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Popular Mechanics

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RETURN TO THE TITANIC
Closeup Photos Reveal The Eerie Mystery Of This Sunken Legend

HOW TO RESTORE AN OLD CAR

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PRO TIPS TO A FRESH, GREEN LAWN

Homeowner's Guide To Beautiful Grounds

CLOSET HOT RODS

Running The Wheels Off 14 Low-Profile, High-Performance Cars

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08



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Popular[®] Mechanics

AUGUST 1992
VOLUME 169
NO. 8



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PM PHOTO BY RICH COX

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EDITOR'S NOTES

● The guy with his arm around our Science/Technology Editor, Abe Dane, is Dr. Anatoly Sagalevitch, head of the Manned Submersibles department at the P.P. Shirshov Institute of Oceanology in Moscow, Russia. He's the guy who designed and piloted the *Mir* submersibles used on the dives to the *Titanic*, which resulted in the unreal photos of the wreck you see in the article beginning on page 23. Sagalevitch was also the overall head of the expedition, directing operations aboard the *Akademik Keldysh*, the largest research



Dane and Dr. Sagalevitch in Newfoundland.

ship in the world. Our Mr. Dane was along for part of the expedition, and I think you'll find his report as fascinating as the photos that resulted. . . . If you would have told me that I would soon be in a hot-air balloon soaring over the western hills of New Jersey, I would have told you that you were out of your skull. I wasn't going anywhere near anything that goes up in the air without a motor. Yet, there I was in the official balloon of the U.S. Navy Balloon Team soaring over the Garden State. I'm going to kill Tom Hall for talking me into this. After the first 10 minutes, they chiseled my hands off the edge of the basket and it was actually pretty cool. The view was fantastic and the perspective memorable. I recommend a balloon ride to anyone who hasn't been on one. I also recommend looking for the Navy Balloon Team in your area. The team travels all

over the country, participating in balloon festivals, giving rides and generally making itself highly visible. It's part of the Navy's public relations and recruiting program. Hey, it's not just a job, it's an adventure. (P.S. I still prefer a Corvette.) . . . When I first transferred over to POPULAR MECHANICS from *Motor* magazine, one of the big-interest topics here was kitplanes—planes you buy in a bunch of pieces, put together and hope they fly. Back then, kitplanes were mostly what used to be called ultralights—flimsy little things powered by lawnmower engines. You sort of rode on top of, rather than in, them.



The official U.S. Navy Balloon Team (l. to r.): AMS1 Marvin Johnson, CPT Roger Hull, Balloonist 10th Class Oldham and AD2 David Mulso.

What a difference a decade makes! As you can see in this month's cover story by contributor Bill Garvey, today's kitplanes are a far cry from the contraptions of 10 years ago. But you still buy 'em in pieces, put them together yourself and hope they fly. Till next time.


Joe Oldham

Editor-In-Chief Joe Oldham

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LETTERS

Wingships

Wingships may be the transcontinental transportation of the future. However, as a sport fisherman, I wonder how this will affect me. I spend a great deal of time on the coastal waters off Florida's East Coast and the Florida Keys. Fishing these waters is most exciting. In addition to actually catching a fish now and then, we must dodge submarine periscopes and are buzzed occasionally by military jet jockeys from Homestead AFB and Key West NAS. Fishing at night, we experience drug chases nearby. But the thought of a monster ground-effect wingship passing 40 ft. overhead at 500 miles per hour makes me wonder if it's time to take up golfing.

GERALD L. JOHNSON
DELRAY BEACH, FL

With all of those people in northeastern shipyards about to be put out of work because of defense cutbacks, and with many defense contractors struggling to find consumer-oriented civilian products, wouldn't this be an ideal time for some of these parties to get together? Companies like Boeing or General Dynamics could team up with the union, the airlines and the workers to organize the building of a few wingship prototypes.

JOSHUA LANDESS
CHICAGO, IL

The new airships promise to be revolutionary, but such vehicles will never happen. Why? The craft fill a logical niche by being cost

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



A 1959 photo of a P6M before takeoff from Chesapeake Bay.

efficient as well as practical. When was the last time government or business climbed onboard a good idea? The ground-effect aircraft will suffer the same fate as the lighter-than-air airships of yesterday.

WESLEY GLENN JOHNSON
WAYCROSS, GA

The commercial potential of the Navy's 4-jet P6M SeaMaster, a high-speed flying boat that commenced trials at Baltimore in 1955, was never explored. Faults in the tail design required fixing before 11 follow-on P6Ms intended for a sea-plane strike force could demonstrate, as they did, an ability to operate within much the same flight parameters of a modern-day Air Force B-1. In the interim, the Navy found it would be too expensive to pursue both an SSF and a subma-



Bringing Olympic Games coverage to the world: Intelsat V/V-A (left) and Intelsat VI.

rine ballistic missile strike force, then being perfected. To add insult to injury, all P6Ms were subsequently scrapped to recover \$70 million in "reusable parts" for other Navy weapons programs.

WILLIAM WELLING
NEW YORK, NY

Intelsat

In your article "Worldcasting The Games," the image used to depict the two Intelsat (International Telecommunications Satellite Organization) satellites in the illustration is that of *Early Bird*—the very first Intelsat satellite, launched in 1965. Intelsat carried coverage of this year's Winter Olympic Games from France via three Intelsat VI and five Intelsat V/V-A satellites over the Atlantic and Indian Ocean regions. Broadcasting for the Sum-



mer Games will be even greater.
MICHAEL NEWSOM
INTELSAT
WASHINGTON, D.C.

Tree Pruning

Your article on tree pruning gave advice that's counter to recommendations by today's trained arborists. Flush cutting, re-cutting of old close branch stubs and painting of tree wounds are out. Cutting close to the collar around a limb but not through the branch collar is correct. And since tree wounds do not heal but seal over with new wood, no tree wound dressing has been found to improve the process.

JAMES E. BILLER
AMERICAN SOCIETY OF
CONSULTING ARBORISTS

Possible Dreams

The exhibit is proof that it all starts with a vision—and a nurturing team to help make it a reality.

JERRY FITZ
CLEVELAND, OH

Fabulous show! I remember my mother under the electric curling dome, and I made milk shakes at a drive-in with the same kind of mixer.

ROBERT McCABE
DETROIT, MI

The exhibit brings to mind many recurring needs and the evolution of technology to address them.

JOE IAQUINTO
FARMINGTON, MI

Correction

PM's July 1992 cover illustration of the F-15E Strike Eagle was done by Mark McCandlish. **PM**

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TIME MACHINE

90 YEARS AGO: AUGUST 1902

POPULAR MECHANICS

Women House Builders in Arizona



Women House Builders in Arizona

Homes By Hand

At the turn of the century, women rebelled against their closeted Victorian roles and sought anthropological evidence of their own equality. The Hopi Indians of Arizona were a case in point. Not only did Hopi women own the tribe's adobe houses, they also built them. Construction materials consisted of chips of rock and mud toted in troughs from the riverbeds below the mesas. What's more, Hopi homemakers used no tools: The houses were literally handmade.



Power Train

Railroad rivalry gathered steam when the New York Central inaugurated year-round, 20-hour luxury service between New York and Chicago on the "Twentieth Cen-

tury Limited." The Pennsylvania Railroad matched the offer with its new "Pennsylvania Special," and the Great Speed War was on. Both railroads later trimmed their schedules to 18 hours.

60 YEARS AGO: AUGUST 1932

POPULAR MECHANICS MAGAZINE

SEE PAGE 182



Frazier Hunt D.H. Burnham
Barney Oldfield

Water Strider

Naval architects of the era loved hydrofoils, although back then the high-stepping watercraft offered a rather bumpy ride. But that didn't stop a German engineer from designing a 60-passenger trans-Atlantic hydrofoil speedster. Air screws would provide propulsion as the boat glided on six ladder-style foils. German shipyards built large hydrofoils during World War II, but Allied bombing raids kept the 60-knot attack craft from entering the fray.

Two To Tango

Hollywood quickly became America's fantasy factory during the Depression years. Special effects would soon leap into public consciousness with the release of "King Kong," but even the tamer musicals benefited from camera trickery. On Paramount sets, a dancing movie camera locked arms with a starlet and waltzed her across the floor. Audiences got the impression of dancing with her. The robo-cam's hat, trousers and chalked face no doubt put the actress at ease.



30 YEARS AGO: AUGUST 1962

POPULAR MECHANICS

Build a 38-m.p.h. Fun-Boat— for \$38
Secrets of Buying the Best Transistor Radio
Wizards of Wallops Island: Sheerling Convent



Supersonic Helicopter I

Hop And Pop

Supersonic flight and vertical takeoff dominated aeronautical thinking in the early '60s. Naturally, some engineers sought to combine the two. Pete Girard conceived the heliplane—with a triangular wing that whirled for liftoff, then locked into place for cruise. A variant had two counterrotating wings, mounted above and below the fuselage. But like so many vertical-takeoff concepts of the day, the heliplane never jumped off the drawing board.

Boom Town

At secluded Wallops Island on Virginia's Eastern Shore, NASA engineers tested the new Scout research rockets and groused about the good old shoestring days. The facility dated back to World War II, but its budget had mushroomed since the birth of NASA. Now trim steel launch pads and solenoid cable releases replaced makeshift plywood scaffolds and oyster-men's ropes. No longer did engineers calibrate radar off a .22-caliber bullet fired over the ocean. **FM**





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TECH UPDATE

News Of Tomorrow's Technology Today



PM ILLUSTRATION BY PAUL DWANE

Bailout 2000: Escape From The X-30

WRIGHT-PATTERSON AFB, OH—The National Aero-Space Plane will fly through unknown territory: Basic propulsion, flight control, sheer speed and altitude will be like nothing any aircraft has ever experienced. All the more reason to pack in some crew-escape technology should something go horribly wrong.

Air Force investigators believe the most likely technique would be equipping the craft to literally blow its own head off in an emergency.

A separable forward section would jettison from the rest of the plane, either with explosives or passively. Then a drag chute could deploy to slow the forebody,

ideally to a speed between Mach 0.7 and 1.3. At that point the crew members could bail out on modified ACES 2 ejection seats.

Researchers are currently analyzing the variables in this scenario with a computer program modified from software used in the early stages of the Space Shuttle and B-1 bomber programs.

So far studies reveal that the crew still might have to eject from the forebody at higher speeds and altitudes than are considered safe. Engineers will have to design protection systems that can withstand high windblast,

Editor: Abe Danc
Assistant Editor: Greg Pope
Contributors: Lisa Busch, Philip Chien,
Mike Fillon

g-loads and aerothermal heating. Options include partially or even fully encapsulated ejection seats.

X-30 escape sequence: Forward fuselage jettisons explosively, then crew ejects from decelerated forebody.

Highlights This Month

- **Taxi To The Stars**—Latest on the Personnel Launch System.
- **Final Approach**—What happened to the YF-22A?
- **Black Hawk's Brood**—New Sikorsky chopper taps UH-60 tech.
- **Spun Glass**—Rotating furnace casts biggest mirror yet.
- **Long Shots**—DARPA's deadly new stretching ammo.
- **Three-Way Driving**—Sanyo's triple-powered electric car.

Space Taxi Takes Shape

HAMPTON, VA—A study by Lockheed's Skunk Works has confirmed the technical feasibility of Personnel Launch System HL-20 (see *Tech Update*, page 15, Jan. '91). Engineers at NASA's Langley Research Center, who developed the HL-20 concept, are now analyzing the Skunk Works' cost and production schedule forecasts.

The vehicle has evolved since it was first publicized. The HL-20's large outboard fins, originally flat, are now cambered on top for extra lift. Wind-tunnel tests and approach-and-landing simulations have shown that the HL-20 would glide stably.



The Lockheed study also okayed the rocket-assisted launch-escape system and

the use of a Titan III as a booster for an unmanned prototype.

HL-20 would go up on solid core of National Launch System.

YF-22A Is Crippled

EDWARDS AFB, CA—A fiery April 25 belly-flop landing has put the only flying F-22 prototype out of commission.

The YF-22A, built by Lockheed, Boeing and General Dynamics, was swooping low over a runway for a photo opportunity when something threw the jet into a series of bucking-bronco pitch oscillations. After about 7 seconds, the plane's tail end slapped onto the runway. Fire damaged only



Its maimed wing and fin wrapped in black plastic, the YF-22A has retired to an Edwards Air Force Base hangar.

about a quarter of the airframe, and the pilot escaped with merely a sore back.

Crash investigators are focusing on some of the capabilities that make the

YF-22A the Advanced Technology

Fighter. When the bucking began, the jet was employing its thrust-vectoring nozzles and firing its afterburners while simultaneously retracting its landing gear.

Not until 1995, when engineering and manufacturing prototypes take to the air, will an F-22 fly again.

Secret Satellite Kicker

CAPE CANAVERAL, FL—The Air Force's secretly

launched DSCS-III communications satellites have some new flexibility, thanks to an extra stage tacked to the spacecraft.

Called the Integrated Apogee Boost Subsystem, or IABS, the extra rocket stage kicks its satellite into a circular geostationary orbit, then detaches. The versatile motor has an intriguing feature—it carries its own solar-power

array. That's unusual because the DSCS-III's solar panels, even folded, could generate enough power to

feed the IABS's batteries for a short period.

But the solar array on the little booster keeps its electronic systems operational for at least 12 days. That means 12 days can elapse between launch preparation and final positioning of the satellite in space. The extra time can stretch the launch window or allow Air Force planners to postpone a decision on placing the satellite.

Although the IABS was designed specifically for the DSCS-III, the government now owns the design and could adapt the motor to propel an all-purpose orbital maneuvering vehicle.



Apogee-boost rocket can wait 12 days before placing DSCS-III.



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The Aquatred "Contact Patch," the key to the tire's performance.

It's not electronic. It's not mechanical.

Yet, *Popular Science* awarded it the "Best of What's New Award." And *Popular Mechanics* awarded

it the "1992 Design and Engineering Award."

It's a tire. The Goodyear Aquatred all-season radial. Its deep groove aquachannel helps channel water away as you drive. For

superior stopping, cornering and steering.

Goodyear Aquatred is designed and engineered to be the best wet-traction tire you have ever put on your car.

And while you gain so much in the wet, you sacrifice nothing in the dry.

The deep groove Aquatred all-season radial. Only from Goodyear.

Technology makes it different. Wet traction makes it superior.

GOODYEAR

THE BEST TIRES IN THE WORLD HAVE GOODYEAR WRITTEN ALL OVER THEM.

New Chopper On The Block

STRATFORD, CT—Sikorsky Aircraft has developed a big new helicopter that bears a striking family resemblance to the UH-60A Black Hawk now in widespread military use. But the new rotorcraft, designated S-92, will carry 19 passengers to the Black Hawk's 11, thanks



Sikorsky S-92 has 54-ft. fuselage with enough interior space to carry 19 passengers.

stuffed into C-130 airlifters, a requirement that doesn't cramp the S-92. Inside, there's 200 cu. ft. more cabin space and a 6-ft. ceiling that allows most passengers to walk nearly upright. That's not surprising, since the helicopter is aimed at civilian users as

much as the military.

Much of the S-92 derives from the Black Hawk line, including the transmission and powertrain, the aluminum airframe and the avionics suite. The rotor blades, however, are wider and end in a hook that adds about 450 pounds to the S-92's lift in hover. Another new feature is a rear loading ramp.

Maximum takeoff weight is 22,220 pounds, a little more than the Black Hawk's. It will cruise at 160 knots, with a top range of 400 miles.

The S-92 will likely be a seabird: Offshore oil rig support should be a major civilian use, while the military versions could replenish Navy ships or land Marines in amphibious assaults.



to a dramatic increase in cabin volume.

The rather squat Black Hawk was designed to be

passengers to walk nearly upright. That's not surprising, since the helicopter is aimed at civilian users as

Silent Space Chiller

PALO ALTO, CA—A small, ultracold refrigerator that could run for more than a decade without vibrating would be a boon for satellite-borne sensors such as infrared telescopes and gamma-ray detectors. Now, Lockheed engineers, working with the British firm Lucas Aerospace, say they've developed such a device.

The cryocooler consists of two compact refrigerators that weigh less than 30 pounds each. Based on the Stirling cycle, they consume

little power, and their parts don't wear against each other. They also reuse the same small volume of working fluid instead of allowing it to boil away.

To eliminate the rattling caused by their motors, engineers linked the refrigerators together in such a way that their vibrations cancel each other out. The key is an electronic control package that measures the vibrations from each refrigerator and adjusts the machines' motors to keep the vibrations in phase.

The technology could be useful for long-term space projects such as NASA's Earth Observing System of environment-monitoring satellites.

Mounted back to back, compact Stirling refrigerators cancel each other's vibrations.



LOCKHEED PHOTO

Pea-Soup Simulator

BROOKS AFB, TX—Spatial disorientation, or SD, is probably a major culprit in airplane crashes attributed to pilot error. To combat the problem, the Air Force is examining the physiological basis of SD phenomena, such as the G-excess illusion and the giant-hand effect.

The Visual Orientation Laboratory and the Gyrolab 2000 are simulators that teach how to recognize disorienting conditions and to keep the plane under control. Multi-axis motion and computer-generated visuals con-



AIR FORCE PHOTOS

jure the different illusions.

Coming next year, the Advanced Spatial Disorientation Demonstrator, a follow-on to Gyrolab, will feature a new wide-field-of-view display system that simulates a T-38 jet.



Gyrolab (left) and Visual Orientation Lab (above) mimic SD.

**SURGEON GENERAL'S WARNING: Cigarette
Smoke Contains Carbon Monoxide.**

Lights Kings: 12 mg. "tar", 0.9 mg. nicotine; Lights 100's: 12 mg. "tar", 1.0 mg. nicotine; Full Flavor Kings: 16 mg. "tar", 1.2 mg. nicotine; Full Flavor 100's: 17 mg. "tar", 1.3 mg. nicotine, av. per cigarette by FTC Method. © 1992 Eve Holdings Inc.

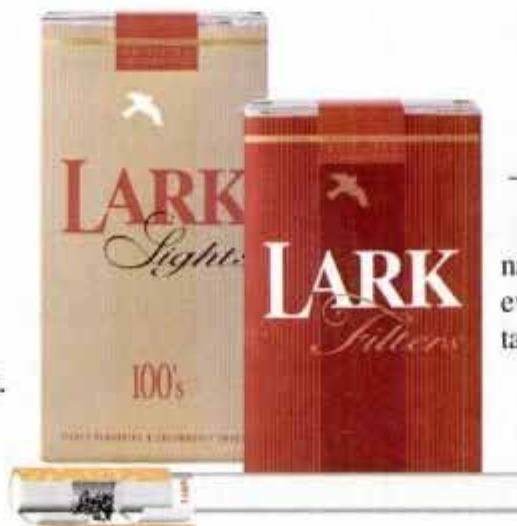
Want your last cigarette of the day to taste as good as your first?

*Thanks to Lark's
unique, charcoal filter
it will.*

Lark's activated charcoal filter absorbs harsh tasting gases for a gentler taste that's incredibly satisfying. Morning, noon and night.

*How does an activated
charcoal filter do that?*

As the smoke passes over and through each tiny granule, certain harsh tasting gases are singled out and trapped. And it stands to reason, that means a more enjoyable cigarette.



*Fresher, richer flavor doesn't
wear out as the day wears on.*

Lark's unique filter lets all the naturally satisfying flavor through. So even your last cigarette of the day will taste as satisfying as your first.

*Get your money back if
you don't agree.*

Try a pack of New Lark and if you're not satisfied, just send us the empty pack along with the purchase receipt and we'll send you your money back.

Available in king size and 100's, regular and lights.

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The last cigarette
of the day tastes
as good as the first.**

Money Back Guarantee: If not completely satisfied, please send your receipt with purchase price circled, (1) empty Lark pack and your name, address, zip code and the statement "I certify that I am 21 years old or older" hand printed on a 3" x 5" piece of paper to: The Lark Challenge, P.O. Box 1680, Church Hill, MD 21690. OFFER EXPIRES 12/31/92. Refund limit, 1 to adults 21 years and older. Club responses void. Offer good only in U.S.A. Void where prohibited. Please allow 6 to 8 weeks for delivery.

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To The Consumer: Caution! Coupon is valid only where the brand style(s) specified are purchased by an ADULT AT LEAST 21 YEARS OF AGE. Any other use is improper and could constitute fraud. Participation in this promotion is at the retailer's discretion. LIMIT ONE COUPON PER PACK OR CARTON PURCHASE. Void where prohibited by law.

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Monster Mirror Is Spun

TUCSON, AZ—The rotating furnace at the University of Arizona has cast a 21-ft. mirror blank—the largest yet created by the machine.



Three months ago, 10 tons of borosilicate glass melted in the furnace, which spun at 7.4 rpm to give the mirror a parabolic face. Since then, the glass has slowly cooled.

Now Steward Observatory Mirror Lab scientists must hoist the blank from the furnace with a suction-footed grapppler. They'll pull out the



Five-pound chunks of borosilicate glass fill furnace, which is then lidded and spun to cast 21-ft. mirror.



honeycomb blocks that lighten the mirror's underside and begin inspecting for flaws. The big reflector is to replace the 6-mirror array on the Multimirror Telescope at Mount Hopkins.

Stretching Tank Killers

LIVERMORE, CA—Kinetic-energy penetrators that elongate during flight are the focus of research work at Lawrence Livermore National Laboratories. The Defense Advanced Research Projects Agency (DARPA) is funding the effort.

Long projectiles fly truer and penetrate targets deeper than short ones. But short darts are easier to launch. The solution is a rod-in-tube configuration, fitted with a rear fin. During flight, air drag on the fin slows the

rod, flying relatively fast—er, slides out and then locks into place.

The extended projectile holds its length upon impact with the target. Although the tube doesn't dig into the target as efficiently as the rod, overall penetration is deeper than that of a conventional projectile.

Livermore is experimenting with scaled-down projectiles fired from cannons at up

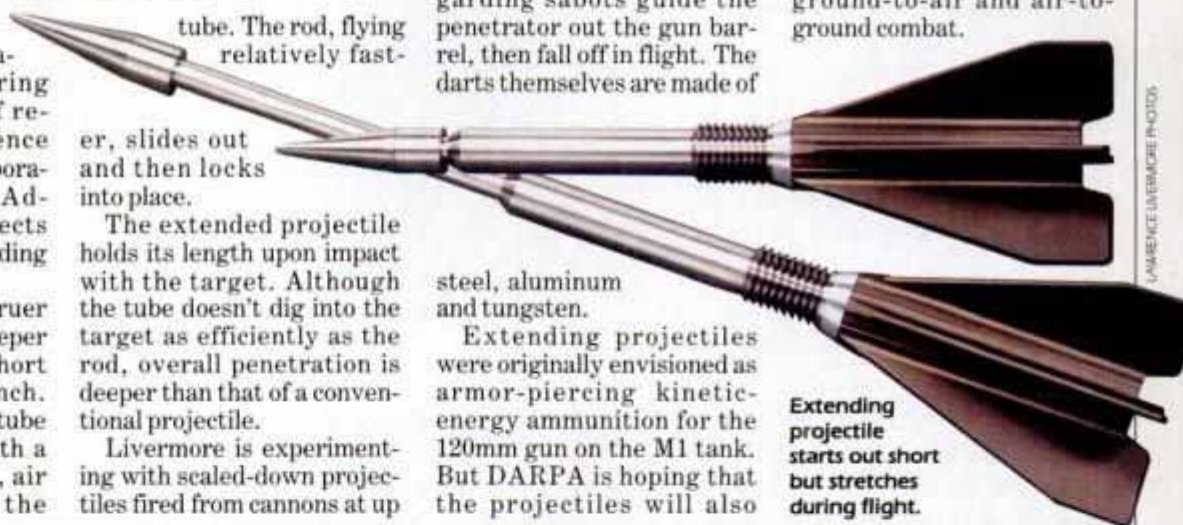
to 1.25 miles per second. Discarding sabots guide the penetrator out the gun barrel, then fall off in flight. The darts themselves are made of

steel, aluminum and tungsten.

Extending projectiles were originally envisioned as armor-piercing kinetic-energy ammunition for the 120mm gun on the M1 tank. But DARPA is hoping that the projectiles will also

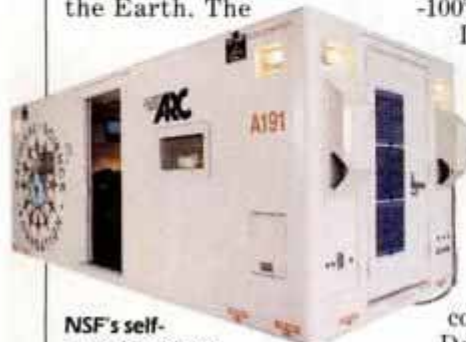
prove suitable for air-to-air, ground-to-air and air-to-ground combat.

Extending projectile starts out short but stretches during flight.



Drop-In Polar Lab

FAIRBANKS, AK—Researchers can now take their homes and offices with them to the most remote corners of the Earth. The



NSF's self-contained field labs and housing modules withstand extreme conditions.

National Science Foundation's new All-Weather Relocatable Complex can withstand temperatures between -100° and 115° F.

Different modules can house living quarters, lab space and utility gear, such as a generator and waste treatment equipment. Each module can run on solar power when sunlight is available. Its oil-fired heater can cold-start at -30° F.

Designed by GDM, Inc., the modules have undergone testing on Alaska's tundra.



Hands-Off Space Lab

KENNEDY SPACE CENTER, FL—The French, Germans and Italians have bundled together an unmanned space laboratory that astronauts are scheduled to release from the Shuttle *Atlantis* this month.

The European Retrieval Carrier, or EURECA, consists of 15 microgravity experiments packed into a 9-ton spacecraft about the size of a VW Beetle.

On board EURECA, crystals will grow, cells will mutate, sensors will measure



radiation and instruments will snare micrometeoroids

during the 10-month orbit. The free-flyer also houses a

EURECA offers unmanned preview of Space Station Freedom experimentation.

gamma-ray telescope and an experimental ion thruster, among other devices.

Next year, EURECA will kick itself back down to the Shuttle's orbit, where astronauts will grab it for later refurbishment. The U.S. will get space on its 1995 flight.

ESA PHOTO AND ILLUSTRATION

Megabytes For Mariners

WOODS HOLE, MA—Sea trials are underway for an electronic nautical chart that could revolutionize ship navigation. A Woods Hole Oceanographic Institute motor-yacht is currently testing the prototype system.

The hardware consists of a computer hooked up to shipborne radar, gyrocompass

and either a LORAN-C or Global Positioning System receiver. During some tests, the system will control the ship's autopilot.

Woods Hole is managing the Electronic Chart Display and Information System (ECDIS) effort. Future tests will take place on a Coast Guard cutter and an oil tanker.



Digital chart shows position, soundings and channel markings.

Hot Crushed Alloys

PITTSBURGH, PA—Carnegie Mellon scientists are subjecting metals, composites and ceramics to vicious forces in an effort to customize their microstructures.

At the new Center For Advanced Deformation Processing Research, engineers are scaling up their unique hot triaxial compactor. It combines 2000° F temperatures with gas pressures of 30 tons per sq. in.—plus a hydraulic ram that puts shear stress on the material sample, aiding densification.

A machine now under construction will hold an 8-in.-dia. compaction vessel, nearly double that of the existing compactor. A future, possibly commercial model will feature a 6-ft.-wide vessel.



Hot triaxial compactor applies shear stress to metal powders, yielding new microstructures.

CARNegie MELLON PHOTO

Triple-Electric Sports Car

TOKYO, JAPAN—So far, electric cars have run on either batteries, fuel-cell power or solar energy. Now, Sanyo has built a \$400,000 2-seat concept car that taps all three power sources.

Amorphous-silicon photovoltaic cells, with efficiencies between 5% and 7%, coat the car's top surfaces.

The fuel cell is a small 250-watt powerplant weighing roughly 66 pounds. Three nickel-hydride cells, each weighing about 6 pounds, supply the hydrogen fuel.

The backup battery pack is made up of familiar nickel-cadmium units.

The car's top range on a sunny day is 94 miles, but only 30 miles without solar power. Weighing under 900 pounds, the vehicle stands no chance of being more than a technology demonstrator. Besides the power sources, the car features a voice-controlled, CD-ROM color mov-

ing map with a Global-Positioning-System-based navigator. **YU**



Sanyo's electric car draws power from photovoltaic cells, fuel cell and batteries.

SANYO PHOTO



No matter where only one plug guarantees

A lot of spark plugs claim they'll give your car better performance. At Bosch, we guarantee it. No matter if your car was built across the street or across the world, if you don't feel the difference with Bosch Platinum, we'll pay for the plugs.*



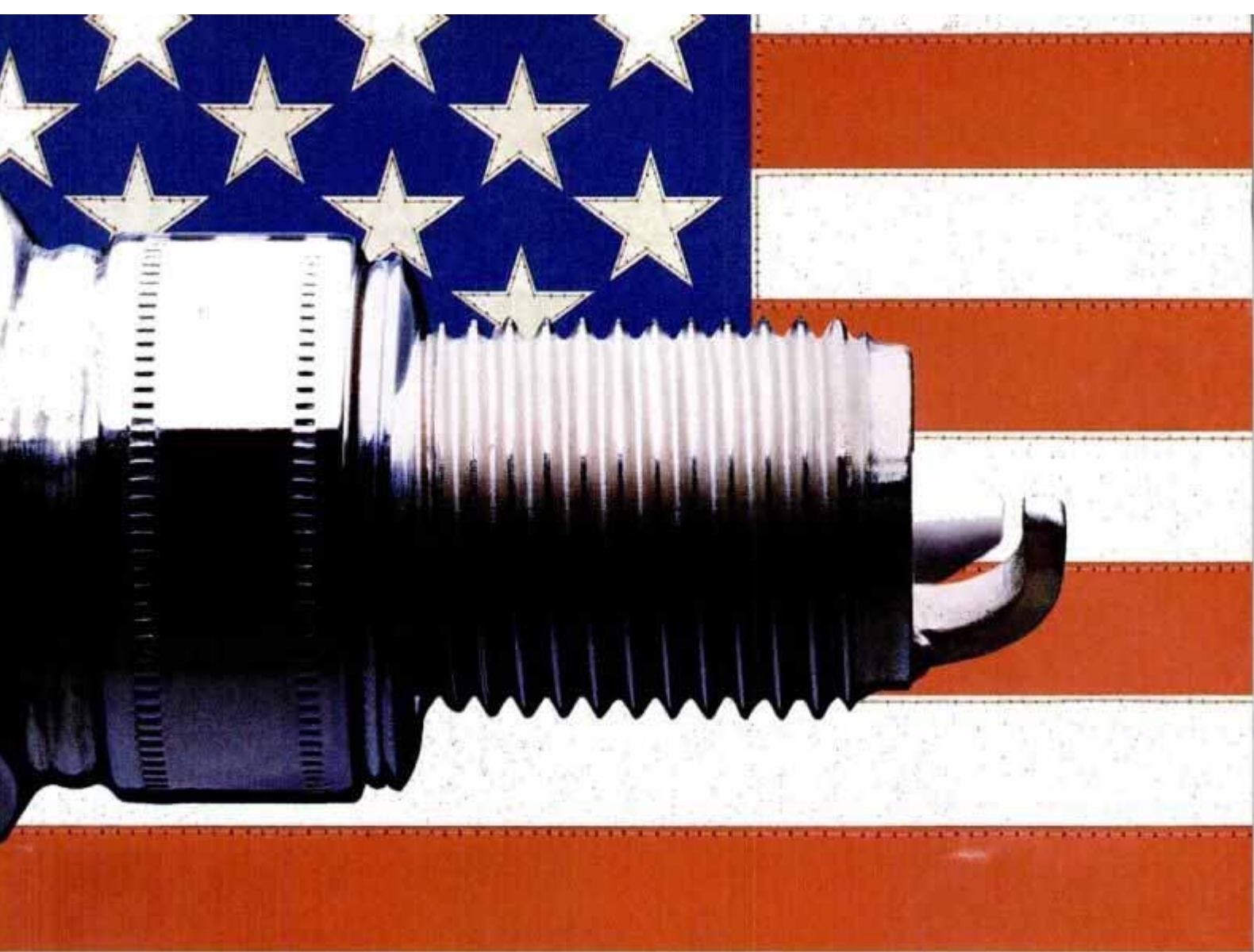
The 99.9% Pure Platinum Center Electrode plus our extended insulator design give the Bosch Platinum plug a wider heat range than standard plugs. And the effective gap between its electrode and tip remains virtually unchanged over the life of the plug.

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*See store for details.

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fact remains that it continues to be the only plug with a 99.9% pure platinum electrode engineered into a revolutionary extended insulator design.

The result is quicker starts, smoother acceleration and improved fuel efficiency.

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Speed vs. fuel efficiency.

An interview with Michael Andretti



Within a few years of his 1983 Indy Car debut, Michael Andretti had become runner-up in the CART/PPG Championship no fewer than three times. Then in 1991 he drove his Kmart/Havoline car to a record 8 official victories in a single season, and the championship was his. One factor contributing to Michael's success was mastery of the age-old question of whether to sacrifice fuel efficiency or speed:



"Indy Car rules require you to maintain at least 1.8 miles per gallon of fuel during a race," Michael says. "Like it or not, each team is allocated the same set amount of fuel, and if you run out, that's your problem."

"So how do you go fast enough to win—efficiently enough to finish?" Michael continued. "You do it through a combination of teamwork, driving technique, and technology—which is becoming increasingly important. And as more manufacturers use motorsports to extend their research and development, you can expect more racing technology to find its way into cars we drive on the street."

Fuel management.

"The heart of an Indy Car's fuel management system is the ECU—the Electronic Control Unit—like the 'black box' you find in many modern street cars. It's basically a computer that adjusts fuel mixture to varying ambient conditions. We program it—which we call 'mapping'—prior to each race according to our strategy. Data from the ECU and other functions is sent back to the pits via telemetry. That helps me drive to a pattern of fuel consumption that my team manager, Ed Nathman, and I have decided will carry us either to



the next pit stop or to the end of the race. It's a little scary, because in an Indy Car you don't get an exact measurement of fuel remaining in your fuel cell—just the amount of fuel flow. It's all based on calculation, and in past years we've been known to pay a penalty or two for miscalculation."

From the cockpit, the modern Indy Car driver can control fuel mixture (from 90% to 100% rich), turbo boost, front and rear brake bias, and front and rear anti-roll bar (swaybar) stiffness. His dashboard typically has a digital tachometer, and at the flick of a switch can tell him oil and coolant temperatures, lap times, and fuel flow, among other things. At his right hand lies a gearshift lever that gives him 6 forward speeds, plus reverse on road tracks. So how much of all this does Michael Andretti use in traffic that on superspeedways can exceed 240 mph?

"All the above," he answers. "In varying degrees, of course. I usually don't play a lot with turbo boost and unless the dash flashes a warning, I don't pay great attention to temperatures. But I often make brake and suspension changes to chase down weather, fuel load, and/or tire wear. And I adjust mixture or driving style to chase down fuel consumption. Each element, of course, has a symbiotic relationship with the other. Suspension adjustments help increase

cornering speeds, which can give you momentum to go faster on less fuel. And I try to be as smooth on the throttle as possible—which is also useful on the street."

Racing performance and everyday performance.

At Texaco, we race not just to prove, but to improve the quality of products we make for your car. Michael Andretti understands that very well. He had this to say about it:

"It's another example of racing technology becoming everyone's technology.

For instance, my Newman-Haas team has shared our experiences on the track with Texaco people. An experience we're sharing right now is the use of Havoline Formula¹ Motor Oil—an oil everyone can buy off the shelf, that we use regularly right out of the bottle in our Indy Cars. On the road, Havoline Formula¹ is very effective against heat stress, starting friction, and engine dirt. And on the track, we haven't had a single oil-related failure with it. As for Texaco System¹ Gasolines, I use them in my everyday driving. System¹ constantly cleans a car's engine, which can help an older car run younger and a new one stay in its prime—and System¹ comes in every octane grade. Cleaning is important because residues from fuel and combustion can restrict flow and reduce energy. And energy means performance—on the track, or on the road."



TEXACO SYSTEM¹ AND HAVOLINE FORMULA¹

A GHOSTLY RETURN

The most complex and costly deep-diving expedition in history unshrouds the tragedy of the *Titanic*.

BY ABE DANE, Science/Technology Editor

● The pace of life is slow 2½ miles beneath the sea. In the abyssal blackness, a ratfish glides. A seastar gropes. Anemones feed with gentle motions. Eighty years ago, the *Titanic* came to rest among these simple creatures, a mysterious visitor from the unknown world above.

As decades passed, the great ship settled into its new surroundings. Fresh-painted steel gave way to a thick coat of dangling rusticles, and the magnificent salons and staterooms were colonized by new life. What once had been the perfect expression of man's paradoxical brilliance and blindness became a rich oasis in a dark world beyond his reach.

Only a handful of people have actually visited the place

A GHOSTLY RETURN



described here. And all of them had to risk their lives, traveling into pitch-black depths where the water bears down with 6000 pounds per sq. in. of pressure. Their reward? The chance to squint through the viewports of deep-diving submersibles at dimly lit patches of the most storied shipwreck of all time.

Scenes from a shipwreck

I had a much better view of the wreck, although my journey to the *Titanic* involved nothing more perilous than a plane ride to Toronto, Canada. There, I saw a preview of unedited footage for the Imax feature "Titanica," scheduled for release this October.

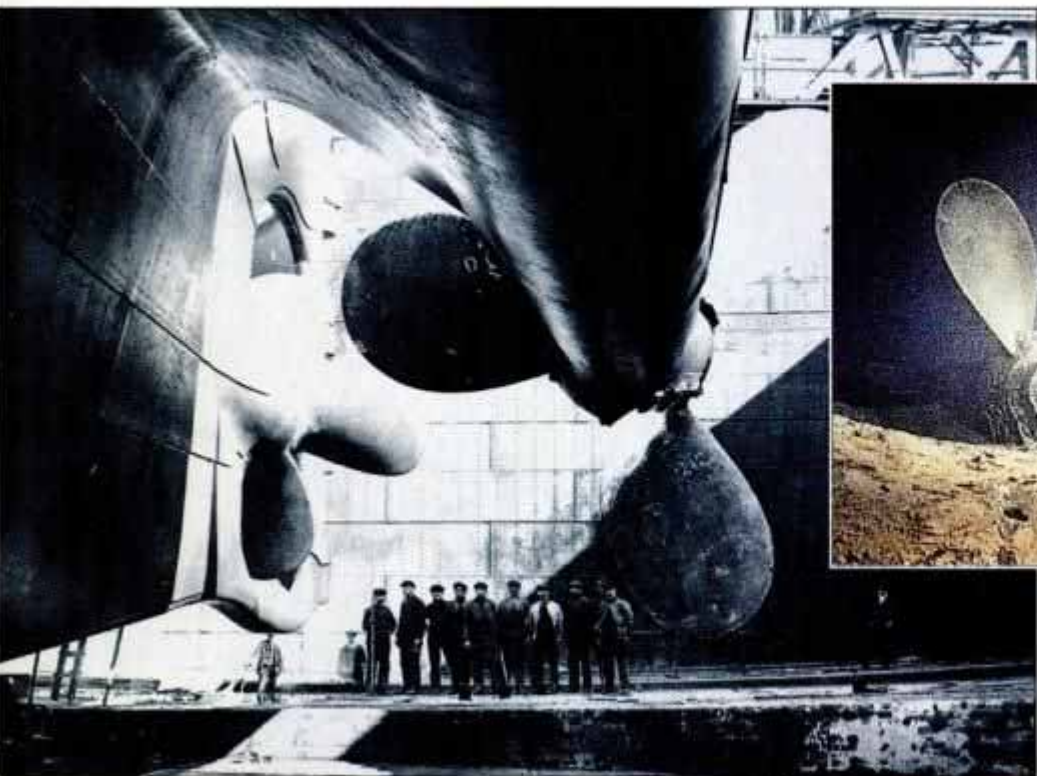
The product of a \$6-million expedition that brought together recent strides in deep-sea lighting, uniquely

capable Russian submersibles and state-of-the-art Imax film technology (see "Back To The *Titanic*," page 118, Oct., '91), it was an awesome spectacle. Brilliantly illuminated on a 6-story screen, the vast, encrusted hulk becomes a teeming visual wonderland, so rich in opportunities for exploration that one can't hope to take it all in. After 80 years obscured beneath the sea's funereal shroud, one feels that a new *Titanic* is revealed, transformed by its long stay in the depths.

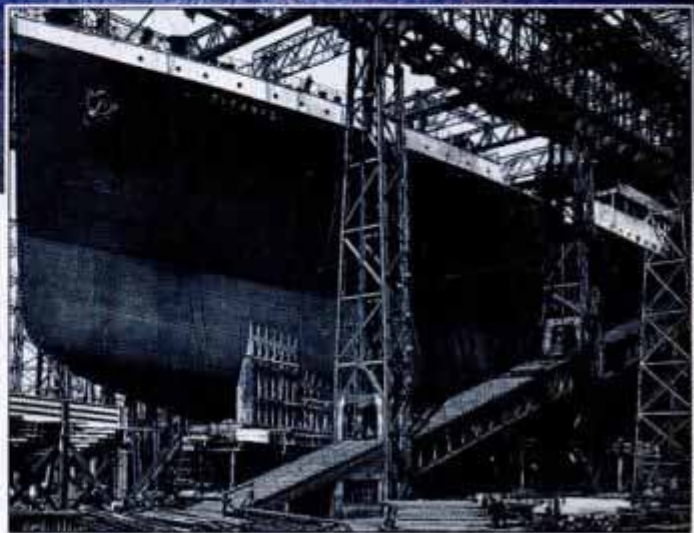
The vessel is utterly changed, and yet unmistakably reminiscent of what

was once the glittering crown jewel of the White Star Line. Bedecked in rivers of rust that hang like Spanish moss, "It has turned into this huge, Victorian-era haunted house," says veteran *National Geographic* photographer Emory Kristof, who accompanied the Imax team.

Along with the fascination of the wreck itself, there are more profound implications to these sharply rendered scenes of the world 12,000 ft.



ULSTER FOLK AND TRANSPORT MUSEUM PHOTO



ULSTER FOLK AND TRANSPORT MUSEUM PHOTO (LEFT); LOW FIELDS INTERNATIONAL PHOTO (ABOVE)



EMORY KRISTOF/NATIONAL GEOGRAPHIC PHOTO

Russian sub pilot Evgeny Chernjaek peers out from *Mir* (inset top). On the bottom, windows of a first-class stateroom look out on the murk (top). Black-and-white photos from Belfast's Harland and Wolff shipyard show stout hull plating, and huge, bronze propellers. *Mir* stumbled on one during its second dive (above).



beneath the sea. Says "Titanica" director/producer Stephen Low, "If people can see how spectacular and beautiful it is down there, and how varied and rich the wildlife is and the geology, they will begin to think of it not as just a dark and lonely cold place, but as something that's wonderful and curious and interesting and worth preserving."

Intermingled with the expedition's cinematic agenda was a program of

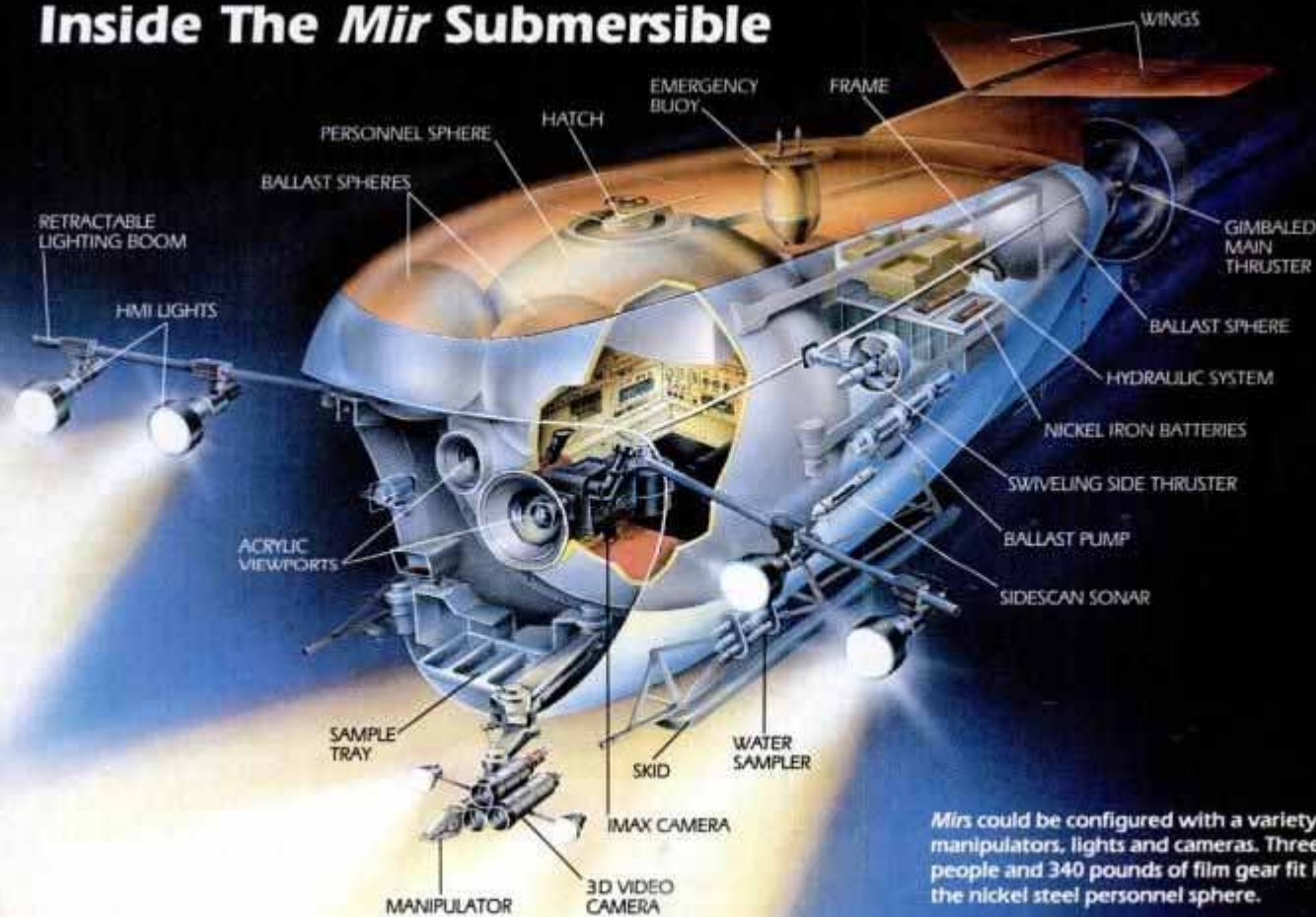
scientific observation. Not only does the Imax footage itself provide a unique record of conditions at these relatively unexplored depths, but time was taken during the dives to gather samples of the decaying wreck, the seafloor and the surrounding water. The results were unexpected. "There's a perception that the deep ocean is inert, it's isolated, it's a void," says the Bedford Institute of Oceanography's Steve Blasco, who served as the expe-



Director/producer Low prepares to dive with Chernjaek (above). Subs were launched from starboard deck cradles with the help of divers and a hydraulic crane.

EMORY KRISTOFOROV/INTERNATIONAL GEOGRAPHIC PHOTOS

Inside The *Mir* Submersible



Mir could be configured with a variety of manipulators, lights and cameras. Three people and 340 pounds of film gear fit in the nickel steel personnel sphere.

A GHOSTLY RETURN



Massive, steam-driven windlass (above) was used to hoist cargo, and now dissolves into rust on the forecastle. *Mir* photographs *Mir* (right) near the bronze steering telemotor that held the ship's wheel inside the now-demolished wheelhouse. A rattfish (below) glides over broken champagne bottles and White Star Line china.



dition's chief scientist. "We learned that the area was quite active." Russian zoologist Lev Moskalev counted 24 species of invertebrates and four kinds of fish in the vicinity of the *Titanic*. And the wreck itself proved an invaluable measuring device, since its age is known precisely and can be used to gauge the rate at which natural activity occurs around it.

Lights, camera, submersibles

However compelling the rationale for the expedition might have seemed, it would never have been contemplated

had it not been for the availability of a few critical technologies.

Central among these is the Imax medium itself. Although it has been around for more than 20 years, it remains the most powerful method yet devised to convey visual images to a wide audience. Imax uses 70mm film turned on its side so that each frame spreads over 10 times the area, and thus contains 10 times the photographic detail of those on normal 35mm movie film. Imax film also flits through the projector three times as fast, producing an absolute flood of visual information. "In imagery, it's the

amount of information that's important," says Low.

Wound sideways through an immense rolling loop projector, the pictures spill out onto giant screens that fill the entire field of view. The aim, according to Low: "to eliminate the clues that you're watching a film."

Under the best of circumstances, Imax movies are difficult to make. The cameras are cumbersome 100-pound masses of delicate machinery that can tear through a 1000-ft. magazine of film in 3 minutes. At the *Titanic* site, they would have to operate under conditions that make even the simplest task complex.

Only five submersibles in the world can operate at the depths required. Of these, the two best suited for film work are the matching *Mir 1* and *Mir 2*, which are owned by the Russians. Their 7½-in.-thick, 200mm-dia. acrylic viewports accommodate wider angle lenses than the 120mm ports aboard other subs, and their 100-kw nickel iron batteries permit 20-hour dives, with plenty of power to spare for lights and other accessories.

Both *Mirs* operate from a single ship, the 400-ft. *Akademik Keldysh*, described by Kristof as "the greatest oceanographic ship with greatest capabilities that exists." It was Kristof who in 1988 contacted Dr. Anatoly Sagalevitch, head of the manned submersibles department at the P.P. Shirshov Oceanographic Institute in Moscow, and began discussions that ultimately led to the expedition.

But getting to the site of the wreck would have been pointless without lights that could cover the Imax cameras' large fields of view without draining the submersibles' batteries. No such system existed prior to this expedition, but HMI lights, which had been used in shallow water for the movie "The Abyss," showed potential. Technical consultant Chris Nicholson of Deep Sea Systems was charged with developing a setup that could operate at 12,000 ft. The effort led to a 150,000-watt 4-lamp system more powerful than any used in the deep sea before, and 20 times as powerful as that aboard *Alvin* on the original *Titanic* dives.

Somehow the glare of the lights dispels none of the *Titanic*'s mystery, though. If anything, it grows deeper and more complicated. Coming back from the expedition, Kristof spoke of the experience: "The *Titanic* now is this monument from the world before World War I, and a high point of Edwardian technology," he said. Looking at the wreck and what it's become, it is certainly worthy of the legend. **FM**

CLOSET HOT RODS

ROAD TEST

Low profile, high performance. These 14 stealth stormers are the Clark Kents of today's cars.

BY TONY SWAN, Automotive Editor
PM Photos by Rich Cox



● One of the fundamentally appealing things about today's performance cars is also one of their biggest drawbacks: They *look* like performance cars.

This is fine when you or your girlfriend or your buddies are doing the looking. But it's not so fine when that sleek shark shape attracts the attention of someone wearing a cop suit. And since most cops like cars just as much as we do, it's quite likely to do just that.

Well, if you're addicted to the joys of acceleration and/or crisp handling, you already know there's no sure way of avoiding tickets. But it helps if your car doesn't attract attention just by being there, right?

That's what this test is all about. Every car in this collection offers something special in the way of driving fun, but it's not apparent at a glance. True, there's a rear wing or two in the mix, but wings have become

commonplace. For the most part, these are not the kinds of shapes that will get you arrested for intent—though we do recommend against red paint.

Since this is obviously a mixed bag, ranging from the Suzuki Swift GT to the superb Mercedes 500E, we have no overall winner. We also understand you might be able to list some other closet hot rod candidates—any classification becomes arbitrary at some point. But there's plenty of low-profile fun in this 14-car pack.

Acura Vigor GS

Although it's not as nimble as the Integra, its smaller Acura stablemate, the Vigor is deceptively quick and agile in its own right. The 176-hp dohc 20-valve inline Five is smooth and provides more low-end response than you might expect.

CLOSET HOT RODS



ACURA VIGOR GS



FORD TAURUS SHO

ALFA ROMEO
164S



Like many front-drive sport/luxury cars, the Vigor is a little undersprung and underdamped for really hard work on twisty back roads or a demanding set of curves and corners like the Streets of Willow test circuit. We also think the steering is a little numb, particularly on-center.

On the other hand, the brakes (4-wheel discs with antilock) are excellent and the Vigor is devoid of any wallowing or weirdness. And on the open road, its manners are strongly reminiscent of the bigger Legend sedan series—quiet, comfortable and luxurious, particularly in our leather-lined, wood-trimmed GS model.

It also has a remarkably strong sense of coupe-like intimacy for a 4-door sedan, thanks to its cockpit-style control and instrument layout.

Alfa Romeo 164S

Few cars in the luxury/performance class have the all-around sporting character of the Alfa 164, and those few aren't represented in this test. With its stiff chassis and firm suspension components, the 164 offers the precision and response of a sports car

clad in tastefully subdued sheetmetal.

The Alfa's 3.0-liter sohc V6—200 hp in the S model—has exceptional punch through a wide rpm range, and its seats offer the kind of lateral support we associate with racing cars, without sacrificing comfort.

Given the excellence of the chassis, we think the Alfa could use a little more tire. The P4000 195/65R15 Pirellis that come with the car ride well, but a little more contact patch and a lower profile would help both slalom and braking performance.

Aside from that, the 164 is an exceptionally appealing closet hot rod, with a broad range of capabilities and more personality than anything in its class. It can be called pricey—but it can also be called unique.

Dodge Spirit R/T

Did we mention the wisdom of avoiding red paint? Well, we better say it again here, because when you put your foot in this one, the result is the kind of red blur that sets sirens wailing. Wow! With 224 hp, the Spirit R/T's 2.2-liter dohc 16-valve inter-cooled turbo Four transforms this

modest midsize sedan into a torrid pavement-ripper that'll humiliate a lot of V8 muscle cars.

The R/T's suspension and chassis aren't well conceived to keep up with all this go-power. It took coaxing and patience to hurry the R/T around the Streets of Willow—too much understeer, too much wallowing, too much difficulty in getting all that power to hook up for the straight places.

But once the R/T is pointed straight, it pins its ears back and just flat disappears. If your idea of hot-rodding runs largely to acceleration, here's your ride.

Ford Taurus SHO

Even in an age of excellent V6 engines, the SHO's 3.0-liter dohc 24-valve aluminum V6 stands out. Designed (to Ford specifications) and built by Yamaha, the SHO (Super High Output) V6 makes 220 hp, enough to change the sleek-but-sensible Taurus into a tiger.

There's been some chassis tuning to go with the extra muscle, but, in our opinion, not enough. The engine is faster than the car. To be a real con-



DODGE SPIRIT R/T



ISUZU STYLUS RS



NISSAN SENTRA SE-R



MERCEDES-BENZ 500E

tender on a road circuit, the Taurus needs some stiffening, as well as better brakes—just a couple of hot laps provoke brake-pedal sponginess.

However, if sheer joy of horsepower is your priority, here it is—beautifully engineered, elegantly packaged and well-nigh invisible, thanks to the millions of Tauruses out there.

Isuzu Stylus RS

Although there's more power in the 1.8-liter dohc 16-valve Four this year—140 versus 130 in '91—the Stylus RS doesn't really come into its own until the road starts looking like a snake with a case of colic. Then you'll find yourself reeling in all sorts of high-powered traffic.

The key to this little car's impressive agility lies in the Lotus-tuned strut suspension. Stiff but still supple, the RS package provides remarkable balance, as good as anything in the small front-drive sedan class and better than most. It loves to be tossed around a tight racing circuit, it's devoid of vices and its all-disc brake system is fade-free and powerful.

We also liked the tire choice that goes with this package—205/50R15 Bridgestone Potenza RE71s on alloy wheels, probably the most performance-oriented setup in the bunch. And if your idea of a closet hot rod runs to back-road disappearing acts—or astounding everyone at your local autocross—this is one sweet setup.

Mercedes-Benz 500E

Okay, a Mercedes isn't exactly low profile. On the other hand, what qualities do you associate with these cars? Power? Of course. Meticulous engineering and assembly? Ditto. Safety?



MITSUBISHI DIAMANTE LS



NISSAN MAXIMA SE



MERCURY COUGAR V8



OLDSMOBILE CUTLASS SUPREME I-SERIES



OLDSMOBILE ACHIEVA SCX

Durability? Comfort? Luxury? Status? All of the above.

But when you get into the realm of Teutonic hot rods, the names that spring most readily to mind are Porsche and BMW.

And that's exactly why the 500E—a 300-series chassis with a 322-hp dohc 32-valve alloy V8—came to be. Tired of its somewhat stodgy image,

M-B partnered up with Porsche's R&D arm to create this car. To make a long and thorough development story short, the 300 chassis was substantially revised to handle the V8's power, and the car itself is assembled by Porsche at Weissach.

This thing is fast, friends and neighbors. Quick and fast. Quick and fast and agile. It sticks like a limpet and

changes directions like a cheetah.

We did find something to dislike, though. Part of the 500E's long list of standard features is a traction control system (ASR) that retards power when you exceed the limits of tire adhesion. This occurred frequently on the Streets of Willow, effectively eliminating power-on oversteer from the 500E's bag of tricks and thus limit-

These 14 cars represent every level of the high-performance, low-observability spectrum—but if you're really interested in avoiding tickets, we do recommend avoiding red paint.



ACURA VIGOR GS



ALFA ROMEO 164S



DODGE SPIRIT R/T

SPECIFICATIONS AND DIMENSIONS

MANUFACTURER/ MODEL	BASE PRICE/ PRICE AS TESTED	ENGINE/ DISPLACEMENT (ci/cc)	ENGINE HP, NET/ TORQUE (ft.-lb.)	ENGINE/ DRIVE LAYOUT	TRANS- MISSION TYPE	WHEEL- BASE/LENGTH (in.)	TRACK FRONT/REAR (in.)	WIDTH/ HEIGHT (in.)	HEAD-, LEG-, HIPROOM, F/R (in.)	CURB WEIGHT HP/WEIGHT R (lb./hp)
Acura Vigor GS	\$25,650 \$26,084	L5 SOHC 20V 150/2451	176 @ 6300 rpm/ 170 @ 3900 rpm	front/ front	5-speed manual	110.4/ 190.4	59.8/ 59.4	70.1/ 53.9	F: 38.6/44.3/52.2 R: 36.8/30.7/52.1	3212/ 18.25
Alfa Romeo 164S	\$34,990 \$35,535	V6 SOHC 180.6/2959	200 @ 6000 rpm/ 189 @ 4400 rpm	front/ front	5-speed manual	104.7/ 179.4	59.6/ 58.6	69.3/ 54.8	F: 38.2/29.3/57.5 R: 36.1/33.9/57.5	3325/ 16.63
Dodge Spirit R/T	\$18,674 \$19,804	L4 DOHC Turbo 135/2212	224 @ 6000 rpm/ 217 @ 5600 rpm	front/ front	5-speed manual	103.5/ 181.2	57.6/ 57.2	68.1/ 53.5	F: 38.4/41.9/51.7 R: 37.9/38.3/52.0	3089/ 13.79
Ford Taurus SHO	\$24,329 \$26,409	V6 DOHC 24V 206/3370	220 @ 6200 rpm/ 200 @ 4800 rpm	front/ front	5-speed manual	106.0/ 192.0	61.6/ 60.5	71.2/ 54.1	F: 38.3/41.7/55.2 R: 37.6/37.5/54.8	3131 14.23
Isuzu Stylus RS	\$10,749 \$13,768	L4 DOHC 16V 96.9/1588	160 @ 6600 rpm/ 150 @ 4800 rpm	front/ front	5-speed manual	96.5/ 164.1	56.3/ 55.3	66.7/ 51.8	F: 37.4/43.8/50.9 R: 32.0/30.4/42.7	2738/ 17.11
Mercedes-Benz 500E	\$79,200 \$81,890	V8 DOHC 32V 303.5/4973	322 @ 5700 rpm/ 354 @ 3900 rpm	front/ rear	4-speed automatic	110.2/ 187.2	60.6/ 60.2	70.7/ 55.4	F: 37.5/41.5/53.0 R: 36.9/33.5/55.4	3855/ 11.97
Mercury Cougar V8	\$21,962 \$26,171	V8 OHV 302/4948	200 @ 4000 rpm/ 275 @ 3000 rpm	front/ rear	4-speed automatic	113.0/ 199.9	61.6/ 60.2	72.7/ 52.7	F: 38.1/42.5/57.6 R: 37.6/36.5/56.6	3587/ 17.93
Mitsubishi Diamante LS	\$26,450 \$31,785	V6 SOHC 181.9/2972	202 @ 6000 rpm/ 199 @ 3000 rpm	front/ front	4-speed automatic	107.1/ 190.2	60.4/ 60.2	69.9/ 55.5	F: 38.6/43.9/54.2 R: 36.9/34.2/53.5	3505/ 17.3
Nissan Maxima SE	\$21,490 \$23,115	V6 DOHC 24V 180.6/2960	190 @ 5600 rpm/ 190 @ 4000 rpm	front/ front	5-speed manual	104.3/ 187.6	59.4/ 58.7	69.3/ 55.1	F: 39.5/43.7/54.3 R: 36.9/33.2/48.8	3146/ 16.55
Nissan Sentra SE-R	\$12,165 \$15,285	L4 DOHC 16V 121.9/1998	140 @ 6400 rpm/ 132 @ 4800 rpm	front/ front	5-speed manual	95.7/ 170.3	56.9/ 56.3	65.6/ 53.9	F: 38.5/41.9/51.2 R: 36.6/30.9/53.4	2414/ 17.24
Oldsmobile Achieva SCX	\$12,715 \$16,329	L4 DOHC 16V 137.9/2260	180 @ 6200 rpm/ 160 @ 5200 rpm	front/ front	5-speed manual	103.4/ 187.9	55.6/ 55.3	67.2/ 53.1	F: 37.8/43.1/48.9 R: 36.5/33.9/50.7	2690/ 14.94
Oldsmobile Cutlass Supreme I-Series	\$21,795 \$23,276	V6 DOHC 24V 137.9/2260	210 @ 5200 rpm/ 215 @ 4000 rpm	front/ front	5-speed manual	107.5/ 193.9	59.5/ 58.0	71.0/ 53.3	F: 37.8/42.3/51.9 R: 37.1/34.8/53.3	3221/ 15.33
Suzuki Swift GT	\$9699 \$10,706	L4 DOHC 16V 79.2/1298	100 @ 6500 rpm/ 83 @ 5000 rpm	front/ front	5-speed manual	89.2/ 147.4	53.7/ 52.8	62.4/ 53.1	F: 37.8/42.5/51.1 R: 36.5/29.8/42.5	1894/ 18.94
Toyota Camry SE	\$18,528 \$19,908	V6 DOHC 24V 180.6/2959	185 @ 5200 rpm/ 195 @ 4400 rpm	front/ front	5-speed manual	103.1/ 187.8	61.0/ 59.0	69.7/ 55.1	F: 38.4/43.5/56.0 R: 37.1/35.0/56.8	3153/ 17.04

1. Times from a steady-state 40 to 70 mph. 2. Best speed while weaving through 8 cones placed in line, 100 ft. apart. Speeds provide index of transient response. 3. G-force generated during steady-state travel around a 200-ft.-dia. circle. Chart number is an average of best cw and ccw. 4. Based on 12 basic maintenance functions.



MITSUBISHI DIAMANTE LS



NISSAN MAXIMA SE



NISSAN SENTRA SE-R



SUZUKI SWIFT GT



TOYOTA CAMRY SE

ing its lap times. Even so, this bodacious Benz was quickest round the circuit by a substantial margin.

It probably won't surprise you that all hands considered this the most desirable closet hot rod. But if \$80,000 seems a little steep, the 400E, with a 268-hp 4.0-liter dohc 32-valve alloy V8, will approximate the 500E experience for \$24,000 less.

Mercury Cougar XR7

Although it's no back-road bandit, the Cougar's torquy 5.0-liter V8 provides satisfying go-power and effortless high-speed cruising. In fact, the XR7 is more cruiser than hot rod. It's roomy and nicely appointed—just the thing for luxurious traveling with the occasional squirt of speed.

We have to say that the 4-speed

automatic isn't user-friendly for hurrying, however. Upshifts are abrupt, kickdown slow. The over-assisted power steering is extremely numb, providing no sense of where the front wheels are pointed, and three hard laps on the Streets of Willow produced unacceptable brake fade.

On the other hand, the Cougar's *(Please turn to page 89)*



FORD TAURUS SHO



ISUZU STYLUS RS



MERCEDES-BENZ 500E



MERCURY COUGAR V8

TEST RESULTS

STEERING TYPE/TURNS LOCK-TO-LOCK	TURNING CIRCLE (ft.)	WHEELS/ TIRES	BRAKE SYSTEM FRONT/REAR	FUEL ECONOMY (MPG EPA city/hwy.)		ACCELERATION		PASSING ¹	BRAKING	700-FT. ²	200-FT. ³	PM ⁴
				PM test	0-60 MPH (sec.)	1/4-MILE (sec. @ mph)	ACCELERATION 40-70 MPH (sec.)	60-0 MPH (ft.)	SLALOM MPH	SKIDPAD (lateral g)	SERVICEABILITY INDEX	
Power rack & pinion/3.5	36.1	15 x 6-in. alloy 205/60R15	4-wheel disc ABS 11.1-in. vented/10.4-in.	20/26 27.7	10.4 17.7 @ 79.1	8.7	161	53.0	.75	10		
Power rack & pinion/3.2	35.4	15 x 6-in. alloy 195/65VR15	4-wheel disc ABS 11.2-in. vented/9.9-in.	17/25 23.9	8.45 16.66 @ 84.7	7.6	164	56.3	.74	7		
Power rack & pinion/2.5	40.5	15 x 6-in. alloy 205/60VR15	4-wheel disc 10.2-in./11-in.	19/26 26.6	8.0 15.99 @ 87.2	5.3	205	58.3	.76	8.5		
Power rack & pinion/2.5	38.6	16 x 6-in. alloy 15/60R16	4-wheel disc ABS 10-in. vented/10-in. vented	18/26 26.9	8.15 16.21 @ 87.8	6.6	151	55.3	.75	7		
Power rack & pinion/2.8	34.2	15 x 6-in. alloy 205/50VR15	4-wheel disc 9.7-in. vented/10.1-in.	25/33 29.3	10.3 17.47 @ 77.1	9.0	170	56.4	.78	7.5		
Power recirc. ball/3.1	38.4	16 x 8-in. alloy 225/55ZR16	4-wheel disc ABS 11.8-in. vented/10.9-in. vented	14/17 20.8	7.1 15.75 @ 89.7	5.6	123	59.4	.81	8		
Power rack & pinion/2.8	37.5	15 x 6-in. steel 205/70R15	Disc/drum ABS 10.8-in./9.8-in.	20/27 22.3	10.7 18.04 @ 78.5	9.5	149	54.0	.74	7.5		
Power rack & pinion/NA	36.7	15 x 6-in. alloy 205/65VR15	4-wheel disc ABS 10.9-in. vented/10.5-in. vented	18/25 25.5	10.9 18.83 @ 76.9	9.1	149	53.5	.69	7		
Power rack & pinion/3.1	36.7	15 x 6.5-in. alloy 205/65VR15	4-wheel disc ABS 10.9-in. vented/10.1-in. vented	26/21 22.3	8.85 16.89 @ 84.4	6.9	150	53.7	.74	7.5		
Power rack & pinion/2.7	30.2	14 x 5.5-in. alloy 185/60R14	4-wheel disc 9.76-in. vented/9.13-in.	32/24 29.2	9.9 17.19 @ 79.9	7.8	174	53.2	.75	9.5		
Power rack & pinion/2.5	35.8	16 x 6-in. alloy 205/55R16	Disc/drum ABS 10.2-in. vented/7.87-in.	19/30 23.5	9.05 16.76 @ 76.8	7.6	142	58.8	.76	7.5		
Power rack & pinion/2.6	40.0	15 x 6.5-in. alloy 225/60R16	4-wheel disc 10.5-in. vented/10.1-in.	17/26 21.3	10.2 17.86 @ 80.0	10.4	148	55.4	.71	5.5		
Rack & pinion/3.6	30.2	14 x 5-in. steel 175/60R14	4-wheel disc 9.76-in./9.33-in.	28/35 38.0	10.0 17.78 @ 79.1	11.6	147	55.5	.75	8.5		
Power rack & pinion/3.0	36.7	15 x 6-in. alloy 205/65VR15	4-wheel disc ABS 15-in. vented/14-in.	19/25 27.8	9.1 16.82 @ 82.9	8.8	143	54.1	.72	7		



OLDSMOBILE ACHIEVA SCX



OLDSMOBILE CUTLASS SUPREME I-5



SUZUKI SWIFT GT



TOYOTA CAMRY SE



As Comfortable As Your And Just As Rugged.

***"Best-Built" claims based on an average of consumer-reported problems in surveys of all 1991 models designed and built in North America. Sales by Division. **Buckle up — together we can save lives.** Optional captain's chairs and rear bench seat shown.

The 1992

Favorite Jeans

Is this really the interior of a pickup truck? You bet it is. But you'll only find it in the 1992 full-size Ford pickup.

You'll fit into it as easily as your favorite jeans. Not just because it's so comfortable, but for everything else it has to offer.

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

There's a redesigned instrument

panel that's more functional and user friendly, a more efficient console and easy-to-reach available power controls.

It's the only full-size pickup with available power lumbar seats, and the SuperCab has the security of three-point outer safety belts in the available rear bench seat.

And the rugged Ford truck is not only America's best-built full-size pickup,* but it's been the best-selling pickup for fifteen straight years.

So what are you waiting for? Isn't it time you tried one on for size.



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



Full-Size Ford Pickup.

BLOWN

Supercharged, 4000-hp drag boats are faster than ever. Equipped with indestructible Kevlar driver's capsules, they're safer, too.

BY JOHN WOOLDRIDGE, Contributing Editor; PM Photos by Rich Cox



● As the driver in a Top Fuel Hydroplane drag boat, you sit virtually level with the water and look down parallel rows of buoys that seem to stretch into infinity. This particular quarter-mile track is laid out on Puddingstone Lake, near Los Angeles, California. A starter tells you to get into position, and you pull hand over hand on an overhead rope until you're centered in the lane. Selecting the right starting position is crucial, because steering is extremely limited.

Yellow starting lights begin flashing on the countdown tower about 125 ft. away. With a flip of your hand, you close the air lock on your face mask. For the next 20 minutes, you're breathing compressed air. You crank up the 4000-hp Funny Car engine. The scrupulously massaged 565-cu.-in. V8 sucks air and nitro-methane fuel into the supercharger and roars to life. You pull down the overhead canopy, and latch it from the inside. All is ready for blastoff.

The yellow lights stop blinking, and a large digital clock starts to count down from nine. When it reaches

six, you engage the pneumatic clutch and mash the accelerator foot pedal. You've timed it just right and hit the starting line as the clock flashes zero and the lights turn green. G-forces slam you back into the seat and tear at your grip on the steering yoke. The tach rockets to 7000 rpm. You nail the shifter and grab high gear. The boost in power kicks you firmly in the pants.

Now you concentrate on the boat's running attitude. It seems to be riding on rails, straight and flat. In less than 6 seconds, you cross the finish line at more than 200 mph. Your speed and time are locked in by an electronic trap. Quickly running out of space on the track, you pop the braking chutes. The run is over. It's short and, oh, so sweet. Thrills at warp speed are brief, but they don't get much better.

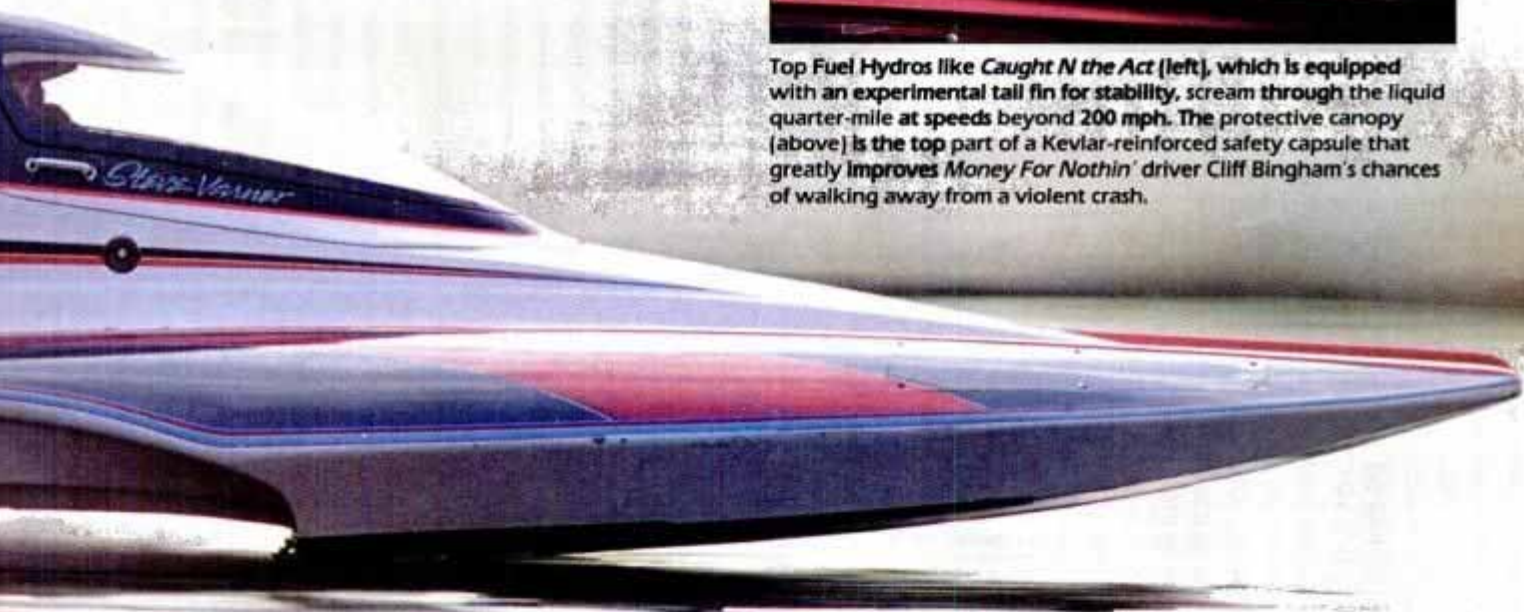
Smoke on the water

This is drag-boat racing the International Hot Boat Association (IHBA) way—high excitement, high speed and safe. The IHBA, which is based in Ontario, Califor-

AWAY!



Top Fuel Hydros like *Caught N the Act* (left), which is equipped with an experimental tail fin for stability, scream through the liquid quarter-mile at speeds beyond 200 mph. The protective canopy (above) is the top part of a Kevlar-reinforced safety capsule that greatly improves Money For Nothin' driver Cliff Bingham's chances of walking away from a violent crash.



nia, was started at a time when racing was done in open-cockpit boats without safety harnesses. Driver's accepted the risks and fought hard against change, but eventually the introduction of powerful, exotic engines pushed the boats beyond their limits of stability. Drivers began getting killed at an alarming rate.

The crisis point came in 1986 when eight fatalities occurred during a single racing season. This was a wakeup call that couldn't be ignored. With the future of the sport at stake, the IHBA worked to develop safety-capsule technology to protect drivers during crashes that completely destroyed the rest of the boat. Today, with Kevlar-reinforced safety capsules mandatory in the fastest classes, drag racing is safer than ever. And with the introduction of NHRA Funny-Car-inspired engines, it's faster and more exciting, too.

Drag boats are separated by hull designs, fuels and engine modifications into 15 racing classes by the IHBA. The fastest of these classes uses 3-point hydroplane hulls, which are recognizable by their distinctive

twin-sonson, pickle-fork bows. At WOT speeds, the boats touch the water at three small points—two on the aft end of the forward sponsons and one at the bottom of the 2-bladed stainless-steel prop. Virtually nothing else touches to create drag.

Top Fuel Hydros like Ralph Padilla's 208-mph *QuarterFlash* burn nitro-methane in supercharged V8 engines. After two back-to-back, second-place seasons, Padilla is working furiously to push his boat into the elite "two-teens" club—between 210 to 220 mph.

To achieve this goal, *QuarterFlash* is equipped with a KB Chrysler Hemi aluminum block that displaces 565 cu. in. At 7200 rpm, it produces upward of 3500 hp. Key items in its high-performance parts list include: Enderle injectors in the scoop or "hat," a Mooneyham blower, a multidisc AFT 3-speed clutch and a Casale V-drive with a 2.37:1 drive ratio.

With speeds approaching 190 mph, Blown Alcohol Hydros are the next fastest class of drag boat. These boats are also equipped with 565cid engines, but in-

BLOWN AWAY!



The hull of *QuarterFlash* (far left) features the classic twin-sponson, 3-point-hydro design. Beneath the canopy (left), is a tight but well laid-out cockpit. Note the safety restraints on the supercharger on the boat's massive tower of power (below). Top Fuel Hydro *Spirit of America* (opposite page) attacking a sub-6-second run.



stead of a nitro mixture, they burn methanol. This year's hottest Blown Alcohol boat is *Money For Nothin'*, belonging to Cliff Bingham. The heart of Bingham's powerplant is an Aries aluminum block outfitted with Enderle injectors, a Mooneyham supercharger, a 2-speed Lenco transmission and a Casale V-drive set for either a 1.92:1 or 2.13:1 ratio, depending on conditions. The engine cranks out 2400 hp at 8300 rpm.

Interestingly, *Money For Nothin'*, like other alcohol-burning boats, runs its engine without a cooling system. It can get away without one because of the comparatively cool running temp of methanol. All other classes use water-cooled engines.

Fast flats

Flatbottom boats are the next fastest IHBA class. These hulls feature a wide planing surface and a

The Safety Capsule



PH ILLUSTRATION BY GEORGE BETHACK

POLYCARBONATE WINDSCREEN

GELCOAT

UNIDIRECTIONAL FIBERGLASS

DIVINYCELL FOAM CORE

KEVLAR

FIBERGLASS MAT

cavitation plate astern that can adjust boat trim by means of a foot pedal. This setup not only results in more wetted hull surface and less speed than 3-point hydros, but also requires greater driving skill, because the added drag and trim control present increased variables.

Last year's Blown Alcohol Flat champion, Rod Corning, beat all comers with speeds above 150 mph in *Wasted Nights*, which burns methanol in a ubiquitous 565cid V8 engine. At the heart of Corning's engine is a Rodak aluminum block dressed up with Enderle injectors and a Mooneyham supercharger and intake manifold. It cranks out 1600 hp at 8500 rpm. Power is delivered through a pneumatically engaged dog clutch and a Casale V-drive that's set at a 1:1 ratio. Corning was

the first in his class to use a side-mounted safety capsule, which is the traditional layout for flatbottom boats outside drag racing.

Funny Cars and computers

At this elite level of drag-boat racing, engines of choice among the top competitors are virtually identical to those used in NHRA Funny Cars. Each is cared for by professional crews who pull them apart after every pass to make a visual inspection of the high-performance components—Crane and Isky Racing cams, Hooker headers, Arias forged pistons, Manley rods and Dart heads. Weight is kept to a minimum by using aluminum blocks and heads, as well as magnesium valve covers, intake manifolds,



Wasted Nights, a Blown Alcohol Flatbottom, offsets the driver to counterbalance engine torque. Safety capsule (above right) has protected drivers in crashes at 220 mph.



blower housings and injectors.

On-board computers are also standard items among serious competitors. These electronic units monitor exhaust temperature for each cylinder, oil pressure, supercharger boost in the manifold and fuel pressure. Print-outs chart this data against rpm and time curves. Pit crews then use it to help dial-in the engine and prop for the next run. IHBA rules prohibit computer-assisted engine adjustment after a boat leaves the pits.

Like all high-performance boats, dragsters use hand-layup construction methods that employ resin, gel-coat and fiberglass. A bare Blown Alcohol Hydro hull will weigh in at about 400 pounds. A Top Fuel Hydro will tip the scales around 700 pounds. Completely outfitted with an engine, drive system, safety capsule, driver and fuel, a Blown Alcohol Hydro will weigh approximately 2100 pounds.

Forming the backbone of these speed machines are two massive hardwood stringers that run down the center axis. These stringers are cross-braced and heavily fiberglassed in place. Motor-mount plates and brackets are bolted directly to the stringers.

The safety capsule

Also attached to the stringers is the safety capsule, which is built separately from the hull and attached by means of four 1/4-in. stainless-steel bolts. The bolts are designed to break free in a violent crash. The outer shell is made of layers of vinylester resin, Kevlar and fiberglass surrounding a Divinycell foam core. The basic component of the hinged canopy is a polycarbonate windshield. Some of the earliest capsules were essentially cut-down F-15 canopies, but most are custom-built now.

Denver Mullins, a racer and custom bike builder from San Bernardino, California, builds many of the safety capsules for the Pro Class. Mullins is a drag racer himself, and recently put his capsule to the ultimate test. He crashed at 188 mph and walked away with only minor injuries.

Inside the capsule, built-in flotation adds insulation, stiffness and positive buoyancy. A framework of chrome-moly steel tubing adds strength and provides solid mounting points for the canopy, the steering column, engine controls and the racing seat. Interior latches are designed to provide a watertight seal and to enable rescue teams to open it from the outside in case the driver is knocked unconscious during a crash.

A bob-up float is attached for help in locating a submerged capsule. Early designs lacked sufficient flotation

to keep capsules near the surface, but current standards demand that capsules have the ability to float on the surface with a driver aboard. Finally, each capsule carries a 20-minute supply of compressed air in a steel bottle strapped rigidly to the floor.

Good drivers can feel exactly when a boat starts to get out of shape under acceleration. Most will abort and come back to race another day. A clean run is a thing of beauty to witness. The boat comes through the starting gate in a perfect attack attitude, raising a rooster tail that increasingly climbs skyward. By the midpart of the course, the unmuffled thunder of the engine reaches the spectators and assaults their ears until shutdown just beyond the finish line. Then, as the smell of nitro-methane wafts across the water, the crowd goes wild.

PM



Clockwise from top right: Twin Dietz parachutes and a 4-plus-gallon fuel tank are features on the Blown Alcohol Hydro *Money For Nothin'*; an anodized housing guards the split shaft of the Casale V-drive; and an Enderle fuel-injector hat and Mooneyham supercharger sit atop an aluminum Aries-built intake manifold, heads and block.

HOW TO RESTORE

Part 1: Getting Started

First of a multipart series that takes you step-by-step through an old-car restoration.

BY RICH TAYLOR, Contributing Editor; PM Photos by Jean Constantine

● POPULAR MECHANICS is restoring a 1967 Camaro convertible in honor of the Camaro's 25th anniversary this year. But virtually everything we'll show you about this project is applicable to restoring any old car from a Model T to a Lamborghini. And every restoration project provides the same deep-down satisfaction of bringing a dying car back to life. There's no thrill like it.

Before you start spinning wrenches, your first step should be a subscription to *Hemmings Motor News*, P.O. Box 1108, Bennington, VT 05201. In *Hemmings*, you'll find not only cars for sale, but advertisements for parts, tools, suppliers, books and the specific marque club for your car. These are all things that you're going to need before you've finished your project.

You're also going to need a place not only big enough for the car but for you to work around it. With a ground-up restoration like our Camaro, we easily filled another bay just storing old parts coming off the car and new parts waiting to go on. Thousands of people have restored old cars under a tree in the backyard, but we'd say the minimum practical space is really an empty 2-car garage.

You'll also need a minimum amount of automotive knowledge. Happily, old cars are much simpler to work on than today's computer-controlled machines. As you work on your restoration you'll also learn a lot, which is half the reason to do a project like this in the first place.

Any old car can be divided into sub-assemblies. Don't think about restoring a whole car—that's far too intimidating. Instead, set yourself an attainable goal: "Today, I'll sand, prime and paint the wheels." Once the wheel subassembly is restored, set another goal for tomorrow. If you restore enough subassemblies, pretty soon you've completed the whole car.



Cheap replacement fender was part of a 10-year-old "restoration"—note the poor fit.



There's no way to repair this front fender, the only alternative is to replace it.

How long will it take? Our Camaro is a pretty complicated project, but we're also professional automobile restorers. We'll have between 1200 and 1500 man-hours in this car before it's finished. Figure you'll spend at least 1000 hours on almost any ground-up old-car restoration—and probably a lot more. That's why the car you se-

lect to restore is so important since you'll be spending a lot of quality time together.

We found our Camaro convertible through the local want-ad press. It turns out to be a very rare Camaro, serial No. 4524, built within the first few weeks of production in August 1966. For the purposes of this project,

AN OLD CAR



Stock door panels were cracked from age and had been cut up for speakers.



Luckily, inexpensive reupholstery kits and replacement seat foam are available.



Incorrect trim and corroded emblems are typical of what you'll find on any older car.



Rust-through in doorjamb is typical of older unibody cars.

we wanted a car with considerable rustout, so we could show you what is possible to accomplish. Unless you truly enjoy the challenge of difficult bodywork, however, we'd recommend you look for a car with a chassis and/or unibody as rustfree as possible. Anyone can bolt on a new front fender—replacing the entire rear uni-

body is a little more complicated.

We knew going in that our restoration could never be pure since our car carried a later 307 V8 instead of the proper 327. We had already decided that we wanted to try

There are dozens of publications with old-car classifieds, from *Car & Parts* to *The Sunday New York Times*.

Chevrolet's new HO 350 "Bowtie" replacement engine fitted with a modern 4-speed overdrive TH700 transmission. The increased performance mandated optional front disc brakes instead of the drum brakes that came on our car.

Since it could never be totally authentic, we decided to upgrade our Camaro with both the optional SS and RS packages, and change the car to red with a white interior instead of white with red.

Is this pukka? Does it matter? Our car will be a totally stock 1967 Camaro in appearance inside and out, but with 1992 levels of performance. It's not a hot rod, but rather the perfect marriage between authentic looks and improved performance. Would we make these changes in a car with the original matching-number engine? Never. But our car would not have survived at all without us, so we say: "Hey, let's build a really neat Camaro we'd be proud to drive."

Years ago, I started to replace a rotten board in the porch of my Victorian house. Behind that board was another rotten board. And another rotten board. By the time I got done, I'd replaced the entire porch. This Camaro is a lot like that old porch. I drove it home 200 miles with no trouble at all. But once we started to take it apart, each piece was rustier than the piece we'd just taken off. By the time we were done, we had stripped our car till all that was left were the firewall, the rocker panels and the lightweight structure that supports the trunklid.

This is some pretty scary stuff. My friend Murph Mayberry came by. He's the legendary auto racing me-



HOW TO RESTORE AN OLD CAR

chanic who built, among many other things, Mark Donohue's Trans-Am Camaros. "I've never seen a car so far apart," said Murph, and left shaking his head. But we had confidence. Why? Because we were incredibly systematic and we always thought in terms of attainable sub-assemblies, not of the vastness of the whole project.

Step One: We put down a huge plastic tarp that covered the whole shop floor. This kept us from losing small parts, kept the freshly painted floor



The rusty unibody must be cut apart very carefully, like peeling an onion.



Air-powered shear makes a clean cut as to the jagged edge left by the air hammer.

much cleaner and made it easier to sweep up each night, too.

Step Two: We recorded everything. As each part was unbolted, the part itself was labeled and then placed in our empty storage bay in the approximate position it occupied on the car.

Each set of bolts was put into a clear plastic ziplock bag with an identifying label, then all the bags were safely stored in a bin in the order in which they'd come off.

Step Three: It takes surprisingly little time and surprisingly few tools to disassemble a car. It took us approximately 75 man-hours to carefully reduce a working Camaro to a pile of parts, using primarily hand tools. We also used a lot of penetrating oil.

Step Four: We started by unbolting the wheels, doors, bumpers, hood,

A Clean, Well-Lighted Place



The ideal workshop—neat, bright, spacious, not out of reach of an enthusiastic amateur.

● Three tools are indispensable for a restoration shop: a big air compressor, a lift and a pushbroom. A 5-hp compressor with an 80-gallon tank is really the minimum for running a sandblaster, bead blast cabinet or air tools. Once you achieve that air superiority, you'll wonder how you ever sputtered along without it.

The same goes for a lift. A chassis lift like ours costs surprisingly little, and will save not

only hours of time, but quite literally your back. We move our Camaro up and down a dozen times a day, adjusting the part we're working on to a comfortable height. I promise you, within a week you'll never want to see another jackstand.

The pushbroom is self-explanatory. Our shop gets swept and vacuumed at least once a day, more often if there's dirty work going on. Other recommendations for your shop: bright and easily cleaned gloss white enamel walls, epoxy-painted floor and lots of light. We use not only overhead fluorescents, but portable photofloods on tripods to get light where we need it. Of course, you must have 220-volt, 50-amp service for the air compressor, lift and welder.

Don Breslauer, the master welder who did much of the bodywork on our Camaro, used to work for Jaguar racer Bob Tullius. Tullius, like most mechanics, is an absolute nut about cleanliness. In Tullius' shop, says Don, they even had a word for making things cleaner than clean, neater than neat, more perfect than perfect. Everything had to be "punkin." And to make something punkin was to "punkinize." That's the motto of our shop, too. Punkinize. —R.C.T.



Our 5-hp, 80-gallon compressor and 3/4-hp buffer get used every day.



Handy spot blaster removes a quarter-size patch of paint at a time, perfect for revealing hidden rust and cleaning small areas. Remove spot welds by carefully drilling with this special bit.

trunklid, taillights, grille and valence, front fenders, radiator, inner fenders and other small parts. The engine, transmission, driveshaft and rear axle came out with surprisingly little work, as most are held in with only a few large bolts. The most difficult items to remove were the rear springs and the front subframe.

The rear spring perches were bolt-

ed into blind nuts that had long since rusted solid, so we ended up having to cut away part of the floor to get them out. The four huge bolts that hold the front subframe to the unibody were equally stubborn. After repeated soaking in penetrating oil, it took two men with a 4-ft. extension handle on the wrench to pop them loose. Even our biggest impact wrench wouldn't budge them at all.

Step Five: Then we tackled the interior, carefully removing, labeling and saving the top frame, seats, console, carpets and all trimpieces including each and every screw. Replacement interior trim is notoriously difficult to find, even for a popular car like the Camaro.

Compared to working under the car with a 3/4-in. ratchet and a long extension, interior pieces require extreme delicacy and care.

Step Six: Once every piece that could be unbolted had been, we started carefully slicing away at the unibody. The rear fenders were the first



Air shear makes a neat job of sectioning floor pan at seat tubs.

to go, chopped off with an air hammer, metal shears and a rotary cutoff tool. This is dirty, potentially dangerous work. You must wear goggles, hearing protectors and heavy gloves. Expect to come out absolutely filthy at the end of the day.

We thought of the unibody as an onion—we tried to peel away each layer without damaging the next one down. Before cutting away, we'd use our sandblaster and spot blaster to look for solid metal. As it turned out, there was virtually nothing solid left in Camaro No. 4524. We peeled away until we reached the core. If we'd gone one step further, there would have been no car to restore.

As it was, we left the barest bit of a skeleton from which we could position our replacement parts as we welded them on and brought our Camaro back from the grave. And that's where we'll leave it this month—we've done the easy part, taking our Camaro as far apart as it will go. Now all we have to do is put it back together! **FM**

SOURCE LIST

The following is a list of some of the suppliers for this project:

- Auto Body Specialties, P.O. Box 455, Middlefield, CT 06455; (203) 346-4969 (Body parts)
- Campbell-Hausfeld, 100 Production Dr., Harrison, OH 45030; (513) 367-3130 (Air compressor and air tools)
- Chevrolet Division, General Motors Corp., 30007 Van Dyke Ave., Warren, MI 48090; (313) 492-8855 (Engine and transmission)
- Coker Tire, 1317 Chestnut St., Chattanooga, TN 37402; (800) 251-6336 (Reproduction old-style tires)
- Daytona Mig, 1821 Holsonback Dr., Daytona Beach, FL 32117; (800) 331-9353 (Mig welder)
- D&R Classic Automotive, 31 W. 208 Diehl Rd., Suite 107, Naperville, IL 60563; (708) 369-2030 (Camaro restoration parts)
- DTS, 22250 Scheman Rd., Warren, MI 48089; (800) 521-0628 (Rear axle ring and pinion)
- Eagle Equipment Co., 23 Wetherill Place, Plainville, MA 02762; (800) 535-0016 (Lift)
- The Eastwood Co., 580 Lancaster Ave., Frazer, PA 19355; (800) 345-1178 (Specialized restoration tools)
- Gearbox Grannies, 3944 Indian Ripple Rd., Dayton, OH 45440; (513) 429-5642 (Even more specialized restoration tools)
- General Motors Service Parts Operations, 6060 W. Bristol Rd., Flint, MI 48554; (313) 635-6980 (Body, suspension and trim parts)
- Goodyear Tire and Rubber Co., P.O. Box 9125, Akron, OH 44305; (216) 796-2490 (Contemporary tires)
- Kanter Auto Products, 76 Monroe St., Boonton, NJ 07005; (800) 526-1096 (Springs, shock absorbers)
- Minisport, Jackson Hill Rd., Sharon, CT 06069; (203) 364-0311 (Complete auto restorations)
- OEM Glass, P.O. Box 362, Route 9 East, Bloomington, IL 61702; (800) 283-2122 (Auto glass)
- PST, P.O. Box 396, Montville, NJ 07045; (800) 247-2288 (Suspension bushings, antisway bars)
- Sharon Auto Body, Route 343, Sharon, CT 06069; (203) 364-0128 (Finish bodywork and painting)
- TIP Sandblast Equipment, P.O. Box 649, Canfield, OH 44406; (800) 321-9260 (Sandblaster, bead blast cabinet, paint sprayer)
- Wurth USA, 93 Grant St., Ramsey, NJ 07446; (800) 526-5228 (Fasteners, i.e. nuts and bolts)



With front bodywork unbolted, engine/transmission removal is a snap using an engine hoist. High-powered sandblaster cleans off rust and old paint like magic. Almost as far down as a car can go—all that's holding it together are the firewall and rocker boxes. Rear frame rails and valence hold position until new pieces are welded in.





PM PHOTO BY G. PHOTO

POSSIBLE DREAMS

The automobile revolutionized America's quest for record-breaking speed.

BY MARY SEELHORST

● A brilliant blue bullet hurtles from a distant horizon, leaping off the crowded newsstand and into your hands. The bullet is an airplane. The horizon is painted. The magazine in your hands is **POPULAR MECHANICS**.

Newsstand browsers beware. Boats, planes, trains, cars, motorcycles and indescribable oddities speeding across the colorful covers of **POPULAR MECHANICS** have intrigued enthusiasts for the past 90 years.

Today, some of PM's most characteristic covers race across a wall of Henry Ford Museum & Greenfield Village in Dearborn, Michigan. From "Fastest Gasoline Launch In Ame-

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

rica" of 1902 to "World's Fastest Plane" of 1991, the PM covers form a sweeping backdrop to "Man's Quest For Speed," a section of the museum's exhibit "Possible Dreams: **POPULAR MECHANICS** and America's Enthusiasm for Technology."

Before them lies a sampling of the stuff of speed featured in PM over the past 90 years. And all around are the PM illustrations and commentary that have inspired kids and adults, professionals and amateurs to pursue the dream of speed in their own ways.

Andrew Riker's way was electric. By the time he entered the 1901 auto race described in PM's premier issue, Riker had already built up and sold a thriving business in electric vehicles. He went on to become the first president of the Society for Automobile

Engineers (now known as the Society of Automotive Engineers), eventually donating his early electric racer to Henry Ford Museum.

Now a part of the "Possible Dreams" exhibit, Riker's low-rigged racing frame had covered the 1-mile course in 63 seconds—an astonishing 57.1 miles per hour. A photo accompanying PM's story showed Mr. Riker and his mechanic crouched low over the controls, straddling the racer's 900 pounds of lead-zinc batteries. It was the magazine's first photo of an automobile.

Breaking speed records became increasingly important to manufacturers and enthusiasts alike. Soon PM was covering myriad attempts to break records in every type of vehicle imaginable under every possible condition. The exhibit features a short film covering two classics of beat-the-clock competition—a 1956 NASCAR event at Daytona Beach, and Mickey Thompson's 1960 attempt at the land speed record across the famous salt flats of Bonneville in his "made-by-Mickey" Challenger.

The annual Indianapolis 500 is probably America's favorite speed contest and unquestionably **POPULAR MECHANICS**' favorite. The "Two Faces Of Indy" as described by PM—"the machines and the merrymakers"—are here. The machines materi-

(Please turn to page 107)



Bob Ottenbacher: Ford Employee

"I build the engine that broke the tradition."



Traditionally, overhead cam V-8 engines have been found only in expensive imported cars. Ford Motor Company changed all that. Our 4.6 liter overhead cam V-8 captures the brilliant performance and the exhilarating power that has long been out of reach, and puts it under the hood of a Ford, Lincoln or Mercury.



Ford • Lincoln • Mercury • Ford Trucks

QUALITY IS JOB 1. IT'S WORKING.SM

Buckle up—Together we can save lives.

Always insist on genuine Ford Motor Company collision repair parts.

COVER STORY

KITPLANES GROW UP

Kitplanes are a technological leap beyond anything you can buy from a factory.

BY WILLIAM GARVEY
PM Photo by Rich Cox



KITFOX SPEEDSTER



LANCAIR IV



KIS



BERKUT

● What with Gee Bee racers, Desert Storm air-war vets and a salvaged Lockheed Constellation on display, and an invasion force of World War II fighters, trainers and transports thundering overhead, it was easy to get distracted at last summer's Experimental Aircraft Association Fly-In at Oshkosh, Wisconsin.

But then you'd pass under the main arch and onto the grass infield, and they'd hit you right in the eye. For there, at stage center of the 15,000 airplane gaggle were the latest offerings of homebuilt airplanes, the machines upon which the EAA was founded and the reason for which the fly-in was begun. This display of aeronautical ingenuity and precision craftsmanship never disappoints.

The variety of amateur-built flying machines seems to have grown exponentially in recent years, especially since composite construction came of age. Some of the standouts from last year's gathering follow, and there's every indication that this summer's crop will be even better.

Seawind

The go-anywhere-and-stay-awhile kitplane, S.N.A., Inc.'s Seawind has strong appeal for those who like to get away from it all—and take some soulmates along for the ride. This big amphibian seats four in a cruiser-size cabin, 4 ft. wide × 8½ ft. long. When fitted with a 300-hp Lycoming, the Seawind will sail off from the concrete straight for your favorite backwoods fishing hole at a landplane-like 191 mph.

And once you put down, just pop the huge canopy and unroll your sleeping bags—a camping configuration can

easily accommodate two in back.

Since it is constructed almost entirely of composites, the Seawind is particularly resistant to corrosion—the principal nemesis of all watercraft. And in the event that the hull is damaged, there's enough foam and trapped air in the plane's design to keep it floating, with the engine high and dry.

Seawind comes in eight subkits that total \$39,900. Add an overhauled engine, new prop, avionics, wiring and upholstery, and you'll have \$65,000-plus invested in your land/sea project. (The only comparable production amphib costs six times as much.) Completion time is approximately 1000 hours, plus 100 to 300 hours for sanding and finishing.

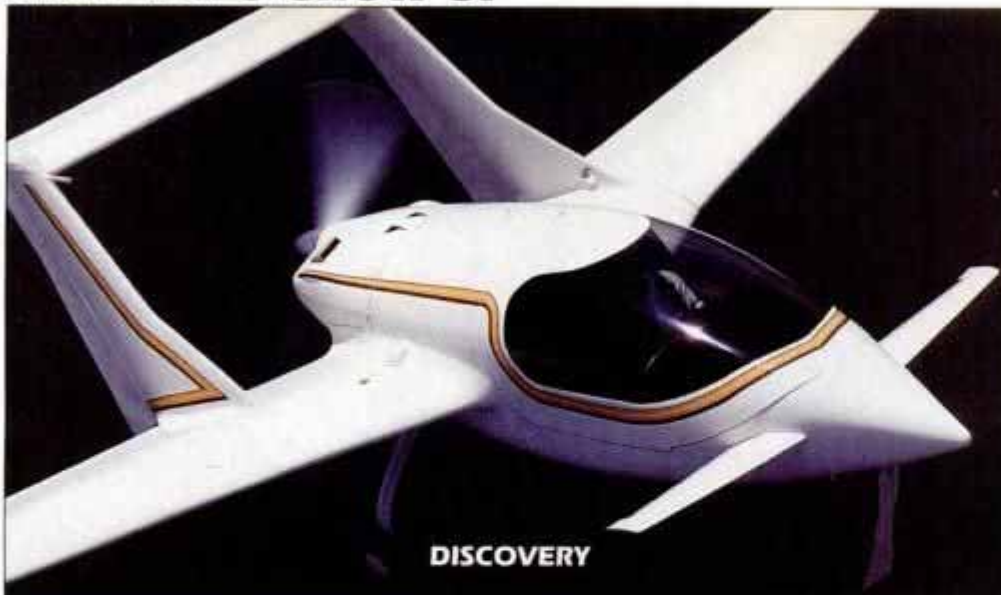
For more information, contact S.N.A., Inc., P.O. Box 607, Kimberton, PA 19442-0607; (215) 983-3377; Fax (215) 933-3335.

Exec 90

The hands-down champion of the vertical-lift set, Rotorway International's Exec 90 may be one of the fastest homebuilts extant as well—to build, that is. This, the latest iteration of the popular 2-place chopper, boasts a score of improvements, like eyebrow windows, larger rotorshaft and bearings, center console and dual electronic ignition. Plus now a "quick kit" is available which should halve the typical 500-to-600-hour construction time.

To hasten fabrication, Rotorway does all the welding, prefinishes the tail boom and blades, and provides a complete wiring package. This extra service adds \$6000 to the Exec 90's \$45,000 price. Keep in mind that base price buys a complete aircraft, from the skids and seats

KITPLANES GROW UP



PROGRESS AERO PHOTO

right through drivetrain, flight controls and Rotorway-built 162-cu.-in. water-and-oil-cooled powerplant—the works. All you need to add is the avionics, paint and pilot.

As for performance, the kit craft can hold its own with the store-bought competition: Cruise speed is 95 mph, rate of climb is 1000 fpm, and it tops out at 10,000 ft. With 17 gallons of fuel on-board, it can stay airborne for up to 2 hours.

Rotorway has thought the building process all the way through and delivers the goods in shrink-wrapped parcels along with step-by-step manuals packed with 750 photos. You also get maintenance, powerplant and flight manuals as well. And if you don't know how to do it vertically, Rotorway conducts a flight school for its buyers.

For further information, contact Rotorway International, 300 S. 25th Ave., Phoenix, AZ 85009; (602) 278-8899; Fax (602) 278-7657.

Kitfox IV

Even though it has shipped over 1800 kits in the past few years, Denney Aircraft has a new offering, the Kitfox IV. It delivers such improved performance over its predecessors that

it may prove to be the most popular of the series. The design goal was to retain the Kitfox's STOL characteristics while upping cruise speed. Thanks to a new laminar-flow airfoil and flaperon, Denney has been able to do even better. Traveling speed is now a respectable 110 mph (an impressive 25% increase), while stall has actually been lowered a couple of notches to a butterfly-like 22 mph.

The spread between these figures becomes even more remarkable when the recently announced Speedster option is added. Shortening the wings and adding wheel pants and other fairings brings cruise speed to 125 mph—without increasing stall speed.

Classic in design and construction—a tandem-seat, high-wing taildragger made of steel tubing wrapped in fabric—the Kitfox assembles in just 500 to 600 hours.

Price is surely a part of the Kitfox appeal as well—a full kit goes for \$9950 (\$11,945 for the Speedster). Add \$7190 to that for a 2-cylinder Rotax 582LC, or \$12,545 for the 4-cylinder, 80-hp Rotax 912. After that, it's a couple of gauges, compass and radio and you're flying in a new machine for as little as \$20,000.

For more information, contact

Denney Aircraft Co., Nampa Airport, 100 N. Kings Rd., Nampa, ID 83687; (208) 466-1711; Fax (208) 466-7194.

Discovery

One of the most noteworthy new airplanes to appear at Oshkosh last summer, Discovery was designed and built by William Shaw, of Pebble Beach, California. This side-by-side, all-composite flyer is a 3-airfoil airplane, with canard, main wings and stabilizer. Particularly distinctive were the airplane's fins joined at the top by the stabilizer and elevator, much like the Rockwell OV-10 Bronco used by the U.S. Marine Corps. The pusher prop,

powered by a 180-hp Lycoming O-360, turns within the upside-down U formed by the empennage. The nose gear retracts, but the mains are fixed.

The design delivers speed, stability and visibility. Shaw reports cruise speeds in excess of 180 mph, while stall is listed at 70 mph. And since the canard stalls first, lowering the aircraft's nose when it does, the main wings never quit flying. Visibility throughout is spectacular, thanks to the 190° wraparound windscreen and the utterly clear forward view, because the prop's in back.

Progress Aero estimates build time at between 900 and 1000 hours. Price is \$17,800.

For more information, contact Progress Aero R&D, Inc., 813 Airport Rd.; Monterey, CA 93940; (408) 625-0665.

KIS

Richard Trickel thought companies were addressing the high and low performance ends of the kit-built market just fine but had left a wide gap in the middle. So, five years ago he set out to correct that oversight. He flew his answer to Oshkosh in July of last year. It's a side-by-side low-wing airplane of conventional design, simple construction and reasonable performance. He calls his tricycle-gear creation KIS, an acronym for Keep It Simple. (He left off the second S, traditionally reserved for "Stupid," because: "We didn't want to offend anybody.")

Since Trickel runs a company that produces composites for outfits like Lancair and Experimental Aviation (Berkut), it comes as no surprise that KIS is a composite airplane as well. But Trickel says ease of construction was as important



SNA PHOTO

an element in its design as performance.

"We've tried to make it as easy to reproduce as possible," Trickle says. "We use a lot of premolded ribs and spars. There are some minor tape lay-ups to be done, but we've tried to keep that to a minimum. And we've kept the systems simple to build."

The prototype, which first flew in April of last year, is fitted with an 80-hp Limbach L2000. It delivers a 135-mph cruise speed (150 mph tops) and stops flying at 55 mph. Useful load is 520 pounds. The aircraft can also accept other engines, such as the 100-hp Continental O-200 or 108-hp Lycoming O-235, raising cruise speed to 150 mph and 165 mph, respectively.

A simple KIS sells for \$15,500—less prop, engine and upholstery. All inclusive, a VFR machine will go for \$24,000 to \$35,000 and take about 800 hours to build.

For more information, contact Tri-R Technologies, 1114 E. 5th St., Oxnard, CA 93030; (805) 385-3680; Fax (805) 483-8366.

S-11 Pursuit

One of the most unusual kitplanes to come along in years appeared only in photos at Oshkosh. An accident following an engine failure required design modification and a rebuild of the prototype, and it wasn't ready in time for the show. But a new version has been flying since January, and if it makes it to the show this year, it's going to get noticed.

Reminiscent of the experimental lifting bodies NASA flew some decades back, the S-11 comprises a blended wing design to get more of the airplane flying than just the airfoils. By spreading the lifting "wetted area" across an extensive amount of the fuselage and thus reducing the stress on any one area, the aircraft could be made lighter, have a more voluminous structure and provide a wider envelope of performance than most others in its class.

Fitted with an 80-hp Rotax 912, the S-11 has an empty weight of just 575 pounds and a useful load of 500 pounds. It can take off in 300 ft., climb out at 1000 ft. per minute, cruise at 140 mph and stall at 65. As we go to press, the new prototype is still undergoing tweaks that the manufacturer believes should wring considerably better performance out of the blended wing design.

Despite its light weight, the



RANS S-11 PURSUIT

RANS PHOTO

airplane is hardly weak. In fact, the S-11 will be fully aerobatic, stressed for 9 positive and negative g's.

The S-11 airframe can accommodate both single or side-by-side twin seats, but RANS expects to offer the single-seater first. All models are comprised of a welded chromemoly superstructure, with some aluminum ribs and spars, and covered with a fiberglass shell. Parts are pre-painted and prepunched and the plane assembles quickly—RANS estimates a builder should be flying in 400 hours. Cost for the kit, which should enter production in about six months, is expected to come in at a little more than \$20,000.

For more information, contact RANS, 4600 Hwy. 183 Alternate, Hays, KS 67601; (913) 625-6346; Fax (913) 625-2795.

Berkut

A kind of LongEze on growth hormones, the prototype Berkut arrived at Oshkosh just days after its maiden flight at Camarillo Airport in California. Designed to provide more performance and room than the first generation of canard/pushers, Berkut does that precisely.

Powered by a 205-hp Lycoming IO-360, the 1-ton Berkut (nearly half of that is useful load) will carry two adults and 11 cu. ft. of baggage cross-country at 240 mph, and it will carry them far—some 1400 miles on the 53 gallons of fuel stored aboard. Design-

er Dave Ronneberg stresses that these performance figures are conservative.

The cockpits in this 17.6-ft.-long machine are wide and tall, and each is fitted with a separate canopy, F-4 Phantom style. The tricycle gear is fully retractable.

Comprised of a core of balsa or divinycell foam, sandwiched between three layers of fiberglass, plus carbon-fiber spar caps and wing skins, the Berkut is built tough. In a step typical of the care Experimental Aviation appears to have lavished on the plane's development, the first seven kits are being built by their owners at the factory, so that hidden glitches can be ironed out before full-scale production begins.

The kit is expected to enter production within three to six months after this year's Oshkosh Fly-In, which begins July 31. Expect to pay \$22,000 to \$25,000 for the kit alone, and to spend a total of \$42,000 or so by the time your project's complete.

For more information, contact Experimental Aviation, 3021 Airport Ave., Hangar 109, Santa Monica, CA 90405; (213) 397-0803; Fax (213) 391-8492.

Lancair IV

No matter whether its medium is earth, sea or sky, if it's a going machine, going faster gets the gold. And in kitplanes, the glory these days goes to the Lancair IV, the breathtaking answer to the question: "How ya gonna beat the (2-place) Lancair?"



ROTORWAY EXEC 90

ROTORWAY INTERNATIONAL PHOTO

KITPLANES GROW UP



BERKUT

PHOTO BY MARK D. BENZER



BERKUT

PHOTO BY RICH COX

The IV has a combination of lines, capacity and capability that's unmatched by any other kit or production airplane.

Four numbers tell the story: 350 hp, four seats, 342-mph cruise, 1450-mile range. Some toy, huh?

But there are other numbers behind the IV's story. Like a 2000-to-2500-hour build time, a \$44,900 kit price and an all-up-and-running IFR-ready tag in excess of \$125,000. But then speed has never come cheap, even when you torque the lugs yourself.

Even though there's still only one Lancair IV flying, the manufacturer has already come up with some significant improvements.

Most noteworthy is the announce-

ment that a pressurized IV is now being offered—a first in the kitplane arena. Its 5-psi system will provide a 10,000-ft. cabin at 25,000 ft. Pressurization will require reinforcing the door and adding more carbon layups

to the cabin, and all that will add about 60 to 70 pounds to the empty weight while lightening your wallet of another \$14,500. But in return, you'll get an additional 35-to-45-mph cruise, and more than a passing familiarity with speed restrictions.

Said one Lancair executive, "We're turning the world on fire with that airplane." He was excited, but not surprised.

For those interested in additional information, be advised that Lancair International, Inc., has relocated to a new 27,000-sq.-ft. state-of-the-art manufacturing, R&D and customer service facility. The new address: 2244 Airport Way, Redmond, OR 97756; (503) 923-2244; Fax (503) 923-2255.

PM



KIS



LANCAIR



KITFOX

PHOTOS BY RICH COX

PHONE IT IN

New telephone technology makes it easier to do everything—or nothing.

BY MICHAEL J. McDERMOTT
PM Photo by Brian Kosoff

• Besides the automobile, probably no modern invention has had as great an impact on day-to-day living in the 20th century as the telephone. Since Alexander Graham Bell placed the first call to his assistant, Watson, in 1876, telephone technology has advanced exponentially. As we approach the 21st century, it's unlikely old Mr. Bell would even recognize today's sophisticated equipment as the offspring of his first crude handset.

A number of technological developments are behind the great leaps in telephone service and equipment we are seeing today. Digital transmissions make the signal clearer. Fiberoptic cables increase signal capac-

ity. But perhaps the most significant development in telephony is the marriage of the conventional telephone with the computer, a union made possible by the availability of ever-smaller, ever-cheaper processing chips and integrated circuit boards.

Shopping made easy

One of the newest fruits of this marriage is a product dubbed ScanFone. A joint venture between US Order and Bell Atlantic (one of the baby Bells), ScanFone combines a telephone with a lightpen that scans bar codes (those combinations of black and white lines found on virtually every product sold today) and a device that reads the information encoded on the magnetic strips on the back of most credit cards. The telephone also sports a 16-character display panel.

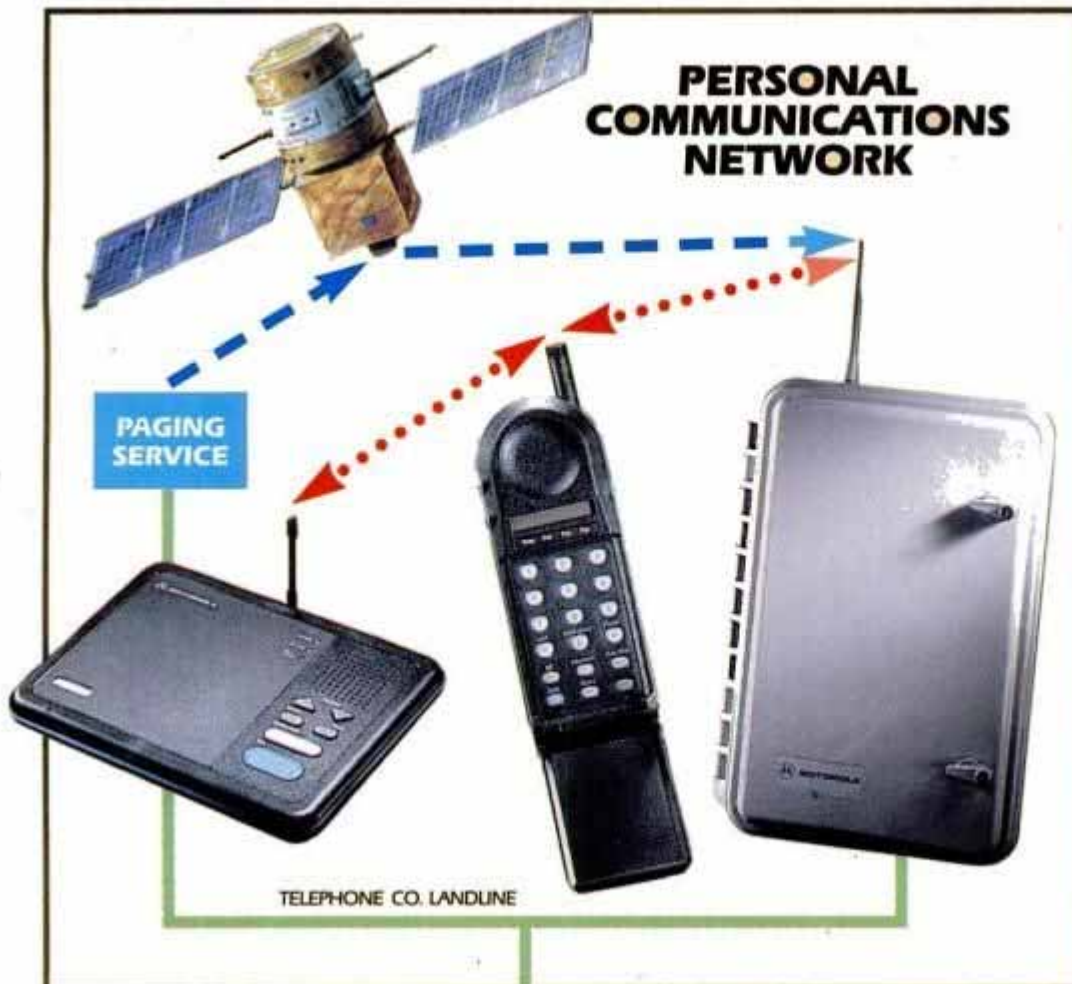
You can use ScanFone to pay your monthly bills, buy groceries, even go on shopping sprees—all without ever talking to another human being. In addition, you can use the ScanFone to access a variety of services offered by the telephone companies, such as Caller ID and voice mailboxes, without purchasing the add-on equipment that might



SCANFONE

A. Circo Distributors. We provide you with the most comprehensive selection of products available in the market...
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PHONE IT IN



As envisioned by Motorola and other companies, a Personal Communications Network would link home units, small handsets and relay boxes with a satellite paging system.

otherwise be required.

Along with the ScanFone hardware, users get a sheet of bar codes representing the companies to which they make monthly payments, like their mortgage holder, oil company, utilities, credit card companies and so on. When it's time to pay the bills, you dial the appropriate phone number, scan the bar code with the lightpen and pull your credit or debit card through the magnetic-strip reader. A separate set of bar codes is scanned to input the amount and the date on which it is to be paid.

Retailers participating in the ScanFone system provide customers with their own catalogs of bar codes. Customers read each item's bar code with the lightpen. When they are done, they get an estimate of the total cost and a chance to make any changes if they want.

An outfit called Shoppers Express, which provides home delivery service for a number of major supermarket chains, delivers the groceries to the customer's door. Customers choose the delivery date and time with the same bar codes used to set bill payment schedules. They can pay for the order by running a credit or debit card through ScanFone's magnetic-strip

reader, or the old-fashioned way—by check on delivery.

The service was rolled out in the San Francisco market in January. The marketing of ScanFone is now being done by Bell Atlantic, so it's likely the service will be next available in Washington, D.C., and other areas served by Bell Atlantic. Nationwide service is expected next year.

Customers pay \$6.95 a month for the basic service (which includes use of the phone) and another \$3 for the bill-paying service. There is also a charge of \$9.95 for each grocery delivery. ScanFone plans to add more services, such as the ability to order takeout food and pay-per-view movies, to buy tickets to sporting events and concerts, and even to use an interactive link to the stock and bond markets.

In truth, neither the technology nor the services offered by ScanFone are new. The technology is a scaled-down version of EDI (electronic data interchange), the massive computer/telephone hybrid system through which big retailers place orders with major suppliers, track inventory and pay invoices.

Nor are electronic shopping and bill-paying services any break-

through. Personal computer users have long been able to do those things through services such as Prodigy and CompuServe, and a number of banks offer some bill-paying and banking services through conventional touch-tone telephones.

What's different about ScanFone is the range of services it offers through a unit not much bigger than a standard telephone. Personal computers have penetrated U.S. households at a much slower rate than was predicted in the early 1980s, limiting the market for electronic shop-at-home services. And existing electronic bill-paying services are costly.

ScanFone's greatest appeal may be to the computer-phobic, especially the elderly. Although US Order sees its primary market as time-pressed dual-income households, fully 30% of the customers in its pilot project were over age 60. ScanFone's grocery delivery service is also likely to have particular appeal to elderly and disabled people. The service promises to honor coupons and provide the same dis-

counts offered to traditional in-store shoppers.

Getting the picture

After almost 30 years of unfulfilled promise, AT&T has finally rolled out a workable consumer version of the videophone, which allows callers to see as well as converse with each other. The \$1500 gadget sports a miniature video camera, a small full-color display screen and a set of specialized chips that use signal compression technology to allow it to work over existing copper telephone lines, rather than the fiberoptic cables many experts predicted would be required.

The videophone works like this: The camera takes a picture of the caller, and the digital-signal processing chips convert the image into millions of pixels, or individual picture elements, at a speed of about 15 frames per second. (Movies move at about 24 frames per second.) Another set of chips choose the key pixels, such as facial features, and ignore less important ones. The image is compressed and sent, along with the audio signal, to the receiving videophone, which reassembles the pixels and displays the image.

For the time being, videophone's

high price, relatively poor picture quality and jerky motion will likely consign it to the gimmick category. However, new models that will deliver much higher-quality images are in the research-and-development pipeline. If the price comes down far enough, we may all be shaving before we answer the phone in a few years.

Telephony is advancing on other fronts as well, although many developments will have specialized applications. AT&T and a number of other companies have made great strides in voice-recognition technology, for example. One result will be automated systems that can respond to normal speaking voices.

An early example of this capability is a feature of the Sapura S2000 HF phone from Temasek (1-800-Hello 2U). Billed as the first hands-free, voice-activated telephone, the \$199 S2000 HF lets you answer incoming calls simply by saying "hello." Thereafter, you communicate with callers as you would with a conventional speakerphone. The phone automatically disconnects after the other party hangs up.

Long range and wirefree

Sometimes small changes in existing technology can result in big changes in performance. That's the case with new cordless phones that operate in the 900 megahertz (MHz) band rather than in the 46 to 49 MHz range that is used by conventional cordless phones.

The new 900-MHz cordless phones boast a

range of up to a ½ mile, are less prone to interference, provide better sound quality, are more secure and use a shorter antenna. The secret behind this improved performance has to do with the nature of radio waves. A wave in the 900 MHz range is about 1 ft. long, while a

AT&T VIDEOPHONE

49 MHz wave measures about 18 ft. A 900-MHz phone with a 5-in. antenna boasts an antenna efficiency of about 2 to 1. A 49-MHz phone would need a 10-ft. antenna to achieve the same efficiency. Since most 49-MHz cordless phones sport antennas less than a foot long, their efficiency ratio is more like 20 to 1.

And since there is less traffic in the 900-MHz spectrum, the phones are less prone to interference from other electronic devices. The 900-MHz phones are also designed to be more secure. For example, the Escort 900-MHz cordless phone made by Cincinnati Microwave, the radar detector maker, transmits its signal digitally using a spread spectrum technology. By using spread spectrum technology, a signal can be sent across a wider bandwidth—in this in-

stance the 902 to 928 MHz bandwidth allocated by the Federal Communications Commission—than is actually necessary for voice communications. By transmitting across a wider highway, the signal is less likely to encounter interference even at maximum distances. The result is clearer reception. The spread spectrum signal is also harder for potential eavesdroppers to intercept. Most manufacturers, in fact, are also incorporating digital security codes to make it extremely difficult if not impossible for someone to eavesdrop on your conversation.

Better performance, though, currently translates into high prices. Panasonic's KX-T9000 lists for almost \$500. VTECH's Tropez 900DX lists for \$350, and Cincinnati Microwave's Escort model lists for around \$250, to cite just three examples. These 900-MHz cordless phones are also power hungry. For example, talk time on the Tropez 900DX is 4½ hours, about half of what you'd get on a 49-MHz model. Standby time is 43 hours versus about a week for many 49-MHz models.

Personal communicators

The day may soon arrive when everyone has a phone with them all the time. In fact, the technology for what's being called a personal communications network (PCN) is already here. If it becomes widespread, it will be almost impossible for anyone to ever say they missed a phone call.

PCNs are made possible by a technology called CT-2/telepoint. It combines the newest generation of digital cordless telephones with a network of many low-powered transceivers and a

(Please turn to page 103)



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HOME&SHOP JOURNAL



SHOP TECHNIQUES MARQUETRY

Add a new dimension to your next project—paint a picture with wood.

TEXT AND PHOTOS BY ROSARIO CAPOTOSTO,
Contributing Editor

● If you think of woodworking solely as joinery, finishing and good functional design, you may be missing the whole picture. Making things out of wood has always had an aesthetic component. And, a good number of the choices you make—whether to round a corner or taper a leg—are based on what you feel will make your work look its best. In fact, some facets of woodworking are often devoted exclusively toward these artistic concerns.

And one of the most popular is marquetry.

Marquetry has been around for centuries, and examples abound in both traditional furniture and architectural ornamentation. The idea is simple and based on standard veneering techniques. However, where veneering usually involves covering each surface with a single layer of wood selected for its visual appeal, marquetry goes one step further. Here, small pieces of contrasting veneers are fit together and glued to a ground, or substrate, to produce either a geometric pattern or pictorial representation.

Marquetry isn't to be confused with inlay work, a related decorative woodworking technique. Inlay, sometimes called let-in work, involves



cutting a recess into solid wood in which a veneer is placed. This technique is commonly used for bandings or repetitive motifs. Marquetry, on the other hand, involves creating a single veneer sheet comprised of small pieces that's applied to a ground similar to standard veneering. Sometimes, the word parquetry is used to describe marquetry that's geometric, such as a backgammon game board.

Tools And Materials

Woodworking outlets that handle veneering supplies will have most of the materials you'll need to start a marquetry project. Some suppliers offer kits that contain full-size patterns as well as the veneers. Two sources are: Constantine's, 2050 Eastchester Rd., Bronx, NY 10461 and The Woodworker's Store, 21801 Industrial Blvd., Rogers, MN 55374.

In addition to the veneers, you'll need a razor knife, veneer saw, tracing paper, carbon paper, pencil (4H is best), gummed veneer tape, masking tape, glue, wax paper and sandpaper. To glue the marquetry assembly to a ground, you'll need clamps and wood for cauls and crossbearers, to apply even pressure. For shading and detailing techniques, you'll need shading sand (fine silver sand from a pet shop also works), a hotplate and a woodburning pen (Photo 1). You'll also need a cutting board—avoid hardboard or particleboard because they dull your knife faster. For tips on handling veneer and plans for a veneer press, see our veneer technique story (see "Veneering," page 45, Feb. '92).

Suppliers offer veneers in a wide range of natural colors and grain figure. You can buy them by individual



1 Tools and materials used in marquetry include a razor knife, tracing paper, carbon paper, 4H pencil, gummed veneer tape, masking tape, white or yellow carpenter's glue, wax paper, woodburning pen, shading sand, sandpaper and clamps.



2 Veneers used in marquetry are available in a wide range of natural and dyed colors. A veneer sample kit is a good way to start.

species or in assortment packages. Also available are artificially colored veneers that are pressure dyed so the colors won't sand out. A veneer kit containing 50 different samples, 36 sq. in. each, is available from some dealers (Photo 2). It's best to buy two kits—use one for your project and save the other for reference.



3 One way to create a design is to trace a motif that you like. Follow the bold outlines and use heavy tracing paper.

You can also create marquetry patterns yourself, or copy designs from photographs, greeting cards, book and magazine illustrations, calendars, wallpaper designs or even a dinner plate (Photo 3). Tape good-quality tracing paper over the original and trace the bold, simple outlines to make the pattern.

The Cutting Process

For our project, we've chosen a relatively simple floral motif for a mahogany serving tray. The marquetry technique that we used is called the window method. Here, a razor knife is used to cut an opening, or window, in a background veneer. The window then serves as a template for cutting a contrasting piece that fits precisely in the opening. If the picture fills the entire area of the background, the background veneer is called a waste veneer because it only serves as a template for cutting the actual veneer shapes. In this case, the appearance of the waste veneer is of no impor-



4 Make practice cuts to become familiar with using the knife. Always cut away from the corners to avoid splits and tears.



5 To transfer pattern to veneer, hinge tracing paper to veneer and place carbon paper in between. Then trace outline.

tance and an easy-cutting wood such as white sycamore should be used.

In our example, the marquetry picture covers only part of the background, so we chose mahogany for the background veneer to match the solid mahogany tray sides. Before starting to cut out your marquetry design, it's a good idea to try out your knife on a piece of scrap veneer (Photo 4). Experiment with curved and straight cuts, and practice cutting into corners cleanly. Avoid tilting the knife to one side or the other.

Once you've familiarized yourself with some basic cuts, begin the actual project by cutting the background veneer 2 in. oversize in both directions. Prepare a line drawing of your design on heavy tracing paper, lay it upside down on the back face of the background veneer and hinge it with masking tape along one edge. By working from the back face and with a reversed image, all the cuts can be made from the back and the image will appear correct on the front face. This ensures that each piece will fit snugly on the finished surface, due to the V-shape cut the knife makes.

Place the carbon paper between the

tracing paper pattern and the background veneer, carbon side down. Trace the outline of the first piece to be cut by going over the pattern lines with a sharp, hard pencil (Photo 5). Parts adjoining the first piece may be traced as well, even though they won't be cut immediately. Then, lift the pattern out of the way and remove the carbon paper.

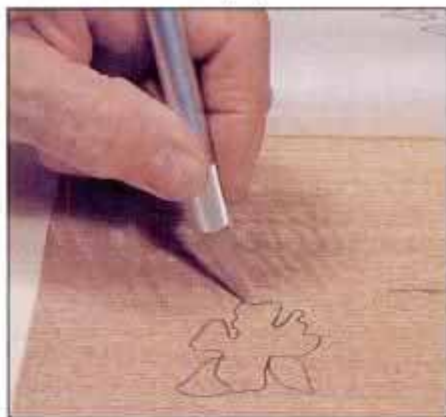
With the shape of the first window on the background veneer, make a light, scoring cut on the outline with the razor knife held almost vertically (Photo 6). Follow the scoring with a series of deeper cuts until the veneer is cut through. For sweeping cuts along gentle curves, lower the knife handle slightly. When you reach tight, intricate corners, raise the knife handle to a nearly vertical position and make a series of small jab cuts. To minimize splintering on the side of the cut that the knife exits—the finished side of the piece—apply masking tape under the cutlines. It's important to use a sharp blade. As soon as you notice extra resistance during a cut, switch to a new blade for best results.

When the first outline has been cut

through, remove the waste to create the window—the template for the first marquetry element. Then, slip a contrasting veneer under the window for tracing a precise mating piece (Photo 7). In our floral pattern, the flower shape is made from curly maple veneer. Temporarily tape this veneer to the back of the background veneer to keep it from shifting.

With the edge of the window serving as a template, lightly pass the knife around the contours to mark the shape on the bottom veneer (Photo 8). Be sure to hold the knife so the point follows the edge of the window as closely as possible. Then, remove the veneer from the background, take it to your cutting board and cut out the shape (Photo 9). Again, work carefully and slowly, making the cut with several light passes rather than a single heavy one. When the shape is cut, position it over the window and press it in place (Photo 10). Then, fasten it with masking tape applied on the finished side of the background veneer.

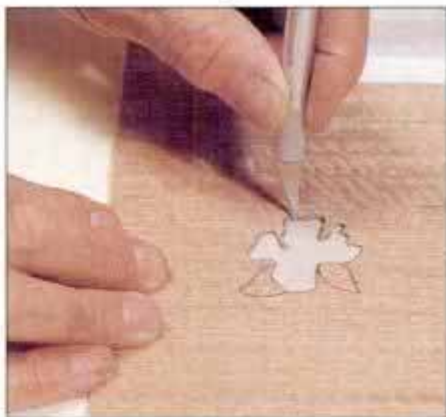
The next step is to cut an adjoining shape—in our example, the green leaf next to the curly maple flower. We cut the leaves from a piece of emerald-



6 Begin first window cut by lightly scoring around the outline to establish a knife track. Then make successively deeper cuts.



7 After the window is cut, place the selected fill veneer under the opening and tape in place to prevent shifting.



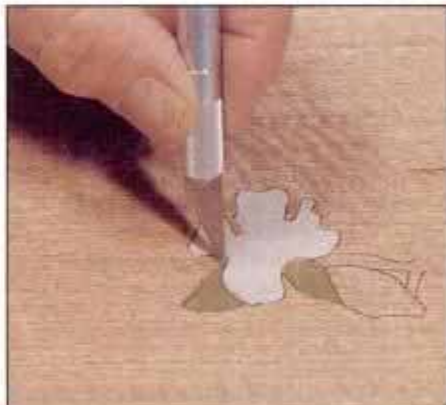
8 With the edge of the window acting as a template, run the knife point lightly around the outline to mark the cutting line.



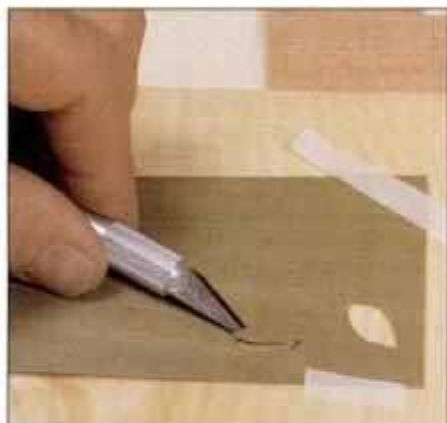
9 Then, remove the veneer and lay it on the cutting board. Cut out the shape by making light passes with the razor knife.



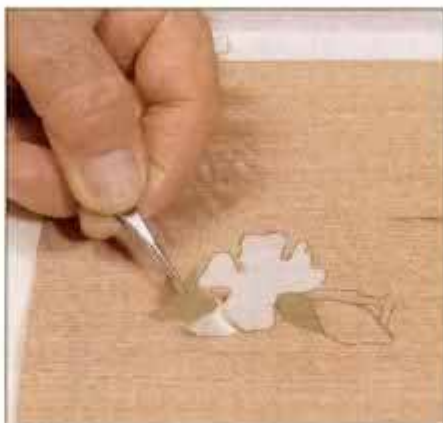
10 Return the cutout piece to the window, press it flush with finger pressure. Then apply tape on the other side.



11 After cutting the windows for adjacent pieces, the next veneer is placed underneath and outlined for cutting.



12 Then, cut shapes with razor knife. Note that certain shapes should be oriented with the grain to prevent breaking.



13 Return the shapes to the background and fit them in place. Again, secure them with masking tape on the underside.



14 Follow the procedure for each piece to be cut and fitted. Here, leaf shapes in our floral pattern are cut from the background.



15 The leaf cutout on the background acts as a template for the actual leaf piece. Hold the knife vertically for scoring.



16 Use masking tape to hold the veneer on a cutting board for better control. Use solid wood or plywood for cutting board.



17 Masking tape can build up on the underside. Remove small pieces and use fewer long pieces to even out assembly.

green-dyed veneer. Follow the same procedure described for the first piece. Lay the tracing over the work, insert the carbon paper and trace the next piece on the background. After cutting the window, tape the fill veneer to the back, score the outline and remove the veneer to cut the piece (Photos 11 and 12). Then, tape the finished piece in its window on the background (Photo 13).

Depending on the shapes in your

design, it may be important to orient the grain direction of the veneer to line up with the dominant direction of the shape to avoid breakage. Note that for our design, the grain direction of the flowers is arbitrary. However, the leaves and stems should be positioned so the grain runs parallel to the long axis of the shape. The stems on our project are made from English brown oak veneer.

Add each new segment following

the steps described (Photos 14, 15 and 16), and tape each piece in its place. Avoid a heavy tape buildup at any one location, as this can interfere with the tracing and cutting operations. You can reduce tape buildup by replacing several small pieces of tape with fewer large pieces (Photo 17). Once all the pieces are fit, you can move to applying special effects that highlight the pictorial representation, or go directly to assembly.

Special Effects

The illusion of roundness on the flower petals in our example is produced by scorching the petal ends in hot sand. We also added striations to the petals and vein lines in the leaves with a woodburning pen, and the dark center spots are made by scorching with a hot nail. Before removing the segments from the assembly for detailing, code each piece and its corresponding location on the pattern to avoid mixups.

To add shading by scorching, place about 1/4 in. of shading sand in a metal pan and heat it on a hotplate or range-top. Hold the piece to be shaded with



18 Heat shading sand in pan on hotplate and insert veneers to create gradated tone. Test process with scraps first.



19 Use a woodburning pen to add linear details, such as petal striations and veining in leaves. Hot nail scorches dark center.

needle-nose pliers and dip its end into the hot sand. Hold it there until the veneer is scorched so it fades from a deep brown to the wood's natural color (Photo 18). Try to keep the sand at a constant temperature, and use scraps to test for the best time period to achieve the desired effect. It's a good idea to time the scorching process so that you can shade each piece uniformly. Bear in mind that sanding

will lighten the effect, so it's best to sand the finished test pieces when determining the length of time for scorching.

To scorch the center spot on our flowers, we first filed the edge of a common nailhead so it was slightly irregular. Then, with the nail held in locking pliers, heat it over an open flame. Touch the nail to the veneer with a slightly rocking motion to

achieve an irregular scorched impression. Avoid overheating the nail to prevent burning through the veneer, and test the technique on scrap before moving to your finished pieces.

To add detailing lines, first mark the lines with a pencil. Then, trace over the lines with a woodburning pen. Move the pen quickly and press lightly to avoid burning through the veneers (Photo 19).

Assembly

After the detailing is finished, return the segments to the background veneer, and then turn it upside down. Remove any masking tape and apply gummed veneer tape to the finished side of the assembly to hold the pieces in place. Moisten the tape with a damp sponge, and lay it in parallel lines (Photo 20).

We mounted the marquetry assembly on a 1/4-in. plywood ground. Install a balancing veneer on the opposite face to prevent warping, and orient the surface-grain direction of the plywood at right angles to the predominant grain direction of the marquetry. If you're using a solid-wood ground, align the grain direction of ground and veneer so they're parallel.

The marquetry, backing veneer and ground are assembled with white or yellow carpenter's glue. A veneer press is ideal for applying uniform pressure, but it's not essential. You can also use four clamps to apply pressure. To distribute it evenly, use two flat pieces of 3/4-in. plywood for cauls and four 2 x 4 crossbearers. Also, have several sheets of newsprint paper on hand to act as a cushion and wax paper to keep the assembly from becoming glued to the newsprint or plywood cauls.

First, hinge the marquetry assembly and the backing veneer to the ground by taping along one edge of each. Apply glue to the bottom face of the ground and spread it evenly with a plastic applicator or squeegee. Flip the backing veneer onto the ground, turn the assembly over and repeat the process for the marquetry side (Photo 21). Do not apply glue to the veneers, as they will curl as they absorb moisture from the glue.

Place wax paper on the bottom plywood caul, lay the panel on top and place wax paper on the marquetry side as well. Add about six layers of newsprint paper over the wax paper on the marquetry side. This will help even out pressure caused by variations in veneer thickness. After laying the top 3/4-in. plywood caul over

the assembly, position the crossbearers and clamps, tighten the clamps and let it dry overnight (Photo 22).

When the glue is dry, remove the veneer tape by lightly moistening with a damp sponge (Photo 23). Allow the adhesive to soften, then lift one end of each strip and peel away (Photo 24). Allow the surface to dry and sand flat with 180-grit sandpaper and a wood—or semirigid rubber—sanding block. Follow up with 220- and 320-grit paper. You can use an orbital sander for the last two grades. However, proceed carefully to avoid sanding through the veneer.

We finished our project with three coats of Constantine's Wood-Glo finish, lightly sanding between coats. **PM**



20 Remove masking tape and replace it with parallel strips of gummed veneer tape. This side will be the finished side.



21 Apply glue to ground, not to veneer, and use backing veneer to balance assembly. Plastic applicator spreads glue.



22 Sandwich assembly between wax paper and 3/4-in. plywood. Use newsprint as a cushion and apply clamps to crossbearers.



23 After the glue is dry, use a damp sponge to soften the veneer tape adhesive. Avoid wetting surrounding area.



24 Use a chisel to start lifting the veneer tape at one end. Then, peel away tape. If glue still holds, remoisten tape.

APPLIANCE CLINIC

BY STEVE TOTH,
Contributing Editor

Washer Stops

My Whirlpool washer, model No. LDA5800W3, serial No. C63817419, will stop several times during all cycles. To get it to start again, I have to hit it on top or open the lid and drop it. Would this problem be due to the load select mechanism, the timer or what?

MARK TINDER
NEW HUDSON, MI

It appears that the timer is causing your problem. If the timer's contacts are pitted or worn, current will not be sent to the drive motor circuit and the appliance will stop at the wrong time in the wash cycle. When you drop the washer's lid, you jar the contacts enough so that the washer works for a little while longer.

To replace the timer, first unplug the washer. Next, turn the timer knob counterclockwise with one hand while holding the timer dial with the other hand. Now lift the timer dial off the D-shaped timer shaft.

Remove the two Phillips head screws at each lower corner of the console—these are the screws at 45°.

Place an old towel on top of the washer. Grip the console at both ends, pull it forward about 1/2 in., and lift it up and out so its locking tabs clear the four holes in the top. Tilt the console forward, and lay it on the towel.

Next, remove the two 5/16-in. hex-head screws on the front of the console that hold the timer in place.

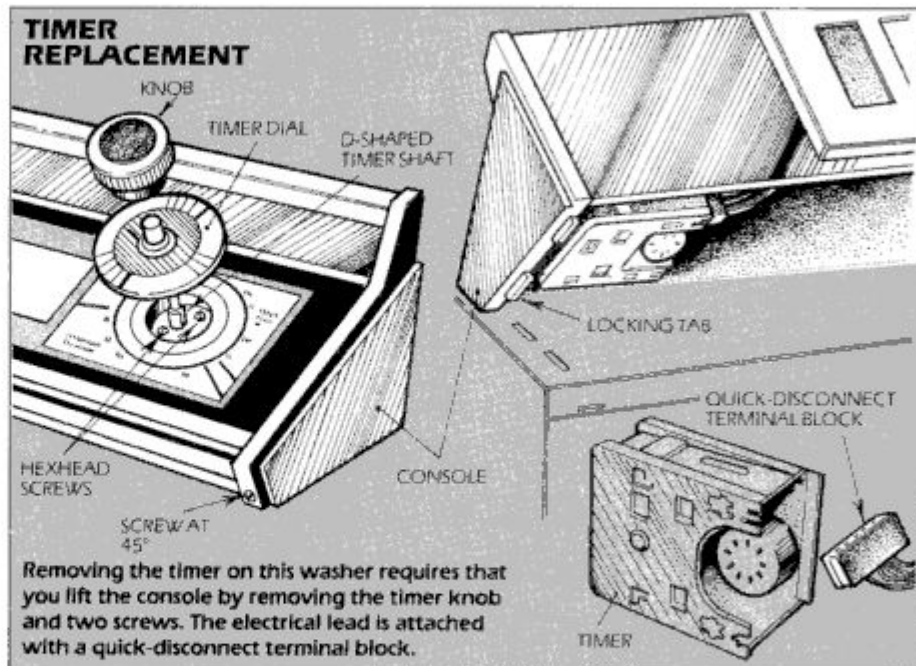
Slip the timer out from under the console. The electrical leads are connected to the timer with a quick-disconnect terminal block. Press down the locking tabs on both ends of the terminal block, and separate the block from the timer.

Press the terminal block onto the new timer and then reassemble the machine.

A replacement timer for your model washer is available from a Whirlpool parts or service center under Whirlpool part No. 660750. It costs about \$65.

Greasy Washer

I have a Maytag washer, model No. A-206, serial No. 330891 HH. The machine continuously throws gear



grease onto the floor at the perimeter of the machine's cabinet. I removed the front panel expecting to see grease all over the inside housing, but was surprised to see there wasn't any. There is no gear grease on the upper and lower sections of the shaft that is visible with the front panel removed. With the continued loss of grease, I'm concerned the gears will seize and do some damage.

JOHN KLAPP
FLORAL PARK, NY

The grease is probably coming from a worn or cracked rubber O-ring shaft seal inside the transmission. When this seal goes bad, grease will leak from the transmission's bottom shaft.

The bottom shaft is underneath the base frame of the washer, so you won't see any grease when you remove the front panel—the grease is leaking below the base frame. Over time, a machine that is operated with such a leak will become very noisy. Eventually, the transmission will seize when the grease is gone.

The best way to repair the machine is to have a rebuilt transmission installed, and this costs about \$350. This is a more reliable repair than just installing a new seal. If the lack of grease has damaged the transmission, then a new seal will only fix part of the problem, and be a waste of money.

Fan Works, Heater Doesn't

I have a Holmes Air portable heater, model No. HFH-105. One day, the heating element stopped working and

would not work again, but the fan continues to work. This heater is assembled with safety screws to prevent curious home repairmen from tinkering with it. Should I scrap this heater, or do you think it can be fixed without too much trouble?

RICHARD POULIN
MERIDEN, CT

You are right about the tamper-resistant triangle head screws that hold the heater together. These screws discourage people from disassembling the heater.

If your heater is less than a year old, follow the instructions on the warranty registration card, and the company will send you a new heater.

If the warranty has expired, the company has an out-of-warranty trade-in program. For your model appliance, send the heater to Holmes Products, Inc., Customer Service, 233 Fortune Blvd., Milford, MA 01757. Enclose a check for \$15 along with the heater.

In three to four weeks, you should receive a new heater with a 1-year limited warranty.

*The cost of this service varies depending on the type of heater. The HFH-105 is one of the company's smaller models. Readers who have further questions regarding Holmes heaters should contact the company's customer service department. **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.

**HOME
 IMPROVEMENT**
**COMMON-
 SENSE
 LAWN CARE**

TEXT AND PHOTOS BY
 MERLE HENKENIUS

● Lawn care can be a labor of love or the bane of one's existence, depending on your point of view. For many of us, it's a chore, and a confusing one at that. Few of us have the time, or the inclination, to learn all there is to know about turf grasses. So we blunder forward, in a perpetual struggle for damage control. It's enough to make us long for a middle ground, where a few simple rules and a minimum of chemicals would carry us happily from season to season.

We took our questions to Dr. Roch Gaussoin, a turf-grass specialist with the University of Nebraska. The information he provided offers just what we had hoped for, a common-sense, low-energy approach to lawn care. For specific information about lawn care in your area, contact your county or state extension office.

Turf-grass geography

Where you live has a lot to do with how you maintain your lawn. There are basically two types of turf grass in this country. The northern three-fifths of the nation (Section 1 on the map) is dominated by cool-weather grasses, usually bluegrass or fescues, such as creeping-red or tall fescue.

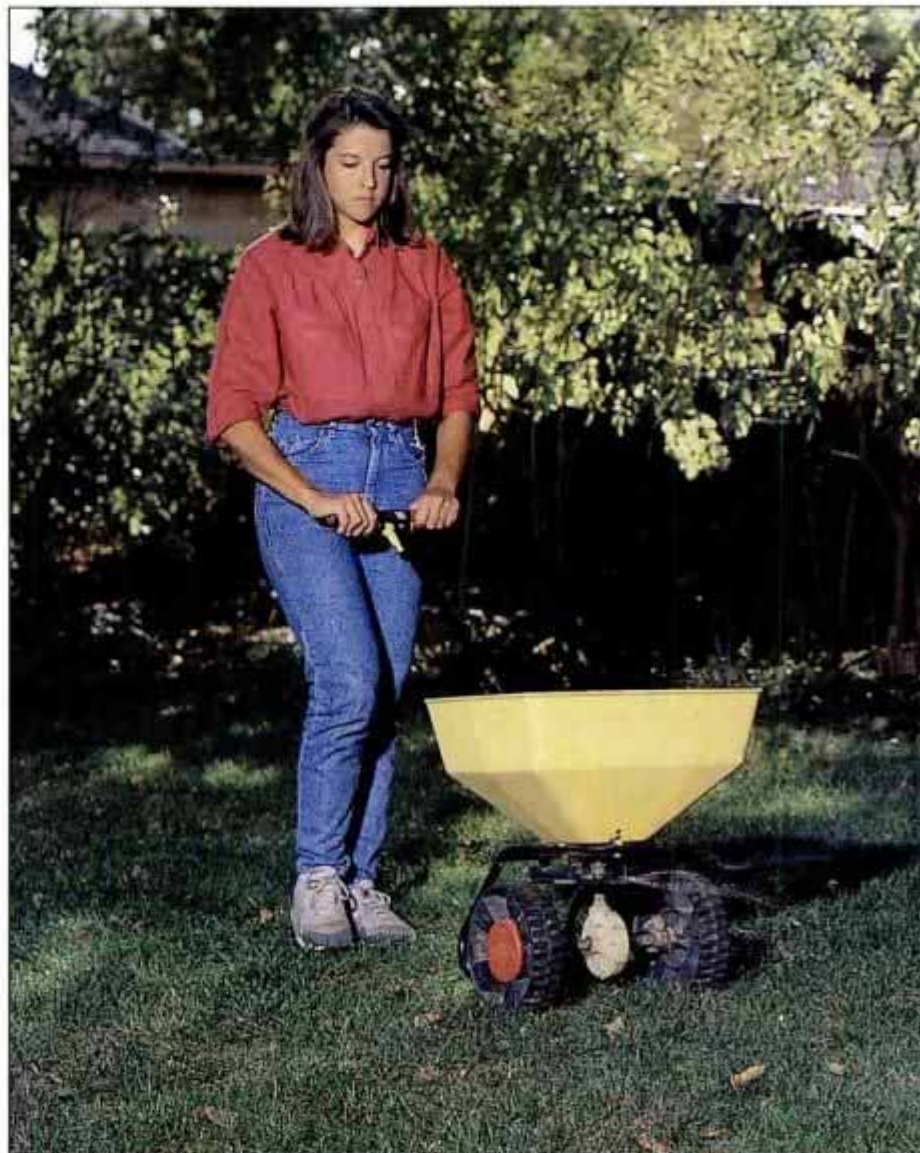
The southern one-fifth of the nation (Section 3) relies on warm-weather grasses dominated by bermuda grass and zoysia grass.

A transition zone (Section 2) supports both warm-weather and cool-weather grasses.

Fertilization schedule

Fertilize your grass to produce a healthy root system. If the roots are healthy, the top growth will be too. While some sources recommend fertilizing several times a year, a late fall treatment with a high nitrogen content is best for cool-weather grasses. In this case, half the mix activates immediately, while the remainder is released over several months.

The best time for a fall fertilization is after you've put the lawnmower away. The goal is to build the root sys-



tem while the top remains dormant. The root system remains organically active right up to when the ground freezes solid. By fertilizing in the spring, you produce more top growth instead of contributing to a healthier root system.

Warm-weather grasses, by contrast, produce peak top growth in the summer, so fall fertilizing is not very effective. With these grasses, fertilize in the early spring, just after dethatching. Water deeply after fertilizing to carry nutrients to the roots.

Aerating and dethatching

Tall fescues seldom need dethatching, but bluegrass, creeping red fescue and all warm-weather grasses should be dethatched yearly.

Thatch is a dense accumulation of dead plant matter that accumulates at the base of the grass. As it builds, grass sends roots into it instead of into the soil. In cool weather, the plant thrives in this nitrogen-rich sub-

strata, but in warm weather, the thatch dries out and the roots burn.

Rent a dethatcher each spring. Go over your lawn and remove the thatch that is turned up (Photo 1).

An aerator is similar to a rototiller, but instead of churning up the soil, it removes thousands of small soil plugs as you walk it over your lawn (Photo 2). By aerating the soil, the machine reduces weed growth because weeds grow best in compacted soil, while grasses thrive in uncompacted soil.

The holes poked through the turf provide a direct path for moisture and nutrients to reach roots, and the plugs of sod that are scattered over the turf quickly break down. This accelerates the return of nutrients to the soil. Aerate and dethatch just before you fertilize.

A mowing schedule

Most of us mow when we find the time, usually every weekend. While this routine fits our schedules, it isn't



1 A dethatcher pulls thatch out of the lawn so it can be raked up. Grass roots will grow down, instead of into the thatch.



2 A rental aerator punches holes through the turf and lifts out soil plugs. This helps water and nutrients reach the grass roots.



3 Loosen the soil before reseeding using a rake or cultivator. This breaks up the soil so seeds can germinate.

necessarily best for the grass. Instead, let the lawn dictate when you mow, using the one-third rule. This rule stipulates that most grasses grow best if you don't cut more than one-third of their height at a time. Cutting more than one-third leaves too little leaf to gather sunlight and drive the photosynthesis process.

Let's say you mow the grass to a height of 2 in. When it reaches 3 in., mow it again. The one-third rule reduces mowing time by nearly a third, and the clippings are small enough that they don't need to be bagged.

According to Dr. Gaussoin, leaving short clippings on the ground is preferable to bagging them. Clippings don't add significantly to thatch because they are 90% water, and the 10% of plant matter adds nutrients to the soil as it breaks down.

Will you need a mulching mower? Not if you follow the one-third rule faithfully. But there will be times



4 Spread straw over a newly reseeded area. The straw protects the seed from birds and keeps it warm in cool weather.

when the grass has gotten ahead of you, and a mulching mower would be a big help. A good compromise, however, is a bagging mower that can be used without the bag. If your mower cannot be used safely without the bag, check with the manufacturer about a conversion kit.

Finally, don't mow your lawn too short. While some warm-weather grasses can be cut as low as 1½ in., cool-weather grasses should never be cut shorter than 2 in. in the cooler months and 2½ to 3 in. during the hottest months. Mowing the grass shorter stresses the root system.

A watering schedule

Fewer deep waterings are better than frequent shallow waterings. Light watering encourages shallow root growth and possible heat stress. There are two exceptions to this rule, however. First, lightly water newly seeded areas. Second, don't deeply



5 Inspect a lawn for grubs by using a spade to cut out a square foot of turf that is 3 to 4 in. deep. Peel the square back.

water cool-season grasses during the hottest weeks of late summer. Instead, rely on frequent shallow waterings during the early morning to keep your lawn green. As temperatures heat up in late July and August, cool-season grasses conserve energy by shrinking both their root systems and top growth. With shallow roots, a deep watering wastes water.

Warm-weather grasses, by contrast, need plenty of water during the peak-growth summer months.

Reseeding

You can spread seed in the spring or fall, but a fall seeding yields better results with cool-season grasses. This is because the young shoots, with their shallow roots, cannot bear the heat of summer. As such, you can expect a survival rate as low as 50% with a spring seeding. Spring seeding also forces you to avoid using pre-emergent herbicides—one of the most ef-

fective forms of weed control—because it may kill the young grass.

To reseed an area, rake the soil to loosen it. Then, apply the seed and rake it lightly to bury some of the seeds. Spread straw on the seeded area to protect the soil from sprinkler erosion, provide shade and maintain soil temperatures on cold days (Photos 3 and 4). After seeding, keep the soil moist for several weeks.

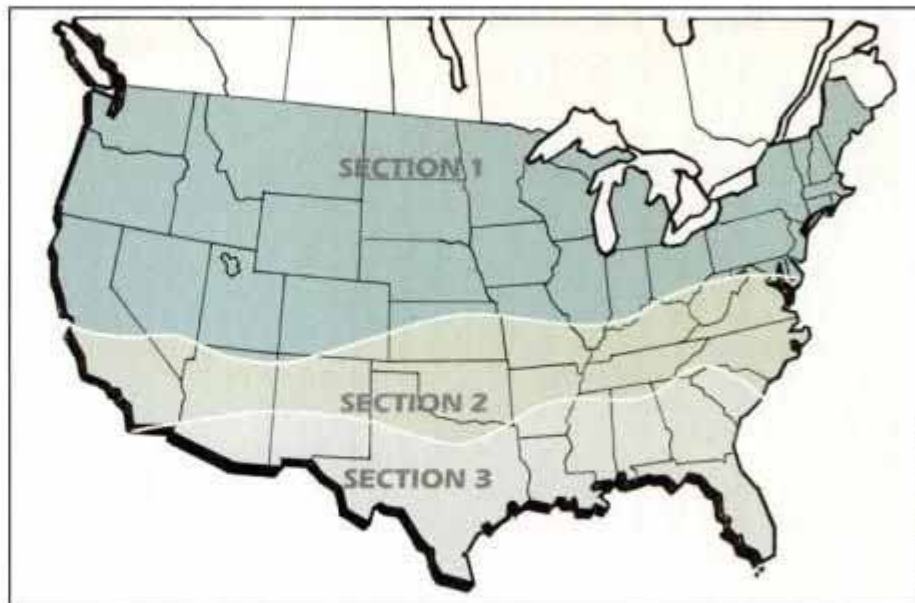
Weed control

You can remove a few weeds by hand, but judicious use of herbicides is in order if there are lots of weeds. The leaf structure of the weed determines the type of herbicide you use. Broadleaf weeds, such as dandelions and bindweed, are treated with a broadleaf herbicide applied after the plant is up and growing.

Grass-like weeds, such as crabgrass, foxtail and goosegrass are best treated with a pre-emergent that is applied in early spring, before the weeds have a chance to sprout. Grassy weeds can also be treated after sprouting with a liquid crabgrass killer—but only when the plants are very young.

You'll find a variety of herbicides on the market, and all work well when applied properly. Read all directions carefully. By doing it right the first time, you'll save time, money and reduce herbicide runoff when it rains.

When using a dry, or granular, broadleaf herbicide, wet the lawn before spreading. The herbicide will adhere to the leaves, and the plant will absorb it more readily. Allow several



Cool-weather grasses grow in Section 1. Warm-weather grasses grow in Section 3. Both types of grass grow in Section 2, considered an intermediate zone.

days before watering again. When applying a liquid herbicide, simply spray it on and then avoid watering for several days.

Pre-emergent herbicides, by contrast, do their work below the soil surface. As such, you'll want to water the lawn immediately after treatment.

Insect control

Not all damage is inflicted on turf grass by weather or careless cutting, insects can damage turf grass, too. Treating insects varies from region to region, so we'll focus on one of the more common insects, the annual grub, also known as a June bug.

It's common to find a few grubs

while digging in your yard. Most cool-weather lawns have some. The experts say that less than 10 grubs per sq. ft. is acceptable. More than that may do noticeable damage. Check for grubs by spading down and peeling back sections of lawn (Photo 5).

Grubs can only be killed when they are feeding heavily, and this occurs in mid-August. Don't apply today's short-lived pesticides earlier than mid-August, because it is a waste of money and an unnecessary assault on other insects and birds.

A grub treatment should be watered-in well so that the pesticide can be carried several inches below the surface.

BOOK REVIEW

COMMON-SENSE PEST CONTROL

● This book is as diverse as it is appropriately named. When it says pest control, it means pests of every kind—except your neighbor with the loud stereo.

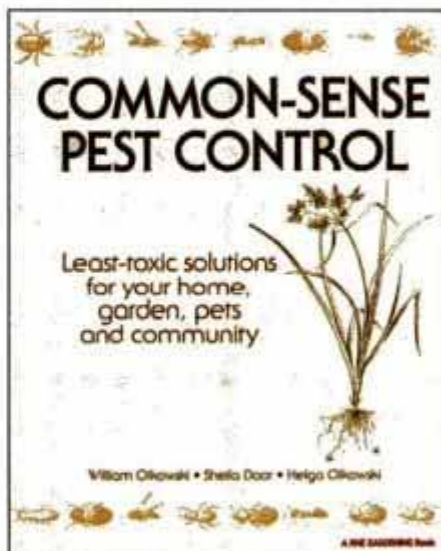
Pests from cockroaches to dandelions to bats, mites and fungi are all covered in its 715 pages, along with how to treat them. Also included here are pages of addresses for products and sources of information.

The authors emphasize using the least toxic materials and methods to keep the upper hand in controlling pests, as opposed to using powerful chemicals. The chapter devoted to lawn care, for instance, promotes soil

quality, turf maintenance and low-toxicity chemicals, rather than spreading herbicides and powerful fertilizers at will.

Many people view low-toxicity methods as impractical, but nothing in this book struck me as such. The authors make clear that in many, but not all cases, low-toxicity methods require more work and investigation on your part, but they feel that reducing potentially harmful chemicals in our surroundings is worth the extra effort.

The book costs about \$40 plus \$4 shipping from The Taunton Press, 63 S. Main St., P.O. Box 5506, New-



town, CT 06470. You can also call the company's order department: (800) 888-8286.

—Roy Berendsohn

HOMEOWNERS CLINIC

BY NORMAN BECKER, P.E., Contributing Editor

Drainage For Concrete Block Wall

I have a painted concrete block retaining wall on the property line with my neighbor. When it rains, excess moisture forms a white powder on the wall, and its paint flakes off. How can I treat my side of the wall to stop the moisture seepage and prevent the paint from flaking? We were advised to tar the wall's back.

Drains were installed at the wall's base, but the clay in the soil seems to prevent the water from seeping down to the drains.

GERALD A. LARUE JR.
SAN PEDRO, CA

The white powder on the wall is efflorescence, a mineral deposit that forms when the water carrying the minerals evaporates. To prevent this, and stop the paint from peeling, you must stop the water from seeping through the wall by installing better drainage. Treating your side of the wall won't solve the problem.

You are correct in saying that the clay in the soil prevents the water from reaching the drain. Soil with a high clay content does not drain well. This soil should be excavated from behind the wall and replaced with gravel. A perforated drainpipe should be installed as shown. Water will percolate through to the pipe.

It is important that the pipe have a free-flowing outlet, to allow the accumulated water to drain.

Do not simply tar the wall's back and then backfill with the same soil—the tar will seal the wall and prevent the water in the soil from escaping to the outside. If the water builds up, it can exert enough pressure on the wall to crack it or heave it.

Flood Alarm

A few years ago, we bought a house that got water in the lower level with every heavy rain. We solved this by adding extensive landscaping, putting in drain tile along the foundation and reworking the sump pumps. We even installed a generator to keep the sump pumps going when the power goes out. I'd like to install an alarm for stormy nights that would wake us if the power goes out, so we can turn on the generator. Do you know of such a device?

BERRY J. CONWAY
WOODBURY, MN

I suggest you contact the Heath Co., P.O. Box 8589, Benton Harbor, MI 49022. This company sells a battery-operated device called the Flood-watch. The device sounds an alarm when it comes in contact with water. You can install it in a bracket in the sump pit. If the sump pump is not operating because the power is out,

water in the pit will rise above the point where the sump pump would normally turn on and trigger the alarm. Its part number is GD-3660, and it costs about \$20.

CO Detector

I would greatly appreciate it if you could provide me with a source for a carbon-monoxide detector. I have an oil-fired hot-air heating system that has, under certain conditions, the potential to send carbon monoxide into our home (via a defective heating exchanger).

MICHAEL CARUSO
KEARNEY, NJ

It sounds like you need a new furnace rather than a detector for carbon monoxide. Nevertheless, Gas Alert Plus makes three CO detectors that are sold through hardware stores. The first is an adhesive-backed plastic card containing a circular spot that changes color from orange to tan to gray or black depending on the CO content in the vicinity. It is simply called the Carbon Monoxide Detector, model CO-D. It costs about \$5. You hang the card in front of one of the heating system's supply registers.

The second unit, model SA-5 (110-V), plugs into a 110-volt outlet. It sounds an alarm when CO reaches a dangerous level. It sells for about \$65. A similar device, model SA-5 (12-V), is available for mobile homes and boats, and runs on 12 volts. Both are sold at Ace hardware stores and Builders Square home centers. Write to Gas Alert Plus, 5300 A McDermott Dr., Berkely, IL 60163.

Wash A Painted Wall

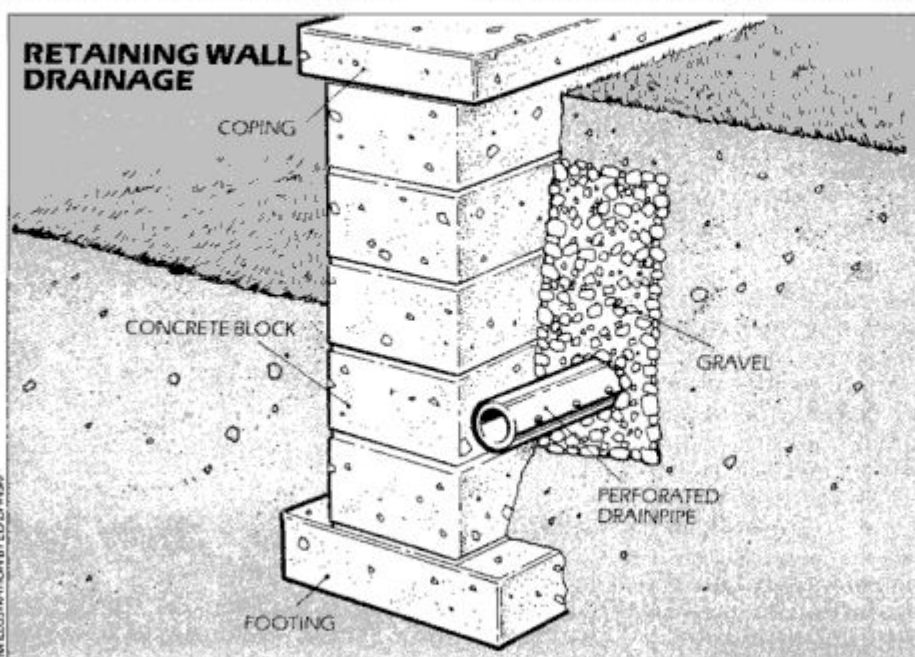
Can you give me some tips on how to wash painted walls? The walls are painted with white, washable paint.

FRANK W. SPOHN
READING, PA

*If you are interested in just cleaning a dirty wall, you can use soap and water. A gentle liquid soap, such as Ivory, is good. Rub the wall down lightly with a towel or sponge. Don't scrub too hard, or you will create a slight gloss by removing the pigment. **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 retaining wall should have adequate drainage behind it. This reduces the hydrostatic pressure on the wall, and the cracking and heaving caused by such pressure.

NEW PRODUCTS

OZONE-FRIENDLY PAINTS

BY MERLE HENKENIUS

● If you can remember when you first heard the term ozone layer, and the fact that it's in trouble, there's a good chance you associate it with propellants used in aerosol spray cans. Although it seemed hard to believe that such a small, taken-for-granted component of modern life could be responsible for affecting life in the largest sense, our environmental watchdogs assured us it was true and that something had to be done.

Well, limiting the types of aerosol propellants was a start. But today, halting the depletion of the ozone layer means taking bold and sweeping steps to control what we allow to drift up through the atmosphere. One of the major thrusts in this direction concerns volatile organic compounds, or VOCs. And, like changes in aerosol spray products before, VOC regulations will affect both industry and consumers. As far as homeowners are concerned, one of the big changes will take place in reformulated paints and finishes. The question is: Will these new regulations raise the cost and lower the quality of residential paints?

VOCs, paints and finishes

VOCs are released from fossil fuels, dry-cleaning solvents, hair sprays, lacquers, thinners, paints, stains, degreasers and a dizzying array of other familiar products. The VOC problem was first addressed by the Clean Air Act of 1970, which has since been expanded and amended by more stringent requirements.

In the case of the paint industry, compliance with the regulations means reformulating paints and finishes to reduce the amount of VOCs that evaporate into the atmosphere. Quite simply, this is done by lowering the solvent levels in each product. (While water is technically a solvent, we'll use the term to designate fossil-fuel solvents.) VOC levels are measured in grams of solvent per liter, and current regulations limit VOC content to 250 grams per liter. Paint manufacturers have been quick to reformulate products that are easy to bring into compliance, while waging technical battles with regulatory districts on the rest. However, no one we spoke with really wants to maintain previous levels of VOC emissions.

The issue is one of defining limits.

As you might expect, it's been fairly easy to lower the VOC solvent content in water-borne (latex) paints. This has already been done with little or no effect on price or quality. If you use water-borne paints, VOC regulations will have little effect on your paints or your painting.

In fact, this is a delineating point in the industry. Large manufacturers that target the nationwide residential market feel little of the strain of those in product categories such as varnishes, sealers and stains, for example. Glidden's Jim Sainsbury estimates that nearly 95% of the paint sold to homeowners is of the water-borne variety. In fact, some of the D-I-Y merchandisers supplied by Glidden don't even carry traditional solvent-borne paints.

The reasons are simple enough and have little to do with environmental issues. Even before latex paints were very good, they appealed to homeowners. Latex paints clean up easily, have short drying times and emit less odor than solvent-borne paints—all important factors when you live in the rooms that you're painting.

A quality issue

Solvent-borne paints, also known as oil-base paints, are another matter. To understand why they exist, it helps to look at their evolution. As recently as 100 years ago, paints were custom-made by painters in a process that involved grinding natural pigments into a natural-oil carrier, such as linseed oil. Around the turn of the century, synthetic pigments and stabilizers supported uniform manufacturing on a large scale.

In the '30s and '40s, synthetic oils (alkyds) were formulated and gradually took over the market. Alkyds offer great product uniformity and provide a good base for the qualities we've come to expect in paints, such as evenly suspended color, short drying times, good bonding properties, cleanability, color fastness, hardness and good leveling characteristics (the ability to smooth out brush strokes and surface imperfections).

With today's technology, however,



these qualities fall off dramatically when the solvent content drops below 380 grams per liter. When solvents are reduced substantially, pigments and hardeners are less likely to remain suspended, drying times are extended to five days or more, more coats may be required due to poorer leveling characteristics and, ultimately, surfaces may require more frequent repainting.

Although certain heavy-duty water-borne varnishes have gained acceptance on a commercial level for use on industrial hardwood floors and gymnasiums, there's a general consensus at the residential level that consumer-quality water-borne paints

PHOTO BY MERLE HENKENIUS

don't hold up as well as the solvent-borne variety for high-traffic surfaces that require extra durability. Solvent-borne paints are also preferred by some homeowners and are recommended in certain problem situations, such as ocean-front housing.

One could argue that it's simply best to switch to water-borne paints entirely. While this may be one answer to stricter VOC regulations, it's not a totally satisfactory response. Some specialty solvent-based coatings needed at the residential level are not so easily substituted—spray paints, wood stains and wood-and-concrete sealers are a few examples. The traditional swimming pool finish is a chlorinated rubber paint that relies on high solvent content. While epoxy paints are a good substitute on indoor pools, they are subject to surface oxidation when exposed to sunlight. The result is a degraded surface, and the remedy is frequent repainting.

The larger picture

An unfortunate result of stricter regulations for paints is that manufacturers are affected in widely disparate degrees. While many large manufac-

turers (with their residential market share) have been able to reformulate fairly easily, it's the smaller, regional manufacturers that suffer most.

Quite often, these companies concentrate on commercial or specialty coatings—most of which are in the high-solvent category and require the most difficult and costly reformulations. Ironically, these are often the companies least able to afford expensive research-and-development programs. With nearly 1000 suppliers of architectural coatings nationwide, it's a safe bet that most fall into the regional or specialty categories.

Large company or small, development costs are sure to appear as price increases. When asked how large an increase, Robert Wendall, a representative of the Dunn-Edwards Co., tentatively speculated that complete reformulation could add 30% to 100% to the prices of some products.

Setting the standards and enforcing them have been difficult issues—for both sides. While the federal government sets guidelines and deadlines as to VOC limits, including automotive and industrial emissions, it's up to individual environmental con-

trol districts to set specific industry standards. Large states may have several districts, each with its own air-quality problem. And, because enforcement is most manageable at the point of purchase, that's where the controls are often focused. Products that may be in compliance in one district may not be in others.

Manufacturers argue that aside from being unattainable, some restrictions are also poorly reasoned. For example, if a paint's quality is substantially reduced by lower solvent levels, more coats and more frequent repainting will be required. In that case, wouldn't the cumulative VOC emissions be greater than that of a single coat of a high-quality, high-solvent paint? This argument was prominent in a successful lawsuit brought against a California district by 22 manufacturers and distributors of architectural coatings.

While a 250-grams-per-liter limit is the target, the industry has been given a number of extensions at the 380-grams-per-liter level. These extensions have just about run their course, however, and some manufacturers may not survive the storm. **PM**

NEW TOOLS

TWO SAWS FROM SEARS

● Sears is pitching its new radial-arm saw and its sliding compound miter saw as machines that can satisfy the hobbyist who wants a powerful machine or the contractor who needs one. Both saws are equipped with 8¼-in. blades, and the radial-arm saw also comes in a 10-in. size.

The compound miter saw can cross-cut a 2 × 12 at 90°, and the radial-arm saw can reach across a board 15½ in. wide. Cutting depth capacity is similar on both saws—the radial-arm saw cuts to 2¾ in. deep, while the compound miter saw reaches to 2½ in. The horsepower and amp ratings are close, too. The radial-arm saw is slightly more powerful with a 2½-hp, 13-amp motor versus the compound miter saw's 2-hp, 10-amp motor.

The motors, however, are quite different. The compound miter saw has an induction motor, and the radial-arm saw has a universal motor. Although induction motors are preferable in most woodworking machines, our contact at Sears says the tradeoff was necessary on the radial-arm saw



because the company couldn't get an induction motor to fit the saw.

Both saws will cut dados. Like any radial-arm saw, you can raise the head on this model so it cuts across the face of the board and not completely through the thickness. In a similar manner, with the compound miter saw, you can lock the head pivot and then pull the head across the stock.

If you have complex angle cutting planned, you might find it helpful that the base on the compound miter saw has rafter and crown molding angle references.



The sliding compound saw weighs about 70 pounds, largely due to its cast-iron base and induction motor. With its particleboard worksurface, the radial-arm saw weighs 74 pounds.

The radial-arm costs about \$280, and the sliding compound miter, about \$450. Both are sold through Sears stores and through the company's 1991-'92 Power and Hand Tools Catalog. For more information, write to Sears, Roebuck and Co., Dept. 903-PM, Sixth Floor, Sears Tower, Chicago, IL 60684.

—Roy Berendsohn

HOME IMPROVEMENT

INSTALLING AN AIR CONDITIONER

BY PAUL BARRETT; PM Illustrations by Don Mannes



● If you are among those people who find that a window-mounted air conditioner fulfills your cooling needs, you might want to consider installing a through-the-wall air conditioner. These appliances provide the same amount of cooling as a window-mounted appliance without taking up any valuable window space, and they are

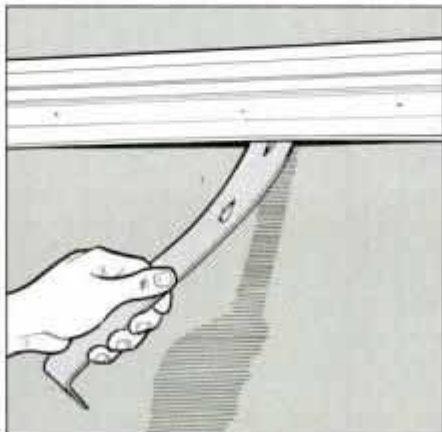
not difficult to install yourself.

Don't plan, however, on using a window-mounted air conditioner for a through-the-wall installation. There will not be enough airflow around the appliance, and you could have further problems with condensation leaking into the wall cavity.

A through-the-wall air conditioner



1 Pry baseboard off the wall and remove outlet covers. You may see stud markings on wall framing behind baseboard.



2 If the installation is below a window, it may be necessary to remove the window apron with a flat bar.

has a sleeve that supports it and ensures sufficient airflow. The sleeve also directs condensation to the outside of the house.

Where to install it

Install the air conditioner on a wall that allows the cooled air to flow freely into the house. And, it's best to install the unit on a wall that already has electrical service. However, major rewiring may be needed if the circuit is already crowded or if your appliance requires 220 volts.

Unless you are going to plug the air conditioner into a nearby wall outlet (as in our case), hire an electrician to do the wiring. This is especially important when the air conditioner needs 220 volts, or when the service panel is old and crowded.

We installed our air conditioner under a window. The weight of the wall was supported by the framing over the window, so this simplified the job.

Building the frame

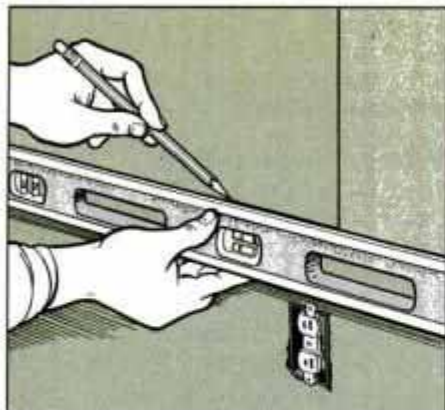
Begin by removing the baseboard and—if necessary—the window trim in the area of the installation (Figs. 1 and 2). To do this, use a nailset and drive the finish nails holding the trim out the trim's back side. If the trim is painted and the nails are not visible, simply pry it off with a flat bar. Remove any outlet covers that will be in the way.

Draw the outline of the air-conditioner opening on the wall using a level (Fig. 3). Then, find the studs in the installation area. We used an electronic stud finder (Fig. 4). Another way to find studs is to darken the room and shine a light along the wall. The nails that hold the drywall to the studs often are backlit as rows of little bumps. In other cases, you may see markings for wall studs (an X mark) along the wall framing where the trim was removed. The other option, of course, is the method of tapping along the wall. As you tap the drywall over the stud, you'll notice a significantly different sound. Test for a stud at that location by driving a finish nail.

Once you find a stud, you should have no problem locating others—they should be 16 in. on center from the one you have located.

Locate a stud on each side of the opening, and draw a plumb line in the center of it, to the floor. Then find a stud beyond the other side of the installation and mark it.

Remove the drywall by cutting along the lines with a utility knife. If



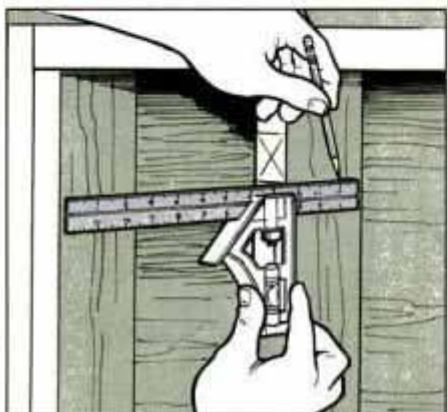
3 Using a level, pencil in the vertical and horizontal lines of the opening for the air conditioner sleeve.



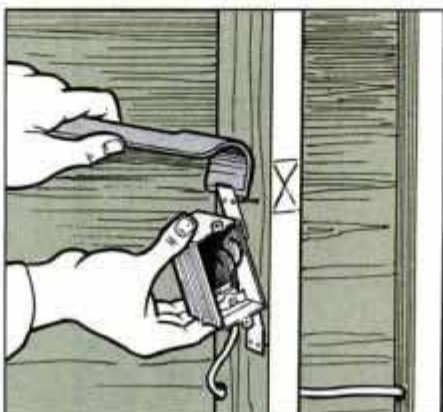
4 An electronic stud finder is one way to locate wall framing. Mark stud location with a small vertical line.



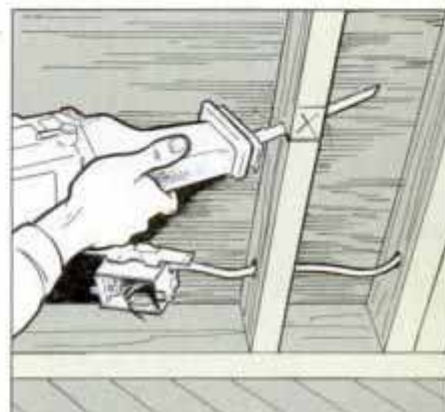
5 Remove drywall with plumb cuts centered on studs. Using a level, draw the opening across edge of each stud.



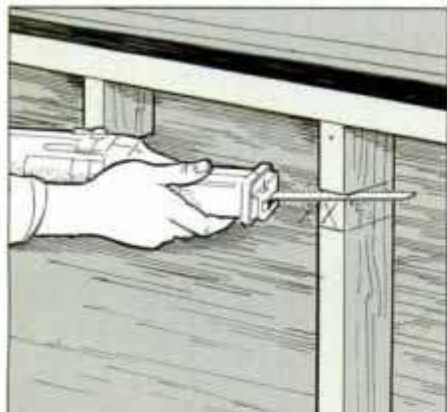
6 Draw an X on each stud to indicate location of new framing. Use a combination square when marking on stud's surface.



7 After the power is disconnected, remove the outlets and switches by prying them off the stud.



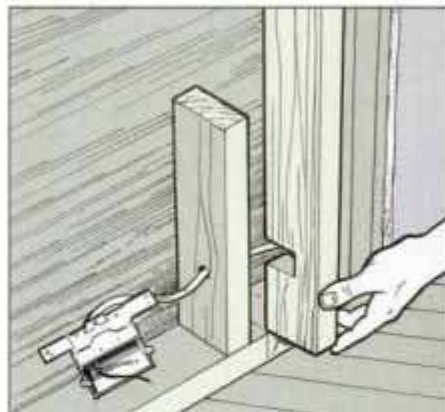
8 Rent a reciprocating saw or use a short handsaw to cut the studs below the X mark (at base of the opening).



9 At the top of the stud, saw above the X mark. Be sure to avoid cutting through the plywood sheathing.



10 Toenail a 2 x 4 on the X mark. Start with the stud slightly to one side—toenailing drives it into position.



11 Where necessary, notch new studs to fit around wiring. Try not to remove more than two-thirds of the stud's width.

you manage to remove a large piece of drywall, save it for later.

You will need to build a rough frame to support your air conditioner. It consists of two vertical 2 x 4s on the sides of the opening, a horizontal 2 x 4 at the bottom of the frame called the sill, a horizontal 2 x 4 at the top of the frame called the header and shorter 2 x 4 blocks above and below the opening called cripples. For toenailing, use 8d common nails. All other framing is fastened with 12d common nails.

The rough frame is slightly larger than the sleeve that supports the air conditioner by about 1 in. in both width and height. This space allows for shims (wood scraps or cedar shingles) to be slid between the sleeve and the frame.

Mark the location of the frame members, using a level to draw across the studs (Fig. 5). Mark the position of each horizontal member with two lines and an X (Fig. 6).

Disconnect the electrical power to

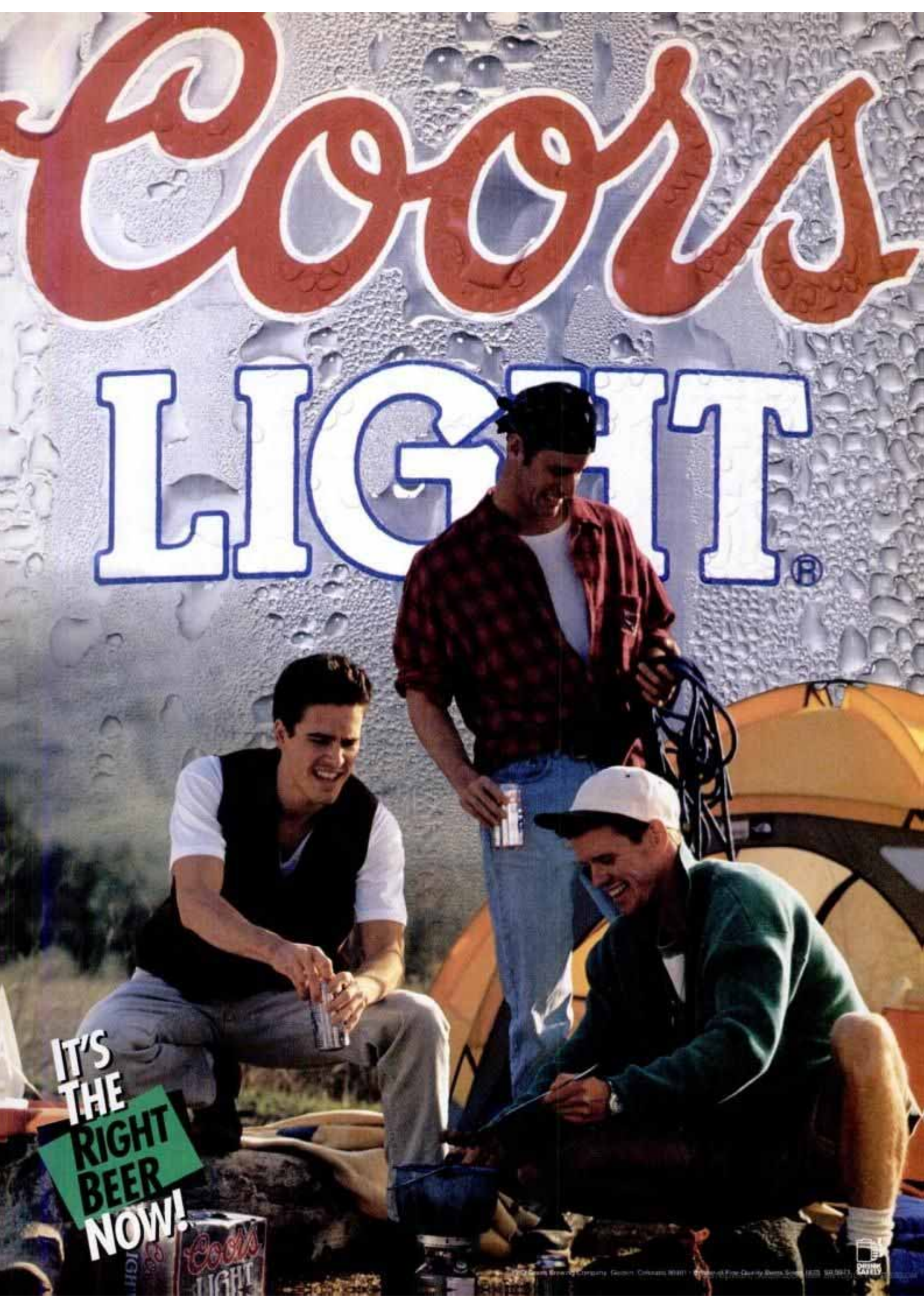
any outlets that need to be moved, and free the outlets from where they're attached (Fig. 7).

Use a reciprocating saw to cut away the stud where you will later nail the sill and the header (Figs. 8 and 9). Do not cut through the sheathing, however. Pry the stud sections off the sheathing, then clip off the nails protruding through the sheathing using end-cutting pliers.

Nail the studs on their marks to form the sides of the frame (Fig. 10).

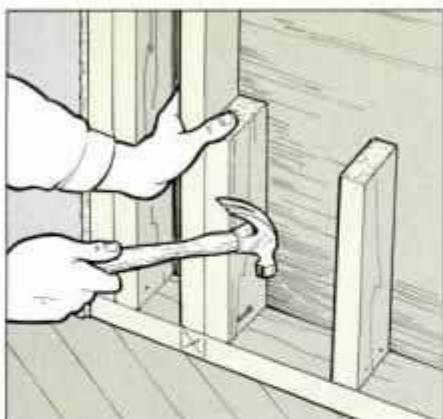
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12 Toenail short studs, known as cripples, into the 2 x 4s that form the bottom plate and the vertical frame member.



13 Toenail the sill into the vertical studs, and nail directly through the face of the sill, into the end of the cripples.



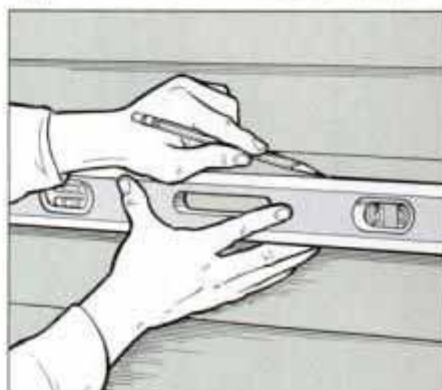
14 Before installing the header, start toenails at corners. Nail the header to the cripples above it, then drive in toenails.



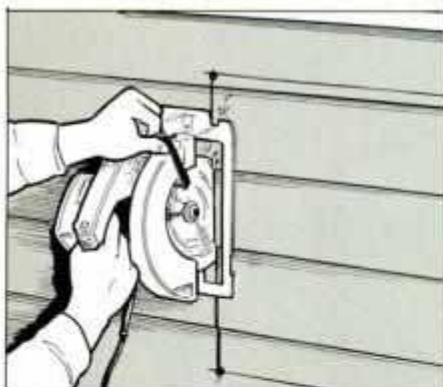
15 Position the electrical box right below the sill, and screw or nail the box to the cripple studs.



16 To mark the location on the outside of the house, bore through the sheathing and siding at each corner of the opening.



17 Connect the four holes with a pencil line. Use a level or a straight piece of lumber to guide the pencil.



18 Cut from hole to hole with a circular saw. Finish cuts at the corners with a hand saw. Then, remove the square.

Notch the studs, where appropriate, to clear wiring (Fig. 11).

Crosscut cripples to fit against the studs, and toenail them in place (Fig. 12). Nail the sill into the stud next to it and into the cripples below it (Fig. 13).

Crosscut the header so it fits tightly between the studs, and start the toenails at its corners. Wedge the header in place and drive nails through it into the cripples above it. Next, drive the toenails at the corners of the frame

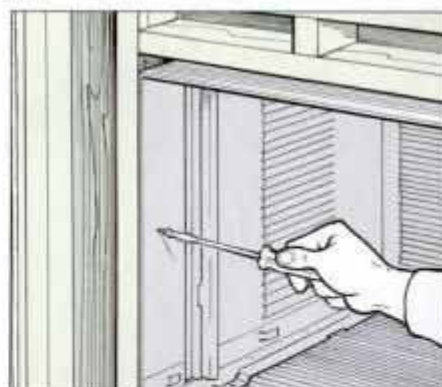


19 Position and shim the sleeve in the frame with flashing tucked under the siding. Drill holes to attach the sleeve.

(Fig. 14). Then reattach the electrical box (Fig. 15).

To mark the opening on the outside of the house, bore through the sheathing with a small diameter drill (Fig. 16). Connect the holes on the outside of the house with a pencil line, guided by a level or a straight piece of lumber (Fig. 17).

Set a circular saw for a shallow cut, and cut along the lines (Fig. 18). Cut just to the corners of the lines and



20 Screw the sleeve to the frame. Drive four screws in both sides, and in the bottom and top shim behind the screws.

finish the cut with a handsaw. Then remove the square.

Installing the sleeve

Slide the sleeve into the opening, and shim it so it tips outward slightly from level to drain condensation. On the inside, the sleeve should project about 1 in. beyond the frame. Check your installation manual for specific clearances. This positions the sleeve's edge 1/2 in. beyond the typical 1/2-in. drywall surface.



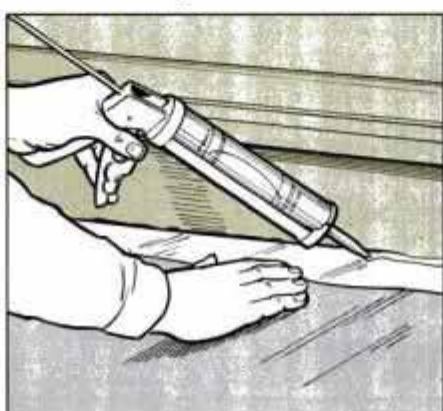
21 Drill through the flashing into the sleeve's top with a $\frac{3}{16}$ -in.-dia. drill. Space holes about 4 in. apart.



22 Lift flashing slightly and apply a generous bead of silicone or other exterior caulk under the flashing.



23 Rivet the flashing to the air-conditioner sleeve. Smooth the caulk that is squeezed from under the flashing.

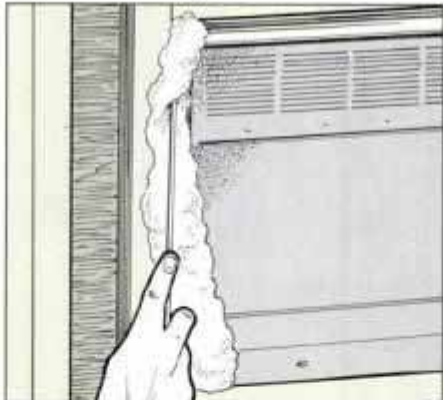


24 Spread caulk along the top of the flashing, along flashing's front edge, on top of rivets and down sides of sleeve.

Cut a piece of 20-ga. aluminum flashing slightly longer than the width of the sleeve. Bend it in half, along its length, so it forms a right angle. Use this piece as flashing at the top of the sleeve. Slide one side of the flashing under the siding to seal the joint where it meets the sleeve.

To prevent distorting the sleeve when you screw it to the framing, place a shim between the sleeve and the frame everywhere you intend to drive a screw. Bore through the cabinet, the shims and into the frame, and screw it to the frame (Fig. 19). We used four 1-in.-long No. 10 panhead wood screws, but any roundhead screw of the same length will work. Use four screws for each side, and on both the top and bottom (Fig. 20).

Once the sleeve is fastened to the frame, move to the outside of the house. Bore through the flashing and into the top of the sleeve with a $\frac{3}{16}$ -in.-dia. drill. Space the holes about 4 in. apart (Fig. 21). Wipe away shavings and spread a bead of exterior caulk under the flashing (Fig. 22). Rivet the flashing to the top of the sleeve with $\frac{3}{16}$ -in. rivets. Smooth the caulk that squirts from under the



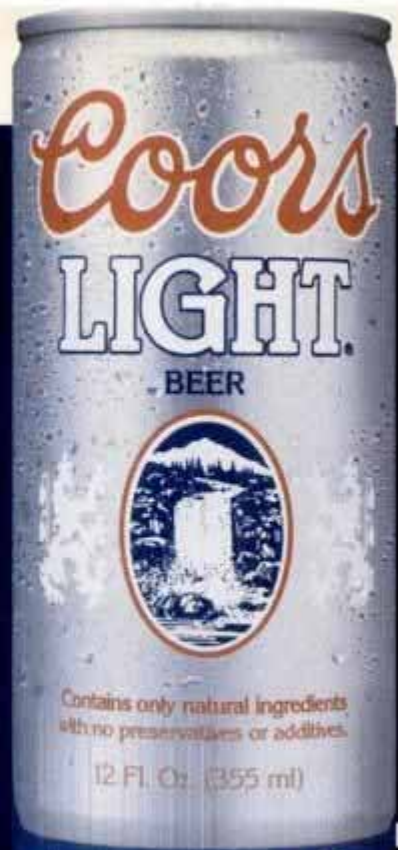
25 Pack fiberglass insulation with a screwdriver into the space between the sleeve and the frame.

flashing, and spread another bead of caulk between the flashing and the siding (Figs. 23 and 24). Caulk the top of each rivet head.

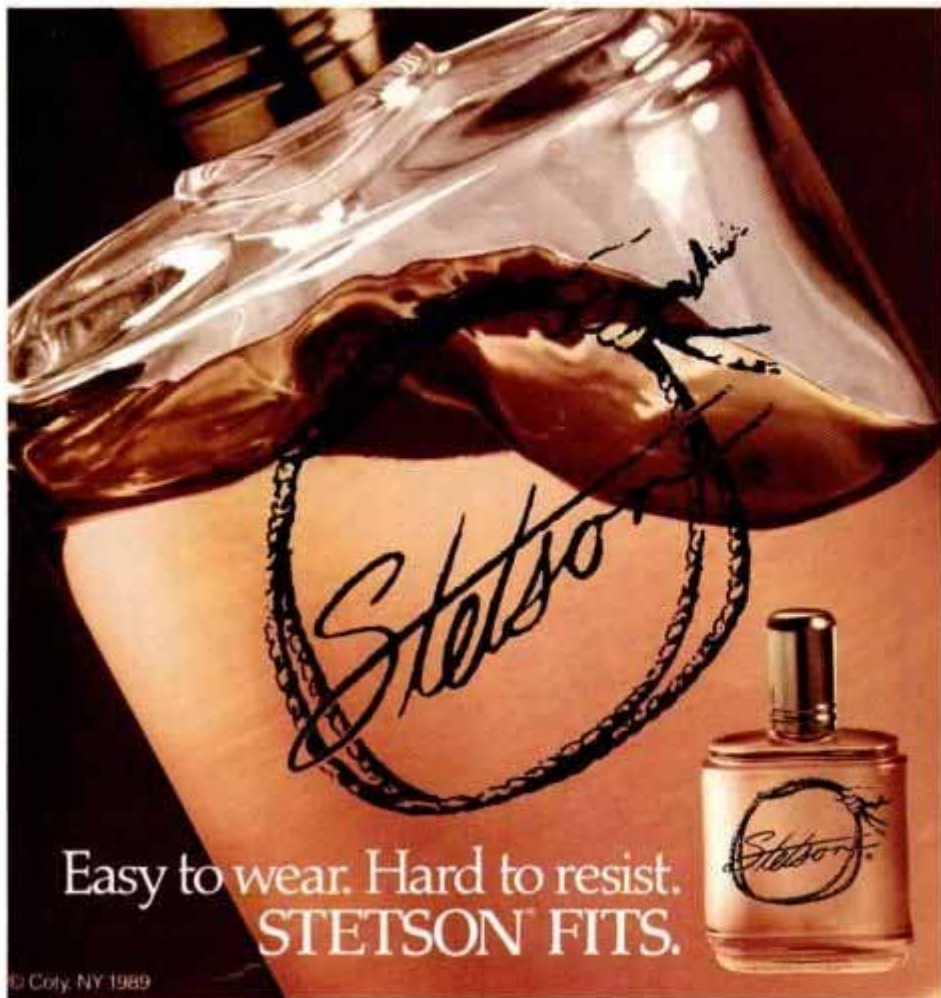
Return to the inside of the house and pack insulation loosely between the sleeve and the frame (Fig. 25).

Cut a piece of drywall to fit around the sleeve and nail it in place (Fig. 26). Finish the drywall joints with joint compound and tape. Then, prime and paint the drywall after the trim is installed.

Fit the cover over the sleeve before



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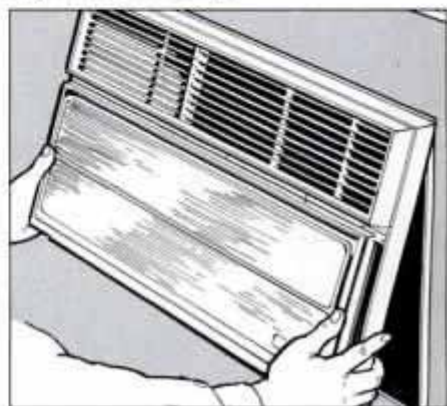
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HOME&SHOP JOURNAL



26 Cut drywall to accommodate the sleeve, and nail it to the wood frame and adjacent wall framing.



27 Fit the cover over the sleeve before measuring for the trim that will surround the air conditioner.



28 Cut and miter door casing around the cover. Leave a slight gap between the edge of the trim and the cover.

measuring for the trim that surrounds it (Fig. 27). And, miter the trim to fit around the air-conditioner cover (Fig. 28). There should be a slight gap between the trim and the cover to allow the cover to be slid on and off the sleeve.

When you're done, simply slide the air-conditioning unit into the sleeve, according to the manufacturer's instructions. Then plug it in, turn on the power and cool off.

PM

CAR CARE

CAR CLINIC

BY MIKE ALLEN,
Associate Automotive Editor

Cruisin' The Belt Parkway

My mechanic says it's time to replace the rubber timing belt on my car before it snaps and destroys my engine. Is this necessary? The car only has 50,000 easy miles on it. He says none of those belts last longer than 60,000 miles—but the maintenance schedule in the owner's manual doesn't say anything about ever replacing the belt.

TOM JENNINGS
KNOWLES, TX

Rubber timing belts have a finite lifetime. Some engines are not tolerant of a failed belt—there's not enough clearance between the valves and the top of the pistons when the camshaft stops turning and the crankshaft continues. The valves will lose this argument every time.

Other engines don't have this particular problem—but there's still the inconvenience of the engine stopping abruptly when the belt fails late some dark and stormy night far from home.

Should you replace your belt at 60,000 miles? Probably—it's inexpensive insurance. Should you replace it sooner? Maybe.

Illustrated here are some of the common failure modes of the rubber timing belt. Most cars use a belt that costs less than \$20—so if you're tearing off the protective covers to check the belt, it's poor economy not to simply install a new one.

Also shown is a severely worn sprocket, probably as a result of being driven under dusty conditions and minus the protective covers. Be sure to install the covers, even if you never drive down dusty roads—snow or the occasional pebble are perfectly capable of popping the belt if they manage to get into the works.



Where There's Smoke...

My 1982 Cressida blows out blue smoke when I accelerate after letting the engine idle for 15 seconds or so. This doesn't happen at cruising speed—even if the accelerator is pressed to the floor. A compression test came out fine, and gas mileage is fine. What's wrong, and do I have to fix it right away?

WILLIE SALMINEN
ROCHESTER, NY

It's probably the valve guides. The high manifold vacuum at idle is pull-

ing oil past the seals as the valves rock back and forth in the worn guides, and the oil pools inside the clearance in the guide. Then when you run the revs up, all the oil gets sucked into the cylinder and burns.

Do you have to get this fixed right away? Probably not. If your compression stays high, and consistent among all four cylinders, then the valves are still sealing to the seats. But if oil consumption starts to go up rapidly or you lose compression in one or more cylinders, it's time to pull

CAR CARE

the head before one of the valves fails and really does some damage.

You might get an estimate for replacing just the valve stem seals. This can be done by removing the camshaft, holding the valves shut with compressed air pumped into the spark plug hole and then removing the valve spring.

I'd start scraping my money together for a valve job, a rebuilt engine or, better yet, a new car.

Going Steady

The temp gauge of my '88 Grand Am keeps cycling back and forth between 190° and 210° F, until the car has been driven for a considerable distance.

Also, I can hear air bubbling out of the radiator cap after the engine is shut off. But there's never any coolant missing. The exhaust doesn't smell of burning antifreeze.

I've replaced the temp sender, thermostat and radiator cap, pres-

SERVICE TIPS

● Chrysler TSB 07/03-91A details diagnosis of chirping or snapping noises that may sound like electrical arcing or a bad alternator bearing. It suggests using a spray bottle filled with water to check for pulley misalignment which may be the real cause of the noise. Spray water onto the belt—if the noise subsides momentarily the pulleys are out of alignment. It may be necessary to shim pulleys to correct this problem.

● If your 1988 or '89 GM van has an intermittent no start, dead battery, faulty dash lights and a CODE 24 (vehicle speed sensor) condition, check for water intrusion into the bulkhead electrical connector through the hinge seal slot. If so, disconnect the connector, inspect and clean all of the contacts, grease with chassis grease and reinstall. TSB 89-8b-123

● If your SAAB 900 or 9000 has intermittent idle problems, possibly caused by a bad automatic idle control (AIC) valve, TSB 10/88-1081 has the correct procedures for checking out the valve with a digital voltmeter.

sure tested the system, and verified the proper operation of the electric cooling fan.

HAROLD BORDERS
PAINT LICK, KY

The cycling of the temperature is caused by the thermostat alternately opening and closing. As the 'stat opens, the temp momentarily goes down as a plug of cool water from the radiator is flushed through the engine. Then the 'stat closes as the engine cools. Whereupon the temperature goes up and forces the 'stat closed. Eventually, there's an equilibrium reached, and the 'stat stays open part way.

As for the bubbling, that's steam forcing its way past the radiator cap into the overflow reservoir. The engine is still plenty hot after it's shut off. Coolant will boil in the hotter areas for a few minutes. Once the engine cools off, the condensed liquid coolant in the reservoir will be sucked back into the radiator.

Steamy Situation

Last fall, my 1987 VW Golf started to do some strange things. Turning the heater to the defroster setting would make the windshield fog up almost instantly. No matter how long it's on or how hot it gets inside the car, the window never clears up. To top it off,

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CAR CARE

smoke comes out of the heater vents, and there's a constant smell of, if you can believe it, maple syrup. I'm losing coolant at a very steady rate.

It seems to me like the defroster isn't powerful enough to clear the window. I've tried using antifog compounds.

JAMES GIANOTTI
NO ADDRESS GIVEN

You're describing the classic symptoms of a leaky heater core. The moisture and sweet smell come from the coolant leaking into the car. That's where the coolant is going.

But you don't get much heat when there's not enough liquid in the system to get to the heater core. You've got either a pinhole in the heater core (a big chore to replace) or a leak where the hoses clamp onto the fittings (which might mean a simple repair by tightening the hose clamp one turn with a screwdriver). **PM**

DO YOU HAVE A CAR PROBLEM?

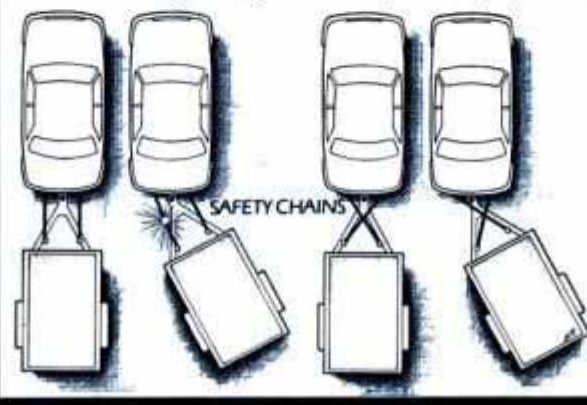
Just ask Mike about it. Mail your question to Car Clinic, Popular Mechanics, 224 W. 57th St., New York, NY 10019. While letters, faxes or phone calls cannot be answered individually, problems of general interest will be discussed in the column.

All Crossed Up

● I finally got to hooking up the race car trailer to yet another truck last weekend, and had to deal with making up a new set of safety chains, as the last set had mysteriously walked off last winter.

Remember that safety chains have lifesaving responsibilities in the eventuality of the hitch disconnecting. So don't scrimp—use heavy-duty chain capable of keeping the trailer with you until you can stop.

But give them an even chance—use the shortest length you can make work. And rig them crisscross under the tongue, rather than straight fore-and-aft. Check the diagram below. Chains need to be kept from dragging on the ground, but still be long enough to permit cornering. Crossing improves the geometry considerably. If the chains run straight back from the hitch, they'll tighten up as you turn. Make them long enough to corner, and they'll probably drag on the ground. But if they cross, the distance between where they attach to the hitch and the tongue remains more constant.



A side benefit is that if the hitch ball comes out, the tongue will fall onto the crossed chains, and not onto the ground. Got only one safety chain? Not a good plan.



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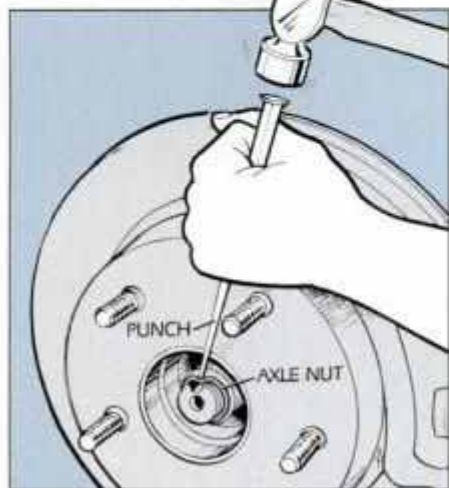
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MAINTENANCE BASICS

WHEEL BEARING

BY DON CHAIKIN,
Contributing Editor



Wheel bearings on many new cars have a nut which is peened into a locking groove and must be discarded after it is removed.

- The bearings in your car's non-drive wheels need to be periodically inspected, cleaned and lubricated.

Jack up the end of the car that you will be working on, and support it on safety stands.

- Spin the raised wheels—the parking brake must be released if you are inspecting the rear wheels. The wheel should spin smoothly with no squeaking, shrieking, grinding or rattling. Do not confuse the scraping noise of brake pads dragging on the brake rotor with bearing noise.

- Be certain that the wheel's lug nuts are snug, then grasp the tire at top and bottom and try to rock the wheel in and out. You should not be able to feel any discernible movement. If you can feel any looseness or roughness, or if you have not cleaned the bearings and repacked them with grease in 30,000 miles or so, disassemble and clean them.

- With the tire and wheel off, pry the dust cap from the middle of the hub. If the nut is held by a cotter pin, remove and discard it. Install a new cotter pin later. If your car uses a special lock-nut, use a long punch to unlock it from the slot in the axle. Use a new nut when you reassemble. Use a socket on a ratchet to undo the nut. Rock the hub to remove the retaining washer and outer bearing.



- Slide the hub off the axle and place it on two blocks of wood. Use a long drift or punch to knock the grease seal out of the back of the hub. The inner bearing will fall out with the seal.

Thoroughly clean all the pieces with mineral spirits. Allow the bearings to dry by themselves on a clean cloth.

- Carefully inspect each roller and the thin metal cage that holds them. Also inspect the bearings' outer races—the hard metal ring that is



A bearing that shows chips, spalling or deep scratches must be replaced.

pressed into the hub—that the rollers run against.

Any deep scratches, spalling, chips or heat discoloration means the bearing must be replaced.

- Pack the cleaned bearings with fresh wheel-bearing grease. Do not use multipurpose grease. Force the grease into and around all of the rollers. Also fill the cavity in the wheel hub at least one-third full with grease.

- Place the inner bearing back in the wheel hub and install a new seal. Use a ball-peen hammer against a block of hardwood or a hockey puck to seat the new seal.

- Carefully slide the hub onto the axle shaft, and replace the outer bearing and the retaining washer. Spin the hub as you tighten the retaining nut.

Check your carmaker's specifications for tightening the retaining nut.

- Insert a new cotter pin—loosening rather than tightening the nut to align the nut's slots if necessary—and bend over its ends or peen down the tab of a new nut for cars that use special locking retaining nuts.

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HOW IT WORKS

INDEPENDENT SUSPENSION

BY DON CHAIKIN,
Contributing Editor

● All vehicles are equipped with a suspension system, which not only carries the vehicle's body, frame and load, but simultaneously insulates the driver and passengers from dips, bumps, holes and other road hazards while keeping all the tires firmly planted on the road.

The last two tasks translate into ride comfort and road handling—and successfully accomplishing both often requires compromises. The extent of the compromise depends on the intended purpose of the vehicle.

Based largely on complexity and cost, carmakers use a variety of different suspension systems. The system that will dovetail with the largest number of differing requirements is a fully independent suspension.

Independence!

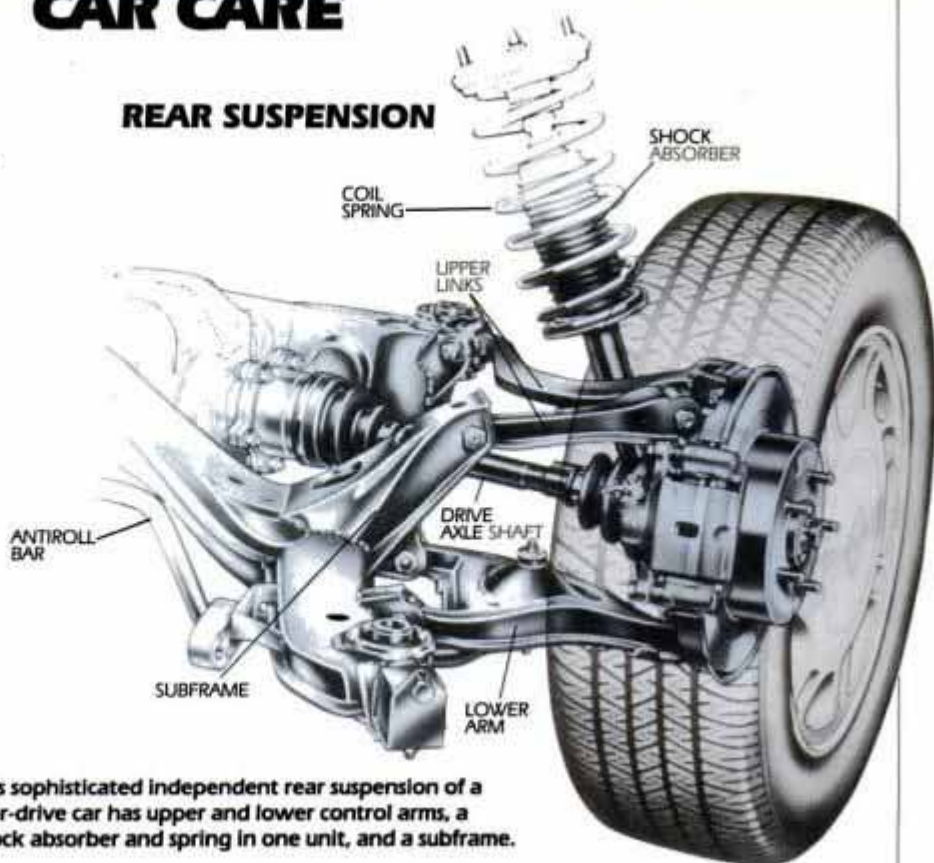
An independent system is simply one in which each of the vehicle's wheels is free to react totally separate from any of the other wheels. If the right rear wheel hits a bump, the left rear wheel is undisturbed. Since the whole car does not bounce and shake every time one of the wheels hits a pothole, passenger comfort is greater than in cars without fully independent systems. And, since the other three tires maintain full contact with the road surface, road holding is also superior.

More complicated than it sounds

The essential components of each suspension system is a spring at each wheel to absorb the road's shocks, a shock absorber that controls the spring (see "Shock Absorbers," page 80, Jul. '91) and various arms and links which actually connect the wheel to the car.

While the car's ride softness can be tailored for varying degrees of comfort through the choice of the firmness of springs, shock absorbers and assorted rubber bush-

REAR SUSPENSION



This sophisticated independent rear suspension of a rear-drive car has upper and lower control arms, a shock absorber and spring in one unit, and a subframe.

ings, the car's handling is also critically affected by the configuration of all of the pieces.

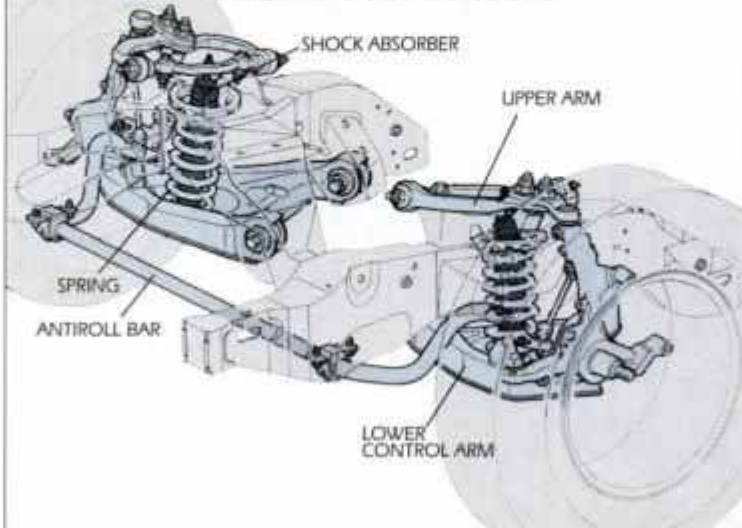
For optimum road holding, each tire must keep the maximum amount of tread in contact with the road under all conditions. To do this, the independent suspension is designed to keep the wheels as close to perpendicular to the road as possible when they move up and down over bumps and the car leans in corners. The upper and lower connecting arms and links—collectively called upper and lower control arms—are attached at the top and bottom of the wheel. The

control arms pivot at both ends—at the wheel and at their connection to the car body. The design causes the control arms to remain essentially parallel as they move up and down with the wheel and as the wheel stays close to perpendicular to the road.

In addition, to keep the wheels from turning or splaying in and out due to any force other than from the steering system and adversely affect handling, the upper and lower control arm mounts keep the wheel from twisting or deflecting during cornering or after hitting a bump. This is accomplished through careful positioning of the arm and link mounts on the car. The positions of these mounting points also control the amount the body squats or dives when the car's weight shifts as it accelerates or decelerates.

However, when the car corners, the body leans to the outside and puts all the load on the outer tires, unloading the inner tires and allowing them to lose some of their effectiveness. To help keep the tread of the inside tires on the road, the left and right suspension components are tied together by a long, transversely mounted metal rod called an antiroll bar.

FRONT SUSPENSION



Typical independent front suspension for a rear-driver has the shock absorber and spring mounted between the upper and lower control arms.

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SATURDAY MECHANIC

DIAGNOSING OXYGEN SENSORS

BY JOHN DECKER

● You're running late for work, again. Your car starts fine, runs perfectly for the first few frantic minutes. But just as you enter the highway, it starts to stumble, making you spill hot coffee on your pants. And when you press on the gas, the engine surges. Worst of all, the CHECK ENGINE light is on.

You know you don't need a tuneup. You're worried that the car's computer might be shot. It could be, but it's not likely. A likely culprit is the O₂ sensor, or it may be an engine problem that causes the sensor to act up.

The sensible sensor

In a world of high-tech engines, it's nice to know that the O₂ sensor is extremely simple: It tells the engine computer how much oxygen is left in the exhaust.

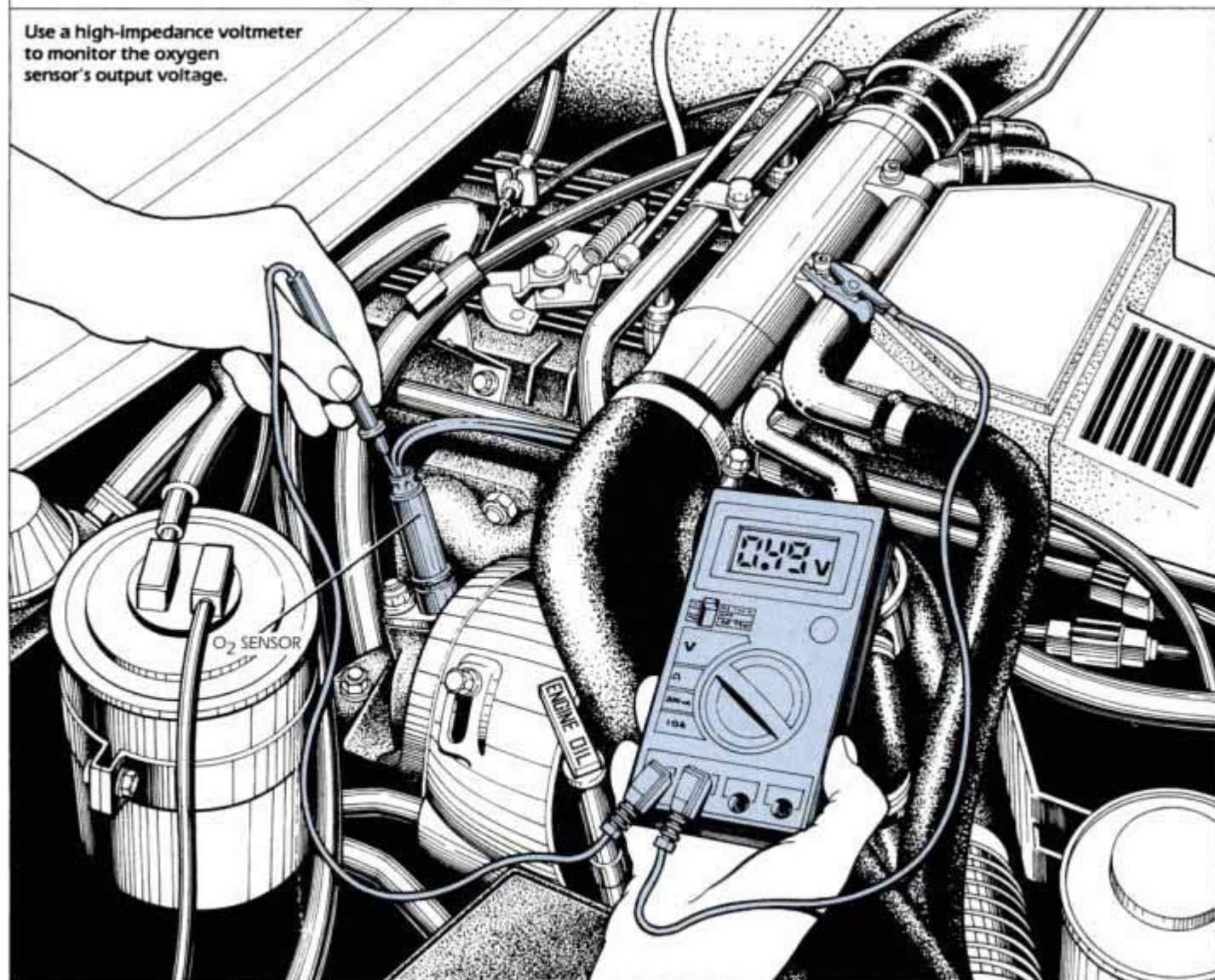
By analyzing exhaust gas oxygen levels, the engine's computer can determine the best air/fuel ratio—something that became much more critical when cars got catalytic converters. For an internal combustion engine, complete burning occurs when there is about 14.7 parts air to 1 part fuel (by weight). The fancy scientific name

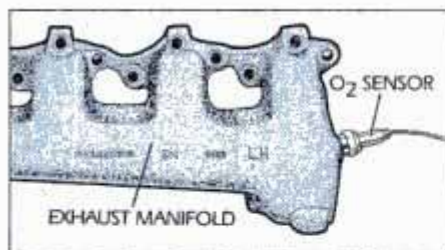
for this ideal 14.7:1 air/fuel ratio is stoichiometry.

If the O₂ sensor detects too little oxygen in the exhaust, it signals the computer that the engine's air/fuel mixture needs less fuel. Under these conditions, the engine is running rich. Too much oxygen indicates a lean mixture and the need for less fuel.

To perform its signal-sending feat, the O₂ sensor acts like a simple battery. The main portion of the sensor consists of a hollow ceramic finger. Outside air reaches the hollow inner portion of the sensor while the outer

Use a high-impedance voltmeter to monitor the oxygen sensor's output voltage.





The O₂ sensor can usually be found at the rear of the exhaust manifold.

portion sits directly in the exhaust stream. Both sides of the finger are plated with a porous platinum alloy. When the engine is running rich, there is little oxygen in the exhaust. That allows oxygen ions from the fresh-air side of the ceramic to push their way to the exhaust side of the ceramic, which, in turn, creates an electrical signal of about 1 volt. To the computer, that's a clear message to make the mixture lean.

When the engine runs too lean, sensor voltage drops because oxygen is present in equal amounts on both sides of the sensor, and there is no transfer of ions—an equally clear message to the computer that the engine is rich.

An important thing to remember, however, is that an O₂ sensor doesn't do anything until it's really hot (about 600° F). So when the engine is cold, the computer ignores all inputs and governs the air/fuel ratio based on its own programming. During this warmup phase, the engine is in open-loop mode.

Once the sensor is warm, the computer goes into closed loop, an endless cycle where the O₂ sensor switches back and forth between voltage (rich) to no voltage (lean), while the computer reads the switches and adjusts air and fuel accordingly.

A sensor can have as many as four wires coming out of it. If that's the case, two of the wires are simply grounds, the third wire is for sensor voltage and the fourth wire supplies current to a built-in heater that

warms the sensor so it can start sooner (about 400° F) when the engine is cold. It also warms the sensor when exhaust temperature isn't sufficient to do the job. Two- and 3-wire sensors may, or may not, have an auxiliary heater. Consult a manual to figure out which wire does what.

Sensor tests

When there's a problem that relates to the O₂ sensor, the computer knows about it right away. And it lets you know by illuminating the CHECK ENGINE light and storing the appropriate trouble codes.

For example, on some GM cars, Code 13 indicates that the sensor is not switching back and forth, even when the engine is warm. Code 44 indicates the sensor is constantly telling the computer the engine is lean. Code 45 indicates the sensor is constantly telling the computer the engine is rich. Other cars have different trouble codes for the same problems.

A set trouble code is not an automatic indication that the O₂ sensor isn't working. In fact, the opposite may be true. The sensor might be working perfectly and simply indicating that there are other problems. For example, a sensor that constantly indicates a lean mixture could mean that the engine is indeed really running lean all the time. The problem could be due to a vacuum leak, a bad EGR valve or a malfunctioning carburetor or injector. The sensor will also indicate lean operation if a cylinder is misfiring—since a misfire dumps all the oxygen from the unburned charge directly into the exhaust.

If the O₂ sensor constantly indicates a rich mixture, the problem could be the sensor. Or a malfunctioning carburetor, dribbling injectors or some other problem may be giving the engine too much fuel.

Sensor checks

If you suspect a sensor-related problem, start verifying whether the O₂

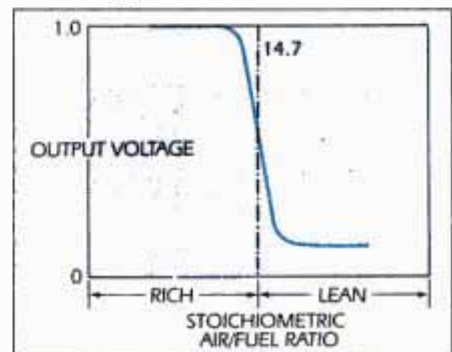
sensor is operating properly.

Start by making a visual inspection. The electrical connection should be clean and tight. Many sensor problems have been cured by simply unplugging and replugging the sensor's connector—which does nothing more than clean the terminals sufficiently to reestablish electrical connection.

Many sensors fail because the fresh-air intake on the outside of the sensor becomes plugged. Inspect the sensor for signs that the air intake is covered with engine oil, grease, dirt or undercoating.

If the sensor appears to be okay visually, you can check to see whether it is operating properly by using a high-impedance digital voltmeter.

Begin by connecting the voltmeter between ground and the sensor's con-



Sensor voltage swings sharply around the proper stoichiometric air/fuel ratio.

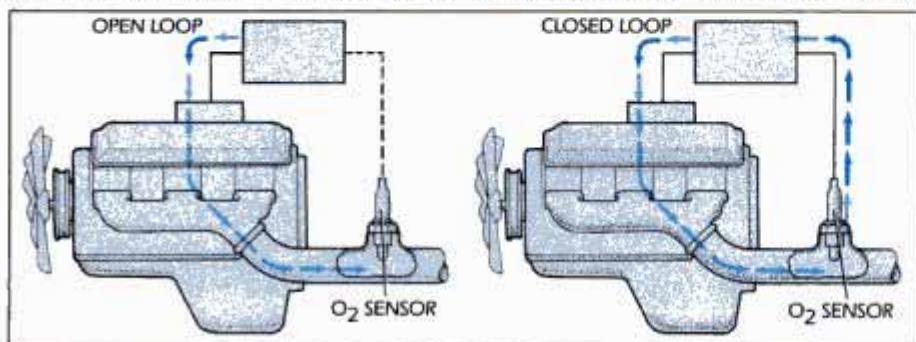
nect. If you can't get to the sensor connector, you might have to rig a jumper wire between the sensor and the wire. In any event, *don't* pierce the wire to establish contact, because the wire will eventually corrode enough to ruin the connection.

On GM cars, the voltmeter should read 400 millivolts when the key is on and the engine is not running. This reference voltage is generated by the computer. If you don't see it, disconnect the wire from the sensor and see if the reference voltage appears at the wire. If you do, it indicates that the sensor is shorted out and should be replaced. If the voltage still doesn't appear, then there is a problem with the wiring or the computer.

Once you've performed this test on General Motors cars, or you're working on another kind of car, start the engine and run it for a few minutes at about 3000 rpm. This will assure that the engine has gone into closed-loop operation.

Swinging the sensor

If the sensor is working normally, voltage will swing between about zero



The computer relies on feedback from the O₂ sensor to maintain closed-loop operation.

and 1 volt. If you see this voltage swing, it means the sensor is working as it should and the computer is changing the air/fuel mixture between rich and lean.

If you don't see the swing, you can use a 1.5-volt flashlight battery to determine if the problem is engine related or if it's caused by the sensor itself. With the engine running, disconnect the sensor wire and connect the negative side of the flashlight battery to a good ground and the positive side of the battery to the sensor wire. This fools the computer into thinking the engine is running rich. So it leans things out and should make the engine speed drop or even stumble as it goes lean. At the same time, voltage at the sensor should stay low, as the sensor reads the lean mixture.

Conversely, if you disconnect the flashlight battery and then ground the sensor wire, the engine should go rich and the sensor voltage should rise dramatically as the sensor indicates the rich mixture. You can tell the sensor is bad if these tests cause changes in engine performance but the sensor readings indicated on the voltmeter show the sensor isn't responding.

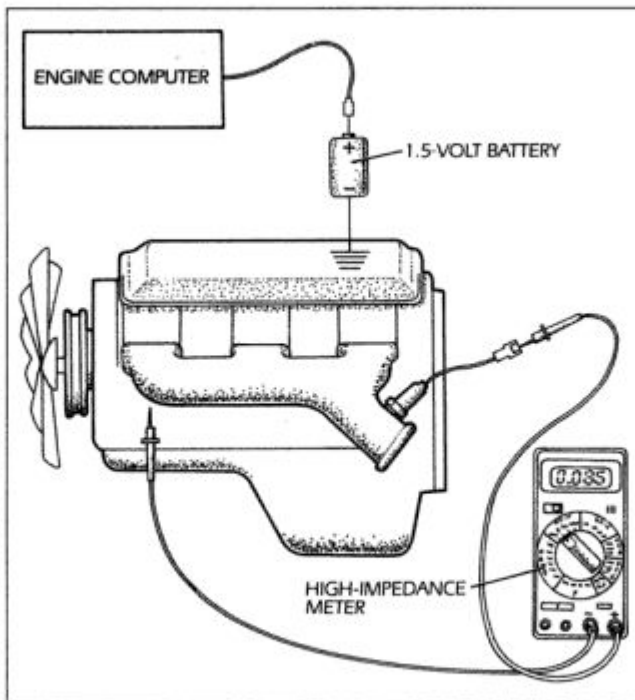
Once you find a bad sensor, you can simply replace it. However, there's a good chance the sensor will go bad again—if you don't find and correct the problem that caused the sensor to malfunction in the first place.

Sensor poisoning

A common cause of sensor failure is poisoning—the most likely candidates being lead, carbon and silicon. When one of these elements coats the ceramic, it no longer gets oxygen and the sensor either fails completely or gives erroneous readings. Excessive oil consumption can also cause failure as the burned oil deposits plug the sensor.

Lead poisoning shouldn't be a problem, unless you've been using a funnel to gas up with leaded fuel.

Carbon fouling of the sensor is similar to carbon fouling of the spark plugs. It occurs when the mixture runs too rich, coating the ceramic with black, sooty carbon. Fortunately, the effect on the sensor is only temporary if you eliminate the cause of the problem, such as a stuck choke or other condition that is causing the en-



Fool the computer with a 1.5-volt battery to check for proper operation while using a voltmeter to monitor sensor output.

gine to receive too much fuel.

Silicon contamination causes the sensor to give false rich signals, which, in turn, cause the engine to run lean. Surges, high-idle and poor running are the result. There are three primary causes of silicon contamination. One is gasoline that's contaminated with silicon. But a much more common cause has been the use of RTV gasket material when reassembling an engine. The gaseous residue given off by the fresh RTV gets into the oil and it is eventually sucked through the PCV and burned in the engine. Silicon contamination can also come from silicone lubricants that get into the engine intake when sprayed around throttle or choke linkages.

Unlike carbon contamination, silicon contamination is permanent and a new sensor must be installed. Use only RTV compounds that are labeled for use with engines that have O₂ sensors.

Good reading

You can read an O₂ sensor for contamination in much the same way mechanics used to read a spark plug for proper air/fuel mixture.

Silicon contamination appears on the louvered part of the exhaust side of the sensor as a soapy film—ranging from a light haze on slightly contaminated sensors all the way to a heavy white coating.

Lead contamination appears as a tan or shiny deposit. And carbon appears jet black, just as it does on a spark plug running in a rich mixture.

Sometimes sensors simply wear out or fracture—though a typical sensor will last at least 50,000 miles.

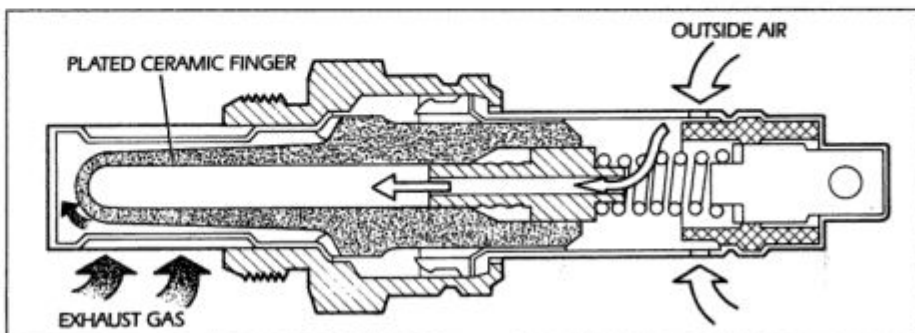
Replacing a sensor

Replacing a sensor is almost like replacing a spark plug. All you do is disconnect the sensor

wire and unscrew the sensor. But because the sensor is mounted in the hot exhaust manifold, it is sometimes difficult to unscrew. If that's the case, heat the sensor and the manifold slightly by running the engine and then try to remove the sensor. You can also use penetrating oil to free the threads.

Before installing a new sensor, make sure the sensor threads are free of rust and corrosion by cleaning them with a wire brush or a spark plug thread chaser. New sensors usually come with high-temperature anti-seize compound already in place. If you want to reinstall an old sensor, you'll have to install new compound. Dry-type, high-temp anti-seize is available from AC-Delco.

After threading in the sensor by hand, be sure to torque it to the proper specification. When reconnecting the sensor wire, make sure the connector snaps fully in place. **PM**



Platinum-plated ceramic electrode produces the signal voltage when heated to 600° F.

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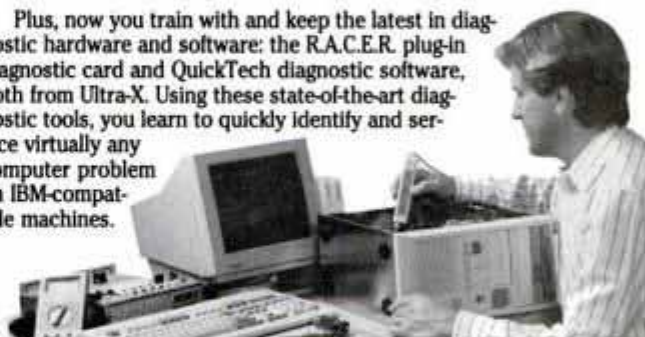
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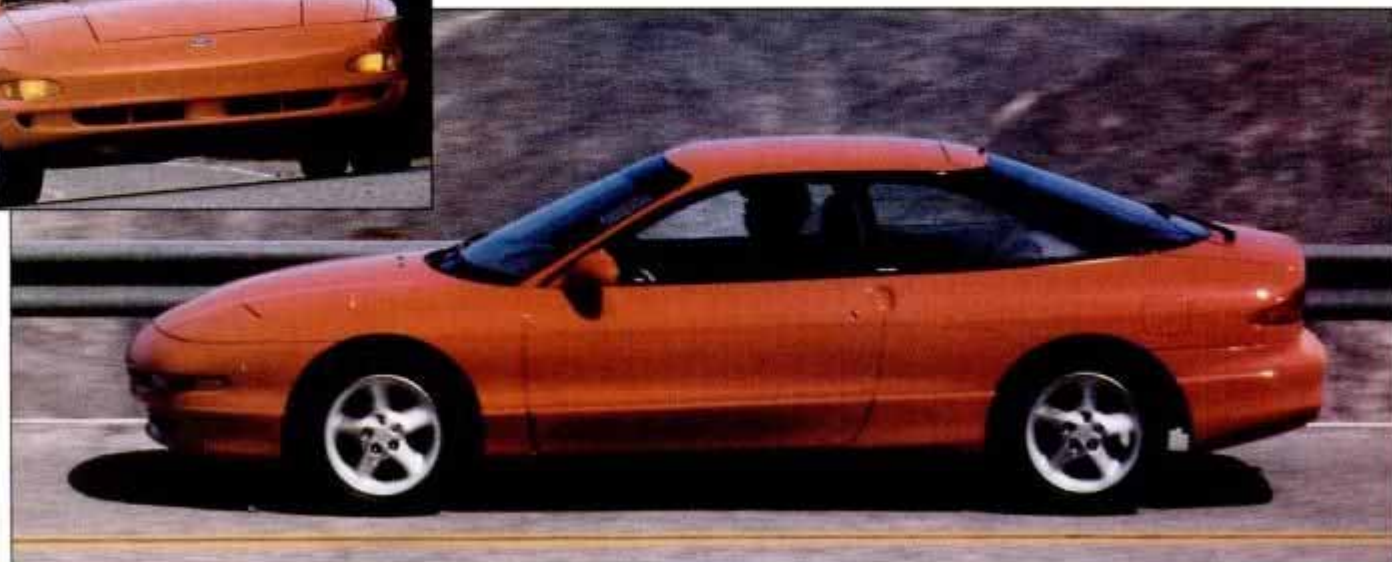
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NEW CARS



Ford Probe

● A couple months back, we passed along our first impressions of the new Mazda 626 sedan and MX-6 coupe, a pair of midsize sweethearts. Now here's the Ford sequel, a head-turning fastback offered in two flavors.

As with the original Probe, generation two uses the same engines and front-drive platform as the new Mazdas—a platform that's been stretched 4 in. (to 102.9 in.) in the wheelbase and broadened by more than 2 in. between the wheels, producing a much more aggressive stance.

Unlike the original Probe, however, Ford's engineering team was involved in the design and development program from day one. The result is a car that offers more personality distinction than the original.

The engines, both from Mazda, are all-new—a 2.0-liter 115-hp dohc 16-valve Four and a 2.5-liter 164-hp dohc 24-valve 60° V6 developed from the 1.8-liter V6 employed in Mazda's MX-3 coupe. Transmission options are a 5-speed manual, which is standard equipment, or a 4-speed automatic.

The V6 powers the sexy new Probe GT, which is the real eyecatcher, and it's also a far easier car to drive at its limits than the old turbocharged 4-cylinder GT. As part of our introduction to the new model, we spent a half-day lapping the demanding Willow Springs, California, road-racing circuit, which produced a striking contrast between new and old. Although

the V6 doesn't offer quite as much full-throttle squirt as the old turbo, it's smoother and much more linear, requiring none of the irritating throttle management needed to keep the old turbocar spooled up and pulling. And if the new V6 isn't quite as potent as the old turbo (rated at 145 hp at 4800 rpm—it made much more at higher revs), it hauls the GT to 60 mph in roughly the same time—well under 8 seconds.

Even more importantly, the new Probe is devoid of the torque steer that plagued the old GT in hard acceleration. Handling is also much better, partly from revised spring and damping rates, partly from revised front suspension geometry and partly from the addition of a very aggressive wheel/tire package—225/50VR16 tires on handsome 7 × 16-in. cast-alloy wheels.

Inside, the Probe is distinguished

from its Mazda cousins by a wrap-around instrument panel treatment that extends back into the door panels. The GT's instrumentation is exceptionally comprehensive and exceptionally legible, as well. Seating is also all-new, and we were particularly impressed with the GT's sporty, nicely bolstered front buckets. Although front-seat legroom is plentiful, the rear seats, like most 2+2 sports coupes, are cramped.

Like the Mazdas, all Probes have a standard driver's airbag, and antilock braking is available as an option on all trim levels.

Other new Probe options include a remote keyless entry system, a CD player (among a variety of sound system choices), one-touch-down power windows and a power sunroof.

A capable performer on a race-track, the new Probe is also thoroughly civilized on the street. Ride quality



Ford Probe shares platform and powertrains with Mazda 626 and MX-6.



Roomy new Toyota Camry Wagon offers an optional rear-facing third row of seats, expanding passenger capacity to seven. When folded, cargo volume is 40.8 cu. ft.

is smooth, even in the slightly stiffer GT edition, and the revised front suspension geometry, with the strut towers canted back from the vertical, provides much better response when the driver turns the wheel. Steering feel in the power-assisted rack-and-pinion system—2.9 turns lock to lock—is also improved.

Like the Mazdas, the Probe will be built in the soon-to-be-jointly-owned factory in Flat Rock, Michigan, and all the cars are considered to be domestic models. Probe pricing starts at \$12,845 for the base model, ranging up to \$15,174 for the GT, exclusive of optional equipment. —Tony Swan

High-Volume Camry

Bigger isn't always better, but the physical expansion of Toyota's new Camry lineup seems to be one instance where a size increase has been successful right across the board.

We've been impressed by this bigger breed of Camry since our first encounter with the sedan, and we were impressed once again after a week of driving the new station wagon version.

Our test wagon, like our long-term test sedan, was an LE model, powered by Toyota's excellent 185-hp 3.0-liter dohc 24-valve V6 (the basic engine is a 130-hp dohc 16-valve 2.2-liter Four), with a 4-speed automatic. This continues to impress us as one of the best powertrains available in the midsize class today—smooth, potent and library-quiet.

Although the Camry wasn't conceived as a sport wagon, there's enough power available to make it more than capable in traffic and an effortless open-road cruiser, even with family-size loads on board. Similarly, the supple suspension system soaks up just about any kind of road surface irregularity before it finds its way to the roomy, comfortable passenger compartment.

Roominess and family-size loads, of course, are what the Camry wagon is all about. Options for the new wagon

include a rear-facing third row of seats, expanding passenger capacity to seven. And even though the wagon is just 1.6 in. longer than the sedan, it encloses a whopping 140.8 cu. ft. of interior volume with the second and third seats folded flat. Folding just the third seat flat yields 40.8 cu. ft. of cargo volume.

Camry Wagon prices start at \$16,898 for the basic Deluxe model, \$20,528 for the V6-powered LE. Like their sedan counterparts, the Camry Wagons are built at Toyota's Georgetown, Kentucky, plant, with sufficient local content to qualify as domestic cars.

The Greening Of Nissan Pickups

Although changes to its 1993 pickup truck line are limited largely to cosmetics, Nissan does bring one major bragging point to the marketplace—the first freon-free air-conditioning system offered by any light-duty truck manufacturer.

A/C systems in '93 Nissan trucks will use Dupont's new R-134a in place of the traditional chlorofluorocarbon (CFC or, more popularly, freon) refrigerant. The switch, part of a company-wide program to eliminate

CFCs from its products, has earned Nissan the EPA's Stratospheric Ozone Protection Award.

Elsewhere, the Nissan pickups have new front-end treatments outside and new instrument panels within, as well as a number of other civilizing detail improvements.

Powertrain offerings remain the same—a 134-hp 2.4-liter sohc 12-valve Four is standard in most models, with a 153-hp 3.0-liter sohc V6 available as an option. The trucks are offered in standard, long-bed and king-cab editions, with 4-wheel drive available on all but long-bed models.

Transmission choices include a 5-speed manual (standard) and 4-speed automatic. A limited-slip differential is also offered, as part of a Sport/Power package available on SE-V6 king-cab models. Rear antilock braking is standard on 4x4 models.

Standard Nissan pickups with 5-speed transmissions offer tow ratings of 3500 pounds with a 1400-pound payload. Long-bed versions can tow up to 5000 pounds or carry up to 2000 pounds in the bed.

BMW Rediscovered The V8 Engine

Responding to competitive offerings from Stuttgart and Japan, BMW has come up with its first V8 engines in 28 years. Designed in 3.0- and 4.0-liter displacements, both engines are

(Please turn to page 88)



Besides small detail refinements, '93 Nissan pickups will have freon-free air conditioning.



BMW's 7-series sedans will get V8 power for '93. The new dohc 32-valve aluminum engines will be BMW's first production V8s since 1965.

oversquare 90° designs, featuring aluminum alloy blocks, heads and crankcases, with Nikasil cylinder liners, dual overhead cams and four valves per cylinder.

Both are destined, initially, for sale in BMW's big 7-series sedans, but only one—the 4.0-liter version—is slated for sale in the United States, at least for now.

Although BMW is relatively late in its return to the V8 game, the new engines do have a number of interesting technical touches, most of them aimed at weight savings. The sintered connecting rods, for example, are 17% lighter than conventional cast con-rods. Extensive use of recyclable plastic in the intake manifold makes it 63% lighter than a cast-aluminum manifold. Double-wall exhaust mani-

folding not only saves weight, but improves catalytic converter warmup and reduces noise. And magnesium valve covers, at 3.7 pounds each, represent another 37% savings over aluminum covers.

Like many contemporary engine designs, the new BMW Eights use self-adjusting hydraulic tappets. The cams are driven by double-row chains, and sprockets are rubber-coated for noise reduction. Each cylinder has its own coil, and there are four knock sensors.

The net result is a powerplant that's only 20 pounds heavier than the 208-hp 3.5-liter inline Six offered as the basic engine in the current 7-



series. The 3.0-liter V8 tops this output by 7 hp, while the 4.0-liter version makes 282 hp at 5800 rpm and 295 ft.-lb. of torque at 4500—more than either the Lexus or Infiniti V8s, and almost identical with the Mercedes-Benz 4.2-liter V8.

Mated to a new 5-speed automatic transmission, which may or may not be available when the engine reaches U.S. showrooms this fall, the new BMW 4.0-liter V8 has enough grunt to propel these big sedans (just under 2 tons for the 740i, slightly over for the long-wheelbase 740iL) to 60 mph in less than 7.5 seconds—about the same as the V12-powered 750i. Top speed, which is electronically limited, is just under 150 miles per hour.

If all that sounds appealing, you could be the first on your block to own the first BMW V8 since 1965. Or, if you'd like your BMW V8 wrapped up in something a little sportier, you could wait for a while. BMW-watchers expect to see both the 3.0- and 4.0-liter V8s offered in the smaller, lighter 5-series sedans within the next year or two.



New Altima will replace Nissan's Stanza for 1993.

Harley-Davidson's Rolling Heritage



● No motorcycle company has more heritage behind it than Harley-Davidson, and this limited-edition FLSTN for 1993 will serve as a rolling reminder.

Included in the package are Dunlop D402 wide whitewall tires on chrome wire wheels, a special black-and-white color scheme, cloisonné H-D Fat Boy tank emblem, Fat Boy saddlebags, a

custom seat, wide FLH-style handlebars and a 5-gallon Fat Boy tank.

The familiar H-D 74-cu.-in. V-Twin engine is finished in black with chrome highlights, and the shotgun-style exhaust system includes fishtail-finned mufflers. The Heritage Nostalgia FLSTN will carry a retail price in the \$13,000 to \$14,000 range.

Nissan Name Games

A going-away view is all we've had so far of Nissan's replacement for the current Stanza, but Nissan thinks the new car will be so new that a new name is in order. The name is Altima.

While the new car will still be slotted between the Sentra and the Maxima in Nissan's lineup, the product planners want to improve its image and position Altima squarely against the Toyota Camry, Honda Accord, Mazda's new 626 and even the Ford Taurus. This suggests substantial gains in size and volume, as well as more luxurious trim levels.

Developed at Nissan Design International, in La Jolla, California, the Altima's lines are much more rounded and flowing than the rather boxy look of the current Stanza. Nissan sources say that the Maxima provided much of the inspiration for the Altima, but our first glimpses suggest strong influence from the Infiniti lineup. The fallaway lines of the rear deck, for example, are strongly reminiscent of the new Infiniti J30 sedan. **PM**

smooth ride and leather interior make for very pleasant long-haul motoring.

Mitsubishi Diamante LS

Aimed squarely at the increasingly populous realm of the Acura Legend, the Diamante LS is a rolling treasure trove of the latest automotive technology. Included under this heading are traction control and computer-controlled shock absorbers that adjust damping rates and ride height to cornering forces and vehicle speed.

Mitsubishi's unique addition to traction control is called "trace control," designed to keep drivers from getting themselves into irrecoverable understeer situations on twisty roads in dry conditions. However, as with every traction control system we've encountered, this hampers the car's ability to get around a dry racetrack.

Still, the Diamante LS showed us one of the stiffest, best-balanced chassis in this field, along with a smoothly potent 3.0-liter dohc 24-valve V6 and excellent 4-wheel disc brakes backed by ABS. It's hard to think of this elegant, high-tech sedan as a hot rod. But if it's hard for us, it's hard for the guys with the radar guns, too. And for sure-footed hurrying in sloppy going, we'd bet the Diamante would stand near the head of this pack.

Nissan Maxima SE

Nissan likes to call this good-looking sedan the 4-door sports car, which we think is stretching a point. There's sports car rigidity in the chassis, but, like so many passenger cars, the suspension tradeoff between ride and handling leans toward the former. As a consequence, even in its sportier SE trim the Maxima is a little soft for really hard cornering, displaying understeer that progresses from mild to mulish the harder it's pushed.

Balancing this is the SE's optional 190-hp 3.0-liter dohc 24-valve V6, a very precise 5-speed gearbox, a viscous limited-slip differential, excellent brakes (with ABS) and power-assisted rack-and-pinion steering that's among the best. This is sports car hardware, all right, and in any environment short of racing, the Maxima more than holds its own.

Our test crew was taken by the Maxima's clean styling and spiffy interior, which includes stylish black-on-white analog instruments. In fact, stylish describes the entire car.

Nissan Sentra SE-R

Talk about low profile—the Sentra SE-R looks about as garden-variety as a car can be. But there's hot stuff under all this innocence—a 140-hp 2.0-liter dohc 16-valve Four, viscous limited-slip differential and, like the Maxima, a nice stiff platform.

The Sentra SE-R is a very close cousin to the hot little NX 2000, which offers a little more in the way of handling but looks about as innocent as Madonna. The Sentra loves to be pitched around a racing circuit—it's nicely balanced and thoroughly forgiving. Its handling could be even better with a more aggressive tire, which also applies to its braking performance.

Few small sedans are more fun to drive than this one. And when it comes to the all-important invisibility quotient, the SE-R is just about tops.

Oldsmobile Achieva SCX

Pontiac's Grand Am may have the edge in flash, but when it's time to put the hammer down, here's the GM N-Car that's got the right stuff: Close-ratio 5-speed gearbox, lower final drive ratio, stiffer suspension components and a 190-hp version of the dohc

16-valve 2.3-liter Quad 4, all wrapped in an unadorned Achieva body.

Like last year's W41 version of the Calais, the SCX has a little more in the way of ride height than you'd associate with aggressive handling, but the Olds chassis engineers have done a good job of controlling excess body roll and the car gets down a slalom course with impressive zeal. It was also quick around the Streets of Willow—a close third in this group—and if it's not as fast as the Spirit R/T going straightahead, it's certainly quicker around corners.

The brakes, too, have been improved, but we still think Olds has skimped a little in this department, even with the addition of standard ABS. After three laps around the Streets they needed a rest.

Even so, the SCX is a very satisfying car to drive. It's quick, it's fast, it gobbles up twisty roads and there's a gratifyingly rasty growl to the exhaust note. This car delivers impressive all-around performance for the money. It strikes us as the personification of the closet hot rod concept.

Oldsmobile Cutlass Supreme I-S

Who would suspect this elegant mid-size Olds of hot rod hustle? Decked out in International Series trim, it looks more like something you'd expect to see in an embassy garage than lighting up its tires on a dragstrip.

Nevertheless, with GM's 3.4-liter dohc 24-valve V6 sending 210 hp to the front wheels, the Cutlass Supreme gets out of the blocks in a faster than ordinary hurry. And unlike some of the other excellent V6 engines in our collection, it emits a very satisfying snarl in the process.

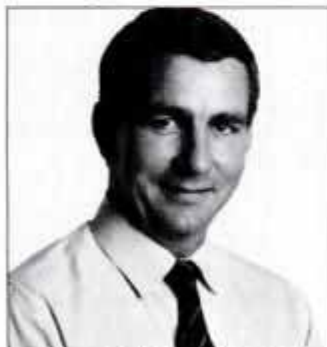
When it comes to hurrying around a

(Please turn to page 91)



PEOPLE WRITE TO PENNZOIL

Straight Answers from the Automotive Experts.



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

The Maximum Protection Story

Q. I hear that today's engines run hotter than the older models and require the highest quality motor oil available. What do you recommend? *E.W., Hebert, LA*

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FUTURE DIRT

BY JOE SKORUPA, Boating/Outdoors Editor



● The dirt bike of the future will have stationary rims with revolving tubeless tires. Oil/air bladders will provide front and rear suspension. Steering will be hydraulically controlled. Exhaust noise will be canceled out by a negative frequency electronic synthesizer. And a single oval-shaped ceramic piston will compress the charge of both cylinders within a lightweight, composite-block engine.

As envisioned by Next World Design, of Reynoldsburg, Ohio, the dirt bike of the future won't even be called a dirt bike. It will be known as an *environmental or enviro bike*, because many of its cutting-edge technologies are designed to appeal to a growing segment of bikers who'd rather go on nature rides than eco blitzkriegs. Members of this group, which include a fair number of female riders, want low-impact, low-noise off-road machines.

To achieve this goal, the design team of Tim Clemens and brothers Ken and Glen Laivins had to eliminate a number of familiar components in a project bike called the **Rim Rider**,

which was created for the motorcycle builder KTM America.

Color me gone

Gone are all major metal parts, including the metal engine block and the frame. Sophisticated composites like carbon fiber and Xenoy 2000, which is used in the body of the Saturn automobile, achieve a new level of weight reduction.

Gone are the chain- and belt-drive systems with their weight and noise. In their place is a hydraulic, rear-wheel-drive system that delivers power through a cogwheel connected to paddle points inside the rear tire.

Gone are axles, spokes and center hubs. The front rim is solidly fixed to the front swing arm (no forks), and the tire revolves on a hydraulic track around the stationary rim. The rear rim is attached solidly to frame, too.

Gone are air-filled tires and the potential for flats. The tires are solid and have holes in the sidewalls that can be left empty or filled with gel inserts to help adjust suspension.

Gone are shock and coil-spring sus-

pension systems. In their place are ribbed oil/air bladders that are similar to those used in Class-8 tractor-trailer trucks, which are the biggest rigs on the road. The suspensions are adjustable by altering the mixture of oil and air in the bladder.

Gone is the long muffler pipe. Its sound damping function is performed by a black box that contains an electronic synthesizer. The system uses negative sound waves to cancel out engine noise while still enabling compression to be tuned.

Special features *added* to the Rim Rider include ABS front brakes, hydraulic steering, a vertically flexing handlebar, an automatic transmission and an air-cooled fuel-injected 2-stroke engine from 125 cc to 350 cc that uses one piston to function inside two open-wall cylinders.

Next World Design and KTM America don't foresee the Rim Rider emerging whole from R&D status soon, but predict that many of the components and design elements will appear in production bikes through the '90s. Future dirt is here. **FM**

CLOSET HOT RODS

(Continued from page 89)

road course, the Cutlass Supreme has the same general limits we found in most of the other sedans we assembled for this test: It's competent, devoid of surprises and bolstered by plenty of stopping power (including ABS), but its handling is compromised in favor of ride. The 4-speed automatic, though smooth and well matched to this engine, doesn't help on a race circuit either.

But this isn't intended to be a race car. It's intended to be an edge-of-luxury road car with more than enough power to beat the blahs—without attracting the wrong kind of attention.

Suzuki Swift GT

One of the great things about cars that look like little boxes is that most people, including most cops, don't associate little boxes with speed. Well, there's a wildcat inside this particular box. The Swift GT doesn't have as much top speed as most of our other closet hot rods, but it's cat-quick and cat-agile, a bantamweight street fighter that'll land three jabs and a left hook before the other guy remembers to put up his dukes.

The Swift's chassis is stiff and precise, the 100-hp 1.3-liter dohc 16-valve Four loves to rev and the beautifully bolstered bucket seats reinforce the car's ready-to-race feel.

To make it even more attractive, the Swift GT is capable of impressive fuel economy numbers. Combine that with the lowest sticker price in the field, and you have what Rick Titus calls "lots of scoot for the loot."

Toyota Camry SE

As you may have noticed, there's already a quantity of new Camrys rolling around out there, which provides protective coloration for this one. That's good, because the SE is a little more equal than its brethren, thanks to its 5-speed manual transmission and slightly stiffer suspension tuning.

The Camry's department is very reminiscent of the Maxima's (these are the only directly comparable cars in our group): outstanding highway comfort, an outstanding dohc 24-valve V6 engine and a limited appetite for fast corners and slalom work. For handling, we'd give the edge to the Maxima chassis and allied hardware, but there's not much to pick between the two engines.

And that's what the Camry SE is all about. Whether you're chasing horizons or seized by an urge to startle some more conspicuous hot-rodder when the light turns green, the SE's V6 provides the right stuff—and the 5-speed makes the most of it. **PM**

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DETROIT SPY REPORT

BY JIM DUNNE, Detroit Editor



Future Charger

● GM's electric vehicle, the Impact, isn't due for public sale until 1995, but prototype chassis are being tested now at GM's proving grounds in Milford, Michigan.

In the photo above, an Impact chassis "mule" is running a suspension testing schedule as part of its development program. Although the electric motor and drivetrain is absent—this vehicle is powered by a 4-cylinder gasoline engine driving through the front wheels—the frame, suspension, brakes and related systems are designed for use in the Impact.

Simultaneous engineering calls for separate development of different parts of the car well before a complete vehicle can be assembled.

Zebra Van

Although we usually see this 1995 Ford prototype van with its front end covered, the disguise came off long enough for us to see the shape of the hood and grille opening. This zebra-striped prototype shows what Ford is

planning as a midsize van that will eventually replace the Aerostar.

Unlike the Aerostar, the new van will be front-wheel drive. A Taurus front-drive system, including V6 engine, will be used. Front drive will give passengers a lower step-up distance and a flatter floor, but trailer-towing ratings will be lowered.

Fire For The Bird

GM is heaping on the coals by dropping the super hot 350-cu.-in. Corvette LT1 engine into the Trans-Am edition of the all-new 1994 Firebird models.

While the LT1 is good for 300 ponies in the Vette, it loses 15 horsepower in the 'Bird due to a more restrictive exhaust system dictated by packaging requirements. The Trans-Am will be joined by one sister ship when the

new Firebirds fly in next year as 1993½ models. This medium-performance, base Firebird will be powered by GM's 3.4-liter pushrod V6 and will come with a much more affordable price tag. Safety isn't being overlooked either, as dual airbags will be available and should help offset some of the insurance costs. Basically, what's going on with the Firebirds, as far as number of models and engines, is being mirrored over in the Camaro camp with the LT1-powered Z28 and V6 base Camaro.

Up Tempo

Tempo will be the next member of the Ford family to get a complete redesign. Set for introduction as a 1994 model, the bread-and-butter compact will have a rounder appearance overall with more curved lines in the hood, fenders, roof and trunklid.

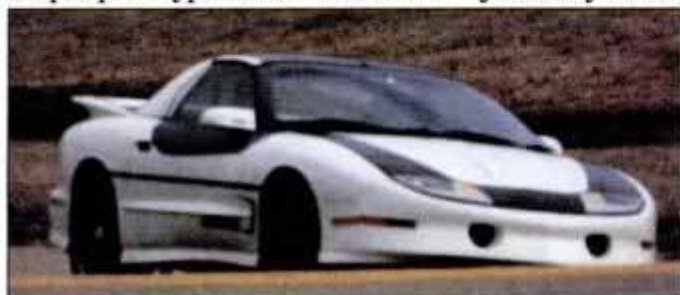
Highlights include lower cowl and hood heights, and a well-disguised hatch door at the rear that extends up



Ford's front-wheel-drive minivan should appear in 1995.

to include the rear window. At the front, Tempo carries a standard Ford air intake, à la Taurus.

In the prototype shown opposite, snapped during testing in Michigan, the rear door glass is painted over to



Pontiac's 1994 Firebird will get a slightly detuned version of Chevy Corvette's LT1 V8 engine in the 'Bird's Trans-Am edition.





Look for a more upscale Ford Tempo/Mercury Topaz lineup in '94, as shown in this studio shot (above) and spy photo (below).

disguise the C post, and wheel covers are taped to hide the Ford nameplate.

The line will have a more upscale beat when the new models make their debut late next year. The cars will grow longer wheelbases and get a fresh look inside and out.

Styling will take some cues from some Japanese models, specifically the more rounded body lines that are now in vogue. A new model—a 4-door hatchback—will also join the lineup, and Ford will be pushing its optional V6 engine to quicken the tempo of both nameplates. With larger size Ford Tempo and Mercury Topaz models, Ford will be stretching its Escort to fill the gap between its compact and subcompact lines.

Off The Mark

You won't be seeing that new Mark VIII Lincoln originally intended to be introduced this year. The plan was to give the new Mark VIII a slightly fresher look. But Ford looked at the luxury competition from Japan—Infiniti, Lexus and Mazda's 929—all with smoother, more rounded sheet-metal, and decided that the sharp-edged design of the current Mark wasn't a better idea after all. So instead of just a freshening, the new Mark VIII will get all-new, more rounded styling. At first glance, it may appear smaller, but it's actually stretched 4 in. overall to 207 in., and rides on a 113-in. wheelbase—almost 5 in. longer than the '92 Mark.



'94 Riviera

More photos of the next Buick Riviera, first revealed in our March '92 issue (Detroit Spy Report, page 84), show the extreme rounding of the corners and the exaggerated swoop of the front end. Probable power? A third-generation Chevy-based small-block V8. This prototype was caught on a Southern California freeway during a test session.



PHOTOS BY PIED PHOTOGRAPHIC

Picking Up On Pickups

When Toyota said earlier this year that it would market a midsize pickup in the United States, was Detroit worried? Nope. Ford had already made plans to build its own midsize truck, and also make its F-series line of full-size pickups even bigger. Chrysler's already been out there with its midsize Dakota. GM was the least prepared of the Big Three and is now playing catch up by working on a completely new midsize pick-'em-up.

Mod Squad

Modular engines figure into Ford's future with a whole line of powerplants that have similar combustion chambers in V8, V6 and 4-cylinder configurations. You'll find the first of the

modular family under the hoods of the big Lincolns, Fords and Mercurys. It's the 220-horsepower, 4.6-liter sohc V8. A dohc version in the works will up the ante to over 285, and this hot num-

(Turn to page 94)

ber is slated for the Mark VIII. Working down the modular lineup, you'll find two planned V6s. The first one is a rather tame 2-valves-per-cylinder, earmarked for the Taurus/Sable and Tempo/Topaz models. Later on, a dohc V6 will crank out some 200 horsepower and go into Ford's high-performance compacts and midsize cars. At the bottom of the modular heap is a 4-banger for Escort and other small-car models.

Ford expects to have all of its modulars humming away within the next four years.

On The Line

Chrysler's Jefferson Avenue plant in Detroit is the site where the first Chryslers were built in 1924. Today it is the newest auto assembly plant in the world, turning out Jeep Grand Cherokees since January of this year. But the story here is as much the work force as the advances in production technology. It's a thoroughly seasoned, veteran group with an average worker age of 51 years and an average seniority of 21 years. Instead of foremen directing workers, work teams of seven technicians decide how to complete their mission. There are no time clocks. The new Jefferson is a comparatively small plant in size, the better

to keep unneeded expansion in check and efficiency high.

Freon Free

GM cars will be freon-free by the mid-1990s. By that time frame, GM will no longer install freon in its vehicle a/c system. The move is part of a worldwide attempt to limit the amount of freon released into the atmosphere where it is a factor in destroying the Earth's protective ozone layer. Other automakers are planning freon-free cars on different schedules.

Soft Speakers

Remember all the noise about those noise-canceling exhaust system speakers to be installed by the factory? The anti-noise speaker box looked like a tiny muffler, and was designed to cancel out the low frequency sound waves that came from your engine's exhaust. The concept promised a freer-flowing exhaust system with less backpressure and easier engine breathing for better performance and economy. Well, those speakers aren't here yet, but the concept is still alive. Right now, development of the new type of muffler is aimed at stationary engines, like industrial powerplants. But auto applications are still being studied. Researchers at Walker Muf-

fler, for example, are using the anti-noise speaker as a helper for the standard muffler.

Men Of Steel

Plastic body panels have been replacing steel at a growing rate. But the steel industry is fighting back with new laser welding technology. The benefits include reducing the number of steel parts needed for an application, body parts that are lighter in weight, stronger structures and a better overall fit.

Laser welding is more precise than conventional welding techniques, so steel sheets of differing thickness and different mechanical properties can be welded together. The welds of those parts are so strong that, in some cases, there is no need for reinforcements. Look for laser-welded steel panels to show up on Ford's 1993 Ranger pickup truck doors first.

Super Saturn

GM's Saturn Corp. has been making steady gains in production and sales during the past 12 months, and is the leader in sales per dealer outlet.

Now a change is planned to boost sales even more. Look for Saturn to introduce a world-class V6 engine to appeal to buyers who want even bet-

OVER \$100 MILLION PHOTOTRONS SOLD AT \$399.⁹⁵

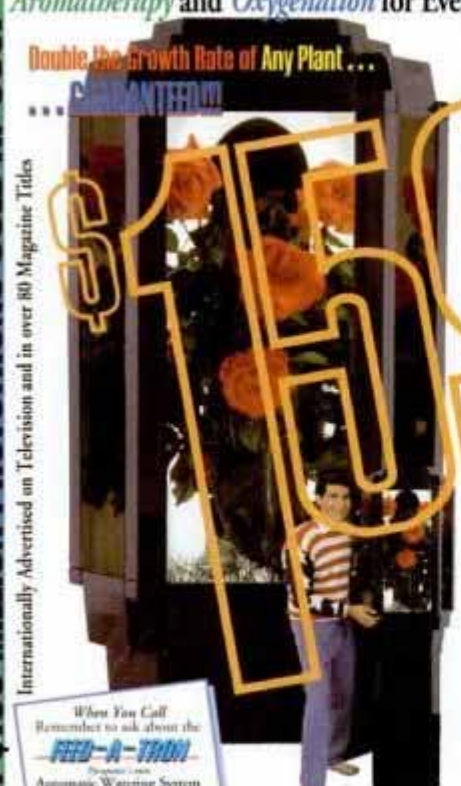
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ter acceleration and performance.

Details are still guarded, but insiders are talking about a 2.5-liter 60° aluminum V6 with five valves per cylinder and variable valve timing, as well as 100 hp per liter. That adds up to a whopping 250 hp, which certainly will rate as world class.

Look for Saturn to offer a special sports sedan and performance coupe with this engine.

Mirror, Mirror

More changes in automotive mirror technology are on the way in the months ahead. In addition to powered, self-dimming and heated mirrors, you might see one that vibrates itself dry in wet weather.

That's what Japanese engineers are researching for Toyota. The idea is to have the mirror vibrate to a frequency that makes the water atomize, thus clearing the surface.

But it's more than just vibrating the mirror. Separate plates have to be designed to spread the vibration evenly over the whole face of the mirror. Research has proven that a self-drying mirror that withstands repeated vibrating cycles can be built.

White's Right

White is still the color of choice among new car buyers. That's the word from Detroit's paint experts.

White will continue to lead the color charts for a number of reasons. New car dealers order white for inventory so that they won't have to load up their lot with all the other choices. Because 85% of new cars are ordered by the dealer—not by the customer—white will continue to be the leader.

White also makes cars appear larger than they really are, so it is a natural choice for small-car buyers.

Fading Fluorescents

You see bright fluorescent-colored cars in auto shows, but chances are you won't see them in new car showrooms anytime soon. The problem is that they fluoresce. Sunlight creates a chemical reaction that bleaches out the finish, leaving the paint a soft pastel instead of a vibrant color.

Still, auto designers and display experts like the fluorescent technique, and will use it when colors can be fixed to avoid fading. Meanwhile, look for more 2-tone paint jobs.

V8 Vitality

Rumors of the imminent demise of the V8 engine have been greatly exaggerated. Two new variations of world-class V8s made their debut this year: Cadillac's Northstar and Ford's dohc version of its modular design 4.6-liter.

Both are power top-of-the-line vehicles—Cadillac's in the 1993 Allanté and later in the Seville and Eldorado, Ford's in the 1993 Lincoln Mark VIII.

You will find strong similarities between the two engines. Both have 4.6-liter displacement, aluminum heads and blocks, double overhead camshafts with four valves per cylinder and horsepower ratings in the 290 to 300 range.

When you figure that new engines are designed for a life of at least 20 years, these new V8s will be around until the year 2012 AD.

Knock On Wood

If you can. Ford and Chrysler no longer offer real wood trim in their cars. Not even the Lincolns or Imperials have wood-trimmed interiors. It's too expensive, say the automakers.

Instead, both companies use metal trim that looks like wood. But Cadillac still uses wood, even though it may add as much as \$500 to the price of the vehicle. How important is wood? Infiniti reports that many wood-free Q45 buyers are ordering aftermarket wood kits from their dealers at \$1500 per car. **PM**

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ASIMOV'S VISION

BY ABE DANE, Science/Technology Editor

● Even though the future isn't here yet, it is in many ways familiar. We know it as a time populated by hard-working robots dexterous and intelligent enough to be good golf partners. Space travel is commonplace and practical. And eventually, man will build colonies on other planets.

How do we know all this will happen? It's largely a matter of faith. A faith fostered by a handful of visionaries, who invented and gave life to the future as we know it through a vast body of stories that extrapolate science fact into fiction. The world lost one of the most original and influential practitioners of this art when Isaac Asimov died this past April.

Memories of the future

Asimov's most noted quality was his prodigious output. He wrote nearly 500 books over the course of his 72-year life, and countless shorter pieces. Best known were his science-fiction works, the first of which was published when he was 18. But he also wrote nonfiction on a range of subjects too broad to attempt to encompass here. He was a scientist as well, completing his doctorate in chemistry at Columbia in 1948, and holding a professorship for many years at Boston University's School of Medicine.

While critics seldom speak of science fiction as a form of serious literature, and scientists often dismiss its technological underpinnings as wildly speculative, there can be no questioning Asimov's lasting impact on the world. Many great figures in modern science were first attracted to the profession by the enticing prospects Asimov spun out, and now gladly acknowledge their debt to him. His was a vision of possibility and promise, of worlds where technology not only enabled man to master the forces of nature, but to overcome his own foibles as well.

The pages of *POPULAR MECHANICS* were thus a natural outlet for Asimov's work, and it appeared here on more than one occasion. His most recent effort in this magazine bore the title "How We'll Live On The Moon" and appeared in March of '88. It is typical Asimov—a grand, sweeping account that combines imagination



with a broad range of scientific fact. Former *PM* Science/Technology Editor Tim Cole, who prepared the piece for publication, remembers working with Asimov fondly.

"He was real easy to edit," says Cole. But more striking was the impression Asimov made as a person.



For all his fame and accomplishments, Cole found him "very engaging, warm and friendly." He was also accessible. Generally his wife answered the phone, while the celebrated author could be heard typing away in the background.

This personable prodigy will certainly be missed. But fortunately for future generations, he poured so much of himself into his writing that an ample legacy awaits anyone who cares to share his vision.

Sudden Death Baseball

"Sudden death" is not normally a part of the baseball lexicon. But tragically, a few youngsters lose their lives each year while participating in the national pastime. The numbers are small—over a 10-year period the Consumer Product Safety Commission counted 51 instances nationwide—but not small enough. In fact, among children between the ages of five and 14, more deaths are attributable to baseball



GM PHOTO

Pitching machine fires fastballs at child-size dummy to test protective gear.

than to any other sport.

The leading cause of these fatalities was sharp blows to the chest delivered by fast-moving pitches and line drives. Although not sufficient to cause significant tissue damage, these impacts upset heart rhythms through a mechanism that is not fully understood.

In an effort to provide some insight—and to come up with preventive measures—researchers at Wayne State University and the School of Medicine at the University of Michigan have teamed up with counterparts at General Motors' Biomedical Research Lab. GM was called in because years of crash safety research give them experience in analyzing the effects of all kinds of impacts on the human body.

Dr. David Viano, who lead GM's part of the effort, is the originator of what are known as viscous injury criteria. These mathematical formulas enable researchers to predict how various types of blows will affect the soft tissues of the body. In a review of the data available on the cases of death by baseball impact, Viano and colleagues came to the conclusion that a viscous mechanism was probably what was at work.

With that determined, Viano set about simulating the fatal scenarios by shooting baseballs at an instrumented crash dummy at speeds around 60 miles per hour. The dummy used was one specifically designed to mimic the characteristics of a 10-year-old child. Viano took measurements with various types of padding over the dummy's chest, and even tried shooting at it with a softer baseball designed to reduce injuries.

So far, no solutions have turned up. One noteworthy finding, however, is that the safety equipment being touted to deal with the hazard is ineffective. At least this should prevent school boards and athletic leagues from being taken in by overzealous promoters until a real solution is found.

PM

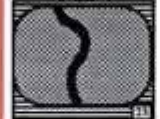
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ELECTRONICS

TRAFFIC FIGHTERS

BY FRANK VIZARD, Electronics Editor



● Bumper-to-bumper traffic congestion is a nightmare shared by every driver. But while gridlock may be the ultimate bad dream, drivers may soon find themselves waking up to new technologies that keep traffic moving.

Traffic congestion, of course, is a major problem in many localities and it seems destined to worsen. Some authorities, for example, estimate that in California in the year 2000 the average speed on highways will be only 11 mph. Attacking the problem, though, are a number of new technologies known collectively as Intelligent Vehicle/Highway Systems (IVHS).

One of the first IVHS technologies under development is a joint undertaking by AT&T and Lockheed. AT&T is marrying its "smart card" technology with Lockheed radio transmitters to create an electronic toll collection system. The system, awaiting approval by federal authorities, would allow drivers to pay tolls without stopping.

In this system, drivers would carry small plastic cards embedded with microprocessors and memory chips carrying information about the driver and the amount of credit available. As a driver approaches the toll collection area, the driver inserts the smart card into a small radio transponder mounted on the windshield or dashboard. Receivers mounted above the road or in the pavement note the pass-

ing of the car. The amount billed to the driver is transmitted back to the dashboard communicator and a record of the transaction is written onto the card. The entire transaction takes only milliseconds. The card can operate as either a prepaid debit card or as a credit card with monthly billing. The smart card can also be configured to calculate a variable toll based on distance traveled.

The developers estimate that a smart card communicator would cost about \$100. The system can also be modified to deliver special messages and traffic advisories to the driver.

Constant, up-to-the-minute traffic advice is the goal of a new service called Autotalk now operating in Los Angeles. Access to Autotalk is through a \$129 keypad that connects between the car radio and the antenna. Once a driver punches in the correct numerical code for a given area, he receives instant information on local traffic patterns.

The idea is to provide traffic information virtually on demand and faster than reports generated by all-news radio stations. Traffic

reports are gathered from police and aerial surveillance, as well as from on-the-ground reporters, and then relayed to Autotalk-equipped vehicles. The Autotalk signal is actually a television signal or more precisely, the second audio program (SAP) channel of a local television station. There is no subscriber fee. Autotalk, Inc., expects to expand into 30 markets within the next five years.

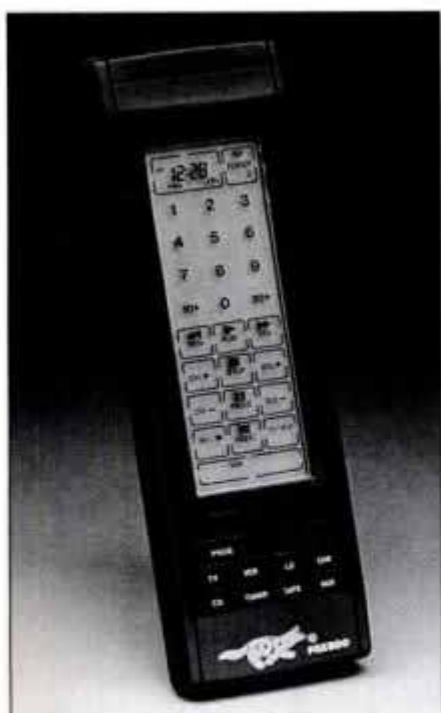
One of the newest technologies being used by police to monitor traffic uses laser beams to track possible speeders. Called LIDAR (Laser Detection and Ranging), the system operates by bouncing a laser beam at intervals off a moving car. Speed is calculated by measuring the time used to get from one position to the next. LIDAR systems are expensive, however, so only a few hundred municipalities have it at present.

As might be expected, radar detector manufacturers are responding with devices that detect LIDAR. The first laser detector on the market is being made by the Escort Division of Cincinnati Microwave, Inc.; (800) 433-3487. Called the Passport 1000 and priced at \$99, the detector features a test/dark mode, a three LED meter, alert light and pilot LED. There's also an adjustable audible alarm loud enough to be heard over the car radio.

The device measures $2\frac{11}{16} \times \frac{7}{8} \times 4\frac{7}{16}$ in. in size, making it small enough to fit inside a shirt pocket. Power is supplied by plugging the unit into the cigarette lighter socket.



"Smart card" (top) pays tolls. Autotalk (above) reports traffic.



The Fox 800 universal remote control stores up to 39 functions in memory.

Universal Remote

Lovers of home entertainment systems know that with every piece of electronic gear, there's a remote control to go with it. Remote-control clutter, of course, is nothing new and a variety of manufacturers have developed universal remotes—a single device designed to control every component. One of the more interesting universal remotes to catch our eye is the Fox 800 made by Fox Electronics & Technology, Inc.

The Fox 800 is eye-catching because it utilizes a touch-sensitive LCD screen that can be backlit for nighttime operation. Press a function at the bottom of the remote and the LCD changes to present the appropriate controls. The Fox 800, which lists for \$100, has eight separate component buttons. More inexpensive versions of this product offer fewer component choices.

The real number to worry about, though, is how many functions can be stored in memory, something not obvious from the packaging. The Fox 800 can store 39 functions in memory. This may sound like a lot until you put six remote controls together and start counting buttons. The Fox 800 is an incomplete and relatively expensive answer to remote-control clutter, but it is handy if all you're doing is using some basic functions.

Many of the infrared codes used with various remotes are already preset. And it's easy to teach the remote new codes. The Fox 800 can also be used to program a videocassette recorder.

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HOME IMPROVEMENT

PROBLEM SOLVER OF THE MONTH

BY JEFF WILLIAMS, Contributing Editor

Recover 2000

No-wax vinyl floors have some serious problems. Yes, when new, they shine like crazy with only a damp mopping. Yes, when new, the surface looks wonderful, even in bright angled lighting. But for how long? Unfortunately, not very long.

No-wax floors are made of composite layers of various materials. The base layer depends on the manufacturer and the quality—read price—of the floor. Some base layers are very thin and fragile, others are thick and spongy. The middle layers are the embossed resins that make up the pattern. The upper part that you walk on is the no-wax magic. These are made of a variety of thermoplastic and urethane resins.

The average household has two adults, two children and a pet. Under those circumstances, the average no-wax floor will look good for two to three years. Once the no-wax surface is damaged or worn, restoring the floor to a nice look has always been a problem.

The inventor of Recover 2000 claims that those days are over. Recover 2000 is a special blend of urethane resins, micronized waxes and other secrets all dispersed in a water-based emulsion. The challenge has been to create a formula that would stick to a surface that was intended to be nonstick. That's where the secrets come in.

The liquid is thick and slightly milky straight from the bottle. When dry, it is clear and shiny. Not quite as shiny as the typical no-wax floor, but shiny enough. High-speed buffing will improve the gloss considerably, but I doubt the average homeowner will have a buffer in the closet.

Application is simple. The shiny areas of your no-wax floor surface are rubbed with 00 steel wool or a very fine sandpaper to roughen the surface. If the surface is already dulled, this step can be omitted. Keep in mind that you should not rub through the upper no-wax film. If you do, you will damage the color embossings of the floor's pattern underneath.

Once prepared, use a slightly damp sponge mop to distribute a light, even

coating of Recover 2000. Most applications will require three light coats to build the necessary film thickness. These can be applied at 2- to 3-hour intervals.

We tried the system on an inexpensive no-wax floor in a light office environment. The floor was installed about six years ago. There were a few



No-wax floors only remain no-wax for a few years. The finish can be renewed with this new easy-to-apply product.

stains that seemed to have undermined the original surface film. Those were bleached successfully prior to application.

We followed the instructions, and applied three coats. The label said to wait until dry, usually 2 to 3 hours. Ours dried to the touch within 30 to 45 minutes. The entire process took about 3 hours, and the results were

very gratifying. The floor really did look new again.

Recover 2000 is packaged in 32-ounce containers. Our test floor was 7 ft. x 10 ft., or 70 sq. ft. We used about one-third of the bottle, so you could expect to treat about 210 sq. ft. per bottle. Each bottle costs \$22.50, plus \$3.50 for shipping and handling—a total of \$26 landed at your front door. That means you can restore a no-wax vinyl floor for about 12 cents per sq. ft.

You can use Recover 2000 as an ongoing maintenance finish. The manufacturer suggests that every nine to 12 months the film be refreshed by applying another full coat to the cleaned surface.

If you have ever tried to replace a sheet vinyl floor, you know what a horrible pain it can be. The various layers I described earlier delaminate and you end up having to use a razor scraper to remove the flooring and glue from the substrate.

Plus, the average no-wax floor costs about \$13 per sq. yd. at retail, and can cost as much as \$25 per sq. yd. Considering an average installation cost of \$5 per yd., prep cost of \$5 per yd. and material cost of \$19, for a total of \$29 per yd. (\$3.22 per sq. ft.), the Recover 2000 option seems unavoidable.

All of the ingredients used to manufacture Recover 2000 are environmentally safe and require no special handling or disposal. I found the odor to be a bit annoying, so be sure to have adequate ventilation during application. All the tools and accessories you will need are available at the local hardware store.

This product is very new. Retail distribution channels had not been established as of this writing. You can order Recover 2000 by calling (800) 542-1600; or writing to Pillans Products, Inc., 705 Richardson Place, Tampa, FL 33606. **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.

PM HOTLINES

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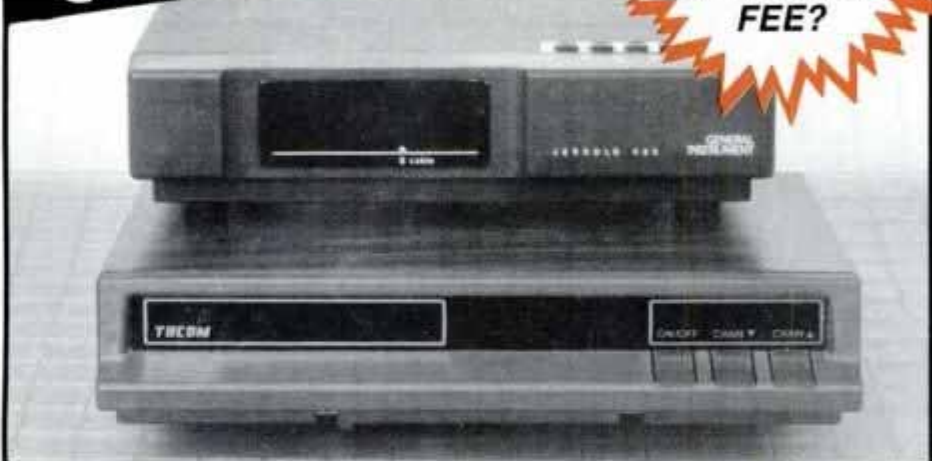
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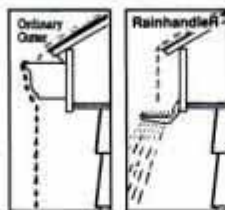
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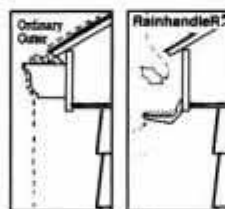
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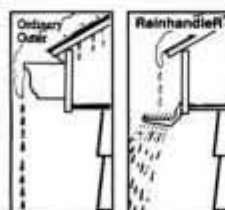
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TRANS-AM TUNING

BY TONY SWAN, Automotive Editor



● Based on the selective view afforded by the TV camera, the life of a major-league race car driver looks pretty glamorous—an unending round of trophy queens, autograph-seekers, semiworshipful reporters and well-wishers, punctuated from time to time by a few minutes' worth of brake dust and glory. The reality of this life is far different, and it boils down to something that looks very much like plain old hard work.

To get a better idea of what a Trans-Am team does between races, we spent a day with the Archer Brothers during a test session at the Mid-Ohio road-racing circuit near Lexington, Ohio. It was the final development session for Tommy and Bobby Archer before the Detroit Grand Prix, the second date on the 1992 Sports Car Club of America Tide Trans-Am Tour.

Testing tedium

A racing test session is a far different activity than a race. The driver climbs in, warms up the car, then runs a few laps—usually no more than five—and comes back to the pits to consult the stopwatches and suggest possible adjustments.

Like most Trans-Am cars, the Archer Brothers' Dodge Daytonas offer a wide range of adjustments—spring rates, shock preload, antiroll bars, camber, transmission gearing, final



Yes, this Daytona, under Trans-Am rules, is front-engined, rear-wheel drive.

drive and so on. Getting all these elements into optimum harmony requires endless changes, one element at a time.

Thanks to the wide experience of crew chief Pat McFall, who lists past Trans-Am winners David Hobbs, Willy T. Ribbs, Les Lindley and Stu Hayner among his former clients, this work progresses in an orderly fashion. But even with savvy in the pits, isolating the effect of each adjustment can be a frustrating job—particularly when there are mysteries.

Understeer, oversteer

The mystery that plagued the Archers at Mid-Ohio was one that had been baffling them since Long Beach. Adjust as they might, the Dodges had a tendency to go from understeer while entering a corner to oversteer at the exit. Inevitably, this combination lengthens lap times, and while

the times were respectable by current Trans-Am standards, they weren't pole times. Worse, the cars were tricky to manage.

As the day wore methodically on, the problem continued to defy diagnosis and more than once the team found itself cleaning grass out of the radiators following a spin. The adjustments began to defy logic. To get the back end of the car under control, McFall and the Archers found themselves making the front end stiffer and stiffer, aggravating the understeer problem.

It was time to look elsewhere. Elsewhere ultimately proved to be a problem with the locking rear differentials, which were allowing wheelspin on the inside rear wheel in hard cornering, making it difficult to get the cars to hook up exiting the corner.

There were other problems to conquer as well—high operating temperatures, a difficulty addressed by relocating the oil coolers, and a slight shortage of horsepower, something that engine-builder Joey Arrington was addressing for the Detroit race.

But solving the hookup problem is an excellent illustration of what it takes to make a good team one of the best—hundreds of man-hours, hundreds of miles of test track tedium and a level of perseverance that goes way beyond 9-to-5.

You could call it dedication.

PM

PHONE IT IN (Continued from page 51)

satellite paging service. Subscribers carry the same handset they use at home when they travel anywhere within the network's service area.

Users can place calls from the small, lightweight handsets as long as they are within range of a transceiver, which is typically mounted on a telephone booth or an exterior wall of a building. The satellite paging system beams the number of an incoming call to the handset. The subscriber can press a single button to dial the number or choose to return it at a later time—or not at all.

CT-2 handsets are smaller, lighter and require less battery power than cellular phones. Their digital circuitry provides much better clarity and sound quality, and their low power draw means users can go longer between recharges. What's more, PCN is much cheaper than cellular service—just the price of a regular landline phone call plus a service charge of probably 25 cents per call.

CT-2/telepoint networks are up and running in several countries in Europe and Asia, and a number of successful pilot programs have been run in the U.S. Providers are waiting for the FCC to designate radio spectrum for the new service before they can roll out full-blown systems. Both the telephone companies and cable television companies are looking to be providers of PCN service.

A similar, though less-sophisticated, service is now offered by AT&T. Dubbed Easy Reach, the service assigns subscribers a personal telephone number with a "700" prefix that allows them to be reached at any telephone in the U.S. They must program the telephone when they arrive and remember to deprogram it when they leave, or their calls will continue to be forwarded there.

Future versions of PCN telephones may be able to identify incoming callers, pinpoint their location, decide whether to sidetrack the call to an answering machine and select what recording to play—all automatically.

All this is leading toward a society in which a caller can precisely locate the person with whom he wants to speak, some experts say. "By the end of the 1990s, a telephone with its bell ringing insistently for attention will strike us—and especially our children—as a crude anachronism," W. Russell Neuman, a communications policy expert at the Massachusetts Institute of Technology, told an FCC hearing last year. "In retrospect, we will come to see a telephone call as something akin to an electronic Scud missile, not well targeted and often unwelcome."

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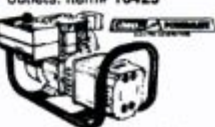
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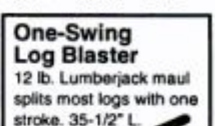
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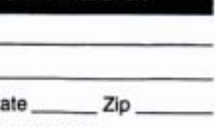
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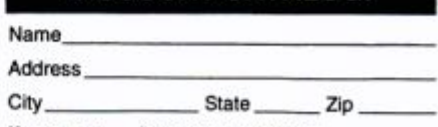
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SHOOTING WET

BY GEORGE SCHAUB

● Every once in awhile a product comes along that changes the way we do things. In cooking it was the microwave oven, and for audiophiles it was the compact disc player. Now underwater photographers have a similar opportunity with the recent introduction of the Nikonos RS/AF, the world's first underwater autofocus SLR. With this camera, you can say goodbye to bulky housings and focusing guesstimates and say hello to a system that will allow diving photographers to make images never before imagined.

There's no question that this system is for the ardent and affluent diver. The body retails for \$3486, with lenses ranging from \$978 (for the 28mm standard lens) to \$3288 for the zoom (a 20-35mm lens). But what you get for your hard-earned dollars is a state-of-the-art product that is arguably the best underwater photographic rig ever made.

The birth of modern underwater photography took place in the late '50s, when Jacques Cousteau developed the CalypsoPhot, named after the famous boat of the same name. Nikon eventually worked with Cousteau and made underwater cameras accessible to all. The last manifestation before the RS/AF was the Nikonos V, the first such camera with TTL (through-the-lens) metering. The Nikonos V, by the way, will still be available, and at a list price of \$890 for body and standard 35mm lens, it's a good alternative buy.

The RS/AF weighs in well above 2 pounds, and measures 7.7 × 5.9 × 3.3 in. But that heft is relative, and the



PHOTO BY STEVEN PERK

weight translates to about 1 pound underwater. The RS/AF is what divers call "negatively buoyant," which means it will drift slowly to the bottom should you let it go.

Over 30 years of experience, and lots of thought, went into the design of this new camera.

First off, there's the extremely bright viewfinder with 60mm-high eyepoint relief—a design that makes it surprisingly easy to see what's going on when wearing a mask, even in the murkiest depths. The viewfinder is canted to a 9° offset angle, which adds to the ease of seeing. The viewfinder display is always illu-

minated when the camera is turned on, another nice feature.

The new lenses and autofocus systems in the RS/AF are what really make it an underwater photographer's dream come true. Because of the optical properties of light traveling through water, distances can be deceiving. Objects appearing to be 3 ft. away are actually 4 ft. away (the ratio is 1:1.33). This might not be a problem when shooting longer distances, but can be critical when shooting closeups. When shooting extreme closeups, the only way to get truly sharp focus in the past was to mount a set of macro brackets or a distance-finding rod on the front of the lens. This worked out fine for stationary coral, but was truly tricky if you wanted to photograph a skittish fish. Autofocus gets you in focus quickly, shows the image in the viewfinder as a sharp shot and eliminates brackets.

The RS/AF sports a number of au-



Nikon's new RS/AF rig goes where no camera has gone before.

to focus modes, most of them familiar to any SLR fan. There's a single-servo with focus lock mode (best for when the main subject is to the side of the viewfinder frame), continuous (for seeking through a changing scene) and focus-tracking (for when the subject is in motion). There's also a "freeze" focus mode, in which you set a certain distance and the camera fires when anything passes through that plane of focus (great for capturing constantly moving underwater life). Don't want to shoot with autofocus? Nikon has added a power manual focus, activated by an oversize lever on the front of the camera body.

A trio of new lenses accompany the RS/AF, with more to come in the future. The standard lens is the R-UW/AF Nikkor 28mm f/2.8. Underwater, it focuses as close as about 10 in. and provides excellent coverage for most environmental shots. However, don't attempt to focus this lens above water—it won't work. Why? If lenses wider than 35mm are used underwater, the different refraction of light causes distortion. The water, in essence, pressures the front of this wide-angle lens to complete the optical formula for sharp focus. In fact, the lens actually reacts to different pressures at different depths, and moves slightly in and out of the camera body to adjust. This system is rated down to 328 ft.

The same goes for the 20-35mm zoom, a truly remarkable lens that allows for a great degree of compositional control. If you jockey around while getting your composition set, there's the danger of kicking up silt, which can quickly ruin your picture. The zoom allows you to remain in one spot. It focuses as close as a little over 1 ft.

The real jewel in the crown of the lens offerings is the Micro-Nikkor 50mm lens (\$1535), which can focus as close as about ½ ft. Combine autofocus with a 1:1 (life-size) capability, and you are working quickly and effortlessly in a truly mysterious and fascinating realm. This lens makes nigh-on impossible shots easy and allows you to get eyeball to eyeball with the amazing creatures of the deep. By the way, you can shoot with this lens above water.

To make flash easy, Nikon has added the SB-104 Speedlight (\$1532, including cord, brackets and arms) to the mix. You can work the flash in any number of ways—Matrix-balanced fill blends the ambient light with flash exposure on the principal foreground subject, center-weighted TTL is for automatic flash that concentrates on

(Please turn to page 106)

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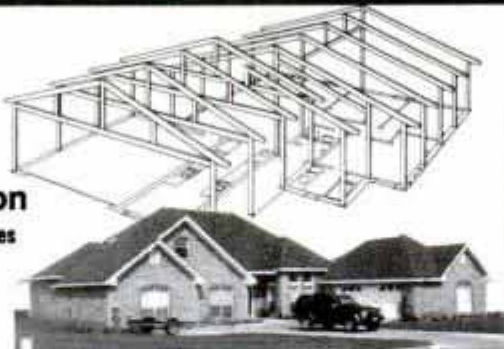
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PHOTOGRAPHY

(Continued from page 105)

the centered subject, and manual control can be used when you want to control shutter speed and depth of field more critically when using flash.

There are also some flashy tricks available. You can set the flash/camera for rear-curtain sync, which, when set with a fairly slow shutter speed, can make a natural sweeping motion appear in your stills. Or you can use a second speedlight for even more creative control. You can even trip the camera from a distance by firing one flash at a second camera-mounted flash, via the wireless "slave" trigger. This can come in handy if you want to photograph, say, a shark feed from a discrete distance.

The tripod-socket on the base of the RS/AF lets you set up the camera virtually anywhere. And the various brackets and arms can be configured to virtually any angle of flash coverage.

Measuring wetness

Just how do manufacturers rate their all-weather and underwater cameras for resistance to moisture? Though most people won't be diving to the 328-ft. depth rating of the Nikonos RS/AF, many use those so-called all-weather cameras when fishing, skiing, boating or even just hanging out at the beach.

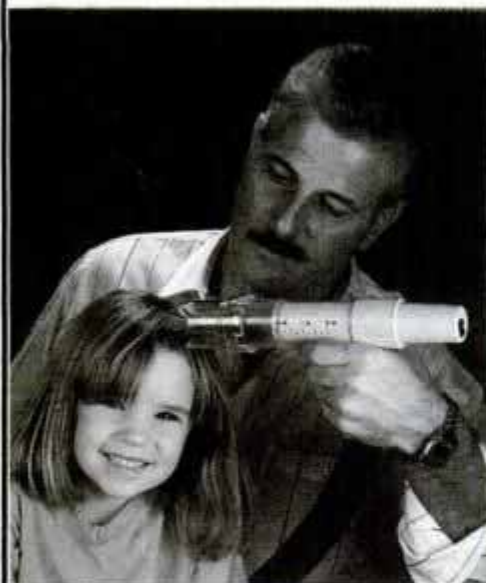
When Pentax recently announced the world's first weather-resistant zoom compact camera, the IQ Zoom 90-WR (38-90mm), we began to wonder how these cameras are put to the test.

Believe it or not, there is an organization that rates such things—the International Electrotechnical Commission, based in Switzerland. According to its International Standard for "degrees of protection provided by enclosures," there's a 6-point scale, starting at No. 1 for an "enclosure protected against vertically falling water drops" through No. 6, "protected against powerful water jets." The tests themselves are standardized—for example, to achieve a No. 5 rating, a camera must be able to withstand water sprayed from a 6.3mm-dia. nozzle at a rate of 12.5 liters per minute for at least 3 minutes from a distance of about 10 ft. Quite a soaking.

How does the new Pentax rate? With its numerous O-rings and low-rigidity rubber packing around the lens barrel (which is what makes for its ability to be both weatherproof and offer a zoom lens), plus a water-repellent filter on the grip, the IQ Zoom 90-WR (\$405) qualifies for the aforementioned No. 5 rating.

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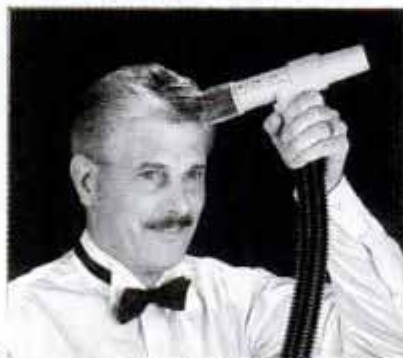
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alize in the form of Jimmy Clark's 1965 Lotus-Ford, the first of the revolutionary rear-engined cars to win at The Brickyard. The merry-makers are represented by a checkered tie, a checkered seat cushion and a 1971 copy of PM's annual racing guide.

Commercial sponsorship of cars quickly became big business as companies realized that advertising the products used by winning racers could sell tires, gasoline, motor oil, spark plugs and other automotive products. Several ads and endorsements from PM's pages are reproduced in the exhibit, including my personal favorite—a 1934 cartoon with the following exchange. Spectator: "You broke every speed record from 200 to 3000 miles with Pennzoil!" Driver: "Not even castor oil has ever gone so far so fast."

Whether you're an Indy driver or a Sunday driver, you'll find something your speed in the "Possible Dreams" exhibit. In its zeal for racing and records, PM did not forget that different people experience the thrill of speed at different rates. That's why the museum's exhibit planning team also included a sampling of the everyday thrills to be had on the highways and sidewalks of America.

"There are thrills in motorcycling that no other sport can match," claimed a PM ad for the 1937 side-valve, L-head Harley-Davidson motorcycle on exhibit. "The thrill of flashing getaway. . . . The thrill of eager power. . . . The thrill of road mastery."

Near the Harley is another motorized wonder, the 1915 Autoped. With 2 hp and a 35-mph top speed, the world's first motorscooter was promoted as the perfect vehicle for messenger boys, society social calls and ladies' recreation. A 1916 PM photo spread titled "Women's Interests, Ideas And Activities" shows two women racing their scooters down a stretch of Long Island beach.

Visitors can also see that mechanical marvel of 1957—motorized roller skates. Strap on a 19-pound, 1¼-hp engine, grab the hand-operated accelerator and speed away at 17 mph. The chief thrill? No brakes!

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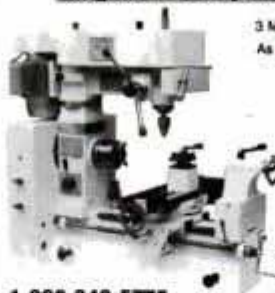
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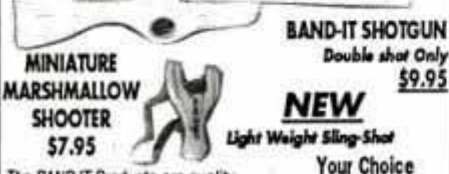
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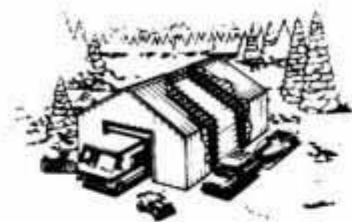
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