is finding craftsmen capable of doing the job.

Ornamental plasterwork is either run or cast. Run ornament is the process used to create most linear moldings, and involves pushing a template of the cornice profile over wet plaster. Cast ornament is formed by allowing plaster to set in a mold. This is the way decorative elements, and things like ceiling medallions, are made.

Believe me, there's a great deal of skill involved in restoring plaster moldings. Let's take a look at how to find a plasterer to do the job, and what it will entail.

### Finding a craftsman

Don't expect to find an ornamental plasterer listed as such in the Yellow Pages. It'll probably take some digging to locate people who are experienced with this type of plasterwork. A local plastering contractor's association, bureau or institute is a good place to start your search. If there isn't one listed in the phone book, call a local plasterer. He or she should be able to tell you how to get in touch with a local association. The staff there, in turn, should be able to recommend a few ornamental plastering

*Contributing Editor Bob Vila is host of public television's "This Old House."*



Precast plaster ornaments are available in a variety of different designs for various applications. The small sampling above includes (clockwise from upper left) a pilaster capital, scroll bracket, cornice, Greek Revival medallion, Greek Ionic capital and a floral plaque.

experts in your area. Try the local plastering contractor's union, too. Someone there may know of a plasterer who does this kind of work.

Be prepared to pay dearly for this type of restoration work. Like anything else, the old supply/demand axiom comes into play here. Although working rates will vary depending on locality, about \$30 an hour—per person—is a pretty good average. When you understand what the job entails, you'll see the expense is justified.

### A team effort

There are two ways to run a linear plaster cornice molding: "on the bench" or "in place." As its name implies, the former process involves forming the cornice on a flat surface and then attaching it to the wall. It's used a lot when you're working with

finished walls, like brick or marble. The latter involves actually creating the cornice on the wall. It's this process I've seen used most in old, plaster-walled houses. It usually takes two professionals and a trained laborer, who is responsible for things like constructing the scaffolding, keeping the tools clean and mixing the plaster, to do the job right.

The first step in duplicating a piece of straight cornice is to make a template of the original molding's profile. This template must match the cornice design exactly. One of the easiest ways to do this is to make a saw cut across the existing cornice and insert a thin piece of cardboard or posterboard in the cut.

Then the existing profile is merely traced onto the cardboard. This shape is cut out

and transferred to a piece of sheet aluminum, which is cut to shape and attached to a wooden handle.

Obviously, any severely damaged lengths of cornice will have to come out. This may involve more work than you think, especially if the deterioration is due to water damage. The plasterers will have to see how far the damage extends. This may involve tearing out plaster several feet beyond the area of apparent damage. Any deteriorated wood lath is replaced with wire lath, and two coats of plaster, the scratch and brown coat, are applied. The plaster must be allowed to set overnight between coats.

Once this rough work is done, the room must be squared off and "screeded out." This process involves making the new ceiling and wall surfaces level and "plumb." This is an important step, since everything must connect evenly.

Straight screed or runner rods are then placed on both the ceiling and walls to guide the molding.

Making sure the plaster is the right consistency for each particular job is an art in itself. Generally, one man applies the material or feeds the mold while the other draws or pushes it. Timing is of the essence—they've really got to have a certain rhythm to keep things running smoothly.

As you can see, there's a lot involved here. If half the cornice is damaged in a 15-ft.-sq. room—say about 25 ft. or so—it could take a 3-man team (two plasterers and a helper) three days to run the new molding and get the room back in shape. Based on the estimate of fees I gave earlier (don't forget you'll have to pay the laborer, too!), a little arithmetic will show you that this is going to be expensive.



## Plaster casting

Once the straight cornice or moldings are run, any decorative work, like egg and dart, leaves or scrolls, are cast separately and attached. This process involves pouring a rubber substance over a model, which may be an original piece of the plaster ornament or a replica sculpted from clay. The rubber sets, forming a flexible mold. The model is removed and the rubber mold filled with plaster. Once set, the plaster creates an exact replica of the original model.

If they don't do this type of plaster-work themselves, the craftsmen you've hired should be familiar with casting houses that specialize in it. They should know how to go about ordering the enrichments, as these decorative pieces are called, to complete your cornice.

Although I've rarely run into this, there is a chance that your old cornice may have been cast originally. A plaster cast cornice can be pretty fancy, with lots of design work. Obviously, this has to be duplicated the same way it was made. Usually, a mold is made in place and a replacement piece cast.

## Adding a new molding

If your old (or new!) house doesn't have plaster moldings and you wish it did, there's a relatively easy way to add them. You can still buy cornice moldings and other ornamental plaster castings, like ceiling medallions, from a casting house or studio. (A few such companies are listed below.) Plaster castings of cornice moldings generally start at about \$4 or so a linear foot. Both adhesive and mechanical fasteners, usually either dry wall screws or toggle bolts, are used to secure these pieces.

Replicas of cornices, medallions and other architectural trimwork made out of high-density polyurethane are also available. Some look remarkably like the plaster pieces they're modeled from. Generally priced about the same as ornamental plaster castings, these pieces are lightweight, durable and factory primed. Proper cornice installation usually includes the use of a special adhesive and finish nails. Both types of installations involve finish work. If you're not familiar with putting up moldings and don't have good carpentry skills, I don't recommend taking on either project yourself. **FM**

### SOURCE LIST

#### Ornamental Plaster Suppliers

- Architectural Sculpture Ltd., 242 Lafayette St., New York, NY 10012, catalog \$2
  - British Plaster Moulding Co., Inc., 6395-C McDonough Dr., Norcross, GA 30093, catalog \$3
  - Feiber Studios, Inc., P.O. Box 551, 110 Ardmore Ave., Ardmore, PA 19003-0551, catalog \$2
  - Hosek Manufacturing Co., 4877 National Western Dr., Suite 205, Denver, CO 80216, catalog \$3
  - San Francisco Victoriana, 2245 Palou Ave., San Francisco, CA 94124, catalog \$3
- Plastic Moldings Supplier**
- Focal Point, Inc., 2005 Marietta Rd. N.W., Atlanta, GA 30318, free catalog

# PRODUCT WARNING

Reports have been received from the field where the combination of a Smith & Wesson L-frame .357 Magnum revolver and some .357 Magnum ammunition has resulted in unacceptable cylinder binding. L-frame revolvers bear model numbers 581, 586, 681, 686 or 581-1, 586-1, 681-1, 686-1, 686CS-1.

Cylinder binding can cause a **failure to fire**. Mishandling a revolver while freeing the cylinder can result in **accidental discharge**.

Cylinder binding can result from a number of causes, including characteristics of an individual revolver or the use of ammunition which does not conform to industry pressure specifications or is particularly fast burning. Recent developments in ammunition manufacture emphasize the production of .357 Magnum ammunition with increased velocity and greater primer sensitivity.

Although there have been very few reported incidents of cylinder binding, in view of our concern for our customer's safety and the reliability of Smith & Wesson products in all circumstances, we issue the following warning:

**IN A SITUATION WHERE A FAILURE TO FIRE CAN BE CRITICAL — SUCH AS LAW ENFORCEMENT OR PERSONAL PROTECTION — DO NOT USE .357 MAGNUM AMMUNITION WITH AN L-FRAME REVOLVER BEARING MODEL NUMBERS 581, 586, 681, 686 OR 581-1, 586-1, 681-1, 686-1, 686CS-1 WITHOUT AN "M" OVER THE MODEL NUMBER UNTIL YOU HAVE HAD THE REVOLVER MODIFIED.**

Those who need to use their L-frame revolver under these conditions prior to modification can safely fire .38 Special ammunition.

Smith & Wesson has developed a modification to improve existing L-frame revolvers. This improvement enables them to fire all .357 Magnum ammunition, currently being manufactured to industry specification, without cylinder binding. Shipments of L-frame revolvers from our factory after August 21, 1987 already include this improvement.

You can check if your revolver includes this improvement by looking at the left side of the frame when the cylinder is fully open. If your revolver has been stamped either with a "2" or higher number after the basic three-digit model number or with an "M"

above the model number, your revolver includes this improvement and does not need modification. If your revolver bears the model number 581, 586, 681, 686 or 581-1, 586-1, 681-1, 686-1, 686CS-1 without an "M" over the model number, it does not include this improvement and you should have your revolver modified.

Smith & Wesson will modify your L-frame revolver free of charge to eliminate the possibility of cylinder binding with .357 Magnum ammunition. Law enforcement agencies wishing to arrange for modification of L-frame revolvers should call the special toll-free number, 800-458-8469 (except callers from Massachusetts, who should call collect to 413-734-8244). Other users should send their revolvers to a Smith & Wesson Warranty Service Center, specifying "L-frame Improvement Program" and enclosing their name and return address.

If you need to obtain the name and address of your nearest Smith & Wesson Warranty Service Center, please call the special toll free number set up for the L-frame Improvement Program. This number, available Monday through Friday between 9:00 a.m. and 6:00 p.m. Eastern time, is 800-458-8469 (except for callers from Massachusetts, where it is a collect call to 413-734-8244).

One of the modifications to improve the L-frame revolver is the installation of a new hammer nose. This obsoletes all old L-frame hammer noses (part numbers 4702 and 7513) and all old L-frame hammer assemblies (part numbers 3366, 3378, 3380, 3382, 3391, 4722, 4723, 4726 and 4728) in field parts inventories. Superseded parts should never be fitted into a modified revolver as this may result in malfunction. It is essential for safety that you return these obsolete L-frame hammer noses and obsolete L-frame hammer assemblies for a free exchange to Smith & Wesson, Service Department, 2100 Roosevelt Avenue, Springfield, MA 01101. Do not return L-frame hammer-nose bushings from your spare parts inventory inasmuch as they are useable in J, N and K-frame revolvers which are not included in this Product Warning.

We regret any inconvenience this may cause. Smith & Wesson's first concern is the safety of its products and the protection of its customers.



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\*Excludes other GM products.



# FREEWHEELING

BY TONY SWAN

## The Ultimate Test Environment

**I**n the belief systems of the men and women involved in automotive journalism, one of the most commonly held prejudices is that the German *Autobahn* represents the greatest development facility on the planet. Anyone who has experienced this ultimate expression of the freeway concept—speed limits left to the discretion of the driver and the capabilities of the car—comes away with the unshakable impression that automobiles designed and built to function in this unforgiving environment are superior to those made elsewhere.

In the course of our interview with GM President Bob Stempel for this month's issue (see "Car Of The Future," page 45), this pet prejudice came to the surface. If American cars were developed to measure up to the demands of a road system like the *Autobahn*, we contended, wouldn't they be better cars?

### Stand Up And Take It

Mr. Stempel, who brings the refreshing (and much-needed) point of view of a real car guy to GM top management, had a little different opinion.

"The *Autobahn* is fine if you're developing cars for high-speed performance on smooth roads," he said. "But that doesn't really represent what most cars have to stand up to on a daily basis, there or here."

"What we see as a much more realistic all-around test of just about any vehicle system you care to name is the sort of driving you encounter around Detroit, Los Angeles or New York City. A Ger-



Manhattan may be a better proving ground than a no-speed-limit German *Autobahn*.

man car might give you great performance and stability on the *Autobahn*, but put that stiff suspension in Manhattan for a couple months of daily driving and see what happens to it. Then take a look around. We've got thousands of Caprices out there that stand up to it every day and keep coming back for more."

Mr. Stempel was referring, of course, to the taxi fleet in New York City, which runs heavily to Chevy Caprices and Ford LTDs, cars that give something away to BMWs in style, performance and handling but are almost masochistic in their ability to absorb punishment.

### Development Versus Testing

But if this is true of vehicle development, what about vehicle evaluations, as in the POPULAR MECHANICS road test program. As someone new to the magazine, as well as Manhattan, my initial reaction was to view the basic PM test environment with an apprehension that bordered on alarm. As a consequence of being spoiled for several years by the benign climate and relatively good roads of southern California, that first morning heading up Eighth Avenue was nothing short of forbidding. Lane dimensions were rubbery, at least in terms of the interpre-

tations of my fellow drivers, most of them steering either delivery trucks or one of Mr. Stempel's yellow Caprices. This was strictly no-prisoners stuff, with every green light resembling the start of the Daytona 24-Hour. And to make it more interesting, the pavement had rearranged itself into random waves and ripples, punctuated by more than a few potholes and iron slabs covering who-knows-what sort of excavations.

Although I'd driven in Manhattan many times before, it was never with the prospect of doing so daily. (Not to mention facing up to the considerable challenge of parking.)

### The Up Side

I remember reflecting that there was only one positive aspect of this driving environment versus the one I'd left behind. For all the hollering and gesturing (you know which gesture, right?) and honking (the horns on those Caprices are getting a *good* workout, Mr. Stempel), at least we're not shooting at each other back here in New York City. Well, occasionally, over parking spots.

However, that chat with Mr. Stempel has caused me to reassess my thinking about the environment that's the foundation of our vehicle evaluations here, particularly our long-term tests.

The 2-season climate of

southern California—summer and not-quite-summer—certainly lends itself to getting magazine chores like fifth wheel testing and photography done without too much drama. But for really finding out what a car is made of, it's hard to imagine a better place to wring it out than right here in Manhattan, because it's hard to imagine an environment more hostile to automobiles than this one.

### The Down Sides

It can be argued that other environments serve up more of a particular brand of hostility. Minneapolis, for example, is much colder during the winter months.

There's more snow in Denver, more salt in Duluth and more wet in Seattle. San Francisco is tougher on brakes, Phoenix tests the limits of cooling systems, and Santa Fe provides a unique profile of operation at higher altitude.

We can't compete with Santa Fe, of course. It's 6500 ft. there and not much more than sea level here. But seasonal variations are certainly part of the picture in New York City, the paving is patchy at best and the traffic is exceptionally fierce.

Now, we don't expect this litany to make you envious because you're not driving in Manhattan and environs on a daily basis. But we feel it's noteworthy, because when you read a "PM Long-Term Report," you know the car has endured tortures that are simply not part of the testing and evaluation procedure for any of the pure automotive titles.

Somehow this thought makes Eighth Avenue a little more endurable. **PM**



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346957. Steve Winwood—Back In The High Life. (Island)  
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319996-399998. Motown's 25 #1 Hits From 25 Years. (Motown)

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348318. The Police—Every Breath You Take—The Singles (A&M)  
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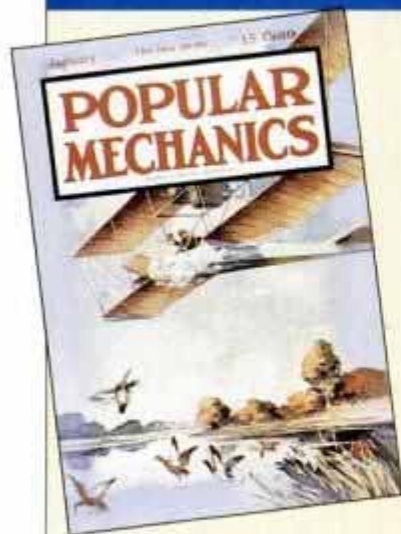
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# TIME MACHINE

75 YEARS AGO: January 1913



Flying for sport?

## Air Raid

Under the heading of sporting activities that never quite caught on: Shooting ducks from a flying boat. PM presented this questionable subject three-quarters of a century ago to a readership hungry for aviation news. Author Glenn H. Curtiss, the aviation pioneer, described the pastime in a broader piece on how "gay blades" were racing flying boats on Long Island Sound in those carefree days before WWI. Stung by aviation's spotty safety record, Curtiss proclaimed, "The flying boat has



Motoring across time.

now placed aviation among the 'safe and sane' sports."

## The Wonder Car

The bullet-shaped 3-wheeler was so named because London society wondered what it was. "It's a car of the most freakish appearance," PM

wrote, carrying one passenger ahead of the driver and equipped with a tiny engine tucked unobtrusively within a streamlined cowling.

## Fibrillations

Using an electrical charge to stimulate the heart muscle, Dr. Joseph Erlanger described how an electrode attached to the positive pole of a battery could pass through an incision to the heart. Completing the current by touching a negative electrode on another part of the body, he said "It's almost like raising the dead."

50 YEARS AGO: January 1938



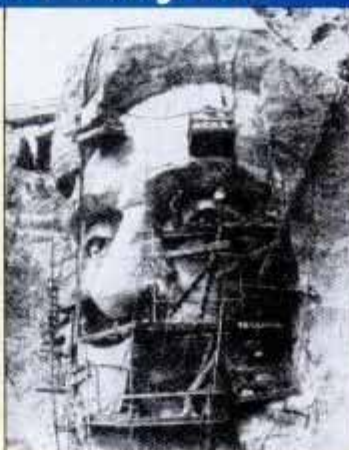
Razing the roof.

## Demolition Derby

Modernized muscle was beginning to perform the wreckage once wrought by crane and ball. A half-century ago, PM described how a compact bulldozer could demolish a building floor by floor from the top down. How to jump the "dozer" down each level? A guy and derrick setup swung the tracked vehicle out over the side of the building and inserted it in a window of the floor below.

## Facelift

The 66-ft. visage of Abraham Lincoln was big news in the



Sculpting our heritage.

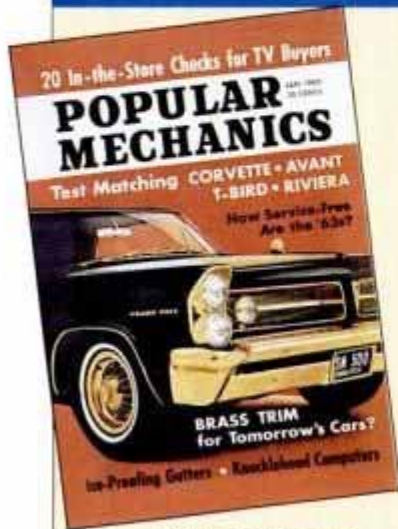
Black Hills of South Dakota at a place called Mount Rush-

more. Sculptor Gutzon Borglum had just finished forming the beard of our nation's 16th President, and was sizing up nearby outcroppings for his later relief of Theodore Roosevelt.

## Ice Monsters

The E Skeeter iceboat set a new speed record of 107 mph on the hard, black ice of Lake Geneva, Wisconsin. Departing from the stern-steering Hudson River iceboats, it placed the steering runner on the forward fuselage for the first time, which enhanced directional control.

25 YEARS AGO: January 1963



Building with brass.

## Touch Of Brass

Faint rumblings in the motor city a quarter-century ago indicated that the burnished warmth of brass was making a comeback as automotive trim. It had first appeared on the Pierce Arrows and La Salles of yesteryear. Improvements in tarnish-fighting brass coatings included better-bonding lacquers, ultraviolet light absorbers and anti-oxidants. To demonstrate the suitability of brass, PM brass-plated the trim of a Pontiac Grand Prix. The idea lost luster with a chrome-loving public.

## Up In The Air

Before satellites became our remote-sensing mainstay, NASA and the military lofted Earth-resource instruments by huge balloons. As a result, important strides were being made in balloon technology 25 years ago, including superpressurization using mylar/polyester film. The technique kept balloons suspended at a constant altitude despite nighttime cooling. In the early '60s balloons deployed Stratoscope I, an airborne telescope that gave us the first closeups of sun spots and solar flares.



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## Join the Future or Be Left Behind

Today the consumer electronics industry represents a whopping \$26 billion opportunity for the new breed of consumer electronics technician.

Today's consumer electronics revolution is creating huge servicing and repair mar-

kets that are just starting to boom.

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## Inside Your TV

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# AVIATION

BY FRED MACKERODT

## Scorpion Revisited

**T**HE letters flew in after the *Scorpion* idea plane appeared in our August issue ("Wings For Tomorrow," page 70). If you saw that edition, you'll recall that *Scorpion* was PM's attempt to come up with some definitive ideas on what the entry-level airplane of the future will be like. Reader response ranged from "The best thing since sliced bread" to remarks like the one reportedly overheard at Kitty Hawk: "Stick to bicycles Wilbur, it'll never fly."

I was impressed by the thoughtfulness and the time that went into the letters, both pro and con. *Scorpion* definitely stirred emotions.

Fred W. Hensel of Butler, Pennsylvania, wrote: "The collection of talent that you had in one place at one time was phenomenal." But then the pilot and aeronautical engineer added: "Fly-by-wire? No-No-No. Never. I have seen too many temporary blackouts and total failures in computers to ever consider using solely a fly-by-wire system to move control surfaces on conventional aircraft." Fred also questioned the twin-engine design, saying the single-engine "risk" would be acceptable to him when balanced against the cost of a twin.

John Hicks, a retired Air Force pilot, wrote to say that he had built and flown two Burt Rutan designs—the Quickie and the Long-Eze. "I swore I wouldn't build another aircraft, but after seeing the POPULAR MECHANICS *Scorpion*, I'd go right to work again if the plans were available."

The man who wrote the *Scorpion* article, Budd Davisson, thought the article had "had the proper effect." The *Scorpion* "got a lot of worthwhile people thinking about the problems at hand."

And some of those worthwhile people were very criti-



PM's *Scorpion* concept plane sparked numerous love-hate reactions.

cal of the *Scorpion* concept. Dave Blanton, president of Javelin Aircraft of Augusta, Kansas, "the world's leading manufacturer of special aircraft fuel systems," referred to *Scorpion* as a "pipe dream" and counseled PM to "stick to sensible concepts."

Some people felt that the way *Scorpion* was presented was misleading. Our very own *Scorpion* design team member Burt Rutan said, "It wasn't clear that we were not talking about the airplane of tomorrow, but the airplane of the future."

Rutan also pointed out a feature of the fly-by-wire system that we should have elaborated on a bit in the finished article. In fact, the fly-by-wire flight characteristics the *Scorpion* team envisioned go a long way toward answering a lot of the comments we received on the stability of the design and other control questions.

Rutan points out that *Scorpion's* fly-by-wire system is an "attitude control" rather than a "rate control" device. With a conventional airplane, you establish a bank and then return the controls to neutral. The airplane will remain in that bank until the controls are reversed to bring it out of the bank. As Rutan sees it, with *Scorpion's* fly-by-wire control, the sidestick will be moved to command, say, a 20° bank, and then held in that position until the bank is completed.

When the sidestick returns to a straight-up position, the attitude control will command "straight and level" and the aircraft will assume and remain in that attitude. Rutan sees this "automatic stabilization" as a great safety and design feature. It could end one of the

biggest causes of general aviation accidents—loss of control in the clouds.

Burt also emphasizes that the *Scorpion* would fly different from conventional airplanes. A student who learns to fly in the *Scorpion* will have to have some additional training to be able to transition into airplanes with more conventional controls. He likens it to pilots of tricycle landing gear airplanes having to learn how to fly airplanes with tailwheels. But he stresses that the *Scorpion* will be extremely easy to fly, and even easier for an experienced pilot to transition into.

Rutan also believes that the fly-by-wire controls will be as reliable or more reliable than the mechanical cable-and-bellcrank controls in use today. And about cost, he says: "We can develop a low-cost flight control system that has adequate redundancy. And once you design a servo to operate a control surface, you can use that same servo on almost any airplane."

Will anything come out of *Scorpion*? We think so. At the very least, to paraphrase Budd Davisson, it got a lot of people thinking about airplanes.

### Oshkosh Reprise

Rick Cruwell is a 13,000-hour pilot friend who accompanied us in Aztec N87A out to the annual Experimental Aircraft Assn. Fly-In Convention at Oshkosh, Wisconsin—his first visit.

His comment: "It was fantastic! I never knew what I was missing."

When it comes to airplanes, there is nothing like Oshkosh. This year's event, is scheduled from July 29 to August 5.

For information, write Oshkosh '88, EAA Wittman Airfield, Oshkosh, WI 54903-3086.

See you at the Big One! **PM**



People and planes—Oshkosh '87 had them both in spades—800,000 people and 15,000 planes. Planning continues for this year's fly-in.



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The Shape You Want To Be In. snow or ice, the 1988 Topaz offers the all-wheel-drive option.

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LINCOLN-MERCURY DIVISION 

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BY TIM COLE

## How To Catch A Neutrino

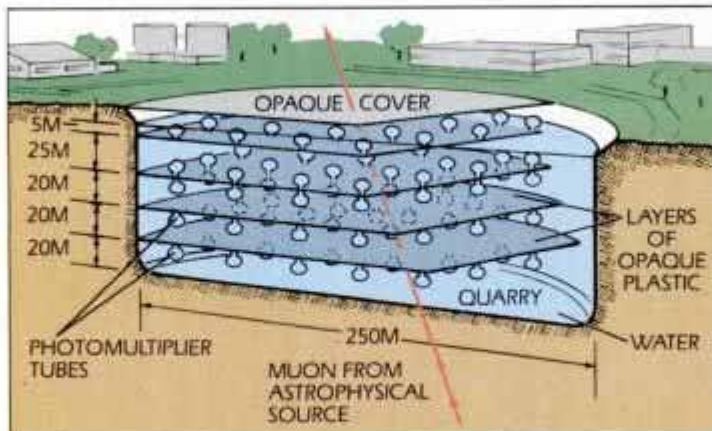
**N**EURINOS are the smallest, most elusive particles in the universe. They are presumed to have neither mass nor electrical charge. They're so weak that they can pass completely through the Earth without disturbing other particles.

Massive neutrino pulses were recorded at underground detectors in Ohio and Japan following the recent observation of Supernova 1987A, fueling the theory that collapsing stars are a prime neutrino source. Understanding neutrino behavior—in particular whether or not neutrinos might have mass—can help astronomers understand the rate of intergalactic expansion and other keys to the cosmos.

To aid in this study, scientists at the University of California, Irvine—led by Dr. Frederick Reines and Dr. Hank Sobel—are proposing the world's largest neutrino detector. Dr. Reines codiscovered the neutrino in 1956 and has played an active role in neutrino detection—which is focused currently at the underground Irvine-Michigan-Brookhaven neutrino detector located near Cleveland, Ohio. Reines and his colleagues now visualize a neutrino detector much larger than the IMB version.

Their plan calls for a detector located in a gravel pit or quarry 1000 sq. ft. and 250 ft. deep. It would have 1000 times the sensing area of the IMB unit. Other neutrino detectors are buried deep within the Earth to shield them from cosmic rays and other stray particles. The less costly Irvine detector would be positioned on the surface, and would use the Earth as shielding, allowing scientists to observe only those neutrinos that emanate from the opposite side of the world.

The Irvine detector would be filled with purified water and the top would be covered



U.C. Irvine's proposal for a device that detects the elusive neutrino: Start with one good-sized quarry and then add purified water.

with opaque black plastic to keep out light. A neutrino from some astrophysical source like an exploding star would pass through the Earth's interior, where it would interact to produce a radiation-emitting muon. The muon would traverse the detector, where it would be sensed by layers of downward-facing photomultiplier tubes, or PMTs (see illustration). A PMT, like a photographer's lightmeter, is ex-

tremely sensitive to light. A neutrino-derived photon would hit the surface of the PMT, which would then emit an accelerating string of electrons. Scientists would measure the resulting electron pulse to get a reading on neutrino number and intensity. U.C. Irvine researchers are trying to locate a suitable site for the \$15 million detector—inexpensive for a project that may one day unlock the secret of the universe.

## A Quasar—By Computer

U.C. Irvine physicists will rely on empirical observation to reveal the universe at work. Conversely, Cornell professors Stuart Shapiro and Saul Teukolsky have developed a computer simulation to give scientists a glimpse at one of the most intriguing phenomena in space—the creation of a quasar.

Shapiro and Teukolsky have used an IBM 3090-400 mainframe computer and a Cray XMP to produce a movie of star clusters collapsing into a black hole. These cosmic maws devour gas, dust, light and whole stars—squeezing the matter into brilliant incandescence, forming the brightest objects in the universe, before disappearing from view.

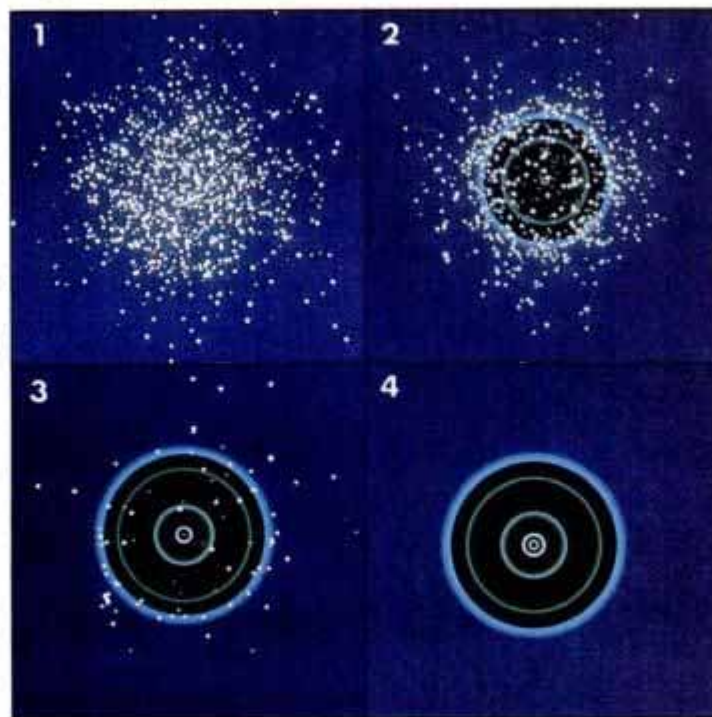
In a project sponsored by the National Science Foundation, Shapiro and Teukolsky created a computer model involving 100 billion separate calculations based on Einstein's Theory of General Relativity.

"We really don't understand how the central engine of a quasar—the black hole—forms from ordinary matter," Shapiro says. "But our model shows that a dense galactic nucleus, composed of a multitude of neutron stars, could become unstable and undergo gravitational collapse to form a supermassive black hole."

The Cornell black hole movie shows star clusters accelerating at the speed of light and forming a coherent ring. Light rays are trapped forever in the ring and the quasar is born.

The Shapiro/Teukolsky model also illustrates how a black hole affects time, the gravity field around it and the orbit of nearby stars.

"Our calculations offer a possible glimpse into one of the most fascinating processes in the universe." **PM**



In frames 1 and 2 of the Cornell simulation, star clusters accelerate to the speed of light and start to collapse. A coherent ring of light results (3). Finally, an all-consuming black hole is formed at the center (4).





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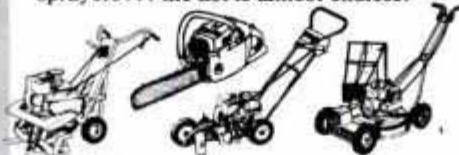
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# OUTDOORS

BY JOE SKORUPA

## Water Trials For Jeep Cherokee

**T**HERE are a number of ways to test a 4x4 sport/utility vehicle. Bumpy roads and muddy ruts. Radar guns and handling courses. Here's a tougher test. Boat duty.

I recently plunged a 1988 Jeep Cherokee Chief, with a 4.0-liter, 6-cylinder engine into the role of long-term tow vehicle for a Sea Ray Pachanga 22. Fully loaded with nearly 3500 pounds of boat and trailer, I drove hundreds of miles and launched at a number of steep and tricky boat ramps.

I drove rainslick roads and jockeyed for position on high-speed highways. And, not least importantly, I backed into obstacle-strewn driveways and parked in extremely tight quarters.

Have to admit I had some doubts about the 6-cylinder



V6 Cherokee Chief ready for boat duty.

Cherokee's ability to handle a \$30,000 boat in some of the situations I placed it. My doubts proved groundless.

The Cherokee's electronically fuel-injected powerplant cranks out 177 horses and 224 ft.-lbs. of torque. This gives it steady acceleration up hills and more than enough punch to merge smoothly into high-speed

traffic while fully loaded.

Harnessing the Cherokee's horses is a 4-speed automatic transmission with an optional "Selec-Trac" full-time 4wd system. On one long-drive in a teeming rainstorm, the full-time 4wd gave an added sense of sure-footedness while towing the big boat.

On days when my Chero-

kee wasn't proving itself to be a dependable workhorse, it was strutting around as a head-turning sport vehicle. There are too many power and comfort features to list here, but their sum comprised a vehicle of surprising power and grace.

Over the course of 15,000 hard miles, not all of which I drove, the Cherokee was ready for some minor servicing. Driver's side door lock and passenger side window tended to get stuck, and engine idle was a bit rough. I had a chance to drive it after servicing and found no lingering problems.

With shift-on-the-fly 4wd, 71 cu. ft. of cargo space and room for five adults, the \$15,000 Cherokee Chief is a versatile 4x4 that takes well to water, or at least to getting your boat and gear there.

## Fishing Reel With Built-In Byte

You begin to pity poor, defenseless fish as you walk through the American Fishing Tackle Manufacturers Assn. (AFTMA) show, which I did recently in Atlanta. Let's face it, they're out-gunned. The show featured miles of aisles of the most advanced fishing gear on the market, some of which seemed right out of "Star Wars."

Consider the Miya Epoch 1000 computer-controlled fishing reel with motorized crank, for example, which can be used for trolling, jigging and bottom fishing. All

Fishing by remote control with computerized, power reel.



functions are done automatically and activated by hand-held remote control.

The reel's features are uncanny. When the sinker reaches bottom, the reel stops and winds back to the desired depth. Jigging cycles are simply a matter of programming and are automatically repeated.

A depth memory ensures that after a fish is pulled in, the computer will return new bait to the same spot. And, the motor changes speeds according to the pulling power of the fish to create positive drag at all times.

The Miya Epoch 1000 weighs 13.2 pounds, holds 1000 yards of line, hoists 105 pounds and operates from a 12-volt DC power pack or the boat battery. Cost for this future-shock reel is \$1700.

What will we see at the next AFTMA show? Probably Robo-Bait or fish-seeking torpedoes. If Captain Ahab were alive today, Moby Dick wouldn't stand a chance.



Ski-Doo snow speedster has power to do 2-up cruising in comfort.

## Full-Squeeze Snow Cruising

Space is a luxury. It's one thing to push your snowmobile *full squeeze* across an open field or groomed trail. It's another to do it with your *main squeeze*. Few snowmobiles can comfortably do both. Ski-Doo's new Escapade can. This deluxe speedster is built to handle a second passenger, and that's only the beginning of its dream-machine features.

The Escapade has heated handlebars, full instrumentation, Heatflow cab and electric start. Its suspension system—progressive independent front and long-travel rear—is designed to distribute the shock load down the stable longitudinal axis rather than across the narrow width of the sled.

Steering has also been redesigned for comfort and safety. Ski-Doo has separated the spring/shock unit from the steering linkage. The result is a steering system less vulnerable to extreme vertical deflection.

The Escapade has a 496-cc, oil-injected engine and a price to match its cruiser luxury—\$4749.

FM



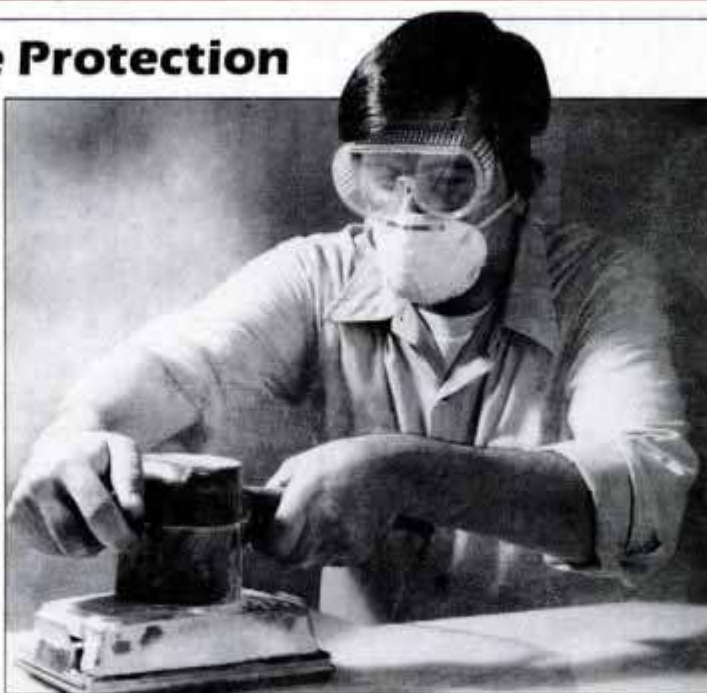
# WORKBENCH BASICS

BY ROSARIO CAPOTOSTO

## Preventative Protection

**P**OWER tools, both portable and stationary, are indispensable in today's workshops. However, using power tools creates certain health hazards, primarily to your eyes, lungs and ears, that every do-it-yourselfer should know about. Fortunately, protection from wood-chip projectiles, sawdust clouds and screaming routers is easy and inexpensive.

Visit any well-stocked hardware store to find all the protection you'll need. For eye protection, there are goggles and face shields. Goggles have a pliable rubber frame, plastic lens and an elastic strap that holds them snugly over your eyes. The frames are perforated with ventilation holes to deter fogging. A face shield has a flip-down panel that is fitted to an adjustable head band. Face shields are comfortable to wear since no part touches



Sanding dust can irritate your eyes and respiratory system. Protect yourself by wearing eye goggles and a paper dust mask.

your face but goggles hug the face, so they provide better dust protection.

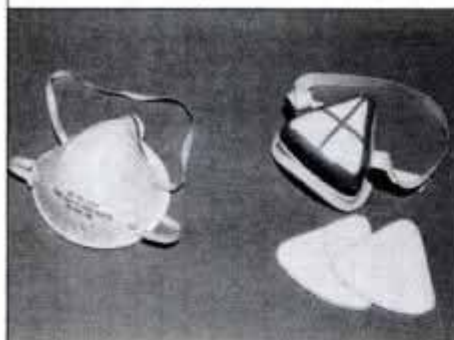
Nearly all woodworking power tools produce fine dust

that can irritate your respiratory system. This dust can be filtered out with a dust mask. Essentially a paper filter, the dust mask hugs your

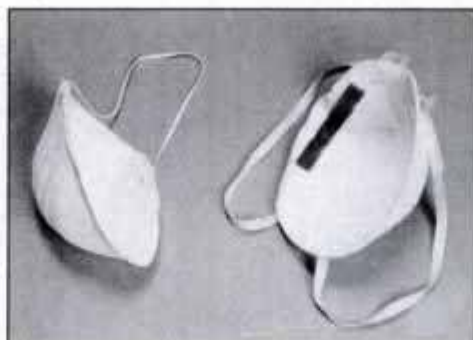
face and covers your nose and mouth. Dust masks are available in various styles, including disposable types and those that accept replacement filters. Keep in mind that these masks are designed to handle wood dust only. They will *not* filter out harmful vapors or fumes. In such cases, you must wear a cartridge-type respirator. (Respirators will be discussed in an upcoming "Workbench Basics.")

Ear protection is also important in the workshop. The two basic types are the earmuff style and soft-rubber ear plugs. Both styles are effective in reducing harmful noises, but the earmuff style is easier to slip on and off, as necessary.

Remember: Owning eye, lung and ear protection is not good enough. You must *use* them every time you work in the shop. **PM**



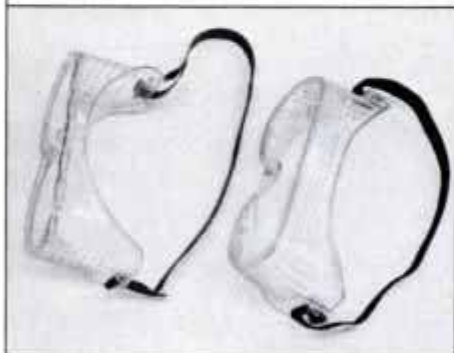
The two most common types of dust masks include the disposable kind (left) and the type that accepts replacement filters (right).



Here are two types of disposable dust masks. On the left, is a thin, cheap model. Thicker, better mask (right) has two head straps.



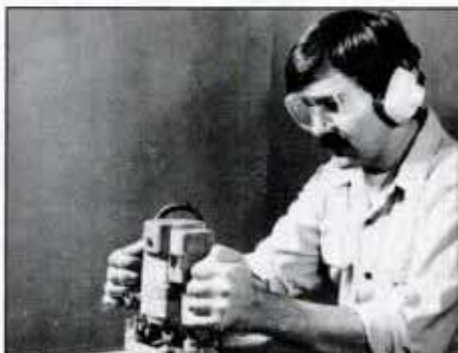
Eye protection, either goggles or face shield, is extremely important to block flying splinters and chips when using a table saw.



Two common types of eye goggles: Goggles on right have a broader frame that offers more perforations for better ventilation.



Face shield provides protection for eyes and entire face. Plastic shield flips up and down easily. Head band adjusts for exact fit.



Comfortable earmuff-style protection quiets the piercing scream of a router. Note that eye goggles are also necessary.



# CAR CLINIC

BY MORT SCHULTZ

## Triple Threat

**W**HY is my 1986 Chevrolet Celebrity's V6 engine so hard to start in the morning and also after being parked for 1 hour or longer during the rest of the day? Service managers at two dealerships give the engine high marks. There are no trouble codes stored in the computer, and the ignition, electrical and fuel systems have gotten A+ ratings. Is it true that this is normal for an engine with multipoint fuel injection?

JOHN M. RINIKER  
TROY, PA

*I don't buy that, John. If this were normal, all engines with multipoint fuel injection (MPFI) would be hard to start, which is not the case. There are four MPFI-related components I would look at. One of them could be the cause of your hard-starting condition. They are: problems in the fuel pump electrical circuit, a bad fuel pump check valve, a faulty fuel pressure regulator, and a fuel injector that's not closing when the ignition is turned off. The*

*last three of these components can allow pressure inside the fuel system to bleed off when the car is shut down for a period of time.*

*If the fuel pump isn't getting juice from the normal source, once the engine has cranked long enough to build oil pressure, a second set of contacts in the idiot-light sender will supply the pump, and get the car running. This extra circuit is intended to get you home in the event of a failure in the fuel pump circuit. Have someone turn on the key, without cranking the engine, while you listen near the fuel tank. You should hear the fuel pump whine immediately.*

*A fuel injector that's staying open when the ignition is turned off allows gas to flow into the cylinder, which causes flooding. Crank the engine (warm) a bit, but don't let it start. Then, remove the sparkplugs. If the tip of a plug is saturated, the injector serving that cylinder is sticking. You'll have to replace the injector. Injectors may not leak enough to wet the plugs, so*

*you might need to remove an injector and look for seepage.*

*The job of the fuel pump check valve, which is inside the fuel tank, is to prevent gas from draining out of the fuel pump when the engine is off. If the valve is bad and gas drains back into the tank, it takes much longer for fuel pressure to build up when you start the engine. Test the check valve by connecting a fuel pressure gauge to the pressure gauge fitting on the fuel rail. The fuel rail is the pipe around the engine that delivers gas to fuel injectors. When the ignition switch is turned on, pressure should rise to between 234 and 325 kilopascals (24 to 47 psi). When pressure reaches this level, turn off the ignition switch and keep the fuel pressure gauge connected for 15 minutes. If pressure drops significantly during this period (and the injectors are okay), it confirms a faulty check valve or pressure regulator. To replace the check valve, the fuel tank has to be removed from the car and the fuel sending assembly taken out of the tank.*

*To find out if the fuel pressure regulator is shot, turn on the ignition. When the gauge shows pressure at its peak, pinch the hose extending from the fuel pressure regulator to the fuel tank to close it. This is the fuel-return hose. If pressure recorded on the gauge drops, it means the diaphragm in the fuel pressure regulator is damaged.*

## Time For A Respite

I'd like to borrow space in your column to suggest that sometimes the reason for car trouble can be both simple and complex at the same time.

After thousands of miles, my splendidly operating 1982 Capri 3.3-liter engine equipped with a 1-barrel Holley carburetor occasionally

began idling rough, dying and shooting black smoke from the exhaust.

No big deal, I said to myself. Surely, I'm dealing with an overrich condition, and that's easy enough to square away. My diagnosis was correct, but my supposition was all wet. I spent months looking for the reason, replacing half a dozen parts in the process. I was about to pop for a new carburetor, but decided to pull the needle valve one more time. I had replaced it early in my search.

The needle valve in this carburetor is held inside a retainer. I'd noticed this the first time I changed the part, but this time I went further. You can't examine the valve seat unless you remove the retainer, which I proceeded to do. What I found was a small sliver of a plastic-type material. I'm not 100 percent certain, but I think that sliver would from time to time hold the needle valve open and cause the engine to flood.

Where did it come from? Best as I can tell, from the fuel filter that's screwed into the carburetor inlet. Ford put a fillet of cement around the filter to seal it. My guess is that some of this cement fell off and worked its way into the needle valve retainer. The engine runs as perfect as ever since I cleaned the retainer. What do you think about that?

HERB SCHNEIDER  
WESTERN SPRINGS, IL

*Fascinating. Thanks for this helpful info, Herb.*

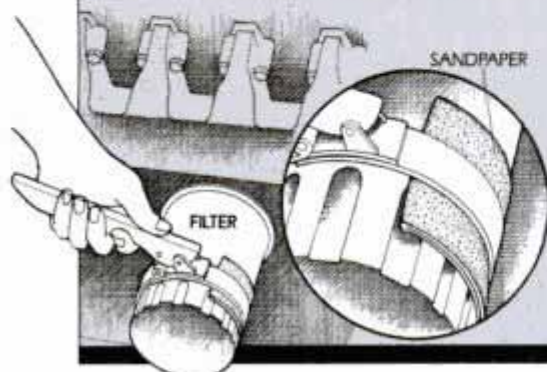
## Whine Country

A whine from the alternator of my 1984 Buick Park Avenue when the headlamps are on is quite audible and very annoying. The electric system has been given a clean bill of health by a Buick mechanic who informs me that this whine is common to  
*(Please turn to page 32)*

## True Grit

"While changing the oil filter on my car the other day, the filter wrench kept slipping and wouldn't take hold, making it impossible to remove the filter," writes Joe Fernicola of Levittown, New York. So what did Joe do? Just this—"I folded a strip of sandpaper in half and wrapped it around the filter so there was grit against the filter and grit facing up," he says. "I then placed the wrench around the grit side facing up, tightened the wrench and turned it. What holding power! The filter came off easily."

Don't tell me Yankee ingenuity is dead. Our method of last resort for removing stuck filters was to hammer a screwdriver sideways through the can, but now we'll use Joe's more elegant method.





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Thermostats

## CAR CLINIC

(Continued from page 30)

Oldsmobile 307-cu.-in. V8 engines. Has a solution been suggested by either Buick or Oldsmobile?

BRUCE POLCZYNSKI  
MILWAUKEE, WI

A technical service bulletin (TSB) has not been issued by Buick or Olds to deal with alternator whine although, as the mechanic says, it is a recognized condition with the standard 60-amp alternator used with the 307 engine.

I can't recommend that you replace a good (albeit noisy) alternator until you

drive a Park Avenue having an 80-amp alternator to satisfy yourself that the noise level of the higher output alternator is acceptable.

However, you can try to reduce the noise level by fiddling with the bracket setup. For example, place rubber washers under the bolts to see if they soften the noise. Or wrap insulation around the brackets. Or both.

## Remains To Be Seen

I have one of the first-produced 1986 Ford Taurus models. Except for one problem—a loud thump when driven normally over rough roads—the car is quite satisfactory. The coil springs have been replaced with stiffer units, but it hasn't helped. Other Taurus owners I've spoken to complain of the same thing, indicating a common condition that you may have an answer for at your fingertips. Do you?

DR. SANFORD M. KLEIN  
PITTSBURGH, PA

We'll see. There are three TSBs that offer a possible solution for the kind of noise you describe:

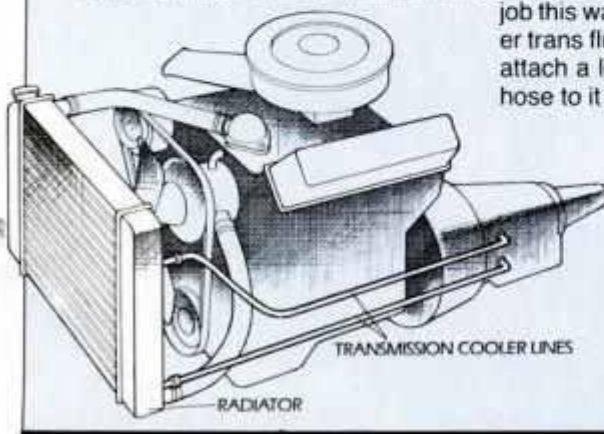
■ TSB 86-14-6 recommends a step-by-step procedure for getting rid of front and rear suspension noise. It suggests examining certain parts, checking struts, and

(Please turn to page 34)

## Cool Cure

Suppose an automatic transmission is inadvertently overfilled. To prevent the foaming and slipping that excess fluid can cause, you have to drain it, right? Oops, there's no drain plug in the transmission pan. And unscrewing transmission pan bolts is time-consuming and gets pretty messy as fluid slobbers down all over your arm.

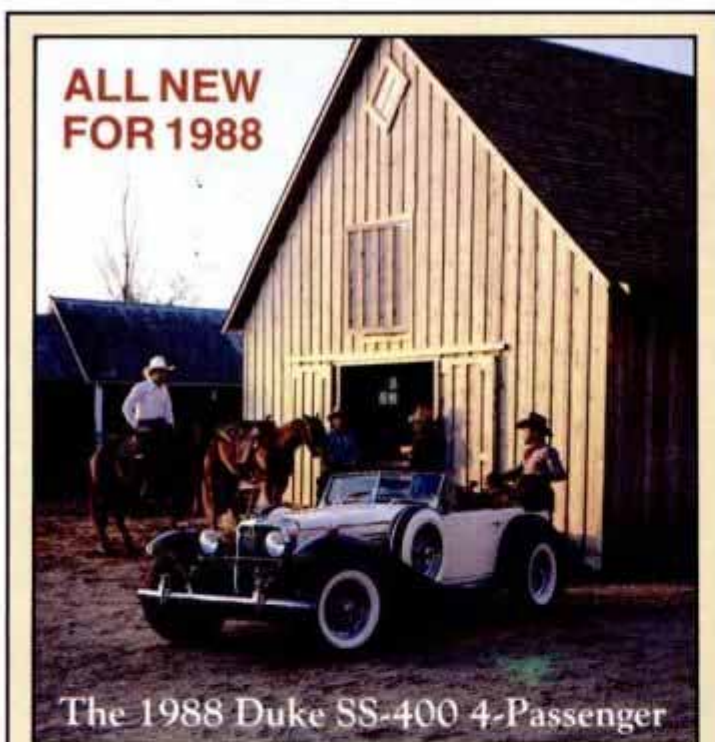
However, if the vehicle has a transmission oil cooler, you don't have to do the job this way. Instead, unscrew the lower trans fluid cooler line at the radiator, attach a length of fuel-line or vacuum hose to it and aim the other end into a clean container. Start the engine, count off exactly 3 seconds and turn off the engine. Reconnect the line and check the transmission dipstick. If too much fluid has been pumped out, simply add the quantity necessary from the clean container to bring the level back to normal.







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## CAR CLINIC

(Continued from page 32)

installing insulating sleeves on the top coils of springs.

■ TSB 86-7-5 concerns eliminating a "squeak/grunt" from the front and/or rear suspension stabilizer bar insulators.

■ TSB 86-21-9 recommends installing an insulator between sheetmetal and the parking brake adjuster bracket to stop a rattle.

### In De Clutch

What could cause a 1987 Pontiac 1000 to stall when the clutch is disengaged while the car is in motion?

K. DOUGLASS  
WALWORTH, NY

A couple of things. Right off, I'd check the idle speed control (ISC). Next time you're driving along, disengage the clutch but feed the engine a little gas as you do. If the engine doesn't stall, have the ISC adjusted.

But if the engine stalls anyway, then I suspect you're shorting something out as you're using the clutch pedal. It could be the clutch switch.

It could also be that a wire harness near the clutch pedal assembly has been rubbing against the clutch linkage, bar-

ring wires carrying current needed for ignition—wires that are shorting whenever they come in contact with the clutch linkage. If shorting out is the problem, wrapping the wires with insulating tape and moving the harness away from the linkage will stop this.

### Olds Obscurata

I'm trying to restore a 1960 Oldsmobile 98, which includes overhauling the engine. I've been caught short by not having a shop manual. I would be forever in your debt if you could find one for me.

JIM REED  
FAYETTEVILLE, NC

You're in luck, Jim. I got in touch with my friends at Lansing Lithographers, in Michigan. This is the company that does manual production for Oldsmobile. The chassis manual for the 1960 Olds just happens to be the oldest one on the company's shelves. You can get your hands on this scarce book by sending your name, address and \$10.50 to the company at P.O. Box 26128, Lansing, MI 48909.

### 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 you haven't found out why your 1987 Ford, Mercury or Lincoln car or Ford van or light truck with electronic fuel injection has an incessant rough idle, look to the wire terminals plugged into the hardshell connectors of the fuel injectors. TSB 87-13-5 explains that if each wire can't withstand a wiggle or two without parting company from the connector, the fuel injector wire harness should be replaced with one of different design.

■ Before having the 440-T4 automatic transaxle in your GM car torn apart, because the transmission isn't upshifting at all or is shifting erratically, work on the governor assembly. If it's leaking, replace it. If it's okay, clean it with solvent, put the governor cover back on the transaxle, start the engine, move the shift selector to DRIVE and let the engine run for 20 seconds. Then, reinstall assembly. This should purge the transaxle of particles of Imprex that may be lodged in the governor pressure channels where they're causing the trouble. Imprex is a plastic material used to help seal leaks in the transaxle case caused by casting porosity.

■ Does the 2.6-liter engine of your 1984-87 Caravan, Voyager or Mini Ram Van have less power in cold weather than in warm? Look inside the air cleaner box. If the walls of the box, the filter element and/or induction hoses are coated with condensation or ice, have a cold weather driveability kit (part No. 4419436) installed. Details in Chrysler TSB 18-05-87.

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# ELECTRONICS

BY STEPHEN A. BOOTH

## Some Current Trends

automatically creates separate files for each day's weather, thereby compiling the database for subsequent analysis. In addition to its plug-in circuit card and disk-based software, the package includes an electronic rain collector, temperature probes, solid-state transducer for barometric pressure, an anemometer (for wind measurements) and extension cables for installation.

Follow the weather on any IBM-compatible computer.

**W**HAT Mark Twain said about weather still holds true: There's still nothing you can do about it no matter how much you talk about it. But now there is something you can do with the weather, or, to be more precise, there's something else you can do with your computer on rainy days. Why not turn the computer into a weather station?

You can, for about \$575, with the PC Weather Pro from Technology Marketing. This hardware and software package contains everything you need to record and analyze weather conditions. All you have to supply is an IBM-compatible computer, and some weather.

The program, through its measurement devices, lets you monitor and store weather variables including temperature, barometric pressure, wind speed, wind direction, wind chill and rainfall. The program lets you display a weather bulletin screen with up-to-the-minute readings—and even lets you set audible and visible alarms for specific weather conditions.

The PC Weather Pro logs its measurements every half hour, even if you're using the computer for other tasks. It

To order the PC Weather Pro, or for more information, contact Technology Marketing at 4000 Kruse Way Pl., Bldg. 2, Suite 120, Lake Oswego, OR 97035.

For those of you not interested in this hands-on approach to weather, but who want to know which way the wind blows even while the water's pouring down on you, there's the Weatherbeater from Multitech.

No, it's not another soap-on-a-rope radio for the shower stall. The Weatherbeater will give you AM and FM radio—but it lets you make and receive phone calls, too. The entire unit, including the phone cable, is water resistant. And you can shave while you gab on the phone, because Weatherbeater is a hands-free speakerphone. You can, of course, install it outdoors, too. The Weatherbeater costs \$50, comes with a Velcro-type attachment kit, and is available in white, pink or blue.

Another colorful and durable addition to the world of consumer electronics is the line of My First Sony products designed for kids.

These aren't toys—they're for real, but designed to be handled and man-handled by children. This means they

have tough plastic shells with rubber bumpers, oversized control buttons marked with easily understood words and symbols. And there's a built-in volume limiter to protect young ears.

The first products in the My First Sony line include a walkie-talkie (\$50), cassette recorder with jumbo microphone (\$45), an AM/FM/cassette recorder (\$60), and a headphone/cassette player (\$35). Multicolor blank cassettes come two for \$4.

For grown-ups, Sony's offering a new Watchman pocket TV. The FD-270 (\$160), available in mature blue, white or black, improves on the current Watchcam's 2-in. tube with a 2.7-in. black-and-white display—and requires only two AA batteries. It also runs on larger, external batteries or AC.

Not impressed? You'd like something larger, perhaps? You got it!

Last autumn, we reported on Mitsubishi's XC-3710C—some \$10,000 worth of color TV with a 37-in. tube screen ("Electronics," page 14, Sept. '86). Would you care to guess the going price for a 200-in. picture?

Well, if you've got 50 grand to spare and have always wanted a movie theater in your home, Mitsubishi's VS-2000 projection TV is just the thing for you.

We sent reporter Jeff Co-



Make phone calls, hear tunes in the shower.

hen to check out the VS-2000, and he learned that the set is designed for either front or rear projection onto outboard screens measuring from 120 to 200 in. Mitsubishi pulls off the trick by using three 13-in. cathode-ray tubes with wide-diameter lenses. Most projection TVs use 7-in. CRTs. Liquid cooling and coupling for the tube/lens combo results in an extremely bright picture for a projection TV—some 675 peak lumens, or about 3½ times the brightness of conventional projection sets.

Like the XC-3710C, the VS-2000 is marketed by Mitsubishi's Industrial Video Division for commercial applications only. So you can bank the \$50,000. Or, you can invest \$4400 of it in Mitsubishi's VS-683R, a rear-projection TV with a bright, 60-in. picture and 181 channel tuner. It's available now, and you won't have to add a wing to your home to house it.

"Kid-fi" from Sony is designed for children.





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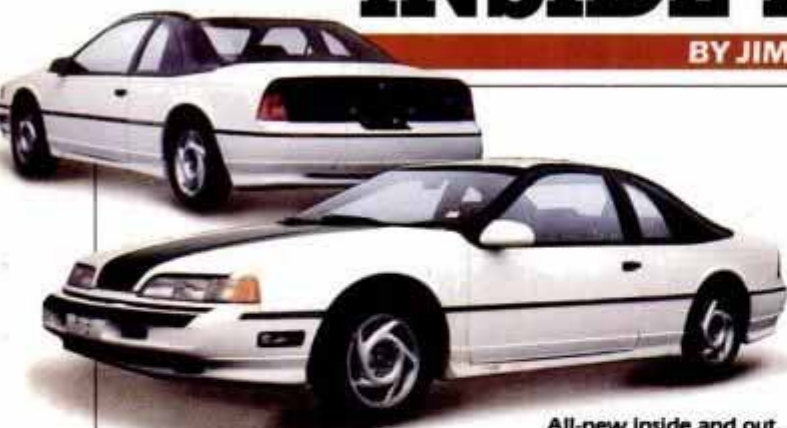
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<p><b>CHEROKEE</b> Available for right and left sides. 23½L x 14H x 8½W.</p>	<table border="1"> <thead> <tr> <th>YEAR</th> <th>VEHICLE</th> <th>LT.</th> <th>RT.</th> <th>PRICE</th> <th>QTY.</th> <th>AMOUNT</th> </tr> </thead> <tbody> <tr> <td></td> <td></td> <td></td> <td></td> <td>\$89.00 ea.</td> <td></td> <td></td> </tr> <tr> <td colspan="4">(Circle One) VISA / MC / COD / CHECK</td> <td colspan="3">TAX *6.50 ea. TEXAS ONLY</td> </tr> <tr> <td colspan="2">CREDIT CARD NO.</td> <td colspan="2">EXPIRATION DATE</td> <td colspan="3">SHIPPING &amp; HANDLING *5 ea.</td> </tr> <tr> <td colspan="4">Signature As On Card</td> <td colspan="3">TOTAL</td> </tr> </tbody> </table> <p><b>LIDO INCORPORATED</b></p> <p>ENCLOSE UPS ADDRESS FOR SHIPPING! 13615 TOPPER CIRCLE #2 SAN ANTONIO, TX 78233-4031 SATISFACTION GUARANTEED!</p>	YEAR	VEHICLE	LT.	RT.	PRICE	QTY.	AMOUNT					\$89.00 ea.			(Circle One) VISA / MC / COD / CHECK				TAX *6.50 ea. TEXAS ONLY			CREDIT CARD NO.		EXPIRATION DATE		SHIPPING & HANDLING *5 ea.			Signature As On Card				TOTAL			<p><b>BRONCO II</b> Available for right and left sides. 19L x 13H x 8½W.</p>
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# INSIDE DETROIT

BY JIM DUNNE



All-new inside and out. '89 T-Bird gets supercharger.

## Tale Of The Two Birds

**T**WO Thunderbirds will be built in 1989—a standard model and a Super Coupe to replace the Turbo Coupe. The Super Coupe has a supercharger on its 3.8-liter V6 engine, a combination that develops more than 200 hp and is expected to provide much better low-end response than the current 2.3-liter turbo. The body shape on all the new T-Birds is different, with an emphasis on smoothness. Wheelbase is greater by more than 6 in., but overall length is only slightly changed, diminishing front and rear overhang while simultaneously improving ride quality.

### Escort

Ford may be planning to copy much of the design of the German-made Scorpio for its 1990 Escort replacement. The company plans to offer this car, code-named CT-20, at the same time the current Escort is being phased out, so both cars will be on sale at the same time for a short period. Wheelbase will be about 4 in. longer than the 94.2 in. of the current Escort, but like the 1989 Thunderbird wheels are set out closer to the ends of the car, reducing overhang. The

stretched wheelbase and all new suspension should give the new car a big improvement in ride and handling.

### Olds Silhouette

Oldsmobile recently held a consumer clinic just outside Chicago to test the appeal of its supersecret Silhouette concept car. The clinic brings in typical buyers of Oldsmobile cars to a showroom where they see what Olds is planning for the future in the way of car size and styling.

The invitees are paid a small sum, usually \$25, to view the new product and give their opinions, tell what they like and what they don't.

What they saw at the Silhouette clinic was a 4-passenger, low-volume, specialty sedan much like the Acura Legend. Body panels are planned to be plastic, while the chassis will be 4-wheel drive. A 200-plus-hp version of the Olds-developed Quad 4 engine will provide sportscar level performance. This car will be exclusive to Olds, just as the other GM divisions have their exclusives—Corvette, Fiero, Allante and the new Buick Reatta.



Silhouette: Olds' new plasticar.

lac will use, insiders say both may be offered, with the customers making the choice between them. However, the choices will *not* include the type of setup the prototypes are using. Those cars are being tested with the mini-skirt on the right side, the midi on the left. The last Cadillacs to use fender skirts were built in 1977.

### Skirts And Bustles

DeVilles also have a revised rear end for 1989, which includes longer rear fenders, new taillights and bumpers and extended fender caps. In addition, the sail panel in the rear of the roof and the rear

window are also slightly revised. The net effect is to give the mainframe Cadillac a longer, heavier and more substantial look. Insiders who have seen the new car say it bears a strong resemblance to the current Cadillac Brougham, the division's biggest sedan.

### Bright Is Back

You may be startled to see the amount of chrome trim on the new Chrysler New Yorker Brougham.

The sides of the car are almost dripping with brightwork, applied in quantities that haven't been seen on American automobiles since the early 1960s.

"Chrome is back," one Chrysler executive commented. "We're betting you'll see more on luxury sedans in the coming years." He went on to add that chrome trim is not being planned for all types of cars. Sporty models and lower-priced sedans will hold onto their body-colored bumpers and muted trim.

If the Chrysler bet is correct, you can score Highland Park as headquarters for trend-setting, because neither Ford nor GM is using this much brightwork . . . yet.



Bronco II's new face for '89.

### Double Overlay Olds

The resurgence of chrome trim reminds me of the story of the design of the 1958 Oldsmobile, one of the most lavishly chromed cars ever, even in an era when chrome trim was commonplace. About 18 months before the 1958 model made its appear-



'90 Ford Escort may feature styling from Merkur Scorpio.



ance, Olds stylists put on a show-and-tell program for Olds management.

The technique was simple: Project a red sedan on a viewing screen, and cover it with a selection of overlays that showed where the chrome trim would be attached. Each overlay projected a different trim design, from which the managers were expected to select the final design.

It seems that at one point in the presentation, two overlays got stuck together, so a double dose of chrome was shown on the screen. As one man, the managers jumped to their feet pointing and shouting, "that's the one." The "one" turned out to be what was produced, the 1958 98 sedan, a car that makes the high point, in terms of sheer mass, of chrome use at Oldsmobile.

## Two-Stroke Race

Chrysler powertrain engineers are working in deep secrecy on development of a 2-stroke engine that will be ready for production in the early 1990s, possibly as early as 1991. Chrysler reportedly is working on a 3-cylinder in-line type. But don't be misled. The 3-cylinder engine develops the output of a Six, generally speaking, because a 2-stroke has a power stroke for each revolution of the crankshaft. In a 4-stroke engine, combustion occurs every other revolution.

A small 3-cylinder engine, of less than 2-liters displacement, could easily turn out 150 to 200 hp. Small engine size, some increase in fuel economy, and light weight are other advantages of the 2-stroke. Drawbacks are high exhaust emissions, a problem that seems ready for a solution.

## Super Caddy

"If we have a V12, it will go into a car above the Allante." That statement from a Cadillac executive says two things: The luxury car division is definitely considering a V12 engine, and a supersedan is a possibility, too. "There is no way the Seville competes with the biggest Mercedes and BMWs," the Cadillac source admits. "So if we want to compete, we have to have a bigger, more expensive product." Tentative plans at Cadillac shape up this way: An aluminum, twin-cam, 48-valve 12-cylinder will be built if Cadillac is serious about establishing itself as a world-class luxury carmaker. The engine will be fitted north-south in a front-drive or 4-wheel-drive sedan. The price of this car will "exceed that of the Allante," possibly topping \$60,000. Timing would put the super Cadillac on the road no sooner than 1991. Its appearance—or nonappearance—will determine whether Cadillac is truly serious about regaining its stature as "an American Standard for the World."

## Mazda Detroit

Mazda's new Flat Rock, Michigan, assembly plant just outside Detroit will build the Ford Probe, the 4-seat sporty coupe that uses an MX-6 chassis with a hatchback body designed by Ford in Dearborn. Besides supplying Probes to Ford in the U.S., Mazda also has plans to export the car for sale to Japan.

This is a turnabout, made possible partly because the cost of building a car in the U.S. is now much more competitive with the cost of building one in Japan, thanks to rising labor costs in Japan and the increased value of the yen against the dollar.

Something else is different at the Mazda Detroit plant. Employees are furnished with work uniforms by Mazda, all of a green color, and all with a "Mazda" patch and a name patch sewed above the shirt pockets. The uniforms consist of pants, jacket and shirt, all washable. Manufacturing workers get five shirts and three pairs of pants. Non-manufacturing workers get three shirts, two jackets and three pairs of pants. The idea of uniforms is catching on among traditional U.S. manufacturers, too, and identically dressed employees could become a common sight in a couple of years.

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# AUDIO

BY FRANK VIZARD

## Rock Around The Clock

**T**HE term changer probably dredges up memories of stacked-up, 45-rpm singles. But you'd have to go back to the ill-fated BSR Accutrac 33-rpm changer of the '70s to get the nonstop programming possibilities offered by compact disc changers. Instead of just loading a single disc into a CD player, changers have "magazines" that let you load a number of discs all at once.

An increasing number of audio manufacturers offer CD changers for either home or car use but, so far, Pioneer appears to be the first to bring a degree of compatibility to both environments.

Pioneer introduced its home CD changer some time ago, with a magazine that can handle up to six discs. Recently, the company introduced its CD changer for the car. Logic would dictate that the same 6-disc magazine be used for the car player and, indeed, that's exactly what Pioneer has done. The benefit is obvious: It makes transferring your CDs from your car to the house and back again very simple. Now let's look at some of the other attributes of the new car CD changer.

For one, you get three music sources, not just two. Most car CD changers offer an AM/FM tuner as an option, but Pioneer's version comes with the radio and includes a cassette player as well. Pioneer's CD changer is actually one product sold in two pieces for a list price of \$650 each. The KEX-700 head unit looks much like a cassette receiver but also includes the controls for the CD changer. The CDX-M100 CD changer is mounted in the trunk and connected to the KEX-700 via cable.

Why sell the two pieces separately? My guess is that Pioneer will offer a head unit without the cassette option in the near future. Or, you



Front-loading Pioneer CD changer for cars uses 6-disc magazine. Infrared remote operates its dash-mounted CD/cassette/radio head unit. Technics changer accepts 12 discs, has infrared remote for the CD/radio dash unit.

can buy the KEX-700 now and add the changer mechanism at a later date. Introducing the KEX-700 at this time makes sense because with CD still a relative newcomer, you'll probably want to utilize both your CD and cassette libraries.

The Pioneer CD changer has all the features you'd expect from a top-of-the-line product. The changer is programmable so that you can play tunes in any order you want from all six discs. The CD changer can also play disc tracks randomly.

On the analog side, the cassette section has both Dolby B and C noise-reduction circuitry and features auto reverse as well. The tuner section sports 24 presets that double as the control panel for the unit's "secret code" security system. The system remains inoperable until you enter the correct code. You can, of course, change the code on a whim.

The Pioneer system comes with a wireless infrared remote control that will not overwhelm you with its complexity. There are only six buttons. One selects the function mode. Two more turn the volume up or down. The fourth mutes the volume. The other two, depend-

ing on the mode, either advance CD track selection forward or backward, activate music search in fast forward or rewind, or select the next preset station in the desired direction on the radio band.

The CD changer itself is a front-loading machine somewhat longer and narrower than its competitors—a design which may give it an edge in certain installation situations. Technics, for example, recently introduced a top-loading CD changer perfectly suitable for most trunk-mounting applications but which may not be as suitable for vehicles such as hatchbacks and wagons. Where no trunk is available, a front-loading CD changer is practical because it can be installed under a seat or inside a glove compartment if necessary.

Potential buyers should note that CD players are sensitive to vibration so it's important to choose the mounting location with this in mind. Recently, I test-drove a Jeep Cherokee that was equipped with the new

Technics CD changer. In this instance, the changer was bolted to the floor at the extreme left and rear of the vehicle. Although this location made the CD changer easily accessible from the rear door, it was also a spot that seemed to amplify even the smallest vibration into a laser-skipping, very audible "bump" in the stereo system.

Aside from the susceptibility to vibration, which I attribute to the choice of mounting location, the \$1000 Technics 12-disc changer performed very well and I particularly like the fact that the remote control is programmable. This means I was able to choose the order of track playback while I was still at home. When I got into the car, I simply "transferred" the programming data via an infrared beam into the system's in-dash head unit.

### Mice That Roar

Getting full-bodied sound out of small loudspeakers is a problem addressed by nearly every speaker manufacturer, if only because many music lovers lack the space for larger models but still want the wide frequency response and deep bass that big speakers can reproduce. Even for people with large living rooms, small speakers might be more welcome in the dining room or for the audio/video system in the bedroom.

The efforts of two compa-



Bose 2.2 makes up for small size by channeling backwave of the bass woofer through a tuned slot to reinforce low frequencies.



nies, Bose and ADS, characterize the current approach to optimizing the performance of smaller speakers.

Bose has developed a methodology the company calls "stereo targeting" for its new Model 2.2 speakers. Whereas most speakers radiate their sound patterns directly at the listener, the tweeters and woofers of the Bose 2.2 are angled inward in an effort to create a more widely dispersed stereo image. Deep bass is achieved by exploiting the speaker's enclosure. While the woofer pushes bass notes forward into the room, it alternately retracts as well. Bose conducts this backwave energy through the inside of the speaker so that it emerges through a vertical slot or port near the speaker's outer edge. The construction of the port is such that it "tunes" the escaping air to a low bass frequency that permeates the room. List price for the Bose 2.2 is \$299 per pair.

By contrast, the model CM5 from ADS has the familiar look of a speaker with woofers and tweeters facing the listener. On closer inspection, though, you'll notice some differences. Though conforming to bookshelf dimensions (10 x 7 x 6 in.), the CM5 is much heavier than other speakers of its size. Rather than construct the cabinet from a wood material as most speaker makers do, ADS uses a metal-impregnated polymer material that gives the CM5's enclosure greater density and inertness—despite its relative thinness. The idea is to prevent internal resonances and enclosure vibrations from adding a false coloration to the sound.

Similarly, new materials are used for the tweeter and woofer. Both drivers utilize a stiff proprietary copolymer material designed to prevent unwanted bending and flexing of the cones, while still being light enough to follow musical waveforms easily. The accuracy of the drivers has also been improved by using a stainless-steel bobbin for the voice coil that links the cone to the electromagnet. Among other attributes, this helps maintain a linear, piston-like motion as the speaker cone moves to and fro. Additionally, energy transfer between the tweeter and the woofer has been made smoother through the use of a better-quality crossover network—one that costs \$35 alone. A crossover is the traffic cop that directs bass, midrange and treble signals to the proper cone.

The materials used in the CM5 make it a superior speaker, and this is reflected in its list price of \$500 per pair. ADS has extended its use of new materials into slightly larger speakers listing for \$850 (CM-6) and \$1350 (CM-7) per pair, all three of which are collectively known as the Compact Monitor series. Larger floorstanding models from ADS, the M series, feature wood cabinetry and are priced as high as \$2750 per pair. **PM**

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# SANSUI SUPER-COMPO CONTEST

## AND THE WINNER IS...



**T**HE nicest thing about magazine contests is that although only one person takes the prize, everyone comes out a winner. Our "Sansui Super-Compo Contest" is a case in point.

Instead of sweepstakes, in which a winner is picked from a hat, POPULAR MECHANICS prefers to pose contests, which give us the opportunity to challenge the knowledge, skills and imaginations of our readers. We learn a great deal about you from the responses we receive. If we're doing our jobs correctly, we use this understanding to improve our magazine—to the benefit of all concerned.

Nearly 3300 of you responded to the challenge in our "Sansui Super-Compo Contest" (page 90, Dec. '86) for a chance to win the \$4000 hi-fi system. That remote-controlled package includes a digital-audio compact disc player, programmable turntable and AM/FM tuner, twin-cassette tape recorder, 160-watts-per-channel amp, graphic equalizer, loudspeakers and a rack. You were asked to solve two problems, and your solutions were illuminating.

By solving the first prob-



Sansui's \$4000 Super-Compo system, shown here and above, now graces the home of contest winner Lawrence Jedlicka.

Reader Lawrence Jedlicka wins our Hi-Fi Contest with an illuminating answer—infrared light.

lem, 82 percent of you qualified to win the prize. The problem involved a piece of music 80 minutes long, composed of four parts (17, 17, 26 and 20 minutes). Given a 90-minute cassette, with only 45 minutes of play time per side, you were asked how to record the piece so that the parts could be heard in their proper order—without interrupting the music in any part. The solution is to record Part 4 then Part 1 on the first side of the cassette, Part

2 then 3 on the other. To hear the parts in order, you begin with Part 1 on the first side, continue on to the other side for Parts 2 and 3, then back to the first side for Part 4.

The second problem was calculated to stimulate your imagination. It asked you to devise a way to get sound to a pair of loudspeakers located across the room from a hi-fi system, without any wires being visible.

About 40 percent of you came up with some pretty

clever ways to *conceal* the wires. The rest of you suggested some means of sending the signal wirelessly—which was getting warm. The 20 percent of all contestants who opted to transmit the music on a wave of light—such as infrared—were getting hot. It wasn't easy to select a winner from this large group, but when Lawrence Jedlicka submitted a hand-built scale model of a listening room to illustrate his well-reasoned argument for infrared transmission, he took the prize.

Mr. Jedlicka, 37 years old, has been a PM subscriber since high school and shows the wide-ranging interests we often find among our readers. When the retail grocer is not commuting to his Euclid, Ohio, store by motorcycle, he relaxes by scuba diving or by recreational flying. When he finds himself landlocked, he builds loudspeakers for friends. And when he really wants to exercise his woodworking skills, Jedlicka builds customized consoles for limousines. The day we contacted Jedlicka, he'd also received his PM subscription renewal notice! Our winner confided he was of a mind to re-up. **PM**



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# CAR OF THE FUTURE

*The Car of the Future. With the possible exception of aviation and space travel, no aspect of modern transportation has captured a bigger slice of our collective imagination. This goes right back to the very dawn of the automotive age, practically to the day when Gottlieb Daimler and Karl Benz wheeled out their respective inventions. You can almost hear the guys saying, "Yes, but what should they look like next year? Perhaps a bit more chrome."*

*Though most interpretations of the Car of the Future concept over the years have been entertaining to look at, not all of them have been totally in touch with reality. In fact, a number have bordered on Twilight Zone. Buckminster Fuller's pre-World War II Dymaxion comes quickly to mind. Streamlining was in, and Fuller's vehicle sought to be the ultimate expression of the no-hard-edges school of design. What emerged looked very much as if it could have been an egg laid by a U-boat—or maybe the prototype for generations of unborn Airstreams.*

*The business of giving shape and substance to the Car of the Future has become considerably more scientific since the day of the Dymaxion. We call them concept cars now, and they've been emerging in small but regular numbers over the past few years, each serving as a showcase for designs and technology that lie just over the next hill. A number of the most recent examples, including*



## CHRYSLER PORTOFINO

Sporting a 225-hp aluminum Lamborghini V8 with four Weber carbs and 5-speed transaxle, this mid-engine sedan is capable of a 150-mph cruising speed. Monocoque body has doors that pivot upward hydraulically, with no B-pillar to block entry.







Chrysler's wild, new, scissor-doored, V8-powered, 150-mph Portofino, hit of the recent Frankfurt Auto Show, accompany this story.

But these cars—Portofino, Pontiac Pursuit, Chevy Express, Ford Probe V and Oldsmobile Aerotech—are only automotive portents of the future interpreted in terms of technology that exists today. What can we expect tomorrow—just beyond the vehicles that the designers and engineers and product planners already have in their computers and cycle plans?

As we suggested earlier, the business of divining the automotive future has become a much more exact science than in the past. Thus, it's not unreasonable to attempt to forecast that just-over-the-horizon Car of the Future. Which is precisely what we intend to do. Over the next five issues, we're going to delineate the Car of the Future, system by system, curve by curve, design priority by design priority. We'll examine what's around the corner in suspension systems, electronics, automated systems, powertrains and, finally, exteriors. Our horizon is 2001 and beyond, a date we've all been conditioned to regard as the future, thanks to Stanley Kubrick. Yes, it's true that 2001 isn't as far away as it once was. But it's still sufficiently distant for us to be looking at elements that haven't found their way into any soon-to-be-produced designs.

Before we begin rummaging through the parts bins of tomorrow, though, we want to pass along an industry overview of the Car of the Future. Accordingly, we've corralled some of the men who will give shape to the ongoing dream—from top executive management, from advanced engineering and from the uppermost echelons of designs. Though you'll find some commonality in their thinking, their interpretations of the Car of the Future are far from uniform.

And that's what has made cars so interesting all along.—Tony Swan



"The next giant leap forward will happen in the dealerships."

**LEE A. IACOCCA**, Chairman of the Board, Chrysler Corporation.

After 41 years in this business, I have learned that you can't predict the future. It's gotten really tough the past several years because the market changes faster now. We were able to hit the market right on in a big way with the minivan, but that was a 5-year project. If you try to look farther out, you are really guessing at what the future holds.

And for every home run like the minivan, there have been items like the Wankel engine that never really clicked. Everybody's talking now about 16-valve engines and 4-wheel steering. But those features may be history in 10 years. Many of the big breakthroughs people were predicting still haven't happened.

Today, every manufacturer has access to the same technology, so it's going to be hard for anybody to jump out ahead of the pack with a radically new engine or other innovation.

Plastics, for example, still haven't been able to replace steel. There have been some interesting developments in electronics, but the real breakthroughs take time. There is not going to be a technical revolution. It is going to be an evolution and, basically, a car built in 2001 may not be all that different from the cars we are offering in 1988.

Actually, I think the next giant leap forward in this industry won't happen in Detroit. It'll happen in the dealerships. It'll happen when one dealer body earns a national reputation for being better than all the rest in customer service. Think about it: The industry is 100 years old, but no franchise has ever built and kept an advantage in the market based on service. Chrysler is making a strong pitch to be the first, starting with our extended warranties.

Obviously the manufacturers have to build in durability and reliability, but, in a few years, there will be no clear quality leader because everybody is getting good. Our service reputation will be more important than technical features.

Don't get me wrong. I hope to see more technological advances. I love to tinker with cars, and we have a ball putting together a concept model like the Portofino. That's the fun part of the job. But the real success is going to come in giving the customer what he wants, in providing consistent, first-rate quality in product and, more important, in service. Technology is more exotic, but service is what is going to separate the men from the boys—and the women from the girls—in 2001.



#### PONTIAC PURSUIT

Everything's electronic and computer-controlled in this dream car from the people who build excitement: steer-by-wire, 4-wheel steering, auto traction control, antilock brakes and active suspension. Power is from a 16-valve, twin-cam, intercooled, turbocharged Four rated 200 hp.







**FORD PROBE V**— As its name suggests, this is the fifth in the Ford Probe concept series, and the sleekest yet with a world record  $C_d$  of 0.152, exceeding even an F-15 fighter. Seating is 2+2, and interior amenities include heads-up holographic instrument displays.



"We're going to see a tremendous premium on better reliability."

**DONALD E. PETERSEN**, Chairman of the Board, Ford Motor Company

When I think about what's over the horizon in the early part of the next century, the first thing that comes to mind is something that applies to this business right now: The company or companies building the right products will be the company that's listening to the customers and giving them what they want.

Consistent with this, I believe we're going to see more and more variety in automobiles, which means each car will have a narrower, more specialized market. It's going to be up to us to figure out how to make money with this approach. That's going to be a real challenge.

As far as product attributes go, we're going to see a tremendous premium on better and better reliability. We're seeing a sharply rising curve of expectations in this area already, and as cars continue to improve, those expectations can only escalate.

One likely response to this trend by the various manufacturers is continuing sophistication in on-board diag-

nostic systems.

Cars will be able to store information that will not only help technicians locate problems but tell how the car's been running generally. This is part of the ongoing revolution in automotive electronics, and it's having a dramatic effect on products. It's going to make the car progressively better in terms of how well it does what it is the customer wants it to do.

Aerodynamics, of course, have played an important role in our recent designs and I don't see anything that's likely to alter this in the future. I think our Probe series shows how much farther we can go with the science of applied aerodynamics.

Performance will also continue to be important. There's just no substitute for performance. If there's anything we should understand about our customers, today and tomorrow, it's that they like good performance, a car that responds.

I also expect to see major improvements in interior friendliness—better comfort, with ergonomics that also provide more usable room.

I can't say that I expect to see any major changes in the fundamentals. We'll very likely continue with the internal combustion engine as a power source, for example. I do hope that by the turn of the century we will, at least, have moved on to mixed fuels, particularly methanol-gasoline mixes.

We have the technology now. Perhaps we'll see a viable electric car. The recent developments in conductivity made me think this might be close at hand for a time, but it looks as if it's still out

**CHEVROLET EXPRESS**

Capable of 150-mph cruising speeds with 25-mpg fuel economy, Chevy's Express clearly belongs to a future time. Complex electronics include ETAK navigation and power is furnished by a GM AGT-5 gas turbine. Express  $C_d$  is 0.195.







there over the horizon somewhere.

It's also very possible we may see guidance systems that will offer drivers the option of active or passive participation in the driving. But now, of course, we're talking about something that's way out beyond the year 2001.



"People will take to the new automotive technology quite readily."

**ROBERT STEMPEL**, President,  
General Motors Corporation

To begin with, we can say with certainty that the car of tomorrow is going to have four wheels, it's going to use rubber tires—rubber in the sense of the materials we use in its place—and it's going to use an internal-combustion engine. If you look at the last century of the automobile as a sorting-out process, this is what's emerged as the way to go.

From a manufacturing point of view, we look for a dramatic reduction in response time. A new car program that might have required four or five years will take only two or three. The Japanese motorcycle industry has had a profound affect on all of us in this respect. Their product development cycles are phenomenal. Of course, the capital investment that's allied with this is also phenomenal, regardless of corporate resources. So you can look for more and more cooperative ventures.

That doesn't mean fewer companies, though. For a time, a few years ago, we expected that we'd have fewer car companies by 2001. Now we expect just the opposite—continued growth and continued fractionalization in the market, with more and more manufacturers coming in. Nobody's going to sell a million of any one car any more. People like to have as many choices as possible.

We also believe that people will take to new automotive technology quite readily. They'll want the very latest. Look what has happened to stereos and personal computers. This is 180° away from the not-so-distant past, when you got praise for keeping it simple. The old Chevy Six was designed to that standard. It was tough. It could survive lots of neglect. And you could take the whole thing down with just a couple of wrenches.

If we tried to sell an engine like that today, we'd have a real sales disaster on our hands. If it doesn't have four valves and twin cams and knock sensors and port injection and so on, well, you're out of business. Not so long ago, say 15 years or so, we wouldn't even have thought about an engine like the Quad 4. Now it's hardly unusual at all, though we happen to think it's pretty good.

As far as engines are concerned, I think we're on the threshold of seeing some phenomenal power output from small displacements, and it's going to be consistent with clean running and good fuel economy. And at the same time, the pace of obsolescence is going to pick up even more. We may see new engines coming along with a production life cycle of as little as three to five years before they're either replaced totally or before

evolution of the next generation comes along.

Durability and reliability, of course, are going to continue to be top priority, and the better we get at providing this, the longer the service intervals become, the more people are going to take them for granted. This is particularly critical, because it's so important to make sure the customer's experience with a particular brand is positive. He won't care any more whether it was built in Detroit or Japan or Korea or wherever. Only that it's always shiny and ready to go.

Also, that it's fun to drive. There are a lot of components in this. It has to look good. It has to be easy to drive. It has to perform. And it better be fun to drive, because he or she will probably be commuting in it, just like today.

Something that's consistent with this is safety. Cars today are already outstanding on this score. But by 2001, they'll be significantly better. This will mean better in the sense of active safety—better control, better adhesion, better braking, handling, proximity sensing. Passive safety is completely overworked as a concept. Anyone worth his salt puts his seatbelt on, and that's all we ask.

We also expect that we'll see our highway system brought up to a proper maintenance standard and operating at design levels, which means faster than 55 or even 65 mph.

And the fundamental condition that makes the picture look so positive to us—challenging but positive, nevertheless—is the fact that people still love their cars and their trucks and the personal mobility that goes with them. We fully expect that will continue well into the next century.



"New glass will be thinner and be strong enough to be structural."

**JOHN J. TELNACK**, Vice President,  
Design, Ford Motor Company

We plan a continuation of the aero look in our cars of the future. We may not talk about it as much. It will just be an accepted part of our design.

There will be more glass in our cars. Owners may worry about that from a protection standpoint. But the kind of glass material we will use will be safe. We will still have to meet rollover requirements. Glass is heavier than sheetmetal. But we're not concerned about weight. The new stuff will be thinner, and be strong enough to be structural.

Drivers will notice increased visibility, and a more open feeling inside the car. Glass will be formed to match the shape of steel, so there will no longer be a strong delineation between glass and steel.

Proportions of the car will change a lot. I could call it a 1-box form as opposed to the 3-box that you have now—with hood, passenger compartment and trunk. A fast angle to the windshield and backlite will bring the hood and trunk more into the passenger compartment. That may sound pretty reachy, but you see the trends al-



ready, especially on the concept cars we build for shows. You may not like that idea today, but the rate of change in auto design is much faster now, so there's plenty of time to change your mind. The overall design will not be an eggshape. There will be dramatic sculpturing in the sheetmetal.

Also, the cars will be lower. We can go lower in height than what you see on the Taurus—1 to 2 in. lower would be a big selling point. Our research shows that people are willing to accept this even in the 4-door sedans.

Look for passive restraint systems to have a dramatic affect on interiors. Big hubs in the steering wheel are needed to house the air bag for the driver. On the passenger side, the instrument panel has to move rearward just to get the air bag in the correct position.

While cars will be about the same size on the outside as they are now, we will create more room inside with thinner doors, like the Europeans, and molded plastic seats. The seats will be highly formed to give the passenger more lateral and lumbar support. We will end up with a much more sculptured seat that can be built at a lower price. Plastic needs no sewings or tie-downs for upholstery. That's where the savings are.

There will still be a place for chrome. But instead of simply adding it onto the side of the car, we will design it into the sheetmetal. Look at what we're doing around the windows of Taurus and Sable now. The trim on those cars is fitted flush. This keeps it from having a tacked-on appearance.

On the Taurus of the next century, we will probably plan bigger tires and wheels, with a 16-in.-size as standard and even bigger ones available as option. They give the car a better stance visually, and better handling. On the subject of tires, we will have run-flat types that need no spare, which will open up the trunk for more room.



"By 2005, I expect to see glass roofs ... you'll dial in opaque or clear."

**CHARLES M. JORDAN**, Vice President,  
GM Design Staff, General Motors Corporation

We're not in the '50s anymore. We no longer are styling cars. What we do is work with engineers now to design a car where concept is woven into technology.

We picture a Ciera of the future with a lean, thin-wall appearance. It may look like it came out of an aircraft factory. Glass will be flush with metal, and there will be more of it. Windshields will be faster (steeper angle), and we'll have a different shape to the backlite. The backlite will flow into the trunk and both those parts could be made as one.

Sure, we'll have rounded aero shapes, but they won't be squirrel-cheeked.

They won't be fat. There are an infinite number of ways to design an aero body without making it a teardrop. Our philosophy is

not to design cars that are flat like a board, or fat like a jelly bean. We can do anything with shapes, anything that is consistent with good aerodynamics.

With the thin-wall, tubular look, you design a shell around people. Doors will be thin all the way so you won't have excessive fat hanging out under the glass windows.

By 2005, I expect to see glass roofs, the kind where you dial in opaque or clear depending on how hot the sun is. It's likely the whole upper part of the car will be glass, but it will be strong as sheetmetal.

We will still have exciting cars. Nothing changes in that regard. We have to look at a new car and respond to that car. Shapes will be different for each type of car. For instance, a Cadillac must be elegant, aloof, expensive—and exciting. Corvette will be different. We want to be sitting almost on the ground in a sportscar. That is part of the racy feel. Corvette will get more and more like a Formula One racer.

Even in one platform, there will be less overlapping of body parts. You won't see the five flavors of one sedan like we did with the J-car. We will have high vehicles for those who want them, and also wagons that are more like 4-passenger sportscars. It's just a matter of how much creativity we have the guts to apply to the new vehicles we design.

Finally, on the outside, we believe that wheel design is absolutely important in the design of a car. Bigger wheels are coming, and it is possible that 17-in. wheels will be common on midsize sedans. A change in wheel design may have more impact for less cost than just about any other feature. We have lots of development in wheels and tires that will show up before the year 2000.

The interior of the car will be one totally integrated compartment, not just seats, instrument panel and door trim. Controls and instruments will be felt and seen easily.

Space and the feeling of space will be important. Cowl heights will be low for better visibility. And windshields will be bigger. We have one experimental Corvette with a windshield that goes back to the second post. It's like we discovered Cinerama.

Heads-up displays of gauges will be important, too. We plan to project an image on the windshield out to sight at the distance of the front bumper. That's where it's easiest to see and still keep our eyes on the roadway

*(Please turn to page 90)*

#### OLDSMOBILE AEROTECH

Oldsmobile's Aerotech is a dream car with a difference—the world closed-course speed record. Powered by a 750-hp, 2.0-liter turbo version of the Olds Quad 4, the Aerotech and A.J. Foyt flew to a new closed-course mark of 257.123 mph, and also set a new flying mile record of 267.399.





Tearing across a dry lake bed in California, Pete Smiley's 30-ft.-long, streamlined speedster, *Indian*, has a 20-ft.-wide rear axle for stability at high speeds.



**T**HE competition seatbelt closes with a metallic snap as you slip on the helmet. Overhead, the Dacron sail snaps, its power waiting to be unleashed while the streamlined mast rumbles on its bearings. A pat on your shoulder comes from behind and you twist around to nod readiness.

Off to one side, you see a race official begin his walk along the line of machines, carrying the rolled-up starting flag under his arm. As he passes, you give him a gloved thumbs up. At the end of the starting line, he turns to survey the race course, then whips the flag downward.

Feet wedged firmly on the steering pedals, you frantically pull in line, trimming the sail inward.

You begin moving slowly with power from a push start. The sail snaps full and you feel a surge of acceleration. On your left and right, similar machines are accelerating hard and looking for clear spaces to break away from the pack.

You have a good start, and your speed is climbing fast—30, 40, 50. One machine is ahead of you and you steer slightly above him, aware of the taste of dust and the rattle of gravel from his tires. The first mark comes up fast and you slam a steering pedal down, the G-forces push you sideways in your seat as you rocket tightly around the flag.

The next leg is downwind and the breeze is picking up. You glance down at the speedometer and the



# DIRT BOATS

Skimming over the desert floor, wind-powered landsailers break the 100-mph barrier.

TEXT AND PHOTOS BY CHRIS CASWELL



needle hovers at 70. You hear the rigging start to hum. A rough patch of hard-packed silt makes your eyes blur and your teeth rattle. In the distance, you see the fast approaching second mark. Another push on the pedals and you turn more directly for the flag as the sail slams across overhead. Glancing over your shoulder, you can see that three other machines are close behind and another is slightly ahead. You find an opening and duck behind the leader to get the inside position.

Sweeping into the mark, your feet dance on the steering pedals as the fat road-racing tires briefly lose traction and then bite again as you round the flag in a long powerslide. You can hear the chatter

of the leader's tires behind you and, with the finish line in sight, you strain to trim the sail in another fraction for more speed. The ploy works. You move into the lead as the checkered flag waves you past.

That's what it feels like to race a high-speed, high-tech landsailer—a low-slung, 3-wheeled, sail-powered speedster that blends the best of sailboating, iceboating and automotive racing.

Just like a sailboat, landsailers rely on mast and sail for propulsion. At that point, however, any similarity ends. They have a single front wheel for steering and a pair of rear wheels spread far apart by a long axle for stability. Many are spiderweb frames of metal tubing, but newer models have





Recent breakthroughs include the wing/sail (above) on the hyper-speed *Zephyr*, and the aircraft-style cockpit (below) on *Scudoo IV*.



sleek streamlined fiberglass or aluminum bodies.

Steering is done with foot pedals, leaving hands free for lines controlling the sail, while the driver reclines in a deep bucket seat to reduce wind drag. Even the smallest landsailers reach 50 mph, while the larger machines go well beyond 100.

The first real record of landsailing, which has been traced to ancient times, comes from Holland in the 1500s when a landyacht was built for Prince William. Square-rigged wagons were soon reported trundling along hard-packed Dutch beaches at the thrilling speed of 25 mph.

America's first landsailing pioneer was known as Wind Wagon Thomas, who rigged sails on his Conestoga wagon while heading West. More ambitious was a French general and 11 other enthusiasts who landsailed across the Sahara desert in 1967, covering 1700 miles in 32 days, despite more than 500 flat tires.

Today's landsailers fall into two categories: open classes and 1-design. The open classes are composed of a

mixture of styles and designs, and most are homebuilt. The classes are further divided by the amount of sail area (ranging from the big Class II machines up to 121.6 sq. ft. down to Class V with only 49 sq. ft.), but the design of the landsailer itself is up to each owner-builder. Costs for building open-class racers range from a few hundred dollars to thousands.

Interestingly, the designs of the most advanced landsailers reflect the backgrounds of their owners. Those with boating backgrounds use the latest in fiberglass production techniques, while builders with automotive or motorcycle interests lean toward welded tubing and aluminum skinned craft. Some are long and lean like dragsters, while others more closely resemble runaway railroad bridges on wheels.

Many of the least likely craft have proven to be embarrassingly fast. Several years ago, an Englishman arrived at the America's Gold Cup Regatta, held annually at a hard-packed dry lake on the California-Nevada border, with a crate of spare parts. He assembled the parts into a scruffy and spindly landsailer and, naturally, blew everyone away.

Noted yacht builder/designer George Olson, a pioneer in ultralight displacement boats, produced one of the fastest breakthrough Class II landsailers a few years ago. His *Pterodactyl* features a 30-ft.-long fiberglass body and a 20-ft.-wide springy axle, with fat road-racing tires for traction. The sleek machine weighs just 600 pounds.

One of the most popular landsailers is the Manta, a tiny American-made landsailer that sports a 54-sq.-ft. sail.

Springy rear axle on *High Velocity* (above) transforms energy into forward thrust, while flared front wheel (below) reduces drag.



A new Manta, ready to race, costs about \$900, and its simplicity makes it ideal for weekend outings. Mantas are the most numerous landsailers in the country and rate a 1-design class of their own.

Certainly one of the most unusual landsailers to appear at recent America's Gold Cup races is *Zephyr*, built by Phil Rothrock of Portland, Oregon. *Zephyr* sports a wing mast rather than a conventional cloth sail, a result of more than a year of studying NASA reports on high-lift aerodynamics. After comparing various wing shapes on a computer, Rothrock chose a design with double-slotted flaps on the trailing edge. On its first outing in a 5- to 8-knot breeze, the aluminum-bodied 2-seater zoomed to 46 mph before bending the mast.

The cockpit of Rothrock's speedster bears a resemblance to that of an early aircraft, with numerous wheels to control angle of attack and camber. Utilizing cams, bicycle chains and sprockets, Rothrock can rotate the entire wing, or adjust the angle of flap to match the wind speed and direc-





tion. The wing itself is a birch plywood skin over wooden ribs, with a leading edge made of foam. Both the flap and foam nose are protected by fiberglass. Rothrock admits that his biggest problem is "keeping everything together, because it produces so much more power than we expected. But it's definitely the wave of the future in landsailing."

Confirming his prediction, Rothrock's Class III winged machine beat all comers at the recent Gold Cup Regatta, including the much larger and faster Class II fleet.

**The George Olson-designed, dragster-like *Pterodactyl* burns up the desert floor.**

Other designers are equally determined to defeat the enemies of speed: weight and drag. Many of the larger landsailers sport streamlined boots to enclose the wheels, with a wide diversity of opinion concerning the proper shape. End plates at the top of the mast and along the boom are used to channel the wind flow more efficiently, and block-and-tackle systems, which control the sail, are enclosed in drag-reducing skirts.

Although a race course may be several miles in length, a race lasts only a few minutes, because of the speed. Each race begins from a standing start and a push from a helper. The courses are usually triangular in shape, to create different wind angles and tactical situations. No races are started in less than 10 mph of wind.

The races are particularly exciting when the large Class II machines come roaring into a turn at speeds of 80 mph. The fastest way around a corner is in a controlled slide, and there is always a tense jockeying for the best position. On the reaches between the marks, the faster machines trail long plumes of dust, much like roostertails at a powerboat race.

In spite of the speeds, landsailing is a remarkably safe sport. Rollbars protect the drivers of the larger craft, while seatbelts and helmets provide insurance against spills. The combined mast structure and axles keep landsailers from turning over.

That isn't to say there aren't some hazards, and it definitely pays to be ahead of the fleet. On beach races, goggles are necessary to protect against the spatter of sand and spray kicked up from the leader's tires. On some American deserts, where cattle roam untended, the numerous "cow pies" are a course hazard. Unscrupulous leaders have been known to detour slightly in order to fling these pizza-sized deposits back at the fleet.

There is something addictive about gliding along effortlessly in a landsailer, every gust being converted into more and more speed. No other sport can match this feeling—going 100 mph propelled by nothing more than the wind.

**FM**



Moments before the start of a Class V race with home-built and 1-design Manta landsailers.





Silhouetted by a Texas sunset, the Rockwell International B-1B stands on alert with PM's Tim Cole.



# FAIL

# SAFE '88

BY TIM COLE, Science/Technology/  
Aerospace Editor; PM Photos by Kirby Harrison



**T**HIRTY-three-year-old Air Force Capt. John Chilstrom uses thumb and index finger to apply left spoiler to the control stick of the B-1B. And the strategic bomber—call sign “Pyote 21”—instantly snap-rolls perpendicular to the horizon, beginning a descent from 17,000 ft. to 500 ft. at just under the speed of sound.

“We’re entering the Strategic Training Range Complex,” Chilstrom explains over the B-1B’s interphone as the ground rushes up to meet us. “There aren’t too many people up here to disturb, so it’s a great place to train.” We level out at 500 ft. and the rolling hills, gulleys and grasslands of eastern Wyoming flash by the windscreen. “It’s also a great place to demonstrate how we elude fighters,” Chilstrom pushes the four throttle levers forward to the lock, and the four General Electric F-101s spewing fire out the back literally kick the bomber from .66 to .85 Mach. In roughly 6 seconds, we achieve a 173-mph increase in speed that pastes us in our seats.

At the same time, Chilstrom’s thumb and index finger gingerly work to skirt a tree-studded hillock.

“You see, first the bad guys have to find us. Then they have to catch us.”

Indeed, those twin demands placed on enemy fighters, the first line of defense against low-level attack bombers like the B-1B, are the reason the B-1B was designed and built. Strategic bombing doctrine shifted radically in the mid-’60s from high-level saturation attack to low-level penetration. Masking a lone bomber’s position in the terrain—as we were doing while Wyoming became a memory and bits of Montana screamed by 500 ft. below us at 630 mph—was determined the most lethal and effective way to deliver ordnance, nuclear or otherwise.

Hence the rationale for the swing-wing B-1B, America’s newest bomber, and the follow-on Advanced Technology Bomber, which will enter this nation’s nuclear deterrent in the mid- to late-’90s. The 100th and final B-1B is scheduled for roll out at Rockwell International this April, and B-1Bs are filling the flight lines at Dyess Air Force Base in Abilene, Texas, Ellsworth Air Force Base in Rapid City, South Dakota, and Grand Forks Air Force Base in Grand Forks, North Dakota. How are they performing?

“The pilots and crews think they’re fantastic,” says Chilstrom as we roll below the lip of a canyon, the bomber streaking atop the sun-flecked mist of a South Dakota morning. “It’s got it all over everything else that flies.”

That’s a tall statement—one that’s echoed by a lot of pilots



**"It's vital, serious work, charged with all the complexity—and danger—of the real thing."**

and ground personnel. But we wanted to find out firsthand how well the bomber performs its assigned mission, which is why we are here, inside the belly of a B-1B, ripping along at speeds ranging from 156 mph to well over 600, and at altitudes from 500 ft. off the deck to 24,000 ft. We're on a training flight that will simulate a low-level bomb run against enemy territory—the same mission Pyote 21 would perform if the crew were ordered to strike a pre-assigned enemy target in the event of war. This kind of flight training is a dynamic element in working the B-1B into the Strategic Air Command. It's vital, serious work, charged with all the complexity—and danger—of the real thing. Bird strikes and mountains pose real threats—even in peace-time. (See sidebar.)

Intensive training is also a natural extension to the B-1B's awesome ground preparation. Chilstrom explained earlier as Pyote 21 taxied out to the head of the Dyess runway, ready for our 7-hour flight to Montana and back. Chilstrom was joined in the cockpit by Copilot Capt. Jeff Beene, Defensive Systems Officer Capt. Jon Antonson, Offensive Systems Officer Capt. Lance Dickinson and Avionics Instructor Capt. Tim Young.

My personal training for this mission began back in the altitude chamber at Andrews Air Force Base outside Washington, D.C., where I learned the intricacies of altitude physiology and how to operate a standard Air Force oxygen delivery system. Riding aboard the B-1B requires additional instruction in working the plane's interphones, deploying the instructor pilot's (IP) seat between pilot and copilot, and exiting quickly if there's an emergency on the ground. Because the IP seat cannot eject, I was fitted with a parachute and learned the procedure for departing the plane in flight, called the "bottom bail out" technique. It involves manually equalizing cabin pressure, then blowing away the bottom hatch and stairway with an explosive charge. The details—each tiny move—became etched in my mind when Pyote 21 received takeoff clearance and started to roll.

A scant 3 minutes elapsed between brake release and level off at 17,000 ft. ATC soon cleared us to 24,000 ft. and the crew became quiet, business-like. The 2-tone green visual situation display (VSD) provided us with artificial horizon, ground speed, air speed, radar altimeter and time to target.

Engine performance was indicated by neat rows of white bars showing power level, fan rpm, engine temperature, core rpm, oil pressure and oil quantity. I sat next to the tiny galley, so I spent some of the time acting as flight attendant, serving lemonade, water and coffee.

"One thing we'll do today is closely monitor the timing on each leg of the route," said Capt. Beene from the right seat. Pilot and copilot each had stopwatches strapped to their right thighs, along with fat loose-leaf notebooks containing innumerable checklists and admonitions. Back in the dimly lit offensive/defensive officers' station, Lance Dickinson and Jon Antonson continually monitored the "threat environment" amid the speckled glow of 100 tiny indicator lights. While Antonson monitored the signals around the plane with his passive systems, Dickinson kept tabs on our Inertial Navigation System position and double-checked the stores bays—actually loaded with a removable fuel cylinder, but loaded with gravity bombs and short-range attack missiles in simulation.

An hour and a half into the flight, we made ready to enter the Strategic Training Range Complex (STRC) near Harrison, Wyoming—a predesignated ground track with a 4-mile-wide zone on either side of it. Five-point seat harnesses were double-checked, oxygen masks were snapped to helmets, Nomex gloves were flexed over hands and sun visors were lowered in place. Chilstrom and Beene read off the low-level attack checklist: Fuel panel, checked; altimeters, set; radar altimeter index, set; Identification Friend or Foe, on; ejection mode knobs, auto; throttles, set; wingsweep, 67.5°; altimeters, cross-checked. Small computer-actuated canards forward are linked to the Structural Mode Control System (or SMCS) which evens out the bumps and provides a stable launch platform. Chilstrom engaged the system and executed a sharp roll to port. We descended through crystalline air to the craggy, burnished Wyoming countryside.

The low-level attack begins.

The Pyote 21 crew is in the midst of its TFR training, so we are hand-flying the STRC today. It's expected we'll vary our altitude by as much as 100 ft. plus or minus—gauged by the radar altimeter—as we jink through the terrain trying to outrun phantom fighters. With SMCS (the crew pronounces it "smucks") working overtime to even out our ride, the experi-



From top to bottom: A cockpit view as a B-1B, call sign Pyote 21, rolls with the countryside through the Strategic Training Range Complex. Aircraft Commander Captain John Chilstrom completes checklists after practicing the art of "terrain-masking." A boom operator aboard a KC-135 tanker refuels a B-1B, performing a vital strategic function. A rotary dispenser bearing inert weapons illustrates the B-1B's sophisticated weapons handling system.

PHOTO BY TIM COLE

PHOTO BY TIM COLE





The sculpted muscle of a B-1B streaks over the clouds at .90 Mach.

ence is pleasant, if surreal. The ride is surprisingly smooth, and I have no difficulty keeping the lemonade in my paper cup. We fly almost casually over the ground and bank sharply around hillsides, pilot and copilot discussing terrain-masking options: "Let's duck behind that mountain." "Can you squeeze over that hill?" "How about down inside that canyon?" Meanwhile, the offensive systems officer reads the radar to warn of upcoming ridges. Occasionally, we have to look up at the canyon rims as they streak past. By leaning forward during a sharp roll, I can see the B-1B's shadow sketching along the Earth in a blur. Chilstrom continues his 2-finger grip on the control stick, "I like to keep the inputs deliberately small." He gives the airplane to Beene, who has a practiced but aggressive touch. Chilstrom is the artist. Beene is the warrior. The aircraft responds to each and assumes their personalities.

Along the STRC, we'll lock on to targets in Powell, Wyoming, Forsyth, Montana and Belle Fourche, South Dakota. For training missions, the offensive system avionics emit a tone on bomb release that ground-based computers sense and score. Of-

*(Please turn to page 99)*

## When Training Turns To Tragedy

**C**ALL sign "Taupe 52" flew out of Dyess Air Force Base on the morning of September 28 and never returned. Its young B-1B crew was engaged in a low-level training mission when the aircraft flew into a large flock of Swainson's hawks near La Junta, Colorado. The plane suffered multiple bird strikes, which knocked out engines No. 3 and No. 4. The effect was like being hit by 4-pound bowling balls at 500 mph. Witnesses reported seeing a fire near one engine nacelle, which may have been sparked when damaged turbine blades sliced through fuel and electrical lines. The pilot fought for altitude to give the crew time to bail out. Three made it. Three did not. And Taupe 52 became the first production B-1B to crash, another victim of the more than 2500 bird strikes the Air Force records each year. Some encounters with birds result in minor damage. Some can down an airplane. The danger multiplies when the aircraft is flying fast and low—the way the B-1B was designed to fight.

The Air Force identified the victims as Maj. James T. Acklin, 37, an instructor pilot, 1st Lt. Ricky M. Bean, 27, a student pilot, and Maj. Wayne

D. Whitlock, 39, an instructor defensive systems officer. Surviving crewmembers were Capt. Joseph S. Butler, 33, a student defensive systems officer, Capt. Lawrence H. Haskell, 33, a student aircraft commander, and Maj. William H. Price, 42, an instructor offensive systems officer.

The Air Force will complete its investigation in coming months. But having flown in the instructor pilot's seat, I can speculate on why the survivors got out—and why the victims didn't. Although the Air Force declines comment, insiders theorize that the two crewmen sitting aft in the defensive/offensive systems station ejected safely. Then, one of the pilots in either the left seat or the right seat punched out, too. That left the two observer/instructors in their non-ejecting jump seats. Their only option—as Taupe 52 tumbled out of control—was to stow their seats, blow away the air stairs and exit out the bottom. Struggling to move inside the wildly pitching aircraft, they simply ran out of time. The remaining pilot chose to stay at the controls 'til the end to keep Taupe 52 in the air—and give his friends a fighting chance.

—Tim Cole





# SUPER HOME VIDEO

The latest super VCRs and TVs surpass today's broadcast standards—and set the pace for tomorrow's.

BY JAMES B. MEIGS, Contributing Editor

**S**HARPER than a TV broadcast. More resolution than a laser video disc. Able to capture live action like a mobile news camera. It's Super VHS, S-VHS for short, and it represents a quantum leap in home video picture quality. Moreover, this new breed of VCR will carry home video through the rest of the century, sparking improvements in broadcast and cable TV transmissions along the way.

After this enthusiastic buildup, you're probably wondering what S-VHS means for you. The first Super VCRs and camcorders are making their debut in retail stores. Does this portend early retirement for your current VCR and tape library? Will you have to invest in a new TV to enjoy the doubled picture-detail that S-VHS offers?

After examining the new Super VCRs, and trying them out with some of today's—and tomorrow's—top television monitors, we have some good news and some bad news. The good news is that S-VHS really does provide a dramatic improvement in picture quality over today's home video formats. It could open the door to even more stunning improvements in broadcast and cable television. In fact, manufacturers of the Beta VCR and LaserVision video disc formats have announced they are working on enhanced versions of those video media.

The bad news is that, yes, your current video equipment is to some extent





JVC's GF-S1000HU Super VHS camcorder uses full-size cassettes for up to 8 hours of recording. Like Zenith's VRD700HF Super VHS VCR, its picture resolution exceeds broadcast standards. Y/C jacks (inset) improve it further.



# SUPER HOME VIDEO

obsolete. But before you rush to trade in your system, take a good look at that "to some extent." At this stage, S-VHS is definitely not for everybody. To determine whether S-VHS is right for you—and to know how to take advantage of the new format if you do decide to spring for it—it helps to understand how S-VHS works.

Although many new video fans don't realize it, the picture quality of most home VCRs today is really only fair—not even as good as a live TV telecast. Engineers measure picture resolution by counting the vertical bars or lines recorded left to right on a test pattern. The greater the number of lines reproduced, the finer the detail of the image. (This measurement, confusingly described as "lines of horizontal resolution," shouldn't be confused with the 525 standard scanning lines that deliver the TV picture.) U.S. television broadcasts can transmit up to about 330 lines of resolution, and today's best TV monitor/receivers can reproduce more than 400 lines. But the average VHS VCR offers about 240 lines at best. S-VHS offers a crystal-clear 440 lines of resolution, nearly twice the detail of today's best VHS VCRs.

Like the original VHS format, S-VHS was largely developed by engineers at JVC in Japan. Their goal was to produce a radical improvement in VHS picture quality while changing the VHS operating system as little as possible, in order to minimize any incompatibility between S-VHS and conventional VHS. To do that, JVC retained the same cassette size, tape

speed and method of audio recording. The method of video recording (frequency modulated, or FM, "color under" recording) is also similar, but the engineers made one big change: They shifted the luminance signal (the black-and-white portion of the TV signal) to a much higher frequency.

Conventional VHS records the luminance signal in a frequency band between 3.4 and 4.4 megahertz (MHz). The S-VHS signal is recorded in a band from 5.4 to 7.0 MHz. The S-VHS signal is not only higher, but also occupies a band that is 60 percent broader (1.6 MHz compared to 1.0 MHz) than conventional VHS. That broader bandwidth means it can handle far more picture information, especially high-frequency signals.

This is visible in the fine details of the picture: Skin texture, hair, foliage, woven fabrics and other delicately featured surfaces and shadow areas stand out crisply in S-VHS, whereas they blend into flat, cartoon-like strokes in conventional video images. In addition to this expanded frequency bandwidth, S-VHS VCRs also boast a new form of video noise reduction developed by American electronics innovator Yves Faroudja. The system uses a digital delay circuit to boost the picture information relative to the background noise.

The high-frequency recording of S-VHS would never have been possible without the enormous progress magnetic tape manufacturers have made in improving videotape. Although the new S-VHS tape uses essentially the same kind of iron-oxide material employed by regular VHS tape, manufacturers have refined the familiar material for better performance. The magnetic particles in the new tape are substantially finer than those of ordinary tape. This means more particles can be packed on the tape. This combination reduces noise, and is better for

recording high frequencies.

All S-VHS VCRs can play and record regular VHS tapes, so you won't have any problem playing back tapes from your existing collection or the local video store, or recording on conventional cassettes. And, since S-VHS cassettes have a special identifying hole, the new decks will be able to distinguish between the two types of tape. An S-VHS cassette will also work fine if you use it to record in a regular VHS deck (it won't give you an S-VHS picture, but it will perform like an excellent high-grade).

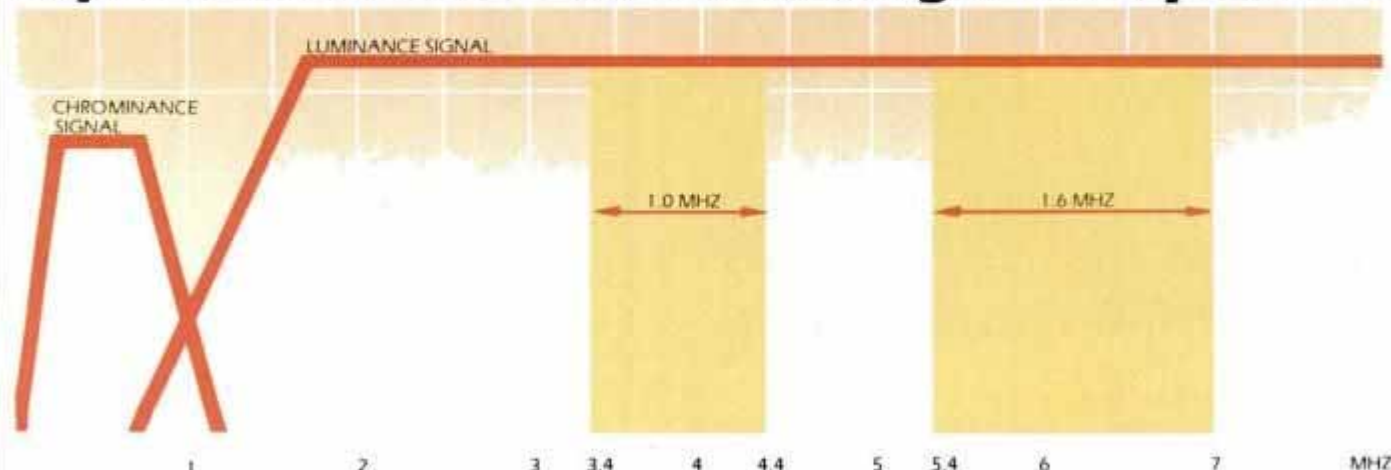
The one thing you can't do is play back a recorded S-VHS cassette in a conventional deck. Because of the shift in frequency, your old VCR won't even pick up the S-VHS signal. That's going to complicate tape trading among friends and family: If you have an S-VHS model but your friends don't, you can play back their tapes but they can't play the ones you record, unless you record in the conventional mode.

Some prospective S-VHS buyers might worry that after spending all that money on a new Super VCR they will have to turn around and buy a new TV, too. Fortunately for most buyers, that won't be the case.

Monitor/receiver TV sets (models with direct video and audio jacks on the back and comb filters for improved pictures) have improved dramatically in recent years. Almost all offer picture quality far better than that delivered by today's TV transmissions. In a sense, S-VHS is simply catching up with the high standard already set by current TV monitor technology. If you purchased your monitor in the past three years, you should be able to take advantage of virtually all the quality boost in S-VHS.

Actually, the compatibility question is a bit more complicated. In addition to direct video jacks, S-VHS

## Super VHS: Wider Bandwidth, Higher Frequencies



The 1.6 MHz bandwidth that Super VHS (right) uses to store luminance signals captures more detail-bearing high frequencies than VHS.



manufacturers include a new type of connection specifically for S-VHS, called an "S-connector."

The new hookup actually contains two separate signals in a single cable. All VCRs record the luminance (or black-and-white) portion of the TV signal separately from the chrominance (or color). Normally, these two signals are combined in order to travel through the cable to the TV set. But the S-connector keeps them separate. This is a common feature with professional video equipment—the pros call it a "Y/C" connector (the Y stands for luminance, C for chrominance). Keeping these signals separate helps prevent the interference or "crosstalk" between them that can cause minor picture problems such as graininess or vibrating moiré patterns. The S-connector helps improve the already excellent picture of S-VHS, but it is by no means necessary.

For many video enthusiasts, the camcorder is the most exciting aspect of the S-VHS revolution. So far, every company offering an S-VHS VCR also plans to introduce a Super camcorder. The home moviemakers will come in two types: full size (using a full-size VHS or S-VHS cassette) and VHS-C (using the cigaret-pack-sized C cassette in either its VHS or S-VHS form). Either type can play back high-resolution S-VHS images directly on your TV set.



Compared to conventional videotape, Super VHS has finer particles, and more of them, to capture greater detail. These electron microscope photographs from Scotch/3M show (from left) standard VHS and Super-VHS particles magnified 42,000 times.

Interestingly, the S-VHS-C camcorders offer one striking advantage over their conventional counterparts. All VHS-C camcorders give you the choice of shooting in the SP (standard play) speed, which allows 20 minutes of taping on the miniature cassette, or shooting in EP for 1 hour of recording on one cassette. With conventional VHS-C camcorders, the 1-hour speed offers barely acceptable picture quality, but the new Super models should deliver stunning quality even at the slower speed. Preliminary tests have shown surprisingly little difference between the SP and EP performance of S-VHS VCRs. That translates into an hour of high-quality S-VHS recording with a camcorder that weighs under 3 pounds. In fact, in terms of picture quality the new S-VHS camcorders have actually leapfrogged

some costly professional video systems used by TV news crews.

Even more than with home movies, VCR owners are in love with the Hollywood variety. So what about prerecorded movies in S-VHS?

The technology to mass produce S-VHS prerecorded cassettes already exists. U.S. movie studios probably will release S-VHS titles as soon as the population of S-VHS VCRs here passes the 1 million point—sometime this year. Owners of ordinary VHS decks can rest easy, though. With well over 100 million VHS VCRs in homes around the world, and hundreds of millions of VHS cassettes in video stores and home collections, conventional VHS will carry on as the mainstream home video format for quite some time. S-VHS will coexist with it as a kind of luxury option. **FM**

## Happy Birthday, Superman!

**O**UR lead illustration is more than coincidental with the arrival of "Super" home video. Fact is, Superman flew into our lives 50 years ago and landed, hands on hips, firmly in the midst of our imaginations. This year marks the golden anniversary of the friendship between this superhero from Planet Krypton and the people of Earth, and new videotape releases, a television special and other events will commemorate the occasion.

CBS, for example, plans to air a special tracing the Man of Steel's career since its 1938 beginnings. In Washington, D.C., an exhibit at the Smithsonian Institute's National Museum of American History explores the impact of Superman on American culture. Celebrations are also planned for New York City (a.k.a. Metropolis) and in Cleveland, birthplace of the legend.

Superman began his career as a comic book character created by Jerry Siegel and Joe Shuster. A decade later, he moved to the silver screen and his star has shone in Hollywood ever since.

Three actors have portrayed Superman over the years. Christopher Reeves, most recently of "Superman IV" fame, is probably the most familiar to younger fans. But Warner Bros. is appealing to nostalgia buffs



George Reeves, TV's Superman, lives on tape.

with the videotape release of "Television's Best Adventures Of Superman," starring George Reeves.

Each of the initial two volumes in this series contains two episodes from the 1951-1957 TV series, one black & white and one color. Volume I features the 1951 b/w pilot episode "Superman On Earth" and the final 1957 color adventure "All That Glitters." Volume II contains the 1953 b/w "Crime Wave" and 1957 color "The Perils Of Superman."

Each volume also contains a Superman cartoon created by acclaimed 1940s illustrator Dave Fleischer. Warner has produced new prints of the 17 Fleischer cartoons, long cherished among collectors. Simple math indicates that Warner will release 34 of the 104 Superman TV episodes available. List price for the first two volumes in the series is \$25 each. "Superman And The Mole Men" (\$60), an hour-long 1951 TV feature, is also available on videotape.

While the popularity of George Reeves as Superman is seemingly assured, he was not the first actor to portray the Man of Steel on film. That honor belongs to Kirk Alyn who starred in a 15-chapter serial made in 1948, now available from Warner as a 2-video-cassette volume called "Superman—The Serial" (\$100).

—Frank Vizard





TEMPERED GLASS

MAGNUM  
SERRAVALLO

ICE



It's dark. It's cold.  
And the only way out is a 6-ft. hole.  
But risk is the reward for a small band  
of wintertime scuba devotees.

BY JOHN FINE  
PM Photos by Robert McQuilkin

**T**HE ice forms a thin, rock-solid barrier between two vastly different worlds. On top, a freezing wind snaps around the pressure ridges and ice heaves, gnawing at skin and lungs. Underwater, two divers are engulfed in frigid silence. A lost tether or an equipment failure can lead to quick death in this sub-freezing water.

They're not polar scientists or Arctic explorers. They're ordinary people who go ice diving every winter—just for fun.

"Once you go in, the feeling you get is hard to describe," says Joe Oliver, a veteran ice diver from Chicago. "The light. The motion of the water. The colors. You have to try it to really experience it."

Robert McQuilkin, a professional sports photographer, has taken his cameras below the ice. He relates a common lure.

"Take Lake Superior," he says. "There is amazing visibility under the ice that you just can't get in summer. I can take a picture of a shipwreck 100 ft. deep, see it and the divers clearly, and get the ice on the surface—all in the same frame."

How do they gain entry to this very special world? Hard labor, teamwork, well-engineered equipment—and a healthy dose of fortitude.

## Cutting through

Ice diving is a team operation, usually requiring four to five people whose tasks are carefully assigned. A lot of heavy gear is required. In addition to the scuba equipment, ice divers need ropes and harnesses, warmup tents, a chain saw, snow clearing equipment and backup emergency gear. It all has to be carried or snowmobiled out to the site where the divers want to go in.

When the snow is cleared off the surface of the ice, a triangular hole is chopped, but more frequently chain sawed, through. The block of ice is pushed down in the

# DIVERS

water and slid back under the ice so it won't come back to block the hole.

"We use a triangular shape because it's easier to get in and out. We can simply wedge in a corner. A circle is too slippery," Oliver explains. The team also uses the snow cover over the ice to shovel out a spoked-wheel or other pattern visible to divers looking up from below. Sunlight filtering through the shoveled pattern



A scuba-equipped ice diver comes in from the cold (opposite page). From top, an ice diving expedition begins with a long haul out to the site. Triangular-shaped holes allow divers to wedge in corners. Taking the plunge, an ice diver remains secured to a topside safety team. Finally, danger and fascination converge as a diver confronts a hard-water barrier.





## ICE DIVERS

shows them the way back to the hole.

Divers are careful to replace the ice block before they leave so it will refreeze, posing no danger to snowmobilers or ice fishermen. The hole is then marked with a tree branch as a warning.

### Team players

Divers usually adhere to one cardinal rule: Never dive alone. In some cases, ice divers amend that rule. Gary Cholwek, an ice diver out of Squaw Bay, Wisconsin, often puts only one diver down at a time.

"What we do may be considered controversial by some," Gary explains. "But we prefer to put one diver at a time under the ice with a tight tend manned by experienced ice divers. Every 30 seconds, the tender gives one pull for an 'Are you okay?' If there's no response, the line is reeled in quickly."

Instructor Cholwek shackles his divers into a harness worn over the dry suit equipped with locking mountaineering carabiners. The end of the line is eye-spliced and set into the ice with pitons or ice screws so that even if the tender drops the line, it will be secured.

"The line limit is 150 ft.," Gary continues. "We have a standby safety diver ready to jump in if there's a problem. The safety diver has 300 ft. of line. If a diver gets lost, or if the line somehow becomes detached, he's been trained to go to the surface. He waits for the safety diver's safety line to come by as the reserve diver sweeps around just under the ice with his longer line."

If two or more divers go in under the ice simultaneously, a separate tender is required for each diver. Gary contends that having two or more people under the ice at the same time complicates the job of the surface tenders and standby safety diver. He concedes that some ice diving instructors and professionals insist on the buddy system, which, of course, increases the number of people required on the team.

### Gear

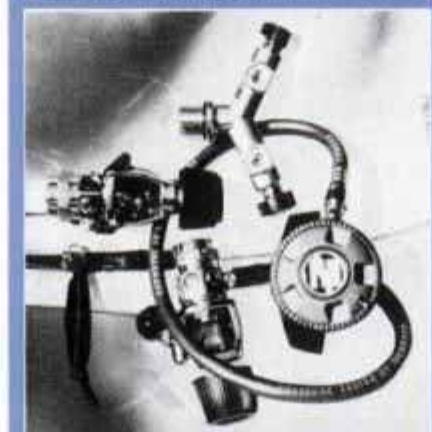
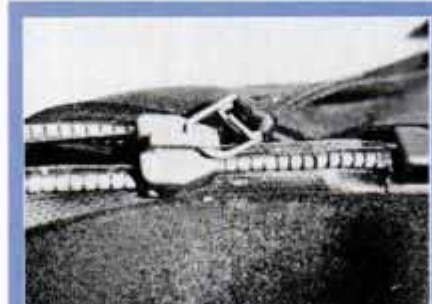
State-of-the-art breathing systems that won't freeze up, and technology adapted from various disciplines—including mountaineering and space exploration—insure a margin of safety where there's no room for mistakes.

Before space-suit zippers came along to make sport diving suits air- and watertight, ice divers wore thick neoprene wet suits—some almost 1/2 in. thick. A wet suit is just that. It permits a layer of water to get be-

tween the suit and the diver's skin. The water eventually warms up, but the first few minutes in freezing conditions can be brutal.

"It was like jumping into a snow bank naked," Joe Oliver remembers, his wet suit days now a thing of the past. Enter the dry suit.

An element as simple as a common zipper is the key. To insure total integrity from water and air seepage, modern dry-suit zippers incorporate tiny rubber discs between bronze fastenings. When the suit is zipped, the zipper completes an impregnable rubber-to-rubber contact. Steel grommets clamp the rubber together,



Henderson dry suit reveals the key to modern ice diving—a high-tech zipper (top) that forms a tight rubber-to-rubber seal. The Sherwood Blizzard regulator (above), made especially for ice diving, relies on an antifreeze-up design.

forming a tight seal. The special zippers keep divers warm inside, and also permit compressed air from the tank to be used to inflate the suit, providing both buoyancy and insulation. The diver's underwear is generally a potpourri, everything from long johns to special 1-piece wooly-bears and insulated suits designed for use under dry suits.

While dry-suit advancements have limited an ice diver's exposure to temperature extremes, special engineering also had to go into the regulator. The equipment developed by Jim Fox and engineers at Sherwood Scuba have revolutionized the way regulators are designed and made. The Sherwood Magnum Blizzard regulator is unique to the diving industry.

"Anyone who dives in fresh water where the temperatures get down to 45° F can develop regulator freeze-up," Jim says. "A frozen regulator will free-flow, and a diver can lose his entire air supply in seconds."

Sherwood's solution is simple and effective. "In traditional regulators the first stage, the part that is attached to the tank, is equipped with a spring-loaded piston," Fox continues. "The piston chamber traditionally has holes in it so that water can enter the chamber. As a diver descends, the increasing weight of the water increases the pressure affecting the spring, which increases air pressure. This is how the regulator 'regulates' the air that flows through the hose to the second stage as the diver breathes."

The Sherwood Magnum Blizzard keeps water out of the first stage so there's no problem of ice forming around the spring. The key is a dry-air bleed system equipped with a purge.

"We have air bleeding through the piston at a controlled rate. It is really an insignificant amount of air, about 13 to 17 cc per minute, the equivalent of maybe one breath of air used by the bleed system per hour," Fox explains. "Air coming through the piston fills the spring-chamber, this air exits through a 1-way bleed valve. The unit is venting a little stream of bubbles all the time. That air pressure keeps water out. And keeping water out prevents freeze up."

Further, the Blizzard's second-stage, the mouthpiece part, is coated with Teflon to prevent ice from sticking to it. And finally, the Magnum Blizzard relies on simple but ingenious mechanical engineering to keep the demand lever near the mouthpiece from freezing.

"The second stage has heat transfer fins in the mouthpiece," Fox says. "It takes the heat from the diver's exhaled breath and directs it to the lever assembly where second-stage freeze-ups occur."

### Cold wilderness

A lot of ice divers make money doing salvage jobs when snowmobiles or vehicles break through.

For Gary Cholwek, who teaches ice diving, the best salvage was the \$21,000 Eldorado convertible that went through the ice—and is now back on the road.

But the real challenge for most of them is the thrill of exploring a wilderness few people experience.

Jim Fox sums it up.

"There's excitement in knowing that the water just outside your dry suit is cold enough to kill you." **PM**



# SAW BLADES

A comprehensive guide to today's best saw blades.

BY JOSEPH TRUINI, Shop And Tools Editor  
PM Photos by Brian Kosoff

**S**AWING a piece of wood cleanly and precisely is one of the many enjoyable subtleties of woodworking. Much of the credit for executing such a cut rightfully belongs to the skillful woodworker and the saw itself. However, credit is seldom given to the primary reason why the cut is successful—the saw blade. If a blade is dull or if the wrong blade is used, all the skill in the world won't produce a clean cut regardless of the sophistication of the saw.

Circular saw blades come in different styles and sizes to cut a wide variety of materials. The 20 blades shown on the following pages represent a relatively small, but significant, sampling of the incredible number of blades available. The blades can be used on the table saw, radial-arm saw, portable circular saw and power miter box. Choosing the correct blade depends on several factors including the kind

of saw, type of cut and the material you're cutting. There are blades available for sawing nearly every imaginable material including wood, plastic, metal, concrete, ceramic tile, cast iron, hardened steel, bricks and marble. Another deciding factor when choosing a blade is the degree of smoothness desired. There are many blades available that will produce a supersmooth cut. However, for certain jobs an extremely smooth cut isn't particularly important. Therefore, you may want to use a less expensive, faster-cutting blade that



## SAW BLADES



*RemGrit*

"GRIT-EDGE"

7"

SEARS / CRAFTSMAN

*Excalibur*

INDUSTRIAL QUALITY  
CARBIDE TIPPED  
CROSSCUT

32033

ARBOR  
5/8"

leaves a slightly rougher cut.

**Blade styles**—Each saw blade is designed for a specific purpose since no single blade can handle all cutting tasks. There are some versatile combination and general-purpose blades that can rip and crosscut. However, these blades don't perform either cut as well as a blade made specifically for ripping or crosscutting. Some of the most common blade styles include rip, crosscut, combination and plywood. You also have a choice of blade construction: steel or steel with carbide-tipped teeth. Steel blades have teeth that are cut in the steel blank that forms the blade body. The teeth are then sharpened and set, or bent, alternately to the left and right of the blade. This forms a kerf slightly wider than the blade body to prevent it from binding in the cut. Steel blades are inexpensive and, although they dull rather quickly, their teeth can be resharpened easily in the shop with a file. Carbide-tipped saw blades are the choice of all serious woodworkers. These long-lasting blades have teeth of supertough tungsten carbide. The teeth are brazed to a steel body and then ground sharp. A carbide-tipped blade will remain sharp



7

8

freud

LUP™

10



BLACK &amp; DECKER

Piranha

Carbide-Tooth Saw Blade

11

many times longer than a steel blade. However, once it does become dull, a carbide-tipped blade must be sent to a professional sharpening service or returned to the manufacturer for reshaping. Many saw blade manufacturers sharpen both steel blades and carbide-tipped blades. Some makers even offer an express sharpening service, for an additional charge, that rushes the blade back to you within a couple of days. Carbide is rated for hardness on the Rockwell scale. Most saw blade manufacturers use C1, C2, C3 or C4 carbide. Carbide that's rated C4 is the hardest with a rating of 94. A diamond, for example, rates 100. Look for blades with large, C4-grade tips. The larger the tips, the more often the blade can be reshaped. How long will a carbide-tipped saw blade last before it needs reshaping? This is difficult to say. It depends on many factors including the quality of the blade, how often it's used and, most importantly, what type of material was cut with the blade. However, in the average home workshop, a good-quality, C4-grade carbide-tipped blade could last a full year before reshaping, and have a lifetime of many years with the proper care and periodic sharpening.

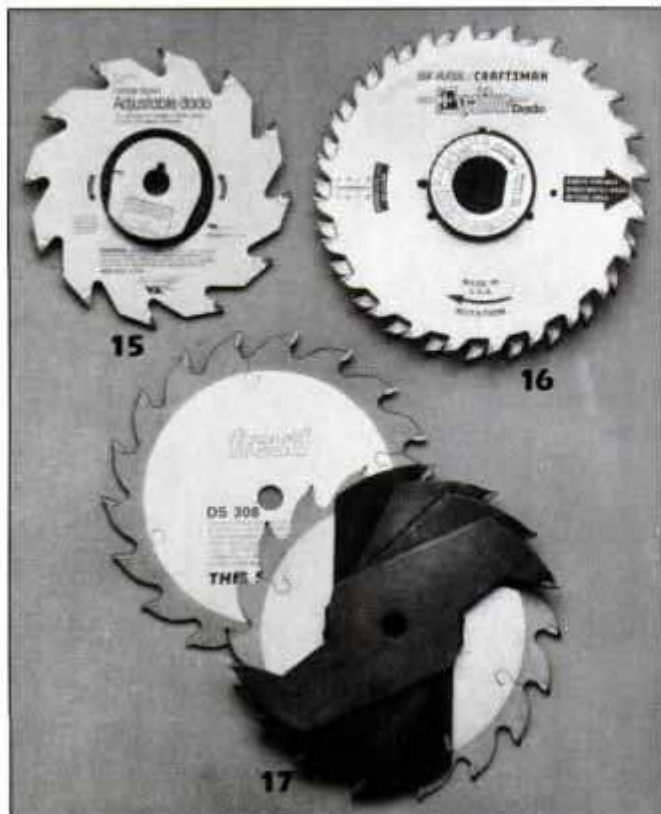


## SAW BLADES

### Telltale teeth

The designed purpose of a saw blade is often revealed by its teeth. Generally, the fewer teeth a blade has, the rougher it will cut. Conversely, for a smooth cut, use a blade with many teeth.

Saw blade teeth come ground in four common shapes: alternate top bevel (ATB), triple-chip grind (TCG), flat-top grind (FTG), and 4-tooth with raker. ATB-teeth have very sharp alternating top bevels that sever wood easily and smoothly. ATB-blades are often used for crosscutting and mitering. A TCG-saw blade is not quite as sharp as an ATB-blade, but it holds its cutting edges longer.



Therefore, it needs to be resharpened less often. TCG-teeth produce a smooth-cutting, general-purpose blade that can rip and crosscut.

For fast, aggressive sawing, use a FTG-blade. This heavy-duty tooth pattern is used primarily on rip blades. Flat-top teeth cut like tiny chisels.

The 4-tooth and raker blade consists of two pairs of ATB-teeth and one FTG-raker. The ATB-teeth sever the wood and the raker cleans out the kerf. This type of tooth pattern is popular with combination blades.

Note that some blades have deep gullets between the teeth, such as the combination blade (No. 3) and rip blade (No. 6) shown. Gullets are necessary in aggressive-cutting blades to clean away wood dust and chips.

Also, some blades, such as No. 10 and No. 11, have narrow expansion slots cut in their edges. Expansion slots allow the blade to expand slightly when it heats up. Otherwise, the blade would warp. The round hole at the end of each slot prevents stress cracks. A few saw blade manufacturers are using lasers to cut expansion slots (No. 9 and No. 12). These supernarrow slots eliminate most of the noise caused by standard expansion slots.

### Blade care

Saw blades are most effective, and safest, when they're sharp. Replace a blade once it has become dull and never use a blade with cracked or chipped teeth. Store blades between pieces of cardboard to protect the teeth from damage. Whenever you're changing blades, be sure that the saw is disconnected from the electrical outlet.

Saw blades often collect sticky wood resin and pitch. To remove a gummy buildup, soak the blade in turpentine or kerosene. Then, remove the softened resin with steel wool. Another way to remove stubborn resin is with spray-on oven cleaner. After cleaning the blade, apply a light coat of machine oil to the blade to resist rust.

All saw blades have a maximum rpm rating. Never use a blade on a saw that exceeds the blade's rating. Be sure that all blade guards are in place and operating properly before using a saw. And, of course, always wear eye protection when operating any power tool.

Now let's take a look at the following blades.

**1. Hollow-ground plywood**—With 146 tiny teeth, this 7½-in. blade is designed for splinter-free sawing of plywood, paneling and wood veneers. The blade is hollow ground to prevent binding. It's thickest at the toothed edge and then it tapers down slightly, for about 1½ in., toward the center. This allows the teeth to have no set for smooth cutting. The blade shown costs about \$11.50. Also available in 9-in. and 10-in. sizes. For details, contact Credo, 2765 National Way, Woodburn, OR 97071.

**2. Rip blade**—Large teeth and deep gullets allow a rip blade to cut effectively *with* the wood's grain. Use it primarily on a table saw or portable circular saw to rip softwoods and hardwoods. Rip blades are commonly available in sizes ranging from 6½ in. to 10 in. The 10-in., 36-tooth blade shown costs about \$10.60 at hardware stores and home centers. For more information, contact Oldham Saw, 2084 Lockport Olcott Rd., Burt, NY 14028.

**3. Combination blade**—For fast, semismooth wood cutting in any direction—rip, crosscut or miter—use a combination blade. The 8-in. blade shown (\$7) has 12 sets of teeth. The sets are separated by a deep gullet and each set has five teeth—one raker and four precision-filed-and-set teeth. Combination blades are popular, in part, because they reduce the number of times you need to change blades. They're sold in sizes from 6½ in. to 16 in. Contact DML, 1350 S. 15th St., Louisville, KY 40210.

**4. Grit-Edge blade**—For cutting the tough stuff, nothing beats the Grit-Edge blade from RemGrit, 939 Bar-

(Please turn to page 96)





DELL / DELTA

# BAND SAW BASICS

A craftsman's guide to using the band saw—your shop's most versatile saw.

TEXT AND PHOTOS BY ROSARIO CAPOTOSTO  
Contributing Editor

**W**HEN woodworkers have to cut curved, irregular-shaped workpieces, the tool they turn to first is the band saw. This saw's thin, flexible blade allows the work to be maneuvered easily and accurately along a winding line-of-cut and in and out of tight corners. The ability to perform these difficult cuts so effectively has, ironically, hurt the band saw's reputation as a versatile shop tool. In many workshops, the band saw is used *only* to cut curved workpieces.

The band saw is capable of performing a wide variety of cuts including such *straight* cuts as rip, cross-cut, miter and, if the saw has a tilting worktable, bevel and compound miter. It's also an excellent tool for resawing, that is, cutting a thick board into thinner ones. Also, when fitted with an appropriate blade, the band saw can cut various metals and plastics. Some



## BAND SAW BASICS

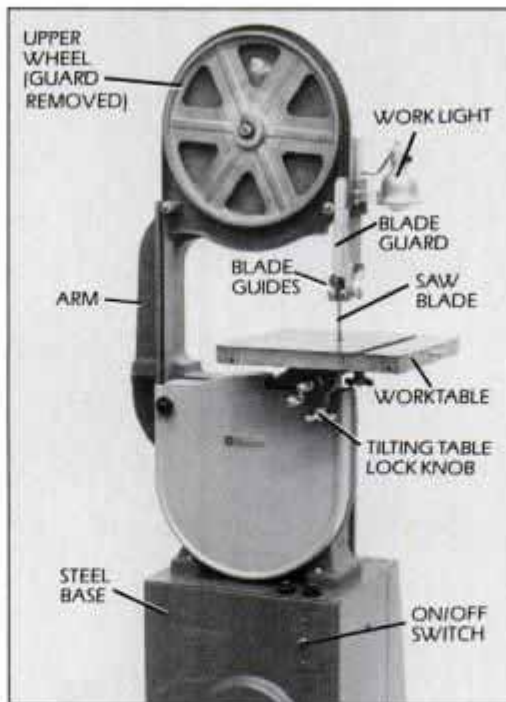
band saws will even accept a sanding belt.

On the following pages we'll introduce basic band saw practices and show how, through various sawing techniques and shopmade jigs, you can expand your use of this tool to make many workshop procedures easier—including cutting curves.

### Meet the machine

The band saw is named for its saw blade that is a continuous loop, or band of steel that has teeth on one edge. The blade rides over two wheels that are rimmed with thin rubber tires. Some benchtop band saws have three wheels. The tires provide nonslip traction to drive the blade in a clockwise, downcutting direction. The belt-driven lower wheel powers the blade. The free-spinning upper wheel is an idler wheel. The blade passes through a slotted insert in the center of the worktable.

A band saw has a few simple adjustments that are important to ensure accurate, trouble-free cutting. These include saw blade tensioning and tracking, and upper and lower blade guide adjustments. The upper, idler wheel adjusts up and down to permit installing the saw blade and applying the proper amount of tension. The upper wheel can also be tilted in or out to adjust the tracking so that it runs on the center of the tires.



Here's a typical home workshop band saw—a 14-in. Delta—with its major components identified.

A band saw has two saw blade guide assemblies—one above the worktable and one below. Each guide consists of a ball-bearing wheel that supports the back edge of the blade and a left and right guide block that support the sides of the blade. The back support wheel prevents the blade from being pushed off the rubber tires as the workpiece is advanced into the blade. The two side guide

blocks keep the blade from twisting as the workpiece is manipulated along the line-of-cut. Adjust the side guide blocks so that they just clear the sides of the blade and are back far enough to clear the blade's teeth. The upper guide assembly, which also includes a blade guard, is adjustable up and down to accommodate stock of varying thicknesses. In use, adjust the upper guide so that it's  $\frac{1}{4}$  in. above the top of the stock. (Note that for clarity, some photos show the guide adjusted slightly higher than it should be.)

Band saws are sized according to their approximate cutting capacity as measured from the blade to the arm. For example, the 14-in. saw shown has a cutting capacity of  $13\frac{3}{4}$  in. The maximum stock thickness that a band saw can handle is determined by the distance between the worktable and a fully raised upper blade guide. A typical 14-in. band saw has a maximum thickness capacity of about  $6\frac{1}{4}$  in.

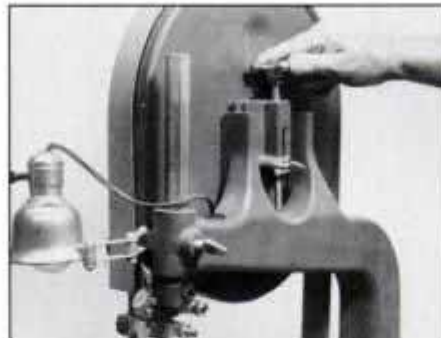
### Saw blades

Band saw blades are commonly available in widths ranging from  $\frac{1}{16}$  in. to  $\frac{3}{4}$  in. Various tooth sizes and styles are also offered. Selecting the correct blade depends on the material being cut, the thickness of the material and the type of cut.

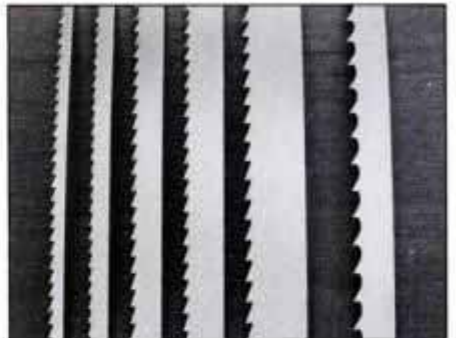
Generally, the more teeth a blade has, the smoother it will cut. To ob-



Underside of tilting worktable has a scale and pointer that indicates the degree of tilt. Note high-quality, cast-iron construction.



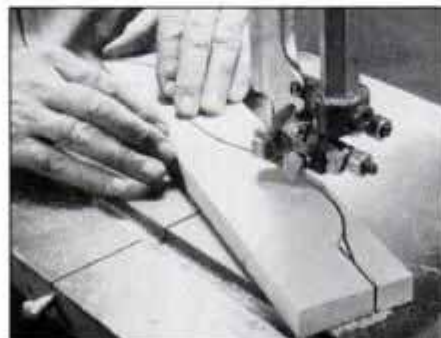
To raise and lower the upper wheel, which allows you to install a blade and then adjust its tension, turn elevating knob, as shown.



Standard-tooth woodcutting blades (left to right) range from  $\frac{1}{8}$  in. to  $\frac{3}{4}$  in. wide. At far right, is a fast-cutting, skip-tooth saw blade.



When two curves meet at a sharp, inside corner, first cut straight into the corner. Then, saw the two curved cuts to free the waste.



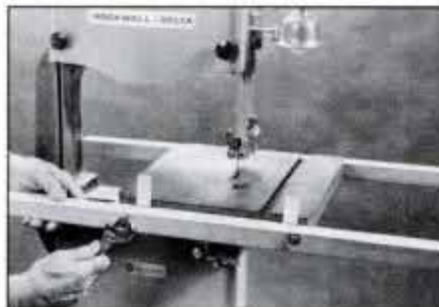
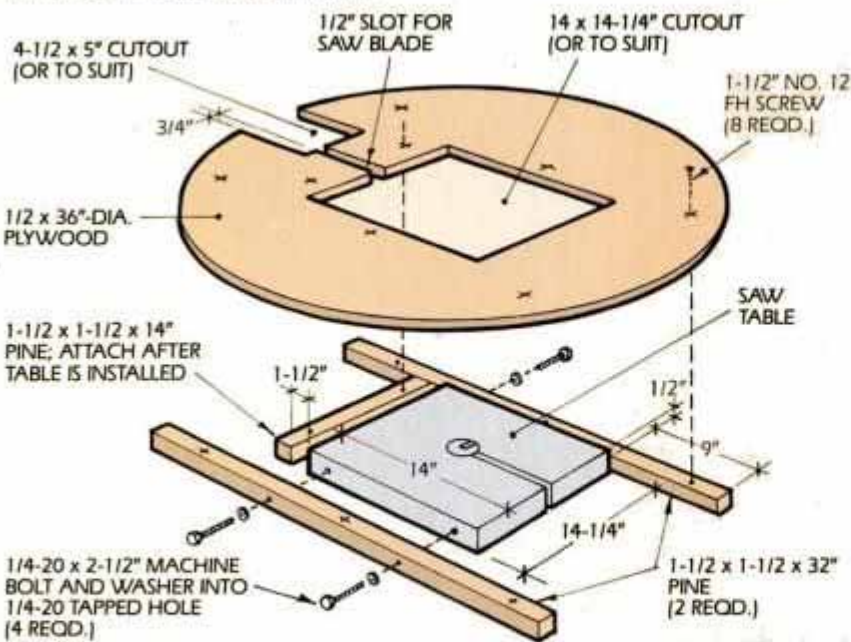
To saw corners neatly, first cut into the corner. Then, backtrack slightly and saw around it. Come back later and finish it up.



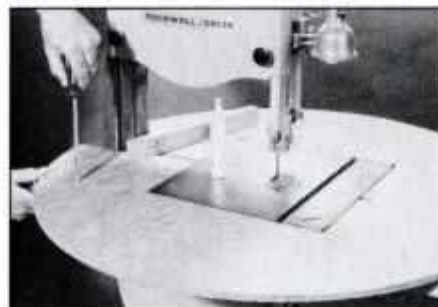
To cut curves with a wide blade, make tangential cuts or cut to the line several times, and then saw away waste (background).



## BAND SAW EXTENSION TABLE



Bolt 2x2s to opposite edges of the saw table to support the plywood extension table. Add thin cardboard shims for clearance.



Glue and screw the plywood table to long 2x2 supports. Then, attach crosspiece to plywood underside with screws only.



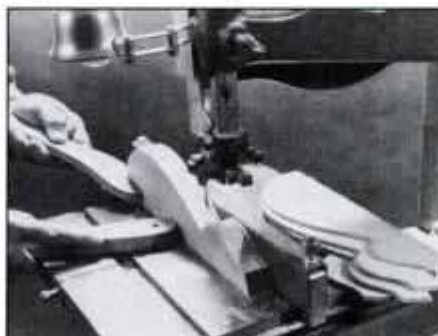
When sawing thin stock, such as sheetmetal, tape a 1/4-in. plywood panel to the saw's worktable to ensure smooth, burr-free cuts.



Use a miter gauge for accurate crosscuts. The wood bar clamped to the worktable acts as a stop. Butt stock to stop and make crosscut.



This setup shows how to employ a shopmade V-shaped cradle and a miter gauge to saw round stock, such as pipe and tubing, safely.



Here's an easy way to cut several identical parts. First, saw the stock to the desired shape and then resaw the stock, as shown.

tain smooth cuts, use a fine-tooth blade. For rough, fast cutting, choose a coarse-tooth blade. Coarse-tooth blades work best on soft, resinous or wet wood and for cutting thick stock. For extremely fast, and rough cutting, use a skip-tooth blade. This type blade has large, widely spaced teeth with deep gullets that expel sawdust and wood chips effectively.

To saw curves, use a narrow blade. The narrower the blade, the tighter a radius it can cut. For example, a 1/16-in.-wide blade can cut a minimum radius of about 1/8 in. A 1/8-in.-wide blade cuts a 1/4-in. radius. A 1/4-in. blade has a 1/2-in. radius. However, a 3/8-in.-wide blade will cut only about a 1 1/2-in. radius. A 1/2-in. blade: 2 1/4-in. radius; 3/4-in. blade: 3 1/2-in. radius.

A band saw is an excellent metal-cutting saw when it's equipped with the appropriate blade. But, metalcutting should only be practiced on saws that are capable of operating at the required reduced speed. To cut metal effectively, the saw must be able to operate at about 300 fpm (ft. per minute) or slower. The standard speed for woodcutting is 3000 fpm.

## Basic band saw cuts

Most band saw cuts are made freehand, that is, without the aid of a fence or guide. Freehand sawing is a 2-hand operation. Use one hand to push the work into the blade and the other to steer it along the line-of-cut.

Before starting a curved cut, visu-



The miter gauge is also useful for sawing miters of various angles. Use a wide saw blade and slow feed rate to produce smooth cuts.



To make resawing easier, use a simple shopmade pivot block. Clamp the block to the worktable and guide the board against it.



## BAND SAW BASICS

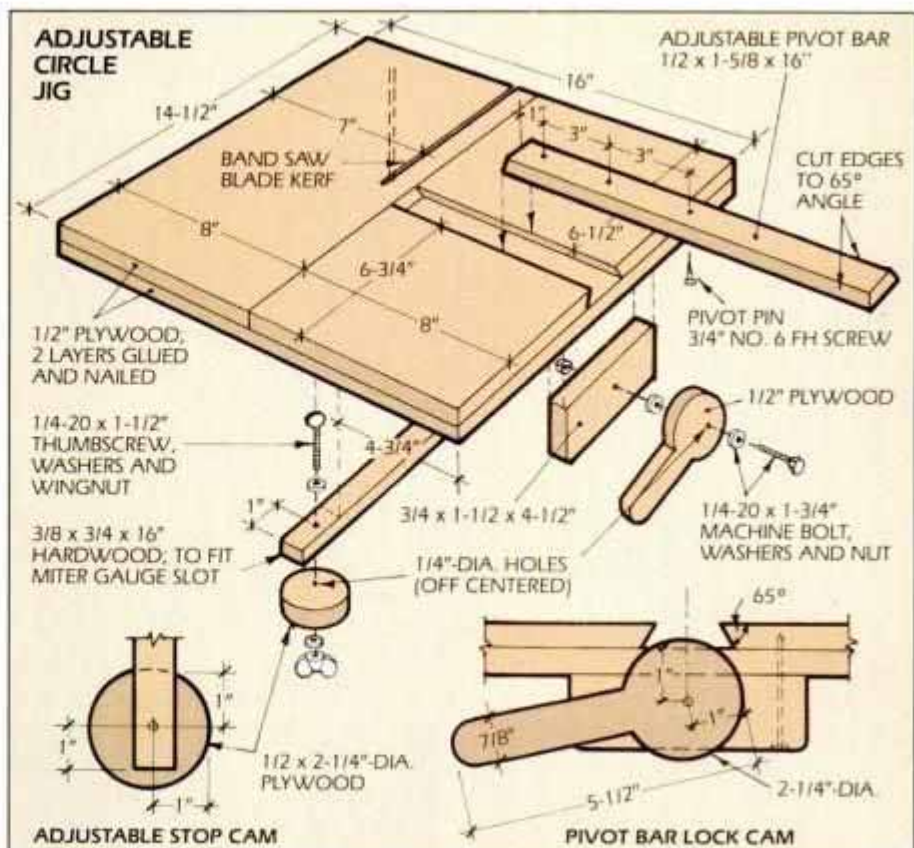
alize the work being sawed along the cut line. This may help prevent interference with the saw's arm as the piece is maneuvered through the cut. Starting the cut from the other end of the line will often provide clearance for the piece. Try to avoid getting the blade trapped so that you have to backtrack to free the blade. When you must backtrack, do so slowly to avoid pulling the blade away from the guides and off the wheels.

When executing an intricate cut, it's not usually possible to make the cut in a single, continuous pass. Instead, make a series of shorter cuts to minimize backtracking. It's often easier to bypass small, detailed areas and come back later, after a majority of the waste has been sawed away, and finish them with short cuts.

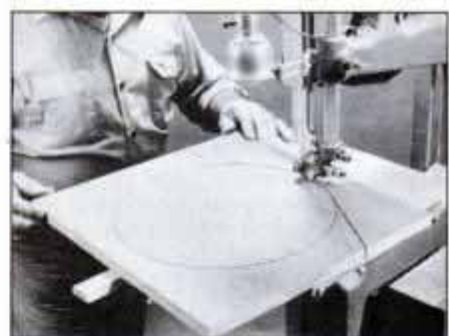
When two curves meet to form an acute, inside corner, it's necessary to first make a cut through the waste area directly into the corner. Then, cut along one of the curved lines and into the corner. Repeat the same cut along the remaining curved line to complete the cut.

When band sawing thin material, such as wood veneer or sheetmetal, the underside of the material often splinters or forms burrs. This is caused by the clearance space around the blade as it passes through the slot in the table insert. It's this lack of support right at the blade that allows the work to splinter. To ensure smooth cuts, make an auxiliary worktable surface out of a piece of 1/4-in. plywood or hardboard. Cut about halfway into the plywood panel and then secure it to the saw's worktable with masking tape. Because the saw blade now has very little clearance as it passes

(Please turn to page 120)



Easy-to-make circle-cutting jig fits over the saw's table. The bar extending from the jig to the right, adjusts for various size circles.



With the workpiece rotating on the pivot pin, a sharpened screw, a perfect circle is cut. The jig shown cuts circles up to 30 in. dia.

## How To Fold A Band Saw Blade

**B**AND saw blades come neatly wound in easy-to-handle packages. However, once a blade is unwound, getting it wound back to its original, convenient size can be downright frustrating. The photos below show how to fold a 93 1/2-in. blade into a neat triple-loop spool.

To start, hold the blade with its teeth facing up. Place both elbows inside of the blade and turn it down and in toward

yourself (Photo 1). Bend the wrists and bring your hands closer together until the blade forms a loop (Photo 2). Be sure to keep a firm grip on the blade. Next, slide out your elbows, one at a time, and shift your hands to allow the loops to overlap (Photo 3). Finally, shake the blade gently until it forms three equal-sized loops (Photo 4). Use masking tape to secure the folded blade and keep it from unwinding.—J.T.



**1** Grasp blade firmly, teeth facing up. Apply downward pressure to form first loop.



**2** Turn wrists in and move your hands together. Bend blade up and keep elbows apart.



**3** Slide out elbows, hold blade firmly in one hand as the other brings the loops together.



**4** Wiggle blade in your hands until three loops are the same size. Secure blade with tape.



SPECIAL REPORT

# IMPORTS '88



- ALL THE NEW MODELS
- ALL THE CHANGES
- COMPLETE PRICE LIST

PM PHOTO OF MAZDA RX-7 CONVERTIBLE BY HUMPHREY SUTTON





CALIFORNIA  
1SUP518

FERRARI TESTAROSSA



**IMPORTS '88**



**BMW 750i**

# A WIDER WORLD OF CHOICES

From Acura to Yugo, it's a Buyer's Market.

**B**UYER confusion may be the hallmark of the automobile scene in the 1980s. What car is best for me? With close to 200 different model lines to choose from, the task of picking the right one can seem a bit forbidding.

To simplify your choice, it helps to separate the so-called "domestics"—so-called because the lines are blurring—from the "imports." Generally speaking, domestics are those cars designed and built in the U.S. or Canada—the North American cars. We covered them last October ("The Priority Is Design," page 51).

Imports are all the other cars—the cars designed and built overseas and sold in this country by the traditional American companies as well as import firms. Included in the imports are cars from Europe, Japan, Korea, Mexico and Brazil. We also include

BY JIM DUNNE  
Detroit Auto Editor



**BMW V12**

The heart of BMW's flagship sedan (top) is this new, 300-horsepower, all-aluminum single-overhead-cam V12 engine.

some cars designed abroad but assembled in the U.S. The Honda Accord, Mazda MX-6, Nissan Sentra, Toyota FX-16 and Chevy Nova are all examples of this new phenomenon, and there will be more.

In all, there are 33 companies bringing cars into the U.S. offering choices, from the superexpensive, \$150,000-plus Rolls Royces and Italian sport models, to under-\$6000 econoboxes like Yugo, Hyundai and Festiva.

While the proliferation of models and nameplates can be confusing, it does provide one distinct advantage. Besides the product improvements that go with intense competition, the phenomenon of more and more manufacturers competing for slices of the same pie puts more and more leverage in the hands of the person who signs the purchase agreement—you.



**VOLVO 760**



**ALFA ROMEO 164**

PM PHOTO BY WADE HOLT



# It gets ugly wh



*Nissan Hardbody SE Regular Bed 4x4. Equipped with automatic locking front hubs and the following options: alloy wheels, 31 x 10.5R15 tires, fender flares, light bar, off-road lights, brush and grille guards, and fog lamps.*

BELT  
YOURSELF 



# en you drive it.

A lot of people think the Nissan Hardbody™ SE is one of the best-looking 4x4's on the road.

But who cares? The real beauty of this beast is how it performs off the road.

That sleek, aerodynamic hood, for instance, wasn't just designed to be sleek and aerodynamic. The slanted shape also gives you a clear view of whatever it is you're about to drive over. Or through.

We gave the Hardbody over ten inches of ground clearance. And added skid plates, since a lot of stumps and boulders refuse to be shorter than ten inches high.

Then we dropped in 145 horsepower worth of fuel-injected V6. Making the Hardbody perfect for those quiet Sunday drives through the underbrush.

But don't just take our word for it. Take a Hardbody for a drive and you'll see that it can get pretty ugly.

No matter how good you think it looks.



Built for the Human Race.™



# IMPORTS '88



TOYOTA COROLLA GT-S



SUBARU JUSTY 4WD



MERCEDES-BENZ 300CE

In the pages that follow, we'll detail what's on tap in the 1988 imported car market, including major product changes and basic manufacturer's suggested retail prices. (In cases where pricing wasn't finalized at press time, these numbers represent a best guess made in collaboration with the manufacturer.)

## Acura

All of the Legend sedans have the 165-hp, 2.7-liter Legend Coupe V6 engine for 1988, replacing the 2.5-liter of 1987. In the sedans, L and LS models will include antilock brakes. Integras have a slight increase in power from their dohc 4-cylinder engine. The sensational Legend Coupe is unchanged.

## Alfa Romeo

Milano sedans have a 3-speed automatic transmission to add to the 5-speed manual. The automatic cars have self-leveling rear suspensions

that maintain clearance between the underbody and the rear-mounted transaxles. The Milano 3.0-liter V6 now has antilock braking as standard. Alfa expects to sell about 5500 Milano sedans and 4000 of its evergreen 2-seat roadsters in 1988. The handsome new 164 sedan, expected to debut as a 1988 mid-year, may not appear until fall, as an '89 model.

## Aston Martin

Only about 60 exotic vehicles bearing the Aston Martin badge will be sold this year in the U.S. They include the Lagonda 4-door, Volante convertible, Vantage coupe, V8 Coupe and the Vantage Volante.

You will see some styling changes in the Lagonda. Body lines are softer, more rounded, to make the car appear more aerodynamic. Inside, the instrument panel will have vacuum fluorescent gauges instead of the cathode-ray tube of the 1987s. Other models are mostly carryover in design and

appearance. Ford Motor Co.'s purchase of Aston Martin in 1987 won't affect the model lineup or the dealer network for at least another year.

## Audi

A complete new body style and all new model names show up in the Audi line for 1988. The Audi 80 replaces the 4000 series, with an all-new skin and increased engine displacement (2.0 liters from 1.8 last year). Transmission choices are 3-speed automatic or 5-speed manual and a 4-wheel-drive Quattro model is also available.

Just above the 80 in the lineup is the Audi 90, a sedan outfitted with higher levels of equipment, though it shares platform and body shape with the 80. A Quattro with 2.2-liter 5-cylinder engine that delivers more torque through the power range and features antilock brakes is the top car in this brand-new line.

Audi's exquisite 5000 series continues into '88 largely unchanged.



DAIHATSU CHARADE



CHEVROLET SPECTRUM TURBO

PHOTO BY STEVE PARKER





SUBARU XT6



HONDA CRX SI



TOYOTA MR2

### Bertone

There are essentially no changes in this latest version of the veteran X1/9 mid-engine 2-seater aside from new fabrics and upholstery colors.

### BMW

Two new models and a V12 engine highlight the 1988 BMW line. The flagship 750i is one of the new cars, and certainly the most visible. It carries a new 5-liter 12-cylinder, 300-horsepower engine. Built in a 4-door sedan version only, U.S. editions of the 750i are 4½ in. longer than the 735i sedan for additional rear-seat room, and will carry an "L" designation for long wheelbase. The \$70,000 sedan will also have an electronic throttle that eliminates the mechanical linkage between the accelerator pedal and the engine throttle.

The second new car is the 325iX, an all-wheel-drive sedan built on the 325 chassis. This car will sell in the

\$33,000 range and like all North American BMWs will include antilock brakes standard.

### Chevrolet

Three Japanese-designed model lines—Sprint, Spectrum and Nova—continue virtually unchanged from 1987. Chevrolet has renamed its Sprint ER econo leader as the Metro. This car is once again the top fuel miser in the U.S., with EPA ratings of 37 city/43 highway. Sprint is built by Suzuki in Japan.

Spectrum, which is built by Isuzu, retains its two notchback sedans 4-door and 2-door. The Spectrum Turbo continues as the performance entry, powered by a 110-horsepower turbocharged engine. Chevy claims a 0 to 60 mph time of 9 seconds for the Turbo. Other carryover models are the Express and the standard Spectrum. A new option this year is the Sport, a coupe with firmer F41 suspension.

Largest of the off-shore-design

Chevys is the Nova, a Corolla clone built by the joint GM-Toyota assembly plant in Fremont, California. Nova will have Chevy's first regular production multivalve engine, Toyota's 1.6-liter twin-cam, 16-valve Four, scheduled for installation in about 10 percent of the '88 Novas. The engine produces 110 horsepower, which is about double the output of the standard Nova engine. The new 4-door Twin Cam model has special tires, sport suspension, alloy wheels and 4-wheel disc brakes.

### Chrysler

With Chrysler's acquisition of AMC, the American Motors Medallion is now Medallion-Imported for Eagle, which is a new Chrysler division that will handle Renault imports. Look for the 1989 Medallion to be introduced early this year with few changes, though a 4-wheel-drive version is in the works.

Often overlooked in a list of fully



MERKUR SCORPIO



AUDI 90 QUATTRO

EVN PHOTO BY SHARI HARTFORD



# IMPORTS '88

MITSUBISHI  
GALANT SIGMA



MAZDA 929



equipped sporty cars is the 2+2 Conquest TSi, one of Chrysler's Mitsubishi imports. Rear drive, a 188-hp, turbocharged, intercooled 2.6-liter engine, 4-wheel disc brakes and anti-lock rear brakes are standard features.

Colt returns as the price leader of Chrysler's imports. For 1988, a 5-door station wagon has been added to the line, which also includes a 4-door sedan and 3-door hatchback. Major dimensions and powertrains are unchanged for '88.

An exotic Lamborghini joins the ranks of Chrysler imports for 1988. Chrysler purchased the famous Italian sportscar maker last year, and, technically, it imports the car for sale in the U.S. However, final fold-in plans have not been released, so buyers who have saved up the \$120,000 required for the shark-like Countach will have to continue shopping at established Lamborghini dealers.

Chrysler's TC by Maserati goes on sale this month. The \$35,000 fwd convertible will be sold through regular Chrysler dealers.

## Daihatsu

Charade is the name of the subcompact that Daihatsu will offer to American buyers this year, its first in the

U.S. market. A solidly established model in Japan, the Charade just went on sale here. Specifications of the \$6000 3-door hatchback include 5-speed transmission and front-wheel drive. The tiny 1.0-liter, transverse-mounted, 3-cylinder engine makes 53 horsepower.

## Ferrari

Ferrari sells about 1100 of its exotic, high-performance coupes and convertibles to well-heeled customers in the U.S. each year. The company plans no changes in that sales rate nor the cars themselves for 1988.

## Ford

Four imports are sold under the Ford umbrella. Lincoln-Mercury dealers handle three of them—the made-in-Mexico Tracer (based on Mazda 323 chassis and powertrain) and the made-in-Germany Merkur XR4Ti and Merkur Scorpio. Ford dealers have the Korean-built Festiva.

The turbocharged XR4Ti for '88 has a single, rear spoiler in place of the notorious two on earlier models, and minor changes were made in the trim and tires. The luxurious Scorpio was introduced as an '88 model last spring. It uses a 145-hp, 2.9-liter V6 engine and offers a choice of automatic or 5-

speed overdrive manual transmissions. Four-wheel disc brakes with antilock are standard.

Both the XR4Ti and Scorpio are rear-wheel drive. Scorpio 4x4 (seen with right-hand drive, page 79) is sold in Europe and may come here later in '88. Watch for the Merkur name to quietly melt away during the coming year, with the cars marketed just as Scorpio and XR4Ti.

Tracer is a compact-size sedan, built in 3- and 5-door hatchback, and station wagon body styles. Motion is generated by a 71-horsepower, 1.6-liter 4-cylinder engine driving the front wheels.

Ford's Festiva comes in one body style, a 3-door hatch. The subcompact is the smallest car in Ford's lineup, and also its price leader. A 1.3-liter 4-cylinder engine is standard. Two overdrive manual transmissions, a 4-speed and 5-speed, are available.

## Honda

Civics for '88, including CRX, are totally redesigned—exterior, suspension, drivetrain. Two engines are offered, sohc 1.5- and 1.6-liter Fours with 16 valves, though the 105-horsepower, 1.6 version is available only with the CRX Si and 4wd wagon. Wheelbase is longer by 4.7 in., and all



MAZDA 626  
4WS



HONDA PRELUDE  
SI 4WS

## 4-Wheel Steering: 2 Ways

**H**onda and Mazda both claim improved high-speed handling and low-speed maneuverability for their 4ws. Honda's is mechanical, with rear lock related to degree of steering wheel rotation. Up to 140°, rear wheels steer in

phase with fronts, turning 1½° maximum. Beyond 246°, rears steer out of phase, up to 5.3°. Mazda's microprocessor-controlled system is speed-sensitive, steering out-of-phase at low speed, in-phase above 22 mph. Honda's Prelude system costs about \$1300. Mazda's adds about \$1100, but is part of a \$3200 package on the 626 Turbo.





PEUGEOT 505 SW8



MITSUBISHI STARION

wheels are independently suspended.

Accord LXi has a larger engine that puts out 122 horsepower, up 11 percent from 1987. Changes include camshaft revisions and use of a dual-stage intake manifold. The Prelude, new in mid-1987, offers 4-wheel steering and a 16-valve, dohc, 2.0-liter engine.

### Hyundai

Hyundai, the Korean company that jumped to fourth place among U.S. imports during its first sales year, will be mostly carryover for 1988, though trim levels are proliferating. Grille textures will be new, and some grille colors will be changed. An entry-level, 4-door sedan joins the \$5295 3-door Excel at the low end of the price lineup. A sporty GS 3-door, featuring sport seats, alloy wheels and bigger tires, is new. On all cars, the carburetor solenoid was replaced to improve cold start and engine smoothness.

### Isuzu

No new models for '88, but the 2-door sporty Impulse has a newly tuned suspension—by Lotus—and a larger 2.3-liter engine. Horsepower of the Impulse has been increased by 20 percent to 110. Isuzu's other model line, the I-Mark—known as Spectrum at Chevrolet—is essentially unchanged.

### Jaguar

Last May, Jaguar introduced its all-new 1988 XJ6 sedans with the super-smooth, 3.6-liter, 24-valve, 181-hp inline Six. A recent update increases engine output by 14 horsepower with a higher 9.6:1 compression ratio, giving the Big Cat a nice performance boost. The XJ-S Cabriolet continues as Jaguar's highest-priced production model at \$50,450, though a true convertible can be ordered at about \$55,000. The drop-top XJ-S is converted by Hess and Eisenhardt.

### Lamborghini

(See Chrysler.)

### Lotus

Only one car, the Turbo Esprit, will be imported to the U.S., but the body is an all-new design. The concept is

the same as far as engineering goes, with a 215-horsepower, midship-mounted, 2.2-liter 16-valve 4-cylinder driving the rear wheels. The 2-seat coupe sells for \$62,000. Lotus hopes to sell 400 or so in 1988, up from the 250. Lotus Cars U.S.A., Inc., with 68 dealers nationwide, operates independently from GM, which purchased the British firm early last year.

### Maserati

Chrysler's new subsidiary features three models for 1988. The Biturbo i Spyder, Si coupe and 425i 4-door are all powered by the 2.5-liter 18-valve V6 with twin turbos (a 2.8-liter version is on the way). Later in '88 we'll get the 228, a new model, larger than the Biturbo series. It has a more modern body design that features flush glass and rounded body contours. It was introduced in Europe in 1987.

### Mazda

Three new models—626, 929 and the MX-6—plus important changes in the RX-7 sportscar give the Mazda lineup a new look for 1988. The MX-6 is a 4-place sporty model, and the first Mazda car to be built in the U.S., at Flat Rock, Michigan. The MX-6 uses a 2.2-liter 4-cylinder engine that has three valves per cylinder and develops 110 horsepower. A turbocharged version of the car, the MX-6 GT, develops 145 horsepower. Front-wheel drive and a choice of 5-speed manual or 4-speed overdrive transmissions are other highlights.

Mazda's 929 is a new entry for the company in the U.S. Aimed at the luxury sedan market, the 929 accommodates five passengers, uses a 3.0-liter 18-valve 6-cylinder engine, and—surprise—has a rear-wheel-drive chassis. That's to provide "superior handling, ride quality and favorable weight distribution" for this class of car in Mazda's judgment.

Meanwhile, the 1988 626 line has been redesigned for improved aerodynamics and better performance. Now available in only 4- and 5-door sedans, the 626 uses the same powertrains as the MX-6.

Available on the Turbo Sedan is a 4-

wheel-steering system that automatically changes the direction and steering angle of the rear wheels according to vehicle speed and the steering angle of the front wheels. The rear wheels are steered in the opposite direction as the front at speeds below 22 mph, to improve low-speed maneuverability, and in the same direction as the fronts above 22 mph, for better handling at high speed. Antilock braking and adjustable shock damping are also available on the 626.

In the other Mazda lines, the RX-7 adds a convertible model with a unique Wind Blocker behind the seats that cuts down on turbulence and noise. And the 323 series adds a GT sedan and fun-to-drive GTX hatchback with 132 horsepower, 16-valve, turbocharged, 1.6-liter engine, 4-wheel disc brakes and full-time all-wheel drive.

### Mercedes-Benz

Mercedes made major changes in its North American lineup for 1988, dropping diesel sedan models—the 190D, 2.5 Turbo, 300D, 300TD wagon and 300SDL Turbo—and adding the graceful new 300CE. The \$52,000 300CE is a midsize coupe, using a 177-horsepower, 3.0-liter, inline 6-cylinder engine. Built on a 106.9-in. wheelbase, 3½ in. shorter than the 300 sedan, the Coupe includes antilock braking, driver's-side air bag and automatic seatbelt presenters.

Other new models are a 300TE gasoline-powered station wagon and 300SEL 4-door sedan.

Of the diesel cars, which once accounted for 75 percent of Mercedes sales, only the 190D remains.

### Mitsubishi

Galant Sigma is the name of Mitsubishi's '88 entry in the growing luxury-sedan field. The 4-door, 5-passenger flagship has a front-drive layout, with a 3.0-liter, 142-horsepower V6 engine and choices of 5-speed manual or 4-speed automatic transmissions. Optional equipment includes automatically adjustable suspension and antilock brakes.

Precis, a Hyundai by any other



# IMPORTS '88



CHEVROLET NOVA



HONDA CIVIC HATCHBACK



JAGUAR XJ6

name, is the Korean-built base car in the Mitsubishi lineup and carries over unchanged from its mid-'87 intro.

The Mirage is offered primarily as a 4-door model, save for the 105-hp, turbocharged, 3-door hatchback.

Tredia, the subcompact sedan line, and Cordia, the Tredia's 2-door cousin, are essentially unchanged from 1987. Both offer 116-hp turbo models.

The Starion line drops the LE model, but continues with the flagship ESI-R (188-horsepower, 2.6-liter turbo Four) and the ESI.

Mitsubishi's Wagon was new in 1987, so continues in 1988 without significant changes.

## Nissan

Since 1987 was a year of big changes for Nissan, 1988 sees only minor revisions.

The most significant new technology is the "Sonar Suspension," optional on the Maxima GXE. A transmitter and receiver mounted above the right front wheel measures the road surface and automatically adjusts shock damping to match the road.

Pulsar has a 125-horsepower, 1.8-liter, dohc, 16-valve engine for the SE model, replacing the 113-hp, 1.6-liter version of the engine used last year.

Sentra has fuel injection in place of carburetion for 1988. Stanza is unchanged, and wheel styling is the only change in the 200SX line.

Nissan's 300ZX gets an increase of 5 horsepower in both turbo and normally aspirated editions. A new turbocharger in the 300 Turbo improves throttle response.

## Peugeot

You'll see more power for the Turbo 505 sedan, an 8-passenger version of the wagon (all seats face forward), and a new 505 GLX sedan. Turbo muscle gets an increase in horsepower to 180 (from 150), accomplished primarily by changes in the wastegate that increase boost. The value leader 505 GLX uses Peugeot's familiar 145-horsepower, 2.8-liter V6 engine, and the price is under \$20,000.

## Pontiac

From Germany by way of Korea comes Pontiac's import subcompact, the LeMans. Introduced in mid-1987, the LeMans is based on the Opel Kadett line. It's powered by a 1.6-liter 4-cylinder engine rated at 74 horsepower. Pontiac claims 0 to 60 mph times in

# 1988 IMPORT PRICES\*

ACURA	
Integra	\$10,189
Legend Sedan	21,010
Legend Coupe	23,096
ALFA ROMEO	
Spyder Graduate	\$15,400
Milano 2.5	17,200
Milano 3.0	21,200
164	25,000**
ASTON MARTIN	
V8 Coupe	\$112,000
Lagonda	167,000
AUDI	
80	\$18,600
80 Quattro	22,700
90	24,330
90 Quattro	27,720
5000S	22,180
5000S Quattro	26,490
5000CS Turbo	30,010
5000CS Turbo Quattro	33,800
BERTONE	
X1/9	\$12,495

BMW	
325	\$24,000**
325is	28,500
325i Cabriolet	32,500
325iX 4wd	33,000**
M3	34,000
528e	31,500
535i	36,000
M5	46,500
L6	52,000**
M6	59,000**
735i	53,000
750i	70,000**

CHEVROLET	
Sprint Metro	\$5725
Sprint Turbo	8470
Spectrum	8450
Spectrum Turbo	10,955
Nova	9105
Nova Twin Cam	11,705

CHRYSLER	
Colt	\$5899
Colt Turbo	8868
Colt Premier Turbo	9691

Conquest TSi	18,155
Vista	11,122
Vista 4wd	12,405
Medallion	14,500**
TC by Maserati	35,000**

DAIHATSU	
Charade	\$6000**

FERRARI	
328 GTB	\$68,500**
328 GTS	74,000**
Mondial 3.2	72,000**
Mondial 3.2 Cabriolet	78,750**
Testarossa	122,000**

FORD	
Festiva	\$5765
Tracer	7926
Merkur XR4Ti	17,832
Merkur Scorpio	24,048

HONDA	
Civic	\$6095
CRX HF	8295
Prelude	13,495
Accord DX	10,535

HYUNDAI	
Excel	\$5295

ISUZU	
I-Mark	\$7439
I-Mark Turbo	10,409

Impulse	\$13,629
Impulse Turbo	15,529

JAGUAR	
XJ6	\$43,500
XJ-S	44,500
XJ-S Cabriolet	50,450
XJ-S Convertible	55,000**

LAMBORGHINI	
Countach 5000S	\$120,000

LOTUS	
Turbo Esprit	\$62,000

MASERATI	
Biturbo i Spyder	\$39,975
Biturbo Si	37,395
Biturbo 425i	38,138

MAZDA	
323	\$5999
323 GT	11,499
323 GTX 4wd	12,749
626	10,499
626 Turbo	13,999
626 4WS	17,149
MX-6	10,599
MX-6 Turbo	14,499
RX-7	15,480
RX-7 Convertible	20,500
RX-7 Turbo	21,800
929	18,950

\*Prices in effect Oct. 15, 1987.

\*\*Estimated price.





MASERATI BITURBO SI



BENTLEY EIGHT



VOLKSWAGEN FOX

the 13-second range with the 5-speed transmission. Two body styles are offered, a 3-door hatchback (the Aero-coupe) and a formal sedan available with either two or four doors. The price tag is \$5995 for the basic Aero-coupe and \$7925 for the 4-door.

**Porsche**

There are few changes in the Porsche lineup for 1988, although there is a new package on the 911 Turbo. The 930S is a slant-nose option for a racy look. The lineup is otherwise unchanged with the Coupe, Targa and Cabriolet versions of the timeless 911. The 924S gets an 11-hp boost from a change in the fuel management system. Air bags for driver and passenger sides are now standard on 944S and 944 Turbo.

**Rolls Royce**

Two major changes for 1988 are the addition of antilock braking on all models, and passive restraint safety belts on the Silver Spirit series.

**Saab**

Antilock braking for the flagship 9000 line highlights the changes in the Saab for 1988. Called ABS+3, the antilock hardware, furnished by Teves, is integrated with the 9000 brake system, not an add-on. Saab's 900 Turbo adopts the 9000 turbocharger design, with a liquid-cooling feature added to the turbo shaft, to reduce operating temperatures and prevent oil charring. Also, all 900 models have been fitted with ventilated front discs and the parking brake now operates on the rear wheels instead of the fronts.

**Sterling**

Three new exterior paint colors are available for this British version of the Acura luxury sedan. Other changes are minimal. A late 1987 model revision replaced the center console on the 825 SL with one that places controls in a handier positions.

**Subaru**

A horizontally opposed 6-cylinder engine of 2.7 liters displacement will be added to the XT coupe for 1988. The new engine is similar in design to the flat Four Subaru has used for many years, and puts the XT in a more competitive position among the red-hot sport coupes.

Subaru's Justy gets an on-demand, 4-wheel-drive system, rounding out the availability of 4-wheel drive in all

**MERCEDES-BENZ**

190E 2.3	\$30,000**
190D 2.5	30,000**
190E 2.6	34,400**
260E	38,300**
300E	43,900**
300CE	52,000**
300TE	47,200**
300SEL	52,200**
420SEL	57,700**
560SEL	68,200**
560SEC	75,500**
560SL	61,400**

**MITSUBISHI**

Precis	\$5295
Mirage	8349
Tredia	10,039
Cordia	10,569
Starion	16,649
Galant Sigma	16,549

**NISSAN**

Sentra	\$6499
Sentra Wagon	8499
Sentra Wagon 4wd	10,699
Stanza	11,025**
Stanza Wagon	11,900**
Stanza Wagon 4wd	13,385**
Maxima	16,949
Maxima Wagon	17,850**

Pulsar NX	11,649
Pulsar NX SE	12,400**
200SX	11,899
200SX SE	15,225**
300ZX	20,649
300ZX Turbo	23,475**

**PEUGEOT**

505 DL	\$15,495
505 GLX	19,850
505 Turbo S	24,615
505 SW8 Wagon	18,545

**PONTIAC**

LeMans Aerocoupe	\$5995
LeMans Four-door	7925

**PORSCHE**

924S	\$25,910
944	30,235
944S	35,930
944 Turbo	38,795
911 Coupe	44,400
911 Cabriolet	51,250
911 Turbo Coupe	67,255
911 Turbo Cabriolet	83,310
928S 4	67,955

**ROLLS-ROYCE**

Bentley Eight	\$99,500
Mulsanne S	107,500
Silver Spirit	117,500
Silver Spur	129,500

Corniche II	183,500
Bentley Continental	182,900
Limousine	198,000

**SAAB**

900	\$14,983
900S	18,718
900 Turbo	21,995
900 Convertible	29,740
9000S	23,337
9000 Turbo	28,141

**STERLING**

825 S	\$20,198
825 SL	25,238

**SUBARU**

Justy DL	\$5566
Justy GL 4wd	7066
GL Hatchback	7866
GL Hatchback 4wd	8466
DL Sedan	8866
GL Sedan 4wd	11,125
DL Coupe	9166
GL Coupe 4wd	11,424
XT DL	9866
XT6	15,780
XT6 4wd	16,630

**TOYOTA**

Tercel EZ	\$5948
Tercel 4wd Wagon	10,488
Corolla FX	7948

Corolla FX16	9978
Corolla Deluxe	8898
Corolla SR5	9898
Cressida	20,250
MR2	12,808
MR2 Supercharged	16,418
Celica ST	11,198
Celica GT Convertible	17,848
Supra	21,290
Supra Turbo	23,760
Camry	10,898
Camry Wagon	12,388
Passenger Van	12,588

**VOLKSWAGEN**

Fox	\$5990
Golf	7990
Jetta	8990
Jetta GLI 16v	13,725
GTI	12,725
Cabriolet	14,000**
Quantum	15,600**
Scirocco	11,500**

**VOLVO**

240 DL	\$16,585
740 GLE	21,450
760 GLE	31,200
780 Coupe	37,790

**YUGO**

GV	\$4199
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## IMPORTS '88

Subaru models. The option will make Justy the lowest-priced 4-wheel-drive car on the U.S. market.

### Toyota

Completely new styling and all front-wheel drive highlights the new Corolla lineup. Body lines have gone to a smoother, more rounded look, and glass is mounted almost flush with the sheetmetal. There's also a new engine, a twin-cam, 16-valve Four developing 90 horsepower, an increase of 16 horsepower over the 1987 Corolla. Minor refinements in the 1.6-liter Four used in the FX16 model raise its horsepower rating slightly to 110, though the slick new Corolla GT-S coupe gets a 115-horsepower edition. Interiors are also all new.

The popular MR2 sportscar gets an intercooled Roots-type supercharger that boosts horsepower to 145 (from the 115 of the normally aspirated engine).

All-wheel drive has been added to the Camry line, and is also available in the Celica line on a new model, the All-Trac Turbo.

### Volkswagen

Golf and Jetta get a large boost in horsepower—from 85 to 100—through changes in computer-controlled spark advance and fuel-injection systems. The 8-valve engine in the GT models now puts out 105 horsepower, while the 16-valve continues with its 123-hp rating.

The popular Cabriolet gets its first facelift since its 1980 introduction. Changes include a urethane-covered bumper, integral front air dam, fender flares and rear apron. Scirocco, Quantum and Fox are all unchanged.

### Volvo

Major changes for '88 are in the 760 and include a completely new independent rear suspension, restyled front end and new front and rear valances. Front-end styling is softer and smoother, in the modern aerodynamic mode. The rear suspension is an independent type that is shared with the high-priced 780 Volvo coupe.

The 240 series is still alive and well, with only minor changes for 1988.

### Yugo

Price is still the prime selling feature for the Yugo. The GV is \$4199, up from \$3990 in 1987. A second model, the GVS, has a suggested retail price of \$4699. Another new model, the GVL, will sell at \$4499. Both are upgrades from the base GV. Technical features are the same as in 1987. A new-for-'88 sporty version, the GVX, has a 1.3-liter engine.



# PM TECH UPDATE

JANUARY 1988

## Orbital Engine Sparks Automakers' Interest



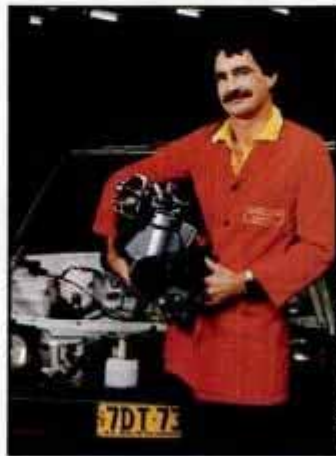
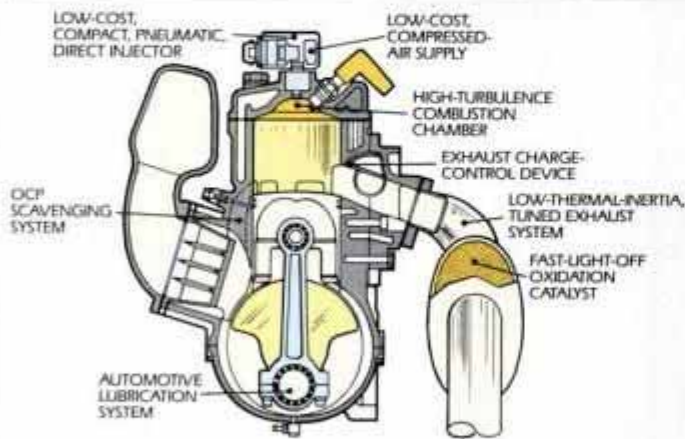
**P**ERTH, AUSTRALIA—Engineers at Ford and General Motors are testing a highly touted new 3-cylinder, 2-stroke engine outfitted with advanced combustion control. The engine is the brainchild of self-made engineer Ralph Sarich, whose Orbital Engine Co. is negotiating with Japanese and European automakers.

Despite the company's name, the engine is not a rotary. Sarich adapted the fuel-injection technology that powers the 1.2-liter engine from an Orbital design that he has since tabled. The 90-pound engine reportedly matches the horsepower of 4-strokers three times its weight. Yet unlike conventional 2-stroke engines, says Sarich, it burns clean, easily meeting U.S. emissions standards with a simpler, low-cost catalyst that controls unburned hydrocarbons and carbon monoxide.

In addition, Sarich's fuel-injection design allows the engine to run at air/fuel ratios as lean as 70 to 1. At the heart of the Orbital engine is an air compressor that blasts fuel directly into a stratified combustion chamber.

The refined combustion process could mean a 30-percent boost in fuel economy in a vehicle designed to take advantage of the engine's reduced size and weight. An Orbital-fitted car, with its reduced engine weight and volume, wouldn't need power steering and would accommodate more under-hood components.

If Orbital's claims hold up, the small, cheap, 2-stroke engines that have tantalized auto engineers for years may become a reality.



ORBITAL ENGINE PHOTOS

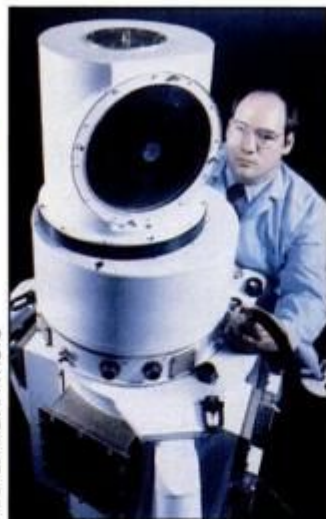
The Orbital combustion process powers an engine that's light enough to tuck under your arm yet capable of 90 horsepower and a performance-caliber torque curve. The flat torque curve matches that of a production engine, and emissions easily meet U.S. standards.

Editor: Tim Cole  
Assistant: Gregory T. Pope  
Contributors: Nick Nichols, Chris Davis,  
Josh Eppinger, Mike Fillon



## Remote Toxin Detector

EL SEGUNDO, CA—The Remote Active Spectrometer (RAS), being developed at Hughes Aircraft Co., will enable troops to detect chemical weapons up to 3 miles away. The detector bounces four infrared laser beams off a chemical cloud or pool. Each beam can be independently tuned to a specific frequency. Since any given chemical absorbs light at a characteristic frequency, the device can identify possible poisons by analyzing the unabsorbed infrared light that



HUGHES AIRCRAFT PHOTO

RAS smells distant poisons.

the target reflects. The RAS is designed to replace handheld detectors that only registered when a soldier walked into a toxic environment.

## Digital Med Archiving

ISELIN, NJ—The Picture Archiving and Communication System (PACS) stores images from X-rays, CAT scans, magnetic resonance and other tests. Developed

by Siemens Medical Systems, PACS can sharpen features with an edge-enhancing filter or enlarge details with a "zoom" function. Looking at a PACS terminal instead of juggling files, doctors can use the simultaneous display to verify diagnoses.



Doctors compare PACS-stored images from different tests.

## Floating Hotel Near Australia's Great Barrier Reef

QUEENSLAND, AUSTRALIA—The world's first offshore floating hotel is now anchored adjacent to Australia's Great Barrier Reef, 44 miles off the mainland. The 322,500-sq.-ft. Four Seasons resort features a desalination plant for fresh water, on-board sewage and waste treatment, an underwater observatory and a semisubmersible vehicle for coral-reef cruises, as well as the usual luxury hotel amenities.

Moving the 7-story hotel building was something of an engineering challenge. Construction got underway in June 1986 in a Singapore shipyard. Last fall, engineers guided a

half-submerged, heavy-lift carrier vessel under the floating hotel structure and then pumped the carrier dry, raising the building out of the water. The ship brought the hotel to the lagoon and reversed the loading process. Work crews connected the hotel building with pontoons that carry tennis courts, a marina and the rest of the complex. Anchoring the whole resort is a mooring system originally developed for oil supertankers. The hotel's powerplant, according to the developers, will operate at almost noiseless levels so as not to disrupt the reef's delicate ecosystem.



FOUR SEASONS ILLUSTRATION

Helicopters and high-speed catamarans will bring guests from the mainland to the floating hotel.



## Kidney Stone Smasher

ST. LOUIS, MO

—Shockwave therapy—the technique that has taken the agony out of kidney stone treatment—may become even more convenient with the Lithostar system.

Lithostar's main feature is its ability to deliver shockwaves, otherwise known as lithotripsy, without having to resort to painful surgery or immersing the patient in a water bath.

Newly developed electromagnetic shockwave generators, housed in compact applicators, have made this dry coupling possible. Siemens Medical Systems, Lithostar's manufacturer, says the electromagnetic generators also eliminate the need to re-



SIEMENS MEDICAL SYSTEMS PHOTO

**Kidney stone treatment is made easier with Lithostar system.**

place electrodes. Dry coupling, in turn, has allowed Siemens Medical to incorporate other features into Lithostar. A digital imaging system monitors the progress of the therapy, preventing

shockwave overload. And a computer-driven table, guided by X-rays, positions the patient over the applicators. In addition, by tracking the patient's breathing, Lithostar delivers the shockwaves

only when the movements of the patient's lungs shift the kidney into its best target position. An acoustical lens focuses the shockwaves as they pound the kidney stone, shattering it into easily passable particles. Most procedures performed on the Lithostar require no more than local anesthesia.

Lithostar's maker indicates the device is appropriate in treating other urological disorders.

Not yet approved by the FDA, Lithostar is currently being tested at Washington University in St. Louis and the University of Virginia in Charlottesville.

Used in Europe for more than a year, Lithostar has made kidney stone removal a routine procedure.

## RPV Advancements

NEW YORK, NY—The world of remotely piloted vehicles continues to expand.

Borrowing the tilt-rotor technology that's currently emerging in the V-22 Osprey, engineers at Boeing Helicopter Co. are exploring ways to develop remotely piloted vehicles that take off like a helicopter and fly like an airplane. The miniature tilt-rotor under study, called *Pointer*, will be able to hover for extended periods under concealment in enemy territory, while an operator miles away controls onboard systems. In a reconnaissance role, *Pointer* will use television cameras and infrared sensors to spot tanks, artillery and helicopters. Lasers would pinpoint targets for beam-riding missiles and artillery shells.

Meanwhile, the CM-44, a California Microwave product already in production, is unique among remotely pi-



FM ILLUSTRATION BY JERRY BARNARD



**A hovering Pointer sends an image to a remote operator while another flies horizontally overhead.**

loted vehicles in that it can also accommodate a pilot. Based on a design by Burt Rutan of *Voyager* fame, the single-engine craft can con-

duct offensive as well as reconnaissance missions thanks to its wing munitions mounts.

Its developers say the CM-

44 can also carry Stinger missiles to attack helicopters. Fiberglass, composites and structural foam give the CM-44 a "stealthy" radar profile.

Unlike most current RPVs, the CM-44 can land conventionally instead of being caught in a net. The remotely piloted vehicle may draw the attention of Army strategists seeking a craft with a pilot/autonomous option for reconnaissance and electronic warfare.



**Sleek CM-44, 29 ft. across, can cruise for more than 1700 nautical miles.**

CALIFORNIA MICROWAVE PHOTO



## Holographic Quality Control

BRISTOL, ENGLAND

Holography combined with optical processing may help automate quality control of precision components such as the printed circuit boards in electronic products. Scientists at British Aerospace have developed a system to check for defects in circuit boards as they roll along assembly lines. The system—Automated Equipment of Surveillance using Optical Processing (AESOP)—can check an entire board in one scan and locate faults.

LONDON PICTURES SERVICE PHOTO



New holographic manufacturing control.

First, a hologram of a perfect finished circuit board is created and used as a standard. The checking system uses a spatial light modulator to convert ordinary light into a coherent laser beam, which it uses to make a hologram of a freshly made circuit board.

The optical processing circuitry reduces the hologram to a series of mathematical functions, then compares the results to those of the test hologram. The technology has possible future applications in 3-dimensional TV and computer-aided design.

## Most Intense X-Rays Ever

ARGONNE, IL—A new facility that will produce the most powerful beam of X-rays ever—10,000 times "brighter" than X-ray beams now available—is scheduled to open at Argonne National Laboratory in 1993. It's called the 9 GeV Advanced Photon Source (APS), and its diameter will

ARGONNE ILLUSTRATION



APS accelerator will whip positrons up to near light-speed.

The facility's efficiency will be due in part to a newly developed vacuum system that will suck air molecules out of the way of the speeding positrons. The system, 10 times as powerful as conventional vacuums, includes an oil-free pumping mechanism and materials, known as "getters," that trap gas molecules on their surfaces.

In addition, a new fast, accurate X-ray detector will enable researchers to record data without exposing materials too long to the punishing X-ray beams.

The resolution provided by a superintense X-ray beam will help scientists look at the fine structure of viruses, superconducting ceramics and other still-shady materials.

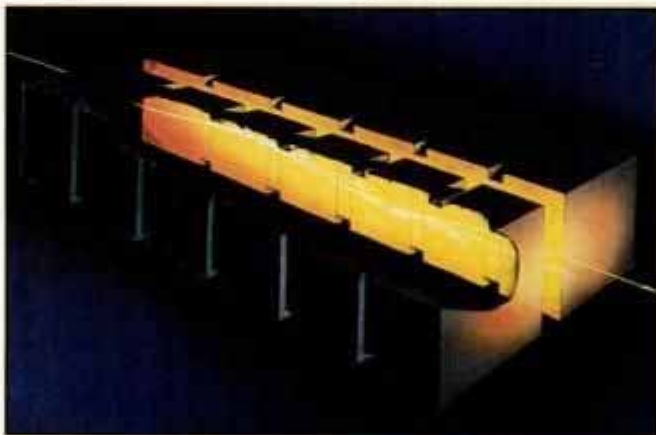


ARGONNE PHOTO

Positrons fly through vacuum pipe.

equal the length of nearly four football fields. APS will cost \$380 million to build.

Inside, positrons—positively charged electrons—will race around a ring at close to the speed of light. Magnets will introduce vibrations into the path of the positrons, which respond by emitting X-ray energy. In the APS control room, computer systems will tailor the characteristics of the energy beam to allow as many as 100 X-ray-dependent experiments to proceed at the same time.



"Wiggler" magnet warps path of positrons, triggering X-ray.

## Small-Package Power

RED BANK, NJ

The tiny battery was developed at Bell Communications Research and is powerful, rechargeable and readily adaptable.

Unlike many other lithium batteries, this one, based on a silver molybdenum sulfide cathode, operates at room temperature.

A thin-film cell adaptation could run a digital watch or maintain the information stored in integrated circuits.



The cathode breakthrough.

A bigger version could one day replace an automobile's lead-acid battery.

## Appliances In Orbit

BENTON HARBOR, MI

Whirlpool hopes its designs to ease housekeeping chores in microgravity will wind up on the Space Station. The concepts include a refrigerator equipped with a desiccant-based defrost mechanism and net-covered drawers, a spinning dishwasher that uses centrifugal force to pull water and food particles away from used plates, and a vacuum-driven clothes washer that expands for use as a dryer.

The appliances are also energy-efficient and virtually vibration-free.



Clothes won't wrinkle in space.



## Emergency Smoke Hood

ALDERSHOT, ENGLAND—The breathing device is known as ELSA (Emergency Life Support Apparatus) and provides air during emergencies such as in-flight or post-flight aircraft fires or a chemical leak in a factory. Developed by Sabre Safety Ltd., ELSA consists of a polyvinylchloride hood connected via a hose to a compressed-air unit that lasts for 5, 7 or 10 minutes.

Some models feature higher air-flow rates if strenuous activity is called for.

A polyurethane hood is also available for situations where low temperatures are anticipated.

The company also makes more elaborate ELSA units for use by airline crews evacuating planes during in-flight or post-crash fires. The ELSA-CREW features a

INTEL SAFETY INSTRUMENTS PHOTO



ELSA protects against toxic gas, flame- and heat-retardant hood, a speech diaphragm for unmuffled communication, up to 20 minutes of compressed oxygen, a carbon monoxide absorption filter, and a cooling unit for exhaled gas.

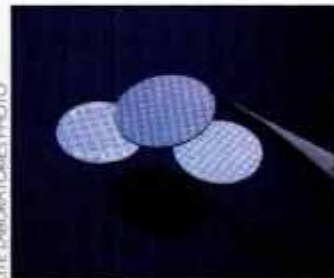
Still on the drawing board are ELSAs for airline passengers to supplement life preservers, escape slides, oxygen masks and other safety equipment.

## High-Power Transistors

WALTHAM, MA—Transistors that propagate their own internal metal connections are a focus of research at GTE Laboratories. By combining silicon with the conductor tantalum disilicide, researchers have used existing silicon crystal-growing equipment to make the new "volumetric" transistors. The transistors may trigger a revolution in solid-state architecture because they are circular: Current enters through the center, radiates out and drains across the circumference. Since the connections form within the growing silicon crystal, contamination is less of a problem during manufacture.

Volumetric transistors also differ from conventional solid-state devices in that the

current-carrying channel extends the full depth of the transistor, rather than being restricted to a 10-micron surface coat on an inactive substrate. This means the transistors can handle strong currents, with applications in high-power pulse switching, for example. They are also more sensitive to light, responding to a much wider spectrum of frequencies than



GTE transistor wafers.

normal photodetectors—with implications for solar energy converters, cameras and optical communications.

## Light Vehicles

FORT LEWIS, WA—The U.S. Army Development and Employment Agency is currently looking at a hybrid

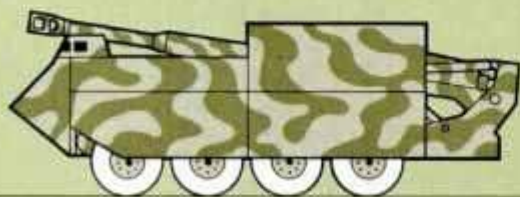
self-propelled howitzer to fill the need for air-transportable, mobile fire support for its new Light Infantry Division. Standard Manufactur-

ing Co. of Dallas is demonstrating its 8x8 Trailing Arm Drive (TAD) vehicle chassis as the platform for a piggyback-mounted M102 105-

mm towed howitzer. The TAD was originally designed to carry a Vulcan anti-aircraft gun.

If baseline firing trials go well, the development program will begin in earnest. First, a British-designed M119 105-mm Light Gun will be grafted onto a truck version of the TAD. The next stage will be the reduction of the system's weight to allow for transport of the complete vehicle by a CH-47 helicopter. A further development will be the permanent integration of the gun and truck within the specified weight parameters. Ultimately, the Army hopes to see the 105-mm ordnance supplanted by a new "ultralight" 155-mm howitzer.

If all goes well, the Light Infantry Division's critical need for light yet lethal fire support will be met.



Wheeled TAD comes in Vulcan carrier configuration [photo] or medium combat truck version [illustrations] with light 105-mm howitzer.

PMA ILLUSTRATION BY GERRARD BICHTER



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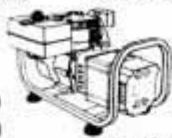
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**CAR OF THE FUTURE**

(Continued from page 49)

ahead. In recent years, we OD'd on electronics in our gauge displays. We are now going back to clear operation of controls. There is a place for a mechanical, machinery feel of controls. We miss that feel—things like knobs for radios or other controls.



"Look for lower cowls  
and side glass."

**THOMAS C. GALE**, Vice President,  
Product Design, Chrysler Corp.

Look for bigger wheels, longer wheel-bases that put the tires out farther toward the ends of the car and a "command position" for the driver. Those are trends you see now that should carry over into the new century.

Sure, there will be some aero lines, but there will still be a hint of boxy shapes too, on certain models. We will continue to see softer, more organic forms. They will not be aero precisely, but shapes will be in that vein. But the benefit of aero is that it's efficient, so that's why it won't go away.

Changes will come gradually, in an evolutionary process, not the result of a revolution in design. To implement this, we're looking for some logical benefit to the customer. In the past, we've made mistakes by talking to ourselves when all the time it is the customer who really should be telling us what to produce.

For the driver personally, we will have lower cowls and side glass so that he can get a better feel of control over the road. That's a big benefit that design will deliver. Low cowls will be a significant feature of the car of 2001.

But for safety, the front of the car will continue to have a hood dimension. We will keep the engine compartment about the same size, to give the room we need for impact crush.

We are also looking more at modular construction. That would mean we can combine the major parts of the body panels in one package, like putting together the hood, front fenders, bumper and grille as one unit, probably using plastic. Then we can attach those front ends to another module, perhaps a steel module for a wagon, coupe or 4-door sedan. Customers could get a wider choice of body styles at a reasonable price.

Don't look for lower, sleeker cars to dominate the next century. Our van is a tall car. That's one of the reasons it's so popular. You don't have to step up or step down to get inside. And we have buyers who recognize that. In

addition, the tall car setup is part of the driver control I talked about earlier. We will still have low-slung sportscars that are not as roomy or easy to get in and out of as sedans. But a lot of buyers want 4- and 5-place sedans, and that's what they'll get.



"Typical engine will be  
a 4-cylinder that  
develops 180 hp."

**DONALD L. RUNKLE**, Director,  
Chevrolet-Pontiac-GM Canada  
Group Advanced Vehicle  
Engineering, General Motors Corp.

Take a typical midsize 4-door sedan, a car we'll build in the year 2005. What we put in that vehicle will stick close to the four most important things a customer wants—good looks, good ride, safety and long life. We listen to the customer, and those are the features we hear again and again.

Good looks means styling, inside as well as outside the car. I'll leave comments on that feature to Chuck Jordan. But I can tell you we'll have cars with efficient body shapes that are aerodynamically better than anything on the road today.

Good ride actually means a lot of things, like smoothness, handling, steering, quiet interiors—all the things that make driving pleasant. Where we engineers look is right down to the tire patch, the footprint a tire makes on the pavement. Control that and you have control over handling.

Active suspensions that keep a car level in turns and riding smoothly are a good bet for many cars 15 or 20 years from now. They do the best job of controlling the tire patch. But active suspensions are expensive, and it's unlikely they'll be on all cars.

Less expensive models will have antilock brakes and traction control. They will also have automatically adjustable shock absorbers, the kind that react to the road surface, not to a preset adjustment.

Steering will get a lot of attention. Trends toward variable effort steering—the kind that change power assist from light when you're parking to firm when the car reaches a certain speed—will continue.

Also look for electric motors to replace hydraulic pumps in some power steering. Smaller size and less complexity are its attractions. We could even go to steer-by-wire, with no mechanical connection at all between the steering wheel and the front wheels. Aircraft have used that type of control for years, so there is no problem of safety that can't be overcome. But it will still be a long time before we get away from mechanical connections like we have now.



Four-wheel drive may be too expensive to put on every car. And, with our control of the tire patch through antilock and traction control, plus variable-rate shocks, traction gets so good there's no need for 4-wheel drive.

I don't see anything seriously threatening the 4-stroke internal-combustion engine in the future. Fuels may vary—gasoline, diesel, methanol or ethanol. But there will be no Sterling or gas turbine breaking through. However, if we can solve some emissions problems with the 2-cycle, that engine is a possibility in the under 2-liter size.

On a midpriced sedan built in the year 2005, here's what we foresee as a typical engine: A high-performance 4-cylinder that develops 180 horsepower. It will use four or five valves per cylinder that will be controlled by a computer to change lift, overlap and timing of each cylinder. Balance shafts to eliminate shake will be common. Monoblock construction that builds the block and head in one structure should be in production at that time, too.

Finally, aluminum will be the prime engine material, with some ceramics used in high-temperature areas. To go with this, the customer will be able to select 4-wheel steer as an option and get a 5-speed automatic transmission as standard.



"Block and head may be built in one piece—a monoblock."

STUART FREY, Vice President,  
Technical Affairs, Ford Motor Co.

Let's talk about the Continental, the car we put our innovations into in recent years. We are looking at V12 engines, mostly because we see them in the newer prestige cars in Europe. We have a problem getting that engine in a front-wheel-drive layout. But it does offer silky-smooth performance. The V12 may come about for competitive reasons. I think the average customer will feel the difference between a V8 and a V12 and like it.

In any event, the engine will not be much bigger than those we have now. Maybe 4.0 to 4.5 liters.

Look for three or four valves per cylinder in any new engine. That's the technique we'll use to get good performance. Multivalves produce better breathing and that adds power. But we also can get higher compression ratios because dual exhaust valves don't get quite as hot as just one valve. Higher compression means more power. And the more powerful engines will also get good economy.

Aluminum will be used for the engine block for weight savings and also because the block and head may be built in one piece—monoblock construction. There may be a psychological problem with mechanics there. We think the overall quality of the monoblock engines will be way up. But when you have a problem, with valves or such, it will be a major one.

We can build an active suspension with 4-wheel-steer and produce a car that handles superbly. But we never have to lose the Continental ride. The Lotus active suspension has its drawbacks. It takes a tremendous amount of power, something like 40 kilowatts. That's wasteful, and maybe not necessary with the advances we're making with our Continental even this year.

Speed-sensitive 4-wheel-steering, similar to the kind Mazda produces, has a couple of advantages that Continental owners would like. First, it is easier to park. And, with the rear wheels turning, the tire slip angle in turns is smaller. Cornering forces get better. So you can have the handling of a well-mannered car, and still not be too sporty (stiff) in its ride.

I'm not so sure you'll see a 5-speed automatic transmission on the 21st century Lincoln. Instead, the CVT (Continuously Variable Transmission) looks probable. The main problem with CVTs is getting the drive belt to handle high torque. So the jury is out on that decision.

Antispin traction systems are a cinch for almost any car of the future. The government will not ignore antilock brakes. I expect NHTSA will mandate it for all cars. Since antispin just reverses the logic of antilock, it is no big problem to put in a car.

Safety is important, and when you talk about steer by wire, I get really nervous. Sure, airplanes have that kind of control. But airlines have rigid maintenance, and redundant systems. We can't depend on the owner to do perfect maintenance. We can have electric motor systems, but they'll be backed up by a mechanical connection.



"I can imagine suspensions capable of responding to voice commands."

ROBERT M. SINCLAIR,  
Vice President,  
Engineering, Chrysler Motors

The way we go at designing a car is from the customer's point of view. In the year 2005, like now, we plan to go to the basics. We will deliver superb reliability, pleasing driving, and at a price that makes sense.

We could talk about block materials, multivalves, electronic ignitions,

but what it all comes back to is an engine that starts instantly every morning at any temperature and any altitude. It must be quiet, a bullet-proof engine that is reliable. Owners don't want to do ring jobs or valve jobs. They want the engine to last without fuss for at least 10 years.

So I don't see any revolution in engines. The piston engine will continue. It is a mechanical marvel and it won't go away as long as there is fuel to make the pistons go up and down.

Bulletproof also means we have to get rid of leaks, with new gaskets. It is not romantic, but that is where the advances are.

As for materials, the block will not necessarily be aluminum. But the aluminum head is a strong possibility.

Turbocharging will be refined, with lighter parts, ceramic wheels on the hot side and other changes that produce power at all engine speeds.

I see adaptive suspensions coming. But they are expensive, especially the way they were first designed. Adaptive suspensions do things that variable suspensions you see on cars now can't do.

They can change the roll rates. Why not bank into a turn instead of rolling the opposite way? But the price of things like 3000-psi hydraulic systems and sensors make today's adaptive suspensions too costly.

We will get around the cost eventually and come up with some wrinkles that are almost unheard of right now. Things like a radar/sonar setup that will anticipate potholes in the road ahead and adjust the suspension in 1 millisecond to ride right over them.

And, picture a switch on the instrument panel that will let me tell my suspension in the morning, "Hey car, I'm tired today. Treat my body gently. Give me the Montovani mode." The next day, "I feel better. Give me your sporty ride setting."

Every command from the driver to the lights or wipers I want in the 10 or 2 o'clock position within fingertip range of my hands on the wheel. The other controls, including radio and heater, will answer to my voice.

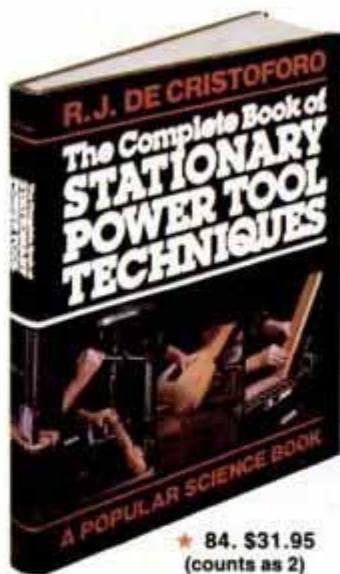
But in some things, I like the old way. Gauges should be round dials in black and white, with maybe a red needle. I strongly object to the so-called heads-up display. Don't have things that flicker and change shape projected on the windshield. That's too much distraction.

Finally, over my dead body will we have drive by wire, or accelerator control by wire. Even if it is triply redundant, it can still fail. Maybe only one in a million will fail, but that is too many. There still must be a mechanical connection keeping the driver in direct control.

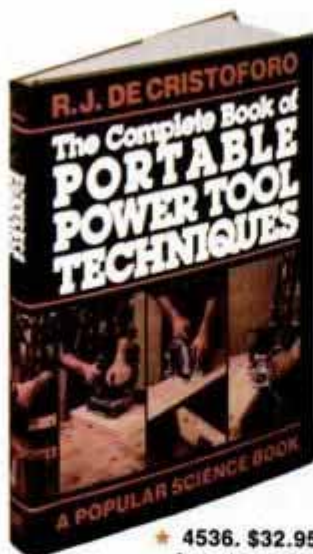


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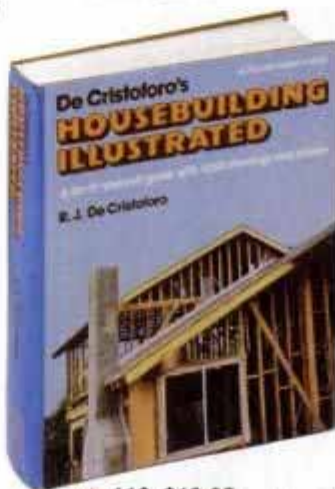
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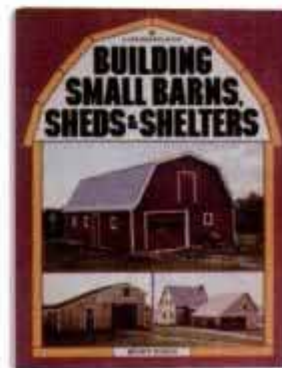
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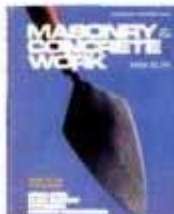
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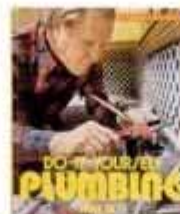
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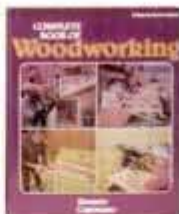
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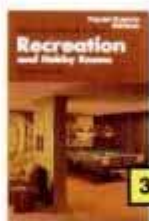
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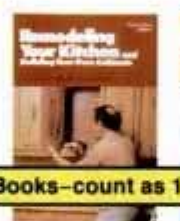
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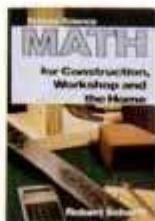
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## SAW BLADES

(Continued from page 68)

num Ave., Bridgeport, CT 06608. The blade's unique cutting edge is made of thousands of tiny tungsten carbide chips. Use it to saw through sheet steel up to 16 gauge, synthetic marble, particleboard, Lexan, fiberglass, tempered hardboard and other abrasive materials. Grit-Edge blades are available in sizes from 6½ in. to 10 in. The 7-in. blade shown costs about \$62.

RemGrit also manufactures Grit-Edge hole saws and blades for hacksaws, saber saws and band saws.

**5. Crosscut blade**—This carbide-tipped blade is designed exclusively for cutting across the wood's grain. Note that the teeth are at a lesser angle, known as the rake or hook angle, than a rip blade (No. 6). This contributes to smooth, clean cuts.

New from Sears, the Excalibur 10-in. crosscut blade (\$60) has 60 ATB-teeth. Use it for crosscutting all types of wood, plywood and particleboard. Excalibur rip and combination blades are also available. Contact Sears, Sears Tower, Dept. 703-PM, Chicago, IL 60684.

**6. Rip blade**—Like a steel rip blade (No. 2), this 12-in. saw blade has large teeth and deep gullets for fast, aggressive ripping without bogging down. However, this blade is equipped with 30 long-wearing, FTG, carbide-tipped teeth for superior cutting. It's available in diameters from 8 in. to 16 in. The 12-in. blade costs about \$61. Contact United States Saw, 1 Wizard Ave., Burt, NY 14028.

**7. Sanblade**—Here's a unique general-purpose woodcutting blade that cuts and sands. The 10-in., 40-tooth blade has 80-grit aluminum oxide abrasive bonded to both of its sides. The smooth-cutting blade also features ATB, C4-grade carbide teeth for executing rip, crosscut and miter cuts. The 10-in. Sanblade costs \$139.50. Other sizes range from 8 in. to 14 in. When the abrasive wears out, return the blade to the manufacturer for "re-abrading." To place an order, or for more details, contact Forrest Manufacturing, 250 Delawanna Ave., Clifton, NJ 07014.

**8. Nail-cutting blade**—When it's necessary to saw through lumber or flooring that contains an occasional nail, this is the blade to use. Its tough carbide teeth are specially ground to resist breakage. Also, note that the teeth are set at a negative hook angle—they actually tilt back slightly. The 8-in., 18-tooth blade shown costs about \$21. Contact DML, 1350 S. 15th St., Louisville, KY 40210.

**9. Cut-off blade**—The high-performance Freud cut-off blade (model No.

LU85M) is engineered for one specific task: to produce glass-smooth cross-cuts consistently with virtually no splintering. Use it on all species of hardwoods and softwoods in a radial-arm saw, power miter saw or table saw. The 12-in., 96-tooth blade (\$153) shown features C4-grade carbide, ATB-teeth. The blade body has laser-cut expansion slots and a special anti-grip coating that is self-lubricating. It's available in diameters from 8 in. to 15 in. Contact Freud, 218 Feld Ave., High Point, NC 27264.

**10. Piranha blade**—Black & Decker's Piranha is a general-purpose blade that has ultrasharp curved carbide-tipped teeth. This unusual tooth design, combined with its thin-kerf body, allows the Piranha to cut quicker and cleaner without getting bogged down. Use it to rip, crosscut and miter all types of wood, plywood, hardboard, particleboard and plastics. It's available in various sizes from 5½ in. to 10 in. The 10-in., 60 ATB-tooth blade shown costs about \$65. Contact Black & Decker, 10 N. Park Dr., Box 798, Hunt Valley, MD 21030.

**11. Radi-All blade**—Are you tired of arm wrestling your radial-arm saw? Then try a Radi-All blade. Designed specifically for the radial-arm saw, this blade virtually eliminates over-feeding—the tendency of the blade to advance quicker than it can cut. The supersmooth cutting blade has a repeating tooth pattern of four ATB teeth and one FTG raker. The 12-in., 80-tooth blade shown costs about \$110. It's also available in 8-in., 9-in. and 10-in. sizes. Contact DML, 1350 S. 15th St., Louisville, KY 40210.

**12. Woodworker I & II**—This pair of 10-in., carbide-tipped saw blades can handle nearly all of your woodcutting tasks. Woodworker I is a thin-kerf (⅜-in.-wide) blade that's engineered for use on a radial-arm saw. Its 60 clean-cutting TCG-teeth can rip, crosscut and miter. It costs \$84.50.

Woodworker II (\$81.50), designed for the table saw, has 40 ATB-teeth for fast, smooth ripping and crosscutting in tough hardwoods and cabinet-grade plywood.

Both blades feature C4-grade carbide and laser-cut expansion slots. To place an order or request details, contact Forrest Manufacturing, 250 Delawanna Ave., Clifton, NJ 07014.

**13. Wizard blades**—Here are two new saw blades that, through modified tooth designs, provide superior woodcutting. The Supreme Wizard (\$99) is a versatile combination blade that can rip, crosscut and miter wood, plywood, particleboard and plastic laminate. Its 60 TCG-teeth are ground to a clean-cutting 45° angle in-

(Please turn to page 98)



# Homeowner Drills His Own Backyard Water Well

A tip from his wife turned into a money-saving hobby.

Interview with Capt. Charles Anders, Airline Pilot

I'm Rex Roach, Factory Sales Manager of DeepRock Mfg. Co. Today I'm talking with Capt. C.H. Anders of Atlanta, Ga. who who is an airline pilot. Capt. Anders, you purchased a Hydra-Drill about 3 months ago. Are you having pretty good luck?

A. Yes, I haven't drilled a well yet that I didn't hit water, so I consider that pretty good luck.

Q. Capt. Anders, what made you decide to drill your own well? Why not hire a commercial driller?

A. I had planned to do that. Then my wife saw this ad about the Hydra-Drill and how you can drill your own well. She was kidding me about it because I had told her how I helped dig a well when I was a boy. But I got the literature and it was so interesting I decided to order one.

Q. How many wells have you drilled?

A. Four — actually, I'm drilling the fourth now, and it looks very promising. I'm already down about 75 feet, and I'll probably go another 30 or 40 feet. I expect to get about 600 gallons of water per hour at that depth.

Q. Is that good?

A. Around here, it sure is. Some of my neighbors hired commercial drillers and got about 300 gallons per hour.

Q. That's a lot of water. Why do you need more?

A. Well, for irrigation — you



know, flowers and sprinkling the lawn and things like that. This is a dry area. We just don't get a lot of rain like other parts of Georgia. In fact, we've really had a drought here for over a year, and a lot of people have had a well drilled recently.

Q. But you had never drilled a well before?

A. No, but I saw how simple it is. It's really fascinating how this Hydra-Drill works. It's not

complicated, and it's very easy to operate. Anyone could do it.

Q. Could you drill a well by yourself?

A. Yeah, if my neighbors would let me. Every time I start drilling, they come drifting over wanting to help. It's more like fun than work and everybody wants to try it.

Q. What do your fellow pilots think about your well drilling?

A. At first they thought it was a joke. Then they came out and saw the green lawn and all the sprinklers going full blast — they tried to buy the Hydra-Drill from me. I had to promise to drill wells for a couple of them.

Q. It sounds like you are getting into the well drilling business.

A. Not really. I plan to keep flying for a long time. This drilling wells for friends is just a hobby, and I'm enjoying it. The Hydra-Drill has already paid for itself so I'm doing it just for the fun of it. It's really something to see that drill go down, and when that water starts flowing, you feel like you've really accomplished something.

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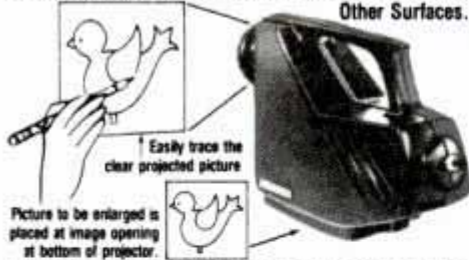
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## SAW BLADES

(Continued from page 96)

stead of the more usual 30° angle.

The Mitre-Thin Wizard (\$99), also a 10-in., 60-tooth blade, is designed specifically for use on a power miter saw. Its thin-kerf design puts less strain on the motor and keeps stock loss to a minimum. The ATB-teeth are ground to a razor-sharp 30° bevel instead of the standard 15°. This ensures supersmooth crosscuts with practically no splintering.

Both Wizard blades come in sizes from 9 in. to 14 in. For details, contact United States Saw, 1 Wizard Ave., Burt, NY 14028.

**14. Abrasive blades**—These two blades may be toothless, but they still have plenty of bite. The 8-in. masonry blade (\$5) shown is made of silicon carbide. Use it to saw concrete block, brick, ceramic tile and limestone.

The 7-in., metal-cutting blade (\$4.75) shown, made of aluminum oxide, will cut through steel, iron, brass, aluminum, bronze and copper.

Both blades are reinforced with fiberglass to help prevent them from shattering. Sizes range from 6 in. to 8 in. Contact Credo, 2765 National Way, Woodburn, OR 97071.

**15. Wobbler-type dado blade**—This dado consists of a 6½-in., 12-tooth blade that's fitted with an adjustable hub. The hub causes the blade to wobble from side to side as it rotates. Adjust the hub to cut a groove, rabbet or dado from 3/16 in. to 13/16 in. wide. It's sold at hardware stores for about \$34. Contact Vermont-American, Box 340, Lincolnton, NC 28093.

**16. Twin-blade dado**—Here's a unique dado that features two 8-in.-dia., carbide-tipped blades joined together by an adjustable collar. To adjust the width of cut, from ¼ in. to 13/16 in., simply turn the dial on the collar. The dial tilts both 24-tooth blades simultaneously on a double-cam hub. The Excelsior dado costs about \$90 at larger Sears stores and through the Sears tool catalog. Contact Sears, Sears Tower, Dept. 703-PM, Chicago, IL 60684.

**17. Stacking dado**—This professional-quality dado consists of two 8-in., 18-tooth outside blades and four inside cutters, known as chippers. The blades are 1/8 in. wide and the chippers include one 1/16", two 1/8" and one 1/4"-wide units. The chippers are stacked between the outside blades to obtain the desired width cut. The maximum cut is 13/16 in. wide, but additional chippers can be purchased for wider cuts. **Caution:** Never use inside chippers without the outside blades. The set costs \$205. Contact Freud, 218 Feld Ave., High Point, NC 27264. **PM**

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## FAIL SAFE

(Continued from page 57)

ficers on the ground can determine the effectiveness of Pyote 21 on this sunlit prairie morning.

Powell, Wyoming, is over the horizon and attention focuses on the offensive systems officer. When Dickinson's radar image matches up with a predetermined radar image of the strike zone, we hear a dull tone in our headsets. Time to move on to Forsyth and Belle Fourche, where Dickinson again takes over and drops the simulated ordnance. The bomb run is a tightly integrated exercise in crew coordination.

Beene takes the controls on our last 5 minutes of low-level flying. He finds a perfect canyon stretching forth like a tree along the ground—a deep, wide trunk quickly branches into several subcanions. His mind racing out ahead of the charging bomber, Beene swoops Pyote 21 down the middle of the chasm and bends it with subtle determination around the corners. We're actually flying inside the surface of the Earth just before we exit the STRC and pull back up to 19,000 ft. We've scheduled a rendezvous with a KC-135 tanker out of Castle Air Force Base in California, call sign "Tease 93". We'll take on 10,000 pounds of JP-4, which will hardly register on the B-1B's fuel gauge. It's just an exercise to give the tanker's boom operators some practice.

A ½-hour later, we polish off our standard Air Force in-flight box lunches and complete checklists before linking up with Tease 93. Our air-to-air radar picks up the tanker off to starboard at 2 o'clock. Soon, we can make out the faint wink of light reflected from the tanker's flanks. Chilstrom and the tanker pilot, Maj. Joseph Forstie, coordinate their speeds and the B-1B slowly closes ranks. A few minutes pass and Pyote 21 assumes the "precontact" position aft and below the KC-135.

We're flying along at 320 knots when Chilstrom and Forstie agree to join up. The B-1B's refueling door opens in a rush of air and the bomber eases gently forward to contact. We push the boom inward slightly, a dash panel indicator says "latched" and the fuel begins to flow. It takes no time at all to bring 10,000 pounds aboard.

Thus far, the aircraft has performed way beyond my expectations. In fact, there appears to be a distinct divergence of opinion regarding the B-1B. People who have never flown it have said it won't do the job. At 19,000 ft., I hear a different story.

"It handles like an F-111 and it carries twice the bomb load of a B-52. It's

fast. It's comfortable. And it's sneaky. It's a fantastic platform," says one Pyote 21 crewman.

Part of the ongoing debate over the B-1B stems from our naive understanding of what it takes to field a weapons system of the B-1B's complexity. We want 100 perfect airplanes for our \$20.5 billion (fiscal '81) dollars. But it takes time and a great deal of energy to bring men and machines up to fighting speed.

Nettlesome faults—like fuel leaks—have admittedly vexed the airplane. Dyess maintenance chief Col. Dan Wollam counters that the most severe fuel leak the B-1B ever experienced was no more than a sporadic drip, troublesome but not enough to keep aircraft from flying if they had to. Air Force personnel donned protective gear and ventured inside the fuel tanks of the afflicted airplanes to effect a cure, and the Strategic Air Command no longer considers fuel leaks a priority problem.

In addition, the aircraft's electronic countermeasures—the suite of 107 black boxes that help the B-1B detect, evade and defeat enemy defenses—have run into development problems. A Congressional concurrency mandate called for the creation of some B-1B components simultaneous with actual airframe production. Individual electronic countermeasures bench tested well, but there have been difficulties integrating all the systems into the finished aircraft. The Air Force predicts a 16- to 18-month period before the B-1B's full ECM capability is realized. But, as Gen. John Chain, commander-in-chief of the Strategic Air Command, points out: "The B-1B can still do its wartime mission better than any other bomber in the world."

Spare parts for operational B-1Bs have also been slow in coming while primary production continues. That means the Air Force has had to engage in parts swapping between aircraft in the maintenance cycle and aircraft scheduled for flight training. The parts count is expected to "ramp up" when the 100th airplane is completed. Further, the B-1B's terrain-following radar (TFR) encountered software glitches in some early aircraft. The system emits a radar signal up to 10 miles ahead of the plane, automatically guiding it around mountains, ridges and other obstructions during night, all-weather attacks. The latest TFR software is now in place, according to the Air Force, and air crews are learning how to use it.

Of more pressing concern, according to some defense experts, is developing tactics and technology that will

(Please turn to page 100)

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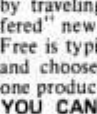
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## FAIL SAFE

(Continued from page 99)

mask the B-1B's TFR and active weapons system radar signature from the Soviet AA-10 air-to-air missile, which homes in on radar. Frequency hopping, "squirt" radar emissions and infrared sensing are all being discussed as ways to improve the B-1B's ability to fly fast and low.

Col. Don Jensen, commander of the 96th bombardment wing stationed at Dyess, is obviously enthused about the B-1B's ability to perform this vital function. "Right now, we can get a threat's range, bearing and azimuth with our passive systems, and if we know that, we can fly around him. Even if he can find us down on the ground, he's got to be able to follow us, fly his own plane through the terrain as well as we can, then shoot.

"On top of all that," Jensen continues, "We're incredibly accurate. We're so accurate, it's like throwing an egg at 900 ft. per second and hitting a trash can with it."

Those are fighting words, and they go hand in hand with some of the B-1B's notable strengths. The airplane has 1/10 the radar signature of the prototypical B-1A and 1/100 that of the aging B-52. It can fly intercontinental missions unrefueled and carry a mixed array of conventional and nuclear weapons.

The B-1B's armament is pre-mounted on rotary dispensers, which are in turn loaded into the plane's three weapons bays. The B-1B can deliver twice the conventional gravity-bomb payload of a B-52, up to 20 long-range cruise missiles and up to 24 short-range attack missiles. Additional fuel is carried in a removable cylinder that mounts in the forward weapons bay. Takeoff weight of the fully fueled and armed aircraft is 477,000 pounds.

Underway, the B-1B's wings sweep from 15°, providing high lift for short-field escape, to 67.5°. The B-1B can attain supersonic speeds at altitude and high subsonic speeds on the deck, where the plane was designed to fight.

The Space Shuttle has five IBM 101 computers onboard; the B-1B has nine, each offering redundant flight and weapons systems management. In fact, computers control everything from weapons delivery, to navigation, to crew comfort when you consider the way "smucks" can even out the bumps.

Combined with a highly reliable, hyper-accurate inertial navigation system (INS), a payload capacity tipping 74,000 pounds internally, and the ability to mount an additional 50,000 pounds on external hardpoints, the B-



1B is a powerful component in America's nuclear arsenal. Just one, equipped with cruise missiles, can knock out 20 separate hardened targets. A handful become a formidable—yet flexible—fighting force.

More and more B-1Bs are going on alert at the airplane's various main bases, and McConnell Air Force Base in Wichita, Kansas, is expected to receive its own B-1B Wing in the future. The number on alert is kept deliberately small for the time being to build aircrew proficiency quickly. Virtually all B-1Bs could be made alert-ready on very little notice.

We've got a few minutes to spare as Pyote 21 nears the end of its flight plan, so John and Jeff demonstrate some of the B-1B's approach-to-stall and handling characteristics. They set the power and allow the speed to bleed off. The nose begins to rise until Pyote 21 starts to buffet and the stall warning light comes on. Chilstrom gently puts the nose over and applies power to make it stop. They also demonstrate approach-to-stall maneuvers with gear, flaps and slats fully deployed, wings swept fully forward and power chopped. Same light buffet and pitch up, which disappears the instant the stick goes forward.

Back in the Dyess pattern, we complete six touch-and-goes—wings forward, slats and flaps down, gear locked, air speed 156 knots. A flight envelope box on the VSD tells the pilots where to keep the nose of the airplane in bad weather. According to Beene, you just fly the plane to the white stripes and grease it in. No flare. No funny stuff. Keep it simple.

On one low approach, Chilstrom simulates a 2-engine-out go-around by pulling back the two portside throttles. He's got more than 60,000 pounds of thrust with the two remaining engines and aside from a distinct yaw effect, the B-1B pulls away from the runway with aplomb.

It's 2 p.m. when we land Pyote 21 and take her to the chocks. We've flown 2500 miles in just under 7 hours. After a debriefing with Col. Jensen, we're in the officer's club for a beer by 4:30. Pilots and crews from other B-1B training flights filter in, and soon, hands and arms bank and jink, re-creating the day's low-level runs with the airman's universal gestures. The verdict is in as far as these pilots are concerned. Despite the time and expense of massaging the B-1B into our nation's strategic system, this is the plane they want to fly if they ever have to go to war.

Still, the irony of the nuclear age is as clear today as it was 43 years ago. The B-1B will have done its job if we never have to use it. **PM**

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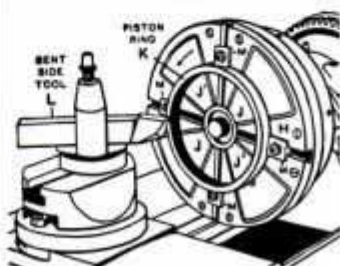
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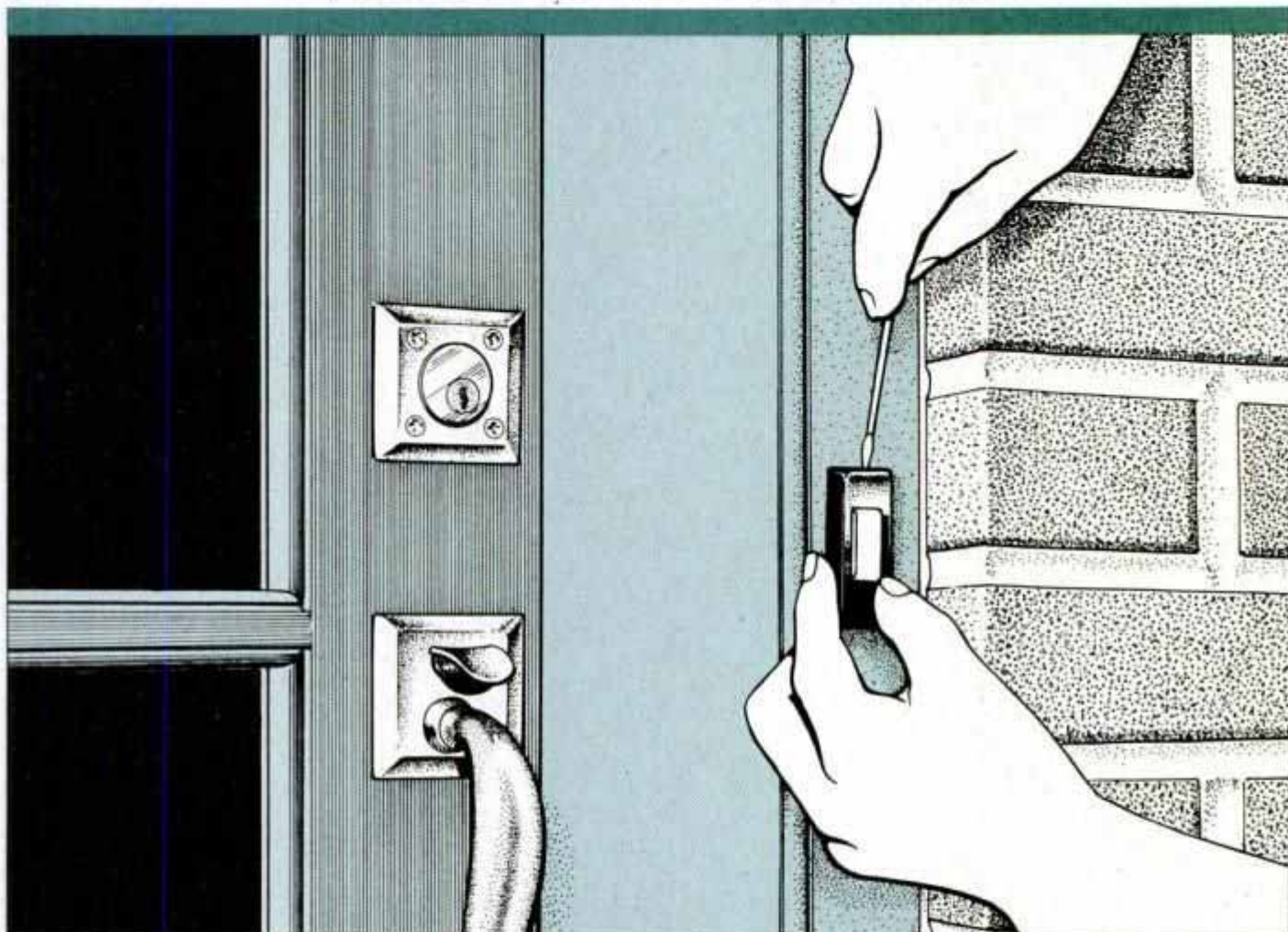


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# THE BETTER HOMIE



## How To Repair A DOORBELL

BY MERLE HENKENIUS; Illustrations by George Retseck

**I**F your doorbell has had the life rung out of it, don't despair. Defective doorbells are easy and inexpensive to fix. And since a doorbell system operates on low-voltage current, there's little of the danger associated with regular household electrical work.

Doorbells also have few components, which makes problem diagnosis quick and easy. Every doorbell system is composed of a button, transformer and bell, buzzer or chime mechanism. Aside from a possible break in the wiring, a problem with your doorbell will eventually be

traced to the faulty operation of one of these components.

### Start with the button

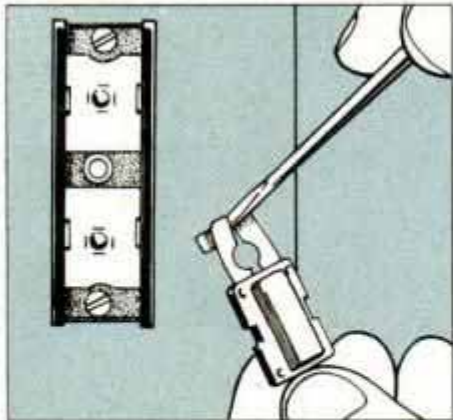
Because the button gets the most physical abuse and is located on the exterior of the house where it's subjected to the elements, it's often the component that fails first. If you press the button and hear no sound at all, it makes sense to start your investigation here.

Start by removing the button from the exterior trim. Buttons are either screwed directly to the trim or snap-mounted to a base that's screwed to

the trim. If you can't find the screws, you have the snap-on variety. Remove this type by gently prying under the button housing edge with a small screwdriver to pop it free.

The button is simply a spring-loaded switch that completes the low-voltage bell circuit allowing current to flow through the other components. You can determine whether the transformer and sound-generating unit are in working order and the wires are intact by bypassing, or jumping, the button. On the back of the button housing you'll see two wires connected to screw terminals. Remove one wire and briefly hold it against the other wire to jump the switch. If the bell rings, you know the rest of the system is fine and the button is at fault. Although you can attempt to clean the screw terminals and contacts, simply replacing the button is often the most practical solution. Install the new button by fastening the two wires to it and reattaching





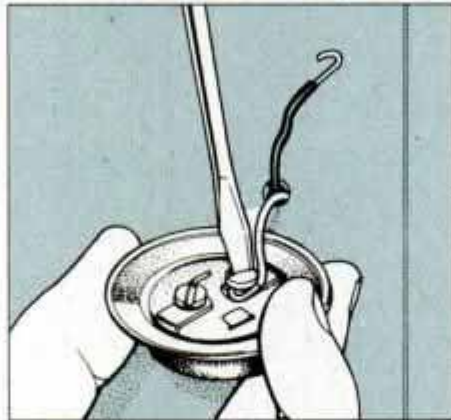
**1** Buttons with lights often have two brass spring tabs. Be sure they're clean and make contact with mounting plate terminals.

it to the trim. If bypassing the button didn't cause the bell to ring, assume for the meantime that the button is in good operating condition and the problem is located in the transformer, the sound-generating unit or is caused by a broken wire.

## Bells and buzzers

These mechanisms both employ a similar arrangement of coils and contact points to generate sound. Bells ring when current passes through electromagnetic coils which become energized and attract the clapper. As the clapper is pulled toward the coils, it strikes the bell. At the very instant the clapper strikes the bell, contact points on the clapper arm open, the circuit is broken and the coils lose their magnetism. Then, spring tension on the clapper arm returns it to its original position, the contacts close and the process is repeated for as long as the doorbell button is held down. Buzzers differ only in that they lack a clapper and bell. The sound produced is simply a result of the contacts opening and closing.

If your bell or buzzer makes any

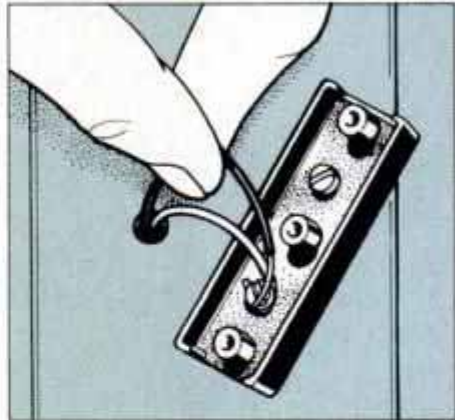


**2** Older-style buttons mount directly to the trim. Each of two low-voltage wires is connected to a brass screw terminal.

sound at all—even a muffled, raspy hum, it's fairly safe to assume that both the transformer and button are in working order and the wires are not broken. In this case, your job is to check out the sound-generating unit.

Begin by using a thin-blade screwdriver to pry the cover from the bell or buzzer and inspect the wiring and contact points. Some units have covers that can be popped off by simply pressing at the top or bottom. If the sound was muffled, check for grease and dust clinging to the moving parts. Use an old toothbrush and a drop of lighter fluid to clean the components. After cleaning, resist any temptation to lubricate the moving parts. Dust has a greater tendency to cling to surfaces that are oiled than to dry surfaces and you'll only be shortening the time until the next overhaul.

Next, check the wire connections. If a wire is loosely connected to its terminal, tighten the screw. If the insulation on either wire is frayed, cut off the bad section, re-strip the wire end and connect it to the terminal. Clean the coils with the toothbrush and lighter fluid. The contact points



**3** To test the button, remove one wire and touch it to the other terminal. If the bell rings, you've got a defective button.

can be checked by pulling the clapper away from its seat.

If you see a buildup of dirt and tarnish, clean the contact points with fine sandpaper or emery paper. The striking surface of a matchbook is a good substitute if you don't have any fine sandpaper on hand.

After you've checked the wires and connections, cleaned the entire mechanism, and dressed the points, reassemble the unit and try the doorbell. If it rings, the problem was simply a case of long overdue maintenance.

## Cleaning and repairing chimes

Many modern homes feature doorbells that strike chimes rather than ring a bell or buzzer. After years of service, chimes will often sound in muted tones. In other cases, you'll hear only one note of the chime's 2- or 3-note sequence. The rest may sound more like dull thumps than clear tones. This too can be caused by dust accumulation, but more often, is the result of worn pads on the tone bar mounts.

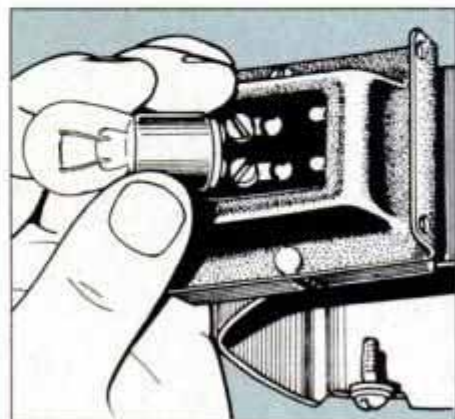
To clean a set of chimes, pop off the



**7** Use a toothbrush and lighter fluid to clean the parts of a bell, buzzer or chime. Don't lubricate to avoid collecting dust.



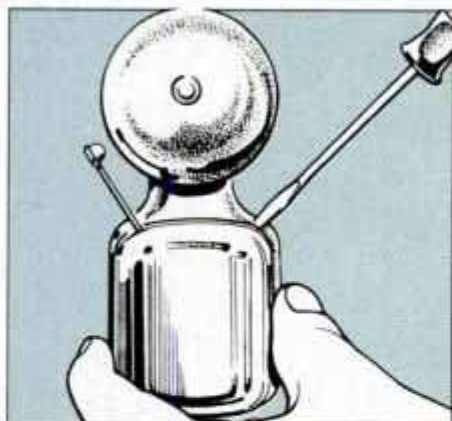
**8** Rubber grommets in a chime unit isolate tone bar from its mounting. Get replacements if they're worn, hard or missing.



**9** To test a transformer, remove the low-voltage wires and hold a 12-volt bulb to the terminals. If bulb lights up, all is well.



# THE BETTER HOME



**4** Use a screwdriver to gently pry off the cover of a bell or buzzer. Some covers pop off when you press the top or bottom.

cover and look for dust around the plunger springs and tarnish buildup on the tips of the plungers. Again, use a toothbrush and lighter fluid to clean the plungers and return springs.

Next, check the rubber pads, or grommets, on the mounts of each tone bar. These pads insulate the tone bars from the mounts so that the tone bars can vibrate freely. If you find worn, hard or missing pads, you'll need to buy replacements. Check with a local hardware store or electrical supply outlet for the pads.

If you have trouble finding new pads, you may have to replace the entire chime. Remove the old chime by disconnecting the wires and loosening the screws in the mounting plate. Simply reverse the procedure when installing the new chime.

## Checking the transformer

Every low-voltage doorbell system has a transformer that reduces the 110-volt household current to between 8 and 16 volts depending on the specifications of the bell, buzzer or chime unit. You'll find the transformer connected to a junction box, usually

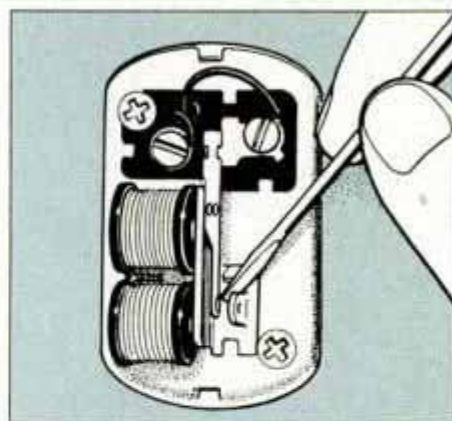


**5** Pull back the clapper to check the condition of the bell contact points. If necessary, clean them with a piece of fine sandpaper.

in the basement and often near the electrical entrance panel, where it's wired to a 110-volt house circuit. The low-voltage wires are connected to the transformer by screw-type terminals and are safe to handle. The connections inside the junction box carry the full 110-volt house current.

To check if your transformer is doing its job, undo the low-voltage wires and hold the terminals of a 12-volt automotive bulb to the low-voltage terminals on the transformer. Don't test the unit by jumping the terminals with a screwdriver. Some models have built-in fuses that will blow with this procedure. If the bulb lights, the transformer is working. If not, you'll have to install a replacement.

Before attempting to remove the old transformer, shut off the house circuit that supplies current to the transformer. Find the appropriate circuit breaker at the main panel and switch it off. If your panel has fuses, simply unscrew the fuse. Then, remove the junction-box cover plate and disconnect the transformer wires that connect the unit to the house current. Undo the box connector that holds the



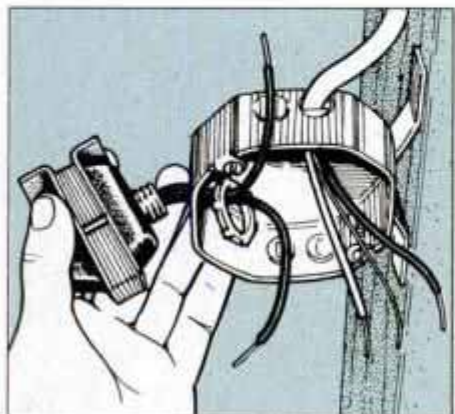
**6** Buzzer contact points should also be cleaned. Spread them apart with a screwdriver to check their condition.

transformer to the box and pull the unit out. Reverse this procedure to mount the new transformer and, finally, reconnect to the 110-volt circuit and turn it back on.

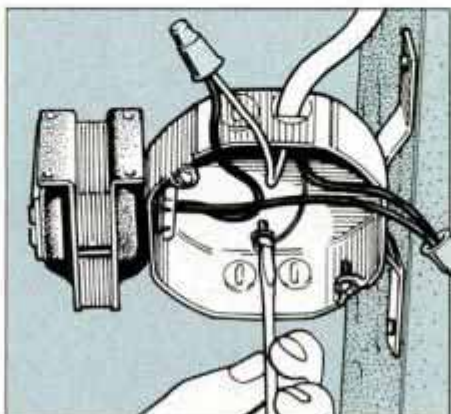
Doorbell systems require an 8-, 10-, 12-, 14- or 16-volt transformer. While any brand will do, make sure the new transformer has the same voltage rating as the original when purchasing a replacement.

## Checking the wires

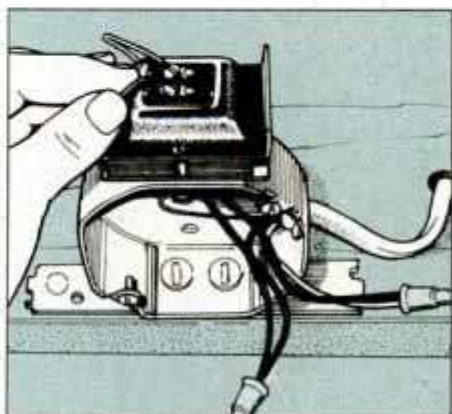
If the three main electrical components of your doorbell system check out, and your doorbell still doesn't work, you probably have a broken wire. You can check this by disconnecting the two low-voltage wires at the transformer and holding the probes of an automotive continuity tester to each wire while a helper holds the doorbell button down. If the tester light comes on, the wires are intact. If not, you'll need to string new wires through the basement or attic. You can often attach the new wires to the old and then pull the new wires through walls and other blind spots.



**10** Transformer is connected to house circuit at a junction box. After shutting off circuit, disconnect wires and remove.

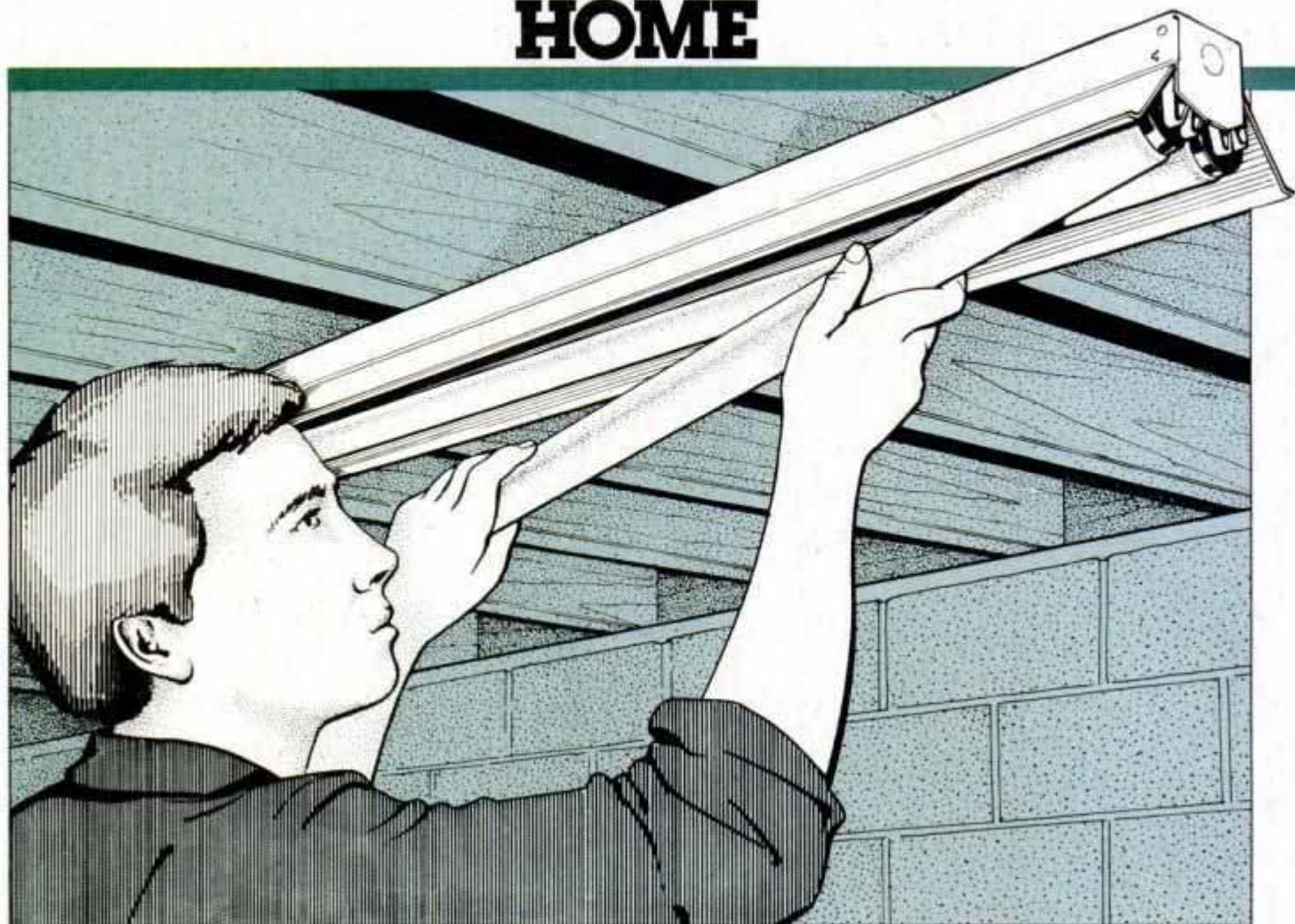


**11** Install new unit by connecting the transformer wires to the incoming black and white wires. Ground is screwed to box.



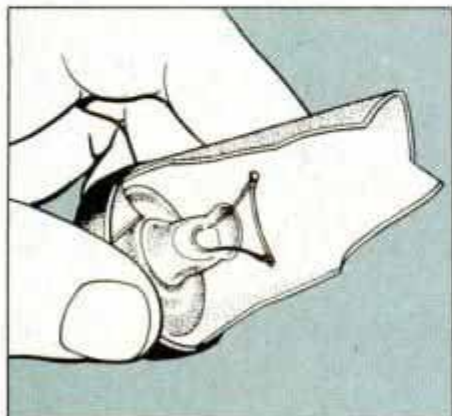
**12** After you've connected the transformer to the house current, fasten each low-voltage wire to a transformer terminal.





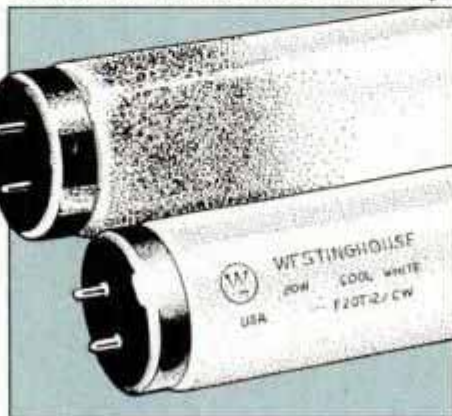
## How To Repair A FLUORESCENT FIXTURE

BY MERLE HENKENIUS  
Illustrations by George Retseck



**1** The cathode filament charges the mercury gas. Fluorescent coating inside the tube changes the radiation to useful light.

**D**ISMANTLING a fluorescent light fixture can be intimidating, because once you get past the tube, repair goes from the mechanical to the electrical in a hurry.



**2** Blackened ends indicate the tube should be replaced. Be sure the new tube matches the specs printed on the old tube side.

Instead of the simple ON/OFF switch and familiar wire terminals characteristic of incandescent fixtures, what you'll find is an almost empty channel, a few meandering wires and the quintessential little black box. Somehow you expect more. If there were more, you reason, you might be able to figure the thing out.

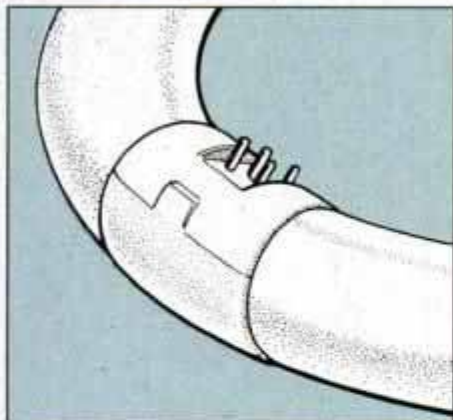
The fact is, fluorescent lamps are not much like incandescent lamps. To achieve the high efficiency and long life they've become noted for; they're more complex.

Even so, completely diagnosing and repairing a troublesome fluorescent fixture is well within the reach of the average homeowner.

### How fluorescent lamps work

Most of us have a fairly good idea of how an ordinary incandescent light bulb works. Turning on the lamp closes an electrical circuit which sends current through a metal filament contained inside a glass bulb. The filament burns white-hot and becomes luminescent much in the same way that an electric range burner glows red when it's on. In short, the filament is the source of light. When something goes wrong, it's usually a break in the





**3** Round fluorescent tubes are only different in shape. The four pins correspond to the two found at ends of a straight tube.

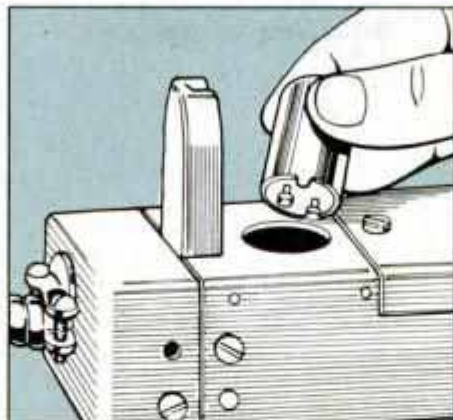
circuit—a burned out filament or faulty switch. Fluorescent fixtures, on the other hand, rarely just quit working completely, but show their ill health by flickering, producing less than normal light or hard starting.

A fluorescent tube glows because a mixture of mercury and argon gas, sealed inside, is charged with electricity. The charge is generated by a cathode filament at each end of the tube. When enough electrons are generated, the gas conducts an electrical arc through the tube. The charged mercury vapors radiate invisible ultraviolet light and a narrow band of the spectrum that is visible as a blue-green glow. This radiation falls on a fluorescent chemical coating on the inside surface of the glass tube which absorbs it and radiates light at a useful level and color.

The amount of electricity needed to keep the gas glowing is a lot less than to get it started. When you turn on a fluorescent fixture an initial voltage surge is sent across the filaments which charges the gas. Once current is established through the gas, the power is reduced to a normal operating level. Because the cathode filaments glow at full force only at start-up, repeated switching on and off can actually be less efficient and cause the tubes to fail sooner than simply leaving the light on. In general, fluorescent lamps last years and burn five to six times more efficiently than incandescent bulbs of the same wattage.

## Starters

Some fluorescent fixtures require a separate component to control the initial voltage surge to the filaments that begins current flow through the gas. This switch is called a starter. If your fixture uses starters, you'll find one of these small cylindrical objects pro-



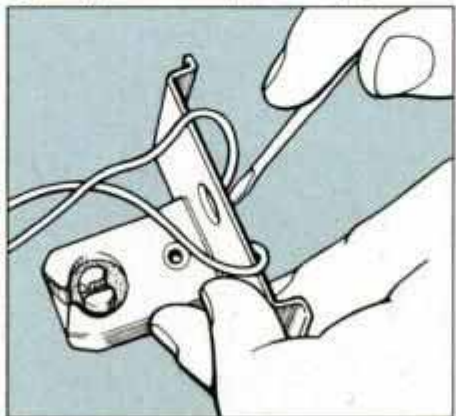
**4** Some units use starter switches. These have two contact pegs which lock into place when you press in and turn right.

truding from the lamp housing near each tube. When the filaments are hot enough to charge the gas, the starter switches off the high-voltage current. The charged gas then maintains the current flow at a reduced level. This 2-step ignition explains the familiar hesitation of older lamps when they're first turned on.

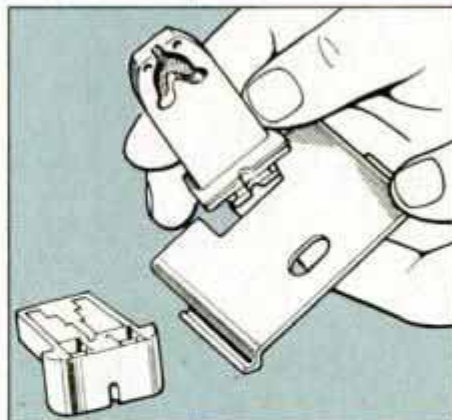
## Ballasts

The heart of every fluorescent fixture, old or new, is its ballast (that black box you were wondering about). A ballast is a kind of current-limiting transformer that serves two essential functions. When a fixture is turned on, its ballast provides a high flow of current to preheat the cathodes. Once gas conduction has taken place, the ballast reduces the current to a stable operating level.

Modern fixtures have ballasts designed to charge the tubes instantly without the need for starters. These are called rapid-start fixtures. While there are many different fluorescent fixture types in commercial use, virtually all fixtures used in residential lighting are of the preheat type with



**6** Many sockets have push-in terminals. To release a wire, push a small screwdriver into the release slot next to the wire.



**5** Sockets mount to the channel with screws or by snapping into place. This design slides into a slot in channel cover.

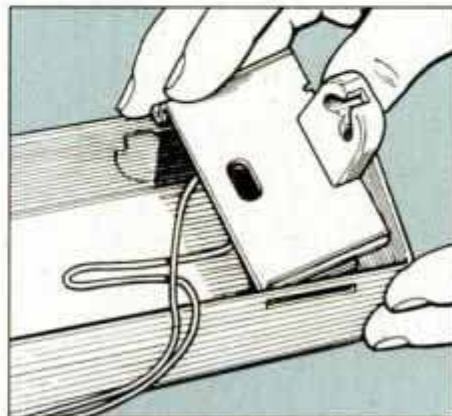
starters or rapid-start design. Both have tubes with 2-pin ends.

## Where to begin

If your fluorescent fixture is acting up, start by checking the tube. Most problems begin and end there. A tube will seldom go out abruptly, but will flutter and hesitate long before it fails completely. First, check the tube ends. A little gray discoloration is normal, but if the ends are black, the tube needs to be replaced.

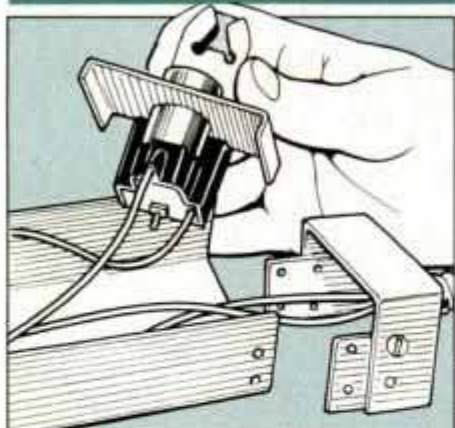
To remove a defective tube, rotate it one-quarter turn and gently pull it down out of its holders. In the unlikely event your tubes have a single-pin configuration, push the tube in one direction against its spring-loaded holder and drop down the other end.

If the tube ends are not black, it may simply need to be resealed in its sockets or the pins may need to be cleaned. The constant vibration a house endures can cause a tube to slip, thereby interrupting its contact with the socket. With the lamp switched on and the tube in place, try turning the tube slightly. If this doesn't work, remove the tube and inspect the ends. If



**7** When installing a socket mounted to a snap-in plate, slip one tab into its slot and spread the channel to accept the other tab.





**8** The socket shown here contains the seat for starter. When replacing this type, make sure you get an exact matching part.

you find dirt or corrosion on the pins, clean them and reinstall the tube. With fluorescent tubes you should look for little things. They can be temperamental. In some cases, you can get extra life out of a tube by simply removing it, turning it end for end and reinstalling. If nothing works, buy new tubes. As some fixtures are wired in sequence, you may have to replace both tubes, or two of four tubes within a fixture to correct the problem. If you'd like to ensure yourself several years of trouble-free operation, replace them all.

## Starter problems

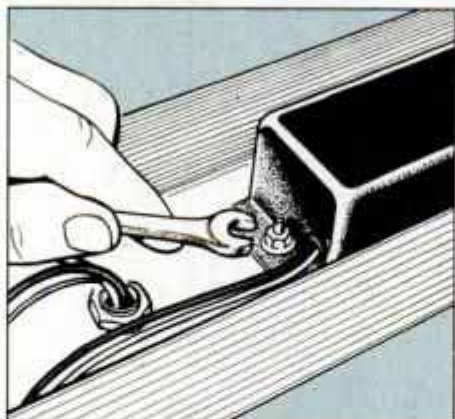
Because starters fail about as often as tubes, many electricians replace them each time they replace a tube. Problems that signify starter trouble are continuous flickering and tubes that only glow at their ends. If you have a tube that's flickering all the time, try reseating the starter. Remove the tube, press in on the starter and turn it to the right to seat it properly.

If only the ends of a fluorescent tube light up, don't bother reseating the starter. Simply replace it. To remove a defective starter, press in and turn to the left.

## Defective sockets and ballasts

There is a limit to the amount of money you should invest in a fluorescent fixture. This limit becomes a factor when the lamp sockets and ballast appear defective. If you shop around, you'll find that a new fixture can cost less than replacing the parts of an older fixture. However, older fixtures can be completely rebuilt. A classic old desk lamp, for example, can continue to offer years of service with an electrical overhaul.

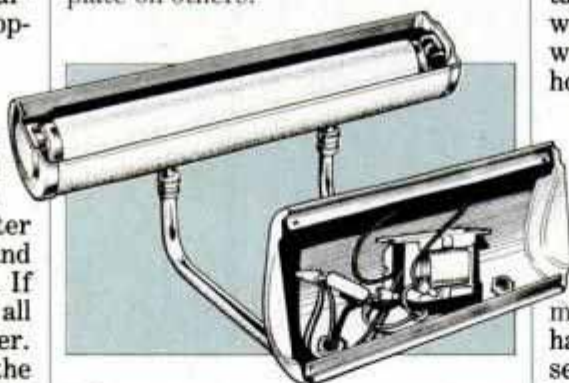
If you find that a lamp socket is bro-



**9** Ballast is held in place by two mounting screws and nuts. It's a good idea to make a wiring diagram before removing it.

ken or will no longer hold a tube against its contact, go ahead and replace it. When doing so, make sure the components you buy match the design and voltage rating of the originals. When in doubt, take the part with you for comparison.

To remove a defective socket, shut off the power and look for two mounting screws at the base of the socket. These screws are visible on some models but are concealed by a cover plate on others.



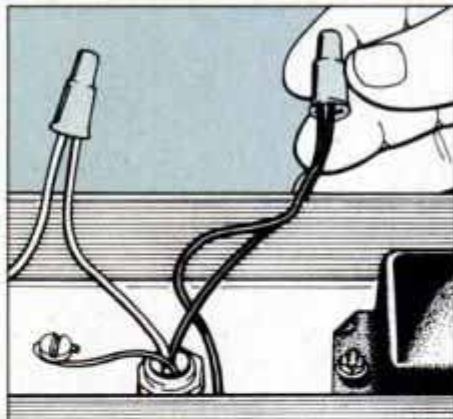
**11** This desk lamp is a preheat model, but it has no starter. It's turned on by holding the switch down until the light pops on.

Remove these screws to reveal the wire terminals on the socket. Disconnect the wires, fasten them to the replacement socket, and reinstall.

Some models have push-in wire connections. In this case, the wires will likely enter the front or back of the socket. To release each wire, slide a small screwdriver into the release slot next to the wire. Then, just slide the stripped ends of the loose wires into the new socket connectors.

## Replacing a ballast

A defective ballast is signaled by a buzzing sound, sharp asphalt odor, tubes that glow only at their ends, or a black oily substance dripping from the fixture. When shopping for a new bal-



**10** Attach black and white wires from ballast to the corresponding house circuit wires. Ground wire is screwed to channel.

last, make sure you buy one with the same voltage rating and design characteristics as the original. Each fixture brand will have its own specific wiring diagram and installation procedures. Follow them carefully.

In general, the ballast is fastened to the channel by two or more sheetmetal screws. You'll find up to eight color-coded wires disappearing under the ballast cover. Two of these, the black and white wires, should be attached to the corresponding black and white wires of the house circuit with wire nuts. The ground wire from the house circuit is generally screwed directly to the metal channel with a sheetmetal screw. The remaining wires attach to the lamp sockets.

Start by undoing these wires from their sockets, taking care to note the position of each wire. It's a good idea to make a color coded map of the wire connections so you have a reference when you're reassembling the unit. Then, undo the mounting screws and remove the ballast. Screw the new ballast in place and connect the new wires, keeping in mind the original wire connections and paying close attention to the wiring diagram supplied with the replacement ballast.

## Other considerations

Before investing time and money in dismantling a fluorescent fixture and buying expensive parts, it may pay to investigate possible trouble spots outside the unit. A defective wall switch or a loose wire-nut connection are always possibilities. These alternatives should be investigated if the fixture fails to come on at all. If some part of the fluorescent fixture works, you can usually assume that the external wires and switches are in good shape and the problem is within the unit itself.

PM



# Homeowners' Clinic

BY NORMAN BECKER, P.E.

## Chimney Safety Tip

Now that we're into the heating season, it's important that you check your chimney to make sure that the carbon monoxide-laden exhaust is not backing up into the house. Sadly, we occasionally read that a family has succumbed to carbon monoxide poisoning as a result of a clogged chimney. Carbon monoxide is colorless, odorless and quite poisonous. The degree to which it poses a hazard is related to its concentration and the duration of exposure.

Use the following steps as a guide when checking your chimney at the beginning of each heating season.

1. Pull the vent pipe out and look into the opening. Remove any obstructions and clean away soot.

2. Hold a lit candle at, or blow smoke near, the chimney opening. If the flame or smoke is drawn into the chimney, the draft is okay. If not, the chimney is clogged.

3. Examine and clean the vent pipe that connects the furnace to the chimney. Make sure there are no breaks or holes through which exhaust can leak.

4. Properly replace the vent pipe so that it has an upward slope from furnace to chimney. Make sure that the pipe is not pushed in so far that it touches the back of the chimney.

## Plastic Ducts

The lot we've selected for our new home lies in a relatively low area where there's a possibility that water might get into the foundation. Our builder suggested using large PVC pipes for the heating and cooling ductwork under the concrete slab. What are your thoughts? D.T. CHAN  
STILLWATER, OK

Since PVC carries the National Sanitary Foundation seal of approval for potable water and is used by many municipalities for buried water service pipes, I don't see why it can't be used for heating and cooling ducts.

The use of PVC pipe is generally limited to a maximum temperature of 120° to 140° F when the pipe is under pressure. When the pipe is used for heating ducts, higher temperatures could be realized. This should not be a problem, however, because the pipe

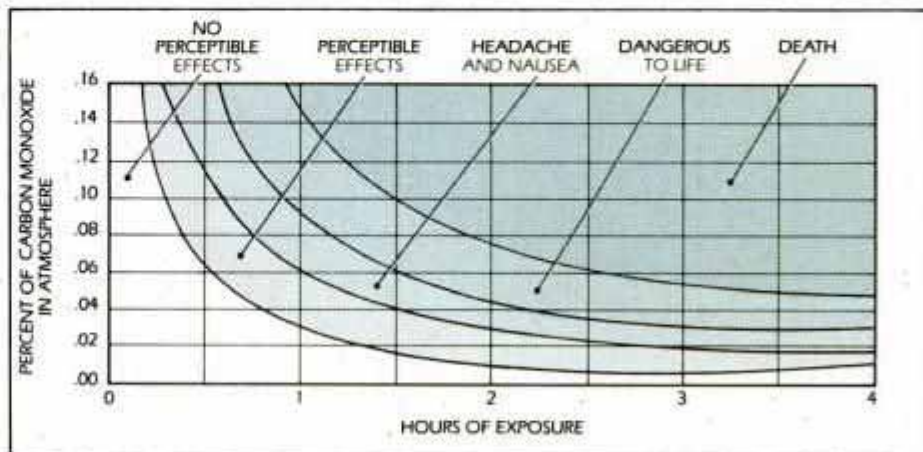


Chart illustrates how lengthy exposure to poisonous carbon monoxide at low levels can be as hazardous as a relatively brief exposure to a higher concentration.

will be under minimum pressure.

Be sure to check whether your local building codes permit using PVC pipe. In the event of a fire, PVC produces toxic gases. Some localities don't permit it regardless of where and how it's used.

I agree that if there is a possibility of water accumulation below the concrete slab, you should not use sheet-metal ducts. I've inspected many houses where water seeped into the ducts through open joints. This is a particular problem in the summer when the air conditioner is turned on. The air picks up moisture as it flows through the ducts and carries it into the house. Instead of the air conditioner removing moisture from the air, it increases humidity.

## Asbestos In Ceiling

My 9-year-old house has a sprayed-on "popcorn" ceiling. I've read that such coatings contain asbestos. Is this true and is it a health hazard?

JOHN CABLE  
LEHIGH ACRES, FL

The only sure way to know if your "popcorn" ceiling contains asbestos is to have a sample analyzed by a testing laboratory. If it does contain asbestos—don't panic. Simply containing asbestos doesn't make it a health hazard. If the material is in good condition and is unlikely to be disturbed, then any effects of the asbestos are considered negligible.

If your ceiling contains asbestos and you have deteriorating or dam-

aged sections, asbestos fibers may be releasing into the air creating a health hazard. In this case, contact an asbestos abatement company and have the ceiling removed.

Do not simply scrape the "popcorn" off because you'll be releasing asbestos fibers. Contact your local Health Department or the Environmental Protection Agency for the names of licensed abatement companies.

## Circuit Breaker Source

I'm trying to find replacement circuit breakers for the Square D-type XO circuit breaker boxes. I've checked all the local supply houses and can't find the breakers in either the 15- or 20-amp size. Can you help?

KEN RUBIN  
NEW YORK, NY

I checked with the Square D Co. and was told that the XO-style circuit breakers are discontinued and their stock was depleted about 10 years ago. Unfortunately, its new QO-style breakers are not interchangeable with the old ones. If your existing breakers are faulty, you'll have to replace the entire panel. You can, however, add circuits by installing an auxiliary circuit breaker box that's powered from the main panel. **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.



# Appliance Clinic

BY STEVE TOTH

## Dispenser Won't Open

I have a Lady Kenmore dishwasher model No. 587.720715, serial No. 1291681-0874. Lately, the soap dispenser fails to open. It seems to move freely and I've cleaned out the spray arm. Do you know what could be causing this?

JACK CHAPPELL  
EAST ALTON, IL

You may have a problem with the wire connections to the detergent cup bimetal. To check them, first disconnect the power to the dishwasher. Then, open the door and let it rest on your knee. Remove the outer door panel by first unscrewing the two top, then the two bottom retaining screws. Then, slowly close the door while removing the outer door panel.

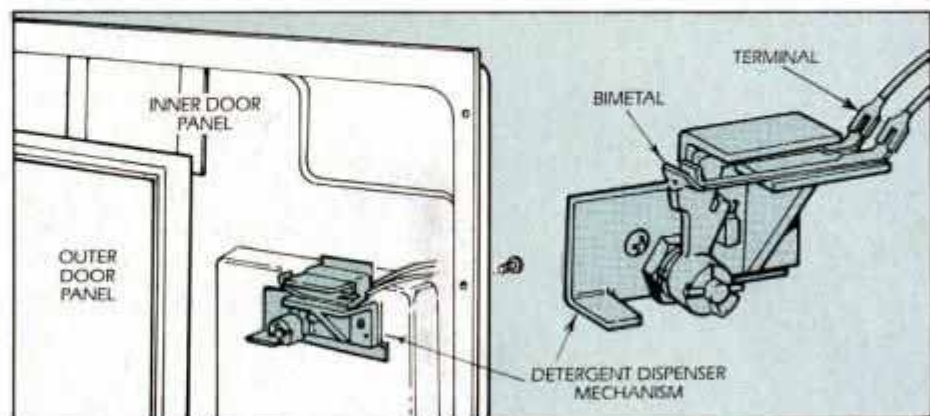
Near the center of the inner door panel you'll see the back of the detergent cup assembly. Check the wire terminals carefully. If you find them loose, burned or corroded, cut the wire back and add a new 1/4-in., spade-type terminal to the wire. If the bimetal terminals are badly corroded, you'll need to replace the bimetal. It's Sears part No. 808507 and costs about \$3.

## Fridge Gurgles

The gurgling problem with my GE refrigerator model No. TBX23ZGB, serial No. MS562867 has stumped every service technician that has heard of it. Every 5 or 6 minutes the unit emits gurgling noises that last for about 3 minutes and vary in intensity. Can you help?

WILLIAM WIEHN  
LOCKPORT, IL

I contacted the General Electric factory about your problem. They told me that your mysterious noise may be caused by a pocket of refrigerant vapor. This vapor bubble forms inside the capillary tube and results in a pulsing flow of refrigerant into the evaporator or freezer section of your refrigerator. Although this is an unusual occurrence, the problem is correctable. The small capillary tube which monitors the refrigerant through the sealed system needs to be rerouted and clamped to a specific location on the hot compressor discharge tube. This transfers heat to



Inspect the detergent dispensing mechanism by carefully removing the outer door panel. Then, check for loose, burned or corroded connections between the wires and bimetal.

the capillary tube which will help eliminate the vapor pocket and keep the refrigerant in a liquid state. This procedure should only be handled by a qualified service technician. GE recommends that you recontact the service agency that looked at your fridge and have them get in touch with the GE factory service representative for a solution to your problem.

## Needs Parts

I have been unable to find parts for my indoor grill. It's a Char-Glow Waste King Universal recessed open-top broiler model No. CG29. Do you know of any sources?

W.F. SHULTZ  
COLUMBUS, OH

There are a limited number of parts for your older model grill available from the manufacturer. Try contacting Thermador/Waste King, 4731 E. 52nd Dr., Los Angeles, CA 90052, Attn: Customer Service.

Ask for a list of available parts and related price list for your model grill and get the name and address of the nearest Thermador/Waste King parts distributor in your area.

## Gas Cooler Info

I need a service manual and a few interior parts such as freezer door and bottom gas burner cover for my Servel gas refrigerator model No. 104GD4080630. I understand Servel is no longer in business. Is there another source for parts?

JEFFREY GADD  
PHOENIX, AZ

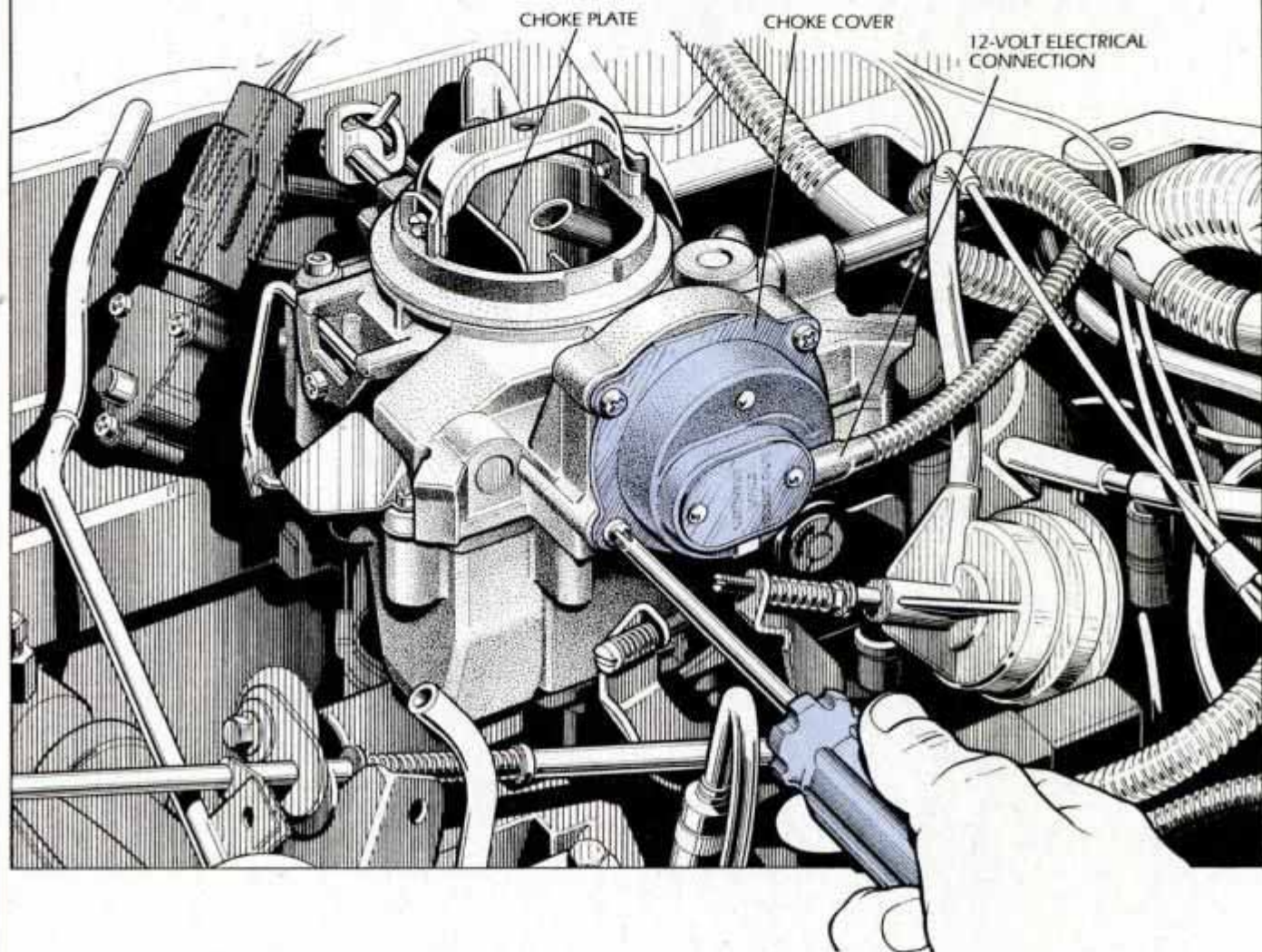
I'm afraid I can't help you find parts such as interior door panels and freezer doors. However, Kern's Gas Refrigerator Co. should be able to supply other necessary repair parts and literature for your vintage Servel unit. Its address is 3929 LeMesa, Central Valley, CA 96019. The manual covers several different Servel refrigerator models and costs about \$5 plus postage. It explains how to level your refrigerator, clean the flue, adjust the burner and cold control, and other useful servicing tips. The manual also identifies each part of the unit to simplify ordering. The company can rebuild your old cold control, if necessary, and supply you with a retrofit burner, orifices and turbulators. They also stock door gaskets for refrigerators manufactured as early as 1947. **PM**

## Service Tip

The seventh in Whirlpool's series of do-it-yourself manuals deals with electric range repairs. All manuals, including those on ice-makers, washers, dryers, refrigerator/freezers, dishwashers and trash compactors are available from any Whirlpool dealer or parts distributor for \$7.50 each. To order by mail, send \$8.50 for each manual to General Accounting, Whirlpool Parts Distribution Center, La Porte, IN 46350.

If you have a problem with any appliance, send your question, 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.





## Fixing Automatic Chokes

BY MORT SCHULTZ

**T**HE choke system in your car is probably locked up inside a riveted housing. But even though the carmaker seems to be saying "Hands Off," don't be intimidated. This very important component on carbureted engines can be reached for maintenance and repair, and you can

do the work yourself. First, you should understand exactly how a choke operates.

The job of any type of choke is to enrich the air/gasoline mixture in starting a cold engine. This is done by a valve that blocks the throat of the carburetor, cutting off air trying to

To reach choke, loosen screws that hold cover. A small electric heater that expands a bimetal spring opens choke plate gradually.

get into the engine. The richer mixture allows the cold engine to start quickly and keep running.

As the engine gets warmer, the choke valve opens and unblocks the carburetor throat. If it doesn't open, the fuel mixture will be too rich for the engine. The result will be overchoking and flooding. The engine stalls and won't restart until the excess fuel evaporates.

With the exception of some extra components, added primarily to help meet federal emissions control standards, the modern automatic choke is not much different from the first automatic choke ever installed as standard equipment. That was back in 1932. The car was the Oldsmobile, and the choke was one introduced a year earlier by the Bendix Stromberg Carbure-



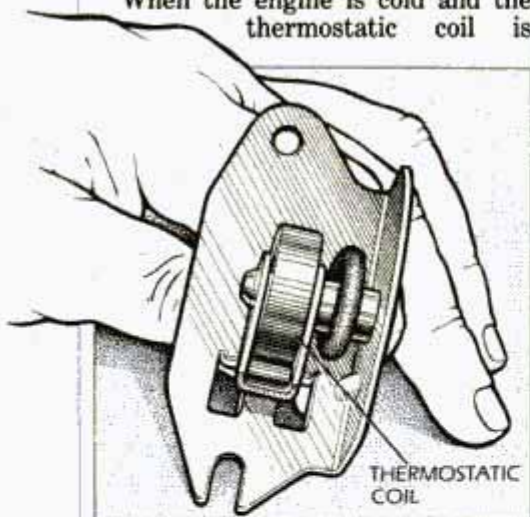
tor Co. The major components of a modern choke are a heat-sensitive bi-metal thermostatic coil, and a small vacuum-operated piston that pulls on the choke valve to open it as the thermostatic coil releases it.

The thermostatic coil is the part that holds the choke valve closed when the engine is cold and allows it to open as the engine warms up. Heat is directed into the thermostatic coil housing via a tube coming from the exhaust manifold or by an electric heating element. In many cases, a combination of the two heating methods is used. Some vehicles even route water from the radiator into the choke to supply heat.

The thermostatic coil is connected to the choke valve by a short link or by a shaft that pivots as the thermostatic coil contracts and expands.

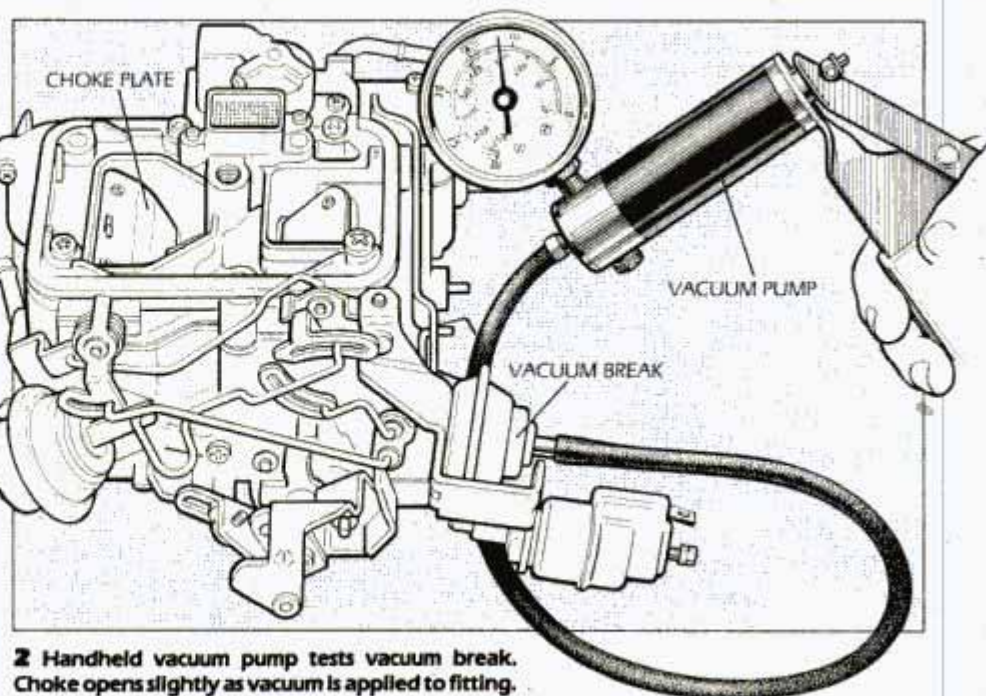
In the old days the carburetor-mounted choke system was referred to as the stove-type choke, a term you may still hear today. There is a second type of automatic choke system. It's commonly called the manifold-mounted or crossover-type choke, because the thermostatic coil is inside a well in the exhaust crossover passage in the intake manifold of V-type engines (Fig. 1).

When the engine is cold and the thermostatic coil is



1 This manifold-mounted choke is warmed by engine heat rather than electrically.

curled tightly, the coil pulls on a long rod connected to the choke valve. This keeps the valve closed. As the engine starts and begins to throw off heat, the thermostatic coil unwinds, releasing the long rod and, consequently, the choke valve. Electric elements are also used in some manifold-mounted choke housings to hasten the opening of choke valves.



## Breakdown by manufacturer

Carburetor-mounted chokes have been used almost exclusively by AMC, Ford, GM and import carmakers. Chrysler has made the manifold-mounted choke its main system. But there are variations, so don't take anything for granted. Check the carburetor housing for the coil housing. If it isn't there, the thermostatic coil is in the manifold.

Whichever system you have, your first indication that it's giving a problem is erratic engine behavior. Symptoms of possible choke system failure are these:

- If the engine is cold, it won't start or seems to take forever before it does start. Once started it idles roughly, hesitates or stalls until it warms up. This suggests that the choke valve may not be closing.
- If the engine is warm, it chugs, smokes and may not restart for a period of time. This suggests that the choke valve may not be opening.

On a day when the ambient temperature is less than 70° F and the engine is cold (having been shut off overnight), take off the carburetor air cleaner. If the choke valve isn't already closed, blocking the throat of the carburetor, press the accelerator pedal to the floor once and release it. The choke valve should close.

Start the engine. The choke valve should crack a bit, but not much—just enough to let a little air into the carburetor. Now, as the engine warms up,

the choke valve should open.

If the choke valve doesn't work this way, the cause of the problem could be ordinary dirt that has built up on the choke linkage or around the choke valve. Spray linkage and valve pivots with carburetor solvent and use an old toothbrush to get rid of the deposits.

Let the engine get cold again and repeat the test. If the valve still isn't closing and opening the way it should, do a step-by-step test of individual components.

Testing a choke involves letting the thermostatic coil get cold, so the choke valve can close. Depending on how hot the coil has gotten, and the outside temperature, the length of time you have to sit and wait can vary from minutes to an hour or more.

Once the coil is cold and the choke has closed, its position must be compared to specs. On some chokes the cover that fits over the coil is marked with a scale. Next to the scale, on the carb body, is a pointer. To adjust, rotate the cover to the position specified in the manufacturer's service manual (lead illustration).

Most recent GM carbs are adjusted by removing the coil cover and gauging the choke valve lever position with a 1/8-in. drill bit or rod gauge. See your manual for details.

Other choke system adjustments are necessary to maintain good cold starting and driveability. These include vacuum break, fast idle and—on most GM carbs—fast idle/choke valve relation.



## Testing choke vacuum break

The choke vacuum break is a vacuum-operated rubber diaphragm connected by a link to the choke valve. Its purpose is to open the choke valve against the tension exerted on the valve by the thermostatic coil when a cold engine starts. This prevents engine flooding. Vacuum breaks are part of both carburetor- and manifold-mounted choke systems.

When the vacuum break diaphragm sprouts a leak, which is not an uncommon occurrence, the choke valve can remain tightly closed. This causes a cold engine to load up with gasoline and stall. In addition, the engine may throw off black exhaust smoke for as long as it runs.

If there's an indication of a damaged vacuum break, check for the vacuum to work the diaphragm. Pull the hose off the vacuum

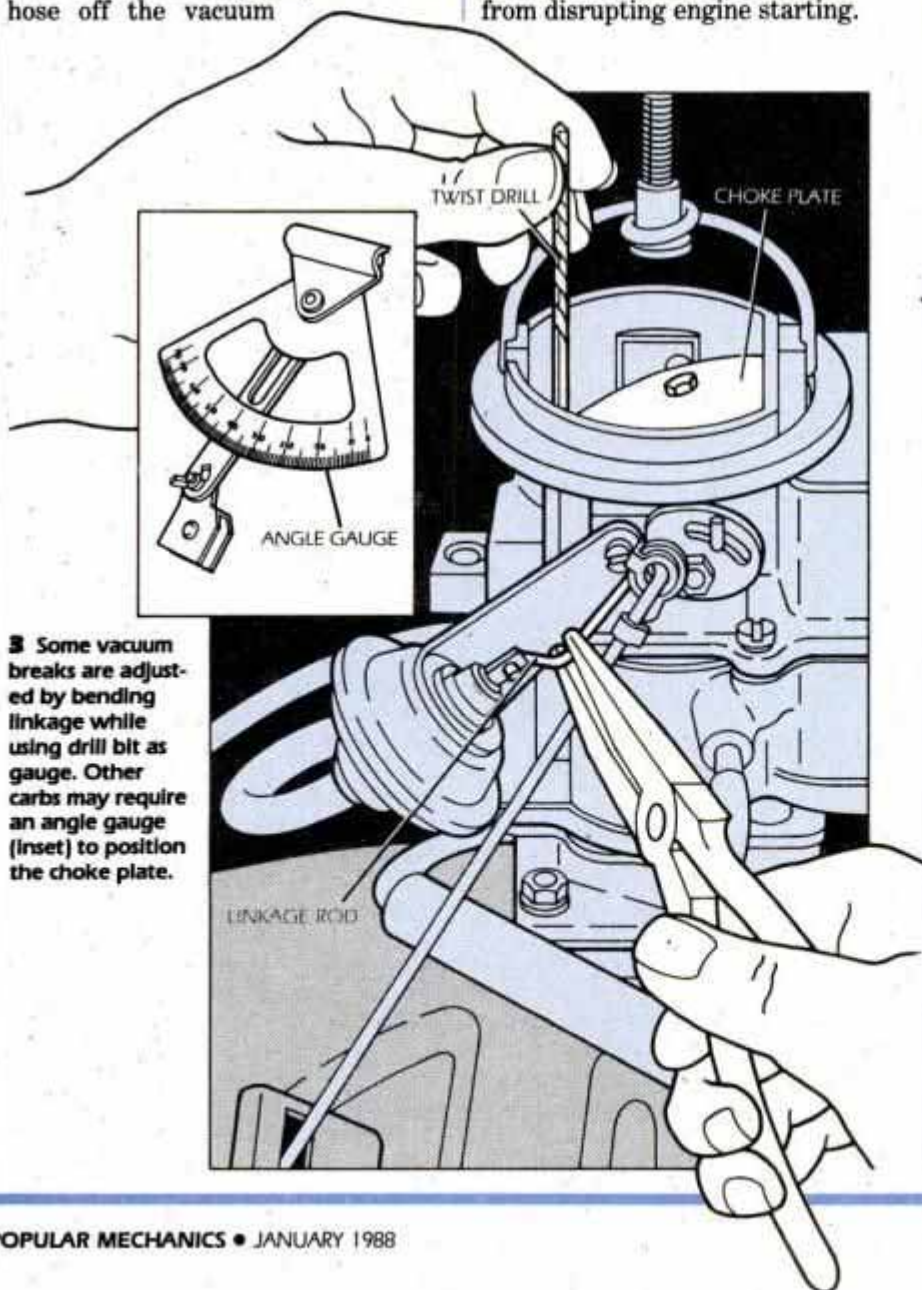
break nipple and start the engine. Hold your thumb firmly over the end of the hose. The pull should be strong. If it isn't, the hose is probably damaged or loose on the other end.

With this test completed, turn off the engine. If there are two vacuum breaks, examine them to see if either has a tiny bleed hole in it. If you spot one, tape it closed for testing. If there's only one vacuum break, it won't have a bleed hole.

Some 2- and 4-barrel carburetors, especially those made by GM's Rochester Division, have this type of dual vacuum break setup. One is the primary vacuum break, the other is the secondary vacuum break. The job of the secondary vacuum break is to help the primary vacuum break overcome thermostatic coil tension and keep the choke valve wide open in warm weather to prevent a rich mixture from disrupting engine starting.



4 Test for 12 volts at choke cover with test light while engine idles. Light should glow.



3 Some vacuum breaks are adjusted by bending linkage while using drill bit as gauge. Other carbs may require an angle gauge (inset) to position the choke plate.

To test a vacuum break, disconnect the hose and connect a handheld vacuum pump (Fig. 2) to the vacuum break nipple. If your system has two vacuum breaks, connect the pump to either. The engine must be switched off and cold, and the choke valve must be closed.

Pump up about 15 in. of vacuum. The vacuum break link should move and the choke valve should open slightly. Furthermore, the vacuum pump gauge should show a steady vacuum reading for at least 30 seconds showing that the vacuum break diaphragm has not developed a small leak. If these things don't happen, replace the vacuum break. If your system has two vacuum breaks, test the other vacuum break the same way.

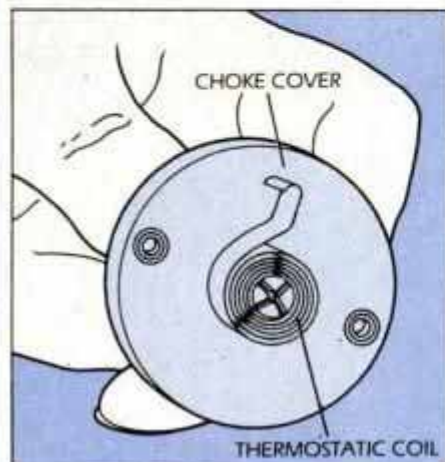
The vacuum break on a few GM cars is controlled by a thermal vacuum switch (TVS) that requires special handling. To find out if your GM choke system has a TVS, take off the top of the carburetor air cleaner to check for the presence of this switch. It can be distinguished from an air cleaner temperature sensor by a hose extending between the switch and the vacuum break. Make sure hoses between the TVS, vacuum break and vacuum source are tightly connected and in



good shape. To test a TVS, put a cold rag or ice cube on it for several minutes to cool it down.

Disconnect hoses and connect a handheld vacuum pump to the switch's vacuum inlet port. Place your thumb over the outlet port. Pump the vacuum. If you feel any pull on your thumb, replace the TVS.

Reconnect hoses and reinstall the



**5** If thermostatic coil or heating element (behind cover) fails, replace choke cover.

air cleaner cover. Warm up the engine. Now, connect a vacuum gauge to the vacuum break nipple. With the engine idling, the vacuum gauge should record the presence of vacuum. If it doesn't, replace the TVS.

*Note:* Vacuum breaks and thermal vacuum switches may be covered by the 5-year or 50,000-mile emissions control system warranty. Before shelling out for a new part, check your warranty agreement.

If you replace a vacuum break yourself and the new part causes the choke valve to open too much or not enough, an adjustment will probably be necessary to avoid an engine performance problem. To do the job precisely you need the specification and the size gauge spelled out in the car's service manual. There's no general specification I can suggest that applies to all carburetors.

A 1982 Oldsmobile service manual, for example, reveals that the primary vacuum break angles of 27 different carburetors used that year range between 21° and 28°.

Speaking about angles, some manufacturers suggest using a choke angle gauge to measure how much the vacuum break is allowing the choke valve to open. Other manufacturers recommend an opening of a fraction of an inch, which is determined by using

a specific size drill bit or some other type of fixed gauge (Fig. 3). You place this between the choke valve and carburetor body to determine how much the vacuum break is allowing the choke valve to open.

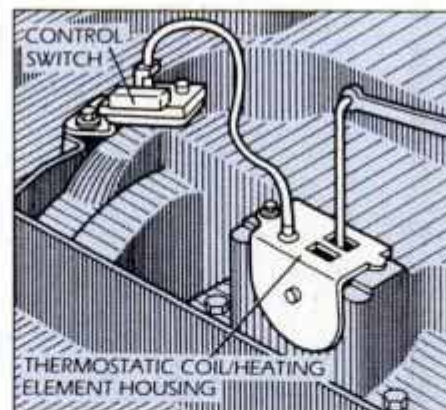
The actual method used for making the vacuum break adjustment varies with the car. Some units are adjusted by bending the link connecting the vacuum break and choke valve. Others are adjusted by turning an adjustment screw on the vacuum break chamber to control the movement of the diaphragm.

### Testing electric heaters

Since the mid-1970s many automatic chokes have been outfitted with electric heating elements in the choke housing. To determine if the choke on your car is equipped with a heating element, examine the choke cover on the carburetor or on the manifold. If you see an electric wire attached to it, there's an element inside.

The purpose of the heating element is to apply heat to the thermostatic coil so it unwinds and opens the choke valve. If you see that the choke valve isn't opened fully 1 to 2 minutes after starting a cold engine, suspect a faulty electric element. If the heating element isn't working, flooding may result.

You can test the functioning of an



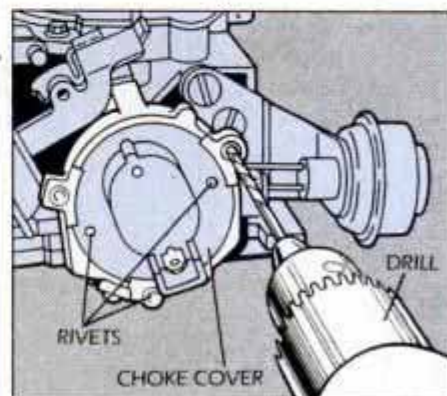
**6** Manifold-mounted chokes might have a switch to control an electric heater.

electric heater easily enough. With a carburetor-mounted choke, let the engine get cold.

Start the engine and use a test light to see if there's current at the terminal (Fig. 4). If the test light doesn't glow, current is not reaching the heating element. This means the wire is bad, a fuse has blown or a switch has gone bad.

Switch? Some choke electric ele-

ments receive current through the engine oil pressure switch. That's so the choke won't be off unless the engine is actually running, or you might not be able to restart the engine if it stalls on a cold morning. You'll find this on some manifold-mounted chokes. So don't overlook the possibility of a bad oil pressure switch. Electric heating elements that don't work off the en-



**7** Drill out and replace rivets with self-tapping screws for reassembly.

gine oil pressure switch get current directly from the ignition switch.

If current is reaching the choke cover, but the choke valve isn't opening fully, the heating element is probably bad. Remove the choke cover and replace the element, thermostatic coil and cover assembly (Fig. 5).

To test the electric heating unit of a manifold-mounted choke, notice that the wire enters the choke cover on the manifold, but there is no terminal at this point. Trace the wire back to the electric choke control switch (Fig. 6). Connect a test light to the terminal of the control switch.

Start the engine. If the test light doesn't glow, there's an electric failure. The cause is often a burned-out control switch. If the test light glows, however, replace the heating element and thermostatic coil assembly.

### About the thermostatic coil

A thermostatic coil can rust and freeze in place. It can also wear out. In either case, the choke valve won't work properly. If you haven't found the reason for the choke valve test failure to this point, replace the thermostatic coil by removing the choke housing cover. If the cover is riveted in place (Fig. 7), drill out the rivets. A repair kit usually contains self-tapping screws that are used to reattach the cover/coil/heater assembly to the choke housing. **PM**



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## BAND SAW BASICS

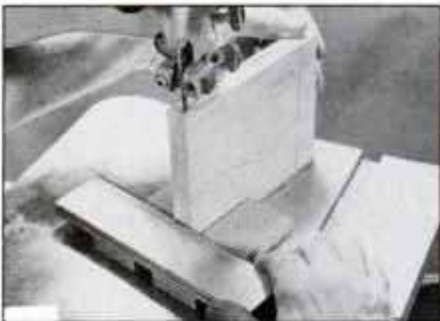
(Continued from page 72)

through the plywood panel, you can saw thin stock with virtually no splintering or burring.

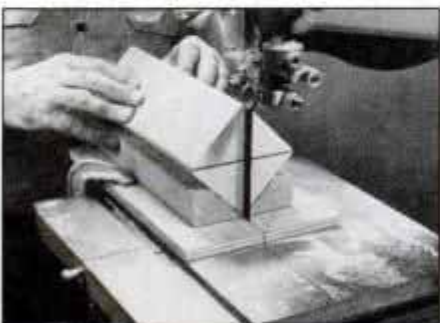
The most common straight cuts done on a band saw include crosscutting, ripping and resawing. Crosscuts can be made freehand, but for really straight, accurate cuts, use a miter gauge. The miter gauge slides in a slot milled in the top of the saw's worktable. Also use the miter gauge for making miter cuts. Most miter gauges adjust 60° left and right.

Accurate rip cuts are possible with the aid of a rip fence. Much like the fence found on a table saw, the band saw's rip fence can be positioned anywhere on the worktable and then locked in place. If your band saw doesn't have a rip fence, a straight-edged board clamped to the worktable works just as well. When ripping stock be sure to use wood pushsticks to keep fingers clear of the blade. Most worktables tilt 45° to the right and 10° or 15° to the left for making angled rip cuts and compound miters.

A band saw, with its thin blade and great cutting capacity, is an ideal tool for resawing. For best results, use as wide a blade as possible. This is especially important when resawing wide stock. To help guide the board and keep the cut on-line, use a simple shopmade pivot block, as shown. Clamp the block to the worktable at the desired distance from the blade.



A simple wrap-around pushblock ensures safety when executing tricky cuts. Make block from three pieces of 1/2-in. plywood.



V-shaped cradle is used to cut centering kerfs in ends of turning blanks. Clamp cradle to table and advance blank into blade.

Then, feed the board into the blade while guiding it against the block.

## Shopmade accessories

To increase the versatility of your band saw, we've included plans showing how to build two handy accessories: an extension table and a circle-cutting jig. Both of these accessories are designed to fit a 14-in. Delta band saw. However, they can each be altered to fit your specific saw.

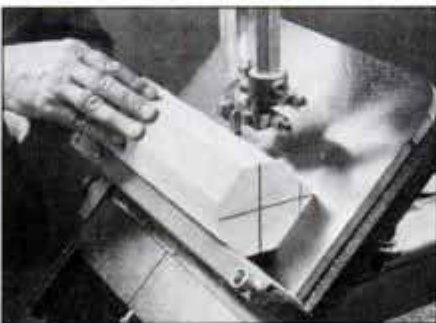
The extension table is a simple 1/2 × 36-in.-dia. plywood table that wraps around the saw's existing worktable. It's indispensable when cutting long or very large workpieces. And, the extension can be removed easily.

The plywood table is supported by an H-shaped frame that is bolted to the saw's worktable. Cut the frame parts from 2x2 stock. Next, drill and tap the edges of the saw's table to accept 1/4-20 machine bolts. Drill the holes to secure the two long frame parts 1/2 in. below the top of the saw's worktable. This 1/2-in. offset accepts the plywood table. Bolt the two long frame parts to opposite edges of the table. Place a thin cardboard shim between the frame and the table, as shown, to provide clearance for removing the extension table.

Now cut out the plywood table as shown. Be sure to cut a 1/2-in.-wide slot in the table for the saw blade. Glue and screw the plywood table to the two long frame parts. Then, attach the short crosspiece of framing with screws only. Hold the crosspiece



Complex work often requires compound sawing. Mark the profiles on two adjacent surfaces. Then, make the first series of cuts.



Tilt the saw table 45° and use the rip fence to cut off the corners of the blank. Octagon-shaped blank is now ready for the lathe.

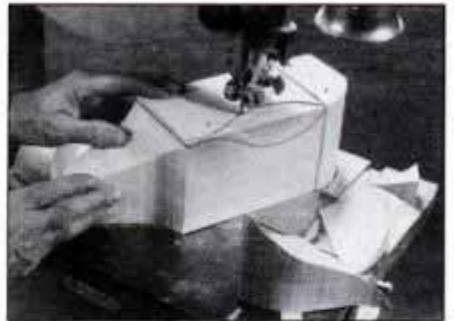
against the left edge of the table and secure it by screwing down through the plywood table.

The adjustable circle-cutting jig allows you to cut perfectly round parts—up to 30 in. dia.—accurately and consistently. The jig consists of a 1-in.-thick plywood table, made from two layers of 1/2-in. plywood, fitted with an adjustable pivot bar. A hardwood strip, attached to the underside of the plywood table, fits in the saw's miter gauge slot.

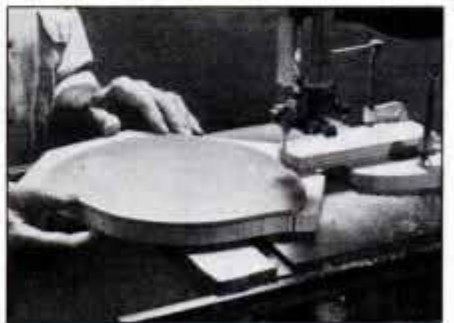
The pivot bar houses the pivot pin—a 3/4-in. No. 6 screw sharpened to a fine point. The dovetail-shaped pivot bar slides in a matching slot and is locked in place by a lock cam mechanism. Slide the bar until the distance between the pivot point and saw blade is equal to the circle's radius. Push down on the lock cam handle to lock the pivot bar in place. The jig also has an adjustable stop cam, located at the end of the hardwood strip, that is used to align the pivot pin precisely with the saw blade teeth—regardless of the blade's width. Slide the jig forward until the stop cam hits against the edge of the saw's worktable. Then, rotate the cam until the blade teeth and pivot pin align. Tighten the wingnut to secure the cam.

To make a circular cut, first slide back the jig and place the workpiece on the pivot pin. Next, turn on the saw, slide the jig forward into the blade until it comes to a stop and then rotate the work slowly one full revolution.

PM



Now, tack-nail the first cutoff parts back onto the workpiece. Rotate work and make the next series of cuts on the adjacent face.



Try template-cutting to make identical parts. Tack-nail template to workpiece. Guide template against guide-arm clamped to table.



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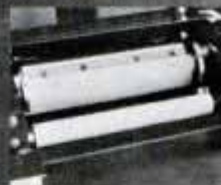


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As part of its Anniversary Publicity Campaign, a leading New York firm will distribute one million (1,000,000) of its most expensive spin rods—the Famous Nationally Advertised™ SWIFT-660/F™ Telescoping WhisperCast™ WhamRod™—for the astonishing “Anniversary Price” of only \$5 each to the first one million persons who write to the company address (below) before midnight, March 27, 1988.

**This original Anniversary Ad must accompany your request. Copies or photostats are not acceptable.**

These are the same famous SWIFT-660/F Telescoping WhisperCast WhamRods nationally advertised in leading media. A full standard 66 inches from base to tip, they spring to complete length in an eye-blinking *6/10ths of a second!*...then telescope down to a mere 16 inches for easy storage in kit bag, glove compartment or attache case.

Crafted of aluminum, stainless steel and space-age fiberglass for extra strength and flexibility, they provide full response along the entire length of the rod, without “flat spots”. And allow precise placement of small flies with a minimum of surface displacement.

Weighing a featherlight 3.75 ounces, they are the perfect ultralight rods for today’s “compleat angler”. Designed for casting powerfully over long distances, they’re at home on virtually every lake, stream or waterway in America, and ideal for land-casting, general wading, and boat-fishing. Small wonder they are the fastest selling (and most expensive) spin rods ever offered by this giant multi-million-dollar New York firm.

Each rod is covered by the company’s full one-year money-back guarantee. There is a limit of two (2) rods per address at this price. But if your order is mailed early enough (before March 19) you may request up to five. These Famous Nationally Advertised SWIFT-660/F Telescoping WhisperCast WhamRods will *not* be sold at this price by the company in any store.

To order, mail this *original* printed ad (no copies or photostats) together with your name and address and \$5 for each rod. Add only \$2 shipping no matter how many rods you are requesting. (New York residents add sales tax.) Allow up to 6-8 weeks for shipment. *Make check payable to: RBM Ltd.* Mail to: RBM, FISHING ROD OFFER, Dept. 114-118, Box 1736, Hicksville, N.Y. 11855.

(R29380)

(R29980)

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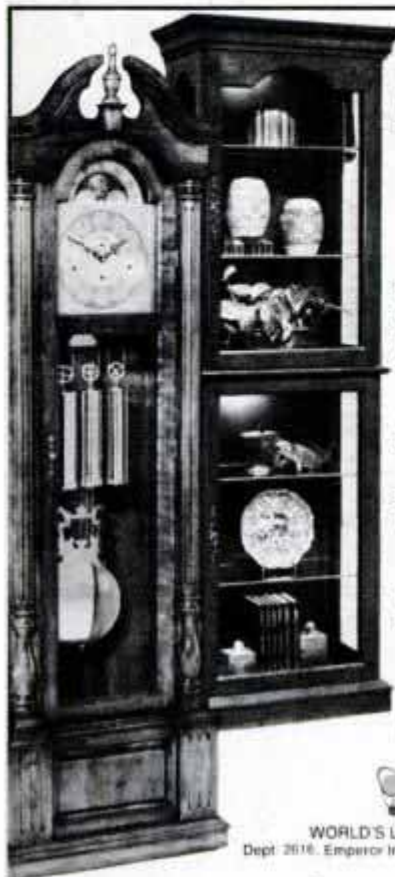
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The Platinum GaSaver installs in a matter of minutes and works effectively on all gasoline engines. Cars, trucks, motorhomes, boats and even implements using gasoline engines all can achieve a 22 to 40% increase in fuel efficiency with the use of this device. The manufacturer guarantee at least a 22% increase in actual gas mileage.

Even with a properly tuned engine, nearly a third of the gasoline it consumes is not burned. That unburned gas creates carbon deposits that shorten engine life, interfere with proper combustion and cause pings and knocks. And then the auto manufacturers attempt to solve the problem by using a catalytic converter to consume the unburned gasoline in the exhaust system before it returns to the atmosphere.

On February 28, 1984, four years of administrative procedures were completed by the Consumer Protection Department of the U.S. Government reviewing this process.

The government's conclusions? That National FuelSaver Corporation invented and markets a product called (Platinum) GaSaver which brings about more complete combustion and better gas mileage in automobile engines by means of platinum catalysis. That the (Platinum) GaSaver offers up to 30 percent fuel savings when applied properly to a gasoline engine. And that independent testing parties make stronger claims for (Platinum) GaSaver than does National FuelSaver Corporation.

The device takes only minutes to install on an automotive engine and allows 90 percent rather than the normal 60 percent of the gasoline in the combustion chamber to be burned during the power stroke. That means more power is developed by a given amount of gasoline. The device works on both leaded and unleaded gasoline, and meets or exceeds Environmental Protection Agency and California emission standards.

Federal Judge Walter Jay Skinner concluded a five-year administrative procedure studying the device by stating, "Independent testing shows greater fuel savings with the GaSaver than the 22 percent claimed by the developer."

The gas-saving system was tested by the Concord-Carlisle Regional School District in Massachusetts, which installed the devices on a fleet of 26 school buses and cars equipped with V-8 engines.

"We've been pleased with the results," Francis D. Curran, transportation manager for the school district, concluded. The fleet has averaged a 20 percent increase in gas mileage, as well as an improvement in cold weather engine starts.

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## Device increases gas mileage by 22% to 40%

On July 11th, the government awarded National FuelSaver Corp. \$22,000 for developing a simple automotive accessory that increases gas mileage by 22 percent.

Called the Platinum GaSaver, it injects microscopic quantities of platinum into the airstream entering the engine.

The injector itself takes only minutes to install, while the platinum entering the engine increases the percentage of each gallon burning in the engine from the normal 68 percent to 90 percent.

Normally, that 22 percent would only burn when it came in contact with the platinum-coated surfaces of the catalytic converter. But with the GaSaver introducing the platinum into the engine, platinum catalysis can now burn that fuel in the engine where the release of that heat and energy is harnessed to drive that vehicle.

With 22 percent more of each gallon burning in the engine, 22 percent fewer gallons are required.

The process works on both leaded and unleaded gasoline, and meets EPA and California standards.

The Federal Judge in charge concluded the five-year administrative procedure studying the GaSaver by stating, "Independent testing shows greater fuel savings with the GaSaver than the 22 percent claimed by its developer, National FuelSaver Corp."

In another study concluded recently, the government confirmed that the Platinum GaSaver raises the octane of gasoline, eliminating the need for premium gasoline.

Joel Robinson, the developer, commented, "We've already sold over 70,000 GaSavers. Ironically, we find more people buying the GaSaver for its third benefit of extending engine life, than buy it for fuel savings or octane boosting. Ever since our economy became battered by OPEC in 1973, we were convinced it would be a small company like ourselves that would reverse the trend of higher fuel costs."

The Platinum GaSaver has passed a 4 year administrative study of the U.S. Government. And has a full money back guarantee.

North American Research Corp.  
1-800-255-2342

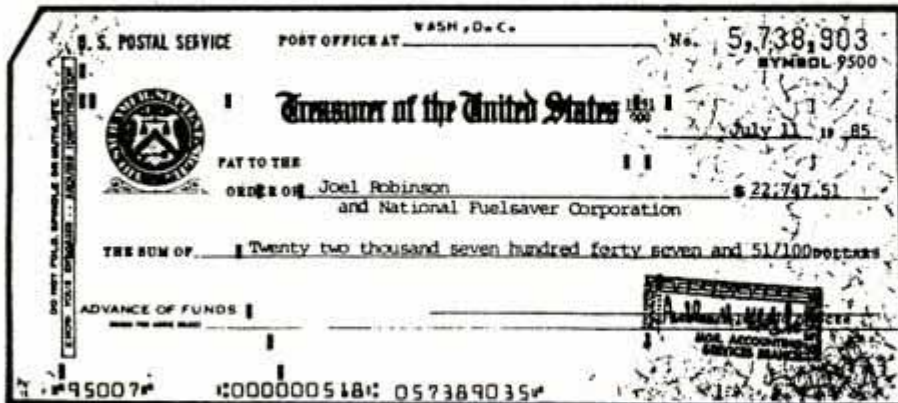
In addition to the \$44,000 savings in fuel costs for the school district, the transportation manager notes that the real savings comes from reduced major engine repair on the buses as a result of cleaner burning engines that produce more power for the same amount of fuel.

In a press interview the developer states that the only problem the company has encountered is keeping up with the demand. With the heavy demand in the transportation industry and the ever increasing use in the farm community and now the news has spread of the tremendous benefits in recreational Vehicles, Motor Homes and Boats as well, we are working around the clock to keep the orders filled. At this time we are able to guarantee delivery within 3 weeks. But at the present growth rate, we can see considerably longer delivery times in the near future.

Taken from a Report presented to  
The American Chemical Society  
April 11th, 1984  
St. Louis, MO

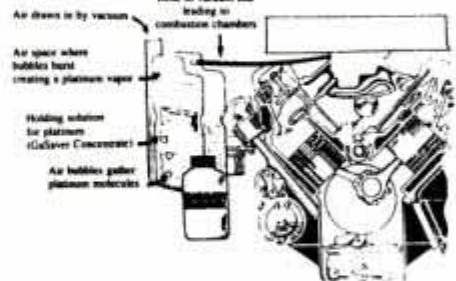
"In a report delivered to the Society of Automotive Engineers, The Engine Technical Center of the Komatsu Engine Company showed conclusive research that if carbon deposits are eliminated from the combustion chamber that there is no significant wear of the cylinder walls or rings, thus prolonging engine life dramatically." The Platinum GaSaver has been found to be one of the most effective devices for the elimination of carbon deposits in gasoline engines. Since carbon is simply another form of unburnt fuel, by burning the gasoline more completely in the cylinder by means of platinum catalysis, the cylinder remains clean and free from carbon deposits thus reducing friction and prolonging engine life dramatically.

## Government awards \$22,000 for development of a simple device that increases fuel efficiency 22 to 40%



### How the Platinum GaSaver System Works

The device needs only to be connected to one vacuum hose. Hose and T adapter are supplied.



### Guarantee

If after 3000 miles of driving with the Platinum GaSaver you haven't achieved at least a 22% increase in fuel efficiency or if for any reason you are not 100% satisfied, simply return the unit for a full refund.



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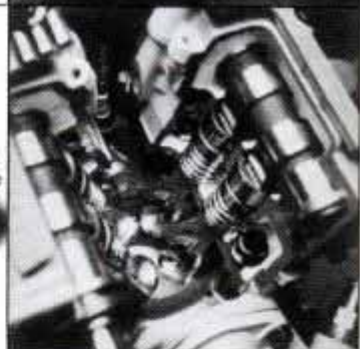
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