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Popular Mechanics

WORKSHOP PROJECT
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44 WAYS TO KEEP YOUR CAR GOING FOREVER

PLUS A Photo Gallery Of Great Classic Cars

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454 Chevy vs. 460 Ford In A Battle Of Brute Force

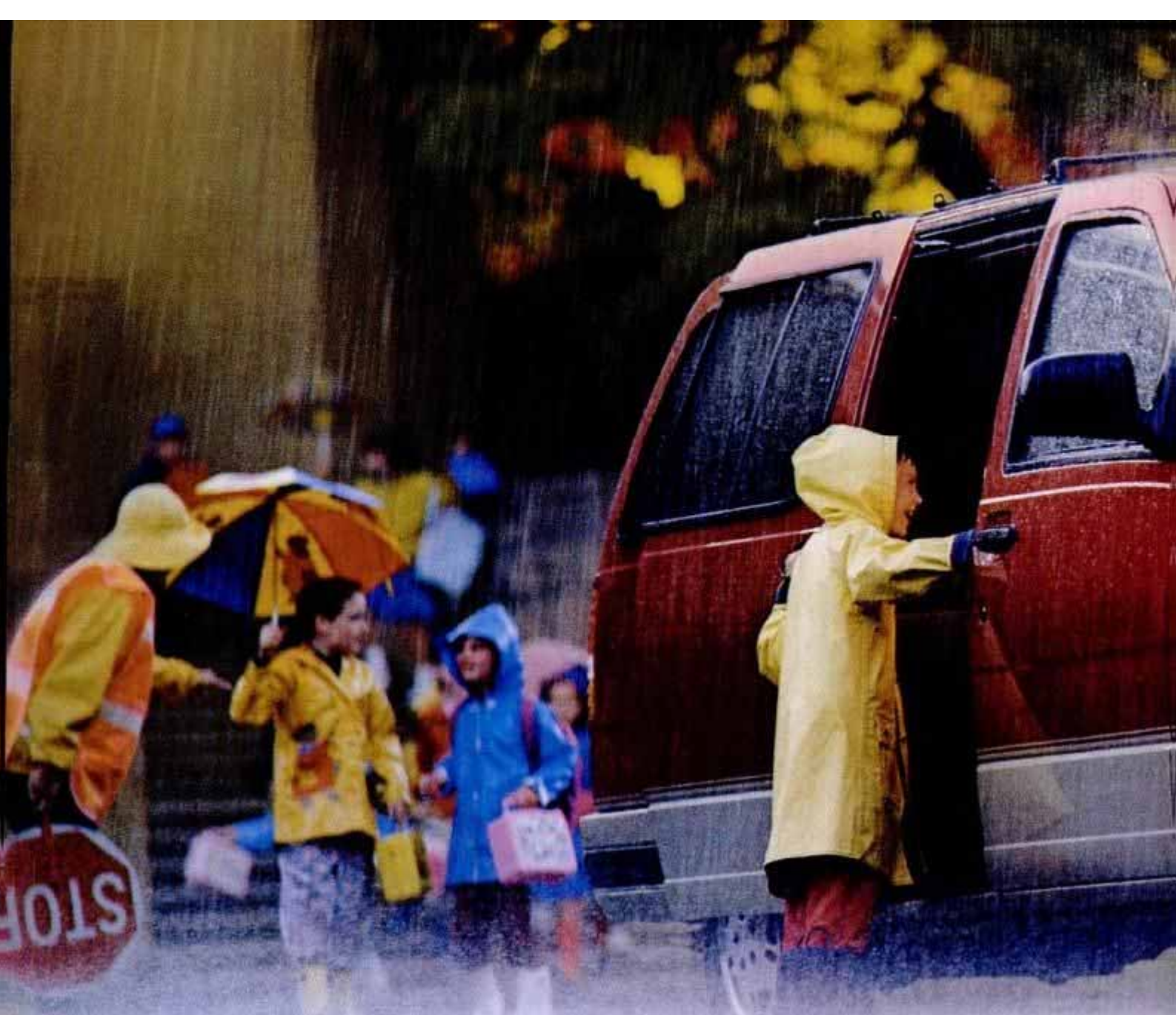


This like-new '71 Plymouth Hemicuda convertible is one of only 7 made. Owner: Bill Drake of Rochester, NY.

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12-Story Skimmer Will Safeguard Our Shores

NEW SUPERPOWER LAPTOP COMPUTERS
Hands-On Test Of The 6 Top Models





Four-wheel drive, rear anti-lock brakes and peace of mind come standard.

The new Electronic 4-Wheel Drive Ford Aerostar with rear anti-lock brakes makes peace of mind a new standard feature for you and your family. That's because this Aerostar gives you improved traction and control in all kinds of weather.

Full-time traction and more controlled braking.

Aerostar's sophisticated 4-wheel drive is a full-time system which electronically senses

road conditions and adjusts the amount of power given to each set of wheels accordingly. The rear anti-lock brakes are designed to prevent rear wheel lock-up and help you make straight stops.

Powerful 4.0L V-6, standard.

Advanced technology isn't all there is to the Aerostar story. In addition to its standard 4.0L V-6, the new 4WD Aerostar offers attractive styling, a comfortable interior and impressive capability. Put this all together and you've got a

Buckle up—together we can save lives.



vehicle that gives you not only peace of mind, but pride of ownership, too.

Transferable 6/60 powertrain warranty.

Covers you and future owners on major powertrain components for 6 years/60,000 miles. Ask to see a copy of this limited warranty at your Ford Dealer.

1990 Motor Trend award-winner.

Recently, Motor Trend selected the 4WD Aerostar as the winner of



its prestigious 1990 "Truck of the Year" award. Once again, Ford's commitment to quality and philosophy of continuous improvement pays off.

New 4WD Ford Aerostar

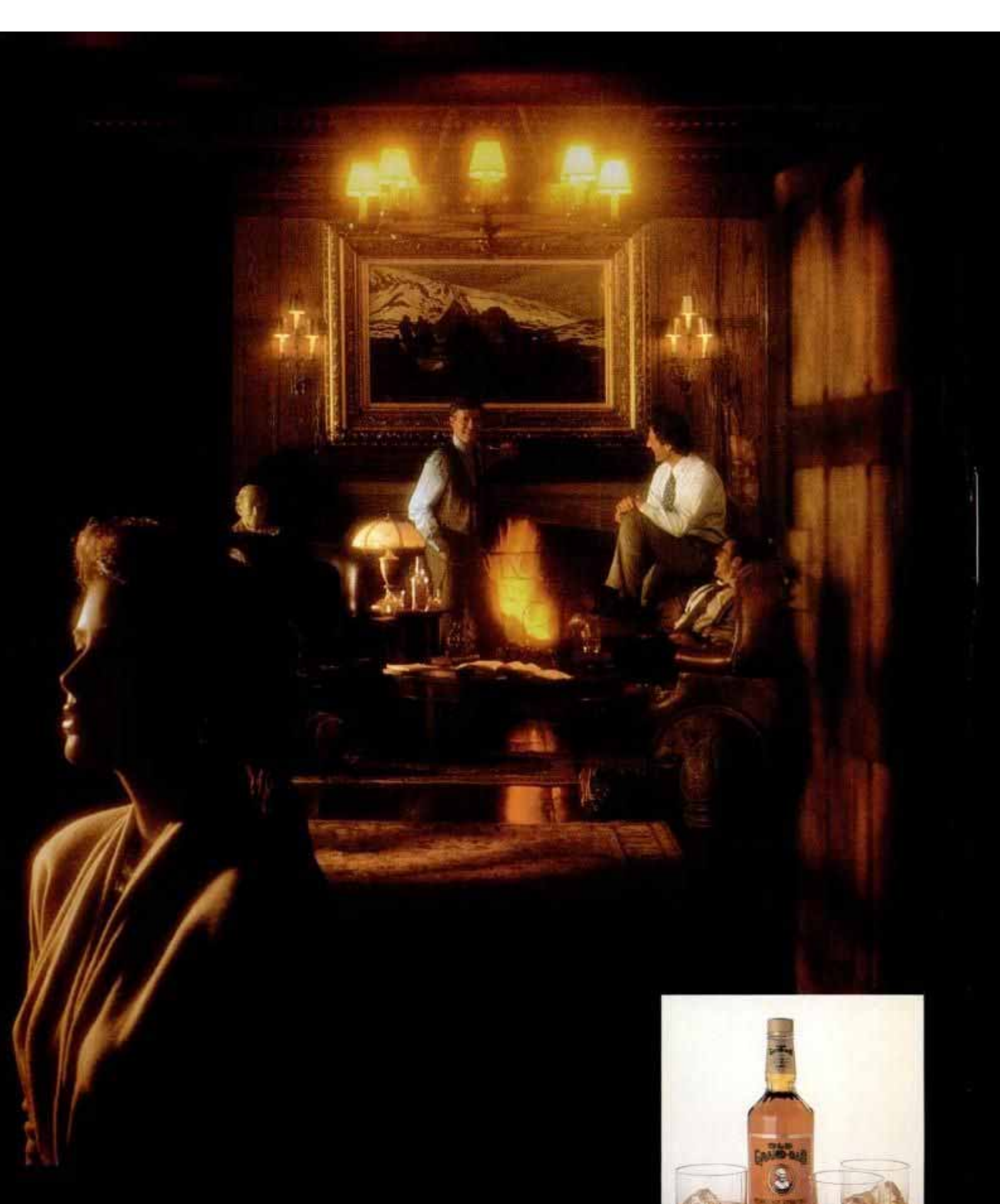
Have you driven a Ford...lately?



This One



11QB-4WZ-WJKC



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WHEN THE LADIES LEAVE THE ROOM.**

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Popular[®] Mechanics

MAY 1990
VOLUME 167
NO. 5



87 CAR CARE GUIDE

Keep your car looking as great and lasting as long as Bill Drake's '71 Hemi Barracuda with our 44 car care tips.

—PM photo by
John Grieblich



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NEW
TECHNOLOGY



Radar Warning Breakthrough

Digital Signal Processing (DSP) allows new ESCORT to warn you of traffic radar much sooner than previously possible

When we introduced the original ESCORT in 1978, its superheterodyne technology provided an incredible increase in warning distance. One magazine said we "struck panic into the whole radar detector industry."

Our new ESCORT will have the same effect.

History repeats itself

Since 1978, we've continued to advance the science of radar warning, and our original ESCORT and PASSPORT have won test after test. But we've never stopped working to develop another breakthrough to redefine radar detection again. And now we've done it.

Incredible new technology

Our all-new ESCORT provides an incredible increase in detection distance. And it's only a fraction of the size of the original ESCORT. The key is Digital Signal Processing (DSP), an incredible computer technology.

DSP is used by NASA to create detailed space photos from blurry images. It's used to deliver sharp images of internal tissue from medical scanners. It's used by military radar to distinguish enemy from friendly aircraft.

And now we're using DSP to find radar signals too weak to be detected by conventional technologies.



The heart of ESCORT's DSP circuitry is a custom version of the Motorola DSP 56000. This 20 MHz 24 bit parallel HCMOS processor is capable of 10.25 million instructions per second, and is also used in Steve Jobs' new \$10,000 NeXT computer.

How it works

The new ESCORT's DSP circuitry samples incoming radar signals 50,000 times a second, slicing them into discrete bits of information. This information is digitized and continuously analyzed by an incredibly fast signal recognition computer. The end result is remarkable.

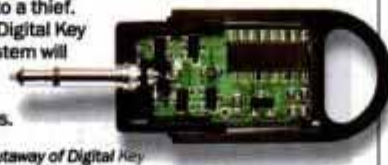
New Anti-theft System

Escort comes with a tiny "Digital Key" to put on your keyring. When you first receive your Escort, and then about every two months, you'll use your Digital Key to "unlock" your Escort.

For someone who doesn't have the proper Digital Key, your Escort simply won't work.

So while your Escort is valuable to you, it's of little value to a thief.

Our new Digital Key security system will help keep your new Escort yours.



Actual size cutaway of Digital Key

Breakthrough performance

ESCORT's advanced signal processing provides an incredible increase in sensitivity on both bands. Quite simply, this means that the new ESCORT picks up radar signals further away than was ever before possible, even distant instant-on radar signals. And its advanced City/Highway circuitry lets you optimize ESCORT's warning system for either driving environment.

"The new Escort packs ultimate sensitivity into a small package. Nothing else even comes close, and no wonder... No analog device can hope to match this performance."

BMW Roundel

Intuitive warning system

ESCORT's warning system keeps you fully informed. Upon radar contact, ESCORT's alert lamp glows and its variable-pulse audio begins a slow warning. Simultaneously a bar graph of Hewlett Packard LEDs shows radar proximity.

As you get closer, the audio pulse quickens and the bar graph lengthens. You'll understand ESCORT the first time you use it.

No compromise design

We've spared no expense in making ESCORT the best equipped radar detector ever. A photocell adjusts the visual display for the light level in your car (there's also a Dark mode for more discreet operation).

ESCORT's adjustable volume and Mute switch let you adjust the audio level, and we've added a new "AutoMute" that automatically turns the volume down after the initial alert.

ESCORT's aluminum housing, finished in non-glare black, provides ruggedness that will last for years and years, unlike plastic housings. And ESCORT comes complete, period.



The new ESCORT is only 7/8" high and 3 1/4" wide.

All accessories included

For installation, ESCORT comes with both visor clip and windshield mount. For power connection, we supply both a coiled and a straight cord to plug into your car's lighter. There's also a cord for permanent wiring into your car's electrical system, if you prefer.

We even include a leather carrying case, which fits easily in a coat pocket or briefcase, so you'll always have ESCORT with you.

Test-drive ESCORT at no risk

For more information, or to place an order, just call us toll-free. We only sell direct from our factory to you, and we guarantee your satisfaction.

After you receive ESCORT, if you're not completely satisfied within 30 days, just return it. We'll refund all your money and your return shipping costs. There are no hidden charges.

With the new ESCORT, we've revolutionized radar detection again. But don't take our word for it. Order today and see for yourself.

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EDITOR'S NOTES

THE GREAT THING about old cars is that you can really love them. It's not so easy to love, say, a 1990 Ford Tempo. It might be a good car that gets you where you're going. But love it? Nah. Now take a 1957 Chevy Bel Air convertible. With the Power Pack 283. There's a car you can love. Perhaps in 20 or 30 years, someone will be talking about 1990 Ford Tempos with the same lust as we feel today for '59 Cadillac convertibles or '71 Hemi Barracudas or '33 Cadillac V8s. Maybe. A lot will depend on what kind of shape the Tempo is in. And as we found when shooting all the great cars you'll find in this month's special Car Care Guide (page 87), owners of great old cars take just as much pride in the way they care for their cars as they do in how their cars look. What we've done in this year's Guide is compile the most important things you can do to any car to keep it new forever. Hey, who knows? Perhaps in our May, 2020 issue, we'll have a photo of your 1990 Ford Tempo in our photo gallery of great old cars. . . . A canoe is perhaps the most romantic of all watercraft. How many times has a movie star



Aaboe, Klenck and canoe.

proposed to his female co-star in a canoe? I wish I had a buck for each. Now you can take your special lady for a cruise in your own personal canoe—if you follow the instructions in this issue and build your own. The craftsman who built ours, while Associate Home and Shop Editor Tom Klenck soaked up the expertise, is Kim Aaboe of Jeddore, Nova Scotia. Aaboe began his career with a boatbuilding apprenticeship in his native Denmark. After moving to Canada, he continued to specialize in boat construction and restoration, eventually assuming the post of curatorial assistant at the Maritime Museum of the Atlantic. Today, he's a noted authority on canoes of all sorts—from restoration and building of traditional canvas types all the way through to modern fiberglass construction. Our cedar-strip 14-footer is about as classic as you can get, except for one made of birch bark. Let me know how yours turns out. . . . Ever watch Dale Earnhardt tough his Lumina around Daytona on TV and wish you could drive a snarling NASCAR stocker around a banked superspeedway? You can. Just ask our Automotive Editor, Tony Swan. He's had plenty of racing experience, but he'd never driven a stock car. So we sent him to school—race driver's school. Former NASCAR great Buck Baker runs it, and you get to drive real Winston Cup stockers around Rockingham. Swan had lots of fun and even learned a new trick or two—which is almost impossible to imagine. Till next time.


Joe Oldham

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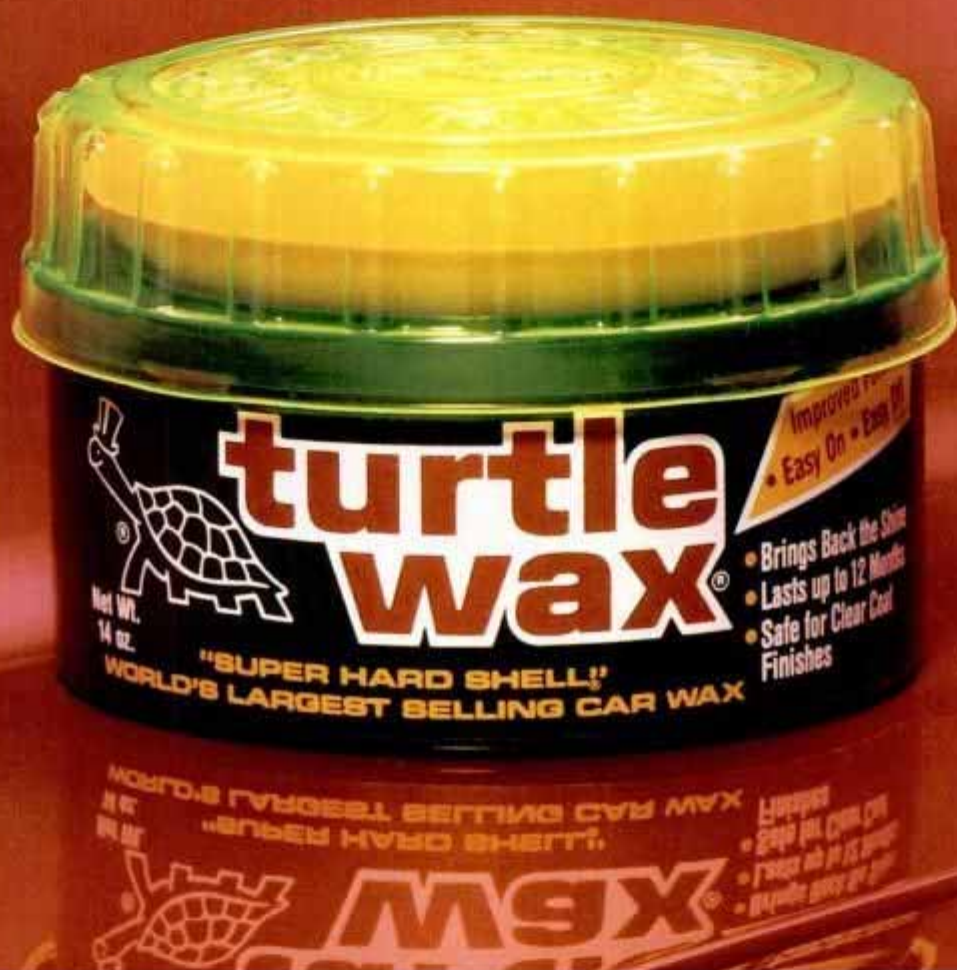
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There's never been a car like Thunderbird. And there's never been a Thunderbird like this.

Quality by design.

The idea is simple: commitment to the excellence of each vehicle component can result in improved vehicle quality overall. An example: over 400 of Thunderbird's mechanical, operational, and comfort features were compared to features on cars like Mercedes 190E, Toyota Supra L, and BMW 633CSi. By employing this kind of detailed analysis, Ford strives to make each new vehicle superior to what we've offered before. It's all part of insuring that Quality is Job 1.

Structural integrity.

Thunderbird was designed with increased structural adhesives at joints and two-part expanding foam throughout.

Buckle up—together we can save lives.

This not only results in reduced noise and vibration in the passenger compartment, but allows for a longer, wider wheelbase that gives the vehicle a more substantial feel over the road.

Ride and handling.

Thunderbird features a four wheel independent suspension with rear control arms and a front tension strut that are "double isolated." All of which helps to insure less harshness in ride and in handling.

"Speed sensitive" rack and pinion steering also adds to the Thunderbird's "feel." It adjusts the amount of power assist from light effort steering at lower speeds to a firmer feel at faster speeds.



Power.

Thunderbird's 3.8 liter V-6 features "low friction" roller tappets and sequential electronic fuel injection. Also, lightweight components like magnesium rocker covers assist in providing a better power-to-weight ratio.

Aerodynamics and ergonomics.

This is the most aerodynamic Thunderbird ever designed. Which translates into less wind resistance, improved handling, and reduced interior noise. Ergonomically, there's more head, shoulder, hip, and leg room than the Thunderbird of just a couple of years past.

Fully equipped.

Thunderbird LX features air condition-

ing, power windows, electronic AM/FM stereo with cassette player, speed control, fuel/distance computer, and full electronic instrumentation. All standard.

Best-built American cars.

The best-built American cars are built by Ford. This is based on an average of consumer-reported problems in a series of surveys of all Ford and competitive '81-'89 models designed and built in North America. At Ford, "Quality is Job 1!"

Ford Thunderbird

Have you driven a Ford...lately?



LETTERS

(Un)dress Code

REFERENCE is made to the photo for the special section, Boating '90 (page 93, Feb. '90). A photo of this type has no place in your magazine. It is rather embarrassing to your women readers.

If you continue to run photos of this type, I will cancel my subscription.

JOHN RODECKER
CINCINNATI, OH

We're not sure we understand your complaint. Are you complaining that we showed females (and males) on beaches, and on or around boats and, furthermore, that they were wearing (gasp!) bathing suits? What do women wear when they go boating in your neighborhood?

Tanker Talk

Your story "America's Oil Tanker Mess," (page 51, Nov. '89) was read with interest, but perhaps it's mistitled: America does not have a tanker problem—the world does!

I remember Linc Crane, chief of the Stability and Control Division of the Davidson Laboratories at the Stevens Institute of Technology, and Art MacKenzie, who served on Congress's Office of Technology Assessment panel that studied tanker safety in the 1970s (both of whom are quoted in your story) when they were employed by Exxon. Whether double bottoms or double hulls or some other design variation is the ultimate solution, we will find out some day, and probably too late—and after great studies (again) by esoteric panels. Fancy nav systems with all their alarms sound just grand. What good are they if the operators silence the alarms in crowded waters?



Here's another look. What's wrong with this picture?

And a note for your non-maritime readers: As quoted, the stopping times and distances of supertankers may look like stops made from full-ahead engine speed with a stop-engine order only—letting the mass \times velocity² just erode naturally. Any tanker officer will tell you that turning the rudder from one side to the other, or putting the engines full astern, will shorten the times and distances quoted considerably.

And "deadweight" is not the weight of the ship's cargo alone. It's everything except the hull and its fixed equipment. No big deal, but there's less than 20,000 tons of cargo being carried on a 20,000-ton deadweight tanker.

Lastly, a question: Will the public pay the additional cost, 20-30 percent, to fill the double-bottom voids with seawater rather than oil to get the same amount of cargo transported? It's a major piece of the cost of a gallon of refined product at the pump.

HILLIARD L. LUBIN
INTERNATIONAL MARITIME
SYSTEMS
CAMDEN, ME

The Alaska Department of Environmental Conservation is working on a Certificate of

Commendation for state employees who provided efforts beyond the call of duty during the oil spill response. Your November issue cover illustration of the tanker would be excellent to be included on our certificate, and I hope we can get your permission to use it.

JOE FERGUSON
INFORMATION OFFICER
STATE OF ALASKA
DEPT. OF ENVIRONMENTAL
CONSERVATION
JUNEAU, AK

You've got PM's permission to use the illustration, and a duplicate transparency is on the way to you.

Healthy, Wealthy And Wise

Way back in the olden times, circa 1930, when I was but a tiny tot in New Mexico, in my total innocence and naivete as a child, I fell under the spell of a force that has influenced my life, lo, unto this very day. What happened was that I was a precocious brat, slightly on the puny side, and I got interested in reading at an early age—like 5.

Now, in *them* days, there were no such things as baby sitters, so whenever my mammy and pappy wanted to go out and trip the light fandango, they would get me POPULAR MECHANICS, and I could stay up *late* with it.

We know that reading is the primary root of learning, and that's how I learned to read—and enjoy it. The words I didn't know would become clear when I looked at the pictures. I also figured out the word by words I did know in front and behind the word in question—a bootstrap process. Now, that itch to learn more and more has scratched for 60-odd years, and I'm still scratching. Did you ever think of PM as an intellectual scratching post?

So, that's how I became wise. The healthy part came from the multitude of safety tips and instructions and information on machinery and tools and how to use them. I am still using my original issue of fingers and eyes—like my tools, worn but serviceable.

Wealthy. That comes from all the money I saved by learning how to make stuff for myself and others, and the friends I have made thereby, and good tools and ideas accumulated.

D.T. SMITH
FLORISSANT, MO

Tool-ade

Your woodworking articles in the November issue were fantastic and timely. I had just begun building a workbench when my router quit. The repair shop wanted nearly the router's value to fix it. I decided to think this over when, while walking through an airport, PM's cover caught my eye, so I stopped to peruse its contents. The woodworking articles looked interesting, so I bought the issue. Serendipity! My answer was in the pages. Mr. Capotosto's excellent articles inspired me to take out an old set of chisels I had received as a kid, borrow my father's plane and buy a few other tools to build the work table.

I was amazed at how quiet the work was. Then a feeling of closeness to the work swept over me. The transformation was amazing. I am still slow and don't always cut things perfectly straight, but what a joy to be so intimately connected with the project. I'm hooked on hand tools. As I get better, things can get done quite quickly. What a discovery, I can't thank you enough. Everything was there, all the articles were immensely satisfying and useful.

WILLIAM L. DONNELLY
LONG BEACH, CA

ONE LOW PRICE.



ONE GREAT VACATION!

Introducing the 1990 Sports Afield Family Adventure. Unique, week-long vacations designed specifically for the outdoorsman with a family. The most exciting, comprehensive, and affordable summer vacations available.

Sponsored in conjunction with Sports Afield and some of the nation's leading sporting goods manufacturers, they're vacations as vacations are meant to be—with sports galore, beautiful weather, and luxurious accommodations. Hassle free.

The Sports Afield Family Adventure includes everything—lodging, day camp for the kids, your unlimited choice of more than 14 out-



door activities, even the sporting equipment—for one low, unbeatable price. Choose among fishing, boating, horseback riding, camping, mountain biking, trap and rifle shooting, archery, golfing, swimming, and so much more...for the ideal sportsman's holiday.

Last year's Family Adventure in magnificent Crested Butte, Colorado, proved so popular, we've added a second location: beautiful Loon Mountain, New Hampshire. Each spot offers unique advantages to the sport enthusiast. But both are sure to prove the perfect setting for the family vacation of a lifetime.

Space is limited—act now to reserve your place.

The Sports Afield Family Adventure at Loon Mountain is just \$549 per person (\$299 for kids six and under). Call toll-free 1-800-433-3413 to reserve your place or to get more information.

The Sports Afield Family Adventure at Crested Butte is just \$489 per person (\$299 for kids five and under). Call toll-free 1-800-544-8448 to reserve your place or to get more information.

American Airlines

Official Airline of the Sports Afield Family Adventure

TIME MACHINE

75 YEARS AGO: MAY 1915



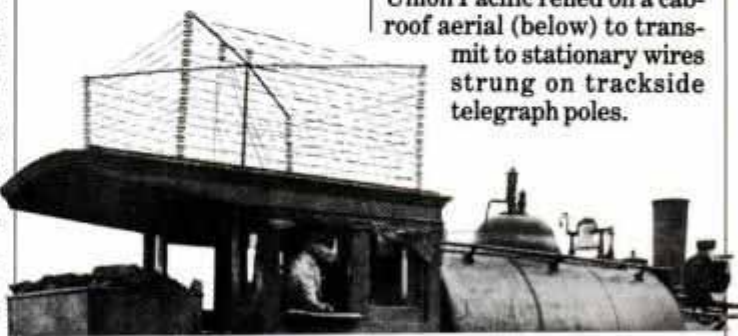
Firing On The Clock

The war in Europe brought new significance to a simple concept—the now-commonplace expedient of referring to the numbers of an imaginary clockface in guiding the attention of others to points of interest. In the form of a practice known as “firing on the clock,” the technique had become widespread among combatants wishing to direct rifle and artillery fire. We pictured the idea on our cover as an emblem of the rough-and-ready inventiveness spawned by war.

Radio On Rails

As wireless technology advanced, radios were turning up everywhere. Next stop? The railroads. Lackawanna

demonstrated an especially powerful system using wires run along the tops of the cars to carry on conversation with a station 27 miles away. Union Pacific relied on a cab-roof aerial (below) to transmit to stationary wires strung on trackside telegraph poles.



50 YEARS AGO: MAY 1940



Ship Stalkers

German mines seemed to be turning up out of nowhere, wreaking terrible destruction on British shipping. The suspicion among British authorities was that the Germans had mastered the technologically tricky problem of laying their sensitive magnetic mines from aircraft. PM explored how this might be accomplished, including an artist's concept of a flying boat that deployed 300-pound mines attached to parachutes by water-soluble, hard-salt pins.

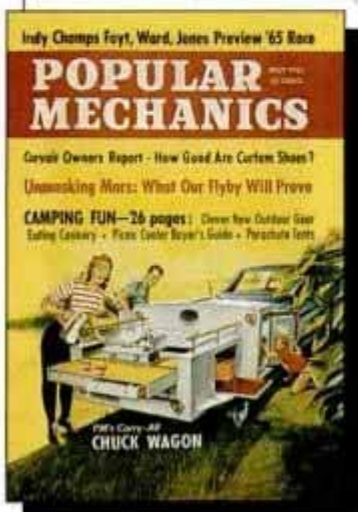
Dawn Of An Era

A year after television's debut at the New York World's Fair, a massive effort was underway to bring the new medium to the masses. Tech-

nical standards were set, wavebands allotted and facilities constructed. Stations in New York and Los Angeles already offered 10 hours of programs a week.



25 YEARS AGO: MAY 1965



Tag-Along Kitchen

Mealtime was always a problem for families vacationing on the road. Greasy spoons, soggy sandwiches or overcrowded rest areas all threatened to spoil a restful interlude. To the rescue came our chuck-wagon project—a 2-wheeled trailer with an icebox, cupboards and a countertop that flipped down to expose a gas stove. An outdoor hi-fi speaker, along with space for folding chairs and dress-up clothes, brought further graciousness to the roadside meal.

Revolution At Indy

With the coming of lightweight, rear-engined racers powered by Ford V8s, the dynasty of the front-mounted Offenhauser was coming to a close. We interviewed A.J. Foyt, Parnelli Jones and Jack Ward to see where

they thought Indy technology was heading. Ward was sold on the new layout. The others expressed doubts about the new cars' seemingly dangerous fuel tank layouts, and the difficulty of hearing a car that is approaching from behind. **PM**



Cambridge

YOUR CHOICE OF A CIGARETTE SAYS SOMETHING ABOUT YOU.

YOU'RE A SHREWD ONE, AREN'T YOU?



THE SMART MONEY IS ON CAMBRIDGE.

Taste and Compare!

SURGEON GENERAL'S WARNING: Smoking Causes Lung Cancer, Heart Disease, Emphysema, And May Complicate Pregnancy.

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17 mg "tar," 1.1 mg nicotine av. per cigarette by FTC method.

Finally. A sophisticated weapon in the war against plaque.

As long as people have had teeth, they've had to fight plaque. And all too often it's been a losing battle, resulting in gingivitis and gum disease. But now the Interplak® Home Plaque Removal Instrument represents one of the most advanced ideas in home dental care since the toothbrush. And offers you a technologically advanced way to help fight plaque more effectively than ever before.

Nothing works better.

Clinical studies show that manual brushing only removes some of the daily plaque buildup on your teeth. Those same studies show that the Interplak instrument cleans teeth nearly plaque free and reduces gingivitis to improve the health of your gums. So when you use the Interplak instrument, you're not just winning the battle, you're winning the war.

It cleans circles around ordinary brushing.

Unlike manual toothbrushes that only clean back and forth, or up and down, our ten tufts of bristles rotate 4200 times a minute. And they reverse their direction 46 times a second to literally scour off plaque and stimulate your gums. When the tufts reverse direction, the

bristles extend fully to clean deep between teeth and under your gumline.

Even the big guns agree.

Dental professionals across the country have enthusiastically accepted the Interplak instrument and recommended it to their patients.

It's easy to use, cordless, and it recharges itself every time you place it in its stand. Plus you can buy color-coded, interchangeable brush heads for the whole family.

Ask your own dentist about the benefits. Or for more information call toll-free 1-800-334-4031.

The Interplak instrument. In the war on plaque, it can give you peace of mind.



Bristles rotating 4,200 times a minute literally scour plaque off your teeth.

INTERPLAK®
HOME PLAQUE REMOVAL INSTRUMENT

Interplak is Acceptable as an effective cleaning device for use as part of a program for good oral hygiene to supplement the regular professional care required for good oral health.
Council on Dental Materials, Instruments and Equipment, American Dental Association.



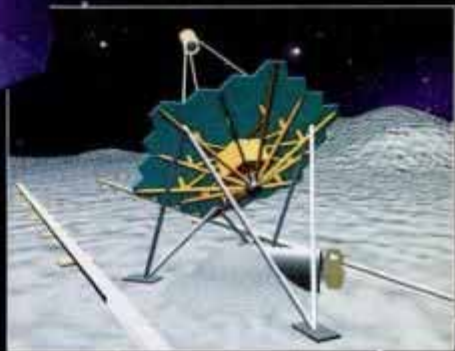
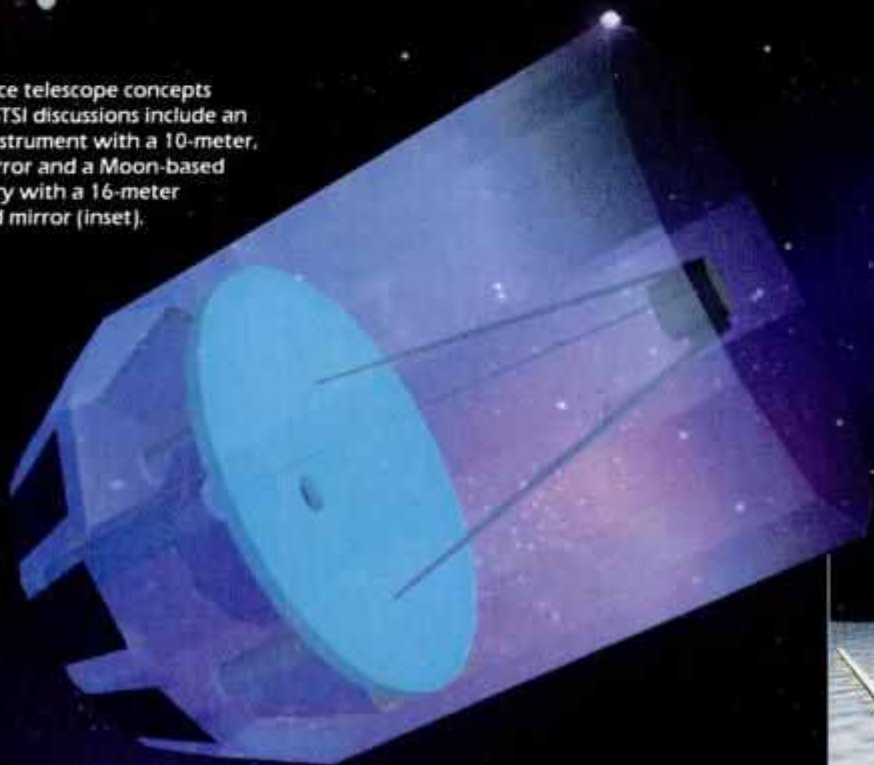
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TECH UPDATE

News Of Tomorrow's Technology Today

Future space telescope concepts based on STSI discussions include an orbiting instrument with a 10-meter, 1-piece mirror and a Moon-based observatory with a 16-meter segmented mirror (inset).



SPACE TELESCOPE SCIENCE INSTITUTE GRAPHICS

Next Generation Of Space Telescopes Planned

BALTIMORE, MD—Even before the long-awaited Hubble Space Telescope (see "Eyes On The Universe," page 72, March '90) takes to the sky, astronomers are exploring followup concepts that would bring us another quantum leap closer to the stars. And there's little time to waste. Although Hubble is designed to last for 15 years, it has now been more than 25 years since the project first began. A similar lead time is expected for a next-generation scope.

The process of defining basic goals for the program began late last year. At a symposium sponsored by NASA's Space Telescope Science Institute (STSI), 130 research astronomers, optical engineers and instrument designers got together to dis-

cuss what sort of telescope would be needed.

There was general agreement that the instrument would have to mount a mirror between 30 and 52 ft. in diameter (Hubble has an 8-footer). Very likely, it would be necessary to transport such a large mirror into space in segments for assembly in orbit and an active optics system would be needed to adjust the position of its segments many times a second. The group also agreed the new telescope should be placed as far from Earth as possible, to avoid having it block out the sky as it does for half of Hubble's orbit. Thus, lunar observatories are also being considered.

Editor: Abe Dane
Contributors: John Boyd, Mike Fillon,
John Rhea, Robert Scheier, Rod Smith

Whatever approach is ultimately adopted, the group hopes to have a telescope at

least seven times as powerful as Hubble operating by the year 2010.

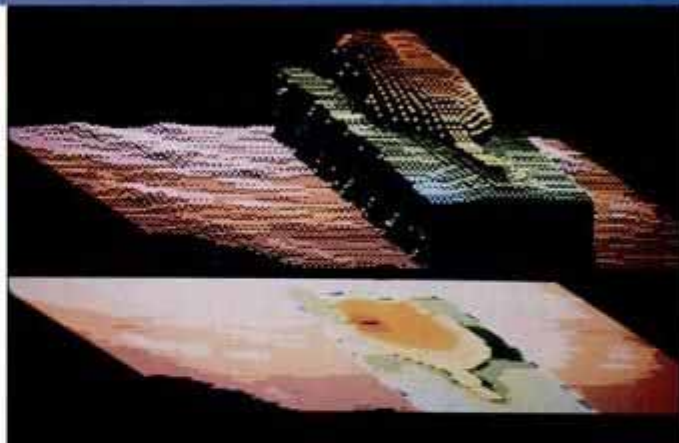
Highlights This Month

- **Jet For Tomorrow**—Biggest jetliner engine ever will be the force behind a new breed of passenger planes.
- **Gunning For Orbit**—Magnetic launcher to hurl satellites into space.
- **Home Of The Future**—Japan's new Tron house showcases a fully automated lifestyle.
- **Mechanics Of Matter**—Detector 6000 ft. underground hunts the elusive neutrino.
- **Cutting-Edge Shave**—How \$200 million of r&d produced a 25-cent shaving cartridge.
- **Undersea Endeavor**—Sub, sonar and swath ship team up in laying world's deepest power cable.

Laser Radar Hits The Mark

EGLIN AFB, FL—The Air Force has tested a system that produces detailed images of objects by bouncing a laser beam off them. Called a Laser Radar, or LADAR, the device offers the potential to give guided missiles vision sharp enough to classify different types of targets and head for their weakest points.

The sensor was tested by placing it on a 300-ft. tower, then aiming it at targets on the ground. By firing pulses from a linear array laser and timing their return to sensors, the system was able to



LADAR image (left) shows contours of M-48 tank shown in photograph (top left). The image can be processed by computer to produce rotated view (above).

create complete images of targets with a single motion of its scanner. Different colors assigned to different

ranges show the contours of the target as well as its outline. Estimated to cost about \$2000 apiece when produced

in quantity, LADAR sensors could be fielded in a variety of munitions in as few as six years.

Biggest Jetliner Engine

EVENDALE, OH—General Electric has announced plans to build a high-bypass turbofan engine that will eventually produce up to 95,000 pounds of thrust. Ten percent more efficient than current designs, it will serve as the basis for a new

Newly unveiled mockup of GE 90 engine gives a view of its wide-chord fan blades which will be fashioned from composites.

generation of long-range, wide-body, twinjet airliners, such as Boeing's recently announced 767-X.

To meet the 1995 production date, many systems, including lubrication and

thrust reversers, will be borrowed from earlier engines. But to produce the tremendous thrust called for, it will also be necessary to incorporate new technologies. For example, the engine's 10-ft.-dia. fan will be made up of 20 composite wide-chord blades. The large twinjets run by engines in this size range will replace aging trijets, such as the Douglas DC-10 and Lockheed L-1011.

Magnetic Satellite Gun

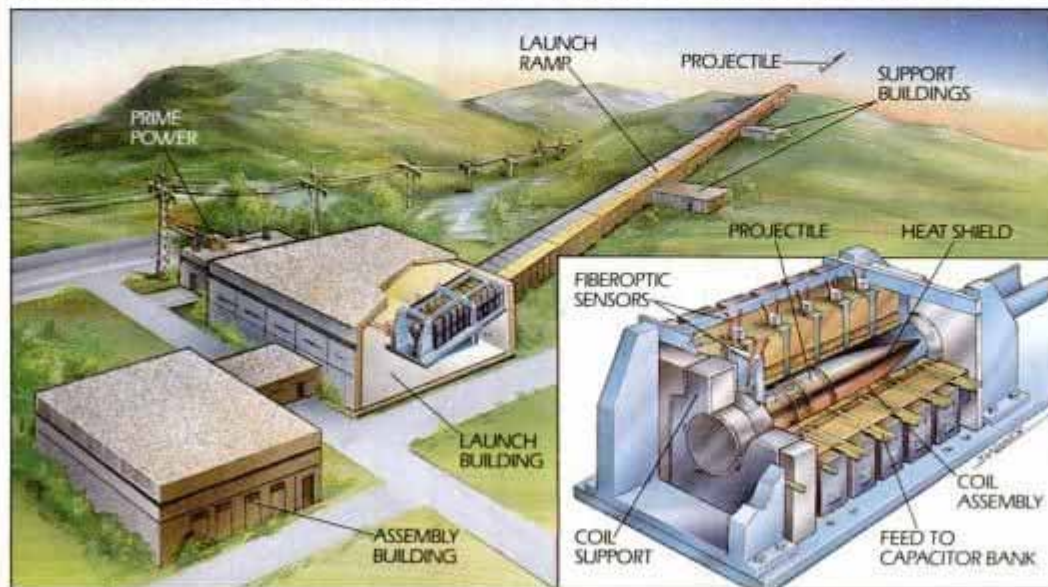
ALBUQUERQUE, NM—Star Wars technology may make it possible to hurl projectiles into orbit with a giant Earth-based gun. Sandia

National Labs has already built small versions of the device, called a coil gun, which, if successfully scaled up, could reduce satellite launch

costs 100-fold. Like earlier rail guns, the coil gun propels projectiles by energizing a series of electromagnets in rapid succession. It differs, however, in that the projectile is magnetically levitated

within the barrel, avoiding friction which causes rail guns to self-destruct after a few firings.

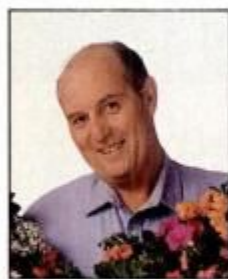
Presently, Sandia is experimenting with a gun that can propel a 7-pound projectile at up to 316 meters per second. A proposed 600-1000-meter version would propel a 1000-pound projectile fast enough to reach orbit with a small booster rocket.



Concept of future coil gun launch facility (left) is scaled up from a 6-stage gun (above) now in operation at Sandia National Labs.

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America's Master
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- A. 16" Hi-Wheel Mower**
Push mower. 5-hp Tecumseh Premiere engine. 22" side discharge cut. Fully baffled for smooth grass flow. 7-position height adjusters. Optional side-mounted grass catcher.
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12-hp Briggs & Stratton Industrial Commercial engine. Bagger-ready full-floating 38" cut mower deck. 5-speed transaxle. Optional rear-mounted grass catcher. 2-year limited manufacturer's warranty.

Manufacturers may vary.
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The quality you need, the price you want.

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69.88

A. IDC 500 Gas Trimmer
Unique positive pulse carburetion system with fingertip throttle control for easier starting and more responsive acceleration. Lightweight. 28-cc engine.

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B. IDC 520 Gas Trimmer
Dual-line trimmer converts to an edger. Unique positive pulse carburetion system. Lightweight. Adjustable handle. 28-cc engine.

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Heavy-duty dual-line trimmer doubles as a brush cutter. Unique positive pulse carburetion system. Lightweight. 28-cc engine.

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D. IDC 580 Gas Trimmer
Designed for easy clearance of hard-to-reach areas. Has dual-line trimming head and 8" brush cutter blade. Unique positive pulse carburetion system. Lightweight. 31-cc engine.

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16" Hedge Trimmer**
Universal gear-driven motor for plenty of trimming power. Patented blade design cuts branches up to $\frac{3}{8}$ " thick while reducing vibration. 8124

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**C. Black & Decker
9' Bump Feed Yard
Trimmer**
Trigger switch for quick start and stop. Easy to use. Bump Feed System automatically advances more line. 82209

24.94

**D. Black & Decker
10' Bump Feed Yard
Trimmer**
Heavy-duty 73-mm motor provides power for tough cutting jobs. Bump Feed System automatically advances more line. 82300

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Feeds 5,000 sq. ft.
Develops thick, green lawns. Provides vigorous, continuous growth. Contains slow-release nitrogen. Easy to use. Also available in liquid formula.

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- B. Super K Gro 25-3-3 Weed & Feed**
Treats 5,000 sq. ft. Weed control with fertilizer. Provides thick, green lawns. Easy to use. Also available in liquid formula.

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- C. Drop Spreader**
20" spreading width. 70-lb. capacity, non-corrosive hopper. FH-22

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4' x 8' spreading width. 50-lb. capacity, non-corrosive hopper. SB-50

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Chilton's

MAY 1990

PRODUCT PREVIEWS



SPONSORED BY **Chilton's** AUTOMOTIVE MARKETING

**WHAT'S HOT IN
AUTOMOTIVE PRODUCTS?**

Part No. 7019

**CHILTON'S
AUTO REPAIR
MANUAL
1988**

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Years
of Coverage



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INTAKE VALVE CLEANER

There has been much research into driveability problems in fuel injected engines. Originally it was thought that blocked injector tips were the cause, but even after the addition of new injector cleaning detergents to gasoline, the problems did not go away.

Further testing by B.M.W. (the most active company in this research) showed that another reason for these problems (just as harmful as blocked injectors) was a buildup of intake valve deposits that soak up gasoline from the fuel charge. Furthermore, the detergents designed to keep injectors clean actually increased the deposit formation.

Driveability problems caused by intake valve deposits are not restricted to expensive European cars. All modern high efficiency engines can suffer from them. The more finely tuned the engine, the more likely it is to have problems—particularly if it has a multi-valve configuration.

The B.M.W. Parts No. 88-88-6-900-307 is recognized as the highest standard of effectiveness for additives that keep intake valves clean. Bardahl Intake Valve Cleaner is authorized to carry this parts number and is very competitively priced.

Circle #1 on Reader Service Card



BODY REPAIR: NO EXPERIENCE NEEDED

Fixing minor auto dents and dings is quick and easy with this brand new kit from Bondo, the nation's leader in automotive body do-it-yourself products.

It's the only kit designed especially for the person who's never repaired a dent. Every tool, every ingredient, needed to do the job right is included. A full color illustrated instruction sheet guides the beginner through the job step-by-step. There's even a toll free "helpline" available seven days a week for personal help from a knowledgeable Bondo expert.

Until this kit came along, auto body repair seemed intimidating for the amateur. It was even difficult to know what materials were needed to do the job. Now everything needed comes in the gold Bondo package: body filler, several grades of sandpaper, auto primer, applicators, glazing compound, instructions, even a dust mask and a dent puller. And the suggested retail price is just \$14.95.

Those who use the kit agree—it's an easy way to fix minor dents and dings (although major body damage still is best left for the professional auto body repair shop). Call toll free for your nearest dealer: (800) 241-3386.
Circle #2 on Reader Service Card



TODAY'S HIGH PERFORMANCE AUTOMOTIVE LIGHTING FROM PHILIPS

The halogen headlamp, invented and popularized by Philips, is one of the most significant developments in the history of automotive lighting. This powerful headlamp produces up to 50% more light than standard sealed beams, enabling motorists to see farther.

What's more, halogen light is characteristically bright and whiter than the light from standard headlamps, so whatever appears in your field of vision while driving is more clearly defined. Halogen headlamps also maintain constant light output for the full life of the lamp, while others lose light output as they age.

Philips Lighting Company manufactures a full line of halogen headlamps designed to fit the make and model of just about any car. Also, Philips offers a variety of miniature lamps used for brake, indicator, and parking lights, and to illuminate everything else from the ash trays to the trunk space.

Circle #3 on Reader Service Card



CALIFORNIA COLORS BY GRANT

The hot new look in automotive fashion is California Colors by Grant. California Colors steering wheels are available in eight bright colors with hand stitched features and black anodized spokes. Also brand new are California Colors premium steering wheel covers, the ultimate stitch-on cover with the look of luxury. California Colors is by Grant Products, the leading manufacturer of custom steering wheels offering more than 100 different wheel designs and six series of steering wheel covers.

Circle #4 on Reader Service Card



Grant
**PRODUCT
PREVIEWS**
SPONSOR: Grant Automotive Marketing



NEW RALLY CAR WAX: THE DIFFERENCE IS CLEANING

All waxes offer shine and protection. But quality wax performance begins with a paint surface totally free of the road grime, tar, and dirt that can dull your car's finish. That's why Rally Car Wax has been reformulated. It thoroughly cleans the paint's finish, then lays down a long-lasting protective shine. And this unique formula safely revives any kind of car finish, including new multi-layered and clear coat paints. Try New Rally Car Wax. It cleans first, for a longer lasting shine later.

Circle #5 on Reader Service Card

ANES PRESENTS THUNDERBOLT PORTABLE STROBE ALARM

A visible deterrent to any potential vandal. Unlike installed alarms hidden from view, the THUNDERBOLT alarm is highly visible on the dash and the flashing LEDs alert any would-be intruder that the vehicle is being protected. The THUNDERBOLT alarm has its own back-up battery, which takes over in the event the unit is unplugged or tampered with. The built-in panic button allows you to activate the alarm in a personal emergency. The alarm is portable and needs no costly installation!

Circle #6 on Reader Service Card



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Gabriel introduces an advanced performance system for light trucks and 4-Wheel Drive vehicles: The Ryder Command® Variable Ride Control System. Ryder Command is an electronically controlled suspension system that allows you to instantly choose the ride you want. A simple push of a button will give you the touring setting, for smooth highway driving, or the sport setting, for firmer, more responsive handling on rough roads or off road. The Ryder Command comes with easy-to-follow instructions and all of the hardware you need for easy installation. Available from Gabriel, the performance leader worldwide.

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Now when you buy the hottest performance muffler around—Cherry Bomb® Turbo—you can get a lightweight, racing jacket for just \$12.95, plus \$2.50 for shipping and handling. It's a performance look that goes with the performance of the Cherry Bomb Turbo—a muffler that boosts power and acceleration with a deep, mellow sound. The jacket, a \$45 value, features an embroidered logo and is available in four colors. Offer good through August 31, 1990, at participating automotive parts stores.

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STRONG ARM® GAS-CHARGED LIFT SUPPORTS



Maremont's Strong Arm lift supports make it easy to fix a weak trunk, hatch or hood. Just follow the simple directions. You can install them yourself in about 10 minutes and save money doing it. And Strong Arm lift supports are quality-crafted with exclusive features like the multi-lobe seal that prevents pressure leaks. So you'll get a smooth, reliable support for your hatch, trunk or hood.

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FIX-A-FLAT AND TACH ONE UNDERHOOD SHAMPOO

Nationwide Industries Inc., a leader in sales and technology, presents the NEW FIX-A-FLAT—the first non-flammable, environment friendly, PERMANENT emergency tire repair system available in a full range of sizes. It contains no chlorofluorocarbons. Nationwide also has the new TACH ONE brand line of high performance products. Tach One Underhood Shampoo removes grease and grime, leaving the entire engine compartment looking like new with biodegradable, non-flammable detergents and dispersants.

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PRODUCT PREVIEWS
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A difficult job has now been made easy. If you can plug a lamp into a wall socket, you can do this. It requires no tools—no wire cutting, splicing or taping. Revolutionary new system works on any auto, van, utility or pickup truck—domestic or imported. Hundreds of thousands now in use. Available at most automotive, RV, marine, farm, and home and hardware stores. See retailer selection guide for applications. Call or write: HOPKINS MANUFACTURING CORPORATION, Box 1157, Emporia, KS 66801-1167, (316) 342-7320.

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Protect your car's interior with 3M's AutoPak™ Scotchgard™ brand products. They're the #1 name in protection for almost any surface in your car—from upholstery to carpet to leather. Scotchgard™ products clean and protect against soil and stain damage. Also look for new Scotchgard™ Protective Gel that cleans and enhances vinyl surfaces inside and outside your car. For more information, write: Connie Schrandt, 3M CONSUMER GROUP SERVICES, 3M Center, Bldg. 223-4S-01, St. Paul, MN 55144-1000.

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PRODUCT PREVISIONS
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ENERGIZER® EVERSTART™ ...THE BATTERY THAT KEEPS STARTING AND STARTING AND STARTING™.

A unique blend of innovative and traditional automotive battery technology, the Energizer® EverStart™ features a main battery and a backup battery built into one case. The MAIN battery provides 525 CCAs while the "BACKUP", engaged by a SELECTOR™ located on top of the battery, features 275 CCAs for a total of 800 CCAs. Motorists owning an Energizer® EverStart™ enjoy the security and convenience of always having a fully charged backup battery under the hood. For more information, contact the JOHNSON CONTROLS INC., SLI Battery Division, P.O. Box 591, Milwaukee, WI 53201. Circle #13 on Reader Service Card

AFFORDABLE CONVERTIBLE

Royal Rubber's Survivor reversible car mats truly are "convertible". One side is great for fair weather with its plush nylon carpet. The flip side is a heavy-duty, weatherproof, rubber mat, channeled to catch dirt, ice and water. These mats won't fade, mildew or deteriorate, and they absorb road noise. Convert to Royal's Survivor...the mats that will give you the ride of a lifetime. ROYAL RUBBER & MANUFACTURING, 5951 E. Firestone Blvd., South Gate, CA 90280-3795, (213) 928-3381. Circle #14 on Reader Service Card



RAIN-X—“THE INVISIBLE WINDSHIELD WIPER” AND NEW RAIN-X ANTI-FOG

Incredible RAIN-X dramatically improves wet weather visibility! It covers exterior windshields, side and rear windows, mirrors and lights with a transparent polymer coating that disperses rain, sleet and snow on contact to let you see clearly with and without wipers! Whatever the weather, whatever you drive, use RAIN-X for improved all around visibility, safety and driving comfort.

New technology RAIN-X Anti-Fog is the answer for home and auto fog-free interior windshields, windows, mirrors and glass doors. RAIN-X Anti-Fog can be instantly applied to remove fog and treat interior glass surfaces simultaneously. Keeps bathroom, kitchens, and all fog-prone interior windows and doors fog-free.

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LET WAGNER HALOGENS SHED A LIFETIME OF LIGHT.

The benefits of Wagner Halogen Headlights are plain to see. They are 40% brighter and shine 200 feet farther down the road than regular headlights. And Wagner Halogens are the only headlights backed by a Lifetime Warranty.*

What else would you expect from Wagner? The company has spent 100 years servicing the customers. And it's the only lighting company dedicated solely to the automotive market. Now, as it begins its second century, it's more committed than ever to developing better lighting products for the automotive needs of today and tomorrow. So let Wagner Lighting brighten your future with Lifetime Warranty Halogen Headlights.

*See your retailer for details on limited lifetime warranty.
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**SWISS OFFERS FIVE DOLLAR
CONSUMER REBATE**



Trusted SWISS quality now at a tremendous savings. Receive a \$5.00 rebate on the purchase of the most popular SWISS Body Filler product, Life'n'Easy, one gallon (Part No. 3431). Life'n'Easy is the easy to use, fast sanding body filler you know you can trust for strong, permanent repairs. Ask your retailer about the expanded line of SWISS products. There are 35 new auto improvement and repair items added to the 1990 SWISS line, as well as the addition of Hammerite, the rust stopping metal paint.

Circle #17 on Reader Service Card

**PROFESSIONAL RESULTS IN MINUTES
AND A ONE DOLLAR REBATE**

The Body Patch is the most significant auto body repair innovation since the introduction of plastic body filler. The Body Patch and SWISS Body Filler combine to form a super strong, reinforced repair. This unique peel and stick patch self-adheres to the damaged area. The open weave of the fiberglass mesh and the hundreds of tiny holes serve to grab and hold the body filler to assure an extra strong permanent repair. The Body Patch is available in four sizes, and for a limited time you will receive a one dollar rebate when you purchase any size.

Circle #18 on Reader Service Card



I HATE RUST.

All year long rust attacks the guts of your car. But now there's a way to whip rust once and for all. With Hammerite®—the toughest, longest lasting, most beautiful rustproofing paint in the world.

NOW AVAILABLE IN AEROSOL.

Hammerite® comes in 14 exciting colors plus white, goes on fast and easy—without primer—and dries to a gorgeous, steel-tough finish. Just apply one generous coat directly onto metal. As Hammerite® dries, millions of heat-hardened glass flakes and aluminum particles bond together into an interlocking "armor coating". Moisture can't get through. Dirt can't get through. Rust can't get started. And you don't need to repaint for years and years.

HAMMERITE® PROTECTS WHAT'S YOURS.

Hammerite® is perfect for protecting rear axles, bumpers, wheels, engine compartments, fenders, and more. And you can use Hammerite® on all your vehicles—from motorcycles to travel trailers, ATVs to snowmobiles. Hammerite® even protects and beautifies wood, plastic, and fiberglass. Next project, buy the rustproofing paint that hates rust. Hammerite®.

DO IT RIGHT. HAMMERITE®.

For more information, please send for our free Hammerite® brochure: HUNTING SPECIALTY PRODUCTS, INC., 265 S. West Street, Lebanon, Ohio 45036 (800) 733-4413.
Circle #19 on Reader Service Card





RISLONE ENGINE TREATMENT

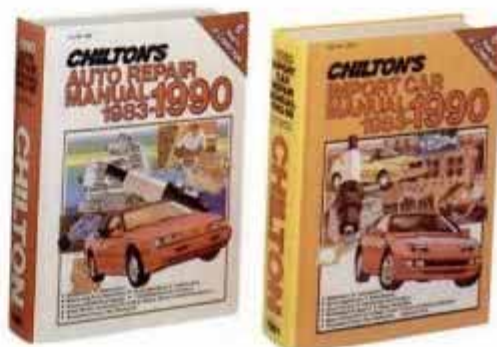
Rislone Engine Treatment is formulated to keep internal engine parts clean and free of varnish, sludge, and other harmful deposits. This unique formula is beneficial to all cars and trucks, whether new or old. At oil change time, a quart of Rislone, used in place of a quart of motor oil, ensures smooth, efficient engine operation. For more information about Rislone, write for your free "Lube Tips" booklet to THE SHALER COMPANY, POB 471, Waupun, WI 53963.

Circle #20 on Reader Service Card

CHILTON'S AUTO REPAIR MANUALS 1983-90

The manuals that do-it-yourselfers have always relied on for money-saving repairs are available in their latest editions. The two illustrated repair manuals contain eight years of coverage (1983-90) for domestic and imported cars. The domestic edition covers Detroit's newest models including Eagle Summit, Dodge Spirit, Plymouth Acclaim, and Ford Taurus SHO. The import edition is the most complete, up-to-date service manual made that covers virtually every car imported into the U.S. and Canada. New manufacturers include GEO and Porsche.

Circle #21 on Reader Service Card



MOOG PERFORMANCE COIL SPRINGS—AUTOMATICALLY ADJUST TO ROAD AND LOAD CONDITIONS—IMPROVE RIDE PERFORMANCE.



Available in three models, these patented variable-rate springs increase resistance to swaying, dipping and bottoming out. Improve ride quality and handling—especially under load and towing conditions. Improve your ride with Control Coil™ springs for front MacPherson struts, Tuff Coil™ springs for the fronts of light trucks and vans, and Cargo Coil® springs in the rear for loads and towing.

Get Moog Performance Coil springs, with lifetime warranty, at better automobile service centers.

Circle #22 on Reader Service Card

THE SIMPLE SOLUTION FOR DIRTY PROBLEMS.

There is always an easier way to do a job. When it comes to cleaning up your car Simple Green® is all you need. Its concentrated formula makes several cleaners to degrease the engine, clean wheels, tires, carpets, upholstery—even wash your car. Best of all Simple Green is non-toxic, biodegradable and non-abrasive. It's the safe, simple cleaning solution. Available at automotive and hardware stores everywhere.

©Sunshine Makers, Inc. 1990

Circle #23 on Reader Service Card



PRODUCT PREVIEWS
SPONSORED BY EMGEE AUTOMOTIVE MARKETING

FREE "BEAUTY TIPS"



Put salad oil in the wash water? Should a car cover "breathe"? The answers are in a free brochure from Kimberly-Clark, makers of Evolution® 3 fabric. This handy guide is full of information to help you keep your car beautiful. And it lets you compare the performance of Evolution 3 fabric with other types of car-cover material. Call now for your free brochure, complete with an Evolution 3 fabric sample and "where-to-buy" information, (800) 554-3600.

Circle #24 on Reader Service Card

THE ABSORBER®

The Absorber® from Emgee Marketing of Westmont, IL, is a super-absorbent, durable and easy-to-use drying towel with an amazing capillary attraction for water. Unharmed by grease, oil or solvents, the Absorber® absorbs three times faster than a natural hide chamois, has no adverse affect on the waxed finish, is tough, lintless and fully washable, and stores damp and ready to use in its own attractive plastic tube. For more information, contact EMGEE MARKETING, 648 Blackhawk Drive, Westmont, IL 60559 or phone (708) 887-7707.

Circle #25 on Reader Service Card



EXTREME CONDITIONS DEMAND ULTRA PROTECTION.

From your cooling system to your brakes, when it comes to protecting your car from extreme heat, cold and corrosion, nothing works like Zerex automotive products.

For years you've relied on the extreme protection of Zerex Antifreeze Coolant. Now you can get the same kind of unsurpassed protection for your cooling system with Zerex Ultra Sealer and Zerex Ultra Protector Antirust and Water Pump Lubricant. Plus, exceptional cleaning action with Zerex Ultra Flush. And unmatched protection for disc and drum braking systems with Zerex Ultra Brake Fluid.

Look for the ultra family of fine Zerex Automotive Products—along with easy-to-use Flush Kit and Antifreeze Coolant Tester—in selected stores near you.

Circle #26 on Reader Service Card

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COMMANDER THE NEW SINGLE LID, POLY/STEEL CROSSOVER FROM DELTA

The COMMANDER Crossover combines a polymer exterior, a steel framework and a single lid to create a revolutionary new crossover box. The polymer exterior, ingeniously formed over a specially designed lid and HERCULENIUM BONDED™ floor creates a body with outstanding load bearing capabilities. Other features include limited lifetime guarantee against sagging, dual gas spring lid assists, push button locking system, and sliding tray. For details, phone (800) 643-0084 or FAX (501) 935-2974.
Circle #27 on Reader Service Card



PRODUCT
PREVIEWS
FORWARD TO: CHRYSLER AUTOMOTIVE MARKETING

SURE AND FAST COVERAGE FROM THE COMPANY KNOWN FOR QUALITY. DUPLI-COLOR®.



CLASSIC-CARE™ ACRYLIC ENAMEL assures superior coverage and durability. Smooth, even finish. Fast drying. Full range of colors. TRUCK AND VAN PAINT acrylic lacquer dries to a durable, high-gloss finish. Cans imprinted with manufacturer's color code for all makes and models. Lead free. SCRATCH-FIX® TOUCH-UP PAINT—premium quality, lead-free acrylic lacquer. Colors computer-matched to vehicle standards. Available at your automotive parts store. DUPLI-COLOR PRODUCTS COMPANY, Elk Grove Village, IL 60007-5677, (312) 439-0600.

Circle #28 on Reader Service Card

VENTVISOR® RAIN DEFLECTORS

VENTVISOR® Rain Deflectors, an innovation from the Auto Ventshade Company, Chamblee, GA, is made from impact-resistant, high density smoke-colored acrylic. Specifically designed for passenger cars, vans, pick-ups and utility vehicles without vent windows, VENTVISORS® allow vehicle windows to remain partially open in all weather. They vent stale air out and let fresh air in without creating excessive drag.

Paintable smoke colored acrylic EZ SHADE™, the original stainless steel VENTSHADE®, and the new R.V.1 smoke colored acrylic Rear Window Deflector are available for vehicles with vent window.

All of Auto Ventshade's products install easily. For further information, contact the sales department at (800) 241-7219 or (404) 451-3505.

Circle #29 on Reader Service Card



MOTORCRAFT AIR FILTERS. JOIN THE MOTORCRAFT AIR FORCE!

Protect your car's engine from dirt, grime and other harmful contaminants with top quality Motorcraft air filters. As original equipment on Ford, Lincoln, and Mercury vehicles, Motorcraft is the name Ford and Lincoln-Mercury owners look for when they want original equipment quality and performance. What's more, there's a full line of quality Motorcraft air filters for all other makes of cars and trucks. There's no replacement for the Peace of MindSM that Motorcraft quality gives you. Join the Motorcraft Air Force today! For the Motorcraft retailer nearest you, call (800) 521-5181.

Motorcraft. Quality Parts for Quality Cars.
Circle #30 on Reader Service Card



RETAIL SHOPPER

The retail chains listed below specialize in selling automotive parts, chemicals, and accessories. With some products, there is an 800-number toll-free customer service line to help locate the nearest store which carries this merchandise. **AUTOMOTIVE MARKETING** has made every effort to make this list of auto parts retailers as comprehensive as possible for the convenience of automotive do-it-yourselfers.

ALABAMA

AutoZone
Carpport Discount Auto Parts
Cash & Carry Auto Parts
Chief Auto Parts
Harco Drug
National Automotive Superstores
Pep Boys
Super Shops, Inc.
Taylor Parts Inc.

ALASKA

B&C Auto Supply
Grand Auto

ARIZONA

AutoZone
Checker Autoworks
Chief Auto Parts
Fletcher Enterprises
Grand Auto
Pep Boys
Super Shops, Inc.

ARKANSAS

AutoZone
Chief Auto Parts
O'Reilly Automotive
Stinger Sam Auto Parts
Super Shops, Inc.

CALIFORNIA

Auto Giant
Cal Auto
Chief Auto Parts
Fast Company
Grand Auto
Indy Auto Stores
Katella Auto Parts Inc.
Kragen Autoworks
L&M Tire Co. Inc.
Marc C. Bloom Div./DCH Inc.
Pep Boys
Scherbas Auto Stores, Inc.
Super Shops, Inc.
Trak Auto
Von Housen Auto Parts Stores

COLORADO

Champion Auto Stores
Checker Autoworks
Super Shops, Inc.

CONNECTICUT

ACME Auto Supply Inc.
ADAP
Benny's
Fisher Big Wheel
Motomart
Performance Centers of America
PV Performance Center

DELAWARE

Ben Pilla Speed Shops
Pep Boys
R&S/Strauss

DISTRICT OF COLUMBIA

Hi-Gear Tire & Auto Supply
Pep Boys
Trak Auto

FLORIDA

Ace Auto Parts Co. Inc.
AutoZone
Apollo Auto Parts
Bennett Auto Supply
Denny's Auto Parts
Discount Auto Parts Inc.
Inter-City Auto Stores Inc.
Harco Drug
National Automotive Superstores
Nationwide Auto Parts
One Stop Auto Parts
Parts City
Rose Auto Stores
Super Shops, Inc.
Taylor Parts Inc.
Trout Auto Parts
U Do It Auto Inc.
Wall's Auto Parts
Wingate Automotive Inc.

GEORGIA

AutoZone
Butler Auto Supply
Nationwide Auto Parts
Parkway Auto Parts
Parts City
Pep Boys
Super Shops, Inc.
Taylor Parts Inc.

HAWAII

Ron's Auto Parts and Performance

IDAHO

KAPS Auto Stores
Schucks Autoworks
Thrifty Auto Parts Inc.

ILLINOIS

Autoworks
AutoZone
Blue Star Auto Stores
Forest City Auto Parts
Giant Auto
Linkon's Auto Supply
Robertson's/Big Bear
Strum Auto
Super Shops, Inc.
Trak Auto
Whitlock Auto

INDIANA

Autoworks
AutoZone
Blue Star Auto Stores
Fisher Big Wheel
County Post
Hire's Auto Parts
Nationwide Auto Parts
Quality Farm & Fleet
Ridge Auto Parts
Super Shops, Inc.

IOWA

American Auto Parts
Art's Auto Parts
Autoworks
Big Bear
Bongaars
Champion Auto
Strum Auto
Super Shops, Inc.
Whitlock Auto

KANSAS

Autoworks
O'Reilly Automotive
Super Shops, Inc.
Whitlock Auto

KENTUCKY

Autoworks
AutoZone
Chief Auto Parts
Cobre Tire
Kentucky Motor Service Inc.
Nationwide Auto Parts
Super Shops, Inc.
Toohey's Auto Supply Co.

LOUISIANA

AutoZone
Hi/LO Auto Supply
National Automotive Superstores
Super Shops, Inc.

MAINE

Motomart
Parts Depot
VIP Discount Auto Center

MARYLAND

Ben Pilla Speed Shops
Gatlings Auto Stores Inc.
Hi-Gear Tire & Auto Supply
Pep Boys
Professional Auto Parts Associates
Trak Auto

MASSACHUSETTS

ADAP
AutoPalace
Lappen's Discount Auto Parts
Parts Depot
PV Performance Centers

MICHIGAN

Action Auto
Auto Parts World
Autoworks
County Post
Fisher Big Wheel
Murray's Discount Auto Stores
Nationwide Auto Parts
Quality Farm & Fleet
Ridge Auto Parts
Short's Auto Parts

MINNESOTA

Big Bear
Big Wheel/Rossi Auto
Champion Auto Stores
Crown Autoworks
Propper Oil & Auto
Supply

MISSISSIPPI

AutoZone
The Carport
Harco Drug
Super Shops, Inc.

MISSOURI

Autoworks
AutoZone
Big Bear
Eastside Auto Parts
O'Reilly Automotive
Stinger Sam Auto Parts
Super Shops, Inc.

MONTANA

Champion Auto Stores
Checker Autoworks

NEBRASKA

Arts Auto Parts
Autoworks
Bomgaars
Champion Auto Stores
Cowdon Auto Elec.
Super Shops, Inc.

NEVADA

Checker Autoworks
Chief Auto Parts
Grand Auto
Kragen Autoworks
Pep Boys
Super Shops, Inc.

NEW HAMPSHIRE

ADAP
Maynard Supply Co.
PV Performance Centers
VIP Discount Auto Center

NEW JERSEY

AID Auto Stores Inc.
Ben Pilla Speed Shops
Kar Parts Inc.
LDC Auto Stores
Pep Boys
Performance Centers of
America
R&S/Strauss
Royal Auto Supply

NEW MEXICO

AutoZone
Checker Autoworks
Chief Auto Parts
Cobre Tire
Pep Boys
Super Shops, Inc.

NEW YORK

AID Auto Stores Inc.
Auto Barn Stores
Fisher Big Wheel
Forest City Auto Parts
Hutchins & Angert
Auto Part
ITTCO Sales
National Auto
R&S/Strauss
US 1 Auto Parts

NORTH CAROLINA

Advance Stores
AutoZone
Crazy Joe's
Nationwide Auto Parts
Super Shops, Inc.

NORTH DAKOTA

Champion Auto Stores
Crown Autoworks

OHIO

All Parts Automotive
Auto Parts Warehouse
Outlet
Autoworks
County Post
Fisher Big Wheel
Forest City Auto Parts
Giant Auto Parts
Nationwide Auto
Midwest Auto Specialties
Quality Farm & Fleet
Rieth Auto Stores
Short's Auto
Super Shops Inc.
Whitlock Auto
Worldwide Auto Parts

OKLAHOMA

AutoZone
Brad's Auto Parts Centers
Endurance Auto Parts
Guy Henshall Supply
Co. Inc.
O'Reilly Automotive
Osborne Distributing Co.
Save Auto Stores
Super Shops, Inc.

OREGON

G.I. Joe's, Inc.
Knecht's Discount Auto Parts
Schucks Autoworks
Super Shops, Inc.

PENNSYLVANIA

Beacon Auto Parts
Ben Pilla Speed Shop
D.G. Nicholas Co.
Fisher Big Wheel
Forest City Auto Parts
Galling's Auto Stores Inc.
National Auto Stores
Pep Boys

R&S/Strauss
Royal Auto Supply
Whitlock Auto
Worldwide Auto Parts

RHODE ISLAND

ADAP
Auto Palace
Benny's
Fisher Big Wheel

SOUTH CAROLINA

Advance Stores
AutoZone
Crazy Joe's
Nationwide Auto Parts
Park's Auto Parts
Parts City
Super Shops, Inc.

SOUTH DAKOTA

Bomgaars
Champion Auto Stores
Crown Autoworks

TENNESSEE

Advance Stores
AutoZone
Chief Auto Parts
Nationwide Auto Parts
Parts Depot
Super Shops, Inc.

TEXAS

ACI/Binswanger
AutoZone
Checker Autoworks
Chief Auto Parts
Hi/LO Auto Supply
Johnie's Discount Auto Supply
Kissinger Discount Auto Stores
Osborne Distributing Co.
Pep Boys
Pettigrew-Smith
Sanchez Auto Supply
Super Shops, Inc.

UTAH

Bradshaw Auto Parts Co.
Checker Autoworks
Cobre Tire
Super Shops, Inc.

VERMONT

Maynard Supply Co.

VIRGINIA

Advance Stores
Ben Pilla Speed Shop
Hi-Gear Tire & Auto Supply
Nationwide Auto Parts
Parts Depot
Pep Boys
Trak Auto
Twin "B" Auto Parts

WASHINGTON

Al's Auto Supply
B&B Auto Parts
Schucks Autoworks
Super Shops, Inc.
Thrifty Auto Parts

WEST VIRGINIA

Autoworks
Fisher Big Wheel
Gallings Auto Stores
Nationwide Auto Parts

WISCONSIN

Autoworks
Big Bear
Champion Auto Stores
Crown Autoworks
Super Shops, Inc.
Whitlock Auto

WYOMING

Champion Auto Stores
Checker Autoworks
Cobre Tire

**NATIONAL AUTO
PARTS RETAIL
CHAINS**

Auto Express
(Montgomery Ward)
All Pro
Auto Value
Big A
Bumper to Bumper
Carquest
NAPA
Parts Plus
Pronto
Western Auto

**DISCOUNT AND
DEPARTMENT
STORES**

Ace Hardware
Bradlees
Coast To Coast Stores
K mart
Pace Membership
Warehouse
Roses Stores
Sears
Target
True Value Hardware
Wal-Mart
Walgreen Drug

For more retailers in your area, consult your Yellow Pages.

THE ONLY REQUESTED HIGH PERFORMANCE WINDOW TINT

The first really new window tint product in years. Best of all...it was requested by auto film users.

A nationwide survey of film users (both professional and do-it-yourselfers) concluded that scratch resistance, maximum heat rejection, fade and crack prevention, and superior visibility for the driver are the most requested features of a window tint.

Our Polyhard High Performance Series of films provide these features. Scratch resistance? You bet! It meets Federal Abrasion Resistance Specifications Z26.1.83. Solar control? Absolutely. Polyhard provides maximum heat rejection while blocking 99% of the damaging ultraviolet rays that fade upholstery and crack leather and vinyl. Visibility? True innovation. The Polyhard High Performance Series is a tint system matched for the front and rear windows of your auto. Top shaded for driver/passenger side windows and dark shaded for rear windows. And for more, how about the super appearance that Polyhard film gives to your pride and joy.

Polyhard High Performance Tint does it all...and we guarantee it for the lifetime of your vehicle. Polyhard films are available at leading auto parts stores nationwide. Or phone toll-free at (800) 528-4481, 8 A.M.-5 P.M. MST, for the location of the nearest store to you.

ALL GILA FILMS ARE MANUFACTURED WITH THE HIGHEST QUALITY POLYESTER FROM HOECHST CELANESE.

Circle #31 on Reader Service Card



BATTERIES, CHARGERS AND ACCESSORIES FROM ONE DEPENDABLE SOURCE.

Exide—the world's leading manufacturer of lead acid batteries—now offers a complete line of battery chargers and accessories.

The Exide charger line includes manual and automatic models for 6 and 12 volt batteries as well as top-of-the-line micro-chip models, and a full line of marine starting and deep-cycle chargers.

Exide battery accessories cover every requirement from terminals to cables, hold-downs and trays, primary wire and special battery tools.

Available in the automotive department of your favorite retailer. EXIDE CORPORATION, 645 Penn Street, Reading, PA 19601, (215) 378-0500.

Circle #32 on Reader Service Card



World's Fastest Amphibian

CHESAPEAKE BAY, MD—A tracked vehicle capable of planing over the water at 33.8 mph is exploring technology for the next generation of amphibious assault vehicles. Called the High Water Speed Technology Demonstrator, it may enable the Marines to adopt new beachhead tactics.

For high-speed running, it deploys a folding hydroplane from the bow, chine flaps under the treads, and a water jet that is powered by a 1609-horsepower engine. Throttling up the engine causes the whole vehicle to leap out of the water and spout a rooster tail of foam.

In its current form, the strictly experimental craft carries only a 2-man crew. But if tests go well, the next



Artist's concept of future planing assault vehicle (above) is based on test bed (left) which recently hit 33.8 mph in Chesapeake Bay tests.

step will be to find a powerplant strong enough to drive a full-scale vehicle.

Envisioned as a replacement for the 1970s vintage LVTP-7, the vehicle would let Marines dash ashore from support ships located over the horizon.

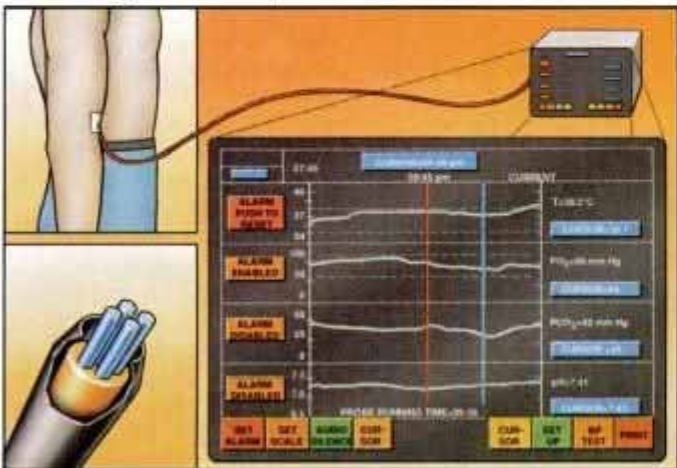
U.S. MARINE CORPS PHOTO
PM ILLUSTRATION BY ED VAUGURSKY

In-Body Blood Tester

BOSTON, MA—Tufts University researchers have developed a fiberoptic testing technique that may cut down on the need to remove blood from the body for laboratory analysis. Inserted through a needle into a blood vessel, the strands are tipped with a fluorescent dye. When laser light sent down through the fiber strikes the dye, it fluoresces in a way dependent on the concentration of the substance to be measured. Light returning from the dye is

then sent to a photodiode which gauges its intensity and color.

Although the idea of fiberoptic blood testing is not new, the Tufts researchers are the first to develop a reliable system for coating fiber tips with dye. Their technique, which suspends the dye in a polymer bound to the fiber, would allow thousands of the sensors to be manufactured at once, whereas earlier they had to be individually handcrafted.



In-Vivo Blood Gas Monitor interprets data from multistranded fiberoptic sensor (lower left) inserted into blood vessel.

PM ILLUSTRATION BY HANK ISEN

Smart Home Opens In Japan

TOKYO, JAPAN—A new scheme to unite home appliances, computers, climate-control systems and even autos into a single, intelligent network that would anticipate the owner's every whim has been unveiled by a consortium of Japanese manufacturers. The system, known as Tron, was demonstrated at a specially built home in Tokyo.

In the kitchen, a computer with an optical disk guides users through 300 recipes, showing pictures and controlling cooktop temperatures. Outside, weather sensors open and close windows. Every room has a TV, which automatically lowers its volume when the phone rings. The plants water themselves, and in the bathroom, the toilet automatically checks blood pressure, pulse rate and urine samples, storing the information in a computer for long-term health tracking.

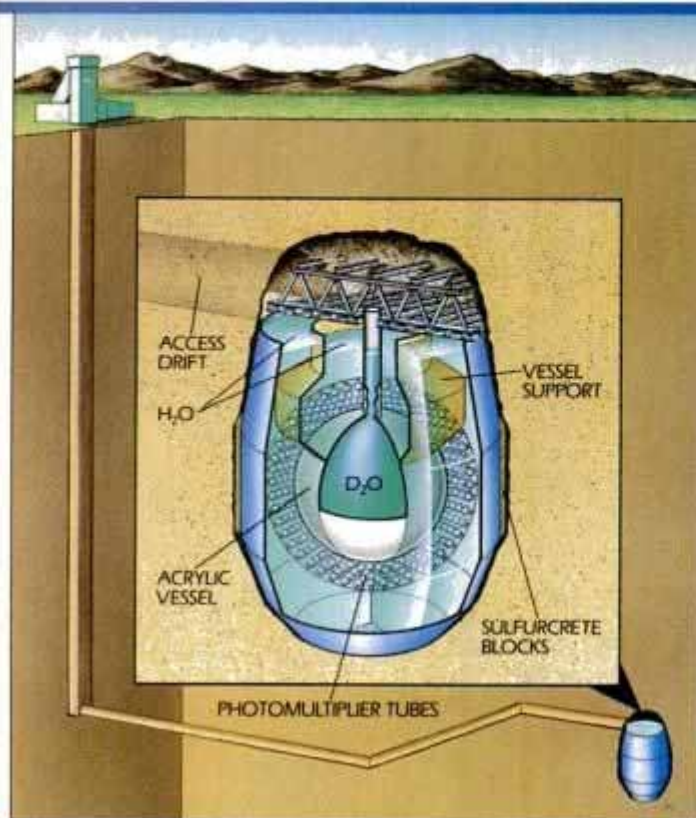
The system's inventor, Dr. Ken Sakamura of Tokyo University, believes that one day Tron will interconnect

homes, offices and transport systems throughout Japan into one huge network.



Tron kitchen (top) has a computer-controlled laserdisk cookbook. Toilet (above) monitors health.

PM PHOTOS BY JOHN BOND



PM ILLUSTRATION BY HANK KEN

Huge Detector Will Hunt Down Neutrinos

KINGSTON, ONTARIO—The Canadian government plans to build a neutrino detector 50 times as sensitive as any presently in existence. Neutrinos are one of the fundamental building blocks of matter. Given off by supernovas and other distant stellar cataclysms, they are extremely difficult to detect because they can easily pass through a slab of lead 100-light-years thick without being absorbed.

Called the Sudbury Neutrino Observatory, the Canadian detector will consist of a 10-story-high, acrylic vessel filled with 1000 gallons of heavy water, and surround-

Canadian neutrino detector uses heavy water to pick up neutrinos as they pass through the Earth.

ed by 2000 photomultiplier tubes.

To shelter the detector from extraneous solar radiation, it will be placed 2070 meters underground in an old mineshaft, and shielded by a band of sulfurcrete blocks, and thousands of gallons of water. The result, say the designers, will be the most radiation-free spot on Earth.

The detector's operation depends on the fact that when neutrinos pass through heavy water, they emit a faint glow. This passes through the walls of the acrylic vessel, and is amplified by the photomultiplier tubes. The project, which will cost about \$35 million, is scheduled for completion in 1995.

Robot Scans For Toxic Waste

PITTSBURGH, PA—A 6-wheeled robot now under development at Carnegie Mellon University could speed the task of investigating hazardous waste dumps, while protecting humans from toxic compounds. Directed by a combination of radio signals and instructions preprogrammed into its com-

puter, the robot scans the sites with a ground-penetrating radar, resulting in maps that can be used to plan cleanup operations.

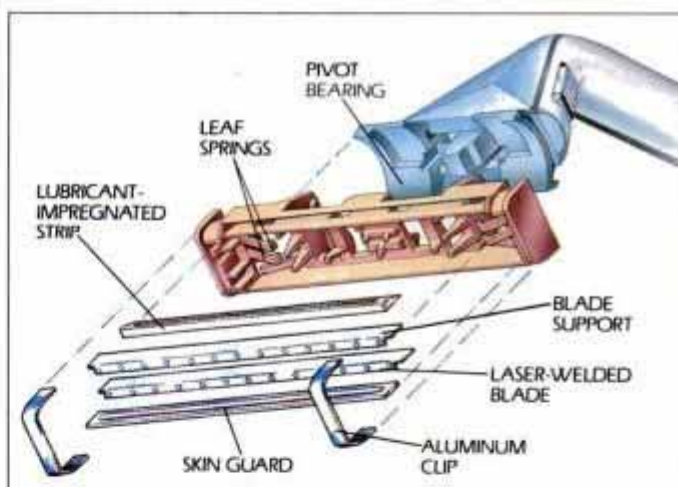
The robot produces more accurate maps than a manually operated radar would, because it can position the radar antenna very precisely, allowing the robot's computer to piece together highly focused radar returns into a larger picture.

Although a prototype will be ready this summer, the first use of the robot will probably not be for another two years.



Six-wheeled robot (above) guides ground-penetrating radar over hazardous waste sites, producing image of barrel (top).

CARNegie MELLON PHOTOS



PM ILLUSTRATION BY MARIO FERRO

Cutting Edge Redefined

NEW YORK, NY—Representing \$200 million of research and development, Gillette's Sensor razor is the greatest concentration of technological firepower likely to be leveled at our whiskers for a long time to come.

Sensor was born in the company's research facility in Reading, England. Looking for a way to take advantage of new thin-blade technology, a researcher there created a prototype with twin blades independently suspended on tiny rubber tubes. The concept

Pivoting sensor cartridge contains independently sprung skin guard and twin blades.

was passed along to Gillette's shaving technology lab in Boston to see if it could be produced affordably. They replaced the rubber tubes with plastic leaf springs molded into the shaving head, and adapted a laser welding technique to affix the paper-thin blades to stainless-steel stiffeners. The cost of putting all this technology to work on your beard? Gillette estimates it's about 6 cents per shave.

SNOOPER Beats Passport by a Mile!

New SNOOPER radar detector is long range champion! Costs \$115 less!



SNOOPER takes on Passport* — and wins!

Instant-On Radar. The words strike fear into the heart of every driver. It's for real. It's made a lot of detectors obsolete. And, there's only one way to beat Instant-On radar. Superior range. See them before they see you.

When it comes to range, Passport's been the one to beat. And SNOOPER did just that! Decisively. In road tests specifically designed to measure effective range. Rigorous tests supervised by an independent testing lab. With SNOOPER and Passport matched head-to-head.

The winner? SNOOPER 5010 — by a MILE! Literally. SNOOPER detected radar over one full mile before Passport even knew it was there! While Passport was still asleep, the new SNOOPER 5010 was already blasting out

its warning. In plenty of time to slow down.

Radar Technology Used In The F-16.

What makes the SNOOPER 5010 so good?

(1) **Superior Range:** SNOOPER 5010 uses antenna technology derived from U.S. military radar warning systems, including the F-16 Fighting Falcon and F-14 Tomcat jet fighter planes and the Defense Early Warning radar tracking system. The result? Far superior range.

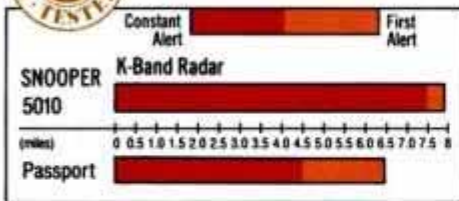
(2) **"Lock-on" circuitry:** SNOOPER is designed to "lock-on" to police radar signals from far away, before radar locks on to you. From the instant that radar is detected, SNOOPER sounds the alarm, with a clear, unmistakable radar alert.

(3) **Minimal Falsing:** Advanced triple superheterodyne circuitry and solid, all-metal (not plastic) case construction ensure that false alarms are filtered out. When the SNOOPER 5010 sounds its alarm, you know there's radar ahead — and you still have time to slow down.

SNOOPER's advanced technology beats Instant-On radar with superior X- and K-band range. Highway/City settings. Audible warning and simultaneous dual alarm lamps. Variable volume control. Easy to use. Comes with visor clip and dashboard mount . . . everything you need for the earliest possible warning.



CERTIFIED INDEPENDENT TESTING LAB RESULTS**



Your results will depend on actual driving conditions.
*Passport is a registered trademark of Cincinnati Microwave Inc. for radar detectors.
**Results available upon request.

Superior Range: The Only Defense Against Instant-On Radar.

Instant-On Radar is police radar emitted in intermittent bursts. When turned off, you can't detect it. When turned on suddenly, it's too late — they've got you. The defense: Superior Range. See them before they see you. When they're aiming at drivers way ahead of you, you can pick up the signal — before they turn the gun on you! SNOOPER's superior range and "lock-on" technology are the winning combination for beating Instant-On Radar.

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Extension 500-118

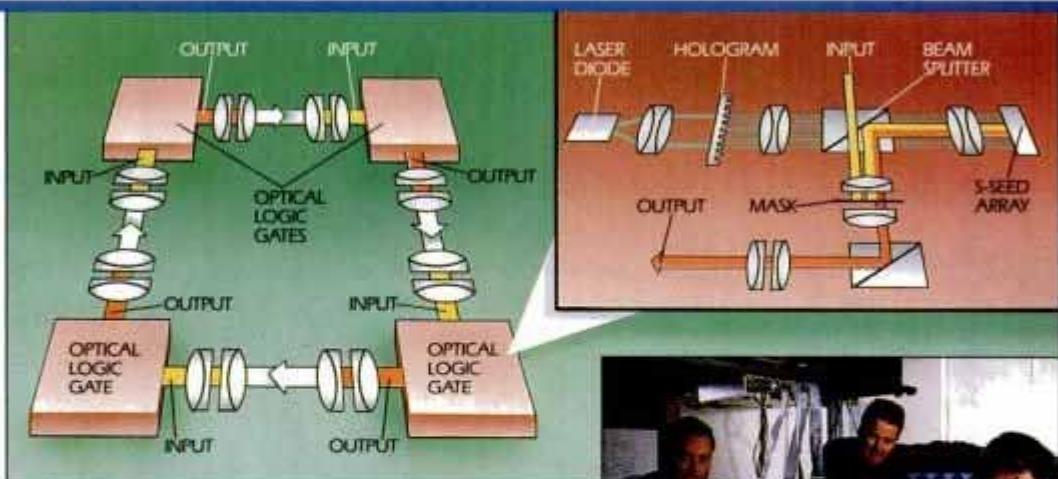
By mail send full amount to address at left. Orders processed immediately.

First Optical Processor

HOLMDEL, NJ—An infant technology that may lead to computers thousands of times faster than any yet built has taken its first halting steps.

By operating the world's first optical processor, Bell Labs has proven that it is possible to compute with laser beams in place of electricity.

The experimental processor consists of four optical logic gates, each of which contains an array of 32 S-SEEDs, or Symmetric Self-Electro-optic Effect Devices. These are essentially tiny switches that enable beams of light to control one



another, much as transistors do with electrical current.

Although the processor is now slower than a typical PC, the technology it contains should allow for speeds hundreds of times greater in the near future.

Optical processor (right) has a laser in each logic gate. The beam is split by a hologram, then reads input data on the S-SEED array, and goes to the next logic gate.



PM ILLUSTRATION BY GEORGE RETSECK

BELL LABS PHOTO

Cable Laid At Record Depth

HONOLULU, HI—The Hawaiian Electric Co. has laid a test version of the world's deepest electric power cable on the sea floor 6000 ft. beneath the Pacific. Stretching 35 miles, the cable will eventually carry 500 megawatts of energy from a geothermal powerplant on Maui to the electric grid of Honolulu.

Called on to dispense the cable was a 5000-ton vessel called Flexservice #3. Moving under the control of a dynamic positioning system

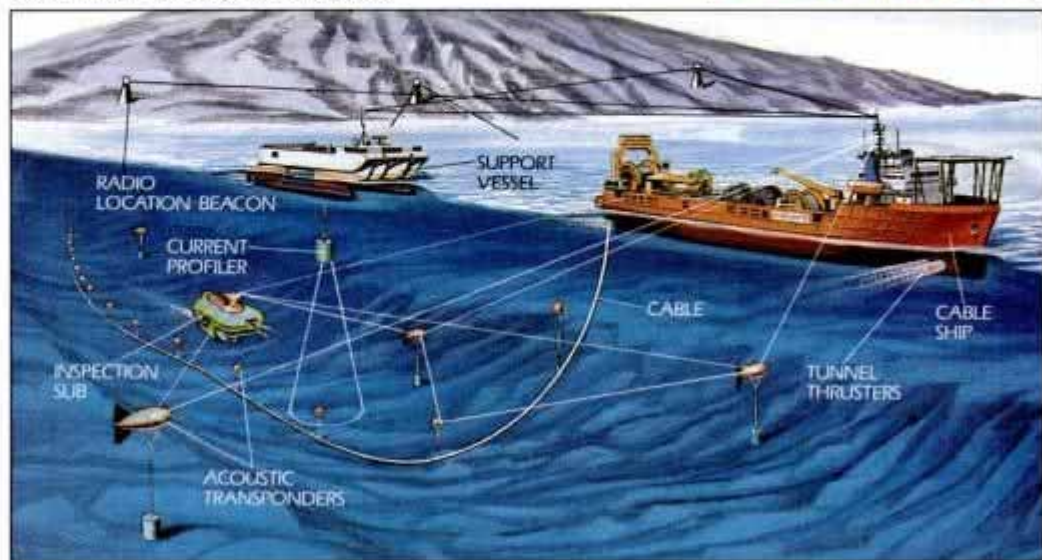
capable of holding steady in North Sea storms, she unwound the cable from 140-ton-capacity spools under precisely controlled tension. A highly stable small water-plane hull (SWATH) ship followed, dragging acoustic doppler current profilers. Data transmitted from these to a computer aboard Flexservice #3 helped in guiding the cable's descent.

To confirm the cable was on the proper path, disposable acoustic transponders

were tied to the cable at regular intervals, and their positions compared to those of transponders anchored to the bottom. Final inspection of the cable was carried out by the deep-diving submersible *Pisces V*.

When completed in 1995, the \$2 billion project should supply nearly a third of the Big Island's power. **TU**

Acoustic transponders were tied to cable (right), forming part of a computerized integrated control system that also included shore stations, and current profilers (below).



HAWAIIAN DREDGING PHOTO

PM ILLUSTRATION BY ADOLPHE BROTMAN



Battelle engineer holds rapidly spinning fan, frozen on high-speed video system behind him.

Video System Tops Camera Speed Record

COLUMBUS, OH—Researchers at Battelle labs have devised an all-electronic system that can snap high-speed photos several times faster than any film camera. Based on a video camera running at up to 12,000 frames per second, it can freeze events such as an exploding firecracker or bursting balloon. Computer memory stores up to 4096 consecutive images, which can then be played back in any order, or sent to a disk for storage. Electronic storage means the system is not only far faster than film cameras, but cheaper as well. Battelle expects the system to study very rapid events in science, industry and medicine.

BATTELLE PHOTO



Who else offers 228 action-packed days. And an education.

With the cost of college getting higher and higher, it's great to know that someone is willing to help foot the bill.

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To join it takes about two days a month and a few weeks a year. In return, you could be eligible for up to \$5,000 in tuition assistance through the Montgomery GI Bill. You may also qualify for an additional \$2,000 enlistment bonus. Finally, you'll earn a minimum salary of \$11,000. It adds up to \$18,000 you can put towards your education.

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Address _____

City _____ State _____ Zip _____

Phone Number () _____

U.S. Citizen Yes No Date of Birth _____

Soc. Sec. No. _____

I am: In High School In College

H.S. Graduate College Graduate

Prior Military Service: Yes No

Branch _____

I understand there is no obligation. The information you voluntarily provide, including your social security number, will be used for recruiting purposes only. Your SSN will be used to analyze responses. Authority: 10U5C-503.



Americans At Their Best.

DETROIT SPY REPORT

BY JIM DUNNE, Detroit Editor



Chrysler Van Facelift

CHRYSLER WILL offer a new look for the 1991 models of the Plymouth Voyager, Dodge Caravan and Chrysler Town and Country vans. Front- and rear-end caps are completely redesigned. Gone is sharp-angled body styling. In its place are rounded lines, a softer, more modern appearance. For the most part, the specifications of the new models will duplicate those of the 1990 offerings, which include: Front-wheel drive, a choice of a V6 or a 2.5-liter 4-cylinder engine and a spacious interior. The modest facelift should help the Chrysler lineup to remain the first choice of buyers in the minivan field through the early 1990s, in

spite of a rash of new competitors in this area.

Test In U.S., Sell In Europe

Thanks to long distances, light-traffic roadways and a wide range of weather conditions, the U.S. has become a favorite testing location for cars that are built in Europe and Asia. Subcompact-size Rover 400s were seen on winter test schedules near the Canadian border last February, checking high-speed driving over long periods, stopping with frozen brakes, cold-start quickness, engine warmup times, heater/defroster output and other systems. The Arizona license plates on the cars

show that the hot climate state was also a test site. Both left- and right-side steer models were examined in this fleet. The Rovers, built by the folks who sell Sterlings in this country, were introduced to Europe in April, 1990. Rover has not

in the 1991 models. Last year, and again in 1990, Cougar offered a 3.8-liter V6 and the optional 3.8-liter supercharged V6. But Mercury planners wanted to get the V8 back in the Cougar as soon as possible. The hoodline was too low to cover Ford's carburetor atop the V8 engine. So the Cougar had to wait until the 5-liter was equipped with fuel injection. That will happen this summer when the 1991 Cougars are introduced. Insiders look for the V8 in Cougars to outsell both the V6 and the supercharged V6 combined.

Lincoln's Jaguar

Ford will not depend on its recently purchased Jaguar line to compete against other superluxury cars without help. The help may come in the form of a new automobile, a super-Lincoln that will



The '91 Mercury Cougar finally gets V8 power in fuel-injected trim.

announced plans to sell the car in the U.S., but it's a possibility. Other foreign test cars I've spotted on U.S. roads include Volkswagen, Peugeot, Fiat, Mercedes, Toyota, Nissan and Mazda.

Cougar Muscle

Ford finally has a V8 engine to fit in its newly designed Cougar. The 5-liter powerplant option will be available

sell in the \$40-55,000 range. A secret project at Ford now is to build a 4-door, 5-passenger version of the new 1992½ Mark VIII Lincoln. Later, when market studies are completed, and after extensive testing of the prototype, Ford will decide whether the car should go into production. Technical details are similar to those of the super-

(Please turn to page 24)



Unmarked, Honda-powered Rover 400s are being tested in the U.S.

Acura Integra GS.....	\$16,685	Ford Escort GT.....	\$10,588	Oldsmobile 98 Regency Brougham.....	\$21,595
Acura Legend Coupe LS.....	30,690	Ford Tempo LX.....	11,422	Peugeot 405 Mi16.....	21,990
Alfa Romeo Veloce.....	20,950	Ford Mustang GT.....	14,803	Plymouth Laser RS.....	12,675
Audi 80 Quattro.....	22,800	Ford Taurus LX.....	16,180	Pontiac Sunbird GT.....	12,444
Audi 100.....	26,900	Ford Probe GT.....	15,543	Pontiac Grand Am SE.....	15,194
Audi Quattro V-8.....	47,450	Ford Thunderbird Super Coupe.....	20,390	Pontiac Firebird Trans Am GTA.....	23,320
Bentley Mulsanne S.....	133,200	Ford LTD Country Squire.....	17,921	Pontiac 6000 S/E.....	16,909
BMW 325is.....	28,950	Honda Accord EX.....	16,595	Pontiac Bonneville SSE.....	23,994
BMW 535i.....	43,600	Honda Civic.....	10,920	Pontiac Grand Prix SE.....	17,684
BMW 750iL.....	70,000	Jaguar XJ-6 Vanden Plas.....	48,000	Porsche 944.....	41,900
Buick Skylark Custom LE.....	13,145	Lamborghini Countach.....	145,000	Porsche 911 Targa.....	59,900
Buick Regal Limited.....	15,860	Lexus LS 400.....	35,000	Porsche 928.....	74,545
Buick LeSabre Estate Wagon.....	17,940	Lincoln Town Car.....	27,986	Rolls-Royce Corniche II.....	215,800
Buick Electra Park Avenue.....	21,750	Lincoln Mark VII LSC.....	29,468	Saab 900.....	17,515
Buick Reatta.....	28,335	Lotus Esprit.....	71,500	Saab 9000 CD.....	32,995
Cadillac DeVille.....	27,540	Mercedes-Benz 190E.....	31,600	Sterling 827SL.....	29,975
Cadillac Allante.....	50,900	Mercedes-Benz 300CE.....	55,700	Subaru Legacy LS.....	14,699
Chevrolet Beretta GT.....	12,500	Mercedes-Benz 500SL.....	83,500	Subaru XT-6.....	17,111
Chevrolet Camaro IROC-Z.....	15,360	Mercury Topaz LS.....	12,360	Suzuki Swift GS.....	9,264
Chevrolet Lumina.....	14,240	Mercury Sable LS.....	16,067	Toyota Camry LE.....	14,658
Chevrolet Caprice Brougham.....	16,325	Mercury Cougar XR-7.....	20,213	Toyota Cressida.....	21,498
Chevrolet Corvette ZR-1.....	58,995	Mitsubishi Galant GSX.....	17,171	Toyota Corolla LE.....	11,703
Chevrolet Geo Metro.....	8,465	Mitsubishi Eclipse GSX.....	17,260	Toyota Celica GT-S.....	17,258
Chrysler LeBaron.....	15,995	Nissan Stanza GXE.....	14,775	Toyota Supra Turbo.....	25,200
Chrysler Fifth Avenue.....	20,860	Nissan Axxess SE.....	16,749	Volkswagen GTI.....	10,800
Dodge Daytona ES Turbo.....	13,700	Nissan Maxima SE.....	18,749	Volkswagen Jetta GLI.....	14,555
Dodge Colt Vista.....	13,906	Nissan 300ZX Turbo.....	33,000	Volkswagen Corrado.....	17,990
Eagle Premier ES.....	17,845	Oldsmobile Cutlass Calais SL.....	14,015	Volkswagen Passat GL.....	14,770
Eagle Talon TSi Turbo.....	15,613	Oldsmobile Cutlass Supreme Intl.....	17,995	Volvo 240-DL.....	18,450
Ferrari Testarossa.....	150,600	Oldsmobile 88 Royale.....	15,995	Volvo 780.....	38,735

Source: Automotive News 12/18/89, "Pricing the '90 Models"



Isn't your car worth the extra protection?



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Rich. But not expensive.

DETROIT SPY REPORT

(Continued from page 22)

luxury sedans now on the market, including a multivalve V8 engine, rear-wheel drive, traction control and adjustable ride firmness.

Olds' Flagship

Move over Toronado, Olds is planning a top-of-the-line sedan for 1993 that will be a near rival to Seville in luxury and technical advances. First of all, it will have its own styling—a near copy of the Lexus and Infiniti. Front-wheel drive and a multivalve V6 engine will be borrowed from the Olds 98 line as GM's investment in a first-rate drivetrain for its full-size cars continues to pay dividends. As yet unnamed, early design studies of the car have carried Aerotech badges. Differences like V6 engine and optional traction control will make this model a few thousand dollars less in price than the Seville.

Hot Capri

Mercury's 2-seat Capri convertible is at least a year overdue in showrooms, and some of the delay can be traced to an extended testing program. Ford engineers found that the aluminum housing atop the floor-mounted shifter tended to soften from heat that developed on long

trips. The solution: Install an insulating blanket between the transmission and floorpan. Ford expects that the Capri will compete against Mazda's highly successful Miata.

Russians Are Coming

Fiat's latest hookup with the Soviet Union will mean that ultralow-cost Russian cars will be streaming on to European markets. Fiat has a joint venture with the Russians to produce a 3-cylinder minicoupe, the size of the Uno, that will be sold both inside Russia and shipped to the West. Among details of the agreement, Fiat will establish a much-needed service chain in the Soviet Union, while the Russians must ship cars that are competitive in quality with those built in Western Europe. Fiat will buy 70-90,000 of the cars from a new 300,000 annual output plant at Yelabuga in the Soviet Union and sell them wherever. Port-of-entry price of the cars is estimated at \$2700. That means the 3-door coupes could retail for under \$5000 at the dealer.

Camaro/Firebird Green Light

General Motors has finally given the go-ahead notice for production of the 1993 F-cars, Camaro and Firebird ("Detroit Spy Report," page 24, Dec. '89). The

front-engine, rear-drive coupes will be radically restyled, and offer a lighter weight chassis in a smaller package. Look for a hybrid body with both plastic and metal panels, better to keep weight down and improve fuel economy. Questions remain about the type of engine planned. Best guesses are that a high-performance, multivalve V6 will be the option and a 3.1-liter V6 will be standard. Because of fuel economy and weight goals, it is questionable whether a V8 will continue to be offered. Styling cues from the current models will be continued even though the cars are totally redesigned. Camaro will have recessed headlights, though they will be about half the size of current lamps. Firebird will carry over its hidden headlight style, with the trademark Pontiac split grille set below the main bumper bar.

Antilock Standard?

A massive cold-weather testing program by Kelsey-Hayes, a brake system supplier to the auto industry, on ice-covered lakes in northern Minnesota last winter, could be the tipoff to the future of antilock brakes for light trucks. K-H assembled a fleet of pickups, vans, utility vehicles and even an Italian car at a frigid resort for three months of antilock testing and demonstrations. A regular network of roadways crisscross the lake. They lead to a cleared ice area that appears half a mile long by several hundred yards wide. On this surface, antilock testing goes on continuously during the day. At night, snow plows clean and scrape the icy surface smooth. Testers who drive the vehicles there claim that 2-wheel antilock may become standard on light trucks within five years. Four-wheel antilock is seen as an option on even the lowest priced commercial vehicles. Demonstration and testing vehicles there include S-10 Blazer, Isuzu Trooper, Explorer, Dodge van, Ford stake truck and a Lancia Thema. K-H hopes to be one of the main suppliers of new antilock systems to the auto companies in the coming years.

Taurus Town Car?

That seems to be the design Ford has settled on for its 1992 restyling of the Ford Crown Victoria. Its aerodynamic shape looks much like the Taurus and features a slit opening in the sheetmetal up front for the grille, and notchback trunk profile at the rear. However, the hoodline is longer and higher than that of the Taurus, more akin to the hood on the Town Car. The result is a modern design of classic proportions, which is somewhat stately in overall appearance. Now Detroit observers are wondering whether this Taurus/Town Car hybrid will outshine (outsell) the new Chevy Caprice, a car with distinctly different styling.

FM

No Matter Who Cuts The Grass, There's Just One Way To Cut It.



The minute you take the driver's seat of the new Cub Cadet Riding Mower you feel the confidence that comes from a stable, low center of gravity.

No other riding mower is built as ruggedly as this Cub Cadet. The cast-iron front axle can take the bumps. Yet, with extra large 12" x 5" front tires, you almost float across your lawn!

Mowing around trees and shrubs is no problem with this Rider's tight 15" turning radius. You don't even need to shift gears in a sharp turn. Just press the pedal down part way and the "Continuously Variable Transmission" (CVT) eases you through the turn smoothly.

What's more, with a headlight, you can finish mowing even if you get a late start. So down through dusk, no matter who does the mowing, Cub Cadet's the way to cut it.



P.O. Box 360930
Cleveland, Ohio 44136

Tough Riders For Your Little Corner Of The World.

ELECTRONICS

BY FRANK VIZARD, Electronics Editor



Dial The Future Now

IF YOU'RE curious about the type of phone you may be using in the next few years, then take a look at PhoneMate's ADAM. All future telephones may not look like ADAM, but they'll be very similar in operation.

ADAM stands for All-Digital Answering Machine. As you might expect, it's the all-digital aspect of the phone that makes it interesting.

ADAM is the first telephone answering machine to use the digital signal processing now used in voice mail computer systems. Instead of recording an incoming message on tape, ADAM's digital signal processing circuitry converts voice information into a series of signals. These signals are compressed into a complex computer algorithm and stored in memory. When you want to play back a message, the signals are retrieved

from memory and reconstructed into the original voice patterns.

Digital signal processing lets you manipulate messages like never before. Messages can be scanned at a speed 30 percent faster than normal or slowly reviewed at a speed 30 percent slower than normal. Either way, messages are understandable. There's also a search function to access messages quickly.

It talks back

ADAM also allows you to skip, repeat and save individual messages. For example, you can save the second and fourth message while erasing the others at the touch of a button. ADAM audibly confirms your intentions with responses like, "I will save message 3."

ADAM doesn't allow you to record as many messages

as tape-based devices. Memory capacity is 20 minutes. Additional memory of about 5 minutes should soon be available as an option; a slot on the underside of the machine will accommodate it.

ADAM's 20 minutes of recording time translates into about 12 to 14 messages on average. Heavy users will be happy to know that ADAM can be operated remotely from another phone so that messages can be erased.

You can also use ADAM to listen in on your office or home. Pressing 6 activates a microphone in ADAM for 15 seconds at a clip.

ADAM is surprisingly lightweight, but sits broadly on a tabletop for a solid feel. A large display makes operation easy. The number of messages, the time, the dialed number and other machine functions all appear on the display. Cosmetically, ADAM draws both cute and ugly responses, making it the

telecommunications equivalent of a Cabbage Patch doll. Buttons rather than rubber slashes might improve its looks and make dialing somewhat easier.

Other features include message transfer to another phone and a 3-digit security code. There's also on-hook dialing, a feature that would make more sense if there was a speakerphone. All-in-all, though, ADAM is a version of the future you can live with. The list price for this phone is \$299.

Caller ID

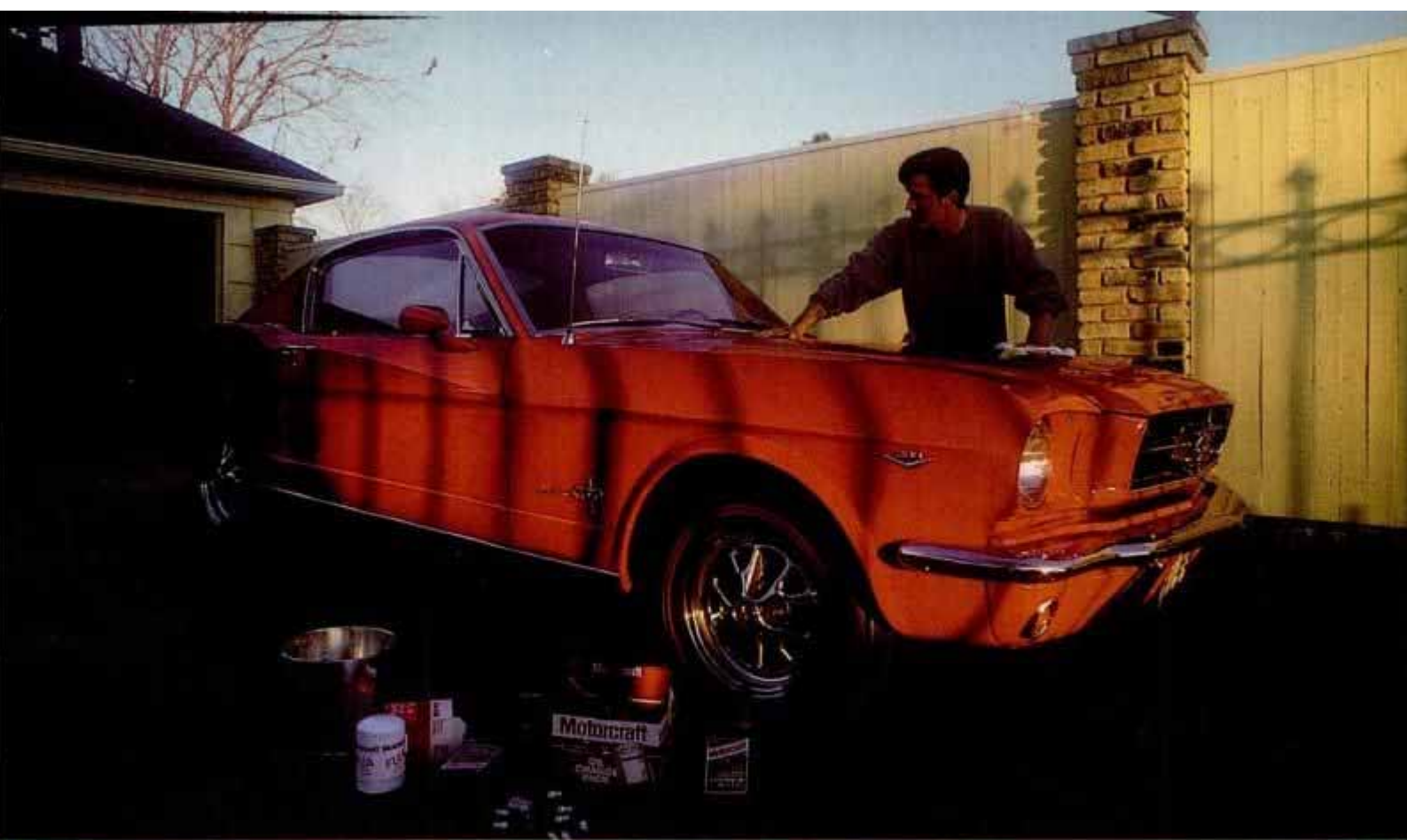
More problematic for some, however, is a new telephone from Northern Telecom. Called Maestro, the phone is the first to include a display that shows the incoming telephone numbers of callers.

Northern Telecom, which builds phones for a number of telephone operating systems, says consumers want to know who is calling them and they want the ability to decide which call to answer. Caller ID would put an end to crank calls as well.

Critics maintain that the Caller ID feature is an invasion of the caller's privacy. Caller ID could be used by businesses to discriminate against callers from certain areas. The latter seems more likely than the former and outweighs the elimination of crank calls. The issue seems destined to be decided in Congress or in the courts, however.

On another front, Canon is linking the telephone and the computer in a product called the Navigator. Listing for \$2995, the Navigator combines a telephone, answering machine and personal computer with a display panel

(Please turn to page 28)



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There's a full line of Motorcraft Quality Parts for Ford, Lincoln, and Mercury, as well as other makes of cars and trucks.

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Motorcraft 

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The Maestro is the first phone to show the incoming numbers of callers.

that serves as a touch-sensitive control panel.

Phone numbers stored on a floppy disk can be put into the Navigator and displayed on the screen. Touching the desired number on the screen makes the call. Fax transmissions can be made the same way. Computer memory is 640 KB. The machine also features a dual, 3.5-in. floppy disk drive.

Given the inclusion of modems in personal computers, it seems a natural step

to include the phone in the computer chassis. The touch-sensitive screen promises ease of operation as well.

AT&T, meanwhile, is offering a residential system that allows telephones to be used as pagers and intercoms within the house. The Intercom Speakerphone system uses one master phone and up to five extension telephones. Users can page any or all extensions at the touch of a key. Each telephone comes with its own built-in speaker so that the system works as an intercom as well. Other phones can connect to the system, but they won't have access to the intercom feature.

The master phone and an extension are packaged together for a list price of \$300. Additional extensions are available for a list price of \$150 each.

Pocket dialing

Lastly, cellular phone users should note that Motorola is debuting a stripped-down version of its tiny Micro Tac. Like the Micro Tac, the PT-500 is only 7 in. long when in use and 5½ in. folded. The PT-500 has less memory than the Micro Tac (see "Electronics," page 52, Oct. '89), and is devoid of some convenience features. The PT-500 lists for \$1395, less than half the original cost of the Micro Tac. The low cost of the PT-500



Navigator marries phone, answering machine and computer with touch screen.

means a pocket-sized personal phone is now that much more affordable.

New TVs, Old Names

The Mighty Monarch of the Air flies again with the resurrection of the Majestic brand name for television. Joining Majestic in its new-found life is Crosley, another brand from a generation ago.

Both the Majestic and Crosley names are being used by two different companies with the same idea. The idea is to offer televisions and other products in markets largely deserted by the big TV companies. Both brand names haven't been seen in decades. Majestic, for example, first appeared in 1936, but hasn't been used with TV since the '50s.

Majestic, once advertised as the Mighty Monarch of the Air, plans to initially market a line of 11 televisions, including five consoles, ranging in size from 20 to 27 in. and priced between \$500 and \$870 list. Majestic is owned by D&H Distributors, a former RCA distributor based in Maryland.

Crosley, a company formed by 40 independent television distributors, is ambitiously offering a wide range of video and audio products. The Crosley gear is made by Philips while the Majestic TVs are produced by Wells-Gardner of Chicago. American interest in TV manufacturing appears to be rekindling.

Skinny Light

If you need to get a little light into some tiny, dark recess, you might try a new lighting device by Willow Bend Co.

Willow Bend makes what it calls the IC-3 fiberoptic inspection adapter. The IC-3 is a slender monofilament optical-grade fiber which attaches like a wand to the head of a Mini-Mag flashlight. The fiber provides a high-intensity, cold illumination with 90 percent efficiency at 10 meters. The fiber itself is only 2 mm or .079 in. in diameter and it's available in a variety of lengths. The IC-3's small size allows you to poke your nose into places you wouldn't see into normally.

The IC-3 is available only from the manufacturer for a list price of \$14.95. Willow Bend is located at P.O. Box 203, Chelmsford, MA 01824.

PM

Power Klean™ Blasts Dirt Away Without Scrubbing.

18 Times More Powerful Than A Garden Hose, and Uses 75% Less Water.

Power Klean™ is a high pressure washer system that will quickly and easily wash and wax vehicles, degrease engines and prep surfaces for painting. A wide variety of kits and accessories make it the most versatile washer ever made.

High Pressure Washer System

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BEL CREATES A LEGEND



BEL LEGEND 3
Model 966
Actual Size

FMT®: Unequaled Sensitivity

To duplicate LEGEND 3's X, K, and Ka sensitivity levels, existing technology would require three separate radar detectors, each specifically designed to receive only one radar frequency.



Current radar detector designs use a harmonic of the fundamental mixer to detect K and Ka band radar. This significantly reduces sensitivity on these radar frequencies.



For maximum sensitivity, LEGEND 3 detects X, K, and Ka band radar using a fundamental mixer response for each of these radar frequencies.

Revolutionary New 3 Band Radar Detection

BEL-TRONICS, the pioneer of 3 band technology, introduces LEGEND 3: a new radar detector offering unsurpassed detection range for X, K, and Ka band radar.

LEGEND 3's revolutionary performance is achieved through a patented design called FMT® (Fundamental Mixer Technology). FMT® redefines how a detector processes X, K, and Ka band radar. With FMT®, LEGEND 3 provides a level of sensitivity never before achieved.

LEGEND 3 also breaks new ground in terms of selectivity. An advanced signal processing technique known as RSV® (Radar Signal Verification) automatically eliminates Intermediate Frequency (IF) interference—the most common source of false alerts. With RSV®, LEGEND 3 sets a new standard for selectivity.

Unmatched in sensitivity and selectivity, LEGEND 3 reflects a commitment to detail, quality and innovative thinking. And LEGEND 3's refined and convenient features make it unlike any radar detector ever designed.

Revolutionary 3 band performance is available today for \$379.95. And backed by a 3 year limited warranty. To order or for the name of a dealer near you, call toll-free:

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Join RADAR and protect your right to use a radar detector. For more information call (513) 667-5472.

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BEL-TRONICS LIMITED
The Intelligent Choice

IMPORTS

BY RICK TITUS, West Coast Editor



The Scoop On Scoupe

A THIRD MODEL is joining the Hyundai lineup for 1990. The all-new Scoupe will be here in July to fit as a midline model between the base-level Excel and high-end Sonata. Billed as a 2+2, the Scoupe is cleanly styled with clear family lineage. Powered by a 1.5-liter, electronically fuel-injected, sohc, 4-cylinder engine, the Scoupe can be had with either a 5-speed manual or a 4-speed automatic transmission. Typical Hyundai features like rack-and-pinion steering, power-assisted ventilated front disc brakes and front antisway bar will be standard. In the LS trim

level, feature appointments will include power windows, dual remote mirrors and a 4-speaker AM/FM stereo cassette. The option list is equally well loaded. Air conditioning, rear spoiler, sunroof, alloy wheels, 2-tone paint, cruise control and the usual litany of sound-system upgrades. Hyundai wasn't talking at press time, but best guesstimates would put the Scoupe's base price at about \$8300, with a fully loaded LS cranking \$11,000.

Lotus Gets Noticed

With all the talk about how much like the old Lotus Elan

the new Mazda Miata is, it shouldn't be too surprising that the new Lotus Elan is a lot like the Miata—only better. And for \$34,000 it had better be! Built as the first front-wheel-drive Lotus in the company's 41-year history, the new Elan's lines have

nation should give the car outstanding torsional rigidity. Four-wheel independent suspension, large (for vehicle weight) 10-in. front and 9.3-in. rear disc brakes and 205/50ZR15 Michelin tires should permit the Elan to achieve the company's handling claims of "near race-carlike performance."

Bimmer's A Beauty

Just when we figured it doesn't get any prettier than this, BMW introduces the 635CSi replacement, the all-new 850i. A sneak-peek of a prototype ("Imports," page 40, Jan. '89) showed that it's definitely prettier. BMW is pulling no punches with the 850i, and has squarely aimed



Lotus Elan is said to deliver "near race-carlike performance."

not been a secret. A right-on artist's concept was seen in "Imports" in July '88 (page 26). The roadster is powered by a 165-hp, 1.6-liter, twin-cam, 16-valve, turbocharged and intercooled, 4-cylinder engine—built by Isuzu and tweaked by Lotus. The current Elan started on a clean-sheet-of-paper, from a design and engineering standpoint, but is based on the same thinking that the company's founder, Colin Chapman, designed into the original Elan. A mild-steel, backbone chassis has outriggers supporting a Vacuum Assisted Resin Injected (VARI) composite floorpan and body panels. The combi-

it at the high end of the sports-sedan market. Priced at \$73,600, not including a \$1000 gas guzzler tax, the newest Bimmer is not for the faint of heart or weak of wallet. It is, however, for those who expect the absolute state of the art in automotive engineering and creature comfort.

The 850i's 300-hp, sohc, V12 engine has 332 lb.-ft. of torque and pulls for the Moon like a note from an opera star's throat. Balance, ride, power, braking and comfort, not to mention styling, have been addressed with the goal in mind of setting new standards in the sport/luxury field.

PM



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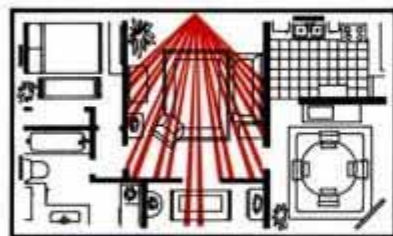
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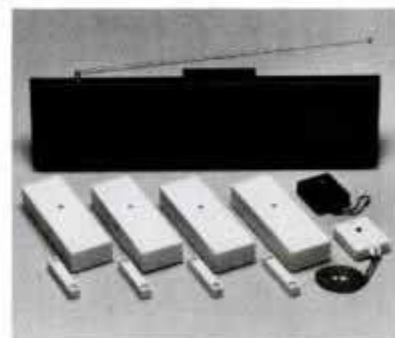
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SCIENCE

BY ABE DANE, Science/Technology Editor

FRANKLIN INSTITUTE/TECH-HISTORICHER RANSOM PHOTO



Museums For The Future

I'LL BE HONEST. A lot of museums put me to sleep. Except for the kind where you can push buttons and watch things move around, or otherwise tinker with the exhibits. Those are fun. Maybe that makes me childish, but if so, it's a kind of childishness that's sweeping the country. More and more science museums are finding ways to get visitors involved with their exhibits, and business is booming. Attendance is higher, and more new facilities are being built than at any time since the 1960s, when the *Sputnik* scare gave new urgency to science education. It's a heartening contrast to continuing reports of America's poor level of technological literacy compared to our economic competitors.

Most of the museums now springing up don't really fit the usual definition. Referred to typically as science centers, they place a heavy emphasis on teaching about science and technology, rather than simply serving as

historical archives.

One of the most notable new examples is the \$71-million Futures Center shown in the architect's model above. Opening this May at Philadelphia's Franklin Institute, the oldest hands-on science museum in the country, the 90,000-sq.-ft. complex of theaters and interactive exhibits is dedicated to illustrating technology's power to shape the future, and the choices that that power will oblige us to make.

Seven permanent exhibits



Giant keyboard is assembled for walk-through computer.

will focus on the potential impact of science on space exploration, health, energy, the environment, information technology, materials and lifestyle. Among the items on display will be a 37-ft. walk-through mockup of Space Station *Freedom*, a giant model of a living cell, a simulated rain forest ecosystem and a scanning electron microscope visitors can look through to examine advanced materials.

An eighth exhibit, called *The Future and You*, will give visitors an overview and explanation of the museum

as a whole. Along with the introduction, visitors get cards that identify them to a computer system with terminals in each exhibit. After providing the computer with a profile of themselves and their interests, guests carry the cards with them, and check in at the terminals for suggestions about what to see, and followup information on a variety of science topics.

Choosing the future

Rather than presenting a single vision of a future high-tech wonderland, the overall aim of the exhibits is to demonstrate the multiplicity of alternate worlds that technology might bring. Driving this point home is a 150-seat auditorium called the Future Choices Forum. Each seat is equipped with a computer-



The trackball that will control the walk-through computer.

ized voting station that will let visitors respond to presentations that highlight the dilemmas we will face as our ability to manipulate nature steadily increases. Results of the votes will be projected on a large screen at the front of the auditorium and circulated to policymakers in Washington.

For many, however, the most important decision that the Futures Center can help with is the choice of a profession. The Future Careers

COMPUTER MUSEUM/MICHAEL SHACKLEFORD PHOTO

Center will give access to resources that go far beyond what the typical school guidance office can muster. Central to the facility is an electronic version of a *Help Wanted* section from a typical 21st century newspaper. Visitors push buttons to pick ads and get a look at the accompanying job descriptions, education and experience requirements, starting and average salaries, and the number of jobs expected to be available in the selected field.

Behind the scenes

How do you design a museum to achieve all the ambitious educational goals that the Futures Center sets for itself? Speaking to Bill Booth, vice president for exhibits at the Franklin Institute, I got the sense that like any form of teaching, coming up with exhibits is as much art as science. But it also presents challenges all its own. Unlike textbook lessons, the unstructured learning that happens in a museum is nearly impossible to measure or predict. In a process Booth calls random access learning, people choose their own paths through the information made available to them, much as they do in the real world. As a result, the usual methods of quizzing people to gauge what they've taken away from the experience aren't really appropriate.

Typical ways of evaluating an exhibit include videotaping people's interaction with it, and questioning them on the concepts it's intended to convey afterward. Admittedly, such methods are imprecise, but they pick up basic flaws in a presentation. For example, surveys found that a common misconception among visitors to the Franklin Institute was that gravity was caused by air pressure. Exhibits that suggested otherwise were simply assumed to be broken. Booth's group responded by designing an exhibit that let visitors pump the air out of a cylinder and see for themselves that gravity still applied.

Over years of observation, it has been possible to extract some general principles to guide the design of exhibits. One thing that needs to be taken into account is the fact that people approach things with a variety of different learning styles. According to Booth, some like to talk, some like to interact with an object, and others prefer a more passive approach like watching a video. Ideally, an exhibit will present opportunities for all these activities.

It's also a good idea to gear an exhibit to accommodate mixed age groups, such as families. According to Bonnie Vandorn, executive director of the Association of Science-Technology Centers in Washington, D.C., such groups learn together more efficiently than groups of people who are alike. And it's not al-

ways the old teaching the young. Often, for example, a child will eagerly push buttons or manipulate an object in a way that yields surprises for adults who would have taken a more deliberate approach.

Perhaps the most basic principle of all is one that hardly needs restating in this magazine. As Booth puts it, "People like to learn by doing."

Boston's giant computer

One of the grander examples of how these common-sense educational ideas can be embraced in a single exhibit is a huge walk-through computer scheduled to open this June at The Computer Museum in Boston. Scaled up to 20 times normal size, the \$1.2-million machine will incorporate a 25-ft. keyboard you step on to operate, a working, 5-ft.-high trackball and a 108-sq.-ft. monitor that displays the operation of a custom-designed hypercard program.

Aside from the sheer impact of its size, the exhibit promises to make computers understandable in a way that has up to now been maddeningly elusive to most people. Walking inside the machine reveals the network of components that makes these inscrutable boxes tick. The floor makes up the motherboard, complete with rows of memory chips and vertical expansion cards. At its center are the microprocessor brain and the clock that synchronizes the activities of all the different parts. Thrusting back from the front panel are a floppy drive and a spinning hard disk platter. Pulsing light fibers simulate connecting cables, and show how signals travel through the machine as visitors work the giant controls outside. Many of the components are equipped with viewports that let you see their inner workings right down to the most basic level. Interactive computer stations placed around the exhibit provide supplementary information.

Learning versus fun?

Certainly it's possible for people to understand technology without access to giant computers or \$71-million museums. But the benefits of exposure to these carefully selected experiences should not be underestimated. "There's an incredible need to make the more symbolic things that happen in classes have a more concrete basis," says Vandorn. Abstract concepts are fragile and easily forgotten without a compelling illustration in one's own personal experience. And although the museums that put this idea into practice may seem a departure from tradition, the way they teach science is actually much more in tune with the experimental principles on which the practice of science has been based from the beginning. **PM**

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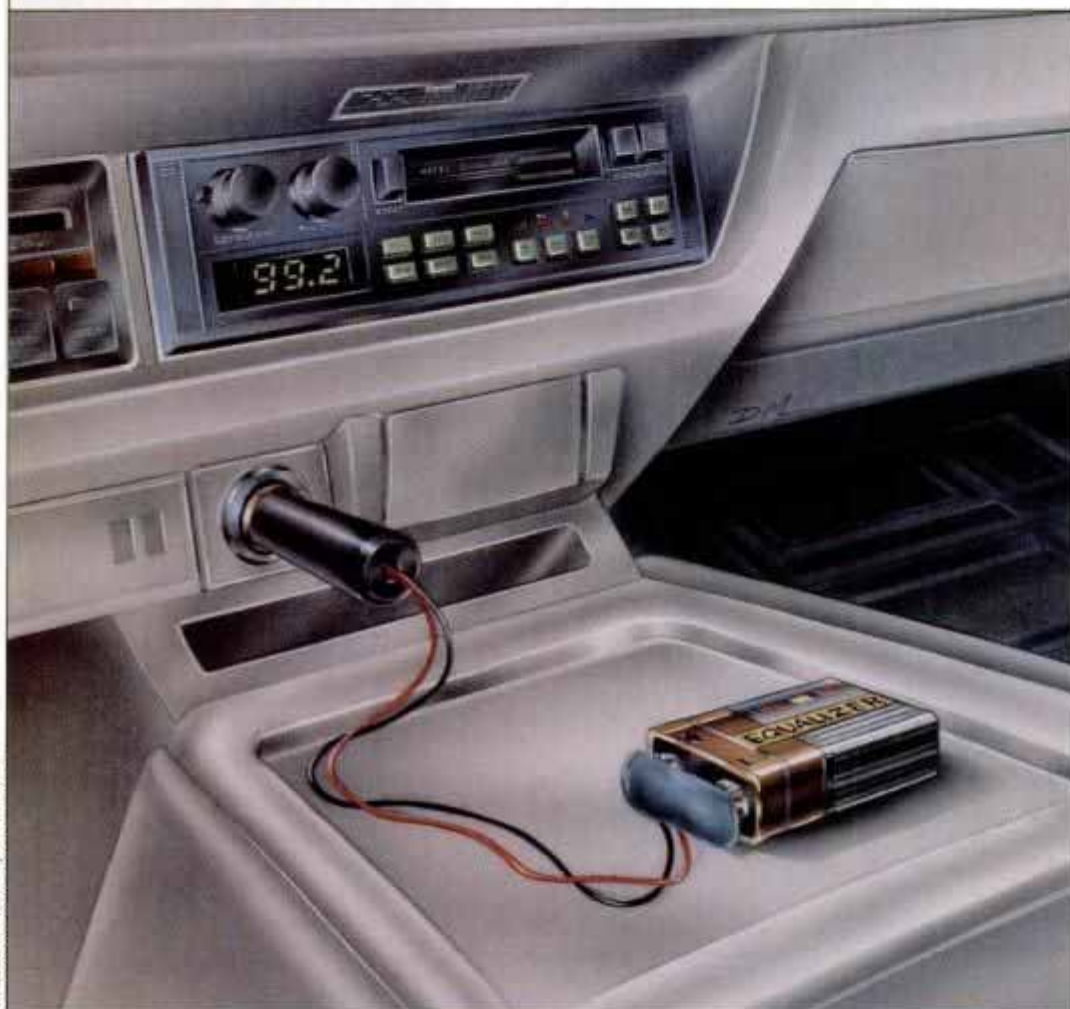
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CAR CLINIC

BY MIKE ALLEN, Assistant Auto Editor



PM ILLUSTRATION BY DON MANNES

on the radio are stored in computer memory—which disappears until you reprogram them manually.

Next time you need to remove a battery, try this trick: Use a 9V transistor radio battery to supply the small amount of voltage necessary to keep the memory alive. I've shown a cigar lighter plug and a snap connector attached to a battery, but you could use clip leads. Just be sure to get the negative side of the battery connected to ground. This will only work as illustrated if the cigar lighter works when the key is OFF—otherwise the battery will have to be clipped across some circuit that is electrically hot full-time.

Battery Puzzle

Several readers have written in about the illustration in the February "Car Clinic" (page 22) wondering why the second battery doesn't make the starter motor run all the time. Several have suggested that a switch could have been used to cut the second battery in or out, or that a battery isolator might be used to prevent a problem.

In the text, we refer to the fact that the starter motor won't run until the ignition switch (which, for the sake of simplicity, isn't illustrated) is turned. The lead from the second, auxiliary battery should be connected to the post on the starter (or as I mentioned twice in the text, external starter solenoid if one is used) where the original factory positive lead is attached. Also mentioned in the text is the use of a high-current switch which shouldn't be confused with the ignition switch.

Readers who suggested the use of a battery isolator (Please turn to page 44)

Memory Needs A Jolt

I'M HAVING a lot of trouble with the battery in my Cavalier. I finally decided to spring for a new battery even though the old one is only three years old.

I've had to borrow a battery from my wife's car to get to work, and every time I remove the battery and install a different one—including the last time with the new battery—the car acts very weird, running poorly and with thick black smoke for a few blocks. Also, all the preset radio stations on the radio seem to reset.

I not only don't understand how a bad battery can do this to my car—but now my wife's

car does exactly the same thing after I replace the battery! Is this one of those computer viruses? Is it safe to drive? Is the battery in my wife's car going to die soon?

LEROY THOMPSON
MEMPHIS, TN

There's nothing wrong with your wife's car. There's probably not anything wrong with your car, assuming the charging system isn't killing the battery by overcharging or undercharging it. Three years is a little premature, but certainly within normal limits for a modern light-duty battery. For instance, just leaving the lights on over-

night once or twice can take a lot off the life of the battery.

The bizarre behavior of the engine is entirely normal for a computer-fuel-injected vehicle that's had the battery disconnected for any length of time. The engine computer stores a number of parameters in its memory, which it will promptly forget if there's no voltage.

Those parameters will be relearned within a few miles—but the computer uses permanently stored default values until then. The defaults are fail-safe—and run the engine very rich and with retarded spark timing to prevent engine damage from detonation.

Additionally, the presets

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CAR CLINIC (Continued from page 42)

should refer to Illustration 3, and then the last paragraph of our reply, which discusses a battery isolator.

Several other readers make points. For example, Ford starter solenoids are not intended for continuous-duty use (although I've had one in service on my pickup for 12 years in the fashion I recommend), and may not be as long-lived as an identical-appearing, continuous-duty solenoid available from several manufacturers. Standard Blue Streak is one. Almost any high-current relay rated for continuous-duty should work, regardless of its appearance.

More Dear Than Premium

I recently drove my diesel car to Seattle, where the cost of diesel fuel was 10 to 25 cents more than unleaded regular—and often more than premium. I thought diesel was cheaper to make than gasoline.

JOE PIFER
SPRING VALLEY, CA

Diesel fuel contains more heat energy per gallon than gasoline—so it gives slightly better miles per gallon. But it comes from the same barrel of crude oil as gasoline and household heating oil. The percentages of each of those can be

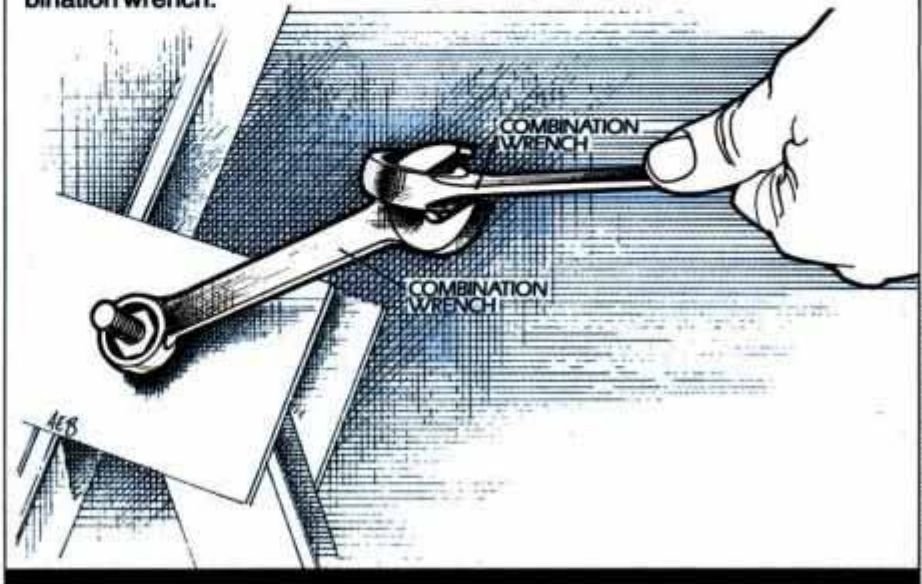
Combination Leverage

It's pretty easy to get more torque onto a bolt when there's a socket over the head—just use a longer ratchet. If that doesn't give you enough leverage, use a piece of pipe slipped over the end of a breaker bar or flex handle.



Yes, I know it's risky. I've broken a couple of ratchets cheating like this. But sometimes you just have to put on your safety glasses and get the job done.

But, what do you do when there's no way to get a socket over the bolt head? Simple. Just hook the box end of another wrench over the prongs of a combination wrench.



PM ILLUSTRATION BY ADOLPHE BROTMAN



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changed somewhat at the refinery, depending somewhat on the particular grade of crude oil being refined.

The price of diesel fuel is consequently more dependent on supply-and-demand than considerations like manufacturing cost or value.

Bolt From The Blue

I've always reused parts that had good life left in them.

When rebuilding an '82 Ford 4-cylinder motor, the instructions with the gasket set said, "Never under any circumstances reuse the old head bolts." Why?

They specify torquing new bolts to 44 lb.-ft., then tightening an additional half turn in quarter-turn increments. They ended at about 60 lb.-ft. Why not just 60 lb.-ft. and be done with it? What grade of bolts are these?

EARNES DUBECT
MASSILON, OH

A lot of modern engines specify this torque-plus-angle method of tightening head bolts. In order to ensure positive clamping at all temperatures and over the life of the engine, the head bolts are designed to stretch somewhat as they come down to their final tightness. During this yielding phase, the

torque you read at the handle of your torque wrench doesn't accurately reflect the stresses inside the bolt. Stretching work hardens the bolt—and the next time it will be too brittle to handle the strain.

These bolts are intended only for a specific application, and fall completely outside the normal "grades" that more common bolts are classified in. They're not necessarily stronger—they simply are designed to be the best possible head bolt.

Don't Wait, Metricate

Is Ford Motor Co. marking its thermostats in Celsius degrees rather than Fahrenheit? My '86 Ranger says 92°/106°, a new thermostat from Ford is stamped 92°.

J.C. McCLENDON
VICTORVILLE, CA

*Celsius it is. The American automotive industry went metric over 10 years ago. Virtually everything designed since then is metric. You'll find a lot of metric-sized parts on your Ranger. **PM***

DO YOU HAVE A CAR PROBLEM?

Just ask Mike about it. Mail your question to Car Clinic, Popular Mechanics, 224 W. 57th St., New York, NY 10019. While letters, faxes or phone calls cannot be answered individually, problems of general interest will be discussed in the column.

SERVICE TIPS

■ Cadillac TSB T-89-135 describes replacing the 1-2 band stop, preventing intermittent loss of drive in 1985 DeVille, Eldorado, Seville or Allanté models.

■ Installing 75mm oil filters, like the PC-40, PC-45, PC-47, PC-51, etc., must be done correctly. Lightly oil the gasket, and tighten a minimum of two-thirds turn after the gasket contacts the base. Run the engine 3 minutes and check for leaks. Buick TSB 89-6-13

■ Mazda TSB 054/89 recommends that all nonturbocharged Mazda engines be operated on regular unleaded gasoline. The lower volatility of super unleaded may cause overly lean conditions, manifesting as starting and driveability problems.

■ Early production 1989 Sentra and Pulsar XE vehicles may have the electrical harness to the starter positioned too close to the EGR valve, resulting in heat damage to the wires and a no-start condition. TSB TS88-134

■ Fuel-injected cars may let the fuel pump run-on a few seconds after the engine is shut off, as the oil-pressure sensor may still see the 4 psi minimum that turns the pump on. This is most likely when a cold engine has been run for only a short time. All fuel pumped during this period is returned to the tank, and no corrective action is necessary. Pontiac TSB 87-6(Gasoline)-63

You wish.

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OLD HOUSE RESTORATION

BY BOB VILA, Contributing Editor



ROBINSON IRON PHOTO

Period Lawn Ornaments

IT'S THAT TIME of year again when our thoughts and energies turn to the outdoors. If you're restoring a turn-of-the-century garden, now is a good time to think about adding that special finishing touch: a cast-iron lawn ornament.

This period addition can be as elaborate or simple as you like. The choices range from adding a simple urn or sundial to installing an ornate figured fountain. The choice is yours, and really depends on the garden you're re-creating and, of course, that all-important restoration budget.

Many original cast-iron

lawn ornaments were lost to the search for metal during both world wars. Fortunately, these period lawn decorations are still manufactured. In some cases, the same molds and patterns that were used to make these ornaments at the turn of the century are used today. Replicas of some of these old pieces are also manufactured in cast aluminum. And, for those of you who only want original turn-of-the-century pieces, there's always the antique shops and auctions or the salvage yard to search out just the right piece.

Re-creating gardens past

The right placement of the right lawn ornament can really set off an authentic restora-

tion. Knowing what was commonly used in turn-of-the-century gardens is the first step in this exterior restoration project. Sometimes, a little archeology work will turn up old footings or pieces of stone with an imprint of an urn base or other piece of statuary. This type of find can go a long way in helping you recreate what was originally there. If your search doesn't turn up much—or you don't like what you did find—the following guidelines should help you decide what should go where.

Many times, fountains are placed at the ends or crossing points of different paths. The dominant fixture, feature or focal point of the walkway, they are often surrounded by plant beds, forming a centerpiece for the garden area. If

Reproduction urn, like this cast model, makes a great addition to a garden restoration project.

the fountain also serves as a bird bath, it should be placed in a location where you and your guests can both see and enjoy it without scaring the birds away, like near a large window, porch or garden sitting area.

Common decorative fountain motifs include aquatic flora and fauna, like cranes and bitterns, bird-type figures shown wading in marsh grass, lilies and other water plants, frogs and turtles.

Urns, along with statuary-like whippets or lions, are often placed at either side of an entry or gate. Sundials should be placed where they can take advantage of the sun. Because of this, sundials are often found on the south side of an open terraced or lawn area. Low bedding plants may surround it as long as they don't obstruct the sun.

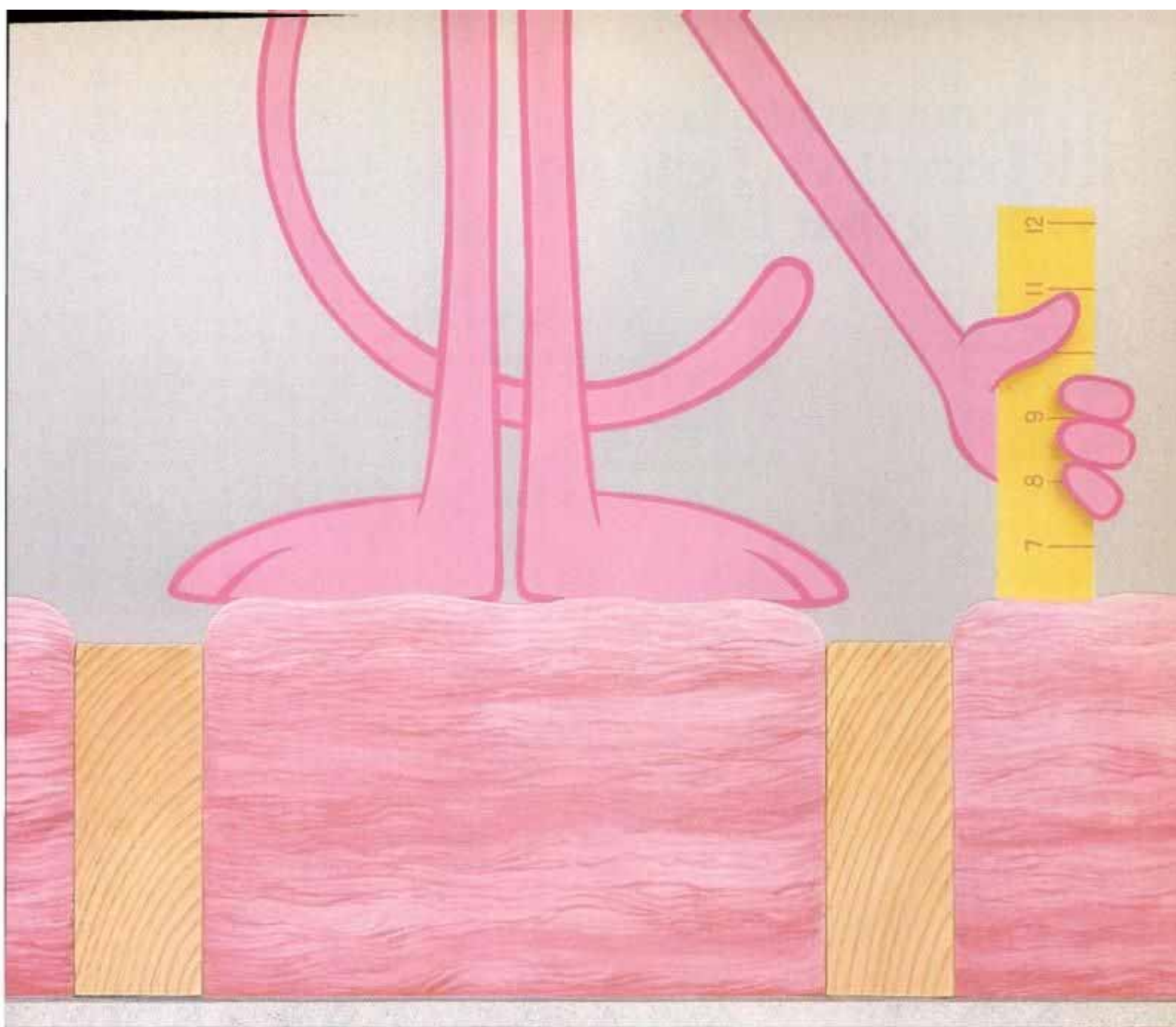
Today's cast iron

Many of the cast-iron ornaments manufactured today, like those from Robinson Iron, are based on well-documented patterns from original antique catalogs. The only difference in the way most of these pieces are currently made is that they are arc welded, rather than bolted, together. The reason is a simple one that is attributed to progress: Arc welding wasn't around years ago.

Other than that, the manufacturing process is the same. The pattern is packed in sand to create a mold and molten metal is then poured into it. After the casting is shaken out of the sand, it's ground smooth to remove any flashing or gating. Finally, the pieces are assembled and painted.

An exception to this is the
(Please turn to page 48)

Contributing Editor Bob Vila hosted public television's "This Old House" for 10 years.



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OLD HOUSE RESTORATION

(Continued from page 46)

manufacture of some statuary. Often based on Greek or Roman mythological figures, these pieces were originally made out of zinc alloy. This allowed them to be soldered together, rather than bolted, then smoothed with files for a nice clean seam. Today, they are either made out of iron or cast aluminum. The latter material, which is welded, more closely approximates zinc in both its lightness and its workability.

Cast aluminum is also used today in the manufacture of some of the other lawn

ornament reproductions we’ve talked about, including urns and hitching posts. Unlike cast iron, cast aluminum won’t rust. It’s a lighter, easier material to handle. And, ornamentation made from this material is less expensive than that made from cast iron. Once painted, it’s hard to tell the difference between a product made from cast aluminum and one that’s made from cast iron.

The salvage story

When only an original cast-iron relic will do, there’s always the salvage route. Of course, the stock in a salvage shop is constantly changing. But, with a little luck,

you can expect to find things like urns, statuary, perhaps a hitching post or two, and maybe even a fountain at any given time.

The main problem with salvaged pieces is the condition they are likely to be in after years of exposure to the weather. The most common problem with these cast-iron pieces is rust. Occasionally, a shop may sandblast a piece to remove rust, thus restoring it.

Another problem is missing pieces. Very few urns, in particular, survive the years with both handles intact. Many old fountains must have their bowls replaced before they can be of any use in today’s gardens. Years of holding water takes its toll on the iron. Sometimes, if a fountain was left uncovered in the winter, the expansion and contraction that naturally occur—when the water trapped in the bowl freezes and thaws—weakens the metal. And, of course, you must buy a new pump and run new copper piping before you can delight your family and friends to the sights and sounds of rushing, cascading water.

Depending on what you’re looking for, you may pay less for an old cast-iron lawn ornament than you would for a new reproduction. For example, if you want a fairly common, plain urn, perhaps one that only has a bit of fluting around the edges, an original may well be cheaper than a reproduction. On the other hand, the original of a more ornate urn with birds or other designs may cost more than a new reproduction because it’s a harder piece to find.

To give you an idea of what types of things you’re likely to find and at what prices, original old urns range from about \$400 to \$1500, depending on size, style and ornateness, at a leading salvage shop. At the low end, you’re looking at a fairly plain urn that’s about 24 in. off the ground; at the high end, you’re talking about an ornate urn with handles that’s about 5 ft. tall. A small, iron fountain about 3 ft. high with one figure and one bowl runs about \$3500.

Adding a lawn ornament to your turn-of-the-century garden will go a long way toward re-creating the feel of years past. Whether it’s a newly manufactured cast-iron reproduction, a cast-aluminum replica or an original salvaged piece, it can only enhance your restoration. **FM**

Source List

The following is a list of some suppliers of period lawn ornaments:

- Moultrie Manufacturing Co., P.O. Box 1179, Moultrie, GA 31776, (800) 841-8674
- Otto Wendt & Co., 417-A Gentry, Spring, TX 77373, (713) 288-8295
- Park Place, 2251 Wisconsin Ave. N.W., Washington, D.C. 20007, (202) 342-6294
- Robinson Iron, P.O. Box 1119, Robinson Rd., Alexander City, AL 35010, (205) 329-8486
- United House Wrecking Corp., 535 Hope St., Stamford, CT 06906, (203) 348-5371

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THE BEST MAN ORDERED GOLD.**

OUTDOORS

BY JOE SKORUPA, Boating/Outdoors Editor



ATVs: Perception And Reality

DURING A RECENT backcountry trip to the red-rock monuments of Arizona, I reacquainted myself with the usefulness of ATVs. I spent a week in off-road locations lugging around two vanloads of equipment and realized I couldn't have done it without the help of a motorized, all-terrain workhorse.

The location was the Cocino and Yavapai areas of the Mogollon Rim, which separates the low-altitude southern portion of the state from the high-plateau north. The landscape is ruggedly spectacular.

Sunrises and sunsets in this country are justly renowned and we saw both each day. We also saw a good

deal of the bright stars at night. I guess you could say we were busy.

What kept us on schedule was a pair of utility ATVs from Yamaha, the 250-cc YFM250 (\$3449) and 350-cc YFM350 (\$3749). These durable, go-anywhere 4-wheelers proved to be wonderful beasts of burden. We loaded up the front and rear carrying racks and clawed our way over boulder-studded trails, near-vertical inclines and rugged canyon walls. The ATVs exhibited marvelous maneuverability, traction and versatility. Most importantly, they saved us dozens of man-hours in the outback.

Can this be the same vehi-

cle I recently saw a national TV show call, "the vehicle Americans love to hate"? Is this the same vehicle that the respected *New York Times* (Dec. 30, 1989) headlined "All-Terrain Vehicles: Still A Safety Hazard"?

TV versus ATV

Recognize this television news script? A man behind a desk announces that ATVs are a threat to America's children. Cut to home video of a boy riding an ATV. The boy waves to the camera. The next instant the ATV tumbles end over end. Cut to interview with grieving parents. Cut to announcer citing ATV injury statistics. Lead into hidden-camera footage of ATV salesman promising to sell an ATV for use to an

obviously underage boy.

Nothing succeeds like success, and variations on this theme have run on local, national and cable newscasts for the past three years.

Are there factual errors? No. Are ATVs a subject of legitimate concern? Yes. Do reports like this help or hurt the situation? Despite certain misgivings, I must admit they help, because they raise the issue of responsibility, which is at the heart of the debate.

Who's responsible? Can a child be held responsible for committing an error while riding an ATV? The answer is definitely, No. In all levels of society, we separate children from adults in terms of responsibility. So who's responsible, parents of the child or distributors of ATVs? The answer is both.

Living dangerously

Statistically speaking, the most dangerous sport I've attempted was skydiving, although driving on the left side of the road in England was personally more frightening. If I had to pick between the two, I'd rather jump out of a plane. But this is a subjective response and what we need are hard numbers.

It was hard numbers that got ATVs into trouble with consumer groups in the mid-1980s. The result was a court action, called a consent decree, that banned sale of 3-wheel models, restricted sale of full-size units to youngsters, and compelled the industry to provide free driver training, among other provisions. (See "ATV Wheels Of Misfortune," page 26, May '88.)

It was also hard numbers that sparked current media attention. A monitoring

(Please turn to page 52)

agency recently announced that the number of ATV-related deaths has remained virtually unchanged, despite implementation of the 1988 agreement. Also, that a substantial number of ATV dealers fail to comply with the provisions of the consent decree. These figures were released by the Consumer Product Safety Commission (CPSC).

Final numbers aren't in yet for 1989, but it's projected that ATV-related deaths will total 299, the same number as in 1988. This is down from the all-time high in 1986, which was 351, but it's virtually unchanged from 1987, the year

before the consent decree.

Given less attention in recent reports is the fact that ATV-related injuries during the 1988-89 period showed a steep decline. Injuries were down from 77,400 in 1987 to a projected 56,000 in 1989. While this is attributed to driver training and awareness provisions of the consent decree, no one from the CPSC or the ATV Safety Institute could explain the unchanged rate.

The number of ATV dealers who take a buccaneer approach to the consent decree is a most disturbing revelation, because it could lead to further

restrictions. Working undercover last June, the CPSC found that 56 percent of 227 dealers were in violation of the consent decree. Only 59 percent of the dealers had attached the required hang tags to their ATVs and only 70 percent displayed the safety and warning posters.

Unfortunately for the ATV market, the yahoo spirit infects its ranks. This is true for dealers and users.

The leading causes for death and injury on ATVs are the following: riding double, children riding full-sized models, children riding without adult supervision, riders not wearing helmets, riders under the influence of drugs and alcohol, excessive speed and driving on paved roads.

I recently saw hidden-camera footage of a yahoo ATV dealer and a father who was shopping for a full-size ATV for his 15-year-old son. The dealer told the undercover investigator that the consent decree is a "formality and we can get around it."

Strangely enough, the dealer was telling the truth, because the consent decree applies only to distributors (Honda, Kawasaki, Suzuki, Yamaha and Polaris). It's up to these five companies to enforce the guidelines, and chief among them are rules regarding age—12 years and older for ATVs 70 cc to 90 cc, and 16 years and older for ATVs greater than 90 cc.

So we get back to the question: Who's responsible? The answer is the five ATV companies. Steps should be taken against any dealer who refuses to comply with the consent decree. These outlaws do their industry an injustice. Any company that doesn't investigate a flagrant offender and move toward his eventual termination deserves law suits that will inevitably follow.

But equally responsible is each and every ATV rider. If the rider isn't an adult, then the child's parents must be held responsible. ATVs aren't toys. They're heavy, motorized vehicles. They're operated in wilderness locations. They deserve a great deal of what my father calls respect.

No one of sense believes in statistics, of course, so I won't waste time arguing that ATVs are safer than using spray cans or taking baths. But I believe the new campaign on training and rider awareness will continue to bring down the number of injuries and, ultimately, deaths. (By the way, as with all POPULAR MECHANICS endeavors, we set an example by operating motorized vehicles legally, courteously and ethically.)

To me, responsibility is the catch word for the 1990s, especially regarding the two areas I care about most: children and wilderness. As adults, we must assume full responsibility for both or accept the consequences. **PM**

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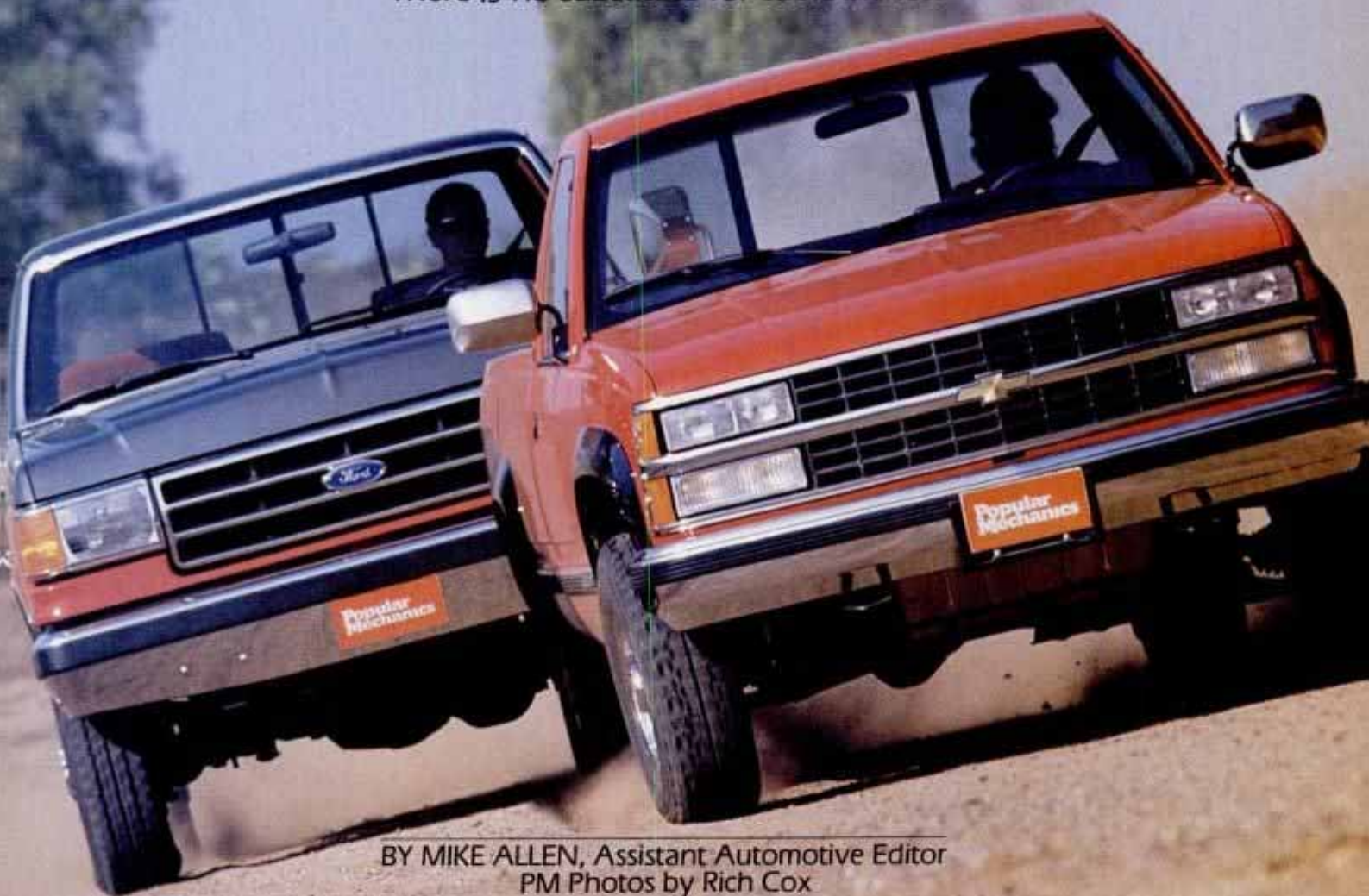
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HEAVY METAL HAULERS

There is no substitute for cubic inches.



BY MIKE ALLEN, Assistant Automotive Editor
PM Photos by Rich Cox

BIG-BLOCK V8s. They're still around, these dinosaurlike reminders of an era before OPEC, CAFE, NHTSA, DOT, CHS, EPA and a half-dozen other acronyms that have mandated downsized, more efficient modes of transportation. You have to look hard to find the big V8s these days as they're relegated to only one category of vehicle—big, nasty trucks. Ford and Chevy both now have over 7-liter mountain motors available in pickup trucks while Chrysler's big-block was last available in 1978, leaving just the bow tie and blue oval to battle it out in the big-inch wars.

What's the use?

Why does anybody *need* a truck with as much engine displacement as a beer keg? And a cargo box big enough to bury a Yugo inside? Obviously, these are working

trucks. These are vehicles to carry a plumber and all his tools through a slimy construction site excavation, or a farmer hauling a new gearbox out to the windmill in a spring-thaw field. These are the trucks that will carry a well-used 7-ft. snowplow blade all winter. And for the next 20 winters, too.

Performance here is measured by a different yardstick. Certainly not in quarter-mile times, which, from the test results, are rather leisurely. Handling? Skid-pad times are nothing to write home about, and they tell you nothing about how these trucks handle off the pavement. The slalom speeds are among the slowest we've ever recorded. Turning diameters, because of the 4-wheel-drive underpinnings and bowling-alley-long wheelbases, are wide enough to require an environmental impact statement. Skating through traffic isn't very easy, as the things are just too big—although, to

HEAVY METAL HAULERS

their justice, traffic does tend to part like the Red Sea in front of them. Fuel mileage is startlingly poor at around eight or 10 miles per gallon. This makes the out-of-pocket cost of operation over 10 cents per mile, which effectively eliminates these rides for daily commuting.

In short, you better *need* one of these monsters.

The real measure of this class of vehicles isn't how much fun they are to drive. In truth, they're *not* much fun to drive. What counts here are two things: the ability to get the job done, and the ability to absorb an incredible amount of abuse over a long lifetime.

So how do Chevrolet's K3500 with a 454 and Ford's F-250 with a 460 compare when put to the test?

Technically, an F-250 is a ¾-ton-rated truck, while our test Chevy was a 1-ton. The difference is a higher-

rated front axle and stiffer springs in the rear. We don't consider these differences to be significant for our test purposes, as virtually all other specifications were identical.

This is reflected in the 800-pound extra payload capacity that our test chart shows for the Chevy. Ford's F-350 version of this truck is more comparable in this category. Both Ford and Chevy have a bewildering array of drivetrain and equipment options available to let you order a truck that's rated closely with your needs. Both trucks were capable of carrying well over 2 tons of payload, which includes passengers, fuel, optional equipment and the contents of the box.

Three-quarter or 1-ton, there's only one real cargo rating on this kind of vehicle anyway—it's how much will stay in the bed without spilling over onto the roadway. And if you're hauling something substantial, like cinder blocks (42 pounds each), it's easy to overload almost any truck. Let your conscience be your guide.

Chevrolet K3500

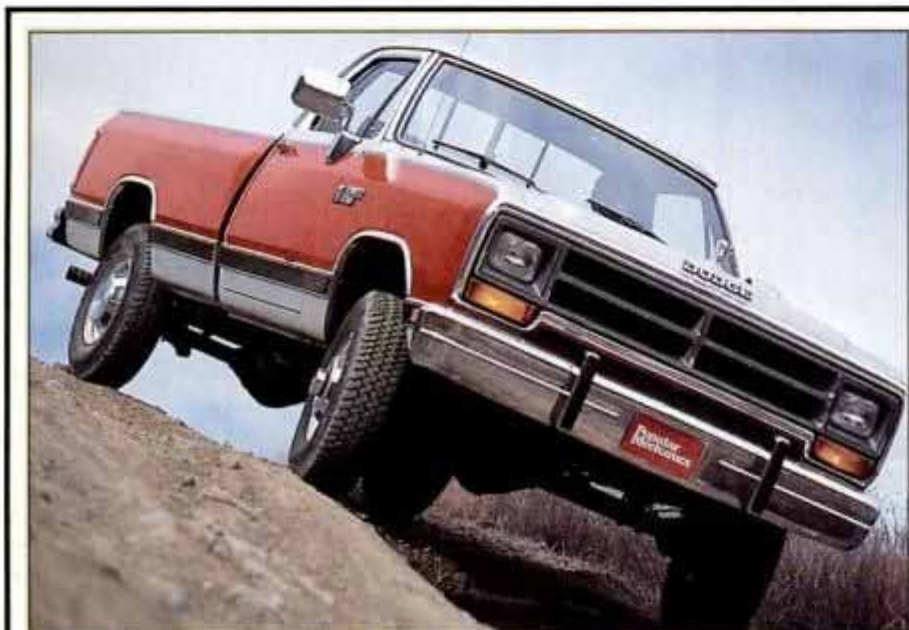
In spite of concerns about the deceptively diminutive throttle-body injector lost in space under the hood, the Chevy's 1990 version of its 454 V8 has 230 horsepower at a near-subterranean 3600 rpm. The term torque was invented to describe this engine, and indeed, it twists out 385 lb.-ft. at a tractorlike 1600 rpm.

We intended to test an automatic transmission Chevy, but what showed up on test day was a 4-speed. Actually, Chevrolet calls low gear LOW gear, and labels the next three: 1, 2 and 3. They're right. It's really a 3-speed trans, with LOW gear more suitable for pulling oceanliners up onto the beach at low tide. We did our acceleration runs, as well as around-town driving, ignoring LOW.

Frankly, in spite of the better mileage we got with the manual, the shifting was so difficult that we strongly recommend the automatic transmission. Acceleration times suffered from agonizingly slow shifts. This problem was also reflected by the relatively good 40- to 70-mph times laden, as there is only one shift required.

The only other complaint was the interior, especially the too-firm seating and the hard-to-read gauges. We never have gotten used to the adding-machine styling of the radio controls on GM cars—and their trucks.

The exterior is a little more flashy than the Ford, but we'll predict the spiffy urethane fender flares won't look nearly so neat after a few seasons of rough work.



Dodge's Full-Size Pickup

GIVEN THE NUMBER of Mopar loyalists among our readers, the obvious question is: Why wasn't the Dodge Ram pickup included in our comparison? Because, quite frankly, it wouldn't have been fair. The Dodge's 360-cu.-in., 170-hp V8 is just plain out-gunned by the larger-engined Ford and Chevy. However, as one of this country's leading work trucks, we didn't want to leave it out entirely.

Still regarded as one of the most bulletproof vehicles in a field filled with plenty of stout contenders, the Dodge Ram enters the 1990s tough as ever. Large in turning circle, firm in ride and short on appointments, the Ram pickup is best described as purpose-built. This is no Rhinestone Pickup.

However, our test truck, though slower in comparative acceleration tests, did show quite well in the slalom handling evaluations. In both unladen and 1000-pound-load tests, the Dodge Ram exhibited excellent corner point-in and stable transient demand behavior. Much to the Ram's credit, its

suspension design and tire package serve the handling well. Without the benefit of ballast, it managed to squeak in below 20 seconds at the strip, turning a 19.94 at 68.4 mph. More importantly, it was difficult to maintain pace with traffic on the freeway toward Mojave, requiring downshifting to keep the cruise control from dropping off-line.

As we attempted to ascend a 300-ft. knoll at 25° on a narrow, rut-filled, rock-infested, gravel-and-dirt fire lane, we gained ample insight as to our test truck's 4-wheel-drive capabilities. The Dodge Ram, which was carrying bags of salt, car batteries and test equipment, fared very well in these conditions, making even an inexperienced off-roader look good.

Though its external styling may be growing a little long in tooth, and the absence of some of its competitors' creature comforts put it in a somewhat uncompetitive posture, the Dodge Ram pickup remains a solid truck value. What it lacks in sizzle, it clearly makes up for in steak. —Rick Titus



One nice touch is the pockets in the sidewalls of the bed, intended for 2x6 timbers to lie across, permitting simple double-decking of cargo.

Ford F-250 HD 4x4

Ford's brawny 460 V8 was the recent recipient of a neat direct port fuel-injection system replete with shiny cast-alloy intake manifolds and other high-tech plumbing. Horsepower for 1990 is up to 230 at 3600 rpm and all those curves pump out 390 lb.-ft. of torque at 2200 rpm.

Also recent is the A40D automatic transmission, which uses a bank of electrical solenoids to replace a Byzantine maze of hydraulic controls. Shifting is governed by the same EEC IV electronic controller that

controls the fuel injection and ignition. The EEC IV compensates for a wide range of conditions from transmission load, up to and including wear in the clutches. And considering how brutal the shifting of the veteran C-6 could be on occasion, the A40D is a welcome improvement. How it holds up remains to be seen, but at least the solenoids are easily accessible if anything does go wrong.

Drag racing these monsters was a real education. There was enough torque to spin the tires most of the track. The Ford would gain enough wheelspin to make the trans shift into high gear, as the rear tires would be

spinning fast enough for the interstate. Then they'd hook up, promptly precipitating a downshift or two. Clearly, the best times were to be had by keeping the rubber hooked up and driving away from the light more carefully. Even with the Chevy's manual, a considerable amount of careful tap dancing on the pedals was necessary for consistent quarter-mile runs.

Meaningful testing

As we said earlier, we ran these trucks through our regular battery of performance tests although the test results were relatively meaningless in the context of how these vehicles are meant to be used. However, we did add some special test procedures that are meaningful.

Chevrolet 454 SS

SO FOR A SPLIT second there, you wanted a Z-28 Camaro. Something with style. A car that makes you feel good when you slide into the seat. A throttle pedal that does something more than lie there. A car you drive, not just ride in. Ah, but between work and keeping up the house, you gotta get a truck. There are tools to carry, tree limbs to haul, fences to build and the occasional off-road work to do.

Well pal, we've got good news for you. How about a vehicle that feels and acts like a Z-28, but works like a truck? A double throw-down, take-no-prisoners, fence-post-hauling machine that'll make you take the long way home.

We're talking about a truck with style. With seats that make you feel like you're bolted in and a throttle pedal that makes lots of stuff happen in the power department. It's called the 454 SS, and to quote Chevrolet, "It's a limited-edition, half-ton pickup that adds a bold new dimension to a growing segment of the market that some refer to as 'sporty' trucks."

Equipped with a 230-hp, 7.4-liter, electronically fuel-injected V8 that pro-



duces a hefty 385 lb.-ft. of torque, a 3-speed automatic transmission, a limited-slip 3.73 rear axle and a performance handling package, the 454 SS sets new pickup truck standards for hardware and performance levels. The standard features list reads heavy-duty radiator, engine and transmission oil coolers, Bilstein gas-filled shock absorbers, 32mm front stabilizer bar, 12.7-to-1 fast-ratio steering gear assembly, heavy-duty jounce bumpers and P275/60R15 B.F. Goodrich Radial T/A tires mounted on 15 x 7-in. styled chrome wheels.

Add to this air conditioning, high-back bucket seats with center console, an AM/FM stereo radio with cassette tape,

digital clock and graphic equalizer, power door locks and windows, sliding rear window, tilt steering wheel, electronic speed control, auxiliary lighting and special all-black 454 SS exterior appearance package, and you start to feel like you want to jump behind the wheel and start smoking the rear tires—which the Chevrolet 454 SS is very good at doing.

Current plans call for only 10,000 454 SS pickups to be built for the model year. Base priced at \$18,413, Chevrolet's biggest problem is likely to be the screaming from dealers over lack of supply. Because this ain't just a truck, it's The Terminator. —Rick Titus

HEAVY METAL HAULERS

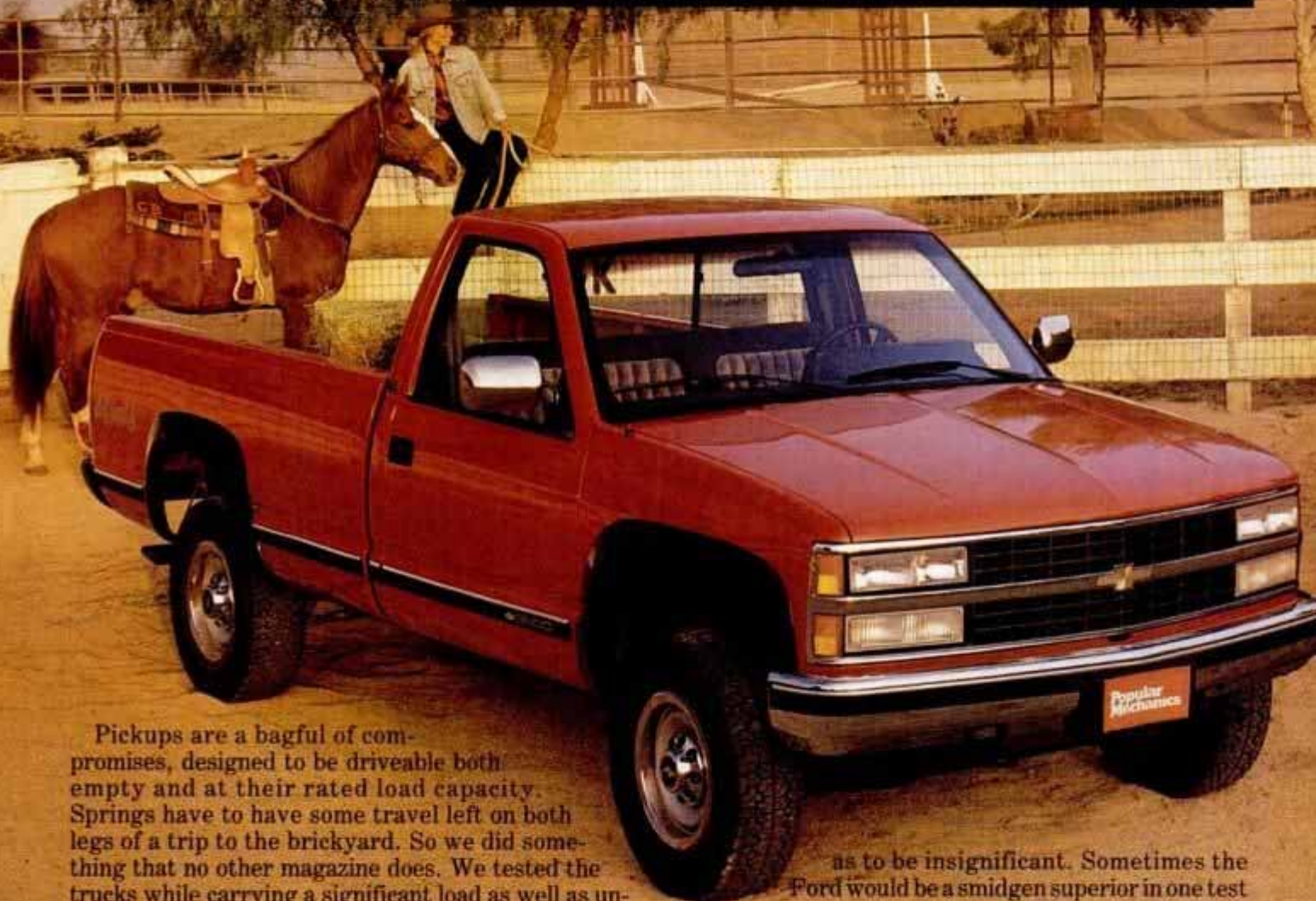
SPECIFICATIONS AND DIMENSIONS

MANUFACTURER/ MODEL	BASE PRICE/ PRICE AS TESTED	ENGINE/ HP, NET/ TORQUE (lb.-ft.)	TRANS- MISSION	WHEEL- BASE (in.)	LENGTH (in.)	CURB WEIGHT (lbs.)	PAYLOAD CAPACITY	CARGO BED DIMENSIONS (in.) ¹
Ford F-250 HD 4x4	\$15,858/ \$19,948	7.5L MPFI/ 230 @ 3600/390 @ 2200	4-speed auto	133.0	210.2	5482	4010	70.0/50.8/ 82.1
Chevrolet K3500	\$16,033/ \$18,840	7.4L TBI/ 230 @ 3600/385 @ 1600	4-speed manual	131.5	212.6	5200	4883	61.89/49.1/ 78.7

1. Interior Width/Width Between Wheelwells/Length. 2. EPA does not report mileage for trucks over 8500 GVW.

3. Times from a steady-state 40 to

Chevy's instruments, radio controls were hard to read. And its seats were too hard. Throttle-body-injected 454 manages to fill swimming-pool-sized engine compartment.



Pickups are a bagful of compromises, designed to be driveable both empty and at their rated load capacity. Springs have to have some travel left on both legs of a trip to the brickyard. So we did something that no other magazine does. We tested the trucks while carrying a significant load as well as unladen. Our load, in this case was 1000 pounds of bagged salt—chosen for portability, rugged bags and low cost. It was one of those ideas that sounded good in the office, and in retrospect, sounds good again—now that we've had a couple of days to sift through the data and reach our conclusions. But on a sunny 80° test day (at L.A. County Raceway in Palmdale, California), it seemed like we were moving enough salt around to melt all the ice on all the sidewalks in the Midwest.

As you can see from the test data panel, there was a significant difference in results of all the tests we performed after we added the 1000-pound payload. But actual differences between the two vehicles were so small

as to be insignificant. Sometimes the Ford would be a smidgen superior in one test category, sometimes the Chevy. Likely as not, when the salt was added, the other truck would be first.

Hard stops

The braking distances we recorded are nothing to brag about, but we can't blame that on the brakes, exactly. The limiting factor is the tires—mud-and-snow-rated light-truck radials (many less serious pickups wear passenger-car-rated rubber). Truck tires use tread compounds formulated more for long wear rather than high traction. Hence, the ironlike ride, too. Both trucks wear load-range E-rated M&S radials. With carcasses that probably will stop small-caliber bullets, and knob-

TEST RESULTS

EPA INTERIOR SPACE INDEX	GAS MILEAGE (PM TEST) ²	¼-MILE UNLOADED/LOADED	0-60 UNLOADED/LOADED	40-70 PASSING TIMES UNLOADED/LOADED ³	BRAKING 60-0 UNLOADED/LOADED	700-FT. SLALOM UNLOADED/LOADED ⁴	200-FT. SKIDPAD ⁵
62.5 cu. ft.	8.47 mpg	18.6 sec./74.0 mph 19.2 sec./70.1 mph	10.2/11.5 sec.	9.4/11.2 sec.	190/195	48.7/47.7 mph	.63G
63.8 cu. ft.	10.22 mpg	18.7 sec./74.6 mph 19.3 sec./70.6 mph	10.4/11.7 sec.	9.9/10.3 sec.	203/185	52.3/51.2 mph	.62G

¹70 mph. ²Best mileage. ³Best speeds passing slower vehicles. ⁴Best speeds weaving through 8 pylons spaced at 100-ft. intervals. ⁵Lateral acceleration around a 200-ft.-dia. circle. Figures are average of best cw. and cow.



Ford's port-injected 460 was very evenly matched performance-wise with Chevy, but interior rated higher on seating comfort, gauges and ergonomics.



by, mud-slinging tread patterns, braking performance of both of these trucks is mediocre.

Both the Chevy and Ford pickups come standard with a rear-wheel antilock brake system (ABS), a simple single-channel design that modulates both rear wheels together, taking its rate-of-change information from the differential. We've always said that ABS won't necessarily make your vehicle stop any faster, and that's mostly true. What ABS does is allow you to slam on the brakes without locking up the wheels. Once your tires start to slide, stopping distances lengthen. Pickup truck brakes have to be biased to the empty-bed, worst-case weight-distribution scenario, which means the rear brakes do virtually none of the braking—even when the box is full and the rear axle is carrying enough weight to keep the tires rolling. But with ABS to keep the rears from locking, more bias can be used on the rears, in theory.

The Chevy did stop a little shorter loaded. In fact, the shortest distance we saw was in the heavy Chevy, which means the ABS was doing its job. The rear brakes had more authority once they had enough load-

ing. The Ford, in contrast, stopped better light, although either way there was plenty of complaint from the twin I-beam front suspension in the form of shuddering and thumping. What didn't happen is more important—the rear end of the trucks stayed to the rear, obediently tracking the front. No hopping up and down or slewing sideways—leaving you with some chance of actually steering around an obstacle, instead of slamming into it sideways.

Unlike most ABS systems, the brake pedal on both trucks didn't feel like you'd stepped on a buzz saw when the ABS cut in, which was a welcome relief.

Naming names

Regular readers know that we always call a winner in our comparison tests. But with nearly identical specifications, performance and prices, it's impossible to call a winner this time. The Ford gets better marks on interior styling and comfort, but neither of these haulers is what you'd call comfortable.

Remember, it's not a fashion show. What counts is guts and stamina. On that score, it's a dead heat. **PM**

OIL SLICK BUSTER

Rising 12 stories above the waterline, this mammoth oil-skimming rig will battle spills in rough seas.

BY ABE DANE, Science/Technology Editor; PM Illustration by Jeff Mangiat

MORE THAN A year after the *Exxon Valdez* ran aground, the National Oceanic and Atmospheric Administration continues to track the dark stain as it marches out into the Gulf of Alaska. The total damage? Incalculable. And so far, there's no reason it couldn't happen again. We still have no way to fight spills under any but the easiest circumstances. Skimmers, booms, oil mops—all are puny when pitted against a major spill, and totally useless when the weather gets rough.

But late last year, a plan was unveiled that might turn the tables. An environmental dreadnaught called *SeaClean* has been designed for the moral equivalent of war on oil. Based on an already-built mobile offshore drilling platform, it would stand high above the sea on a pair of 260-ft. submerged pontoons. Thus isolated from wave motion, it could go about its work unfazed by seas up to 23 ft.

Buoys for troubled waters

SeaClean's acres of deck space and belowdecks areas would be studded with an array of equipment enabling it to function as a central offshore staging area and command post for the fight against a major spill. But the vessel's primary mission is to strip oil off the heaving water's surface. A pair of disc-shaped floats known as monster buoys would be lowered from the forward corners of the vessel. Thirty-six ft. in diameter and weighing 80 tons, the buoys are designed to ride the waves while a 38,000-gallon-per-minute pump pulls oil and water through slot-shaped openings around the perimeter. Inside the buoys, the mix passes through skimmers that split oil and water. Designed in the late '70s by Lockheed, they consist of stacks of rotating discs that shunt oil toward a sump that draws it up into the ship.

Whatever gets past the monster buoys is funneled into a central caisson between the platform's legs. After

passing through a grill, it hits a 20-ft.-wide conveyor that hauls up oil, tar balls and debris.

The vile stew drawn in by the buoys and the caisson enters a processing plant occupying most of the second deck. Four segregation conveyors size and sort solid materials for recycling, incineration or storage. Recyclable materials are processed on washing lines that immerse them in vats of solvent, and shake oil loose with ultrasonic transducers. Cleaned materials are set aside for shipment to shore. Whatever can't be recycled is routed to a 2-stage, rotary kiln incinerator equipped with a gas scrubber. The emissions are clean enough that the device has been issued a permit by the Alaska Department of Environmental Conservation.

The processing plant would also handle oil-sodden waste ferried in by helicopters and boats from other cleanup sites. Three aircraft-carrier-type elevators would lower the muck onto the processing deck. Between spills, *SeaClean* could help earn its keep as a processing plant for municipal or oil-field wastes.

Expensive, but cost effective

Assuming the ship performs as Louisiana designer Schellstede and Associates promises, the big question becomes: Who will pay for it? One vessel would cost about \$35 million, and five or more would be required to cover most of the locations around the U.S. that have heavy tanker traffic. Two 3000-hp electric motors propel the ship at 8 knots. A tugboat assist could raise that to about 15 knots, so the vessel could reach spills 1000 miles away in time to be effective.

Still, as representatives of the Coast Guard and oil industry evaluate the proposal, one fact may help bring the price into perspective. Costs for cleaning up Prince William Sound long ago passed the \$1 billion mark. Schellstede is betting that with the stakes so high, *SeaClean* will seem a worthwhile insurance policy. **PM**



Vessels dispensing containment boom and performing support functions are lowered from SeaClean's 275-ft.-long main deck by 70-ton-capacity cranes. Stretching ahead from rails on the platform's forward supports, the booms direct oil toward the twin monster buoys and central caisson that make up SeaClean's skimming system. Coordination of cleanup operations is carried out in command post rising above the main deck.

POWER PACKAGES

Six of 1990's best boat-motor-trailer packages fully loaded and ready to go for \$12,000 or less.

BY JOE SKORUPA, Boating/Outdoors Editor; PM Photos by Skip Gandy



SEA RAY 160 BOWRIDER



EBBTIDE 170 XY

SO MANY BOATS and so little time. This has never been more true than now with the victory of the package-boat revolution firmly established. So many great deals are now being offered on integrated boat-motor-trailer units that mamma's advice, "You better shop around," has never been more appropriate. Or more daunting.

Few of us have time to burn these days, especially for comprehensive comparison shopping. So, the PM test team decided to help out. We scouted recent boat shows for the best deals we could find and then brought the select group to Florida for lake testing. We decided to focus on the core segment of the package-boat market, the versatile family boat—big enough to accommodate a passel of passengers, fast enough for skiing, comfortable enough for fun in the sun.

After a considerable amount of kicking props and thumping hulls, we became convinced that dollar

value, or bang for the buck, was the heart of a good package-boat deal. So, although our fleet differs dramatically in many respects—length ranges from 16 ft. 6 in. to 19 ft. 10 in., layouts include bowriders and small cuddies, and power is supplied by outboard, sterndrive and L-Drive engines—they all have one thing in common: price. Each boat costs less than \$12,000.

We assembled our fleet on the surprisingly secluded Butler chain of lakes, which borders Disney's Magic Kingdom, in Orlando. Since the boats differed so widely, our standard comparison-test format wasn't feasible. Instead, we considered each boat on its own terms and made judgments based on measurable data and hands-on analysis. Here's what we found.

Bayliner 2072 Capri Cuddy

Other companies experimented with boat-motor-trailer units first, but Bayliner is the undisputed package-boat king. Nobody offers more models or sells more



Pick a package from these top rigs parked drive-in style near shore (left to right from top of opposite page): VIP 1900 Vision, Four Winns Freedom 170, Sea Ray 160 Bowrider, Sunbird Corsair 185, Ebbtide 170 XY and Bayliner 2072 Capri Cuddy.

POWER PACKAGES



units. Sheer bulk enables Bayliner to optimize economies of scale and pass-along value. Consider the 2072 Capri Cuddy, part of the aerodynamically redesigned 13-model Capri line. This 20-footer is the largest boat in the fleet and the only daycruiser.

As expected from a slick Bayliner, fit and finish is sound. Any 20-footer with a cuddy wrestles with space limitations, nevertheless the 2072 has a 6-ft. V-berth and plenty of stowage, although headroom and ventilation are restricted.

Power is supplied by a US Marine 120-hp L-Drive—a 2-stroke powerhead mounted inboard with a stern-drive-type drive leg. The test team

discovered it to be quiet at WOT (wide-open throttle) and highly trim sensitive, but also prone to strong steering-wheel torque. Responsiveness was a bit sluggish, but top speed is adequate for skiing, which makes this a versatile daycruiser.

Ebbtide 170 XY

We've tested several Ebbtide boats in recent years and each of the small builder's models has compared favorably with bigger, more famous names. The 170 XY is no exception.

The test team was impressed with the 170 XY's handling. It tracks straight at speed and true in G-force turns. Its agility was demonstrated

on the performance course where it finished well ahead of faster boats.

Fit and finish is craftsmanlike and includes tasteful teak strips at entry/egress points. Execution of dash panel was less successful due to sight-line obstruction of instruments.

The XY designation (four models for 1990) stands for Exclusively Yamaha and refers to a system where boat and motor—in this case a 110-hp, 3.0-liter Yamaha sterndrive—were matched at an early stage of development. Few noncustom boats are built this way.

Four Winns 170 Freedom

The 170 Freedom demonstrates Four Winns ability to put big-boat quality into small packages, a skill that's helped make it the nation's third largest boat builder.

Many design features help make this model the fleet's top ski boat. These include a ski eyehook, back-to-back lounge seats, wide swim platform and 3-step ladder with transom handle for easy reboarding. The obstruction-free 115-hp, 3.0-liter OMC Cobra sterndrive is also a plus.

Throttle response and handling were predictable, but the engine was fairly green, and we felt that performance would improve after a full break-in period.

As a member of the OMC family and a builder of its own trailers, Four Winns is able to achieve a unique level



BAYLINER 2072 CAPRI CUDDY



EBBTIDE 170 XY



FOUR WINNS 170 FREEDOM

SPECIFICATIONS AND DIMENSIONS

MANUFACTURER/ MODEL	PRICE AS TESTED	ENGINE	ENGINE HORSEPOWER	LENGTH/BEAM/ WEIGHT/ FUEL CAPACITY	TRAILER
Bayliner 2072 Capri Cuddy P.O. Box 24467, Seattle, WA 98124	\$11,995	4 cylinder, 1.6-liter US Marine L-Drive	120 hp @ 5250 rpm	19' 10"/7' 4" 1850 lbs./31 gal.	US Marine Escort, galvanized or painted
Ebbtide 170 XY Jones Creek Rd., White Bluff, TN 37187	\$11,250	4 cylinder, 3.0-liter Yamaha sterndrive	110 hp @ 4600 rpm	16' 6"/6' 10" 1925 lbs./20 gal.	Ebbtide Custom, galvanized or painted
Four Winns 170 Freedom 4 Winn Way, Cadillac, MI 49601	\$10,495	4 cylinder, 3.0-liter OMC Cobra sterndrive	115 hp @ 4400 rpm	18' 6"/7' 3" 2050 lbs./18 gal.	Sure Load, detachable tongue
Sea Ray 160 Bowrider Sea Ray Blvd., Knoxville, TN 37914	\$11,563	4 cylinder, 1.7-liter 115 Mercury Outboard	115 hp @ 5250 rpm	16' 9"/7' 1" 1900 lbs./20 gal.	ShoreLand'r, local dealer option
Sunbird Corsair 185 2348 Shop Rd., Columbia, SC 29201	\$11,599	6 cylinder, 4.3-liter OMC Cobra sterndrive	150 hp @ 4400 rpm	18' 4"/7' 1" 2150 lbs./23 gal.	Sunbird, galvanized or painted
VIP 1900 Vision P.O. Box 232, Vivian, LA 71082	\$11,995	6 cylinder, 4.3-liter OMC Cobra sterndrive	150 hp @ 4400 rpm	18' 10"/7' 1" 2000 lbs./28 gal.	VIP, galvanized or painted, bearing protection

of boat-motor-trailer integration. The 170 Freedom is new for 1990.

Sea Ray 160 Bowrider

The 160 Bowrider's rich glasswork and plush upholstery help make it our leader in fit and finish. Other elements that contributed are padded dash, tasteful hull graphics and Art Deco-inspired accents. These craftsmanlike elements are hallmarks of Sea Ray, the nation's number-two boat builder.

Features of note are a huge swim platform, 2-step boarding ladder and Sony radio/cassette. Unlike the other boats, the trailer for the 160 package is supplied by the dealer.

At WOT, the 160 was the fastest boat in the fleet (48.25 mph). Hole shot was also quick and should get quicker, once the 115-hp Merc outboard fully breaks in. But on the performance course, we found the 160 lost prop bite in WOT wheel-lock turns. Experimenting with an after-market prop would no doubt help.

Sunbird Corsair 185

South Carolina-based Sunbird may be the first builder to offer an all-package fleet. Its newest model is the Corsair 185, a Eurostyle runabout powered by a 150-hp, 4.3-liter OMC Cobra sterndrive.

This well-built bowrider is a punchy performer that's capable of neck-snapping hole shots and blazing top-end speeds (48 mph). Credit here is



due to the torquey sterndrive, which provides impressive power, but also occupies valuable interior space.

With its low-end torque and back-to-back seating, the Corsair is an ideal ski boat. Sluggishness on the performance course was due to wide steering ratio. If tightened, the Corsair would pin turns with conviction.

VIP 1900 Vision

The dark horse of the fleet is the 1900 Vision, made by Louisiana-based VIP. It's the second biggest runabout at 18-ft. 10-in. and a driver's favorite. It scorched the water in hole shot and top-speed runs. Some credit must go to the boat's 150-hp, 4.3-liter OMC

Cobra sterndrive. But credit for the 1900 Vision's fleet-leading performance-course marks, where it pinned the test team to the gunwales, must be given to the design of the hull.

While the VIP's appointments and overall fit and finish were on the Spartan side, many elements were outstanding, such as ski eyehook, pullout swim ladder and roomy deck layout.

We found the dash instruments a bit obstructed, but overall the VIP is a spirited performer and a good value.

Although our test fleet is composed of models of different sizes and features, they all have one thing in common—value, which is the heart of any good package-boat deal. **PM**



SEA RAY 160 BOWRIDER

SUNBIRD CORSAIR 185

VIP 1900 VISION

TEST RESULTS

TOP SPEED	HOLE SHOT 0-35 MPH	PERFORMANCE COURSE	DECK AREA/ STOWAGE SPACE	DECIBEL READING IDLE/WOT	FUEL FLOW @ 2000 RPM/4000 RPM/WOT	FIT & FINISH
38 mph, big boat for engine	9.37 sec., quick to WOT	22.5 sec., surprising handling	31.13 sq. ft./ 33.42 cu. ft.	67 dB-A/90 dB-A	3.9 gph/6.9 gph/ 12.9 gph	Redesigned Capri line is a winner
42.88 mph, adequate for thrills	8.67 sec., good response	21.56 sec., handles WOT turns	30.97 sq. ft./ 25.79 cu. ft.	68 dB-A/94 dB-A	2.75 gph/9.1 gph/ 11.25 gph	Classic marine stylings and values
41.13 mph, sufficient for skiing	10.68 sec., will improve	22.7 sec., predictable cornering	18.06 sq. ft./ 26.27 cu. ft.	68 dB-A/92 dB-A	4.9 gph/6.75 gph/ 8.25 gph	Good detailing, designer's touch
48.25 mph, speed king of fleet	8.59 sec., fast, will improve	23.38 sec., try new prop	32.06 sq. ft./ 24.03 cu. ft.	61 dB-A/91 dB-A	3 gph/8 gph/ 11.9 gph	Rich glasswork, plush upholstery
48 mph, V6 makes it scream	7.6 sec., blistering	23.78 sec., tighten steering ratio	19.25 sq. ft./ 23.46 cu. ft.	63 dB-A/92 dB-A	3.9 gph/11.9 gph/ 15.5 gph	Sleek Eurostyling, many design touches
47.88 mph, driver's favorite	7.51 sec., headsapping	20.99 sec., pins G-force turns	29.66 sq. ft./ 28.87 cu. ft.	69 dB-A/92 dB-A	4 gph/10.8 gph/ 17.9 gph	Interior Spartan but big engine

MOTORSPORTS

SPEED

If you're ready for the supertrack high banks, Buck Baker's Winston Cup Driving School is ready for you.

BY TONY SWAN, Automotive Editor



SCHOOL

SEE THOSE MARKS on that wall?"

Buck Baker, 2-time NASCAR champion and chief instructor of the Buck Baker Driving School, takes one hand off the wheel of his van to wave toward a section of Rockingham's concrete outer wall, just at the exit of turn two.

Despite its fresh coat of paint, the concrete is scored with deep, ugly gouges. Lots of them. And it takes no more than a glance to figure out that only a very solid shot could create gouges like that. None of your mere scrapes or wimpy little ricochets.

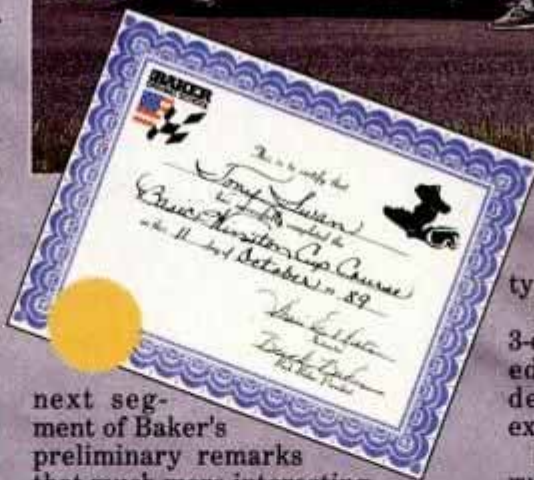
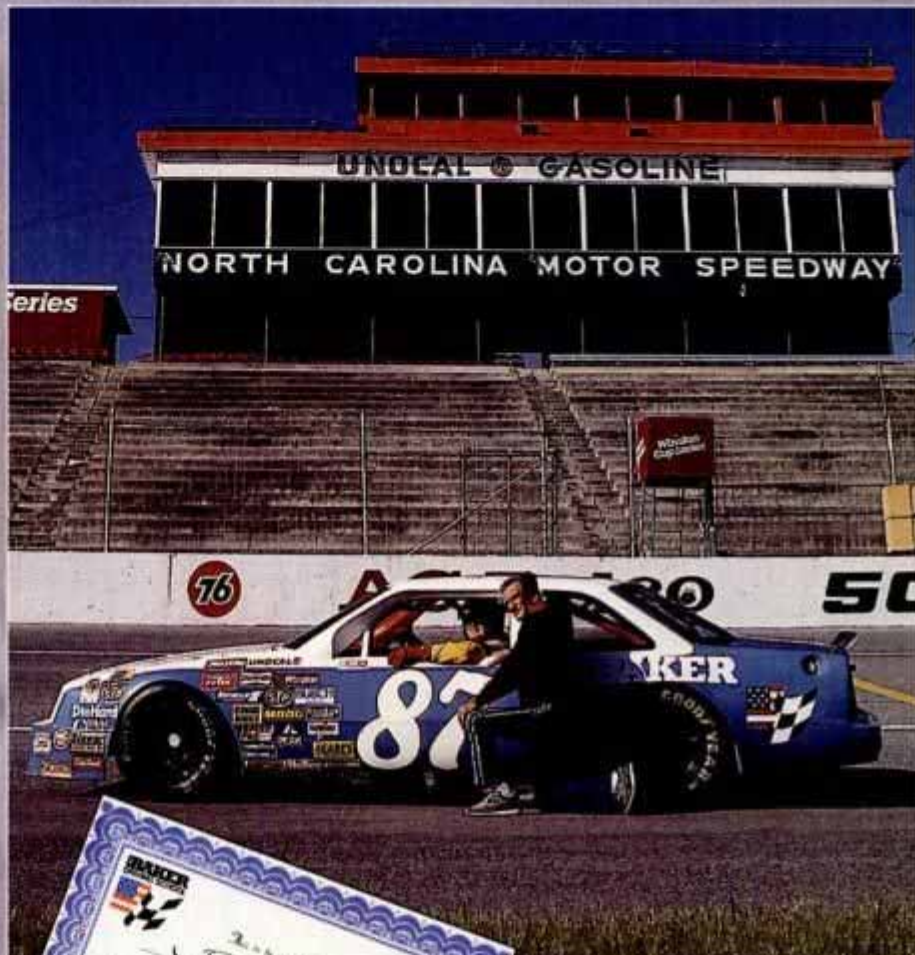
"Well, those marks were put there by experts."

The line draws a laugh from Baker's passengers, getting their first tour of the Rockingham, North Carolina, 1-mile high-banked oval. But the unspoken message is clear. We are *not* experts. If we add our own inscriptions, however small, to that wall, Mr. Baker will not consider it amusing. Not even remotely.

While it's true that most race driving schools begin with some sort of discussion of consequences, nowhere are the consequences of inattention so unmistakably displayed. That endless exterior girde of uncompromising concrete is one of the distinguishing features of NASCAR racing, and also the feature that sets the Baker School apart. If you screw up here, buddy, you're into something hard, right now.

It's hard to say how many times Buck Baker has delivered this little message during the 10 years he's operated the school. But the school's safety record shows his students are listening. Even though some of the school cars have had their sheetmetal rearranged occasionally, there's been only one incident that resulted in an injury, and that one injury was quite minor.

All of which makes the



Chief Instructor Baker and author confer on finer points of high-banked oval.

next segment of Baker's preliminary remarks that much more interesting. Though he has an obvious concern with safety, his basic driving philosophy is to be as aggressive as possible, a trait that marked his driving career.

"There's only one way to win, and that's by runnin' up front," he says in a gruff down-home accent.

"A lot of people are runnin' with good equipment and good sponsors, and all they are is just steerin' wheel holders. That applies to a lot of guys drivin' Winston Cup today, maybe even half of 'em.

"So what that means is there's plen-

ty of room for good drivers."

The classroom portion of the basic 3-day course is mainly a get-acquainted session, where the students describe their previous racing experience.

My group, a typical cross section, runs the gamut from young, dirt-track veterans wanting to move up—Baker has a special place in his heart for drivers like these—to people like me, with a fair amount of road-racing experience, to men who have watched NASCAR racing all their lives and just want to know what it's like to be out there.

We find out soon enough. Before there's even time to wonder about lunch, we find ourselves climbing into a beat-up old Chevelle with Buck Baker himself, to learn the fine art of 360° spins on a watered skidpad. It's a trick that can pay big dividends on

SPEED SCHOOL



PM PHOTO BY RON HUSSEY

Almost all the Baker school cars have seen action in NASCAR's Winston Cup Championship. Course includes segment on chassis setup.

NASCAR's banked circuits, where it's extremely difficult to see more than 100 yards down the track.

And when we've finished spinning, the next step is to climb into a school car for a couple hot laps around the circuit with one of the two instructors—Brandon Baker, Buck's grandson (the school is heavily salted with Bakers) or Shari Minter, an aspiring driver from Martinsville, Virginia.

As intended, this portion of the curriculum is a real eye-opener, one that lends new meaning to lateral Gs and

inspires a new level of respect for this form of racing. Although TV coverage has given amazing insights into this action, the magic eye will never convey the visceral sensations that go with slamming a 3500-pound race car into Rockingham's first turn.

The cars are the real McCoy, ex-Winston Cup cars for the most part, with one former IROC Camaro thrown in for variety. The engines are all Chevy, since Chevy racing hardware is so readily available (ironically, the IROC car wears Thunderbird

bodywork). Though these cars would be a second or so slower than the front of a Rockingham grid, most are still fast enough to run with the midfield pack, and some find their way into real races on a rental basis.

"I've found that these cars do something peculiar to people's brain cells," he says. "They get in and fire 'em up and first thing you know, they forget everything we told 'em." I can feel my reason fogging as I flip the start switch and some 500 horsepower comes to potent, throbbing life under the hood.

In the first few solo circuits, it quickly becomes clear that the lessons of road racing don't apply here. The trick is to turn in early and let the car scrub off speed by climbing the banking a little bit. If you climb too high, you hear about it in the post-session debriefing, with observations relayed by radio from Baker, who sits high in the grandstands to keep an eye on our progress.

And that's the whole on-track teaching technique. We circulate a few laps and return to have Baker's comments—edited, in some cases, for ego preservation—passed along. Lots of observations.

Although Rockingham isn't a particularly fast track—straightaway speeds for the class probably don't go much over 130 mph—it's ideal for teaching, because no two of its turns are identical. By the third day we're all cruising around reasonably well, and the final afternoon is devoted to passing maneuvers and pit stops.

There is one other classroom segment, conducted outdoors by Randy Baker, one of Buck Baker's sons who takes care of the school cars when he's not campaigning his own NASCAR Grand National stocker. Although the presentation is brief, the part on chassis setup is full of meat, a condensed rundown on tire stagger, front steer, rear steer, "bite," Ackerman steering, spring rates and other arcane mysteries of oval track racing.

Whether it's three days or three weeks, this sort of fun is always over too soon, and before we know it, we're all graduates. Some will go on to Baker's advanced course, at Atlanta, where straightaway speeds are higher, others will simply savor this taste of what Rusty Wallace, Dale Earnhardt and Bill Elliott experience every weekend.

But we're unanimous on one point. For anyone who wants to know what American super-speedway racing is all about, this is \$1500 well spent.

Contact the Baker Driving School, 5000 Currituck Dr., Charlotte, NC 28210, (704) 527-2763.

PM

Buck Baker—A Lifetime Of Fast Forward

IF YOU WANT a microcosm of NASCAR's roots, you need look no farther than the career of Buck Baker.

Here are all the classic ingredients—the rural Southern farmboy with a passion for cars, high-speed chases on Southern back roads with loads of white lightning for ballast, years of fender-banging on small-town dirt tracks and a distinguished career in NASCAR Grand National racing.

Born March 4, 1919, in Chester, South Carolina, he began life as Elvie Wylie Baker, but it wasn't long before his family started calling him Buck, in honor of the feisty family bull. Even then he displayed the aggressive temperament that helped make him a winner.

He attended his first race in the late '30s, and quickly decided that this activity wasn't very different from the demands of the alco-

hol transportation business. This led to countless short-track appearances, which led to NASCAR. Baker was in the field for the first NASCAR race at Charlotte, North Carolina, in 1947, and was one of the sport's superstars until his retirement in 1977.

Along the way he won 46 major NASCAR races, including three Southern 500s (at Darlington, South Carolina), and season championships in 1956 and '57. He's also won on road circuits—Watkins Glen, Bridgehampton, Elkhart Lake and Daytona—and took the season title in NASCAR's old Indy Car class in 1952. He reckons his total victory count at something like 650 races of all kinds.

Like many racers, Baker is also a pilot. Unlike most, however, he holds multiengine and instrument ratings.

Baker and his wife Susan got their road-racing school off the ground in 1980 after a stint in the nondairy (soybean) milk business. Susan developed the curriculum based on Buck's racing knowledge. Graduates include names familiar in current NASCAR circles—Bobby Hillin Jr. and Robbie Moroso, for example—as well as Derek Bell, of sports-car fame, Lynn St. James, Patty Moise, Desiré Wilson, Debbie Gregg and rock-and-roller John Oates.

Although there are other driver schools, Baker's operation is unique. Come to think of it, so is its founder.

—Tony Swan



Buck Baker



Baker won NASCAR championships in '56 and '57.

PM PHOTO BY RON HUSSEY

LAPTOPS WITH MUSCLE



Zenith's 5.9-pound MinisPort operates for an honest 3 hours per charge. There are two versions available: the basic model listing for \$1999 and a \$2799 model with extra memory.

New notebook-sized personal computers offer mobility and lots of processing power.

BY RON SCIBILIA

THE CONCEPT isn't really new, but it's certainly compelling: take-me-anywhere computing. Computer users have dreamed for years about computers that would be as easy to carry, and as easy to use, as a notebook. Well, notebook PCs are here and they pack amazing computing power into tiny packages.

POPULAR MECHANICS tried out some of today's computer bantamweights, going a few rounds with the Zenith MinisPort, NEC's UltraLite and Toshiba's T1000SE. All three come from companies that are already veteran club fighters on the computer circuit. A fourth, Psion, promises to be a contender with a new lineup of lightweight laptops due out this spring. Mindful of how every ounce counts when you're traveling, the PM weigh-in rule was set at 6 pounds or less. Here's how they shape up.

Zenith MinisPort

The 5.9-pound MinisPort is, as you'd expect from one of the leading makers

LAPTOPS WITH MUSCLE

of portables, an intelligently designed machine that knows its user. Strong points include a comfortable keyboard with excellent typing feel, a full complement of ports including serial, parallel, external video (CGA) and external floppy disk drive. There's also built-in file transfer software (Rupp's Fast Lynx XL) that can even install itself on a remote computer without the need for carrying additional floppy disks in your satchel, and a quick-charging battery (4 hours will do it) that provides an honest 3 hours per charge. Battery packs are replaceable.

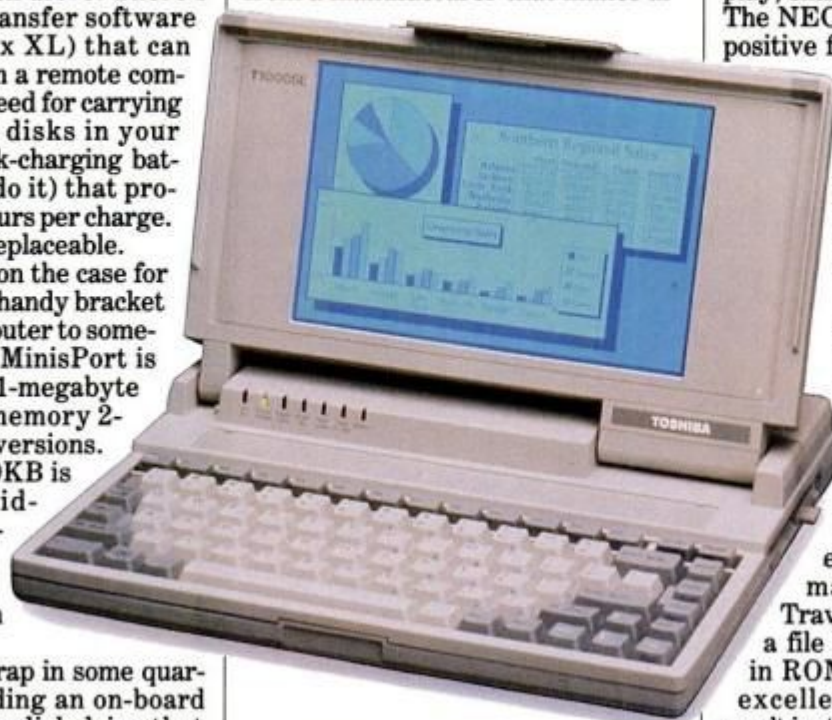
There's a handle on the case for easier toting, and a handy bracket for locking the computer to something secure. The MinisPort is available in either 1-megabyte (\$1999) or extra-memory 2-megabyte (\$2799) versions. Memory above 640KB is available as a solid-state hard disk. MS-DOS 3.3, the basic operating software, is contained in ROM.

Zenith's taken a rap in some quarters for also including an on-board nonstandard floppy disk drive that uses 2-in. hard-shell floppies holding 720KB (\$9.90 list) for data storage. The tiny 2-in. drive is less convenient than the common 3.5-incher for exchanging data with another computer. If viewed, as Zenith intended, purely as a midget-sized backup device, the 2-in. drive makes more sense than battery-backed RAM cards, which can expose precious data to possible loss if a battery should fail.

The MinisPort uses a version of the 8088 processor that runs at either 8 MHz or 4.77 MHz. Processing speed is unspectacular, about 70 percent faster than the classic IBM PC/XT, but, in conjunction with the electronic hard disk, it's certainly adequate for all but the most demanding computing problems

you're likely to encounter on the road. Running the MinisPort at the slower 4.77 MHz speed is an option designed to conserve battery power.

If the MinisPort computer has a real flaw, it's the display, surprising from a manufacturer that makes ar-



Listing for \$1695, the well-designed Toshiba T1000SE weighs in at 5.9 pounds. The display screen is easy to read. Battery life is 3 hours-plus. There's also a practical number of external ports for expansion.

guably the best VGA color monitor on the market. Zenith calls the LCD technology it uses in the MinisPort transreflective and maintains the display offers easy viewing in low light with backlighting turned on or in bright light with backlighting turned off. We can't agree. The MinisPort's screen is marginal in both situations.

NEC UltraLite

There's a saying that goes you can never be too thin or too rich. In the notebook PC world, you can never be too light or too fast and the NEC UltraLite scores on both counts. Lightest of the three notebook computers at just 4.4 pounds, the UltraLite, in its black finish, cuts a decidedly trim and elegant figure. The unit is quick, too. Its powerful NEC V30 processor runs at either 9.83 MHz or 4.92 MHz and easily outpaces both the Zenith and Toshiba in real-world trials. On the popular Norton Utilities SI meter, an accepted software program

Fast and light is the best description of the NEC UltraLite. The machine weighs only 4.4 pounds and it processes information quickly. There's also a built-in modem for telephone communications.

used for measuring computer processing speed, the UltraLite rates a 5.1, compared with a 1.7 for Zenith's MinisPort and a 2.2 for Toshiba's T1000SE.

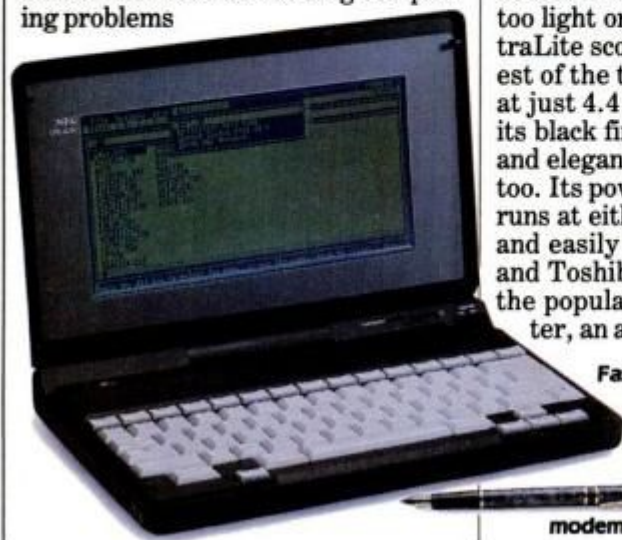
Another plus is the UltraLite's display, sharp and bright blue-on-white. The NEC keyboard doesn't have the positive feel of the Zenith MinisPort keyboard, which PM rates as the best of these three notebook PCs by a small edge. But despite short key travel, which makes for harder typing, it's still a very usable keyboard with a crisp action.

The machine has a built-in Hayes-compatible 2400-bps modem as standard equipment, something that really should be de rigueur in portable machines by now, and two software programs—Microsoft's MS-DOS Manager, a menu-driven file management system, and Traveling Software's LapLink, a file transfer program—stashed in ROM. Although LapLink's an excellent program, this version won't install itself on another computer, and you'll need to bring a 3.5-in. or 5.25-in. NEC diskette, if you plan remote linkups on the road.

The UltraLite comes in two versions, both sporting silicon hard disk drives. A model with 2MB of storage costs \$2999; a model with 1MB of storage runs \$2499. In both versions, an abbreviated version of MS-DOS 3.3 is built into ROM.

Where the otherwise impressive UltraLite disappoints is in three areas: battery life, data storage convenience and peripheral interfaces. The machine now has replaceable batteries, unlike the original version, but you'll likely need at least two for real-world situations. Battery life per pack is well under 2 hours, barely acceptable for a portable to be really useful. Moreover, battery recharging time, from 7 to 10 hours, is also considerably longer than either Zenith's MinisPort (3 hours) or Toshiba's T1000SE (4 hours). For primary data storage, NEC offers its battery-backed silicon hard disk or slide-in 256KB battery-backed RAM cards (\$299 list). A plug-in external 1.44MB 3.5-in. floppy disk drive is available as an option (\$399 list). If you use it, make sure you bring along your AC adapter.

Without the external drive or the pricey RAM cards, you're dependent on the silicon hard drive as a data repository. NEC says the backup batteries in the unit will keep data alive for as long as a week when the normal



operating batteries are depleted. They also advise keeping the unit plugged into an AC adapter, when not in use. This need for data vigilance is likely to make at least some users a bit uneasy, and NEC may have gone a bit too far in downsizing the unit given the lack of permanent on-board data storage and the short battery life. Add to your traveling kit the better-safe-than-sorry accessories, and the UltraLite isn't so "lite" anymore.

NEC also skimped on peripheral ports to keep size and weight down. There's no built-in parallel port. If you plan to use a parallel-interface printer, you'll need to buy (and carry with you) either a separate parallel printer adapter (\$199 list) or the external floppy disk drive, which has a parallel port included. Using a printer, NEC cautions, requires putting the unit on AC power.

Toshiba T1000SE

Newest of the fine series of Toshiba portables, the 5.9-pounds T1000SE (\$1695 list) upgrades the still-available T1000 in virtually every area while managing to knock half a pound off in weight. There's an excellent backlit screen that runs neck and neck with NEC's UltraLite for brightness and clarity. The 8 MHz 8086 processor

isn't blindingly quick, but it's more than twice as fast as the old T1000.

Toshiba takes the PM prize for all-around practicality in the lightweight class. For starters, there's a wide selection of ports, lacking only an external video output, which Toshiba probably felt this computer, with its easy-to-read screen, didn't need.

The keyboard keeps the solid feel and admirable layout of the T1000. Unique among these three, Toshiba has wisely chosen not to double up the much-used cursor direction keys with the PAGE UP, PAGE DOWN, HOME and END keys, making movement around the screen faster and more convenient. With both Zenith and NEC, you're forced to access the latter group by depressing an "Fn" (second function) key first.

Battery life, with replaceable batteries, is reasonable, about the same as Zenith's at 3 hours-plus. Charging time, is also short, at about 4 hours. For heavy users, Toshiba offers an optional charger that will charge three battery packs at once (\$349 list). Battery packs list for \$79 each.

One megabyte of RAM comes standard on the T1000SE. The unit is expandable, via user-installable RAM cards, to either 2 or 3MB (\$699 and \$1199, respectively). RAM be-



Psion's new MC600 laptop computer uses erasable flash memory IC cards rather than a traditional disk drive. List price for the MC600 is \$2999.

yond 640KB is configurable as either hard RAM for an electronic hard disk drive or as expanded memory or, if you choose, a combination of both. As with the MinisPort and the UltraLite, MS-DOS 3.3 is burned into ROM on the T1000SE.

Toshiba also incorporates an industry-standard, high-density, 1.44MB 3.5-in. floppy disk drive in the T1000SE, making data exchange with many desktop machines very convenient. A 5.25-in. external floppy disk

(Please turn to page 134.)



Pocket Power

IF EVEN TODAY'S notebook PCs have too much heft for you, you can check out two DOS-compatible computers that are forging a new category, the pocket-size PC.

These 1-pound wonders come from an oldtimer in the computer wars, Atari Corp., and a startup, Poqet Computer. Both arrive with software in ROM, non-backlit LCD screens and promise long battery life on AA cells.

Atari's \$395 Portfolio can run specially adapted DOS programs, but to handle most contemporary software, you'll need to expand the computer's memory from the standard 128KB to 640KB. Al-

though the Portfolio's DOS compatibility is a good marketing tool, the unit makes more sense as an alternative to hand-held computers like Sharp's Wizard.

The unit has a QWERTY keyboard, but its extremely cramped size and Chiclet feel render it unsuitable for anything but 2-fingered, hunt-and-peck typing. The 8 x 40-in. LCD screen is surprisingly readable, and the unit can use RAM/ROM cards for data storage. Besides a version of MS-DOS 2.11, the Portfolio holds a word processor, calculator, diary, phone directory/autodialer and Lotus 1-2-3 compatible spreadsheet program.

Poqet Computer's Poqet PC, unlike Atari's Portfolio, is intended to go head to head with larger notebook and laptop

computers. It has DOS 3.3 in ROM and comes standard with 512KB RAM, plus a word processor, file program, scheduler, communications and file-transfer program in ROM. Like the Portfolio, the Poqet uses RAM/ROM cards for storage and has two built-in card drives. Poqet expects a slew of well-known DOS programs to become available for the \$1995 unit. PM tried a preproduction unit and found the QWERTY keyboard less than congenial, in either feel or size. This is not a keyboard for touch typists.

On the whole, our view is that the pocket-size PC isn't quite ready for prime time—at least not until some way is found to provide a larger keyboard or an alternate form of data input. —R.S.

LONG-TERM TEST CARS

We've got some good news and some bad news.

OUR LONG-TERM test fleet has seen two additions since our last report—the Cadillac Seville STS and the Eagle Talon TSi-AWD. Our sporty Mazda Miata and utilitarian Mazda MPV continue to pile up miles without major incident. And the Thunderbird SC is gone.

Cadillac Seville STS

Cadillac is back. After several years of floundering around seemingly without direction, after several years of trying to be a high-volume luxury car marketer, after several years of trying to sell Chevys with Cadillac script plastered on the fenders, Cadillac is back.

Because of Cadillac's resurgence,

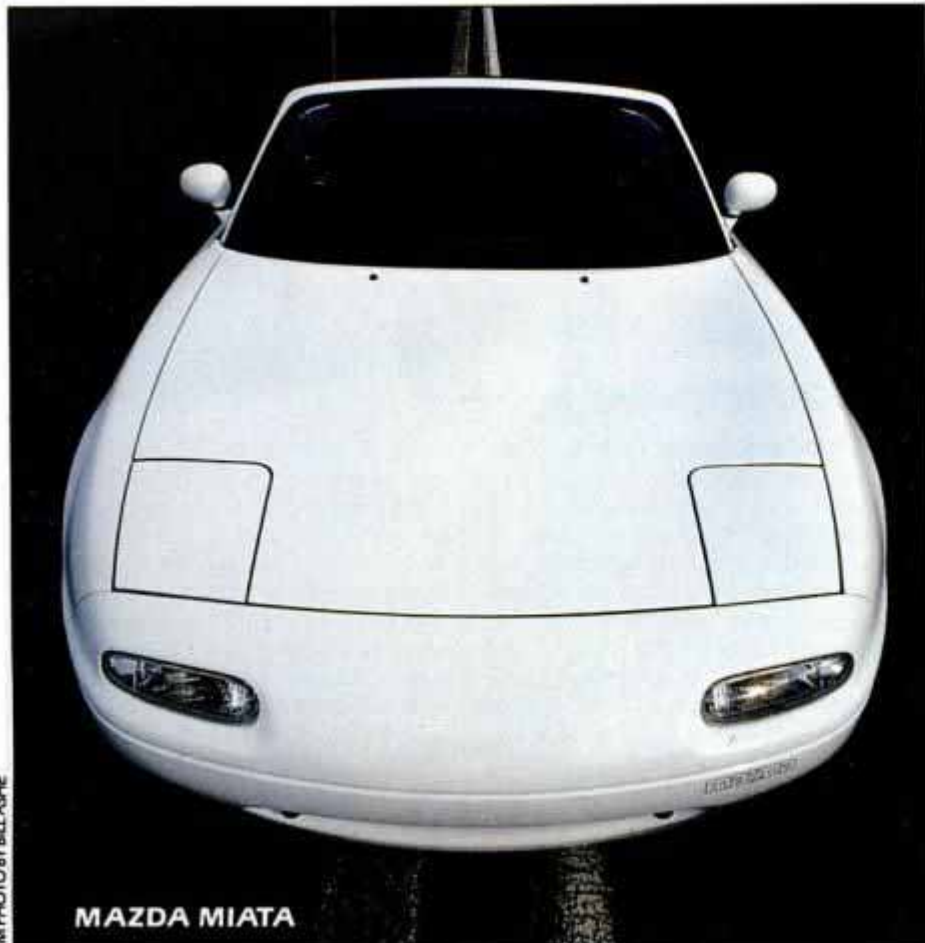
we've been paying more attention to its product. In the March issue, we tested and compared the Brougham to its competition, and it did very well. Now we're adding a 1990 Seville STS to our long-term test fleet to gauge Cadillac's response to a marketplace that is demanding ever more from cars that are available.

The Seville STS is the most expensive sedan Cadillac sells. Only the over-\$50,000 2-seater Allanté costs more. So we figured if any car in the Cadillac line could deliver the goods on all that is demanded of a car in the luxury category today, it's the Seville—specifically the STS version.

The base Seville, if you can call it that, is loaded with every comfort and

convenience item known to man. The STS model adds such items as a firmer touring suspension, fat tires on alloy wheels, special exterior ornamentation, a sumptuous leather interior with four bucket seats and full-length center console, and a special 3.33 final drive ratio. Some of these items, like the interior appointments and special axle ratio, are not available even as options on the base Seville.

Every Seville gets a responsive 4.5-liter V8 engine. Output is up to 180 hp at 4400 rpm and 245 lb.-ft. of torque at 2000 rpm for 1990 with the addition of port sequential fuel injection. The uprated engine, combined with the torque multiplication of the standard 4-speed automatic transmission and



MAZDA MIATA

PHOTO BY BILL ASHE





FORD THUNDERBIRD SC

FM PHOTO BY HUMPHREY SUTTON

the special axle ratio, makes for very spirited driving. Punch the throttle to the floor, and the front wheels are spinning and you're gone. Given its head, this car loves to cruise at 85. And there's still plenty left. Watch your mirrors. On the other hand, the Seville STS is just as happy cruising at 55 mph or puttering around town at 30 mph.

Matching the engine perfectly is the chassis setup. Firmer springs, shocks and stabilizer bars, fat

P215/60R16 Goodyear Eagle GT+4 radials and power 4-wheel disc brakes with a computerized Teves antilock system all combine to make the Seville STS an incredible machine for rapidly transporting oneself from Point A to Point B. The car is there for you, in any weather condition, any kind of road surface, at any speed, legal or otherwise.

One particular banzai, take-no-prisoners run from New York City to Lime Rock, Connecticut, in an hour

and 50 minutes, stands as our testimony to a car that we pushed to the max, and it never once bit us or even hinted at being a bit unruly.

So we've established the Seville STS's credentials for road manners. Styling is personal, between you and the car. We like the way the Seville looks, especially in STS trim. So the only question left is whether the package will still be appealing after a year's worth of miles have passed under the Goodyears. So far, we've



EAGLE TALON TSI-AWD

FM PHOTO BY HUMPHREY SUTTON

LONG-TERM TEST CARS



CADILLAC SEVILLE STS

clocked around a thousand and all's well. We'll keep you informed.

—Joe Oldham

Eagle Talon TSi-AWD

Our first impressions of the Talon came rather abruptly. We were forced to drive it straight through from Detroit to New York City on New Year's Day in horrific weather. This kind of baptism gets you real familiar with a car real fast.

The Talon's traction and controllability are nothing short of phenomenal. The viscous-coupled center differential keeps all four wheels working, even through the goopiest slush. Chrysler admits to 195 hp, but somehow it feels like more, and all those ponies are wearing 4-season radial shoes.

On dry pavement, the 4-wheel drive is still worth the 200+ pound weight penalty. Four-wheel-drive cars with excess horsepower tend to be a handful, spinning their tires and darting off sideways. The Talon just leaves in a hurry.

Mileage is, well, okay, at 22-23 mpg in freeway tripping, and 17 or so in the nightmare of Big Apple commuting. But the Talon is so much fun to drive, with your foot well into the turbo, that mileage becomes secondary in

importance to full-bore bashing.

So far, only a few complaints. The cigar lighter is down on the console, next to the ashtray. Which seems appropriate until you try to plug in a radar detector or cellular phone. Then the cord hangs up in the shifter.

We've never been forced to sit in the back seat, and that's about what it would take to get a full-sized adult into there—force, and maybe some grease.

Our loaded Talon has the CD player option, but the space in the package bin between the seats is just ¼ in. short of closing when a CD box (which otherwise fits nicely) is in residence. More bad planning.

And two days after we picked it up, some low-life took his car keys to the paint on the driver's door, leaving a foot-long scratch down to the metal. Apparently, there's at least one person who doesn't like Eagle Talons—but we do.

At around 18 grand, Talons come in at just about one-fourth the price of a Porsche Carrera 4. Sounds like a bargain to us.

—Mike Allen

Ford Thunderbird SC

The ultimate measure of any PM long-term test car is how much we hate to see it go when the term is up. This

may not be what you'd call scientific, but it's a reaction virtually everyone experiences when it's time to trade horses, and, on this emotional scale, the supercharged T-Bird grades out better than most.

True, we've recorded some gripes during the T-Bird's 12,000-mile New York experience. Clutch pedal effort is excessively high, something we're reminded of each time we navigate the maddening stop-and-go of the Lincoln Tunnel. And engine vibration intrudes itself on the driver's consciousness at low speeds.

The passenger-side window doesn't seal properly, producing excessive wind noise at freeway speeds. We think there should be more in the way of interior lighting—individual map lights, for example—and we had one episode of circuit failure in the anti-lock braking system.

On the open highway, this sleek, long-legged cruiser is pure pleasure. The supercharger delivers lots of instant low-end grunt, which translates as vigorous acceleration, even in FIFTH gear. Ride quality is surprisingly supple for a car that handles as well as this one, and the exterior still draws plenty of envious looks, even though it's been around for a couple of years.

There's a price for horsepower, of course. The supercharged Bird has a fair-to-middling thirst, particularly when it's challenging the New York taxi fleet. We averaged 17.4 mpg for the duration, considerably lower when the diet was all urban.

Even so, this is one of those cars that creates fond memories—good to look at, stirring to drive. And it's one we'll miss.

—Tony Swan

Mazda Miata

While this is everyone's favorite toy in the PM long-term fleet, our Miata (Please turn to page 130)



MAZDA MPV

PM PHOTO BY BILL ASHE

JOURNAL

SHOP PROJECT

CEDAR-STRIP CANOE

Ply waterways in this easy-to-build 14-ft. cedar-strip canoe.

BY KIM AABOE



IF YOU'VE ALWAYS dreamed of building a boat, but were intimidated by the special skills required, then this updated version of a traditional guide canoe may be the key to turning your dreams into reality. It's not only fun to build, but its unique construction virtually guarantees that you'll end up with a useful, durable craft—whatever your skill level.

The hull is planked with cedar strips and then entirely sheathed in fiberglass. This method eliminates internal frames and the canvas outer covering of traditional canoes. It also

makes the canoe easy to carry—ours tipped the scales at just 44 pounds.

While boatbuilding *is* woodworking, there may be a few terms that you're not familiar with. The most important is the word *fair*. This describes a curve with no bumps or irregularities. Checking for a fair curve is done by bending a straight, uniform-grain wood strip called a fairing batten. The *sheer* is the curve that runs along the top edge of the hull from one end to the other. Other special terms are defined in our drawing.

Be sure to use fiberglass cloth and



epoxy resin on the canoe—polyester cloth and resin are not recommended. Always follow manufacturer's instructions and proportions of resin to hardener. To glue together the stem components, Coldcure or G2 epoxy are both appropriate. Use acetone for epoxy resin cleanup.

Lead and inset photos: Pierre St. Jacques
How-to photos: Thomas Klenck and Kim Aaboe
Technical art: Eugene Thompson

THE MOLDS AND STEMS



1 Clamp all molds square with centerline. Place every station mold except center mold on midships side of station line.



2 Use a level held against the mold centerline to check for plumb. Place shims underneath 2x2 cleat to adjust mold.



3 When each mold is plumb and square, screw to strongback from below. This allows hull to be removed later.



4 Tack a strip across all molds at the centerline. Adjust each mold for plumb with level. Then check molds for fairness.



5 After steaming stem blanks, bend around mold. Clamps fit in holes and caul evens pressure on tight portion of curve.



6 When stems have cooled, replace clamps with screws. Brass screws do less damage to cutting tools if they're accidentally struck.

S ELECT STRAIGHT, dry 2x6 and 2x8 stock for the strongback spine and top. Plane the top edge of the spine perfectly flat. Cut both pieces to 12 ft. long and shape the ends of the top as shown in the drawing.

Secure the spine to the top with glue and screws. Screw the 2x4 legs to the spine and level the strongback top along its length and across its width. Secure the legs to the floor.

Lay out a permanent centerline on the top surface by stretching a string from end to end. Then spray paint over the string so a line is left behind. Find the midpoint of this centerline and lay out the center mold position perpendicular to it. Then mark the remaining station lines.

Lay out the molds on $\frac{1}{4}$ -in. plywood and mark the centerline and sheer position on each mold. Cut the molds on a band saw or sabre saw, and smooth the edges. Bore clamp access holes in the stem molds and screw 2x2 cleats to all the molds as shown.

Clamp a mold to the strongback at station line. Note that all of the cross-sectional molds are placed on the midships side of their station lines except the midships mold which is centered. Align the centerlines of the mold and

strongback and check that the mold is square (Photo 1).

Then, check the mold centerline for plumb (Photo 2). Shim under the cleats, if necessary. Screw the molds in place from below (Photo 3). At the midships mold, secure a right-angle brace so that the mold is plumb fore and aft. Plumb and secure the stem molds, and screw the first and last cross-sectional molds to them. Secure the remaining molds by tacking a thin strip along the mold tops (Photo 4).

Check for fairness by laying a fairing batten across the molds to simulate the planking. If necessary, slightly shift molds forward or backward to smooth out a bump or hollow and shave down any high spots. Mask all mold edges with masking tape.

Cut straight-grained ash stem blanks to size. Then use a marking gauge to mark the centerline and two outside lines $\frac{1}{4}$ in. from the edges on one face of each stem, as shown on the drawing. Round one end of the opposite face as shown.

To bend the stems, first fill an electric kettle and allow the water to boil. Place a 4-ft. length of 4- or 5-in.-dia. duct over the spout. Place the stems in the duct, cover the top with a block

MATERIALS LIST—CANOE

Key	No.	Size and description (use)
A		$\frac{1}{4}$ x $\frac{1}{2}$ x 16' western red cedar (strip)—50 bd. ft. required
B*		5 yds. 38"-wide 6-oz. fiberglass cloth, 11 yds. 60"-wide 6-oz. fiberglass cloth
C*	1	6-liter kit 83-HA4 epoxy resin
D	2	$\frac{1}{4}$ x $\frac{1}{4}$ x 42" ash (stem)
E	2	$\frac{1}{2}$ x $\frac{1}{4}$ x 42" ash (false stem)
F**	2	$\frac{1}{4}$ x $\frac{1}{4}$ x 165" ash (inwale)
G**	2	$\frac{1}{4}$ x $\frac{1}{4}$ x 165" ash (outwale)
H**	2	$1\frac{1}{2}$ x 4 x 13" walnut (deck half)
I**	1	2 x 6 x 34" ash (yoke)
J**	4	$\frac{1}{4}$ x $1\frac{1}{4}$ x 30" (seat thwart)
K	4	$\frac{1}{4}$ x $1\frac{1}{4}$ x 7 $\frac{1}{2}$ " (seat rail)
L	12	$\frac{1}{4}$ x $1\frac{1}{4}$ x 14 $\frac{1}{2}$ " (seat slat)
M**	8	$\frac{3}{4}$ -in.-dia. x 3"-long dowel (spacer)
N	16	$\frac{3}{8}$ -in.-dia. x 2"-long dowel
O	1	$\frac{1}{4}$ x $\frac{1}{4}$ x 131" ash (keel)
P†	2	$\frac{3}{8}$ "-wide x 48"-long brass stem band
Q	50	$\frac{1}{4}$ " No. 8 fh brass screw
R	50	$1\frac{1}{4}$ " No. 8 fh brass screw
S	10	2" No. 8 fh brass screw
T	25	$\frac{1}{4}$ " No. 4 fh brass screw
U	25	$\frac{1}{4}$ " No. 6 ovalhead brass screw
V	25	Finish washer for ovalhead screw
W†	10	$\frac{1}{16}$ -in.-dia. x 4" bronze carriage

Misc: Plastic resin glue, G2 or Coldcure epoxy*; microfibers*; acetone; glue syringes; Arrow Ceiling staples; wood filler; sandpaper and discs; 5' 9" foam rollers; 4" autobody squeegee; disposable gloves; respirator with filters for organic vapors; marine bedding compound; spar varnish; $\frac{1}{4}$ -in.-dia. canoe strip flute (No. CS-AS) and cove (No. CS-BS) available from Furnima Industrial Carbide, Inc., Beirnaikie Rd., Barry's Bay, Ontario, Canada K0J 1B0

* Available from Noah's, 2246 Lakeshore Blvd. W., Toronto, Ontario, Canada M8V 1A5

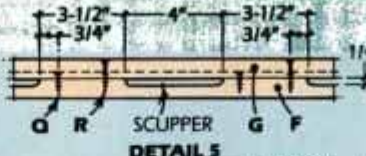
** Cut to fit

† Available from Northwoods Canoe Shop, RFD 3, Box 118-2A, Dover-Foxcroft, ME 04426

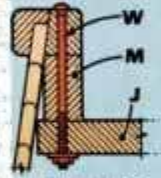
BOLT—W
CUT TO LENGTH

CEDAR-STRIP CANOE

22" HIGH x 34" WIDE
x 13'10" LONG



DETAIL 1

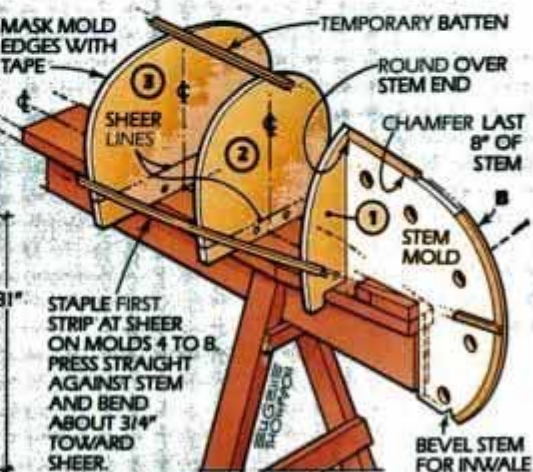
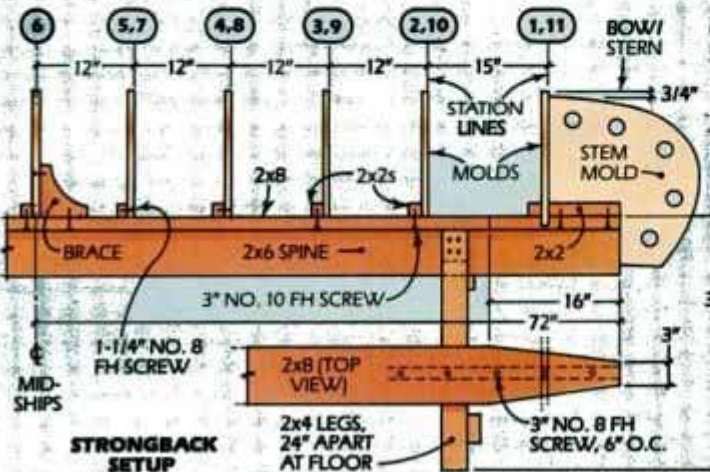
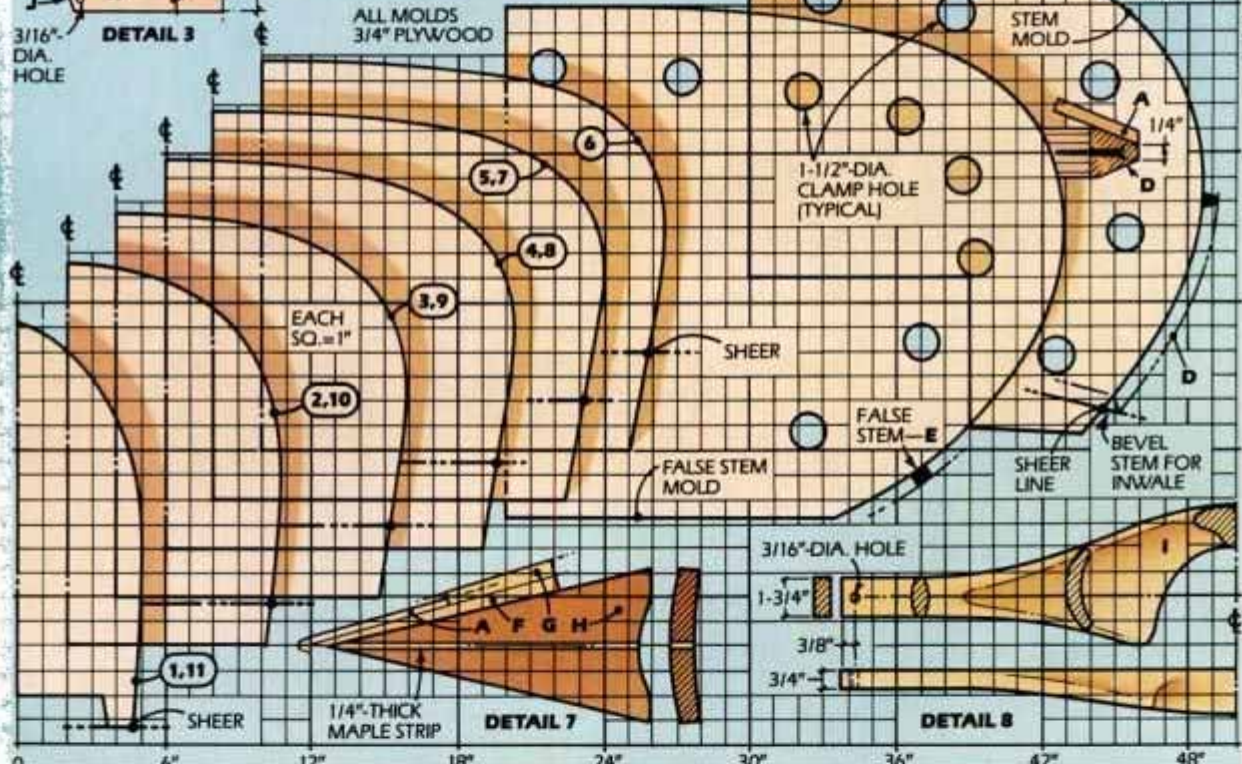
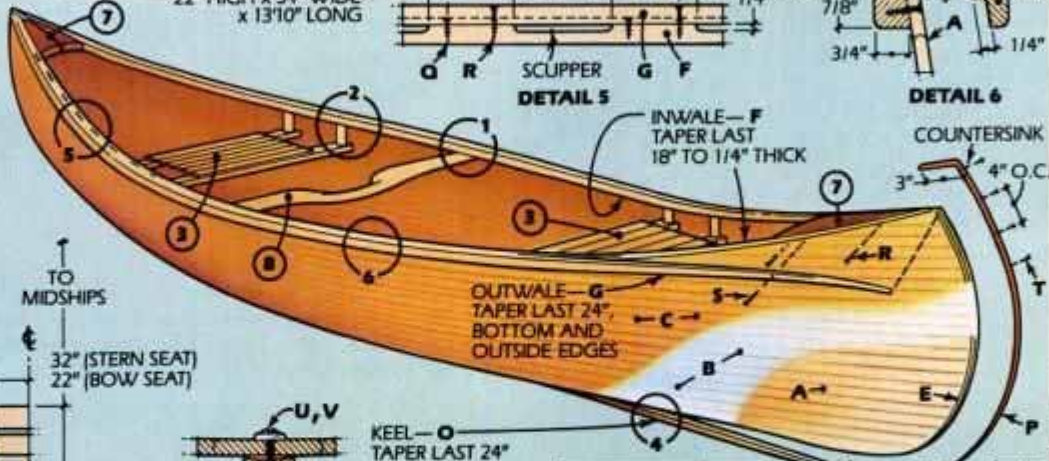


DETAIL 2



DETAIL 3

3/16" DIA. HOLE



of wood and let the stems steam for 1 hour.

Prepare a caul that matches the severest portion of the stem mold curve. When the stems are ready, pull one from the duct and clamp it to the stem mold near the first station mold. Carefully pull the stem around the mold, clamping as you go (Photo 5).

After both stems have cooled overnight, install three 1½-in. No. 6 brass screws in each stem and remove the clamps (Photo 6). Bevel the stems about two-thirds of the way up to receive the cedar strips, using a fairing batten as a guide (Photos 7 and 8).



7 Use a fairing batten to determine stem bevel and check for mold alignment. Note rounding of stem end near first mold.



8 Bevel stem with spokeshave while continuing to check with fairing batten. Stop bevel about two-thirds of the way up.

PLANKING



9 After ripping the ¼-in.-thick × ¾-in.-wide strips, shape the ¼-in.-dia. convex and concave edges on the router table.



10 Staple the first strip to molds No. 4 through 8 at the sheer mark. Drop the strips about ¼ in. from straight at stems.



11 Apply glue to strip edge with syringe. Press next strip in place and staple. Alternate sides and epoxy strips at stems.



12 With the sides of the hull completed, move back to the bow areas and plank down to the sheer with short scrap strips.



13 As the planking nears the flat run of the stem, bevel the stem to accept the strips and align with first cross-sectional mold.



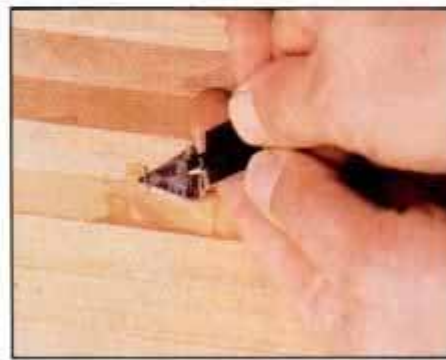
14 Complete one side of the hull, letting strips run over the centerline. Then, snap a chalkline along the center and cut to line.



15 The remaining pieces are mitered at one end, pressed in place and marked for the miter at the other end. Cut and install.



16 After bending false outer stem on separate mold, secure with epoxy and screws. Remove screws after epoxy cures.



17 Use a can opener with the point sharpened to remove staples from hull. Fill staple holes and any gaps with wood filler.



18 After removing false stem screws, trim the stem flush with the planking. Taper stem to meet hull at hull bottom.



19 Smooth hull with a sharp hand plane. Work diagonally to remove ridges, dents and glue. Then plane with the grain.



20 After planing, smooth the hull with an orbital sander. Follow by hand sanding with the grain until the hull is smooth.

RIP ¼-IN.-THICK, 16-ft.-long cedar boards into ¼ × ¼-in. strips. The strips are routed with one concave and one convex edge so they will butt tightly around the hull. We shaped the edges with ¼-in.-dia. canoe strip flute and bead cutters installed in a router and router table (see our Materials List for cutter information). Rout all the convex edges first. Then install the concave cutter and rout the opposite edges (Photo 9).

Staple the first strip, concave side up, to molds No. 4 through 8 at the sheer marks using Arrow's Ceiltite staples (Photo 10). Then, hold one free end against the stem mold without pushing it up or down. Shift the strip about ¼ in. toward the bow sheer mark, check that the curve is fair, staple in place and repeat at the other end. Apply Coldcure or G2 epoxy to the stems before stapling.

Apply a bead of plastic-resin glue to the first strip with a syringe (Photo

11). Press the next strip in place and staple. Fasten three or four strips on one side, rough-cut the excess at the stems, and plank the other side. As you progress, double-check that the molds are fair and wipe off the excess glue. If a mold is low, don't staple to it. If it's high, shave it down. Use scrap strips to plank the bow sections toward the sheer (Photo 12).

As you progress, finish shaping the stem bevel so the strips fit properly (Photo 13). When you reach the point where the strips on one side will butt against those on the other, stop planking one side and continue the other side, letting the strips run across the centerline. Let the glue dry.

Snap a chalkline along the hull centerline (Photo 14) and remove the waste with a handsaw. Then, plank in from the other side, mitering the ends to fit (Photo 15). Don't staple the last three strips until the very last piece has been cut and fit. Then, spring

them all into place and staple.

When the glue has dried, remove the stem screws and trim the strips flush with the stems. Steam bend each false stem around the false stem mold. After they've cooled, dry fit them to the stems with screws. Remove the stems and mix G2 or Coldcure epoxy adding microfibers to thicken the mixture to the consistency of heavy molasses. Apply the epoxy to the stems and use waxed screws to hold them until the epoxy has cured (Photo 16). Remove screws.

Use a can opener filed to a sharp point to remove all staples (Photo 17). Fair the false stem to the hull with a spokeshave and lightly round the corners (Photo 18). Plane the hull diagonally and then with the grain (Photo 19). Fill all staple holes and gaps with wood filler, and orbital sand with 60- and 80-grit paper (Photo 20). Finish by hand sanding with the grain. Cut the sheer slightly proud of the marks.

FIBERGLASSING



21 Begin fiberglassing by laying 38-in.-wide cloth over the hull. Cut to a football shape that matches the bottom.

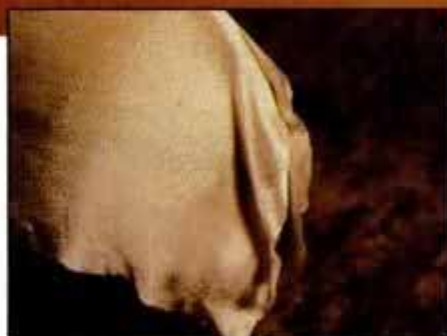
THOROUGHLY CLEAN the hull, lay 38-in.-wide fiberglass cloth over it and cut the cloth to a football shape that covers the bottom (Photo 21). Smooth out the cloth by hand and then cut a 60-in.-wide piece about 2 ft. longer than the canoe. Lay



22 Lay a 60-in.-wide piece of cloth over the hull and cut it 1 ft. longer at each end. Smooth the cloth so it conforms to the hull.

this over the first piece and smooth out (Photo 22). Cut the cloth at the sheer leaving a few inches overhang. Then, make a slit at each end to the point where the cloth leaves the hull (Photo 23).

Before applying the epoxy resin,



23 Silt the cloth ends along the centerline to where the cloth meets the hull. Cut along the sides about 2 in. below the sheer.

make sure that your workspace temperature can be kept at 70° F and you have appropriate respirators and gloves on hand for you and a helper. Mix the 83-HA4 epoxy in 300-ml batches as you need it. Follow manufacturer's instructions precisely.



24 Mix 300-ml batches of epoxy resin at a time. Pour a small amount on the hull and work into the cloth with a foam roller.

Pour the first mixture in a tin pie plate and apply a small puddle to one side of the hull bottom at midships. Saturate the cloth by rolling with a foam roller (Photo 24). Continue working down one side and toward the ends. At the ends, cut the cloth so it just overlaps the stem. Apply resin to the ends with a paintbrush cut short. Then, move to the other side.

After the entire hull is covered, wait a short time for the resin to begin curing (thickening). Then, starting where the resin was first applied, wipe the excess away with a squeegee



25 After the hull is covered with epoxy, use a squeegee held at an angle to remove excess. Wipe waste in plastic container.

held at a slight angle (Photo 25). Dispose of this resin. Squeegee out any small bubbles that appear.

When the resin has hardened, sand the hull lightly, cut the excess at the sheer, wipe clean and coat the entire hull again. Repeat this until the weave of the cloth is completely filled.

When the last coat has cured, sand with 80-, 100- and 120-grit aluminum oxide paper. Then unscrew the molds, turn over the boat and tap the molds free. Smooth the inside with a disc sander and 80-grit paper, moving the sander swiftly up and down the sides.



26 Inside of hull is smoothed by sanding. Start with disc sander and coarse paper. Finish with orbital sander and by hand.

Hand sand into the bows with a 40-grit sanding disc. Finish using an orbital sander with some foam between the paper and pad (Photo 26).

Clean the hull, lay in fiberglass cloth and smooth it out. Allow the excess to overhang the sides. Apply only one coat of epoxy resin—the cloth texture will provide a nonskid surface inside the canoe. If you have trouble at the ends, cut the cloth slightly short and apply two long bias-cut strips in the ends. When the resin has cured, trim the sheer to a fair curve and apply epoxy resin to the edge.

FINISHING



27 Lay a straightedge across center of hull and use bevel gauge to determine gunwale bevel. Then bevel outwales and inwales.

MAKE THE OUTWALES and inwales that comprise the gunwales from $\frac{3}{4}$ -in.-thick ash ripped to $\frac{7}{8}$ in. wide. If your stock isn't long enough to run the full length of the canoe, join two shorter pieces with a scarf joint and epoxy glue.

Check the gunwale bevel angle with a bevel gauge and straightedge laid across the midships section of the boat (Photo 27). Then rip the outwales and inwales to this angle as shown.

Lay out the scuppers so they don't conflict with the seat and yoke bolts, and shape on the router table with a straight bit. To avoid tearout, move



28 Carved yoke makes canoe easy to carry on shoulders. Secure to inwale at midships with bronze bolts, washers and nuts.

the stock into the bit at the right end of each scupper, back the stock away and complete the cut from the other end against the bit rotation. Cut the inwales to fit and taper as shown. Clamp in place $\frac{1}{4}$ in. higher than the sheer and secure with brass screws.

Make the decks as shown in the drawing, fit them at each end and secure with screws. Use a table saw to cut the rabbets in the outwales. Then cut them to length and taper the ends. Clamp in place and secure with brass screws.

Cut the yoke on the band saw and use a gouge and disc sander to custom



29 Use $\frac{3}{4}$ -in. dowels with holes bored through centers as spacers to align seats parallel to bottom. Secure with bolts.

fit it to your shoulders. Apply varnish and install (Photo 28). Construct the seats as shown in the drawing and fit them to the hull. Install the seats parallel to—and about 10 in. from—the hull bottom with dowel spacers as shown (Photo 29).

Hollow the keel hull mating face by passing the stock at a 45° angle over a slightly protruding table saw blade with an auxiliary fence in place. Taper the keel and secure as shown. Then attach the stem bands. Wet sand the canoe with 180-grit paper and apply four coats of spar varnish that contains an ultraviolet screen. **FM**

HOW IT WORKS DISHWASHER

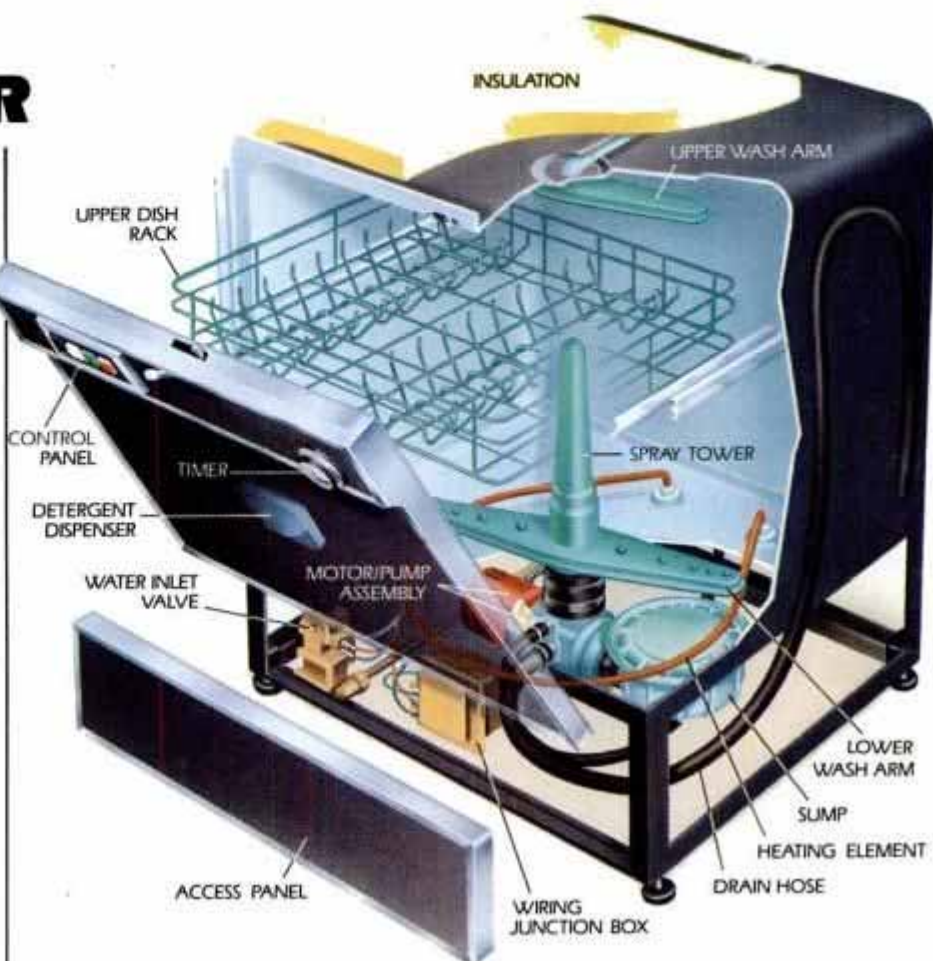
BY STEVE TOTH,
Contributing Editor
PM Illustrations
by George Retseck

THE MODERN KITCHEN has become so much a part of our lives, that its basic mechanical components are now considered absolute necessities. A fridge, stove and hot- and cold-running water are more than just labor-saving devices, we simply wouldn't know how to get along without them.

There is one major kitchen appliance, however, that, while not as indispensable as a stove or a fridge, is rapidly achieving must-have status—the dishwasher.

Although it might seem like a recent invention, the idea of letting a machine take over this daily after-dinner ritual isn't new. In 1850, J. Houghton, of Ogden, New York, was issued a patent for a crude, hand-operated, wooden paddle-wheel device that splashed water over dishes to clean them. Of course, it took another 100 years or so before the dish-pan hands around the nation began to get effective relief. With today's dishwasher, you simply put in your dishes, add detergent, close the door and press a button. Here's a look at what happens behind that closed door.

The dishwasher combines water and detergent in a high-pressure spray that removes food particles from dishes and utensils. The dishwasher's effectiveness is due in part to the very hot water it uses and to heavy-duty detergents that are too



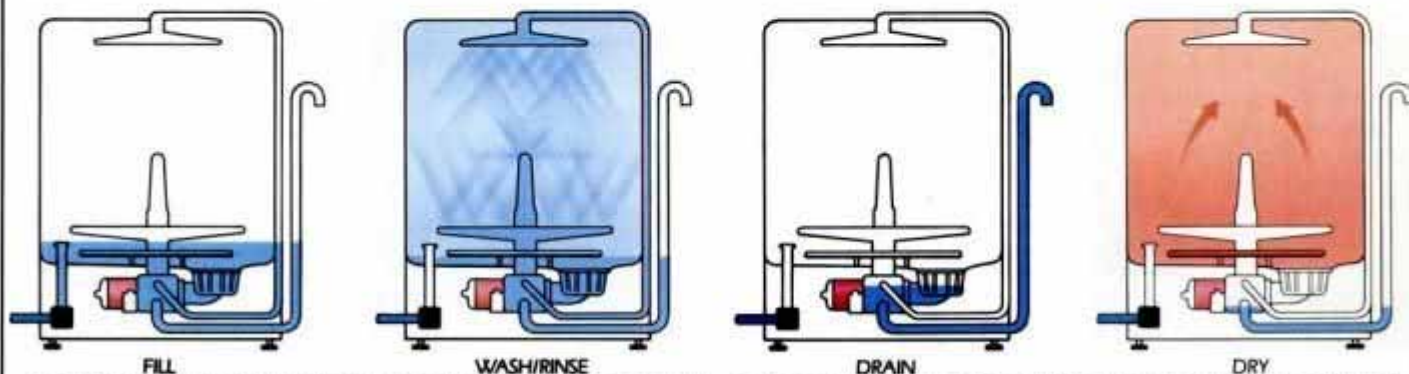
powerful to be used by hand. When you operate your dishwasher, it goes through a series of cycles, each composed of three distinct phases: filling, washing/rinsing and draining.

The first several cycles comprise the prewash phase. Usually, this is accomplished with clean, hot water. However, some machines have an extra, external detergent cup that you can use to add detergent to the prewash for heavy dishwashing jobs. After prewashing, the main detergent dispenser opens and the dishes

Dishwashers use a high-pressure hot-water spray and heavy-duty detergent to get the job done. The timer controls the motor and pump, water valves, detergent dispenser and heating element. Wash cycle duration is set at the control panel. Spray tower extends and arms rotate under water pressure to disperse water and detergent over dishes.

are washed and then rinsed. After each wash or rinse period, the dirty water is pumped out and clean water is admitted for the next cycle. When the last cycle is over, many dishwashers automatically dry the dishes to

OPERATING CYCLE



A typical operating cycle begins when the timer activates a solenoid that opens the water-inlet valve. Water enters the machine under normal household water pressure. When the tub is full, the motor and pump direct the water under high pressure through the spray arms

and tower to clean the dishes. As the dirty water falls back to the tub, it's filtered before being pumped again through the spray arms. Then, the tub is drained. After several cycles that wash and rinse the dishes, a heating element dries the dishes.

finish the job. The brain of the machine is its timer. This clock-like mechanism controls all the electrical circuits in the dishwasher and activates each component at just the right time. The dishwasher's control panel allows you to tailor the length of the wash cycles to match your dishwashing load.

Ready to wash

A typical series of cycles begins after the dishes are loaded, the detergent is added and the door is closed. Latching the door engages a switch that activates the timer and other controls. Placing this main switch in the latch prevents the machine from operating with the door open.

Once the timer button is pressed (or a dial is turned), the timer opens the water-inlet valve by activating an electromagnetic mechanism called a solenoid. On some models, the water that enters the tub is heated to between 140°F and 160°F by the heating element located at the bottom of the tub. It's controlled by a thermostat on the inner door panel.

The height that the water reaches in the tub is controlled either by the timer which regulates the length of time that the water-inlet valve stays open, or a pressure switch that senses water pressure in the tub and closes

the fill valve at the appropriate moment. Dishwashers also have overflow devices that prevent the tub from overflowing if the timer should stick or the drain system becomes clogged.

Once the water is at the proper height, the timer advances to activate the motor-driven pump. The pump sends the water through the pump housing and into the spray arms and tower. The water is directed with such force, that it causes the spray arms to rotate dispersing hot water over the entire rack of dishes. Food particles are floated off the dishes and collected in the water below. As the pump continues to move water through the system, food particles are removed by a filter in the sump.

After the timer has allowed the first rinse period sufficient time, it signals the machine to empty the dirty water into the household drain system. Some dishwashers accomplish this by using a reverse-direction motor and pump. During the pump-out period, the motor and lower impeller in the pump assembly reverse direction. This forces the water out the discharge port to the drain.

Other dishwashers use a single-direction motor and pump along with a solenoid-operated drain valve. At the appropriate moment, the timer opens the drain valve to allow the

dirty water to be pumped out.

After pumping out the water, the timer continues with a series of fill, prewash and drain cycles before going into the main wash cycle.

Detergent cycle

At this point, the timer signals the detergent dispenser to open and empty its contents into the water-filled tub. It does this through a series of levers, a drive spring and a bimetal strip. When current is sent through the bimetal strip, it generates heat which causes the strip to bend. This, in turn, opens the cup.

The hot water and detergent are then pumped throughout the machine to break down and loosen the soil on the dishes and utensils. The timer then directs the pump to drain the tub and refill with clean, hot water to rinse the detergent off the dishes.

After the final rinse, the water is drained and the automatic drying period begins. This is accomplished by a heating element in the bottom of the tub that heats the dinnerware through convection, or through a combination of a heating element and blower that circulates the air. Some machines have an energy-saving option for bypassing the automatic drying period and allowing the dishes to air-dry without heat. **PM**



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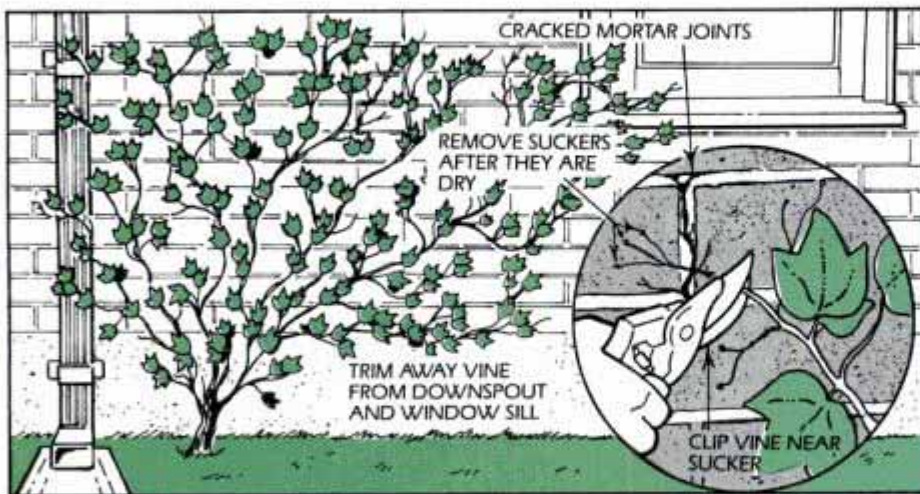
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HOMEOWNERS CLINIC

BY NORMAN BECKER, P.E., Contributing Editor



PM ILLUSTRATION BY ED LIPINSKI

Clip the vines off bricks; don't pull them off. Scrub off suckers after they dry.

Ivy On Brick

I recently purchased a 27-year-old brick house that has one side covered with vines. I just don't know whether I should let them grow or remove them so they don't damage the wall. Do you have any recommendations?

PIPER BECKER
BRANT BEACH, NJ

Many people feel that vines enhance the beauty of a building and they don't care about the problems that they can create.

Vines, although aesthetically pleasing, are undesirable because they can conceal termite shelter tubes, nesting insects and cracked mortar joints. They can widen cracks, loosen shingles and crush downspouts. Also, the dampness associated with vines promotes rot in framing and wood trim.

If you decide not to remove the vines, keep them trimmed away from the roof edge, gutters, downspouts, windows and wood trim.

The Brick Institute of America recommends carefully cutting vines away from the brick, rather than pulling them off. Pulling off vines can damage the brick and mortar joints. The suckers that attach and hold the vines to the wall will be left on the wall.

Wait about two or three weeks until the suckers dry up and turn dark. Then remove them with a stiff brush and some laundry detergent. If you wait too long before removing the suckers, they may rot, oxidize and become so hard that removing them will damage the wall.

Septic Chemicals

I recently purchased a home that has a septic tank and leaching field, and I am looking for information on how to maintain the system. I have also started receiving mailers describing septic system bacteria enhancers that claim, "Put an end to pump outs." Do these products work or should they be avoided?

STEVE MATT
AURORA, CO

First, a good general source of information on septic systems is your state's Department of Health or Extension Service.

Because of bacterial action, the wastes that enter the septic tank break down into a liquid and sludge. When the liquid level is high enough, it flows into the field where it leaches into the ground. The sludge settles to the tank's bottom and eventually must be pumped out.

If the system is designed properly and not abused, as from dumping garbage down toilets, the only maintenance needed is periodic inspection and pumping.

Bacterial enhancers are enzymes (catalysts) that speed up the biochemical reaction by which sludge is broken down. Enhancers reduce the rate at which sludge builds up, but don't attack inorganic matter such as sand, grit and ash, which are also present in septic sludge. Consequently, it will always be necessary to pump out the tank. Any company that claims otherwise is obviously using misleading advertising, and its product should not be used.

Whether or not you use enhancers depends on cost effectiveness. If the tank needs to be pumped every four years instead of every two, calculate the weekly or monthly cost of using enhancers during that period and compare it with the cost for pumping. Regardless of what method you use, it's very important that the sludge not build up to where it overflows into the leaching field. The sludge will fill the gaps between the gravel that surround leaching pipes, preventing adequate drainage.

Seepage Patch

My problem is concrete foundation cracks causing seepage leaks during heavy rain. Do you know of any products that I can use to remedy this problem?

DONALD GRIFFEY
SKOKIE, IL

There are several effective nonshrink hydraulic cement products that are available at hardware stores and home centers. Some typical names are Thoro's Waterplug, Tamm's Speed Plug, Five Star Waterproof Plug, and UGL Fast Plug. Follow the manufacturer's directions for preparing the cracks prior to applying the product.

Tarnished Silver

We bought a breakfront with glass doors to store silverware. Because glass doors can't make an airtight seal, the silver tarnishes very quickly. What can I do?

CHARLES SMITH
BROOKLYN, NY

Silver is susceptible to tarnishing from sulfur compounds in the air. Air normally contains varying amounts of impurities, such as sulfur. Many of these air components are generated within and around the home. Even if you were able to get a good seal around the breakfront's doors, and controlled the air inside it, you would not eliminate the tarnishing. Every time the doors are opened, contaminated air enters. If you have a lot of silver items, try cleaning them with a cloth glove impregnated with a silver cleaner that inhibits tarnishing.

DO YOU HAVE A HOME-MAINTENANCE OR REPAIR PROBLEM?

Just ask Norman about it. Send your question to Homeowners Clinic, Popular Mechanics, 224 West 57th St., New York, NY 10019. While letters cannot be answered individually, problems of general interest will be discussed in the column. For more home-repair and maintenance help, get PM's Home Care Guide, \$5.95 postpaid. Send your order(s) to Popular Mechanics, Box 1014, Radio City Station, New York, NY 10101.

**NEW PRODUCTS
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Ten tools for a better yard and garden.

BY ROY BERENDSOHN,
Assistant Home and
Shop Editor



They're Back

Reel mowers, once a yard care mainstay, stage a comeback with this new lightweight version. Weighing only 25 pounds, its 5-blade, ball-bearing reel cuts an 18-in. swath. Cutting height is adjustable from 1/2 to 2 1/4 in. To ensure a clean cut, the heat-treated alloy steel blades are hand adjusted relative to the bedknife at the factory. Other features include lightweight plastic wheels and a chrome-plated handle. It costs about \$100 at hardware stores and home centers. For more information, write American Lawnmower, P.O. Box 369, Shelbyville, IN 46176, (800) 633-1501.



The Hole Thing

Powered by a portable electric drill, these earth augers bore holes for fertilizing, running wire or planting bulbs. Made from zinc-plated, cold-rolled steel, they come in a range of sizes, diameters and lengths. The 24-in.-long, 3/16-in.-dia. shank earth auger and the 9-in.-long, 1/4-in.-dia. shank bulb planter cost about \$14 and \$7, respectively. They are available at hardware stores and garden centers. For more information, write to Johnson's Industrial Supply, 1941 Karlin Dr., St. Louis, MO 63131.



Slow Drip

This hose weeps water through its wall to irrigate plants and uses 70-percent less water than other irrigation systems, its manufacturer says. Made of polyethylene and recycled rubber, it hooks to a hosebib or garden hose,

and its connectors hook up with compression fittings. It can run above or below ground. A starter kit waters 150 sq. ft. and costs \$20 at lawn and garden centers. For more information, write to Aquapore Moisture Systems, 610 S. 80th Ave., Phoenix, AZ 85043.



Take Wing

Called the Winged Weeder, this 2-pound hoelike device is used in a to-and-fro mopping action, to slice out weeds and aerate the soil. Its spring steel blade has 21 in. of cutting surface and the manufacturer claims it never needs sharpening (the blade is self-sharpening in use). Its shank is cold-rolled steel and the 54-in.-long handle is hardwood. It costs about \$22 at hardware stores and lawn and garden centers. For information, write Creative Enterprises, Inc., P.O. Box 3452, Idaho Falls, ID 83403.



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On A Roll

You roll this 25-pound rake forward for faster pickup of leaves and light thatch, with less back strain, its maker says. Mounted on 11-in.-dia. wheels, the head has spring steel tines that rake a 29-in.-wide swath. Its body is powder-paint coated to resist rust, and its chrome-plated steel handle is adjustable to suit user's height and set raking depth. It costs about \$90 at hardware stores and lawn and garden centers. For more information, write to Porta Nails, Inc., P.O. Box 1257, Wilmington, NC 28402.



Power Spray

This sprayer has a built-in pump powered by four D-cell batteries. With the 1-gallon polyethylene tank filled, it weighs about 12 pounds, and can be handheld or carried with a shoulder strap (available for \$2 by writing the manufacturer). The nozzle on the brass wand is adjustable from fine mist to jet spray, and the sprayer is turned on and off by a thumb switch. It costs about \$44 at hardware stores and lawn and garden centers. For more information, write to Melnor Industries, Moonachie, NJ 07074.



Thatch Attack

This 4-pound dethatcher attachment bolts to most 18- to 22-in. walk-behind mowers. Just unbolt the front wheels and slip the mounting plates over the axle ends. Its height is adjustable for light or heavy dethatching. Each finger is really a straightened end of a steel spring. The fingers catch on thatch and spring it out in front of the mower. It costs about \$40 at hardware and department stores. For more information, write Power Lawnmower Parts, Inc., P.O. Box 60860, Rochester, NY 14606.



Keeping Track

This meter records an engine's running time to help you determine its maintenance needs. Weighing about an ounce, it sticks to the engine with its own adhesive tape that is heat, solvent and water resistant. Powered by a 5000-running-hour lithium battery, it's switched on and off via a wire to the engine's sparkplug. Running time is displayed in digital numbers. It works on 2- and 4-cycle engines and costs about \$37 at outdoor power equipment dealers. Write to SIPAP Electronics, Inc., 11 Ridge Rd., Lansing, NY 14882.



Hold It

These clippers hold a thorny stem upright once it's clipped, so you don't touch it. The stainless-steel blades have a built-in wire cutter, and the molded plastic handles have a spring return and a button latch to keep them closed. It costs about \$13 at hardware stores and lawn and garden centers. Write Fiskars Mfg. Corp., 7811 W. Stewart Ave., P.O. Box 8027, Wausau, WI 54402-8027.



Water Worker

Toro's sprinkler system is designed for homeowner installation. Build it to suit your lawn's shape using rigid or flexible PVC pipe and plastic pop-up and fixed sprinkler heads, fittings, valves and electronic timers. The average homeowner system costs between \$500 and \$1000, and is sold at lawn and garden centers. Write to Toro, 5825 Jasmine St., Riverside, CA 92504-1183. **PM**

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APPLIANCE CLINIC

BY STEVE TOTH,
Contributing Editor

Drain And Fill Washer

I have a Maytag washer model No. KA 806, serial No. 775986UD. The tub can only be filled halfway. At that point, the tub starts draining while water continues to enter it. I shut the machine off and the water completely drained from the tub. This happens every three to four wash cycles. A Maytag repairman I contacted said he never heard of the problem before. Could it be a timer or valve making the pump inoperable?

KEITH YANKOVICH
HUDSON, OH

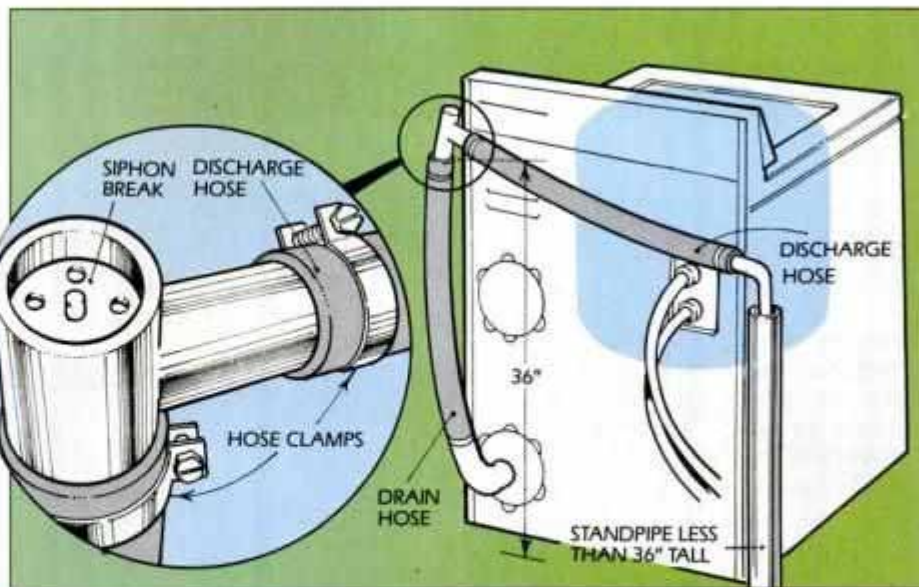
It sounds as if your washer has developed a siphoning condition. When water enters your washer, it automatically flows down into the water pump under the tub. A discharge hose is attached to the water pump and goes up the back of the machine and empties into a stationary tub or a standpipe.

The drain hose must come up to a height of 36 in. from the floor before bending down and draining into the tub or standpipe. If the bend is below 36 in., the tub will fill to the height of the bend, then the water will siphon out of the tub because the drain hose is lower than the tub's water level. This siphoning can also occur when the drain hose is slipped over an undersized standpipe and there is no air gap between the pipe and hose, or if the hose is taped to the standpipe preventing air from entering around it.

To correct this, raise the drain hose 36 in. from the floor. If the hose drains into a standpipe, be sure there is an airspace between the hose and the inside of the pipe and that the hose doesn't extend into the pipe below the washer's water level.

If the standpipe is not 36 in. tall, you will need to install a siphon break on the drain hose (Maytag part No. 2-1112), which costs about \$8.

To install this device, position the part at the left side of the rear panel. Raise the drain hose straight up to the part, measure 36 in. from the floor, and cut the drain hose. Slip the device into the hose and clamp securely. Take the other end of the drain hose and attach it to the discharge side of the device and clamp it



A short standpipe can cause the water to be siphoned from the washer's tub, interfering with normal wash cycle. Prevent this by installing a siphon break in the drain hose.

in place. Run the discharge hose into the standpipe.

Beater Search

I have a Dormeyer Silver Chef Mixer model No. 4300, serial No. 013002, and I am looking for two SA 4291 beaters. CHARLES MALACYNski
BROADALBIN, NY

You're in luck! You can still get a set of beaters for your mixer by sending a check for \$10.50 to Factory Services, Inc., 85 Willis Ave., Mineola, NY 11501. Along with the check, attach a note stating the brand and model number of your mixer, and that you need a set of beaters.

No-Dump Icemaker

I have a Montgomery Ward automatic frostless refrigerator-freezer model No. HMG2292, serial No. 28K31769702, which has an automatic icemaker that will no longer dump the ice tray. Montgomery Ward is no longer located in Utah, and I don't know how to get a replacement. A local repair shop said parts are no longer available and will not touch it. Any ideas? RICHARD ALLEN
LAYTON, UT

Apparently, your local repair shop has given you some wrong information about the parts availability for your Montgomery Ward icemaker. Although the company is no longer based in Utah, you can still order repair parts for your model icemaker, or a new icemaker, by contacting the Montgomery Ward National Parts Sales Center. You can call them at

(800) 323-1965, from 7 am to 8 pm Central time, to order the parts. A complete new icemaker, part No. 69462677, costs about \$120.

Close Shave

I own two Sunbeam shavers. The 5-bladed one just needs new blades and the 2-head, 6-bladed one needs new blades plus the screen. There is no service available in this area, and I have written to Sunbeam in Chicago, but got no response. Can you help?

STANLEY DAVIES
QUEENSBURY, NY

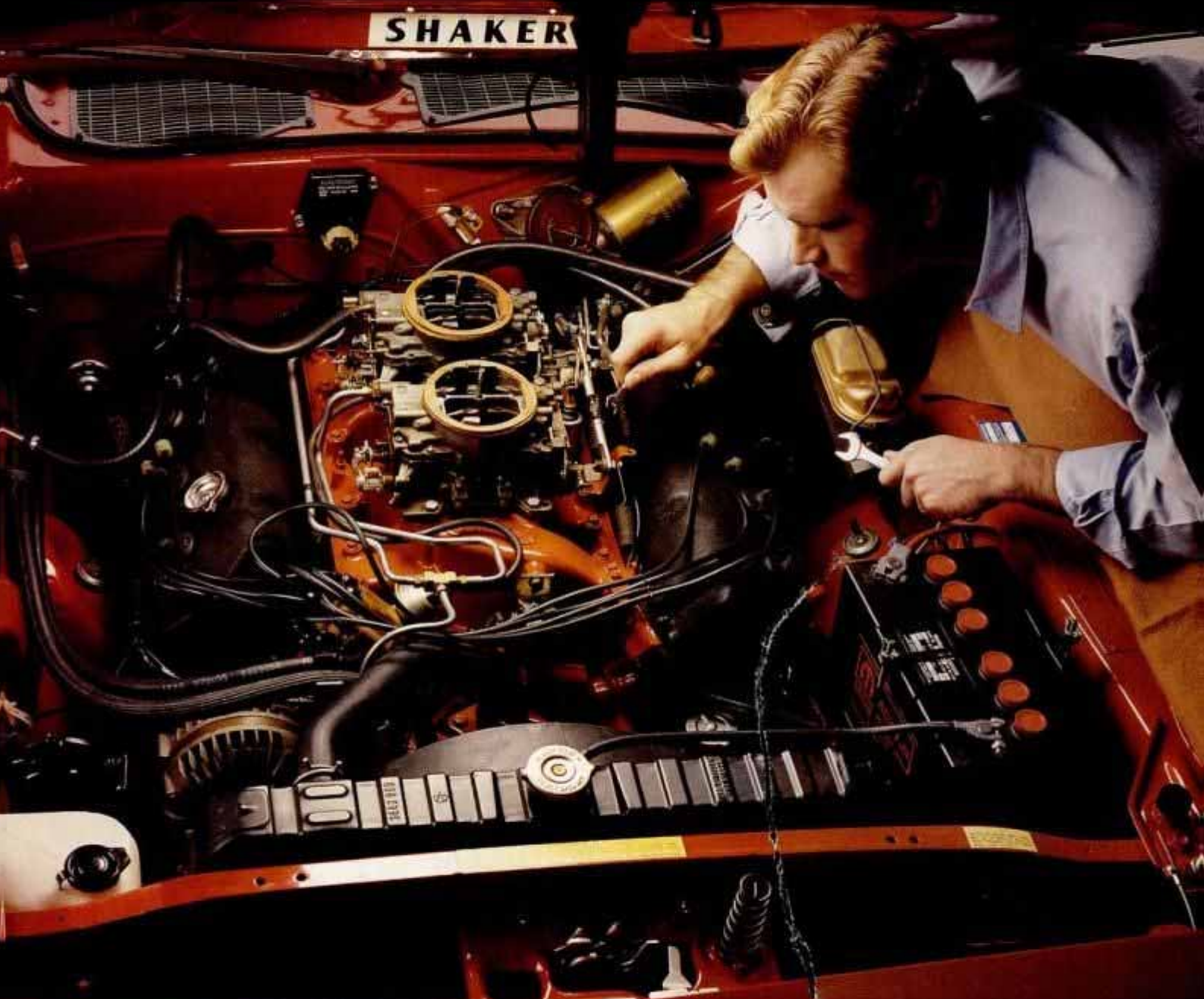
Sunbeam has been out of the shaver business for about 15 years, and many shaver parts are no longer available. Fortunately, there is a company in Illinois that may be able to help you. Now independently owned, the company was once the last Sunbeam-owned service branch in the country.

I suggest you pack up both shavers with a note stating what you want done and send them to Household Appliances Sales and Service Co., 7427 N. Harlem Ave., Niles, IL 60648; (312) 647-8250. They will examine your shavers, check their inventory and send you a written estimate if they can be repaired. The company also has a small number of Sunbeam 5 shavers still in stock. They cost about \$28.

DO YOU HAVE AN APPLIANCE PROBLEM?
Just ask Steve about it. Send your question, along with the model and serial numbers, to Appliance Clinic, Popular Mechanics, 224 West 57th St., New York, NY 10019. While letters cannot be answered individually, problems of general interest will be discussed in the column.

CAR CARE GUIDE

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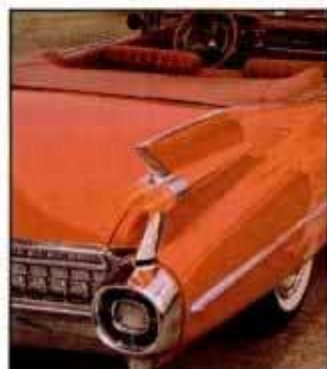
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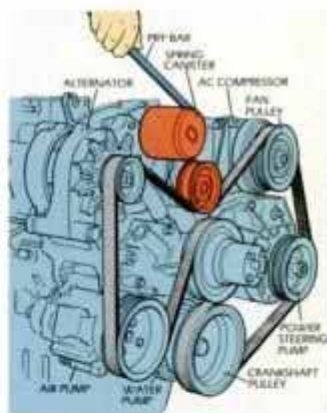
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PM PHOTO BY ROY ATTAWAY



PM PHOTO BY RICH COX



PM ILLUSTRATION BY FRED WOLFF



JOHN GREIBSCH PHOTO

CAR CARE GUIDE

THE CAR CARE PAYOFF

Treasured collector status can be one dividend of meticulous maintenance.

BY CLIFF GROMER; PM Photo by John Lamm

IT'S HARD TO CONCEIVE of changing the oil or a fan belt on your daily driver as being part of America's love affair with the automobile. There's little romance in blackened 10W-40 gushing out of a crankcase drain or grease globbering out of a tie-rod end.

But with the right kind of luck, your econodriver of today could well be the high-buck collectible of

tomorrow. Back in the '50s, who ever would have thought that a '57 Chevy or a '59 Cadillac or even a '48 Chrysler Town and Country convertible would have the cult following or command the collector prices that they do today.

But before your car could ever possibly command attention from collectors, it first has to survive the rigors



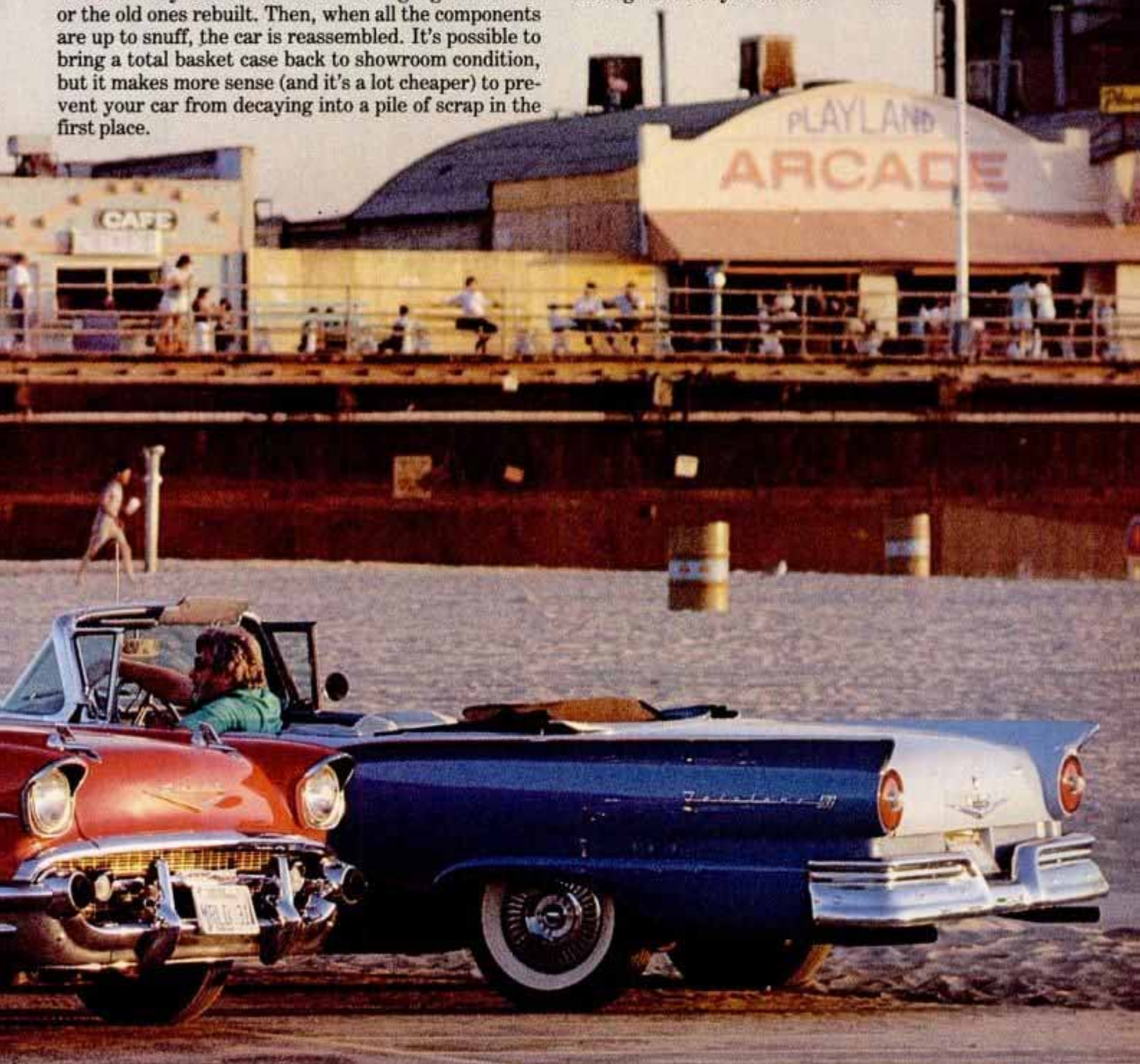
and stresses of the daily grind. That's where maintenance comes in.

The mechanics of preserving your car can run the gamut from the simple, such as checking belts and hoses, to a total restoration where the car may be disassembled to its essential components: The engine and drivetrain may be removed from the chassis and sent out for rebuilding, the body may be lifted from the frame (on cars with separate body/frame construction), and then all the parts stripped to the bare essentials.

A complete restoration would continue with the interior being totally gutted. Seats would be re-covered and new door panels, carpeting and headliner installed. The dash may be refurbished and new gauges installed or the old ones rebuilt. Then, when all the components are up to snuff, the car is reassembled. It's possible to bring a total basket case back to showroom condition, but it makes more sense (and it's a lot cheaper) to prevent your car from decaying into a pile of scrap in the first place.

The gallery of great old cars on the following pages are shining examples of machines that, for the most part, have been meticulously maintained by their current owners. It's only natural that, as the cars become more collectible and increase in value, they become pampered pets and exempt from the normal duty for which they were intended. So while some of the cars are exercised regularly, others only get to enjoy the sunshine when parked on a show line.

Our tips on how to keep your car forever will go a long way in helping it shake off years and miles. These are simple, yet effective tips, well within the ability of the average Saturday mechanic. **PM**



Forever '50s Chevy Bel Air and Ford Fairlane 500 convertibles (both '57s) just keep rising in value.



**IF YOU WERE BEING SLAMMED BACK AND FORTH
6,000 TIMES A MINUTE, WOULDN'T YOU
WANT ALL THE PROTECTION YOU COULD GET?**

Your engine starts. Pistons move up and down 100 times a second. Engine parts are tortured at temperatures exceeding 400°. Tolerance levels between pistons and cylinder walls are within one micron. High-compression engines get so hot, they can glow. Oil breakdown can shorten the life of vital engine parts.

That's why there's Castrol GTX 20W/50.

Castrol's higher viscosity helps sustain a protective film between metal surfaces while providing maximum



protection against viscosity and thermal breakdown. (For geographic areas where temperatures are consistently below 20° F, Castrol also offers 10W/40, 10W/30 and 5W/30.)

Use Castrol GTX 20W/50. After all, if you were brushing up against a 440° piece of metal, wouldn't you want all the protection you could get?

**CASTROL GTX 20W/50.
ENGINEERED FOR TODAY'S SMALLER CARS.**

A GALLERY OF GREAT CARS



1933 Cadillac Sport Coupe

Owner: Errol Wind
Bayside, New York

CADILLAC MADE ONLY 34 copies of this model, which sold for about \$4000 when new. According to the LaSalle/Cadillac owners club, only two remain: the example you see here and a parts car. Three engine options were available—a V8, a V12 and a V16. Errol Wind's Sport Coupe packs the flathead V8. The Fisher body, riding on a 134-in. wheelbase chassis, has never seen rust. Wind is the third owner of this pampered classic which has won several prestigious awards.



1959 Cadillac Series 62 Convertible

Owner: Russ Barton
Orange, California

STAND A 1959 CADDY up on its rear bumper, and it looks like a Detroit version of the Space Shuttle about to blast off into orbit. That, in a nutshell, is the appeal and cult following devoted to the model. Nineteen-fifties nostalgia is big right now, and the '59 Caddy is perhaps the ultimate statement of the era—big, fins and, oh, those bullet taillights!

Russ Barton acquired his Caddy in 1975 from a naval commander. The Caddy wore its 45,000 miles well and was in good mechanical shape, needing nothing more than a new master cylinder. Barton did go for a cosmetic restoration including a paint job and a new top.



1964 Pontiac GTO
Owner: George Richardson
Alexandria, Virginia

THREE DEUCES AND a 4-speed and a 389."* That's the classic line in Ronnie And The Daytonas' '60s hit, *Little GTO*. George Richardson has the classic muscle—the car that started the musculcar revolution—to match the lyric. Richardson is the Goat's fourth owner and has rolled up half of its total 91,000 miles since buying the car in 1975. He replaced the timing gears and chain—a weak point on the 389 engine—with heavy-duty components, and detailed the car to show standards. The GTO gets 17 mpg on the road.

* © Buckle Up Music, BMC. All rights reserved.



1966 Volvo P1800S

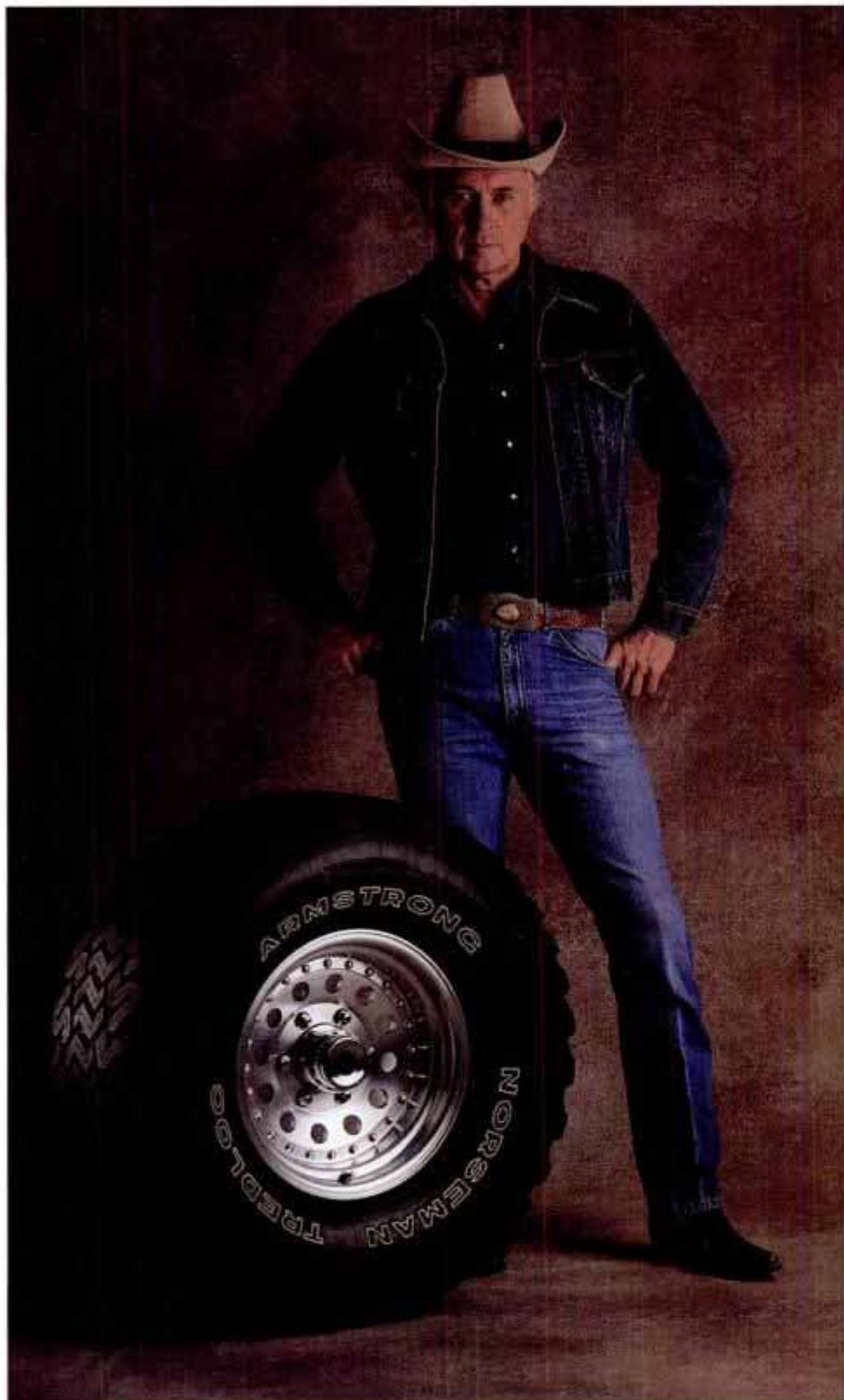
Owner: Irv Gordon
East Patchogue,
New York

IRV GORDON'S VOLVO has to be a monument to the payoff of proper car care. Irv bought the car new and has rolled up a total of *one million, thirty thousand miles!* What's more, this car is his daily driver in the bumper-to-bumper commute on the notorious Long Island Expressway. And that includes treks through winter's salt and slush. Furthermore, Irv parks his Swedish sportster outside exposed to the sun and salt air.

Wait, it gets even better. Irv *drives* his Volvo cross-country to compete in Volvo Club shows. Last year, he scored National Second Place.

So what's his secret? Irv follows the book for recommended service intervals, changing his oil every 3000 miles, and hosing salt off the undercarriage with high-pressure hot water.

Norseman® Tredloc®. Because Things Are Tough All Over.



The great outdoors isn't so great when you're in it up to your wheel wells. But since you're not about to change where you go, think about changing how you go. With Armstrong Norseman Tredloc Radials.

Instead of the usual criss-crossed layers of steel belts, Norsemans are wrapped with two continuous woven belts of DuPont Kevlar®. It's a process so unique, it's patented. Kevlar's lightweight, but pound-for-pound, it's five times stronger than steel—so you begin to get a pretty good idea about where the "strong" in Armstrong comes from.

Those Kevlar belts also let the tread flex more easily—so it contours itself to whatever off-road surface you subject it to. And, with low-inflation performance that's equally awesome, it's no mystery why *Off-Road Magazine** calls the Norseman Tredloc one of the best year-round, off-road tires on the market.

Hard to believe a tire so good at riding out tough times can feel so good on the road, but Norseman handling and steering response are nothing short of

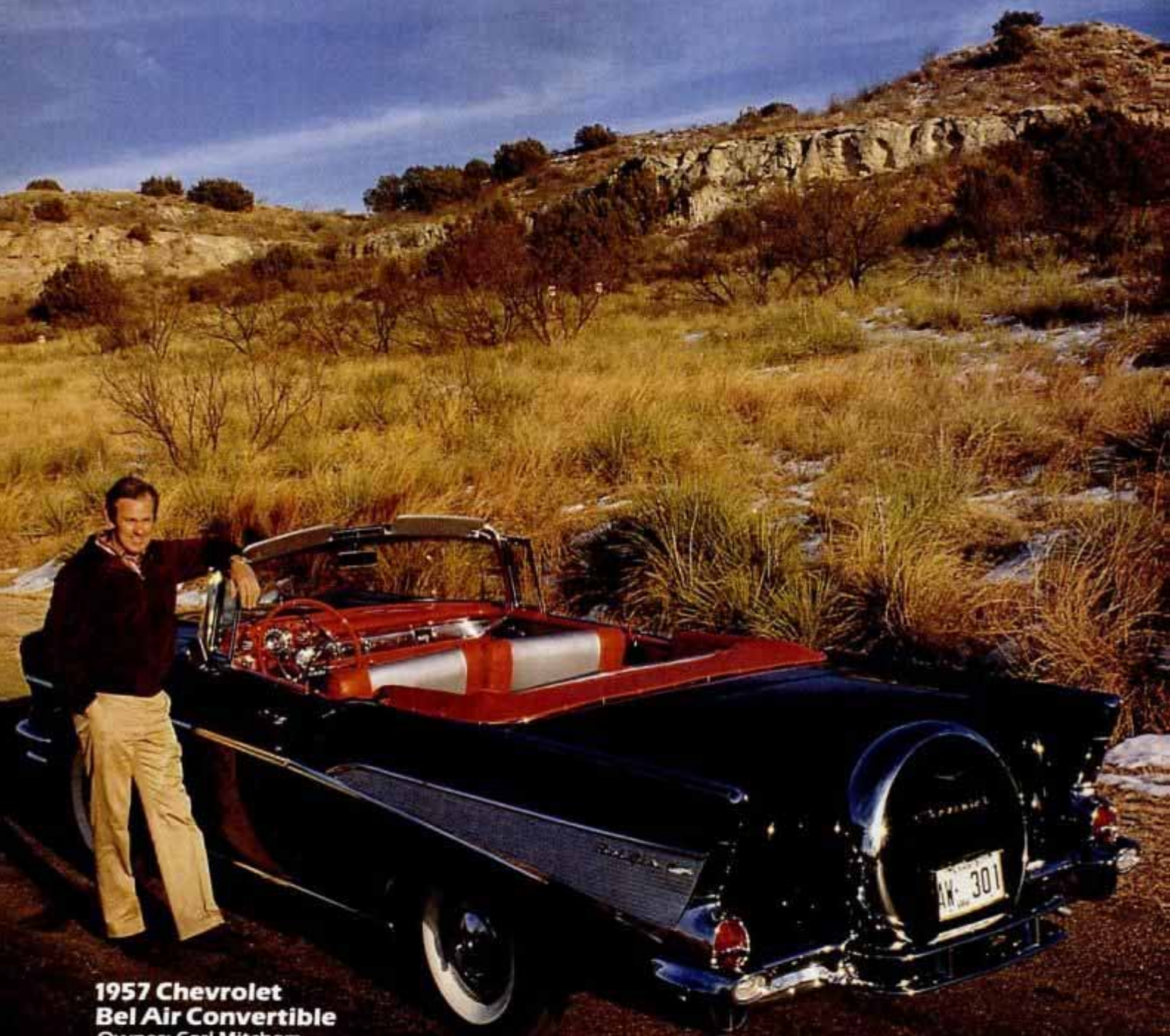


excellent. Its bigger "footprint" comes from that woven belt construction to allow the entire tread to stay flat on the road.

No matter what you're driving, there's an Armstrong Norseman tread pattern and size to fit most 4WD and 2WD light trucks, vans and RV's.

So check it out now. Because when things are tough all over, your ride doesn't have to be.



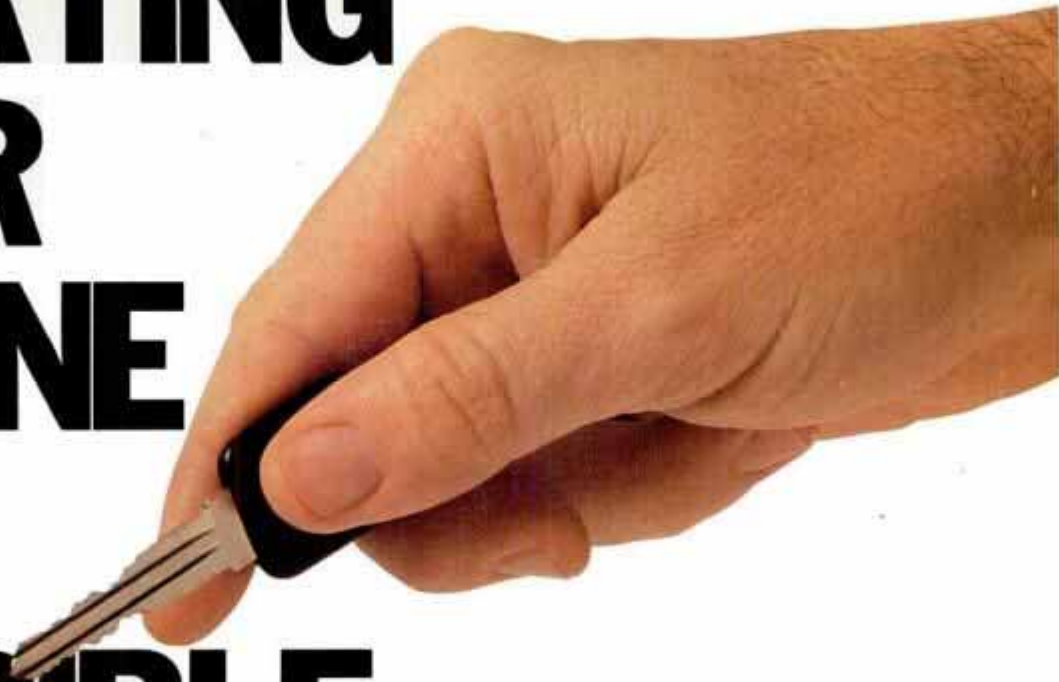


**1957 Chevrolet
Bel Air Convertible**

Owner: Carl Mitcham
Amarillo, Texas

THE '57 CHEVY CONVERTIBLE is one of the hottest movers in today's collector market. And someone will no doubt try to keep this black beauty forever. Certainly the former owner didn't, as Carl Mitcham found this car under a tree with no engine or transmission, and top and seats rotted out. Carl totally restored the Bel Air from the frame up, equipping it as original with the Power Pack option of that year—single 4-barrel, dual-exhaust, 220-hp, 283-cube V8.

STARTING YOUR ENGINE IS A TERRIBLE THING TO DO.



Because at start-up, your oil's in the pan, not in the engine. So when you turn the key, parts grind together. And in those first critical seconds, 70% to 80% of all engine wear takes place.

Slick 50 Engine Treatment does what no other lubricant can

It protects engines at start-up. So even during dry starts when oil and additives aren't there, Slick 50 is lubricating and protecting your engine to help reduce wear.

In fact, Slick 50 was recently tested by a major EPA-recognized independent laboratory. And when the results were in, the Slick 50 treated engine had less than 50% wear compared to the test engine run with reference oil alone.

And additional tests have also shown a dramatic reduction in fuel consumption.

It's not an additive, not an oil

It's Slick 50 Engine Treatment. A special treatment that bonds PTFE to working metal engine parts to create a tough slippery coating that lubricates and protects for more than 50,000 miles.

So to keep your vehicle on the road longer and drive down operating costs, treat your engine to Slick 50.

Because without it, starting your engine really is a terrible thing to do.

SLICK[®]
The Engine Wear
Protector. 50

Available nationwide at Chief Auto Parts, Autoworks, Crown Autoworks, Kragen Autoworks, Checker Autoworks, Schuck's Autoworks and Pep Boys Outlets.



1970 SS 454 Chevrolet Chevelle

Owner: Ron Banach
Toms River, New Jersey

DETROIT DIDN'T BUILD THEM much hotter than Chevy's solid-lifter LS-6 454-cube, 450-horse big block. Which was just fine with Ron Banach, who bought the Chevelle brand new and raced it for three years, usually against the five other LS-6-powered Chevelles that were in a 3-block radius.

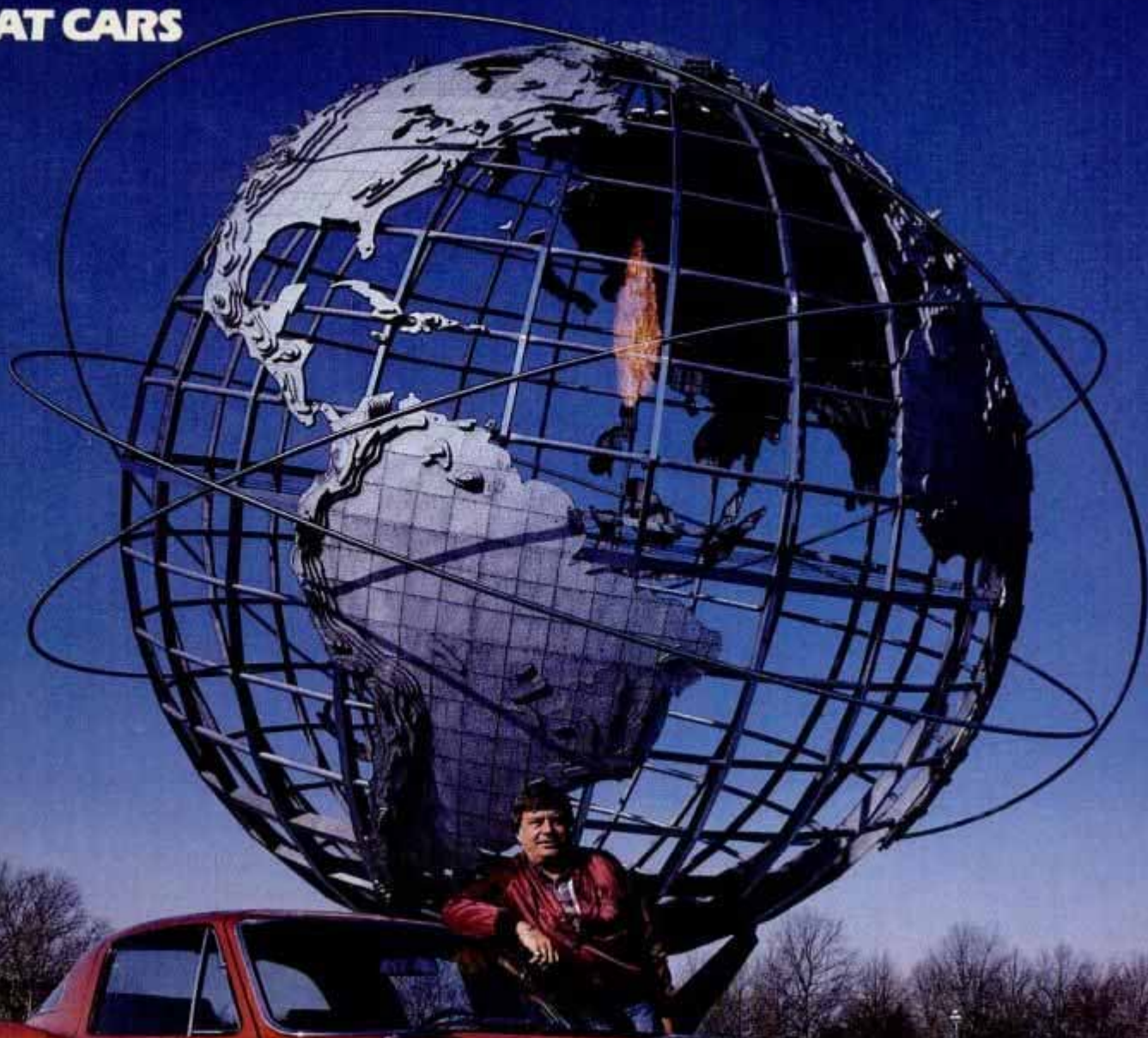
After rebuilding the engine, Ron decided to preserve the car for posterity. The 70,000-mile musclecar now sees oil and filter changes at 1000-mile intervals.

1966 Mustang GT Convertible

Owner: Bob Petrie
Seattle, Washington

BOB PETRIE'S high-mileage pony had 135,000 miles showing on the clock when he bought it from the original owner in 1981. The car had been maintained as a daily driver, and Petrie redid the entire car himself except for machine shop work required for the engine rebuild, some body repair and paint. Petrie's 'Stang is the GT model, worth about 50 percent more than a standard convertible. GT features include the 225-horse 289 engine, firmer suspension with larger sway bar, GT stripes and dual exhaust with trumpets that go through the bodywork.





1967 427/435 Corvette Coupe

Owner: Sam Feinman
Bayside, New York

CORVETTES ARE HOT collector cars these days, and the hottest of the hot are the '67s with the big-block 427 cu.-in. engine. Chevy offered no less than three street versions of its 427, king of the hill being a solid-lifter, tripower-inducted firebreather good for 435 horsepower at 5800 rpm. Sam Feinman's car is unusual in that it is one of 108 Corvette coupes to be exported by GM for '67. Feinman is the second owner of this 39,132-mile classic which was restored by the original owner 10 years ago. It's now a 99-plus-point show car.

MAKE IT LAST FOREVER

44 ways to lengthen the life of your car.

BY PAUL STENQUIST

THE REAL SECRET to making a car last forever is proper preventive maintenance.

In spite of what the marketing people would like you to believe, modern cars aren't maintenance-free. We feel the recommended 6000- or 7500-mile oil-change/service interval is way too long for a car in normal, back-and-forth-to-work

driving. In many areas and for many drivers, this "normal" driving qualifies for severe service.

Over the lifespan of your car, proper preventive maintenance will lower operating costs—a fact well-understood by fleet owners. Also, the following 44 tips will help your car last well beyond its normal lifespan, if not forever.

ENGINE MAINTENANCE

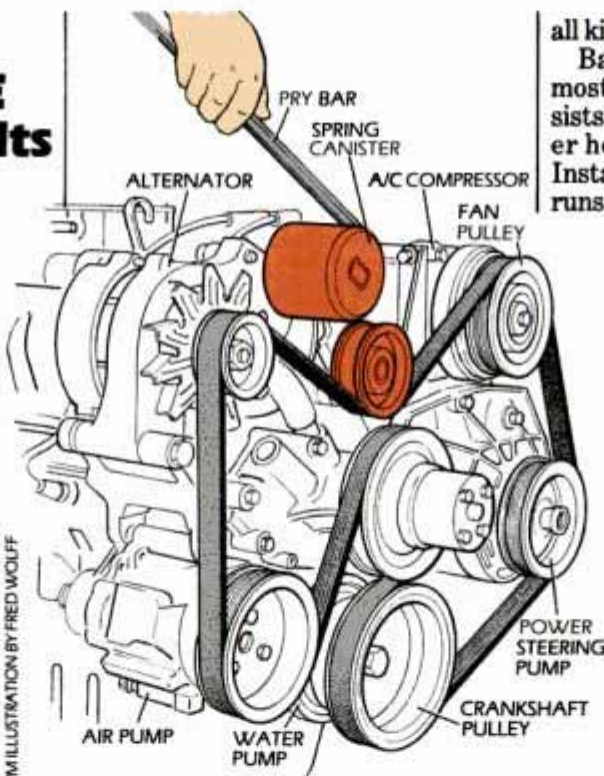
1 Replacing Belts And Hoses

The key to extended vehicle life is regular maintenance. We recommend comprehensive 15,000-mile maintenance procedures. A quick check of all hoses and drive belts should be a part of this procedure. Every three or four years, you should replace all belts and hoses regardless of condition.

At your 15,000-mile service intervals, replace any belt that shows excessive wear, severe glazing, cracking on the bottom of the belt, or frayed cords (Fig. 1A). All specifications—such as the width and pitch of V-belts—must match the requirements for your car. A belt that's the right length but differs in other specs will fail prematurely.

Check tension of new and old drive belts. A tension gauge is recommended—necessary, in fact, for checking cogged or ribbed belts. Placed over the belt, this tool gives you a reading that you can compare to manufacturer's specs. If you don't have a tension gauge, you can check a conventional V-belt by pressing firmly on the belt in the middle of a span. It should not move more than about 1/2 in. Examine hoses for signs of cracking, swelling or oil and grease contamination. Make sure the clamps aren't cutting into the hoses.

Start your cold engine with the radiator cap off and let it reach operat-



1A Replace serpentine belts by pushing the spring canister down with a pry bar.

ing temperature. Then watch the coolant as it runs through your radiator. If you see black flecks, you can bet that the hoses are deteriorating inside. Replace them, if necessary (Fig. 1B).

2 Cooling System

The annual cooling system flush and refill is absolutely essential if you plan to keep your car for the long term. A system that is not flushed will soon corrode and clog, eventually causing

all kinds of problems.

Backflushing kits are available at most auto parts stores. The kit consists of a tee that you install in a heater hose and supporting hardware. Install the tee in the heater hose that runs from the heater core to the top of the engine (rather than the one to the water pump).

To backflush, remove the radiator cap and unscrew the cap on the tee. Attach your garden hose to the tee connector and open the radiator petcock drain. Let the used coolant drain into a bucket and dispose of it in an environmentally approved fashion. Turn on the water supply. Water should start gushing out of the radiator. Start the engine and let it idle with the heater control set to high. Give it at least 5 minutes, or until the water runs clear. Be sure no pets drink the coolant, and that none of it drains onto your lawn or flowerbeds.

After backflushing, fill the system with concentrated coolant equal to half the volume of the cooling system. Add water to fill, making a 50-50 mix.

3 Oil Change

If you want your car to last forever, you can't change your oil and filter too often. Most professional mechanics change oil in their personal cars at 2000- or 3000-mile intervals. Manufacturer-recommended intervals of 6000 to 10,000 miles are stretching things too far, in our opinion.

Warm your engine fully by driving

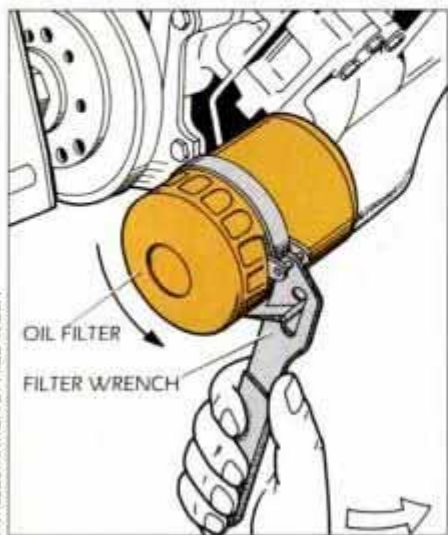


1B Slit a stubborn radiator hose to ease removal, but don't gouge tank connectors.

the car for at least 20 minutes before changing your oil. Then, raise the car on jackstands or ramps so that it's level, which means you'll have to raise both the front and rear of the car for the oil to drain properly. Locate jackstands only in the manufacturer's recommended positions, and observe all vehicle manufacturer warnings in regard to jacking up your car.

Make sure your drain pan is big enough to hold all the oil. Use a box wrench to loosen the drain plug. Some cars have a square or hex drive hole in the plug. Use an Allen wrench or the square drive of a ratchet to loosen these. If your oil drain plug is fitted with a gasket, replace it before reinstalling the plug. Don't reinstall the plug until every drop of oil has drained. Start the plug in with your fingers to prevent cross threading.

While the oil is running out, change the filter. A number of different types of oil filter wrenches are available. Our favorites include the steel-band type, that can be tightened and turned with a ratchet and extension,

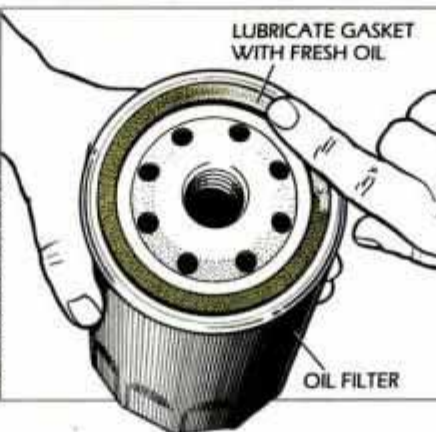


3A Strap-type oil filter wrench works fine where access is good from side of filter.

and the fabric strap type (Fig. 3A).

When the old filter has been removed, check to make sure that the gasket didn't stick to the filter mounting flange. Clean the mount area, then lube the new filter gasket with oil (Fig. 3B). Install the filter, tightening it according to the manufacturer's recommendations or a three-quarter turn past the point where the gasket makes contact.

Don't use just any oil and filter you happen to find on sale. The oil must be of the viscosity and the same or higher grade recommended by the vehicle manufacturer for your climate and driving conditions. For most engines, a 10W-30 multiviscosity is recommended for most types of driving. If your car is extremely high mileage, it might benefit from an oil that exceeds the manufacturer's specs for viscosity, such as a 20W-50. High-performance engines will not benefit from



3B Lube the oil filter gasket with clean engine oil before installing it.

high-viscosity oils. Heavy oil causes drag and horsepower loss.

Don't buy a no-name oil. Some are okay, but some are not. You can trust a premium product from a known manufacturer.

The same is true of oil filters. Some brands offer advantages in terms of filtering and contaminant capacity. Again, the premium offerings of the nationally advertised brands are generally best.

4 Find The Noise

No noise is good noise, but some noises are worse than others. In general, anytime you hear rattles, clanks or clinks coming from the area under the hood, further investigation is called for. To help your judgment, we'll outline a few noises that are not serious. If your noise persists and is not the result of a cause described



4 A piece of hose makes a good impromptu stethoscope for tracking engine noises.

here, see your mechanic.

First, make sure you're using the correct oil. Many engine noises, particularly those that occur only when the engine is hot, are due to using an oil of incorrect viscosity. One of the most frightening, not-so-bad noises we've heard is a banging or metallic thud that occurs when a cold engine is started. The sound grows in volume as the gas is applied, but disappears after 2 or 3 minutes of running.

The likely cause is a bad manifold heat control valve. This device is located in the exhaust manifold of some domestic cars. You can usually tell if this valve is the culprit by listening to it through a stethoscope or a piece of heater hose (Fig. 4).

If you use a hose to locate this or any other engine noise, take care not to touch a sparkplug wire. The carbon black in hoses is a good conductor and you could be treated to a good, stiff application of high voltage to your rather sensitive ear.

Engine noises that are heard all of the time or occur only when the car is warm can be caused by a variety of easy-to-fix conditions. Loose torque converter bolts can cause a horrible ratchet that sounds like the engine is getting ready to pitch a connecting rod. A few minutes on the creeper, armed with a bottle of threadlocking compound and a box wrench, can work wonders.

Rattles and pounding knocks that seem difficult to pinpoint are frequently caused by an exhaust system component in contact with the body or chassis. Every exhaust part must be suspended on a flexible but secure mount away from the car.

A broken crankshaft balancer or pulley hub can cause a very metallic

noise. You can usually detect a bad hub by watching the crank pulley while the engine is running. However, we've seen cases where at least partial disassembly was necessary for detection.

If your car has a carburetor and mechanical fuel pump, suspect a worn pump pivot point should a muted banging noise gradually develop inside your engine. This problem seems to be common on GM V-type engines.

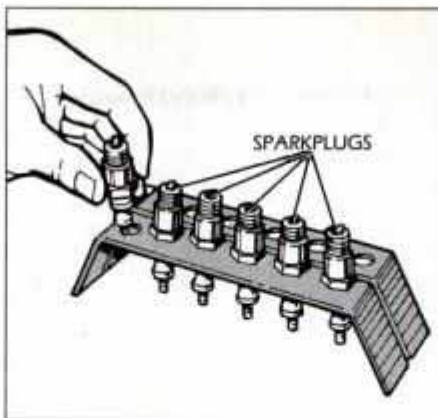
If your engine ticks loudly when you first start it and then hushes up, you may be suffering from common hydraulic lifter bleed down. Although this sounds pretty bad, it's really not very serious. What happens is the lifter valve allows the cushion of oil to bleed out when the car is parked for more than a few hours. In most cases, no real damage is caused, although camshaft wear could be accelerated slightly. The only real fix is lifter replacement.

IGNITION SYSTEM

5 Replace The Sparkplugs

Because modern electronic ignition systems have so increased the life expectancy of sparkplugs, we sometimes tend to forget that they ever need to be replaced. Yet it's the sparkplugs that begin the whole combustion process: Without them, the show can't go on the road. Although plugs may last 30,000 miles or more on a car with high-voltage electronic ignition, we recommend inspection and cleaning at 15,000-mile intervals.

To remove and check or replace the sparkplugs on any engine, you'll need a 3/8-in. drive ratchet, a medium-



5B Keep plugs in order so you can check plug appearance and engine condition.

length extension and the correct size sparkplug socket. Depending on how tight access is on your car, you may also need other length extensions, a swivel-head sparkplug ratchet and a sparkplug socket with integral swivel joint—usually known as a universal plug socket (Fig. 5A). Let the engine cool off for an hour, first.

Before you remove the sparkplug cables, number them with pieces of masking tape. Then remove them by holding each rubber boot and twisting it back and forth until it releases from the plug insulator. Pull the cable off by its boot once you're sure the boot is disengaged.

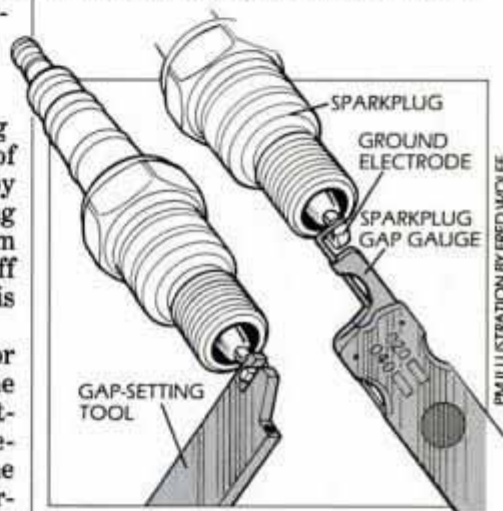
Before removing your plugs, buy or make a plug holder (punching some plug-insulator-sized holes in the bottom of a shoe box is fine). Then remove the plugs and insert them in the holder or box, business-end up, in order (Fig. 5B).

Examine all the plugs to make sure that they are approximately the same color. Normal color ranges from gray or brown to white or tan, depending on fuel used and engine calibration. A plug that is black and/or wet with fuel has probably stopped firing. If your

ignition tuneup doesn't bring that cylinder back to life, you'll have to do further diagnosis. While you have the plug out, you may want to check cranking compression with a hand-held compression gauge.

An oily plug that was still firing is a sure sign that oil is getting past the guides or rings—a major problem requiring internal engine service. (A plug that has stopped firing may oil up even if the engine is in good shape. If the plug *was* still firing, you should see a small area on the bottom of the outer electrode and the tip of the inner electrode that is burned clean by the spark.) If the edges of the plug's outer and center electrodes are eroded, replace it.

But if the plug is merely coated with light deposits, clean it, regap it and reinstall it. Use a wire brush to clean the electrodes and tip of the in-

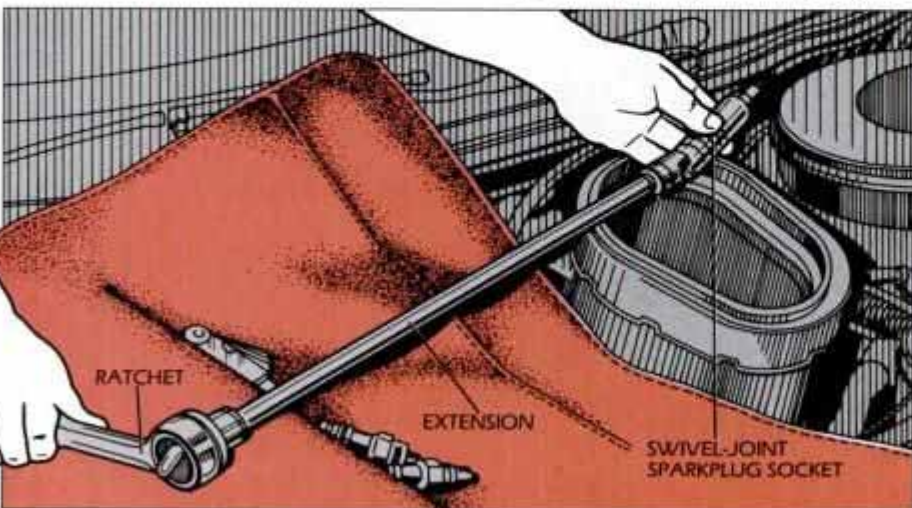


5C Wire gauge slips between electrodes. Bend electrodes with tool on gauge.

ulator. Use a small point file or fingernail file to sharpen the top of the center electrode and the bottom of the outer electrode. Use a tiny screwdriver or knife to scrape deposits from between the insulator and the plug's outer shell.

If you purchase replacement plugs, make sure they're of the heat range recommended by the manufacturer. In almost all cases, changing heat ranges will have a detrimental effect on engine performance. If your plugs were running too cool, as indicated by very dark deposits, or too warm, as indicated by insulator blistering, you most likely have another problem. Gap your cleaned plugs or new plugs to the manufacturer's specs. Use a wire gauge to check the gap. Bend the electrode using the tool at the end of the gauge, if necessary (Fig. 5C).

Use a small dab of antiseize compound on the threads, especially if you have aluminum heads. If possible,

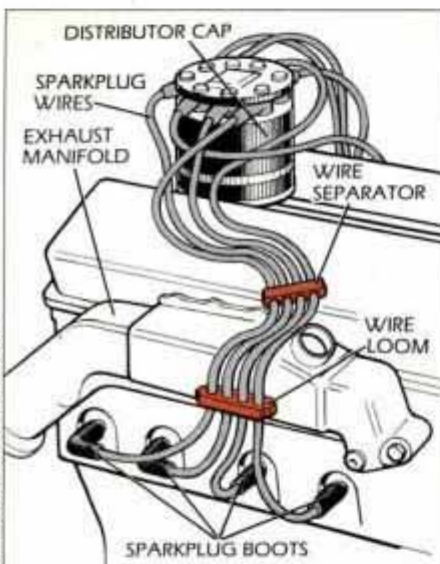


5A You may need a swivel-joint socket and long extension to remove some sparkplugs.

screw the plugs partway into the heads with your fingers to avoid cross threading. If you can't reach them with your fingers, use a piece of rubber hose slipped over the insulator. Don't start plugs with the ratchet. It's too easy to cross thread them. Snug them up with the ratchet. If possible, tighten to 20 lb.-ft. with your torque wrench. If not, tighten only moderately. Don't muscle them down.

6 Replace The Ignition Wires

Heat, moisture, road salt and dirt exact a heavy toll on your plug cables. And because a misfiring cylinder is detrimental to long engine life, keeping the cables fresh can help extend the life of your engine.



6 Route new ignition cables using all of the original separators and looms.

Check your cables every time you check your sparkplugs. Look for brittleness, cuts, cracking, burns or excessive corrosion of the terminals. After three years or 30,000 miles, the wires should be replaced even if they look okay. If your sparkplug check showed one dead cylinder, replace all the cables. If the cables are brand new, replace just the cable that was connected to the dead plug.

Note that on most Chrysler products, the sparkplug cables can't be pulled from the cap. They are retained by means of clips and must be disengaged from inside the cap before they can be removed. This is accomplished by squeezing the sparkplug cable clip with needle-nose pliers.

Don't buy cheap cables. They're almost certain to leak voltage on a high-powered ignition system and won't last very long even on a conventional

ignition system. Purchase silicone-jacketed, graphite-core wires from a name-brand supplier. Don't use solid-core wires. For maximum performance, spiral-core silicone wires are best, but they will cause more radio interference problems than the graphite-core cables.

Install new cables by removing one old cable at a time and matching it to a new cable. Route the new cables where the old ones were, using all looms and separators (Fig. 6).

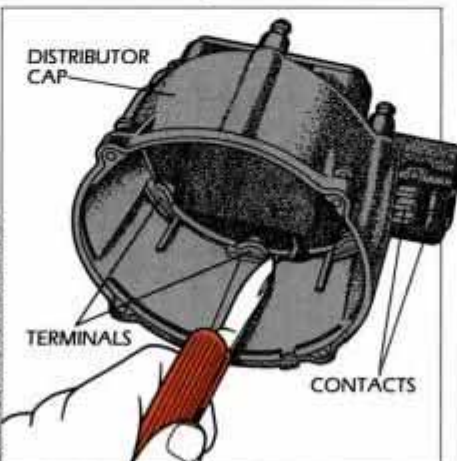
7 Check Cap And Rotor

Like cables, your cap and rotor won't last forever. And, once again, should they fail, an engine-damaging misfire will result. The key, then, is to replace them before a misfire occurs. Inspection at your 15,000-mile service intervals should be adequate. Replacement at 30,000-mile intervals is required.

Cap removal can be fairly complicated on some new cars where access is tight. On GM cars with the big, high-energy distributor, disengage the plug wire retaining cap and set it aside. On many cars, you'll have to remove several sparkplug cables to be able to lift the cap off of the rotor and turn it over.

Most Chrysler products have cables that cannot be removed until the cap is off of the distributor because the cables are retained in the cap by means of internal spring clips. See the previous section on cable replacement. Number each cable removed with a piece of masking tape and number the cap towers to correspond. Release the spring latches or unscrew the screws that retain the distributor cap. To disengage a spring clip, insert a screwdriver blade behind it and lift.

A lot of GM caps have latches that



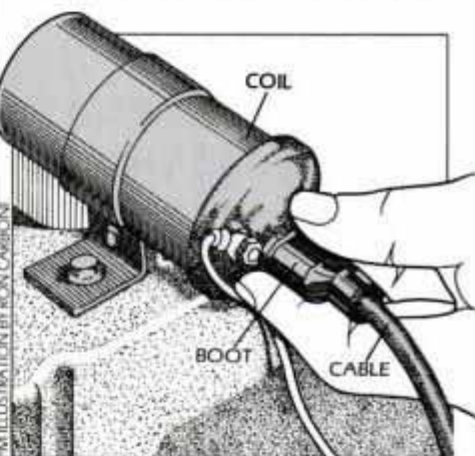
7 Clean terminals with a pen knife. If corrosion can't be easily removed, replace cap.

look like screws and are released by pushing down with a screwdriver while rotating them a quarter-turn. Maneuver the cap into a position where you can see inside it. Check for cracks, fractures or carbon tracks between terminals. Light surface corrosion on the terminals can be scraped off with a knife blade (Fig. 7). If it can't be scraped off, the cap should be replaced.

Check the rotor for corrosion and clean it up with a knife. Replace it if it's badly corroded. Turn the rotor over and check its post mount for cracks or signs of ignition burn-through. Any damage is grounds for replacement.

8 Replace Cap And Rotor

Before installing a new rotor, compare it to the old one very carefully. A lot of rotors look the same, but are actually slightly different. Note the



8 Squeeze cable boots to relieve trapped air as you install them on cap or coil.

length of the conductor and its width at the point where it transfers voltage to the cap. Check the position of the keyway in the rotor's mounting hole. Take a look at the distributor shaft before installing the new rotor. If there's a felt pad inside the distributor shaft, apply a few drops of engine oil or machine oil to the pad before installing the rotor. Install the rotor making sure that it seats fully in its keyway.

If the terminals inside your old distributor are greasy, apply an equal amount to the new cap before installing it. Locate the keyway on the bottom of the cap on the corresponding key in the distributor body. The cap only goes on one way. The two latches are not interchangeable.

Once the new cap has been installed on your distributor, carefully disen-

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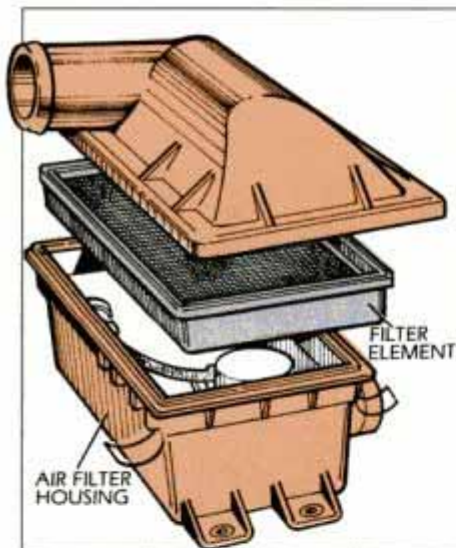
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gage each cable from the old cap one at a time and transfer it to the corresponding tower on the new cap. If you removed some cables previously, note their number and the number of the tower on the old cap that corresponds. Locate the same tower on the new cap and install the cable. Continue until all cables are installed. Check to make sure each terminal clicks into its tower. Squeeze each boot to release trapped air while you push the cable into the tower (Fig. 8).

FUEL SYSTEM

9 Replace The Filters

Part of making a car last is making sure that it's running right. If the fuel mix is right on the money, everything burns nice and clean, the cylinder walls get the right amount of lubrication, the oil doesn't get diluted with

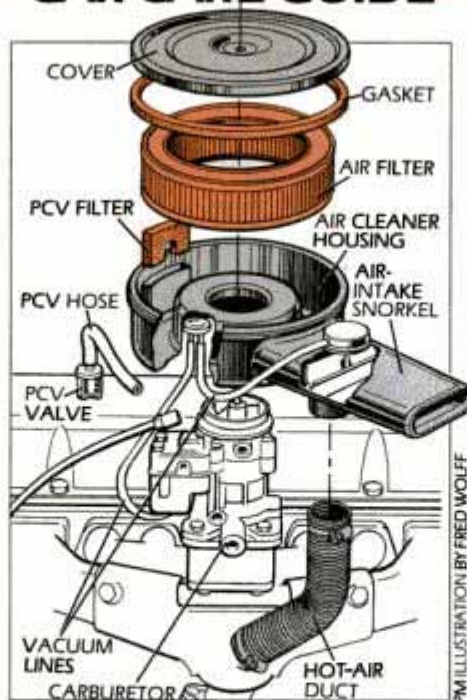


9A Remove the top cover of most fuel-injection air cleaners to service the element.

gas. Your engine is happy. And it will live a lot longer.

All fuel system filters should be serviced at your 15,000-mile maintenance intervals.

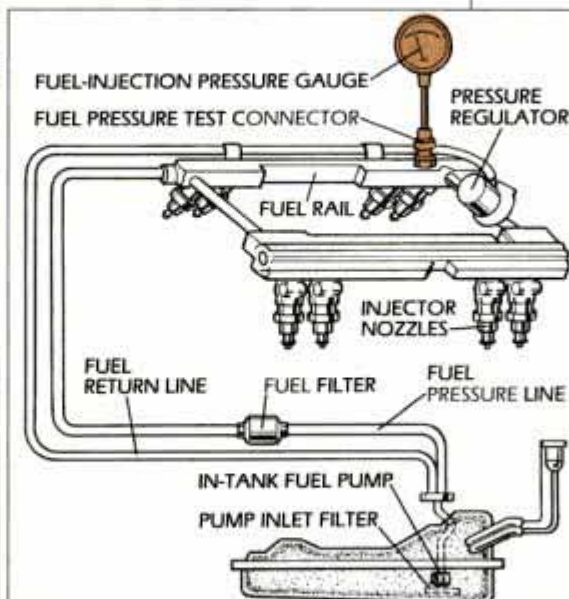
Let's start with the air filter. On most cars, you get to the air cleaner by unscrewing the wingnut in the center of the air cleaner housing. On others, the top of the air cleaner housing is retained by spring clamps (Fig. 9A). In either case, remove the top of the air cleaner carefully. You'll probably find that it's attached to other parts of the engine by means of hoses and perhaps even wires. Disconnect each, marking their position with masking tape, if necessary.



9B Note all connections when removing the air cleaner on a carbureted car.

Most air cleaner housings will contain both the air filter element and a PCV filter, which is located directly behind the point where the PCV hose attaches (Fig. 9B). Remove the PCV filter and replace it with a brand-new element. On many cars, the PCV filter is held in place with a spring clip. You should also replace the PCV valve at this time. Make sure its hoses are not cracked or brittle. Replace them if necessary.

Install a new air filter, making sure that it corresponds exactly to the old one in dimensions and seal areas. Before reinstalling the air cleaner housing on a carbureted engine, complete



9C Replacing the inline fuel filter may require relieving pressure in the fuel rail at the pressure gauge Schrader fitting.

the cold-start system checkouts listed below. (Some throttle-body-type fuel-injection systems are equipped with the hot-air part of the cold-start system.)

Replace the fuel filter. If your engine is carbureted, the filter is either in the fuel line between the pump and carb or behind the carb's inlet fitting. Catch any spilled gas with a rag when removing the filter.

On fuel-injected cars, replace the fuel filter (Fig. 9C) as required by the manufacturer's severe service schedule. We recommend the more frequent service unless you drive only on interstates at moderate speed, in good weather, over long distances. On some cars, in-tank filters are replaced only if they fail. When replacing a filter on any fuel-injection system, you must relieve fuel pressure before you begin. You'll find specific instructions for relieving fuel system pressure in your service manual. Follow them carefully as this can be dangerous if mishandled.

Check your owner's manual to see if your car has any other filters that should be replaced. For example, some cars have an EGR solenoid filter that should be replaced at regular intervals.

10 Service The EGR Valve

An inoperative EGR valve causes spark knock, which can make your engine old before its time. If your car produces the death-rattle noise of spark knock under moderate to heavy load, suspect the EGR valve. And because EGR is critical to proper fuel system calibration, check its operation at your regular maintenance intervals.

Because a number of different types of EGR valves are used on today's and yesterday's cars, specific checking procedures vary. You'll have to consult your service manual for exact details.

But make sure your test answers these three basic questions: 1. Is EGR control vacuum available at the specified level? 2. Does the EGR valve open when control vacuum is applied? 3. Are the exhaust passages in the valve and engine clear and allowing exhaust flow to reach the intake manifold?

11 Tune Up The Fuel Injection

Fuel-injection systems require less maintenance than carburetors, but they can't be ignored.

One of the first areas of concern with a fuel-injected car should be the fuel you use. Buy a brand that advertises fuel-injection cleaning additives. Most of the majors now provide these detergents. Without detergents, injectors can clog, causing rough idle, stumbling or hesitation, and a lean mixture in the cylinders.

If you suspect that you already have clogged your injectors, add a can of fuel-injector cleaner to your tank. All of these products are not created equal. Generally, we've found that the most expensive ones work best.

At your 15,000-mile maintenance intervals, clean the fuel-injection throttle linkage with carb cleaner and lube it lightly with light engine oil or machine oil.

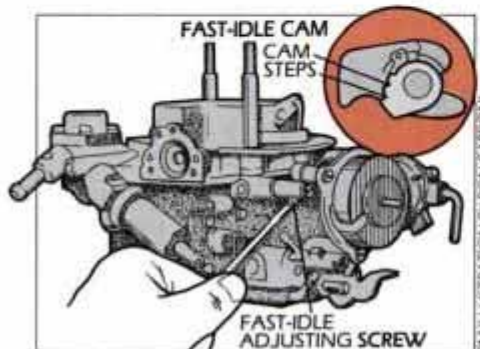
Check the torque on all mounting bolts to prevent misfires caused by air leaks. Check the gas-cap gasket for an even imprint all around. This indicates a good seal. Replace the gasket if it's brittle or deteriorated.

12 Check Systems

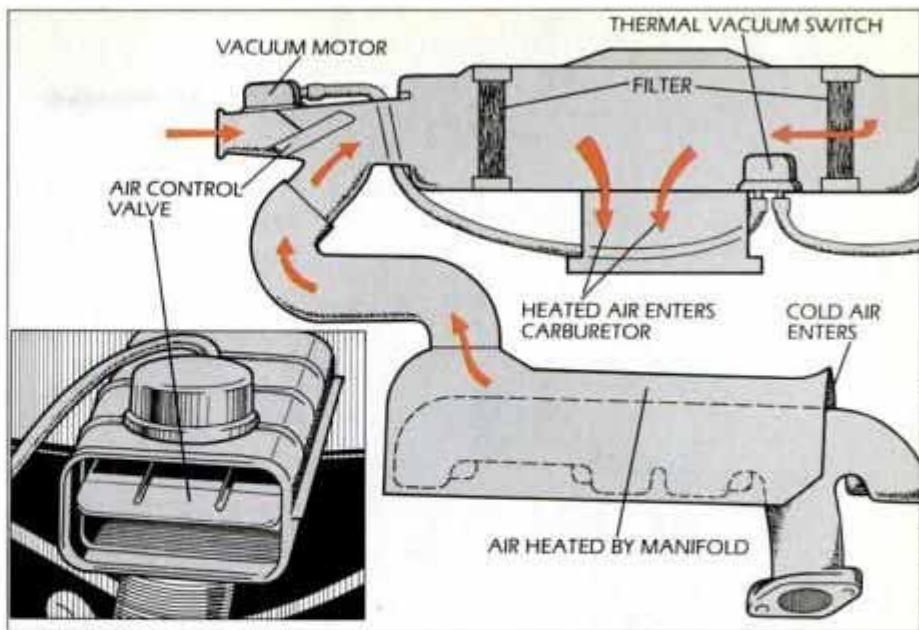
If your engine has a carburetor, you should check choke performance at your maintenance intervals. A good eyeballing of the choke in action will tell you whether or not it's functional. If your car has cold driveability problems, you may have to do more specific choke system diagnostic work.

To check basic choke operation, make sure the choke plate snaps closed when the engine is cold and you open the throttle for the first time before starting the engine. If the choke doesn't close, it's binding or out of adjustment.

Check also to make sure the fast-idle screw comes to rest on the speci-



12A Set fast idle with screw on correct step of fast-idle cam with engine warm.



12B If the hot-air system sticks, overheated air may cause spark knock.

fied step of the fast-idle cam. Your service manual should tell you which step is the correct one for cold-engine fast idles (Fig. 12A). When the car is started, the vacuum brake should pull the choke open just a bit to maintain airflow. As the engine warms and you open the throttle, the choke should gradually open wider and wider.

The heated-air system found on many carbureted and throttle-body fuel-injection systems is essential to good cold driveability and overall engine health. The system provides hot air during warmup by means of manifold stove, a duct and a door.

Most hot-air systems are regulated by a vacuum motor that controls a door in the air cleaner snorkel. The vacuum is switched on and off by a thermal vacuum switch in the air cleaner housing (Fig. 12B).

To check, start the cold engine and use a flashlight and mirror to make sure the door is in the HEAT-ON position. If it's warm outside, you may have to apply an ice cube to the thermal-control switch to make the door move to the HEAT-OFF position. As the engine warms, watch the door to make sure it moves to the HEAT-OFF position.

ELECTRICAL SYSTEM

13 Make Good Connections

High resistance is the enemy of all electric circuits because it reduces the amount of voltage available. It's particularly devastating in the high-amp

starting circuit of your car. A lack of voltage here will leave you at the curb with a car that won't crank. Use a voltmeter to hunt for resistance in the wiring to the starter (Fig. 13A). Any voltage reading seen while the starter motor is cranking in excess of 1 volt or 2 is indication of high resistance in the circuit being checked.

Your maintenance intervals should include a battery-care regimen that can help battle high resistance and keep those electrons flowing.

Start by removing the battery's negative terminal, then the positive terminal and hold-down clamps. Using a good, stiff scrub brush, wash the entire battery with a mixture of baking soda and water, then rinse with more water.

If your battery isn't maintenance free, check the electrolyte level and add distilled water to bring it up to the indicated mark. Some batteries that are packaged to look like maintenance-free batteries are not maintenance-free. You may find slotted caps flush with the case or a big square cap that pulls off.

If you have a top-post battery, clean the posts and terminals with a post and terminal cleaning tool—an inexpensive brush device available at all auto parts stores. Clean the terminals and posts of side-post batteries with a knife. Make sure all cables are free of corrosion and tightly secured at the opposite end. If your cables are attached to the terminals by means of screws and straps, replace them with a set of molded cables that have soldered terminals. The other type is a frequent cause of no-starts as straps, cables and screws corrode rapidly.

O N L Y O N



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Both of these Eagle Talons get their grip from one, and only one, make of tires: Goodyear Eagle street radials.*

When the Eagle Talon was designed, its engineers cut no corners.

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Which is one of the reasons the Talon handles so well. Especially in the corners.

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Credit its fully independent suspension. Its quick-ratio steering. Its all-wheel drive.

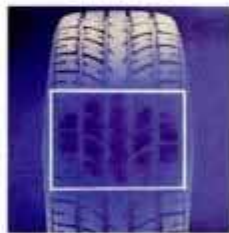
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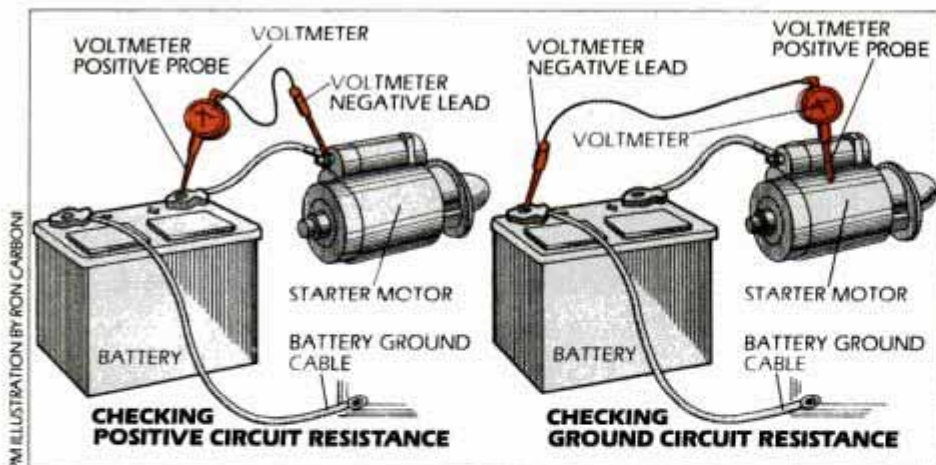


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*Tires shaved to racing depth. Before you race on Goodyear street radials, write The Goodyear Tire & Rubber Company, P.O. Box 9125, Akron, Ohio 44305 for preparation recommendations and procedures.

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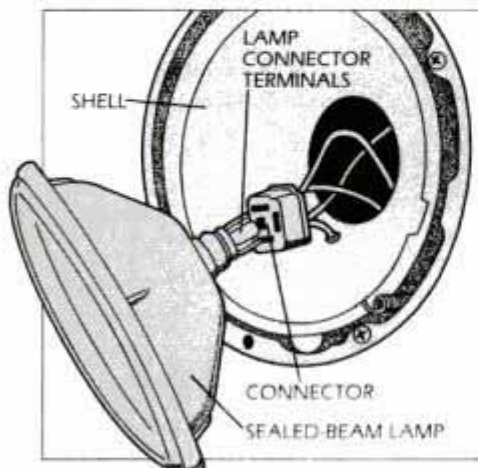


13A Check for excessive circuit resistance by measuring voltage drop across the circuit.

Don't neglect other fronts in the battle against circuit resistance. At your 15,000-mile maintenance intervals, check and clean all plug-in connectors that you can find under the hood. But don't forget to disconnect the negative battery strap first. Pay particular attention to the fuel-injector connectors on cars so equipped. Check all alternator and charging circuit connectors as well. Clean any corrosion from connectors with a sharp pen knife or small nail file. If any of the connectors are coated with dielectric grease, purchase some at your auto parts store.

Headlamps are frequently plagued by bad connections, due to corrosion and increasing electrical resistance. In fact, a lot of good headlamps are tossed on the trash heap because the connector was corroded. When the new headlamp is plugged in, some of the corrosion is knocked loose and the unwitting car owner thinks the problem was a burned-out headlamp.

Before replacing a headlamp that shows no physical signs of failure, try scraping the corrosion off of the connectors and reinstalling the old lamp (Fig. 13B).



13B Check connectors for corrosion before condemning headlamps as burnouts.

If you really want to keep everything right up to snuff, clean the terminals as a matter of course at your 15,000-mile service intervals.

14 Check The Battery

You can check battery condition at your maintenance intervals with a hydrometer. After topping off (if necessary) and cleaning the battery, check the top of the case to see if it has a built-in eye-type hydrometer (Fig. 14). This eye, which is installed in most maintenance-free batteries, changes color as the specific gravity of the electrolyte changes. A bright green eye indicates that the battery is at least 75 percent charged. A dark or black eye indicates that the battery is in need of a charge. A light or yellow eye means that the electrolyte is below the plates and the battery must be discarded. *Never attempt to charge or jump start a maintenance-free battery that has lost electrolyte.*

You'll need a hydrometer to check the specific gravity of conventional batteries. The best hydrometers look like turkey basters with a float inside. The tool should come with instructions in regard to relating temperature and specific gravity. At 80° F, a specific gravity of 1.26 indicates 100 percent charge.

If the hydrometer reading was below spec—below about 1.120 at 80°—the battery is discharged. Confirm this by checking with your voltmeter. At 70° F, a fully discharged battery will show less than 10 volts, a fully charged battery should read about 13 volts.

You can tell whether or not the battery is beginning to take a charge by checking the charger's ammeter. If the meter shows that no current is being passed to the battery, it's not taking a charge. But if the ammeter fails

Retail Outlets

Nationwide: Kmart. **Alabama:** Carport Auto Parts, Chief Auto, Western Auto, Westwood Auto Parts. **Alaska:** Grand Auto, Western Auto. **Arizona:** Checker Auto Parts, Chief Auto, Pep Boys, Target. **Arkansas:** Chief Auto, O'Reilly Automotive Stores, Roy Roger's Auto Stores, Target. **California:** All American Auto Parts (Southern), Auto Giant (Southern), BAP/GEON Imported Parts (Southern), Cal Auto Stores (Northern), Chief Auto, Economy Imports (Northern), Foreign Auto Supply (Southern), G&H Auto Parts (Southern), Grand Auto, Graves Auto Parts (Southern), Jarco Auto Parts (Southern), Kragen Auto Parts, Pep Boys, Scherbas Auto Parts (Northern), Target, Trak Auto, Unlimited Auto Parts (Southern), Von Housen (Northern), Wesco Auto Parts (Southern), Western Auto. **Colorado:** Checker Auto Parts, Target. **Delaware:** Pep Boys, R&S Strauss. **Florida:** Discount Auto Parts, Nationwide, One Stop Auto Parts, Rose Auto Parts, Western Auto. **Georgia:** Nationwide, Pep Boys, Western Auto. **Hawaii:** Western Auto. **Idaho:** Schuck's Auto Parts. **Illinois:** Auto Works, Jack's Discount, Inc., Nationwide, Target, Trak Auto, Western Auto. **Indiana:** Auto Works, Nationwide, Target. **Iowa:** Jack's Discount, Inc., Target, Western Auto. **Kansas:** Auto Works, O'Reilly Automotive Stores, Target, Western Auto. **Kentucky:** Auto Works, Chief Auto, Nationwide, Target. **Louisiana:** Fischer's Auto Stores, Himel Motor Supply, Target, U.S.A. Auto Stores, Western Auto. **Maine:** VIP Discount. **Maryland:** Pep Boys, Trak Auto, Western Auto. **Michigan:** Auto Works, Nationwide, Target. **Minnesota:** Big Wheel/Rossi Auto Stores, Crown Auto Parts, Target. **Missouri:** Auto Works, Jack's Discount, Inc., O'Reilly Automotive Stores, Target, Western Auto. **Montana:** Checker Auto Parts, Target. **Nebraska:** Auto Works, Target. **Nevada:** Checker Auto Parts, Chief Auto, Grand Auto, Pep Boys, Target. **New Hampshire:** VIP Discount, Western Auto. **New Jersey:** Pep Boys, R&S Strauss. **New Mexico:** Checker Auto Parts, Pep Boys. **New York:** Auto Barn, R&S Strauss. **North Carolina:** Western Auto. **North Dakota:** Crown Auto Parts, Target. **Ohio:** Auto Works, Nationwide, RAL Auto Stores, Target, The Andersons. **Oklahoma:** Chief Auto, O'Reilly Automotive Stores, Target, Western Auto. **Oregon:** G.I. Joe's, Schuck's Auto Parts. **Pennsylvania:** Frank's Auto Supply, Giant Auto Parts, National Auto Stores, Pep Boys, R&S Strauss, Royal Auto Stores, Western Auto. **South Carolina:** Nationwide, Western Auto. **Tennessee:** Chief Auto, Nationwide, Roy Roger's Auto Parts, Target, Western Auto. **Texas:** Checker Auto Parts, Chief Auto, Fischer's Auto Stores, Gateway Auto Supply, Johnies Discount Auto Supply, Midway Auto Supply, Pep Boys, Target, Van's Auto Parts, Western Auto. **Utah:** Checker Auto Parts. **Virginia:** Advance Auto Parts, Pep Boys, Trak Auto, Western Auto. **Washington:** A's Auto Supply, Grand Auto, Schuck's Auto Parts. **Washington, D.C.:** Pep Boys, Trak Auto. **West Virginia:** Auto Works, Nationwide. **Wisconsin:** Big Wheel/Rossi Auto Stores, Crown Auto Parts, Target. **Wyoming:** Checker Auto Parts, Target.

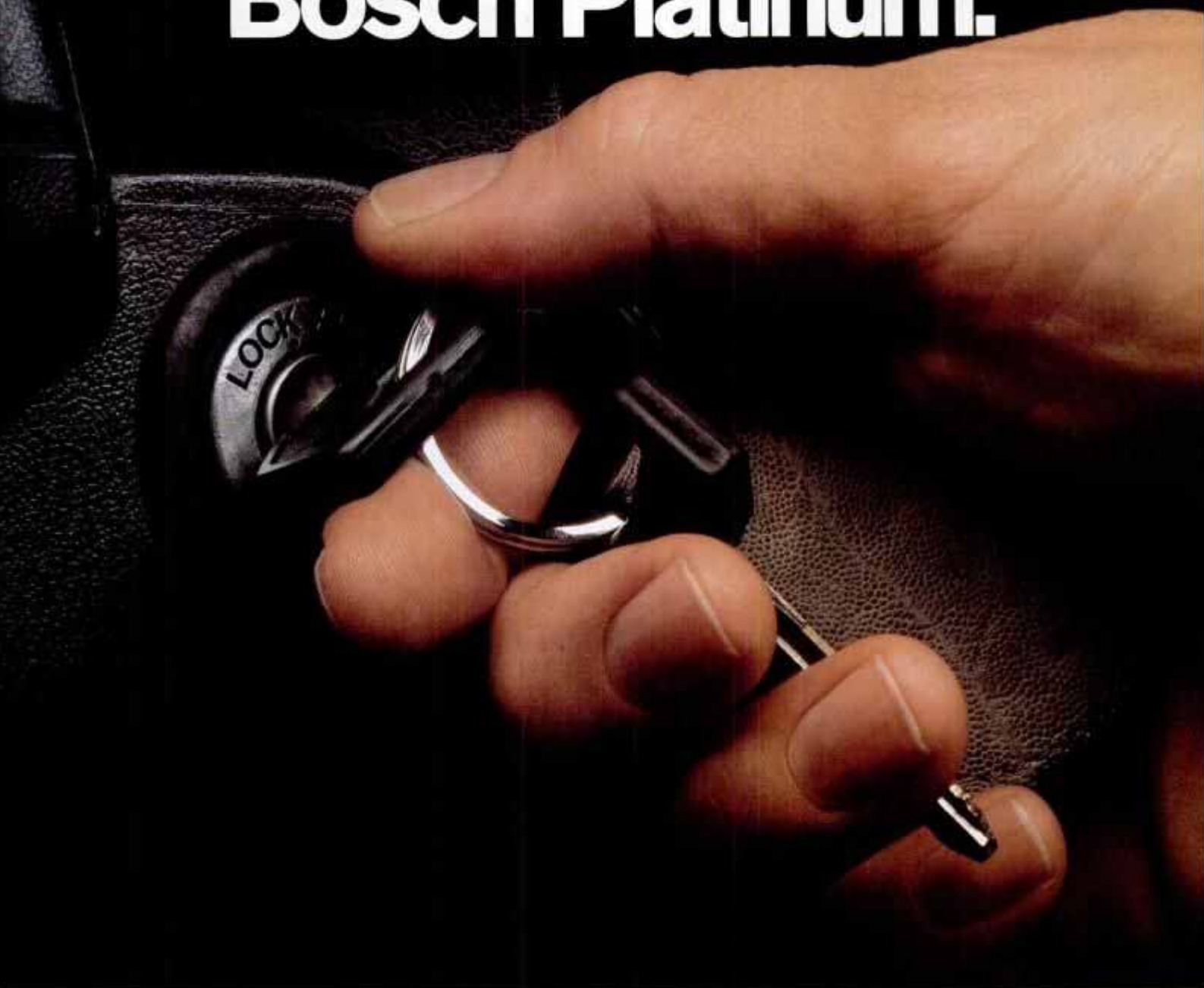
Service Outlets

Acc-U-Tune: California (Northern). **Firestone:** Nationwide. **Precision Tune:** AK, AR, AL, CA, CO, CT, DE, FL, GA, IA, IL, IN, ID, KS, KY, LA, MD, MI, MN, MO, NV, NJ, NM, NY, NC, OH, OK, OR, PA, SC, TN, TX, UT, VA, WA, WI.



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**17 Service The
Auto Trans**

If long-term car ownership is your goal, you should treat your automatic transmission to new fluid and filter at every other maintenance interval—every 30,000 miles. If you use your car or truck to pull a trailer or drive in 90° heat more than half of the time, change the fluid and filter at every 15,000-mile maintenance interval.

Drive your car for at least 20 minutes before changing the transmission fluid. Then, jack and support the car according to manufacturer's instructions. Drag out your biggest drain pan and crawl under the greasy side.

Some transmissions have drain plugs. In this case, changing the fluid is simply a matter of pulling the drain plug and watching the fluid pour out.



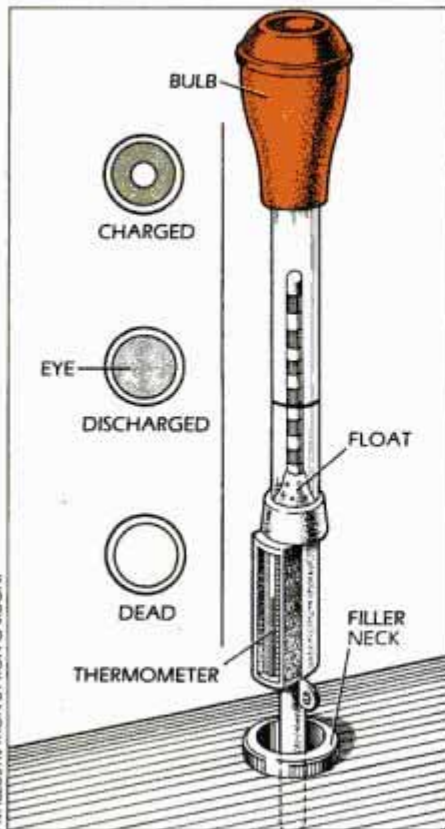
17A You'll find the transmission filter right under the pan, under the valve body.

Keep watching, by the way, just in case your drain pan isn't quite big enough.

If your transmission is like most others and is not fitted with a drain plug, place your drain pan under one rear corner of the transmission oil pan and remove all pan bolts except three in the corner opposite the drain pan. Slowly remove these last three bolts, allowing the fluid to drain gradually from the opposite corner of the pan.

Once you've drained as much fluid as possible without completely removing the bolts, support the pan with one hand and remove the bolts with the other. (This is a good test of dexterity and determination. Those who fail get a bath, so you might want to let the fluid cool a bit more before proceeding here.)

Whether or not your car is



14 Maintenance-free battery's eye can provide a rough estimate, but a hydrometer will read the exact state of charge.

to budge even after extensive charging, replace the battery.

**15 Trace
Circuits**

As cars get older, things stop working. And as things stop working, your car becomes more of a burden than a joy. But there's no need to resign yourself to automotive senility. Some electrical detective work can frequently restore accessories to working condition.

To check a circuit for power, you'll need a simple test lamp, which can be purchased at any auto parts store. This tool is a lightbulb with a probe that can be touched to the positive wire or terminal of a circuit, and an alligator clip that's attached to ground. Most unpainted bolts should provide good ground. For all but the most simple circuits, you'll also need the circuit diagram in your service manual.

If more than one accessory is not working, start troubleshooting at the source of the circuit that these components share—the point closest to the battery positive terminal. If only one part is inoperative, begin your check at the component itself by touching the probe of your voltmeter to the terminal where power is supplied.

If battery power is available to the part, you know that the accessory component itself has failed and should be replaced. If it's not available, work back through the circuit toward the point of power supply.

For example, a switch is likely to be the next component in the circuit. If power is available at the output side of the switch but not at the accessory, you can surmise that the wire between the switch and the accessory is bad. Or if voltage is available at the input side of the switch but not at the output side of the switch (when it's turned on of course), you can be fairly sure that the switch is defective. Work your way back toward the power supply until you find the culprit.

In working your way back toward the power supply, you're almost certain to run into a loom at some point. The loom, a group of wires wrapped with tape or plastic, makes things tougher. But all wires in a loom should be color coded, and the path of the circuit should be illustrated in your circuit diagram. Thus, you should be able to find the same wire at the other end of the loom.

**16 Repair
Circuits**

Once you've found the source of your circuit problem, repairs are quite simple. You can insulate a bare wire, for example, by wrapping it with electrical tape. Or, for a neater job, use heat-shrink tubing, which is available at most auto parts stores. The tubing slides on over the wire. When heated, it shrinks tightly around the wire for a nice, neat repair.

If you have to replace a piece of wire, use wire that's as big in diameter as the old wire or bigger. Don't splice wires with a simple twist and tape job. Braid the strands together, twist them tight and solder them.

To solder, heat the joint with your soldering iron and apply resin core solder to the wire itself, not to the soldering iron tip. (Never use acid-core solder on an electrical connection.) It should flow into the strands. Insulate with tape or heat-shrink tubing. (If you want to use the heat-shrink tubing, you'll have to remember to slide it over the wire *before* you splice.)

To repair wiring on late-model GM cars with aluminum front-body wiring, you'll need the special aluminum wire repair kit that's available from General Motors dealers. This wiring can't be soldered. So, you have to use the special connectors that come in the kit.

equipped with a drain plug, you'll have to remove the pan to service the filter. Once the pan is off the car, you'll probably find a slurry of clutch material and brass powder in the pan. This is normal: Don't be alarmed.

Now you should be eyeball-to-eyeball with the transmission filter, which is secured to the bottom of the transmission, just above the pan. It's probably attached by means of one or two bolts or screws. Remove it and replace it with a new filter, taking care to properly insert any O-rings or gaskets (Fig. 17A). Remove the old oil pan gasket, clean the pan and make sure its gasket surface is flat.

If the transmission pan gasket surface is not flat, but bulges around the bolt holes, flatten it using a ball-peen hammer and a block of wood under the flange. Secure the new pan gasket with fast-drying adhesive. Use just enough to hold the gasket in place (Fig. 17B). Then carefully place the pan and gasket on the transmission case. Start all bolts by hand first, just a couple of threads. Then, snug them with a wrench, working from side to side, in an alternating pattern.

Check your torque converter (the big round object found between trans and engine), for a drain plug. Some Ford torque converters, to name just one, have a drain plug. Most GM vehicles do not. If you find a plug, drain the fluid from the torque converter.

Refill the trans with ATF. Use only the product recommended in your owner's manual. (There are several different types of ATF.) Don't overfill. The cold level will be much lower than the hot level.

Don't just check transmission fluid capacity in your owner's manual and pour in that amount. The torque converter is probably still full. Even if it

Some dipsticks have a cold level mark, others do not. Don't fill the transmission all the way to the normal hot-fluid "full" mark yet.

When you're fairly sure that you're getting close to the full mark, drive the car for at least 20 minutes. If you notice any sluggishness on shifts or going into gear, you may not have enough fluid in the transmission. Once the transmission is good and hot, check fluid level again and fill to the hot fluid full mark.

18 Check FWD Parts

Every time you do a chassis lube on your front driver, you should check the front driveshaft boots for signs of wear and deterioration. These boots cover the constant-velocity joints. If a boot tears and exposes the joint to road grit and gravel, joint failure is almost certain to follow.

To check the boots, turn the steering wheel to full lock right or left. This

do it yourself with

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The All-American Value Team

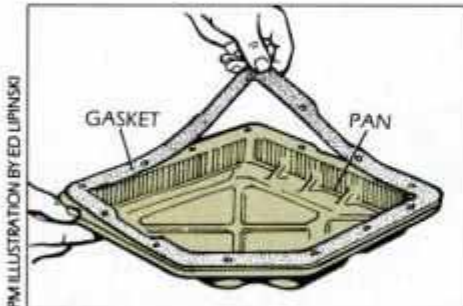
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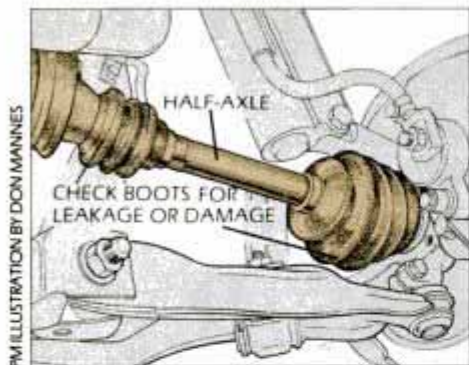
In U.S.A.: Arrow Fastener Company, Inc., 271 Mayhill Street, Saddle Brook, N.J. 07662
In Canada: Jardel Distributors, Inc., 6505 Metropolitan Blvd. East, Montreal H1P 1X9 Quebec



17B Hold new gasket to the trans oil pan with a thin layer of fast-drying adhesive.

has a drain plug, it will retain *some* fluid.

When you think the transmission is almost full, start the engine and move the shifter through the gears. Check cold fluid level with the trans in park.



PM ILLUSTRATION BY DON MANNES

18 If the boots are torn, the front constant-velocity joints will soon fail.

will spread the folds of the boot on one side and make cracks obvious. Look for grease, cracks, splits, tears and holes (Fig. 18). Then turn the wheel all the way in the opposite direction and check the other boot.

After you've scrutinized the bottom of each boot carefully, put the trans in neutral and turn each wheel 180° so that you can easily see the other side of each boot. If your car is supported on wheel ramps, you'll have to jack each wheel to do this. But make sure you lower it onto the ramp again before crawling underneath.

If you do find a bad boot, it will have to be replaced. Split boots that can be installed without removing the half-shaft are available, but they're a compromise at best. Assuming you can get a good seal with the split boot, you still have the problem of contaminated grease on the CV joint. The best fix is half-shaft removal, followed by inspection of the joints. If the joints are okay, they can be cleaned and repacked with fresh grease. Avoid disassembling the joint as the parts have developed wear patterns and will not mate properly if they're mixed up.

Don't attempt the half-shaft removal job without the benefit of a factory service manual. And read the instructions carefully before you begin. You may not want to attempt this repair on some cars, as special tools may be required.

19 Check RWD Parts

Rear drivers require drivetrain attention as well. At every 30,000-mile service you should examine all moving drivetrain parts for signs of trouble.

While you're under the car, grasp the front of the driveshaft with both hands and attempt to move it sideways and up and down. Watch the shaft and front universal joint for any sign of looseness. If something

moves, the joint is worn. Do the same at the rear of the shaft and, with 2-piece shafts, at the center support.

Replace any worn joints immediately. They'll just continue to get worse, and total failure could happen at any time as the vibration and pounding take their toll. If the situation really gets out of hand, you could end up replacing the transmission output yoke or driveshaft as well.

U-joint service is relatively easy on most cars and within the reach of experienced do-it-yourselfers. Check the instructions in your service manual to see if you have the tools and expertise to do the job. In most cases, all you'll need are a good vise, a couple of sockets and a big drift. On some cars, snap-ring pliers may be required.

EXHAUST SYSTEM

20 Inspect All Parts

Periodic inspection of your exhaust system is essential to the health of your car—and you. Exhaust fumes are deadly.

Inspect the entire exhaust system, front to back. Look for holes, corrosion and dents that might restrict the flow. Take a good look at the flange right behind the catalytic converter. This is often the first part to corrode and leak.

Check all joints for signs of leakage, frequently indicated by carbon accumulation. Pay particular attention to the exhaust manifold-to-exhaust pipe gasket, especially on front-drive cars. Check weld seams for corrosion. Examine all brackets and hangers. If you find any sloppy universal hangers or homemade hangers, replace them with original equipment hardware.

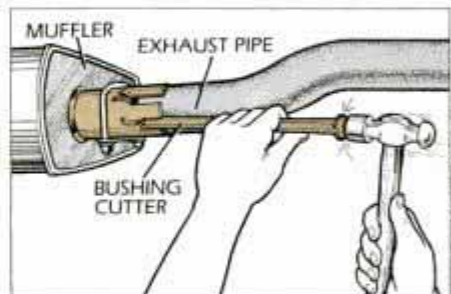
Don't be misled by a muffler that appears almost new at first glance. Pay special attention to the rearward end of the muffler, and look for small rust holes or spots appearing on its surface. Mufflers frequently rust from the inside out, due to condensation. Poke around with a screwdriver.

21 Install New Mufflers

Purchase only original-equipment specification exhaust parts, including hangers. Don't settle for less—not all brand-name parts are OE spec. For some cars, the dealer's parts department may be the only reliable source of OE spec exhaust parts. Don't ever

settle for universal pipe hangers, although that's the first thing that a lot of parts store counter men will pull off the shelf.

If you're going to save the rear pipe or front pipe, cut the bad muffler off with a bushing cutter. This is a spe-



PM ILLUSTRATION BY DON MANNES

21 A bushing cutter will peel back muffler flange from good pipe underneath.

cially shaped chisel that allows you to peel away one layer of metal (Fig. 21).

Start the tool at the edge of a joint, catching the blade just under the edge of the outer pipe. Hammer on the tool and let it work its way in. Don't push it down into the inside pipe.

Before installing a new muffler, check its inlet and outlet tubes. If female tubes are out of round, straighten them by pounding a cone expander or other cone-shaped piece of metal into the tube. For male tubes, use the inside of the cone expander and tap it over the end of the pipe to chamfer the edges. If you don't have a cone expander, you can purchase one through most auto parts stores.

Support the new muffler in place with a jack stand while you attach the hanger. Don't tighten the clamp until all the pipes are in place.

When reinstalling the tailpipe, maneuver it into place with the back of the car jacked up and the rear wheels hanging. However, the rear wheels should be supported at normal height for final positioning and securing of the tailpipe. For this, you'll need a wheel lift or a set of ramps.

22 Replace The Converter

A clogged catalytic converter can cause severe driveability problems and accelerated engine wear. Any exhaust blockage problem can be diagnosed by means of a vacuum gauge measurement of intake manifold vacuum. A vacuum gauge reading that drops to near zero when the throttle is opened rapidly and doesn't rise to the specified normal level for your engine (usually 15 to 20 in. Hg below atmospheric) when the throttle is closed indicates the possibility of a clogged

— CAR CARE GUIDE —

exhaust system.

Original-equipment catalytic converters are extremely expensive. If your car doesn't have a back-pressure-controlled EGR valve (check for this in your service manual), you can purchase an aftermarket universal cat in place of the original equipment item. Some replacement cats sell for less than \$100, while the OE piece may cost \$500 or more.

If you have to replace only the cat, you can almost always remove the muffler and forward pipe as one unit. The tailpipe will probably have to be removed separately as it has to be steered around the rear axle. In either case, the car has to be raised well off the ground to maneuver the tailpipe around the axle.

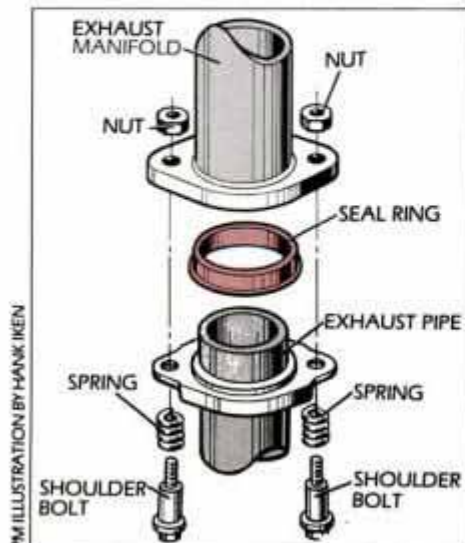
You may not be able to save the tailpipe even if it's good, because you might have to cut it off the muffler in order to remove it.

You'll probably have to cut off the old rear converter pipe flange, as it is almost always severely corroded. The forward converter flange is more likely manageable, as it's stainless steel.

Mount the catalytic converter using new hardware where necessary. Make sure that any part of the cat—or any other exhaust component—does not contact any other part of the car. Make sure the cat is well away from brake and fuel lines since it can get very hot. You should pay particular attention to this when using a universal-replacement cat as it may differ dimensionally from the OE part.

23 Replace Gaskets

The gasket between the front exhaust pipe and the engine's exhaust mani-

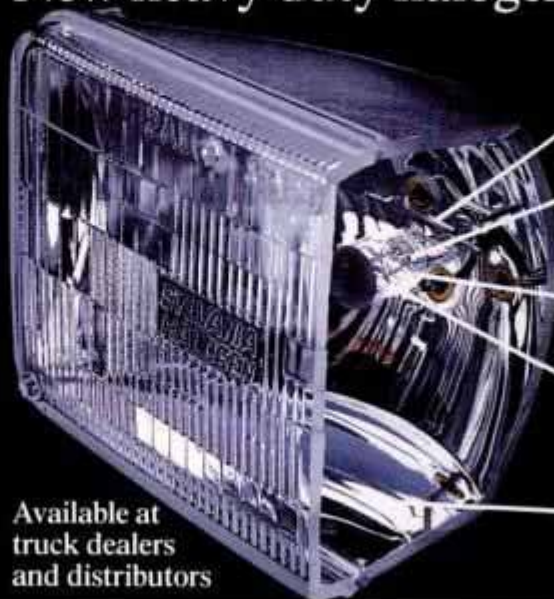


23 Exhaust gaskets on some fwds use a ball-joint seal that may fall prematurely.

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fold is frequently a troublemaker, particularly on front-drive cars which have a flexible bushing between these parts. The bushing may leak long before the pipe corrodes (Fig. 23).

To change the exhaust pipe gasket, remove the muffler, catalytic converter and exhaust pipe as one unit if possible. As noted previously, the tailpipe will probably have to be removed separately in order to steer it around the rear axle.

You'll probably find that the nuts securing the exhaust pipe to the exhaust manifold are severely corroded. Try pounding on a deep-well socket that is slightly too small for the nut. For example, a 13-mm socket can usually be driven onto a $\frac{9}{16}$ -in. nut. Then apply heat to the socket and nut with a propane torch. Be careful to avoid any fuel lines or grease spills.

The first stud may break if it's severely corroded. Fortunately, they usually break in the middle, leaving you something to work with. If the first stud breaks, chisel the nut off of the remaining stud(s), so you'll have a full stud to work with. If you have to, you can try heating the corners of the manifold flange a bit while you turn the stud with a stud puller.

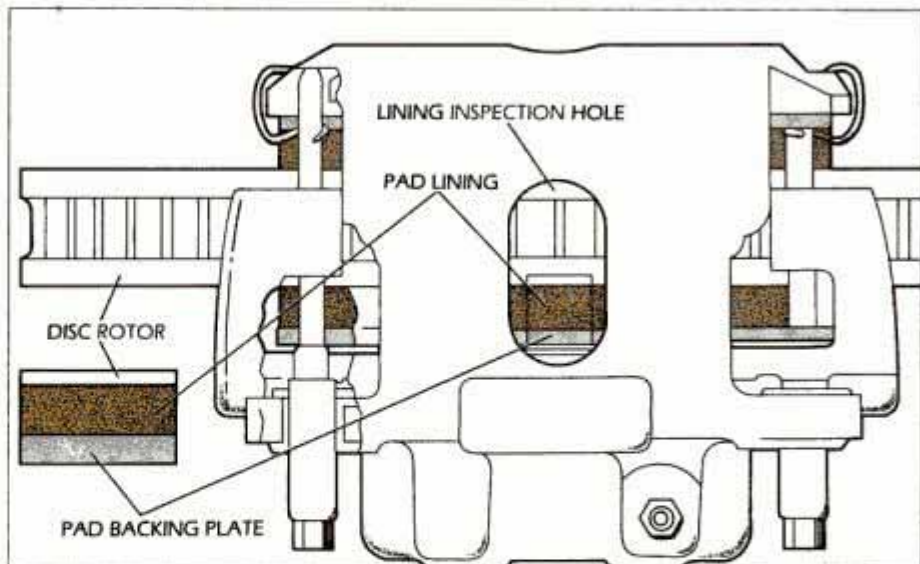
When replacing the gasket, make sure you reinstall any collars that you may find between the gasket and the exhaust pipe. Use brass nuts on the studs and coat them with antiseize lubricant. Don't tighten the nuts until all other exhaust parts have been installed and positioned.

BRAKE BASICS

24 Replace Brake Pads

The most critical part of brake maintenance may well be getting to it soon enough. Badly worn pads and shoes can easily destroy rotors, drums, wheel cylinders and calipers, elevating the cost of service to astronomical levels. What's more, pads and shoes that are devoid of friction material won't stop your car. That's why we recommend 15,000-mile inspection of brake components, including pads.

On most recently produced cars, disc brake pad inspection is simple: You just keep your ears open and your wits about you. These cars have wear indicators that contact the brake disc when the pad has reached minimum thickness. Nevertheless, take a look at your wear indicators during your regular maintenance check. If



24A Some calipers have an inspection hole that allows you to check lining thickness.

you see that they're within $\frac{1}{16}$ in. of the disc, replace the pads.

If your car has no wear indicators but is equipped with bonded brake pads, you can check lining thickness through the access hole in the top of the caliper. The thinnest part of the pad should be thicker than the pad's backing plate (Fig. 24A).

If your car is not equipped with an access hole in the caliper or if you've never serviced your brake pads and don't know whether they're bonded or



24B If your pads are riveted, you may have to remove them to gauge wear.

riveted, you'll have to remove the caliper to check the pads. For GM cars and most Chrysler products, the calipers can be removed by extracting the two caliper retaining bolts. To remove the calipers on most Japanese imports, just unscrew one caliper bolt and swing the caliper up away from the disc. Most Ford calipers are retained by a key that must be removed before the caliper can be disengaged.

If your car is equipped with rear

disc brakes and no access holes, consult a shop manual for specific instructions regarding caliper removal. Because most of these calipers incorporate parking brake mechanisms, their design varies widely and is usually complex.

On all applications, examine the friction material that remains on the old pads. If the pads are nonmetallic, they should have more than $\frac{1}{16}$ in. of friction material above the rivets or—for bonded pads—an amount that exceeds the thickness of the backing plate. Semimetallic pads, which can usually be recognized by their dark gray color, should have at least $\frac{1}{32}$ in. of material above the rivets. Again, if bonded, the friction material should be thicker than the backing plate (Fig. 24B).

25 Replace Brake Shoes

Although some cars have been produced with brake drum access holes that let you eyeball the friction material, the only certain way to check is with the drums removed.

Don't begin this job without your particle mask, as some brake shoes contain asbestos. If your car has drum brakes on the front or if it's a front driver with drum brakes on the rear, you'll have to remove the wheel bearings (Fig. 25A) before the drums can be pulled off the car. Consequently, you can combine your 15,000-mile wheel bearing repack with brake shoe inspection. Don't neglect the front wheel bearings on rear drivers. They should be cleaned and repacked at 15,000-mile intervals as well. (Most front-drive cars have sealed wheel bearings at the front wheels.)

CAR CARE GUIDE

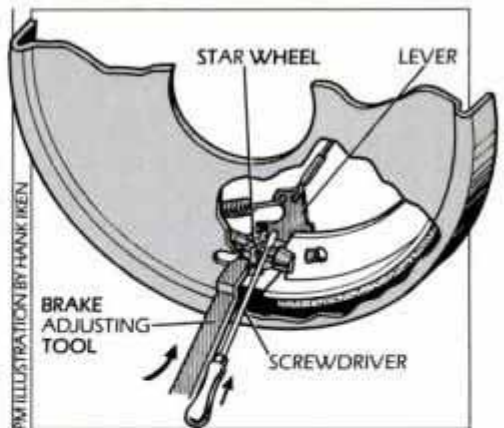
If your drums have never been removed, you'll probably find a retainer washer on one stud of each drum. Cut it off and throw it away.

On low-mileage cars you may find that the drums can be pulled right off of the studs. On most cars, however, you'll have to retract the brake shoes.

To draw those shoes in on cars with adjusting slots in the backing plates, remove the rubber plugs that cover the slots. Then reach in with a small

screwdriver and lift the self-adjusting lever away from the star wheel. While holding the lever with the screwdriver, insert your brake adjusting tool in the slot alongside the screwdriver. With the adjusting tool engaged in the teeth of the star wheel, pull it up or down to back off the brake adjustment and loosen the shoes (Fig. 25B).

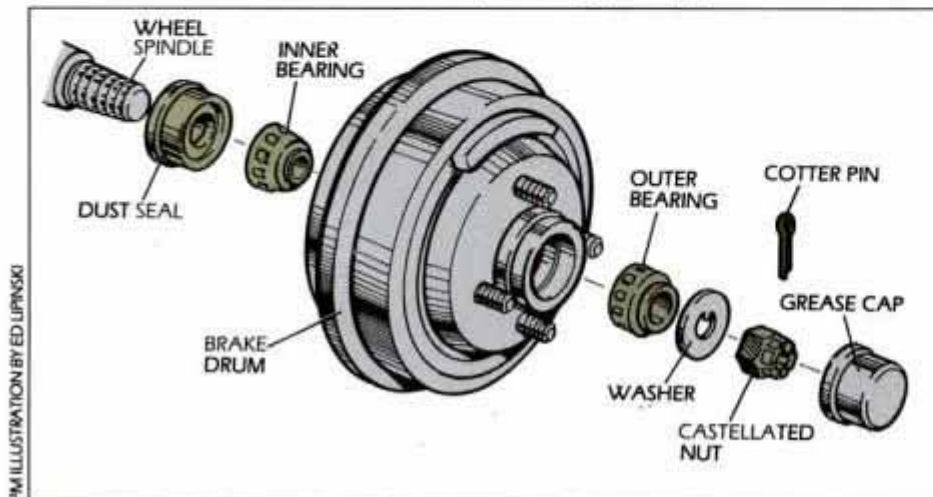
If you find adjusting slots in the front of the drums rather than in the backing plates, you'll need a hook to



25B Back off adjustment while releasing star wheel by lifting with a screwdriver.

hold the self-adjuster lever away from the star wheel.

After making sure that your breather mask is in place, remove the drum. Check the inside of the drum for scoring or deep wear. If the drums aren't pretty near perfect, have them machined. If a drum is blue or surface-cracked from excessive heat, it must be replaced. Bonded lining should be more than $\frac{1}{16}$ in. thick. If it's riveted, it should extend at least $\frac{1}{32}$ in. above the rivets.



25A Pull cotter pin and unscrew castellated nut to remove front brake drums.

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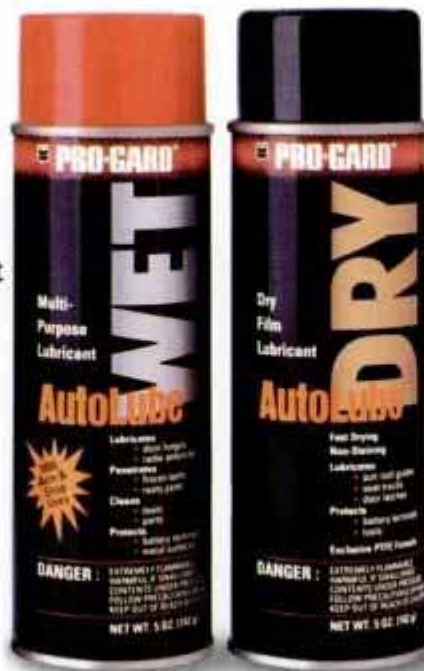
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26 Use Good Brake Pads

Because a brake shoe or pad fits your car doesn't necessarily mean that it's the right pad or shoe for the car. Friction materials vary in respect to their ability to generate friction and resist fade, while wearing at a reasonable rate. And the original equipment linings provided by the manufacturer are usually the best compromise for any vehicle, driven in a normal way.

Cheap, discount store linings are almost always inferior to OE. Sometimes even a lining that is allegedly high performance can have a negative effect on your street-driven car.

A few examples: Semimetallic friction material will resist fade better than most material without metallic content, and it is used in a lot of racing applications. But it has to get hot. Pads designed for road-racing use will never get hot enough in normal street driving to provide efficient stopping power. And if your rotors were engineered for nonmetallic lining, semimetallics may eat them alive.

On the other hand, a car that was engineered for semimetallic linings may wear out a set of nonmetallic pads within a few thousand miles.

How do you get the right friction material for your car? We see two alternatives. One: Buy original equipment lining from your dealer. Two: Buy a top-line product from a name-brand manufacturer.

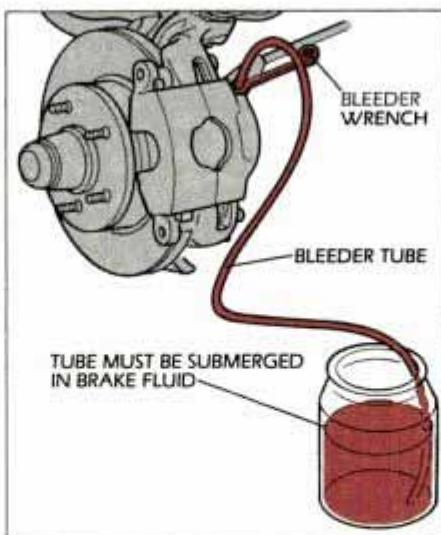
27 Bleed The Brakes

If your brake pedal pumps up on repeated application, something's wrong. If there is no fluid loss, the pump-up problem is a result of air in the hydraulic system. Bleeding the system should take care of it. Hint: Keep brake fluid off bodywork, unless you want to see your paint job on the floor.

Unless your master cylinder was recently removed, the air is probably at the wheel cylinders. If you suspect air in the master cylinder as well, check your service manual.

To bleed air from the wheel cylinders and lines, pump the brake several times with the engine off. Find a box wrench that fits the bleeder valves. Attach a transparent tube over the bleeder valve end. Submerge the other end of the tube in a container full of brake fluid (Fig. 27).

Have your helper depress the brake slowly and hold. Loosen the bleeder of the right rear wheel, and



27 Bleed fluid into a clear bottle filled with clean, new brake fluid.

let the pedal sink to the floor. Tighten the bleeder, slowly release the pedal, and wait 15 seconds. Then do it all again. Repeat until you don't see any air bubbles in the container of fluid. Keep the master cylinder filled.

After bleeding the right rear, continue with the left front, left rear and right front, in that order. Repeat the entire procedure if necessary to eliminate any pump-up or sponginess.

STEERING AND CHASSIS

28 Lube The Chassis

The lubrication of chassis joints at oil change intervals will help ensure that your car will continue to steer and handle with much of the same precision and safety that made it so neat when it was new. But don't limit lube service to steering linkage parts, make sure every moving part under the car is lubricated.

Start with the grease fittings in the suspension and the steering linkage. Some cars have plugs installed where grease fittings should be. If that's the case, buy some grease fittings at your auto parts store and install them in place of the plugs.

Some cars don't have conventional grease nipples. A few have flat dish-shaped fittings that are serviced with a special needlelike grease nozzle. A few, including Porsche, Mercedes-Benz and some Toyotas, use sealed chassis components that do not require periodic lubrication.

Make sure you service every grease fitting. You'll find a list of them or perhaps even a diagram in your owner's

manual or service manual. Some cars have as few as four. Some have as many as 20. If your car has independent rear suspension, expect to find a few at the rear-axle control arms. Check the driveshaft U-joints as well.

Some parts have a rubber dust cover to hold grease—ball joints for example. When servicing these, pump in grease just until the cover swells a little. On parts without a dust cover, pump in new grease until old grease oozes out of the joint (Fig. 28).

Check the lube level in your rear differential and top off if necessary. Use the lube recommended in your owner's manual—SAE 90 hypoid for most cars. Cars with limited-slip differentials require a special lube. For most cars, the differential unit is full when lube begins to run out the hole.

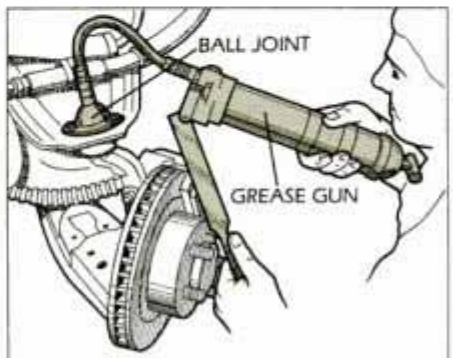
Most manual transmissions on rear-drive cars use SAE 90 lube as well, but check your owner's manual to be sure, as modern cars sometimes specify ATF or even engine oil.

On front-drive cars, some manual transaxles are filled with automatic transmission fluid, others with engine oil. Check and top off at your 15,000-mile intervals, or more often, if you have reason to suspect a leak.

Check automatic transmission fluid once every 500 miles or so, more often if you have a leak. There are several types of fluid—use only the type recommended for your car.

Treat the parking brake cable guides to a small amount of grease. Lube trans and clutch linkage parts with engine oil. As noted in the section on brake service, wheel bearings should be cleaned and repacked at 15,000-mile intervals in combination with a brake shoe and pad inspection.

While we're talking lube, don't forget the topside. You should check your power steering fluid level every time you lube the chassis parts, and more often if you have a slow leak. Add power steering fluid as required. Don't use ATF unless your owner's



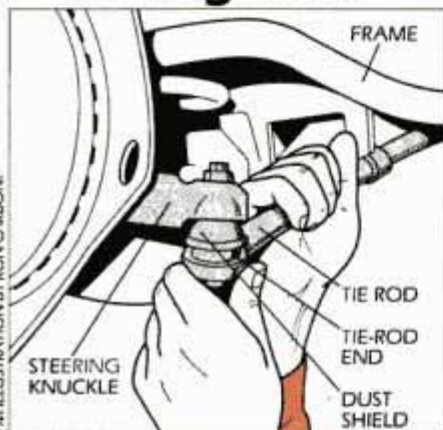
28 Pump in grease until the boot swells—but don't burst the boot by overfilling.

manual specifies it for your car.

Check brake fluid and top off only with new DOT 3 fluid from a freshly opened can. Don't try to save brake fluid on the shelf once the can has been opened. It will absorb moisture from the air and become contaminated.

Clean the throttle linkage with carb cleaner and lube with light machine oil. Use engine oil to lube the door hinges, hood hinges and hood spring anchor. Lube the door locks with light machine oil. Slap some chassis grease on the hood latch. Wipe the radio antenna mast with a dry rag, then lube it with Teflon spray or silicone spray lube. (You can use this type of lube on the carb linkage and door locks if you prefer. It won't attract as much dirt as the light machine oil.)

29 Keep Steering Taut

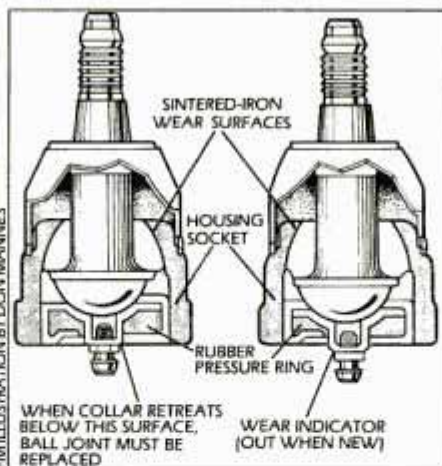


29A Check for rod end wear by grabbing the tie rod and shaking it vigorously.

If you want to keep your car at its best well into its twilight years, you should check all moving chassis components for excessive wear at your 15,000-mile major maintenance intervals.

Begin with the steering linkage parts. Check the four tie-rod ends of a parallelogram linkage or the two outer rod ends of a rack-and-pinion system by grabbing the tie rods and shaking them (Fig. 29A). If a rod end is sloppy or loose, it must be replaced. All joints *should* allow some horizontal movement, but not unrestricted vertical movement. Replace loose joints and any joints with torn or missing dust boots.

You'll need a tie-rod end pickle fork or a tie-rod end puller to disengage the joint from its mount. Before unscrewing the rod end from the tie rod, measure from the center of the rod end to the center of the opposite rod end or—on rack-and-pinion systems—to the boot retaining groove. When you install the new rod end or ends,



29B Most cars have wear indicator ball joints. This is the most common type.

screw them in to the point where you achieve the same dimension. Cars with parallelogram linkage have an idler arm that suffers much abuse and wears out fast. Check it by pushing the end of the arm attached to the center link up and down. It should show only slight vertical movement. GM, for example, specifies $\frac{1}{8}$ in.

To replace the idler arm, you'll need that tie-rod pickle fork to disengage the idler from the center link. Use a

new locknut for reassembly.

Ball joints are another steering linkage part that should be checked for wear at your regular maintenance inspections. Most cars now have easily checked wear indicator joints.

Some of these joints use the grease fitting as a measurement device. On this type, a collar encircles the grease fitting. As the joint wears out, the collar sinks below the surface of the joint. When it drops below the edge, the joint is a goner (Fig. 29B).

Other wear indicator joints can be checked by attempting to wiggle the grease nipple. If you can move it, the joint is bad. This type of joint is found on Chrysler products and a few other applications. You'll want to turn to your service manual for instructions on checking joints without wear indicators.

30 Fix The Steering

Do you have to tug at the wheel constantly to keep your car moving in a straight line even when traveling on a flat road with no crown? If so, you should try to find the cause of this



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steering imbalance and correct it before the resulting friction wears out your chassis parts and tires.

The first step is an examination of those tires. (Let's assume you've already checked the obvious, and they're inflated properly.) They must match size-for-size, left to right. Try rotating them and test again for pull. If the pull moves to the other side or disappears, you've located the cause.

Check for worn steering linkage parts as described in the preceding section. Then have a chassis specialist do a proper 4-wheel alignment.

On rack-and-pinion systems, check for an off-center valve adjustment. See your service manual for specific details, or ask that chassis specialist to have a look.

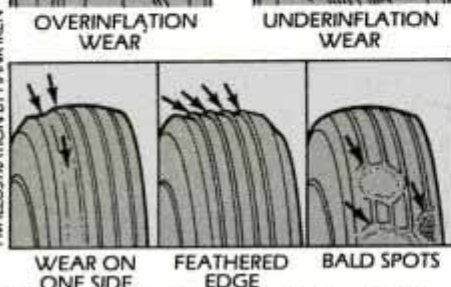
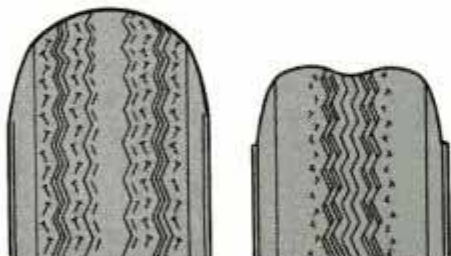
WHEELS AND CHASSIS

31 Align The Wheels

Make it a habit to check tire pressure every time you purchase gasoline. If you don't own a tire gauge, buy one.

Every few thousand miles, you should eyeball tire tread for signs of unusual wear patterns. First, look for excessive overall tread wear. Most tires have tread wear indicators that are visible when wear exceeds normal limits. These appear as 1/2-in.-wide bands across the tire tread. Tires without wear indicators are worn out when less than 1/16 in. of tread-groove depth remains.

Unusual wear patterns usually are a sign of trouble. Wear that occurs only in the middle of the tire signals overinflation. Wear that occurs only on the outer edges of the tire signals



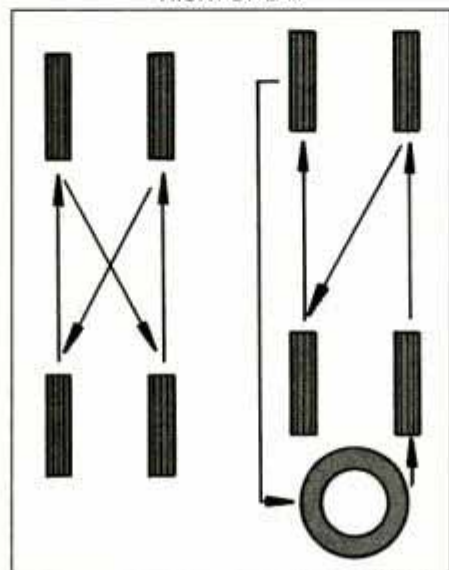
31 Uneven wear means incorrect tire pressure, or chassis or alignment problems.

underinflation. Some radials, however, may wear normally even when under- or overinflated.

Excessive camber causes one side of the tread to wear more. Incorrect toe-in causes the edges of the tread to feather. Cupping, scalloping and bald spots are usually the result of tire and wheel imbalance (Fig. 31).

32 Rotate The Tires

FRONT OF CAR



4-TIRE ROTATION 5-TIRE ROTATION

32 Rotate tires to prevent uneven wear, usually at 7000- to 15,000-mile intervals.

Tire rotation yields dividends in terms of more uniform tread for best traction and an extended tire life. The more often you rotate, the more evenly your tires will wear. As a rule of thumb, rotate new tires when they begin to show wear, and then at equal intervals thereafter. On some cars, wear may appear as early as 7000 miles. (If you notice a lot of wear right away, you have a wheel alignment problem that must be addressed immediately.) At the very least, rotate your tires at 15,000-mile intervals.

Ignore any instructions you may have seen in the past regarding different rotation patterns for radial and bias tires. Rotate all tires using the cross-rotation plan in Fig. 32.

Tighten the wheel lugs with a torque wrench to avoid warping wheels, brake discs and brake drums. Torque in a side-to-side pattern, bringing the lugs only to half of the torque figure first time around.

You should find a lug nut torque spec in your owner's manual or service manual. If not, torque 1/2-in.-dia. lugs to 85 lb.-ft. and 7/16-in. lugs to 70 lb.-ft.

33 Balance The Wheels

Out-of-balance or out-of-round wheels will quickly wear out tires. Worse yet, the constant vibration will accelerate wear of suspension and steering components. And of course, a car with a vibration is just plain nasty to drive.

At this point, we'll assume you've already checked your tires and wheel bearings and found them to be free of defects like bumps or bald spots, visible damage, or loose wheel bearings.

Usually, a wheel vibration caused by imbalance is speed dependent—you'll only notice it at certain speeds. The right fix is a wheel balancing that corrects both static and dynamic imbalance. The shop should have a balancer that runs the wheels up to speed and electronically measures imbalance. A bubble-type wheel balancer measures only static balance and is not adequate.

To make sure they do the job right, clean the inside and outside of the wheels yourself before bringing them in for a balance job. Remove any stones lodged in the tread.

34 Install The Wheels

A nice set of lightweight, aluminum alloy wheels can reduce unsprung weight for possible improvement of both ride and handling. Some smooth-faced wheels with holes at the circumference may even help reduce aerodynamic drag and cool brakes.

The new wheels can be wider than the original wheels (providing the bigger tires clear the wheelwells, struts, brake calipers and other components), but they must be dimensionally correct in every other way.

If you're fitting new tires to your new wheels, they must be of a size approved for that particular wheel.

The wheel bolt pattern, must be correct, of course, and the center hole fit on the hub should be the same as the original equipment wheels. Most importantly, wheel offset should be maintained.

Wheel offset is probably the most critical dimension in terms of suspension component wear and vehicle handling. Offset is the distance between the rear mounting surface of the wheel and the wheel centerline. This dimension should match the original equipment specification. If it doesn't, the suspension geometry will be altered and suspension components may be overloaded.

SPRINGS AND SHOCKS

35 Inspect The Shocks

Depending on loads carried, the types of roads you drive on and the way you drive, your shocks may last anywhere from 5000 miles to 50,000 miles. But they won't last forever. You should check your shocks at those 15,000-mile major maintenance intervals or at 5000 miles, if you tow a trailer.

Driving your car is part of the shock absorber inspection procedure. How does the car feel in turns? Has it lost some of the certainty it once had. Does it assume a solid, level position with one sure move after the lateral force has unloaded when you come out of the turn? If not, the shocks may not be providing enough damping to control oscillation caused by weight transfer. How about when you hit a bump or dip? Do the wheels move once and then settle into a firm solid position as they should?

If the shocks pass the driving test give them a visual inspection. Get the

car up on jackstands and examine each shock absorber. If there are signs of a fluid leak, the shock is dead.

36 Choose New Shocks

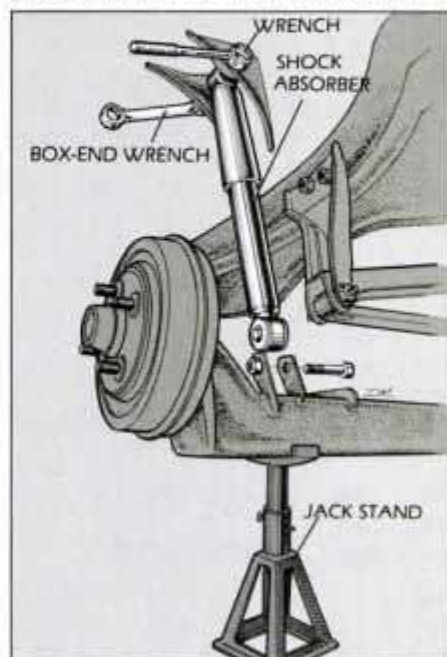
If you would like to duplicate the balance of ride and handling your car achieved when new, you should replace your shock absorbers with units that meet original-equipment specs to the letter. Of course, you'll only achieve like-new ride and handling if all your suspension bushings and springs are new as well.

A high-performance shock is set up with stiffer valving so that hydraulic fluid in the shock chamber is not as easily displaced. This transmits more road shock to the passenger cabin, but also helps control overtravel.

Some of the best premium shock absorbers combine firm action with gas pressurization. By using gas to pressurize the reservoir chamber, aeration of the fluid over bumps is prevented. For you, this means the damping action won't fade on bumpy roads where shock action is almost constant.

37 Install New Shocks

If your car is fitted with MacPherson struts rather than conventional shock



37 Support rear axle with jackstands when removing shock absorbers.

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absorbers, let a professional do the job. But on cars with conventional shocks, replacement is usually a fairly simple matter.

If the upper shaft of the shock is retained in its mount with a single nut, you'll have to hold the shaft with a square drive socket or a pair of locking pliers while you turn the nut with a box wrench. In some cases, you'll find that the nuts are frozen. Chisel them off or use a nut splitter.

Rear shock absorber installation is usually quite easy (Fig. 37). On some cars, you'll find a single bolt and nut is used to retain the shock's round bushing mount at each end. On others, you may find a flat mount plate at one end of the shock that is retained with two bolts.

Don't cut the retaining wire on gas shocks until they're bolted in.

38 Test The Springs

One sure sign of worn-out springs is body sag. But sometimes it's difficult to gauge body sag by eye alone. When your car is new, you should record a measurement from the lower edge of each bumper to level ground. Then, you can check for sag simply by repeating the measurement.

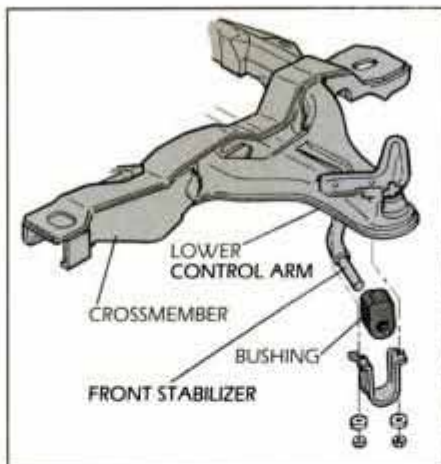
Some auto manufacturers provide ride height specifications. In most cases, these specs require a measurement from a spot on the rear axle to a snubber or other component on the frame. Up front, you might have to measure from a point on the front spindle to a location on the frame.

The measurements are then compared to a service manual spec to see if they fall in the acceptable range. If not, the springs should be removed and replaced. This is a job for a professional. Once ride height is corrected, all four wheels should be aligned.

39 Fix Chassis Rattles

Your 15,000-mile maintenance checks should include a thorough undercar inspection. Check all rubber bushings for deterioration and looseness. Control arm bushing replacement can be a big job, but it may be necessary to rid yourself of a rattle and fully restore new car ride and handling.

Note especially those bushings that are found at each end of front or rear stabilizer bars and at the points where the sway bar attaches to the frame. These bushings wear out rapidly and are a common source of rather loud and nasty rattles (Fig. 39). They're



39 Stabilizer bar bushings are a common, but easily cured, cause of rattles.

also quite easy to replace.

Check the engine and transmission mounts for looseness or cracking of the rubber mount sandwich. If you find that your shift linkage binds when you accelerate, suspect torquing of the drivetrain caused by a broken mount. Sometimes you have to raise the engine slightly with a jack under the oil pan to notice a broken engine mount.

Check all undercar bolts for proper tightness. If you find that a bolt continuously works its way loose, reinstall it with anaerobic sealant.

EXTERIOR CARE

40 Touch Up The Paint



40 Repair chips by dabbing touchup paint into chip with a match or tiny brush.

The only perfect fix for door nicks, stone chips and similar nastiness is a new paint job. But with a little patience and a light touch, you can do some temporary repairs that will do much to restore the old buggy's good looks and help prevent rust. Since most paint chips occur below the beltline in relatively inconspicuous places, a simple recoloring of the affected area goes a long way.

First, purchase a can of touchup paint that is an exact match for the color of your car. You'll find model and paint information on the container. Choose the brush-applied paint if you can find it. If not, you can make do with an aerosol can. Spray some of the aerosol into its own cap, or other container, and allow it to thicken for 10 minutes.

Using a penknife remove all rust from the nick area (Fig. 40). Don't sand the area. You want to leave the edge of paint around the nick to serve as a sort of reservoir for the new paint.

41 Wax The Finish

To do a detailer-quality wax job, you need four products: bug and tar solvent, a fine-grit polishing compound intended for hand application, polymer sealant and pure carnauba wax.

To begin, remove any glop with the solvent, then polish. Remember, if your car has a metallic or clear-over-base paint, use a polish formulated for metallic/clearcoat paint.

After you've polished the car thoroughly, wash it with warm water. Then dry with a chamois that has been completely soaked in water and wrung out. Keep wringing out the chamois as you work and dry the finish completely. Coat the finish with polymer, according to the directions on the can.

When the polymer has dried to a haze, polish it with a soft polishing cloth. Once the polymer has been buffed to a shine, apply the carnauba wax right on top of it.

(Some waxes advertised as carnauba are *not* pure carnauba and may contain abrasives. Be careful. An abrasive will remove your expensive polymer.)

When the carnauba has dried to a haze, polish it off with a soft, lint-free polishing cloth.

The polymer will outlast the carnauba by at least three to one. You might choose to renew the carnauba every couple of months and repeat the whole procedure once a year.

INTERIOR RENEWAL

42 Shampoo Carpeting

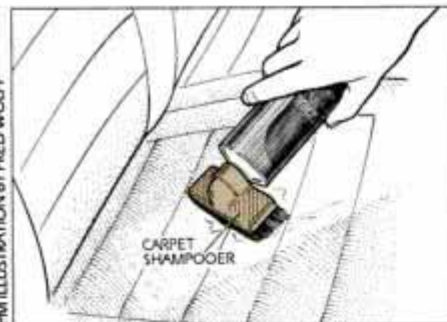
Thoroughly vacuum all cloth surfaces and carpets. If possible, use a vacuum with a brush attachment so you can scrub a bit as you vacuum to help dig out down-deep dirt particles. The more dirt you get out *before* you shampoo, the cleaner the carpets will be after you finish.

You can buy aerosol cans of car-interior shampoo at any auto parts store. Or, you can purchase regular carpet shampoo and a hand applicator at most department stores.

If you're using household shampoo, the hand-applicator you bought probably has a brush and sponge attached to a bottle. Simply scrub the carpet with this in two directions while squeezing the bottle slightly.

If you're using the automotive shampoo, spray some on and work it in with a scrub brush (Fig. 42).

With either type of shampoo, don't soak the carpet. It won't dry, and it's not necessary. Wipe up any excess shampoo with clean rags, soaking up



42 Shampooing is only the first half of the job—vacuuming is needed to remove dirt.

as much of the diluted dirt as possible.

Let the seats, door panels and carpets dry thoroughly before you go near them. You can't overdo it here, because it's the final vacuuming that actually picks up most of the dirt.

43 Clean The Upholstery

You'll find a variety of vinyl upholstery cleaning compounds at your auto parts store. Spray the product on the vinyl and on a rag, then scrub small areas with the cleaner-dampened rag.

Finally, wipe dry with a soft, clean rag. Sometimes it takes several applications to remove all of the dirt.

When everything is clean, we like to treat all vinyl surfaces except the

seats to a coating of a vinyl and rubber protector like Armor All or Son Of A Gun. These products will give the vinyl a bit of a shine and help prevent hardening and brittleness.

Don't apply them to vinyl seats because they seem to make the surface somewhat slipperier, and for enthusiastic driving, vinyl seats are already too slippery.

The vinyl and rubber protector can also be used to dress up tire sidewalls and other external, black vinyl, plastic or rubber parts.

If you take good care of your leather upholstery from the day your car is new, it may last almost forever. In this case, good care means regular cleaning and treatment with a product that will help prevent dry-out and cracking. We find that good old saddle soap is still the best choice here.

Just dip a damp rag in the can and get a good smear of saddle soap. Then work the saddle soap thoroughly into one section of the leather. Wipe off the excess saddle soap, but don't wipe the leather dry. After the wet film has air dried, polish the seat with a soft, dry cloth. You'll get a slight luster and a nice overall appearance.

If your leather upholstery is really filthy, you may have to start with something stronger. Most auto parts stores have solvent-type leather cleaners that can be used to remove heavy-duty dirt. After using a leather solvent, follow up with saddle soap.

WHEN ALL ELSE FAILS

44 Restore The Car

Suppose, however, you've managed to neglect your car or truck to the point where the maintenance is more than preventive, more than just keeping ahead of entropy.

Suppose you've got a clunker. A candidate for the crusher. Not that there's anything actually trashed or crashed, or major amounts of rust. It's still running—you drive it every day. But you wear shades when you do, 'cause you're *ashamed* of it.

You've got two choices: Get rid of it, or restore it.

Restorations, like cosmetic surgery, come in degrees of seriousness. Assuming that this car of yours is really bad, and you really like it (or liked it when it was new), be prepared to spend lots of time and money.

A serious, ground-up restoration job will consume at least a year. Be sure you've got a place that's warm,



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dry and pleasant to work in, because even though much of the work will be farmed out to experts, plan on spending a lot of time in the shop attending to details.

Start by disassembling the car. All of it. The drivetrain can go into a corner, covered with plastic, waiting for rebuild later in the process. The same is true of the interior and seats. You don't want a freshly rebuilt engine or new upholstery to sit around in a dusty garage while the rest comes together. The exterior chrome, if it needs replating, can go anytime, as it won't deteriorate just being stored.

If there's much bodywork to be done, it might be better to have that done first, while the car will still move under its own power. Leave the exterior in primer, or you'll be repairing a lot of wrench marks accidentally inflicted during the disassembly.

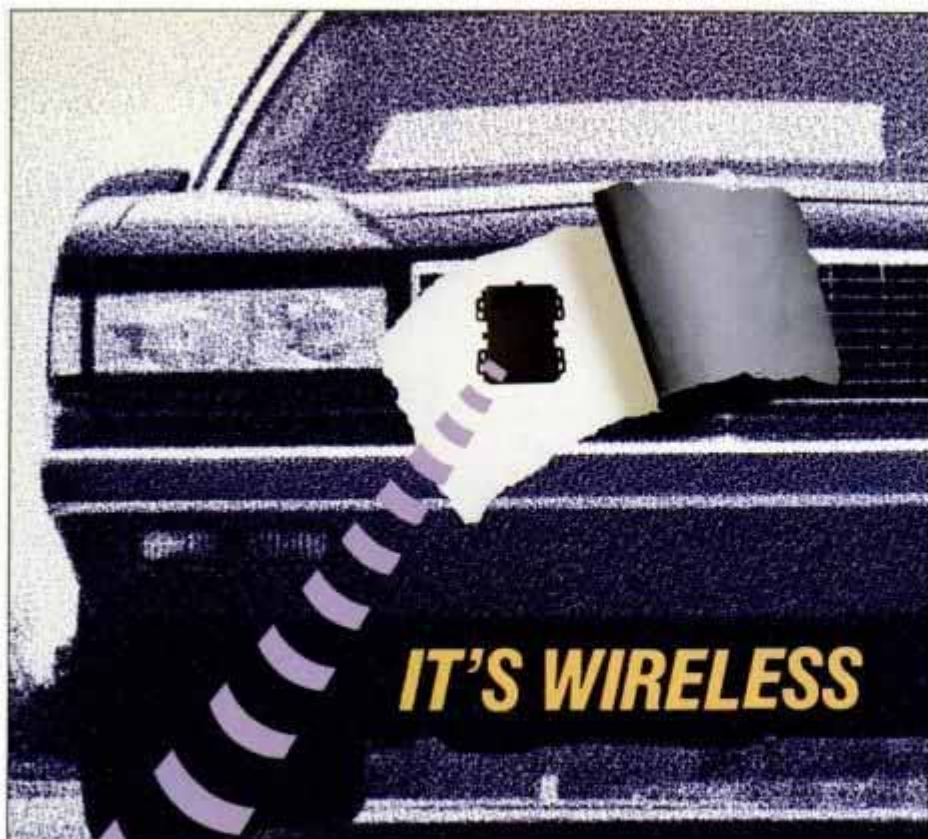
Assuming that the body and paint work is well underway, either at the hands of experienced, highly paid professionals or a less-experienced but highly motivated owner, then it's time to find an upholstery shop to start into re-covering the seats and door panels. If the door panels are plastic instead of vinyl or fabric covered, they can be repainted. Be careful—there are several different types of plastic, and using the wrong paint may turn your panel into slime. Consult a professional before painting any kind of plastic interior part.

Other interior parts, like the urethane-foam dashboard, may not be restorable—you'll have to buy new (or at least newer) parts. Headliners can usually be cut from OEM or near-OEM fabric. Installing a headliner is pretty tricky—farm this one out unless you've done it before.

While the bare chassis is up on stands, detail the engine compartment and trunk. More popular vehicles have reproduction wiring harnesses available, which simplifies the cosmetics and functionality of getting the electrical system restored.

When the end is in sight, it's time to actually get the engine and transmission off to the rebuilders. The best plan is to have the body shell, with the first coat of paint in place, sitting on the rebuilt suspension as the interior parts are done. Install the interior. Now is when the engine and trans go in. Finish up the final sanding and painting, and install the chrome.

If that sounds like a big job, it is—even a moderate restoration job will take months of full-time work by experts. Now is the time to start planning ahead—and keeping this one in like-new shape. **PM**



IT'S WIRELESS



That's why Maxon's remote radar detector is worth looking into.

Remote radar detectors used to have one annoying drawback—the wire that had to be run from the radar receiver behind the grill . . . around the engine . . . through the firewall . . . under the dash . . . and plugged into the control module mounted inside the car. But not anymore. Not since Maxon introduced the revolutionary RD-30 "wireless" micro.

Maxon's RD-30 consists of a remote-mount radar receiver/radio transmitter and a wireless, compact control module that will easily fit into a shirt pocket,

purse, console or door compartment—or practically anywhere.

The RD-30, additional receiver/transmitter units and control modules are available at electronics and automotive accessories retailers.

For more information, call 800-922-9083 (816-891-1093 in MO) or write to Department 777, 10828 NW Air World Drive, Kansas City, MO 64153.

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PHOTOGRAPHY

Still Pictures In 3D

Two new cameras add the third dimension.

BY FRANK VIZARD, Electronics Editor

THERE'S NO ONE who isn't familiar with the concept of 3-dimensional visual images. Most of us have seen or used the cardboard glasses needed to view 3D movies in the theater. Those glasses with their red and blue lenses are probably what's kept 3D from becoming real popular. Video and film in 3D has remained strictly a novelty.

If you're a still photographer interested in the novelty of the 3D experience, then you might want to check out the Nishika camera offered by American 3D Corp. in Henderson, Nevada. The camera, which lists for \$129.95, uses standard 35mm ISO 100 film to produce a 3D print. The 3D print is viewable without any special glasses or viewer.

The Nishika 3D camera is similar in many respects to another 3D camera marketed under the Nimslo name some years ago. American 3D Corp., in fact, purchased the patent rights to the Nimslo camera. The new Nishika, however, is somewhat different than its predecessor.

For one thing, the Nishika is bigger and boxier than the old Nimslo. The Nishika also has a 3-position switch for sunny, partly sunny and overcast shooting conditions. There's also a handy reminder for proper composition of the picture (more on that later). The old Nimslo offered two film speed settings; the Nishika only offers the ISO 100 speed setting.

How it works

The most visible difference between normal cameras and the Nishika is the lens. The Nishika actually uses four lenses to achieve the 3D effect. The camera uses two frames per shot with each frame being split in half to ac-

commodate the use of four lenses. This means, for example, a 24-print roll of film will yield 12 3D prints.

Shooting a scene with four lenses simultaneously is what produces the unusual sense of depth in the 3D photo. Each lens sees the scene somewhat differently. The 3D effect occurs when all four viewpoints are combined. This type of film processing is only available at American 3D's labs in Henderson, Nevada. Processing costs 99 cents per print.

Composing the shot

While 3D offers a certain amount of novelty appeal, shooting a 3D picture is no simple matter. Proper picture composition is critical. The best 3D effects occur when the subject is 15 to 22 ft. from the camera. Indoors, the optimum range is 10 to 14 ft., and subjects should be shot with a flash.

Objects in the foreground should be no closer than 6 ft. Foreground elements should crossover or partially overlap more distant objects. Subjects should also be well lit, and a variety of bright colors in the picture will enhance the 3D effect. Flat backgrounds are to be avoided. The camera must also be held horizontally; the 3D effect won't work vertically. These pointers are in an instructive videotape from American 3D Corp.

The novelty of the Nishika 3D camera is also evident in how the product is sold. The Nishika camera isn't available in stores. The camera is sold through a pyramid marketing program similar to that used to sell products like Mary Kay cosmetics. To inquire about the Nishika 3D camera, write American 3D Corp., 15 Cactus Garden Dr., Henderson, NV 89104,



or telephone (702) 454-7000. American 3D Corp. will also process film taken with the old Nimslo 3D camera.

The competition

Everyone has competition, of course, and Nishika is no exception. A second 3D camera called Trilogy is being offered for sale at various local photography shows around the U.S. Like the Nishika camera, the Trilogy makes 3D images viewable without special glasses. There are some differences, however.

For one thing, the Trilogy camera uses just three lenses to capture an image on 1 1/2 frames. This works out to be 28 images from a roll of 36 prints. Prints cost \$1.10 each. To speed processing time, a Federal Express mailer is included in the kit.

Another difference between Trilogy and Nishika involves the type of film used. While the Nishika camera uses only ISO 100 film, the Trilogy can use any type of 35mm film. Also included with the Trilogy is a built-in electronic flash.

The Trilogy is also considerably more expensive than

the Nishika. List price is \$250. If you don't see the Trilogy at a local photo show, you can contact Trilogy in care of Sean McDonald, 2700 Neilson Way, Suite 332, Santa Monica, CA 90405, (213) 396-7401.

Bar Codes And Icons

Canon is introducing a couple of new cameras with technical innovations that make photography simpler and more flexible. Two of these noteworthy achievements are included in the company's new EOS 10S model while the third is part of the new EOS 700 camera.

The EOS 10S is the first SLR camera to use bar code programming as an aid to picture-taking. All you do is thumb through a magazine-sized booklet of sample photos until you see the effect desired. You then pass a bar code reader over the bar code printed on the page. The memorized bar code is then transferred to the camera which automatically sets itself to duplicate the technique in the sample photo.

(Please turn to page 130)

Another stated first is an autofocus sensor that provides either automatic or manual selection of one of three focusing points within the frame. In the automatic mode, the EOS 10S analyzes a scene to determine where within a frame the main subject lies. The appropriate focus point—right, left or center—is then selected. This process can be done manually as well. The idea is to widen the possible focus area and prevent out-of-focus, off-center subjects.

Bar code programming and a new focusing system are just two of the features offered in the EOS 10S. List price

for the EOS 10S body is \$730. The bar code reader is optional and lists for \$60. The remote controller lists for \$19.

The EOS 700, meanwhile, is notable because of a reversible selector dial that makes this SLR attractive to both the novice and veteran photographer alike. On the one hand, you can select one of eight icons symbolizing a variety of photographic situations. Flipping the dial over, though, offers more control by allowing you to adjust shutter speeds as you see fit. The EOS 700 lists for \$600, a package that includes a 35 to 80mm power zoom lens. **PM**

(Continued from page 72)

hasn't seen a great deal of action since our last report. Even in a roadster as free of vices as this one, winter is sports-car hell, and winter is what we're still experiencing as this issue goes to press.

But don't equate the traditional winter woes of this car's British progenitors (MG, Triumph, et al.) with the Miata. The Miata's heater is easily equal to the task of preserving life in the coldest weather. The top seals superbly and the engine comes to life at the first turn of the key. We have noted a tendency for the plastic backlight to fog up when it's chilly, but that's about the only cold-weather vice.

Our original endorsement of this car's performance continues to be valid at 2123 miles. This car is unalloyed fun, and attracts more positive attention in New York City—a city of dedicated autophobes—than any ride in recent memory.

The pounding of Manhattan's treacherous pavement has provoked an occasional rattle in the top mechanism, and we still feel that drivetrain and road noise are likely to irritate some drivers. Mazda is planning to address this problem when the Miata gets its first update. Also, an automatic transmission will soon be available. Meanwhile, we're happy with our car just the way it is. And we can hardly wait for spring. —Tony Swan

Mazda MPV

Our MPV has had only one problem—the blower motor died twice. First time was in late summer so we had no air conditioning. Second time was in the coldest part of the winter. Right. No heat.

As it turns out, the problem wasn't the motor at all, but rather the resistor that is used to slow down the motor at lower speeds. It was simple enough to replace, although it is buried inside the dashboard.

In commuting service, the MPV has given yeoman service, although its long suit isn't schlepping one human being into town day after day. Nor is it particularly good for hauling around a photographer and cubic yards of gear to a photo shoot—at least not until you remove the rear seats. Removing the rear seats isn't hard, but it's not really easy either.

What the MPV excels at is carrying six or seven adults around without making them feel like they're in a bus.

We've now put almost 10,000 miles on our Mazda MPV, and we've averaged 22.6 mpg. There's not much else to report on the MPV and we know this makes for boring reading. But the MPV just keeps going. What can we tell you?
—Mike Allen



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The Secret is POLY

"Poly" is short for polytetrafluoroethylene (TFE). It is the slipperiest substance known to man. The 1989 Guinness Book of World Records (pg. 184) says: "The lowest coefficient of static and dynamic friction of any solid is 0.02, in the case of Polytetrafluoroethylene—equivalent to wet ice on ice."

A one quart treatment of Slick 50 will bond slippery "poly" to your engine for a minimum of 50,000 miles. Unlike some temporary products on the market, Slick 50 does not need to be added every time you change your oil. By reducing engine friction, Slick 50 increases gas mileage and horsepower and it reduces wear, defraying costly overhauls.

Slick 50's Credentials are Impressive

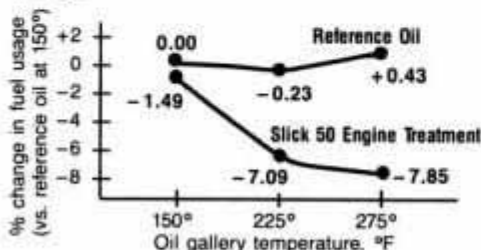
"Slick 50 does reduce engine heat and ordinary wear, and our informal tests indicated that it will improve gas mileage by about two or three miles per gallon . . . Slick 50 does exactly what Petrolon claims it does." *Consumer Digest* (Mar/Apr 1982, p. 35)

In 1989, the premiere engine and lubricant testing lab in the U.S. tested Slick 50. This EPA recognized lab conducted a strictly controlled experiment using industry standard ASTM procedures. Results showed Slick 50, compared to a standard reference oil, reduces engine wear by more than 50%. Be cautious of those Poly treatments that cannot back up their claims with such solid evidence.

In a fuel usage test conducted by this same prestigious lab, results showed that Slick 50 (compared to a standard reference oil at 150°) reduced fuel consumption in the test engine by 7.09% at an oil temperature of 225° and 7.85% at 275°. Once warmed up, most cars operate within the range of 225° to 275°.

Especially interesting is the fact that fuel usage with just the reference oil increased (see graph) as the oil got hotter than 225°. This is due to the well known fact that oil gets thinner at higher temperatures, causing increased friction (and wear) in your engine. However with Slick 50, fuel usage actually decreased, showing that Slick 50 produces its greatest friction reducing benefits at higher temperatures, which is exactly when your engine needs it the most.

As with any lab test, these results may not translate exactly the same percentagewise for every engine under every type of driving condition in the "real world." However, the conclusion for these test cases is clearly that Slick 50 does reduce engine wear and does increase gas mileage.



The Federal Aviation Administration has fully accepted a similar product—Slick 50 Aircraft Treatment (F.A.R. #33.49).



start them, before the oil has a chance to circulate. Up to 90% of engine wear can be caused by this starvation. You receive all these benefits for less than the cost of two tanks of gas (\$39.95).

Will Slick 50 Harm my Engine or Affect my Warranty?

No! The base oil for Slick 50 meets, or exceeds, every manufacturer's engine warranty requirements and carries an API service classification SG-CD.

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TUV, a prestigious German testing laboratory, tested Slick 50 and found substantial increases in both gas mileage and horsepower. The Space Shuttle Columbia uses the chemical "Poly" in its gears and bearings because it is the only chemical lubricant which can withstand the heat and corrosive elements of space.

The Cranfield Institute, known worldwide for its work in tribology (the study of friction), concluded a five-year study on Slick 50 in 1989. Results showed Slick 50 does indeed coat metal surfaces, dramatically reducing friction and extending the life of metal.

Perhaps the most dramatic of all is the torture test seen by thousands of viewers on NBC TV station KPRC. A Lincoln Town Car was treated with Slick 50. During the broadcast, the oil was drained and the car was driven without the oil plug for about 30 minutes. The water temperature never rose and the engine sustained no apparent damage.

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AUDIO

Fine-Tuning CD Players

New models are even more musically accurate.

BY FRANK VIZARD, Electronics Editor



ARE THERE ANY sonic differences between compact disc players? There's a question that just won't go away. While the answer may ultimately be an entirely subjective one for many people, there's little doubt that the manufacturing of CD players is evolving and changing.

If a CD player is prone to inaccurate playback, the problem usually becomes apparent as distortion at the lower end of the audio spectrum where the bass notes are located. Critical to the accurate playback of compact discs is the performance of the digital-to-analog converters (DACs) inside CD players. DACs convert the audio signal from the digital domain into an analog waveform that speakers can reproduce. Initially, CD players used a standard system that sampled 16 "bits" of information at a time. Manufacturers soon adopted systems that added extra bits to the sampling rate. Simply stated, the idea was that the more bits sampled, the less distortion you might conceivably hear.

Now as if to turn logic on its head, manufacturers are offering CD players that use a 1-bit system they claim is superior to previous systems. How can 1 bit be worth more than 16, 18 or 20 bits? In this instance, it appears less is more.

While it is somewhat over-

simplified, the best analogy that describes how this is possible comes from the technical people at Technics. A 1-bit system is used in their new SL-P370 CD player listing for \$219.95 and in other models. Other CD player makers, like Philips and Sansui, are also using 1-bit systems that employ perhaps minute variations from the system used by Technics.

Water into a bucket

Think of DACs as cups holding a certain amount of water that's poured into a bucket. A conventional DAC system, therefore, uses 16 cups with varying amounts of water or data in them. Each of these cups can have a certain minuscule amount of inaccuracies or error in terms of the amount of water they contain. As all of these cups are poured into the bucket, the amount of error accumulates into what can become audible distortion.

By contrast, a 1-bit system uses a single cup to pour water into the bucket very rapidly. Since only one cup is used, the amount of error stays minuscule, if it exists at all, and doesn't accumulate in the bucket.

Refinements of DACs are not likely to stop with the development of 1-bit technology. Technics, for example, combines a 1-bit system with a noise-shaping technology developed in conjunction with Nippon Telegraph and

Telephone (NTT). Technics uses Multi-Stage Noise Shaping (MASH) on the SL-P370 and in other units.

Instead of using more conventional resistors which can introduce what's called differential linearity error, MASH players use a high-speed switching device in the digital-to-analog conversion process. The aim is to produce smooth and musical quiet passages while making louder passages more accurate and lifelike.

Keep in mind that the numbers involved in the digital-to-analog conversion process are tremendous. For example, in a CD player that uses the conventional resistor-ladder system that requires each resistor to be switched on and off by the digital signal from the digital filter, there are 65,536 combinations that represent different levels of loudness. Each resistor must have the correct value. If the incorrect voltage continues on through to the output stage, the result is distortion.

Unlike the resistor-ladder network, the MASH system outputs the analog signal on a precise time-axis using a crystal oscillator clock. The MASH switching system turns on and off in approximately 30 billionths of a second. Technics says this methodology eliminates differential linearity error and, by extension, distortion of the audio signal. Internal



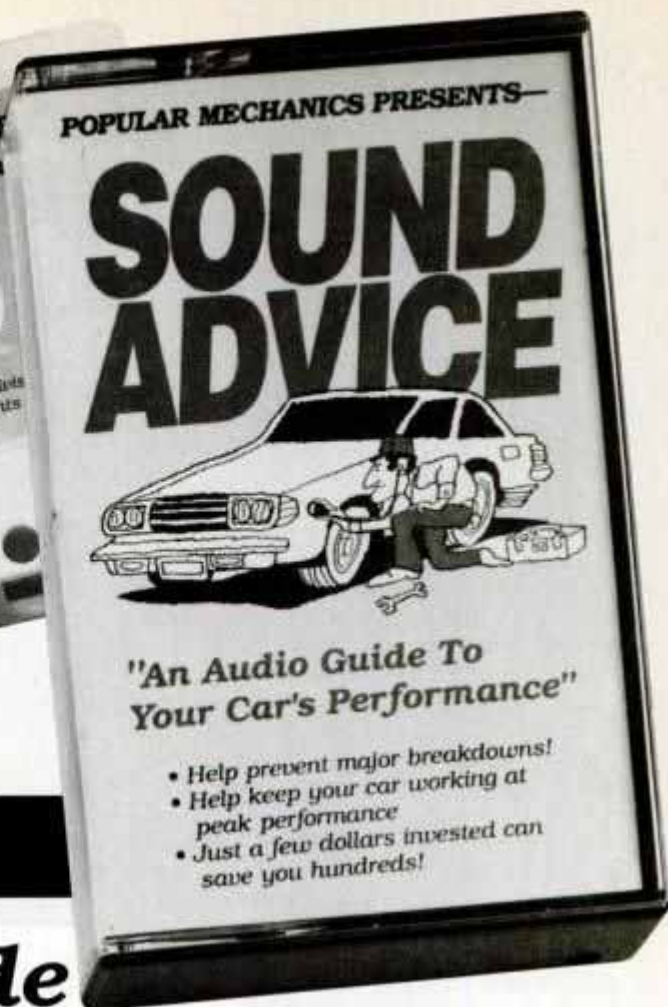
machine noise is also eliminated from the audible spectrum before it reaches the switching device.

Better consistency

Another byproduct of the MASH system is better manufacturing consistency. Because laser-trimming of the resistor-ladder network isn't required, variation from one DAC to another is dramatically decreased. This brings a level of consistency to the manufacturing process that results in significant cost savings as seen in the price of SL-P370.

DACs are the cornerstone upon which the sound quality of a CD player rests. Indeed, an argument could be made that the relative quality of DACs used in various CD players accounts for the price differential between models and for any perceived differences in sound. If all CD players are not built the same, then it may be reasonable to assume they don't all sound

(Please turn to page 134)



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drive is optional (\$499 list).

Toshiba has paid close attention to all the key design elements important to computing-on-the-run with this machine and combined them in a unit that sells at a reasonable price.

The Zenith MinisPort, NEC Ultra-Lite and Toshiba T1000SE are not the end of the evolutionary ladder as far as laptop computers are concerned. Psion, well-known for its Organizer II handheld computer, has launched a 3-model line of "Mobile" computers incorporating some radical technology. The high-end model, the MC600, which lists for \$2999, is fully DOS-compatible. Two less-expensive models use proprietary operating systems with graphic user interfaces and built-in TouchPads for moving around the screen. At only 4.5 pounds, the Psion's MC computers rival the NEC for lightness, and their 8086 processors should rank them at least on a par with the T1000SE for speed. While production models were unavailable, PM did examine the MC600 in its prototype stage.

Like the UltraLite, the MC line relies on solid-state electronics rather than disk drives for its built-in storage. However, Psion's computers avoid the problem of possible data loss by using a new EPROM-based technology from Intel called Flash Memory which burns in data on read-only IC cards. Importantly, the Flash Memory storage cards require no battery backup. They can be erased and new data stored whenever desired.

Another strong selling point of the Psion line is extended battery life. The company claims a pack of ordinary AA alkaline batteries can power the high-end MC600 for up to 30 hours, the low-end MC200 for as much as 75 hours.

Compaq Computer LTE

To appreciate the virtues of these lightweight laptops, it's helpful to compare them against slightly heavier competition. Long one of the pre-eminent makers of desktop PCs, Compaq Computer has lately vaulted into the ranks of the top-selling portable manufacturers as well.

Compaq's biggest claim to fame in the notebook category is a unit complete with hard disk drive. This latter model, with both 1.44MB floppy drive and 20MB of fast hard disk data storage, weighs just 6.7 pounds and carries a list price of \$2999. If you're both a power user and a notebook PC fancier, this may be the machine for you. If weight is the primary issue, then you may prefer a lighter machine like those from Zenith, NEC, Toshiba or Psion. **PM**

the same. Nevertheless, the sonic differences are still likely to be so subtle that only a pair of good ears listening to only certain types of music may notice anything awry.

Direct To CD

As the manufacturing of CD players evolves, so does the technological capability of those making CD recordings. Worthy of note is what appears to be the first direct-to-compact-disc recording ever done. The album is called *Dick Hyman Plays Fats Waller* and is produced by San Francisco's Reference Recordings Ltd. The process involved the conversion of music waveforms to a digital bitstream for transmission via microwave directly to a compact disc. This process eliminated the use of recording tape as is currently the practice. By eliminating the tape recording step, there is no loss of information due to dropouts or other tape flaws.

This technological feat was made possible through the use of a Bosendorfer SE computerized reproducing piano. Dick Hyman's performance was stored on a floppy disk. As the performance was played back on the Bosendorfer, microphones picked up the sound waves for conversion to a digital format. The digital information was then broadcast to the CD mastering facility.

Utility Sound

Ford scores a first in OEM sound systems by offering a sophisticated sound system in a sport/utility vehicle, the 1991 Explorer.

Designed in conjunction with JBL, the system uses two amplifiers to power nine speakers. One 80-watt amplifier powers a subwoofer mounted in the lower left side panel in the rear of the Explorer. The second 52-watt amplifier drives four tweeter/midrange combinations installed in the doors. The Explorer is also offered in a 2-door model and as you might expect, the 2-door version has the rear satellite speakers positioned at each side of the rear seat.

An AM/FM cassette player is standard with the system. For those music lovers already part of the digital age, a compact disc/radio and a multidisc changer are available as options.

Interestingly, no special cushioning is used to protect the sound system in the Explorer from the bumps and jolts that rough terrain may cause. The ride in the Explorer is smooth enough to make such precautions unnecessary in the eyes of Ford engineers.

Ford is also upgrading the JBL systems available in the Lincoln Town Car, Ford Taurus and Mercury Sable. The upgraded systems use the same bi-amplified approach for a punchier bass that's used in the Explorer. **PM**

Nonstop Radio

Anyone who drives a great deal knows that the radio can help make a long trip more enjoyable. If you drive far enough, though, you'll soon be out of range of your favorite radio stations. Once that happens, you then have to go through the sometimes tedious process of sampling a range of broadcasters before you settle on a selection.

Now there's a new convenience feature for long-distance drivers who like radio. The feature is called ID Logic. While this feature will ultimately be widely available, the first unit to offer it is the Technics' CQ-ID90 cassette receiver listing for \$799. ID Logic basically lets you find the radio station of your choice at the touch of a button. Stored inside the ID Logic chip is information on over 4500 AM and 4900 FM radio stations in 5100 U.S. cities representing populations of 10,000 or more. The CQ-ID90 can display the call letters, city and state of origin and the programming format of each station in its memory.

More to the point, however, is the CQ-ID90's ability to find broadcasters operating within a particular format even as you journey from one city to another. Once the CQ-ID90 is programmed to your home city, a touch of a directional button every 60 miles will make the radio lock onto the six strongest stations in the area. These six stations will be those in the format selected before you started driving.

Changing over from rock to another format is done at the touch of a button. Other formats available in the CQ-ID90 include classical, country, jazz, easy listening and talk radio.

The ID Logic memory only stores those stations broadcasting with 1 kilowatt of power or more. While this limitation may seem arbitrary, it's done mostly to keep the ID Logic chip from going out of date. Most call letters or programming changes involve small radio stations. Technics' research indicates that only 3.4 percent of radio stations undergo a change in a given year. The CQ-ID90 can be updated by a service technician if required, however.

It is hoped that ID Logic—a trademark of the PRS Corp.—will not be limited to expensive cassette receivers. Helping to keep the price of this unit high is the inclusion of a 25 watt-per-channel amplifier, Dolby B and C tape noise-reduction systems, an input for a compact disc changer, and a variety of cassette and tuner controls.

More than a half dozen car audio manufacturers appear destined to have ID Logic this time next year. If past practice is any indicator, competition should drive down the price. A lower price for ID Logic would give long distance drivers a leg up on the world. **PM**

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Redwood Patio Furniture—Six durable pieces made of heartwood redwood, built to withstand exposure to heat and moisture, resist warping and fulfill specific needs. The barbecue cart has two drawers, a maple cutting board and a broiler pan on the food preparation side and a built-in ice chest and bottle storage rack on the other side. The chaise lounge can be adjusted either to a reclining position or placed flat so several people may sit. Four additional pieces are included. (PM-1013—\$6.95)



Model SS United States—The glorious, record-breaking flagship of the U.S. Merchant Marine. No passenger ship has ever matched her top speed. The professional quality model is drawn in detail on 3 full-size blueprints. Over 2-ft. long; made of wood and metal. (PM-1200—\$9.95)



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Roll Top Desk—Nostalgia buffs will especially appreciate the always popular roll top desk for both home and office. It's antique style is cherished by many. Make one yourself in fine cherry and take pride in this charming heirloom. You build it as two separate units, a base and a roll top. (PM-1736—\$6.95)



HydroRunner—Taking to the water will never be the same after you blast the throttle in this 40 miles-per-hour personal watercraft. Powered by a 28-hp outboard, this sleek tri-hulled machine measures 8 1/2-ft. long with a 4 1/2-ft. beam, and weighs 200 pounds. Plans contain six blueprint sheets and a detailed photo-illustrated book. (PM-1810—\$15.95)



Wheel Horse—This sturdy three-wheeler is pushed powered, either by its rider or by the rider's friend. It's constructed of plywood and pine and is great for ages 3 and up. Easy-to-follow, step-by-step illustrated instructions. (S-2510-2—\$4.95)



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The friendly guy who worked at the corner gas station in the days before the Middle East oil squeeze, and who checked your oil at every fill-up, also had a weather-eye cocked for loose belts, leaks, corroded battery terminals or any other problems under the hood. But in today's please-pay-first, self-serve, maintenance-free world, he's been replaced by a cashier who knows or cares nothing for your car's state of health.

Don't let your investment in a car, new or old, suffer from lack of preventive maintenance. For example, replacing a worn fan belt yourself might take only 10 minutes on a Saturday afternoon—if you catch it before it gives up the ghost. But if that belt breaks on the road, you might be looking at a bill for towing, or even a new engine.

For even light maintenance, you'll need the usual simple tools and probably some special ones. The days of fixing your car with a pair of locking pliers and a Boy Scout knife are over. You just can't do much today without a starter set of combination wrenches, sockets and a torque wrench.

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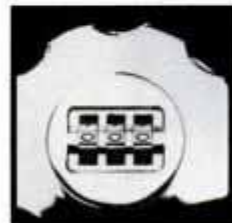
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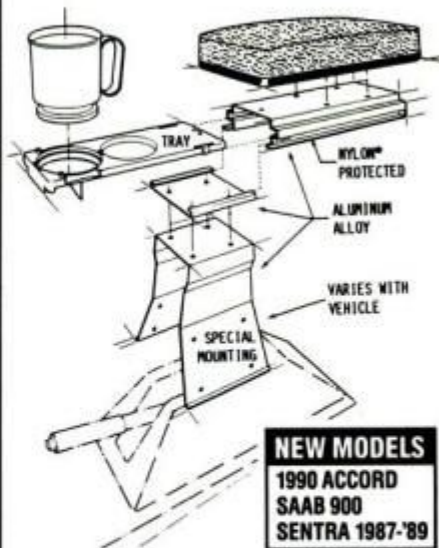
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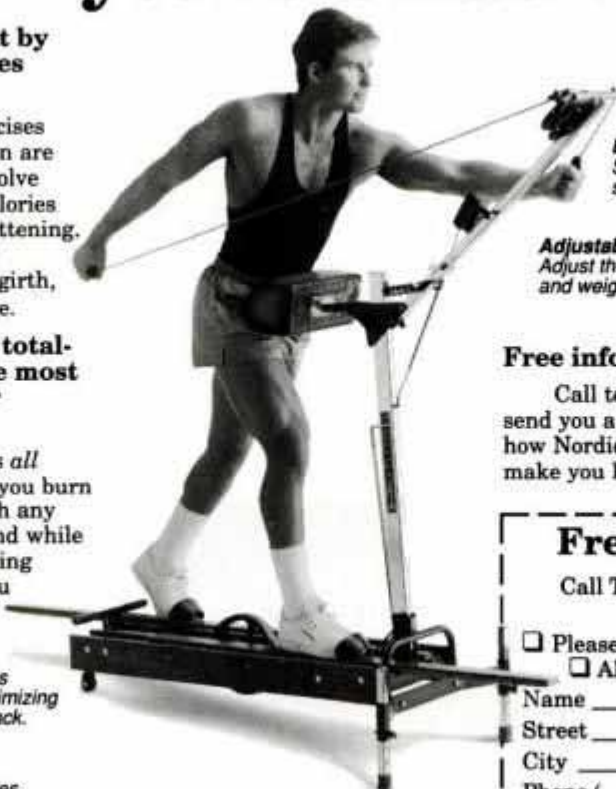
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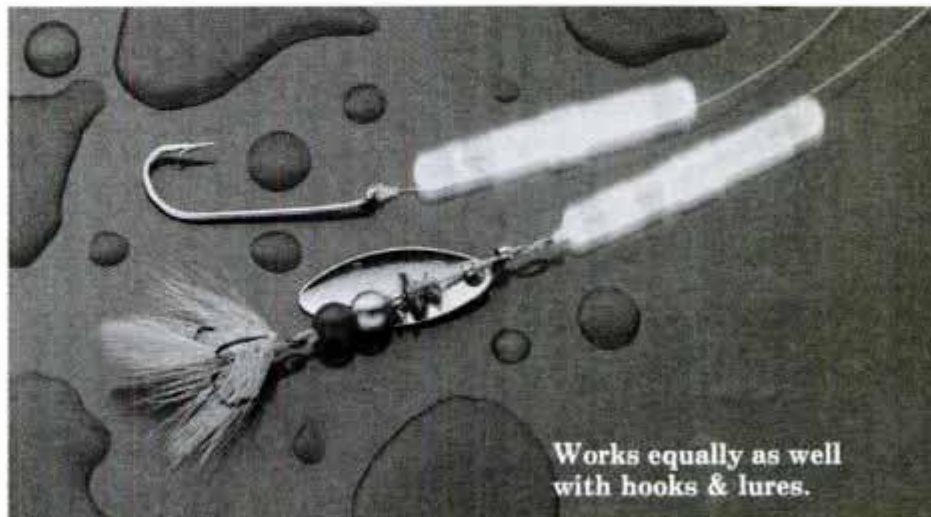
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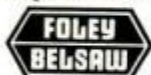
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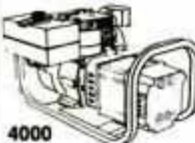
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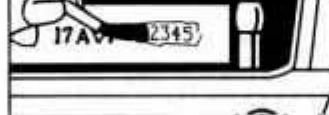
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