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The 1992 Crown Victoria. A new way to get the comfort and security you're used to, wherever you go.

HAVE YOU
DRIVEN
A FORD
LATELY?



This One



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GOODYEAR

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EDITOR'S NOTES

● Life gets more complex every day. You can't change your car's oil and just dump the old oil into a sewer. Not anymore. And you can't simply throw your old battery into the trash can and not care what happens to it. We have to care.

The trouble is, what do you do with the old oil after you drain it? What do you do with those old tires, batteries and spark plugs? You want to do the right thing, but no one has told you what the right thing is. Until now. This year's Car Care Guide is devoted solely to explaining the right thing to do. We call it "Green" Car Care. Associate Auto Editor Mike Allen



Landen D. Schooler (center) accepts his award from Trish Serratore (right) of ASE and me.

and contributor Don Chaikin have produced what may be the most comprehensive information yet printed on the subject of environmentally friendly car care. We hope you use the information you'll find in this issue. . . . You may notice signs posted at your local auto parts store or repair shop this month touting



The Tokyo Motor Show is a mindblower.

The Year award. The winner, Landen D. Schooler, is an ASE certified Master Technician. He has been an automotive service technician for Montgomery Ward since 1984 and is currently working at the Des Moines, Iowa, facility. Now that's the kind of guy I want working on my car when I can't do it myself.

. . . Frankfurt, Tokyo and Detroit.

These are the auto shows where the car companies roll out their most incredible goodies. Of the three, Tokyo is the mindblower. There are more concept cars at the Tokyo Motor Show than you'll see at any three other shows. Automotive Editor Tony Swan, Detroit Editor Jim Dunne and I roamed the shows to compile "Concept Internationale," a look at the future direction being taken by the import car companies. Good stuff. Till next time.




Joe Oldham

Popular Mechanics

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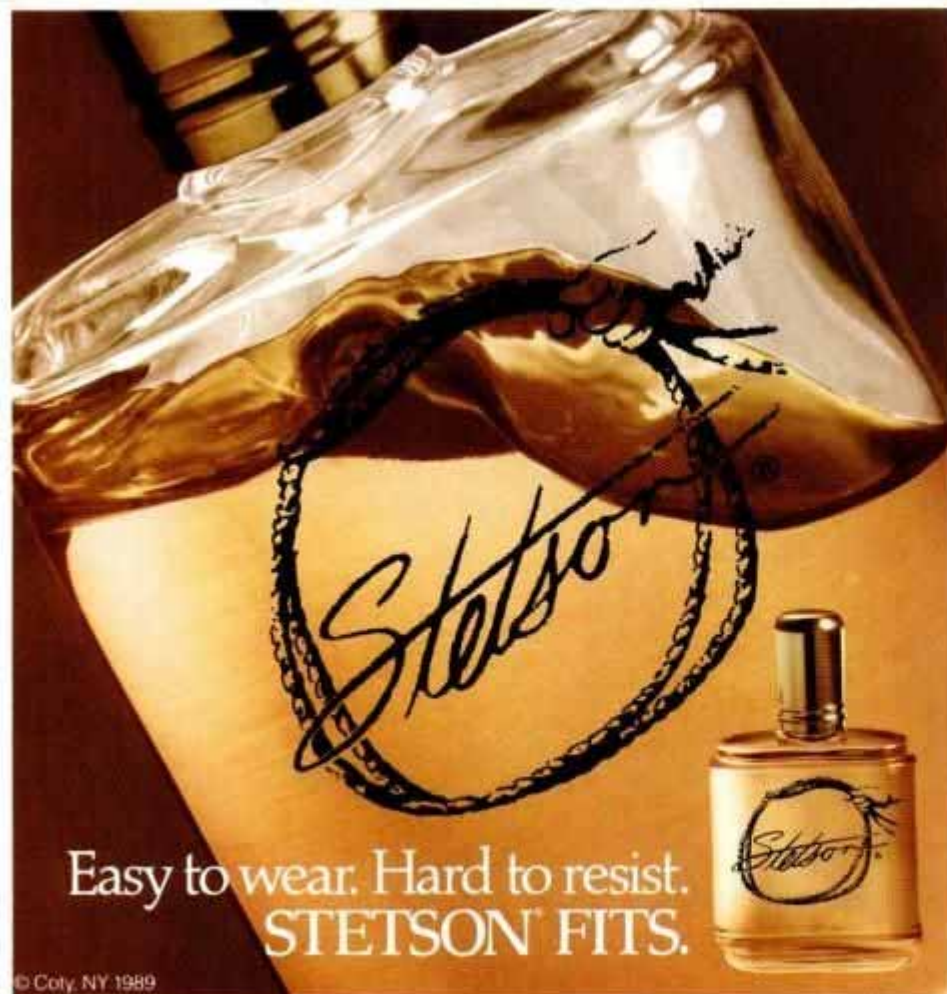
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LETTERS

Thanks For The Memories

Your 90-year anniversary issue brought to mind childhood memories of the '50s and '60s: Predictions of flying-saucer cars and commuter Moon rockets in the now future. A roll-film Kodak with flash gun, and a blurred photo of President Kennedy. B-47 Strato-bombers parked near our home. *Mercury, Gemini* and *Apollo*.

RAYMOND BATES
TAMPA, FL

Congratulations on your 90th anniversary of a great magazine. PM's truly *the one* for those of us interested in all you write about.

FRANK BLOOD
VALDEZ, AK

I wish you could reprint some of those early issues and offer them for sale. I have a 1919 May issue and find it a lot more interesting than current issues. It certainly teaches one much more about the mechanics of things than the contemporary "techno wiz" versions of PM.

ROBERT W. SCHILLER
DENMARK, WI

I have exposed myself to this wonderful magazine for quite a few years. I still have the 1935 and 1941 editions of *POPULAR MECHANICS Shop Notes*. The paper is still quite good, and both were published in Chicago.

F.W. PETERSON
ST. ANN, MO

Your "Possible Dreams" exhibit article made me recall that I have Vol. 4 of *The Boy Mechanic* printed in 1925. It's a classic.

JOHN F. BRUNO
PT. RICHEY, FL

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

POPULAR MECHANICS



I have been reading PM for 64 years. Your anniversary issue brought back many memories of growing up in Chicago where I was born in 1915. I was there when the Chicago World's Fair ended and they took down the tower of the skyride on Midway Island (now Meigs Field). PAUL VAN BOLHUIS
WESTMINSTER, SC

The history of PM is a great nostalgia trip for long-time readers. Looking forward to the 100-year anniversary issue. BUD OHRENSTEIN
BURBANK, CA

Only recently was I introduced to *POPULAR MECHANICS*, and I just finished reading the 90-year-anniversary essay by Mary Seelhorst. I am speechless. You underrated her when you named her *The Source*.

SHIRLEY INGRAM
TYLER, TX

Mary Seelhorst deserves all the accolades bestowed on her for the 20 pages of copy in the 90th anniversary issue. I have been an avid reader since the age of seven, which was 69 years ago. I spent a couple of hours nearly every Saturday evening reading all the

Popular
Mechanics

90

YEARS

back issues available at the library. Being a farm boy, I learned a great deal from the articles titled "How to do it when you don't have the right tool or the right material."

At 18, I took the admission test to the GE Apprentice-Toolmaker Program. Because of all I learned from your magazine, I received a score on the Mechanical Aptitude Test that was higher than anyone had ever achieved. Certainly, PM was written so this 8-year-old boy could understand it! Thank you for 69 years of educational, enlightening and enjoyable reading. Looking forward to your 100th anniversary issue. WAYNE I. PRIBBLE
NEW HAVEN, IN

Although I fully enjoyed your anniversary issue, I was disappointed with your profiles on electricity and radio. The articles failed to mention Nikola Tesla, who was a prominent figure in the development of the alternating-current motor and wireless transmission of electricity. In 1943, the U.S. Supreme Court ruled Guglielmo Marconi's wireless patent invalid in favor of Tesla's 1900 patent.

CRAIG J. MAGUIRE
OLEAN, NY

Without Nikola Tesla's inventions, we would be without such things as AC

current, radio and television. His most famous invention, the Tesla coil, is used in every radio device we own.

JAMES NIEBERDING
ROCKVILLE, MD

Mary Seelhorst replies: *I wrote about how POPULAR MECHANICS presented these topics to its readers, not necessarily how current historians view them. Looking back at popular coverage during that time period, Marconi was the prominent figure in the press.*

Thank you for a very pleasurable look back at 90 years of progress. It is a tribute to all who have brought forth their ideas and inventions, and how we have made the word "technology" commonplace in today's society.

As much as your article was informative, I did come across a misconception regarding the laser. As a technician for a company that manufactures solid-state lasers, I would like to clarify somewhat the statement, "a laser, for instance, begins life as ordinary, incoherent light." This phrase tends to let the reader think that any light, in general, can be made into laser light if focused with a lens or mirror. In truth, laser light is the product of a specific material that when stimulated by an electrical discharge, emits its own light of a specific wavelength. Light of a specific wavelength is said to be monochromatic, and hence the most coherent type of light.

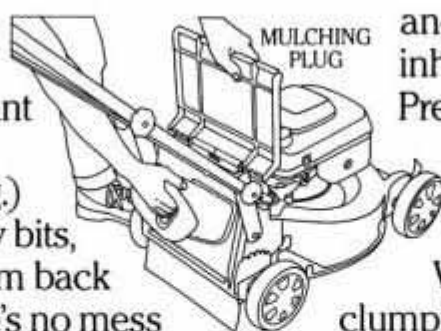
Keep up the great work on a great magazine.

ANDREW N. VOURLOS
FLUSHING, NY

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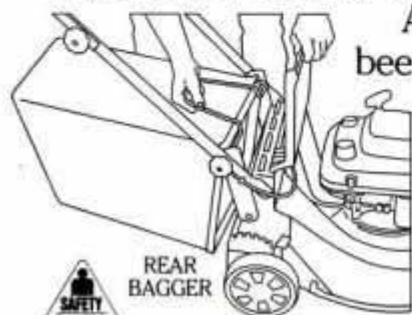
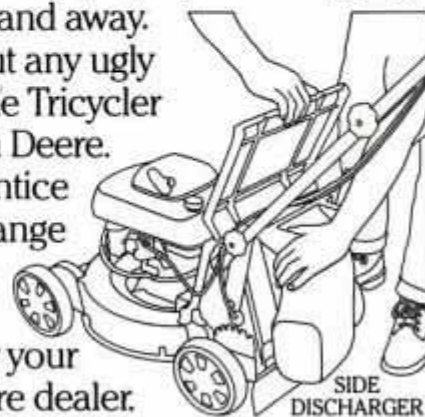
The John Deere Tricycler™ mower is quite a quick-change artist. Let's say you want to mulch with it. (Simple, just insert the molded-plastic plug.) As you cut your grass into tiny bits, the Tricycler mower feeds them back to your lawn as fertilizer. There's no mess to deal with. No bags to dispose of. Very environmentally friendly, all around.

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of my head. As I came over
kicked it into fifth and
I couldn't hear a word
she said.

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*To qualified customers. See Dealer for details. †Motorcyclist, Aug. and Rider, May 1991. Specifications and availability subject to change without notice. California version differs slightly due to emissions equipment.

A photograph of a Honda motorcycle, likely a V-Twin model, parked in a desert canyon. The scene is bathed in the warm, golden light of a sunset or sunrise. The motorcycle is the central focus, with its chrome accents and engine details clearly visible. The background shows the rugged, layered rock formations of a canyon under a hazy, orange sky. The overall mood is one of adventure and freedom.

rock canyon unfolded in
But no matter how hard
last words out
the ridge, I
suddenly

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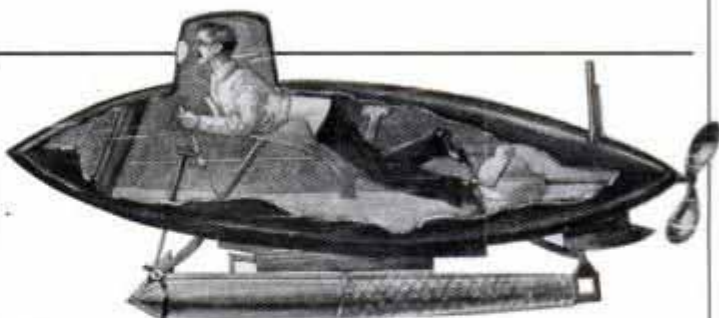
TIME MACHINE

90 YEARS AGO: MAY 1902



Night Train

Steam locomotion was flourishing, as railroads vied for passengers by offering express travel in excess of 100 mph. Chicagoans heading west by night were treated to the latest turn-of-the-century technology, including electric arc headlamps that lit up the track for a mile and a half. On locomotives running the Chicago, Milwaukee and St. Paul line, warning lights also blazed skyward because the trains often emerged suddenly from behind mountainous terrain.



Water Baby

As the Great Powers dove ahead into a naval arms race, the submarine was drawing attention. A Rhode Island engineer built one of the smallest yet, an 11-ft. torpedo craft. On the surface, an internal combustion engine

provided propulsion. Underwater, the lone crewman had to pedal. After the externally mounted torpedo fired, a collapsible keel dropped for stability. In an emergency, a hatch sprang open and the diver, clad in an inflated jacket, shot to the surface.

60 YEARS AGO: MAY 1932



The Rocketeers

Rocket research was taking off, ignited by the work of Robert H. Goddard and Wernher von Braun. In Germany, experimenters launched into speculation on high-speed transport applications. Future rocket planes would look like zeppelins with retractable wings, the crew strapped into the cockpit horizontally. Trips from Berlin to Chicago at a 600-mile altitude would last 15 minutes, but the Germans hadn't quite worked out the landing procedure.

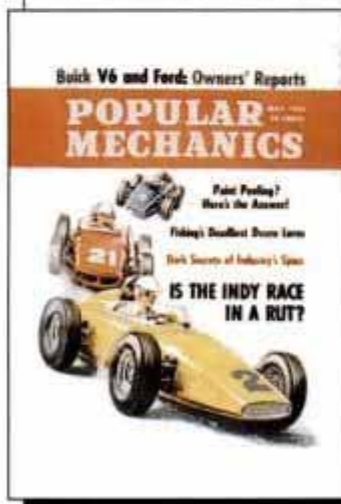
Sand Blaster

The reigning king of speed, Sir Malcolm Campbell, explained how he spurred the fabled Bluebird to 257 miles per hour at Daytona Beach. Key was the new 1450-hp 12-cylinder supercharged Napier engine. This monster devoured gasoline at 45 gallons

per hour. Campbell also whittled Bluebird's front radiator down to a bullet shape, lowering the car's nose. He shifted the driveshaft left of center and added an offsetting stabilizing fin at the rear. Campbell believed nothing stood between him and 300 mph. Indeed, he breezed past that benchmark three years later.



30 YEARS AGO: MAY 1962



Turn Left

Critics were hammering Indy, charging that the race had become a proving ground that proved nothing in either auto technology or driving skills. But change was in the wind. Rear-mounted engines, such as Mickey Thompson's Buick Special V8 began appearing at qualifying trials. Jack Zink brought a Boeing gas turbine. Both cars had independent suspension. Another Grand Prix influence was the proliferation of aluminum and titanium components.

Flipper Tech

The Navy's flirtation with marine mammals was heating up, as engineers probed the porpoise's remarkable engineering. How did the playful animal slice so cleanly through rough water, outracing any Navy ship? Could the denser blood vessels and wrinkled skin around the tail heat the water to smooth out turbulence? And torpedo designers took great interest in the porpoise's sonar system, which the creature uses to home in on its favorite food. **FM**



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Gillette

The Best a Man Can Get™

TECH UPDATE

News Of Tomorrow's Technology Today



PM ILLUSTRATION BY PAUL DIMARE

Silicon Ants Could Prove Tireless Workers

BOSTON, MA—Dust accumulated in a micromotor is like a rock lodged in your car's engine. Tiny specks pose big obstacles for the miniature moving parts of micromachines. But a Lilliputian actuator developed by a Boston University engineer may be able to sidestep the problem—and make possible ant-size walking machines relatively immune to small-scale wear and tear.

Jan Smits' piezoelectric motor is based on a cantilever beam of silicon. Across the top of the beam would lie a layer of piezoelectric material (such as zinc oxide) sandwiched between two thin electrodes. Fed voltage, the beam flexes up or down.

The motor, the leg of Smits' walking machine, consists of twin beams connected by a V-shaped "foot." A syncopated rhythm of electric pulses applied to each beam would impart a walking motion to the foot, raising it, cocking it forward and then lowering it.

A similar device, derived from two legs, could form a pair of jaws for seizing objects such as chemical grains or even blood cells.

Dust, friction and miniature electric fields would have little effect on the machine, which would also need only a tenth the energy of an

Editor: Abe Danc
Assistant Editor: Greg Pope
Contributors: Mike Fillon, David Freeman, Paul Ruben

electrostatic micromotor. A microrobot based on the device could run off of a solar cell.

An army of laboratory-cleaning silicon ant robots scuttles about on piezoelectric "legs."

Highlights This Month

- **Flying Eyeball**—Bubblehead plane offers sweeping vistas.
- **Liquid Powder**—Army's wet-propellant cannon.
- **Coast Guarding**—Industry's new fleet of oil-slick busters.
- **Up, Up And Away**—Japan's balloon-launched rocketplane.
- **Mine Blowing**—Waterjets sluice out hidden explosives.
- **G Swing**—Carousel flight simulator for fun parks.



Big Eye In The Sky

OLATHE, KS—A unique observation plane, recently certified by the Federal Aviation Administration, will soon prowl American skies.

Built by FLS Aerospace in Bournemouth, England, the Optica features a cockpit that's more plexiglass than

aluminum, opening 340° panoramas.

Right behind the cockpit, a 260-hp Lycoming piston engine drives a 5-blade ducted prop. This powerplant responds sharply to throttle changes in the plane's slow, 70-to-140-knot speed range.

Loitering at 70 knots, the plane can stay up for 8 hours or cover 655 miles. That's far better performance than a helicopter, the only other aircraft with comparable visibility. And operating costs are far lower.

In addition, rubber mountings cushion the engine pod, isolating the cockpit from

Round plexiglass cockpit and ducted-prop powerplant lend Optica a dragonfly silhouette.

noise. These buffers allow use of TV cameras and other equipment without special vibration-damping gear.

Kansas City Aviation Center is the exclusive U.S. distributor for Optica.

Star Bus From Semi Rig

METAIRIE, LA—Can a semi truck chassis deliver the kind of luxury ride that celebrities demand from their tour buses?

The Genesis can, says its manufacturer American Coach International. It's based on a Peterbilt 372 cab and chassis, with a front-mounted powertrain and a hybrid leaf-spring/air suspension system.

The latter, a Peterbilt option for fragile cargo, places large air canisters between



frame and axle. Like hydraulic active suspension, the system responds to sensors to keep the frame rail flat during turns or bumps.

Also unique in the tour-bus world is the 45-ft. one-piece fiberglass body, built for Genesis by Tillotson-Pearson, Inc.

Stars who've already sampled the bus include Burt Reynolds, former GM chairman Roger Smith, Howie Mandell and Al Copeland's speedboat-racing team.

Peterbilt semi chassis and cab is basis of current Genesis tour bus (top) and future version (left).

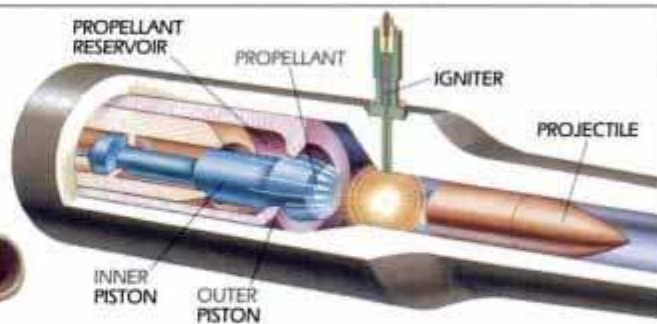
Army's Wet Gunpowder

PICATINNY ARSENAL, NJ—The Army's next generation of artillery will fire with a liquid propellant.

The Advanced Field Artillery System (AFAS) could stretch the range of Army cannons to 26 miles, 11 miles better than current models.

Developed by General Electric, AFAS also offers improved accuracy and safety, and requires a smaller crew.

A computer-controlled propellant-metering system feeds the liquid into a reservoir behind the



Liquid-propellant cannon (left) uses concentric piston arrangement (above right).

head of a piston in the gun's breach. This device measures out propellant according to the type of round, desired trajectory and range.

Then an igniter touches off a priming charge, which shoves back both the reservoir piston and a surrounding outer piston. The liquid propellant is squeezed forward,

spraying through a gap that opens between the two retreating pistons. As in a diesel engine, pressure and temperature trigger the main detonation to fire the round.

At the Yuma Proving Grounds, Arizona, the system is currently undergoing tests as a 155mm cannon mounted on an M115 chassis.



While every 4x4 devotee knows the road to heaven isn't paved at all, the road to the road to heaven assuredly is. Thus the wisdom of the new Yukon. A full-size sport utility that is not only obliging of your desire to bully the Continental Divide, but nimble on

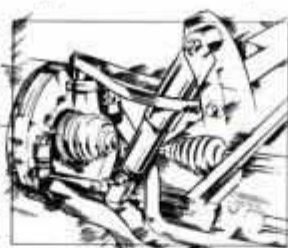
OUR ALL-NEW YUKON. IN PERFECTING IT, WE DID MORE THAN SIMPLY TAKE IT OFF-ROAD.

terrain that resists the encroachments of lesser sport utilities: The slalom. The skid pad. Urban surface streets. Eight-lane superhighways. Yukon's 111.5-inch wheel-base, longer than its predecessor's and the longest in its class, and lower 71.5-inch roofline, contribute to a smooth, stable on-road feel. Independent front upper and lower wishbone control arms and tuned rear leaf springs yield road handling that is customarily precise and agile.

It wouldn't do to have a vehicle that can take you to the widest of open spaces crowd you. So inside, Yukon is wide open, too. It's the first six-passenger sport utility, with comfortably wide bolstered seats, and more leg, hip and shoulder room than Ford Explorer. When *Popular Mechanics* took a Yukon to the Canadian Yukon, their photographer spent "the entire trip (in the back seat) and never complained once. Honest."

Yet its gentility does not come at the expense of off-road vigor. Yukon puts 6.9 inches of ground clearance between you and the scrub – more than any other sport-utility. Shift-on-the-fly Insta-Trac 4-wheel drive keeps you tracking without getting you out of the truck. And an aggressive, fuel-injected 5.7L V8, supported by a 30-gallon gas tank, ushers Yukon into territories where fuel trucks dare not tread.

The sum of these strengths is an inspiring new experience of paths both unbeaten and heavily travelled. An experience you can expect only from GMC Truck. Over 80 years of truck experience have wholly prepared us to create Yukon – to create a vehicle whose combination of off-road power and on-road agility and comfort carves out a *new* trail, a path no four-wheeler has travelled before: The path of least resistance.



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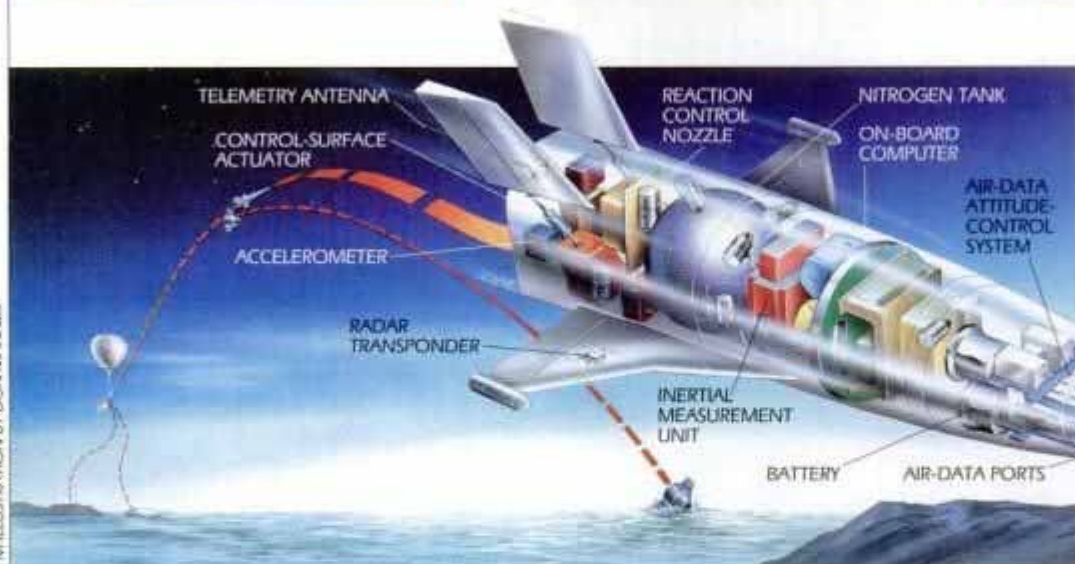


THE STRENGTH OF EXPERIENCE

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HIMES demonstrator uses balloon and rocket to climb to 50 miles before coasting home.

hoisting the 6½-ft. craft 12 miles into the air.

From there, a rocket kicked it up to a 41½-mile altitude and then tumbled away. The vehicle glided back to Earth, reaching about Mach 3.7.

On the way back down, control surfaces and cold-gas reaction control nozzles responded to a processor guided by a nose-mounted air-data-sensor system.

Japan's Institute of Space and Aeronautical Science is running the tests. If built, HIMES will hit speeds of Mach 10 and demonstrate unmanned approach and horizontal landing.

Balloon Is Step To Space

SAGAMIHARA, JAPAN—Among the many spacecraft concepts under study in Japan is the Highly Maneuverable Experimental Space

(HIMES) vehicle, a reusable unmanned winged rocket. Engineers have now flown a small-scale HIMES demonstrator using an unusual first-

stage booster—a balloon.

The point of the flight test was to study how the vehicle would behave during atmospheric re-entry. The balloon helped engineers avoid aerodynamic heating by gently

Collider Is On Course

WAXAHATCHIE, TX—Science's all-time biggest machine—the Superconducting Supercollider—is now under construction.

Diggers have begun sinking 70 miles of tunnels and eight experimental chambers into the shale and chalk of Texas. Right now, construction manager PB/MK is holing out the first of six oval-mouthed magnet-delivery shafts.

Tunnel-boring machines will get busy at the bottom of each shaft. Then cranes will lower the 50-ft. lengths of tube-shaped magnet horizontally to the shaft's bottom. There, they'll be

fitted together to form the double-tiered main ring, 54 miles in circumference.

Robots To Trash A-Bombs

ALBUQUERQUE, NM—At Sandia National Laboratories, engineers spent decades designing nuclear weapons. Now they're coming up with ways of dismantling them without exposing workers to the risks of radiation and explosives.

One solution is a robotic system that fires waterjets to separate weapons-grade plutonium or uranium from the high-explosive trigger. The robot then puts the radioactive "pit" into a handling drum for storage.

It will be tested at the Pantex plant in Amarillo, Texas,

where 7000 recently decommissioned nuclear weapons are now heading.



Sandia's robot isolates weapon's plutonium "pit" and plants it in handling drum.



Magnet-delivery shaft is oval-shaped to accept magnet tubes, which can't be tilted.

Waterjet Mine Clearer

ALBUQUERQUE, NM—High-pressure jets of water could scour land mines out of former battlefields in Afghanistan or Kuwait, according to research at Sandia National Laboratories.

A proposed application calls for a 20-ft. barrel mounted on an armored truck, which would carry a water pump and haul a 300-gallon tank on a trailer. At



the barrel's tip, a small-orifice nozzle would shape a supersonic 10,000-psi jet, strong enough to carve away

soil from a buried mine. Fiercer water pressure could wash the mine out of the path to be cleared or even cut cer-

Teleoperated Army truck fires waterjet to chew path through minefield.

tain types of land mines to pieces.

Accidental detonation wouldn't pose a hazard—the truck would be far enough away to protect it. The system could even be operated by remote control for use during combat.

The concept has worked in proof-of-principle tests in New Mexico.



Cars Courtesy of Heavenly Bodies International, Inc., New Milford, NJ.

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Pour on our Liquid Glass Wash Concentrate, Pre-Cleaner and Polish/Finish today – and see how their dazzling glow reflects on you. Then rejuvenate your leather, vinyl and rubber with our Connoisseur's Choice® duo – the miracle cross-linked mixtures with Mink Oil. But don't wait. Once you experience a touch of 'Glass, you'll never settle for less.

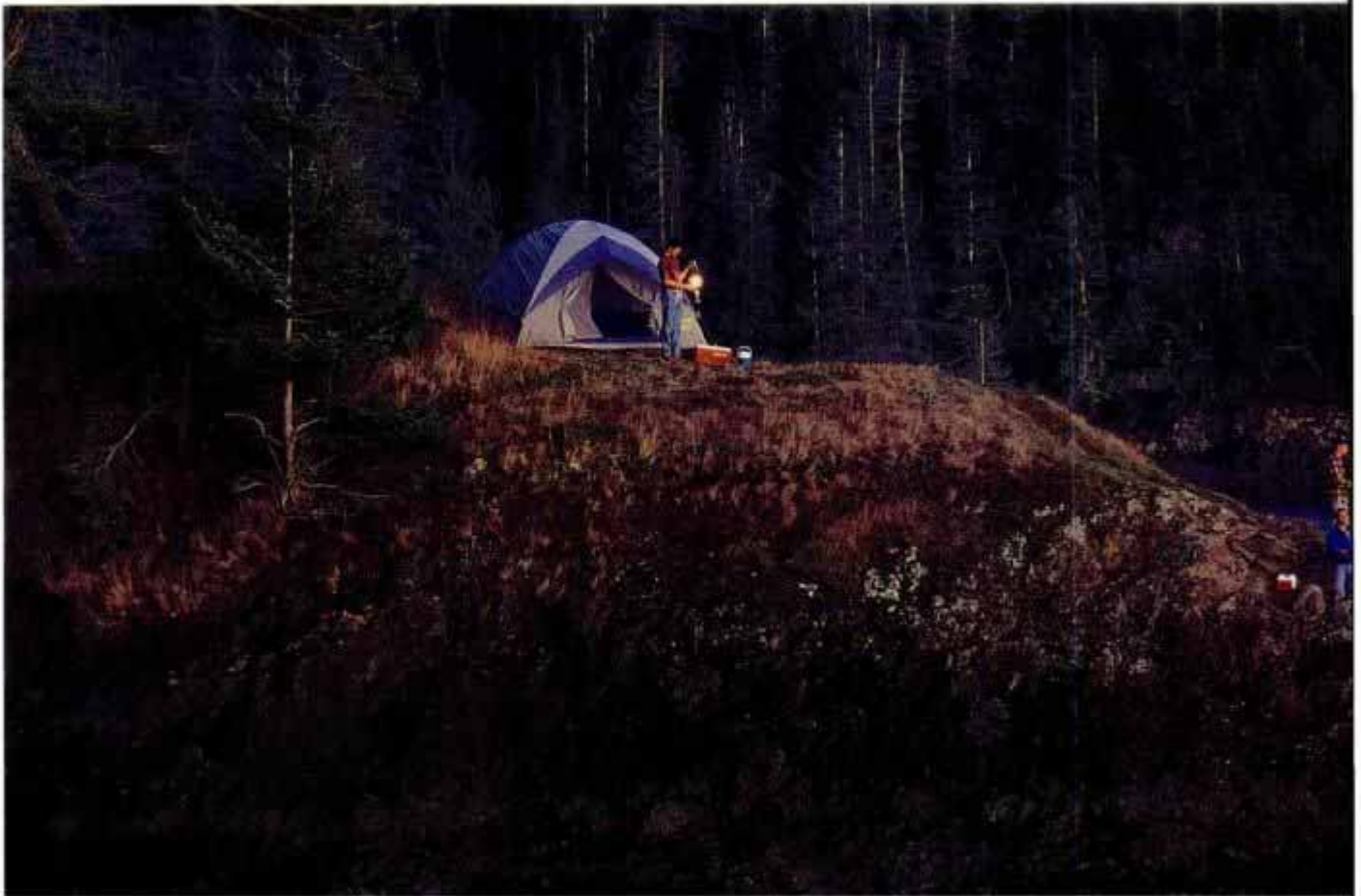
Liquid Glass Polish/Finish is sold only in the gold can with the red Corvette on its face. We do not manufacture or private label an "Advanced" version of any of our products. Never have, never will!

The Liquid Glass Total Appearance System is sold at quality conscious retail stores nationwide, or call now, toll free: 1-800-548-5307 for the name of your nearest Liquid Glass Products Distributor. In N.J., call (201) 387-6755.

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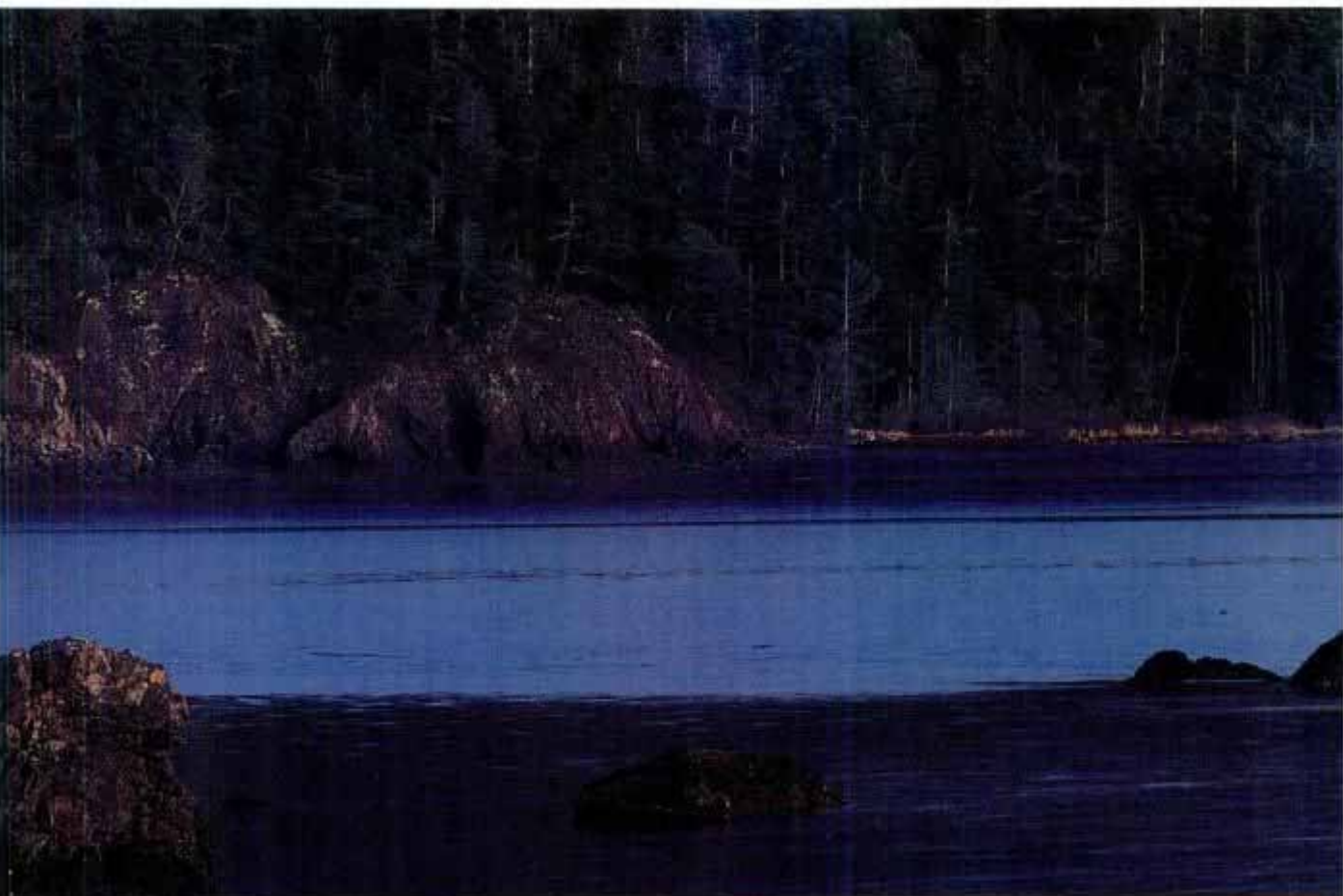
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2.6-gallon fresh water tank, 4.3-gallon waste holding tank, built-in deodorant, and easy to use push-button operation.

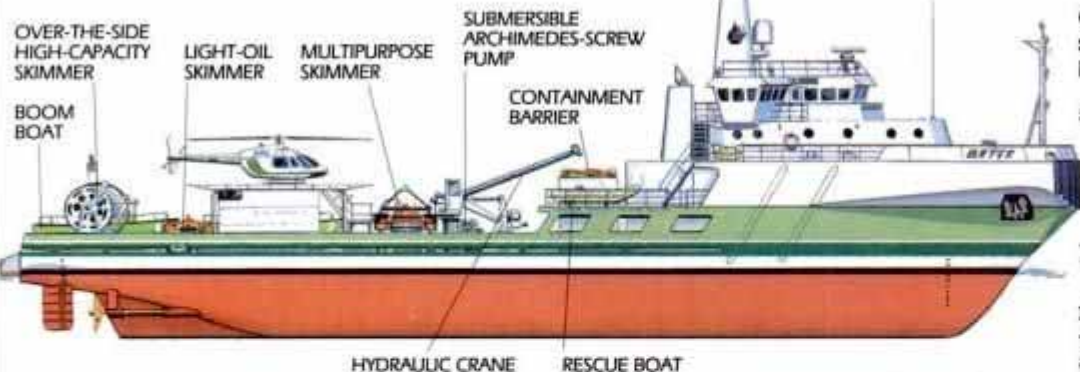
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PM ILLUSTRATION BY ED VALIGURSKY



Oil-spill fighter will carry skimmers and containment barriers, or booms.

separators into heated recovery tanks in the ship's hold, which can store more than 4000 barrels. Pumps then transfer the oil to towed barges or floating bladders.

The industry-funded Marine Spill Response Corp. will own the vessels, now being built at Halter Marine and Bender Shipbuilding.

Home ports will be New York; Port Everglades, Florida; Lake Charles, Louisiana; Long Beach, California and Seattle, Washington.

Slick Fighter

NASHVILLE, TN—After the Exxon Valdez disaster, Congress ordered the petroleum industry to devise a

master plan to deal with future catastrophes. The result: a fleet of 16 new spill-response ships, to deploy nationwide next February.

Based on an offshore sup-

ply design, each 208-ft. ship will be able to recover, at best, 1900 barrels of spilled oil per hour. Skimmers, booms and pumps will pass the slick through oil/water

Fusion Profusion

ABINGDON, ENGLAND—Last fall, the world's largest fusion-energy test reactor pumped out a megawatt for 2 seconds, a hundredfold power jump over previous efforts. The breakthrough took place here at the Joint European Torus (JET). The experiment was the first to use tritium, a radioactive isotope of hydrogen that boosts fusion's efficiency.

JET physicists plan to steadily jack up power output by adding more and more tritium to the conventional deuterium fuel.

Since the isotope is so rare,



the reactor creates its own by bombarding a lithium vessel lining with neutrons

Huge European tokamak passed the megawatt mark last November.

released during fusion.

With sufficient tritium, the reaction can run hot enough that engineers can switch off the external plasma-heating systems that pull so much energy.

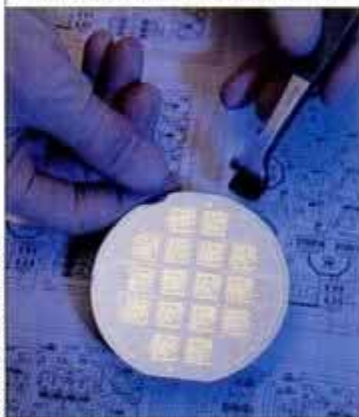
This self-heating condition, called ignition, should come before the JET program shuts down in 1996.



JET PHOTOS

Smart Skins Made Easy

CHURCHILL, PA—Westinghouse believes it can soon crank out miniature ra-



Wafer that houses multiple radar cells is only 1/4 of an inch thick.

dar modules for \$100 apiece. The technique promises phased-array radar antennas that fit under the curves of an aircraft's surface (see Tech Update, page 15, Jan. '90).

Developed under the Air Force's Smart Skins program, the Westinghouse device is a 3-in. gallium-arsenide wafer containing 16 transmit/receive cells.

Each cell operates independently, raising the possibility of missiles that can jam separate hostile radars while zeroing in on a target.

Westinghouse has delivered five wafers to the Defense Advanced Research Projects Agency for testing.

The Tiny Tim Of Torque

TOKYO, JAPAN—While micromachinists learn to carve midget motors from silicon, engineers at Toshiba Corp. have developed what they bill as the world's smallest electromagnetic motor.

Coils, magnet, bearings and control circuitry all fit into a cylinder only 2/10 of an inch long. A single integrat-

ed-circuit controller replaces conventional brushes and position-detecting sensors.

Because it generates torque electromagnetically rather than electrostatically, the motor uses very little power—only 2 to 3 volts. Low power consumption is viewed as essential to the development of microme-

chanics. Japan is embarking on a 10-year, \$200-million program to commercialize micromachines.

Toshiba Corp.'s flea-size electromagnetic device shrinks motor technology by 40%.



TOSHIBA PHOTO



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It's easy enough to want a Harley-Davidson®. But when you can get your very own fresh out-of-the-crate Sportster® for the price of a mere motorcycle, it's enough to really get you going. If it doesn't, chances are nothing will.

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*\$4495 Sportster® 883 in vivid black only. Other colors, Arkansas and California models slightly higher. Price listed is Manufacturer's Suggested Retail Price, excluding taxes, title and registration fees, destination charges and dealer prep (if any), and is subject to change without notice. Call 1-800-443-2153 for the location of a Harley-Davidson® dealer near you. We care about you. Sign up for a Motorcycle Safety Foundation rider course today. Ride with your headlight on and watch out for the other person. Always wear a helmet, proper eyewear and appropriate clothing, and insist your passenger does too. Protect your privilege to ride by joining the American Motorcyclist Association. © 1991 Harley-Davidson, Inc.

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“Out-powers and Ford and Chev compact or

Comparing a Dodge Dakota V-8 to other pickups is easy. There's simply no comparison.



Dodge Dakota 4x2 Club Cab out-runs the compact extended cabs 0-60, with 960 lbs payload and with 5,850 lbs combined payload and trailer weight!

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BUY OR LEASE AT YOUR DODGE DEALER. Buckle up for safety.

out-accelerates y hands down, half-ton."

-Certified by SCORE International, January 1992

With that 230 hp power plant pulling for it, Dakota over-powers *full-size* Ford and Chevy half-tons, as well. Out-running them, empty and loaded. And delivering more horsepower and more available towing than a standard F150 or C1500 pickup.

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Dodge Dakota 4x2 Club Cab out-paces full-size regular cab pickups 0-60, with 1,150 lbs payload and with 6,040 lbs combined payload and trailer weight.¹

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¹All trucks equipped with auto. trans. & max. avail. axle ratios. Graphs not proportional to test data. ²See limited warranties, restrictions & details at dealer. Excludes normal maintenance, adjustments & wear items. ³Overall total scores of combined model segment comparisons.



Sucking Away Drag

EDWARDS AFB, CA—A suction system installed on a jet's wing has proved effective in siphoning off the turbulent air that contributes to drag. Built into the wing of a supersonic civil or military jet, such a system could boost fuel efficiency and cut aerodynamic heating.



F-16XL, gloved with laminar-flow panel, tests device for future supersonic transport.

called a laminar-flow glove, consists of a sheet of titanium riddled with millions of tiny laser-cut holes. Through these, an engine-driven suction pump draws air. A fiberglass fairing helps to blend the raised panel into the wing's upper surface. Rockwell Intl. designed and built the system for NASA.

Significantly, the system created laminar flow (the unruffled passage of air over the wing) at speeds of up to

Mach 1.5 and altitudes of 50,000 ft. Drag fell by about 9%. The angle of attack, it turned out, affected laminar flow less than expected.

A second F-16XL will soon begin flying with a system covering more than 60% of its wing chord, developed at NASA's Langley Research Center. NASA also plans to see how well the laminar-flow glove works without the suction pump, saving weight. Meanwhile, Boeing is testing a similar system that only draws away air at the leading edge.

Workers at NASA's Ames-Dryden Flight Research Facility fitted the suction panel to the broad delta wing of a General Dynamics F-16XL on loan from the Air Force. The panel,



ROCKWELL INTL. PHOTOS

Breath Diagnosis

COLUMBUS, OH—A machine that pinpoints trace chemicals in breath may detect disease or exposure to hazardous chemicals.

Developed by the Battelle Columbus Lab, the device combines a breather interface with a trace atmospheric-gas analyzer (a specialized mass spectrometer sometimes deployed as an air

monitor at hazardous waste dumps). Exhalations go through a tube and build up in a chamber heated to prevent trace chemicals from condensing on its sides.

From there, the gases are ionized and nitrogen is stripped away. Ion-transfer lenses focus the gases into the analyzer, which is tuned to find a contaminant by its mass.



Breath analyzer measures minute quantities of dangerous chemicals.

Since the analyzer gives continuous readings, the machine can determine how quickly the body vents itself of toxins, such as dry-cleaning compounds. It's also proven itself capable of detecting dimethyl sulfide, a chemical that indicates liver cirrhosis.

BATTELLE PHOTO

Flight-Sim Carousel



ORLANDO, FL—Flight simulators and videogames continue to exert influence over the design of new amusement rides. Latest example: the Chameleon, billed

as the first interactive simulation attraction.

Chameleon comes in two varieties: a stationary single-pod unit or a multi-arm version. Pods on the latter are


mounted on planetary axes and can pivot in three dimensions while the ride spins at 15 rpm. Inside each pod,

riders watch a large computer screen and play a videogame, using a joystick or steering wheel. Movements of the

stick or wheel feed back into electric actuators that swing the pod, generating a continually changing acceleration field to match the rider's twists and turns. A PM

Chameleon thrill ride follows individual passengers' commands via joystick or steering wheel.

correspondent rode it this winter at the Orlando convention where it debuted, and emerged shaken but impressed.

The machine, which should become available within a year, can run video software featuring car chases, F/A-18 dogfights or futuristic space combat. 



PAUL L. RUBEN PHOTO

PM ILLUSTRATION BY ADOLPHE BROTHMAN

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The Bayliner Classic series takes Bayliner to an all-
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 A detailed illustration of the Orlyonok amphibious aircraft, a massive wing-in-ground-effect flyer. The aircraft is shown from a low-angle perspective, skimming the surface of the water. It has a white fuselage with a prominent orange-red stripe running along the side and a large orange-red section on the tail. The tail features the Russian flag. The aircraft's wings are long and flat, and its nose is rounded and pointed downwards. The background shows a blue sky with light clouds.

WINGSHIPS

Massive wing-in-ground-effect flyers combine jetliner speeds with steamship economy.

BY ABE DANE, Science/Technology Editor

● Amid the ruins of an empire worn down by the long-smoldering standoff of the Cold War are scattered jewels of technology. Born out of decades of steady and secretive toil by the best minds this vast nation could muster, many are unlike anything the Free World has ever seen.

One of these is called *Orlyonok*, or Little Eagle. Half

airplane, half watercraft, its prototype emerged quietly from a shipyard along the banks of Russia's Volga River more than a decade ago. It is the realization of a concept that Western engineers have only toyed with.

Able to skim a few feet over the wavetops at 250 mph and land 30 tons of troops, missiles and supplies on an embattled beachhead, *Orlyonok* was designed to fight a



war that never came. Now, desperate to make their vast investment pay off, the builders of *Orlyonok* are hunting for new markets—and beginning to share their secrets.

The lines of communication between East and West are still shaky. But interviews with Russian sources and Western aerodynamicists are beginning to yield a detailed view of a technology that could, if properly nurtured, deliver the first major advance in high-speed transport since Boeing brought jetflight to the masses.

On thin air

Orlyonok is a massive and complex machine. With a length of 190 ft. and a maximum takeoff weight of 275,000 pounds, it is on the scale of a medium-size widebody airliner like the Boeing 767. What sets *Orlyonok* apart, how-

ever, is that, along with a handful of similar Russian craft, it is the first practical, large-scale flying machine built to harness a powerful aerodynamic phenomenon known as the ground effect.

Familiar since the dawn of aviation, the ground effect is what accounts for the simple fact that winged craft fly more efficiently when they're close to the ground. It works by altering airflow patterns to increase lift and reduce drag.

In normal flight, high-pressure air spilling up from beneath each wingtip stirs up tornado-like currents called wingtip vortices. These trail back from the wing and deflect the passing airstream downward. This gives the airstream's overall direction a slight downward slant. And since lift runs perpendicular to airstream, the wing

tends to pull the plane backward slightly as well as upward.

Aerodynamicists have developed a number of ways to address this, including the winglets now commonplace on the tips of jetliner wings. But none of these match the effectiveness of flying so low that the ground blocks the swirling vortices.

While any airplane can benefit from the ground effect simply by staying within about half a wingspan of the surface, it takes a different breed of air vehicle to take full advantage of it. The reward is substantial, however. A purpose-built ground-effect vehicle—known as a wing-in-ground-effect craft (WIG), or *ekranoplane* in Russian—can fly on about one-fifth the power of a similar-size airplane flying out of ground effect. That means five times the fuel efficiency.

WIGs and PARWIGs

Over the years, numerous small prototypes have been built that test all kinds of WIG configurations. One of the most advanced is the 2-seat Flarecraft, which appeared on our July 1989 cover and recently entered production. But all of these are aerodynamic playthings compared to what the Russians have built.

"They are hands down, 30 years deeply in advance of the West," says Stephan Hooker, a top U.S. ground-effect expert who has visited several

where it is trapped by trailing edge flaps and wingtip endplates. The result is a cushion of air that lifts the craft off the surface and enables it to move easily at low speeds, much like a hovercraft.

PAR solves a problem that has always dogged seaplane designers. Namely, that water is about 800 times denser than air. That means it takes a tremendous amount of energy to get a plane moving through the water fast enough to take off. Historically, the solution has been to sacrifice flying

performance by overpowering the craft and by giving it a lot of wing area so it can get airborne at low speed. PAR reduces the need for such compromises.

Son of a Seamonster

Orlyonok's design was developed by the late Rostislav Evgenyevich Alekseev, a revered figure in Soviet aerodynamics. An earlier effort of his, known in the West as the "Caspian Seamonster," is the source of *Orlyonok's* basic shape. Built in the early



Designed for amphibious assault, the thoroughly proven *Orlyonok* could evolve into a variety of civilian vehicles.

of the Russian design bureaus.

This sophistication is based not only on strong theoretical analysis and thorough testing, but on decades of practical experience. Where others have sketched, the Russians have built. A sampler of the resulting knowhow can be found in *Orlyonok*. Although the Russians are quick to point out that it is not their most advanced design, it is far and away the most advanced WIG that Westerners have been allowed access to.

A key feature originated by the Russians, and built into all of their large WIGs, is the ability to use something called the Power-Augmented Ram (PAR) effect. In the case of *Orlyonok*, this is created by a pair of Kuznetsov NK-8 turbofans mounted inside the nose. Swiveling nozzles direct exhaust back beneath the wings,





FM ILLUSTRATION BY MARK MCCANDLISH

Early conceptual design study for a 10-million-pound wingship is one of several developed by Stephan Hooker for the Pentagon.

1960s, that one-of-a-kind vessel was powered by 10 turbine engines and was about 300 ft. long, making it one of the largest aircraft ever built.

In Alekseev's designs, lift comes from a stubby, low-aspect-ratio wing mounted amidships and a large, horizontal tail surface mounted high atop the vertical fin. This twin-wing configuration overcomes longitudinal instability that has plagued other ground-effect vehicles. The problem arises from a tendency for the center of pressure supporting the craft to move fore and aft with changes in altitude. Alekseev locates the tail surfaces high enough out of ground effect and shapes them so that these complex dynamics aren't a problem.

In the case of *Orlyonok*, the high vertical tail also provides the perch for a Kuznetsov NK-12 turboprop engine, well known to NATO for its use on the Bear strategic bomber. Fitted with twin counterrotating propellers, it puts out 15,000 horsepower to drive *Orlyonok* in cruising flight, during which the forward PAR engines are usually shut down. Not only is the turboprop more efficient than a jet, but its variable pitch provides remarkable low-speed maneuverability in PAR mode.

What is it like to fly such an unorthodox craft? Valentin Vassilyevich Nazarov, chief designer with the Ekolen design bureau and one of *Orlyonok's* test pilots, spoke to us about it by phone from St. Petersburg, Russia.

"The procedure is similar to the one of any flying device," he says. "You have to start the engines, place all the crew in their places, run a check on all the equipment, warm the takeoff engines and the main engine. Then the

takeoff engines start pumping the air under the wing, and the horizontal movement starts. The craft starts to lift itself from the water. It gains speed up to 150 kmph [93 mph]. Thereafter, the pilot can use all aerodynamic surfaces to fly the craft." Normal cruising altitude is between 25 and 40 ft., depending on wave height.

Some of the strain of maintaining altitude so precisely is relieved by a computerized flight control system, which uses inputs from surface-scanning Doppler and conventional radars. To avoid obstacles, altitudes of up to 5000 ft. are attainable—but at a high cost in efficiency.

Going commercial

While remarkable in many ways, *Orlyonok* represents the past rather than the future of wing-in-ground-effect flight. "*Orlyonok* is already history," says Nazarov. Strapped for cash, but full of ideas, Ekolen has already designed a whole range of new civilian ekranoplanes to replace it.

According to the bureau's president, Ilya Lvovich Gerlozin, these represent a distinctly different approach. "I would use just one word to describe it: comfort. In *Orlyonok*, there was no such thing as comfort because it used to be a military vehicle." Neither Nazarov nor Gerlozin would discuss details of the new craft, elements of which they say are now being patented.

Ekolen's efforts represent just a small portion of the ekranoplane activity now emerging from secrecy in the former Soviet Union. Another, far larger consortium is also known to be carrying on Alekseev's work. Also, a substantially different, but similar-

ly refined, approach is reportedly being pursued by the followers of the Italian/Soviet designer Roberto di Bartini. Their efforts could lead to vehicles suited to travel over the barren tundra of Siberia, as well as over water. However, no Russian company has the resources to undertake a major building program on its own. All are looking for foreign partners.

Wingships: the next wave

One American keenly interested in pursuing such a relationship is Stephan Hooker. His engineering firm, Aerocon, has been commissioned by the Pentagon's Defense Advanced Research Projects Agency (DARPA) to explore the potential of wing-in-ground-effect flight. The hope is that it may turn out to be a technology of considerable military and economic value to the United States.

The upshot of Hooker's thinking is that if WIGs are to be practical as long-range transports, they will have to be big—very big. Typical of the early conceptual design studies he is working with is a 500-ft.-long craft, weighing 10 million pounds. He calls this class of vehicle a "wingship."

Initially, the idea of building a flying machine roughly 10 times the size of the largest airplane on Earth seems outlandish. But Hooker's arguments are logical. They begin with economics. "If you're a Boeing commercial airplane designer, cents per seat-mile is your big thing," he says. This consideration has kept the pressure on to build steadily larger aircraft. As the progression continues, however, the demands of aerodynamics and structural integrity begin to clash. Aerody-

(Please turn to page 123)



CONCEPT INTERNATIONAL

The world's top designers forecast the shapes and systems of tomorrow.

BY JIM DUNNE, Detroit Editor

● It's clear that concept cars are designed to help generate interest in the cars of tomorrow. In our recent visits to the Frankfurt and Tokyo auto shows, we saw the zoomy shapes we expect at major shows. But there was another strong theme: we came to think of it as the Green Path, a growing corporate commitment to a cleaner environment, conservation of resources and recycling of reusable materials.

Does this mean the exotic shapes and power promises that have titillated showgoers since the days of the GM Autorama are destined to fade from the scene? No. The halls at Frankfurt and Tokyo—as well as the recent North American International Auto Show in Detroit—had plenty of future supercars on display.

But it does mean you'll see greater balance in the thinking that goes into the cars of tomorrow. The concepts go well beneath the skin—and well beyond outmoded manufacturing ethics.

HYUNDAI HCD-1

The most exciting car to carry a Korean brand name, the Miata-size HCD-1 has a 94-in. wheelbase and is 154½ in. long. Its 2.0-liter 16-valve Four is rated at 150 hp. Designed in California for the U.S. market, the HCD-1 is reputedly destined for production, perhaps by 1995. Hyundai plans to bring the production version to market for about \$13,000 to \$14,000.



NAZCA C2

Created by Giorgetto Giugiaro's Italdesign Studios in Turin, Italy, the Nazca C2 could be the next supercar from BMW. The midengine rear-drive coupe uses a carbon-fiber chassis. Power is supplied by BMW's 5.0-liter V12.

CONCEPT INTERNATIONALE



DAIHATSU X-021

The X-021 is basically a Miata on fast-forward. With a curb weight of 1540 pounds and 140 hp on tap from a 1.6-liter sohc 16-valve alloy Four, this is one hot little number. The engine is set well back in the chassis, yielding a 50/50 weight distribution. Suspension is forged-aluminum double wishbones all around, the brakes are 14-in. discs with ABS, and there's a driver's airbag and door beams.

ISO-RIVOLTA GRIFO

Here's one concept that's well on its way to reality. The revival of the old Iso-Rivolta, which made its mark in the late '60s and early '70s using Corvette powerplants, is scheduled for 1993. The Grifo will use either a turbocharged LT-1 Corvette engine or a normally aspirated LT-5 from the ZR-1, with a 6-speed ZF gearbox. The target is 435 hp.



VOLKSWAGEN CHICO

This tiny 4-seat hybrid uses a 2-cylinder gasoline engine for acceleration and freeway travel. On city streets, its electric motor kicks in. Double-acting doors make it easy to get in and out of, even for rear-seat passengers and there are three different roofs available—conventional, convertible and solar. A parking beeper senses obstacles fore and aft, increasing beep frequency with proximity.

AUDI QUATTRO SPYDER

A 2-seat sports car that demonstrates the weight-saving benefits of an aluminum-tube chassis and aluminum body skin. With a 2.8-liter V6 that develops 172 hp installed behind the driver, the 2420-pound Spyder has a top-speed rating of 150 mph. Overall dimensions are about the same as the Audi 80 sedan, but the Spyder uses oversize, 18-in. wheels. Besides the recycling advantage, aluminum's light weight will mean performance and fuel economy advantages in production sedans.



AUDI AVUS QUATTRO

Its name recalls the glory days of the 16-cylinder Auto Union Grand Prix cars, and its burnished-aluminum bodywork pays tribute to the new environmentally conscious commitment of recycling reusable materials. There's Grand Prix power behind the seats, too: 500 hp from a 6.0-liter W12 engine—three Fours sharing a common crankshaft.



PM PHOTO BY G PHOTO

ACURA FS-X

Could this be Honda's answer to the Lexus LS 400 and Infiniti Q45 luxury cars? Some elements—the video-screen navigation system and blind-spot monitor, for example—may be 21st century, but competitors think this car could be in Acura showrooms within the next 18 months. Other FS-X features: airbags front and rear, a 280-hp 3.5-liter V6 and full-time 4-wheel drive.



PM PHOTO BY G PHOTO



MERCEDES-BENZ S-C 112

It looks like a racer for good reason—this prototype is based on the Sauber Mercedes Group C car that won a world championship in 1990. The 402-hp dohc 48-valve V12 is the same engine used in the new Mercedes 6-series cars, and it's capable of pushing this prototype to 192 mph. The car's sophisticated systems include active suspension, active variable aerodynamics, variable brake-pressure distribution, traction control, cybernetic rear-wheel steering and antilock braking.

TOYOTA AXV-III

The lightweight aluminum-bodied AXV-III demonstrates, among other things, the next level of safety with door-mounted airbags to protect passengers in side impact collisions. It's also designed to keep you from getting lost, with a global-positioning system that uses Earth-orbiting satellites. And—shades of Capt. Kirk—it's voice-activated. The driver simply asks the car where he or she is, and the answer flashes up on the car's computer screen.



HONDA EP-X

Anyone who remembers the old Messerschmidt 2-seaters that used to terrorize European streets won't think this 1+1 is farfetched at all. Power comes from a 1.0-liter engine, and fuel economy is projected in the 85-mpg range. Bodywork is aluminum, and both passenger and driver are protected by airbags. Honda claims it could build and sell this car today for less than \$20,000.



NISSAN FEV

The Future Electric Vehicle is a 2+2 coupe that can be recharged to 100% battery capacity in just 15 minutes, according to Nissan, although the power draw from the recharging station to do so is impractical at this point. Top speed is 81 mph, while range at 45 mph is 100 miles. A heat pump handles air conditioning and heating. A roof-mounted solar cell and regenerative braking help extend range.

WILD THINGS

Speed and sex appeal collide in a trio of firebreathers from performance boating's Big Three.

BY JOE SKORUPA,
Boating/Outdoors Editor
PM Photos by Brian King

● Let's get one thing straight. Off-shore muscle boats are serious performance machines. They're unmuffled, 1000-hp firebreathers. They're high-speed, rock-solid wave busters. They're sexy, macho, stunningly expensive and so aggressively styled that they practically strut to the dock with an in-your-face attitude.

So what am I doing in a Cigarette 38 Top Gun that's running in formation with a Wellcraft Scarab 38 Thunder and a Fountain 35 Lightning? Just lucky, I guess.

Much as I'd like to think I was born to be a muscle-boat jockey, the truth is that these boats don't exactly fit my lifestyle. At nearly \$200,000 a copy, they cost as much as my house and 15 times more than my car. But don't let the plush amenities and luxury stickers fool you. These aren't comfy mirrors-and-velvet yachts. They're true offshore warriors with leading-edge technology and a proven racing lineage.

Cigarette 38 Top Gun

Ever since Don Aronow built the first Cigarette, in 1969, this off-

Shredding Miami's Biscayne Bay from top: Cigarette 38 Top Gun, Fountain 35 Lightning and Wellcraft Scarab 38 Thunder.



FOUNTAIN

SCARAB



WELLCRAFT SCARAB 38 THUNDER

A new firebreather from Wellcraft, the 38 Thunder is a headturner at speed and on the beach. Power to burn comes from twin HP465 Mercs. The high-performance dash features Nordskog speedo.

shore muscle boat has defined the breed. To many people, *all* long-nosed speedsters are Cigarette boats no matter who builds them. But the truth is, there's only one Cigarette, which is now officially called the Cigarette Racing Team.

The Cigarette we put to the test was the 38 Top Gun equipped with twin MerCruiser HP425 engines and Merc TRS outdrives. This is the boat's standard rigging. Some standard. It delivers a whopping 850 hp.

All Cigarettes have a reputation for being bulletproof, and a close look at the 38 reveals why. To provide hull integrity under stress, the 38 uses multiple longitudinal stringers and bulkheads, plus a unique system of foot-wide Klegecell-cored bands. Coring of balsa and Trevira (a high-tech nonwoven fiber) is also used in the hull's bottom and sides.

While the cabin area is suitably macho, the 38's focus is on performance: steel race mounts for the engine, heavy-duty trim tabs, Zero Effort throttles and shifters, fuel-booster pumps and high-mounted instrumentation.

The crew was impressed with the richness and strength of the 38's construction, and noted that fit and finish was second to none. Small wind deflectors and a low helm fairing offer minimal protection for the average boater, but, hey, average boaters don't drive Cigarettes.

Fountain 35 Lightning

The only other man to pull off the Don Aronow hat trick of designing, building and racing his own line of offshore muscle boats is Reggie Fountain, a former tunnel-boat legend who continued to win races after moving up to offshore boats in the late 1970s.

Reggie personally drove a 35 Lightning to our test and equipped it with the fleet's most exotic power package—twin HP525SC Merc engines with Weiand superchargers and Bravo One drives. With all 1050 horses in full gallop, the 35 hit 78 mph.

Like the 38 Top Gun, the Fountain 35's focus is on high performance. Longitudinal stringers, multiple bulkheads and Klegecell-coring provide structural integrity. Nonwoven bi- and tridirectional fiberglass, plus high-tech Trevira, add maximum

strength with minimal weight.

Standard speed features include: aluminum racing mounts for the engine, heavy-duty trim tabs, boost gauges, Zero Effort throttles and shifters and Nordskog speedos. One ear-saving option we liked is the Silent Choice exhaust, which routes engine roar below the waterline at the flip of a switch. While dash instrumentation is complete and compactly arranged, some gauges are low and cramped around the wheel.

Some items, such as a bolt-on windscreen and low headroom below, often take a back seat to the focus on high performance. But for the thrill of pure macho speed, the 35 places you squarely in the driver's seat.

Wellcraft Scarab 38 Thunder

Like the other speed machines, the Scarab marquee and image was honed by a unique man, Larry Smith, boat designer extraordinaire. Smith's designs for Wellcraft have won a warehouse full of trophies since Scarab was introduced in the mid-1970s. They've also attracted a glittering stable of celebrity owners by concentrating on

SPECIFICATIONS AND DIMENSIONS

MANUFACTURER/MODEL	BASE PRICE/ AS TESTED	LENGTH/BEAM/ WEIGHT/ FUEL CAPACITY	ENGINE/ BLOCK	CRANKSHAFT HP/ PROP HP ¹	DRIVE UNIT/ PROP	DRAFT/ DEADRISE
Cigarette 38 Top Gun 3131 N.E. 188th St., N. Miami Beach, FL 33180	\$180,000/ \$180,000	37'6"/8' 9900 lb./260 gal.	MerCruiser HP425/ GM 454 cu. in.	425 hp @ 5200 rpm/ 400 hp @ 5200 rpm	MerCruiser TRS/ 21" Mirage	24"/ 24"
Fountain 35 Lightning P.O. Box 457, Washington, NC 27889	\$143,000/ \$165,000	35'8"/4' 7300 lb./160 gal.	MerCruiser HP525SC/ GM 454 cu. in.	525 hp @ 5200 rpm/ 490 hp @ 5200 rpm	Bravo One/ 20" Mach 4-blade	22"/ 24"
Wellcraft Scarab 38 Thunder 1651 Whitfield Ave., Sarasota, FL 34243	\$154,000/ \$190,000	37'10"/8'9" 8950 lb./191 gal.	MerCruiser HP465/ GM 502 cu. in.	465 hp @ 5200 rpm/ 445 hp @ 5200 rpm	Bravo One/ 25" Mirage	24"/ 24"

1. HP shown per engine in twin-engine installations. 2. GPH at wide-open throttle went beyond scale of flow meter. 3. With Silent Choice, engaged readings were



FOUNTAIN 35 LIGHTNING

The latest bolt from Fountain, the 35 Lightning is equipped with twin supercharged HP525SC Mercs. Ready for racing, the dash features boost gauges for the superchargers and throttles mounted on the left.

design, graphics and amenities—areas often overlooked by builders dedicated to speed.

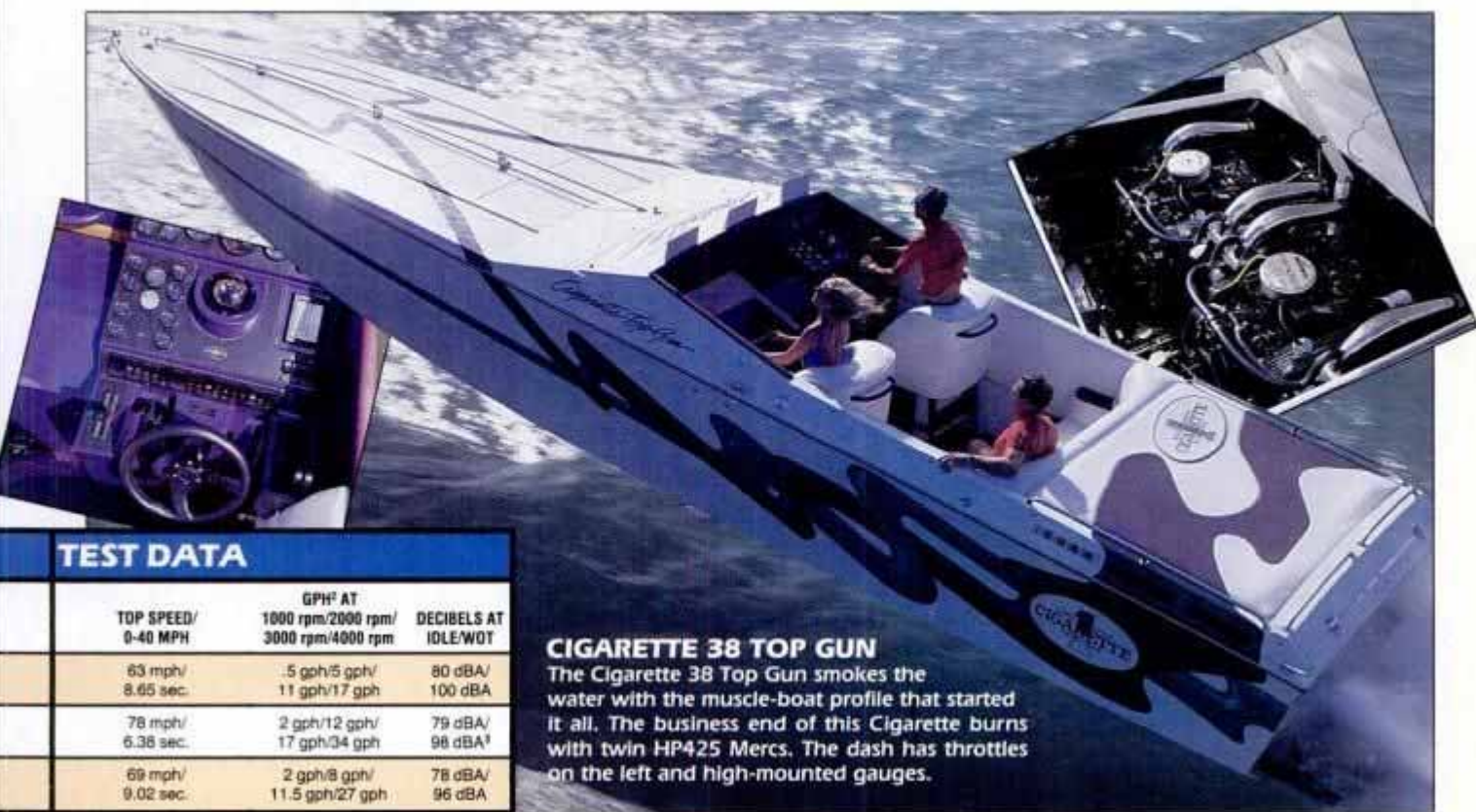
Our 38 was one of the new breed of Scarabs called the Thunder Series, which features a conscious return to the speed-comes-first philosophy. To achieve both lightness *and* strength in the hull, the 38 Thunder uses a new composite-alloy laminate made of bi- and triaxial fiberglass woven with Kevlar strands. Divinycell coring is

used in the deck and hull. For extra stiffness, the spaces between the strakes are filled with a layer of DuPont microballoons.

Our 38 came equipped with twin 465 Mercs and Bravo One drives, which produce a blistering top speed of 69 mph. Go-fast features on the 38 include Zero Effort throttles and shifters, Latham hydraulic steering and wheel, K-Plane heavy-duty trim tabs and Nordskog speedos. Special

features we liked are a functional windscreen, diamond-plate finish in the engine compartment, well-laid-out helm instrumentation with great sightlines and too many others to list.

While the 38 Thunder is lean and mean compared to most Scarabs, it makes a serious effort at combining speed with eye-catching style. Is this important at 70 mph? You bet it is. In this crowd, image and attitude are everything. **PM**



TEST DATA

TOP SPEED/ 0-40 MPH	GPH ² AT		DECIBELS AT IDLE/WOT
	1000 rpm/2000 rpm/ 3000 rpm/4000 rpm		
63 mph/ 8.65 sec.	.5 gph/5 gph/ 11 gph/17 gph		80 dBA/ 100 dBA
78 mph/ 6.38 sec.	2 gph/12 gph/ 17 gph/34 gph		79 dBA/ 98 dBA ¹
69 mph/ 9.02 sec.	2 gph/8 gph/ 11.5 gph/27 gph		78 dBA/ 96 dBA

CIGARETTE 38 TOP GUN

The Cigarette 38 Top Gun smokes the water with the muscle-boat profile that started it all. The business end of this Cigarette burns with twin HP425 Mercs. The dash has throttles on the left and high-mounted gauges.

71 dBA at idle and 90 dBA at WOT.



POSSIBLE DREAMS

America's dreams of flight soared with the invention of the airplane.

BY MARY SEELHORST

● Ever since Icarus and his father soared into the misty, mythological skies of ancient Greece on wings made of feathers and wax, the dream of flight has fueled our technological imagination as no other. His fate, however, was a warning for those who presumed to fly like the gods. And for centuries to come, mankind's imagination was all that soared.

When POPULAR MECHANICS was founded in 1902, public interest in vehicles of the air was growing, although most people still regarded this "wild dream of crazy inventors" with skepticism. Yet, by the end of World War I, both PM and flying machines were fundamental features of the American scene. And between 1902 and 1919, PM described the dream and the debate—a record of success, failure and pure entertainment that offered lots of things and thoughts from which to put together an excit-

Mary Seelhorst is curator of the "Possible Dreams" exhibit at Henry Ford Museum & Greenfield Village in Dearborn, Michigan.

ing section for Henry Ford Museum's "Possible Dreams" exhibit.

The name for the section on early aviation was drawn from a 1908 PM observation: "America is rapidly contracting the flying fever and with the hustle which characterizes the American in business or pleasure, it will not be long before this country becomes a seriously considered rival to France." Devising the Flying Fever section was a thrill in itself as the planning team matched stories in the magazine with 20 aviation-related objects in the museum's collection.

The team's biggest discovery (literally) was that Louis Bleriot's 1909 crossing of the English Channel—a pivotal event in aviation history—had been covered extensively in PM. This flight that so startled the world was accomplished in a Bleriot XI monoplane—and the museum owns one.

So what if the plane hung from the ceiling in the back of the museum directly over large, immovable objects? So what if it had a 28-ft. wingspan? So

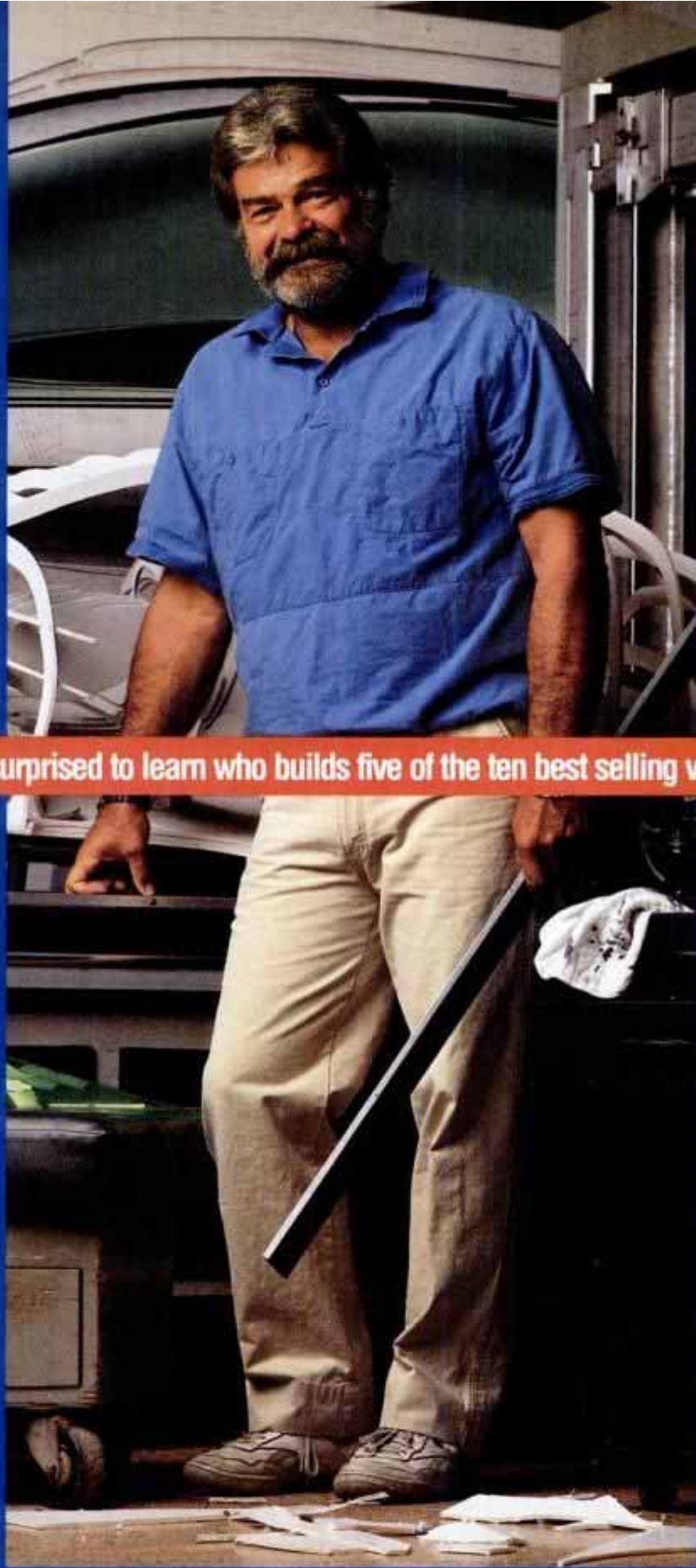


what if it had to be moved to the front of the 12-acre museum and rehung? If Bleriot could fly it across the Channel, the exhibit team would find a way to move it across the museum.

Visitors who know the details of Bleriot's famous flight may notice that the 3-cylinder, air-cooled Anzani engine, original to his craft and the one in the museum, has been replaced with a 7-cylinder Gnome rotary. After depending on the 25-hp Anzani to carry him across the waves, Bleriot himself recommended the lightweight yet powerful Gnome—named for its diminutive size. Eventually, it became standard equipment. Nearby, a 9-cylinder Gnome rotary has been displayed for closer inspection.

Today, the museum's Bleriot monoplane buzzes the entry to the "Possible Dreams" exhibit, surrounded by other evidence of Flying Fever.

(Please turn to page 121)



Al Gerstenberger: Ford Designer

"You might be surprised to learn who builds five of the ten best selling vehicles in America."

At Ford Motor Company, when we set out to design a new car or truck, we never forget that your opinion is the most important one. So, we get input from customers at every stage of new product development to find out exactly what you're looking for. That may be why five of the ten best selling vehicles in America are made by Ford Motor Company.*



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QUALITY IS JOB 1.SM IT'S WORKING.

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*Based on 1991 Calendar Year sales data

Always insist on genuine Ford Motor Company collision repair parts.

Материалы, связанные с автомобилем, являются товаром.

SHOWS

Here are our eye-opening picks from the Consumer Electronics Show.

BY FRANK VIZARD,
Electronics Editor

● The clever, the amazing and the future are all highlighted at CES. This year's show in Las Vegas was no exception. Most eyes were on the future, though. A new digital audio tape format and widescreen TV are within sight. Meanwhile, a watch James Bond would love, a self-cooking microwave and an electronic baseball wizard are already at hand.

By the way, the biannual CES is opening its doors to the public for the first time—on May 30 and 31 at the McCormick Place Convention Center in Chicago, Illinois.



Home-Theater Monster Controller

Make King Kong really roar with the Integra TX-SV909PRO audio/video receiver from Onkyo. Inside the cabinet there are seven amplifiers providing 100 watts per channel to the left, right and center channels, 30 watts each to two rear channels and another 30 watts each to two "front-enhance" channels, which can also be used to power a second pair of speakers in another room. The TX-SV909PRO is reportedly the first receiver with full digital surround sound for lower distortion, better stereo separation and better localization of movie sound effects. A digital sound processor lets you simulate various acoustic venues as well. List price is \$1800.

Hidden Agenda

When the lid is closed, this watch looks like most other analog watches with hour, minute and second hands. When you flip open the lid, however, you have the Casio Data Bank watch. The Data Bank stores 50 telephone numbers. Each "page" consists of a maximum of eight letters and 12 numbers. There's also a schedule memo of eight letters per page and a free memo of six pages with 15 letters each. The free memo mode is for writing short notes to yourself. Also included is a calculator and five daily alarms. List price is \$350.



Effortless Cooking

This Sharp microwave automatically senses how long food should be cooked. A sensor checks the amount of humidity emitted by the food and compares its findings to a built-in data bank. There's also one-touch buttons for popcorn, defrosting, reheating and a variety of other functions. The R-3H83 Smart & Easy microwave lists for \$330.

Driver To Navigator: Where Am I?

Tired of asking strangers for directions? Ask Sanyo's VoiceMap instead. The system features a 4-in. LCD screen and a trunk-mounted data storage unit. Orbiting satellites identify the vehicle's current position, VoiceMap does the rest. By audibly prompting the machine, you can see your location and destinations, or locate restaurants, hotels and other points of interest. VoiceMap should be available sometime next year.



Talk To Las Vegas

Biaupunkt combines a cellular telephone and cassette radio into a component that installs into a car's dashboard. Dubbed the Las Vegas, it allows you to use voice commands to place and receive calls. The unit remembers up to 85 phone numbers. The radio, cassette player and optional CD changer also respond to voice commands. It will be available later this year.

TOPPERS

Digital Sound On Tape

The Digital Compact Cassette (DCC) promises CD-quality sound on tape. Set to debut this fall, DCC machines offer backward compatibility. This means that existing analog cassettes can also be played on DCC tape decks. DCC is a rugged audio format very suitable for car and portable use. The format has widespread industry support, so its success is virtually assured. Price is expected to be about \$700, very low for a new technology.



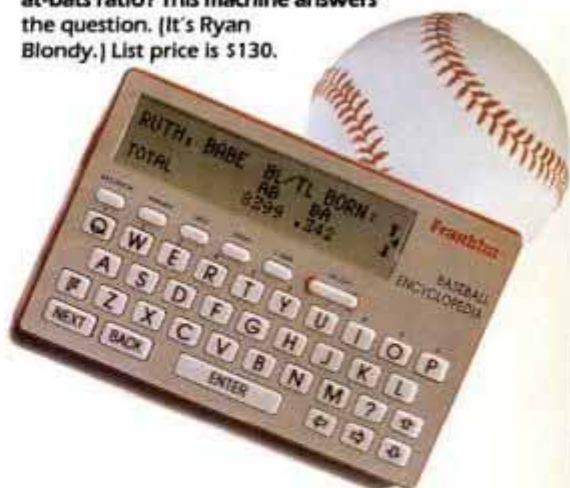
Game Blaster

No, this isn't a new surface-to-air missile launcher. It's a new videogame accessory from Nintendo. Position Super Scope 6 on your shoulder, aim and fire to destroy on-screen targets. The device uses an infrared beam to hit targets. This means you can score hits from anywhere in the room as long as you have line-of-sight with the TV. Listing for \$60, Super Scope 6 comes with a 6-game pack.



Baseball Know-It-All

Baseball statistics from Day One are packed into a tiny, handheld device from Franklin Electronic Publishers, Inc. Weighing just 5 ounces, this electronic encyclopedia has 620,000 batting and 270,000 pitching statistics. There is also biographical data and year-by-year information for every player in the history of the game. Which 1930s American League player with more than 100 at bats had the highest triple to at-bats ratio? This machine answers the question. (It's Ryan Blundy.) List price is \$130.



Widescreen Television

Expect the first widescreen televisions to debut later this year under the RCA and ProScan brand names. The first widescreen TV will have a 34-in. screen. Widescreen TV has a 16:9 aspect ratio, as opposed to the 4:3 ratio currently used. These TVs can be upgraded to a future high-definition standard when the time arrives.

PM

BUICK
PARK AVENUE
ULTRA

LONG-TERM TEST CARS

We say hello to Oldsmobile's new Eighty Eight and farewell to four solid citizens.

Oldsmobile Eighty Eight Royale LS

● There's a new guy in our garage. So far, we've had the car about six weeks and we've put 3500 miles on it. But even in that short time, we've reached some conclusions about the '92 Oldsmobile Eighty Eight Royale. As a combination of style, performance, handling and luxury, this could be one of the best cars GM has ever built.

Granted, we don't know yet how it will hold up. But we can tell you that all three staff members who have driven the car for any substantial amount of time have come back with rave reviews.

One of the reasons we like it is that we "built" it on the assembly line. We

don't always have that opportunity. We first spec'd the LS option, which gets you not only the upgraded trim level but also equipment like antilock brakes, cruise control, power door locks and other amenities. Then we added the LSS option. Available only on cars equipped with the LS trim level, the LSS option adds bucket seats, console, floor shifter for the 4-speed automatic trans, full gauges and touring suspension package. The touring suspension package (also available separately) includes firmer suspension components, quicker steering, a leather-wrapped steering wheel, automatic load leveling, 16-in. aluminum wheels mounting 225/60R16 tires, 3.06:1 final drive ratio and a

high-capacity cooling system. (By the time you read this, the LSS will be a separate model with all this equipment standard.)

All of the above magically transforms an Eighty Eight Royale from a 4-door sedan into a high-performance luxury car that gives new meaning to the term "New Generation of Oldsmobile." This is a car that you want to push hard. You look for unsuspecting BMWs on freeway on-ramps. You check maps for a longer, more twisty route to your destination. You look for opportunities to exercise the incredibly taut yet supple suspension. In short, this car handles. It's tight and stable and firm, yet never harsh. How do they do that?



**OLDSMOBILE
EIGHTY EIGHT
ROYALE LS**

Chevrolet Corvette Convertible

It's only been a couple of weeks since I began driving this car, and already it has left a series of strong impressions. Some pretty good, some not so good.

"Goodest" on the list of good points is the engine and automatic transmission. With 300 hp on tap, there's enough grunt to handily dispose of lesser vehicles at stoplights and toll-booths. The traction control will keep the back end in back, should you add a little too much throttle while cornering. And the LT-1 engine has enough torque to obviate most downshifting



**CHEVROLET
CORVETTE
CONVERTIBLE**

We added other options such as tan leather upholstery, super stereo and a driver information system.

To go along with all the handling is General Motors' ubiquitous 3800 V6 engine, rated 170 horsepower at 4800 rpm and 220 ft.-lb. of torque at 2000 rpm. Frankly, there are times when we yearn for more, even though 0-to-60 times of about 9 seconds aren't slow. But the suspension could handle extra power.

Inside our gleaming black test car, the tan leather buckets cradle you in supreme luxury and you're sorry to see your trip end. Happily for us, our Eighty Eight Royale will be around for a long time.

—Joe Oldham

in everyday driving. We drove from New York to Washington, D.C., down the New Jersey Turnpike, running with traffic—often at technically illegal speeds—and averaged just under 27 mpg. Phenomenal.

That freeway run also brought out a couple of the bad points. The cruise control became irritatingly intermittent on the way back. And the only way to keep this car from going way too fast is to use the cruise. We had a couple of inadvertent near-misses with New Jersey state troopers' radar. Also, the in-dash CD player won't accept about half of our collection—CDs that work fine everywhere else. On top of that, it skips when the car hits bumps any taller than the print on a subway token.

The FX3 electronic adjustable suspension system can be set to three settings. The all-out racing setting makes the car—and our kidneys—chatter sideways on any corner with even the smallest surface irregularity. Needless to say, we've been using mostly the other two for a softer but controlled ride.

As we speak, it's at the dealer for an oil change, a new CD player and cruise control repairs. —Mike Allen



**SUZUKI
SWIFT GT**

LONG-TERM TEST CARS



OLDSMOBILE
CUTLASS SUPREME

Buick Park Avenue Ultra

The Buick Park Avenue is one of those cars we don't want to give back when the test is over—which it is. We don't say that about all cars. Some cars we can't wait to give back. Not the Buick. It has become a good friend—totally reliable, ready to transport five people in luxury and comfort.

And since our test car was an Ultra, not a regular Park Avenue, it's as much at home on a winding road in upstate New York as it is on Park Avenue in Manhattan. Its upgraded suspension and tires provide excellent handling and a controlled—but always luxurious—ride.

The only complaint any of us had was that we would have liked more power in certain passing situations. That's been addressed in the '92 Ultra by way of supercharging the 3800 V6 engine. Power goes from the 170 in our '91 test car to 205 with the blower.

Yes, we liked the Park Avenue. And yes, we'd recommend it to a friend as a fairly priced American car that gives nothing away to any import in its class. And that's saying a lot.

—Joe Oldham

Suzuki Swift GT

This is the final report on our Suzuki Swift GT, and we wish it was only the first. In the course of 8215 miles, most of them accumulated in and around Manhattan, our relationship with this little car has blossomed into a full-fledged love affair.

When it comes to all-around utility, of course, its size can be a handicap. Although front-seat legroom is plentiful, accommodating rear-seat passen-

gers requires *lots* of cooperation and goodwill. Low-speed steering effort, as we've noted before, is excessive, and there are plenty of econocars that will deliver more on the econo side of the ledger.

But on the other hand, what you're getting here is really a sports car in econobox clothing. And if the Swift GT isn't in the 50-mpg league, it's certainly respectable—we averaged 31.2 mpg over the course of the test, and we weren't sparing the horses.

It may be that this car is suited only to individuals who want to add adventure to big-city traffic. But for those individuals, the Suzuki Swift GT should top the shopping list. If Walter Mitty had faced a daily blend of Lincoln Tunnel, Broadway and the perils of lower Manhattan, this would have been his car.

—Tony Swan

Oldsmobile Cutlass Supreme

With just under 14,000 miles on the clock, our Cutlass Supreme is headed back home to Lansing, Michigan.

There's not much to report since



CHEVROLET C2500 SILVERADO



DODGE DAKOTA SPORT V8

our last installment, aside from a rear window replacement, thanks to a Manhattan break-in. The small pane, positioned behind the opening section, set us back the princely sum of \$68, installed.

Fuel consumption has remained in the low 20s, heavily dependent on traffic and how hard your right foot prods the 3.4-liter dohc 24-valve V6. Thanks to this engine's gratifying response, we found ourselves doing this frequently.

There was precious little snow here last winter, but when there was some, the ABS system proved itself admirably. This system has a strange pedal feel, which bothered at least one tester. Regardless of the pedal feel,

(Please turn to page 104.)

HOME & SHOP JOURNAL



TOOL TECHNIQUES

COMPOUND MITER SAW

The tool for fast, accurate miter cuts is now more versatile than ever before.

TEXT AND PHOTOS BY ROSARIO CAPOTOSTO,
Contributing Editor

● It goes without saying that cutting wood to length accurately—and at a precise angle—is one of the most fundamental operations in woodworking. Whether your job entails rough carpentry, finish work or cabinets and

furniture, the accuracy and speed of your crosscuts determine the quality of the finished project and the efficiency of your production. Years ago, woodworkers relied on a stiff, long backsaw and miterbox to get the job

done. In its most basic form, the miterbox is a simple wooden jig that holds both the stock and the saw at a consistent angle.

Today's power miter saw has rendered the traditional miterbox all but obsolete. Some versions are little more than a heavy-duty circular saw mounted on a pivot so the saw can be swung down into the stock. The work is held against a fixed fence that supports the stock against the blade rotation. To handle a complete range of miter cuts, the saw can be rotated and locked at any angle from 90° to 45°, left or right, in relation to the fence. Compound miter saws feature an additional pivot point that allows the blade to

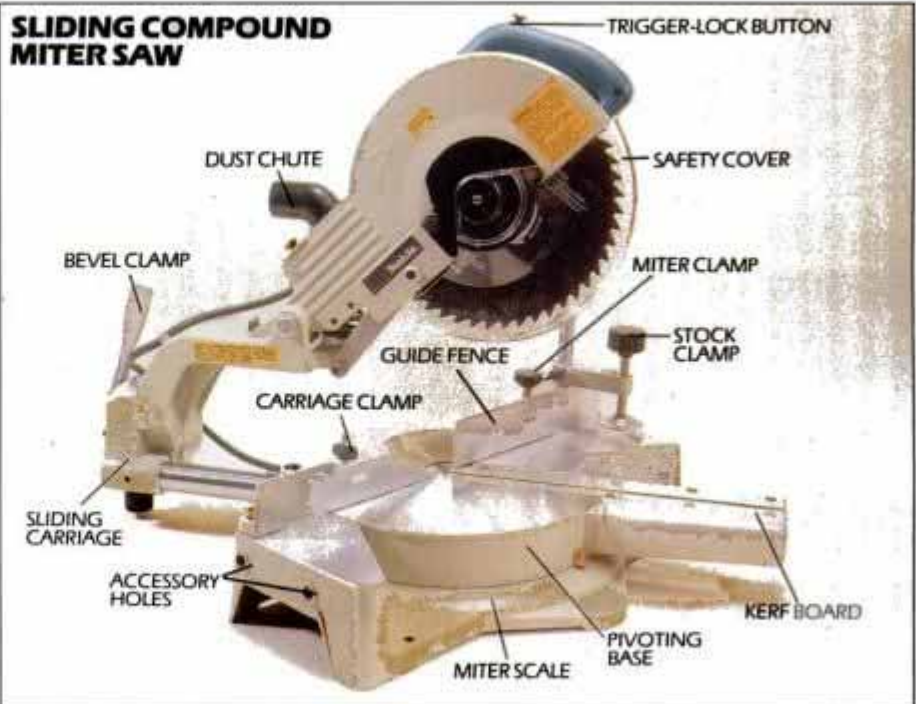
be tilted up to 45° to one side for cutting bevels. In combination with mitering capacity, this tool can cut quick and accurate compound angles.

While both versions are effective, their single drawback is a limited crosscutting capacity. Although their portability gives them the edge over a radial-arm saw in many applications, the crosscutting capacity of most standard miter and compound miter saws is limited to the width of a 2 x 6 cut at 90°.

The latest version of this tool addresses this problem by employing a sliding carriage similar to a radial-arm saw. Like its predecessors, the sliding compound miter saw has a spring-loaded circular saw head that can be lowered into the work for a chop, or press cut. However, by sliding the saw head across the work, the tool achieves roughly twice the capacity of a standard model. As opposed to standard radial-arm saw practice, the sliding miter saw is pushed into the work rather than pulled. An articulated blade guard automatically adjusts to provide continuous protection as the blade is raised and lowered.

Most blade manufacturers offer synthetic blade designs suited to producing the best possible cuts on a

SLIDING COMPOUND MITER SAW



Sliding compound miter saw has fixed guide fence for positioning work consistently. Saw head pivots for miters and tilts for bevels. Sliding carriage can be locked in place for press cuts.

power miter saw. Some miter saws come with a combination blade which has positive-hook teeth (the underside of each tooth angles back to form a chisel-type cutting edge). Ideally,

sliding miter saw users should replace this blade with a negative-hook, carbide-tipped blade. This blade eliminates the lifting thrust of an ordinary blade as it's pushed through the stock.

Extension Tables

Miter saws are intentionally designed with small tables so they're easily portable. But, unless proper support for long work is provided, the work is difficult to hold in place, and accuracy and safety are compromised. Most manufacturers offer optional accessories for supporting long stock. Our extension tables are not only easy to build, but feature greater stability, capacity and versatility (Photo 1).

We used nominal 1-in. pine for construction, with hardwood used for the stopblocks. The dimensions shown suit the Makita LS1011 saw. You'll have to modify the design to suit other



1 These easy-to-make extension tables provide 72 in. of work support. Holes allow clamp access for securing workpiece.

EXTENSION TABLES

LEFT TABLE SHOWN—RIGHT TABLE IS MIRROR IMAGE WITH NOTCH SHOWN (BOTTOM LEFT)

TABLES DIMENSIONED TO SUIT MAKITA LS1011 SLIDE COMPOUND SAW. ALTER TO SUIT OTHER SAWS

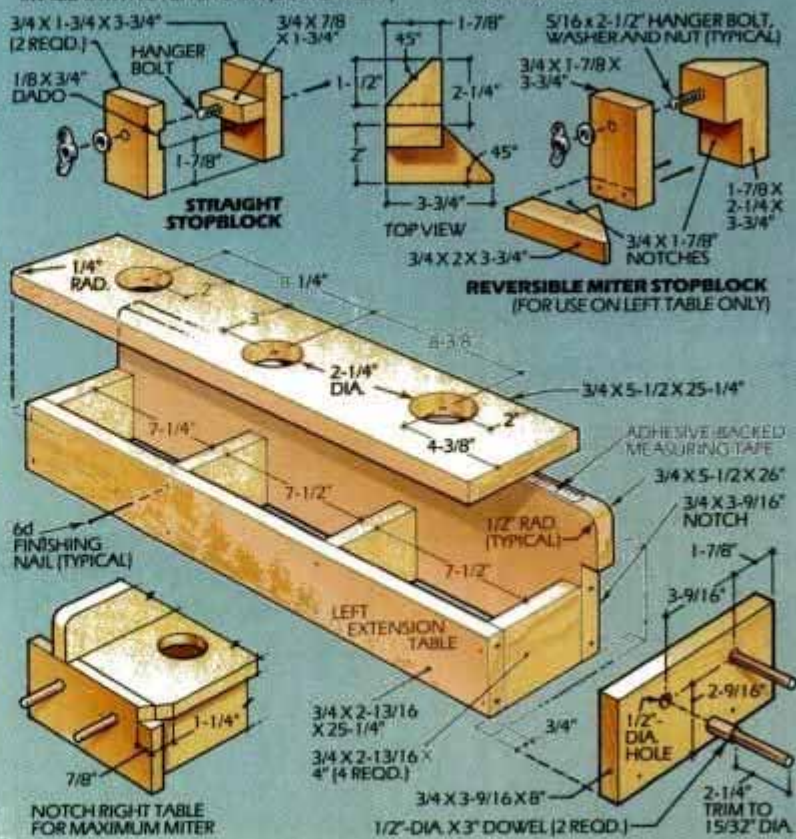


PHOTO ILLUSTRATION BY EUGENE THOMPSON

makes and models. Note that two extension tables are required—one for each side. The right table is an exact mirror image of the left, except that the left has an angled notch on one corner to allow the blade to reach maximum mitering capacity.

Begin construction by ripping and crosscutting the pine stock to the specified widths and lengths. Then use a holesaw to cut the three 2¼-in.-dia. holes in each tabletop as shown. These are clamp access holes for se-

curing the stock. Cut the notches in the back pieces with a sabre saw. Then, shape the rounded corners as shown, sand the pieces smooth and assemble the front, back and top pieces to the short crossmembers.

An additional block on the inside end of each table holds the pins that align the tables with the saw base. After cutting these blocks to size, bore ½-in.-dia. holes to hold the aligning pins. Use a file to trim the exposed portion on the pins so they fit in the

holes in the saw base. Then, glue the pins in the end blocks and cut the miter notch in the right table as shown.

Cut and assemble the stopblocks, and use hanger bolts, washers and wingnuts to clamp the blocks to the extension table backs. We secured an adhesive-backed measuring tape to the back top edges at the appropriate distance from the blade kerf. In conjunction with the stopblocks, this provides a quick and accurate method for cutting stock to length.

Saw Operation

Because of its relatively small base, it's best to bolt the machine down to a stable work surface to prevent tipping. And, never remove the blade guard or defeat its action.

The basic operation on all miter saws is the press cut. This is used for relatively narrow stock with a cross section that falls within the periphery of the blade at its lowest position. The model we used handles stock up to 5½ in. wide in this manner. For press cuts on a sliding compound miter saw, push the carriage back toward the guide fence and lock it in place. Secure the workpiece, switch on the power and allow the blade to reach full speed. Then, gently lower the saw head to make the cut. After switching

off the power, allow the blade to come to a complete stop before returning the head to the elevated position (Photo 2).

For accuracy and safety, always make sure that the workpiece is held firmly against the guide fence, and that sawdust and small scraps are kept clear of the saw table and fence. While it's common to hold the stock in place with hand pressure alone, clamping it down is the best bet for an accurate cut. Always check that the miter and bevel locking knobs are tightened, and any other adjustable components are secured before making a cut.

The smoothness of the cut is influenced by the rate of feed—how fast you push the saw head down—and the

type of blade. A slow feed produces a finer cut than a fast feed. And, a 60-tooth blade produces a smoother surface than a 24- or 48-tooth blade. You can afford coarse cuts when framing or performing rough carpentry, but molding, picture frame and furniture joints require the smoothest cuts.

When crosscutting to a marked line, it's often difficult to position the stock so the blade splits the line precisely. Many pros first align the lowered blade a little to the waste side of the line with the power off (Photo 3). Then, with the head raised, the saw is turned on and a partial test cut is made. After raising the head, the work is shifted slightly to bring the mark closer to the blade, and a second cut is made (Photo 4). The process is



2 A press cut is made by gently lowering blade into stock. Carriage is locked at fence position on sliding compound miter saws.



3 To make a cut precisely on a marked line, first lower the blade with the power off so it's slightly to the waste side of the line.



4 Make a partial test cut. Then, shift the stock and retest cut location. Continue test cuts until stock is positioned accurately.



5 To make a slide cut, move carriage to its extended position. Then, start motor and push the blade through the workpiece.



6 Cut stock that's wider than saw capacity by first cutting in from one side. Clamp work to table for maximum stability.



7 Finish the cut by flipping over the workpiece. Use partial kerf and blade to align stock accurately, and clamp work to table.

repeated until the stock is accurately positioned for the final cut.

Stock that's too wide for a press cut is handled with a push, or slide cut. First, loosen the carriage lock and pull out the carriage completely. Then, switch on the power, lower the saw head completely and push the carriage toward the fence to finish the cut (Photo 5).

Stock that's wider than the saw's sliding crosscut capacity can be handled by first cutting into the wood as far as possible from one side. Then, flip over the stock, align the blade with the first kerf and complete the

cut from the other side (Photos 6 and 7). Another technique for increasing crosscut capacity slightly is to insert a spacer block under the work so that a wider portion of the blade makes the cut (Photo 8).

Repetitive cuts are best made with a stopblock clamped securely to the saw or to an extension table. Many manufacturers offer an adjustable stop to suit their machines. When setting the stop, first cut one of the pieces to exact length. Then, without shifting the work, slide the stop up against the opposite end and clamp or lock it in place.



8 To increase crosscutting capacity slightly, place a spacer under the work so it is contacted by a larger section of the blade.

Miters And Bevels

One of the real advantages of a power miter saw is, of course, its ability to produce consistent and accurate crosscuts at angles other than 90°.

To adjust the saw for a miter cut, simply loosen the screw that locks the pivoting base, rotate the base left or right, and align the pointer with the desired angle on the miter scale. Then, tighten the locking screw. Most saws have detents so the saw head can be quickly set at the more commonly used miter angles.

As with ordinary, square crosscutting, using a stopblock simplifies the task of cutting repetitive miters and makes the work more accurate. While

it's generally better practice to place the finished piece between the stopblock and the blade, sometimes the length of the work requires placing the stopblock on the waste side of the cutline. To cut rafter ends for a boxed cornice, for example, first set the stopblock on the waste side of the cut so the blade is aligned with the angled-rafter end line (Photo 9). Cut all the rafters with each end butted against the block. Then, reposition the stopblock to cut the miter that frames the underside of the cornice, flip over all the rafters and make the second series of cuts (Photo 10).

To cut mitered frame members to exact length with the miter stopblock

shown in the drawing on page 54, first cut a miter on one end of each frame piece. If the faces of the stock are different, as in the case of molding, cut the first miter on the same end of all pieces. Next, rotate the saw head to the opposite side and align the edge of the miter stopblock at the desired position, using the tape measure attached to the extension table back to gauge the correct length. Then, make the cut (Photo 11). You can also set the stopblock by cutting the first piece to a mark on the work and using this piece to position the stopblock at the other end of the work.

Alternatively, you can cut the pieces to exact finished length (Photo



9 When cutting repetitive miters, such as rafter ends, use a stopblock clamped to the extension tables to locate each piece.



10 Make the bottom rafter cut by flipping over the rafter and aligning work with blade. Install stopblock and cut all rafters.



11 To cut frame miters, first cut one miter on each piece. Set the miter stopblock for frame length and miter opposite ends.



12 To cut accurate mitered frames with a straight stopblock, first cut each frame member squarely to exact finished length.



13 Next, clamp scrap stopblock to table so the blade intersects the corner of the work. Cut similar end of each piece.



14 Cut opposing ends by reversing block and miter angle from right to left. Flat stock can be handled from one side.

12) and use a stopblock on the waste side of the miter, positioned so the blade intersects the corner of the work (Photo 13). For moldings, you'll have to shift the blade angle and stopblock to the opposite side to cut the opposing miters (Photo 14).

Angled cuts that appear on the side of the board are generally called bevels. Where miter settings can be made to the left or right, bevels can only be cut on one side of the table (Photo 15). To make a bevel cut, loosen the locking screw and tilt the saw head to the desired angle as indicated on the bevel scale. Then, lock the saw in posi-



15 Compound miter saws only tilt to one side, so the opposing bevels shown are made by reversing the workpiece ends.

tion. Cuts are made in the same manner as described for press and slide cutting, bearing in mind that pressure is applied parallel to the blade when sliding or lowering the saw head.

Combination bevel and miter cuts, or compound cuts, are used to form joints for crown and cove moldings, and for frame and box constructions that have slanted sides (Photos 16 and 17). Because the compound miter saw can be tilted for left bevels only, opposing-angle cuts necessitate shifting the miter angle from one side to the other, and by alternating the edge of the workpiece that contacts the fence.



16 To cut inside or outside miters on crown molding, miter and bevel adjustments are made to produce compound cut.

To cut crown molding, first set the appropriate miter and bevel angles. Standard crown molding has a 52° ceiling angle and a 38° wall angle. To set the saw to produce a 45° inside corner miter, set the bevel angle at 33.9° and the miter angle at 31.6° to the right, and hold the ceiling edge of the molding against the fence. The waste falls on the right side of the blade. For the opposite end, pivot the miter cut to 31.6° left and hold the wall contact edge of the molding against the fence. Most compound miter saw manuals include typical settings for inside and outside joints.



17 Use compound cutting to make tapered boxes and frames. Kerf cut in wood fence ensures stock alignment with blade.

Specialty Cuts

With a few simple adjustments, the sliding compound miter saw can be used to cut dentil molding, dados and repetitive surface designs. The latter two can only be made on saws that feature a stop adjustment that limits the cutting depth of the blade. Although a sliding compound miter saw isn't as versatile as a radial-arm or table saw for special applications, it will handle a wide variety of work.

To make dentil molding, first lock the sliding carriage in position so that when the head is brought down, a partial cut is produced in the workpiece held against the fence (Photo 18). Po-



18 To make dentil molding, position and lock carriage so partial cut is made. Kerf in guide strip helps in aligning stock.

sition the work vertically, and use a 2 × 2 guide strip clamped to the extension tables that allows the work to slide across the table for each successive cut. Cut into the guide strip to create a kerf that's lined up with the blade. Then, mark the dentil positions on the work and align the marks with the kerf in the guide strip to make accurately positioned cuts. After making the two outside cuts that define the width of each dentil cut, remove the waste in between by making successive overlapping cuts.

A dado blade must never be used on a miter saw. Instead, remove the waste with a series of overlapping

cuts. To cut a dado, first adjust the saw's stopper plate to the desired depth of cut. Then, clamp a 1 × 3 spacer to the table to move the work away from the fence. This allows the bottom of the blade to traverse the entire length of the dado. Use a kerf cut in the spacer to align marks on the stock with the blade (Photo 19).

One type of decorative miter saw operation is shown in Photo 20. Set the depth of cut to about two-thirds the thickness of the board. Lock the carriage so the blade is centered across the board width. Make a series of spaced cuts, with the miter set to the left and then to the right. **PM**



19 Lock blade depth for partial kerf, and make slide cuts to cut dado. Spacer behind work ensures uniform cutting depth.



20 Make a decorative pattern by locking the blade depth and making angled press cuts at regular intervals along a board.

TOOL TEST

**ANGLEWRIGHT
 ADJUSTABLE TRIANGLE**

TEXT AND PHOTOS BY ROSARIO CAPOTOSTO, Contributing Editor



AngleWright is a 0° to 45° pivoting triangle used to set blade angles or to position stock for making cuts like face miters with a radial-arm saw.



1 AngleWright's flanged surface is 11 in. long, more than enough to span even large-diameter saw blades.



2 Both of the tool's working surfaces are wide flanges. This makes it easy to stand the tool and tilt a blade against it.



3 The tool makes for extremely precise setup. Here, it's butted between the table saw blade and the miter gauge fence.



4 Set AngleWright by loosening its knurled thumbscrew and positioning the red line at the desired angle.

● If you're a stickler for precise woodworking, you might be interested in the AngleWright. This pivoting adjustable triangle has a variety of uses. It can precisely position wood for angle cuts on table saws and radial-arm saws. Also, it helps you accurately adjust and set up these machines. And, even before you build the project, you can use it at your drafting board to produce extremely accurate drawings.

The manufacturer claims it is accurate to plus or minus .083°. I put the tool through some tests, and while I didn't check it with a micrometer, I found it to be right on the money in helping to make tight-fitting joints.

I wasn't surprised by my test results. Even before trying the tool, I was impressed by its old-fashioned look and feel. It's made from high-quality materials. The body is extruded aluminum, and the adjustment knob is knurled brass.

AngleWright has two flanged work-surfaces measuring 1½ in. wide × 11 in. long. They provide solid support to the material being cut and ample bearing surfaces when making adjustments. I found, however, that a workpiece tends to slide off these surfaces. To prevent this, I followed the manufacturer's suggestion and applied a strip of fine-grit, peel-and-stick sandpaper to them.

I was quite satisfied with the results on both the radial-arm saw and the table saw. In both cases, I used the tool to position a workpiece to cut face miters, and then tilted the blade against the work to cut a miter across the thickness of the workpiece (see lead photo and Photos 1 and 2).

AngleWright allows you to switch quickly between 90° crosscuts and miters on the radial-arm saw without swinging the arm. I was particularly pleased by being able to do this. It also made for fast setup and accurate cuts when paired with the miter gauge on the table saw (Photo 3).

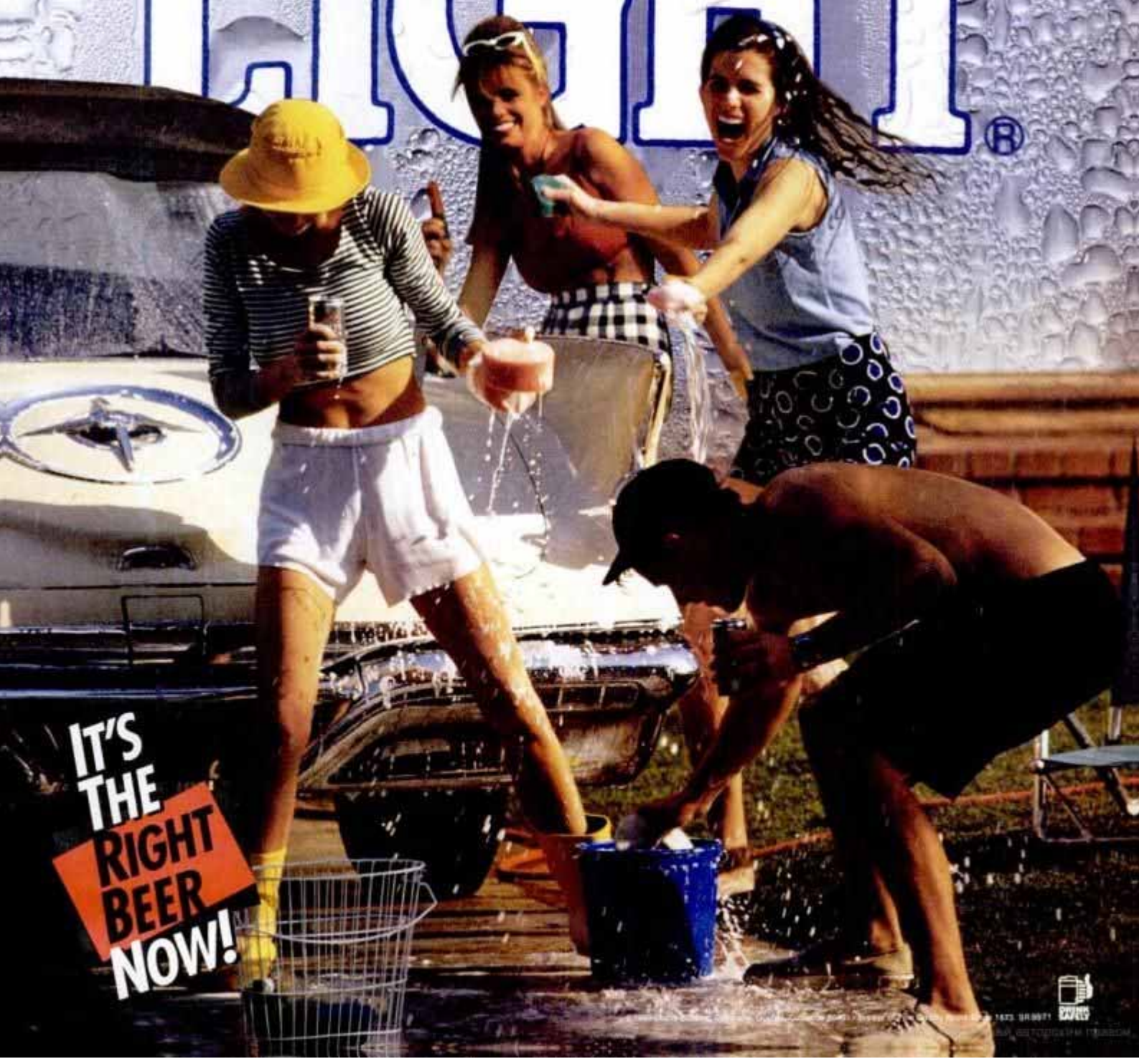
The tool has a large, easy-to-read protractor with two scales. The outer edge of the scale is graduated in 10-minute intervals (60 minutes equal 1°). The scale's inner edge is divided in increments of 2/10°.

To set the tool, loosen the thumbscrew, pivot the sloped side and place the red line in the plastic cursor at the desired angle (Photo 4).

It costs about \$80 (postage included), but the tool is well worth its price if you are a fussy woodworker. Write AngleWright Tool Co., P.O. Box 25632, Los Angeles, CA 90025. **PM**

Cool

LIGHT[®]



**IT'S
THE
RIGHT
BEER
NOW!**



HOW IT WORKS

GARBAGE DISPOSER

BY STEVE TOTH,
Contributing Editor
PM Illustrations by
George Retseck

● These days, being concerned about the environment means more than just driving fuel-efficient cars with reduced emissions. Our overwhelming solid-waste problem has made us all more conscious of what we throw away—and where it goes. You may be surprised to know that there's one common household appliance that not only makes your life easier, but can help play a small, but important, part in managing solid waste effectively—a garbage disposer.

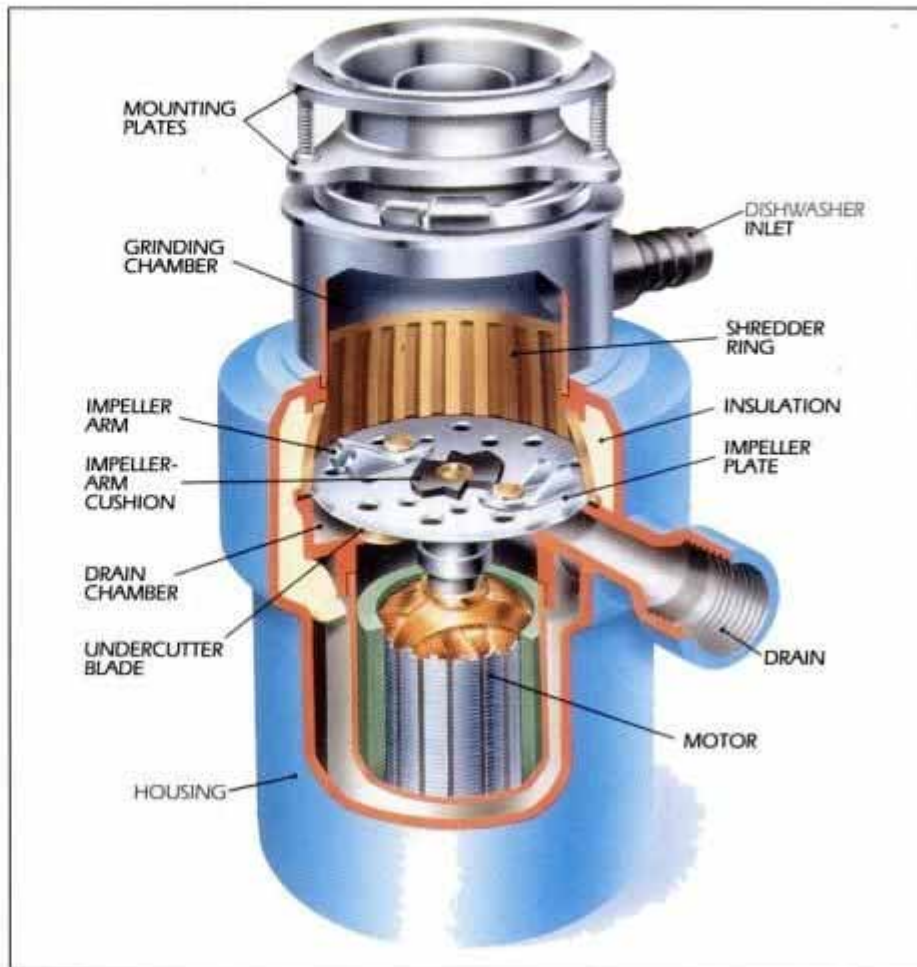
This specialized kitchen accessory plays its ecologically appropriate role by changing the final resting place of solid waste generated in food preparation and cleanup. Instead of ending up in your local landfill, a garbage disposer routes it through the sewer system where it's handled by a sewage-treatment plant.

Here, the waste decomposes much faster and can later be turned into fertilizer or a ground conditioner. In this way, food waste is returned to the earth to help support plant and vegetable growth. And, if your home is serviced by a private septic system, the waste from a garbage disposer can help encourage the bacterial action necessary for a smooth-running septic system.

In the beginning

The disposer was invented in the late 1920s by John Hammes, a Wisconsin architect, and his creation eventually led to the founding of the In-Sink-Erator Manufacturing Co. The premise was simple: Rather than bag the garbage and carry it out for the garbage collector, why not grind it up and flush it down the drain?

After about 10 years of design development, the first disposers became commercially available. Since then, continued refinements and improvements from several manufacturers have produced the compact, quiet, under-the-sink appliance we know today. Attached directly to the sink drain hole, today's garbage disposer comes in a range of sizes and



A garbage disposer is secured to the sink drain with mounting plates. Waste enters grinding chamber and is forced against shredder ring by spinning impeller plate and arms.

capacities, and many are designed for easy, do-it-yourself installation. Nearly 50% of all homes in this country have a garbage disposer hooked up to the kitchen sink.

Looking inside

Many people visualize a garbage disposer as a kind of blender with long sharp knives whirling at high speeds waiting to gobble up anything that comes near—including your fingers. And, while you shouldn't stick your fingers into the chamber, the fact is, most units are more like motorized, rotary cheese graters. Rather than chop up the waste, it's ground up into small bits. Along with water from the tap, the waste then flows down the drain to enter the sewage-treatment system.

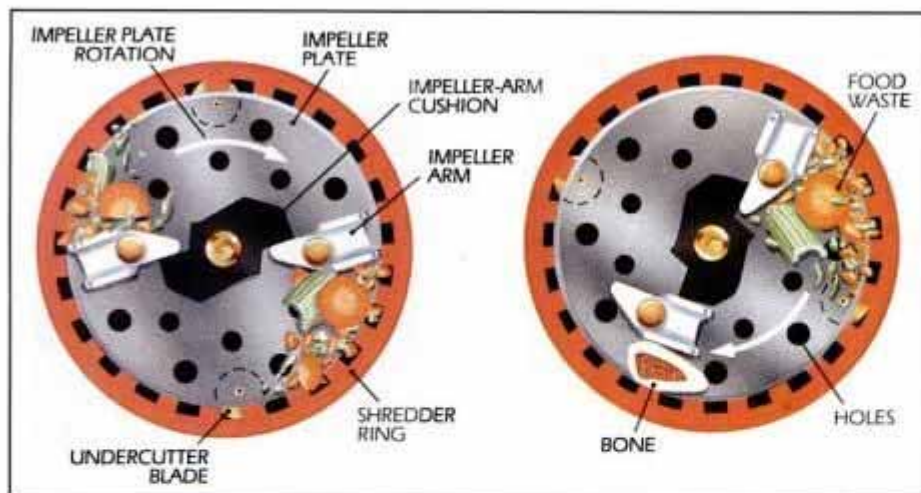
While specific designs vary from manufacturer to manufacturer, most garbage disposers operate in the same way. The shaft of a compact electric motor is attached to a round, rotating impeller plate with holes in it. Typical motors range from 1/3 to 1 horsepower, and are usually either induction motors or permanent magnet

motors. Riveted to the plate are two pivoting impeller arms.

As the motor spins at high speed (some models operate at up to 2700 rpm), the impeller arms swing to the outside of the plate, due to centrifugal force, and are held at this position by the impeller-arm cushion. Around the outside of the plate is the shredder ring. This stationary ring has either vertical cutting teeth or holes that do the actual grinding up of the food waste. On better models, the grinding components are made of corrosion-resistant stainless steel or cast nickel. Other units may feature galvanized steel components. Grinding chambers are either plastic or stainless steel.

Grinding action

When the waste is fed into the garbage disposer, it fills the grinding chamber and lands on the impeller plate. Typical grinding chamber capacities range between 1 and 2 quarts. Once on the impeller plate, the waste is immediately forced to the circumference through the centrifugal force generated by the spinning plate.



During operation, the spinning impeller plate forces food to the circumference where it's held against the shredder ring by the pivoting arms. Undercutter blades handle stringy material. Arms pivot to prevent large objects from jamming disposer (right).

Here, the pivoting arms hold the food waste up against the fixed shredder ring. As the waste is ground into finer and finer particles and mixed with water, it eventually flows past the plate and enters the drain chamber. To chop up long, stringy waste that might pass into the drain chamber and clog the drainpipe, the impeller plate has circular blades, called undercutter blades, mounted underneath. Insulation packed around the grinding chamber helps keep noise to a minimum.

The pivoting action of the impeller arms helps prevent large hard food-waste particles, such as bits of bone, from becoming lodged against the shredder ring and thereby jamming the electric motor. The impeller arms move out of the way for large particles, while continually forcing them up against the cutting edges of the shredder ring until they're completely ground away into small enough particles to pass by the plate. From here, the waste moves out of the machine and into the sewer system. Most modern machines have a dishwasher inlet for simplifying the connection between your dishwasher and the drainpipe. Some models feature an automatic reversing switch that changes the direction of the impeller rotation should jamming occur.

Types of disposers

Two types of garbage disposers are available for use in your kitchen sink—continuous-feed and batch-feed models. The most common type is the continuous-feed garbage disposer. This version utilizes an on/off switch that is usually located on the wall near the sink, and is wired to the disposer motor.

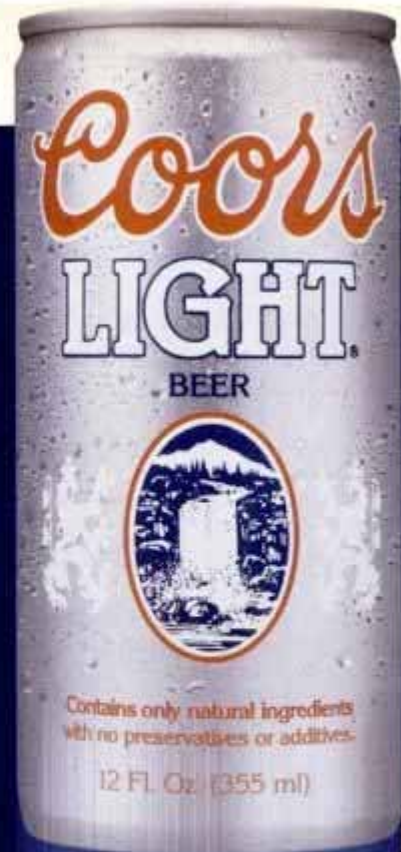
To operate the disposer, you simply turn on the cold water, feed the food waste down the disposer opening and turn on the switch. (Keep in mind that cold water is recommended when running the disposer. This helps clot animal fat and grease so that it adheres to food particles instead of coating the inside of the drainpipes. Cold water also helps the appliance run cooler, which increases the life of the motor.)

Continuous-feed models have a rubber splash guard over the sink opening that prevents food particles from being pushed back up into the sink. As its name implies, waste from food preparation can be fed into this type of disposer continuously.

With a batch-feed garbage disposer, the unit is loaded before it's turned on and there's no wall switch. Instead, the sink stopper is inserted into the mouth of the disposer and turned or simply pushed down to activate the motor. To operate this type, first scrape the food waste into the opening, turn on the cold water and install the stopper.

Only for food

Remember that although they're commonly referred to as garbage disposers, a better name would be food-waste disposer. These appliances are designed strictly for disposing of the typical food waste generated in your kitchen. They won't handle other types of solid waste that should be disposed of responsibly or recycled. Not only might the machine be damaged, but drain lines may become plugged, necessitating costly repair. Used properly, however, this modern-day appliance should provide years of troublefree and environmentally friendly service. **PM**



IT'S THE RIGHT BEER NOW!

The Silver Bullet.

HOMEOWNERS CLINIC

BY NORMAN BECKER, P.E., Contributing Editor

Garage Door-Spring Restraining Cable

The spring on my roll-up overhead garage door recently broke. Luckily, I wasn't standing nearby and my car was out of the driveway. Otherwise, I could have been injured, or my car damaged by the broken spring as it whipped by. The father of a friend of mine lost a fingertip because of a broken garage door spring. Since a spring could snap at any time, is there any way to prevent an injury or serious damage?

HERBERT KLEIMAN
 SHAKER HEIGHTS, OH

When a garage door spring breaks, the loose end whips around with considerable energy. To prevent this, install a restraining cable through the center of each spring. This prevents the spring from whipping around.

The cable is secured at each end with plates that are bolted down, and it will not interfere with the action of the spring or the door.

Cables can be purchased from a garage door service company. Restraining cables are inexpensive, a worthwhile safety feature and a good do-it-yourself project.

Garage Door Safety

A garage door can weigh a couple of hundred pounds and slam shut with considerable force. The door can sag, bind and become a nuisance. On the

other hand, it can work smoothly and safely, year after year. With that in mind, Stanley Home Automation suggests the following:

- 1. Visually inspect the garage door springs, cables, rollers and door hardware for signs of wear. Call a garage door servicer to make needed repairs or adjustments.*
- 2. Install a door-spring restraining cable.*
- 3. Inspect the garage door opener once a month as part of your regular home maintenance. Put a 2 x 4 block facedown on the floor in the door's path, and activate the door. If the door fails to stop and reverse upon striking the block, disconnect the opener and call a servicer.*
- 4. When installing a garage door opener, place the control out of children's reach.*

For more information, write Stanley Home Automation, 41700 Gardenbrook, Novi, MI 48393-1965.

Stained Bricks

I made the mistake of putting a potted plant (with a dish under the pot) on the red bricks in front of the fireplace. There is now a round water stain left by the dish. Is there a way to remove the stain? Thank you in advance for your help.

RUTH SUGERMAN
 LOS ANGELES, CA

Water stains on brick are difficult to remove. But, here's something worth

trying: Make a solution of laundry detergent and water, then add some bathroom talc to form a paste. Smear the paste on the stained area with a trowel. After the paste has dried, scrape it off. Repeat the process if necessary.

If this doesn't work, get a copy of the Brick Institute of America's Technical Notes No. 20, titled "Cleaning Brick Masonry." Among other items, this 8-page booklet discusses the removal of stains resulting from external sources. The booklet costs \$1 plus postage from BIA, 11490 Commerce Park Dr., Reston, VA 22091.

Taped Return Register

My husband and I have a running argument about a register in our bedroom. We don't heat our bedroom in the winter, so he covers up the return air register with tape. I say that the tape stops the removal of cold air from our room. He says that if the hot air is shut off, the return air register should also be shut off. Which is the correct answer?

E.C.
 BRISTOL, IN

I agree with you, but it depends on what your husband is trying to accomplish. By sealing off the return register, he is isolating your bedroom from the central heating system, especially if the bedroom door is kept closed. Unless you keep a window open in your bedroom for air circulation, sealing the return register will result in the room's air becoming stagnant. This lack of air exchange can cause some discomfort, especially if someone smokes in the room.

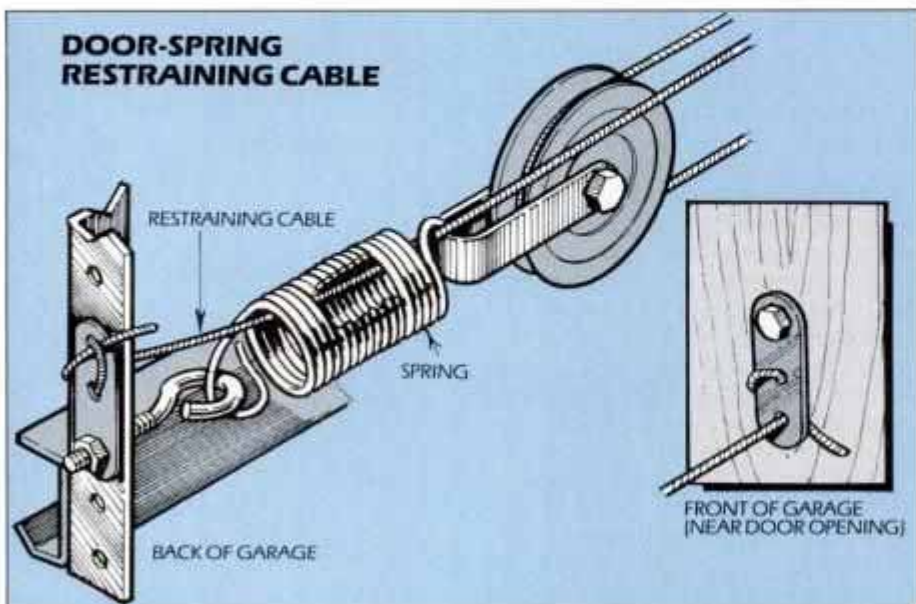
By not sealing the return register, there will be air circulation within the room. The return air will create a negative pressure in the bedroom. In turn, this causes the air in the house to migrate into the room through the door opening or under the door if the door is closed.

The extent to which sealing the return register will reduce your fuel consumption is difficult to determine. I would assume that the effect is relatively minor.

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 garage door restraining cable prevents pieces of the garage door spring from flying through the air should the spring snap. It's an easy-to-install safety measure.

RESTORATION

OLD HOUSE SECURITY

BY LOUISE PARISI MCGOWAN

● Securing an old house isn't just a matter of installing the biggest, toughest lock you can find. Aesthetics are also important in old house restoration. The goal is to secure the building without sacrificing charm.

On most restoration projects, the original locks have long since been removed from the front and rear doors. Indeed, the doors themselves may be gone. If you are starting from scratch, there are two ways to tastefully lock up the old house. The first is to replace the existing doorknob and lock with one that looks historically accurate, and to add an unobtrusive deadbolt. The second alternative is to install a reproduction lock with a built-in deadbolt.

Before we go much further, a quick overview may be helpful to understand why old locks (and their modern counterparts) look the way they do.

Locks through the ages

In the early days of our country, people were more concerned about privacy than keeping out burglars.

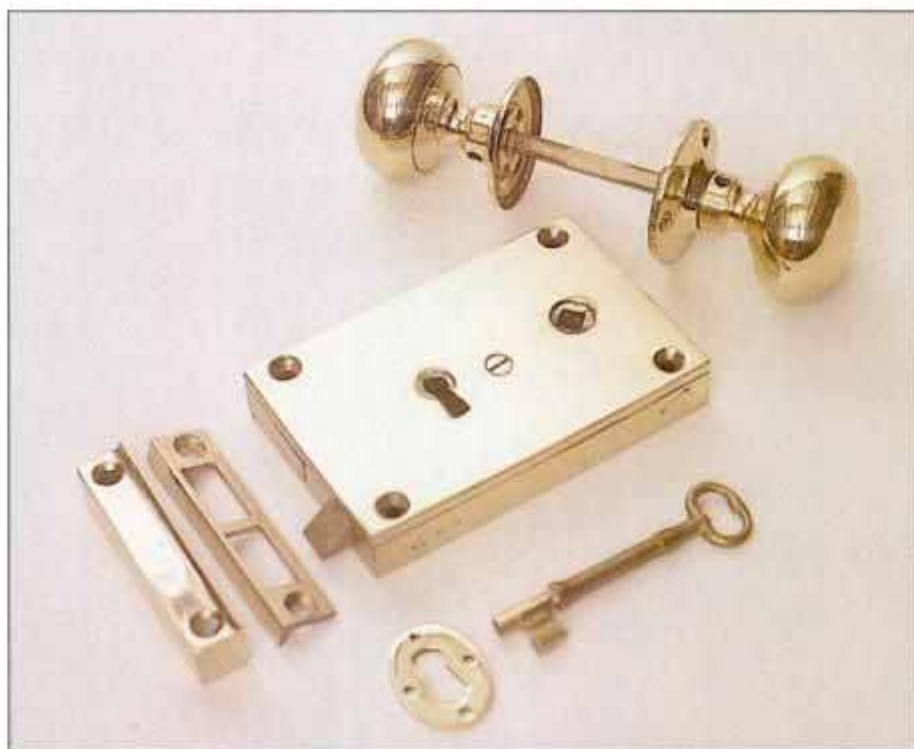
Many of the settlers' earliest locks were merely thumb-latch sets that could be locked only when someone was home. A locking pin secured the latch from the inside. These consisted of a handle and thumb piece on the outside and a latch bar, catch and keeper on the inside. Some of these latch sets had a string that went through the door, from the outside, and attached to the latch bar on the inside. When people wanted privacy, they simply pulled the string out so it couldn't be opened from the outside.

The Colonial forerunner of the modern lock used a bit key, also known as a skeleton key. The locking mechanism was contained in a large rectangular box attached to the surface or rim of the door. Hence, these were called rim or box locks.

An improvement on these was the mortise lock that was widely manufactured from 1850 to 1950. As its name implies, this lock had its mechanism installed in a mortise cut in the door. Early mortise locks also used bit keys. A version with pin tumblers, which are more difficult to pick, came



This rim lock has a built-in deadbolt. The brass box mounts inside the door and the key cylinder mounts outside. The knob spindle mounts through square hole in the box.



The hardware above is a more modest version of a reproduction antique rim lock. It works on a regular bit key, and does not have deadbolt capacity. This, and its smaller size, explains the difference in price, about \$250 compared to \$700 for the one at top.

along in 1865, though this type didn't catch on until about 1900.

Unfortunately, an intruder need not even pick a bit-key lock, although it is easy to pick. A good kick or a deft yank with a crowbar between the door and the jamb is all that's necessary to gain entry. Why? Because the

part of the lock that projects into the doorjamb, known as the throw, is only $\frac{3}{8}$ in. to $\frac{1}{2}$ in. long, much stubbier than today's 1-in.-long standard.

Yesterday's locks today

Your first step in restoration is to find out what kind of hardware is appro-

priate for your door. The suppliers listed at the end of the article can help, as can your local library and historical society. Visiting restored or reconstructed towns, such as Colonial Williamsburg, may also provide insight (as can restored houses that serve as museums).

Adding a deadbolt is simple. A local home center or lumberyard should have them. Pick one that is as unobtrusive as possible, and install it (see "How To Install A Deadbolt Lock," page 136, Jul. '87), or have it installed by a carpenter or locksmith.

Fortunately, there are national sources for reproduction locks. Some of these have modern pin-tumbler mechanisms, and others have a deadbolt that is operated with a skeleton or regular key, so they look antique but offer substantial security. Prices for restoration hardware range from extremely expensive (several hundred dollars per item) to slightly more expensive than ordinary hardware. As with any purchase, it pays to shop carefully.

Locking double or French doors properly just takes a bit more work

than locking a single door. Generally, most double doors are secured with cane bolts at the top and bottom rails. The other door swings shut against it and is locked to it. The sources listed here should be able to come up with matching or similar pieces for just about any broken or missing piece.

Period slide bolts and Dutch door quadrants are a couple of other items still available to make old houses more secure, as are security bars. The latter come with metal stirrups that are attached to the wall on both sides of the door. Entry through the door is unlikely when the bar is in the stirrups and fastened to the door.

Window security

Making double-hung windows secure is more difficult than making doors secure. One of the easiest ways to do this is with window pins, devices dating back to the Colonial period. A window pin is a 1/4-in.-dia. dowel inserted through a hole bored through both window sashes, thus locking both sashes in position. Sometimes the pin hangs from a leather thong nailed to the window trim, or else it is left stick-

ing out of the inside sash then pushed home to lock the two.

A word of caution is necessary here, however. Window pins, bars and other security devices do make a house more difficult to enter by force, but they also can hinder your ability to escape quickly in a fire. To ensure that the house is safe in both regards, balance your security needs against those necessary for safe escape. When in doubt, contact your local fire department for an inspection of your house. **PM**

SOURCE LIST

Some restoration hardware suppliers:

- Ball & Ball, 463 W. Lincoln Hwy., Exton, PA 19341. A 108-page catalog costs \$5.
- Crown City Hardware Co., 1047 N. Allen Ave., Pasadena, CA 91104. A 227-page catalog costs \$6.50. (Supplier of hardware shown.)
- Kayne & Son Custom Forged Hardware, 76 Daniel Ridge Rd., Candler, NC 28715. No catalog available. This company makes custom hardware and can accurately match many old pieces.

For a directory of suppliers, write:

- Old House Journal Catalog, 2 Main St., Gloucester, MA 01930. Company does not sell hardware directly, but does publish a 254-page catalog that lists 1500 suppliers of hardware and other old house items. The catalog costs about \$19.95.

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NEW PRODUCTS

LAWN AND GARDEN GEAR

BY ROY BERENDSOHN, Assistant Home Improvement Editor



Hose It Down

This machine lets you hose a pile of yard debris down to size. It's trim, at 23 in. wide, and it weighs about 100 pounds. You can wheel it to the pile and then rake leaves into the funnel at the end of the vacuum hose. Remove the lid and drop bulky yard debris into the polyethylene hopper. Chip branches by feeding them into the funnel. It's powered by a 5-hp industrial-commercial Briggs and Stratton engine, and costs about \$780 (includes vacuum attachments) at Baker outdoor power equipment dealers. Write to Tornado Products, Inc., W190 N11260 Carnegie Dr., Germantown, WI 53022.



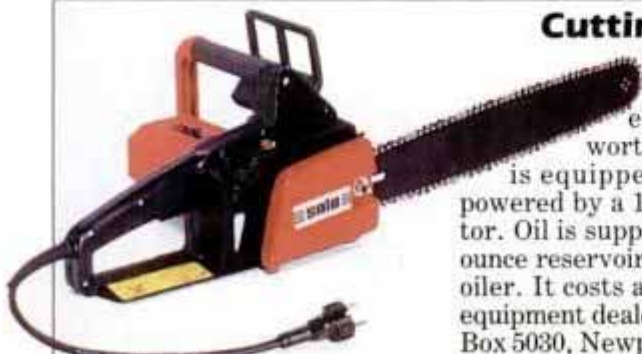
Covering New Ground

If this machine looks unfamiliar, it's with good reason. It's supposed to be the first of its kind—a walk-behind, chipper-shredder vacuum. A 4-hp model and a self-propelled 5-hp model are available at outdoor power equipment dealers, direct from the factory or through Troy-Bilt dealers. The machine pulls in leaves and debris through a 20-in.-wide snout, made from Xenoy, a new impact-resistant GE plastic. From there, the material is shredded by the vacuum fan blade and blown into a 3½-bushel waste bag with a double-layer dust filter. Branches up to 3½ in. in diameter are chopped up by a chipper blade spinning at 3750 rpm. Options for it include a vacuum hose attachment, a leaf tray so leaves can be raked into it (standard on the 4-hp model) and a vacuum inlet cap that diverts more power to the chipper. Both models cost about \$1000. For more information, write to Garden Way, Inc., 102nd St., Ninth Ave., Troy, NY 12180.



Cutting Close To Home

If most of your woodcutting is close to home, this electric chain saw is worth considering. The saw is equipped with a 16-in. bar and powered by a 12-amp, 1.9-horsepower motor. Oil is supplied to the chain from a 3.4-ounce reservoir and a gear-drive adjustable oiler. It costs about \$350 at outdoor power equipment dealers. Write to Solo, Inc., P.O. Box 5030, Newport News, VA 23605.



Stay On The Ground

Stay off the ladder while you're trimming branches with this extending battery-powered pruner. It has an 8-ft.-long telescoping pole, and its manufacturer says it cuts limbs up to 3 in. in diameter. To use it, loosen the locking ring, extend the fiberglass pole and retighten the locking ring. Squeeze the trigger and safety button to power the saw head. The saw chain and bar are designed as a compact cassette. When the chain dulls, replace it or the entire cassette. The pruner costs about \$100 at home centers and Sears. Write Oregon Cutting Systems-Blount, Inc., P.O. Box 22127, Portland, OR 97222.



A Light Mulch

To keep its newest mulching mowers lightweight (60 to 75 pounds), Homelite made their 20-in.-dia. decks out of aluminum. The 5-hp self-propelled model costs about \$430, and the 4-hp push model costs about \$330 at Homelite dealers. Both models have twin mulching blades. Their other features include a durable powder paint finish on the deck and handles, 5-position height adjustment for cutting grass from 1 to 3 in. tall and a 2-year warranty. Write Homelite Division of Textron, Lawn and Garden Marketing Mgr., P.O. Box 7047, Charlotte, NC 28241.



Two Of A Kind

Simplicity has introduced two new GT garden tractors, a 14-hp and a 16-hp model. Both have free-floating 3-blade decks and a 24-in. turning radius. The 16-hp model has a 50-in. cutting width, and the 14-hp has 44 in. The two share such features as 18-ga. steel hoods, drum/shoe-type brakes, all-welded steel frames and hot-forged and heat-treated axles. The 16-hp model (shown) is about \$5200, and the 14-hp about \$4200, at Simplicity dealers. Write Simplicity Manufacturing, 500 N. Spring St., P.O. Box 997, Port Washington, WI 53047.

Water The Lawn

RainScapes (below) is a low-volume aboveground sprinkler system that hooks to an outdoor faucet with a back-flow preventer. A \$30 kit waters about 500 sq. ft., and includes 1/4-in.-dia. flexible tubing, push-fit connectors, sprayers and bubblers. RainGear in-ground components (bottom) replace impact sprinklers or expand a watering system. The pop-up sprinklers are supposedly silent in action and have a snap-fit cap that covers the spray-adjustment disc. The sprinkler screws into an ABS plastic housing and can be lifted out to clean the filter. A gear-drive mechanism lifts the sprinkler, and a stainless-steel spring retracts it. The RainGear pop-up sprinkler costs about \$27 at hardware stores and home centers. For more information, write to L.R. Nelson Products, 7719 N. Pioneer Lane, Peoria, IL 61615.

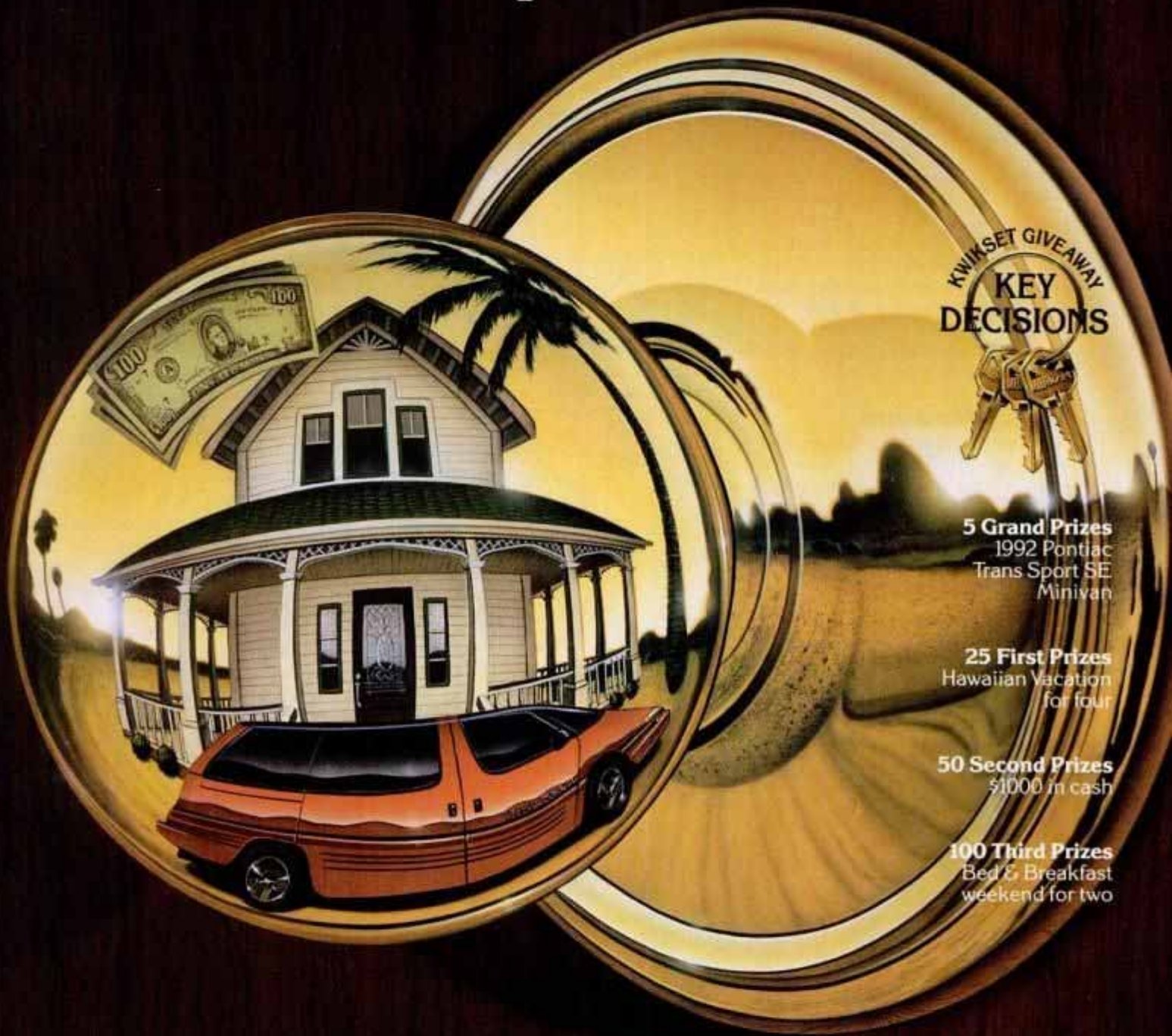


Support Group

Homeowners with aching muscles or tender joints can find support and comfort with SafetyMates, a line of lightweight machine-washable supports, such as the padded, antivibration gloves (shown) made from washable pigskin. Also included are padded, washable supports for your back, wrists and elbows. Each item comes in small, medium, large and extra-large sizes, and closes with Velcro flaps. They cost from \$12 for a tennis elbow support to \$40 for the back support at home centers and hardware stores. For more information, write to Ergodyne Corp., 1410 Energy Park Dr., Suite 1, St. Paul, MN 55108.



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Shoe Test

Even the best yard tools can't get the job done if you call it a day because your feet ache. That's why we tested these boots. We've found them to be exceptionally comfortable and lightweight. Their manufacturer says they've tried to bring the comfort of sneakers to work boots, and we think they succeeded. They're also durable. Our boots show hardly any wear after eight months.

The boots have a flexible polyurethane Comfort Core cushion mortised into the sole. The cushion is $\frac{3}{4}$ in. thick at the heel and a $\frac{1}{2}$ in. thick elsewhere. The cushion's antibacterial cover pulls sweat away from your foot. The boots cost about \$80 at shoe stores and work-clothing stores. Write to Georgia Boot, P.O. Box 10, Franklin, TN 37065.



Step Right Up

This product may not be for everyone, but the idea of "kick-starting" a lawnmower is so interesting we thought you'd want a closer look. The 10-piece device fits most walk-behind models (except Snapper and Toro), the manufacturer says, and it installs without having to drill holes in the deck. It costs about \$30 at hardware stores. Write Universal Industrial Products Co., 1 Coreway Dr., P.O. Box 628, Pioneer, OH 43554.

Happy Medium

John Deere's latest lawn tractor is a hybrid, made of parts from lawn tractors and lawn-and-garden tractors. It costs about \$4300 with a 48-in. deck. It has a 20-in. turning radius and a 17-hp engine with pressurized lubrication and a replaceable oil filter. Power transmission is by a 6-speed inline-shift transaxle with internal wet disc brakes. Its other features include a 2½-gallon fuel tank and a high-back seat. It's sold at John Deere dealers. Write John Deere, 1400 13th St., East Moline, IL 61244.



Why Shovel?

If you own a heavy-duty pickup and get tired of shoveling out the bed to unload it, maybe this electrically operated dump trailer is the answer. It has a 3-cu.-yd. dump bed with a 4700-pound capacity. The dump mechanism is activated by a control with a 7-ft. extension cord (another control is by the tailgate). The bed is built from 12-ga. steel, and it measures 8 ft. long \times 5 ft. wide at its top. It costs about \$3800 (plus shipping) from Tiger Line Equipment, P.O. Box 121, 1115 N. Ohio St., Minster, OH 45865.



Take Your Pick

Here are picks and planting tools with a fresh approach. Each tool comes in a 2-pound short-handle version (about \$13) and a 5-pound long-handle version (about \$27). The handles are hickory, and the heads are ductile cast iron with a rectangular tapered eye. They are sold at hardware stores and home centers. Write V&B Manufacturing, P.O. Box 268, Walnut Ridge, AR 72476.



Set It Up, Feed It In

Hoffco set this lightweight shredder (28 pounds) on legs so you can position it over a 30-gallon garbage can. Feed yard debris into the 18-in.-dia. funnel, and three nylon cutting blades shred it. It's powered by a 49.2-cc, 2-cycle engine with a cleanable air filter. It comes with a set of replacement blades and a pair of safety goggles. It costs about \$290 at hardware stores and Hoffco dealers. Write Hoffco, Inc., 358 Northwest F St., Richmond, IN 47374.



Stand And Clip

The Clipstik cordless trimmer weighs only 4.7 pounds, but it can cut a 7-in.-wide swath for 45 minutes, says its manufacturer. The 6-volt tool recharges overnight. It comes with a plug-in recharger, five snap-in replacement line cartridges and foam-covered wrist and hand supports. It costs about \$50 at lawn and garden centers and hardware stores. For more information, write Poulan/Weed Eater, 5020 Flournoy-Lucas Rd., Shreveport, LA 71129. **PM**

NEW TOOLS

**DELTA MORTISER
AND SHAPER**

BY THOMAS KLENCK, Associate Home Improvement Editor



The Delta Hollow-Chisel Mortiser cuts holes up to 1/2 in. sq. Its rack-and-pinion system is counterbalanced by a gas-filled stabilizer. It can also be used as a drill press with the 3-jaw chuck accessory, and features an adjustable fence and hold-down assembly. It's powered by a 1/2-horsepower motor.

● Once you've equipped your shop with all the basic stationary machinery, it's time to look at the specialized stuff that separates the weekend woodworker from the serious enthusiast. Delta has recently introduced two machines with high-end capabilities that are sized just right for the home workshop.

The Delta model 14-600 Hollow-Chisel Mortiser (about \$588) is designed to cut square holes for traditional mortise-and-tenon joinery. It features cast-iron and steel construction with a rack-and-pinion system for raising and lowering the head. A gas-filled stabilizer counterbalances the head on the down stroke and assists on the up stroke.

The tool handles up to 1/2-in.-sq. bits with 3/8-in. shanks, and it has a maximum 4 1/2-in. stroke. Available accessories include a bushing for 3/4-in.-shank bits and a 3-jaw chuck for using the tool as a drill press. Power is supplied by a 4.8-amp, 1/2-horsepower induction motor.

Next on the Delta agenda is the model 43-355 Wood Shaper (about \$867). This is a 2-speed machine (7000 and 10,000 rpm) that's powered by a 1 1/2-horsepower motor. It has a cast-

iron top mounted to a steel stand. The spindle can be reversed to handle either 1/2- or 3/4-in.-bore cutters.

Especially notable is the unique Delta sectional fence. Made up of layers, the fence can be adjusted to conform to the shape of the cutter you're using. This eliminates the need to cut custom auxiliary fences and helps improve chip removal and dust collection. Contact Delta International Machinery Corp., 246 Alpha Dr., Pittsburgh, PA 15328. **PM**



Featuring an adjustable fence that conforms to cutter profiles, the Delta 43-355 Wood Shaper handles 1/2- and 3/4-in.-bore cutters.

Clamp. Release. Clamp. Release.



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You can do this with other locking pliers. But with ours, you can do it single-handedly.

By designing a pair of locking pliers that are less complicated to use, we've made a lot of tasks easier.

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APPLIANCE CLINIC

BY STEVE TOTH,
Contributing Editor

Noisy Motor

I have a Whirlpool refrigerator with a noisy fan motor in the freezer compartment. The model number is EDD191SKYR0, serial No. S61992565. Could you please give the proper procedure for replacing the motor?

DAVID PARKER
MOCKSVILLE, NC

First, stop by your local Whirlpool parts distributor and pick up a replacement fan motor, Whirlpool part No. 482569. It costs about \$40.

Unplug the refrigerator and remove all food and shelves from the freezer. Next, remove the three shelf studs on the left rear of the freezer liner. The studs are removed one of two ways, depending on the type of stud that is used on your appliance. Each stud will be attached with either a Phillips head screw or the whole stud will twist out by turning it counterclockwise.

Remove the plastic air-grille cover at the top right of the evaporator cover, and remove the Phillips head screw behind it. Remove the screws that hold the evaporator cover in place and lift out the cover.

Next, remove the screw holding the fan scroll, then remove the scroll. Remove the screw holding the fan motor and bracket to the rear wall.

Disconnect the electrical leads from the motor. Disassemble the motor bracket from the motor. Now remove the fan blade and install it on the new fan motor facing the way it was on the old motor. Reassemble the appliance.

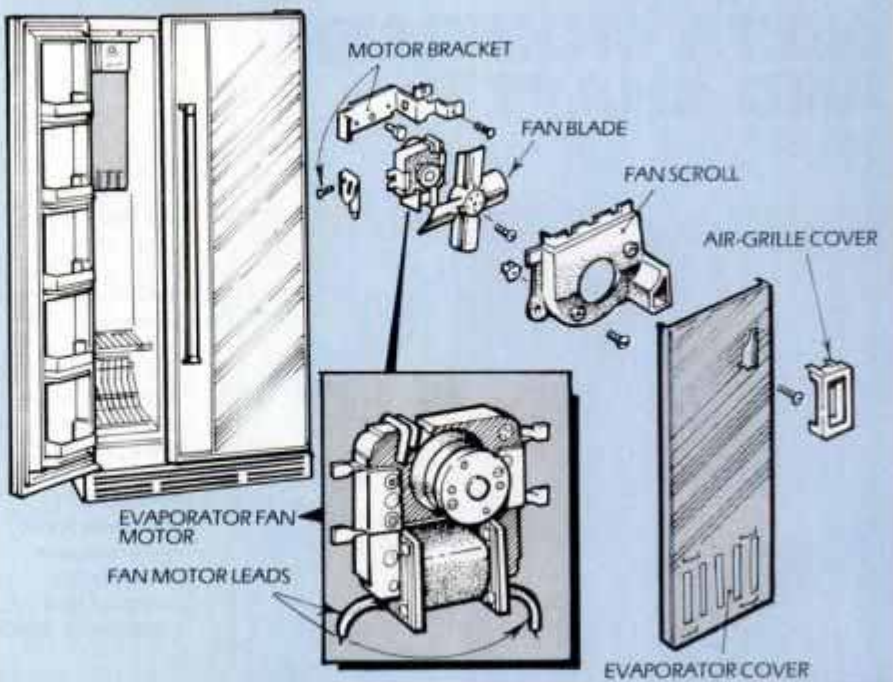
Gas Range Needs Valve

Our Sears gas range, model No. 647.7157041, needs a thermal valve, Sears part No. 560344. Sears says the part is no longer available. Any suggestions for replacing the valve?

DAVE BLAUBACH
GRAFTON, WI

I asked the range parts buyer at Sears to check with the Roper range company (Roper built your model range for Sears). I was told your valve is no longer stocked, and there is no substitute part.

NOISY FAN MOTOR



Replacing a noisy Whirlpool fan motor requires a fair amount of disassembly at the back of the freezer cabinet. Begin by removing the air-grille cover and work back.

However, checking with the manufacturer of the gas valve, Eaton Corp., revealed that a replacement gas valve is available.

The Sears part number is referenced to Eaton part No. Y-30111-3AF. Eaton Corp. doesn't sell parts to the public, but it will give you the name and number of a parts distributor who can get you the part. Contact Eaton Corp., Control Division, 191 E. North Ave., Carol Stream, IL 60188; (800) 332-4643.

Frosty Fridge

I have an 8-year-old Amana refrigerator with a bottom freezer compartment, model BC20E. The line that drains the defrost water into the drip pan underneath the appliance freezes, and the bottom of the freezer builds up with ice. After removing the ice, I have made sure that the drain hole is not blocked. After a couple of days, I then find that the drain hole has frozen again. What do you think could be the problem?

LLOYD ZABLOSKI
MINNEAPOLIS, MN

You may need an Amana servicer to correct the problem. Assuming the defrost drain tube is not plugged, defrost water may have leaked between the drain tube and the foam insulation below. Now the insulation in that area has become frozen. As a result, the drain tube cannot warm

adequately during the defrost cycle.

In turn, defrost water cannot drain completely. It overflows on the compartment floor and freezes.

A servicer may cut away a small section of the back of the refrigerator and dig out the foam insulation, if it is wet, and reseal the tube to make sure it doesn't leak again. The repaired area will need to be packed with new fiberglass insulation or sprayed with foam insulation.

The servicer may choose to adapt a drain heater to the tube to keep this area warm during defrost to prevent the ice buildup.

Product Alert

Magic Chef Co., Cleveland, Tennessee, manufactures gas ranges under the brand names Magic Chef, Admiral, Norge, Hardwick and Crosley. Those that were manufactured between Jan. 1 and Aug. 23, 1991, may have faulty top-burner gas valves which could fail and cause a fire. If you recently purchased one of these ranges, contact the company at (800) 544-2538 so they can determine if your range has defective gas valves. If it does, the valves will be replaced 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.

TOOL TEST

BLACK & DECKER SAWCAT

TEXT AND PHOTOS
 BY THOMAS KLENCK,
 Associate Home
 Improvement Editor

● These days, the name Black & Decker appears on everything from toasters to cordless vacuum cleaners. Well, just in case you've forgotten, the company also makes power tools—and not just the garden-variety consumer models either. One of B&D's latest offerings in the professional power tool market is the Sawcat line of circular saws. We decided to try out the top-of-the-line, 13-amp model 3064 7¼-in. Super Sawcat to find out just how well this tool stacks up against the competition.

All other saws are either pivot-foot models, where the base pivots at the front to expose or retract the blade, or drop-foot saws, where the blade moves straight up and down through a channel assembly. The Super Sawcat is a rear-pivot-foot saw with a sliding channel and locking mechanism similar to drop-foot models. It has the smoothest-operating depth-of-cut adjustment of any saw we've tried. And, there's a depth scale on the blade guard that beats out competing models for readability.

All of the controls are easy to operate, and the tool has a large aluminum base for good stability. Unlike any other saw we've tried, the Super Sawcat can be adjusted for blade/base alignment—a good idea if you use straightedge cutting guides and demand the best cuts.

Other notable features include an electric brake, a shaft lock to speed blade changes and an inch scale on both sides of the kerf indicator to quickly gauge cutoffs. The base is dimensioned so that the distance from the kerf to one side is 5½ in. (the width of a 2 × 6), and 1½ in. (the thickness of nominal 2-in. lumber) on the other. The blade angle can be set 5° higher than ordinary saws—up to 50°—and the handle has a unique cord clip that's handy for keeping the cord away from the cutline in certain applications. In use, the saw is comfortable, fairly well balanced and smooth



B&D's model 3064 Super Sawcat features an innovative blade-depth mechanism, modular construction, blade/base alignment adjustment and a maximum 50° bevel capacity.

operating. This Sawcat also features Black & Decker's modular design system that's claimed to make the tool easier to repair. We did find, however, a rattle between two housing components that might not have been there with conventional construction.

Black & Decker's suggested retail

price is about \$236. The Super Sawcat is also available with an 8¼-in. blade (model 2965). By the way, if you like yellow, look for DeWalt's model DW 364—it's virtually identical to the B&D 3064. For more information, write to Black & Decker, 10 N. Park Dr., Hunt Valley, MD 21030. **FM**



Front knob locks or loosens modified pivot-foot blade-depth adjustment. Scale on blade guard indicates depth of cut.



Alignment between blade and aluminum base edge is adjusted at pivot joint. Parallel alignment ensures smooth and accurate cuts.



A maximum 50° bevel setting is 5° more than typical 7¼-in. saws. Large knob and smooth action make adjustments easy.



Clip-on handle helps keep cord away from blade in certain applications. Model 3064 is double insulated with a 2-prong plug.

TOOL TEST

MACH 1 SAW BLADE

● The new Craftsman Mach 1 saw blade caught my attention because of its aggressive hook angle and shallow-gullet teeth. Sears touted it as fast and smooth-cutting, but lots of companies say that about their saw blades. To find out how well it works, I used a 10-in.-dia. 40-tooth Mach 1 to rip and crosscut thick pieces of maple,



1 The Mach 1 saw blade has carbide-tipped teeth and a very aggressive tooth pattern. Cutouts help blade run cooler.

oak and ash. I also built some furniture with it. I found it performed as well as Sears said.

The thin-kerf saw blade breezed through the 3-in.-thick stock with hardly any burn marks and produced surfaces as smooth as the very expensive saw blades that I use. Of course, professional saw blades are more durable, but most hobbyists won't put this blade to that kind of use. For the money, it's a very good blade.

The fact that the blade produces such a smooth edge is a handy feature. In finish carpentry, for example, there are times when you glue a molding or an edge band to the sawn sur-



2 The blade breezed through thick hardwood stock, like red oak, while ripping and crosscutting.

face, without first running the workpiece over the jointer or smoothing it with a hand plane.

It also enables you to quickly and accurately saw out tenons. I sawed several tenons with the blade, and all of them had nice, smooth cheeks and shoulders. This makes it far easier to slide the tenon into the mortise.

All the Mach 1 blades have carbide-tipped teeth and are available in 6½-in., 7¼-in., 8¼-in., 9-in. and 10-in. diameters. They cost from \$10 to \$35 at Sears stores and through the catalog. Write Sears Roebuck & Co., Sears Tower, Chicago, IL 60684.

—Rosario Capotosto



3 A piece of red oak is resawn with the Mach 1 to demonstrate glue-quality surface left by saw blade.

PHOTOS BY ROSARIO CAPOTOSTO

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CAR CARE GUIDE

BENNETT ACNE-RS





'Green' Car Care: Why It's Important

Being kind to the environment includes being kind to your car—and vice versa.

● We like cars. We like to drive them, we like to work on them—and we'd like to continue to do so.

Cars, car enthusiasts and backyard mechanics are on the edge of political correctness in modern, post-OPEC, responsible-'90s society. We've had a reputation for ecological irresponsibility that isn't entirely misplaced, with our penchant for more power, disdain for CAFE regulations and emissions controls, and a nasty habit of utilizing our used crankcase drain oil and antifreeze for weed control in vacant lots.

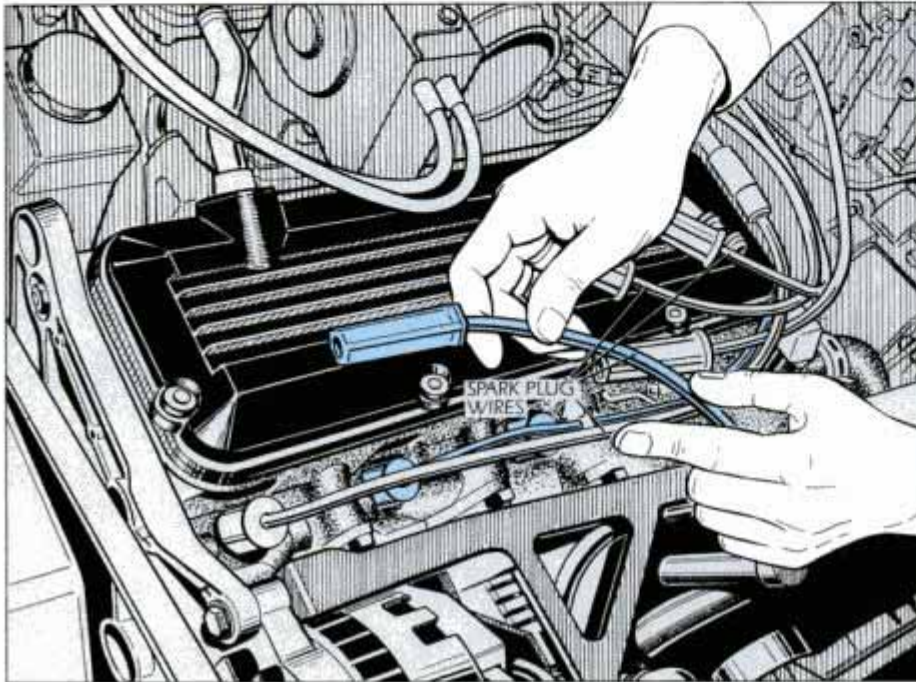
But it doesn't have to be that way. Modern cars have heavily integrated, highly efficient fuel injection *cum* emissions systems. Efficiency means burning fuel and extracting all of the heat energy, which translates into more power and lowered emissions. Recycling, new buzzword elsewhere, isn't new to the automotive field, as Henry Ford used lumber from packing crates as floorboards on Model Ts. Virtually all of a modern car's metal parts and many of its plastic ones can be recycled.

Used crankcase oil, used coolant from your radiator, old batteries and tires are now the focus of federal, state and, in many cases, local legislation. More importantly, they're the focus of viable marketing programs by such notable corporations as Kmart, Sears and Exxon (among others) to provide a place for the do-it-yourselfer to bring materials to be recycled.

No one has seriously suggested that backyard mechanics be prohibited from working on their own cars. Yet. But commercial repair shops are already subject to a bewildering array of regulations covering the disposal and recycling of these everyday items. These regulations are sometimes difficult to comply with, and increase the already high overhead carried by the shop owner. If every one of us who works on his own cars manages to reduce nonrecycled waste to acceptable levels, and maintains his high-tech automobiles to meet emissions regulations, we'll be able to continue to do our own maintenance and repairs.

—Mike Allen

Engine Tuneup For Peak Efficiency



To avoid confusion, first match the replacement spark plug wires to the old ones.

● Despite your car's supertech computer controls and leading-edge mechanical sophistication, it still needs to be tuned up regularly in order to run at its full potential. While sealed electronic components and seeming wizardry have forever done away with such rituals as setting breaker points and adjusting the idle mixture, you still must inspect spark plugs, plug wires and filters. And you should look over the computer's shoulder and check that the ignition timing and idle speed are set correctly.

There are still some new cars—as well as a lot of older ones—that use manually adjustable valves. So a correct valve adjustment can buy some efficiency and performance.

Gotta breathe

Regardless of your car or truck's make, model and vintage, whether it runs on gasoline

or diesel fuel, it still needs air in order to run. Begin the tuneup by checking the engine's air filter.

In most modern cars with port fuel injection, low hoods and cramped engine compartments, you'll find the air-filter housing mounted away from the engine's air intake. The housing is typically in one of the front corners of the engine compartment where it can easily collect fresh air and feed it via a duct back to the engine's intake. On older rigs and some trucks, which have either a carburetor or throttle-

body fuel injection, the air filter is mounted directly over the carb or throttle body.

Carefully inspect the filter element. If it is torn, obviously dirty, oily or otherwise suspect, you must replace it.

If only the small section of filter opposite the fresh-air intake is dirty, you can turn the filter 180° and re-

install it. If you are not sure whether to replace it or not, do so. A clean element ensures freer breathing for more efficiency than even a slightly dirty one. Before putting the filter back in the housing, wipe clean the inside of the housing and inspect its sealing lip for tears or cracks.

Next, undo the connections at both ends of the intake duct—as well as any intermediate connections—so you can remove and thoroughly inspect the duct itself. Check it for pinholes, cracks and tears. Any leak in the duct of a remote-mounted filter allows unfiltered air into the engine. It may be possible to repair small holes or tears using a dab of silicone sealer. Be sure that the duct is totally clear of debris. When you reinstall the duct, make sure all clamps are in place so the duct seals at both ends.

Be sure that a carburetor- or throttle-body-mounted filter housing is sitting squarely, and that the gasket underneath the housing is intact and in place before tightening down the wingnut. Also, be certain that the small sealing washer under the wingnut is in place when reinstalling the housing cover.

Despite being fed an unabated volume of clean air through the filter and intake, your engine can still run like it is suffocating if the intake valves are not all opening as far as they should be. Likewise, if the exhaust valves are not opening entirely, exhaust gases will not be totally scavenged from the combustion chamber. In both cases, performance, fuel economy and emissions suffer.

If your car has hydraulic tappets and requires no valve adjustment—and you hear no ticking from the valvetrain and don't notice a specific drop in performance—fine. The hydraulic tappets are doing their job of keeping valve lash where the engineers designed it. However, if your car does not have self-adjusting hydraulic tappets, you must adjust the valve lash, whether your engine has pushrods or overhead camshafts.

If your engine is warmed to operating temperature, don't immediately reattach the duct between the air-filter housing and the intake. Leave it



Tighten the locknut until the feeler gauge drags between valve stem and rocker.



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CAR CARE GUIDE

off and clear away any other components that might be blocking the valve cover, or covers on V-type engines. If the engine is *not* fully warmed, however, reattach the duct and run the engine until it reaches normal temperature before adjusting the valve clearance. In either case, have a new valve-cover gasket ready for when you reinstall the cover.

With the engine warmed and not running, remove the valve cover(s). While certain specifics of checking and adjusting valve clearance do vary from engine to engine, other elements of the process are universal.

Depending on your engine, you may check the clearance by sliding a blade-type feeler gauge between the top of the valve stem and the rocker arm, between the camshaft lobe and the valve, or between the cam and tappet, for instance. You may change the clearance by loosening a locknut and turning an adjusting screw on the rocker in or out, or perhaps by turning an adjusting screw inside the tappet, or even placing shims under the tappet, for example.

Regardless of the particulars, use the correct size blade-type feeler gauge specified by the carmaker. Typically, intake and exhaust valves have different clearances due to the different rates of heat expansion of the valves. As you check each valve's

clearance, double check whether it is an intake or exhaust valve. Always check the clearance when the valves are fully closed. That's when the round part of the camshaft—180° from the high point of the cam's lobe—is opposite the valve or tappet, or the pushrods are free of tension.

The easiest way to ensure that you check the valve clearances properly is to do so when the piston is at the top of the compression stroke and both the intake and the exhaust valves are fully closed. Check and adjust the intake and the exhaust valves for cylinder No. 1, and then turn the engine so that the next piston in the firing order is at the top of its compression stroke. Now you can check and adjust all the valves in only two revolutions of the crankshaft.

Use a large box wrench or socket and long-handle ratchet on the crankshaft pulley bolt to turn the engine. To make turning easy, remove all the spark plugs so there is no compression. In fact, remove the plugs anyway, since you should be changing spark plugs as part of the tuneup. If your engine is a diesel, relieve compression by removing the glow plugs.

Hot and on time

After the valves are adjusted and the valve cover(s) are replaced with a new gasket, you can install new spark plugs. Check each plug's gap before you install it. Also match the new spark plugs to your old ones. Make sure the threaded terminal end is the same size as your old plug. Also, check the wire-connector end of the plugs to see if you have to thread terminal connectors onto the plugs' tips.

Inspect each old spark plug as you remove it. The electrodes should be golden brown. If the electrodes are blistered white or sooty black, there is a fuel mixture or other kind of problem in that cylinder. When installing the new spark plugs, remember to put a dab of antiseize compound on the threads so you can remove them at your next tuneup. This is especially

important on an engine with aluminum cylinder heads. You should also put a dab of silicone grease or spray some silicone into the spark plug wire boot as you attach each plug wire. This not only helps the boot come off easier, it also seals out moisture and reduces radio interference.

Before reattaching the spark plug wires, however, inspect them. Due to the extremely high firing voltages of today's cars, even the slightest crack or other damage to the wire's insulation is enough to cause a misfire. Plug wires with cracked or brittle connector boots must be replaced. A simple check for spark plug wire voltage leaks is to use a household sprayer—such as one used for misting plants—to spray water at the wires while the engine is running. If the engine stumbles or misfires as you spray, replace the wires. Use an ohmmeter to check the continuity of the wire if you suspect that the wire can be broken internally. Check your shop manual for the resistance specs for your car's wires. Always place the plug wires in their looms, and avoid placing the wires for sequentially firing plugs adjacent to each other.

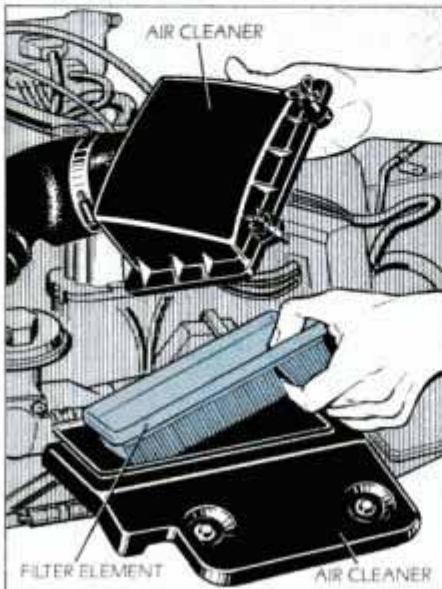
Next, verify that ignition timing is correct—even if your car has computer-controlled ignition.

Check the underhood tuneup decal or shop manual for the specifics of an ignition timing check. You may have to temporarily raise engine speed and disconnect a vacuum hose or a wiring connector. Clip the inductive pickup of the timing light around the No. 1 spark plug's wire, connect its leads to the battery and aim the light at the crankshaft or flywheel-mounted timing marks. If you cannot clearly see the marks, you may have to highlight the numbers on the pulley or marker with some white shoe polish or even typewriter correction fluid.

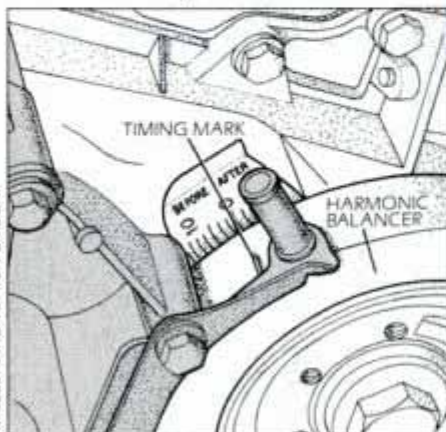
To adjust the timing on an engine that has adjustable timing—one not equipped with computer-controlled timing—loosen the distributor's hold-down bracket just enough to swivel the distributor as needed. Tighten the bracket and recheck the timing. **PM**

'GREEN' CAR CARE TIP

- Each time you install new plugs, you use up some of the Earth's resources and add to the solid-waste problem. So get more useful life from your next set of spark plugs by installing a set of precious metal- (such as platinum) tipped plugs. Though these plugs cost more than other spark plugs, they fire cleanly for two to three times longer than others.



Most air cleaners now are small, rectangular and mounted away from the engine instead of directly on top in the center.



Timing marks are easier to read if you highlight them before checking the timing.

PM ILLUSTRATION BY HANK IRWIN

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Troubleshoot Fuel Systems

ILLUSTRATIONS BY RON CARBONI



A faulty injector spray is a result of dirt or wear, and may require cleaning or replacement.

● Science-fiction author Arthur Clarke (who invented the geosynchronous satellite, among other things) says that any technology that is sufficiently advanced is indistinguishable from magic.

As advanced as the modern car's fuel-management system is—trust us, it's not close to magical in character. And, it responds to all of the familiar laws of physics. It's all a matter of understanding what's supposed to be happening under the hood as a prerequisite to fixing it when it's not working properly.

Just about all of the current cars have electronically controlled fuel-injection systems—either with an injector mounted right at the cylinder's intake port or in a centrally mounted throttle-body housing. The injectors used in diesel engines and some older gasoline engines are mechanical. And, of course, there are still many cars and trucks running around equipped with carburetors.

Reading the signals

Regardless of the way your engine gets its fuel, the symptoms of an overly rich mixture and an overly lean one are universal. If your engine is ping-pong, running hot, showing blistered spark plug electrodes and putting out unacceptable levels of NO_x , check for a problem that would cause a lean mixture. If your engine is leaving gray or white smoke, stumbling on acceleration, using more fuel than it used to, showing dark sooty deposits on the spark plugs and pegging the needle of the CO or HC meter on the

emissions tester, look for an overly rich mixture.

Of course, on cars equipped with a self-diagnosing, engine-management computer, you will be alerted to the problem early by the CHECK ENGINE warning light glowing at you from the dash. In that case, you can use the computer to help you pinpoint the problem by accessing the computer trouble codes.

But not all problems are within the purview of the computer or subject to the car's self-diagnosis capabilities. And cars with less sophisticated fuel systems can't help you find fuel-system problems. For instance, if you seem to be filling the tank more often than before and smell gasoline—even occasionally—you must rely on your own skills to check for a fuel problem.

Under pressure

You already know the usual cautions about making repairs to the fuel system: Disconnect the battery's ground connection before you begin, and do not smoke. When you are working on a fuel-injection system, add another caution: Relieve fuel pressure in the system.

'GREEN' CAR CARE TIP

● The precision of a fuel injector can be critically altered by even the smallest piece of dirt in the fuel. Therefore, fuel-filter care is even more important with fuel-injected engines than with those equipped with carburetors. Replace the fuel filter at least every year, or 12,000 miles, and be sure to check its connections for wear and possible signs of leakage each time.

Unlike a carbureted fuel system, which typically has a mechanical pump supplying enough of a stream of fuel to the carb to keep the fuel bowl full, a fuel-injection system needs to be pressurized from the tank all the way to the injectors.

A tank-mounted electric pump fills the filter, the fuel lines and a special manifold, called a fuel rail. What fuel the injectors do not use gets recirculated back to the tank. A fuel-pressure regulator ensures that the system always has the correct pressure.

Relieve pressure in the system before undoing fittings or disconnecting fuel lines. A 50-psi shot of gasoline in the eye is no fun. While some systems have a special fitting to release the pressure, others do not. If there is no specific procedure in your shop manual for relieving fuel-system pressure, pull the fuse for the electric fuel pump. Then crank the engine a few times. In any case, cover a fitting with a clean shop towel before loosening it and have a container in place to catch the spillage.

Given that the entire system is always pressurized, it becomes evident that even a tiny leak has the potential to become a deluge very quickly. You should periodically—twice a year—inspect the entire system for any signs of leaks.

Start at the tank and work your way to the engine. The tank itself should be dry. If there is physical damage to the tank, such as pinholes or cracks, the tank will leak. The tank may be damaged around its mounting straps or bolts, along the bottom—if you typically drive off-road—and around areas of stress, such as the filler-neck connection.

Fuel-injected cars usually have the pump mounted in the tank, along with the gauge sender. Check the connections from the pump to the fuel line, as well as the return line back to the tank.

Next, check the fuel filter. The filter for a fuel-injected vehicle may be mounted under a rear wheel well, inside a frame rail, inside the engine compartment on the firewall or on a

strut tower. Check the filter connections and the area around them for signs of leakage, stains and even wetness. If the filter connections are leaking, do not simply tighten them, remove the filter and determine why they are leaking.

While some filters have threaded connector fittings, others have flexible hoses with clamps and some have special, quick-connect-type fittings. Inspect the fuel line connectors and the ends of the fuel line where they attach to the filter. Small cracks, hardened hose and grit on the connectors will all cause a leak. Be sure to use the right size flare-nut wrenches when loosening and tightening flare-nut fittings.

Next, check the fuel line from the filter to the fuel manifold or pressure regulator on fuel-injected cars, or to the carburetor on engines equipped with one. Check those connections for signs of leakage. If there are any, correct them.

On fuel-injected cars, you must also inspect the injectors at the fuel rail as well. Depending on your vehicle's injection system, the fuel injectors may be attached via small fuel lines or directly to the rail. Also, the injectors may be held in the intake manifold separately or by the fuel rail.

An injector that is not properly seated or attached to the fuel rail will leak fuel. An injector that is not properly seated in the intake manifold will allow air to seep into the intake, creating an overly lean mixture.

Also check the fuel return lines, from the rail to the tank or pressure regulator for leaks.

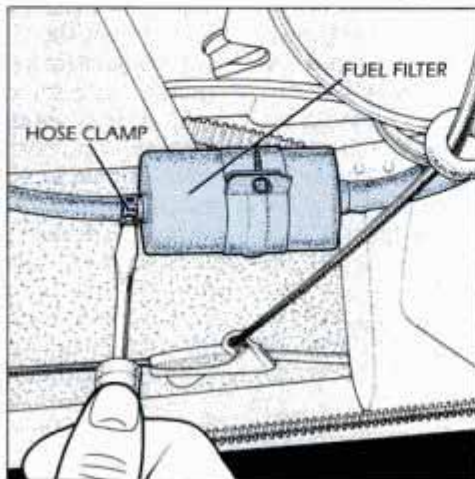
The last place the fuel may leak is past the injector tip into the engine. A dripping injector causes hard starting, rough idle and stumble. While there are specific—but expensive—injector test gauges, you can check for a dripping injector by seeing if the fuel system maintains its specified pressure by tapping a pressure gauge into the system and noting the pressure drop. Compare how long the system holds pressure versus factory specs. A system that will not hold

pressure may also have a defective pressure regulator or check valve, as well as a leak.

Injector checker

Unlike a defective carburetor, you can't rebuild a bad injector. But you can replace defective fuel injectors.

Depending on your injection system, you may be able to remove the injector from its bore in the throttle body or intake manifold and have it fire into a container. The fuel spray should be a conical-shaped mist, spreading out from the orifices in the injector's tip. If the fuel sputters, comes out in a stream or partial spray pattern, check the injector's tip—it



You may never smell gasoline leaking at a loose fuel-filter clamp hidden in a frame rail.

may merely be caked with varnish or other deposits. While a properly equipped repair shop can pressure clean the injector for you, you can also first try adding a fuel-injector cleaner to your tank. Or simply replace a poorly spraying injector.

If you can remove the injector without disconnecting it from the fuel rail or line, you can check it for a leaking or dripping tip. If the injector is dripping, replace the injector.

You should also check the resistance of electric injectors. Disconnect the electrical connection from the injector, and hook an ohmmeter across its terminals. Compare the reading with specs. If it's too high or too low, then it should be replaced.

A rough-running engine can be caused by uneven injection. If any injector is not receiving enough voltage—or none at all—trace its wiring back to the control module. Repair chafed or cut wires and clean all connections.

Rich or lean
While a carburetor uses a choke to reduce air to

create a richer-than-normal mixture for starting the engine, most fuel-injection systems enrich the mix by adding fuel via a special cold-start injector.

If the cold-start injector continues firing after the engine is warm and running, performance, economy and emissions all suffer. If the injector fails to work when the engine is cold, the engine will be difficult to start, and may not start when temperatures head south.

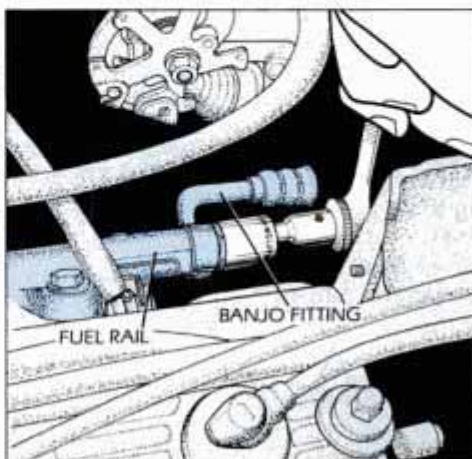
Check your shop manual for the specifics of the injector's operating parameters. The injector should receive current only under specific engine conditions—connect an ammeter/voltmeter to the injector's wiring and determine that it's operating properly. You should also check the injector's resistance. Replace a suspect cold-start injector.

Too much or too little air will also cause performance and emissions problems. While the engine computer relies on input from the airflow sensor in the throttle body to know how much fuel the injectors should deliver, simple mechanical elements can still alter the airflow.

While restrictions in the intake stream—a dirty filter element or a crimped or blocked duct—cause performance problems and an overly rich mixture, the engine computer may compensate by reducing fuel flow, further killing performance.

However, air or vacuum leaks—especially after the airflow sensor—can cause a critically lean mixture. Most injection systems provide a vacuum port on the intake manifold or throttle body for vacuum checks. If vacuum is lower than specifications, check for a leak.

Besides checking all vacuum hose connections, also check seals around



Fuel leakage at connector fittings may require disassembly and installing a new washer.

fuel injectors and the throttle body itself. Check the throttle shaft seals—by spraying them with oil and then watching the vacuum reading—as well as the seals on the ductwork. And don't overlook the obvious—check the intake-manifold gasket, the throttle-body gasket or the carburetor gasket.



Reduce Rolling Resistance

● Maybe because it's such an obvious truth that so many people overlook it. But, the less energy your engine needs to simply overcome the vehicle's resistance to rolling, the better its performance. Or, put another way, the lower your car's rolling resistance, the less fuel it consumes and the less exhaust it produces. So, to make sure you are, in fact, getting maximum performance, be certain that your vehicle's rolling resistance is as low as possible.

Tires

Start by making sure your tires are properly inflated, since underinflated tires require more energy to roll than properly inflated ones. Underinflated tires also produce more heat as they roll—accelerating tire wear and increasing the likelihood of tire failure.

With the popularity of quick-in/quick-out filling stations and the near-universal use of radial tires, fewer people are being asked—or thinking to ask—if their tires are properly inflated when they stop for fuel. And even the educated eye can look at a severely underinflated high-performance, low-profile radial and judge it to be just fine when it is not.

As inflation pressure goes down, the tire's tread deflects more as it contacts the road. That deflection increases friction between the tire and the road, increasing rolling resistance. Also, tread that deflects, or squirms, when it contacts the road does not stay open to shed water as well as the tread of a properly inflated tire. In addition, thanks to the lack of air, an underinflated tire's sidewall flexes excessively during hard cornering. This flexing lifts the edge of the tread, further reducing traction. The flexing of the sidewall as well as the squirming tread contribute to overheating the tire.

To ensure that each tire is doing its full share all the time, check the inflation of your tires—spare included—at least twice a month. Remember, the normal action of the tread hitting the pavement and sidewalls flexing and straightening as you drive, heats the tires, raising pressure. Check inflation before you drive the car that day. Use a quality pencil- or dial-type inflation pressure gauge. Make sure your gauge reads to at least 60 psi if you have a temporary mini spare. And, do

not rely on the gauge attached to the air pump at the filling station—abuse and neglect make these gauges notoriously inaccurate.

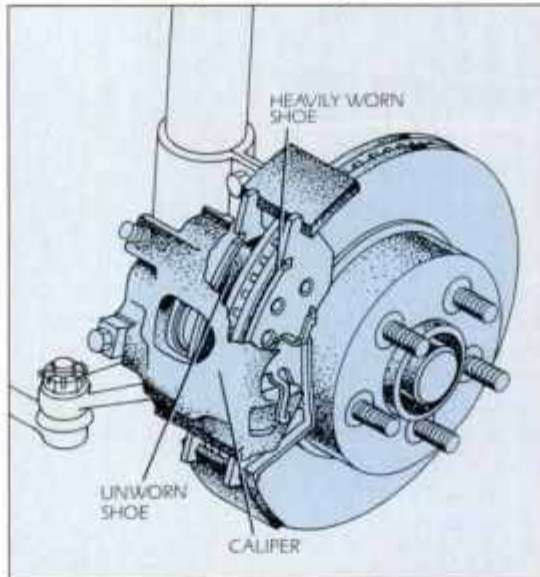
The tires should be inflated to *at least* the pressures recommended by your carmaker. Check those recommendations on the decal that's either on one of the door posts or in the glove compartment. However, remember that the manufacturer's recommendations for tire inflation pressures are for a compromise of a soft ride, handling and fuel economy. You can increase your car's fuel economy by upping the pressure by a few psi. However, you may give up something in ride softness since the increased inflation reduces the sidewall flex of the tire.

The volume of air inside the tire also determines how much load the tire can carry—the more air, the greater the load. This is critically important if you're towing a trailer or filling the bed of your pickup. However, when pumping up the air pressure, be sure to not exceed the tire maker's inflation limit which is embossed on the sidewall of the tire.

And since air pressure is temperature dependent, be sure to check pressures if the weather gets cold. Every 10° F drop in temperature is worth 1 psi. Likewise, as summer temperatures soar, you might have to bleed some air. But do not bleed air pressure from a tire that has had its correct pressure raised by driving. The pressure will return to normal as the tire cools.

Alignment

Wheel alignment is simply the relationship of the wheels, and tires, to the geometry of the various suspension members. Carmakers send each new car out into the world with its alignment set to specified angles. However, as suspension components



If one disc-brake shoe or pad is visibly worn more than the other, the brake caliper is sticking.

'GREEN' CAR CARE TIP

● Unneeded friction at the wheels is only one form of fuel-robbing drag. An equally serious impediment to efficiency is poor aerodynamics. Do not, as a matter of course, load gear on a roof rack when it will fit inside the vehicle. If you must travel with cargo, luggage or camping gear thrusting upward from the roof, load it as flat and as aerodynamically as possible, covering it tightly with a secure tarpaulin to reduce disturbances to the airflow. Or use one of the modern, sleek roof racks which totally encloses the load.



Tire tread wear indicates (from left to right) worn suspension, overinflation, underinflation, toe and camber problems.

PM ILLUSTRATION BY RUSSELL J. VON SAUERS

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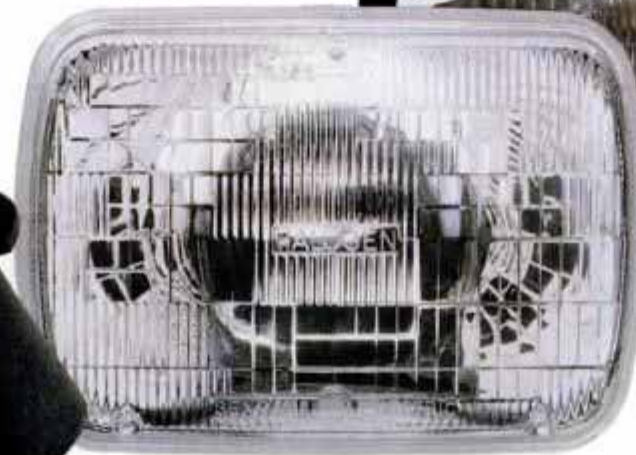


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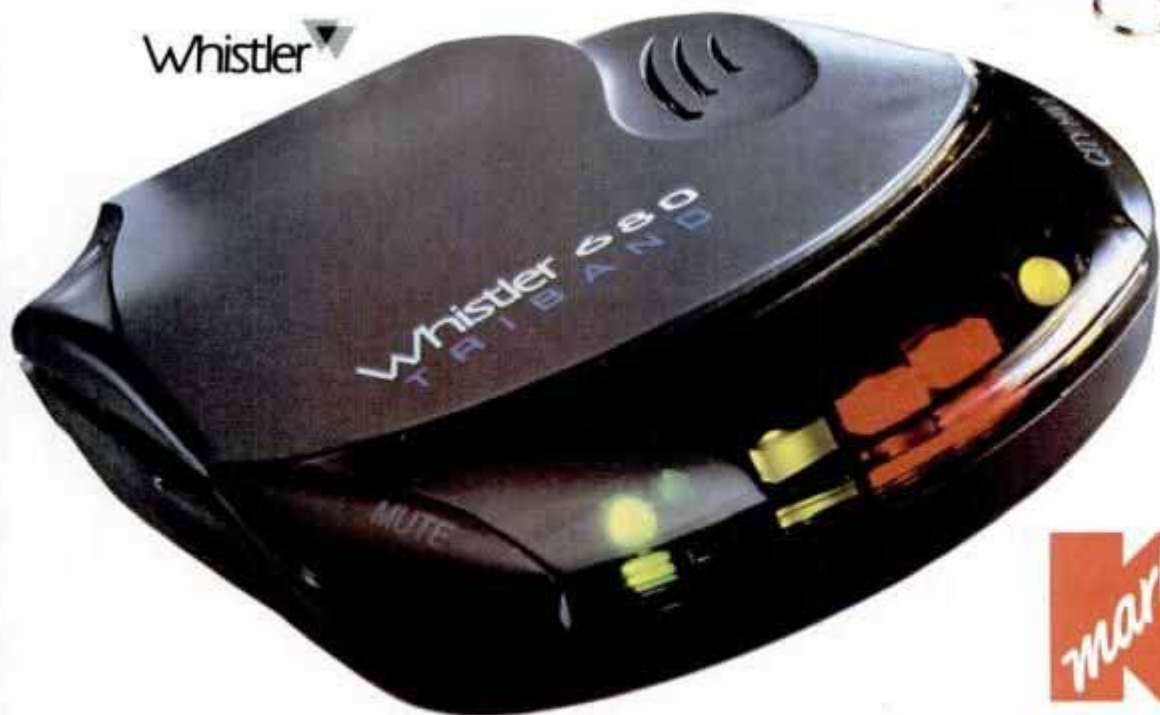
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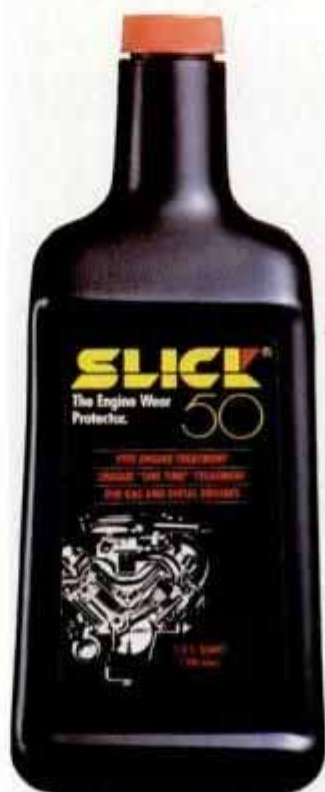


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wear and the car accumulates the hard knocks of miles, the parts stretch, deform and loosen, changing those angles.

Wheel alignment consists of three measurements, and for most cars, adjustments. They are caster, camber and toe.

Caster is the angle between where the steering axis would intersect with the road and where the center of the tire contact patch is located. Picture the front forks of a motorcycle going all the way to the ground, way ahead of the tire, to visualize the concept.

Camber is the amount—also measured as an angle—that the wheels and tires on the same axle lean to or away from each other at top and bottom. Tires that are closer at top than at bottom have negative camber. Those that lean away from each other at the top have positive camber.

Toe—measured in fractions of an inch—is the amount wheels and tires on the same axle point to or away from each other at front and back. Tires that point toward each other have toe-in, away from each other toe-out.

While changes to your car's caster and camber affect steering, handling and tire wear, they have little effect on fuel consumption. But incorrect toe causes the tires to be dragged as they roll, which does hurt fuel economy.

A careful inspection of the tire tread will reveal a severe or long-running alignment problem. But misalignment can occur after hitting a pothole or curb, and your tires may not show the ill effects for months of driving—but performance will be down. Therefore, have your car's alignment checked—and reset to specs—twice a year or when you notice the car no longer tracks or steers quite properly.

And thanks to the proliferation of independent rear suspensions on to-

day's cars, you must have the alignment of all four wheels checked. On vehicles with anything but a live, solid-axle rear suspension, rear wheel alignment has as much effect on performance as front alignment.

Bearings and brakes

Regardless of a tire's inflation or alignment, it's going to rob performance and fuel if it has to overcome a tight bearing or sticking brake to roll.

You should check the front wheel bearings of rear-drive cars and rear wheel bearings of front-drive cars

bearing for wear and damage.

Before removing the wheel bearing, be sure you have what you'll need to put it back together—anything from a new cotter pin to a new special self-locking nut, depending on your car, as well as a new grease seal.

Inspect both the inner and outer bearings for missing or chipped rollers, deep scores or cracks or breaks in the bearing's roller cage. Replace both inner and outer bearings if any part of the wheel bearing is defective.

Reassemble the cleaned or new bearing, packing it with wheel-bearing grease, not multipurpose grease.

Follow the carmaker's sequence for loading the bearing. Do not overtighten the bearing or you will damage it.

A tight bearing is not the only thing that can cause a wheel to drag. A frozen disc-brake caliper or sticking drum-brake shoe has the same effect as trying to drive with the brakes partially engaged.

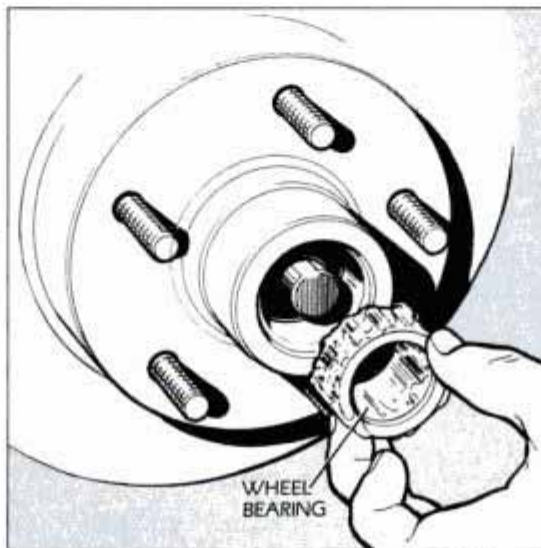
Inspect disc brakes by removing the tire and wheel, and either looking through the inspection hole in the caliper or at the exposed edges of the pads at the caliper's outer edges. If one pad is worn more than the other, the caliper is frozen. If the caliper is frozen, you must determine why and repair the problem. To do that, begin by removing the pads and the caliper. Check if the caliper pins or grooves are rust- or dirt-caked, preventing the caliper from sliding properly. Also, inspect the piston and see that it moves smoothly in and out in its bore.

Before installing new pads and re-installing the repaired caliper, check if the side of the rotor that had the frozen pad is scored and needs to be machined or replaced.

To free a sticking drum-brake shoe, you must remove the wheel and brake drum. Use a brake adjusting tool and a thin, long-blade screwdriver to relieve spring pressure on the brake shoes by freeing up the star-wheel adjuster.

Even if only one shoe is sticking, replace both brake shoes' return and hold-down springs. Check that the brake shoes are not hanging up on the raised platforms on the brake's backing plate—apply a dab of brake-shoe grease to the platform before re-installing the shoe.

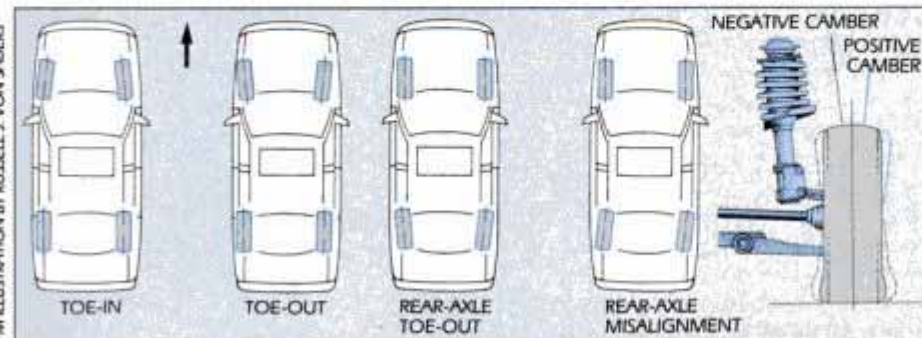
If the cause of the sticking shoes is the parking brake not releasing, replace the cable. **FM**



Inspect and repack nondrive wheel bearings. Tight or dry bearings waste fuel, loose bearings hurt handling.

twice a year by spinning the wheels when the wheels are off the ground and the car is on safety stands. The wheels should rotate smoothly and there should be no grinding or rattling noise coming from the hub. Also, grasp the wheel at the top and bottom and try to rock it on the spindle. There should be minimal or no movement in and out. Check your car's shop manual for the free-play specs.

If the bearing is overly tight, rough, noisy or loose, remove the wheel and the hub and inspect the



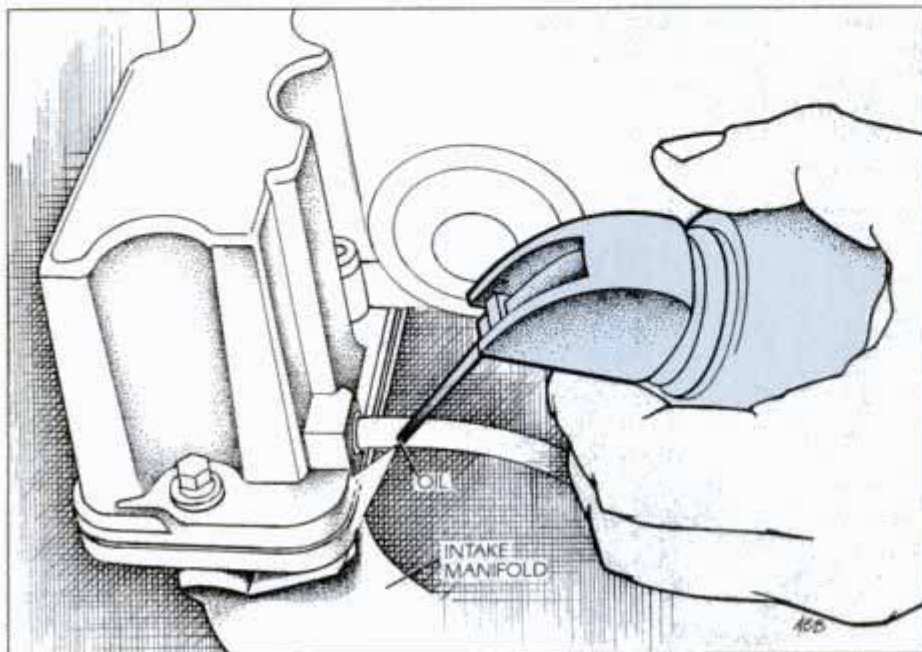
Cars with 4-wheel independent suspensions require alignment checks and adjustments for caster, camber and toe at all four wheels, not just at the front.

FM ILLUSTRATION BY FRED WOLFF

FM ILLUSTRATION BY RUSSELL J. VON SAUERS



Troubleshoot Emissions Controls



Spraying oil at the intake-manifold gasket reveals an NO_x increasing vacuum leak.

● The specific components of your car or truck's emissions system depend on its make, model and year. In fact, the same cars from the same maker with different engines may have different emissions controls. And, while nearly everything on your engine concerned with efficiently producing power can rightly be considered part of the emissions control system, certain components are dedicated to scrubbing the exhaust clean.

Air Injection

The cleaning process begins as soon as the exhaust gases leave the combustion chamber. On many engines, fresh air is injected into the hot exhaust through a special air-injection manifold (V-type engines have two air-injection manifolds) mounted on the exhaust manifold. This helps complete the combustion of partially burned fuel and reduces hydrocarbons (HC) and carbon monoxide (CO). You must inspect the air-injection manifold's tubing and fittings for the ravages of heat corrosion.

If the damage is limited to tiny pinholes in an otherwise solid manifold, patch them with muffler-patch cement. If the damage is worse, the manifold must be replaced. Bathe any

fittings or connecting bolts with penetrating solvent before attempting to loosen them. When installing the replacement, coat the threads with anti-seize compound.

If your car has an air pump to supply the fresh air to the manifold, check the pump's drivebelt for tension and wear. Replace the belt if you have not done so in at least two years. Check the connections between the pump and the air manifold. Inspect the check valve which keeps exhaust from bleeding back through the system to the air pump. The valve should pass air only from the pump to the air manifold.

Exhaust Injection

Under part-throttle driving conditions, many engines rely on an exhaust gas recirculation (EGR) valve to direct a portion of the exhaust gas back into the combustion chamber to reduce oxides of nitrogen

(NO_x). Consider an EGR problem if your engine won't idle smoothly or is inexplicably down on power.

While the specifics of EGR controls vary from engine to engine, essentially, vacuum is directed to the valve at certain engine speed ranges to open the valve. The EGR valve itself is typically mounted on the intake manifold and has a tube running to the exhaust manifold.

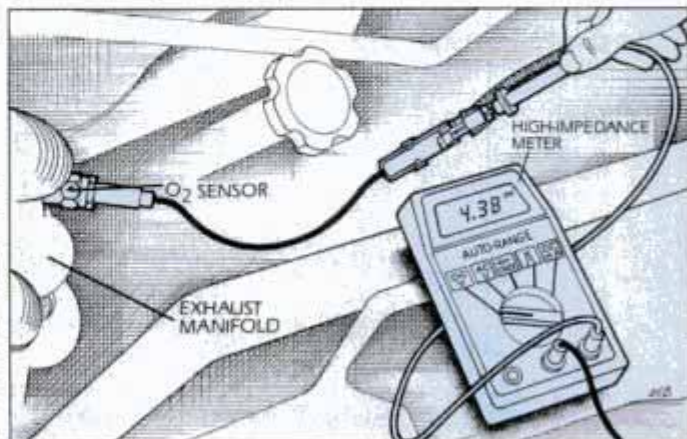
Check the operation of the EGR valve by applying vacuum directly to the valve—either via a manual vacuum pump or via a constant source of engine vacuum—and watch to see if the valve stem moves. If you cannot see the valve stem, apply vacuum while the engine is idling and note if idle speed and quality drop. Release the vacuum and note if idle improves.

If necessary, remove the valve and clean accumulated carbon from the valve stem and seat. Also check the valve's port in the intake manifold and the exhaust tube that feeds it.

Verify that your engine is not getting unwanted EGR by attaching a vacuum gauge to the valve's vacuum hose. Check your factory manual for specifications. Note that there is little or no vacuum during engine conditions when there should be no EGR—cold engine, idle, full throttle—and that there is vacuum when there should be EGR.

What goes in

Today's computer-controlled engines rely on a sensor in the exhaust stream



Compare the output voltage change of the O₂ sensor against factory specs while the engine is idling to check sensor operation.

to read the amount of oxygen in the exhaust. The computer uses this data to adjust the air/fuel mixture that goes into the engine for maximum efficiency. This exhaust gas oxygen (O₂) sensor is also subject to the harshness of working in the hot exhaust stream, and may be coated with carbon or other deposits, and thus give false readings or fail altogether.

As the oxygen content of the exhaust constantly fluctuates while the engine is running, the voltage produced by the sensor fluctuates, too. Attach a voltmeter to the sensor's lead. Compare the voltage readings with the specifications listed in your factory manual. Replace a defective O₂ sensor. Universal replacement sensors are available at your local auto parts store.

Also inspect the wiring and connections between the sensor and the engine computer. Repair any chafed, torn or cut wire, and clean and tighten any corroded or loose connections.

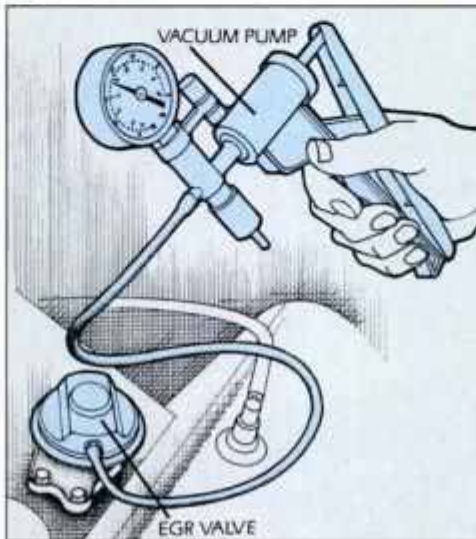
Clean and out

Your car's last chance at cleaning the exhaust is the catalytic converter. As the exhaust passes through the catalyst, the various precious metals in the catalyst cause the harmful exhaust components to combine with oxygen to form water vapor, nitrogen and carbon dioxide (CO₂).

For all this to happen, the O₂ sensor must be working properly and the catalyst must be hotter than its light-off temperature—well over 300° C. That means, among other things, that any special electrical catalyst heater must be working, and that the engine should get no combustion-cooling EGR until the catalysts have been warmed.

The catalytic converter relies on oxygen to complete the reactions with the exhaust gases. This means that the air pump and all its plumbing between the pump and the converter must be intact and operating properly.

So inspect the catalytic converter itself for physical damage—such as dents which would also increase back-pressure, or loose clamps and connectors. Eventually—well past the 50,000 miles mandated by the federal government—the monolith in the



Applying vacuum to the EGR valve should cause idle quality to deteriorate.

converter wears out. However, don't accelerate that process by using leaded fuel in a vehicle equipped with a catalytic converter. Replace a defective converter.

Sucking in fumes

Another element of your engine's exhaust is the exhaust gases that are forced by the piston rings into the crankcase as blow-by vapors. These

gases are recirculated back into the intake by way of the vacuum-operated, one-way positive crankcase ventilation (PCV) valve.

Under conditions of very high vacuum—such as at idle—the vacuum keeps the valve closed so no blow-by gases enter the intake. Under other conditions, when vacuum to the valve is light, a spring opens the valve, permitting the blow-by gases back into the intake. A separate breather hose runs from the fresh-air intake or air-filter housing to the engine to help purge the gases from the crankcase and keep the pressure in the crankcase slightly positive.

Check the PCV valve at least twice a year. Shake the valve to be sure that it is free—if it doesn't rattle, replace it. If it does rattle, blow through it in both directions. It should pass air from the engine back to the intake.

Many cars are equipped with a small separate filter to clean the air that the crankcase ventilation system draws in. The filter is typically located inside the air-filter housing. Inspect it each time you inspect the PCV valve or when you check the air-filter element. Replace an oily or otherwise dirty filter. Also inspect the hose from the PCV valve to the intake—replace it if it's cracked, mushy or hardened. Also check the valve's sealing grommet. **FM**

'GREEN' CAR CARE TIP

- It is counterproductive in more ways than one to disable any parts of the emissions control system. With computerized controls and sensors, the goals of good fuel economy, clean exhaust and maximum performance are inexorably intertwined. If emissions suffer, so do fuel economy and performance.

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Don Johnson, V.P. Product Engineering
Pennzoil Products Co.

The Multi-Viscosity Story

Q. For many years I have been under the impression that multi-viscosity motor oils lose their viscosity in service. After as little as 500 miles, a 10W-30 oil would break down to just a plain 10W oil.

My mechanic says to use a straight SAE 30 for the best protection, but my owner's manual only recommends SAE 5W-30 or SAE 10W-30. Who's right?

E.W., Hebert, LA

A. Follow your owner's manual recommendations. Multi-viscosity oils flow well at cold temperatures while maintaining a high

viscosity at hotter operating temperatures, resulting in longer engine life. Engine manufacturers recommend SAE 5W-30 and 10W-30 to provide the best of both worlds.

Some multi-viscosity oils, however, may have a tendency to break down during operation, breaking down an SAE 5W-30 to perhaps a 5W-20 or less. This viscosity may not provide all the protection your engine needs.

Pennzoil Multi-Vis™ is the industry leader and outperforms any leading motor oil against viscosity breakdown.

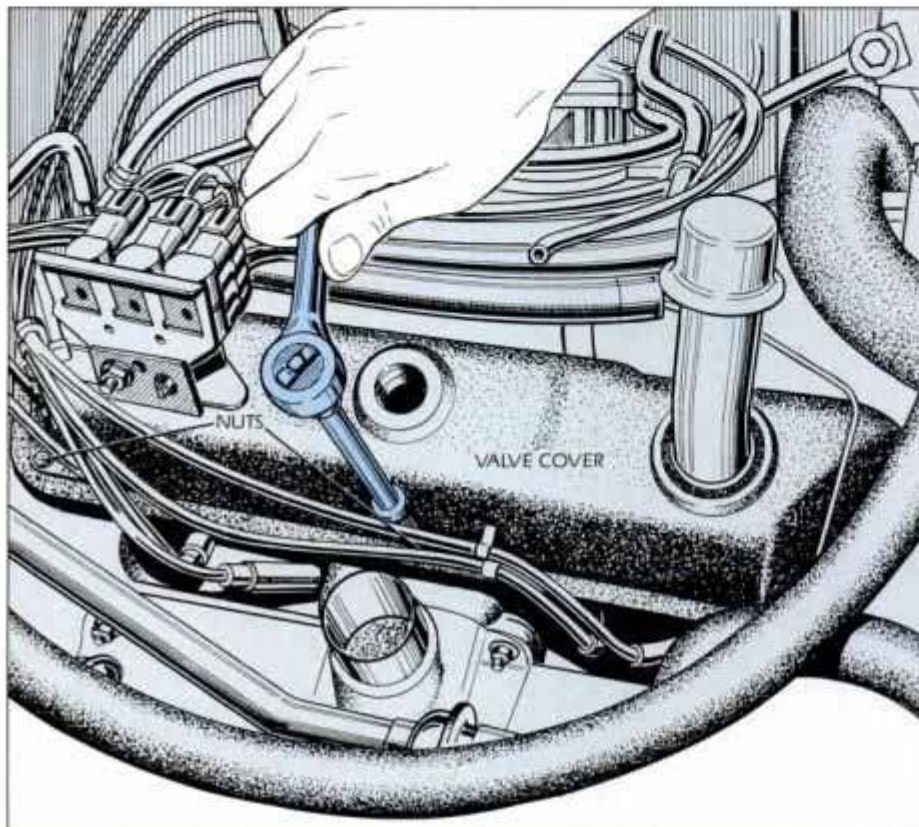
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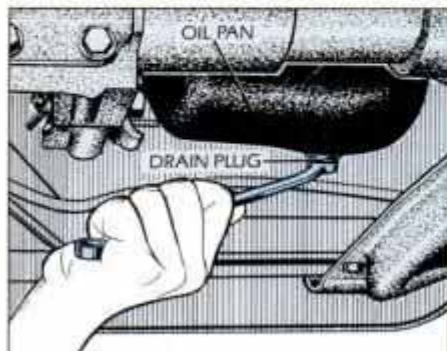
Plug Engine Oil Leaks



Don't overtighten small valve-cover bolts when trying to stop a leak at cover gasket.

● Changing your engine oil and filter frequently—say every 3000 miles—is good, unless you're changing it a quart at a time to replenish oil that is leaking. Then it's bad.

Before you repair any oil leak, you have to locate its source. This sounds easier than it may be. An engine that's been leaking oil for even a few thousand miles can be so dirt and grime covered that dirty oil will be running and dripping all over. There-



Make certain that the oil drain plug is snug and that its sealing washer is intact.

fore, the first step to stopping oil leaks is to thoroughly clean the engine using a biodegradable cleaner. Also clean your garage floor or driveway, so you will be able to quickly spot fresh stains.

After the engine and its compartment are clean and dry, drive the car and inspect the engine—from above and below. Dripping oil follows circuitous routes, clinging to components, brackets and following the ridges of engine contours. While it is possible that a puddle on the garage floor is being fed from a leak directly above it, it's not very likely.

If you can't pinpoint the source of a leak, dust the clean engine with talcum powder or cornstarch and run the engine. The leaking oil will mark its trail to the source. Or, you can have a special leak-tracing additive—a fluorescent dye—poured into the oil, and then have the engine inspected under a black light which will highlight the additive, pinpointing the leak.

Leaks from covers—including the

oil pan, front timing cover and valve covers—are usually due to a loose or broken gasket. These leaks may be cured by simply snugging down the cover's bolts. If not, you must change the gasket. Before installing the new gasket, however, check the cleaned gasket surfaces for gouges, cracks or nicks that might be too deep for the gasket to seal. Also check the cover itself. If it is distorted, twisted or has bolt holes pulled higher than the surrounding metal, you can try to straighten it with a block of wood and a hammer. Otherwise, replace it.

Check each mounting-bolt hole to ascertain whether the hole is blind or goes through, possibly to an oil gallery. If the bolt hole goes through, oil will work its way along the threads and leak from under the bolt's head, unless you prevent it. Put a sealing washer under the head of the bolt or coat the bolt's threads with gasket sealer before installing it.

If you use RTV silicone to make a new gasket instead of using a pre-cut one, put down an unbroken bead and be sure to fully encircle all bolt holes.

A leak at a shaft seal mandates a replacement seal—often possible without removing the shaft. Before installing a new seal, however, inspect both the shaft surface that the seal rides on and the bore of the seal cover. If either is nicked or gouged, the new seal will leak.

When searching for the source of the oil leak, don't forget the obvious—including the seal on the oil-fill cap, oil-pan drain plug, PCV valve or breather hose and oil-filter base gasket. Inspect the dipstick to be sure that it's seated in its tube and check the base of the dipstick tube. Also, check the oil-pressure sender unit as well as any oil cooler fittings. **FM**

'GREEN' CAR CARE TIP

- Each time you install a new oil filter, lightly coat the new filter's gasket with some clean oil to prevent the gasket from deforming as you tighten the filter. And resist the temptation to *really* tighten the filter. Overtightening will distort the gasket and the filter base, causing a leak. Follow the filter maker's recommendation for tightening—typically only hand tight.



INTERNATIONAL AUTO CARE CRUSADE

May has always been car care month here at Popular Mechanics. It's always the month we run our annual Car Care Guide. That's where we bring you the best and latest information on keeping your car running like new. This year, the theme is "green" car care. We hope you'll take care of your car and take care of our environment too. It's an important issue and we all have to do our part at the grass-

roots level for this thing to work.

Take care of your car on a regular basis and everyone wins. You'll have a better running car. Your car will get better fuel mileage. Your car will give off less emissions. Your car will last longer. And you'll save money in the long run.

This May is even more important than usual. It's the kickoff of the International Car Care Crusade, a program initiated by the Automotive Parts & Accessories Association and fully supported by Popular Mechanics. APAA is the auto-motive aftermarket's largest association. Its members will be participating by running special promotions, special sales and giving out free literature and information in their stores to help you take better care of your car.

Start by visiting one of the participating Member Retailers listed on this page. We'll bet you'll find at least one money-saving special that will make the trip worthwhile. Your car will be happier and you'll be doing something good for this world of ours.

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All States



MD, VA, DC, CA, IL



VA

Plug Transmission Leaks

● Compared to an engine, the opportunities for oil to leak from a transmission are relatively limited. Transmission cases are less complex than a typical engine—there are fewer gaskets, fewer seals and just fewer places that oil may leak from. In fact, before you decide that the transmission is leaking, ascertain that the dripping oil is not coming from the engine.

Automatic transmission fluid is thinner, redder in color and smells different than engine oil. Most manual transmissions use gear lube which is heavier and much different in odor than engine oil.

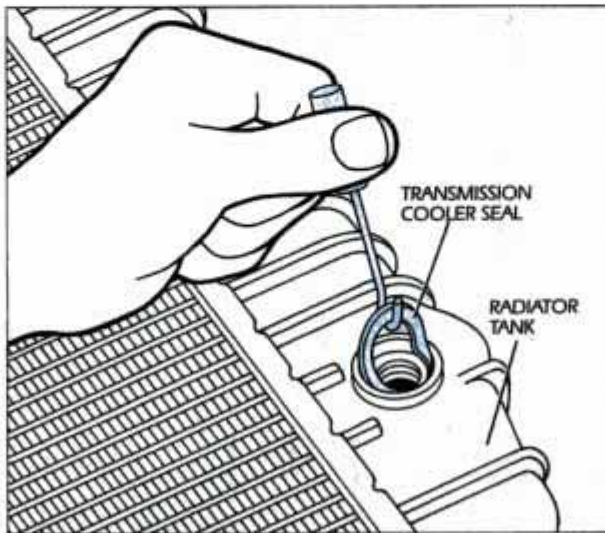
The most likely places for an automatic trans to leak from are the front and rear seals and the pan gasket on the bottom. Any oil leaking from a manual transmission is probably coming from the front or rear seals, the gasket of any inspection cover, or the fill or drain plug.

Other possible sources of transmission leaks may be the seals for linkage shafts or threaded fittings, such as for a governor. Also, the lines and fittings for the transmission oil cooler are always suspects.

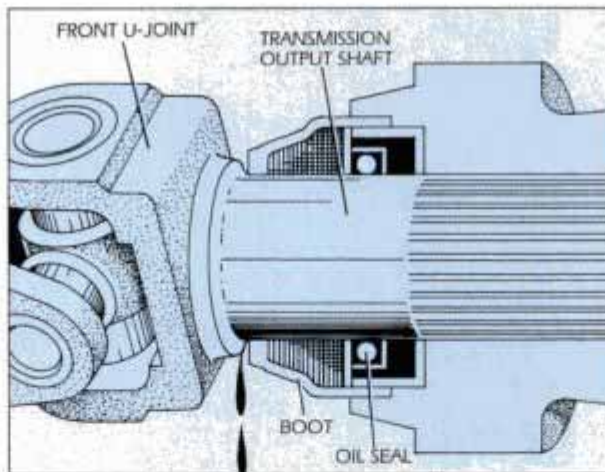
Resealing

A leak from the front, rear or axle shaft seal requires a new seal. If your car is a rear-driver and it's the front seal that is leaking, you must remove the transmission to replace the seal. With the transmission off and the torque converter removed from an automatic, be certain that it's the shaft seal and not the transmission case near the seal that is leaking.

Depending on your vehicle, you may be able to replace a leaking rear seal without removing the gearbox. However, you still have to drop the driveshaft from the differential and remove the output shaft from the rear of the transmission. If the leak is from an axle shaft seal on a front-driver, the axle shaft must be removed before the seal can be replaced.



Try replacing the seals under the transmission cooler's fittings if ATF is leaking at the radiator.



Leaky trans output-shaft seals can be replaced without pulling the transmission out of the car.

When replacing any shaft seal, look for damage to the seal's mounting bore or the shaft's sealing surface. Thoroughly clean the bore and the shaft. Be sure to inspect both for deep scratches, gouges or scores that

'GREEN' CAR CARE TIP

- Take care when checking the oil level in your automatic transmission. The automatic trans gets hot as you drive and actually expands. If you overfill the transmission by filling it to the dipstick mark when it's cold, the fluid may overflow when it heats up. Consult your owner's manual for the correct dipsticking procedures.

would keep the new seal from doing its job. If the transmission case is damaged in the front seal area, you must either replace the case or the front cover, depending on the transmission. If the shaft is scored or grooved, you must replace it if no over-size seal and shaft spacer sleeve are available.

When installing a new seal, take care not to cock it in the bore, nor catch the sealing lip on the sharp tip of the shaft. And, always be certain to install an oil seal with the sealing lip facing the proper direction. Use a soft-headed mallet or block of wood to tap the seal into place.

Blowing a gasket

If the leak is from a gasket—the pan of an automatic, an inspection cover on a manual or a drive flange on a transaxle—you may be able to stop the flow by simply tightening the cover bolts. Tighten the bolts in a crisscross pattern—follow the torque specs for the bolts and do not overtighten them.

If the bolts are snug, then the gasket or the cover is defective. You must remove the pan, cover or flange to fix the leak. With the cover off, clean all of the old gasket material from both mating surfaces and thoroughly clean them before installing the new gasket.

When putting the bolts back in, check if the bolt hole goes through to the inside of the transmission case. If so, the bolt needs to be sealed before you install it. Either put sealant on the bolt's threads or place a crushable washer under it.

Not so fitting

If the oil seems to be leaking from a fitting, such as for the transmission oil cooler, you may be able to simply snug up the fitting. If tightening does not work, you must replace the fitting.

Don't overlook the transmission's dipstick and tube—be sure the tube is snug in its bore and that the dipstick is properly seated in the tube. **FM**

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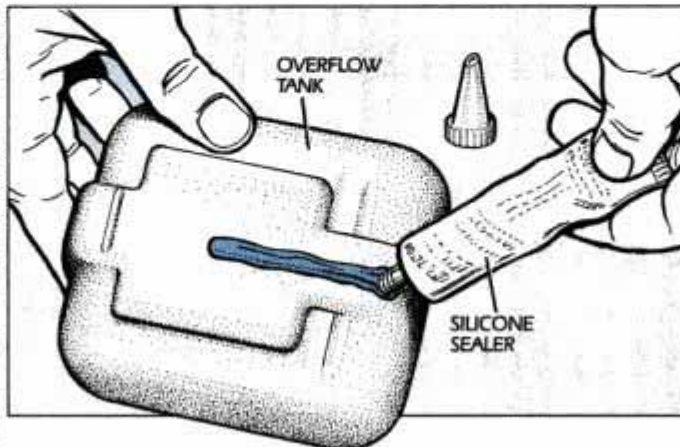
Plug Coolant Leaks

● A cooling system leak is more than a nuisance. The coolant lost from your engine represents lost engine cooling capacity. Even if you continually "top up" when the system is obviously low, the engine still runs hotter in summer, developing power-robbing hot spots around the combustion chambers and lowering a/c performance. Low coolant also cuts heater performance in winter.

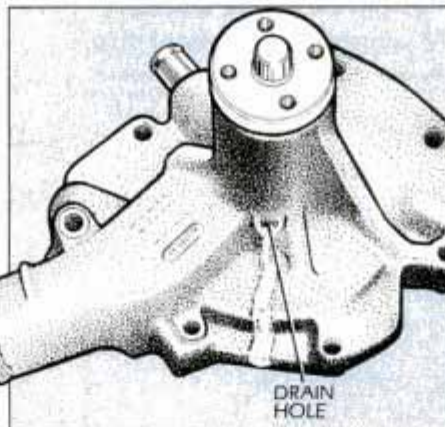
And now there's a new concern: the U.S. Environmental Protection Agency has labeled engine coolant (potentially laden with heavy metals) a hazardous waste product.

Professionals either pay to have used coolant carted away or they recycle it with special equipment. The EPA and other agencies aren't after the Saturday mechanic, but do-it-yourselfers do account for about two-thirds of antifreeze purchases. Check with local authorities on how you can participate voluntarily in a solution—perhaps by taking your old engine coolant and engine oil, stored separately in clean plastic containers, to a collection center.

But besides dealing responsibly with your old coolant, it is also critically important to keep coolant in the system by stopping leaks. Coolant generally leaves a flow-line stain on metal, so if you spot one at a hose or gasket joint, you've found a leak (remember it may not be the only leak, however). Often, all it takes to fix the leak is for you to simply tighten a hose clamp. The clamp may have begun leaking not because it's worked loose, but because the rubber underneath has taken a set. However, before you make the attempt, understand that only worm-drive band clamps can be successfully retightened. Replace others, such as the double-wire and screw-tower varieties. Replace the first type because it digs into the hose and can damage it, the second because it applies relatively uneven clamping pressure. For even clamping, use worm-drive or spring band clamps as a replacement.



Leaking radiator overflow tanks can usually be patched with silicone sealer. Apply a second bead inside as well.



A small seepage of coolant from the water pump drain hole is normal—drops or a stream mean that the seal is leaking.

Hose clamps are not the only likely leak culprits, however. Coolant temperature sensors are also common leakers. The coolant may actually seep from the sensor's body. If this is the case, you must replace the part.

'GREEN' CAR CARE TIP

● Ethylene glycol, the major component of engine coolant, is harmless to handle, but toxic when ingested. The lethal dose is only a few spoonfuls for an adult, and proportionally much less for small children and pets—who are attracted to its syrupy sweet smell and taste.

Mop up or rinse away any spillage promptly. Store any unused coolant, or the container you've drained and not yet run off to be recycled, with other household chemicals not safe for kids.

Or, coolant may leak from the threads, in which case you can wrap the threads with Teflon tape and reinstall the sensor. Don't try super-tightening a leaking sensor or you may overdo it, distorting threads and making the leak worse.

If coolant flows from the cylinder head through the intake manifold, periodically check the intake-manifold bolts' torque—retighten them to specs if necessary.

Look for a continuous flow from the water pump drain hole with the engine running. All water pumps weep

the odd drop or two, but even a tiny stream means the pump must be replaced. Pumps on some imported cars (particularly Honda) have two holes, so be sure to check both.

What if you know coolant is leaking from somewhere, but you can't find the leak? Keep checking. Some hose connections are really buried. Apply 16 to 18 psi to the system with a pressure tester (\$20 to \$50 at auto parts stores) and the coolant leak should show up from any external source on the engine or radiator.

Still no luck? Inspect the system's overflow reservoir carefully for a leaking crack. If the reservoir is cracked—check the plastic's molding seams carefully—you may be able to save the part from the scrap heap. Repair the crack with a thick film of RTV silicone or epoxy—first thoroughly clean and dry the reservoir and then apply a bead or smear of the sealant both on the inside and outside. It also helps to first thoroughly rough up the repair area of the polyethylene plastic using emery or sandpaper. Then clean off the grit.

Minimize minor seepage with a single can of cooling system stop-leak when you put in a fresh fill of antifreeze on older cars. Stop-leak isn't a cure-all, however, and too much may plug narrow tubes in the heater.

All late-model cars' overflow reservoirs have well-identified full-level lines, so include a coolant-level check with every underhood inspection. **PM**



Plug A/C Freon Leaks

● R-12, best known by the trade name Freon, is the refrigerant gas used in your car's air-conditioning system, and it's on its way out. There's scientific evidence that when it escapes from the system, it eventually rises and erodes stratospheric ozone, a layer 20 to 40 miles from the Earth that protects us from the harmful rays of the Sun.

By international agreement, production of R-12 has been cut sharply and will stop by 1997. (As we go to press, President Bush has asked to speed up even that ambitious timetable by several years.)

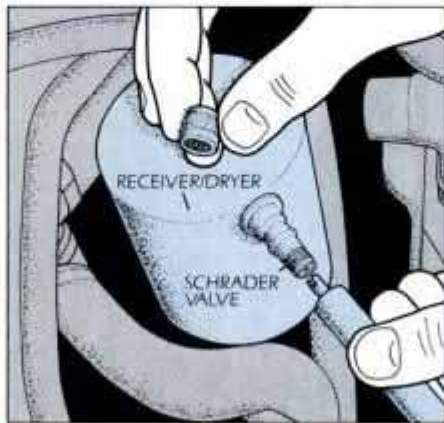
Work is being done on substitute refrigerants, and carmakers are gradually switching to one called R-134A. However, there's nothing available at this time that can be added to an R-12 system, and there's no known way to convert an R-12 system to R-134A at reasonable cost.

Do not under any circumstances add R-134A to a system intended for use with R-12. The two refrigerants operate at different pressures and temperatures, and aren't compatible. Furthermore, the R-134A will contaminate any R-12 recycling system, so no shop would be able to reclaim any of it.

How can we keep R-12 systems pouring out cool air? As of Jan. 1, most professional shops must capture and purify any R-12 removed from a/c systems they service, using special equipment. It's illegal for them to vent it to the atmosphere. Later this year, small 1-pound disposable cans of R-12 will be available only to shops with this recycling equipment, and by Jan. 1, 1993, all professionals who service a/c must recycle R-12. The cheapest recycling machine is more than \$1500, so it's not something a Saturday mechanic is likely to buy.

There are several things you can do to prevent loss of R-12 from your system. The price of R-12 has skyrocketed, in part because of new federal taxes, so anything you do will not only help preserve the ozone layer, but save you money, too.

● Check all refrigerant line joints



A valve tool is used to tighten Schrader valves. Be sure to reinstall the valve cap.

—at the compressor, condenser, evaporator (all you can see of the underdash-mounted evaporator are the joints at the cowl), receiver-dryer or accumulator—and look for an oil film, which probably indicates a refrigerant leak carrying some oil out of the system. It may be caused by a loose connection, so if there's a bolt or nut, tighten to specifications with a torque wrench and crowfoot bit.

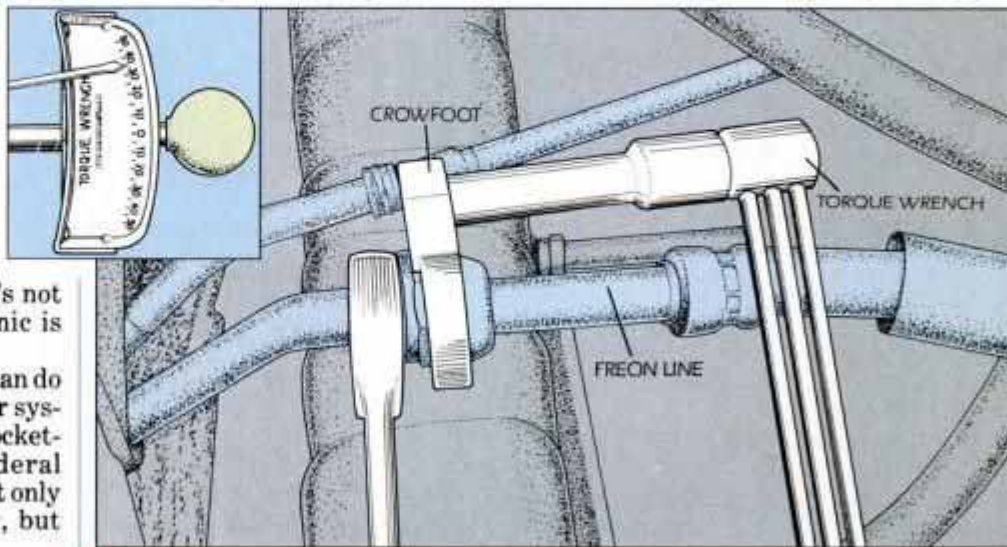
Don't overtighten, or you may damage an O-ring inside the joint. Not all refrigerant lines have fittings you can tighten. Many have special spring-lock couplings, and if these leak, leave them to a pro.

● Not sure an oil film indicates a leak? Check the joint with a propane flame

leak detector (under \$40). Light and adjust the torch as the instructions indicate. Run the search hose around the joint and if the flame changes color from pale blue to yellow, there's a small leak. If it changes to bluish-purple, a larger one. Be sure to probe carefully near the underside of the fittings, as R-12 is heavier than air and will leak more from the bottom.

Alternatively, you can brush or spray a solution of dish detergent and water on the fittings, and look for bubbles of leaking refrigerant. This will catch larger leaks. Professional a/c technicians will have more sophisticated methods, capable of catching even the smallest leak. This includes electronic detectors and fluorescent dyes that glow under black light. Obviously, if you suspect a leak and can't find it yourself, avail yourself with the services of a pro.

● Inspect the front of the compressor and the hood's insulator pad above it (if the compressor is mounted at the top of the engine), looking for a/c refrigerant oil. This may indicate a leaking compressor-shaft seal, which can be replaced by a professional who will capture and reinstall any R-12 still left in the system. Some seepage from the compressor shaft might be normal, particularly with older compressors. A small oil streak doesn't always mandate a new compressor seal. If the seal leak is small enough to trigger



Use a torque wrench and, if necessary, a crowfoot to torque refrigerant fittings.



CAR CARE GUIDE

an electronic leak detector but does not show on a propane detector, you should look elsewhere for any significant loss of refrigerant.

The a/c system typically has two tire-type service valves (called Schrader valves) through which system pressures are tested and R-12 is added or removed. If a Schrader valve is loose, tighten with the same type of tool used for tire valves. If the thread-on cap is missing, get a replacement and install it, as the cap is an important seal.

Clean any bugs, mud, leaves and other debris from the front of the condenser, so there's good airflow. If it's restricted, the R-12 in the condenser can get so hot that a/c performance drops, and even worse, the pressures in some systems may get so high that R-12 pops a relief valve and escapes into the atmosphere. Other cars have a high-pressure cut-out switch that triggers first, so at best, the a/c compressor will disengage and the cool airflow will stop.

Make sure the engine cooling system is operating normally. On most cars, the radiator is just behind the condenser, and if the engine runs hot, the heat from the radiator transfers to the condenser, causing a pressure buildup and performance drop.

If your car has an electric fan, make sure it comes on after turning on the a/c, or within a couple of minutes. If it doesn't, a/c pressures will also build up to unacceptable levels. If it has an engine-driven fan, check to be sure

the fan clutch isn't slipping (with the engine hot, shut it off and make sure there's considerable resistance when you try to turn the fan).

Many Japanese cars and some oth-

ers have a separate fan for an a/c condenser that sits alongside the radiator instead of in front of it. Be sure to check the operation of this fan when you turn on the air conditioner. The

main (radiator) fan may or may not come on as well, depending on the particular system.

Don't routinely give switches threaded into the R-12 system an extra turn with a wrench. All you may do (particularly on plastic parts) is distort threads and possibly cause a leak. If there is a leak, it may be from a Schrader valve behind a switch or a defective O-ring seal you can't see.

More R-12 doesn't equal better performance. Most Chrysler products and imports have a sight glass (a "window" into the a/c lines), and bubbles in the window often are interpreted inaccurately as a low refrigerant level. However, the only way to know for sure on any system is to check pressures with gauges and make a performance test according to factory manual procedures. If you add too much R-12, even by a few ounces, system performance generally will drop.

If you've always had a fresh fill of R-12 installed in

your system every spring, leave it in, or have a shop remove it, purify it in a recycling machine to get rid of acids and moisture, and then put it back.

Got a definite but minor leak? Don't ask the shop to just top up the system with R-12 for the season, because that's illegal. Get the leak traced and repaired, and be a good citizen of planet Earth.

PM

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Guarantee applies to GM cars and light trucks. See your participating dealer for details. No purchase necessary. Void where prohibited. Must be licensed driver 18 years of age or older. Contest ends May 30, 1992.

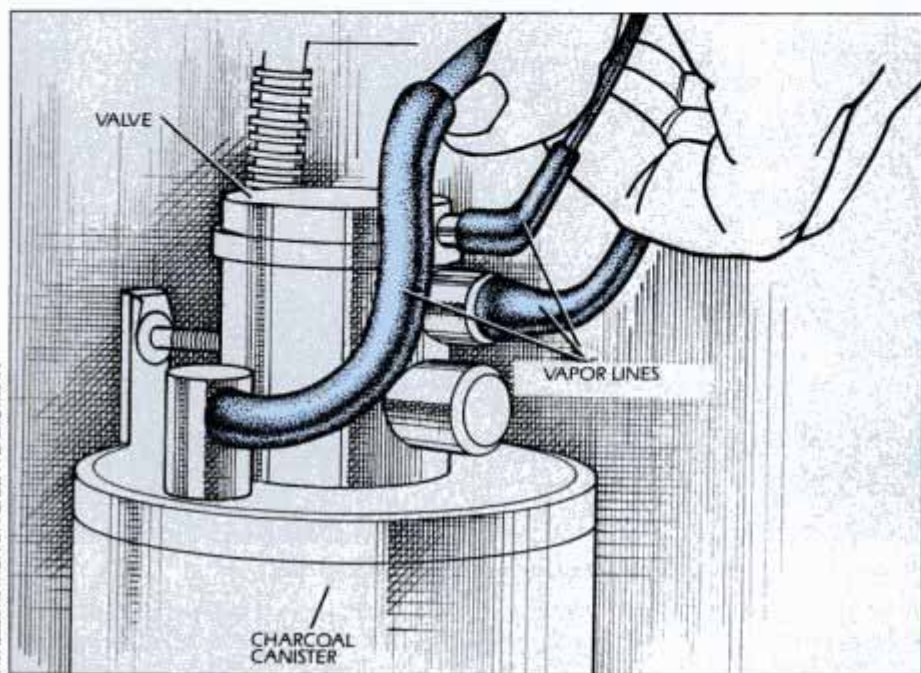
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'GREEN' CAR CARE TIP

• Every month or so—even in the middle of a subzero winter—run your air-conditioning system for a few minutes. This will free up sticky pistons or vanes in the compressor, sticky valves, and generally keep things from seizing from disuse. It will also lubricate the compressor seals, lowering the possibility of leakage when the system is started in the spring.



Plug Fuel And Vapor Leaks



FM ILLUSTRATION BY ADOLPHE E. BROTMAN

Inspect the charcoal canister, vapor lines and fittings, and the purge valve for leaks.

● When there's a gasoline odor under the hood but no apparent leaks, check the car's fuel vapor control system. This system collects and routes vapors from the gas tank and fuel system to storage in a charcoal canister. It then meters them back into the engine to be burned as if they were still liquid gasoline from the tank.

Some minor gas odor from the canister is normal after a car cools down in a garage for several hours in hot weather, when the ambient temperature produces lots of fuel vapor. However, the control system should purge the vapor into the engine when it's warmed up and running. If the vapor odor is almost always apparent, find

out why. On many cars (particularly GM), the vapor purge—controlled by a thermostatic vacuum valve or a solenoid energized by the engine computer—may allow a tiny amount of vapor flow at idle. In other cases, however, including most purge valves that have only a vacuum control, all the flow occurs when the engine is running above idle speed.

To troubleshoot a vapor odor, inspect all canister hoses for cracks and poor connections. Replace a bad hose with one that is fuel line quality only. Check hose routings, comparing them with the underhood decal or a service manual, and smooth out the routing to eliminate dips, bends and kinks.

Inspect the canister for cracks. If it's hidden in a fender wheel well, you may have to remove a plastic wheel-well shield to see it. But if the canister has vibrated loose, it surely could be damaged. A replacement ranges from \$30 to \$80.

On older cars, the

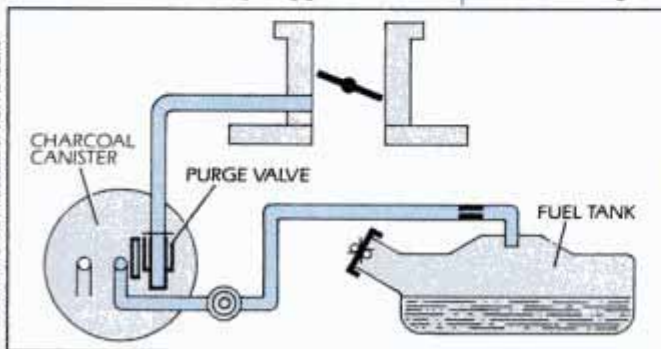
canister has a fiber-inlet air filter, and if it's plugged, the canister won't purge properly. Later-model canisters have an air-inlet vent that requires no service.

The purge valve or purge solenoid valve must work properly. If it's stuck closed, the canister won't ever purge and there will be fuel odor. If it's stuck open, it will continuously purge—even at cold idle—and the engine will run rough and stall. If you can blow easily through the valve with the engine off, it's stuck open.

For diagnosis, disconnect the canister's purge hose and check for at least 10 in. of vacuum (to draw out vapor) with the engine warm and running at part throttle. Little or no vacuum? Disconnect the other section of purge hose (at the valve, from the intake manifold or air intake) and check the hose end for good vacuum. If there's enough vacuum feeding in, but it doesn't get through, the valve is not working. If it's vacuum-controlled, check the vacuum supply hose.

If it's a solenoid valve, probe the terminals with a computer-safe test light or high-impedance voltmeter—first with the engine cold right after it starts, then with the engine warm and at part throttle. The voltage should go on in one case, off in the other—which one depends on the circuit. If it flickers at part throttle, you should feel the valve assembly pulsing.

When the circuit is on, unplug the wiring connector with your fingers on the solenoid, and you should feel some valve movement. If there's juice at the solenoid, but no movement, it's defective. No voltage at all? There's a break in the wiring to the solenoid or possibly a defect in the engine computer circuit that controls it. **FM**



FM ILLUSTRATION BY RUSSELL J. VON SAUIERS

The canister meters trapped fuel vapors back to the engine.

'GREEN' CAR CARE TIP

● If you've inadvertently lost your gas cap at some self-service station, don't be tempted to replace it with just any cap that fits—say one from the lost-and-found bin at the next gas station down the freeway. Why not? Because the gas cap is an important component in the evaporative fuel emissions control system, and the cap that fits the threads may or may not have the right pressure relief valve or seals.



Use Recycled Parts



This BMW, like other new European and domestic cars, has a high percentage of recycled and recyclable materials.

● Besides swallowing a colossal volume of fossil fuels and clean air as they drive, our cars and trucks also consume other resources from the environment. The steel, aluminum and assorted metals needed to build the complex pieces of machinery we drive are nonrenewable resources. When the world's iron ore is gone, it's gone.

Clearly, it makes good ecological sense for the carmakers to use recycled materials when they build new cars. In fact, the world's carmakers are doing just that—as well as building their cars with recyclable materials, so as much of the car as possible can be reclaimed once the vehicle is at the end of its useful life.

But it also makes good sense for you to repair and reuse already manufactured components whenever it's practical. Most components—from engines and transmissions to alternators and water pumps—are available to you used, rebuilt or remanufactured.

As good as new

When you need to replace a component, you can often return the old, failed unit to the parts dealer for a credit. He sells the component to a rebuilder who takes the unit completely

apart, checks and replaces the individual pieces that are worn or failed, and reassembles it back to factory specifications.

In the case of a properly remanufactured component, you not only save money but you save that component's worth of raw materials, and you get a part that should give you reliable service for as long as the factory-new equivalent would.

Avoid problems before leaving the parts counter by comparing the replacement part to your old one, checking numbers, weight and configuration. To help reduce the chance of a problem, shop only at auto parts

stores that you trust—ones that serve the local professional mechanics. These stores depend on the quality of their remanufactured parts. And, make sure you get a guarantee with the rebuild.

Totally used

Just because a car or truck has found its way to the scrapyard doesn't mean that there aren't pieces on it that have many more years of good service left in them. In fact, less costly in many cases than buying a rebuilt component—and way less costly than buying brand-new body parts—is buying a used part from the scrapyard.

While there are scrapyards that still live up to the stereotype of being run by mean people and guarded by even meaner dogs, many more are efficiently run, professional auto parts suppliers.

The damaged cars are disassembled carefully, preserving such important and reusable components as doors, hoods, fenders, seats, axles and various driveline components. Many yards have the facilities to test alternators and other commonly purchased pieces before selling them.

In addition, as carmakers



Clean, neat and inventoried, these used engines typify a modern scrapyard. Transmissions, axles and sheetmetal parts are handled similarly.

have continued to maximize manufacturing efficiencies, many models from the same maker—over a period of many years—share the same components. The properly equipped scrapyard has cross-reference manuals that list the application of parts between makes, models and years.

You can save both time and money by buying complex units—such as an entire door assembly—at a dismantler rather than at the dealership. For roughly the cost of only the sheetmetal at the dealership, you would get the door—maybe even painted in your car's color—complete with window glass, window lift, door liner and trim. If you only bought the sheetmetal at the dealer, you would have to transfer all of the other parts from your old door to the new one.

And times and technology are such that many of the larger most efficiently operated dismantlers are linked by computer so they can help locate and obtain a part that may not be in stock.

Recycled fluids

While it's true that engine oil itself does not wear out, it's also true that its additives do. So as your engine operates, the oil in it is accumulating deposits and contaminants, and slowly losing the effects of the viscosity enhancers, pour-point depressants and other elements.

Facilities exist around the country for taking the old oil, cleaning the deposits and contaminants from it and replenishing the weakened or missing additives. This oil is sold as re-refined oil. While this oil may meet your carmaker's service requirements, it may not. Re-refined oil—where available—is also not necessarily any less expensive than new oil.

Re-refined antifreeze is a different story. Some repair establishments can either clean and purify used ethylene glycol antifreeze on the spot or actually redistill it back to factory, undiluted spec, including the addition of an appropriate additive package. There are also several firms marketing recycled coolant. Some of this is already prediluted, and shouldn't have water added. Read the label. **PM**

'GREEN' CAR CARE TIP

• Just because you cannot find re-refined oil—or elect to not put re-refined oil into your engine—does not mean that you should not continue bringing your old oil somewhere to be recycled. There are a myriad of other important uses for your old oil—from making gasoline to heating oil to various industrial lubricants.



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Recycle Auto Waste

● Okay, you are as concerned about the environment as you are about caring for your car. But just what are you to do with the waste that is a very real byproduct of good auto maintenance?

Used oil

Only a dim-bulb cretin like Saddam Hussein still thinks it's okay to dump oil onto the ground. So when you drain your vehicle's engine oil, collect the old oil in a large, sealable container or two. Use a long-neck funnel to pour the old oil from your drain pan into a jug—an old, but rinsed, chlorine bleach container or windshield washer solvent container works fine—and bring it to a recycling collection center. In fact, most service stations and auto repair shops will accept used oil that has not been contaminated by materials not found in engine oil. In some locales, any shop or auto parts store that sells you oil

must also be willing to accept your used oil as well. However, there are usually limits on how much oil they will accept—typically 1 to 5 gallons.

Your old oil is then recycled. The oil is cleaned of contaminants and re-refined, possibly to be packaged and sold as engine oil, an industrial lubricant or heating oil. There is even a test program underway in which used industrial lubricants are re-refracted and used as feedstock for gasoline, which neatly solves two problems at once. You see, not only does improperly disposed of oil pollute, it means that more virgin oil must be used in its place.

Take a little extra care when draining engine oil. Be sure your drain pan is large enough to hold the volume of old oil and is properly positioned beneath the drain plug to avoid spillage. Reposition the drain pan to catch the oil from the oil filter when you loosen the filter.

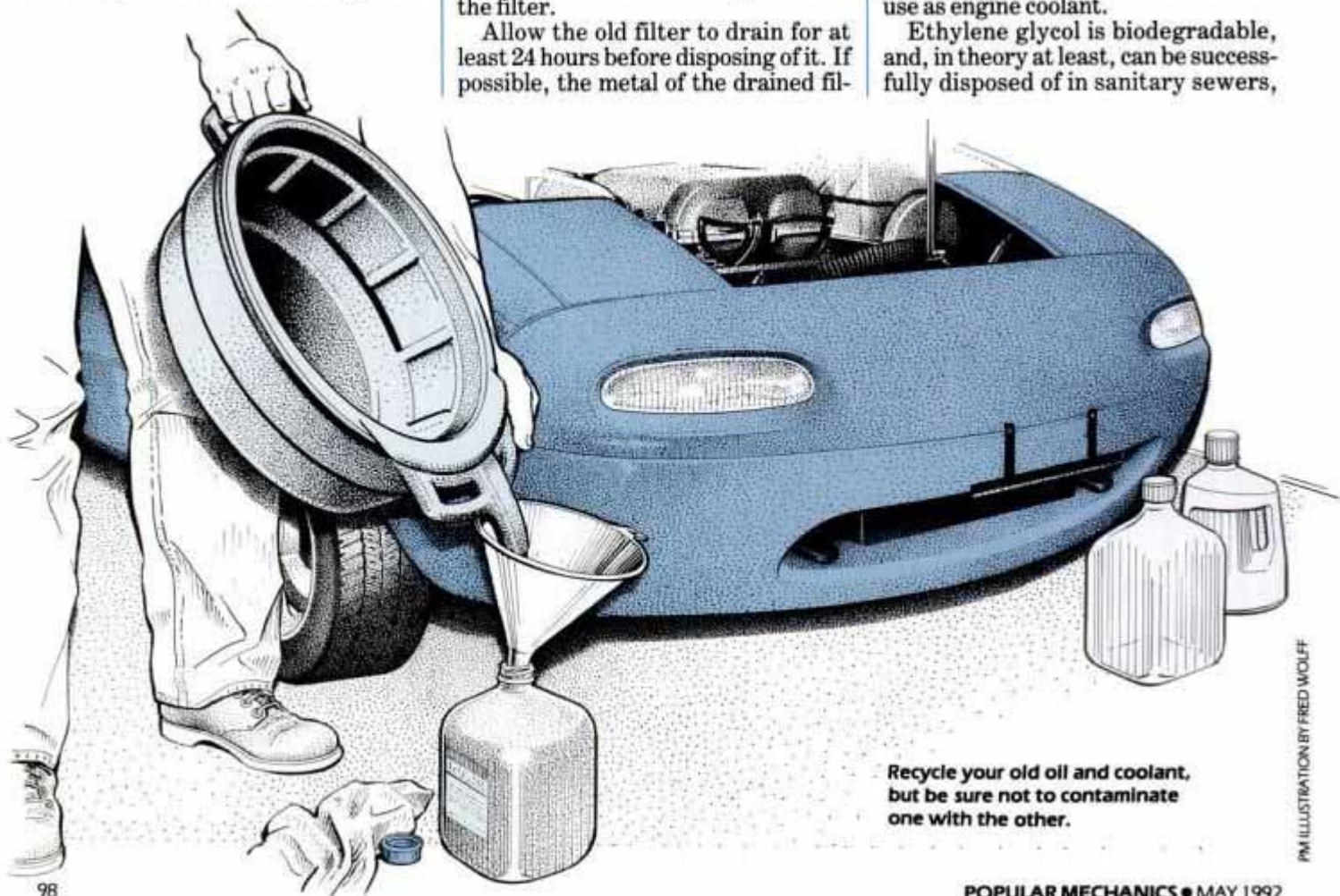
Allow the old filter to drain for at least 24 hours before disposing of it. If possible, the metal of the drained fil-

ter should be recycled. Ask at the local shop where you take the old oil if they will accept your filter, too. Many repair shops now crush their old filters and send them to a metal recycler. If you have no other recourse, dispose of the filter in the trash—but first punch a hole in the top of the filter and let it drain sitting upside down an additional 24 hours.

Coolant

When you flush your cooling system, catch as much of the old antifreeze as possible and pour it into a cleaned, sealable container, or use a coolant recycling kit to flush and catch the old coolant. The old coolant can be recycled, so take it to a shop that has a recycling machine. More and more shops are now equipped to clean out the contaminants and replenish the additive. This reprocessed antifreeze meets manufacturers' standards for use as engine coolant.

Ethylene glycol is biodegradable, and, in theory at least, can be successfully disposed of in sanitary sewers,



Recycle your old oil and coolant, but be sure not to contaminate one with the other.

PM ILLUSTRATION BY FRED WOLFF

where it is broken down with the rest of the organics. Unfortunately, the lead solder in your radiator and heater core leach out into the coolant—this high concentration of lead makes it inappropriate to just pour it down the drain.

Whatever you do, take care when pouring new or old antifreeze, it is highly poisonous. Children, pets and wildlife are attracted to its bright color and sweet taste. If you spill any, wipe up the spillage and flush the remaining spill with clean water.

Batteries

If the minute amounts of lead found in used engine coolant can be considered hazardous, you need not be an M.I.T. professor to understand that old lead/acid batteries should simply not be tossed out with yesterday's coffee grounds. Besides the harmful lead, your car battery is filled with sulfuric acid—which has plenty of lead salts in solution to boot.

In fact, there are now 32 states which have enacted lead/acid battery recycling laws—and an additional four which prohibit the disposal of batteries in landfills or incinerators. And due to the high number of states that do mandate battery recycling, the EPA has not "branded" batteries as toxic wastes, which makes their sale, handling and disposal require all manner of special permits. This, in turn, would drive up the cost of replacement batteries substantially.

What all of this means to you—even if you live in a state which does not require battery recycling—is that when you replace your old battery, bring it to the battery dealer.

The old battery will then be shipped to one of the many new facilities that will disassemble the battery, neutralize the acid in the electrolyte and actually reclaim the lead in a smelter.

Do not, under any circumstances leave your old battery in the trash.

Tires

An ecological benefit to the fact tires last longer than ever is that there are fewer old tires to accumulate at landfills and scrapyards. And while uses for old tires vary from retaining walls at racetracks to artificial reefs to backyard swings and dockside bumpers, tires are still piling up. Tires may wear out on your car, but they simply do not decay and disappear readily from the Earth.

Unfortunately, there are still severe problems to be overcome in the disposal of tires. For one thing, burn-

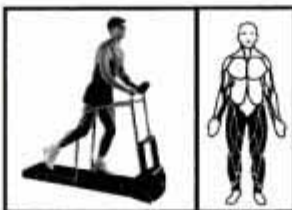
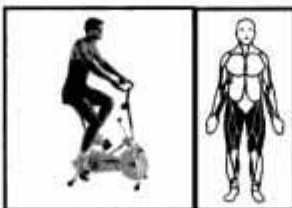
ing the rubber is not a viable solution and recycling uses and processes are still in the experimental stages. However, instead of tossing old tires in the trash, you should leave them at the tire dealer when you have new ones installed. The old tires are valuable to the growing number of recyclers who have found other uses for them. They shred these tires and use them for various industrial purposes, including as an additive to paving materials for improving roadways.

For more information

If you're not sure how to dispose of your automotive wastes, contact your state's appropriate agency or the local office of the federal Environmental Protection Agency. The federal EPA has 10 regional offices to help you.

Your local or state government's equivalent of department of waste management or department of environmental protection can help you find out where your nearest recycling collection centers are located. **PM**

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Diesel engines run on air and fuel—no fancy computerized ignition systems involved here. So to increase the efficiency of your diesel, you must deal in the basics of getting more air in and exhaust out more quickly and cleanly. That's just what the Gale Banks Engineering Power Pack system is designed to do for Chevrolet and GMC trucks with the 6.2-liter diesel engine. The Power Pack system addresses both ends of the breathing equation with a low-restriction, cold-air intake

assembly and a carefully designed Y-pipe pulse converter, high-flow muffler, 3-in.-dia. exhaust piping. The package also includes all the clamps and hangers necessary for installation. The high-flow muffler uses acoustically engineered chambers instead of baffles to reduce noise with a minimal loss of power. The cost for the Power Pack system is \$595. It's available from Gale Banks Engineering, 546 Duggan Ave., Azusa, CA 91702; (818) 969-9605.

Nonpolluting Power Tool

Pneumatic tools ultimately depend on electricity to run the air compressor that powers the tool. And cordless electric tools rely on some source of electricity to recharge their lead-filled batteries. However, the Quik-Tork wrench can spin fasteners 350 rpm without depleting any energy source but your own. The tool operates by means of a large squeeze trigger. Each squeeze spins the drive 1 1/4 revolutions, with up to 27-in.-lb. of torque. You can also use the trigger as a lever to turn the tool into a ratchet for 140-in.-lb. of torque. The drivehead accepts a special 1/4-in. drill chuck or various

drivers. Cost is \$27.95 for a 12-bit set with slotted and Phillips screwdrivers as well as sockets. WorkTools, Inc., 20759 Plummer St., Chatsworth, CA 91311; (818) 407-1503.



Vacuum Leak Tester

Pinpoint performance problems caused by anything from a simple intake leak to bad valves or incorrect timing with a vacuum gauge. Neward Enterprises has introduced a new vacuum gauge and low-pressure fuel pump tester, part No. 5510. The gauge features white markings—in metric and standard—and needle against a 3 1/2-in.-dia. matte-black face for easy readings. If your car or truck is carbureted and has a mechanical fuel pump, you can use the gauge to check pump performance. It's \$21.95 from Neward Enterprises, Inc., 9251 Archibald Ave., Cucamonga, CA 91730; (714) 987-8975.



Modify Computer-Controlled Ignition

You can improve the performance and efficiency of your computer-controlled GM or Ford car or truck by customizing its ignition curve. Smart Spark is a programmable ignition computer that installs between your car's electronic control module and the ignition module. You can dial in as much as 19° more than the factory computer calls for, and you can also indicate up to 12 changes in advance in the ignition timing throughout the engine's speed range. It's priced at \$275, from Digicon Engineering, Inc., 4177 Quarry Ct., North Vancouver, B.C., Canada V7K 3C3; (604) 929-1213.



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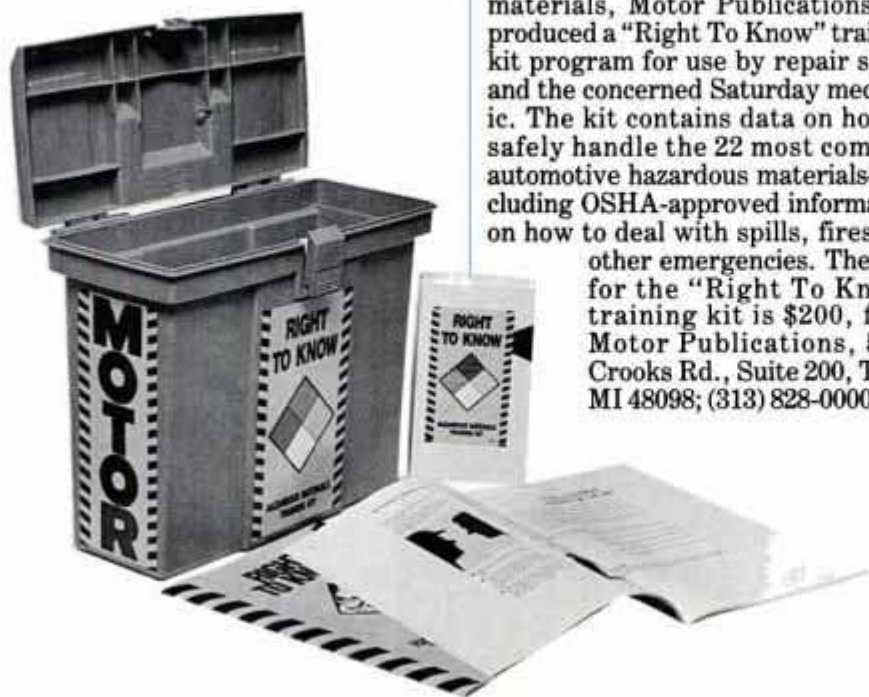


CAR CARE GUIDE

What You Need To Know

Taking care of your car requires you to handle and dispose of about two dozen different materials that are

considered hazardous by the federal government. To help you fully understand how to safely deal with these materials, Motor Publications has produced a "Right To Know" training kit program for use by repair shops and the concerned Saturday mechanic. The kit contains data on how to safely handle the 22 most common automotive hazardous materials—including OSHA-approved information on how to deal with spills, fires and other emergencies. The cost for the "Right To Know" training kit is \$200, from Motor Publications, 5600 Crooks Rd., Suite 200, Troy, MI 48098; (313) 828-0000.



Corrosion Preventer

Your car's battery is necessary but evil. It starts the engine, but its acid—and vapors—are dangerous to you and your car. This Battery Mat is an inexpensive and simple way to protect your car and garage floor from the destructive effects of that acid. The mat's porous material absorbs corrosion-causing acid and the fibers' coatings neutralize it. The Battery Mat costs \$3.99, plus \$1.50 for shipping, from The Battery Mat, P.O. Box 3601, Winchester, VA 22601; (800) 392-1888.

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CAR CARE GUIDE

Tire-Pressure Monitor



Proper tire inflation is critical for good handling, ride, safety, tire life and fuel economy. An automatic tire-pressure monitor and warning system called TRAK—Tire Risk Advisory Kit—constantly keeps you informed of tire pressure as you drive. Miniature temperature/pressure senders mounted inside each wheel supply information to a dash-mounted receiving unit. A digital readout gives the updated and accurate inflation of each tire. If the pressure exceeds driver-programmed limits, the unit sounds and flashes an alarm. Price for the TRAK is \$390, from TRAK System International, 1 Galleria Blvd., Suite 912, Metairie, LA 70001; (800) 969-TRAK.

Biodegradable Car Wash

Being concerned about the environment means being concerned about what goes down the sewer or storm drain—including the rinse water when you wash your car. To ease your mind, Turtle Wax has introduced a biodegradable car wash, Finish 2001. The cleaner has been formulated to float away dirt and grime, without af-



fecting the car's finish. The cleaner includes water softeners and buffers for quicker and easier rinsing—to help conserve water. Finish 2001 costs under \$3.50, from Turtle Wax, Inc., 5655 W. Third St., Chicago, IL 60638; (708) 563-3600.

Fuel Tank Repair Kit



Leaking fuel is not only a pointless waste of a precious resource, it's foolish pollution as well. But now there's a fuel tank repair kit developed by the Syon Corp. that lets you repair a leaking fuel tank without draining or removing the tank. The same kit can also be used to plug leaks in oil pans, radiator tanks and transmission covers. The repair utilizes a gasoline- and oil-resistant epoxy adhesive and special fiberglass tape that comes in the kit. Price for the Fuel Tank Repair Kit is \$11.55. It's available from Syon Corp., 280 Eliot St., Ashland, MA 01721; (508) 881-8852.

6 DYNOMAX TECH SERIES

3" RACE MUFFLERS FOR YOUR VEHICLE?

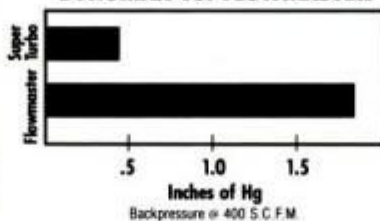
Now you can run the same muffler that Paul Rossi used to win IMSA championships and Pike's Peak.

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On the track or street, DynoMax 3" Super Turbos are for the enthusiasts who demand the best. For more information, call our Tech Line at 313-852-9347. Or for the nearest DynoMax retailer, call 1-800-767-DYNO. Prices start at \$150 for the stainless version and \$100 for the aluminized.

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LONG-TERM TEST CARS

(Continued from page 52)

though, the braking action is fine, which is the real criterion.

That one observation aside, though—we can't really call it a complaint—we said goodbye to this Olds with warm fuzzy feelings. It's a comfortable, well-appointed family sedan that can turn into a tiger with one stab of your right foot—the Clark Kent of its class.

—Mike Allen

Chevrolet C2500 Silverado

With the end of the '91 racing season, our big Chevy went from a steady diet of towing to a mixture of odd hauling assignments that ranged from moving furniture to transporting auto parts. The results were the same, though. No matter what the job was, it was no problem.

With its 454-cu.-in. V8, the Chevy's performance was always the same, empty or loaded.

We can also say—again—that fuel economy falls from not so good (about 13 mpg) empty to worse (10 mpg and less) with heavy loads.

A couple of rattles showed up at about the 12,000-mile mark, which isn't surprising in a truck that's seen plenty of hard work. And aside from

that, it's as good as new—better, really, because once the rings seated in properly, it didn't use a drop of oil between changes.

This isn't a truck for macho profiling. Although it has some creature comforts, like cruise control, a/c and a decent AM/FM/cassette sound system, it's not the sort of rig that turns heads. But if you're looking for a truck that's not afraid of hard work, here's one that'll get the job done—whatever it is—without breathing hard.

—Tony Swan

Dodge Dakota Sport

The leaking drain plug we fixed just before our last long-term report was definitely the only source of oil loss. Since then, oil consumption has dropped to essentially zero. Fuel mileage hovers near 20.

Now that it's time for the Dakota to head home—with 9418 miles on the odo—we've finally started to use it for hauling stuff rather than just profiling up and down the beach. The box is admittedly smaller than a full-size truck, but, then, we've been backing into narrow driveways where a full-size truck might not fit at all.

The net of our hauling activities, however, is that this V8-powered midsize truck can do a man-size job—and look good doing it.

—Mike Allen



Filter Base Wrench



If you overtighten your oil filter or neglect to lubricate its base gasket when you install it, the filter's metal base may, unfortunately, stay with the engine when you remove the old filter. In that unhappy event, a special socket-type wrench like this Filter Fang makes it simple for you to get the stuck base off. The Filter Fang has teeth that slip into the filter base's holes and a square drive hole to accept a 3/8-in. drive ratchet. Filter Fang is available in a set of four sizes to match all popular automotive, industrial and agricultural thread-on oil filters. Cost is \$5.95, from Filter Fang, 5637 Melody Lake Dr., Minneapolis, MN 55436; (612) 920-8354.

Benchtop Sandblaster



Sandblasting is an effective and environmentally safe way to clean parts. Unfortunately, it also creates a serious mess of sand and grit. A convenient sandblast cabinet from The Eastwood Co. allows you to clean parts up to 34 in. long in safety and convenience. The cabinet comes disassembled, with directions and all hardware. The 24 x 24 x 34-in. unit has 8.57 cu. ft. of usable interior space for blasting and a heavy screen floor to support your work. The Sandblast Cabinet Kit costs \$329 plus \$11.95 shipping, from The Eastwood Co., 580 Lancaster Ave., Malvern, PA 19355; (800) 345-1178. **PM**

NEW CARS



MX-6 And 626: Mazda Hits Two More Homers

● Mazda has staged more dramatic design turnarounds in the past three years, and here are two more eyeball-grabbers. The new MX-6 coupe and 626 sedan are longer, lower, wider, more aerodynamically efficient and a few pounds *lighter*.

They are also more refined in every dynamic category—better ride quality, better handling, improved braking and better engines.

Two new engines are offered for both cars—a 118-hp dohc 16-valve Four and a superb 2.5-liter dohc 24-valve 60° aluminum V6 rated at 164 hp with 160 ft.-lb. of torque. Transmission options are a 5-speed manual (standard) or 4-speed automatic.

The refinement extends to the interior of the new cars, which have also been redone throughout. Besides

a more contemporary appearance, there's also more room, particularly in the 626's rear seats.

Pleasant as they are to look at, the new Mazdas are even more fun on the road. The longer (by 3.8 in.) wheelbase makes for a marked improvement in ride quality, and Mazda's extensive wind-tunnel homework pays off in a reduction in wind noise.

We were also impressed with the improved handling. The sporty MX-6 was the basis for our initial impressions. It has a more neutral feel, turns in with more authority and changes direction with less reluctance.

Several subtle changes contribute to the overall improvement. Increased chassis rigidity tops this list, complemented by engine mounts that are further aft relative to the front axle centerline, improving weight distribution. Mazda also canted the



Redesigned cockpit reinforces sporty look and feel of Mazda's all-new MX-6 coupe.

front struts rearward, which changed the caster angle and improved steering response.

The new V6 doesn't make as much peak horsepower as the turbocharged Four of the old MX-6 GT, but it's much nicer to live with. The peaky power and attendant torque-steer that plagued the turbo is gone, and if the V6 MX-6 isn't quite as quick, it's far from slow: Mazda expects 0-to-60 times in the low 8-second range.

V6 fuel economy is projected at 21/27 mpg city/highway, with a 5-speed transmission, while the Four is estimated at 26/34. Antilock brakes are optional on all models, but airbags won't come along for a couple of years.

While it's hard to think of Mazda as an all-American make, there's enough local content to qualify the MX-6 and 626 as domestic cars. They'll be built alongside Ford's new Probe at Mazda's Flat Rock, Michigan, plant.

Pricing in this first encounter was pure conjecture, but expect a range of \$14,000 to \$20,000. —Tony Swan



Size increase of new 626 sedan yields substantial improvement in rear-seat legroom.

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YTHING

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THE HEARTBEAT OF
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Increased length and wheelbase of Grand Cherokee delivers more room, improved ride.

Jeep Grand Cherokee

The new Jeep Grand Cherokee bears a strong resemblance to its popular namesake. And a quick comparison of the vital statistics and engineering features of the two tells you only that the Grand Cherokee is, in fact, grander by 9.7 in. in length and 4.5 in. in wheelbase.

But it's much more than a mere freshening and stretching of the standard Cherokee. Jeep's engineers have created a new vehicle that has seriously upped the ante in the sport/utility market.

The Grand Cherokee retains Jeep's solid front- and rear-axle suspension, but the rear axle is now located by the same 4-link setup used in front. Attention to spring, shock and bushing rates—as well as a more upright rear shock mounting—results in a ride that rivals the independent suspension systems used by competitors.

Handling is crisp. Jeep engineers claim that the Grand Cherokee's 4-door unitbody design—20% stiffer than the standard Cherokee—is supe-

rior for ride and handling to the body-on-frame used by other sport/utilities, and our initial driving impressions tend to bear this out.

Off road, the 8.2-in. ground clearance, long-travel coil springs and solid axles allow the Grand Cherokee to climb over and through rough stuff

Behind the engine the choices get complicated. First, you can opt for a 5-speed which comes with Jeep's Command-Trac part-time 4wd. Or, with a 4-speed automatic, you can opt for either Selec-Trac—which operates in 2wd or full-time 4wd with an open differential between front and

rear axles—or Quadra-Trac all-wheel drive, which has a viscous coupling between the front and rear.

Though the Grand Cherokee is bigger than the Cherokee, it is smaller than the Ford Explorer—



\$135,000 V12 600SEC is new Mercedes-Benz flagship.

that would stall its competitors.

The only engine you'll find under the hood, for now, is the stout 4.0-liter inline Six, with 190 hp and 225 ft.-lb. of torque. But if you want more, there's a 5.2-liter V8, with 220 hp and 280 ft.-lb. coming this fall.

about 8 in. shorter. The Grand Cherokee's interior is also somewhat less carlike than the Explorer's, but it does offer features that are rare in most sport/utilities, such as 4-wheel antilock brakes and a driver's airbag. Prices start at \$18,980 and climb to \$27,433.

—Don Chaikin

Mercedes 600SEC

The new Mercedes S-Class coupes—500SEC and 600SEC—may not be the best cost-is-no-object personal luxury vehicles the world has to offer. But we can't think of anything that could be classified as better.

The new coupes embody all the refinements of the new S-Class sedans—double-pane side glass, four separate climate controls, ASR (traction control), adaptive damping, ABS with automatic lateral-g adaptivity—with the styling sexiness that can only be achieved in a 2-door.

These stylish heavyweights (the 600SEC is close to 2½ tons) are sleek, silent and fast—for all its mass, the 600SEC can go from 0 to 60 mph in less than 6 seconds. Both cars are electronically limited to a top speed of 155 mph.

The principal difference between the two models lies under their hoods. The 500 gets M-B's 5.0-liter dohc 32-valve aluminum V8—a mere 322 hp and 354 ft.-lb. of torque—while the



A Friendlier MR2

● A little oversteer in a sports car can be a good thing. A lot of it can be not-so-good. The latest generation of MR2s—particularly the turbocharged models—drew criticism for a little too much of this trait. So Toyota has fixed it, making the little midship 2-seater much easier to drive quickly.

The problem was excessive rear-wheel toe-out during hard cornering. Toyota's fix entailed longer (by 4 in.) lower control arms, stiffer suspension bushings, stiffer spring and shock rates and

a lot more tire: 195/55VR15 front, 225/50VR15 rear, versus 195/60R14 front, 205/60R14 rear. Toyota also changed front and rear strut mounting points to improve anti-dive and anti-squat characteristics.

Based on a day of racetrack driving—current versus new—we can say unequivocally that the fix is effective. Not only can the '93 Toyota MR2 be herded around corners quicker, it's much more forgiving.

—Tony Swan

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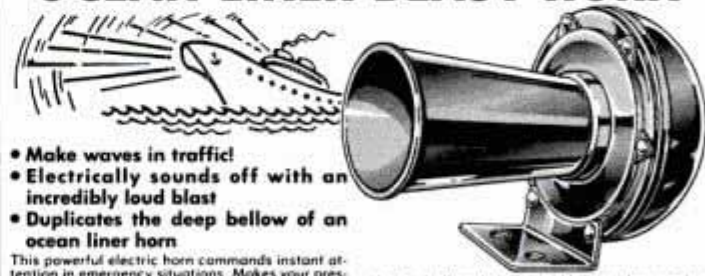
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- Electrically sounds off with an incredibly loud blast
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This powerful electric horn commands instant attention in emergency situations. Makes your presence known in sluggish highway or street traffic. You'll sound "big" even if you're driving "small". Compact—only 7" long and 5-1/2" wide. Mounts easily under hood or near radiator shell. Durable

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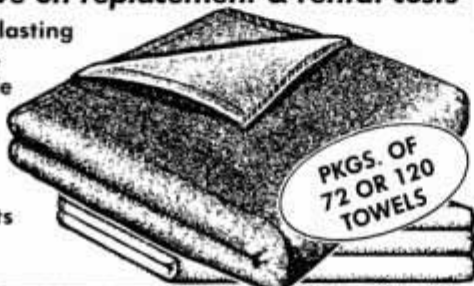


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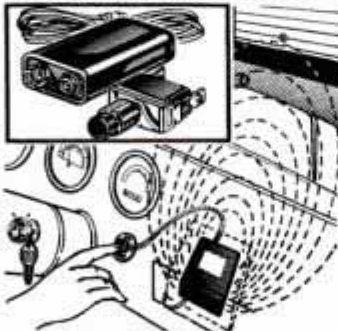
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600 is propelled by the new 6.0-liter dohc 48-valve aluminum V12: 402 hp and 428 ft.-lb.

Pricing will range between about \$100,000 to \$105,000 for the 500SEC and \$135,000 to \$140,000 for the 600—before luxury and other taxes. Mercedes anticipates that about 500 North American buyers will pay for this kind of exclusivity in 1992.

Nissan Quest

Although Nissan has been turning out winners in the passenger-car game the past few years, its minivan program hasn't fared so well. The Stanza Wagon and Axxess were both disappointments, leaving Nissan as the only major player without an entry in this popular class of vehicles.

However, we'll bet the new Quest minivan is going to change all that. Smooth, well-equipped and versatile, this new front-driver rivals the carlike qualities that have helped Chrysler's minivans dominate the segment.

The Quest is Nissan's half of a cooperative effort with Ford that will yield

a virtually identical minivan—the Villager—wearing Mercury badges. Major body panels, chassis and powertrain come from Nissan, while assembly will take place at Ford's plant in Avon Lake, Ohio.

Although the powertrain will come from Japan, the rest of the package will be produced in the U.S., and the Quest/Villager qualify as domestic vehicles.

Both the Stanza Wagon and Axxess lacked the interior volume to compete in the U.S. minivan market, something that's been corrected in the Quest. Riding a 112.2-in. wheelbase, the Quest is wider, taller and considerably longer than a standard Dodge Caravan, and only slightly shorter than the stretched Grand Caravan. This adds up to adult-size legroom front and rear.

The flexibility of the cargo capacity shows real imagination. There's room enough behind the rear seats for groceries, and the rear seats fold up to double that capacity. When even more space is needed, the second set of seats is easily removed, à la GM's minivans, and the folded rear seat can slide forward all the way to the front seatbacks.

When it comes to road manners, the Quest is a clear frontrunner. Nissan set out to achieve a carlike blend of ride and handling, which is what the

Quest delivers. With struts at the front and twin leaf springs and beam axle at the rear, it feels like a family sedan, with excellent ride quality, competent handling and a very impressive quiet cabin.

The Quest is powered by a 3.0-liter sohc V6 rated at 150 hp and 170 ft.-lb. of torque, with a 4-speed electronically controlled automatic transmission. With 3782 pounds to haul around, it's not quick, but it's competitive, and exceptionally smooth and quiet.

It also promises to be near the top of the minivan class in fuel economy with EPA mpg ratings of 19 city, 29 highway and 23 combined.

Antilock braking is available on both Quest trim levels—XE and GXE—although airbags won't be offered until the 1994 model year. How-



Size, V6 power, good road manners make Nissan Quest a contender.

about an inch lower than the sedan, the hood longer (by 3.1 in.), the rear deck shorter (by 1.2 in.) and width is increased by about a half-inch. All of this adds up to a more aggressive look, as well as a 2% reduction in overall drag.

Powertrains are identical to the 3-Series sedans—a 138-hp dohc 1.8-liter 16-valve Four in the 318is, and a 189-hp dohc Four-valve straight Six for the 325is. Both cars are available with either a 5-speed manual or 4-speed.

The 318is carries a suggested retail price of \$23,600, the 325is is \$29,100.

Range Rover Defender

In an era of burgeoning sport/utility sales, it's getting increasingly difficult to express your rugged individualism. But here's one you won't see coming around every corner. The limited edition (500) Land Rover Defender combines the excellent off-road capabilities of the Range Rover with a macho index that wimpifies everything but the civilian Hummer.

With 8.5 in. of ground clearance, go-anywhere 4-wheel-drive system and the Range Rover's 3.8-liter V8 (180 hp and 220 ft.-lb. of torque), the Defender can handle all kinds of dirty work—with ease. And when it's time to one-up the Lamborghinis and Bentleys at Chez Moustache, the Defender's unmistakable profile and exterior roll cage just ooze paramilitary chic.

Defender pricing is expected to start at about \$40,000. **PM**



Short deck, long hood give BMW 3-Series coupes knockout looks.

ever, the Quest does meet 1993 federal passenger-car safety standards.

Like most minivans, the Quest is technically a truck. But that's a technicality that's hard to remember behind the wheel. This may just be the most mannerly minivan of them all.

Look for pricing to range from \$16,500 to \$25,000. —Tony Swan

BMW 3-Series Coupes

BMW's new 3-Series sedans have been drawing rave reviews since their introduction a year ago, but if the sedans are stimulating then we'd have to say the new coupes—the 318is and 325is—are going to be veritable adrenaline-generators.

Unlike previous 3-Series cars, the coupes share no body panels with the sedans. The roofline is



Limited-edition Range Rover Defender will sell for \$40,000.

Amazing New Product Gives Crisp, Clear TV Reception WITHOUT Cable!

Until recently, the only convenient way to guarantee great TV reception was to get cable installed. But who wants to pay those irritating monthly cable fees just to get clear reception? Now, thanks to years of micro-electronic research, a new device has been developed that's so advanced it actually makes other antennas a thing of the past. It's called the SWEDA™ Power Antenna and is without a doubt "the single most important thing you should own if you have a TV!"

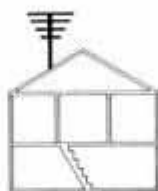
A PICTURE OF ADVANCED TECHNOLOGY!

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A THOUSAND FOOT ANTENNA?

Power Antenna is a highly sophisticated electronic product (like a transistor radio) with a simple function. It takes the electrical wiring in your house or apartment (hundreds or thousands of feet) and turns it into a

Just plug your Power Antenna™ into any ordinary outlet and watch in amazement as your entire house turns into a giant TV reception station!



BEFORE:



AFTER:

giant TV reception station! It's almost like having an antenna the size of your entire house! Imagine how effective that would be. But there's more, because Power Antenna takes that signal and electronically boosts it before it gets to your TV set. The results are amazing! You can finally enjoy your favorite prime time shows or sports events the way they were meant to be watched.

WHAT ABOUT MY TV "DISH" ANTENNA?

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SCIENCE ON A KITE STRING

BY ABE DANE, Science/Technology Editor

● Think of it as the meteorological equivalent of old-fashioned hand-line fishing. Instead of dangling your bait down where the big ones feed, you're sticking a package of instruments tens of thousands of feet up into the sky, trolling for atmospheric data. And instead of a sinker, you're using a kite.

Although kites were a primary source of airborne meteorological data in the U.S. at the turn of the century, they were cut loose as serious scientific tools in the 1930s. Balloons, airplanes, rockets and, eventually, even satellites took over various parts of the job. But there are still a few things that only kites can do, like hang in the same spot for days or even for months at a time, monitoring the changes in a given piece of atmospheric real estate. Another thing about kites is that they're remarkably cheap.

It took awhile before meteorologists began to miss these unique attributes enough to do anything about it. But now, 59 years after the U.S. Weather Bureau closed its last kite station, there is a move afoot to restore the kite to the service of science.

The new models are a far cry from their silk and bamboo ancestors. "I prefer to think of them as tethered lifting systems," says Joe Williams, president of Modelsym, a Pennsylvania company which is using state-of-the-art CAD/CAM techniques to design the new-generation devices. Modelsym is at work on parafoils that could climb into the stratosphere, where vital questions about ozone depletion and global warming can be researched.

Their first kite was built at the re-



Parafoil launch in the stiff breezes of Christmas Island.

quest of Ben Balsley, an aeronomer at the University of Colorado at Boulder. It was about the only way he could think of to study very large-scale atmospheric electric fields on a reason-

able budget. The fields, which build up at a rate of about 100 volts per meter of altitude, had intrigued scientists for some time. "If you look at the distance between the ground and the ionosphere, the difference is 300,000 to 400,000 volts," says Balsley. What causes it? The current best guess is that air is charged up by the convective action of thunderstorms.

That raises some interesting possibilities. "If you measure the field in one place, you can tell how many thunderstorms are active around the world at any one time," says Balsley. "You can get all the convective activity. That's important for climate."

Williams was quick to decide that a parafoil was the best aerodynamic device for the job. "It's really the most efficient free-air lifting body around for its weight," he says. Made of ripstop nylon, the 133-sq.-ft. foil he designed weighed only 3½ pounds, but would produce about 86 pounds of lift in a 16-knot wind. Even so, supporting the 20,000-ft. tether needed to reach the altitudes Balsley aimed for might have been too much of a burden. The solution was an ultralight line made of 900-pound-test Kevlar.

Balsley gave the kite its first trial on Christmas Island, a remote dot of land in the Pacific. The site was ideal because of its steady trade winds and lack of aircraft traffic. The kite performed exactly as predicted, climbing to about 11,000 ft. by the time all the tether was payed out and staying

there for four days. Dangling from the tether were seven styrofoam spheres containing instruments to measure temperature, barometric pressure and humidity, as well as the electric

fields. Unfortunately, problems with the instruments prevented Balsley from getting all the data he wanted. But he proved the kite system was workable.

The amount of modern technology incorporated in the new parafoils gives some appreciation of how ingenious earlier scientific kite flyers must have been. Although parafoils have the potential to go much higher, they have not yet even approached the altitude records set during the first half of the century.

Way back in 1898, the U.S. Weather Bureau was operating 17 kite stations around the country. These were remarkably advanced, handling chains of multiple kites on a single 300-pound-test steel wire with power-driven winches. Carrying aloft a wide range of clockwork recording instruments were elaborate box kites known as Hargrave kites, typically with about 68 sq. ft. of lifting surface. In 1910, one of these stations set a record of 23,385 ft. with a chain of 10 diamond-shaped Eddy bow kites. Twenty years later, a German group flew a string of eight kites to 31,955 ft., a record that stands to this day.

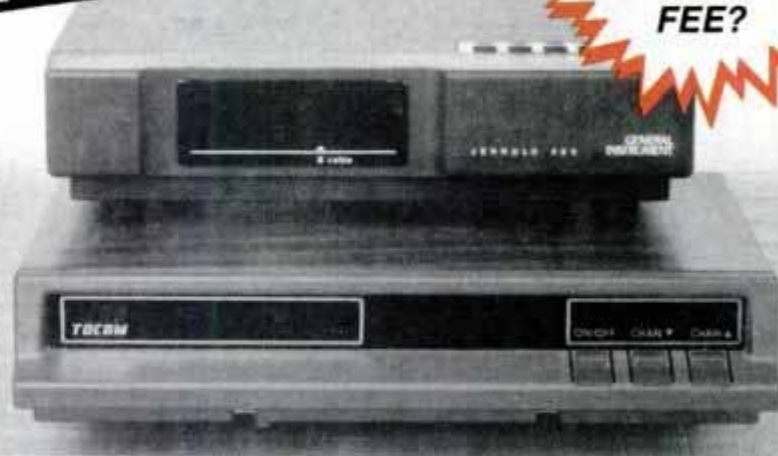
"They really had a big, beautiful technology going," says Balsley. If he has his way, however, those old records won't stand much longer. He now has a proposal with the National Science Foundation to follow up his Christmas Island effort with a larger lifting system that could reach up to 60,000 ft. From these stratospheric heights, he could address the big issues of meteorology—ozone depletion and climate change.

As currently envisioned, the system would consist of either one or two 1000-sq.-ft. Mylar foils and would be able to carry about a 30-pound payload. Because something on the order of 20 miles of cable would be involved, the simple wooden reel and manual sailing-yacht capstan of the Christmas Island effort would no longer be adequate. The cable dynamics would be complex enough to require an automatic-feedback system, monitoring cable tension, cable angle and a variety of other parameters, then spooling line in or out accordingly.

It would not be cheap. But to put it into perspective, consider that in order to explore the $\frac{1}{10}$ -sea-level-pressure air of the stratosphere, NASA now relies on retired U-2 spyplanes, which are vastly more expensive to operate and put pilots' lives at risk. It may very well turn out that after having been reduced to the status of a frivolous pursuit for over half a century, kite flying may be on the verge of getting serious again. **PM**

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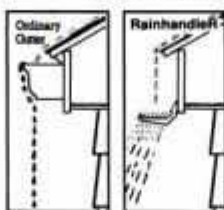
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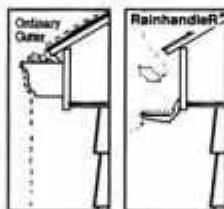
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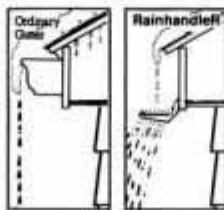
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DETROIT SPY REPORT

BY JIM DUNNE, Detroit Editor



Rearranged Ranger

● Ford will have a full line of redesigned Rangers when the new pickup is introduced later this year. In addition to the standard and extended-cab body styles, Ford plans a number of distinct front-end styles.

At the basic end of the model range will be a rounded grille/hood/fender design. Further up the line, in the sport group, will be a front end with a more elaborate grille with thick grille bars and surrounds.

At the top of the line is a high-performance sport truck (shown above) that features all the other styling cues, plus an airdam that houses round high-intensity driving lights.

Spirit Of '93

This 1993 version of Dodge's Spirit (below) features a new grille that's consistent with the look established in recent Dodge products. The horizon-



1993 Dodge Spirit will get trademark family grillwork.

tal and vertical bars split the air intake in a fashion seen on Dodge pickups and even the new Dodge Viper. Of all the automakers, Chrysler seems most determined to carry out the frequent face-lifts that were once a common practice.

Rocket Olds?

Two separate sources inside Oldsmobile have told us the division is seriously considering a V8 engine option for the Eighty Eight Royale line. Oldsmobile sees the Eighty Eight competing against high-performance luxury

imports like the Lexus ES 300, and the thinking is that the V8 engine would give the Eighty Eight Royale an edge on its V6-powered competition.

General Motors' lusty 210-hp twin-cam 3.4-liter V6 was considered but rejected—not enough low-end torque and insuf-

ficient image differentiation.

Presumably, the V8 would be a variation of the Chevy-based small-block that's just been reengineered for use in the Corvette, as well as the '93 Camaro and Firebird.

Mobil 200,000

Mobil has a new version of its premium-priced synthetic Mobil 1 motor oil that the company claims will keep your engine parts in like-new condition for 200,000 miles.

In addition, Mobil claims the oil will help keep emissions at federal standards even after the equivalent of 15 years' hard driving. The new Mobil 1 remains stable in the hotter temperatures of fast-running smaller engines.

It's interesting to note that in all of these tests, oil and filter were changed at intervals specified by the carmakers' owners manuals.



New Chrysler LeBaron will do away with covered headlamps.

LeBaron Lamps

Chrysler is in the process of finalizing changes to the LeBaron front end for the 1993 model year. It's just a simple facelift that replaces the current hidden headlamps with exposed, oval-shaped glass.


The redesign is similar to the modifications made to the 1992 Dodge Daytona. They're intended to lend a more contemporary appearance and help the LeBaron stand out in traffic.

There are solid economic reasons for the change as well. The external headlights are cheaper to build. And, because they're simpler to install, they will cut assembly costs and should improve quality.

PM

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EPA Est. MPG	18 city/28 hwy	17 city/23 hwy
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HOME IMPROVEMENT

PROBLEM SOLVER OF THE MONTH

BY JEFF WILLIAMS, Contributing Editor



Ceramicote is an insulated coating system that can improve the energy performance of almost any structure. The house on the left has the product installed on both the roof and the sidewalls.

Ceramicote

● Thanks, NASA. Thanks, Space Shuttle program. The technological developments of your space-age science have brought us Ceramicote. On the surface, this is a product that is similar to a number of insulated coating systems available today. Most are marketed as texture coatings and impart only a marginal insulation value. But none of them works like Ceramicote, a system comprised of a primer, a midcoat and a finish coat. According to the manufacturer, it's suited for application on walls and roofs, and, for that matter, on almost any substrate.

The primer and topcoat aren't too surprising, it's the midcoat where things really get interesting. It's an acrylic elastomer that retains 100% elongation after cure. That means you are applying a coating that dries to a huge rubber band enveloping the building. Inside the rubber band are millions of hollow ceramic beads. These beads range in size from 10 microns to 30 microns. When the paint film dries to a 10 to 20 mil. thickness, the beads cluster together and provide a dead airspace that demonstrates heat loss characteristics of R-6 and heat gain characteristics of R-20. Independent laboratory testing has confirmed that even higher insulation properties are calculable when applying the equations only for cold weather.

er. The manufacturer claims to use the most conservative test results for product promotion. By comparison, fiberglass insulation is rated at R-3.5 per inch and expanded polystyrene is rated at R-4.1 per inch.

Ceramicote is applied using standard brushes, rollers and sprayers, making it a do-it-yourself project. But the system is very sensitive to film thickness, so special attention must be paid to following the application instructions. And, keep in mind that many paint applications fail due to defects in construction. For example, older wood houses without adequate vapor barriers can allow moisture to undermine any paint job. Make sure the siding of your home is in good repair. This system is not cheap, and a defect in the overall construction could ruin the job.

The developer of the Ceramicote system, Tom Brammer of Coastal Coatings, explains it this way. "It doesn't take a rocket scientist to understand how this works. The difference between our product and others is the presence of ceramic spheres,



the highest quality flexible resins money can buy and the lack of perlite fillers." The perlite fillers are the stuff you find in most texture coatings. They are also the reason why many texture coatings begin to crack and peel after five years or so. They are also the reason that most texture coatings have no film elasticity. Without these fillers in the chemistry, the paint film has a better chance of lasting for 10 to 15 years. The way the Ceramicote system is set up, all you

need to do is freshen the topcoat every seven to 10 years, and the primer and midcoat should remain unaffected.

When applied to a sound, leak-free residential shingle roof, the system may extend shingle life indefinitely. Sun, rain and heat are responsible for the aging of shingle roofs. The Ceramicote system eliminates those elements.

Energy savings of as much as 40% could be realized using this system. Typical material costs are as follows: To cover a wood or masonry wall, the product costs about 56 cents per sq. ft.; for a sloped shingle roof, it costs about 63 cents; for a sloped metal roof, it's about 68 cents; and for a flat roof, it's about 84 cents.

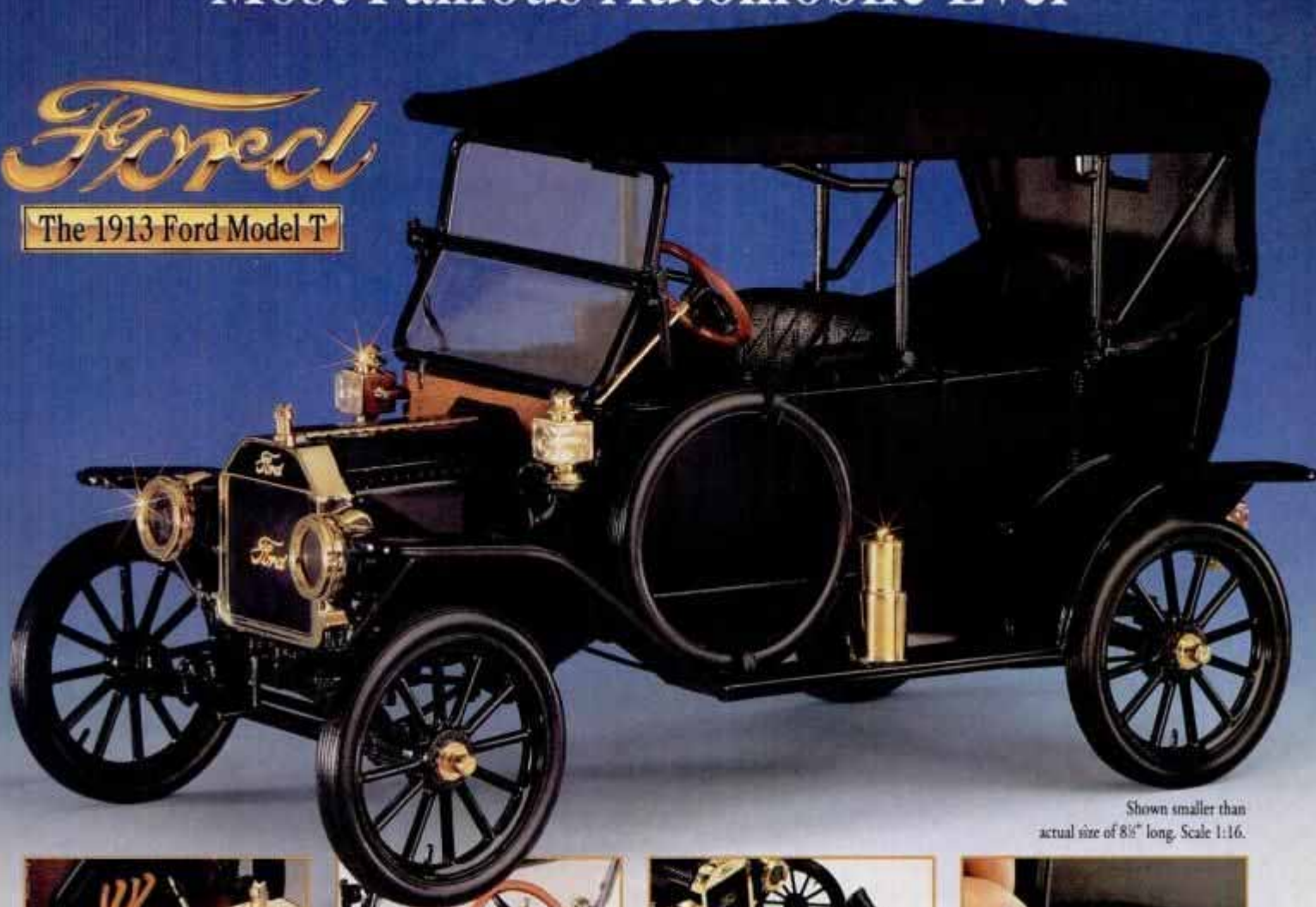
Ceramicote is marketed nationally direct to the consumer. Ordering and information are available by writing to Coastal Coatings, 5313 W. Crenshaw Ave., Tampa, FL 33624. **PM**

Jeff Williams is the host of "The POPULAR MECHANICS House Doctor," a satellite broadcast radio talk show about home improvement. Anyone interested in submitting problem-solving products for review in future issues of this column should send information to Jeff Williams, 4275 34th St. S., No. 340, St. Petersburg, FL 33711.

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AUTOMOBILES

HAVE YOU OFF-ROADED A FORD LATELY?

BY MIKE ALLEN, Associate Automotive Editor



● Automotive journalists get the opportunity to test drive a bewildering number of 4x4 vehicles. But rarely do we get a chance to actually go off-road in them, save a few laps around some rutted area of the proving grounds.

Well, that mirrors the experience of the buying public, which rarely ever engages its 4-wheel drive or drives on anything less paved than the overflow parking lot at the country club.

But there's a small, deviant subculture that actually enjoys coming home smeared with mud up to the door handles. Ford and Warn Industries (manufacturers of not only a line of off-road winches, but most of the locking front hubs, axles and transfer cases used on Ford 4x4s) sponsor a series of short off-road adventures that caters to these people.

We were invited, along with a couple of dozen other journalists, spouses

and significant others, to attend a weekend's worth of stump-jumping on the Flying M Ranch in Tigard, Oregon. This is conveniently located near Warn's Portland headquarters, and in the middle of some terrifically gorgeous country.

Also in attendance was Cliff Blake, director of the off-road industry's Tread Lightly program (which PM happens to help sponsor). And treading lightly was the order of the day, with vehicles spending their time on logging roads and carefully groomed, well-established trails through the woods. This is not to say that there wasn't some challenge to the driving.

There was plenty of time and many places to get stuck—something I personally never managed to do. But Susan (my significant other), managed to strip the splines from a front hub of an Explorer about a third of the way up a lengthy 30° slope covered with apple-size rocks.

This necessitated a lengthy delay, a winch ride to the top of the hill and spending the remainder of the day riding in the back of another vehicle. There were a few delays throughout the day, as several vehicles needed the aid of winches to make it to the top.

Ford managed to have our truck extract-

ed from the woods and fixed by the next morning—in time to try it again on some other hills, including a barbecue lunch on the top of a mountain followed by another barbecue dinner back at the Flying M.

It's easy to see why Warn Industries has chosen to make the Pacific Northwest its home. With plenty of mountainous territory—a lot of it still being actively logged—there are plenty of places to do some serious off-roading in the name of product development.

The Tread Lightly mindset was certainly much in evidence throughout the trip. The trails had been well groomed by Flying M staffers wielding chain saws to avoid damage to either protruding branches or Ford truck sheetmetal. Only existing trails and logging roads were used, and there was certainly no need to blaze new paths through the woods to get our jollies.

The weather did cooperate. In fact, a sprinkle or two might have helped keep down the dust, as we spent two days doing severe testing of the air-infiltration characteristics of new Ford trucks. I'm still getting dirt out of my cameras, although the insides of the vehicles weren't too bad. There were a couple of guys in a topless Bronco who, by lunchtime, bore a remarkable resemblance to movie desperadoes. In their case, however, I don't know that mud would have been any better.

PM



Not everyone made it up the hills unassisted.

EXHIBIT (Continued from page 46)

Here, visitors can see books from the Boy Aviator series that were advertised in PM classifieds and toys that inspired boys and girls alike during the "First Aviation Christmas." Dirigibles are represented by a feather-weight propeller that belonged to Horace Wild, an aviator whose entry in a 1907 race was captured in PM.

As airplanes and dirigibles became more common, PM's pages filled with the news of fabulous prizes awarded for various record-breaking flights. How outrageous was the rage for records? You be the judge when you see the elaborate bronze sculpture awarded to Earle Ovington for "being the first American aviator to fill a dinner engagement in an aeroplane." Ovington's other, more famous, first was as the pilot of America's first airmail flight. Some of his instruments, his crash helmet and his good-luck doll are on display.

Of course, Glenn Curtiss, the most renowned and dashing pilot of his day, is not ignored. His first taste of fame was as a designer and builder of engines. Visitors can see a 1910 advertisement his company ran in PM selling "Airship Motors And Engines For Mechanical Devices." Presented in the exhibit is one of his less-renowned engines, the Curtiss OX-5. Frequent mechanical problems made the engine a tinkerer's dream—or a tinkerer's damn, depending on how you look at it. Nonetheless, it was used on Curtiss's famous Jenny that trained WWI pilots and later became a favorite of barnstormers and wingwalkers.

PM's do-it-yourselfers were not left out of the aerial glory days. Plans for PM's 1909 glider and the famous 1910 Demoiselle monoplane are reproduced in the exhibit, along with an editorial warning for would-be aviators: "It is necessary to possess some mechanical skill and ability, and plenty of common sense."

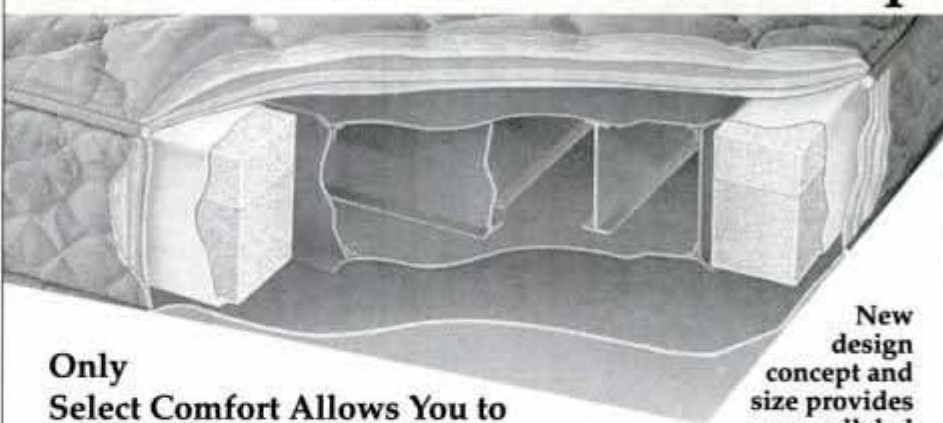
Had Icarus seen POPULAR MECHANICS' advice, perhaps he would not have flown so close to the Sun. **PM**

IF YOU GO . . .

• Henry Ford Museum & Greenfield Village is a national museum of American history and technology founded by Henry Ford in 1929. The museum is an independent, nonprofit educational institution that is not affiliated with the Ford Motor Co. or the Ford Foundation.

Henry Ford Museum & Greenfield Village is located at Oakwood Boulevard and Village Road in Dearborn, Michigan, about 12 miles west of Detroit. For complete information about museum hours and admission fees, nearby hotel/motel accommodations and other area attractions, call (800) 343-1929.

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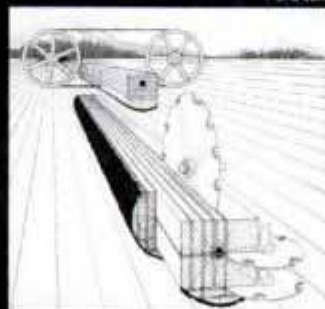
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AUDIO

SOUND DELIVERIES

BY FRANK VIZARD, Electronics Editor



● Not every innovation in audio arrives in a package bigger than a breadbox. Witness the PCD7 personal compact disc player from Fisher, a product not much bigger than a thick slice of bread, which pointedly claims to have little shock value.

While personal CD players are indeed portable, they don't react well to sudden jarring. Upon impact, the laser pickup mistracks, introducing an audible skip into the program reminiscent of old record turntables reacting to similarly jolting situations. Personal CD players, as you might expect, have not been very suitable for joggers or anyone else engaged in an active lifestyle.

Active-types may find the PCD7 more suitable, however. The PCD7 includes circuitry designed to make the unit more shock resistant. What this circuitry does is store a few seconds of upcoming music in memory. When the laser pickup mistracks due to jarring, the music stored in memory is accessed so there is no interruption in playback. In the meantime, the laser pickup moves quickly back into its original position and resumes operation. Since the memory writing speed is twice as fast as the musical output, the transfer is seamless. List price is \$500.

Interestingly, this same antishock feature is a highlight of the Sony Mini-

Disc portable player scheduled for introduction later this year. Sony's Mini-Disc player does have a record mode, a feature not available with existing CD players. Mini-Discs, however, are not compatible with existing players. If antishock circuitry becomes more widespread for personal CD players of the Fisher type, it may make the argument for Mini-Discs less compelling.

Wireless Headphones

Ever since the Federal Communications Commission loosened restrictions regarding short-range broadcasting in the 900 MHz range, a number of products have appeared that let you broadcast audio/video signals within a range of about 100 ft. One product of this type that we've become fond of is the wireless headphone system from Recoton listing for \$130.

The system is comprised of a small transmitter that connects to virtually any audio source equipped with either audio output jacks or headphone jacks. The sound is then broadcast to a calculator-size receiving module you carry on your person. All you do is plug in any pair of headphones into the receiver. Now you can do housework, exercise or anything else while listening to music or TV, all without disturbing anyone.

This system seems to work better than the infrared wireless headphones that have been available for some time. Infrared systems depend upon a line-of-sight transmission between the transmitter and the receiver. This limitation effectively confines you to one room. The RF transmitter broadcasts throughout the house, providing much greater freedom of movement. Sound quality is generally better than infrared transmissions as well.

Dubbing Tape

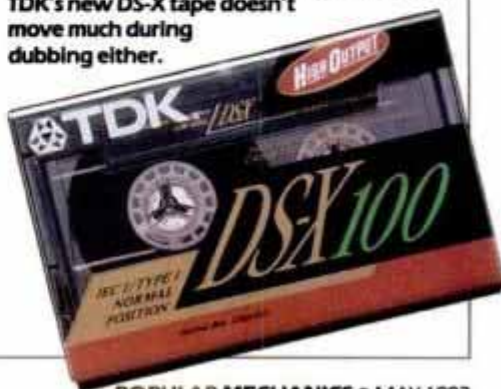
With compact discs well entrenched and new audio formats like the Digital Compact Cassette on the horizon, you might think that little thought is now given to the ubiquitous analog cassette we've been using for years.

Not so. TDK is bowing a normal bias (Type I) audio cassette designed for high-speed dubbing. Many dual-well cassette decks, especially those included with portables, allow you to copy from one tape well to another at high speed. At high speeds, however, tape-to-head contact may be less than perfect, and that will affect the sound quality of the copy.

TDK's new DS-X tape has a new antiresonance mechanism that helps keep the tape on track. Bass response is improved and a new formulation yields a higher sensitivity to mid and upper frequencies. DS-X blank tape is available in 60-, 90- and 100-minute lengths at list prices ranging from \$2.50 to \$3.70.

FM

Fisher's personal CD player (top) resists jolts. TDK's new DS-X tape doesn't move much during dubbing either.



WINGSHIPS (Continued from page 38)

namics requires that wings must grow steadily longer and thinner if speed and efficiency are to be maintained. Eventually, it becomes impossible to make them strong enough to resist bending.

Hooker's solution is to integrate the wing with the fuselage. "You have to bring the structure back in. Make it look like a Kleenex box," he says. "You build ships that look like that that are much heavier than 10 million pounds." That takes care of the structural problem, but leads to a shape that lacks aerodynamic efficiency. Unless you fly it in ground effect.

That introduces the question of seaworthiness. As Hooker puts it, "The standard-size airplane can't compete with the standard-size ocean wave." So, under typical open-ocean conditions, you'd have to fly too high to make use of the ground effect. The only way around this is to build a bigger aircraft. Not only will it be able to survive the occasional wave impact, but it will also have a greater wingspan, and thus be able to stay in ground effect up to higher altitudes. In other words, says Hooker, "In order to build a large aircraft, I have to build a huge aircraft."

Unquestionably, building a wingship would be a massive undertaking. But it would not be unprecedented. Harvey Chaplin, director of technology at the Carderock Division of the Naval Service Weapons Center, compares it to the effort that led to the Air Force's C-5 Galaxy transport jet. "You have to really be motivated to do it," he says. "But if one took that step, it would have a commercial payoff."

Hooker estimates that wingships could reduce the cost of travel between here and Europe to somewhere between \$75 and \$100 per person, and make it far more comfortable. "They're a bit like the old oceanliners in terms of space availability," says Wayne Thiessen, a colleague of Hooker's at Aerocon. What's more, crossing times would not suffer significantly. Hooker's current concepts would be capable of about 500 knots, just slightly slower than a jetliner. And like today's jetliner fleet, wingships could be called on to serve as military transports when necessary. But their tremendous payload and 10,000-mile range would make them far better suited to this role.

Ultimately, Hooker's vision is of a world brought closer together. "As engineers, our roots lie in bridge building," he explains. And with political barriers between countries now crumbling, engineers can at last get on with the task of spanning the geographic barriers that remain. **PM**

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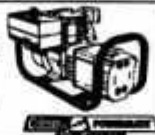
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AVIATION

FRENCH REVOLUTION

BY WILLIAM GARVEY



BILL CRUMP PHOTO

● It happened almost every time we were handed off to a new air traffic controller, all the way from Dallas to Washington, D.C.

"Uh...300 Papa Whiskey, say again your airplane type."

"Papa Whiskey is a TBM 700."

"A what?"

"A TBM 700. It's a French turboprop built by Aerospatiale."

"Never heard of it."

At that point, the exchanges varied. One controller asked if we were "one of those composite airplanes" (No.); another said he assumed we were "some odd military aircraft" (Wrong.); and another, an unabashed airplane enthusiast, simply asked for a ride sometime (He got a "Yes," and a number to call.).

That the computer identifier for our radar target was unfamiliar to these air cops was understandable. In a world where new equipment takes years to evolve, an all-new airplane suddenly appearing on the scene, certified and in production, is a radical departure from the norm. But then, the TBM was radical

from the day it was conceived.

While one engine is fine for mobile machines—be they road-graders, subway trains, limousines or submarines—when you put wings on it and passengers in it, two motors are much preferred. The fact is, airplanes built

such arrangements ensure a backup engine in case of failure.

It's an admittedly inefficient way to assure continuous propulsion, but it was thought that people who own, fly, regulate and ride in serious, for-business planes would accept nothing less.

Au contraire, mon ami.

The folks at Aerospatiale do not shy from challenging convention. After all, it was they who helped design and build the *Concorde* and then went toe-to-toe with Boeing and McDonnell-Douglas by creating Airbus. After carefully reviewing the aviation marketplace, they concluded that the world's manufacturers had simply ignored a viable category of aircraft—the very high-performance, high-altitude, cabin-class single. Since the kind of performance they had in mind was a sizzling 300 knots (approximately 350 mph), the need for turbine power was obvious.

The program was launched in June 1987, and proceeded at lightning pace. First flight occurred 13 months later, French certification was



Smart, functional Eurostyle interior allows a total of seven to share TBM's 350-mile-per-hour ride.

for business—and that's virtually every airliner, business jet or civilian turboprop extant—have two, three or four engines. It's not that they all need the extra horses, but rather that

awarded in January 1990, U.S. certification followed that August, first delivery came five weeks later and the first U.S. aircraft was delivered last May. The program's speed underscores the intelligence behind the design. While the concept of a single-engine business turboprop is radical, the plane itself relies so heavily on proven technology, it almost seems familiar.

Spurning exotic composites, Aeroespaciales cut this speedster out of airplane-grade aluminum and gave it a flush-rivet fit and finish that would make Piaget proud. As for aerodynamics, canards, winglets and such were bypassed in favor of a conventional fixed main wing and empennage. And for propulsion, the designers quite sensibly chose the Pratt & Whitney Canada PT6A, the most popular, most proven turboprop in the air today. Mean time between in-flight shutdowns for the PT6A is over 220,000 hours. That means if you operate it 8 hours a day, 365 days a year, you might want to keep a closer eye on your engine gauges in, say, 75 years.

It has often been said that a plane that looks right, flies right. Well, the TBM looks terrific. It's big for a single: almost 35 ft. from spinner to tail cone, 42 ft. from tip to tip and its fin rises over 14 ft. from the concrete.

Climb through the clamshell doors and you enter an elegant, but spare, cabin with club seating for four or five. Up front, the flight deck is all business, its panel packed with a full IFR complement of Bendix/King Silver Crown avionics including a KFC 275 flight director. EFIS 40 tubes are available, and most buyers will likely sign on for the \$96,000 option. Ditto for the optional Loran, weather radar, Freon air conditioning and Stormscope. Otherwise, just about everything is standard, including de-icing boots, electrically controlled prop and heated windshield, intercom, environmental-control system and emergency oxygen.

Maximum takeoff weight is 6579 pounds, with over a ton available for people and fuel. With tanks brimful with 278 gallons of Jet A, payload is 679 pounds, giving it a maximum range of over 1800 statute miles. In short, it is a serious, all-weather, cross-country machine.

Light the fire on the PT6A-64 and it's immediately obvious what sets the TBM 700 apart from its lesser, piston brethren. The turbine sound is unmistakable (though surprisingly quiet) and the feel of 700 shaft horsepower 5 ft. forward of your toes is, well, exhilarating. As TBM Vice President Brant Dahlfors and I held for takeoff from the company's U.S. headquar-

ters in Grand Prairie, Texas, just outside of Dallas, a controller asked what kind of performance to expect. "Handle us like a King Air 300," Dahlfors replied. That's impressive company.

Cleared, I advanced the power lever and maxed my apprehension. Would I be able to keep all that torque tracking true? The answer was quick and friendly, the beast was just another single. At 85 knots indicated, I hauled back, and the numbers started to run. Gear up, steady at 140 knots, and we were grabbing sky at 2000 ft. per minute. By 24,000 ft. at 160 knots, we were still climbing at 1000 fpm. Once level at 27,000 ft. (TBM is certified to 30,000), we settled down to a comfortable cruise edging past the advertised 300 knots. A tail wind bumped us to 328 knots. No wonder the controllers kept asking questions.

A scant 3½ hours after departing Big D, I was setting up for final to Runway 15 at Washington National. The flight had been flawless, and as we threaded our way along the Potomac and past the Pentagon, the airplane, thanks to its wide Fowler flaps and responsive aileron/spoiler system, showed itself to be docile at low speeds as well. Touchdown was uneventful, which says a lot about the TBM, considering it was my first

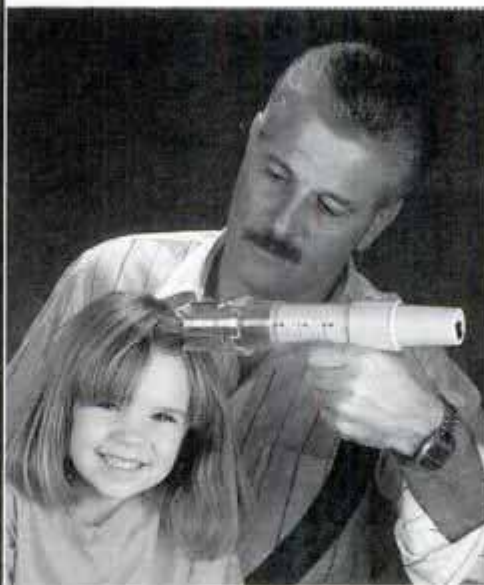
landing in it. Actual buyers need not worry about their technique since FlightSafety training is a part of the purchase price. We shut down outside Butler Aviation's front door. Total fuel burn was 197 gallons, miserly when you consider the tonnage moved, convenience and speed. And despite the fact that we were surrounded by Gulfstreams, Citations and Lear's, we got the stares and questions. Oh the price of celebrity.

The TBM 700 is so beautifully crafted, so pleasurable to fly and so formidable in performance that it's difficult to find any technical fault with it. Now, the only test remaining is the marketplace. So far, it's passing with flying colors.

Some 90 TBMs have been sold to date, and Aeroespaciales plans on adding three or four more to the worldwide fleet every month. The majority of buyers are go-for-it entrepreneurs like stereo king Ray Dolby and Formula One champion Nelson Piquet, but corporations are slowly coming round to the TBM's solo appeal.

After all, at \$1.4 million per copy, the TBM is half the price of any aircraft of comparable performance, and in this lean-and-mean era it could be that the TBM's most impressive performance is the timing of its debut. **PM**

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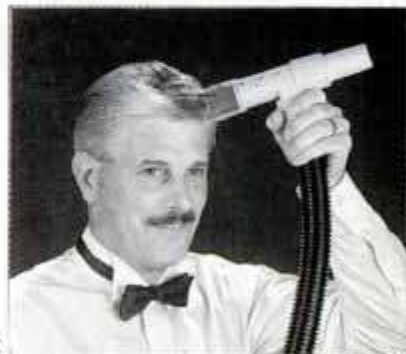


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ELECTRONICS

PREVIEWING WIDESCREEN TV

BY FRANK VIZARD, Electronics Editor

● Not every great performance at the 16th Winter Olympic Games was rewarded with a medal. Clustered behind the skating rink in Albertville, France, where Olympians glided for gold, a group of technicians sat crammed into a group of trucks and vans packed with broadcasting equipment. The signal they sent heavenward was not the TV signal seen in the U.S. The signal they sent heavenward offered a wider image, better screen resolution, brighter colors and sound quality rivaling compact discs. This isn't the picture you get at home.

Who are these guys sequestered behind a chain-link fence away from inquisitive eyes? Collectively, you could call them the Savoie 1250 group (Savoie refers to the French region in which the Olympics were held). Basically, they are a group of broadcast engineers and electronics specialists culled from the ranks of top European electronics companies like Thomson and Philips. Their job is to broadcast the first live high-definition television (HDTV) signals.

HDTV is characterized by a number of features you don't get with your current television. Immediately apparent to the viewer is the wider screen. Your TV at home has an aspect ratio of 4:3 while HDTV screens have an aspect ratio of 16:9.

Secondly, the audio signal is digital. This means the sound quality is akin to compact discs. Lastly, the picture quality is vastly improved since the number of horizontal lines is doubled from 625 to 1250 lines.

What does HDTV mean for television viewers? Let's say you were watching the Duchesnay ice dancers of host country France competing for a medal at the Olympic ice skating rink. The couple momentarily sepa-



Widescreen HDTV lets viewers see more of the action.

rates to execute a series of synchronized spins. Normally, a cameraman might have to decide which skater to follow because he won't be able to get both framed in his lens. The HDTV camera can capture both skaters. You see a picture more representative of what you'd see with your own eyes if you were at the event.

The same effect was apparent during the broadcasting of other Olympic sports. In hockey, you see more of the ice, and therefore more players and that critical off-the-puck action. Downhill skiing no longer requires long telescopic lenses that distort distance and speed. What's more, the crowd and the rush of skates on ice or skis on snow are

all sounds that are heard clearly, not just as indistinguishable background noise.

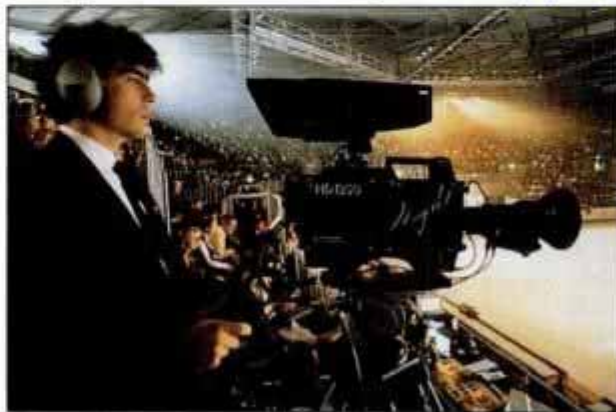
Translate this HDTV capability to sports like baseball, football and basketball, and you can see the possibilities for sports fans alone. Music and theater lovers might see the entire stage. Movies could be seen as they appeared in the theater.

New techniques

As you might imagine, producing an HDTV signal requires a new broadcasting methodology. The Savoie 1250 engineers use a technique they call the double 4:2:2 concept that basically couples two digital videotape recorders, each of which processes a single 625-line signal.

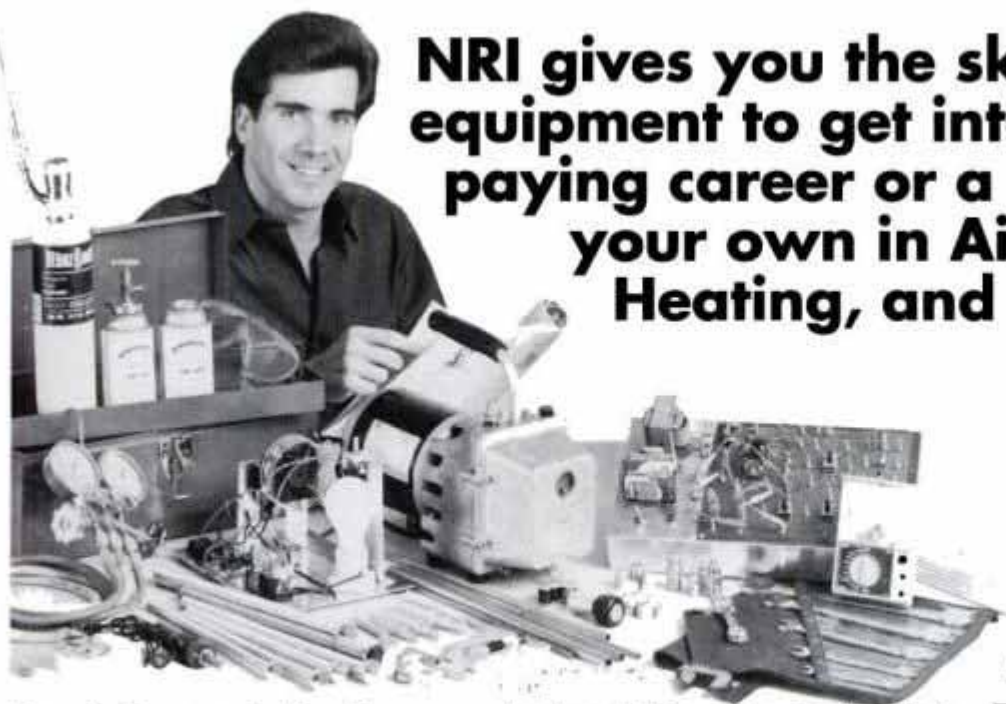
The process begins by digitizing and splitting the camera's analog signal so there are two 625-line signals. Each signal is then processed by a special-effects generator and a color corrector. The two 625-line signals are then recombined for satellite transmission or display on a 16:9 TV monitor. All the equipment needed to process the HDTV signal, as well as a studio, were in the trucks and vans parked behind the ice skating rink in Albertville. Direct feeds

(Please turn to page 130)



A portable HDTV camera covers the ice.

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Were we impressed? Yes. The wider screen, the great sound and the improved resolution almost made you feel like you were watching television again for the first time. Colors were amazingly vibrant and sharp. The details were astounding—you could see the hairs on a person's head. All of the high-definition television prototypes on view had 34-in. display screens. There was also one 55-in. projection model on display that was stunning in its lifelike qualities.

Still, like any new technology learning to walk, there were some areas that could stand improvement. All of the HDTV sets on display were prototypes, and it was clear that a more energetic power supply was needed to display a white field of ice at the hockey arena evenly across the screen. This problem is likely to be rectified in production models.

Silhouetting effect

Another odd effect was the silhouetting of studio announcers. This effect was not caused by the HDTV monitor, but by lighting techniques used at the studio. HDTV requires much brighter lighting than normal TV broadcasts. In the studio, the bright lights caused the announcers to be silhouetted against the backdrop. The effect was very unnatural. Solving this problem is not insurmountable, but it does illustrate the fact that HDTV will require broadcasters to learn some new production techniques. The Savoie 1250 team will be working the Summer Games in Barcelona, Spain (probably with a different moniker), in an effort to eliminate these types of problems.

HDTV, of course, is still a few years away. In the U.S., the Federal Communications Commission (FCC) will decide on an HDTV technical standard next year. A large number of electronics companies and broadcasters like NBC are now lobbying the FCC in favor of one of four digital video standards expected to be under consideration. Whether the picked standard is similar to that being used for Europe remains to be seen.

TV viewers, however, will get a taste of widescreen TV when RCA introduces a 34-in. model later this year. It will have a 16:9 aspect ratio, but the picture will be similar to existing TV as far as resolution is concerned. The picture, of course, will be wider than that of any existing TV.

The DBS angle

The question does remain as to what people will watch on 16:9 monitors.

ELECTRONICS

(Continued from page 126)

also came from other Olympic Game venues via fiberoptic cable.

This broadcast signal, incidentally, is different than the PAL/SECAM standard presently used in Europe. This signal, called High Definition-Multiplexed Analog Components (HD-MAC), transmits color, brightness and sound separately rather than together as did the PAL/SECAM standard. The new HD-MAC standard contributes greatly to a brighter,

sharper picture. Under the PAL/SECAM standard, only 120,000 pixels or picture elements were available. HD-MAC is expected to offer as many as 700,000 pixels by 1995.

A long, wide view

Who saw these HDTV pictures? HDTV monitors were placed in 50 locations throughout Europe. One of these locations was in the Olympic venue of Les Arcs, a small village hosting the speed skiing event where this correspondent, by contrast, was



DirecTV uses a small, 18-in. dish antenna to receive a satellite signal.

There is, fortunately, an existing base of letterbox movies available on laser-disc that will fit nicely into the 16:9 format. And for the most part, 4:3 telecasts and videos can be punched up to the wider 16:9 format, although with some loss of quality.

There may be some delay, though, before broadcasters and cable companies deliver programs in a 16:9 format. With that in mind perhaps, Thomson, which produces RCA, GE and ProScan televisions, is working with Hughes Communications, Inc., to develop a direct broadcasting satellite (DBS) system that could bypass both broadcast and cable sources to offer 16:9 programming.

Called DirecTv, this project would supply more than 100 channels of programming directly to individual homes. The signal would be sent via satellite and received by consumers using an 18-in. saucer-shape antenna. Picture quality is said to be similar to Super VHS tape and sound quality is reportedly comparable to CDs.

The first DirecTv satellite is scheduled for launch in December 1993, and it will carry 16 high-power, 120-watt transponders. Digital compression technology will allow each transponder to carry four live video signals or eight movies. Consumer receivers and antennas are expected to be available early in 1994. Target price is \$700 for the gear, not including installation. At least some portion of the programming is expected to be in the 16:9 widescreen format.

Olympic sound

As long as PM is handing out medals for technical brilliance at the 16th Winter Olympic Games, we would be remiss if we didn't mention the fine job Bose did in providing sound systems for every venue. The well-known Massachusetts-based speaker company used a proprietary computer software program to design an appropriate sound system for each venue. PM particularly appreciated the sound quality of Bose's pro-sound speakers at the freestyle skiing event in Tignes. The masters of moguls ski the course to the sound of rock-and-roll. Grateful Dead tunes at the Olympics? Absolutely. By the time freestyle skiers like U.S. gold medalist Donna Weinbrecht and U.S. bronze medalist Nelson Carmichael reached the bottom of the hill, both the crowd and contestants were really pumped. Poor speakers would have made the whole event far less enjoyable. The only thing missing was a wooden dance floor. Maybe Bose will have that ready for the Winter Games in Lillehammer, Norway, in 1994. **PM**

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THE SAILFISH & THE SEA V2

BY JOE SKORUPA, Boating/Outdoors Editor



● The sailfish jumped a half-dozen times. It walked on its tail. It somersaulted in midair. It ripped off 100 yards of line. It dove to the bottom. In short, it put up the fight of its life. But it was no match for the experienced fisherman on the other end of the tether, who was equipped with the latest high-tech gear. Eventually, the 50-pound billfish tired and was brought to the *Grady Lady*—a Grady-White 225G Tournament off-shore fishing boat.

The fisherman kept the line taut. The captain carefully guided the boat. The photographer snapped pictures. I billed the fish.

Billing a fish is a straightforward procedure. You put on canvas gloves, grab the fish's bill and then hang on. My first concern was to keep the sharp, abrasive 2-ft. spike away from myself and others. My second was to control the animal so that it could be properly tagged. Since scientists who study pelagic species—wide-ranging ocean fish—have very little hard data

to work with, every tag helps.

The situation became complicated when a photo boat arrived. Now, instead of concentrating on the fish, our attention was diverted to photography. For one ill-considered shot, the entire crew moved to port, and the *Grady Lady's* center of gravity abruptly shifted to the side. The boat



The correct method of billing a fish before its release. Going overboard isn't required.

tilted so suddenly that I began to fall overboard. It was a slow-motion fall because my feet were hooked beneath a rail and my knees were hugging the gunwale, but my balance point was terminally overboard.

I was staring into the huge black eye of an extremely pissed-off fish only inches away. When I hit the water, what would I do? Let go of the bill and take a chance that he'll run me through? Despite having a vision of the line breaking and the fish towing me out to sea like a human trophy, I decided to hold on. In the nick of time, an unseen hand grabbed my belt and halted my imminent plunge. The crew succeeded in pulling me back into the boat, but for an instant, I came closer to a role reversal with a hooked fish than I ever thought possible.

The fisher king

The place: Key Largo, Florida. The time: Late December. Offshore fishing doesn't get any better than this, especially if you stay at the ultra-posh

Ocean Reef Club. It was three days of fine weather, hungry fish and a choice of offshore or skinny-water fishing. Given the choice, I'll pick offshore fishing every time. And I did.

While I didn't hook a sailfish, I did catch some nice-size dolphin, plenty of cerro mackerel and several strange-looking junk fish. Our spot was about 5 miles out from a major Key Largo inlet, where the dropoff ranges from 100 ft. to 140 ft. deep.

The technique used was typical for South Florida small-boat fishing. We slow-trolled a 4-rod pattern of live bait, mostly pilchard, which we had netted. We also used two big buckets of dead bait, comprised of pilchard and ballyhoo, and trailed a chum line. We threw dead bait frequently to create a school-of-fish effect, which proved to be attractive to surface-feeding billfish and dolphin.

The best part of our technique, as far as I was concerned, was the choice of boat: the Grady-White 225G Tournament with a 200-hp Yamaha outboard. This was the first time I'd ever been offshore fishing in a small, dual-console boat, and I quickly found out that it was well suited to the task.

All of my previous small-boat, offshore experience involved boats with either center-console or walkaround-cuddy configurations. Both are ideally suited to saltwater fishing, but the walkaround-cuddy is more friendly to fishermen when the weather turns foul. Although nothing stops a truly macho fisherman, a center-console boat places only a small windscreen between you and the elements.

What I learned about the 225G Tournament is that it incorporates the best qualities of both kinds of boat. Its layout has plenty of wide-open fish-fighting space, like a center console, and its dual consoles with a connecting windscreen offer the protection found on a walkaround cuddy.

Interestingly, the aft cockpit of the 225G Tournament is probably larger than most center-console boats in its class. The reason? The consoles are located farther forward than in a center console. The tradeoff is that the forward area is diminished, but since most offshore fishermen I know spend the bulk of their time in the aft cockpit, this isn't much of a problem.

One morning we got a chance to test the effectiveness of the boat's sheltering design. A huge thunderhead moved into our path as we headed out to the fishing grounds. With the bimini top up and the walkthrough windshield shut, we plunged into the squall and rode it out for about an hour. Although the storm was short, it was strong enough to demonstrate that

the boat offers real protection from the elements when you need it.

Except for the brief squall, we enjoyed three days of warm, bright, calm weather, which is ideal for fishing, but a nightmare for testing boats. Fortunately, the passing thunderhead briefly whipped up 4-footers, and we took advantage of them to test the seaworthiness of the hull.

Like all Gradys, the 225G Tournament displayed a great riding attitude when launching over the crests of waves and a classic soft landing when reentering the water. To our surprise, we ran comfortably through the waves at more than 40 mph, which is pretty good for a small boat. The reverse chines did their job by throwing spray well away from the cockpit.

While I've always appreciated the seaworthiness of Grady-White boats, there was a new wrinkle evident in the improved handling of the 225G Tournament. I found out that this was due to the breakthrough hydrodynamics of a new hull design.

The Sea V2 hull

This may come as a surprise to some, but the vast majority of pleasure-boat builders rarely work with true naval architects. This has always been a mystery to me. Although naval architects are scholars of applied hydrodynamics and experts on state-of-the-art technology, pleasure-boat companies have traditionally kept away from them. They've instead opted for the trial-and-error method of hull design using consumer feedback as the ultimate judge.

Eventually, this method produced a number of successful designs, which made creating new boats relatively easy. All that was required was a little fiddling on a proven hull. Is it any wonder that powerboats relied on non-planing, displacement-influenced hulls for decades before discovering the efficiency of the modified or deep-V shape?

For eight new hulls in its 1992 line—all boats 22 ft. long and up—Grady-White did something all too rare in boatbuilding: It sought out a naval architect, Boston-based C. Raymond

Hunt, who is a well-known pioneer in deep-V hull design and a highly regarded designer of commercial ships and custom yachts. The state-of-the-art design that Hunt came up with is the Sea V2 hull.

What's different about the Sea V2 hull is that it breaks away from the traditional constant-V, which maintains the same angle of deadrise from the stern to a point well beyond amidships. In the Sea V2 hull, the deadrise continually becomes sharper from the rear to the front of the boat. It goes from 20° at the transom to 31° under the helm to 56° forward. Each of these angles is carefully chosen.

The 20° deadrise at the transom gives the boat a stable platform at rest and an efficient configuration for tracking and popping up on plane. The 31° angle under the helm is important, because this is where the waterline strikes the hull when running through waves. Compared to the relatively flat angle of constant-V hulls at this location, the sharp angle here in the Sea V2 lessens the effect of the pounding. The same principle applies to the extremely sharp 56° angle forward, which enables the boat to effectively knife through rollers.

Another benefit of the Sea V2 hull is exceptional tracking. A walk down any aisle at a boat show reveals that builders put all manner of bulges (convex shapes) amidships or in the bow of the hull. The theory is that the waterline strikes primarily in the aft area while running, so the bow doesn't affect handling.

The problem is that offshore boats spend a lot of time at slow-trolling speeds, where the entire hull is in the water. The result is that a poorly designed hull exhibits a problem called bow steering, which feels to the driver like the boat can't hold a straight line. The Sea V2 eliminates all convex shapes and steers a true track at either fast or slow speeds.

In addition to a top-performing hull, the 225G Tournament comes with a long list of standard features, including: eight vertical and four horizontal rod holders, three fishboxes (a 190-qt. box, a 135-qt. divided box and a 60-qt. box), cockpit toe rails, rigging area with a cutting board, lockable console tackle drawers, a plexiglass-covered instrument panel, a helm footrest, two cushioned pedestal chairs and many others.

To catch a fish, some experts say you have to think like one. After facing the prospect of reversing roles with a hooked sailfish recently off Key Largo, I'd advise that it's much better to think like a fisherman than a fish.

FM

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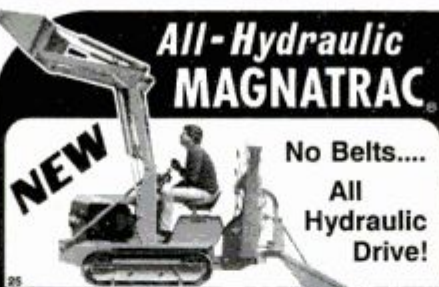
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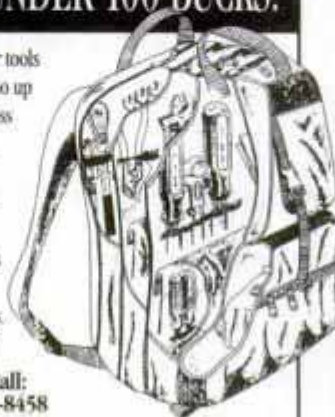
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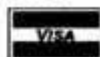
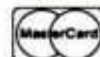
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