

MAY 1991 \$1.95

# Popular Mechanics

TEST PILOTS  
THEIR THRILLS AND CHILLS

## 41 PROVEN WAYS TO KEEP YOUR CAR LIKE NEW

Restoration Pros Tell You How

**PLUS** Our Annual Gallery Of Great Classic Cars



*Little GTO, you're really looking fine. Three deuces and a 4-speed and a 389.\* This 1966 Pontiac GTO is owned by Merle Green of Pepperell, MA.*

**SATURN VS. THE WORLD**  
First Comparison Test Of GM's New Hope

**JOURNEY TO THE CENTER OF THE EARTH**  
Huge Drill Probes The Earth's Crust For Cheap Energy

**SHAPE UP YOUR LAWN AND GARDEN NOW**  
New Power Equipment Makes It Easy



# To Be The Best-Selling Truck, Than Tough.

**BETTER  
VALUE  
RETENTION**

*A Ford F-150 is not only priced less than a comparable Chevy when you buy it,\*\* an independent survey predicts: over the next five years, the Ford will cost less to operate. And, will retain more of its value at trade-in time.\*\*\**

**LOWER  
OPERATING  
COST**



*Ford's exclusive "Touch Drive" system is now available on select F-150 pickups. It lets you switch from 2- to 4-wheel drive High and back, on the fly, at the push of a button. Automatic locking hubs are standard on all F-Series 4x4's and of course, manual hubs are optional at no extra cost.*

**P R N D 2 1**

*Ford's full-size pickups offer an advanced electronic automatic transmission designed for smoother shifting and 25% better highway mileage.\**



Buckle up — together we can save lives.

# You've Got To Be A Lot More

*Inside: F-Series pickups offer comfortable, well-appointed interiors in a wide choice of models. SuperCab shown.*



*Outside: Wide, deep pickup boxes provide big maximum payloads and cargo-handling flexibility that are tough to beat.*

If the truck you buy is going to last for years, it better be more than tough.

That's why Ford keeps making its trucks even more comfortable. The roomy interiors get better appointed, the choice of amenities, wider. And the list of engineering advances

**Ford Trucks.  
The Best Never Rest.™**

grows longer. There are even new models like the sporty Nite Truck.

It's no wonder the competition has found that catching up is considerably more than tough.

*The F-150 Nite Truck: new for '91. Available only in black with special blacked out trim.*



THE BEST-BUILT, BEST-SELLING AMERICAN TRUCKS  
ARE BUILT FORD TOUGH.



\*"Best-Built" claim based on an average of consumer-reported problems in a series of surveys of all '81-'90 models designed and built in North America; "Best-Selling" claim based on full-line sales by division.  
\*EPA hwy. estimate 20 mpg. for 1991 E40D vs. 16 mpg. for 1990 C-6 transmission in F-150 4x2 with 4.9L engine.  
\*\*MSRP Ford F-150 XLT Lariat (auto trans.) vs. comp. equipped Chevy C1500.  
\*\*\*The Complete Small Truck Cost Guide, 1991, IntelliChoice™ Inc., San Jose, CA. F-150 vs. C1500 base models with selected options and most popular engines. Value retention based on projected 5-year value. Actual operating costs and resale prices may vary.



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# How to drive the superspeedways.

with *Mario Andretti*

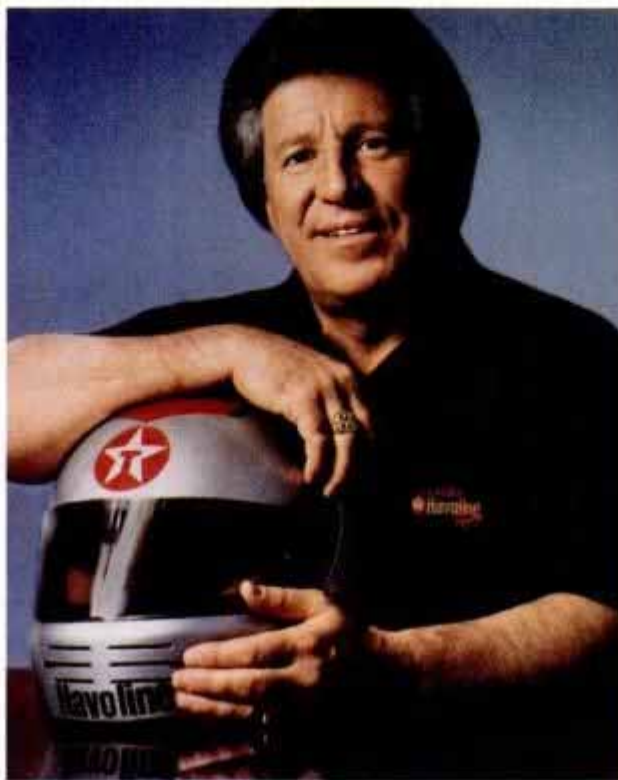
**H**e has won more Indy car pole positions and led more Indy car laps than anyone. He is the only American ever to have won both the CART Indy Car Championship and the Formula One World Championship. He has won the Indy 500, the Michigan 500, and the prestigious NASCAR Daytona 500. Mario Andretti is also probably today's most articulate spokesman on the science of driving a race car. This is what he says about driving the superspeedways:

"You can't really tell someone how to do it because each corner is different and each driver has to suit his own style. Yet you have to drive to limits defined by a car's technology — limits that increase as technology improves. For example, in my first Indy 500, the limit of what you could see in front of you equalled around 7 seconds. Now it equals about 1½ seconds.

"If I had to choose the single technological factor that distinguishes racing on the superspeedways, I guess it would have to be aerodynamics — especially at Indianapolis. Wind is a big factor at Indy because the track is surrounded on three sides by grandstands that act as wind catchments. A headwind increases velocity through your ground-effects tunnel, and you get more front-end bite. A tailwind does the opposite and your car can develop oversteer, become loose. Sidewinds give you yaw. Now, we're talking really tiny increments. So you check the wind socks on each straight on each lap at Indy. When you're doing 240mph and never lift going into a corner, you'd better know which way the wind is blowing."

## The discovery of ground effects.

While a race car's wings, air dams, and spoilers help it stick to the track, the ground-effects tunnels on the bottoms of Indy cars account for some two-thirds of their downforce. "Ground effects weren't discovered in the wind tunnel, but by accident," Mario says. "When I was racing for



Lotus in Formula One we tried adding skirts to the bottoms of vertical airfoils on the sidepods. We discovered that we were getting downforce from creating a vacuum beneath the car. That was the beginning of ground effects.

"Of course, ground effects aren't allowed in NASCAR. But aerodynamics are even more pronounced because the cars are bigger. For example, it used to be that you could draft from half-way down the straight in NASCAR. Now you can only draft when you're practically on another car's tail. Drafting is tougher today because manufacturers are making cars more aerodynamically slippery — on the street as well as the track. That changes driving strategy. When cars were less aerodynamic, you didn't want to lead the last lap of a NASCAR race. Now you do. Fuel strategy is also changed. Except for tank size, there aren't fuel restrictions in NASCAR like there are in CART. But fuel is weight. The less you need, the less weight you carry, and the faster you go. You may also get by with fewer pit stops.

## Technology probes the limits.

"Technology in all its aspects — from aerodynamics to electronics to engine design — has brought enormous differences in racing. But some things remain the same. You're still pushing your equipment to the absolute limits. Only the limits have changed. Today, we'll run an engine at 12,400 rpm all race long in the Michigan 500. That was unheard of a few years ago. Technology may bring 13,000 or even 15,000 a few years from now."

Technology will continue to break records in motorsports, but other records are likely to long remain. Many of these were set by Mario Andretti. As one of Mario's principal sponsors, Texaco is proud to be associated with him. And as a company competing for your business, Texaco has learned a great deal from Mario and from motorsports technology. We

learn valuable lessons in aerodynamics, fuel management, and combustion that we apply to System<sup>3</sup> gasolines. We also learn valuable lessons about engine technology that we apply to Havoline Formula<sup>3</sup> Motor Oil. And the Havoline Formula<sup>3</sup> that lubricates Mario Andretti's racing engine is the same Havoline Formula<sup>3</sup> that you can buy off the shelf in Texaco stations or in stores. In fact, Mario says this about it:

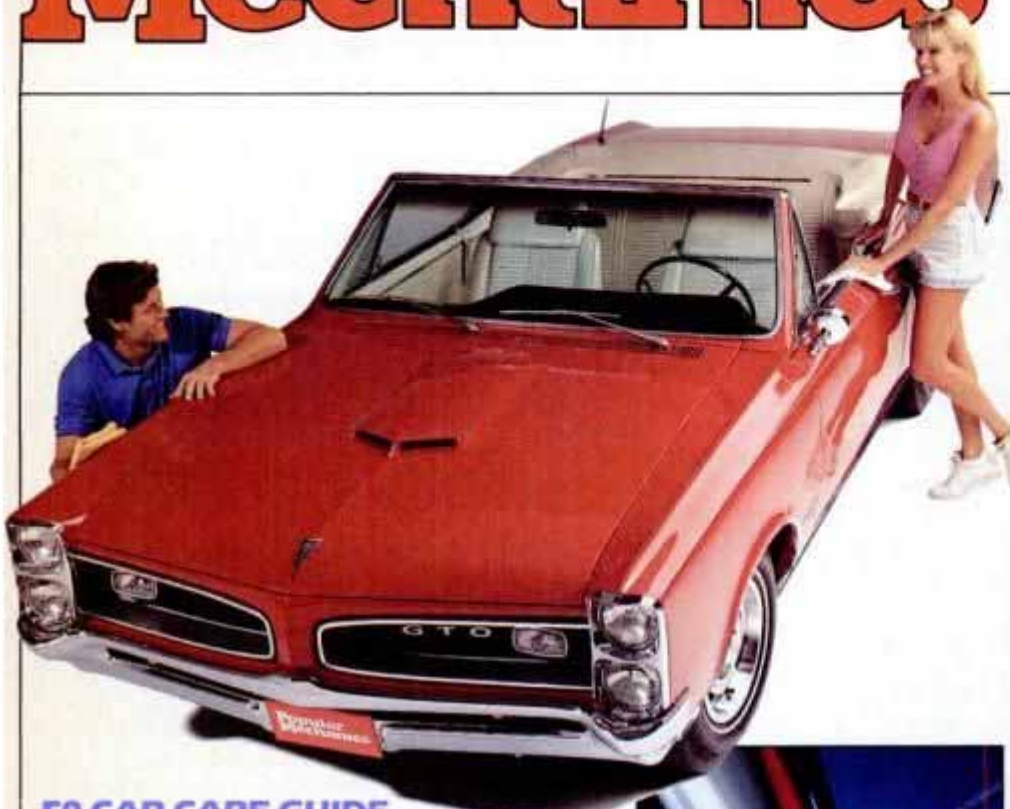
"In the past, you couldn't buy — off any shelf — the motor oil that you put in a race car. Today we're putting in race cars the motor oil that anyone can buy off the shelf. That's no accident. It's technology. Can you imagine the extra buffer you have in your private car with that kind of oil?"



TEXACO SYSTEM<sup>3</sup> AND  
HAVOLINE FORMULA<sup>3</sup>

# Popular<sup>®</sup> Mechanics

MAY 1991  
VOLUME 168  
NO. 5



## 59 CAR CARE GUIDE

—PM cover photo by Bill Ashe

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# EDITOR'S NOTES

● To me, spring has always meant cars. Not that I'm not car crazy the rest of the year, too. But spring is special. The weather is warmer. I always feel like working on my car in the spring. Even if it means just washing and waxing the exterior, vacuuming out Old Man Winter and blowing out the winter cobwebs on a deserted stretch of backcountry road. Clean cars always run better, right? And so, here we are right at the beginning of spring, and what better time to run our annual Car Care Guide? This year, we asked pros who restore cars for a living to tell us their secrets for making old cars look new and how they make them stay that way. Their collective wisdom begins on page 76. And don't miss our annual photo gallery of some great old cars that never grew old. Their owners believed in the one thing that can keep any car new forever: preventive maintenance. . . . Speaking of cars, I wanted to update you on some changes we recently made in our automotive editorial coverage.

First of all, we started a new section that will run every month (except this month, because of our annual Guide) called Car Care. You've been asking us for more car care information, so we've combined lots of new things with old favorites such as Car Clinic and Saturday Mechanic to form the new section. I hope you like it. Second, with Hondas being made in Ohio and Toyotas being made in Kentucky, we thought our old Imports column was outdated. So we've



Special thanks to Merle Green for use of his GTO cover car.

dropped it and started a new column called, simply, New Cars. This is where we'll report on all the new cars regardless of where in the world they are manufactured. . . . If you're not a car guy, then you're a home guy (or both). In that case, the arrival of spring will have you thinking lawn and garden. Which gives me a chance to plug this month's Home & Shop Journal. As usual, it's packed with good stuff. But of particular interest is the rundown on the newest and best lawn and garden equipment, which should make all your yard chores pleasant ones. . . . The world certainly is changing. In fact, even the way it looks on a map is changing. Computerized map making is the reason why the world may look a lot different to you than the way you remember it from geography class. Check our report on page 34. . . . And check the first comparison test of the car everyone is curious about—GM's new Saturn. Our auto editors corralled both a coupe and a sedan, and ran them against the world to see how the new kid on the block stacks up against its marketplace competition. See page 21 for the results. Till next time.

  
Joe Oldham

# Popular Mechanics

Editor-In-Chief Joe Oldham

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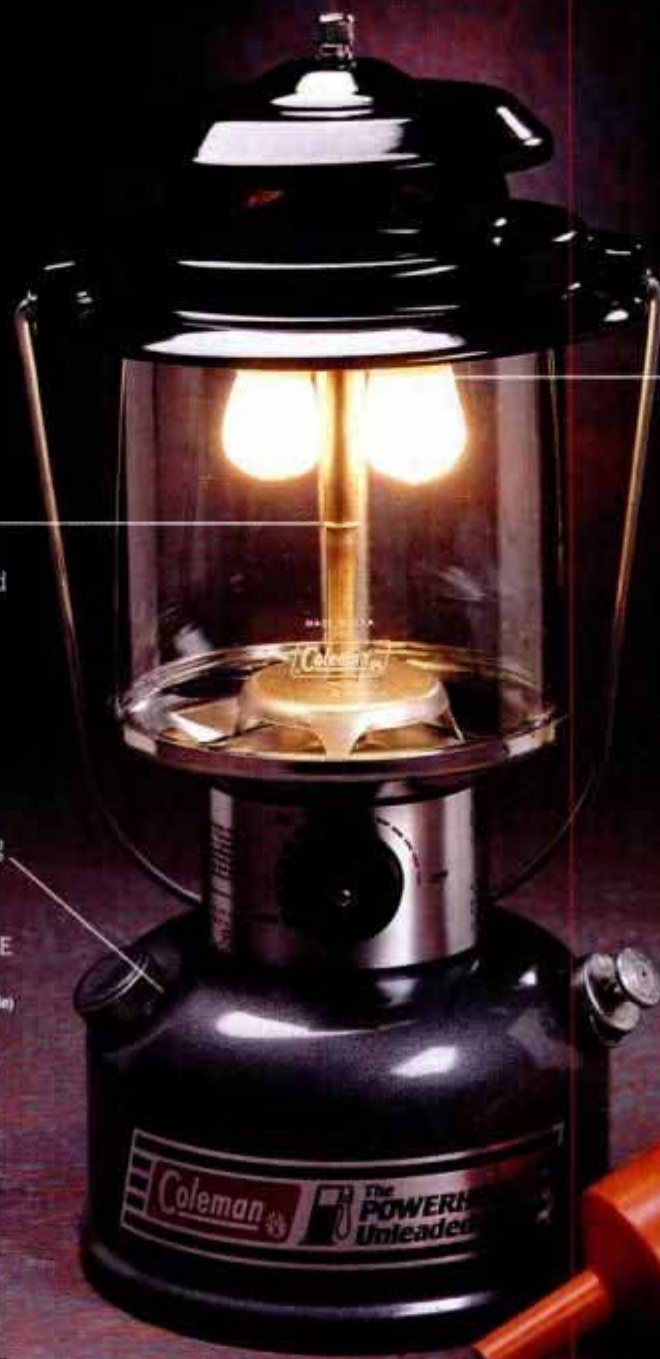
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New high-vaporization generator has increased surface area for increased burning efficiency.

New brass burner tubes are corrosion-resistant and easily replaceable.

Operates on standard camping fuel or on unleaded gasoline for maximum savings.

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## How this new Coleman® Dual-Fuel Lantern can save you up to 90% in fuel costs.

This new Dual-Fuel Lantern burns Coleman® fuel, of course. But it also operates efficiently on the same unleaded gasoline you use in your car.

And that can save you 70% to 90% on fuel costs, as shown in the chart above.

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**Convenience** — Unleaded gas is readily available anywhere automotive fuel is sold.  
**Odorless operation** — Burns cleanly

and efficiently, with no gasoline odor.

**Adjustability** — Light goes from bright to dim with the twist of a knob.

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**Durability** — Built for years of trouble-free operation, and backed by a limited 5-year warranty.

In addition to three new Dual-Fuel Lanterns, Coleman also offers four new Dual-Fuel Stoves.

They're all extremely versatile. And like all Coleman products, they're all unbelievably tough.

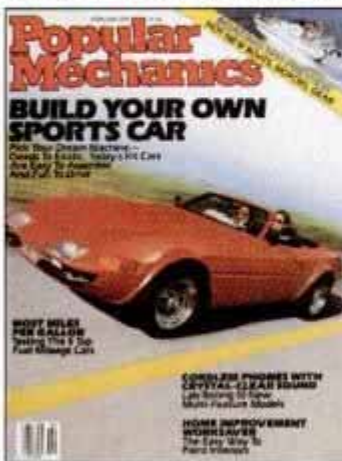


**UNBELIEVABLY TOUGH**

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# LETTERS

## Automakers



I read your article on specialty cars with great interest. However, I must point out an error in the article. The photo of the Cobra replica shown as an Everett-Morrison kit is, in fact, an ERA replica. The photo was taken by Curt Scott, as was the photo of our GT-40 replica shown in the same article. Although to the casual observer, all Cobra replicas may appear to be the same, they are not. We at ERA take great pride in our products. I'm sure you can understand our consternation at seeing a competitor's name attached to one of our products.

PHILIP R. GAUDETTE  
PRESIDENT

ERA REPLICAS AUTOMOBILES  
NEW BRITAIN, CT

*ERA's reputation as one of the finest Cobra replica builders is the envy of the industry. We regret the error.*

—Ed.

Having built a Classic Motor Carriages Speedster, I was very disappointed that your article left it out. I love my car and attract a lot of attention and envious questions wherever I go.

FORREST L. GAGER JR.  
SWEET BRIAR, VA

Letters are subject to editing for length, style and format.

My kit car is a 1934 Mercedes 500K replica from Heritage Motor Cars in Miami, Florida. I found the kit very complete, instructions adequate and their 800-number very useful. I started the project in February 1989 and finished in May 1990—about 600 hours later.

NORTON KOLLMAN  
WEST ALLIS, WI

I finished my 427SC Cobra by North American Fiberglass in January 1989. As you wrote in your article regarding your kit, an average mechanic can build this kit with few problems. No exotic tools are required, and the most important tool is patience. I spent two years on mine, but worked on it only when I wanted to. In the two years I've been driving my Cobra, I've found that the work was well worth the effort. It's a beautiful candy red, blindingly fast with over 400 horsepower, and it handles like a true sports car. The only drawback is that it draws a large crowd wherever I go. My total investment is \$20,000.

BILL WALLACE  
NEWPORT NEWS, VA

### Super Soviets

My regards to David North for his superb article on the Soviet super fighters, the MiG-29 and Su-27. His insights show that even with radically different design philosophies, the Russian aircraft-design bureaus can equal and surpass the performance of the best designs from the West. Having seen the MiG-29 perform at the Dayton International Airshow '90, I can attest to the power, performance and agility demonstrated by this remarkable fighter. However, I must take exception to one statement made by Mr.

North. He states that the F-14D is the first American aircraft with built-in infrared search-and-track capabilities (presumably for air-to-air modes). My research shows no fewer than three U.S. fighters, all designed before 1972, that possessed such built-in capabilities. These include the F-4B Phantom II, F-14A Tomcat and the YF-12 interceptor version of the SR-71A Blackbird. This doesn't even take into account the FLIR/LANTIRN infrared target designation and navigation capabilities built into such attack aircraft as the F-111F or the F-117A.

JOHN H. CLARK  
BRAintree, MA

*It is true that relatively crude airborneIRSTs were experimented with during the '60s. These were hampered by short range, inability to see through clouds and frequent false alarms.*

*We should have said that the F-14D was the first operational American aircraft with a reliableIRST system.*

—Ed.

### 40 Something

After reading your article, I wonder if the rest of it is as inaccurate as the reporting and testing on the Volkswagen Jetta.

I have had two diesel Rabbits. I drove one 103,000 miles and the other 164,000 miles before selling them. I always got 47 to 49 miles per gallon. I am currently getting 49-plus with my '89 Jetta. I find the economy and relative comfort of the Jetta well worth the extra cost at time of purchase.

GEORGE W. LAUGHLIN  
NEW JOHNSONVILLE, TN

I'm sick and tired of you guys running down Volkswagens in every comparison test.

First it was the Vanagon. Now it's the Jetta diesel. If you ever really gave a VW a chance, you'd find out it is a well-made, reliable automobile—something you can't say for the Detroit trash you're always bragging about.

WOLFGANG KNEUBBLE  
LANCASTER, PA

*Hey, fahrvergnügen to you, Wolfgang.*

—Ed.

### Guitar Boogie

Hats off to Thomas Klenck, Alex Layman and Eugene Thompson for the article in the Home & Shop Journal on how to build a solid-body guitar. After owning several guitars, I now have one of which I am truly proud. With a few modifications and the help of my wife on the finish, we were able to complete it in about a month. I am sure it will provide many hours of pleasure. Just showing it off is a blast.

JOHN DUNN  
HAUGHTON, LA



Reader John Dunn's handbuilt electric guitar.



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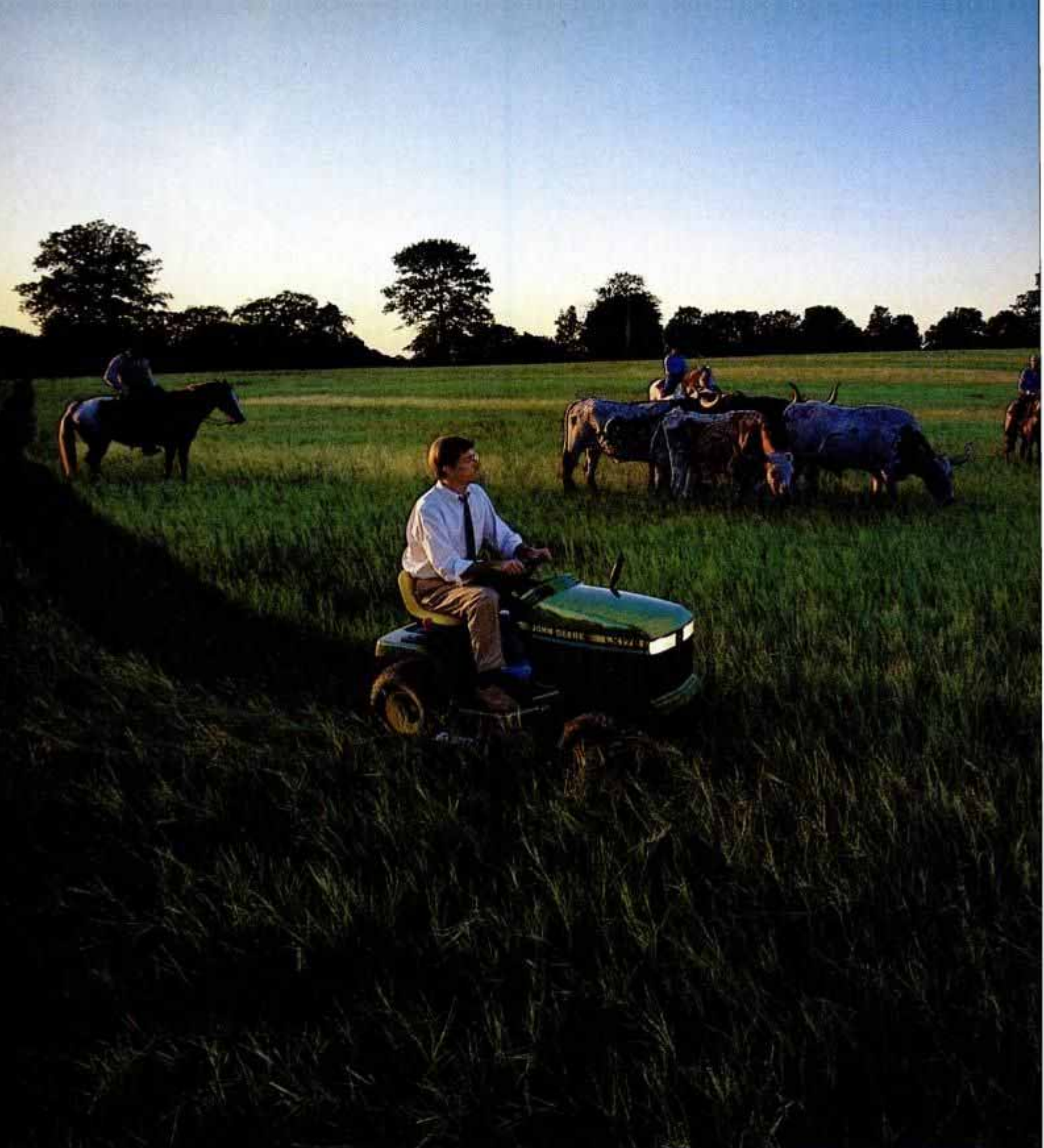


better be in one big hurry. This offer ends June 30, 1991. And missing it would be a big mistake. For the location of your nearest General Tire dealer, call toll free: 1-800-255-2550.

\*By mail. \$7.50 per tire when you buy 3 or 4. \$5.00 per tire when you buy 1 or 2.

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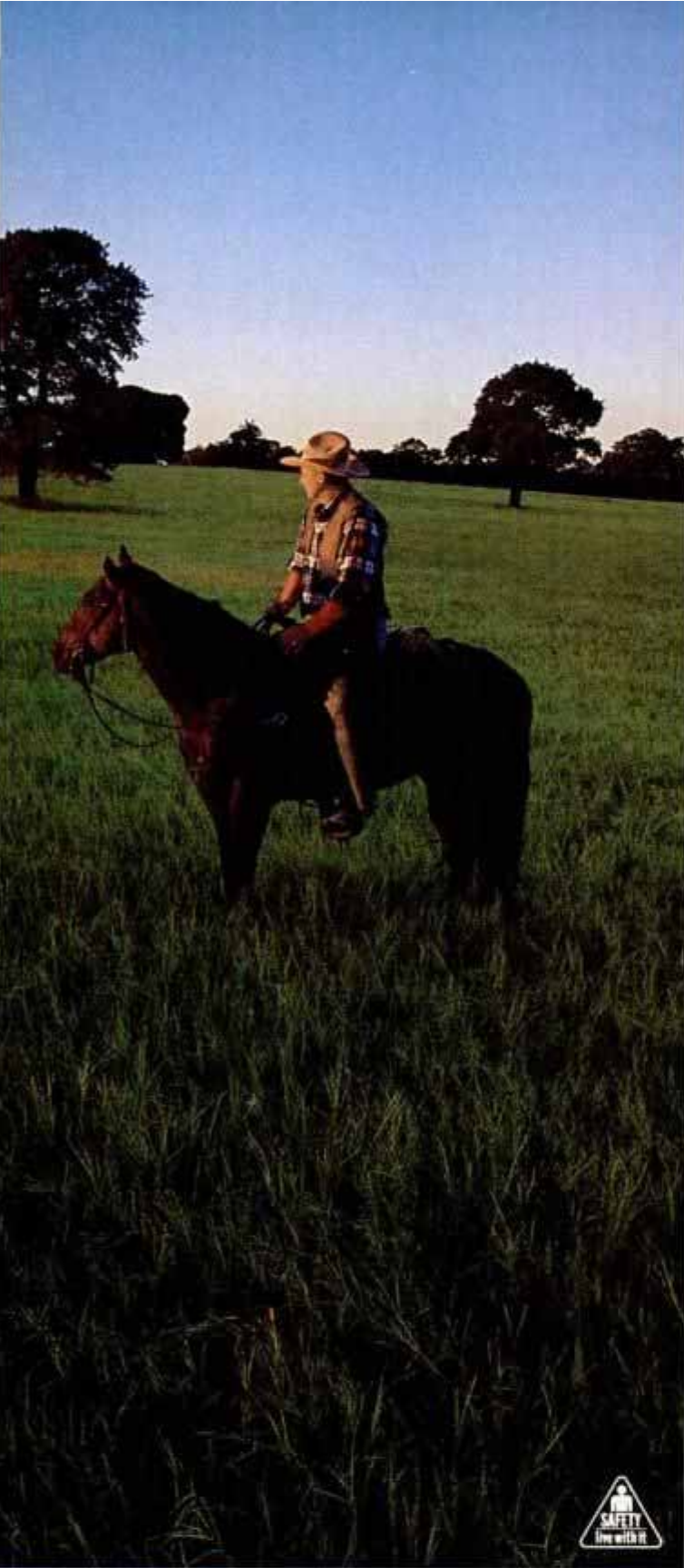
## Even after mowing from Chicago to Amarillo, you could still get your money back.

When you buy just about any John Deere mower, you get 30 days to test it out. If for any reason you're not happy, you get your money back. No questions asked.

Of course, *how* you test it is up to you.

At minimum, you should take it home and mow your lawn a couple of times before you make a final decision.

On the other hand, it's a big world out there. And if you happen to be even the least bit



carry our 30-day money-back guarantee.

All six John Deere walk-behinds. From the low-priced 14PZ to the self-propelled 14SB. Each features a 21-inch cutting width and 2½-bushel, easy-off rear bagger. After testing one out on your own lawn, you may as well resign yourself to accept the inevitable, and let your neighbors borrow it.



Rather ride than walk? Our new, economical GX Riding Mowers offer shift-on-the-go five speeds, while our deluxe SRX75 does all the shifting for you, up to a top speed of 5 mph. You could easily mow a nine-hole golf course just working four weekends.



Our affordable STX30, with its overhead valve engine and 22-inch turning radius, can cut almost an acre an hour. A single month of dawn-to-dusk operation would nicely trim about 250 football fields.



Which brings us to our new LX series. The LX176 features a powerful 14-hp overhead valve engine, hydrostatic transmission with foot speed control and a 20-inch turning radius. Best of all, it has a contoured coil spring seat, for exceptional comfort on month-long journeys.



adventurous, the possibilities are limitless.

In 30 days, for example, with our fast, new LX172, you could cut a 38-inch swath all the way from the Great Lakes to the Texas panhandle. (Of course, that's based on a 40-hour workweek. With overtime, you could make it to the Gulf.)

Naturally, we can't expect you to customize a test until you've had a chance to pick out one of our mowers. So, briefly, here are the models which

For more information, call 1-800-544-2122 for the John Deere dealer nearest you. He'll be glad to help you pick out just the right mower, and give you 30 days to try it out.

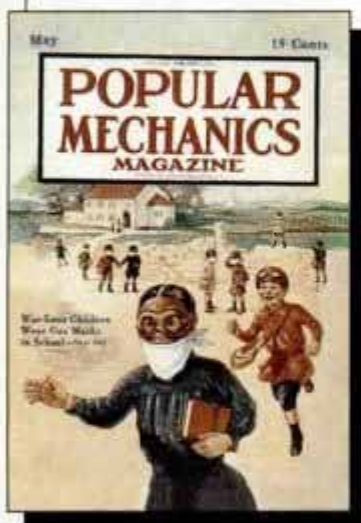
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**NOTHING RUNS LIKE A DEERE.®**

# TIME MACHINE

75 YEARS AGO: MAY 1916



## Life in Wartime

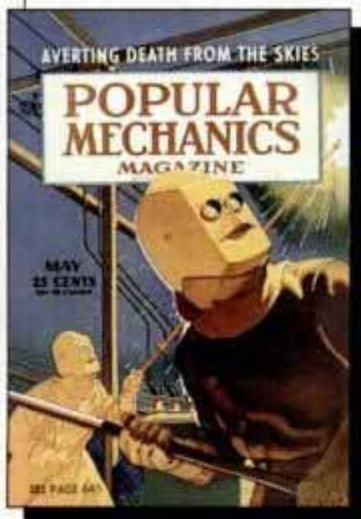
The winds of war drifted from the battlefields to civilian life—quite literally—as clouds of chlorine and phosgene gas blew back from nearby trenches into French and Belgian villages. Both Central and Allied forces had been using gas for a year, and the sight of children wearing gas masks shook readers as much then as it shakes TV viewers today. While the first respirators distributed to civilians were crude, with timely warnings, they prevented casualties.

## A Lift For Loggers

Skidding logs from forest to freight train was always an exercise in brute force, whether done by lumber gangs or elephants. To mechanize the operation, a lumberjack-turned-inventor patented an aerial tractor, featuring a trolley suspended from a 2-in.-thick cable. A 35-hp engine drove both a hoisting drum and grooved wheels that gripped the cable. Pacific Northwest loggers still use aerial cables to transport lumber, but their tractors stay on the ground.



50 YEARS AGO: MAY 1941

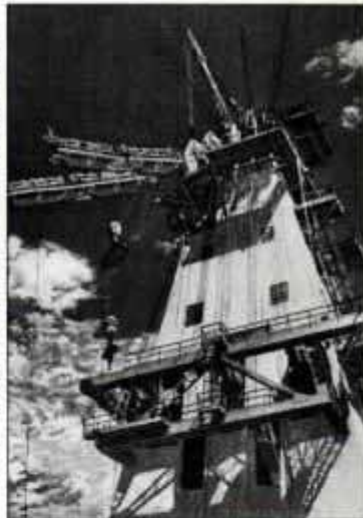


## Power Suits

The men who kept America's power grid humming in the 1940s faced peril from the pylons and lines they tended. Threats included vicious voltages, high-temperature arcs and even shrapnel from exploding ceramic insulators. So they took extraordinary precautions. When they poked at overhead switches with long hooked poles, they donned two pairs of gloves—one of horsehide, one of rubber. Their coats were heavy chrome leather, their helmets armored with steel.

## Water Works

In the 1940s, now-familiar demons plagued California's agricultural empire: floods in the North, drought in the South. Officials gave the green light to an engineering solution worthy of Hercules. The Central Valley Project rerouted the San Joaquin River and filled its bed with water from the Sacramento. The task required dams, pumping stations, aqueducts and canals—and what at the time was the greatest mustering of construction equipment in history.

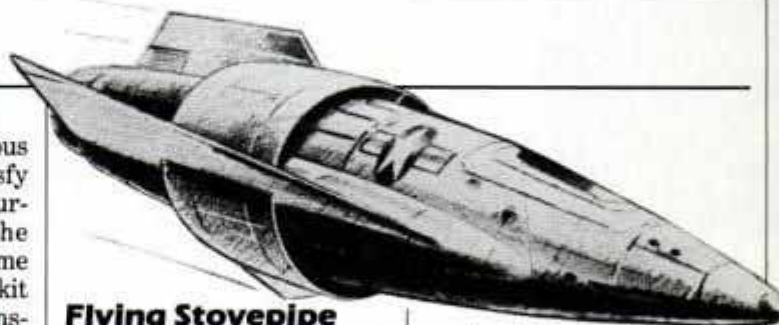


25 YEARS AGO: MAY 1966



## Water Buggy

Only a homebuilt amphibious off-road vehicle could satisfy the outdoorsman/do-it-yourselfer who read PM in the 1960s. Our Bush Buggy came to life as a combination of kit assembly (for engine, transmission and steering) and home-shop construction. The body was fashioned from plywood, the pontoons from fiberglass-laminated styrofoam. Not exactly a muscle machine, the vehicle ran off a 4-hp engine on land and a battery-powered electric motor on water.



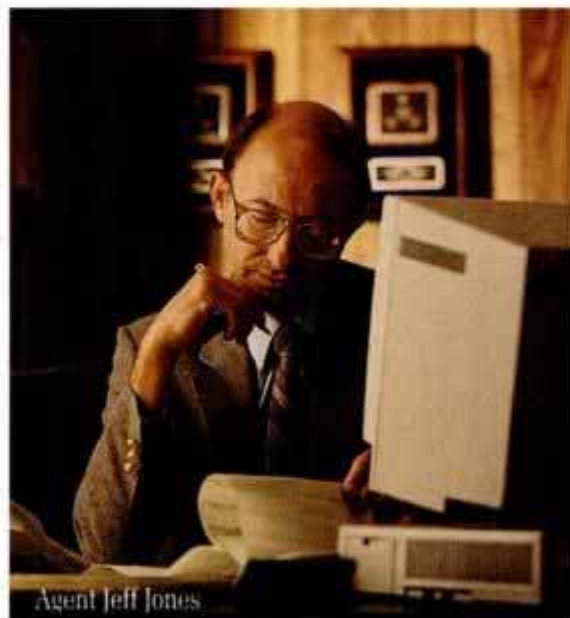
## Flying Stovepipe

On the drawing board even then was the propulsion system that will drive the X-30, the Mach-25 vehicle now under development by NASA and the Air Force. That system is the scramjet, or "flying stovepipe," an engine that would burn hydrogen while air raced through its

combustion chamber at supersonic speed. Engineers reported successfully demonstrating components of a scramjet in a 7000-mph shock tunnel. One researcher compared it to keeping a match lit in an open convertible while speeding along the Los Angeles Freeway. **PM**

Paoli, Indiana since 1972:  
3,650 people,  
1,260 babies,  
2 floods,  
2,647 auto claims

...and 1 State Farm agent.



Agent Jeff Jones

Paoli's not a big city by any stretch. But even in a small town like this, things keep changing. They put up a new church not far from the courthouse last year. Families are building houses. Babies are being born. And every time something changes, someone's insurance coverage needs reviewing. That's where Jeff Jones, Paoli's State Farm agent for the last 18 years, comes in.

Like State Farm agents across the country, Jeff offers all his policyholders a free State Farm Family Insurance Checkup. That helps them make sure that no matter what's changed, their insurance coverage won't be out-of-date. Whether it's auto, home, life or health insurance.

In 18 years, about the only thing in Paoli that hasn't changed is Jeff. And that's the way folks in Paoli like it.



Like a good neighbor,  
State Farm is there.

State Farm Insurance Companies  
Home Offices: Bloomington, Illinois

# Less Filling.

- 1529-lb payload.
- 2.5-liter engine.
- 5-speed transmission.
- Rear-wheel anti-lock brakes.



**23** EPA  
EST. MPG  
CITY

**27** HWY.

\*Based on 1989 light-duty truck registration data. Chevrolet, the Chevrolet emblem and S-10 are registered trademarks and Chevy is a trademark of the GM Corp. © 1991 GM Corp. All Rights Reserved. Let's get it together... buckle up.

***Chevy S-10 EL. Better gas mileage than the leading import. At a nice, low price.***

Chevy S-10 EL is one of the lowest-priced pickups you can find. And it has better fuel economy than the leading imported compact pickup. No wonder more truck owners switched to Chevy last year than to any other truck.\* Think about it the next time you buy gas.

More People Are Winning With *The Heartbeat*  of America. **TODAY'S TRUCK IS CHEVROLET.™**

Материал, предназначенный для ознакомления с продукцией

# TECH UPDATE

News Of Tomorrow's Technology Today



PM ILLUSTRATION BY PAUL DIMARIE

## Russia Designs Reusable Heavy-Lift Rockets

MOSCOW, USSR—Building on the *Energia* heavy-lift rocket—bedrock of their future space program—the Soviets are proposing a megabooster that could wing its way back to Russia like a shuttle after delivering its payload.

All major components of the system would be reusable, including the four strap-on boosters. After separation, these would deploy foldout wings and V-shaped tails. Small jet engines would then power them home.

The vehicle could hoist as much as 150 tons into orbit, outlifting the expendable version of *Energia* by 50 tons. Instead of carrying payloads piggyback, as *En-*

*ergia* does, the flyback booster would house its cargo in a long nose fairing.

Once in orbit, the front of the fairing would swing open and a spring would pop the payload into space. Then the empty fairing would telescope down over the booster's forward end, shortening the vehicle by 50 ft. and rebalancing trim for reentry.

The Soviets have tested scale models in a wind tunnel and developed active cooling systems to replace the thermal-protection tiles used on current shuttles. Other features are lifted from the Soviet space shuttle *Buran*.

Editor: Abe Dane  
Assistant Editor: Greg Pope  
Contributors: Mike Fillon, Oliver Fultz

But how soon the flyback booster will take off depends on the political and financial climate in the Soviet Union.

Concept shows jettisoned strap-on boosters sprouting wings. In actual flight, wings would deploy after freefall.

### Highlights This Month

- **Coal Miner's Robot**—Four-legged juggernaut slices out coal with waterjets.
- **Flying Blind**—Satellites bring home the big jets, regardless of weather.
- **Cruise Control**—Future radar plane will guard us against sub-launched missiles.
- **Catching Rays**—Superconcentrators reproduce the Sun on Earth.
- **Bombs Away**—Navy's future strike weapon swoops in from 20 miles away.
- **Shooting Out Sparks**—Star Wars technology powers your car.



PM ILLUSTRATION BY ED VALIGURSKY

## Air Surveillance 2000

HANSCOM AFB, MA—The Strategic Defense Initiative may shield the nation from high-flying ballistic missiles, but what will protect us from ground-hugging cruise missiles? The Air Force is studying follow-ons to the Airborne Warning And Con-

trol System (AWACS) that would address that concern.

One proposal from General Electric features a modified Boeing 747 that carries a monster phased-array radar inside a 40-ton aerodynamic plandome. Wind-tunnel tests on a scale model have shown

that a jet so burdened would need canards and tail endplates to keep stable.

The North American Aerospace Defense Command (NORAD) wants the radar to be acute enough to detect submarine-launched cruise missiles, while operating in a target-cluttered, jammed environment. It's

**Future AWACS patrols North American coast and alerts F/A-18 to sub-launched cruise missile, NORAD's nightmare.**

likely that the system's sensors will be tested in the Air Force's upgraded E-3A Sentry surveillance plane.

Flight testing of the 747-based system would begin after 1995.

## Brighter Than 1000 Suns

CHICAGO, IL—Solar concentrators can do everything from heating bath water to simulating nuclear blast effects. But engineers intend to bring even more applications to light as they push the technology beyond today's limits.

A concentrator tested last summer at the University of Chicago multiplied sunlight to 84,000 times its normal intensity on Earth, besting the previous mark by 40%. Physicists there opted away from normal optics, which shrink

an image of the Sun. Instead, in their device, sunrays bounced off a primary reflector and funneled through a nonimaging cone of sapphire, a gem with renowned light-bending properties.

The resulting beam of light unleashed 72 watts per square millimeter, more energy than is generated at the surface of the Sun itself. That kind of power, say the researchers, could separate isotopes to refine nuclear fuel, destroy hazardous



SANDIA PHOTO

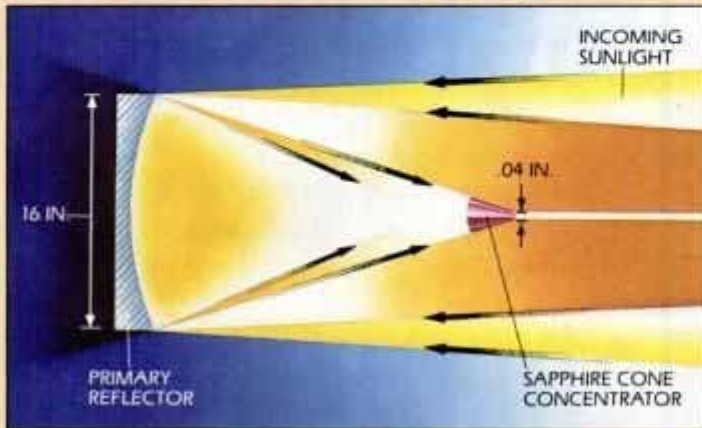
**Spokes hold Sandia's giant lightweight reflector in paraboloid shape as it focuses sunlight on sodium receiver.**

waste, or even energize big lasers for missile defense, an application that has reportedly intrigued Israel.

Meanwhile, other researchers have concentrated on making the primary reflector bigger and cheaper. To replace the standard heavy glass mirror, engineers at Dallas-based Solar Kinetics have fabricated a huge, ultrathin stretched-membrane reflector. They took a 4-mil-

thick sheet of stainless steel, coated it with a shiny polymer, and deformed it with hydraulic and vacuum pressures into a parabolic dish 23 ft. in diameter.

Sandia National Labs is using the reflector to heat liquid sodium and power a generator. The next step is a 36-ft. dish to work with a Stirling cycle engine in order to generate up to 25 kilowatts of electricity.



Chicago concentrator uses standard 16-in. telescope mirror with sapphire cone to focus sunlight into the brightest beam ever.



# THE WEEDS WILL BE BACK NEXT YEAR. WILL YOUR TRIMMER?



It happens all too frequently. You grab your trimmer, top off the gas tank, and give it a crank.

It doesn't start.

A few more tries. Then another. And another. Something rattles inside. Now, you're rattled.

You only bought the thing a few seasons ago. Repairs are probably going to run half the cost of the trimmer. Some bargain.

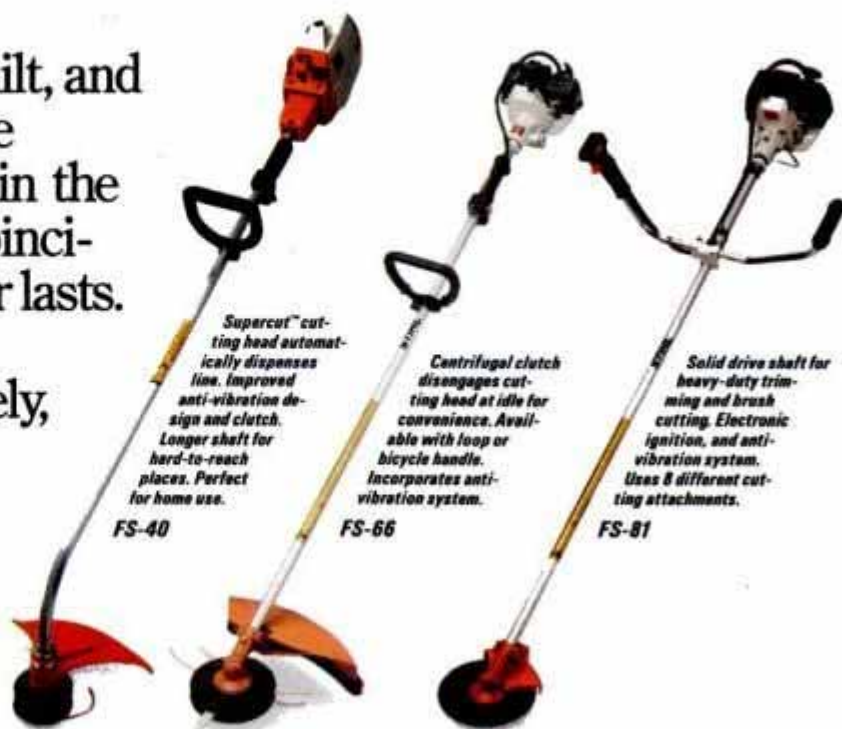
If what you really want is equipment you can depend on, see your Stihl dealer.

Every Stihl is built, and tested, to what may be the most exacting standards in the industry. So it's no mere coincidence that a Stihl trimmer lasts.

Stihl. It'll put an end to weeds. And, definitely, any notion of bothering with a discount trimmer.

**STIHL**

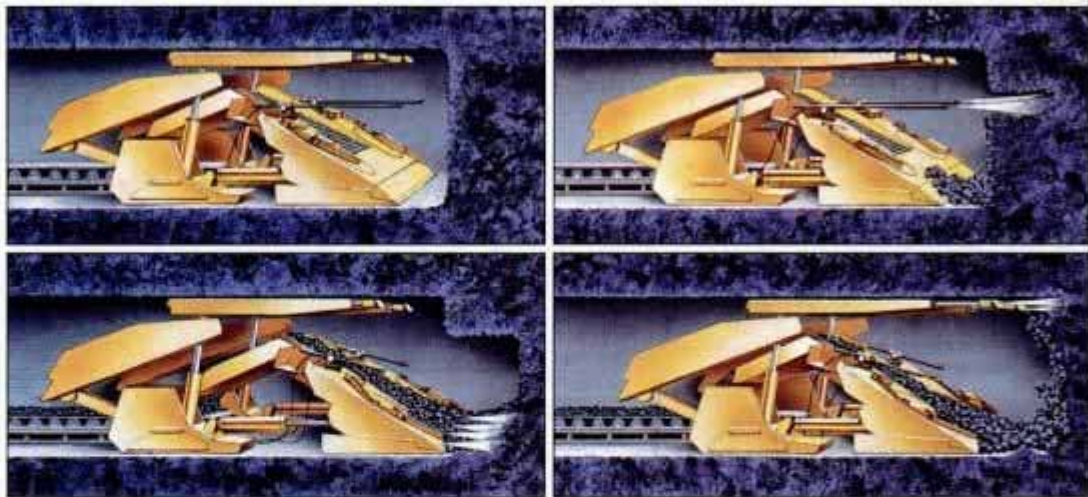
*When You Depend On Tools,  
Depend On Stihl.*



## Squirt Gun Coal Miner

ROLLA, MO—For years, coal miners have inhaled dangerous dust and risked cave-ins, even when working with mechanized excavators. A radical new machine should eliminate both threats. It's called RAPIERS (Room And Pillar In-Seam Excavator/Roof Supporter).

Instead of swinging a mechanical pick, RAPIERS fires high-pressure waterjets as it juggernauts its way into a coal seam. First, a pair of jet-lances carve a horizontal slot in the center of the seam's face. Then jets slot the top and bottom of the face, and wedge-shaped cutters move in to crush coal toward the midface slot.



Waterjets first gouge slot in seam face's center. Bottom wedge then fires jets and drives into the base, crushing coal toward the slot. Twin top wedges finish the job. RAPIERS' rear then waddles forward.

Two counterrotating arms gather the coal pieces onto a conveyor belt. Once both top and bottom wedges have pushed forward, pistons at the excavator's rear retract,

and RAPIERS walks forward to start anew.

By dampening the coal, the waterjets keep dust levels low. In addition, the top wedge can shore up the tun-

nel's ceiling until miners insert support bolts.

The University of Missouri and NASA's Jet Propulsion Laboratory have teamed to build a prototype.

## NASA's New Shuttle

KENNEDY SPACE CENTER, FL—In September, engineers at Rockwell International's Space Systems Division will begin mounting orbital-maneuvering rockets on *Endeavour*. After final checks, it will then be ready to test its wings in 1992.

Workers have "scarred" the new spacecraft for extended-duration missions that could last up to 28 days. That involves wiring and plumbing the Shuttle to accommodate beefed-up life-support systems and extra cryogenic hydrogen and oxy-

gen tanks to power fuel cells.

For a 28-day flight, the cryogenic tanks and nitrogen tanks for crew air would sit in the rear of the payload bay. The vehicle's nose would house a regenerable carbon dioxide scrubber.

*Endeavour* will feature a drag parachute to slow itself during landings, easing wear on brakes and tires. So far, construction is on schedule and under budget.

**Workers prepare to mate *Endeavour's* upper forward fuselage with its crew compartment.**



## Sweden's Full-Tilt Express

STOCKHOLM, SWEDEN—The forerunner to the Fas-train proposed for Florida (see *Tech Update*, page 11, July '90) is now whisking

Swedes at 125 miles per hour between Stockholm and Gothenburg. Built by ABB Traction, the X2000 joins Europe's growing army of

high-speed locomotives.

While it can't match France's TGV for raw speed, one thing the X2000 can do is handle tight curves on existing track. The train employs body-tilting technology,

banking up to 6½° in turns. In addition, rubber components in each bogie let axles follow curves more freely.

Three-phase thyristor-controlled engines produce 4400 horsepower and feature the latest diagnostic electronics. The train's aerodynamic fiberglass nose is shaped to withstand collisions with an elk, a common problem on Sweden's railroads.

**X2000 barrels along existing Swedish track at 125 mph, taking curves by tilting on hydraulic cylinders.**



PHOTO ILLUSTRATION BY ED VALIGURSKY, NASA



## Touchdown Via Satellite

WALLOPS ISLAND, VA—NASA and Honeywell have demonstrated yet another use for the versatile Global Positioning Satellite system—a setup that guides planes in for no-visibility landings.

To test the idea, engineers from Langley Research Center rigged a Boeing 737 with an arsenal of recorders and a windowless cockpit in the middle of the cabin. From

there, a flight crew flew the plane blind (an emergency crew stood by in the exterior flight deck).

GPS data streamed in from the satellites, both to the flight deck and to a runway-parked transceiver, which also broadcast its location to the plane. The flight crew made 36 blind landings without a hitch.

The experiment's success may position GPS as a rival to



GPS sats send altitude and runway location data to crew in internal flight deck.

the microwave landing systems that airports are now adopting. GPS could also guide in spacecraft.

## Combined Starter/Alternator

SCHENECTADY, NY—A single lightweight device can turn over your car's engine and then turn itself over to powering the electrical system. The combination start-

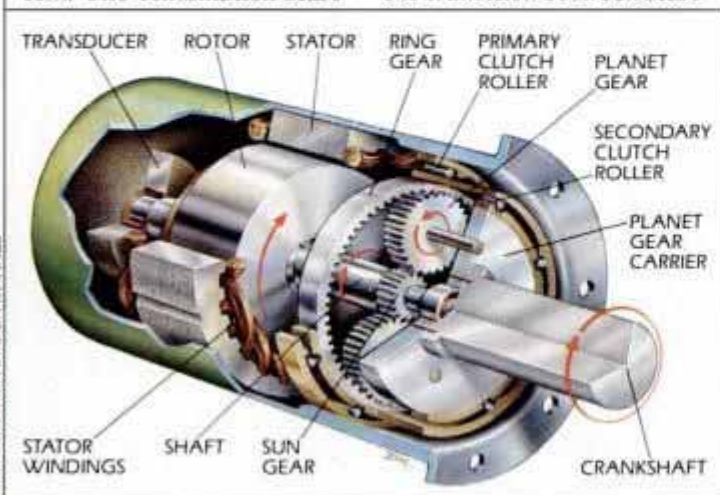
er/alternator incorporates power electronics, a permanent-magnet motor and a novel set of planetary gears.

Two 1-way clutches handle the transition between start-

er and alternator modes. In starter mode, the car's battery powers the motor via a DC-to-AC voltage inverter. The primary clutch locks up, and the gearset multiplies the motor's torque to crank the engine to life.

Once the engine is running, the secondary clutch locks up and the primary clutch overruns. This locks the crankshaft to the motor shaft. The crankshaft now delivers torque with no multiplication straight back to the motor, which now operates as an alternator. The resulting AC current is then converted to DC to charge the battery.

Inventor Robert King of General Electric's Research and Development Center claims the machine saves weight and is one-third more efficient than conventional alternators.



In starter/alternator, gears multiply torque in starter mode, then lock so crankshaft turns motor in 1-1 ratio, generating electricity.

## Russia's Mini-Energia

MOSCOW, USSR—While pressing ahead with development of their herculean *Energia* booster, the Soviets appear to be hedging their bets with a smaller craft based on the *Energia*'s first and third stages.

Called *Energia-M*, the new booster's core vehicle is probably *Energia*'s single-engine upper stage, which would normally be piggybacked into space on the main 4-engine booster. The two strap-on rockets also derive from the big booster.

*Energia-M* could orbit 30-ton payloads, outlifting any U.S. launch system.



Prototype of *Energia-M* on engine test pad at Soviet Baikonur Cosmodrome.

MIKE PLASTER PHOTO



## Smartest Bomb Yet

CHINA LAKE, CA—Smart bombs have seized the world's attention. But the Navy is studying a new air-to-surface weapon that may make them all obsolete.

Three teams of contractors are vying to develop the Advanced Interdiction Weapon System (AIWS). A highly aerodynamic winged bomb, the vehicle can glide for more than 20 miles before deliver-

ing its warhead or releasing submunitions.

Dropped from a strike jet, the bomb deploys wings and shifts tail control surfaces to follow one of several stealthy preprogrammed flight paths. Global Positioning System satellites keep its inertial guidance system up-to-date as the vehicle heads to its target. A video seeker then guides the vehicle in to

F-4 drops one version of AIWS. Vehicle glided, banked twice, then swooped in for a low-level run on its target.

its final destination.

Once this baseline version has proved itself, an even smarter AIWS will communicate with the aircraft to sharpen precision.

The Navy plans to pick a development team for the



weapon later this year. AIWS would have been the workhorse weapon of the now-canceled A-12 Avenger, but is still slated for full-scale development in 1992.

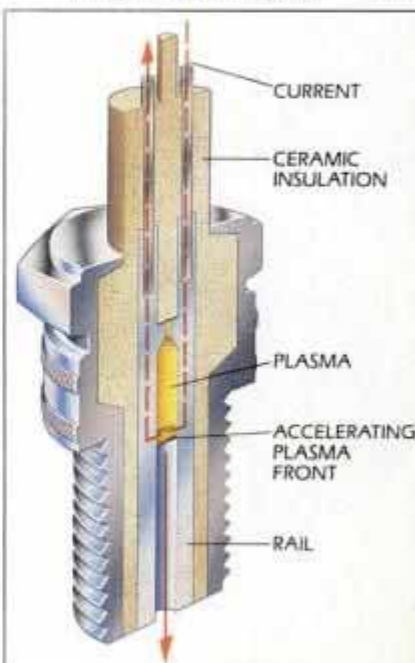
## Star Wars Spark Plug

AUSTIN, TX—The invention of the hypervelocity weapon known as the railgun sparked strategic-defense research in the 1980s. Now a miniature railgun that's being developed at the University of Texas may do some sparking of its own—in automotive engines.

Just as a railgun catapults a projectile to great speeds, the rail plug accelerates a jet of hot ionized gas or plasma. First a strong voltage is applied to two conducting rails. That triggers an electric arc to leap between the rails, igniting and ionizing a fuel mixture. The current in the rails creates an electromagnetic force that shoots the plasma down the rail plug.

The speed at which the plasma enters the combustion chamber sets off turbulence, which increases the burning efficiency, boosting fuel economy, reducing emissions

and suppressing engine knock. The rail plug also works well with leaner fuel mixtures. Researchers believe it will need a lot more electricity than a standard plug, however. The technology may also replace jet engine igniters to improve high-altitude flight. **TU**



Current flowing through rails throws plasma into combustion chamber.



## The Finishing Touch


COATBRIDGE, SCOTLAND—Hoping to whittle factory costs, engineers are training robots to do labor-intensive finishing tasks on manufactured components.

A Scottish robotics firm has developed a machine that automatically fettles, or grinds away unwanted metal from sand castings. The robot must run blind since a machine-vision system wouldn't stand up in the smoky, gritty environment. Instead, the machine traces

Five-axis fettling robot grinds off chunks of metal from sand-cast engine block, guiding itself by monitoring friction.

the contours of the cast object, monitoring friction on the fettling wheel.

Meanwhile, at Sandia National Laboratories, a robot combines machine vision with force sensors to bevel machined components. The technique allows the robot to operate without human supervision and compensates for positioning errors.

The company that introduced the first minivan now presents the first one with a driver's minivan air bag: the 1991 Plymouth Voyager.\*  **Advantage: Plymouth** So once again, we're leaving the competition spinning their wheels. The 1991 Voyager also offers available safety features like 4-wheel anti-lock brakes, all-wheel drive, and standard rear seat shoulder belts.† In addition, there's a completely redesigned interior, including a new instrument panel and glove box. Plus contemporary styling outside. In fact, 80% of all key parts are new on the Voyager. And you get 7 years or 70,000 miles of powertrain protection.‡ So for purchasing or leasing information, stop by your local Plymouth Dealer or call 1-800-PLYMOUTH.

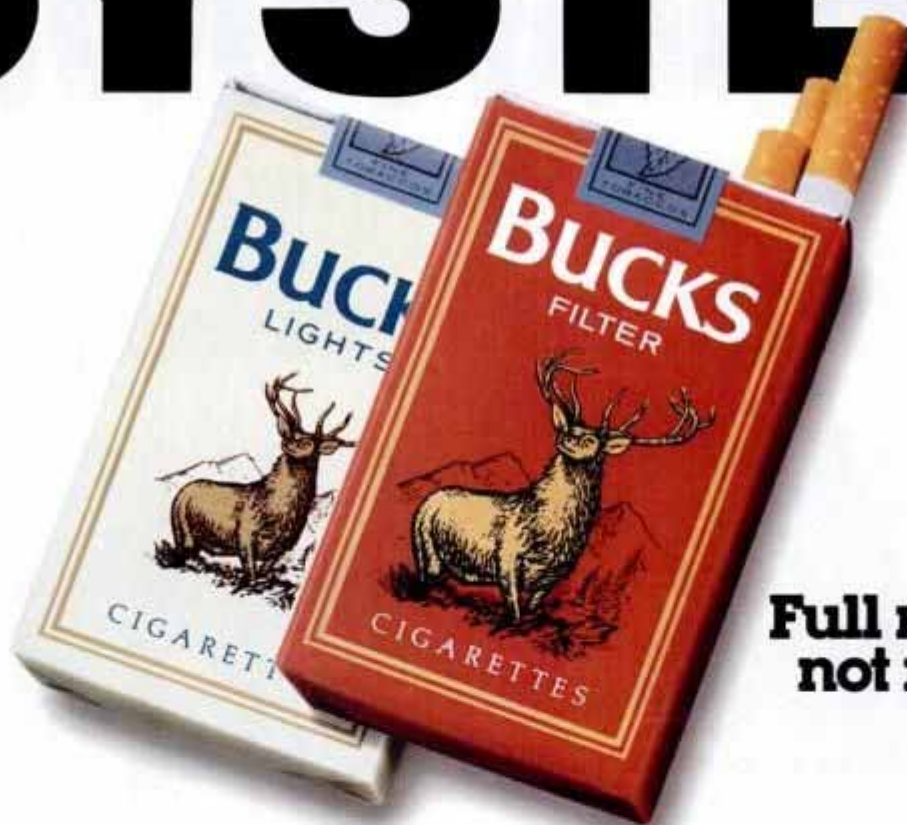
# NO OTHER MINIVAN HAS OUR STOPPING POWER.



*Announcing the New 1991 Plymouth Voyager. The first minivan with an air bag.*

\*Minivan air bag is fully effective only when used with seat belt. †Lap belt on center rear seat. ‡Protects engine, powertrain and covers outerbody rust-through. See limited warranty at dealer. Restrictions apply. Buckle up for safety! © Plymouth/Chrysler Corp., 1991

# BUCK THE SYSTEM



**Full rich flavor,  
not full price.**

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

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Mfr's. suggested retail price.

Kings Lights: 11 mg "tar," 0.7 mg nicotine—Kings: 14 mg "tar," 1.0 mg nicotine av. per cigarette by FTC method.

COMPARISON TEST

Popular  
Mechanics  
MAY 1991

# SATURN SHOWDOWN



GM's new coupe and sedan fight for respect in the world of subcompacts.

BY TONY SWAN, Auto Editor,  
& RICK TITUS, West Coast Editor  
PM Photos by Ron Hussey

● No new American car in recent memory has generated more anticipation than the Saturn. We've tracked this project from concept to production. And now the moment of truth is at hand—the road test. Saturn versus the world. Saturn's mission—reclaiming territory that GM had all but ceded to Asian carmakers—is ambitious. To measure the mission's success, we assembled a fleet composed primarily of prominent Japanese makes.

What we have here is two tests in one: Saturn sedan versus a selection of subcompact 4-door best sellers, and Saturn coupe against some of the most potent pint-size hot rods. We think you'll find the results interesting.

# SATURN SHOWDOWN

## THE COUPES A Matter Of Taste

The sports coupe buyer is considered by many to be the most informed in the market. This is *the* class of comparison buying. It's a showdown of looks, performance, image and value, and the competition is fierce.

### Saturn SC

To start with, a good sports coupe has to be good looking. Sitting low, swoopy and slick, our bright-red tester turned heads everywhere we went, and in California that's not easy.

Another essential ingredient is driver positioning—well back from the windshield and centered on the instrument panel and the controls.

Gearshift, switches, and climate and radio controls must be easy to reach. And the gauges should tell you more than when it's time to call the auto club. The Saturn SC has these.

But from an enthusiast's point of view, performance is the ultimate yardstick, and the Saturn SC measures up very well. We were pleasantly surprised with its outstanding

handling, acceleration and braking, which topped every instrumented category of our testing.

The 123-hp 1.9-liter dohc 16-valve engine makes all the right sounds, and the chassis provides outstanding handling and balance. Several testers found the engine a little loud, and felt the shift linkage still needed refinement. But we all felt the Saturn SC comes to the fight ready to win.

### Acura Integra LS

The Integra came to our test as the standard setter, and the handling target of the Saturn development team. Its size, performance and price put it a cut above most of these cars.

The Integra's 112-hp 1.8-liter dohc engine is silky smooth throughout the rev band and was the smoothest engine and driveline in the test. Its transmission gearing is well spaced and crisp on the shift. The chassis is sure-footed and was faster in the high-speed slalom than its cousin, the Honda CRX Si.

The Integra's steering feel is light—too light for some of our testers—but excellent for tight parking.

Its interior is roomy and is comfortable for long hauls.

While we feel the Saturn chassis team hit its mark in terms of competitive handling, one of the Integra's strengths is not so easily matched: The Integra commands exceptional resale value.

### Honda CRX Si

The CRX is readily classifiable as a sports car and readily converted for successful showroom stock racing. Honda's 108-hp 1.6-liter sohc 16-valve engine pulls from the low end of the tach with surprising authority. And its chassis is so precise you'll feel you have the hands of a violinist.

But as good as all that might be, it's not for everyone, and it's surely not for everyone every day. The CRX Si is long on quality, economy, performance and fun. But it's short on ride comfort, it's limited to two passengers, and it has high steering effort at low speeds. Its ride is firm, which on the long haul begins to get harsh.

You see where we're headed here. The CRX Si is a little car of limited practicality. But it's cute and sexy,

HONDA CIVIC EX



TOYOTA COROLLA LE



HYUNDAI EXCEL GL



PLYMOUTH  
SUNDANCE



NISSAN SENTRA XE



SATURN SL2





and packs impressive levels of low-cost fun into its small exterior.

### **Isuzu Impulse XS**

The Impulse XS is a shared platform with the Geo Storm. The Storm got the looks, the Impulse got the performance. The XS is fitted with a 130-hp 1.6-liter 16-valve twin-cam engine that's potent at top end, weak in the lower ranges.

But the tipoff to this car's character lies in two small fender badges: Handling by Lotus. Put this car on a demanding stretch of back road and it quickly races to the front of the pack. Although there's body roll, the Impulse is wonderfully precise, whether the surface is smooth or corrugated. The Impulse was more pure driving fun than any car in this group.

Front-seat space is good, and the bucket seats are well matched to the car's handling potential. Rear-seat room falls into the preschool category, but luggage space is quite large. Our only negative response to all-around comfort lies in the area of noise—there's a good deal of buzz from the engine when it's working hard.

### **Nissan Sentra SE-R**

Poise is the word that comes to mind in connection with the Sentra SE-R. Throughout our testing it looked calm, it felt calm, yet it was quick and pleasant to drive.

Designed to be the hot rod of the all-new Sentra lineup, the SE-R is hauled with verve by a new 140-hp dohc 2.0-liter engine, the most potent powerplant in its class. Its 5-speed transmission is light and accurate. Its overall feel is one of refinement.

The most appealing aspect of the Sentra's performance is its ability to get from point A to point B. Relatively soft suspension and so-so OEM tires limit its capabilities on twisty roads, although it's free of any vices other than resolute understeer.

On the other hand, ride quality is excellent, and the quality of construction and materials is very high. Stir in serious stoplight quickness and you have a package that's a very satisfying blend of comfort and hustle.

### **Ford Escort GT**

Designed in a joint engineering effort with Mazda (it

shares the Protegé platform), the new Escort is a welcome development of the line and a much better car than its predecessor.

In GT trim, the Escort uses the 127-hp Mazda 1.8-liter dohc 16-valve Four, an engine that would look right at home in an open-wheel race car.

Of the 12 cars in our test, the Saturns and the Escort drew the most attention from sidewalk traffic and produced the most inquiries.

However, we don't think the interior matches the contemporary exterior. Though spacious and comfortable, the car feels dated with its high cowl and seating position, and the seats don't measure up in lateral support.

While the interior isn't particularly sporty, the Escort's all-around performance is. The 1.8-liter Mazda engine pulls well throughout its operating range, and makes little noise in doing so. Like the Sentra, aggressive driving produces much body roll, but with no nasty surprises.

And we'd say the same for this car's overall quality. The Escort is a solid package—a balanced blend of space, comfort, looks and performance.

NISSAN SENTRA SE-R



FORD ESCORT GT



ISUZU IMPULSE XS



ACURA INTEGRALS



HONDA CRX SI



SATURN SC



# SATURN SHOWDOWN

## SPECIFICATIONS AND DIMENSIONS

MANUFACTURER/ MODEL	BASE PRICE/ PRICE AS TESTED	ENGINE/ DISPLACEMENT (ci/cc)	ENGINE HP, NET/ TORQUE (ft.-lb.)	ENGINE/ DRIVE LAYOUT	TRANS- MISSION TYPE	WHEEL- BASE (in.)	LENGTH OVERALL (in.)	WIDTH OVERALL (in.)	TRACK FRONT/REAR (in.)	CURB WEIGHT (lb.)
<b>Acura Integra LS</b>	\$13,975/ \$13,975	L4 DOHC 16V 111.9/1834	130 @ 6000 rpm/ 121 @ 5000 rpm	front/ front	5-speed manual	100.4	172.9	67.4	58.1/58.1	2550
<b>Ford Escort GT</b>	\$11,484/ \$12,704	L4 DOHC 16V 112.2/1839	127 @ 6500 rpm/ 114 @ 4500 rpm	front/ front	5-speed manual	98.4	170.0	66.7	56.5/56.5	2318
<b>Honda CRX Si</b>	\$11,330/ \$11,330	L4 SOHC 16V 97.0/1590	108 @ 6000 rpm/ 100 @ 5000 rpm	front/ front	5-speed manual	90.6	148.5	65.9	57.1/57.3	2174
<b>Isuzu Impulse XS</b>	\$12,049/ \$13,994	L4 DOHC 16V 96.9/1588	130 @ 6800 rpm/ 102 @ 4600 rpm	front/ front	5-speed manual	96.5	166.1	66.7	56.3/55.3	2411
<b>Nissan Sentra SE-R</b>	\$10,970/ \$13,465	L4 DOHC 16V 121.9/1998	140 @ 6400 rpm/ 132 @ 4800 rpm	front/ front	5-speed manual	95.7	170.3	65.8	56.5/55.5	2415
<b>Saturn SC</b>	\$11,775/ \$14,465	L4 DOHC 16V 116.0/1901	123 @ 6000 rpm/ 121 @ 4800 rpm	front/ front	5-speed manual	99.2	175.8	67.5	56.8/55.8	2375



ACURA INTEGRA LS



FORD ESCORT GT



HONDA CRX SI

### THE SEDANS How Small Is Small?

Although we came much closer to a consensus in the sedan portion of the Saturn Showdown, we were truly unanimous on only one point: You can get a lot more for your money at the small end of the sedan market today.

#### Nissan Sentra XE

Nissan's overall product line has undergone an amazing turnaround in the past three years, and the Sentra is the latest proof. The new car shares basic platform dimensions with its stodgy predecessor, but not much more. Nis-

san's chassis engineers have done an excellent job of giving the Sentra the ride and feel of a larger car, something that can also be said for the interior design team. In addition, new materials have been lavished on seats and trim, giving the whole package a high level of comfort and eye appeal.

Although Nissan's new 140-hp dohc 16-valve Four is limited to the Sentra coupe, the line's old 90-hp 1.6-liter sohc base engine has a new 16-valve dohc cylinder head and 20 more hp to go with it. This is enough to stir the Sentra sedan along quite respectably.

While the Sentra's handling is still

short of true agility, its ride quality and sound isolation are top drawer. And it's this quality—all-around civilization—that distinguishes the Sentra from the rest of this group.

#### Saturn SL2

Our Saturn sedan test car enjoyed an edge, thanks to its optional 123-hp dohc 16-valve Four. We asked for the 85-hp sohc engine, which powers the basic car, but Saturn was apparently unwilling to have this edition measured against its peers.

Another Saturn edge is its size—it actually measures up as a small com-

## SPECIFICATIONS AND DIMENSIONS

MANUFACTURER/ MODEL	BASE PRICE/ PRICE AS TESTED	ENGINE/ DISPLACEMENT (ci/cc)	ENGINE HP, NET/ TORQUE (ft.-lb.)	ENGINE/ DRIVE LAYOUT	TRANS- MISSION TYPE	WHEEL- BASE (in.)	LENGTH OVERALL (in.)	WIDTH OVERALL (in.)	TRACK FRONT/REAR (in.)	CURB WEIGHT (lb.)
<b>Honda Civic EX</b>	\$12,075/ \$12,075	L4 SOHC 16V 97.0/1590	108 @ 6000 rpm/ 100 @ 5000 rpm	front/ front	4-speed automatic	98.4	168.8	66.7	57.1/57.3	2412
<b>Hyundai Excel GL</b>	\$8900/ \$10,295	L4 SOHC 89.5/1468	81 @ 5500 rpm/ 91 @ 3000 rpm	front/ front	4-speed automatic	93.8	168.3	63.3	54.7/52.8	2310
<b>Nissan Sentra XE</b>	\$9800/ \$10,625	L4 DOHC 16V 97.4/1597	110 @ 6000 rpm/ 108 @ 4000 rpm	front/ front	4-speed automatic	95.7	170.3	65.8	56.9/55.9	2387
<b>Plymouth Sundance</b>	\$8546/ \$9826	L4 SOHC 135.0/2213	93 @ 4800 rpm/ 122 @ 3200 rpm	front/ front	3-speed automatic	97.0	171.7	67.3	57.6/57.2	2654
<b>Saturn SL2</b>	\$10,295/ \$12,890	L4 DOHC 16V 116.0/1901	123 @ 6000 rpm/ 121 @ 4800 rpm	front/ front	4-speed automatic	102.4	176.3	67.6	56.8/55.8	2345
<b>Toyota Corolla LE</b>	\$12,148/ \$13,292	L4 DOHC 16V 96.8/1587	102 @ 5800 rpm/ 101 @ 4800 rpm	front/ front	4-speed automatic	96.7	170.3	65.2	56.3/55.3	2352



PLYMOUTH SUNDANCE



HONDA CIVIC EX



HYUNDAI EXCEL GL

1. Times from a steady-state 40 to 70 mph. 2. Best speed achieved while weaving through seven cones placed in line, 100 ft. apart. Speeds provide index of transient response.

		TEST RESULTS							
STEERING TYPE/TURNS LOCK-TO-LOCK	BRAKE SYSTEM FRONT/REAR	FUEL ECONOMY (MPG EPA city/hwy. PM test)	ACCELERATION 0-60 MPH (sec.) 1/4-MILE (sec. @ mph)	PASSING <sup>1</sup> ACCELERATION 40-70 MPH (sec.)	BRAKING 60-0 MPH (ft.)	700-FT. <sup>2</sup> SLALOM (mph)	200-FT. <sup>2</sup> SKIDPAD (G)	EPA CARGO VOLUME (cu. ft.)	EPA INTERIOR VOLUME (cu. ft.)
Power rack & pinion/ 3.5	F: 10.3-in. vented disc/ R: 9.4-in. disc	24/28 24.8	8.9 16.7 @ 80.8	8.3	141	61.0	.78	16.0	79.0
Power rack & pinion/ 3.1	F: 10.1-in. disc/ R: 9.9-in. disc	26/31 28.0	9.0 16.8 @ 80.2	8.4	137	61.2	.76	17.3	90.5
Manual rack & pinion/ 4.1	F: 9.5-in. vented disc/ R: 9.4-in. disc	28/33 29.3	9.0 16.9 @ 80.4	8.2	154	62.4	.79	23.2	NA
Power rack & pinion/ 3.0	F: 9.7-in. vented disc/ R: 10.1-in. disc	26/33 23.7	9.6 17.1 @ 77.6	9.2	146	63.0	.81	11.0	78.5
Power rack & pinion/ 3.3	F: 9.7-in. vented disc/ R: 9.1-in. disc	24/32 29.6	8.3 16.3 @ 83.4	7.8	134	61.5	.75	11.7	95.5
Power rack & pinion/ 2.7	F: 9.9-in. vented disc/ R: 9.7-in. disc, ABS	24/34 27.7	9.5 17.1 @ 80.4	7.6	139	63.4	.80	10.9	76.4



ISUZU IMPULSE XS



NISSAN SENTRA SE-R



SATURN SC

fact—but since the basic car is priced against subcompacts, this is an advantage you can take to the bank.

Besides its acceleration, we were impressed with the Saturn's handling, clearly the best in this group. We were also impressed with Saturn's braking—which was augmented by an antilock system—as well as the seating, the 4-speed automatic transmission and the car's serviceability.

Two traits keep this car from being best in group. First, the engine's noise and vibration, acceptable in the sporty coupe, is unacceptable here. Second, ride harshness, which is Sat-

urn's tradeoff for lively handling.

Still, we see the Saturn as a serious new contender in an increasingly competitive field.

### Honda Civic EX

Long the small-car pacesetters, Honda's Civic lineup is headed for a major revitalization this fall, and it's a good bet the kids from Tokyo will advance the state of the art once again.

Meanwhile, the current edition no longer appears to be king of the hill.

The Civic's great virtue continues to be interior design that makes the most of outside dimensions, particu-

larly in trunk space, and affords excellent driver sightlines. Control layout is another standard Honda strong suit, as is solid construction and standard equipment.

Performance, provided by the EX's 108-hp sohc 16-valve 1.6-liter Four, is good, but we found the 4-speed automatic too willing to downshift. The Civic strikes a very good balance in the ride/handling tradeoff, and is devoid of bad manners—if you discount its over-assisted power steering.

Good as Honda is at packing lots of space into small packages, though, our biggest reservation about the

		TEST RESULTS							
STEERING TYPE/TURNS LOCK-TO-LOCK	BRAKE SYSTEM FRONT/REAR	FUEL ECONOMY (MPG EPA city/hwy. PM test)	ACCELERATION 0-60 MPH (sec.) 1/4-MILE (sec. @ mph)	PASSING <sup>1</sup> ACCELERATION 40-70 MPH (sec.)	BRAKING 60-0 MPH (ft.)	700-FT. <sup>2</sup> SLALOM (mph)	200-FT. <sup>2</sup> SKIDPAD (G)	EPA CARGO VOLUME (cu. ft.)	EPA INTERIOR VOLUME (cu. ft.)
Power rack & pinion/ 3.7	F: 10.3-in. vented disc/ R: 7.1-in. drum	24/29 30.5	13.2 19.2 @ 66.7	12.2	125	60.0	.76	12.0	76.0
Power rack & pinion/ 2.9	F: 9.5-in. vented disc/ R: 7.0-in. drum	28/32 28.3	16.0 20.4 @ 65.1	19.4	145	59.1	.72	9.3	85.0
Power rack & pinion/ 2.7	F: 9.8-in. vented disc/ R: 7.1-in. drum	27/36 28.3	14.2 19.6 @ 68.7	14.6	133	60.1	.74	11.7	95.5
Power rack & pinion/ 2.7	F: 10.2-in. disc/ R: 7.9-in. drum	23/27 25.3	17.0 21.0 @ 65.9	16.2	138	58.0	.70	13.1	101.8
Power rack & pinion/ 3.0	F: 9.9-in. vented disc/ R: 9.7-in. disc, ABS	23/32 27.9	10.0 17.5 @ 78.1	9.2	128	62.8	.78	11.9	88.7
Power rack & pinion/ 3.4	F: 9.4-in. vented disc/ R: 7.9-in. drum	25/33 32.6	13.5 19.3 @ 70.9	12.6	137	57.3	.69	12.7	84.0



NISSAN SENTRA XE



SATURN SL2



TOYOTA COROLLA LE

3. G-force generated during steady-state travel around a 200-ft.-dia. circle. Chart number is an average of best clockwise and counterclockwise.

# SATURN SHOWDOWN



SATURN SL2

The Saturn SL2 sedan (top) offers good front-seat legroom, excellent seating and attractive appointments. New 1.9-liter dohc 16-valve alloy 4-cylinder engine is peppy but noisy. Saturn SC coupe (below) provides first-rate handling.



SATURN SC

Civic has to do with legroom. But if you don't top 6 ft., and you don't have adult-size rear-seat passengers, the Civic continues to be among the best of breed.

## Toyota Corolla LE

Here's a familiar face, due for a change this fall. The Corolla's strengths—quality construction, durability and value—are also familiar, and if reliable transportation is your objective, this car is still a good bet.

While Corollas can be ordered in lots of flavors, from bare bones to sporty, our test car represents the mainstream.

In 105-hp tune, the 16-valve 1.6-liter dohc 4-cylinder engine is a solid workhorse, though low-end performance is sluggish, limited partly by the

3-speed auto, partly by tepid torque. It also makes a fair amount of noise when it's hurried.

Handling is deliberate, though thoroughly predictable, with good braking performance. Ride quality is only average, but there's respectable room inside, and comfortable seating.

Overall, we'd call the Corolla sedan bland but solidly in touch with the needs of small-family sedan buyers.

## Plymouth Sundance

While GM has been expending barages of ballyhoo on the Saturn challenge to the Japanese, it's only fair to note that the Sundance, and the Dodge Shadow, have been out there fighting this same battle for five years—and with a fair measure of success.

Our test car was a fairly basic mod-

el, powered by Chrysler's venerable 92-hp 2.2-liter sohc Four with a 3-speed automatic. This is a proven powerplant, but it tends to be noisy when it's pushed, and the 3-speed isn't as smooth as some.

On the plus side, the Sundance was predictable in the handling department, and the overall level of fit and finish compared well against the entries from the Far East. We'd characterize the roomy interior as relatively spartan, something that's reflected in the car's price.

## Hyundai Excel GL

Hyundai staked out its U.S. market claim by offering decent basic transportation cars at attractive prices. However, in the past couple of years, Hyundai's pricing has crept closer to the rest of the pack.

Facelifted last year, our Excel GL has a pleasant, if somewhat generic, look to it, and offers good interior space, substandard trunk capacity.

The Excel's 81-hp sohc Four has to work hard to produce acceleration, and its passing exposure times are poor. Its real-world handling is also unimpressive. Braking performance rates as no better than acceptable.

For all this, we still regard the basic Excel as a good transportation buy.

## Postscript

As we noted, this double test pits Saturn against a selection of its chosen competitors. Some key players were absent. From the sedan side, the VW Fox, Mazda Protegé, Isuzu Stylus and Mitsubishi Mirage/Dodge Colt come to mind. Among the coupes the Dodge Shadow Turbo, Chevy Cavalier Z24 and Toyota Corolla GT-S are conspicuous by their absence.

As a result, we aren't prepared to say that Saturn has beaten the Japanese at their own game. But we are prepared to say that it would be a mistake to omit the Saturn from your small coupe or sedan shopping list.

The Saturn is an impressive achievement, and an even better car than we expected it to be. **PM**

# JOURNEY TO THE CENTER OF THE EARTH

Drilling miles into our planet's crust, engineers are pushing the frontiers of technology and geology.

BY GREGORY T. POPE  
PM Illustrations by Jeff Mangiat

● Earth's face is familiar, but what lies beneath those superficial features? No one knows—no one's been down there. Theories about our planet's inner self emerge strictly from experiments carried out on the surface. But geologists aren't satisfied with indirect evidence. They want to peer right into the bowels of the Earth for a first-hand look.

To do that means to drill miles into the planet's crust, opening geology's final frontier. Such super-deep holes—dubbed "telescopes into the Earth" by their creators—challenge the limits of drilling technology. Engineers must send machines into a hellish environment, hemmed in by high pressure and hard rock, and riddled with hot, corrosive fluids.

So far, the Soviet Union has shown the most interest in meeting this challenge, with plans to complete 11 exploratory shafts by the year 2000. The deepest so far, on the Kola Peninsula, east of Finland, has now plunged well over 7½ miles. The Soviets say they won't stop until they're nearly 9 miles down. Meanwhile, a new shaft in the Ural Mountains will surpass the Kola hole sometime in the mid-1990s. Germany has also embarked on a superdeep project, aiming to bore 6½ miles under the Black Forest.

The United States, constrained by skimpy budgets, has avoided getting caught up in a race to inner space. The deepest that scientific drillers have ventured here is 11,515 ft., at Cajon Pass on the San Andreas Fault. Instead of burrowing headlong into the depths, Americans target geological hot spots, such as the fault and the volcanoes of California and Alaska. These well-aimed holes guarantee big scientific pay-offs.

Nevertheless, the Soviet and German sites attract

**German KTB drill navigates miles into the Earth with hydraulically powered steering runners, controlled by inclinometers and electronics. Electricity to power cutting head and hydraulics comes from mud-driven turbine generator.**



# JOURNEY TO THE CENTER OF THE EARTH



The unguided Kola drill wandered as much as 2700 ft. off vertical as it bored through granite-based crust, penetrating near-surface ore deposits, two deeper ore strata and a layer of shattered rock.

hundreds of American scientists each year. Not only have the boreholes pioneered superdeep technology, but they're forcing researchers to rewrite the rules of geology.

## Kola miners

A good example is the Soviet hole at Kola, now in its 21st year. In the mid-'70s, the Kola rig was supposed to plunge through the legendary Conrad discontinuity, thought by geophysicists to be the interface between the granite-based middle crust and basalt-based lower crust. Their evidence: seismic surveys, in which experimenters send sonic blasts into the ground, then time echoes from underground rock layers. By analyzing the change in sound-wave speeds, researchers calculated that the granite-basalt border lay 4½ miles down. But today, the Soviets are miles below that level and have yet to hit basalt.

"In reality, we did not find a physical border," says Boris N. Khakhaev, mastermind of the Soviet superdeep program. Director general of the quasi governmental deep-drilling outfit NEDRA, Khakhaev spoke with POPULAR MECHANICS by telephone from his home in Yaroslavl, 150 miles northeast of Moscow. "This hole," he adds, "drastically changes our concept of deep structure in the Earth." Instead of marking the basalt border, geologists now surmise, the phenomenon found by the seismic surveys may be the roof of a granite sublayer shattered by water that was squeezed from shallower strata.

Not only has the Kola hole undermined geological assumptions, but the project is also showing drillers how unforgiving Mother Earth can be. Emergencies are frequent, admits Khakhaev. The most recent came last November when loose rock 7½ miles down crushed the interlock between two lengths of drill pipe, pinching off the shaft. "The fact is," he says, "that at very low depths, crystalline rocks are quite unstable and subject to collapse"—another scientific surprise.

One lesson learned at Kola is the importance of sinking as straight a shaft as possible. The Kola hole corkscrews into the ground, meandering as far as 2700 ft. off the vertical. The curvature puts dangerous strain and wear on the drill pipe. In NEDRA's two newest superdeep holes, Khakhaev's crews address the problem with a 2-pronged, gyroscopically stabilized drill bit. Each of the bit's twin-

cutting heads is powered by a separate turbine motor that follows it down into the hole. These downhole turbines are themselves fixed to an assembly that spins with enough angular momentum to keep the whole drill vertical.

## Stay the course

Having witnessed the Soviet tribulations at Kola, Germany has sunk a major technological investment into its superdeep project, the Kontinentales Tiefbohrprogramm (KTB) in Bavaria. Instead of a passive steering system like the Russians', German engineers have built active navigational equipment into their downhole assembly.

Behind the cutting head, inclinometers detect any deviation from the vertical. The sensors then trigger one of four hydraulic pistons to push a runner against the side of the shaft, forcing the cutter back on course.

"One thing we've learned from the Russians is that we have to use these systems at shallow depths," says Peter Kehrer, project co-director with Germany's Geological Survey of Lower Saxony, "because if we don't keep vertical at those levels, we'll never make it." To that end, drillers first bored a shallow test hole to 13,120 ft., coring the rock for later analysis. Now that the KTB hole is under way, drillers can concentrate on staying vertical to the depth of the test hole and save the coring for the unprobed deep layers.

While the Germans' steering systems are new and experimental, their strategy for retrieving the downhole assembly is more conservative.

Superdeep drillers must periodically pull their machinery to the surface to replace drill bits and empty the core barrel of rock samples. Traditionally, this involves "round-tripping," driller lingo for yanking the whole drill pipe out of the shaft. In the Soviet Union, NEDRA developed an ingenious way of flushing the assembly out of the hole. Operators reverse the flow of drilling mud, a polymer-based fluid that's pumped through the drill pipe to drive a downhole turbine and cool the cutting head. Flowing backward, the mud propels the downhole machinery to the surface.

The Germans have chosen to stay with the foolproof, if time-consuming, round-tripping approach. To speed the process, surface-rig robots quickly unscrew, examine and stack pipe lengths as they emerge from the hole.

Just like their Soviet counterparts, the German drillers have met some surprises. The KTB hole marks the spot where two continental plates collided and fused 350 million years ago.

Sandia's Long Valley Caldera drill sits atop a volcano that last erupted 700,000 years ago, with several thousand times the force of Mount St. Helens. The drill will probe toward molten magma, a potential energy source.

Seismic surveys had suggested that rock layers from each plate overlapped horizontally at the suture. But once again, drilling revealed a different picture: The collision triggered folding and buckling that jackknifed rock layers almost vertically.

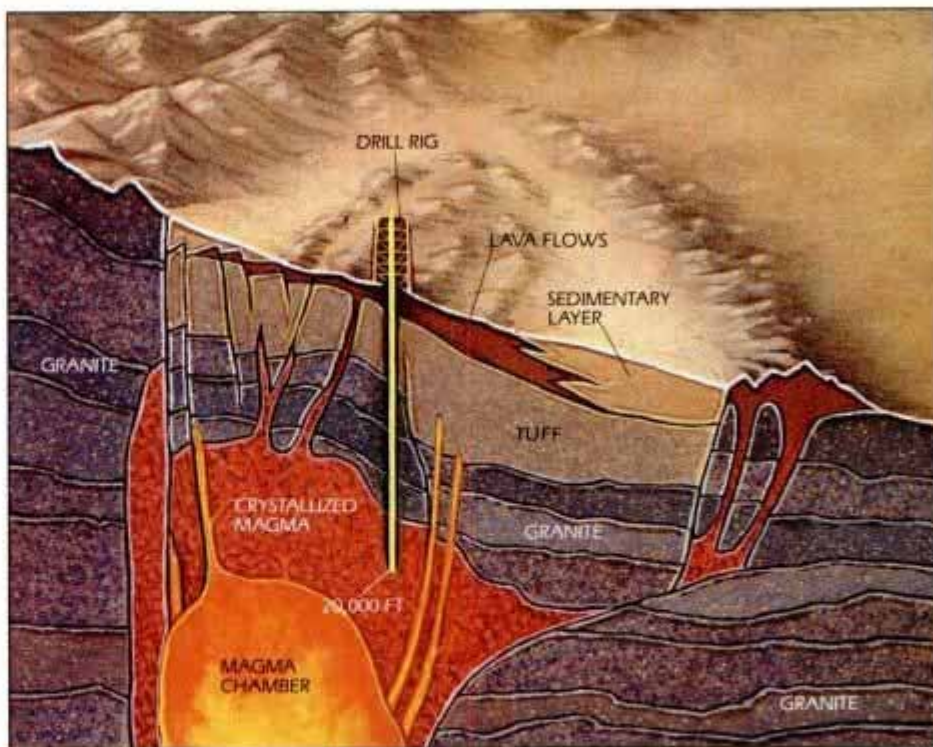
More alarming was the suture's high temperature. Last year, when drillers completed the test hole, they gauged the temperature at the bottom to be a toasty 244° F—almost 72° higher than expected. Since the Germans aren't about to push their equipment past 572° F, the discovery means that the KTB hole must stop several miles short of its original goal.

### Holes for heat

By contrast, drilling into scalding temperatures is precisely the goal at several locations in the United States. The hottest among current projects lies near the California/Nevada border. The site is the Long Valley Caldera, a collapsed volcanic crater that probably caps a huge reservoir of molten rock, or magma.

Unlike the Soviets and Germans, Long Valley drillers from Sandia National Labs aren't taking continuous core samples. They're seeking simply to verify the magma's existence. Lacking core-barrel equipment, with its elastomeric seals and other heat-sensitive parts, the Long Valley drill can push on until temperatures hit 932° F—possibly as far as 20,000 ft.—creating the deepest scientific hole in the U.S.

Should drillers find the magma,



step two would be to drill a second hole straight into the 1000° F rock and tap the heat to power steam generators for geothermal energy. To penetrate the magma chamber, waterjets will probably blast ahead of the drill bit, chilling the molten rock before cutting into it. Converting the magma's heat to energy, however, will call for equipment not yet developed. Meanwhile, geologists are now digging through a landslide of data from a 5370-ft. hole at Valles Caldera in New Mexico, completed in 1988. The project explored a complex volcanic system that last blew its top 600 years ago. It is America's hottest, deepest continuously cored hole.

Temperatures at the bottom hit 563° F, a trial by fire for hot-drilling

technology. Engineers had to ad-lib as problems arose, at one point tossing iron bolts into the hole to sharpen the cutting head. But the project was completed on time and within budget, proving that scientific drills can handle fiendish temperatures. "Right now we could easily go to 650° to 750°," says Sandia project director Peter Lysne.

Why subject expensive equipment to such punishment? Volcanoes, geologists say, remain one of Earth's most mysterious—and threatening—features. "These are tremendously powerful and dangerous systems," says Sandia geochemist John Eichelberger, "and we have a wealth of hypotheses but little direct observation."



Kola rig (left) pioneered superdeep technology, now being applied in new Urals rig (above). German KTB rig (right) employs robotic pipe handling for fast round-tripping.



COMPARISON TEST

# TAKING A BOW

Head to head in five open-bow sport boats. Plus a first look at the new Volvo Penta 500 Duoprop.

BY JOHN WOOLDRIDGE; PM Photos by Skip Gandy



● Nothing beats a bowrider for top-down, wind-in-your-hair fun. If your idea of a good time is to hit the lake with tunes in the cassette player, skis in the locker, iced drinks in the cooler and no particular place to go, then an open-bow runabout is the perfect boat.

Bowriders combine sports-car looks and performance with party-platform roominess for a fun quotient that tops the scale. It's no

wonder that the popularity of enclosed-deck sport boats has fallen off in recent years while bowriders' has soared. Once thought of as strictly a small-boat design, the multimission bowrider is now so popular that it's offered in cruiser-size hulls up to 24 ft. long.

The PM test team decided to take a look at the new generation of big bowriders and selected five of the best 20-footers we could find. We

brought them to a chain of lakes, near Orlando, Florida, and put them through their paces. Power for the fleet was supplied by Volvo Penta 500 Duoprop stern drives, which are based on newly retooled 190-horse GM 5.0-liter V8 blocks. Here's what we found.

## **Baja 208 Islander**

We didn't know what to expect with the 208 Islander. It was our first





## BAJA 208 ISLANDER

look at a boat built by Ohio-based Baja, a company with a name reminiscent of sunny beaches south of the border. Well, it turns out we should have expected a lot. With solid firsts in top-end speed, comfort factor (a combination of layout and features), engine noise levels and usable deck space, the 208 Islander emerged as our comparison test champ.

Plush design touches are every-

where. Air scoops flow into molded contours. Hull graphics are laminated into the gelcoat. An attractive white grille covers the flush-mounted horn. Pop-up cleats retract out of sight until a button is pushed. A handheld shower is built into the swim platform. A convenient electric lift opens the engine hatch. Deep-pleated cushions cover each interior surface and tightly hug each contour. And last but not least,

an innovative Coleman electric cooler/heater, especially designed for food, is located beneath the passenger-side console.

While top speed was a brisk 50.3 mph, hole shot and performance-course time lagged. Part of the problem is the Islander's heavy hull, which keeps engine noise to a minimum but tends to slow it down. Another problem is difficulty to pin a turn. Instead of grabbing, the Is-

## TAKING A BOW

lander tends to slide wide in wheel-lock turns.

But built-in quality and head-turning good looks are the Baja's strong suits. Combine this with fleet-leading speed and the Islander is one bow-rider that deserves to take a bow.

### Chaparral 2000 SL

Leading the fleet in overall performance, with second-place marks in top speed and hole shot, and a first in handling, the 2000 SL is a driver's favorite. In addition, Chaparral kept the 2000 SL sleek with a hidden ladder in the swim platform, aft cleats set inside the transom and bow rails angled into the cockpit. The net effect is a sporty runabout that satisfies style and performance needs.

Although the 2000 SL was on the small side in usable deck space, it more than compensated by putting in fleet-leading storage capacity.

Chaparral calls this boat a midline model, but fit and finish is impressive. Upholstery is topnotch. A bow cushion converts the bow area into a second sunpad. The sporty helm comes with a tilt steering wheel and supportive bucket seats.

The only minor glitches we could find are cramped kneeroom beneath



RINKER 206 CAPTIVA

LARSON 200 LEGACY

the consoles for tall drivers and, under full throttle, the 2000 SL is a bit noisy. A little sound damping would make this overall excellent boat even better.

### Stingray 596 ZPX

When it comes to performance, Stingrays run with the best. The 596 ZPX was hole-shot champ by a wide margin, and challenged the leaders in top speed and performance-course time.

With a pair of second-place rankings in deck area and stowage space, the 596 ZPX is also a champ at utiliz-

ing interior space. Among many features of note are deep freeboards, vent windows on the windshield, high-backed buckets with good support and copious legroom beneath the consoles. These features plus the optimum use of interior space give the boat high marks in comfort factor.

A shortage of nonglare above the instrument panel, lack of footrests in the deep footwells and a slight tendency to oversteer in hard corners are small nits to pick in the Stingray, a solid performer that tied the Chaparral overall for second place.

### TEST PARAMETERS

Boats were propped and tuned by Volvo Penta. Top-end, acceleration and performance course data are averages of multiple runs with two riders and matched fuel. Comfort factor is a combination of roominess, layout, special features and sound damping. Noise level is measured amidships at wide-open throttle. Bold numbers on each line indicate ranking in fleet.



MAKE/MODEL	1. BAJA 208 ISLANDER	2. (TIED) CHAPARRAL 2000 SL
LOA/Beam/Weight/Fuel Capacity	21'8"4"/3350 lb./43 gal.	20'3"8"/2650 lb./41 gal.
Top-End Speed	1. 50.3 mph, winner by a nose	2. 50.1 mph, among the elite 50-plus speedsters
Acceleration 0-30 mph	5. 7.15 sec., slowed by hull weight	3. 6.22 sec., quick to plane
Performance Course	5. 30.26 sec., slid wide through turns	1. 24.89 sec., pins wheel-lock turns with conviction
Deck Area	1. 77.66 sq. ft., wide beam allows open spaces	4. 70.62 sq. ft., limited by huge stowage space
Stowage Space	4. 46.05 cu. ft., more than adequate	1. 63.41 cu. ft., no opportunity missed
Noise Level	1. 85 dBA, the silent type	4. 91 dBA, loudest by far
Fit And Finish	2. Outstanding glasswork, custom-fit upholstery	3. Good upholstery, strong fundamentals
Comfort Factor	1. (tied) Superb seats, legroom, grab rails	3. Adequate but snug seating, low consoles
Price As Tested	\$19,150	\$20,045
Address	Baja Boats, P.O. Box 151, Bucyrus, OH 44820; (419) 562-5377	Chaparral Boats, P.O. Drawer 928, Nashville, GA 31639; (912) 686-7481



Volvo Penta 500/DP features new GM block.

Attractive dash with excellent nonglare. Clear view of all instruments. Padded wheel and throttle ideally located.



Convenient tilt wheel. Gauges are angled for visibility. Nonglare needed behind dash. Throttle mounted a bit high.



STINGRAY 596 ZPX



CHAPARRAL 2000 SL

## Larson 200 Legacy

In a world of copycat boat builders, Larson is an innovator, and the Legacy 200 is the Minnesota-based company's latest cutting-edge creation.

The first thing you notice is the curvilinear lines, from the rounded bow cockpit to the semicircular sunpad to the arced swim platform. Then, you notice the unique features—removable table in the bow that converts to a cushion-topped sunpad, wraparound bench seat in the main cockpit, freshwater sink and hidden Porta Potti.

These amenities, plus a second-

best ranking in noise level, give the Legacy a fleet-leading mark in comfort factor. Another top ranking is in fit and finish, a Larson hallmark.

In many ways, the Legacy was the test team's favorite boat. But the numerous built-in features eat up stowage and deck space, and the result in these categories is back-of-pack rankings. Top-speed and hole-shot marks also trailed, but only slightly. And despite the slower speeds, the Legacy finished second on the performance course, thanks to its superb handling.

Overall, the Legacy is a uniquely

impressive boat and destined to be much imitated by industry copycats.

## Rinker 206 Captiva

Affordability and practicality are bywords for Rinker, and the 206 Captiva is no exception. This boat scored well in all ranked categories except those affected by the company's entry-level philosophy—fourth in comfort factor and fifth in fit and finish.

For overall performance, the 206 Captiva scored surprisingly well. It leaped out of the hole to finish second in acceleration and clocked a close third on the performance course.

Despite a spartan appearance, the Captiva tied for second in sound damping. It finished with solid thirds in total stowage and deck area.

Legroom in the bow is tighter than most, as is clearance beneath the stainless-steel grab rails. Backrest cushions against the consoles are a bit thin. A portable cooler below the passenger console, while a nice feature, limits legroom, and the holding straps wouldn't stay fastened.

Not all boats are created equal, but bowriders are among the most popular boats on the market. Builders give them their best shots, and our test fleet bore this out. **PM**



2. (TIED) STINGRAY 596 ZPX	3. LARSON 200 LEGACY	4. RINKER 206 CAPTIVA
19'5"/7'10"/2480 lb./28 gal.	20'/7'11"/2500 lb./40 gal.	20'6"/8'2"/2800 lb./40 gal.
3. 50.0 mph, fast in a fast fleet	5. 48.3 mph, quick enough for skiing and thrills	4. 49.9 mph, slightly behind the lead pack
1. 5.96 sec., instant throttle response	4. 6.40 sec., not far off the leader's pace	2. 6.16 sec., a jackrabbit out of the hole
4. 25.53 sec., no misbehavior, near the leaders	2. 25.42 sec., handles like a dream	3. 25.47 sec., a smooth operator in corners
2. 73.84 sq. ft., room for the family to stretch out	5. 70.01 sq. ft., wraparound seating eats up room	3. 71.14 sq. ft., sufficient for group comfort
2. 49.77 cu. ft., excellent use of available space	5. 40.54 cu. ft., space filled with extra features	3. 47.83 cu. ft., missed out around the engine
3. 89 dBA, adequate but could be improved	2. (tied) 88 dBA, solid construction values pay off	2. (tied) 88 dBA, effective sound damping
4. Midline approach, exposed fiberglass in interior	1. Craftsmanlike attention to detail	5. Spartan approach, but price leader
2. Comfortable seating, roomy layout	1. (tied) Loaded with extras, great seating	4. Adequate, bow needs more handholds, legroom
\$17,587	\$23,880	\$17,250
Stingray Boats, P.O. Box 669, Hartsville, SC 29550; (803) 383-4507	Larson Boats, Paul Larson Memorial Dr., Little Falls, MN 56345; (612) 632-5481	Rinker Boats, 300 W. Chicago St., Syracuse, IN 46567; (219) 457-5731

<p>Nonglare dash is fine, but mounted in high-glare console. Instruments well positioned. Wheel a bit high, but throttle ideal.</p>		<p>Twin banks of highly visible Faria gauges. Sporty tilt steering wheel. Padded visor and top of console a nice touch.</p>		<p>Good visibility and protection behind the windscreen. Excellent view of all gauges. Small, unpadded sport wheel.</p>	
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# EARTH'S NEW LOOK

Computer map-making techniques offer new perspectives for familiar places.

BY MICHAEL J. McDERMOTT; PM Photos by Roy Attaway

● John Boccino's Intergraph workstation gives him a unique perspective of the world. He most often views the Earth through the big, high-resolution monitors of this futuristic computer console. And while the viewpoint it affords him might be vicarious, the power of the Intergraph makes the world as realistic as it would be to a seasoned traveler, and yet far more accessible.

Boccino, who works for map publisher Hammond, Inc., is one of a new breed of computerized map makers. Using state-of-the-art workstations, sophisticated software and mathematically based plotting solutions, these new-age cartographers can produce extremely accurate, up-to-the-minute maps.

Computer cartographers are able to generate a wide variety of projections, incorporate the thousands of minute alterations that are constantly

changing the face of the Earth and do it all almost instantaneously. Map revision projects that used to take months can now be done in a matter of minutes. Maps can now be presented in ways that are more informative and even entertaining. The Bonne projection of the world, for example, is heart-shaped.

The Intergraph used by Boccino is the Rolls-Royce of computerized map makers, but even it has not made the old ways obsolete. In the bowels of the Hammond building, researchers pore over a collection of newspapers, journals and maps from around the world—just as their predecessors have done for centuries. They meticulously record changed names, relocated cities, new roads, diverted rivers and thousands of other constantly changing details.

Rather than just becoming notes on an index card, this vast reservoir of information is now entered into





©COPYRIGHT BY HAMMOND, INC., MAPLEWOOD, NJ

Africa looks like a big potato in a misshapen world. The angles of intersection between countries are true, however, in this Feigenbaum conformal projection—useful as a navigation tool.

# EARTH'S NEW LOOK

a huge electronic database that is updated constantly. A second database contains longitude and latitude information for virtually every point on the globe. Together, these textual and linear databases give the new breed of map makers the raw materials they need to produce computerized maps.

Intergraph workstations are set up so that the computer's horsepower is used primarily for map graphics. Depending on the level of detail, a map may require as many as eight layers of film. The Intergraph makes any changes and produces new film in minutes, a job that would take artists and draftsmen a couple of weeks.

Hammond's computerized map-making efforts tap another area of old-world craftsmanship. Hunched over an enormous drafting table down the hall from the Intergraph room, Ernst Hofmann, a 68-year-old Viennese, produces topographic models that are unmatched anywhere in the world. Working sheets of aluminum foil with wooden and metal probes, he creates incredibly detailed and accurate landscapes.

Hofmann's pride is a "terra-sculpture" process developed over a 37-year career with Hammond. His huge relief sculpture of the entire globe, dubbed the Terrasphere, serves as the model from which Hammond's terrain and topographic maps are photographed. His work is one aspect of map

making that likely will never be computerized.

What ties all these diverse elements together is a fractal-based formula created by Mitchell Feigenbaum, the same mathematician who

maps were topnotch. All compass directions appeared as straight lines, and land masses and bodies of water retained the same shape as they appear on the globe. It became the favored depiction among map publishers, but that, cartographers say, was unfortunate, since the picture presented by the Mercator projection bears little resemblance to how the world really looks.

All the meridians (north-to-south lines) on the Mercator projection are evenly spaced vertical lines. The parallels (east-to-west lines) are horizontal and spaced so their length has the same relation to the meridians as on a globe. But the meridians on a globe converge at higher latitudes. They can't on a flat map, so the parallels have to be drawn farther and farther apart to maintain that relationship.

Most people, therefore, suffer from the delusion that Greenland is a huge body of land relative to most of the rest of the world. A glance at the globe will quickly dispel that notion. In fact, it's not just Greenland that is distorted on the Mercator projection. Only the equator is true to scale. The farther north or south you go, the greater the amount of distortion.

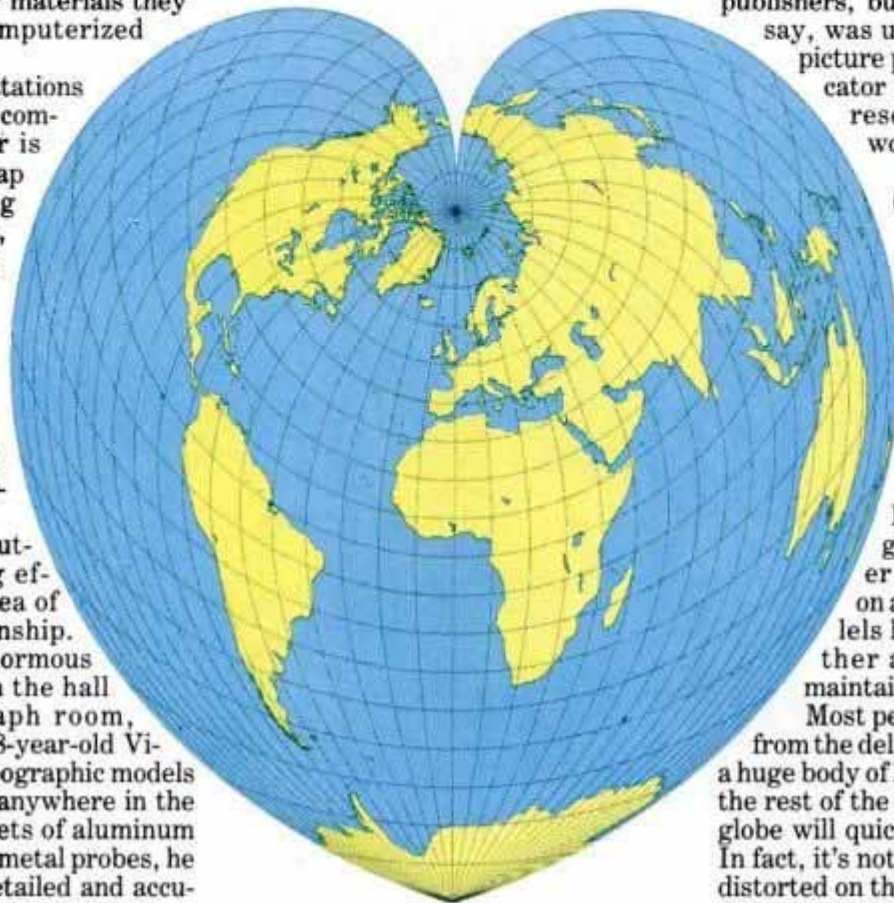
In fact, any attempt to project the surface of the globe onto a flat map will distort in at least three and often all four of the following ways: Shapes will be deformed, sizes will appear larger or smaller than on the globe, distances between points will be depicted as longer or shorter, and direct routes between points will not appear as straight lines.

These distortions can be controlled to some degree by using different projections. For example:

- Orthographic projections present a realistic view of the globe in visual terms. The increase in distortion toward the edges matches the distortion your eye normally experiences looking at a spherical object. Orthographic projections can only show one hemisphere at a time, but distortion is limited to the center area.

- Sinusoidal and Mollweide are both equal-area, oval projections that maintain the correct relative sizes of all regions. The sinusoidal is pointed at top and bottom, and its parallels are truly spaced horizontal lines. Outer regions are severely distorted, but

*(Please turn to page 97)*



The whimsical Bonne projection depicts a heart-shaped world.

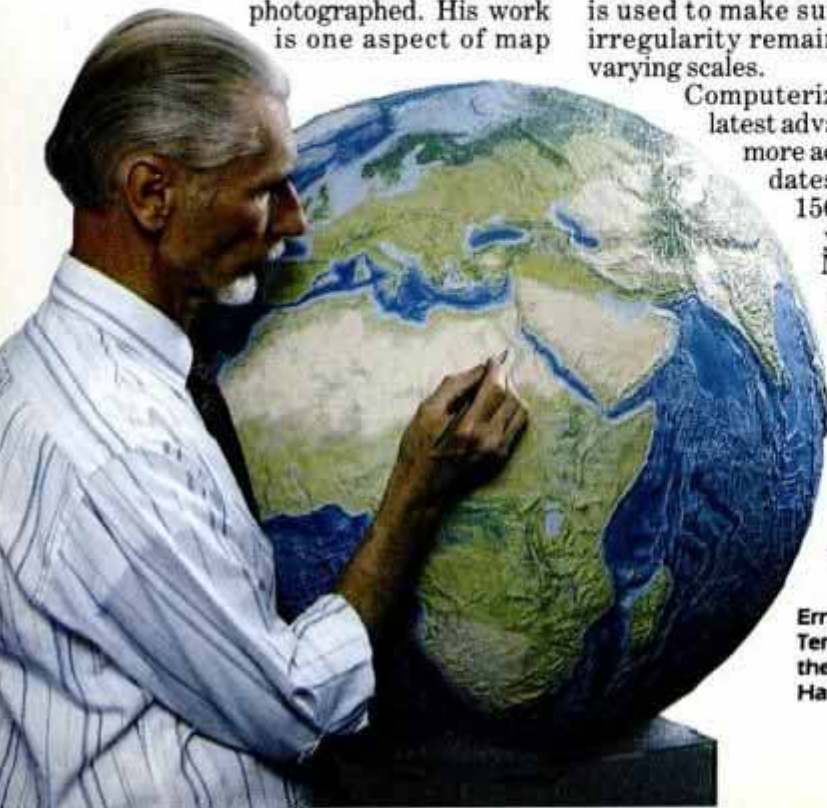
developed the formula for the predictability of chaos. This fractal geometry measures qualities, such as coastlines, that otherwise have no clear dimensions. The Feigenbaum formula is used to make sure the degree of irregularity remains constant over varying scales.

Computerization is just the latest advance in a quest for more accurate maps that dates back to at least

1569. That was the year Gerardus Mercator first published a flat map of the world as a way to publicize his method of making improved nautical navigation charts.

As an aid to seamen, Mercator's

Ernst Hofmann's Terrasphere is the model for Hammond's maps.



# MILLIONS INVESTED IN GUM DISEASE REMEDY

His first invention made him a success. His latest invention actually stops gum disease in 30 days!

BY GUY WAID AND PIERRE PASTEUR

In 1952, Philippe-Guy E. Woog, a scientist from Geneva, Switzerland, was himself troubled with gingivitis and began searching for ways to overcome the problem.

In the course of his research he discovered that there was an absence of gum disease in primitive cultures where only roots and raw meat were eaten. Eating such tough, fibrous foods stimulated the gums and cleaned the teeth, eliminating gum disease. With the coming of civilization, diets shifted to softer, refined foods; then plaque buildup and gum disease appeared.

Dr. Woog reasoned that the natural forces inherent in eating raw foods and meat were the proper ones for cleaning teeth and massaging gums.



Dr. P.G. Woog

On the basis of these studies, Mr. Woog developed the first oscillating motor electric toothbrush, the Broxodent®. In 1959 E.R. Squibb & Sons introduced it in the United States where it became a runaway success.

More than 150 other brands of electric toothbrushes have come on the market since his invention. Yet they all retain some serious disadvantages: battery powered models which cannot achieve sufficient torque to produce an efficient cleaning power; brushes with a fast circular motion that can wear away enamel and cause gums to bleed, or which clog when used with toothpaste; or monojet irrigators that can actually cause gums to bleed.

Dr. Woog's methodology has been supported by over 160 university clinical tests. He is the recipient of numerous honors for research and development in biomedical and bioengineering sciences.

Dr. Woog's interest in his own gum disease made him a success. But that was not enough for his inquiring mind. Dr. Woog realized that if an electric toothbrush and an oral irrigator were combined with periodontal attach-

ments in one machine, for the first time, gum disease could actually be arrested by a home dental system.

After 30 years of exhaustive research, design innovation, worldwide clinical testing and a personal investment of millions of dollars, Dr. Woog has created a radically new remedy for tooth and

gum disease, the Dr. Woog® PerioSystem. Built around a hydraulically-powered handle energized by a 60 watt motor, this system cleans teeth, loosens and removes plaque. It stimulates gums with absolutely no damage to sensitive, even bleeding gums when used as directed. And it's safe for family use.

U.S. Dental Research says: "You have a 75% chance of developing gum disease"!

## STOP BLEEDING & ARREST GUM DISEASE IN 30 DAYS!

Simply Use

### The Dr. Woog® PerioSystem®

The 3-In-1 Home Professional Periodontal System.



**INSTEAD OF:**

- 1) An Automatic Toothbrush (like Interplak®)
- 2) An Oral Irrigator (like WaterPik®)
- 3) Regular Hand Flossing and Gum Stimulation

Geneva, Switzerland — Revolutionary Swiss methodology arrests bleeding and gum disease in less than 30 days. Plus it eliminates 97% of plaque. Proven by over 160 university clinical tests, worldwide.

**100,000 Satisfied Customers Worldwide**

Dr. P.G. Woog, Ph.D., Toulouse University. Inventor of the first electric toothbrush (1956), owned by E.R. Squibb & Sons as the BROXODENT™ since 1968. He has contributed to over 160 scientific papers.

**More powerful than Interplak®**

Yet only the hydraulically-powered Woog gently and effortlessly massages your gums, strengthening them and eliminating disease.



"Arrests gum disease, stops bleeding gums and prevents loss of teeth." — University of California at San Francisco

**Safer than WaterPik®**

17,000 micro-droplets of water and air per second instantly shower away loosened plaque and debris, act as an hydraulic toothpick and accelerate circulation.

**Easier than hand flossing**

Woog's 4 custom periodontal attachments and micro-fractionated action reach, clean and massage where other systems simply can't ... even around orthodontics, brass or chrome bridges, and partial dentures!

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With so much to gain, shouldn't you call or write today for a 30 day risk free trial?

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Chester, CT 06412-1353, or call Toll-Free.

**1-800-677-5556**

(In Canada 1-800-999-4744)

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# JOURNAL



## HAND TOOLS

### SNIPS

Keep at least one of these metal cutters on hand—for the sheer pleasure of it.

BY THOMAS KLENCK,  
Associate Home Improvement  
Editor; PM Photos by Stan Silver

● They may not be among the very first tools that you'll own, but, sooner or later you're bound to need a pair of snips. These are the tools that handle metal—and other tough sheet materials—in much the same way that ordinary scissors are used on paper and cloth. Like scissors, snips don't simply cut through the material, but rather, shear through it by pushing up the material on one side of the cutline and down on the other side. The shearing action is accomplished by two sharp blades that slide by each other and through the material.

The similarity with scissors ends here, however. Snips are designed for

heavy-duty cutting power and utilize high-leverage designs to work through tough material. The simplest type, generally referred to as a tinner's snip, is characterized by long handles and short, stout jaws. Depending on size, it will handle low-carbon cold-rolled steel that ranges from 23 to 16 gauge. Like most other tools, snips come in a wide range of design variations. The following is a collection of the more common types used in home and industry.

**1 Straight-pattern tinner's snip**—Simple in design and robust in construction, the basic tinner's snip is one of the most common sheetmetal tools



1

and similar materials. It features a spring that automatically opens the stainless-steel jaws after each cut. A catch incorporated at the ends of the handles locks the jaws in the closed position for storage. Write to Stanley Tools, Division of Stanley Works, 600 Myrtle St., New Britain, CT 06050.

**4 Short straight-pattern snip**

—This is the short, 7-in. version of the straight-pattern tinner's snip shown at left. Scaled down for lighter work and confined areas, it costs about \$10 from American Tool Cos., Inc., 301 S. 13 St., Suite 600, Lincoln, NE 68508.

**5 Light metal-cutting snip**—Not all snips are designed for big jobs. This 7-in.-long tool handles everything from wire and paper to light sheetmetal, and it's ideal for small-scale appliance and electronics work. It features straight jaws, solid forged-steel construction and costs about \$17. A curved-jaw version is also available. Contact Cooper Tools, P.O. Box 728, Apex, NC 27502.

**6 Light metal- and wire-cutting shears**

—Similar in purpose to the tool above, this design has spring-loaded handles and a metal catch to lock the jaws shut for storage. The handles are plastic sheathed for comfort. This versatile tool handles many materials and is offered in a short-jaw version, as well. It costs about \$16. For more information, write to Channellock, Inc., P.O. Box 519, Meadville, PA 16335.

**7 Pipe and duct snip**

—If you've ever tried to cut stove pipe or metal duct to length, you know that ordinary snips are not quite up to the job. One side of the cut is always curling the wrong way which makes a straight cut impossible. The unique tool shown features

a 3-piece jaw that solves the problem. A central cutter slides past two side jaws resulting in an  $1\frac{1}{16}$ -in.-wide cut. The strip removed by the central cutter simply curls away from the cutline. This snip features a compound lever action that amplifies cutting force applied at the handles. It is also useful for cutting nonmetallic sheet materials such as fiberglass panels and plastic laminates. It costs about \$21. Contact Cooper Tools, P.O. Box 728, Apex, NC 27502.

**8 Curve-cutting compound-action snip**

—You may have heard this tool being called an aviation snip. That's because the spring-loaded, compound leverage design was first developed to handle the tough alloys used in the aircraft industry. Today, it's become the mainstay of just about all of the sheetmetal trades. The linkage that connects the jaws to the handles increases leverage without increasing handle length. The model shown is designed to cut curves that move to the right. A similar model with reversed jaws handles left curves. Most manufacturers ad-

in the home and workshop. Characterized by extra-wide, drop-forged carbon-steel jaws, this tool handles straight cuts best, but will accommodate gentle curves—especially in lighter material. It's available in lengths from 7 to 14 in. A longer model (16½ in.) with very short jaws for extra leverage is called a bulldog-pattern snip. The 12-in. Prosnip tool shown costs about \$16. Contact American Tool Cos., Inc., 301 S. 13 St., Suite 600, Lincoln, NE 68508.

**2 Duckbill-pattern tinner's snip**

—The flattened jaws of this type of snip allow it to cut much tighter curves than its straight-pattern cousin. Because it cuts both left and right curves moderately well without losing straight-cutting capabilities, the versatile duckbill snip is popular with homeowners and pros alike. It's available in the same range of sizes as the straight pattern, and the 10-in. model shown costs about \$13. Write to American Tool Cos., Inc., 301 S. 13 St., Suite 600, Lincoln, NE 68508.

**3 Light-duty snip**—This Handy-shear snip by Stanley (about \$8) handles light-duty tasks in galvanized sheetmetal, leather, heavy cardboard



2

3

4

5

6



here to a standard handle color coding: Red handles cut left, green handles cut right. The cutting edges are serrated for better gripping power. Write to the Ridge Tool Co., P.O. Box 739, Berea, OH 44017.

**9 Straight-cutting compound-action snip**—Similar in design to the above model, this tool features flattened, duckbill-type jaws that handle straight cuts and wide curves. If you're only going to own one pair of compound-action snips, this type is a good choice. Color-coded yellow handles signify straight cutting. This tool costs about \$20. For more information, contact Channellock, Inc., P.O. Box 519, Meadville, PA 16335.

**10 Replaceable-blade snip**—The Stanley Snipmaster snip looks like an ordinary straight-pattern tinner's snip, but has a unique special feature.

Screwed to each jaw is a blade that can be replaced when the tool gets dull. Because the hardened-steel blades are independent, the body of this tool can be made from a lighter aluminum alloy for comfort and reduced fatigue. This 10-in.-long snip (about \$16) also comes in a 7- and 12-in. size. Write to Stanley Tools, Division of Stanley Works, 600 Myrtle St., New Britain, CT 06050.

**11 Offset-pattern tinner's snip**—The straight line of ordinary tinner's snips can make them awkward to use on long cuts—the handles and your hand are in line with the material being cut. The bent handles of the offset snip keep your hands away from the cut for extra safety and ease of use. The 10-in.-long tool shown costs \$20. Others range up to 14½ in. long. Write to

Cooper Tools, P.O. Box 728, Apex, NC 27502.

**12 Offset compound-action snip**—This tool is the compound-action version of the basic offset tinner's snip described above. It handles straight or curved cuts and comes in right- and left-curve models. Like standard compound-action snips, the offset type utilizes color-coded handles. It costs about \$17. For more information, write to American Tool Cos., Inc., 301 S. 13 St., Suite 600, Lincoln, NE 68508.

**FM**



NEW PRODUCT

ASPHALT  
FIX

TEXT AND PHOTOS BY  
ROSARIO CAPOTOSO,  
Contributing Editor

● A revolutionary new product is available for quickly and easily repairing cracks in asphalt driveways. Called Driveway Medic, it's an alternative to using crack fillers applied with a caulk gun or putty knife. It's made from tough polypropylene fabric, backed with adhesive and impregnated with rubberized asphalt. It's sold in a 6-in.-wide × 9-ft.-long roll.

To make the repair, clean the area of loose material and dirt, then unroll the required length of patch material, and cut it to size with a razor knife. Peel off the protective backing paper, and smooth Driveway Medic over the crack. You can lay two or more pieces to cover large cracked areas. The material should be applied when the temperature is higher than 50° F.

Press down the patch by walking on it or driving over it. You can spread driveway sealer on top of the repaired area and the rest of the driveway.

The test patches on my driveway have been down for eight months, during which time there have been a number of hot/cold cycles and plenty of rain and auto traffic. The stuff looks as new as the day it was applied.

A roll of Driveway Medic costs about \$10 at hardware stores and home centers. Contact Co-Fair Corp., 3707 W. Touhy Ave., Lincolnwood, IL 60645. **PM**



Driveway Medic is a durable adhesive-backed polypropylene fabric impregnated with rubberized asphalt. Apply it over driveway cracks as if it were a piece of tape.



1 Unroll Driveway Medic along the length of the crack, cut it to length with a razor knife, then peel off backing paper.



2 Press the patch over the crack. Use more than one piece for large cracked areas. Seal over the patch if you wish.

BOOK REVIEW

NEW  
PLUMBING  
BOOK

● Many people don't need a plumbing book, especially one that's this complete. They either rely on plumbers to do the work or on store clerks to explain how the work should be done. But if you want to be more involved, this book is for you.

Written by journalist Merle Henkenius, this volume is loaded with information, from tips on faucet repair, drain cleaning and toilet trouble-

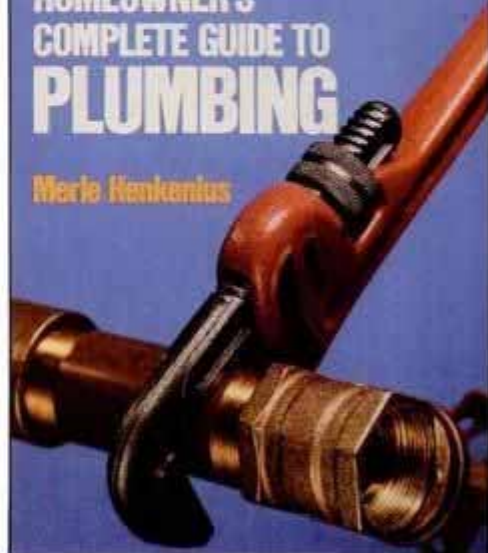
shooting, to the more arcane aspects of the plumbing trade, like proper venting techniques—something most plumbing books avoid because the subject is so difficult—installing and maintaining underground sprinklers, septic systems, water wells and much more.

The book is profusely illustrated with clear, friendly drawings and sharp black-and-white photography. But its most impressive trait is its literate and thoughtful text. It's so rare to find a technical book that is so well written. Called the *Homeowner's Complete Guide To Plumbing*, the book is published by Meredith Press, 150 E. 52nd St., New York, NY 10022. It's available at bookstores for \$32.95.

—Steven Willson

HOMEOWNER'S  
COMPLETE GUIDE TO  
PLUMBING

Merle Henkenius



**SHOP PROJECT**

**A CUT ABOVE**

A contemporary cutting board for any kitchen.

BY ROSARIO CAPOTOSTO,  
Contributing Editor

● This jumbo-sized cutting board will quickly become a favorite in your kitchen. Sized to bridge the sink, you can use it no matter how cluttered your counters get while you cook. Its large opening allows waste cuttings to drop through into the sink.

We built it out of hard maple because it is a dense, close-grained wood that is easy to clean and one that resists knife cuts.

**Preparing the stock**

Rip the boards to width as shown and crosscut them slightly oversize to allow for end trimming (Photo 1). Arrange the pieces with the annual rings facing alternately up and down. Mark the outline for the cutout and crosslines to locate the biscuits that join the strips together (Photo 2). Leave enough room when laying out the biscuits around the cutout so you won't hit them when making the cutout.

Adjust the biscuit joiner to cut a slot for a No. 10 biscuit and set its fence to cut the slot  $\frac{3}{16}$  in. from the top and bottom surfaces of the board. Cut for six pairs of biscuits along each joint (Photo 3).

**Color photo:** J.R. Rost  
**Photo stylist:** Gabe Herrick  
**Black-and-white photos:** Rosario Capotosto  
**Technical art:** Eugene Thompson



**1** Rip wide boards to narrow widths, then reassemble them with their annual rings alternately inverted to prevent warping.



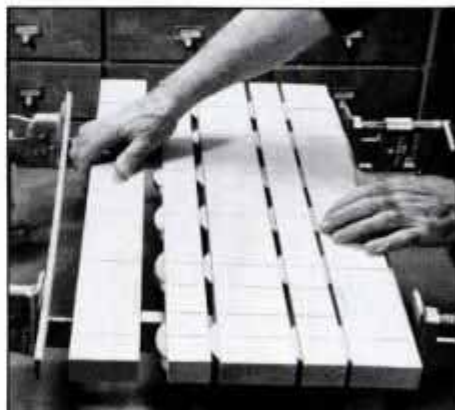
**2** Align the pieces and mark for cutout and biscuit slot centerlines. Leave ample clearance for biscuits around the cutout.



**3** Secure workpiece in a vise to quickly and safely cut the slots. Align fence by eye, and plunge cutter into the workpiece.



**4** Glue the biscuits into one side of each member (except last member). A small squeeze bottle makes dispensing easier.



**5** Dry fit the pieces together first. Support the clamps on blocks, push parts together by hand, then tighten the clamps.

## Glue up

We used water-resistant plastic resin glue to join the ripped pieces together. This glue allows an open assembly time of about 10 minutes, so work quickly. Begin by gluing the biscuits into the slots in one member of each mating pair (Photo 4). Dispense the glue from a small plastic bottle (the kind used to apply hair tint). Insert the biscuits, then dry clamp to check for fit. Spread glue over all the edge joints and biscuit edges with a small brush. Push the pieces together and clamp them (Photos 5 and 6).

## Shaping the board

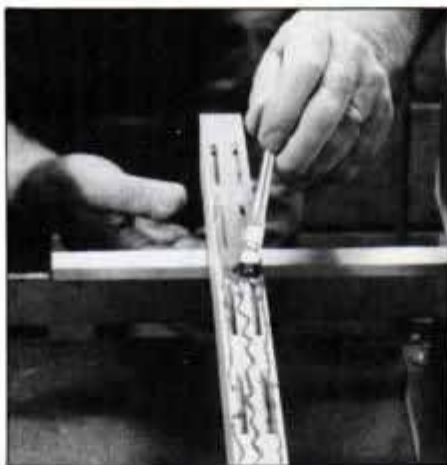
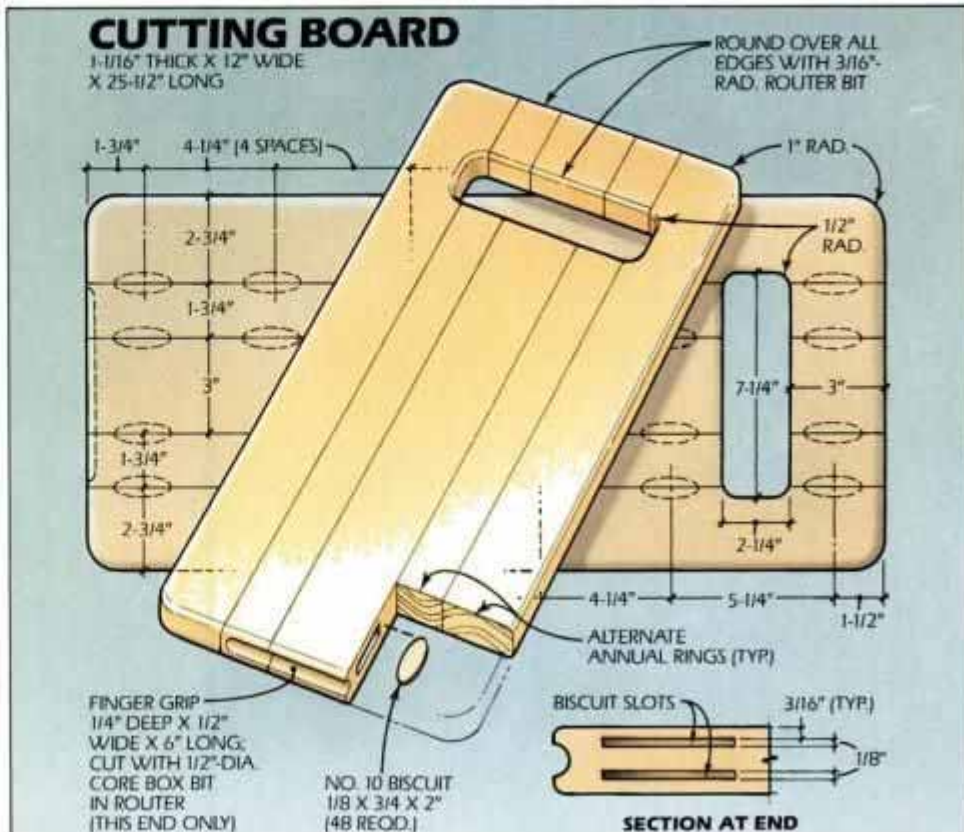
When the cutting board is completely glued up and the glue has dried, use a cabinet scraper to level the board, then trim it to length (Photo 7).

Next, bore 1-in.-dia. holes at the corners of the cutout. Clamp a straight stick across the cutting board to guide a sabre saw while cutting between the holes (Photos 8 and 9). Saw each outside corner round, and use the router with a  $\frac{3}{16}$ -in.-rad. corner-rounding bit to ease all corners.

Next, clamp the cutting board in a vise and cut the finger grip with a  $\frac{1}{2}$ -in.-dia. core box bit. Attach a wide fence to the router to keep it stable (Photo 10).

## Finishing the cutting board

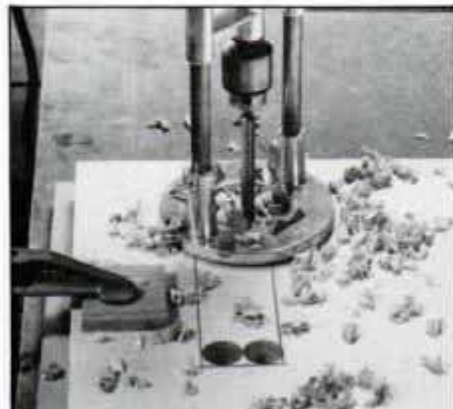
We used Behlen's Master Salad Bowl Finish on the cutting board. Sand the cutting board using 120-, 220- and 320-grit sandpaper. Apply the finish with a lintfree white rag. Allow 6 hours drying time before recoating, and scuff sand with 400-grit paper between coats. Allow the last coat to dry 24 hours, then rub it out with 4/0 steel wool. Allow the finish to harden for 72 hours. This finish is available at paint and hardware stores and from many woodworking supply catalogs. **PM**



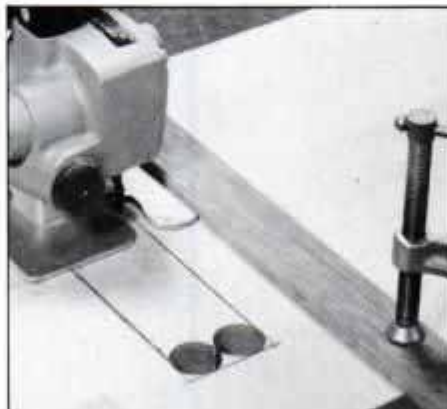
**6** Squeeze out several small beads of glue, then use a short-hair glue brush to quickly spread it evenly along the edge.



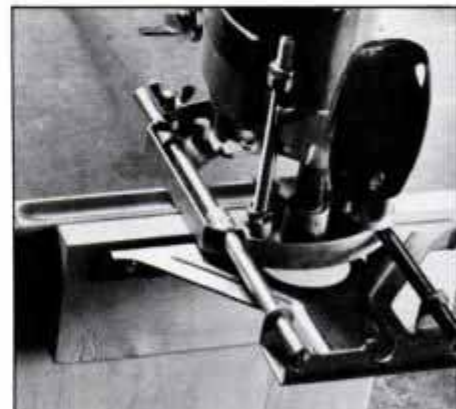
**7** After the glue has dried, clean off the surface with a cabinet scraper. This also reduces the amount of sanding necessary.



**8** Begin cutout by boring holes at corners. We used a drill guide and Stanley Power Bore bit for clean holes.



**9** Clamp a stick across cutting board to guide the sabre saw when making cutout. Sand and file away saw marks.



**10** Stand the cutting board in a vise, and attach a wide fence to the router for additional stability to cut finger groove.

**NEW PRODUCTS  
GREEN TEAM**

24 tools for easier yard work.

BY ROY BERENDSOHN,  
Assistant Home Improvement Editor

**Different Tack**

Ariens takes a different tack with its mulching mowers by giving them side discharge and rear bagging capacity for times when you don't want to mulch, such as when cutting wet or tall grass or cutting during the spring and fall when the weather is cool. The LM21S (shown) comes with a 21-in. steel deck, a side discharge chute and a mulching cover (inset, top left) to prevent side discharge. Both are designed to be quickly interchanged. To improve mulching efficiency, the company has introduced the Mulchmaster (right, about \$17 extra). Fit the plastic insert in the mower's rear discharge chute, and it forces clippings to be repeatedly recut. A dethatcher attachment (about \$70) is also available. The LM21S is powered by a 5-hp Tecumseh engine and is covered by a 5-year warranty. It costs about \$600 (without accessories) at hardware stores and outdoor power equipment dealers. For more information about the mower and its attachments, write to Ariens, 655 W. Ryan St., Brillion, WI 54110-1098.



**Tow It, Then Stow It**

Tow this seed spreader behind your tractor, then put it away. It's designed for minimum maintenance and years of use. Its gears stay clean because they're enclosed and self-lubricating. Its agitator wire is stainless steel so it won't rust, and its tow bar is finished with a black-powder coating. Its polyethylene plastic hopper can't rust and is impact resistant. It has a 90-pound capacity, tow-bar-mounted on/off control lever and a 4- to 8-ft. spread path. It costs about \$60 at hardware stores and lawn and garden centers. Write to Quaker Industries, Ltd., 90 McMillen Rd., Antioch, IL 60002.



**Dig In**

Molded from polycarbonate resin, this trowel is shaped with comfortable use in mind, especially for gardeners with arthritis or carpal tunnel syndrome. Its shape allows your wrist to remain straight while you are digging, and its handle is offset from the blade so you can more easily scrape and scoop with it than with conventional models. It costs about \$12, plus \$4 shipping (\$7 shipping for Alaska, Hawaii and Canada), from Walt Nicke Co., 36 McLeod La., P.O. Box 433, Topsfield, MA 01983.



**Over The Edge**

For a manicured lawn, you can form a straight or bevel edge around sidewalks, patios and driveways with the 1¼-hp Weed Eater electric edger. The 12½-pound edger has six cutting positions that work up to 1 in. deep, and the tool has a blade brake that stops the cutting in 3 seconds. It costs about \$100 at outdoor power equipment dealers. Contact Poulan/Weed Eater, P.O. Box 9329, Shreveport, LA 71139.



PHOTO BY ROSARIO CAPOTOSTO

**Fork It Over**

Ames has introduced a 5-tine fork designed for turning compost (right). Its tines are closer together than comparable forks. It has a 36-in.-long hardwood handle with a D-grip. It costs about \$36 at hardware stores. The long-handled yard tools (far right) are easier on your hands because they have foam-cushioned handles that won't absorb dirt. Included in the line are hedge shears (\$28), lopping shears (\$25), a plastic leaf rake (\$14), a steel leaf rake (\$15), a garden hoe (\$17), a bow rake (\$20) and a long shovel (\$20). They are sold at hardware stores and home centers. Write Ames Lawn and Garden Tools, P.O. Box 1774, Parkersburg, WV 26102.



**About Time**

Thread this timer on an outdoor faucet, then set the daily water cycle. It can water in 15-minute intervals for 3 hours. It has an override feature for other watering chores. The timer is powered by two AA batteries (not included), and costs about \$30 at hardware stores and lawn and garden centers. For information, write Melnor Industries, 1 Carol Pl., Moonachie, NJ 07074.



**Turn Around**

Use this 10-in. string trimmer one way for clean cutting around vertical surfaces, then twist a knob (at arrow) to turn the head 90° to convert it into an edger. A 2.8-amp, 1/8-hp motor spins the line head with automatic line advance. To replace the line head, just pull it off and slip on the new one. It costs about \$45 at hardware stores. Contact Paramount, 5020 Flournoy-Lucas Rd., Shreveport, LA 71129.



**An Easy Switch**

This riding mower switches from mulching to side discharge by removing two nuts and bolts, or it converts to a rear bagger. It cuts grass up to 3 1/2 in. tall and is powered by a 10-hp 4-cycle engine and a 5-speed transmission. The mower costs about \$1900 at Simplicity dealers (grass catcher, \$320 extra). Write Simplicity Manufacturing, Inc., 500 N. Spring St., Port Washington, WI 53074.

**Cost Cutter**

Homelite's 12-hp riding lawn tractor shares features with more expensive machines. With the bagging attachment shown, it costs about \$1800 at outdoor power equipment dealers. It has a 6-speed transmission, a key start and a 40-in. 6-position deck. The tractor is powered by a 12-hp Briggs and Stratton 4-cycle engine. Both the tractor and engine are covered by a 2-year warranty. Write to Homelite, P.O. Box 7047, Charlotte, NC 28241.



**Articulate**

Husqvarna introduces an articulating rear-wheel mower with a 7-in. cutting diameter. It's powered by a 12-hp, Briggs and Stratton Industrial/Commercial engine while a 5-speed trans-axle allows you to match speed to mowing conditions. The mower is equipped with 16-in.-dia. x 6 1/2-in.-wide turf tires to reduce damage on soft ground. The free-floating 38-in. steel deck has three blades to ensure an even cut. Sold at Husqvarna dealers, the 970-12 costs about \$3500 (\$3900 with 6-bushel grass catcher). Contact Husqvarna Forest and Garden Co., 907 W. Irving Park Rd., Itasca, IL 60143.







### Hang In There

Organize your garage with these storage system components that attach to perforated hardboard or 34-in.-long mounting strips. The strips can be screwed to studs or to drywall with appropriate fasteners. A variety of hooks, straps, plastic shelves or bins are available. The Work Space System is sold in sets for about \$13 at hardware stores and home centers. For more information, contact Rubbermaid, Inc., 1147 Akron Rd., Wooster, OH 44691.



Also from Rubbermaid, this 26-pound cart made from impact-resistant plastic carries up to 200 pounds. It's designed for stability and costs \$70 at hardware stores and home centers. Write Rubbermaid Specialty Products Division, 6250 N. Honeytown Rd., Smithville, OH 44677.

### Mulch Master

Bolens has introduced a new system for its riding mowers that mulches grass with four separate blades. First, the main clockwise-spinning blade under the deck cuts grass from 1 to 4 in. high. Then, the clippings are forced into a mulching attachment (see drawing) that has three blades spinning counterclockwise. The 14-hp ST140 mower (mulching attachment included) shown, with a 42-in. deck, costs about \$3800 at Bolens outdoor power equipment dealers. It can retrofit some older Bolen tractors. For more information, write to Garden Way, Inc., 102nd St., Ninth Ave., Troy, NY 12180.



### Get A Grip

Adjust the cutting opening of these pruners for flower stems or shrub work. The pruner's cutlery steel blades have a nonstick coating, a wire-cutting notch, and a sap groove. An ambidextrous safety latch on the top nylon handle allows one-handed use. The pruners cost about \$25 at garden centers and hardware stores. For more information, write to Fiskars Manufacturing Corp., 7811 W. Stewart Ave., Wausau, WI 54401.



### No-Spill Nozzle

This nozzle starts pouring when you want it to and stops when the tank is full, says the manufacturer. Lift the nozzle out and a slide valve seals off the container. The nozzle's concealed vent directs fuel vapors back into the can. It costs about \$12 at power equipment dealers. Contact Vemco, Inc., P.O. Box 335, Dion St., Emmett, ID 83617.

### The Old Soft Shoe

These shovels have a synthetic automotive-grade rubber pad fitted over the blade's lip to cushion your foot as you step down on it. They are sold at hardware stores and lawn and garden centers, and cost from \$21 to \$24. For more information, write to Union Tools, 500 Dublin Ave., P.O. Box 1940, Columbus, OH 43216.



### Clean Up

The Karcher 570 electric power washer is designed to be compact and powerful. It delivers 150 to 1000 psi water pressure and comes with a 33-ft.-long high-pressure hose, trigger gun, 20-in.-long spray wand and wash brush. It costs about \$530 at outdoor power equipment dealers and home centers. Write to Alfred Karcher, Inc., P.O. Box 778, Browertown Rd. and Andrews Dr., West Paterson, NJ 07424. **PM**



# HOMEOWNERS CLINIC

BY NORMAN BECKER, P.E., Contributing Editor

## Chimney Cricket

We would certainly appreciate your suggestions to correct a persistent leak in our roof by the chimney. This leak is causing water damage to the ceiling by the fireplace in our living room. My husband's efforts to tar the edges between the roof and chimney help for a while but don't correct the problem. We replaced the roof, but that made no difference. Will a saddle from the roof to the chimney help?

VERNA DRAKE  
WATSEKA, IL

*A cricket (also called a saddle) should solve the problem. Based on the photo that you sent, your chimney is about 4 ft. wide. Whenever the width of a chimney located along the slope of a roof is more than 2 ft., a cricket should join the roof and chimney. The cricket prevents debris or snow and ice from piling up behind the chimney. This can cause rain or melting snow to back up under the shingles and leak into the house. The cricket also deflects water running down the roof around the chimney.*

*The cricket's slope should be the same as that of the roof. If the cricket is large and exposed to view, it should be covered with the same shingles as those on the rest of the roof. A small or nonexposed cricket can be covered with metal. The joints between the cricket and chimney, and the cricket and roof, should be flashed.*

## Flame Spread

Can you tell me what "Flame Spread 200 or less" means? I saw it on a label on the back of a 4 x 8 plywood panel that had a decorative finish.

PAUL MAUCH  
MT. VIEW, CA

*Flame spread is the propagation of a flame over a surface. The flame-spread rating classifies the fire hazard potential of different building materials. It is based on tests performed by independent labs using procedures developed by Underwriters Laboratories. Inorganic materials and untreated red oak provide the range against which flame-spread ratings are made. Inorganic materi-*

*als, which include concrete, cement-asbestos board and metal, have a flame spread of 0. Untreated red oak has a flame spread of 100.*

*Building codes require materials that have a low flame-spread rating (0-25) to be used in fire escape routes, such as in stairways and exits. Where passageways and corridors are not part of an enclosed exit, the flame-spread rating of the material should not exceed 75. Materials used for interior walls and ceilings generally have a flame-spread classification of 200 or less. This includes most untreated plywood or paneling.*

## Squeak Cures

*After reading the column on "Squeaking Floors" in Homeowners Clinic (page 88, August '90), Fred Gaca of Antioch, Illinois, sent in his suggestions.*

*If you are repairing a squeaking floor, use 1½-in.-long drywall screws instead of nails to attach the plywood to the joist. Drywall screws don't require predrilling a hole and will countersink themselves. They hold tighter than nails and won't come loose even if the wood shrinks.*

*In my area, where a typical year sees temperatures go from subzero to more than 100° F and humidity from 0% to 100%, some contractors use these screws, instead of nails, on outdoor decks so everything stays tight. I used drywall screws when I built my deck two years ago, and every board is as tight as when it was attached.*

## Day & Night Search

*I had a gas-fired water heater made by the Day & Night Manufacturing Co. installed in my home when it was built in 1958. It still works, but may go out at any time. I would like to know if it's still being produced. Thanks for any information.*

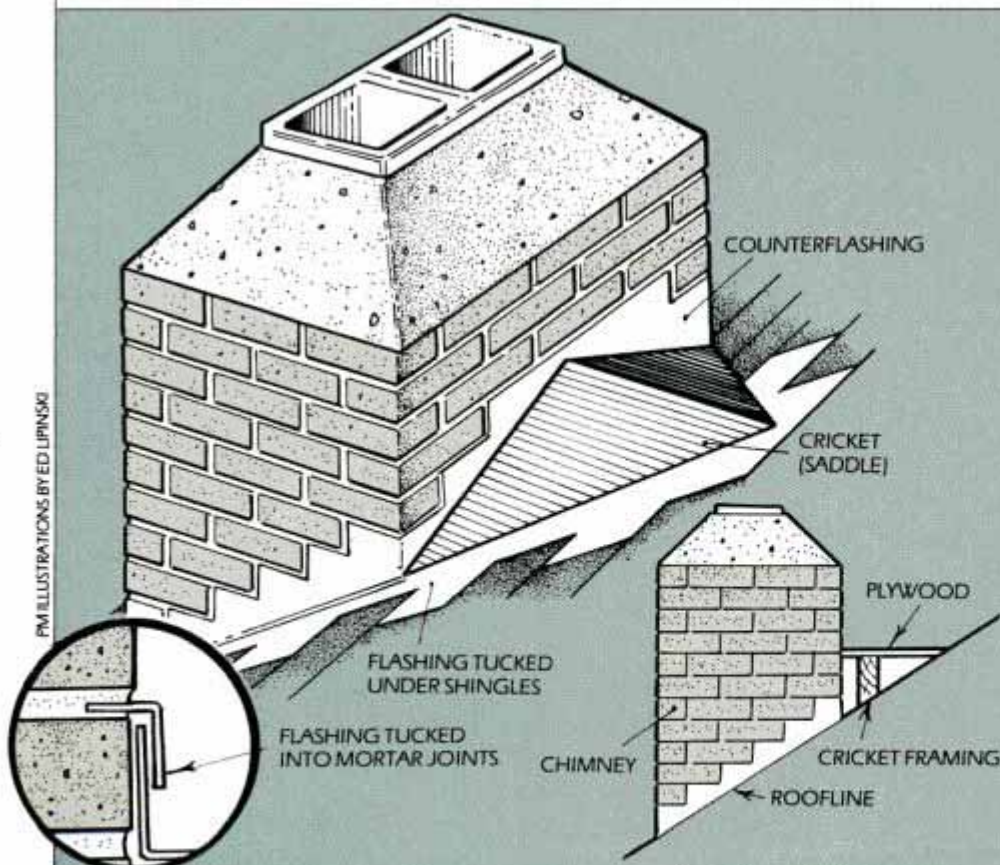
SIMON HAYDEL  
NEW ORLEANS, LA

*Day & Night water heaters are no longer being manufactured. However, there are a number of other good-quality gas-fired water heaters on the market to choose from. Check with a plumbing supply store.*

PM

## 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.*



A wide chimney should have a cricket, also known as a saddle, built behind it. This prevents debris, snow and ice from accumulating behind the chimney, causing roof leaks.

PM ILLUSTRATIONS BY ED LIPINSKI

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100-051

## HOME IMPROVEMENT

# 5 QUICK FIXES

BY GARY BRANSON  
PM Illustrations  
by George Retseck

### 1 Repairing Concrete Steps



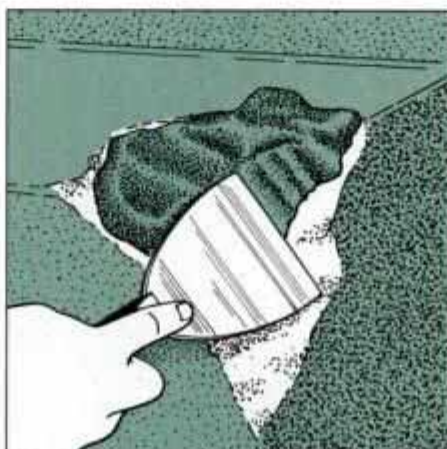
**1A** Clean away debris on damaged concrete with a wire brush. Concrete patch will bond poorly unless corner is prepared.

● The corners on concrete steps tend to get cracked and damaged over the winter. This was once a tough repair, but today's concrete bonding products help make the job easier and increase the odds of a longlasting patch.

First, using a steel-wire brush, remove the loose concrete particles, working down to a firm surface. Next, apply a latex bonding liquid to the repair area (some concrete patch products contain this adhesive). In a cardboard mixing pail, available at



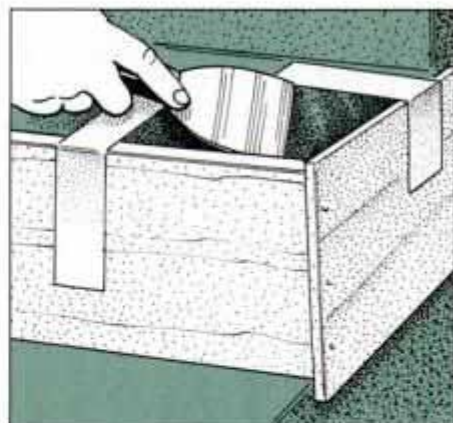
**1B** Use a paintbrush to apply concrete bonding adhesive to the damaged area. A synthetic bristle brush works best here.



**1C** Mix concrete patch in a disposable paint bucket, using a paint stirring stick. Apply patch with a flat knife.

your paint store, mix the concrete patch material. Use a paint scraper or trowel to apply the patch. Build up the patch until it's shaped roughly like the corner.

After the first application of concrete patch, place the wood form on the corner as shown, holding it in place with duct tape. Coat the inside of the form with oil to keep it from



**1D** Tape form around the corner. Pack remaining patch into the form and leave the form in place until patch is dry.



**1E** Remove form and smooth over patch with a wet paintbrush. Avoid patch until it is fully hardened in a few days.

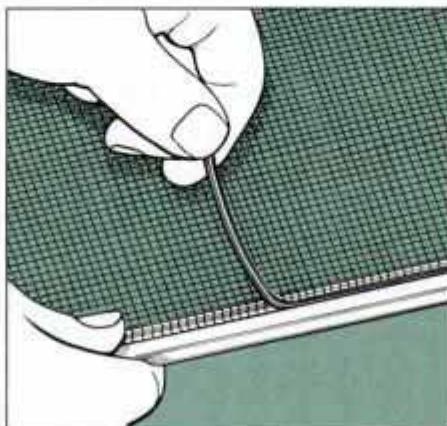
sticking to the concrete. Fill the form with concrete patch until you've built up a smooth, even corner.

While the concrete is still wet but firm, smooth the repair with a wet paintbrush. This also helps fill small voids in the concrete. Set up a ladder or other barrier to keep people off the step until the patch is dry and hard, usually overnight.

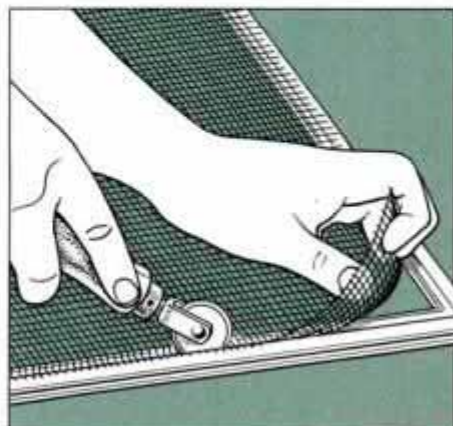
### 2 Replacing A Window Screen

Warm weather means it's time to throw open your windows, but it's also time to repair broken window screens. Start by buying a 2-wheeled spline roller, vinyl spline and screen at a hardware store.

Now, pry the vinyl spline and damaged screen from the frame groove using an awl or a sharp knife tip. Discard the old spline, in most cases it is too dry and brittle to reuse (besides, new spline is inexpensive). Use a razor knife to cut a piece of screen slightly larger than the frame, then lay the frame on a table and the screen over



**2A** Lift up the old vinyl spline using an awl or other sharp tool, then peel it out of the frame. Next, remove the screen.



**2B** After slitting screen corners, place new screen over frame, and tape it down. Roll screen into frame with convex wheel.

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Inside Corner	14"L x 4"H	\$10.40 ea
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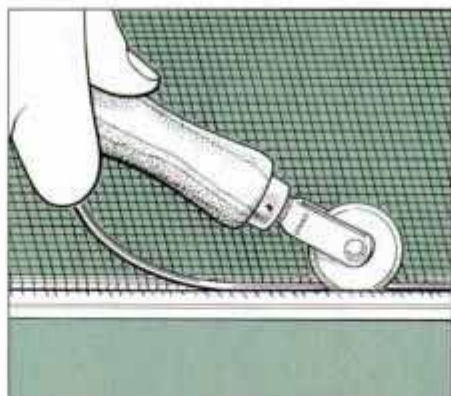
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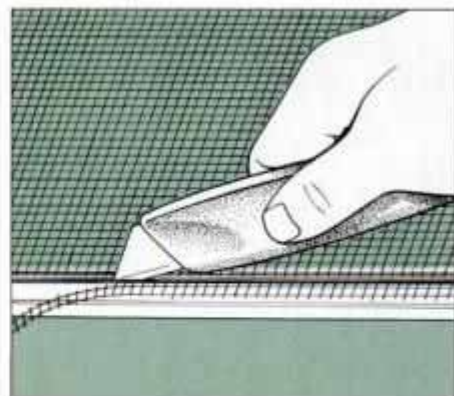
## HOME&SHOP JOURNAL

it. Tape each edge of the screen to the table, and make a diagonal relief cut at the screen's corners, stopping at the frame groove. The relief cut prevents the screen from tearing at the corners or bunching up when it is rolled into the corner of the frame.

Press the screen into the frame groove on one side with the convex roller. This will cause the tape to pull loose from the table. Pull the screen tight from the opposite side and repeat the process. Do this on the other two sides. Press the spline into the groove with the concave wheel. Trim off excess spline and screen with a razor knife.



**2C** Cut new vinyl spline roughly to length. Then roll it into the frame with concave roller at opposite end of the spline tool.



**2D** Trim off the excess screen using a razor knife. Press the knife's tip into the outside edge of the spline groove.

### 3 Reviving Damaged Lawns

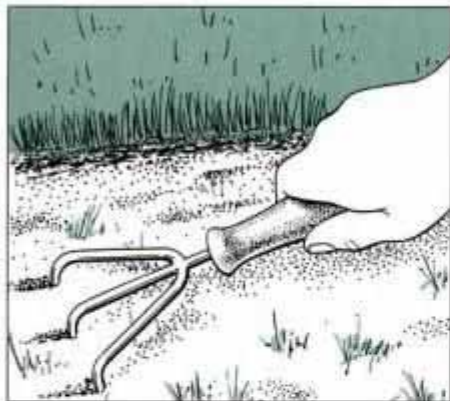
It's not unusual to find areas of dead grass on your lawn in the springtime. These dead spots are the result of snow being shoveled or plowed in deep piles along the driveway or street. Heavy, compacted snow, and salt and other chemicals used to melt ice or snow kill small areas of grass. Fortunately, if these areas are at-

tended to early in the growing season, they should be strong enough to withstand the withering weeks of late July and August.

To repair these damaged areas, wait until the ground is soft after a rain or watering, then scrape away the dead grass with a garden fork. Next, prepare the spot by loosening up the top layer of soil. Rake the soil smooth. Ask your lawn and garden dealer to recommend a gypsum soil

conditioner, and apply it to the areas according to the product's label directions.

Next, reseed and fertilize the area, or cover it with sod. Sod is good to use on slopes, where seeds are liable to be washed away. Avoid walking on the grass and cutting it until you are sure it has firmly taken hold. Whether you sod or seed the area, water the patched area well to get the grass off to a good start.



**3A** Water the damaged turf, or wait until after a rain when ground is soft, to remove old grass from damaged spot.



**3B** Remove enough dead grass and soil so sod can be fitted into patch. Cut the sod to fit using an old kitchen knife.



**3C** Spread potting soil around patch to fill gaps and level the joint between old and new grass. Keep the sod watered.

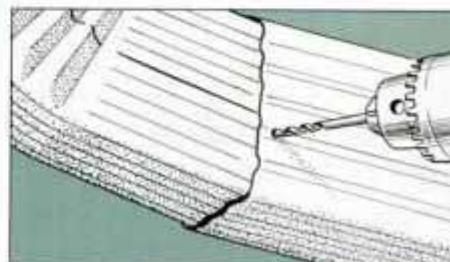
## 4 Repairing Rain Gutters

Gutters can get beat up over the winter from ice and storm damage. Here are a few tips to get them back in shape for the summer rains ahead.

Variable-speed electric drills are great for gutter work because you can set them at low speeds. High drill speeds are fine for woodwork, but a fast-turning bit will spin on a gutter

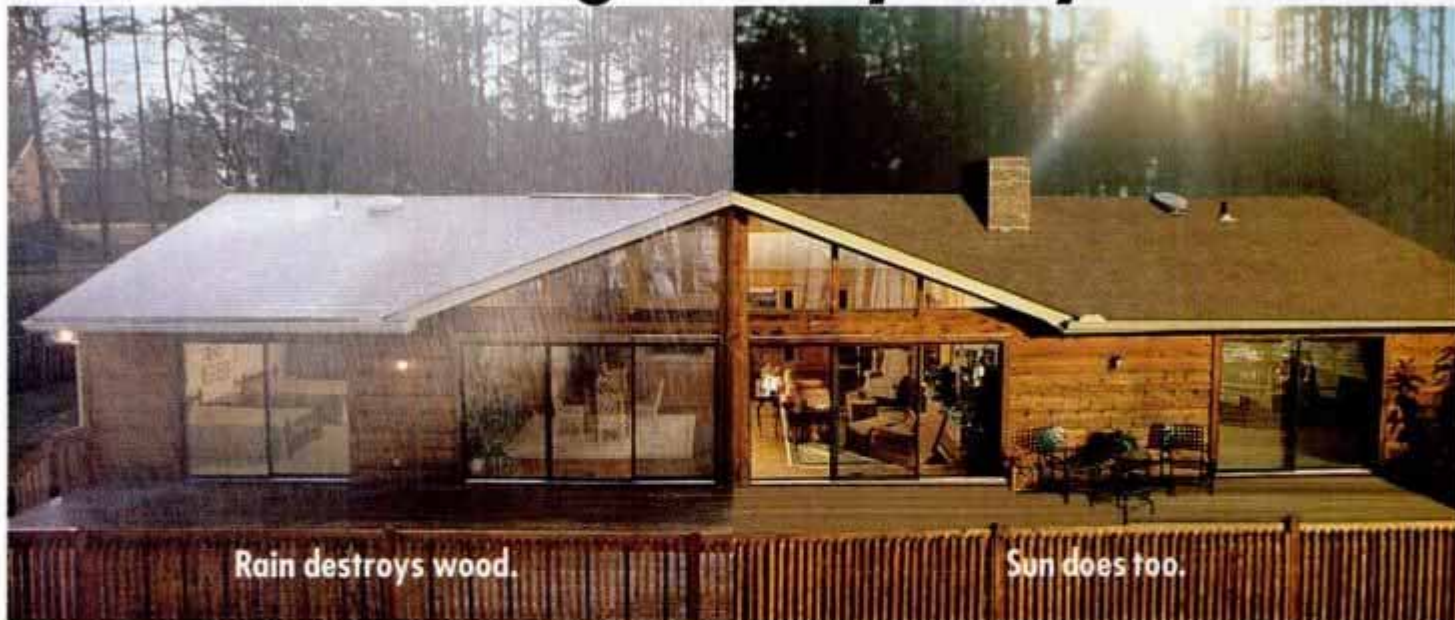


**4A** Use a metal punch to make a small dent over where you want to drill. Dent holds drill bit as it bites into metal.



**4B** Run the drill at slow speed and don't force the cut. High-speed, high-pressure drilling can overheat the bit, dulling it.

# There's never a good day for your wood.



Rain destroys wood.

Sun does too.

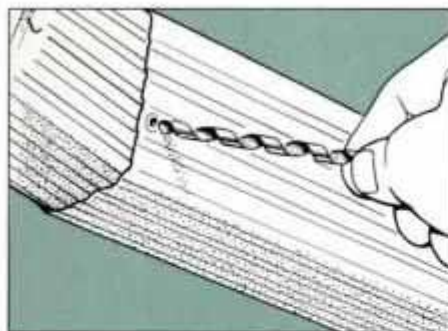
## Thompson's protects full-time against water, sun and mildew.

Your house is constantly being attacked by sun, wind, rain, mold and rot. That's why your wood needs the full-time protection of Thompson's® Wood Protector.

Thompson's unique formula contains powerful waterproofer to protect against splitting, cracking

and warping; mildewicides to prevent mold, mildew and rot; and sunscreens to help prevent fading and greying. So use Thompson's Wood Protector. You'll see how just one coat can give your home full-time protection for a longer life expectancy than you ever expected.

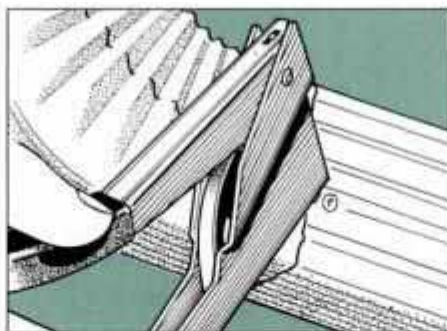




**4C** Use a slightly oversize bit to smooth burrs around the rivet hole. Lightly turn the bit with your bare fingers.

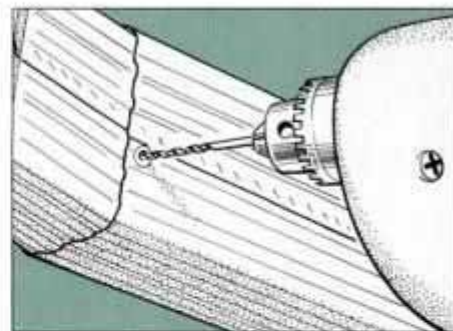
downspout or gutter bracket without cutting.

Mark where you want to drill with a metal punch. The dent left by the punch holds the bit while it bites into the metal.



**4D** Fasten parts together with one or two aluminum rivets. On downspouts, top part always goes inside part below it.

Use pop rivets to join gutter components together. Usually only one or two rivets are necessary to hold pieces together. To remove a rivet, just drill out its head with a 1/8-in.-dia. bit. Run the drill slowly until you have



**4E** To remove a rivet, drill through its head with a bit matching the rivet's diameter (usually 1/8 in. dia.).

drilled through the rivet head. Remove the head and punch out the rivet shank with the metal punch. Seal all repairs to the gutter with silicone or other suitable caulk, but this isn't necessary on downspouts.

## 5 Lawnmower Tuneup

You don't have to be a professional mechanic to give your lawnmower a preseason tuneup. If your mower won't start, it's usually one of three things: The spark plug is fouled, the

air filter is clogged, or the carburetor is dirty.

Unlike your car, which has multiple spark plugs, your lawnmower has only one. Because small-engine spark plugs work so hard, they frequently become fouled. Buy several spark plugs at once. Clean or replace the

plug at the first sign of poor starting.

First, remove the ignition wire from the plug, then use a socket wrench to remove the plug. Check the plug's electrode to be sure it is not burned or dirty. Clean the plug's electrode with fine sandpaper, or replace it. Leave the plug disconnected.

# QUIKRETE® MAKES JOBS SO EASY ANYONE CAN APPLY.

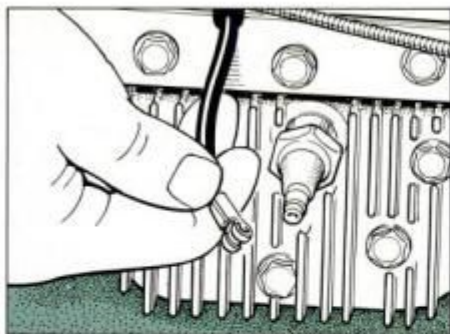


Use QUIKRETE® for home repairs and there's no experience necessary. Because our products make jobs easy. Gray Concrete Crack Seal fills cracks. Hydraulic Water-Stop plugs masonry leaks in 3 to 5 minutes. Quick-Setting Cement sets in just 15 minutes. Anchoring Cement is ideal for setting bolts, posts, handrails into concrete. Vinyl Concrete Patcher repairs small areas in most masonry surfaces. And all QUIKRETE products are available at your nearest home center, lumber and building materials supplier, or hardware store. So if you want to make home repairs easy, remember: nothing works better than QUIKRETE.

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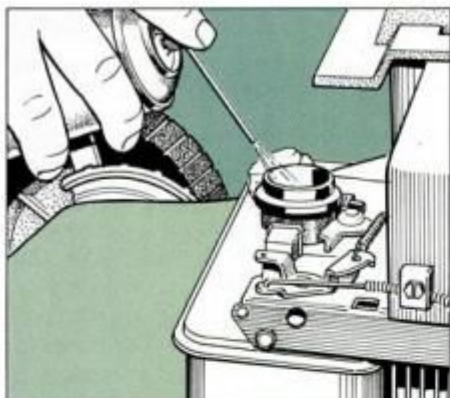




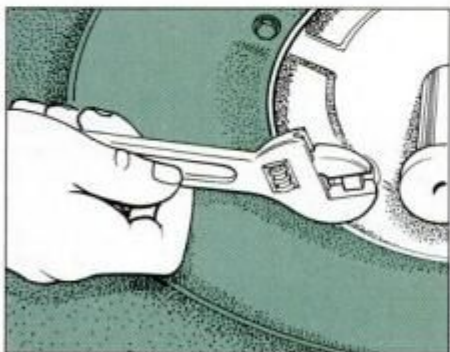
**5A** To prevent accidentally starting the mower, begin tuneup by removing the ignition wire from the spark plug.



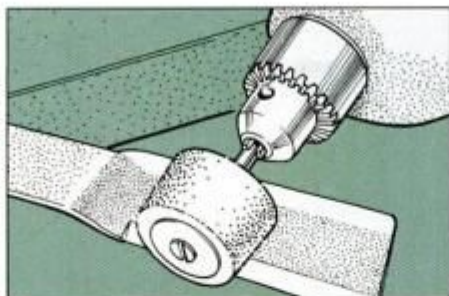
**5B** Use a screwdriver to loosen the slotted bolt that holds the air cleaner. Clean the filter element or replace it.



**5C** Spray aerosol cleaner such as Gum-Out into carburetor throat and on linkage. Lightly oil linkage after cleaning it.



**5D** To drain oil from mower, remove the drain plug on the underside of the mower deck. Refill crankcase with fresh oil.



**5E** Sharpen the mower blade with an abrasive drum chucked in an electric drill. If blade is badly nicked, replace it.

Unscrew the bolt that holds the air cleaner. Take the top off the cleaner, and remove the air filter element. Replace it or clean it in warm water and detergent, and squeeze it dry.

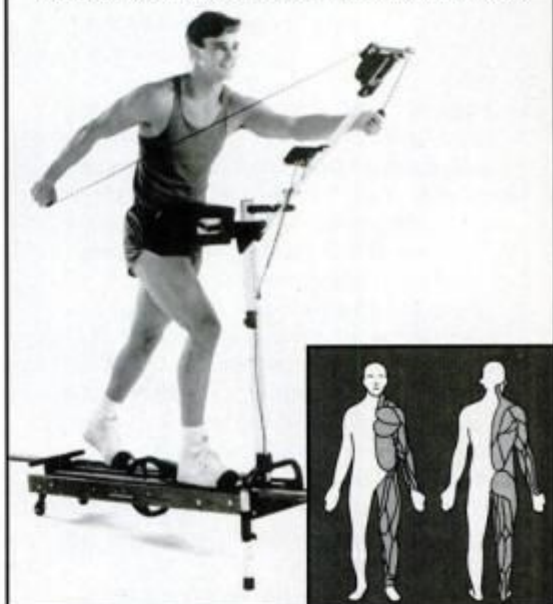
Next, spray a cleaner such as Gum-Out over the carburetor and its linkage. Lightly oil the control cables and linkage, and reinstall the air filter.

Next, remove the oil drain plug (near the shaft and mower blade) and change the oil. Drain the old oil into a pan and return it for recycling. **FM**

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141C Jonathan Blvd. N., Chaska, MN 55318

# APPLIANCE CLINIC

BY STEVE TOTH,  
Contributing Editor

## Springs Broke

I have a Magic Chef gas range, model No. DA319W-2KLX, serial No. 3X943-12088. Both oven door springs are broken. I purchased two new door springs at my local appliance parts store, but how do I install them?

I can see where one end of the spring attaches on the door hinge, but where does the other end attach? To add insult to injury, I can't find the broken spring. My local appliance parts store was no help.

JOHN PODOLINSKI  
MINEOLA, NY

*I suggest you shut off the gas to the range, pull the range away from the wall, and unplug it from its power source. Next, remove the burner grates, then take off the main top or prop it up. Slide out the broiler drawer and open the oven door.*

*Remove the side panel to gain access to the door spring and hinge. Remove the three screws along the front edge of the side panel. Check the top of the panel for a screw (some models have one screw, others have none). Now move to the back of the range, and remove the three screws at the rear of the panel. Lift the panel up and off the range.*

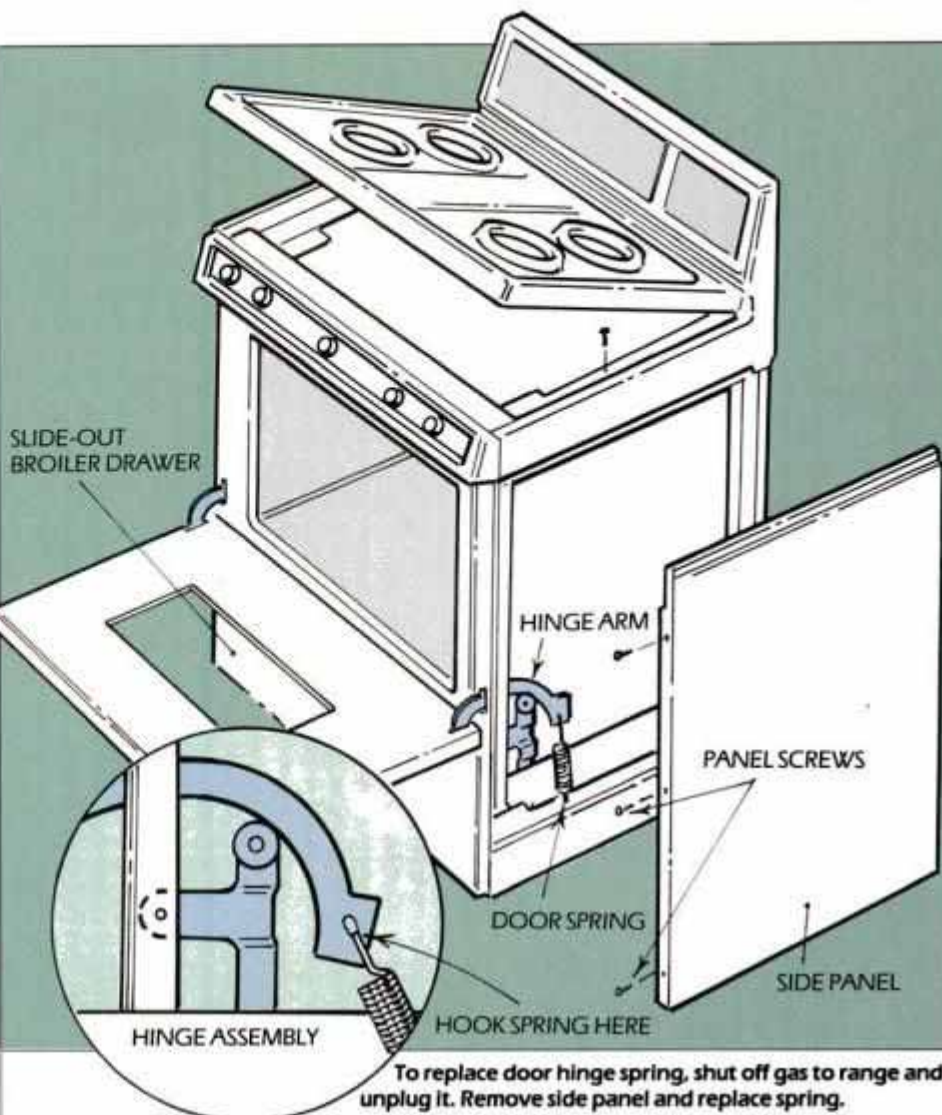
*Close the door and peel back the fiberglass insulation to gain access to the hinge assembly and to retrieve the broken spring which is probably buried in the insulation. The new spring can now be hooked into the center hole at the base of the range and stretched with locking pliers into the teardrop hole in the hinge arm. Fold back the insulation and reassemble the side panel. Follow this same procedure to install the door spring on the other side panel.*

## Needs Furnace Parts

I have a Chrysler Airtemp model No. 4211-40 gas furnace. Chrysler no longer manufactures furnaces. I would appreciate any help in finding someone who still handles the parts for this furnace.

BRUCE DAHM  
CORPUS CHRISTI, TX

*Chrysler sold its heating and air-conditioning division to the Fedders*



*Corp. back in 1976. Parts for Chrysler, Climatrol and Fedders can be purchased from Comco, 4168 Manchester, St. Louis, MO 63110; (314) 535-6332. It's a Fedders distributor and ships nationwide. It sells both wholesale and retail. Contact this company if you would like the name and address of a Fedders distributor in your area.*

## Time Out

I have a Modern Maid built-in oven, model No. QE0250, serial No. 49252. It is about 22 years old and works fine, except I need a clock and timer assembly for it and cannot find one anywhere. Can you help?

EVERETT DILL  
CAMDEN, DE

*I contacted Caloric Modern Maid Corp., and they tell me the clock/timer assembly for your model oven is no longer available. I suggest you contact a local appliance parts distributor in your area. Ask them if they can send your old clock/timer assembly to a remanufacturer to have*

*it repaired correctly.*

*Failing that, unplug your oven and remove the old clock/timer assembly, being sure to label each wire as you remove it from the terminals on the timer. Package the timer in a box along with a note stating your name, address, phone number and what is wrong with the timer. Also enclose a check for \$66.50, which is the flat rate charge for either a standard clock/timer or a digital timer repair. Send the package to Professional Appliance Parts, 6360 W. Colfax Ave., Lakewood, CO 80214.*

*The company will repair your clock/timer, send it back to you within 24 hours with prepaid shipping, and guarantee the work for one year. If it cannot repair your clock/timer, Professional Appliance Parts will return it to you along with your check at no charge.*

**PM**

**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.*

# KEEP YOUR CAR NEW



**41** Tips From Pro Restorers To Help  
Your Car Withstand The Test Of Time  
*Plus A Gallery Of Great  
Cars That Never Grew Old*

# THE POWER TO MOVE MOUNTAINS, 11,900 POUNDS AT A TIME.

## THE DODGE CUMMINS TURBO DIESEL. THE HARDEST WORKING DIESEL PICKUP IN AMERICA.

The Dodge Cummins Turbo Diesel is one mountain of a truck. Its 5.9 liter Cummins turbo diesel engine cranks out 160 hp and a massive 400 lbs-ft of torque – the most torque of any diesel pickup.

**Up to 11,900 pounds of pull,  
4,846 pounds of payload.**

With its 11,900 lb available towing capacity and up to 4,846 pounds of payload capacity, the Dodge Cummins Turbo Diesel is a true beast of burden.\*

*Dodge Cummins Turbo Diesel*

And with more available payload and towing capacity than any other full-size diesel pickup, it's easy to see why it's America's hardest working diesel pickup.

**At an altitude of 10,000 feet, it's still going strong.**

Being the only turbo diesel there is, the Dodge Cummins breathes thin mountain air with ease. Which means that at altitudes even as high as 10,000 ft, it doesn't lose any of its 160 horsepower. Ford and Chevy's naturally aspirated diesels, on the other hand, can lose up to 30% of their power at 10,000 ft.

### Works through the worst of times.

For hot weather work, there's just no stopping the Dodge Cummins Turbo. The only full-size diesel pickup to offer a maximum engine cooling system along with an engine oil cooler as standard equipment. Order an automatic and the transmission cooler is standard too. There's also a new charge-air intercooler designed to deliver excellent fuel economy and a cleaner burn. While new



The Cummins Turbo Diesel intercooler delivers excellent fuel economy and a cleaner burn.

engine improvements reduce oil consumption. And it's the only diesel pickup backed with unbeatable 7/100 engine and 7/70 drivetrain warranties.†

**Welcome home to Dodge.**

The Dodge Cummins Turbo Diesel, part of the Dodge full-size pickup line. And without question, the hardest working diesel pickup in America. No wonder people with big loads to haul are coming home to Dodge. So if you've got mountains to move, come see what we're made of.

\*Max. available payload, depending on model. †See these limited warranties and their restrictions at dealer. Buckle up for safety.

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LEASE  
AT YOUR  
DODGE  
DEALER.



Welcome Home, America.  
**Advantage: Dodge.** 

# A GALLERY OF GREAT CARS



## 1932 Packard Twin Six Coupe

Owner: Jay Leno  
Beverly Hills, California

Packard, symbol of American excellence between the World Wars, offered its new Twin Six 12-cylinder engine as an option in 1932. With an output of 160 hp from 445.5 cu. in., the engine is widely regarded as one of the finest ever built. One of just 304 units installed on the 142 $\frac{1}{2}$ -in.-wheelbase Model 905 that year, the big

Packard would just about top the 100-mph mark. "Tonight Show" host Jay Leno, who spends his spare time nurturing an outstanding collection of vintage cars and motorcycles, purchased this Twin Six from racing legend Phil Hill. Unlike many old-car enthusiasts, Leno actually drives his beautifully restored machines.

PM PHOTO BY DENNIS ADLER/CAR COLLECTOR



## 1966 427 Shelby Cobra

Owner: Lynn Park  
Los Angeles, California

The big-block Cobra. Zero-to-100-to-zero in 13 seconds. One of the most awesome automobiles ever conceived and produced. It was Carroll Shelby's answer to Ferrari in World Cup International sports car competition, and an answer to the big-block Corvettes in America, on track and off. Lynn Park's 14,000-mile Rangoon red

roadster is one of the few remaining unmolested examples of the breed. It's original down to the sunburst Halibrand knock-off wheels and 8.15x15 Goodyear Blue Dot tires. It's also one of the 150 or so 427 Cobras that came with the 390-hp Police Interceptor 428-cu.-in. engine backed by a 4-speed. Park keeps the car under wraps in a heated garage and occasionally takes it out—his driving style commensurate with the Cobra's near half-million-dollar value.



## 1948 Mercury Station Wagon

Owner: Terry Johnson  
Denver, Colorado

There's something about wood—real wood—on a car that seems to fascinate people. The last car produced with real-wood side paneling was a '53 Buick. But the last of the full-wood station wagons was the '48 Mercury. Terry Johnson bought his woody five years ago from a large California estate. Amazingly, the car

still wore all of its original wood, an excellent example of what proper care can do. The 63,000-mile wagon had been garaged, and the wood simply varnished from time to time. Even the roof—canvas stretched over wooden ribs—is original and in excellent condition. The 9-passenger model with three rows of leather seats is now maintained in a heated 20-car warehouse. Interesting options include the 2-speed Columbia rear end and the hand/foot-controlled signal-seeking AM radio.



## 1970 Boss 429 Mustang

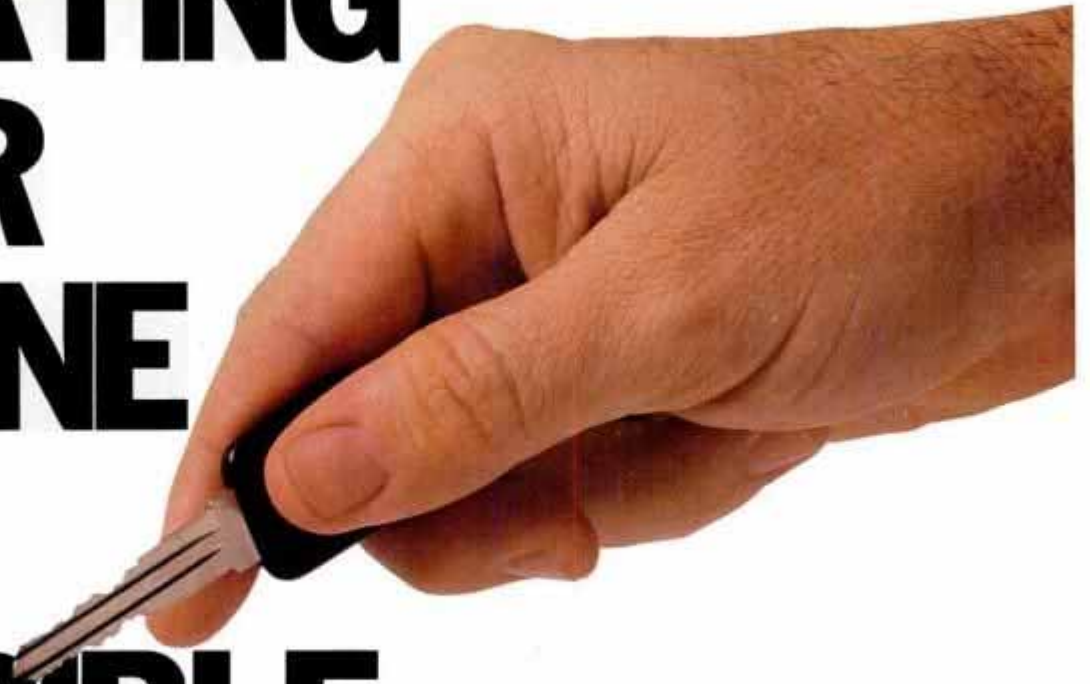
Owner: Arnold Marks  
Tarzana, California

In the late '60s, the heat in NASCAR competition turned up to broil. Cubic inches provided the ticket to speed, and Ford came out with a semi-hemi head Boss 429 engine. In order to homologate the engine for NASCAR, and to promote their image on the street, Ford hired an outside vendor to shoehorn the 429 into 1969-70 fastback Mustangs. The car you see here is one of 15

1970 models built to meet California emissions. The ponycar was restored by its current owner, Arnold Marks, who runs a Mustang restoration and sales business. Originally sold in 1971 by a Ford dealer in California to a serviceman who drag-raced the car, the Mustang was traded in at the same dealership two years later. A second buyer saw the 'Stang, recognized its investment potential, and stored it until 1988, when he sold it to Marks. A ground-up restoration has turned this 42,000-mile Boss into a trailered show car.



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**SLICK**<sup>®</sup>  
The Engine Wear  
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**B**ecause 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.

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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.

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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.*



## 1968 Mercedes-Benz 240D

Owner: Don Rasmussen  
Portland, Oregon

Here's the high roller of our series—not in dollars, but in miles. A million miles! Don Rasmussen's Mercedes dealership sold this 240D new to Ed Donaldson, who used it daily on his 250-mile round-trip commute to his job as a machinist. Piling up about 100,000 miles a year, Donaldson installed a hub odometer on his left rear wheel to keep tabs on his mileage. The Little Diesel That Could also carried the Donaldson family on vacations

that included a drive through Mexico into South America, and a trip around the perimeter of the United States. The dealer, half jokingly, said that when Donaldson hit the million-mile mark, they would swap it for a brand-new Mercedes. The 240D's odometer rolled over for the 10th time in 1979, but the original engine couldn't go the distance, lasting only 907,000 miles. True to his word, Rasmussen took the million-miler and gave Donaldson a brand-new 300SD Turbodiesel in return. The mile-muncher is now used by the dealership for advertising and promotions.



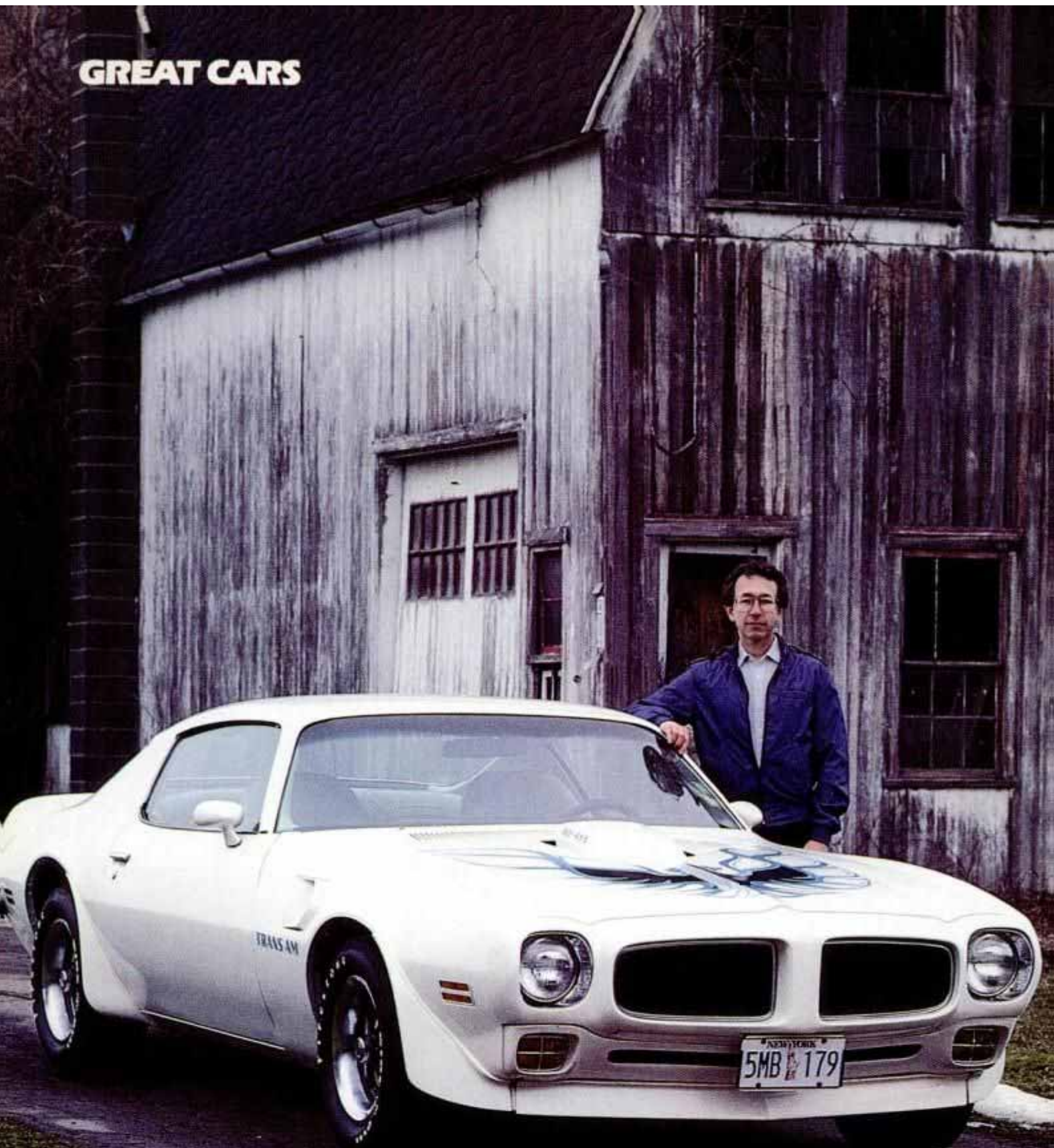
## 1957 Ford Thunderbird

Owner: Don Santee

Bayonne, New Jersey

Originally conceived as competition to Chevy's Corvette, Ford's sporty, 2-place T-Bird evolved along the lines of a personal luxury automobile, while the Vette was engineered toward becoming a true sports car. Don Santee's '57 is the last of the 2-seater series and came with the optional 312-cu.-in. engine and famous porthole window hardtop. Purchased in 1985 from a noted Dallas T-Bird restoration shop, the 85,000-mile sportster has taken a national First Place, Touring Class, in Classic Thunderbird Club International competition and is driven about 2000 miles a year. Santee is a member of the New Jersey Open Road Thunderbird Club.

PHOTOGRAPH BY BILL APPE



## 1973 Pontiac Trans Am SD-455

Owner: Gary Yannl  
Webster, New York

Just when everyone thought the muscle car era was finished, Pontiac unleashed its bombshell—a 455-cu.-in. 310-hp (net) engine called the Super Duty, available in Formula and Trans Am Firebirds. Gary Yannl heard the news and ordered one in January 1973. But the order was bounced back because Pontiac wasn't sure the engine would actually be produced. Seems they tried to slip it past the EPA by claiming it was a regular 455

station wagon motor. But nothing, including block, heads and internals were interchangeable. It wasn't until May that Pontiac actually started building the Super Duty, and the cutoff date for the '73 model year was May 15. As a result, only 252 Trans Ams were built in '73 with the SD engine. Gary had to resubmit his order five times before it was accepted. He drove the car daily during the summer of '73 and then relegated it to show and limited use. With only 16,000 miles on the clock, Gary's TA is all-original right down to its Firestone Wide Oval tires.



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## 1956 Ford F-150 Pickup

Owner: Mark Smith  
Placentia, California

Pickup enthusiasts like the lines of the '56 F-150 as it was the last year before Ford went to the square look. The '56 is the most desirable of the '53-'56 body series thanks to its larger, wraparound windshield. Mark Smith picked up his pickup 11 years ago as a rust bucket

requiring a total restoration. He brought the 292-cu.-in. V8/Fordomatic hauler back to stock condition and kept it that way for six years. But he found the truck wasn't getting attention at shows. So he sold the stock rims and tires for some wider wheels and fat rubber. Lowering the truck 3 in. in the front, using a dropped axle, and 2½ in. in the rear with reversed eye springs, gives this nifty '50s pickup a contemporary look.

PM PHOTO BY MIKE GASPAR

# Quality is Job 1.<sup>SM</sup>

## Profile in Quality #33: Innovation

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are great looking  
and fit the  
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Craig Metros, Designer  
Ford Employee for 5 years.

# Ford Motor Company

FORD, MERCURY, LINCOLN, FORD TRUCKS

Buckle up — Together we can save lives.



**1953 Cadillac Eldorado**

Owner: Ken Gimelli  
Las Gatos, California

The first year for the Eldorado series, the 1953 model was basically a handbuilt, custom-body car produced at Cadillac's Fleetwood assembly plant. The car came with a 210-hp V8 and was fully loaded with luxury features.

The record books say that 532 Eldos were built in '53, but Ken Gimelli, who owns five '53 Eldorados, says he's seen body plate No. 533. Gimelli has owned this ground-up restored Artesian Ocher convertible four years. The clock shows 65,000 miles and ticking, as this gorgeous fair-weather Caddy is exercised whenever the weather permits.



Car owners!

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When **POPULAR MECHANICS** tested TUFOIL, it reported "TUFOIL is absolutely spectacular!"

# GREAT CARS

## 1969 Dodge Charger Daytona

Owner: Dave Jones

New Palestine, Indiana

If your candidate for the most outrageous street car ever produced is the beaked and spoiled Dodge Daytona (and its Plymouth counterpart, the Road Runner Superbird), few would argue with you. Built to counter Ford's stranglehold on NASCAR's high-banked superspeedways, the awesome Daytonas, powered by monster 426-cu.-in. Hemi engines, punched through the 200-mph barrier. Street versions, produced to satisfy NASCAR rules, came through with either a detuned Hemi or 440-cu.-in. engine. Dealers had a hard time selling the weird-looking wing cars, never realizing that their collector value would eventually top \$200,000. Dave Jones bought this Hemi-powered Daytona in 1979. One of the least-optioned examples of the breed, with an original sticker price of \$5000, Jones's Daytona is one of 48 made with the Hemi and automatic combination. The engine has never been apart in its 60,000-mile life. The winged warrior has participated in superspeedway parade laps, but spends most of its life in a heated garage.



NEW! From the maker of Passport



## Self-powered SOLO

Finally, a radar detector so advanced,  
you'll never be bothered with a power cord

Until now, high performance radar detection required a messy power cord. Plugged into your car's lighter. Dangling across your dashboard. And tangling in your pocket.

Now, there is a better way.

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SOLO is a totally new concept in long-range radar detection. All you do is clip SOLO to your visor or windshield, and switch it on. It's that simple.

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SOLO comes complete with all accessories, including visor and windshield mounts that instantly conform to any car, but fold flat for convenient carrying. Both designs are patented.

### How It Works

After years of research, our engineers (who also designed ESCORT and PASSPORT) developed circuitry fifty times more efficient than conventional detectors. This design provides long-range radar warning for 200 hours on a single 9 volt battery.

If you drive one hour a day, you won't need to replace SOLO's battery for over six months. (Even if you drive two hours a day, you'll get over three months.)

### No Compromise Performance

With SOLO, you get long range radar warning with no hassles. And

### WHAT THE EXPERTS SAY

*"No other detector manufacturer has anything even close ... Solo moves the state of the art to a higher plane."* BMW Roundel

*"The most user-friendly detector yet ... we fell in love at first beep."* AutoWeek

you never have to worry about SOLO's performance. SOLO maintains all of its radar warning capability over its entire battery life. SOLO's even smart enough to turn itself off if you forget. When it's finally time to replace the battery, SOLO will tell you five hours in advance.

Then just drop in another lithium battery for 200 more hours (or use a standard alkaline to power SOLO for 80 hours). SOLO costs less than three cents per hour of use.

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You'll slip your SOLO into its carrying case and carry it in your shirt pocket. In your car, just clip SOLO to your visor and switch it on.



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# KEEP YOUR CAR NEW

## 41 Master Restorer Tips

● We began by talking to a number of master restorers—guys who make their living by bringing cars back to their original condition. Some of them specialized in detailing interiors, or rescuing priceless original upholstery on antique cars. Some of them were mechanics who prepared cars for vintage racing meets. Others were paint-and-

body men who frequently hand-fabricate body panels for vehicles so old that replacement parts are only a memory.

They all had horror stories of gross neglect and incredible abuse—and lots of good ideas of what car owners can do to keep their car away from the restoration shop for a long, long time.

### 1 Crud Cleanup

Your car's underbody fights an ongoing battle against corrosion. Just a few simple steps can help keep it rust-free.

Thoroughly flush road-salt residue with a garden hose. Spray especially well inside wheel wells and on the underbody, where accumulated mud and leaves act as moisture traps, creating ideal conditions for rust. Use a stiff brush to remove any clinging bits that your hose misses. While you're there, check for loose or missing splash guards or inner fender panels. These must be reattached or replaced.

Many vehicle doors have drain holes that can become plugged. Use a thin wire or pipe cleaner to scrape them free. Clogging can create a corrosion colony inside that may rust through quicker than exposed parts on the car's underside.

Once each month, get under your car and inspect for clogged drain holes and missing plugs. Loose undercoating can provide a place for salt and mud to collect in contact with the metal panels. Use a putty knife to pry loose any corroded or cracked undercoating, then wire-brush and clean with solvent. Respray with spray-can undercoating, which you can find at the auto parts store.

Similarly, police suspension components, like the top of control arms, for pockets of mud and road debris. Remove any of this material and keep the areas painted.



Periodically clean the drain holes in the lower parts of body panels to prevent moisture from accumulating.

### 2 Suspension Lube

Lubricating the chassis and suspension every 15,000 miles helps preserve your car's ride and handling. To locate the grease points, check your service manual. Don't be surprised if your car has as many as 10 or 20 of them.

Some manufacturers install plugs in the suspension where grease fittings should be. You can purchase grease fittings and install them yourself.

You can also purchase hand-operated grease guns in auto parts stores. Pay special attention to the Zerk fittings in the upper and lower ball joints. (These may be coated with a

layer of grit which must be cleaned off before the lube can be pumped in.) Pump in the grease until you can see it swell, but don't overfill the boot to the point of bursting.

A tip: At the onset of winter, give all rubber hoses, fittings, seals and insulated wires a coat of silicone lubricant to keep them pliable. When the weather warms, wipe away excess lube to prevent dust contamination.

Next, examine all suspension joints. Tighten all chassis bolts using the proper wrench.

Suspension restoration also includes checking the ball joints for wear. Most manufacturers have simplified the task by using wear-indicator ball joints. While the car rests on the ground,

check the ball-joint wear collar that surrounds the grease fitting on the lower surface of the joint. If the collar descends below the joint surface, the joint is worn and must be replaced. On another type of wear indicator, found on some Chryslers, you try to wiggle the grease fitting. If it moves, the joint is worn and should be replaced.

On cars without wear indicator joints, you should check the service manual in order to find the correct diagnostic procedure.

### 3 Power Steering Fluid

Like the brake hydraulics, your power steering system is subject to the ravages of time. Rubber hoses and complex sealing mechanisms can

break down and contaminate the steering fluid. It should be changed every 40,000 miles.

To flush the system, first locate the power steering pump lines. Usually a high-pressure line takes fluid from the pump and is attached to the fitting with a crimped-on steel sleeve. You want to detach the low-pressure return line, which is usually hose-clamped to the return nipple. While adding steering fluid at the reservoir, have an assistant turn the steering wheel back and forth. Get the front wheels clear of the ground with jackstands for this. Continue to drain off the old fluid until clean oil begins to drip from the pump.

Then reattach the return line and top off the fluid reservoir. A few turns of the steering wheel should be enough to force out air bubbles.

Another way to help extend pump and steering rack life is to install an in-line fluid filter. The filter is hose-clamped into the low-pressure return line to the pump. First, drain the power steering fluid, then cut the rubber hose line within an inch or two of the inlet nipple. Hose-clamp the aftermarket filter to the free ends of the hose. The filter's tiny screens remove abrasive particles that can cause pump failure.

## 4 Brake System Checklist

Brakes require more than occasional relining to maintain peak performance. Inspect annually for corroded brake lines and cut, abraded or heavily weather-checked brake hoses.

Disc brakes can benefit from periodic removal of the brake pads and "exercising" of the brake calipers. Use a big screwdriver or pry bar to pry the caliper apart, compressing the piston(s) back into the bore. That will break up any corrosion outboard of the seal before it's advanced enough to freeze up the piston. Repeat this several times for each caliper, by pumping the brake pedal to push the piston back out.

Then remove the pads, and wire-brush or file the pad seating surfaces or sliding channels in the caliper (depending on whether you have 1- or 2-piston calipers) to permit the pads to slip back and forth easily. Lightly lube the sliding surfaces with white grease or antiseize—being careful, of course, to avoid greasing the friction surfaces of the brakes.

Similarly, remove the rear brake drums, and exercise and lubricate the self-adjusting mechanism, as well as



Lubricate handbrake cable and mechanism to prevent corrosion or dragging brakes.

the contact surfaces of the shoes and backing plate.

Inspect the handbrake cables, and squirt some grease or oil into the sheathed portion of the cable. Check out the ratchet mechanism in the handbrake lever as well, lubricating the pivot point and pawl. Once everything is nicely lubricated, you might see if there's a benefit in adjusting the cable itself, generally done where the spreader bar splits the single cable from the handle to the two individual rear-wheel cables.

## 5 Brake Fluid Change

Brake fluid is the lifeblood of your braking system. Periodic flushing—about every 25,000 miles—removes contaminants that can change clean fluid into brown mud.

Unless you own a power bleeder, brake flushing takes two people. First, open the hexagonal bleeder screws located at each caliper and cylinder. Caution: Many older-model cars may have corroded hex screws which can seize. Lube the screw before attempting to loosen it.

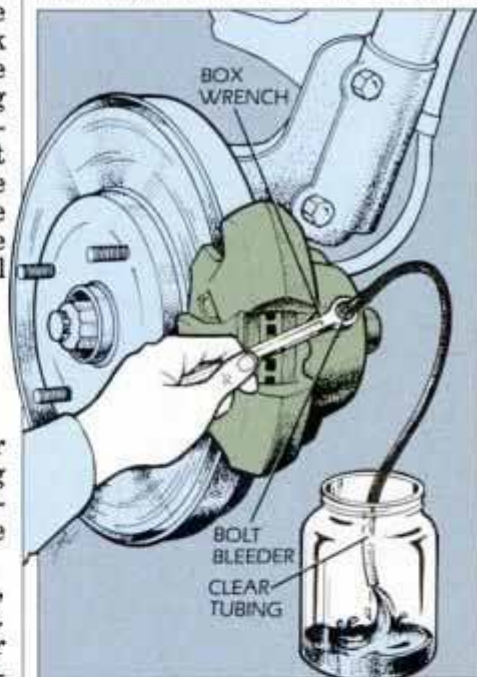
After opening the screws, have your assistant depress the brake pedal several times until no more fluid flows out. Close the screws, then refill the system at the master cylinder. Cover the master cylinder, pumping the brakes several times.

At this point, bleed the brakes at the calipers and cylinders to remove air from the system. Crack the bleeder fittings on all four calipers or brake cylinders—but be careful. These bleeders tend to corrode, especially if the brakes haven't been bled regular-

ly. Use penetrating oil, let it soak for a while, and employ a proper-sized box wrench to turn the bleeder. Then open one rear bleeder, and pump the master cylinder dry by stroking the brake pedal up and down repeatedly. Close the rear bleeder, and pump the front dry as well.

Close the bleeder, and top off the brake reservoir with fluid from a freshly opened can. Have a helper hold the brake pedal to the floor while you open and shut a rear bleeder. Do this repeatedly until you get mostly fresh, clean fluid instead of air. Repeat this for the other three wheels, and then do all four again—but keep the reservoir at least half full.

Many restorers advocate using silicone brake fluid. The advantage of silicone is that it does not attract water into the braking system, greatly extending the life of brake seals and lines. On the down side, silicone is triple the cost of regular brake fluid. Additionally, silicone is to water what oil



Brake fluid needs to be changed on a regular basis, just like other lubricants.

is to vinegar. Unabsorbed moisture can collect in low spots and rust out the hydraulics. Also, some silicones may not be compatible with regular glycol-based fluids, requiring a complete overhaul of the brake system to change over.

## 6 Shocks/Strut Replacement

Shock absorbers last between 30,000 and 45,000 miles, depending upon your car's weight, as well as the severity of the pothole population in



A spring compressor can be rented for the afternoon to replace coil springs.

your area. Proper replacement can help preserve your car's suspension. Bad shocks wreak short-term havoc on ride and handling, and long-term havoc on alignment and the entire suspension system.

Look for fluid leaks at each shock absorber. Shocks which show evidence of a leak *must* be changed. Does your car bounce up and down excessively after hitting a bump in the road? The shocks should be changed.

Replacing conventional shock absorbers involves simply unbolting the old shocks and installing new ones. Most shocks are bolted to the frame by an upper straight pin, held in place by a single nut. You'll have to use a pair of pliers to hold the shaft while you turn the bolt with a box wrench. You may find the two sheetmetal bolts on the bottom frozen with rust. If a wrench won't work, torch or chisel them off, or use a nut splitter.

To reduce weight and conserve space in crowded engine compartments, many manufacturers have moved to MacPherson strut suspensions. Here the strut/damper unit is surrounded by the spring and acts as a suspension support member. Professionals use powerful spring compressors to prevent the springs from suddenly uncoiling. Without these tools and a lot of experience with MacPherson struts, it's best to leave this job to your service mechanic. If you decide to replace the struts yourself, be sure you also have the correct service manual.

## 7 Spring Replacement

Worn springs contribute to tire wear and misalignment by altering your car's ride height. Your car is equipped with either coil springs or flat leaf springs (in the rear only). Exercise extreme caution when servicing coil springs. In nine out of 10 installations, you will need a spring compressor.

In rear-wheel-drive cars, support the lower control arm securely on a jackstand. Apply the spring compressor and attach two spring clips. These clips will become valuable reference points for you later on. Now detach the sway bar pin.

Remove the old spring, stand it next to the new spring, and make matching spring clip marks. Attach clips here. They are your points of reference to help you seat the spring properly. Now add spring clips to the new spring, reinstall it and then reassemble the lower control arm. Using the compressor, remove the spring clips when the new spring is aligned correctly.

Rear leaf-springs are sandwiched together by bolts which can shear off under heavy loads. This shearing causes a condition known as "dog-tracking," where the rear of the car looks as if it's not riding in line with the front. Be sure to use replacement bolts intended for rear springs—these bolts are special, high-toughness pieces. Rear leaves are usually attached by two U-bolts to the frame. After lifting the car on jackstands, look for the two bolts, one at either side of the spring. Simply unbolt them, slide the old spring out and the new leaves in. If the U-bolts are badly corroded, you should hacksaw or torch them off, and then replace them.

A badly sagged rear spring can sometimes be re-arched by a spring shop in order to return it to its original contour. The shop will have to look at the spring to see if it's suitable, of course, as these springs tend to crack in the center. If not, the spring shop often can make a new leaf inexpensively. You might confer with them, then remove the spring assemblies yourself and bring them into the shop. They'll also have the correct anti-squeak spacers to go between the leaves.

Concerned about the correct ride height for your car? Manufacturers publish exhaustive charts of both front and rear specifications. You can find these at your garage or in your service manual.

## 8 Rx For Loose Steering

Sloppy steering can affect road handling and the safety of you and your passengers.

If you have conventional box-type power steering (as distinct from rack and pinion), steering adjustment is not difficult. Your service manual shows you how to find your power steering pump. On top of this is an Allen-type screw that controls your steering adjustment. Most restorers do this by feel. With the engine running, move the adjustment screw in quarter-turns. Turn the steering wheel after each adjustment until you find a comfortable setting. To check, make several turns during a test drive. The steering wheel should return easily as the vehicle straightens.



Adjusting your steering box requires an Allen wrench and a box wrench.

If the steering shimmies, especially right after pavement bumps, you may have to restore your steering linkages. To check their tightness, simply shake the entire wheel assembly with the car on jackstands. Some horizontal movement is always to be expected. Unrestricted vertical play may be a sign of a worn tie rod that must be replaced.

Your car has either parallelogram steering (four tie-rod ends) or rack-and-pinion steering (two tie-rod ends). To replace a tie-rod end, unscrew the nut from the rod end after removing the cotter pin. Use a sledge and pickle fork rod-end separator to unseat the joint. In lieu of a pickle fork, a tie-rod-end puller allows you to squeeze apart the rod ends with no

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This additive, called "Sakura-Lube" in Japan, has just been improved even further and is now available in the USA. Since Sakura-Lube is used by Original Equipment Manufacturers, it is sold under the brand name of **OEM** here in the US. The key ingredient for **OEM** is the fantastic result of over 10 years of research, development, and testing at a cost of \$25,000,000. It is the latest lubrication technology available.

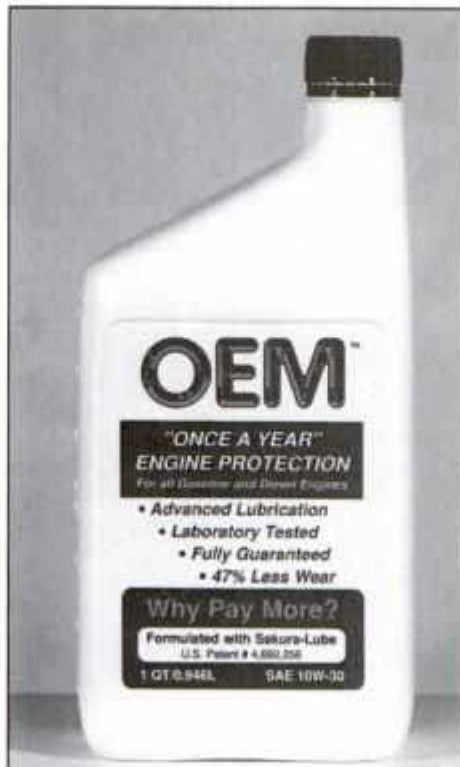
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PMS

damage to the dust boot.

Before replacing the tie-rod end, measure inner-to-outer tie-rod length from center to center. This measurement helps you correctly position the new rod end without changing the toe adjustment. Now you can loosen the locking bolt on the tie-rod collar and unscrew the worn rod end. Install the new rod end, tightening it according to your measurements. After tie-rod or other steering linkage repairs, have your wheels aligned with a 4-wheel alignment machine.

## 9 Plug Wire Patrol

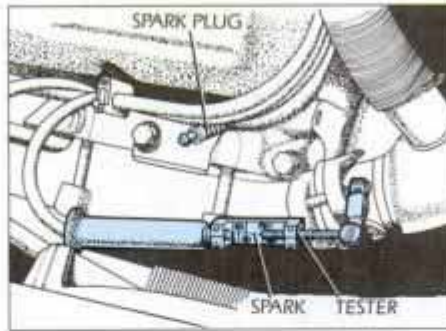
Engine misfire not only causes vibration, but lowers performance and gas mileage as well. It also loads the catalytic converter with unburned fuel, raising its internal temperatures and shortening its lifespan. Check the spark plug wires, distributor cap and rotor (on cars still equipped with distributors). Look for cracks inside the cap (even a hairline) and burns on the plastic of a rotor, and replace the part if it isn't perfect. Inspect plug wires for oil soaking or heat cracks on the insulation, then test each plug wire's condition.

One simple test is to use a low-cost tool that substitutes for a spark plug and provides a rough visual check of the wire's ability to deliver the spark to the plug while the engine is run during cranking or at idle.

Another caveat is to be sure and purchase high-quality replacement wires. The inexpensive "universal" kits are problematic—first off, being universal, they are a compromise in terms of being routed exactly into the original wiring looms. As little as an inch or two of excess length can generate a misfire that you'll *never* track down. Secondly, with today's high underhood temps, only the best insulations can cope with the heat. Conventional wiring will simply give up within a few months.

The downside to this new silicone insulations is its mechanical fragility—yanking on the plug terminal with a pair of pliers is more than likely to damage the rubber. So you may want to invest in a set of plastic tongs intended to be used for just this purpose. The tongs can be found inexpensively at the auto parts store, but you'll be best off going to the new-car dealer's parts bench for the spark plug wires. Be prepared to pay top dollar, unfortunately.

Replace a plug wire if you see external deterioration (particularly at



An inexpensive spark plug tester can be used to check for a hot, blue spark.

the nipples), any looseness of the terminal at each end or if the wire misfires at any time during the test. Be sure to duplicate the original routing of each plug wire, carefully engaging it in its plastic guide. Misrouting of plug wires is a common cause of deterioration and resulting misfire.

The time-honored tradition of pulling a plug wire loose from the plug and holding it next to the manifold while the engine runs is definitely a bad idea. Aside from the cramped situation in modern engine compartments, the electronically generated spark is substantially higher in voltage than the old-fashioned points-and-condenser variety. This will get your attention in a big way if the spark happens to find a better path to ground than the air gap you've created—say through your elbow to the fender. Mechanics who attempt this regularly are generally addressed as "Lefty."

Worse yet, there's some danger of frying an expensive ignition black box if you miss and don't let the spark find a home somewhere.

## 10 Battery Maintenance

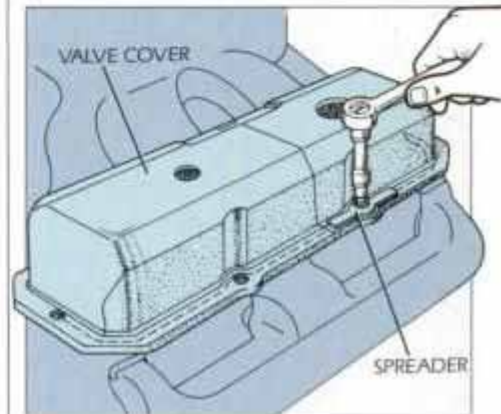
If the battery and cable connections are corroded or loose, the car will be harder to start, and in cold weather, that means more unburned gasoline diluting the crankcase oil, affecting engine lubrication. Just a light film of corrosion—very hard to see—affects the ability of the battery to accept a charge, so wire-brush the cable and battery terminals at least once a year. Don't forget the other end of the cables—the ground connection(s) to the body and/or engine also should be wire-brushed clean, then tightened, and the positive cable connection should be tight.

Keep the plastic surface of the battery clean. After you've cleaned the terminals, rinse the surface with warm water, wipe down with mild de-

tergent to cut the grease, and rinse again. This will prevent an oily film from collecting dirt—which is conductive and will discharge the battery slightly day and night. Finally, cover all the exposed metal parts of the terminals and cables with grease to prevent further corrosion.

## 11 Leak Control

Engine oil leaks not only increase engine friction, but those underhood leaks (particularly at the valve covers) allow oil to seep onto hoses, belts and wiring harnesses, causing them to deteriorate. Periodically tighten the screws holding all oil-sealing covers, like cam or pushrod gallery covers. If a washer is the specially shaped



Oil leaks can sometimes be corrected by torquing the valve cover fasteners.

load-spreading type and it's missing, get a replacement that matches the original, as it significantly improves sealing over an ordinary washer.

Some OEM-type gaskets have been superseded by a newer style because the originals were—you guessed it—prone to leak. So be sure you're buying the newest revision.

Also check the oil pressure sending unit for seepage, and if necessary, remove the unit and wrap the threads with Teflon tape for a better seal.

## 12 Cooling System

An engine that runs consistently hot can age prematurely, even if it doesn't show classic signs of overheating. This makes good cooling system maintenance particularly important, and your program should go well beyond the occasional flush-and-fill. Excessively high temperatures can cause engine knock, which shortens the life of virtually all key engine parts, including pistons, pins, crankshaft and





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bearings. High temperatures also increase friction (and engine wear) by thinning out engine oil and causing parts to warp, affecting engine sealing.

Make sure you've really filled the system. Many late-model cooling systems are prone to trapping air, which not only reduces heater output, but can create harmful hot spots in the engine.

If the car manufacturer has a specific bleeding procedure, including the opening of air bleeder valves on the engine block or cylinder head, be sure to follow it when you fill up. If the radiator cap is not the highest point of the cooling system, jack up the front of the car to raise it, which helps it self-bleed.

Make sure the reservoir is filled to the proper marked level, and recheck the level periodically.

Check the clutch fan on a north-south engine. Most accurate: Measure the air temperature when the clutch locks up. Slip the probe of a pyrometer (temperature-measuring meter) into the fan shroud and run the engine until it warms up.

When the engine is warm, the fan should virtually lock up. Fan noise will increase noticeably and you can note the temperature on the meter, which should be between 150° and 170° F.

No pyrometer? Try to spin the fan with the engine fully warmed up. If it turns easily, the clutch is bad. Also, run a finger around the bearing area at the rear of the clutch assembly. If it picks up a blob of black goo, that's silicone, and it indicates a leak from the clutch assembly. Unbolting the clutch fan assembly and installing a replacement is a straightforward job.

Test the radiator electric fan, or fans. Within a minute of turning on the a/c, at least one fan should turn. Refer to a manual for your car to see when a second fan and/or the high-speed range of a single fan should come on.

You may have to block the front of the radiator or a/c condenser with cardboard to raise coolant temperatures high enough to fully check a multispeed fan system.

Check the fan shroud. If it's loose or missing, the efficiency of the fan drops significantly.

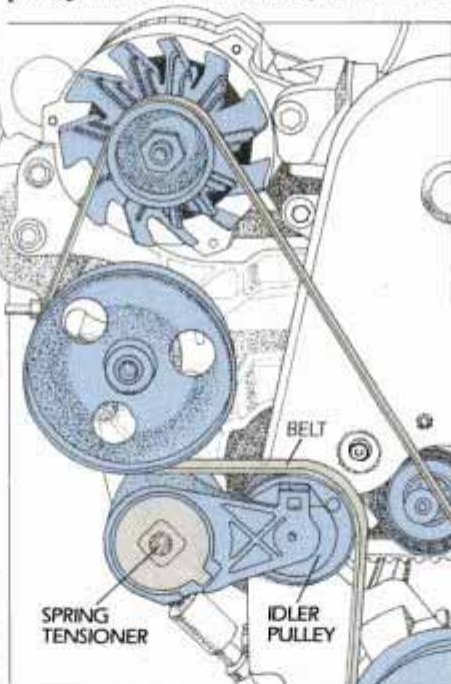
Don't remove the thermostat. It won't cure overheating (unless it's caused by a bad thermostat), and it prevents proper engine warmup. Most engine wear occurs on cold starts before the engine is warm. Cars without thermostats may never

warm up fully—confusing the computer into running in its overly rich warmup mode forever.

Look under the front of the car. Many modern cars draw in cooling air from underneath. If an air dam or chin spoiler is missing, the car may run too hot, particularly in highway operation. Cars with limited grille area may use underbody covers to minimize or direct underbody airflow, and cooling problems occur if they're missing.

## 13 Belt Tension

Run the engine and watch the belt(s) and pulleys. If a ribbed belt seems to be flexing fore-aft, stop the engine and see if it's properly installed on each pulley (it'll track if it's one groove off, but transfer power poorly and expire prematurely). Watch each pulley to see if it wobbles, which indi-



Spring-loaded idler maintains tension until tab on adjuster bottoms out as belt wears.

cates looseness or misalignment. This also affects power transfer, which may cause a belt to pop off and can also damage the shaft bearing of the pulley's accessory. Misalignment often results from a stackup of manufacturing tolerances, and shimming a pulley or the accessory's mounting bolts may be needed to correct it.

Most late-model cars have a single ribbed belt with a spring-loaded adjuster, and although you can't change the belt tension, you can check it. Most GM cars have a tension indicator on the spring housing, and as long as it's not at the far end of the slot, the belt has not stretched excessively. If

there's no indicator and there's a specification for belt tension in pounds, use only a professional-quality gauge made for ribbed belts (and calibrated in pounds of strand tension) to check. The ribbed-belt gauge also can be used for ribbed belts controlled by an adjuster, but you'll need a different gauge for a conventional V-belt.

In either case, the adjuster typically is a jackscrew. Loosen a locknut or nut, then turn the jackscrew to increase or reduce tension. Some car manufacturers provide a belt deflection specification instead of tension but it's more difficult to use this accurately.

## 14 Belts/Hose Replacement

Like most rubber parts on your car, belts and hoses are subject to the vagaries of high engine temperatures, oil and ozone—all of which deteriorate the rubber prematurely. So start by treating the hoses periodically with a rubber protectant or spray silicone. But not, obviously, the belts—the slippery treatment will prevent them from gripping the pulleys.

Even with good maintenance, the rubber will weather-check and begin to fail. Aside from the obvious inconvenience of an outright failure some rush-hour afternoon, a glazed or slipping belt can produce excessively high engine temperatures. This is also true of an oil-soaked lower radiator hose that's softened to the point of collapse under the suction of the water pump at high engine speeds.

So, periodically inspect all the belts and hoses, and replace them before they damage a perfectly good engine.

## 15 Rx For Loose Linkage

Automatic transmissions rely on a throttle position signal to govern shifting and transmission oil pressures, and although that's done electronically on some late-model transmissions, most automatics use either a vacuum diaphragm unit (called a modulator) connected to the engine by a hose, or a linkage (usually a cable) to the throttle assembly. A few transmissions have both.

Even if the transmission shifts have not yet become objectionable, make the following checks as a preventive maintenance routine, because lowered oil pressure could allow some transmission slippage, which trans-

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lates to premature wear. Refer to your service manual for the correct linkage adjustment.

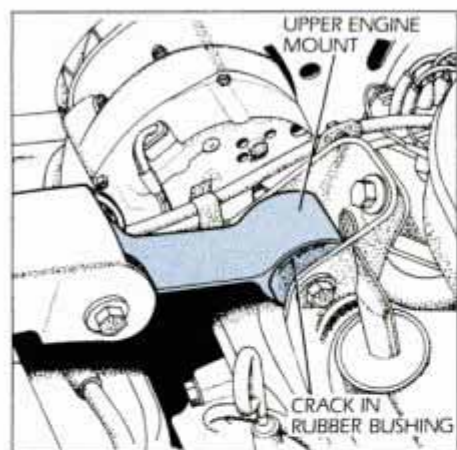
Unplug a modulator hose connection at the transmission. If you find oil inside, the modulator diaphragm is defective. Inspect the hose itself for a crack, and replace if necessary. Push the hose back on all the way. If the hose is stiff, and prone to leaking because it no longer grips the fitting, you need a new piece of vacuum hose.

Clean all external transmission shift linkage joints with a spray penetrating solvent, allow it to dry, then work chassis lubricant into the joint. Check the hoses and clamps in the lines that run to the transmission oil cooler. Seepage from these connections can be difficult to trace, as it's often far from the transmission.

## 16 Mount Replacement

Loose or deteriorating powertrain mounts require careful inspection to spot. Look for missing chunks of rubber, severe cracking, oil soaking and separation of rubber from the metal. Also check for loose, broken or missing retaining bolts. Don't forget the dogbone struts on transverse engines. If they're deteriorated, consider a premium aftermarket replacement that has a hydraulic damper.

Some north-south engines have a mini shock absorber to reduce vibra-



**Worn or cracked engine mounts can contribute to vibration and harsh shifting.**

tion. Disconnect it at one end, compress and extend it, and if you feel any lost motion or roughness, replace it. North-south engines also have a mount at the rear of the transmission.

A few drivetrains require special vibration dampers, which resemble a stack of rectangular plates, bolted to the transmission. A loose damper doesn't do its job, so make sure the retaining bolts are tight.

## 17 Valve Adjustment

Although most engines have hydraulic valve lifters requiring no periodic maintenance or adjustment, there are lots of exceptions, including many late-model Japanese cars. There are two adjustments in use on overhead-cam engines: replaceable shims or



**Even some modern overhead-cam engines still require periodic valve lash adjustment.**

rockers with adjusting screws. Extracting the old shim and installing one that's thicker or thinner requires special tools and assorted shims.

An annual check of valve clearance is good practice and is typically recommended maintenance. With an overhead-camshaft engine, remove the valve cover, turn the engine with a wrench on the crankshaft pulley bolt until you see that the base circle of the camshaft (opposite the lobe that opens the valve) is against the rocker arm or valve lifter. At that point, the valve is fully closed, and you can check clearance between valve stem and rocker tip with a feeler gauge.

The specified feeler should slide in and out with light-to-moderate drag. If clearance is too great, the valve opens late and closes early, reducing engine performance. If it's too little, the valve opens early and closes late, spending too little time on its seat, which is when it transfers heat to the cooling system. Result: The valve runs hot and burns prematurely.

To reset valve clearance, loosen the locknut, and turn the adjusting screw until the feeler drags. Then hold the screw while you tighten the locknut.

Invariably, the clearance changes as the locknut tightens, so you'll have to try it until the gauge just glides out once the nut is snug.

## 18 Dipstick ABCs

Check your automatic transmission fluid regularly. Read the dipstick carefully to make sure you don't underfill or overfill. Many dipsticks have a crosshatch area into which the level line should fall, depending on whether or not the oil is fully warmed up.

To check fluid level, be sure the engine is properly warmed up, but not overheated (say, from pulling a trailer up a mountain). Park the car on a level surface, and leave the engine running. Move the shift lever through all gear positions ending in Park. (Honda is a notable exception, recommending fluid checks within a minute of shutting off the engine.) Remove the transmission dipstick, wipe it with a clean rag, and reinsert it into the tube till it bottoms. The fluid level should be between the Fill and Add marks.

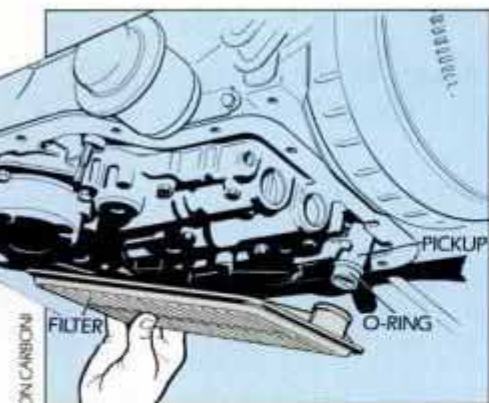
Although underfilling is the obvious problem, overfilling causes fluid foaming, which breaks up the solid column of oil needed to properly control the transmission. There's also the potential for causing leaks.

Similarly, oil level is critical to the lifespan of your engine. The best procedure here is to check the dipstick cold, before starting the engine. Be sure the car is level. Maintain the oil level between the Fill and Add marks, even if it means adding less than a full quart.

## 19 Gearbox Lube/Filter Change

Give an automatic a fresh fill of fluid and a new filter at least every two years if it has a filter you can replace, annually if there's a strainer that is not normally serviced. On all but a handful of cars, you've got to drop the oil pan to drain the old fluid and gain access to the filter. Many filters seal to the oil pump inlet by an O-ring, so whether the O-ring is on the filter or a neck that projects from the pump, be sure to replace it and seat it carefully. Otherwise, the pump may not pick up enough oil, affecting transmission performance. (Usually the filter, pan gasket and any O-rings are packaged together.) If there's a magnet in the drain pan, clean it before reinstalling.

Also, there are aftermarket in-line filters, similar to an oil filter, that you can splice into the cooler lines. Heavy-



Auto trans filter should be replaced periodically. Check for good seal at O-ring.

duty use, like towing, would make an auxiliary cooler a good idea, as well. Put the cooler into the line ahead of the stock cooler in the radiator—the idea is to make sure the ATF isn't overcooled. The radiator will actually warm the ATF to the proper temp even in the depths of winter.

## 20 Lubricant Guidelines

There's rarely a dipstick for the manual transmission, so when you're doing other lube work, remove the fill plug and see if the level is even with the bottom of the plug hole. Drain and refill the transmission at least once every two years, taking care to use only the specified lubricant. Some gear oils will not adequately protect some of the metals of a transmission, or may be so thick they affect shift quality.

Many modern transmissions specify the use of multiviscosity engine oil in the transmission. That's right, engine oil. We did a doubletake the first time we saw that one ourselves. If that's the spec for your tranny, fine—just be sure to use the proper viscosity.

Automatic transmission fluid is often recommended for year-round use in some manual transmissions. However, it may not match the protection offered by gear lube for hard use in hot weather, so if ATF is a winter-only recommendation, change to the specified gear oil in the spring.

Although most automatics can use Dexron II or a name-brand universal transmission fluid that meets Dexron II and Ford Mercon standards, older Ford automatics and some imports require a fluid that meets Type F standards. Use the right fluid, or transmission shift quality will suffer.

Rear axles with limited-slip differentials use a lubricant with friction modifier to prevent chattering

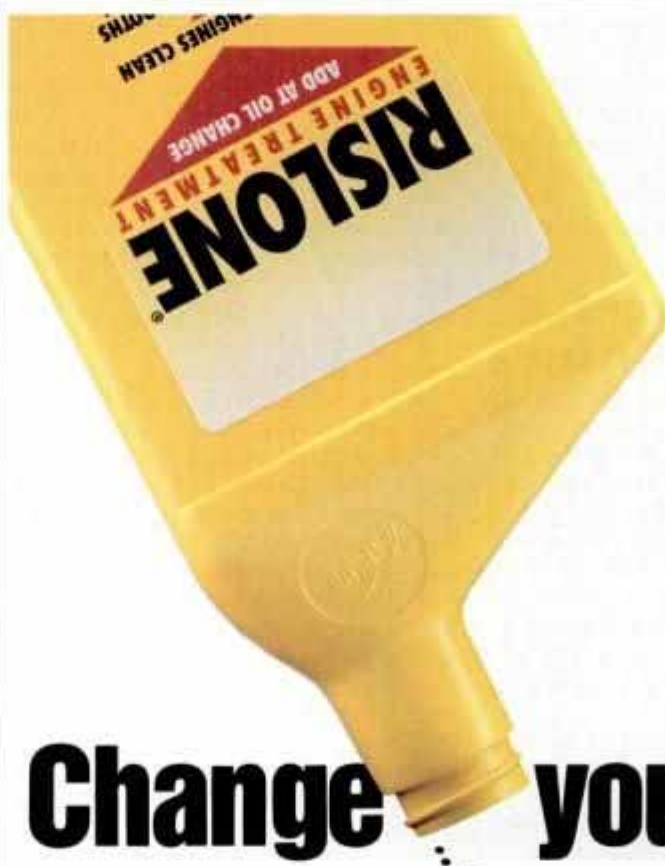
around slow corners. Be sure to check the label on the container to see if you've got the right stuff.

## 21 Driveshaft Upkeep

A rear-drive or 4-wheel-drive car has at least one propeller shaft to the rear wheels. Some 4wd systems have propshafts to both axles. Hold the shaft on each side of a universal joint and try to twist it in both directions. If there's free play, the joint is worn and

should be replaced. Also, carefully try to turn the propshaft back and forth, where it enters the transmission or transfer case, and if there's free play between the propshaft and its mating shaft, the end section of the propshaft (called the slip yoke) may be worn and in need of replacement.

If a propshaft is very long, it may be supported in the middle by a center bearing assembly. Inspect this for a loose mount and turn the propshaft while you feel the bearing assembly for any roughness.



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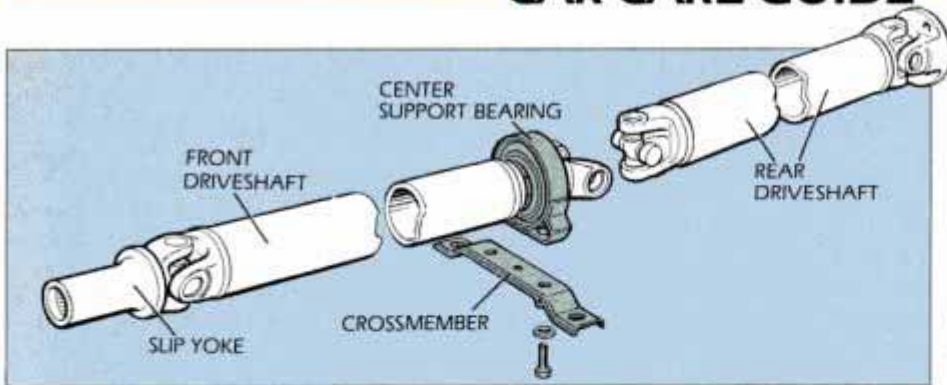
## 24 CV Joint Lubrication

The constant velocity universal joints in front-drive axle shafts normally last a long time, but don't wait for a clicking noise on turns (indicating a bad outer joint) or an axle shaft hum. Inspect the CV joint boots whenever you're underneath, and if you find a small cut without a sign of lubricant leakage, clean the rubber and seal the wound with a dab of silicone RTV.

If there's a large gash in the boot and evidence of grease leakage, but apparently no real damage, remove the boot and inspect it. You should be able to clean out any grease that shows only surface contamination with road film and moisture, repack with fresh grease (use specified CV joint grease) and install a split boot kit—all without removing the axle shaft.

We're wary of being able to properly clean a CV joint without removing it from the vehicle and using solvent and a brush to get out the last bit of dried-out grease and mud. But if you're confident there's no contamination, it may be possible to avoid this step. The split boots have been improved recently and, with careful installation, may last a couple of years.

If the grease leakage is extensive and the first hums or clicks have been heard, check a repair manual. You may find it's possible to take out the shaft and replace the innards of the joint without special tools. Or, buy a factory rebuilt shaft from an auto parts store for the same price as a pair of CV joint kits. Unless the failure of one joint is premature, a complete shaft assembly is a sound investment.



U-joints and center bearings need periodic lubrication to provide long service life.

Even if everything is tight, remove any mud or goo packed into the universal joints, and if there's a U-joint grease fitting, lubricate it. Although original equipment shafts on most recent 2wd vehicles have sealed-and-packed joints, OEM joints for 4wd systems have grease fittings. This is also true for most replacement U-joints.

## 22 Differential Lube Change

Many manufacturers don't specify any change interval for the rear axle/differential lubricant. But we're not willing to believe that the hypoid lube squirted in at the factory is going to last for over 100,000 miles. The manufacturers haven't made this job easy, although the first step is relatively simple. There's always a filler plug, which is where you check the lube level. The lubricant should be within a half inch or so of the lip.

But changing the lube is a little messier because, all too often, there's no drain plug.

You'll have to remove the differential cover to drain the lube—simple enough. Just unscrew the bolts and let the lube drain. Some covers use a paper gasket, while others rely on nothing more than a bead of RTV silicone. Use a fresh paper gasket or a thin bead of RTV intended for gasket applications—bathtub caulking won't cut it. Tighten the bolts in a circular pattern, and refill with fresh lube.

## 23 Clutch Adjust

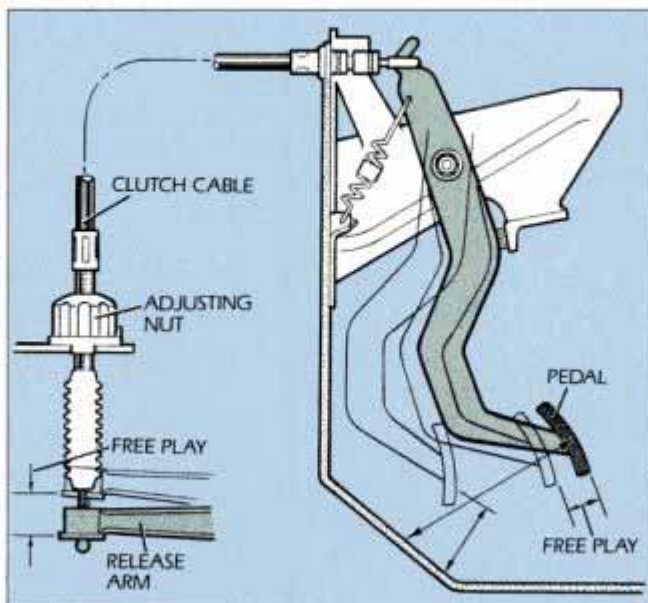
Don't wait for a clutch to slip before doing something. Clutch pedal free play should be  $\frac{3}{4}$  to  $1\frac{1}{2}$  in. If it's excessive, the clutch may not fully disengage, causing grinding and damage to the transmission. If

it's too little, the clutch disc and throwout bearing take extra punishment. If your car has a conventional clutch linkage, refer to a repair manual for the way to turn the adjuster to reset the clearance. Also, lubricate the metal pivots of the clutch linkage with chassis grease, the plastic parts with silicone grease.

Although many clutches are self-adjusting, they have toothed-pawl plastic adjusters that should periodically be lubed (on the pivot and the teeth) with silicone grease.

Many self-adjusting clutches require that you periodically lift the clutch pedal up an inch or so to do the adjusting—which isn't actually self-adjusting in our book, but a darn sight better than having to crawl under the car with a flashlight and a wrench.

Hydraulic clutches may require not only a mechanical rod adjustment, but may also need topping up of fluid in the master cylinder, and perhaps even bleeding. Replacing the hydraulic fluid in the clutch system should be done when you change brake fluid, since it's common for both systems to use the same type of fluid.



Cable-operated clutches are usually adjusted at the transmission end of the cable. Some adjust automatically.

## 25 Trans-axle Lube Change

Front-drive transaxles have had a common oil supply with the final drive (differential) for many years. There have been exceptions, primarily older Chrysler front-drive automatics, with separate drain and fill plugs for the final drive. Though separate, both transmission and final drive use Dexron II transmission fluid.

However, if you have a 4wd system, the transfer case and rear-axle differential housing have their own oil check and fill plugs. These gearboxes typically use SAE 80-90 gear oil type GL-5, though in some

cases they need a special factory oil.

In hard use, change the oil annually (siphon the oil from a differential housing without a drain plug). In normal city/suburban driving, you should change the oil every two years. In each case, check the level at the fill plug during every engine-oil change.

## 26 Paint Touchups

Fixing nicks and scratches as soon as they occur can do more than make your car look better. It can also make it last longer. That's because nicks and scratches—even those that don't go all the way to bare metal—are the first places that rust starts.

To fix a scratch, first determine your car's paint code, usually located on a badge under the hood, in a door jamb, inside the trunk or in some other hidden location. Find your car's code badge by checking a service manual or calling your local dealer.

At the auto parts store, match your paint code with the code in the paint-matching application guide.

For small repairs, purchase a bottle of matching paint that has a brush

built into the cap. If the scratch goes down to bare metal, purchase primer and metal conditioner.

Wash the repair area with mild soap and water, rinse thoroughly and then dry with a lintfree cloth. Remove wax, grease and oil with a wax remover, acetone or lacquer thinner. If rust is present, scrape away as much as possible with a single-edge razorblade, then treat with a rust remover followed by a rust converter (see tip No. 32).

For bare metal that's rustfree, apply metal conditioner according to container directions. Follow by brushing on two or three coats of primer, allowing 5 minutes between coats. Let the primer dry for 30 minutes before applying color coats.

After thoroughly mixing the color touchup paint, apply two or three thin coats in one direction, allowing sufficient drying time between coats. If the original paint has a clear coat, apply two very thin coats of clear to achieve proper color match.

Let the repair dry for at least a week, then use fine polishing compound on a very wet rag to smooth out the repair. Be careful not to rub

through the color. Follow up by waxing and polishing.

## 27 Chrome Restoration

Toxic chemicals that harm the environment are used in the chrome plating process. And because disposing of those chemicals is now strictly controlled by the government, rechroming has become exceedingly expensive—about \$200 for an average bumper. A door handle will set you back \$50. Double these prices for show-quality work.

Rechroming has become so expensive that it's often cheaper to find used parts at a wrecking yard. Sometimes it's even cheaper to buy a brand-new part if it's still available. And if you have a popular make, it's possible to buy parts that have been rechromed using production methods and are, therefore, less expensive.

Of course, it's best to keep the chrome on your car in good shape to begin with. That means it should be polished and waxed with the same loving care you give the paint.

If surface rust is present, remove it



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with chrome polish. Use it with No. 00 steel wool for stubborn surface rust. If a chrome part has a scratch, remove any rust (see tip No. 32), then brush in a zinc-rich paint called cold galvanizing compound to prevent further corrosion. Often, chrome parts start rusting on the rougher inside surface, a problem that commonly goes unnoticed until rust pokes through the front. If you spot rust inside, remove it, then paint the surface with cold galvanizing compound.

If you do decide it's time to head for the chrome shop, check the work they've done for other people, since quality varies greatly from one shop to the next. Like a good paint job, chrome work is only as good as what's underneath. A good shop will strip off all the old chrome, fill all pits, straighten any dents and then give the bare steel a highly polished surface before chroming begins.

## 28 Rx For Leaky Windshields

Just because you see water leaking from the upper-left corner of your windshield doesn't necessarily mean that's where the water's coming in. Many leaks on the driver's side originate on the passenger side, and vice versa.



Leaky windscreens (and rear windows) can often be resealed without removing them.

Fortunately, you can reseat many window leaks without knowing their exact source.

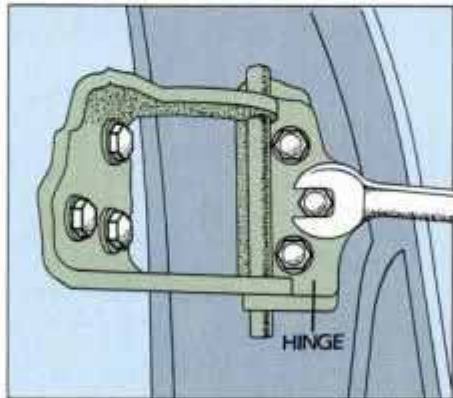
For modern windows that are bonded into place, use 3M Window Weld Resealant. Applied with a caulking gun, Window Weld's thin viscosity allows it to flow into nooks and crannies between the window and the butyl or urethane glue to seal leaks. To apply, remove any decorative trim and squeeze a bead of the resealer around suspected leak areas.

To reseat leaks on older cars where windows are held in place with a rubber gasket, use 3M Grommet Wind-

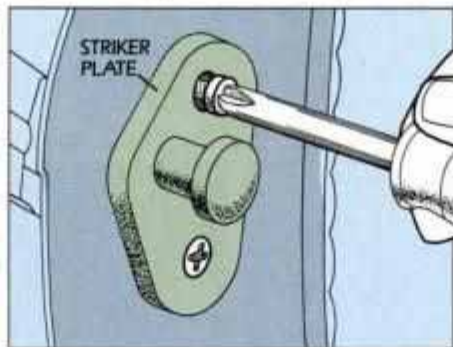
shield Sealer. It flows between the gasket and the window and remains pliable in order to keep the window sealed.

## 29 Door Realignment

Given time, even the sturdiest car doors sag on their hinges. This is es-



Adjust sagging doors at the hinges first to align door at upper and lower edge of front.



Then adjust the striker plate to align rear edge for proper alignment and closing.

pecially true of 2-door models, which have longer, heavier doors.

Before you attempt to adjust a door, inspect the hinges for wear by lifting the end of the door up and down. If there is excessive play, one or both hinges will have to be replaced. If you've neglected the body, the play might be where the door pillar has rusted out.

If the hinges are okay, determine if the door needs to be adjusted up or down, or in or out.

To adjust the door up or down, loosen the hinge-to-body bolts, have an assistant hold the door in the adjusted position, then tighten the bolts. Do in-and-out adjustments only after the up-and-down adjustment is completed by loosening the hinge-to-door bolts and sliding the door in or out appropriately.

Once the door is aligned with an even gap all around and it sits flush with the rest of the body, adjust the door latch striker by loosening it just

enough so that closing the door will cause it to move to the proper position, then unlatch the door and retighten the striker.

## 30 Panel Replacement

Eventually, even the mightiest will fall—and you'll be looking at a rusted-out or bashed-in panel on your car. But unlike simpler, lower-tech cars of two generations ago, hanging a new panel requires considerably more effort than unscrewing a handful of 1/4-in. bolts. Today's cars rarely have exterior body panels that aren't an integral part of the body's structure—and consequently, they're spot-welded into place.

Also, many panels are made of high-strength steels—steels that don't take kindly to being welded with the trusty acetylene torch and a piece of coat-hanger wire. These steels need to be welded with a heli-arc or MIG welder, and that means going to a professional welder at a body shop.

The consequences of doing a less-than-adequate job of welding in a new panel are considerable. Newer cars rely on the concept of controlled crush during an accident to prevent the occupants from being injured in a crash. This means that the front of the car is supposed to crush progressively, absorbing the energy of the crash more gradually. An inadequately attached front fender that pops off right away can't contribute to this.

Also, rethink the option of using an inexpensive aftermarket replacement panel instead of the considerably more expensive factory replacement panel from the dealer. First off, the aftermarket panel is less likely to fit properly, but the lower price often more than makes up for the difference in the labor costs to make it fit. But the alloy and thickness of the panel may be considerably different than the original.

## 31 Prep For Paint

If you're having a car repainted, make sure the shop uses a metal conditioner on bare metal. It etches the metal to eliminate microscopic rust and corrosion. Body shops also use self-etching primers to fight corrosion. If welding is being done, they should use special weld-through primers, which are applied before the pieces are welded.

The best shops also avoid using lacquer putties and fast-dry lacquer-based primer/surfacers to fill sand



## - CAR CARE GUIDE -

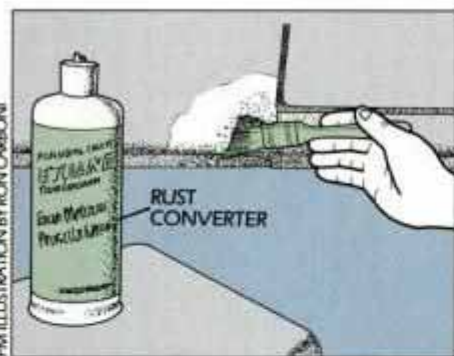
scratches and minor body imperfections. These primers can shrink, revealing scratches not long after the car is painted. Instead, good shops use epoxy-based high-build primer surfacers such as Morton's Eliminator and Dupont's URO Primer-Filler. These new-age primers fill scratches in one or two coats, never shrink, adhere better and are much more durable than other primers.

## 32 Rust Prevention

Rust gets started at a break in the paint, letting in moisture which combines with the iron in the steel panel. Even if you cover the break with paint, the reaction will still continue without fresh water, using atmospheric oxygen that permeates the paint slowly. So it's necessary to either mechanically or chemically remove the rust (sandblasting is a good way—but messy), or to chemically stabilize it.

An acid-based chemical rust remover, such as Oxi-Solve from Eastwood, or commercially available phosphoric acid, actually eats up the rust, leaving fresh new metal exposed for priming and painting.

Chemical rust converters, such as Extend, from Loctite, transforms red, flaky rust to a hard, dark-gray compound that prevents further rusting and forms a stable base for paint.



Rust conversion compounds can prevent rust from spreading beyond damaged areas.

To use a chemical rust remover, scrape and wire-brush away as much of the flaky rust as possible. Remove oil or grease with a solvent such as lacquer thinner, then wet the area with rust remover—keeping it wet for about 2 hours—then hose away the residue. For stubborn rust, you might need to cover the area overnight with rags soaked in rust remover.

Then brush on a coat of converter following the instructions on the label. Once it's dry, the area is ready for painting.

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The wrong wax can be disastrous to your new car's gleaming shine!

## Does your car wax reduce shine?

Many commonly used wax products can actually dull your new car's mirror finish. They use a combination of wax or synthetics and a harsh abrasive polish that causes tiny scratches. The scratched paint can't reflect light as well as new paint. This results in an overall reduction in shine. Your new car should not be exposed to these abrasives. It just needs washing and a follow up with a good abrasive-free wax. For highest gloss, use the best grades of Carnauba wax.

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## 33 High-Tech Paint

If you're having your car repainted, take advantage of the new paint technologies. You no longer have to settle for lacquer, which looks great but lacks durability. Or enamel, which is more durable but also has more orange peel.

The new 2-part polyurethane paints are much more durable than either lacquer or enamel, and they'll give a glass-smooth shine that rivals the best hand-rubbed lacquer.

Colors have also gotten deeper and richer, thanks to paint systems that employ a base color followed by an ultrahigh-gloss clear coat.

Metallic colors also got more dazzling when paint makers began adding mica chips, which pick up and reflect light more brilliantly than standard metallic chips.

Even if you decide to stick with your car's original color, ask your body shop about the newest paints. Your paint job will last longer and look better.

Beware, almost all of the new paint systems use toxic chemicals, so drive-way respraying is out.

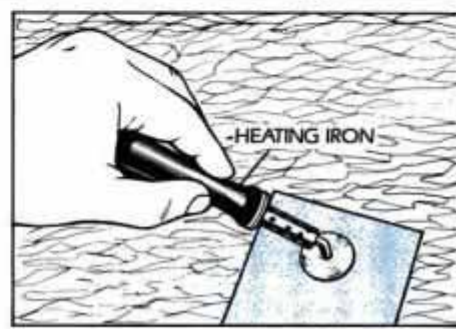
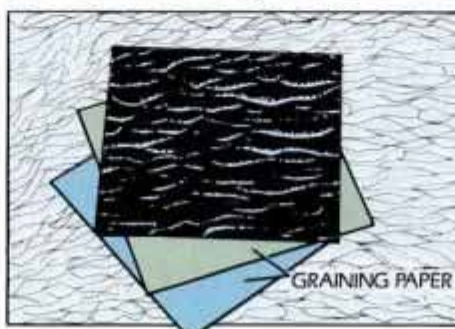
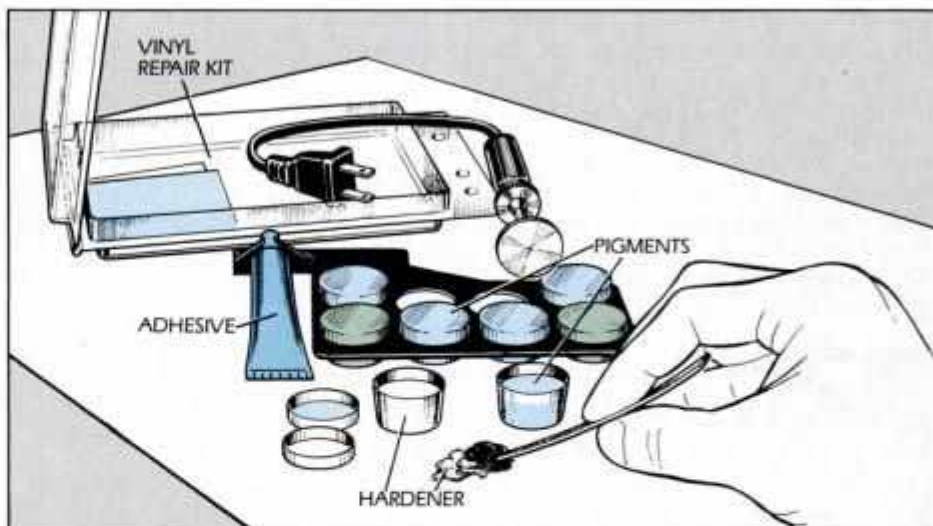
## 34 Vinyl Repair

Vinyl dashboards can be repaired with duct tape. The preferred approach, however, is to take the time and use an inexpensive vinyl-repair kit to make a nearly invisible repair.

Besides containing vinyl-repair paste, the kits also have dyes so you can match the color of your car's seats or dash, and graining paper to help you match the embossed pattern of your car's vinyl. In addition, repair kits specifically for dashboards have filler, like body-repair filler, so you can patch gouges and nicks to the same height as the surrounding area.

Begin the repair to the seat or dash by first making certain that the plastic material you're trying to patch is in fact vinyl and compatible with the repair paste. Heat a straightened heavy paperclip until it glows red. Probe the heated wire into a part of the seat or dash that's hidden from sight to obtain a sample of the plastic material. Then heat the plastic with a torch. If the flame burns bright green briefly, it's vinyl.

Clean the area around the damage to remove dirt, oily film, protectant or polish. With seats, trim any loose threads. If the damage in a seat is a tear that's more than an inch long,



Vinyl repair kits can make an almost-invisible repair in dashboards and seats.

you'll need to back the repair with a piece of vinyl supplied in the kit, held in place with some of the repair paste between it and the underside of the surrounding area. Gouges in a dashboard should be filled. In both cases, use a little rather than a lot of repair paste. Too much will run, ruining the finished look. When building up a dashboard gouge, you may have to make two or three applications of filler, allowing it to cure between each.

Next, mix the dyes to match your color. Take your time here and work in small doses. The repair paste won't cure until you heat it, so there's no reason to rush. The quality of the finished job depends heavily on your good color sense and patience. Check the colors under a combination of yellow (incandescent) and fluorescent light to get the truest match.

After you have matched the color of your seat or dashboard, match the grain pattern with the graining sheets in the kit. One of the supplied patterns should be very close, if not spot-on. However, if you're not satisfied with the graining patterns from the repair kit, you can buy a separate kit that allows you to make a mold of the grain pattern to use. These kits are commonly sold as vinyl-roof repair kits.

Once you have the right graining paper, place it over the damaged

area, grain pattern down, and lightly draw a circle around the damage on the graining paper. Remove the graining paper and apply the repair mix to the damaged spot. Again, too much paste results in a clumsy-looking repair, so apply it sparingly, using the spatula from the kit. Place the graining paper, embossed side down, over the paste, with your circle over the damage. Cure the repair using heat and mild pressure.

The easiest way to apply the necessary heat is with the flat-tipped electric heating iron available in slightly more expensive repair kits. The economical kits supply a similar flat-tipped tool that you must heat by holding against a laundry iron for a few minutes. Since the quality of the repair depends on how the patch cures, it's worth the few extra dollars to get the self-heating tool. Hold the tool against the repair through the graining paper.

Peel back the graining paper and check the repair. If the paper doesn't peel off cleanly, the repair is not yet cured—reapply the heat.

## 35 Seat Renewal

Though the patched look might work as a fashion statement in the seat of your blue jeans, it's hardly appropri-

## - CAR CARE GUIDE -

ate for the cloth seats in your car. And though you can cover badly tattered or frayed seats with semishapeless one-size-fits-all seat covers, you'd do better to install form-fit replacement upholstery covers.

These covers are available in different styles and colors. Naturally, if you want to change the pattern or color, you'll have to recover all the seats, whether they're torn or not. Replacement seat covers come as cushion covers and seatback covers. Installing them requires removing the seats.

To remove front seats, unbolt the seat rail from the floor of the car. Then turn the seat over and unbolt the seat from the seat rail. Rear seats are held by either spring clips or bolts, or a combination. Undo any bolts holding the seat cushion to the floor of the car and pop up the cushion at its front edge, then pull out the cushion.

With the cushion removed, you'll see any bolts or clips holding the rear seatback in place.

Stretch the new cover over the seat cushion, pulling the edges of the cover over the bottom edge of the cushion. The cover is snugly held in place with small, double-pointed ring clips, commonly called "hog rings." Slip one point of a ring through the new cover, at its edge. The other point can either go through the edge of the old seat cover, if it's secure, or through the seat cushion itself or possibly around a seat-cushion spring wire. Then squeeze the ring closed using a pair of pliers. (Special hog-ring pliers are available.) Install the next ring a few inches away, then work your way around the seat cushion. Don't block the mounting holes in the bottom of the seat cushion.

Rear seatbacks, except in cars with fold-down rear seats, are covered the same way as seat bottoms. The front seatbacks and the backs of folding rear seats have finished backs. The covers for these seatbacks slip snugly over the seatback and are held in place at the bottom edge. However, some folding rear seats have separate back covers—typically an extension of the trunk or cargo area liner or carpet—held by screws and trim. Undo the backs of these seats, install the new seat cover and reinstall the back.

If the only damage to your cloth seats is a torn seam, you may be able to restitch the seam. Besides needing heavy upholstery thread of the correct color, you'll also need a special upholsterer's curved needle. The curved needle can be slipped into the fabric and out again, without having to take the seat cover off the seat

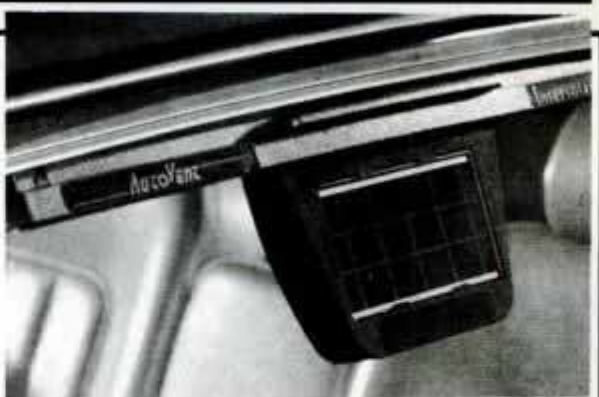


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cushion. Before restitching a seam, insert some backing material under the tear to reduce strain on the torn fabric and to keep the repair from coming undone.

### 36 Leather Restoration

Besides imparting their unique, luxurious aroma to your car's interior, leather seats and door panels endure all manner of abuse for years. Unfortunately, when leather upholstery is badly cracked or torn, the only really effective restoration is replacement.

One of the basic ways to extend the useful life of the leather is by periodically washing it with a solution of mild soap and warm water. Minor scratches and cracks in the leather can be touched up with the proper color leather polish.

You can also repair small tears at the seams by sewing. Insert a backing material—either a small, thin piece of leather or vinyl—under the tear. When you sew, pass the needle and thread through the backing material to relieve the stress on the leather. Use heavy thread and a curved uphol-

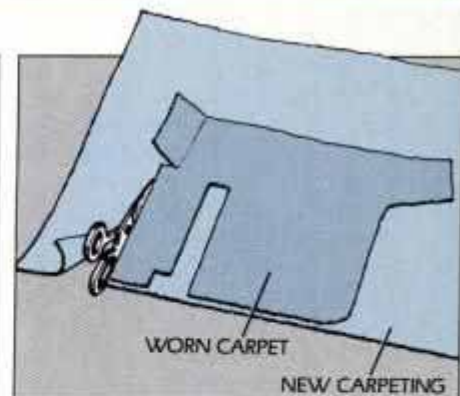
sterer's needle to do the stitching.

Clean, small cuts or tears in the leather can be repaired by gluing the torn piece back in place. Use a water-resistant, flexible glue, like rubber cement. Apply the glue sparingly to the underside of the tear and press the torn section back in place. Clean up any excess glue immediately.

### 37 Carpet Renewal

Though the carpeting in your car isn't trampled all over the way the carpeting in your house is, automotive carpeting is subject to intense wear, albeit in a small area. Each time you drive, you rest your foot in the same place for miles and miles—enough to wear a hole through the carpeting.

If the carpeting in your car is still good—the nap isn't worn—you can simply and effectively repair small worn areas. Trim around the damage. Cut a small piece of good section of the carpet from an edge that's normally hidden under one of the seats. Carefully trim the patch to the size and shape of the hole. Cement a piece of burlap (for backing) to the underside



PH ILLUSTRATIONS BY HANK IKEN

Use the old, worn carpets as templates to cut replacement material. You can also patch small holes with material from a hidden area.

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of the carpet, over the hole. Use a tough, water-resistant cement like automotive trim adhesive. Then glue the patch to the top of the piece of bur-lap, filling the hole.

You can repair smaller damage—such as cigarette burns—even more easily by simply cutting some pieces of carpet pile from a hidden section of carpet and gluing them directly to the burned spot. First, of course, trim away the burned pile using scissors or a razor.

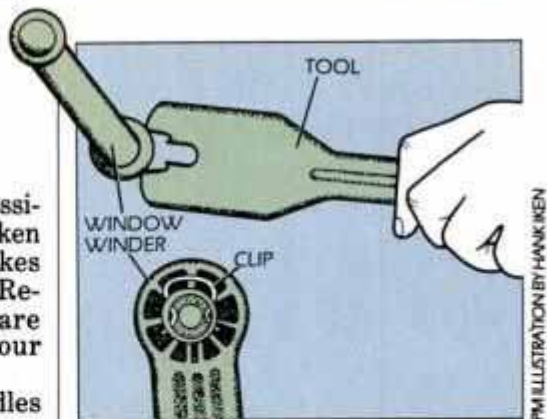
If the carpeting is badly worn, re-place it. Though you can usually buy carpeting already measured and cut for your car, you can also buy less-expensive rolled automotive carpet and cut it yourself to fit. Remove the old carpeting from your car and lay it on the unrolled new carpeting. Use some heavy books or a toolbox to hold the old carpeting down flat while you trace the contour of your original carpeting on the new carpeting, using chalk or narrow masking tape. Use a sharp utility knife to cut the new carpeting. When using your old carpeting as a template, be sure to mark all the small contours, such as around pedals, shift lever and handbrake.

### 38 Door Handles/Window Cranks

Besides making it difficult or impossible to open a window or door, a broken window crank or door handle makes your car's interior look run down. Replacement cranks and handles are readily available, both from your dealer or at auto parts stores.

Window cranks and door handles are held in place either by screws right through the middle of the crank or handle's hub or by ring clips on the back of the hub. Check the center of the hub—there might be a Phillips-, Torx- or Allen-head screw, possibly covered by a piece of decorative trim. If so, simply use the appropriate tool to undo the screw. Then pull the handle straight off the splines.

If there is no screw, there will be a clip on the back side of the crank or handle. The simplest way to remove the clip is with an inexpensive, special flat tool made just for the purpose. Slip the tool behind the arm of the crank or handle, and then gently push. The shape of the tool will force



Inexpensive tool makes removal of window-winder retaining clip simple and easy.

the clip out of its retaining groove.

It's a good idea to buy a package of spare clips when you buy the tool and the replacement handles. Chances are the old clip will fly off to the darkest corner of your garage.

To reinstall a screw-mounted handle, push it straight onto its splined shaft. Reinstall the screw and tighten it snugly, but not overly tight. To reinstall a clip-held handle, first place the clip in its retaining groove on the back of the new handle. Then simply push the handle firmly onto the splined shaft.

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## 39 Foot Pedal Replacement

Each time you put your foot on the accelerator, brake or clutch pedal, you wear off a little of the pedal's rubber cover. With time and miles, you can wear right through the cover.

To remove the old cover from a brake or clutch pedal, pry its lip off the underside of the pedal. Slip on the new cover, and work the lip around.

Accelerator pedals are either held to the throttle linkage by clips on the underside of the pedal, or are hinged to the floorboard and held there by mounting screws.

## 40 Glass Restoration

Before you decide that any piece of glass, from vent window to windshield, is so weatherbeaten and etched that it must be replaced, thoroughly clean it, inside and out. Use a quality window cleaner and newspaper to cut grime and greasy dirt from the glass. To remove any thick residue—such as from cigarette or cigar smoke—clean the glass thoroughly using a mild abrasive cleaner, like Bon Ami and water.

If there are some minor scratches in the glass, try rubbing them out using toothpaste on a clean rag. Or, if there are many minor scratches—as from miles of driving through blowing sand—you can remove them with a glass-polishing kit. The kit contains a polishing powder that you mix with water and a felt buffing wheel attachment for your portable drill that applies and works the compound around.

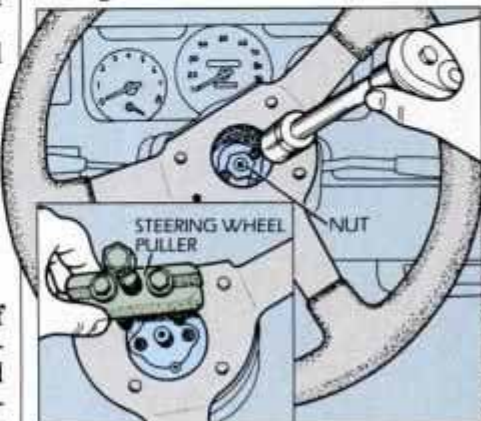
Small chips can be repaired using an inexpensive kit. Place the suction-cup-held jig over the chip. Install the pressure screw in the jig. Install the outer half of the mixture injector in



Try to rescue a sandblasted or scratched windshield by polishing it.

the jig over the chip. Then mix the repair resin and its hardener, and pour it into the injector. Force the mixture into the chip by installing the plunger into the injector.

## 41 Steering Wheel Replacement



It's easy to replace an old steering wheel with a new or sportier version.

You can replace the old steering wheel with a new one, either from your dealer or from a specialty manufacturer.

Before you remove your old wheel, point the front wheels straight ahead so you'll be able to properly install the new wheel. Then remove any center trim or padding that may incorporate the horn button. This usually requires that you remove screws from the back of the wheel's spokes. Pry off the padding. As you lift the pad, check to see if the horn button is an integral part of the assembly. If it is, pull the horn wire from the back of the pad.

Firmly hold the wheel from turning as you loosen the nut. With the nut off, you'll see two threaded holes in the wheel's center hub. Thread two long bolts through a steering wheel puller into these holes. Thread the center bolt of the wheel puller down against the top of the steering column, making sure you don't turn the wheel in the process. Use the puller to pop the wheel off the column.

Bolt the new wheel to its adapter hub. Thread the wire for the horn button or horn ring through its hole in the hub. Align the splines of the adapter hub with those of the steering column shaft, while positioning the wheel for straightahead. Push the wheel down on the steering shaft. Install the mounting nut and tighten it until the hub seats. Snug up the nut. Attach the horn wire to the new wheel's horn button, and install any trim.

## EARTH'S NEW LOOK

(Continued from page 36)

the center provides a good map of Africa and South America. The Mollweide's lateral egg shape elongates everything in the lower latitudes but provides a less-crowded view of the polar regions. Each belt of latitude represents the same area as on an actual globe.

- The Interrupted Goode Homolosine is an equal-area projection that combines the best of the two above. It uses the better-shaped equatorial section of the sinusoidal and the less-compressed polar section of the Mollweide. Each continental segment is keyed to its own central meridian, reducing distortion of the land areas. Its multilobed projection provides a good, if bizarre-looking, world map.

- In azimuthal projections, a part of the globe is projected from a central point onto a plane. Direct routes from that point to all others will be shown as straight lines, and all points equally distant from the center point will be equally distant on the map. A separate map must be made for each central point selected.

- The Feigenbaum projection shown on page 35 is a conformal view of the world. Conformal projections show all directions correctly arranged at each point on the map.

"Despite the fidelity of local angles and lengths, a moment's view of the map should convince the viewer that, globally, no such fidelity holds," Feigenbaum points out. "Thus, Africa is misshapen, while nevertheless the angles of intersection of each of its political subdivisions are true."

Conformal projections are highly technical and very useful for specific purposes, such as navigation.

The application of computer technology to map making has not completely overcome the distortion problem, and it never will. However, most handmade maps are imprecise by a factor of at least 5%. The use of computers and the fractal formula developed by Feigenbaum can cut that margin of error in half.

Paper maps, of course, are in no danger of becoming obsolete. For one thing, current electronic systems can't hold a candle to paper's transportability.

But most map makers believe they have seen the future, and that future is digital. Caleb Dean Hammond III, third-generation map maker and chief executive of the company that bears his name, sure believes it. After touting itself for almost 90 years as "Map makers and publishers since the turn of the century," Hammond has changed its slogan. The company slogan now reads, "Map makers for the 21st century." **PM**

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# DETROIT SPY REPORT

BY JIM DUNNE, Detroit Editor



## New Pontiac Grand Am

● Pontiac's popular Grand Am will be completely restyled for 1992. The front end features a more aggressive appearance, with dramatic lines in the grille opening and headlight shape.

Unlike the current model, the new Grand Am will have an aero profile, with a slanted backlite.

Appearances can be deceiving. This prototype, caught by the camera during cold-weather testing last February, is highly disguised. Wheel openings are painted to appear rectangular, and the grille area is partly masked by black tape.

Chassis details are expected to be largely unchanged, though the car is a few inches longer than the '91 model, and two new versions of the Quad 4 engine will be added to the powertrain lineup, including an sohc edition insiders are calling the Quad 2.

## Extrudaframe

Ford planners think that the frame and body technique of car construction may still have a future.

Though unit-body construction is used on all but a few of today's cars, Ford planners say that chassis frames made of extruded aluminum can slash costs and cut the weight of the car, with savings at both ends—in tooling investment for the company and in fuel economy for the customer.

One big savings is in the cost of dies



Next-generation Grand Am will feature aggressive front-end styling and angled C pillar.

and presses. An extrusion machine with die set costs a fraction of a press machine and matching dies.

Extruded frames would also allow Third World countries to get into the auto manufacturing business.

## Olds Achieva

Olds will have a newly styled Cutlass Calais line for 1992, along with a new name—Achieva.

Olds marketers think Calais is too soft a name. It has no strong identification among American buyers.

But is Achieva any more familiar? It will have smoother, more aerodynamic body lines than the boxy Calais model it replaces. There will also be radical differences in styling between the 2- and 4-door Achieva models.



Ford/Nissan joint venture minivan will be sold as Mercury Villager.

## Mustang Mystery

Mustangs of the future—1994—will have V8 engines, or maybe V6 engines. They will feature rear-wheel drive—or perhaps front-drive. They will be slightly smaller than today's cars—or maybe much smaller.

Those are the mixed signals coming out of Dearborn as Ford planners try to make up their minds about the future of their sporty car.

Fuel economy regulations cause most of the confusion. If government CAFE standards tighten up, the front-drive V6 looks like a safe bet. If the rules are only slightly changed, the rear-drive V8 gets the nod.

## Ford/Nissan Van

It's a hybrid, designed by Ford and Nissan, powered

by a Nissan V6, but built in the United States by Ford.

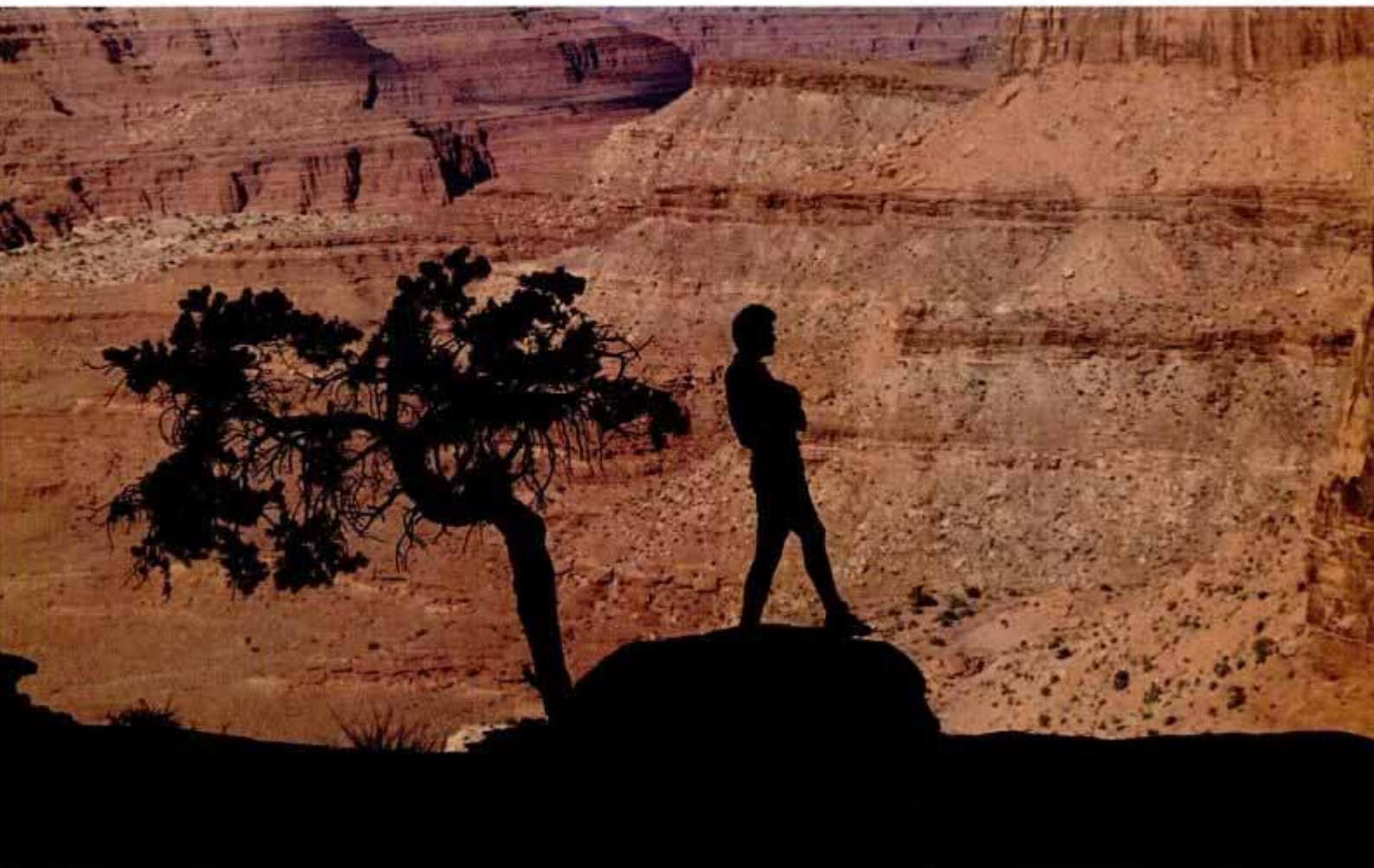
That's the minivan that Mercury will sell as the Villager.

Front-wheel drive is the key here, the first front-drive van offered by Ford Motor Co. The engine is a 3.0-liter V6 that will be made by Nissan in the United States. Dimensions are similar to the Chrysler vans.

The Zebra stripes and front and rear bras on the prototype in our spy photo are designed to hide the Villager's final styling appearance. **PM**



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Have you driven a Ford...lately?

# TEST PILOT TALES

BY ABE DANE, Science/Technology Editor



● No one knows a plane like the test pilot who flies it through the growing pains of its passage from experimental prototype to production model. He's there to see what happens when the dreams of aircraft designers, engineers, managers and customers run up against the hard realities of physics and aerodynamics. It's an enlightening and often dangerous process—one that provides frequent reminders of the tremendous complexity behind today's aeronautical marvels.

Every year, the men who test the world's most exciting aircraft gather at the Society of Experimental Test Pilots symposium and tell of their experiences. I attended the most recent of these events, held late last year in Beverly Hills, California.

At the symposium there were reports from the cockpits of today's hottest aircraft, told in the classic test-pilot style—terse, scientific and unemotional, yet leavened with dry wit. But perhaps the most exciting thing about it from a journalist's point of view was the candor of the presentations.

Basic to a test pilot's job is the ability to deliver facts accurately and un-

flinchingly. In an industry that, like any other, has its share of hype, it's refreshing to meet people who have no trouble admitting that experimental aircraft are called that because they don't always do what they're ex-



Flight testing of Ares (top) was recorded on camcorder (above).



String replaced more complex instruments in the Ares test aircraft.

pected to do. You wouldn't learn anything from them if they did.

It's also fun to see videos of some of your favorite airplanes in the most undignified positions anyone's ever likely to put them in on purpose.

## Irreverent Ares

The most puckish presentation came from a team representing Burt Rutan's Scaled Composites wonderworks. Intended to serve as an easy-to-maintain tankbuster and 'copter killer for operation under battlefield conditions, their Ares light-attack fighter (see [Tech Update, page 22, June 1990](#)) was developed on a shoestring budget. Speakers Douglas Shane and Michael Mellville delighted in pointing out the ingeniously simple ways they solved problems that others might have spent millions on.

Ares was designed without wind-tunnel testing—just two people and a few personal computers. To record flight test results, the Ares team used a standard Sony Camcorder, strapped to the pilot's headrest and aimed at the instrument panel. A piece of string stretched across the cockpit helped in keeping track of con-



U.S. NAVY PHOTOS



Reengined Tomcat made it through catapult steam ingestion testing (left) and high sink-rate landings (above) at Patuxent River, before beginning carrier suitability tests.

control stick position in various maneuvers.

Ares belied its humble origins in a remarkable video showing it in terrain-hugging flight over the Mojave Desert. In this footage, the tiny plane showed itself to be the Mazda Miata of the air, racing up and down dunes, and darting between obstacles.

Not being a pilot myself, I leaned over and asked a couple of retired A-4 jocks sitting next to me for their expert opinion. "Very good stickwork," remarked one. "I'll endorse that," said the other.

### Souped-up Tomcat

As anyone who's ever tried to pep up the family car by stuffing in a bigger engine can tell you, engine transplants are seldom as simple as they seem. That the same rule applies in the world of aeronautics was borne out in a presentation by Navy pilot Lt. Cmdr. Kent Rominger and Jennings Bryant of the Naval Air Test Center in Patuxent River, Maryland.

They and their colleagues were charged with the theoretically straightforward task of shoehorning a pair of General Electric F-110 engines into the Navy's venerable F-14 fighter (see "America's Enforcer," page 39, November 1990). With 27,000 pounds of thrust each, the new powerplants would give the Tomcat 28% more power in afterburner.

Getting the engines in the plane was a matter of "creative metalsmithing," plus adaptations to the gearboxes that drive the airframe's accessories and some retuning to make all the new thrust more manageable. That was complicated, but not unexpected. Things got more interesting

when the test flying began.

Here's a quick sampling of the gremlins that had to be subdued: At certain speeds, transonic buffet shook the plane so badly that pilots couldn't read their instruments, a worrisome engine flameout was never fully explained, conspicuous trails of unburned fuel vapor followed the plane whenever it shut down its afterburners, and a little hole appeared in an afterburner's heat-resistant lining.

When a variety of tweeks, adjustments and tradeoffs had these problems under control, one of the planes went to a simulated aircraft carrier deck at Patuxent River. There, a series of catapult launches, steam ingestion tests and what amounted to controlled crash landings proved that everything on the plane was firmly attached.

Or so they thought. When the test team tried the same thing on a real carrier deck, a turnbuckle broke. The accessory gearbox it supported slipped out of place, and the engine started losing oil, a potentially disastrous condition. The question was, as Rominger put it, "WTF?" or Why did the turnbuckle fail? Conditions on the carrier should have been exactly the same as those during the tests at Patuxent River.

After checking every detail of the two scenarios, it became apparent that the only thing different about the carrier deck was that it had a fresh layer of nonskid coating. Harmless as that sounds, the new coating's grippier surface resulted in landing loads up to four times higher than those on the old surface. The resulting delays were by far the greatest setback of the project.

### Stupid 747 tricks

If the tests for the military aircraft discussed at the symposium seemed rigorous, those required for civil aircraft were truly harrowing. Before getting the okay for revenue service, Boeing's latest jumbo-jet, the 747-400, went through a wide range of what test pilots laconically refer to as "nonstandard procedures."

Joe MacDonald of Boeing showed footage of these immense birds virtually flapping their overburdened wings while bearing huge cargos onto the runway, coming in for landings nearly sideways in 40-knot crosswinds, and dragging their tails down the runway after pilots intentionally overrotated on takeoff. Truly reassuring to anyone who's wondered how forgiving these transports are.

### An historic guest

The final presentation of the symposium was a fitting climax. Valery Menitsky of the Soviet Mikoyan design bureau became the first Russian pilot ever to address the society. Menitsky stood at the podium while a translation of his paper on test flights of the MiG-29 was read.

Even more memorable was the freewheeling question-and-answer session that followed. With the help of a translator and his own spirited, if halting, English, Menitsky fielded a wide range of questions with remarkable openness and good humor. What emerged was a sense that although Menitsky and his audience had been trained on opposite sides of the now-faded Cold War, their traditions were remarkably similar. As Menitsky said when asked to compare the American test pilot's school at Edwards AFB to those in the Soviet Union, it is as if "all of our brothers and fathers had some secret consultation to produce these schools." **PM**

## OLD HOUSE RESTORATION

# RESTORING WOOD FLOORS

BY BOB VILA, Contributing Editor

● If your old house boasts original plank, strip or parquet wood floors, giving them the proper care is the key to retaining their authenticity. You should think of them as an antique underfoot, and therefore treat them with the respect and dignity they deserve.

What you decide to do with your old wood floor depends, first of all, on what type of floor you're dealing with, the appearance you're striving for, how authentic you want to be and, finally, how much maintenance you're willing to devote to keeping the floor in shape. This can run the gamut from leaving an old plank floor unfinished to varnishing or shellacking a Victorian strip or parquet floor.

Knowing a bit about wood floors, along with the choices you face as a sensitive restorer, will help you deal

with this part of your restoration wisely.

### Unfinished planks

Up until about the middle of the 1800s, the wood floors in most American houses were made from wide planks, often pine. Although some favored painting and stenciling these early floors, for the most part they were left bare or unfinished.

Generations of use allowed the wood to wear and cup naturally, creating an aged patina that can't be duplicated. It is these years of living that give an unfinished plank floor its charm and mellowness. So, in many cases, the most authentic way to treat an old unfinished wood floor is to leave it that way—unfinished.

### Sensible protection

Sometimes, though, folks are concerned about exposing the bare wood to the ravages of daily living. Food

and pet stains can wreak havoc with untreated boards.

For those who desire the period look but want some protection on the planks, some restorers suggest treating the planks with a clear penetrating oil, followed by a coat of wax. Depending on the kind of usage it sees, expect to re wax the floor every year or two.

If the floor is in bad shape, how to best bring it back for 20th-century use is often a professional call. More than likely, the job will begin with a good cleaning. Often, all that's used is trisodium phosphate (TSP) and water. I don't suggest trying to sand down an original plank floor. They are usually so worn that you risk ruining the floor.

Early plank floors were butted together—rarely tongue and grooved. In some cases, you can flip the boards around to expose the never-before-walked-on side—a light sanding should give you a beautiful new “antique” floor.

### Cleaning and repair

One restoration company I know uses an interesting historical technique to clean old plank floors. Mimicking the way these boards were often cleaned in the early days, they cover the floor with a layer of sand approximately  $\frac{1}{2}$  in. to  $\frac{3}{4}$  in. thick while they work on the rest of the room. The abrasion caused by movement on the sand above cleans the floor naturally. As an added bonus, the sand cover acts as a protective coating against drops and spills.

Damaged boards can be replaced with original salvaged ones. Just make sure that the same species of wood is used, and check to be sure that the graining and coloration match.

Often the tongues and grooves on these old salvaged boards are broken and must be remilled for their new home. Increasing the depth of their grooves will eliminate the spaces that occur between boards when the wood

There are many ways to refurbish an old floor. But if none of them fits your needs, you can install new flooring (like the wide pine boards at left) that is available from restoration lumber suppliers.

*“Home Again With Bob Vila” is the title of our contributing editor's new TV show.*



CARLISLE RESTORATION LUMBER PHOTO

contracts and expands.

And, like almost everything else in the restoration world, you can also find new wide plank flooring made like the old. If you must sacrifice your old damaged antique and don't want to go the salvage route, this may be the choice for you. It's also a good way to add some period charm to new construction.

### Victorian shine

Plain, unfinished planks gave way to shiny strip and parquet floors in the Victorian era. New finishing products that added a special look to floorboards, like oil varnishes and shellacs, were widely available. Famous for their ornateness, the Victorians did not overlook what was underfoot in their glossy decorating schemes.

If you're restoring a home of this period, opting for a varnish or shellac is a good way to give your floor an authentic, period look. Like painting, preparation is more important than application when you're refinishing an old house floor.

Many times, if a floor has been properly maintained, it's possible to coat over the existing surface with the same finish. First prep a small test area by hand sanding it, then add the chosen finish. If it bites and has the right look, it's probably the same finish that's on there.

### Compatibility of finishing materials

Dissimilar products won't work on each other, so don't be tempted to shellac a varnished floor or varnish a shellacked floor—it simply won't hold. (A note of caution if you choose shellac: This historical finish won't tolerate alcohol and water spills, so be sure to consider the room's usage beforehand.)

You can add a coat of wax over either, if you choose, to preserve and protect the finish while adding a bit of luster to the floor. Keep the surface free of dust and dirt with regular dust mopping. Expect to re wax periodically as this protective coating wears away. It's a small price to pay for retaining a piece of history.

If a previous owner refinished your old house floor with a coat of polyurethane, you may decide to strip it off and bring the floor back in a more authentic manner. (Although this newer finish is extremely durable and offers a longevity most historical finishes don't, many restorers find it looks plastic and doesn't mesh well in restored homes.)

Or perhaps the floor is badly stained and scratched. The thickness of a floor is the indicator you should

use to decide whether sanding is feasible.

### Parquet floors

Extreme care should be taken when working on old parquet floors. Since these boards are generally only about  $\frac{3}{8}$  in. thick, there's probably only about  $\frac{1}{8}$  in. to work with until the tongue is reached. As a result, many restorers will recommend stripping the floor by hand, either with a hand scraper or chemicals if the finish must be removed.

Although this obviously can be a very labor-intensive job, it may be the only way to refinish some old parquet without ruining the floor. Since an old strip floor is thicker, many of these floors can be sanded.

There is another factor that should be taken into consideration when you're deciding whether to sand an early floor. Remember that flooring spans structural members. And the construction techniques common to many old homes are different than those we consider standard today. More than likely your floor joists are 24 in. or 30 in. on center, not 16 in. on center as most floors are built today.

Now, for boards 1 in. or so thick, the thickness of the board is adequate for this large span. But when the board is worn (or sanded) down to  $\frac{7}{8}$  in. or  $\frac{3}{4}$  in., you're apt to get some spring in the floor.

It's interesting to note that every sanding decreases the thickness of a wood floor by about  $\frac{1}{16}$  in. to  $\frac{3}{16}$  in. So, there are only so many times you can sand down a wood floor. (An easy way to gauge the thickness of the old floor you're working on is to remove the molding and baseboard or a floor heating register to reveal the edge of the wood.)

Treating your floor like a valued antique isn't an impossible thing to do. It's a simple matter of knowing the look you're after, then taking the proper steps to achieve it. The rewards will come back to you day after day as you walk through your house. **PM**

### SOURCE LIST

The following is a list of some suppliers of new wide-board flooring:

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- Carlisle Restoration Lumber, HCR 32, Box 679, Stoddard, NH 03464; (603) 446-3937
- Craftsman Lumber Co., P.O. Box 222, 436 Main St., Groton, MA 01450; (508) 448-6336
- Dimension Hardwood, Inc., RD 1 Hardwood Plaza, P.O. Box 160, Eminton, PA 16373; (412) 867-6707
- Dovetail Woodworking Co., Inc., P.O. Box 352, E. Greenwich, RI 02818; (401) 885-2403
- Granville Mfg. Co., Inc., Rt. 100, Granville, VT 05747; (802) 767-4747
- The Woods Co., 2357 Boteler Rd., Brownsville, MD 21715; (301) 432-8419

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## BOATING

# THE INSIDE OUTBOARD

BY JOE SKORUPA, Boating/Outdoors Editor



● Ever since Ole Evinrude invented the outboard motor, in 1907, it's been a naked display of power. Let's face it, hanging there fully exposed and bolted onto the end of a transom, it seems like a crude engineering concept, at least by modern standards. But the concept still survives and even thrives. Why? In its fundamental simplicity, it works.

Now, after more than eight decades, OMC has decided to redefine the outboard approach. With the introduction of the new Quiet Rider propulsion system, OMC brings the outboard engine in from the cold.

The first boat to feature the Quiet Rider technology is the Sunbird Eurosport 190, which was introduced to the public at the recent Miami Boat Show. A couple of weeks earlier, I had the opportunity to test the first production boat off the line at OMC's test facility in Stuart, Florida.

### Outside In

In addition to being an engineering breakthrough, the Quiet Rider represents a new phase for giant OMC. A phase where the boat-and-engine manufacturer begins to flex its vertical-integration muscles. Boat and power package were specifically designed for each other in a way that only a company building both components could pull off.

While the Quiet Rider concept was

envisioned more than a year ago, work on the final product began only last July. After a swift and successful period in R&D, OMC invited its boat divisions to take a look at the new unit. Sunbird liked what it saw and jumped at the chance to bring the Quiet Rider to market. Then, for the first time in OMC history, "Boat people and engine people," as one company official put it, "sat down together to design a complete package."

Basically, what the Quiet Rider propulsion system does is turn outboard powerboating outside in. Like most motorized vehicles in the modern world, the engine is brought into

the structure of the boat and hidden from view under an engine cover. To accomplish this, a new way to trim and tilt was developed, and the transom area was totally redesigned. In fact, the Eurosport doesn't have a stress-bearing transom in the traditional sense of the word.

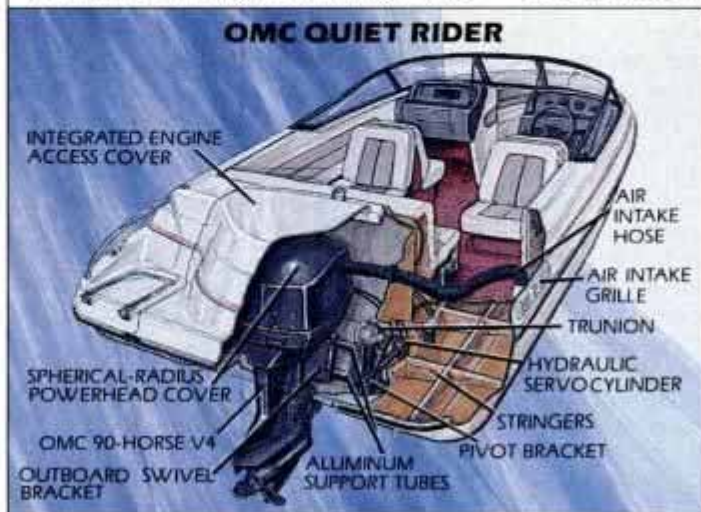
The engine on the 19-ft. Eurosport 190 is a standard V4, 90-horse OMC powerplant. Neither the Johnson nor Evinrude nameplates will be used on Quiet Riders. The boat itself is a nicely detailed open-bow runabout with dual consoles and plenty of seating in the main and bow cockpits.

But the most interesting elements on this complete boat/motor/trailer package are aft of the wide bench seat. This is where the Quiet Rider radically departs from every other outboard built.

### Undercover

The first thing you notice is that the stern area flows smoothly from the gunnels and the bench seat down into a divided swim platform.

(Turn to page 106)



Unique trim assembly lets engine rotate within its own profile.

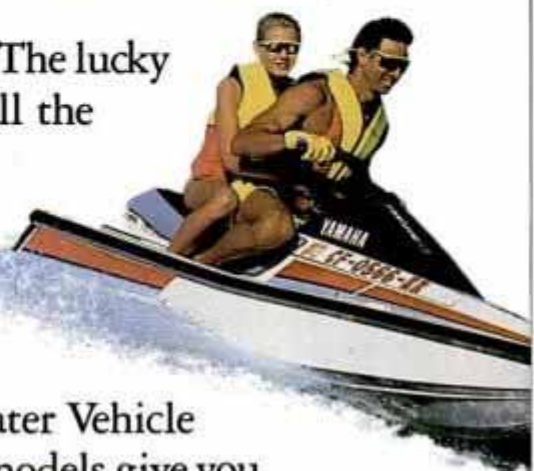
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Where's the outboard? Sleek, Eurostyle swim platform incorporates a hatch to conceal it.

Everything is gracefully curvilinear in eye-pleasing Eurostyle design. A pair of grab handles flank the swim platform, and a boarding ladder is nicely recessed into the port swim step. Much like the exterior appearance of a sterndrive boat, all you see of the engine is the lower drive leg extending below the swim platform.

From the bench seat, you grab two latches and lift up the engine cover. You quickly note that the powerhead is sealed in a small, tight-fitting cowl and fed air through a hose that connects to a vent on the starboard side of the boat.

The next thing you notice is that the engine isn't mounted to the transom. In fact, the transom area is slotted, and the engine appears hung in a dedicated space. By dividing the normally 2-in.-thick, 1-piece transom wall, its role as a stress-bearing component is diminished.

In the Quiet Rider design, the two flanking transom components don't actually support engine weight or bear thrust. This role is handled by parallel aluminum tubes that are attached to cast-aluminum pivot brackets. These brackets are pushed and pulled by hydraulic servo cylinders and pivot on trunions. The whole assembly is attached directly to the stringer system, which sweeps up like a pair of hockey sticks into the walls of the transom slot.

To complete the picture, the engine is fitted to the aluminum tubes by a specially designed mounting bracket that incorporates the steering mechanism. (See illustration on page 104.)

The end result of this new technology is that the Quiet Rider can rotate within its own profile as the engine is trimmed. When conventional engines trim up, they swing high and away from the transom.

Rotation of the Quiet Rider within its own profile is achieved by positioning the pivot point at the geometric center of the engine. It has a trim range of 52° up, which brings it about 1 in. above the bottom of the hull, and 7° down, which gives the boat a solid prop bite for acceleration.

### Water testing

The best time to poke around a new outboard system is when it's up on a trailer. But after an hour, I was itching for a *quiet ride*. Will OMC's new system, as its name implies, solve the most vexing problem of outboard powerboating: ear-splitting noise?

Once on the water, it didn't take long to realize that the new system lives up to its billing. At full throttle, the loudest noises you hear are the wind and chop banging on the hull. Conversations are carried on in normal tones and, at the end of the day, your ears don't ring.

Actual sound levels at full throttle were about 85 to 86 dBA, which is incredibly low for an outboard boat. In fact, it's quieter than most stern-drives. The decibel reading will probably be slightly higher on production-line boats, because red-line rpm was only 5200 on the prototype I tested, which is on the low side for a dialed-in outboard.

The quietness of the ride is the result of putting a cover on the engine and mounting it directly to the stringers. Many people don't realize that the hull of a boat acts as a giant transmitter of engine noise and vibration. Since the OMC Quiet Rider attaches directly to the stringers, these sounds are greatly reduced.

While the torquey 90-horsepower outboard is covered, OMC stresses that the engine isn't fully enclosed. The transom slot is open on the aft

side. This design is important because it means that the ignition and fuel lines are actually outside the boat, which eliminates the need for an air ventilation fan.

Acceleration in the 1800-pound runabout is crisp, handling is rock steady, and top speed is just above 40 mph, which is ideal for skiing.

Like all Sunbird models, the Eurosport 190 comes as a boat/motor/trailer package and is loaded with features. These include a radio/cassette player, a ski locker, back-to-back sun-lounger seats, full instrumentation, a removable ice chest, a galvanized trailer and a canvas top. Price for the complete package is an affordable \$10,699.

### Quiet revolution

The Quiet Rider is a swift followup to OMC's recent triumph with the Silverstar/Spitfire powerhead, an award-winning design. Both units are innovative breakthroughs that will have a ripple effect throughout the marine industry. Don't be surprised if the Quiet Rider wins a few awards in its own right.

The Quiet Rider represents a solidification of OMC's late-1980s vertical-integration strategy. Engine and boat divisions worked well together on this project, which bodes well for the company's future. Also, the Quiet Rider gives OMC, the world's largest outboard engine builder, a new outlet for its core product.

Will the Quiet Rider be a mainstay on the marine market and influence the future of outboard boats? I think the answer is: yes. It gives boaters the advantages of outboard power—compactness, lightness and ease of maintenance—along with the styling and quietness of a sterndrive.

The Sunbird Eurosport 190 equipped with the OMC Quiet Rider is a wonderful entry-level boat for skiing, sunning, swimming and entertaining up to seven passengers. The potential is there for future Quiet Rider models to be rigged in sportboat and fishing boat configurations, although fishermen will probably be content with the unencumbered stern found on conventional outboard rigs.

Right now OMC has no plans to market the Quiet Rider outside its own boat divisions, which should make Sunbird, Chris-Craft, Four Winns and Donzi happy campers.

At the preview, OMC went to great pains to compare the Quiet Rider to the US Marine L-Drive system, which is considered the new product's nearest competitor. The truth is that they aren't competitors at all. The Quiet Rider is in a class by itself. **PM**





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# NEW TAPE FORMAT SET

BY FRANK VIZARD, Electronics Editor

● DCC might sound like the name for a new comic book publisher, but it actually stands for Digital Compact Cassette. And while this new cassette format promises digital sound quality comparable to compact discs, perhaps its most remarkable attribute is that existing analog tapes don't have to go on the junk heap.

DCC tape decks, which should be in stores early next year for about \$600, are backward compatible. This means that existing analog cassettes can be played back on the new DCC machines. Since studies show that the average household owns 50 to 60 cassettes, everyone should be happy to know that DCC technology will not make existing tape libraries obsolete.

The other advantage DCC offers is a relatively low price. If a DCC machine retails for \$600 initially, it's likely the price tag will fall quickly as economies of scale are realized. Digital Audio Tape (DAT) machines already exist, but pricing on DAT machines started high and have yet to come down under \$500. Record industry concern over possible piracy has also delayed its acceptance.

Philips, the inventor of the DCC format, says DCC machines rely on the same tape mechanism used in present-day tape recorders. DAT machines, by contrast, use a more expensive precision mechanism with a servo control and a rotary head. DCC machines are inherently more expensive to make. Philips, incidentally, was the inventor of the analog cassette.

Price is also an advantage as it applies to the actual cassette. Unlike DAT cassettes, which have remained around \$18, DCC cassettes can be duplicated at 64 times normal speed. This ability to mass produce DCC cassettes means the retail price should be comparable to existing analog cassettes. Major players in the record business like Polygram are throwing their weight behind DCC.

On the hardware side, manufacturers like Matsushita (read Panasonic/Technics) and Tandy are also indicating they support DCC. It's this combination of support from machine makers and record labels that makes DCC look like a winner. This type of marriage between hardware and soft-



DCC tape (actual size) promises the fidelity of compact discs at an affordable price.

ware makers hasn't occurred since the introduction of the compact disc.

Why does the world need a digital tape format when the compact disc already exists? The size and ruggedness of the DCC cassette and players makes the format more appropriate for portable and car use. DAT is a high-density system requiring the use of expensive metal-powder tape that is vulnerable to temperature extremes often encountered in portable and car environments. The DCC format uses a less-expensive chrome tape that reportedly remains stable at temperatures up to 194° F.

### Copies restricted

You can also record onto a DCC cassette, something you can't do yet with a CD. DCC machines will have a copy-limiting circuit which will restrict the number of copies that can be made. Digital copies are identical in sound quality to the original. Copy-limiting circuitry is included at the insistence of the record labels.

While basically the same size as an analog cassette, the DCC cassette is somewhat different. The shell only has spindle holes on one side, and these are protected by a sliding steel

cover. The other side of the cassette shell is blank so album graphics can appear there.

Other differences are not so apparent. Since the tape doesn't flip over, each side is called a sector. When you want to access a song, both sectors are scanned at the same time. By using this method, access time is only marginally slower than it is for CDs.

The DCC format also uses what's being called a revolutionary method of encoding information onto the tape. Called Precision Adaptive Sub-band Coding (PASC), this technology takes advantage of how the human ear hears. If the human ear hears two sounds of similar frequency at the same time, the louder sound masks the quieter one. Therefore, musical notes overcome by louder notes of similar pitch need not be coded. Similarly, only those frequency bands containing conspicuous sounds are coded onto the DCC tape.

The idea is to reduce the number of bits needed to record the sound accurately. Philips says DCC uses only 25% of the bits needed for a compact disc recording. Small amounts of random noise are added to conceal any coding errors that may occur. **FM**

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## NEW CARS



FM PHOTOS BY RICH COX

### Seville Rewrites Cadillac Rulebook

● Anyone who harbors any doubt that Cadillac is back hasn't seen the 1992 Seville. Cadillac's current lineup is its best in 20 years, and the new Seville improves it even more.

Due for a late-summer introduction, the new Seville and Seville Touring Sedan (STS) represent a clean sheet of paper and a significant break with Cadillac's recent past.

The new Sevilles are considerably bigger than the old—3 in. longer on the wheelbase, 14 in. overall. Rear-seat passenger legroom is increased by 3 in., and overall interior volume is improved by 10%. More important, though, the sheetmetal is all new and breaks new ground for the Cadillac with its decidedly European look.

Windshield rake and, more surprisingly, rear glass angle are much steeper than previous Cadillac models. The high-mounted center stop-

light is incorporated into the full width of the trunklid.

The interior also represents a well-executed departure from previous Cadillacs. Smooth, clean and very much to the point, it's as close to a high-end driver's car—a la BMW, Audi, Mercedes—as any domestic car has come. Luxury and comfort are still

the central focus. The Seville's interior is clad in leather, with Zebano wood trim. Well-placed controls and a tasteful and informative instrument panel that uses both analog and electronic displays enhance the European road car feel.

Though lovely as a still-life, it's motion that brings out the best in this new car. Our impressions of road feel, handling and comfort: this is the best American sedan we've ever driven, one that stacks up with the world's best.

The computer-controlled suspension system is fast, smooth and perfectly programmed. Road feel is centralized to the steering wheel, where it belongs, and isolates the passengers from bumps, surface changes and traction responses. The driver receives well damped yet surprisingly accurate road/tire inputs. Though the current Seville STS is a capable handler, it lacks the refinement of the

new. The '92 Seville softens the hard edges of the current platform. The '92 chassis is substantially less tiring to drive and much more enjoyable to drive hard.

It also packs oldtime Cadillac-style muscle, thanks to the combination of the recently introduced 200-hp 4.9-liter V8—replete with throaty exhaust



New Seville's styling breaks away from Cadillac tradition.

note—and GM's 4T60-E transaxle. The computer-managed 4-speed automatic generates clean, torque-sensitive gear changes and responds well to power demands.

As we went to press, Cadillac had not finalized pricing for the new Seville, but the projected goal is comparable to the current models. That would put the base Seville in the mid to high \$30,000 range, with the fully loaded STS likely to creep over the \$40,000 barrier. —Rick Titus



Seville interior is clean and understated. Instruments are electronic analog.



Mitsubishi's new Diamante is aimed at the low end of the luxury sedan market.

## Mitsubishi Diamante

If you come to the dance late, you'd best come well-dressed and prepared to boogie—if you want to be noticed. That pretty much sums up the challenge facing Mitsubishi's new Diamante sedan, another contender in the increasingly crowded luxury sport sedan market.

Mitsubishi has lofty targets for Diamante. The goal is to establish a much larger sales base for the company in the passenger car segment. Introduced last year in Japan, the Diamante has had record sales at home.

Domestic orders have exceeded production by a margin of two to one in a class of automobiles that can hardly be considered short on talent.

Substantially larger than Mitsubishi's Galant series, Diamante will come to the U.S. in two trim offerings, differentiated in part by their powerplants. The basic car employs a 175-hp sohc 3.0-liter V6, with a 202-hp dohc 24-valve version of the same engine hauling the high-end LS edition.

In a field full of lookalikes, the Diamante does have distinctive lines, particularly at the front. The basic

Diamante (Spanish for diamond) starts at \$21,000. It offers good power and handling—thanks in part to the same multilink rear suspension used in the 3000GT—and a very good level of luxury trim. It may well be one of the best buys in its class.

The LS will top out at \$28,000. Included at this level is Mitsubishi's Euro Handling Package—one of the most advanced suspension control systems on the market today. Included is Mitsubishi's Active-ECS system and Mitsubishi's Traction Control System, incorporating the company's new "trace control," designed to combat terminal understeer. Four-wheel disc brakes with twin-piston calipers are standard on both models. Antilock braking is optional for the base model, standard on the LS.

With curb weights that start at 3428 pounds, neither of the Diamante models produce neck-snapping acceleration, but they're far from slow. Ride quality is as good as the best, and not much noise finds its way into the nicely designed interior.

We look forward to spending more time with the Diamante. But drawing on first impressions, we think this diamond is highly polished. —R.T.

*(Please turn to page 114)*

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PHOTOS BY RON HUSSEY

## New Vigor For Acura

As Acura's Legend-series cars have moved up the price ladder, the gap between the entry-level Integra and the top-of-the-line has grown, providing a handy slot for an all-new model.

And here it is. Riding a 110.4-in. wheelbase, the new Vigor sedan is slightly bigger than the Integra, slightly smaller than the new Legend. It's also slightly bigger than its Japanese home market namesake.

The new car is 190.4 in. long, 70.1 in. wide, 53.9 in. high, with front and rear track measuring 59.8 in. and 59.4 in., respectively. These numbers give the Vigor an edge in size over its chosen competition—cars like the BMW 325, Lexus ES250, Audi 80/90 and

All-new Vigor sedan series features conservative Acura family styling and typically straight-forward instrument panel design. New 2.5-liter sohc 20-valve 5-cylinder aluminum-alloy engine is mounted fore and aft, for 60/40 weight distribution. With 176 hp on tap, a 5-speed Vigor is capable of 0-60 mph acceleration times in the 8-second range.

Nissan Maxima—and projected pricing—from \$23,000 to \$26,000—should give it a good foothold in this tough sport sedan segment.

As far as the Vigor's sport sedan credentials are concerned, our initial impressions are mixed. We think this Acura newcomer will acquit itself pretty well in the 0-60 derby, but we don't expect anyone will confuse its cornering and transient response with a BMW.

Go-power is supplied by a new 2.5-liter inline 5-cylinder alloy engine, mounted longitudinally and tilted 35°

from vertical to help keep the hood-line low. Like several current Honda engines, the new Five uses a single cam to operate its 20 valves.

The design is undersquare, with stroke dimensions exceeding bore size, a layout aimed at generating torque. There's a fair amount of this—170 ft.-lb. at 3900 rpm—and it starts building well down in the rpm range, thanks to Honda's ongoing work with its 2-stage intake systems. Peak horsepower—a respectable 176—occurs at 6300 rpm, and it's interesting to note that the Acura Five makes more hp per cylinder than the 200-hp V6 that pulls the new Legend.

Although curb weights start at 3150 pounds, the new Five is capable of producing 0-60 times in the sub-8-second category.

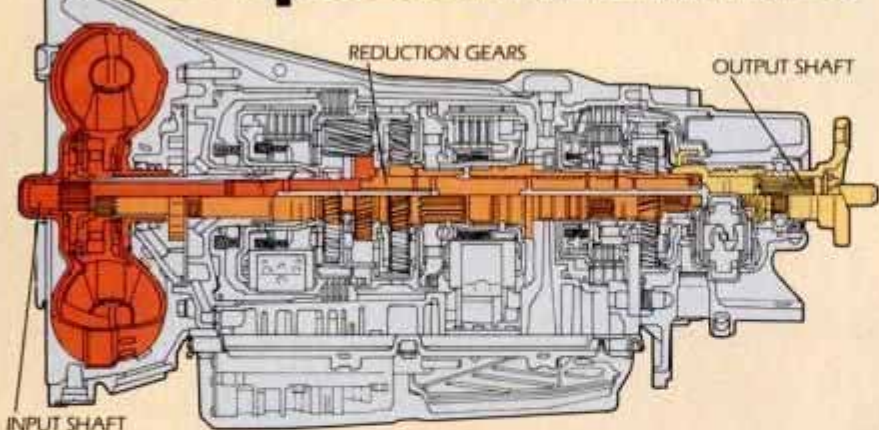
The Vigor rides on a Honda double wishbone suspension system with gas shocks, coil springs and antiroll bars at both ends. It's a stable and thoroughly civilized setup that compromises on hard-edged handling in favor of pleasant highway manners and impressive interior quiet.

One source of that silence is a new floorpan construction technique featuring a resin-impregnated honeycomb material sandwiched between layers of zinc-coated steel.

Another plus is a long list of standard features. The basic LS model includes cruise control, antilock braking, a/c, driver's airbag, power mirrors, power windows, central locking, an 8-speaker sound system, alloy wheels and a security system. The uplevel GS adds only a moonroof, driver's side power seat and adjustable lumbar support, digital signal processing sound system and leather trim.

—Tony Swan

## 5-Speed Automatics



PH ILLUSTRATION BY RON CARBONI

Mercedes-Benz now has a 5-speed automatic transmission for the 300SL, and by this summer on the new S-class cars as well.

The extra gear means that top gear can now be extremely tall, for low noise and increased fuel mileage, without excessive rpm drop when shifting. The lower gears can be more efficiently spaced for improved driveability as well.

BMW is also offering a 5-speed auto on European-spec 5-series cars, but

hasn't any firm plans as to when it will be available in the U.S.

The Corvette ZR-1 already has a 6-speed manual transmission—can a 6-speed auto be far behind? With such a large number of gear ratios available, the operational attractions of a high-capacity CVT (Constantly Variable Transmission) become less compelling. Subaru's CVT-powered Justy has a small-displacement engine, and a larger CVT has yet to be successful.



## Nissan's CRX Response

Honda may have invented the ultimate urban runabout-cum-sports car, but the CRX no longer has sole possession of the field. After years of frustration with its Pulsar series, Nissan is taking dead aim at CRX sales territory with its new front-wheel-drive NX Coupes.

What does the NX series offer? In a word, more—more interior volume, two more seats and more power. The NX has 5.1 in. more wheelbase, is 13.9 in. longer overall and stands 1.5 in. taller. (It's interesting to note here that for all its expanded dimensions, Nissan's CRX-fighter has a slightly narrower track—by .2 in. front, 1.2 in. rear.)

The NX is also heavier than the CRX—by 411 pounds for the top-of-

the-line 2000 model—but there's plenty of power to compensate for the extra weight. The NX 2000 uses Nissan's new 140-hp 2.0-liter dohc 16-valve Four—the same engine employed in the Sentra SE-R coupe—which gives it a decided power-to-weight advantage over the CRX Si. The basic NX 1600 is powered by a 110-hp 1.6-liter dohc 16-valve Four.

Besides its 2+2 seating—which is, incidentally, distinctly cramped—the NX also offers a T-top as standard equipment with the 2000 model, as well as 4-wheel disc brakes and the option of an antilock system. Other NX 2000 performance goodies include heavier front and rear antiroll bars and a viscous limited-slip differential.

That's the good news. The bad news, at least from Nissan's point of view, is that Honda has a new CRX in the works—bigger, more powerful and undoubtedly better than the current edition—and Mazda is set to introduce a minicoupe of its own. —T.S.

## GM Zaps Reatta

When the last of the 1991 Reattas roll out of Buick's Reatta Craft Centre in Lansing, Michigan, they'll also be the last of the breed. GM is discontinuing the luxury 2-seater at the end of the model year as a consequence of disappointing sales.

According to GM President Lloyd Reuss, the Lansing facility will be converted for production of the corporation's first electric-powered vehicle, based on the Impact concept car. However, GM continues to be vague about a production startup date for its electric car.

## Saturn Wagon

If you were impressed by the performance of the Saturn cars tested in this issue—but need the versatility of a station wagon—stand by. GM's newest car line will have a wagon version in dealer showrooms soon, probably before fall.

Built on the same platform used for the sedan, the wagon is expected to be offered in two trim levels—a base model, powered by the 85-hp sohc version of Saturn's new 1.9-liter alloy Four, and an upscale edition using the 123-hp dohc 16-valve version of the same engine. **PM**

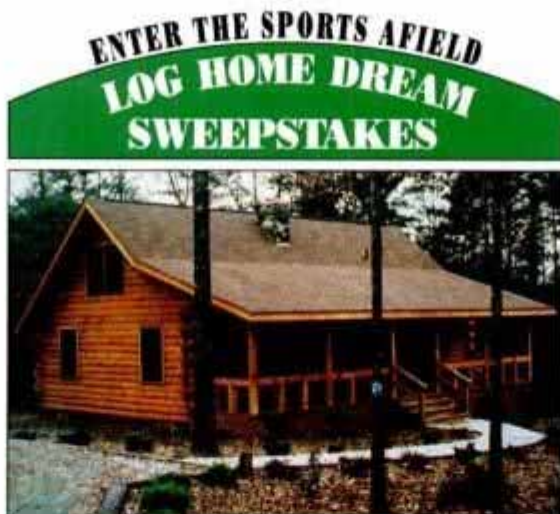


Nissan's 2+2 NX Coupe series replaces old Pulsar line.

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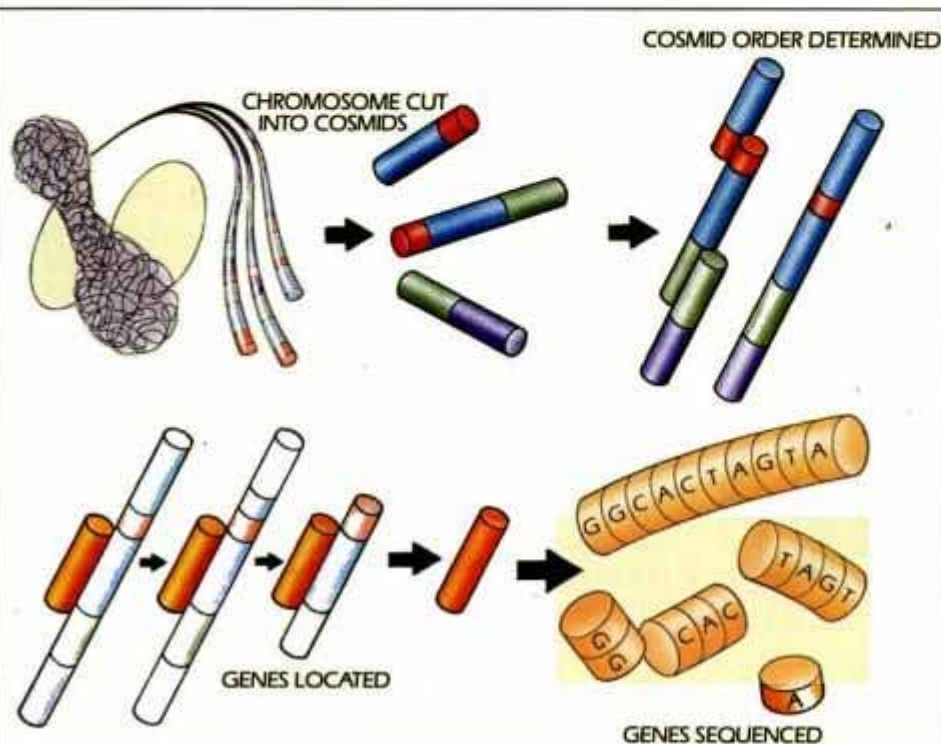
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LOOK FOR THE CABIN MAKEOVER SECTION IN THE JUNE ISSUE OF SPORTS AFIELD

# BIOLOGY'S BIGGEST GAMBLE

BY ABE DANE, Science/Technology Editor



PM ILLUSTRATION BY HANK IKEN

● Coiled inside virtually every cell in your body is a gigantic DNA molecule about 5 ft. long and 50 trillionths of an inch wide. Spelled out in the structure of each strand is the recipe for yourself. Without it, you would be nothing more than a soup of commonplace chemicals.

The reason I bring this up now is that our government, along with several others, is getting ready to spend about \$3 billion over the next 15 years on the Human Genome Project, an effort to find out every word of what this voluminous molecule says. It's the biggest biology project ever. But if you understand how and why it's being done, you're ahead of a fair number of scientists.

That's not because there aren't good reasons for it, but more because the reasons are veiled by the fast-changing complexities of modern molecular biology. So here are the basics you need for a serviceable understanding of the Human Genome Project.

## The library of life

The human recipe, or genome, is written in rungs that span the spiraling strands of our DNA's double helix.

Each rung, or base pair, may be one of four possible types. These form the 4-letter alphabet of the genome. In all, the genome contains approximately 3 billion base pairs—enough to fill a library of 15,000 200-page books.

An exact duplicate of this entire library is found in every cell of the body, except for reproductive cells and mature red blood cells. Each cell's library is divided into 23 pairs of chromosomes, and each chromosome holds one complete molecule of DNA. The DNA molecules are further divided into genes, of which there are somewhere between 50,000 and 100,000 in the entire genome.

These genes are what concoct the ingredients of a human. Each contains a sequence of up to 2 million base pairs that is the recipe for a protein. When the gene is active, it directs the manufacture of one of these highly complex polymers within a cell. The nature of the proteins determines the nature of the cell. And we are the sum of the cells from which we are built.

Although individual people may seem strikingly different to us, there is actually very little variation within the human genome. The fact that 99.9% of one person's genes are the

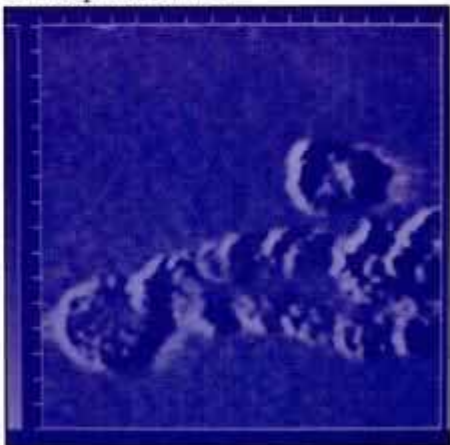
same as those in any other person is a testament to the overriding similarity of all humans. Yet the differences can be profoundly important. Among the possible consequences of variation are about 4000 genetically related diseases, ranging from arthritis to Alzheimers, colorblindness to cancer. Resulting from what amount to typos in an individual's genome, these diseases provide much of the justification for the Human Genome Project.

## When genes go awry

If we could refer to a correct, indexed copy of the human genome, the process of finding these typos would be greatly simplified. The result would be easier prediction or diagnosis of disease, and eventually treatments that get to the genetic root of the problem.

Without such a reference, the difficulty of finding a defective sequence among the 3 billion base pairs of an afflicted person's genome is staggering. As it stands now, we know where only about 1500 of our genes are located. Thus, there is a mind-boggling amount of material to be sifted through in the search for any abnormality.

Because of this, it has been possible to find the typos to blame for only a handful of illnesses. In each case it has taken years of labor, aided by inspired guesswork. The Human Genome Project seeks to change this once and for all by focusing tens of thousands of man-hours on one massive 3-phase effort.



A loop of DNA is magnified a million-fold with a scanning tunneling microscope.

LAWRENCE BERKELEY LABORATORY PHOTO

## Breaking the code

Phase one will have as its goal the completion of what is known as a genetic map. Such maps are based on the fact that sequences of base pairs located near each other tend to be inherited together. For example, people with hemophilia (a disorder that prevents the blood from clotting normally) very often are colorblind as well. Through a rigorous process of observation and inference, such groupings of characteristics can be turned into a sort of map indicating which genes are close to each other and which are far apart.

Built upon the framework of the genetic map will be a more useful index called a physical map. This second phase of the genome project will pick out milestones along the human DNA, state the order in which they are arranged and say how many base pairs lie between them. Completing the map within the five years allotted will demand considerable advances in biotechnology.

Because a whole molecule of DNA is too big to handle, physical mapping begins by chopping up the molecule with chemical scissors known as restriction enzymes (see lead illustration). These recognize certain sequences of base pairs, and snip the DNA where they occur. The result is a noodle soup of different-length strands called cosmids.

The cosmids are sorted by a process called electrophoresis, in which an electric current forces them through a slab of gel. Shorter pieces move farther than longer ones, leaving an arrangement of segments sorted by size. Once measured in this way, cosmids are put back in their original order by matching up the severed ends. At the end of the process, it is clear where along the original strand of DNA all the sequences of the type cut by the restriction enzyme were located. The unknown stretches between these milestones can be shortened by using DNA probes, which seek out sites along the genome that match their own known sequence.

## Phase three

With our DNA thus marked off, the actual sequencing of every one of the 3 billion base pairs in the genome can begin. Scheduled for completion in 2005, this phase is the third, final and most technologically demanding of the Human Genome Project. Although current technology is capable of base-pair-by-base-pair sequencing, it is far too slow and expensive to contemplate for a stretch of material as long as the human genome. Numerous efforts are under way around the world to refine the technology of map-

ping, sequencing, storing, organizing and accessing the genome's message.

Although the technical challenges are formidable, an even greater threat to the genome project's success is the controversy over ethics. There is great concern that while the genome would be a boon to medicine, it could also do great harm if used improperly. Sometimes, it might serve only to notify people of impending illnesses that they can do nothing about. Worse, if that information falls into the wrong hands, it might lead to discrimination by employers or insurance companies.

The National Institutes of Health, which has the largest genome budget of any agency, has pledged to spend 5% of it in the coming fiscal year on research into the ethical dimension of the genome. Certainly, the issues are knotty. But proponents of the project respond that abuses can be avoided in the same way as with currently available medical tests.

If ethical safeguards can be established, the odds are good that the human genome will be not only one of the most powerful medical tools ever developed, but also among the most beneficial. **PM**



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# REBELS AND HALF-BREEDS

BY GEORGE SCHAUB



PHOTO BY GEORGE SCHAUB

● A new crop of affordable 35mm SLR cameras shows how far we've come in today's photographic technology. No longer content with producing cameras for photo enthusiasts who work with basic, automatic exposure and focusing controls, manufacturers now offer features such as Programmed Image Control, Matrix metering, IVP (Intelligent Variable Power) flash, and Fuzzy Logic ESP metering in their SLR's for the guy on the street.

Are these merely marketing buzzwords, or do they represent real breakthroughs in nonprofessional SLR gear? What we have here are highly complex, computerized cameras that allow for both point-and-shoot simplicity and programmable creative controls in one camera.

The three new cameras we'll focus on here are the Canon Rebel, the Nikon N6006, and the Olympus IS-1. All selling for around \$500, they represent a good value for those looking to step up from their point-and-shoot camera to a more flexible machine.

## Stealth SLR

With design lines more inspired by a Stealth bomber or a contoured Indy car than a conventional SLR, the Olympus IS-1 is a handy camera for travel and family photography. Un-

like the other SLRs featured here, the lens on the camera cannot be interchanged for others. The 35mm to 135mm built-in zoom handles lots of picture opportunities, but if you want to go wider to 28mm or get more range from the tele at 200mm, you need the Olympus optional converters.

Strictly speaking, an SLR is defined by the viewing system, a WYSIWYG configuration in which you view the scene directly through the lens. Common usage defines an SLR, in part, as a camera in which you can interchange one lens for another through a flange/mount system. Calling the IS-1 an SLR is, strictly speaking, correct, but a bit of a fudge when you compare it to other SLRs.

Putting definitions aside, the IS-1 is a world-class camera that delivers exceptionally sharp pictures in a wide range of lighting condi-

tions, with and without flash. Though a new breed of camera takes some break-in time for even experienced camera hands, and reading the instruction booklet is a must, there are enough take-charge circuits aboard to make pointing-and-shooting a breeze. But there's also enough overrides to handle any number of creative urges you might want to fulfill.

Two meaningful computer-controlled systems on the IS-1 make it



The Olympus IS-1's many features yield impressive photos (top).

unique—the Intelligent Variable Power flash system and the Fuzzy Logic metering. The camera has two built-in flash units, which you pop up via a pushbutton on the left side. With the elevated flash carriage are two flashtubes—the lower tube is for long range tele shots and gives a full burst of power when needed, while the upper, tinier tube adjusts output automatically according to the focal length in use. Among a variety of flash modes is the Auto-S mode, which emits bursts of light and greatly reduces the dreaded red-eye effect.

Fuzzy Logic, a term used to describe a more flexible digital decision-making circuit, is employed in the IS-1's exposure system, the first such in a still camera. With the camera's ESP (Electro-Sensitive Pattern) metering setup, light is read and then evaluated and compared with 14 separate "possibilities." In other words, the system looks at a range of exposure options rather than just making an either/or decision. Fuzzy Logic does best in difficult lighting conditions, such as where bright reflections, backlighting or very dim lighting conditions prevail.

Other points of note in the IS-1 include a floating cam system, which allows fast zooming and focusing of the lens; an S-wrap film handling system, which advances and winds film in a new way that permits the unique design of the body; and the inclusion of ED (Extraordinary Dispersion) glass in the lens, a major contributor to the etch-sharp images the camera delivers. The car-through-the-wall that decorates the entrance to L.A.'s Hard Rock Cafe was shot with the IS-1 (see page 118).

All this and more for a camera that sells for well under \$500 shows just how far microcomputerization and design technology have affected the SLR for the camera enthusiast. We just can't wait to see what comes next.

### He's a Rebel

The Canon Rebel might be better called the Summation, as it's actually a compilation of past Canon EOS SLR innovations in a very lightweight and easy-to-use package. These innovations include a superfast autofocus system, a host of metering and exposure modes, a command/input dial that gives various shooting options, and a depth-of-field mode, where you "tell" the camera what range of focus you desire and it sets the aperture for you. In a sense, Canon has taken some of the best features of its EOS cameras and distilled

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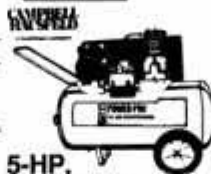
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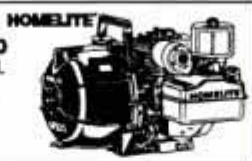
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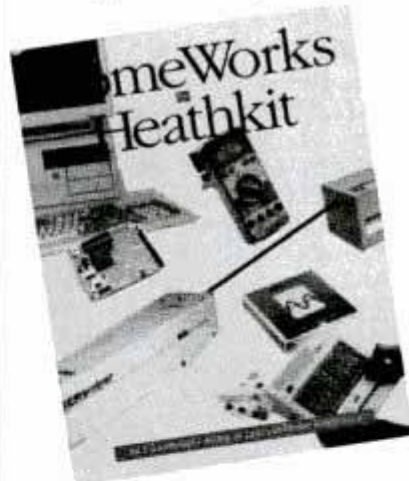
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gle-lens-reflex field is the N6006, a sleek camera with built-in flash and a host of exposure and focus programs.

Geared toward advanced amateurs who want to take advantage of features along the exclusive territory of pros, the N6006 incorporates and adds to the microcomputer controls of its more expensive cousins, the Nikon N8008 and F4S.

With a street price of a little more than \$500, the N6006 delivers a lot for the dollars.

One of the most fascinating aspects of the N6006 is the Matrix concept, used in both light metering and the built-in flash. In short, the Matrix system divides the scene you compose in the viewfinder into five segments, meters each segment and comes up with an exposure via computer analysis. What does this accomplish?

In general, the automatic exposure system on even the most basic camera will do a decent job when the main subject is in the center of the frame and the light is fairly even throughout the scene.

However, when light is dim, or when it comes from behind and places the main subject in shadow, or when it's bright and contrast (such as at the beach or on the slopes), many of these cameras get confused and will expose poorly, giving you bad pictures.

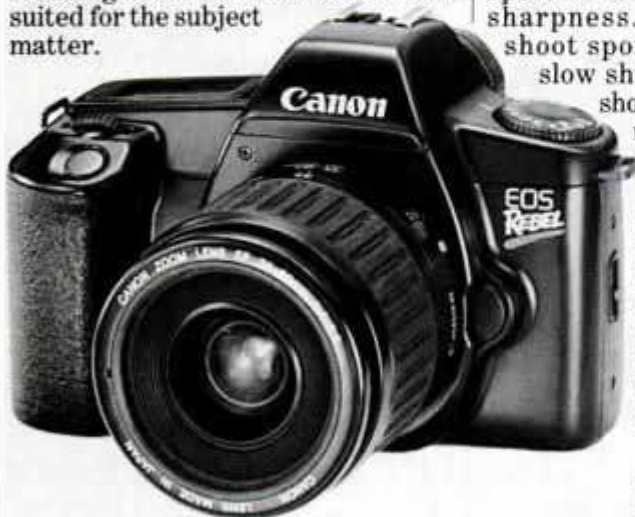
By segmenting the scene and calcu-

## PHOTOGRAPHY

(Continued from page 119)

them into one SLR.

The Rebel can be used as either a full-featured autofocus (AF) and auto-exposure (AE) SLR, or as a very sophisticated point-and-shoot 35mm using Canon's exclusive "Programmed Image Control" system. Choose either PORTRAIT, LANDSCAPE, CLOSEUP or SPORTS modes using the Command Dial, and the camera sets exposure, winding and focusing controls it considers best suited for the subject matter.



Canon's Rebel: image control.

For example, SPORTS mode yields a continuous-wind system (keep your finger on the shutter-release button and the camera goes into rapid-fire sequence) and works with a fast shutter speed to stop the action. LANDSCAPE mode, on the other hand, goes into single-fire mode (one frame per pressure on the release button) with a narrow aperture for near to far sharpness. Want to shoot sports using a slow shutter speed and single-shot winding? Go into manual and follow your creative urges.

One of the real charming features of the Rebel is the price. Camera, zoom lens, battery, flash and strap sell for much less than \$450, a rebellious sticker tag for the many features the Rebel sports.

## A sleek Nikon

Nikon's newest entry into the autofocus sin-



Nikon's N6006: flash sensitive.

lating the problem, the Matrix system works from experience and gives the correct exposure nearly every time.

This Matrix system extends to the N6006's built-in flash and is used to solve the age-old problem of "fill-flash" photography.

Enter the Nikon Matrix Balanced Fill Flash system, which automatically balances the foreground and background available light and adds just enough flash to produce a very pleasing picture.

For those of us who grew up struggling with fill-flash calculations, this alone makes the price of the N6006 a bargain.

PM

## LONG-TERM TEST

# CHRIS-CRAFT 228 CONCEPT

BY JOE SKORUPA, Boating/Outdoors Editor



● Motorboating in the United States, as a recreational sport and industry, was born more than 100 years ago in the town of Algonac, Michigan. Christopher Columbus Smith mounted a newly developed marine engine, built by a Grand Rapids man named Clark Sintz, in one of his duck skiffs and blazed up the St. Clair River at a reported 9 mph.

Smith was already well known in boating circles. He sold his first boat in 1874. His early models were known as Chris-Crafts, which later became the name of his company. Like Henry Ford, Smith didn't invent the motorized vehicle associated with his name, but he built it better and distributed it wider than all others before him.

By the 1920s and 1930s, Smith's

boats were built on such a massive scale that the name Chris-Craft became a synonym for a motorboat. For more than a generation, every fast, beautifully detailed runabout was commonly known as a Chris-Craft—no matter who actually built it.

Today, the granddaddy of production-line pleasure boats, now officially called Chris-Craft Boats, is headquartered in Sarasota, Florida, and still turning out quality runabouts and cruisers. Ironically, this may actually surprise some members of the current generation of boaters. While the company made a smooth transition to fiberglass construction in the 1950s and 1960s, it became eclipsed by other builders in the past two decades. This was especially true in the 1980s when the venerable boat builder suffered under poor management and temporarily sought protection from its creditors.

But the new decade brings a new owner for the proud company. In 1989, Chris-Craft was purchased by giant OMC. Today, buoyed by a deep reservoir of good will associated with its name, Chris-Craft is well on its way to once again becoming a prestige nameplate.

### Concept by Chris-Craft

The first time I saw the Concept by Chris-Craft series of runabouts was at the 1989 Chicago Boat Show. It knocked me out. Like an expensive yacht, the new hulls have two pleasing features: 1. Curvilinear design, which is carried all the way through to wraparound seating and rounded hull sides; and 2. Striking white-on-white color scheme, which extends to an anodized windshield frame and uniquely constructed hardware (more on this later).

At the time, I was searching for a boat to feature on the opening page of the annual PM Boating Special Section. The 167 bowrider, the first boat in the Concept by Chris-Craft series, was an obvious choice (see page 93, February 1990). A few weeks later, I ran the boat for a full day during the photo session and made a mental note to give the smooth-running hull a closer inspection. When it came time to select a long-term test boat in early 1990, the Concept series, again, was an obvious choice.

By this time, it was the 1990 Miami Boat Show, and Chris-Craft had expanded the line. The latest model was the 228 Concept, and it was decided that PM would receive one of the first boats off the line. Our test boat was prepped and tuned at the Shark River Hills Marina, in Neptune, New Jersey and picked up on July 1.

*(Please turn to page 122)*



Cockpit has wraparound seating and removable filler pad.

## First Impressions

The Concept 228 is a minicruiser that's big enough to handle a van-load of family and friends, sprightly enough to tow waterskiers, seaworthy enough to conquer big-lake and offshore waters, and spacious enough to accommodate a modest galley and a 6-ft. V-berth. It also features head-turning looks, deluxe appointments and meticulous craftsmanship.

I ran the boat in both fresh and salt-water conditions, and it performed ably in each. On lakes and rivers, it ran nearly as well as a runabout. This is due to a well-behaved hull and the torque power of a 5.7-liter V8 OMC Cobra sterndrive engine, which came equipped with a 15-in. x 17-in. stainless-steel prop.

It popped up on plane quickly enough for waterskiing, but the rough wake character of its 22° deep-V hull means that it's probably best recommended for Wally Weekender skiing. Those interested in kneeboarding, trick skiing, skurfing and tube-type water toys will also have some fun. Cornering was solid and predictable, but the 228 tends to steer and handle like the big minicruiser it is.

In big-water bays and harbors, the 228's deep-V hull really shines. It slices smoothly through swells and chop, and runs incredibly dry. The cockpit rides high off the water and is protected by a surprisingly deep freeboard. Top speed with the 230-hp engine was a brisk 47.5 mph.

Space is the ultimate luxury, and the 228 makes the most of what it's got. The boat has a centerline length from bow to transom of 21 ft. 11 in. and an overall length of 23 ft. 6 in. (when you add in the integrated swim platform). Beam is 8 ft. 5 in.

The roomy cockpit features seating for six adults in deep-pleated comfort. A huge, wraparound bench seat is located aft and two bucket seats forward. The bench seat comes with a filler cushion that converts the upholstered wraparound bench into a recessed sunpad, which is safe to use while under way. When the boat's at rest, a large sunpad over the engine serves this purpose. The engine cover is hydraulically controlled, and accessibility is outstanding.

If you haven't seen the cleats, bowrails and grab handles on the Concept series, you're in for a big surprise—they're white. Instead of the familiar gleam of stainless steel, the hardware on Concept boats is made of a steel-cored composite plastic. Along with the white anodized frame on the windscreen, this gives Concept boats a distinctive white-on-white appearance. (The PM long-term test boat

The 228's power was supplied by a 5.7-liter V8 OMC Cobra sterndrive spinning a 15-in. x 17-in. stainless-steel prop.



came with optional blue-gray highlighting.)

White-on-white is also featured on the dash panel. To some, this is a questionable decision because it eliminates the possibility of using flat-black or gray as a nonglare treatment around the gauges. Personally, I prefer a dash with nonglare, but I didn't encounter any visibility problems while driving the 228.

Visibility of the high-mounted, analog gauges is also excellent. The gauges feature white faces with a black hand and numbers. The contrast is just as sharp on these units as it is on gauges with reverse coloring.

The only real glitch on the dash occurred with the ignition key lock, which popped out of its housing and hung loosely. It didn't take much to fix, but it was temporarily annoying.

## Down under

The cockpit of the 228, as mentioned earlier, rides high off the water and is protected by a freeboard that seems twice as deep as similar boats. This gives passengers, especially kids and seniors, an extraordinary sense of security while on the water.

The view from the helm, although well off the water, looks over a raised foredeck that further emphasizes the 228's big-boat feel. This feeling is reinforced when you open the cuddy door and catch your first glimpse of the immense cabin space.

Belowdecks, there's full headroom for 6-footers and a surprisingly generous V-berth. While I never used the boat as an overnighter, it would fulfill this function with comfort.

The two areas that make it clear that the 228 is a compromise cruiser are the galley, which is just a sink with running water and an alcohol

stove, and a sitting head, which features a Porta Potti in an enclosed compartment. These accommodations may seem spartan, but they serve a useful purpose—outfitted with galley and head, borrowers can claim the boat as a second home and receive a significant tax break on interest paid during the life of the loan.

Fit and finish, as previously noted, is meticulously detailed. With the forward bulkheads fully carpeted, not an inch of fiberglass is exposed in the cockpit. Upholstery above and belowdecks, which is deeply cushioned, displays no visible snaps, rivets, staples or fasteners. Removable cushions are finished on both sides. Cabinetry has rounded edges for safety and a pleasing finish.

Noteworthy features on the test boat include a large hatch in the cuddy for light and ventilation, a radio/cassette player with above and below-deck speakers, and an integrated cooler located in the port-side console. Suggested retail price of the boat as tested is \$24,265. For further information, write Chris-Craft Boats, 8161 15th St. E., Sarasota, FL 34243; or call (813) 351-4900.

When Christopher Columbus Smith kicked off his career in motorboating in the mid 1880s, he used a 2-cycle Sintz engine, which was the first to feature ignition advance and direct-port fuel injection. While the Sintz engine was a breakthrough in its day, it isn't the engine most commonly associated with early Chris-Craft powerboats. One usually thinks of these boats as powered by naphtha engines, invented by Frank Ofeldt, of Newark, New Jersey.

Naphtha was a trade name for a medium-weight hydrocarbon that appears in the petroleum-refining process between the temperatures that produce kerosene and benzene. At the time, it was considered a useless waste product. Soon after Ofeldt's compact engine went into wide distribution, primarily in pleasure boats, the name of naphtha was changed to gasoline. Within a few years, gasoline was in tremendous demand and, of course, so were Chris-Crafts. **PM**



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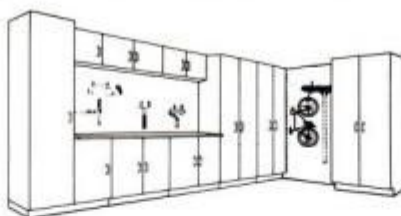
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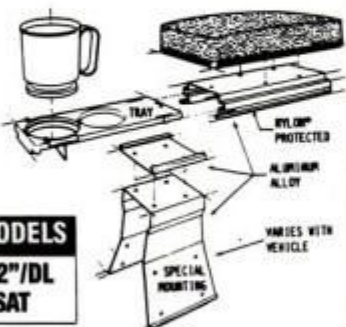
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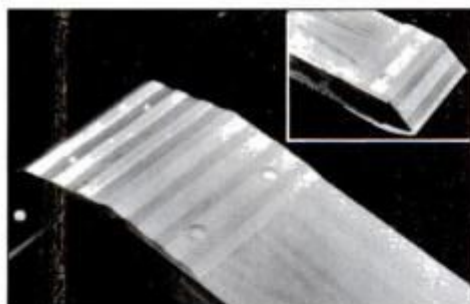
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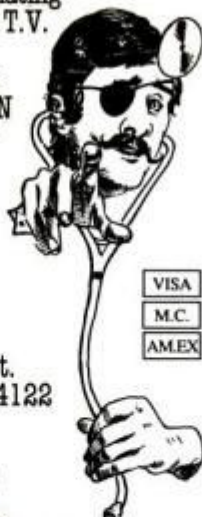
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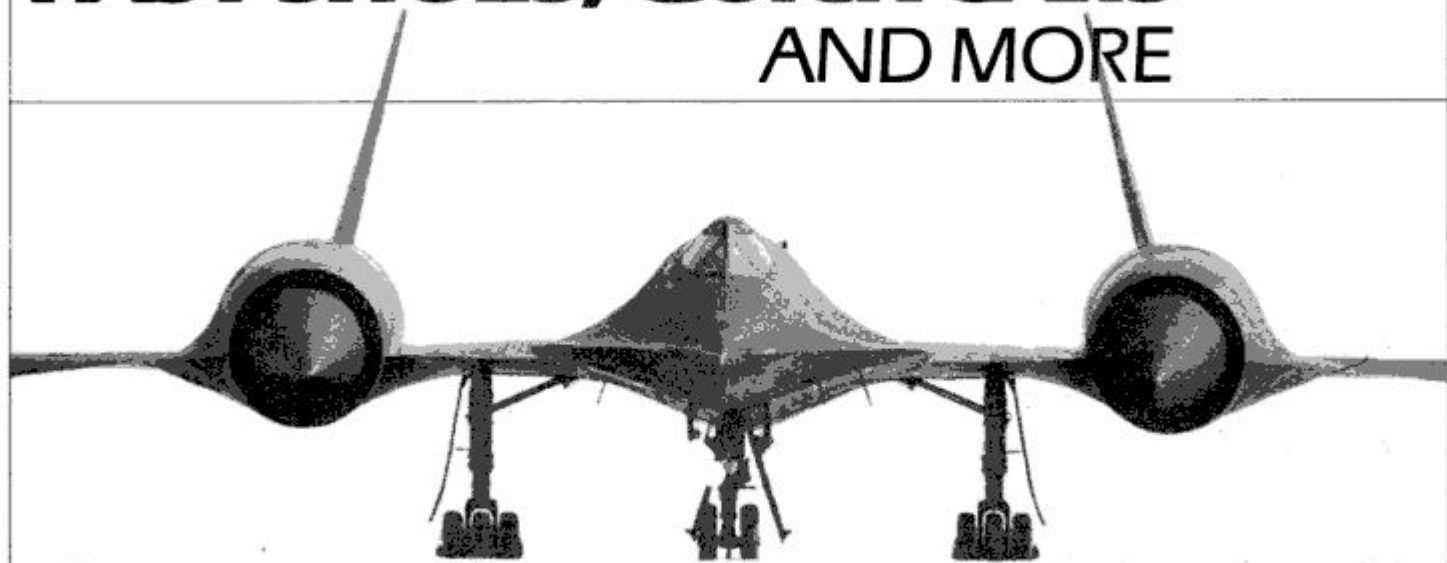
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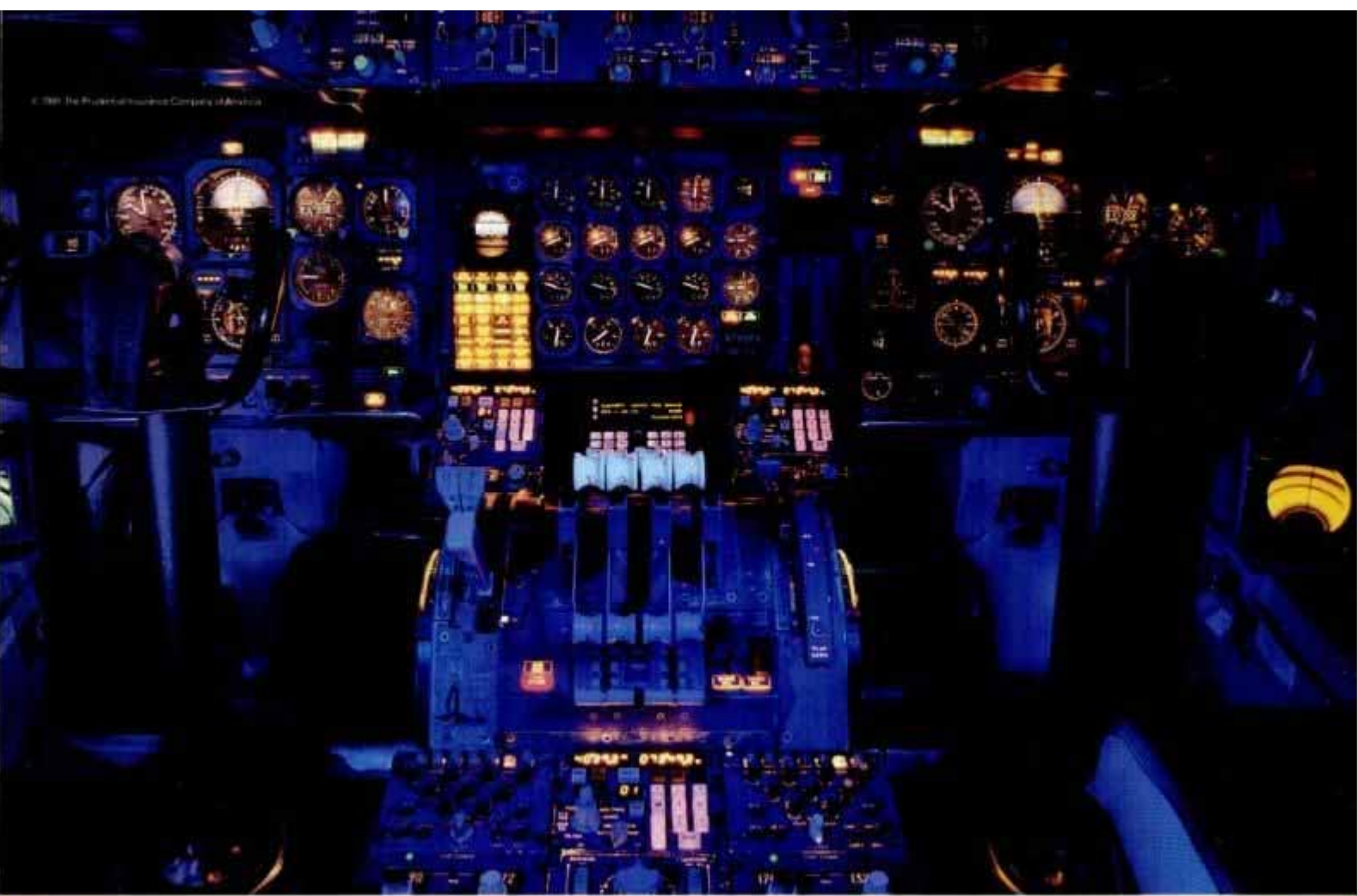
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